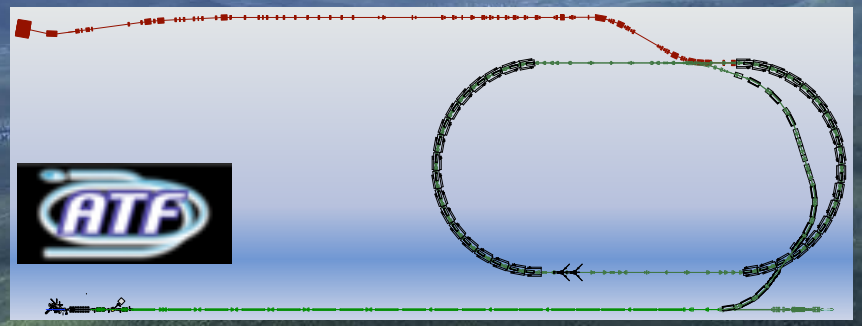

ATF2 studies and preparation for ILC

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G. Balik, K. Kubo, T. Tauchi,
T. Naito, N. Terunuma,
S. Kuroda, T. Okugi, S. Araki,
Y. Morikawa

Outline

- The framework

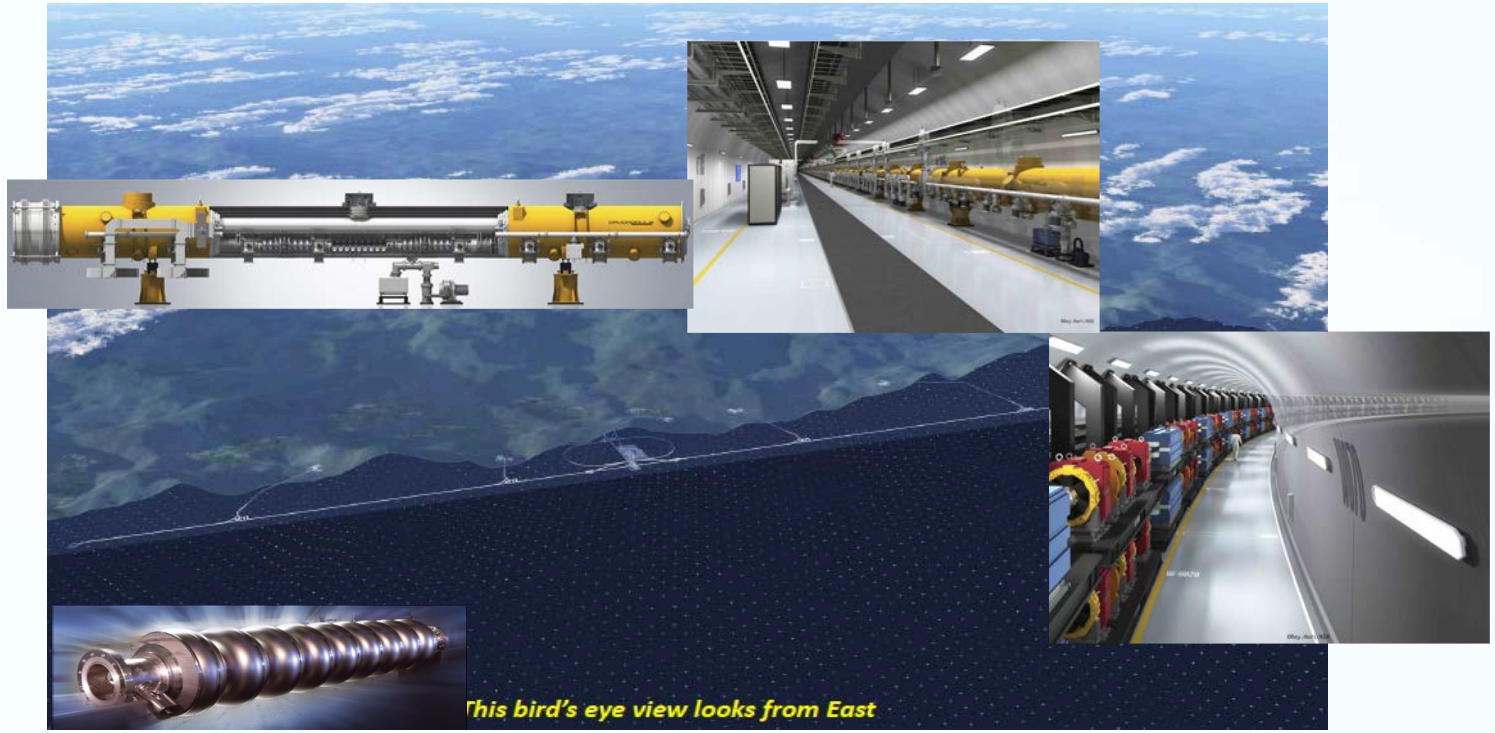
  ILC and ATF2

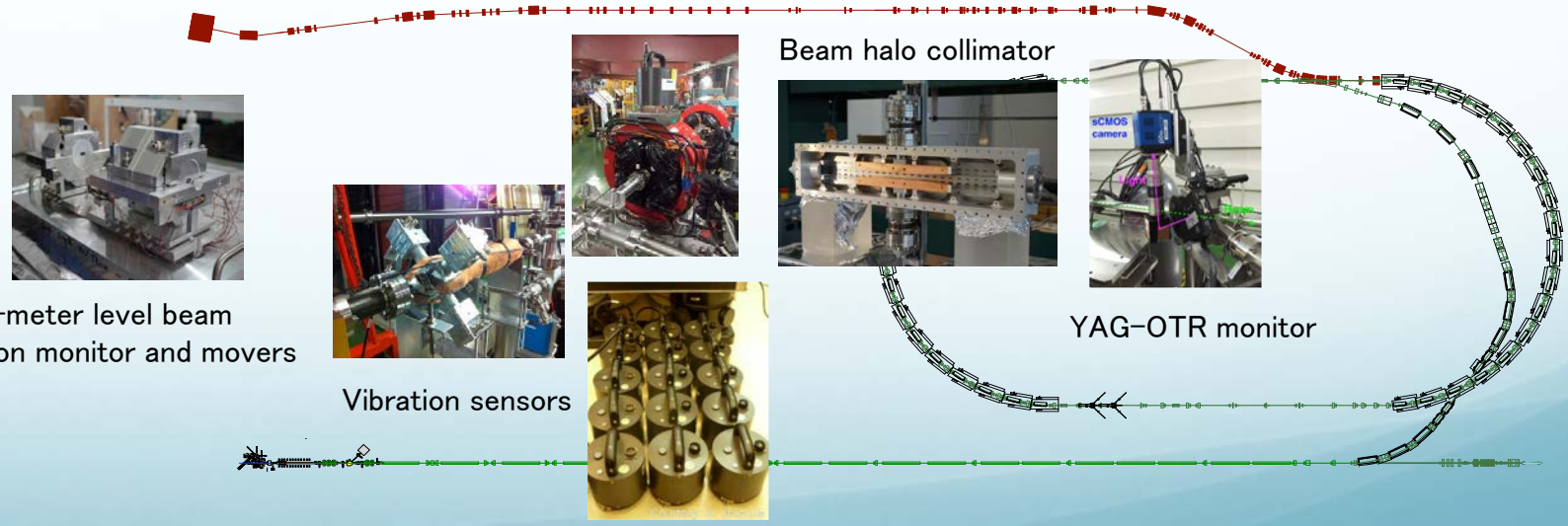
- A_RD_10

  2019 - 2020

- A_RD_10

  2020 - 2021





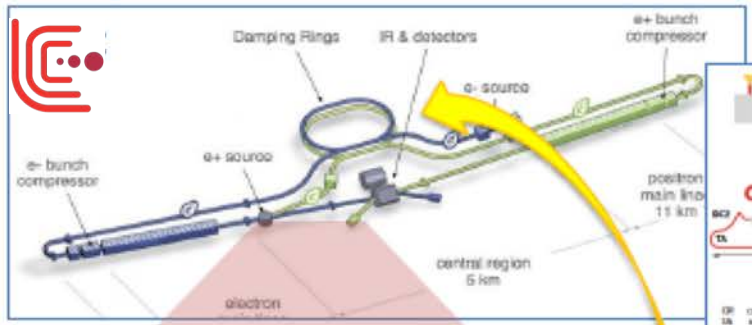
ILC Final Focus: Nanobeam Technology

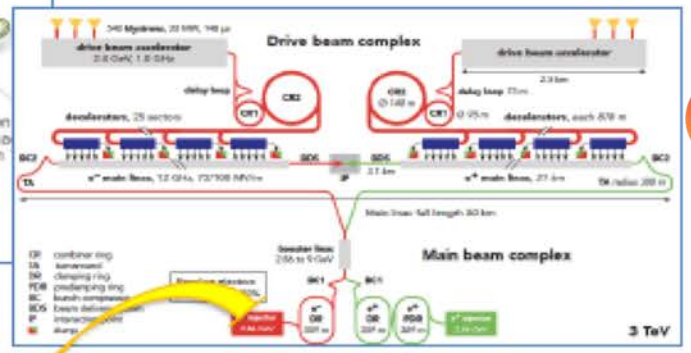
