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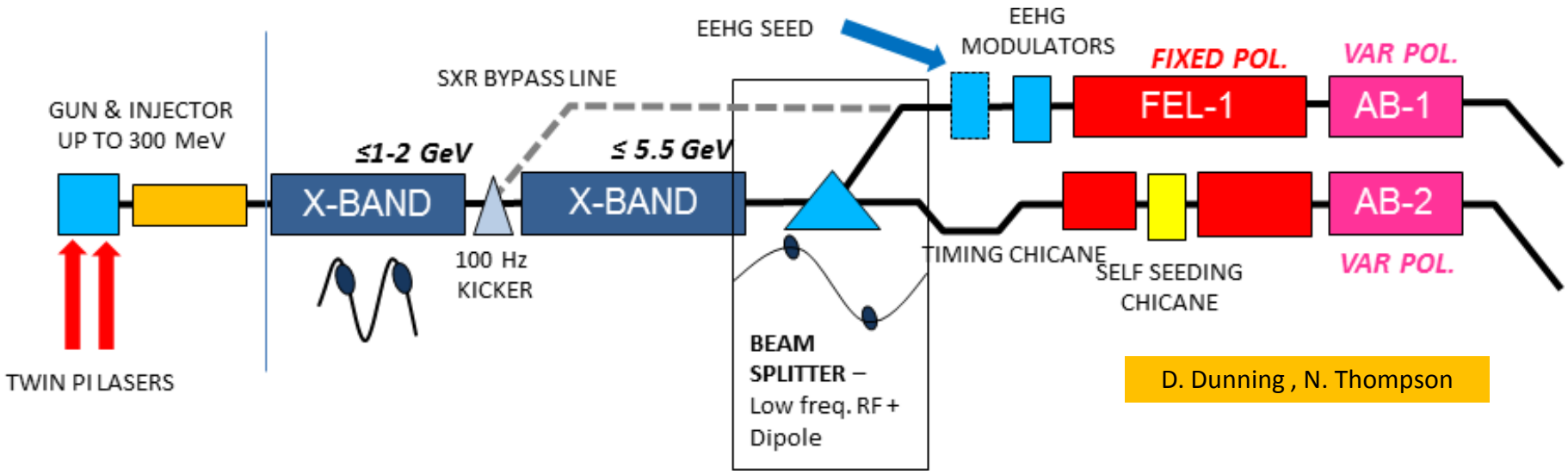
Compact

WP6 update

Avni Aksoy

Institute of Accelerator Technologies

Layout



- Operating modes:

1. FEL-1/FEL-2 independent double pulses to one experiment HXR 100Hz
2. FEL-1/FEL-2 independent single pulses to two experiments HXR 100Hz
3. FEL-1/FEL-2 independent double pulses to one experiment SXR 1kHz
4. FEL-1/FEL-2 independent single pulses to two experiments SXR 1kHz
5. FEL-1 SASE/SEEDED SXR 100Hz + FEL-2 SASE/SELF SEEDED HXR 100Hz

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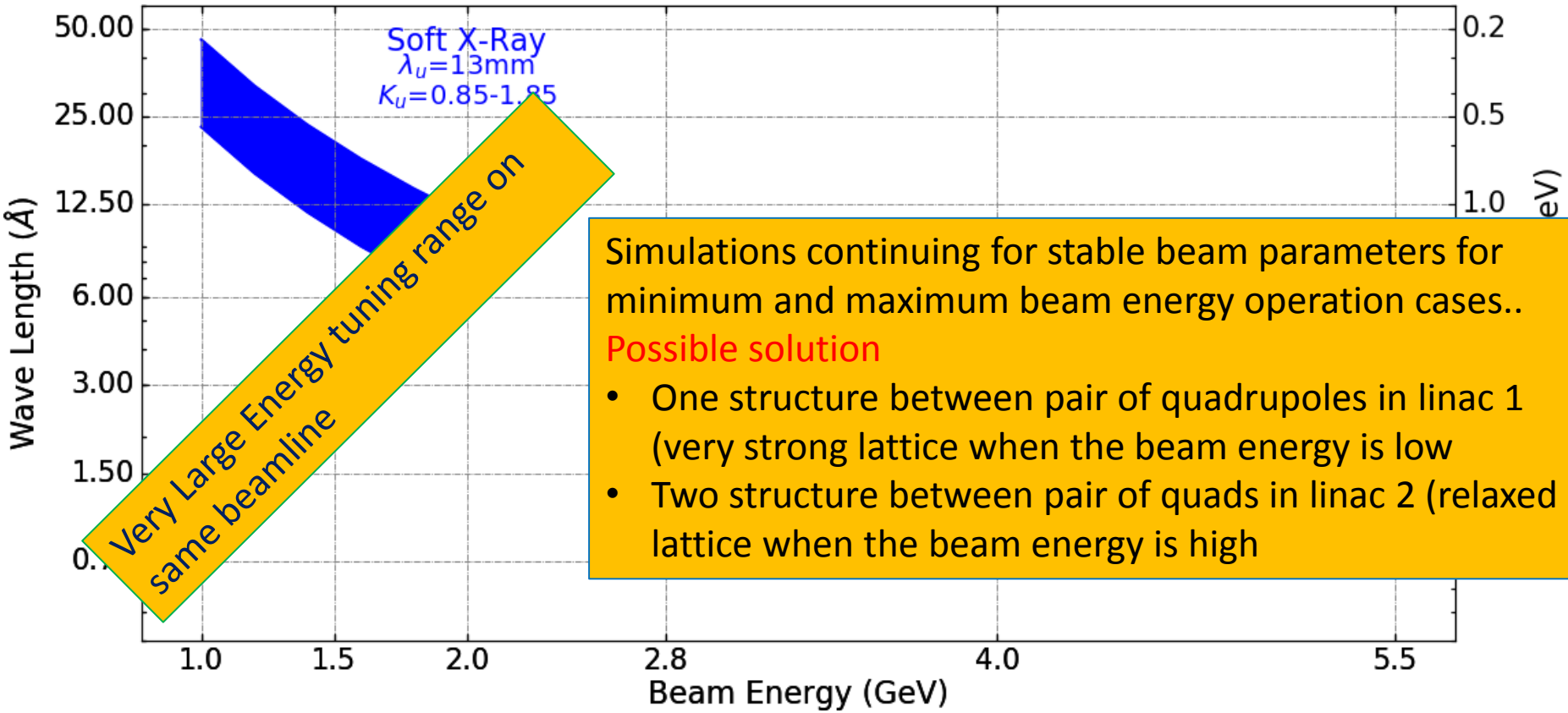
Resonant wavelength

$$\lambda_{FEL} = \frac{\lambda_U}{2\gamma^2}\left(1 + \frac{K^2}{2}\right)$$



Simulations continuing for stable beam parameters for minimum and maximum beam energy operation cases..

