Toshiko Yuasa Laboratory

TYL

France Japan Particle Physics

CNRS/IN2P3-CEA/IRFU-KEK

Proposal 2020

For fiscal year 2020

April 1st, 2020 – March 31st, 2021

Proposal : 36

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FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: HEP_07	Title: SiW ECAL					
Leader (please add email address)	**French Group**			**Japanese Group**		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Vincent Boudry	Dr	LLR	Daniel Jeans	Assoc Prof	KEK
Members	Fabricio Jimnez	Dr	LLR	Taikan Suehara	Assist Prof	Kyushu
	Jonas Kunath	PhD	LLR	Kiyotomo Kawagoe	Prof	Kyushu
	Roman Poeschl	Dr	IJClab	Tamaki Yoshioka	Assoc Prof	Kyushu
	Adrian Irles	PD	ICJlab			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	10 days	1500	IN2P3
Travel	1000	1 travel	1000	IN2P3
Total			2500	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel to France (LLR, IJCLab) [7 days each]	250	3	750	KEK
Total			750	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
E-JADE H2020 RISE	secondment	8000	KEK (US-JP, requested)	equip (SiECAL)	12901
IN2P3 AP		40000	JSPS (requested)	equip + travel	16310
			JSPS (requested)	equip + travel	7136
Total		48000	Total		36347

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	MEXT is expected to make public its stance towards ILC in the weeks after this proposal is submitted, however the current expectation is that it will be positive and will lead to inter-governmental negotiations into the establishment of an international ILC laboratory to be hosted in Japan. This will also lead to a more concrete organization of potential users of ILC's facilities, in particular of detector collaborations who wish to record and analyse the products of ILC collisions. It is therefore important to further the technical design of the detector in preparation for the definition of a Technical Design Report. The ECAL is one of the largest, most complex, and most costly sub-detector of the proposed detectors for ILC. It will therefore naturally continue to be developed by an international team. The key countries presently involved in the ILD/CALICE ECAL development are France and Japan. At present, the silicon ECAL sensors are produced in Japan, the front-end ASICs designed in France, front end cards are jointly produced. Simulation work is based in Japan, while beam test experiments and their analysis are shared between groups in both countries. Expertise on large-scale mechanical and electrical systems for the ECAL is concentrated in France. Since it is essential that these elements work together seamlessly, it is imperative that excellent communication and frequent interchange between these groups is maintained during the next phase of the project. During 2020/21, a new set of prototype detection layers will be produced, which will be tested in particle beams at DESY in March and November by engineers and researchers from French and Japanese groups involved with this TYL project. The main aim of these tests is to validate new designs for two regimes: the response to low energy (mips) characterized by the signal-to-noise ratio, and the global response to electro-magnetic showers, to be realized for the first time with a sufficient number of layers. These measurements of prototype detectors will be used to tune the Monte-Carlo models used in the simulation of the ECAL in the ILD detector. Possible known and unknown limitations will be useful for the adjustment of a fully integrated design. We are starting to investigate possible use of deep learning techniques to apply for calibration of the detectors, particle identification, improvements on particle flow etc. in close collaboration to information scientists. This has the potential to further enforce the advantages of granular calorimeters.
Workshop / satellite session at annual workshop (if applicable)	We foresee to hold an ECAL meeting just before or after the next Linear Collider Meeting, which will probably be held either in Europe or in Japan in the autumn of 2020.
Common Articles Expected (if applicable)	Response to electromagnetic of the first CALICE SiW-ECAL technological prototype.
Seconded / Jointly Supervised Students (if applicable)	We plan to continue our program of student exchanges in visits of several weeks in both directions.

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: HEP-09	**Title: ILC Heavy Flavors**					
Leader (please add email address) **Members**	**French Group**			**Japanese Group**		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Roman Pöschl poeschl@lal.in2p3.fr	Dr	IJCLab/IN2P3	Keisuke Fujii keisuke.fujii@kek.jp	Prof	KEK/IPNS
	Adrian Irles	Postdoc	IJCLab/IN2P3	Yutaka Hosotani	Prof	Osaka U.
	Emi Kou	Dr	IJCLab/IN2P3	Daniel Jeans	Dr	KEK/IPNS
	François Le Diberder	Dr	IJCLab/IN2P3	Yuichiro Kiyo	Dr	Juntendo U.
	François Richard	Dr	IJCLab/IN2P3	Masakazu Kurata	Dr	KEK/IPNS
	Paul Colas	Dr	CEA/IRFU	Yoshimasa Kurihara	Dr	KEK/IPNS
	Maxim Titov	Dr	CEA/IRFU	Taikan Suehara	Dr	Kyushu U.
	Marc Winter	Dr	IJCLab/IPHC/IN2P3	Yukinari Sumino	Dr	Tohoku U.
				Tomohiko Tanabe	Dr	U. Tokyo
				Junping Tian	Dr	U. Tokyo
				Hitoshi Yamamoto	Prof	Tohoku U.
				Akimasa Ishikawa	Dr	KEK/IPNS

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to[4]:**
Visit to Japan	150/day	10 days	1500	IN2P3
Travel	1000	1 travel	1000	IN2P3
Total			2500	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit to France	20/day	56 days	1120	KEK
Travel	160	8 travels	1280	KEK

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

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3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

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Summary of Project	We will complete the ee->tt studies with the fully hadronic final state at least to a level that it can be published as an arxiv note. For this we will revise for example the assignment of final state tracks also known as "vertex recovery". We also would like to investigate further the potential of a clean measurement of the b-quarks that are produced in the t-quark decay. Finally during Yuichi Okugawaäs master thesis we have observed that the measurement of the b-quark charge helps to suppress background from single top. We would like to understand better why this is the case. We will extend the existing studies in two ways. First, the tagging capabilities of the ILD Detector as one of the proposed detectors of ILC, allow for extending the existing results to the light quark flavours uds. One can expect to improve results obtained by DELPHI (LEP) by about one order of magnitude. Experimental requirements are a clean anti-veto of heavy quarks by the vertex detectors and a deep understanding of particle identification, i.e. π/K/p separation, with the TPC of ILD. In a first step the analysis will be carried with fully simulated samples at a centre-of-mass energy of 250 GeV that will become available during 2020. A revision of the physics potential of the linear collider in 2019 showed that GigaZ running adds decisively to the physics potential of the ILC. We propose thus to extend the results for b, c and light quarks using full simulation at the Z-Pole and to apply/adapt the methods developed at 250 GeV. The on average smaller energy of the final state particles may require modifications of the inner part of the ILD detector. An example is the distance of the first layer of the micro vertex detector to the beam axis. The study tau-pair production, currently considering only ILC500, will be extended to ILC250, looking at events both at high di-tau mass and those in the return to the Z pole. The implications of the attainable measurement precisions for asymmetries and polarisations on different BSM physics models will be studied. We will also start to consider areas in which the high precision results of SuperKEKB at lower collision energy will complement the measurements which ILC will make at high energy. Examples are the sensitivity to charged Higgs bosons both directly at ILC and via b -> s gamma decays at B factories, and studies of the $e^+ e^- \rightarrow \tau^+ \tau^-$ process. At a future e+e- Higgs factory below the t-t threshold, top-quark EW couplings can play an important role in the precision determination of Higgs couplings because they can induce considerable corrections to various Higgs processes and EWPOs at loop-level. We will continue our work to evaluate this interplay in an extended SMEFT formalism involving both Higgs and top-quark operators. We will start to investigate the application of Deep Learning techniques to detector data reconstruction, with an initial emphasis on jet flavour identification, building on the success of the current LCFIPlus algorithms. Optimal use of dE/dx and timing information in particle identification, particularly in their role for b and c jet tagging and charge identification, will also continue to be a topic of study.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	- Finish the ee->tt paper on elw. NLO corrections in the next funding period (Kou, Kurihara, Mecaj). - Article on ee->tt (semi-leptonic and fully hadronic, Pöschl, Irles, Okugawa)
Seconded / Jointly Supervised Students (if applicable)	Yuichi Okugawa, presently completing his Master course at Tohoku U., will undertake PhD studies co-supervised between IJCLab/University Paris Saclay and Tohoku in the context of a wider MOU between the two organisations (which was born largely of this TYL collaboration).

FJPPL (TYL) application 2020-2021

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ID[1]: HEP10	Title: Strong dynamics beyond the Standard Model at LHC and Future Colliders

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	DEANDREA Aldo	Professor	IPNL/Lyon 1	HASHIMOTO Michio	Professor	Musashi University
Members	CACCIAPAGLIA Giacomo	Researcher	IPNL/CNRS	OKADA Yasuhiro	Professor	KEK/SOKENDAI
	COT Corentin	PhD student	IPNL/Lyon 1	HARADA Daisuke	associated	KEK
	VATANI Sharam	PhD student	IPNL/Lyon 1			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	14 days	2100	IN2P3
Travel	800	1 travel	800	IN2P3
Total			2900	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	20 days	400	KEK
Travel	150	2 travels	300	KEK
Total			700	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
LAbEx LIO – Univ. Lyon	Workshop organization	9000			
Total		9000	Total		

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	We started last year studies on the phenomenology of models that arise from a new strong interaction that can be used to describe the Higgs sector and the electroweak interactions in a more fundamental way (see [1] for a list of the composite models we consider). In particular we use effective field theory description of the models based on the properties of the higher-energy completion in terms of the fundamental fermions, including the masses and couplings of the light pseudo-Goldstone bosons (pNGB). The presence of stable pNGBs may also allow them to play the role of Dark Matter and will be considered. Composite models predict deviations of the top Yukawa and Higgs-Vector-Vector couplings from the SM values [2,3] and they can be detectable at the HL-LHC. The presence of new vectorlike fermion multiplets give rise to effects which require a detailed consideration of bounds coming from flavor physics, such as the results obtained by BELLE-II. Our FJPPL team discussed a joint work on vector-like fermions (present in composite models as baryon type resonances) which focus on the phenomenology at colliders of vector-like quark multiplets containing a bottom type quark. Various constraints at tree and loop level have to be considered in this case, together with the precision electroweak constraints. We have also considered in detail the mixing effects with the heavy and light standard quark generations. A paper is in preparation on this subject. Moreover, in order to test these models not only using standard perturbation theory tools, but also trying to obtain non-perturbative information, we shall test ideas borrowed from QCD and heavy meson physics in order to obtain new original details on the possible structure beyond the Standard Model. During this year we plan to explore in more detail the connections of these models with Higgs physics and dark matter. We started exploring the Higgs boson pair production process in photon-photon collisions at the ILC in the minimal composite scenarios to see the possibilities of detection and the information that these processes can give on the composite sector. Another important topic both for particle physics and cosmology for these composite models, is the study of their phase diagram in terms of temperature and density. Instead of focusing on a specific model (which would by the way require a numerical treatment of the non-perturbative new strong interactions) we shall consider simplified scenarios including 4-fermion interactions and Nambu-Jona-Lasinio type models. [1] G.Ferretti and D.Karateev, “Fermionic UV completions of Composite Higgs models” JHEP1403, 077 (2014). [2] G.Cacciapaglia, A.Deandrea, N.Gaur, D.Harada, Y.Okada and L.Panizzi, “The LHC potential of Vector-like quark doublets”, JHEP 1811 (2018) 055. [3] M.Hashimoto, “Revisiting vectorlike quark models with enhanced top Yukawa coupling”, Phys. Rev. D96 (2017) no.3, 035020.
Workshop / satellite session at annual workshop (if applicable)	As last year, also this year we plan to organize in Lyon an international workshop in September connected with our FJPPL project, on “Composite connection of Higgs, Dark Matter and neutrinos” with a LabEx-LIO funding from the University of Lyon. If possible, we shall plan a visit of members of the Japanese team in Lyon at that time, to allow a wider discussion with the other interested physicists working in this field (both theorists and experimentalists).

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Common Articles Expected (if applicable)	We plan to obtain a first publication this year on the phenomenological implications of composite models and also on the study of the implication for future colliders.
Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: HEP_11	Title: Looking for dark-sector long-lived particles with ATLAS

Leader (please add email address) / Members	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Leader: M-H. Genest genest@lpsc.in2p3.fr	Dr.	LPSC/IN2P3	Leader: K. Hara hara@hepsg3.px.tsukuba.ac.jp	Asc.P	U. Tsukuba
	N. Lalloue	Mr	LPSC/IN2P3	S. Wada	Miss	U. Tsukuba
	D. Portillo Quintero	Dr	LPSC/IN2P3	Koji Nakamura	Ass P	KEK
				Fumihiko Ukegawa	P	U. Tsukuba

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan (1 senior)	150/day	7 days	1050	IN2P3
Travel	1000	1 travel	1000	IN2P3
Total			2050	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Student Stay at LPSC	15/day	Twicex2 weeks	420	KEK
Travel	150	2 travels	300	KEK
Total			720	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
			JSPS	stay at CERN	1200
			/ U Tsukuba	travel	300
Total			Total		1500

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	Approximately 85% of the mass contents of the universe is in the form of dark matter, which could be composed of new particles. The search for such particles, which could eventually be produced in the proton-proton collisions at the LHC, is underway with the ATLAS detector. These searches have so far mostly focused on supersymmetric particles, whose decay chains contain dark matter candidates (for ex. the neutralinos), and on the direct production of dark matter particles in so-called "simplified" models by looking for mono-X final states (where X=jet, photon, W/Z/H boson). With the start of Run-3, it will be possible to strengthen the limits provided by these types of searches, but the discovery space beyond the already existing limits will be reduced. It is therefore important to cover less explored scenarios which require a very good understanding of the objects in the detector, understanding which can now benefit from many years of data taking. These scenarios can involve the existence of possibly long-lived particles, such as dark hadrons from a hidden QCD sector or heavy neutral leptons, both of which could lead to signatures involving displaced vertices in the inner detector. The focus of the group is now on these types of searches. While the LPSC group is currently focusing on dark QCD scenarios, strong from a local expertise on jets and calorimetry, the university of Tsukuba is currently focusing on the search for heavy neutral leptons, strong of their expertise on tracking. The work is currently ongoing on the searches with the full Run-2 dataset. If these do not reveal any sign of new physics, the work will then focus on identifying possible weaknesses in the parameter space coverage in order to prepare the Run-3 searches. This will necessarily include work on performances and possibly triggers to better identify the peculiar objects. Our main goal is to build a more enhanced collaboration between the ATLAS LPSC and the University of Tsukuba on this topic, benefiting for the experience in exotics searches and calorimetry at LPSC and from the extensive tracking detector experience of the University of Tsukuba group.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	
Seconded / Jointly Supervised Students (if applicable)	Two students could benefit from this collaboration: S. Wada who is doing her PhD at U. Tsukuba and N. Lalloue, a PhD student at LPSC Grenoble.

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: HEP_12	Title: Stronger together to search for new heavy resonances in ATLAS

	French Group			Japanese Group		
Leader (please add email address)	**Name**	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Tetiana Berger Hryn'ova (Tetiana.Hryn'Ova @cern.ch)	CRCN	LAPP/IN2P3	Yosuke Takubo (Yosuke.Takubo@ cern.ch)	Associate Prof.	KEK
Members	Samuel Calvert	CRCN	LPC/IN2P3	Koji Terashi	Assistant Prof.	U. Tokyo
	Reina Cmacho Toro	CRCN	LPNHE/IN2P3	Kunihiro Nagano	Associate Prof.	KEK
	(Julien Donini)	Enseignant-chercheur	Univ. Clemont Auvergne			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Travel cost for TYL-FJPPL annual workshop	600	4 days	600	IN2P3
Total			600	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel cost for TYL-FJPPL annual workshop	300	4 days	300	KEK
Total			300	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project

The search for new heavy particles is an important part of the physics program at the Large Hadron Collider (LHC) and has been the focus of an intense effort to uncover new physics beyond the Standard Model [1, 2, 3, 4] in a broad range of final states. In the cases where new heavy resonances would result from extensions of the SM gauge group, it is possible to systematically classify them and parameterize in terms of mass and couplings. Of particular interest are the singlet and the isospin triplet spin-1 resonances. For example, a generic model with isospin triplets formed by a new neutral Z boson (Z') and a pair of W bosons (W'), Heavy Vector Triplet (HVT) model, in case of flavour universality has four parameters, e.g. a mass and couplings to leptons (g_l), quarks (g_q) and Higgs and vector bosons (g_H). Individual analyses only constrain a subset of these coupling parameters or have a limited sensitivity to them, but combination of channels leads to much stronger simultaneous constraints, exploiting their complementarity.

The ATLAS experiment has taken data for proton-proton collisions with $\sqrt{s}$ = 13 TeV since 2015 (Run 2) and collected a total amount of data of 149 fb^{-1} until the end of Run 2 in December 2018. The ATLAS Collaboration published the first result of a combination searches for new particles decaying to pairs of W or Z bosons (VV, where V represents either a W or Z boson), or to a W/Z boson with a Higgs boson (VH) and pairs for light leptons (ll/lv, where l=electrons or muons and v represents a neutrino) in 2018 by using a part of data taken in Run 2 that corresponds to an integrated luminosity of 36 fb^{-1} [5]. Our project aims the combination analysis with the full Run 2 dataset, where the VV/VH/ll/lv combination will be extended to other channels (di-jets, $t\bar{t}$, $t\bar{b}$, $b\bar{b}$, ττ, τν, etc.), placing even stronger constraints on different new physics scenarios. The addition of the 3rd generation final states is particularly interesting; it will bring much stronger constraints on a new heavy neutral gauge boson which couples preferentially to the second and third generation fermions [6]. Such constraints will have direct impact on the scenarios where the flavor anomalies observed in LHCb and B-factories in the semi-leptonic B-meson decays are explained by the new gauge boson. This project was approved by TYL-FJPPL in 2019 and will be continued until 2021 when we aim to publish our results.

This project benefits from the work of LAPP on the dilepton searches, KEK on the lepton with missing energy search, LPNHE for the VH, U. Tokyo and LPC/Univ. Clermont Auvergne on ttbar and tb channels. The members of this collaboration have extensive expertise in coordinating physics analyses at various levels in the ATLAS experiment and are in position to have a major impact on the upcoming publication. Especially, Koji and Tetiana are the analysis contact and Hot Spot contact with theorists, respectively, in the combination analysis. In 2019, orthogonality between different final states was studied. In addition, analysis results in ll and lv final states with the full Run 2 dataset were published [7, 8], and their templates were provided for the combination. Both ll and lv analyses produced plots of sensitivity to parameters in HVT model, that shows better sensitivity than earlier combination study with 36 fb^{-1} already [9].

We plan to study the following items in 2020; 1) investigation of ll/lv channels in Vector Boson Fusion (VBF) process which may be interesting at low couplings to quarks, 2) finalizing analysis for VH(qqbb) and $t\bar{t}$ (full hadronic) final states for the publication, 3) Unblinding for $t\bar{t}$ (l+jet) final state and 4) deciding which coupling plane the limit should be provided to in the paper, discussing with theorists and CMS group on the common benchmark coupling planes. We expect the first results on the combination using the full ATLAS Run 2 dataset in 2021.

