International Collaboraton

View from INFN

Carlo Pagani – Univ. of Milano & INFN-LASA

PIP-II CD-1 Independent Project Review

12-14 December 2017

In partnership with:

India/DAE
Italy/INFN
UK/STFC
France/CEA/Irfu, CNRS/IN2P3

Outline

- Context: long tradition of Fermilab and INFN collaboration
  - Physics
  - Accelerators: TESLA, ILC, S1-Global, …

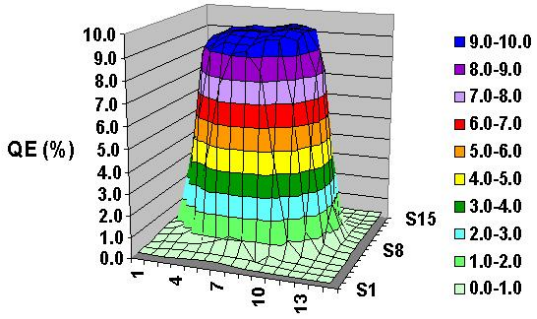
- Other SRF experience at INFN-LASA:
  - LEP-II with Industry
  - ADS: beam dynamics, reliability, elliptical cavities, …
  - SNS cavity design
  - European XFEL: cold masses, cavities, 3H module, ...
  - ESS: 36 MB cavities, dressed and qualified
  - PIP-II: in progress!

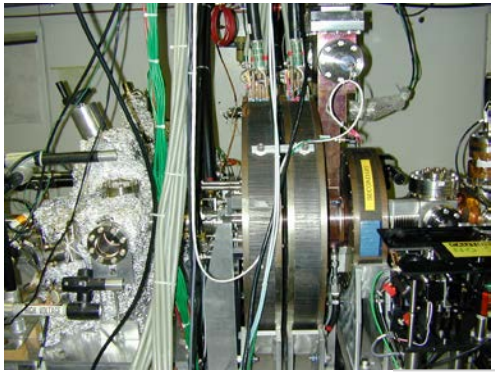
INFN and Fermilab Collaboration

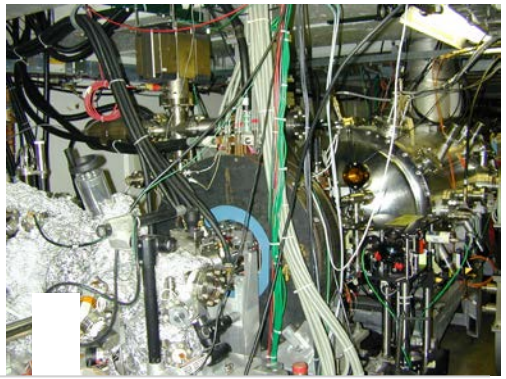
- INFN and Fermilab have a long tradition of fruitful collaboration on High Energy Phys. and accelerator physics and tecnology
- INFN Scientists spent years at Fermilab contributing to the top discovery (Tevatron)
- INFN Scientists are participating in the Fermilab neutrino and muon programs
- INFN/Fermilab joint effort in TESLA contributed significantly to the setting of the modern SRF tecnology.
- After the Cold Recommendation for the global Linear Collider, INFN-LASA helped Fermilab to setup ILC SRF Infrastructures.
- Fermilab and INFN-LASA jointly contribute to the S1-Global experiment at KEK

ILC Components coming from INFN - 1

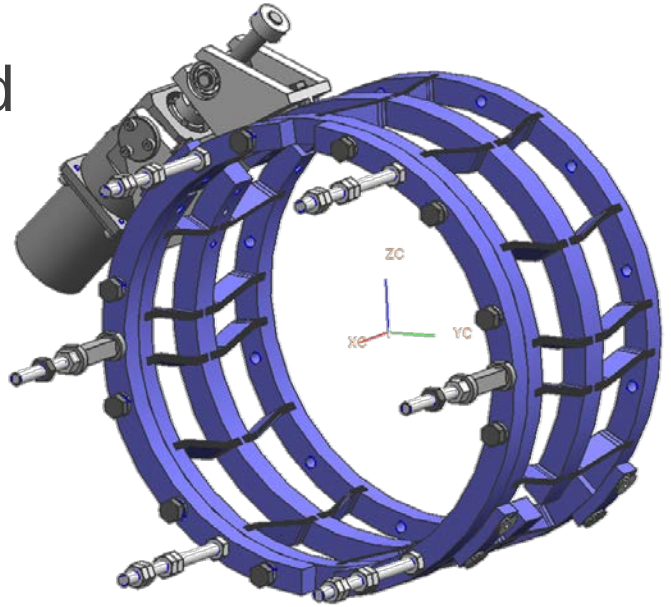
- Cs_2Te Photocathode system – in operation since August 1997 for the A0 test facility







- A set of INFN blade-tuners developed to improve the ILC filling factor



ILC Components coming from INFN - 2

- Cryomodule assembling tools, developed by INFN-LASA for TESLA/XFEL and globally distributed for ILC and LCLS-II

