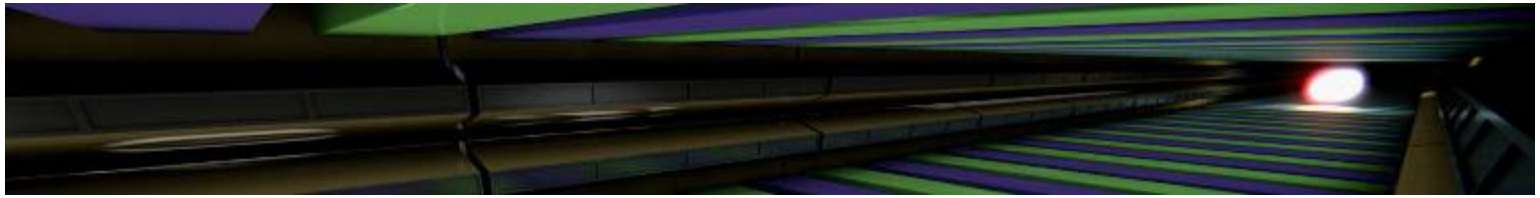
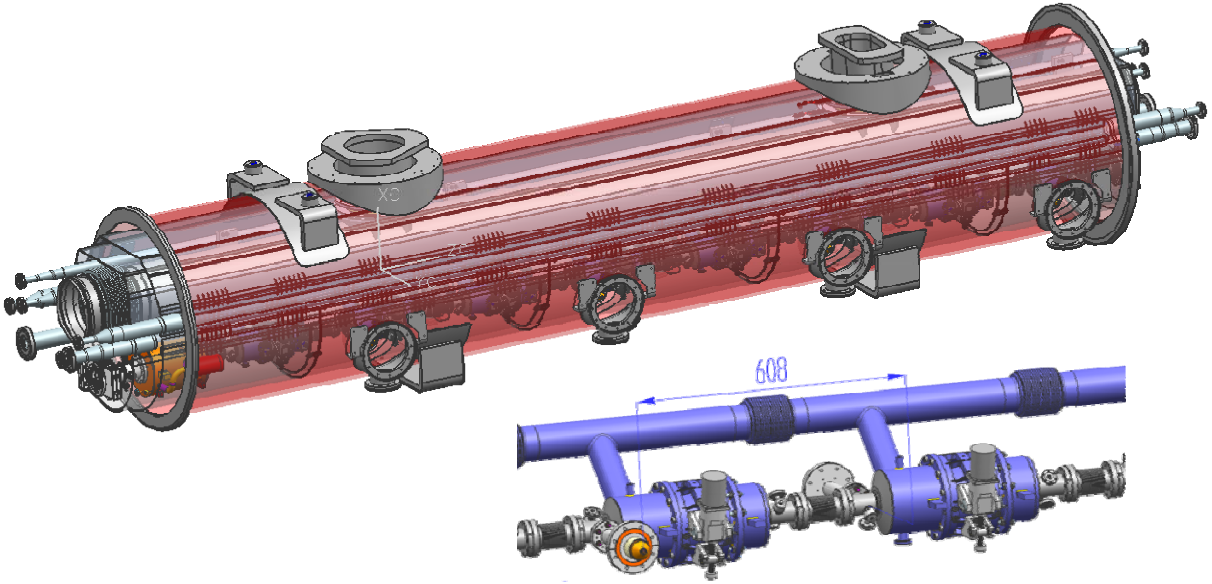


European XFEL

e il Contributo Italiano



Carlo Pagani

Outline

- Come nasce la partecipazione INFN
- Tappe verso l'approvazione di XFEL
- Stato del Progetto
- Stato del contributo Italiano
- L'impegno Italiano attraverso INFN Milano

The TESLA Collaboration Mission

Develop SRF for the future TeV Linear Collider

Basic goals

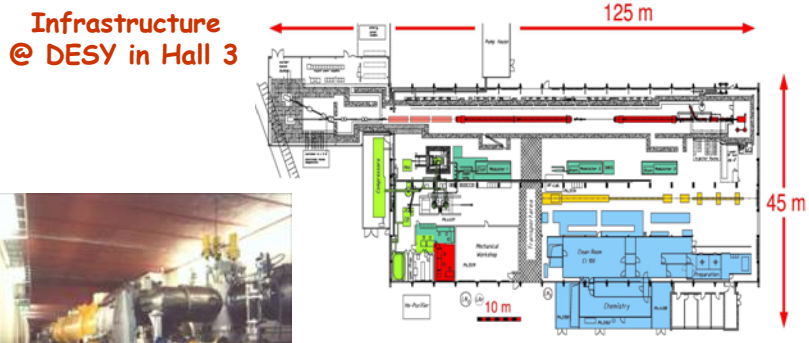
- **Increase gradient by a factor of 5** (Physical limit for Nb at ~ 50 MV/m)
- **Reduce cost per MV by a factor 20** (New cryomodule concept and Industrialization)
- **Make possible pulsed operation** (Combine SRF and mechanical engineering)

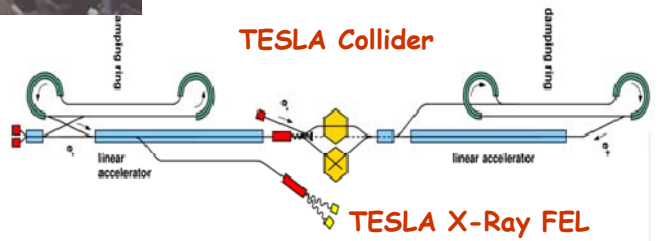
Major advantages vs NC Technology

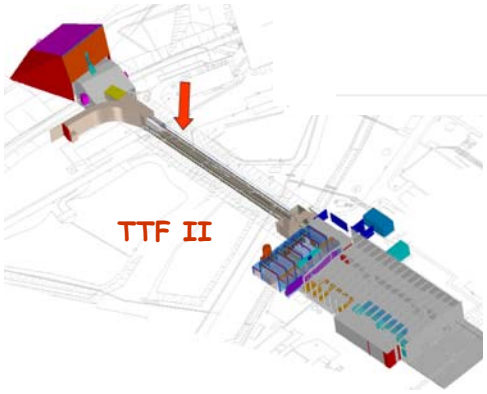
- **Higher conversion efficiency**: more beam power for less plug power consumption
- **Lower RF frequency**: relaxed tolerances and smaller emittance dilution

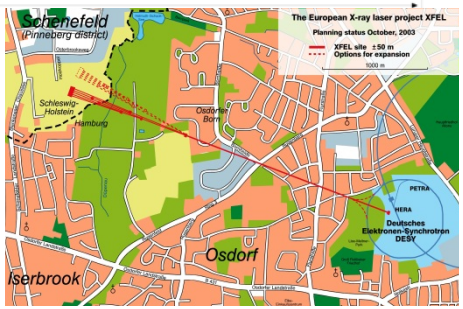
TESLA Collaboration Milestones

- February **1992** – **1° TESLA Collaboration Board Meeting @ DESY**
- March **1993** - "A Proposal to Construct and Test Prototype Superconducting RF Structures for Linear Colliders"
- April **1995 – 25 MV/m in multi-cell cavity**
- May **1996** – **First beam at TTF**
- March **2001** – **First SASE-FEL Saturation at TTF**
- March **2001** – **TESLA Technical Design Report**
- February **2003** –**TESLA X-FEL** proposed as an European Facility,
- 50% funding from Germany
- March **2004** – TTF II/**FLASH** Commissioning start
- April **2004 - 35 MV/m with beam**
- August **2004 – TESLA Technology chosen for ILC**
- August **2005 – ILC-GDE Formed** for design and costing
- June **2007 – European XFEL Project Starts**







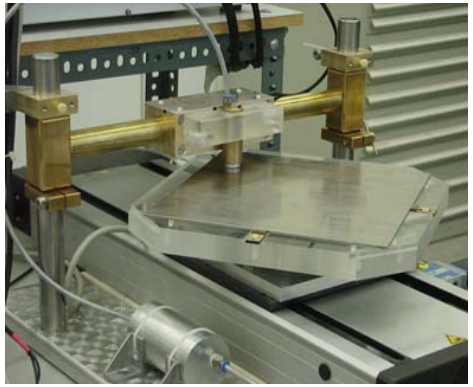


TESLA Technology: SRF Cavities

Major contributions from: CEA-Saclay, CERN, Cornell, DESY and INFN-LASA

(Alphabetic order)

Bulk Nb, 9-cell, 1.3 GHz



Eddy-current scanning system for niobium sheets

Cleanroom handling of niobium cavities

TESLA cavity parameters

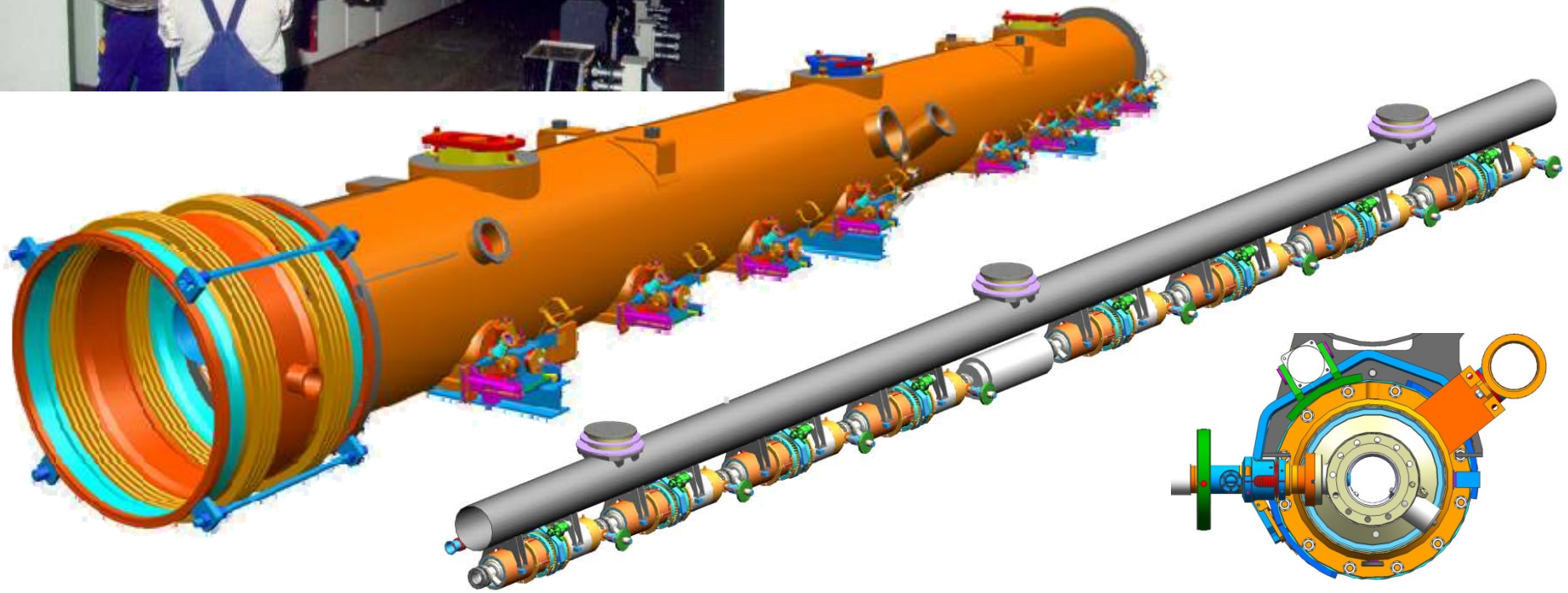
R/Q	1036	Ω
E_{peak}/E_{acc}	2.0	
B_{peak}/E_{acc}	4.26	mT/(MV/m)
$\Delta f/\Delta l$	315	kHz/mm
$K_{Lorentz}$	≈ -1	Hz/(MV/m)^2

Preparation Sequence

- Niobium sheets (RRR=300) are scanned by eddy-currents to detect avoid foreign material inclusions like tantalum and iron
- Industrial production of full nine-cell cavities:
  - Deep-drawing of subunits (half-cells, etc.) from niobium sheets
  - Chemical preparation for welding, cleanroom preparation
  - Electron-beam welding according to detailed specification
- 800 °C high temperature heat treatment to stress anneal the Nb and to remove hydrogen from the Nb
- 1400 °C high temperature heat treatment with titanium getter layer to increase the thermal conductivity (RRR=500)
- Cleanroom handling:
  - Chemical etching to remove damage layer and titanium getter layer
  - High pressure water rinsing as final treatment to avoid particle contamination

