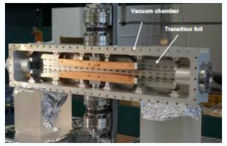
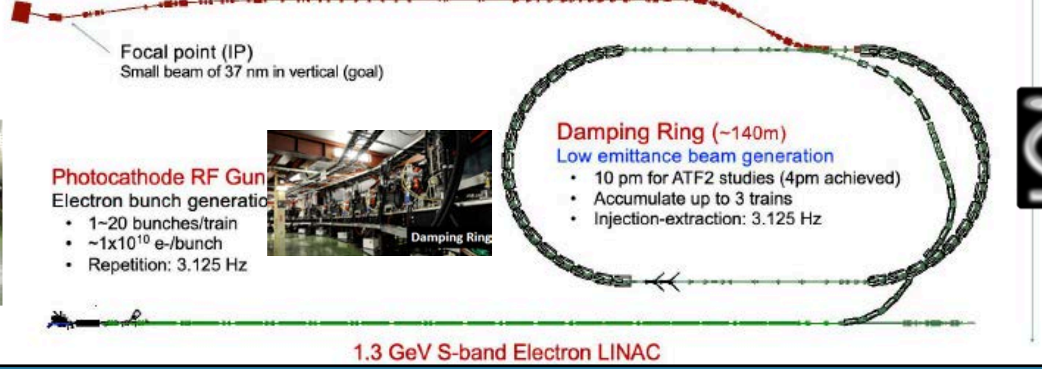
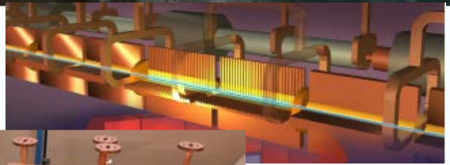


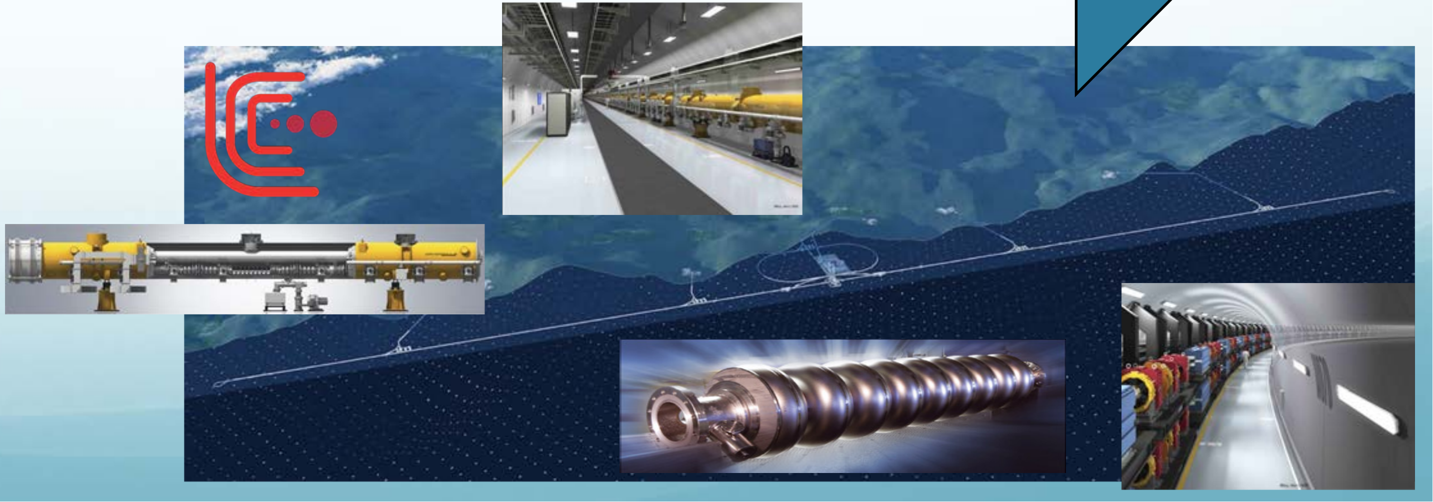




ATF 3

From ATF2 to ATF3 and beyond

A. Faus-Golfe
on behalf of
ATF collaboration and
ILC-IDT WG2: DR and BDS



IJCLab Irène Joliot-Curie Laboratoire de Physique des 2 Infinis

CNRS IN2P3 Les deux infinis

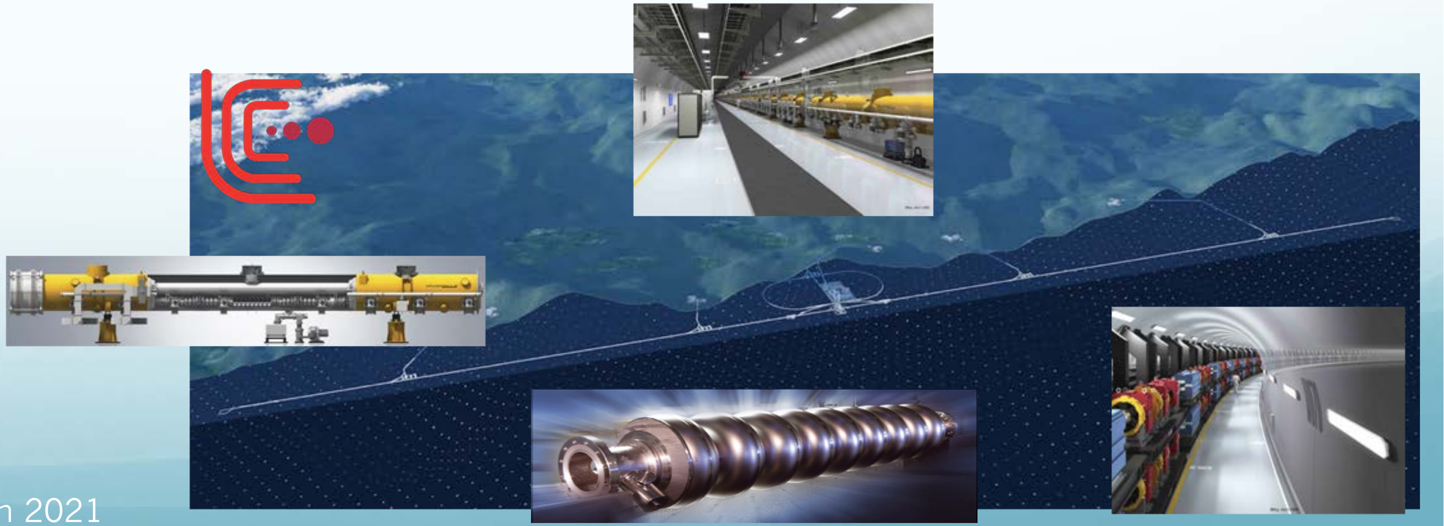
15 - 18 March 2021

LCWS2021

Outline

- ATF2 current status
  - Goals and Recent Achievements
  - Operational Issues
- ATF3
  - Objectives and Collaboration
- ILC-IDT WG2: Technical Preparation Plan for DR and BDS
  - Goals and Tasks

ATF2 final focus test beamline



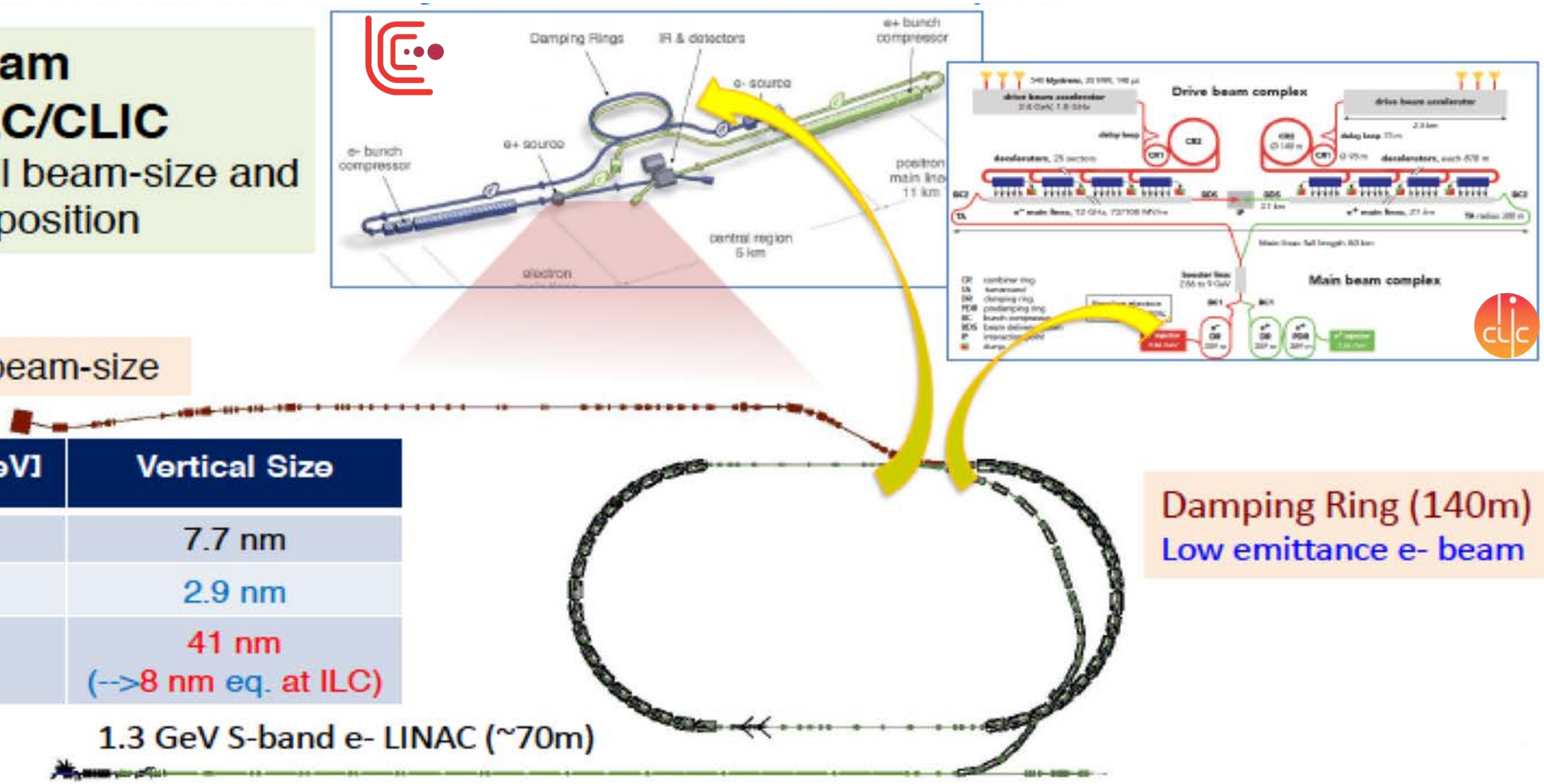
ATF2 the ILC FFS testbench

ATF/ATF2: Accelerator Test Facility

Courtesy: N. Terunuma

Develop nano-beam technology for ILC/CLIC

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



	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)

