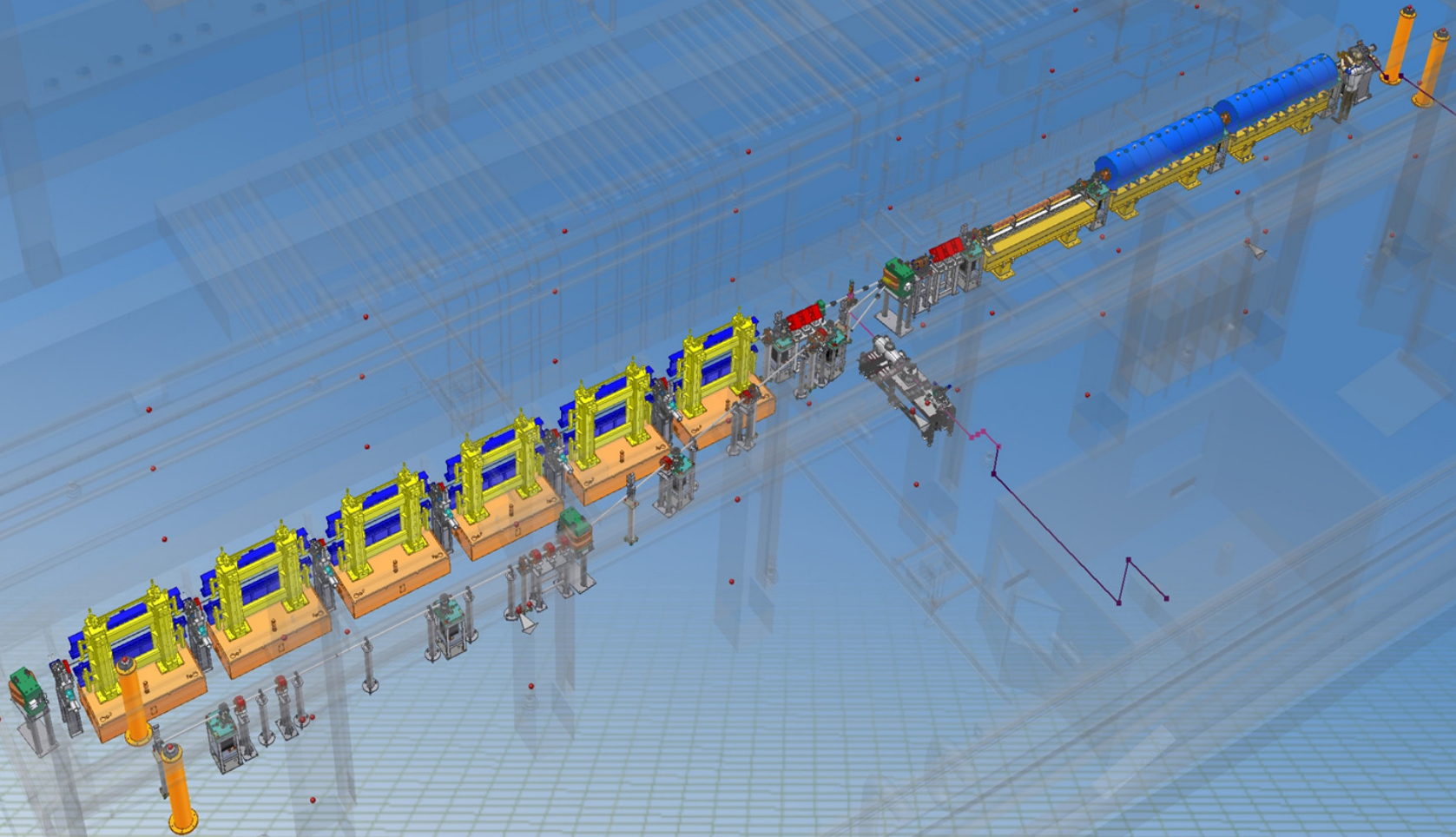
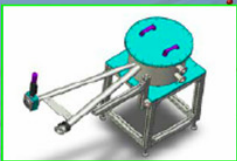


