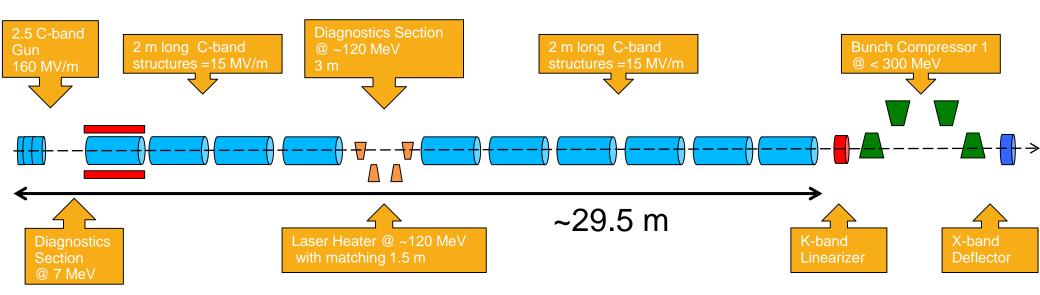






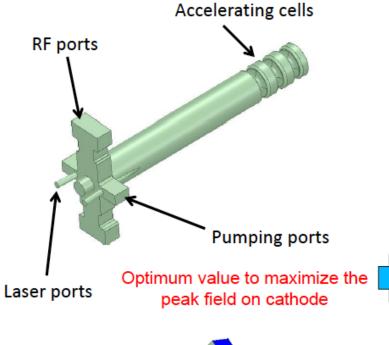
- One injector for all the operational modes (HRR and LRR)
 - 2.5 C-band gun with 160 MV/m cathode peak field => longer drift for diagnostics
 - Copper cathode and TiSa Laser
 - Same gradients 15 MV/m in the 2 m long C-band structures, 0.4 m spacing, max gain 30 MeV/structure
 - Same diagnostics positions (@ gun exit 7 MeV and in the drift parallel to the LH @ 120 MeV)
 - Same beam parameters at the linac exit
 - Solenoid around first C-band accelerating structure, allows also possible VB operation



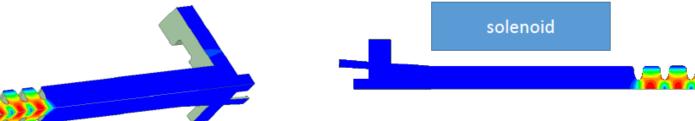
- Optimal BC1 input energy (=> and position)
 - Without Velocity Bunching
 - With Laser Heater
 - K-band Linearizer just before the BC1, X-band RFD downstream BC1







E _{cath}	160 MV/m
Δf _{π/2-π}	≈ 52 MHz
Q ₀	11600
β	3
Filling time (τ_F)	160 ns
P _{diss} @160MV/m	9.7 MW
$E_{CAT}/\sqrt{P_{diss}}$	51.4 [MV/m/(MW) ^{0.5}]
Rep. Rate	1000 Hz
Peak Input power P _{IN}	17.5 MW
Pulsed heating (T _{puls})	<20 °C
RF pulse length (T _{RF})	300 ns
Av diss power (P _{av})	2300 W





C-band gun design



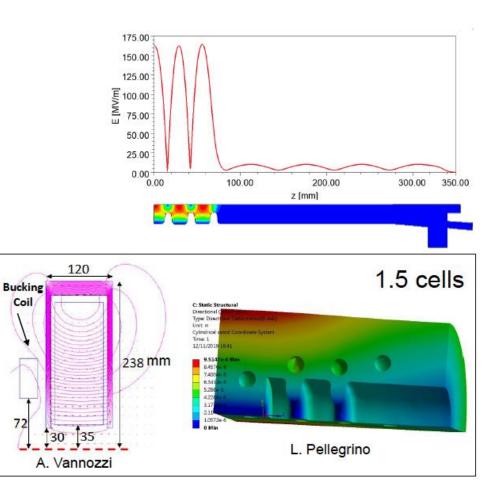
G. Di Raddo





In progress:

