LNF:
New trends of Frascati

Andrea Ghigo

INFN

The Italian Institute for Nuclear Physics is the Italian research agency dedicated to the study of the fundamental constituents of matter and the laws that govern them, under the supervision of the Ministry of Education, Universities and Research (MIUR). It conducts theoretical and experimental research in the fields of subnuclear, nuclear and astroparticle physics.

INFN Structure

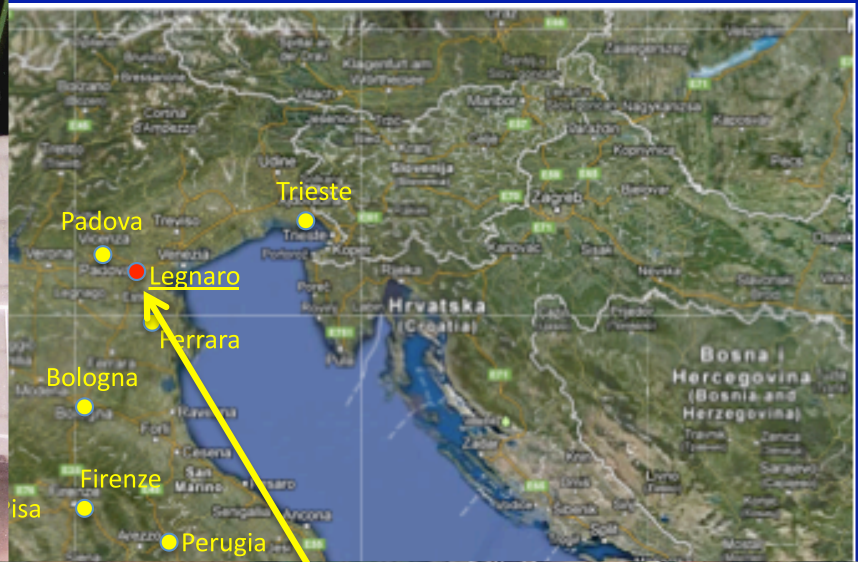
The INFN carries out research activities at two complementary types of facilities: divisions and national laboratories

20 divisions are based at different university physics departments and guarantee close collaboration between the INFN and the academic world.

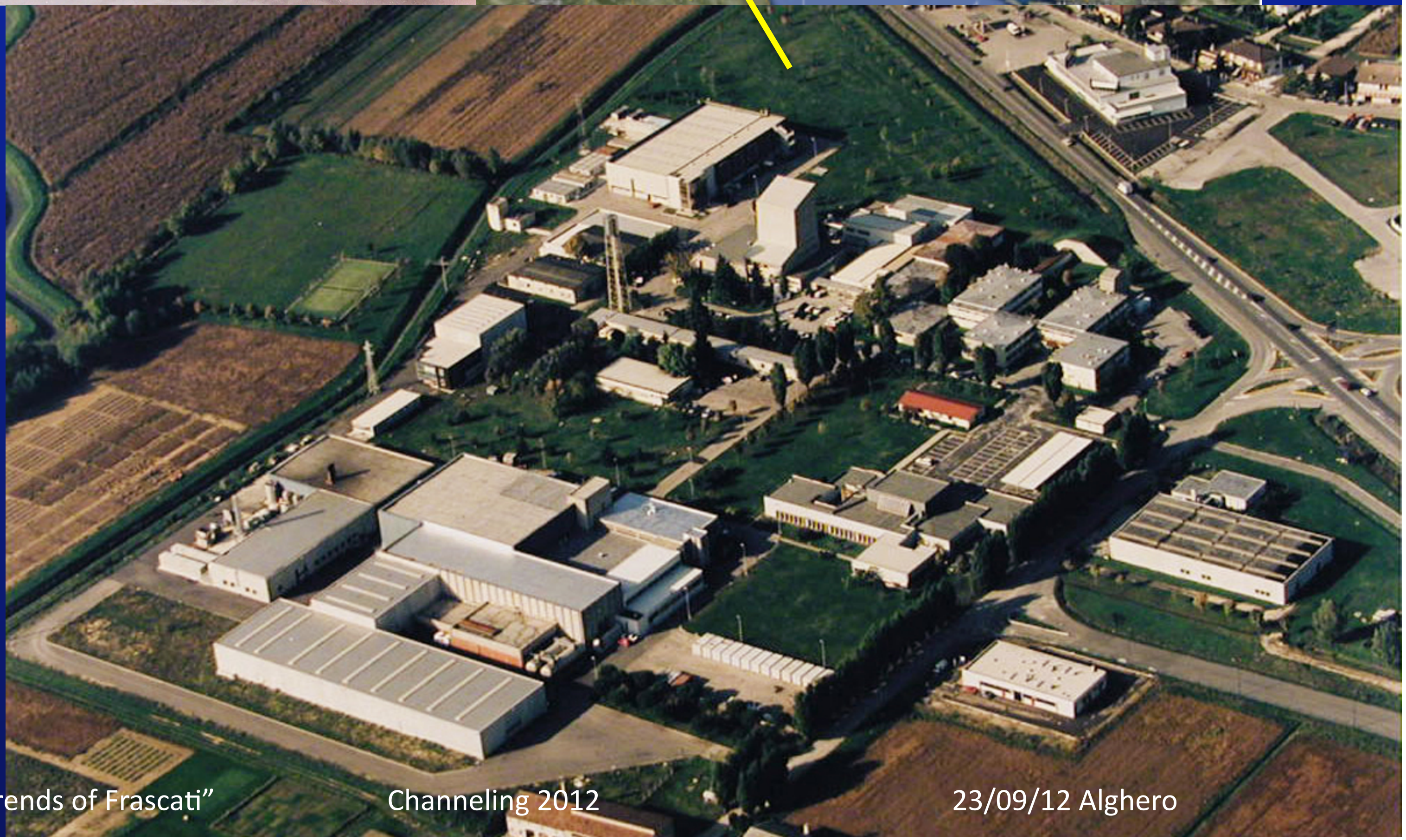
The four national laboratories, based in Catania, Frascati, Legnaro and Gran Sasso, house large equipment and infrastructures

LNF Laboratori Nazionali di Frascati

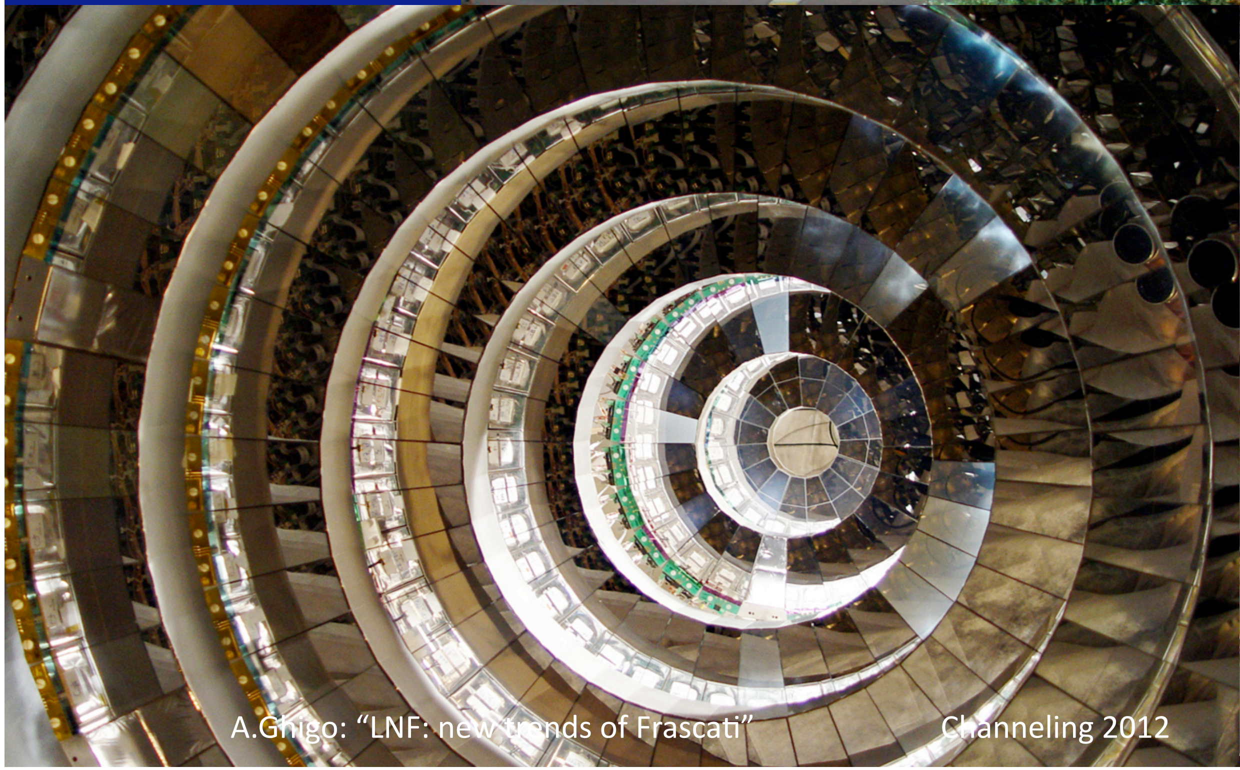
LNGS Laboratori Nazionali del Gran Sasso



LNGS Laboratori Nazionali di Legnaro

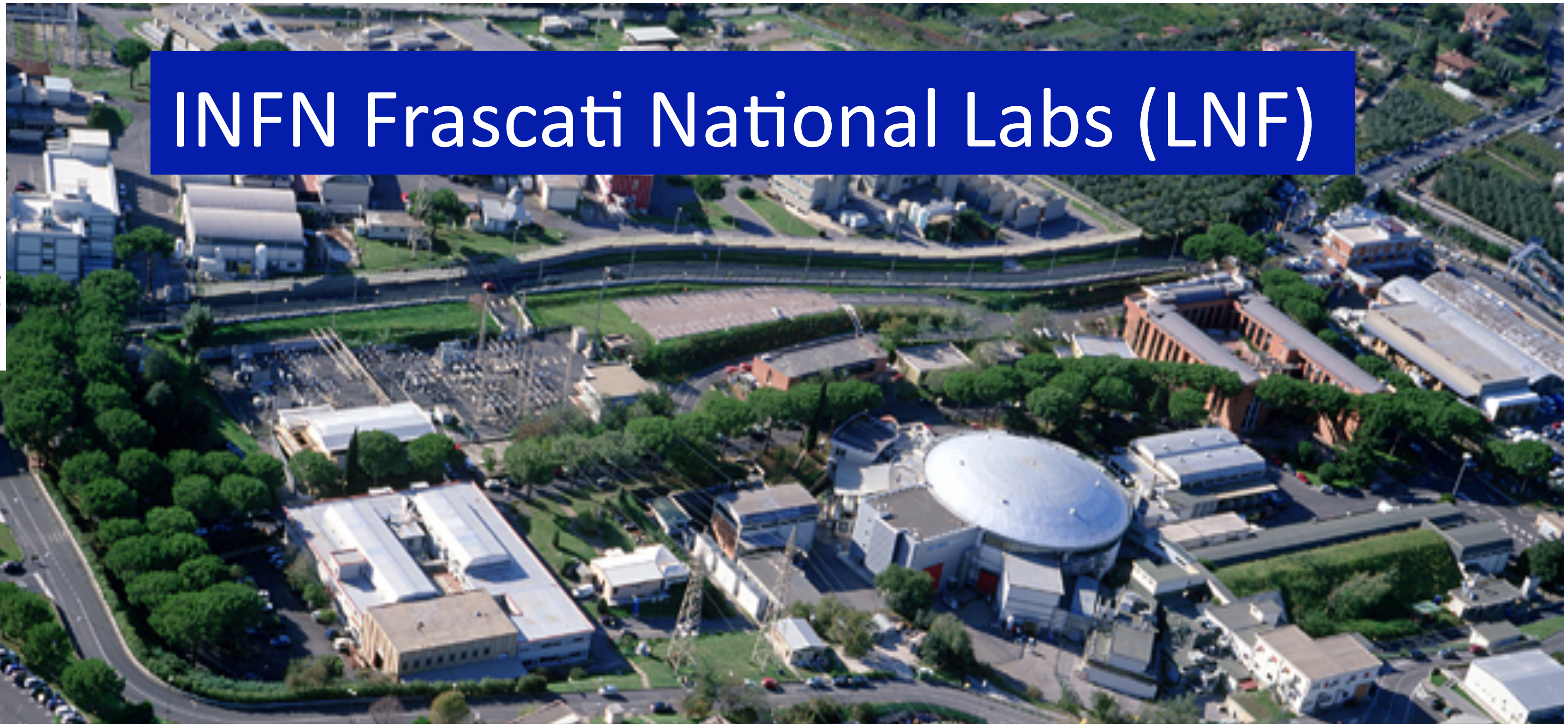


LNS Laboratori Nazionali del Sud

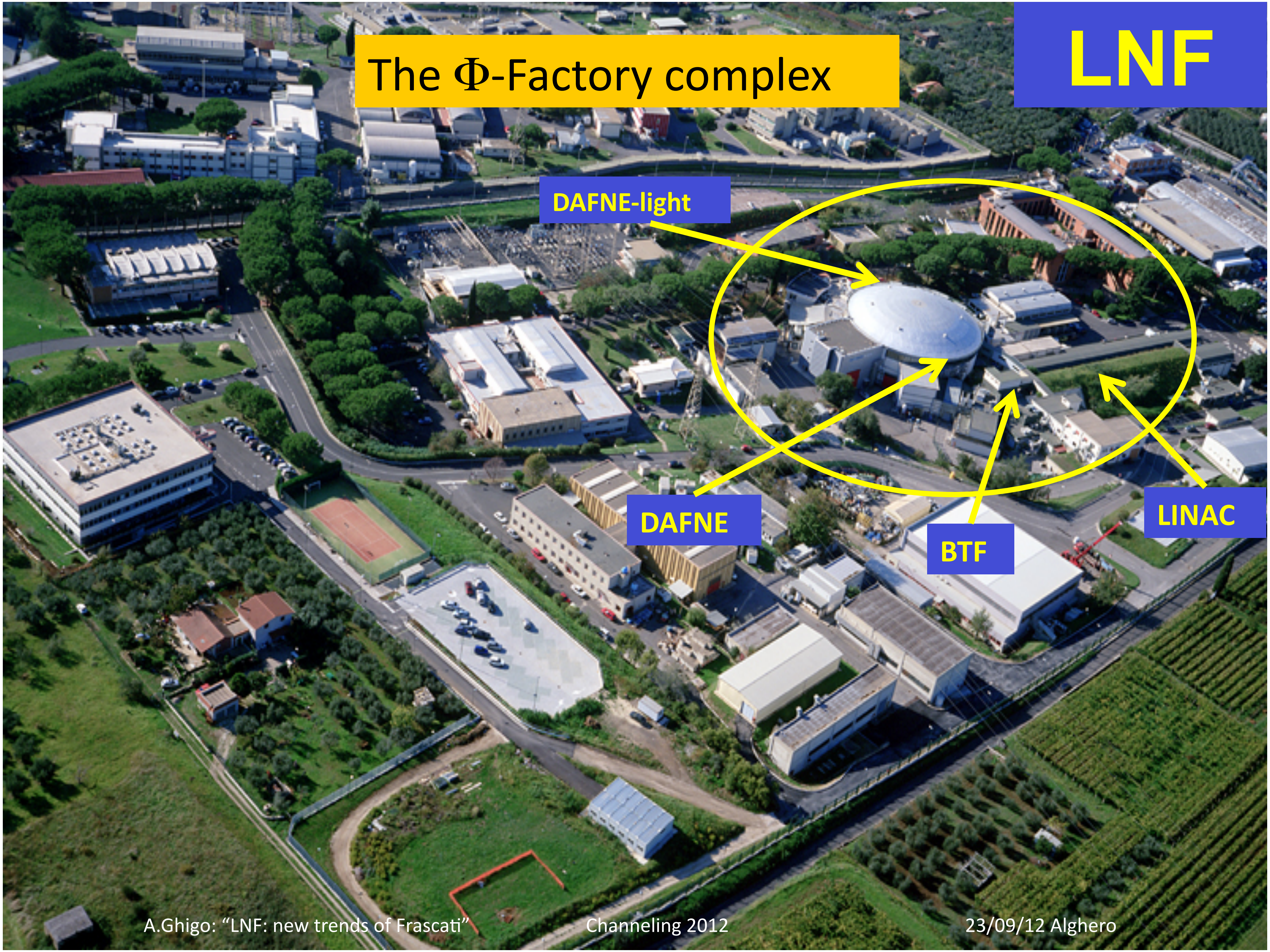


INFN Frascati National Labs (LNF)

INFN
Istituto Nazionale
Di Fisica Nucleare
Laboratori Nazionali di Frascati



Total Staff of which: **364**	**Researchers 98**	**Technologist/ Engineers 57**	**Technicians 170**	**Administration/ Services 39**
External Users 546	**Italian 346**		**Foreign 200**	
Visitors 3960	**Stages 310**	**Conference Workshops 17**	**Participants to Conf. / Work. 776**	**Master Courses 1 (27 positions)**