References

[1] Randall *et al.* Phys.Rev.Lett. 83 (1999) 3370-3373 hep-ph/9905221
[2] Branco *et al.* Phys.Rept. 516 (2012) 1-102 arXiv:1106.0034 [hep-ph]
[3] Contino *et al.* JHEP 1110 (2011) 081 arXiv:1109.1570 [hep-ph]
[4] Pati *et al.* Phys.Rev. D10 (1974) 275-289, Erratum: Phys.Rev. D11 (1975) 703-703; Georgi *et al.* Phys.Rev.Lett. 32 (1974) 438-444; Fritzsch *et al.* Annals Phys. 93 (1975) 193-266
[5] ATLAS Collaboration, Phys. Rev. D 98, 052008 (2018).
[6] Faroughy *et al.*, Phys. Lett. B764 (2017) 126-134; Greljo & Marzocca Eur. Phys. J. C77 (2017) , 548; Di Luzio *et al.* JHEP 1811 (2018) 081
[7] Phys. Lett. B796 (2019) 68
[8] Phys. Rev. D 100 (2019) 052013
[9] https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/PUBNOTES/ATL-PHYS-PUB-2019-031/

FJPPL (TYL) application 2020-2021

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Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	Yes, in 2021.
Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: HEP_13	Title: Higgs physics at the ILC

	French Group			Japanese Group		
Leader (please add email address) **Members**	**Name**	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Jean-Claude Brient brient@llr.in2p3.fr	Prof	LLR	Junping Tian tian@icepp.s.u-tokyo.ac.jp	Assist. Prof	U. Tokyo
	Junas Knuth	PhD student	LLR	Daniel Jeans	Assoc. Prof.	KEK

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	14 days	2100	IN2P3
Travel	1500	2 travel	3000	IN2P3
Total			2550	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	14 days	280	KEK
Travel	150	2 travels	300	KEK
Total			580	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
			JSPS (requested)	travel + salary	8100

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

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Total			Total		

Summary of Project	The investigation of the Higgs boson's properties is the central plank of the physics program of future electron-positron colliders such as the International Linear Collider (ILC). The high precision measurements of the Higgs possible at such a facility will shine light on the nature of EW symmetry breaking, and may well bear the imprint of physics beyond the Standard Model of particle physics. Within this project, we plan to collaborate in developing analysis methods to better understand the Higgs boson properties using measurements at e+ e- Higgs factories. For concreteness, we will emphasise the ILC, basing our analyses on full simulation of the International Large Detector (ILD). Project members perform key roles in the group developing the ILD concept [Brient: ECAL coordinator; Tian: MC generator co-convener, Higgs/EW physics co-convener; Jeans: deputy software coordinator, Executive Team member]. It should be emphasised that the results of these studies will be applicable to any electron-positron Higgs factory. In particular, over the next year we will continue and deepen our collaboration on developing a newly proposed method to improve measurements of the Higgs couplings and branching fractions by making use of data-driven reference samples. This method was presented at the Linear Collider Workshop 2019, and was the main subject of a visit of J. Kunath to KEK immediately afterwards. This study is expected to become a central part of J. Kunath's PhD thesis. We will also collaborate on other topics of Higgs physics, particularly those including decays to tau leptons, where the two groups have strong shared interests. This will include building on existing analyses of Higgs CP measurement in this channel [Jeans, Wilson, Phys. Rev. D 98, 013007 (2018)], as well as investigating the use of multi-prong decays to measure the Higgs mass using the tau lepton flight direction (building on a similar analysis for b-jet decays in [Tian, ILD-PHYS-PUB-2019-001]).
Workshop / satellite session at annual workshop (if applicable)	Meetings will be held on the sidelines of LC conferences and workshops during the year, and, as needed, by Video Conference.
Common Articles Expected (if applicable)	We expect one or more publications related to this topic's research over the next couple of years.
Seconded / Jointly Supervised Students (if applicable)	Jonas Kunath (LLR)

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ID: HEP_14	**Probing the nature of Dark Matter from Galactic to Cosmological scales**					
	French Group			**Japanese Group**		
	Name	**Title**	**Lab./Organis.**	**Name**	**Title**	**Lab/Organis.**
Leader	Vivian Poulin	CR	LUPM	Nagisa Hiroshima	Assistant Professor	Toyama U
Members	Pasquale Serpico	CR	LAPTh	Kazunori Kohri	Associate Professor	IPNS, KEK
	Julien Lavalle	CR	LUPM	Satoshi Iso	Professor	IPNS, KEK
	Gaëtan Facchinetti	PhD (1st yr)	LUPM	Toyokazu Sekiguchi	Postdoc	IPNS, KEK
	Guillermo Franco Abellan	PhD (1st yr)	LUPM	Hiroyuki Matsui	Postdoc	IPNS, KEK
	Riccardo Murgia	PostDoc	LUPM	Takahisa Igata	Postdoc	IPNS, KEK

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to:**
Travel expenses	1500	2 travels	3000	FJPPL
Lodging expenses + per diem	150/day	14 days	2100	FJPPL
Total			5100	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Travel expenses	200	3 travel	600	KEK
Lodging expenses + per diem	21/day	18 days	378	KEK
Total			978	

Additional Funding from France	**Additional Funding from Japan**

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Provided by/Requested to	**Type**	**€**	**Provided by/Requested to**	**Type**	**k¥**
IN2P3	Mission/ Invitation	15kEu			
Total		15kEu	Total		

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Summary of Project	There are nowadays a wealth of observational evidence on a variety of scales in favor of the existence of 85% of matter in our universe in the form of a cold, non-interacting component called Dark Matter (DM). Exotic particle candidates—e.g. from fundamental or effective extensions of the standard model of particle physics—are widely explored and motivated possibilities, in particular Weakly Interacting Massive Particles (WIMPs), which is featured with a very simple production mechanism in the early universe and the cosmological abundance of which is set via the standard freeze-out mechanism. However, the lack of a WIMP detection via collider, direct, or indirect experiments is now reviving the interest for alternative models. It also triggers the interest for new methods to look for non-gravitational identification of the DM, which would potentially hold a lot of information about its nature.This project will be devoted to the study of Dark Matter properties from Cosmological Scales, down to the smallest sub-structures present in our Galaxy, in both particle and non-particle scenarios. This project will be split in two parts. The first part of the project will focus on studying the clustering properties of particle DM on small scales. Particle DM mini-halos are formed in the early universe at scales above the free-streaming scale that depends on the interaction properties of DM and can have major consequences for indirect detection due to high densities reached in compact objects. Small-scale structuring arises naturally in the cold DM scenario, and can be affected by physics phenomena beyond the standard model (such as inflation and early matter dominated era). In fact, such scenarios can lead to the formation of ultra compact DM mini-halos (UCMH) at early times (z~3000), leading to large energy injection that can impact anisotropies in the CMB. As such, CMB data can be used to constrain both the DM annihilation rate and the amplitude of fluctuation at small scales (and therefore new physics scenario). As a starter, we have calculated the typical enhancement in the annihilation rate that is associated to the formation of UCMH. We have related that rate to the amplitude of the power spectrum on small scales. We now will make use of the latest Planck data to derive constraints on the amplitude of fluctuations at small scales and on the DM annihilation cross-section. We will then be able to relate these constraints to specific new physics scenarios leading to the formation of such objects. Moreover, details of the phase-space distribution of DM are crucial ingredients in estimating rates of interaction with detectors on Earth, and can strongly affect annihilation rates in the Galaxy as well as capture in stars. Our goal will be to make use of the newly released GAIA data to further constrain the existence of small dense halos and the dynamics of the galactic DM. This in turn will allow us to shed light on the interaction properties of the particles that might comprise the DM in our universe. Secondly, in the past, we have studied how cosmological observables, and especially the CMB, can be used to look for Primordial Black Holes (PBHs). PBHs can be formed in the very early universe from new physics phenomenon similar to those leading to the formation of UCMH. Therefore any detection of such objects would be revolutionary. Originally PBHs have been thought of as a natural DM candidate, but the constraints on the abundance of such objects in the universe are nowadays so strong (including ours Poulin et al. PRD96 (2017) no.8, 083524), that it has become necessary to consider mixed scenarios. In these scenarios, PBHs represent a sub-dominant fraction of the total DM, while the rest is made of non-interacting particles. Still, such mixed scenarios are very interesting for several reasons. First, the detection of a mass fraction as small as $\sim 10^{-9}$ of the DM in the form of PBHs could rule out the possibility for Weakly interacting massive particles (WIMPS) to be the main contributor of the DM in our Universe. Second, such PBHs could seed Super Massive Black Holes (SMBHs) with masses of 10^6 -- 10^9 solar masses, which are located at centers of high-redshifted galaxies and still unexplained. In the past year we have computed the impact of DM accretion onto PBH and shown that it can tremendously increase the constraints coming from Planck CMB data on the existence of PBH in the mass range M = 1 , 10^4 Msun. The constraints restricts the abundance of PBH to be $3*10^{-9}$ that of the DM at higher masses. Even with such strong constraints however we have not been able to constrain (or confirm) the hypothesis that PBHs are seeds of SMBHs. However, in the future, many experiments will target the high-redshift ($z>6$) 21 cm signal, mainly in order to learn on the birth of the first stars and the era of reionization of the universe. PBHs can have a strong impact on the 21 cm signal. In fact, the first tentative detection of a cosmological 21 cm signal by the EDGES experiment, if confirmed, could provide the strongest constraints to date on the existence of PBHs in the solar mass range (and above). We wish to further study this possibility thanks to our newly derived formalism, which will allow us to significantly improve over former works, and test the hypothesis of primordial seeds of SMBHs.

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Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	G. F. Abellan, N. Hiroshima, K. Kohri, J. Lavalle, R. Murgia, V. Poulin, "Constraints on DM ultra compact mini halos from the CMB" (2020) G. Facchinetti, N. Hiroshima, J. Lavalle, K. Kohri, V. Poulin, "Implication of GAIA data for DM properties on galactic scale" (2021) G. F. Abellan, N. Hiroshima, K. Kohri, R. Murgia, V. Poulin, P.D. Serpico,, "Constraining PBH with EDGES and future 21cm experiment." (2020)
Seconded / Jointly Supervised Students (if applicable)	

Flavour Physics

FLAV_03 : Flavour Physics and the theoretical challenge for precision

FLAV_05 : B flavour and Time Dependent CP violating measurement with Belle II

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ID[1]: FLAV_03	Title: Flavour physics and theoretical challenge for precision

Leader (please add email address) Members	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	E. Kou	Dr.	IJCLab-Theory	**T. Kaneko**	Assoc. Prof.	KEK-Theory
	B. Moussallam	Dr.	IJCLab -Theory	K. Hara	Assoc. Prof.	KEK-Belle II
	F. Le Diberder	Prof.	IJCLab -Belle II	K. Hayasaka	Assoc. Prof.	Niigata-Belle II
	Z. Huang	Dr.	IJCLab -Theory	S. Hashimoto	Prof.	KEK-Theory
	B. Knysh	PhD.	IJCLab -Belle II	A. Ishikawa	Assoc. Prof.	KEK-Belle II
	K. Trabelsi	Prof.	IJCLab -Belle II	H. Kakuno	Prof.	TMU-Belle II
	S. Watanuki	Postdoc	IJCLab -Belle II	M. Nakao	Prof.	KEK-Belle II
				M. Nishimura	Dr.	KEK-Belle II
				E. Waheed	Dr.	KEK-Belle II

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	100/day	20 days	2000	IN2P3
Travel	1500	2 travels	3000	IN2P3
Total			5000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel to France	250	2 travel	500	KEK
Total			500	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Flavor physics had played a crucial role to establish the Standard Model (SM) of particle physics and since then, it has always been providing key information to construct models beyond the SM. The recent appearance of "anomalies" in flavour physics is extremely intriguing: flavor physics may be the one which will bring the breakthrough in particle physics which we are looking for. In particular, the SuperKEKB, which has started its operation, has a capability to increase the sensitivities to many of the flavour observable by a factor of ~50, which promises a rapid progress of the field and gives us a great hope for a discovery.

The goal of our project is to bring a close collaboration on flavour physics between France and Japan as well as between theorists and experimentalists. France joined Belle II in 2017 and LAL Belle II group started playing significant roles in the Belle II collaboration.

In 2020, our TYL project welcome 3 new members, Miki Nishimura (KEK, postdoc), Eiasha Waheed (KEK, JSPS fellow), Zhuoran Huang (IJCLab, IN2P3-postdoc), who will play crucial roles to finalise our scientific program and to reach to some publications to conclude the final year of this TYL project.

The 3 scientific projects, which we are expecting some publications this year, are as follows.

1. $B \longrightarrow D(*)\ l\ \nu$ and Vcb: This subject is becoming one of the main issues in flavour physics these days. It turned out that the so-called Vcb puzzle, the deviation in determination of Vcb from exclusive and inclusive b-> c l nu decays, which was though to be resolved, actually remained to be a problem after careful re-considerations of the Belle experiment 2018 data. Various interpretations have been made but it is not possible to conclude at this stage. The community is eager to see the new lattice QCD result, especially the kinematical value dependence of the form factors, which will surely clear up some of the problems. The Japanese team (T. Kaneko, S. Hashimoto) are currently working on this computation, in competition with an American group. The result is expected this year. Meanwhile, together with the Belle group which did the $B \longrightarrow D(*)\ l\ \nu$ analysis (Melbourne U.), we started investigating the current situation of the Vcb puzzle and the impact of the future lattice result. We have written the multi-dimensional fit (simultaneous fit of form factors and Vcb) program of $B \longrightarrow D(*)\ l\ \nu$ using the technique developed by the French group (E. Kou, F. Le Diberder) for this purpose and now extending it to include the new physics effects (E. Kou, Z. Huang). Our collaborator, E. Waheed, who did the Belle $B \longrightarrow D(*)\ l\ \nu$ analysis in Melbourne U. moved to KEK as a JSPS fellow and she will provide us a great help to complete our scientific program. As soon as the lattice result will be published, we will include them to investigate the Vcb puzzle and to interpret it within and beyond the SM.

2. The axial vector mixing angle θ_K and $\tau \longrightarrow K\omega\nu$ decay: The axial vector mixing angle θ_K, the mixing angle of two 1+ kaonic resonances, is a fundamental parameter which has a long-standing question of the hadron physics: PDG quotes two possible values $\sim 30^o$ and $\sim 60^o$ while there is no clue which one is the correct one. This causes large uncertainties in theoretical predictions of B physics observables. One of them is the new physics search (right-handed current search) in the $B \longrightarrow K\pi\pi\gamma$ process, which we are working on in this TYL project (B. Knysh, K. Trabelsi, F. Le Diberder, A. Ishikawa, E. Kou): the SM prediction of the production and the decay rates of the dominant intermediate decay channel, $B \longrightarrow K1(1270)\gamma$, depends strongly on the value of θ_K. It has been known that an investigation of the τ decays into the two 1+ kaonic resonances, K1(1270)/K1(1400), provides a more precise determination of the θ_K angle while the problem of using their decays $K1 \longrightarrow K\pi\pi$ requires a very complicated resonance studies since the final state $K\pi\pi$ could come from the other kaonic resonances as well. This is also the project we are working on, by writing the event generator including all possible kaonic resonance decays into $K\pi\pi$ (B. Knysh). Last year, we (K. Hayasaka, E. Kou) have started looking into another channel, $\tau \longrightarrow K\omega\nu \longrightarrow K\pi\pi\pi\nu$. The

original motivation to study this channel was simply a possible early publication with Belle II data (~100 fb-1) as this channel has never been studied at Belle/Babar. However, it turned out that this channel is more suitable for extracting θ_K angle since fewer kaonic resonances contribute to this decay as an intermediate state such that the information of 1+ kaonic resonance can be extracted in a cleaner manner. French team (Z. Huang, E. Kou, B. Moussallam) are currently writing an event generator on this decay channel while K. Hayasaka is investigating the sensitivity of the Belle II experiment to the θ_K angle extraction. We should be able to make one publication on this topic this year. The new member, M. Nishimura, is working on the analysis of this channel with the Belle II data, which once she will succeed, would be one of the earliest τ physics publications of the Belle II experiment.

3. Rediscovery of $b \longrightarrow s\gamma$ decays at Belle II : The $b \longrightarrow s\gamma$ is one of the main subjects of this TYL project. In 2019, the Japanese group (H. Kakuno, A. Ishikawa) has successfully delivered the result on the re-discovery of $B \longrightarrow K^*\gamma$ with Belle II data (presented LP2019). This year, the French group will target the re-discovery of $B \longrightarrow K\pi\pi\gamma$ channel (B. Knysh) in collaboration with A. Ishikawa. The reconstruction of inclusive $B \longrightarrow X_s\gamma$ is much complicated than exclusive decays, thus we will start the reconstruction of $B \longrightarrow X_s\gamma$ with a sum of exclusive technique (A. Ishikawa).

In addition, we are hoping a new result on Lepton Flavour violating electroweak penguin process, $B \longrightarrow K(*)\tau\mu$, $K(*)\tau e$ decays with full Belle data (S. Watanuki, K. Trabelsi). These channels are quite interesting in relation to the Lepton Flavour Universality Violation anomaly observed in B decay at LHCb. The project on the CKM angle $\phi 3$ determination via GGSZ method (B. Moussallam, E. Kou) has been in difficulty as our final step requires the Belle data, which was not provided by the collaboration. Recently, by a help of the Japanese team, we got a contact from the person who could provide the sPlot data, which can be translated to the information we need. Once this procedure will be successfully done, we could expect a publication on this topic as well.

Finally, all the members are participating actively to the organisation of Belle II Physics Week (one week school in October at KEK). Namely, S. Hashimoto offers a great help for the local organisation.

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Summary of Project	This TYL project gather together the theorists and experimentalists to discuss the latest topics in flavor physics. In 2020, our TYL project welcome 3 new members, Miki Nishimura (KEK, postdoc), Eiasha Waheed (KEK, JSPS fellow), Zhuoran Huang (IJCLab, IN2P3-postdoc), who will play crucial roles to finalise our scientific program and to reach to some publications to conclude the final year of this TYL project.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	1) K. Hayasaka, Z. Huang, E. Kou: The axial vector mixing angle θK and $\tau \longrightarrow K\omega\nu$ decay 2) T. Kaneko, E. Kou, Z. Huang, et al: $B \longrightarrow D(*)\, l\, \nu$ decay: Vcb puzzle 3) B. Knysh: Belle II note on "Re-discovery of $B \longrightarrow K\pi\pi\gamma$" 4) M. Nishimura: Belle II publication on analysis of $\tau \longrightarrow K\omega\nu$ decay channel
Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: FLAV_05	**Title:** B flavour and Time Dependent CP violating measurement with Belle II

	French Group			**Japanese Group**		
	Name	**Title**	**Lab./Organis.**[2]	**Name**	**Title**	**Lab/Organis.**[3]
Leader (please add email address)	Jerome Baudot baudot@in2p3.fr	Prof.	IPHC/IN2P3	Kenkichi Miyabayashi miyabaya@cc.nara-wu.ac.jp	Prof.	Nara Women's University
Members	Isabelle Ripp-Baudot	DR	IPHC/IN2P3	Alessandro Gaz	Associate Prof.	Nagoya University
	Reem Rasheed	PhD student	IPHC/IN2P3	Yosuke Yusa	Assistant Prof.	Niigata University
	Tristan Fillinger	PhD student	University of Strasbourg	Yutaka Ushiroda	Prof.	KEK/University of Tokyo
	Giulio Dujany	CR	IPHC/IN2P3	Hikaru Tanigawa	PhD student	University of Tokyo

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to**[4]**:**
Visit to Japan	150/day	14 days	2100	IN2P3
Travel	1500	1 travel	1500	Unistra
Total			3600	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit to France	20/day	10 days	200	KEK
Travel	150	1 travel	150	KEK
Total			350	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to**[6]	**Type**	**k¥**
JENNIFER2 H2020 RISE	secondment	2000	Nara Women's Univesisity	Per diem	70
Total		2000	Total		70

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	Our project gathers physicists from Japan and France in order to reach robust time dependent asymmetry measurements (or TDCPV for time dependent *CP* violation measurement) with the Belle II experiment through exchange of valuable but differentiated expertise in both countries. We intend to exploit the high sensitivity of TDCPV measurements to reveal indirectly New Physics in rare transitions $b \to s\gamma$ and $b \to sqq$ (q=s,d), which proceed through penguin diagrams. Since TDCPV measurements require advanced analysis techniques and a good understanding of the detector, our work have started with simple activities and grows in complexity following the accumulated statistics and the detector expertise acquired over the years. For the coming Japanese fiscal year, SuperKEKB is expected to deliver a few 100 fb^{-1}, which should allow the following activities. - Completion of the first detail parametrization of the resolution on the time difference between B mesons. This work has started already with both final states $J/\psi\ K^*$ (Nara) and $J/\psi\ K_S$ (Niigata). It targets the first TDCPV measurement with the $J/\psi\ K_S$ final state during 2020. - Rediscovery of our main channels $B^0 \to K_S\ K_S\ K_S$ (Tokyo) and $B^0 \to K_S\ \pi^+\ \pi^-\ \gamma$ (Strasbourg). For these analyses, which were also conducted with the Belle data, it is especially interesting to discuss comparisons between Belle II and Belle. Possibly, a new analysis technique currently tried (Strasbourg) for the $K_S\ \pi^+\ \pi^-\ \gamma$ final state with the Belle data could be extended to Belle II. We intend to resume our program of visits, which was very successful last year with respect to the progress of the lifetime analysis. Already we are planning a long stay for Tristan Fillinger (PhD student from Strasbourg) in Japan for Spring 2020.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	With the first results on time dependent analysis being presented during Winter and Summer 2020 conferences, we expect to publish also first proceedings.
Seconded / Jointly Supervised Students (if applicable)	Tristan Fillinger, PhD student in Strasbourg, is arranging plans to visit Kenkichi Miyabayashi at Nara Women's University to continue the work on Belle analysis and the transfer of the expertise developed there.

Hadron Physics

HAD_02 : ALICE forward upgrade for high precision high statistics Single- and Di-muon measurements at the LHC

HAD_03 : Observing critical fluctuations in the dynamics of heavy-ion collisions

HAD_04 : QGP tomography with jets

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ID[1]: HAD_02	Title: ALICE Forward Upgrade for High Precision High Statistics Single- and Di-Muon Measurements at the LHC

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Leader: Guillaume BATIGNE	Associate Professor	Subatech (IN2P3/CNRS - IMT Atlantique – U. de Nantes)	Leader: Kenta SHIGAKI	Professor	Hiroshima U.
Members	Ginés MARTINEZ	CNRS Researcher	Subatech (IN2P3/CNRS - IMT Atlantique – U. de Nantes)	Ken OYAMA	Professor	Nagasaki Institute of Applied Science
	Raphael TIEULENT	CNRS Researcher	IPNL (IN2P3/CNRS – U. de Lyon)	Hideki HAMAGAKI	Professor	Nagasaki Institute of Applied Science
	Stefano PANEBIANCO	CEA Researcher	Irfu	Maya SHIMOMURA	Assistant Professor	Nara Women's U.
				Yorito YAMAGUCHI	Research Assistant Professor	Hiroshima U.