Mechanical drawing of the gun and solenoid and final termomechanical analisis



Preliminary Design of 15 MW, 5.996 GHz Klystron

Table 2 – Predicted (1-D code) minimum, nominal, and maximum operational parameters for a typical 15 MW, 5.996 GHz pulsed klystron

Parameter	Minimum	Nominal	Maximum	Units
RF Operating Frequency		5.996		GHz
Peak Power Output	15	15.4		MW
Average Power Output	20	20.54	50	kW
DC to RF Efficiency	42	45		%
Beam Voltage		220	230	kV
Beam Current		154.7	165.4	а
Average Beam Power		170	190	kW
Micro-Perveance	1.45	1.5	1.55	a/V ^{3/2}
RF Power Gain	49	54		dB
RF Input Drive Power		70	160	w
Pulse Width (video)	5.0			us
Pulse Width (RF)	2.0		3.0	us
Pulse Repetition Frequency	400	*	1000	Hz
Video Duty Factor		0.3		%
RF Duty Factor		0.2		%
Instantaneous Saturated				
Bandwidth < 0.2dB Power Variation		>6		MHz
VSWR Tolerance			1.2:1	

June 2020

CPI Proprietary - Do not duplicate or distribute.



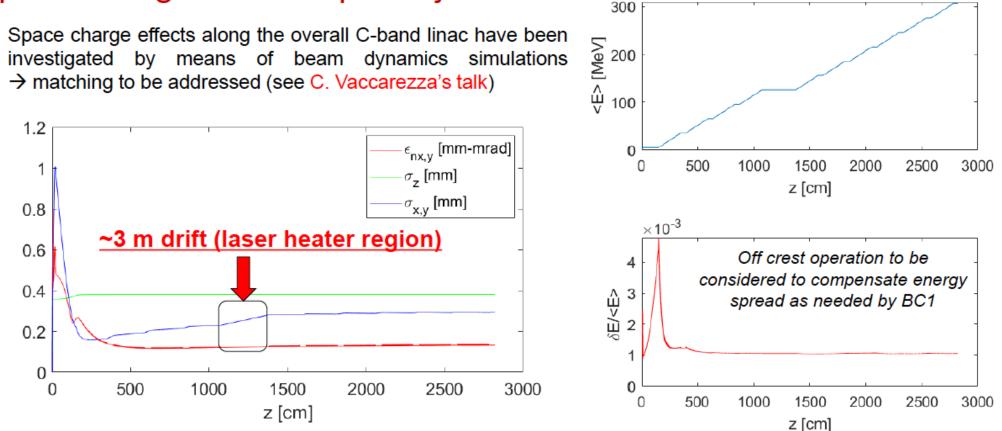
cpii.com

1 Kly for the Gun 1 Kly for 2 accelerating structures => 5 Kly





Space charge effects up to injector exit





Injector Diagnostics

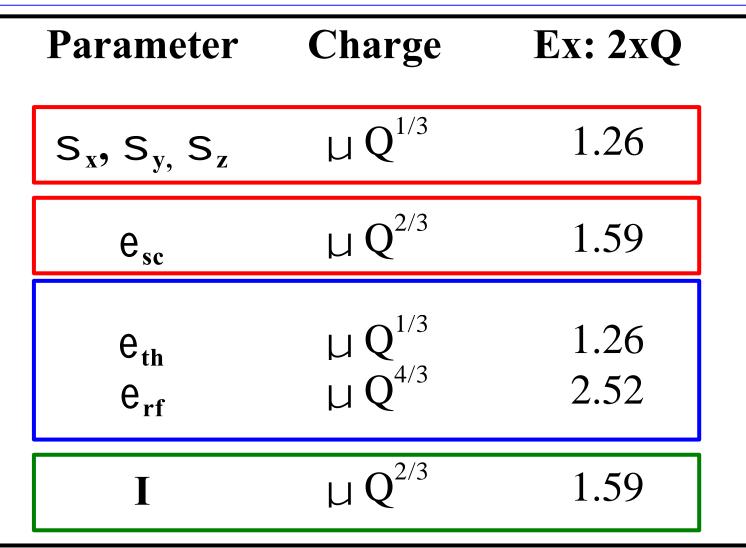


	GUN Solen Starting z=6.6 cm End z=18.6 cm	Valve Estim. Starting z=20 c Estimated End z=30 c		ng z=32 cm				
		Estim 8	ICT 01 Estim, Starting z=75 cm Estimated End z=90 cm		ew Scr nated Starti nated End 2	C Band 02 Starting z=390 cm End z=590 cm		
)c			•	-(
o	01	02	03	04		05	06	
		Estima	1 02+correct ted Starting z=130 ted End z=150 cm	cm	BPM 03+Corrector Estimated Starting z=370 cm Estimated End z=390 cm			
1		View Scre Estimated Starting Estimated End z-	g z=95 cm			_stimated End 2	-390 cm	
