4^{th} SPARC_LAB PAB Meeting

15:00 Welcome – U. Dosselli
15:07 Introduction – P. Muggli
15:15 SPARC_LAB status and plans – M. Ferrario
15:45 Thomson source status– C. Vaccarezza

16:00 Coffee Break

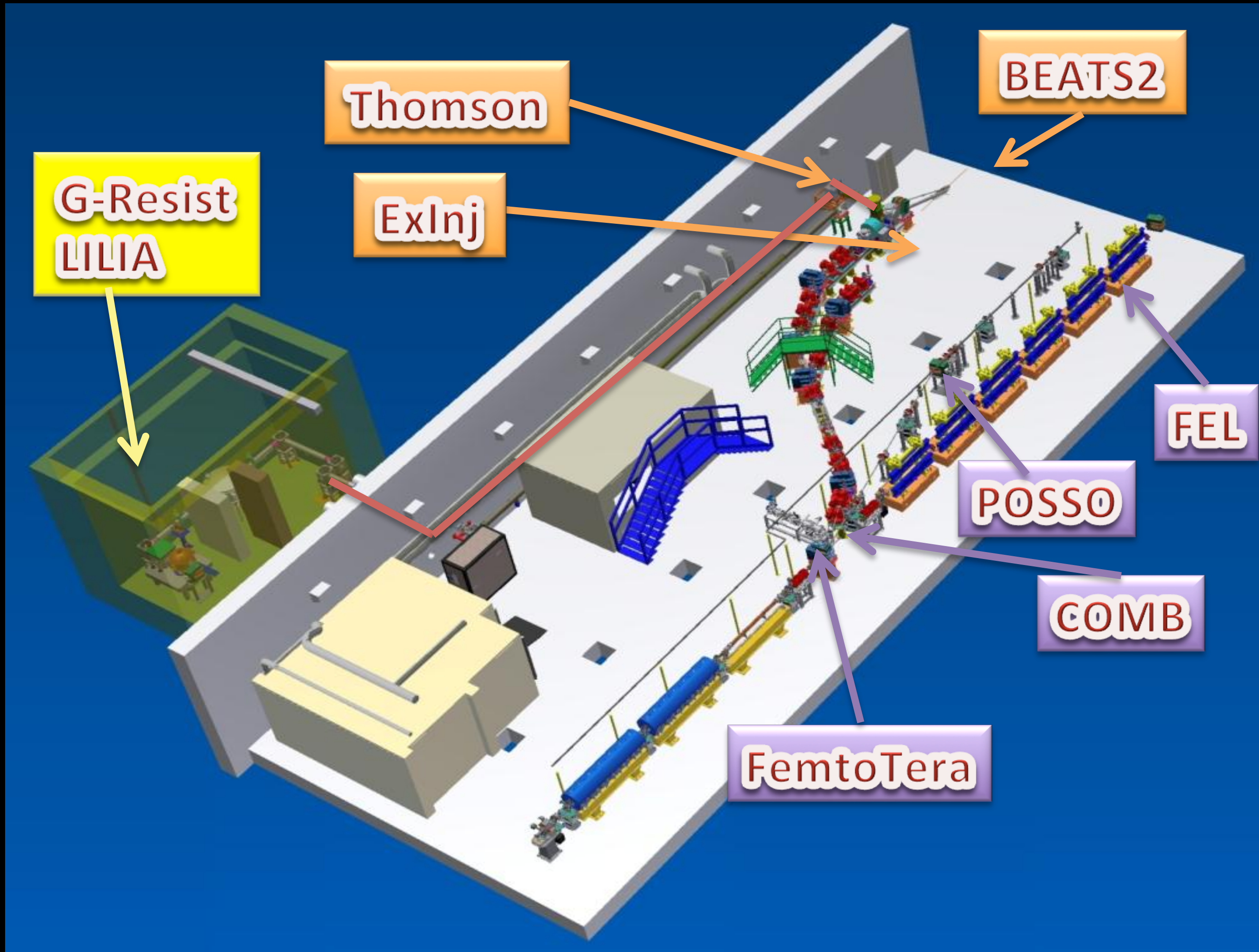
16:15 FLAME activities – G. Gatti
16:30 Experiments with THz radiation– S. Lupi
16:45 Collaboration with Stratclyde University – M. P. Anania
17:00 STAR/SPARC_LAB collaboration – D. T. Palmer
17:15 Measuring Propagation Speed of Coulomb Fields - G. Pizzella

17:30 Final Discussion – P. Muggli

18:00 Closed Session

19:00 Transfer to Villa Mercede

4th SPARC_LAB PAB Meeting



LNF- October 22, 2013

What has been done since PAB_3

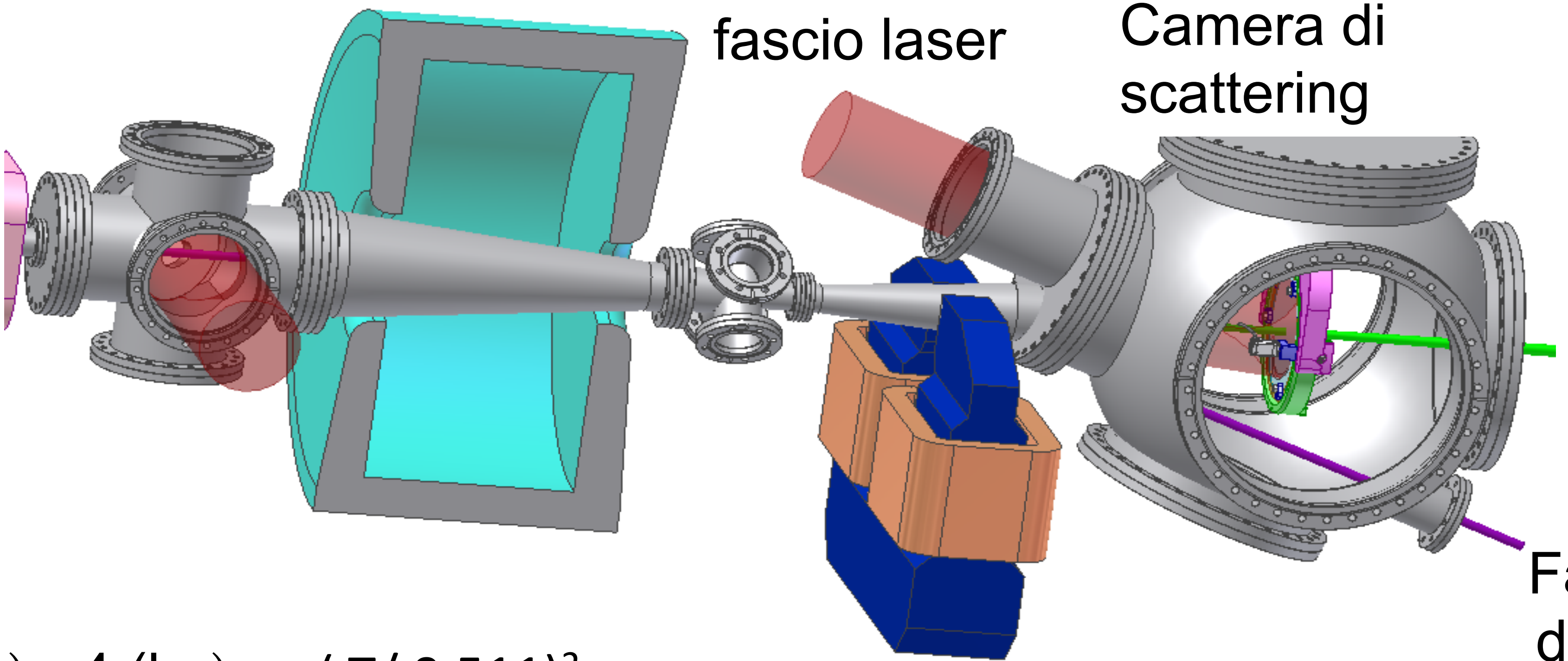
EXPECTED	May	June	July	Aug/Sept	Oct	Nov	Dec
Thomson	Electron Transp.	Photon Transp.	Synch. & First Collisions		Collisions	Collisions /Users	Users
FEL	Seeded 2 Colors Exp.			Inst. New Und.			Exp. With New Und.
THZ		Exp.	Exp.				
C-band	HP Test	HP Test	HP Test	Inst. on line			
Protons	Exp.						
Plasma/ Compton		Exp.					
ExInj./ Comb	Simulatio ns	EoS	Int. Chamber		Int. Chamber	Int. Chamber	Int. Chamber

Actual	May	June	July	Aug	Sept.
Thomson	Electron Transp./ Laser C. room pb	Electron Transp/ Kly problem	Electron Transp/ Kly problem		Kly problem fixing
FEL			Seeded 2 Colors Tentative		
THZ		COMB EOS/THz	Stratc. Univ	Short pulse test	
C-band	RF Test	RF Test	RF Test		Inst. Off line
Protons		Test			
Plasma/ Compton		Exp.			
ExInj./ Comb	Simulatio ns	Int. Chamber	EOS/ emitt.		

X-ray THOMSON Source

More details in C. Vaccarezza talk

Thomson Interaction region (20-550 keV)



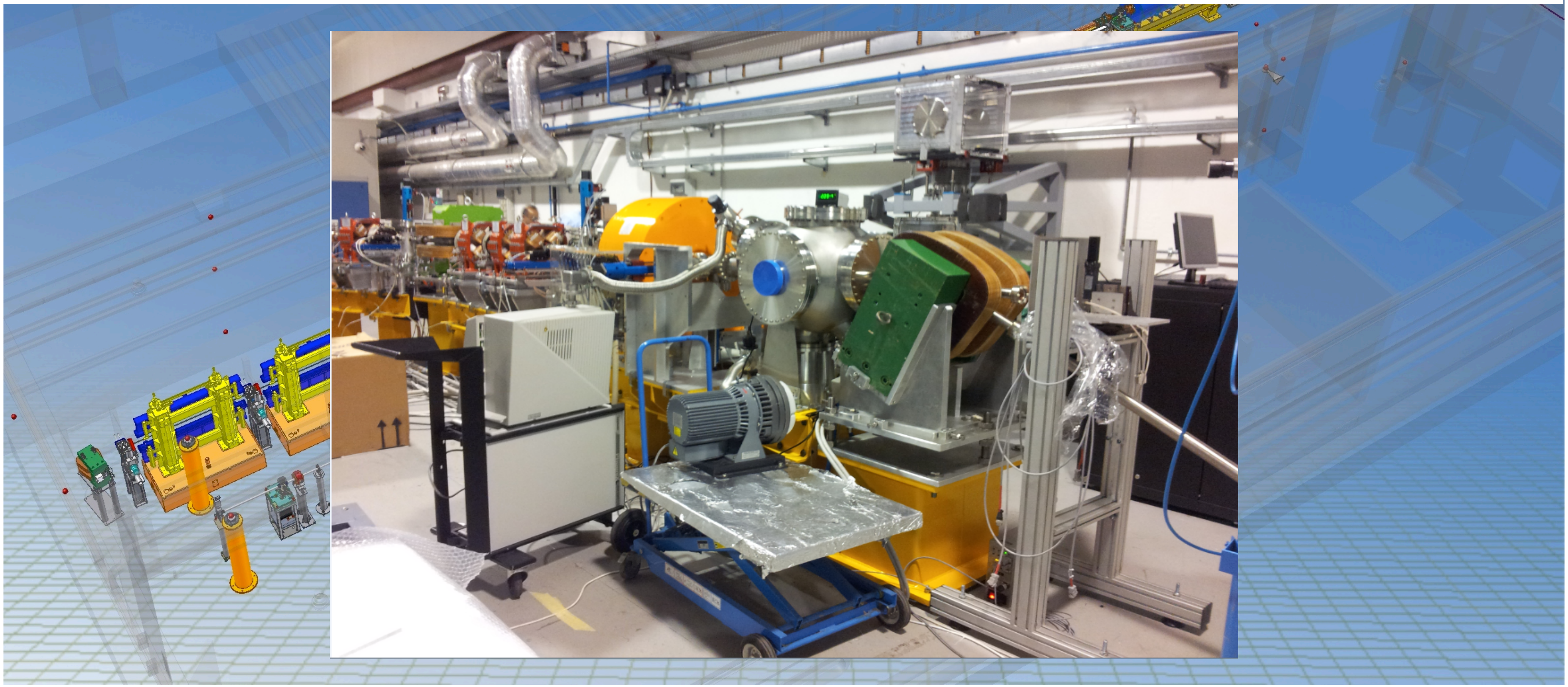
$(h\nu)_X = 4\ (h\nu)_{laser}\ (T/\ 0.511)^2$

$(h\nu)_{laser}$ = 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
α emissione: 12 mrad

Thomson back-scattering source

carica (pC)	energia (MeV)	enx (mm mrad)	eny (mm mrad)	IP sigmax mm	IP sigmay (mm)
230	157	2.7	4.5	.50	.55
220 230	75 50	2.9 1.2	5 2.3	.28 .17	.36 .18



Commissioning status & plan:

- Up to now:
  - ~250 pC e^- beam , Energy= 155-75-50 MeV
  - Down to dumper w flags
- On going:
  - Quads alignement refinement
  - Establish BPM reference orbit
  - Response matrix iterations for lattice optimization
  - Photon beam transport & optimization
- Next:
  - Synchronization & Collision

Physics and Applications of High Brightness Beams Workshop, HBEB 2013

Inverse Compton cross section revisited

C. Curatolo[a,b,*], L. Lanz[a], V. Petrillo[a,b]

[a]University of Milan, via Celoria 16, 20133 Milan, Italy
[b]INFN - Milan, via Celoria 16, 20133 Milan, Italy

Dual color X-rays from Thomson/ Compton sources

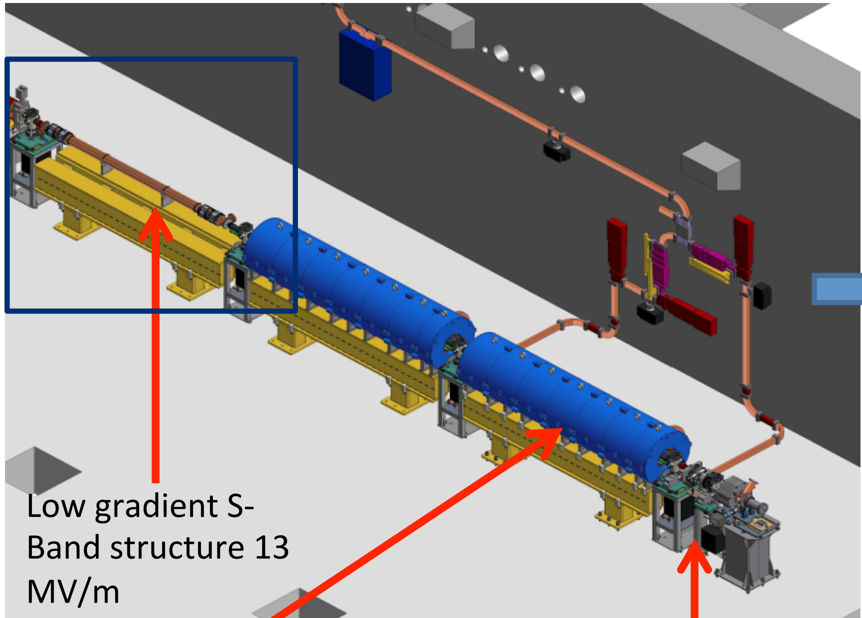
V. Petrillo[1,2], A.Bacci[1], C. Curatolo[1,2], M. Ferrario[3], C. Maroli[2], J.V. Rau, C. Ronsivalle[4], L. Serafini[1], C. Vaccarezza[3], and M. Venturelli[2*]

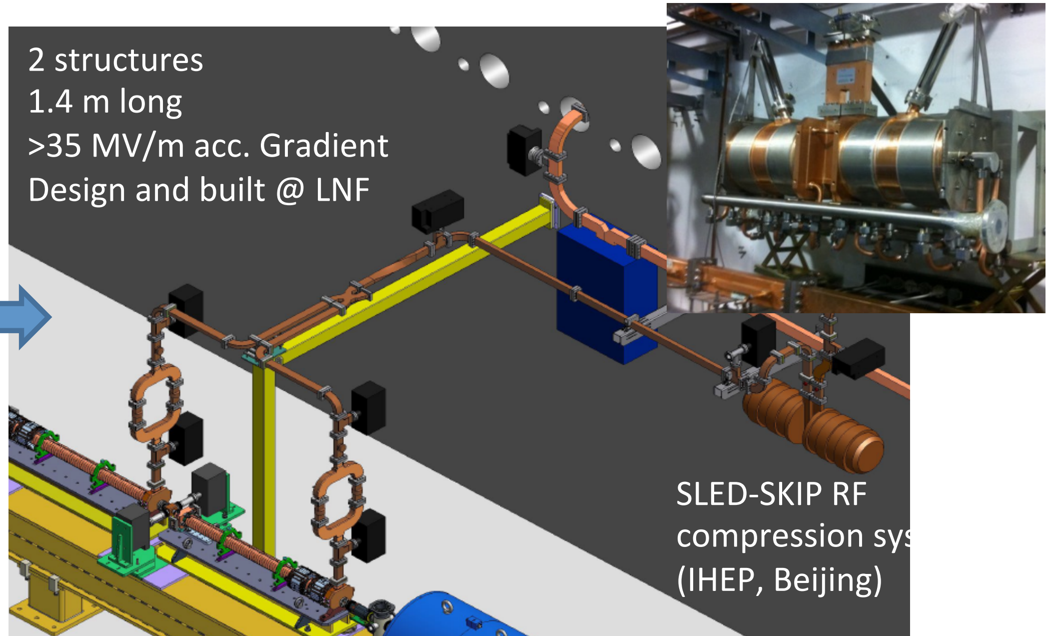
[1] *INFN Milano ,Via Celoria, 16 20133 Milano, Italy*
[2] *Università degli Studi di Milano, Via Celoria, 16 20133 Milano, Italy*
[3] *LNF, INFN Via E.Fermi, 40 Frascati (Roma), Italy and*
[4] *ENEA Via E.Fermi, 45 Frascati (Roma),Italy*

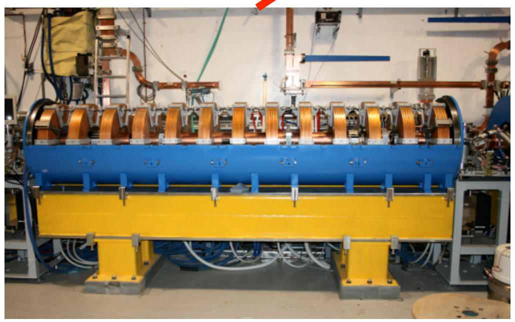
C-BAND
for SPARC_LAB
and ELI_NP

C-BAND ACCELERATING SYSTEM @ SPARC

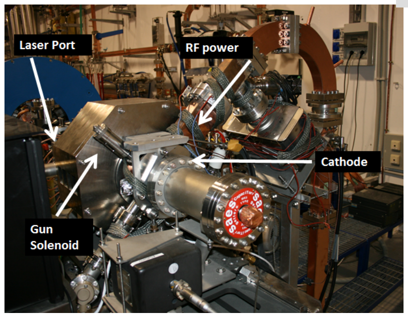
The **energy upgrade of the SPARC** photo-injector at LNF-INFN from 150 to more than 240 MeV will be done by replacing a low gradient S-Band accelerating structure with two C-band structures. The structures are **TW and CI**, have symmetric axial input couplers and have been optimized to work with a SLED RF input pulse. In the SPARC photoinjector the choice of the C-band for the energy upgrade was dictated by the opportunity to **achieve a higher accelerating gradient**, enabled by the higher frequency, and to **explore a C-band acceleration combined with an S-band injector** that, at least from beam dynamics simulations was very promising in terms of achievable beam quality.



