Report on LNF activities

Prof. Mario Calvetti INFN-LNF director

University of Florence

- **e^+e^- Collider DAFNE (Super B)**
- **Free Electron Laser SPARC_X**
- **Advanced Accelerator Concepts PLASMONX**
- **Linear Colliders CLIC & ILC**
- **Hadron Therapy CNAO**
- **KLOE experiment**
- **Educational**

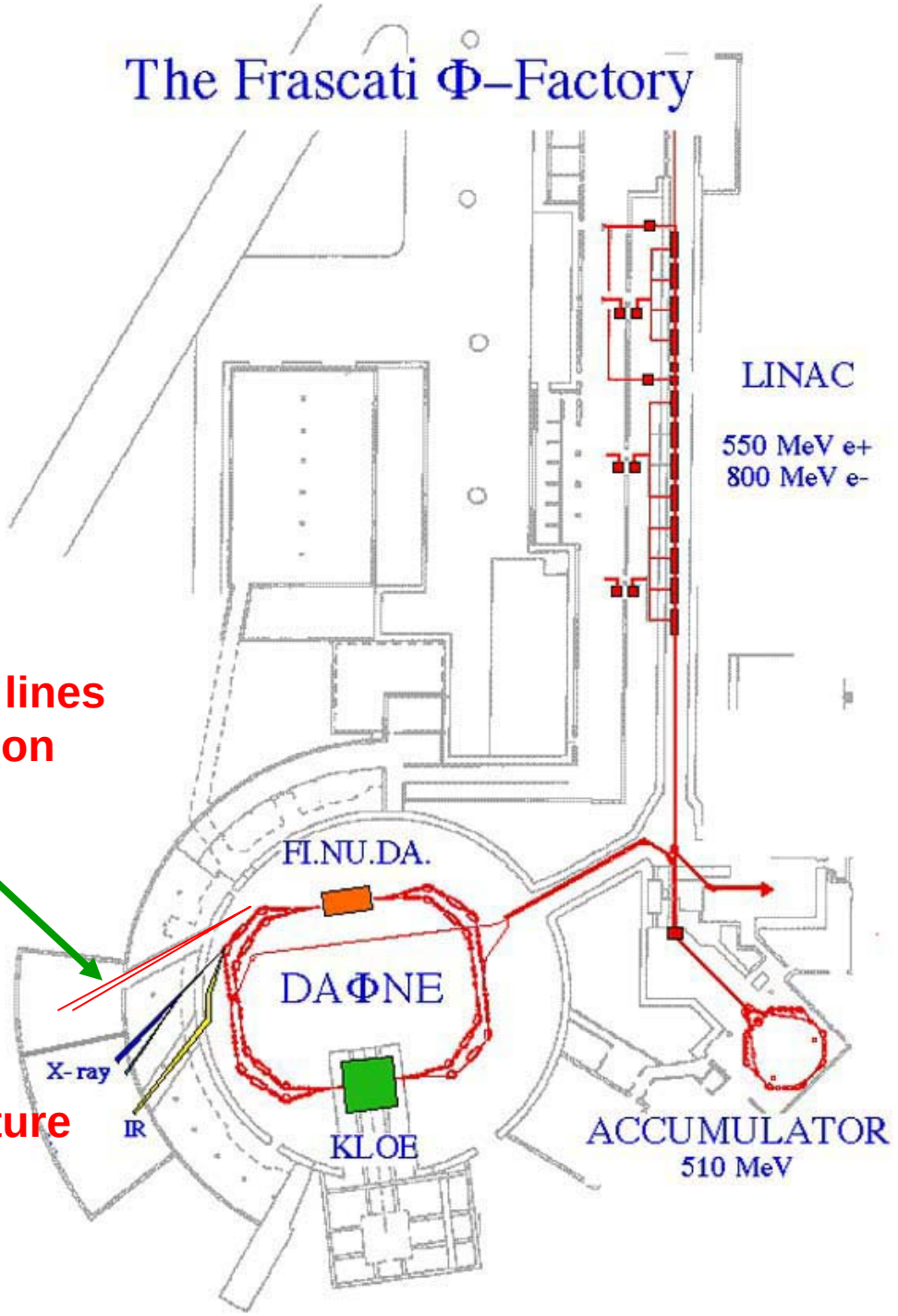
DAFNE

DAFNE- LIGHT
Laboratory

Two new soft X-ray lines
under construction

Syncrotron ligth from DAFNE
SPARC
SPARX
Conventional sources

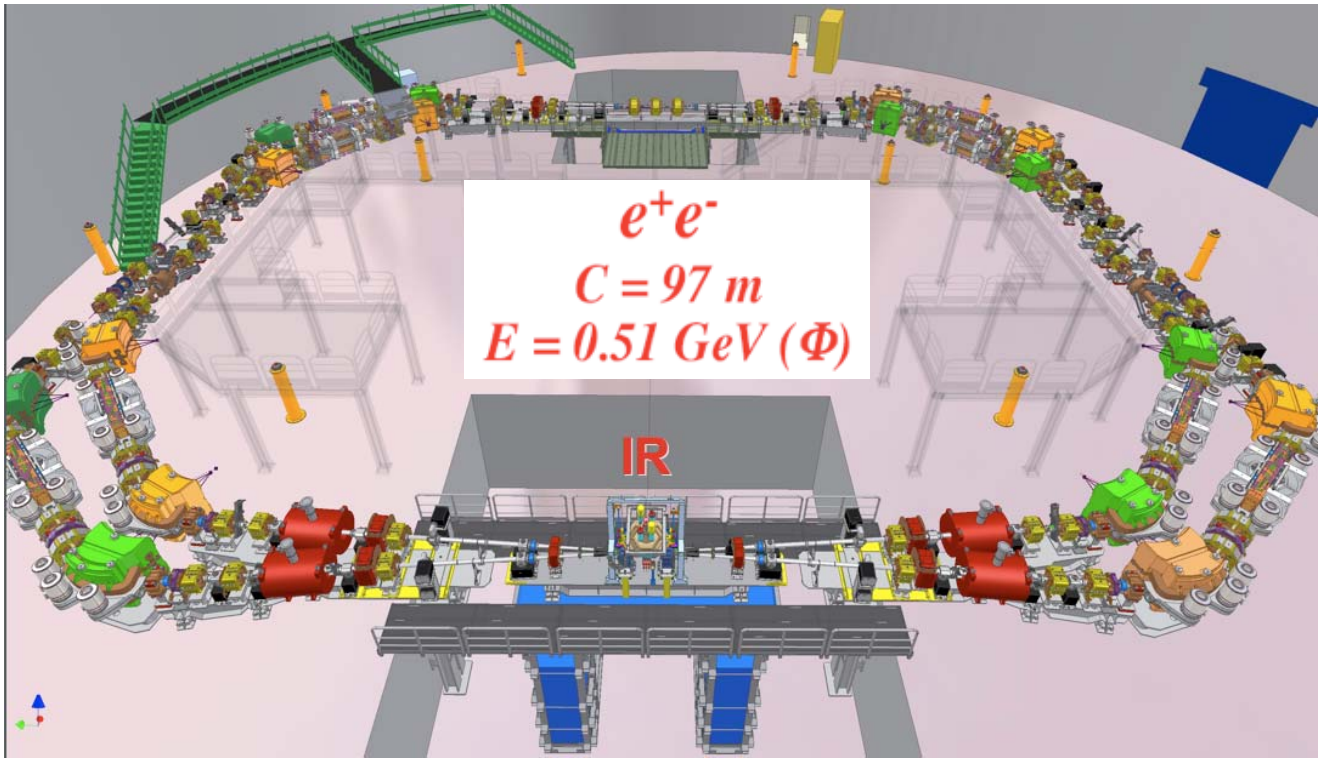
LNF are part of the European Infrastructure for syncrotron light



