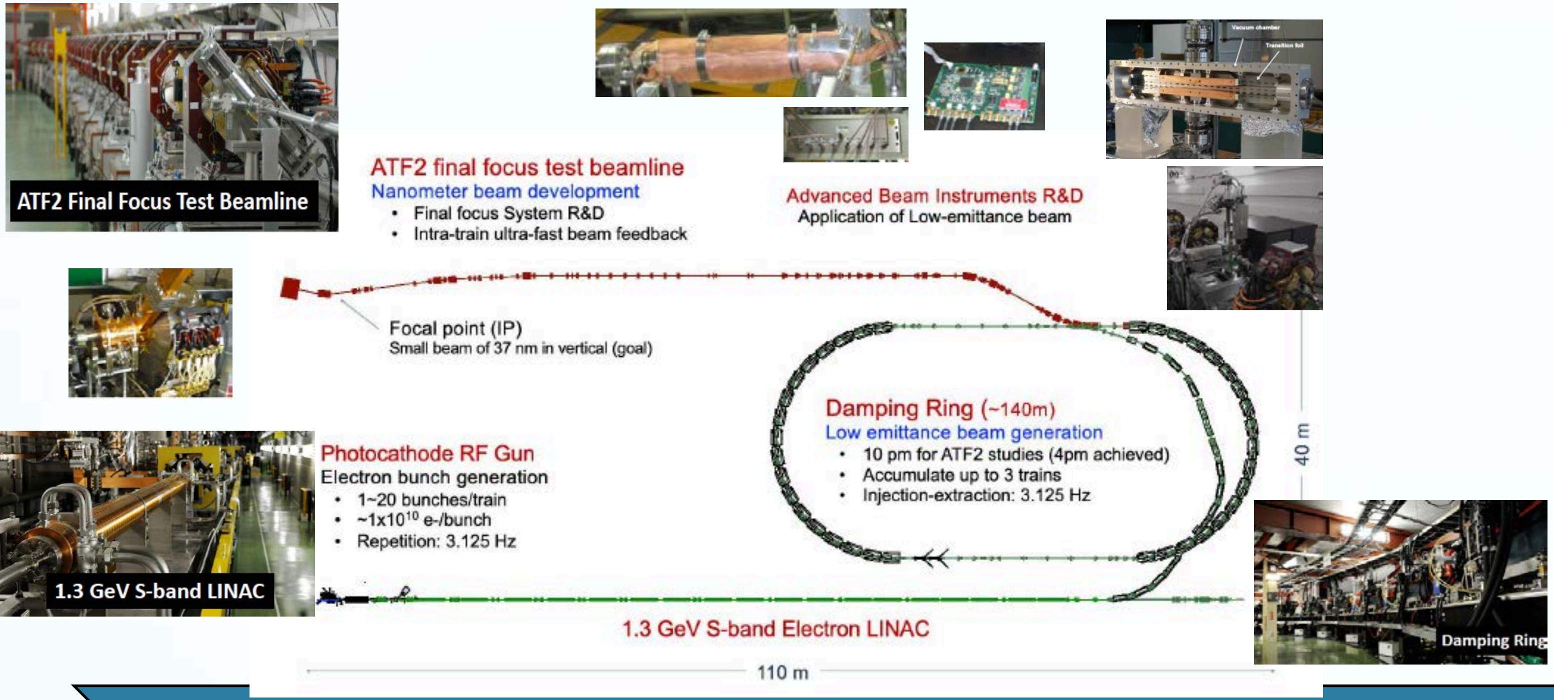
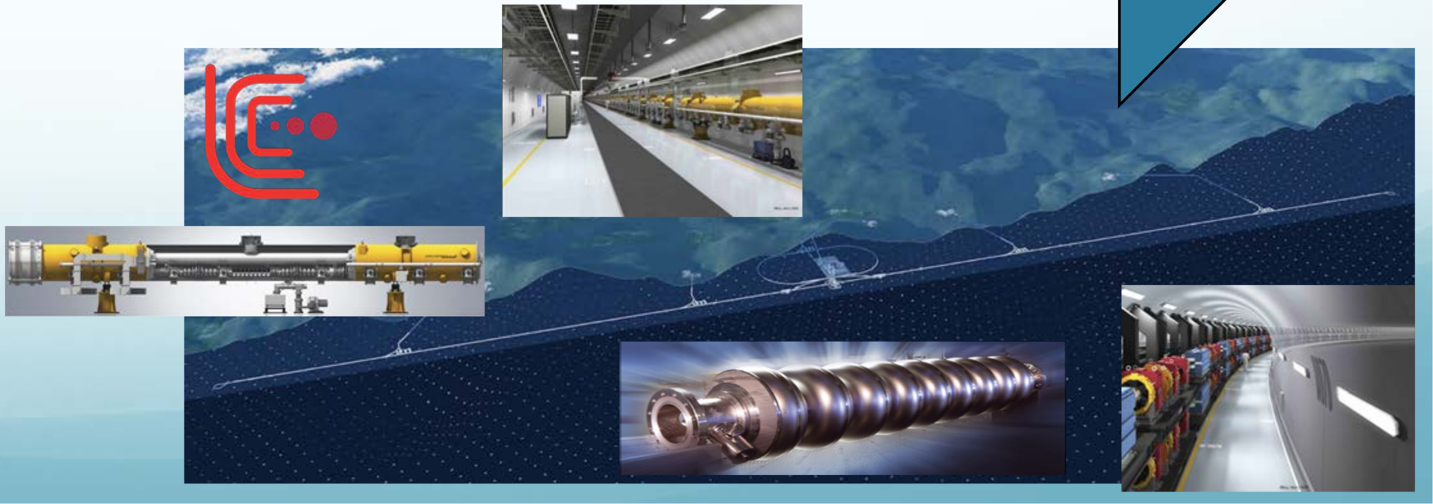


From ATF2 to ATF3

A. Faus-Golfe
on behalf of ATF extended TB



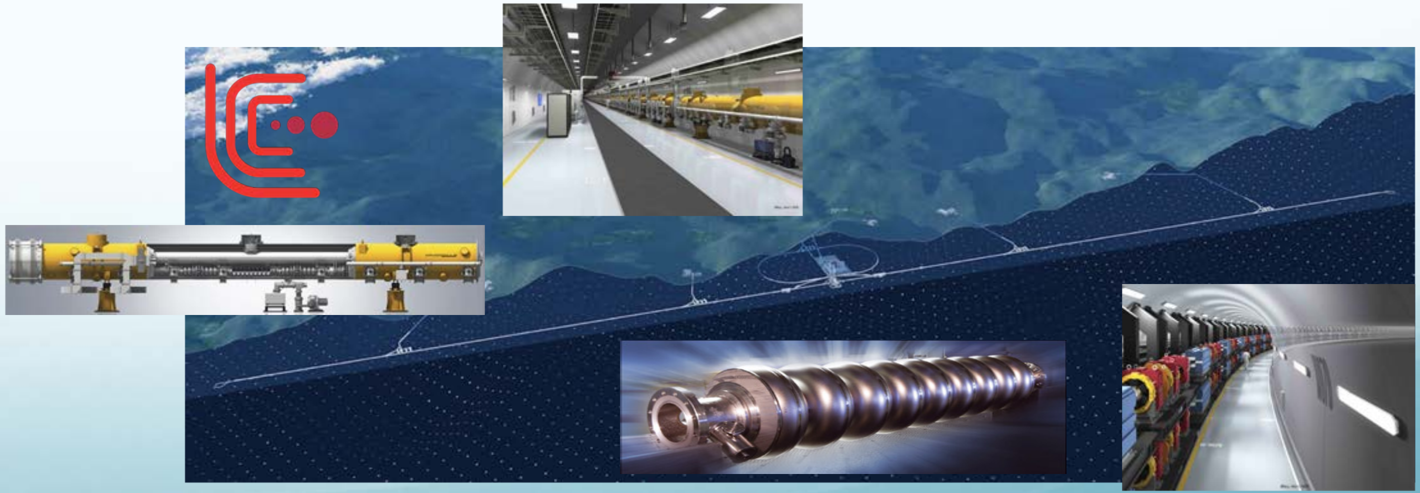
Outline

- ATF2 current status
  - Review process

ATF2 final focus test beamline

- ATF2 and ILC implementation plan

- ATF3



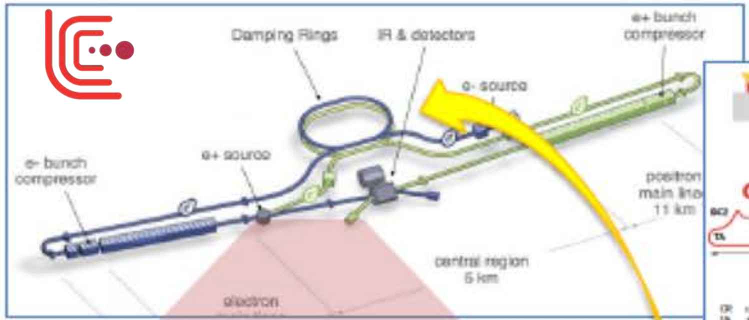
ATF2 the ILC FFS test

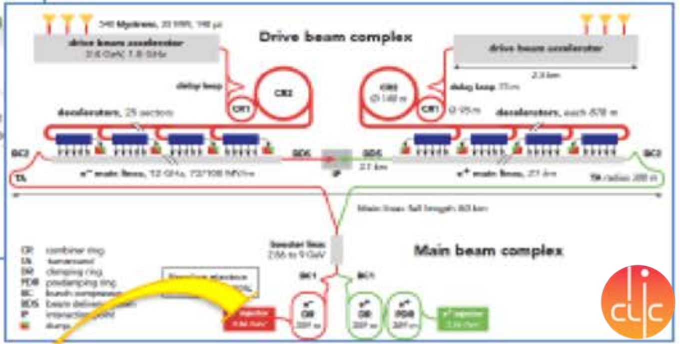
ATF/ATF2: Accelerator Test Facility

Courtesy: N. Terunuma

Develop nano-beam technology for ILC/CLIC

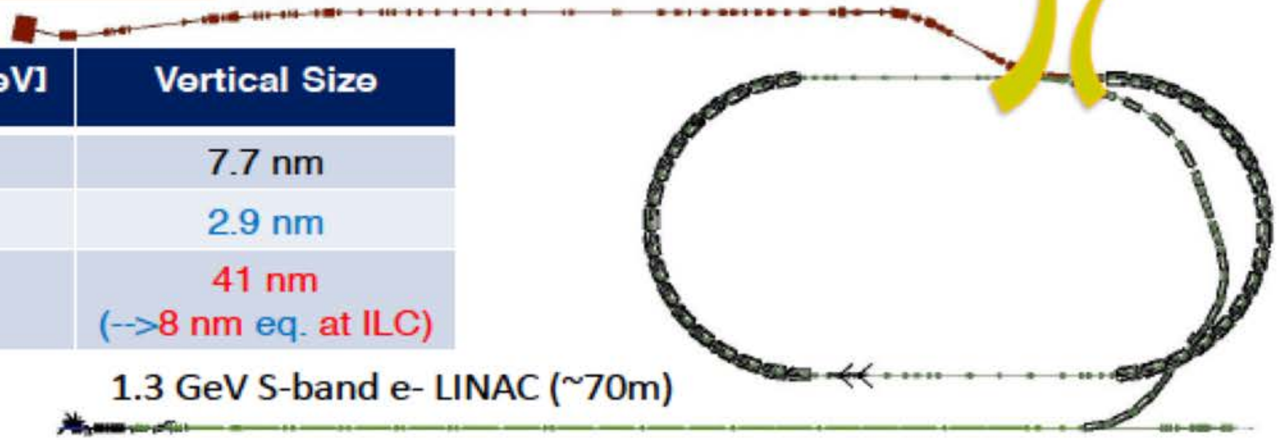
- Goal: Realize small beam-size and theStabilize beam position





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

1.3 GeV S-band e- LINAC (~70m)

A. Yamamoto, 190513bb

8

The context

FFS is among the most challenging sections of a linear collider

- Very-large β and the presence of nonlinear elements make it **extremely sensitive** to **imperfections as:**
  - **Wakefields** introduce energy spread, bunch head-to-tail distortions, and amplify transverse deflections
  - **Magnets misalignment** introduce dispersion, beta-beating, orbit deflections, transverse coupling, …
  - **Beam jitter** unavoidably cause betatron oscillations that propagate all the way to the IP, etc.