	B Es Es		C Bar Starting z End z=35					
	Starting z=0	cm						



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If the charge density remains constant => the beam line does not change

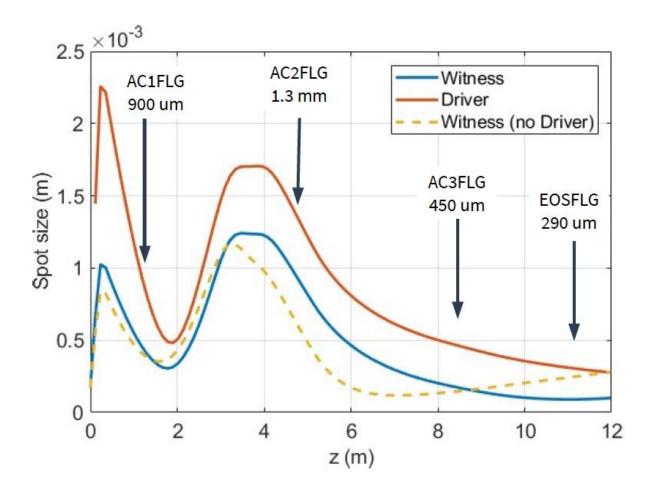


J. B. Rosenzweig, E. Colby, report TESLA-95-04





Using scaling laws we can accelerate two beams 1 ps apart with 200 pC (Driver) and 20 pC (Witness) running together in the same SPARC_LAB beam line





 $l_{drift} = f(R_{52}, \theta)$

0.9

0.8

Drift longitudinal length [m]

0.2

L = 0.1 r

2

Dipole bending angle [deg]

Laser Heater



For large smearing of the laser modulation, we impose: $R_{52} \approx 3 \times \frac{\lambda_{\text{laser}}}{2\pi\sigma'_x} \approx 18 \text{ mm}.$

×10⁻⁴

Emittance

 $\theta = 5.2 \text{ deg} \rightarrow L_{dip} = 0.1 \text{ m}$

Δε_x = 0.05%

R

 $\frac{\Delta \epsilon_x}{\epsilon_x} \simeq \frac{1}{2} \left(\frac{R_{52} \sigma_E}{\sigma_x E} \right)^2 < 0.3\% \quad \text{emittance growth from laser interaction in a dispersive region}$





- Does not need dedicated matching quads
 - At least 30 keV added

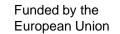




Structure Options

- Ka-band SW solution.
 - Considers 12MW matched input power (w/SLED).
 - Integrated voltage of 11MV/section (10cm), see: link.
 - If higher voltage is needed, then multiple sections are needed (i.e. for 20MV, 2 sections suffice).
 - 2 structures + hybrid needed to avoid reflections to the source.
- SW in a cryo-structure (T=77K).
 - Considers 12MW matched input power (w/SLED).
 - Integrated voltage of 16MV/section (10cm).
 - Heat load and cryogenic capacity to be checked.



