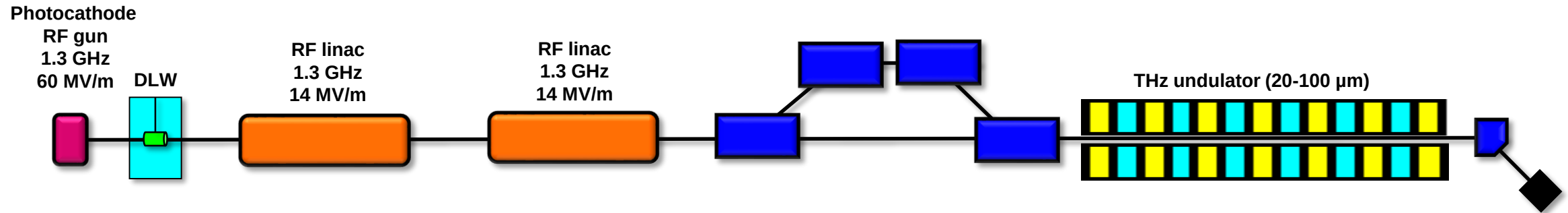


Progress on conceptual design for the accelerator-based THz source at the European XFEL

Prach Boonpornprasert for THz@PITZ team
Mini-workshop on THz@PITZ, 15.03.2023

Layout of the beamline for S2E

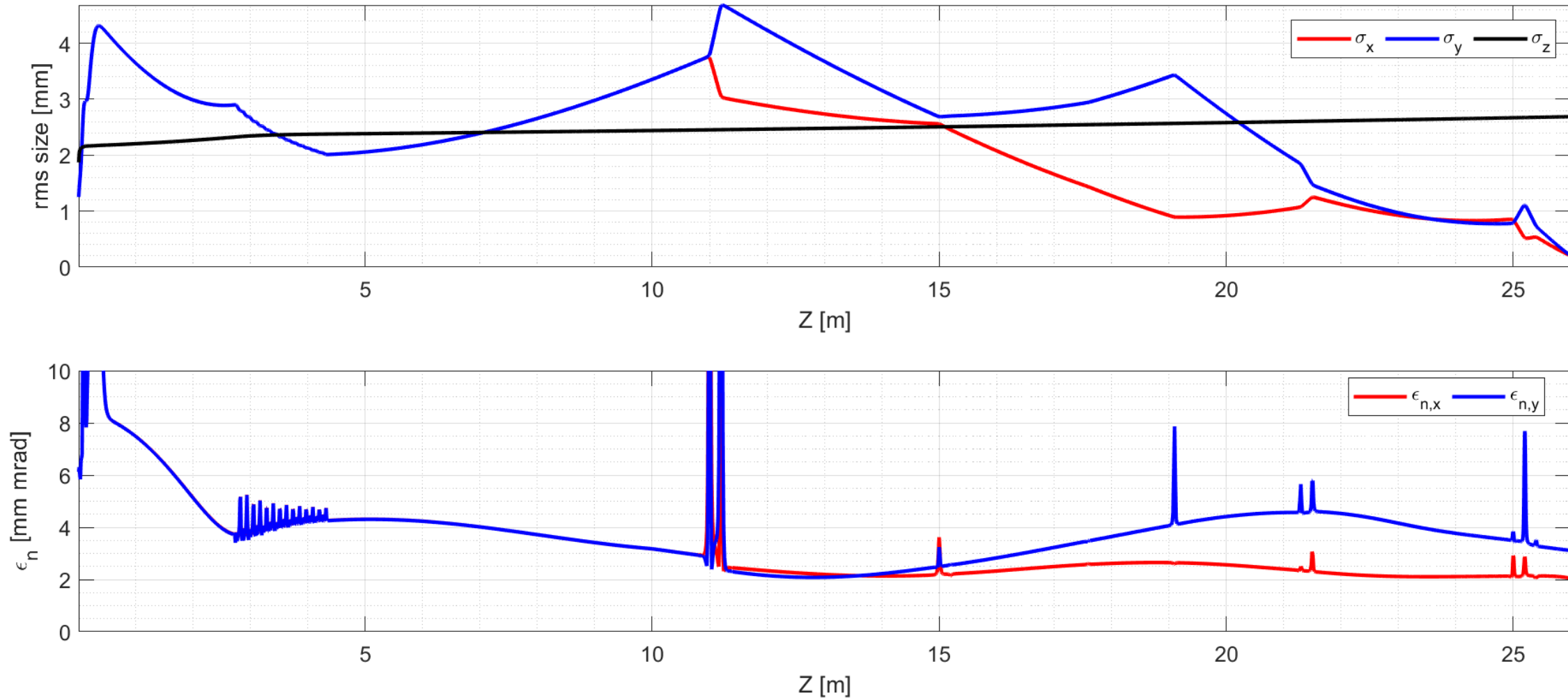


Section	Length	Purpose	Detail
RF gun	0.204 m	Generate and accelerate e-beam	DESY NC L-band RF gun, 1.3 GHz, $E_{\text{max}} \sim 60 \text{ MV/m}$
DLW	a few cm	Induce beam modulation for FEL seeding	Design consideration is ongoing Collab. with Shankar Lal (RRCAT, India)
1 st and 2 nd Linacs	1.710 m	Accelerate e-beam	PITZ-type CDS cavity, 1.3 GHz, $E_{\text{max}} \sim 14 \text{ MV/m}$
chicane	5.500 m	Compress e-beam	Copy of BC0@EXFEL
THz undulator	5.000 m	Generate FEL 20-100 μm (3-15 THz)	$\lambda_p = 40 \text{ mm}$, APPLE-II type undulator

