Introduction

• Following the 19/05/04 meeting at CERN about the "CTF3 accelerated programme", a possible french contribution has been envisaged to the 200 MeV Probe Beam Linac

• Two machine options were suggested, plus

• A third one that appeared in the discussion

• So, main probe beam design options :

Thermoionic gun *vs* **RF photo gun**

Magnetic compression *vs* **Velocity bunching**

Probe beam characteristics

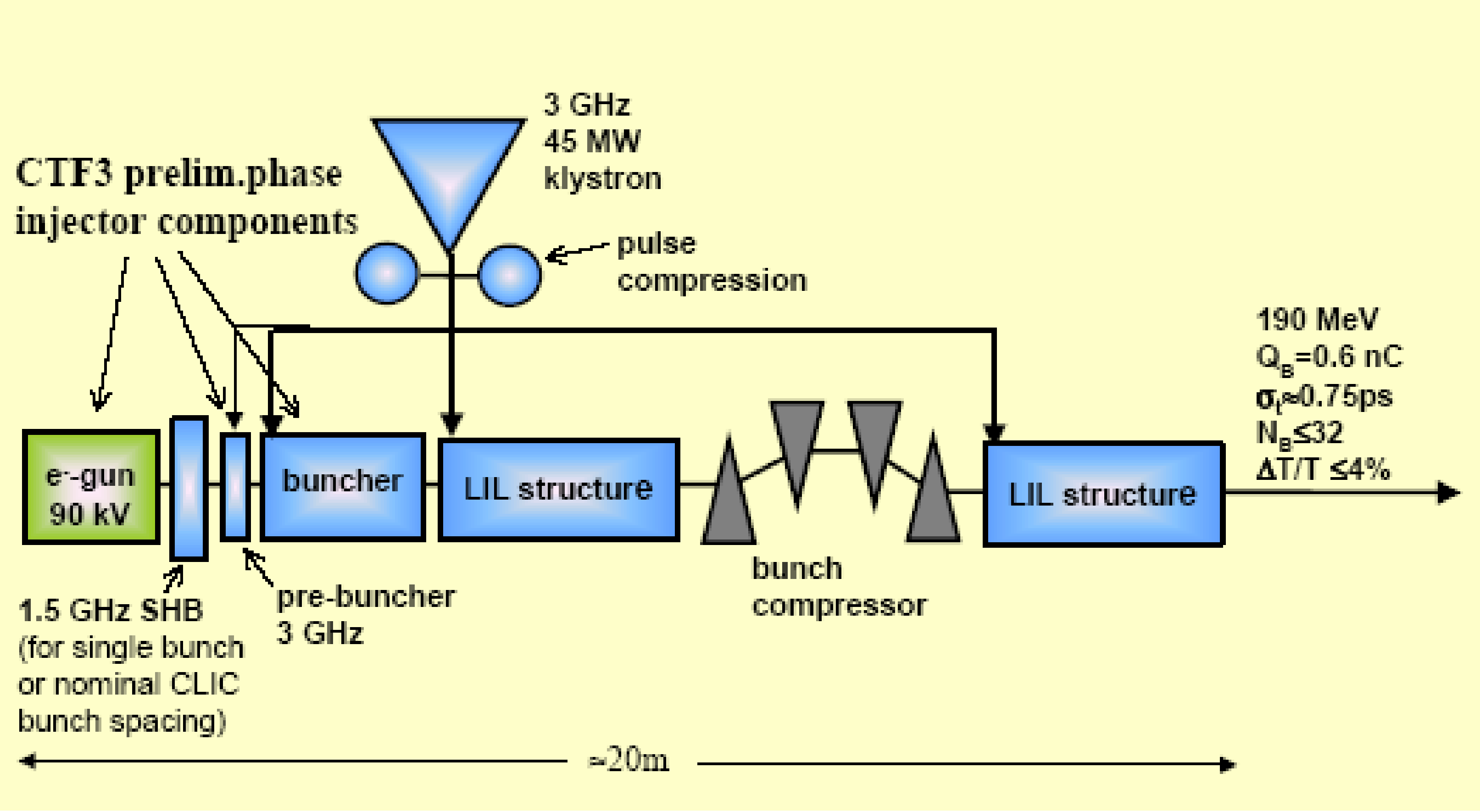
Beam parameters

Charge	nC	**0.6**
Energy	MeV	**~190**
Energy spread (total)	%	**< 4**
Bunch length (rms)	ps	**0.75**
Norm. emittance	π mm.mrad	**< 20**
Bunch frequency	GHz	**1.5**

