

***Luminosity Optimization techniques
for Future Linear Colliders:
experimental tests in ATF2-3 (A_RD_33)***

Toshiyuki OKUGI, KEK

2026/ 5/ 18

2026 Joint workshop of TYL/FJPPN and FKPPN

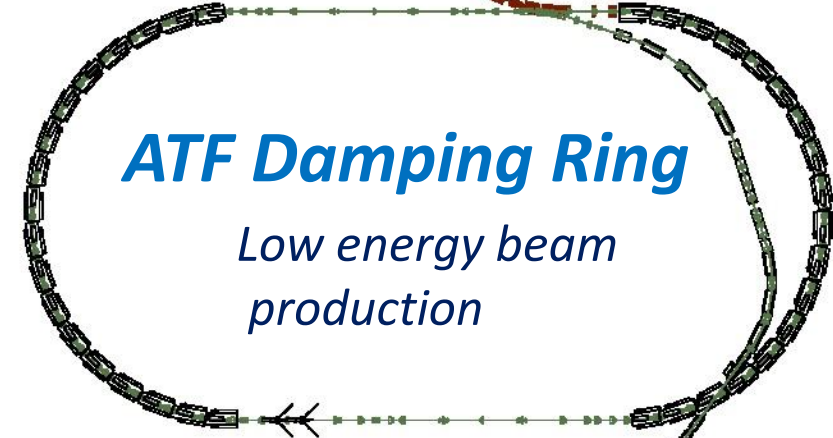
Accelerator Test Facility (ATF)

- Designed, constructed, and beam tested through **ATF international collaboration**
- Researchers and students from **more than 20 countries** have participated.



ATF2 Beamline

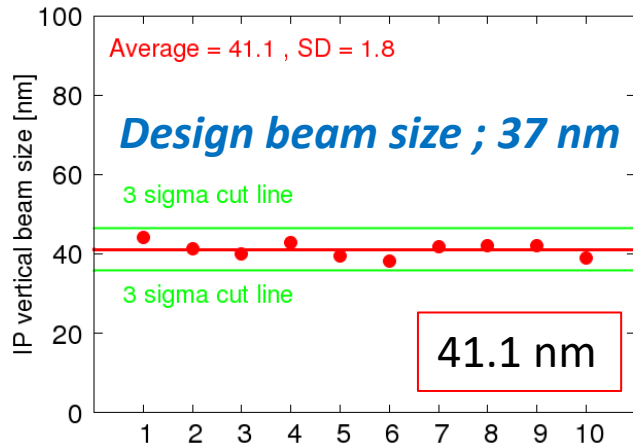
Investigation of
the focus lens system



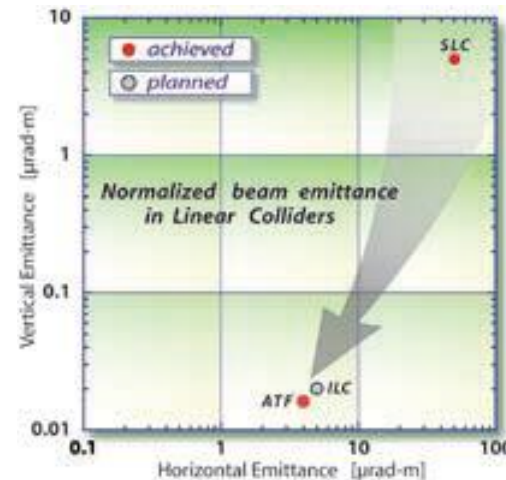
ATF Damping Ring

Low energy beam
production

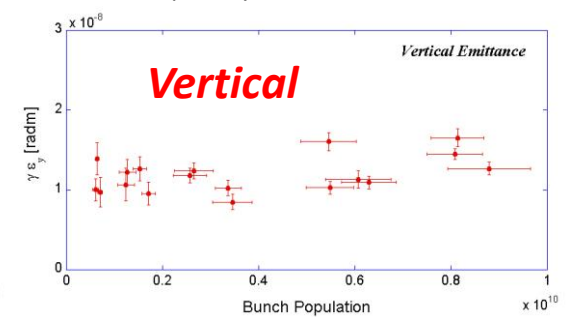
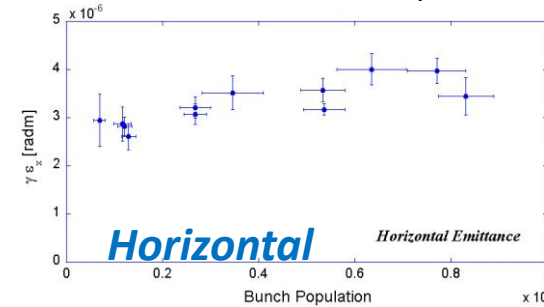
Minimum beam size



presented by Y. Kano and T. Okugi
at ECFA LC workshop 2016.



Y. Honda et al., Physical Review Letters **92** (2004) 054802.



	ILC Requirement	ATF DR
$\gamma \epsilon_x$ [rad·m]	5.0×10^{-6}	4.0×10^{-6}
$\gamma \epsilon_y$ [rad·m]	2.0×10^{-8}	1.5×10^{-8}

Major Institutions Participating in the ATF



Contributed via TYL/FJPPN

Beam Operation of JFY2025

Beam operation

- 14 operating weeks in JFY2025.

2025

April						
Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

May						
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

June						
Su	Mo	Tu	We	Th	Fr	Sa
1	IPAC2025					7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

July						
Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

August						
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

September						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

October						
Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	LCWS					
26	27	28	29	30	31	

November						
Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

December						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

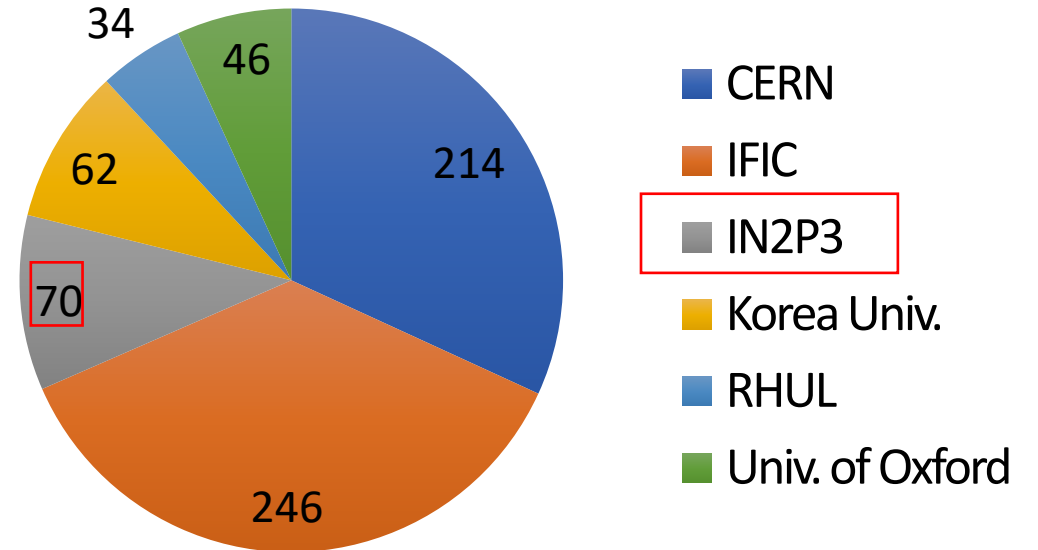
2026

January						
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

February						
Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

March						
Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

JFY2025 Statistics of oversea collaboration



	JFY2023	JFY2024	JFY2025
Operation week	14	20	14
Countries	7	5	5
institutions	11	7	6
person days	387	358	672

ILC FFS - ATF3 objective and collaboration

- ATF2/ATF2 project has been performed based on the **ATF international collaboration**.
- Pursue the necessary R&D to maximize the luminosity potential of ILC.

Goals of ATF2

- **Achieving the IP beam size required for the ILC**
- **Stabilizing the IP beam position required for the ILC**

Since certain achievements were made toward these goals, the ATF3 project is now underway.

Goals of ATF3

- **Maintaining the beam (beam size and position) stably at the IP for a couple days**

Major Research Topics at the ATF3 Project

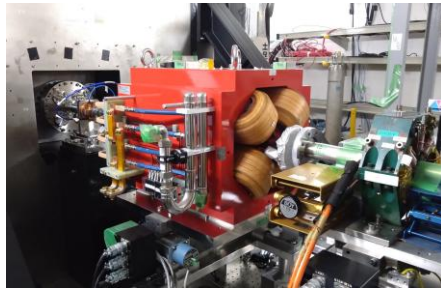
- **Multipole field error mitigation**
- **Wakefield mitigation**
- **Beam instrumentation**
- **Beam stable operation**

Hardware preparation for ATF3 project in JFY2023-2025

2023	2024	2025	2026	2027
<ul style="list-style-type: none"> ● Procurement of correction magnets ● Beam operation and equipment upgrade 	<ul style="list-style-type: none"> ● Reduction of high-order aberrations and wakefield ● Beam operation and equipment upgrade 	<ul style="list-style-type: none"> ● Precision improvement of nano-beam measurement ● Beam operation and equipment upgrade 	<ul style="list-style-type: none"> ● Advanced beam tuning technology ● Beam size <37nm 	<ul style="list-style-type: none"> ● Advanced beam tuning technology ● long-term stability (keep for a couple day)

Final Focus Magnet

- JFY2024 Procurement
- JFY2025 Installation



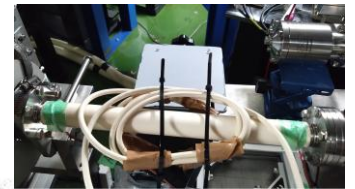
Skew Sextupole Magnets

- JFY2023 Procurement
- JFY2024 Installation



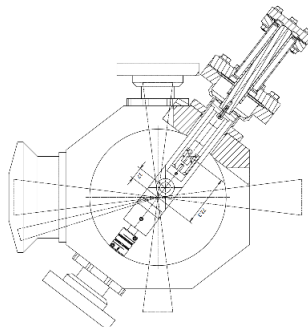
Extraction kicker

- JFY2023 Procurement of ceramic chamber
- JFY2024 Installation of ceramic chamber
- JFY2025 Kicker test will be started.



IP Beam size monitor

- JFY2024 Renewal of IP target
- JFY2025 Renewal of IP-BSM laser



Vacuum Chamber to reduce wakefield

- JFY2023 Prototyping
- JFY2024 Installation

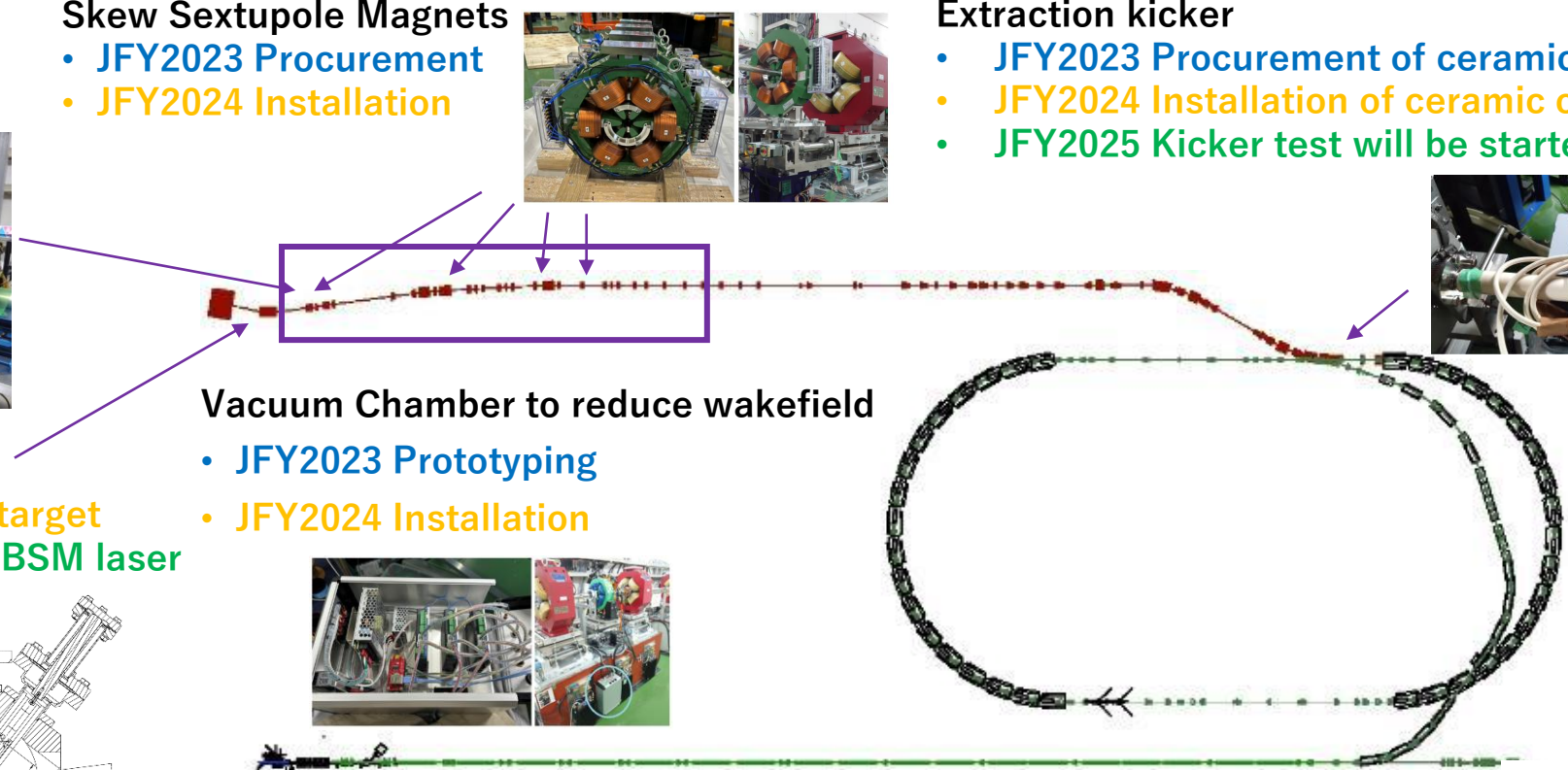


Magnet mover system

- JFY2023 Prototyping
- JFY2024 Installation for sextupole
- JFY2025 Installation for quadrupole

