Future ATF Plans beyond JFY2012 (From JFY2013)

After this, we have to submit final proposal to KEK directorates in May 2011. The approval process at KEK will take several months, then KEK directorates will give us their conclusion to ATF International collaboration team until the end of 2011.

Junji Urakawa
2011.3.22 at ALCPG11

Prospect of ATF achievements until the end of JFY2012

1.3GeV Linear Accelerator (ATF Linac) :
3.12Hz (~6.25Hz) beam operation, 60mA/pulse multi-bunch beam Injection or more.
Stable 100% injection efficiency.

1.3GeV DR (ATF DR) :
200mA beam storage operation with 3 train,
1 or 2pm vertical emittance,
Stable 3 bunches/train extraction,
Stable single bunch extraction with repetition rate 3.12Hz (~ 6.25Hz)
Beam orbit stability less than a few microns vertically

ATF2 beam line:
Demonstration of 37nm beam focusing at IP
Beam orbit stability within ~10nm by FONT at IP

Guideline of research programs for ATF international collaboration

After JFY2012, it is expected that ATF will need to be motivated not only by linear colliders, but also by other science. Moreover, the funding for linear collider R&D at KEK will probably not be enough to fully support ATF operation as now. Global international collaboration is much desired. The extension of ATF/ATF2 beyond JFY2012, together with STF, and the new organization for these projects is part of KEK's "pre-ILC plan".

Following is rough guideline as the consensus of KEK ATF team and ILC group.
R&D contribution to LC ~80% including CLIC related issues,
Application of advanced accelerator technologies to another field ~20%

High quality scientific proposals can be expected to mitigate future funding problems and influence discussions of other changes.

Approval process; first submit the draft to 11th TB meeting, second modify it according to TB comments,
then submit the modified proposal to 6th ICB in March 2011.
After that, we have to submit final proposal to KEK directorates in May 2011. The approval process at KEK will take several months, finally KEK directorates will give us their conclusion to ATF International collaboration team.

1. Super-FQ R&D or new normal FQ R&D (Advanced FQ R&D) to make smaller beam size (less than ~20nm).

Demonstration of **compact final focus & BDS tuning** are critical issues for CLIC and ILC and ATF2 experience invaluable

Ultra-low beta-function with ultra-low emittance beam is very challenging.
Try to reduce the vertical emittance more, say 1pm or 0.5pm.

Beam parameters (Interesting New parameters)

	Nominal RDR	SB2009	RDR Low charge	New low charge
E_{cm} (GeV)	500	500	500	500
Ne	2×10^{10}	2×10^{10}	1.0×10^{10}	1.0×10^{10}
F_{rep} (Hz)	5	5	5	5
N_b	2625	1320	5640	2625
P_b (MW)	10.5	5.3	11.3	5.37
β_x (mm)	20	11	12	8
β_y (μm)	400	200	200	166
$\gamma\varepsilon_x$ (μm)	10	10	10	10
$\gamma\varepsilon_y$ (nm)	40	36	30	10
σ_x (nm)	639	474	495	404
σ_y (nm)	5.7	3.8	3.5	2.0
σ_z (μm)	300	300	150	166
δ_B	0.031	0.056	0.026	0.0241
n_γ	1.3	1.74	0.832	1.01
Dy	19.0	38.4	10.0	24.0
H_D	1.74	1.63?	1.56	1.6
θ (rad)	0.00036	0.00048	0.00023	0.00029
N_{had}	1.1	3.6	0.21	0.66
Trav. focus	No	Yes	No	No
L_0 ($cm^{-2}s^{-1}$)	2.0×10^{34}	1.9×10^{34}	2.0×10^{34}	2.0×10^{34}

