



Status of Start-to-end Simulations S+X - Band Compact Light Option

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**XLS Midterm Review, WP6: Beam Dynamics
Helsinki (FINLAND)**

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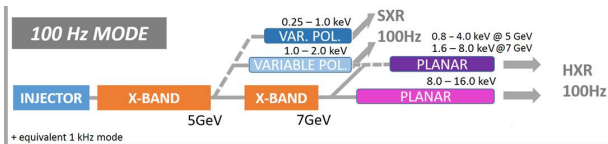
XLS New Design

Injector Distribution (S-Band)

Lattice v2019

Twiss Parameters

Summary



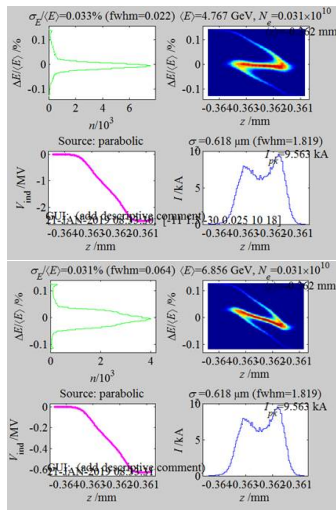
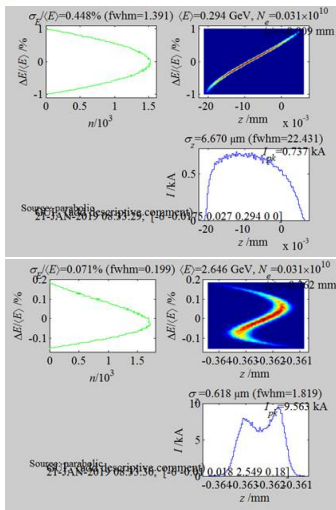
LiTrack

(Longitudinal Phase Space Tracking)

Beamline Parameters

clear						
(beamline legend)						
plot	1	0	0	0	0	0
plot	22	3.125e-05	0	0	0	0
plot	11	0.085	-30	0.1	6	3.2
plot	11	0.085	-30	0.1	6	3.2
plot	11	0.014	202	0.025	10	0.9
plot	6	-0.0175	0.027	0.294	0	0
plot	11	1.3	-25	0.025	10	18
plot	11	1.3	-25	0.025	10	18
plot	6	-0.01	0.018	2.549	0	18
plot	11	1.3	-30	0.025	10	18
plot	11	1.3	-30	0.025	10	18
plot	11	0.975	-30	0.025	10	13.5
plot	11	0.975	0	0.025	10	13.5
plot	11	0.325	0	0.025	10	4.5

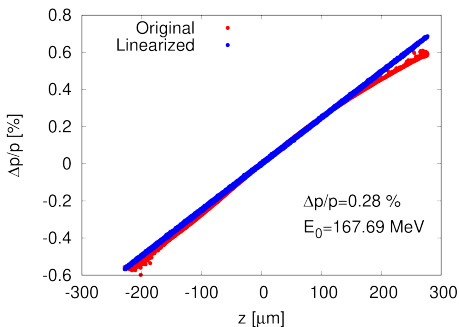
+ longitudinal wake-fields of S and X-band structures



Initial: $E = 160$ MeV (0.5%), $Q = 50$ pC, $\sigma_z = 85$ μm , $\gamma_{e\perp} = 0.2$ μm
 Final: $E = 6.9$ GeV (0.03%), $Q = 50$ pC, $\sigma_z = 0.6$ μm , $\gamma_{e\perp} = 0.2$ μm



- ▶ Injector Operation Mode: Velocity Bunching
- ▶ Output Energy: 168 MeV
- ▶ Normalized Energy Spread: 0.28%
- ▶ # e^- : ≈ 31 k
- ▶ Bunch Charge: 75 pC

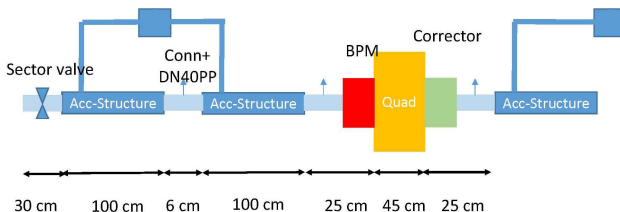


- ▶ Twiss parameters
 $\beta_{x,y} = 50$ m
 $\alpha_{x,y} = 2.0$
- ▶ Emittances
 $\gamma\epsilon_{x,y} = 0.21 \mu\text{m}$
- ▶ Bunch length
 $\sigma_z = 113 \mu\text{m}$

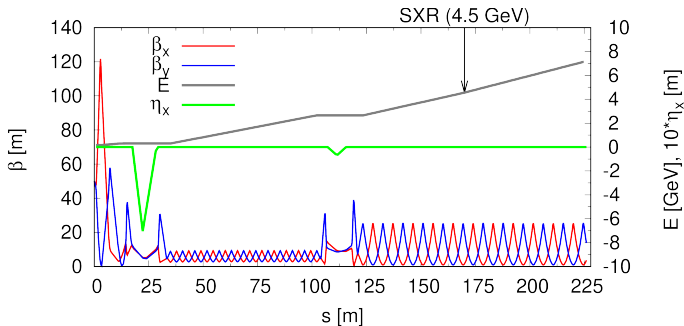
* provided by A. Giribono



- ▶ New lattice fully designed by Placet
- ▶ Linac-1: 2 acc. structures between FODO quads
 - ▶ Module config. presented in the 1st XLS annual meeting by M. Aicheler (WP4: Integration)



