FEL simulation on THz@PITZ

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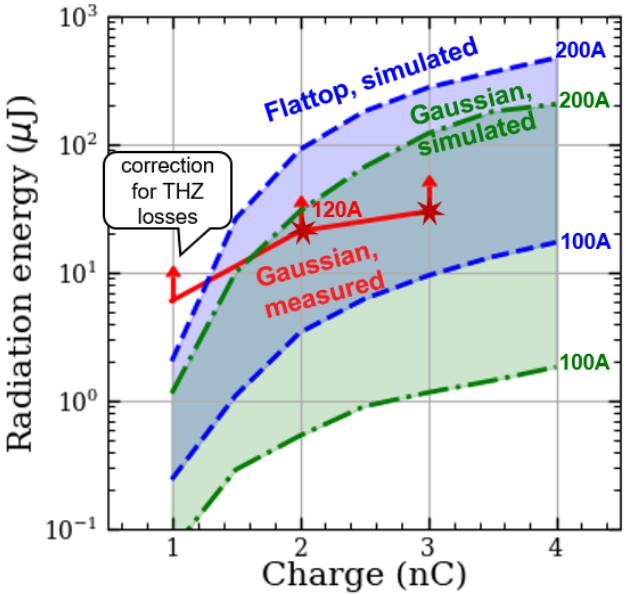
Mini-workshop on THz@PITZ, DESY Zeuthen, 15.03.2023

FEL simulation at PITZ

- Genesis1.3 V2
  - Parameter space study
  - Nominal case → **4 nC, 22 ps flattop**
  - No trans. space charge, no waveguide

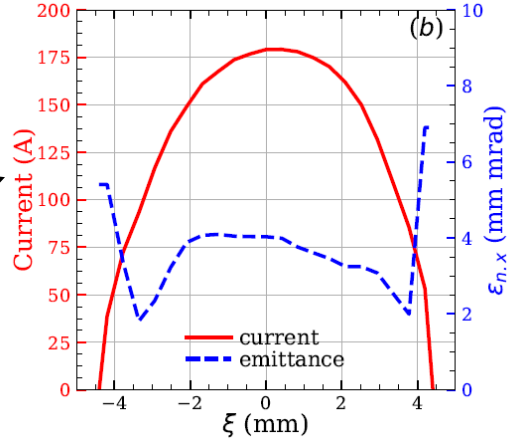


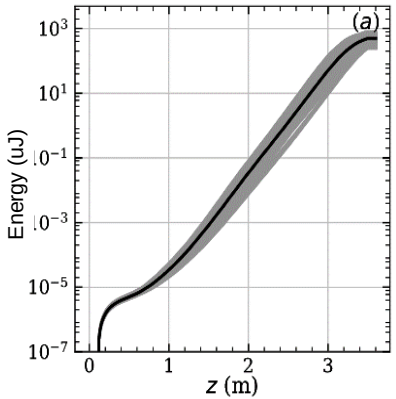
- Warp (Parallel PIC code)
  - Support simulation in **Lorentz boosted frame** → simulation time significantly reduced
  - **Boundary condition** or conductor boundary → **waveguide effects**
  - **Shot noise** to be implemented correctly

Astra+Genesis1.3 simulation

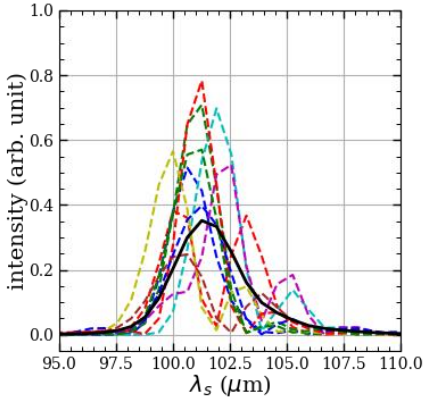
Nominal case

- Input beam for Astra: **4 nC**, flattop 22 ps laser pulse
- Beam momentum: 17 MeV/c → **100 um, 3 THz**