The Φ-Factory complex
LNF
DAFNE-light
DAFNE
BTF
LINAC

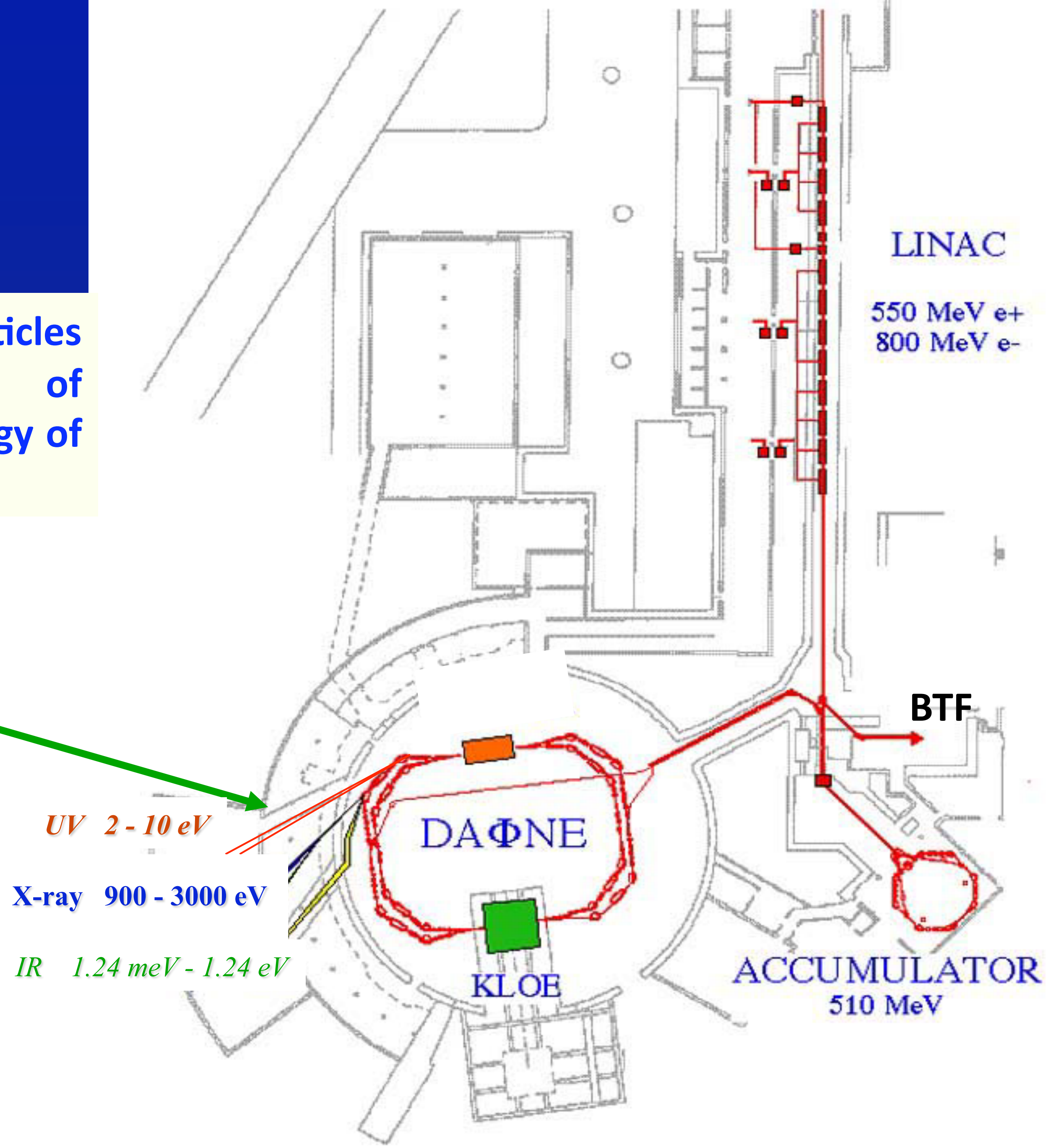
DAΦNE

The Φ-Factory complex

Abundant production of Φ particles coming from the annihilation of electrons and positrons at the energy of the Φ- resonance.

Syncrotron ligth from DAFNE

LNF are part of the European Infrastructure
for syncrotron light



Luminosity Frontiers in Leptons Factories

New colliding schemes for reducing beam-beam effects
(limiting beam currents and increasing beam dimensions)

$$L \propto f \frac{N_1 N_2}{\sigma_x \sigma_y}$$

Intensity frontiers
+ Energy frontiers
Power frontiers
Dimension frontiers

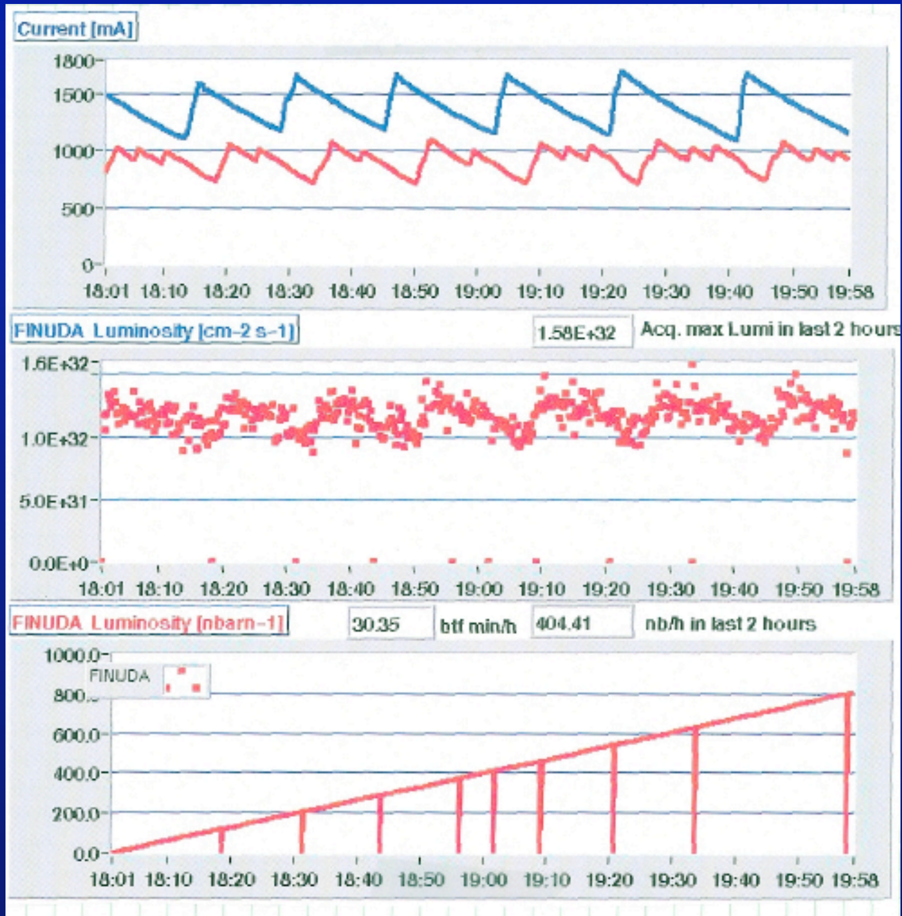
Operating factories	Crossing scheme
BEPC II - tau	'classical' scheme
VEPP2000 -2 GeV	round beam
DAFNE - PHI	crab waist - > (SuperB)
KEKB - B	crab cavity

DAΦNE – LNF - FRASCATI

e+ e-
E = 0.51 GeV
L = 4.5 10^{32} cm^{-2} sec^{-1}

Gain in luminosity

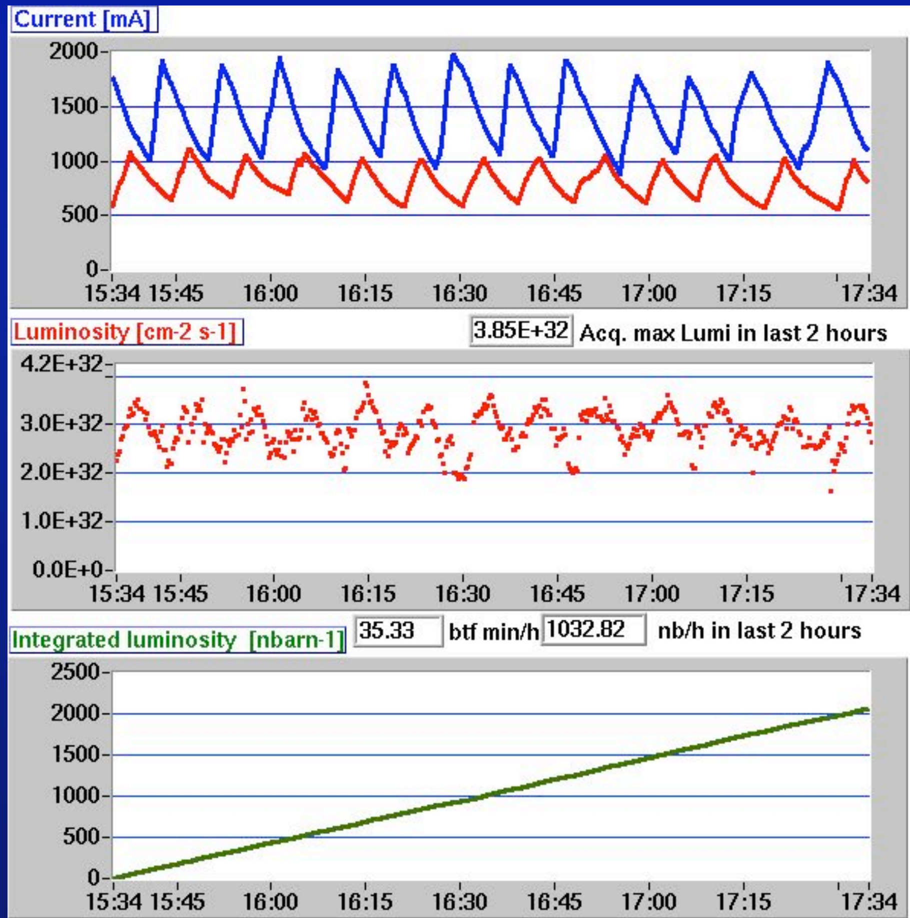
KLOE classical with apparatus solenoidal field