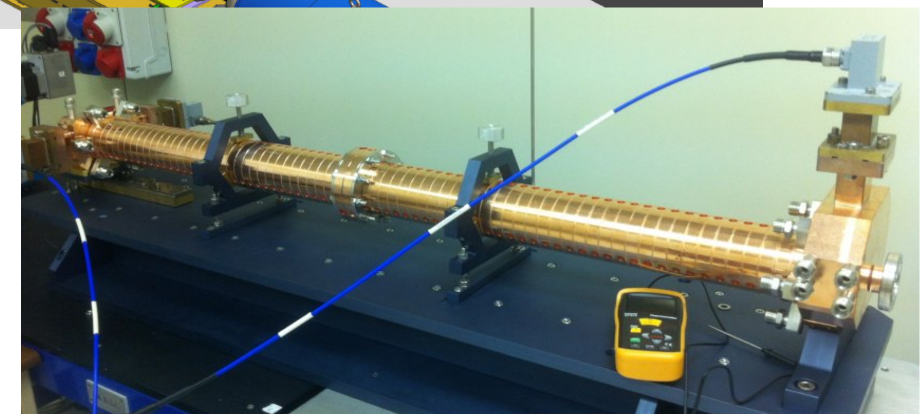




S-Band SLAC-type structure
22 MV/m



S-Band gun 120 MV/m

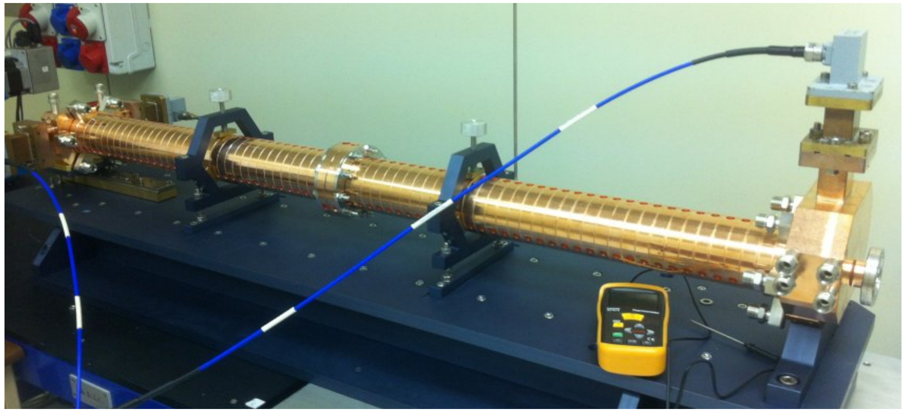


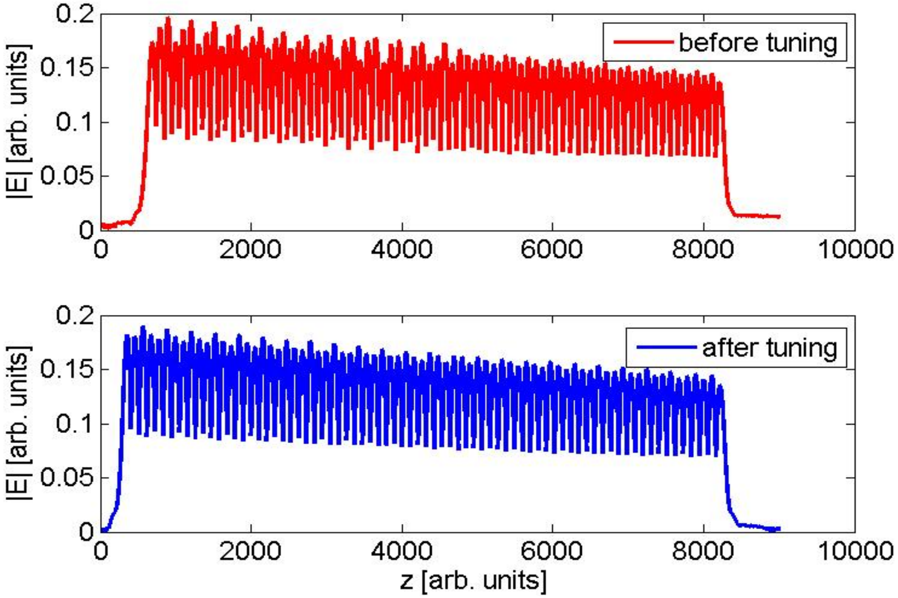
FINAL C-BAND STRUCTURES AND TEST AT SPARC

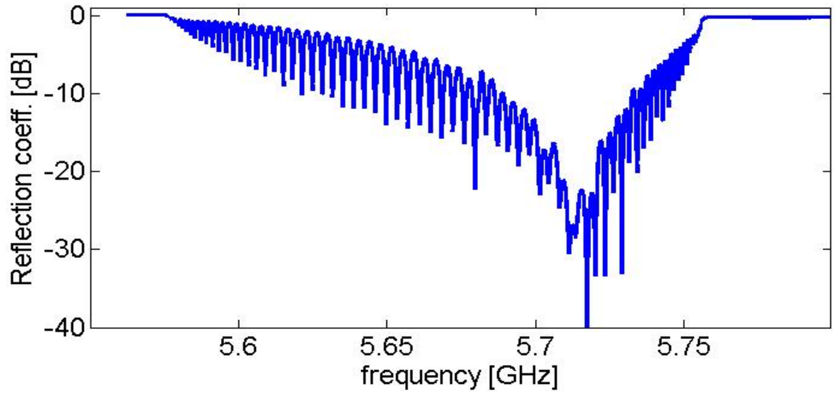
Toshiba klystron and solid state modulator by Scandinova

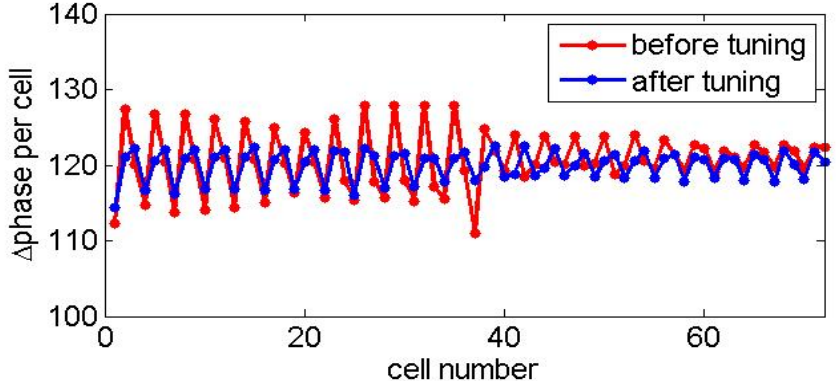
Test stand for high power test

First fabricated C-band structure





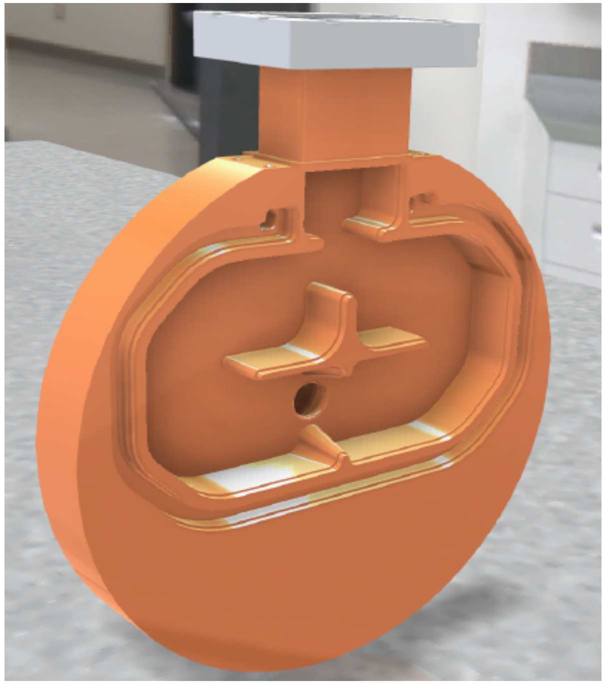




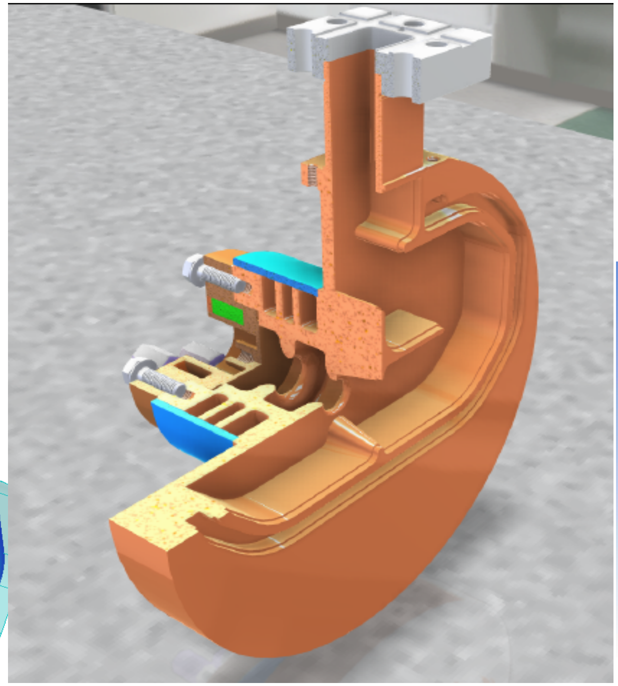
C-BAND RF GUN

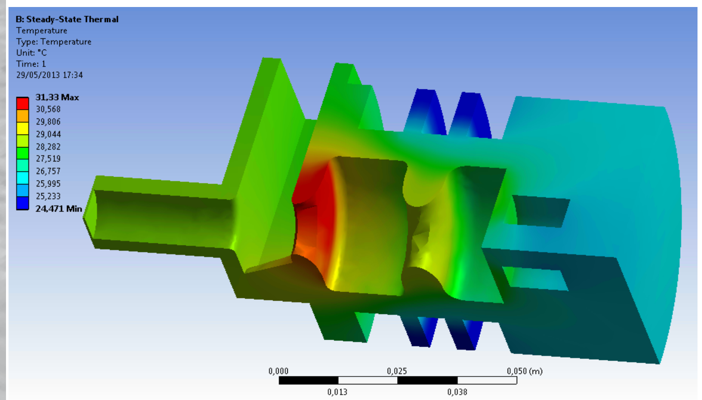
The designed gun integrate a **waveguide coupler** that allows:

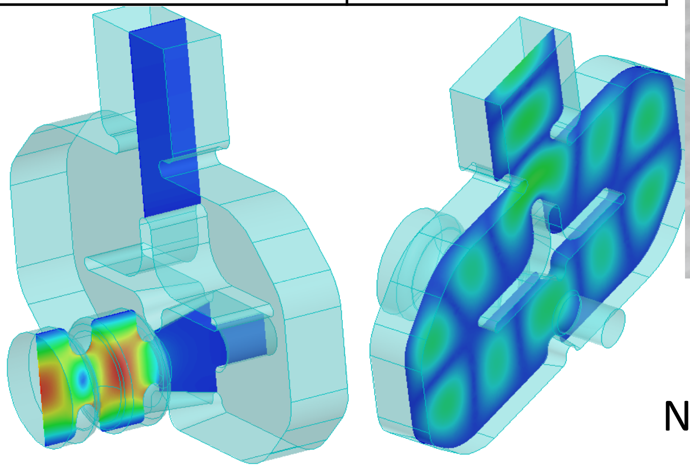
-**high efficiency cooling** of the accelerating cells
-**low pulsed heating** of the coupler surfaces
-**arbitrary solenoids position** around the accelerating cells and on the beam pipe
-**100 Hz operation** in multi bunch
-**fabrication of the gun without brazing processes** (hard copper->higher gradients)



PARAMETERS	
f [GHz]	5712
Q_0	10900
$E_{cathode}$ @10 MW Pin	200 [MV/m]
β	2
Filling time τ	200 [ns]

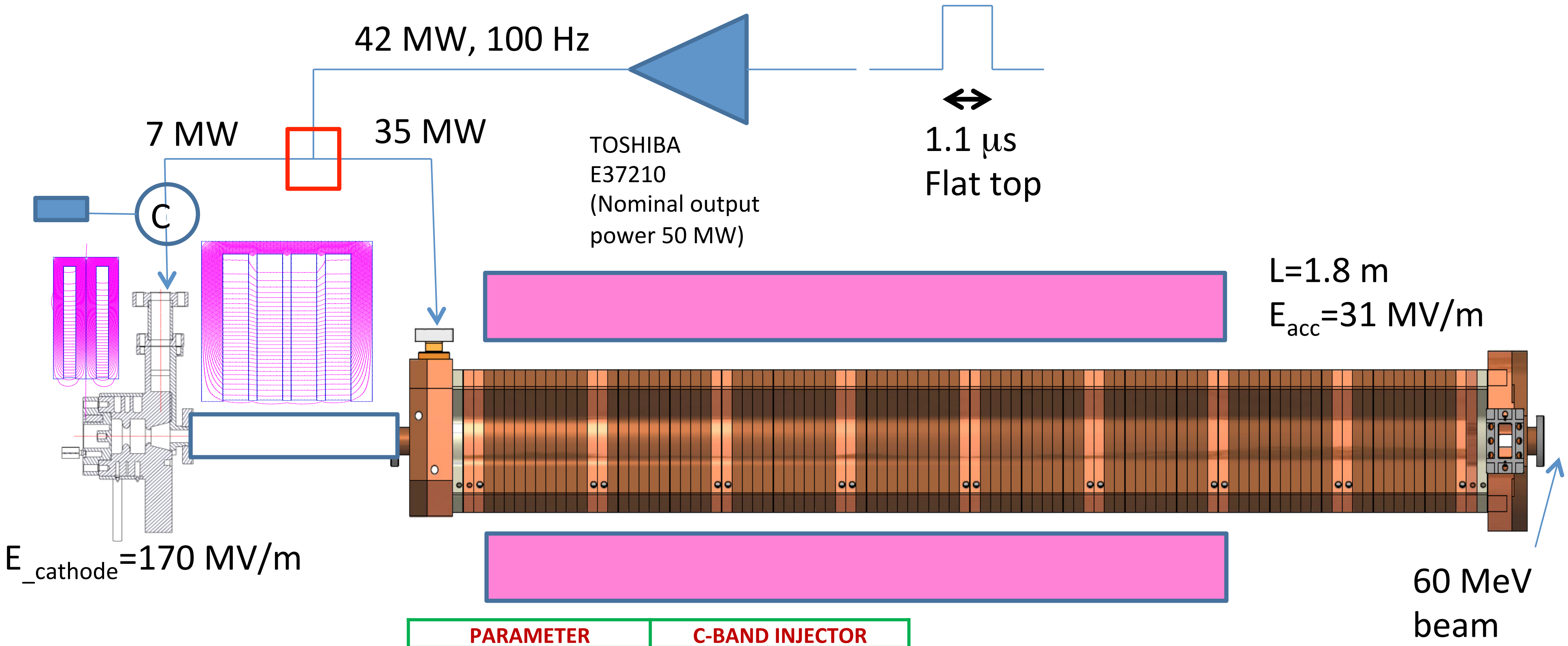






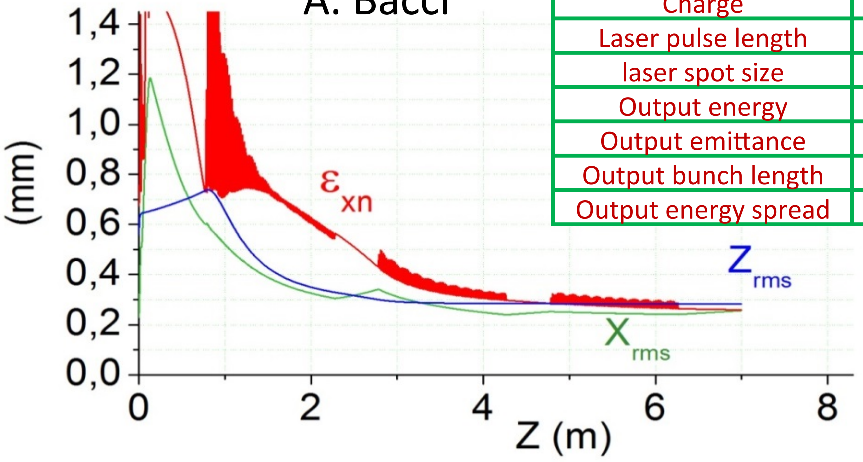
NEXT STEP: $/€/time/people for the first prototype realization

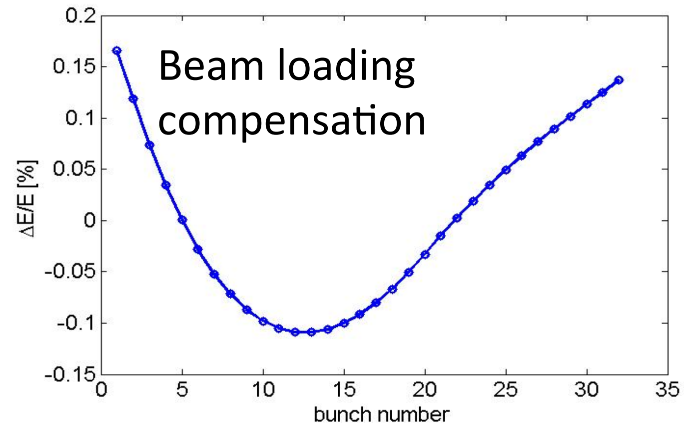
POSSIBLE CONFIGURATION OF A C-BAND INJECTOR



PARAMETER	C-BAND INJECTOR
Charge	250 pC
Laser pulse length	8.5ps
laser spot size	250 μm
Output energy	95 MeV
Output emittance	0.25 mm mrad
Output bunch length	800 fs
Output energy spread	0.38%

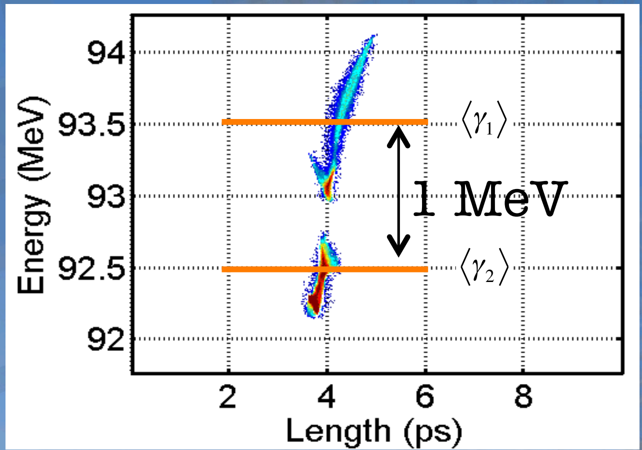
A. Bacci





TWO COLORS FEL

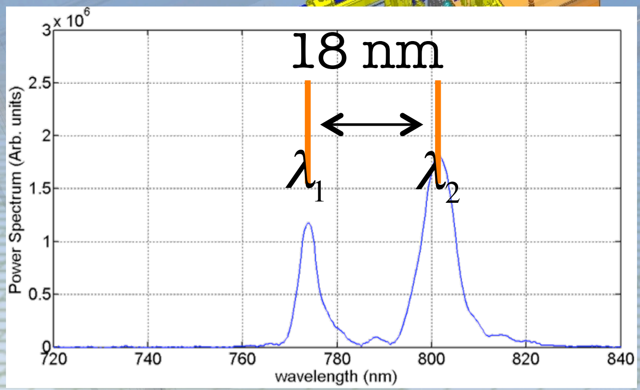
TWO COLORS SASE FEL



two bunches with
a two-level energy distribution
and time overlap (Laser COMB tech.)