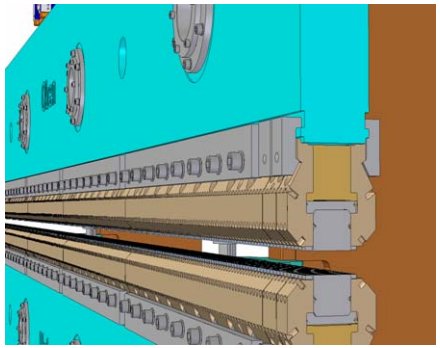
TESLA Technology: the INFN Cryomodule

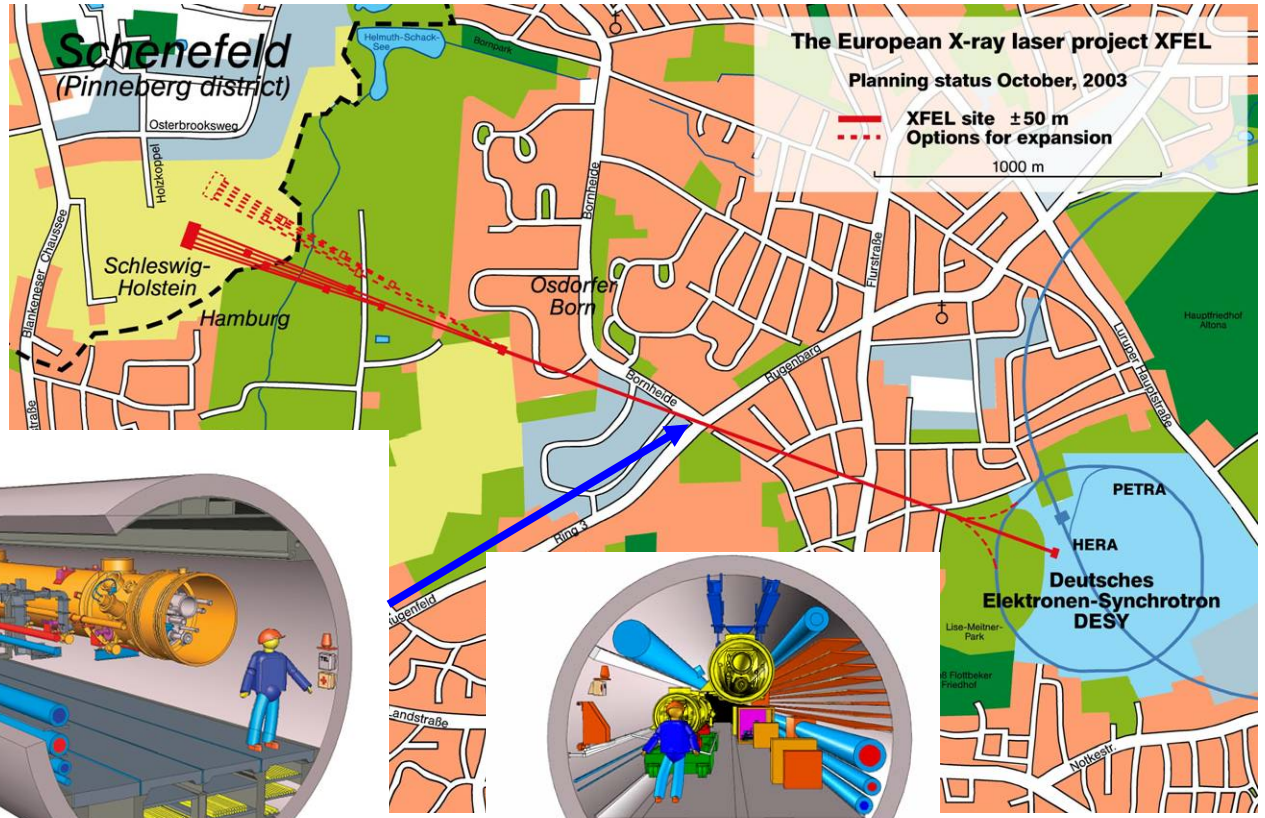
- International collaborative Effort in the three regions for ILC
- Design changes are towards nailing down slot length of components
- Costing should be straight-forward from TTF and XFEL experience

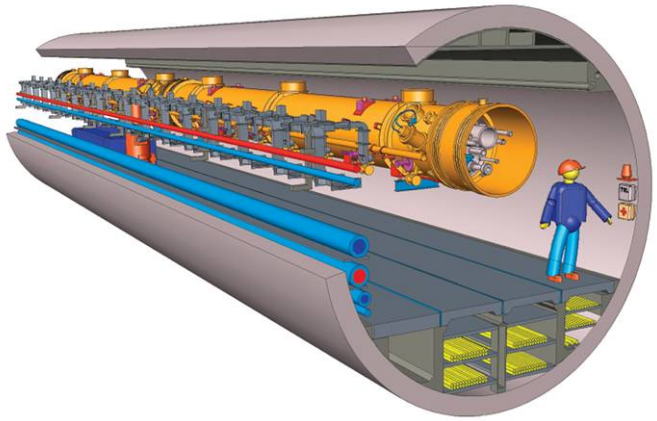


XFEL Overall Layout and Site

3.4km







http://www.xfel.eu/

5777 m di Tunnel completati (giugno 2012)

TUNNEL CONSTRUCTION PROGRESS

On this page, the positions of our tunnel boring machines were shown.

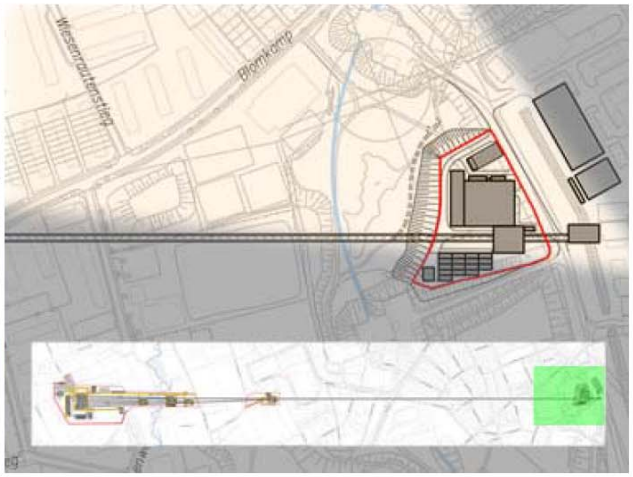
(NB: The lines show the tunnel route with an accuracy of a few meters.)

Drag the map or zoom in and zoom out respectively by clicking the buttons labelled "+" and "-".

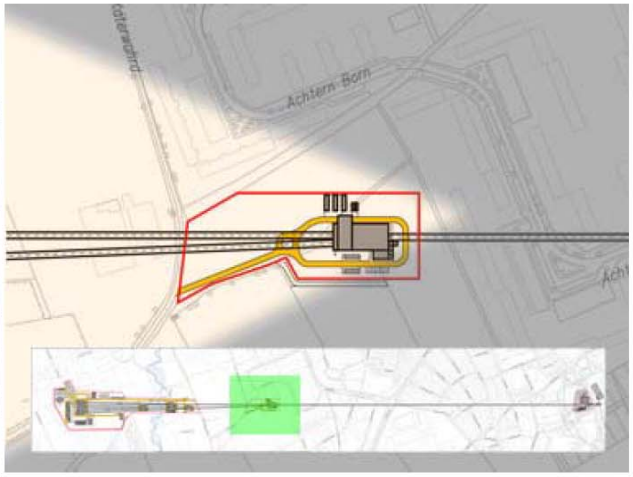
Total length of completed tunnels	5777 m of 5777 m	100.0 %

WEBCAMS – 3/7/2012

DESY-BAHRENFELD

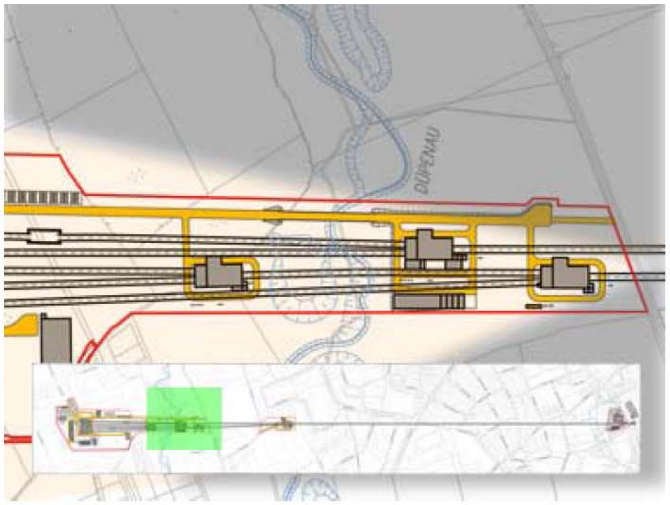


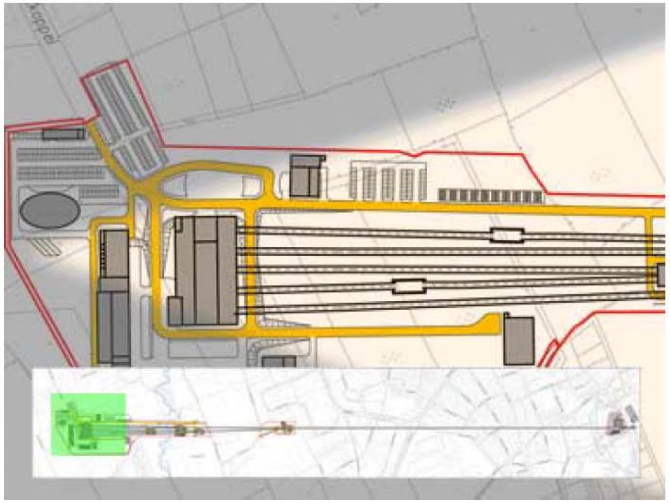
OSDORFER BORN



WEBCAMS – 3/7/2012

SCHENEFELD





Tappe della Partecipazione Italiana - 1

- 2004/2005: MoU, Firmato dai rappresentanti di 13 Paesi (Dirigente MIUR per l'Italia), per la preparazione dell' European XFEL
- Aprile 2007: Sollecitazione MIUR a INFN, ST e CNR per la partecipazione alla "Preparatory Phase"
- Maggio 2007: Lettera del Ministro F. Mussi al Ministro A. Schavan per impegno italiano alla partecipazione alla fase di costruzione dell'European XFEL con una cifra di 40 M€
- Marzo 2009: Lettera del Misistro M. Gelmini al Ministro A. Schavan per conferma impegno italiano alla partecipazione all'European XFEL per una cifra di 33 M€ (indicizzati 2005) con la promessa di impegno per reperire i 7 M€ mancanti.

MoU e lettera MIUR a INFN, ST e CNR

COPY
Signatures as of
November 24, 2005

Memorandum of Understanding

on the Preparatory Phase

of the European X-ray Free Electron Laser Facility

Preamble

A source of high-brilliance, coherent X-rays (below 1 nm) with a high repetition rate and pulse lengths in the femtosecond region will open up totally new research possibilities in solid state physics, geophysics, chemistry, materials science, medicine and structural microbiology. Free-Electron Lasers based on the principle of Self-Amplified Spontaneous Emission (SASE) and realized by using a linear accelerator as the driver provide such radiation.

For Italy
Ministry of Education, University and Research:

Dr. L. Criscuoli
Director General

Done in

on Dec 6/2004

Ministero dell'Università e della Ricerca

Direzione Generale per le Strategie e lo Sviluppo dell'Internazionalizzazione della Ricerca Scientifica e Tecnologica

Prot. n. 99
Roma, 18 aprile 2007

Prof. Roberto Petronzio
Presidente
Istituto Nazionale di Fisica Nucleare (INFN)
Piazza dei Caprettari, 70
00186 Roma

Prof. Carlo Pagani

Subject: The European Research Infrastructure "European XFEL" (ESFRI Roadmap)

The Ministry of University and Research is aware of the preparation of a proposal for the preparation phase related to the EU-XFEL Research Infrastructure and sees it as a possible important tool for ensuring world class research in the field of Materials and Biomaterials in Europe. Italy has asked the following three institutions to participate to the preparatory phase of the EU-XFEL project:

1) INFN – Istituto Nazionale di Fisica Nucleare (Contacts: Prof. Roberto Petronzio, Prof. Carlo Pagani)
2) Sincrotrone Trieste (Contact: Prof. Carlo Rizzuto)
3) INFM-CNR – Istituto Nazionale per la Fisica della Materia (Contacts: Prof. Elisa Molinari, Prof. Giorgio Rossi).

The Italian participation will be coordinated by Prof. Carlo Pagani.

The above participations should be considered in the process taking place during the preparatory phase of EU-XFEL. Based on the results of the present negotiations within the existing the MOU and of this preparatory phase, and taking into account the priorities to be defined within the available budgetary frames, the active participation in the implementation phase will be taken into consideration by our Ministry and/or other funding Authorities in Italy.

for the Director General
Dr. Mario Ali
The Head of Office III
Dott.ssa Maria Uccellatore

Lettere dei Ministri F. Mussi e M. Gelmini

Il Ministro dell'Università e della Ricerca

Rome, 16 MAG 2007
Prot. n. 6AB/24.94

Dear Minister,

I refer to Your letter of April 18th 2007, notably to the X FEL project, You recalled in the margin of our meeting in Würzburg, very efficiently and generously organized by the German Presidency.

As you might remember, during our talks in Berlin last November, I agreed in principle that Italy will provide a contribution to X FEL.

I'm now in a position to officially reconfirm the Italian contribution through the Ministry of University and Research budget and INFN. In the present budgetary constraints we are striving to reach a total amount of 40 Million Euros. We are still looking into the details of such contribution, notably on the in kind component and related conditions, that will be negotiated between our representatives.

Italy is looking with great interest at the participation to the ESFRI process as a whole and to the Hamburg meeting early next June, also with a view to strengthening the overall scientific relations between our two Countries.

Looking forward to meeting You in Rome on May 21th, please accept, dear Colleague, my best regards.