- ▶ Linac-2 (A&B): 4 acc. structures between FODO quads (original lattice)
- ▶ W_{\perp} & W_{\parallel} short wakefields included ($Q_{\text{bunch}} = 75 \text{ pC}$)



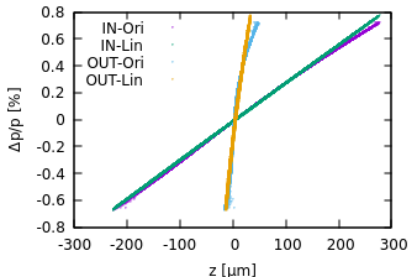
- ▶ Total Length: 227 m
- ▶ 8 bending magnets, 128 Quads, 139 Cavities
- ▶ Energy Profile (GeV):

BC1	BC2	SXR	HXR
0.3	2.6	4.5	7.1

Lattice available at <https://gitlab.cern.ch/XLS-Git/WP6>



- ▶ 4-dipole chicane
 - ▶ Injected normalized energy spread is half than assumed in Li-Track
 - ▶ Injected bunch length is $\approx 30\%$ larger than assumed in Li-Track
 - ▶ R_{56} increases from -0.017 m (Li-Track) to -0.035 m
 - ▶ $|\theta_{\text{dip}}| = 2.86$ deg
- $Drift_{\text{from dip}_1 \text{ to dip}_2} = 5.5$ m



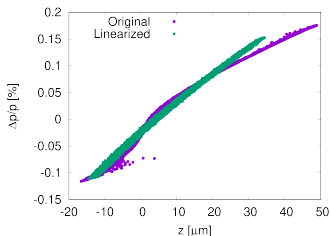
$$\sigma_z = 112 \mu\text{m}$$

↓ BC1 ↓

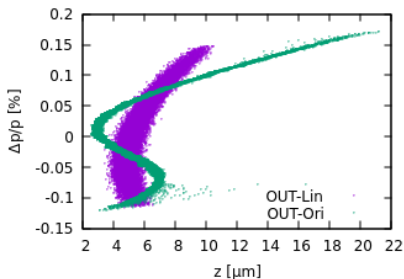
$\sigma_z = 11 \mu\text{m}$	$\sigma_z = 10 \mu\text{m}$
Original	Linearized



- ▶ Lin-1: $\phi = 20.0$ deg Grad = 68.01 MV/m



- ▶ Original: $E = 2.6$ GeV σ_z (rms) = 11 μm $\Delta p/p = 0.06$ %
- ▶ Linearized: $E = 2.6$ GeV σ_z (rms) = 10 μm $\Delta p/p = 0.06$ %

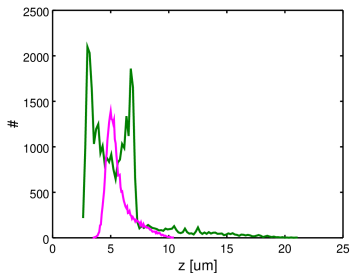


$$\sigma_z = 11 \mu\text{m} \quad \sigma_z = 10 \mu\text{m}$$

↓ BC2 ↓

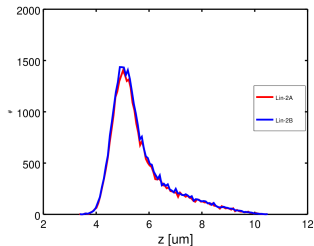
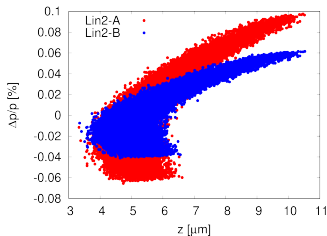
$$\sigma_z = 2.8 \mu\text{m} \quad \sigma_z = 1.1 \mu\text{m}$$

Original Linearized





- ▶ Lin-2A: $\phi = 30$ deg Grad = 72.2 MV/m
- ▶ Lin-2B: $\phi = 0.0$ deg Grad = 72.2 MV/m



- ▶ Lin-2A: $E = 4.48$ GeV $\gamma\epsilon_{x,y} = 0.22$ μm $\sigma_z = 1.1$ μm $\Delta p/p = 0.035$ %
- ▶ Lin-2B: $E = 7.08$ GeV $\gamma\epsilon_{x,y} = 0.22$ μm $\sigma_z = 1.1$ μm $\Delta p/p = 0.022$ %



- ▶ New XLS design features:
 - ▶ Footprint around 227 m for an output energy of 7 GeV
 - ▶ Bunch length $1.1 \mu\text{m}$, $\Delta p/p=0.02\%$, $Q_{\text{bunch}} = 75 \text{ pC}$
 - ▶ Linac-1 stronger focusing lattice than Linac-2
- ▶ Latest S-band injector beam (VB mode $\sigma_z=85\mu\text{m}$)
 - ▶ Significant difference between real and linearized injector distribution

This is not the final design...

- ▶ Still room for optimization
- ▶ Include misalignment imperfections to study the impact of wake-fields on the transverse emittance
- ▶ CSR (trade off between θ and $Drift_{\text{from dip}_1 \text{ to dip}_2}$)
- ▶ Repeat exercise using the C-band injector distribution



Thank you for listening

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