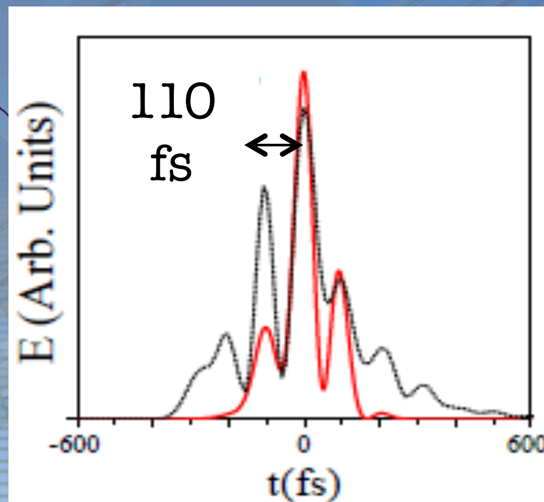
$$\lambda_r = \frac{\lambda_u}{2\gamma^2}\left(1+K_{rms}^2\right)$$

$$\frac{\Delta\lambda_r}{\langle\lambda_r\rangle} = 2\frac{\langle\gamma_1\rangle-\langle\gamma_2\rangle}{\langle\gamma\rangle}$$



produce two wavelength
SASE –FEL radiation
with time modulation

$$\Delta t = \frac{\lambda_u\left(1+K_{rms}^2\right)}{4c\langle\gamma\rangle\langle\gamma_1\rangle-\langle\gamma_2\rangle}$$



PRL 111, 114802 (2013) PHYSICAL REVIEW LETTERS week ending 13 SEPTEMBER 2013

Observation of Time-Domain Modulation of Free-Electron-Laser Pulses by Multipeaked Electron-Energy Spectrum

V. Petrillo,[1] M. P. Anania,[2] M. Artioli,[3] A. Bacci,[1] M. Bellaveglia,[2] E. Chiadroni,[2] A. Cianchi,[4] F. Ciocci,[3] G. Dattoli,[3] D. Di Giovenale,[2] G. Di Pirro,[2] M. Ferrario,[2] G. Gatti,[2] L. Giannessi,[3] A. Mostacci,[5] P. Musumeci,[6] A. Petralia,[3] R. Pompili,[4] M. Quattromini,[3] J. V. Rau,[7] C. Ronsivalle,[3] A. R. Rossi,[1] E. Sabia,[3] C. Vaccarezza,[2] and F. Villa[2]

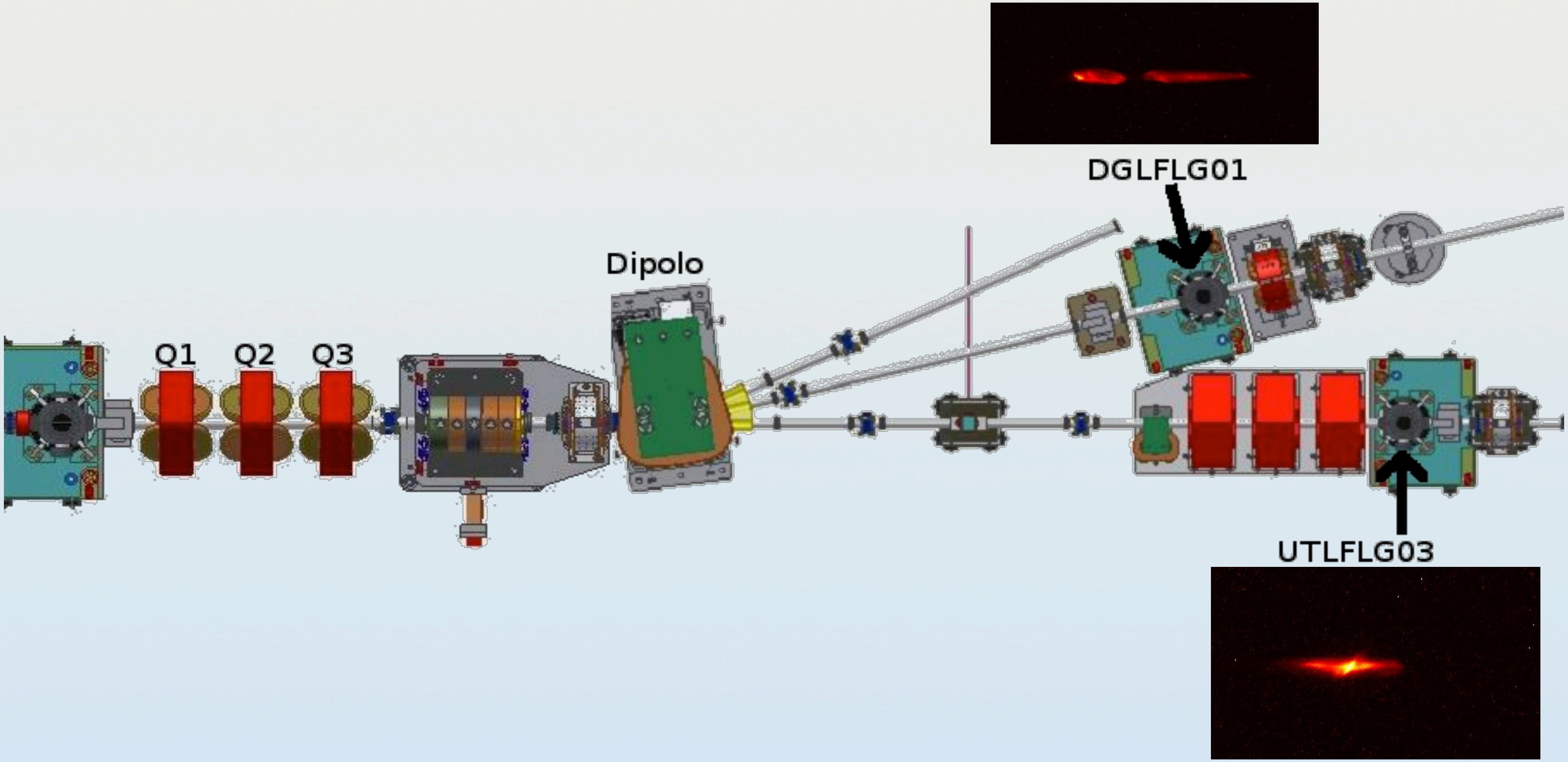
Two Color Free-Electron Laser and Frequency Beating

F. Ciocci[1], G. Dattoli[1]*, S. Pagnutti[2], A. Petralia[1], E. Sabia[1], P. L. Ottaviani[3], M. Ferrario[4], V. Petrillo[5] and F. Villa[4]

Large-bandwidth two-color free-electron laser driven by a comb-like electron beam

C. Ronsivalle[1], M. P. Anania[2], A. Bacci[3], M. Bellaveglia[2], E. Chiadroni[2], A. Cianchi[4], F. Ciocci[1], G. Dattoli[1], D. Di Giovenale[2], G. Di Pirro[2], M. Ferrario[2], G. Gatti[2], L. Giannessi[1], A. Mostacci[5], P. Musumeci[6], L. Palumbo[5], A. Petralia[1], V. Petrillo[3], R. Pompili[4], J. V. Rau[7], A. R. Rossi[3], C. Vaccarezza[2], F. Villa[2]

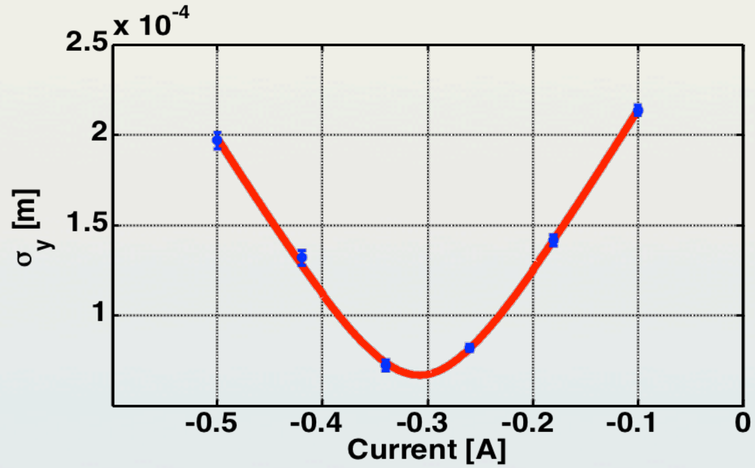
Measuring single beam properties

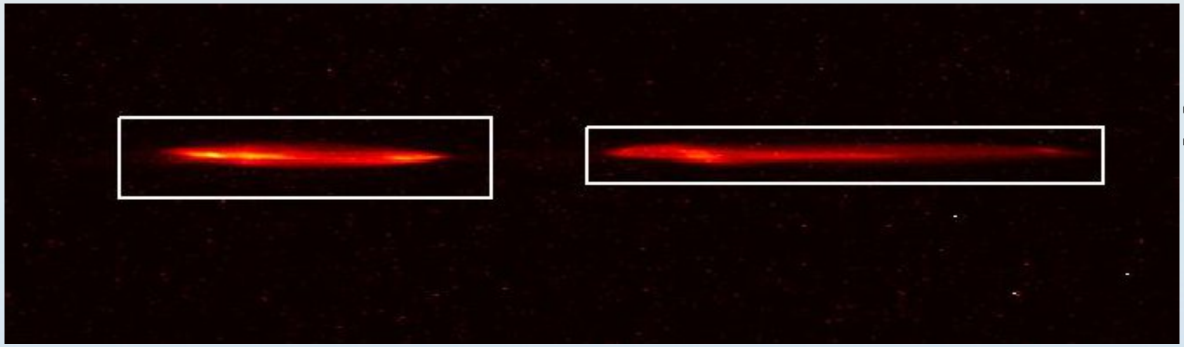


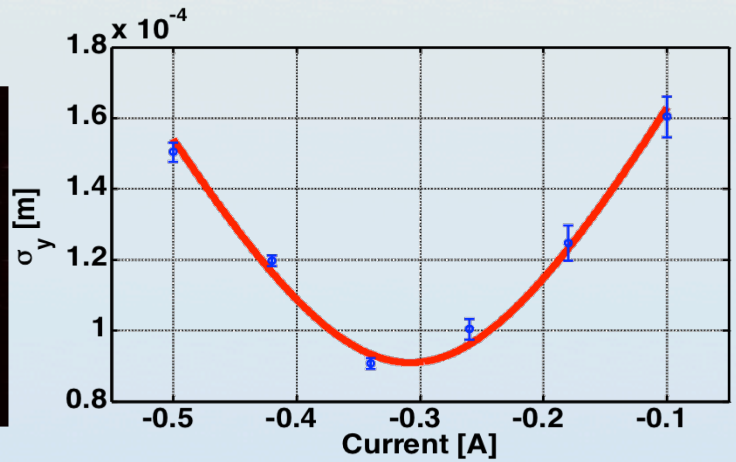
Emittance measurements comb beams

First bunch	$\varepsilon = (1.77 \pm 0.05)$ mm mrad $\alpha = -2.1 \pm 0.1$ $\beta = (27 \pm 1)$ m

Second bunch	$\varepsilon = (1.62 \pm 0.04)$ mm mrad $\alpha = -0.94 \pm 0.05$ $\beta = (13.4 \pm 0.5)$ m







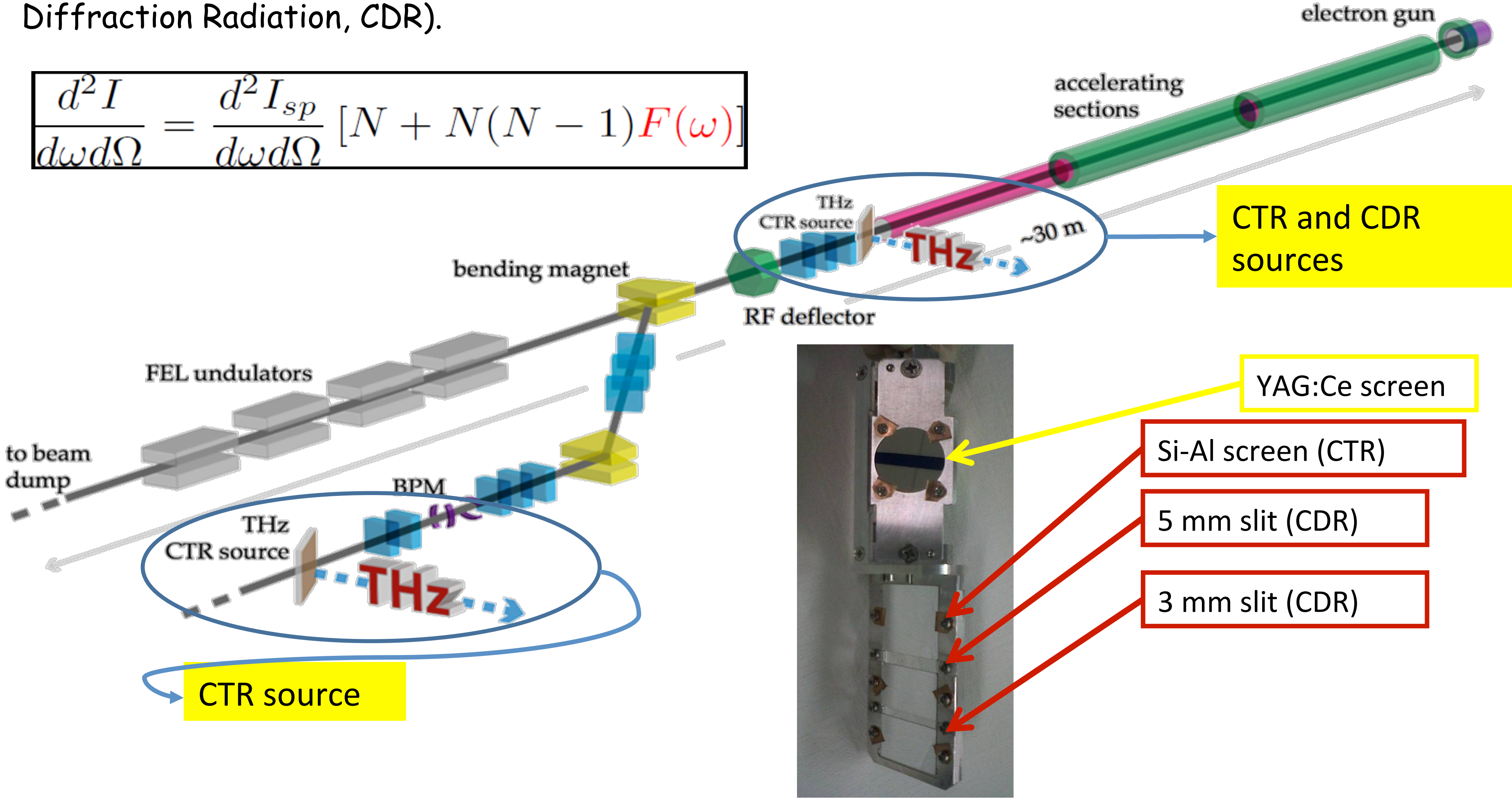
L. Innocenti

THz Source

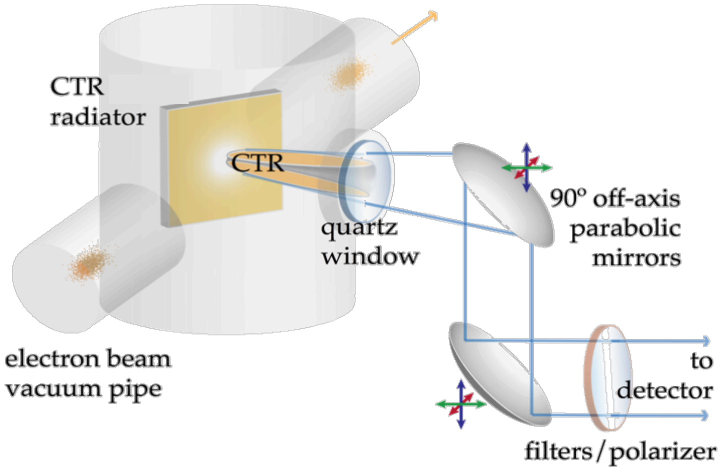
The SPARC_LAB THz beam lines

Linac-based source: Coherent Radiation from an aluminum-coated silicon screen (Coherent Transition Radiation, CTR) and from a rectangular aperture in the metallic screen (Coherent Diffraction Radiation, CDR).