L_{max} =**1.7 10^{32} cm^{-2} sec^{-1}**

0.4 pbarn^{-1} / hour

Siddharta CRAB waist without solenoidal field

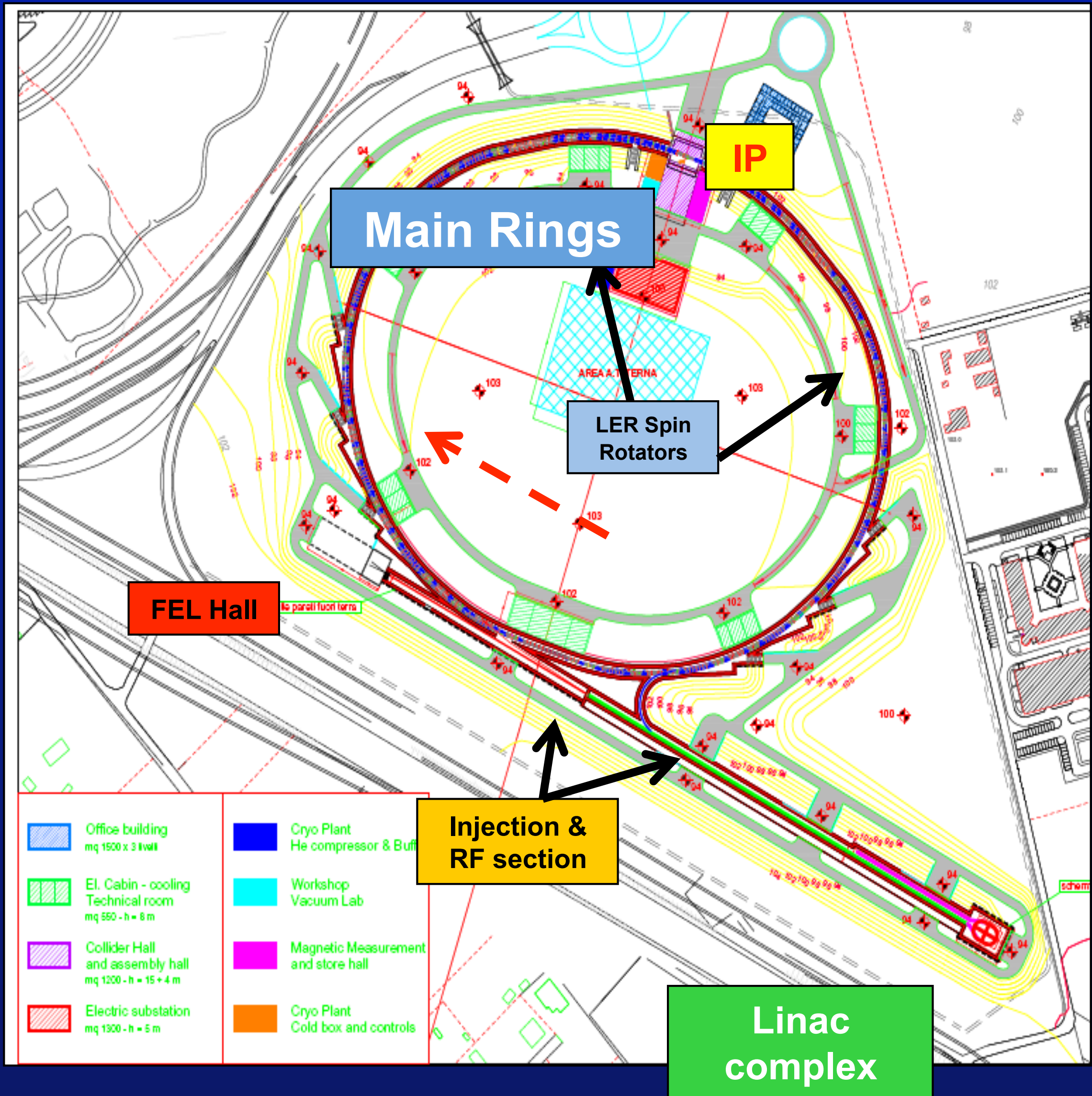


L_{max} = **4.5 10^{32} cm^{-2} sec^{-1}**

1.0 pbarn^{-1} / hour

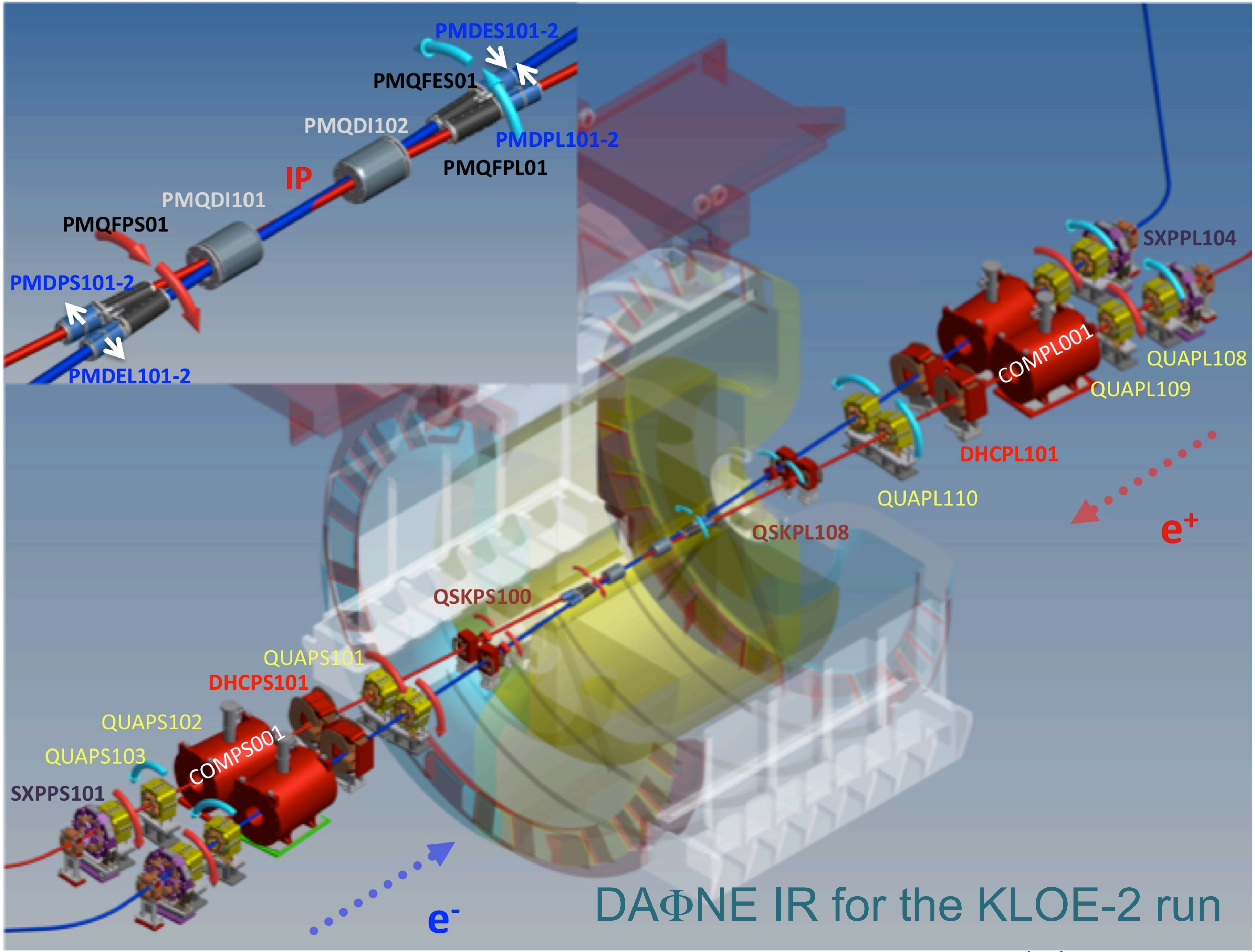
SuperB @ Tor Vergata University campus

Layout



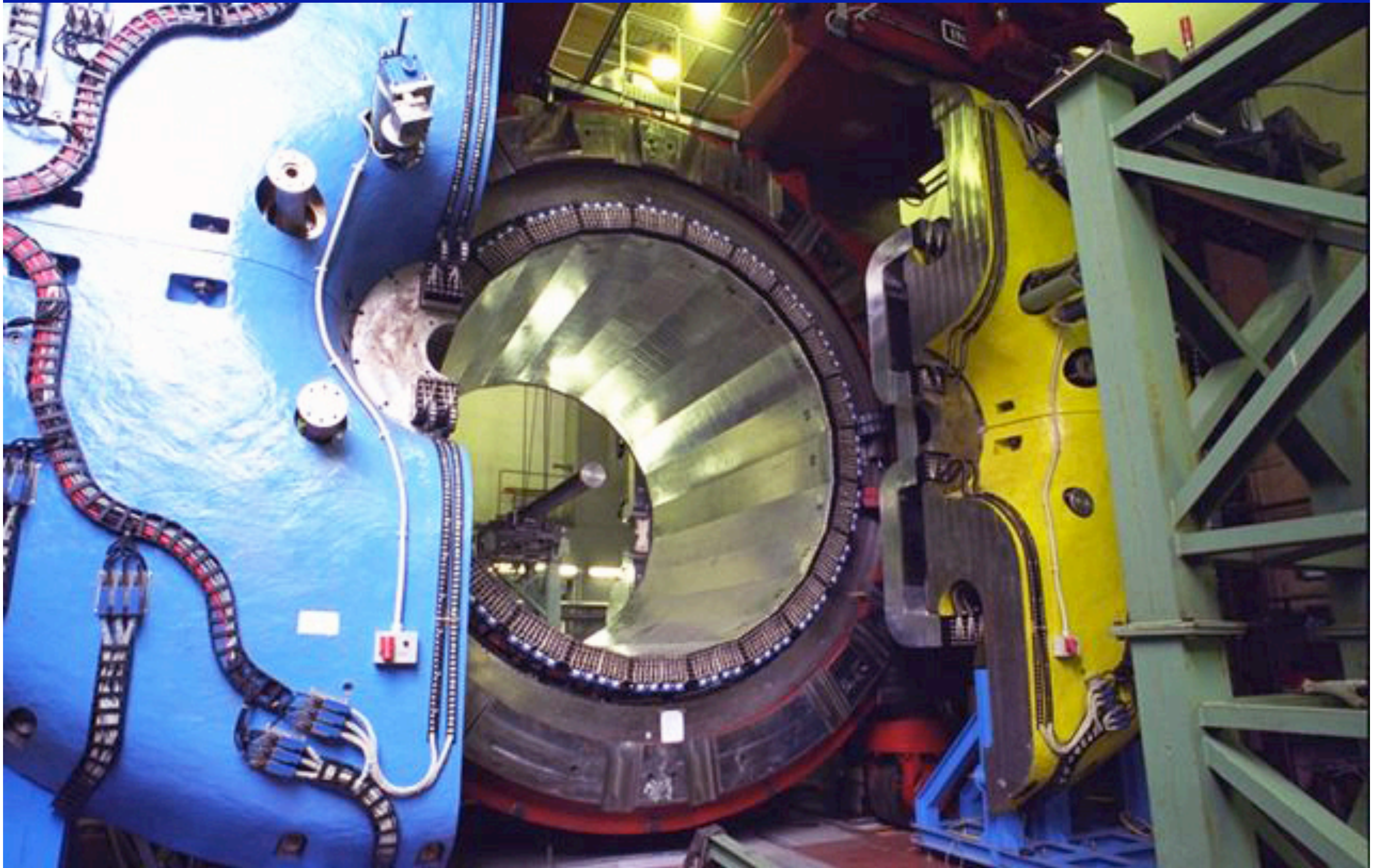
Main parameters

Parameter	SuperB	
	HER (e^+)	LER (e^-)
Luminosity ($cm^{-2}s^{-1}$)	10^{36}	
C (m)	1200	
E (GeV)	6.7	4.18
Crossing angle (mrad)	60	
Piwinski angle	20.8	16.9
I (mA)	1900	2440
$\varepsilon_{x/y}$ (nm/pm) (with IBS)	2/5	2.5/6.2
IP $\sigma_{x/y}$ (mm/nm)	7.2/36	8.9/36
σ_l (mm)	5	5
N. bunches	978	
Part/bunch ($x10^{10}$)	5.1	6.6
σ_E/E ($x10^{-4}$)	6.4	7.3
bb tune shift (x/y)	0.0026/0.107	0.004/0.107
Beam losses (MeV)	2.1	0.86
Total beam lifetime (s)	254	269
Polarization (%)	0	70-80
RF (MHz)	476	

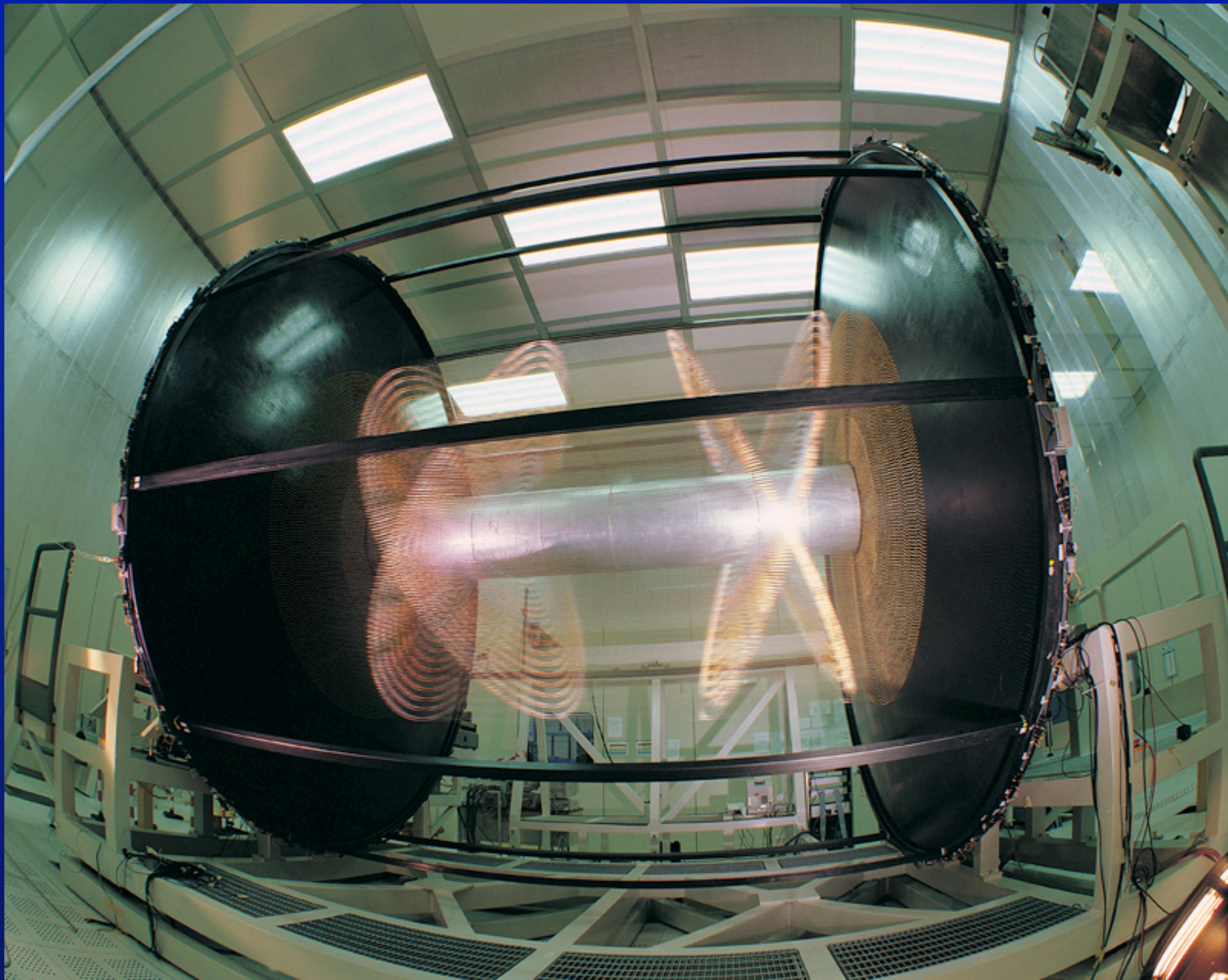


DAΦNE IR for the KLOE-2 run

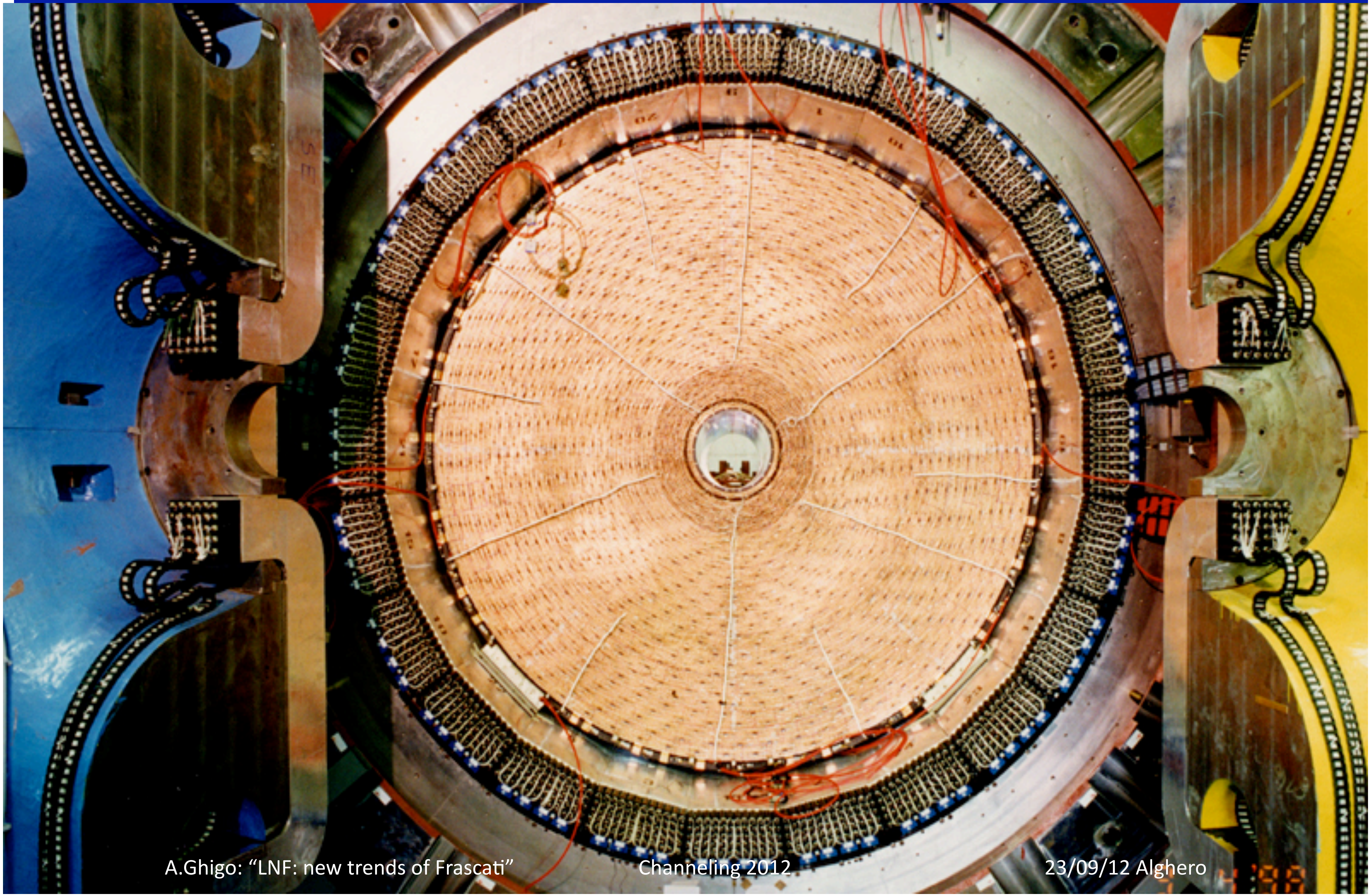
KLOE Experiment Detector: magnet and calorimeter



KLOE Experiment Detector: wire chamber



KLOE Experiment Detector



KLOE-2 Physics Program

"Natural" extension of the KLOE program in the field of flavour and hadronic physics, with some additions, such as $\gamma\gamma$ interactions, or searches for new light gauge bosons. **EPJC 68, 619-681 (2010)**

- Studies on CPT and QM violation with neutral kaons interferometry
- Tests of Lepton Flavor Violation with K_{e2} decays
- Studies on C, P, CP violation using rare η and K_S decays
- Tests of Chiral Perturbation Theory with η, η', and K_S decays
- Searches for signals of a Secluded Gauge Symmetry

Most of them involve decay processes at or very close the interaction point ⇨

- *Charged vertex efficiency near the IP*
- *Acceptance for photons emitted at low polar angles*

KLOE-2 Status

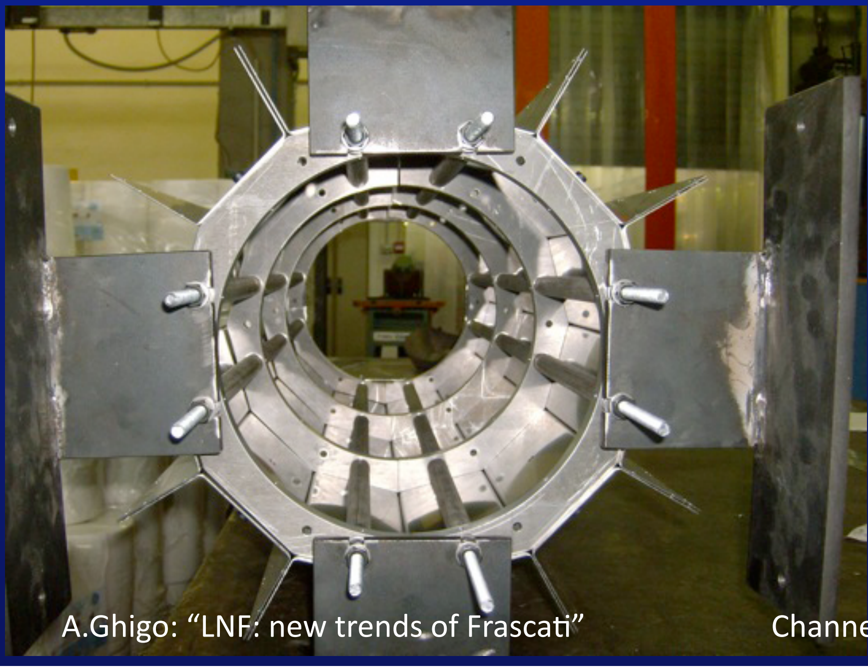
Taggers for $\gamma\gamma$ reactions installed.

