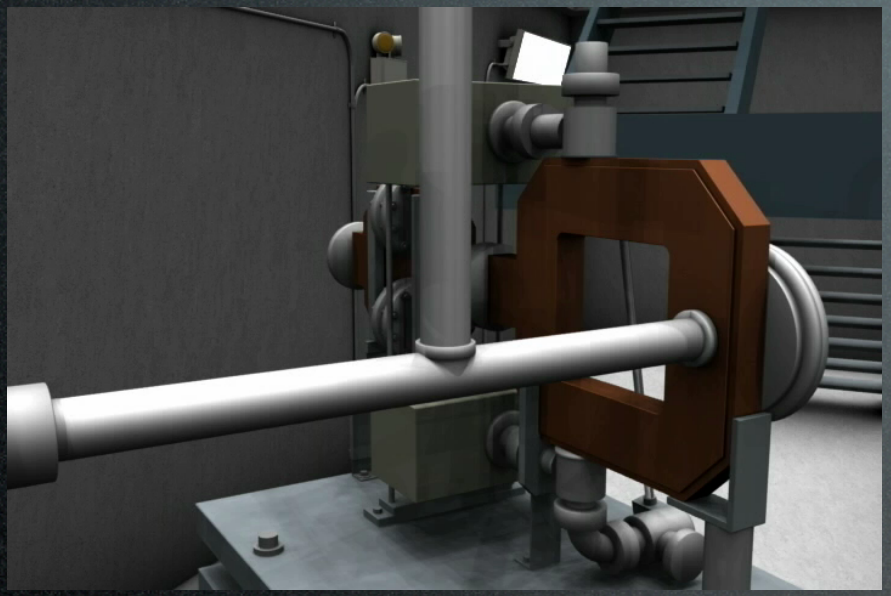
WP3 – Gun and Injector

Massimo.Ferrario@LNF.INFN.IT



- Laser/Photocathode
- RF/DC Gun
- Solenoid
- RF Velocity Bunching

- RF Linearizer and L. Heater
- Magnetic Chicane
- Transv. RF Deflector
- Beam Diagnostics

- To design the Compact High Brightness Injector
- To design the proper matching with the X-band Linac