Possible solution

- One structure between pair of quadrupoles in linac 1 (very strong lattice when the beam energy is low
- Two structure between pair of quads in linac 2 (relaxed lattice when the beam energy is high

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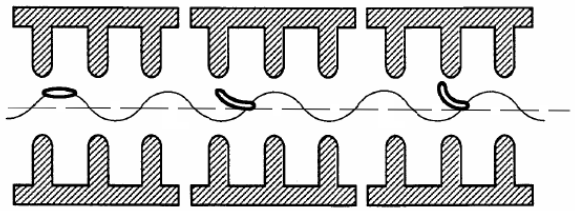
Linac optimization

$N_{struc}/FODO/2$=1-4
Initial energy = 250 MeV
Final energy = 1 – 5.5 GeV
Qbunch=100pC

Maximum slice deflection due to wakefiled

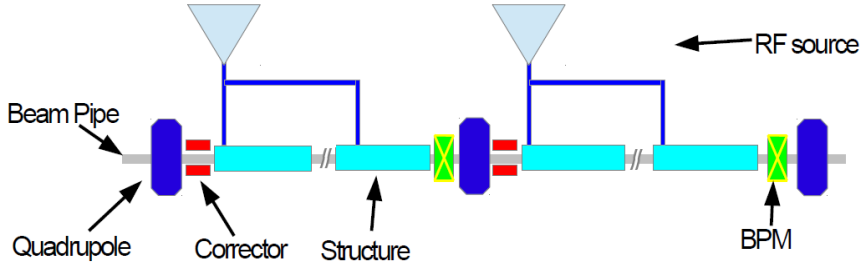


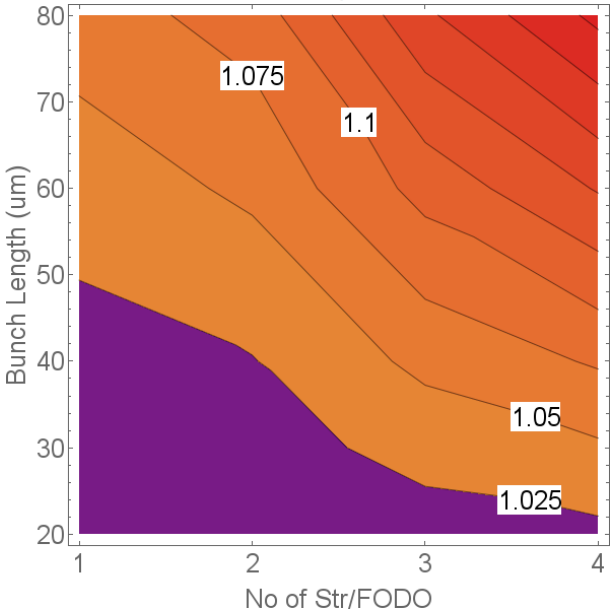
$$A_x = \frac{1}{x_n(0)}\sqrt{x_n^2\,(L) + xp_n^2\,(L)}$$

$$A_y = \frac{1}{y_n(0)}\sqrt{y_n^2\,(L) + yp_n^2\,(L)}$$

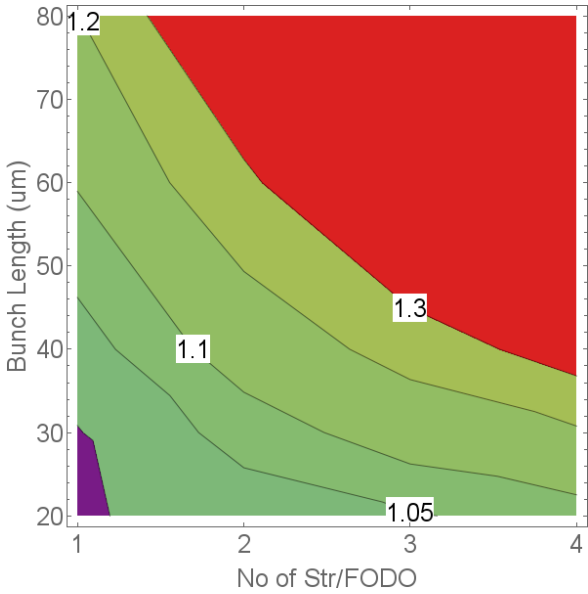
$$A_{max} = Max\,(A_x \vee A_y)$$

- Acceptable tail deflection is 1.15 (≡0.15% of beam size)





For Maximum Energy 5.5GeV



For Minimum Energy (1 GeV)

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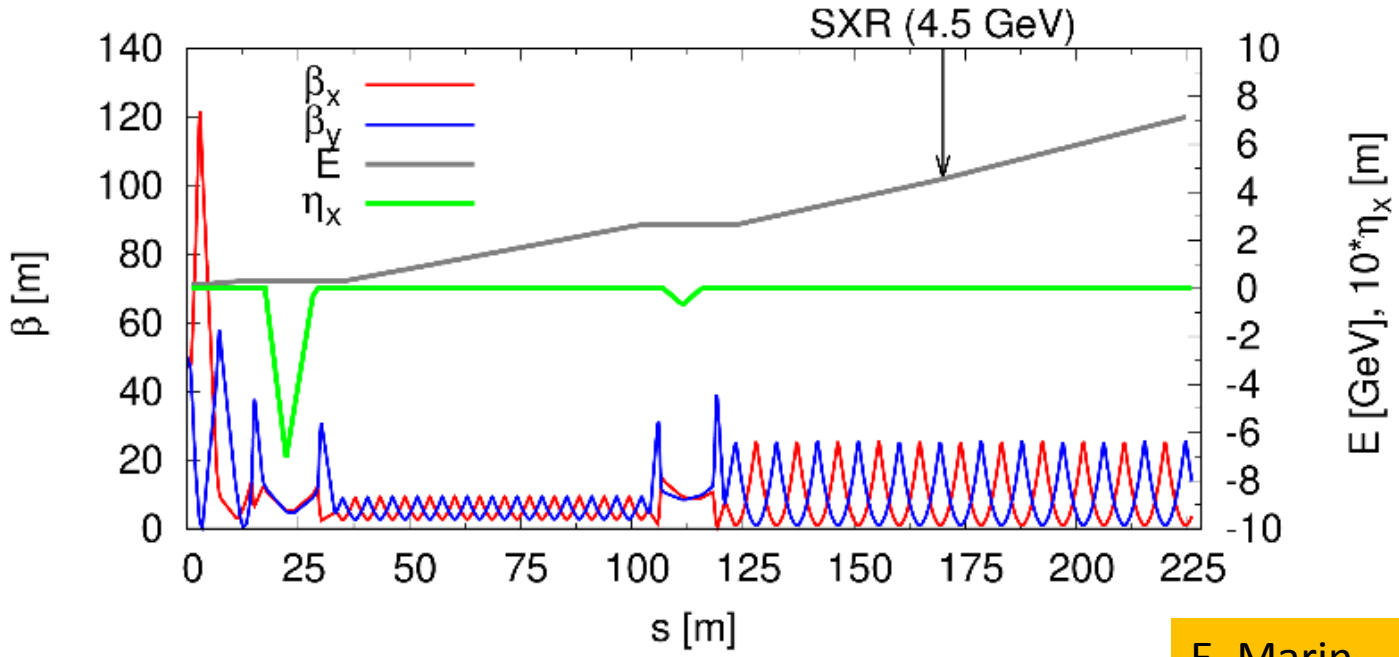
Linac Optimization