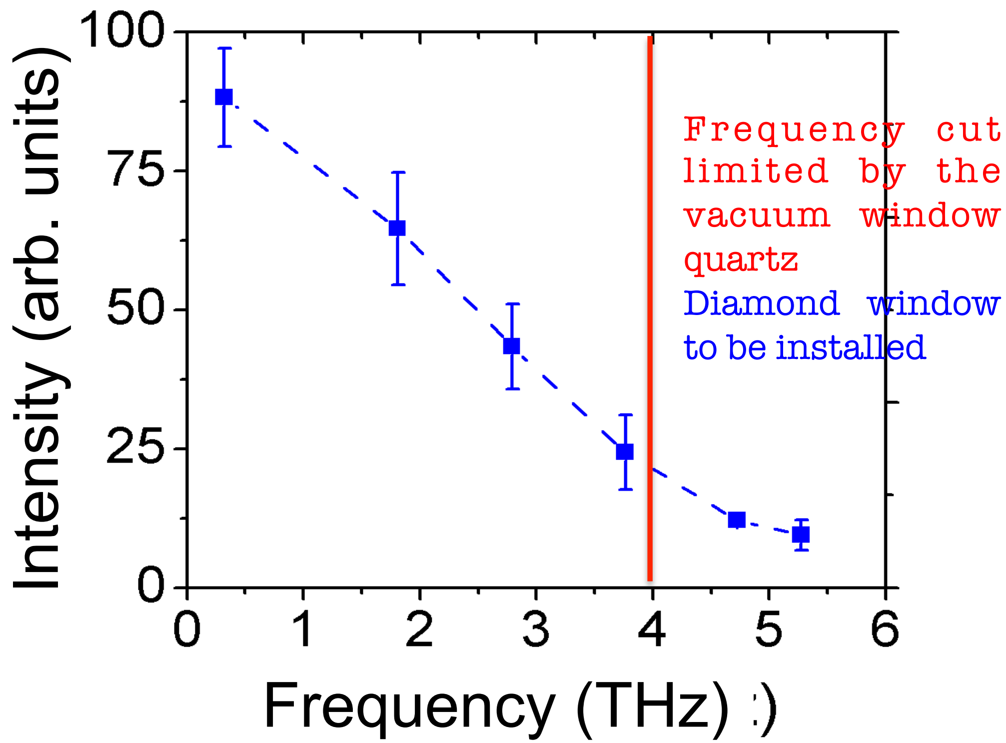
$$\frac{d^2 I}{d\omega d\Omega} = \frac{d^2 I_{sp}}{d\omega d\Omega}\left[N + N(N-1)F(\omega)\right]$$



Broad-band THz radiation: Measurements



Electron beam parameters	
Energy (MeV)	100
Charge (pC)	260
RMS bunch length (fs)	260

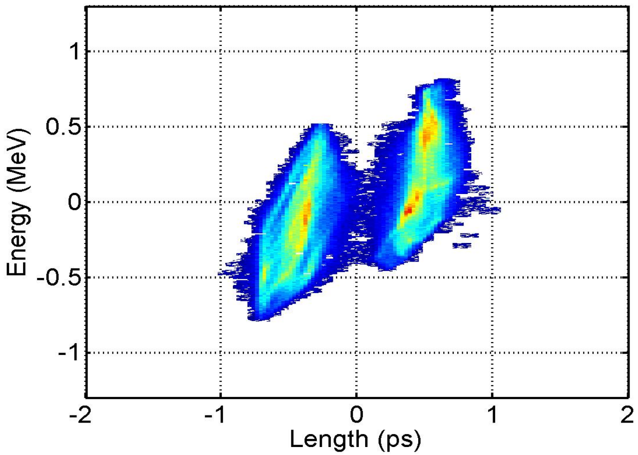


E. Chiadroni et al., Appl. Phys. Lett. 102, 094101 (2013)

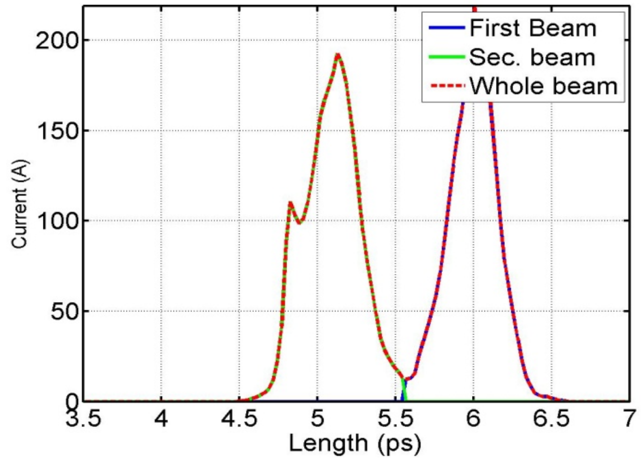
Narrow-band THz radiation:
2-bunches train measurements

Electron beam parameters	
Energy (MeV)	122
Charge/bunch (pC)	80
RMS bunch 1 length (fs)	150
RMS bunch 2 length (fs)	165
Time distance (ps)	0.91 (0.019)

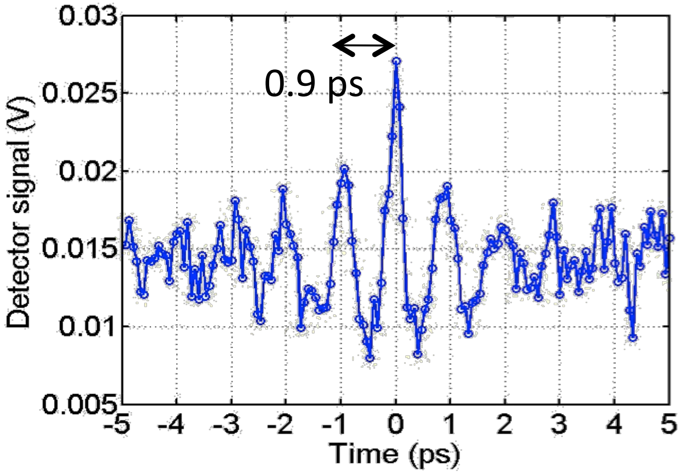
Measured Longitudinal Phase Space (LPS)

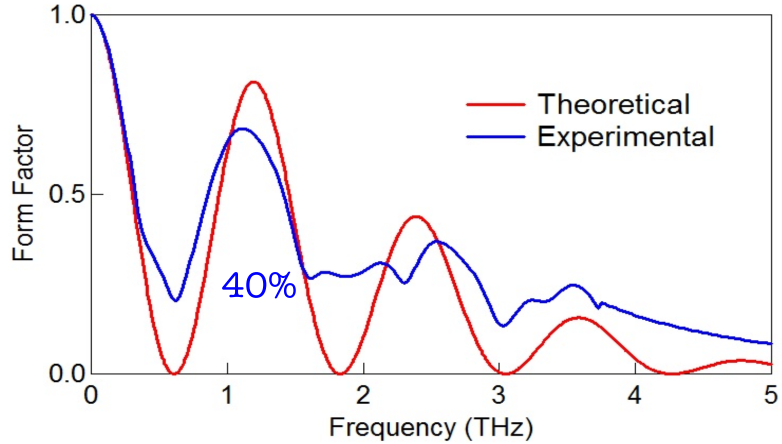


Current profile as measured at the end of the linac



Autocorrelation measurement of CTR with a Michelson interferometer





Achieved THz Performances

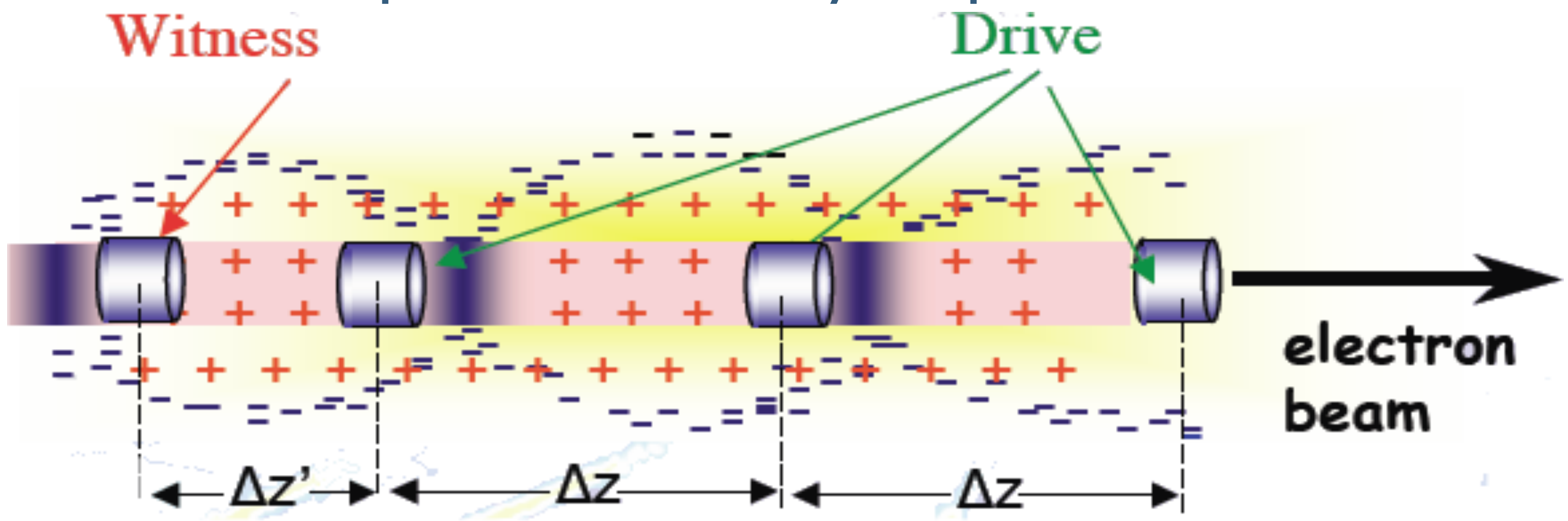
Electron beam parameters	Single bunch (VB mode: max compression)	4-bunches per train (VB mode + laser comb)
Charge/bunch (pC)	300	50
Energy (MeV)	130	100
Bunch length (fs)	160	200
Rep. Rate (Hz)	10	

Radiation parameters	SPARC (single bunch)	SPARC (4-bunches/train)
Energy per pulse (J)	40 10^{-6}	0.6 10^{-6} (@ 1 THz)
Peak power (MW)	> 100	3 (@ 1 THz)
Average power (W)	1.8 10^{-4}	6 10^{-6}
Electric field (kV/cm)	500	> 10
Pulse duration (fs)	160	< 100
Bandwidth (%)	broadband	< 25

COMB_PWFA

COMB Principle

Resonant plasma Oscillations by Multiple electron Bunches

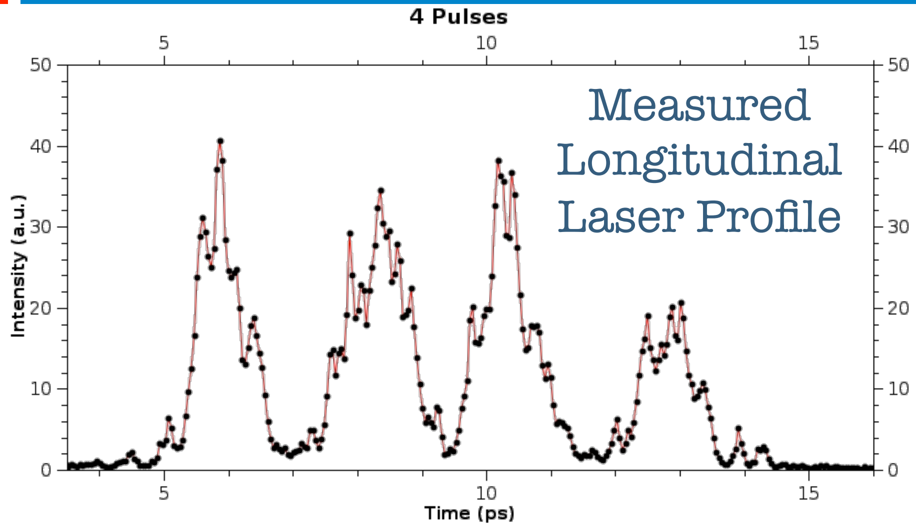


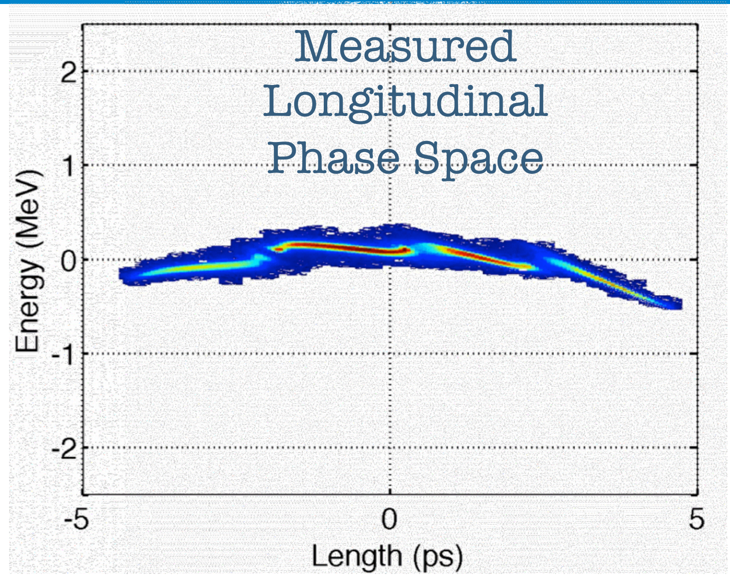
$\Delta z = \lambda_p$ (resonance) $\sigma_z \leq \lambda_p/2$

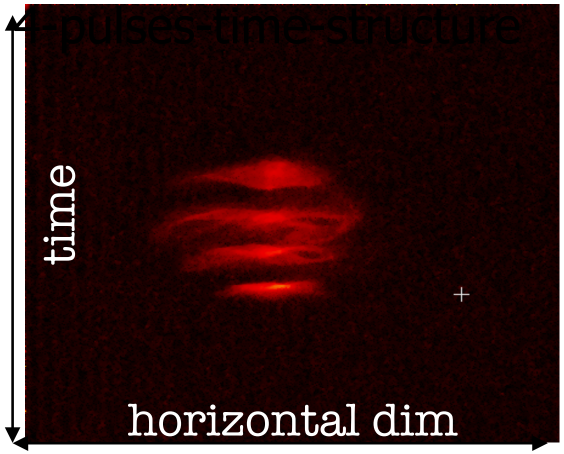
$\Delta z' \approx (m+1/2)\lambda_p$

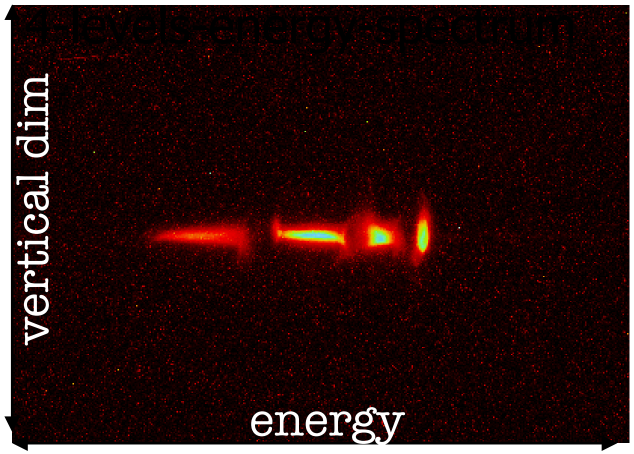
❖ **Weak blowout regime** with resonant amplification of plasma wave by a train of high brightness electron bunches produced by **Laser Comb** technique ➔ **5 GV/m** with a train of 3 bunches, 100 pC/bunch, 50 μm long, 20 μm spot size, in a plasma of density 10^{22} e^-/m^3 at λ_p=300 μm ?

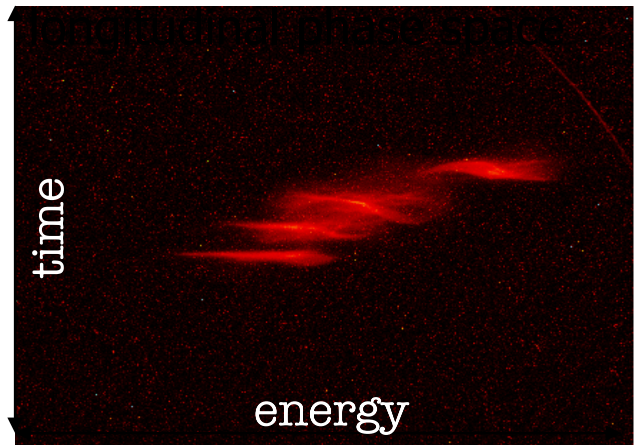
Achieved Comb structure



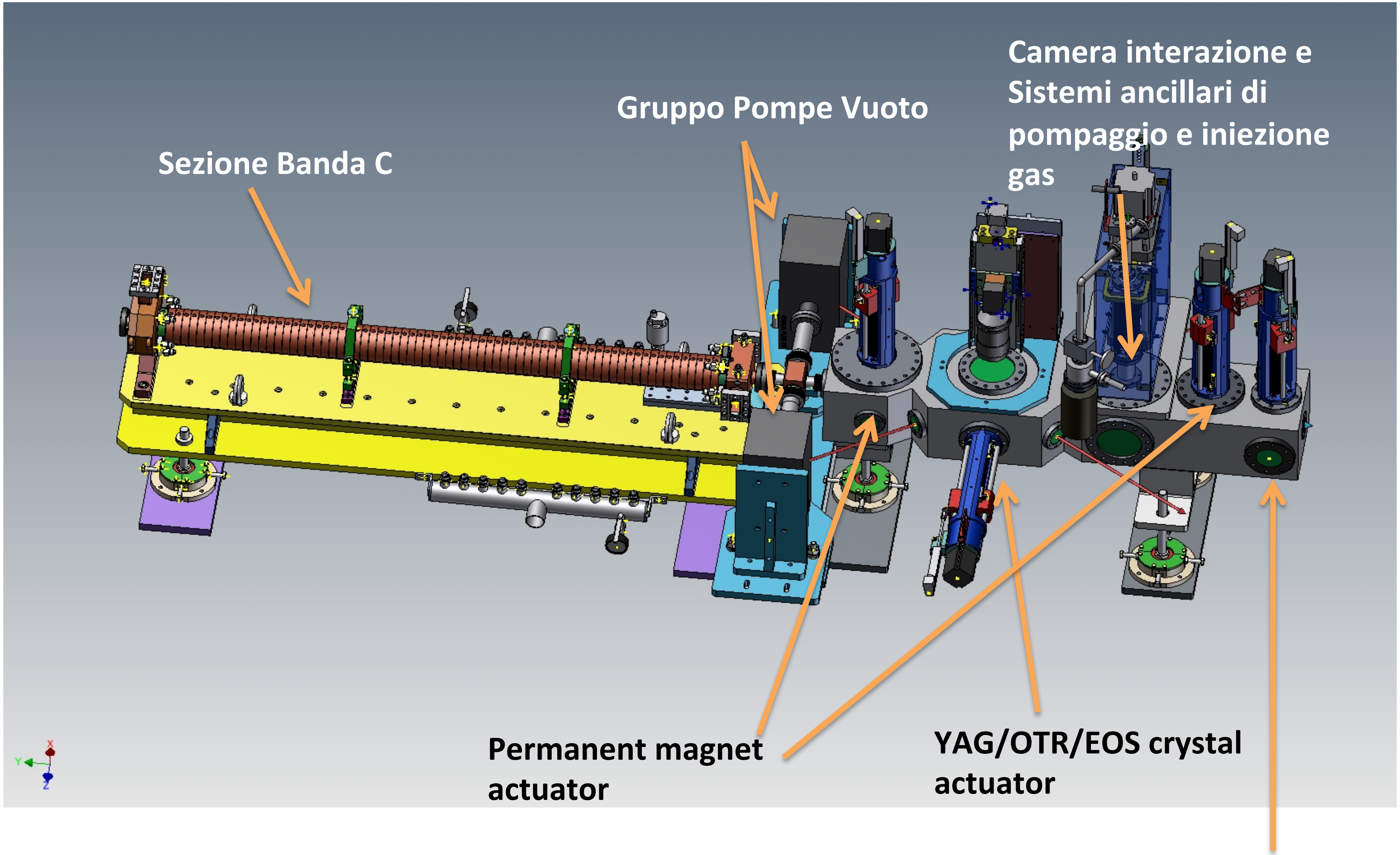








COMB plasma interaction chamber



Transformer Ratio Studies for Single Bunch Plasma Wakefield Acceleration[☆]

F. Massimo[1], A. Marocchino[1], M. Ferrario[2], A. Mostacci[1,2], P. Musumeci[3] and L. Palumbo[1,2]
[1]*Dipartimento SBAI, "Sapienza" University of Rome , Rome, Italy*

Numerical Investigation of Beam-Driven PWFA in Quasi-Nonlinear Regime

P. Londrillo[a], C. Gatti[b], M. Ferrario[b]

Relativistic charged-particle bunch dynamics via the generation of wake field

F. Tanjia[a,b], R. Fedele[a,b], S. De Nicola[c,a,b], D. Jovanović[d]

Self-modulation of a long relativistic charged-particle beam in plasmas. A preliminary quantum-like investigation

