ISTITUTO NAZIONALE DI FISICA NUCLEARE

CSN5

Massimo Carpinelli

CSN5 Budget and FTE 2011

CSN5 Sector	FTE	Budget (k€)
Detectors, Electronics and Computing	172	1512
Accelerators and Related Technologies	88	802
Interdisciplinary Physics	341	1335

CSN5 Budget and FTE 2012

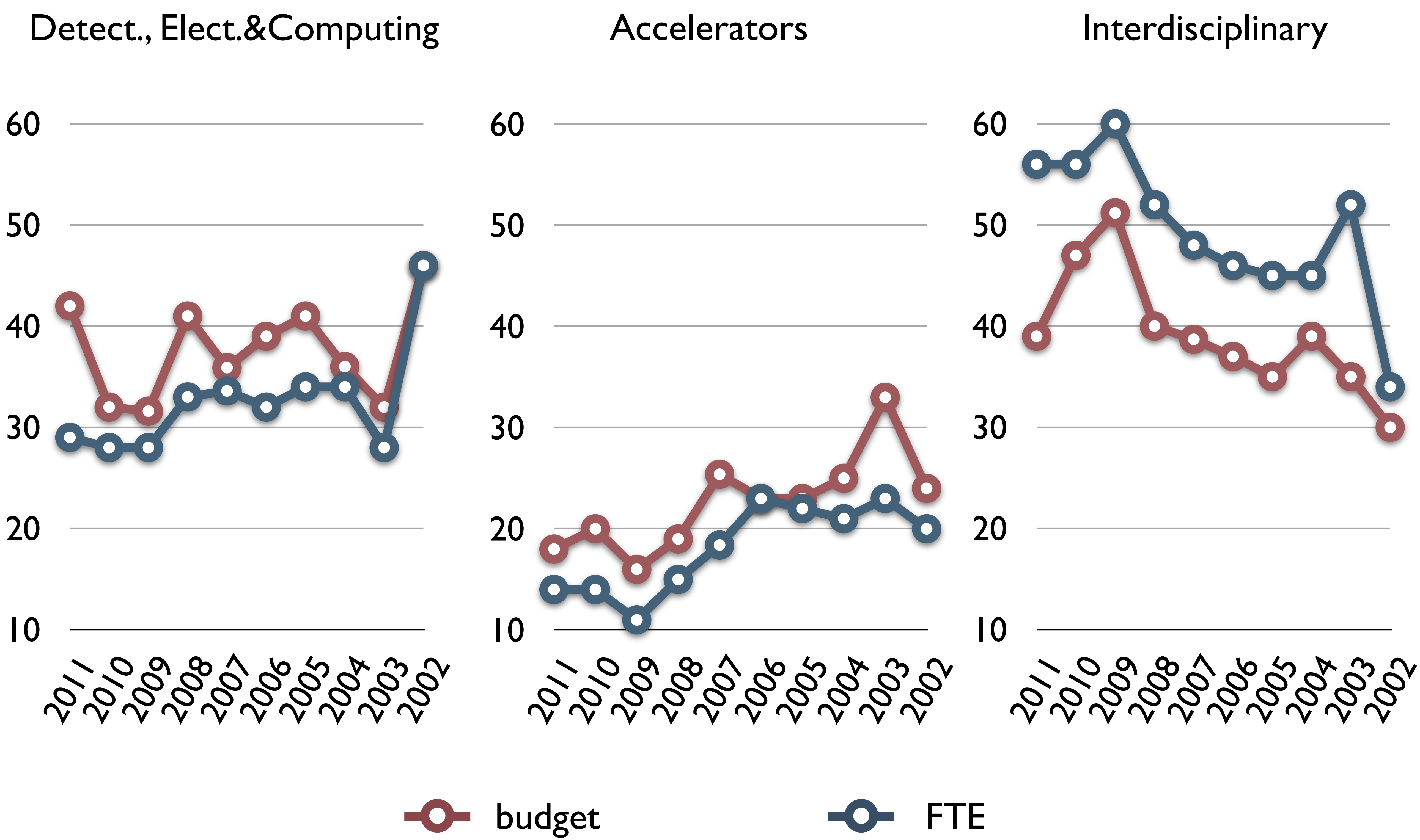
CSN5 Sector	FTE	Budget (k€)
Detectors, Electronics and Computing	164	1466
Accelerators and Related Technologies	81	753
Interdisciplinary Physics	308	1331

CSN5 products analyis 2011

GLV5: L. Catani, N. Randazzo, G. Bisogni

13/07/2012

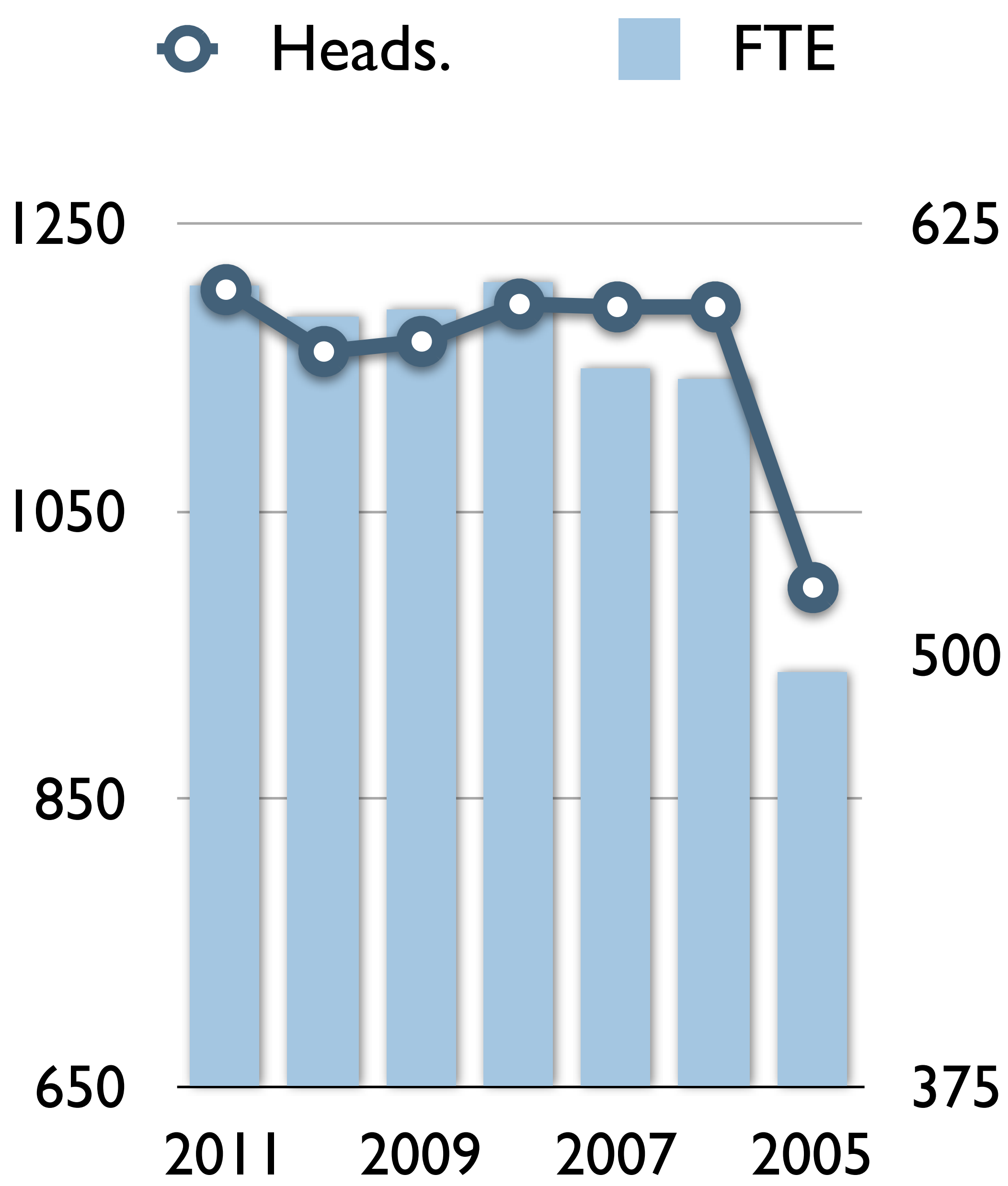
CSN5 research lines
FTE&budget.vs.year

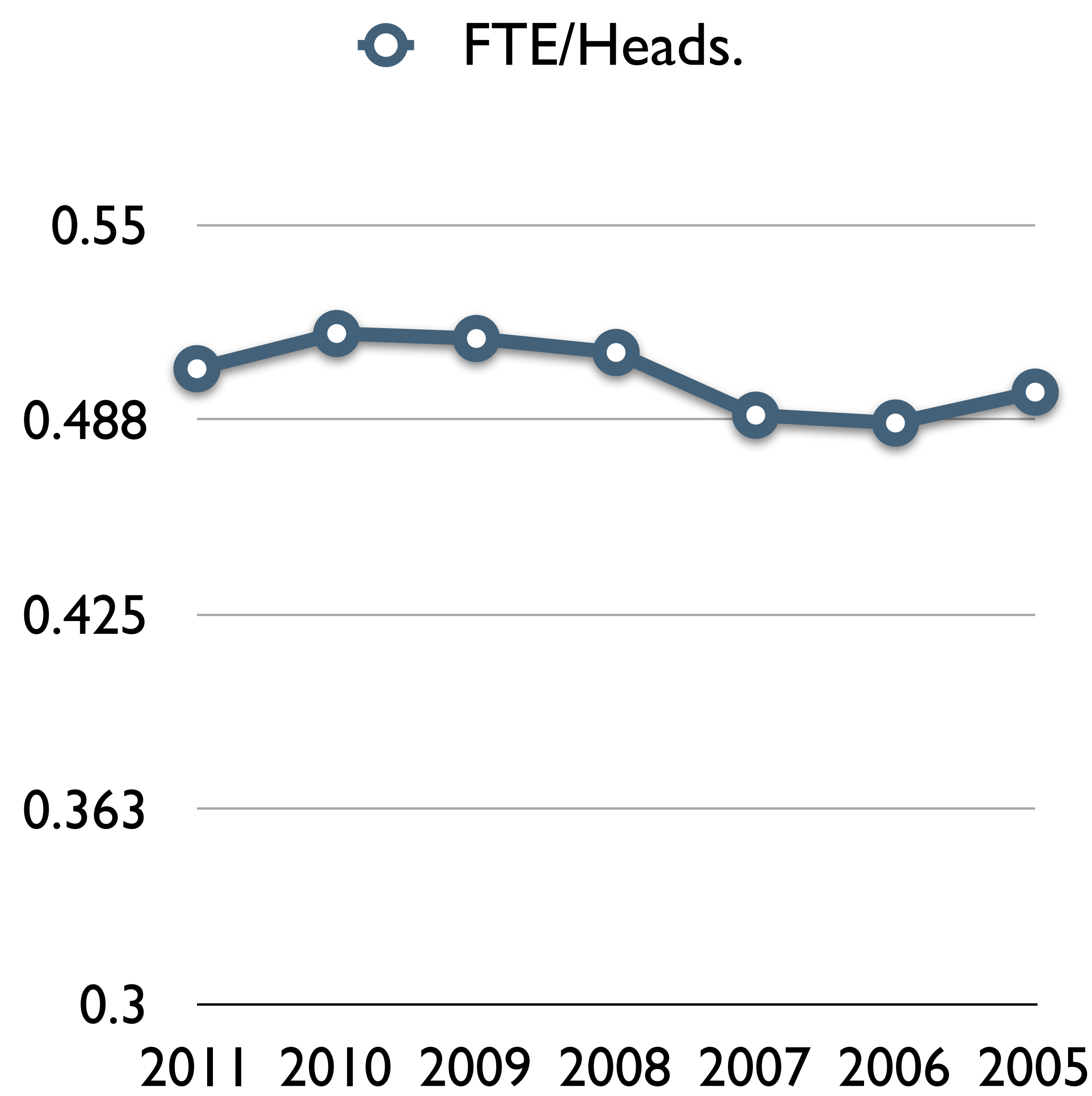


Summary 2011

FTE	607
Heads	1204
Publications	361
Pubb/FTE	0.59
<IF>	1.72
<Prop.INFN>	0.57
Talks at Intern. Conf.	361
Milestones' fulfillment	86%

FTE.vs.year


Heads.
FTE
1250
1050
850
650
625
500
375
2011
2009
2007
2005

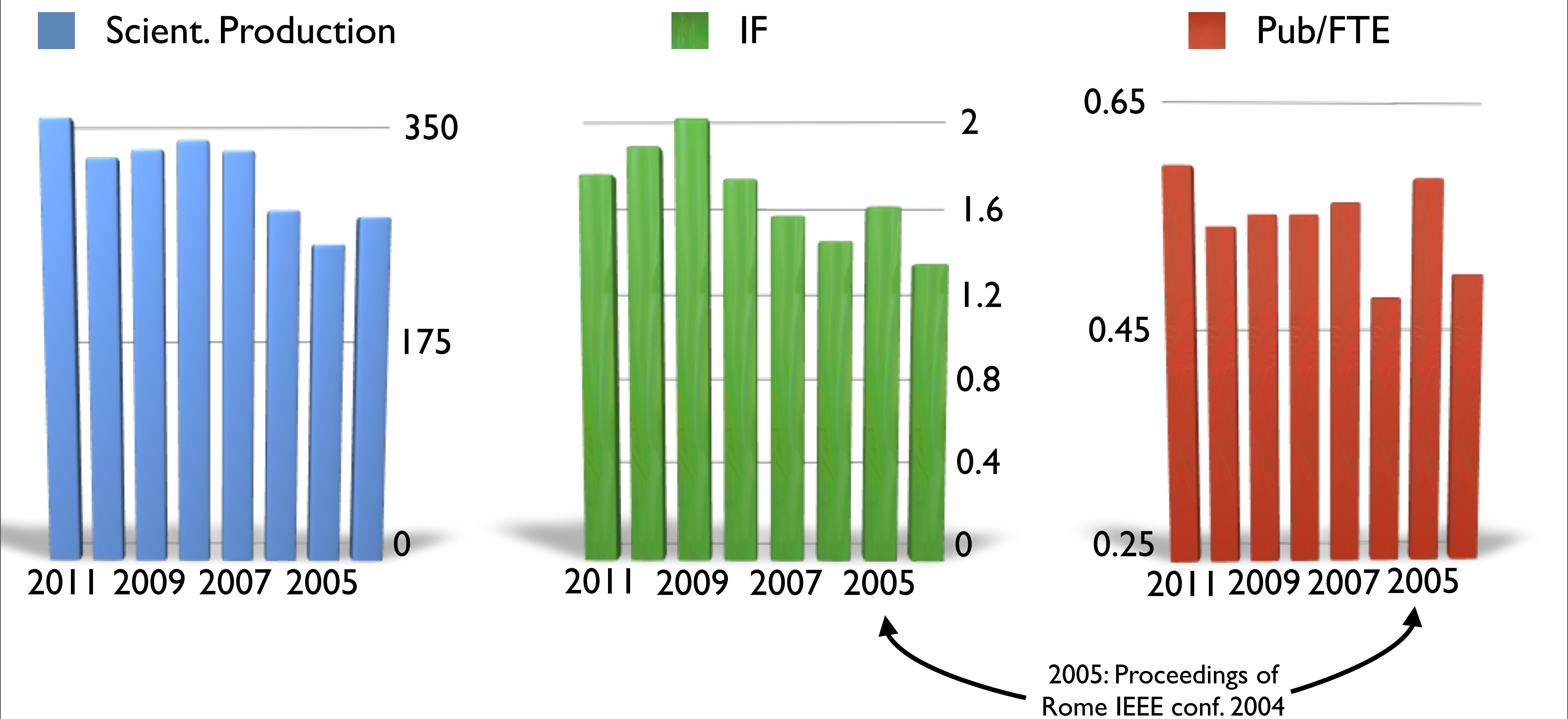

FTE/Heads.
0.55
0.488
0.425
0.363
0.3
2011
2010
2009
2008
2007
2006
2005

IF.vs.year & Pub/FTE.vs.year

335 pubblication in 2011

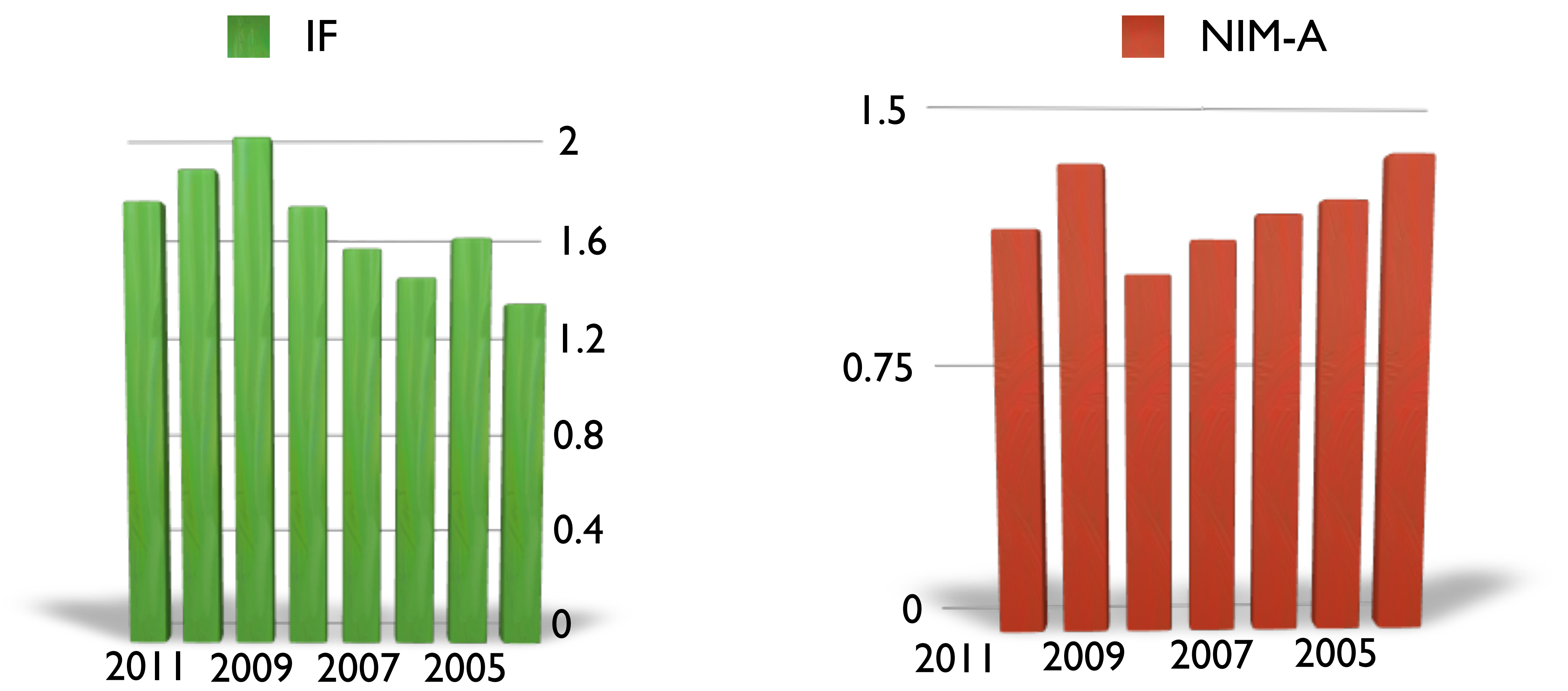
0.56 Pubb/FTE

<IF>=1.72



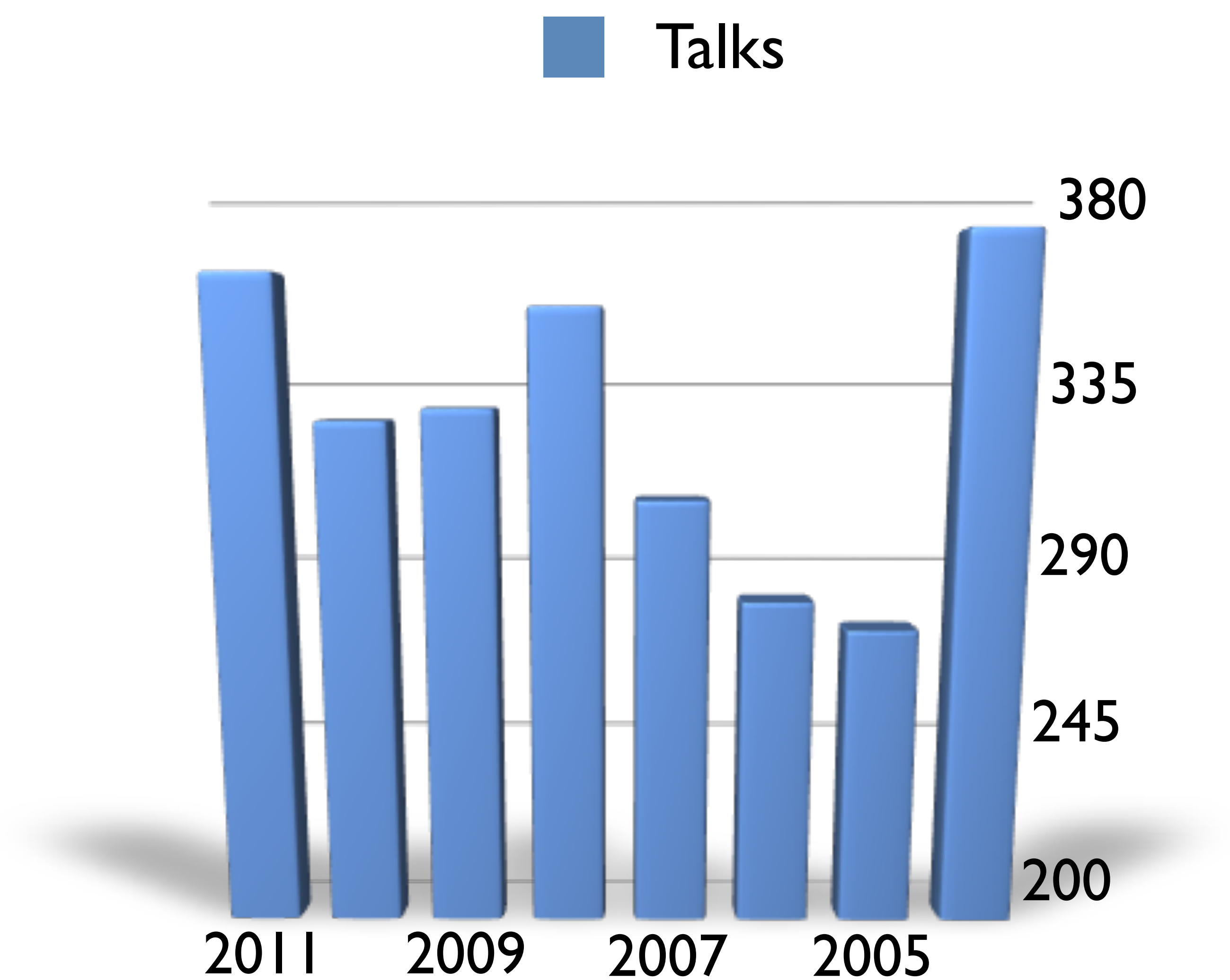
IF.vs.year & IF NIM-A

check for correlations with journals' IF trends



Talks@Intern.Conf.vs.year

361 talks internazionali (no SIF etc.)



Rome IEEE conf. 2004

European Projects submitted since10/2010

- ERC SyG/IDEAS 4
- ERC Advanced Grant 2
- ICT 3
- FP7-People 2
- FP7-SPA 2 (1 successfully)
- ASI 1

Issues

- The Average age of researchers is rather high.
- The number of big scientific enterpises, that often drive R&D, is decreasing.
- European Projects and external (to INFN) funding.
- Technology/Kwnoledge transfer.
- High cost of R&D requires synergy with other CSN

INFN

Research areas

- Roughly speaking two kind of experiments live in CSN5:
- Core HEP, that is R&D finalized to bigger experiment of CSN 1,2,3,4 and R&D for accelerators
- Interdisciplinary, that is research applied to medicine, biology, cultural heritage, environment..