Recent Results of the SPARC Fel Experiments

Massimo Ferrario (INFN-LNF)
on behalf of the SPARC team





Undulators

$$\lambda_u = 2.8 \text{ cm}$$

$$K_{\text{max}} = 2.2$$

$$\lambda_r = 500 \text{ nm}$$

Diagnostic
and
Matching

150 MeV
S-band
Linac

Velocity
Bunching

10 m

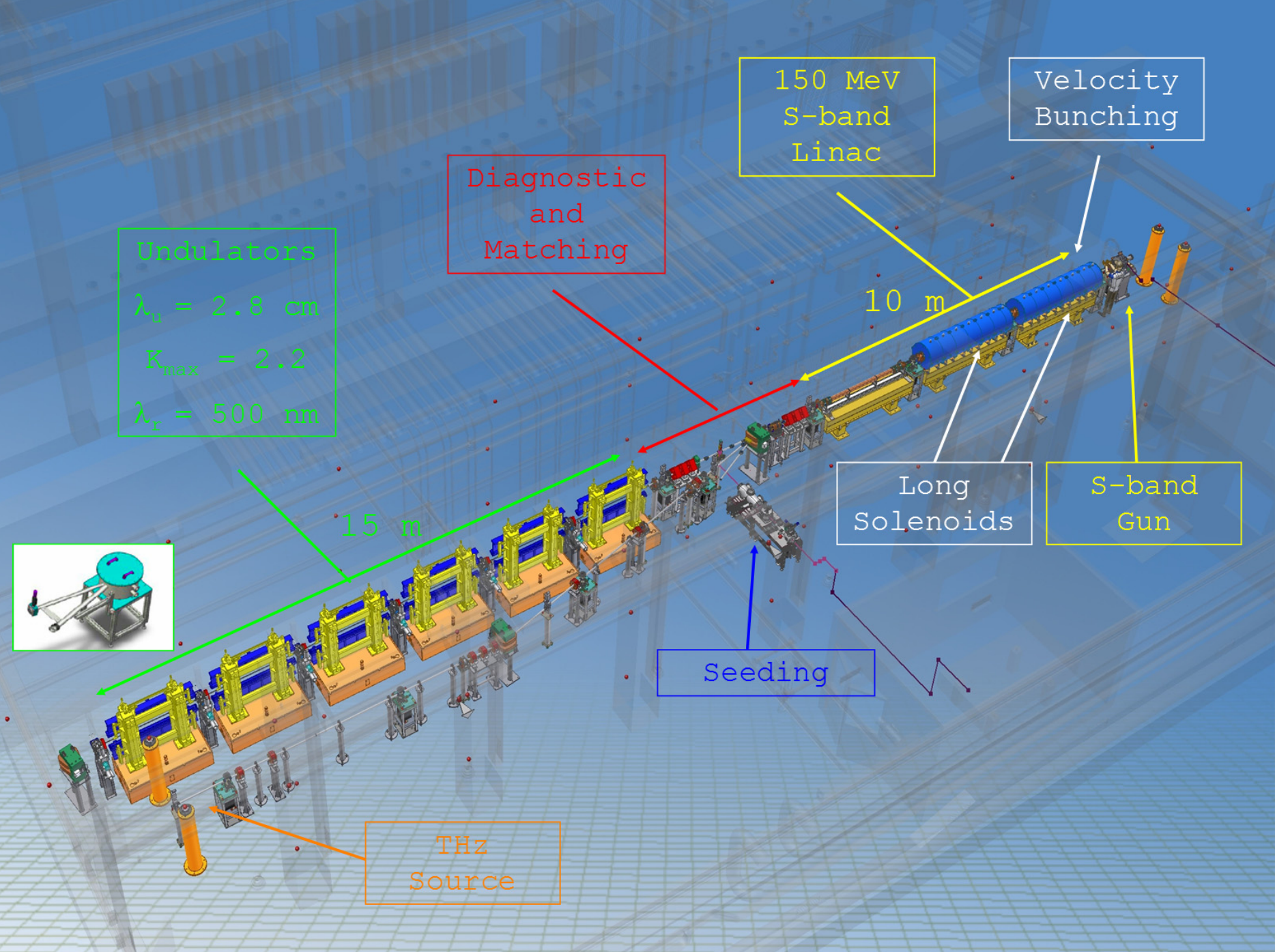
Long
Solenoids