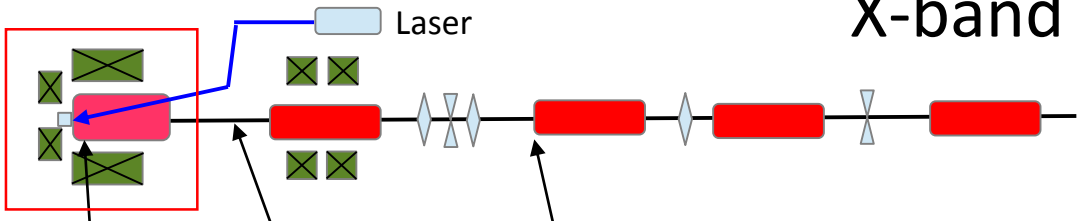


E. Marin

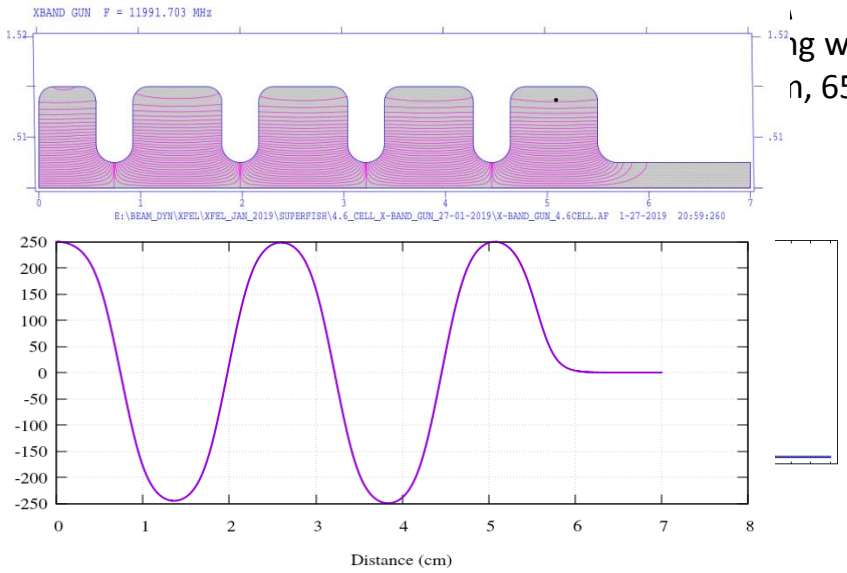
- Total Length: 227 m
- 8 bending magnets, 128 Quads, 139 Cavities
- Energy Profile (GeV): BC1 0.3, BC2 2.6, SXR 4.5, HXR 7.1