Tasks and sub-Tasks

(task leaders institutes in **bold)**

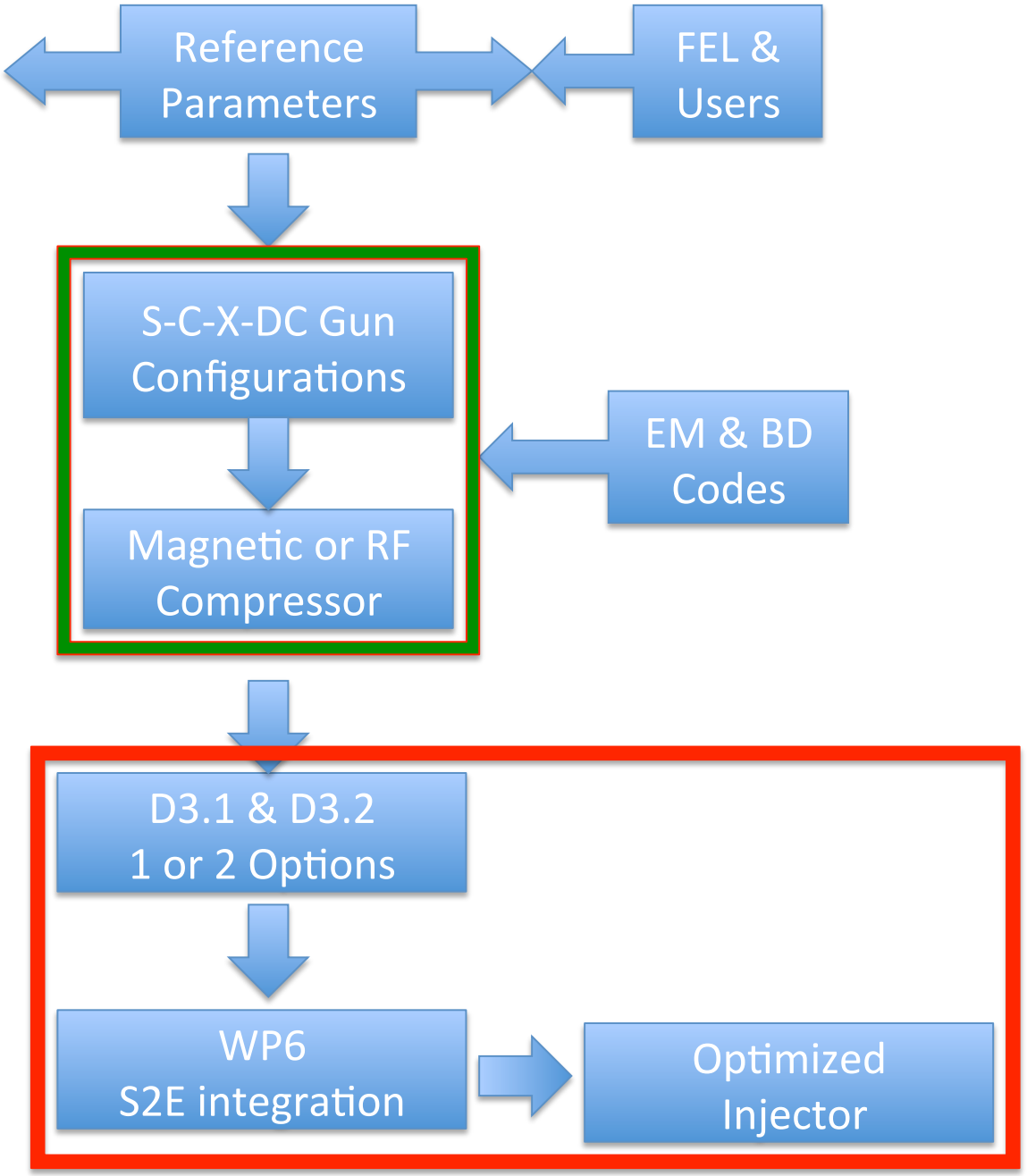
- **Task 3.1 - Gun Design (RF, Solenoid, Cathode, Laser, Diagnostics) => D3.1 M18 => D3.4 M36**
  a) S-Band Gun RF Design (**CNRS** + IASA+UAIAT-INFN+ALBA)
  b) C-Band Gun RF Design (**INFN** +IASA+Sapienza)
  c) X-Band Gun RF Design (**CSIC-IFIC** + UAIAT+ Sapienza)
  d) DC Gun Design (**TU/e**)
  e) Laser/Photocathode (**IASA**+CNRS+INFN)

- **Task 3.2 - Compressor Design (Velocity Bunching, Magnetic Chicane)) => D3.2 M18 => D3.4 M36**
  a) S-Band Velocity Bunching (**TU/e** + IASA+ALBA)
  b) C-Band Velocity Bunching (**INFN** +IASA+TU/e)
  c) X-Band Velocity Bunching (**Sapienza**+CERN+IASA+INFN)
  d) Magnetic Compressor (**ST** + CERN+INFN+CNRS)

- **Task 3.3 – X-Band Transverse RF Deflector** (**Sapienza**+ IASA+) **=> D3.3 M36**

- **Task 3.4 - : RF Linearizer Design => D3.2 M18 => D3.3 M36**
  a) X-Band RF Linearizer Design (**Sapienza**)
  b) K-Band RF Linearizer Design (**ULANC** +Sapienza)
  c) Passive linearizer (**CNRS)**

Parameters	Units	After VB and/or BC1
Charge (Q)	pC	75
Beam energy	MeV	300
rms bunch length (σ_t)	fs	350
Peak current ($Q/\sqrt{12}\,\sigma_t$)	A	60
rms Energy Spread	%	0.5
Projected rms norm. emittance	µm	0.2
Repetition rate	Hz	100 -1000



Next WP3 Deliverables

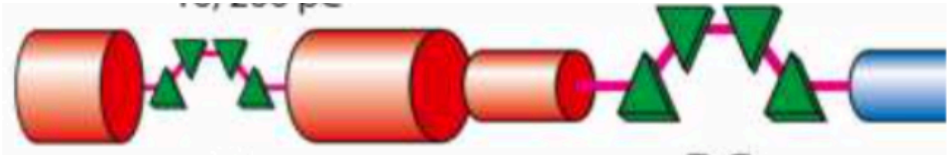
- **D3.1** - Preliminary assessments and evaluations of the optimum e-gun and injector solution for the CompactLight design, **(=>M18**).
- **D3.2** – A review report on the bunch compression techniques and phase space linearization, (**=>M18**).
- **D3.3** – Design of the injector diagnostics/beam manipulations based on a X-band cavities, (**=>M36**).
- **D3.4** - Design of the CompactLight e-gun and injector, with phase space linearizer (**=>M36**).