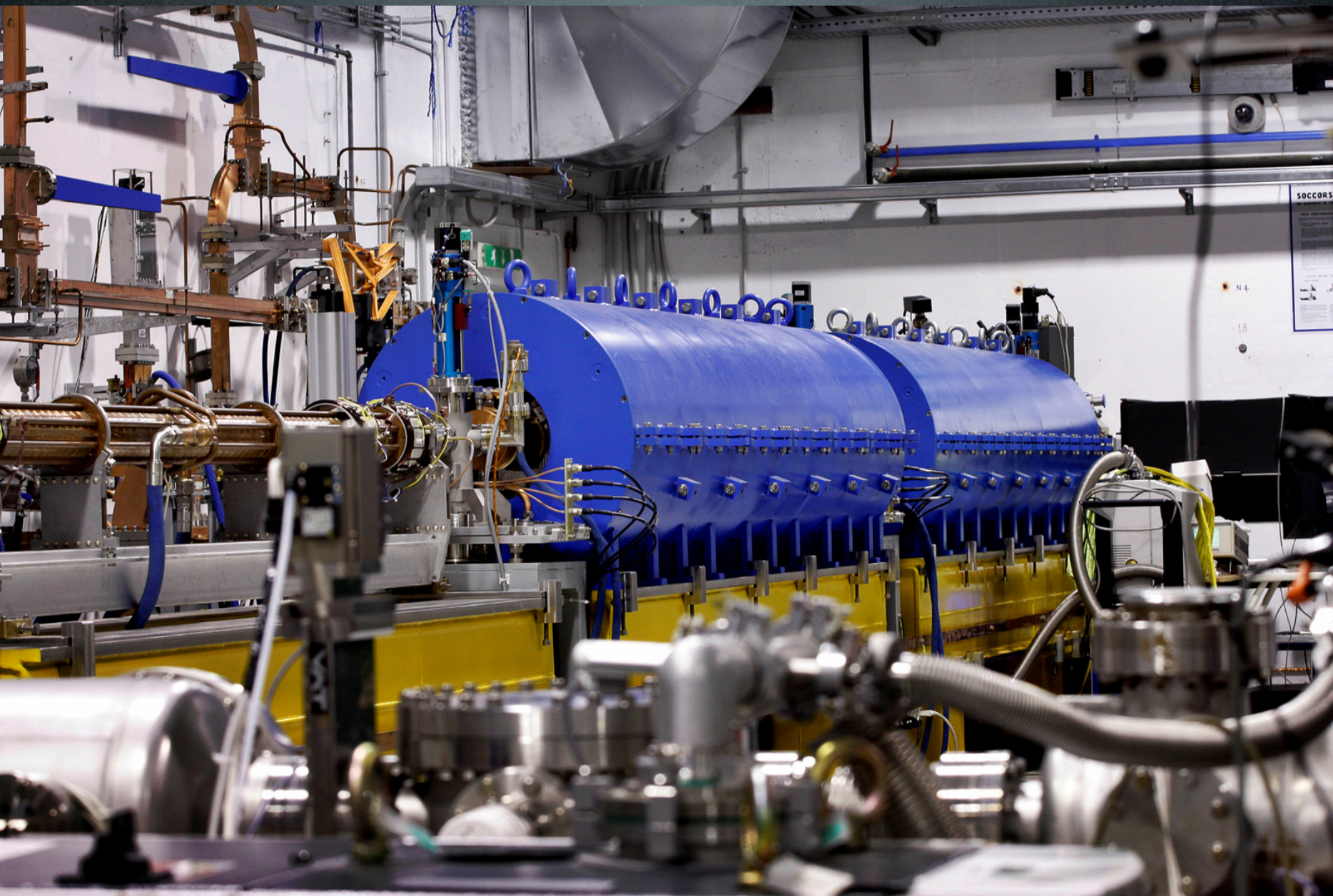
S-band
Gun

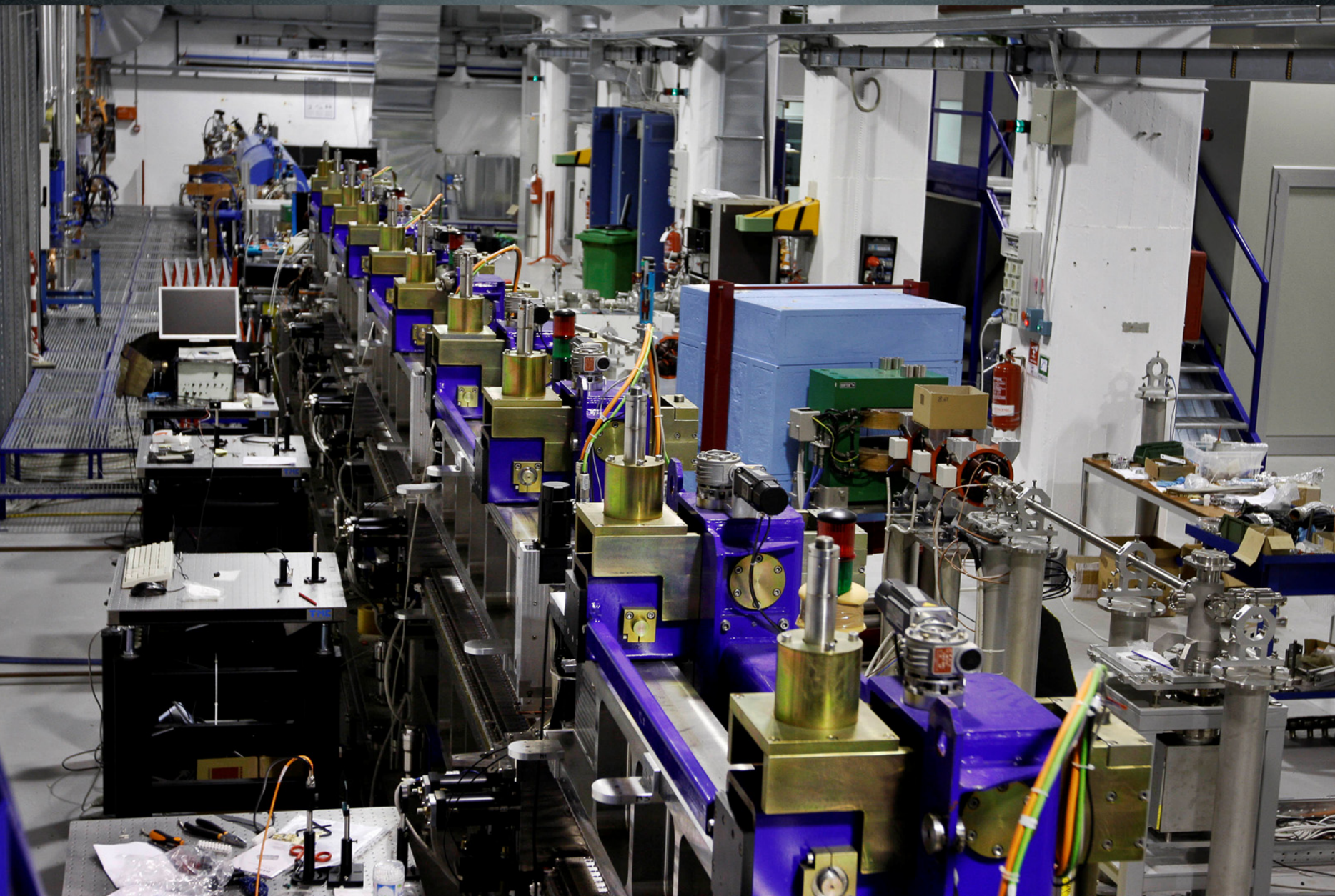
15 m

Seeding

THz
Source

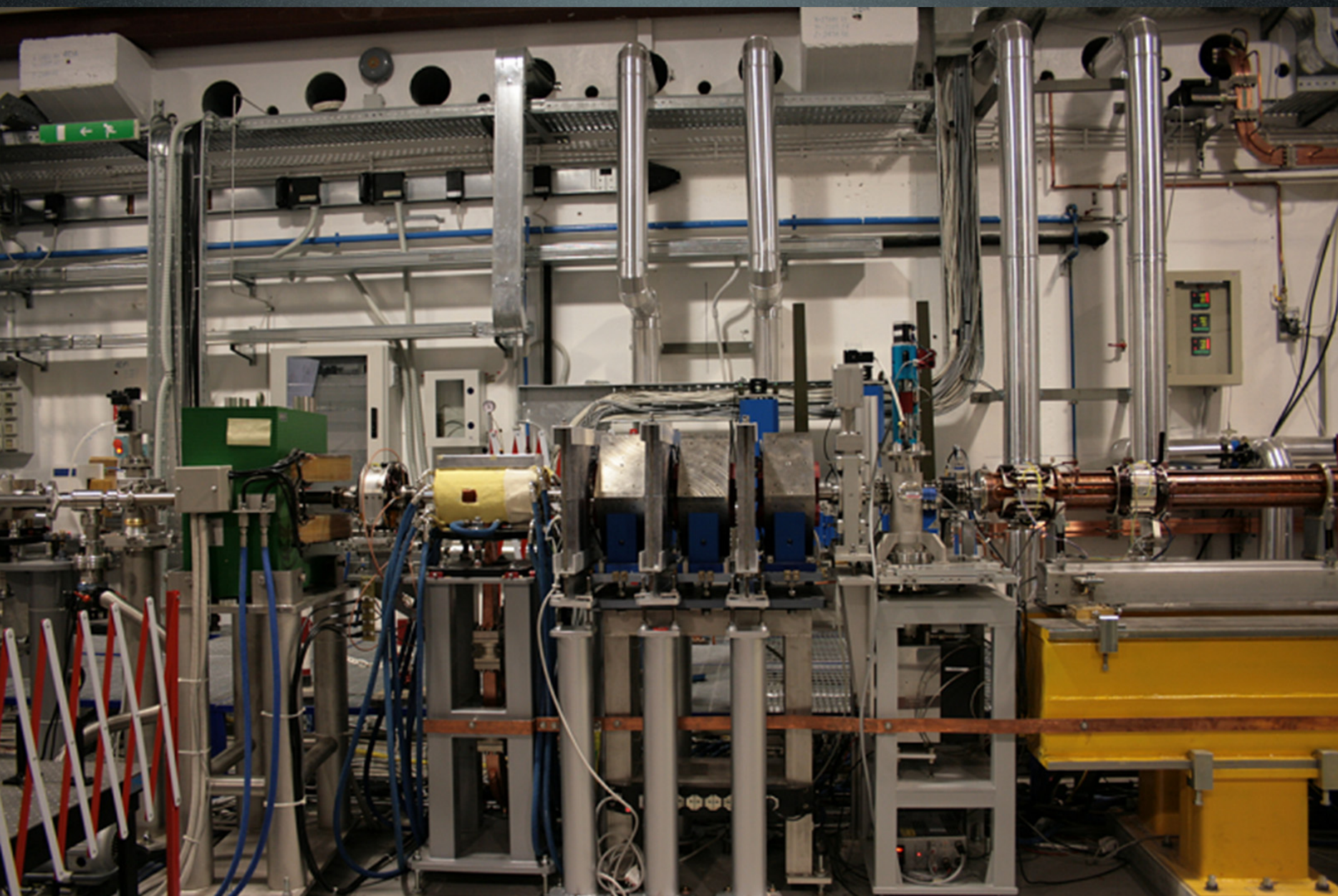




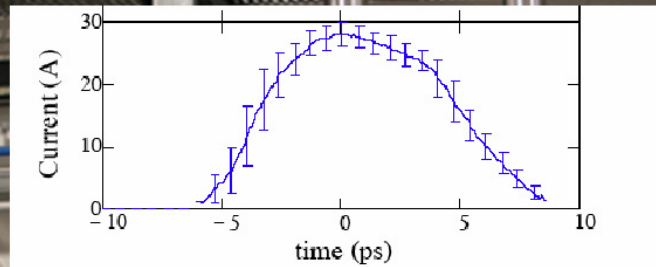
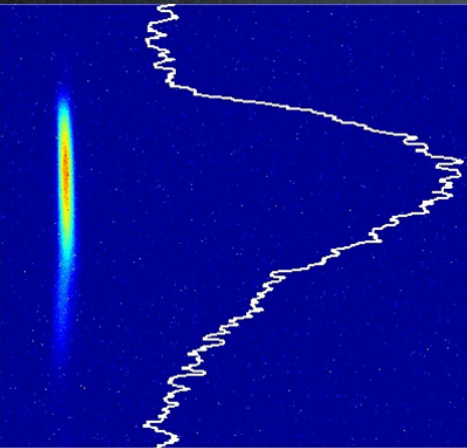


SASE at 500 nm

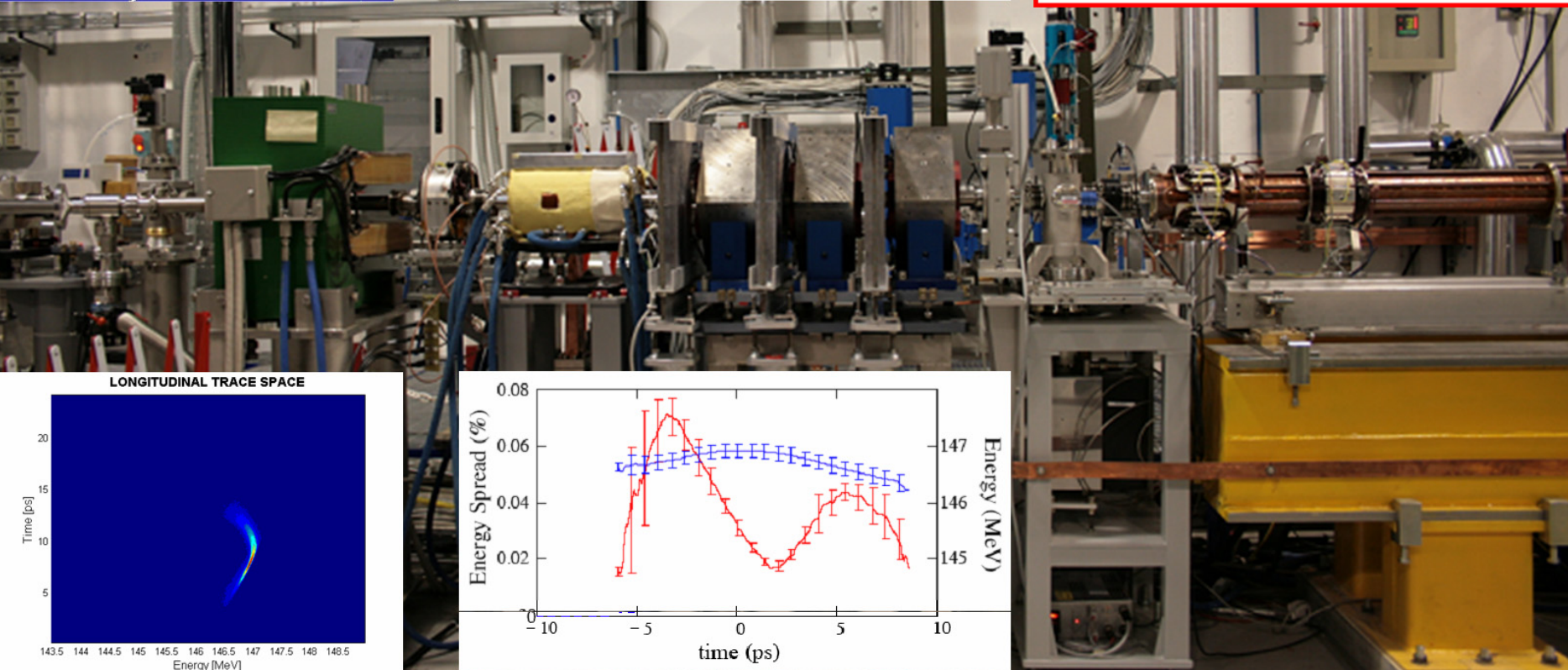
Electron beam parameters at the linac exit



