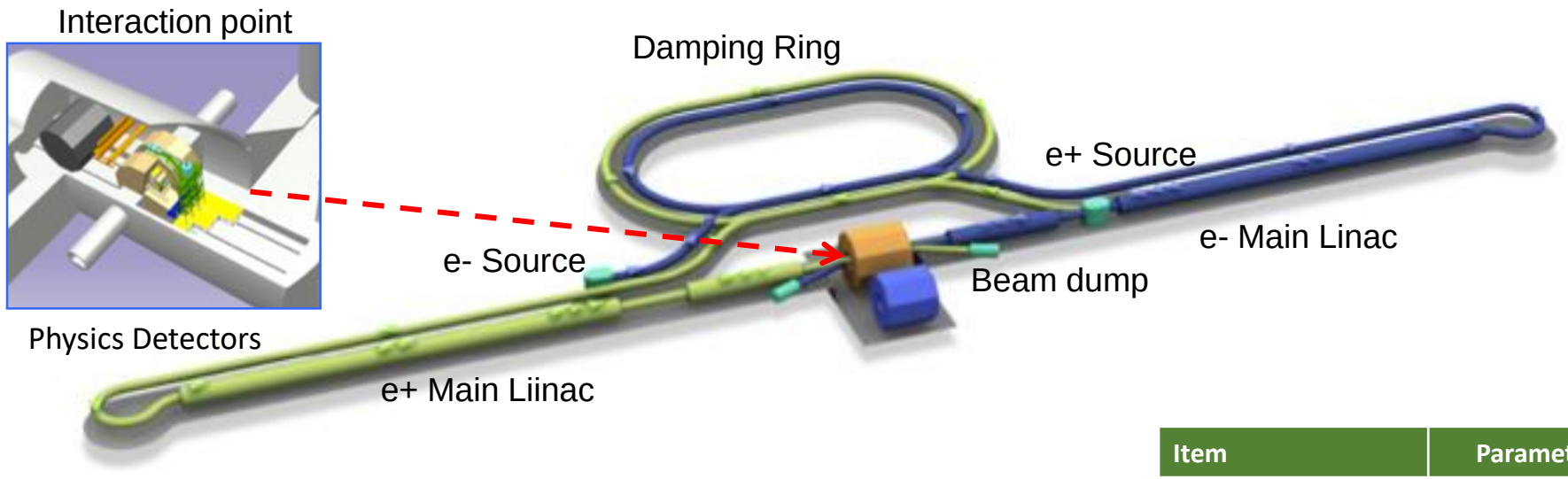
Status of ILC and CASA

Shin MICHIZONO

Center for Applied Superconducting Accelerator (CASA), KEK

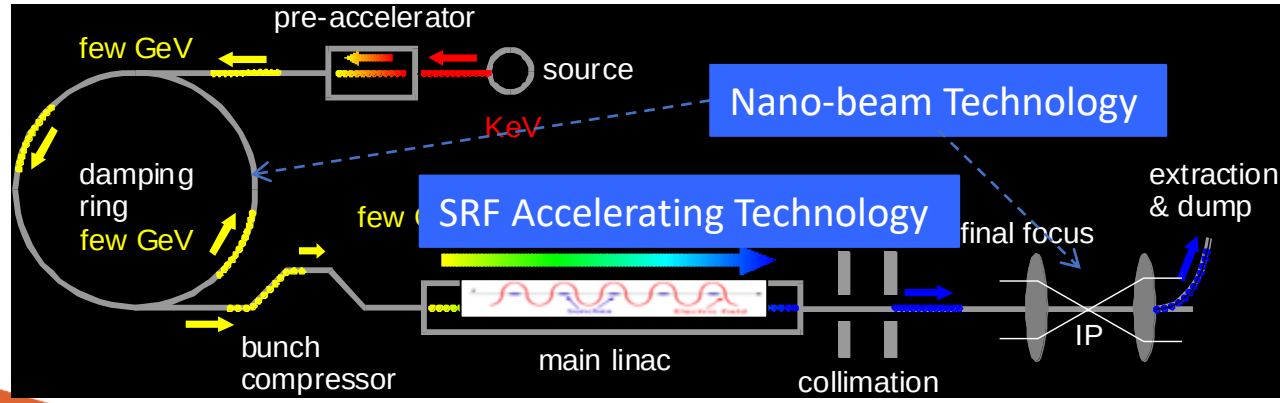
- *ILC*
  - *ILC250*
  - *Recommendations on ILC Project*
  - *Recent ILC status (from March 2019)*
- *CASA*
  - *Reorganization of accelerator laboratory*
  - *SRF application at cERL*

ILC250 Acc. Design Overview



©Rey,Hori/KEK

Key Technologies



Item	Parameters
C.M. Energy	250 GeV
Length	20km
Luminosity	1.35 x10^{34} $cm^{-2}s^{-1}$
Repetition	5 Hz
Beam Pulse Period	0.73 ms
Beam Current	5.8 mA (in pulse)
Beam size (y) at FF	**7.7** nm@250GeV
SRF Cavity G. Q_0	**31.5** MV/m (**35** MV/m) Q_0 = 1x10 ^{10}

Brief history of the ILC R&D

2004 2006 '07 '08 '09 '10 '11 '12 '13 '14 '15 '16 '17 '18 '19

SC Technology selected

ILC-GDE

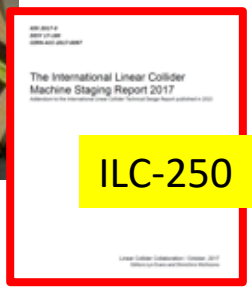
TDR

LCC

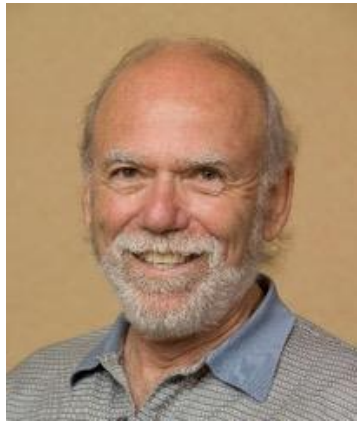
RDR)

Technical Design Phase

TDR：
49 countries
392 institutions
>2400 researchers



ILC-250



Barry Barish
GDE director
(the Nobel Prize winner for physics in 2017)

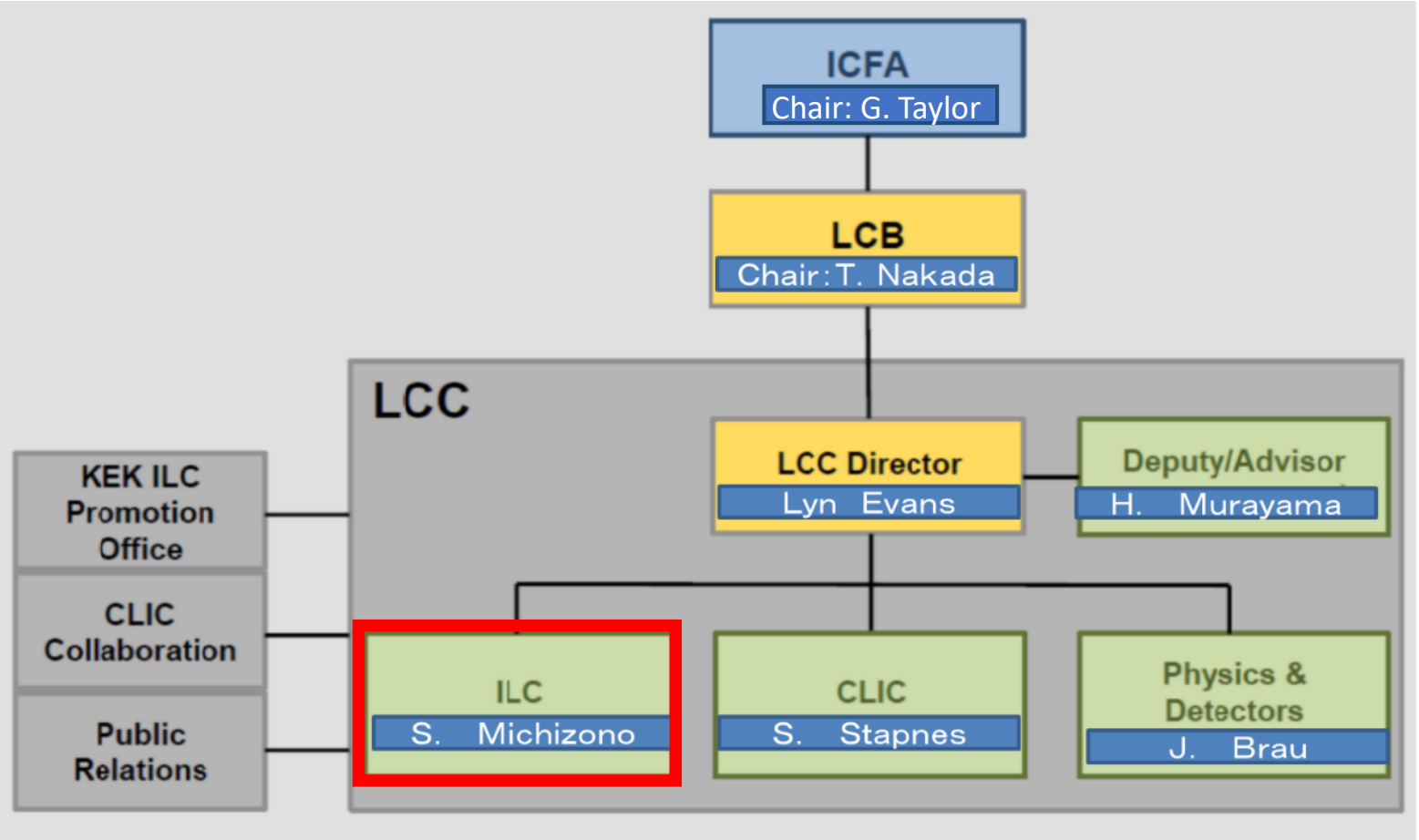
Lyn Evans
LCC director
(former LHC project manager)

