Accelerator Activities in France

A personal (re)view

Main categories of accelerator activities

- e+ sources based on Laser Compton: not supported

  aligned with Tokyo findings about the undulator-based e+ source

- Final focus, MDI and ATF2

- SRF
  - XFEL
  - High gradient cavities

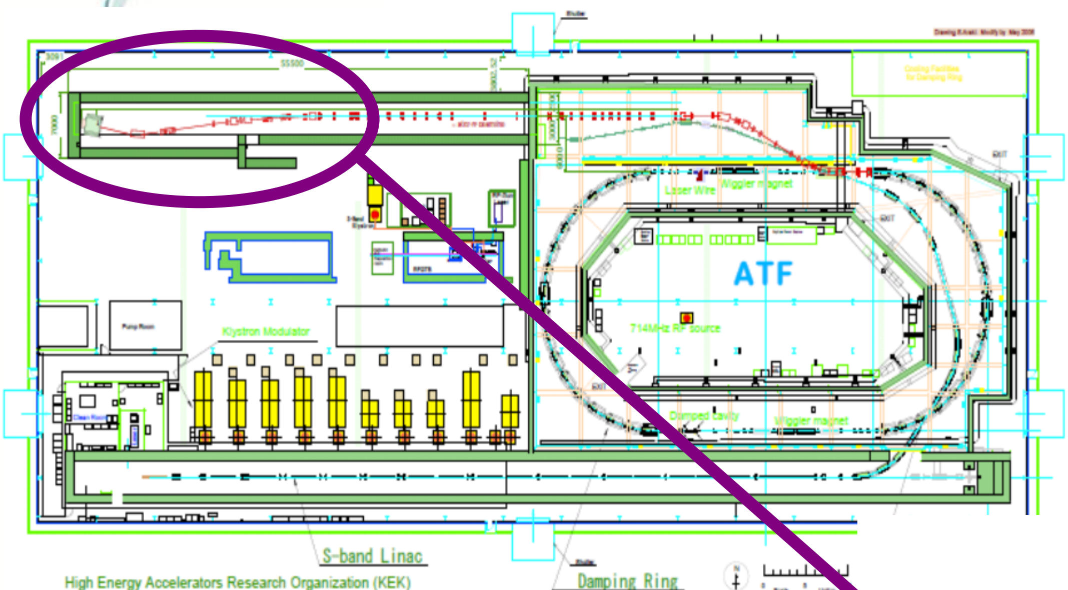
Laboratories involved: LAL, LAPP, LLR, Irfu

What was done by the French teams around ATF2 and the Final Focus/MDI

- ATF2
  - FD support and relative displacement
  - GM feedforward test => can be used for GM survey
  - IP-BPM and IP-chamber
  - Beam-halo evaluation (diamond detectors, simulation)
- CLIC/ILC
  - New optics
  - Integrated feedback studies
  - Stabilisation
  - CLIC MDI: QD0 dummy test