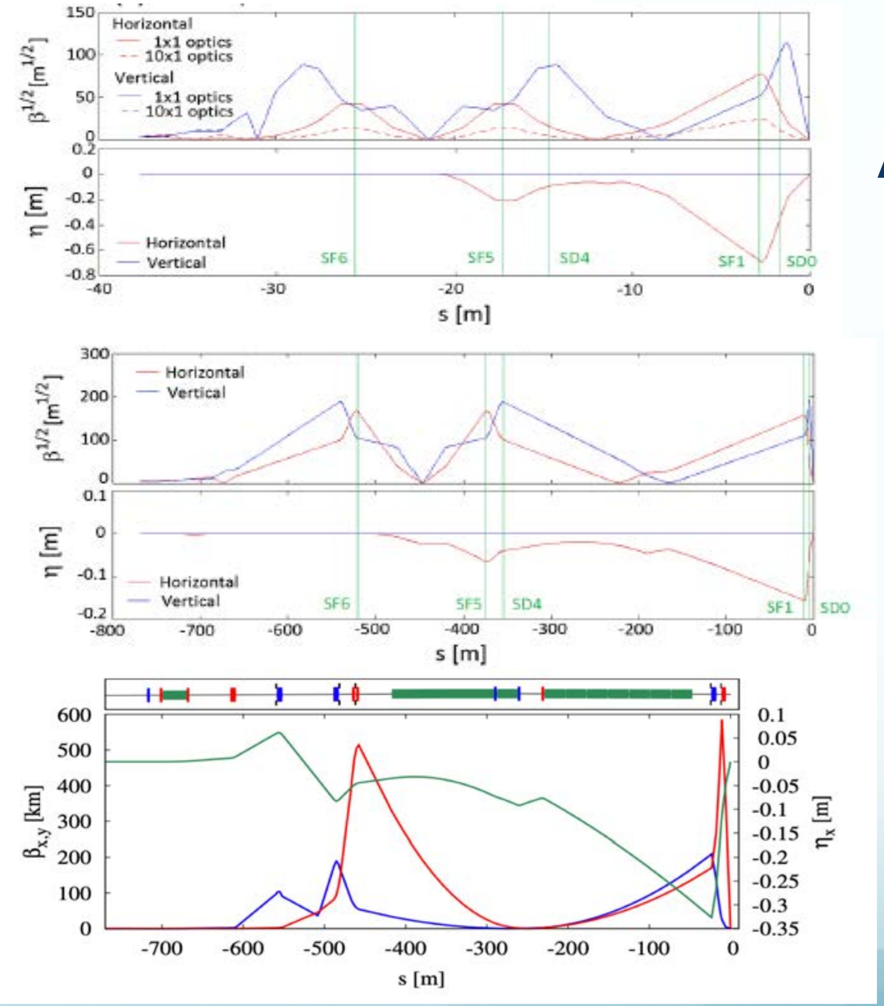
A. Yamamoto, 190513bb

8

The context

	Units	ATF2	ILC	CLIC
E_{cm}	[GeV]	1.3	250	380
$\mathcal{L}$	$[10^{34}\ cm^{-2}\ s^{-1}]$		1.35	1.5
f_{rep}	[Hz]	3.12	5	50
$n_{bunches}$	1	1 - 20	1312	352
N_e	$[10^{10}]$	1.0	2.0	0.52
σ_b	[µm]	7000	300	70
Δt_b	[ns]	154	554	0.5
$\gamma\epsilon_x / \gamma\epsilon_y$	[nm]	5000 / 30	5000 / 35	950 / 30
σ_x^* / σ_y^*	[nm]	9000 / 37	516 / 7.7	149 / 2.9
$IP_{Stabilization}$	σ_y^*	< 0.05	< 0.2	< 0.08
L^*	[m]	1	4.1	6
β_x^* / β_y^*	[mm]	40 / 0.1	13 / 0.41	8 / 0.1

FFS optics



ATF2

ILC

CLIC

The context:

FFS is among the most challenging sections of a LCs

- **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.

- **Similar Chromaticities** ($L^*/\beta^*_{x,y}$): **25 / 10000** (ATF2) , **315 / 10000** (ILC), **750 / 60000** (CLIC) and similar **tolerances** for **FD multipole field errors** (ATF2 and ILC) PRAB 17, 023501 (2014)

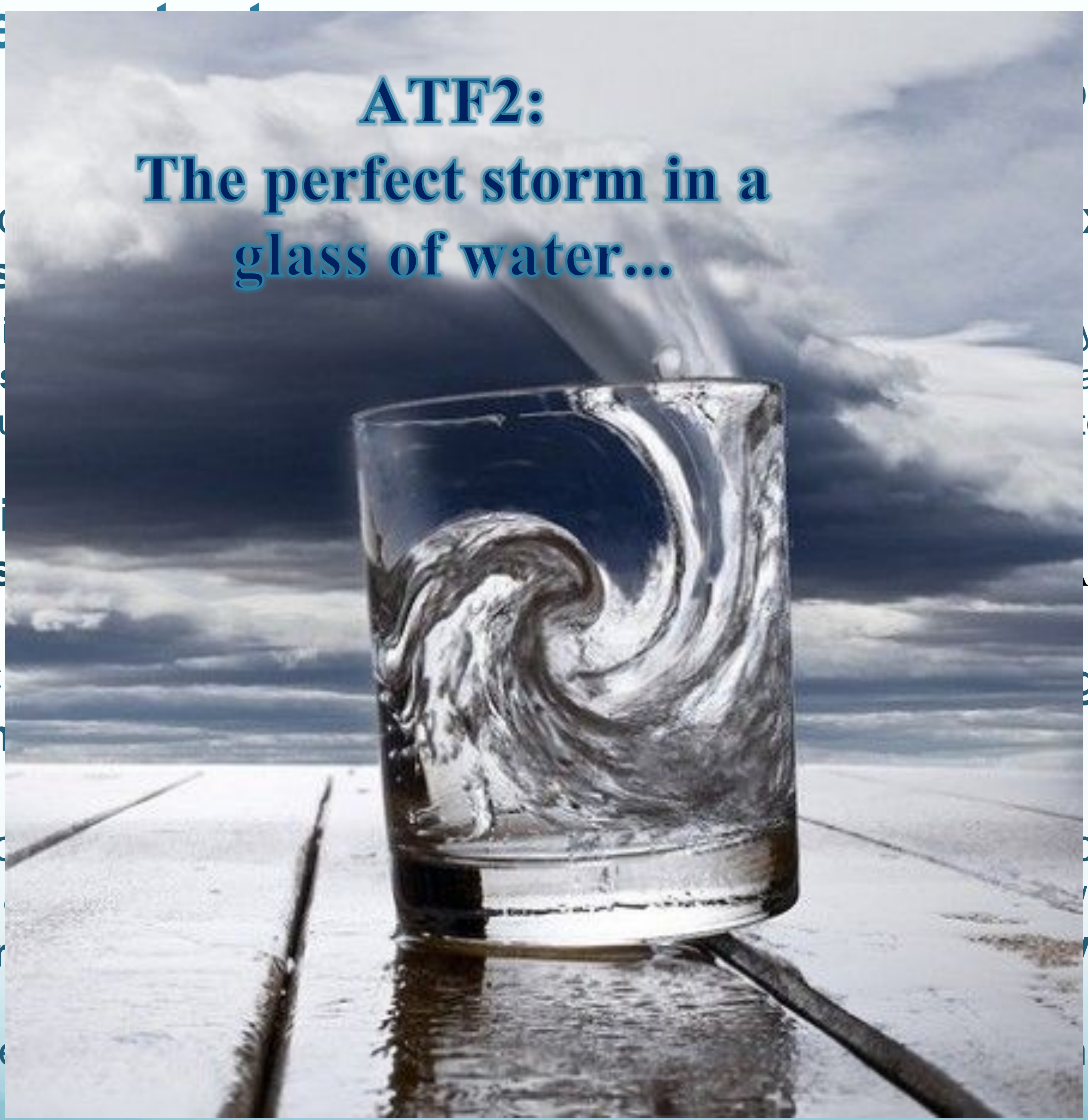
- In **ILC and CLIC**, the **much shorter bunch length** and the **much larger beam energy** make the situation **"simpler"**

- **ATF2** tackles its critical task with **two major disadvantages** w.r.t. its "bigger brothers":
  - **Bunch length** is much longer: 7000 vs 300 (ILC) / 70 (CLIC) µm, **23 / 100 times larger**
  - **Beam energy** is significantly lower: 1.3 vs 125 (ILC) / 190 (CLIC) GeV, **100 / 150 times smaller**

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

The

ns of a linear collider



- Very-large β and ... xtremely sensitive to **imperfections as**
  - **Wakefields** ... y transverse deflections...
  - **Magnets mis** ... ansverse coupling, …
  - **Beam jitter** ... o the IP, etc.

- **Similar Chromati** ... **750 / 60000** (CLIC) and similar **tolerances** ... B 17, 023501 (2014)

- In **ILC and CLIC** ... **ger beam energy** make the situation **"sim**

- **ATF2** tackles its c ... bigger brothers":
  - **Bunch len** ... 100 times larger
  - **Beam ener** ... , 100 / 150 times smaller

- **Measurement** of the ... onitor (IPBSM)

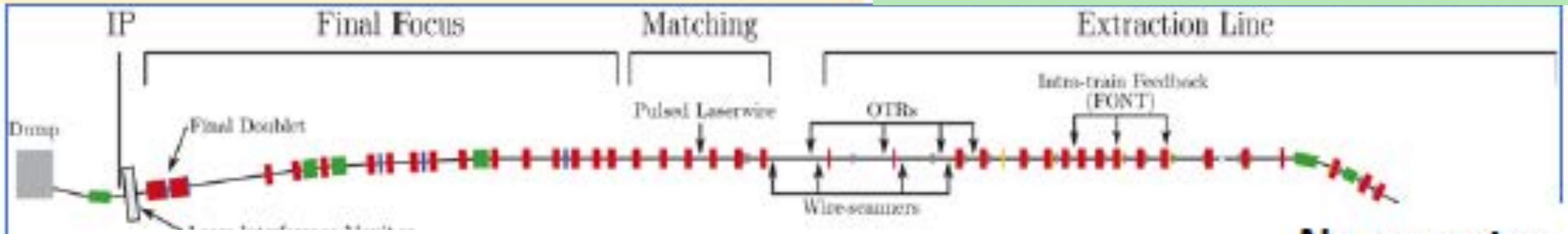
ATF2 goals and achievements

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)

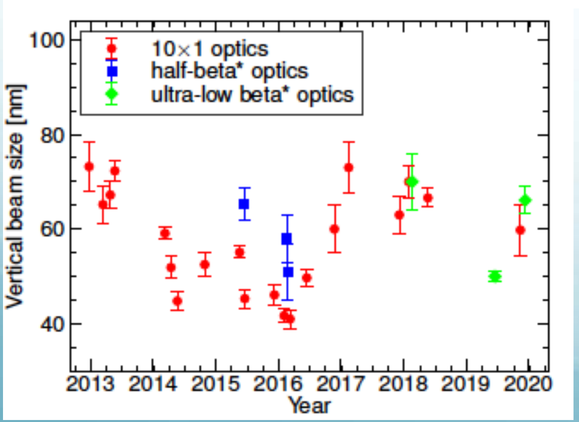
Goal 2: 2 nm beam stabilization at ATF2 IP, (much harder than nm stabilization in collision at ILC).

- **FB latency 133 nsec achieved** (target < 366 nsec)
- **Position jitter at ATF2 IP: 41 nm (2018)** (direct stabilization limited by IPBPMs resolution 20 nm). Upstream FB shows capability for 2nm stabilization. **Demonstrated ILC IPFB system.**

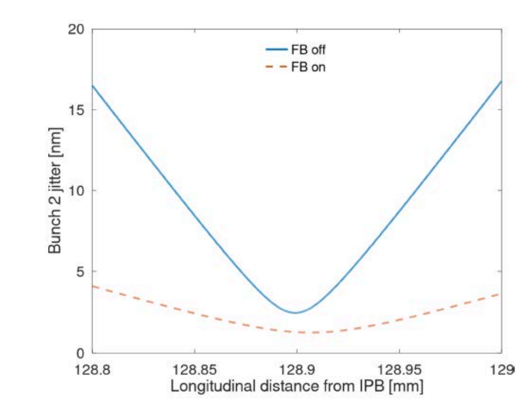


Nanometer beam sizes at IP

Nano-meter stabilization at IP

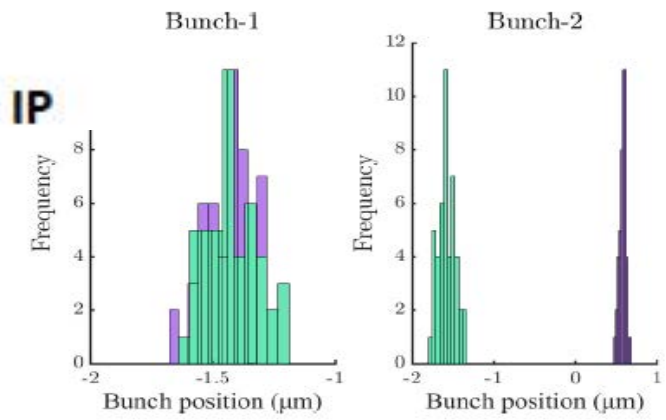


Small beam sizes were obtained with beam intensities of 0.5-1.5 10^9 e^- /bunch (10^{10} design value) and reduced aberration optics ($10\beta_x^* \times \beta_y^*$)



Predicted vertical position jitter with FB on-off

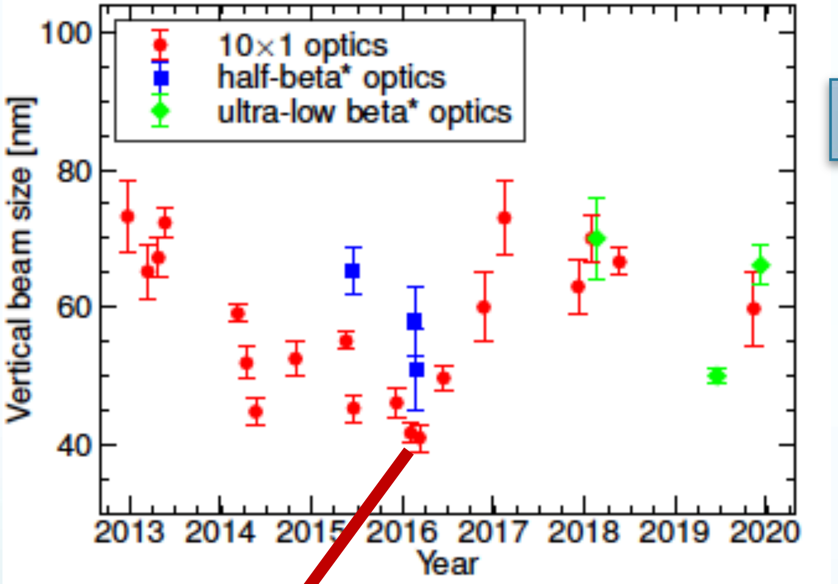
Distribution of bunch positions measured at IPB, with two-BPM FB off (green) and on (purple)