LHC

European XFEL

LCLS-II

LCC international structure



ILC SCRF Global Integration Model

~8,000 x 1.1(Yield = 90%)
~ 9,000 cavities of mass-production

DESY, INFN
CERN
CEA-Saclay, LAL-Orsay
IHEP, PKU
KEK
IUAC,RRCAT
FNAL/ANL
TRIUMF
Cornell
JLAB
SLAC, LCLS-II

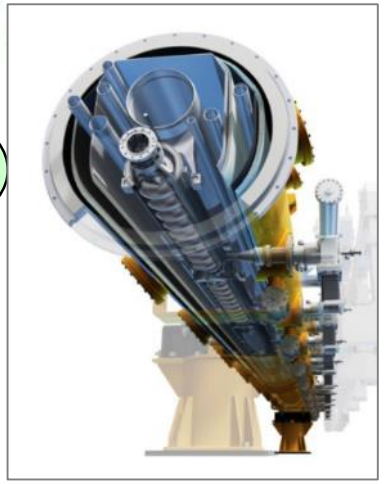
ILC Host/Hub-Lab

Hub-lab: regionally hosting integration & Test

Industry: manufacturing components

Industry worldwide

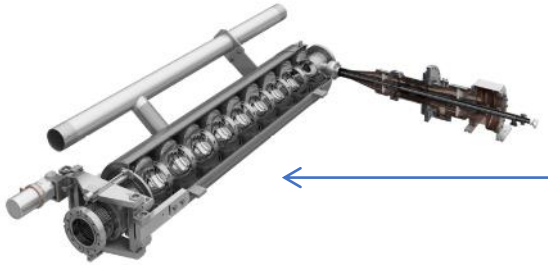
Hub-Lab
Hub-Lab
Hub-Lab
Hub-Lab
Hub-Lab



Cavity production with high quality (keeping the high performance)
Cryomodule transportation from hub-lab to the host (keeping the high performance)

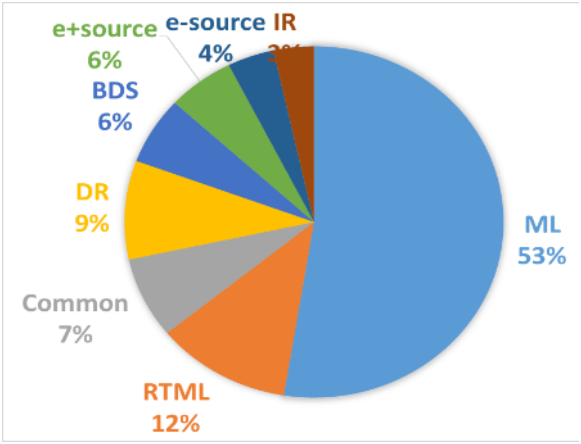
ILC cost reduction R&D

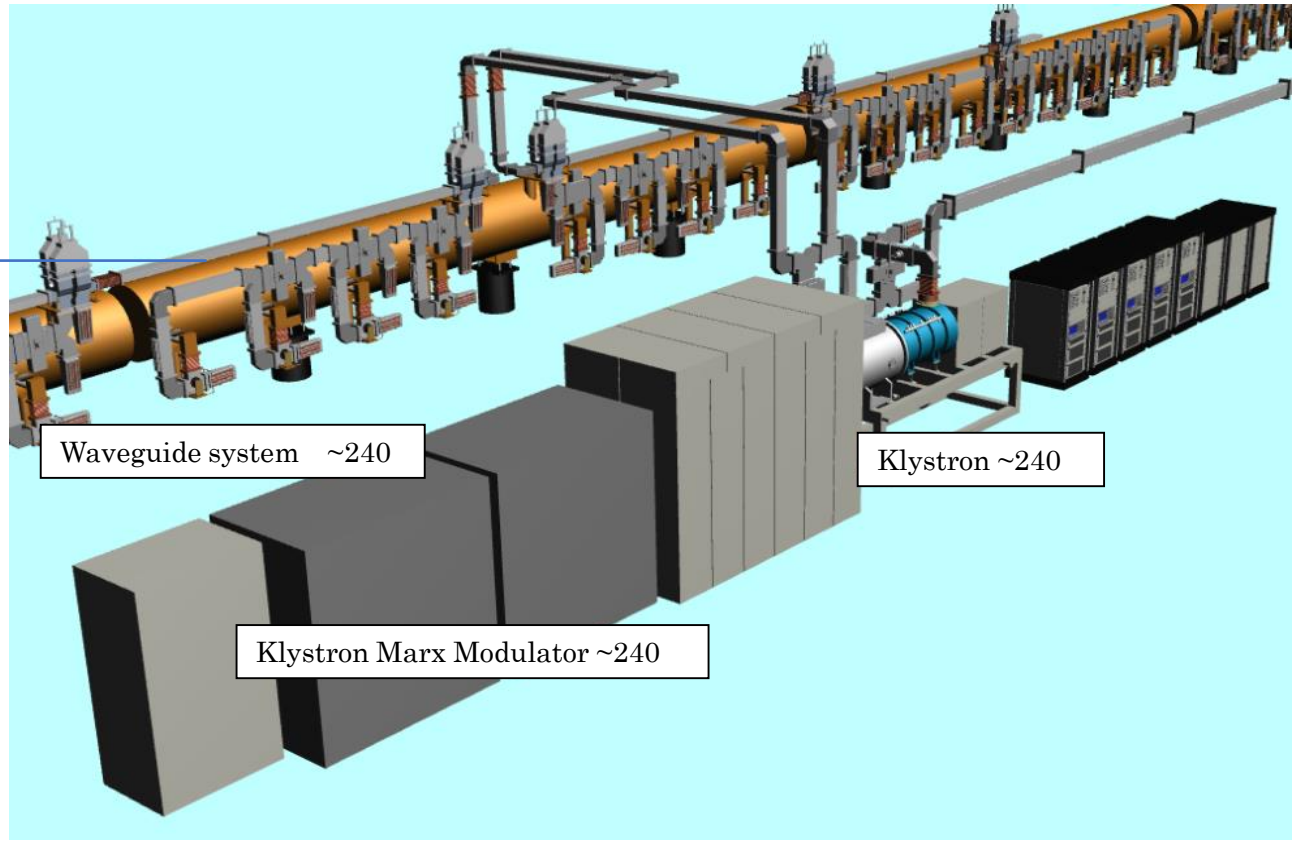
Input coupler ~8,000



Cavity ~9,000

(including ~10% margin)