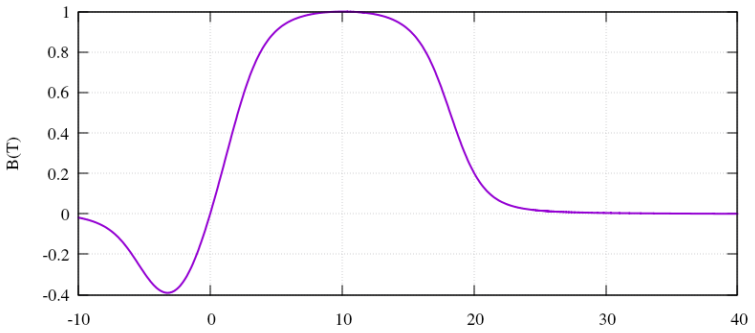
Gun & Injectors

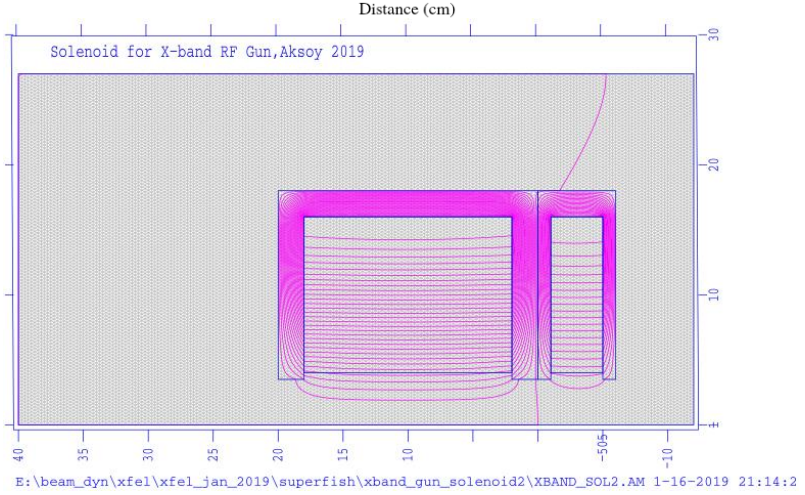
X-band based Injector



ıg wave
ı, 65M



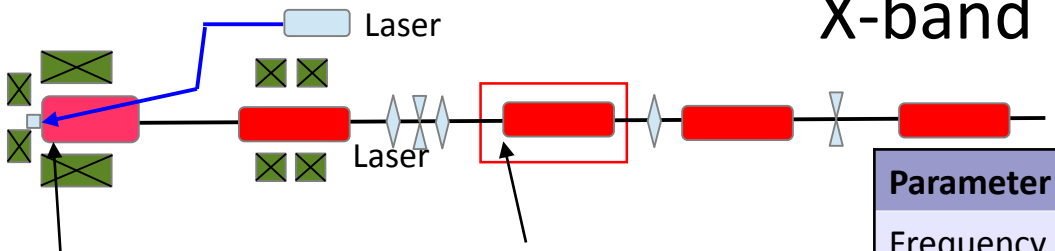




Parameter	Value	Unit
Frequency	12	GHz
Gradient	250	MV/m
Cell number	4.6	#

Gun & Injectors

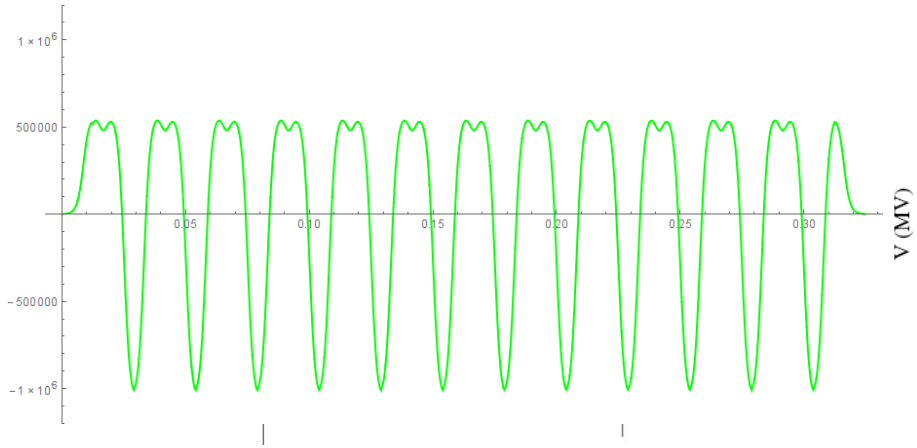
X-band based Injector

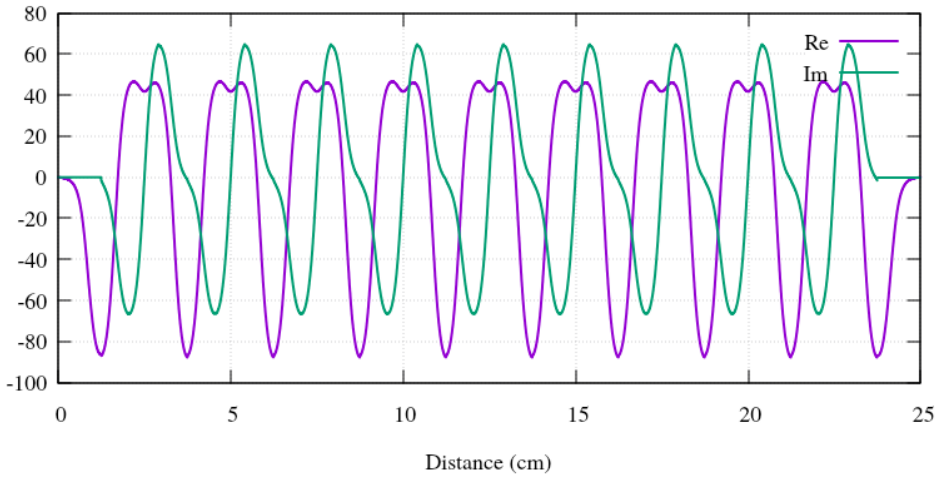


12 GHz RF Gun
5.6 Cell, 250 MV/m

12 GHz Traveling wave structures
108 cell, ~0.9 m, 65MV/m, 120 degree

Parameter	Value	Unit
Frequency	12	GHz
Gradient	65	MV/m
Total lengt	~1	m
Cell number	108	#





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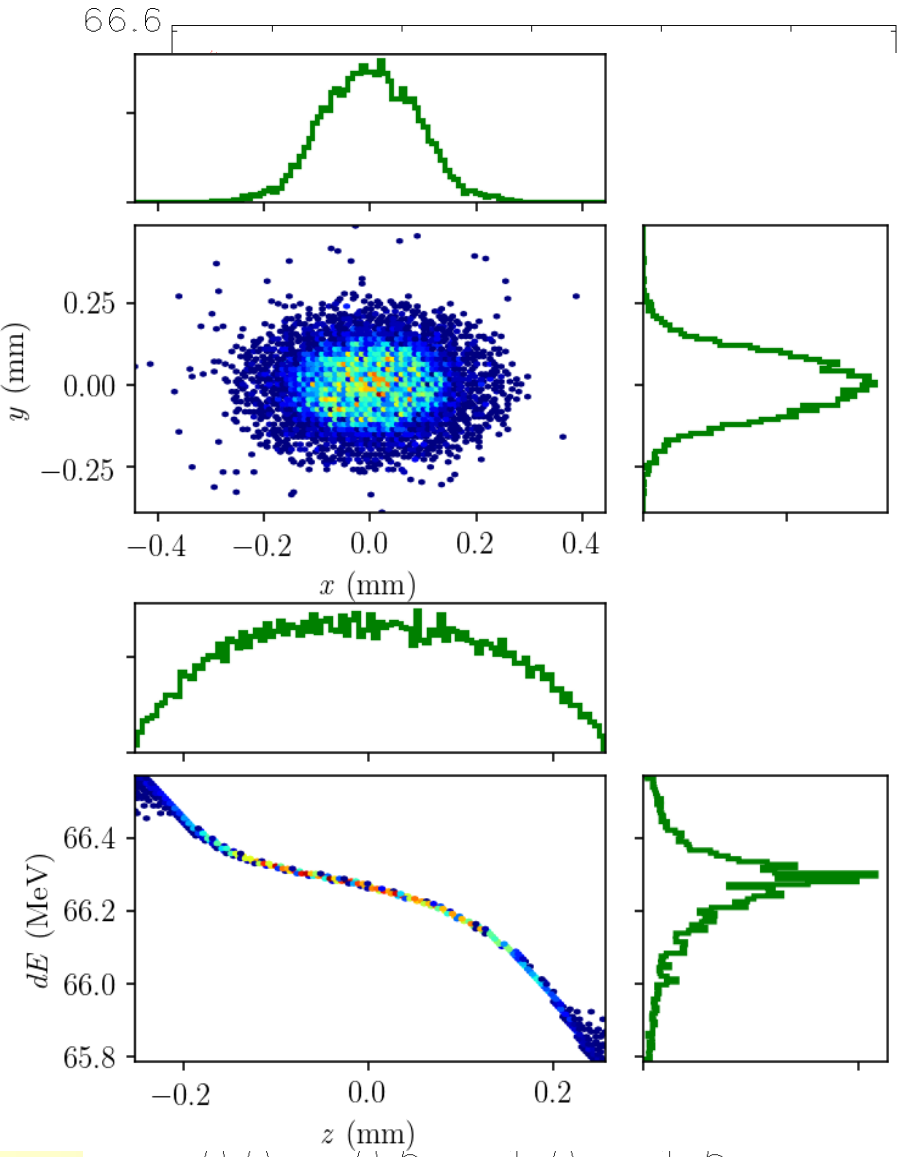
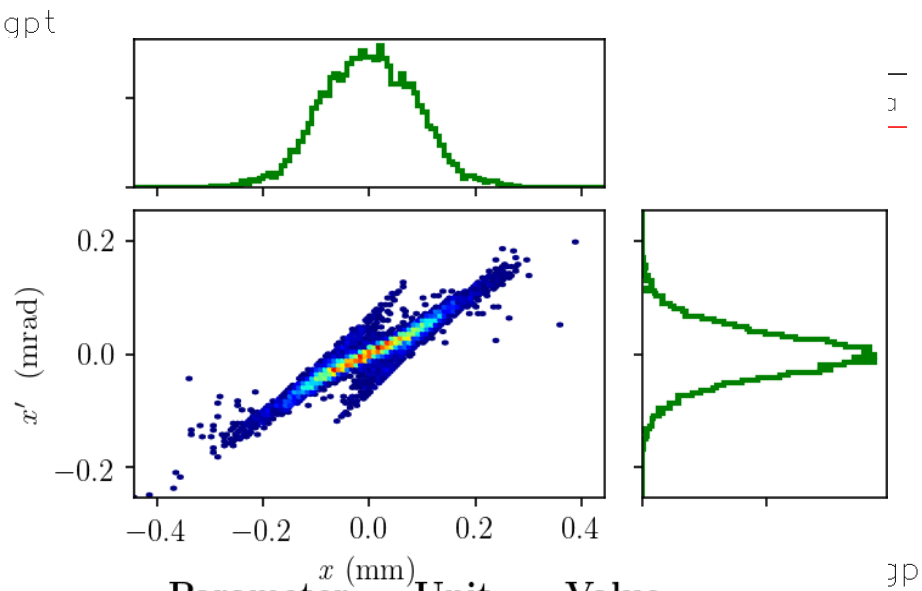
Gun & Injectors