INFN

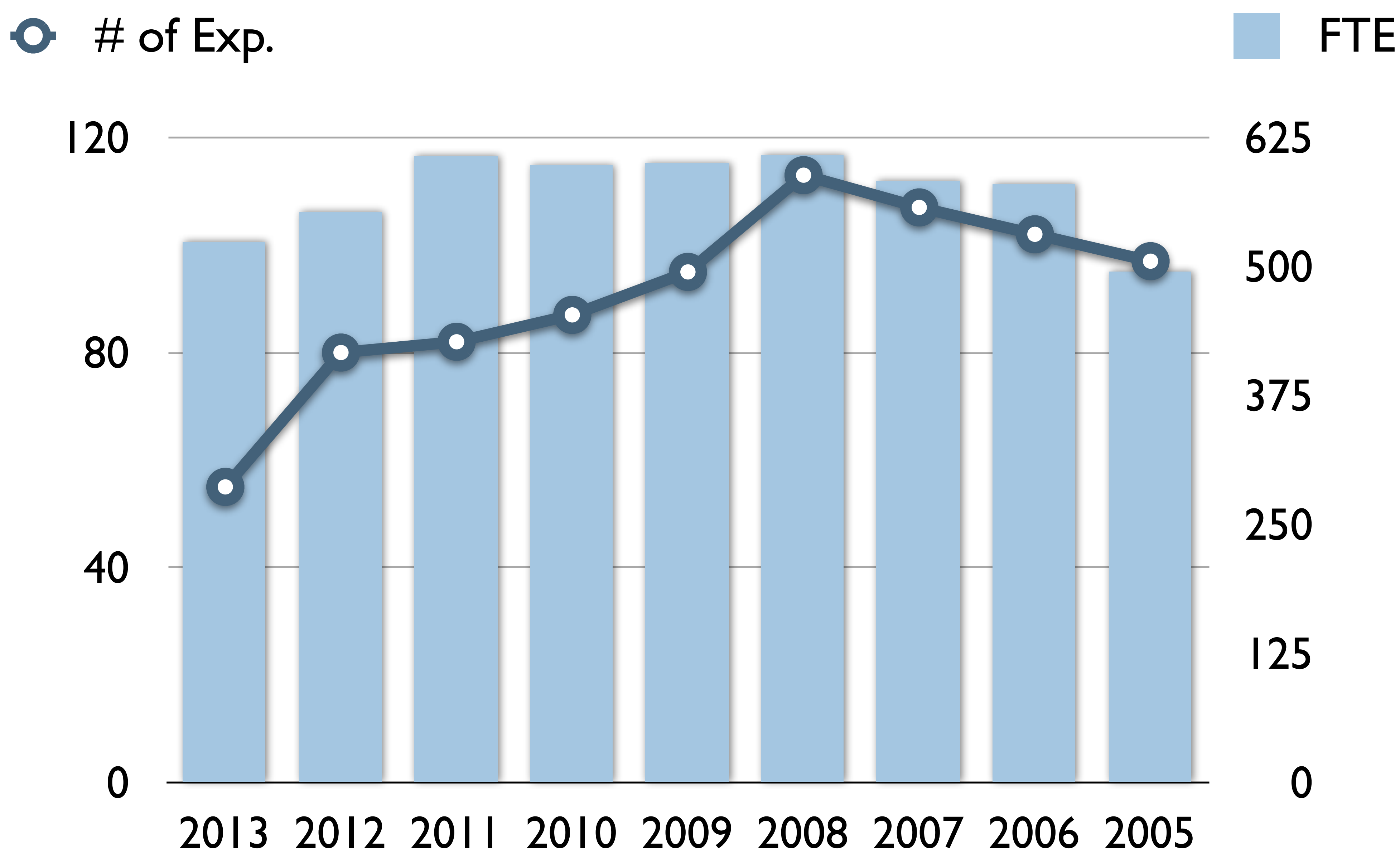
Non-core experiment

- Well defined interest of non INFN institutions (doctors,cultural heritge autorities,etc)
- Ability to attract external funding
- High technology
- INFN expertise well defined and in evidence

Core experiments

- The R&D should be limited in time
- It should be a proof of principle for bigger R&D in other CSN X
- High technology
- R&D of greater “risk”

de-fragmenting CSN5



Bottom up vs top down

- We have decided to implement a “call” oriented approach, in which the research area or the specific R&D is defined by the CSN and the researchers compete for the funding

Bottom up vs top down

- We still want to keep some space for small high quality proposal outside the “call”
- We have to decide the fraction of the budget to be assigned to the two different approach
- A case study will be tested during next year with a limited budget

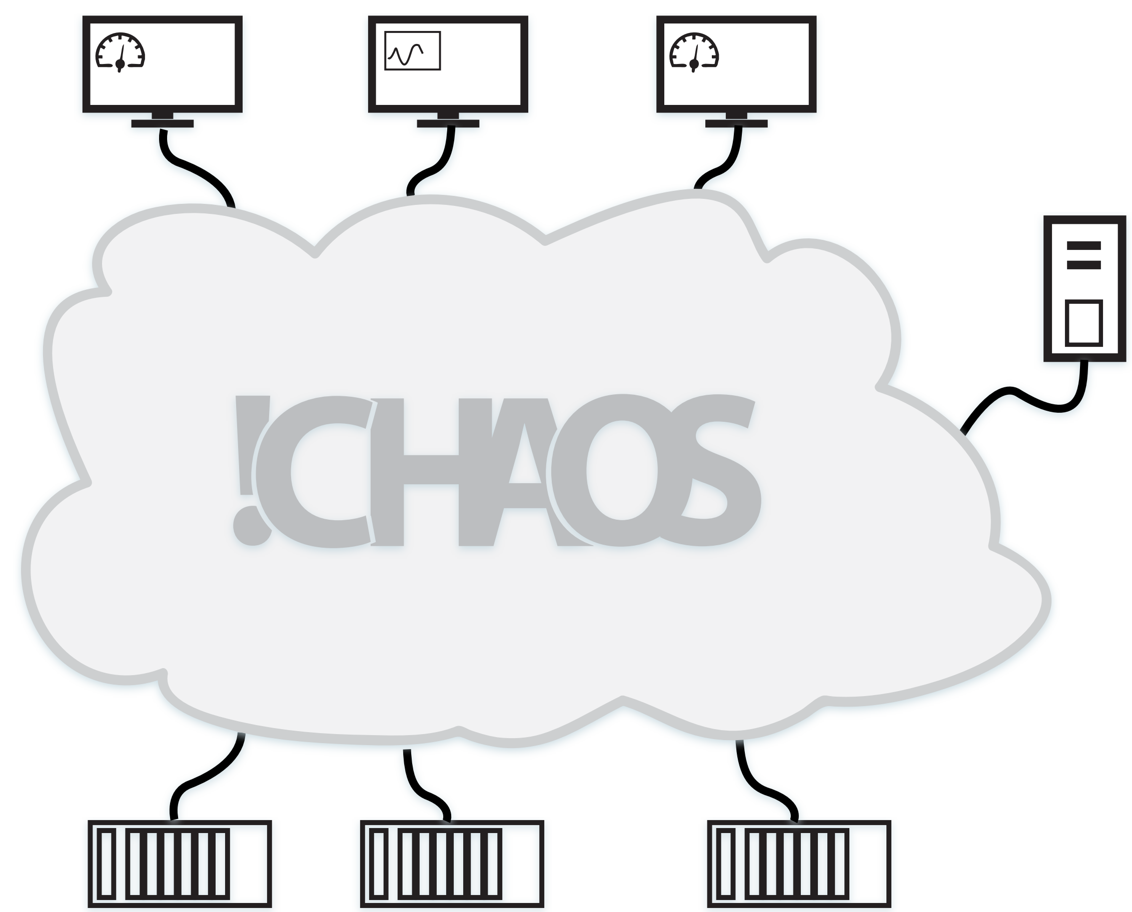
Highlights

!CHAOS

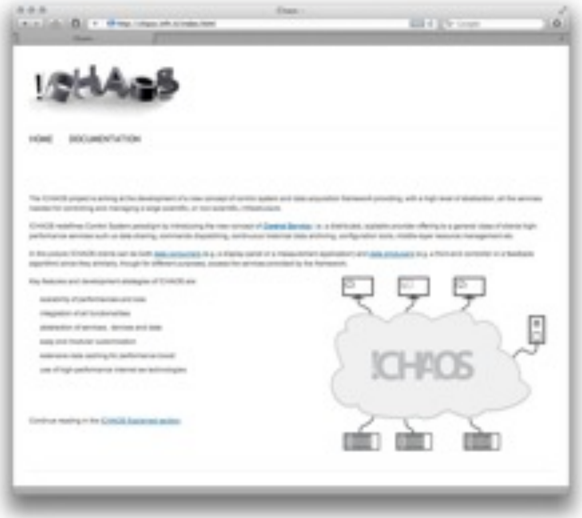
- Area:Electronic&Computing
- Spokesperson:L.Catani (Roma2)
- RM2,LNF

!CHAOS

- aims at the development of a control system for INFN future accelerators and large apparatuses
- introduces a breaking through paradigm based on high performance internet technologies
- profits from INFN long tradition of control systems for particle accelerators, expertise in computing and information technologies
- can be a complement for future INFN interdisciplinary projects
- generates opportunities for collaborations with industries and technology transfer



- !CHAOS launch workshop at LNF (Dec. 2011)
- evaluation release (`!CHAOS_beta_0.1`) ready to download from website
- !CHAOS established as **`Open Source project`** of INFN
- candidate Control System for SuperB accelerator and for slow-controls of experimental apparatus
- collaboration with National Instruments for integration of LabVIEW in !CHAOS
  - NI-!CHAOS meeting at LNF (March 2012)
  - invited at Big Physics Symposium (Zurich - March 2012)
- collaborations with italian industries (agreements for joint developments in preparation)
- academic collaborations: Univ. Roma TV (Fac. Informatica e Ingegneria), Politecnico di Bari, Università di Cagliari (Fac. Ingegneria)

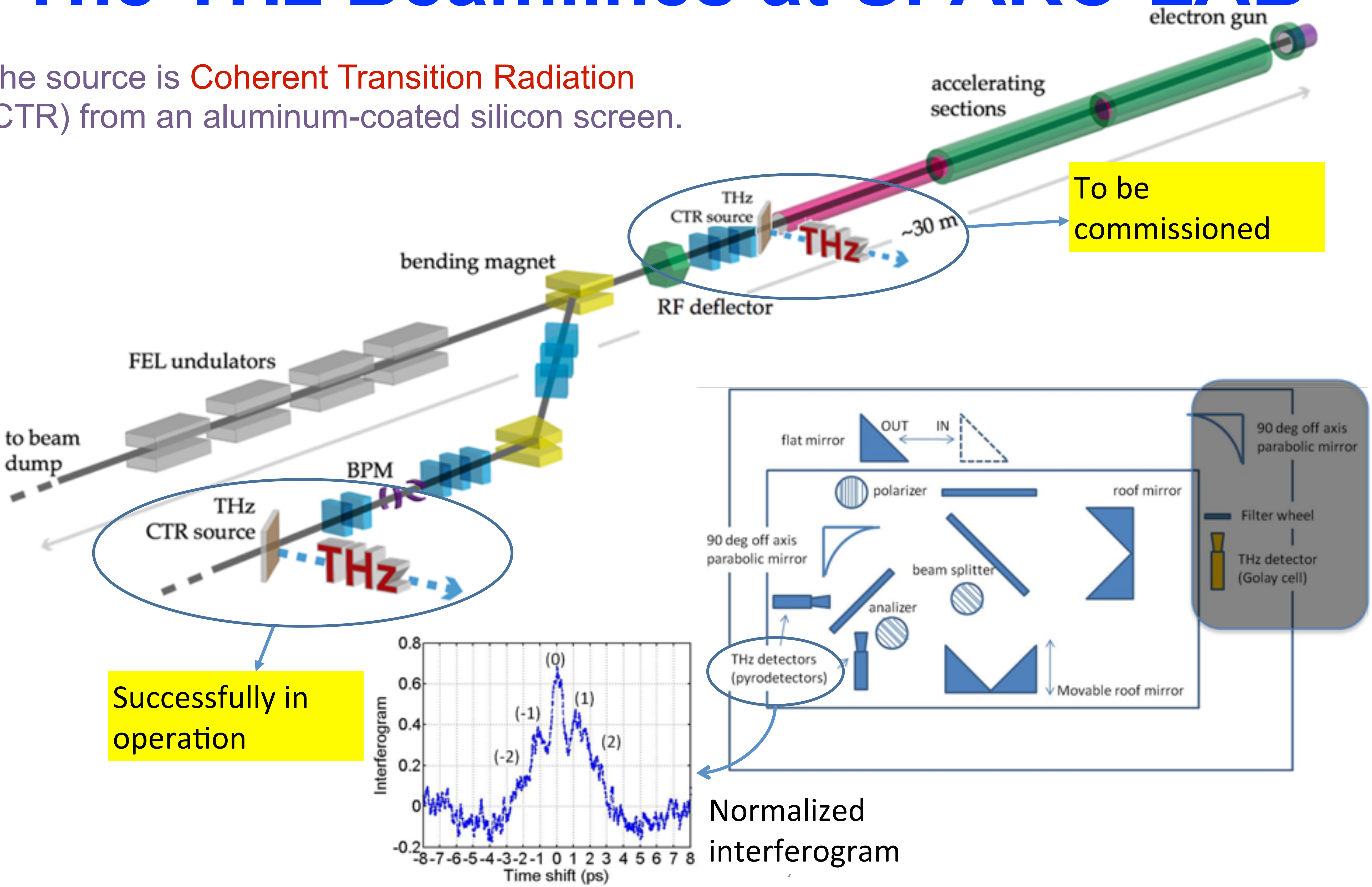


TERASPARC

- Area:Accelerator
- Spokesperson:S.Lupi (Roma1)
- RM1,RM2,LNF,LNS,TO

TERASPARC
The THz Beamlines at SPARC-LAB

The source is Coherent Transition Radiation (CTR) from an aluminum-coated silicon screen.



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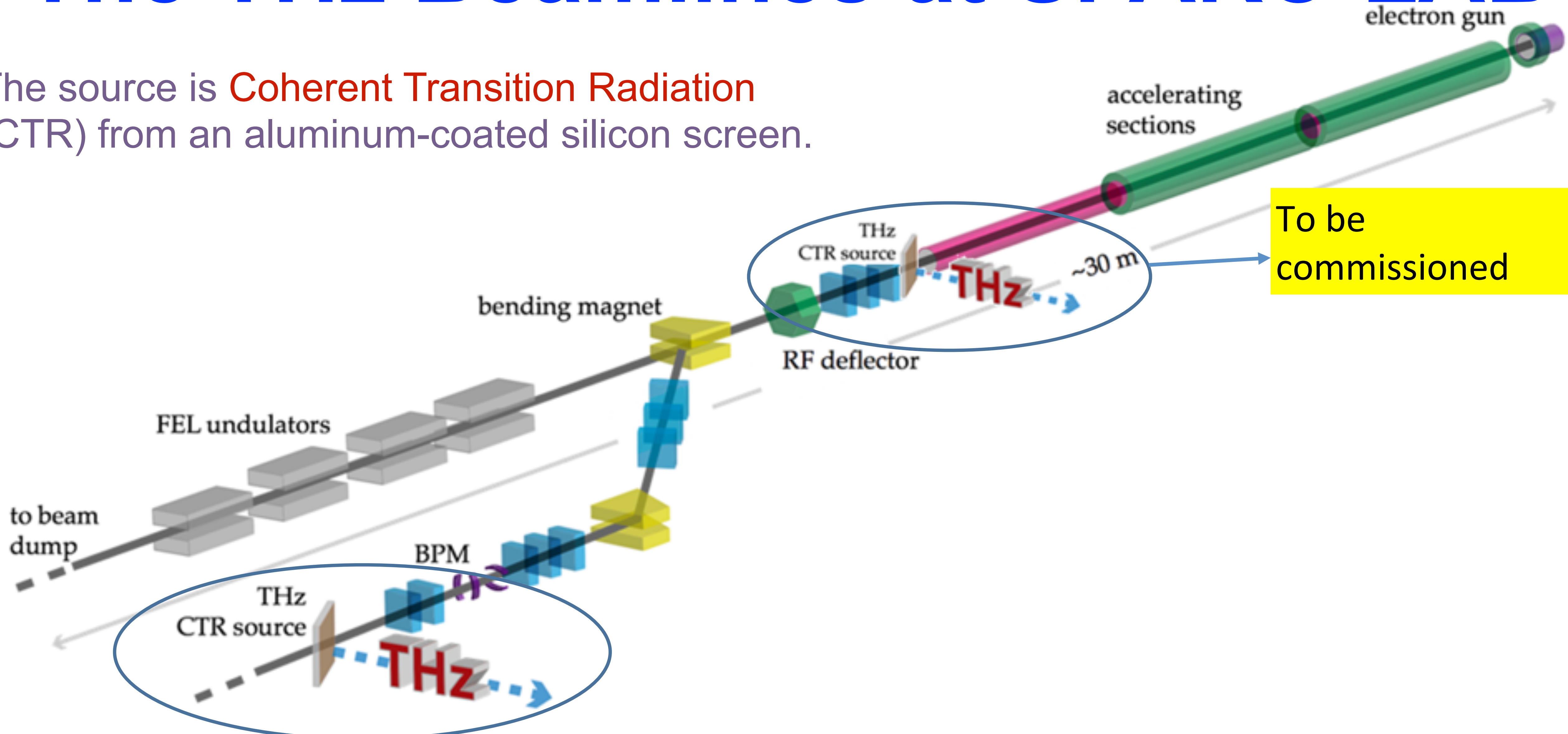

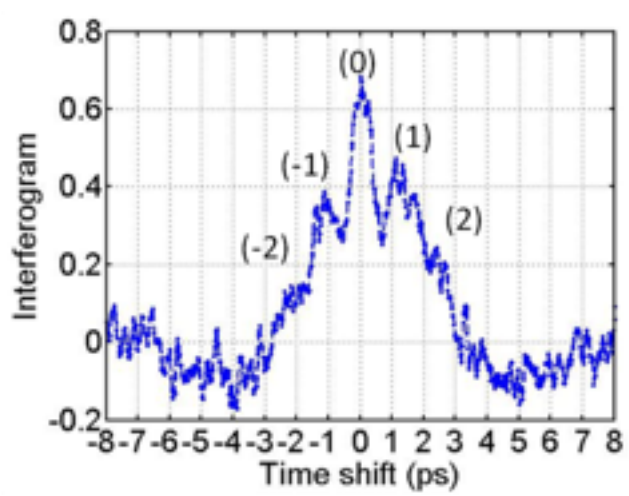

Normalized interferogram

TERASPARC
The THz Beamlines at SPARC-LAB

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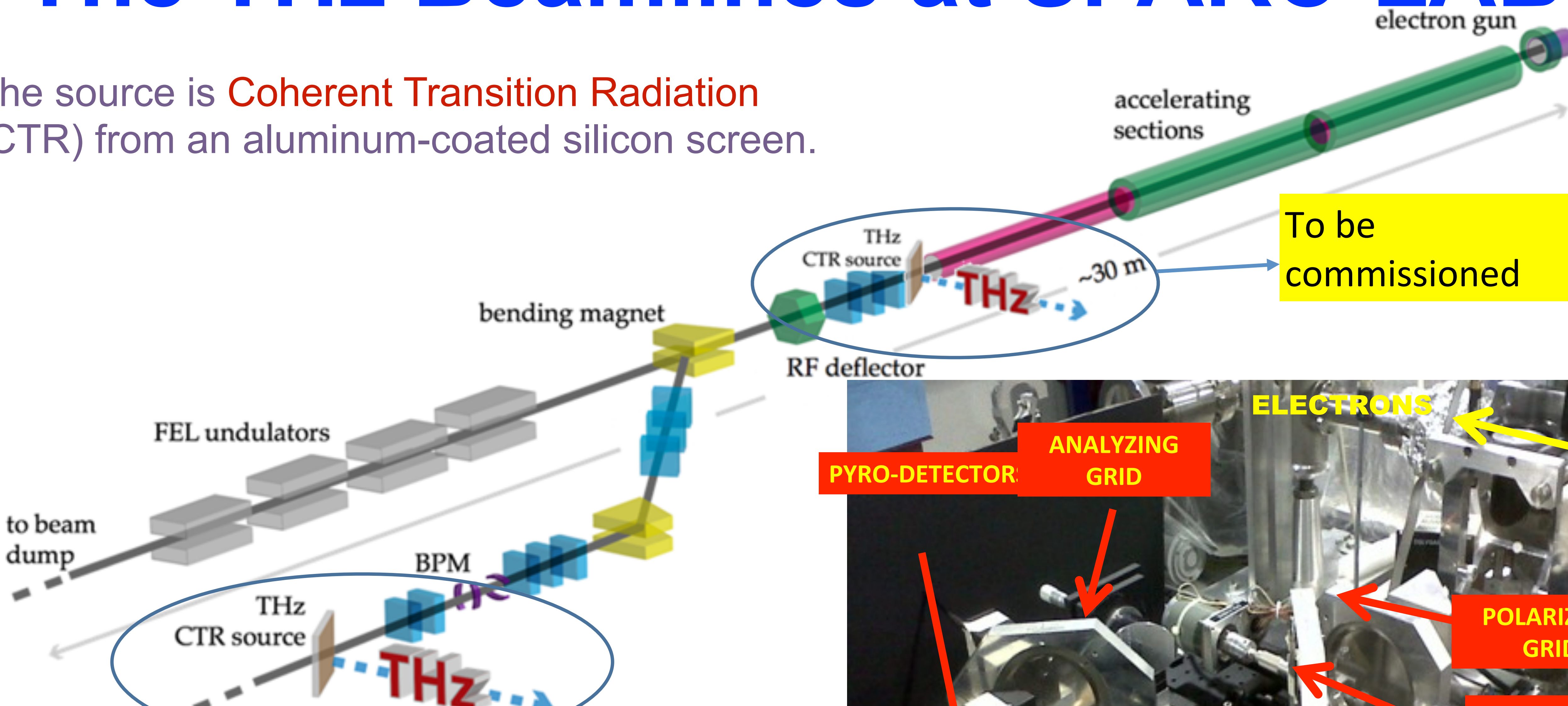
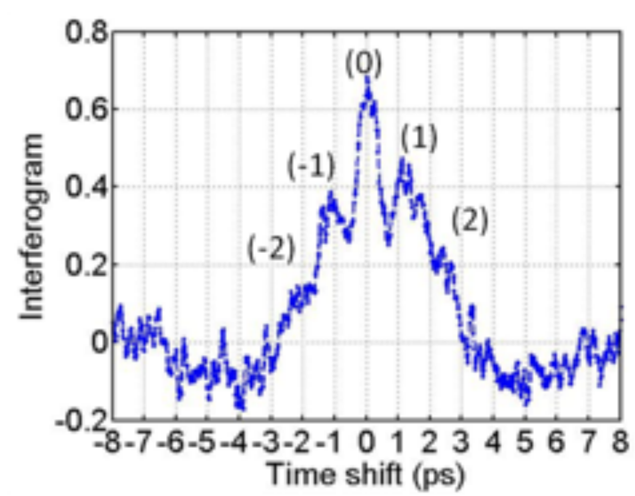
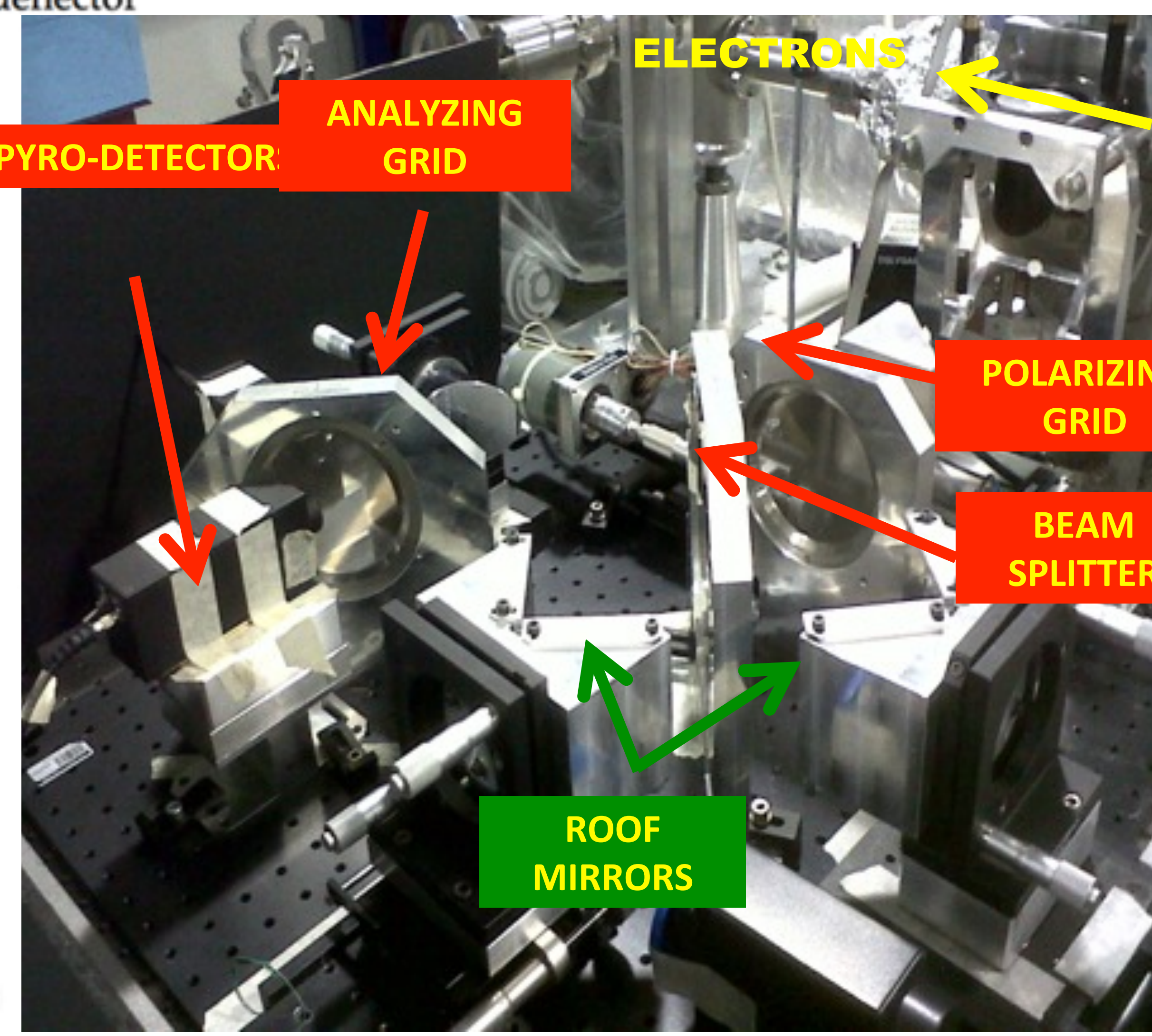