Fabio Mussi

Dr. Annette Schavan
Federal Minister
of Education and Research
Berlin

Il Ministro dell'Istruzione, dell'Università e della Ricerca

Roma 5-3-09

Prot. 450

Onorevole Ministro, Stimata Collega,

vorrei anzitutto ringraziarLa per il Suo messaggio del 9 ottobre u.s. relativo alle grandi infrastrutture di ricerca XFEL e FAIR, e congratularmi con Lei per l'esito positivo delle complesse trattative per la fondazione del Laser ad Elettroni Liberi a raggi X Europeo (European XFEL), condotte a buon fine grazie al Suo costante ed illuminato sostegno.

Sono pertanto lieta di poter confermare nella sostanza, pur nella mutata e più difficile situazione finanziaria, l'impegno assunto nel maggio 2007, per il governo italiano, dal mio predecessore Fabio Mussi, per una partecipazione italiana ai costi di costruzione. Una cifra pari a 33 M€ (indicizzati al 2005) sarà versata sotto forma di contributo in natura ("in-kind" contribution), attraverso la partecipazione responsabile dell'Istituto Nazionale di Fisica Nucleare. L'Azionista (Shareholder) della Società European XFEL sarà il MIUR, nei modi già concordati tra i rispettivi responsabili scientifici. Ci sforzeremo di reperire, nei bilanci degli anni a venire, durante il periodo di costruzione, il contributo ulteriore in contanti di 7 M€, che porterebbe il totale alla cifra di 40 M€ menzionata dal mio predecessore, anche se al momento non sono in grado di impegnarmi su questo punto.

Sarò quindi particolarmente lieta di accettare, compatibilmente con gli impegni dei prossimi mesi, il Suo invito a partecipare alla sottoscrizione degli accordi a Berlino.

Per quanto riguarda il progetto FAIR, i cui tempi per la sottoscrizione degli accordi sono leggermente più lunghi, mi riservo di farLe conoscere quanto prima la posizione italiana rispetto a questo secondo progetto di grande interesse, relativamente al quale ci si attende un rapporto di reciprocità con altre Infrastrutture collocate nel nostro Paese.

Voglia gradire Signor Ministro, i miei più cordiali saluti.

Mariastella Gelmini

All' On. Dr. Annette Schavan
Ministro Federale dell'Educazione e della Ricerca
Berlino

Dalla lettera del 5 marzo 2009

- …sono pertanto lieta di poter confermare nella sostanza l'impegno assunto nel maggio 2007 dal mio predecessore Fabio Mussi …
- …Una cifra pari a 33 M€ (indicizzati al 2005) sarà versata sotto forma di contributo in natura ("in-kind" contribution) attraverso la partecipazione responsabile dell'Istituto Nazionale di Fisica Nucleare.
- L'Azionista (shareholder) della Società European XFEL sarà il MIUR, nei modi già concordati tra i rispettivi responsabili scientifici
- Ci sforzeremo di reperire, nei bilanci degli anni a venire, il contributo ulteriore di 7 M€, che porterebbe il totale alla cifra di 40 M€ menzionata dal mio predecessore.

Tappe della Partecipazione Italiana - 2

- Settembre 2009: Cross-check Conference a Berlino per la verifica di tutti i documenti costitutivi dell'European XFEL, nelle 6 lingue ufficiali (Francese, Inglese, Italiano, Russo, Spagnolo e Tedesco), che hanno uguale valore legale.
- 23 settembre 2009: Sigla a Berlino dei documenti costitutivi dell'European XFEL, nelle sei lingue ufficiali,
- 28 settembre 2009: Costituzione ad Amburgo della società "European XFEL GmbH" con la sottoscrizione provvisoria di tutte le azioni da parte di DESY
- 30 novembre 2009: Firma ad Amburgo della Convenzione, per la definitiva formalizzazione della partecipazione dei vari Paesi, inclusa l'Italia, all' European XFEL

Firma della Convenzione XFEL

NEWS, 30 NOVEMBER 2009

European XFEL established under international law

With their signatures, representatives from ten nations today lay the foundations for the European XFEL under international law.

Ministers, state secretaries and other government representatives from ten partner countries met today in the Hamburg City Hall to sign the international European XFEL agreement.

Impegno Italiano: 33 M€ (2005) in-kind

- Il contributo alla fase di costruzione di XFEL sottoscritto dall'Italia ha le seguenti caratteristiche:
  - E' in-kind, per un valore di 33 M€ (indicizzato 2005) secondo le cifre indicate a "budget book" e approvate insieme alla Convenzione.
  - Comprende attività di sviluppo, di trasferimento di know-how e di produzione con l'industria, di collaudo e certificazione.
- In sostanza, attravesrso la partecipazione responsaabile dell'INFN, l'Italia garantisce la fornitura di metà delle cavità superconduttive, di una parte dei criomoduli e del sistema di terza armonica.

Accordo INFN - Sincrotrine di Trieste

- L'INFN è riuscito a mantenere l'impegno verso il Progetto nonostante il forte ritardo dell'erogazione dei primi fondi e la loro allocazione alla Sincrotrone di Trieste (5 M€ a metà 2011, attraverso il FOE 2010)
- L'INFN ha comunque continuato a fornire l'insostituibile supporto qualificato dei suoi ricercatori del LASA, indipendentemente dall'erogazione dei fondi ad hoc.
- La Società XFEL ha creduto nel fatto che l'impegno economico italiano sarebbe stato rispettato e ha anticipato i fondi per le gare e le commmesse all'industria Italiana (commesse iniziali per ca 30 M€)
- In armonia con il principio espresso dal MIUR nel 2007 per un contributo coordinato dei vari Enti di Ricerca al Progetto European XFEL, e in prospettiva di un ampliamento dell'interesse verso l'attività sperimentale con XFEL, si è proceduto alla firma di un accordo tra INFN e ST, relativo alla gestione dei primi fondi stanziati.

Contributo italiano attualizzato [M€]

	Quota totale	INFN per in-kind sviluppo	ST (PIK)	Collaborazione con XFEL per in-kind industria
FOE 2010	5.0	4.5*	0.5	
FOE 2011	7.57		1.0	6,57
FOE 2012	10.0	2.0		8.0
FOE 2013	10.0		1.0	9.0
2014	10.0		4.0	6.0
2015	4.63		1.7	2.93
TOTALE	**47.2**	**6.5**	**8.2**	**32.5**

erogati stanziati previsti

* tramite contratto ST-INFN

Contributi «Tecnici» di Milano nei WP

Riconosciuti nella struttura di progetto

- WP3 Cryomodule (~concluso)
- WP4 Cavities
  - WPL P.Michelato
- WP7 Tuners
  - WPL A.Bosotti
- WP46
  - WPL P. Pierini

European XFEL

DESY's XFEL Project Group

Organization | Jobs & Tenders | Technical Information | Workshops | Cavity Database | Project Group

XFEL ▸ Project Group ▸ Work Packages ▸ LINAC ▸ WP 4: SC Cavities

WP 4: SC Cavitie...
Specs

WP-04: Super Conducting Cavities

- Cavity baking in-situ
- EP on cavities with tank
- Determination of electrical axis of cavity
- Check mechanical properties of niobium after 800C
- Define processes of cavity preparation and assembly
- Optimum EP parameters
- First 10 nine cell-preparations after EP + 800C + bake
- Material
- EP on half cells, dumb-bells
- Optimum stress annealing + hydrogen degassing temperature (600 1000C)
- Other cleaning techniques: Oxipolishing, BCP 1:1:10, etc
- Development of CO2 cleaning
- Cavity Production
- **Work Package Leader: W. Singer (Desy) / P. Michelato (INFN)**

WP 7: Frequency Tuner

- Define detailed specification for tuner
- Define processes for integration/assembly
- Piezo mechanical design
- **Work Package Leader: L. Lilje (Desy) / A. Bosotti (INFN)**

WP 46: 3.9 GHz System

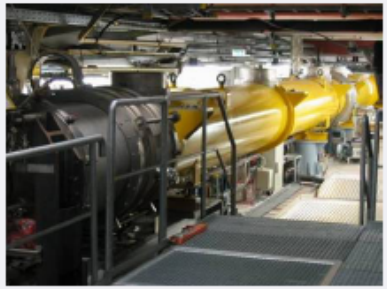
- coordination of the FLASH 3.9 GHz module as XFEL prototype
- procurement of all components for 3.9 GHz system
- module assembly
- RF and RF control
- installation and commissioning of the system
- **Work Package Leader: P. Pierini (INFN) / E. Vogel (Desy)**

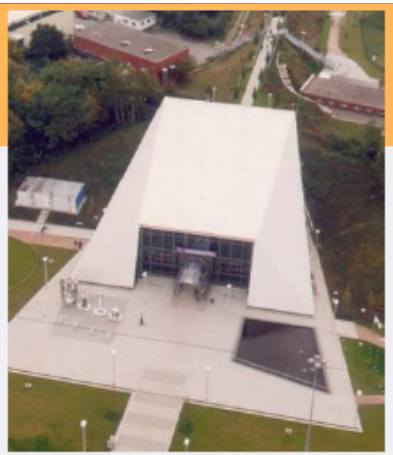
More info

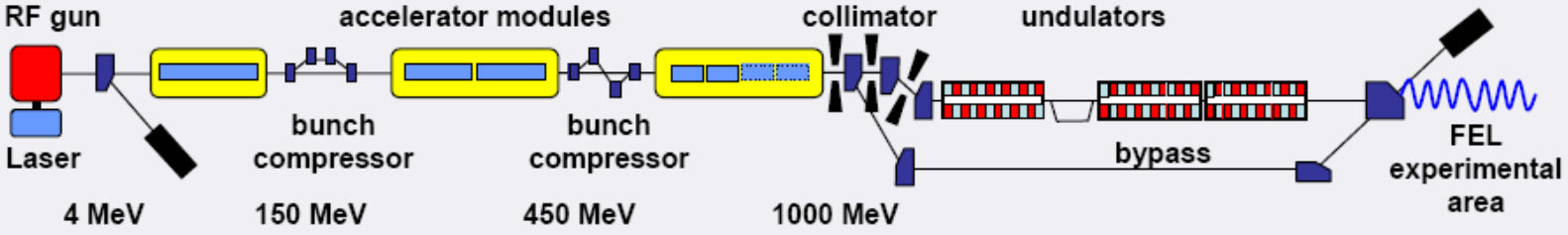
WP-46 status presentation

TTF II – FLASH @ DESY

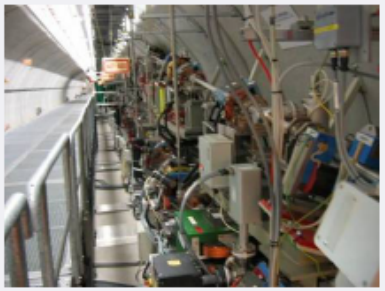
FLASH (VUV-FEL) as XFEL Prototype









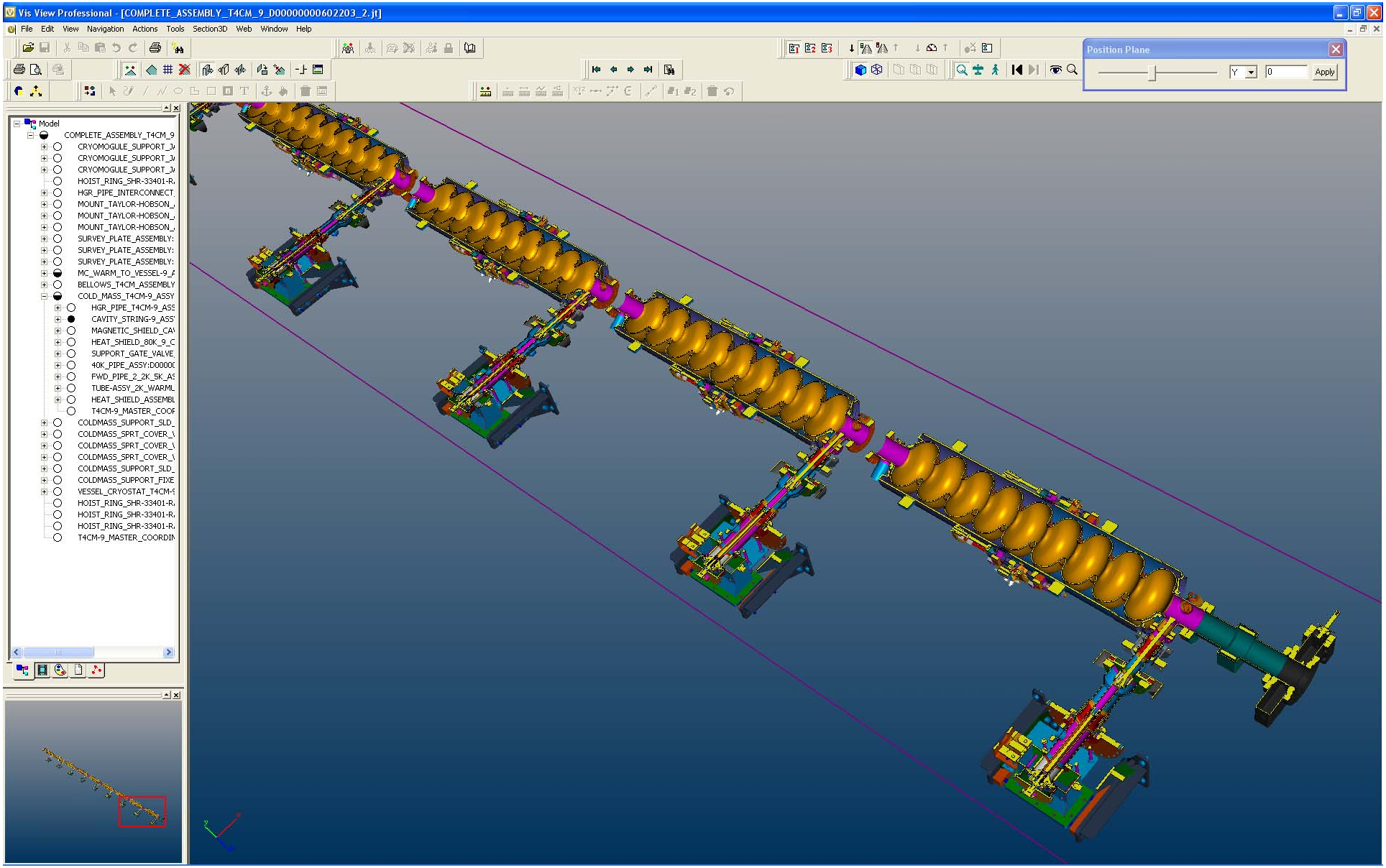

250 m

WP3: Moduli acceleranti

- L'INFN ha sviluppato tutti i moduli acceleranti per FLASH
  - Finanziamenti ex-TESLA/TTF dagli anni 90s
- Leadership mondiale riconosciuta nella progettazione di criostati a basso consumo statico per cavità acceleranti ad alto gradiente
  - Forniti a FNAL per la facility ILC/Project-X
  - Fornitura a KEK per S1-Global
  - Technical Area Group Leadership nel GDE per il TDR di ILC e primary author capitoli criomoduli
- Per XFEL supervisione della produzione del 25% dei moduli prodotti dalla E.Zanon