Ultra-low beta-function

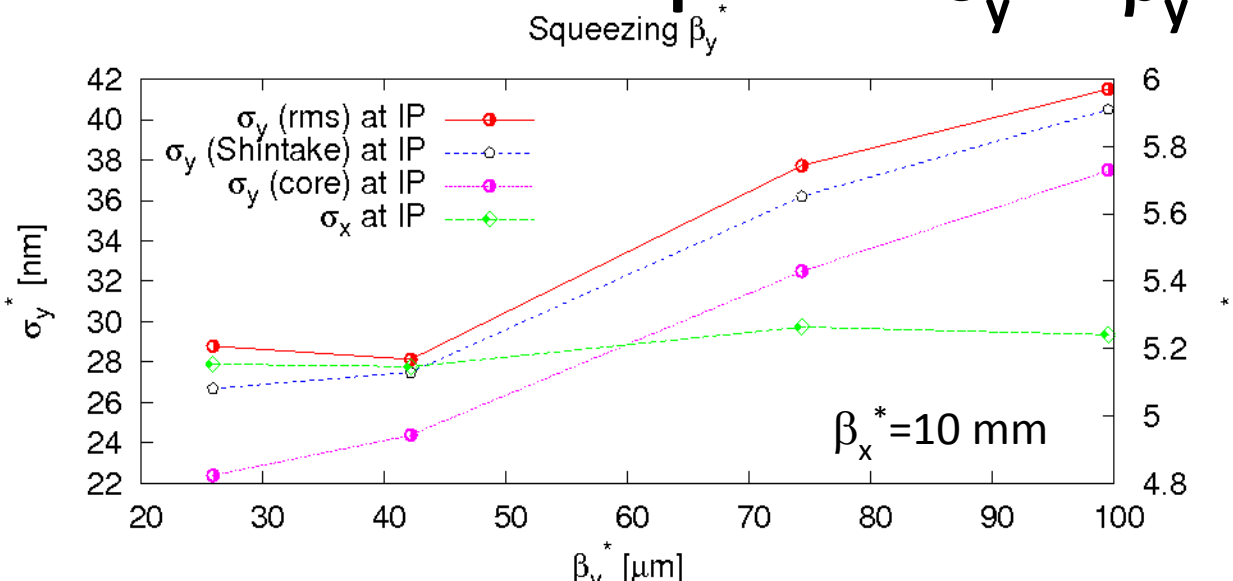
R. Tomas

motivation

project	L^*[m]	β_y^* [μm]	ξ_y
ATF2 nominal	1.0	100	~19000
ILC design	3.5	400	~15000
ATF2 ultra-low	1	25	~76000
CLIC 3 TeV	3.5	90	~63000

To prove CLIC chromaticity levels in ATF2 requires a factor 4 lower IP beta function. The main obstacle is the field quality (already issue for ATF2 nominal)

limitation from multipoles: σ_y^* vs β_y^*



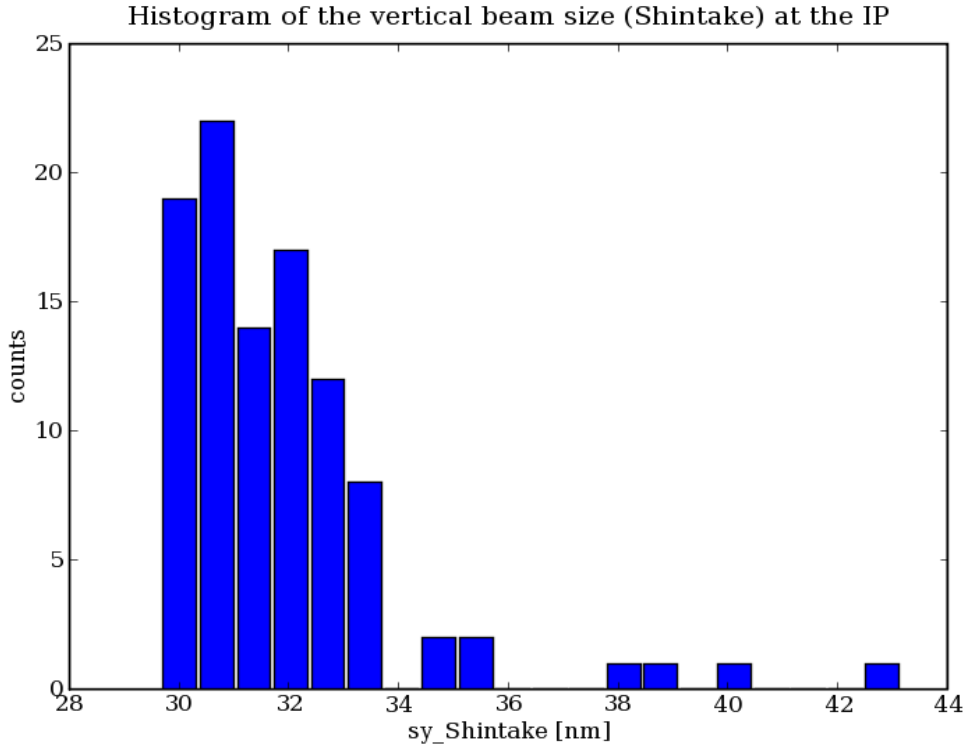
with measured magnetic multipoles; optimization with MAPCLASS; no further reduction when decreasing β_y^* below 40 μm

