

XLS 3-D Sim

Edu Marin

General
Particle Tracer

Compact
Light Source

2.A Lattice - version
2016

Tracking
Results

Summary and
Outlook

3-D simulation for the S-band + X-band option of CompactLight

Edu Marin

CELLS

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Compact 



Acknowledgements: **R. Munoz, B. van der Geer, A. Latina and A. Aksoy**

XLS Annual Meeting

December 10, 2018

Overview

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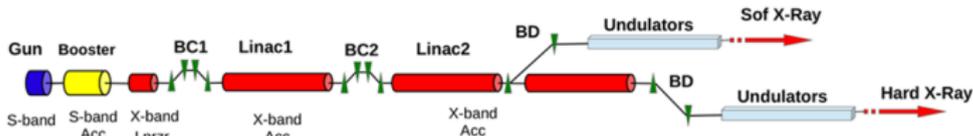
- 1 General Particle Tracer
- 2 Compact Light Source
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General Particle Tracer ¹ is developed, written and maintained by **Dr. S.B. van der Geer** and **Dr. M.J. de Loos**

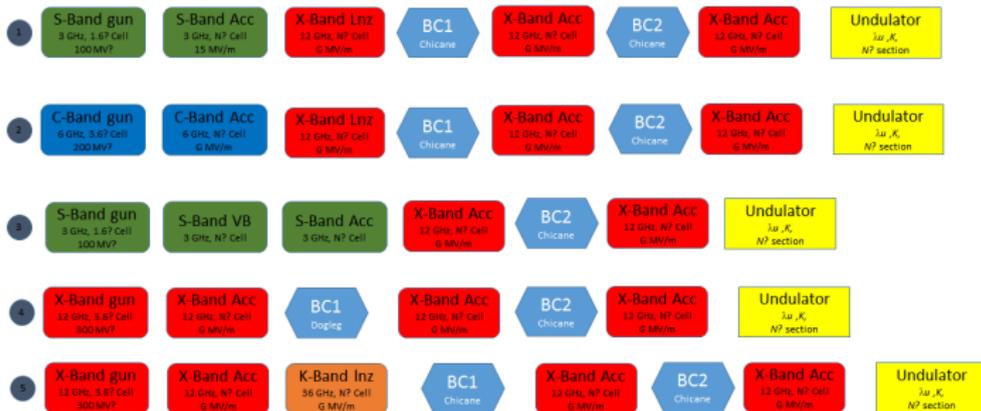
- Ability to track any particle specie
- Well-interfaced to other codes (SUPERFISH, ASTRA, ELEGANT and now PLACET)
- 3-D simulation differentiable electromagnetic fields \Rightarrow Eqs. of motion \Rightarrow solved by 5th-order Runge-Kutta integrator)
- Variety of build-in elements (e.g. traveling wave linac - beam loading) but also the user can create custom elements to its convenience
- Able to include collective effects (space-charge, wake-fields, CSR...)
- Optimization tools (multi-scan, solver and genetic algorithms)

¹www.pulsar.nl

Compact Light Source - Machine Options



Different options regarding Gun/Injector RF and compressors schemes



Our study concerns 2.A option

Lattice

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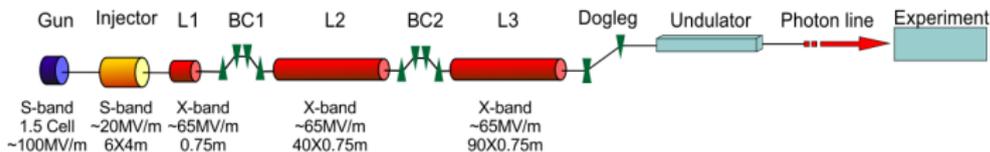
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Files provided by A. Latina (originally designed by A. Aksoy 2016)



- Injector: 3 S-band structures ($\theta = 32$ deg)
1 X-band lineariser ($\theta = 273$ deg)
- X-Band Linacs: Accel. structures: 0.75 m long, 70 MV/m
 - Linac 2: 5 modules: 8 X-band struc. + 2 Quads
 - Linac 3: 9.5 modules: 8 X-band stru. + 2 Quads
- BCs: Magnetic chicanes BC1 $R_{56} = 0.082$ m
BC2 $R_{56} = 0.012$ m