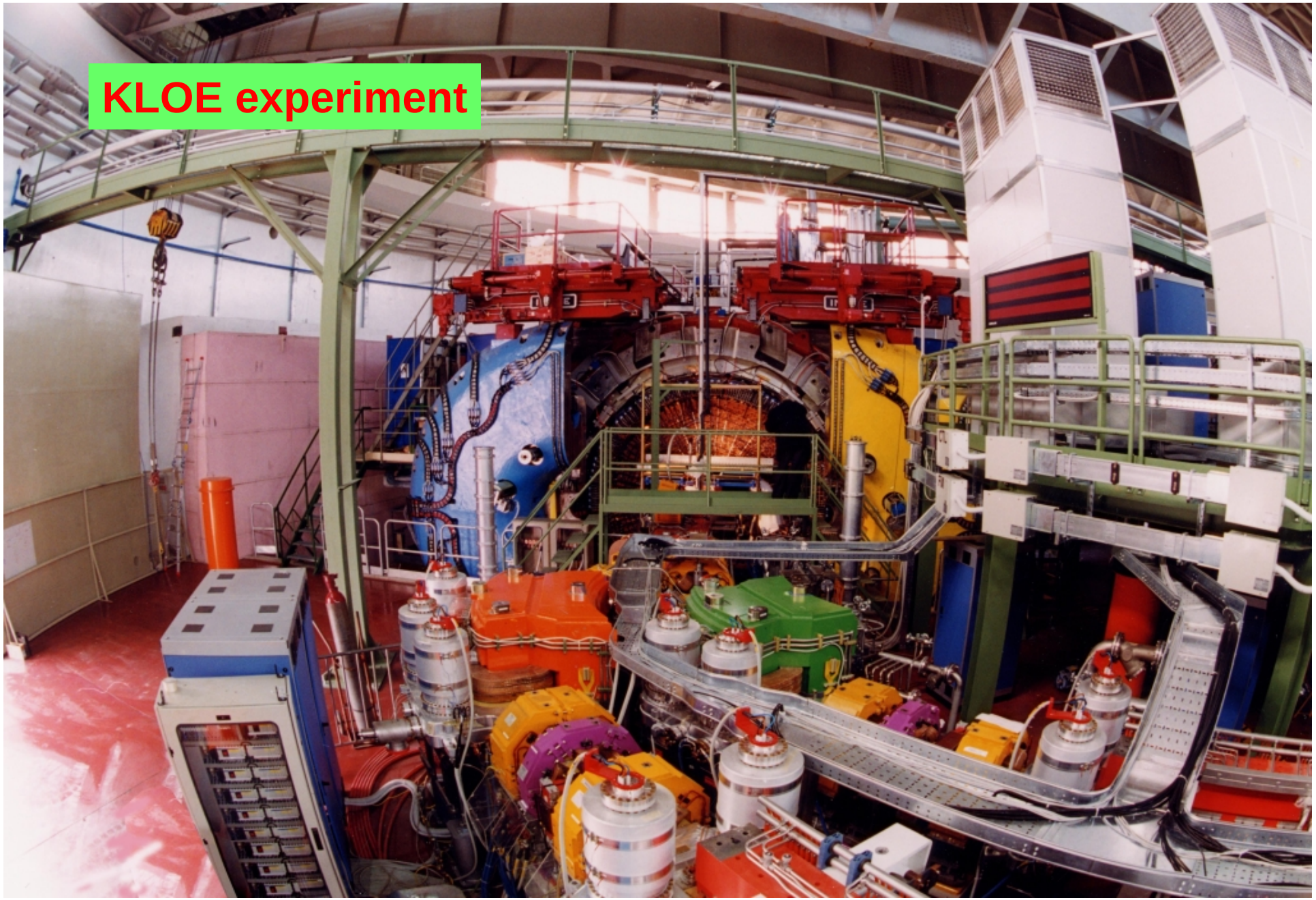
High Luminosity at DAΦNE

- **In 2007 the DAΦNE accelerator complex has been upgraded.**
- **Large Piwinski angle, low–β and Crab-Waist compensation of the synchrobetatron resonances**

- **Since May 2008 DAΦNE has been delivering luminosity to the SIDDHARTA experiment.**



(Courtesy of Catia Milardi)


KLOE experiment

Recent Kaon analysis:

$K_S K_L \to \pi^+\pi^-\pi^+\pi^-$	Quantum Interference	PLB 642 (2006) 315	
CP and CPT violation	Bell-Steinberger rel. + KLOE data	**Accepted by JHEP**	
$K_S \to \pi^0\pi^0\pi^0$	UL on BR at 10^{-7}	PLB 619 (2005) 61	PDG06
$K_S \to \pi e \nu$	BR to 1.3%, form factor slope, charge asymmetry	PLB 636 (2006) 173	PDG06
$K_S \to \pi^+\pi^-, \pi^0\pi^0$	$\Gamma(\pi^+\pi^-)/\Gamma(\pi^0\pi^0)$ to ~0.25%	Accepted by EPJC	PDG06
$K_L \to \pi l \nu, \pi\pi\pi$	Absolute BR's to ~ 0.5% K_L lifetime from Σ(BR)=1	PLB 632 (2006) 43	PDG06
K_L lifetime	from $K_L \to \pi^0\pi^0\pi^0$ to ~ 0.5%	PLB 626 (2005) 15	PDG06
$K_L \to \pi e \nu$	Form factor slopes	PLB 636 (2006) 166	PDG06
$K_L \to \pi e \nu \gamma$	BR to ~ 2 %	Preliminary	
$K_L \to \pi^+\pi^-$	BR to 1.1%	PLB 638 (2006) 140	PDG06
$K_L \to \gamma\gamma$	$\Gamma(\gamma\gamma)/\Gamma(\pi^0\pi^0\pi^0)$ to 1.1%	PLB 566 (2003) 61	
$K^+ \to \pi^+\pi^0\pi^0$	BR to 1.4%	PLB 597 (2004) 139	
$K^+ \to \mu^+\nu$	Absolute BR to ~ 0.27%	PLB 632 (2006) 76	PDG06
$K^\pm \to \pi^0 l^\pm \nu$	Absolute BR's to ~ 1.5%	Preliminary	
$K^\pm$ lifetime	two independent measurements	Preliminary	
etc…			

V_{us} - V_{ud} plane from $K_{\mu 2}$:

Using **BR($K^+ \to \mu^+\nu$)** from KLOE and **f_K / f_π =1.208(2)($^{+7}_{-14}$)** from MILC Coll. (2006) one can obtain **V_{us}/V_{ud} = 0.2286($^{+20}_{-11}$)** from

$$\frac{\Gamma\left(K \to \mu\nu_\mu(\gamma)\right)}{\Gamma\left(\pi \to \mu\nu_\mu(\gamma)\right)} \propto \frac{|V_{us}|^2 f_K^2}{|V_{ud}|^2 f_\pi^2}$$

[Marciano 2006]

Fit with V_{us}, V_{ud} from prev. Slides:

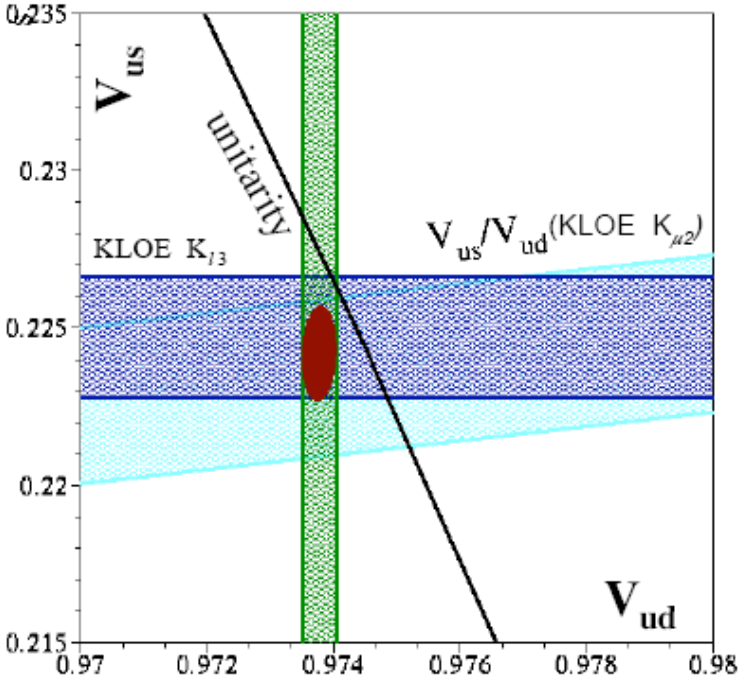
V_{us} = 0.2246($^{+9}_{-13}$)
V_{ud} = 0.97377(27)