High Energy Tagger installations

Low Energy Tagger installations

KLOE-2 Status

Inner Tracker : based on cylindrical GEM (C-GEM)



Beamlines @ DAΦNE-Light

SINBAD - IR beamline

DXR1 - Soft x-ray beamline

DXR2 - UV setup

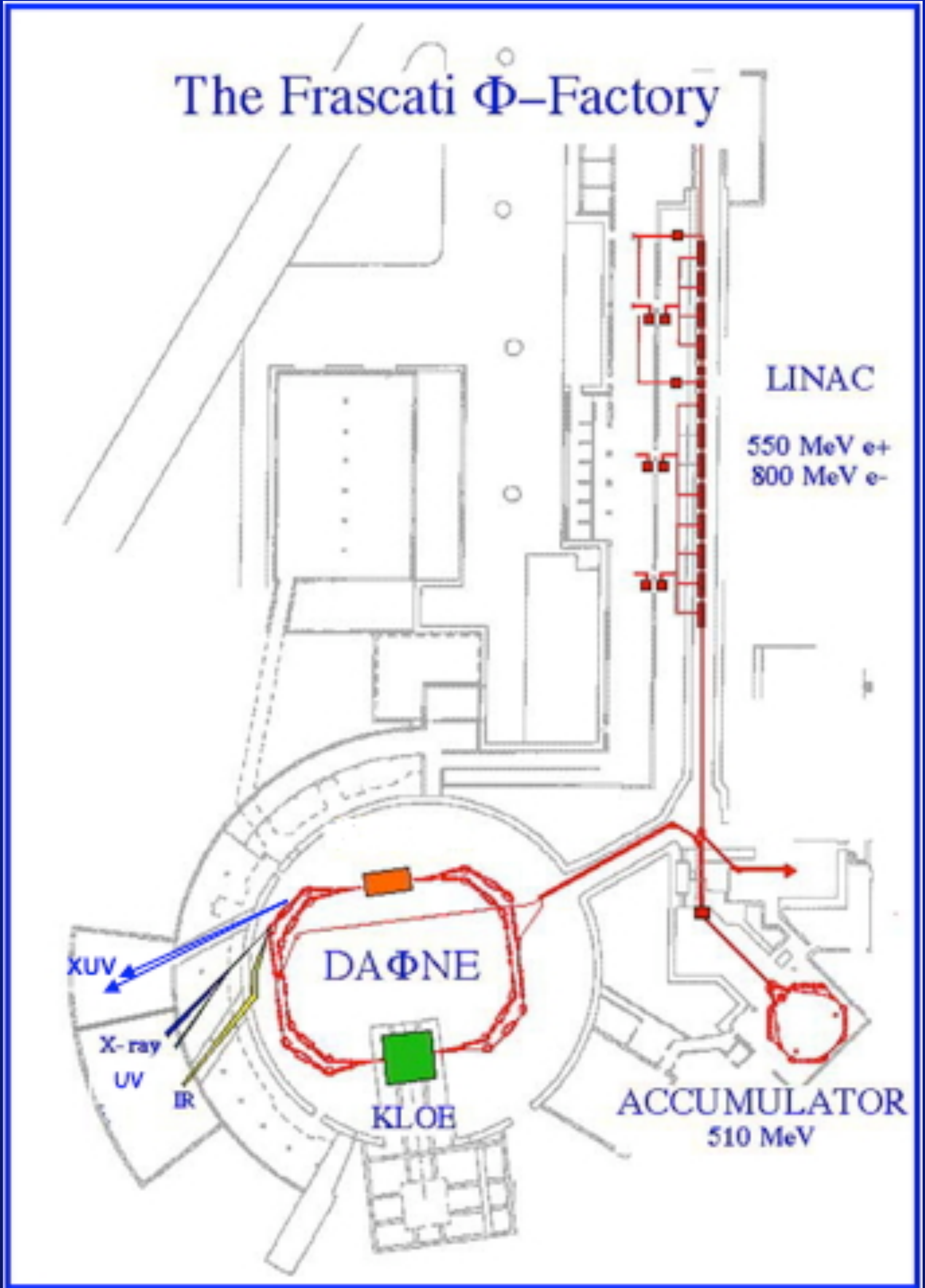
Open to Italian and EU users

DXR2 - New VUV setup ready in 2012

2 new XUV beamlines

Low Energy Beamline (35-200 eV) commissioning in 2012;

High Energy Beamline (60-1000 eV) commissioning in 2012



Activities at the DAΦNE-Light Beamlines

*The **IR** ,the **Soft X-ray** and the **UV-VIS** beamlines are **already open to users** . Beamtime was given to **Italian** and **EU users**, in the framework of the **INFN-Group V experiments**, of collaborations with **Italian Universities**, of the Transnational Access to Research Infrastructures **FP7 E.Li.S.A. program** and of **collaborations** using **F.A.I.** **(2011/2012)**.*

2012 - The ***EU project E.Li.S.A. for transnational access*** ended in ***August 2011***- A new proposal ***C.A.Li.P.S.O***. was submitted in ***November 2011*** –***Negotiation procedure July 2012***.

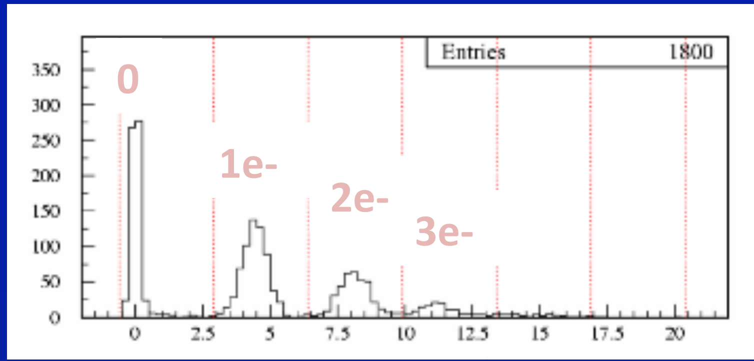
The ***new VUV setup*** is now ***completed.***

The two ***new XUV beamlines*** are ***both ready for commissioning.***

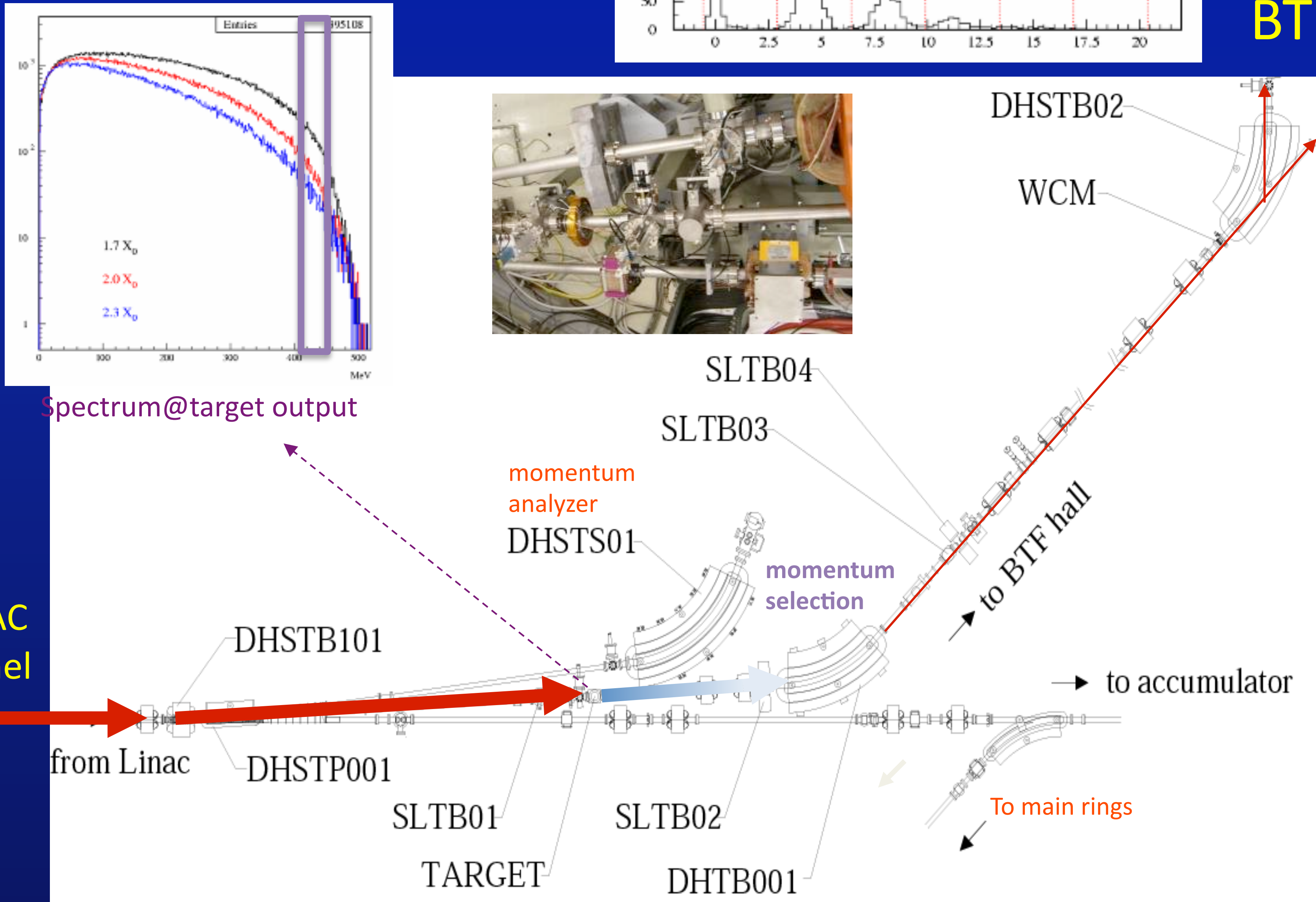
Beam Test Facility (BTF) Infrastructure
@DAFNE Linac

The Frascati **Beam Test Facility** infrastructure is a beam extraction line optimized to produce **electrons**, **positrons**, **photons** and **neutrons** mainly for HEP detector **calibration** purposes. The quality of the beam, energy and intensity is also of interest for **experiments** (~ 20% of the users) studying the **electromagnetic interaction with matter**

BTF layout



BTF Hall



LINAC
tunnel

Beam Test Facility e^+/e^- characteristic

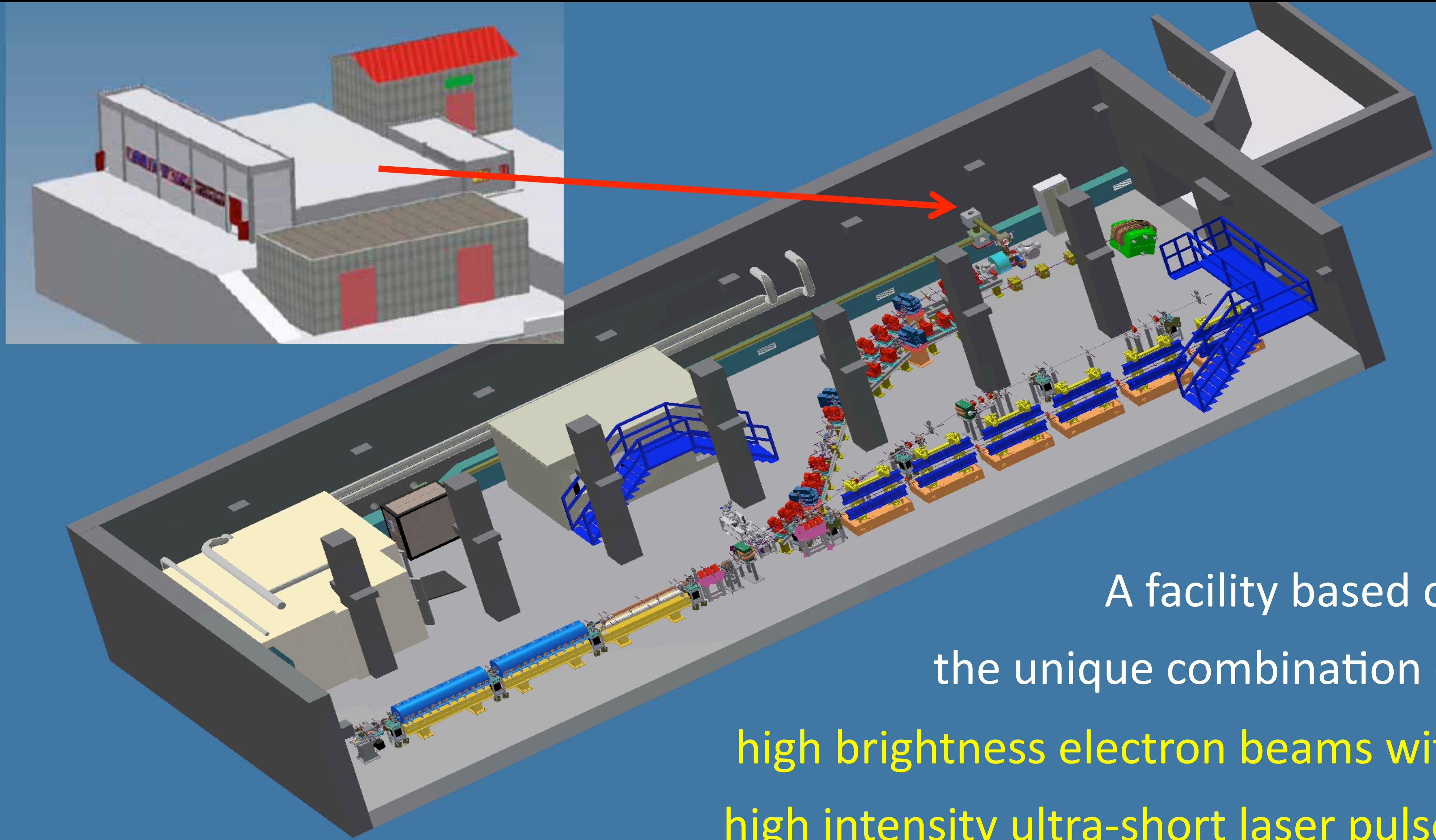
	parasitic	dedicated
Number (particles/pulse)	$1 \div 10^5$	$1 \div 10^{10}$
Energy (MeV)	25-500	$25 \div 750$
Repetition rate (Hz)	20-50	50
Pulse Duration (ns)	10	1 or 10
p resolution	1%	
Spot size (mm)	$s_{x,y} \approx 2$ (single particle)	
Divergence (mmrad)	$s'_{x,y} \approx 2$ (single particle)	

Main applications

- HEP detector calibration and setup
- Low energy calorimetry & resolution
- Low energy electromagnetic interaction studies
- High multiplicity efficiency
- Detectors aging and efficiency
- Beam diagnostics