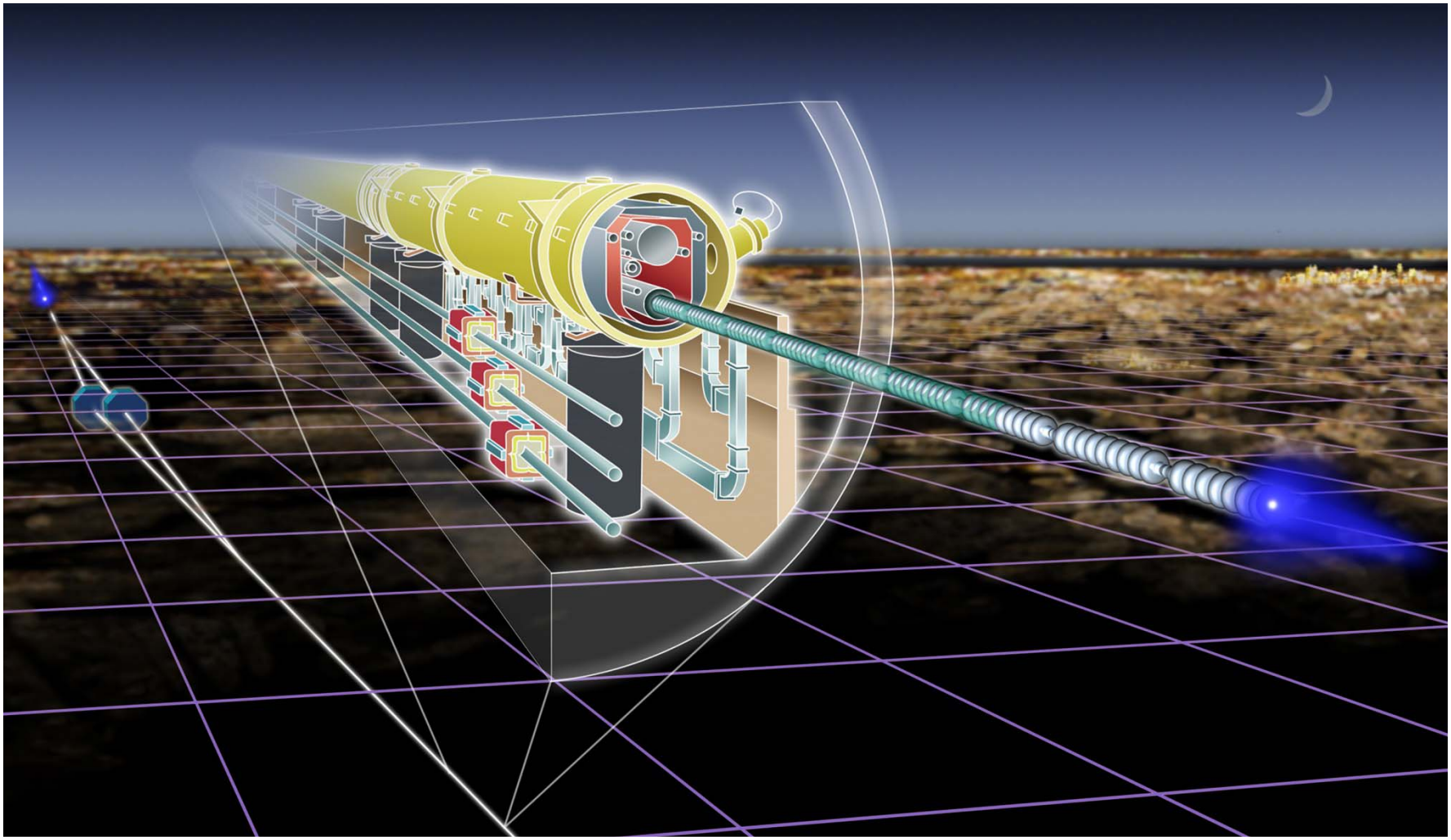
European XFEL

The INFN Cryomodule for XFEL & ILC



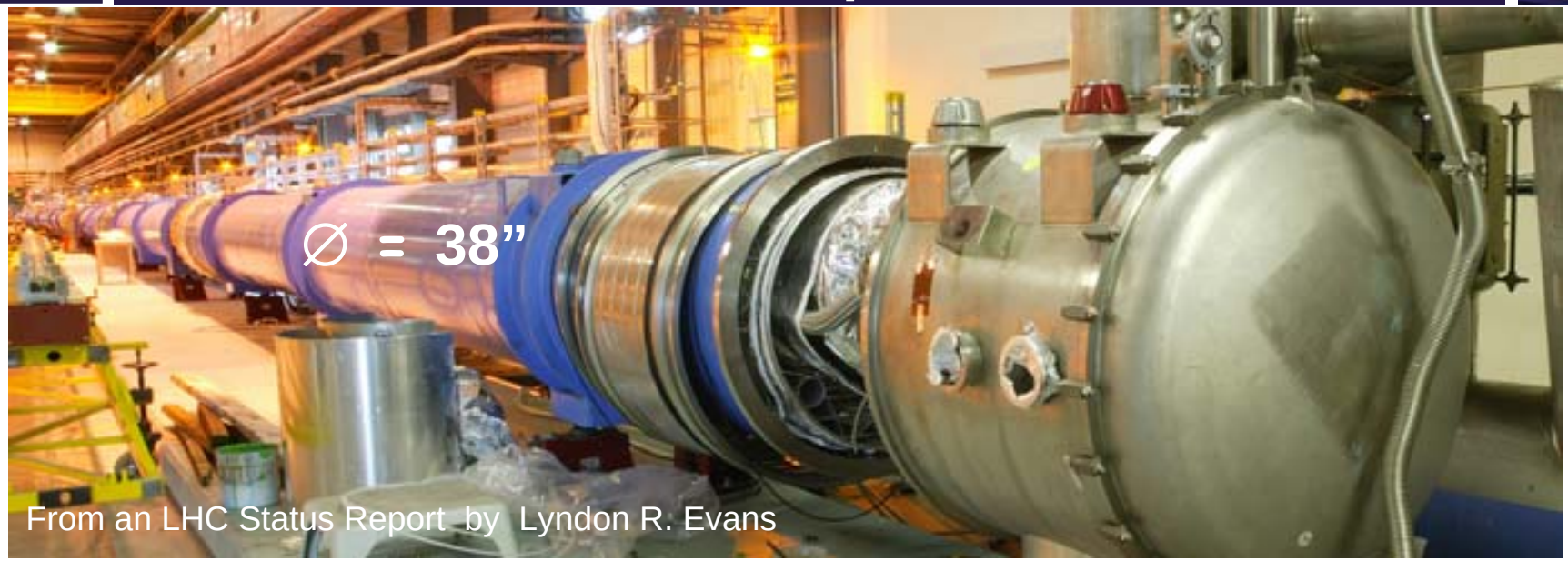
European XFEL

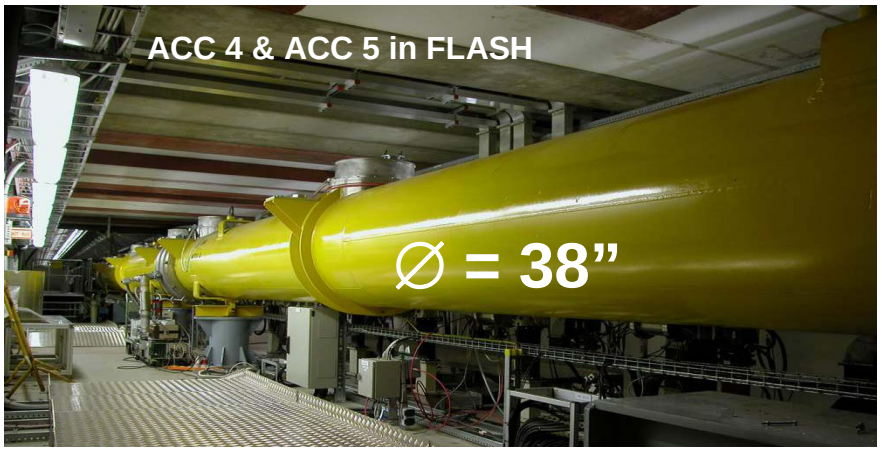
ILC Pictorial View

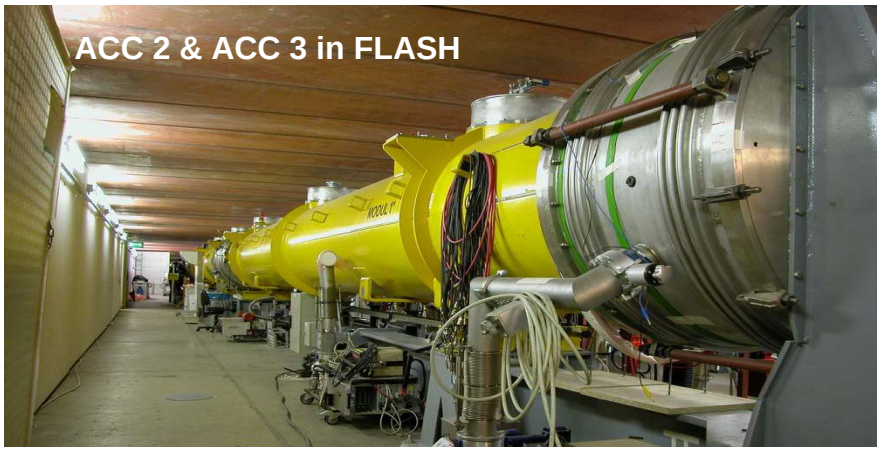


European XFEL

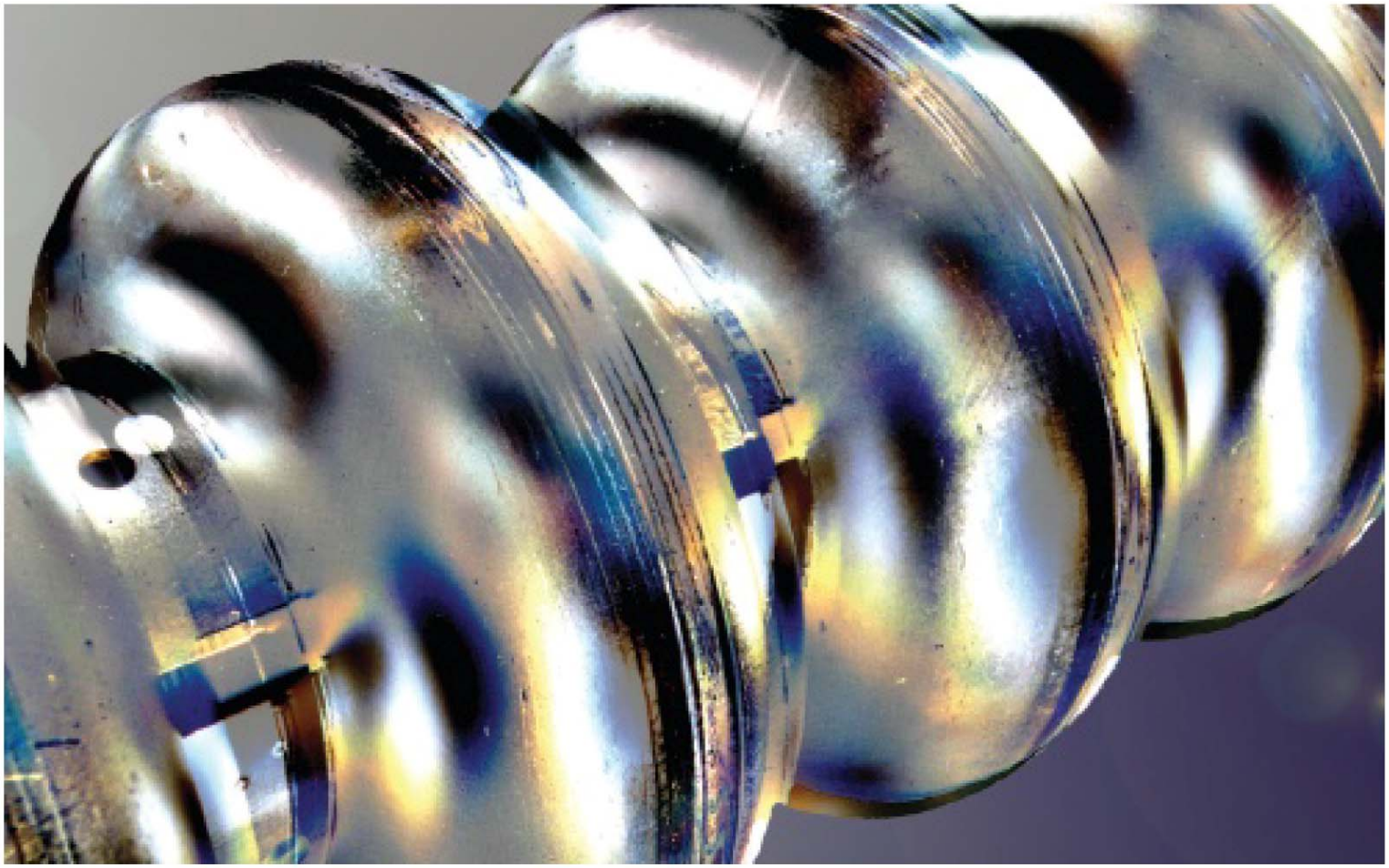
LCH and ILC Module Comparison



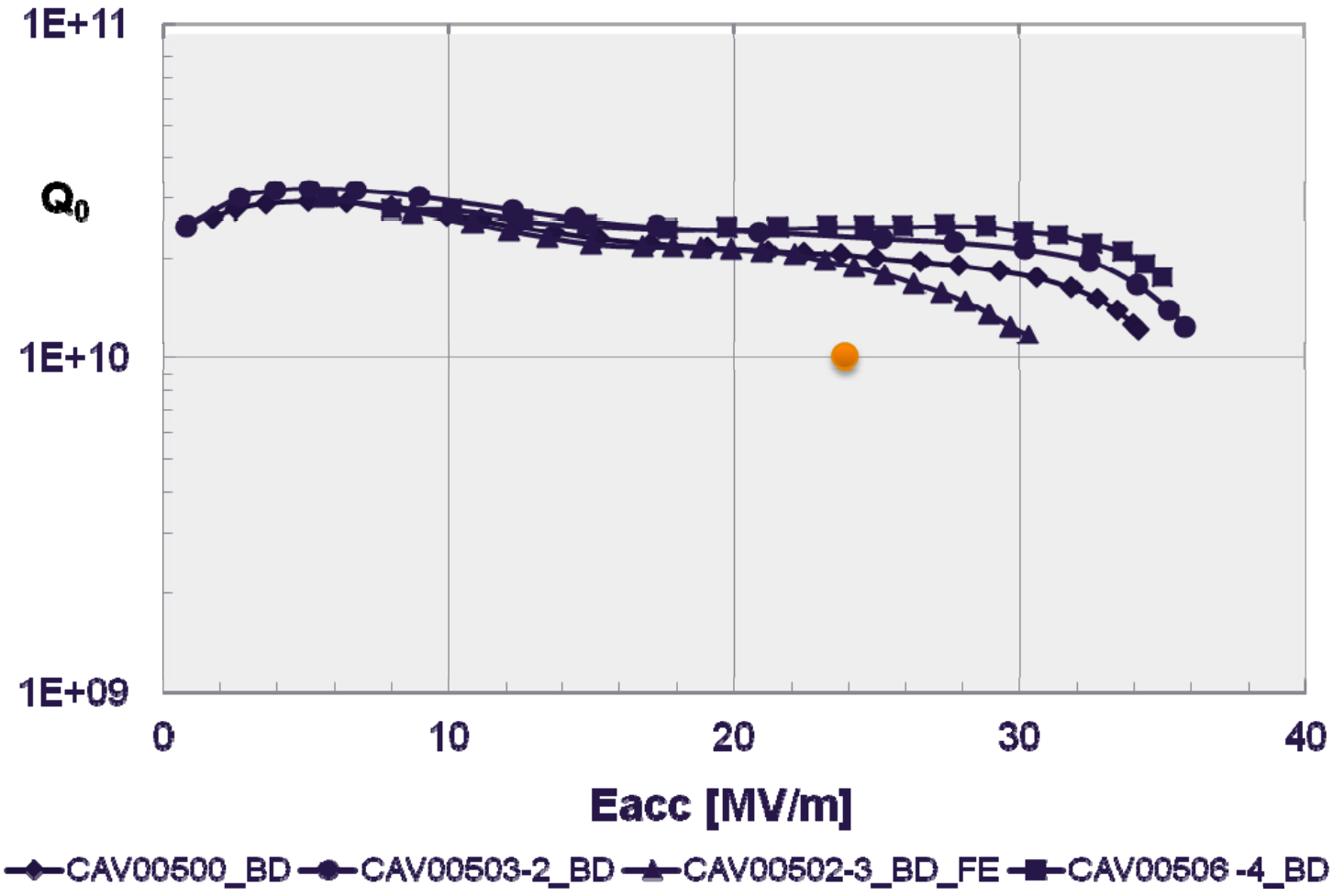




WP4: Cavità SC di accelerazione

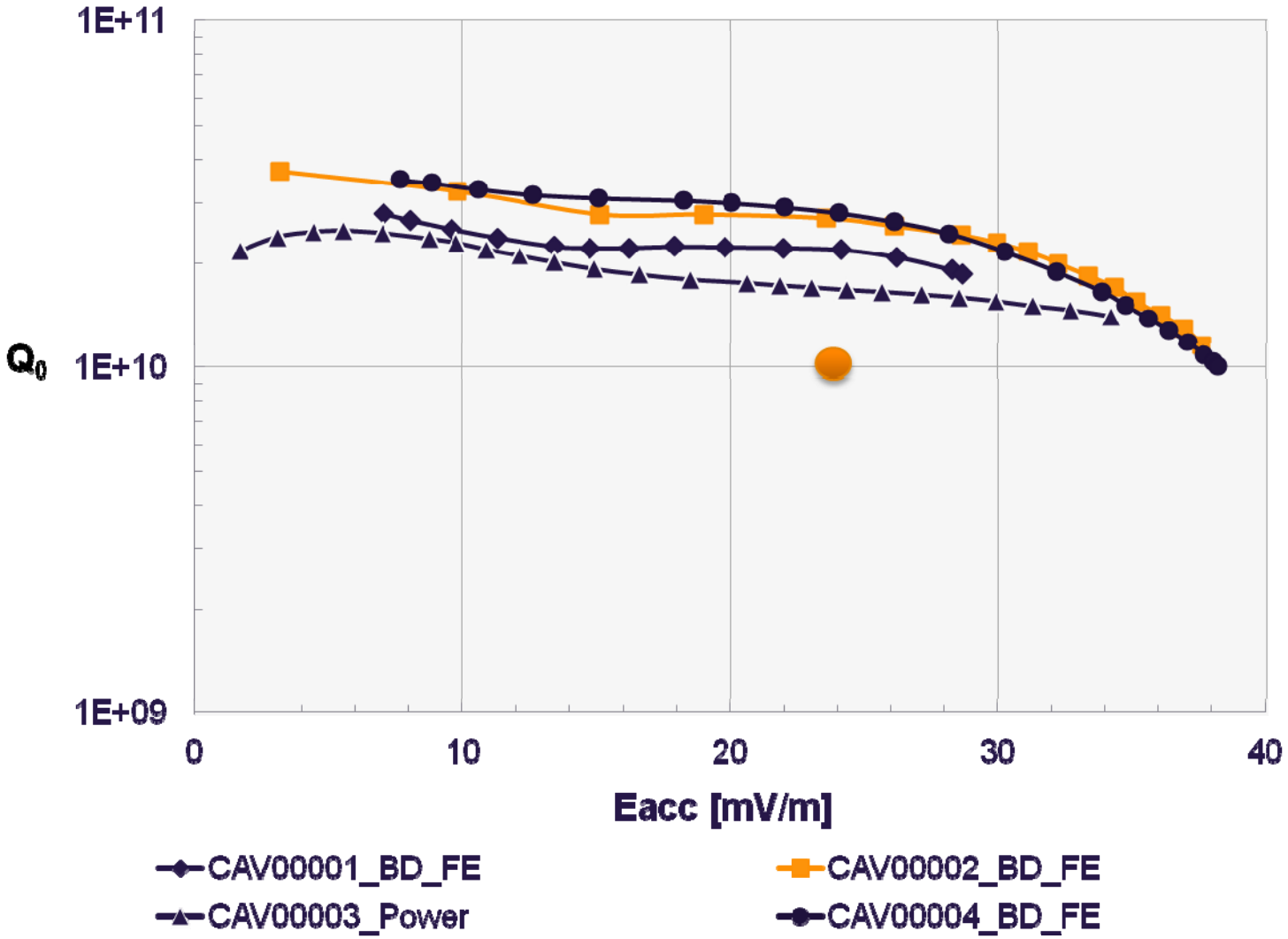


Status of EZ Reference Cavities: fabrication at EZ, treatment and RF test at DESY

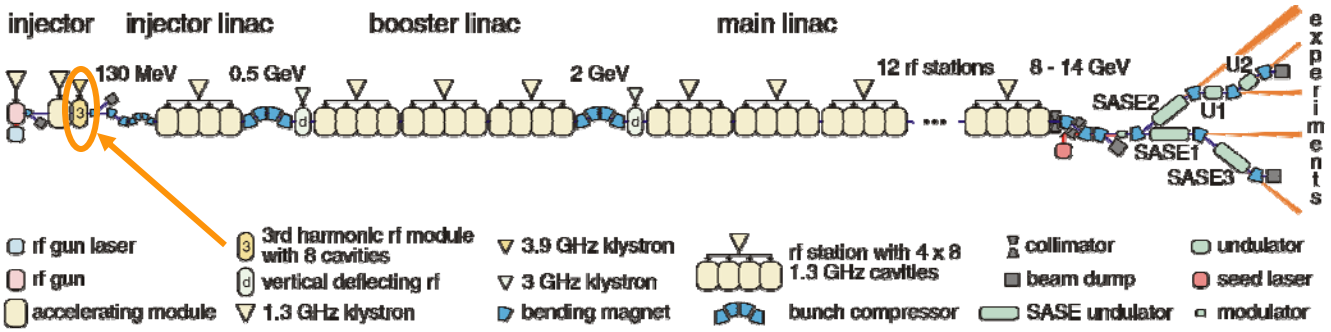