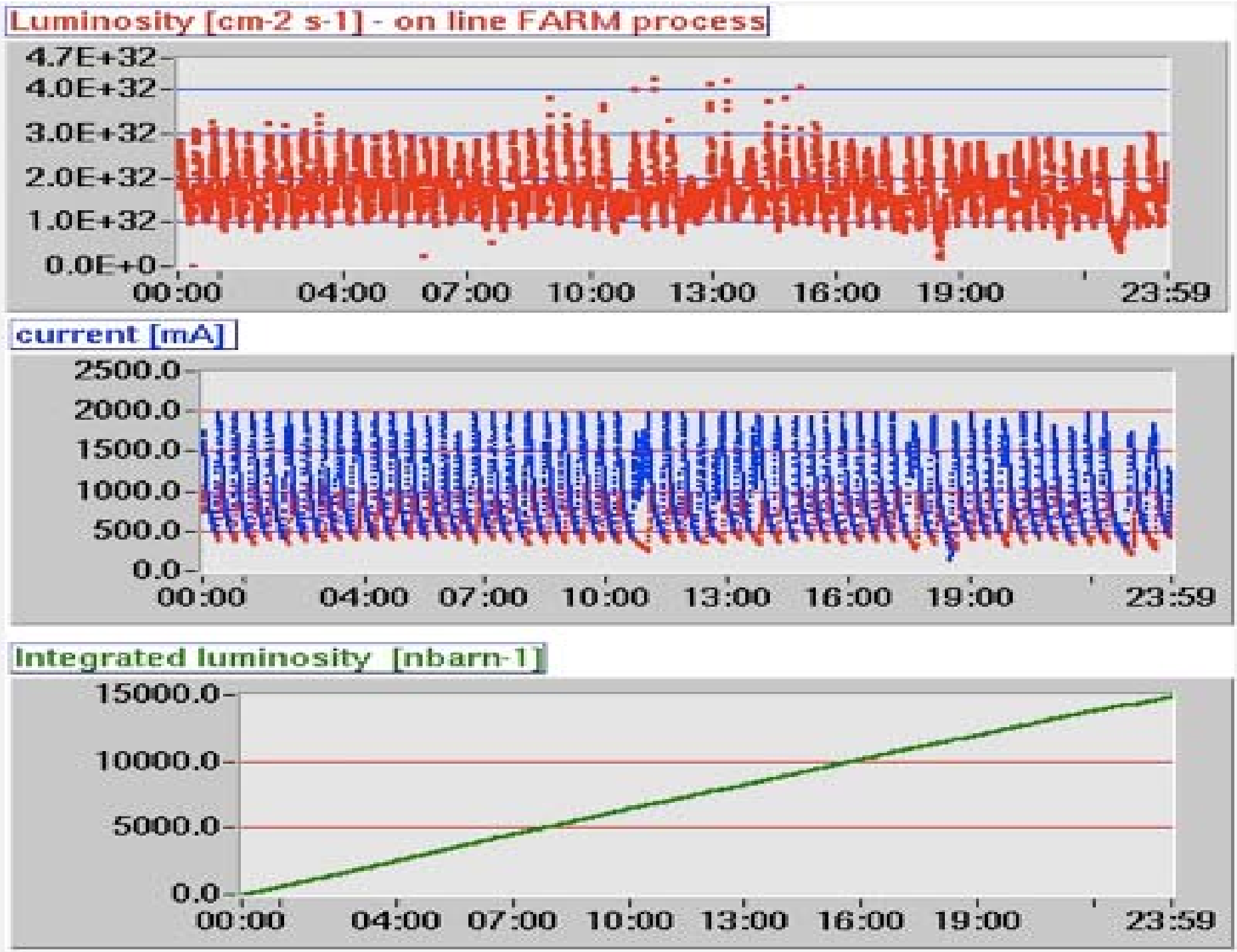
χ^2/dof = 0.046/2 P(χ^2) = 0.97

Fit with V_{us}, V_{ud} + unitarity:

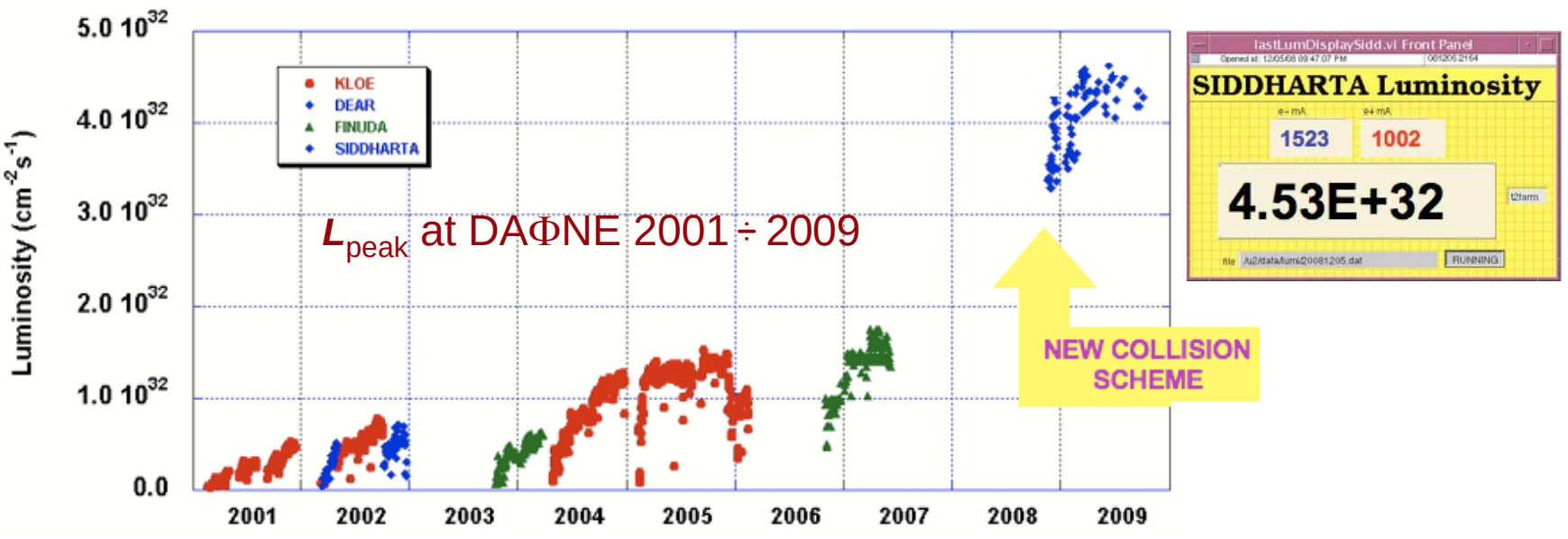
V_{us} = 0.2257(7)
V_{ud} = 0.97420(16)

χ^2/dof = 3.94/1 P(χ^2) = 0.05

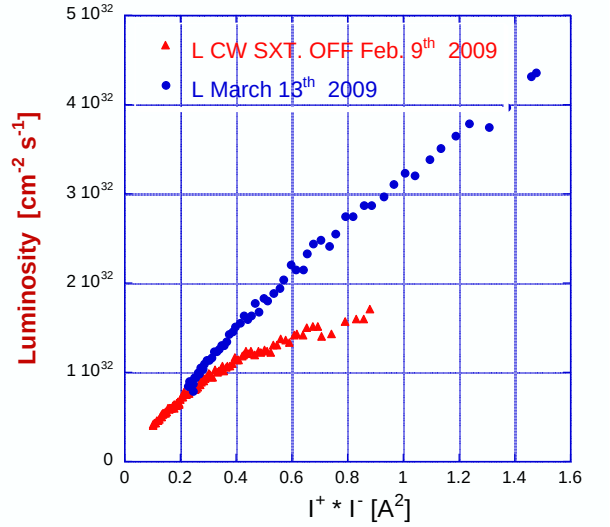



Luminosity [cm-2 s-1] - on line FARM process
4.7E+32
4.0E+32
3.0E+32
2.0E+32
1.0E+32
0.0E+0
00:00
04:00
07:00
10:00
13:00
16:00
19:00
23:59
current [mA]
2500.0
2000.0
1500.0
1000.0
500.0
0.0
00:00
04:00
07:00
10:00
13:00
16:00
19:00
23:59
Integrated luminosity [nbarn-1]
15000.0
10000.0
5000.0
0.0
00:00
04:00
07:00
10:00
13:00
16:00
19:00
23:59