Timing System

- JFY2023 Partially installation
- JFY2024 Fully installation



Hardware preparation for multipole field mitigation and correction

Skew Sextupole magnets

2023 Design/manufacture/delivery

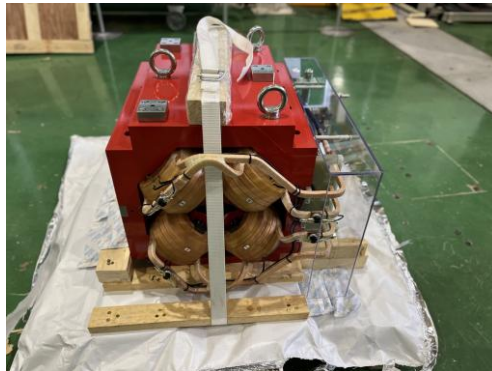
2024 Installation and beam studies with the magnets



Final focus magnet

2024 Design/manufacture/delivery

2025 Installation and beam studies with the magnets



Magnet mover control system

2023 Prototyping and test

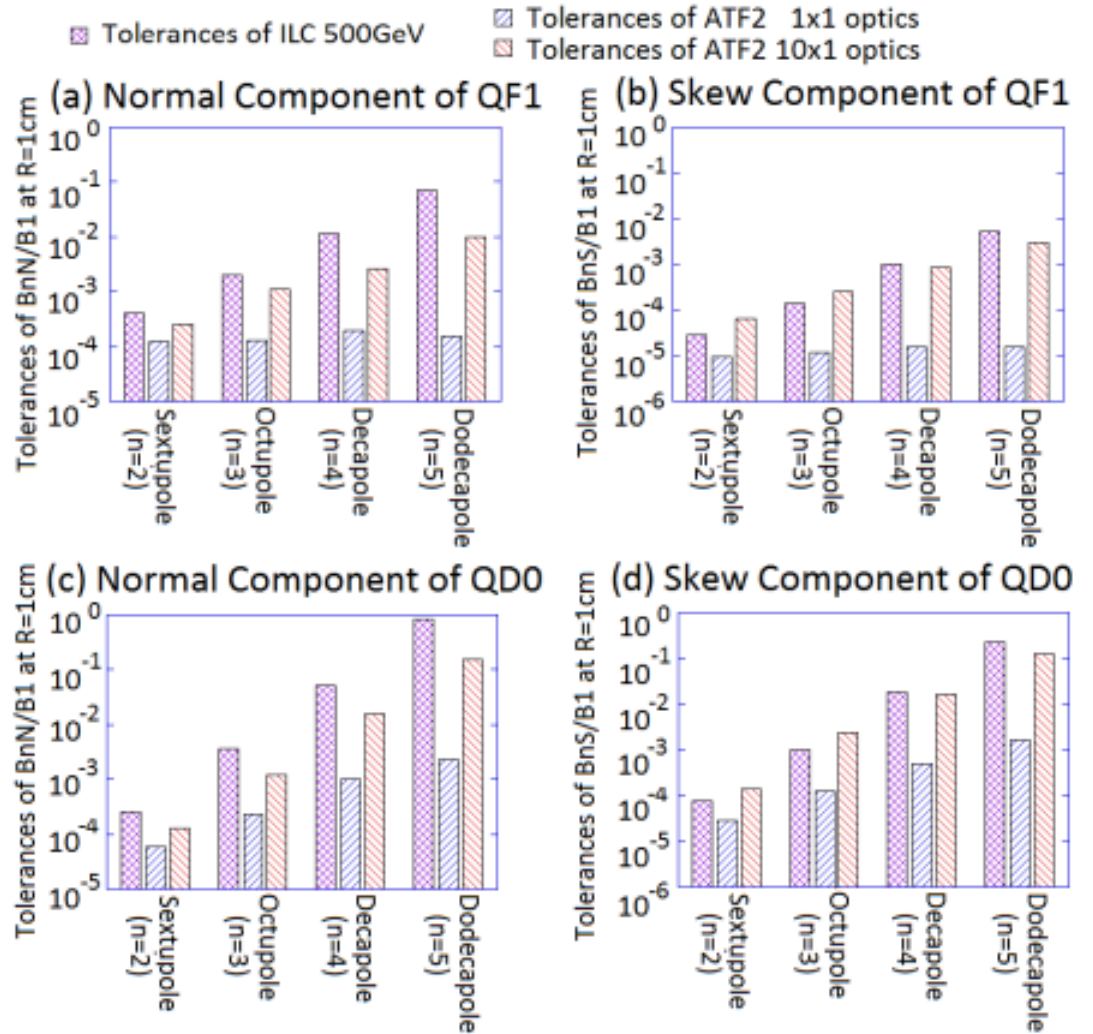
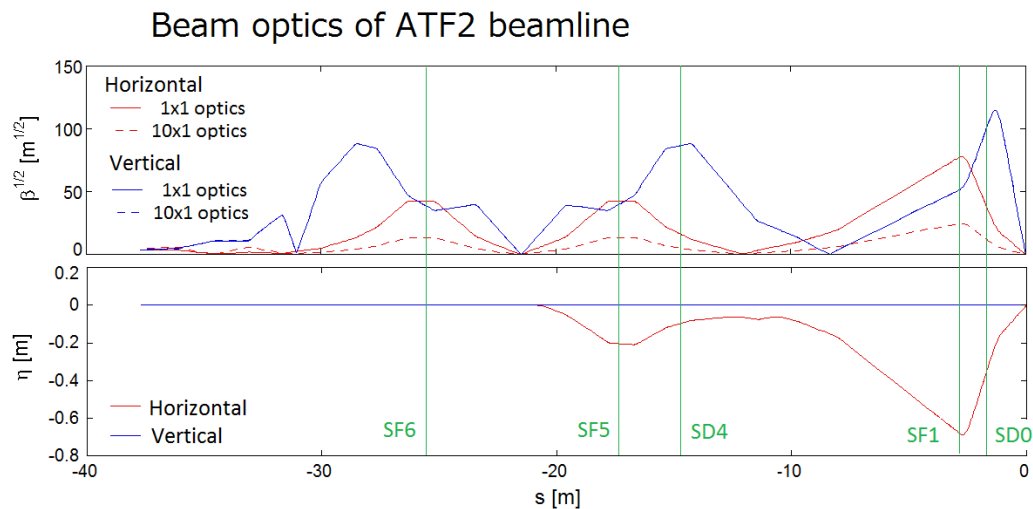
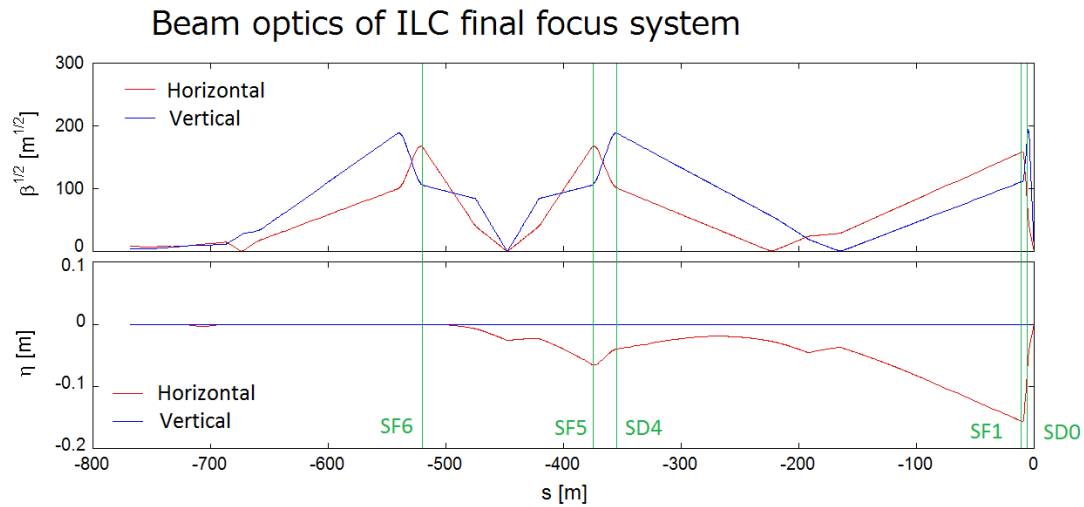
2024-2027 Install to ATF beamline step-by-step

2024 5 FF sextupole and 3 FF quadrupole movers



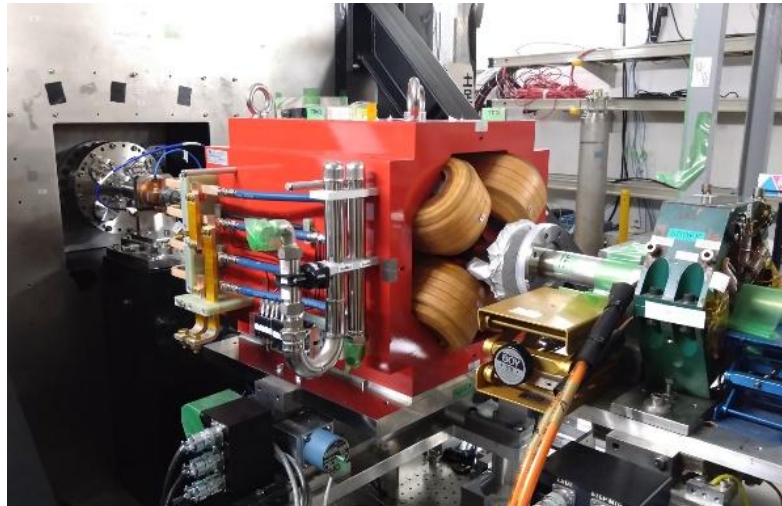
Multipole field error mitigation

- Easy to make conditions with greater multipole impact than ILC
- Ideal accelerator to test the effect of the multipole field error



Renew the final focus magnet

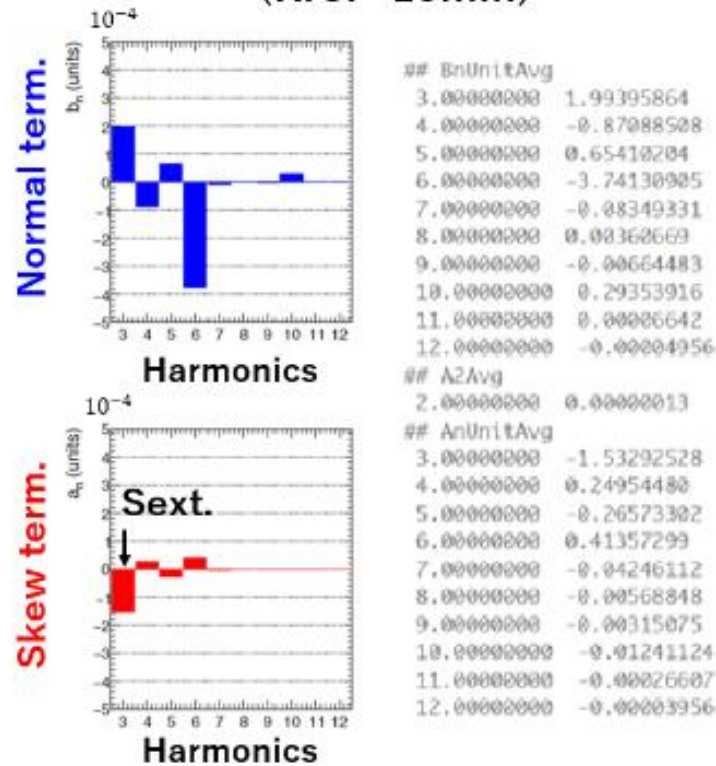
- JFY2024 Procurement
- JFY2025 Installation
 - ✓ Magnetic measurement
 - ✓ Installation
 - ✓ Alignment
 - ✓ Beam test from November 2025



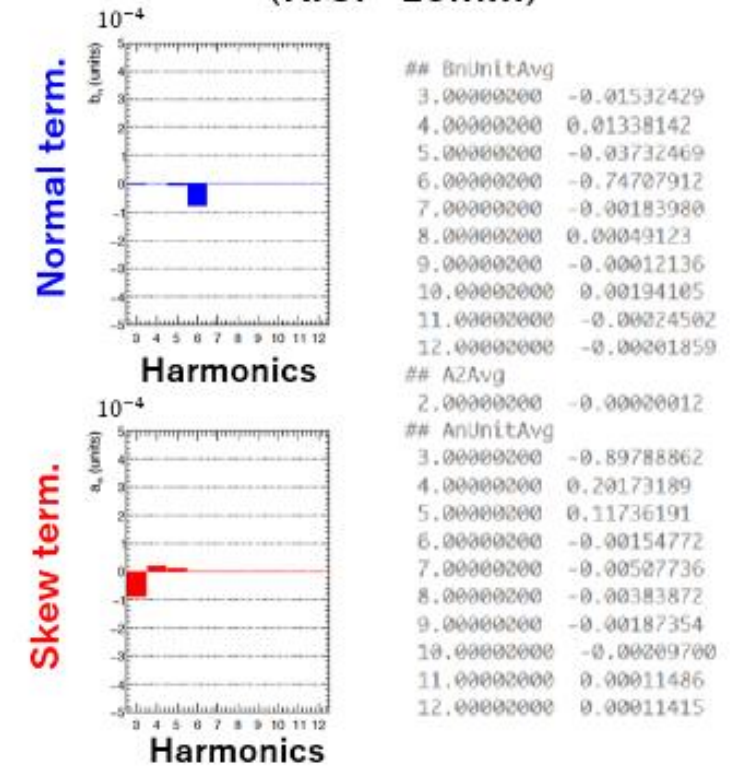
Result of the magnetic measurement

- Improve higher order magnetic field

(a) Quad. mag made by **SLAC**
(Rref=10mm)