- In **ILC and CLIC**, the **much shorter bunch length** and the **much larger beam energy** make the situation **"simpler"**

- **ATF2** tackles its critical task with **two major disadvantages** w.r.t. its bigger brothers:
  - **Bunch length** is much longer: **7 mm** vs **300 μm**, about 25 times larger
  - **Beam energy** is significantly lower: **1.3 GeV** vs **125 GeV**, about 100 times smaller

- **Measurement** of the **nanobeam sizes involves a** complex device: Shintake monitor

The contex

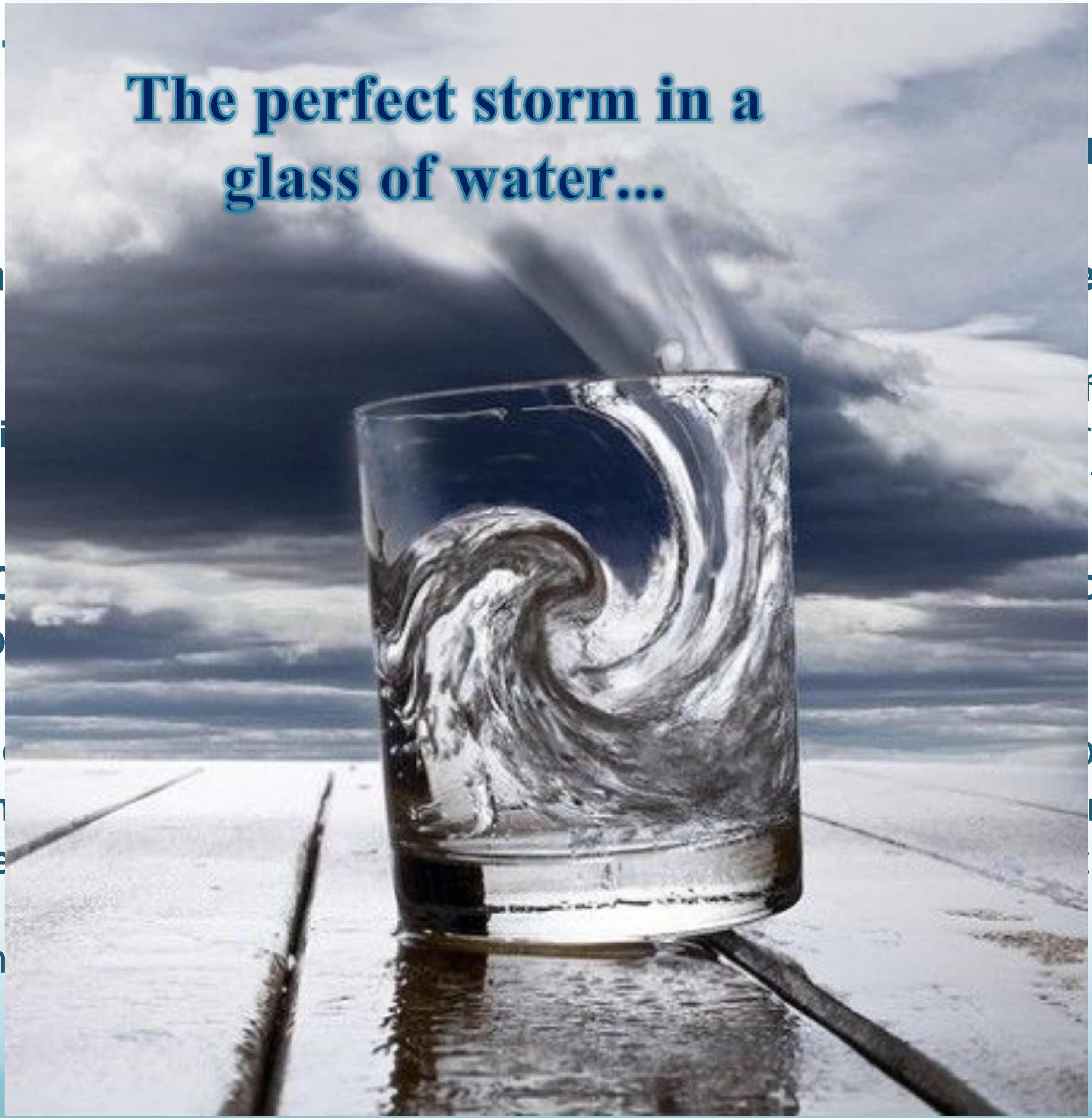
FFS is **r collider:**

- Very-large β an **xtremely sensitive** to **imperfections**
  - **- Wakefields** fy transverse deflections
  - **- Magnets mi** ansverse coupling, …
  - **- Beam jitter** to the IP, etc.

- In the **ILC and C** **h larger beam energy** make the situatio

- **ATF2** tackles its bigger brothers:
  - **- Bunch len** r
  - **- Beam ene** imes smaller

- **Measurement** of th



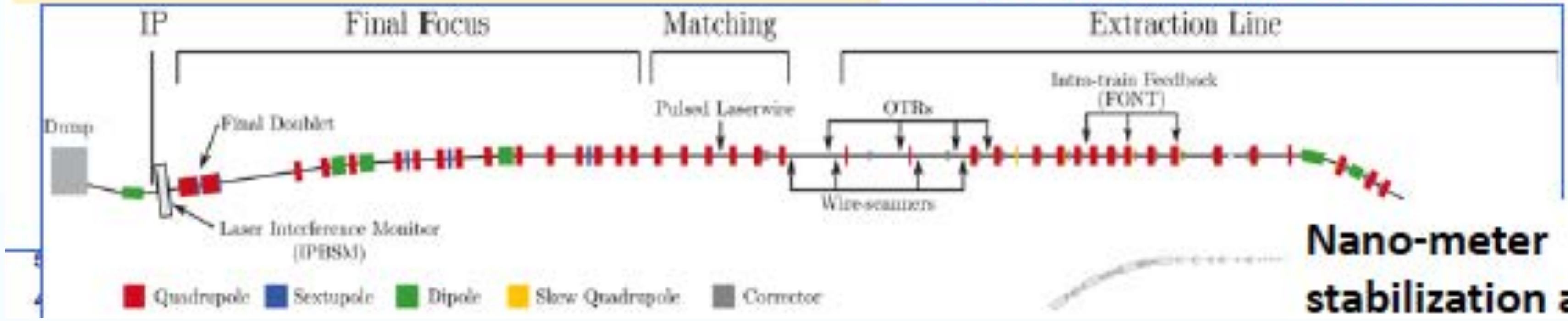
ATF2 goals

Goal 1: Establish the ILC final focus method with same optics and comparable beamline tolerances

- ATF2 Goal : **37** nm → ILC **7.7** nm (ILC250)
  - Achieved **41 nm** (2016)

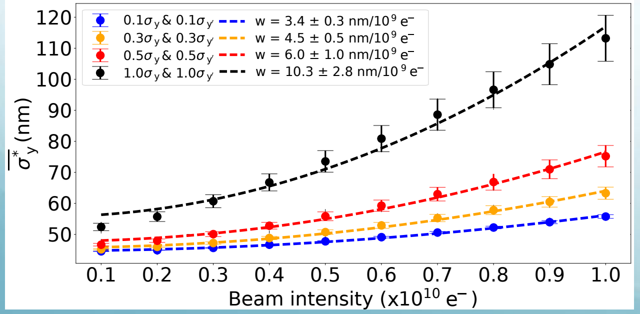
Goal 2: Develop a few nm position stabilization for the ILC collision

- **FB latency 133 nsec achieved** (target: < 366 nsec)
- **positon jitter at IP: 106 → 41 nm (2018)** (limited by the BPM resolution)

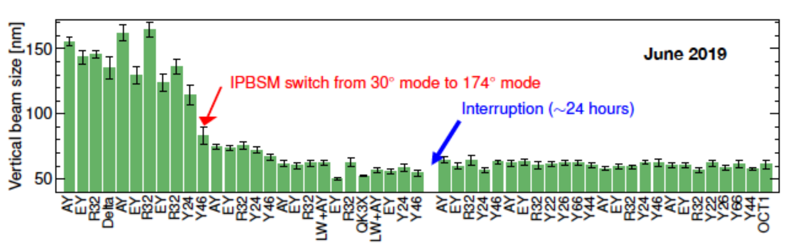


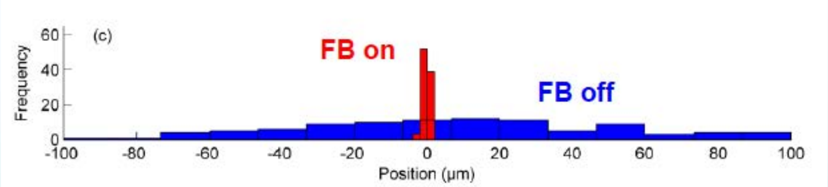
Nano-meter stabilization at IP

Intensity dependence studies

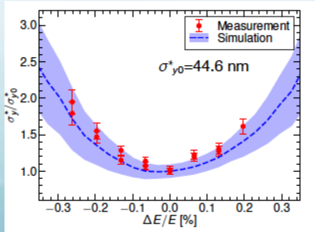


Ultra low β^* studies

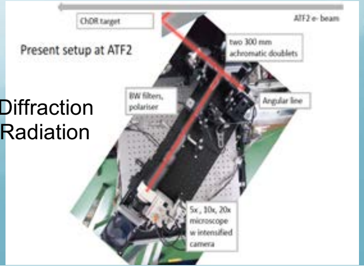




Instrumentation R&D

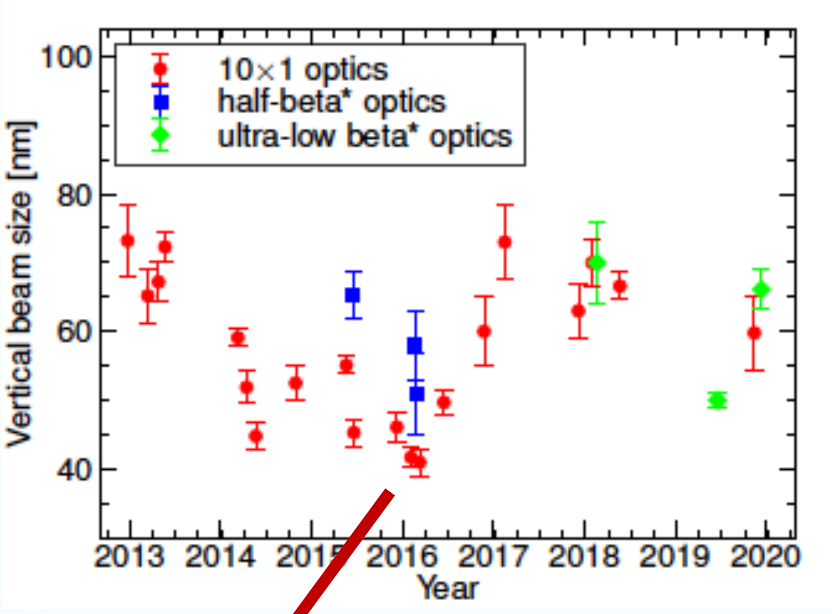


Incoherent Diffraction Cherenkov Radiation (ChDR)