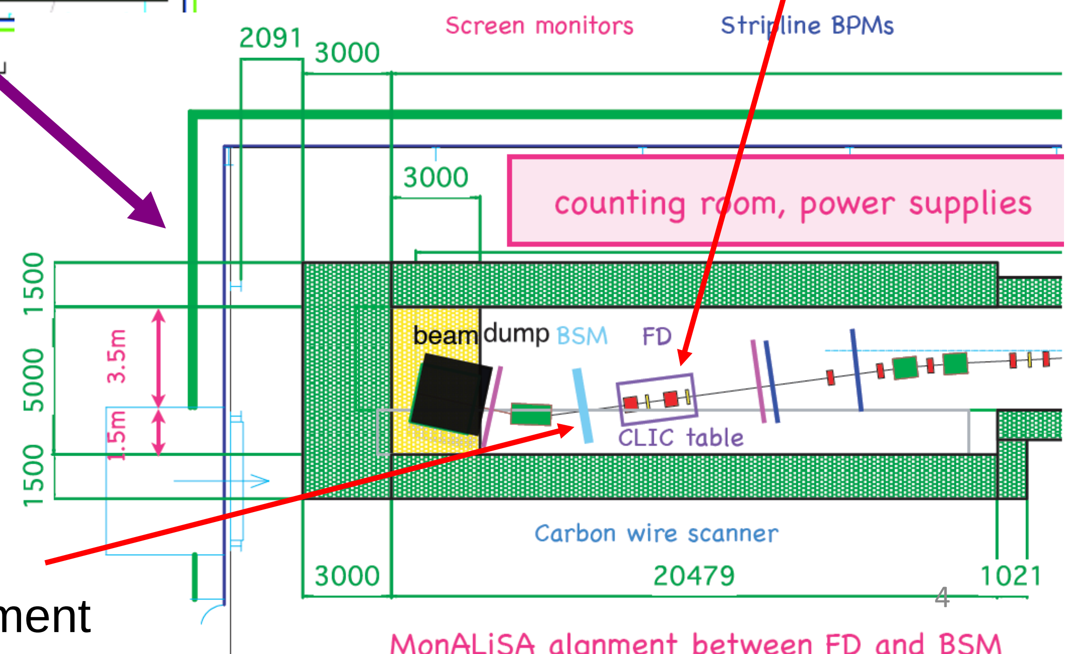
ATF2 layout

- ***Final Doublet relative displacement measurements :***



- Goal 1: 37 nm beam at the focal point in a stable and reproducible manner
- Goal 2: Stable trajectory (Δ<2nm) and ILC-like intra-train feedback

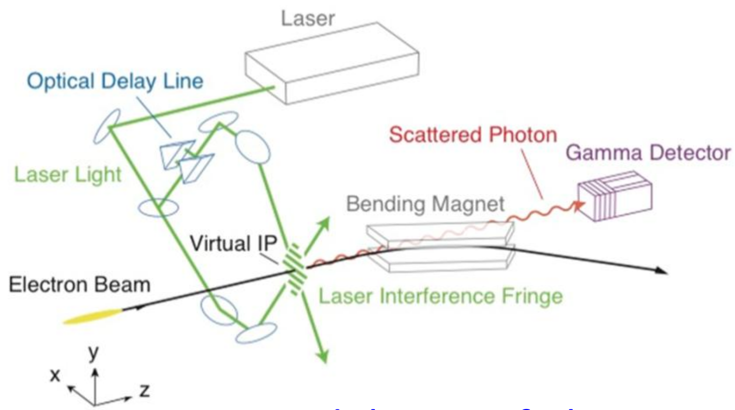
FD : Final Doublet

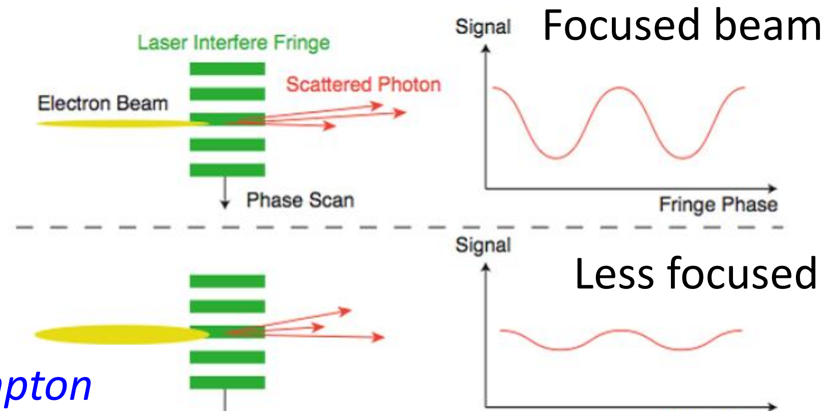


Shintake monitor :
beam size measurement

“Routinely” produce 65 nm beams at ATF2!