(b) Quad. mag made by **KR tech**
(Rref=10mm)



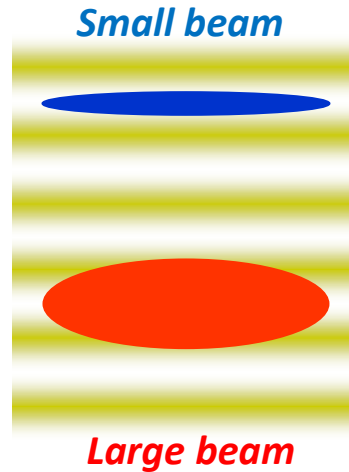
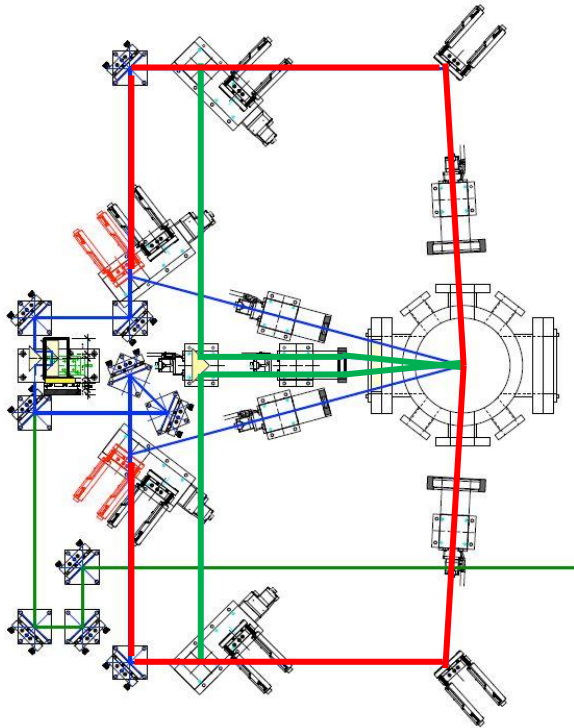
**Low beta optics than nominal ATF2 IP
by utilizing the focus magnet with small multipole field error**

Advancing of IP beam size measurement after IP-BSM laser renewal

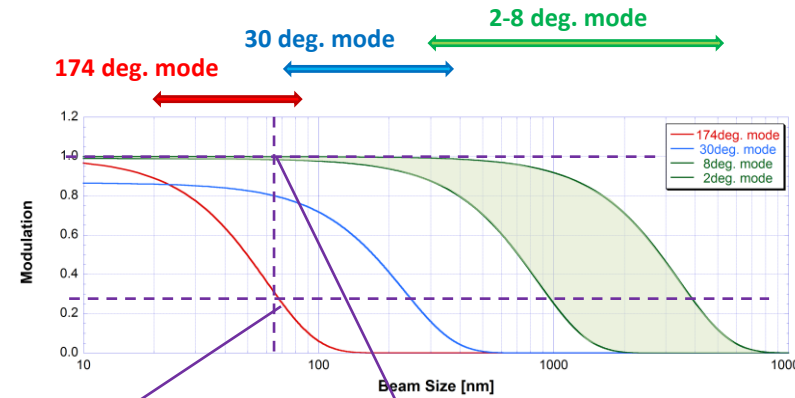
- The accuracy of the beam size monitor improved after the laser was replaced.
- With the hardware upgrade, preparations for beam tuning starting in JFY2026 are now complete.

ATF IP beam size monitor

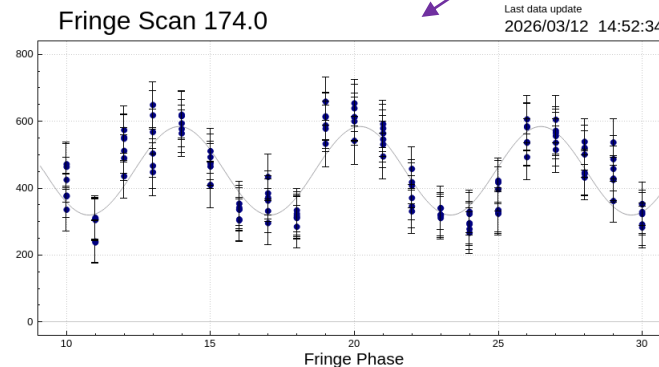
By comparing the beam with the laser interference pattern, the beam size can be evaluated.



Dynamic range of ATF IP-BSM

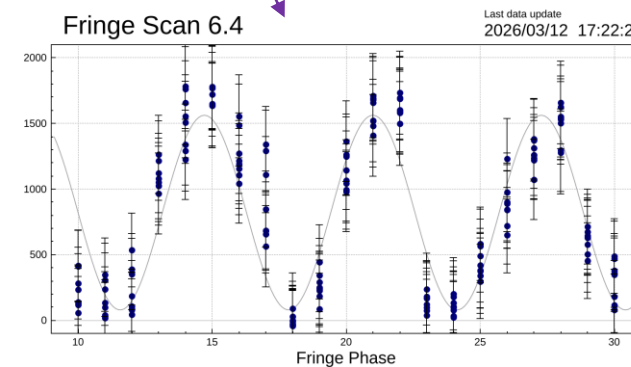


The same beam size was measured in different cross angle modes, the modulation in each mode was as expected.



Lasermirror/lens settings: HWP-IN :0.0000 M174LX: 9.9508 M174UX: 9.6971 HWP-U: 0.0000 M174LY: 9.0356 M174UY: 11.2319 HWP-L: 0.0000 F174L: -0.50 M174LS(tilt): 0.00 F174U: -2.50 M174US(tilt): 0.00
 Fit: Average*(1 + Modulation*cos(Phase-offset))
 Modulation: 0.293 +/- 0.018
 beam size: 66.3, -1.7, +1.7 nm
 Average: 451.8 +/- 6.1
 Phase offset: -1.35 +/- 0.07
 Chi2/n.d.f.: 123.3 / 123

Raw data file: /atf/data/ipbsm/archive/binary/base260312_145052.binary



Lasermirror/lens settings: M8LX: 8.8128 M8UX: 9.1755 M8LY: 8.2096 M8UY: 9.4268 FB: -0.60
 Fit: Average*(1 + Modulation*cos(Phase-offset))
 Modulation: 0.901 +/- 0.043
 beam size: 335.5, -92.4, +75.2 nm
 Average: 823.6 +/- 23.0
 Phase offset: -2.13 +/- 0.04
 Chi2/n.d.f.: 170.2 / 165

Raw data file: /mnt/vtrak/ipbsm/online/Fringe8.dat

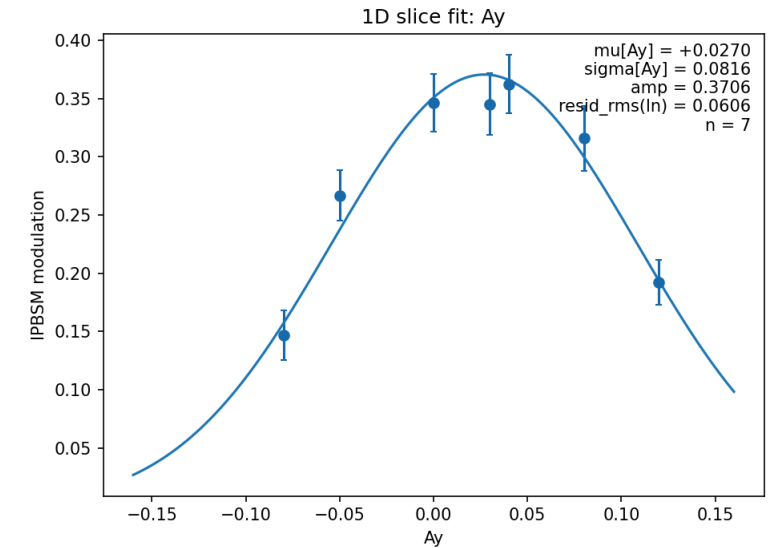
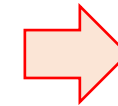
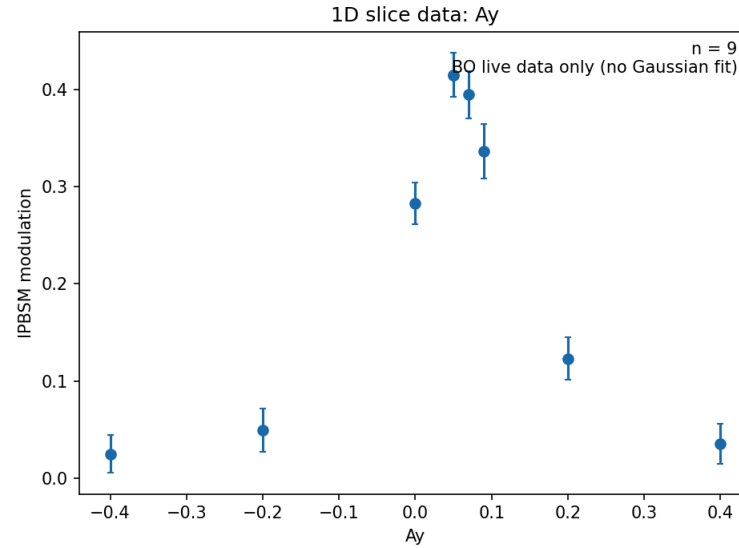
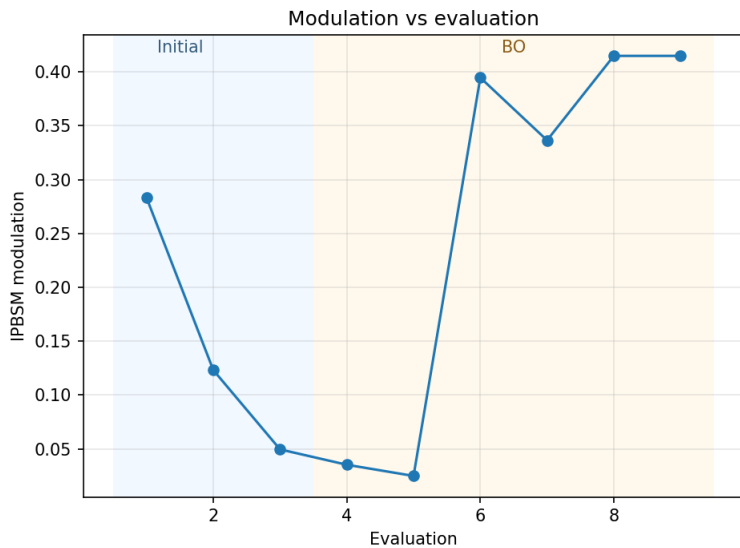
It became possible to generate ideal interference fringes at ATF IP after the laser was replaced.

Machine learning technology

- Advanced research on the latest beam tuning technology through international collaboration.
- The introduction of parameter optimization using machine learning has improved the accuracy of beam tuning.
- Reinforcement learning for beam alignment technology utilizing big data via flight simulator.

Example of A_y parameter optimization

Developing by M.Sato



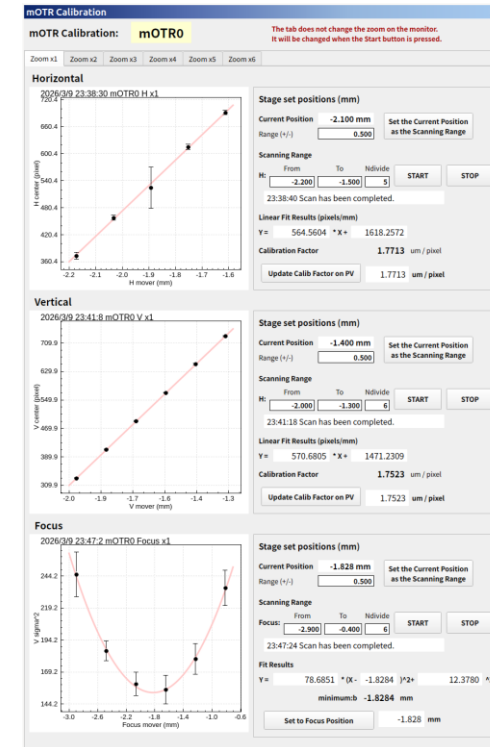
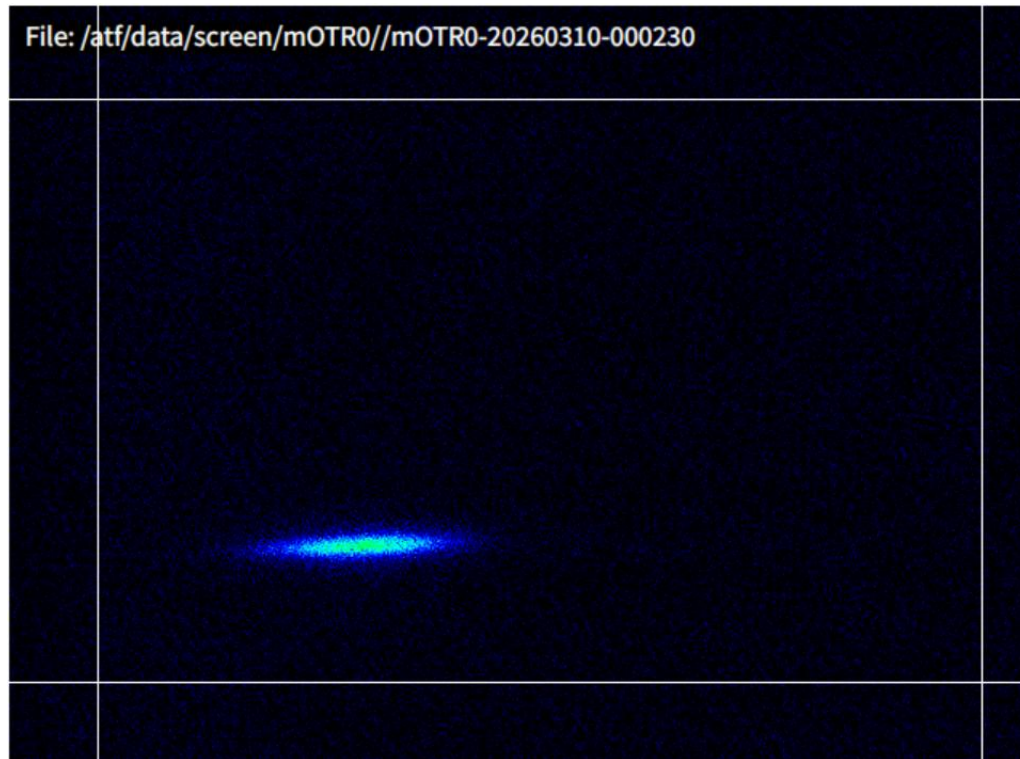
Bayesian optimization was employed to improve scanning speed during wide-range parameter scans.