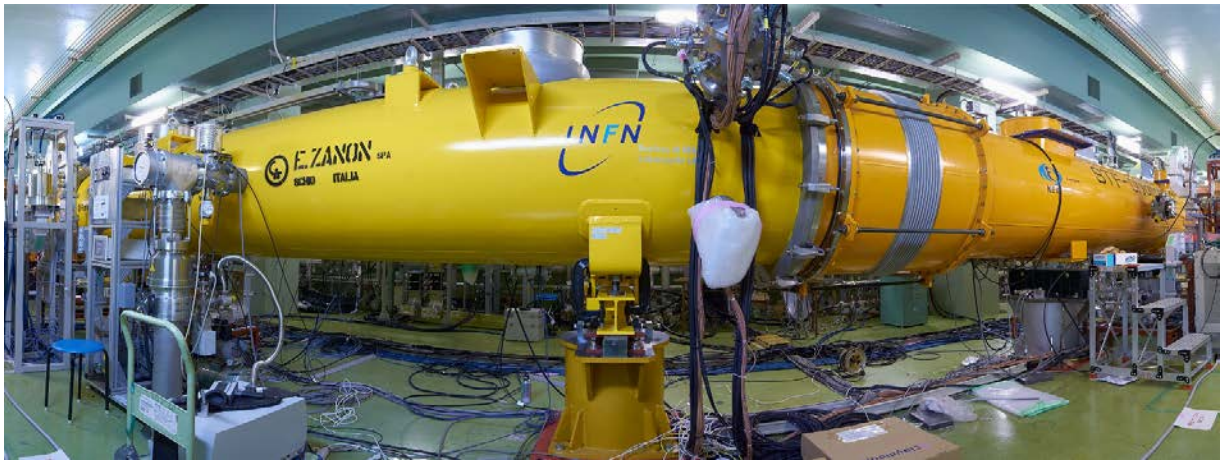





ILC Components coming from INFN - 3

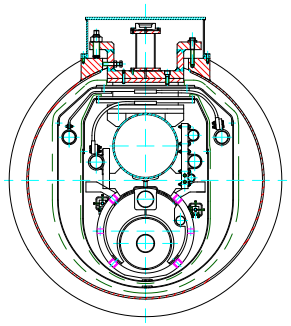
- Second Cold mass to be equipped with Fermilab ‘short’ cavities and INFN Blade tuners

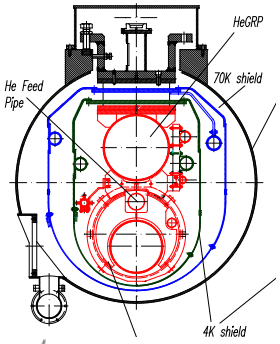
- Special 4 cavity Module and tuners for S1-Global at KEK

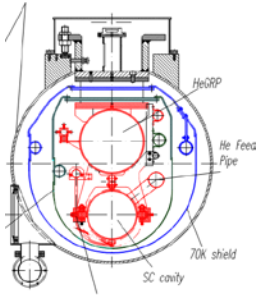


Recent Work at INFN-LASA: European XFEL

- Half of the cold masses (INFN Design)



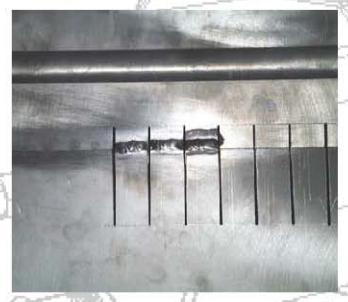


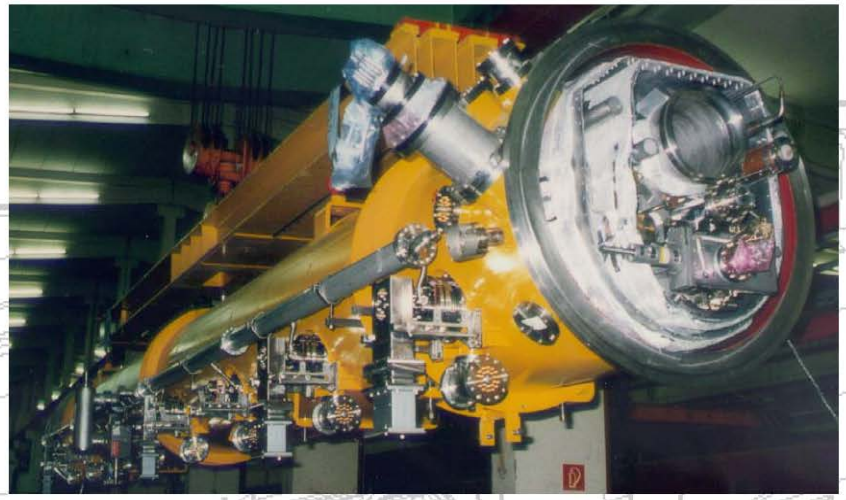


TTF Cryomodule Design

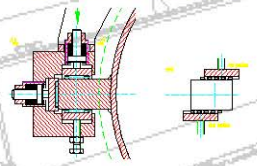
Three "generations" of the cryomodule design, with increasing simplicity and decreasing costs

"Finger Welded" Shields





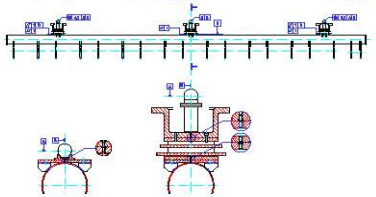
Sliding Fixtures @ 2 K



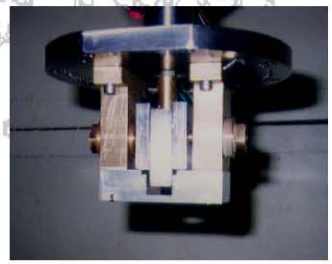
Cryomodule Charactteristics

• Length		12 m
• # cavities		8
• # doublets		1
• Static Losses	@ 2 K	1.5 W
	@ 5 K	8 W
	@ 50 K	70 W