S2E simulation: Beam Parameter Evolutions

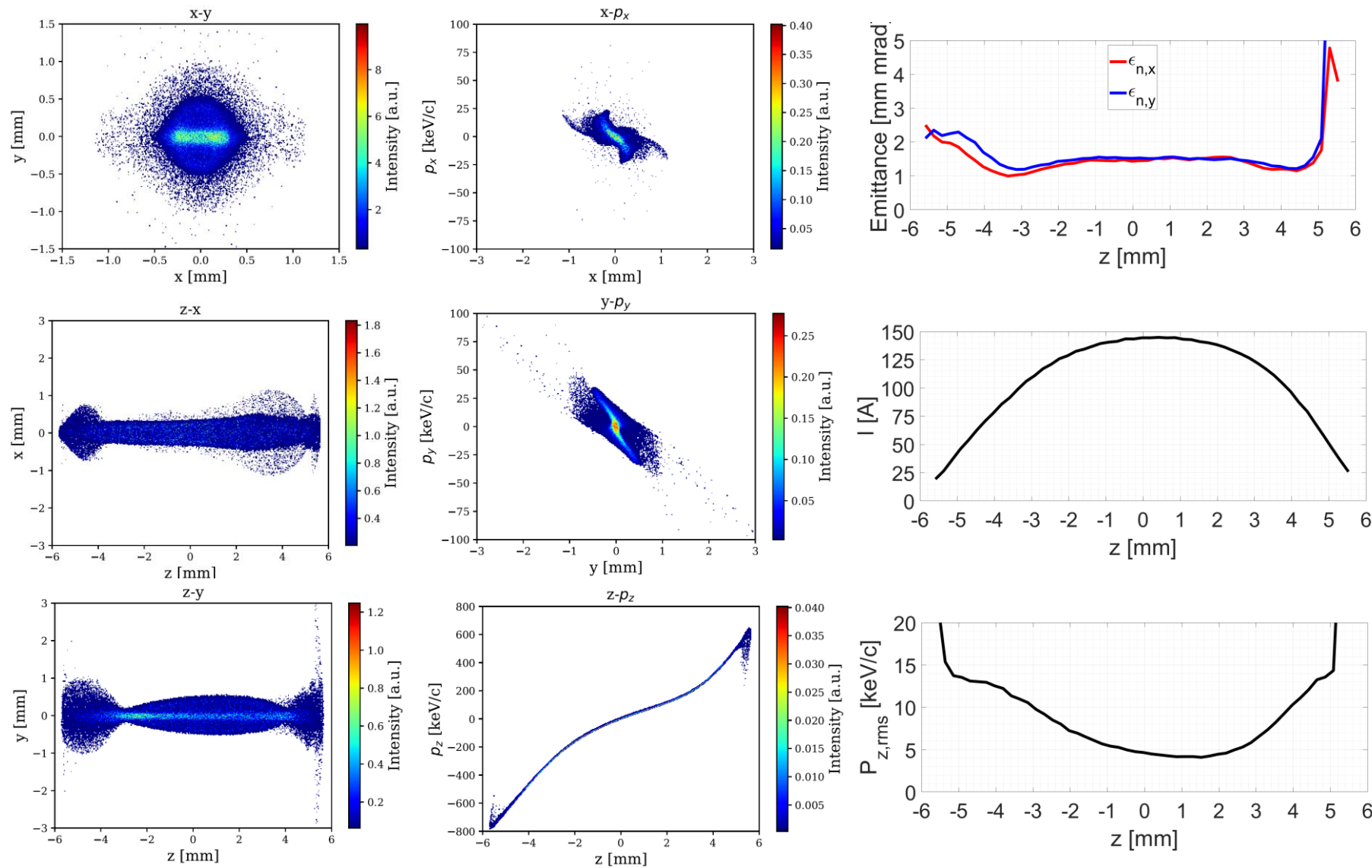
Simulation Tool: ASTRA

4 nC, ~ 15 MeV/c
for $\lambda_{\text{FEL}} = 100 \mu\text{m}$
Helical U, No BC, No DLW



S2E simulation : Beam at the U.Entrance

4 nC, ~15 MeV/c
for $\lambda_{\text{FEL}} = 100 \mu\text{m}$
Helical U, No BC, No DLW