Infrastruttura presso ZANON

Status of 4 RI Reference Cavities: fabrication at RI, treatment and RF test at DESY



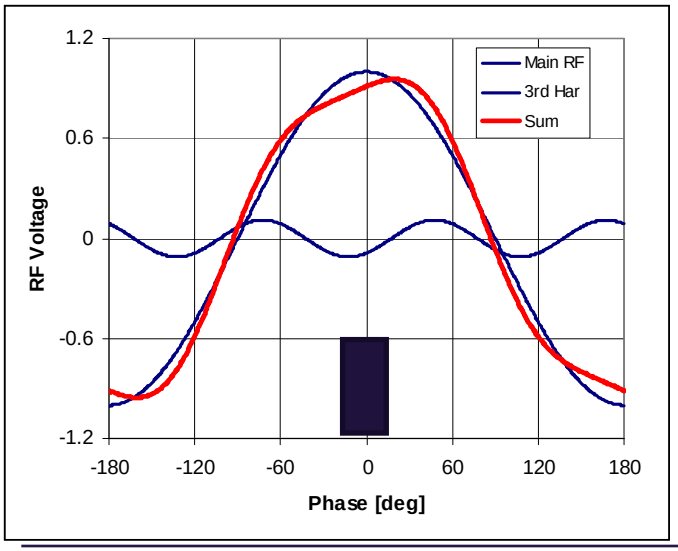
XFEL 3° Harmonic System

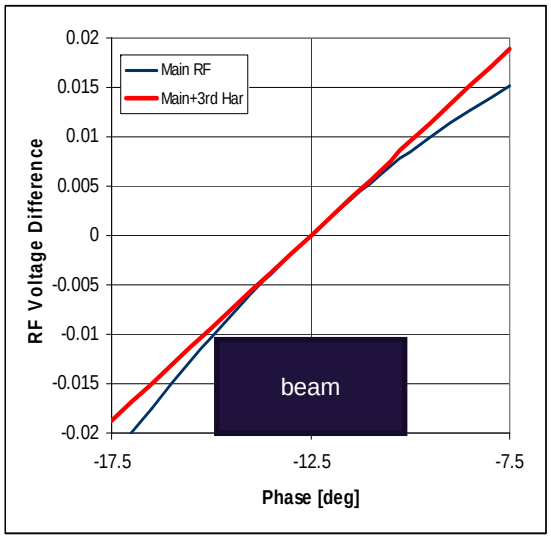


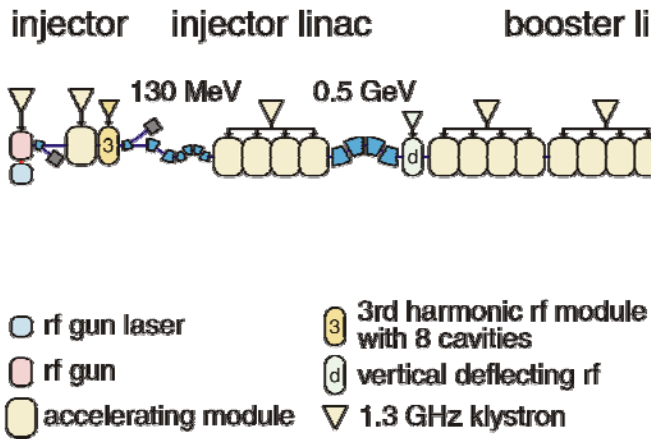
- 3.9 GHz RF system is right after injector module, before first bunch compressor
- Max 40 MV required in a 8 cavity module
  - Gradients are well within possible cavity/module performances (15 MV/m)
    - ➔ cavity active length 0.346 m
  - i.e. standard BCP treatment is sufficient for performance