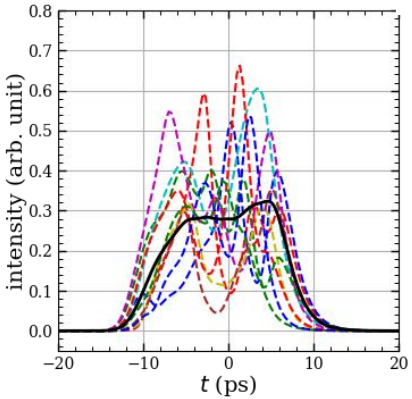




THz pulse energy in undulator



Spectrum



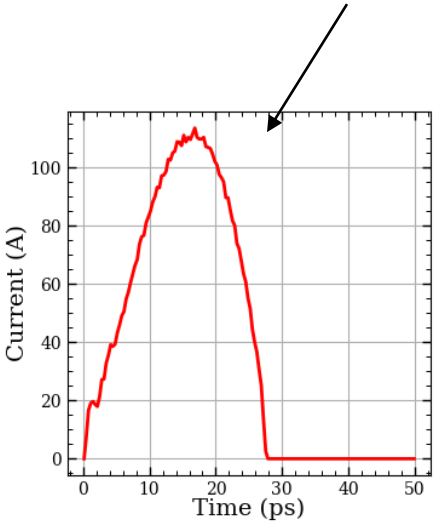
THz pulse profile

Case	100 um	Unit
Electron momentum	17	MeV/c
THz pulse energy	**493.1± 109.8**	μJ
Arrival time jitter	1.5	ps
Center wavelength	**101.8± 0.7**	μm
Spectrum width	2.0±0.4	μm

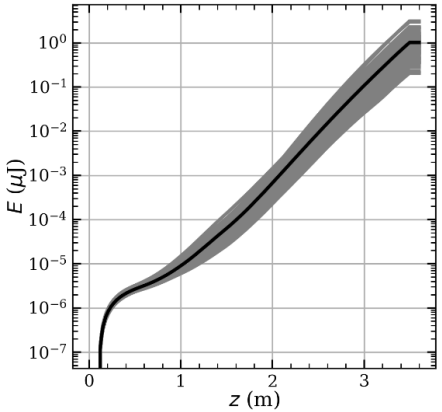
Astra+Genesis1.3 simulation

2 nC as used in experiments

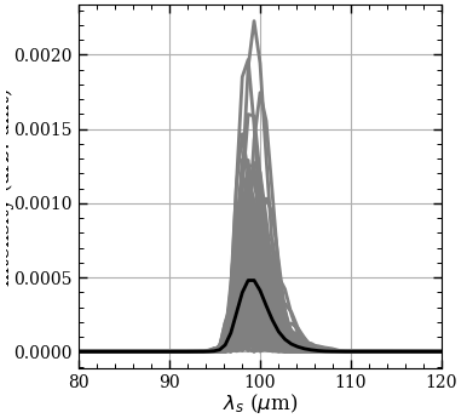
- Input beam for Astra: **2 nC**, MBI laser (6-7 ps Gaussian) → only **1 μJ**



Bunch profile in front of undulator (Astra simulation)