DAΦNE Luminosity measurements

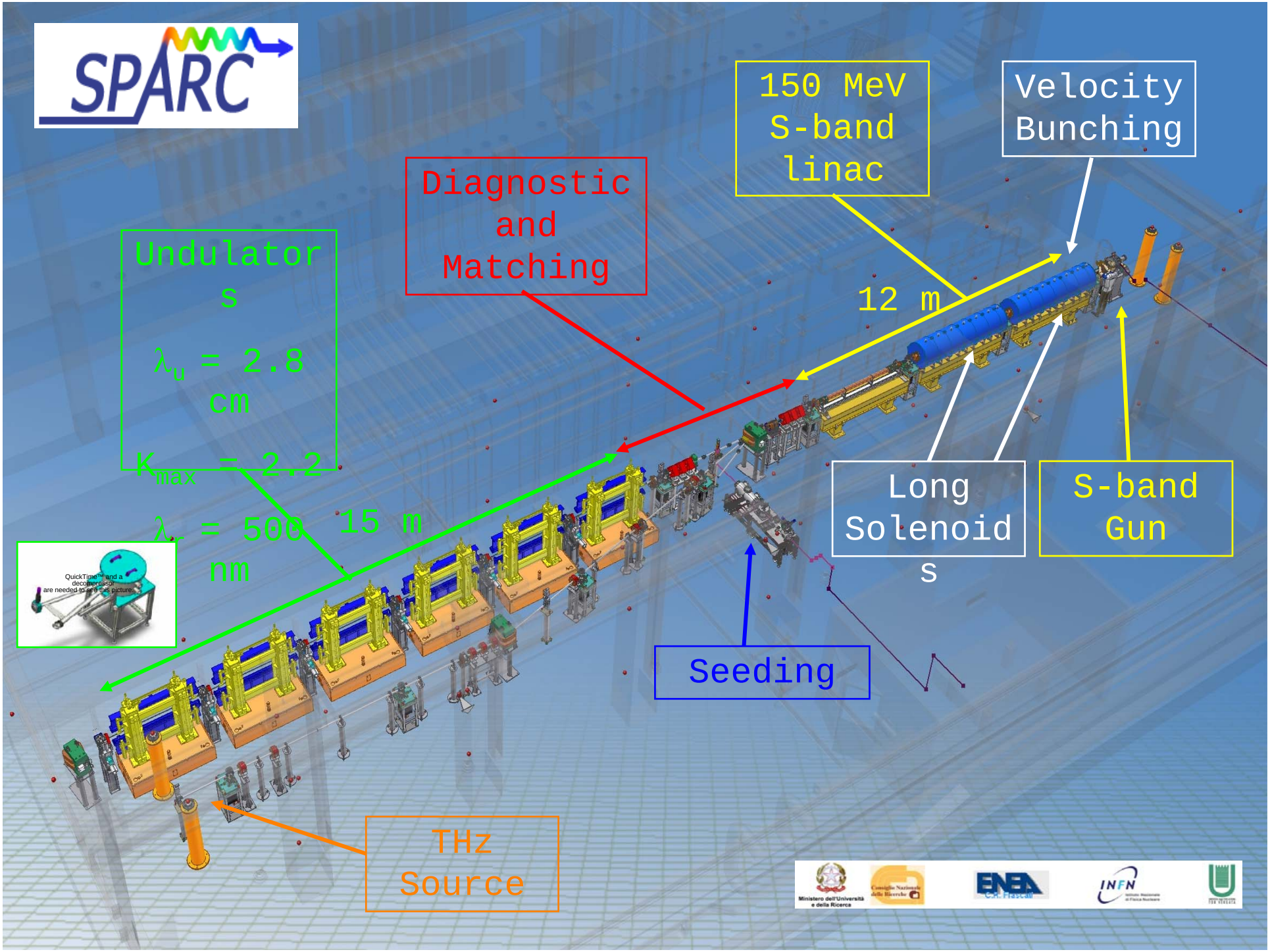


L versus *Crab-Waist* compensation



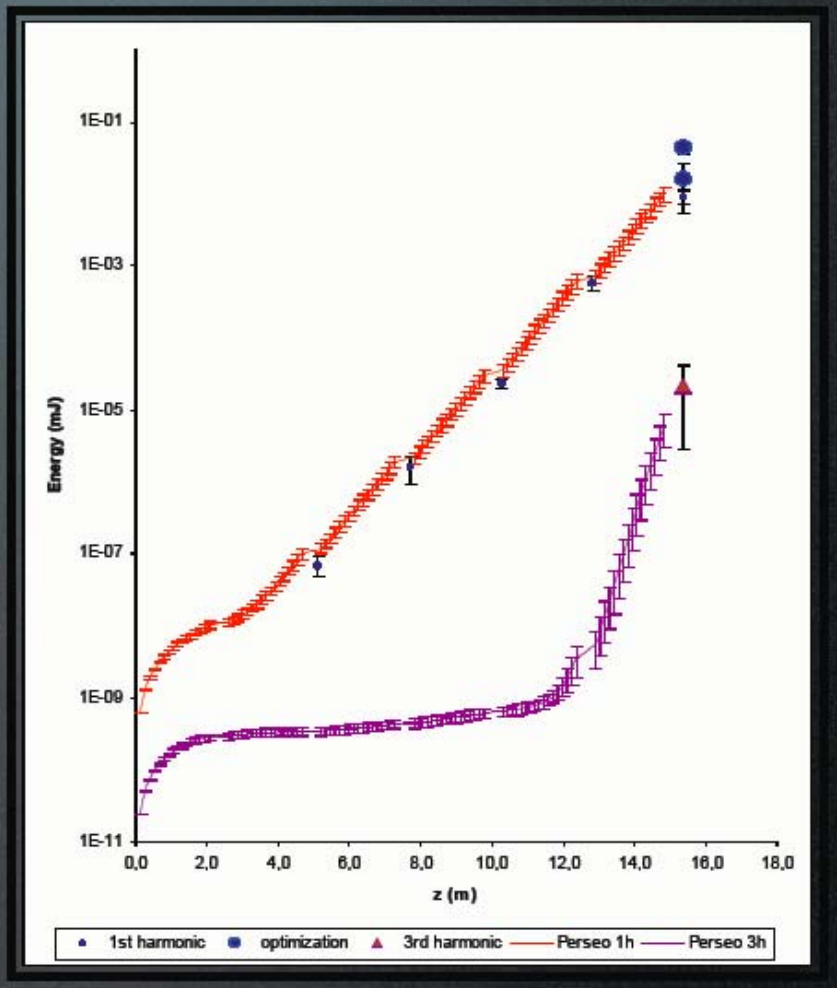
Expected $L_{\int day}$ = 20 pb^{-1}

(Courtesy of Catia Milardi)