Simplified alignement Strategy

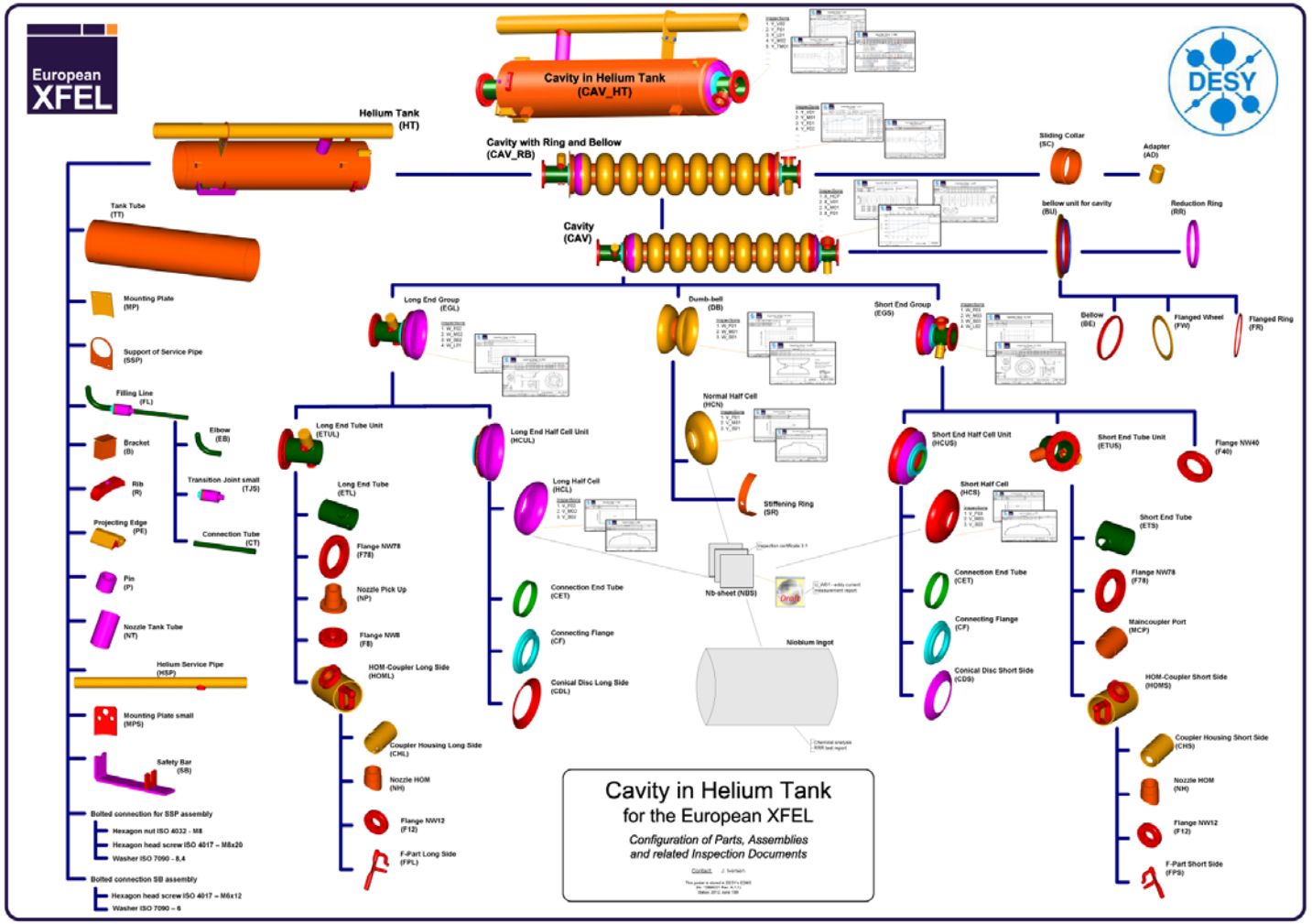


Qualification tests in LASA



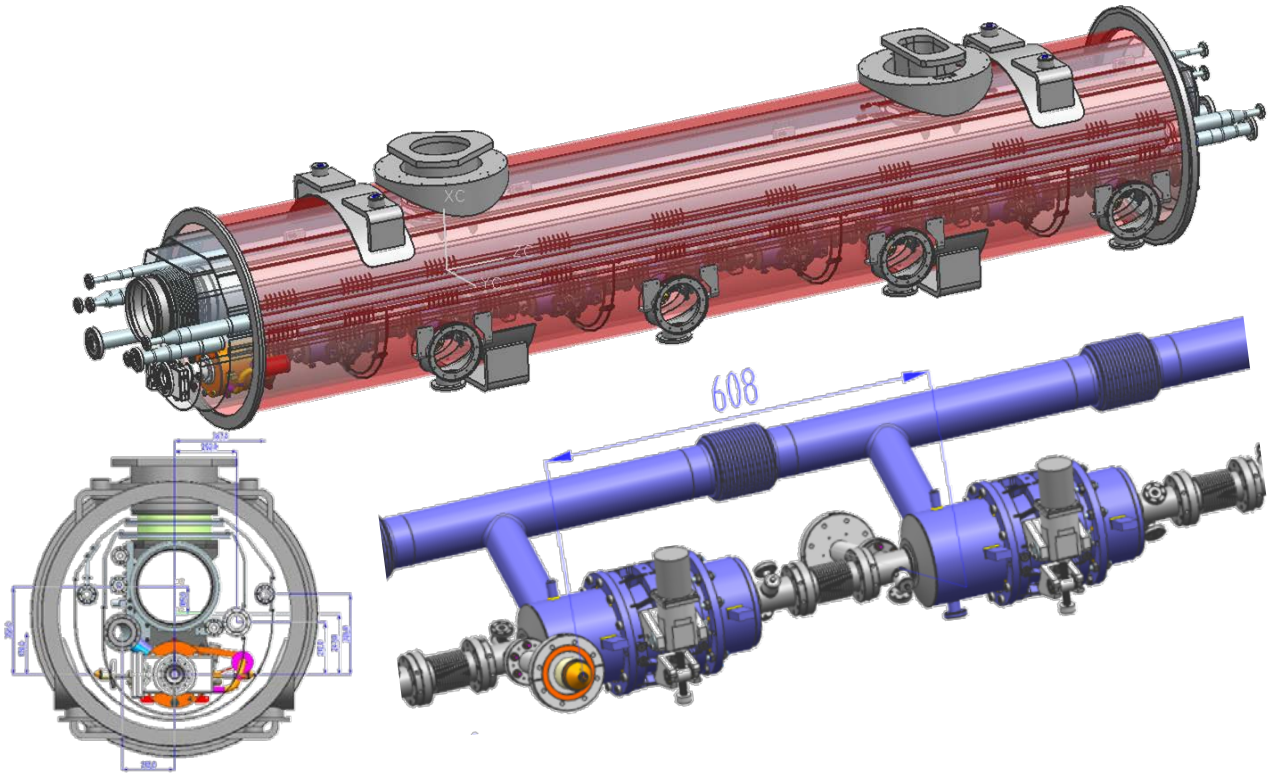
Recent Work at INFN-LASA: European XFEL

- Half of the 800+ 1.3 GHz SRF cavities: bulk EP + final BCP



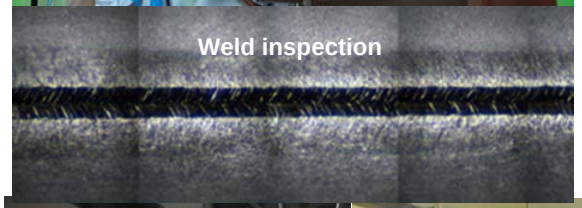
Recent Work at INFN-LASA: European XFEL

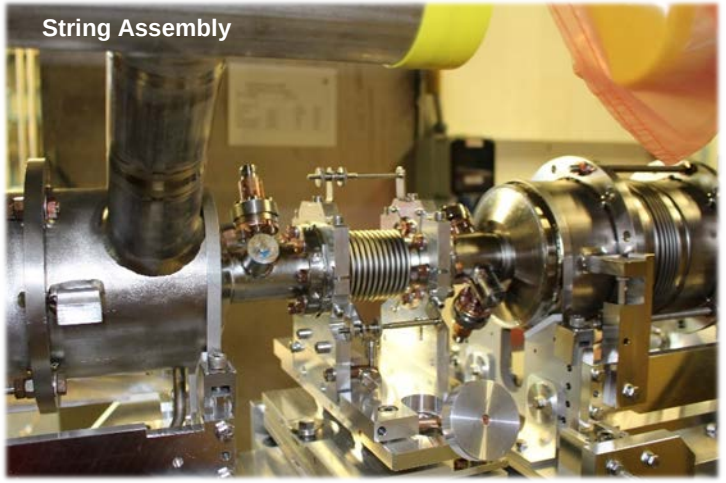
- The Third Harmonic Cryomodule: INFN Design, inspired on FLASH (Fermilab). FPC, cryogenics. and RF from DESY.



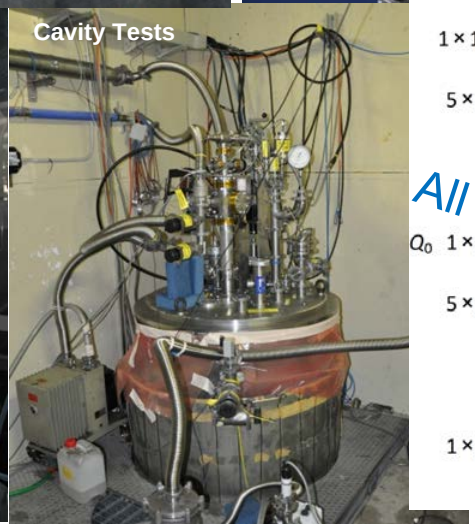
- alternating Power Couplers for kick compensation. Lateral 2-phase He line.
- “slim” type Blade tuner derived by INFN ILC tuner.
- 3rd harmonic module “**Plug compatible**” with XFEL standard modules.