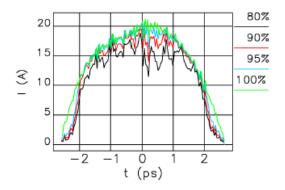


BC1 Simulations

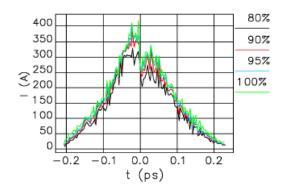


Current Distribution at BC1 exit

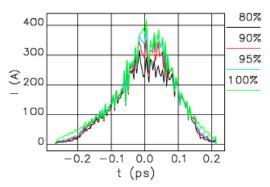
From Phlnj



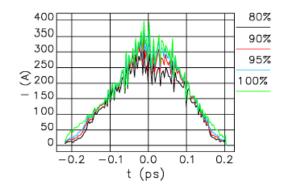
E_{in}= 210 MeV



E_{in}= 160 MeV



E_{in}= 280 MeV





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Achieved parameters

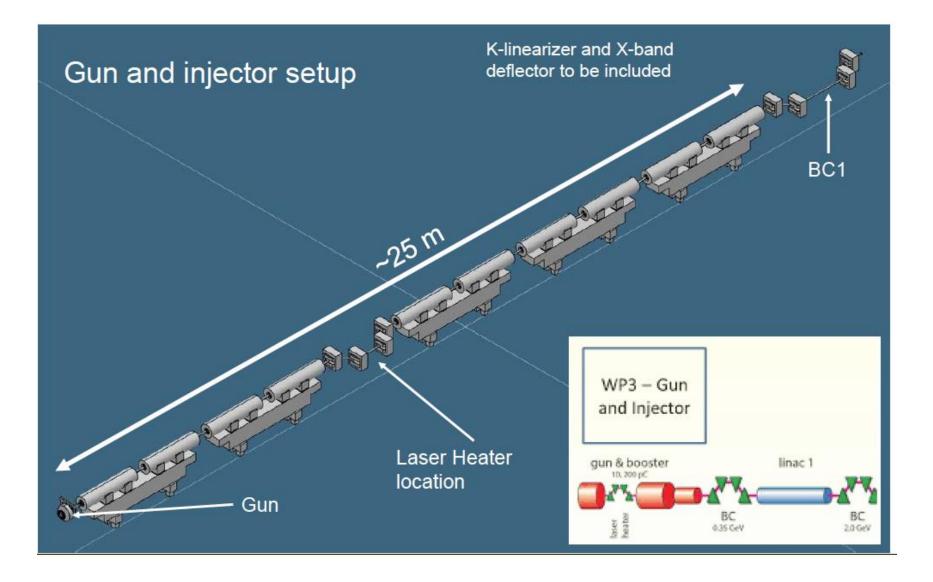


	@laser heater entrance	@BC1 entrance	@BC1 exit	units
Q		75		рС
Rep. rate		1000		Hz
E	126	275	275	MeV
σ_E/E	0.11	1.9	1.9	%
€ _{n,rms}	0.12	0.16	0.2 (CSR) 0.5 (SC)to be optimized	μm
σ_z	380	380	26	μm
Ipeak	20	20	300	Α



CAD Injector Model











- Laser/Cathode system survival at 1 kHz
- Include fringing fields in the gun region
- C-band Power source OK?
- Verify LH energy, not excluding possible VB
- X-band module @ 30 MV/m after LH =>7.5 m less?
- Fix the voltage in the k-band linearizer
- Injector CAD model very welcome