SPARC_LAB

Sources for Plasma Accelerators and Radiation Compton with Lasers And Beams



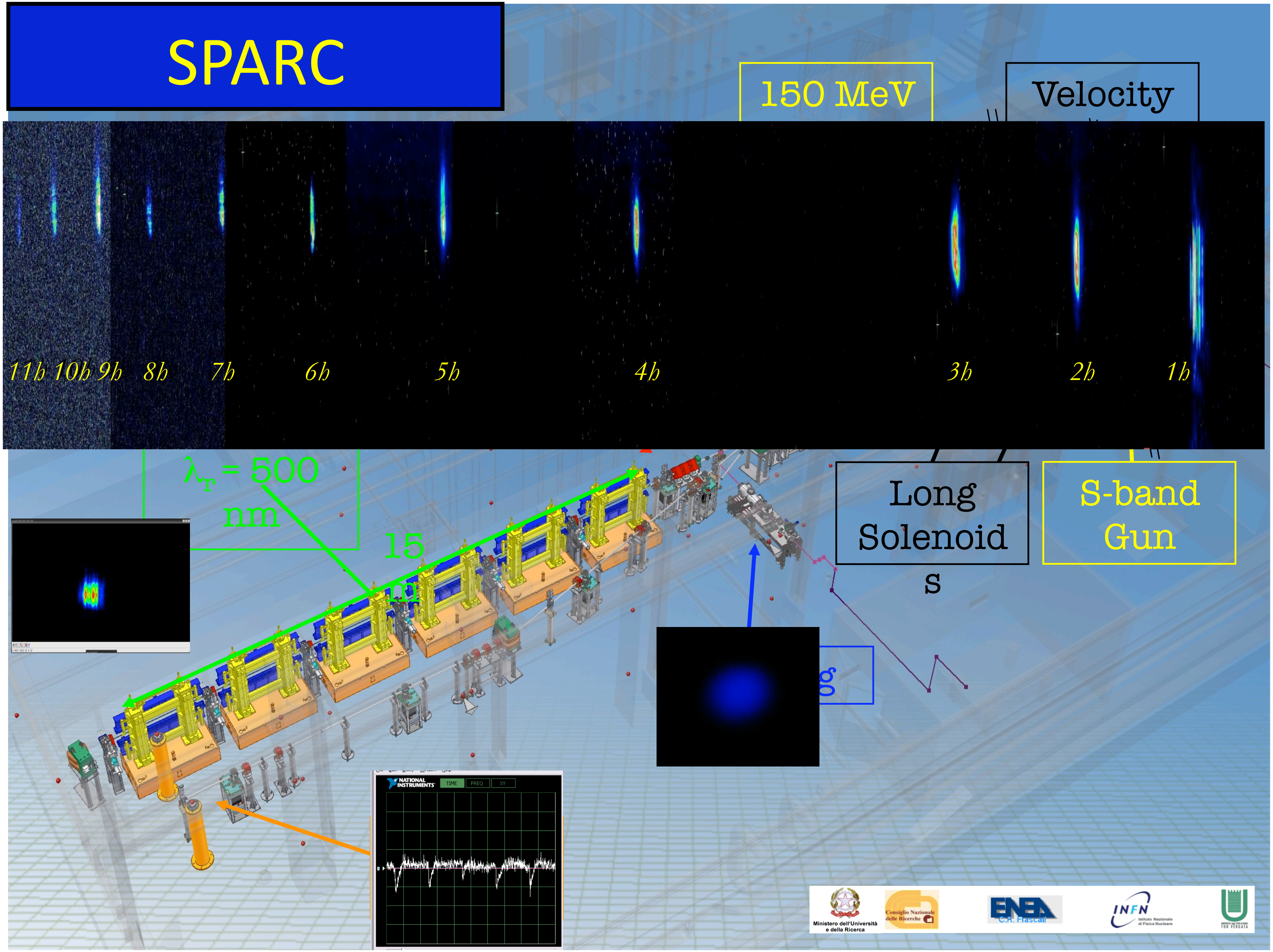
A facility based on

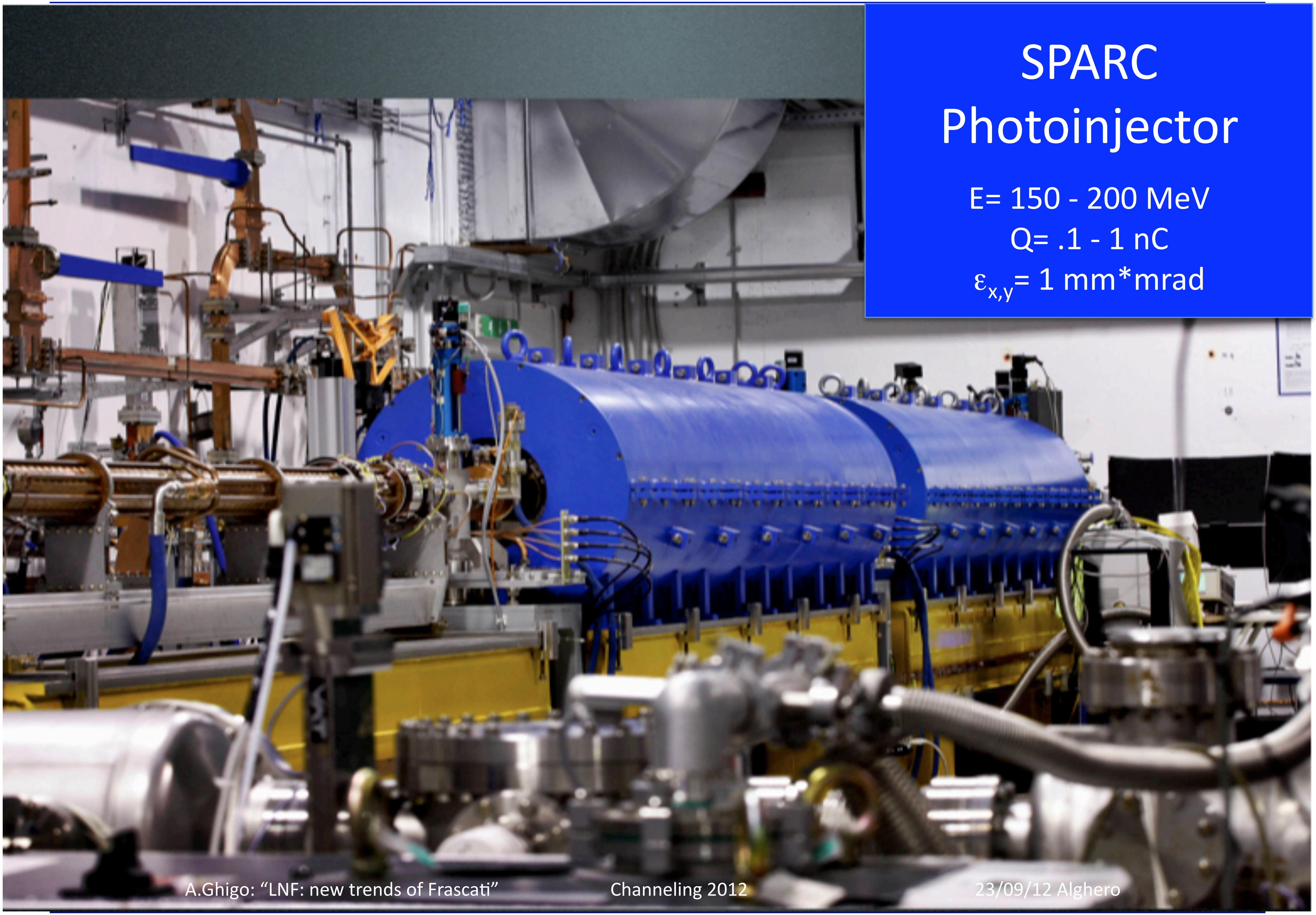
the unique combination of

high brightness electron beams with

high intensity ultra-short laser pulses

SPARC

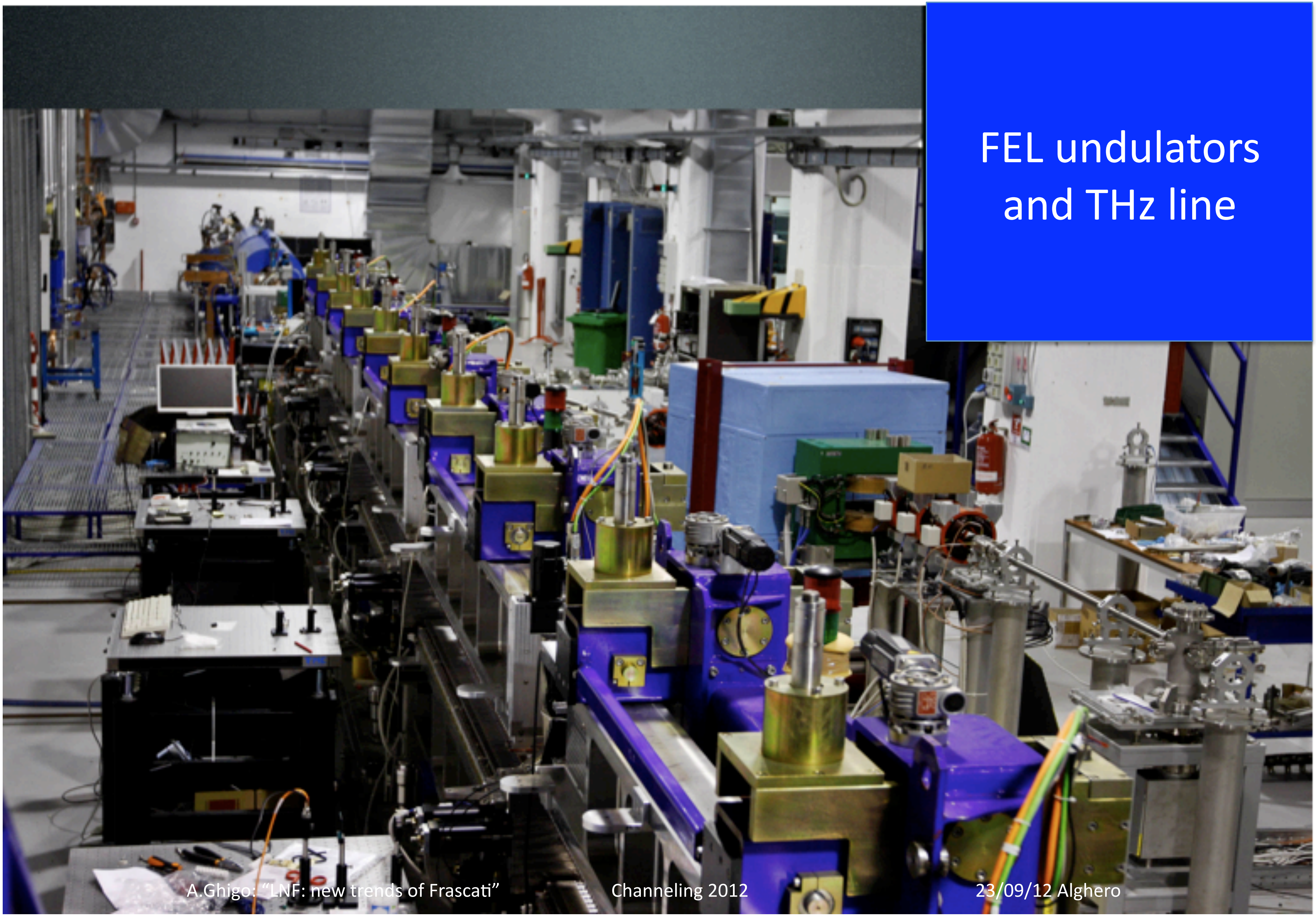

150 MeV
Velocity
11h 10h 9h 8h 7h 6h 5h 4h 3h 2h 1h
λ_T = 500 nm
15
Long Solenoids
S-band Gun
NATIONAL INSTRUMENTS
TIME
FREQ
XY
Ministero dell'Università e della Ricerca
Consiglio Nazionale delle Ricerche
ENEA
C.R. Frascati
INFN
Istituto Nazionale di Fisica Nucleare
TOR VERGATA



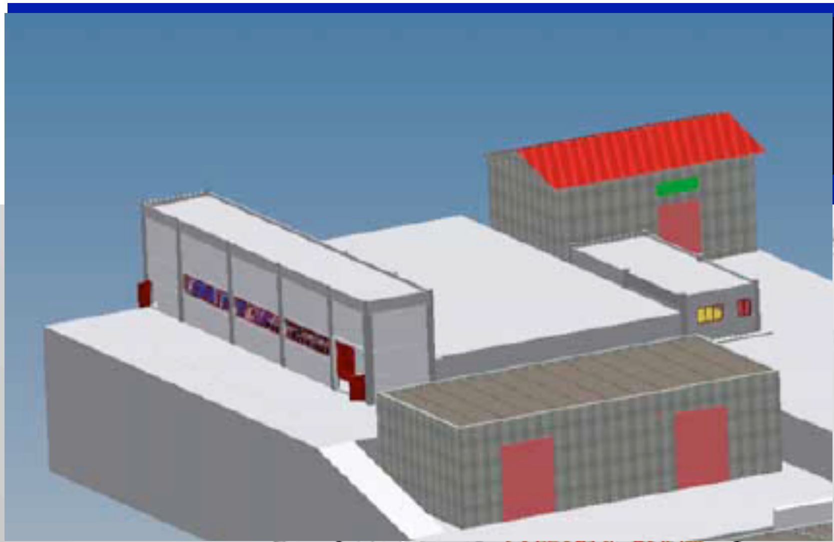
SPARC Photoinjector

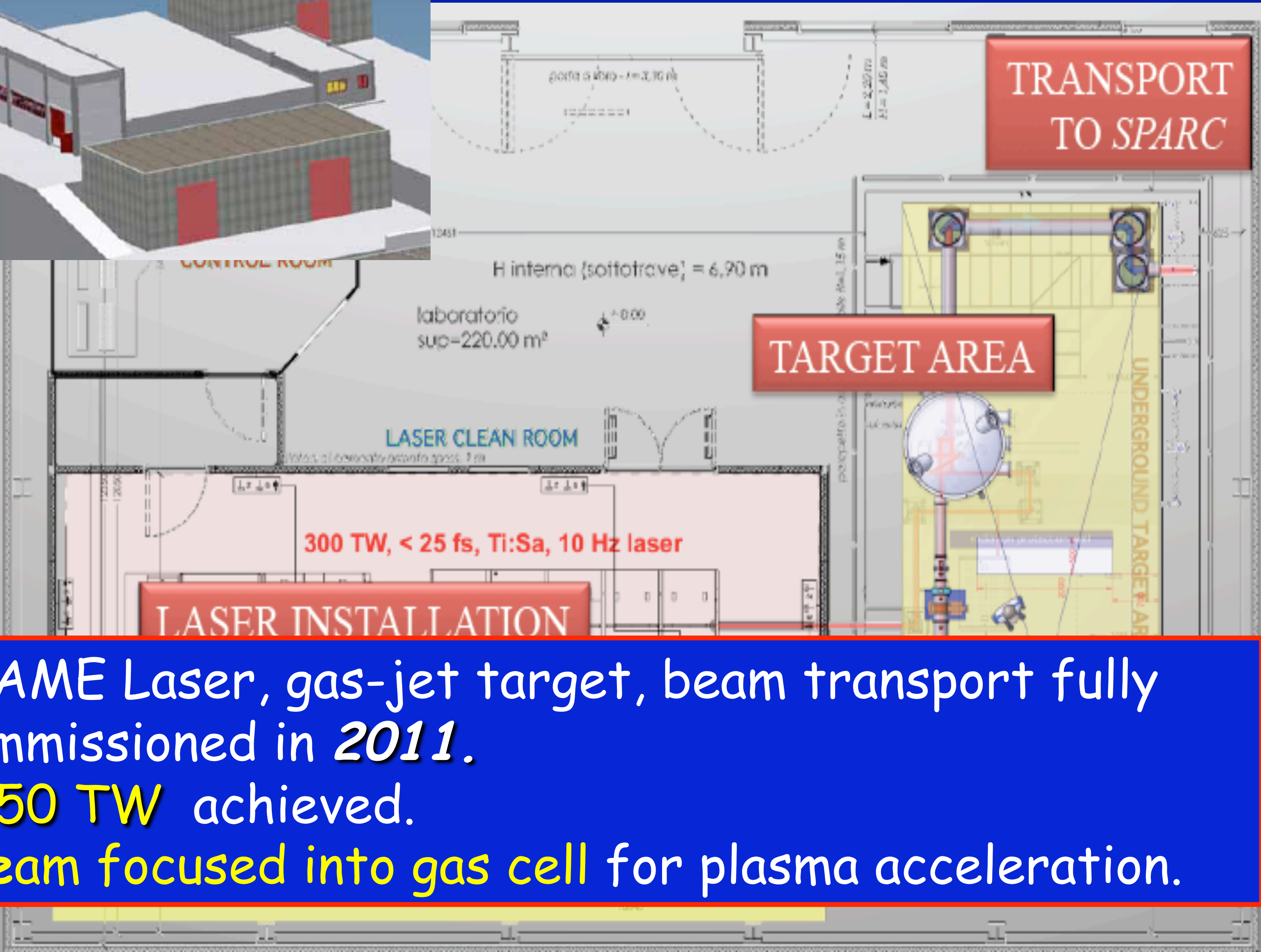
E= 150 - 200 MeV
Q= .1 - 1 nC
$\varepsilon_{x,y}$= 1 mm*mrad

FEL undulators and THz line



FLAME: Frascati Laser for Acceleration and Multidisciplinary Experiments



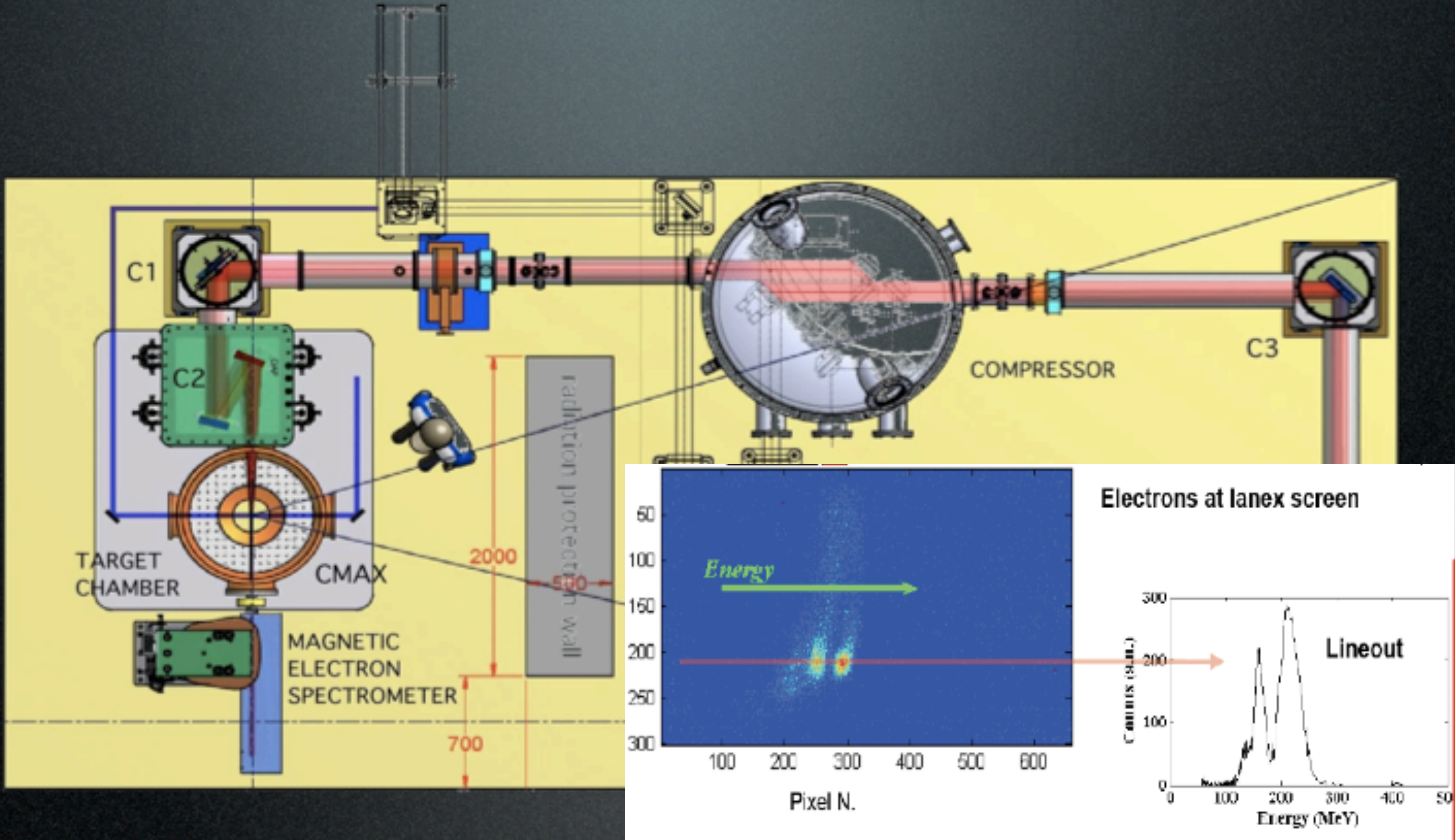


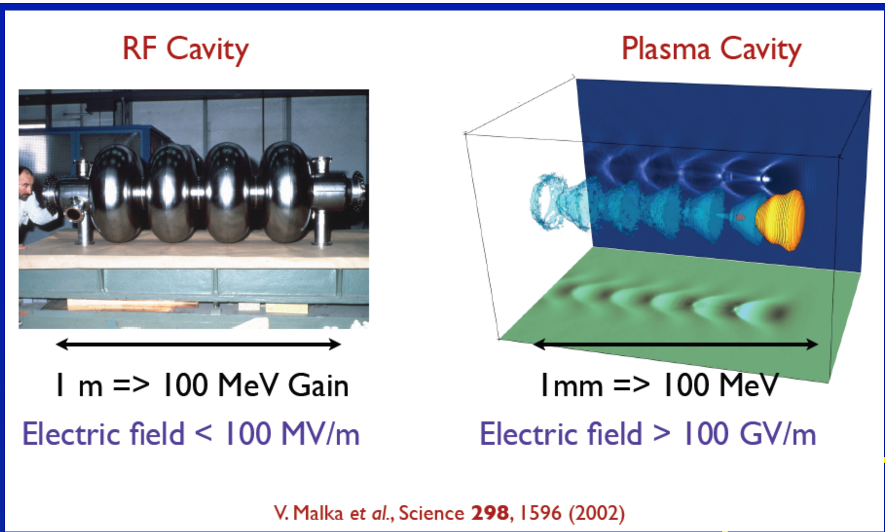
FLAME Laser, gas-jet target, beam transport fully commissioned in ***2011***.