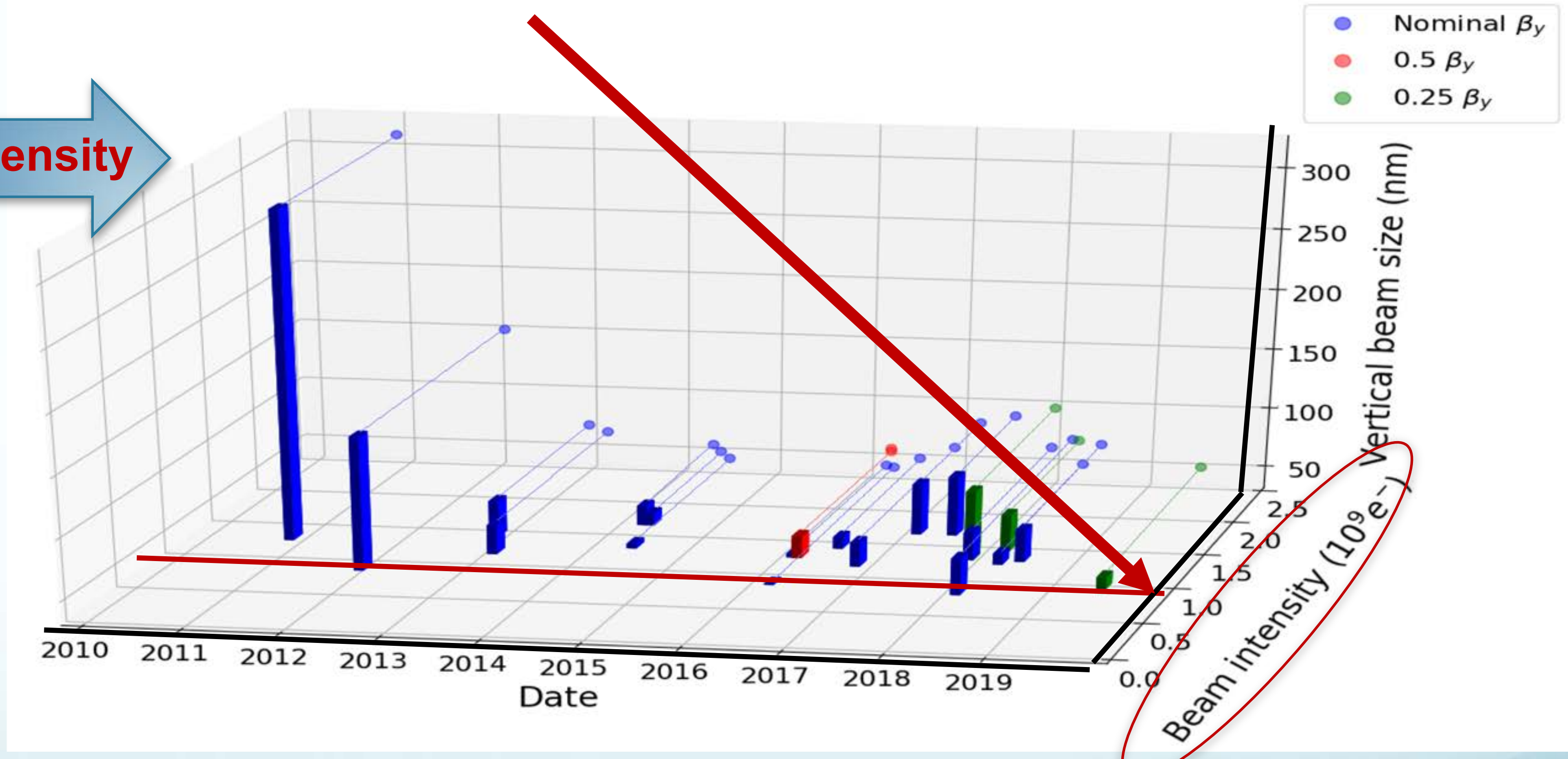
Intensity dependence studies (wakefields)

Beam size History

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



Intensity



smallest beam size ~41 nm (2016)

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

Nominal ($10\beta_x^*$ x β_y^*)
Half ($25\beta_x^*$ x 0.5 β_y^*)
Ultra-Low ($25\beta_x^*$ x 0.25 β_y^*)

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
$\sigma_{y,design}^*$ [nm]	37	25	23
$\sigma_{y,measured}^*$ [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

Recent Achievements: Intensity dependence studies

Since November 2016 a considerable effort in modelling, simulating, measuring wakefields and dedicated hardware changes, has been carried out in order to understand and mitigate the wakefields in ATF2 https://lib-extopc.kek.jp/preprints/PDF/2020/2024/2024004.pdf (P.36)

K. Kubo ATF session LCWS2021

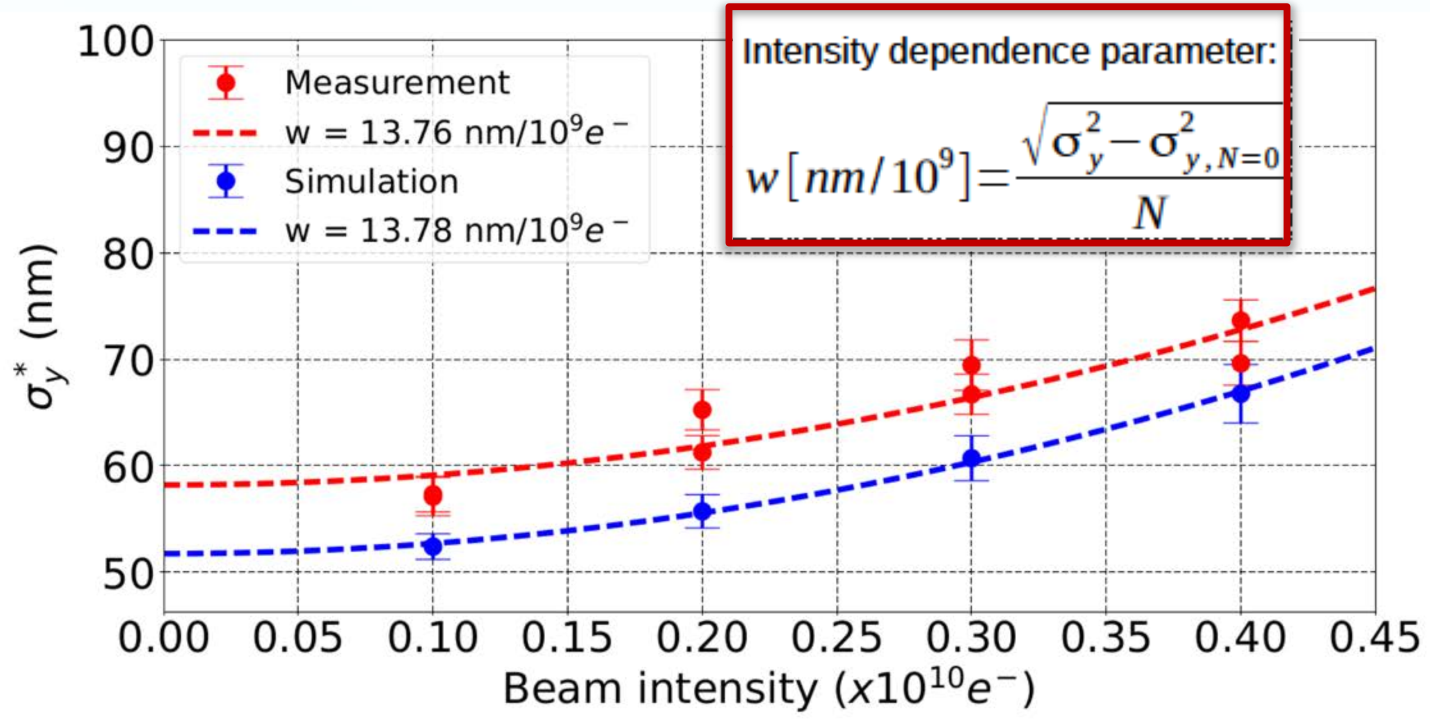


Figure: Comparison between measurements and simulations of the vertical beam size at the IP (σ_y^*) vs. the beam intensity and the intensity-dependent parameter w.

PLACET Simulation vs. Measurements

Case	w [nm/10^9 e^-]	Beam intensity [e^-]	Average σ_y^* [nm]
Measurement	13.76	0.1×10^{10}	57 ± 1.7
		0.2×10^{10}	63 ± 1.7
		0.3×10^{10}	68 ± 2.1
		0.4×10^{10}	72 ± 2.0
Simulation	13.78	0.1×10^{10}	52 ± 1.2
		0.2×10^{10}	56 ± 1.6
		0.3×10^{10}	61 ± 2.1
		0.4×10^{10}	67 ± 2.8

https://ora.ox.ac.uk/objects/uuid:c514ab72-7b99-4182-8e49-89ffd4f14e1d/download_file?safe_filename=Thesis_Korysko.pdf&type_of_work=Thesis

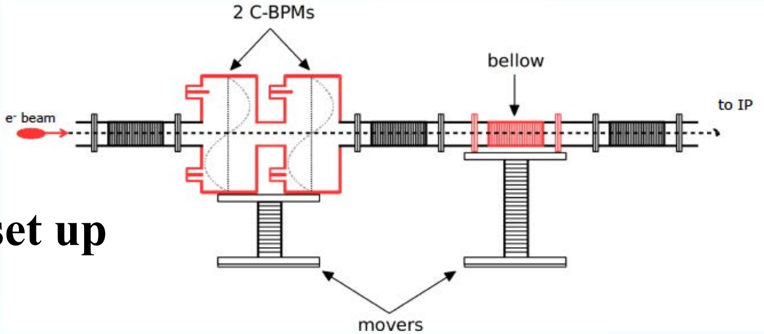
PRAB 23, 121004 (2020)

Recent Achievements: Intensity dependence studies

Mitigation techniques: Wakefields knobs

Goal: Use two well-known wakefield sources on movers to compensate intensity-dependent effects.
Setup: Made of two movers, the first one carries two C-BPMs and the second one carries a bellows.

Wakefield set up



PLACET simulations

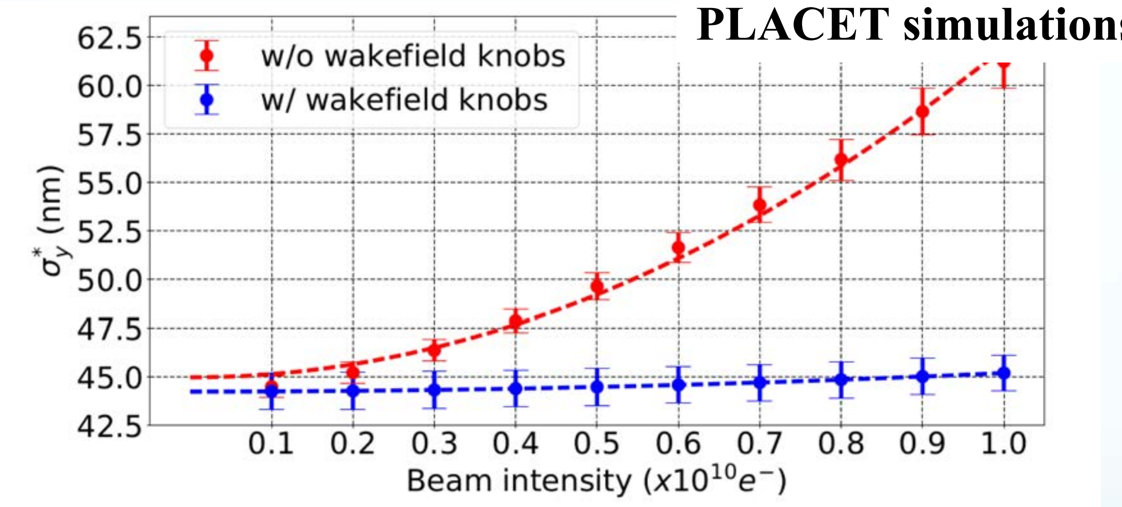


Figure: Simulations of the impact of the ATF2 wakefield knobs on the vertical IP beam size (σ_y^*).