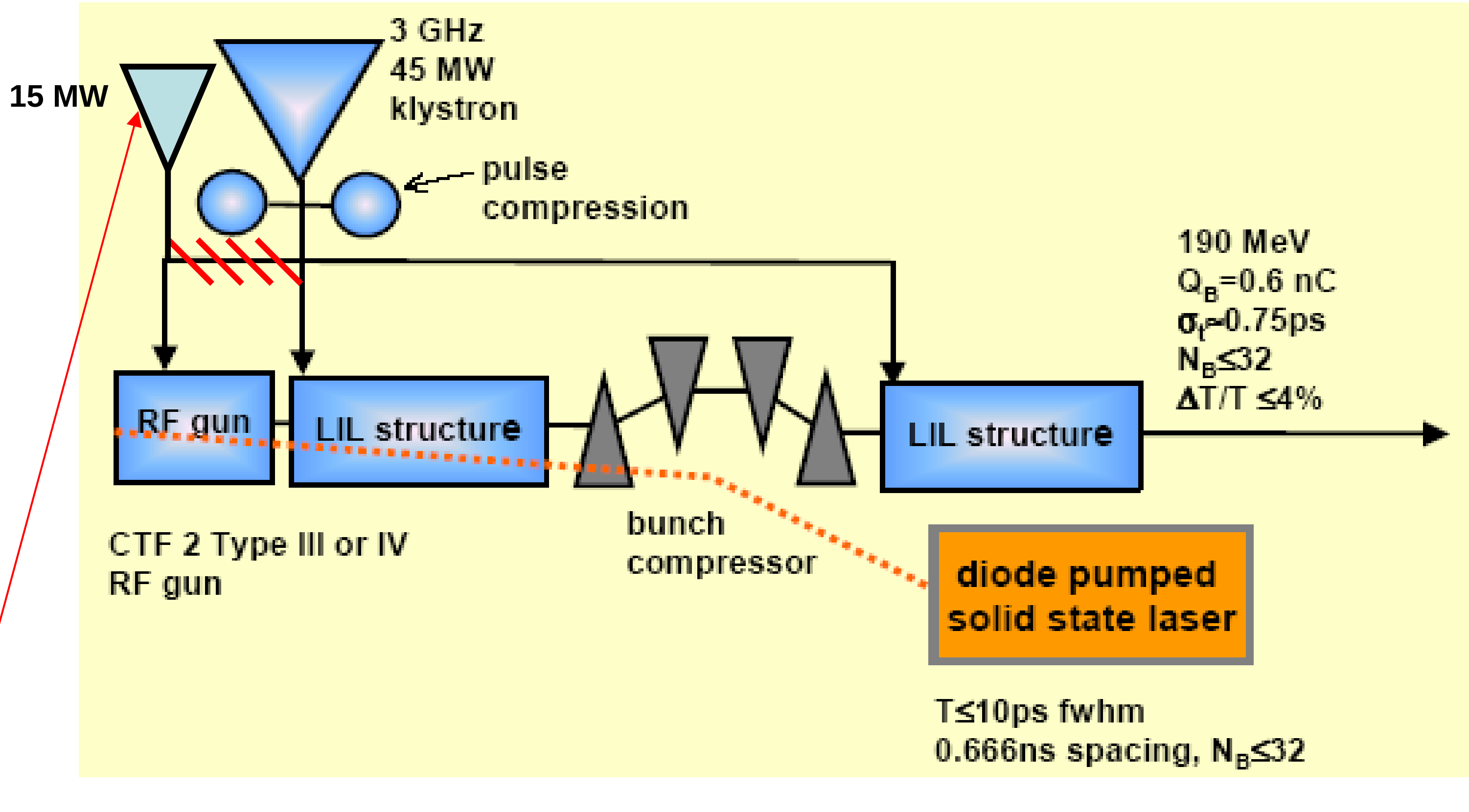
Linac parameters

# accelerating sections		**2**
Section length	m	**4.5**
Section type (LIL)		**TW**
Focusing solenoids	T	**<0.4**
RF frequency	GHz	**3.**
Gradient	MV/m	**20**