-250 TW achieved.

-Beam focused into gas cell for plasma acceleration.

FLAME Target Area





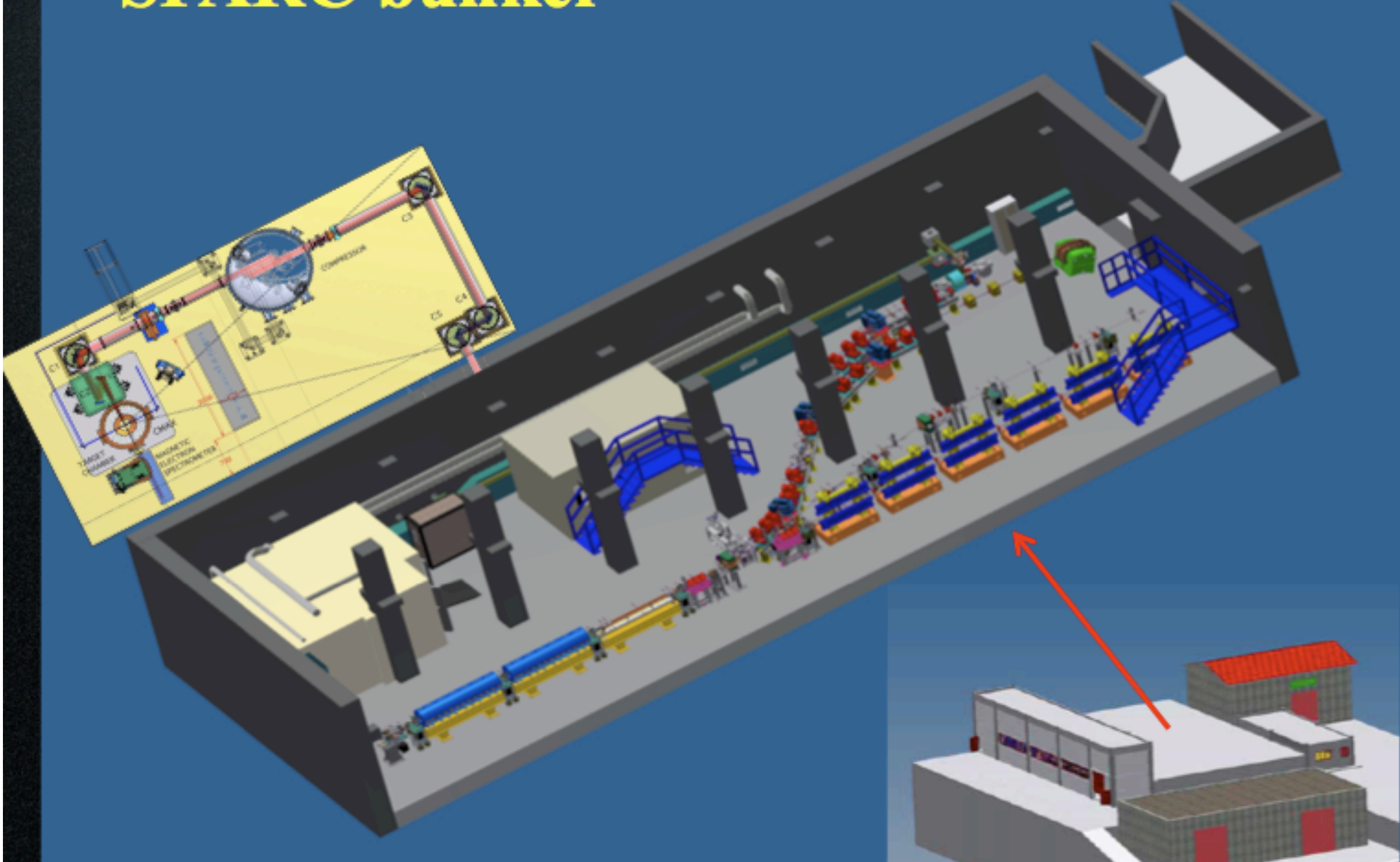
Plasma accelerators:

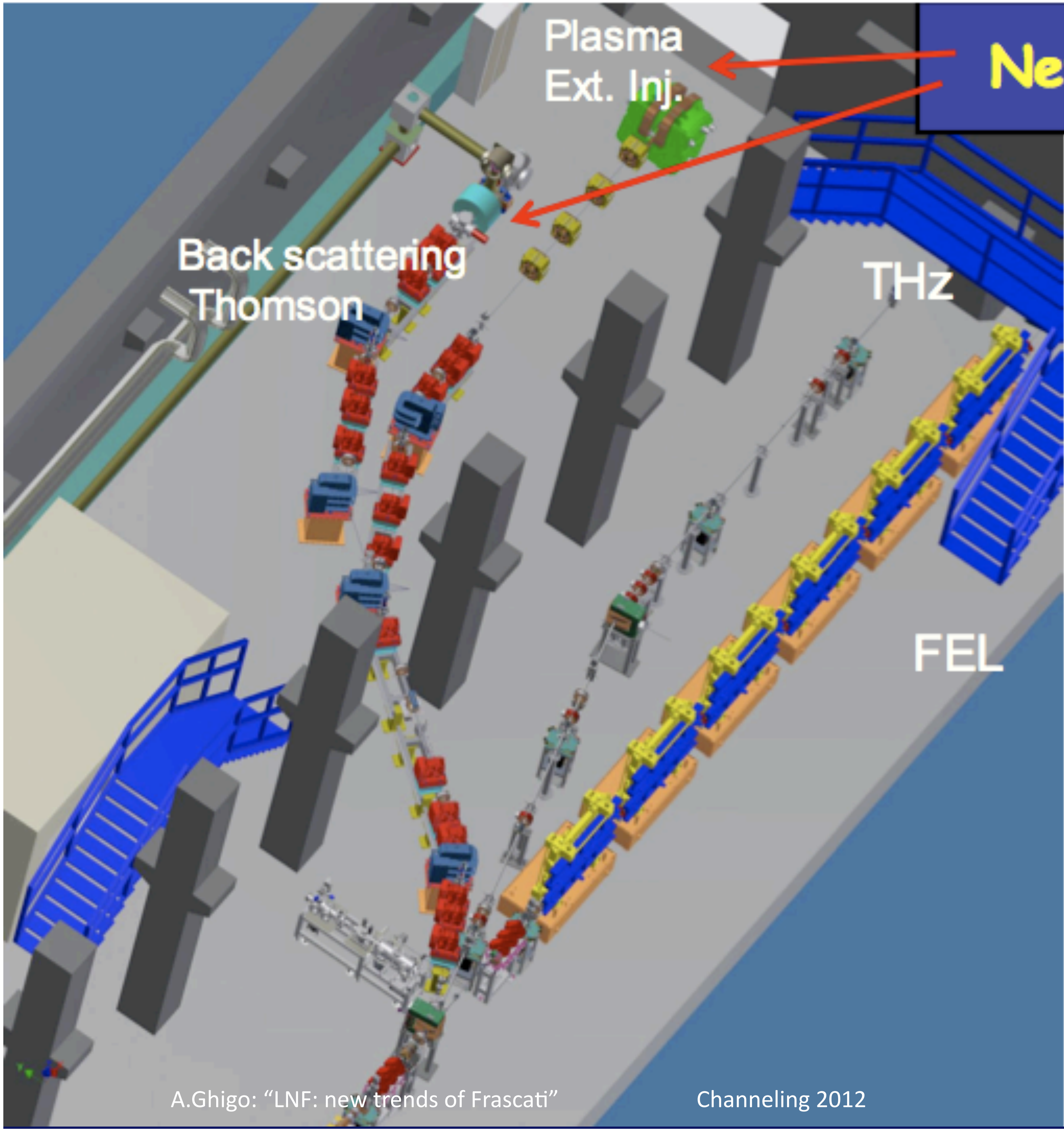
Transform transverse fields into longitudinal fields

- **Laser driven**
  - Self-injection
  - External injection
- **e- driven**
- **p driven**
- **Dielectric wakefields**

Demonstrated accelerating Gradients up to 3 orders of magnitudes beyond presently used RF technologies.

SPARC bunker

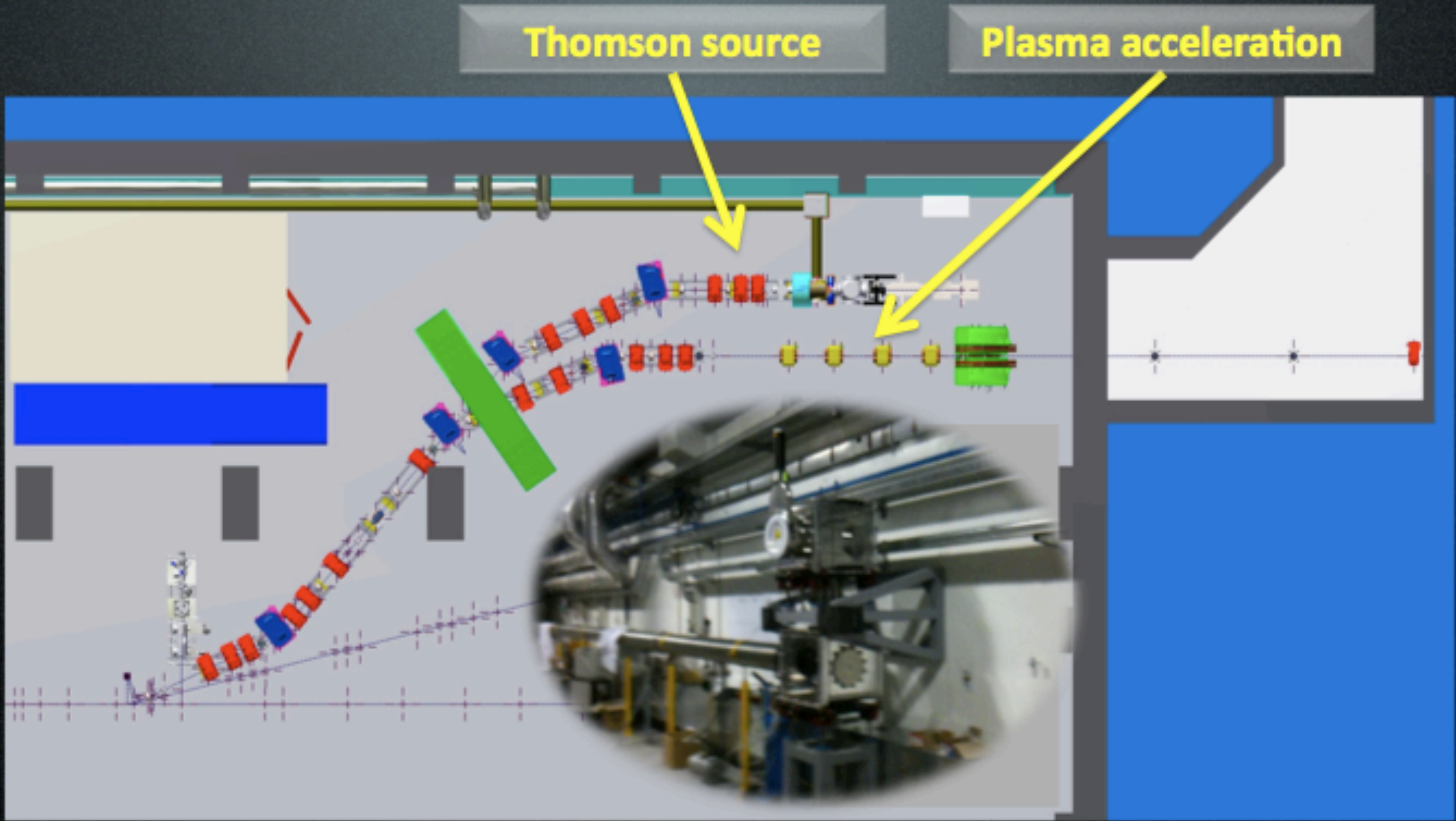




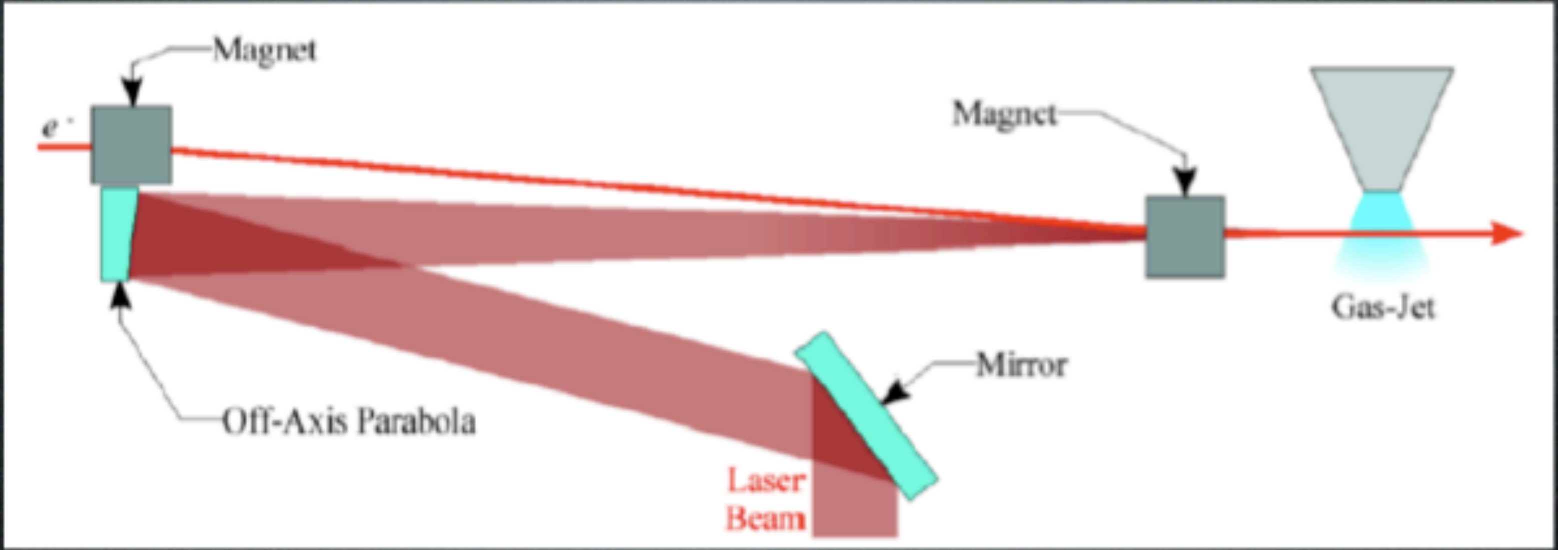
New installations

- Investigation of different configurations of plasma accelerator.
- Production of monochromatic ultra-fast X-rays by Thomson b-s driven by high-quality electron beam.

