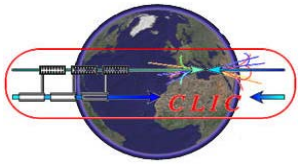


CLIC related CERN-KEK collaboration

- RF structures
  - Collaboration agreement
  - High power test station
  - Structure fabrication
- Beam studies in ATF2
- Nanometer beam sizes studies and tests
- Sub nanometer stabilization studies and tests
- Positron generation by Compton Scattering

Collaboration agreement
High Gradient RF Structure Development

ICA-JP-0103

Agreement on Collaborative Work

between

The European Organization for Nuclear Research
CERN CH-1211 Genève 23
Switzerland
(in the following called "CERN")

and

The High Energy Accelerator Research Organization
1-1 Oho, Tsukuba-shi, Ibaraki-ken 305-0801
Japan
(in the following called "KEK")

2008

APPENDIX 2 TO THE AGREEMENT ON COLLABORATIVE WORK ICA-JP-0103

Collaboration on High Gradient Accelerator Technology Centred at Fabrication and Tests of X-Band Accelerating Structures

Preamble

The Parties have entered into an Agreement on Collaborative Work ICA-JP-0103.

Article 2 of said Agreement stipulates that "the exact scope of each specific collaboration shall be defined in an Apprendix."

1. Objective of the collaboration

Both KEK and CERN in the past decade have been forerunners in the world for the R&D's of high gradient acceleration on the basis of normal conducting accelerator structures. The objective of this collaboration is to facilitate further development of related key technologies, in particular the X-band technologies, by the two parties.

2. Personnel of the Collaboration:

KEK: Yukihide Kamiya, Director of Accelerator Laboratory of KEK
Toshiyasu Higo, Accelerator Laboratory of KEK
Shigeki Fukuda, Accelerator Laboratory of KEK.

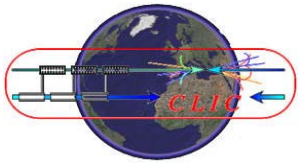
CERN: Jean-Pierre Delahaye, Accelerators and Beams Department
Walter Wuensch, Accelerators and Beams Department.

3. Duration of the Collaboration:

This Appendix shall be valid initially until 31 March 2011.

4. Scope of the Collaboration:

4.1 CERN's scope:



High power test stations of KEK
Nextef and KT-1

Nextef stands for NEw X-band TEst Facility with two klystrons.
KT-1 stands for Klystron Test station #1.

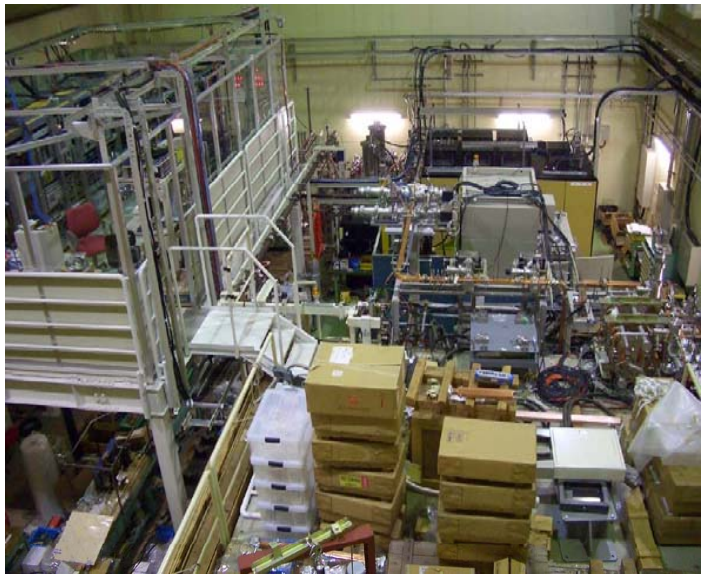
- Nextef

  GLCTA facility was moved to the present place to make these facilities in 2007.
  A 100MW high power station for the X-band accelerator structure tests.
  CERN-SLAC-KEK collaboration on high gradient targeting 100MV/m level.

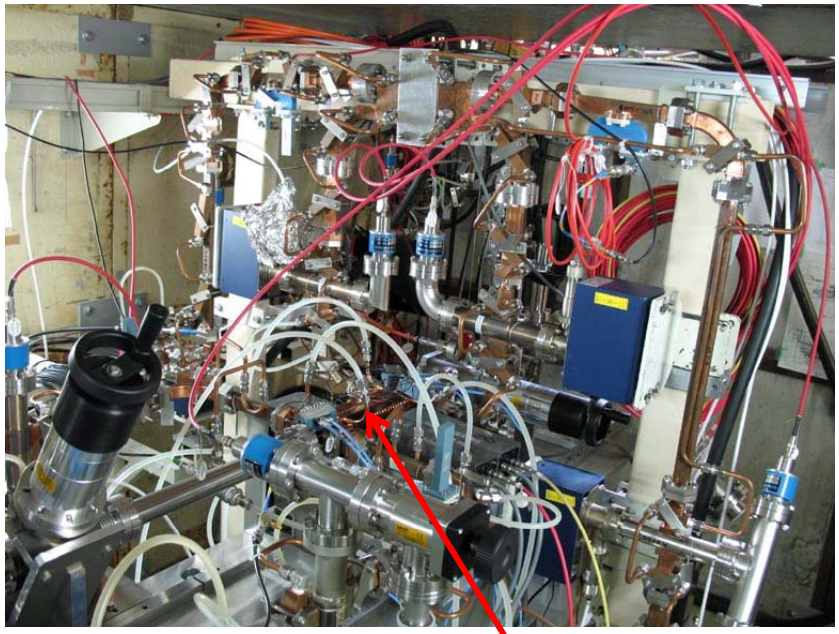
- KT-1

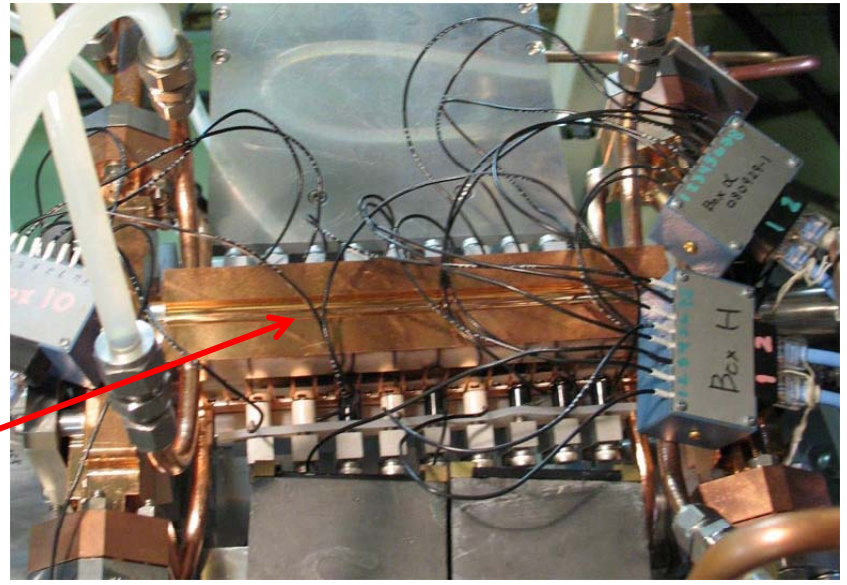
  Small size fundamental studies on high gradient tests.
  Such study as narrow waveguides are proceeded.

Now T18_VG2.4_Disk #2 (processed since Sept 08)



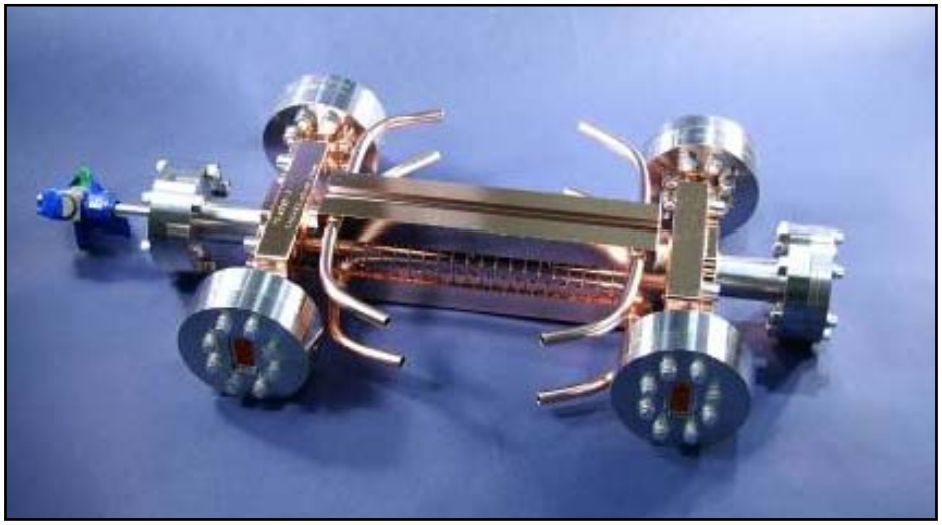
Two klystron facility
Nextef





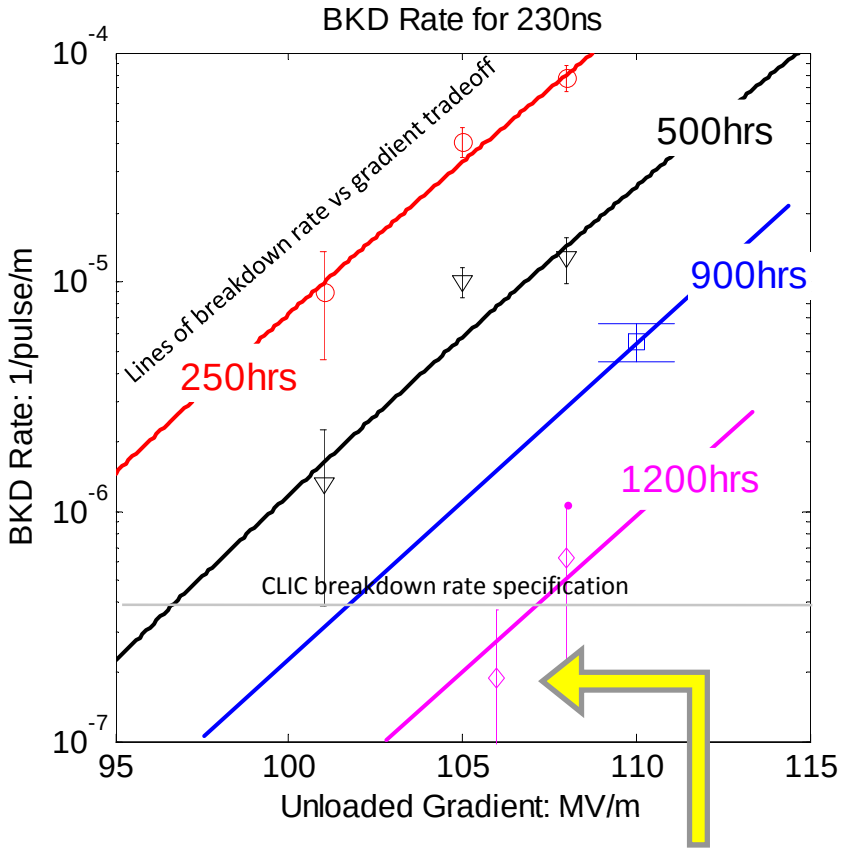
T18_VG2.4_Disk

T18 – Successful fabrication and test of the first CLIC X-band test structure designed for 100 MV/m, low breakdown rate operation