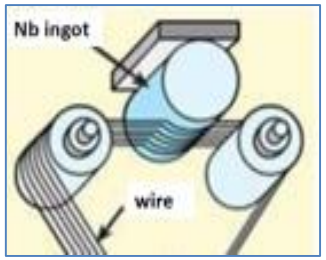


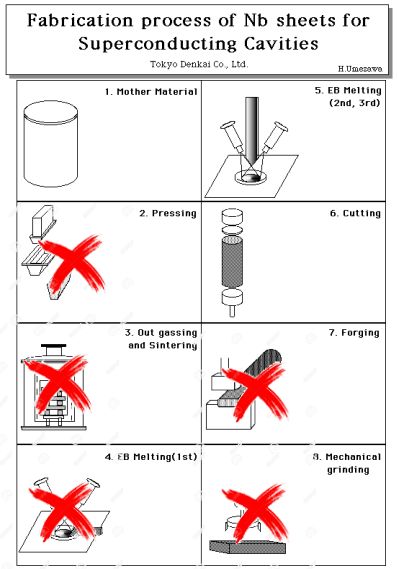
The half of the construction cost is coming from main linac (ML).
Thus we focused our cost reduction R&D into ML (superconducting RF technology)

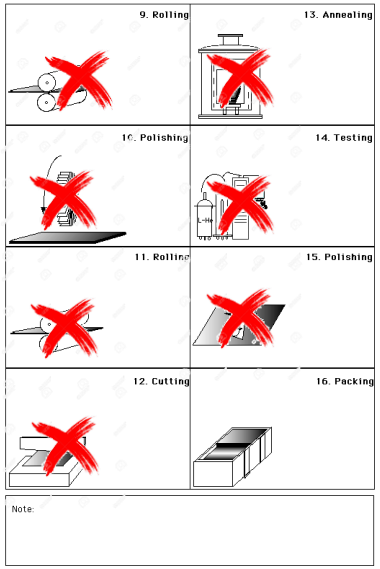
US-Japan ILC Cost-Reduction R&Ds

Based on recent advances in technologies;

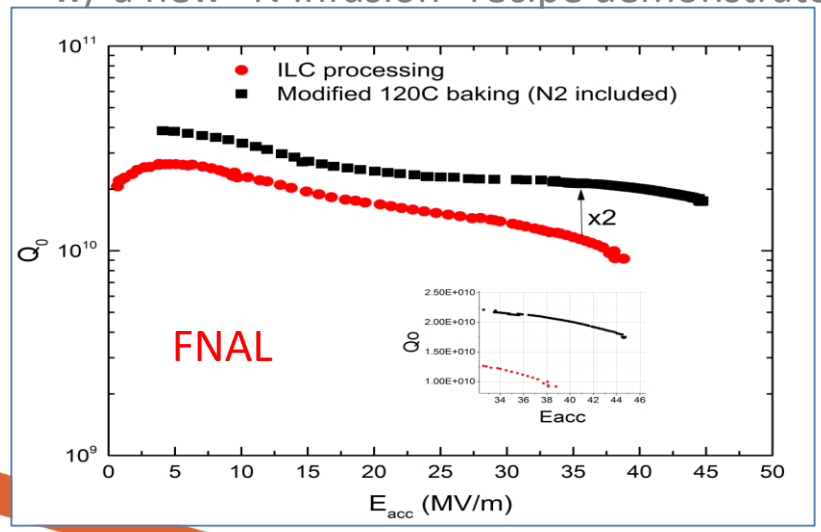
- Nb material/sheet preparation
  - w/ optimum Nb purity and clean surface

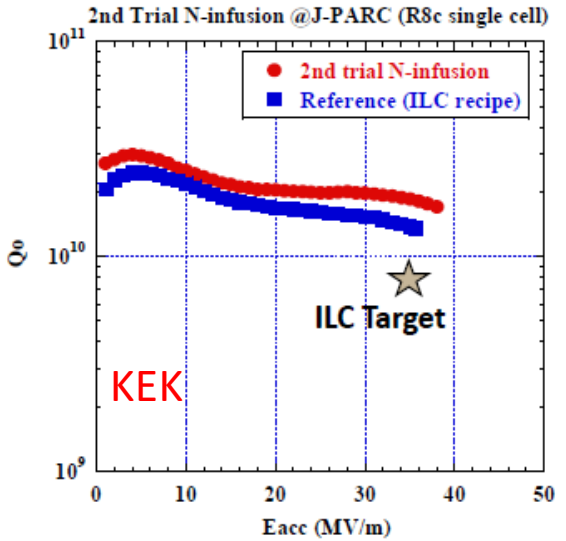






- SRF cavity fabrication for high-Q and high-G
  - w/ a new "N Infusion" recipe demonstrated by **Fermilab**





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Recommendations on ILC Project

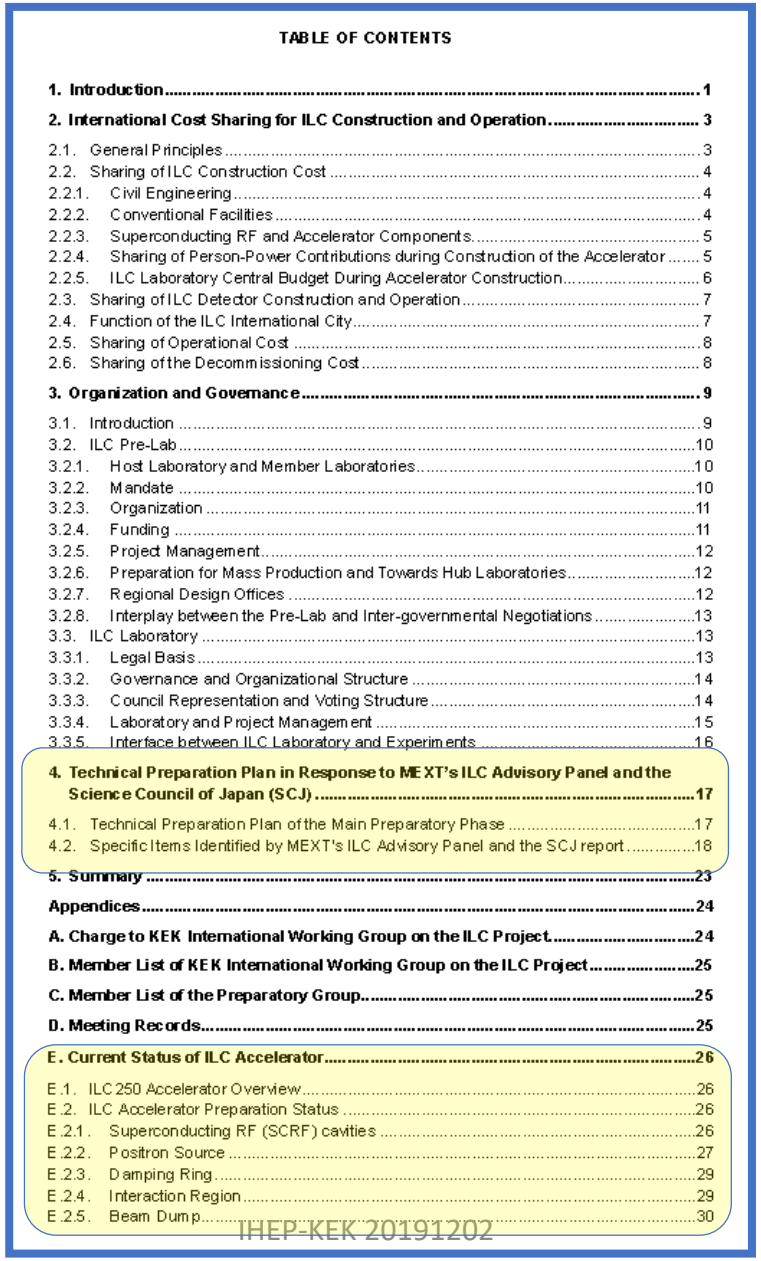
KEK published "Recommendations on ILC Project" based on the discussion at the international WG.

Recommendations on ILC Project Implementation

High Energy Accelerator Research Organization (KEK)

October 1, 2019

https://www.kek.jp/en/newsroom/2019/10/02/1000/
https://www2.kek.jp/ilc/en/docs/Recommendations_on_ILC_Project_Implementation.pdf



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Topics on report of Science Council of Japan

Table 4.2: Technical issues pointed out in the report by the Science Council of Japan.[22]

R&D Issues
[**SCRF**] The design reference value for the SCRF acceleration gradient of 35 MV/m is based on the technical level that is currently achievable. It will be necessary to achieve this reliably and with a good yield including automation techniques; further performance improvement is also desired.
[**SCRF**] It is foreseen that the bulk of the SCRF cavities will be provided through in-kind contribution from the participating countries. An important issue will be the quality assurance that maintains the compatibility among them.
[**Positron Source**] In the main preparatory phase, it is planned that the prototype of the rotating target will be made and the magnetic focusing system immediately after the positron source will be developed. The technology selection is to be made by the second year of the main preparatory phase. The strategy should be clarified, taking into account the R&D cost.
[**Interaction Region**] The technology for the control and feedback system related to the beam focusing and position control needs be established. The acceptable level of microtremor in the interaction region needs to be quantified.
[**Beam Dump**] The soundness monitoring of the window material, the concrete design for a remote-controlled replacement/exchange system, and the detail of the reaction between a high energy beam and water need to be adequately studied during the main preparatory phase.