Reference Parameter List

New: 2 bunches challenge

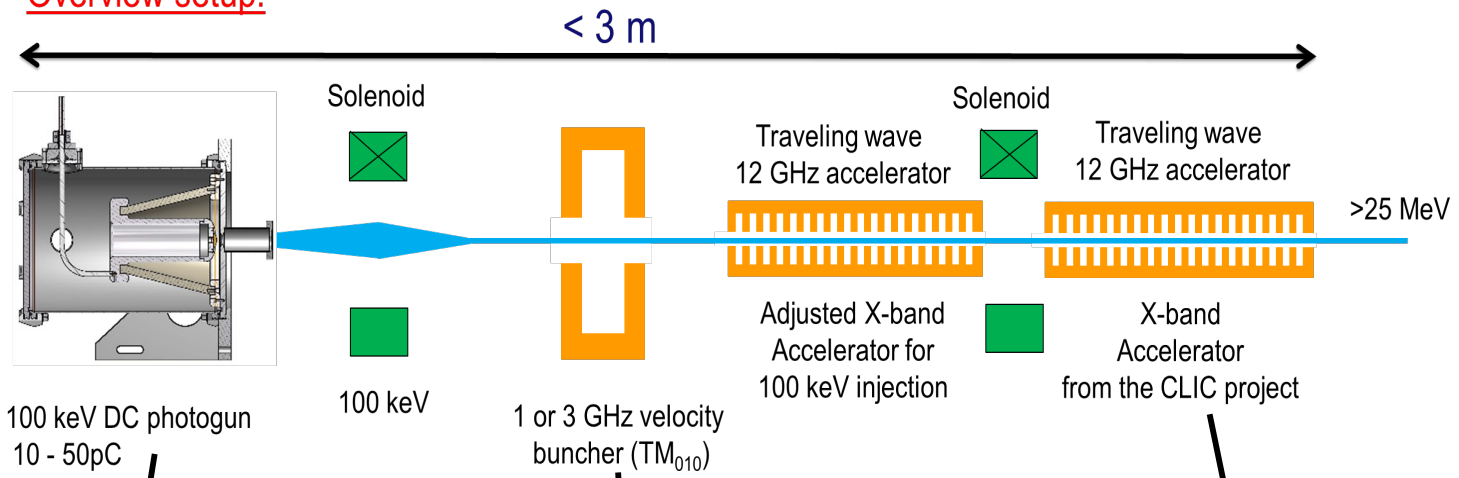
Injector capability 100 – 1000 KHz

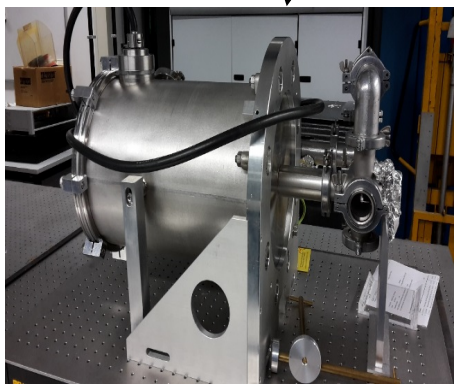
Parameters	Units	After VB and/or BC1
Charge (Q)	pC	75
Beam energy	MeV	300
rms bunch length (σ_t)	fs	350
Peak current ($Q/\sqrt{12}\,\sigma_t$)	A	60
rms Energy Spread	%	0.5
Projected rms norm. emittance	μm	0.2
Repetition rate	Hz	100 -1000