Shintake Monitor: essential for beam tuning

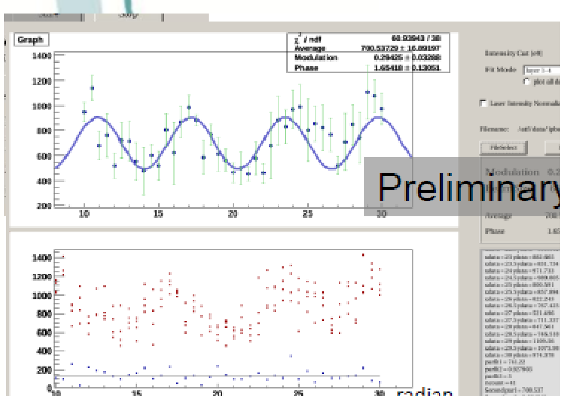


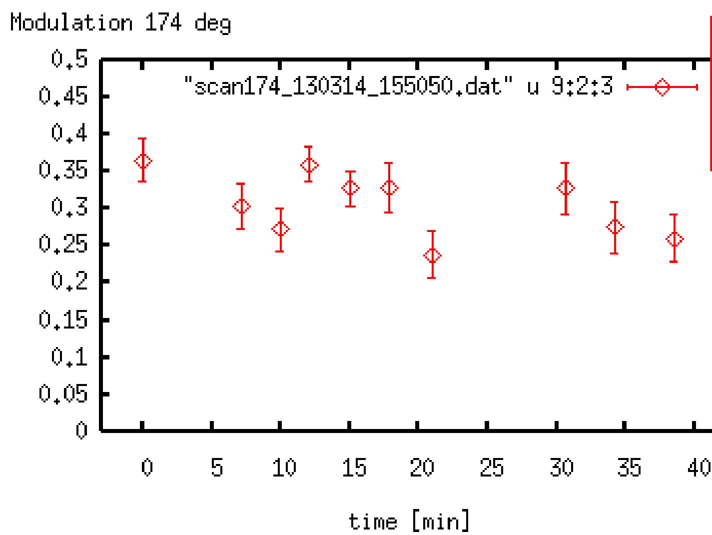


Modulation of photon rate by Compton diffusion on interference fringes

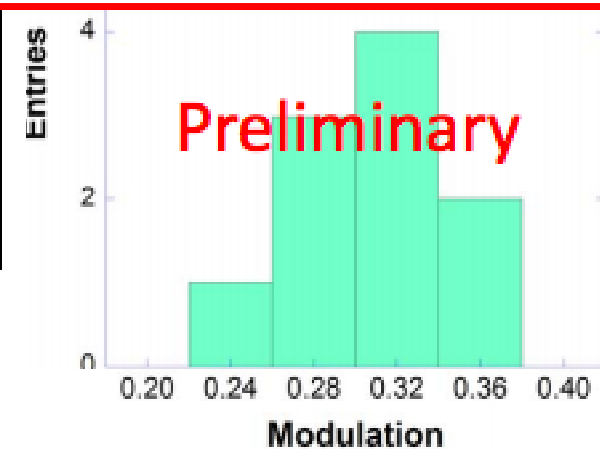
2013/03 /14

after IP-BSM roll alignment
after IP-BSM pitch alignment





M ∼ 0.306 ± 0.043 (RMS)
correspond to σy ∼ 65 nm



Conclusion Outlook (by A. Jeremie)

- Contribute significantly to ATF2 Goal 2
  - GM measurements, Evaluate the impact of vibrations on beam , Halo measurements, Use the IP-BPMs
- Contribute to ILC and CLIC
  - CLIC MDI: sub-nanometre stabilisation, GM feedforward evaluation following CLIC development phase (2012-2016)
  - Follow study on alternative optics
- Successful in several Collaborations (EUROTeV, EuCARD, French ANR funding…) => New applications have been submitted around e+-e- beams and actuator development
- Publications and conferences, Training of students on a working accelerator (preparing future)
- **We will be ready to be an important part of the future effort!**

SRF Activities: XFEL

The four reasons why the XFEL coupler and cryomodule production is useful for the ILC :

in chronological order

1. Industrialization of production (2008-2015)
2. ILC cryomodule demonstration (2013)
3. XFEL linac system test (2016 on)
4. Infrastructures for ‘EU Hub’ for ILC cryomodule production (available in 2016, used when needed)