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
none				
Total			0	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel to France (fare)	150	4 travels	600	KEK
Visit to France (lodging + per diem)	15/day	24 days	360	KEK
Total			960	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
IN2P3	Travel	40 000	JSPS (kakenhi, K.Shigaki)	Travel, Equipment	4 000
CEA	Travel	20 000	Nagasaki Institute of Applied Science	Equipment, Travel	1 000
Total		60 000	Total		5 000

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	Quantum Chromo-Dynamics (QCD) of the strong interaction predicted a new state of matter of quarks and gluons at high energy density or at high baryo-chemical potential, where those elementary particles are released from usual confinement in hadrons. This state of QCD matter, called Quark Gluon Plasma (QGP), has been reproduced and discovered via high energy nucleus-nucleus collisions. Leptons and photons have been recognized as the most promising probes to investigate the QGP properties without disturbed by final state strong interaction. Forward muons at LHC are especially powerful since the physics region of interest and the technical region of covered kinematics overlap at the highest ever collision energy. We propose to build, install, and commission Muon Forward Tracker (MFT) with a strong collaboration between France and Japan at the ALICE experiment. It expands the physics reach of the ALICE muon spectrometer to J/psi, psi(2S), Upsilons and open beauty hadrons down to very low transverse momenta, opening unique programs at LHC. **Research Plan:** • **Year 1 (2017/04 – 2018/03):** 3rd year of LHC Run 2. Muon measurements. Data analysis and publications on Runs 1 and 2. MFT ladder and disk construction. MFT control system development and interface for the water cooling plant. • **Year 2 (2018/04 – 2019/03):** 4th and last year of LHC Run 2. Muon measurements. Data analysis and publications on Runs 1 and 2. MFT cone and barrel assembly. Finalization of MFT control system. • **Year 3 (2019/04 – 2020/03):** 1st year of LHC Long Shutdown 2. Data analysis and publications on Run 2. Installation of the MFT detector into ALICE. • **Year 4 (2020/04 – 2021/03):** 2nd year of LHC Long Shutdown 2. Data analysis and publications on Run 2. Commissioning of the MFT detector and first physics data taking at the LHC Run 3 start up. The MFT project has entered its construction phase since 2016. The Japanese team is responsible for the MFT work package dedicated to services, which includes development of the MFT detector control system (DCS) and its integration into the ALICE DCS and coordination of activities related to the low voltage power system and the water cooling plant. The French teams are responsible for the MFT ladder, disk, cone, and barrel assembly, the readout system, and the low voltage power system and its distribution. The period from 2017/04 to 2021/03 is crucial for the MFT project since the detector has to be ready for physics in 2021 at the LHC Run 3. The collaboration between Japan and France is of major importance for the project, in particular for the DCS, for assembly of the ladders and disks, and final commissioning of the detector. The contribution from the Japanese group will be crucial as the collaboration will require the final detector control system for the installation and commissioning foreseen in 2020. We also expect several physics publications and conference presentations on muons and MFT within this FJPPL collaboration. Given this collaboration is very fruitful, both parts are considering seriously to continue working all together on data taking (MFT detector experts) and on data analysis. In that context, we are considering co-supervision of PhD students.

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Workshop / satellite session at annual workshop (if applicable)	ALICE Muon meeting/workshop on June 20-26, 2020, at Courmayeur, Italy.
Common Articles Expected (if applicable)	• Low mass di-muon and vector meson measurements in pp, p-Pb, and Pb-Pb collisions at the LHC energies. • Heavy flavor and quarkonia measurements in pp, p-Pb, and Pb-Pb collisions at the LHC energies. • Physics opportunities and feasibilities with high precision high statistics measurement of forward di-muons at LHC ALICE.
Seconded / Jointly Supervised Students (if applicable)	Kosei Yamakawa (PhD candidate, Hiroshima University). Rita Sadek (PhD candidate, Subatech). Takumi Osako (PhD candidate, Hiroshima University). Motomi Oya (graduate student, Hiroshima University).

FJPPL (TYL) application 2020-2021

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ID[1]: HAD_03	Title: Observing critical fluctuations in the dynamics of heavy-ion collisions

	French Group			Japanese Group		
Leader (please add email address) **Members**	**Name**	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Marlene Nahrgang	Dr.	SUBATECH	Masakiyo Kitazawa	Dr.	Osaka University/ KEK
	Marcus Bluhm	Dr.	SUBATECH	Hiroaki Ito	Mr.	Osaka University
	Grégoire Pihan	Mr.	SUBATECH	Toru Nishimura	Mr.	Osaka University
	Nathan Touroux	Mr.	SUBATECH / Osaka University			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Travel to Japan	1000	3	3000	IN2P3
Per diem	100	21 days	2100	IN2P3
Total			5100	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel expense (to France)	150	2 travels	300	KEK
Per diem	10/day	21 days	210	KEK
Total			660	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Pays de la Loire "Etoiles montantes"	Travel	1000	JSPS(Kiban-S,approved)	travel	250
	Per diem	1000	Osaka University	travel	100
Total		2000	Total		350

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	With this application we ask for a continuation of our project in 2020-2021. In the past year we have made important progress in modeling the dynamics of critical fluctuations near the phase transition of QCD, notably the implementation of dynamical fluctuations for the Bjorken expansion near the QCD critical point. Since the numerical simulations of higher-order cumulants require large statistics of events, we achieved the implementation of the code on graphic cards. Using the IN2P3 Centre du Calcul, we are now in the position to evaluate all fluctuation observables, which are of experimental interest for the currently running experiments at the RHIC, BNL and the SPS at CERN. They will be crucial for upcoming experiments at FAIR, GSI and at J-PARC in particular. In particular, we plan to couple the stochastic dynamics of the net-baryon current to the stochastic evolution of the energy density and the momentum density. This will improve our approach in two ways: 1) It allows us to investigate a full equation of state which is motivated by QCD: reproduces lattice QCD results at low baryochemical potential and includes a critical point from the 3D Ising universality class. 2) The coupling to the fluctuations in momentum density is important in order to work within the correct dynamical universality class of QCD, which is model H in the classification of Hohenberg-Halperin On this first part of the project for next year, the PhD student Grégoire Pihan (Subatech) will take the leading hand. The excellent master student, Nathan Touroux (Subatech) will spend a part of this M2 research project with Prof. Kitazawa at Osaka university. He will investigate the lattice spacing dependence of the full, nonlinear stochastic diffusion equation. This lattice spacing dependence is induced by the divergent loop diagrams of the field theory underlying our free energy density functional. Currently there is no known method of how to renormalize the real-time dynamics of this field theory. We will look into the possibilities of using analytically known results (from perturbation theory) and performing numerical renormalization by including counter terms into the free energy density functional and by using effective transport coefficients. While at the current stage these are rather technical details there is no other way to create a thorough and reliable approach to the treatment of dynamical critical fluctuations, which can be applied for the calculation of predictions for experimental observables. This project is a crucial part for the physics at high net-baryon density as it treats the quantitative description of fluctuations near the QCD phase transition in a dynamical system, such as heavy-ion collisions. For the understanding of current and upcoming experimental efforts the research outlined here is indispensable.
Workshop / satellite session at annual workshop (if applicable)	- Joint TYL/FJPPL and FKPPL workshops on May 18-20, 2020, Nantes, France - Aspects of criticality, July 27 – 31, Wroclaw, Poland - abstracts will be send to a number of meetings and conferences throughout the year
Common Articles Expected (if applicable)	- Paper on the criticality seen in higher-order cumulants for a system in boost-invariant expansion. - Paper on the coupling of the dynamics of net-baryon density, energy and momentum density near the critical point and a first-order phase transition. - Paper on the lattice spacing dependence of the 3d stochastic diffusion equation and its renormalization
Seconded / Jointly Supervised Students (if applicable)	Participating students: Grégoire Pihan, PhD (Subatech) Nathan Touroux, M2 (Subatech), he will do a joint M2 research project at Subatech and Osaka University with a stay at Osaka University from April-June 2020. Hiroaki Ito, Toru Nishimura (Osaka University)

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Fiscal year April 1st 2020 – March 31st 2021

ID[1]: HAD_04	Title: **QGP tomography with jets**

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	Rachid Guernane	CR	LPSC/IN2P3	Tatsuya Chujo	Prof.	U. Tsukuba
	Gustavo Conesa Balbastre	CR	LPSC/IN2P3	Yasuo Miake	Prof.	U. Tsukuba
Members	Julien Faivre	MC	LPSC/UGA	Motoi Inaba	Prof.	U. Tsukuba Tech.
	Christophe Furget	Prof.	UGA	Toru Sugitate	Prof.	U. Hiroshima
	Jaime Norman	CDD	LPSC/IN2P3	Maya Shimomura	Prof.	Nara Women's U.
	Yves Schutz	DR	IPHC/IN2P3	Hiroyuki Sako	Prof.	JAEA
	Iouri Belikov	DR	IPHC/IN2P3	Hideki Hamagaki	Prof.	NiAS
	Antonin Maire	CR	IPHC/IN2P3	Taku Gunji	Prof.	U. Tokyo
	Fouad Rami	CR	IPHC/IN2P3	Norbert Novitzky	Prof.	U. Tsukuba
	Boris Hippolyte	MC	IPHC/IN2P3	Shingo Sakai	PD	U. Tsukuba
	Christian Kuhn	DR	IPHC/IN2P3	Takashi Hachiya	Prof.	Nara Women's U.

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to[4]:**
Visit to Tsukuba	150/day	28 days	4,200	IN2P3
Travels	1000	4 travel	4,000	IN2P3
ALICE France-Japan Workshop	2000	1	2,000	IN2P3
Total			10,200	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit to Grenoble/ CERN	15/day	28 days	420	KEK
Travels (airfare)	150	4 travel	600	KEK
Total			1,020	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
			JSPS	Kiban (A)	2,600
Total			Total		2,600

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

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Summary of Project

For the JFY 2020-21, we intend to focus our collaborative effort over 3 timescales:

- Finalize our on-going joint **LHC Run 2** analysis work towards publication
- Prepare novel tools and observables for jet physics for **LHC Run 3**
- Kick-off a new joint project (FOCAL) for **LHC Run 4**

The Physics context

In heavy-ion collisions, hard-scattered partons are produced early in the collision, which makes them an ideal **probe of the QGP** and for studying **energy loss within the medium**. This parton energy loss will be reflected in the suppression of the measured heavy-ion jet spectrum relative to a pp reference, also known as ***jet quenching***. Jet measurements performed so far (see Hiroki Yokoyama and Ritsuya Hosokawa PhD theses – co-supervision LPSC-University of Tsukuba) have shown that the jet spectrum in heavy-ion collisions does deviate from what would be expected if the heavy-ion collision could be treated as a simple superposition of independent pp collisions.

After having measured the **magnitude of jet quenching for inclusive jet production** in Pb-Pb collisions from 2015 data, in this project, based on the **large data samples collected in 2018**, we aim at further unravelling jet-medium interactions and the properties of the hot dense medium in QCD, by putting special emphasis on **angular correlations of jets with charged hadrons,** studied in jet p_T bins, p_T bins of the associated hadrons, and as a function of collision centrality. Two analysis will be explored:

Data analysis of LHC Run 2 samples

1. In-medium jet deflection measurement via hadron-jet correlations

Angular deflection of a jet relative to its initial direction, due to momentum transfer with the medium, provides a **direct probe of the QGP**. Jet deflection can only be measured by coincidence observables, in which the deflection of the jet recoiling from a trigger object (hadron, direct photon, jet, Z^0) is measured relative to the trigger axis. Such scattering measurements, carried out over a wide range in energy and resolution scale, can be used to explore the microscopic structure of the QGP.

Modification of the rate of rare, large-angle jets with respect to the hard reference object in nuclear collisions compared to the production rate in vacuum may arise from the scattering off quasi-particles (quarks and gluons or composite objects) of the QGP, thereby probing their nature. In addition, the recoil jet distribution at small recoil angles relative to the trigger axis may be modified by soft multiple scattering in the QGP, which can be used to extract the jet transport parameter. A significant background to the measurement of medium-induced jet deflection is the azimuthal broadening due to Sudakov radiation, which is radiation outside the jet cone that generates a broad peak in the recoil jet angular distribution relative to the trigger axis.

These considerations indicate that **deflection measurements of the lowest-p_T jets that are achievable experimentally provide the most promising approach to address these physics questions**. It is therefore necessary to utilize analysis techniques that can attain **few percent precision** in the measurement of recoil jet angular distributions for low jet p_T and large jet radius R, over the large and complex uncorrelated backgrounds in central Pb–Pb collisions at the LHC. This precision is achievable using the statistical approach to jet background correction, in which the discrimination of correlated and

uncorrelated recoil jet yield is carried out in a fully data-driven way, at the level of ensemble averaged distributions.

A **French-Japanese Task Force** is already at work on this analysis based on the 2015 and 2018 data. We intend to pursue ongoing efforts (including performing detailed comparison with pQCD-based model predictions like JEWEL and JETSCAPE) towards a publication envisaged for 2020.

2. Jet-hadron correlations relative to the event plane

The analysis of angular correlations for different orientations of the jet relative to the event plane allows for the study of the **path-length dependence of medium modifications to jets**. The event plane dependence of azimuthal angular correlations of charged hadrons with respect to the axis of an $R = 0.2$ fully reconstructed jet in Pb-Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV in ALICE will be studied. Results will be compared for different bins of the jet relative to the event plane in mid-peripheral events (30-50 %). The yields relative to the event plane will be quantified through yield ratio calculations.

Preliminaries studies were **part of Ritsuya Hosokawa co-supervised PhD thesis** based on 2015 data, that we aim at complementing with 2018 data within this project proposal.

New jet quenching observables for LHC Run 3

1. Jet substructure

Jet substructure measurements provide concrete and consistent physics information of the modification of jets in a heavy-ion environment. The modification of the jet substructure due to jet quenching has been explored in heavy-ion collisions using tools developed for the measurement of jet substructure in pp collisions for QCD studies and Beyond Standard Model searches. A key tool is iterative declustering, which subdivides jets into branches or splittings that can be projected onto the phase space of such splittings, called the Lund plane. While the splitting map contains kinematic information of all splittings, techniques like grooming can be applied to isolate a specific region of the splitting map according to different criteria such as mitigation of non-perturbative effects, enhancement of the jet quenching signal or simplification of perturbative calculations.

In this proposal, we intent to investigate QCD jet observables in heavy-ion collisions by fostering synergies between experimentalists and theorists. On the experimental side, the advent of LHC Run 3 ALICE Upgrades, and in particular the foreseen gain in tracking precision and efficiency, will definitely help for a detailed qualitative understanding of how jets are modified in the medium created in the aftermath of heavy-ion collisions.

2. Dijet measurements

So far, in the ALICE experiment, fully reconstructed di-jet correlation measurement have been only barely addressed. However, such observable effectively probes the path-length dependence of in medium jet energy loss at fixed centrality and can provide a better understanding of the correlation of the parton energy-loss with the underlying geometry. Furthermore, di-jets bring strong constraints on (n)PDF and will help exploring the non-linear QCD evolution which owes its origin to the non-Abelian nature of

	QCD. The study of this dense but weakly coupled system called *Color Glass Condensate* is a central question of heavy-ion physics which we are eager to work on (see below). **The FoCal forward calorimeter for LHC Run 4** The ALICE collaboration is considering to add a high-granularity Forward Calorimeter (FoCal) to the experiment to measure direct photon production in the rapidity range 3.2-5.3 and at low p_T, to probe the gluon density in protons and nuclei at Bjorken-$x \sim 10^{-5}$ where gluon saturation and non-linear effects in the gluon density may become apparent. The FoCal design is based on the Si-W calorimeter technology, with two or three high-granularity layers with silicon pixel sensors that allow to separate electromagnetic showers with only a few mm distance between them. This unique high granularity makes it possible to reconstruct neutral pions in the forward direction and to reject the decay photon background for the direct photon measurement. Since last year, tangible progress was made to identify a concrete joint contribution to the FoCal project. Even if the project is still under approval, the French-Japanese collaboration has decided to concentrate its resources on the electromagnetic part of the FoCal detector. A new design for the full electronic chain was proposed by the LPSC Grenoble and successfully reviewed at CERN which is based on the French HGCROC chip by the Omega group. A FoCal detector prototype built in Japan fully equipped with its FEE and readout electronics made in France will be assembled in the upcoming year for a test beam campaign foreseen at CERN in summer 2021 in order to validate the final design in view of the Technical Design Report publication. The FJPPL support will be crucial for the success of this endeavor by providing the optimal conditions for close collaboration.
Workshop / satellite session at annual workshop (if applicable)	We are planning to hold our **established annual (since 2014)** "Rencontres ALICE France-Japon" topical workshop on ALICE physics analysis which could not take place in 2018/2019 due to the absence of FJPPL funding. The present plan for this year would be to organize the meeting either as a satellite meeting of the annual FJPPL workshop or sometime in July in the Grenoble region in 2020.
Common Articles Expected (if applicable)	We presently have **4 joint papers:** "Measurement of charged jet cross section in pp collisions at $\sqrt{s_{NN}}$ = 5.02 TeV", S. Acharya et al. (A Large Ion Collider Experiment Collaboration) Phys. Rev. D 100, 092004 (published Nov. 13, 2019) "Measurement of charged jet-hadron correlation w.r.t event plane in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV" (in preparation) "Measurement of charged jet spectra in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE at LHC" (in preparation) "Measurement of the semi-inclusive hadron+jet distributions in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV" (in preparation)

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Seconded / Jointly Supervised Students (if applicable)	- Takuya Kumoka (PhD), U. Tsukuba - Naoto Ito (M2), U. Tsukuba - Yuku Sudo (M2), U. Tsukuba - Keisuke Yasaki (M2), U. Tsukuba - Masahiro Takamura (M2), U. Tsukuba - Hanseo Park (M1), U. Tsukuba - Momo Eshita (M1), U. Tsukuba - Shono Kyan (M1), U. Tsukuba - Shunya Chiba (M1), U. Tsukuba - Antoine Roux (M2), U. Grenoble Alpes

Neutrino Physics

Nu_06 : ND280-Upgrade and the neutrino cross section measurements in T2K

Nu_07: The multi-PMTs option for the Hyper-Kamiokande detector

Nu_08: The Development of the electronics and its synchronization for Hyper-Kamiokande

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ID[1]: Nu_06	Title: ***ND280-Upgrade and the neutrino cross section measurements in T2K***

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	**Margherita BUIZZA AVANZINI (buizza@llr.in2p3.fr)**	**Dr.** (staff)	**IN2P3/LLR**	**Masashi YOKOYAMA (masashi@phys.s.u-tokyo.ac.jp)**	**Professor**	**University of Tokyo**
Members	Olivier Drapier	Dr. (staff)	LLR/IN2P3	Konosuke Iwamoto	Dr (postdoc)	University of Tokyo
	Michel Gonin	Prof. (staff)	LLR/IN2P3	Takashi Kobayashi	Professor	KEK
	Thomas Mueller	Dr. (staff)	LLR/IN2P3	Toshifumi Tsukamoto	Associate Professor	KEK
	Benjamin Quilain	Dr. (staff)	LLR/IN2P3	Takeshi Nakadaira	Associate Professor	KEK
	Sara Bolognesi	Dr. (staff)	IRFU/DPhN CEA Saclay	Tsunayuki Matsubara	Assistant Professor	KEK
	Alain Delbart	Dr. (staff)	IRFU/DEDIP CEA Saclay	Tsuyoshi Nakaya	Professor	Kyoto University
	Sandrine Emery	Dr. (staff)	IRFU/DPhN CEA Saclay	Atsuko Ichikawa	Associate Professor	Kyoto University
	Samira Hassani	Dr. (staff)	IRFU/DPhN CEA Saclay	Tatsuya Kikawa	Assistant Professor	Kyoto University
	Laura Munteanu	PhD student	IRFU/DPhN CEA Saclay	Kenji Yasutome	Ph.D student	Kyoto University
	Paul Colas	Dr. (staff)	IRFU/DPhN CEA Saclay	Yoshinari Hayato	Associate Professor	ICRR, University of Tokyo
	Jacques Dumarchez	Dr. (staff)	LPNHE/IN2P3	Akihiro Minamino	Associate Professor	Yokohama National Univ.
	Claudio Giganti	Dr. (staff)	LPNHE/IN2P3	Giorgio Pintaudi	Ph.D student	Yokohama National Univ.
	Mathieu Guigue	Dr. (staff)	LPNHE/IN2P3, Sorbonne Université	Yoshihiro Seiya	Professor	Osaka City Univ.
	Boris Popov	Dr. (staff)	LPNHE/IN2P3	Kazuhiro Yamamoto	Associate Professor	Osaka City Univ.
	Quoc Viet Nguyen	PhD student	LPNHE/IN2P3			
	Adrien Blanchet	Post doc	LPNHE/IN2P3			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	140/day	20 days	2800	IN2P3
Travel	1000	2 travel	2000	IN2P3
Visit to Japan	140/day	20 days	2800	CEA
Travel	1000	2 travel	2000	CEA
Total			9600	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	20 days	400	KEK
Travel	150	2 travels	300	KEK
Total			700	

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu

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Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to**[6]	**Type**	**k¥**
Total			Total		

[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project

Project overview

The Nu_06 team is foreseen to continue its activity on three main topics:

1. **The hardware upgrade of the T2K off-axis near detector (ND280-Upgrade)**
2. **Preparation of the analysis of the T2K data with the ND280 Upgrade detector**
3. **Measurements of neutrino-nucleus cross sections using data available from INGRID, ND280 and WAGASCI/Baby-MIND detectors**

The common goal of these three activities is to reduce the systematics related to the neutrino-nucleus interaction in order to maximize the sensitivity of T2K. It will also benefit future long baseline neutrino experiments such as Hyper-Kamiokande.

1. ND280-Upgrade: Hardware

In ND280-Upgrade project, **we will start construction of the detectors**. Nu_06 collaborators continue to lead the project. CEA-Saclay and LPNHE are main institutions to develop and produce resistive micromegas and electronics for HA-TPCs. A test beam for HA-TPC prototype in magnetic field at DESY is scheduled in October 2020. For the SuperFGD detector, Japanese institutions will work on the preparation of MPPC and wavelength shifting fiber modules, production of calibration system, development of the DAQ system, and preparation for the final integration in Japan. LLR will develop the frontend electronics based on the CITIROC ASIC chip and procure all the chips. Nu_06 collaborators are expected to work on the construction of both detectors in 2020, which is planned to happen at CERN in the framework of Neutrino Platform project NP07.

2. ND280-Upgrade: Software

Thanks to ND280-Upgrade, designed to enable a detailed characterization of the outgoing nucleons and pions, down to very low threshold, new kinematics variables will be accessible. Including new samples with hadron information to the T2K oscillation analysis, will allow to reduce the systematic errors, and thus improve the precision of the oscillation parameters for T2K-II. **The preparation of a new framework for the oscillation analysis is necessary and should start now**. The Nu_06 team will start to work on the definition of the selection of the new samples, the evaluation of the corresponding experimental systematic uncertainties and the modification of the analysis framework for the fit to the oscillation parameters.