To be commissioned

Successfully in operation



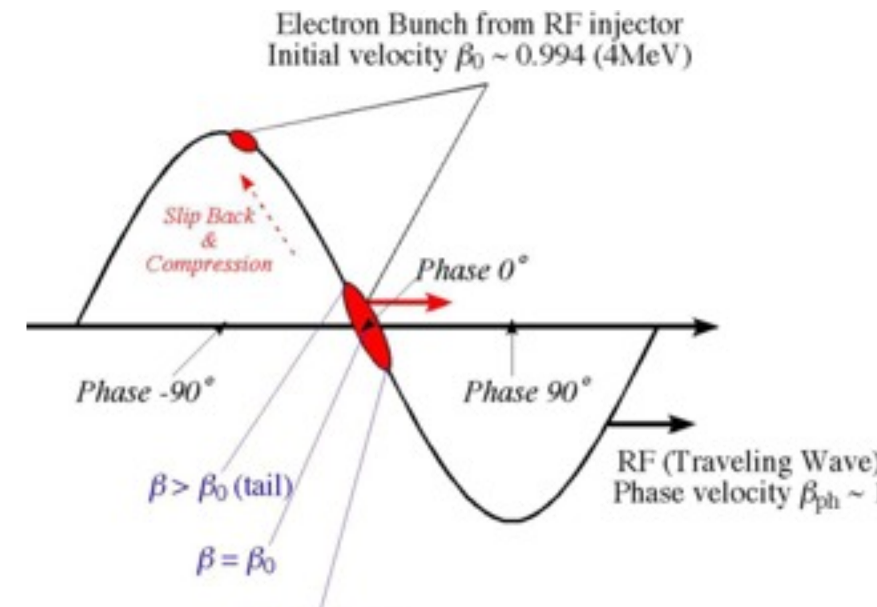


Broadband THz Source

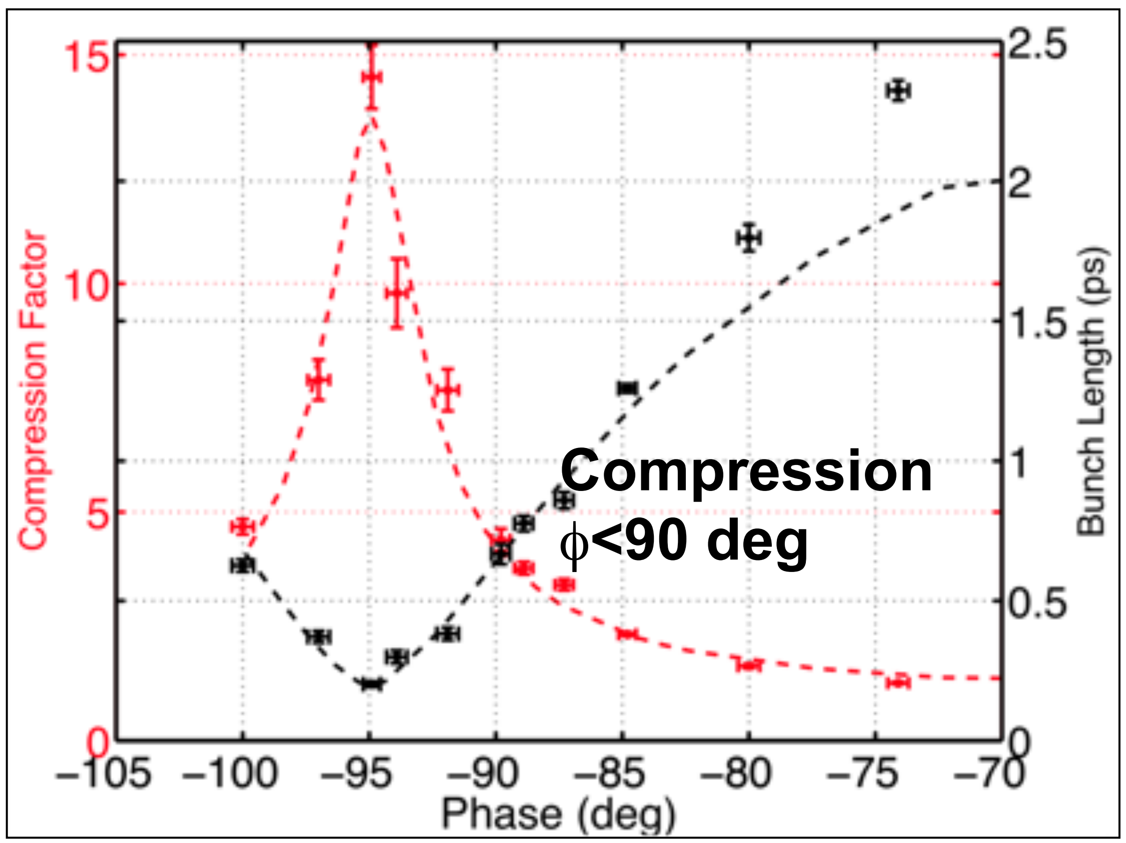
BROAD BAND THz
(150 GHz – 5 THz)
NEEDED
sub-ps high-brightness electron bunches

➡

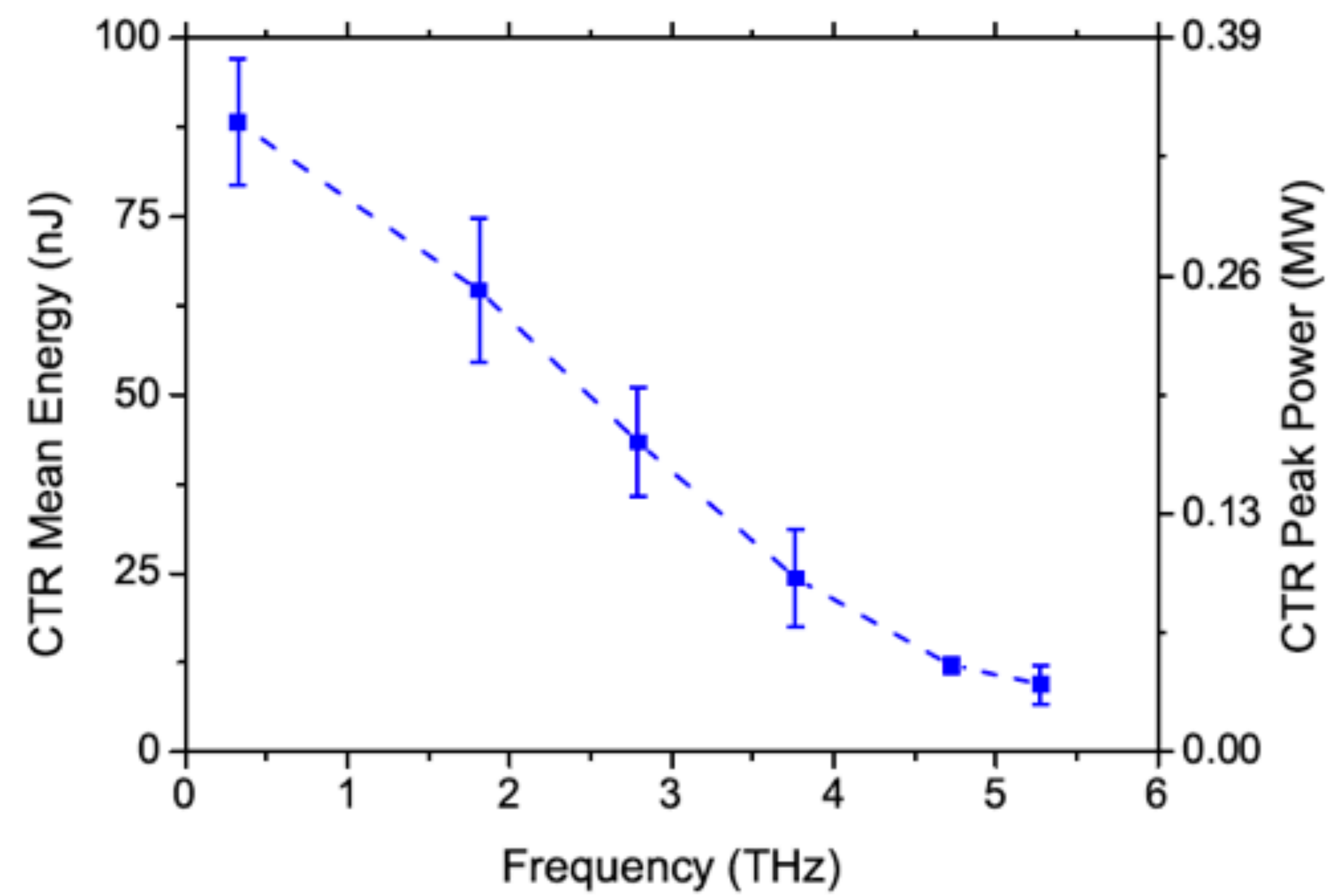
RF compression:
VELOCITY BUNCHING



Over-compression
180 deg<ϕ<90 deg



Compression
ϕ<90 deg



THz Intensity at maximum longitudinal compression

Narrow Band THz Source

NARROW and TUNABLE THz SOURCE

THz source with a **longitudinally modulated beam i.e. comb beam**

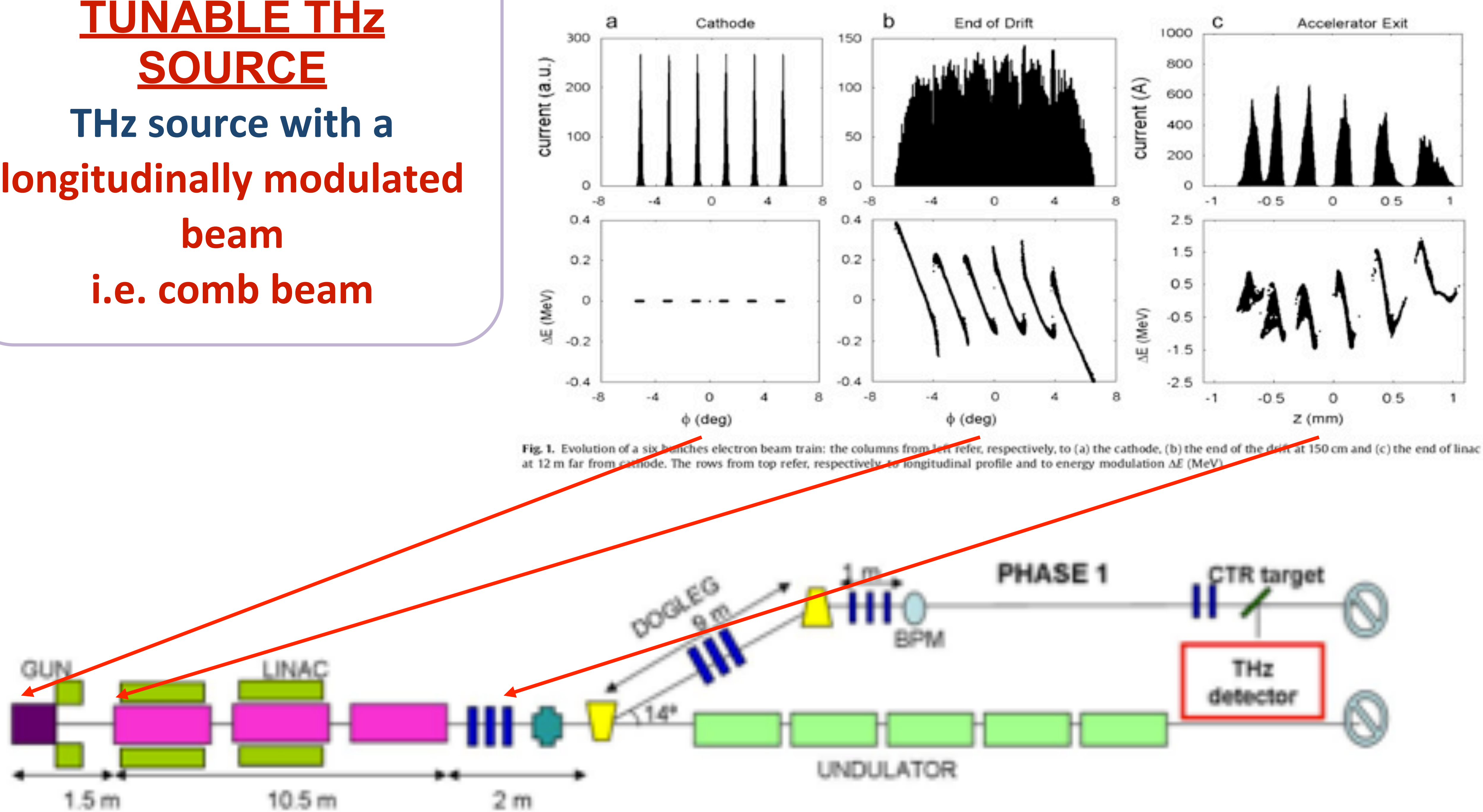


Fig. 1. Evolution of a six bunches electron beam train: the columns from left refer, respectively, to (a) the cathode, (b) the end of the drift at 150 cm and (c) the end of linac at 12 m far from cathode. The rows from top refer, respectively, to longitudinal profile and to energy modulation ΔE (MeV).

M. Ferrario et al., *Laser comb with velocity bunching: Preliminary results at SPARC*, NIM A **637**, S43-S46 (2011)

Narrow Band THz Source

NARROW and TUNABLE THz SOURCE

THz source with a longitudinally modulated beam i.e. comb beam

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NARROW and TUNABLE THz SOURCE

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longitudinally modulated beam

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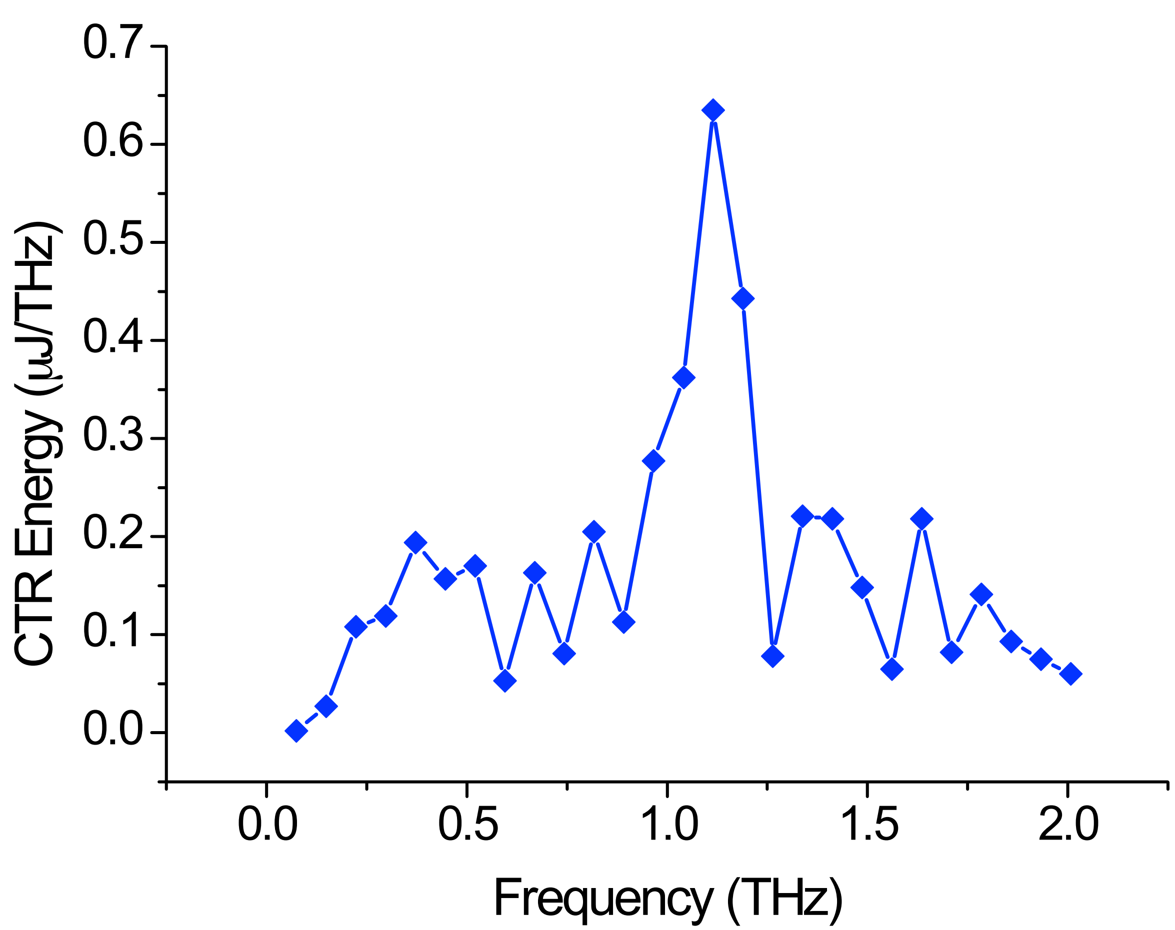
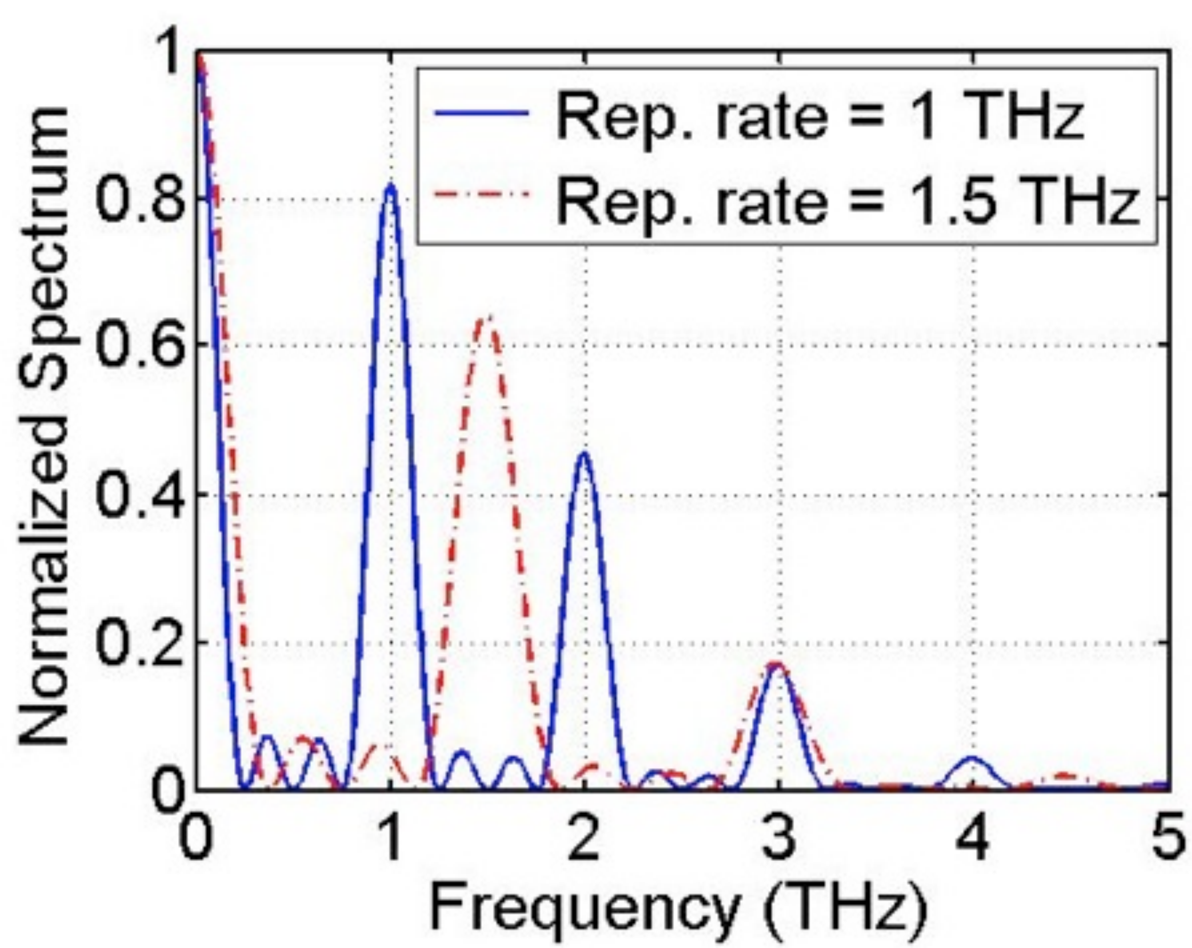


on



TPS

- Area:Interdisciplinary
- Spokesperson:F.Marchetto(TO)
- LNF,LNL,LNS,MI,NA,PI,RM2,RM3,TO

Treatment Planning System

- **TPS for proton and e Carbon ions ready**

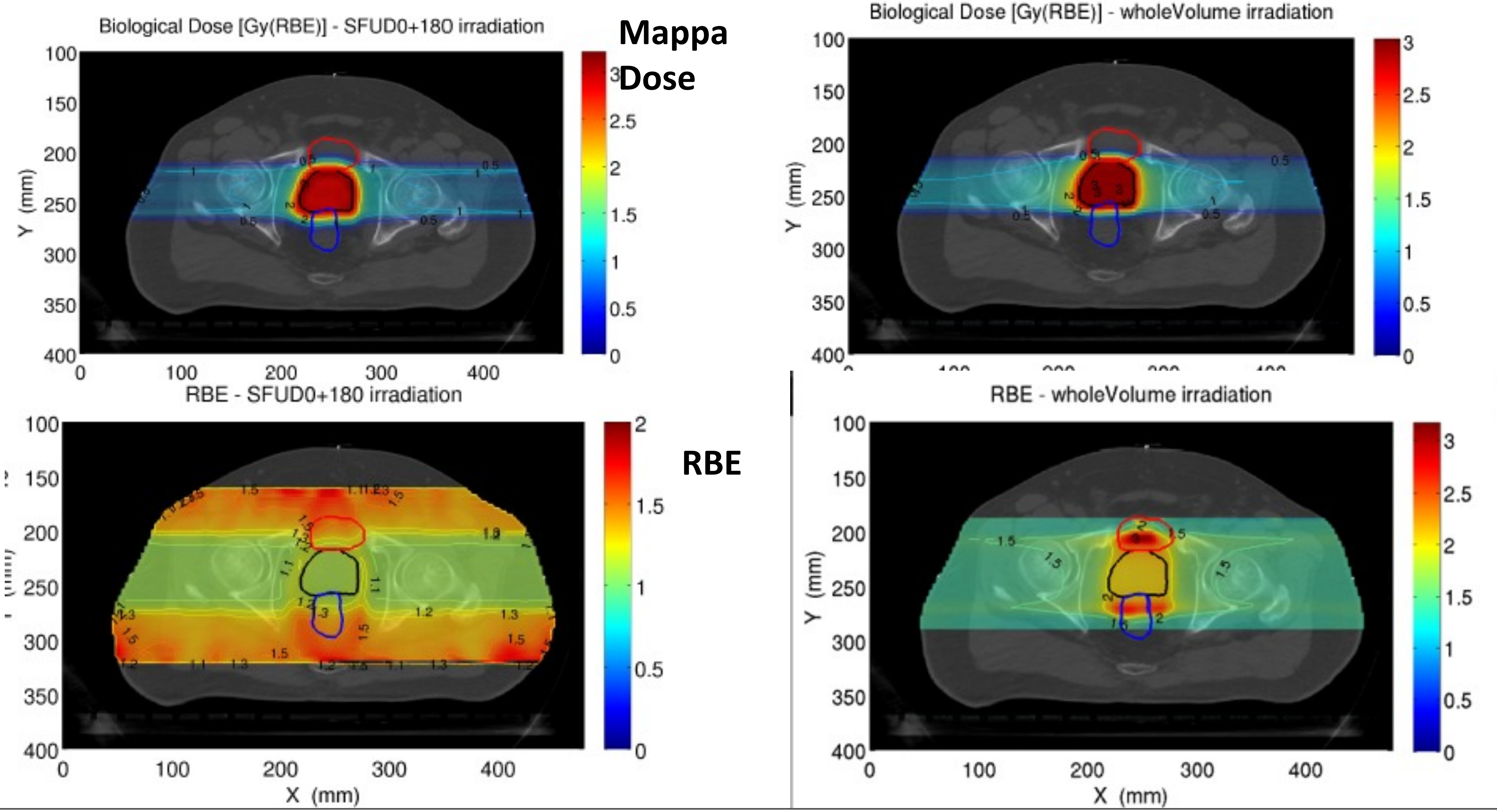
a) software;

b) radiobiology;

c) cross section fragmentation (sinergy with CSN5)

Prostata con irraggiamento da due campi contrapposti

Protoni | **Carbonio**



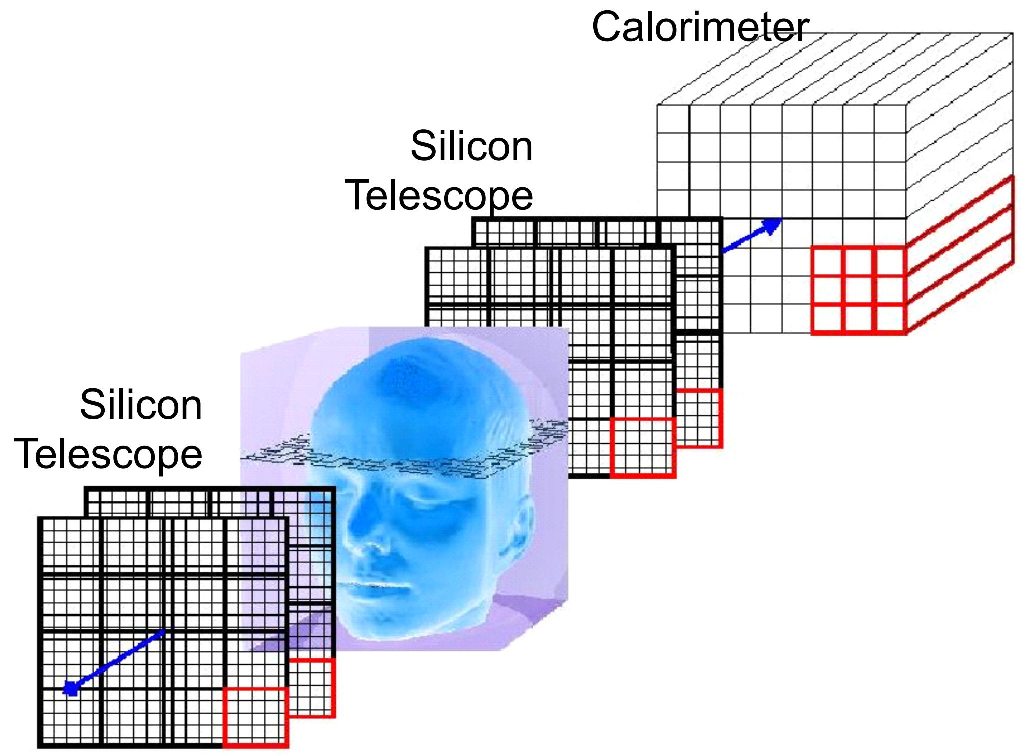
PRIMA+

- Area:Interdisciplinary
- Spokesperson:M.Bruzzi (Firenze)
- CT,FI,LNS

Proton Imaging
Concept

proton Computed Radiography

- Reveal the trace of the single proton using a silicon telescope
- Measure the residual energy of the proton using a calorimeter
- Reconstruct the most likely path of the single proton