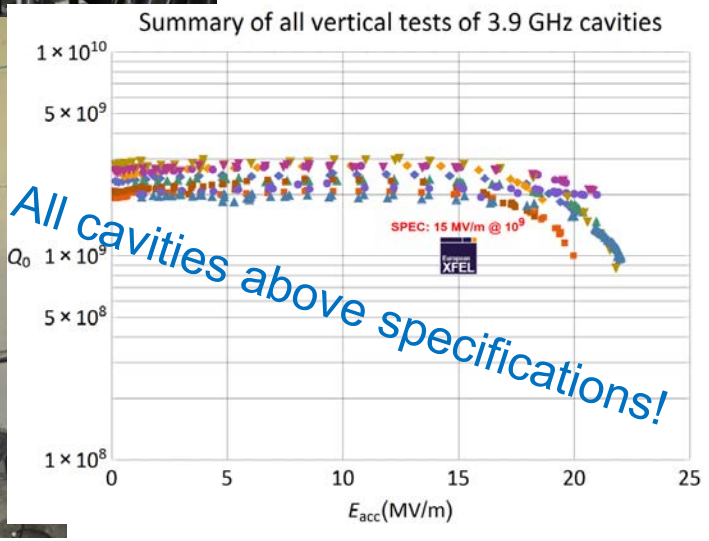
Recent Work at INFN-LASA: European XFEL

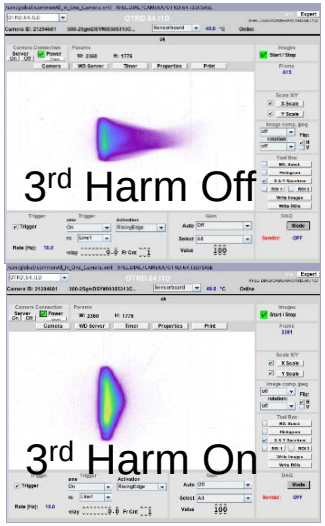




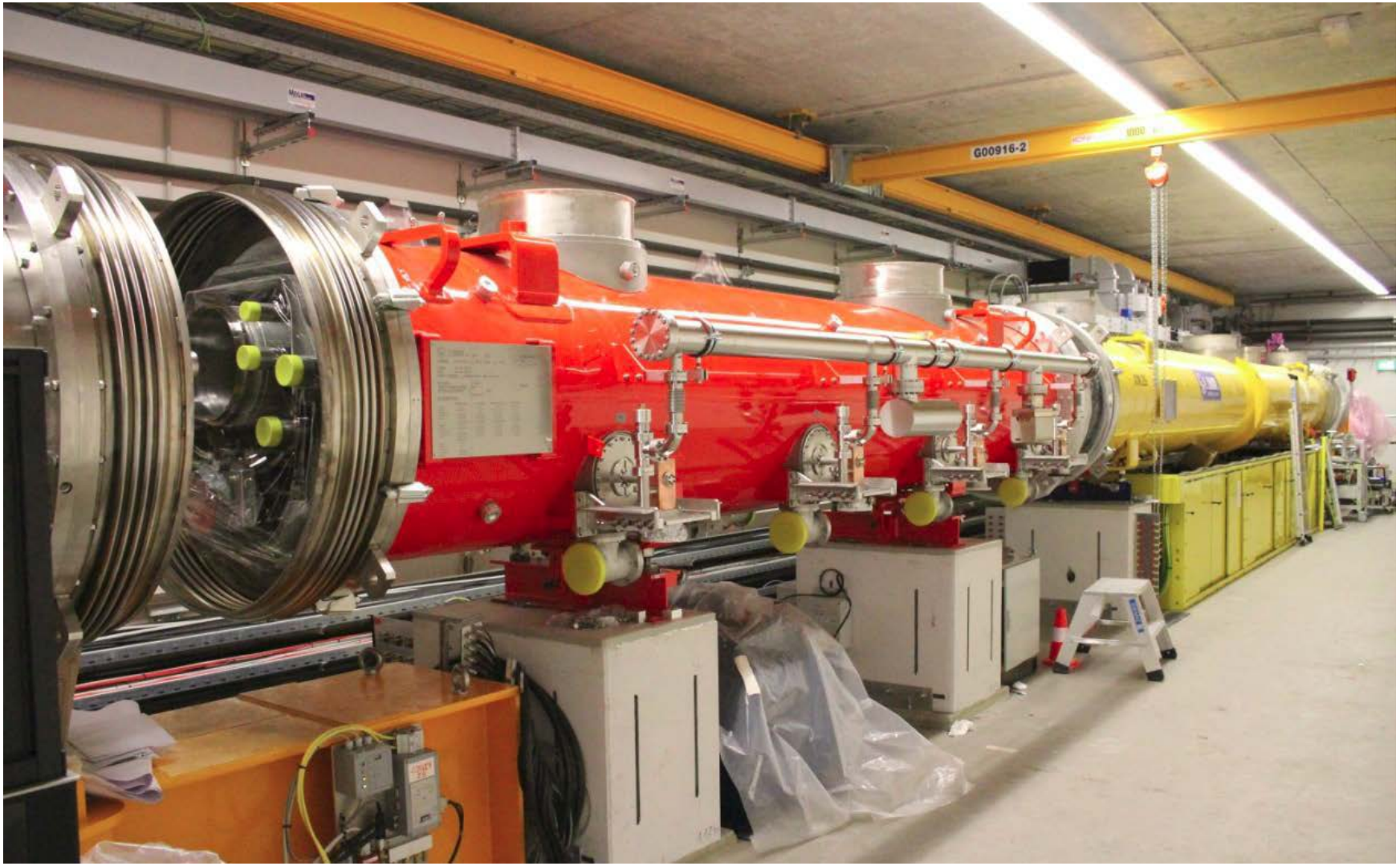
XFEL Injector' Beam







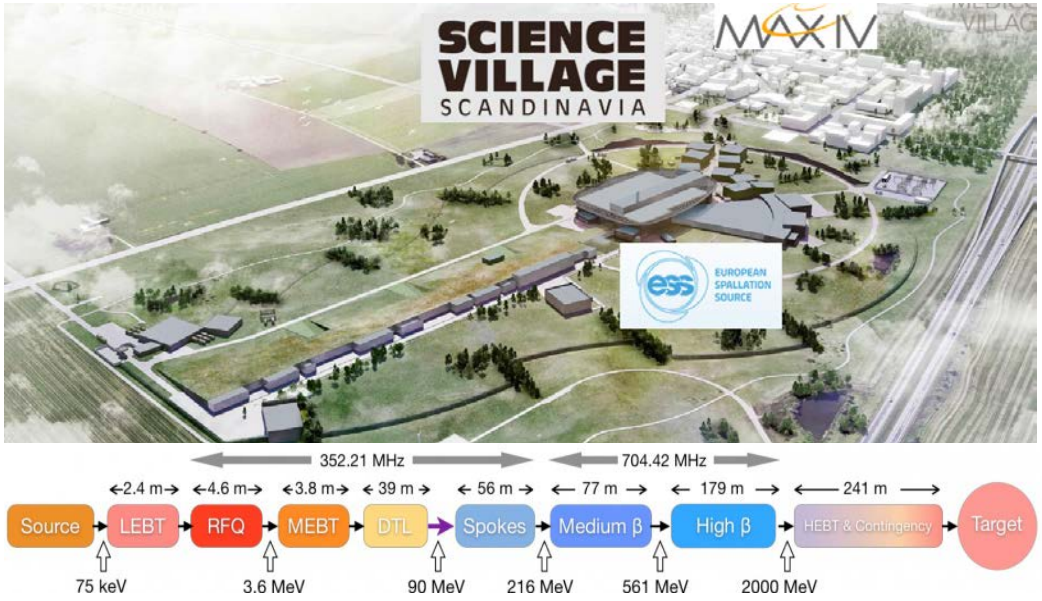
Recent Work at INFN-LASA: European XFEL



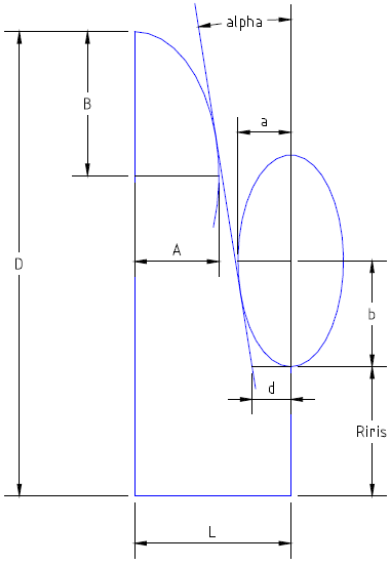
Present Work at INFN-LASA: ESS - Italy in-kind

- **36 medium beta cavities**
  - Cavity fabrication of 36 medium beta cavities in the industry, including treatments, tuning, Helium tank integration. **Full treatment at the vendor.**