ATF/ATF2: Accelerator Test Facility

Courtesy: N. Terunuma

Develop nano-beam technology for ILC/CLIC

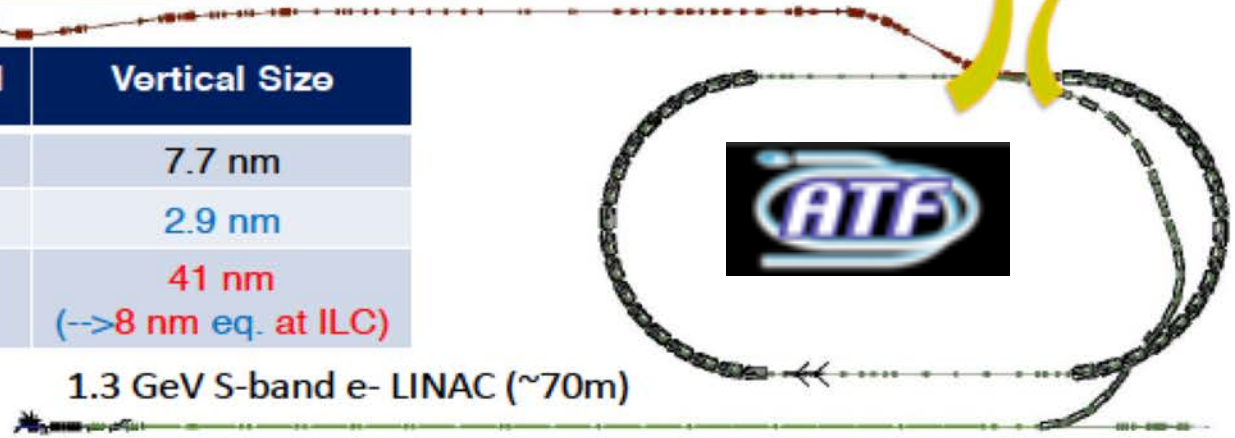
- Goal: Realize small beam-size and theStabilize beam position



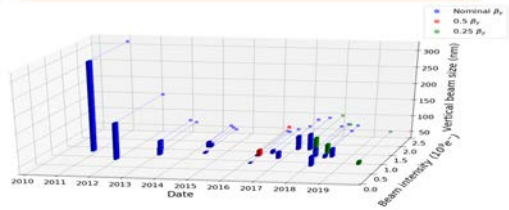


FF: Nano beam-size

	B Energy [GeV]	Vertical Size
ILC-250	125	7.7 nm
CLIC-380	190	2.9 nm
ATF2 (achieved)	1.3	41 nm (-->8 nm eq. at ILC)



Damping Ring (140m)
Low emittance e- beam



Intensity dependence-wakefiels

A. Yamamoto, 190513bb

8

A_RD_10: 2019 - 2020

- **KEK**
  - Contributed as host of the ATF2 project
  - Collaborating for studies of creation of extremely narrow beam with ultra-low beta optics, as well as with the originally designed optics.
  - Studies of intensity dependent effects, mainly wakefield effects. During these studies, stabilities of the beam and beam monitors have been intensively investigated for precise measurements as well as temperature controls of cooling water and air system improvement
  - Collaborated in the ILC design work, optimization of IP/BDS/DR parameters with a 250 center-of-mass energy.