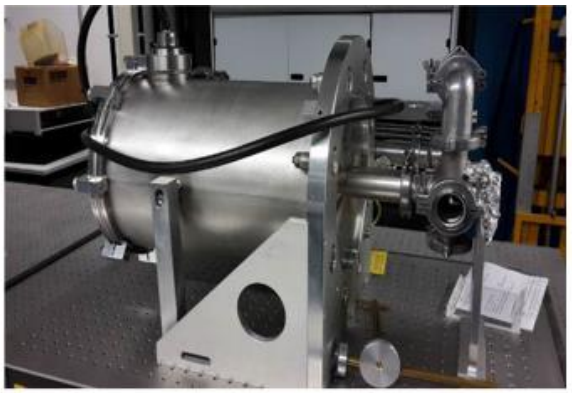


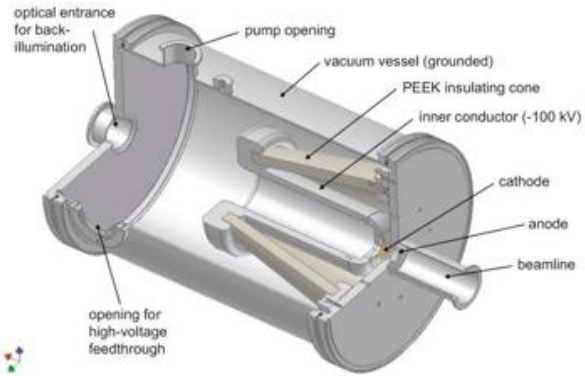
Parameter	Unit	Value
E	MeV	66.245
$\varepsilon_{n,x}$	mm.mrad	0.169
$\varepsilon_{n,y}$	mm.mrad	0.168
ε_z	keV.mm	5.006
σ_x	mm	0.089
σ_y	mm	0.089
σ_z	mm	0.123
σ_E	keV	135.956
$\Delta E/E$	%	0.205

Gun & Injectors

X-band based Injector

- A DC photo-gun has previously been developed by the Coherence and Quantum Technology (CQT) group at Eindhoven.
- This investigation looks at the possibility of using one of these photo-guns as an injector for an X-band FEL.
- Benefits of the DC photogun:
  - Cost effective injection and bunch method.
    - Low energy bunching significantly simpler!
  - High reliability and robustness.





T.G. Lucas

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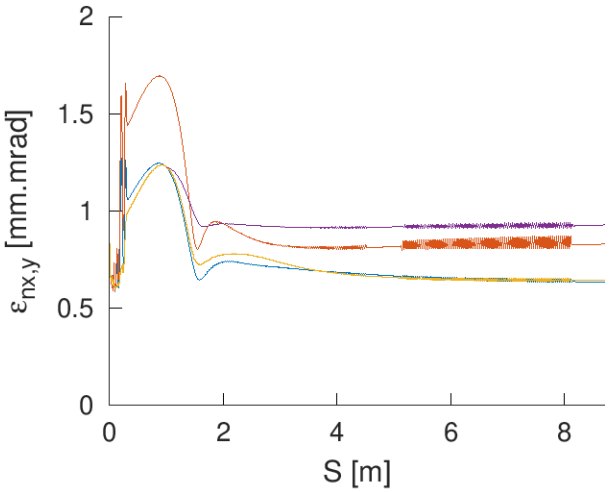
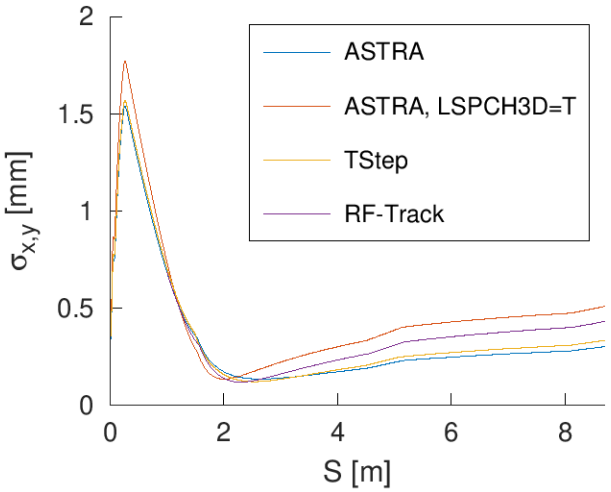
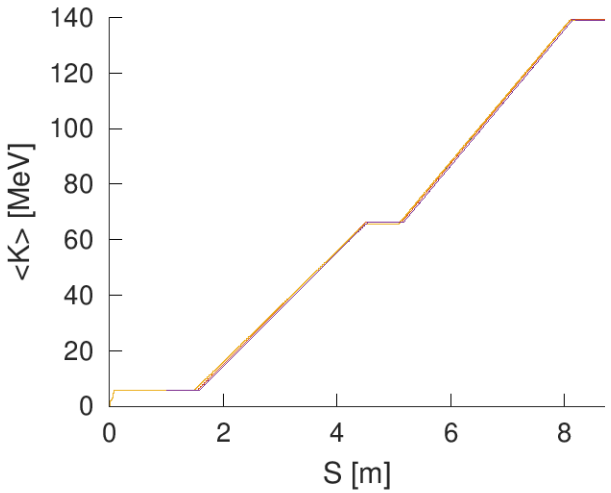
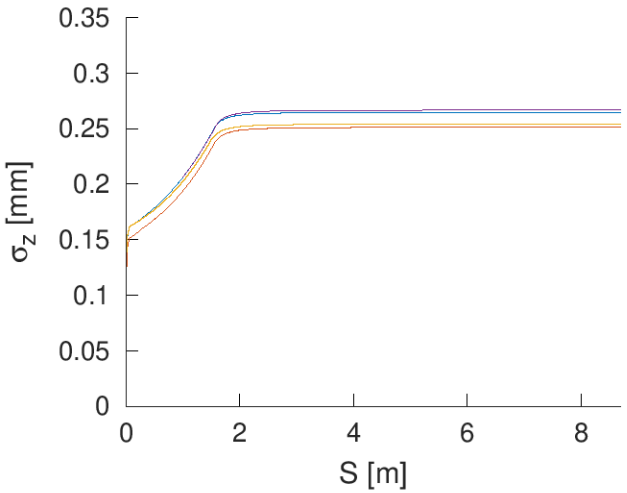
Code Development (RF-Track)