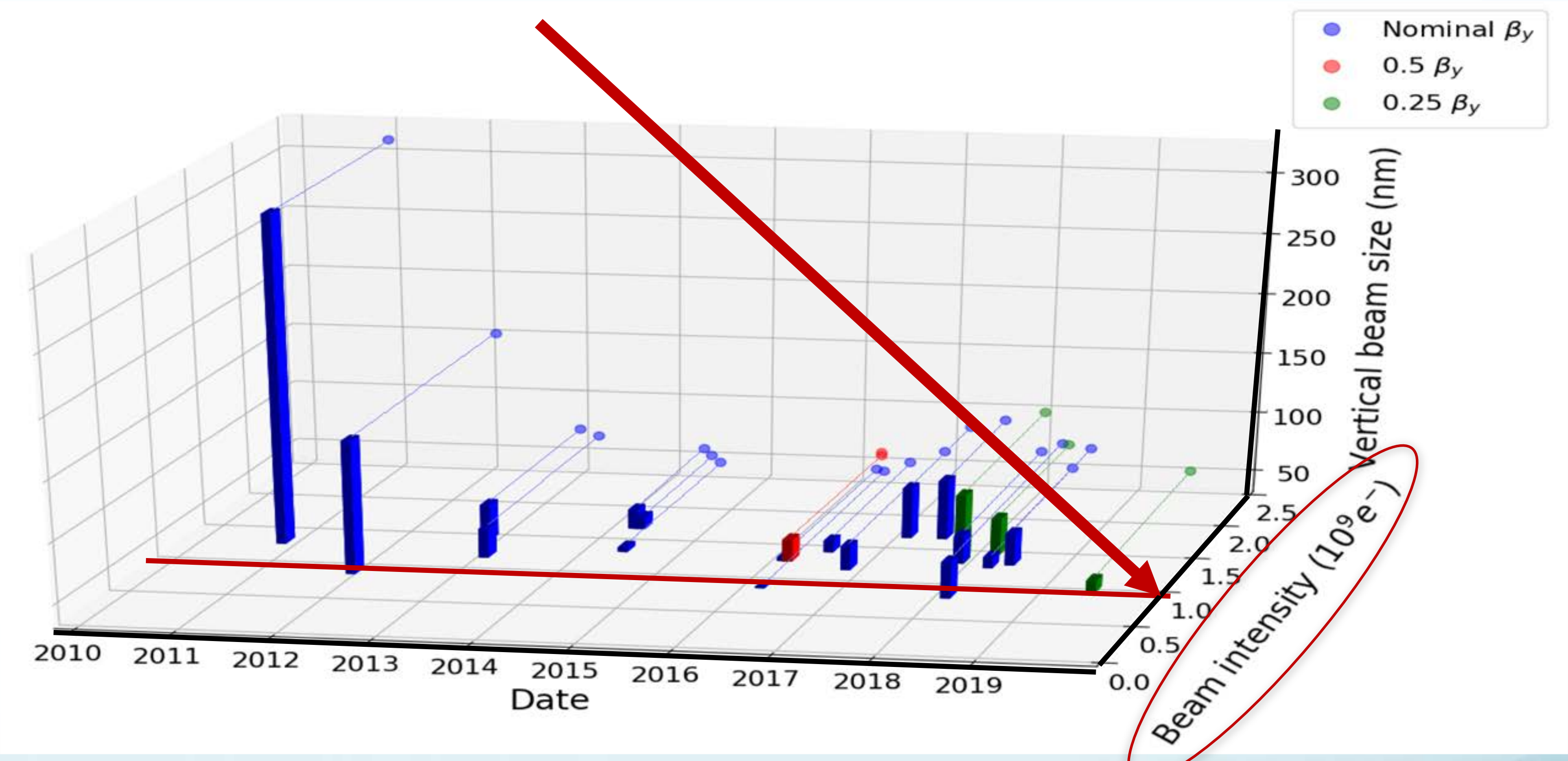
Intensity dependence studies (wakefields)

Beam size History



smallest beam size ~41 nm (2016)

But small beam sizes were obtained with beam intensities of 0.5-1.5 10^9 e^-/bunch (10^{10} design value)



Nominal ($10\beta_x^* \times \beta_y^*$)

Half ($25\beta_x^* \times 0.5\ \beta_y^*$)

Ultra-Low ($25\beta_x^* \times 0.25\ \beta_y^*$)

Beam size shows a degradation with increase of the intensity compatible with wakefields

Reduced optics aberration conditions

Design optics (β_x^* x β_y^*) not tested !!!

ATF2 Beam parameters

	ATF2 nominal	ATF2 half-β^*	ATF2 ultralow β^*
L^* [m]	1	1	1
β_x^* [mm]	4 (40)[b]	4 (100)[c]	4 (100)[c]
β_y^* [mm]	0.1	0.05	0.025
$\xi_y \sim L^*/\beta_y^*$	10000	20000	40000
ϵ_y [pm.rad]	12	12	12
σ_E [%]	0.8	0.8	0.8
$\sigma^*_{y,\mathrm{design}}$ [nm]	37	25	23
$\sigma^*_{y,\mathrm{measured}}$ [nm]	42.3 ± 2.7[b]/41.1 ± 0.7[b,e]	51 ± 6[c]	50.1 ± 0.6[c]

Relaxed optics ($10\beta_x^*$ x β_y^*) is the standard one

b: Optics with ($10\beta_x^*$ x β_y^*)

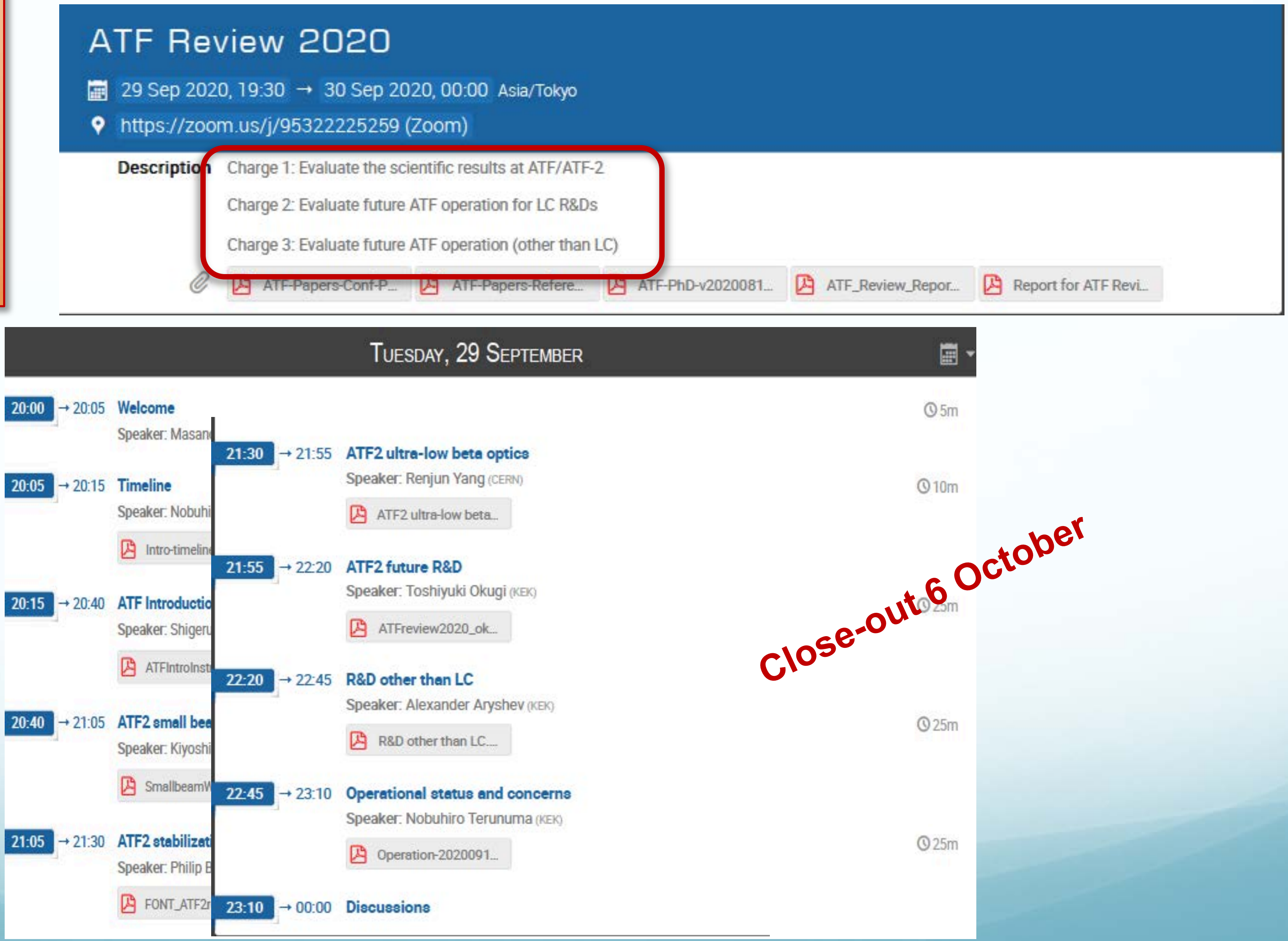
c: Optics with ($25\beta_x^*$ x half/ultralow β_y^*)

e: Results achieved with beam stabilization in two-bunch mode

ATF2 review

https://agenda.linearcollider.org/event/8626/

International Review Panel
K. Oide (chair)- KEK-CERN
V. Shiltev - FNAL
Z. Zao - SARI
T. Pieloni - EPFL
M. Kato - Hiroshima U.



Detailed info on:
***"ATF Report 2020"*, October 2020**
KEK report 2020-4
CERN-ACC-2020-0029
IJClab 2020-001

ATF2 close-out I

Overview- Charge questions

Q1: Scientific results at ATF/ATF2

Outstanding and unique results achieved in ATF/ATF2:

- ✓ The smallest spot size, 40 nm, in any accelerators.
- ✓ Intra-train bunch orbit feedback (FONT).
- ✓ Vertical emittance in the ring, 4 pm, smallest at the beginning of the century.

Pioneering developments on various accelerator components:

- ✓ Fast extraction kickers with rise/fall time less than 3 ns
- ✓ Laser wires measuring 1 μm beam size
- ✓ Cavity BPMs with 20 nm resolution
- ✓ Single- and multi- OTR/ODR beam profile monitors

Q2: Future ATF operation for LC R&Ds

- ➢ Intensity dependent effects on the spot size
- ➢ Optical aberrations <<< β_x*
- ➢ Beam halo and collimation
- ➢ Smaller spot sizes with higher chromaticities

Other components which will benefit the ILC preparation:

- ➢ Polarized e- source, transport, and storage in the DR
- ➢ Beam collimation study using fancy devices such as using a laser or another beam
- ➢ Beam feedback within one turn of the ring circulation to simulate a fast feedback at the extraction of the ILC DR

Q3: Future ATF operation (other than LC)

- ➢ ATF team to expand this effort internationally (conflict with the preparation of the ILC).
- ➢ KEK should not consider any shutdown before exploring the full scientific possibility of ATF

Remarks

- ➢ Contradiction between ILC preparation plan for the ILC in coming years and operation history of ATF in the past five years
- ➢ Cannot judge the feasibility of ILC future plan of the ILC, but still expresses heavy concern on the situation.

ATF2 close-out II

Timeline

- Refine the goal of ATF3 whether to cover other subjects presented in the review.

ATF Introduction, Instrumentation R&Ds

- Improve the instrumentation with AI technology application

ATF2 small beam, Wakefield

- Develop a long L* optics to evaluate optical aberrations.
- Try to squeeze βx^* for a better understanding of the optics

ATF2 ultra-low beta optics

- Continue the exploration of the ultra-low β optics and scaling of beam size with different optics with reduced β_x value (larger aberrations).
- Improve stability of beam size measurements (IPBSM) to resolve beam sizes even below 40 nm.
- Explore the method with a longer L* optics to keep the beam size resolution.
- Small beam tuning (below 50 nm) with nominal optics should be demonstrate to possibly demonstrate the octupole effectiveness

ATF2 stabilization (FONT)

- Give priority (and additional beam time) to allow optimization of the feedback system performance and detailed study of long-term beam trajectory control

ATF2 close-out III

ATF2 future R&D

- Develop a detailed resource-loaded plan for the ILC-related studies in the ILC preparatory period, under the given limited operation budget, availability of experts, and beam operation time.
- Consider an opportunity to carry out SC elements (magnets and cavities) in some other facility with existing cryog

R&D other th

- Continue the ef
other than ILC. The calling for proposals should be open and international
- Try to find more applications which require the flatness of the beam at ATF.
- Start to think about a possibility to convert ATF to a flexible, multi-purpose facility as exploring the possibility to collaborate with other facilities, institutes or universities.