XLS (version 2-A) Linac Sections

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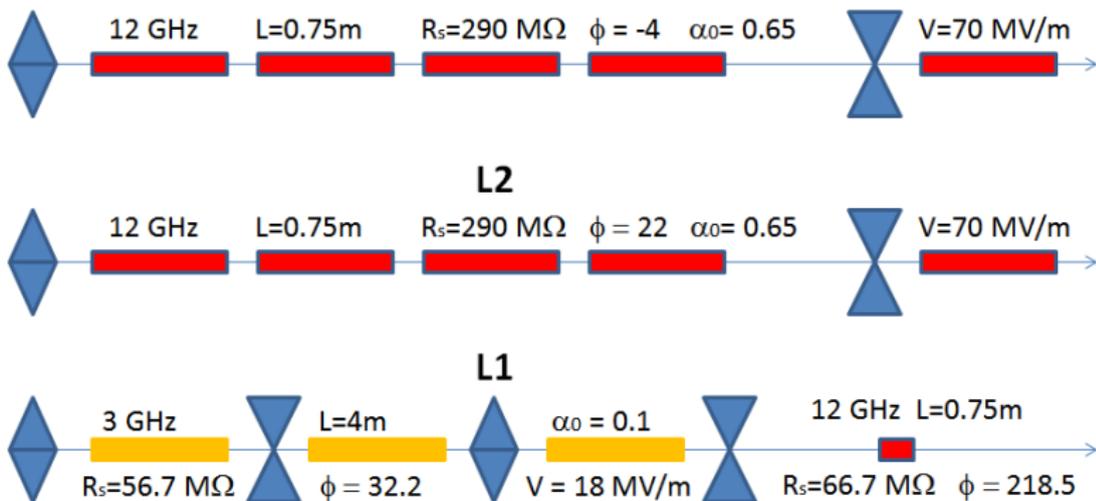
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- Individual phases are grouped in 4
- Attenuation factor (α), shunt impedance (R_s) and input power (P_{in}) adjusted to match ΔE and Δp profile

XLS (version 2-A) BC Sections

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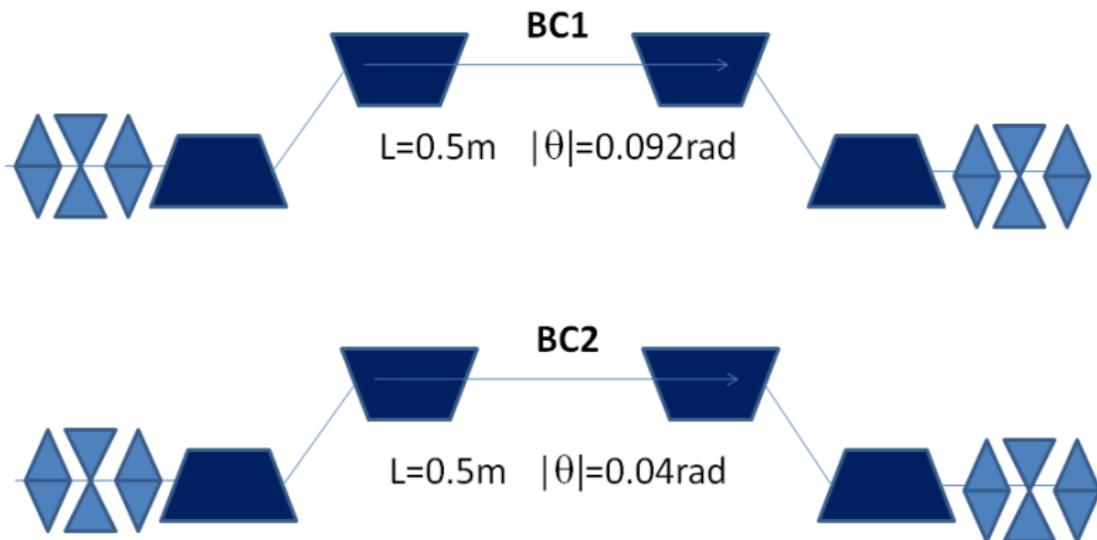
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- Fringe fields of bendings are adjusted to close dispersion
- Matching quads are used to cure the different modelization of quadrupolar components along the beamlines

Lattice Conversion

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It is a tricky process due to the presence of bending magnets \Rightarrow
Coordinate system are treated differently between Placet & GPT
The lattice.lat (PLACET) is converted to lattice.in (GPT)
thanks to

Placet2GPT_XLSFULL.py²

- Units in GPT are SI
- Traveling waves requires: $\alpha, R_s, P_0, P, \theta, \phi, \dots$
- Sector bending requires: $CCSs, R, B, dl, b_1, b_2, \dots$

Adjustments are required after conversion:

- set the RF phases (GPT time domain)
- fringe fields of bendings to adjust trajectory
- matching quadrupoles