3. Neutrino cross-section measurements with current detectors

While preparing for the new detector, we will continue to exploit current T2K data and to provide our best cross-section measurements. **CEA-Saclay, LLR, and ICRR members are coordinating the T2K Cross Section and Neutrino Interaction working groups.**

The simultaneous measurement of Oxygen and Carbon CC0pi cross section with ND280 has been completed and will be published before summer 2020. The CC0pi cross section on water and scintillator with Ingrid (proton + water modules are used) is under collaboration review and results will be public this year. Finally, the first combined Ingrid/ND280 CC0pi measurement on Carbon will be also public this year and a publication will follow.

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Workshop / satellite session at annual workshop (if applicable)	Collaborators meet regularly during the T2K collaboration meetings and ND280 upgrade workshops, so at least 3 times per year.
Common Articles Expected (if applicable)	For 2020 we expect at least a paper on cross-section measurements: the joint O/C CC0pi cross-section measurement at ND280 (final publication) and a paper on the physics potentials of the ND280 upgrade (a first draft). We also expect publications on test beam data for ND280 Upgrade (TPC in DESY 2019, SuperFGD in CERN 2018 and LANL 2019).
Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

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ID[1]: Nu_07	Title: The multi-PMTs option for the Hyper-Kamiokande detector

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Benjamin Quilain (French PI) benjamin.quilain@llr.in2p3.fr	Dr (staff)	LLR/IN2P3	Masashi Ishitsuka (Japanese PI) ishitsuka@rs.tus.ac.jp	Associate Professor	Tokyo University of Science
Members	Michel Gonin	Dr (staff)	LLR/IN2P3 Ecole polytechnique	Michitaka Inomoto	Master student	Tokyo University of Science
	Olivier Drapier	Dr (staff)	LLR/IN2P3	Nao Izumi	Master student	Tokyo University of Science
	Thomas Mueller	Dr (staff)	LLR/IN2P3			
	Margherita Buizza-Avanzini	Dr (staff)	LLR/IN2P3	Tatsushi Kinoshita	Master student	Tokyo University of Science
	Jacques Dumarchez	Dr (staff)	LPNHE/IN2P3	Masahiro Kuze	Professor	Tokyo Institute of Technology
	Alain Blondel	Dr (staff)	LPNHE/IN2P3			
	Marco Zito	Dr (staff)	LPNHE/IN2P3	Shota Izumiyama	Master student	Tokyo Institute of Technology
	Boris Popov	Dr (staff)	LPNHE/IN2P3	Isao Sashima	Master student	Tokyo Institute of Technology
	Claudio Giganti	Dr (staff)	LPNHE/IN2P3	Mark Hartz	Associate professor	The University of Tokyo / Kavli IPMU
	Mathieu Guigue	Dr (staff)	LPNHE/IN2P3 Sorbonne Universite	Guillaume Pronost	Assistant professor	The University of Tokyo / ICRR
	Stefano Russo	Dr (staff)	LPNHE/IN2P3			
	Christophe De La Taille	Dr (staff)	OMEGA/IN2P3			
	Selma Comforti	Dr (staff)	OMEGA/IN2P3			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	100/day	30 days	3000	IN2P3
Travel	1000	2 travel	2000	IN2P3
Visit to Japan	100/day	30 days	1000	CEA
Travel	1000	1 travel	1000	CEA
Total			7000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	13/day	30 days	390	KEK
Travel	150	2 travels	300	KEK

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Shipment of mPMT to Paris	100	1	100	KEK
Total			790	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	**Our team aims to pursue its activity on three main topics:** **1. The measurement and R&D of the 3" PMTs composing the multi-PMT modules (mPMT).** **2. The measurement of the assembled mPMT response in the MEMPHYNO water tank.** **3. The development of the Hyper-Kamiokande (HK) software for both low and high energy sectors.** **1. R&D of 3" PMTs:** In last 2 years, our team has continuously lead the measurements of the characteristics of the 3" PMTs composing the mPMT. Among other characteristics, we reported to Hamamatsu a dark rate value which does not meet our requirements for HK, and also measured its time structure. As Hamamatsu is now attempting to improve this characteristics, the incoming fiscal year effort will mainly focus on: -Measuring the dark rate of the new Hamamatsu PMT, while ensuring other characteristics (QE, time...) are not impacted. -Continuing measurement campaign of other PMT types - among which, PMTs from HZC photonics company – to explore other alternatives and minimize the costs. -Measuring the response of 3" PMTs with a surrounding reflector added to increase their effective light collection. Our measurements will be done on the two existing setups in IPMU and TUS. **2. Measurements of the mPMT response:** During the last year, the MEMPHYNO detector has been partly commissioned, and first cosmic data has been taken using an old mPMT prototype. During the incoming year, we are planning to: -Upgrade the MEMPHYNO detector hardware by adding some B-field cancellation coil, rotational support for the mPMT, temperature and B-field monitoring instrument and implementation of a laser diode calibration source in the tank. -Upgrade the MEMPHYNO/mPMT DAQ by synchronizing the cosmic trigger scintillator planes with the mPMT, developing an online event viewer and slow control system, and testing the clock synchronization system that we have proposed in another application. -Upgrade the mPMT design and electronics from the KM3NeT-design to the design proposed for HK, whose vessel has a larger curvature and electronics is based on flash-ADC board. These different upgrades will allow us to test the almost-final mPMT design characteristics, such as charge and time response, after-pulse and dark rate probability and stability over much longer periods than the existing design. It will also allow us to provide the world unique test the existing electronics and synchronization system before the start of the Water Cherenkov Test Experiment at CERN in 2022, which will consist in testing 130 mPMTs in a charged particle beam. **3. Development of the simulation&reconstruction tools for HK:** During the last years, we have leaded the development of the HK simulation, by implementing mPMTs, low energy reconstruction, by developing a new fitting algorithm, and high energy reconstrution, by enabling the existing software to host an hybrid PMT configuration in which HK will be if instrumented by 20" and mPMTs. Most of our results has shown substantial improvements using mPMTs. In the incoming year, we are planning to: - Upgrade the HK detector simulation, especially by implementing its very first low energy background model. -Improve the low energy fitter performances and evaluate the background impact on low energy neutrino physics. -Improve the neutron tagging algorithm to update HK efficiency of tagging neutron capture on water. -Develop the reconstruction tools to explore the potential of mPMT in the very high energy sector (> 1GeV) in order to quantitatively test their impact on proton-decay, mass hierarchy and very high energy cosmic neutrinos.

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Workshop / satellite session at annual workshop (if applicable)	Collaborators meet regularly at: -Weekly mPMT meetings (remote connection) -At the HK meeting, two times a year (face-to-face). -At mPMT workshops and satellite sessions at T2K meetings: at least one NEPTUNE workshop and one mPMT satellite session in a year (face-to-face). So at least 4 times a year.
Common Articles Expected (if applicable)	For 2020, we expect at least: -The HK technical report to become public and be published. -A Technical Paper on the tests of 3'' PMTs in Japan. -Several proceedings from presentations at international conferences.
Seconded / Jointly Supervised Students (if applicable)	Though there is no official agreement, S. Izumiyama, I. Sashima (TIT) and N. Izumi, M. Inomoto, T. Kinoshita (TUS) are scientifically and technically supported at weekly meetings organized jointly by M. Kuze, M. Ishitsuka, M. Hartz and B. Quilain. Following our method in 2019, we are planning to continue to jointly support the students, through the weekly meetings, at least one trip to France to work on MEMPHYNO, and several trips to Japan from B. Quilain to help them at IPMU, TIT or TUS.

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Fiscal year April 1st 2020 – March 31st 2021

ID[1]: Nu_08	Title: Development of the electronics and its synchronization for Hyper-Kamiokande

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Stefano Russo (French leader)	Dr. (staff)	LPNHE/IN2P3	Yoshinari Hayato (Japanese leader)	Dr.(staff)	ICRR, The Univ. of Tokyo
	Alain Blondel	Dr. (staff)	LPNHE/IN2P3	Yusuke Kataoka	Dr. (staff)	ICRR, The Univ. of Tokyo
Members	Sara Bolognesi	Dr (staff)	IRFU/CEA	Yasuhiro Takemoto	Dr.(Staff)	ICRR, The Univ. of Tokyo
	Jacques Dumarchez	Dr (staff)	LPNHE/IN2P3			
	Sandrine Emery	Dr (staff)	IRFU/CEA			
	Samira Hassani	Dr (staff)	IRFU/CEA			
	Claudio Giganti	Dr (staff)	LPNHE/IN2P3			
	Mathieu Guigue	Dr (staff)	LPNHE/IN2P3			
	Michel Gonin	Dr (staff)	LLR/IN2P3			
	Olivier Drapier	Dr (staff)	LLR/IN2P3			
	Pascal Paganini	Dr (staff)	LLR/IN2P3			
	Thomas Mueller	Dr (staff)	LLR/IN2P3			
	Margherita Buizza-Avanzini	Dr (staff)	LLR/IN2P3			
	Benjamin Quilain	Dr (staff)	LLR/IN2P3			
	Boris Popov	Dr (staff)	LPNHE/IN2P3			
	Marco Zito	Dr. (staff)	LPNHE/IN2P3			
	Christophe de La Taille	Dr. (staff)	OMEGA/IN2P3			
	Selma Conforti	Dr. (staff)	OMEGA/IN2P3			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	100/day	30 days	3000	IN2P3
Travel	1000	2 travel	2000	IN2P3
Visit to Japan	100/day	5 days	500	CEA/IRFU
Travel	1000	1 travel	1000	CEA/IRFU
Total			6500	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	20 days	400	KEK
Travel	150	3 travels	450	KEK

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

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Total			850	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to**[6]	**Type**	**k¥**
JENNIFER2-RISE IN2P3	travel	5000	JSPS	travel	450
JENNIFER2-RISE CEA	travel	1500			
Total		6500	Total		450

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	Hyper-Kamiokande will be the third generation of extremely successful long baseline neutrino program in Japan. It will open fascinating new window on the universe, probing the leptonic CP violation with the highest precision, testing the three-flavor neutrino oscillation paradigm and having a unique capability to probe Grand Unified Theories through proton decay, in conjunction with a strong astrophysical program. The Hyper-Kamiokande detector will be the largest underground water Cherenkov detector with a 68 m diameter and 72 m height cylindrical tank, It will be equipped with up to 40,000 photo-sensors in the inner detector. This project aims to develop and ultimately produce the photosensor front-end electronics and synchronization system of the Hyper-Kamiokande experiment. Timing synchronization of each PMT signal is crucial for a precise reconstruction of the particle tracks due to the trigger-less nature of the detector. In Hyper-Kamiokande, timing resolution of the photo-sensor is expected to be sub-nanosecond and the jitter less than 100ps RMS and, the association between the local time base and the Coordinated Universal Time (UTC) is also crucial to synchronize the data acquisition with the beam sent from the J-PARC particles accelerator in Tokai and to correlate the astronomical events detected by other detectors around the world. To achieve the synchronization goal, we are planning to build a high-speed serial link with embedded clock realized using the Field Programmable Gate Arrays (FPGA) serializer-deserializer following a tree scheme where the clock originates from a master entity and each leaf extracts the clock from the data stream with a deterministic phase shift. The clock source will be an atomic clock associated to a Global Navigation Satellite System (GNSS) receiver to get an UTC reference. A higher precision will be achieved correcting the satellite data using the time products generated by the UTC consortium. The working group that presents this proposal has long experience in this domain and is already conducting an R&D on the described subjects. With this funding a stronger collaboration between France and Japan groups will be initiated and will allow to: • Perform time distribution tests on FE electronics at an earlier stage. • Test the UTC synchronization scheme is situ on the real orography. • Test the prototypes on the existing similar detectors like Super-Kamiokande
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	Time Synchronization Schemes for the Future Hyper-Kamiokande Experiment
Seconded / Jointly Supervised Students (if applicable)	

Muon Physics

MU_03 : Study of Atmospheric Muons and Their Impact to Low Energy Background in Rare Process Experiments

MU_04 : Lepton flavor violation: $\mu \rightarrow$e transitions, and the τ sector

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Fiscal year April 1st 2020 – March 31st 2021

ID[1]: MU_03	Title: Study of Atmospheric Muons and Their Impact to Low Energy Background in Rare Process Experiments

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Cristina Carloganu Cristina.Carloganu @clermont.in2p3.fr	CR	LPC/IN2P3	Satoshi Mihara Satoshi.Mihara@kek.jp	Prof.	KEK
	Valentin Niess	CR	LPC/IN2P3	Yoshinori Fukao	Ass Prof.	KEK
Members				Kazuki Ueno	Ass Prof.	KEK
	Emilien Gadoux	Master student (M1)	ENS Cachan	Masaharu Aoki	Prof.	Osaka University
				Sun Syyuan	Master student (M2)	Osaka University
				Yoshiki Sato	Master student (M2)	Osaka University

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	16 days	2400	IN2P3
Travel	900	2 travels	1800	IN2P3
Total			4200	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	10/day	10 days	100	KEK
Travel	150	1 travels	150	KEK
Total			250	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
IN2P3	AP	4200	JSPS	travel	500
Total			Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	Experimental searches for muon rare decays and processes associated with violation of the fundamental symmetries are drawing attention as such modes are strictly forbidden in the Standard Model (SM), while many new physics models beyond SM predict their existence just below the current experimental bounds. In such experiments tremendous efforts have been made to develop sophisticated detectors along with highly intense muon beams. Thanks to these efforts, their experimental sensitivities are expected to improve significantly the current limits and the background induced by cosmic-ray muons has an increasing impact among the factors limiting the experimental sensitivities. This has been shown recently to be the case, for instance, for the experiments to search for neutrinoless muon-to-electron conversion (charged lepton flavor violation). Therefore it is of significant importance to understand the cosmic ray muon distribution (in particular horizontal ones) at a local site and to develop highly efficient detectors for their detection. The methodology employed by the French group to predict the cosmic-ray muon flux on particular detection surfaces is a new approach, based on an inverse Monte Carlo simulation [V. Niess *et al.,* ``Backward Monte-Carlo applied to muon transport", Comput. Phys. Commun. 229 (2018) 54-67 (2018-08)]. It promises a more precise and robust way of estimating the cosmic-ray muon background by fully accounting for the scattering of low energy muons in the experimental area and by taking into account anisotropies in the differential flux of atmospheric muons induced by local topography. It also makes possible to simulate with very high statistics particular event topologies recognised as dangerous for the final state configurations searched for in the experiments. This proposal is twofold. We intend to validate this precise prediction of the cosmic-ray flux by (1) comparing the classical, analog Monte Carlo approach pursued by the Japanese group and the Inverse Monte Carlo approach by the French group; (2) cross-checking this prediction with precise flux measurements which will be carried out under Japanese leadership at J-PARC, used as a benchmark. A prototype plastic scintillation hodosope along with a prototype of Glass Resistive Plate Chambers (GRPC) being developed by the French group will be used for this purpose. In particular we will need to test the robustness of the prediction against the level of detail in the description of the experimental areas. French group members plan to visit KEK/J-PARC to collaborate in this measurement, taking responsibility for the operation of the GRPC prototype. Once we obtain the data, it will be possible to use the validated flux model to further optimise a Cosmic Ray Veto prototype based on GRPC technology developed at LPC. Japanese group member(s) plan to visit Clermont Ferrand to collaborate in this optimization process.
Workshop / satellite session at annual workshop (if applicable)	We plan to have a satellite kick-off workshop after the TYL meeting in 2020.
Common Articles Expected (if applicable)	An article on the evaluation of the cosmic-ray muon background. Publication on the cosmic ray detector specifications to be followed at later time by an experimental article based on the performance of the GRPC prototype.

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Seconded / Jointly Supervised Students (if applicable)	One M1 student at LPC plans to spend two months at KEK/J-PARC in May-June 2020. Visit by Japanese student(s) at Clermont Ferrand are planned during the second part of 2020 to learn to operate GRPCs in stable conditions.

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ID[1]: MU_04	Title: "Lepton flavour violation: μ →e transitions, and the τ sector"

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader **Members**	Ana M. TEIXEIRA ana.teixeira@clermont.in2p3.fr	Doctor	LPC/IN2P3	Joe SATO joe@phy.saitama-u.ac.jp	Professor	Saitama U.
	Sacha DAVIDSON	Doctor	LUPM/IN2P3	Yoshitaka KUNO	Professor	Osaka U.
	Chandan HATI	Doctor	LPC/IN2P3	Masato YAMANAKA	PostDoc	Osaka City U.
	Jonathan KRIEWALD	Mr	LPC/IN2P3	Yuichi UESAKA	PostDoc	Saitama U.
	Timothy SALGUES	Mr	LUPM/IN2P3	Hiroaki Kakizawa	Mr	Saitama U.
				Kohei Sugawara	Mr	Saitama U.

Funding Request from France

Description	**€/unit**	**Nb of units**	Total (€)	Requested to[4]:
Visit to Japan	100/day	10 days	1000	IN2P3
Travels (air/train fares)	1000	1 travel	1000	IN2P3
Total			2000	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	Requested to:
Travels (air fares)	250 /travel	1 travel	250	KEK
Total			200	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

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Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	This project is the successor of "HEP_06: CLFV – searching for indirect signals of new physics". Like its predecessor, it aims to strengthen French-Japanese collaboration in studying the theory and phenomenology of flavour changing processes among charged leptons, as well as other rare leptonic transitions. In the new project "Lepton flavour violation: μ →e transitions, and the τ sector", we aim at pursuing the studies already started in the previous one, also extending the scope to include rare processes involving tau leptons. The PIs of both groups have changed, and we hope that other groups/collaborators will join the project. Charged lepton flavour violating (cLFV) observables, such as μ →e conversion on nuclei, or the decays μ→eγ, τ→3μ and K→μe , are privileged probes of New Physics, since such transitions are forbidden in the Standard Model (SM), but induced by New Physics – for example, SM extensions responsible for neutrino masses, as well as many appealing models aiming at addressing tensions between the SM and observation. Several dedicated facilities (COMET, Mu2e, MEG-II and Mu3e) are expected to improve the existing sensitivities to μ-e flavour changes (current rates lying around BR ~ 10^{-12}) by one or several orders of magnitude. Belle II aims at improving the sensitivity to τ flavour changes by at least an order of magnitude to BR ~10^{-9}. A first goal of the project is to study known cLFV observables and possibly discover/identify new ones, in particular those that could be studied at COMET. For instance, M. Yamanaka and Y. Uesaka visited France in January 2020 (YU thanks to our previous FJPPL HEP_06), and we discussed a potential new observable in μ →e conversion experiments, that could be sensitive to all contact interactions mediating μ→eγγ. We envisage to explore further observables during the project. We also aim to study the impact of cLFV observables on New Physics, both in explicit models and Effective Field Theory. Our goal is to use cLFV observables (especially those which probe flavour violation in the μ-e sector) to discriminate between SM extensions, and in particular to constrain models including new sources of flavour non-universality. In the EFT perspective, we aim to complete the translation of experimental constraints from low energy to the New Physics scale: the Effective Field Theory (EFT) approach provides a formalism allowing to "peel off" short-distance Standard Model loop corrections that "decorate" experimentally-constrained contact interactions. As a result, experiments constrain calculable combinations of coefficients at higher energy scales, and these identify which observables can discriminate among which models. We have studied this EFT below the weak scale for μ→e conversion, and a Ph.D. student will include taus and implement these results in the public code HEPfit. The study and implementation of EFTs from the weak scale to a higher New Physics scale is more delicate; we plan to study it with collaborators that will hopefully join the project.
Workshop / satellite session at annual workshop (if applicable)	

FJPPL (TYL) application 2020-2021

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Common Articles Expected (if applicable)	A preprint by SD, YK, YU, and MY should appear shortly.
Seconded / Jointly Supervised Students (if applicable)	Jonathan KRIEWALD, Ph.D. student at the LPC Clermont under the co-supervision of A.M. Teixeira, whose Ph.D. thesis is dedicated to "Indirect searches for new physics via flavour violation observables". A student will start their Ph.D. at Montpellier in the fall 2020, on the topic of Effective Field Theories for LFV, with S. Davidson as advisor.