Ultra-low beta-function cont'd

β_y^*=40 μm; β_x^*=10 mm

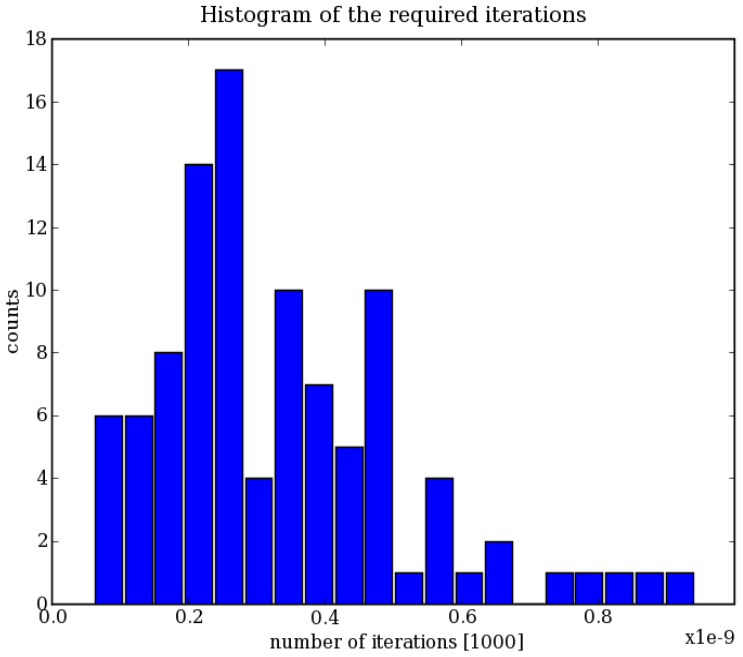
tuning ATF2 ultra-low β_y

R. Tomas,
E. Marin



90% seeds reached a $\sigma_y^* < 34$ nm

Tuning based on an iterative application of knobs. All seeds converge below 1000 iterations.



all elements misaligned and tuning knobs applied; beam sizes after tuning not as good as design; work in progress to improve further

Ultra-low beta-function cont'd

ways to reach β_y^*=25μm E. Marin, D. Schulte, R. Tomas

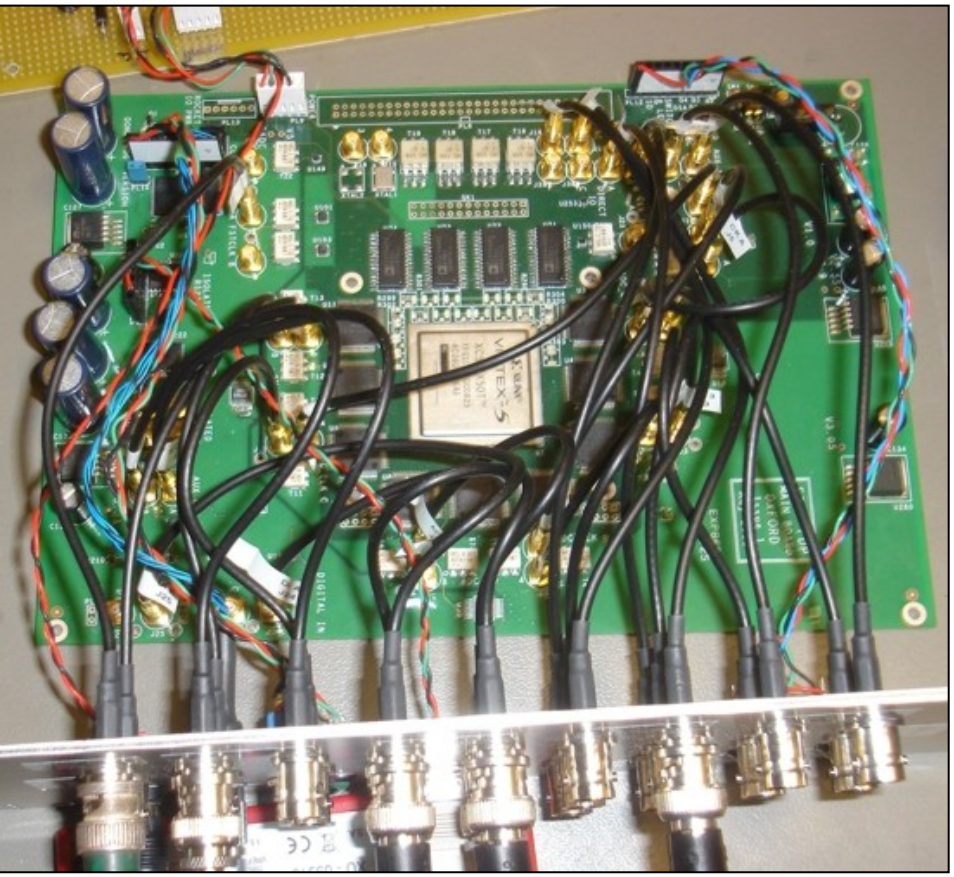
A. **Replacing QF1** with a superconducting quadrupole (B. Parker) removes most of the harming nonlinearities; **if SC Q1 does not become available, CLIC considers building better-quality warm Q1(2) magnets for ATF2(3)**

B. **Reducing DR horizontal emittance** (SC wigglers) **CLIC considers contributing new high-field low-period *Nb_3Sn* wiggler (~15-20% emittance reduction)**

C. **New non-linear corrector magnets** in ATF2 beam line **CLIC could also provide such elements (instead of or in addition to Q1(2))**