For fine-tuning parameter optimization, high precision was achieved in a short time through optimization utilizing a Gaussian fit model.

Emittance measurement by utilizing multi-OTR monitors

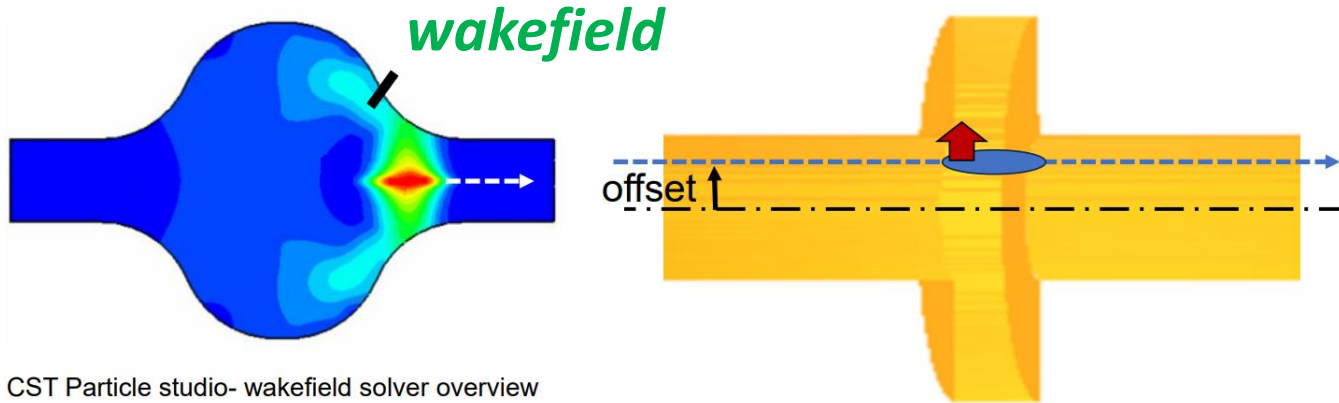
- Accurate emittance measurements at the extraction line are essential for correctly evaluating emittance growth from the ATF damping ring to the extraction line.
- The ATF is equipped with four OTR monitors (minimum measurable beam size: $5 \mu\text{m}$) for emittance measurement.
- We are advancing the advancement of emittance measurement using OTR monitors through international collaboration with institutions such as IJClab.

Calibration of multi-OTR screen



Wakefield mitigation

- Larger IP beam size growth than ILC
- Ideal accelerator *to test the effect of the wakefield to nanobeam*



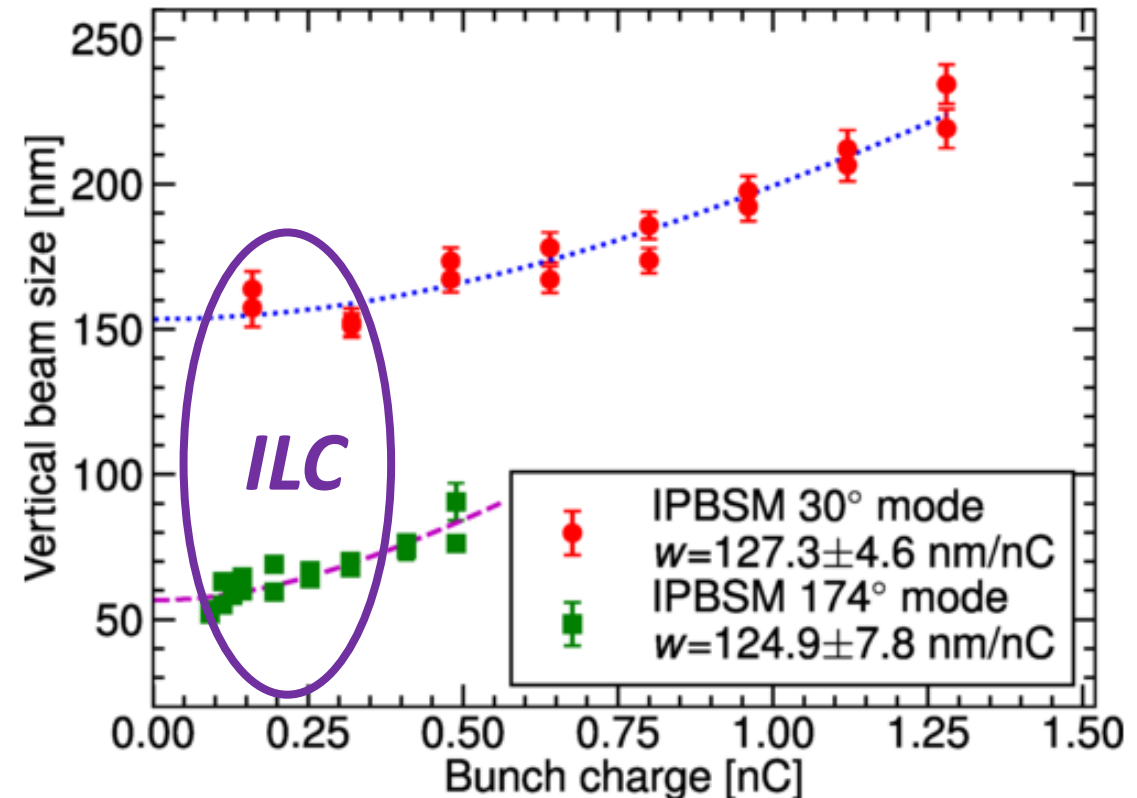
ATF review 2020 by K.Kubo

	ILC	ATF	Ratio of effect (ILC/ATF)	
			misalignment	orbit jitter
Beam Energy	125 GeV	1.3 GeV	0.01	0.01
Bunch Length	0.3 mm	7.0 mm	0.5	0.5
Emittance	0.16 pm	12 pm	8.7	1
Sum of β_y	390 km	61 km	2.5	6.7
Total			0.11	0.032

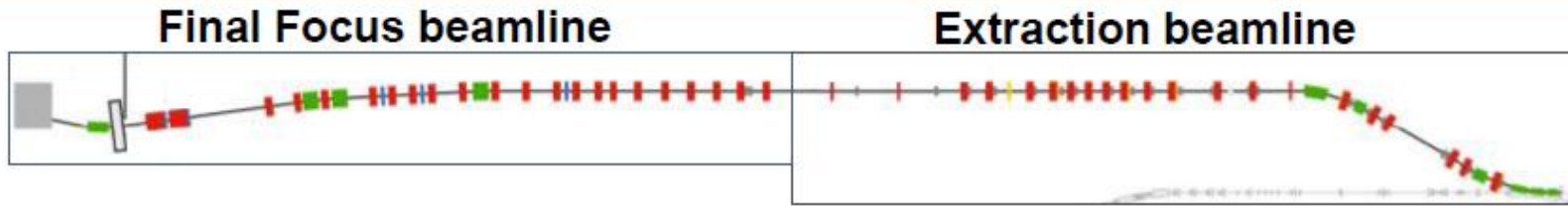
Larger impact than ILC

IP beam size growth at ATF

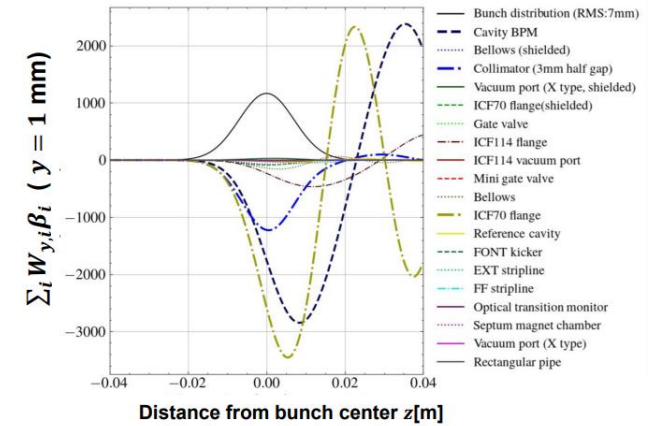
<https://doi.org/10.1103/PhysRevAccelBeams.23.071003>



Wakefield study at ATF2 beamline



- ICF70 flange, bellows, screen monitor and so on are arranged in beamline.
- ICF70 flange, bellows are the major wakefield sources in ATF2 beamline.



- **JFY2023** : The effect of wakefield on ICF70 flange and the effect of RF mask to reduce it were tested with test chamber.
- **JFY2024** : Based on the results, low impedance flanges, bellows were designed and fabricated, and beamline was updated.
- **JFY2025**: The effectiveness of the vacuum components in reducing the wakefield effect on the nano-beam will be tested.

The experimental setups to evaluate the wakefield mitigation

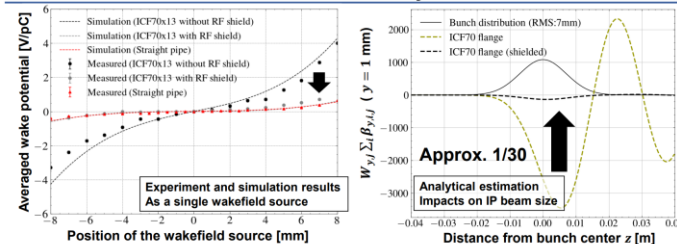
Setup 1. 2: ICF70 flange blocks + RF shields

Setup 1 To evaluate the effect of ICF70 flange (major wake source)
Produced 13 ICF70 flanges structure

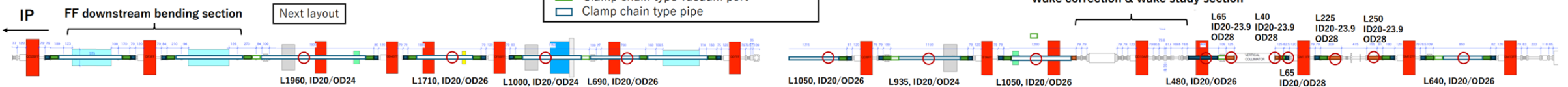
Setup 3: Straight pipe (reference)

Setup 2 To evaluate the mitigation effect of the RF shield for ICF70
Produced 13 ICF70 flanges and RF shields structure

Evaluation results of wakefield effects by ICF70



- Conversion pipe (NW25-ICF70)
- New clamp chain type bellows (NW25)
- Tapered pipe
- Clamp chain type vacuum port
- Clamp chain type pipe



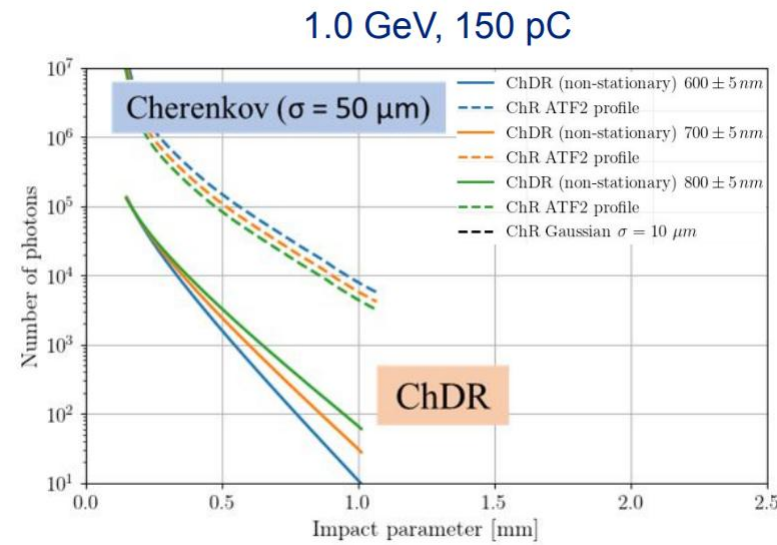
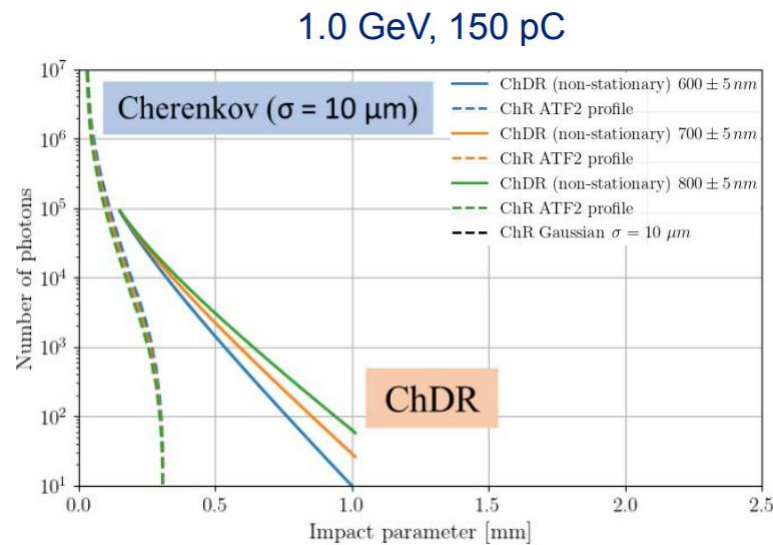
ATF2 incoherent Cherenkov diffraction radiation