XFEL 3° Harmonic System

- To preserve beam quality before compression
  - Linearize RF curvature effects
- Design, realization, test of the main components is an In-Kind Italian contribution to XFEL
  - WP46





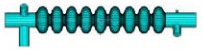
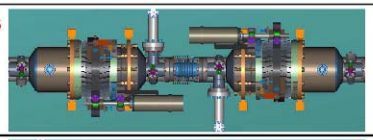
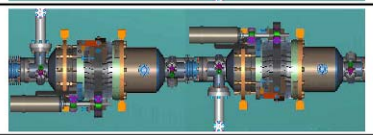
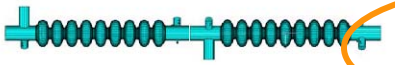


XFEL Cavity string layout: Coupler kicks

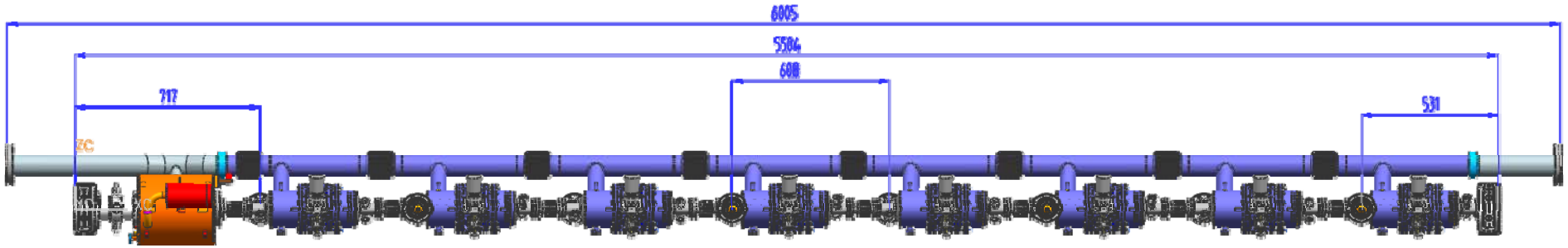
- Analysis of coupler kicks: one string configuration leads to compensation of offset independent kicks
  - Every 2° cavity rotated around longitudinal axis
  - Used in XFEL String
- Quad at module entrance
  - control both planes

M. Dohlus, DESY

summary – complex coupler kick:

cav		a,b arbitrary: $d_0 = d_0(a,b),\cdots$ $V_x^{(n)}(x,y) \approx d_0 + d_x x + d_y y$ $V_y^{(n)}(x,y) \approx f_0 + f_x x + f_y y$
cav+mirror-z		SW: a=b, (equal for sub-structures) $V_x^{(\Sigma,n)}(x,y) \approx 2i\,\mathrm{Im}\{d_0 + d_x x + d_y y\}$ $V_y^{(\Sigma,n)}(x,y) \approx 2i\,\mathrm{Im}\{f_0 + f_x x + f_y y\}$
cav+rot | y-axis		SW: a=b, (equal for sub-structures) $V_x^{(\Sigma,n)}(x,y) \approx 2\,\mathrm{Re}\{d_0\} + 2i\,\mathrm{Im}\{d_x\}x + 2\,\mathrm{Re}\{d_y\}y$ $V_y^{(\Sigma,n)}(x,y) \approx 2i\,\mathrm{Im}\{f_0\} + 2\,\mathrm{Re}\{f_x\}x + 2i\,\mathrm{Im}\{f_y\}y$
cav+mirror-y		a,b arbitrary (but equal for sub-str.) $V_x^{(\Sigma,n)}(x,y) \approx 2d_x x$ $V_y^{(\Sigma,n)}(x,y) \approx 2f_0 + 2f_y y$
cav+rot | z-axis		a,b arbitrary (but equal for sub-str.) $V_x^{(\Sigma,n)}(x,y) \approx 2d_x x + 2d_y y$ $V_y^{(\Sigma,n)}(x,y) \approx 2f_x x + 2f_y y$

from http://www.desy.de/~dohlus/2007/2007.07.ckick/ckick2.pdf



Work share within WP46

- Split between INFN-DESY (48%-52%) in-kind contributions
- **Very rough** splitting of work:
  - INFN
    - Design/procure: **cavities, tuners, cryomodule**
    - **Vertical testing** of all cavities, @ LASA
    - Join assembly/test @ DESY (up to commissioning)
  - DESY
    - Procurement of **quad/couplers/power RF** and controls
      - and **"standard"** 1.3 GHz components...
    - Power **RF testing** (horizontal/module test) @ DESY
    - Most **infrastructural work** for module assembly/testing and installation (besides VT)

INFN: Main deliverables to WP46

- Qualification and characterization of component prototypes
  - Cavity design and supervision of DESY procurement
  - Qualification of the 3 «naked» prototypes in VT
    - ➔ All tested > once: 1 @ specs/1 to retest (setup wrong)/1 lowish Q
    - ➔ Used for setup of the preparation and testing infrastructure
  - Design and completion of the 3 prototype dressed cavities for horizontal testing
    - ➔ Tank design/fabrication/tendering and integration to cavities
    - ➔ Tuner design (Evolution of the «slim» ILC type)
    - ➔ Participation to horizontal tests at DESY

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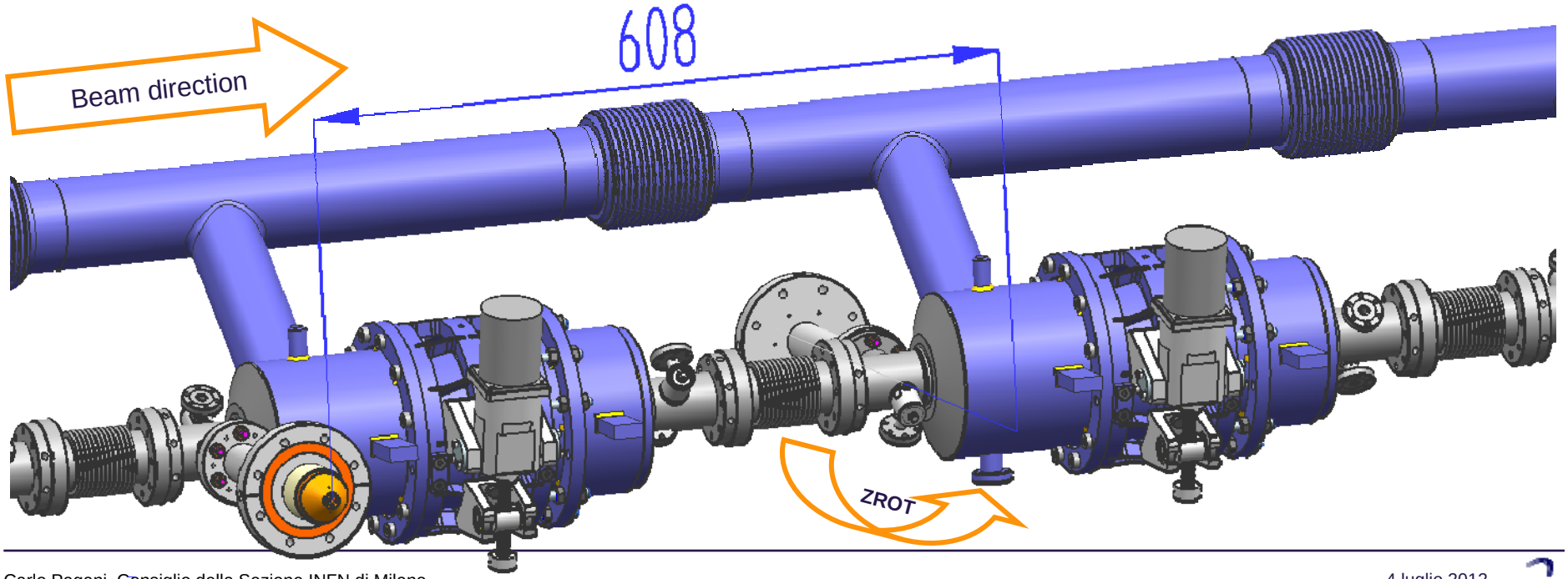
INFN: Main deliverables to WP46 (continued)

- Design, tendering, procurement of main components for 3H
  - String of dressed cavity
    - VT at INFN for qualification (20 MV/m @ 3 10^9)
    - Complete with tank integration and cold tuning mechanism
    - Participation to horizontal testing at DESY
    - Participation to string assembly
  - 3H cryomodule
    - vessel
    - cold mass
    - intercavity bellows
    - magnetic shields
- Participation to installation and commissioning of 3H System

String layout with alternating couplers

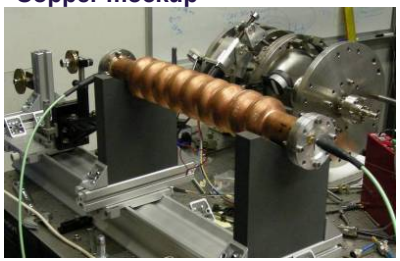
- Due to alternating couplers requirement and to the position of the 2-phase pipe there are two dressed cavity configurations (left and right)
- Blade tuner updated to the “slim” type, concept derived from ILC tuner work by INFN. Lighter, cheaper, motor to the side.



Setting of fabrication/treatment procedures

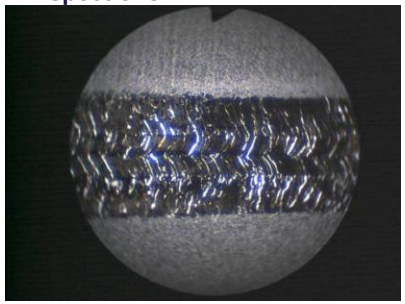
RF “parts”

Copper mockup



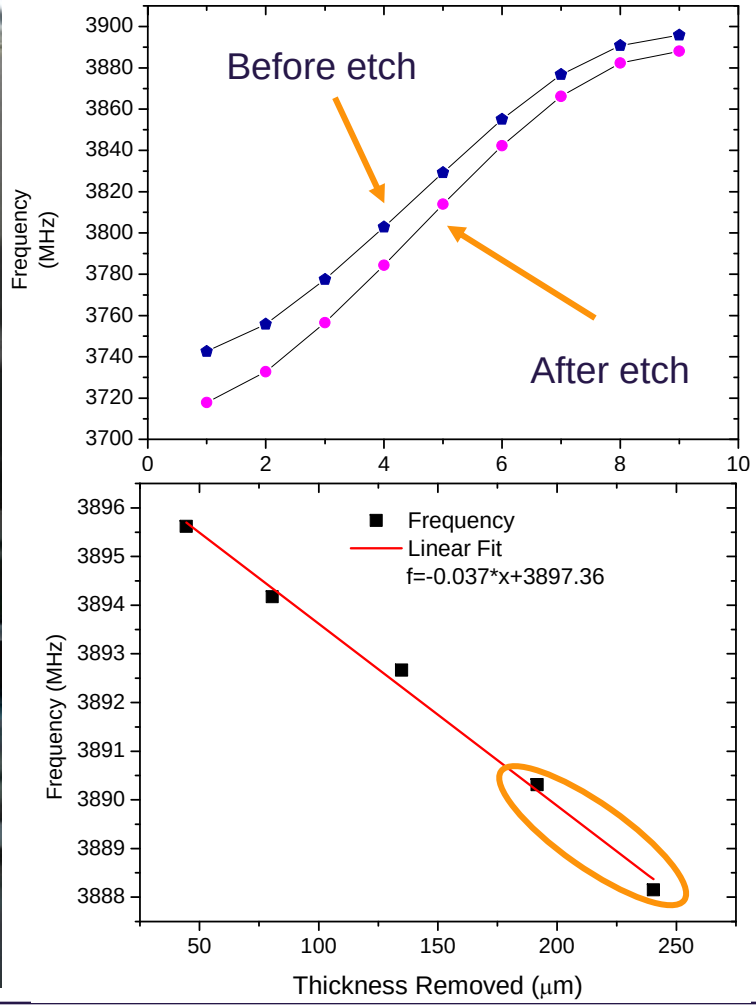
Full Nb mockup

Inspections



BCP Cabinet

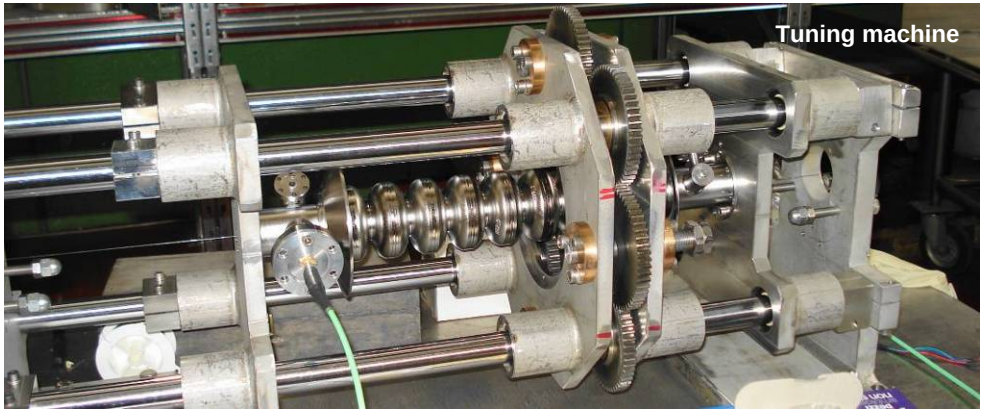
Analysis, derivation of sensitivity coefficients and comparison with FNAL experience