²can be found at <https://gitlab.cern.ch/snippets/633>

Initial Distribution

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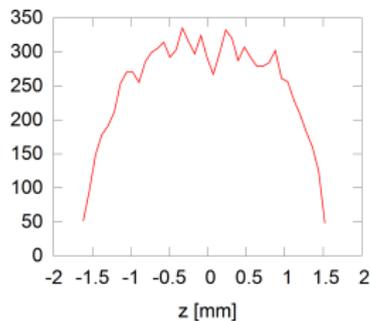
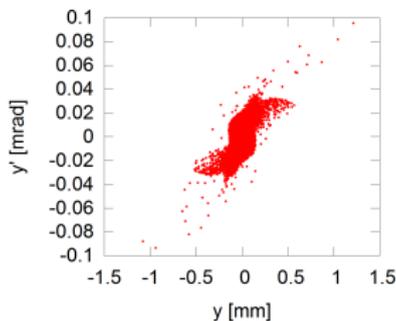
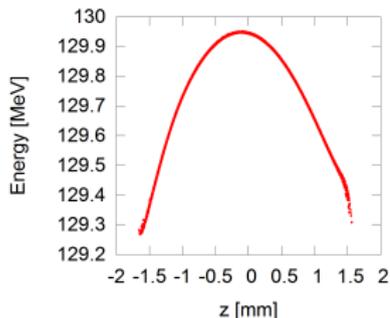
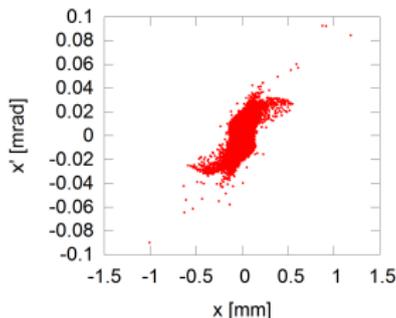
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Incoming beam out of the S-band RF gun



$$\sigma_r = 110 \mu\text{m} \quad \sigma_z = 804 \mu\text{m} \quad \Delta p/p = 0.12 \%$$

Tracking Results I: Injector + BC1

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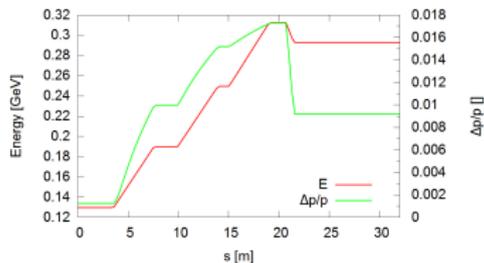
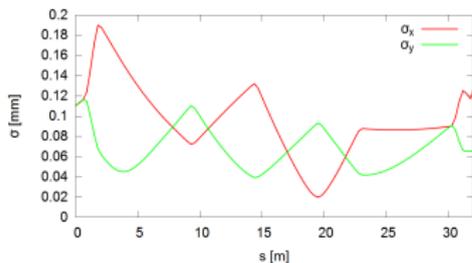
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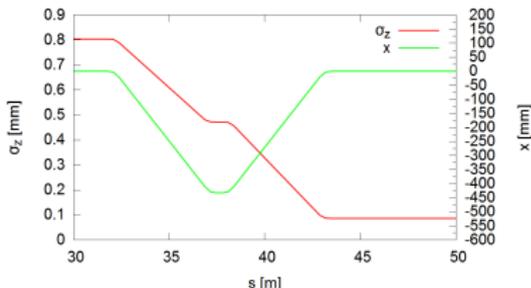
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S-band + Linearizer:



BC1:



Tracking Results II: L2 + BC2

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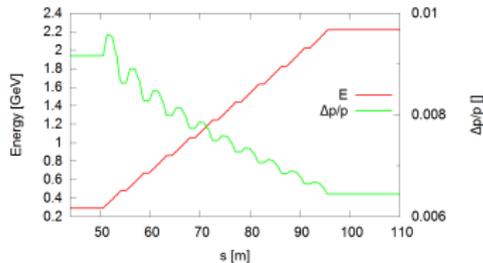
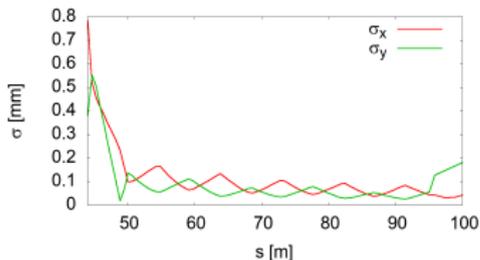
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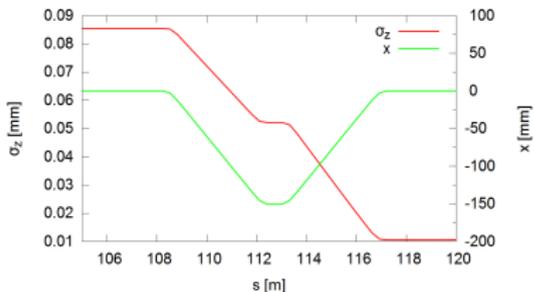
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L2:

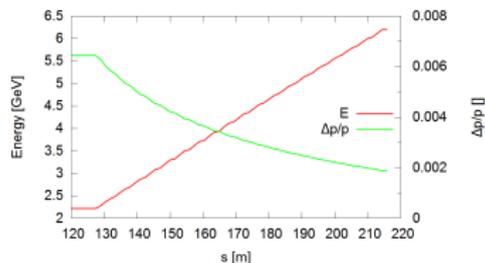
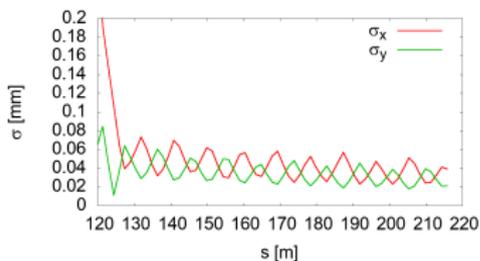


BC2:

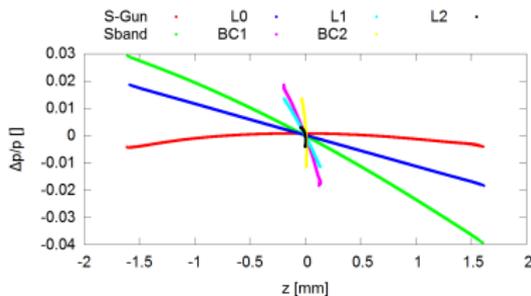


Tracking Results III: L3

L3:



Longitudinal Phase Space:



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Tracking Results: Summary Table

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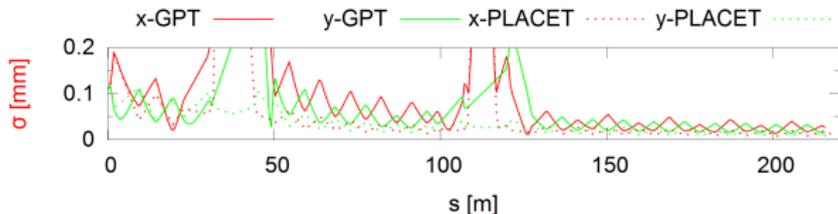
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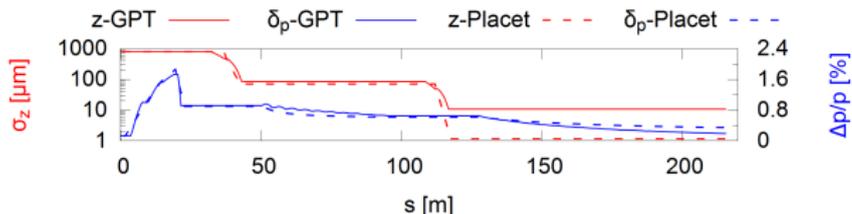
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Section	σ_x [μm]	σ_y [μm]	ϵ_x [μm]	ϵ_y [μm]	σ_z [μm]	E [GeV]	$\Delta p/p$ [%]
L1	56	61	0.3	0.3	804	0.29	0.9
BC1	160	55	0.7	0.6	85	0.29	0.9
L2	48	47	0.7	0.6	85	2.2	0.6
BC2	60	24	0.7	0.6	10	2.2	0.6
L3	22	15	0.7	0.6	10	6.2	0.2



Outlook

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- BC1 Fine optimization: matching quads ($\Delta\epsilon_x$ & $\Delta\epsilon_y$) and bending length (ϵ_z)



Fair comparison between codes

- Replace the build-in elements (e.g trwlinac, sectormagnet) by their field maps (e.g simulation, measurement)
- Update the initial beam coming out of the S-band Gun
- Include wake-fields
- Coherent synchrotron radiation
- Machine imperfections study
- ...

Back-Up: Bunch Compression

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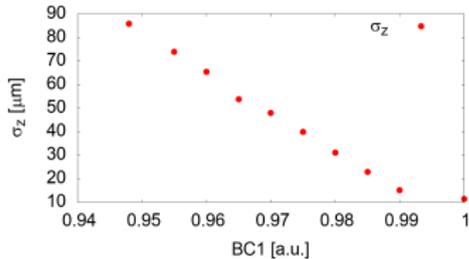
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Back-Up: Phase Space

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