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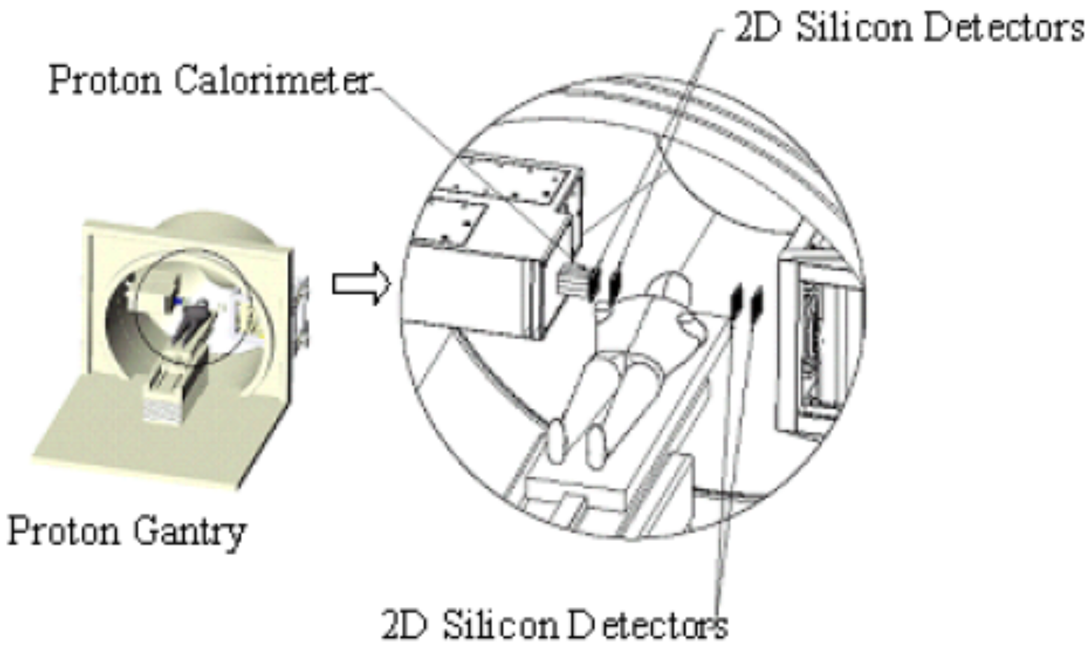
proton Computed Tomography

- pCR for different projections with a rotating gantry
- Reconstruct the image

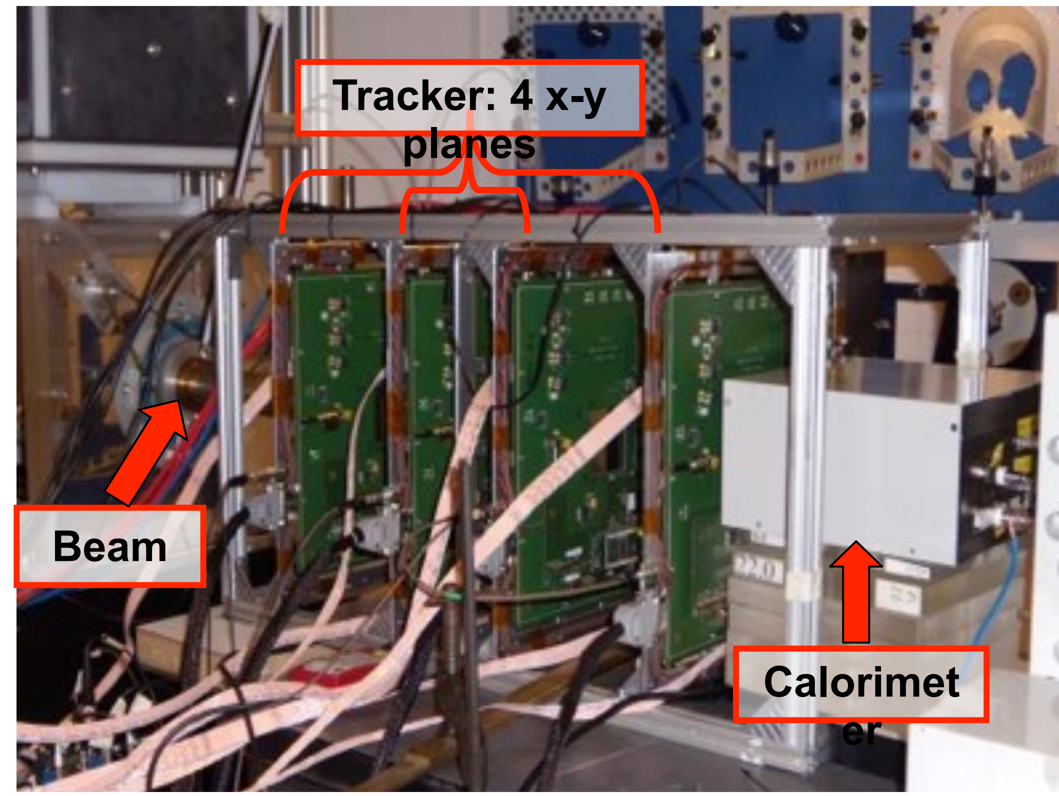


nunzio.randazzo@ct.infn.it

The PRIMA proton Computer Radiography apparatus designed and manufactured by PRIMA

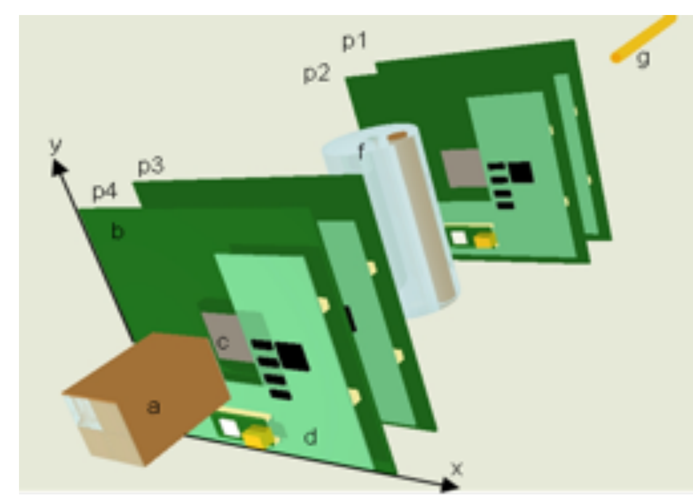
proton Computed Radiography

- Reveal the track of the single proton using a silicon telescope
- Measure the residual energy of the proton using a calorimeter
- Reconstruct the most likely path of the single proton



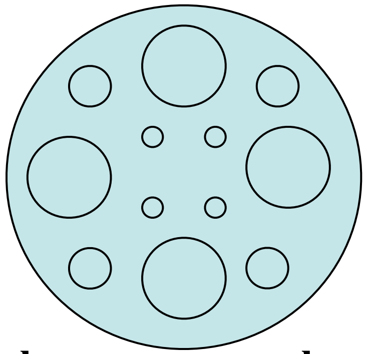
proton Computed Tomography

- pCR for different projections with a rotating gantry
- Image reconstruction



Results: Tests at the LNS with 60 MeV proton beam and non-homogeneous phantoms

sub millimeter precision achieved in radiography



Non-homogeneous phantom

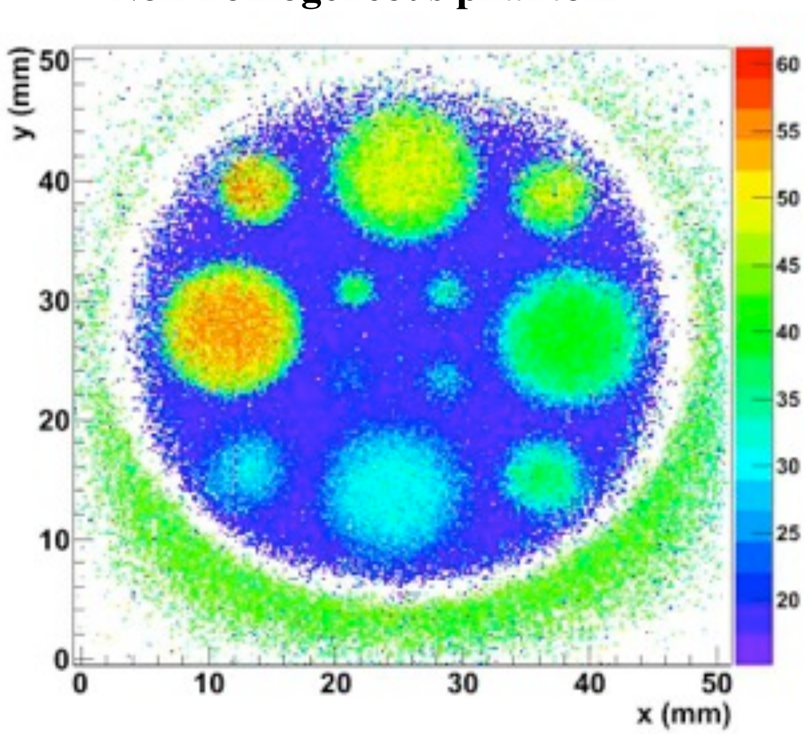
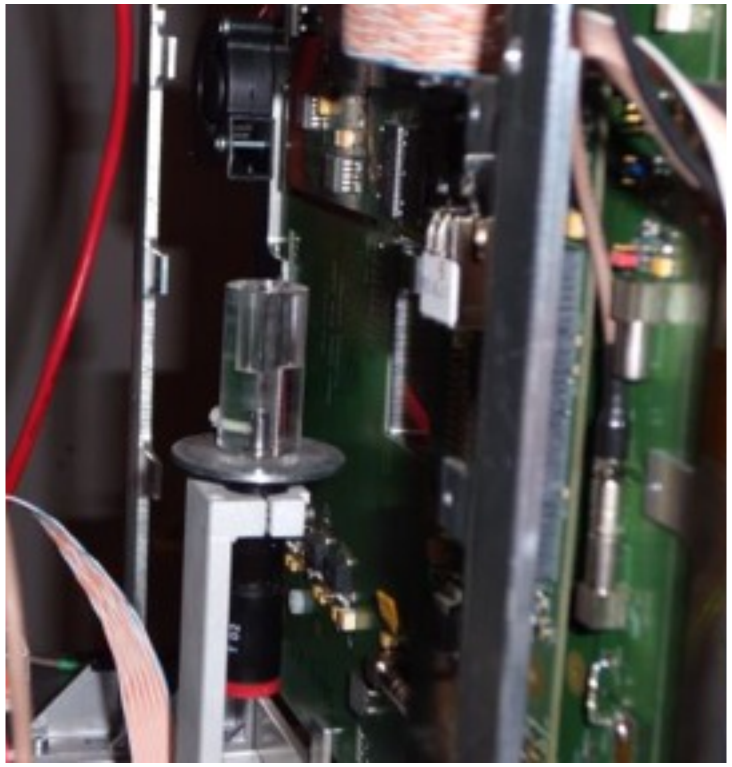
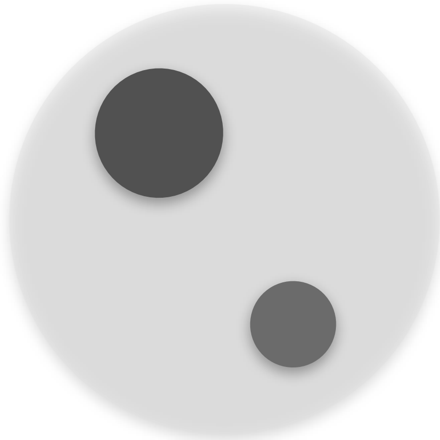


Image obtained with one x-y plane plus calorimeter

First tomography studies promising, data acquired irradiating the phantom at angles from 0 to 360° with 10° steps – limited statistics





First tomographic reconstruction

First tests with high energy proton beam in Autumn 2011 (Uppsala).

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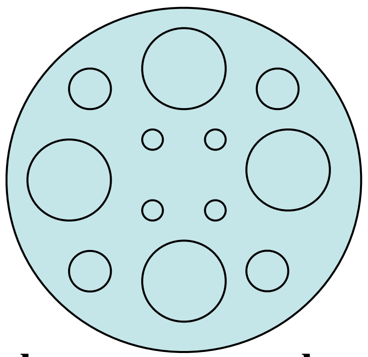
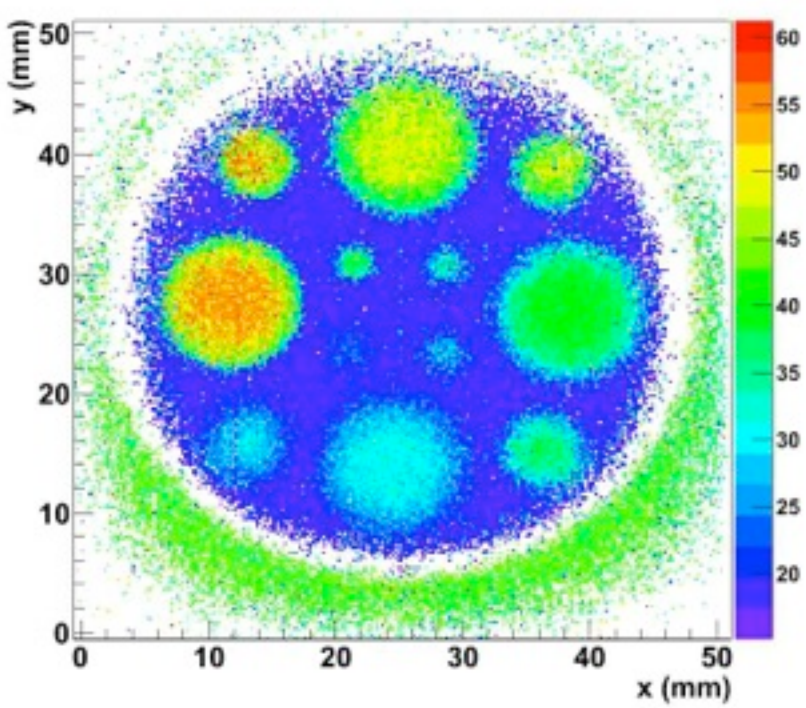


Non-homogeneous phantom



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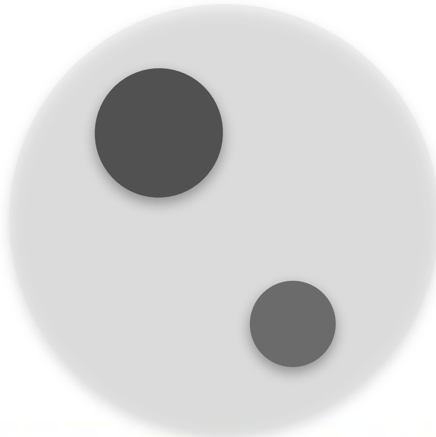

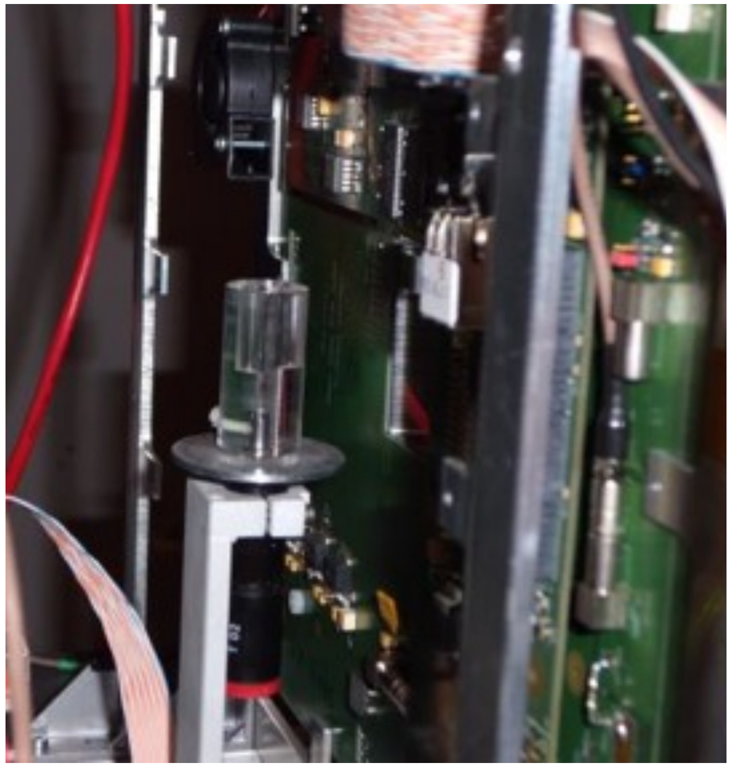

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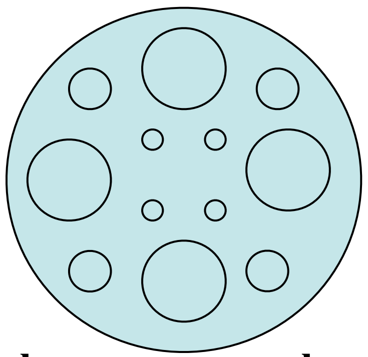

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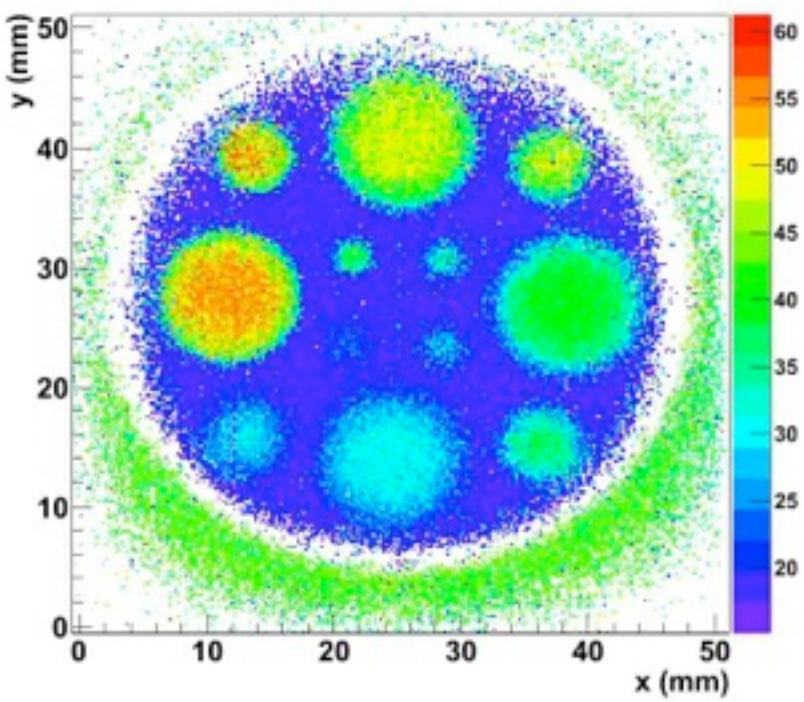

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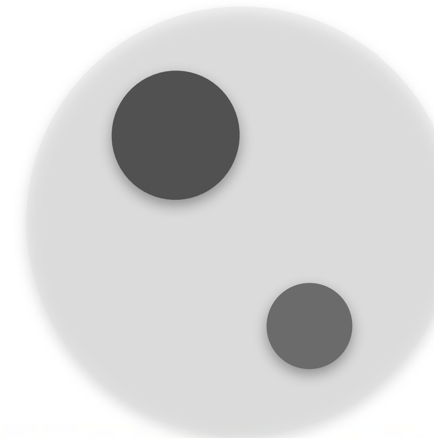
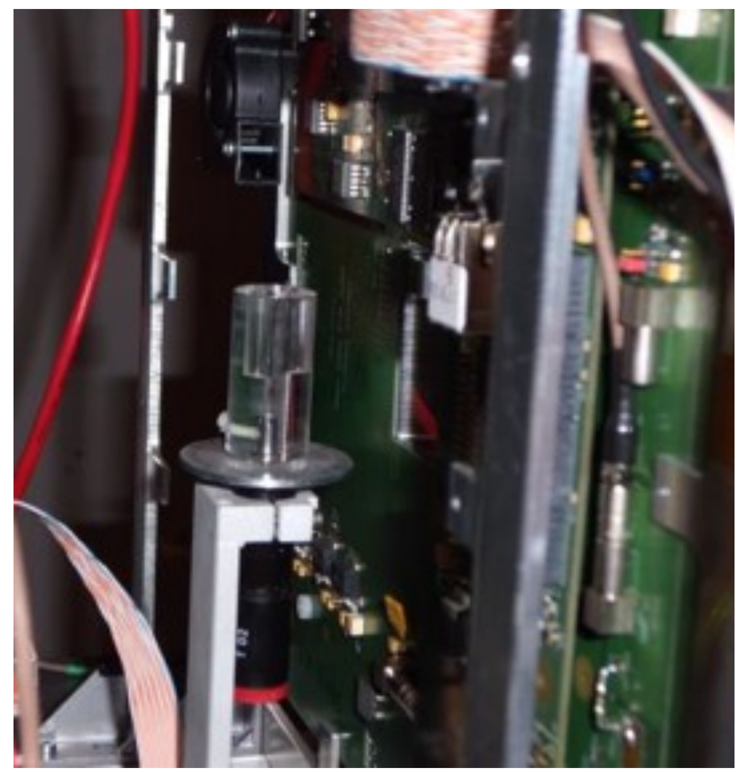




First tomographic reconstruction

- **New data acquired recently to increase statistics – analysis is in progress;**
- **New reconstruction algorithms under development - SART (Simultaneus Algebraic Reconstruction Technique);**

First tests with high energy proton beam in Autumn 2011 (Uppsala).

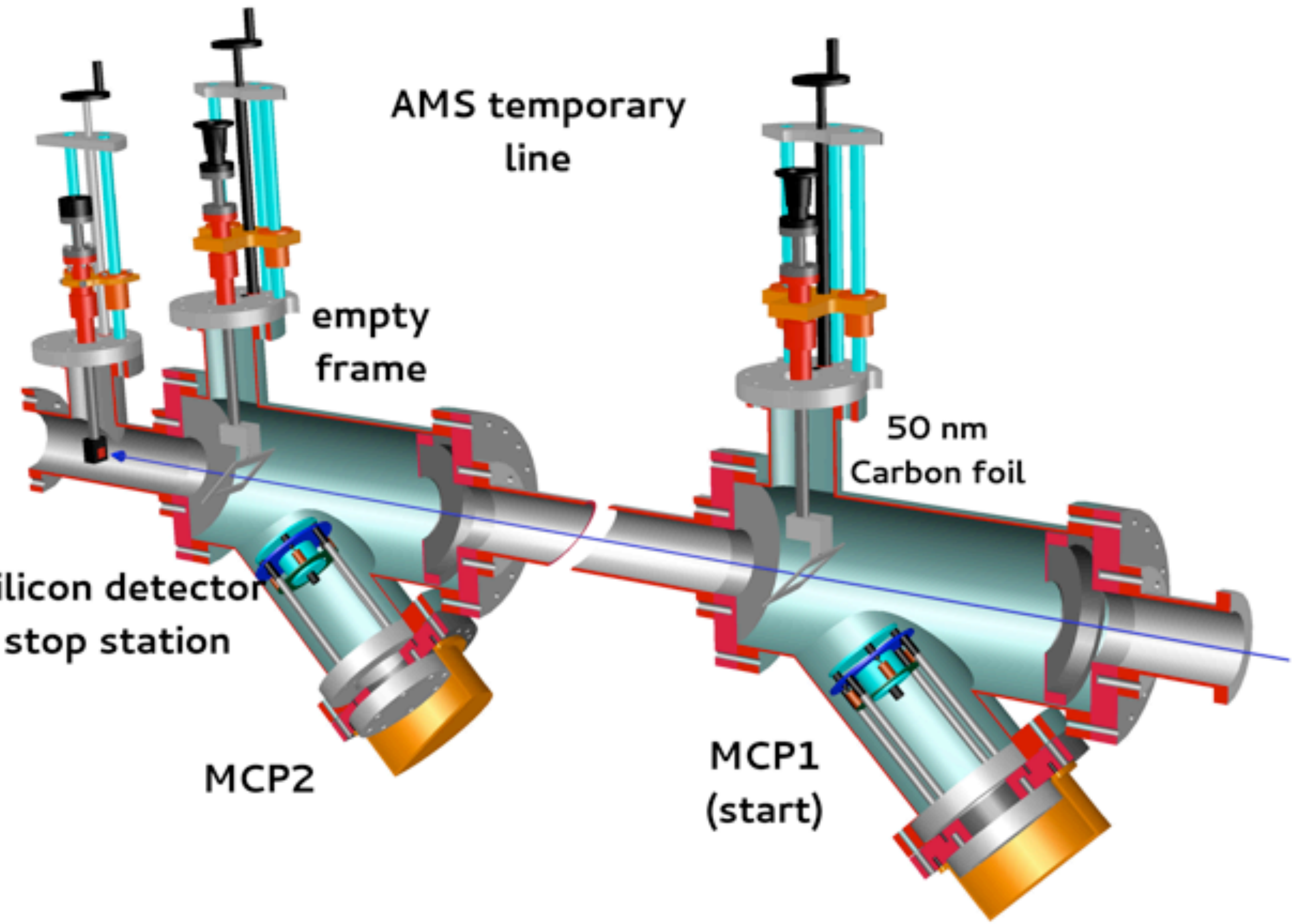
INFN Cultural Heritage

INFN-Dating

V National Scientfic Committee

- The Experiment
- Activity
- Conferences
- Theses
- Publications
- Collaborations

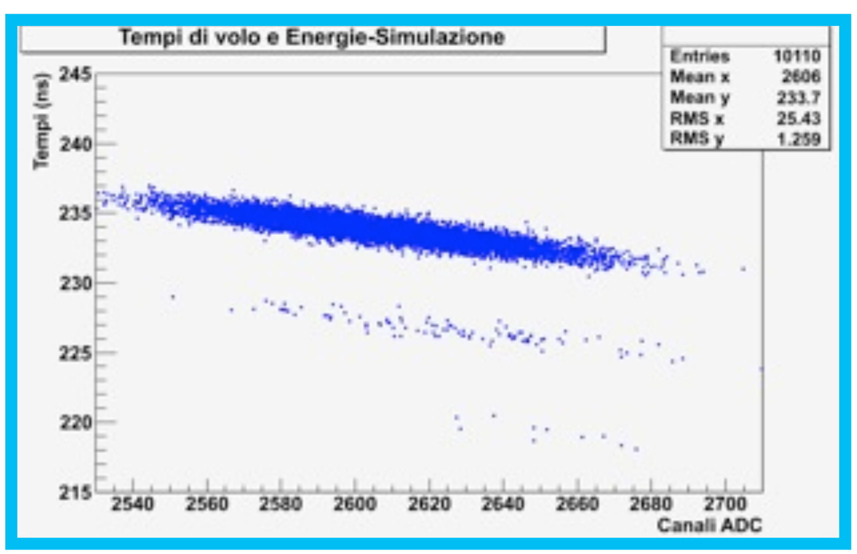
This workpackage (WP_Dating) involves 6 INFN Divisions, Bari (**Ba**), Bologna (**Bo**), Catania (**Ct**), Firenze (**Fi**), Milano Bicocca (**Mi**) and Torino (**To**). It deals with the reduction of uncertainties in dating measurements, mostly related to archeological fields. The WP_Dating is mainly focused on two techniques: Accelerator Mass Spectrometry (**AMS**) and Luminescence, both thermally (**TL**) and optical (**OSL**) stimulated. The AMS technique is investigated in the Fi-Division, at the Labec Tandem accelerator, with the contribution of the Mi-Division for target preparation and background evaluation. The TL and OSL techniques and their related problematics are investigated in Ba-Ct-Mi Divisions. Problems related to TL physical principles (mainly quartz responses to known doses) are carried out by the To and Mi Divisions at the Labec pulsed-beam and micro-beam facilities.