Detector R&D

D_RD_16 : Development of advanced Monolithic Pixel Detector
D_RD_17 : Development of a high-speed detector readout system
D_RD_18 : Toward the technology choice for the TPC of the ILD detector
D_RD_19 : LiquidO R&D novel detector concept for neutrino experiments
D_RD_20 : New Challenge for Internal Pixel Tracker construction (2019-2024)
D_RD_21 : Direction-sensitive dark matter detection with gaseous tracking Detectors
D_RD_22 : Innovative diamond based detector development for charged particle detection

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ID[1]: D_RD_16	Title: Development of Advanced Monolithic Pixel Detector

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	Marc Winter	Researcher	IPHC/IN2P3	Yasuo Arai	Prof.	KEK
Members	Auguste Besson	Assis. Prof.	IPHC/IN2P3	Ikuo Kurachi	Prof.	AAT/KEK,
	Jérôme Baudot	Prof.	IPHC/IN2P3	Akimasa Ishikawa	Assoc. Prof.	IPNS/KEK
	Christine Hu-Guo	Dr.Engineer	IPHC/IN2P3	Toru Tsuboyama	Assis. Prof.	IPNS/KEK
	Maciej Kachel	Dr.Engineer	IPHC/IN2P3	Toshinobu Miyoshi	Assis. Prof.	IPNS/KEK
	Andreï Dorokhov	Dr.Engineer	IPHC/IN2P3	Kazuhiko Hara	Assoc. Prof.	Tsukuba Univ.
	Frédéric Morel	Dr.Engineer	IPHC/IN2P3	Miho Yamada	Assis. Prof.	Tokyo Metropolitan College

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to KEK	150/day	10 days	1,500	IN2P3
Travels	1000	2 travels	2,000	IN2P3
Total			3,500	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
TYL-FJPPL workshop at Nantes and collaboration meeting at Strasbourg	400	2 travel	800	KEK
Total			800	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Part of annual team budget	Chip fabrication	15,000	JSPS	consumable	3,000
Id.	PCB	1,000	JSPS	employment	6,500
			JSPS	travel	400
Total		16,000	Total		9,900

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	In the past fiscal year, we, KEK and IPHC group, worked on SOI/CMOS pixel sensors, developing in particular a digital library for the SOI process, as well as investigating the option of 3D vertical integration of silicon chips anticipated to comply with future project requirements. IPHC has designed two prototype sensors in the SOI technology which came back from foundry in Sep. 2019. Comprehensive tests of the circuits have started at IPHC. The results obtained will, among others, allow to validate and to extend the SOI digital library developed previously by the collaboration. One of the sensors features a pixel front-end foreseen for an application at the ILC. Although there were a few minor shortcomings reflecting the still exploratory phase of the development, significant progress was achieved in terms of understanding SOI process specificities. The next R&D step undertakes to extend the translation of the MIMOSIS sensor into the SOI technology. The ultimate goal of this activity is to realize a 3D sensor, which would feature high-density in-pixel circuitry suited to the ambitioned spatial resolution of about 3 microns for an ILC vertex detector. This follows from the possibility to implement the sensing components and the digital circuitry on two different layers, thereby allowing the pixel size to be shrunk with respect to more standard approaches. In parallel, both groups will pursue their own development line targeting sensors for an ILC experiment. At IPHC, the design of the MIMOSIS CMOS pixel sensor in the 0.18 μm TowerJazz technology is completed. MIMOSIS will be manufactured in Spring 2020. Though dedicated to the CBM experiment at FAIR, its architecture provides the baseline for a sensor oriented toward ILC vertexing and inner tracking. Consequently, its test in the coming fiscal year will bring valuable feed-back. At KEK, the development of the SOFIST sensor realized in the 0.2 μm SOI technology for the ILC experiments, will be carried on. The version 3 of the chip showed that the objective of a simultaneous hit position, amplitude and timing information was reachable. Version 4 of the chip features the same circuitry as version 3, but relies 3D integration, resulting in a much smaller pixel pitch (20 μm) than in version 3 (30 μm). The beam test at FNAL is scheduled at the end of FY2019. Face-to-face and video meetings between KEK and IPHC will be performed using possible occasions to discuss results on developments in each technology (CMOS and SOI) and review the circuits for the next common SOI submission in the 2020 fiscal year.
Workshop / satellite session at annual workshop (if applicable)	We applied a short term stay program of KEK and approved an engineer of IPHC (Maciej Kachel) will stay in KEK for two weeks in FY2020. During his stay, we will work together on a pixel detector and a development of digital library. We are also planning to have a collaboration meeting at Strasbourg before or after the TYL-FJPPL workshop at Nantes.
Common Articles Expected (if applicable)	

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Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: D_RD_17	Title: **Development of a high-speed detector readout system**

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	**Daniel Charlet** charlet@lal.in2p3.fr	**IR**	**IJCLab**	**Satoru Yamada** satoru.yamada@kek.jp	**Lecturer**	**KEK**
Members	Christophe Beigbeder	IR	IJCLab	Ryosuke Itoh	Professor	KEK
	Eric Jules	AI	IJCLab	Mikhiko Nakao	Professor	KEK
	Emi Kou	Dr	IJCLab	Qidong Zhou	Post-doc	KEK
	Francois Le Diberder	Pr	IJCLab	Takuto Kunigo	Post-doc	KEK
	Eric Plaige	AI	IJCLab			
	Patrick Robbe	Dr	IJCLab			
	Monique Taurigna	AI	IJCLab			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Total			0	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	15/day	20days	300	KEK
Travel	250	3 travels	750	KEK
Total			1050	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total		0	Total		0

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	This project is to develop a high-speed readout system for a high-energy physics experiment. The basic functionalities of a readout system is reading out data from front-end electronics boards, formatting and gathering event-fragments and send the data to a PC farm where data are recorded. In the recent progress in the development of high-luminosity accelerators, data throughput to be handled by a readout system becomes larger and larger. In addition to that, the latest particle detectors have higher granularity to achieve higher resolution and avoid piling up in one sensor channel, which could also increase data-size. Therefore, the readout system itself needs to be upgraded with state-of-art technology. In this project, we have been developing a readout system which can be used for the future upgrade of Belle II data acquisition system. In 2019, it was decided that our PCIe40-board-based readout system will be used to replace the current Belle II readout system. Following the decision by the Belle II collaboration, mass production of PCIe40 boards for the Belle II experiment started in October 2019. Our plan in 2020 is to replace a part of the Belle II readout system with the new PCIe40 based system in summer while the accellerator stops for maintenance and saving electricity usage. Since the this shutdown period is only 3month long, we are considering to replace the readout system for two sub-detectors, for a particle ID detector (Time Of Propagation counter, TOP) and a Klong and muon detector(KL and Muon detector, KLM). For those sub-detectors, test benches are available with frontend electronics boards and we can perform commissioning before the installation. If we come to think more sub-detector systems can be replaced before the shutdown period, other detectors' readout system could also be replaced. Before the installation, we need to finish development of full functionalities of firmware and software and we also need long-term commissioning to make sure our new system is stable. Until the summer shutdown, we cannot use front-end electronics boards on the Belle II detector. Therefore, we need to employ test benches for this test. In both LAL and KEK site, there are test bench systems with sub-detectors' front-end electronics boards, we can perform a stress test to find and fix issues before the actual operation with the Belle II detector which will start in October 2020. After the installation, of course we need to keep a close eye on the operation status of the installed system. In case some serious troubles happen during physics data-taking, we will keep the old readout system in standby mode so that we can roll-back to the old system quickly. With the experience of installation and operation in 2020 with the Belle II detector, the rest of the sub-detector's readout systems will be replaced during the summer shutdown in 2021.
Common Articles Expected (if applicable)	"PCI-express based high-speed readout for the Belle II DAQ Upgrade", Q, Zhou, et al., 22nd IEEE Real Time Conference, 13-17 April 2020, Quy Nhon, Vietnam

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: D_RD_18	**Title: Toward the technology choice for the TPC of the ILD detector**

Leader (please add email address) / **Members**	**French Group**			**Japanese Group**		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	S. Ganjour Serguei.Ganjour@cea.fr	Dr.	IRFU/CEA	K. Fujii Keiske.fujii@kek.jp	Dr.	KEK
	P. Colas	Dr.	IRFU/CEA	T. Fusayasu	Dr.	Saga Univ.
	D. Attie	Dr.	IRFU/CEA	Y. Kato	Dr.	Kinki Univ.
	I. Giomataris	Dr.	IRFU/CEA	M. Kobayashi	Dr.	IPNS/KEK
	S. Joshi	Mr.	IRFU/CEA	T. Matsuda	Dr.	IPNS/KEK
	M. Titov	Dr.	IRFU/CEA	A. Sugiyama	Dr.	Saga Univ.
	B. Tuchming	Dr.	IRFU/CEA	T. Takahashi	Dr.	Hiroshima Univ.
				T. Watanabe	Dr.	Kogakuin Univ.
				S. Narita	Dr.	Iwate Univ.
				K. Negishi	Dr.	Iwate Univ.
				Y. Aoki	Miss	Sokendai/KEK
				A. Shoji	Miss	Iwate Univ.
				K. Yumino	Mr.	Sokendai/KEK
				J. Nakajima	Miss	Sokendai/KEK

Funding Request from France				
Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to[4]:**
Visit to Japan	150/day	45 days	6750	IRFU/CEA
Travel	1000	3 travels	3000	IRFU/CEA
Total			9750	

Funding Request from KEK				
Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit to France	20/day	28 days	560	KEK
Travel	200	4 travels	800	KEK
Total			1350	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
CEA/Irfu	ILC R&D	20,000	IPNS/KEK	travel	280
EU	AIDA 2020	5,000			
Total		25,000	Total		280

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	The International Large Detector (ILD) concept at the planned International Linear Collider (ILC) features a Time Projection Chamber (TPC) with Micro-Pattern Gaseous Detector (MPGD) readout as its main tracker. There are two technically viable solutions for its gas amplification device: Gas Electron Multipliers (GEM) and Micromegas. Our TYL program (D_RD_18) is to be prepared for the eventual technology choice by solving the remaining issues for the final design of the TPC to be described in the ILD proposal. On March 7, 2019, the Japanese government, for the first time, officially expressed its interest in the ILC and in continuing discussions with potential partners including the U.S., France, and Germany, while monitoring the European Strategy Update process as well as the Master Plan process of the Science Council of Japan. We are hoping that, once these conditions are met, the Japanese government will approve funding of a few years of technical preparation that goes in parallel with official government-level international negotiations among potential stakeholders. An official proposal call for ILC detectors is expected by the end of this preparation period. Our TYL program would be consistent with this timeline, provided that the funding level for ILC detector R&D would be significantly improved. In the FY 2019, we analyzed data from our 2018 test beam experiment of a new Micromegas modules with a new grounding scheme at DESY using a Large Prototype (LP) TPC and confirmed that the new scheme successfully mitigates distortion due to ExB effect so as to achieve the required performance. The latest analysis results will be presented at the Japanese Physical Society meeting on March 16-19.We have also carried out simulation studies of the gating GEM and the gas amplification process in GEM foils with new geometry and insulator materials, aiming at significant reduction of discharge rate and better gain uniformity over the GEM foil surface, although their prototyping had to wait because of the funding limitations. In the FY 2020 we will further develop simulations for comparison, while optimizing and testing the GEM-like gating device including the measurement of its ion-stopping power, its characterization and comparison with simulations, which will be followed by prototyping if the funding allows. The Japanese team will develop a system to scan the local thickness of a GEM foil and compare the results with the position dependence of the gas gain and its simulation for the new amplification GEM foils with new insulator materials. The French team will continue the R&D (COSTARD project) of a monolithic cooling circuits using 3D-printing technologies for the 2-Phase CO2 (2PCO2) cooling system, while the Japanese team will continue its 2PCO2 system R&D using compressor scheme. As for the definition of the readout electronics, basic design studies will continue in the framework of the LCTPC collaboration. The French and Japanese teams will further the gas property studies including P/T dependence of the gas gain, gas gain fluctuation, etc., using laser beam tracks. For the FY 2020, both the French and the Japanese teams will attend the TYL workshop, which will be an opportunity for 2 or 3 members from each group to have a satellite meeting. In addition, one or two French team members will visit KEK for the preparation of the equipment. Two Saclay visits by 1 or 2 Japanese members are planned for discussing the various simulation studies to monitor and plan our activities. The Japanese group is planning to send one student to Saclay for a month if the travel is supported by the TYL program.
Workshop / satellite session at annual workshop (if applicable)	Planning to have a satellite session attached to the annual TYL WS

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Common Articles Expected (if applicable)	A Time Projection Chamber with Readout based on Resistive Micromegas Design studies on 2-phase CO2 cooling channels Study of gas gain and its fluctuation
Seconded / Jointly Supervised Students (if applicable)	Keita Yumino (Sokendai/KEK)

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID: D_RD_19	**Title: LiquidO R&D novel detector concept for neutrino experiments**					
Leader	**French Group**			**Japanese Group**		
Members	**Name**	**Title**	**Lab./Organis.**	**Name**	**Title**	**Lab/Organis.**
	Cabrera Anatael	Dr	IJCLab	Fumihiko Suekane	Prof	RCNS, Tohoku Univ.
	Yermia Frederic	Dr	SUBATECH			
	Viaud Benoit	Dr	SUBATECH			
	Marquet Christine	Dr	CENBG			
	Chaveau Emmanuel	Dr	CENBG			

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to:**
Visit Japan (1week)	2000	2	4000	
Total			4000	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit France (1week)	30	2	60	KEK
Total			60	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to	**Type**	**€**	**Provided by/Requested to**	**Type**	**k¥**
IN2P3 (Equipement+Mission FR)	AP	10000			
Total		10000	Total		0

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	This is a followup project that started since 2018. The main milestones for the 2020 programme are the following: •Culmination of the R&D phase with prototypes detectors in MeV e- beam spectrometer (IN2P3 facility). •Further develop physics prospects with LiquidO. During 2019, we successfully release the LiquidO technique in a dedicated CERN detector seminar (see report 2019) and submitted our first publication to Nature Physics Communication (see below) — under final stages of scientific review. Our ERC-Synergy-2019 proposal (lead by IJCLab together with CENBG, CIEMAT and Queen's University) reached final staged approval (classed A; i.e. maximal score) but it is on hold in a "reserved list" for funding — still not ruled out. Prof. Suekane is expected to be invited researcher within the ERC programme. A new (improved) ERC-Synergy-2020 proposal has been submitted anyway. Hence, during 2020, our operations continue to rely fully on humble contributions provided by IN2P3 and this FJPPL proposal, specially for the active Japan-France collaboration, which ignited much of LiquidO's science. In 2020, we expect new R&D detector data to be released in the Neutrino 2020 (June, Chicago, USA) — the most important conference in neutrinos in the world. We also expect to release several publications on LiquidO physics, where the FJPPL collaboration focuses on leptonic CP Violation and the use of reactor Neutrino for Unitarity Violation unique explorations using LiquidO — see items below. This year our work on both CP and Unitarity Violation has been reinforced by Prof H. Nunokawa (PUC, Rio de Janeiro, Brasil) now sabbatical in IJCLab during most 2020. The LiquidO international proto-collaboration remains active under the leadership of A.Cabrera and F.Suekane (co-spokesperson) with 19 institutions over 9 countries. The IN2P3 (CENBG, CPPM, IJCLab, SUBATECH) contribution is particularly active where ERC programme might bring new scientific activity to the LNCA laboratory (Chooz) for LiquidO detector demonstration.
Workshop / satellite session at annual workshop (if applicable)	Several important milestones expected within 2020 are: •Neutrino 2020 Conference (Chicago, USA): New Experimental Data Results •LiquidO Collaboration Meeting (Summer 2020, likely in UK) •LiquidO CP-Violation Physics First Release: Conference (to be decided) — paper under finalisation.
Common Articles Expected (if applicable)	These are ongoing publications under preparation or approval: a) **LiquidO Detection First: Novel Detection Principle.** — submitted Oct 2019 to Nature Physics Communication. Main editor: Anatael Cabrera. Corresponding authors: F. Suekane and A.Cabrera. b) **LiquidO Potassium Geo-Neutrino First Observation** — expected submission before April-2020 to Nature Publisher. Strong contributions by RCNS and IJCLab. c) **LiquidO Reactor Neutrino Detection Physics** — expected mid-2020 (likely JHEP). Strong contributions by RCNS and IJCLab+SUBATECH for possible first experimental test of leptonic Unitarity Violation test. d) **LiquidO CP-Violation with Decay-at-Rest Source** — expected mid-2020 (likely JHEP). Main editor: F.Suekane. Strong contributions by RCNS and IJCLab+SUBATECH. e) **LiquidO ββ Physics Prospects** — expected late 2020 (likely JHEP; still studies ongoing). Main editors: A. Cabrera and C. Marquet. Strong contributions by RCNS and CENBG, CPPM and IJCLab. f) **LiquidO Full Detection** — expected late 2020 (likely JINST; still data taking & studies ongoing). Strong contributions by RCNS and CENBG, IJCLab and SUBATECH.

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: D_RD_20	Title: Planar Pixel developments for ITK construction

Leader (please add email address) Members	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	R.Tanaka	Dr.	IJC/IN2P3	K. Nakamura	Dr.	KEK
	A. Lounis	Dr.	IJC/IN2P3	K. Hara	Dr.	Tsukuba University Kobe University
	M. Escalier	Dr.	IJC/IN2P3	Y. Unno	Dr.	KEK
	Lingua Huo	PhD	IJC/IN2P3			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	10 days	1500	IN2P3
Travel	1000	1 travel	1000	FJPPL
Total			3000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	45/ day	5 days	225	KEK
Student stay at Orsay	150/month	1	150	
Travels				
Total				

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
ATLAS ITK	Equipment	5,000	JSPS	Equipment	1000
			JSPS	travel	1500
Total		5,000	Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	. The LHC pixel detectors have performed extremely well in the challenging LHC environment and have been essential to extract the LHC physics. The Phase II ATLAS and detectors are being designed to cope with the very challenging beam conditions of the LHC after 2026. The High Luminosity LHC (HL-LHC) will operate at a higher center-of-mass energy of 14 TeV and collision rates about a factor of 5-10 higher than the one for which the current detector were built. By the end of the HL-LHC program about 4000 fb^{-1}, will be delivered to the experiment. The high instantaneous luminosity will come at the price of extremely high pileup. Up to 140 overlapping events for a bunch-crossing interval of 25 ns are foreseen. In order to operate in such environment, the ATLAS tracker and pixel detectors must be completely replaced. Especially in the layers closer to the interaction region, the next generation detectors must achieve high rate capability using integrated circuits in 65 nm CMOS technology and materials with increased tolerance to radiation dose and single event upsets (SEU). The latter are changes of state in micro-electronic device caused by ions or radiation striking sensitive node. For pixel vertex detectors the HL-LHC requirements translate to a need to develop sensors capable of surviving doses of about $2 \cdot 10^{16}$ n_{eq}/cm^2 and to handle hit rates of about 1GHz/cm^2. After the first step which consists of the market survey operation on sensors production by several foundries, our teams will go towards module assembly and production operations. Mini batches of sensors and ASICS will be produced in order to be flip chipped in some industrial partners (Hammamatsu and IZM) to constitute a pixel module. Each team will be in charge of module assembly which consists on gluing flex attach and wire bonding operation. Each operation will be done with respect to Quality and Control procedures in order to ensure excellent reliability of the modules. CYRIC facilities in Japan will be used as radiation facility for our modules. Temperature and radiation hardness will be the necessary operations to ensure good reliability of the produced assemblies. Our activities will be jointly performed in close collaboration, namely beam tests activities to ensure equal module quality production in France and Japan.
Workshop / satellite session at annual workshop (if applicable)	Workshop on Vertex Detectors, 2020. Hiroshima Conference, Vancouver 2020.
Common Articles Expected (if applicable)	
Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]: D_RD_21	Title: Direction-sensitive dark matter detection with gaseous tracking detectors

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Daniel Santos	Dr.	LPSC/IN2P3	Kentaro Miuchi	Dr.	Kobe University
	Charling Tao	Dr.	CPPM/IN2P3	Hirohisa Ishiura	Mr.	Kobe University
Members	Fabrice Naraghi	Dr.	LPSC/INPG	Takuya Shimada	Mr.	Kobe University
	Olivier Guillaudin	Dr.	LPSC/IN2P3			
	Jean-François Muraz	Mr.	LPSC/IN2P3			
	Cyprien Beaufort	Mr.	LPSC/IN2P3			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan (Kobe University)	150/day	10 days	1500	IN2P3
Travel	1000	1 travel	1000	IN2P3
Visit to Japan (Kobe University)	150/day	10 days	1500	IN2P3
Travel	1000	1 travel	1000	IN2P3
Total			5000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France (Grenoble LPSC)	200(Flight) 20/day	5 days	300	KEK
Visit to France (Grenoble LPSC)	200(Flight) 20/day	10 days	400	KEK
Visit to France (Grenoble LPSC)	200(Flight) 20/day	10 days	400	KEK
Visit to France (Grenoble LPSC)	200(Flight) 20/day	10 days	400	KEK
Total			1500	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Labex Enigmass	Equipment	10,000	JSPS	Equipment	2,000
			JSPS	travel	500
Total		10,000	Total		2,500

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	Revealing the nature of the Dark Matter in the Universe is one of the primary interests in particle physics and astrophysics today. Recoil tracks in a suitable detector will be oriented in direction opposite to our motion around the center of our galaxy. Low-pressure gaseous time projection chambers (TPCs), where the nuclear tracks are reconstructed in 3D, are said to be a suitable device for a directional dark matter search.. In this project, we seek to merge complementary expertise from two leading experiments, namely MIMAC (lead by D. Santos) and NEWAGE (lead by K. Miuchi). Through the MIMAC experiment, LPSC group has a great experience with the calibration of the low energy nuclear tracks. In particular, an ion accelerator named COMIMAC at Grenoble was used to measure the ionization efficiency, or the quenching factor of the nuclear events relevant to the dark matter signals [1]. Meanwhile, NEWAGE has expertise in the so-called negative ion TPC gas technology, which is expected to provide a substantial sensitivity improvement with dedicated electronics [2]. NEWAGE is also preparing a "common observatory" chamber where several groups can bring their detectors in and perform dark matter search together, and this FJPPL(TYL) work would be a good start for this collaborative work. In December 2019, we performed our first joint measurement with COMIMAC, at LPSC Grenoble. We measured the electron and fluorine energy deposition in the SF_6 for the determination of the quenching factor of the fluorine nuclei. We obtained interesting results different from normal (electron-drift) gas. In the year 2020-2021, we plan to perform additional measurements with the COMIMAC facility for a good understanding the SF6 gas as a chamber gas. This measurement would be a unique collaborative work merging the expertise of French (MIMAC measurement strategy and COMIMAC facility) and Japanese (SF_6 gas) groups. Miuchi will visit LPSC in the first half of the year for the discussion, and bring two students in the second half for measurements. Santos will visit Japan afterwards to discuss the data analysis with his students. In the following years, we plan to extend our collaboration for the track length measurement at LPSC and underground measurement at Kamioka in a common observatory chamber. [1] "A table-top ion and electron beam facility for ionization quenching measurement and gas detector calibration" (COMIMAC), J.F. Muraz, … D. Santos *et al.*, NIM A832 (2016), 214. [2] "Study of Negative-Ion TPC Using μ-PIC for Directional Dark Matter Search" T. Ikeda, K. Miuchi, *et.al*, EPJ Web of Conferences 174, 02006 (2018)
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	Electron energy calibration in SF_6 gas using the COMIMAC facility Quenching factor measurement of ^{19}F in SF_6 gas using the COMIMAC facility
Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

ID[1]:D_RD_22	Title: Innovative diamond based detector development for charged particle detection.