New XLS Gantt Chart



VP	Description		Year 1		Year 2		\ear 3	•	Year	4
ask	•	8 8 8			3 14 15 16 17 18 19 20 21		26 27 28 29 30 31	32 33 34 35 36 37		
Project M	anagement and Technical Coord.	MMD	M	M	M	M		M	M	M D
1.1 Project	governance and scientific managem.							Nov.	May	Nov.
1.2 Monito	oring and reporting, partners coordinat.							2020	2021	2021
1.3 Admini	strative and financial coordination									
1.4 Dissem	ination of information									
FEL Scienc	e requirements and Facility Design	M	M	M	M	M		M	M	(M X D
2.1 User re	quests and FEL performance		Ť,	- V	Ť Ť	×.		Ť	Ň.	
2.2 FEL lay	out, accel. and undulator requirements									
2.3 Compa	ctLight CDR									
Gun and I	njector	M	M	M	M	(M)		M		M
3.1 Evaluat	tion of e-gun and Inj. technologies opt.	V								
3.2 Bunch	compressors and phase space lineariz.								03-21	
3.3 Beam d	liagnostics and manipulation								03-21	
3.4 E-gun a	and Injector design									
RF System	15	M	M		M	M		M	D M	M
4.1 Param.	of perf. and cost model of the RF unit				• • • •					
4.2 Design	report of optimized RF unit									
4.3 Accel. S	Structure design and fabrication proced.									
Undulato	rs and Light production	M	M	M.	M	M.		M		M
5.1 Near ar	nd medium term (4-5 years) und. techn.				•					
5.2 Design	report of the facility baseline undul.									
	namics and Start to End modeling	(M)	M)	M)	M	(M)		M	(M D)	M
6.1 Tools fo	or evaluating the facility performance				D					
6.2 Start to	End simulation of the facility									
Global int	egrat. with new Research Infrastr.		M	M		M		M	M	M
	rm rep. for integrat. & services analysis					P				
	port integrat, services & cost analysis									
	trumentation and Diagnostics		++++++				VM)	M .	MD	M
	nentation and Beam Diagnostics layout	Ne	w WP8							
	integration and cost estimation									
D = Deliver	able						╵╵╵╹			
M = Milesto	one o Meeting			C	ompactLight Gan	tt Chart				

www.CompactLight.eu

CompactLight Glasgow Virtual meeting 16-18 June 2020

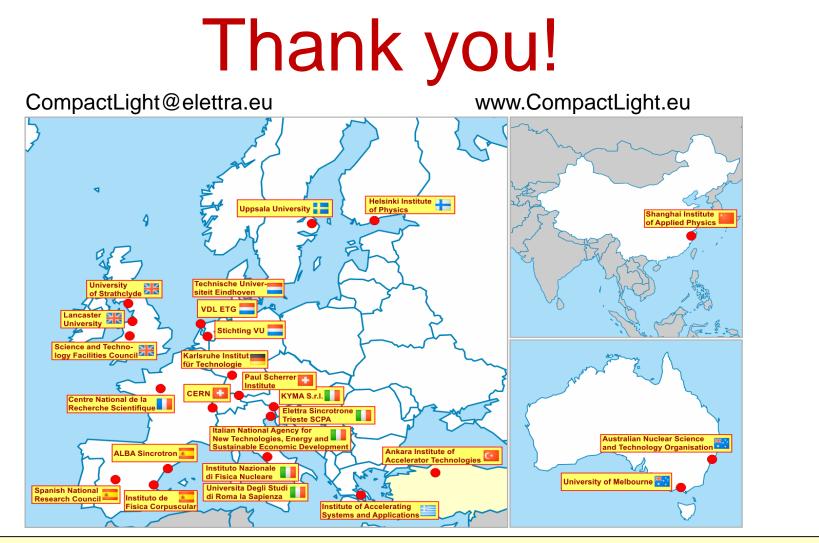
WP3 Deliverables

- **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, (=>M39).
- D3.4 Design of the CompactLight e-gun and injector, with phase space linearizer (=>M39).
- WP3 CDR Contribution





Injversità di R



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