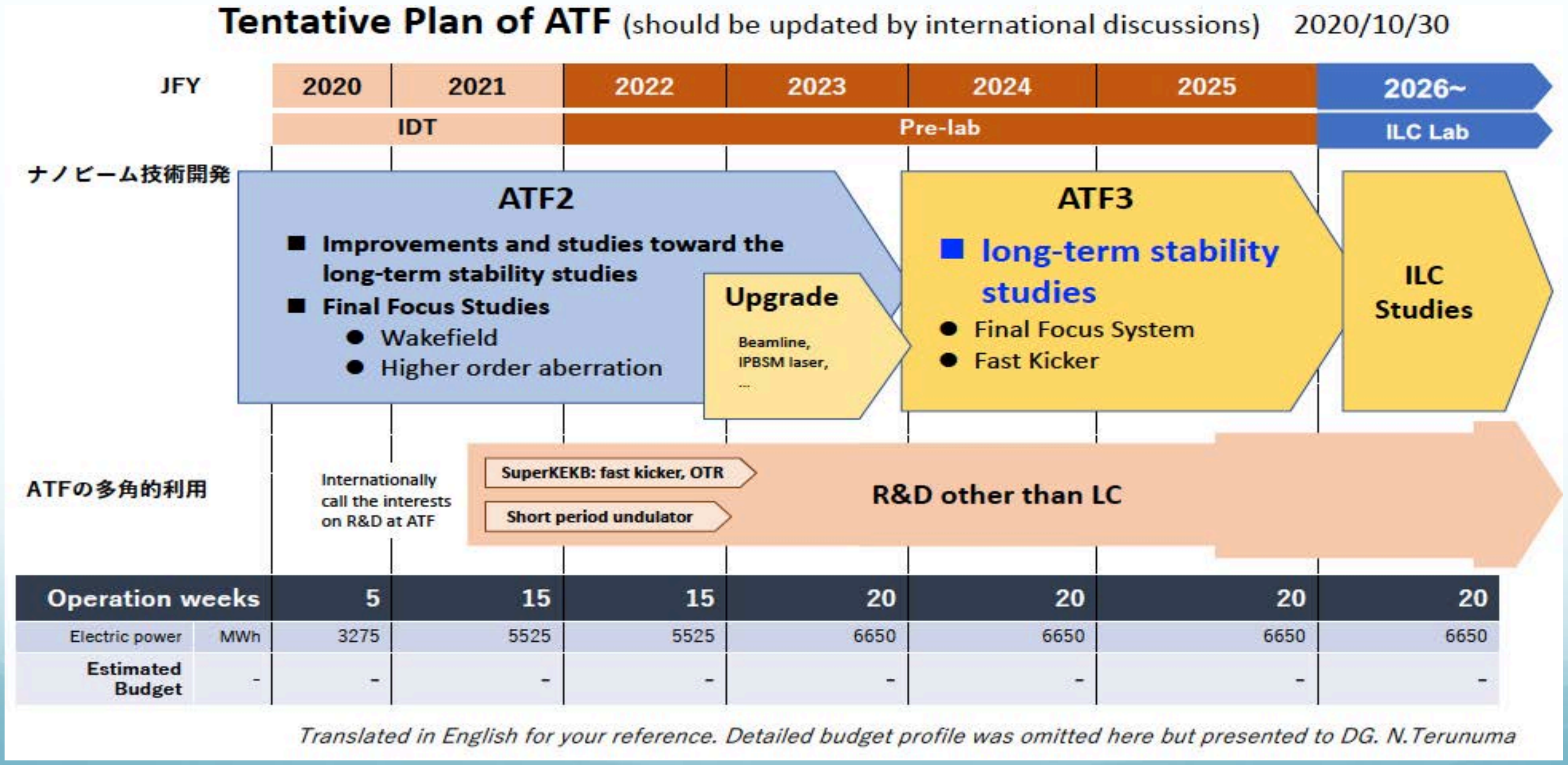
Operational status and concerns

- Consider merging activities at ATF, STF, cERL, etc., and flexibly use the limited budget and manpower
- Continue the efforts to get funds from outside of KEK
- Pay full attention by the entire KEK members
s

Based on this and with the support of the KEK DG we have started to plan the next operation years of ATF2 and the future ATF3

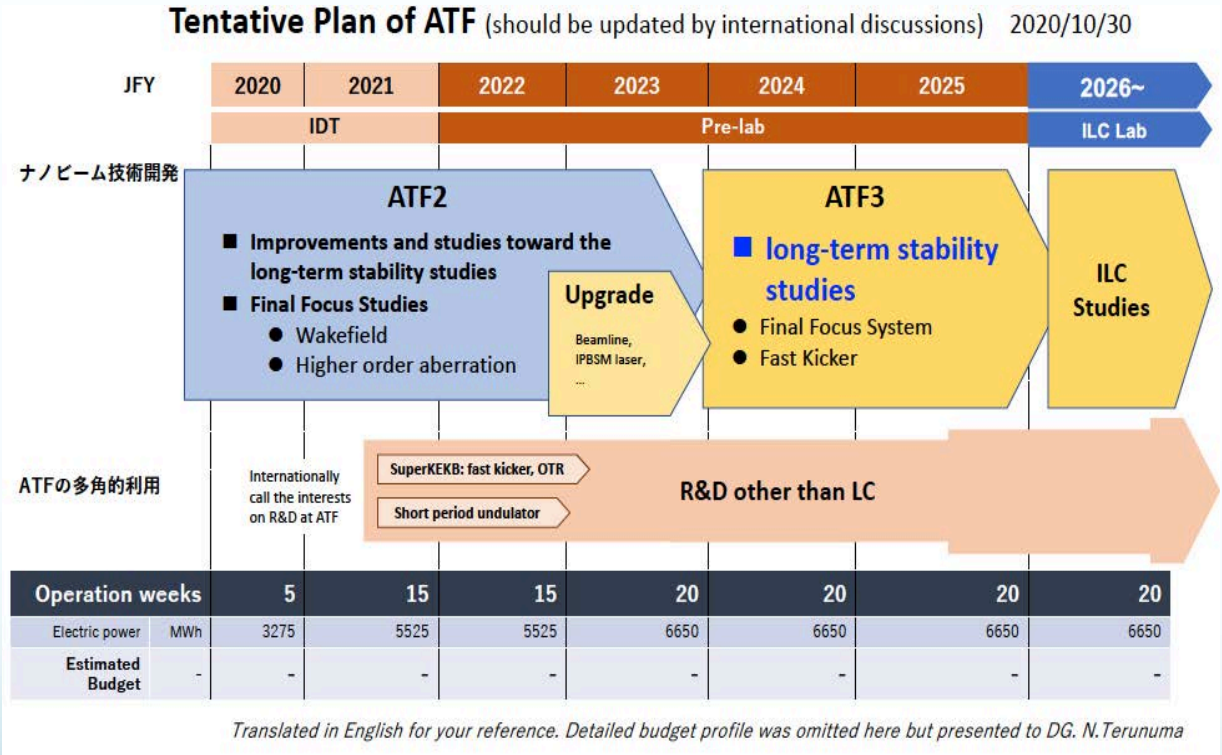
ATF3 objective and collaboration:

Based on the achievements of the ATF2, a follow-on upgraded facility **“ATF3”** for pursuing R&D to **maximize the luminosity potential of ILC** is necessary.



ATF3 objective and collaboration:

Implementation Plan



Extended Technical Board

N. Terunuma - KEK
A. Faus-Golfe - IJClab
T. Okugi – KEK
P. Burrows – JAI
A. Aryshev – KEK
M. Fukuda – KEK
S. Kuroda - KEK
L. Brunetti – LAPP
P. Bambade – IJClab
P. Karataev – RHUL
S. Stapnes – CERN
R. Tomas Garcia – CERN
A. Latina – CERN
R. Corsini - CERN
G. White – SLAC
K. Kubo – KEK
T. Naito – KEK
A. Lyapin - RHUL

ATF3 Implementation meeting Plan (Synergy with ILC-IDT WG2)

- ✓ **30 October 2020:** kickoff (Angeles) https://indico.in2p3.fr/event/22743/
- ✓ **6 November 2020**: Vacuum and Magnets upgrade (Nobuhiro) https://indico.in2p3.fr/event/22726/
- ✓ **13 November 2020:** CBPMs upgrade (Alexey) / beam tuning (Toshiyuki)) https://indico.in2p3.fr/event/22721/
- ✓ **20 November 2020:** ILC preparation (Okugi), CBPMs summary (Angeles) https://indico.in2p3.fr/event/22966/
- ✓ **27 November 2020:** 2nd order correction/wakefields (Kiyoshi), Continuous monitoring and stabilization (Laurent), IP-BSM laser upgrade (Alex) https://indico.in2p3.fr/event/22871/
- ✓ **4 December 2020:** ultra-low beta studies (Rogelio) / Assessing ATF3 beam-dynamics driven specifications (machine design robust to static and dynamic imperfections) and DFS/WFS implementation and other tuning techniques. (Andrea) https://indico.in2p3.fr/event/22947/

- ➢ **11 December 2020**: FONT Upgrade (Phil), IP-BPMs (Alex)
- ➢ **18 December 2020**: Multi-OTR (Alex)

Meetings in progress

ILC- IDT WG2: DR / BDS / DUMPS

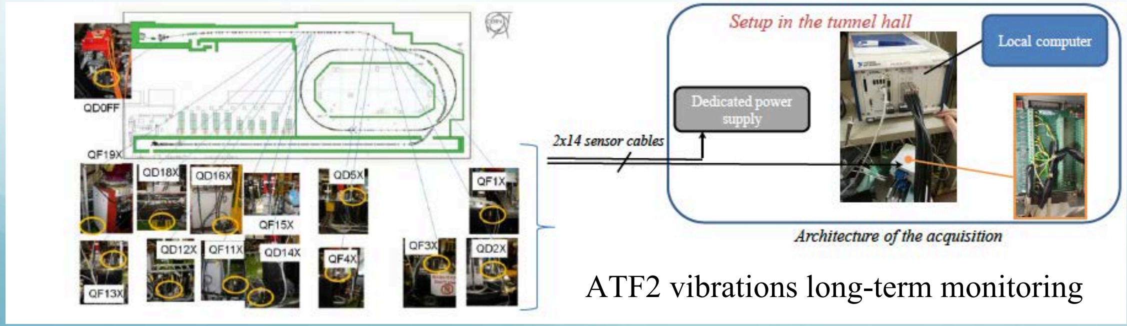
						EDR				
				2022	2023	2024	2025			
	Grade	Items	Technical Preparation	P1	P2	P3	P4	FTE	budget [kUS$]	candiate collaoration
Damping Ring	B	DR optics	System design : Optics optimization with magnet model					2	20	UK national LS, Cornell, LBNL
	B		Simulation : Dynamic Aperture					2	20	UK national LS, Cornell, LBNL
	B		Normal Magnet Magnet : Magnet design					1	10	
	B		Permanent Magnet : Magnet design					2	20	UK national LS, ESS-Bilbao, BNL, LBNL
	B		Permanent Magnet : Prototype (?)					3	600	UK national LS, ESS-Bilbao, BNL, LBNL
	B	Collective effect	Simulation : Electron Cloud Instability					2	20	UK national LS, Cornell, LBNL
	B		Simulation : Ion trapping Instability					2	20	UK national LS, Cornell, LBNL
	B		Simulation : Fast Ion Instability					2	20	UK national LS, Cornell, LBNL
	A		System design : Orbit FB for Fast Ion Instability					1	10	DAΦNE, ESRF, ...
	A		Beam test : Orbit FB for Fast Ion Instability					5	1000	DAΦNE, ESRF, ...
	A	Injection/extraction kickers	Fast kicker: System design; DR and LTR/RTL optics optimization					1	10	(KEK), ...
	A		Fast kicker: Hardware preparation; based on FID pulser					2	200	(KEK)
	A		Fast kicker: System design & Prototyping ; based on induction kicker							CERN, BSS-Bilbao, SLAC
	A		Fast kicker: Long-term stability test at ATF					2	100	ATF (ATF3) collaboration
	B		E-driven kicker: System design, include the induction kicker development							CERN, BSS-Bilbao
		RF system	Prototype test					N/A	N/A	N/A
		Wiggler Magnet	Prototype test					N/A	N/A	N/A
	B	EDR	Engineering design of the damping ring					5	50	
BDS, MDI	**B**	**Final focus optics**	**System design : hardware optimization, include intensity dependence simulation**							ATF (ATF3) collaboration
	B		**Beam test : Intensity dependence correction**							ATF (ATF3) collaboration
	B		**Beam test : 2nd order optics correction**							ATF (ATF3) collaboration
	A		**Beam test : Long-term stability test at ATF**							ATF (ATF3) collaboration
	B	Final doublet (incl. Anti-solenoid)	System design (include the anti-solenoid)					2	20	BNL
	B		Vibration test					1,5	360	BNL
	B	Crab cavity	System design	discussion with SCRF subgroup						
		Anti-solenoid	System design and vibration test	considered within FD package						
		Anti-DID	System design	considered as detector matter						
	B	EDR	Engineering design of the BDS, MDI					5	50	
Beam Dump	A	17MW main dump	System design of water flow system							
	A		System design of window sealing and remote exchange							
	A		System design of countermeasure for failure							
	A/B (?)		Robustness test of window							
	B	300kW photon dump	System design							
	B	EDR	Engineering design of the beam dump					2	20	
Rank	A	Technical preparation, which is recommended by KEK ILC international WG								
	B	Technical preparation, which is necessary to write EDR								

ATF2 (2020-2023) :
Beam tests: Long-term stability

- **High-order aberrations**
  - Design (β_x^* x β_y^*) & Ultra-Low-β_y^*
  - 2nd order correction knobs assessment
  - Energy bandwidth measurements

- **Wakefield evaluation and mitigation**
  - Upstream beam line (relatively low- β_y)
  - Movable set-up mitigation techniques

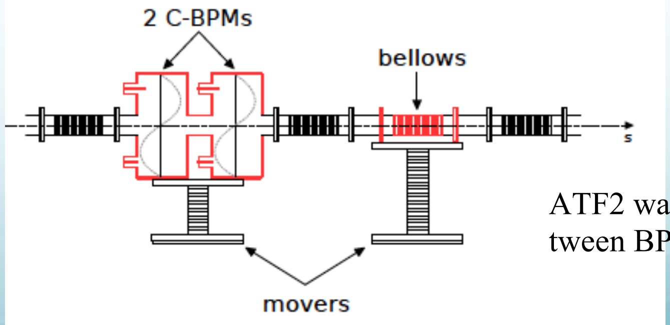
- **Vibrations long-term monitoring system**



ATF2 vibrations long-term monitoring

- **Jitter sources assessment**
  - Measurements (entrance/IP)

- **CBPMs calibration process upgrade**
  - Duration of calibration optimization
  - Lifetime - degradation of calibration over time
  - New time and phase invariant digital processing software to be developed, algorithm could first be tested on simulated data.