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Marie-Laure Gallin-Martel mlgallin@lpsc.in2p3.fr	Dr	LPSC/IN2P3	Hajime Nishiguchi hajime.nishiguchi@kek.jp	Assoc.Prof	IPNS/KEK
	Alexandre Portier	PhD	LPSC -Néel	Satoshi Koizumi	Dr	NIMS
Members	Fatah Rarbi	Ing.	LPSC/IN2P3	Manobu Tanaka	Prof	IPNS/KEK
	Noël Servagent	Assoc. Prof.	SUBATECH/IN2P3	Tetsuichi Kishishita	Assoc. Prof	IPNS/KEK
	Charbel Koumeir	Ing	SUBATECH/IN2P3			
	Philipp Bambade	Dr	IJClab/IN2P3			
	Julien Pernot	Prof.	Néel/INP			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	20 days	3000	IN2P3
Travel	1000	2 travel	2000	IN2P3
Total			5000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	20 days	400	KEK
Travel	150	2 travels	300	KEK
Total			700	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project	***Context*** In nuclear and high energy physics as well as for medical application (hadrontherapy), the development of new generations of ion accelerators generates the need for very accurate charged particle detection apparatus and beam monitors with precise and fast counting in a high radiation environment. Compared to other semiconductor detectors, CVD-diamond based detectors (Chemical Vapor Deposition) exhibit several advantages. A high resistivity (>10^{13} Ω m) coupled to a large electronic gap (5.48 eV) results in a lower noise level and an almost negligible leakage current. The high charge carrier mobility leads to a very fast detector response allowing tens of picoseconds time resolution and high count-rates capability. ***Project R&D objectives*** In this context, the present R&D project aims to develop innovative diamond-based detectors that will benefit from the intrinsic diamond properties to fulfil these requirements. Diamond sensors instrumentation with electronic readout is foreseen as well as first tests using either sources (alpha, beta) and beam facilities (eBIC electron Beam Induced Current) in laboratories or accelerators facilities in France and in Japan. ***Technological solution to reach objectives*** Diamond will be used as solid state ionization chamber. Incoming charged particles will generate charges in the diamond thickness that will be collected on electrodes. To permit charge collection with spatial resolution and low detector capacitance values, diamond detectors will be segmented with double side metallic strips readout (X and Y directions). In order to ensure short carrier drift time and limit the detector current (compulsory for very intense beam pulses and in the case of beam monitoring), the diamond thickness is a key factor and needs to be optimized. Single crystals or CVD-polycrystals (pCVD) may be used. In present project, a particular focus will be given on the elaboration of pn and Schottky diode detectors made in Japanese laboratories. The use of surface-metallized high-purity diamond plates as solid state ionization chambers are promising alternatives for high-performance detectors, enabling their use with low bias voltage, increased charge carrier collection efficiency, and charge amplification and will result in a very compact device. Finally, the specificity of the whole project is the development of an integrated readout electronics (fast preamplifier, current integration) and a data acquisition system in laboratories. ***Methodology to reach the objectives*** **Diamond material – coordinator NIMS and partner Néel/KEK/LPSC** For the diamond detector, as a key issue is the charge collection optimization, it is planned to use either thin diamond (few tens of µm) directly grown and doped by ion implantation at NIMS or commercial sensors purchased by LPSC (e.g pCVD from Element 6 or II-VI or DDK) thinning down to ~100µm or less by plasma / chemical etching. **Diamond characterization – coordinator Néel partner LPSC** Néel has developed eBIC with time-of-flight capability, which enables to draw the 2D response map of a detector. Furthermore, the quality of the diamond relies on the leakage current characteristics. LPSC is equipped with a dedicated test bench. **Diamond assembly - detector instrumentation – coordinator LPSC/KEK partner Néel** The lift-off process (NanoFab from Néel involvement) is used to create stripped electrodes on the diamond to equip a beam monitor. It consists of creating structures (patterning) using a sacrificial material (photoresist). The instrumentation of the commercial metallized diamonds will be done at LPSC and at KEK for the NIMS pn junction. Innovative and demanding electronic developments are planned. Both LPSC and KEK has experience in such development. **Detector performance evaluation coordinator KEK/ IJClab/ SUBATECH partner LPSC** Detector performances for charged particle detection will be evaluated in Japan at KEK Tsukuba campus

	in collaboration with the IJClab/LPSC teams and at J-PARC (KEK Tokai campus). Detector performances will be evaluated in France in collaboration with KEK/NIMS teams i) in AIFIRA with 3MeV alpha or proton micro beams enabling precise localization (pn junction performances evaluation) and inter strip performance evaluation (commercial stripped diamond performances evaluation) ii) in ARRONAX with a proton and alpha beams of 70MeV in a "continuous mode" defined by a standard frequency of 30.45 MHz and a "discontinuous mode" defined by repetitive pulses i.e. trains of bunches with a minimum pulse duration of 10µs and a maximum period of 20 kHz. ***Partnership*** The associated partners have already demonstrated in the past the skills to perform the foreseen developments and characterizations: the activity has been supported in 2019-2020 by the PRCE JSPS-CNRS program. The LPSC has an expertise in detector development for particle physics (ATLAS) and medical physics (beam hodoscope for hadrontherapy). The KEK group is experimented by problematics linked to particle physics and beam accelerators. SUBATECH and GIP-ARRONAX are skilled with the problematic of physics with accelerators. The IJCLab is already involved in the lumiBELLE2 project and is used to the use of diamond for fast luminosity measurement at KEK. NIMS has an expertise in diamond growth and doping. Néel has an international recognition in development of diamond high power electronic devices, diamond processing and eBIC. The aim of the present proposal is to allow useful exchanges and transfers of knowledge between the associated groups with respect to the production, characterization and use of diamond sensors for the new demanding applications in terms of charged particle detection and beam monitoring currently under consideration in Japan and in France.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	An article on pn junction tests at KEK and in France is envisaged in 2020
Seconded / Jointly Supervised Students (if applicable)	Applications are underway to obtain scholarships for a PhD student 2020-2023 There is the possibility to send one student from France to Japan

Accelerator R&D

A_RD_10 : ATF2 studies and preparation for ILC

A_RD_13 : High intensity positron sources for circular colliders (SuperKEKB, FCC –ee)

A_RD_14 : Influence of vibration on the SuperKEKB collider performance

A_RD_15 : Development of an optical cavity system for the advanced photon sources based on Compton backscaterring

A_RD_16 : Magnetic field monitoring and management for Superconducting RF cavities

A_RD_17 : Investigation of an alternative path for SRF cavity fabrication and surface processing

A_RD_18 : Suppression of Field emission by improvements in the clean assembly work and the use of diagnostic tools for SRF cavities and cryomodule tests

A_RD_19 : Heat Treatments for Low Losses High Gradient SRF Cavities

A_RD_20 : Innovative superconducting surfaces applied to cavity scale

A_RD_21 : Advanced optimization algorithms and neural networks for accelerators control

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ID[1]: A_RD_10	Title: ATF2 studies and preparations for ILC

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Angeles Faus-Golfe	IR1	IJCLab/IN2P3	Kiyoshi Kubo	Prof.	KEK
	Philip Bambade	DR1	IJCLab/IN2P3	Toshiaki Tauchi	A.Prof.	KEK
	Andrii Pastushenko	PhD student	IJCLab/IN2P3-CERN	Takashi Naito	A.Prof.	KEK
Members	Vera Cilento	Phd Student	IJCLab/IN2P3-CERN	Nobuhiro Terunuma	Prof.	KEK
	Andrea Jeremie	IRHC	LAPP/IN2P3	Shigeru Kuroda	A.Prof.	KEK
	Laurent Brunetti	IR2	LAPP/IN2P3	Toshiyuki Okugi	A.Prof.	KEK
	Gaël Balik	IR2	LAPP/IN2P3	Sakae Araki	Eng	KEK
	Maurizio Serluca	CDD/CR	LAPP/IN2P3	Yu Morikawa	Eng	KEK

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
LAPP travel to KEK and FJPPL events: meetings and measurements with sensors		2 travels	4000	IN2P3
IJCLab travel to KEK and FJPPL events: experimental tests, meetings		2 travels	4000	IN2P3
Total			8000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	15/day	20 days	300	KEK
Travel	250	3 travels	750	KEK
Total			1050	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
NPC master project IN2P3: Nanobeam and stabilization		32 000			
Total		32 000	Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	This project has to be considered in the framework of the ILC project. Taking into account the outcome of the Japan Master Plan 2020, and observing the progress of other discussions such as the European Strategy for Particle Physics, the discussions about the ILC are progressing. An important effort is on going to solve the issues not only from the viewpoint of science and technology, but also from the regional development point of view. Furthermore given the fact the ILC project is not a domestic project but an international project, a cooperation with international labs leaded by KEK is also in progress. In particular the topic covered by this project was immediately selected when KEK prepared a list of Franco-Japanese collaborative projects to be communicated to the joint working group of the two departments MEXT and MESRI to prepare for international participation to the ILC project. In this frame, the present project for the period 2020-2021 will be focused towards ILC preparations in the field of "nanobeam handling and stabilization at the IP", more specifically to improve the performance of the Final Focus System and its implication for the ILC. **KEK:** The team will continue contributing as host of the ATF2 project. KEK will make the necessary to prepare a high-quality beam for the nano-beam studies. KEK team will continue the studies for understanding the intensity dependence effects and impact of non-linear aberrations and corrections. KEK will continue working on stabilization of the beam, such as improvement of the cooling water and air temperature control system. KEK will also collaborate in the ILC design work, especially of the final focus system related to ATF2 experiences. **LAPP**: In collaboration with CERN, LAL, Oxford and KEK, the main activities in 2020-2021 on ground motion mitigation will be focused on the feedforward approach dedicated to the beam trajectory control. Indeed ATF2 is a unique opportunity to develop and to compare beam stabilization control methods dedicated to the future linear colliders like ILC. In this context, the performed simulation studies and the operations on site have allowed investigating the set-up of a future global multi-control approach. This multi-control demonstration will require having at least one operation period on site. **IJCLab:** in the period from 2020-2021, the main emphasis of the work will be focused in the topics related with the two PhD thesis in Final Focus studies started in October 2018 in the Paris-Saclay University in the context of the CERN doctoral program and being codirected by CERN-LAL. The first PhD is centered in the optimization of CLIC Final Focus System at 380 GeV and the implementation studies for Ultra-low βy at ATF2 by A. Pastushenko. The second PhD is dealing with the optics design of a dual beam delivery system for lepton colliders and experimental measurements of the ATF2 ultra-low βy nanometer beam size by V. Cilento. This TYL-FJPPL project will be crucial to support these studies and provide a suitable collaborative framework for the students involved to continue the quest of the nanobeam sizes studies in ATF2 in view of ILC.
Workshop / satellite session at annual workshop (if applicable)	A meeting in order to review ATF for the R&Ds in the ILC preparatory phase will be organized.

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Common Articles Expected (if applicable)	A report summarizing the experimental program carried out during this period at ATF2 will be made.
Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: A_RD_13	Title: High Intensity Positron Sources for Circular Colliders (SuperKEKB, FCC-ee)

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	I. Chaikovska chaikovs@lal.in2p3.fr	Dr.	IJCLab/IN2P3	Y. Enomoto yoshinori.enomoto@kek.jp	Assist. Prof	KEK
	R. Chehab	Dr.	IJCLab/IN2P3	K. Furukawa	Prof.	KEK
	V. Kubytskyi	Dr.	IJCLab/IN2P3	T. Kamitani	Prof.	KEK
Members	Y. Han	Dr.	IJCLab/IN2P3	T. Suwada	Prof.	KEK
	B. Bai	PhD student	IHEP/IJCLab	M. Satoh	Assoc. Prof.	KEK
				F. Miyahara	Assist. Prof.	KEK
				Y. Seimiya	Assist. Prof.	KEK
				Y. Morikawa	Assoc. Engr.	KEK

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan (2)	150/day	20 days	3000	IN2P3
Travels (2)	1000	2 travels	2000	IN2P3
Total			5000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	20 days	400	KEK
Travel	150	2 travels	300	KEK
Total			700	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
IN2P3-CERN	1 post-doc	50000			
IN2P3 NPC project/ positron sources					

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Total			Total		

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Summary of Project	IJCLab and KEK teams continue development of the high intensity positron sources in the context of the future and currently in operation circular collider projects such as FCC-ee and SuperKEKB. In the case of SuperKEKB, major upgrade of positron source and capture section is planned in summer shutdown 2020. New flux concentrator made of novel Cu-alloy is under test. Several sets of steering coils and beam position monitors are under design and will be installed in the capture section. Upgrade of pulsed power supply and pulse shaping circuit for flux concentrator is also planned. From the following run start October 2020, the positron source is expected to be operated at design performance. Since such major upgrade work, which include disassemble and assemble of positron source and capture section, is as rare as once in a ten years, joining the work is expected to be a precious experience for people working on the design of future positron sources. Therefore, it is planned that the IJCLab group will join the positron source upgrade activity at KEK. In the case of the FCC-ee positron source, the optimization studies of the positron production including positron yield, target energy deposition and the associated Peak Energy Deposition Density (PEDD) together with the capture are ongoing. After the production, the positrons have a large angular divergence, therefore, it is mandatory to introduce the focusing (capture) system immediately after the target to reduce the transverse momenta and match the positron beam to the acceptance of the downstream accelerating structures of the pre-injector linac. The classical focusing systems made of solenoid coils such as Quarter Wave Transformer or Adiabatic Matching Device (AMD) can be employed. Each system has different momentum acceptances and should be optimized. To form adiabatically decreasing magnetic field, the AMD may use a pulsed Flux Concentrator (FC) or superconducting magnet. Both are under investigation. For the coming year we will concentrate on the AMD based capture system studies, in particular a capture scheme using a fringe field of the superconducting solenoid as the AMD allowing higher magnetic field value on the target-converter and DC operation compared to the FC. The past and current SuperKEKB experience in this field is of great importance for all these studies. At the same time, to get a better performance (moving target, thermal load of the target-converter and the reliability of the entire system), in contrary to the SuperKEKB scheme, we proposed to use a bypass line for the positron source within the FCC-ee injector complex. Two bypass proposals based on a dogleg and a chicane are under study. The French and Japanese teams will continue working together for the optimization of the high intensity positron sources in the framework of the SuperKEKB and FCC-ee projects. One KEK visit by 2 IJCLab members is planned for discussing the various simulation studies, plan our activities and participating in the SuperKEKB positron source upgrade/operation. One visit by two KEK members is planned for discussion.

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Workshop / satellite session at annual workshop (if applicable)	8th high power targetry workshop (HPTW2020), 25th – 29th May 2020, Wako, Japan LINAC 2020, 30th Aug. – 4th Sep. 2020, Liverpool, UK LCWS 2020, CEPC workshop 2020, CLIC workshop 2021 IPAC-2020, FCCweek-2020, TYL/FJPPL workshop 2020, POSIPOL-2020
Common Articles Expected (if applicable)	Proceeding in IPAC-2020 I. Chaikovska et al., Paper on the experimental results obtained during the beam tests in 2016 *(in preparation)*
Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: A_RD_14	Title: Influence of vibrations on the SuperKEKB collider performance

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	BRUNETTI Laurent	IR	LAPP IN2P3	MAZUSAWA Mika	Prof.	KEK
Members	BALIK Gaël	IR	LAPP IN2P3	YAMAOKA Hiroshi		KEK
	SERLUCA Maurizio	CDD CR	LAPP IN2P3			
	MUSA Elaf	Student	LAPP IN2P3			
	BAMBADE Philip	DR	LAL IN2P3			
	WALLON Sandry	IR	LAL IN2P3			
	DI CARLO Salvatore	Postdoc	CERN			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
One mission on site for the coupled measurements (beam position, luminosity and vibrations)	2000	2	4000	IN2P3
Travel	1000	2	2000	IN2P3
Total			6000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Total				

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	This research proposal is a joint collaboration work on the SuperKEKB particle collider among LAPP/LAL, CERN and KEK. The research activities will be done in the framework of MNPP-01 (Multi-National Partnership Programme number 1). SuperKEKB uses dedicated orbit feedback systems at the interaction point (IP) in order to maintain an optimum beam collision condition with the nano-beam scheme in the BELLE2 detector. The development of the systems is very challenging and their implementation and performance could be optimized with a real time vibrations analysis close to the BELLE-II detector. Indeed, the main objective of this research activity is to perform a correlation study in time between the short-term response of the beam orbit feedback, measured in terms of luminosity, beam positions and the vibrations close to the IP induced by seismic activities and cultural noise. In this prospect, last year's proposal in collaboration with LAL and KEK has allowed to complete the final setup, which is now composed of four seismic sensors (Guralp 6T): one on the ground and one on the cryostat support at each side of the BELLE-II detector. A dedicated power supply, a real-time acquisition system (NI DAQ) and a developed monitoring system (Labview) were also installed. The measurements are now processing twenty-four hours a day with an acquisition of ten minutes per hour (to limit the quantity of data) while providing a large range of relevant periods all along a day. These real-time measurements are essential to evaluate the level of vibrations in time and to study the correlation between luminosity and vibrations. Until now, both processes (vibrations and luminosity measurements) have allowed to identify some external vibrations, like the disturbances due to an inertial strength experiment close to the KEK site. With the growth of luminosity, it will be interesting to observe the consequences on the beam of the accelerators elements vibrations (particularly the influence of the differential motions between the final focusing magnets of the Low Energy Ring (LER) vs High Energy Ring (HER) due to the mechanical behavior). To prepare the next phase, it is important to perform and develop beam simulations taking into account all the relevant aspects. In this prospect, the goal is to conduct a measurement campaign, acquiring simultaneously the beam position (KEK - BPMs), the vibrations level (LAPP - seismic sensors) and the luminosity (KEK&LAL), during a few short periods with the IP feedback off. To highlight the influence of the vibrations, the possibility to add an artificial and calibrated disturbance with a shaker will also be studied. These measurements will be done on site during the next operating phase (Spring 2020). The aim of this proposal is to complete the provisional budget for the next required missions at KEK.
Workshop / satellite session at annual workshop (if applicable)	IPAC 2020 at CAEN, France ICFA Advanced Beam Dynamics Workshop on High Luminosity Circular e+e- Colliders (eeFACT2020) at Isola d'Elba, Italy
Common Articles Expected (if applicable)	Depending on the results, we will evaluate to submit a paper on a peer-reviewed journal.
Seconded / Jointly Supervised Students (if applicable)	Master probation (March – July 2020)

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ID[1]:A_RD_15	**Title: Development of an optical cavity system for the advanced photon sources based on Compton backscaterring**

Leader
nutarelli@lal.in2p3.fr

Members

French Group			Japanese Group		
Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
D. Nutarelli	Assistant Professor	IJCLab/IN2P3	A. Aryshev	Assistant Professor	KEK
F. Zomer	Professor	IJCLab /IN2P3	T. Omori	Lecturer	KEK
K. Cassou	Engineer	IJCLab /IN2P3	Y. Honda	Assistant Professor	KEK
A. Martens	Researcher	IJCLab /IN2P3	M. Fukuda	Associate Professor	KEK
V. Soskov	Engineer	IJCLab /IN2P3	K. Sakaue	Associate Professor	Waseda
R. Chiche	Engineer	IJCLab /IN2P3	T. Takahashi	Associate Professor	Hiroshima
L. Amoudry	PhD student	IJCLab /IN2P3			

L.

H.