  - Certification activities, documentation, ancillaries
  - **Cold test in a qualified infrastructure** (DESY).
  - Transportation in special boxes and **delivery at CEA** cryomodule assembling facility.

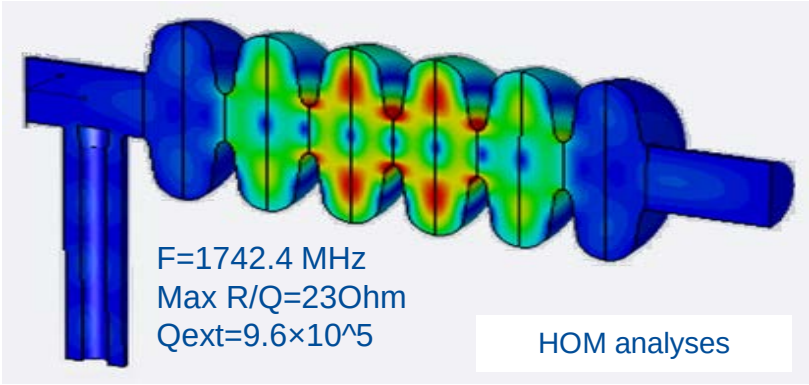
MB cavity technical requirements	
Frequency (MHz)	704.42
Number of cells	6
Geometric beta	0.67
Nominal Acc. Gradient (MV/m)	16.7
E_{peak} (MV/m)	< 45
RF peak power (kW)	1100
Q external	5.9-8 10^5
Q_0 at nominal gradient	> 5 10^9