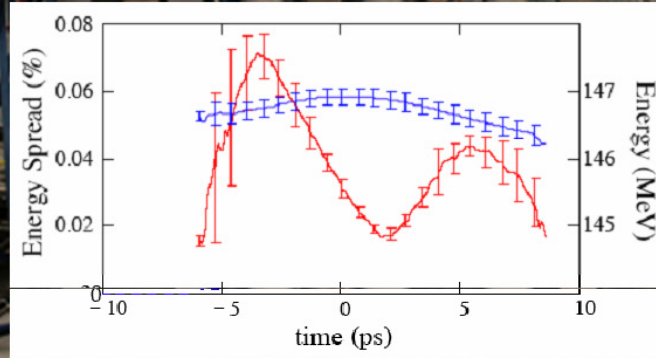
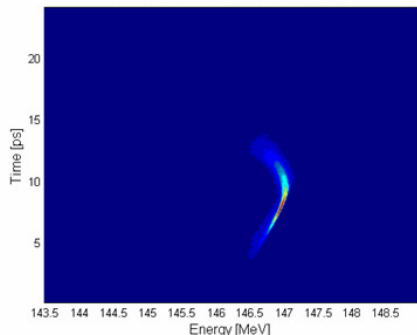
Electron beam parameters at the linac exit



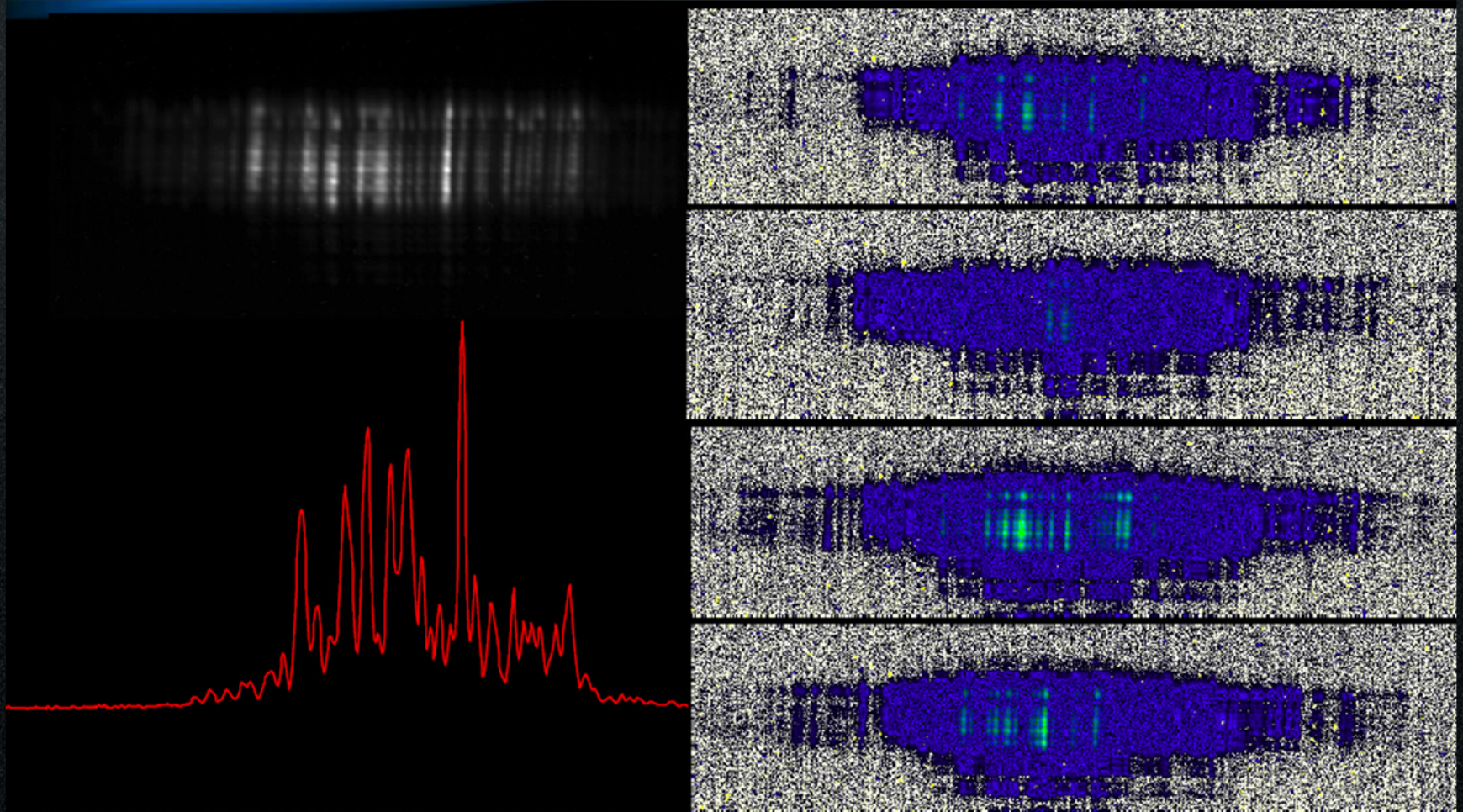
- $E=148$ MeV
- $\sigma_\gamma=0.001$
- $Q=250$ pC
- $\sigma_e=2.5$ ps-rms
- $\epsilon_{x,y}=2.\pi.\text{mm.mrad}$

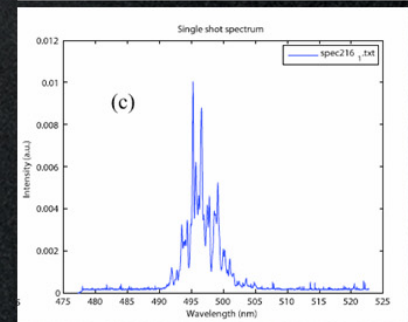
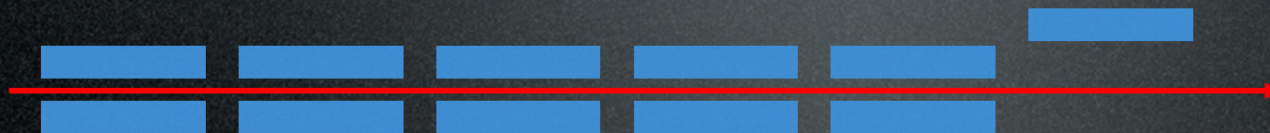
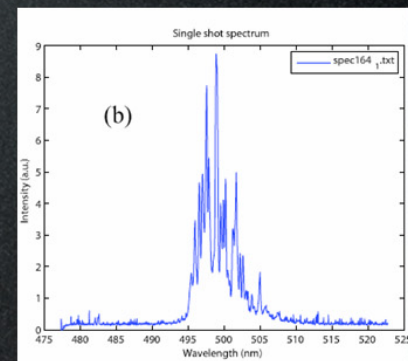
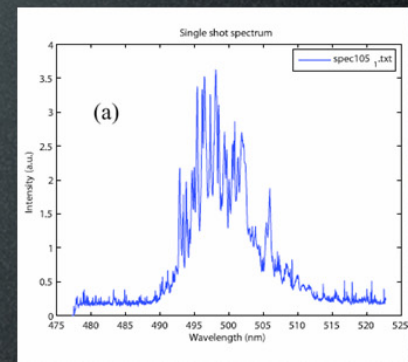
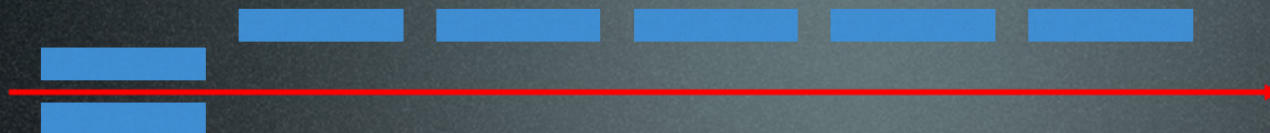