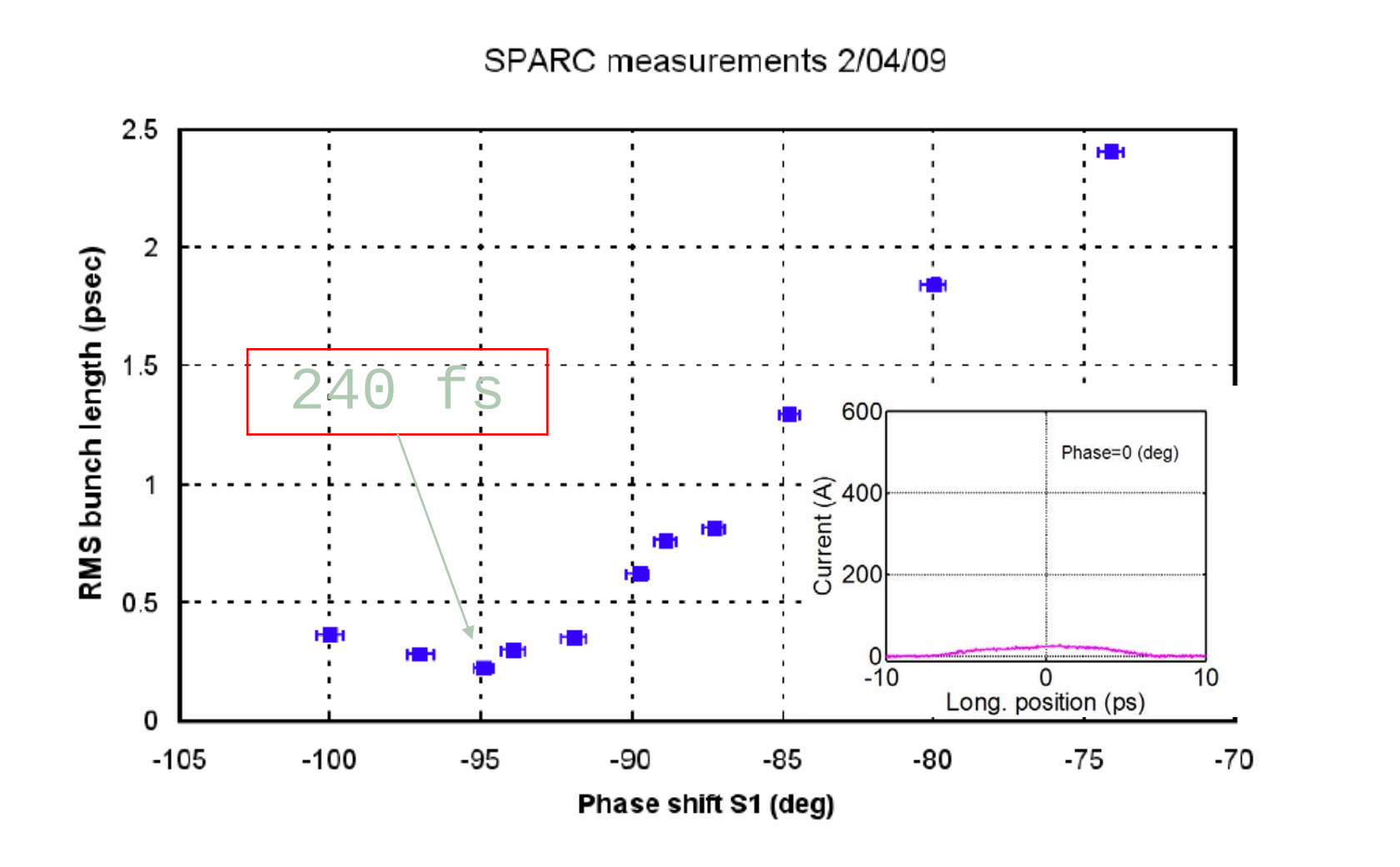

SPARC
150 MeV S-band linac
Velocity Bunching
Diagnostic and Matching
Undulators
λ_u = 2.8 cm
K_{max} = 2.2
λ_r = 500 nm
12 m
15 m
Long Solenoids
S-band Gun
Seeding
THz Source
QuickTime™ and a decompressor are needed to see this picture.

Comparison with simulations

- Third harmonic measured only with 6 undulators
- Perseo 1h & Perseo 3h represent 50 Perseo TD simulations
- Error bars represent 1 standard deviation



Electron Pulse Length versus injection phase



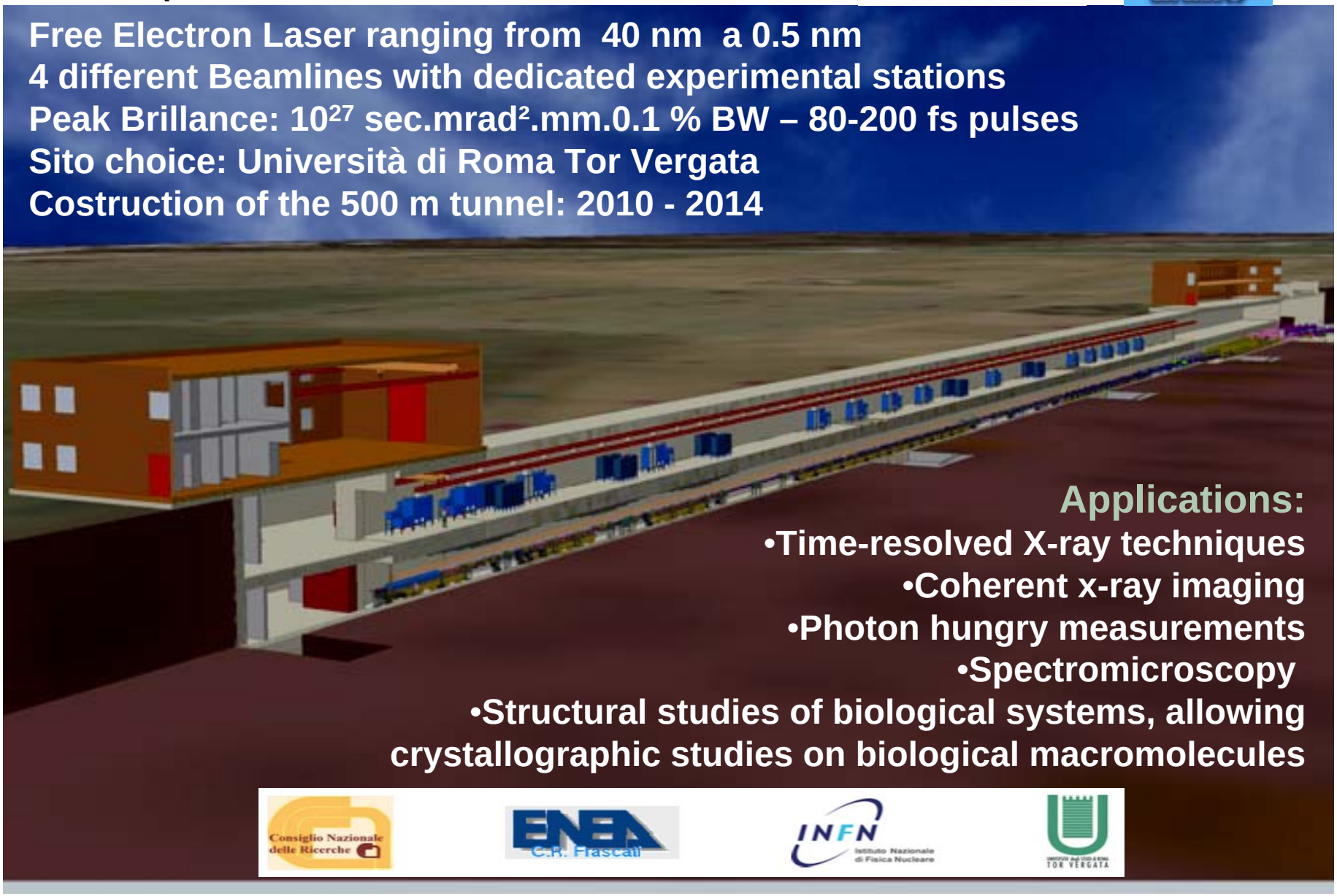
VELOCITY BUNCHING

www.sparx-fel.eu

Ministero dell'Università e della Ricerca

REGIONE LAZIO

Free Electron Laser ranging from 40 nm a 0.5 nm
4 different Beamlines with dedicated experimental stations
Peak Brillance: 10^{27} sec.mrad².mm.0.1 % BW – 80-200 fs pulses
Sito choice: Università di Roma Tor Vergata
Costruction of the 500 m tunnel: 2010 - 2014



Applications:

- Time-resolved X-ray techniques
- Coherent x-ray imaging
- Photon hungry measurements
- Spectromicroscopy
- Structural studies of biological systems, allowing crystallographic studies on biological macromolecules