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan (per diem)	150/day	3x3 days	1,350	IN2P3
Travels to Japan	1000	3 travel	3,000	IN2P3
Total			4350	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	3x3 days	180	KEK
Travel	150	3 travels	450	KEK
Total			630	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
IN2P3	PhD student	35,000	JSPS	travel	630
IN2P3 AP	Support	15,000			

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Total		50,000	Total		630

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Summary of Project	Overview: High intensity photon beams have various applications in advanced accelerators, from medical imagery (X-rays) to high energy physics (polarized positron beams, photon colliders) passing by nuclear physics (fundamental and applied). They can be obtained by laser-Compton backscattering off electrons, the main advantage being the possibility to produce high flux monochromatic photon beams. In this context, an optical cavity is a unique system to reach the requested laser beam power at high repetition rates. LAL and KEK are developing such light sources and are trying to push forward the technical limits to increase the maximal power stored in these optical cavities. Developments in the coming FY: The three-dimensional four-mirror cavity that was installed in KEK-ATF and operated in the end of 2013 allowed demonstrating 35kW stored power over several hours leading to the production of 10^8 photons per second. Building on this experience, competitive with the current highest-flux Gamma-ray facility, R&D is pursued to overcome the thermal effects that are currently limiting the stored power. LAL reached 200kW intra-cavity power for more than half an hour, with stable parameters and concentrates on implementing ThomX cavity and start it's commissioning. In parallel to this activity, experimental implementation of a sub-meter sized cavity and its burst mode operation will continue. A CNRS LabCom is being set with Amplitude Systèmes on this topic, that may be of importance for future LINAC based, high flux high brilliance X-ray sources based on Compton scattering. In this context, several projects are being prepared, among them a reinforced collaboration on upgrading the KEK LUCX installation with an optimized burst mode optical cavity is being prepard within a MoU and the MNPP. LAL also got recently involved in proposing a modern laser system for the Compton polarimeters of ILC and an upgrade of SuperKEKB with polarized electron beams that is currently being discussed. That would certainly reinforce on a very long term ground the collaboration between Japanese and French teams. On the other hand, KEK team will improve stability of GHz-THz multi-micro bunch electron beam generation. With this technology it will be possible to increase the number of colliding electrons in the Compton experiments for more than 10 times. A new fiber laser system for KEK LUCX electron gun is under development now and KEK team is planning to perform electron beam generation tests in the coming year.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	
Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: A_RD_16	Title: Magnetic field monitoring and management for Superconducting RF cavities

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	Leader: Juliette Plouin	Scientist	CEA	Leader: Mika Masuzawa	Prof.	KEK
Members	Enrico Cenni	Scientist	CEA	Kensei Umemori	Assoc.	KEK
	Marchand Claude	Scientist	CEA	Kiyosumi Tsuchiya	Prof.	KEK
	Thomas Proslier	Scientist	CEA	Ryuichi Ueki	Asst. Prof	KEK
				Takafumi Okada	Grad. student	SOKENDAI, the Graduate university for Advanced Studies

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	180/day	10 days	1800	Irfu/CEA
Travels	1200	1 travel	1200	Irfu/CEA
Total			3000	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel	100	1 travel	100	KEK
Visit to France	300	3 travel	900	KEK
Total			1000	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

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[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	**Motivation**: Various studies are in progress for achieving the high-Q operation of superconducting radio frequency (SRF) cavity. High-Q operation is desirable to reduce cryogenic losses. To achieve a high-Q operation, it is essential to reduce the surface resistance of Nb, which is the sum of Bardeen-Cooper-Schrieffer (BCS) resistance and the residual resistance that originates primarily as a result of magnetic flux trapping during the cooling down process. When a cavity is cooled down to a superconducting state, some part of the ambient magnetic field is trapped into the cavity. In order to reduce the amount of trapped magnetic flux, it is necessary to reduce the ambient magnetic field as much as possible. The magnetic shield is used to reduce the ambient magnetic field. The shield design plays an important role as much as choosing proper shielding material. The ambient magnetic field is not uniform in most cases and therefore mapping of the ambient magnetic field is important for optimizing the design of the magnetic shield. It is also important to understand how the ambient magnetic field is trapped and expelled during the cool down process of a cavity as the residual resistance is mostly due to magnetic flux trapping during the cool down process. We plan to continue developing a magnetic field mapping system using inexpensive Anisotropic-Magneto-Resistance (AMR) sensors and use them to monitor the magnetic flux trapping and expulsion around the cavity during the cool down and warm up process of the cavity. **KEK side:** Using the calibration system which we developed last year, we will test about 40 AMR sensors at the liquid Helium temperature. Using the calibrated sensors at both the room temperature and the liquid helium temperature, we will map the magnetic field around the cavity during the cool down and warm up process to see if there is any flux trapping and/or expulsion process taking place. We would also like to examine a correlation between the trapping/expulsion and the performance of the cavity (Q-value) . **CEA side:** Using our own calibration system we plan to develop a device able to move a set of 10 x 3 (for X,Y,Z) sensors around a cavity during tests in helium temperature. A master student will arrive at the end of February to work on cavity diagnostics, and especially on this topic. The goal is to have a real 3D cartography of the magnetic field during the tests, to observe the phenomena of flux trapping/expulsion. We also plan to make new experiments with a permanent magnet, in order to measure the effect of a static magnetic field on the cavity performance. To this purpose, we will use our test cryostat equipped with a special aluminum sleeve allowing the positioning of this permanent magnet close to the cavity. These experiments, correlated with the ones carried out last year, will give us some more statistics about the flux trapping phenomena.
Workshop / satellite session at annual workshop (if applicable)	Next TTC (TESLA Technology Collaboration) meetings in Aomori, Japan
Common Articles Expected (if applicable)	

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Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: A_RD_17	**Title: Investigation of an alternative path for SRF cavity fabrication and surface processing**

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	Longuevergne D. longuevergn@ipno.in2p3.fr	Scientist	IJCLab/CNRS	Takeshi Dohmae dohmae@post.kek.jp	Asst. Prof.	KEK
Members	Antoine C.	Scientist	IRFU/CEA	Yuichi Watanabe	Engineer	KEK
				Masashi Yamanaka	Prof.	KEK
				Kensei Umemori	Prof.	KEK

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to[4]:**
Shipping of small sample to KEK for forming test	100	5	500	IN2P3
Total			500	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit to France	20/day	Total 20days	400	KEK
Travel	200	4	800	KEK
Shipping of small sample to IJCLab for surface characterization	10	5	50	KEK
Total			1250	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
AP IN2P3		2500			
Total		2500	Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	Large-scale production of superconducting radio-frequency (SRF) cavities is an industrial challenge, not only because of the increasing number of unit for future projects but also because of requirements in term of reliability, reproducibility and performances very close to the physical limit of polycrystalline bulk Niobium. Challenging SRF accelerator projects like ILC (International Linear Collider) and FCC (Future Circular Collider) are being studied. For such large-scale facilities, higher performances, reduction in fabrication and operation costs are required and essential to proceed with industrialization. An alternative pathway to reduce these costs and improve performances has been proposed by C. Antoine. Firstly, it consists in applying directly on Niobium sheets an optimized metallographic polishing procedure aiming at removing the damaged layer generated during Niobium sheet manufacturing. This process has been studied in the framework of H2020 European program, European Nuclear Science and Applications Research - 2 (ENSAR2) project (grant agreement N°654002) in collaboration with CEA/IRFU. Secondly, polished Niobium sheets have to be formed and welded to build an elliptical cavity. However, conventional forming techniques might not be applicable as this process would damage too significantly the pre-polished surfaces. All the benefits of the high-quality metallographic polishing would then be lost as a conventional chemical treatment would need to be performed. The aim of this collaborative proposal is to address this second step of the alternative pathway for cavity fabrication. KEK has the experience, ability and facilities to build elliptical cavities. IJCLab/IRFU have the ability and equipment to perform the optimized metallographic polishing procedure for SRF applications and proceed with surface characterization. Sharing and combining our experience and effort will allow us to address, in a very efficient manner, the second step of this alternative pathway. - IJCLab/IRFU will perform the surface polishing and characterization of the samples - KEK will perform mechanical deformation of the samples with optimized conventional techniques The results of the sample study will allow us to proceed to the next step depending on the conclusions - If surface damages induced by the deformation of samples are limited, a Niobium disk required for the fabrication of a full half-cell for a 1.3 GHz elliptical cavity could be polished by IJCLab/IRFU and formed by KEK. - If surface damages are too important, alternative forming method will be investigated and discussed - Compare metallographic polished niobium and conventional/optimized mechanical polished niobium
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	The results obtained in this collaborative project will be published/communicated during dedicated workshops (TTC meeting) or international accelerator conferences (SRF, IPAC, …).

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Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: A_RD_18	**Title: Suppression of Field emission by improvements in the clean assembly work and the use of diagnostic tools for SRF cavities and cryomodule tests**

	French Group			**Japanese Group**		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader	**Enrico Cenni (enrico.cenni@cea.fr)**	Dr.	IRFU/CEA	**Hiroshi Sakai (hiroshi.sakai.phys@kek.jp)**	Professor	CASA/KEK
Members	Stephane Berry	Dr.	IRFU/CEA	Kensei Umemori	Professor	CASA/KEK
	Matthieu Baudrier	Tech.	IRFU/CEA			
	Luc Maurice	Tech.	IRFU/CEA			
	Juliette Plouin	Dr.	IRFU/CEA			

Funding Request from France

Description	**€/unit**	**Nb of units**	**Total (€)**	**Requested to[4]:**
Visit to Japan	150/day	14 days	2100	CEA
Travel	1000	2 travel	2000	CEA
Material shipment	1500	1	1500	
Total			5600	

Funding Request from KEK

Description	**k¥/Unit**	**Nb of units**	**Total (k¥)**	**Requested to:**
Visit to France	20/day	20 days	400	KEK
Travel	150	2 travels	300	KEK
Material shipment	180	1	180	KEK
Total			880	

Additional Funding from France			**Additional Funding from Japan**		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Summary of Project

Motivation:

Field emission is one of the main reasons for the degradation of superconducting cavity quality factor. Its presence can limit the ultimate performances of superconducting RF (SRF) cavities and hence the cryomodule in which they are assembled. In general, the field emitted current tends to become more severe during the beam operation [1,2]. Hence, it can affect the entire machine final performance. Dust particles on the cavity surface is one of the most common source of contamination leading to field emission during the cavity operation.

For these reasons, it is essential to better understand how this phenomenon is generated and evolve from the SRF cavity preparation, in the clean room, through their assembly in the cryomodule until their final test and operation on the machine.

Overview:

CEA and KEK have both long-term experiences and know-how in cavity and cryomodule design, assembly and testing. This project aims to collaborate on the following framework:

A. Clean room cavity preparation: Clean room assembly is of paramount importance for cryomodule preparation in particle accelerators. Clean environment is mandatory in order to preserve the cavity package high performance; each element shall be accurately cleaned and assembled in a dust free area (ISO 4 or better). By means of in vacuum dust particle counter [3] we aim to develop a cavity assembly recipe that avoids dust contamination on the cavity inner surface.

B. X-ray detection: Detecting X-ray pattern emerging from the cryomodule has proven to be an effective method for field emission diagnosis [4,5]. As high energy electrons hitting the cavity surface generate specific bremsstrahlung radiation, any change in its pattern provides fruitful information about the emitter position and the effectiveness of treatment aimed to eliminate the emission sources.

Activities foreseen in the next FY:

CEA will mainly focus on European Spallation Source (ESS) elliptical cavities cryomodule activities, while it will be possible to perform measurements at the compact ERL (cERL) facilities at KEK.

At CEA, SRF cavity and vacuum ancillaries will be cleaned and prepared in ISO5 and ISO4 clean rooms following the ESS procedures. Afterwards they will be shipped to KEK and inspected in the cERL clean room. An optimal nitrogen flow rate will be determined in order to avoid dust particle movement inside the component while assuring enough overpressure to eliminate dust flow from outside.

In parallel, ESS cryomodule tests are ongoing, and we are improving the detection capabilities in the bunker area. The current setup consists of 7 Geiger-Muller detector, 2 NaI(Tl) scintillators and 32 PIN diodes (installed at cryomodule ends). X-ray pattern will be recorded for all the future cryomodule tested in CEA.

These set of measurements will be analyzed and compared with numerical data obtained by means of particle tracking code, in order to simulate electrons moving inside the cavity and Monte Carlo simulation (Geant4) to evaluate the bremsstrahlung radiation produced by high-energy electrons hitting the cavity surface and interacting with cryomodule materials.

At KEK, in the compact ERL (cERL) are also present similar devices. We can measure the x-ray by using PIN diodes during beam operation. And we will compare between the x-ray data and the simulation with CEA and KEK to know the reason of the increase of field emission source during beam operation.

	KEK also has a vacuum particle monitor. We can establish the sophisticated clean assembly work from the experience of the CEA clean assembly procedure to the vertical test. By using this monitor. And finally we can evaluate that this clean assembly works well under the vertical test in KEK. **Summary:** CEA side: • Clean room cavity preparation • X-ray pattern measurements during ESS elliptical cavity cryomodule test • Particle tracking simulation • Monte Carlo simulation KEK side: • Cavity dust particle in vacuum counting at different flow speed • Cavity test in vertical cryostat • X-ray pattern measurements during cERL operation • Particle tracking simulation [1] H. Sakai, E. Cenni, K. Enami, T. Furuya, M. Sawamura, K. Shinoe, and K. Umemori, Phys.Rev.Accel.Beams **22**, 022002 (2019). [2] R. Geng, *Root Causes of Field Emitters in SRF Cavities Placed in CEBAF Tunnel* (Thomas Jefferson National Accelerator Facility, Newport News, VA (United States), 2016). [3] H. Sakai, T. Ebisawa, E. Kako, A. Kasugai, T. Konomi, K. Umemori, and Y. Yamamoto, in (JACOW Publishing, Geneva, Switzerland, 2019), pp. 721–725. [4] E. Cenni, K. Enami, T. Furuya, H. Sakai, M. Satoh, K. Shinoe, K. Umemori, J. Masaru Sawamura, and N. Tokai, SRF2013, Paris, France 672 (2013). [5] E. Cenni, M. Baudrier, G. Devanz, L. Maurice, O. Piquet, and D. Roudier, in (JACOW Publishing, Geneva, Switzerland, 2019), pp. 1147–1151.
Workshop / satellite session at annual workshop (if applicable)	
Common Articles Expected (if applicable)	Joint-communication at SRF2021
Seconded / Jointly Supervised Students (if applicable)	

FJPPL (TYL) application 2020-2021

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ID[1]:A_RD_19	Title: Heat Treatments for Low Losses High Gradient SRF Cavities

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	Leader: Mohammed Fouaidy	Scientist	IJCLab/IN2P3	Leader: Kensei Umemori	Assoc. Prof.	KEK
	David Longuevergne	Scientist	IJCLab/IN2P3	Eiji Kako	Prof.	KEK
	Guillaume Martinet	Scientist	IJCLab/IN2P3	Hiroshi Sakai	Assoc. Prof.	KEK
Members	Enrico Cenni	Scientist	IRFU/CEA	Taro Konomi	Asst. Prof.	KEK
				Mathieu Omet	Asst. Prof	KEK
				Ryo Katayama	Postdoc	KEK
				Hayato Itoh	Grad. Student	SOKENDAI
				Takafumi Okada	Grad. Student	SOKENDAI
				Kotaro Takahashi	Grad Student	SOKENDAI

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	214/day	8 days	1712	IN2P3
Travel	2100	2 travels	4200	IN2P3
Shipment of Materials		1	600	
Total			6512	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	15 days	300	KEK
Travel	200	3 travels	600	KEK
Total			900	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
IN2P3	AP	3000			

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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Total			Total		

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Summary of Project

Motivation

Most current and future large particle accelerators are based on high purity bulk niobium SRF cavities. Furthermore, the RF performances of SRF cavities are determined by: 1) RF losses in a thin surface layer (thickness ~of few penetration depth (for niobium: λ =39 nm)), 2) material thermal conductivity k(T) which has a strong impact on quench field induced by normal conducting defects (inclusions) or impacting field emitted electrons. Vacuum Nitrogen Doping (VND) technique was recently and successfully applied for processing bulk Nb SRF at FNAL, JLAB and KEK. The studies of VND process have shown a reproducible improvement of the unloaded quality factor Q_0 by a factor 2 to 5 but also a systematic reduction up to 40% of the maximum achievable accelerating field E_{accmax} (Figure 1) with cavities that were limited by a quench.

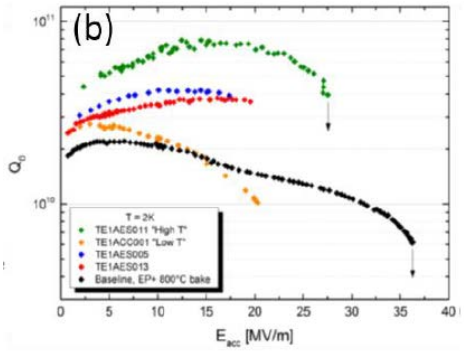

Figure 1: Example of RF characteristic measured at T=2 K showing the effect of VND on a 1.3 GHz 1-cell cavity (Prior to N-doping in black and after VND in green).

Other Vacuum Heat Treatments (VHT) processes are very promising: 1) Vacuum Nitrogen Infusion (VNI), 2) Medium Temperature Baking (MTB) at 120°C, 3) Two-Step (75 °C + 120 °C) Baking. The recent processes 1 and 3 are done in a high temperature vacuum furnace, while the old process (MTB) are performed in-situ (i.e cavity under vacuum on the cryogenic insert). However, the results obtained with VNI are not reproducible from one institute to another and seems to depend on the institutes and/or facilities. For example, Fig. 2 shows N-infusion results, which show scattered performance, from KEK and INP Orsay furnace. Obtained results are actually different between U.S., Germany, France, China and Japan. It is very important to understand what critical parameters ad/or procedures are and to optimize standard procedure to improve reproducibility of excellent SRF cavity performance.

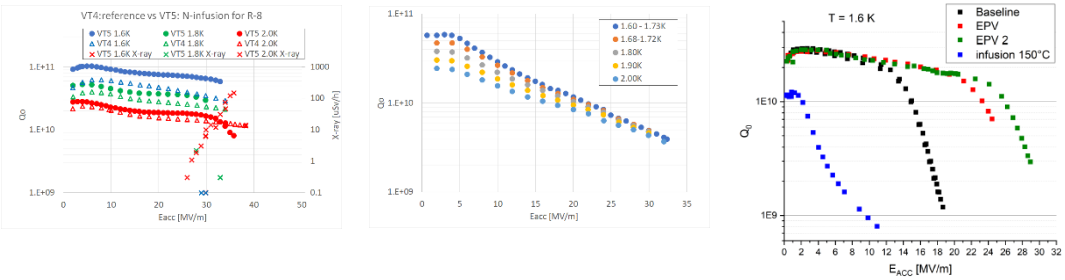

Fig. 2: Example of successful *(left)* and failed *(center)* Nitrogen-infusion at KEK furnace and failed *(right)* Nitrogen-infusion at IPN Orsay furnace.

Furthermore, the surface studies of Nb cavities subjected to VND revealed unusual features compared to Nb samples treated with the standard processes: a) presence of N atoms dopant (100's of ppm) within a surface layer of 100 nm, b) an almost ideal, homogeneous superconducting density of states (DOS) at the surface, c) a very thick and dense protective oxide layer. In contrast, medium temperature baking at θ= 120°C in N_2 atmosphere or in air showed an improvement of E_{accmax} up to 20% but with an unchanged value of Q_0. In order to insure both reliability reproducibility and high yield rate of high RF performances

SRF cavities, the in-depth understanding of the correlations between Q_0, the maximum achievable E_{acc} and materials properties becomes more stringent, down to 10-100 nm scale: new and precise characterization methods and a higher mastering of the involved processes are then needed. A sketch of a Nb RF surface of a cavity prepared according to the usual process (e.g. BCP, electro-polishing, heat treatment, ...) showing its complexity and the complex involved phenomena is illustrated in Figure. 3.

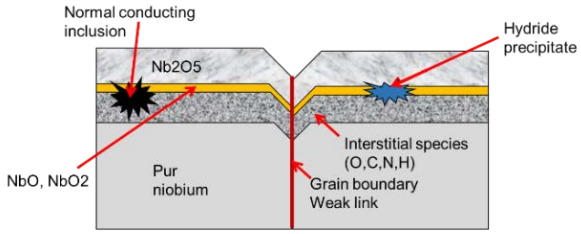

Figure 3: Sketch of a Nb RF surface

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Scientific program

The proposed scientific program is devoted to: 1) Development, optimization and mastering of heat processes of RF surface and/or material with dedicated facilities and equipment (e.g. High Temperature Vacuum Annealing (HTVA) at θ=300 °C-500°C, VND at 600 °C-800°C, MTB at θ =100 °C-200°C, …), 2) Design and development of various new test stands, including special sensing probes with electronics, dedicated to diagnose anomalous RF losses in SRF cavities and characterize several physical properties of superconducting materials either on samples at low temperature(e.g. superconducting properties (gap Δ, critical temperature Tc, critical fields: HC_1, H_{sh} and HC_2), transport properties (electrical and thermal conductivities) and at room temperature (e.g, microstructure, residual mechanical stresses, impurities concentration profiles), 3) Tests on various prototype cavities at different frequencies (e.g, Spoke type resonators at 352 MHz, elliptical resonators at 1.3 GHz, and TE011 cavity at 3.8 GHz and 5.6 GHz); These tests include RF surface resistance measurement in both the so-called BCS regime and residual regime. The dramatic and complex Nb surface modifications and processing hinder our understanding of the involved phenomena and many questions are addressed: 1) How the presence of N dopant affects the superconducting properties at 50n-500 nm scale? 2) Is the increase of Q_0 resulting from N-doping due to the reduction of normal electrons mean path (emp)? 3) Is quench field decrease due a dramatic reduction of the material thermal conductivity (i.e phonon peak) via emp reduction at depth ~1-10 µm? 4) What is the role and the impact of deleterious phase formation (NbHX, NbCX…), the chemical nature of impurities (N, O, C…) on the superconducting parameters of the RF surface?

KEK side

KEK will continue to develop cavity performance by (1) N-infusion, (2) N-doping, (3) Middle-temperature baking, (4) two-step baking and so on. Since cleanness of the furnace is realized as important parameters, we try to clean the furnace procedure and also optimize parameters, such as temperature, Nitrogen pressure and duration time. Middle-temperature baking in furnace is procedure recently developed at KEK. Currently 400 C heat treatment is applied, and high-Q performance are obtained. We will search the temperature parameters and find optimized solution. Mixture of middle-temperature baking + N-infusion, N-doping could be other solutions.

Recently, cold Electrical Polishing (EP) is proposed as new technique to push up cavity performance. KEK has plan to try cold-EP by improving EP facility and evaluate the effect to cavity performance.

KEK has vertical test system with a cancelling solenoid coil for remnant magnetic field. Thus, we can effectively carry on cavity performance test for high-Q values and high-gradient.

In addition to cavity performance test using liquid Helium, we also prepare Niobium samples and analyze details of surface by SIMS, XRR, EBSD etc., in order to understand the mechanism of higher performance.

IJCLab side

Nitrogen doping and infusion studies:

Investigations and characterization of the process on samples (SIMS, SIM-TOF, XRD, RRR, thermal conductivity, …)

Processing in IJCLab vacuum furnace of elliptical 1.3 GHz SRF resonators to be tested at KEK or CEA.

Processing in IJCLab vacuum furnace of the multimode (352 MHz, 704 MHz and 1.3 GHz) spoke resonator and cryogenic test at IJCLab.

Application to a sample to be tested at IJCLab with aTE011 cavity at 3.8 GHz and 5.6 GHz.

Development of diagnostic tools of anomalous RF losses in SRF cavities:

The quench detector (OST and low response time cryogenic thermometers) based on second sound event developed at IJCLab, will be used as diagnostic tools for the test on 1.3 GHz cavities at KEK and CEA. These detectors will be fully characterized at IJCLab.