LONGITUDINAL TRACE SPACE

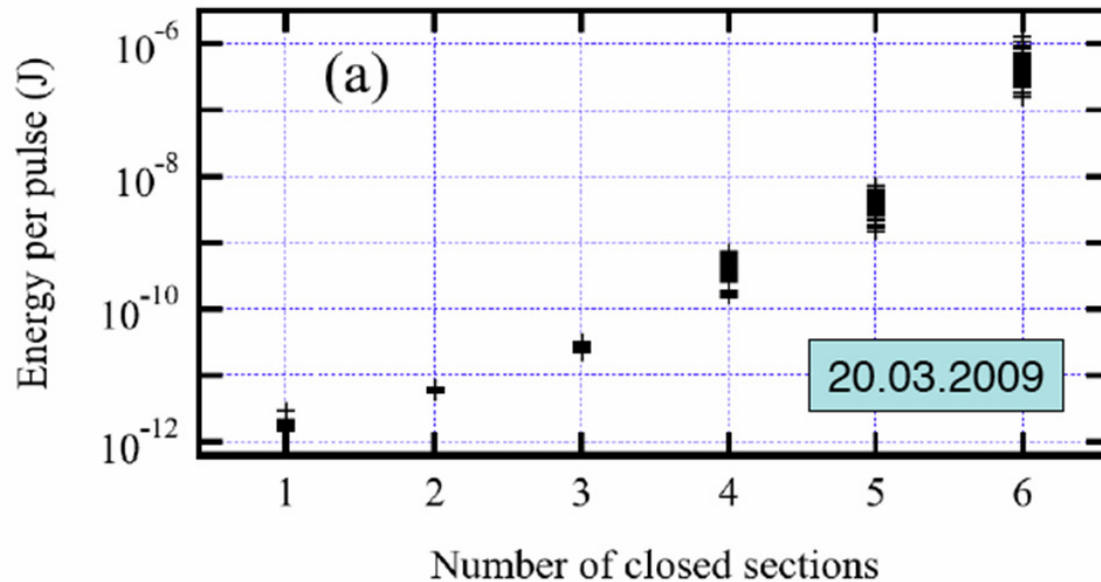


First experimental evidence of SASE on February 17th





Energy per pulse vs number of closed sections



$Q=0.25$ nC

Parameter	Unit	Value
Deflection paramter (K)	-	2.14
Period (λ_0)	mm	28
Number of periods per section	-	77
Number of section	-	6
Distance between sections	m	0.392
Natural focussing in x	-	-2.0×10^{-2}
Natural focussing in y	-	10.2×10^{-1}

Spectral width vs number of closed sections

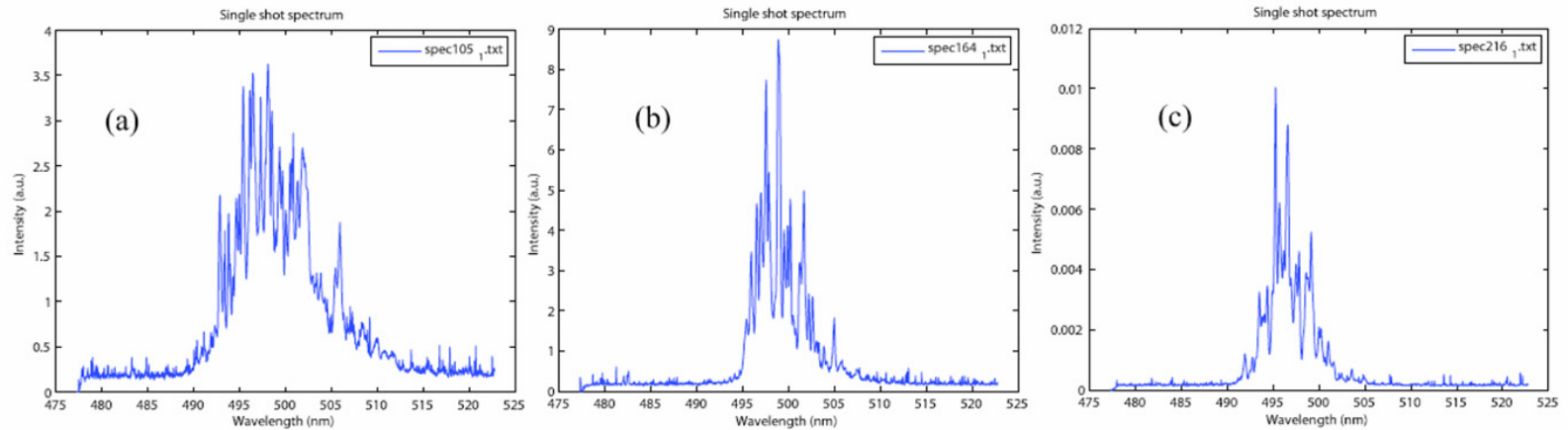
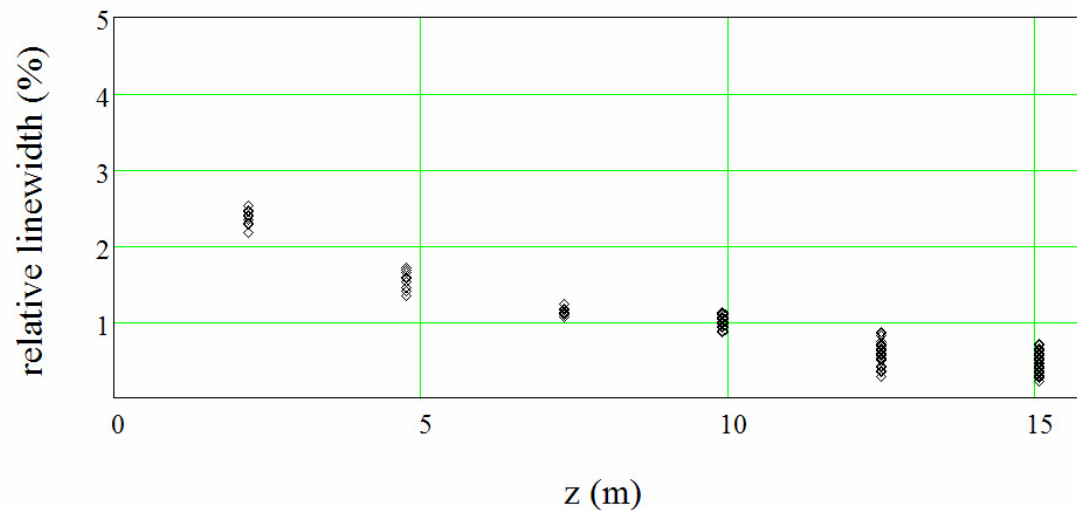
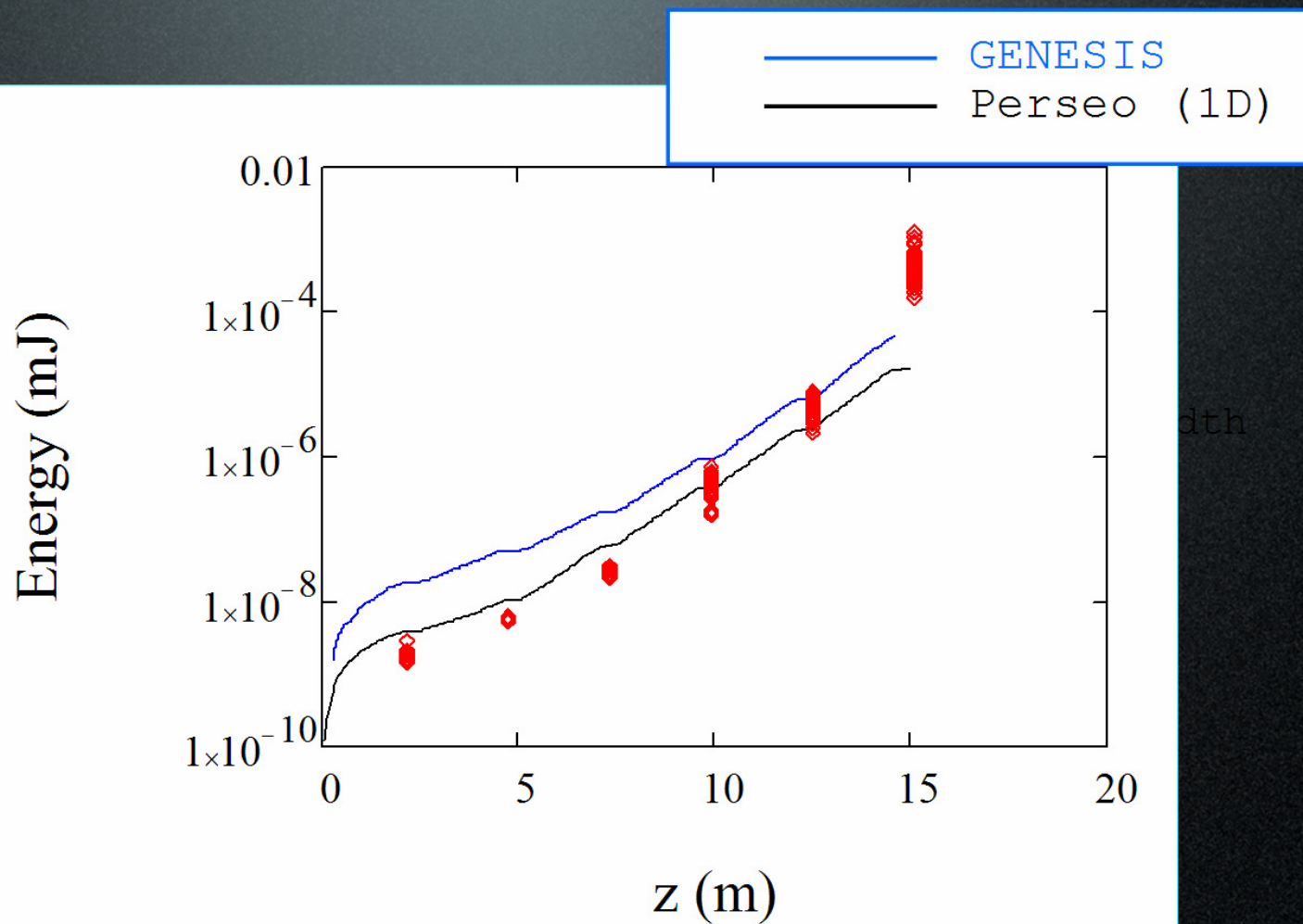