"Thermoionic gun" option



"RF photo gun" option



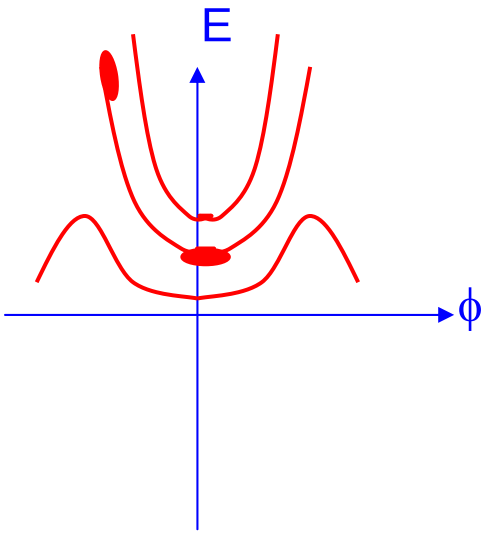
An *additional klystron* is required for the gun because pulsed phase control is different for gun and sections

Thermoionic vs RF photo gun

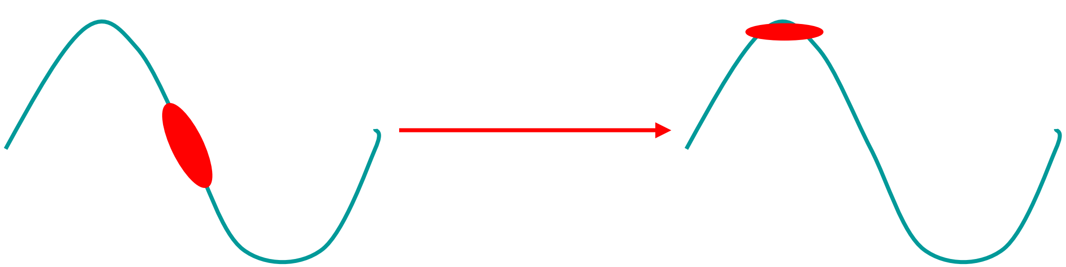
	Thermoionic gun	RF photo gun
Advantages	• Well established technique	• Better emittance • More attractive technique • More flexibility • Synergy with neighbour labs (LAL, ELYSE, ELSA)
Disadvantages	• High frequency (1.5 GHz) grid control difficult • Bunch sequence control difficult (1 to 32 bunches) • Knowhow has gone away from our Lab	• High power klystron+modulator required • Specific expertise required (laser, photocathode)

Velocity bunching

- Classical method with low energy thermoionic guns (see *Septier-Lapostolle*) but...
- New concept (*Serafini, Ferrario*) with RF guns and emittance compensation
- Saves a chicane, then no CSR and less space charge effect
- RF bunching section does not accelerate much
- Will be experimented on SPARC (Frascati)

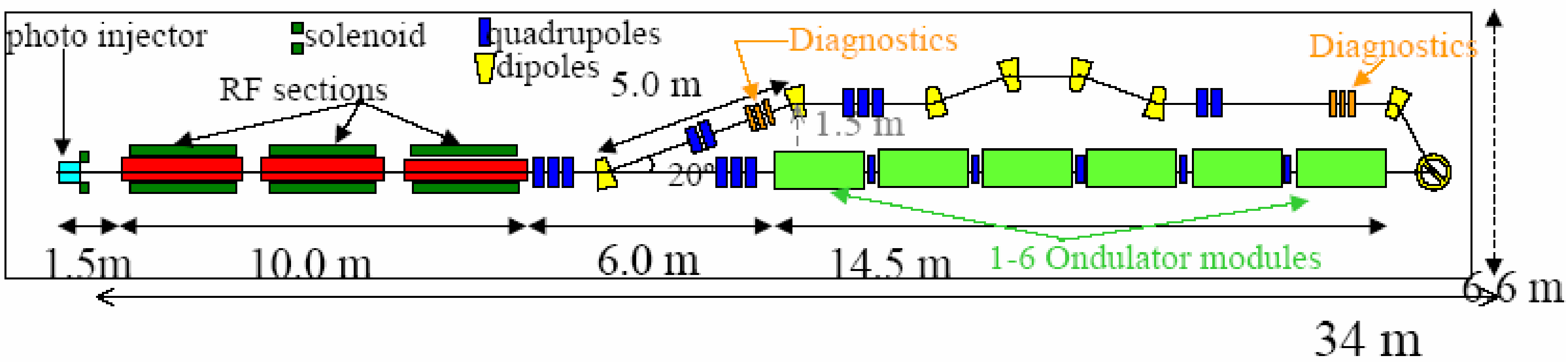


$$\cos\varphi - \cos\varphi_0 = -2\pi \frac{eG\lambda}{m_0 c^2}(E - E_0)$$



"SPARC" project (INFN Frascati)