Experimental results

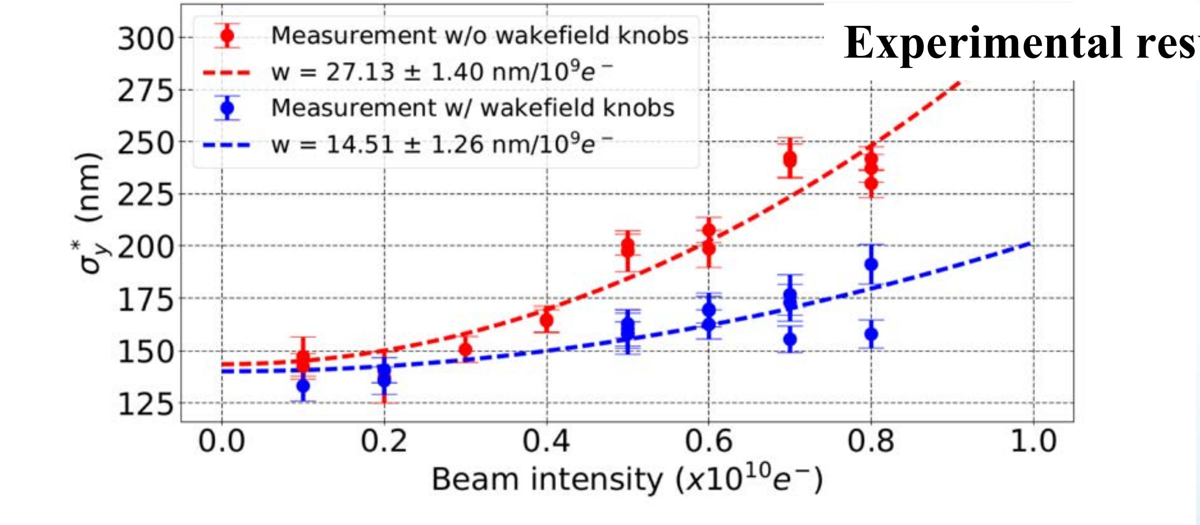


Figure : Measured vertical IP beam size (σ_y^*) vs. the beam intensity before and after applying wakefield knobs.

Case	$\overline{\sigma_y^*}$ [nm]
No source on movers	61.2 ± 1.4
Using the bellow on mover	48.4 ± 1.0
Using the 2 C-BPMS on mover	45.5 ± 0.9
Using both the bellow and the 2 C-BPMs on movers	45.2 ± 0.9

The wakefield knobs reduced the intensity dependence parameter from 27.13 nm/10^9 to 14.51 nm/10^9

Recent Achievements: Intensity dependence studies

Scaling the results for ILC and CLIC

Intensity-dependent effects at ILC 250 GeV

BDS imperfections:
- Misalignments : 50 µm RMS; 200 µrad RMS; strength: 0.1% RMS
- Wakefields from the 104 C-band cavity BPMs
- Resistive-wall wakes from beam pipe

Simulation:
- 100 random machines
- Full tuning procedure (same as in the CLIC case)
- Studied beam size dependence on bunch charge
- Studies impact of long-range resistive-wall in case of multi-bunch

Tuning procedure:
- Global orbit correction (1:1)
- Dispersion-Free Steering (DFS)
- Wakefield-Free Steering (WFS)
- Knobs (Y, YP D XP XP.*XP XP.*YP XP.*D)

First order   Second order

Single-bunch effects:
--> negligible dependence

$$w[nm/10^9 e] = \frac{\left(\sqrt{\sigma_{y,q}^2 - \sigma_{y,0}^2}\right)}{q}$$

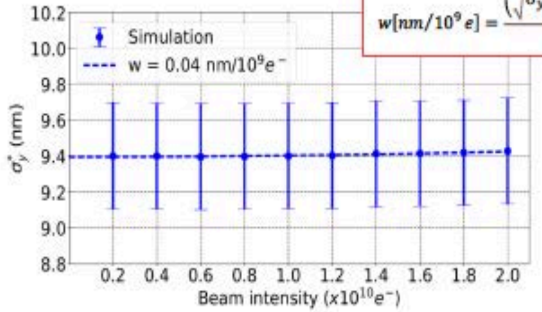


Figure : Vertical IP beam size σ_y^* vs. beam intensity in the 250 GeV BDS, calculated with PLACET with wakefields.

Multi-bunch effects:
--> intra-train correction required

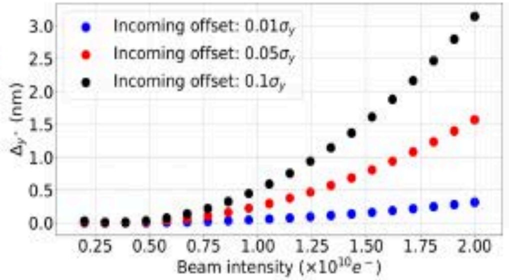


Figure : Vertical orbit deflection at the IP between the first and last bunch of a train Δy^* vs. beam intensity for three incoming constant position offsets 2f the train of bunches in the 500 GeV ILC BDS: $0.01\sigma_y$, $0.05\sigma_y$ and $0.1\sigma_y$, calculated with PLACET with resistive wall effects included.

Intensity-dependent effects at CLIC 380 GeV

BDS imperfections:
- Misalignments : 50 µm RMS; 200 µrad RMS; strength: 0.1% RMS
- Wakefields from the 134 X-band cavity BPMs
- Resistive-wall wakes from beam pipe

Simulation:
- 100 random machines
- Full tuning procedure (same as in the CLIC case)
- Studied beam size dependence on bunch charge
- Studies impact of long-range resistive-wall in case of multi-bunch

Tuning procedure:
- Global orbit correction (1:1)
- Dispersion-Free Steering (DFS)
- Wakefield-Free Steering (WFS)
- Knobs (Y, YP D XP XP.*XP XP.*YP XP.*D)

First order   Second order

Single-bunch effects:
--> small dependence

$$w[nm/10^9 e] = \frac{\left(\sqrt{\sigma_{y,q}^2 - \sigma_{y,0}^2}\right)}{q}$$

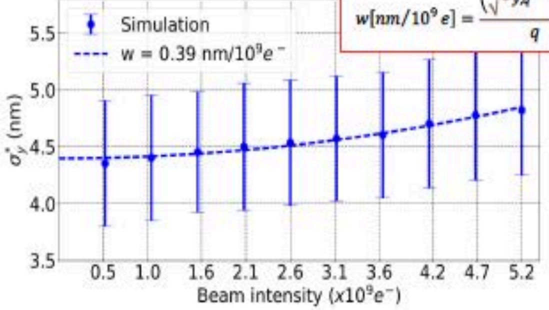


Figure : Vertical IP beam size σ_y^* vs. beam intensity in the 380 GeV BDS, calculated with PLACET with wakefields.

Multi-bunch effects:
--> intra-train correction required

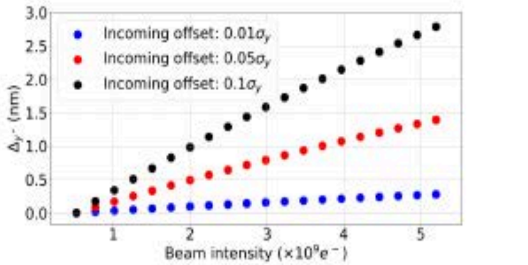


Figure : Vertical orbit deflection at the IP between the first and last bunch of a train Δy^* vs. beam intensity for three incoming constant position offsets of the train of bunches in the 380 GeV CLIC BDS: $0.01\sigma_y$, $0.05\sigma_y$ and $0.1\sigma_y$, calculated with PLACET with resistive walls.

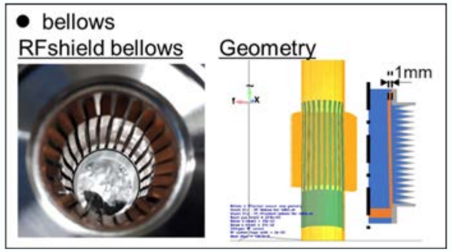
Further studies are needed but, "stable" beam and "stable" IPBSM are essential

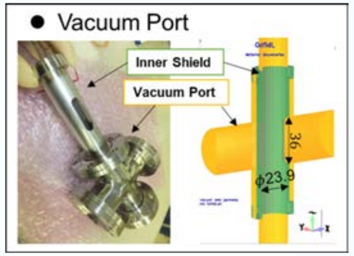
P. Korysko ATF session LCWS2021

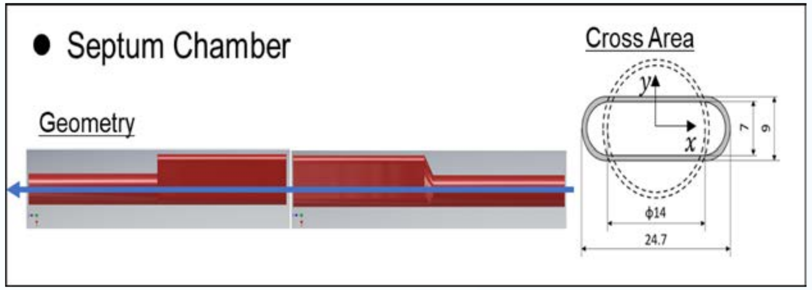
Recent Achievements: Intensity dependence studies

Following the calculations of wakefields sources in ATF2, we are **completing** the **wakefield calculations** for **Septum chamber (**Rectangular chamber), **Bellows** (Forming / straight, RF shield / no shield) and **Vacuum Port** (Shield / no shield)

PRAB 19, 091002 (2016)
NIM A 917 (2019) 31–42



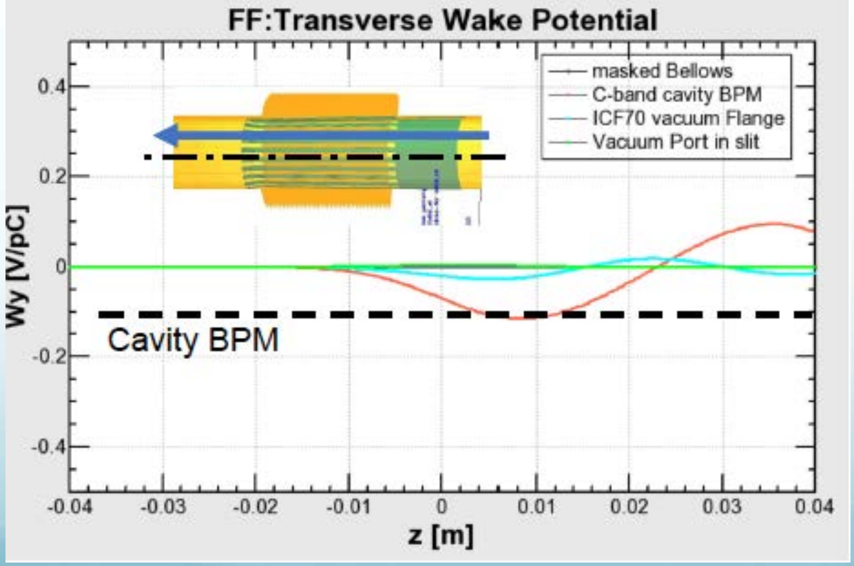


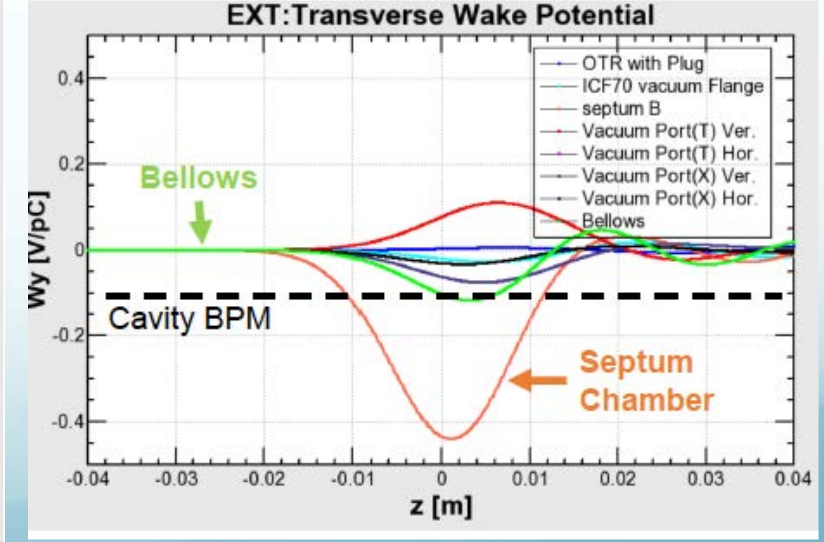


First results:

- Septum chamber **stronger** than Cavity BPM (x4)
- Bellows with RF shield **weaker** than Cavity BPM (1/100)
- Vacuum Port with shield **weaker** than Cavity BPM (1/10)
- **Extraction** wakefield sources**: weak effects**
- **Final Focus** wakefield sources**: strong effects**

GdfiL calculations for y=1 mm





Y. Abe ATF session LCWS2021

Recent Achievements: FONT feedbacks

- ILC IP FB system prototyped + tested:
  meets ILC performance specifications
- Upstream dual-phase FB provides capability for
  1 nm-level beam stabilisation at ATF2 IP
- ATF2 'IP FB' has stabilised beam directly locally
  to c. 40 nm; 25 nm is possible in principle
- Upstream FB reduced observed intensity-
  dependence of beam size by factor ~ 1.6
- Additional beam time would allow:
  optimisation of FB system performance
  study of long-term beam trajectory control