XFEL vs. ILC: Industrialisation

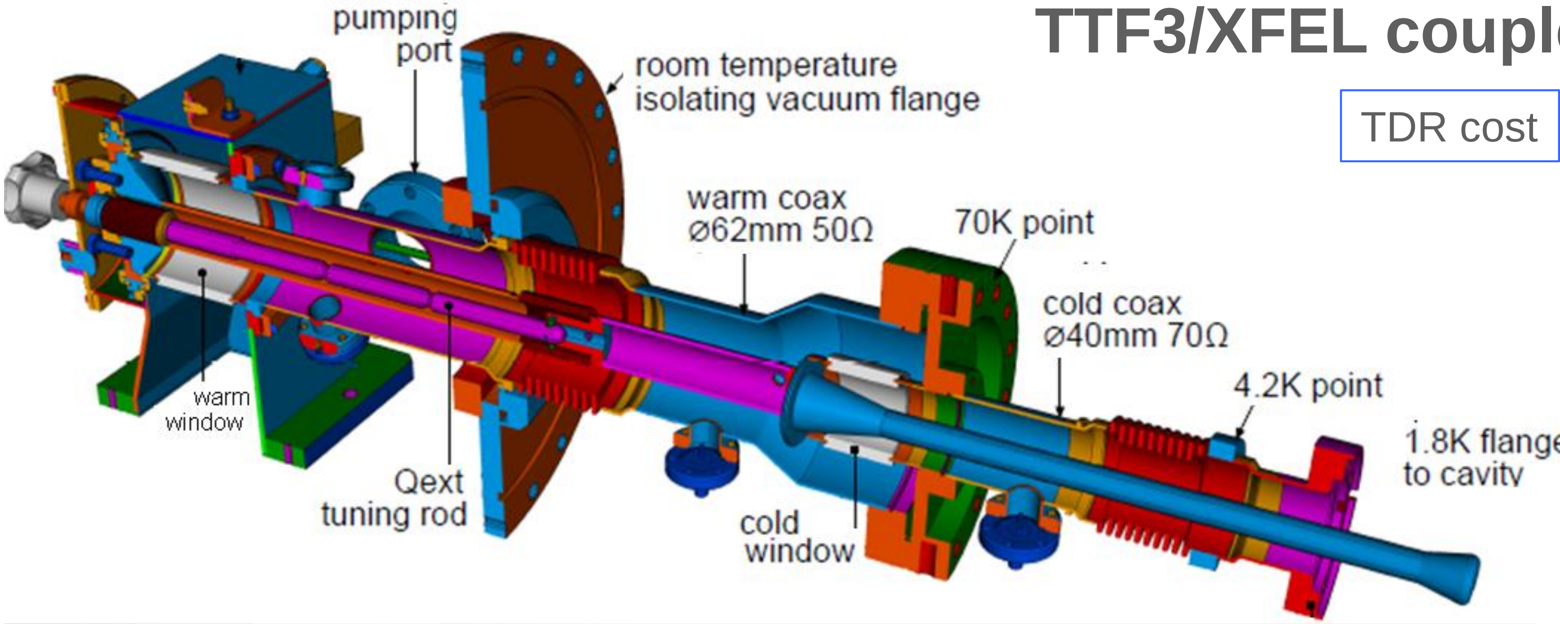
The 5 reasons why the XFEL Industrialisation is beneficial to the ILC:

1. Building of expertise and infrastructure in EU labs
2. Building of expertise and infrastructure in Industry
3. Networking EU industries
4. Breaking ground for key technical aspects, e.g.
    - brazing of couplers for large scale production,
    - pressure equipment certification for cavities and Helium tanks, etc…
    - large scale quality management (industrial methods, EDMS)
5. Reliable costing, including schedule and manpower

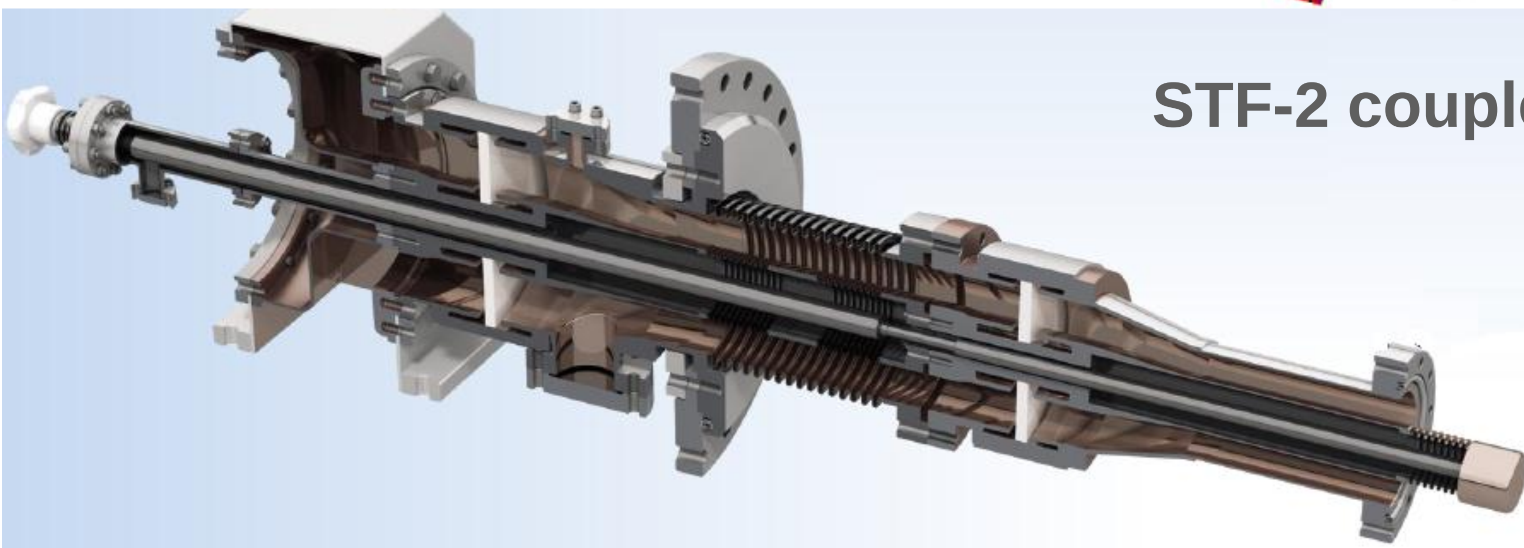
SRF WG at LCWS'13 (Tokyo): In-depth Technical Review of Couplers