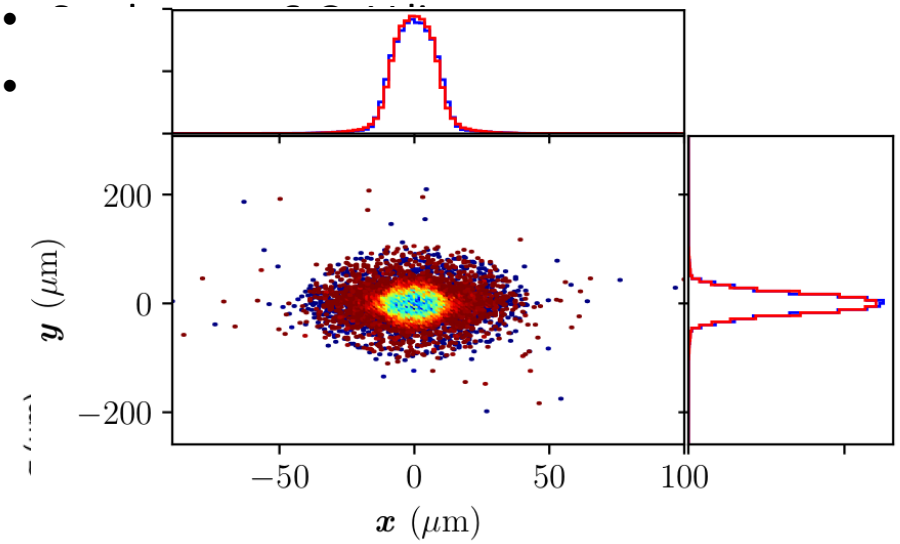
Study Case

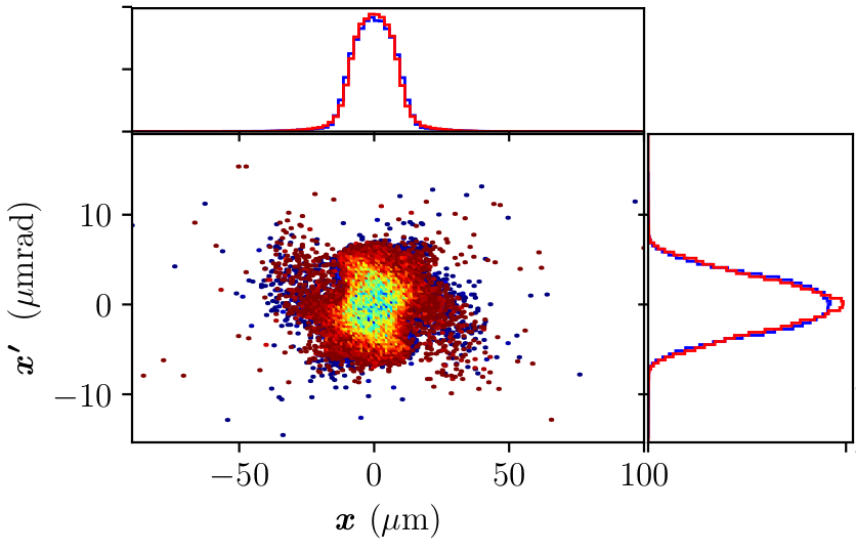
S-Band Injector +
S-Band TW structure

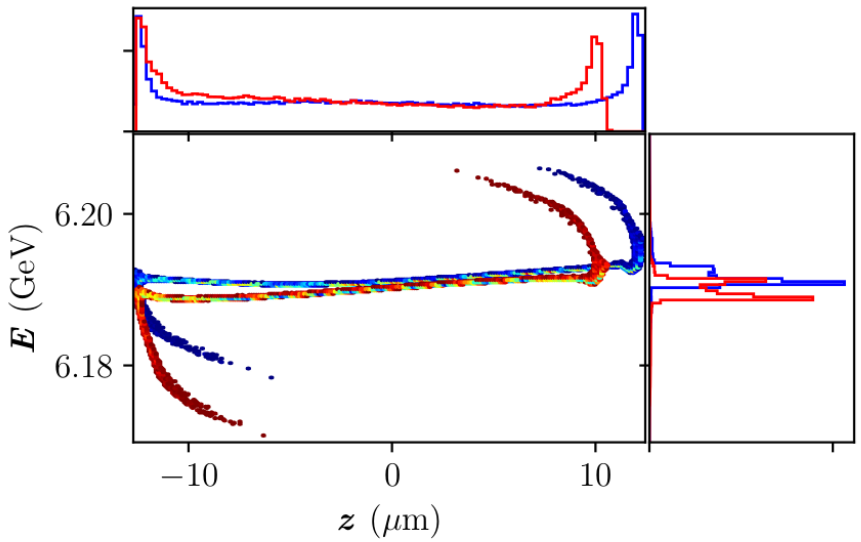
A. Gribono,
A. Latina

Code Benchmarking

-
-







Parameter	Elegant	Placet
E (GeV)	6.192	6.190
$\varepsilon_{n,x}$ (μmrad)	0.273	0.274
$\varepsilon_{n,y}$ (μmrad)	0.269	0.269
ε_z (MeV.mm)	11.019	14.077
σ_z (μm)	8.056	7.539
σ_E (GeV)	1.777	2.463