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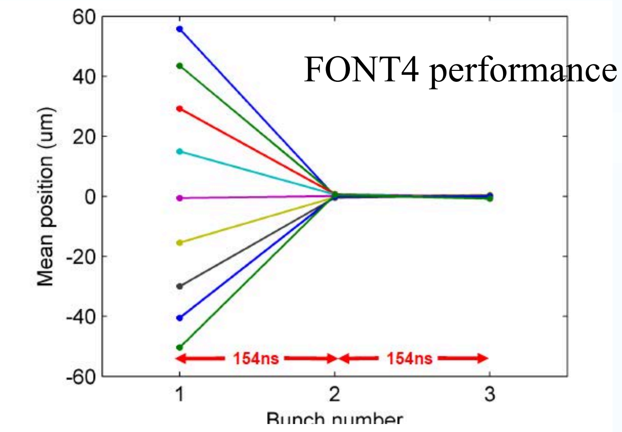
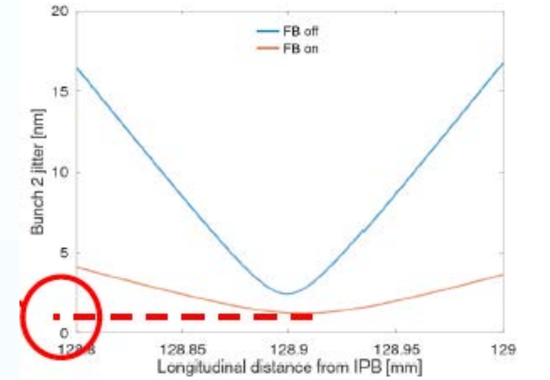
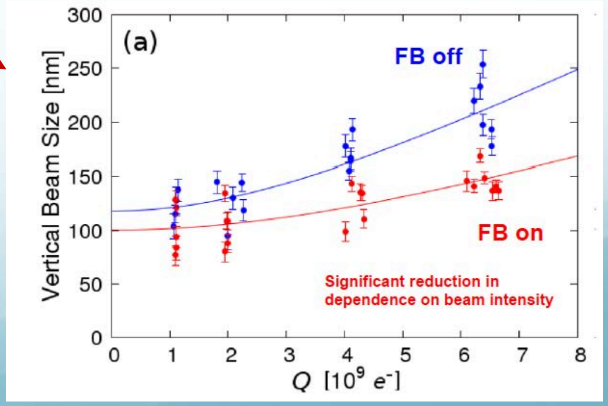




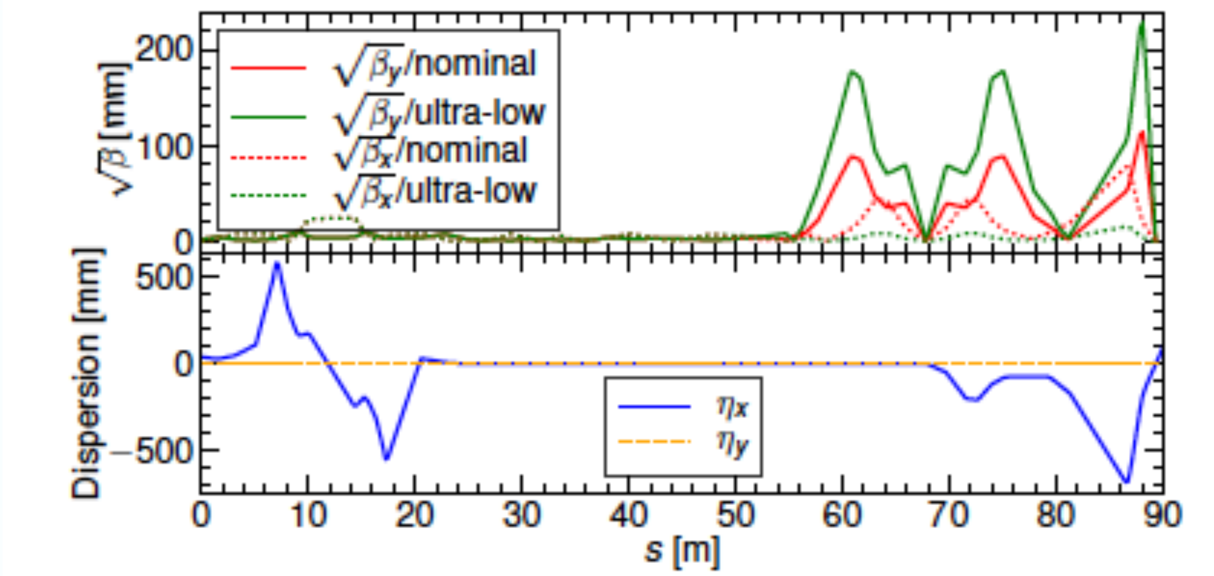


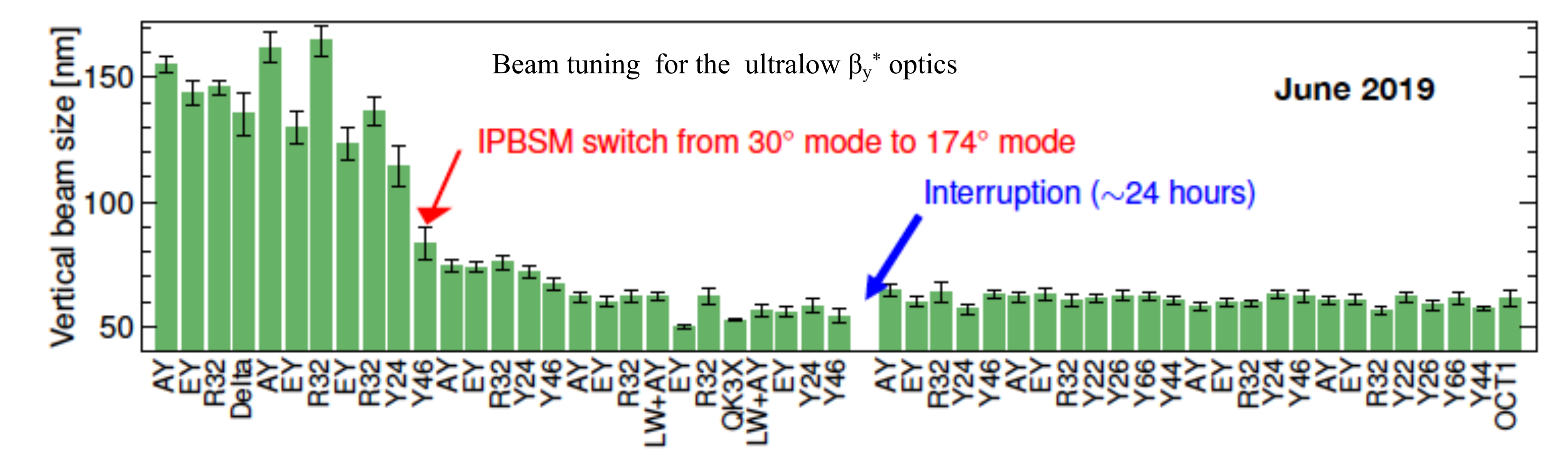
PRAB 21, 122802 (2018), JINST 16, P01005 (2021)

Recent Achievements: Ultra-low β studies

- β^*_y<60 nm (min. as 50.1±0.6 nm) for **ultralow β*** optics was obtained and stabilized **over long periods** in June 2019 (single-bunch)

PRAB 23, 071003 (2020)
CERN-ACC-NOTE 0006 (2020)

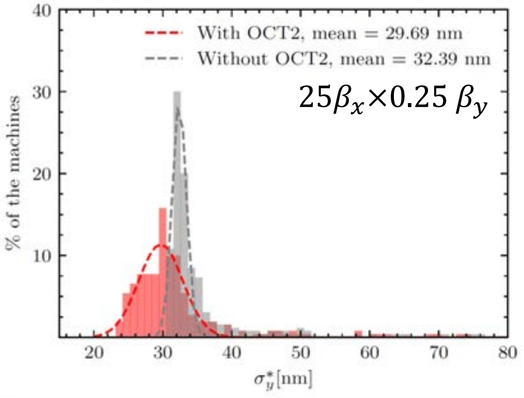




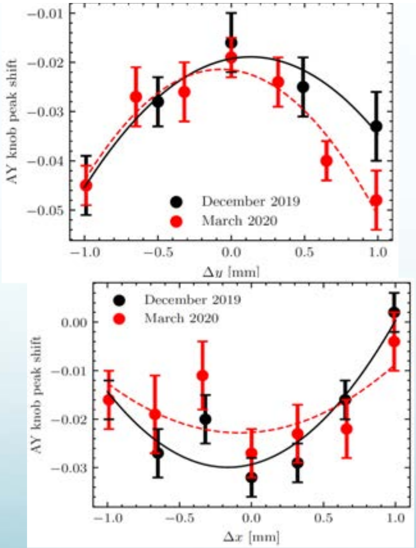
Recent Achievements: Ultra-low β studies

- **3rd-order terms** become dominating when entering **sub-25 nm** region could be correction using **octupoles**
- **BBA strategies** for the new installed **octupoles** have been evaluated

Simulated octupole correction

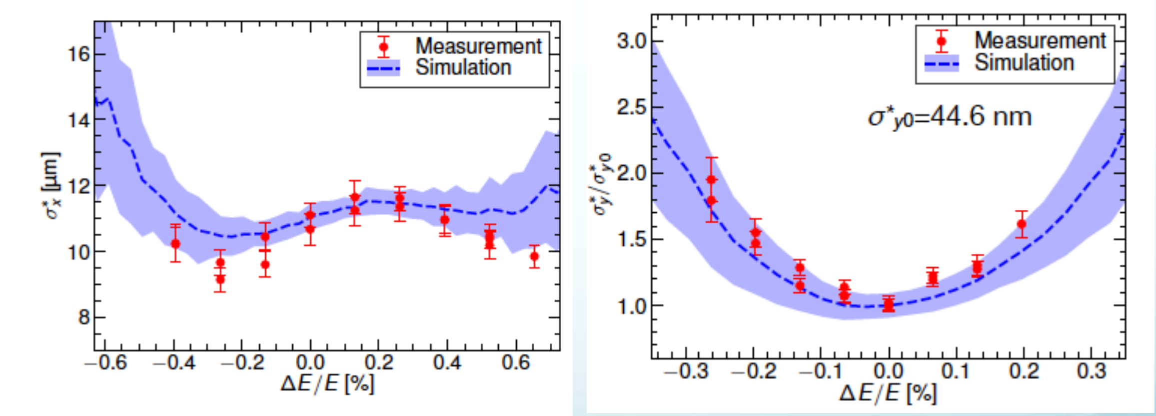


Octupoles knob scan vs H/V position



- **Bandwidth measurements** for the **ultralow β*** optics are roughly consistent with simulations based on operational optics model

H/V Momentum bandwidth measurement



Defined as a 10% increase of σ_{xy}^* for mono-energetic beam

R. Yang ATF session LCWS2021

Recent Achievements: Instrumentation R&D

- **Optical Transition Radiation (OTR)** (2013-2017)

  Sub micron resolution achieved

PRL 107, 174801 (2011); PRST-AB 18, 082803 (2015); JINST 15 (2020) P01020

- **Optical Diffraction Radiation (ODR)** (2017-2018)

  Sensitivity to 3 um with non-invasive technique achieved

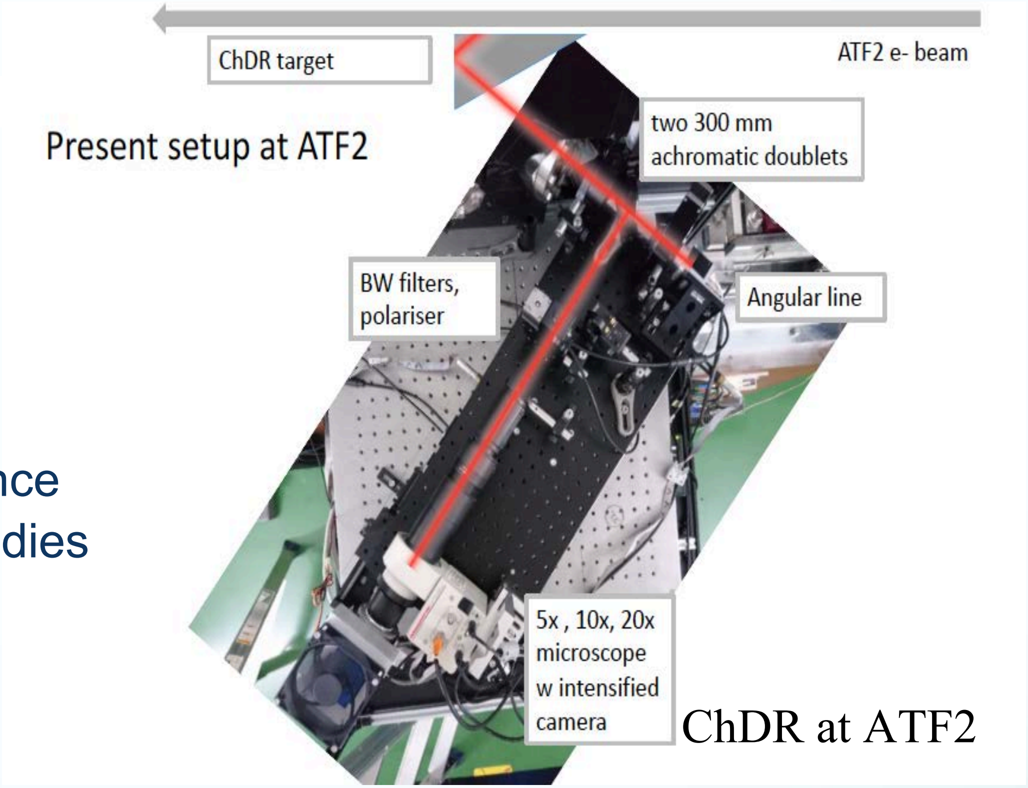
PRAB 12, 032801 (2018); NIMB 402 (2017) 88-91, Phys. Rev. Applied 13, 014041 (2020)