TTF3/XFEL coupler

TDR cost



STF-2 coupler



Conclusions from SRF WG at LCWS'13 (Tokyo)

Cost comparison

- *CPI: STF2 price is 1.9 higher*
- *Toshiba: STF2 slightly lower price*
- *RI: about same price*
- *Industrial study of STF2 for design optimization and cost reduction is recommended*
- *The TTF3 coupler mass fabrication has to be investigated* ***(based on brazing !)***

Recommendation*:*

- *STF2 coupler has to demonstrate stable long time (>6 month) beam operation in a CM (TTF3 coupler has a long history in FLASH)*
- *The ILC management recommend an adapted STF2 design with 40mm cavity flange. In this case more development steps have to follow in order to realize the compatible design. The new design has to be proven with beam operation.*
- *The concept of plug compatibility has to be further developed in view of a spare part concept. We recommend spare modules, not individual parts.*
- *An industrial study of mass production for both designs is recommended*
- *Industrial study of STF2 for design optimization and cost reduction is recommended.*

In clear, the TTF3, or rather the **XFEL Coupler with 40 mm cavity flange** is the reference design for the ILC.

The XFEL production effort at LAL is fully aligned with and breaking ground for ILC

XFEL Cryomodule Assembly at CEA-Saclay

XM-3 : ILC Cryomodule

A success for SRF Technology

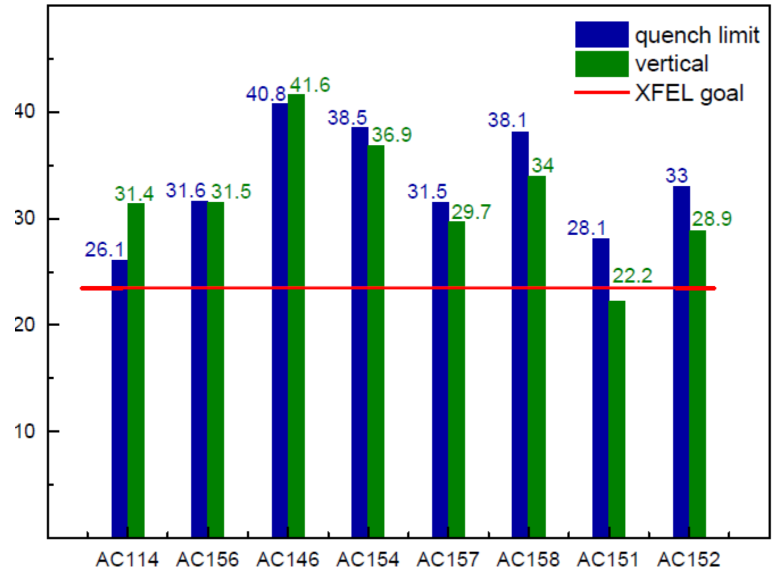
- ✓ Average individual cavity gradient: 32 MV/m
- ✓ Average cavity pair gradient: 29 MV/m
- ✓ Three cavities reach gradients above 38 MV/m
- ✓ Cryogenics losses are lower than specified.

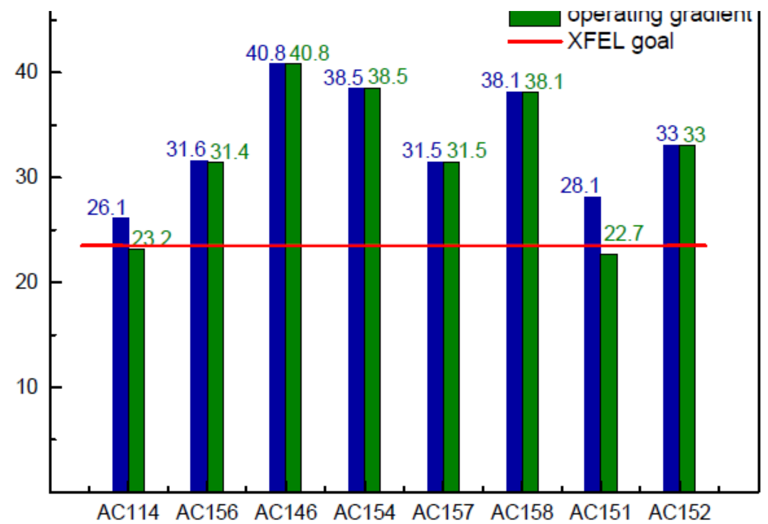
A success for String and Module Assembly:

- ✓ Seven cavities are reproducing VT gradient
- ✓ The cryomodule reproduces gap of 230 MV
- ✓ Cavity 1 is degraded from 31 down to 23 MV/m useable gradient: gate valve/cav1 connection not for training !
- ✓ Qualifies CEA assembly team (100% string assembly by CEA), procedures and partially the production tool (ISO4 clean room, DESY pumping units, 3 mobile clean rooms, procedures, big tools)
- ✓ The clean room vacuum system was not complete (CEA cavity venting on rails)

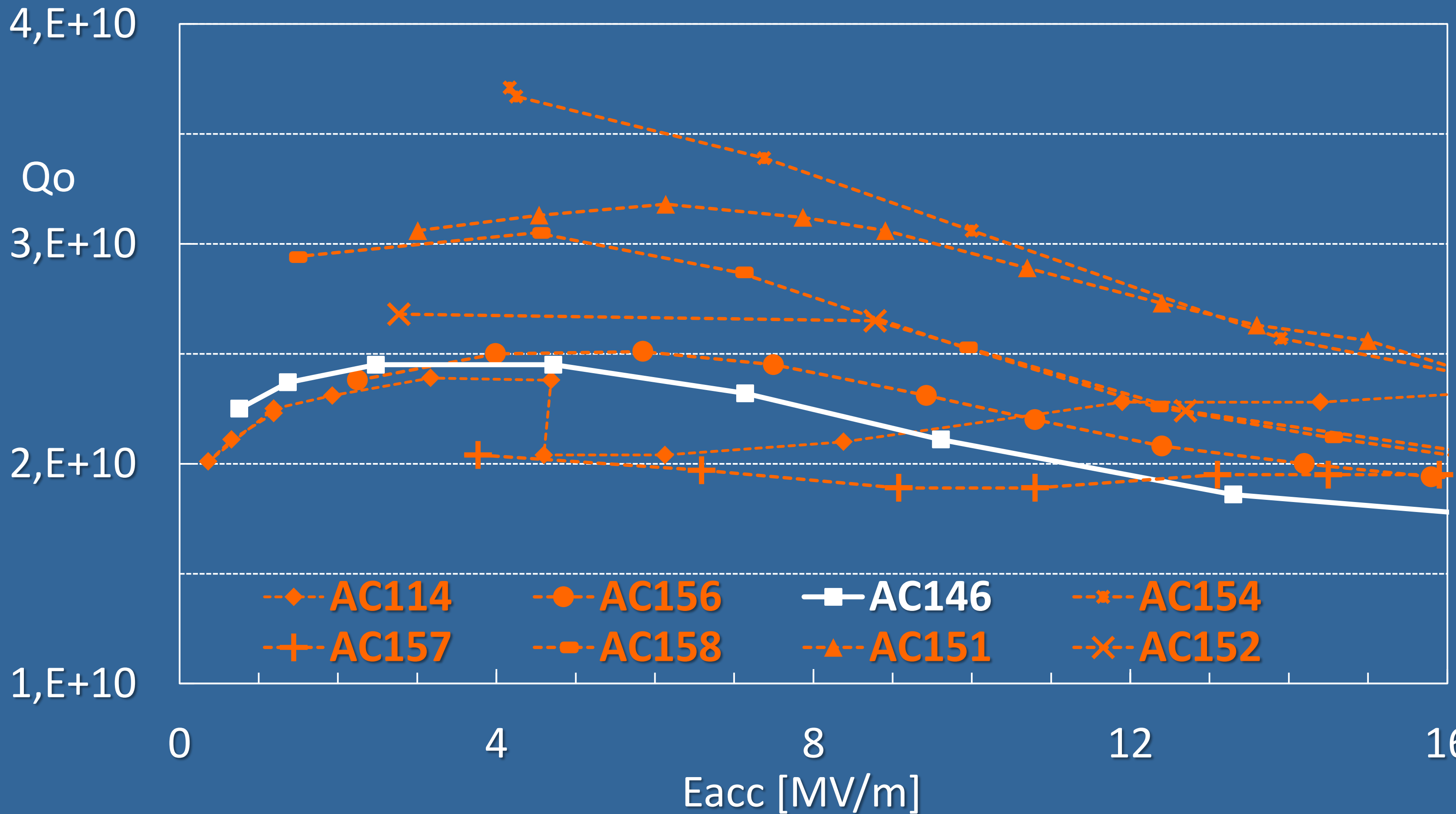
A success for the industrialization process:

- ✓ XM-3 is the assembly demonstration cryomodule of CEA w.r.t. ALSYOM contract.