Present Work at INFN-LASA: ESS Prototypes

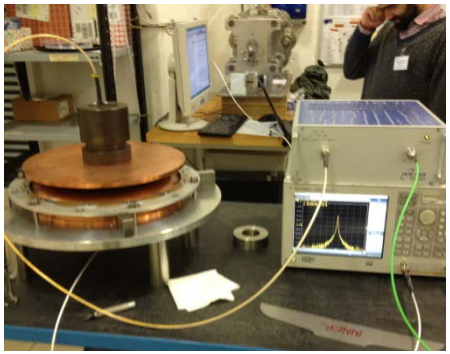


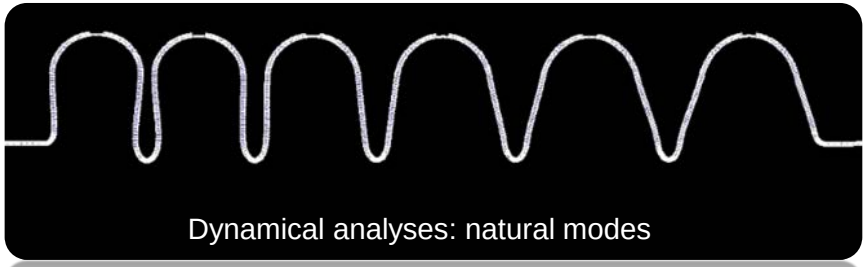
Cell shape design



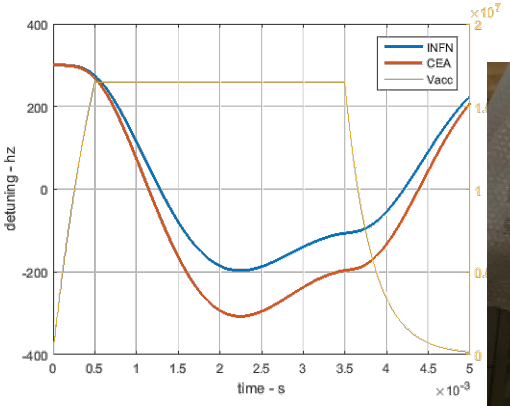
F=1742.4 MHz
Max R/Q=23Ohm
Qext=9.6×10^5

HOM analyses

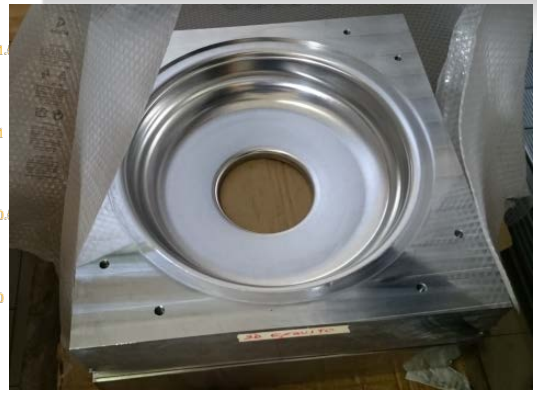


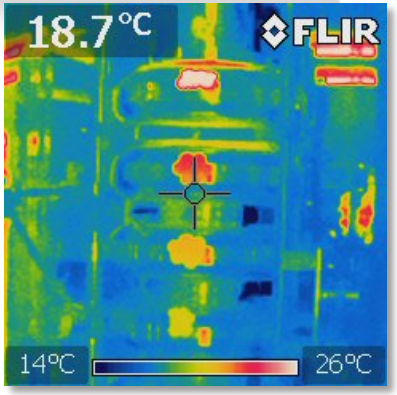


Dynamical analyses: natural modes



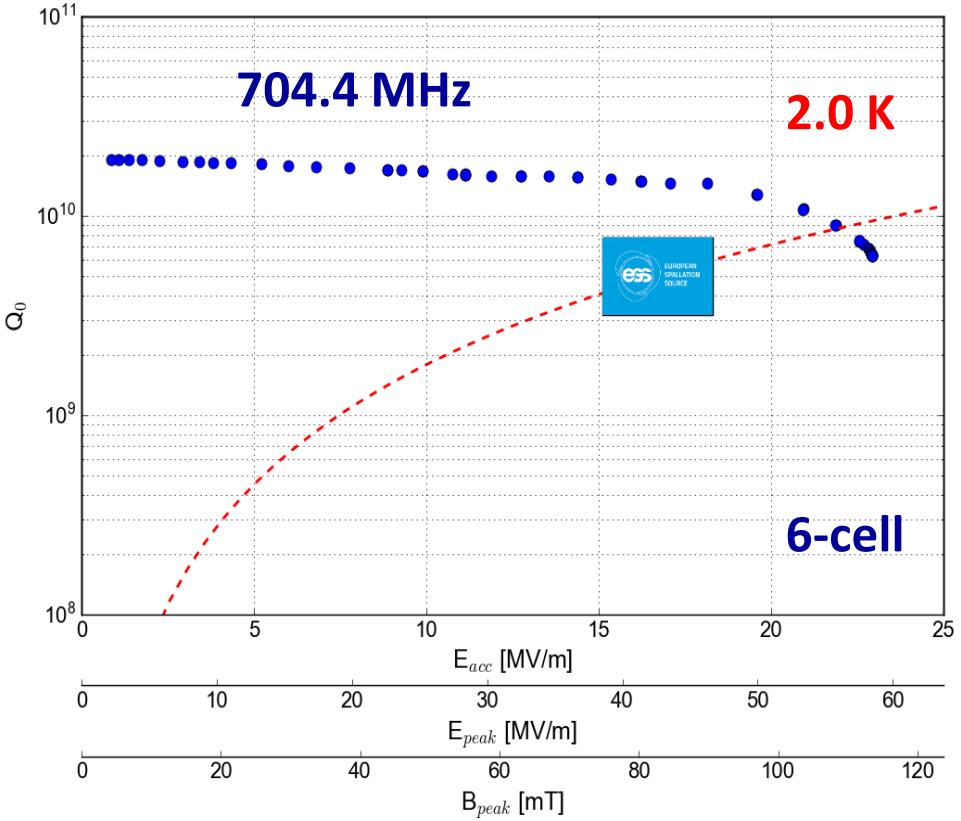
LFD from cavity simulator





Present Work at INFN-LASA: ESS Tests at 2 K

Test well above specs
Series Production approved
All major orders recently placed