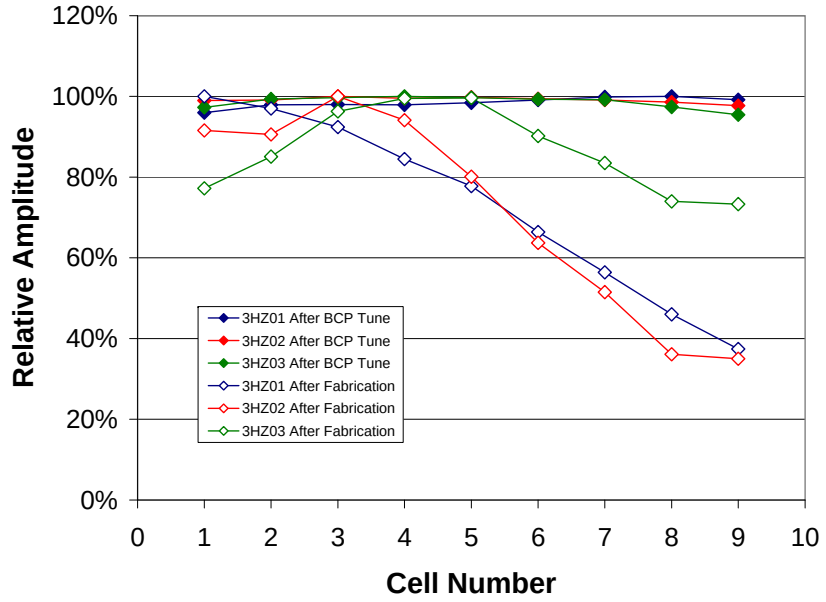
Field Flatness tuning, waiting for tests

- Prepared to FF (>95%)
  - After fabrication, 800°C, bulk 150 um BCP, missing last 20 um
  - within <0.3 mm length(!)

	Frequency, MHz	Length, mm
3HZ01	3894.033	506.20 (+0.22)
3HZ02	3893.965	505.88 (-0.10)
3HZ03	3894.199	506.30 (+0.31)

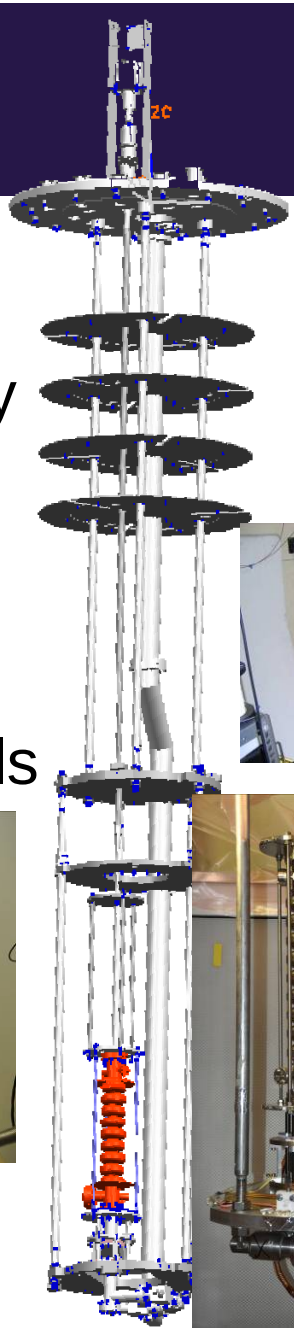


	Before last chemistry			After Fabrication		
Cell #	3HZ01	3HZ02	3HZ03	3HZ01	3HZ02	3HZ03
1	0.960	0.990	0.973	1.000	0.916	0.772
2	0.979	0.991	0.994	0.970	0.906	0.851
3	0.980	1.000	0.997	0.924	1	0.963
4	0.979	0.995	1.000	0.845	0.941	0.995
5	0.984	0.998	0.997	0.778	0.801	0.996
6	0.991	0.994	0.993	0.664	0.637	0.902
7	0.999	0.991	0.992	0.564	0.515	0.835
8	1.000	0.986	0.974	0.460	0.361	0.74
9	0.992	0.977	0.954	0.374	0.35	0.733
Flatness	**96.0%**	**97.7%**	**95.4%**	**37.4%**	**35.0%**	**73.6%**



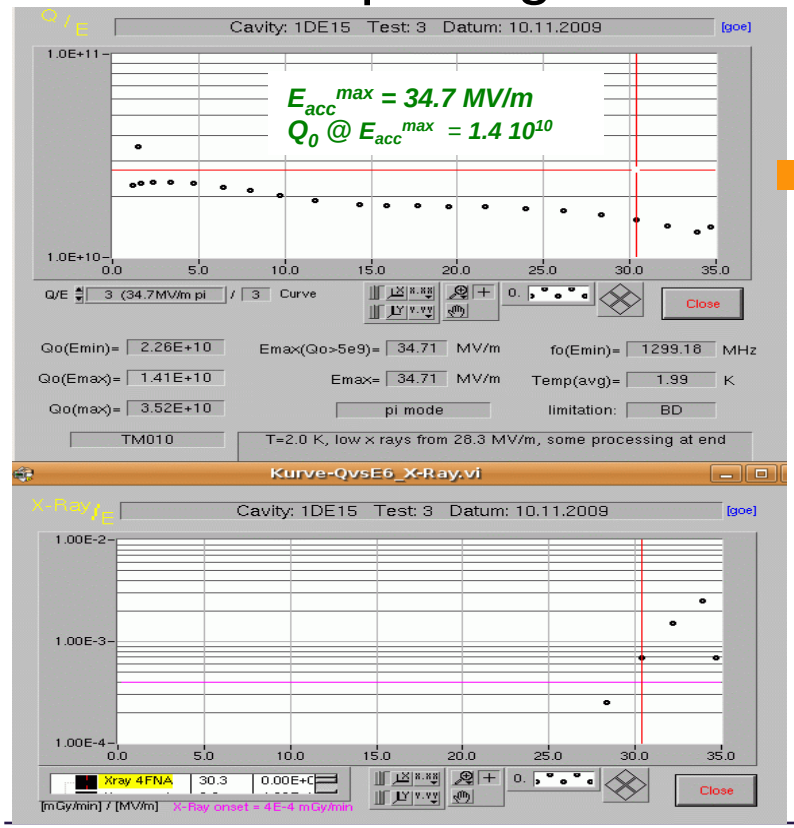
VT area status @ LASA

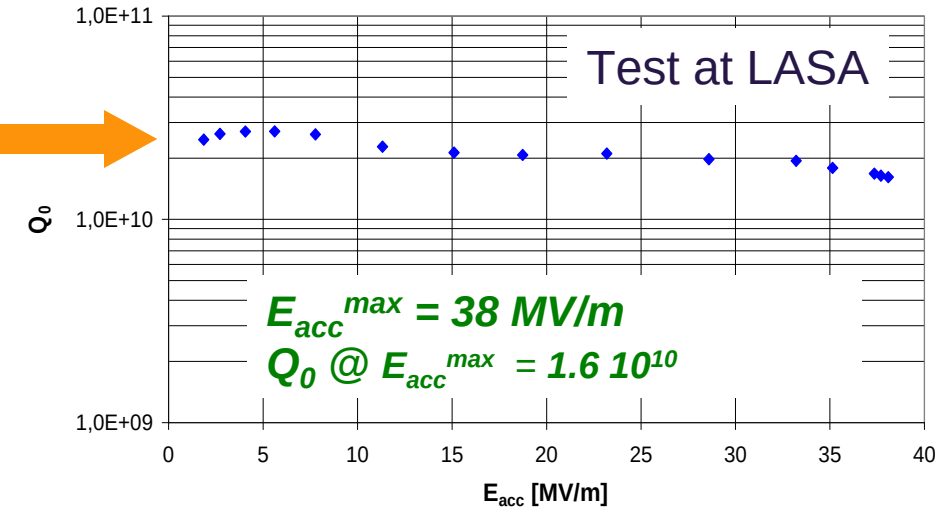
- **Test of all 3.9 GHz cavities at INFN**
- Existing 500-700 MHz Vertical Test Facility
  - Undergone cryogenic refurbishment
    - → 18 W @ 2 K / 10 W @ 1.8 K
    - → less than 1 W in static conditions
  - Adapted VT insert to 1.3 GHz single cells and 3.9 GHz cavities
  - New RF hardware
    - → 100 W at 1.3 GHz
    - → 200 W at 3.9 GHz
- Clean room (9m^2), UPW plant and HPR **under qualification for operation**

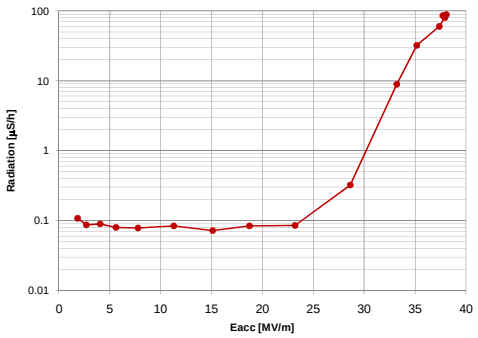


Qualification of test stand

- Calibrated at LASA with 1.3 GHz prepared by DESY
  - "as-received", without opening it, for the VT debuggin
  - after opening and rinsing with HPR

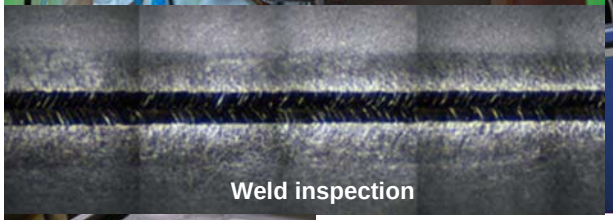


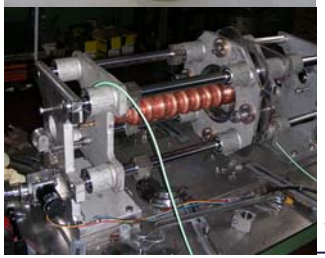


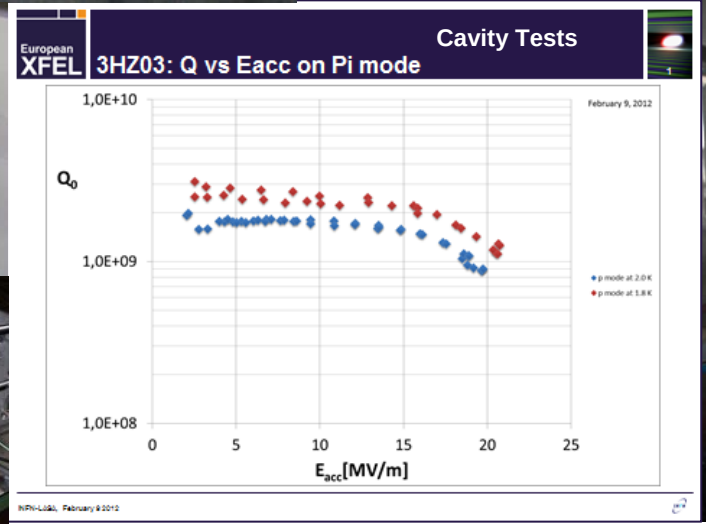


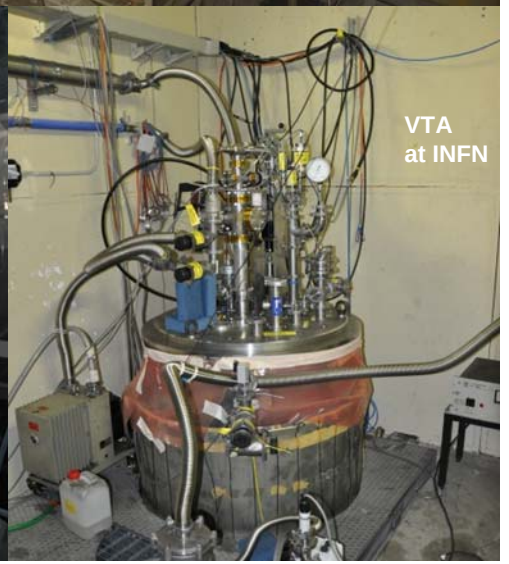
✓ *Completed*
- ✓ *Cryo OK*
- ✓ *RF OK*
- ✓ *DAQ OK*
- ✓ *HPR OK*