2. Nano-beam orbit control (Font study extension). in-kind contribution /3 years (2013-2015)

FONT5 digital FB board



Xilinx Virtex5 FPGA

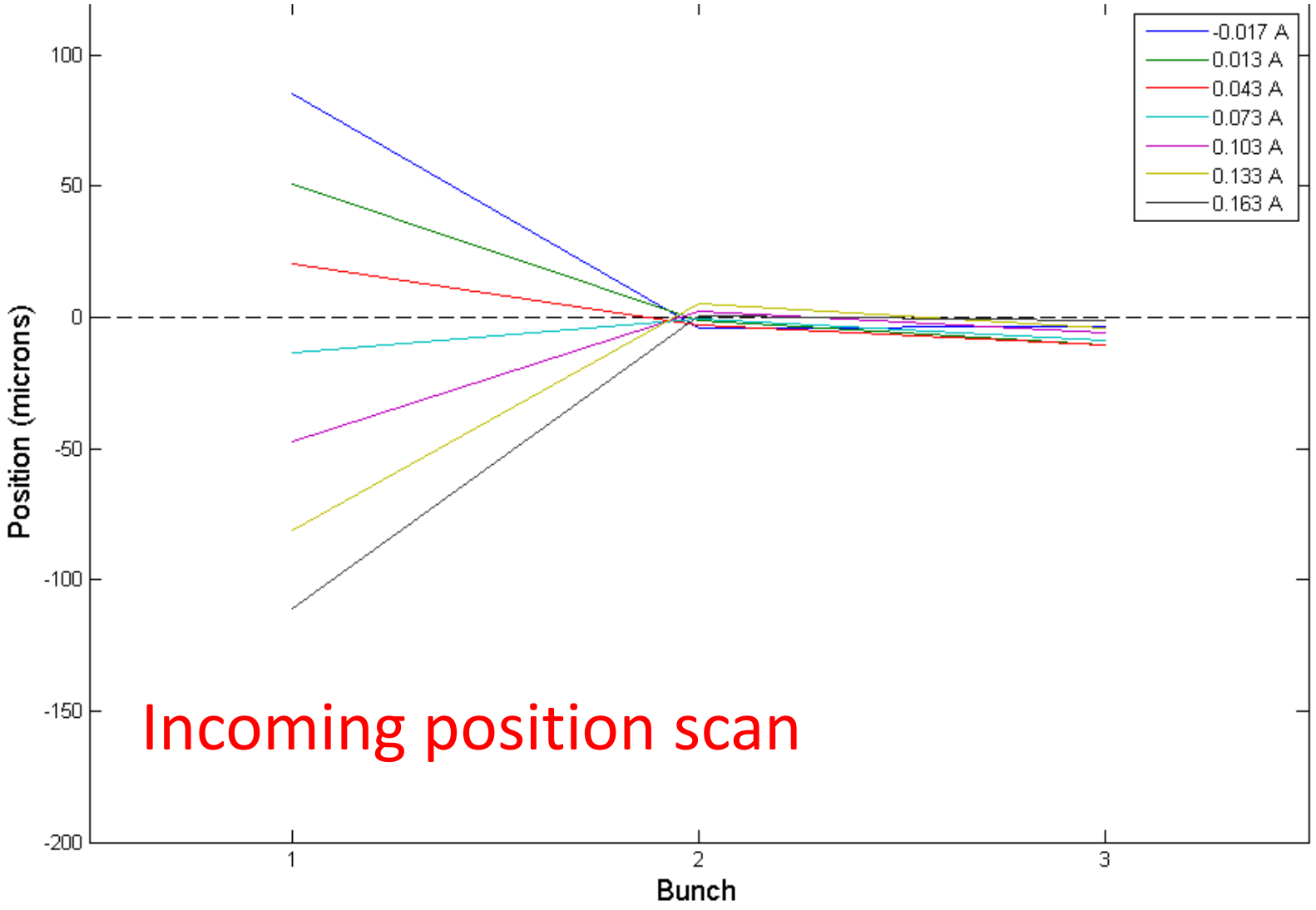
9 ADC input channels
(TI ADS5474)