FIGURE 2: Undulator radiation spectra. Measurement with the high resolution spectrometer. (a) 4, (b) 5 and (c) 6 undulator sections closed. $E=151\text{--}148$ MeV, $\sigma_\gamma=0.0001$, $Q=262$ pC, $\sigma_e=7$ ps-fwhm, $\epsilon_{x,y}=2\pi$.mm.mrad. (Measurement of the 09/03/20).



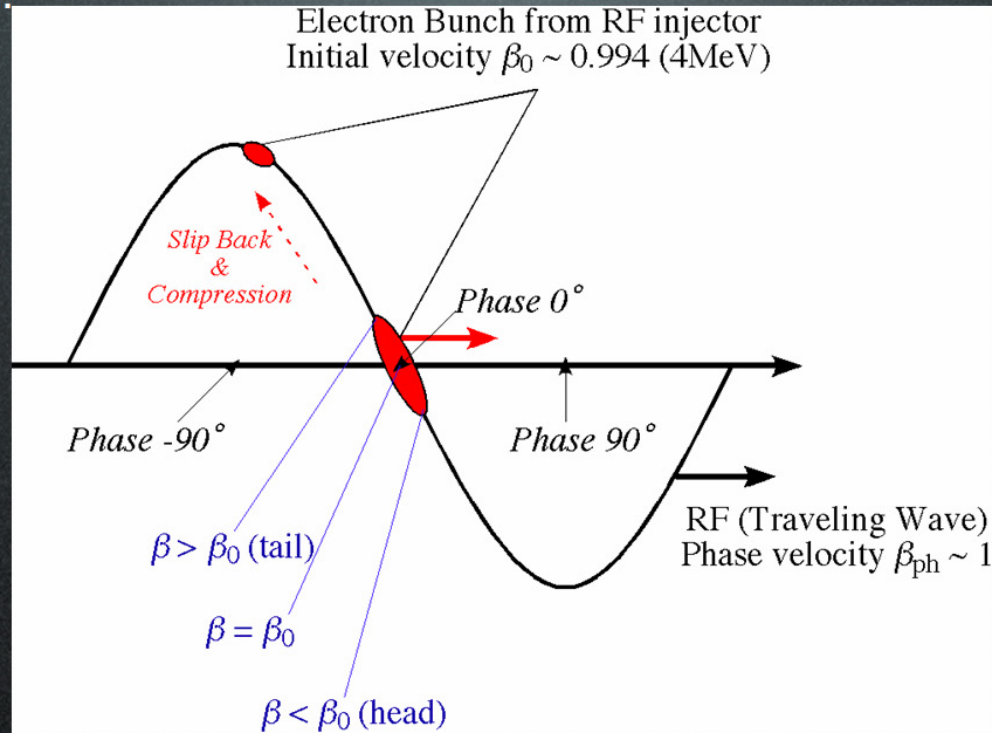
Preliminary data analysis



Velocity Bunching

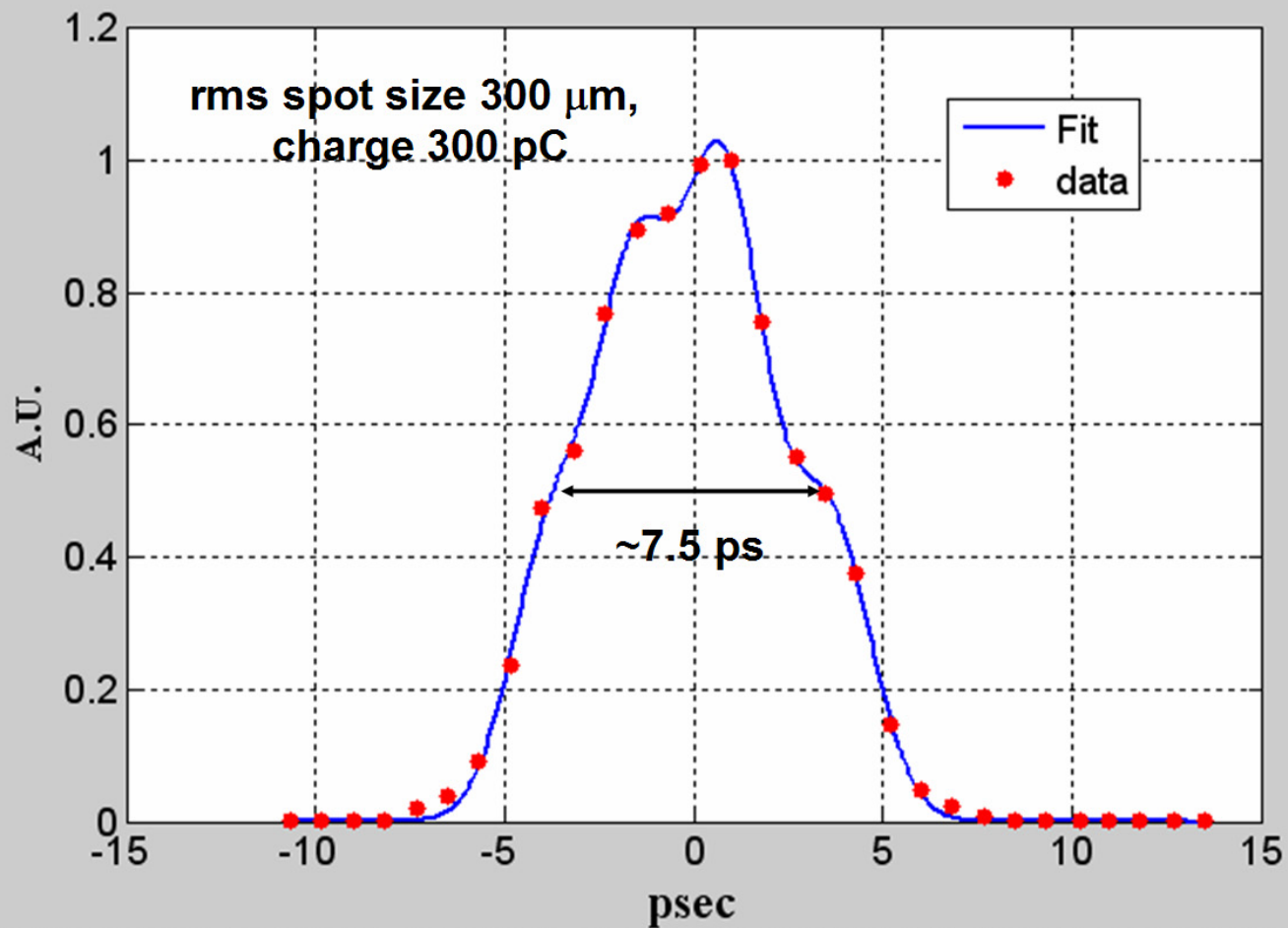
Velocity bunching concept

If the beam injected in a long accelerating structure at the crossing field phase and it is slightly slower than the phase velocity of the RF wave, it will slip back to phases where the field is accelerating, but at the same time it will be chirped and compressed.