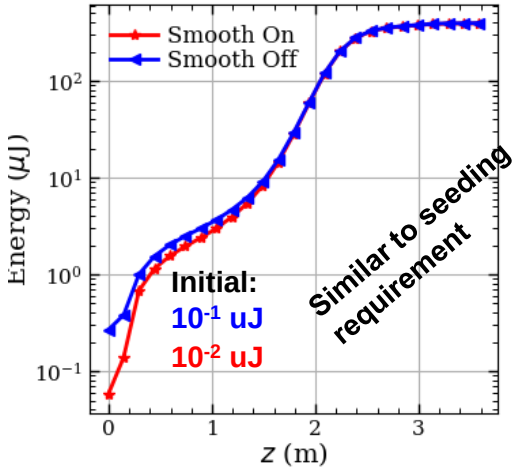
THz pulse energy in undulator



Spectrum

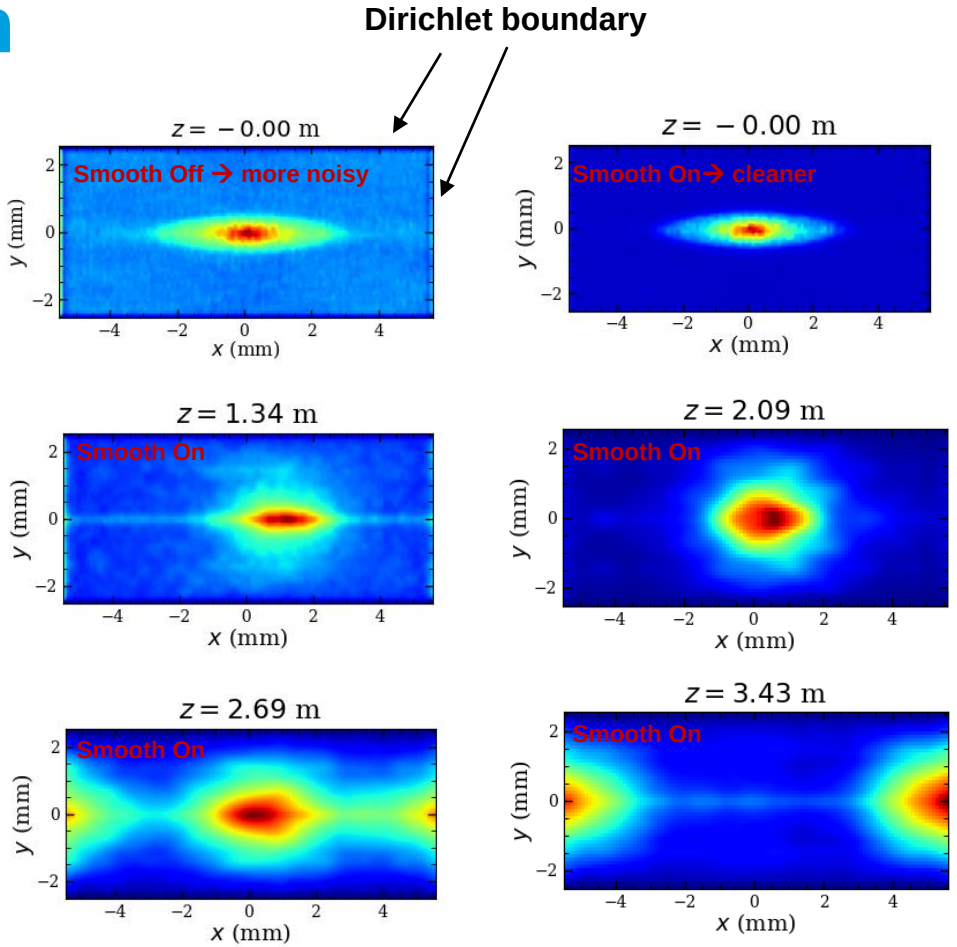
Astra+Warp simulation

- Input: **2 nC** beam from Astra simulation, **1 M** macro particles (**10^4** less than electrons)
- **Smoothing** of charge/current for EM solver switched ON to suppress noise



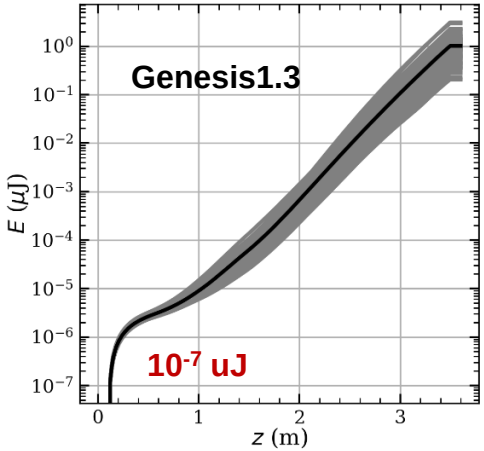
To do:

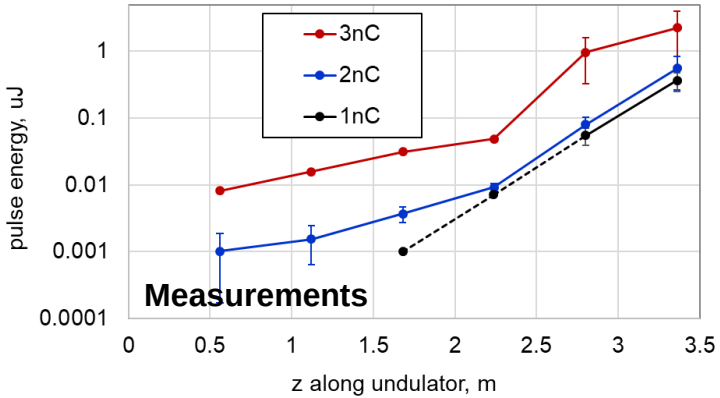
- **Shot noise** implementation
- Initial noise compared to theoretical estimation
- **THz profile** measurement



TE01 + TE21?

Shot noise levels





FAST Simulations (M. Yurkov)