Kacper Lasocha (CERN) @LCWS2025

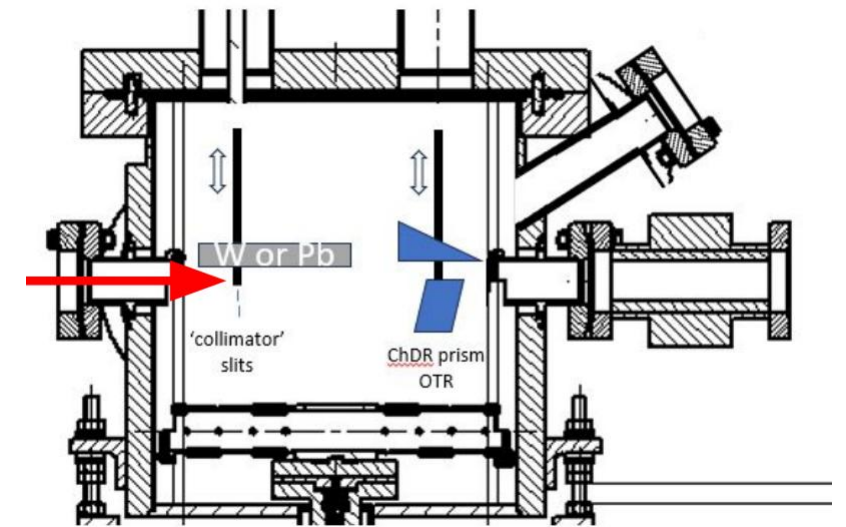
- Development of **non-destructive beam size monitor for high power beams.**
- Academic research for feature of Cherenkov diffraction radiation

Beam test results in 2023-2025

- Characteristic tests of Cherenkov DR using beams.
- Difficult to separate from Cherenkov light by beam tail.
- Develop a device that includes a collimator to cut the beam tail a **from 2025 autumn.**



Upgraded ChDR setup



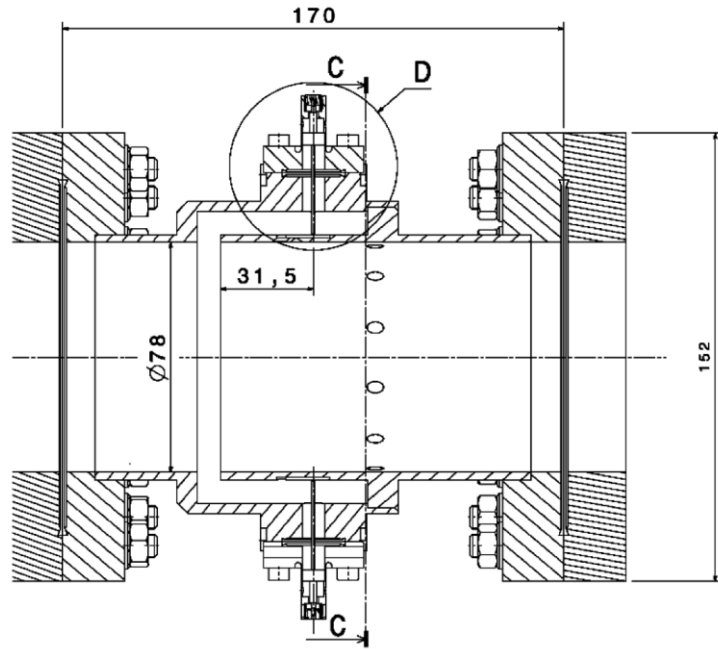
New vacuum pump to improve the vacuum level will be installed and to be tested at 2026 autumn.

Cavity BPM for ILC Main Linac

Laura Karina Pedraza (IFIC) @LCWS2025

Methods employed to enhance the spatial resolution and meet the Main Linac requirements.

Re-entrant cavity BPM



- **The re-entrant designed by Saclay** has been performed to enhance BPM sensitivity and spatial resolution at the end of ATF2 linac **from May 2025**.
- **The re-entrant BPM was optimized to ILC ML and fabricated by IFIC**, and will be tested at the ATF **from May 2026**.

- A preliminary plan is underway to develop a prototype integrating the SCQ and BPM assembly into a test cryostat.

Example of the cavity BPM test cryostat

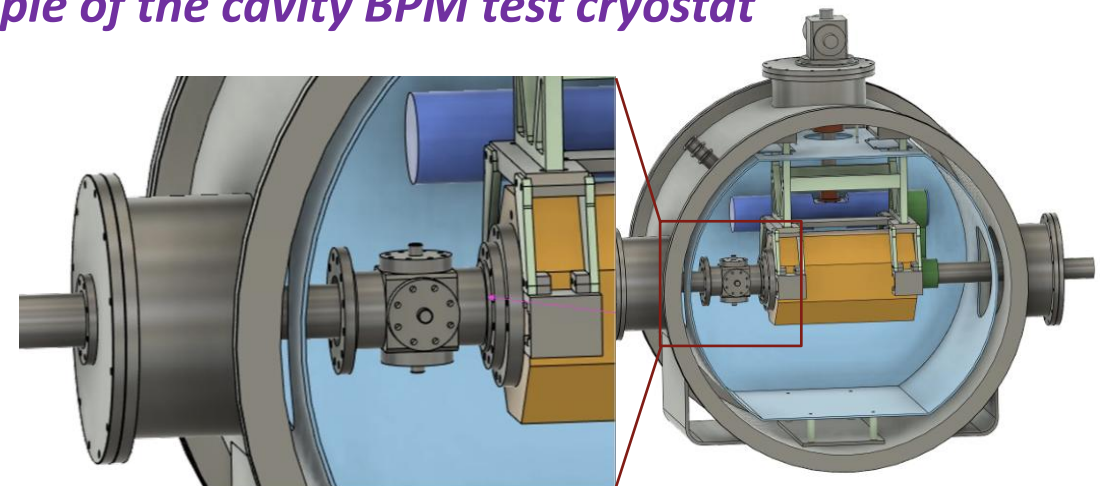
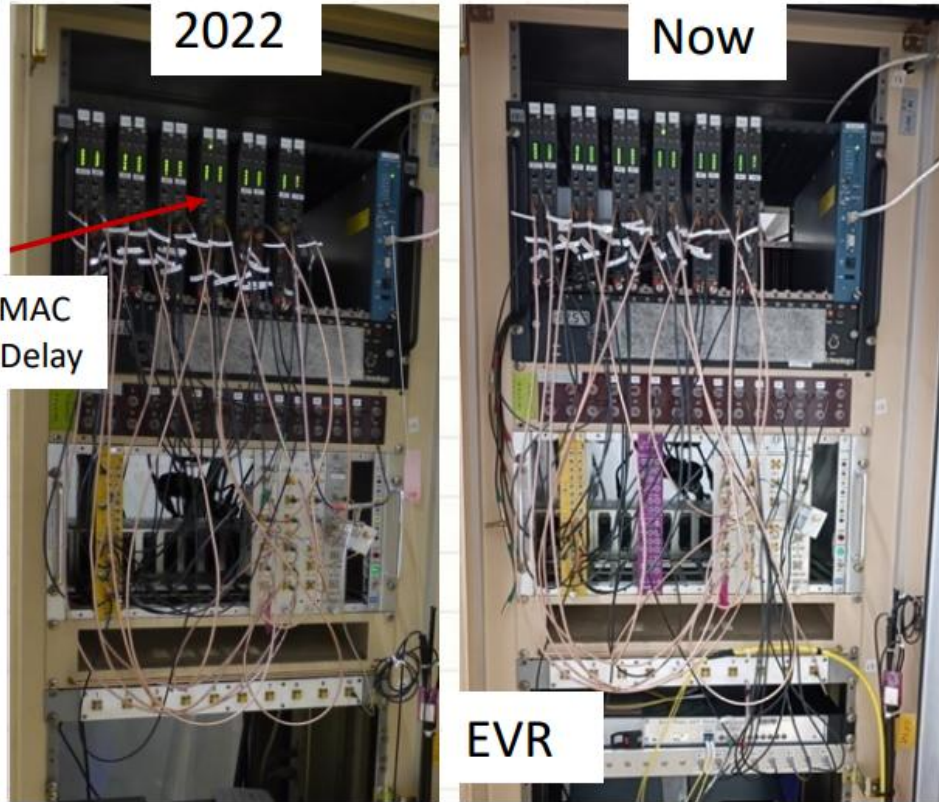


Figure: Cryostat accommodating BPM and SC quadrupole

Timing system upgrade

Alex Aryshev (KEK)

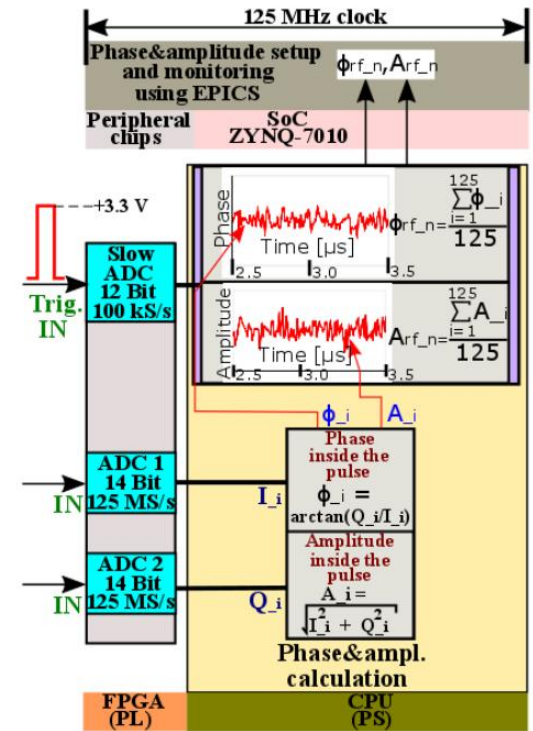
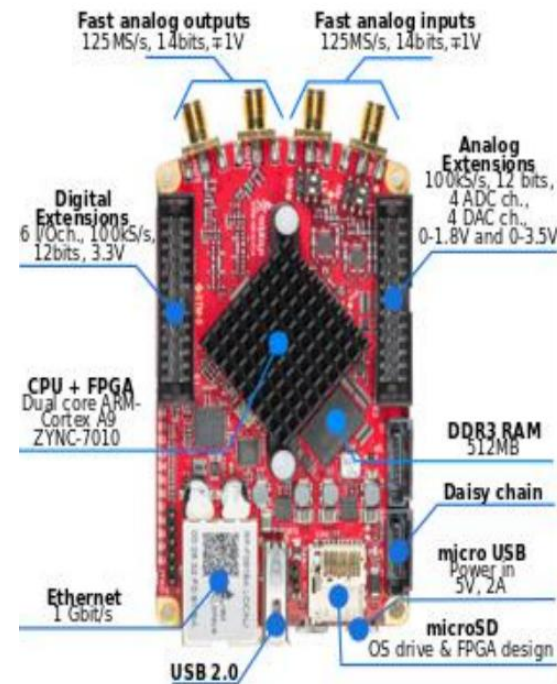


Peak-to-Peak data below shows about 2 times improvement!

e- charge at:	2023	2024
Linac End	~0.01	~0.005
IP	~0.01	~0.005

KEK ATF Linac klystrons High-Power RF field phase and amplitude stability.

Konstantin Popov (KEK)



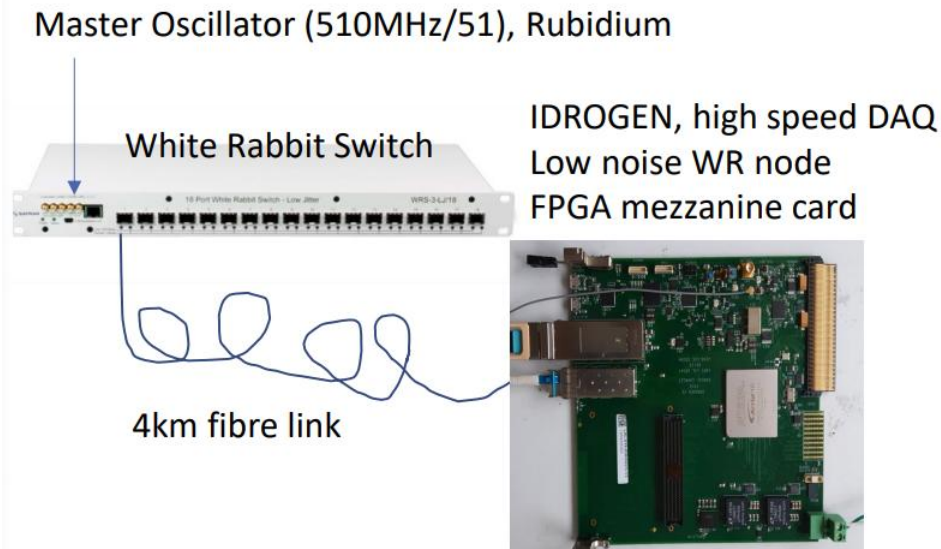
White Rabbit + IDROGEN board based low-level RF system

Test at ATF accelerator in collaboration of KEK and IJClab

- Approved at ATF technical board meeting on October 2025.
- The system test has been performed at ATF accelerator.