Magnetic shielding and flux expulsion studies:

Previous studies have shown that the residual part (Rres) of the surface resistance is dominated by the trapped magnetic flux during cooldown process. In order to investigate this phenomenon, we need to measure dynamically and accurately the

magnetic field near the superconducting surfaces. Sample characterization test-stand requires also precise magnetic field measurement on the sample and small compact sensors must be used. Small compact 3-axis sensors are good candidates for accurate measurement of residual magnetic field on the cavity wall. The work is focused on a 3-axis AMR sensor allowing field measurement on a TE011 cavity and recently developed at IJCLab. Several AMR sensors will be characterized in the temperature range 1.6K-4.2 K (gain, sensitivity, calibration, reproducibility, …) and compared to the sensitec AF755 sensor. The corresponding experimental data will be used for defining technical specifications of the dedicated electronic and mapping system for real time measurements.

CEA side

The facilities at CEA will allow us to perform low temperature baking and two step baking. We are also equipped with a vertical cryostat where it is possible to test SRF cavities immersed in superfluid helium, we can test cavity with a range of frequency from 170MHz up to 2GHz (we are evaluating an upgrade at higher frequencies). In parallel to this activity we are also improving cavity diagnostic capabilities, PIN diodes for x-ray detection, AMR for magnetic field measurements and second sound detector are routinely used in our installation and they will be further developed.

All the high temperature treatment are performed in collaboration with IJCLab with vacuum furnace available in their facility.

Collaboration between CEA, IJCLab and KEK

Between laboratories, we will compare our system and procedures, especially for furnace operation. It is important to compare details of difference each other and understand what critical parameters are. Cavity exchange between CEA, IJCLab and KEK is also an effective way to investigate optimized surface treatment procedures. We will also have plan to exchange Niobium samples to compare the results of surface analysis and try to find possible solution for higher performance.

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Summary of Project	
Workshop / satellite session at annual workshop (if applicable)	TTC (TESLA Technology Collaboration) meetings 30th International Linear Accelerator Conference 2020 (LINAC2020)
Common Articles Expected (if applicable)	
Seconded / Jointly Supervised Students (if applicable)	

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ID: A_RD_20	Title: Innovative superconducting surfaces applied to cavity scale

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[1]**	**Name**	**Title**	**Lab/Organis.[2]**
Leader	F. Eozénou		Irfu	Takayuki Kubo	Dr.	KEK
Members	T. Proslier	Dr.	Irfu	Hitoshi Hayano	Dr.	KEK
	C. Madec	Dr.	Irfu	Shigeki Kato	Dr.	KEK
	C. Antoine	Dr.	Irfu	Hideaki Monjushiro	Dr.	KEK
	S. Berry	Dr.	Irfu	Hayato Ito	Dr.	KEK
	E. Cenni	Dr.	Irfu	Takayuki Saeki	Dr.	KEK
	C. Servouin		Irfu			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[3]:
Travel to Japan	1000	2	2000	Irfu
Visit to Japan	150/day	12	1800	Irfu
Shipping of cavity and samples	1300	1	1300	Irfu
Total			5100	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Travel	250	2 travels	500	KEK
Visit to France	20/day	10 days	200	
Total			700	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[4]	**Type**	**€**	**Provided by/Requested to[5]**	**Type**	**k¥**
Total			Total		

[1] e.g. LAPP/IN2P3 or Irfu/CEA
[2] e.g. IPNS/KEK or …
[3] e.g. IN2P3, Irfu
[4] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[5] e.g. JSPS, RIKEN, Universities,….;

FJPPL (TYL) application 2020-2021

Fiscal year April 1st 2020 – March 31st 2021

Summary of Project

Context

The previous A_RD_9 program, entitled 'R&D on innovative treatments and characterization of SRF surface for future accelerators', made it possible to achieve tremendous results towards obtaining superconductive surfaces with improved performance for the next generation of particle accelerators. The goal is to obtain resonators with improved accelerating gradients and quality factor Q0, and make the process feasible in mass production context.
During A_RD_09 program, theoretical calculations and experiments on samples have made it possible:

- To improve the preparation of the cavities: Electro-polishing in vertical configuration (Vertical Electro-polishing: VEP) for ESS-type (704 MHz) and ILC type (1.3 GHz) elliptical cavities with unique rotating cathodes with wings (Ninja-cathodes).
- To prepare the base-surface of cavities by the VEP towards the advanced surface treatments, like thin-film depositions, Nitrogen-doping (N-doping) and Nitrogen-infusion (N-infusion).
- To anticipate significant improvement of Eacc and Q0 by achieving multilayered (S'-I-S, S'-S, etc.) type superconductors and/or additional advanced treatments (N-doping and/or N-infusion).
- To improve SRF cavity performances by developing surface engineering by ALD such as nano heterostructures.
- To develop set-ups to deposit these layers on samples and cavities
- To develop set-ups to measure the resulting performance (magnetometry at CEA Saclay & KEK, tunneling spectroscopy at CEA) on samples.
- To confirm the theoretical prediction with increased Hc1(effective) field for multilayered samples

Within this context, the potential of multilayered samples has been demonstrated on samples. The goal of this new program is to confirm these results and to extrapolate to the cavity scale.

Vertical Electro-Polishing (VEP) process

ESS cavity case

Symmetrical removal has been achieved on ESS (β=0.86) single-cell cavities. The achieved surface using Ninja rotating cathode configuration is very satisfactory. The extrapolation from ILC to ESS shape, with larger cell-dimensions is then successful. The RF performance is presently under investigation to confirm this promising results.
This effort will be pursued:

A: The performance of the ESS single-cell cavity will estimated after different post-EP configurations:

- Baking at 120°C

- Heat treatment at 650°C without N-doping
- Heat treatment at 650°C and introduction of N_2 gas (N-doping)

Especially, this R&D matches the expectations of MYRRHA Linac which will need improved performance Vs ESS, with 704MHz resonators.

B: The preliminary electropolishing parameters result in a low removal rate (<0.1µm/min). New sets of parameters will be used to trigger the kinetics (increased temperature, acid flow).
The resulting performance after test in vertical cryostat will be precisely investigated in each case and the improved parameter-set will be explored.

C: If the improved performance is confirmed after VEP, a dedicated cathode will be designed to be used on 5-Cell ESS prototype cavity.
The most promising surface preparation will be tested for this cavity.

ILC Cavity case.

Effort will be pursued to demonstrate the reproducibility, and the cost efficiency oriented towards the realization of the ILC.

- New cathodes will be designed to improve the removal profile along the surface
- Parameters will be optimized to increase the removal rate
- ILC 9-cell cavities will be prepared and tested at both KEK and CEA

Thin-film technologies and advanced surface-treatments (N-doping, N-infusion)

During the previous A_RD_9 program, multilayers with structure (S'-I-S, S'-S) were deposited by KEK and their performances were evaluated by magnetometry measurements. The superconducting layers are made of NbN and the insulating one of SiO_2, all deposited by DC magnetron sputtering technique. An optimum for 200-300nm NbN is foreseen with about 20% improvement for Hc1(effective) compared to conventional bulk-Niobium (bulk-Nb).
These results are in very good agreement with theoretical model established by Dr Takayuki KUBO.
Hayato ITO has defended his PhD thesis at KEK/Sokendai University, supervised by Dr Takayuki SAEKI.
At CEA Saclay, the ALD (Atomic Layer Deposition) set-up has been constructed, qualified and is under operation. Several superconducting and insulating layers have been deposited on Nb samples and high surface areas samples. ALD layers have been deposited on two 1.3 GHz single-cell cavities. The homogeneity of the film-thickness inside a 1.3 GHz single-cell cavity is being explored.
KEK has also fabricated several 3GHz Cu and Nb single-cell cavities for the purpose of thin-film depositions and advanced treatments. A 3GHz Cu single-cell cavity and a 3GHz Nb single-cell cavity were sent from KEK to CEA Saclay.
The main tasks foreseen within this new program are listed below:

- Improvement of magnetometers by achieving higher critical fields. The evaluation of superconducting materials will be more precise

	- Confirmation of the increased performance achieved with NbN-SiO_2-Nb and NbN-Nb structures. - Test of additional layers, and other superconducting materials, like Nb_3Sn, with which Hc1(effective) field and accelerating gradient are expected to be about doubled, compared to the conventional bulk-Nb cavity. - Evaluation of samples after deposition of ALD layers achieved with different precursors. - Performance tests of 1.3GHz single-cell cavities in the Vertical Cryostat after ALD depositions at CEA Saclay and/or DC magnetron sputtering depositions at KEK. - Performance tests of 3GHz single-cell cavities in the Vertical Cryostat after ALD depositions at CEA Saclay and/or DC magnetron sputtering depositions at KEK.. - Surface preparation of 704 MHz, 1.3 GHz and/or 3GHz single-cell cavities with N-doping and/or N-infusion recipes and performance tests. A campaign on 6GHz cavities (fabrication, deposition and tests) is also in preparatory phase. This will be accomplished depending on the funding of RF hardware necessary to carry out such measurements. At CEA Saclay, we have also used the tunneling spectroscopy set-up to measure Nb_3Sn films made at FNAL. The tunneling spectroscopy gives the information on the superconducting band-gap and various characteristics of the thin-film samples. The set-up works but its performance is hindered by ambient electromagnetic noise that prevent meaningful measurements for Nb samples. A faraday cage has been bought and will be delivered and set up in March-April 2020 to lower drastically the noise and enable Nb sample measurements.
Summary of Project	
Workshop / satellite session at annual workshop (if applicable)	

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Common Articles Expected (if applicable)	- Results on ESS 704MHz single-cell cavity will be presented at SRF2021. - Results on ILC 1.3GHz 9-cell cavity will be presented at SRF2021. - Results of thin-film studies will be presented at SRF2021.
Seconded / Jointly Supervised Students (if applicable)	C. Antoine has given many lectures at KEK during previous A_RD_9 and e-jade programs.

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ID[1]: A_RD_21	Title: **Advanced optimization algorithms and neural networks for accelerators control**

	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
Leader (please add email address)	V. Kubytskyi kubytsky@lal.in2p3.fr	Dr.	IJCLab/IN2P3	M. Satoh masanori.satoh@kek.jp	Assoc. Prof.	Accelerator Lab/KEK
	H. Guler	Dr.	IJCLab/IN2P3	I.Satake	Enginnier	Accelerator Lab/KEK
Members	I. Chaikovska	Dr.	IJCLab/IN2P3	F. Miyahara	Assist. Prof.	Accelerator Lab/KEK
				K. Furukawa	Prof.	Accelerator Lab/KEK

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan (2)	150/day	22 days	3300	IN2P3
Travels (2)	1000	2 travels	2000	IN2P3
Total			5300	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	20 days	400	KEK
Travel	150	2 travels	300	KEK
Total			700	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**

[1] ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;
[2] e.g. LAPP/IN2P3 or Irfu/CEA
[3] e.g. IPNS/KEK or …
[4] e.g. IN2P3, Irfu
[5] e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…
[6] e.g. JSPS, RIKEN, Universities,….;

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IN2P3 NPC project/ advanced control of accelerators					
Total			Total		

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Summary of Project	Recently, Machine Learning (ML) has been successfully applied to a variety of real-world tasks for the scientific/engineering problems, which gives the justified indications of the success of the ML-based approaches for particle accelerators. Mutually beneficial national and international collaborations between laboratories and universities being essential in this domain are in the stage of formation. Several dedicated international workshops took place since 2018, the one of which (Machine Learning for Charged Particle Accelerators) became the series of annual workshops within the ICFA. The goal of our project is to investigate and demonstrate the use of ML techniques for advanced control and performance optimization of the accelerators and, in particular, the KEK injector. We search for very precise control and stability of the beams, better understanding of multi-parameter non-linear system with comprehensive feature importance analysis. The profound long-standing experience in operation and understanding of the KEK Linac by KEK group is very valuable for this project. Given the experience of IJCLab group, cooperation with the Japanese colleagues on the work concerning the optimization of the injector commissioning and operation is essential, moreover, in the framework of the THOMX commissioning, which will start soon. There are tree major steps in this project. One is the collection, processing, alignment, understanding and labelling of the raw data (machine parameters, diagnostics, BPMs, temperatures, etc.) to form the dataset for further deep learning. The next step is the development of the ML models, training, test and validation of several architectures of deep neural networks (DNNs) and convolutional neural networks (CNNs). Understanding of the model robustness with respect to the noise of different origins is crucial. The final step will be the tests of the models on the live data from the accelerator and analysis of the improvements of the linac performance. The predicted parameters then could be inserted to the EPICS data channel for the monitoring purposes. In such a way, we will explore/validate ML concepts for possible generalization and application for particle accelerators. Therefore, working in a close collaboration with Japanese group, the established goals can be achieved in a more efficient way leading to the relevant scientific results. This project allows strengthening the collaboration between our groups on these items by personnel exchanges via travels to the French laboratory IJCLab and KEK, where the commissioning of the SuperKEKB accelerator complex is currently ongoing.
Workshop / satellite session at annual workshop (if applicable)	IPAC-2020, 3rd ICFA ML workshop.

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Common Articles Expected (if applicable)	Proceeding in IPAC-2020
Seconded / Jointly Supervised Students (if applicable)	

Computing

COMP_04 : Evolution of the computing environment for high-energy and astroparticle experiments

COMP_05 : Computing at Belle II

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ID[1]: COMP_04	Title: Evolution of the computing environment for high-energy and astroparticle experiments

	French Group			Japanese Group		
Leader (please add email address)	**Name**	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Renaud Vernet renaud.vernet@cc.in2p3.fr	Dr. (Leader)	CC-IN2P3/CNRS	Tomoaki Nakamura tomoaki.nakamura@kek.jp	Prof. (Leader)	ARL-CRC/KEK
Members	G. Rahal	Dr.	CC-IN2P3/CNRS	W. Takase	Eng.	ARL-CRC/KEK
	F. Hernandez	Eng.	CC-IN2P3/CNRS	S. Kaneko	Eng.	ARL-CRC/KEK
	F. Suter	Dr.	CC-IN2P3/CNRS	T. Sasaki	Prof.	ARL-CRC/KEK
	B. Rigaud	Eng.	CC-IN2P3/CNRS	S. Suzuki	Prof.	ARL-CRC/KEK
	V. Hamar	Eng.	CC-IN2P3/CNRS	K. Murakami	Dr.	ARL-CRC/KEK
				G. Iwai	Dr.	ARL-CRC/KEK

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan (2 person)	200/day	5 days x 2 p.	2000	IN2P3
Travel (2 person)	1400	2 travels	2800	IN2P3
Local organization expenses for joint workshop in Lyon	500	1	500	IN2P3
Total			5300	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France (3 person)	16/day	12 days	192	KEK
Travel (3 person)	250	3 travels	750	KEK
Total			892	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

1 ID: identification, if program continuation, use previous ID; if new project, ID will be set by the TYL directors;

2 e.g. LAPP/IN2P3 or Irfu/CEA

3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

6 e.g. JSPS, RIKEN, Universities,….;

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Summary of Project	The innovative evolution of the computing environment is one of the common subjects for future high-energy and astroparticle experiments. In the past decade of the LHC era, Grid computing technology has been functioning effectively for sharing data and distributed processing at the computing facilities located at laboratories worldwide. However, the computing requirements of future experiments, which is not only for the accelerator-based experiments like high luminosity LHC but also astroparticle experiments, are expected to be extremely higher, beyond the regular performance improvement of basic computer technology. Multiple approaches for introducing brand-new technologies are necessary for the evolution toward the exa-scale computing environment, for example, construction of more effective data sharing by using high bandwidth network and cloud technology so-called Data Lake, application of machine learning for the optimization of the existing computer system, establishment of integrated authentication and authorization infrastructure, under the collaborative work between Computing Center IN2P3 and KEK Computing Research Center. *Since this research project is going to the second year, the research subjects are not changed significantly. The following items are mainly focused on the update to be performed in this year based on the knowledge obtained in 2019.* **(a) Deployment of HTTP based data transfer system** The effective use of the high-bandwidth international network is one of the key points for massive data sharing even among distant data processing sites. However, it is determined that the support of conventional GridFTP software is terminated by the original developer. In this project, we aim to proceed with the long-range file transfer by the system utilizing wide bandwidth network of more than 10 Gbps and apply them to the real storage systems in production. *The difference in data transfer protocols, and advantages or disadvantages in the parallel streams are revealed by the last year's study of the memory to memory data transfer. This year, we will start the real file transfer by setting up the dedicated data transfer node with high-speed storage in the production network environment for the systematic evaluation. Furthermore, we will try to compare the result with the other data transfer methods like XrootD transfer and cache mechanism (Xcache).* **(b) Study of hybrid computing system of on-premise resource and commercial cloud services** The goal of this study is to extend the local compute capacity against the seasonal lack of resources in a computing center with integrating the services provided by commercial offerings as transparently as possible for the end users. *This subject contains rather long-standing items. A lot of system components are developed in parallel, and styles of public cloud are changing rapidly. We continuously exchange the information on software for virtualization and experience to integrate which is well utilized in Europe and Japan in the existing Grid environment, for example, Singularity middleware.* **(c) Application and development of machine learning for computer system** The applicability of a command-line tool, which is developed at KEK-CRC, to estimate the waiting time of user jobs was confirmed even at the environment of CC-IN2P3 last year. This is one of the successful applications to indicate the effectiveness of Deep Learning. *We investigate the performance improvements of the learning process for that application by deploying this application to the GPU clusters located in CC-IN2P3 this year. In addition to that study, we check the correctness of the obtained estimation by the future job accounting data stored in the batch job scheduler in conjunction with Alea job scheduling simulator which is already used at CC-IN2P3. Then, we try to apply SEQUENCE software module, which is an open-source module of the text pattern recognition, to the job accounting data and the status information of the computer system. A study to apply the SEQUENCE in the workflow of gathering system logs have already been started at CC-IN2P3.*

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Workshop / satellite session at annual workshop (if applicable)	* Workshop on computing at Lyon in December 2020
Common Articles Expected (if applicable)	* HEPiX Fall 2020, HEPiX Spring 2021 Spring workshop * International Conference on Computing in High Energy and Nuclear Physics 2021
Seconded / Jointly Supervised Students (if applicable)	

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ID[1]: COMP_05	Title: Computing at Belle II

Leader (please add email address) / Members	French Group			Japanese Group		
	Name	**Title**	**Lab./Organis.[2]**	**Name**	**Title**	**Lab/Organis.[3]**
	Karim Trabelsi	Dr	IJCLab	I Ueda	Associate Professor	KEK
	Shun Watanuki	Post-doc	IJCLab	Hideki Miyake	Assistant Professor	KEK
	Michel Jouvin	Dr	IJCLab	Takanori Hara	Professor	KEK
	Guillaume Philippon	Eng.	IJCLab	Yuji Kato	Assistant Professor	University of Nagoya
	Aresh Vedaee	Eng.	CCIN2P3			
	Yannick Patois	Eng.	IPHC			

Funding Request from France

Description	€/unit	Nb of units	Total (€)	Requested to[4]:
Visit to Japan	150/day	7 days	1050	IN2P3
Travel	1000	1 travel	1000	IN2P3
Total			2050	

Funding Request from KEK

Description	k¥/Unit	Nb of units	Total (k¥)	Requested to:
Visit to France	20/day	10 days	200	KEK
Travel	150	2 travels	300	KEK
Total			500	

Additional Funding from France			Additional Funding from Japan		
Provided by/Requested to[5]	**Type**	**€**	**Provided by/Requested to[6]**	**Type**	**k¥**
Total			Total		

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3 e.g. IPNS/KEK or …

4 e.g. IN2P3, Irfu

5 e.g. French Embassy, other CNRS or CEA programs, PICS, European grants…

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Summary of Project	The Belle II experiment, the next generation of the B-Factory, is expected to reveal new physics by accumulating, by 2029, about 2 orders of magnitude larger data sample than the Belle experiment, a similar quantity of data than LHC experiments acquired at similar rates. This requires considerable computing, storage and network resources to handle not only data created by the experiment but also considerable amounts of simulated data. The Belle II computing system has to handle an amount of beam data eventually corresponding to several tens of PetaByte per year under an operation of the SuperKEKB accelerator with a designed instantaneous luminosity. Under this situation, it cannot be expected that a single site, KEK, will be able to provide all computing resources for the whole Belle II collaboration including the resources not only for the raw data processing but also for the MC production and physics analysis done by users. In order to solve this problem, Belle II employed the distributed computing system based on DIRAC, which provides the interoperability of heterogeneous computing systems such as grids with different middleware, clouds and the local computing clusters. Since the last few years, MC mass production campaigns have been performed to confirm the feasibility and find out the possible bottleneck of our computing system. In parallel, the data transfer challenge through the transpacific and transatlantic networks has started. In terms of the computing, the first priority at KEK is the raw data acquisition and processing. Therefore, other data centers (at BNL, Germany, Italy, Canada and France) with reprocessing capabilities will be crucial component of the Belle II computing system. In addition, at the early stage of the experiment, that is until the detector performances are well understood, the software and the detector constants will be often updated and consequently the raw data will have to be re-processed frequently. A raw data center in France will store, from 2021, 15% of the total Belle II data sample and should be able to reprocess several times those data. The project aim is to study solutions for the Belle II computing in France, and to find a system capable of handling raw data and produce the simulated data requested (including cloud resources). The collaboration proposed in this application, with an experienced KEK team fully involved in the Belle II computing since last few years, will allow us to prepare efficiently for a raw data center in France (with regular meetings in France and at KEK).
Workshop / satellite session at annual workshop (if applicable)	Regular video meetings are held during the year. A one-day-workshop is planned during the year at KEK or CCIN2P3.
Common Articles Expected (if applicable)	
Seconded / Jointly Supervised Students (if applicable)	