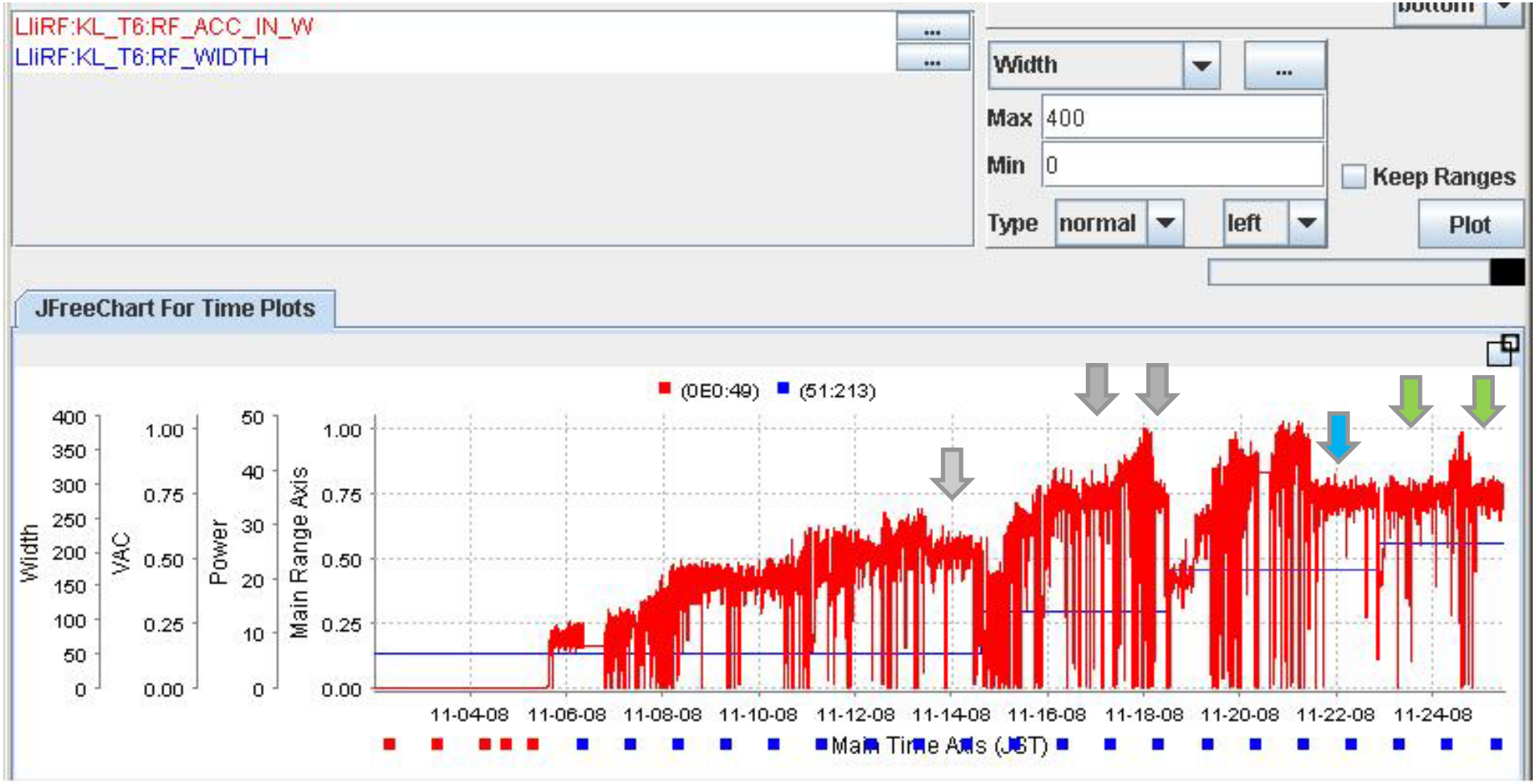
For the connoisseur– 18 undamped cells, 29 cm long, 2.6 to 1% tapered group velocity and manufactured by diamond turning and diffusion bonding.

Fruitful & outstanding collaboration :
designed by CERN,
manufactured by KEK
bonded and tested by SLAC.



The result – After steady improvement, operation below the 4×10^{-7} CLIC breakdown rate specification with above 105 MV/m unloaded gradient.

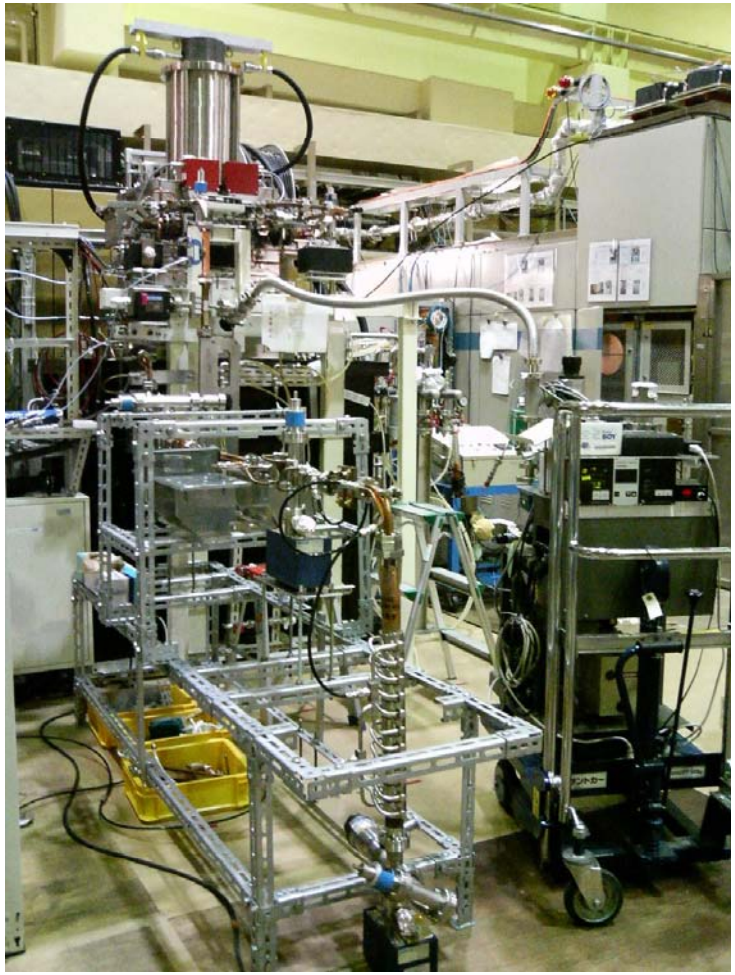
High power tests in NEXTEF (KEK)
T18_VG2.4_Disk #2



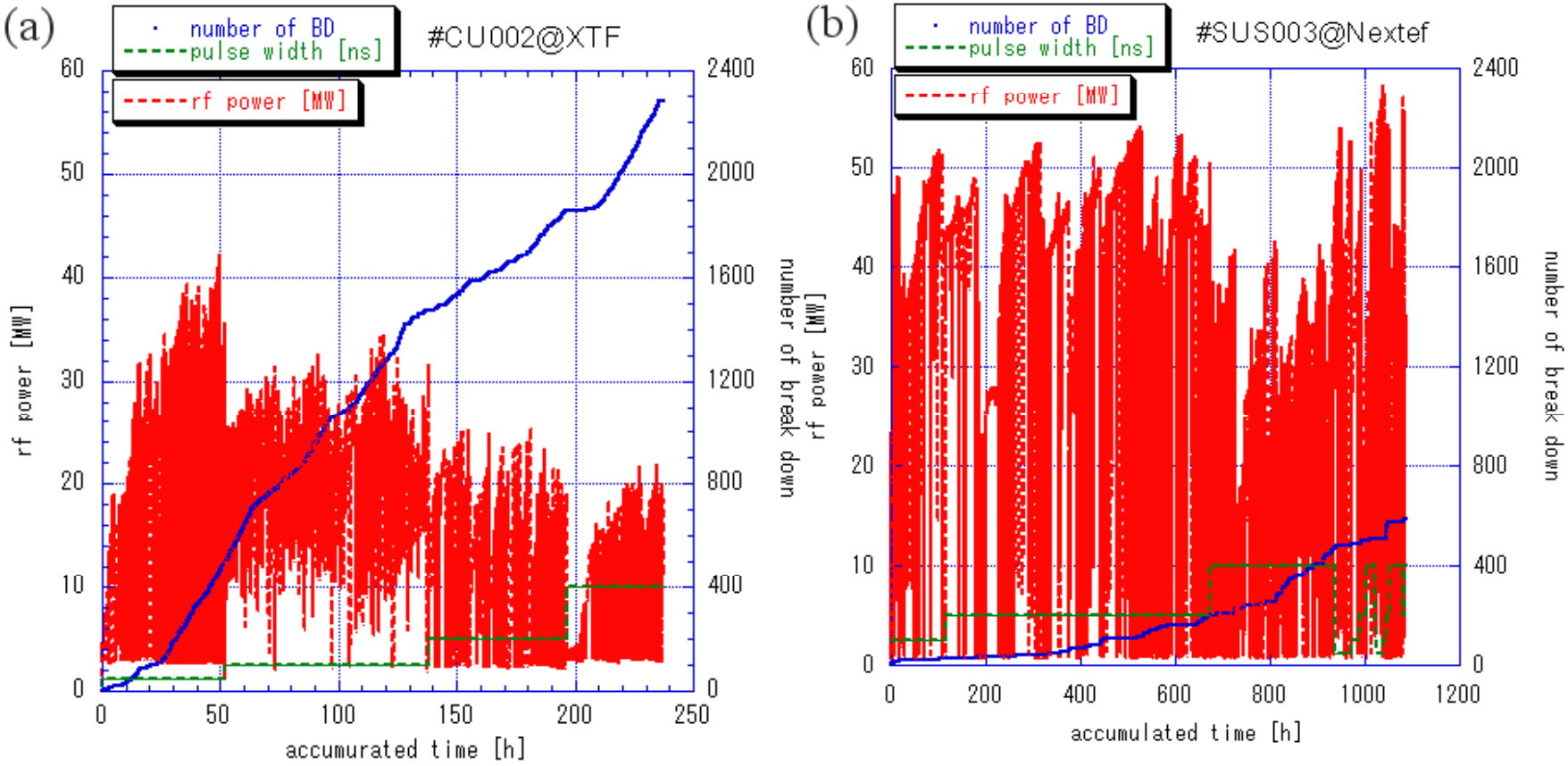
Data taken at 80MV/m.