XM-3 cavities: vertical tests at 2K (7 Large Grain +1 Fine Grain cavity)



Measured dynamic heat load
(J. Sekutowicz)

Vertical EP FACILITIES IN THE WORLD

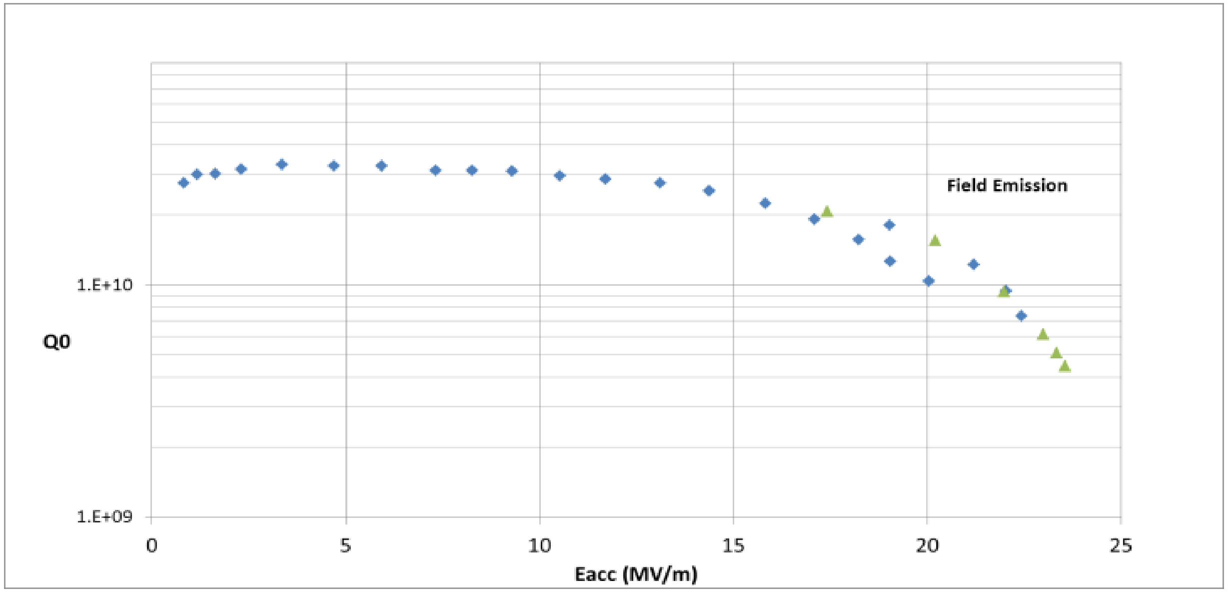
Cornell

CEA/IRFU

CERN

F. Furuta, IPAC 2012, TUPPR045 & SRF 2013, TUIOC01
F. Eozenou et al. PRST-AB, 15, 083501 (2012) & SRF 2013, TUP046
S. Calatroni et al. LINAC 2010, THP032, pp 824-826 & SRF 2013, TUP047

RESULTS ON 9-CELL ILC CAVITY AT IRFU



RF results for ILC TB9R1025 cavity at 1.6 - 1.9K after HEP + 50µm VEP at 6V.

Fermilab

- Results limited by field emission
- New cleanroom in construction will make possible a better assembly of the cavity

R&D Proposal for H2020

Build an ILC 'ultimate cavity' 40 MV/m et Q0=2e10 '**dressed in France**'

- 9-cell cavity 1.3 GHz 'short-short' for ILC

(collaboration ILC-HiGrade, or KEK, or FNAL)

- vertical electropolishing, baking, HPR (Saclay)
- new tuner 'CEA-DESY' or 'SPL' adapted to short beam tubes

(collaboration KEK, CERN as proposed by A. Yamamoto)

- RF coupler (LAL-Orsay)
- internal magnetic shield in Helium tank

(collaboration KEK)

- external magnetic shield (type CEA-XFEL)

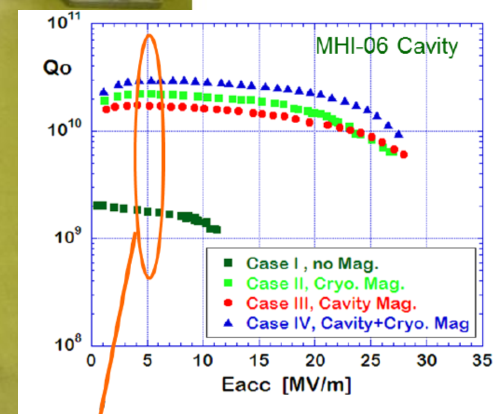
Measure performances in horizontal cryostat horizontal (CryHoLab) w/o shielding:

- at high gradient 40 MV/m, 1% dc $\rightarrow$ Q0, P_{cryo} ?
- at CW gradient 15 MV/m, 100 % dc $\rightarrow$ Q0, P_{cryo} ?