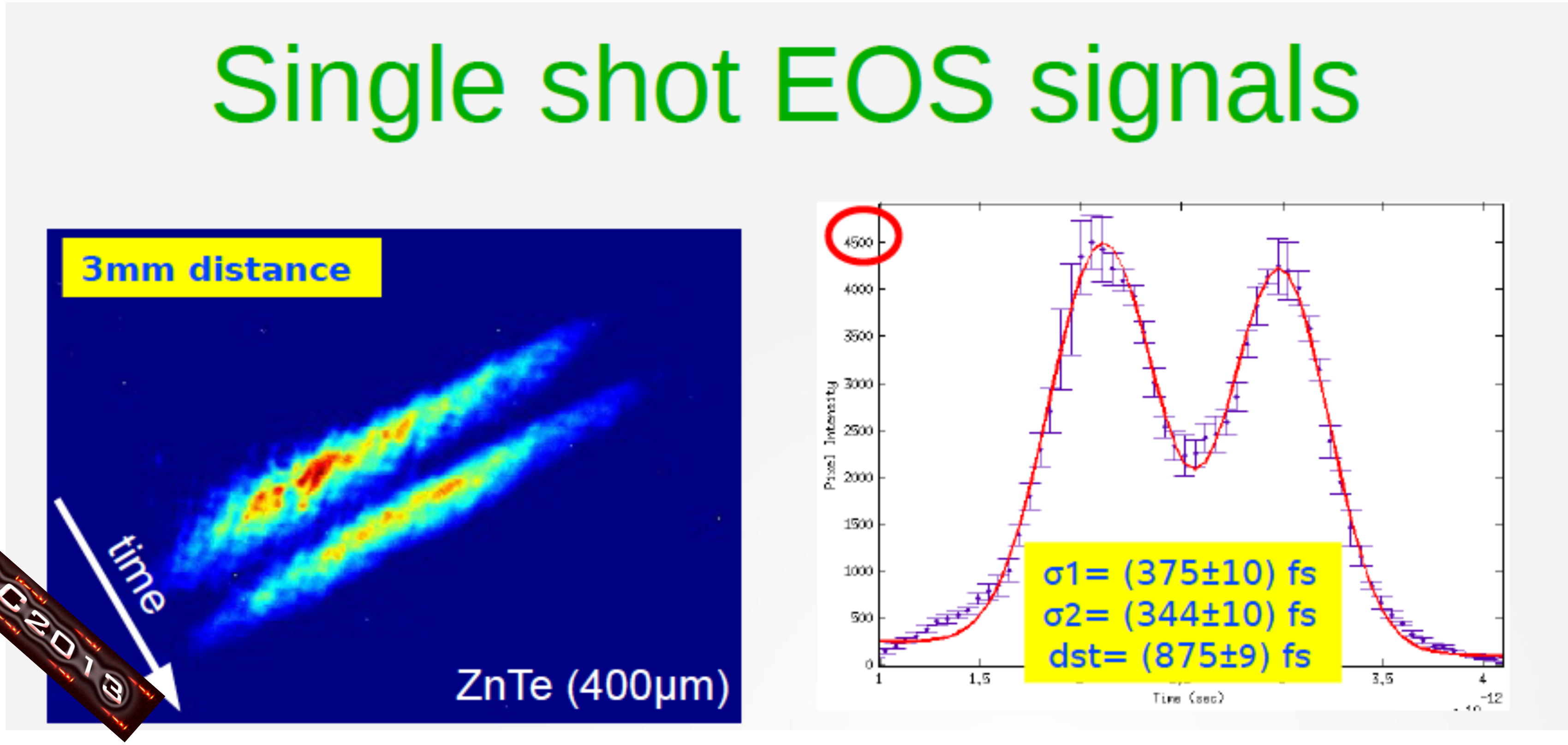
Laser pulse shaping for multi-bunches photoinjectors

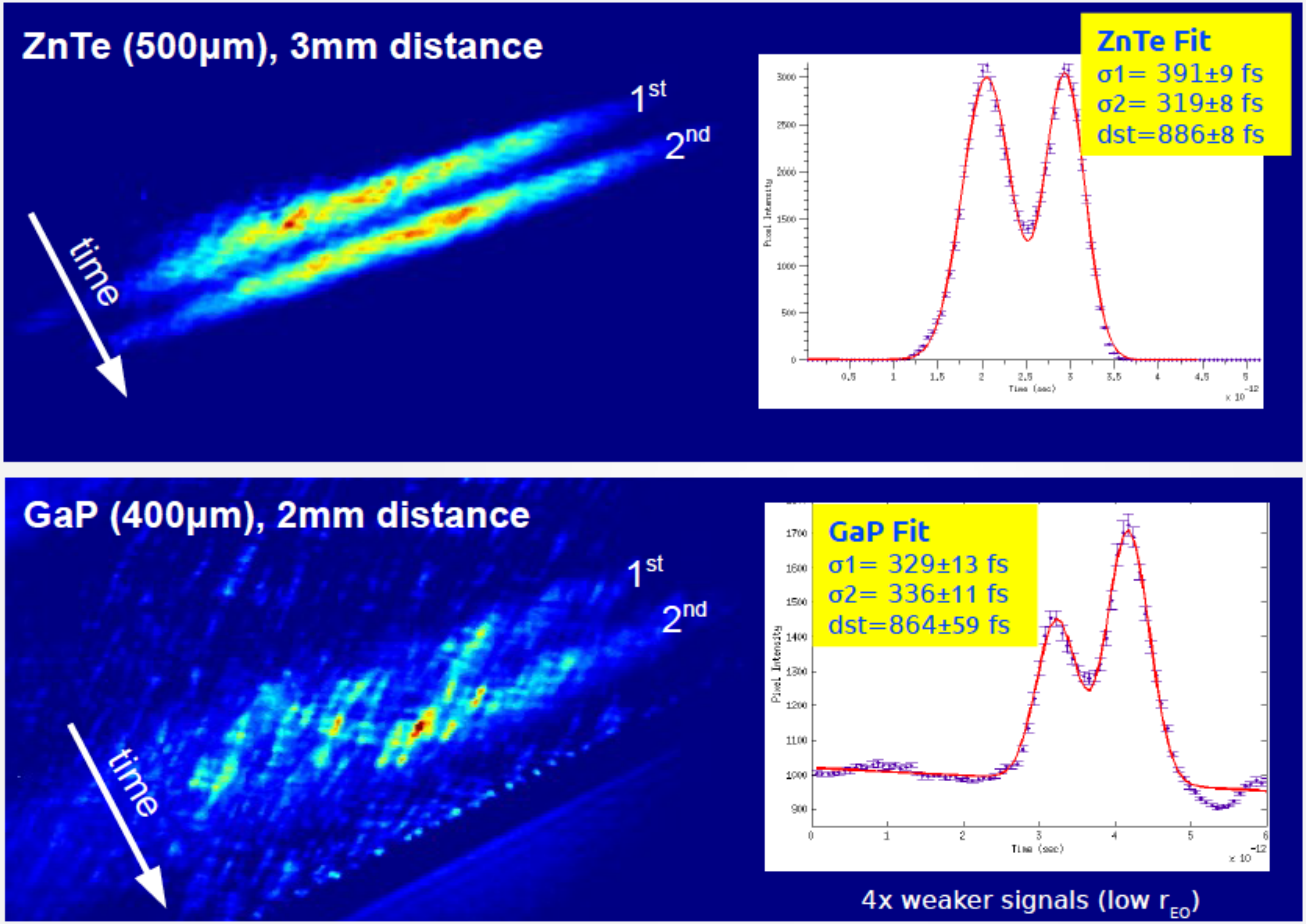
F. Villa[a], S. Cialdi[b], SPARC_LAB collaboration[c]

First single-shot and non-intercepting longitudinal bunch diagnostics for comb-like beam by means of Electro-Optic Sampling

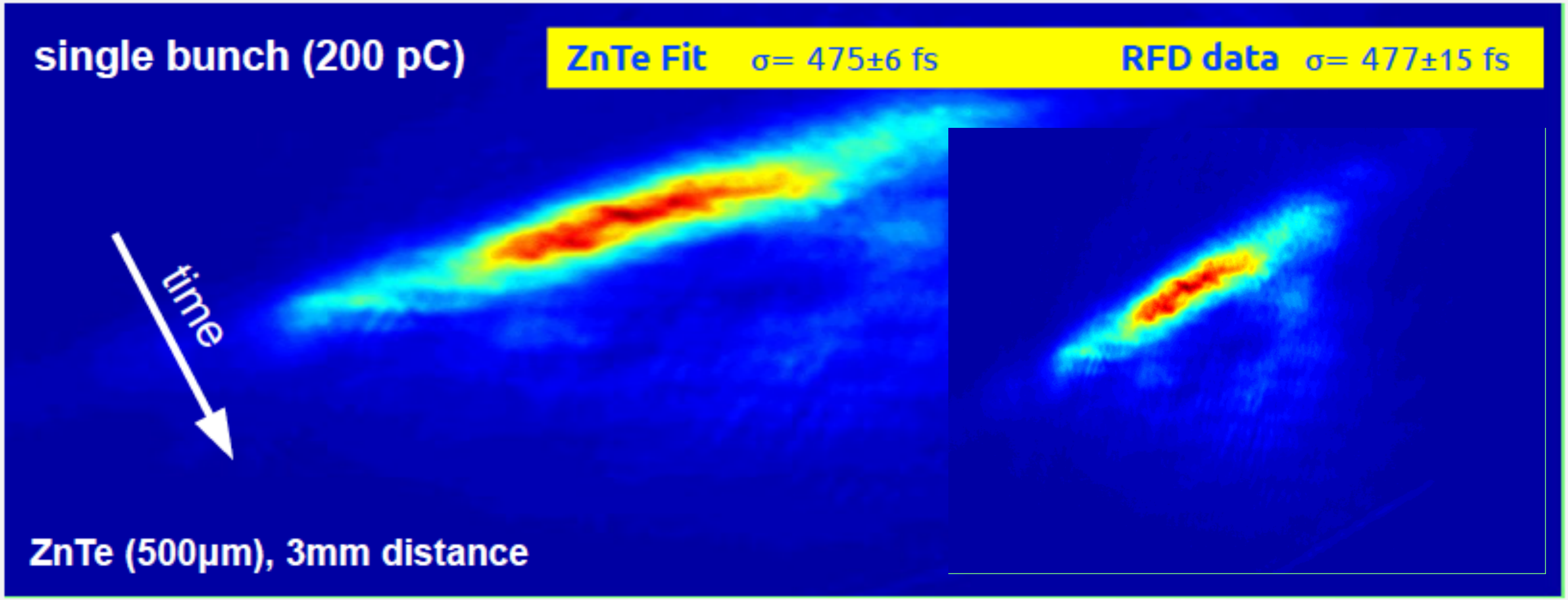
R. Pompili[a,b], A. Cianchi[b], D. Alesini[a], M.P. Anania[a], A. Bacci[c], M. Bellaveglia[a], M. Castellano[a], E. Chiadroni[a], D. Di Giovenale[a], G. Di Pirro[a], G. Gatti[a], F. Giorgianni[d], M. Ferrario[a], S. Lupi[d], F. Massimo[d], A. Mostacci[a], A. R. Rossi[c], C. Vaccarezza[a], F. Villa[a]

[a] *INFN-LNF, Via E. Fermi 40, 00044 Frascati, Rome, Italy*
[b] *Università di Roma "Tor Vergata", Physics Department, Via della Ricerca Scientifica 1, 00133 Rome, Italy*
[c] *INFN-Milano, Via Celoria 16, 20133 Milan, Italy*
[d] *Università di Roma "Sapienza", Physics Department, Via Aldo Moro 2, 00185 Rome, Italy*





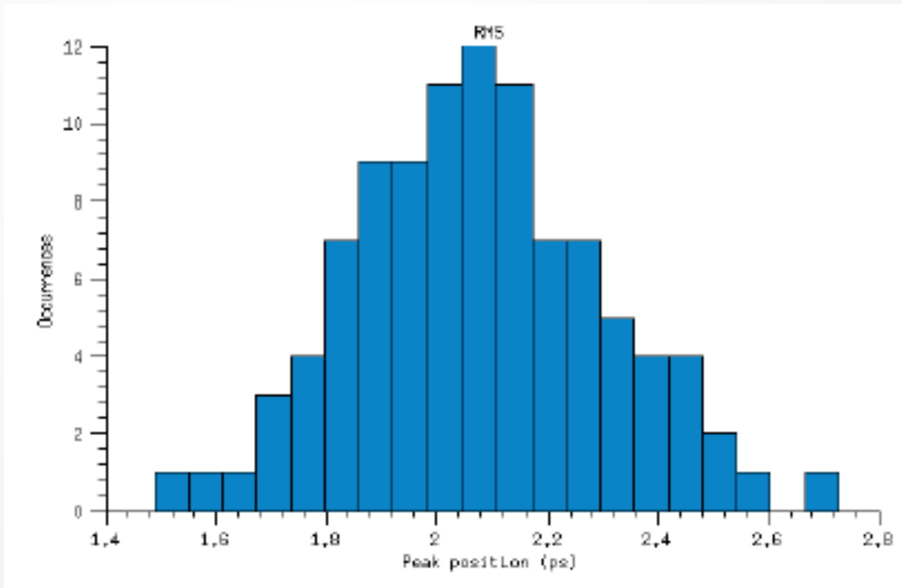
ZnTe (500µm), 3mm distance
1st
2nd
time
ZnTe Fit
σ1= 391±9 fs
σ2= 319±8 fs
dst=886±8 fs
Pixel Intensity
Time (sec)
x 10^-12
GaP (400µm), 2mm distance
1st
2nd
time
GaP Fit
σ1= 329±13 fs
σ2= 336±11 fs
dst=864±59 fs
Pixel Intensity
Time (sec)
x 10^-12
4x weaker signals (low r_EO)



Time Jitter evaluation

- EOS laser directly derived from the photocathode laser -->
- the laser-RF system time jitter can be evaluated:

Δt = 137 fs



Conclusions & Outlooks

- **We demonstrate it is possible to use EOS to measure *multi-bunches (comb-like) beams*.**
- It can be used as a **time-stamp** and/or to evaluate the RF **time jitter**.
- Actually, bunches **larger than 200 fs** are correctly measured.
- **Bunch spacing in COMB beams is well reproduced** while the bunch lengths are too short to be correctly measured → improvements needed for sub-100fs bunches:
  - *Shorter laser pulse* → make a pulse compressor to achieve laser TF pulse length of 60 fs (rms).
  - *Use thinner crystals* → with 100um-thick resolution of about **50 fs (GaP)** rms are achievable.
    - Drawback: very low signals!
  - Exploring different EO crystals...

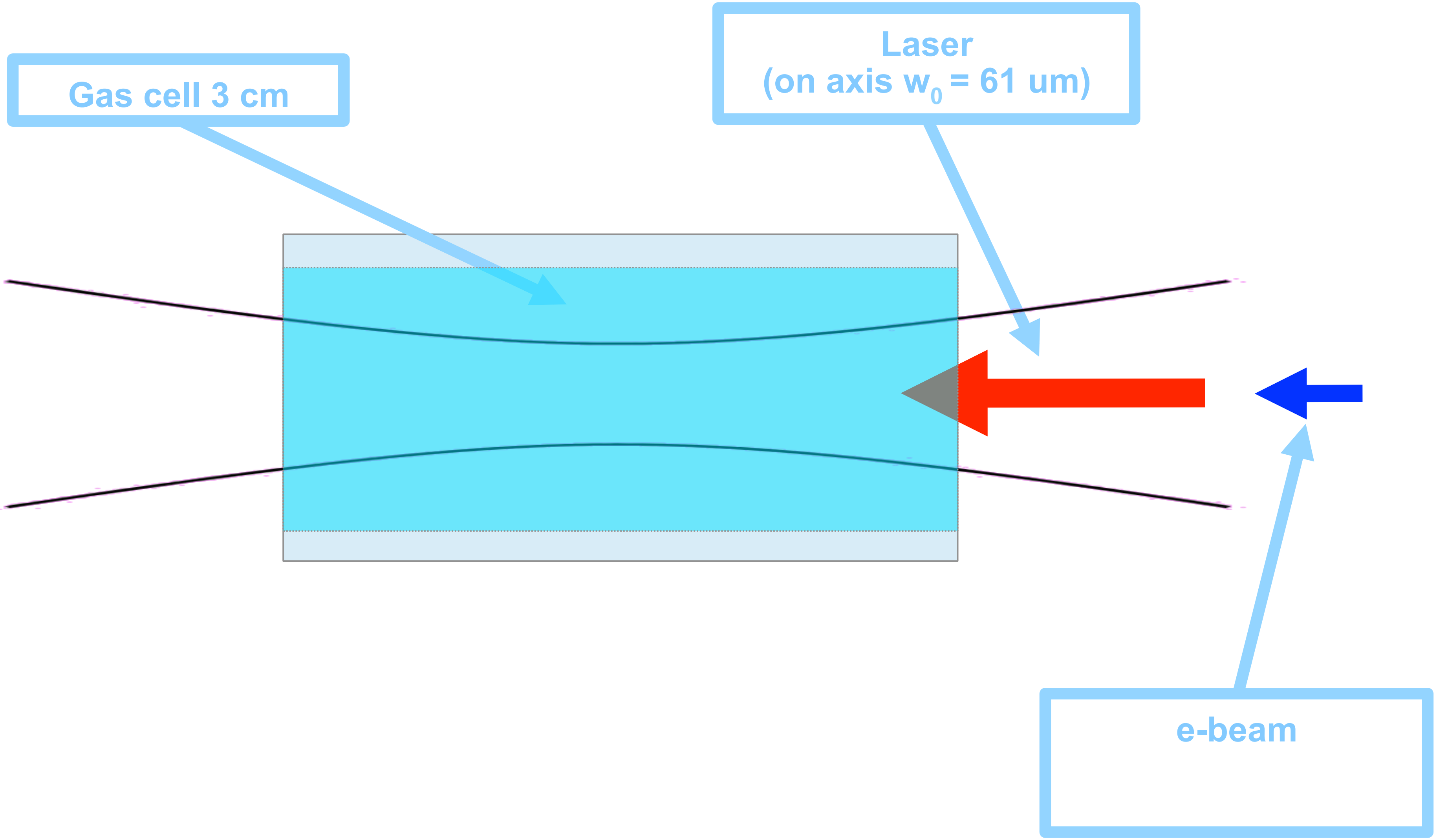
ExInj-LWFA

Electron beamlines

S
P
A
R
C Hall
update

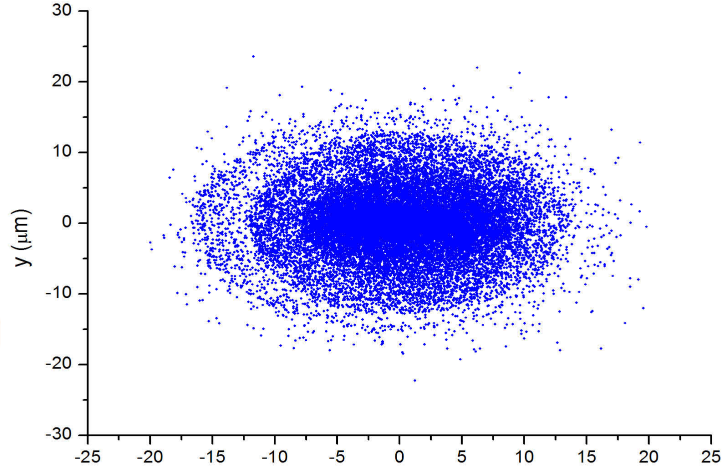
S2E simulation: plasma acceleration

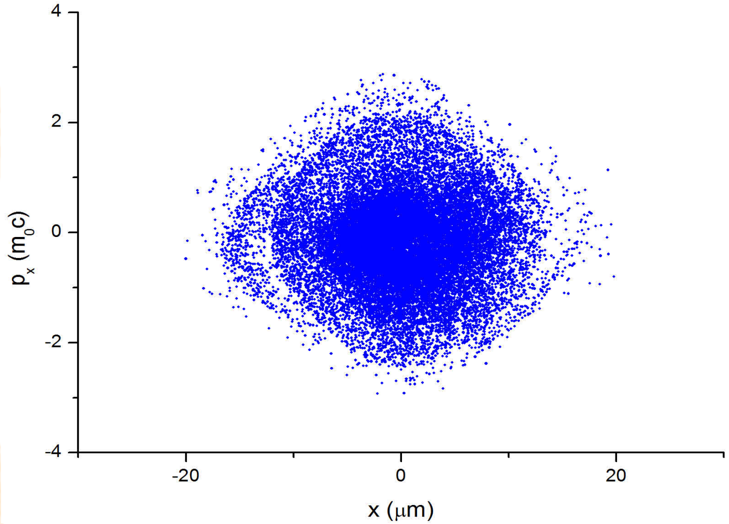
No laser guiding: gas cell, very easy from the experimental point of view.