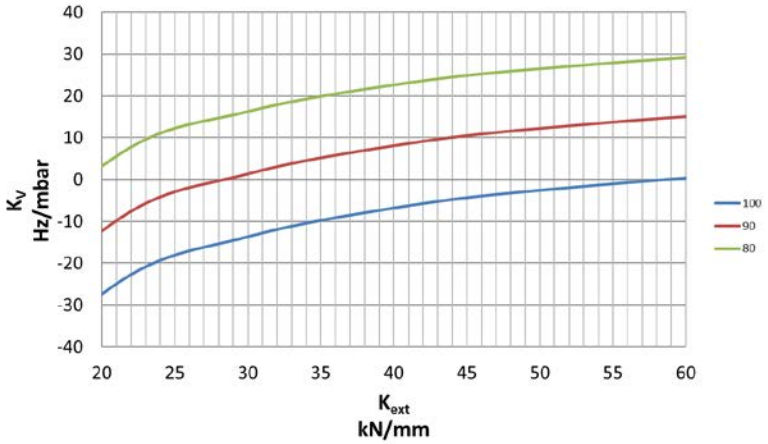


INFN & PIP-II

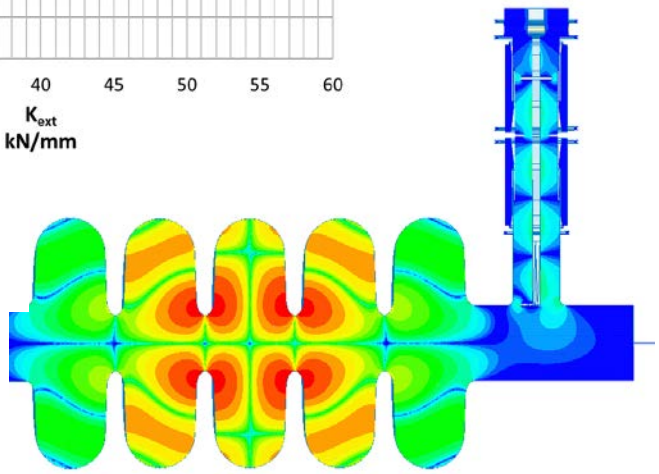
- Well in the frame of the long term fruitful Collaboration between Fermilab and INFN.
- Nicely included in the scientific activities envisaged in the Implementing Agreement signed by DoE and Italian Ministry of Education, University and Research (MIUR) (17.07.2017).
- Neutrino Physics and related high power proton accelerators are specifically mentioned in the Project Annex signed by DoE and MIUR on the same day (17.07.2017).
- Green light from MIUR for an Italian participation to the realization of PIP-II through an in kind contribution mediated by INFN LASA and specifically funded by MIUR/MAECI.
- The envisaged contribution nicely matches with the INFN LASA expertise and it's welcome by the LASA scientists.

INFN & PIP-II – work so far

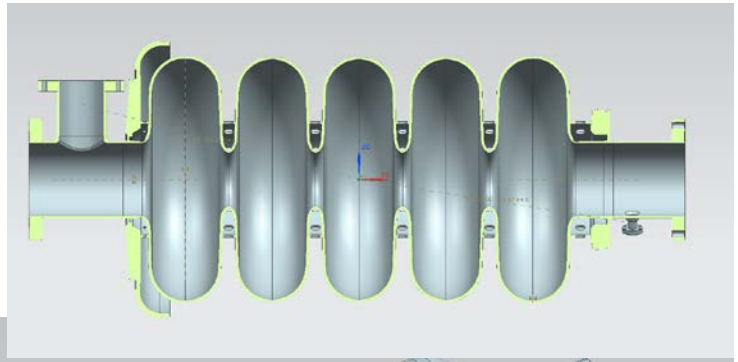
- Several alternative designs have been developed for the LB650 cavity
- The final version from INFN-LASA has been chosen for PIP-II as the best compromise between CW and pulsed operation performances.

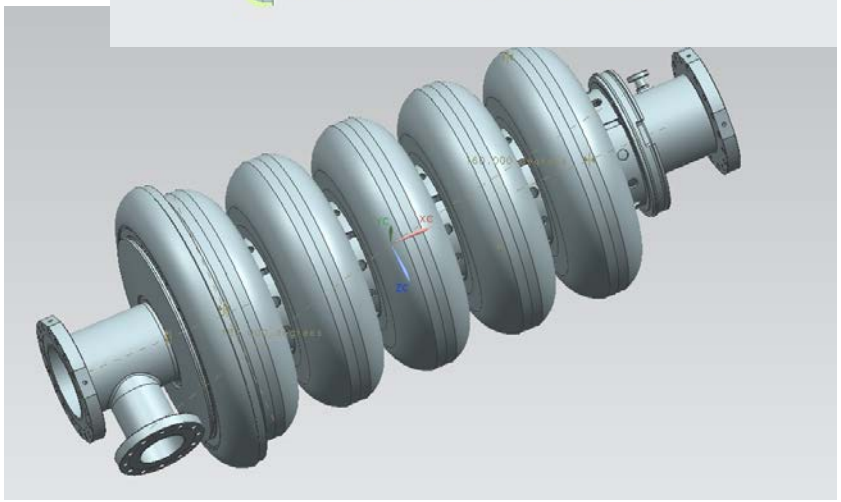


Pressure sensitivity analyses around tuner stiffness at 40 kN/mm



Dipole HOM at 1678 MHz analysis, showing partial reflections in the new FPC





Prototype ready for manufacturing

- Blue-prints are ready for CFT
- INFN administrative support in progress

From the 1995 TTC Meeting in Milano