Laser synchronisation – concept

H. Kaji, D. Charlet



- WhiteRabbit allows to minimize implementation cost
- A simple fiber to bring to the laser
- No expensive/complicated fiber length compensation system to implement



Developments made in parallel at IJClab and KEK:

IJClab:

- Standalone tests with phase noise measurements
- Test new developments on the IDROGEN board quickly

KEK:

- Test within KEK environment for instance at ATF
- Possibility to test with 4km fibre loop easily (shown in Oct'24)
- Possibility to test accelerator/laser synchronisation → rescheduled for June at ATF

ATF project meeting (2025/11/27-28)

Report ; https://agenda.linearcollider.org/event/10859/attachments/40878/65154/Summary_ATF_project_meeting.pdf

- Share the ATF2/ATF3 goal with all collaborators (beam stability over several days).
- Confirm the present status and achievements to the ATF2/ATF3 goal.
- Clarify how each group's research relates to the ATF2/ATF3 goal.
- Confirm the schedule for the next two years to achieve the goal.



**Participants: all collaboration
(17 in person, 10 remote)**

We confirmed in this meeting that

- Most of the ATF beam time for FY2026 and FY2027 will be dedicated to achieving the ATF2/ATF3 goal.
- Cooperation toward the common objectives (ATF2/ATF3 goal) of each group was reconfirmed.

Thank you for your attention

Backup

Timetable of ATF project meeting

Thursday 27 November

Report for hardware update for ATF2-3 program

Session | Location: KEK 2-go-kan, Large Meeting Room (1F)

14:00-14:30 **Hardware upgrade for ATF2-3 project**

Speaker
Alexander Aryshev

14:30-15:00 **Low level RF and timing system upgrades**

Speaker
KONSTANTIN POPOV

15:00-15:30 **New kicker system test**

Speaker
Eiji Nakamura

Coffee break

Break | Location: KEK 2-go-kan, Large Meeting Room (1F)

ATF2-3 project and goals

Session | Location: KEK 2-go-kan, Large Meeting Room (1F)

16:00-16:10 **Opening address**

Speaker
Tadashi Koseki

16:10-16:30 **ATF contribution to ITN**

Speaker
Hiroshi Sakai

16:30-17:00 **ATF2-3 project and goals**

Speaker
Toshiyuki Okugi

17:00-17:30 **Vacuum system upgrade for wakefield study**

Speaker
Yuki Abe

17:30-18:00 **Discussion about the goal for ATF2-3**

Friday 28 November

Report from study groups 1

Session | Location: KEK 2-go-kan, Large Meeting Room (1F)

09:00-09:30 **Timing system study**

Speaker
KONSTANTIN POPOV

09:30-10:00 **FONT**

Speaker
Douglas Bett

10:00-10:30 **Cherenkov DR**

Speaker
Orson Vermare

Coffee break

Break | Location: KEK 2-go-kan, Large Meeting Room (1F)

Report from study group 2

Session | Location: KEK 2-go-kan, Large Meeting Room (1F)

11:00-11:30 **ML BPM (Korea University)**

Speaker
Soohyung Lee

11:30-12:00 **ML BPM (IFIC)**

Speaker
Juan Carlo

12:00-12:30 **Flight Simulator - mOTR (IJCLab)**

Speaker
Anna Korsun

Lunch

Break | Location: KEK 2-go-kan, Large Meeting Room (1F)

Report from study groups 3

Session | Location: KEK 2-go-kan, Large Meeting Room (1F)

14:00-14:30 **Flight Simulator (CERN)**

Speaker
Andrea Latina

14:30-15:00 **Flight Simulator (KEK)**

Speaker
Motoki Sato

15:00-15:30 **Ultra-low beta study**

Speakers
Conrad Caliarì, Lewis Kennedy

Coffee break

Break | Location: KEK 2-go-kan, Large Meeting Room (1F)

Discussion for the future collaboration and closing

Session | Location: KEK 2-go-kan, Large Meeting Room (1F)

16:00-17:30

Discussion of the schedule for the next two years to achieve the goals.

17:30-17:50 **closing**

- **Discussion about each group contribution to ATF2/ATF3.**

- **Share the ATF2/ATF3 goal in collaboration**
- **Hardware status and upgrade plan**

Presentation from each study group about the present status and how to contribute to the ATF2/ATF3 goal.

Each Group Contribution to MEXT-ATD

✓ *Contribute to the beam size minimization and stabilization*

Machin Learning (CERN, KEK, IJClab)

A. Latina (CERN), Wictoria Malek (CERN), P. Korysko (Univ. Oxford), A. Faus Golfe (IJCLab), A. Korsun (IJCLab), M. Sato (KEK), A. Aryshev (KEK), T.Okugi (KEK)

Possible contribution of CERN

- **Flight simulator development based on RF-Track (LINAC, BT, DR, EXT and ATF2 beamline)**
- **Integration to CERN Flight simulator (mOTR, wkefield knob etc.)**
- **Supervised Learning (beam tuning utilizing with DFS, WFS etc.)**
- **Unsupervised Learning (SVD etc.)**
- **Remote participation is important to develop all of these items**
 - *Protection to access to ATF hardware from outside KEK may restricted by epics PV setting ?*

Possible contribution of KEK

- **Integrate the present ATF beam tuning procedure to FS (dispersion correction, IP beam size tuning etc.).**
- **Develop the RL to IP-BSM tuning.**
- **Development of the beam long-term stabilization tool.**
- **Big data acquisition to investigate the beam unstable source**

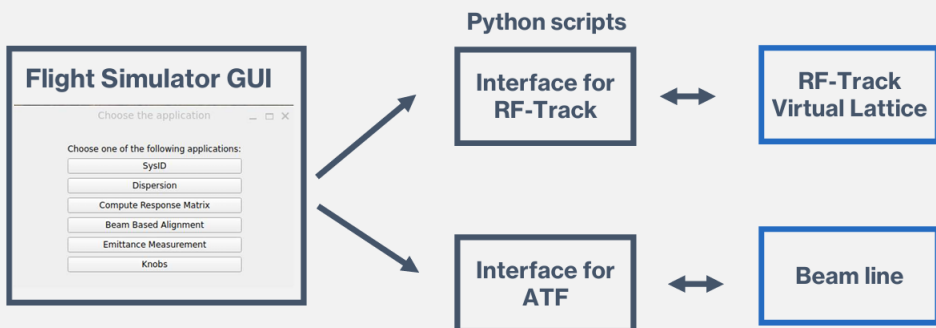
Possible contribution of IJCLab

- **Emittance measurement at EXT.**

Machine Learning Study

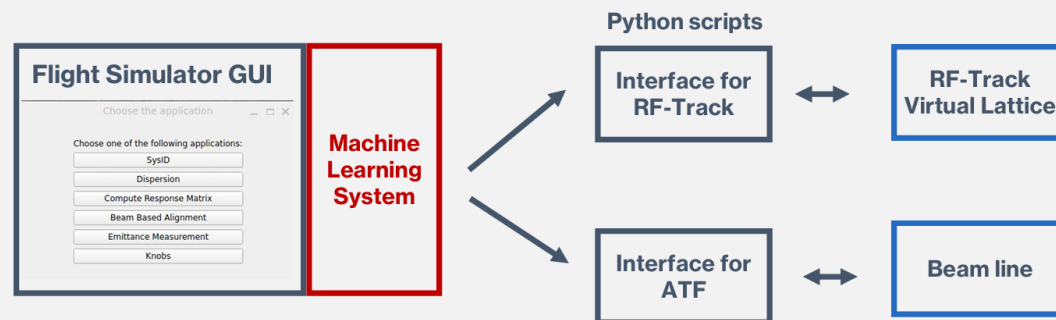
Flight Simulator Project

- A new flight simulator project is underway in collaboration with a group at CERN.



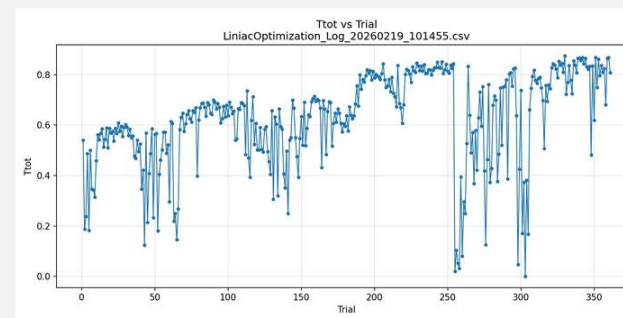
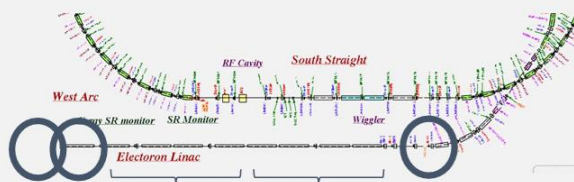
Flight Simulator × ML

- It makes sense to incorporate machine learning into this scheme.



Linac Optimization using BO

- Efficient beam injection into DR
 - RF GUN phase & Klystron phase
 - Klystron Timing
 - Quadrupoles for matching
- Bayesian Optimization



Grouping

GUN, Solenoid and LO phase - 3 parameters
 Klystron phase 1 - 4 parameters
 Klystron phase 2 - 4 parameters
 Quadrupole 1 - 5 parameters
 Quadrupole 2 - 3 parameters

Method	Time to realize	Transmission
Professional	8 hours	0.85
Ternary	20 min	0.72
BO	40 min	0.81
Ternary after BO	1 hour	0.94

✓ *Contribute to the beam size minimization*

Ultra-low beta study (CERN) R. Tomas (CERN), L. Kennedy (CERN), C. Callieri (CERN)

Possible contribution

- *Investigate the effect by multipole field error by utilizing ultra-low beta optics*

Cherenkov DR (CERN) R. Kieffer (CERN), O. Vermere (CERN)

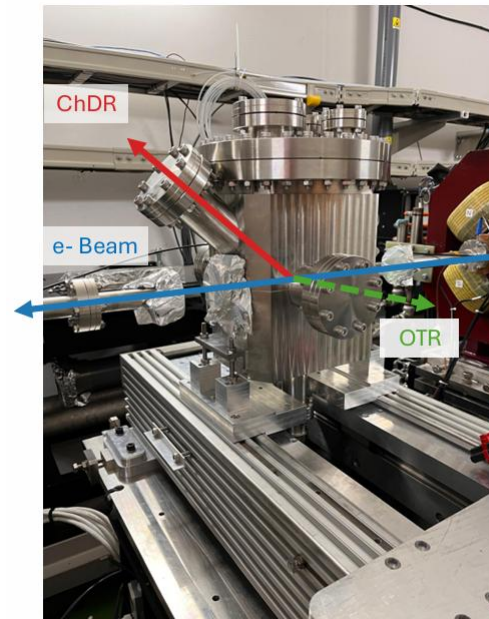
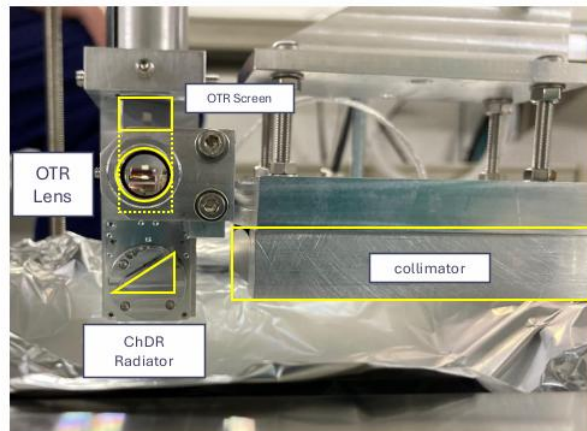
Possible contribution

(1) *Beam size and position measurement by OTR mode*

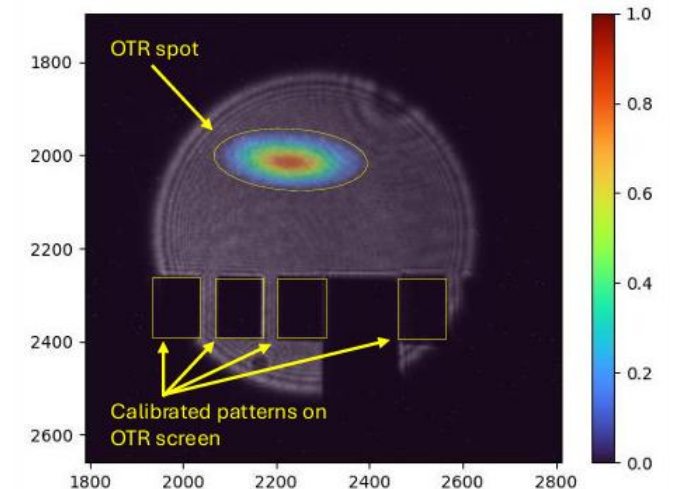
- *Help to observe the beam size at high beta region (beam divergence and coupling measurement)*

(2) *Bunch length measurement*

- *Help to the wakefield study*
- *However, need streak camera*



OTR spot observed with vacuum lens over 100 bunches



✓ Contribute to the beam stabilization

FONT (Oxford University) D. Bett (Oxford Univ.)