Consiglio Nazionale delle Ricerche

ENEA C.R. Frascati

INFN Istituto Nazionale di Fisica Nucleare

TOR VERGATA

A new Project : X-FEL SPARX

Site map

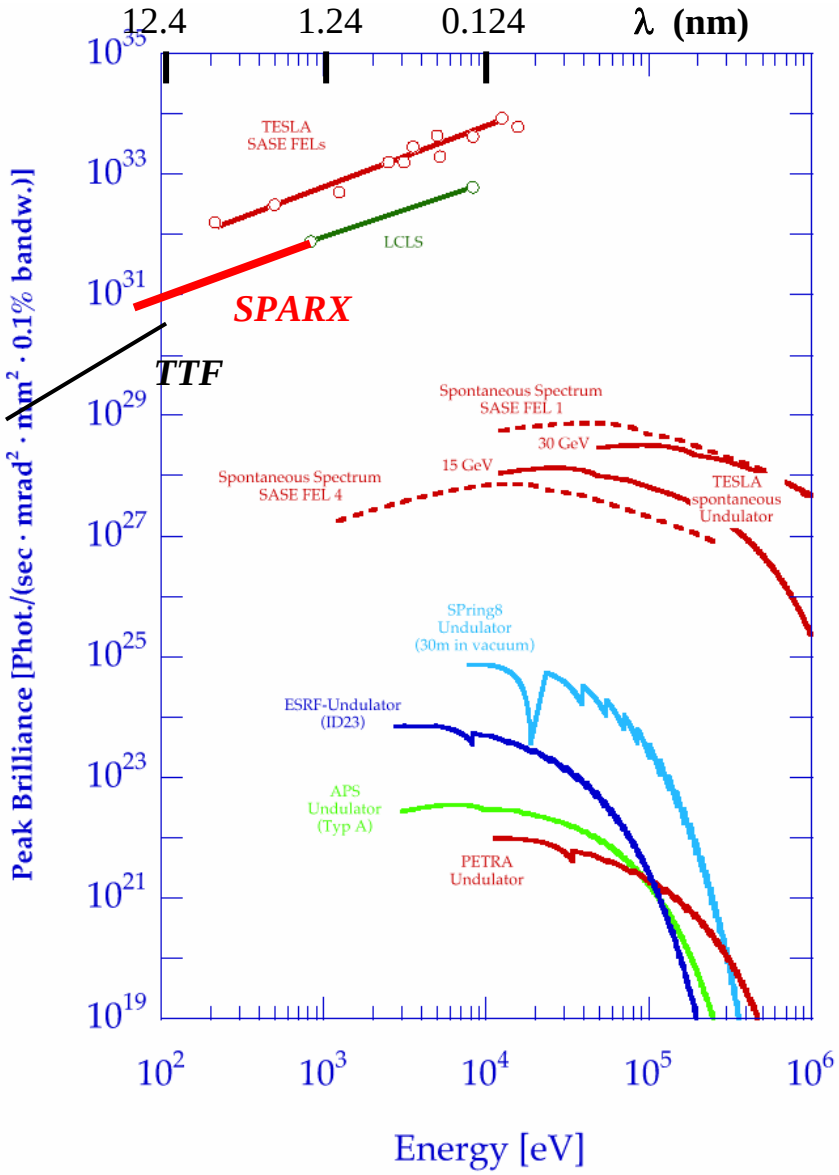
The TDR is ready

2008-2013

A NEW PROJECT
an X-FEL at TORVERGATA

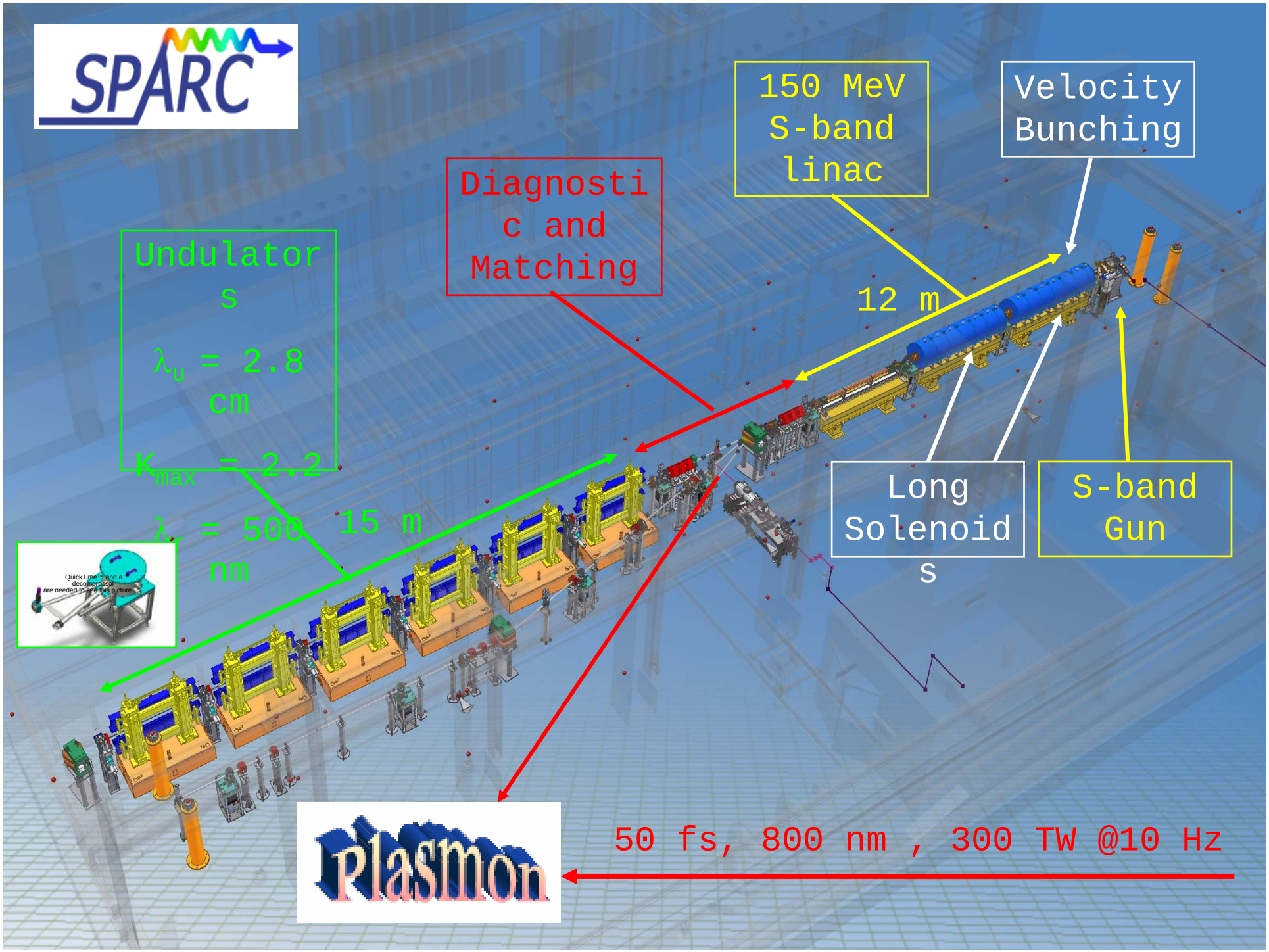
New FEL Covering from the VUV to the 1 Å X-ray spectral range:
new Research Frontiers

Brilliance of X-ray radiation sources

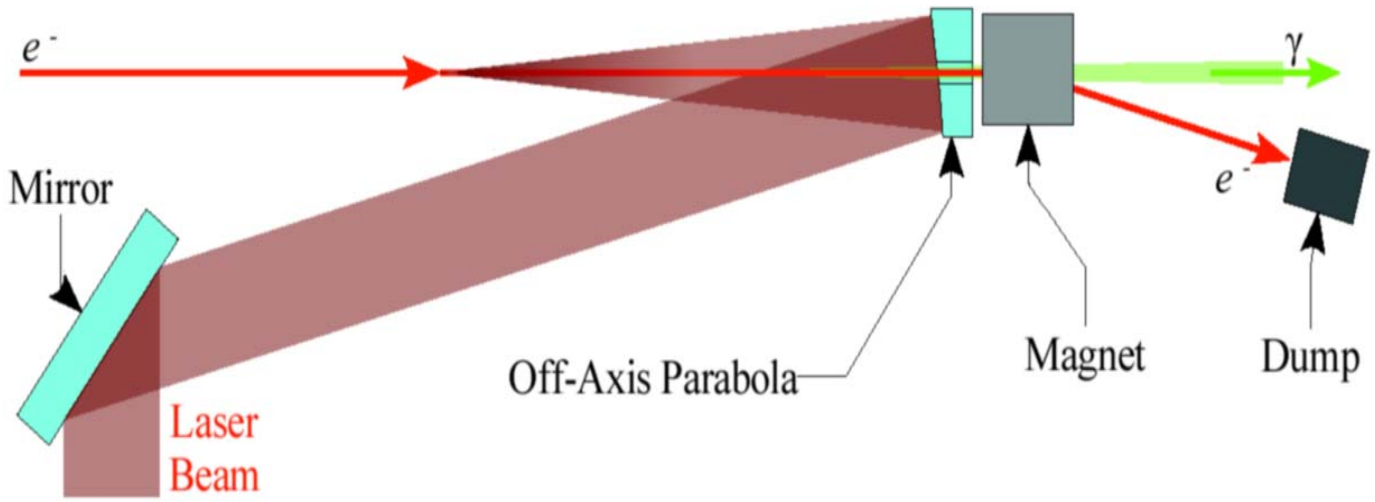


L.Palumbo

Approuved and funded : 2007-2011


SPARC
150 MeV S-band linac
Velocity Bunching
Diagnostic and Matching
Undulators
λ_u = 2.8 cm
K_{max} = 2.2
λ_r = 500 nm
15 m
12 m
Long Solenoids
S-band Gun
QuickTime™ and a decompressor are needed to see this picture.
Plasmon
50 fs, 800 nm , 300 TW @10 Hz