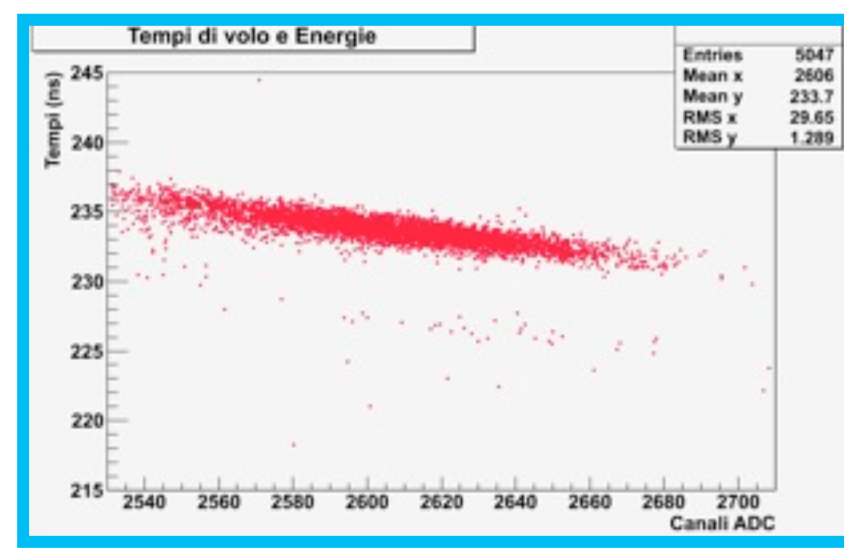
INFN-Dating

INFN-Cultural Heritage

At Labec a new mass spectroscopy line has been built in order to improve rare isotopes sensitivity (up to 10^{-17} in $^{14}C/^{12}C$ case). Tests are in progress.



Preliminary results (obtained with a temporary setup) showed a good agreement between simulated isobars (12CH2 and 13CH) pollution and measured data

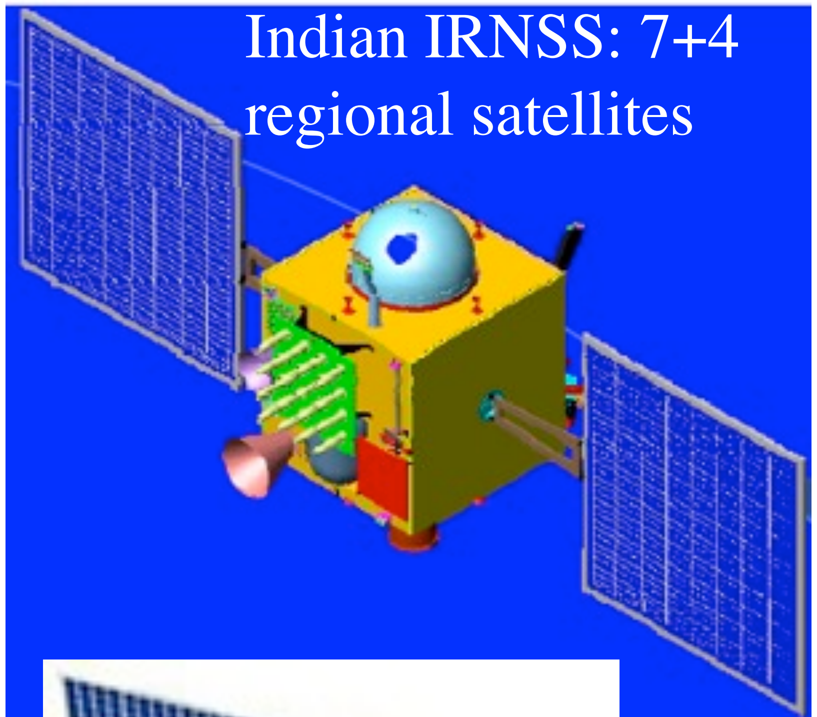


ETRUSCO-GMES

- Area:Detectors
- Spokesperson:S.Dell'Agnello (LNF)
- LNF

Global Navigation Satellite System (GNSS):

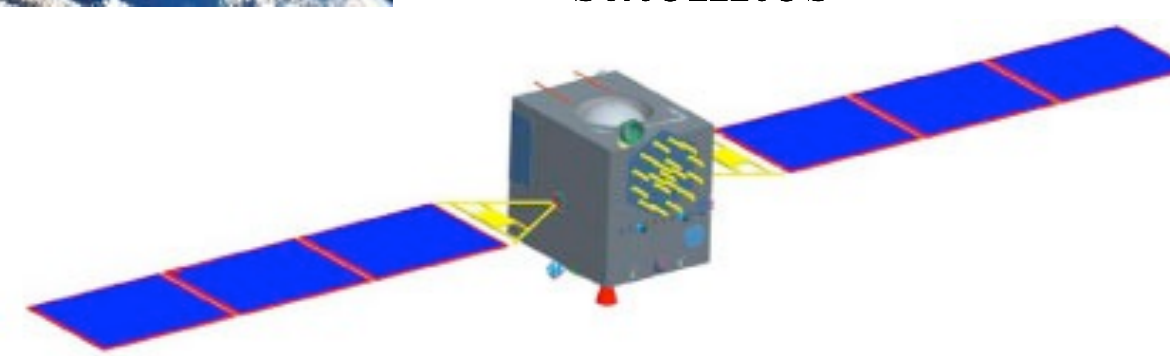
~100 satellites with laser retroreflectors (CCRs)



European Galileo:
30 satellites

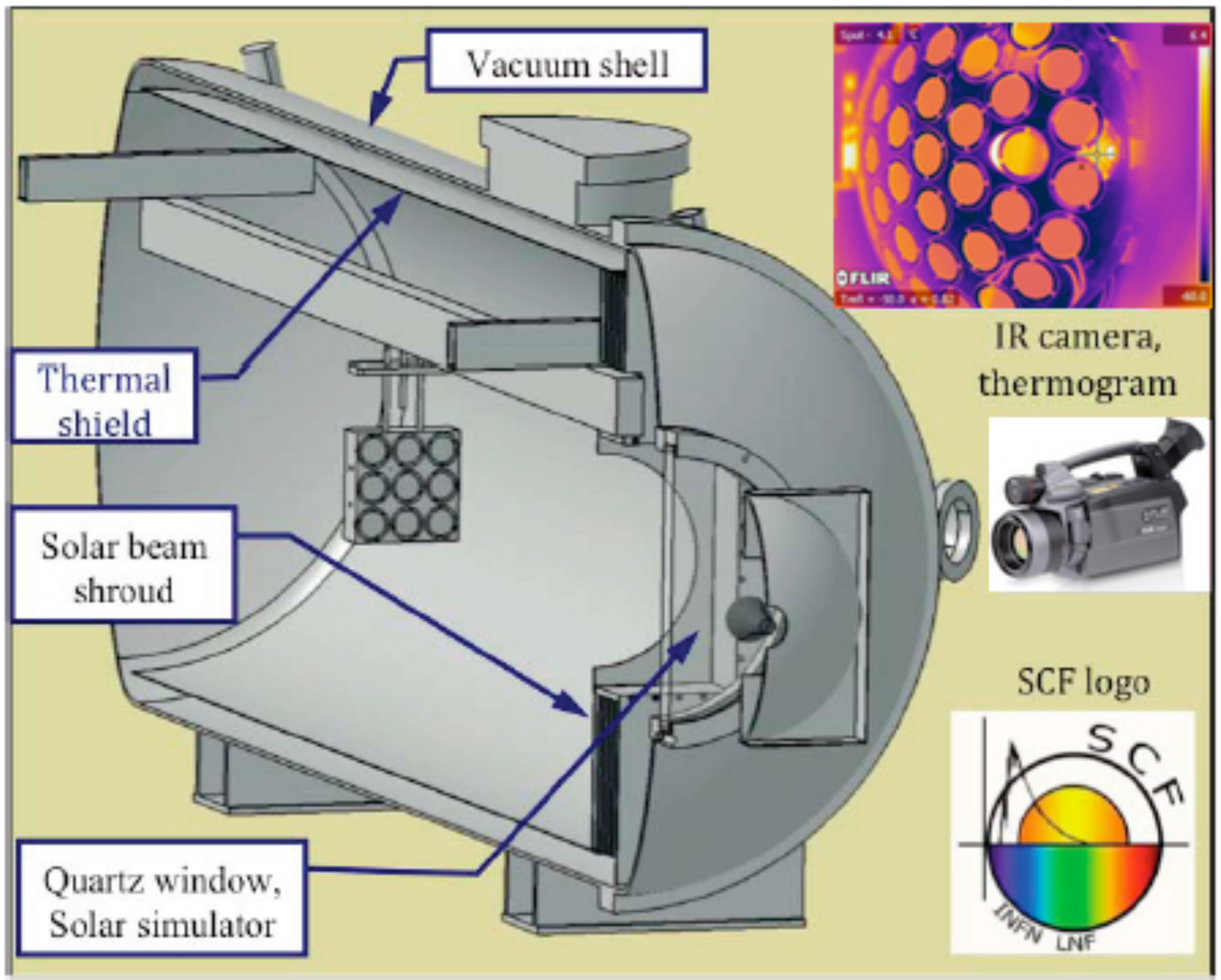
Russian GLONASS: 24
global satellites

Chinese COMPASS: 2
global and 5 regional
satellites



SCF_LAB @INFN-LNF

Two unique OGSE (Optical Ground Support Equipment) facilities in a clean room to characterize the space segment of laser ranging altimetry

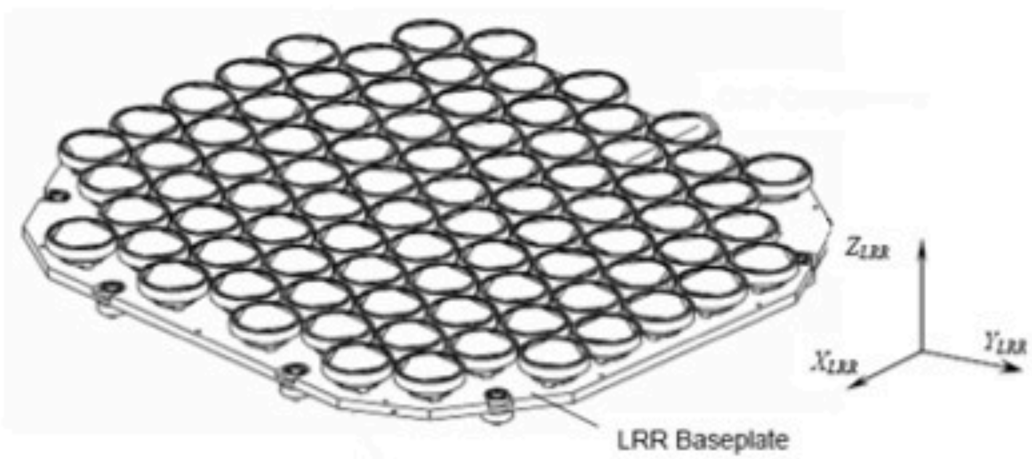


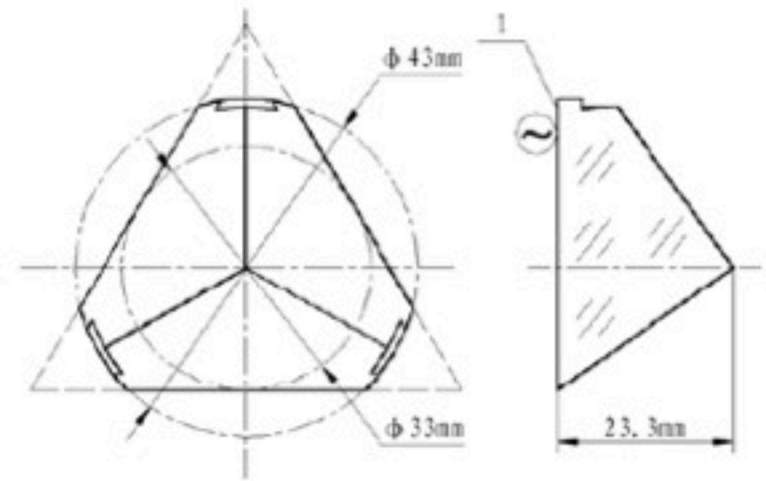
SCF for SL
LLR/
Altimetry
(RD-1, RD-2)

SCF-G for
GNSS
(RD-10)

Public recognition of INFN work for Galileo by ESA on web site of Intern. Laser Ranging Service

Galileo retroreflector array location





Galileo retroreflector array

Galileo corner cube configuration

Retroreflector information courtesy of ESA

RetroReflector Array (RRA) Characteristics:

Additional information about the Galileo retroreflector array can be found in the Galileo-101 and -102 ILRS SLR Mission Support Request Form. Specifications for the Galileo extracted from this support request form:

- Number of CCRs: 84
- CCR size: 33 mm diameter, 23.3 mm height
- Material: Doped fused silica (Suprasil 311)
- Coating: Reflective surface uncoaded, incident surface coated with indium tin oxide

Additional information:

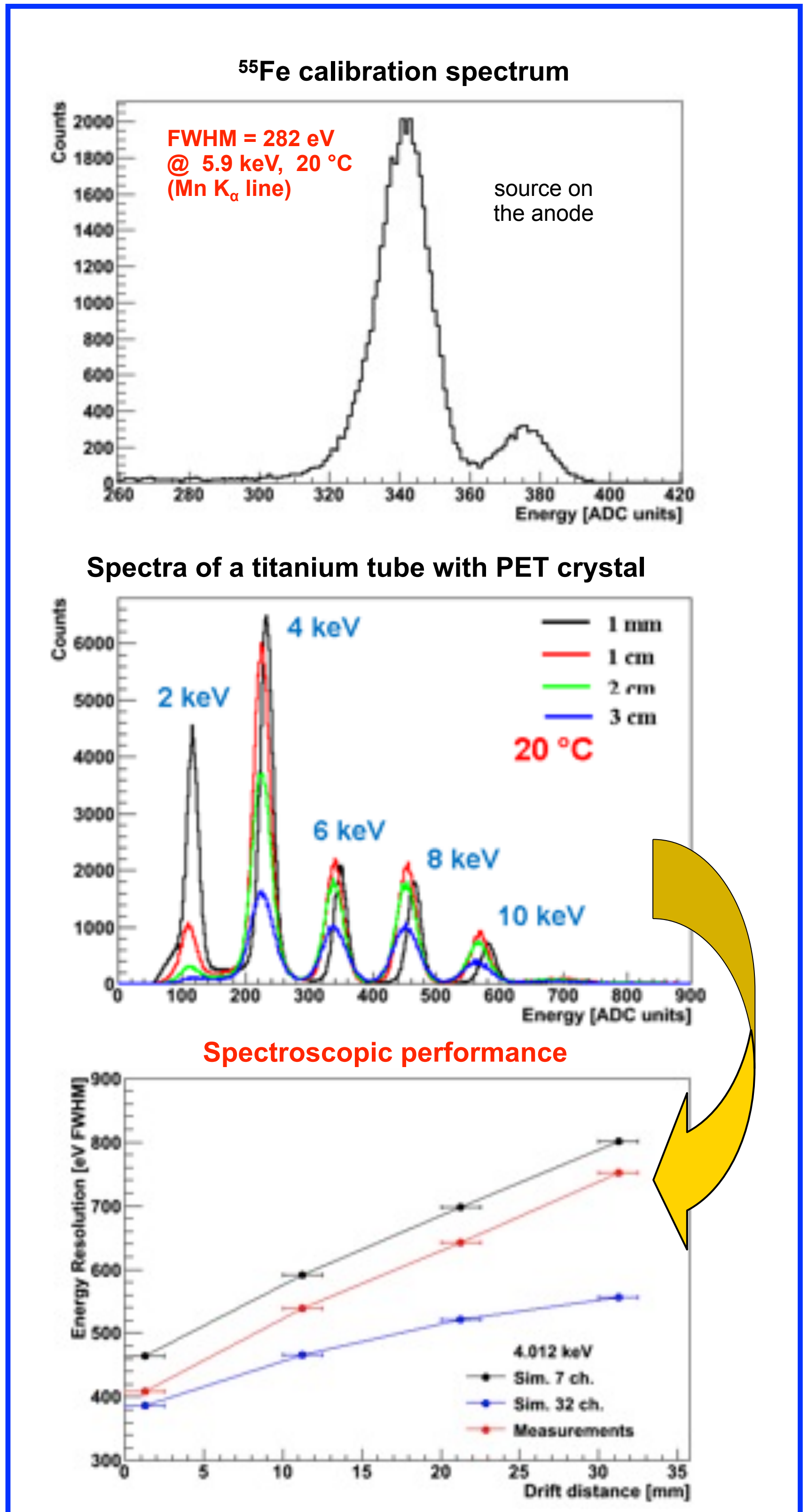
- ESA presentation on Galileo retroreflector design
- "ETRUSCO-2: An ASI-INFN Project of Technological Development and SCF-TEST of GNSS LASER Retroreflector Arrays"

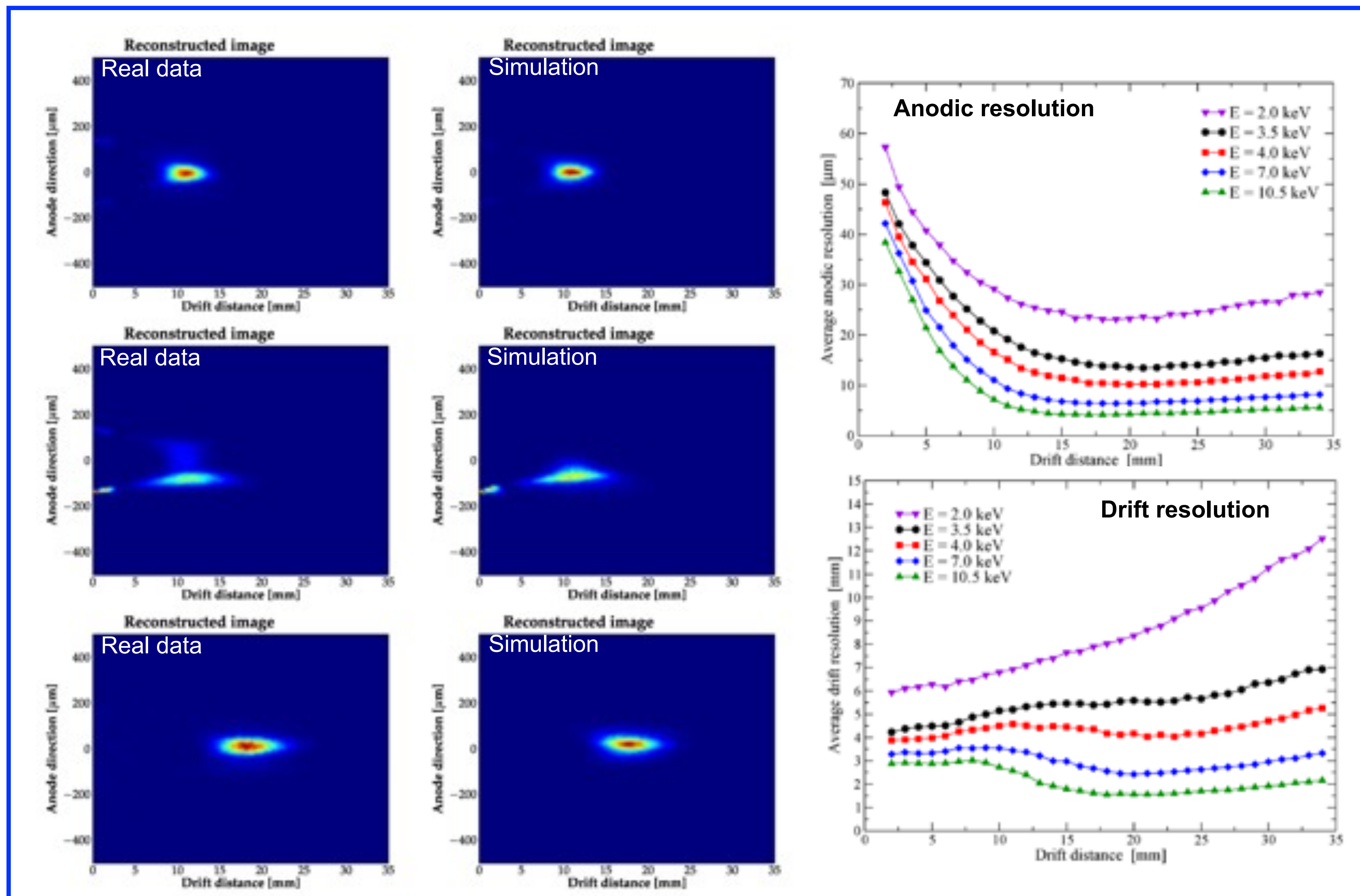
XDXL

- Area:Detectors,Electronics
- Spokesperson:A. Vacchi (Trieste)
- BO,MI,PD,PV,RM2,TS

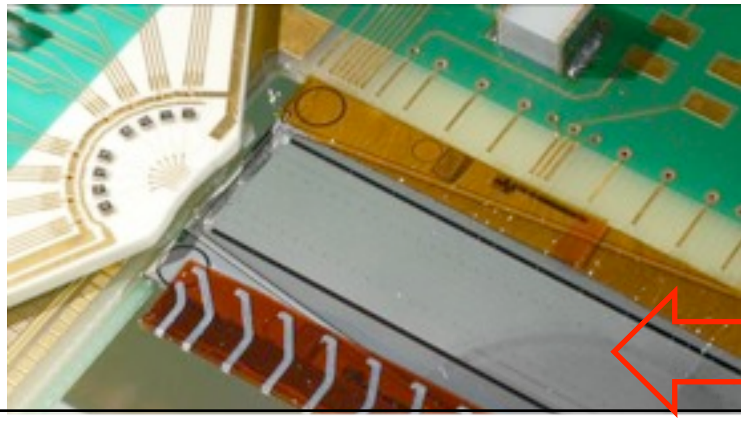
X-ray Drift eXtra Large: performances

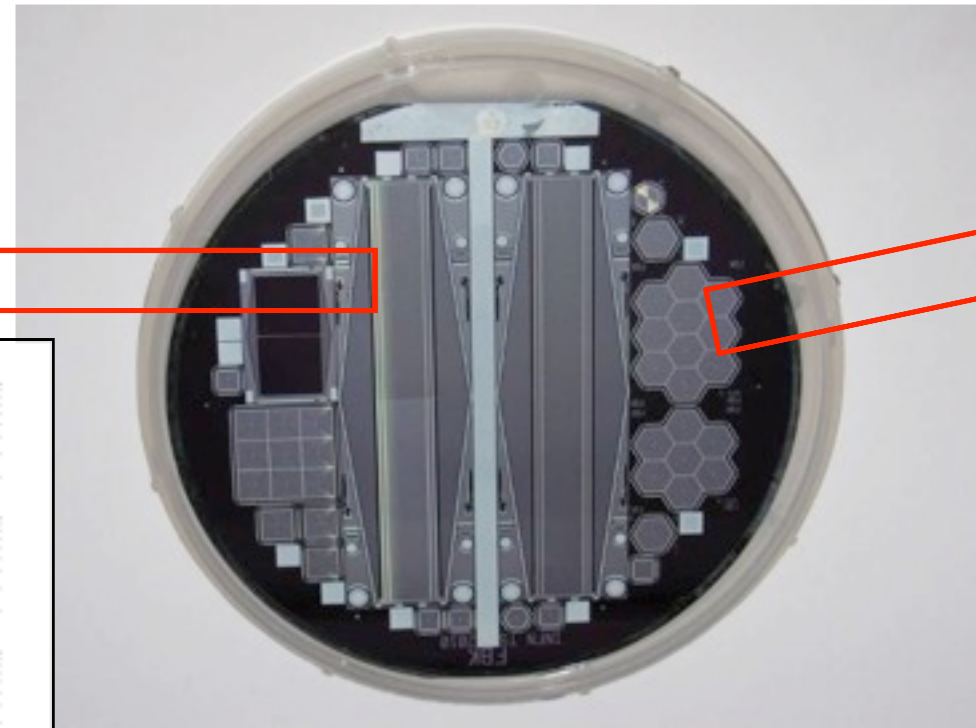
- Very good noise performance: ENC = 25 e$^-$ rms @ +20 °C using a sub-optimal front-end electronics, only 2× worse than the best commercial SDDs operated below -20°C
- Good energy resolution for such area: < 570 eV FWHM @ 20 °C with a full instrumented discrete electronics read-out (realistic simulation)
- Not only spectroscopy: detector segmentation allows 2D imaging (in ALICE → MIP spatial resolution better than 30 µm for both axis)
- X-ray anodic resolution better than few tens of µm down to 2 keV
- X-ray drift length reconstruction by exploiting the signal charge diffusion (no prompt trigger available) → coarse drift resolution better than 6 mm (E ≥ 3.5 keV)