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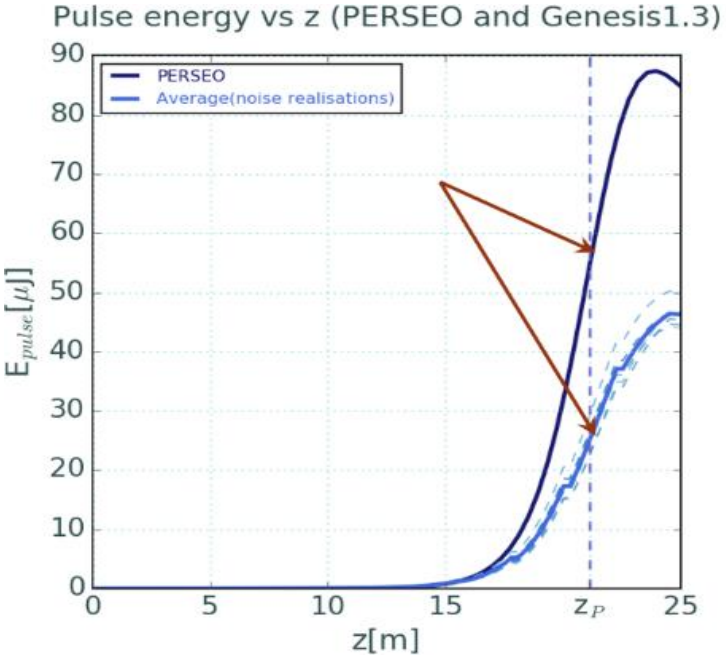
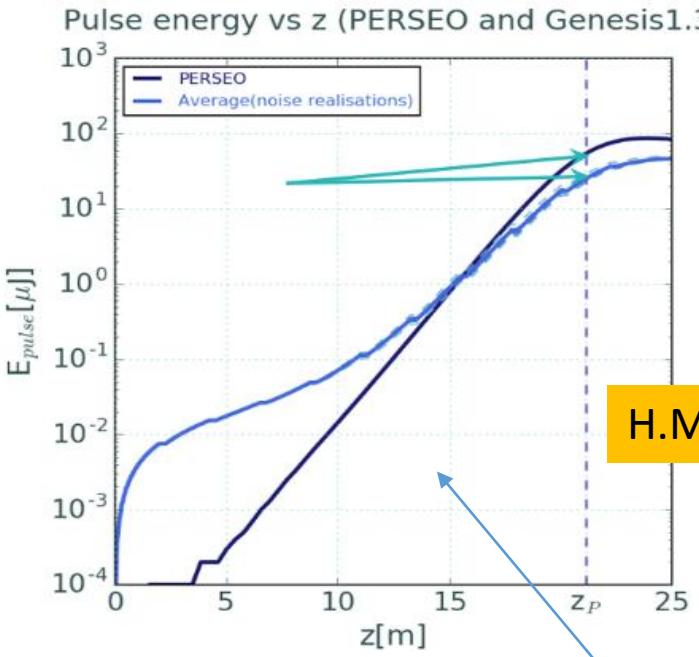
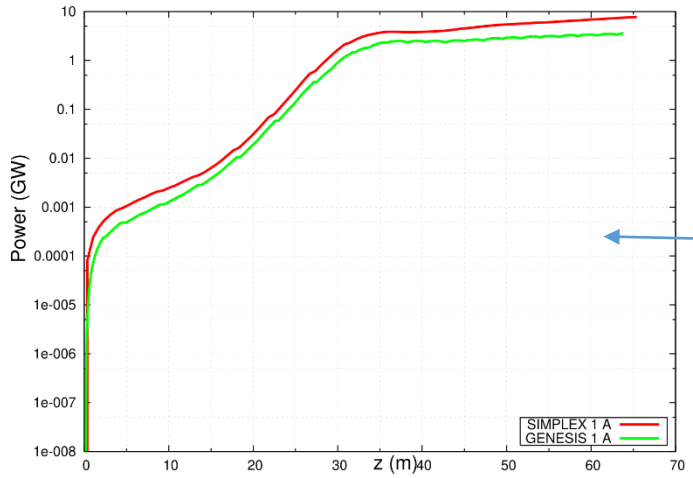
Free Electron Laser





H.M. Castaneda

- Study case
  - Ebeam 5.5 GeV
  - Qb=27 pC
  - Ipeak=5kA
  - Emit=0.2 µmrad
  - λfel=07 A



- Study case
  - Ebeam 5.5 GeV
  - Qb=100 pC
  - Ipeak=5kA
  - Emittance=0.4 µmrad
  - λfel=1 A