4 DAC output channels
(AD9744)

Clocked at 357 MHz
phase-locked to beam

4x faster than FONT4

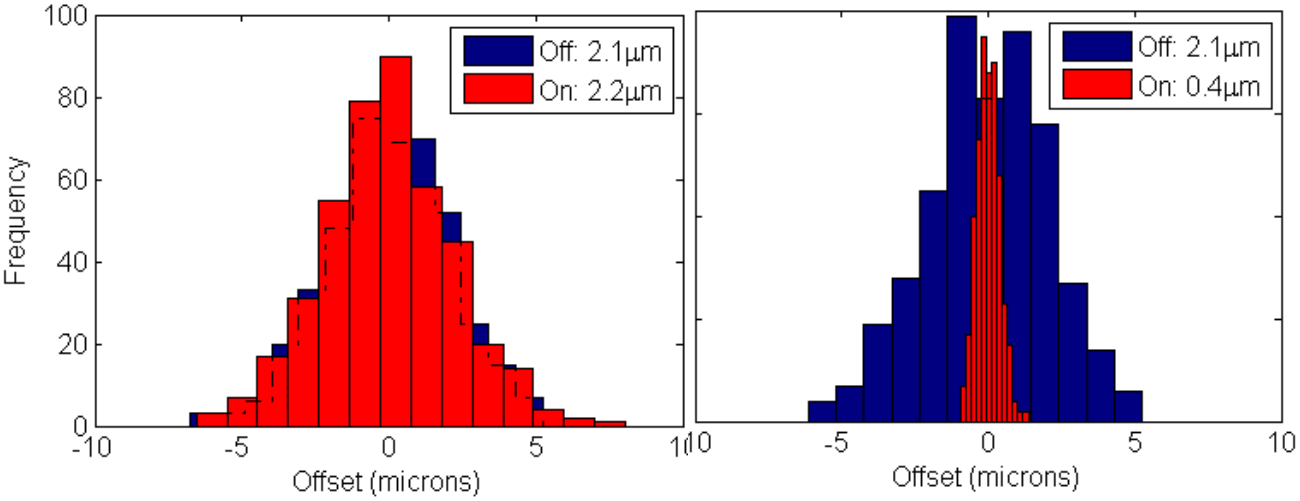
P2 → K1 loop performance



Incoming position scan

P2 → K1 loop jitter reduction

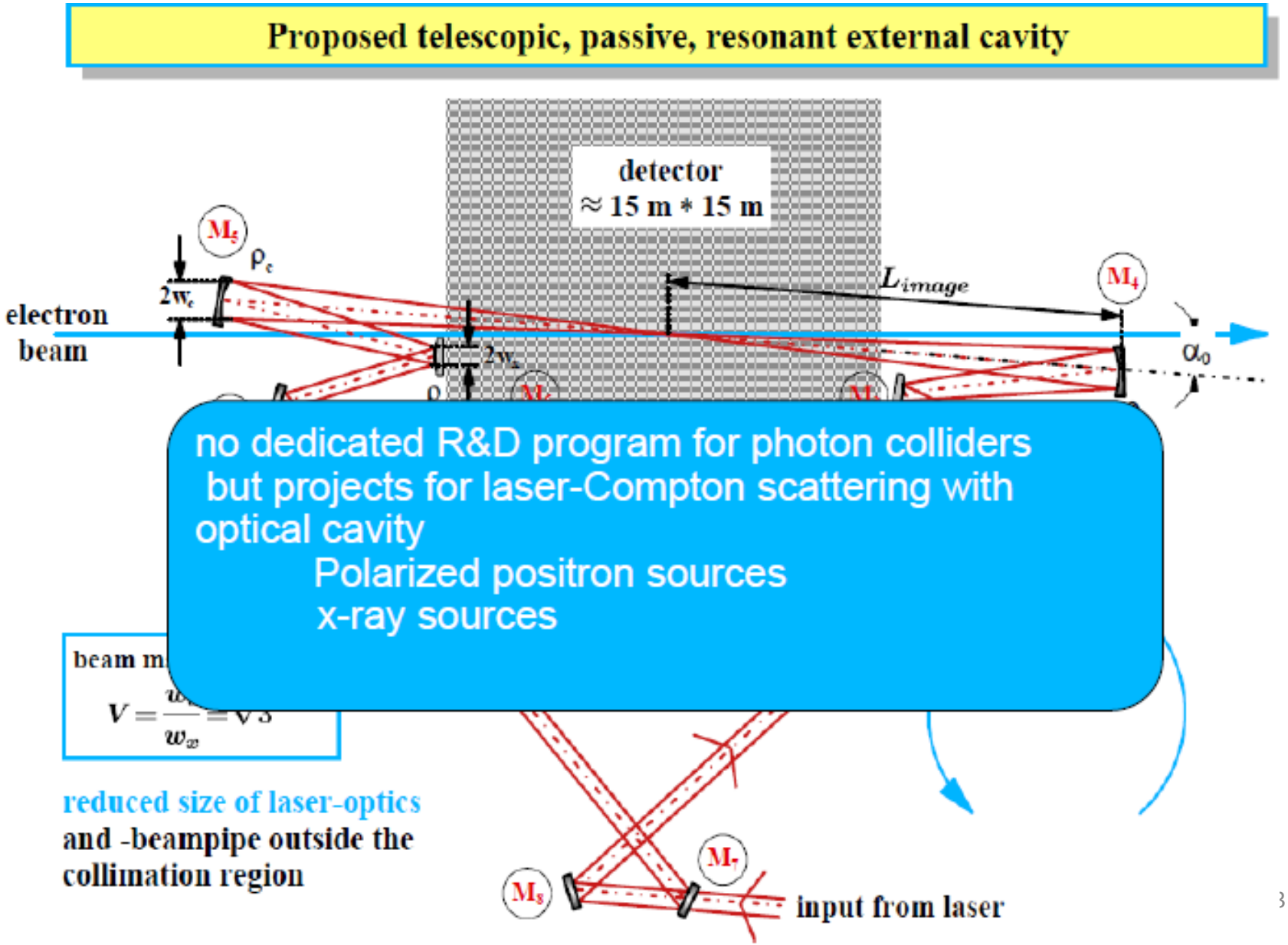
Bunch 1 Bunch 2



2.1 um → 0.4 um

Factor of 5 jitter reduction