- **Incoherent Diffraction Cherenkov Radiation (ChDR)** (Since Nov. 2018) beam size measurement. The motivation for these studies are:

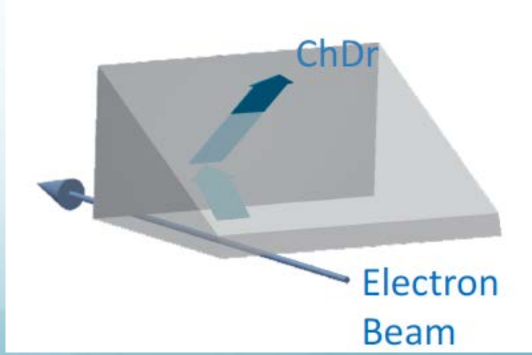
  Suppress Synchrotron Radiation → cleaner signal
  DR and SR are emitted at similar angles
  Looking for a physical process emitted at larger angle

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

PRL 121, 054802 (2018); PRAB 23, 042803 (2020)



ChDR at ATF2

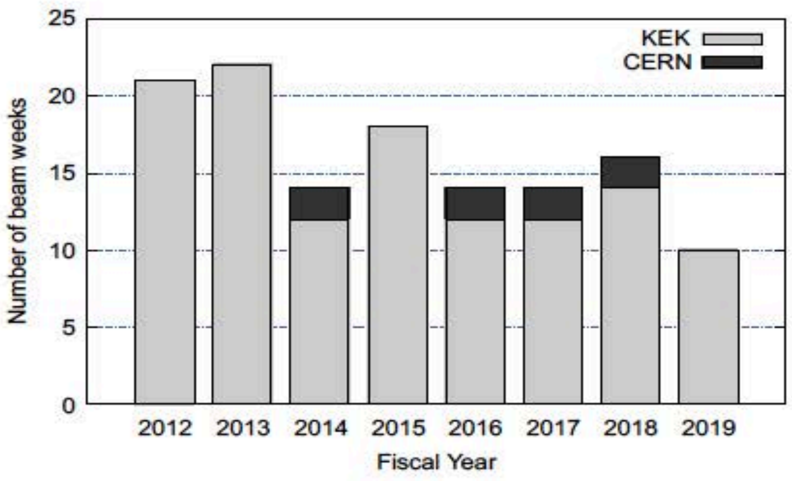


Operational Issues

ATF is a very unique facility internationally, providing **low-emittance beam** for R&D and developing **nanometer beam technology**. However, since the **operating budget** is allocated from the **common budget within KEK**, it is determined by DG by the results of coordination with other R&D, and this common budget itself is **becoming tighter year by year.**

Operation History

The ATF operating budget comes from sharing common R&D resources at KEK.



Beam operation

- 1996 ~ 2013: **21 weeks** per year
- 2014 ~ : reduced about **14 weeks** per year
- Rise of electricity prices (twice!) ← 2011 Great East Japan Earthquake

CERN's budgetary contribution to the ATF operation

- in four fiscal years
- two weeks extension each

Further budget difficulty on 2019 → 10 weeks

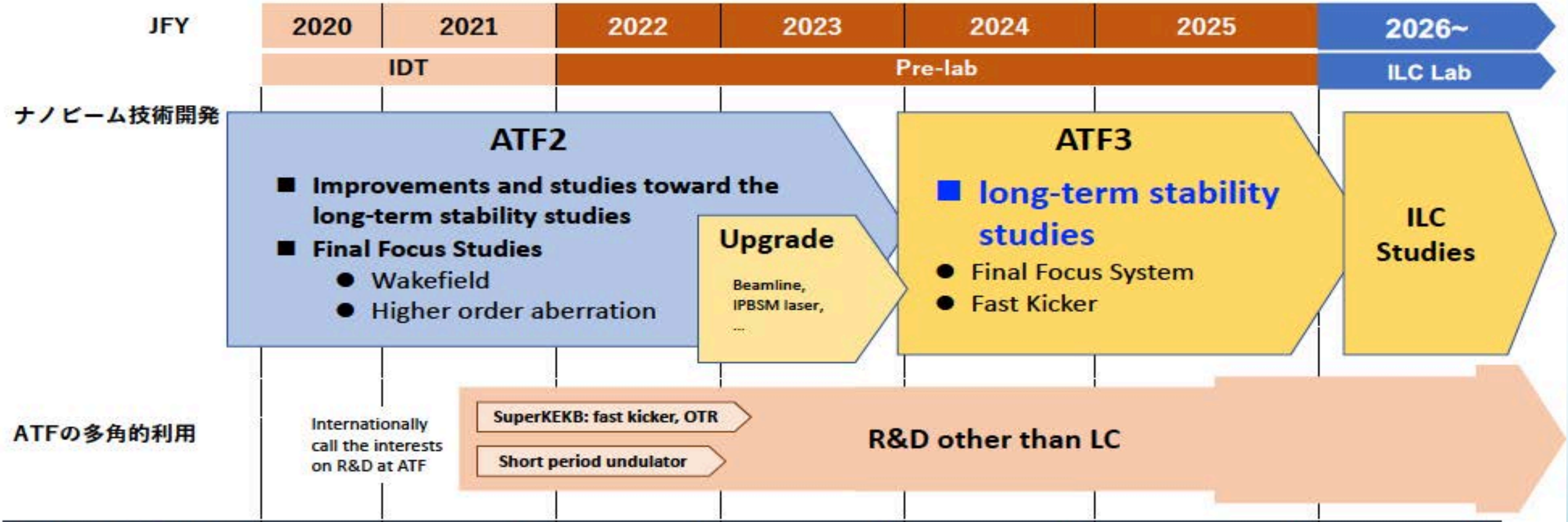
In this year, 2020, five weeks are approved so far, with additional beam weeks possible by the end of March 2021 will be determined, taking into account the recommendation of this ATF review.

Beam operation is postponed by COVID-19 difficulty especially for collaborators.
In addition, the measure of electric breakdown accident in July also postpones the beam **after January 2021**.

ILC FFS - ATF3 objective and collaboration:

Based on the achievements of the ATF2 no showstopper for ILC has been found, **ATF3** plan is to pursue the necessary R&D to **maximize** the **luminosity potential of ILC**. In particular the assessment of the **ILC FFS system design** from the point of view of the beam dynamics aspects and the technological/hardware choices and the **long-term stability operation issues.**

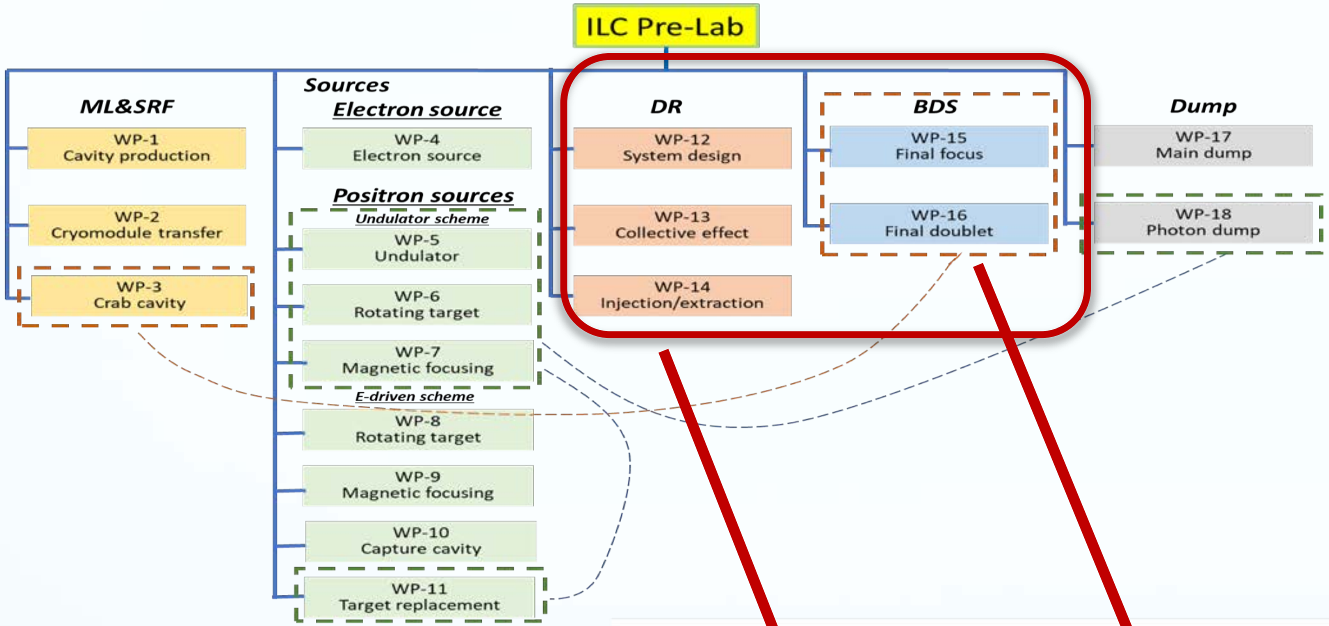
Tentative Plan of ATF (should be updated by international discussions) 2020/10/30

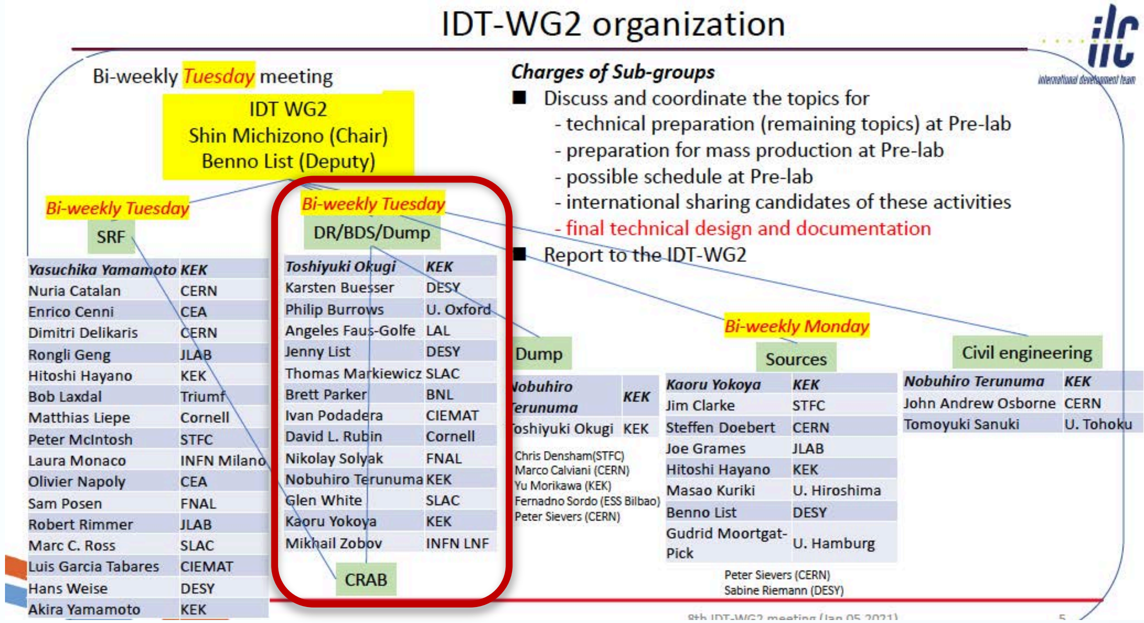


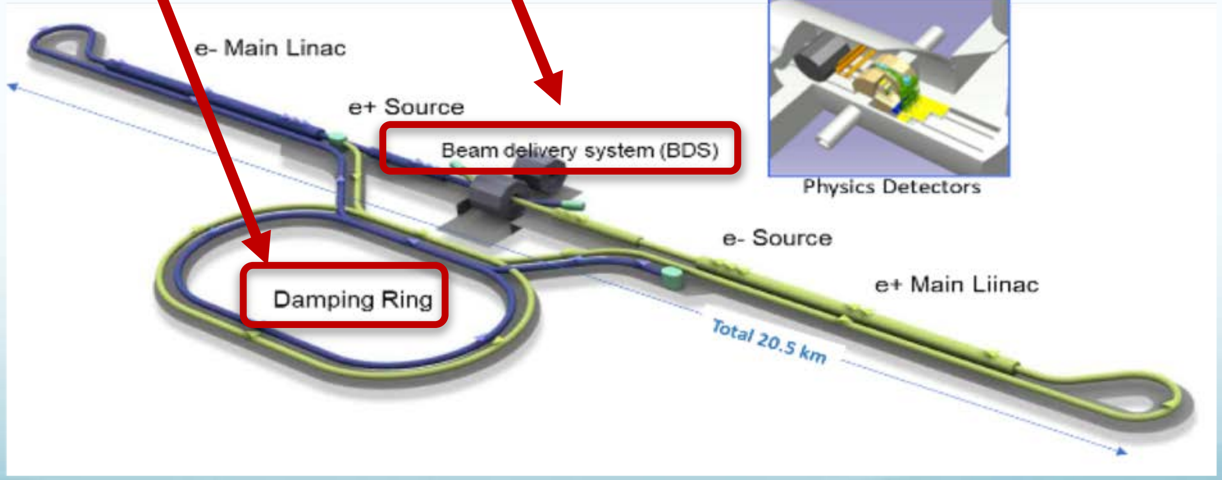
Operation weeks		5	15	15	20	20	20	20
Electric power	MWh	3275	5525	5525	6650	6650	6650	6650
Estimated Budget	-	-	-	-	-	-	-	-