SRF cavity and cryomodule production

SCRF cavity and cryomodule production: SCJ and MEXTs' ILC Advisory Panel had technical concerns about maintaining cavity quality during mass production and cryomodule assembly. The plan is to demonstrate prototype manufacturing using a new cost-effective production method on the scale of 1% of the full production, corresponding to about 100 cavities in the main preparatory phase. Half of the cavities will be produced in Japan and the other half in other regions/countries. The performance of the cavities will be evaluated to test their yields, and plug-compatibility will be checked. Other components, such as couplers and tuners, are also expected to improve in terms of performance; they will also be manufactured, and their yields will be evaluated. Overall testing after assembling these parts into a cryomodule will be the final step of evaluating the performance as an accelerator component. The US and Europe have significant experience in cavity production and in formulation of countermeasures against performance degradation after cryomodule assembly. It is anticipated that Germany and the US will work on cost reduction of the cavity fabrication process and on reproducibility and high yield of cavity performance at the design gradient, while France could play a leading role in automation of cryomodule assembly.

SRF cryomodule transport

SCRF cryomodule transport: SCJ and MEXTs' ILC Advisory Panel also had technical concerns about the effect of cryomodule transport on cavity performance. Europe and the US have significant experience with land transportation of cryomodules. This experience needs to be extended to marine transport, while assuring that performance is maintained. In order to demonstrate performance preservation after transport, multiple cryomodules meeting ILC specifications will be manufactured in the main preparatory phase, and after initial performance testing, they will be delivered to another region, where their performance will be tested again. This work will be performed by international cooperation among KEK and institutes in the US and Europe by transporting cryomodules between two or more regions. It will also provide an opportunity to establish an SCRF hub laboratory in Japan.

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ICFA/LCB@Tokyo

Mar.6 evening: Reception speech by Hon. Kawamura
Mar.7 morning: MEXT talk
Mar.7 evening: ICFA media briefing

ICFA media briefing in You Tube. (from 0:11:00 in the timeline)
https://www.youtube.com/watch?v=SbpS8TjdDkI&feature=youtu.be

Statement by MEXT at LCB Meeting in March 2019

- Following the opinion of the SCJ, **MEXT has not yet reached declaration for hosting the ILC in Japan at this moment.** The ILC project requires further discussion in formal academic decision-making processes such as the SCJ Master Plan, where it has to be clarified whether the ILC project can gain **understanding and support from the domestic academic community**.

- MEXT will pay close attention to the progress of the discussions at the European Strategy for Particle Physics Update.

- The ILC project has certain scientific significance in particle physics particularly in the precision measurements of the Higgs boson, and also has possibility in the technological advancement and in its effect on the local community, although the SCJ pointed out some concerns with the ILC project. Therefore, considering the above points, **MEXT will continue to discuss the ILC project with other governments having an interest in the ILC project.**

Message from the Federation of the Diet Members for ILC

- I believe the ILC should be realized through politically-led efforts, cutting across different ministries and agencies. As such, **we're proceeding to realize a budgeting as a national project with a separate budget outside of the regular science and technology budget.**

- **On the international cost sharing, we have to separate the infrastructure part of civil engineering and conventional equipment that is natural to be taken up by the host country and the apparatus part that is natural to be internationally cost-shared among technically competent countries.**

- As the environment has ripened socially, politically, and administratively, **the next mission for politics is to secure the budget for the construction.** In parallel, with the government's administrative process, we will begin in earnest from our role as political and legislative body to obtain the necessary budget for construction.

Lausanne report (from KEK news)

Linear Collider Community Meeting on April 2019 at Lausanne

Masanori Yamauchi, Director General of KEK, made a presentation regarding KEK's plan for the ILC, at the international conference held on 8-9 April 2019 in Lausanne, Switzerland.

About 100 scientists from around the world who aim for the realization of electron-positron linear colliders gathered at the Linear Collider Community Meeting, to discuss the future linear collider activities.

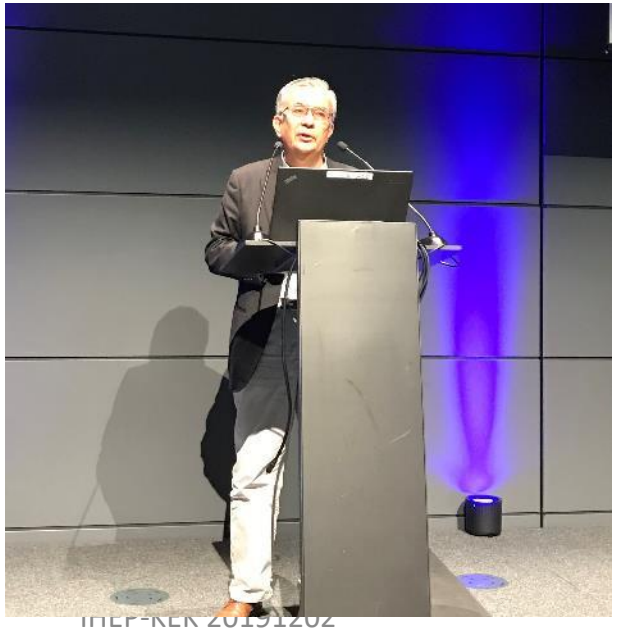
In the conference, Yamauchi presented KEK's plan for the ILC for the upcoming year, summarized as follows:

◇Organise the international working group with close consultation with the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

◇Promote activities to gain a better understanding of the broader academic community in Japan (Propose the ILC project to the Science Council of Japan's Master Plan; Organise a symposium)

◇Cooperate with MEXT to establish the governmental level discussion groups with France and Germany. Also, strengthen the discussion group with the US DOE.

◇Conduct R&D program at ATF, STF and CFF facilities collaborating with the international teams



https://www.kek.jp/en/newsroom/2019/04/12/1700/

KEK
High Energy Accelerator Research Organization

Discussions between MEXT and European governments

M. Yamauchi LCWS2019

- MEXT officials visited Berlin and Paris together with the members of the Japanese National Diet to discuss with BMBF and MESRI on July 1-2, 2019.

- Japanese delegation
  - Three members of the National Diet: Kawamura, Shionoya and Itoh
  - Two from MEXT: Masuko and Todoroki
  - Seven from Japanese physics community and Tohoku

- BMBF: ILC needs to be mentioned in the European Strategy, and remaining time is limited. Germany has several on-going large research projects.

- MESRI: European Strategy is important for MESRI as SCJ Masterplan is important for MEXT. Europe cannot put the ILC on its strategy, unless Japanese government gives positive conclusion.

- Both BMBF and MESRI agreed to start bilateral discussion groups with MEXT. BMBF suggested that trilateral meeting would be useful.

SCJ Master Plan

M. Yamauchi
LCWS2019

- SCJ selected ILC as one of “the large scale academic research program” (long list) after ~1/3 screening, and invited us to the interview in September.
- The “priority projects” (short list) will be selected after another ~1/3 selection by the interview.
- In the previous masterplan process in 2017, MEXT made its own selection starting from the SCJ long list, and made the MEXT Roadmap.

ILC International Working Group

M. Yamauchi LCWS2019

- KEK organizes the international working group for ILC with close consultation with MEXT.
  - Members:
    - Klaus Desch (Bonn)
    - Andy Lankford (UC Irvine)
    - Kajari Mazumdar (TIFR)
    - Patricia McBride (Fermilab)
    - Shin Michizono (KEK)
    - Yasuhiro Okada (KEK, Chair)
    - Claude Vallee (Marseille)
  - Mandate: Update ILC-PIP to describe:
    - ✓ Model of international cost-sharing for construction and operation of ILC
    - ✓ Organization and governance of the ILC Laboratory
    - ✓ International share of the remaining technical preparation
  - KEK received the report from the Working Group in September, and sent the KEK's recommendation to MEXT based on the report.