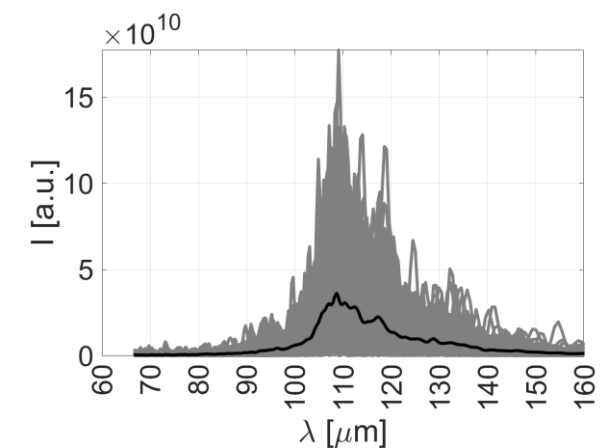
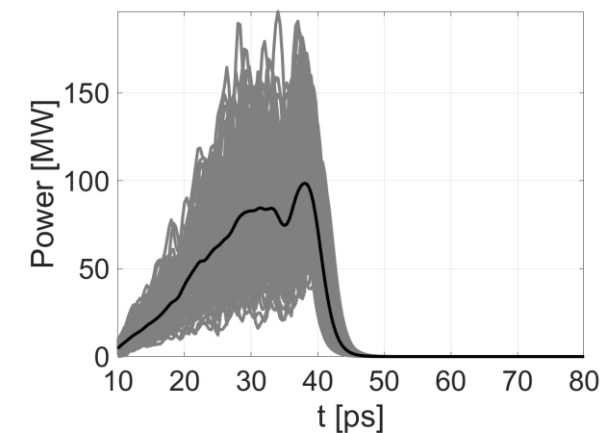
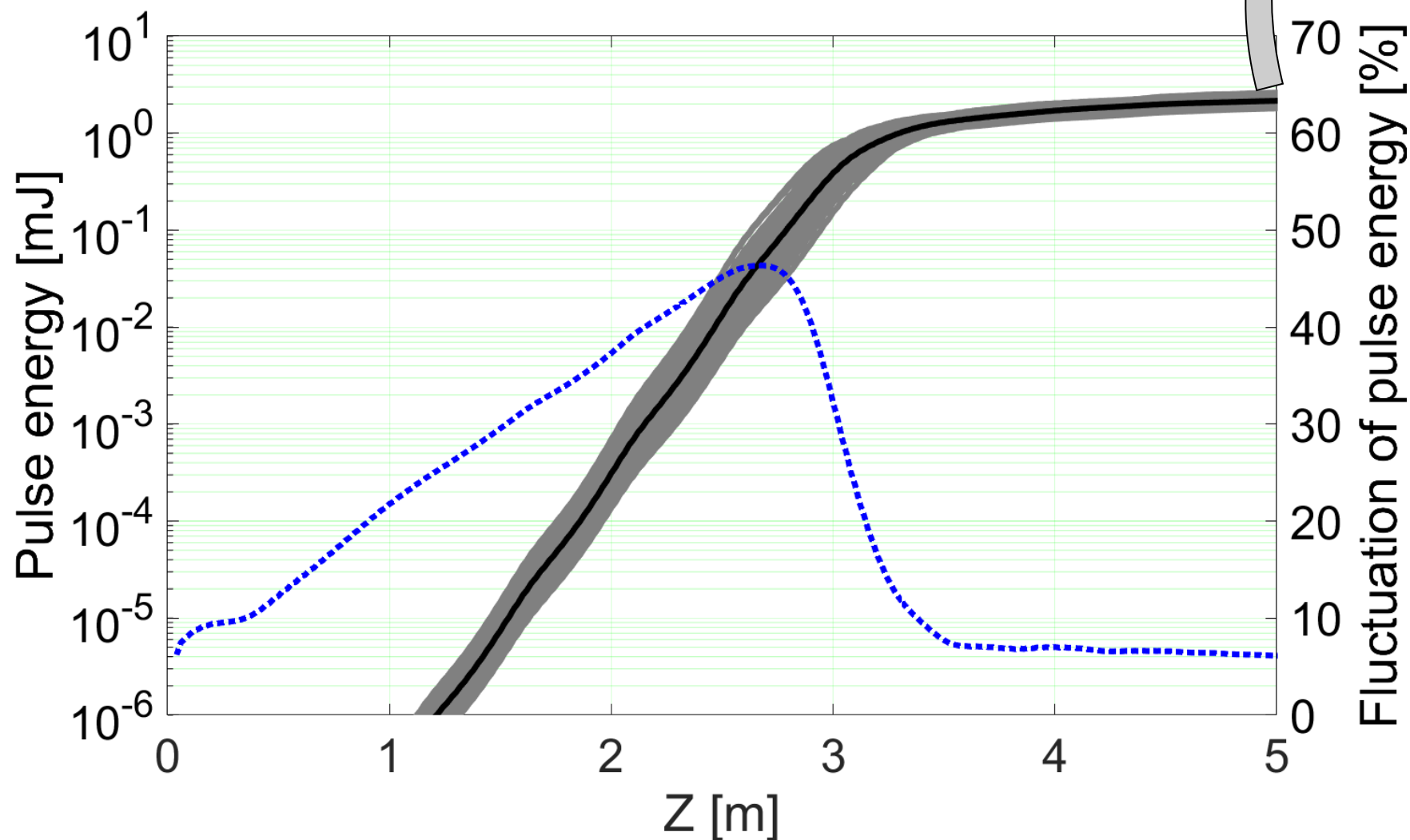


Parameters	ASTRA
σ_x [mm]	0.205
σ_y [mm]	0.204
σ_z [mm]	2.688
σ_{Pz} [keV/c]	257.940
P_z [MeV/c]	15.166
Lorentz factor	29.696
ϵ_x [mm mrad]	2.052
ϵ_y [mm mrad]	3.113
β_x [m]	0.610
β_y [m]	0.396
α_x	1.235
α_y	1.374
γ_x	4.144
γ_y	7.288