Possible contribution

- Beam stabilization for 2nd bunch (original FONT)
- Beam stabilization for single bunch (just the idea)
 - Feedforward with respect to the grand motion (need to support to the grand motion measurement)
 - Feedforward with respect to the DR orbit
- Integration to ATF control system.

Timing system (IJClab, ATF and SuperKEKB)

A. Martens (IJCLab), D. Charlet (IJCLab), K. Popov (KEK), A. Aryshev (KEK)

Contributed to LO stabilization, especially contribute to

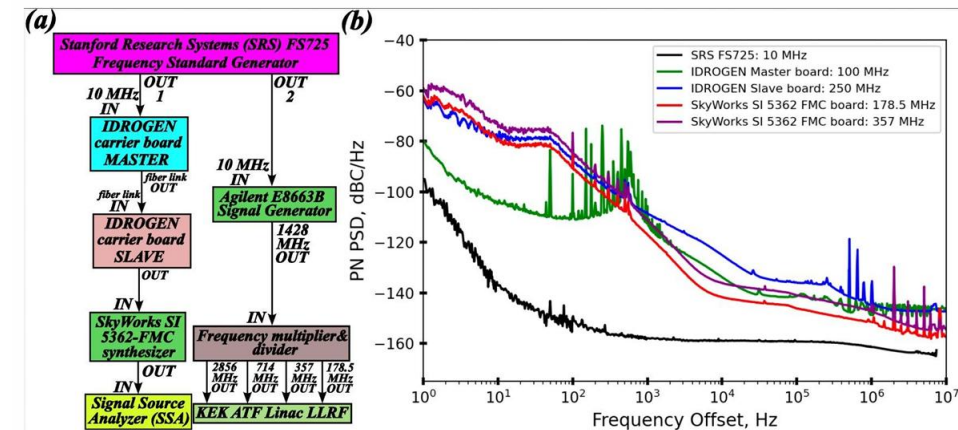
- LR RF and feedback for damping ring RF system
- Delta-F ramp (energy change at DR, EXT and ATF2 beamline)
- Cavity BPM system in ATF2 beamline

Signal	Frequency	Integration range	RMS jitter ^a	RMS jitter ^b
SRS FS725	10 MHz	1 Hz – 5 MHz	0.436 ps	0.437 ps
IDROGEN Master carrier board	100 MHz	1 Hz – 10 MHz	2.312 ps	0.768 ps
IDROGEN Slave carrier board	250 MHz	10 Hz – 10 MHz	2.307 ps	0.755 ps
SkyWorks SI 5362-FMC	178.5 MHz	1 Hz – 10 MHz	1.133 ps	1.119 ps
SkyWorks SI 5362-FMC	357 MHz	10 Hz – 10 MHz	0.906 ps	0.888 ps
SkyWorks SI 5362-FMC	178.5 MHz	1 Hz – 10 MHz	1.496 ps	1.491 ps
SkyWorks SI 5362-FMC	357 MHz	10 Hz – 10 MHz	0.889 ps	0.880 ps
SkyWorks SI 5362-FMC	178.5 MHz	1 Hz – 10 MHz	1.425 ps	1.420 ps
SkyWorks SI 5362-FMC	357 MHz	10 Hz – 10 MHz	0.875 ps	0.866 ps

^a the PN-PSD spikes contribution is taken into account

^b the PN-PSD spikes contribution is not taken into account

Low-level test results at ATF



✓ *Contribute to the beam stabilization monitor development for ILC main linac (ITN WPP-2)*

ML BPM (Korea University) Soohyung Lee

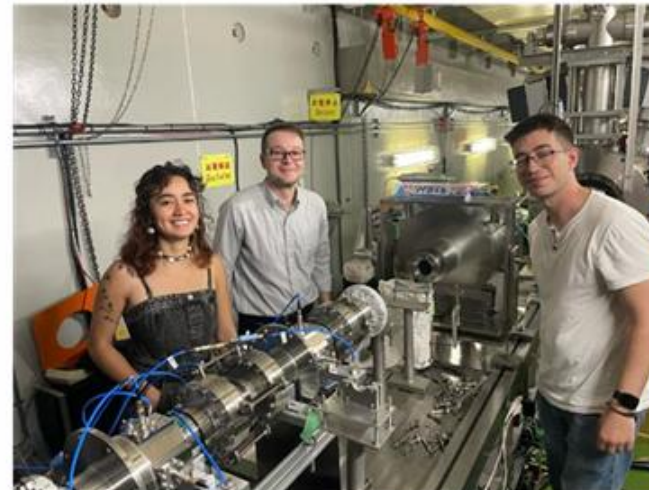
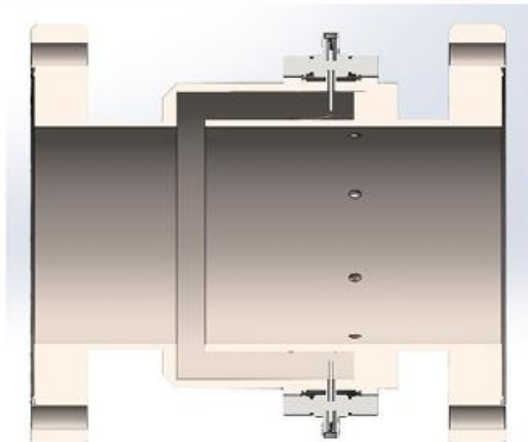
Possible contribution

- *BPM development for ILC ML (a part of contribution to ITN WP-2)*

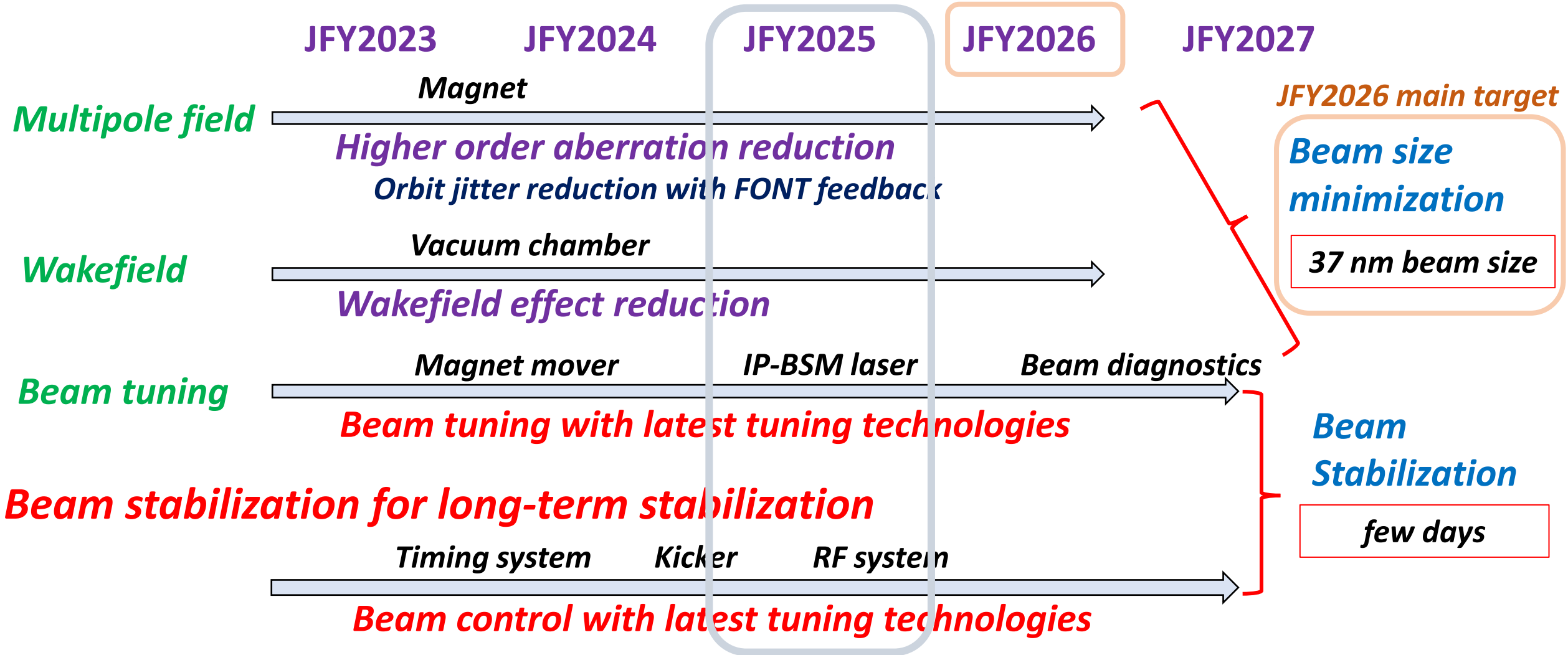
ML BPM (IFIC) Nuria Fuster Martinez, Laura Karina Pedraza

Possible contribution

- *BPM development for ILC ML (a part of contribution to ITN WP-2)*
- *Alignment test in cryomodule is also planed (not at ATF)*



The time schedule for nanobeam development of ATF2/ATF3

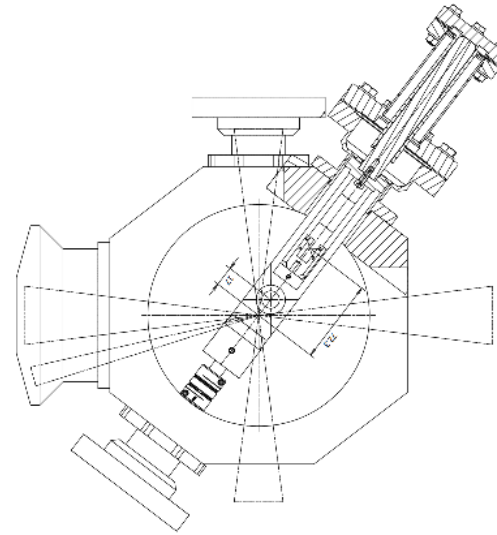
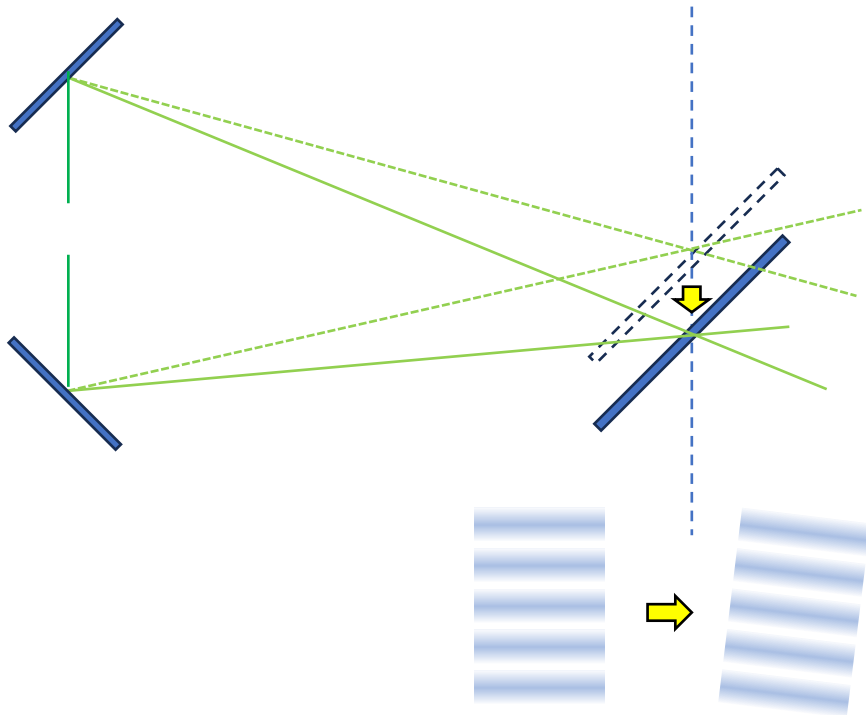


Highly quality beam diagnostic devices is necessary for this purpose.

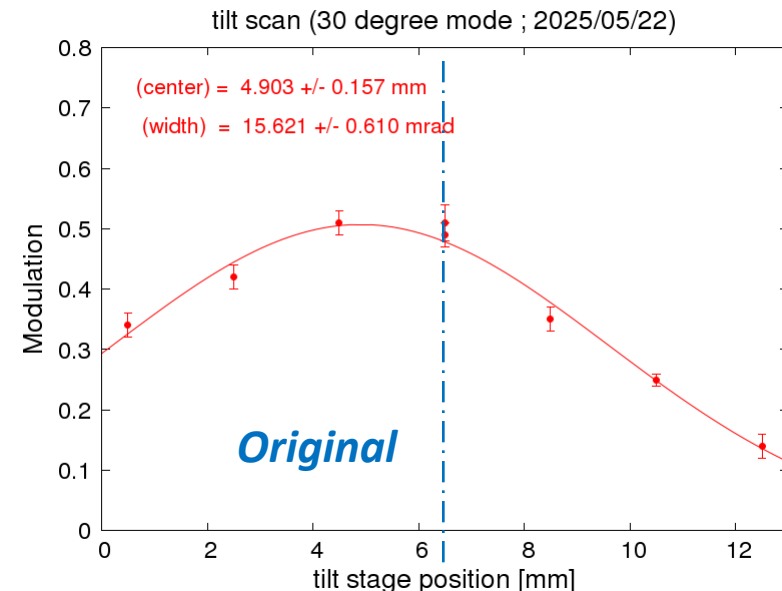
IP target replacement

- The new target was installed in the beamline in February 2025.

- If IP target is misaligned, **the laser interference fringes** used for IP-BSM may **be tilted**.
- It is necessary to identify whether the beam tilt observed by IP-BSM is due to the **monitor origin** or **the beam itself being tilted**.