Z. Nergiz

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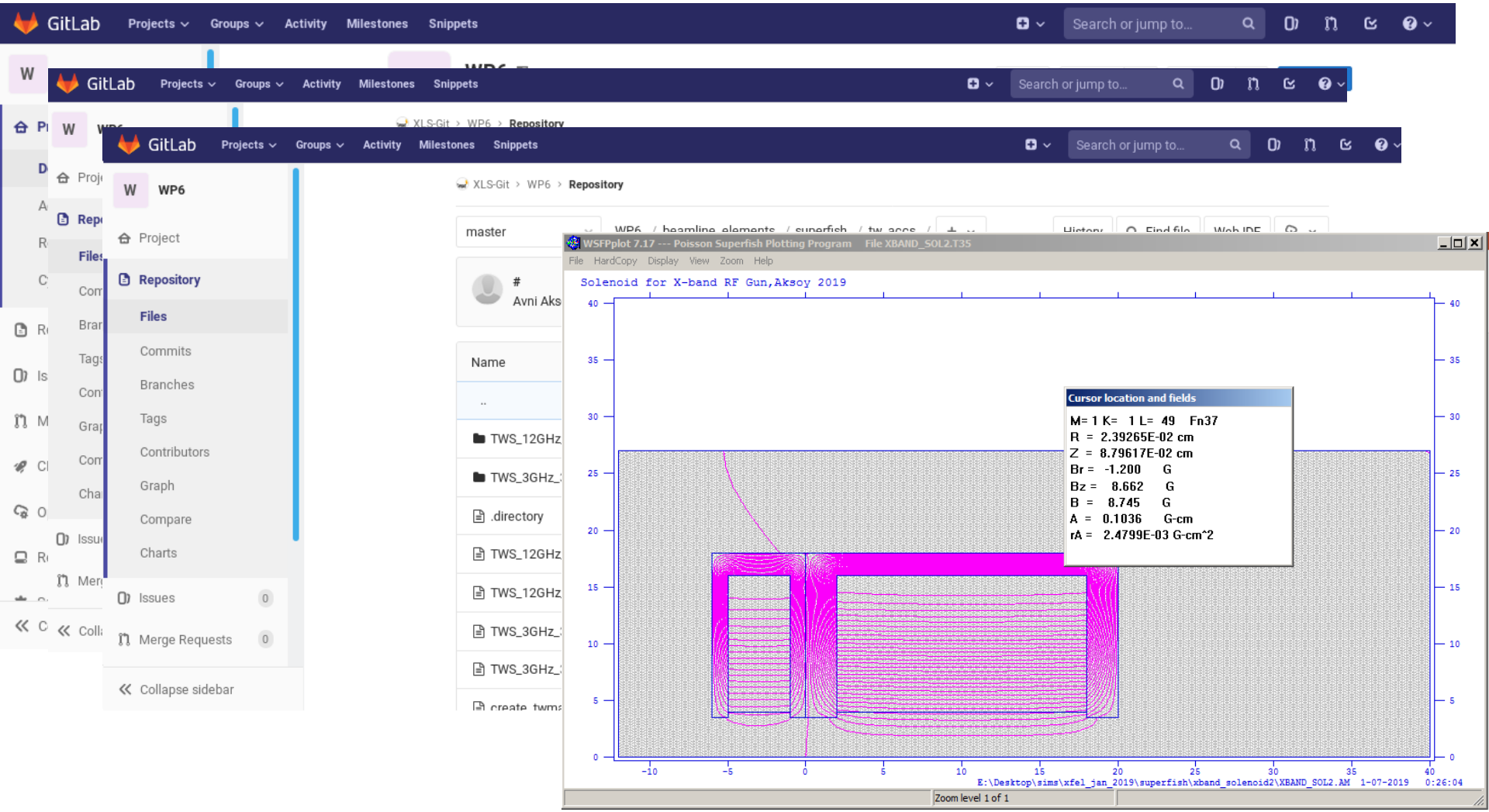
Gitlab

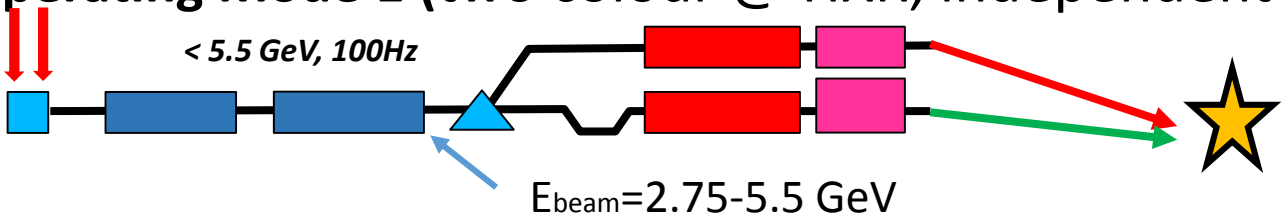
Compact



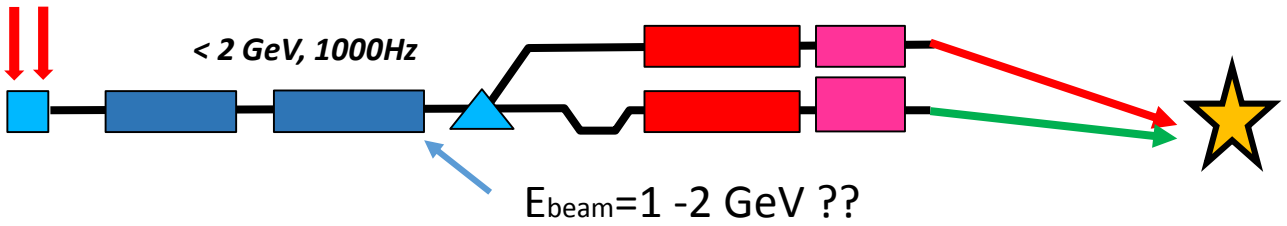
Beam Energies for Full Wavelength Range

Parameter	Value					
Energy (GeV)	5.5	3.9	2.75	1.95	1.37	0.97
Minimum Peak Current	5kA	2.5kA	1.5kA	925A	650A	350A
Normalised Emittance	0.2 mm mrad					
Bunch charge	75pC					
RMS Slice energy spread	1.0e-4	1.4e-4	2.0e-4	2.8e-4	4.0e-4	5.6e-4
Photon Energy Range (keV)	16 - 8	8 - 4	4 - 2	2 - 1	1 - 0.5	0.5 - 0.25
FEL tuning range at fixed energy	X2					

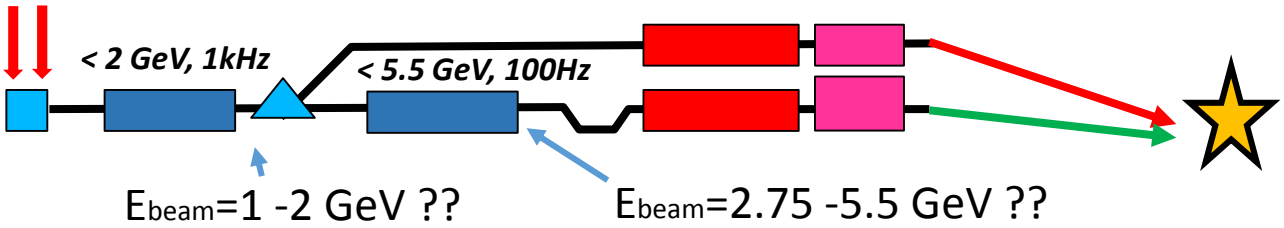
- **Operating Mode 1 (**two colour @ HXR, independent wavelengths)



- **Operating Mode 2 (**two colour @ SXR, independent wavelengths)



- **Operating Mode 3 (**two colour @ HXR & SXR, independent wavelengths)



L2_E_f=1 GeV & L3_E_f=5.5 GeV ??
L2_E_f=2 GeV & L3_E_f=2.75 GeV ??

Conclusions

- To define better lattice configuration the energy levels has to be defined..
- The lattice layout will be defined based on correction methods of static imperfections..
- The multibunch case will be studied..

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Thank you!

Compact

CompactLight@elettra.eu

www.CompactLight.eu

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