Translated in English for your reference. Detailed budget profile was omitted here but presented to DG. N.Terunuma

ILC-IDT WG2 Technical proposal: DR and BDS





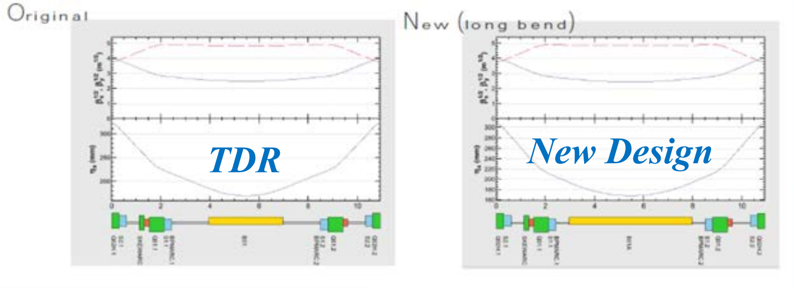


WP 12-14: DRs

Courtesy of T. Okugi

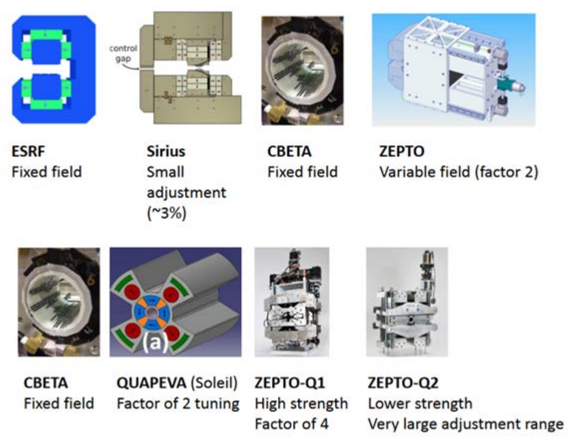
WP12: System design of ILC damping ring

- Present baseline beam optics for **ILC DR** is **updated** to have **a smaller ε_x** than ILC TDR (2017)
- System design of the **updated DR optics** considering **multipole errors** of ILC DR magnets has to be made (synergies with 4th SR sources).



- Study of possible use of **PM** in DR arcs

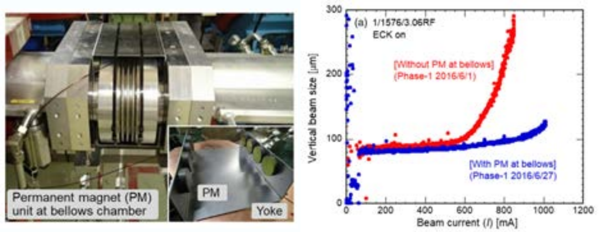
Permanent magnets



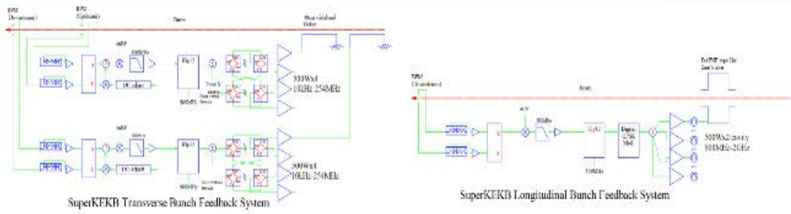
WP13: Evaluation of collective effects in ILC damping ring

- Evaluations of **Fast Ion and Electron Cloud instabilities** not done updated DR optics
- **EC instability** study for updated ILC DR to be made, including the **need** of **2nd positron DR** during the luminosity upgrade.
- MEXT's ILC Advisory Panel expressed technical concerns about the **need high-resolution fast FB for FII**. Evaluation of the EC instability and FB for the instability for the newly updated ILC DR is necessary.

PM at bellows and EC at SuperKEKB

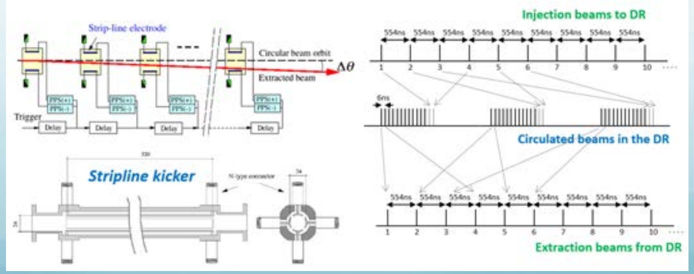


Fast feedback FII circuit at SuperKEKB

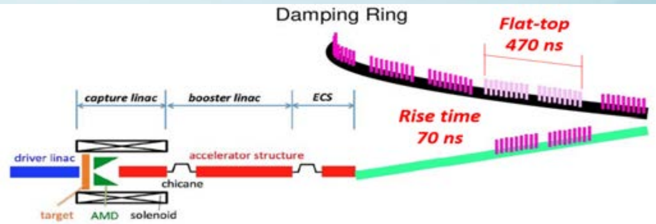


WP-14 : System design of ILC DR injection/extraction kickers

- The remaining task for the **ILC kicker system**, as reported by MEXT's ILC Advisory Panel, is to ensure the **stability and reliability** over **long-term operation.**
- **Injection system** for the **e-driven positron source** is different from others ILC injection and extraction kickers, hence development is needed.



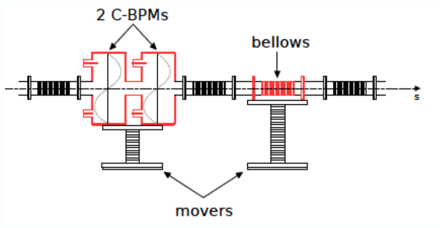
Injection kicker for the electron driven PS



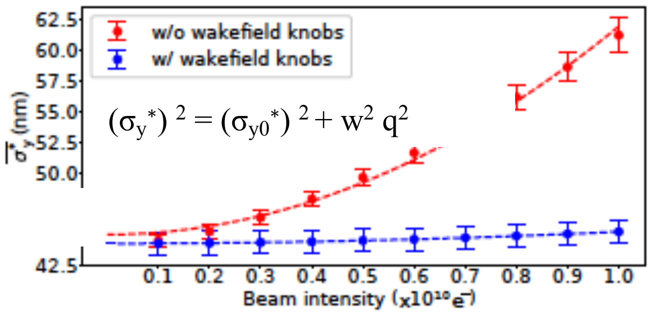
WP 15: ILC FFS – ATF3

Task 1: ILC System design

- **Hardware optimization:** Vacuum Chambers, Magnets (FD), CBPMs and IP-BPMs, FD vibration girder, IP-BSM (laser and stability), FONT-IP feedback, Multi-OTR system.
- **Realistic beam line driven / IP design:** jitter assessment/measurement, magnet errors, wakefields sources and scaling for ILC, vibration mitigation for new FD and Instrumentation assessment including IP.



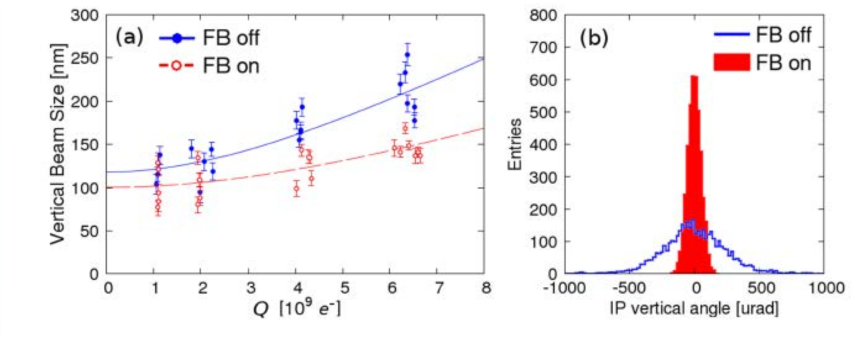
ATF2 wakefield knobs setup



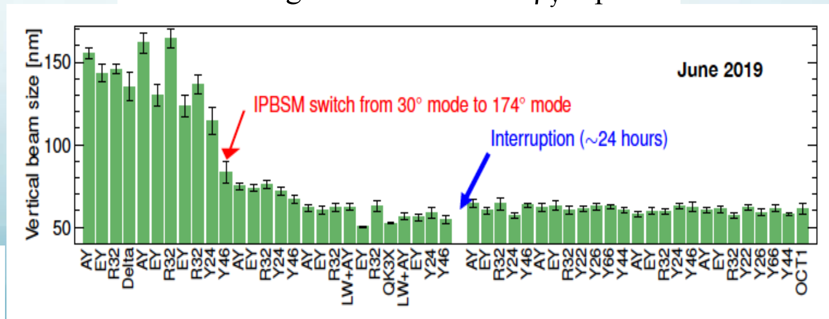
Task 2: ILC beam tests

- **Long Term Stability:** nominal ($10\beta_x^*$ x β_y^*) optics operation routine assessment, wakefield evaluation and mitigation, vibrations long-term monitoring system, jitter sources assessment, CBPMs calibration process upgrade, FONT FB system performance stabilization.
- **High-order aberrations:** design (β_x^* x β_y^*) optics and ultra-low β_y^* (including octupoles).
- **R&D complementary studies**: ILC DR injection/extraction kicker long term stability, new CBPMs, collimation issues, new wakefields setups, OTR, ODRS and ChDR BSM, ML techniques operation,...

Two bunch operation



Beam tuning for the ultralow β_y^* optics



A. Faus-Golfe ATF session LCWS2021

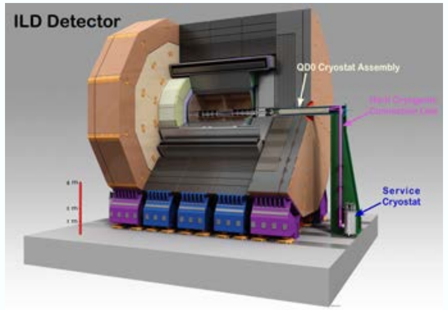
WP 16: ILC Final Doublet Design Optimization

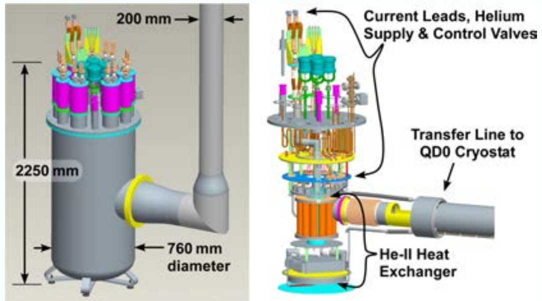
Courtesy of T. Okugi

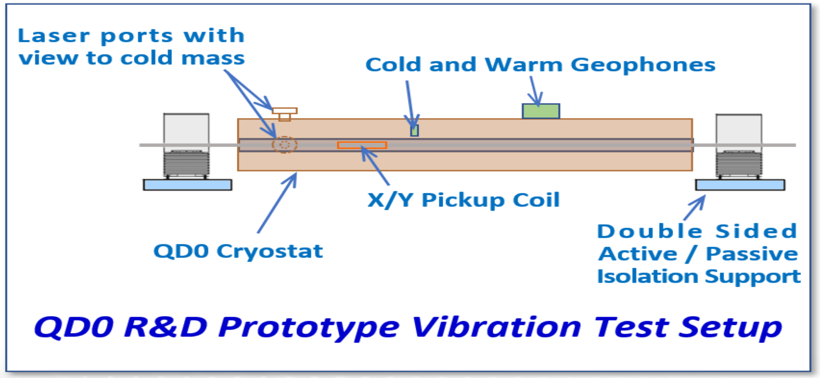
Task 1: Complete QD0 Prototype Vibration Testing

Since 2014 we have progressed significantly in vibration measurement technology thanks to US/Japan collaboration (BNL/KEK) on R&D to measure the vibration stability of SuperKEKB IR magnets.