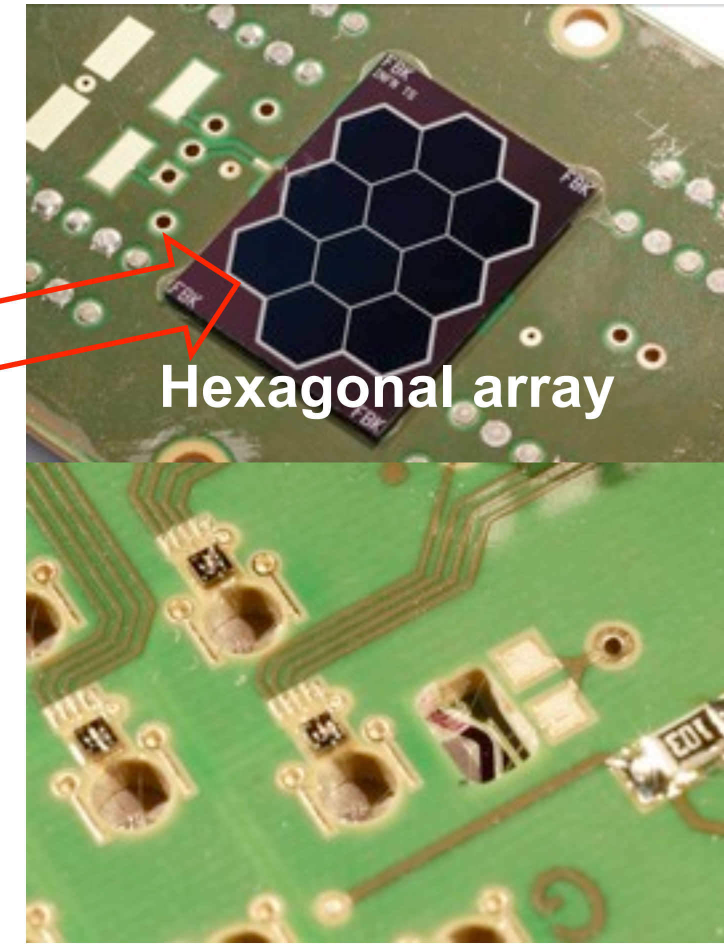


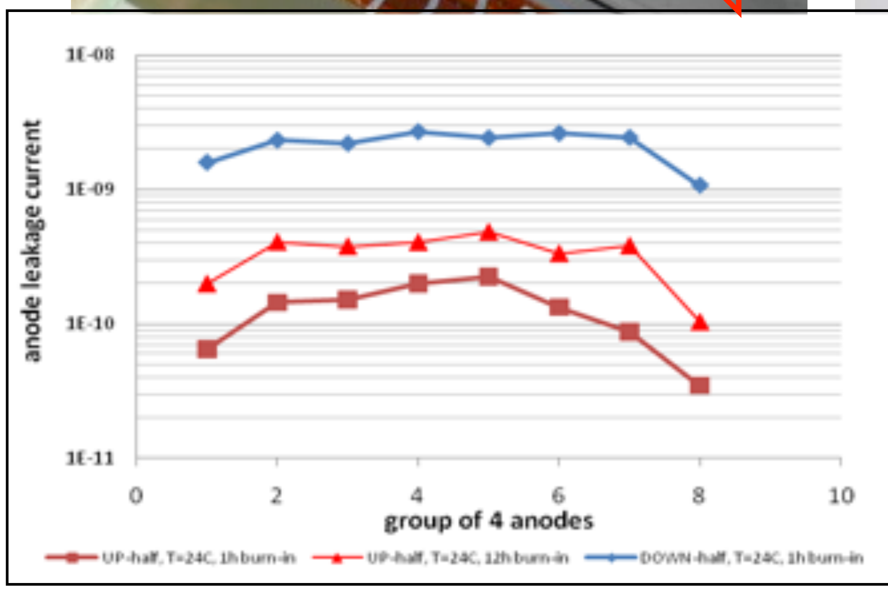
XDXL: SDD developments with FBK-IRST





First prototype wafer layout





FIRST LARGE AREA SDD PRODUCTION BY FBK:

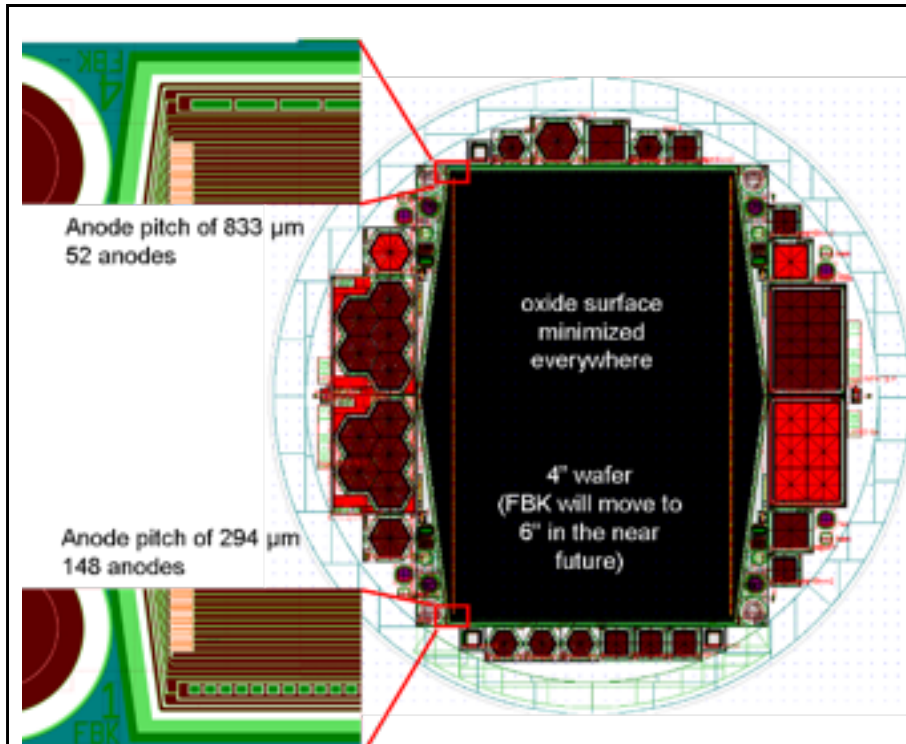
- Bulk leakage < 500 pA/cm^2 with a thickness of 450 μm
- Oxide charge is ~ 1e11 q/cm^2 (expected since Si <100>) but it is lowered to ~ 5e10 q/cm^2 during passivation with LTO OK but will be better the next iteration

From static measurements of the ALI1 and ALI2 SDDs:

- Resistivity of the integrated dividers 3 times lower than that of Canberra SDDs (easy adjustment)
  - ALI1 I_{HV} = 600 μA @ 1200 V
  - ALI2 I_{HV} = 60 μA @ 1200 V → 1/10 power consumption

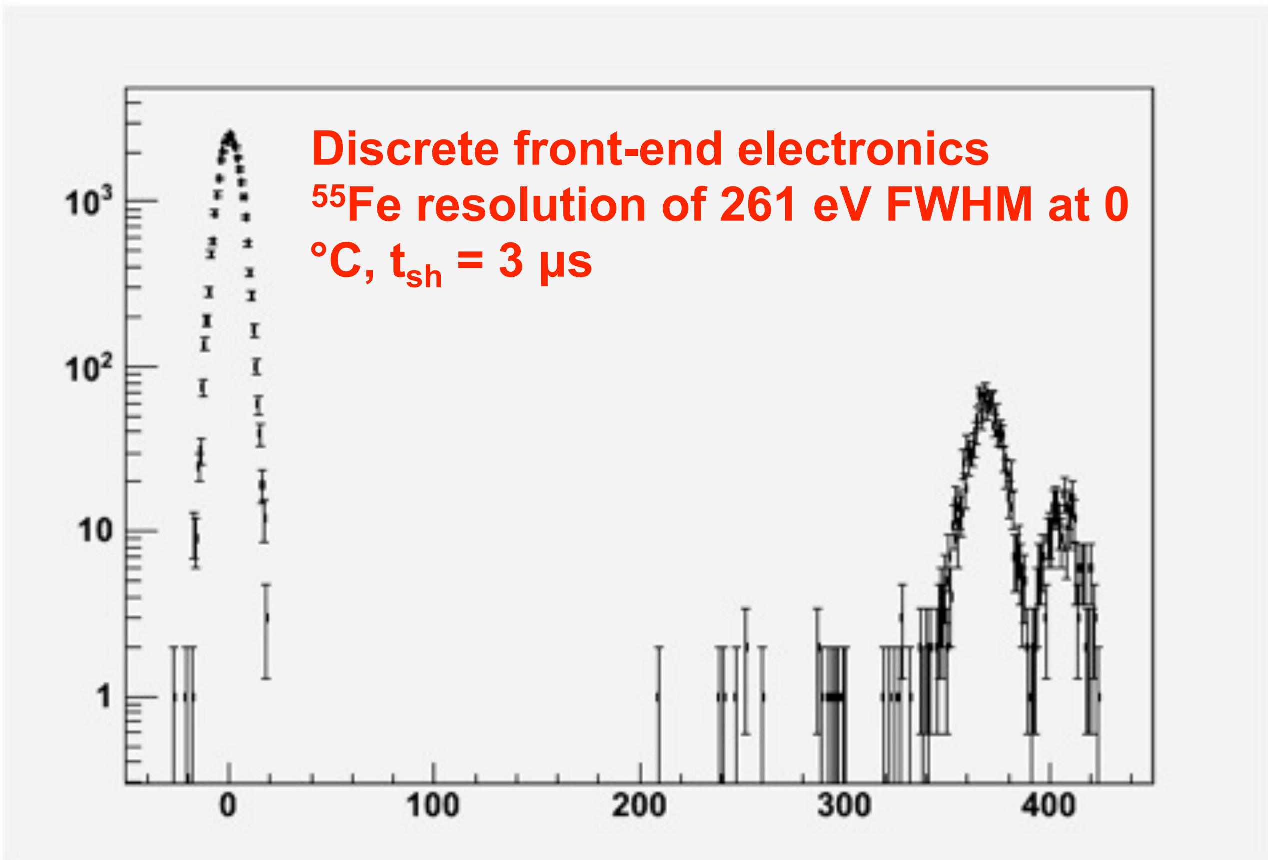
Second prototype production (started end of May 2011, first results by 12/2011):

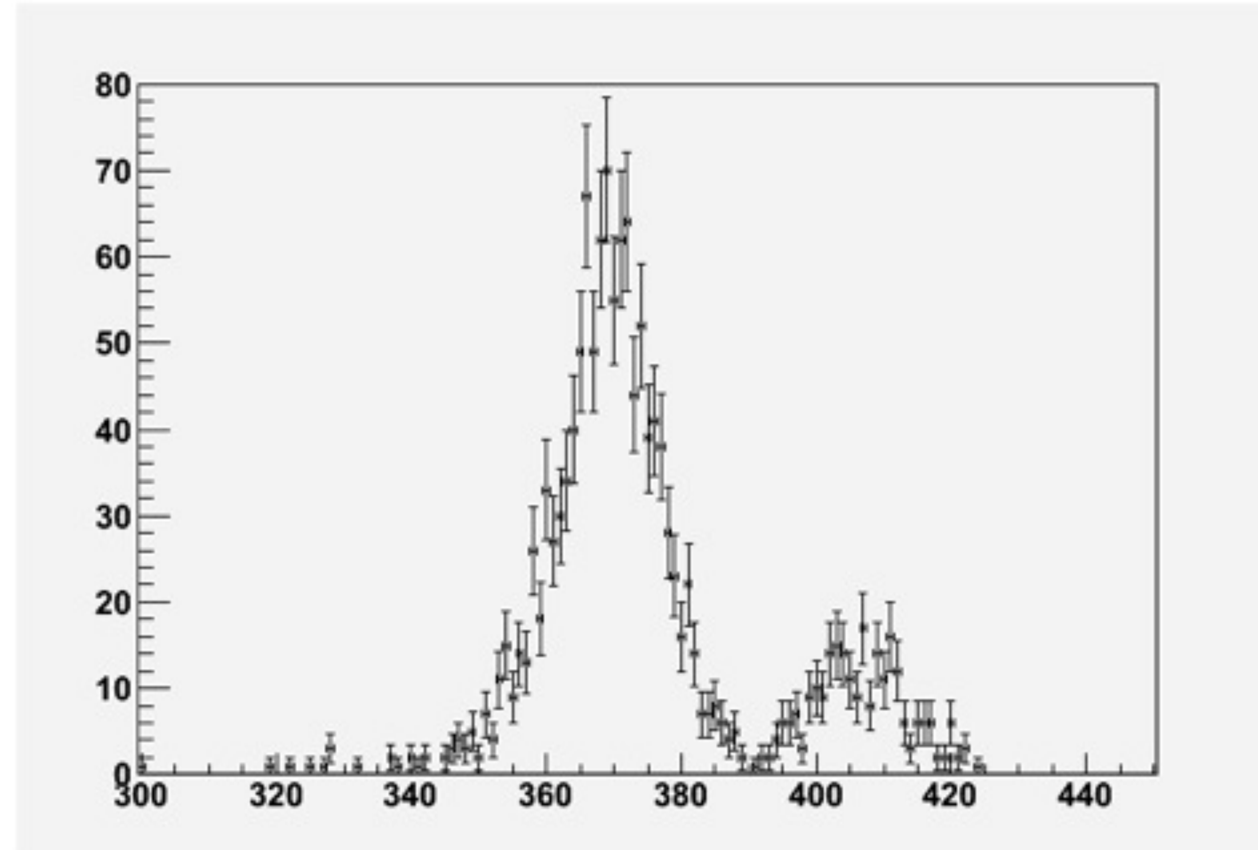
- Largest SDD area in 4" wafer; leakage minimization; large anode pitch to optimize energy resolution in a detector half, small anode pitch for imaging in the second half



Second prototype wafer layout

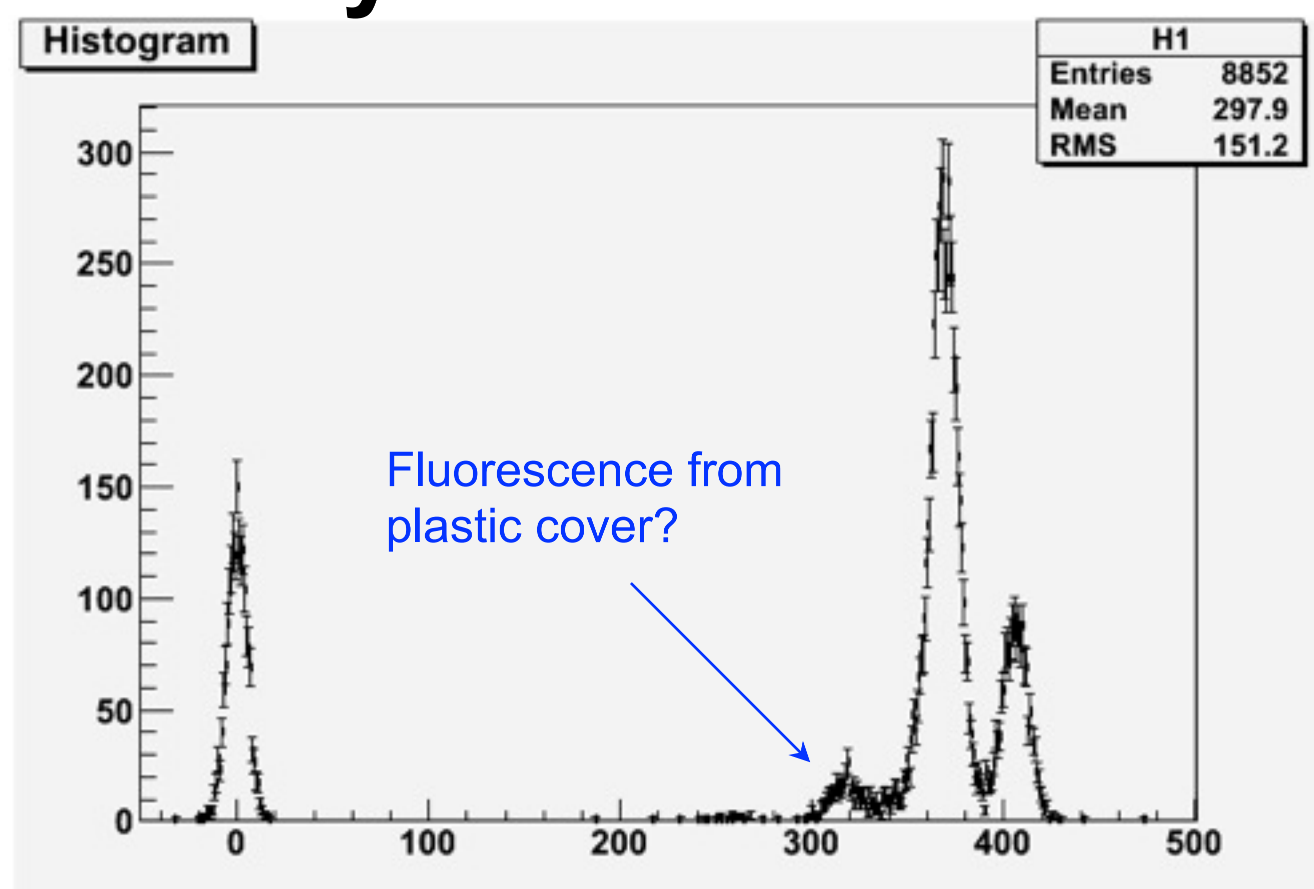
ALI2 detector





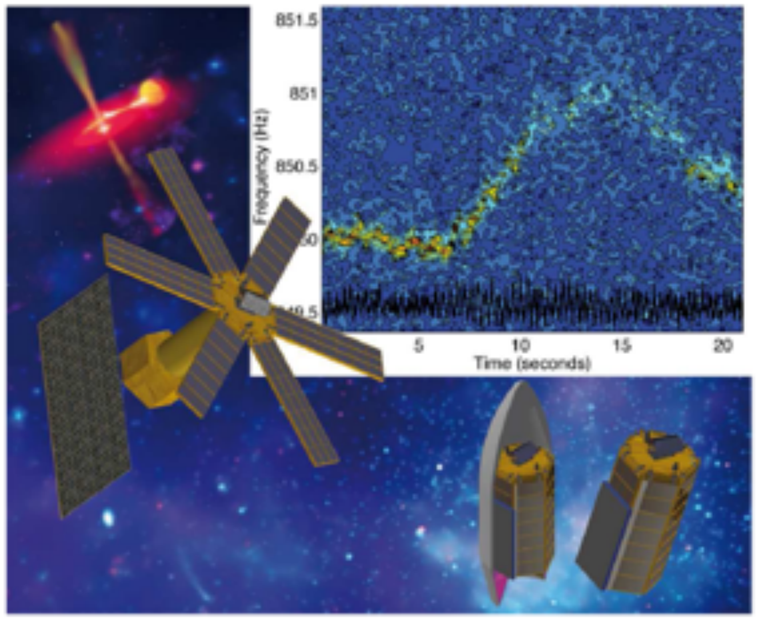
Hexagonal array

- Discrete front-end electronics
- JFETs placed closer to the anodes than the ALI2 setup → less series noise
- Cell sensitive area of 26 mm², array sensitive area of 2.6 cm²
- High leakage current: 23 pA at -10 °C but lower input capacitance (the second FBK run uses advanced steps to minimize leakage)
- ^{55}Fe energy resolution of 253 eV FWHM



XDXL's prospective: LOFT proposal for ESA M3 mission call has been selected (4 out of 40) for the assessment phase

Large Observatory For x-ray Timing



- Based on the SDD technology, a timing mission with an effective area of 12 m^2 (Large Area Detector, LAD)
- Lead glass micro-capillary plates used to collimate X-rays to limit the FOV to 1° FWHM
- X-ray Wide Field Monitor (WFM) based on coded mask architecture

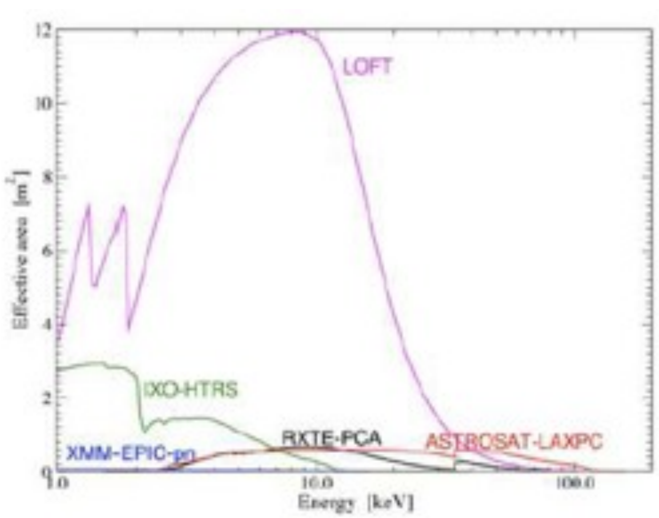
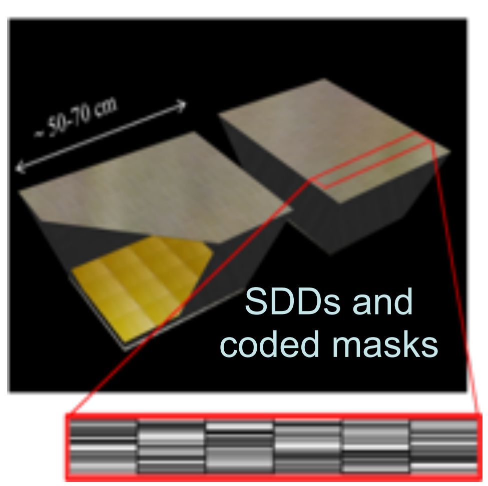


Fig. 2.2 LOFT effective area vs. energy, as compared to that of other satellite for X-ray astronomy



Scientific mission of the LOFT detector

The properties of ultradense matter
- Neutron star mass and radius measurements
- Probing neutron star crust properties

Strong gravity and the mass and spin of black holes
- Neutron star and stellar mass black holes
- Supermassive Black Holes

Plus additional Science Objectives
- The fast-timing variability space that will be explored by the LAD
- The longer timescale variability will be explored by the WFM, singling out specific source activities and/or spectral states
- LOFT has also a great potential for multi-wavelength programs carried out in conjunction with other state-of-the-art ground-based astronomical facilities as well as astronomical satellites

Tab. 4.1 Scientific requirements of the LOFT payload as derived by the science objectives

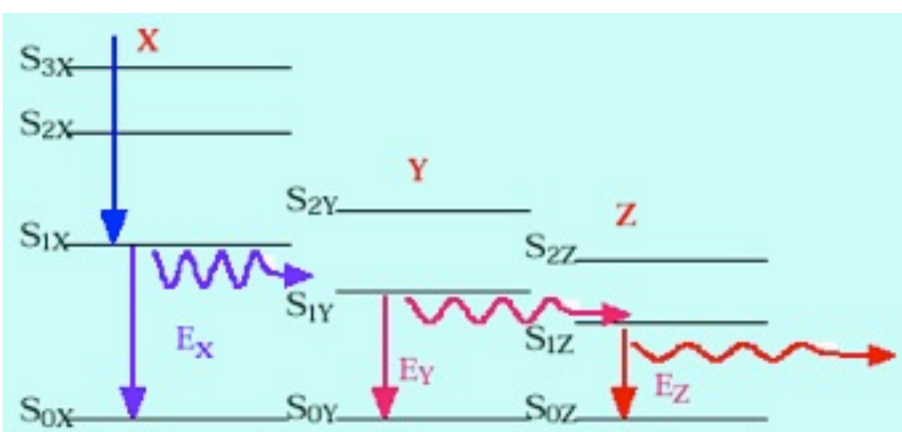
Parameter	Requirement	Goal
LAD		
Energy range	2–30 keV (nominal) 2-50 keV (expanded)	1–40 keV (nominal) 1–60 keV (expanded)
Effective area	12.0 m^2 (2-10 keV) 1.3 m^2 (@30 keV)	15 m^2 (2-10 keV) 2.5 m^2 (@30 keV)
Energy resolution (FWHM, @ 6 keV)	<260 eV (all events) <200 eV (40% of events)	<180 eV (all events) <150 eV (40% of events)
Field of view (FWHM)	<60 arcmin	<30 arcmin
Time resolution	10 µs	5 µs
Dead time	<0.5% (@ 1 Crab)	<0.1% (@ 1 Crab)
Background	< 10 mCrab	< 5 mCrab
Maximum source flux (steady, peak)	>300 mCrab, >15 Crab	>10 Crab, > 30 Crab
WFM		
Energy range	2-50 keV	1-50 keV
Energy resolution (FWHM)	<300 eV	<200 eV
Field of view	>3 steradian	>4 steradian
Angular resolution	5 arcmin	3 arcmin
Point source localization	1 arcmin	0.5 arcmin
Sensitivity (5 σ, 50 ks)	2 mCrab	1 mCrab
Sensitivity (5 σ, 1 s)	0.5 Crab	0.2 Crab

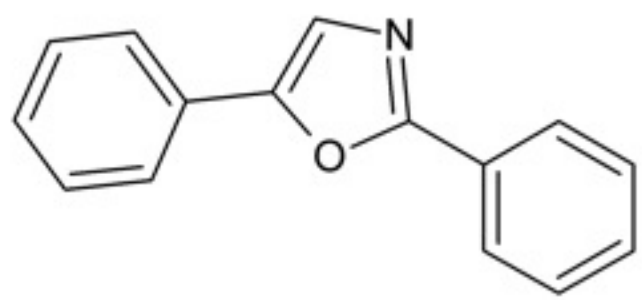
ORIONE

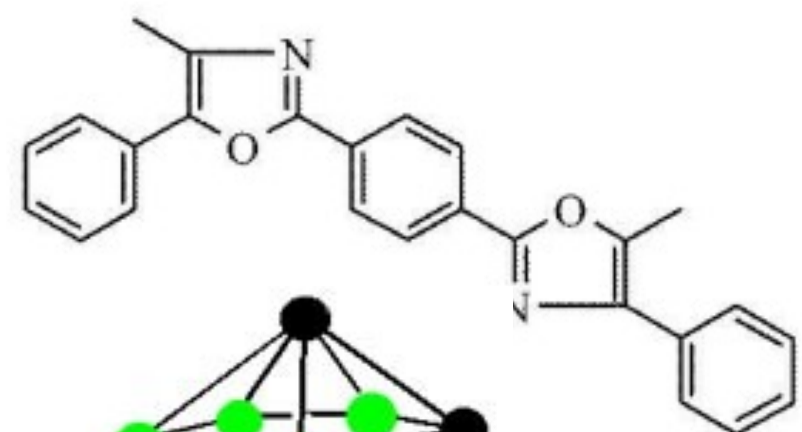
- Area:Detectors,Electronics
- Spokesperson:A.Quaranta (Trento)
- LNL,LNS

ORIONE

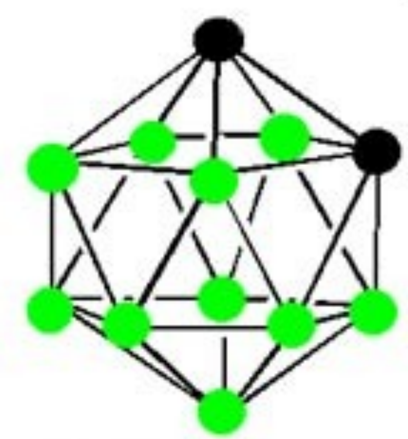
- New polysiloxane organic scintillators (PSS) for neutrons have been produced.
- Polysiloxane are materials stable from -100 to +200 °C and PSS for neutrons are quite cheap (about 1 €/g vs. 14 €/g for commercial boron doped plastic scintillators).
- Luminescent dyes were incorporated for promoting the energy transfer and high scintillation yields at about 430 nm (PPO +dPOPOP).