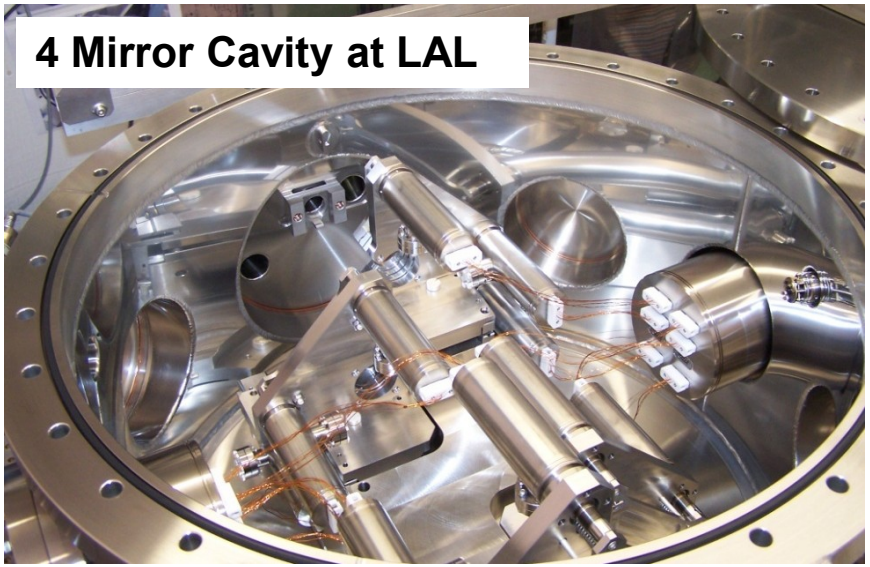
3. Gamma-Gamma laser system R&D. (2013-2017)
(Gamma-gamma collider R&D)

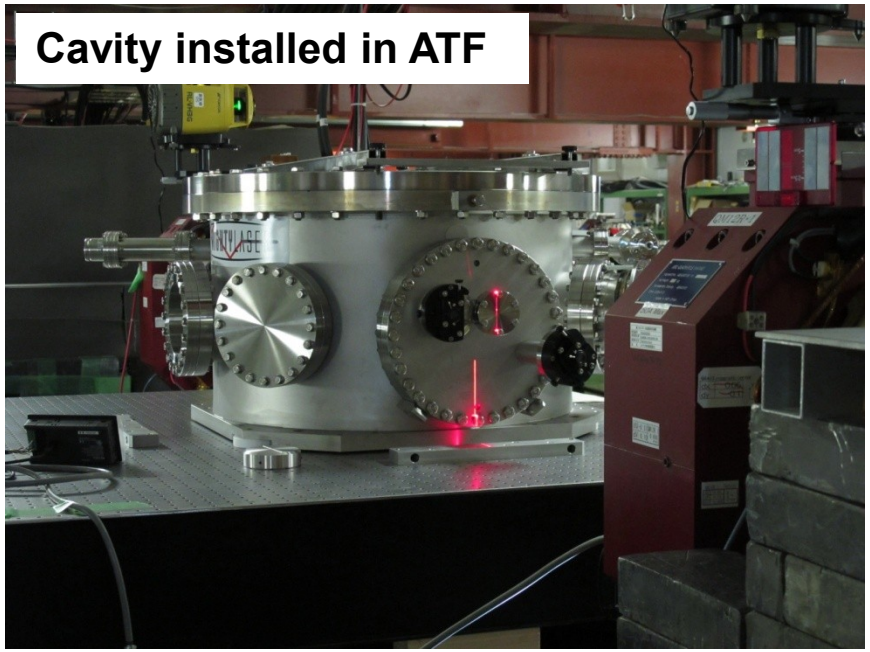


no dedicated R&D program for photon colliders
but projects for laser-Compton scattering with optical cavity
Polarized positron sources
x-ray sources

French 4 Mirror Cavity installed in ATF:

4-mirror cavity has a potential to get a smaller spot





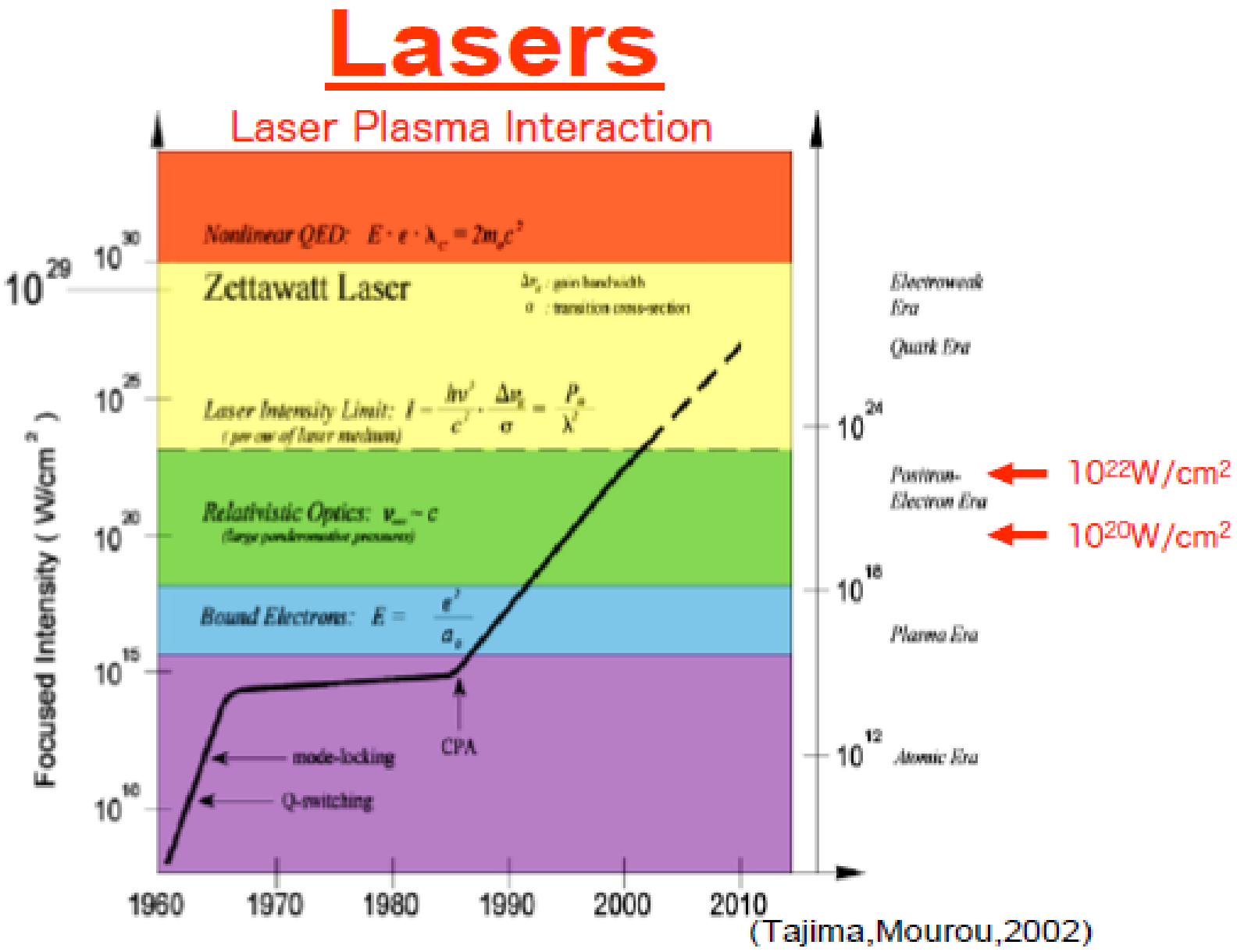
2010 Works

- July-Aug **Cavity installed in ATF**
  French Team (9 persons) at KEK
- Aug/30th Laser locked to Cavity
- Sep/24th Cavity locked to ATF
- Oct/25th **1st gamma observed**
- Nov/1st Laser trouble -> sent to Zurich
- Dec/12th Gamma observed again