INFN: Work on prototypes and VT preparation



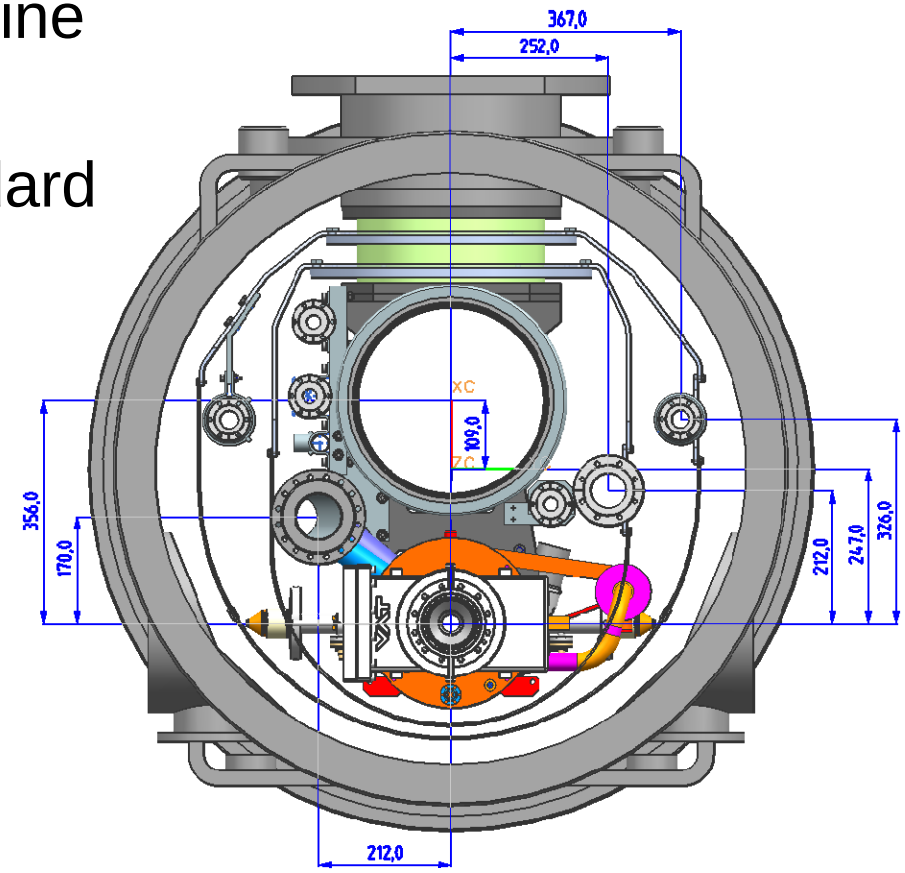




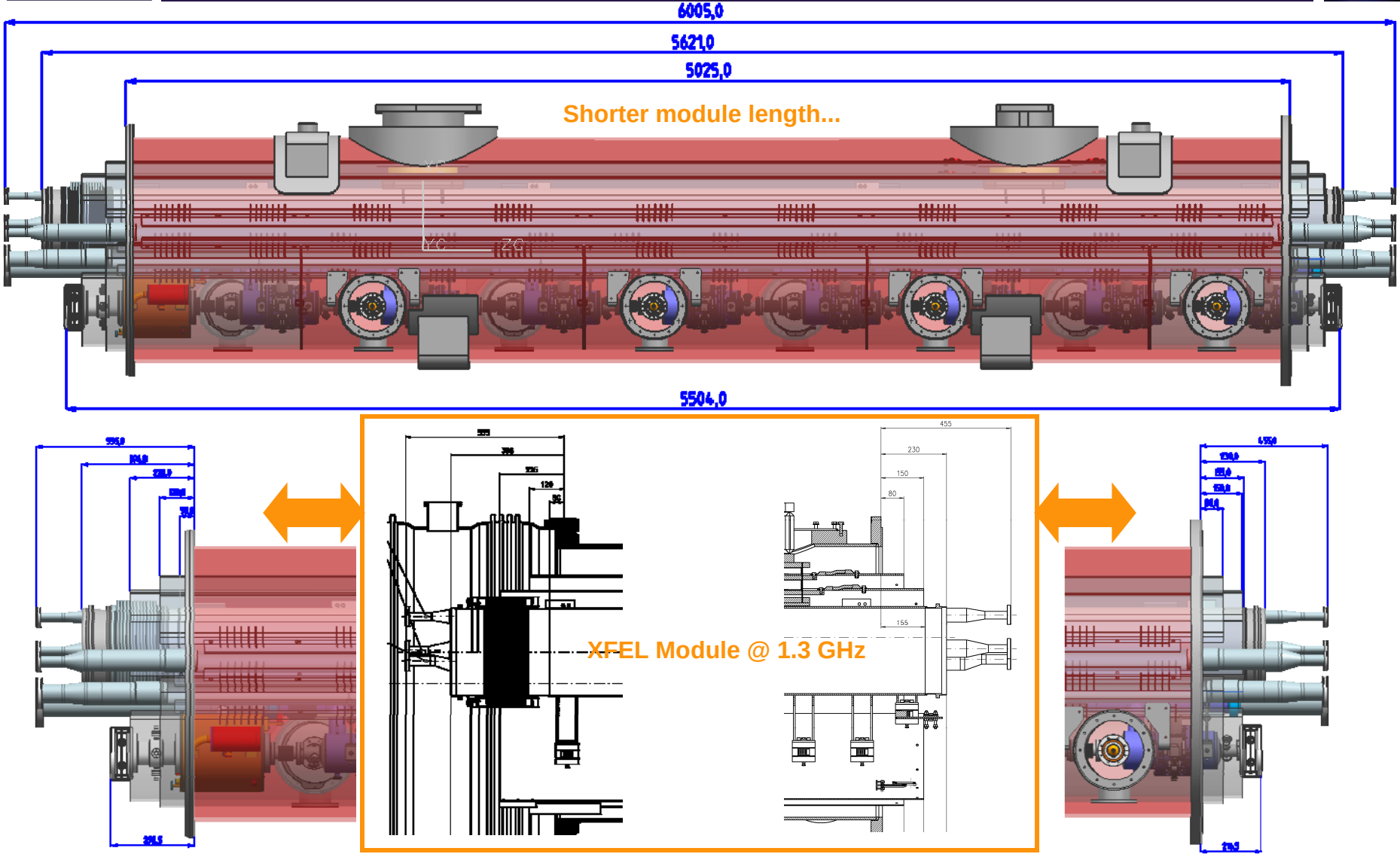


XFEL 3.9 Cryomodule design: transverse layout

- Design is "**Plug compatible**" with Type III+/XFEL modules
  - Identical transverse X-section for all cryo piping
- Module part of the same cryo line with the injector module
  - Adapts at interfaces of standard cryo components
- Shorter module/string lengths
- All cryo piping in the same relative position with respect to beam axis
- **3D models >90% complete**
  - **drawing packages for CFT**



Longitudinal interfaces preserved as in ML



String and module assembly

- DESY Hall III clean room and assembly area will be used for the 3.9 GHz string and module assembly
  - adaptations for cavity, string and cold mass handling are required

Time Schedule/Milestones

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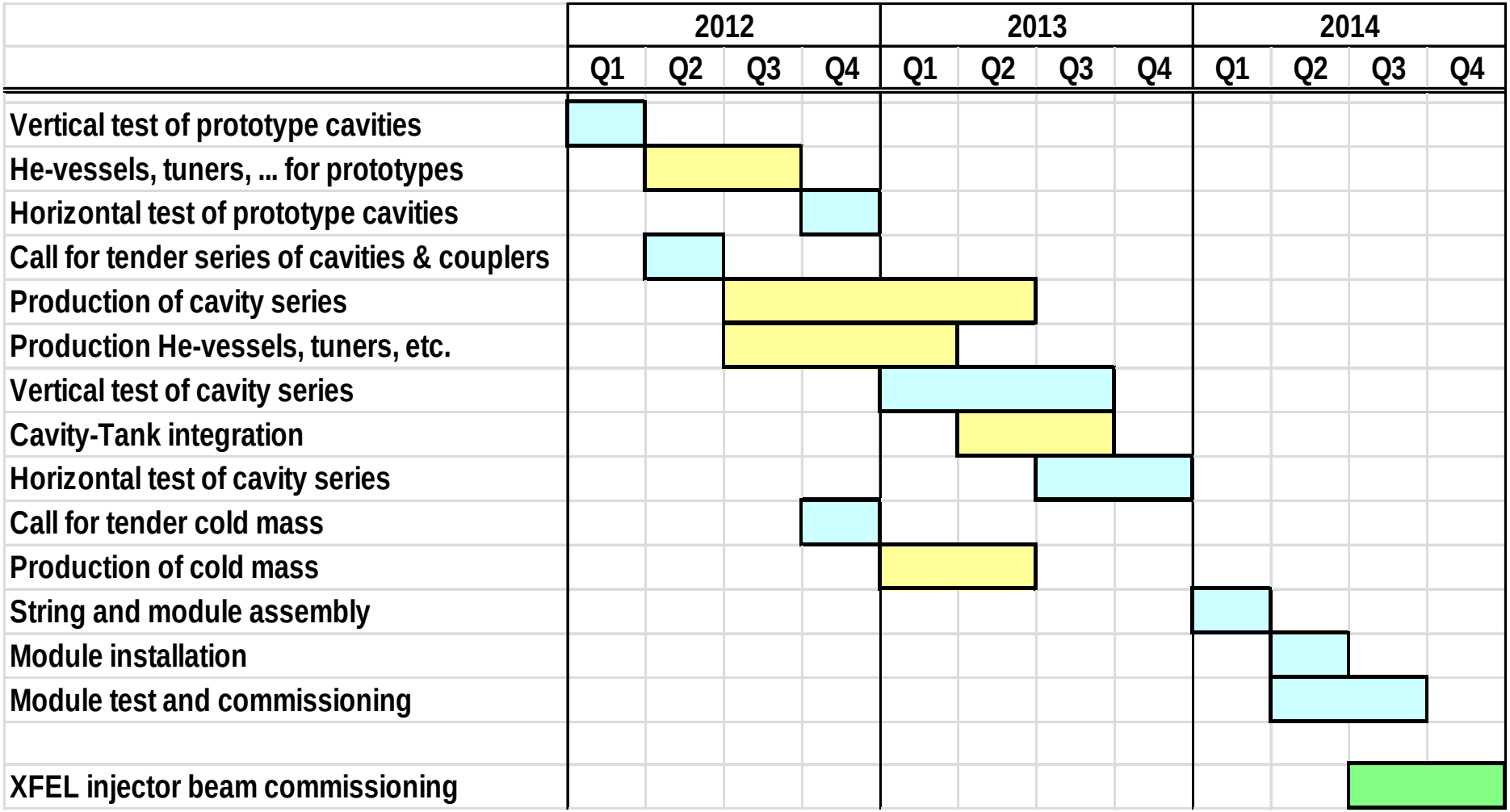

Value of WP46 EoI

- Overall value is 6230 k€, 2005 BB values
  - 3288 k€ investment, 36.6 FTE (at 80.4 k€/FTE)
  - INFN: 3050 k€, DESY: 3180 k€

	Task or Part	INFN-LASA		DESY	
		Invest k€	FTE	Invest k€	FTE
1	Cavities: design & certification, material, fabrication and treatments for cavities	669,22	5,7	0,0	0,0
2	Cavity String: assembly infrastructure preparation, cavity dressing with tanks	127,62	3,3	120,00	1,2
3	Input Couplers: procurement, conditioning and assembly	4,00	0,1	631,00	3,8
4	HOM Couplers and Absorbers: HOM line and absorber	20,00	0,5	51,00	0,6
5	Cavity Tuners: mech. components, motors, drive electronics	88,00	1,6	27,70	0,1
6	String Components: Vacuum, Diagnostics, Magnet, …	12,36	0,0	78,19	0,7
7	Cryostat: design & certification, procurement, preparation of assembly infr.	320,00	5,6	10,00	0,8
8	Power RF: waveguides, klystron, modulator, …	0,00	0,0	491,36	1,5
9	RF Controls (LLRF)	0,00	0,0	105,75	0,0
10	HOM BPM: Development and electronics	0,00	0,0	129,00	3,4
11	Testing: Vertical Tests & Horizontal Tests of cavities and CMTB module tests	201,40	3,2	201,40	4,5
	Total	**1442,6**	**20,0**	**1845,4**	**16,6**

Budget 2005, no V.A.T., FTE according to «XFEL standard»

Anagrafica XFEL 2013

	NTA-ILC	
RICERCATORI	**3,84**	**FTE**
Bellomo	40,00%	
Michelato	91,67%	
Pagani	100,00%	
Pierini	61,11%	
Sertore	91,67%	
TECNOLOGI	**1,92**	**FTE**
Bosotti	91,67%	
Monaco	100,00%	
Paparella		
TECNICI	**2,00**	**FTE**
Bonezzi	100%	
Fusetti	100%	
R&T	**5,76**	
T	**2,00**	

- + 3 Assegni di ricerca in bando
- + altri contratti da definire (ingegneri)