First meeting in Granada, Spain (May 17)

KEK
High Energy Accelerator Research Organization

Outline of the KEK's recommendations

M. Yamauchi
LCWS2019

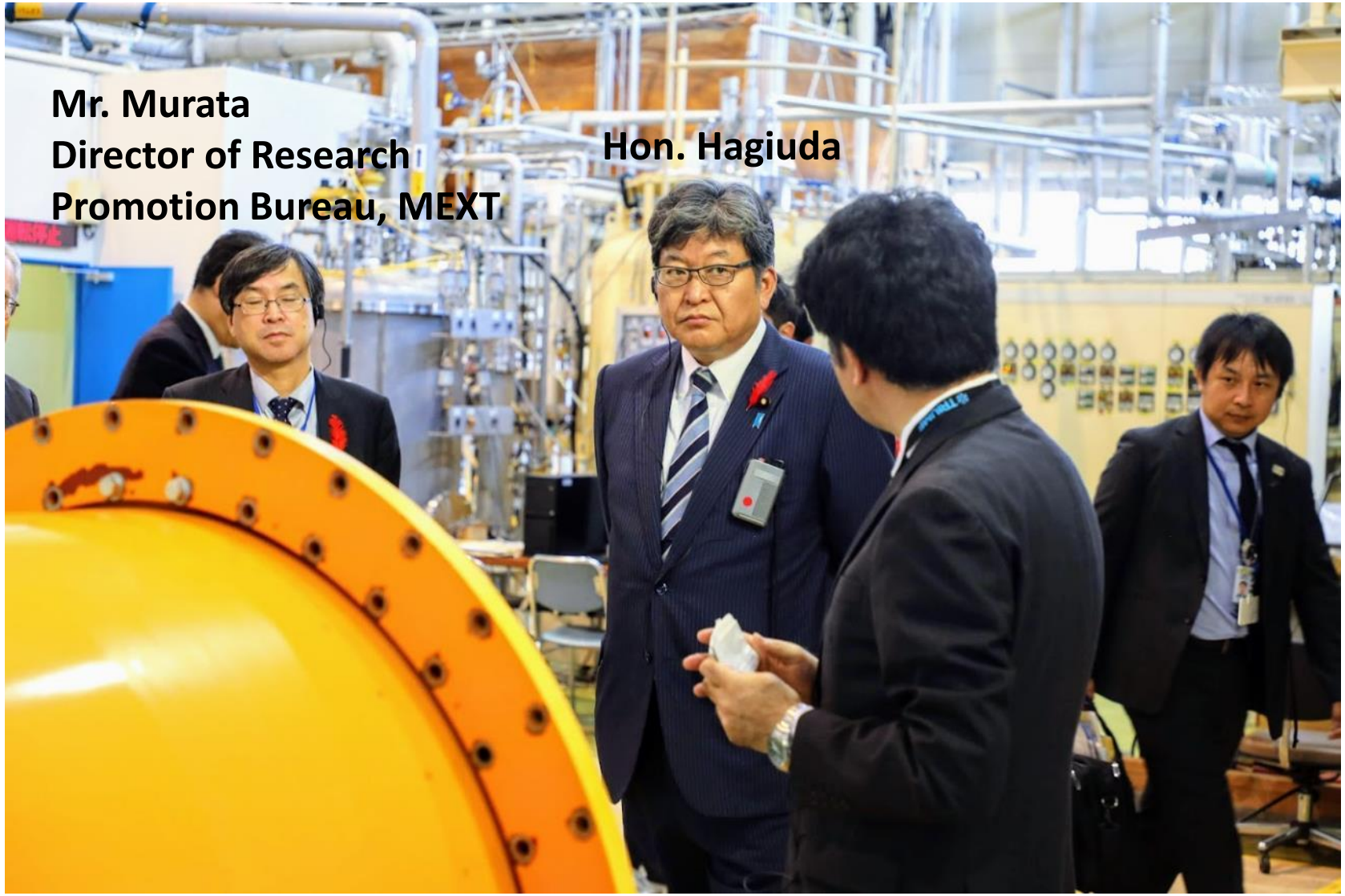
- International cost-sharing
  - Civil engineering and land acquisition are responsibility of the host state.
  - Accelerator components should be provided by all the member states as in-kind contributions
  - The operational cost should be shared among the member states.

- Organization and governance
  - An evolutionary model: ILC Pre-Lab to ILC Laboratory
  - Pre-Lab should be promptly established through laboratory-label MoU's. Its mandate is to coordinate the preparatory tasks and to assist the inter-governmental negotiations.
  - After an inter-governmental agreement, the Pre-Lab is expected to transition into a full ILC Laboratory.
  - Planning of the Pre-Lab should start as soon as possible.

- Intentional sharing of the remaining technical preparation
  - A technical preparation plan is presented with identification of potential international collaboration partners.

New MEXT Minister, Mr. Hagiuda visited STF

M. Yamauchi
LCWS2019



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High Energy Accelerator Research Organization

MEXT statement will be updated in Feb. 2020

M. Yamauchi
LCWS2019

- LCB had a plan to have the next meeting on December 20 in Tokyo, and requested MEXT to attend it to give an update of the statement.

- MEXT, after some considerations, decided not to attend the December LCB meeting, because:
  - Result of the SCJ master plan will not be available before December 20, and,
  - Three months is too short to do preparation and discussion with the other relevant Ministries in Japan.

- Instead, MEXT is willing to attend the LCB meeting in February 2020 at SLAC to update the ILC status in Japan after the SCJ master plan has become available.

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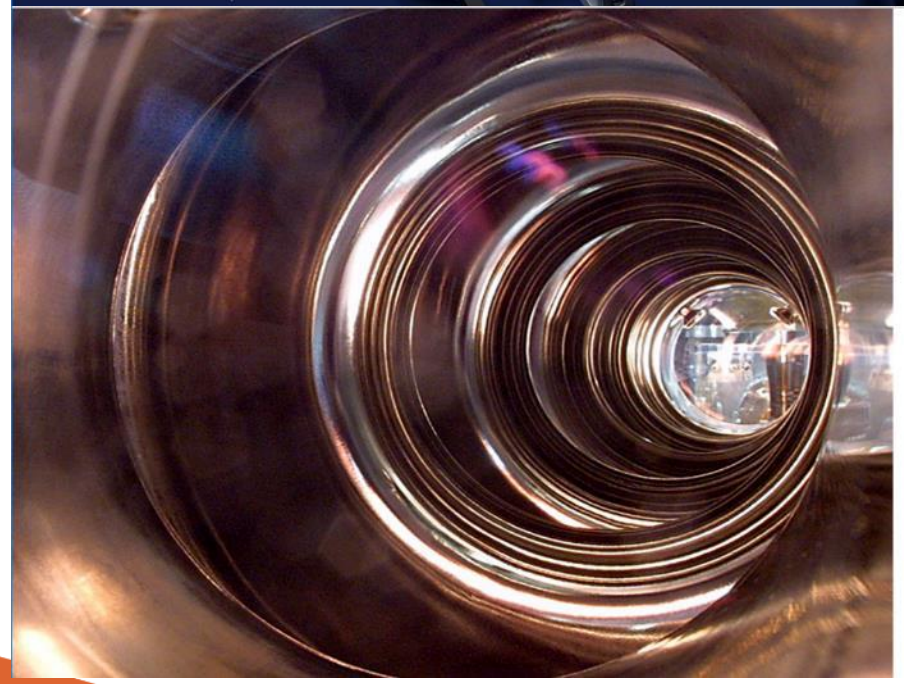
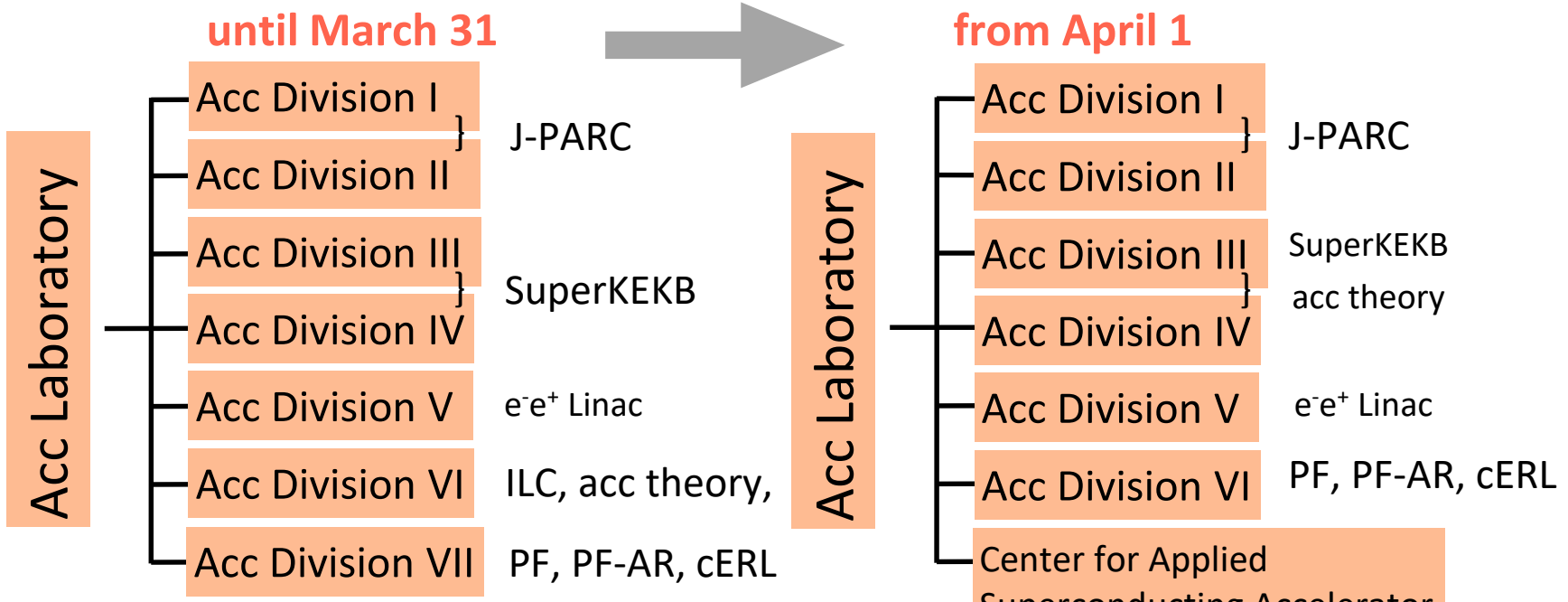