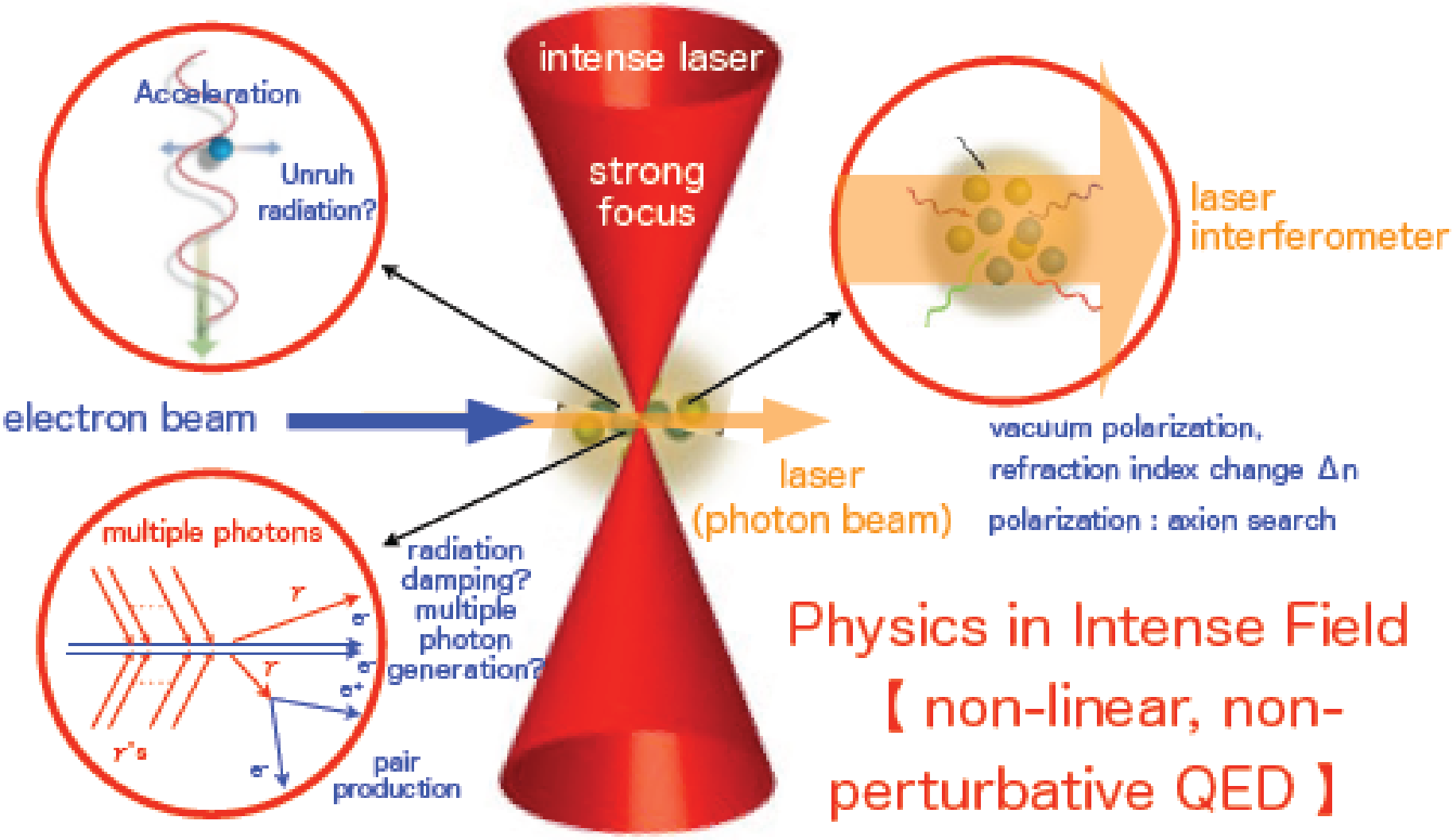
2011 Schedule ?????

- Feb-May Running and improvements
- Summer Major improvements to ultimate enhancement

4. Non linear QED Physics (from high field physics to Vacuum science).
Need 10Hz, 200TW laser at ATF2, **high-field physics at ATF2**



Intense Laser and Electron・Photon Interaction



Summary

Overall the scope of ATF-2 will be significantly widened with proposed new research items.

1. Super-FQ R&D or new normal FQ R&D (Advanced FQ R&D) to make smaller beam size (**less than ~20nm**). In-kind contribution **(2013-2018) , so called ATF3.**
2. Nano-beam orbit control (Font study extension). in-kind contribution /3 years **(2013-2015)**
3. Gamma-Gamma laser system R&D. **(2013-2017)** (**Gamma-gamma collider R&D), this is the extension of Compton collaboration.**
4. Non linear QED Physics (from high field physics to Vacuum science). Need 10Hz, 200TW laser at ATF2, **high-field physics at ATF2**

proposed future CLIC contributions

1) **Ultra-low beta-function**
   Limited by QF1, CLIC considers providing one with larger aperture
2) **Ground motion feedback/feed-forward**
   Ground motion sensors on each relevant magnet to predict beam orbit
3) **Test of quadrupole stabilisation in ATF extraction**
   Could be best way to verify stabilisation performance with beam
4) **Developing damping ring extraction kickers systems**
   Would need ATF3 to verify kicker performance
5) **CSR induced beam instability in ATF-DR**
   Experiments to distinguish between theories
6) **DR optics, emittance tuning & IBS studies**
7) **Superconducting wiggler for ATF**
8) **BPM tests**
   CLIC main linac BPMs developed by FNAL tested at ATF2; more in future
9) **Contributions to ATF2/3 operation**

CLIC related issues

Test of hybrid final-quadrupole solution for CLIC at ATF (small aperture), e.g. close to IP; interesting if a place can be found and if the spot size could be significantly reduced.

Correction of magnet motion with sensor and feedback on the beam could be tested at ATF; sensors still need to be optimized for frequency range of interest; ATF frequency is not optimum but could be increased to 12.5 or at least 6.25 Hz. A fast kicker is used for 30 bunch extraction, spaced 150 ns. The ultimate ATF repetition rate limit is 12.5 Hz, which would start to be interesting for CLIC tests. Reaching 12.5 Hz would need modifications of the laser system (6 Hz possible), and perhaps of cooling system, of kickers, etc…. The RF system already runs at 12 Hz. 6 Hz is more easily possible. Geophones exist at CERN which are sensitive at 6 Hz, though this is different from the future CLIC frequency.

CLIC would like (to continue) to work on **ATF and transfer line tuning, including tuning of the damping ring**. There is always the need for tuning the ring in order to maintain a small emittance. Feedback system can help for stabilization, e.g. orbit feedback.