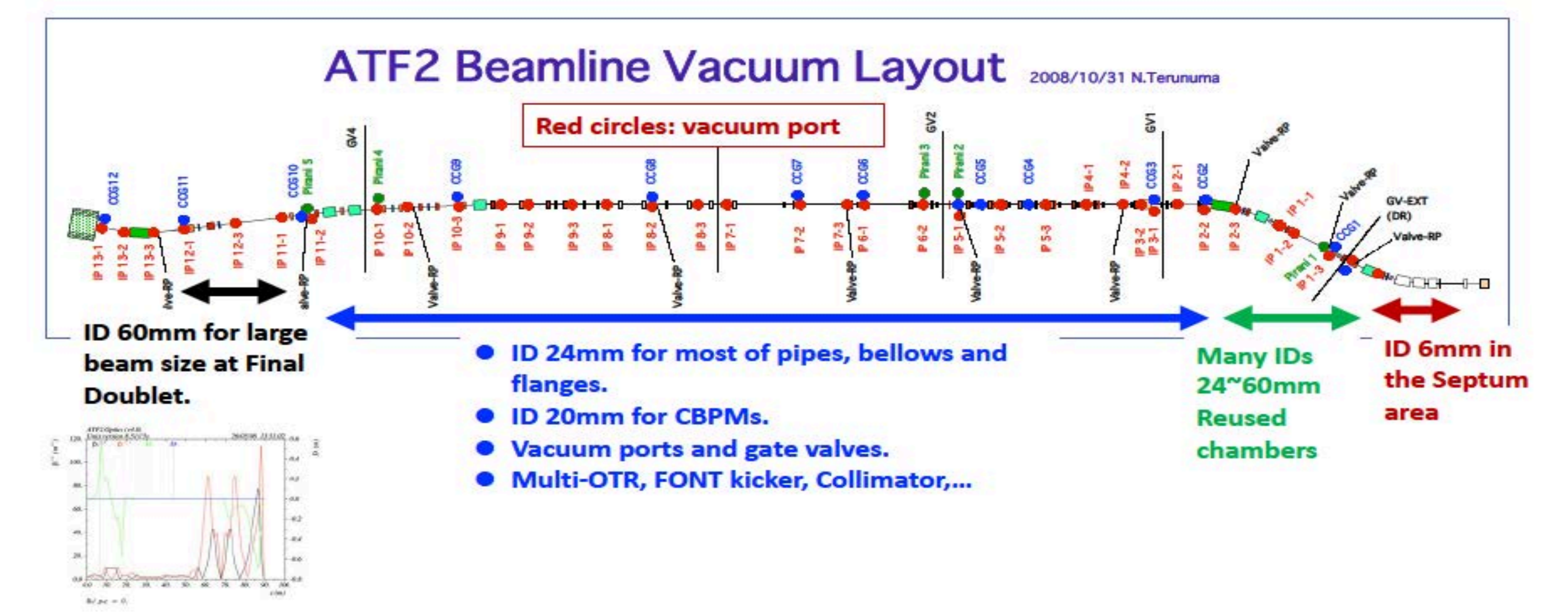
ATF2 wakefield knobs system between BPM QD10BFF and QD10AFF

ATF3 (2024-2025...):

System design: Hardware optimization I

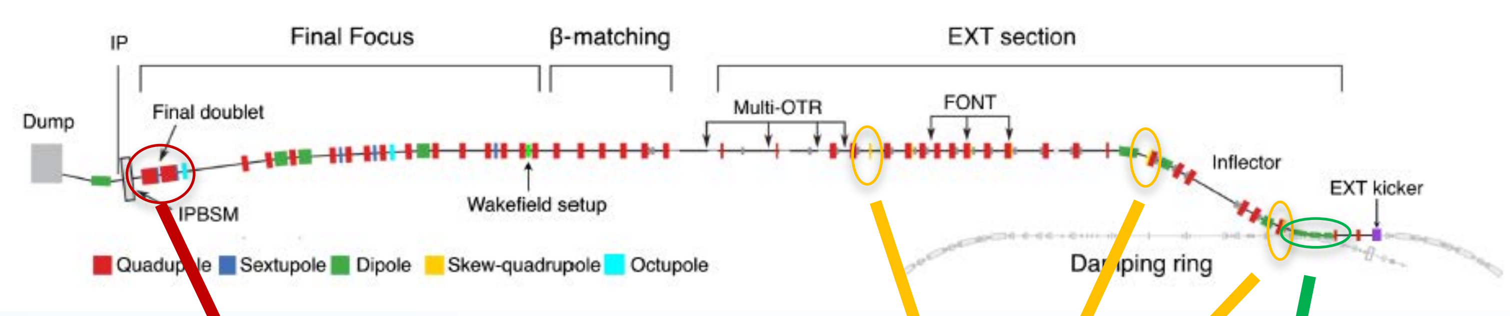
Why this is needed?

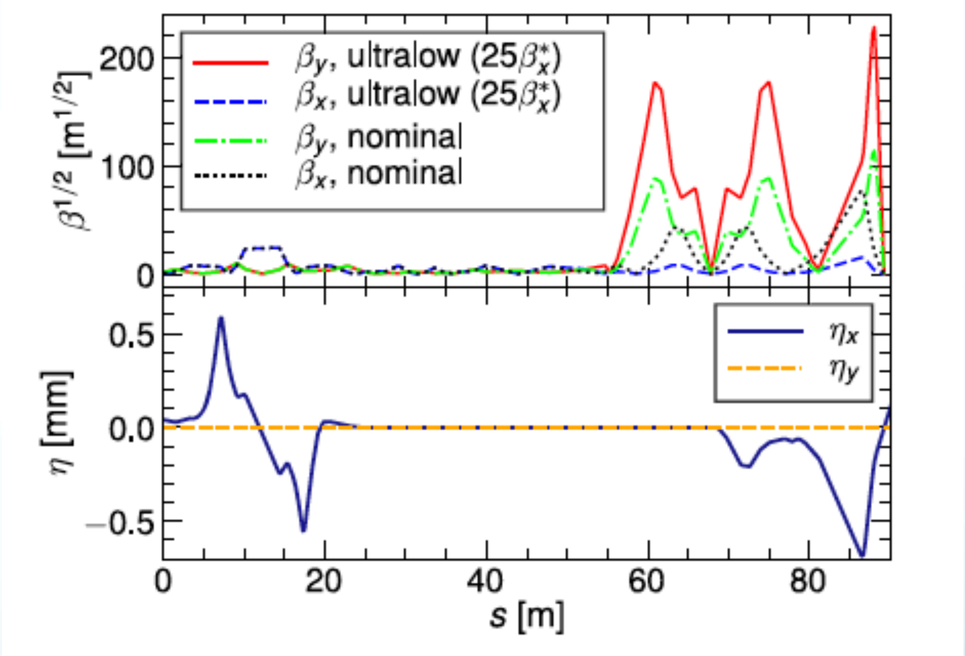
- **Vacuum Chambers**
  - Most of the present EXT-FF vacuum chambers are reused /duplicated
  - The standard ID beam pipe is 24 mm, but due to additional features, the special sections use different cross sections.
  - Wakefields on the EXT line was not taken seriously as the beam passed once, while that on the DR was considered because of the multi-turn of 2 MHz.



System design : Hardware optimization II

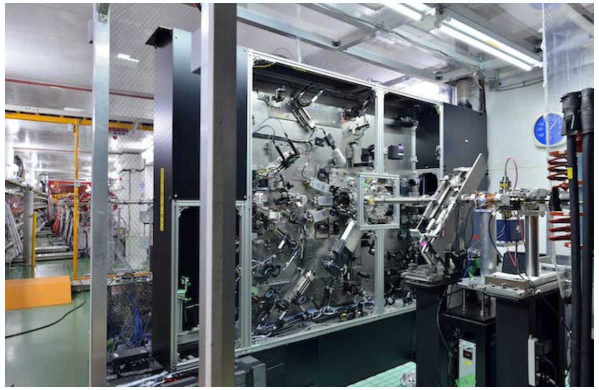
Why this is needed?





- **Magnets**
  - FD magnets recup from SLAC
  - Skew sextupoles poor assembling
  - Septums not optimized....

System design : Hardware optimization III



IPBSM (nanometer beam size monitor)

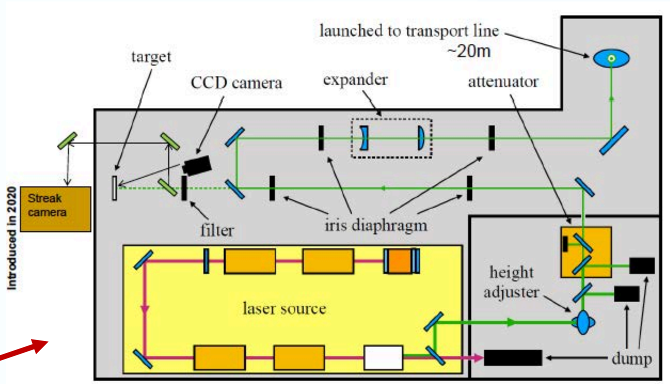
Why this is needed?

➢ **IP-BSM Laser current problems:**

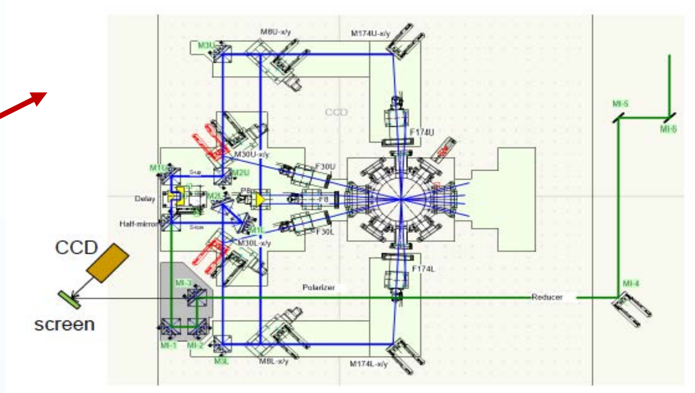
- Stability (Energy, Modes = fringe pattern)
- Laser beam parameters reproducibility and resolution
- Nd:YAG Laser aging (tuning, dust, etc)
- Laser Transport Line (LTL) and laser FF-IP tuning and optimization