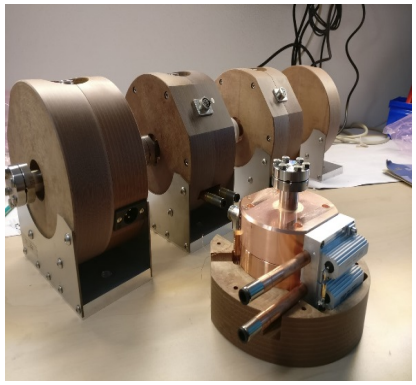
DC gun

Overview setup:

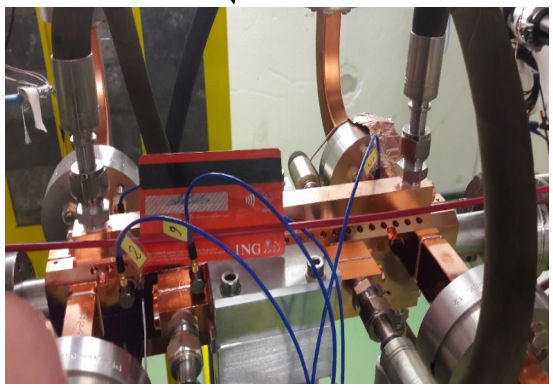




Made by ACCTEC



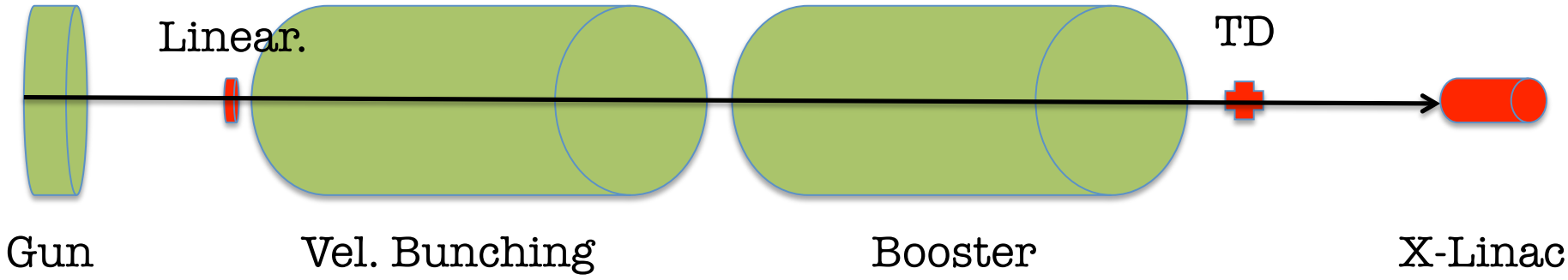
Made by ACCTEC

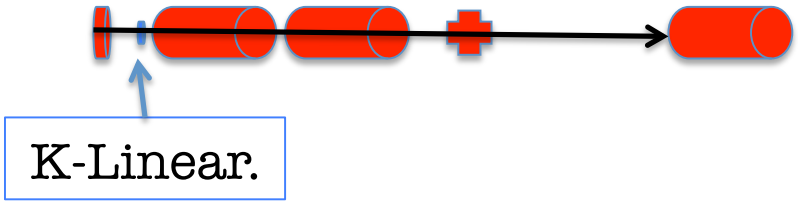


CLIC accelerator

Configurations with Velocity Bunching

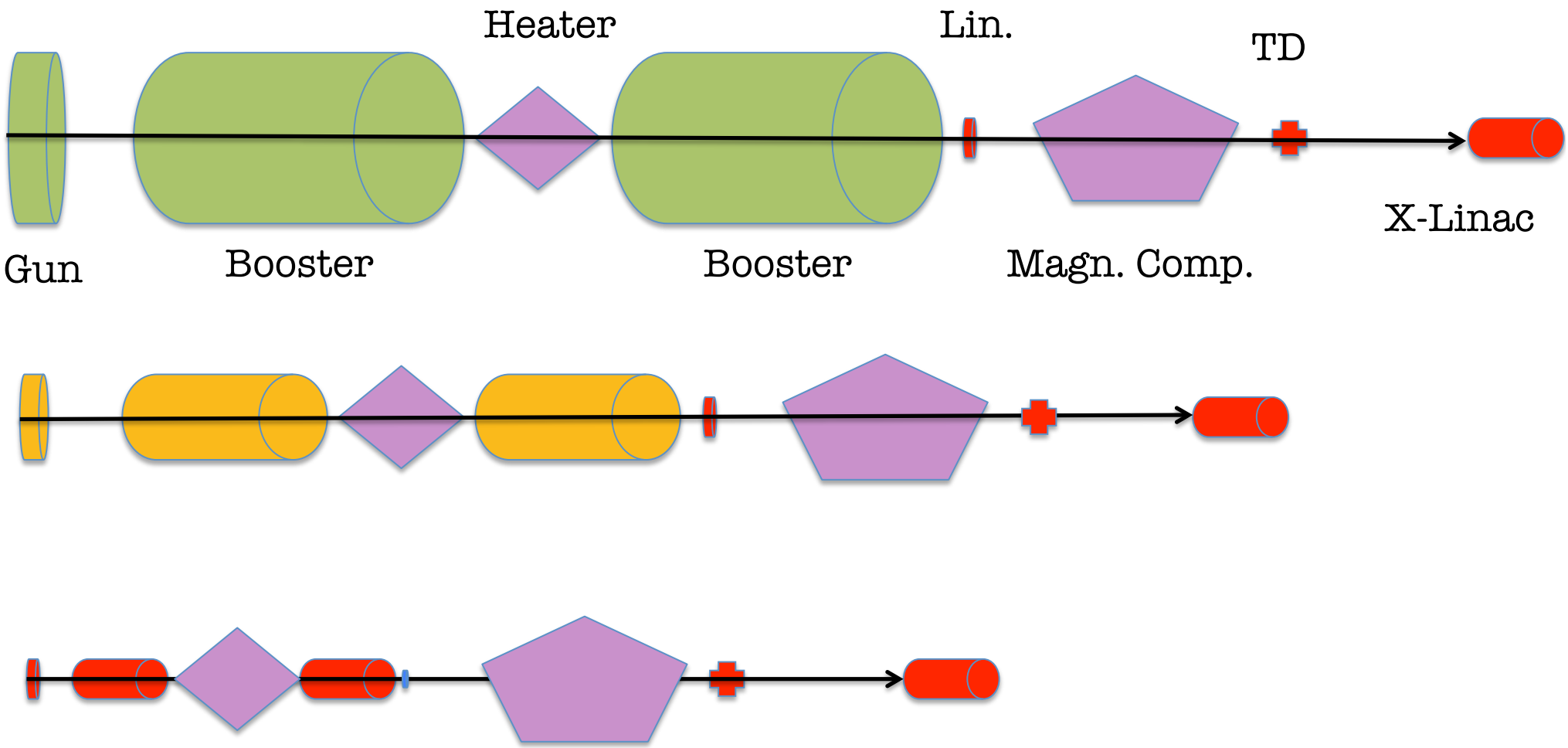
S-band , C-band , X-band , K-band





Configurations with Magnetic Compressor

S-band , C-band , X-band , K-band



XLS Injector Road Map (Wp3-Wp6-Wp2 Joint Meeting)

13-15 November 2019
INFN/LNF
Europe/Rome timezone

The goal of the meeting will be to discuss the current XLS injector designs and to establish an effective Injector Road Map for the preparation of the XLS CDR, identifying the options able to fulfill the XLS FEL requirements.

All the injector designs developed so far (S-C-X RF guns and DC gun) will be compared in terms of capability to fulfill the target injector parameters at 300 MeV (at low and high repetition rates) as predicted by beam dynamics simulations. The Technology Readiness Level (TRL) will be also considered.

The meeting is foreseen to last 2.5 days. It will take place in FRASCATI at the INFN-LNF laboratories from 11 am on November 13 up to 1 pm of November 15.

Motivations for LNF WP3 meeting November

- The priority issue for WP2 is D2.2. (Report summarizing the FEL design with accelerator and undulator requirements.)

- For this we need you all to agree your recommendation for the optimal injector configuration for XLS that meets the needs of the project.