- R&D project to investigate *high brightness e^- beam production*
- Will study both velocity and magnetic bunching schemes



Frequency: 2856 MHz	Normal Conducting
GUN PARAMETERS	LINAC PARAMETERS
Peak Field: 120-140 MV/m (15 MW)	Accelerating Field: 25-30 MV/m (50 MW)
Solenoid Field: 0.3 Tesla	Solenoid Field: 0.1 Tesla
Charge: 1 nC	Beam Energy: 150 MeV
Laser: 10-12 ps x 1 mm (Flat Top)	

Probe beam design options

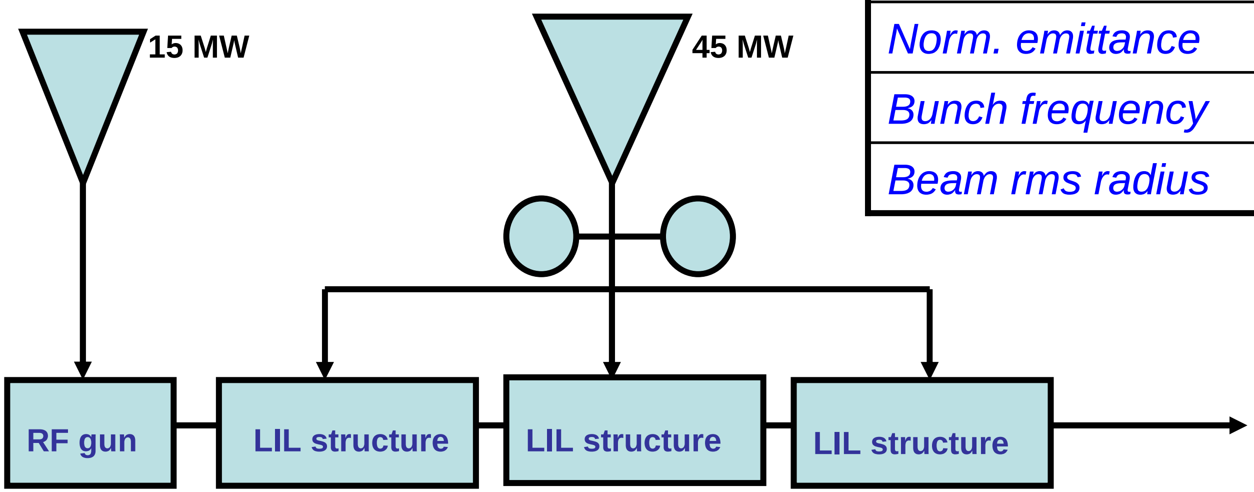
Results of a preliminary HOMDYN study (1)

*Many thanks to **Massimo Ferrario** (INFN Frascati) !*

HOMDYN assumes a *square* initial distribution; **PARMELA** (or **ASTRA**) simulations with *gaussian* distribution are required. This will roughly double the emittance (M. Ferrario)