S2E Simulation: FEL Results

Simulation Tool: Genesis1.3 V2

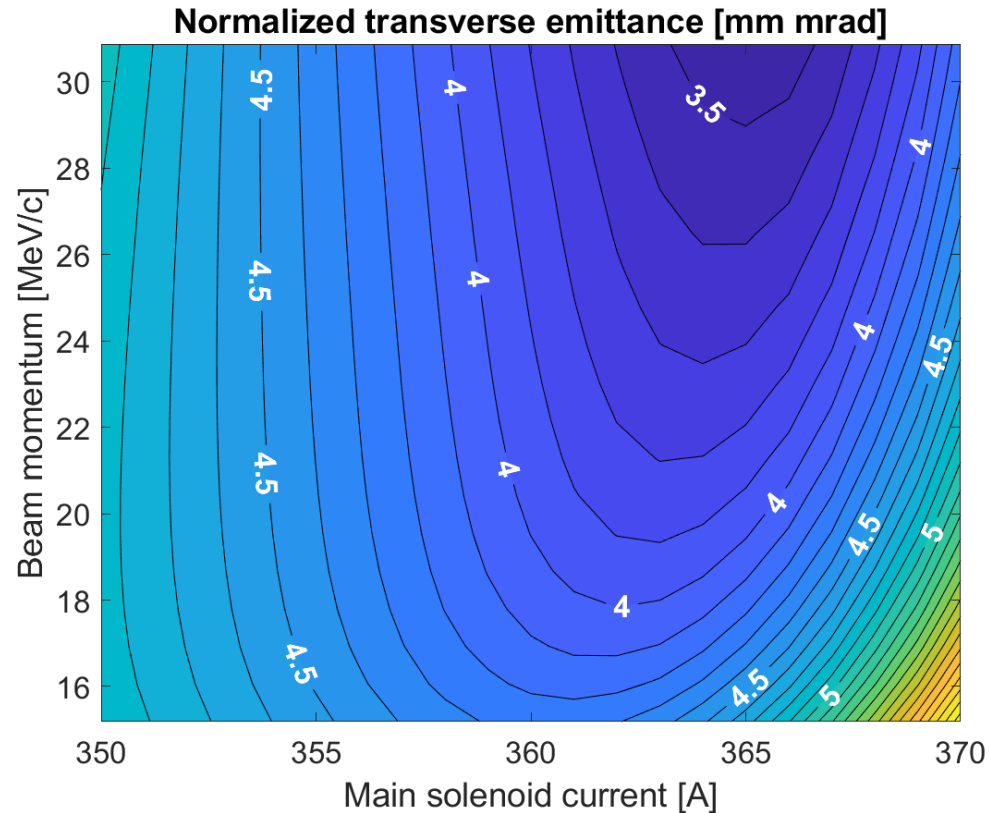
4 nC, ~15 MeV/c
for $\lambda_{\text{FEL}} = 100 \mu\text{m}$
Helical U, No BC, No DLW