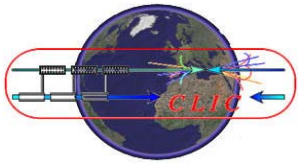
Basic research at KT-1

- Programs which uses present KT-1
  - Typical power ratings is 50MW, 400ns, 50Hz
  - High gradient study in narrow waveguide
  - Testing klystrons
  - Waveguide component test up to medium power
- Pulse compression is also possible
  - Thinking stage
  - High power test of waveguide components will become practical



High gradient study at KT-1
Material comparison





Structure fabrication at KEK

Strategy

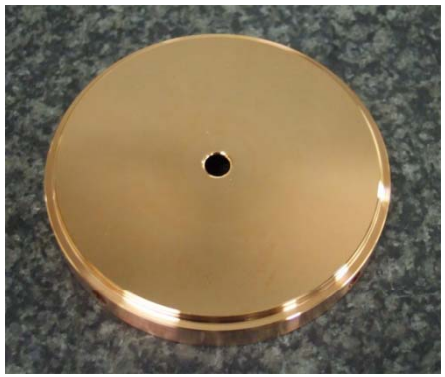
- Re-establish GLC/NLC structure fabrication technique
  - 60-100MV/m
- Extend it to heavily damped structure for CLIC
- Learn about fabrication by all milling
  - Study high gradient performance
  - Study mass production feasibility

➔ CERN-SLAC-KEK collaboration (monthly WebEx meetings)

Structures

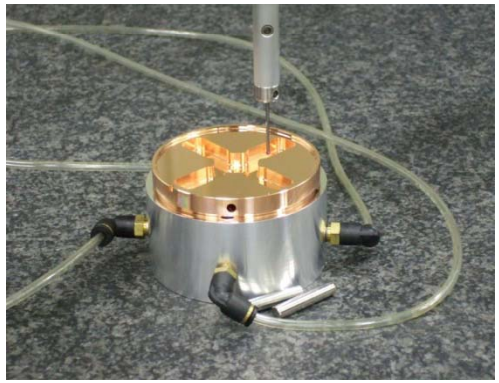
- CLIC_VG1 undamped (T18_VG2.4_Disk x4) (1 under testing, 3 under assembly)
- CLIC_VG1 damped (TD18_VG2.4_Disk x2) (under fabrication)
- CLIC_VG1 damped quadrant (TD18_VG2.4_quad x1) (under fabrication)
- C10_disk undamped (x2) (fabrication will be launched after TD18)
- CD10_disk undamped (x2) (fabrication will be launched after TD18)

TD18_VG2.4_Disk Fabrication test



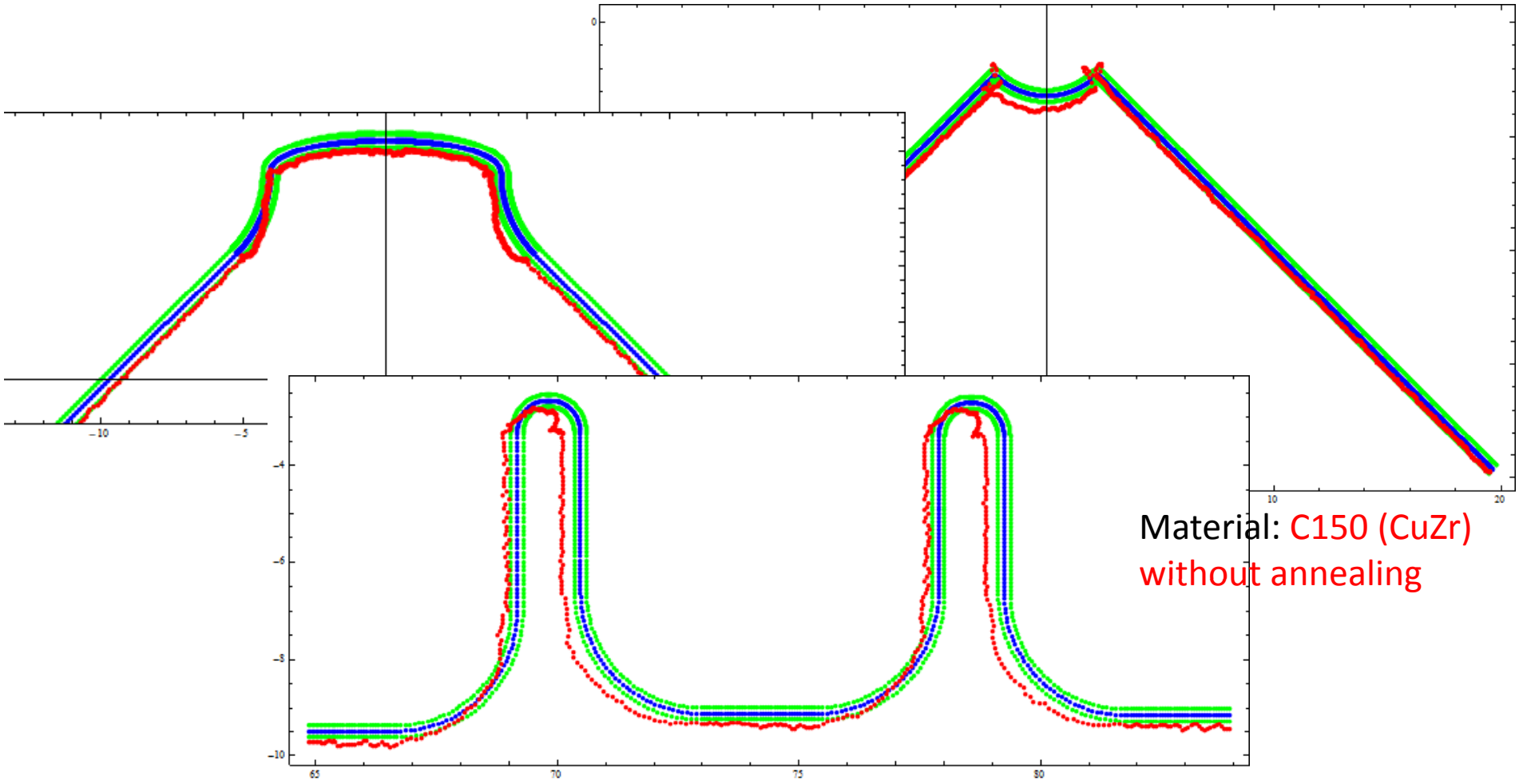
Cell #1

Cell #19



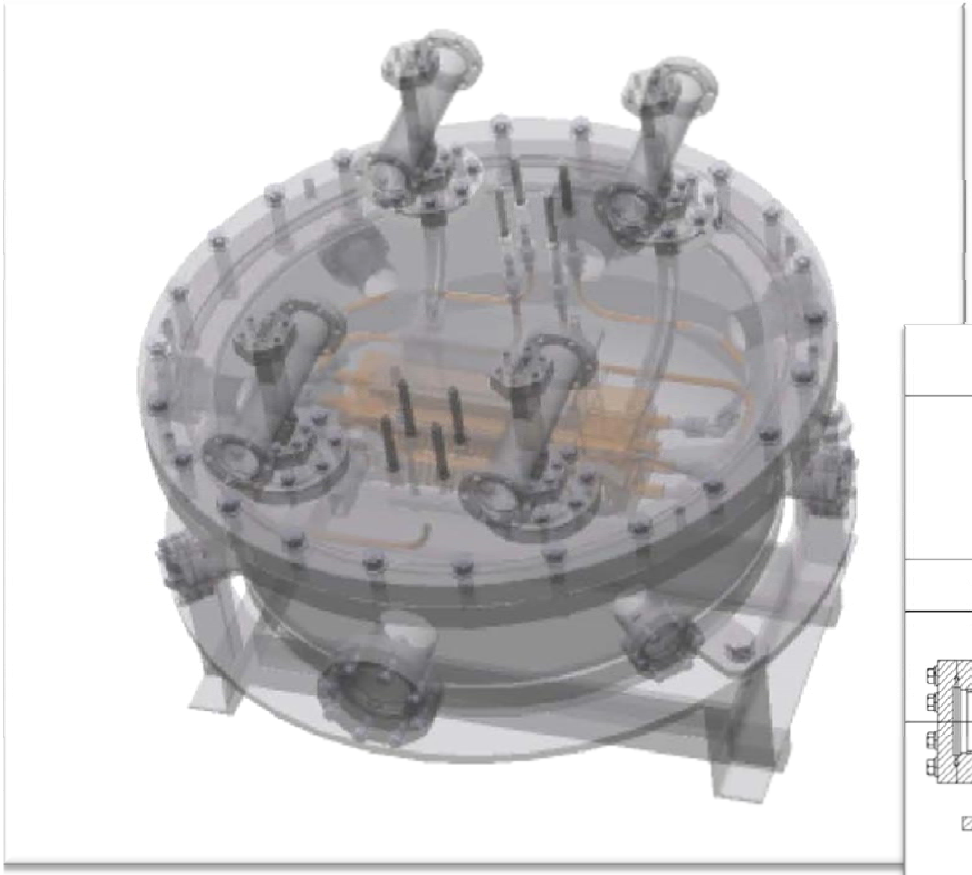
Test of high precision fabrication (+-2.5 microns)
Quadrant Q1-1 profile

Measured w.r.t. A-B-C reference planes. Green lines are ±2.5 microns.
Followings shows worst part out of four measured areas along the axis.