Tuneable X-ray radiation source based on Thomson Scattering

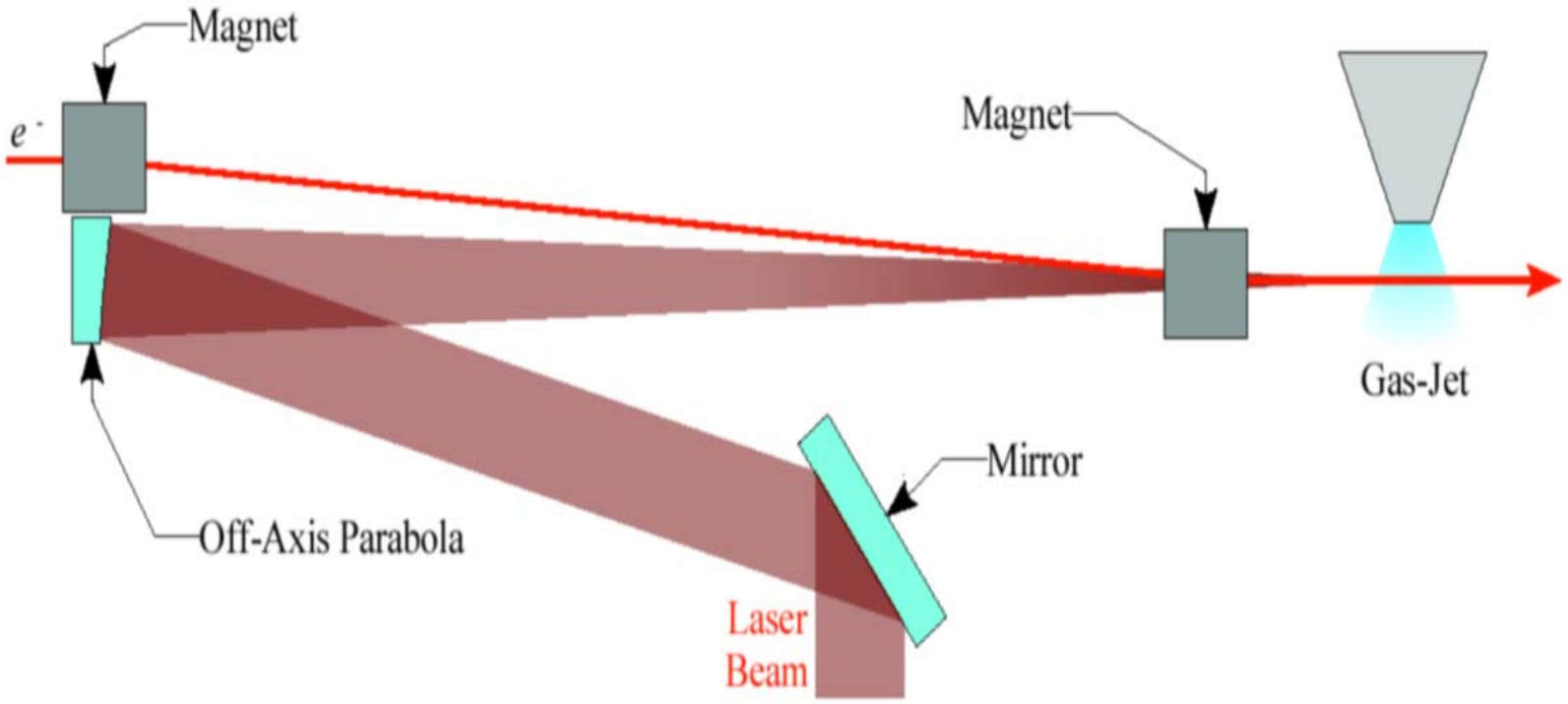


X ray pulses : 10^9 photons/s, 3 ps, 20 keV - 1 MeV

Plasmon

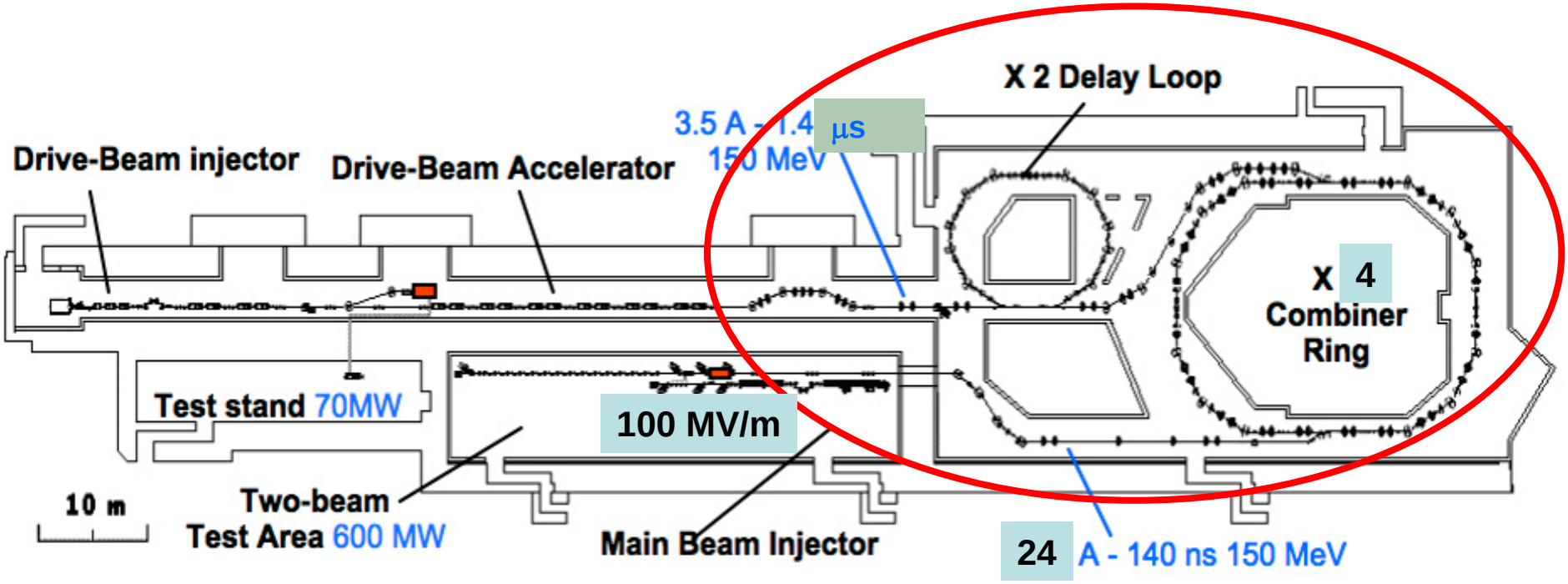
VERY HIGH POWER INFRARED LASER

LWFA acceleration of externally injected electrons in a gas-jet plasma



300 TW 25 fs 0.8 μ laser

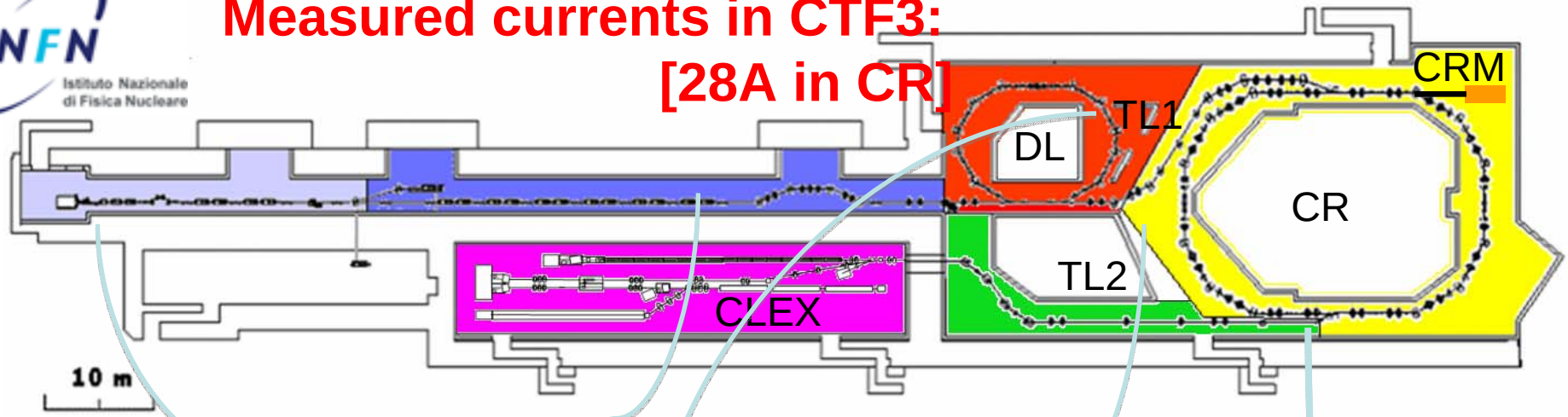
INFN Contribution in CLIC Test Facility: Beam recombination system