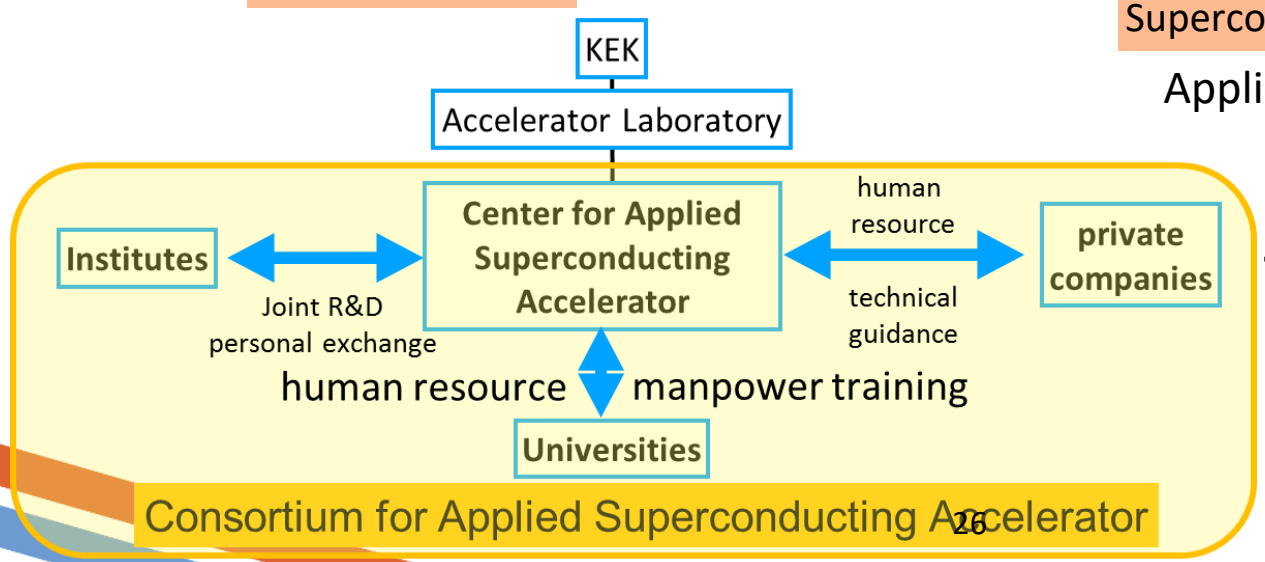
Center for Applied Superconducting Accelerator
応用超伝導加速器センター

CASA has established for SRF applications to medical/industry use.

Reorganization of Accelerator Laboratory

- Establish Center for Applied Superconducting Accelerator (CASA)





Mission of the Consortium

- Research study on needs and seeds of accelerator application
- Formulate R&D strategy
- Collect & Transmit information

Background

- Accelerator applications (medical, industry) are rapidly increasing worldwide.
- - - - industrial and medical application - - - (KEK Roadmap 2013)
- High power beams are required. Therefore, state-of-the-art superconducting accelerators are needed.
- KEK has extensive experience on superconducting accelerators.

TRISTAN Superconducting Cavity System

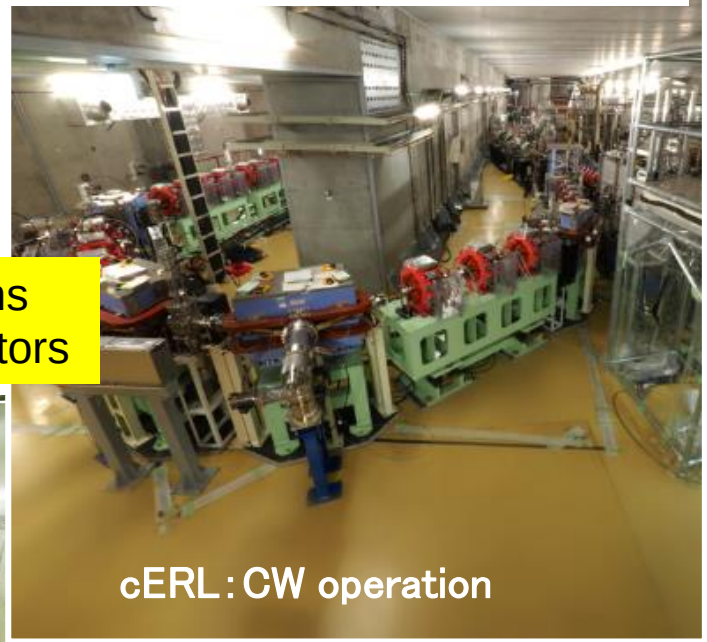
The first large-scale SRF system in the world.

Accelerator related facility in CASA

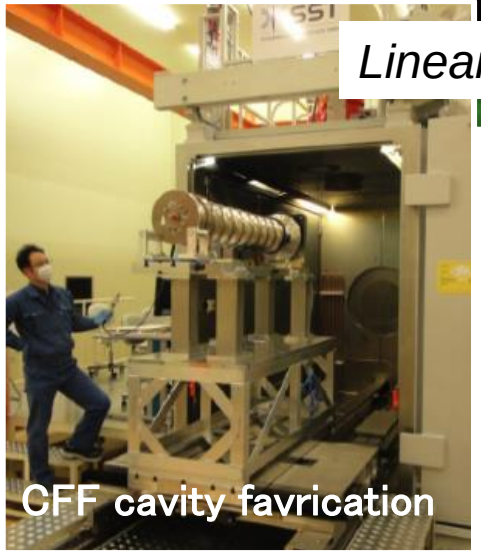
Center for Applied Superconducting Accelerator
応用超伝導加速器センター

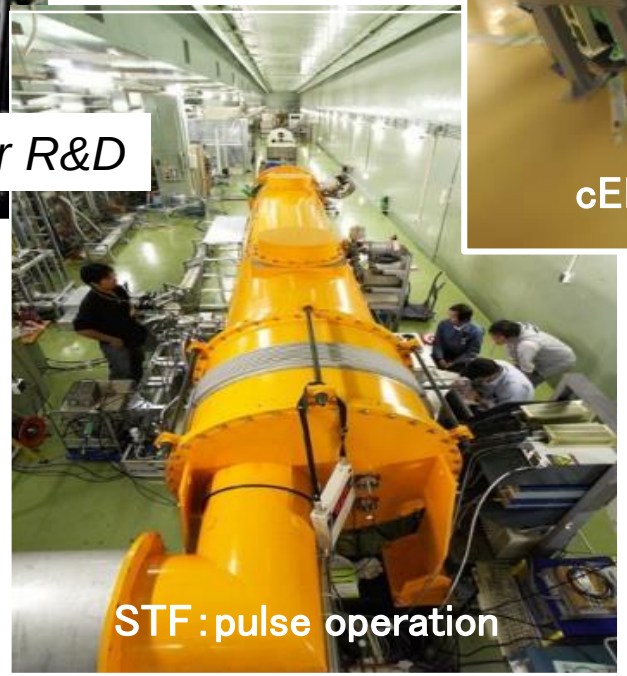
Superconducting accelerator promotion team