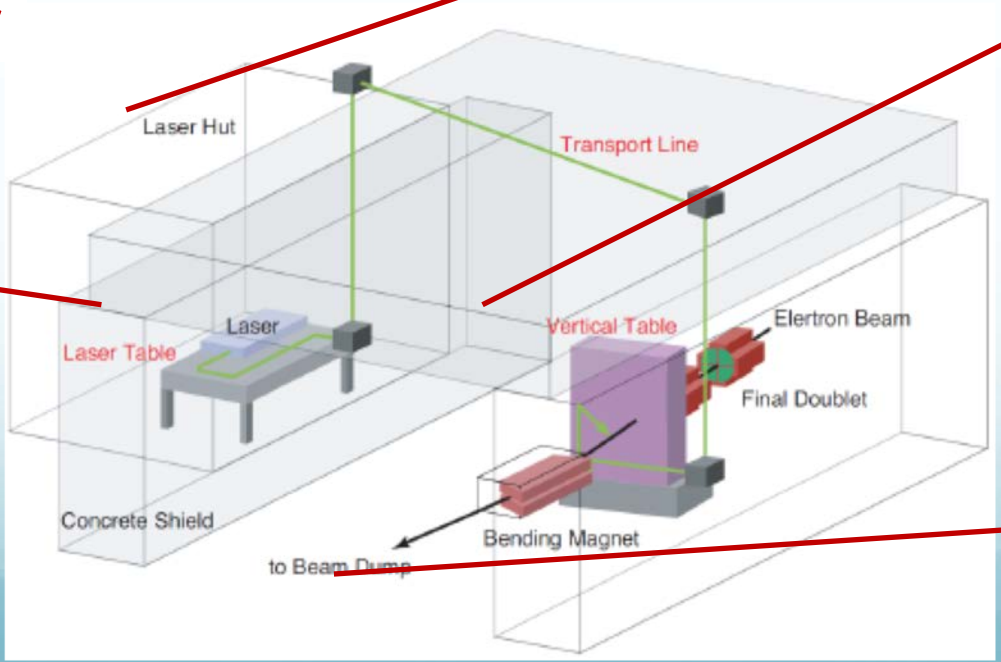
IP-BSM is not just a laser

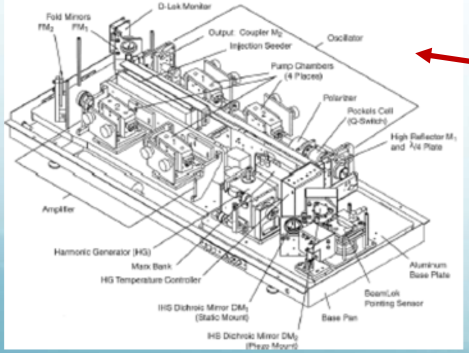
Laser Hut



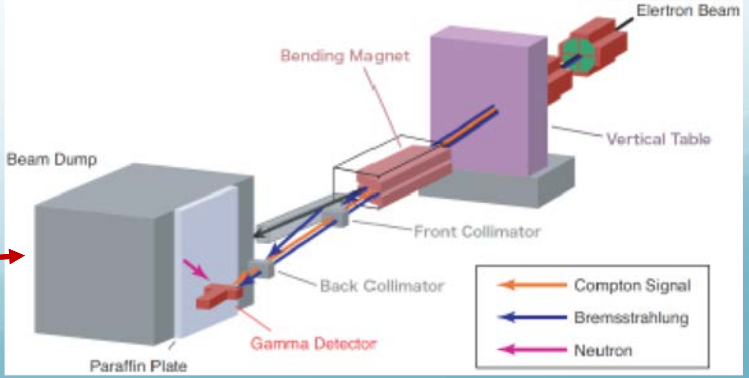
Vertical Table







Spectra-Physics Quanta-Ray PRO 350



System design : Hardware optimization IV

➢ **Vacuum Chambers** (ID beam 24 mm):

- Bellows shielding
- Clamp Flanges (ATF-DR type)
- Cavity BPM tapering (ID 20 mm)
- Stripline BPMs
- Dipole chamber (box type replaced by simple pipe)
- Septum chambers (A, B, C)
- FONT stripline kicker
- Pumping port chamber (ID 24 mm)

➢ **New Magnets**

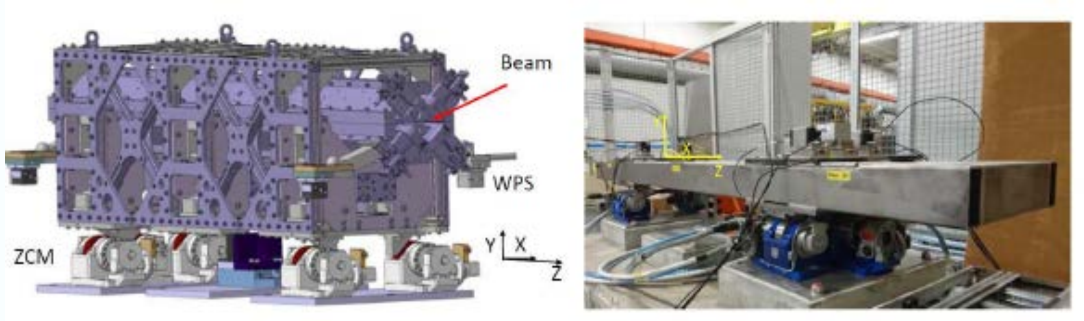
- FD: QD0, QF1, SD0, SD1
- Skew sextupoles including movers
- Septum C (standard dipole)
- ZVOX (between septum B and C)

➢ **CBPMs:**

- Re-installation of all CBPMs (current #24, all #32)
- Add separate fast small movers for centering and position calibration, including mechanical study, specs (~10kg load and um resolution, prioritize high-β regions)
- Electronics: analogue electronics reliable but spares needed
- Digitizers: 20-year old model, higher resolution ADCs would increase the dynamic range.

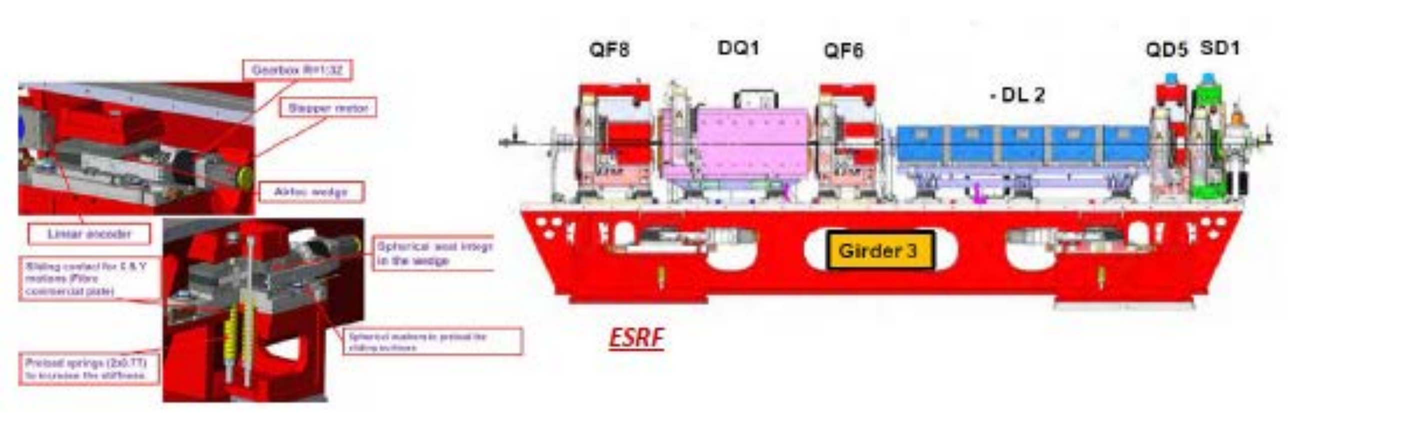
System design : Hardware optimization V

- **IP-BSM Laser:**
  - Nd:YAG laser replacement choice, new laser parameters
  - Start LTL, FF-IP simulation study
  - Start laser stability study (energy, pointing, mode, and fringe pattern)
  - e-beam arrival and timing jitter



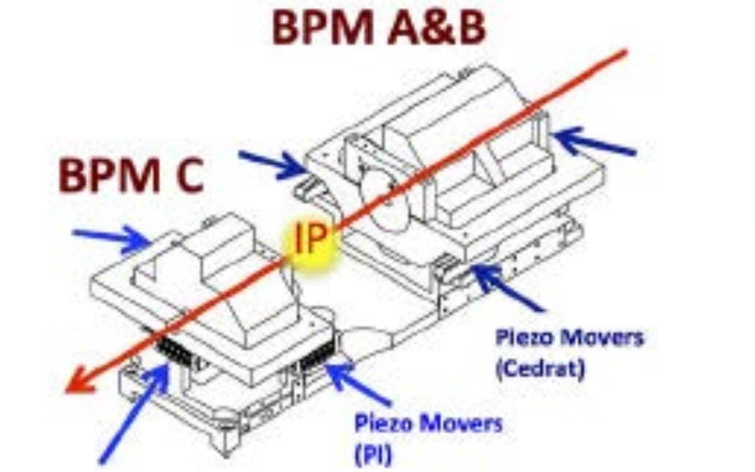
CLIC : Type 4 MBQ and stabilization system mounted on cam movers (left) and test setup including ZCMs, follower girder and local coordinate system (right).

- **FD vibration girder**
  - Girder for all the final elements coupled with a global positioning system

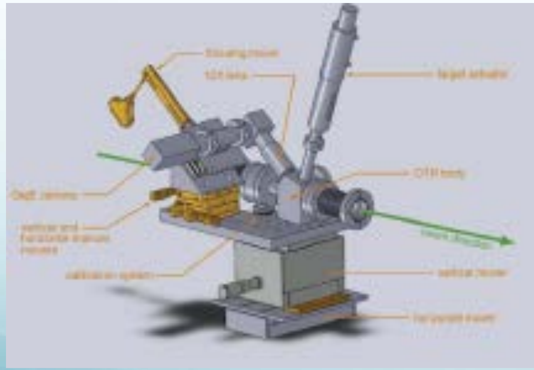


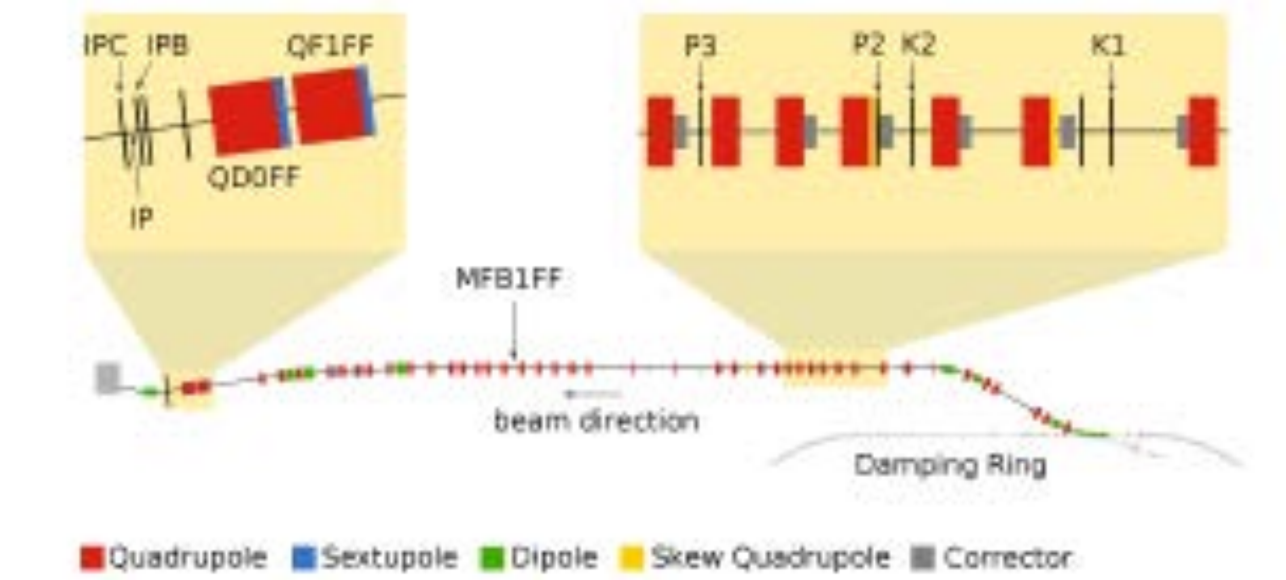
System design : Hardware optimization VI

- **IP-BPMs**
  - Re-desin towards sub-10 nm, wide dynamic range and linearity
- **FONT feedback**
- **Multi-OTR system**