Agenda

- 11:00 G. D'Auria, "Status of the CompactLight project" (20+10)
- 11:30 M. Ferrario, "Introduction and goals of the meeting" (20+10)
- 12:00 S. Di Mitri, "Toward a comprehensive parameter list of CompactLight FEL" (20+10)
- *12:30 Discussion*
- **13:00 Lunch Break**
- 14:30 P. Craievich (PSI), "Overview of the SwissFEL injector design and performances" (40'+20') **(Invited)**
- 15:30 R. Pompili, "Experience with the SPARC_LAB photoinjector" (20+10)
- **16:00 Coffee Break**
- 16:30 C. Vaccarezza, "Status of the S-band injector simulations, VB versus MC options" (20+10)
- 17:00 S. Doebert, "S-band gun direct injection in the X-band booster" (20+10)
- 17:30 E. Marin "Integrated start-2-end simulation results for the XLS S+X-band option" (20+10)
- **18:00 End of the Session**
- **20:00 Restaurant Zaraza'**

- *10:00 SPARC_LAB Tour*
- **11:00 Coffee Break**
- 11:30 T.G. Lucas, "Updates on the DC gun injection option for compact light" (20+10)
- 12:00 M. Croia "Status of the C-band injector simulations, VB versus MC options" (20+10)
- 12:30 D. Alesini/A. Vannozzi, "Status of the C-band injector design" (20+10)
- **13:00 Lunch Break**
- 14:30 D. Gonzalez-Inglesias "Updates on the X gun injection option for compact light" (20+10)
- 15:00 Xingguang Lu, "1D linac design based on C-band and X-band injector options" (20+10)
- 15:30 E. Gazis "Laser-Photocathode Studies and Solenoid 3D design" (20+10)
- **16:00 Coffee Break**
- 16:30 J. Scifo, "Spatial autocorrelation study for laser beam quality estimation" (20+10)
- *17:00 Discussion: Evaluation of the proposed schemes and preparation of the inputs for WP2 and WP6*
- **18:00 End of the Session**
- **20:00 Restaurant Cacciani**

- 10:00 Xiaowei Wu, "Ka-band lineariser and rf system updates" (20+10)
- 10:30 F. Nguyen, "Undulator technologies for the XLS FEL schemes" (20+10)
- **11:00 Coffee Break**
- *11:30 Final Discussion and Conclusions*
- **13:00 End of the Meeting**

G. Technology readiness levels (TRL)

Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

		Goals	DC	S vb	S mc	C vb	S/X	X mc
Charge (Q)	pC	75	10	75	75	75	75	75
Beam energy	MeV	300	270	313	280	346/341	300	300
rms bunch length *(σt)*	fs	350	700	367	300	323/350	133-350	353.5 (83.7 after BC1)
Peak current (Q12σt)	A	60	4	57	60	67/62	65-162	61.23
rms Energy Spread	%	0.5	0.2	0.2	0.3	0.3/0.4	0.3	0.48%(BC1)
Projected rms norm. emittance	μm	0.2	0.25	0.2	0.2	0.23/0.15	0.13	0.17
Peak Field at Cathode	Mv/m	/	10	120	120	240/160	120	200 - 250
Repetition rate	Hz	100 -1000	750-1000	100-400	100-400	100 Hz-1 KhZ	1kHz x-band 400 Hz s-band	100 - 400
Total Length	m	/	11.3	<15	<15+8	10	8.6 m	7 m + Ka-band + chicane
TRL		/		8	8	2	8/5	4
Priority			**?**	**Medium**	**Medium**	**High**	**Medium**	**Low**

FUNDING PROGRAMS

The Ultra Advanced RF Electron Gun

TUAREG

David Alesini
(INFN-LNF, Frascati)

Riunione CSN5, Bari, 16 September 2019

FUNDED BY CSN V INFN: 190 KEuro
⇒ Realization and test of one gun+circulator
⇒ RF Test
⇒ 3 years program (2020-2022)

Accelerator Innovation Pilot Project Proposal Form

Short title of proposed action: C-GUNS

Type of action (Strategy / Development / Prototype): Prototype

Name and Affiliation of main proposer: David Alesini – INFN Frascati (Rome, Italy)

E-mail of main proposer: david.alesini@lnf.infn.it

Requested EC contribution (in k€): 500

ACCEPTED

Conclusions

Compact