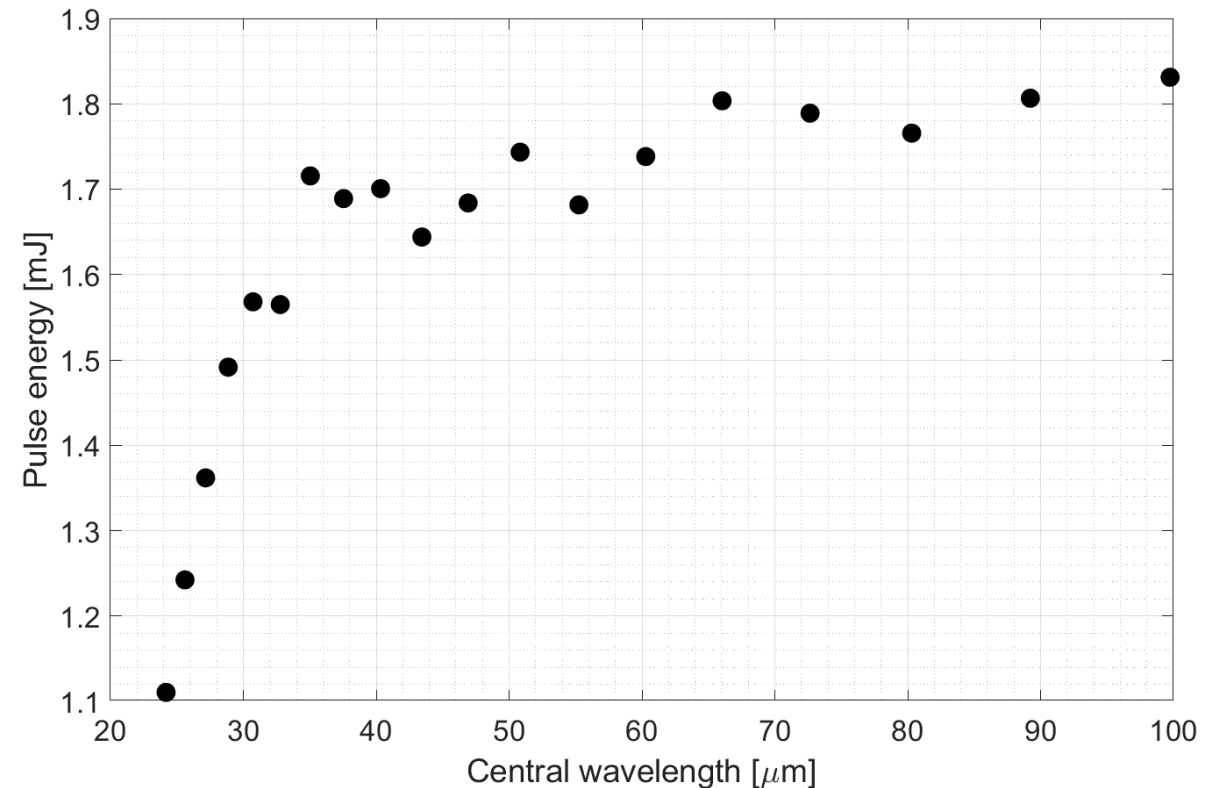
Wavelength Scan Simulation

Assume: No quadrupole magnets, ideal matching at U.entrance

Presented in LINAC2022, MOPOPA04



Normalized transverse emittance at the undulator entrance as a function of the main solenoid current and the beam momentum

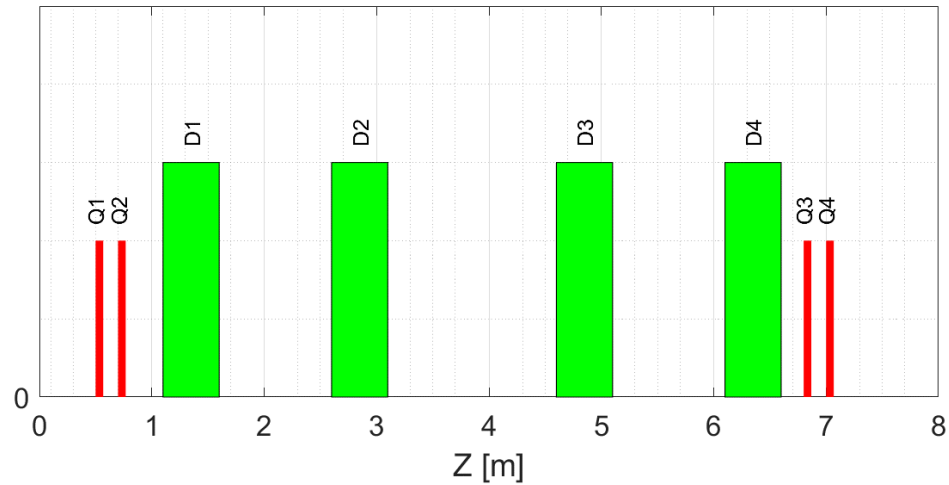


FEL pulse energy at the undulator exit as a function of the center wavelength.