Layout of the three Cavity BPMs at ATF2-IP

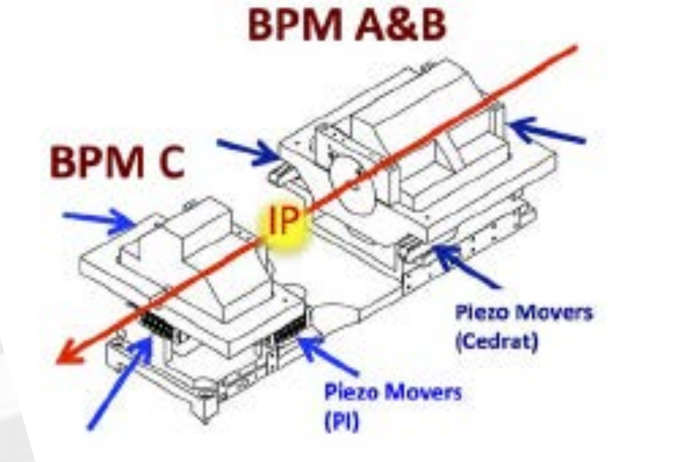

Multi-OTR system



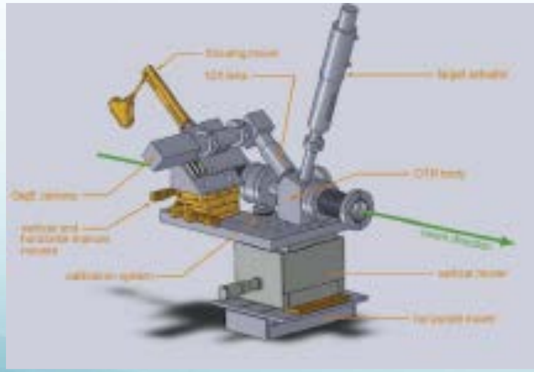
FONT feedback system

System design : Hardware optimization VI

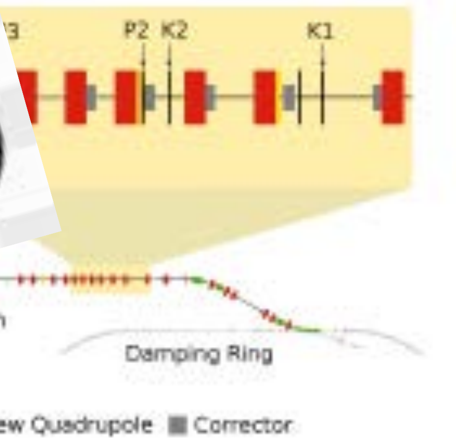
- **IP-BPMs**
  - Re-desin towards sub-10 nm, wide dy
    linearity
- **FONT feedback**
- **Multi-OTR system**



Layout of the three Cavity BPMs at ATF2-IP



Multi-OTR system

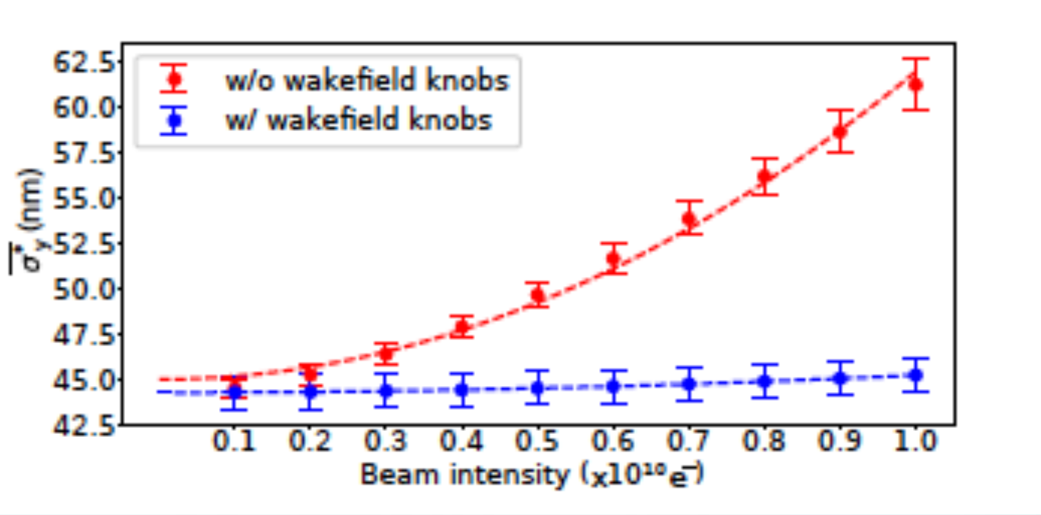


FONT feedback system

System design: Beam line and IP re-design

- **Driven realistic beam dynamics specifications**
  - Realistic simulations should drive the design choices and the goals
    - Jitter assessment/measurement
    - Magnet errors
    - Wakefields source (hardware change)
  - Establish the scaling for ILC in terms of intensity

$$(\sigma_y^*)^2 = (\sigma_{y0}^*)^2 + w^2 q^2$$



- **Vibration mitigation for new FD**

- **Instrumentation assessment**
  - CBPMs calibration and resolution
  - Multi-OTR, screens,...

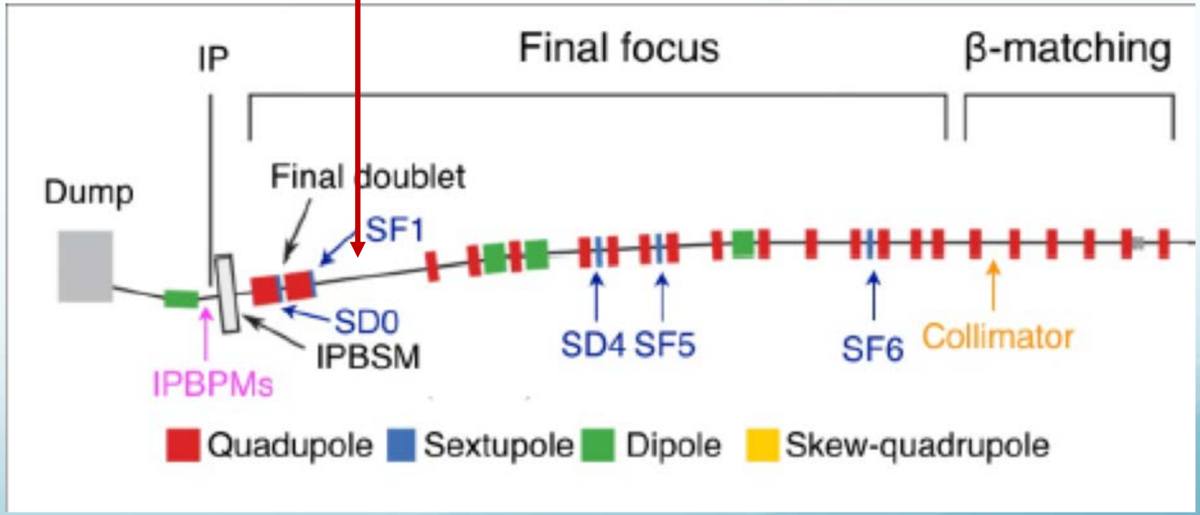
- **IP Instrumentation assesment**
  - IP-BSM
  - IP-BPMs

Beam tests ILC: Long Term Stability

- **Nominal ($10\beta_x^*$ x β_y^*) optics operation routine assessment**
  - Automated steering procedures and basic tuning algorithms (like envisaged for ILC)
  - 2nd order correction knobs assessment (sextupoles and skew, octupoles)
  - Energy bandwidth measurements
- **Intensity dependence / Walkefield studies and mitigation techniques** (bunch length measurement)
- **Vibrations long-term monitoring**
- **FONT feedback studies / multibunch**

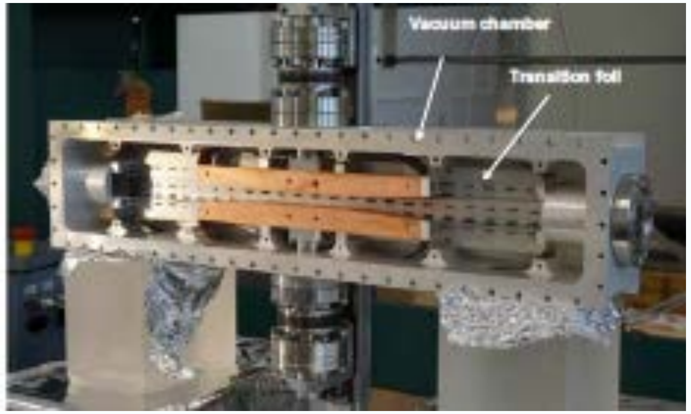
Beam tests ILC: High-order aberrations

- **Design (β_x^* x β_y^*) optics**
- **Ultra-low β_y^***
  - Octupoles
  - Longer L* (move FD to the right /IP towards the dump)



Beam tests ILC: Other studies

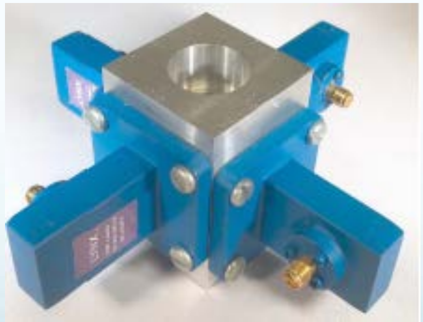
- **ILC DR injection/extraction kickers long term stability**
  - Fast kicker
  - E-driven kicker



- **Collimation issues for ILC**
  - Wakefiled impact
  - Design options

- **New wakefields setups**
  - Passive corrugated structures

- **New CBPMs ideas:**
  - ILC type cavities with Integrated electronics from Instrumentation Technologies
  - Off-the-shelf (FMB-Oxford-Instrument Technologies) triplet of CBPMs
  - Low-wakefield wavegide BPMs, aperture/resolution issues to be estimated (sensitivity degrades as 1/a)



Waveguide BPMs

Hardware

HARDWARE											
	Item	Short description	Unit Cost [k Yen]	#units	Grade	Budget [k Yen]	Budget [k CHF]	Budget [k Eu]	Human Resources (FTE)	Responsible	Interested collaborators
Injector	Klystrons					0	0	0			
Damping Ring						0	0	0			
EXT - FFS	**Vaccum chamber**					0	0	0			
	Shielded Bellows		300	100		30000	270	250,02			
	Taper chamber	For CBPM; ID 20mm	60	40		2400	21,6	20,0016			
	Bend chamber - Large	BH3X	500	1		500	4,5	4,167			
	Bend chamber - Small	BH1X, 2X, B1, B2 and B5	100	5		500	4,5	4,167			
	Straight chambers		100	30		3000	27	25,002			
	Pump port chambers	For ID 24mm	200	30		6000	54	50,004			
	FONT kicker	Stripline kicker	500	2		1000	9	8,334			
	Septum C	à standard dipole	100	1		100	0,9	0,8334			
	Others	Attachment for the gap of CBPM conflat flange, ...				0	0	0			
	Magnets					0	0	0			
	Final Doublet	QD0, QF1	3000	2		6000	54	50,004			
	Final Doublet (Sext)	SD0, SF1	1500	2		3000	27	25,002			
	Skew Sextupole	Poor assembling	1500	4		6000	54	50,004			
	Movers	For Skew Sextupole	2000	4		8000	72	66,672			
		Renewal of motor drivers/controllers				0	0	0			
	Septum A, B					0	0	0			
	Septum C	Standard Dipole + PS	5000	1		5000	45	41,67			
						0	0	0			
	IP-BSM Laser system					0	0	0			
	Laser system		21000	1		21000	189	175,014			
	Optics upgrades		11000	1		11000	99	91,674			
	CBPMs					0	0	0	0.5	A. Lyapin	RHUL
	Movers		1000	32		32000	288	266,688			
	Semsors		104	32		3328	29,952	27,735552			
	Higher resolution digitisers		4200	1		4200	37,8	35,0028			
	IP-BPMs					0	0	0		A. Lyapin	RHUL, JAI?
	Electronics					0	0	0			
	FD Girder									L. Brunetti	LAPP
						0	0	0			
TOTAL						143028	1287,252	1191,995352			