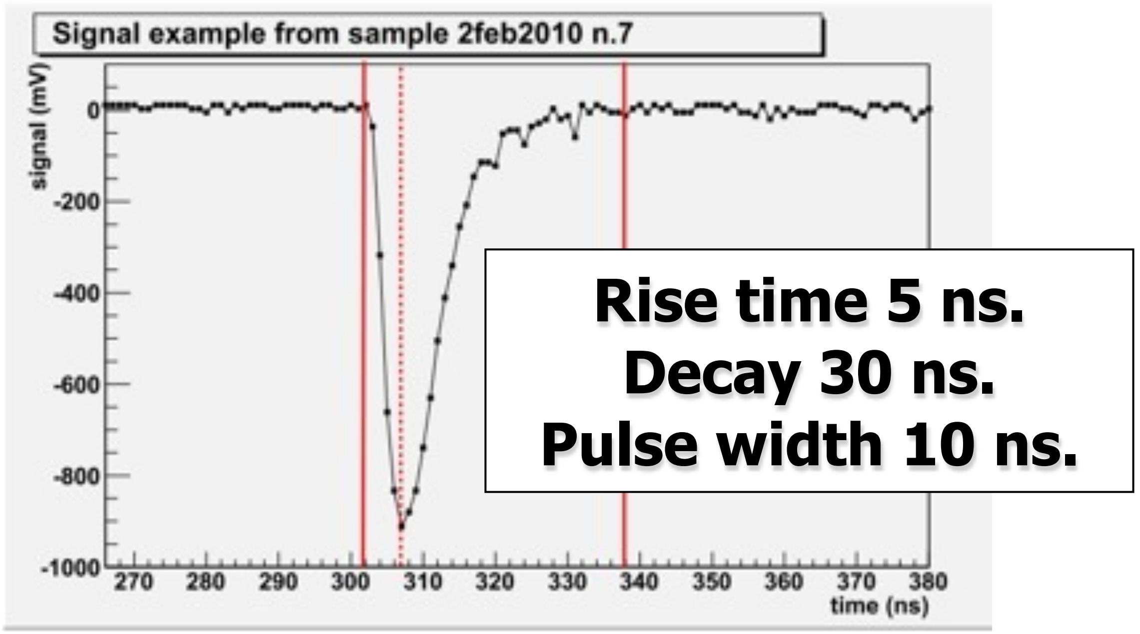




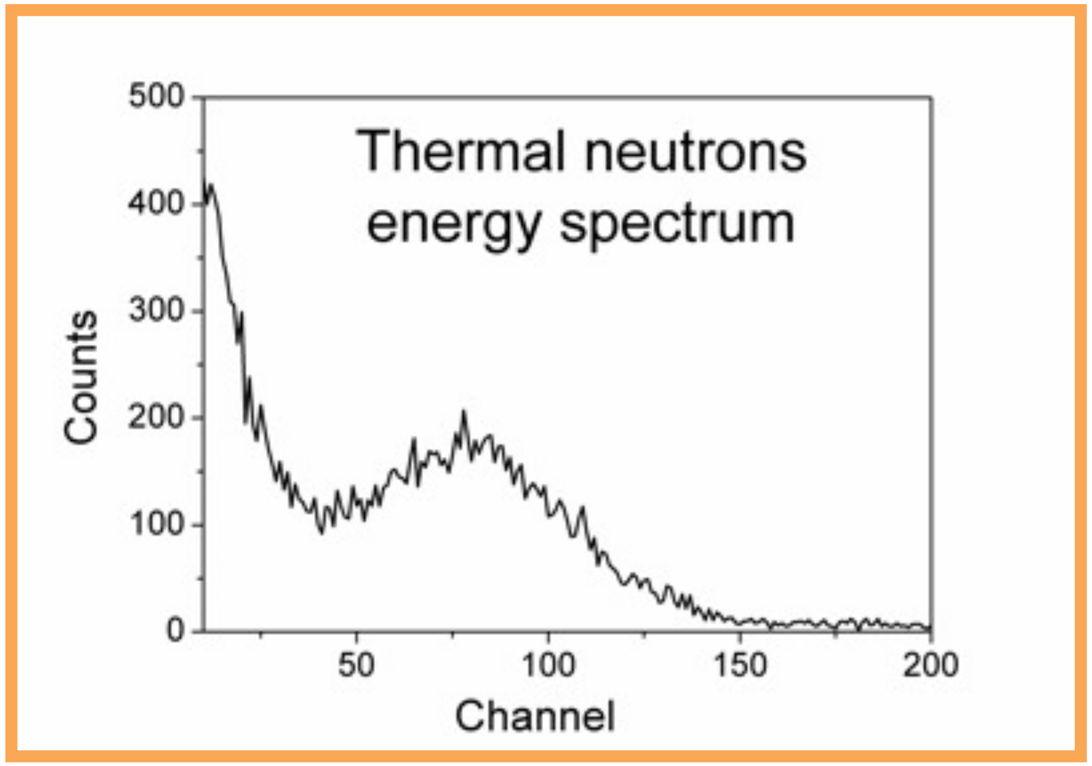
- O-carborane was used as thermal neutron sensitizer.

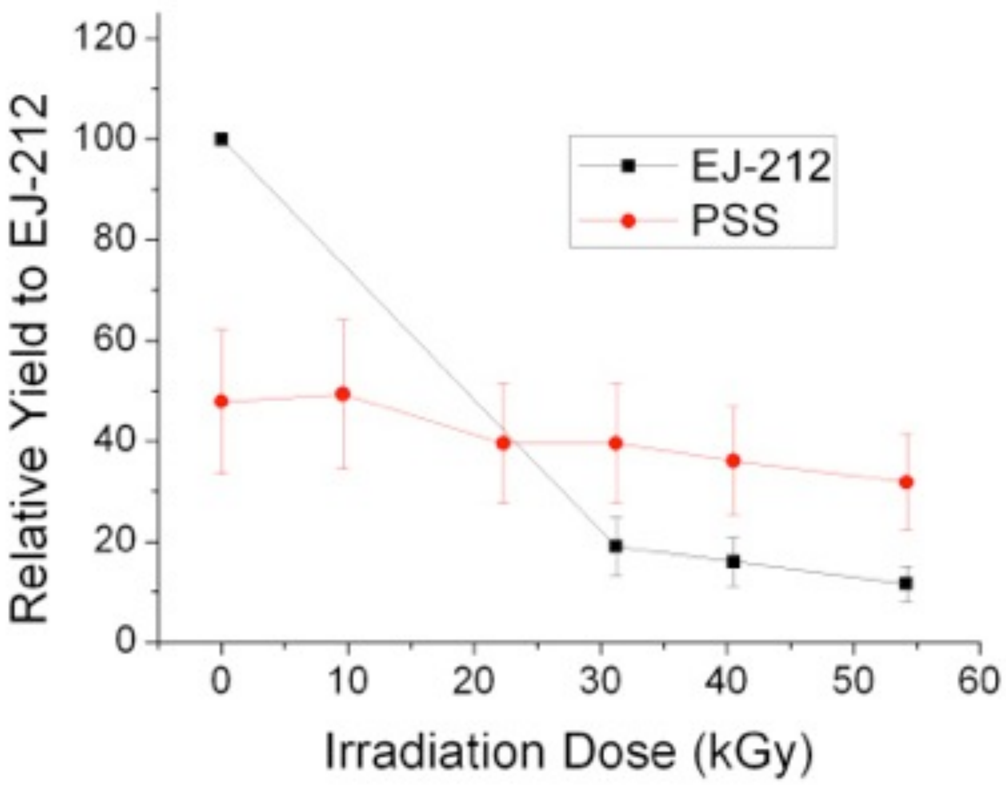


o-Karboran
1,2-$C_2B_{10}H_{12}$



➡ Synthesis based on liquid resins allows the synthesis of scintillators with a wide range of shapes and dimensions.





- Samples without B exhibit a scintillation yield near to EJ-212 (NE102 equivalent).

Sample	α yield (% EJ-212)	γ– yield (% EJ-212)	α yield (% EJ-254)	γ– yield (% EJ-254)
no B	65 ± 16	74 ± 15	-	-
B 4%	44 ± 13	49 ± 12	66 ± 22	69 ± 16
B 6%	40 ± 14	48 ± 11	64 ± 24	62 ± 15
B 8%	37 ± 13	41 ± 17	54 ± 17	57 ± 11

- Increasing the amount of B slightly affects the scintillation yield.

- B concentrations higher than commercial systems (5% max. in EJ-254) can be attained, by increasing the detection efficiency to thermal neutrons.

VIPIX

- Area:Detectors,Electronics
- Spokesperson:V.Re (Pavia)
- BO,PG,PI,PV,RM3

The INFN VIPIX project (Vertically Integrated PIXels)

- **6 labs participating in this program (P.I.: Valerio Re - PV)**:

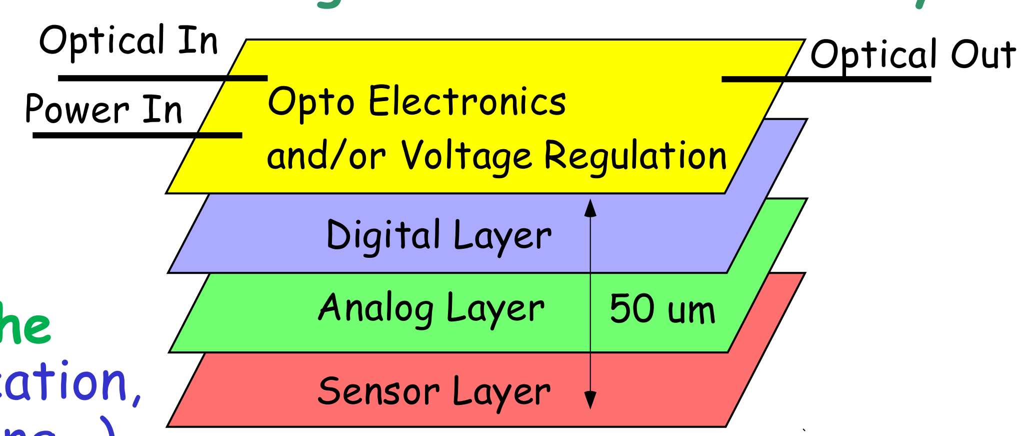
  Bologna, Pisa, Perugia, Pavia, Roma3, Milano

- **VIPIX is investigating the potential of 3D electronics:** "the vertical integration of thinned and bonded silicon integrated circuits with vertical interconnects between the IC layers."

  ⇒ Denser (smaller form factor), lower cost (less expensive than aggressive CMOS scaling), integration of dissimilar technologies (sensor, analog, digital, optical)

- **Vertically integrated pixel detectors** may be able to satisfy the needs of the next generation of **tracking and vertexing devices in high energy physics** experiments and of **imagers at advanced X-ray sources**:

  - **small pitch pixels** capable of handling high data rates.
  - **complex functionalities at the pixel level** (low-noise amplification, zero suppression, time stamping...)

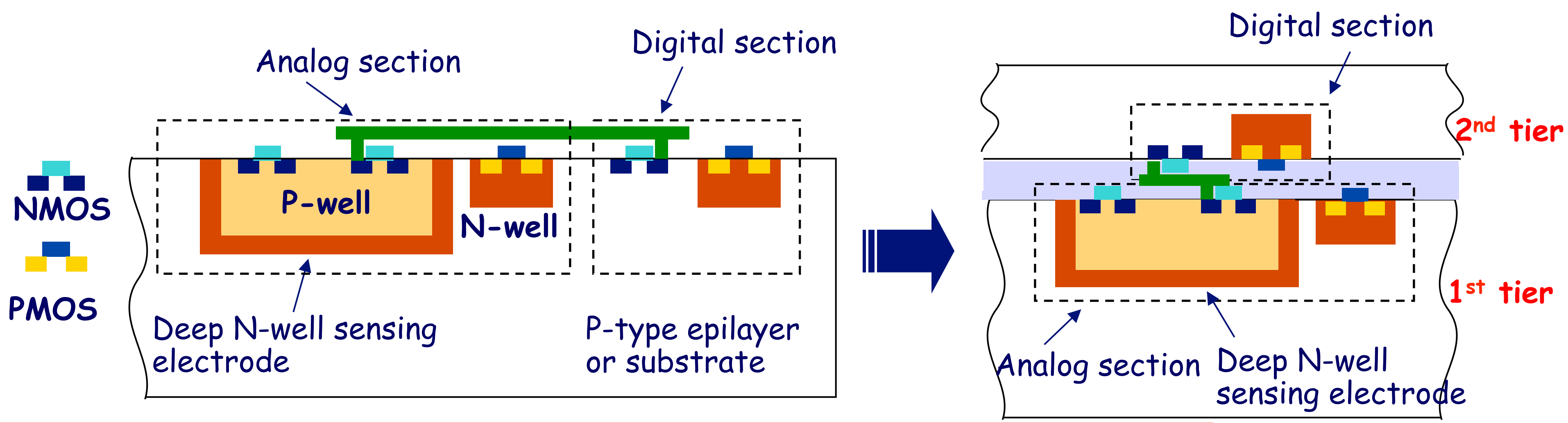


Physicist's Dream

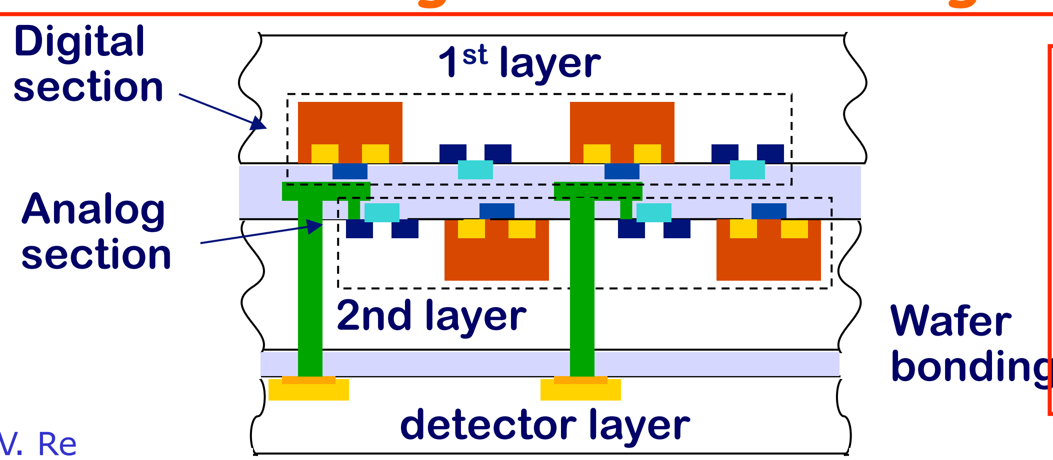
VIPIX concepts for 2-tier devices

3D CMOS sensors

Convert 2D MAPS device to a full CMOS 3D design, with digital readout separated from the sensor and the analog front-end



3D mixed-signal readout integrated circuits



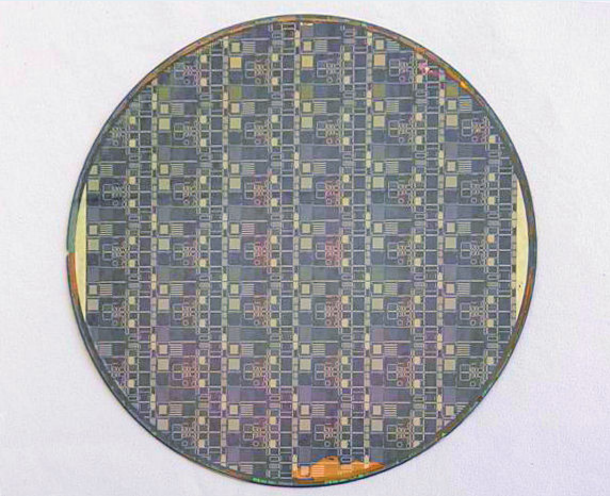
Interconnection between a 3D CMOS readout electronics chip and a fully-depleted high resistivity sensor, possibly with a low-mass, low-pitch technology

Fully-processed 3D wafers and 3D chips and future plans

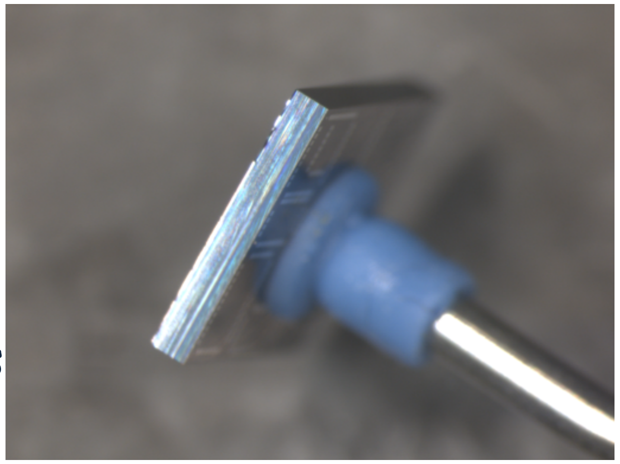
- The first 3D run was organized by the **3D-IC consortium** promoted by Fermilab; VIPIX is a member of this consortium together with 18 international groups
- The first 3D-IC run encountered various problems (eventually solved, but it took 2 years) in the design and fabrication stages. This is a hint that processing for 3D integration is not yet at the same confidence level as for standard CMOS.

  ⇒ **The growing interest for 3D integration will improve the reliability of these processes**

- First wafer-level tests in France show working TSVs and interconnections between tiers
- **Diced chips were finally delivered and testing is beginning now (mid October)**
- Preliminary test results, experience from the first run and support from MPW brokers CMP and MOSIS make us confident to go forward to a **submission of full-scale 3D devices in 1Q 2012:**
  - 3D CMOS sensors
  - 3D CMOS readout chip for high resistivity pixel sensors



First 3D wafers



First 3D chips

Helios

- Area:Accelerators
- Spokesperson:S.Gammino (LNS)
- LNS,Messina

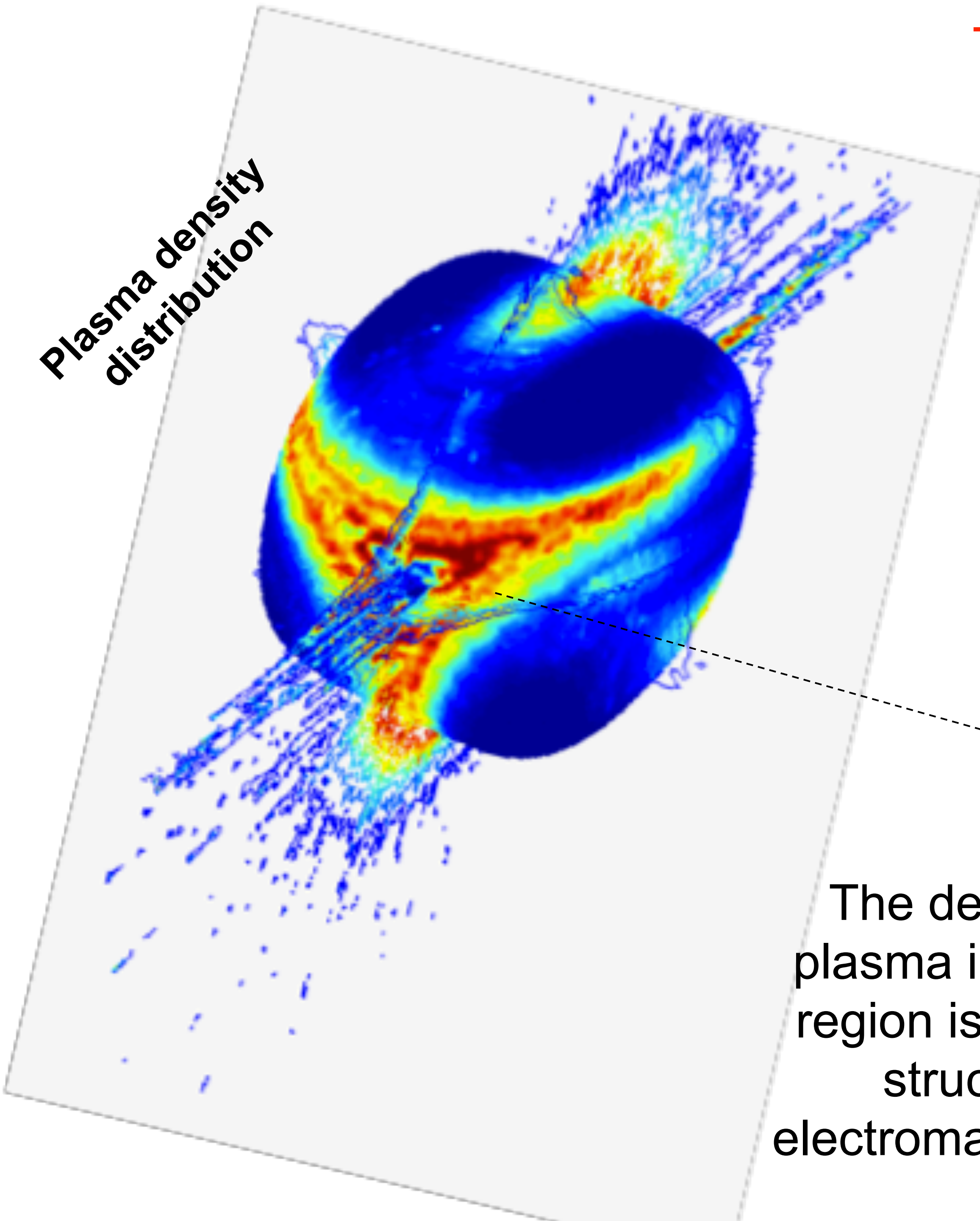
Goals

Improvements of the BEAM BRIGHTNESS for the next generation of ion sources by answering to open issues about the plasma heating dependence on operational parameters of MDIS (Microwave Discharge Ion Sources) and ECRIS (Electron Cyclotron Resonance Ion Sources):

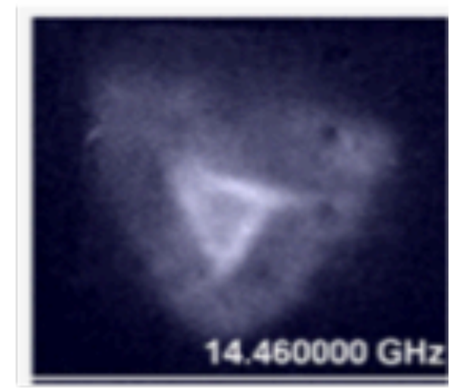
1. How does the RF heating respond to B profile adjustments (the problem of hot electrons)
2. What is the impact of RF heating on the ion beam formation mechanism (hollow beams and emittance)
3. What would be the advantage of alternative heating schemes (overcoming density limitations…)

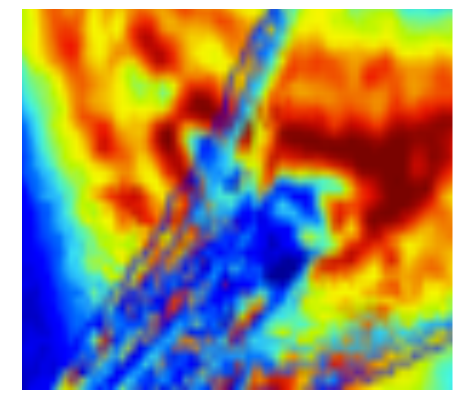
Explanation of frequency influence on ion dynamics and beam emittance

Ion beam properties are due to the density structure of the inner resonance plasma (THE PLASMOID)

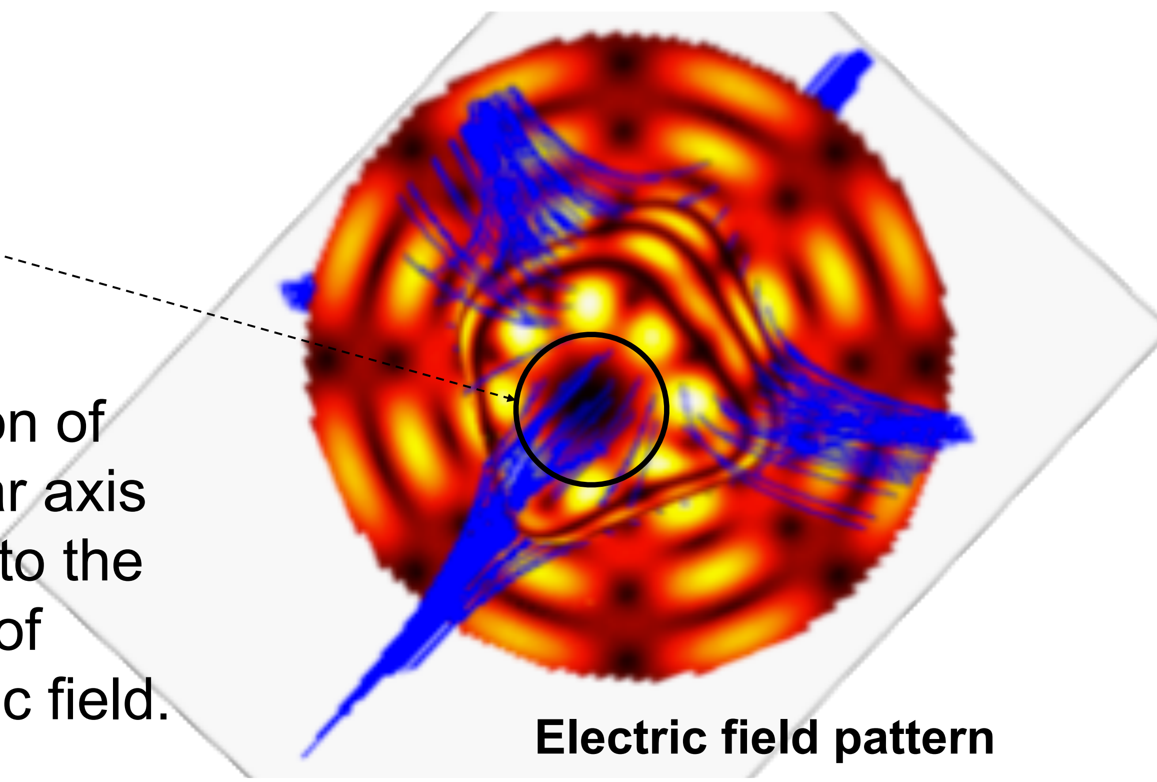


The density distribution explains why for some frequencies the beams appear hollow





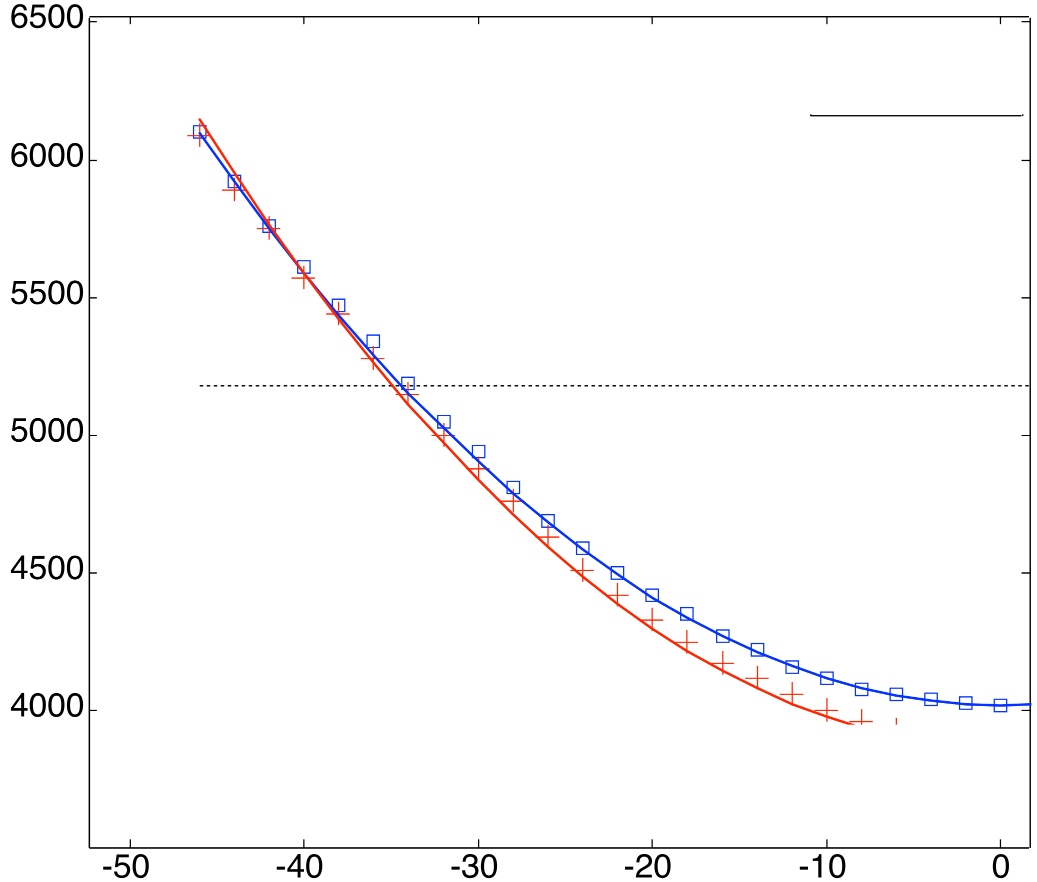
The depletion of plasma in near axis region is due to the structure of electromagnetic field.