Configurations ILC (~10 000 cavités)

Magnetic Shields of KEK Cavities

4 Components per 1 KEK Cavity



Qo at 5 MV/m (1.8 K)

Case I, $Qo = 0.2 \times 10^{10}$

Case II, $Qo = 2.2 \times 10^{10}$

Case III, $Qo = 1.7 \times 10^{10}$, OK

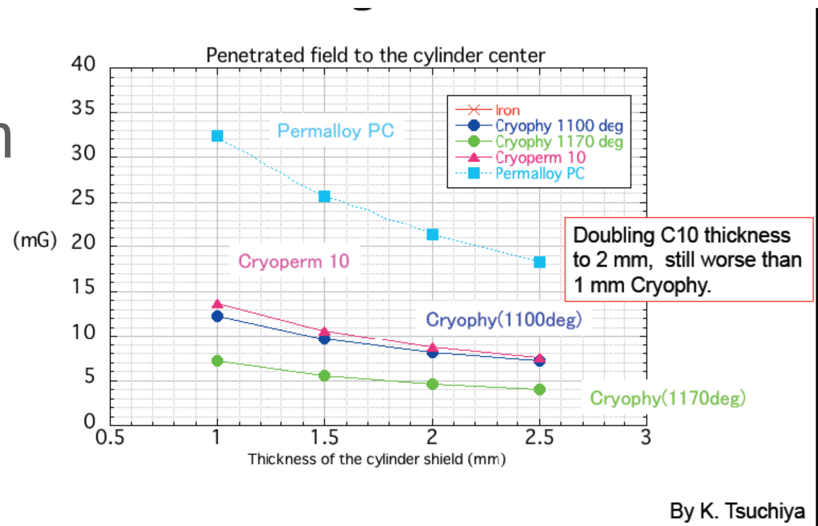
Case IV, $Qo = 3.0 \times 10^{10}$

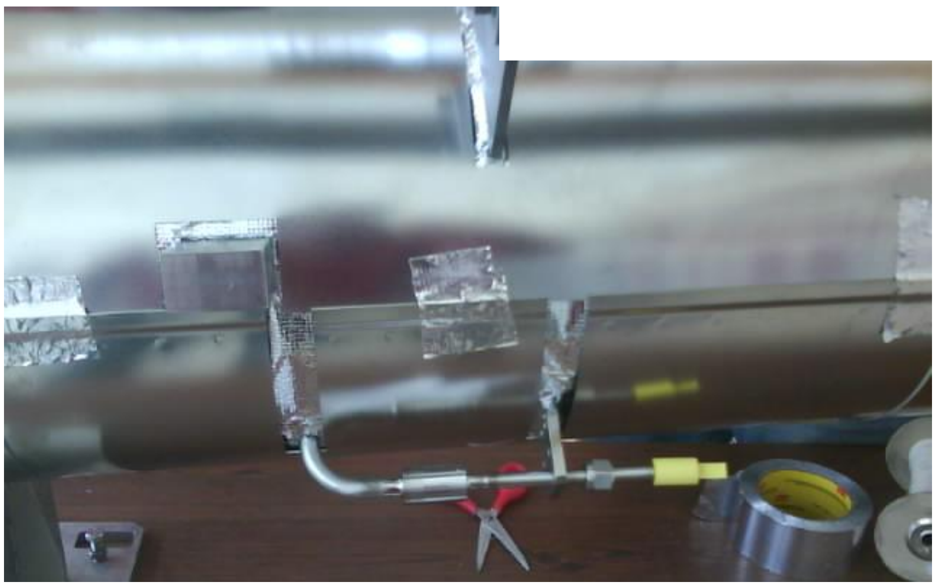
E. KAKO (KEK)
2011' Dec. 07

TTC meeting in Beijing

Magnetic Shielding

Produced by MecaMagnetic from Aperam/Cryophy 1mm sheets





Magnetic shields are qualified by the excellent dynamic cryogenic performance of XM-3

2 K Blankets by Jehier