New installations



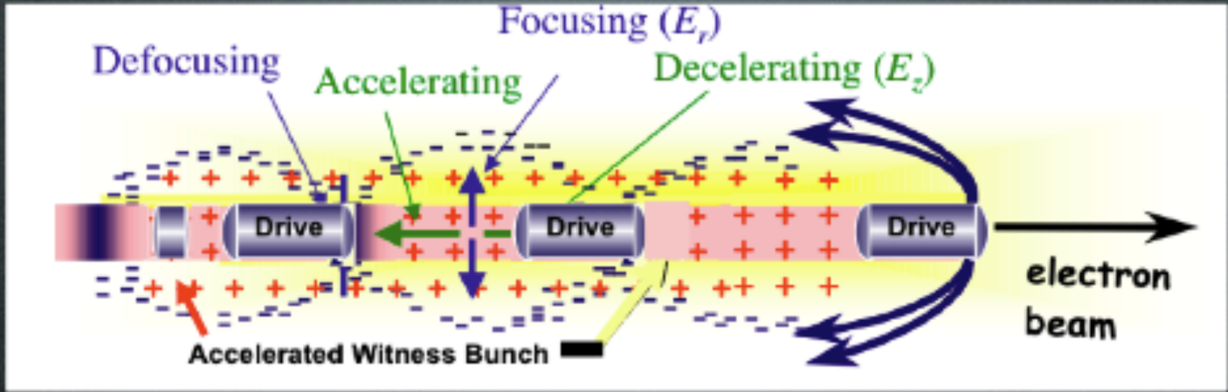
EXIN (EXternal INjection)



n_e [cm^{-3}]	E_{max} [GV/m]	λ_p [µm]	Ldeph [m]	Energy gain over L = 2cm [MeV]	Energy gain over L = 10cm [MeV]
1e16	0.2	330	400	<4	<20
5e16	1	150	5	<20	<100
2.5e17	3.8	66	0.45	<76	<380
7.5e17	7.5	39	0.1	<150	<750
2.5e18	8.5	30	0.04	<190	-

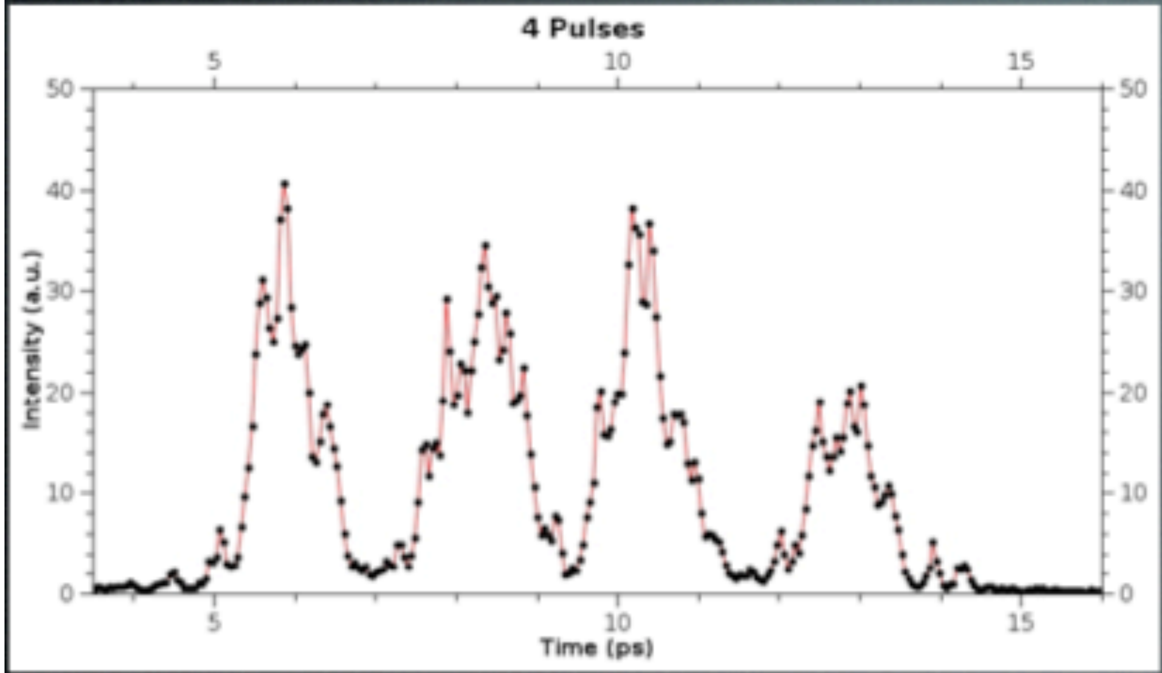
Courtesy L. Serafini

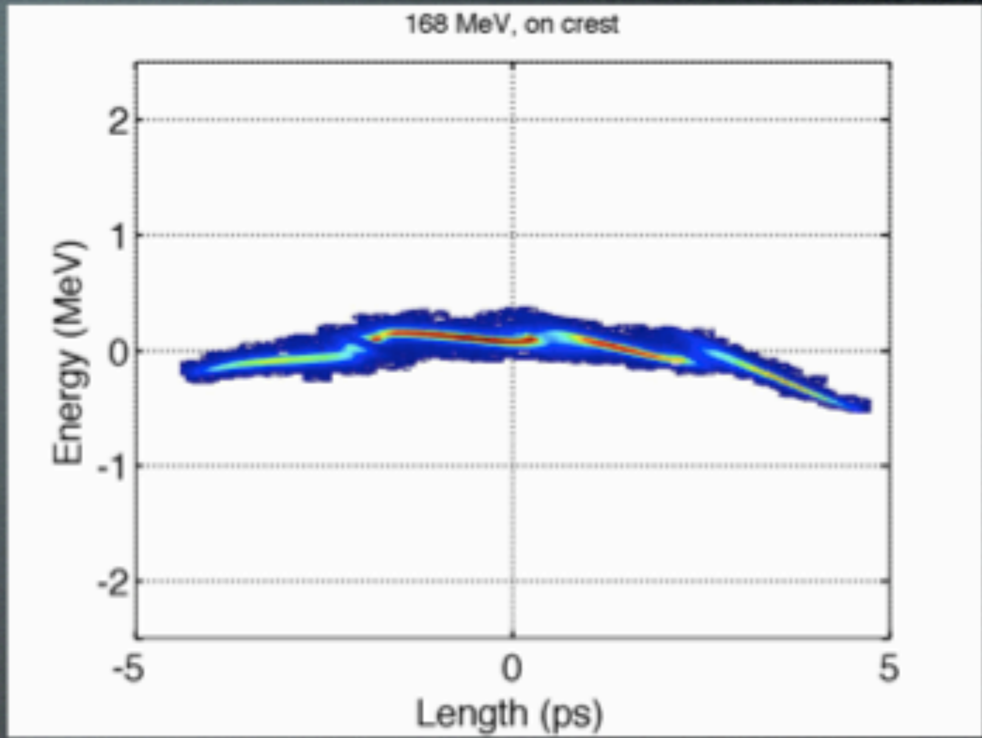
Resonant plasma Oscillations by Multiple electron Bunches

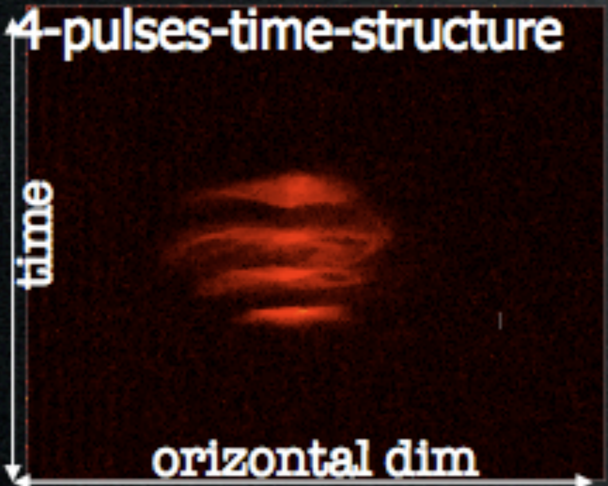


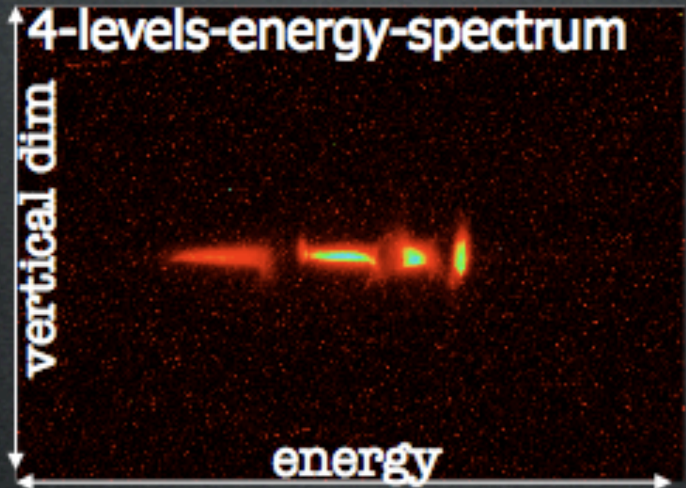
- **Weak blowout regime** with resonant amplification of plasma wave by a train of high Brightness electron bunches produced by **Laser Comb** technique ==> **5 GV/m** with a train of 3 bunches, 100 pC/bunch, 50 μm long, 20 μm spot size, in a plasma of density 10^{22} e^-/m^3 at λ_p=300 μm ?
- **Ramped bunch train configuration** to enhance tranformer ratio?
- **High quality bunch** preservation during acceleration and transport?
- **Strong blowout regime** with pC/fs bunches ==> **TV/m** regime ?

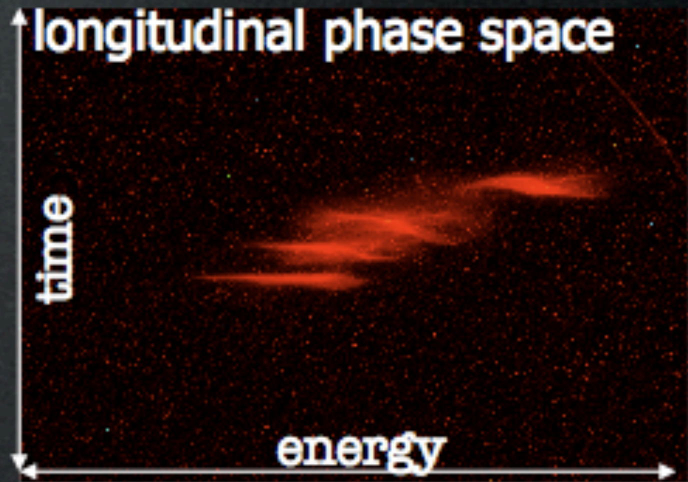
Laser COMB technique



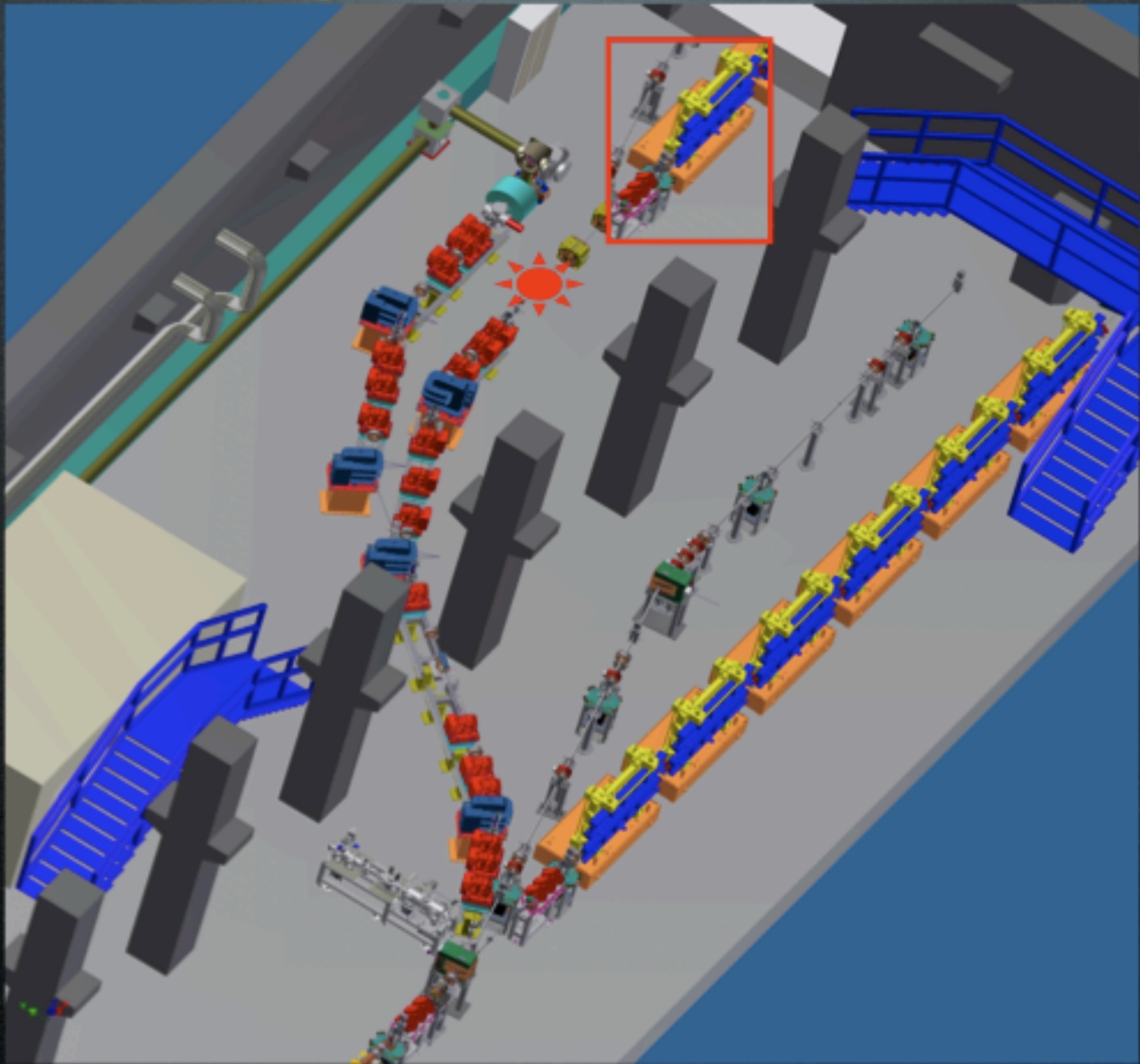








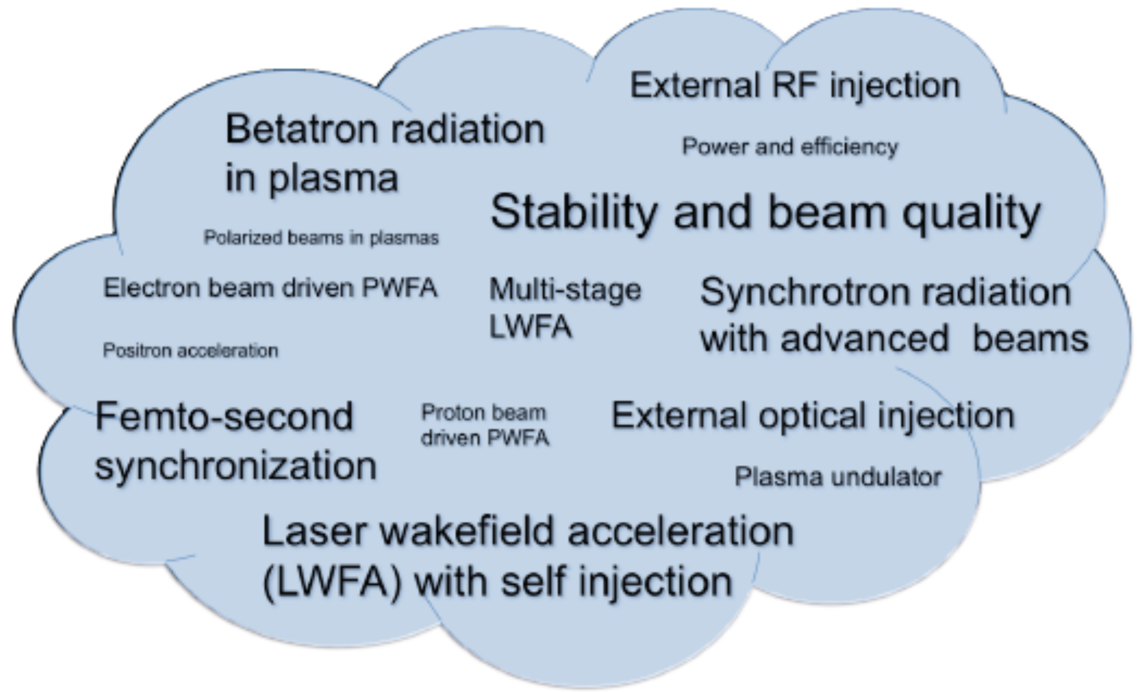
A FEL driven by Plasma Accelerator at LNF?