- **LAPP**
  - Ground motion mitigation have been focused on the feedforward approach dedicated to the beam trajectory control. In particular the feedforward control with the motion of the two main relevant magnets: the QD2X quadrupole, which reveals the most significant disturbances, and the QD5X quadrupole, which is the strongest magnet in this line.

- **LAL**
  - Understanding of the intensity dependence effects
  - Continue the Final Focus ultra-low beta studies for the two PhDs CERN-LAL started in 2018:
    - “Optimization of CLIC Final Focus System at 380 GeV and the implementation studies for Ultra-low βy at ATF2” (A. Pastushenko)
    - “Optics design of a dual beam delivery system for lepton colliders and experimental measurements of the ATF2 ultra-low βy nanometer beam size” (V. Cilento)

A_RD_10: Publications and Meetings 2019-2020

- Publications:

  [1] D. R. Bett, et.al., Real-Time Beam Orbit Stabilisation to 200 Nanometres in Single-Pass Mode Using a High-Precision Dual-Phase Feedback System, IPAC2019-THPRB096.

  [2] R. L. Ramjiawan, et.al., Nanosecond-Latency Sub-Micron Resolution Stripline Beam Position Monitor Signal Processor for CLIC, IPAC2019-WEPGW092.

  [3] P. Korysko, et.al., Intensity Dependent Effects at ATF2, KEK, IPAC2019-MOPGW086.

  [4] T. Okugi, et.al., Intensity dependence of ATF2 virtual IP beam size, Proceedings of the 16th Annual Meeting of Particle Accelerator Society of Japan, 2019 (PASJ2019) p1078 FRPI023.

  [5] V. Cilento, A. Pastushenko, R. Yang, R. Tomas, A. Faus-Golfe, N. Terunuma, T. Okugi, ATF2 Ultra-low beta_y study report for March 2019 run, CERN-ACC-NOTE-2020-0006,17 , January 2020.

  [6] P. Korysko, A. Latina, A. Faus-Golfe, P. N. Burrows, K. Kubo, T. Okugi, N. Terunuma, A. Aryshev, A. Lyapin, Studies of wakefield effects on beam propagation at the KEK Accelerator Test Facility (ATF2) and implications for the International Linear Collider, to be submitted to NIMA.

- A session dedicated to the ATF collaboration was organized during the CLIC workshop in Geneva from 9-13 March 2020 (https://indico.cern.ch/event/850899/overview), but cancelled due to COVID-19.

A_RD_10: 2020 - 2021

- **KEK**
  - Host and organize the project, ATF2.
  - Preparation of high-quality beam for nano-beam studies: Spring 2020 run dedicated to: stabilize FFS orbit drift, check performance of Cavity BPM in EXT/FF beam line, startup of strip-line BPM at QF1R and check IPBSM performances.
  - Continue the wakefield - intensity dependence studies and mitigation techniques
  - High-order aberrations studies

- **LAPP**
  - Ground motion mitigation will be focused on the feedforward approach dedicated to the beam trajectory control.
  - Investigating the set-up of a future global multi-control approach.