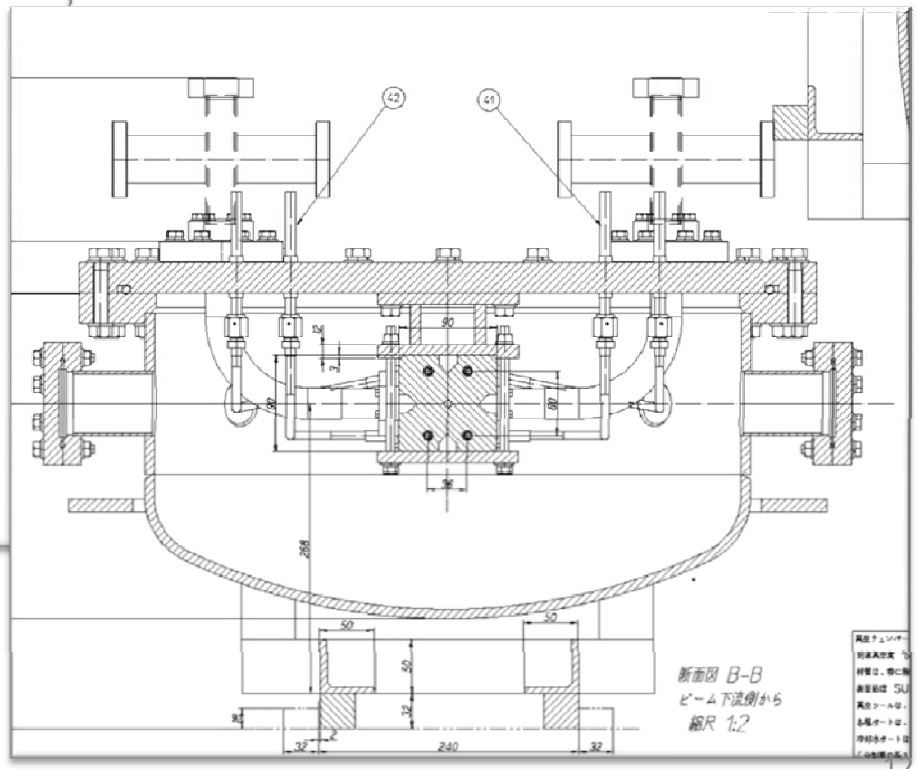


Material: C150 (CuZr)
without annealing

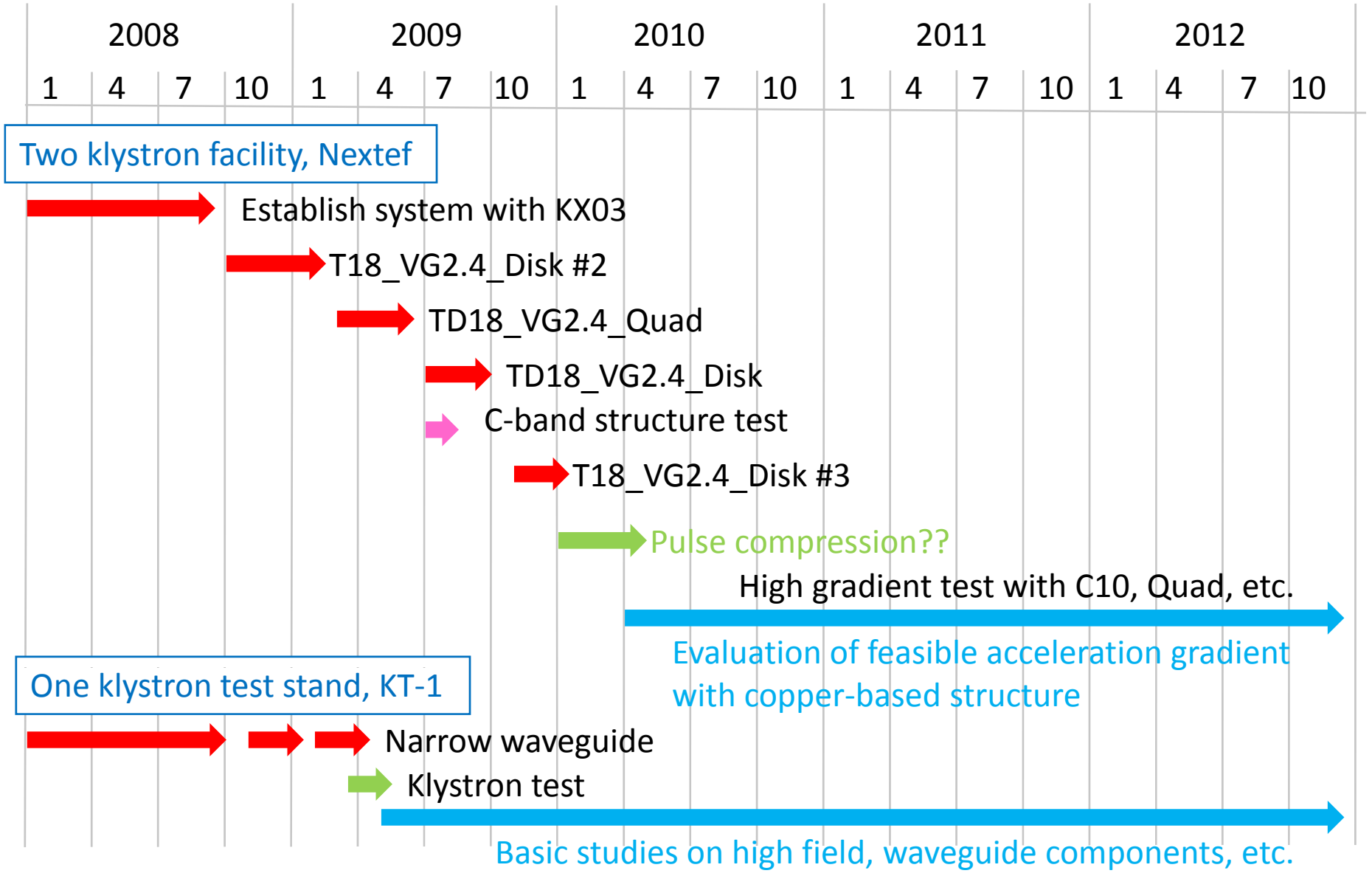
Vacuum chamber for tests with power of accelerating structure in quadrants

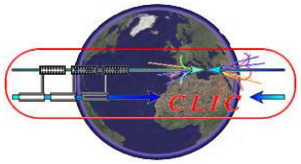


Vacuum chamber under fabrication



Nextef planning





CERN –KEK collaboration on nanometer beam sizes generation and measur. in ATF and ATF2

Exploring ultra-low β^* values in ATF2

P. Bambade, Y. Renier, *LAL (France)*
S. Bai, *IHEP (China) and LAL (France)*
H. Braun, J.P. Delahaye, D. Schulte, R. Tomás,
F. Zimmermann, *CERN (Switzerland)*
J. Gao, D. Wang, X.W. Zhu, *IHEP (China)*
Y. Honda, S. Kuroda, T. Okugi, T. Tauchi, J. Urakawa,
KEK (Japan)
A. Seryi, G. White, M. Woodley, *SLAC (USA)*
D. Angal-Kalinin, J. Jones, A. Scarfe, *CI (UK)*

The proposal

EU contract number RII3-CT-2003-506395 CARE/ELAN Document-2008-002

Exploring ultra-low β* values in ATF2 - R&D Programme proposal

D. Angal-Kalinin[6], S. Bai[1,2], P. Bambade[1], H. Braun[3], J.P. Delahaye[3], J. Gao[2], Y. Honda[4], J. Jones[6], S. Kuroda[4], T. Okugi[4], Y. Renier[1], A. Scarfe[6], D. Schulte[3], A. Seryi[5], T. Tauchi[4], R. Tomás[3,#], J. Urakawa[4], D. Wang[2], M. White[1,5], M. Woodley[5], X.W. Zhu[2], F. Zimmermann[3]

1) CNRS-IN2P3-LAL, Orsay, France
2) IHEP, Beijing, China
3) CERN, Geneva, Switzerland
4) KEK, Tsukuba, Japan
5) SLAC, Stanford, USA
6) Cockcroft Institute, Daresbury, UK

Abstract

We propose to explore the beam sizes and performance of the ATF2 Final Focus System for reduced IP beta functions up to a factor between 2 and 4 below its design. The results will demonstrate the feasibility of the system in a chromaticity regime of interest for

Motivation I: Chromaticity

Project	Status	β_y^* [mm]	L* [m]	L*/β_y^*	ξ_y
FFTB	Design	0.1	0.4	4000	17000
FFTB	Measured	0.167	0.4	2400	10000
ATF2	Design	0.1	1.0	10000	19000
ATF2 pushed	Proposed	0.025	1.0	40000	76000
CLIC	Design	0.09	3.5	39000	63000
CLIC 3TeV	Design	0.09	3.5	39000	63000
ILC	Design	0.4	3.5	8750	15000
ILC pushed	Design	0.2	3.5	17500	30000

Motivation II: Tuning difficulty

Project	Status	σ_y^* [nm]
FFTB	Measured	70
ATF2	Design	37
ATF2 pushed	Proposed	<26
ILC	Design	6
CLIC	Design	2

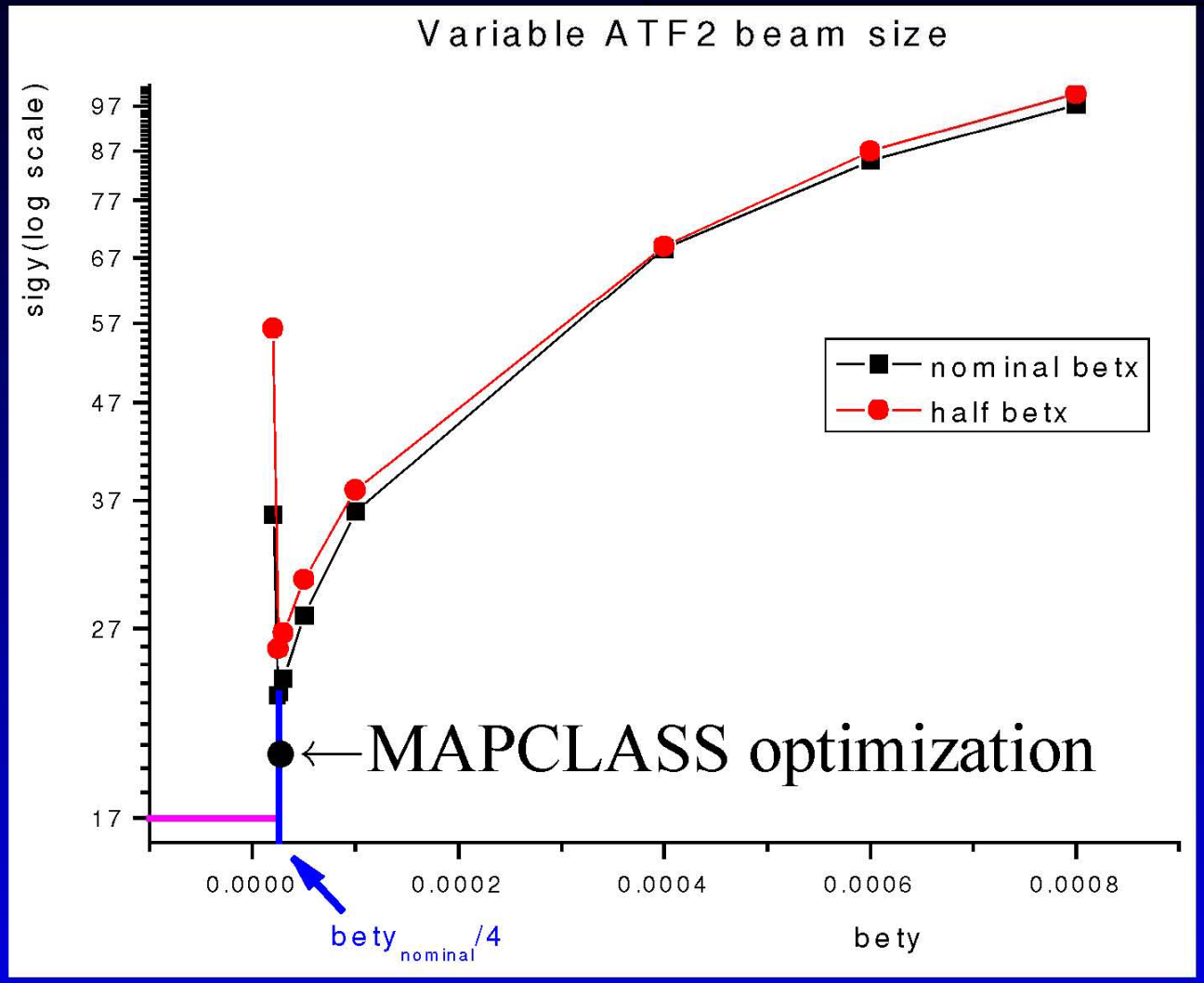
Does tuning difficulty scale as σ_y^{*-1}?

Both ILC and CLIC need as low ATF2 σ_y^* as possible.

What is the minimum achievable σ_y^* in ATF2?

On-going optimization with MAPCLASS

CERN developed simulation program



Sha Bai is still looking into further improvements.