Aiming to develop applications on superconducting accelerators



Linear collider R&D





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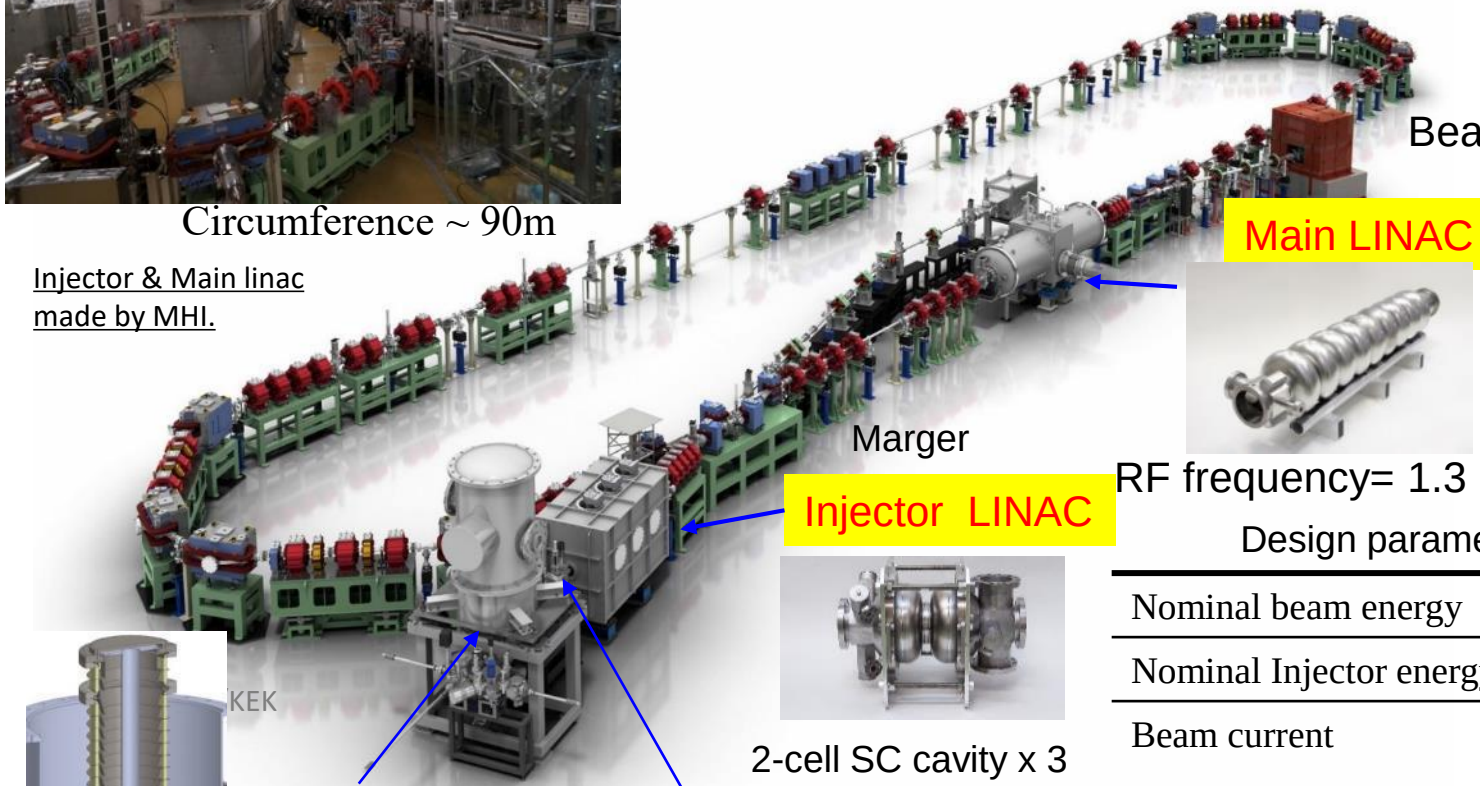
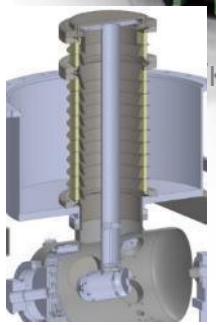
Compact ERL (cERL) in KEK

Compact ERL (**cERL**) has been constructed in 2013 at KEK to demonstrate energy recovery with low-emittance, high-current CW beams of more than 10 mA for future multi-GeV ERL with SRF cavities.

Circumference ~ 90m

Injector & Main linac made by MHI.





Design parameters of the cERL

Nominal beam energy	35 MeV → 20MeV
Nominal Injector energy	5 MeV →2.9MeV
Beam current	10 mA (initial goal) 100mA (final)
Normalized emittance	0.1 – 1 mm·mrad
Bunch length (bunch compressed)	1-3ps (usual) 100fs (short bunch)

RI manufacturing facility for nuclear medical examination (^{99}Mo/^{99m}Tc)

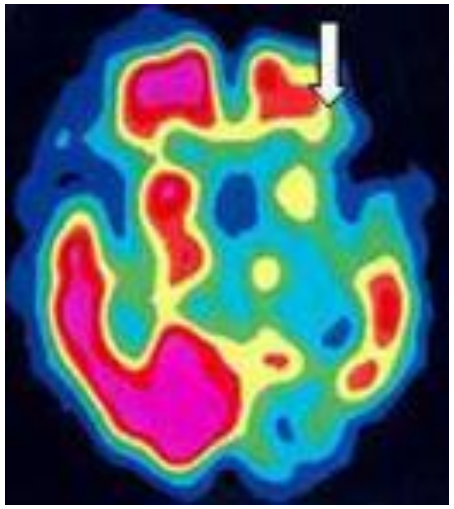
Concern about the stable supply of ^{99}Mo / ^{99m}Tc

- ^{99}Mo is almost 100% imported, even though the largest number of applications in nuclear medicine diagnosis
- Problem of the stable air transportation

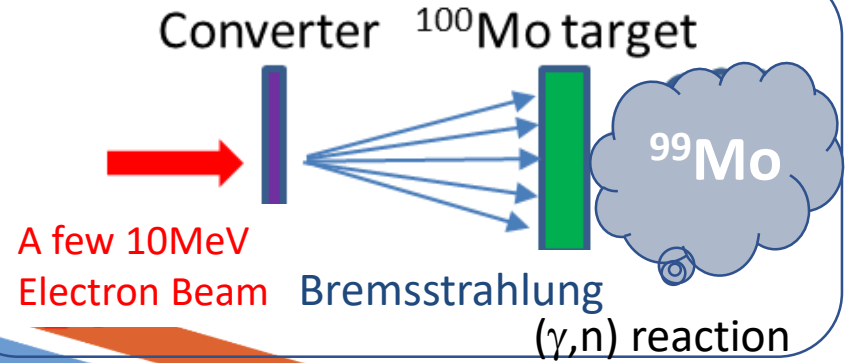
(Problem caused by volcanic eruption in the past)

- Most ^{99} Mo is manufactured in nuclear reactor
- Due to the aging of nuclear reactors, stable supply in the future is a big issue

→ Development of RI manufacturing (^{99} Mo / $^{99\,m}$Tc) by using accelerator for stable supply