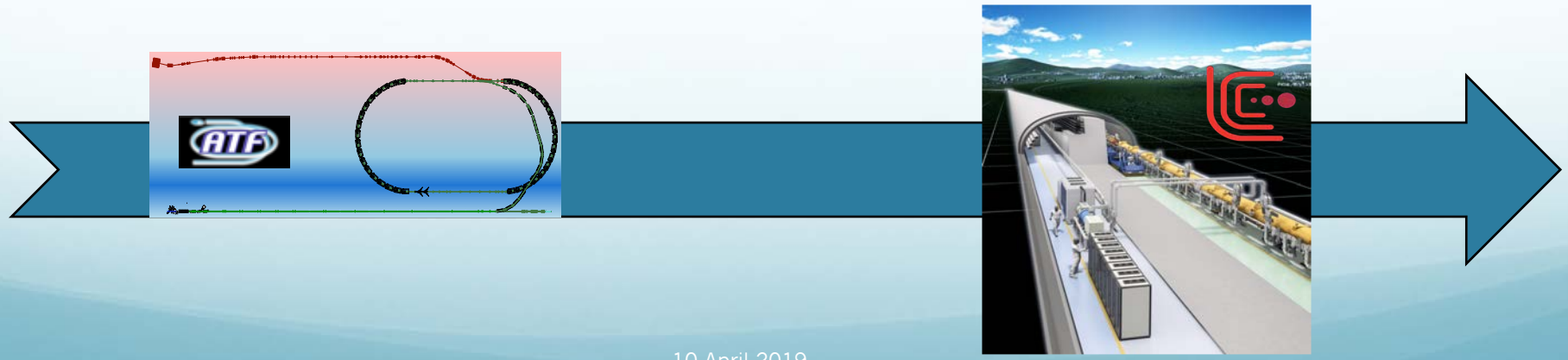
  In collaboration with CERN and Oxford

- **IJClab**
  - Continue the Final Focus ultra-low beta studies for the two PhDs CERN-LAL:
    - “Optimization of CLIC Final Focus System at 380 GeV and the implementation studies for Ultra-low βy at ATF2” (A. Pastushenko)
    - “Optics design of a dual beam delivery system for lepton colliders and experimental measurements of the ATF2 ultra-low βy nanometer beam size” (V. Cilento)
  - Continue the wakefield - intensity dependence studies and mitigation techniques

A_RD_10: Perspectives

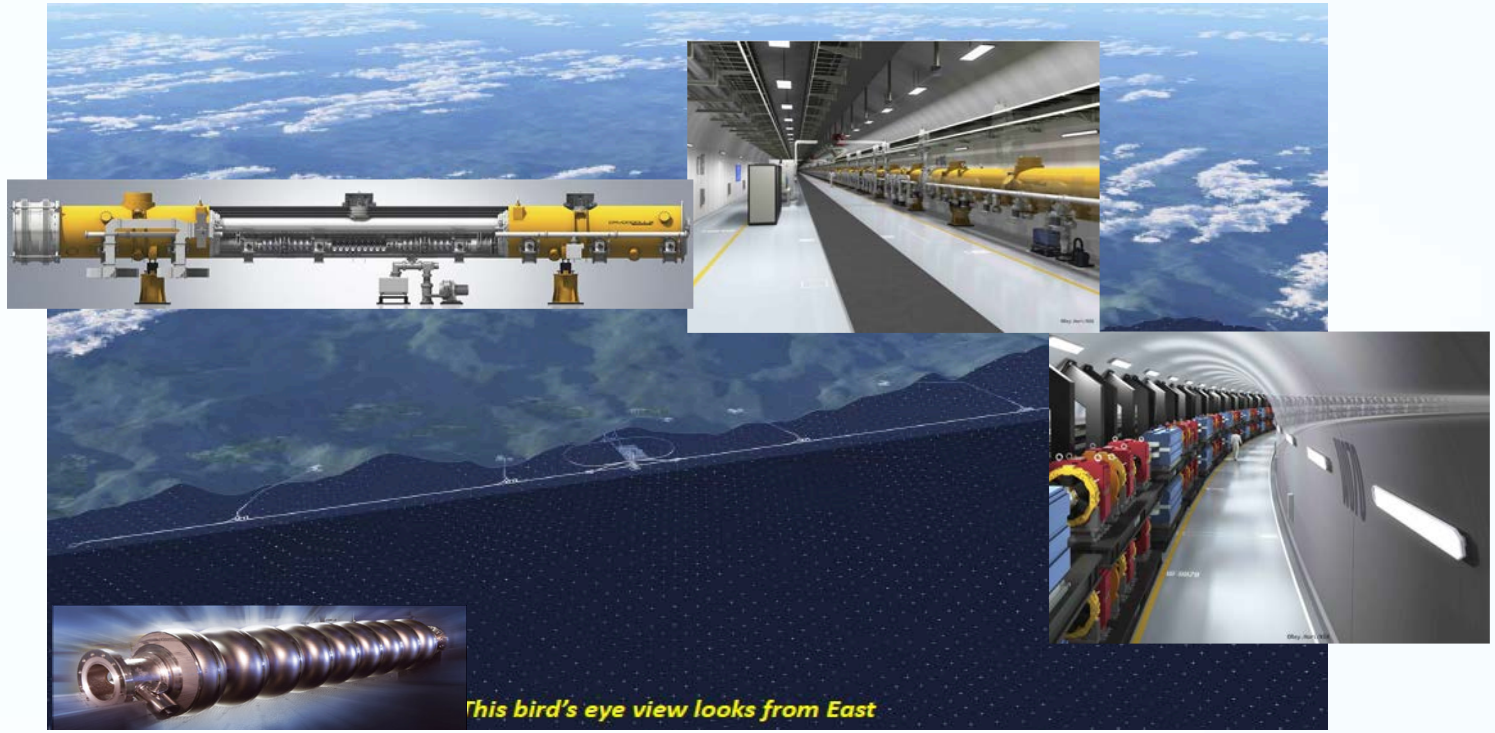
A review of ATF past activities, studies needed and possible in the near future is being organized with the participation of members of A_RD_10. The report will be presented to KEK-DG and evaluated by external reviewers in August 2020.