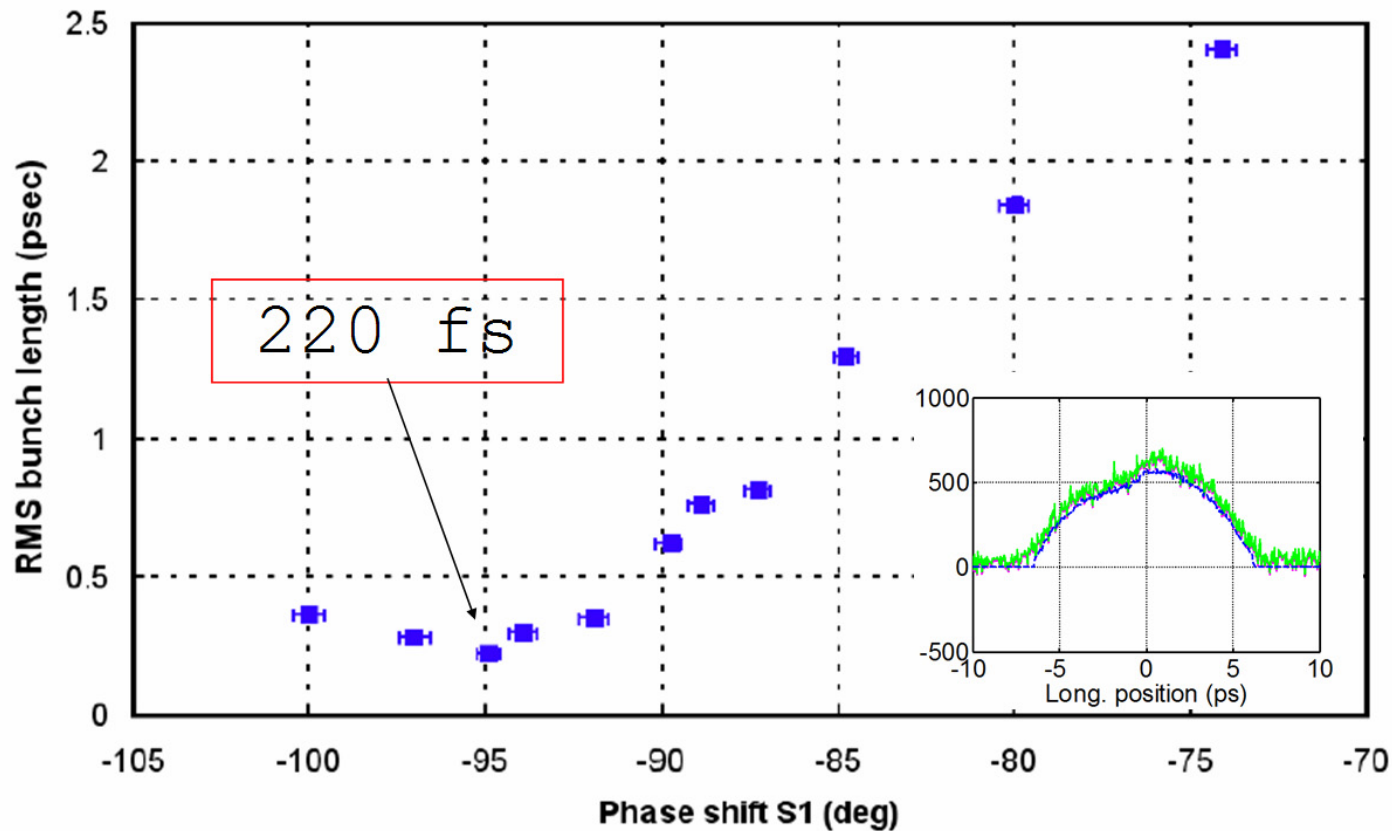
The key point is that compression and acceleration take place at the same time within the same linac section, actually the first section following the gun, that typically accelerates the beam, under these conditions, from a few MeV (> 4) up to 25-35 MeV.