A state of brain blood flow revealed by nuclear medicine diagnosis by 99 ^{m}Tc

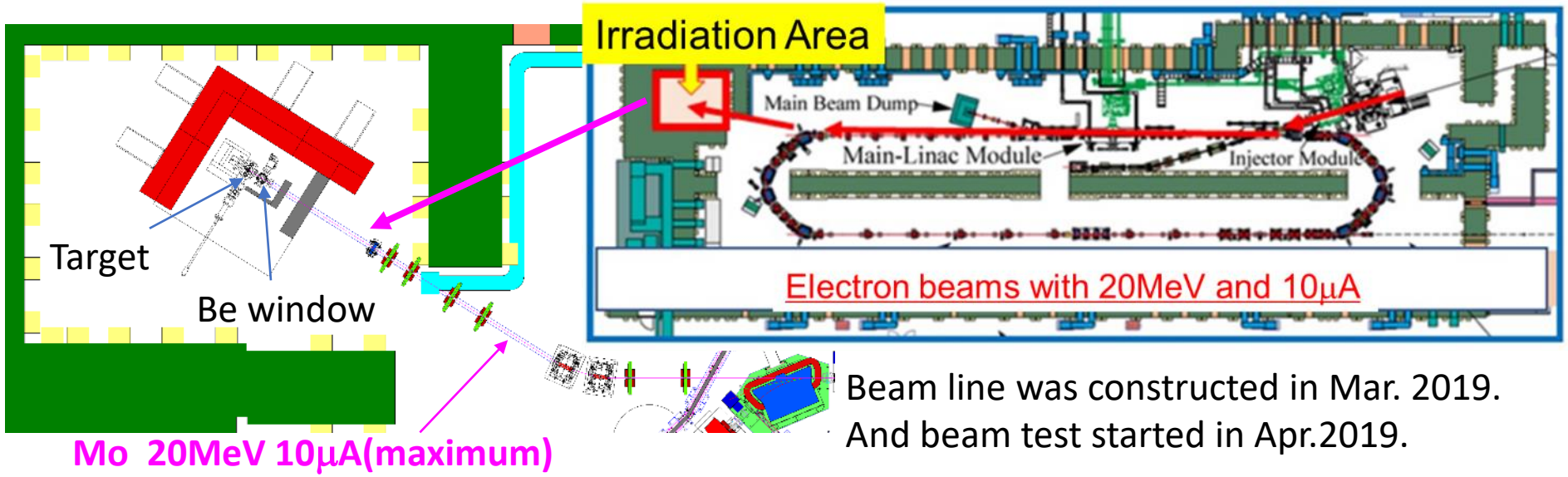


Required Specification for accelerator (final)

- 20 ~ 50 MeV electron beam
- Several mA to 10 mA

Test Experiment to produce ^{99}Mo in cERL

- The test irradiation of electron beams to a multiple molybdenum target has done to produce ^{99}Mo and check the yield of the production in order to realize a real machine with large electron beam power. → start 10uA with 20 MeV (max) electron CW beam
- It is necessary to get several knowledge to design a target system for large irradiation power such as a practical technique for ^{99}Mo production, target thermal design, shielding radiation design and legal procedures, etc. It is the final objective of this project.

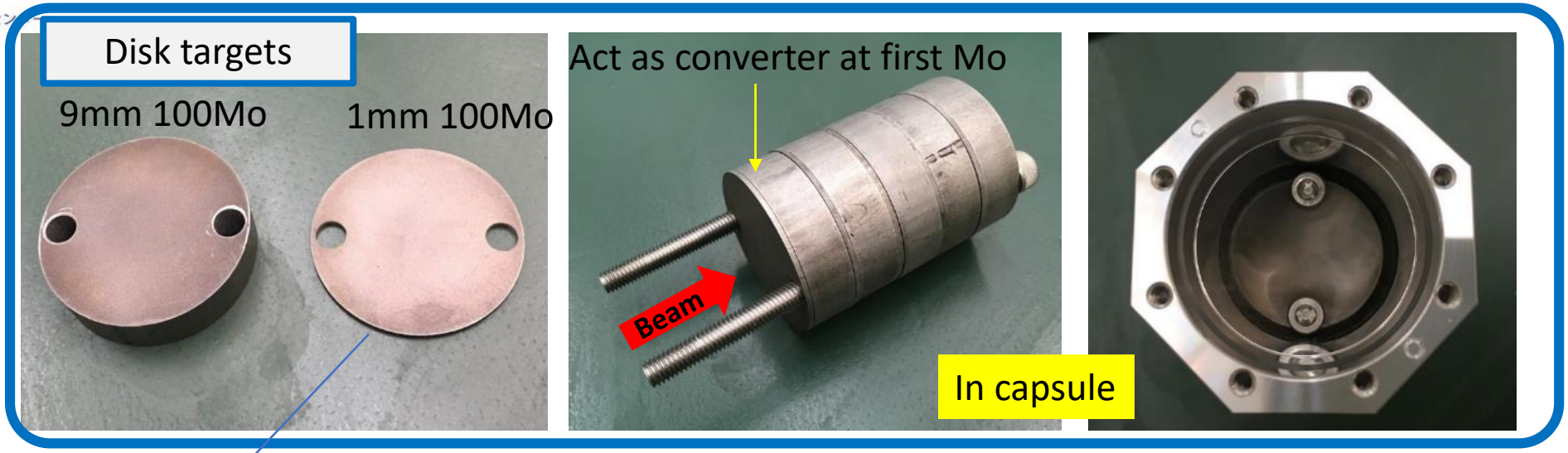


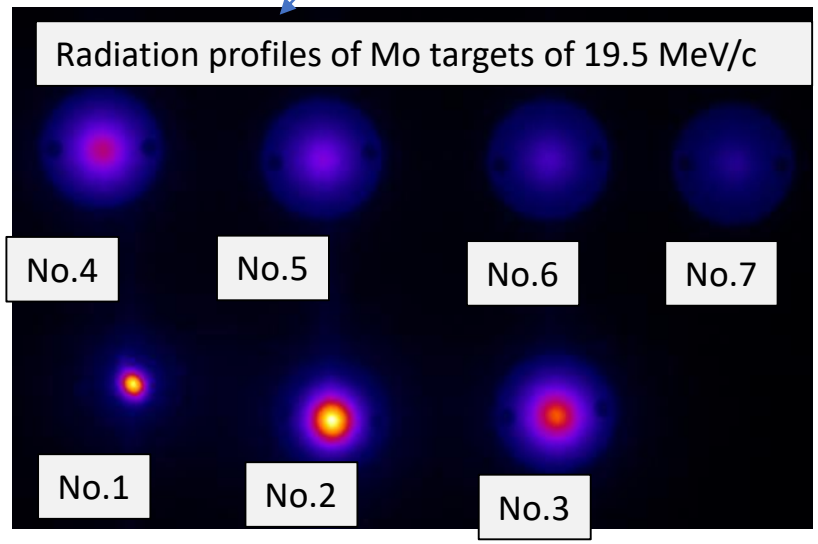
Beam line was constructed in Mar. 2019.
And beam test started in Apr.2019.

We are engaged in R & D on utilization of accelerator beams for radioisotope generation and reforming of organic matter under research contract with "Accelerator Inc." https://www.accelerator-inc.com/

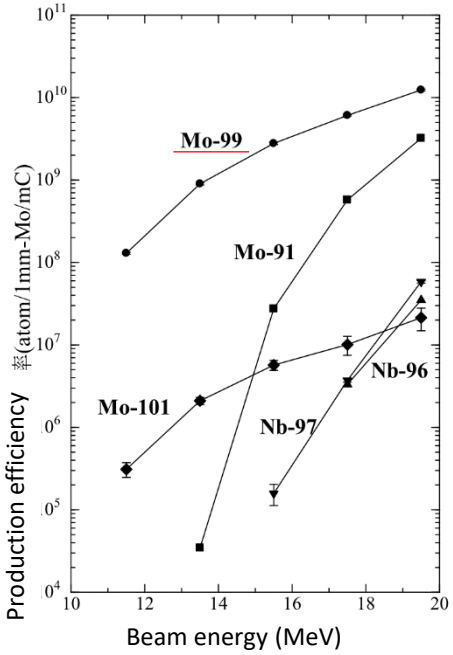
Latest results of RI production by using new beam line

Courtesy of Y.Morikawa, N.Higashi, K.Harada, M. Yamamoto, H.Matsumura and A. Toyoda





Obtain clear beam profile in Jun.2019 in each Mo target @19.5 MeV/c



- Energy dependence of ^{99}Mo production ratio was obtained in Jun. and Oct. 2019.
- These data almost agree with simulation and satisfied our requirements

Press release (2019.Oct.18) : https://www.kek.jp/ja/newsroom/2019/10/18/1400/

Summary

- *KEK published "Summary of Recommendations on ILC Project" based on the discussion at the international WG.*
- *The technical preparation plan in response to reports by ILC Advisory Panel organized by MEXT and the Science Council of Japan is presented.*
- *The plan identifies technical tasks to be carried out through international collaboration.*
- *CASA established in this April aiming for the application of the SRF accelerators to the industry and medical area.*
- *SRF acceleration has long history in KEK and the performance is better and better.*
- *Wide variety of SRF application is expected for industry/medical area.*
- *cERL is trying the application of 99Mo for medical usage.*

Center for Applied Superconducting Accelerator
応用超伝導加速器センター

Thank you for your attention