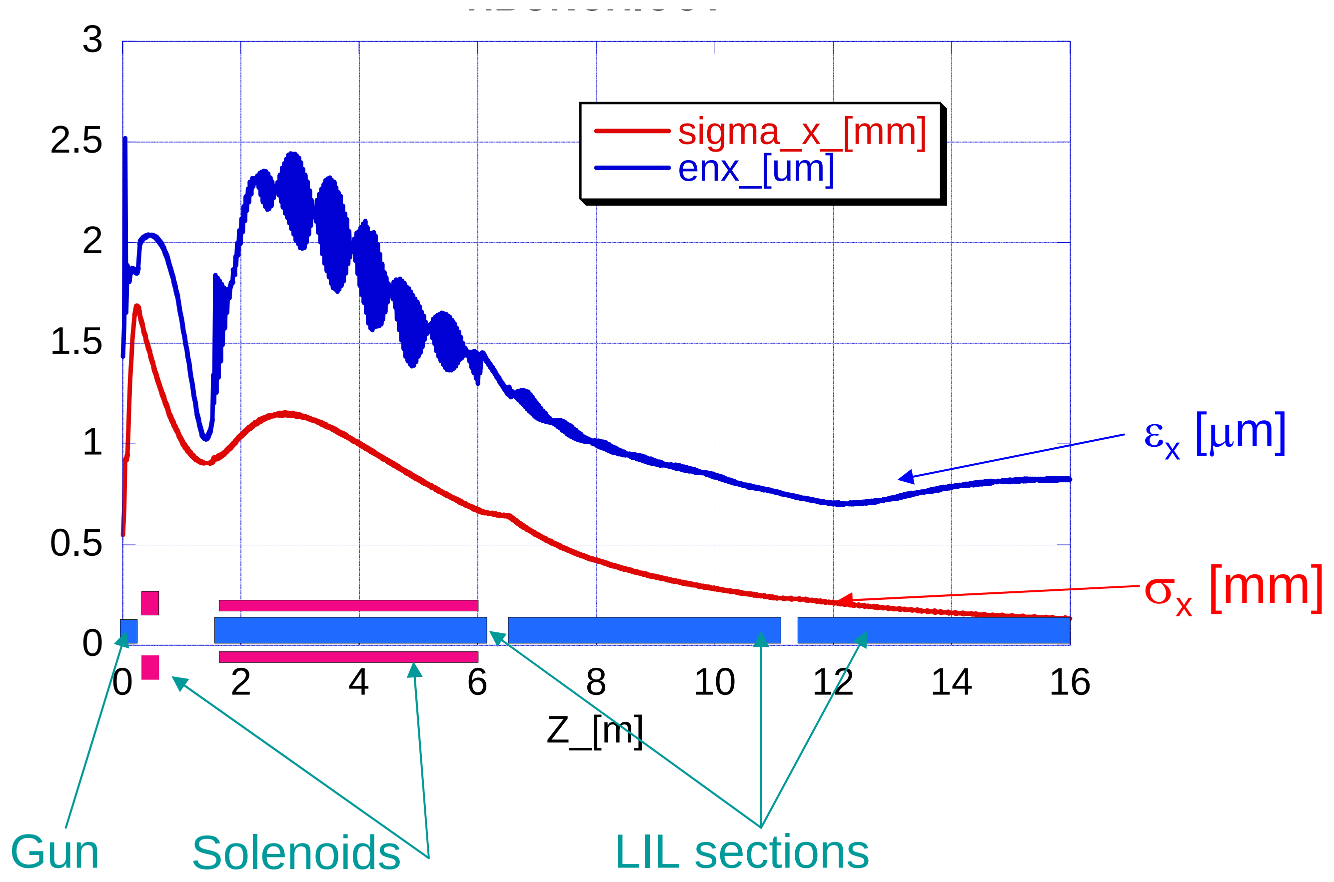
Output parameters

# accelerating sections		**3**
Total length	m	**16**
Energy	MeV	**~197**
Energy spread (total)	%	**0.5**
Bunch length (rms)	ps	**0.67**
Norm. emittance	π mm.mrad	**0.8**
Bunch frequency	GHz	**1.5**
Beam rms radius	mm	**0.2**