S2E simulation: plasma acceleration

Sample beam with gas cell (VERY PRELIMINARY): Δt = 157 fs, σ_x = 3.8 μm.





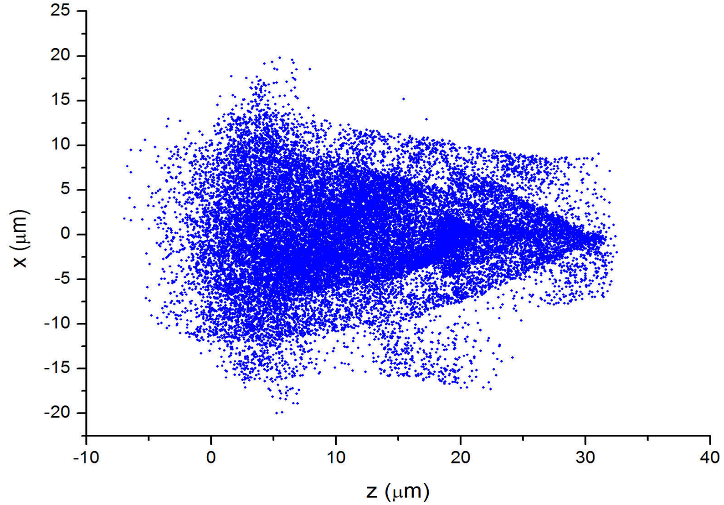
σ_x = 5.4 μm

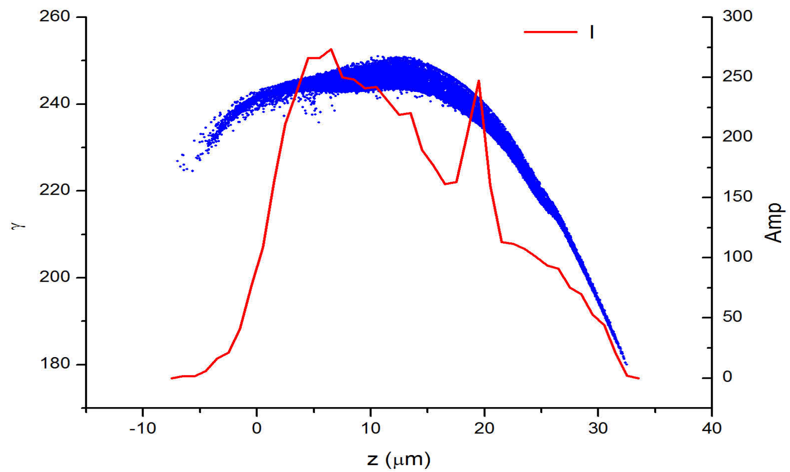
E = 120 MeV

Charge loss = 8%

ε_{nx} = 4.5 μm

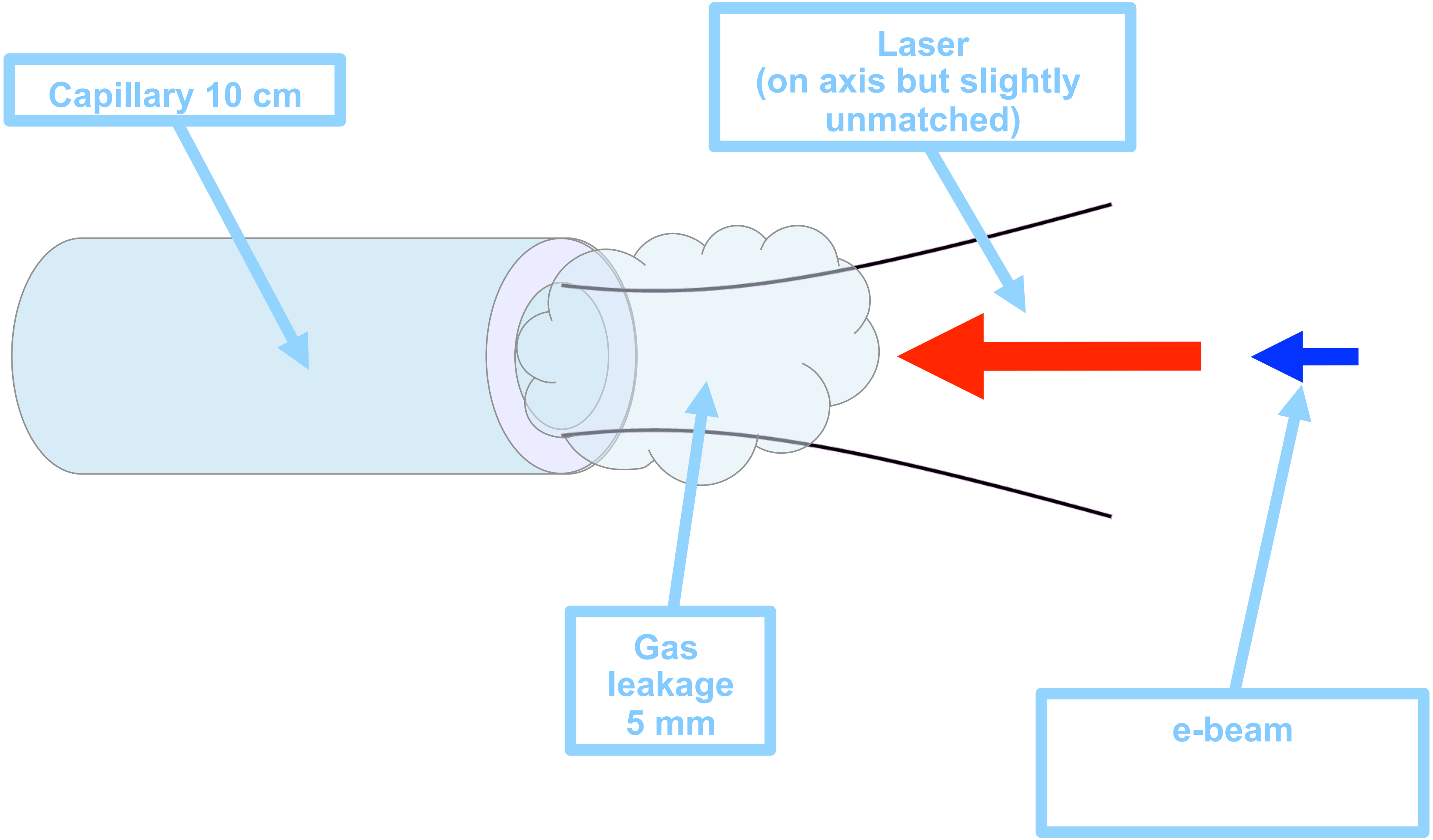
$\Delta\gamma/\gamma$= 4.5 %





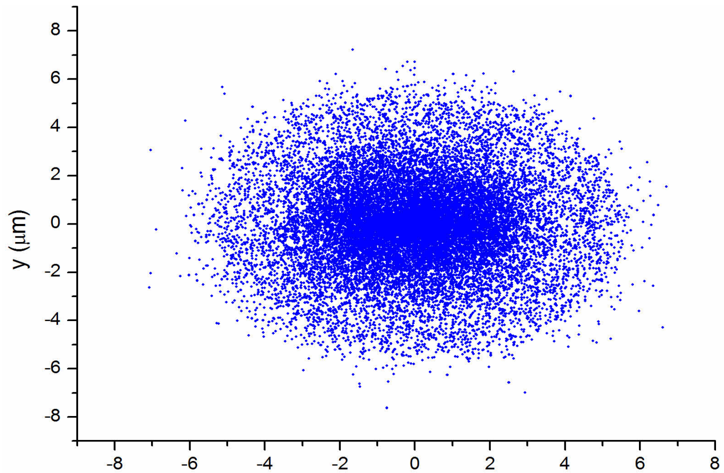
S2E simulation: plasma acceleration

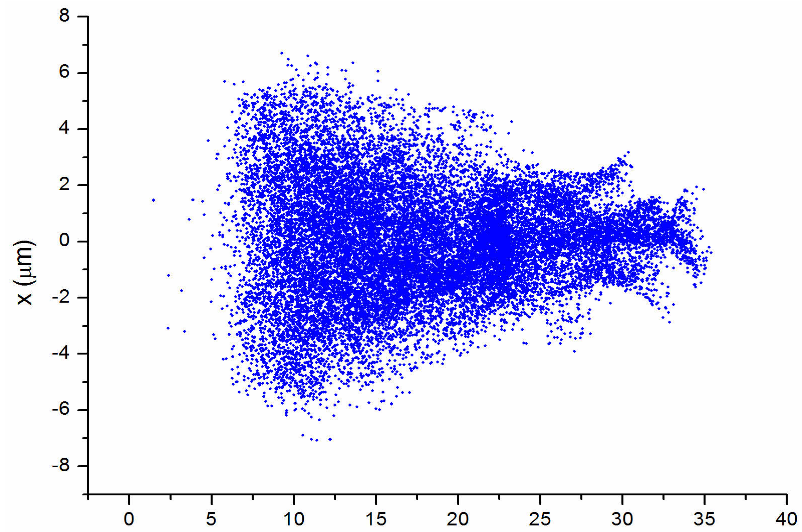
Laser guided by a capillary tube: more performances but much harder to implement



S2E simulation: plasma acceleration

Best beam: Δt = 182 fs, σ_x = 3.8 μm.



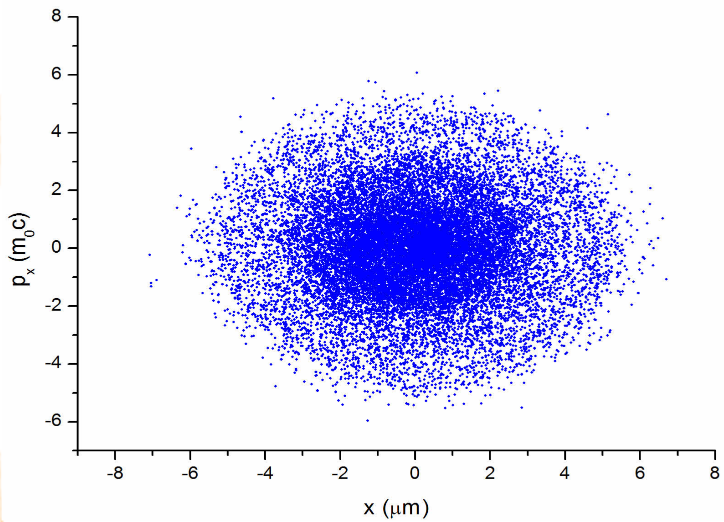


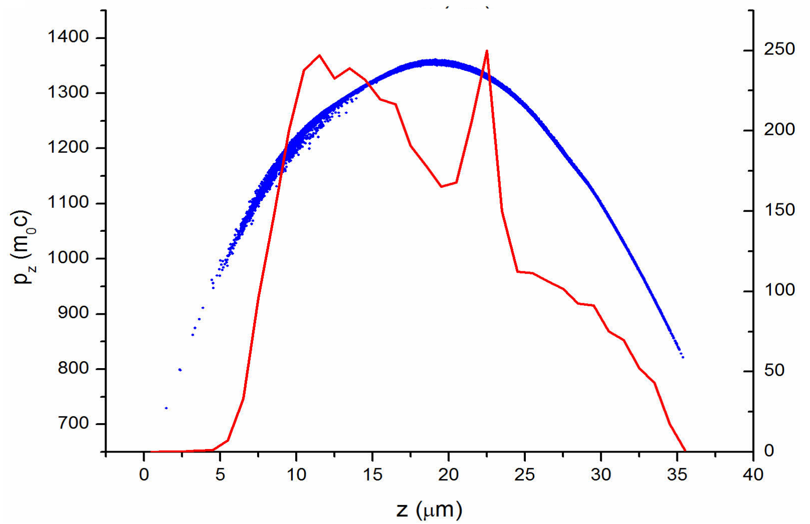
σ_x = 2.0 μm

E = 630 MeV

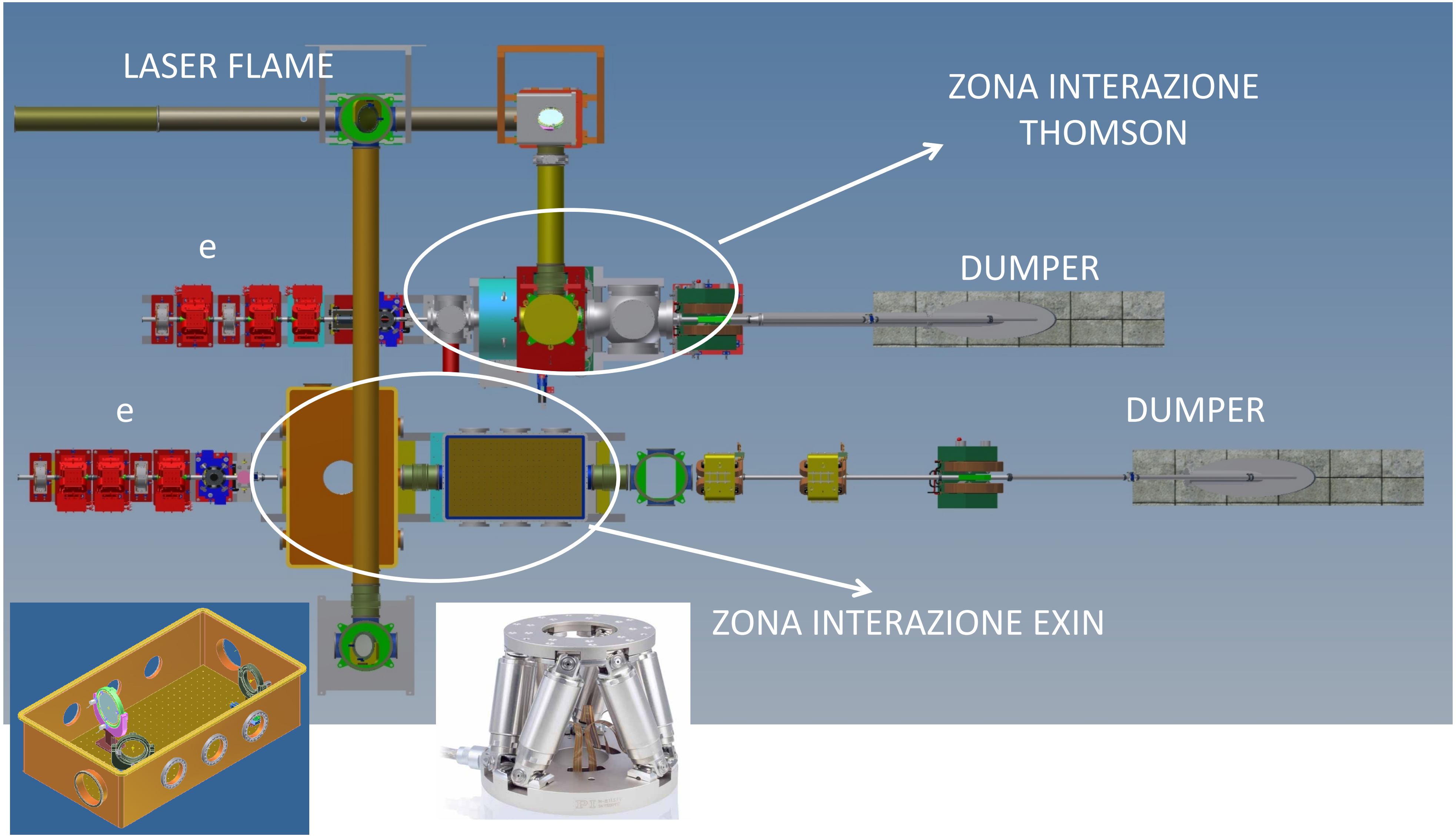
ε_{nx} = 3.5 μm

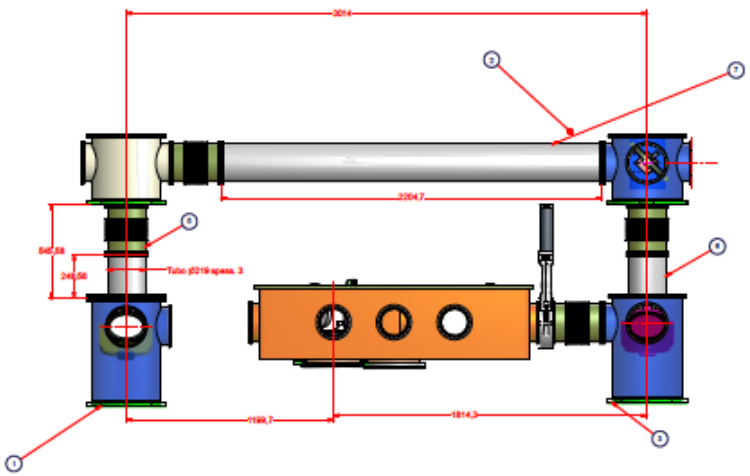
$\Delta\gamma/\gamma$= 7.7 %

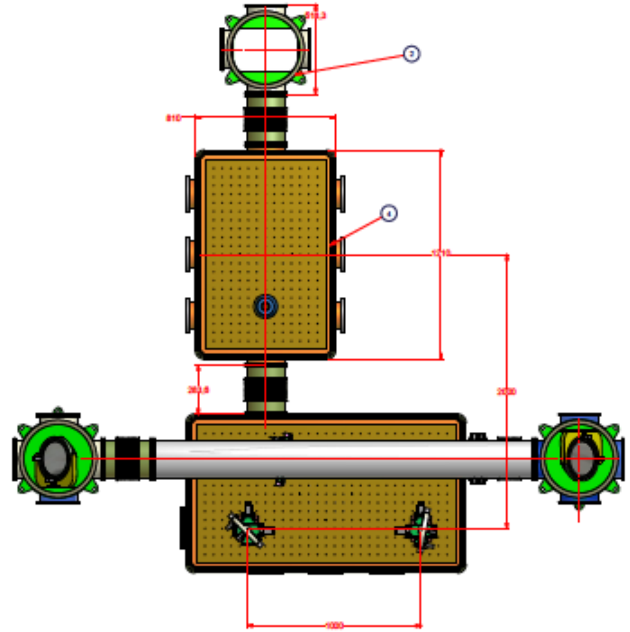




EXIN plasma interaction chamber







NOTE SULLA CAMERA INTERAZIONE
La tavola ottica è in alluminio con fori filettati M6 passo 50mm spessore almeno 10mm
è un particolare a parte rispetto alla camera di interazione e deve essere fissata

Sulla camera di interazione sono previste le seguenti flange
sul fondo
ISO PNEUROP 300 per la pompa

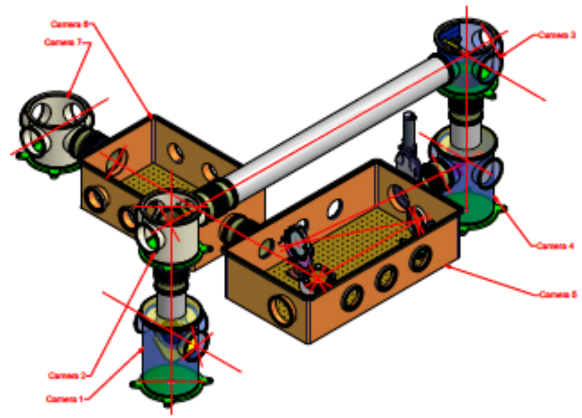
su un lato lungo
CF40 per passante gas
CF40 per alimentazione controllo vuoto
CF100 per flangia connettori ...
CF100 per flangia connettori ...

sul lato opposto
CF 100 per diagnostica
CF 100 per diagnostica

sul lato corto
ISO PNEUROP 300 per soffietto

sul lato corto opposto
ISO PNEUROP 300 per soffietto

sul coperchio superiore
CF 14" per accesso alla camera
CF 14" per accesso alla camera



1	1	EXIN 001 001 000 - camera1
2	4	exin camera2
3	1	exin camera 3
4	1	exin camera 4
5	6	soffietto lespneurop 300x250
6	2	transizione ISO 400-300
7	1	Tubo flangiato lespneurop 300 L2200
8	2	Tubo flangiato lespneurop 300 L635,8
10	1	exin...