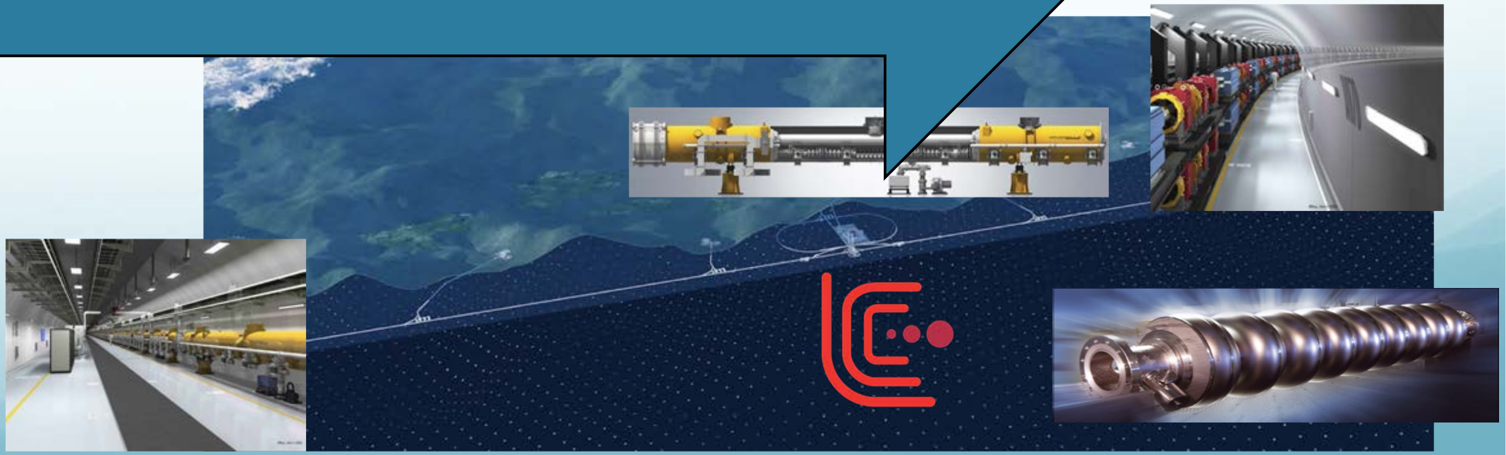
Grade	A	Hardware issues needed in the pre-preparatory phase 2020 -2022 (prototyping)
	B	Hardware issues needed in ILC pre-lab 2022 -2026
	C	Other issues

Beam tests

ATF2	2020-2023				
	Item	Short description	Human Resources (FTE)	Responsible	Interested collaborators
Injector					
Damping Ring					
EXT - FFS	Beam tests	Long-Term Stability			
		High-order aberrations (ultra-low, energy bandwidth..)	1 PhD	R. Tomas-Garcia	CERN, IJClab
		Wakefield evaluation (upstream beamline)		A. Lyapin	RHUL
		Intensity dependence studies - wakefield mitigation			
		Vibration long-term monitoring system		L. Brunetti	LAPP
		Jitter assesment			
		CBPMs calibration	0.5	A. Lyapin	RHUL
ATF3	2024-2025				
	Item	Short description	Human Resources (FTE)	Responsible	Interested collaborators
Injector					
Damping Ring					
EXT - FFS	System Design	Beamline re-design			
		Driven realistic beam dynamics specifications	1 PhD	A. Latina	CERN
		Vibration mitigation new FD		L. Brunetti	LAPP
		Wakefield evaluation		A. Lyapin	RHUL
		Instrumentation assesment: multi-OTR			
		Instrumentation assesment: CBPMs		A. Lyapin	RHUL
		IP Instrumentation			
		IP-BPMs studies		A. Lyapin	RHUL, JAI ?
		IP-BSM laser studies		A. Aryshev	KEK
	Beam tests ILC	Long-Term stability			
		Nominal optics (10bx* x by*) routine operation			
		Intensity depndence studies - wakefield mitigation			
		Vibration long-term monitoring		L. Brunetti	LAPP
		FONT feedback - multibunch			
		High-order aberrations			
		Design optics (bx* x by*)			
		ultra-low by* (long L*, octupoles)	1 postdoc , 1 PhD	R. Tomas	CERN
		Other studies			
		ILC DR Injection/Extraction Kickers			
		Collimation issues			
		New CBPMs (ILC type, waveguides,...)	0.5	A. Lyapin	RHUL

ATF 3

Lets surf in the storm....



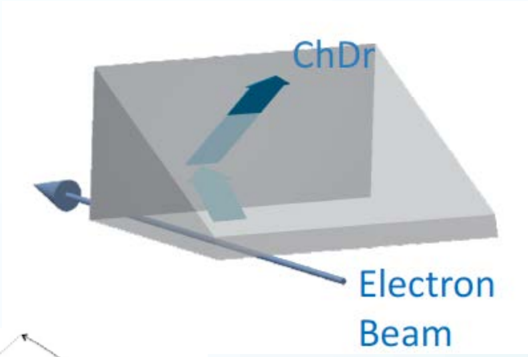
	Imperfections / issues	Detrimental effect	Potential cures (by design or hardware improvement)	Potential cures (during operation)
Static	Dipole / quadrupole misalignment	• Introduces unwanted dispersion (emittance growth) • Deflects the beam • Introduces coupling	• Careful pre-alignment • Add a dipole corrector, or • Put quads on movers • Add skew quads to correct coupling	• BBA techniques • If movers are available, align the quads
Static	Bpm misalignment	• Causes wakefields effects • Falses beam-based alignment algorithms	• Reduce wakefields • Careful pre-alignment • Put bpms on movers	• DFS, WFS • If movers are available, align the bpms
Static	Poor bpm resolution	• Fools beam-based alignment algorithms	• Better resolution	• Statistical averaging (but suffers from jitter)
Static	Sextupole misalignment	• Introduces coupling, beta-beating	• Careful sextupole pre-alignment • Put sextupole on movers	• If movers are available, align the sextupoles
Design	Presence of sextupoles (and octupoles)	• Introduces nonlineartities • reduce the momentum acceptance, etc.	• Revisit the optics to reduce strength • Add skew quadrupoles to correct coupling	• Tuning knobs • Beam-based coupling correction techniques
Design	Lack of diagnostics	• Forces blind operation	• Careful design of diagnostic sections	• Use the diagnostics
Design	Long bunches	• Amplifies wakefield effects	• Bunch compressor [likely not possible]	
Dynamic	Beam jitter	• All of the above	• Reduce jitter at the source	• Feedback systems
Dynamic	Ground motion / vibrations	• All of the above	• Stabilization	• Stabilization

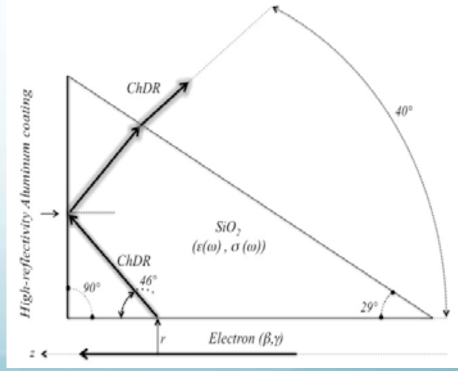
Instrumentation R&D

M. Bergamaschi, T. Lefevre, S. Mazzoni

- **Optical Transition Radiation (OTR) (**2013-2017)
  Sub micron resolution achieved
- **Optical Diffraction Radiation (ODR)** (2017-2018)
  Sensitivity to 3 um with non-invasive technique demonstrated (Bergamaschi et al, Phys. Rev. Applied **13**, 014041 (2020))
- **Incoherent Diffraction Cherenkov Radiation (ChDR)** (Since Nov. 2018) beam size measurement. The motivation for these studies are:
  Suppress Synchrotron Radiation → cleaner signal
  DR and SR are emitted at similar angles
  Looking for a physical process emitted at larger angle

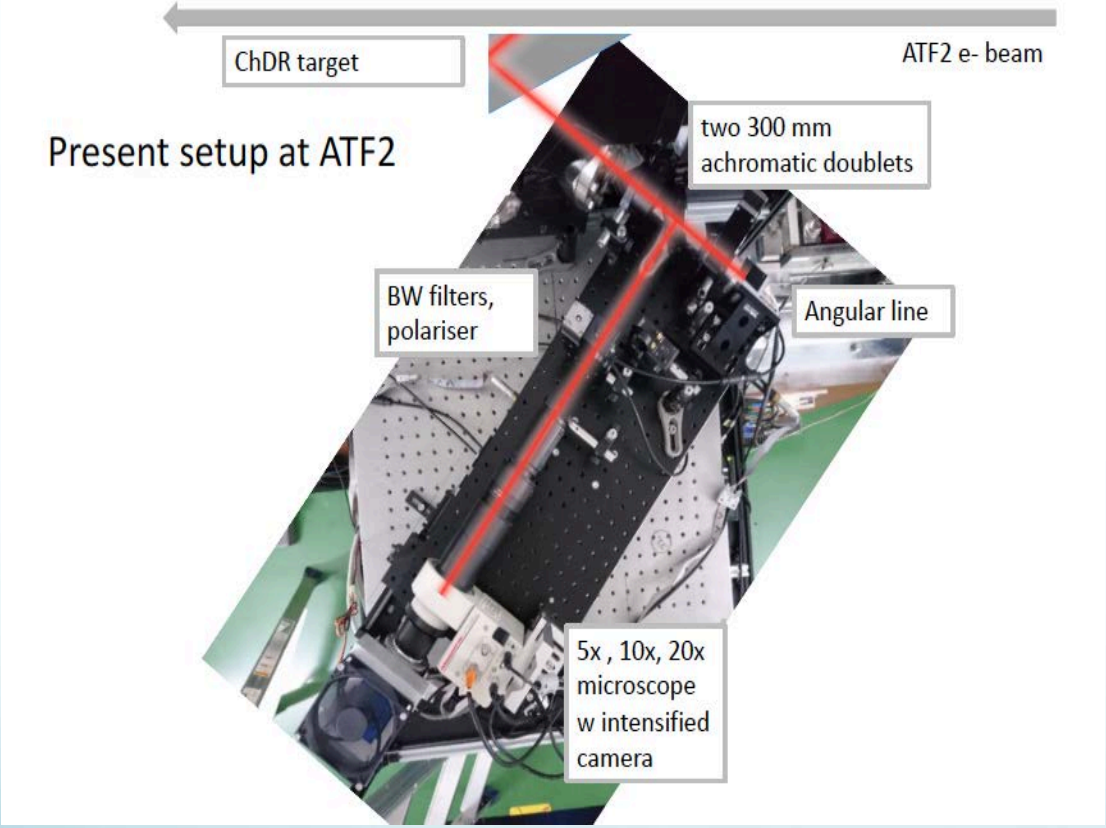
  Larger aperture compare to DR slits (> 500 μm)
  Difficult as DR will provide less photons
  Looking for a physical process providing more photons





Instrumentation R&D

M. Bergamaschi, T. Lefevre, S. Mazzoni



PLANS for 2019-2020

- Results from ChDR shifts in 2019 are probably affected by Cherenokv Radiation produced by halo particles hitting the target
- Plan for 2020 shifts (cancelled due to COVID-19): observe at longer wavelength to increase beam-target distance (reduction of Cherenkov halo background)
- Measure accurately the angular distribution to confirm current ChDR theory from Tomsk group.

Hope to resume activity at ATF2 in 2021 ??

Perspectives: ATF3

A. Aryshev

➢ R&D beyond colliders:

Mini-workshop to discuss potential projects was organized on 28 Aug. 2020 for Japanese community

Project title	Person in charge	Funding	Term	Required ATF modifications	Location
Development of SuperKEKB Fast Kicker .	M. Tawada (KEK)	KEKB	Fall 2021 ~	minor	EXT-mid
Development of SuperKEKB OTR Monitor.	T. Mori (KEK)	KEKB	Fall 2021 ~	minor	EXT-end
New betatron feedback scheme, AC multipole magnets, and ultra-fast quadrupole kicker tests.	T. Nakamura (KEK/JPARC)	?	2021 ~	minor	DR
Accelerator Control System test.	Y. Kaji (KEK)	KEKB	2021 ~	minor	Timing system
Detector radiation resistance tests.	Y. Sugimoto (KEK)	KEKB	2021 ~	80MeV linac optics	Linac-end
Gamma-ray source for user application .	ATF group (KEK)	-	-	minor	DR north
Performance evaluation of ultra-short period undulator.	S. Yamamoto (KEK)	KEK-PF	2021 ~	minor	DR north
Polarized gamma-ray beam generation assuming ILC.	N. Muramatsu (Tohoku Uni.)	?	2023 ~	minor	EXT/FF
Electron beam focusing by active plasma lens.	M. Kando (Osaka U.)	?	2021 ~	New laser, LTL, vacuum bump chamber	EXT-end
Test of the Lorentz invariance.	T. Shima (Osaka Uni.)	JSPS ↑	-	BSM modification	FF
Demonstration of seed FEL (CHG).	Y. Honda (KEK)	JSPS ↑↑	-	EXT beamline modification	EXT-mid
Strong-field QED experiments.	Under discussion	JSPS ↑↑↑	-	ATF2 FF region upgrade and extension	FF

Implementation level
- Relatively simple
- Intermediate
- Difficult