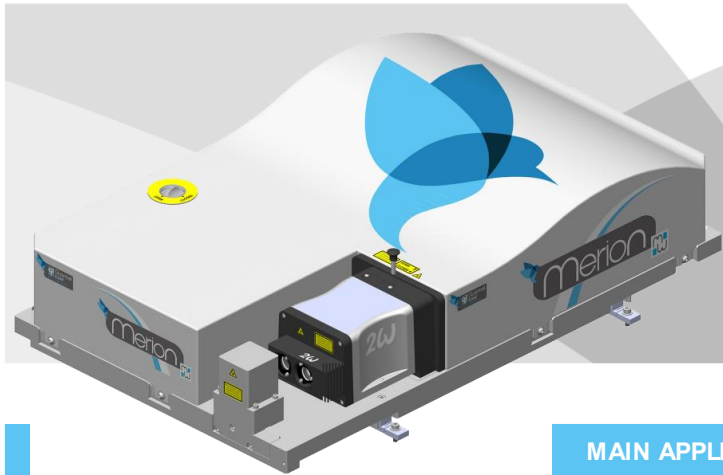


IP-BPM has been removed and replaced with a structure that supports the target from both ends.



New IP-BSM laser system

Laser head



New laser system timeline

- The bidding is finished.
- Quantel has won.
- **Delivery of the new system is expected in January 2026.**
- Laser installation will require:
 - Re-arrangement of the IPBSM laser table including, mechanical attenuator and periscope system.
 - Minor laser safety box modification.
 - Re-tuning of the laser path.
 - Laser control and monitor software.
 - Laser safety inspection.
- Initial startup and Quantel hands-on training is expected within 2 weeks after laser arrival to KEK.
- **IPBSM monitor full recovery and initial beam tests are expected within 1 month after laser arrival to KEK (mid- end February 2026).**

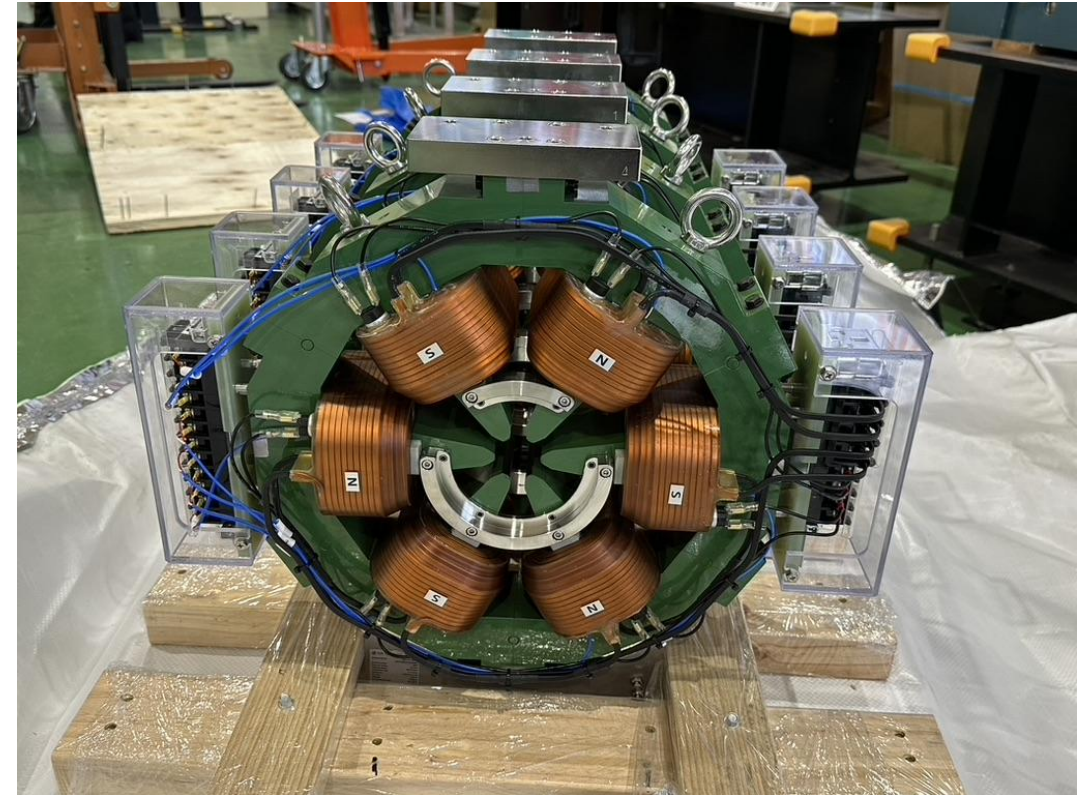
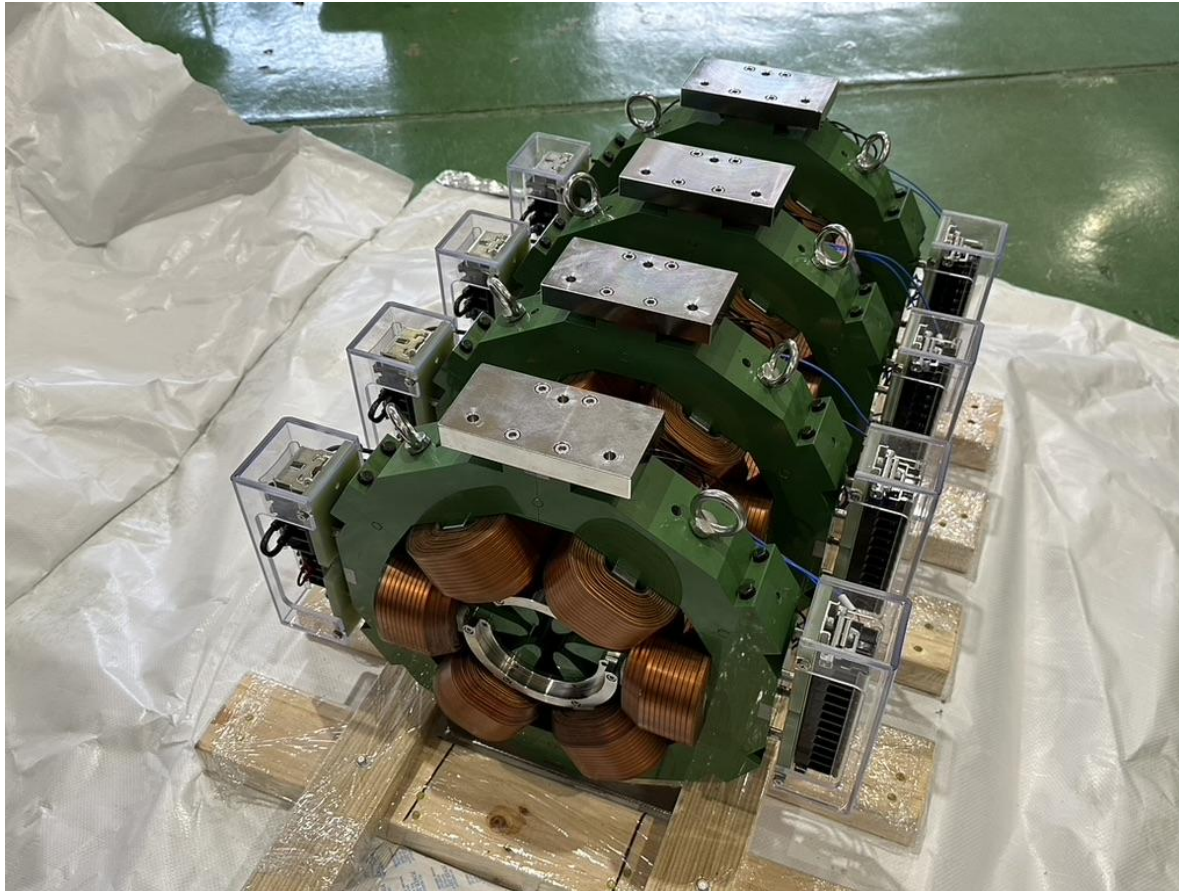
Parameter	Present system (USA)	Quantel/Lumibird
Representative in Japan	Spectra-physics.co.jp	Lumibird.com
Local support, parts	yes	yes
Model	Quanta-Ray PRO 350	Q-smart 1200
Pulse Energy, max @532nm	1.4J (we run w 50% splitter)	550 mJ
Pulse Duration	8ns	6.5 ns
Synchronization	yes	yes
Polarization ratio	> 90 %	> 90 %
Spatial profile	10 mm,	9 mm, Gaussian
Temporal profile	Gaussian	Gaussian
Fluence	0.764 J/cm ²	0.865 J/cm ²
Energy per pulse stability	2 %	1.3 %
Linewidth	0.003cm ⁻¹	0.005cm ⁻¹
M2	2	< 2
Pointing stability	50urad	25 urad
Variable attenuator	-	-
Footprint	1200x500x300 mm	800x500x200 mm
Delivery time	Already in use	4.5 month

Skew Sextupole magnets

2023 Design/manufacture/delivery

- The magnets were delivered on March 2024

2024 Installation and beam studies with the magnets

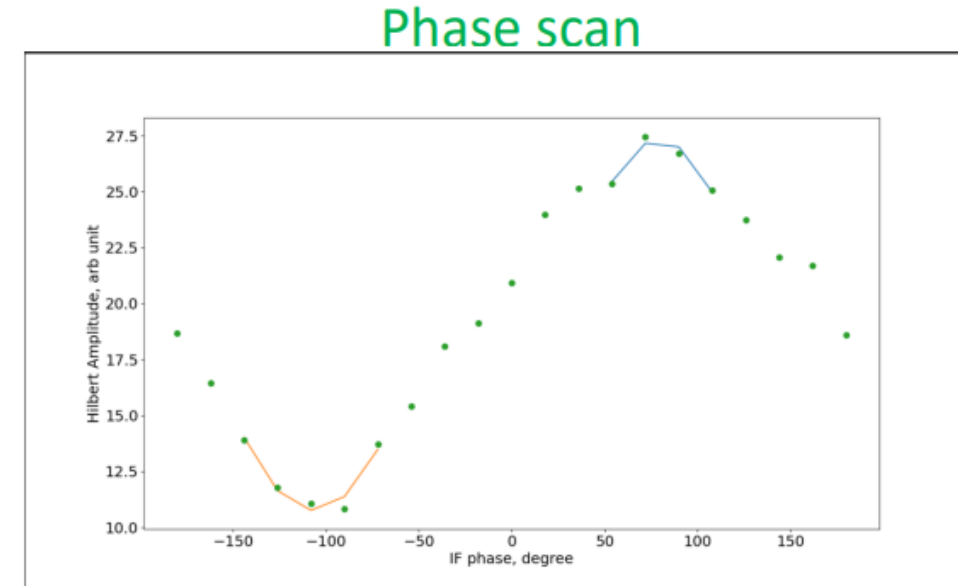
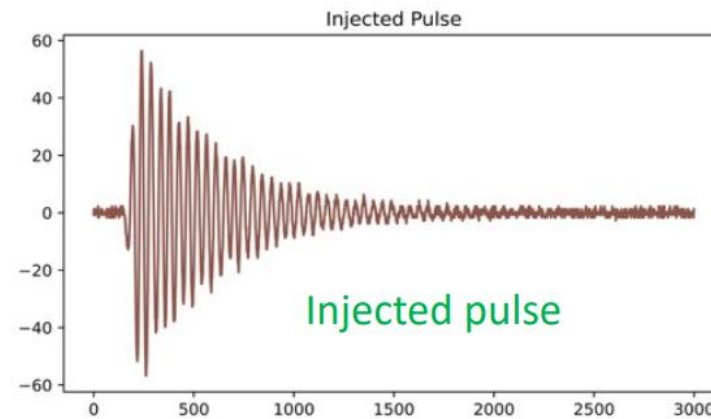
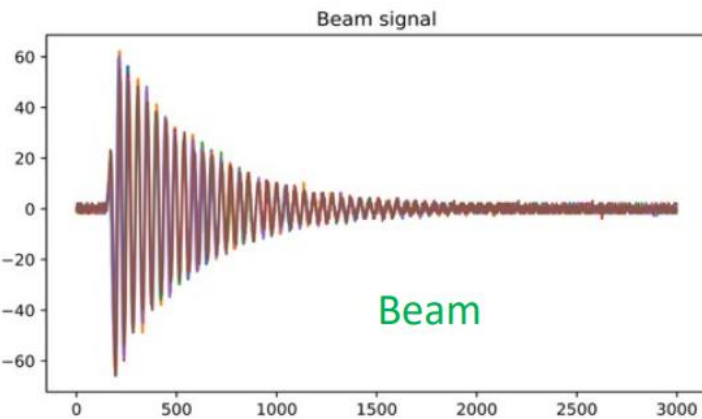


ATF2 Cavity BPM system with calibration pulse injection

Alexey Lyapin (RHUL) @LCWS2025

Calibration pulse injection

- *Cavity-quad offsets: reduce the useful dynamic range.*
- *Regular calibrations required.*
- *Wakefields (as a consequence of the offsets).*



Amplitude of the BPM signal (wakefield of cavity) was reduced by using calibration pulse injection.

Tentative beam operation schedules for JFY2026

- 14 operation weeks or more.

2026

April						
Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

May						
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
IPAC 2026						23
24	25	26	27	28	29	30
31						

June						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

July						
Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

August						
Su	Mo	Tu	We	Th	Fr	Sa
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

September						
Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

October						
Su	Mo	Tu	We	Th	Fr	Sa
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

November						
Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5	6	7
8	LCWS2026					14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					


December						
Su	Mo	Tu	We	Th	Fr	Sa
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

2027

January						
Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

February						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28						

March						
Su	Mo	Tu	We	Th	Fr	Sa
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

 candidate

 backup