Laser temporal profile on cathode



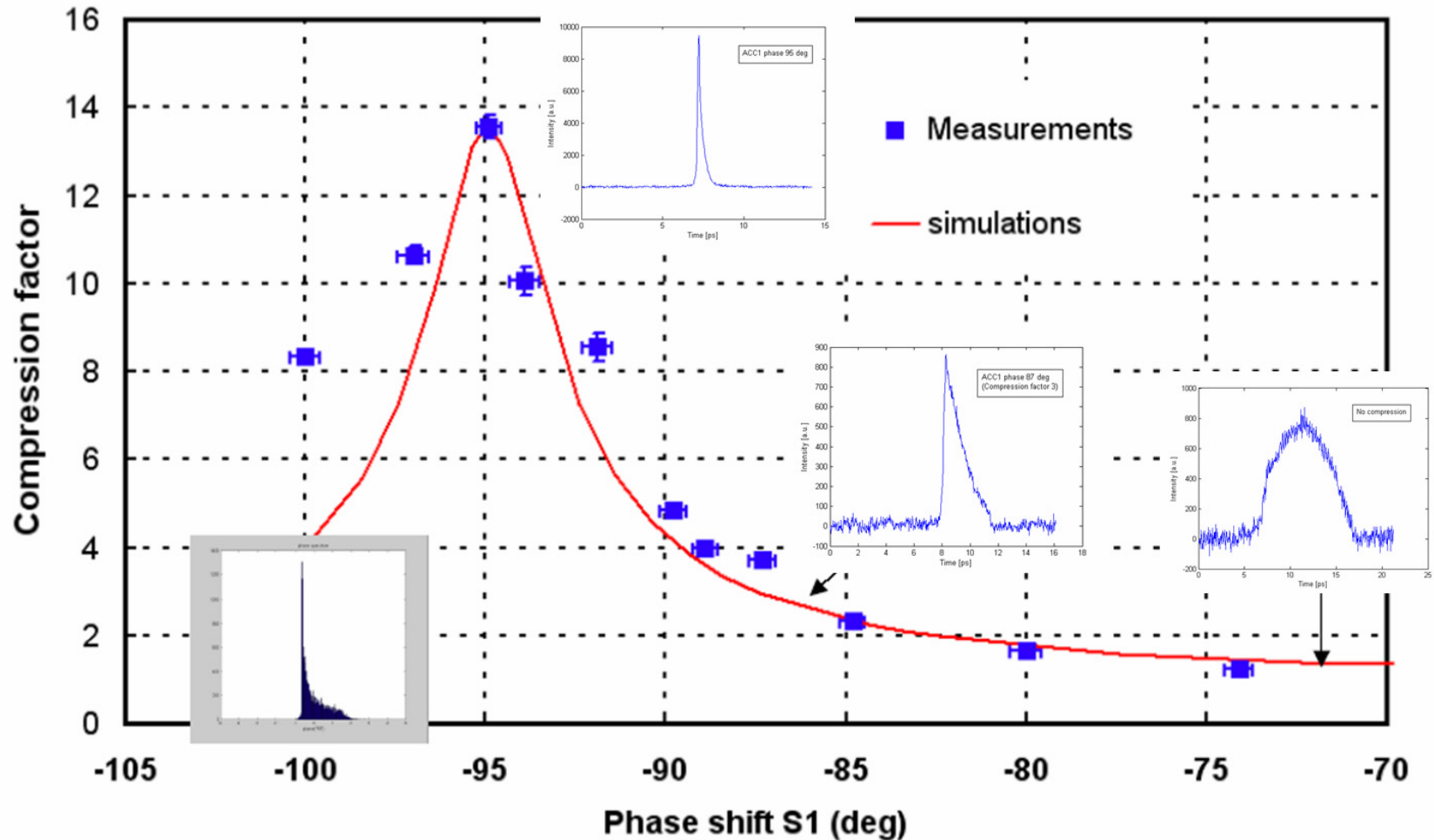
Pulse length versus injection phase

SPARC measurements 2/04/09



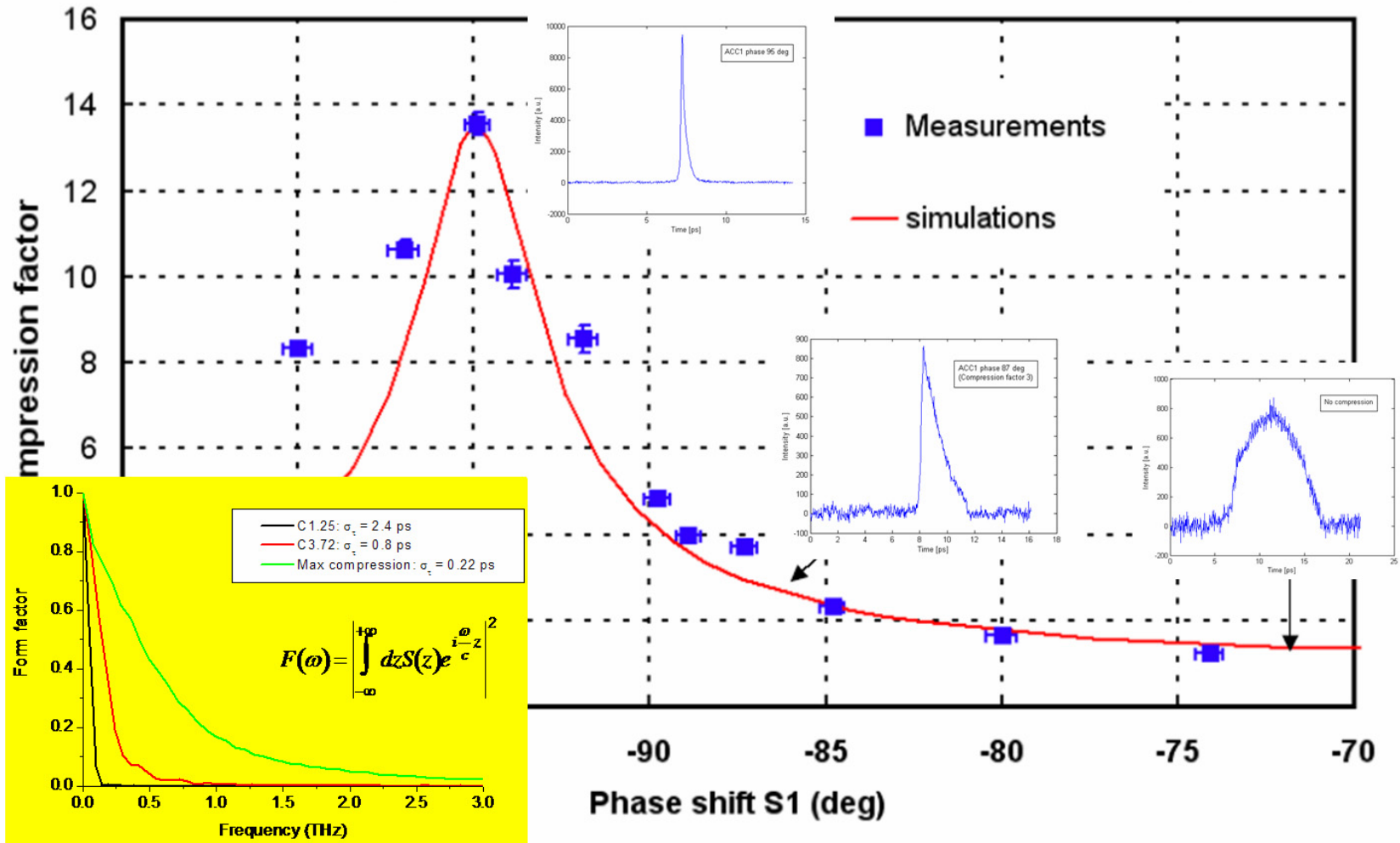
C-factor versus injection phase

Compression curve (measurements of 2/04/2009)



C-factor versus injection phase

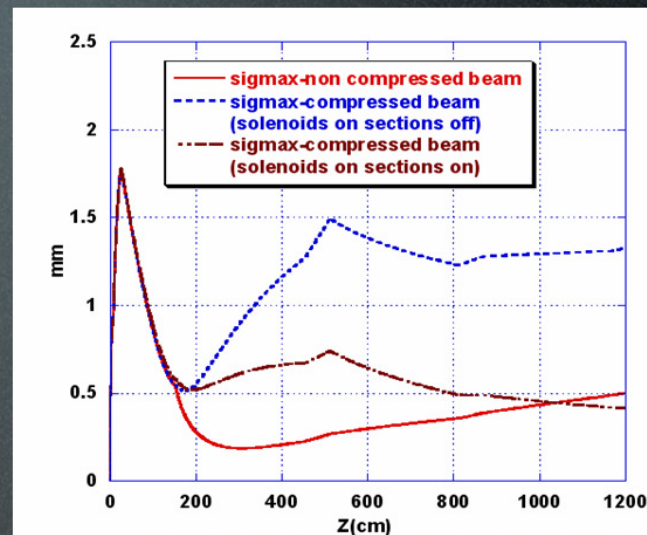
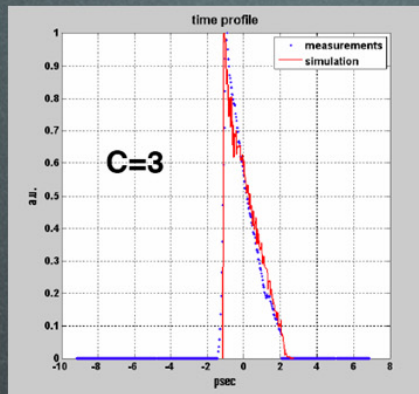
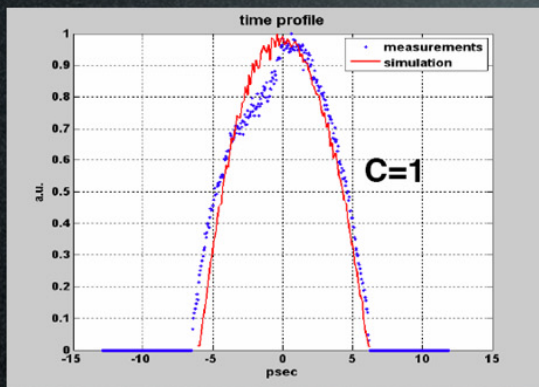
Compression curve (measurements of 2/04/2009)



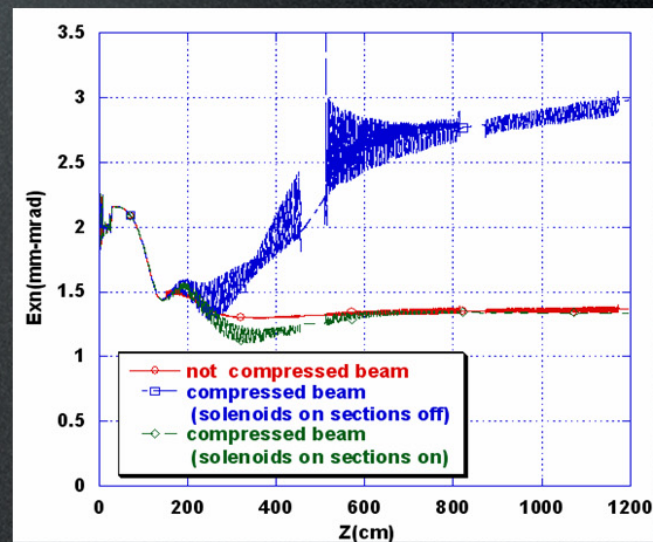
Emittance Compensation Study



Measurement results with compression 3



	No Compression	Compression 3
Bunch Charge	300 pC	300 pC
Injection phase	0 deg	-85 deg
Beam Energy	140 MeV	100 MeV
Total energy spread	0.11 %	1.0 %
Rms Bunch Length	3.25±0.16 ps	1.03±0.10 ps
Norm emittances x-plane	2.33 ±0.11 μm	1.74±0.05 μm 4.33 ±0.83 μm solenoids off
Norm emittances y-plane	1.3 ±0.053 μm	1.44 ±0.03 μm 6.06±0.40 μm solenoids off
Solenoid field	0 Gauss	400 Gauss



SPARC next runs

- SASE Saturation and Harmonics
- VB Higher Compression ratio
- Flat Top and Blow Out
- SASE Single Spike
- THz radiation
- Seeding