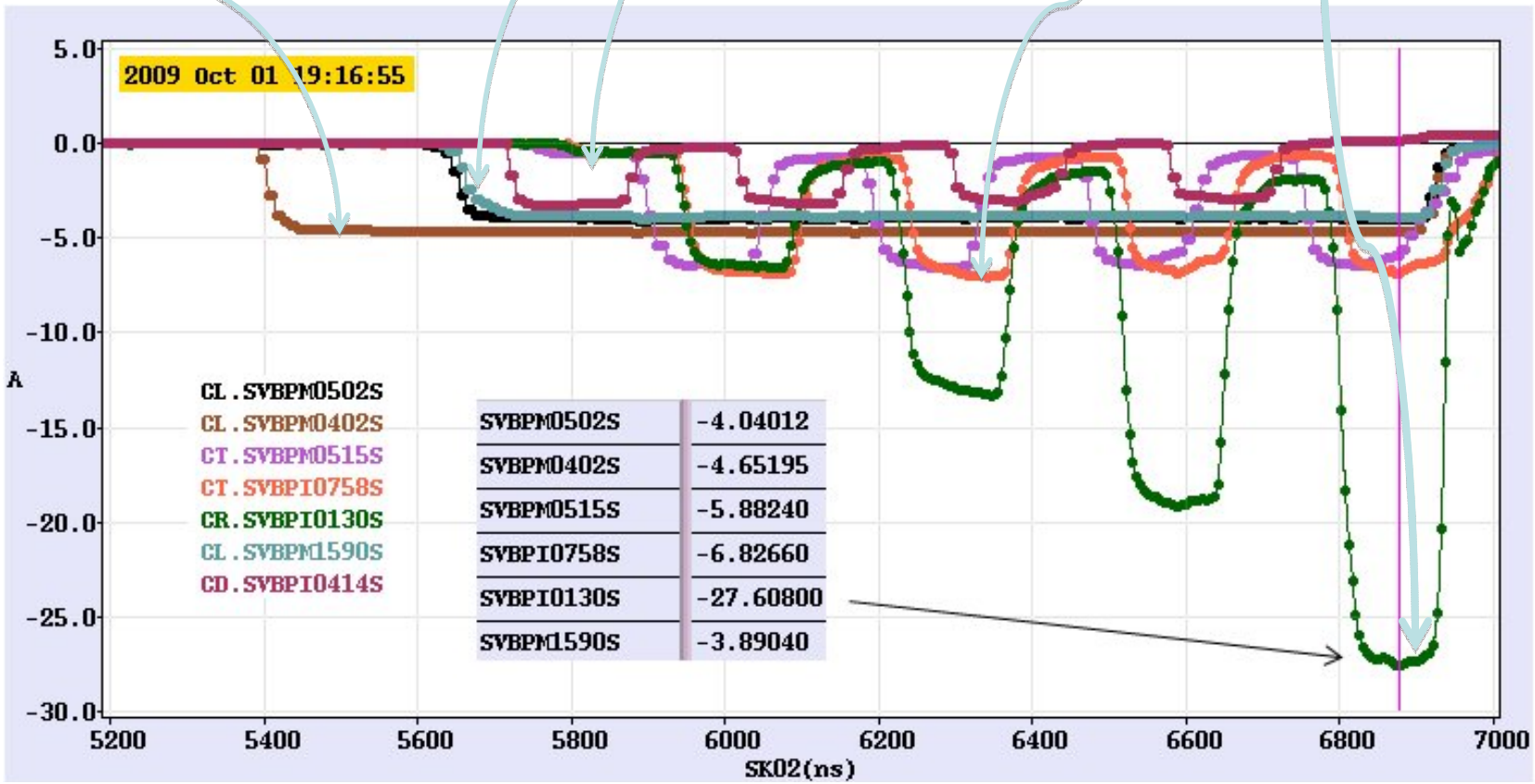


INFN
Istituto Nazionale di Fisica Nucleare

CTF3

Measured currents in CTF3: [28A in CR]





LNF activity is focused on ILC damping rings

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

- 5 Gev damping rings for e^+ and e^- in a shared tunnel
- Circumference 6.4 km
- Number of bunches 2700 - 5400
- extremely low emittance values
  - ε_x = 0.6 nm
  - ε_y = 2 pm (minimum ever achieved)
- Short damping time τ_x = 21 ms
- Wigglers needed: total length ~ 200 m, peak field 1.6 T

Documented in Reference Design Report (RDR), Beijing February 2007

Damping Rings LNF Activity

- Fast kickers R&D
  - kickers with ultra short rise/fall time (< 3 (6) ns for 3 (6) ns bunch distance) are one of the most critical issues since the bunch distance and ring circumference are related to kicker pulse duration
- Electron cloud studies at DAFNE
  - Comparison between measurements and simulation
  - Test of mitigation techniques
- Design of low impedance bellows
- Beam dynamics in wiggler magnets
- Low emittance lattice design

Accelerator Physics and Technology

CNAO

Centro Nazionale di Adroterapia Oncologica in Pavia

CNAO Fundation: no profit organisation created in 2001 to build the national center for hadrontherapy designed by TERA Foundation.
Construction begun in 2004

Collaborations

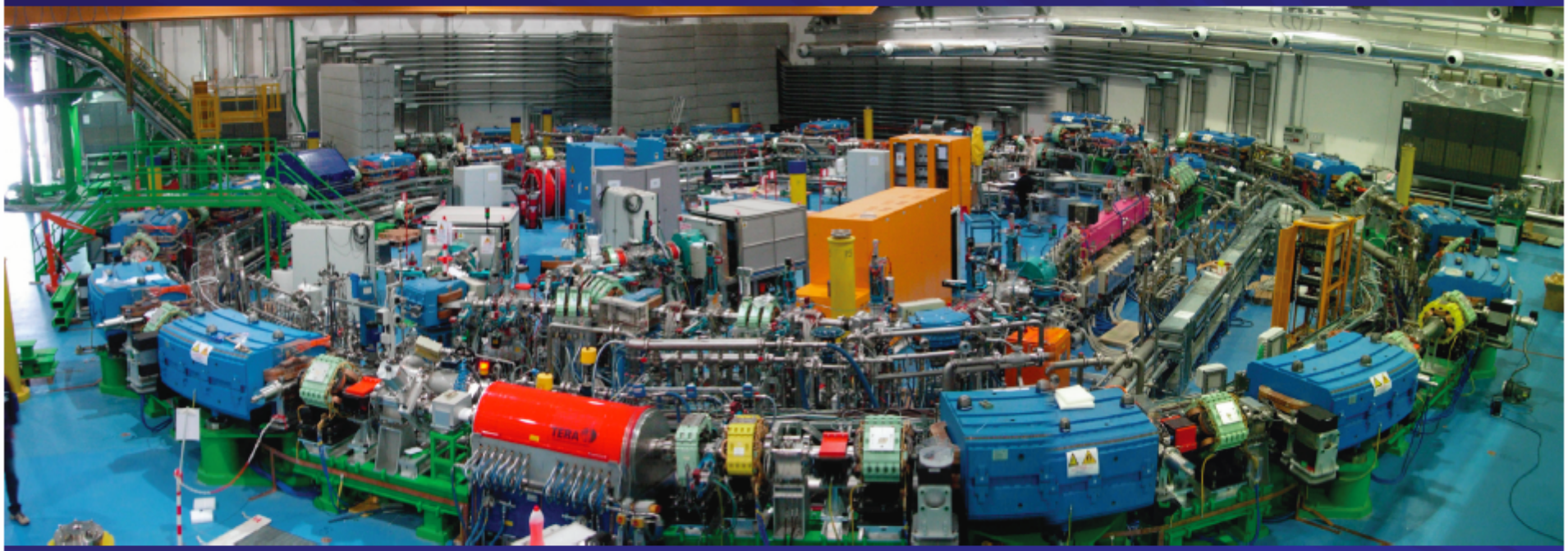
NATIONAL

INFN	co-direction, involvement/responsibility in many technical issues (15), formation
Town of Pavia	land and authorisations
University of Milan	medical coordination and formation
Polytechnic of Milan	patient positioning, radioprotection and authorisations
University of Pavia	electrical plant, power supplies and betatron, safety, formation
Province of Pavia	logistics and authorisation
University of Turin	interface beam-patient, TPS

INTERNATIONAL

CERN	special magnets, dipole measurements and diagnostics (+ PIMMS heritage)
GSI	linac and special components
LPSC (Grenoble)	optics, betatron, low-level RF, control system
NIRS (Chiba)	medical activities, formation

Synchrotron hall (October 09)



250 Mev protons

400 MeV/u Carbon

CONCLUSION:

Accelerator physics and technology
FEL physics and technology
Flavour physics and the KLOE experiment
Space physics (future experiment in space)
High density nuclear matter (ALICE)
Detector technology
Synchrotron light form DAFNE

Frascati school of physics

….we could set up a DUBNA-LNF working group….
“light, fast and efficient”

“…….thank you”