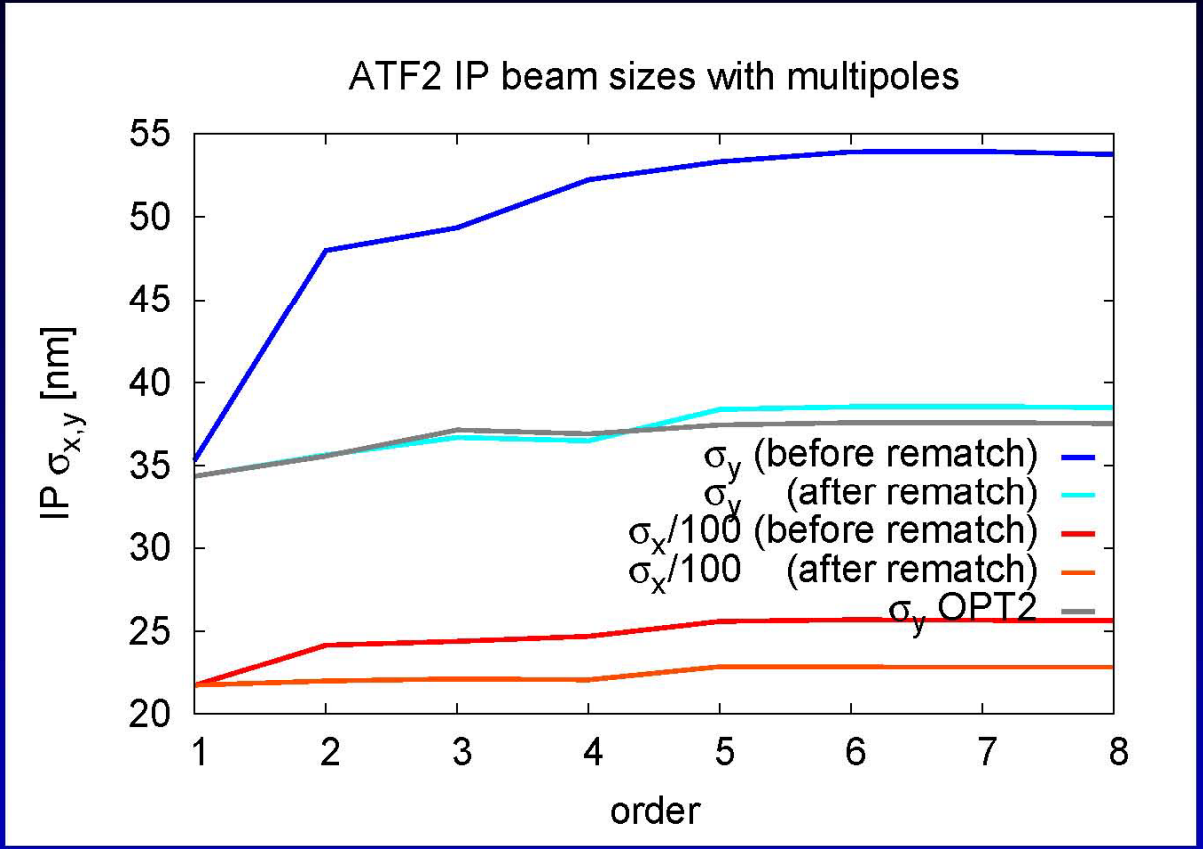
Matching ATF2 with multipolar errors using MAPCLASS

R. Tomás, S. Kuroda, G. White et al

Motivation

- ATF2 measured multipolar errors are bigger than expected
- ATF2 IP beam spot size larger than design
- MAPCLASS is a CERN code ideal for rematching with multipolar errors
- Other existing codes are not ready for this task

Rematching with MAPCLASS



Obtaining the ATF2 current optics with multipoles.

Laboratoire d'Annecy-le-Vieux
de Physique des Particules

CERN-KEK

Stabilisation issues

A.Jeremie

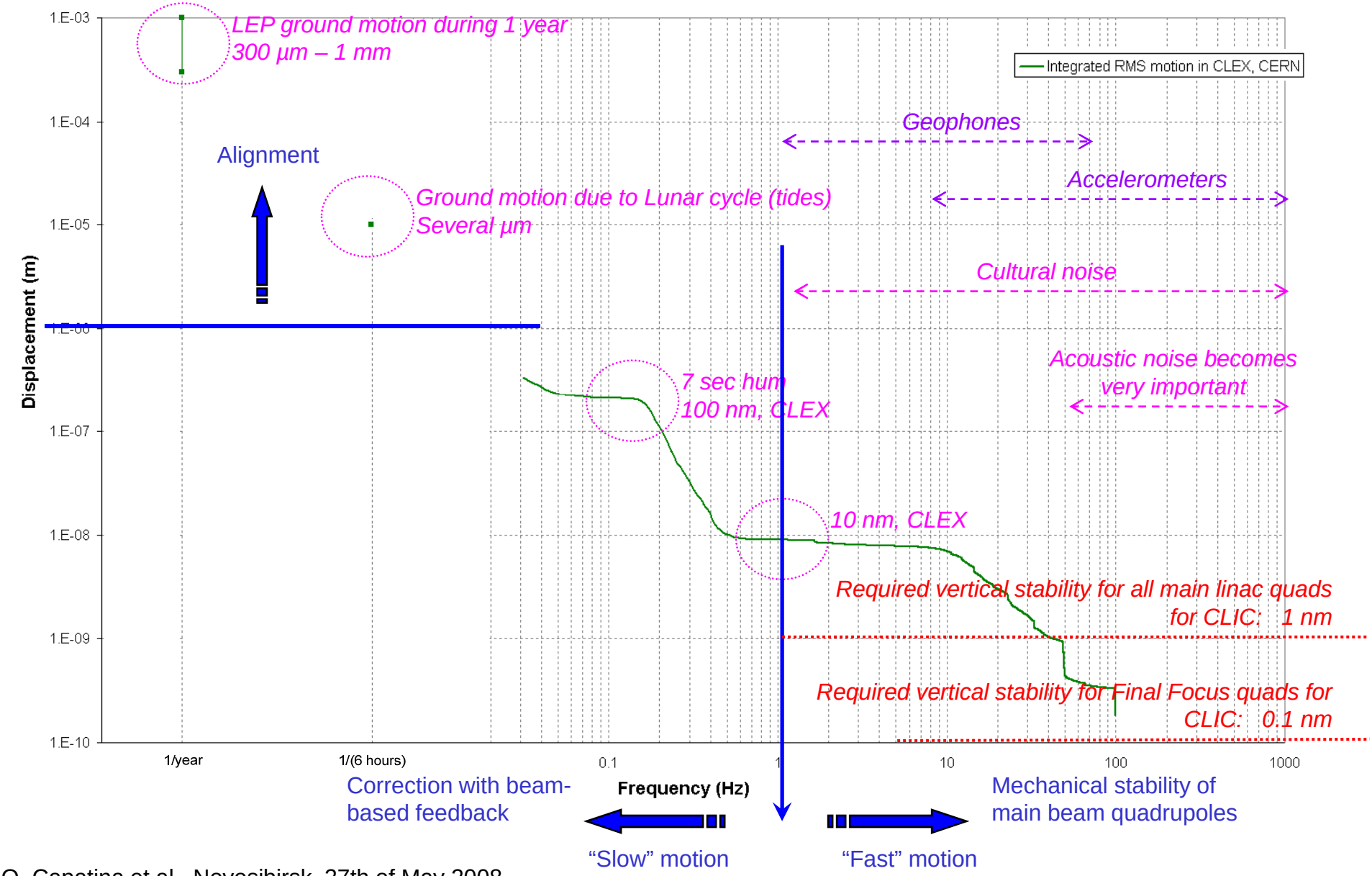
In2p3

CLIC stabilization requirements

	Final Focusing Quadrupoles	Main beam quadrupoles
Vertical	0.1 nm > 4 Hz	1 nm > 1 Hz
Horizontal	5 nm > 4 Hz	5 nm > 1 Hz

- 2 main concerns:
  - Main beam and Final Focus (FF)
  - Can be a “showstopper”
- CERN-LAPP-KEK collaboration on stabilization tests in ATF2 towards FF requirements

Environmental vibration levels (Example of CERN site)



Organisation of stabilisation studies

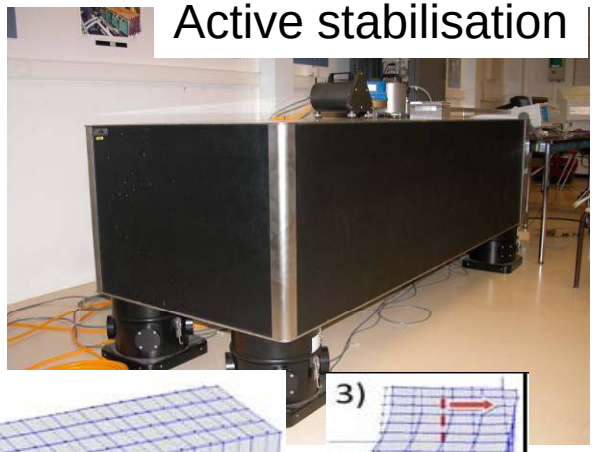
- An integrated approach: stabilization elements to be taken into account at the design phase of CLIC components, ground motion characterization, sensors, actuators, alignment compatibility with beam dynamics

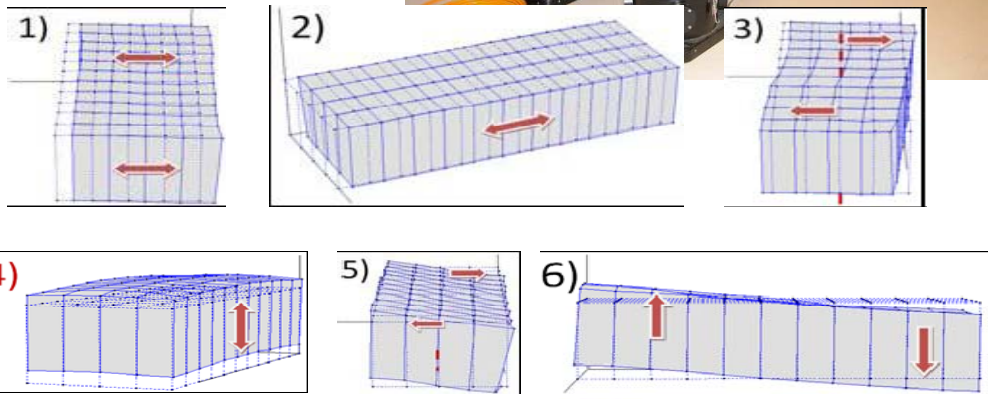
- => stabilisation WG part of the CLIC Technical Committee:
- CERN Claude Hauviller and LAPP Andrea Jeremie (EuCARD task coordinator)
- LAPP/CNRS, CERN, SYMME/Université de Savoie, Oxford
- Some other groups interested
-
- Finances: individual institutes => plus European funding: FP7 EuCARD

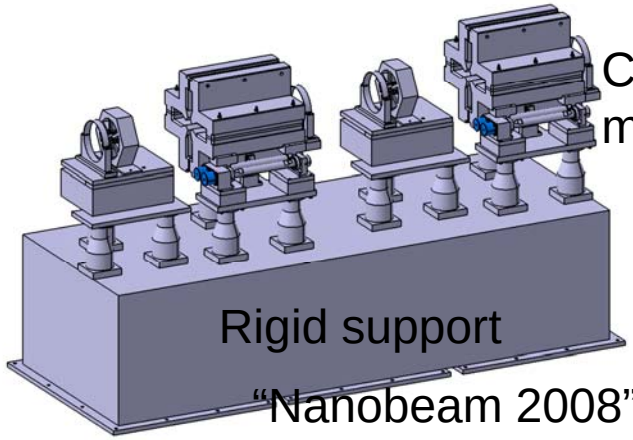
Present contribution to ATF2
Final Doublet support

- Contribution for support material: CERN planned on sending an active stabilisation system but a rigid support contributed by LAPP (CNRS) has been chosen: the active stabilisation amplified vibrations at low frequency (0.1Hz-100Hz)!
- Modal deformations of the honeycomb block with impact hammer=> showed the need to attach block on whole surface to the ground to eliminate the rigid body modes (Michael Guichard TS-MME)
- Contribution for specifications for the glue to fix the support to the ground (Claude Hauviller et al TS-HDO). Traditional glues were too difficult to remove. Beeswax was chosen by LAPP (CNRS) to fix the table.