R&D is needed to compare actual **measured vibration** level w.r.t. the ILC 50 nm requirement.



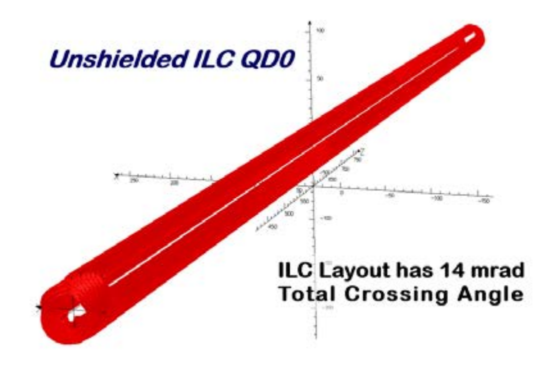


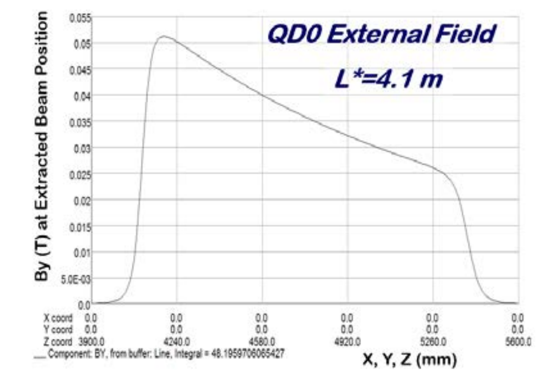


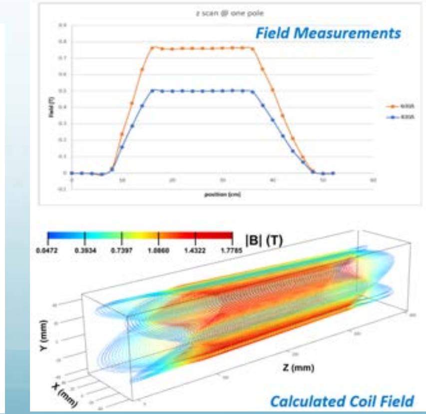
Task 2: Improve the ILC Final Focus Magnet Design

Update the **IR magnet designs** before settling on a final, preferred ILC EDR IR design configuration. Taking into account:

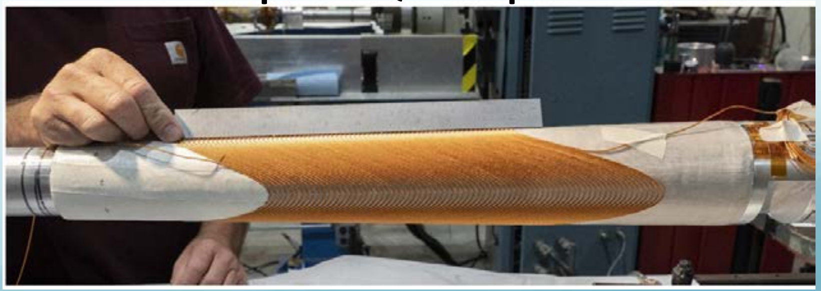
- In the past 7 years BNL Direct Wind technology and IR design experience has advanced tremendously
- Detector specific anti-solenoid configurations and confirm that these designs satisfy optics requirements.
- Coordinate with experiments to implement (or not) any anti-DID coils for background reduction.







Tapered Quadrupole

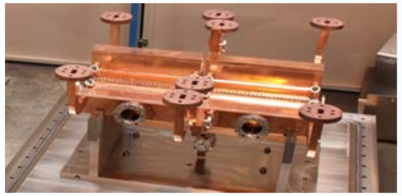


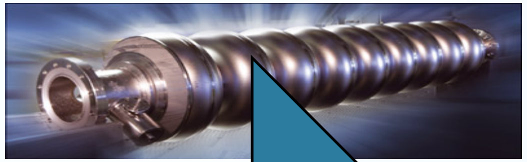
B. Parker MDI-BDS session LCWS2021

Irène Joliot-Curie Laboratoire de Physique des 2 Infinis — CNRS IN2P3 Les deux infinis

Summary

- **ATF2** has obtained **outstanding** and **unique** results for the **nanobeam sizes** and its **stability**.
- Based on the achievements of the ATF2 **no showstopper** for **ILC** has been found,
- **ATF3** plan is to pursue the necessary **R&D** to **maximize** the **luminosity potential** of **ILC**. In particular the assessment of the **ILC FFS system** design from the point of view of the **beam dynamics aspects** and the technological/hardware choices and the **long-term stability** operation issues
- A detailed **R&D Plan** in the framework of the **ILC-IDT Technical Preparation Plan** has been made for the **DRs** and **BDS** during the **ILC pre-lab**.
- This ILC pre-lab period will be of paramount importance for the **training of young acceleration physicist generati**on that will play a **key role** in the early stages of **ILC** commissioning and operation.





Thanks for your attention

	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

ILC DR / BDS Tasks Summary

ILC DR and BDS Tasks	
WP 12: **ILC DR system design**	**T1:** Optics optimization
	T2: Magnet design NC and PM
	T3: Magnet prototyping PM
WP 13: ILC DR collective effects	**T1**: Simulation: Electron Cloud, Ion-trapping instability, Fast Ion Instability
	T2: System design and Beam test for fast FB FII
WP 14: ILC DR extraction/injection kickers	**T1:** Fast Kicker system design of DR and LTR/RTL optics
	T2: Fast Kicker system design and prototyping of induction kicker and pulsar
	T3: Fast Kicker long term stability at ATF2
	T4: E-driven kicker system design, including induction kicker development
WP 15: ILC FFS design and beam test	**T1**: ILC FFS design hardware optimization and realistic beam line driven and IP
	T2: ILC FFS beam tests long term stability, high-order aberrations and other R&D
WP 16: FD design and optimisation	**T1**: ILC FD optimization
	T2: QD0 vibration test

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

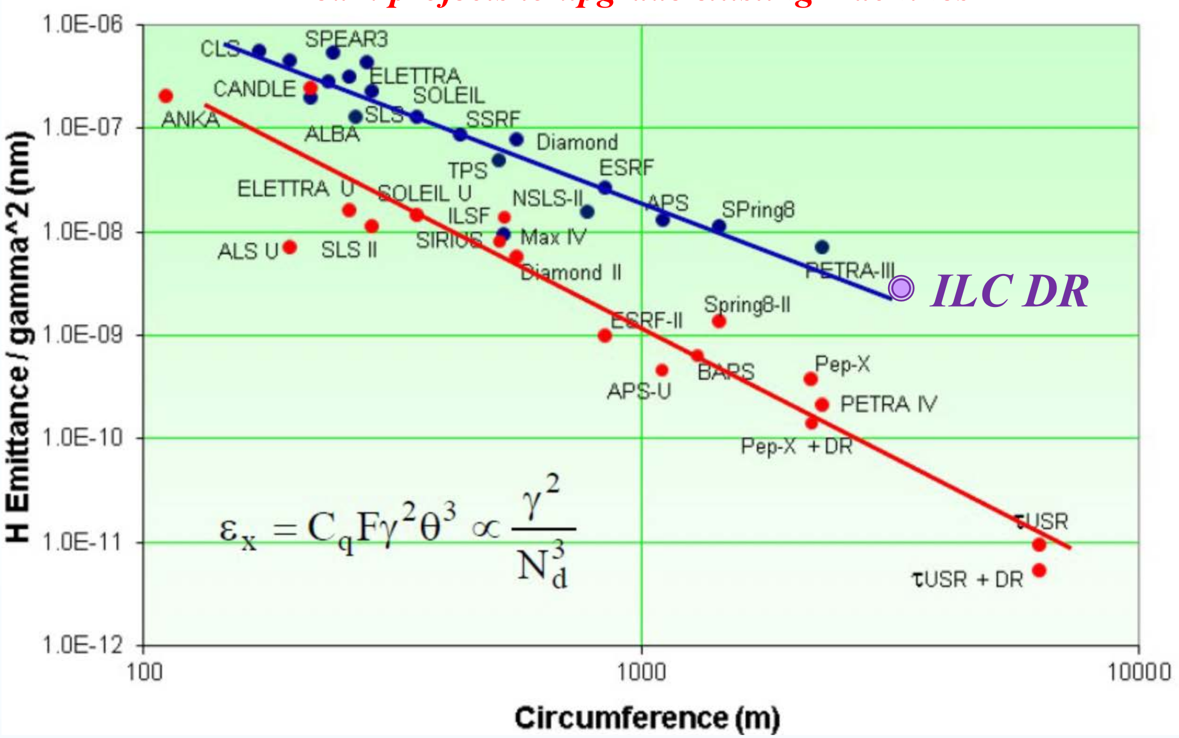
Implementation level: Relatively simple (green), Intermediate (blue), Difficult (red)

Horizontal emittance design of the ILC DR

http://www.esrf.eu/home/UsersAndScience/Accelerators/parameters.html

Blue : existing light sources

Red : projects to upgrade existing machines



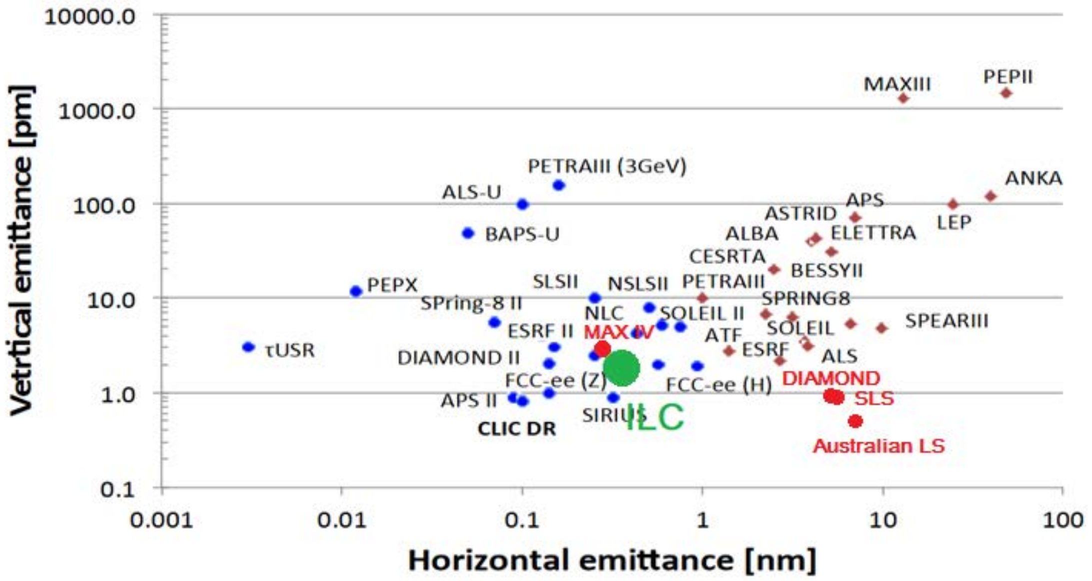
The design emittance for the ILC DR is comparable to those for the light sources currently in operation.

In the ILC, the emittance must be reduced, and the dynamic aperture also must be increased to make the positron capture yield large at the same time. We will start the DR optics optimization to make the dynamic aperture larger for the optics with the emittance, comparable to the light sources currently in operation.

*In the future plan of light source, a machine with lower emittance is designed, but when the emittance is lowered, the dynamic aperture will be smaller in general (**the consideration is next step**).*

Vertical emittance of the ILC DR

The vertical emittance of the ILC DR is 2.5 pm (E = 5 GeV), which is designed to be 0.625% of the horizontal emittance.



Red : existing light sources
Blue : projects to upgrade existing machines

The vertical emittances, which are smaller than the design vertical emittance of ILC DR, are realized in SLS, Australian LS, and DIAMOND LS.

The vertical emittance tunings have been established for the light sources.

Beam current of the ILC DR

	Beam Current
ILC DR	*390 mA*
SuperKEKB LER	*3.6 A (1 A at present)*
SuperKEKB HER	*2.6 A (1 A at present)*
SLS	*400 mA*
Australian LS	*200 mA*
DIAMOND LS	*300 mA*

The beam current of the ILC is about the same as the existing synchrotron radiation facility, which is an order of magnitude smaller than the design value of SuperKEKB.

The vacuum device and collective effect can be referred to the experience of existing light sources.