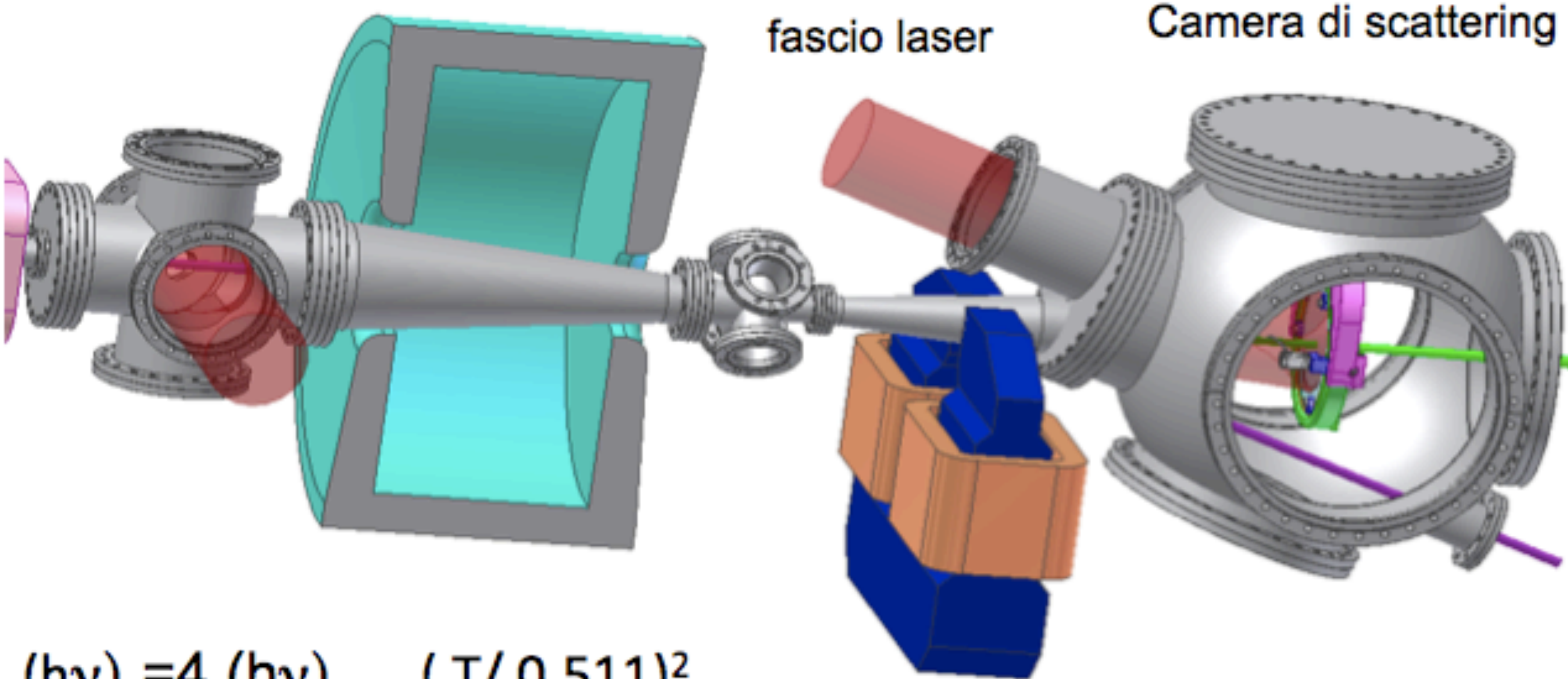
EURONACC: most important Technical Goals

1. External Optical injection
2. External RF injection
3. LWFA with self injection
4. Multi-stage LWFA
5. Synchrotron radiation with advanced beams
6. Electron beam driven PWFA
7. Proton beam driven PWFA
8. Betatron radiation in plasma
9. Plasma undulator
10. Stability and beam quality
11. Polarized beams in plasm
12. Positron acceleration
13. Femto-second synchronization
14. Power and efficiency

Investments :
1 billlion Euro over 10 year horizon
EuroNNAc : 52 institutes



Thomson Interaction region (20-550 keV)

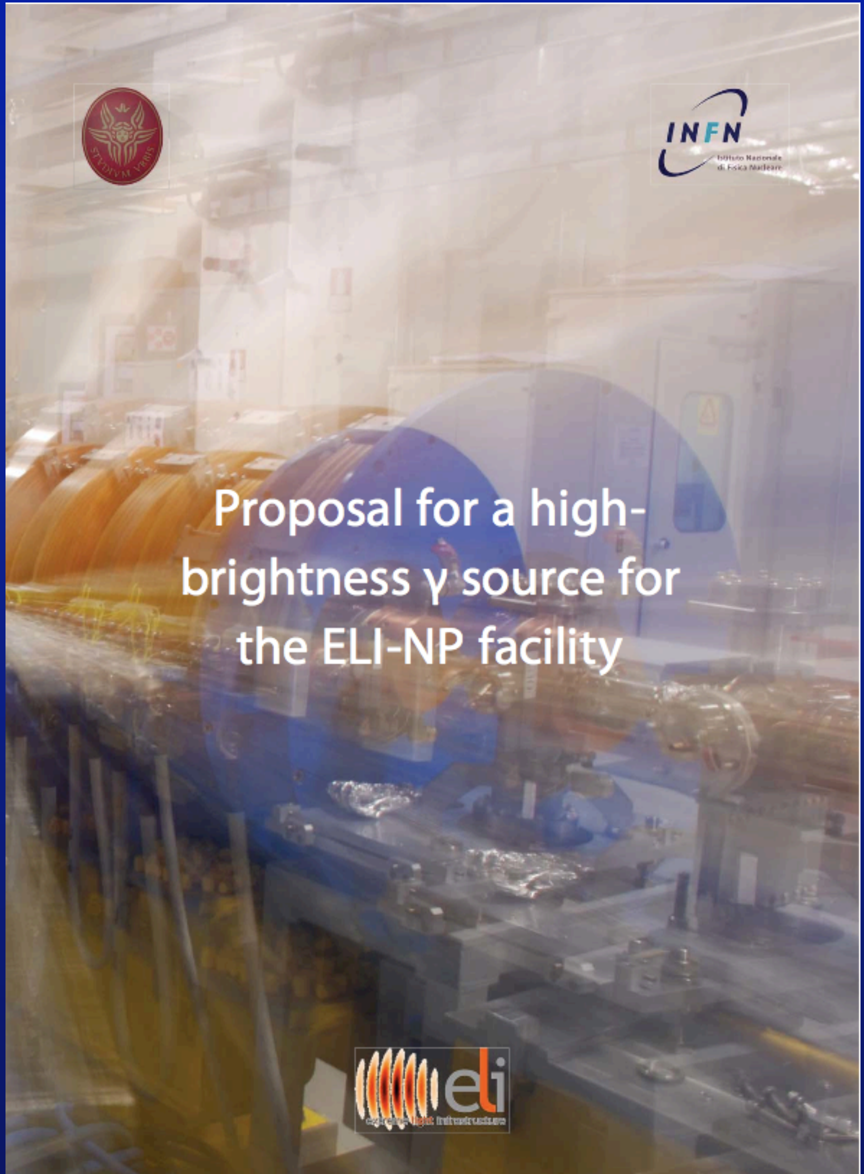


$(h\nu)_X = 4\ (h\nu)_{laser}\ (T/0.511)^2$

$(h\nu)_{laser}$ = 1.2 eV
T = 30.28 MeV
$(h\nu)_X$ = 20 keV mammografia

Impulso laser: 6 ps, 5 J
pacchetto e^- : 1 nC , l: 2 mm (rms)
Impulso X: 10 ps, 10^9 fotoni per interazione
α emissione: 12 mrad

ELI-NP


INFN
Proposal for a high-brightness γ source for the ELI-NP facility
eli

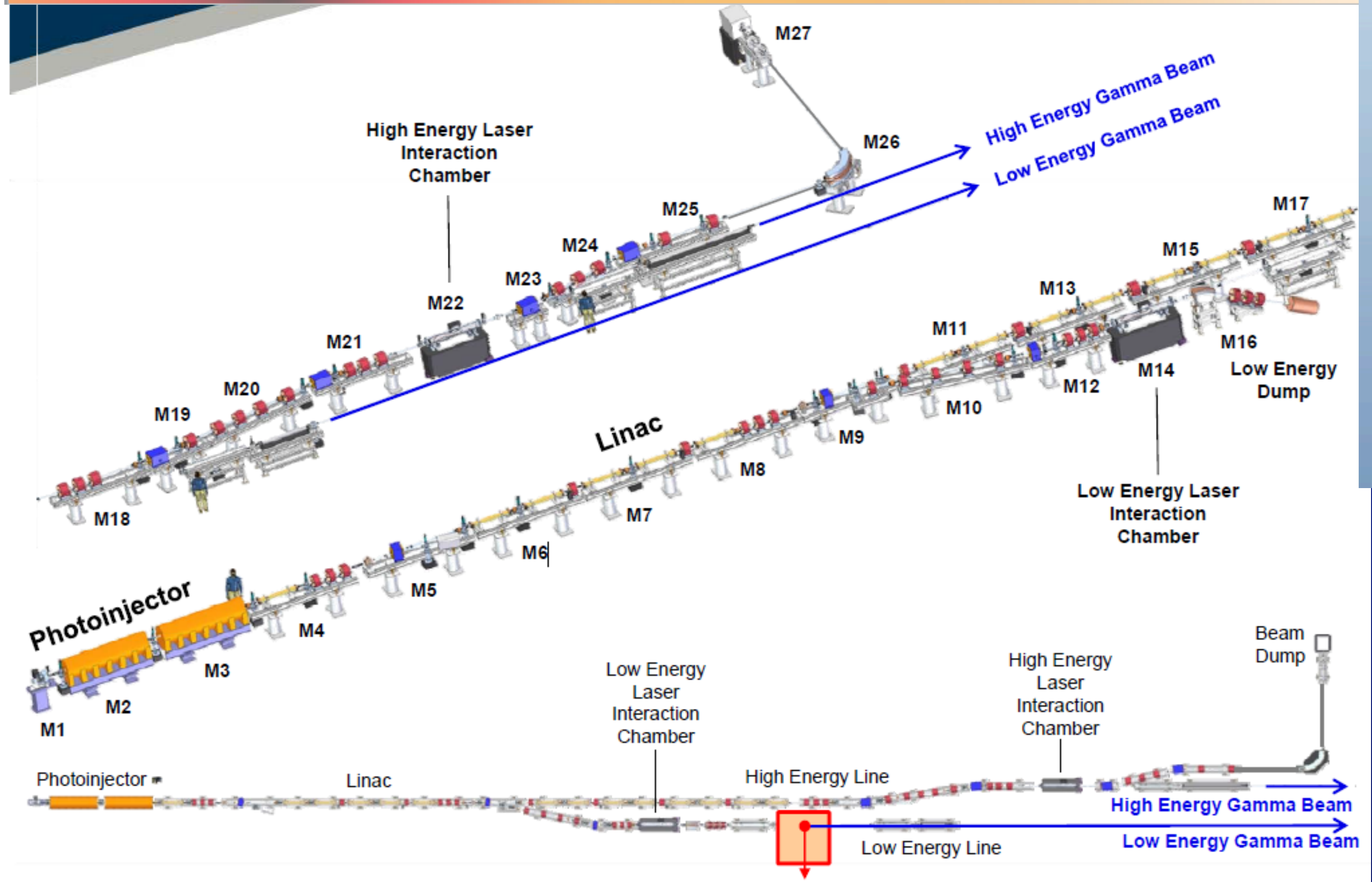

ELI-NP
Bucharest (Magurele)
Romania for ELI

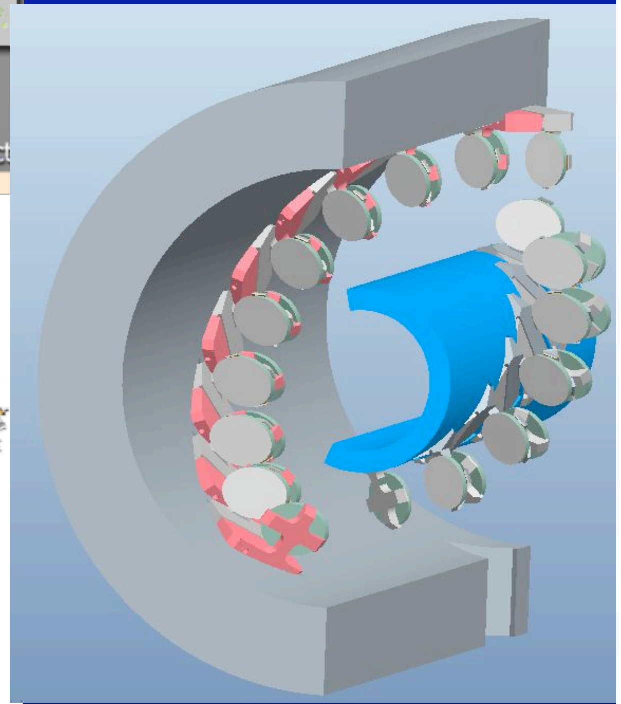
eli Nuclear Physics

SAPIENZA UNIVERSITÀ DI ROMA · INFN Istituto Nazionale di Fisica Nucleare · Science & Technology Facilities Council · CNRS IN2P3 Les deux infinis · Université Paris Sud

European Collaboration for the proposal of a Gamma-Beam System to the ELI-NP Project

TDR ready in Oct. 2012
To be built in 4 years



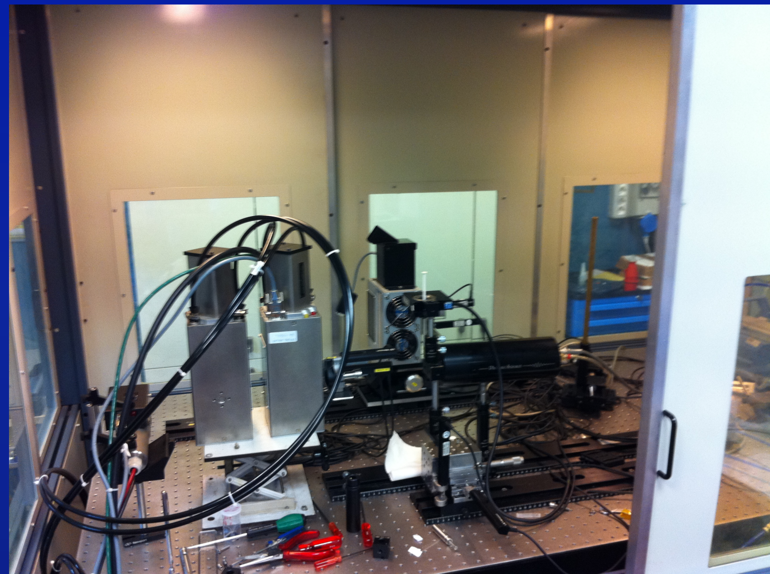


E beam energy : 720 MeV
Photon energy : 20 MeV
Laser pulse energy : 0.5 J
Laser wavelength: 2.4 eV
Rep rate : 100 Hz
# of recirculations: up to 40

XLab Frascati activities

S. Dabagov

X-ray Optics: Polycapillary and Compound Refractive Optics



Material Analisys // X-ray Spectroscopy:

- X-ray Fluorescence
- X-ray Diffraction
- X-ray Imaging

Diagnostic Applications:

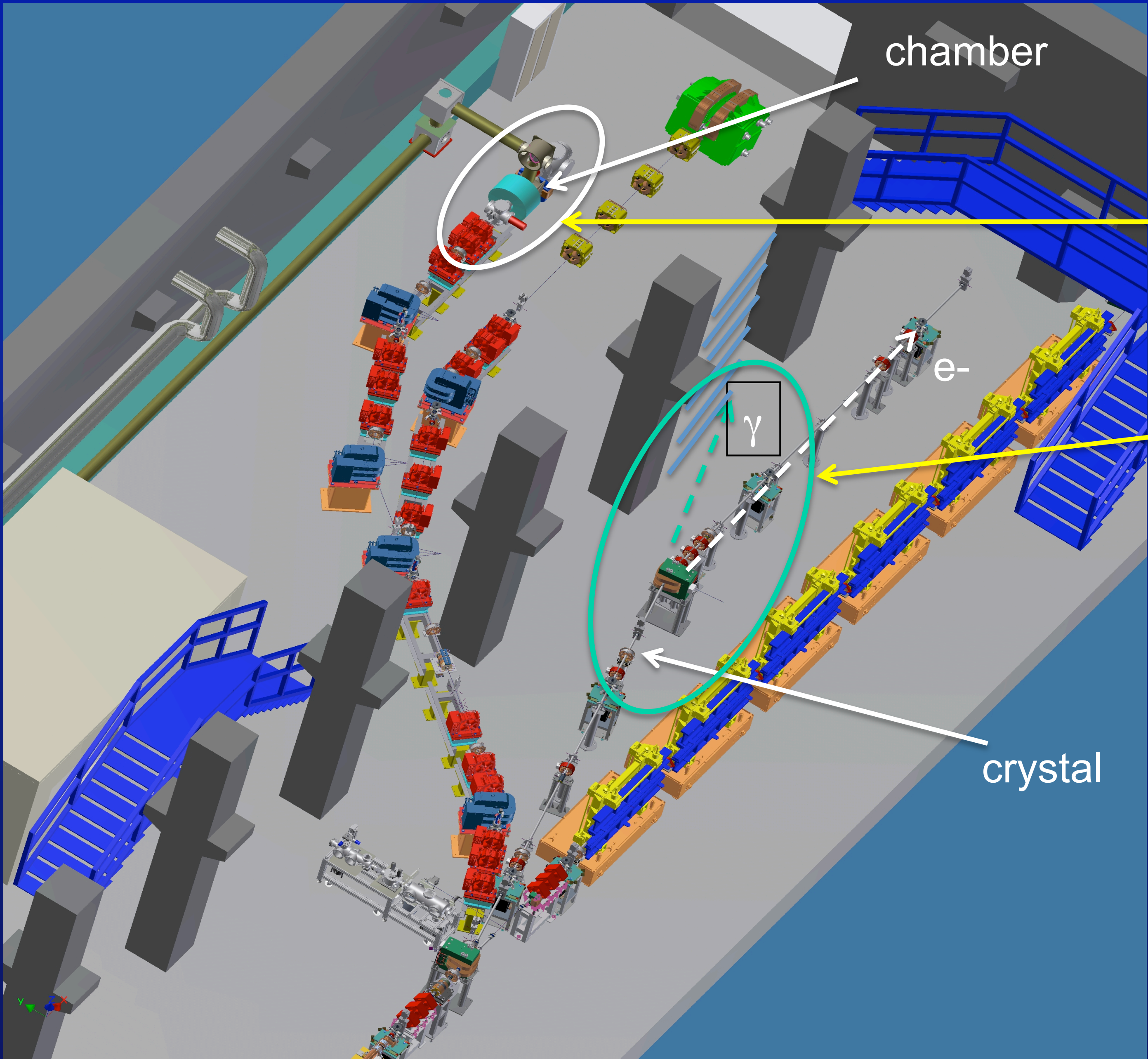
- X-ray Imaging for large object with high spatial resolution

Crystal Characterization for hadron beam collimation by crystal channeling

Novel technologies and experimental setup

- Prototype for XRF – TXRF and X-ray Imaging
- X-ray tube based on Carbon Nanotube Cold Cathod

POSSO: POSITRON SOURCE BASED ON SPARC CHANNELING



Possible solutions:

Thomson

THz line

⇩

More space

Ready instruments

Thanks for your attention