Active stabilisation







Conventional magnets

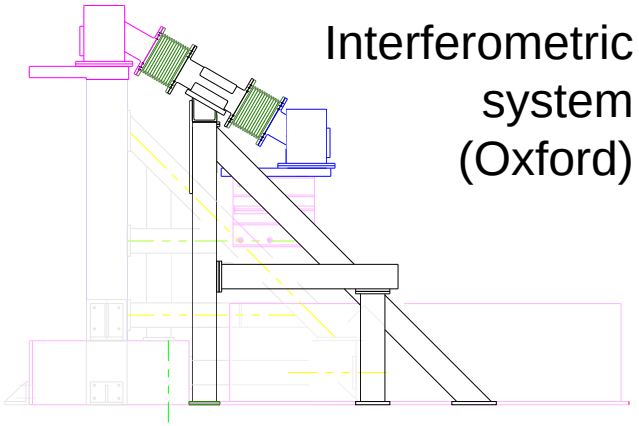
Rigid support

"Nanobeam 2008" Bolzon et al

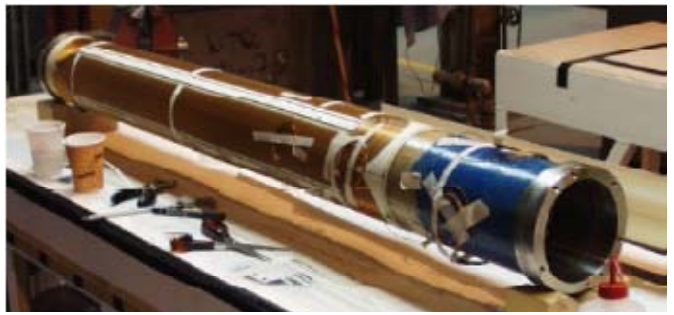
A.Jeremie/LAPP

Near future on ATF2/KEK
Ongoing discussions

- upgrade the FD by new superconducting magnets constructed with the same technology as those of the International Linear Collider baseline FF magnets*.
- study superconducting magnet vibration stability in an accelerator environment.
- incorporate cryostat design features that facilitate monitoring of the cold mass movement via interferometric techniques.
- incorporate a useful active stabilization for ATF2 to use as a CLIC prototype.
- evaluate with a new ground motion generator the ideal response function that an actively stabilized FD system would need to have to improve on the present ATF2 system.



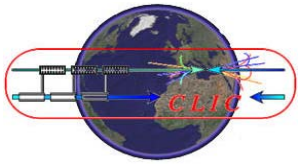
Interferometric system (Oxford)



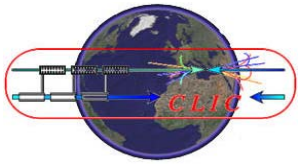
SC magnets : B.Parker (BNL)

Teams involved: CERN, KEK, LAPP, Oxford, LAL, SLAC, BNL

A.Jeremie/LAPP



CERN - KEK collaboration on CLIC e^+ sources



CLIC configurations study

The CLIC e- / e+ sources study considers 3 configurations:

1) Base Line configuration:

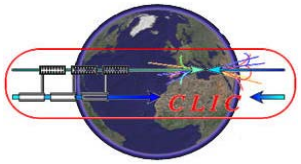
The study is based on 3 TeV (c.m.) with polarized e^- and unpolarized e^+.
Tests on existing e^+ source at KEKB are under discussion.

2) Compton configuration:

The study is based on 3 TeV (c.m.) with polarized e^- and polarized e^+.
Simulations and studies are performed by KEK team for the Compton schemes.

3) Low energy configuration:

The study is based on 500 GeV (c.m.) but with a double charge per bunch: => strong impacts on the e^- / e^+ sources (here only CERN studies).



CERN - KEK collaboration

Polarized e+ from Compton ring:

A Webex meeting is taking place once a month since November 2007. Reviews of progress are made between BNL/CERN/Hiroshima Uni./IPNL/KEK/NSC-KIPT/LAL.

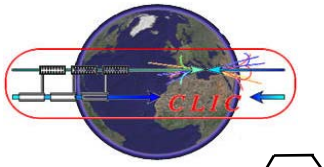
Optical/stacking cavities (2 and 4 mirrors) are discussed with KEK and LAL.

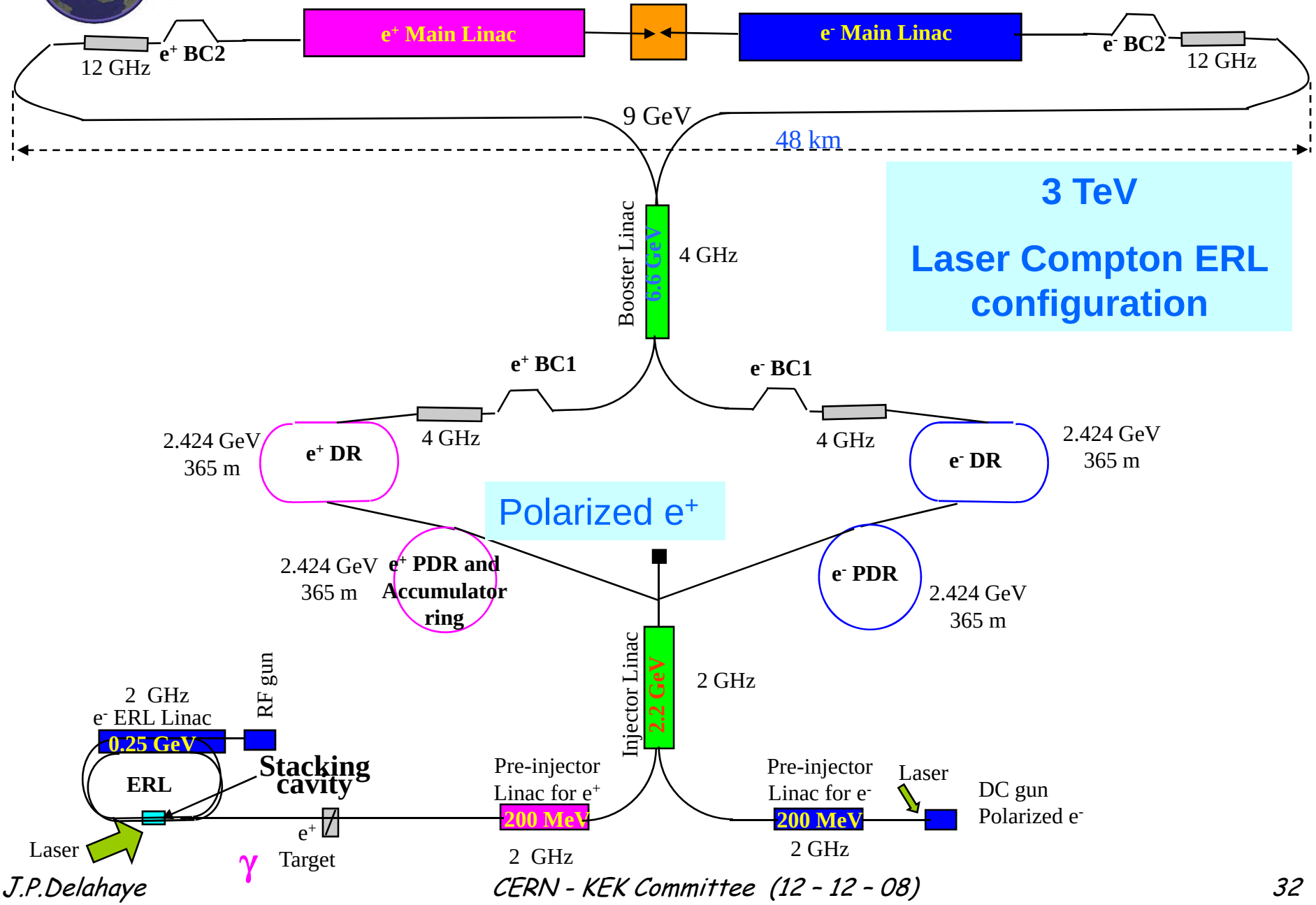
Simulations from Compton sources (polarized photons) are provided by KEK and NSC KI

Results of stacking simulations inside the CLIC Pre-Damping are analyzed.

Three papers will be presented on Compton studies at PAC09 by the collaboration.

CLIC Injector complex (Compton ERL)





joint CERN-KEK Compton source studies started in 2005

Conceptual design of a polarised positron source based on laser Compton scattering – Snowmass'05

Sakae Araki *et al.* CARE-ELAN-DOCUMENT-2005-013, CLIC-NOTE-639, KEK-PREPRINT-2005-60, LAL-05-94, Sep 2005. 39pp. Contributed to 2005 International Linear Collider Physics and Detector Workshop and 2nd ILC Accelerator Workshop, Snowmass, Colorado, 14-27 Aug 2005. e-Print: **physics/0509016**

Updates & improvements:
POSIPOL2006 Geneva
POSIPOL2007 Paris
POSIPOL2008 Hiroshima
CLIC2008 Geneva

physics/0509016
CARE/ELAN Document-2005-013
CLIC Note 639
KEK Preprint 2005-60
LAL 05-94
September 2, 2005

Conceptual Design of a Polarised Positron Source Based on Laser Compton Scattering

— A Proposal Submitted to Snowmass 2005 —

Sakae Araki, Yasuo Higashi, Yousuke Honda, Yoshimasa Kurihara, Masao Kuriki, Toshiyuki Okugi, Tsunehiko Omori, Takashi Taniguchi, Nobuhiro Terunuma, Junji Urakawa
(KEK, Ibaraki, Japan)

X. Artru, M. Chevallier
(IPN, Lyon, France)

V. Strakhovenko
(BINP, Novosibirsk, Russia)

Eugene Bulyak, Peter Gladkikh
(NSC KIPT, Kharkov, Ukraine)

Klaus Mönig
(DESY, Zeuthen, Germany & LAL, Orsay, France)

Robert Chehab, Alessandro Variola, Fabian Zomer
(LAL, Orsay, France)

Susanna Guiducci, Pantaleo Raimondi
(INFN, Frascati, Italy)

Frank Zimmermann
(CERN, Geneva, Switzerland)

Kazuyuki Sakaue, Tachishige Hirose, Masakazu Washio
(Waseda University, Tokyo, Japan)

Noboru Sasao, Hirokazu Yokoyama
(Kyoto University, Kyoto, Japan)

Masafumi Fukuda, Koichiro Hirano, Mikio Takano
(NIRS, Chiba, Japan)

Tohru Takahashi, Hiroki Sato
(Hiroshima University, Hiroshima, Japan)

Akira Tsunemi
(Sumitomo Heavy Industries Ltd., Tokyo, Japan)