ISTITUTO NAZIONALE DI FISICA NUCLEARE
LABORATORI NAZIONALI DI FRASCATI

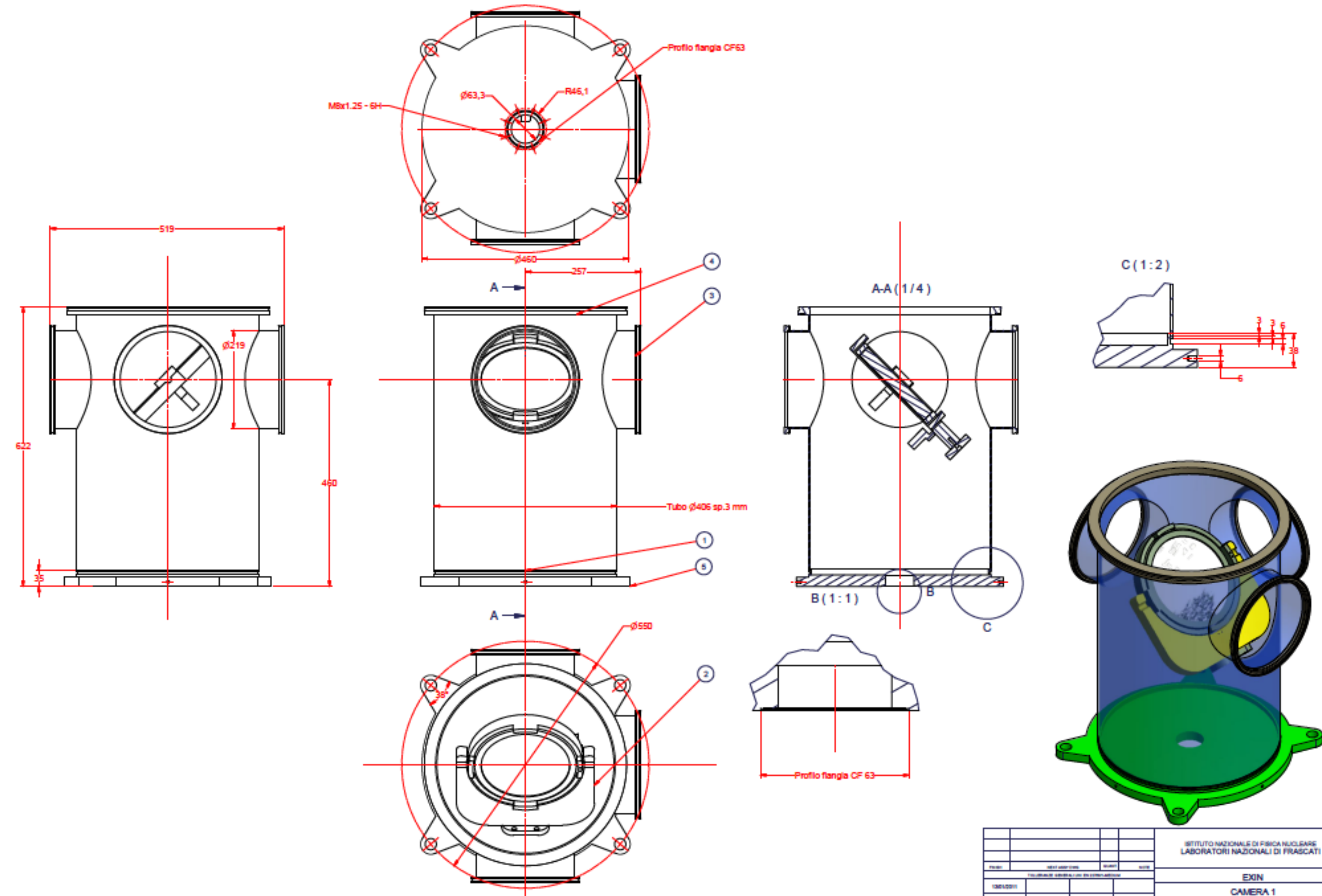
PLASMONX

EXIN

SISTEMA INTERAZIONE

ASSIEME

A0



1	1	camera iso400-tubo 406		
2	1	gimbal 8poll		
3	3	pneurop ISO200 a saldare		
4	1	pneurop ISO400a saldare		
5	1	transizioneB	PIASTRA DI TRANSIZIONE	

ISTITUTO NAZIONALE DI FISICA NUCLEARE
LABORATORI NAZIONALI DI FRASCATI

EXIN

CAMERA 1

ASSIEME

DATA	MATERIALE	Quantità	SCALA
13/01/2011			

VUOTO	DIAGNOSTICA	FISICA	ING. ELETTR.

QUALITY ASSURANCE

DISEGNATORE	PROGETTISTA	RESPONSABILE	APPROVAZIONE

	DISEGNO N.	REV
A1	EXIN.001.001.000	

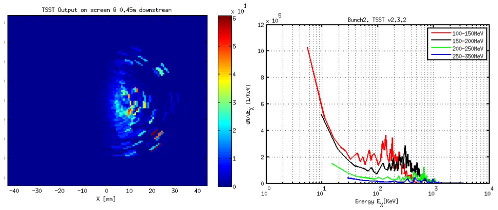
LWFA

More details in G. Gatti talk

γ-RESIST

Inverse Compton scattering of of self-injected, LWFA sub-GeV electrons[1,2]

Exp'ed: 2E8 photons/shot



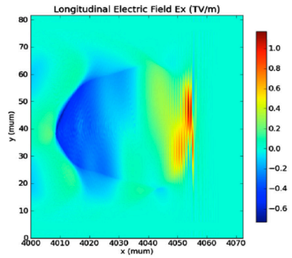
Montecarlo TSST: expected angular and spectral distribution

Photons at screen: image and spectrum

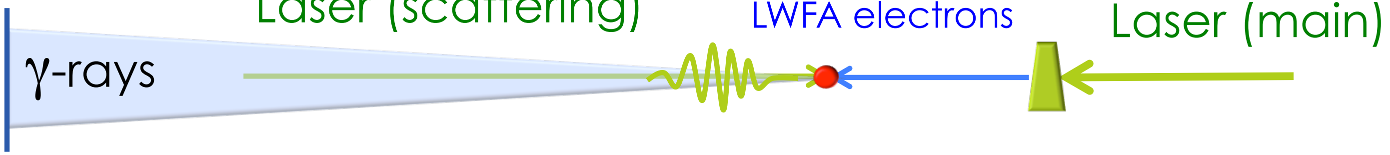
SIMULATIONS

e⁻ bunch

PIC (Jasmine) self-injection on a 4 mm gas–jet

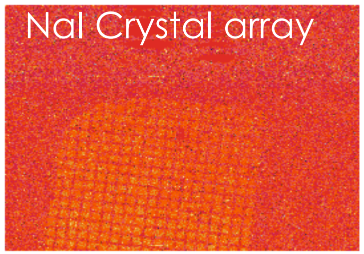


γ-photons



EXPERIMENT

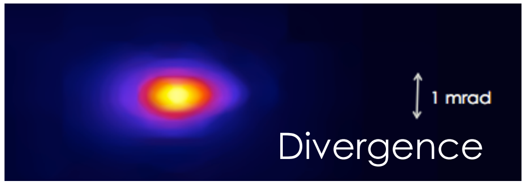
e⁻ bunch

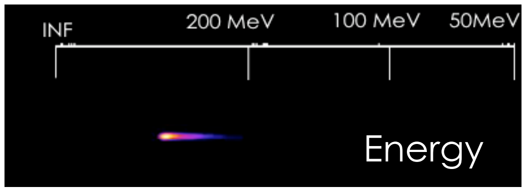


First measured (July 2013) γ-ray signal: low S/N ratio.
Higher shielding, collision stability and laser beam energy needed

γ-photons

Measured bunch fully established July 2013 run:
monoenergetic+
low emittance





[1]L.A. Gizzi et al., NIM B 309, 202-209 (2013);[2]T. Levato et al., NIMA A720, 95-99 (2013) [3]P. Tomassini et al., Appl. Phys. B **80**, 419-436 (2005)

DESY Proposal

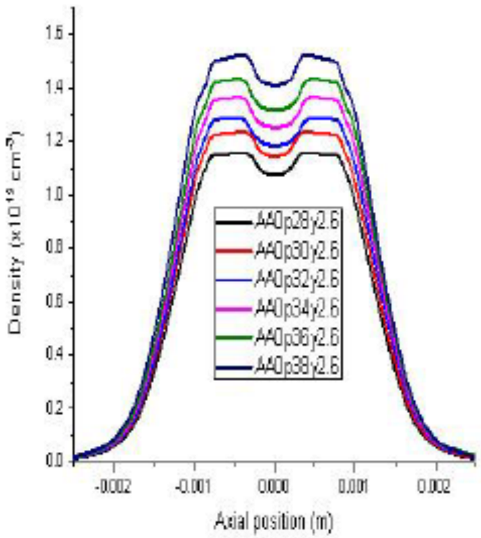
DESY, INO-CNR, Strathclyde University, LNF

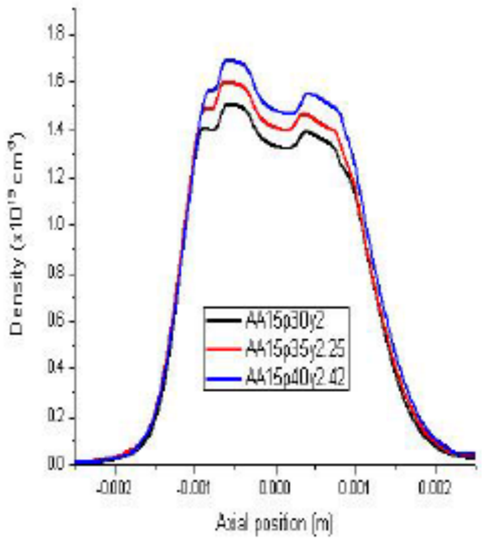
Density Profile Modulation:

Goal → Dephasing Length
Goal → Pump Depletion

Also study of pointing, divergence dependence on the density profile parameters (ramp, plateau)

Expected asimmetries in the 2 planes





FURTHER ON...

2 Gas-Jet → Plasma lensing effect, dependence on the gas ionization (different gases)

Proton Acceleration

SHORT TERM PROGRAM : LILIA PHASE I

- A parametric study of the correlation of the maximum accelerated proton energy, with respect to the following parameters:

- Laser pulse intensity (in the range $10^{18} < I < 10^{20}$ W/cm^2)
- Laser pulse energy (in the range 0.1-4 J)
- Laser pulse length (in the range 25 fs-1ps)
- Metallic target thickness (in the range 1-10 microns).

- In such a frame we would like to deeply investigate the experimental scale rules within the possibilities offered by the FLAME facility. Moreover, this will provide the opportunity to get experience in the development of diagnostic techniques and in target optimization.

Next months

	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec	Jan	Feb
Thomson	Kly 2 Problem fixing	Electrons /Photons Transp		Photons/ Electrons Transp	Collisions Test	X-ray test	X-ray test
FEL					Seeded 2 colors?		Shot Noise Red?
THZ			Experiment				
C-band	Inst.	Inst.	HP-RF Test	HP-RF Test	HP-RF Test		
LILIA			Experiment				
DESY						Experiment	

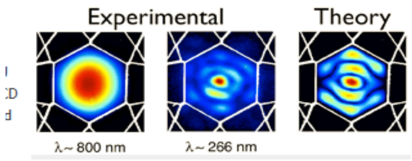
Appeal

- The ongoing SPARC_LAB activities are being studied in several other laboratories, including SLAC, DESY, CERN and KEK with equally or even more ambitious research programs.
- Therefore the time factor becomes very important to remain at the research frontier and to produce results with high-impact on the international scientific community.
- A redefinition of the priorities inside LNF and an increase in the number of dedicated researchers and technician shifts is an indisensabile requirement to keep SPARC_LAB productive.

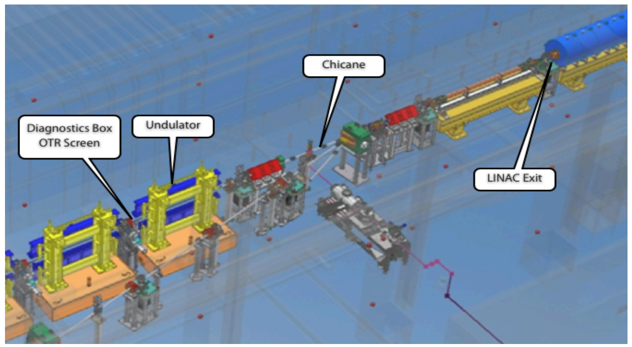
MORE FEL

Scientific collaboration proposals

- Alternative seed sources
  Kagomé fibers
  (N. Joly, MP -
  M.E. Couprie Soleil)



- **Experimental Study of New Effects of Noise Suppression in Relativistic Electron-Beam and Spontaneous Emission Sub-radiance in FEL** (A. Nause, A. Gover, - Tel Aviv University)

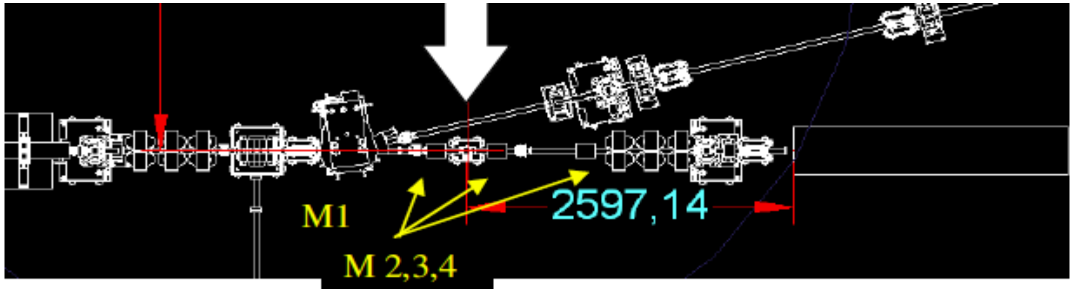


Experimental Study of New Effects of Noise Suppression in Relativistic Electron-Beam and Spontaneous Emission Sub-radiance in FEL

A.Nause, A. Gover, - Tel Aviv University

The Research goals

- Control over electron beam noise in the optical spectral range by means of a process of Coulomb collective micro-dynamics and use of a dispersive magnetic structure, and specifically attain current-noise suppression below the classical "shot-noise limit".



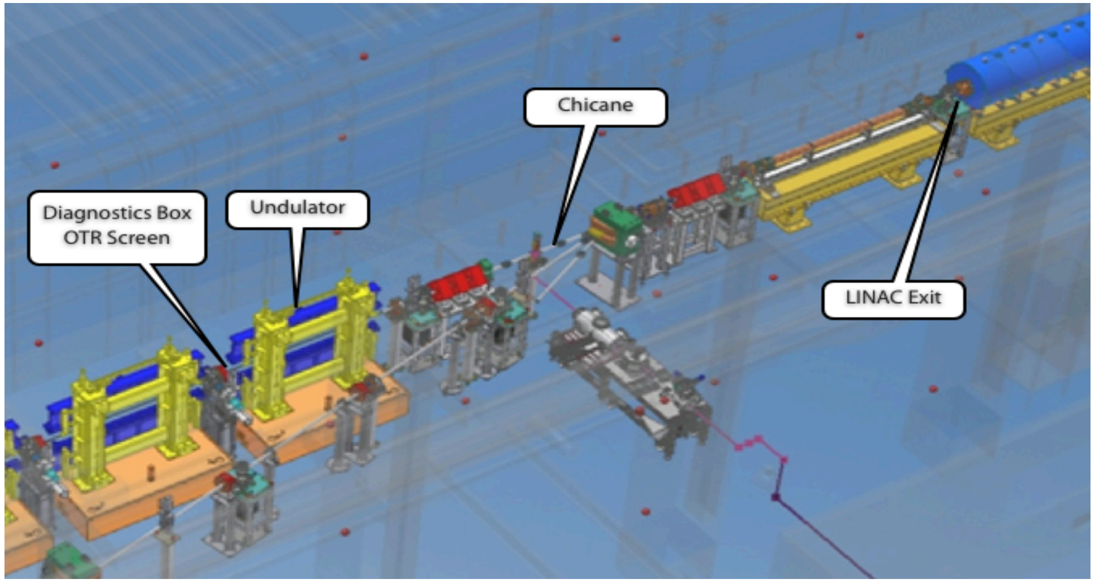
-Suppression of spontaneous (incoherent) radiation emission in electron beam radiation schemes (sub-radiance in the sense of Dicke). Specifically in the context of FELs: demonstrating radiation noise suppression and coherence enhancement of seed radiation injected FEL .

REF.

A. Gover, A. Nause, E. Dyunin, M. Fedurin "Beating the shot-noise limit", "nature physics", published online Oct 14, DOI 10.1038/NPHYS2443, (2012).