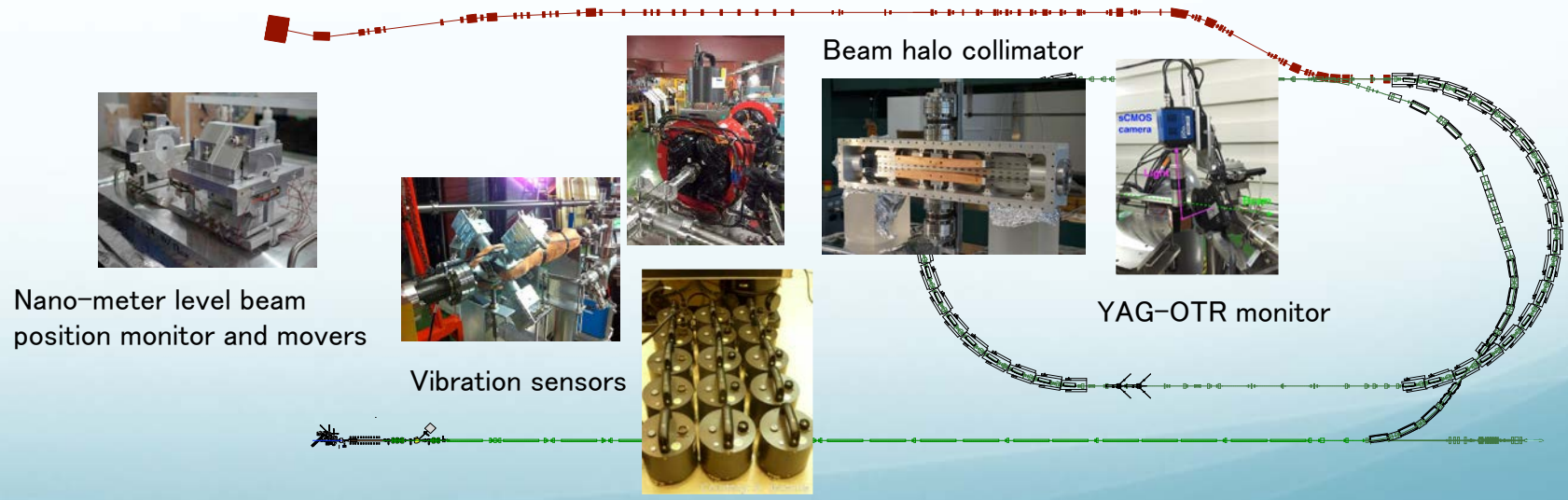
This TYL-FJPPL project will be crucial to support these studies and to provide a suitable collaborative framework for the students involved to continue the quest of the nanobeam sizes studies in ATF2 in view of ILC.