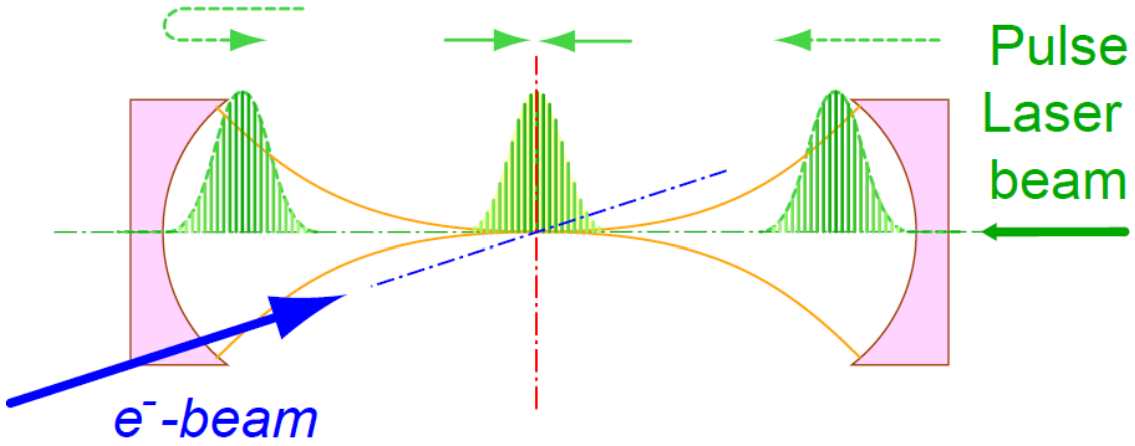
Jie Gao
(IHEP, Beijing, China)

Viktor Soskov
(IHEP, P.N. Lebedev Physical Institute, Russian Academy of Sciences, Moscow)

activity driven by J. Urakawa, T. Omori, M. Kuriki, A. Variola, K. Moenig, L.Rinolfi et al

experimental Compton R/D in ATF

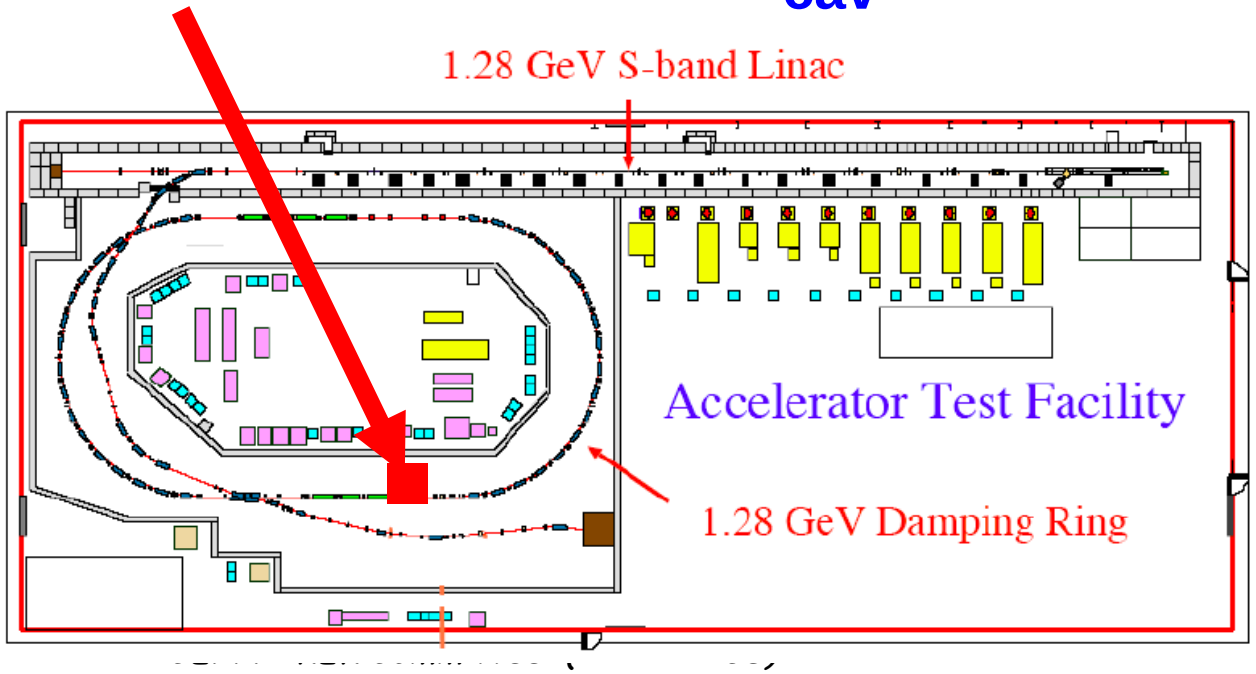
Hiroshima-Waseda-Kyoto-IHEP-KEK + …



1st prototype
2-mirror cavity

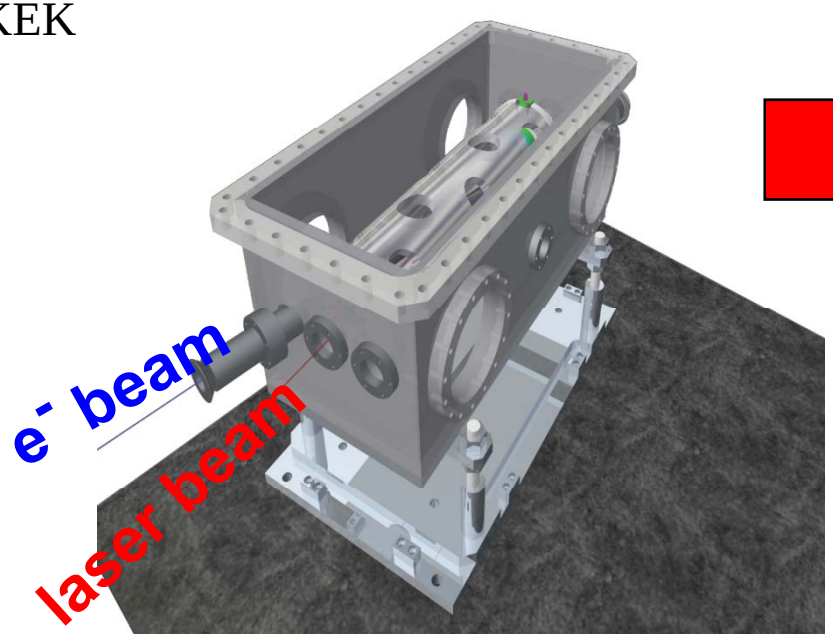
L_{cav} = 420 mm

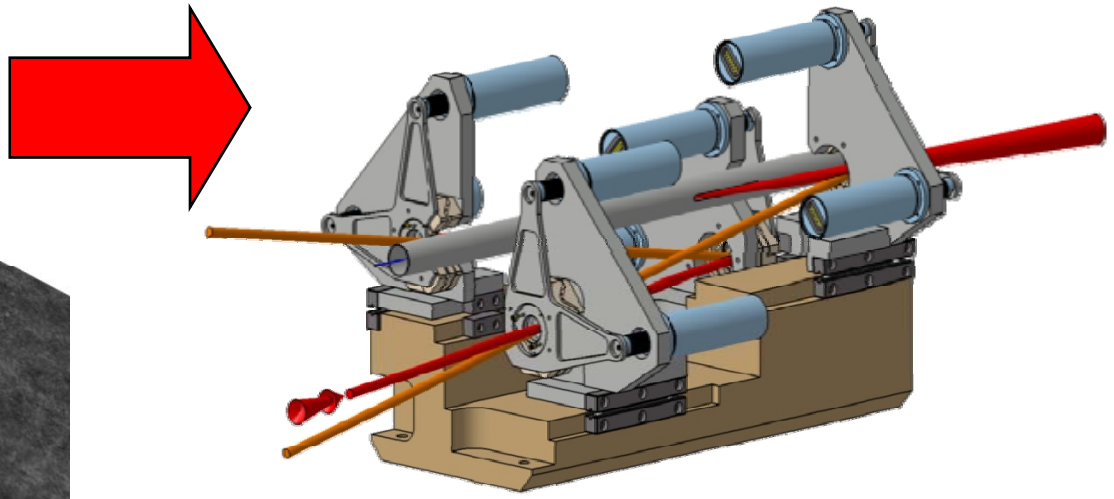
installed in ATF ring since Oct'07



Optical stacking cavity at KEK-ATF

T. Omori / KEK





Spot size = 30 μm
Enhance = 1000

2-mirror cavity

Installed today by KEK =>
3 γ / collision detected

Spot size = 10 μm
Enhance = 10000

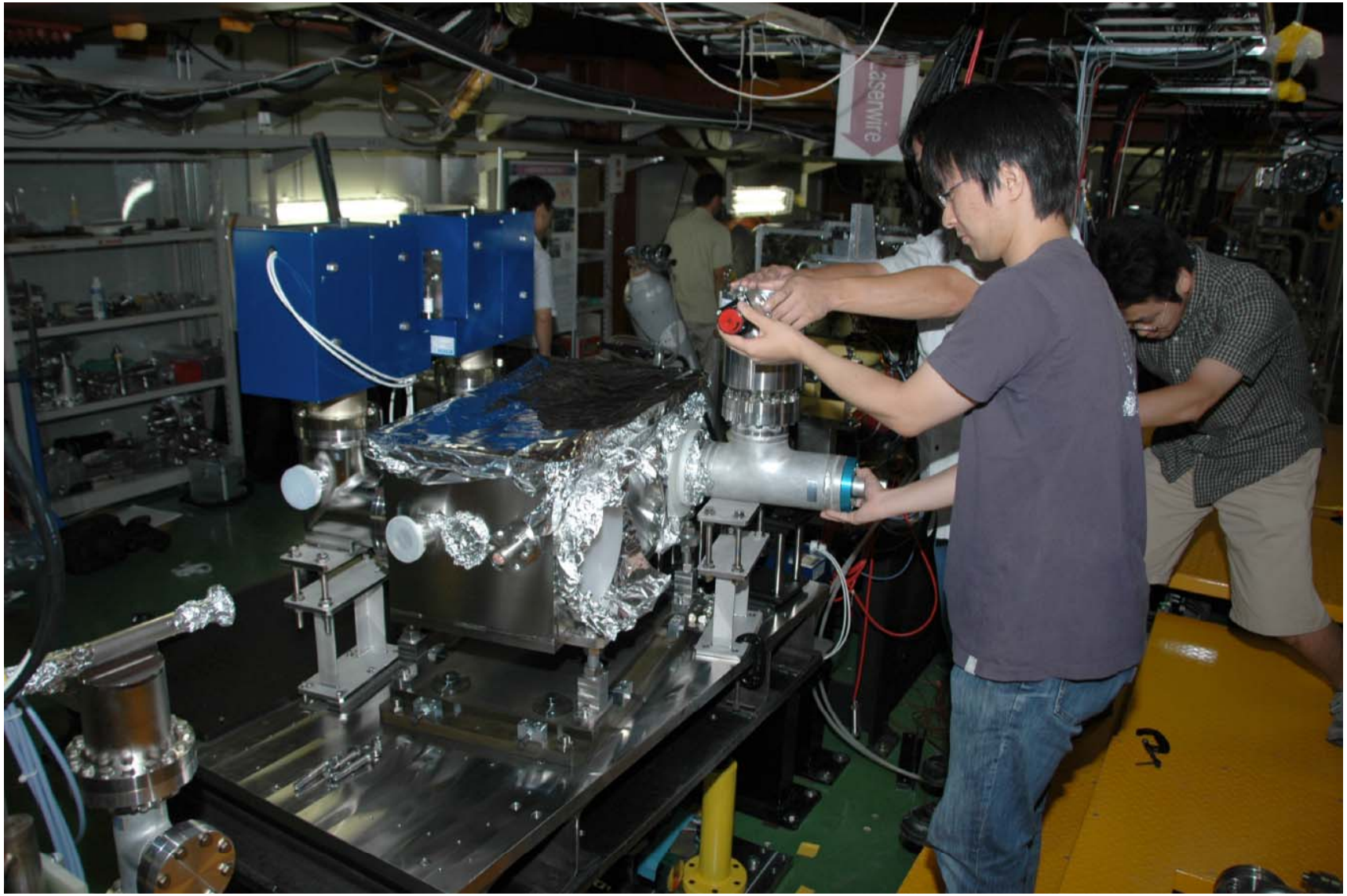
4-mirror cavity

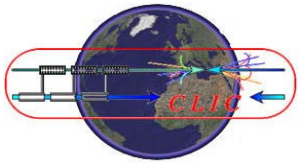
Will be installed in Summer 2009 by LAL

CERN will follow the experiment for CLIC

Laser Stacking Optical Cavity in Vacuum Chamber

October 2007: 2-mirror cavity installed in ATF-DR





Studies &challenges for CLIC Compton schemes

1) Design the Compton ring (or ERL)