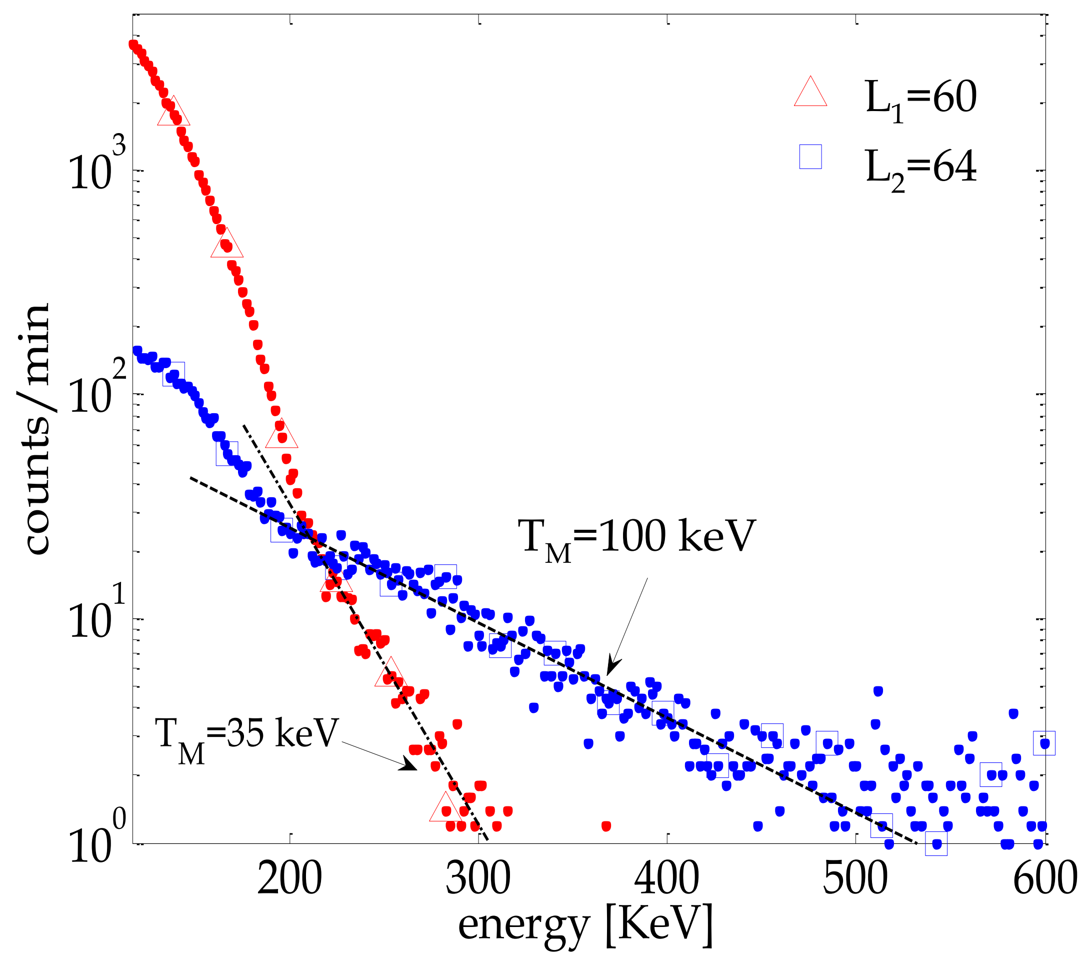
Electric field pattern

[D. Mascali et al. *Oral Presentation at ECRIS workshop* 2010, Grenoble, France]

Production of hot electrons (detrimental for the reliability of the magnetic system) strongly changes for slight variations of the B-profile



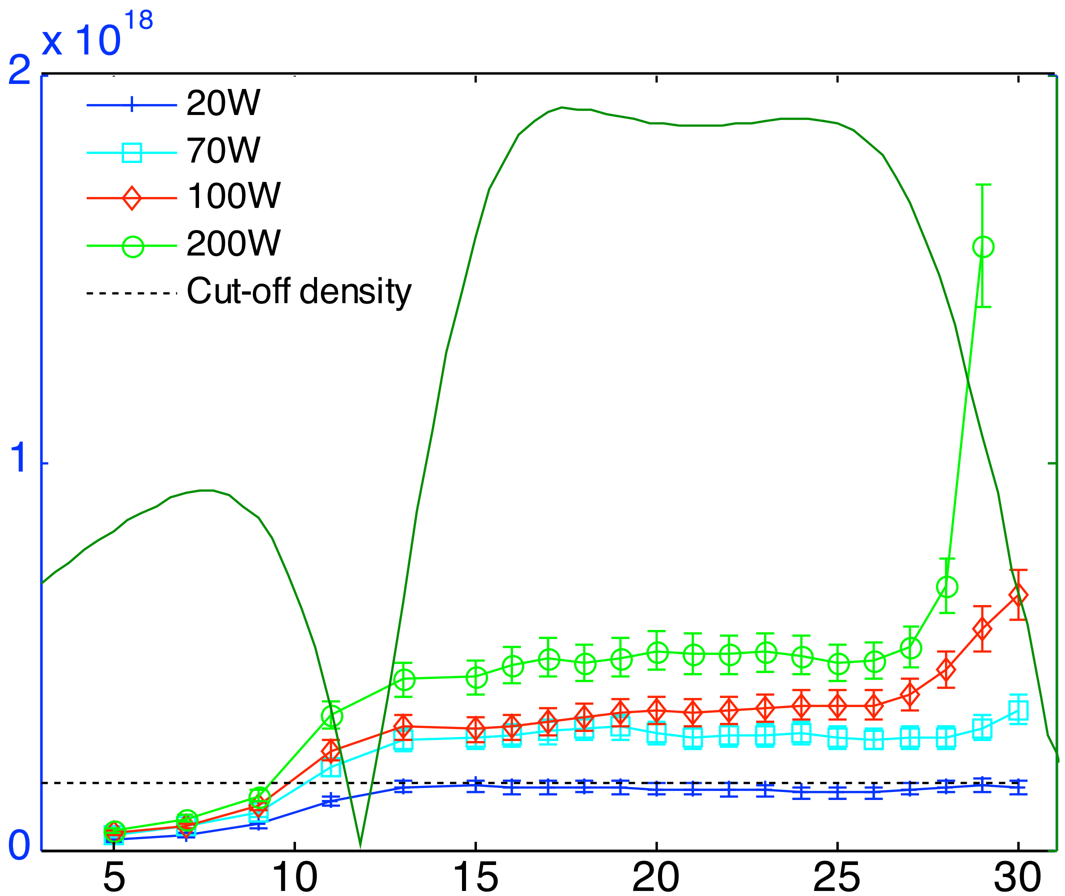
Comparison of the X-ray spectra obtained with slightly different B profiles

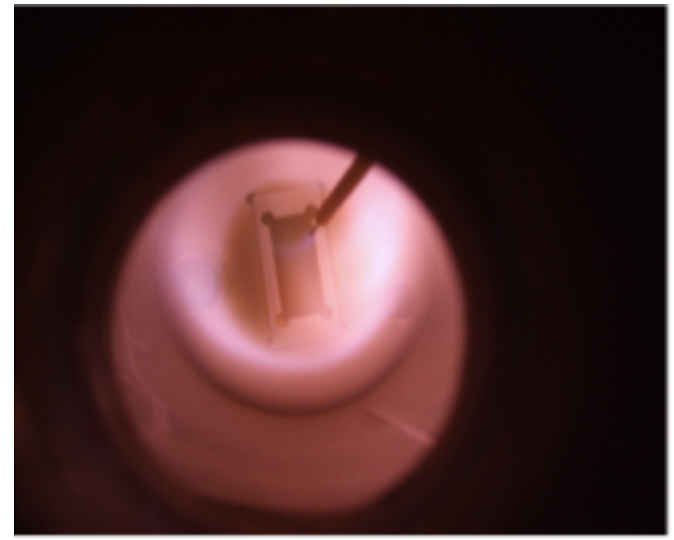


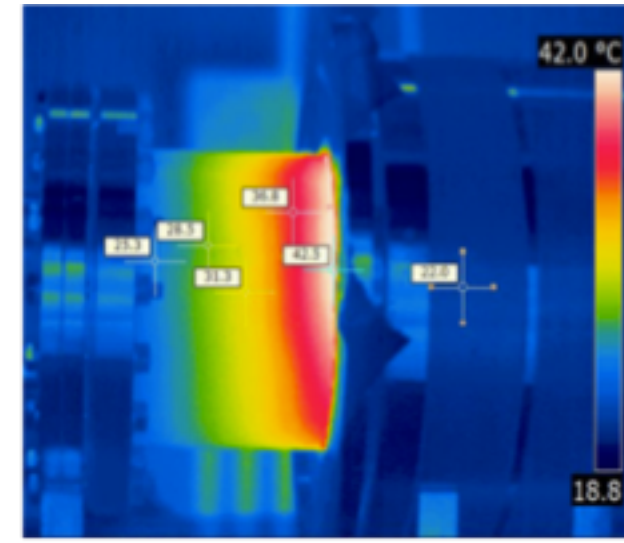
By changing the characteristic length of the mirror trap, L, of just 4mm, we obtained a completely different X-ray spectrum.

$$B = B_{\min}\left(1 + z^2 / L^2\right)$$

Generation of extremely overdense plasmas through ElectronBernsteinWaves in flat-B-field devices

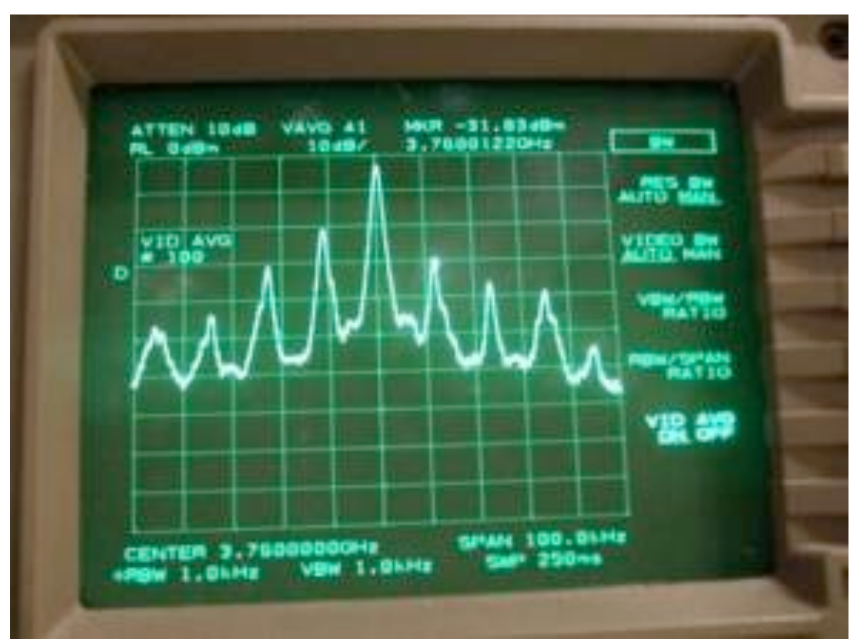




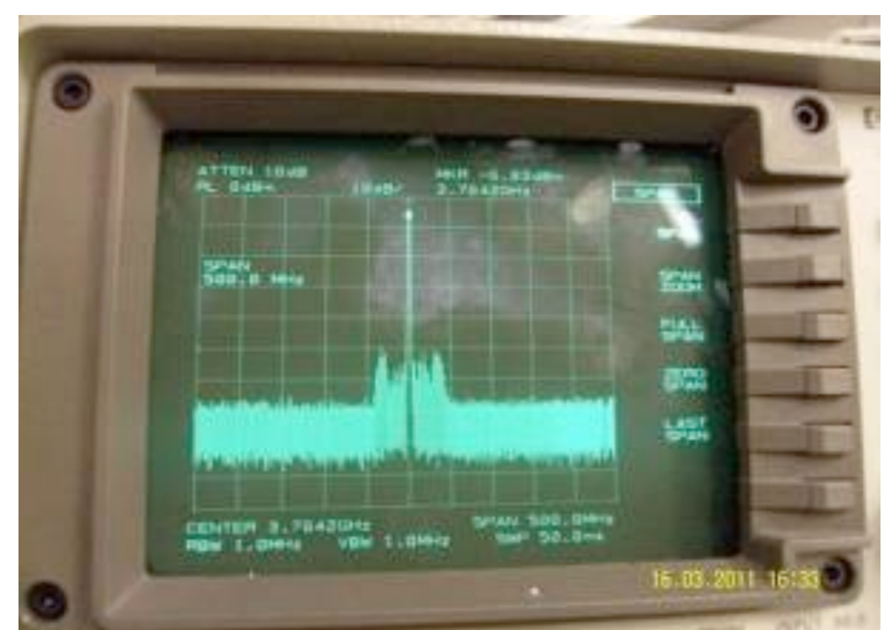


A bright ring has been observed, populated by multi-keV electrons

Sidebands are the fingerprint of EBW-generation!!
B field tuning plays a crucial role



KHz sidebands



MHz sidebands

[D. Mascali et al. *Nuclear Instruments and Methods A*, 2011]

Results of the HELIOS project

The new approach in plasma modeling:

- **Underlines the role played by RF heating** as additional plasma confinement tool
- **Explains the generation of hot electrons by means of turbulence** triggered by the plasma density profile: to suppress hard X-rays, UHR should be avoided (short L, non-axis symmetric B field);
- **Propose EBW-heating as a powerful tool to overcome density limitations in existing machines** (generation of extremely overdense plasmas in simplified magnetic structures).
- **THESE RESULTS DEMONSTRATE THAT IT IS POSSIBLE TO PRODUCE MUCH LARGER CURRENTS OF MONOCHARGED IONS THAN THE ONES AVAILABLE NOWADAYS IN MDIS; POTENTIALLY LARGER CURRENTS OF MULTIPLY CHARGED IONS MAY BE AVAILABLE**

TELMA

- Area:Interdisciplinary
- Spokesperson: E.Previtali (Milano Bicocca)
- LNGS,MIB,PV

TELMA

Trace Element Measurements and Analysis

Collaboration:

Gran Sasso National Laboratory
Milano Bicocca
Pavia

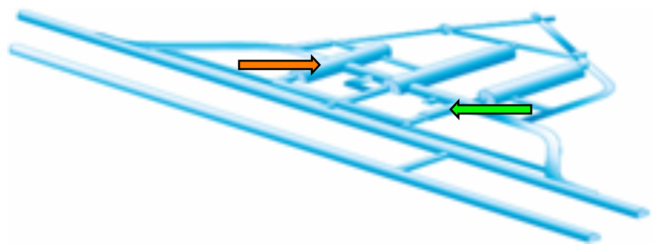
Study, optimization and application of trace element analysis in:

- rare events search experiments
- environmental measurements and analysis
- archeological and historical studies
- ……..

Developed techniques and methods with:

- gamma ray spectroscopy with HPGe
- neutron activation analysis (NAA)
- high resolution mass spectrometry (ICP MS)

Facility for Low Level Radioactivity Measurements



Laboratori Nazionali del Gran Sasso

HPGe installed underground
Shielded with very pure materials
Antiradon systems fluxed with nitrogen

Low Level facility at LNGS is the world wide most sensitive Laboratory to detect radioactivity contamination in materials

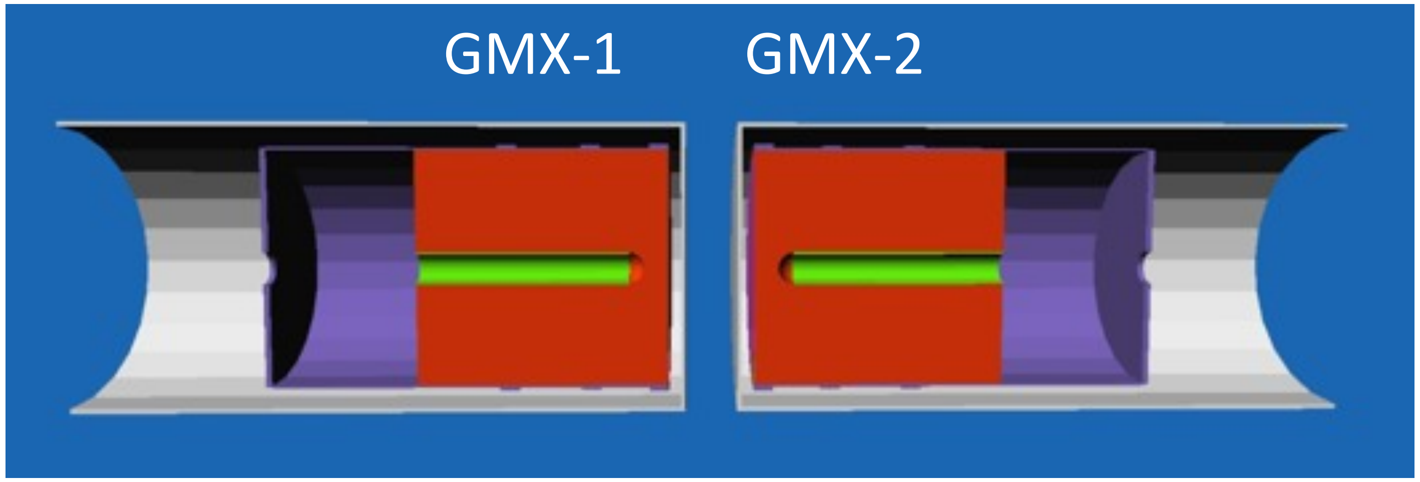
In collaboration with many international Institutions and manufactories
the sensitivity of the HPGe detectors
were improved time by time

time ↓

detector	total and peak background count rate [d^{-1} kg^{-1}_{Ge}]			
	40-2700 keV	352 keV	583 keV	1461 keV
GeMi	555 ± 7	4.1 ± 1.0	1.4 ± 0.5	6.1 ± 0.8
GePV	498 ± 5	2.6 ± 0.7	1.8 ± 0.4	3.2 ± 0.4
GsOr	442 ± 5	2.0 ± 0.5	0.76 ± 0.35	4.2 ± 0.5
GePaolo	222 ± 2	1.1 ± 0.3	0.31 ± 0.16	1.8 ± 0.2
GeCris	77 ± 2	0.29 ± 0.22	< 0.13	0.88 ± 0.22
GeMPI	30 ± 2	< 0.07	< 0.06	0.24 ± 0.03

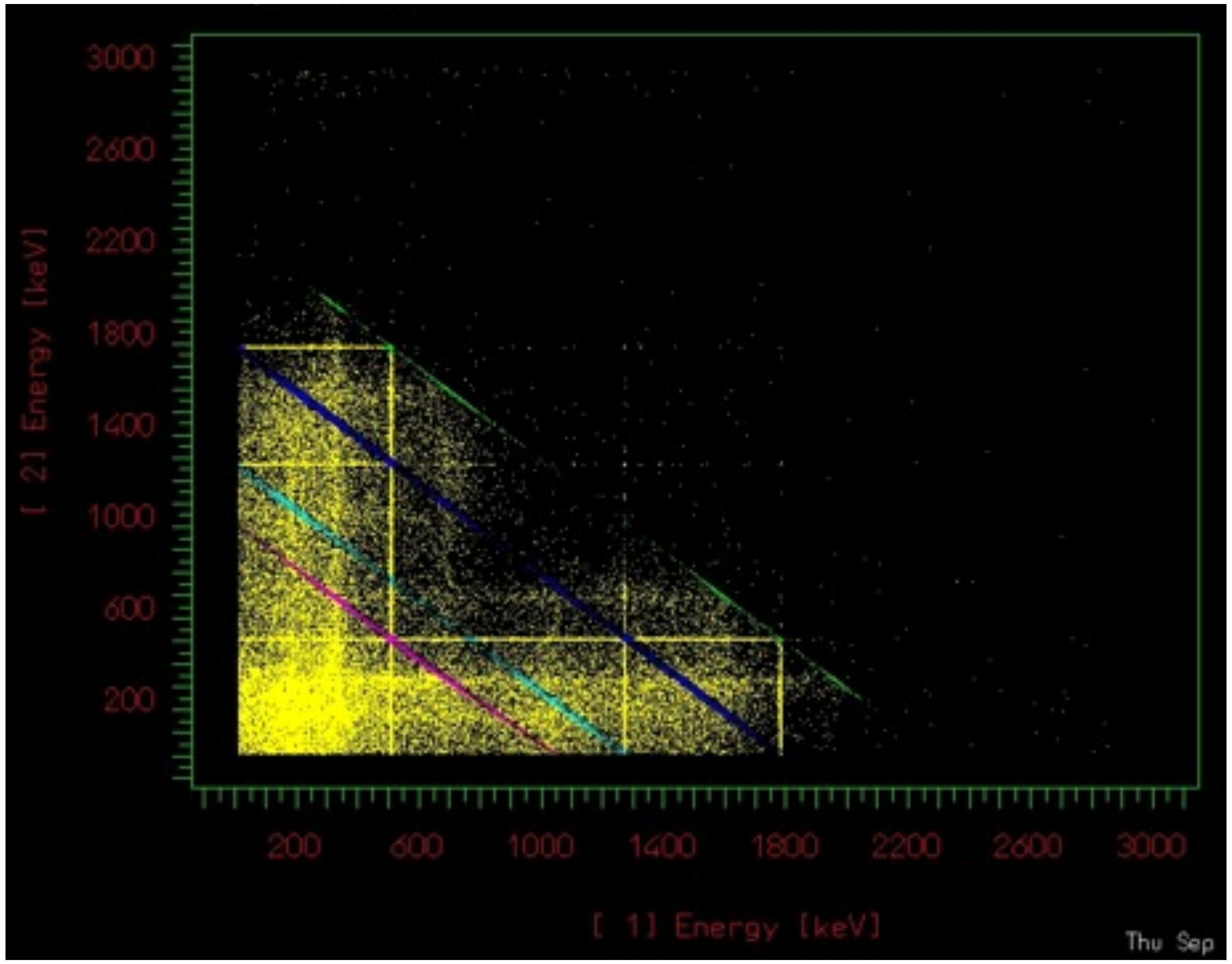
Development of Low Background techniques

Two HPGe detector:
- n type for low energy threshold
- 100% relative efficiency (95 cm diam)
- Selected materials for low radioactivity
- Detectors are operated in coincidence



Scatter plot reconstruction of ^{22}Na source

Detector GMX-2



Detector GMX-1

Thanks to detection system configuration
- efficiency coincidence larger then 50%
- selection of single isotope decays
- strong reduction of gamma background
- allows measurements of gamma cascade

With specific DAQ and dedicated analysis a sensitivity in the range of 10^{-12} g/g for ^{238}U and ^{232}Th with relatively low mass of samples can be obtained

Strategic Facility

- SPARC-LAB
- ELI
- European Spallation Source
- XFEL
- Hadrontherapy center in Catania
- CNAO

High Priority

- Detector for XFEL experiment
- Detector to be installed at the neutron spallation source
- Sensors and microelectronic
- Hadrontherapy
- Advanced medical imaging

High Priority

- Demonstration of a FEL driven by a plasma accelerator
- High-brigthness beam
- TeraHertz radiation
- Compton source
- Ultrafast material science
- Laser-plasma acceleration
- Ion sources