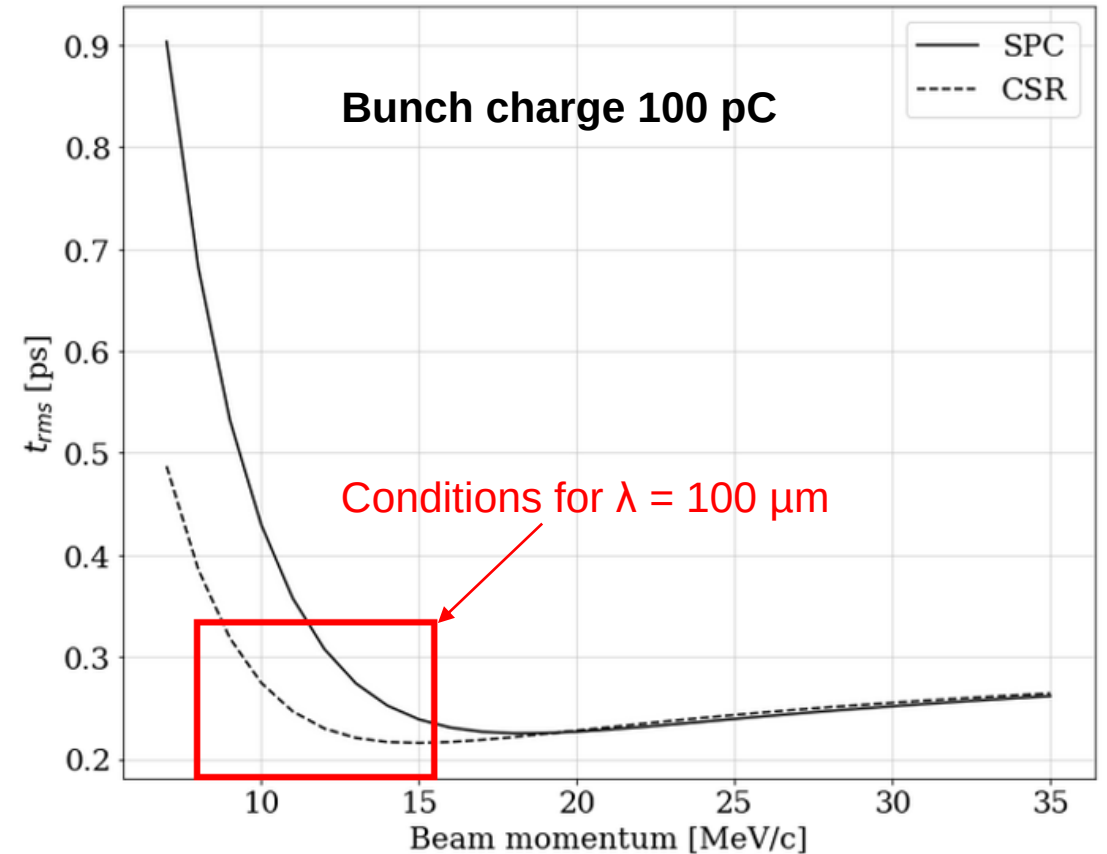
Bunch Compressor Simulations

Simulation Tool: OCELOT

Presented in IPAC2022, MOPOPA04



The lattice configuration of the bunch compressor.



Simulated final RMS bunch lengths as a function of beam momentum.

Summary & Outlook

Preparations

- The first S2E simulation of a SASE FEL for the ideal THz source was done.
 - Beam 4nC, ~ 15 MeV/c $\rightarrow$ $\sim$ mJ pulse energy for 100 μ m SASE FEL
- Wavelength scan simulation $\rightarrow$ $\sim$ mJ pulse energy for 20-100 μ m SASE FEL
- First bunch compressor simulations were done.

Next Steps

- Finalize design considerations (undulator, chicane, DLW)
- Detailed simulations
- Writing the conceptual design report