2) Design the optical cavity

3) Design high power laser system

4) Performance of the polarized e^+ source based on Compton schemes

5) Impact of low e^+ charge on the Pre-Injector and Injector Linacs

6) Stacking process into the PDR

7) Polarization studies (measurements, spin rotators, depolarization effects,…)

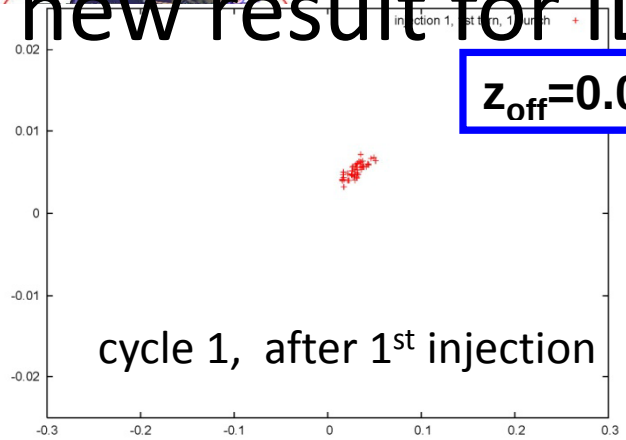
8) Beam diagnostics

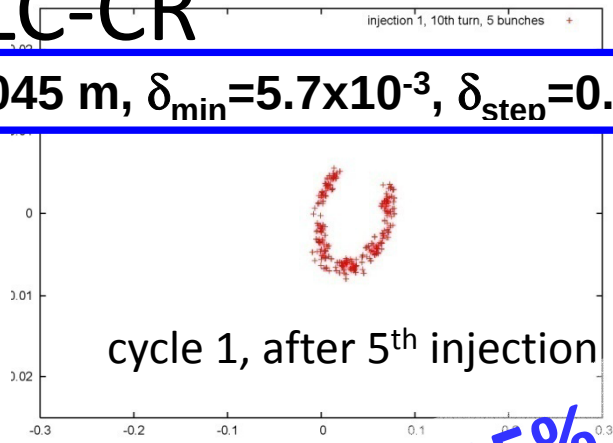
9) …

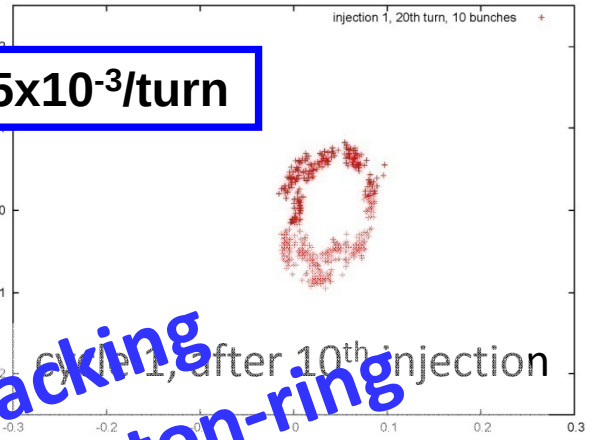
KEK collaboration is very useful on these topics

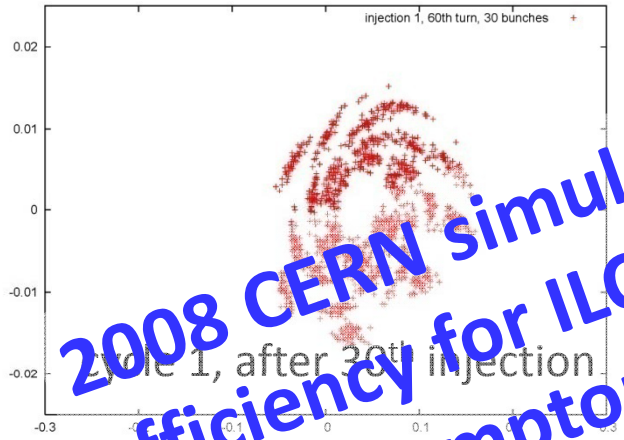
new result for ILC-CR

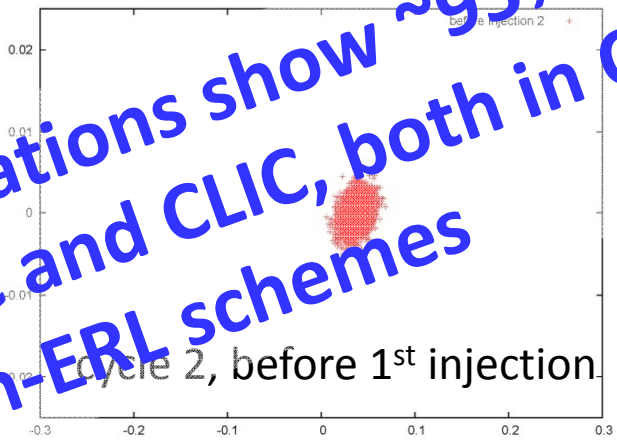
z_{off}=0.045 m, δ_{min}=5.7x10^{-3}, δ_{step}=0.175x10^{-3}/turn

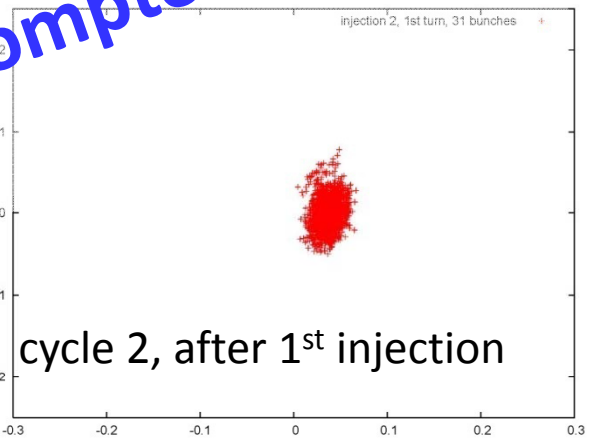


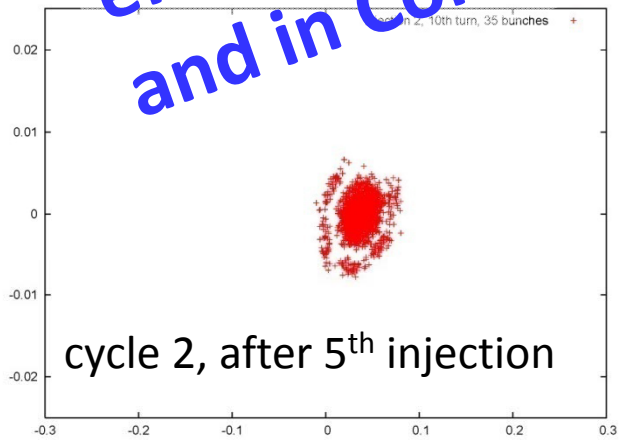


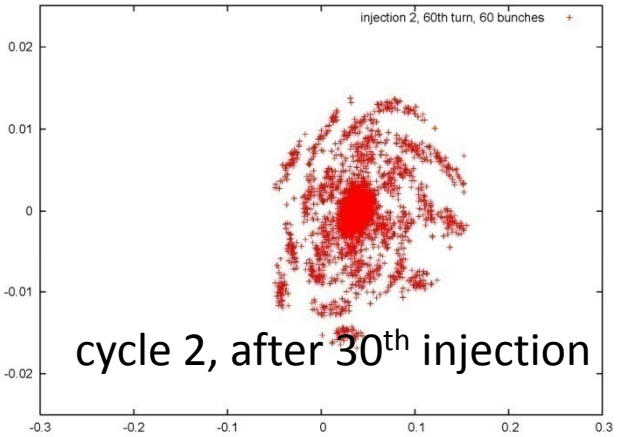


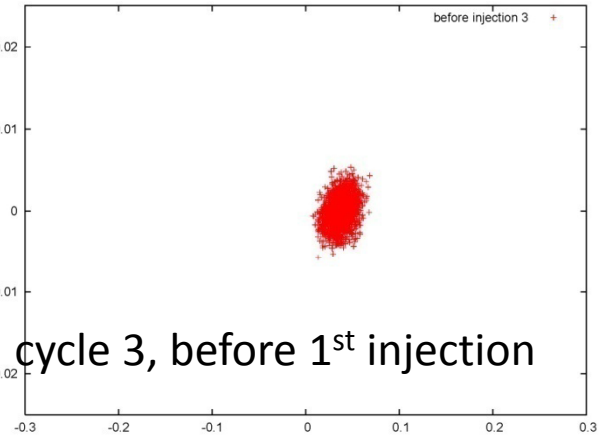












2008 CERN simulations show ~95% stacking efficiency for ILC and CLIC, both in Compton-ring and in Compton-ERL schemes

CERN personnel involved in 2008 ATF & ATF2 studies

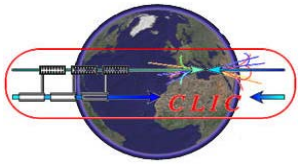
Frank Zimmermann: CERN contact for joint LAL-IFIC-KEK-CI-CERN (France-Spain-Japan-UK-Switzerland) studies on emittance growth between ring and extraction line; ATF laser-Compton R&D group coordinator; CERN representative in ATF Technical Board [~5% of 2008 working time]

Ofelia Capatina: stabilization studies ; CERN representative at ATF2 Project Meeting during Nanobeam 2008 Novosibirsk [~3% of 2008 working time]

Rogelio Tomas: ATF2 final-focus spot size tuning, ATF2 ultra-low betas, measurements of resonances in the ATF damping ring, 2-week visit to ATF/ATF2 in December 2008 [20% of 2008 working time]

Eduard Marin: PhD student, under supervision of R. Tomas, will start in March 2009 to work on ATF2 spot size tuning and ultra-low betas;
He will work 80% of his time on ATF2

Fanuria Antoniou, Yannis Papaphilippou, Louis Rinolfi – Compton studies



Conclusion

- Excellent and fruitful CERN-KEK collaboration on CLIC related subjects:
  - Structures design, fabrication and tests (SLAC contribution)
  - Beam studies in ATF2
  - Nanometer beam sizes generation and tests
  - Sub-nanometer stabilization
  - Positron Generation by Compton scheme
- Well recognised and supported:
  - CERN-KEK collaboration MoU
  - CERN contribution to ATF
- Strong synergy with ILC on number of subjects