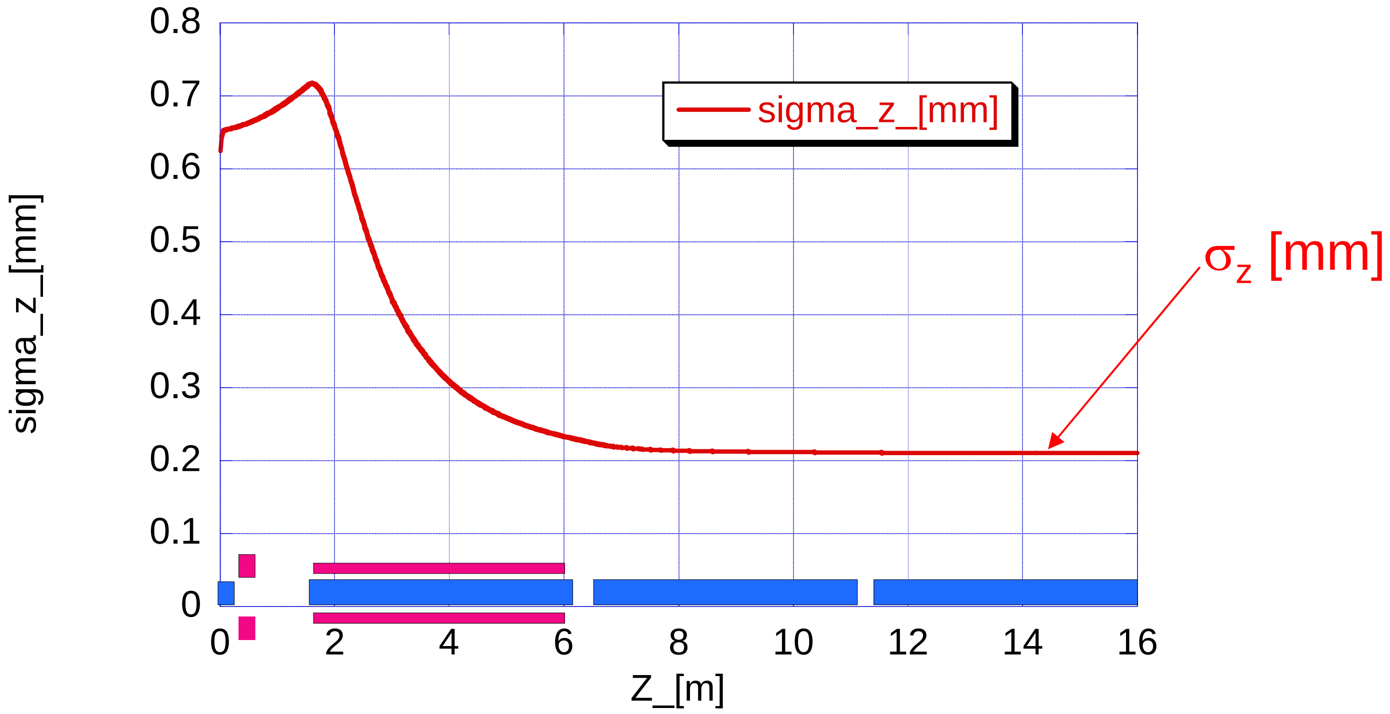
Results of a preliminary HOMDYN study (2)

Evolution of transverse beam size and emittance



Results of a preliminary HOMDYN study (3)

Evolution of bunch length



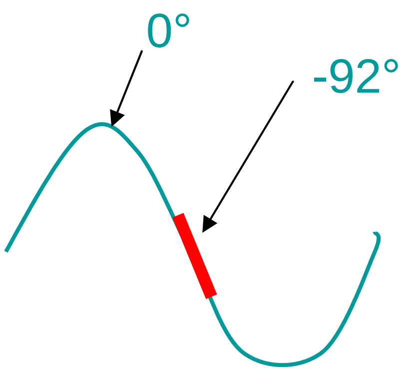
Results of a preliminary HOMDYN study (4)

Gun

Peak field	**120**	MV/m
Phase (90 is the crest)	**27**	Deg
Charge	**0.6**	nC
Laser spot Radius	**1**	mm
Laser pulse Length (Flat Top)	**8**	ps
Solenoid field	**0.26**	T
Thermal emittance (rms)	**0.6**	mm-mrad

RF compressor

# Accelerating Sections	**1**	
Section length	**4.5**	m
Distance from the cathode	**1.5**	m
Accelerating field	**20**	MV/m
Phase (0 is the crest)	**-92**	°
Solenoid field	**0.05**	T



Linac

# Accelerating Sections	**2**	
Distance from the cathode	**6.5** **11.5**	m
Accelerating field	**20**	MV/m
Phase (0 is the crest)	**15**	°

Magnetic vs RF bunch compression

	Magnetic compressor	Velocity bunching
Advantages	• Better known results	• Better emittance • Simpler layout • Simpler operation
Disadvantages	• Requires magnets, quads, diagnostics, special vacuum chamber • CSR effect • Space charge effects	• Requires one more section • Takes more space (?) • RF power distribution more complex

Questions in conclusion

- Is an additional LIL section available ?
- Can one **45 MW klystron + "BOC"** power 3 LIL sections instead of 2 and provide the same 20 MV/m gradient ?
- If not, can as good beam results be obtained with a lower gradient ?
- Is there enough space for 3 sections ?

If all answers are YES, our preferred solution would be

- RF photo gun

+

- Velocity bunching

Thanks to CLIC colleagues and again to Massimo Ferrario