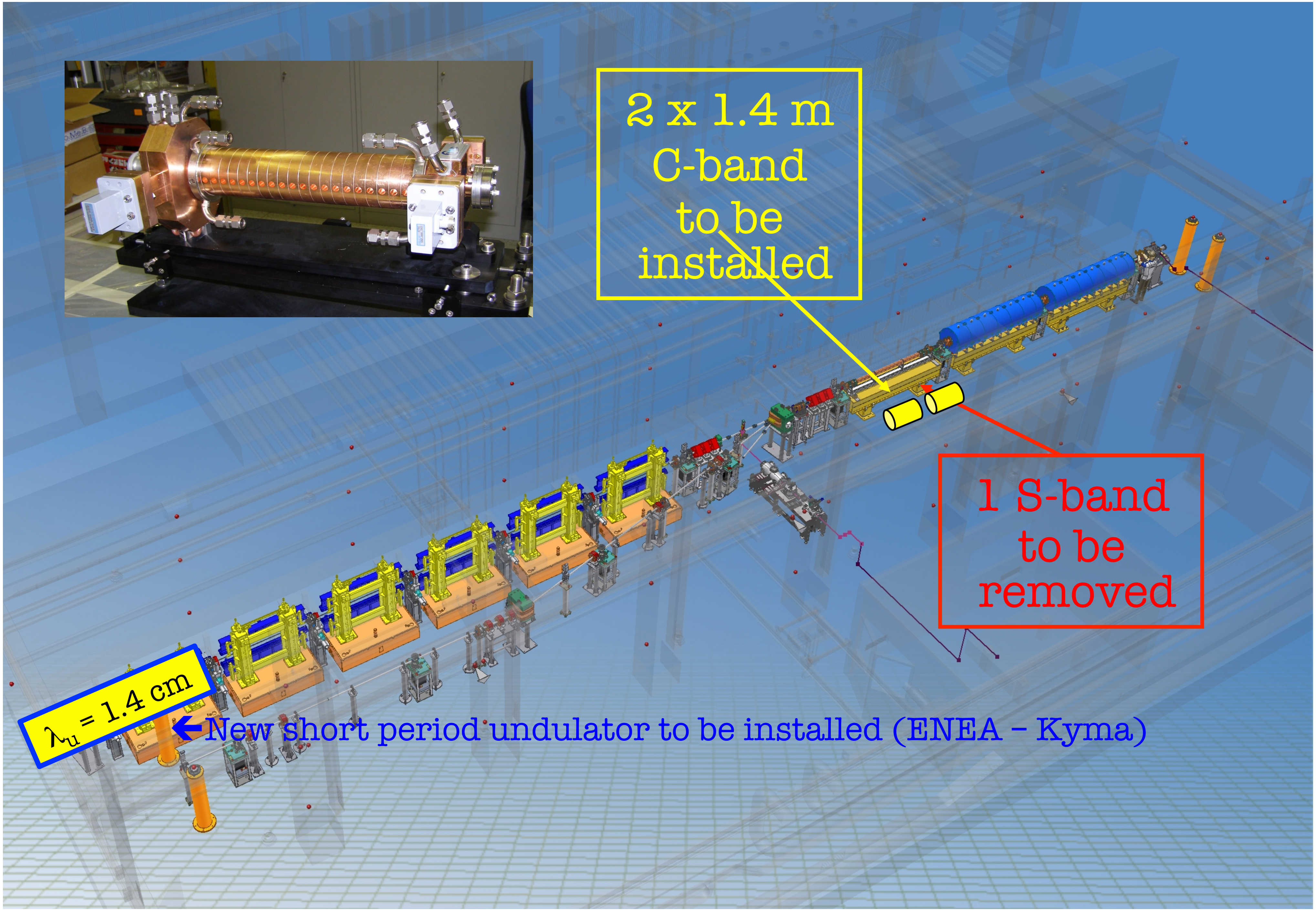
- If observed, the undulator radiation suppression effect would be a first demonstration of Dicke's fundamental effect of spontaneous emission sub-radiance in an FEL structure.

- Since SPARC is equipped with a High Harmonic Generation seed injection laser, it will be also possible to observe the radiation noise suppression and coherence enhancement effect in SPARC's FEL.

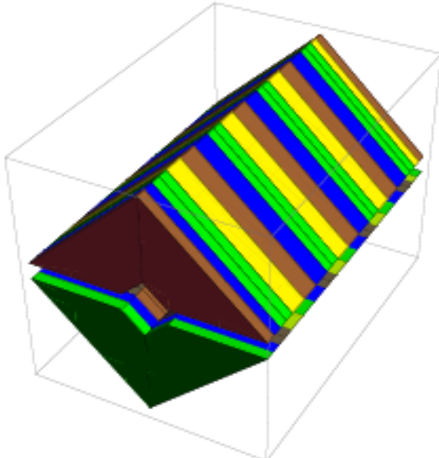


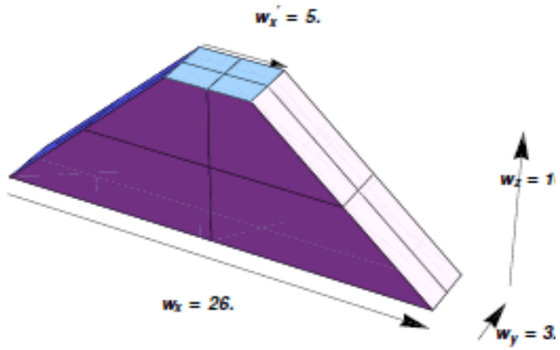
<u>Plan of Visit</u>

Two visits, of 3-4 weeks each, are planned:
(1) Experiment setting, equipment use training and calibration of diagnostics.
(2) Conduction of scientific experiments.


2 x 1.4 m
C-band
to be
installed
1 S-band
to be
removed
λ_u = 1.4 cm
New short period undulator to be installed (ENEA - Kyma)

SPARC-FEL: future developments



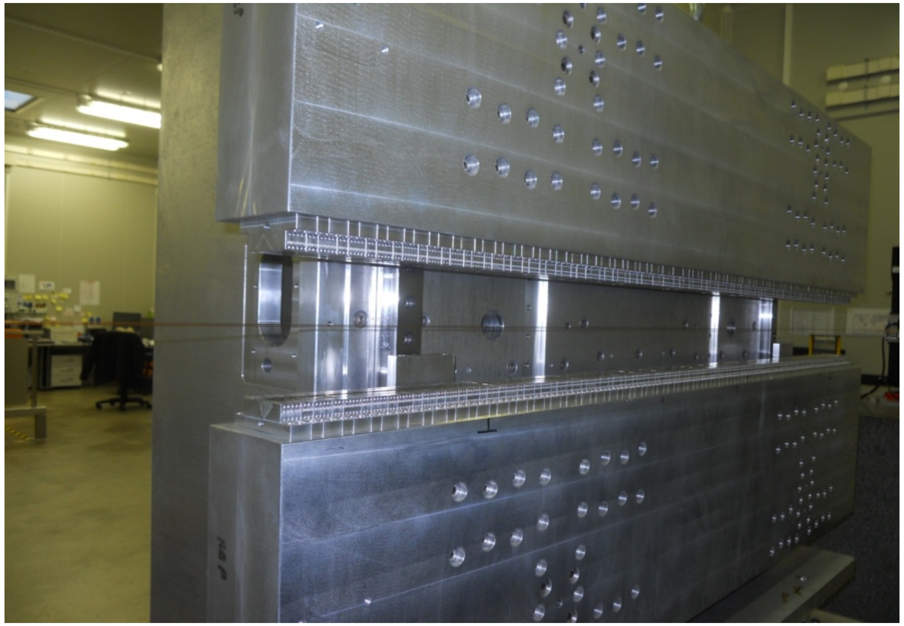


- DELTA like undulator (end of 2012)
  λu = 14.0mm, gap g = 5mm, Br = 1.22T.

  Undulator test in two possible configuration with the actual accelerator:

  1)Two stage SASE-FEL cascade:
  450nm to 150 nm

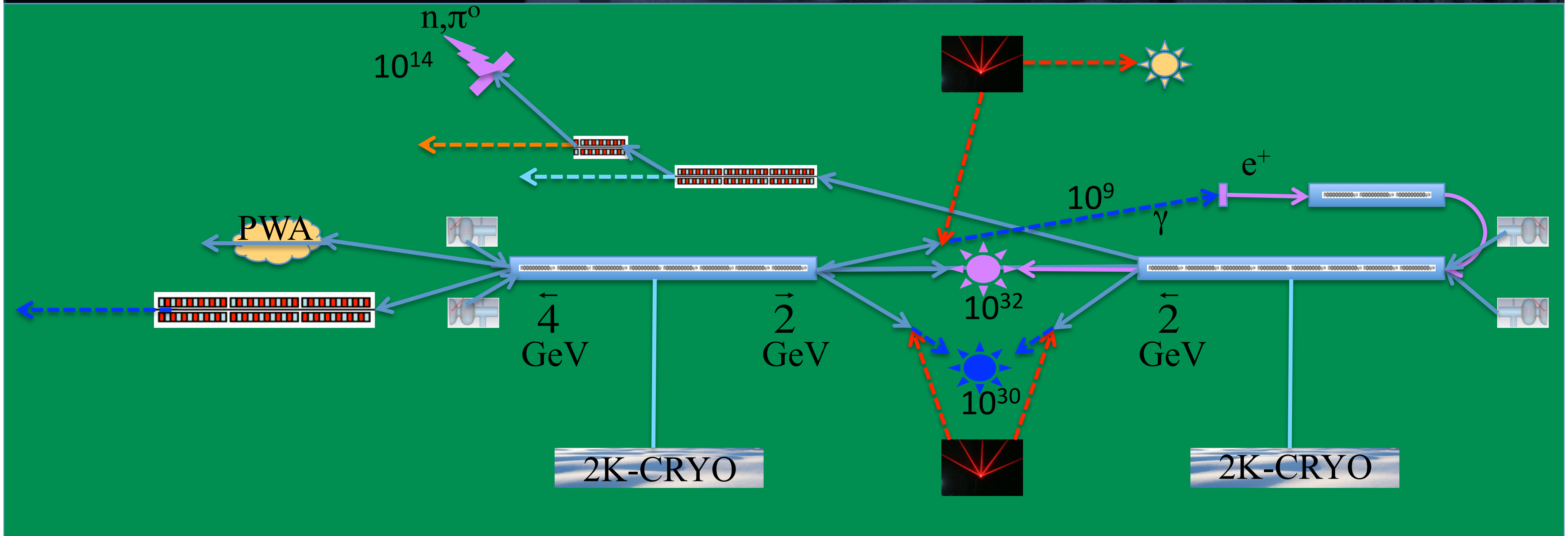
  2)Three stage seeded FEL cascade:
  400nm – 200nm – 100nm



KYMA undulator

IRIDE

I R I D E is a large infrastructure for fundamental and applied physics research. Conceived as an innovative and evolutionary tool for multi-disciplinary investigations in a wide field of scientific, technological and industrial applications, it will be a high intensity "particle beams factory".



Based on a combination of a high duty cycle radio-frequency superconducting electron linac (SC RF LINAC) and of high energy lasers it will be able to produce a high flux of electrons, photons (from infrared to γ-rays), neutrons, protons and eventually positrons, that will be available for a wide national and international scientific community interested to take profit of the most advanced particle and radiation sources.

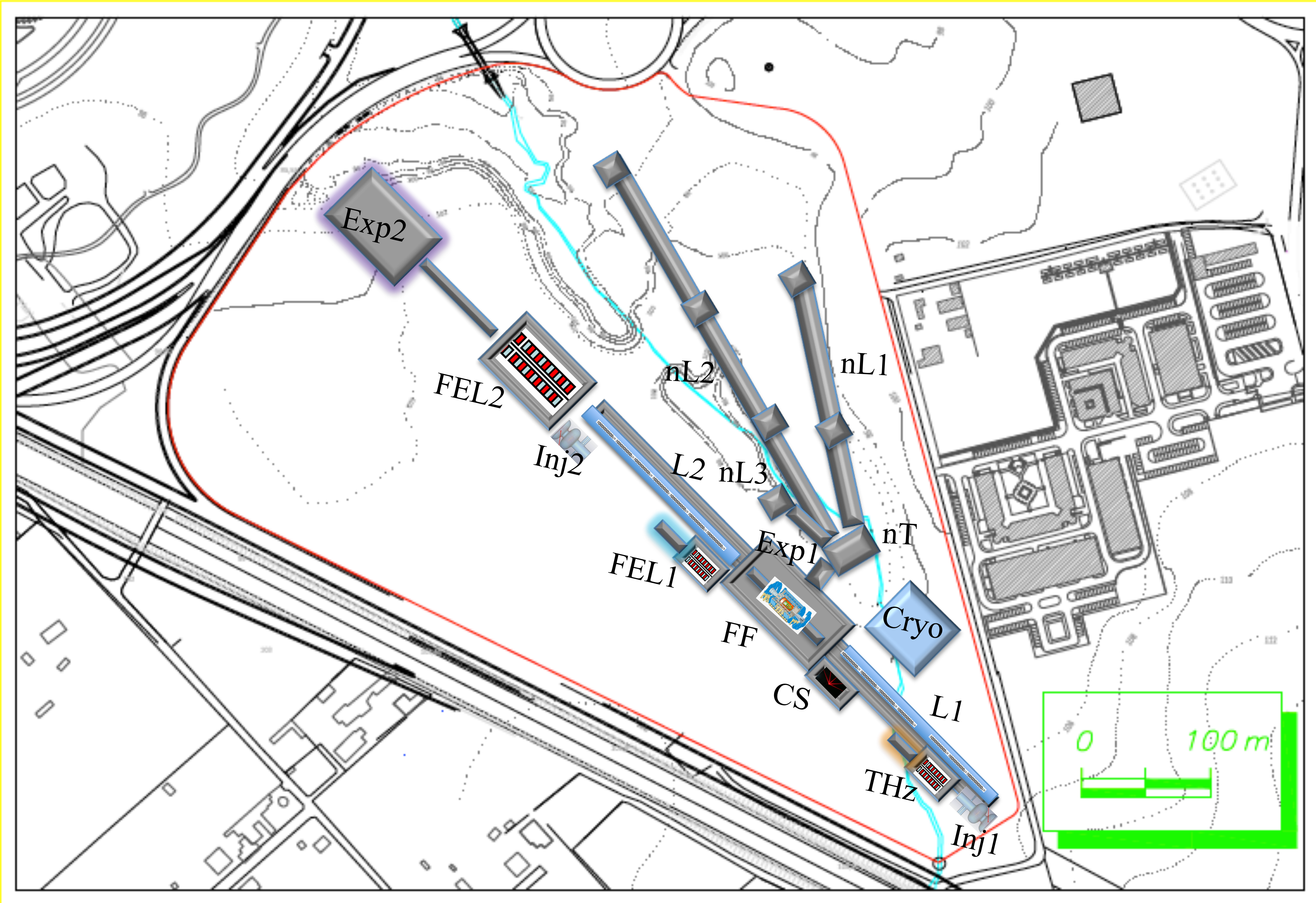
I R I D E

An **I**nterdisciplinary **R**esearch **I**nfrastructure based on **D**ual **E**lectron linacs&lasers

A WHITE BOOK

This report describes the scientific aims and potentials as well as the preliminary technical design of IRIDE, an innovative tool for multi-disciplinary investigations in a wide field of scientific, technological and industrial applications. IRIDE will be a high intensity “particle factory”, based on a combination of a high duty cycle radio-frequency superconducting electron linac and of high energy lasers. Conceived to provide unique research possibilities for particle physics, for condensed matter physics, chemistry and material science, for structural biology and industrial applications, IRIDE will open completely new research possibilities and advance our knowledge in many branches of science and technology. IRIDE will contribute to open new avenues of discoveries and to address most important riddles: What does matter consist of? What is the structure of proteins that have a fundamental role in life processes? What can we learn from protein structure to improve the treatment of diseases and to design more efficient drugs? But also how does an electronic chip behave under the effect of radiations? How can the heat flow in a large heat exchanger be optimized?

The scientific potential of IRIDE is far reaching and justifies the construction of such a large facility in Italy in synergy with the national research institutes and companies and in the framework of the European and international research. It will impact also on R&D work for ILC, FEL, and will be complementarity to other large scale accelerator projects. IRIDE is also intended to be realized in subsequent stages of development depending on the assigned priorities.



Exp2
FEL2
Inj2
nL2
nL1
L2
nL3
nT
Exp1
FEL1
FF
Cryo
CS
L1
THz
Inj1
0
100 m

IRIDE: Interdisciplinary Research Infrastructure based on Dual Electron linacs and lasers

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Abstract

This paper describes the scientific aims and potentials as well as the preliminary technical design of IRIDE, an innovative tool for multi-disciplinary investigations in a wide field of scientific, technological and industrial applications. IRIDE will be a high "particles factory", based on a combination of high duty cycle radio-frequency superconducting electron linacs and of high energy lasers. Conceived to provide unique research possibilities for particle physics, for condensed matter physics, chemistry and material science, for structural biology and industrial applications, IRIDE will open completely new research possibilities and advance our knowledge in many branches of science and technology. IRIDE is also supposed to be realized in subsequent stages of development depending on the assigned priorities.

Keywords: SC Linac, FEL, Particle Physics, Neutron source, Compton source, Advanced Accelerators Concepts

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Previous PAB report comments

2. SPARC_Lab

P. Mugli, L. Rivkin, J. Rossbach (SPARC_LAB PAC), and L. Rolandi and U. Dosselli met with members of the SPARC_LAB and discussed the SPARC-Lab status and plans.

During the past 6 months, SPARC_Lab made impressive progress. Among others, simultaneous FEL operation at two different colors was established for the first time, based on the capability of SPARC to generate and manipulate two bunches with different energies simultaneously. For the Compton Backscattering source, both the electron and the photon beamlines were completed and the interaction chamber installed. In parallel, the team was heavily involved in working out two project proposals. We acknowledge that the SPARC_Lab program is now more focused in view of uniqueness of SPARC and the mission of the lab. In terms of the future program, it is mandatory to understand the role of SPARC_Lab in two proposed projects, which rely heavily on the expertise of the team: a Compton-based Gamma-Source for ELI and IRIDE. Once any of these projects are approved, the SPARC_Lab mission must be adapted accordingly. Generally speaking, we are delighted to see that SPARC_Lab became a seed for two major project options for the lab.

We congratulate on the collaboration agreement with DESY and University of Hamburg on joint plasma acceleration research. This is an important step in establishing international collaboration on using SPARC.

As it was stressed previously, SPARC_LAB represents a very exciting and attractive environment for the next generation as it covers cutting edge technologies from various fields such as lasers technology, accelerator physics, plasma science, RF technology, and digital controls. It is thus once more suggested to define a strong education program as an integrated part of the SPARC_LAB, in collaboration with one or more university faculties. In this context we were disappointed to hear that only two out of the six PhD openings for accelerator physics at the University La Sapienza could be filled. This indicates that more efforts are needed, probably in earlier phases of university education.

2.2 Recommendations

In view of running collaborations and attracting more of them, we remind once more of the need to publish a Technical Design Report and establish and maintain an adequate webpage.

It is necessary to define the program of BEATS2/Mammography more clearly, and it would be helpful to identify a stand alone profile. Proton acceleration should concentrate on external injection and post acceleration of an ultrashort proton bunch, which could be done only at a few places in the world. The scientific case of LIDAR should be strength. Flame: in order to make full and adequate profit of the laser hardware, the focusing technology (adaptive optics) deserved high priority because it determines the power density that can be directed onto a target.


To Be Continued