Backup

- Summary of the 2019-2020 runs for IJClab-CERN ultra-low studies
- Summary of April 2020 runs for ATF2 stabilization issues



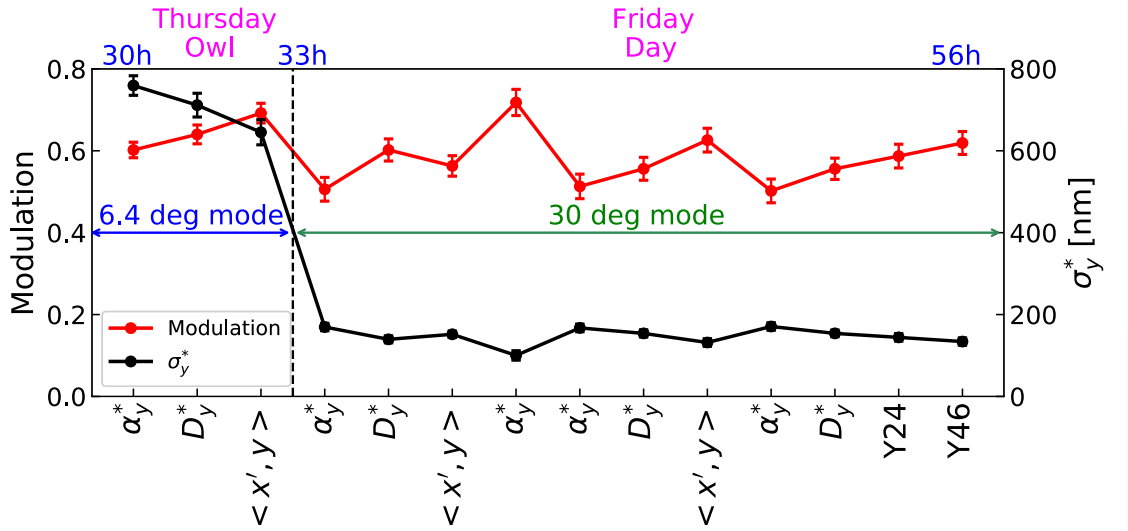


April 2019 - April 2020: Ultra-low β_y^* optics

Optics	Nominal	Ultra-low
Beam size	37 nm	**26 nm**

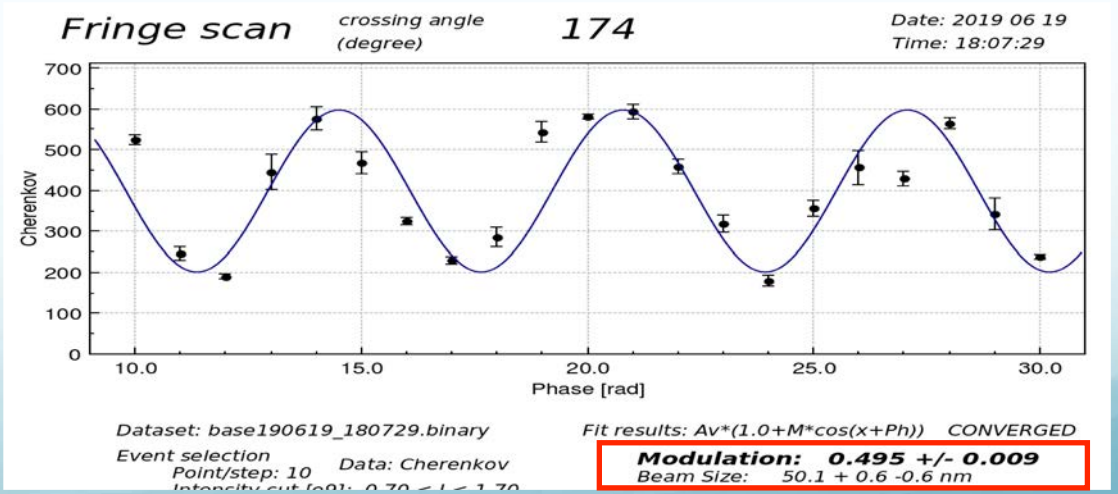
- **March 10 – March 16, 2019**

Beam size tuning with nominal knobs. Smallest vertical β_y^* = 86 ± 14 nm in 30 degree mode (M~0.76) with linear knobs.



- **June 11 - June 22, 2019**

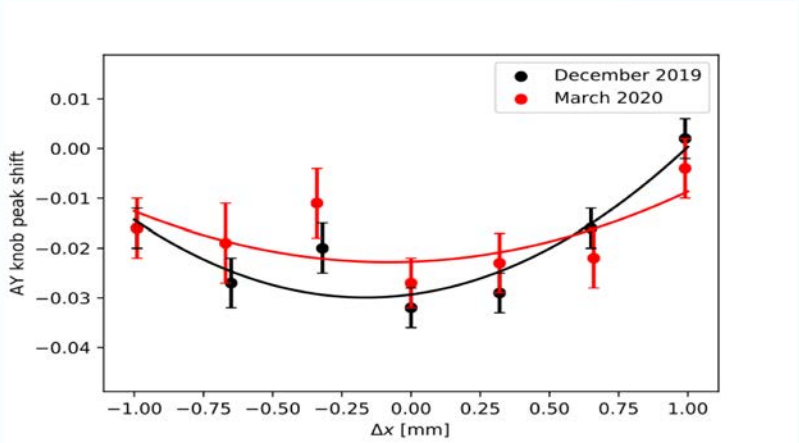
Beam size tuning with the nominal knobs. Smallest vertical β_y^* = 50 nm in 174 degree mode (M~ 0.76) with linear knobs.



April 2019 - April 2020: Ultra-low β_y^* optics

- **December 1 - December 22, 2019**

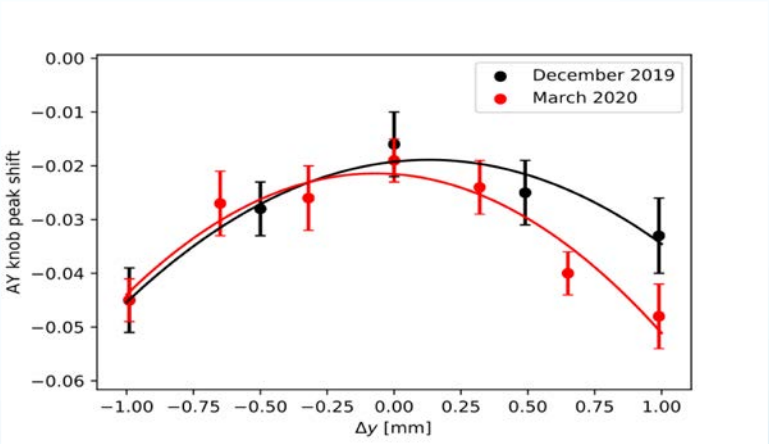
Test of orthogonality of the new ultra-low tuning knobs on the tuned beam with nominal knobs. Beam size was tuned to β_y^*< 100 nm in 30 degree and the orthogonality of the new knobs was confirmed. Octupole alignment was tested with the IP waist shift scan.



OCT, hor. shift. scan

- **February 24 - March 7, 2020**

Beam size tuning with the new ultra-low tuning knobs, Beam size was tuned to β_y^*<100 nm in 30 degree using the new ultra-low tuning knobs.
Octupoles were aligned in 30 deg. mode with this new knobs . Data is consistent with the measurements in 2019 December.



OCT, vert. shift. scan

Systematic beam orbit drift has been observed since 2019 December, making impossible the use of the 174 deg., crucial for ultra-low studies. A campaign of beam stabilization and IPBSM issues is being performed in April 2020.