Parallel operation of SASE1 and SASE3

Artsrun Sargsyan, Vahe Sahakyan

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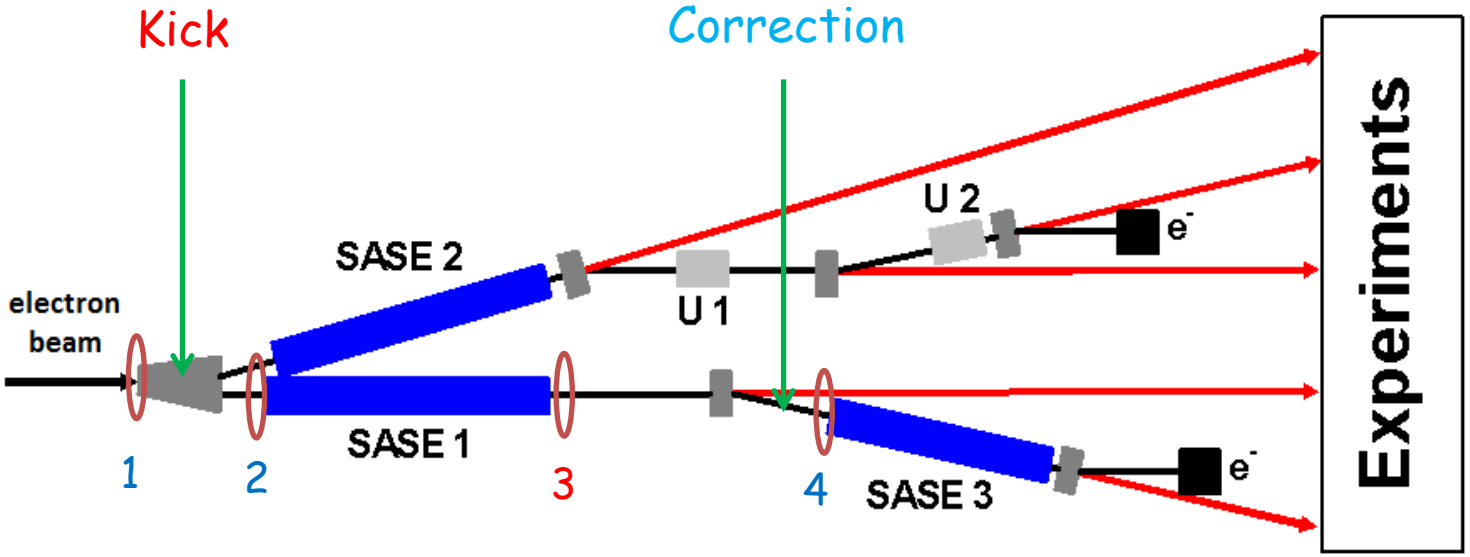
Introduction

Goal: To achieve parallel operation of SASE1 and SASE3.



Considered cases

Beam energy (GeV)	SASE1 λ(nm)	SASE3 λ(nm)
17.5	0.1	0.4
14	0.23	0.4

Conversion scripts

1. astra2elegant (MATLAB script)
2. elegant2genesis (SDDS ToolKit)
3. genesis2elegant (MATLAB script)
4. elegant2genesis

Conversion scripts

1. astra2elegant

ASTRA beam file (x, y, z, px, py, pz, ….) → MATLAB script → ELEGANT beam file (x, x′, y, y′, t, γ, ….)

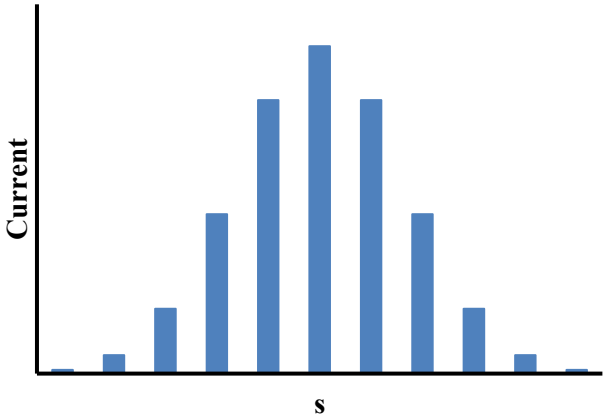
2. elegant2genesis

This program is a part of SDDS ToolKit

3. genesis2elegant

GENESIS	ELEGANT
All slices have the same number of macro particles, but different currents.	All macro particles, have the same charge.

Different treatment of macro particles



genesis2elegant

$$N_i = N_p \cdot \frac{I_i}{I_{\max}}$$

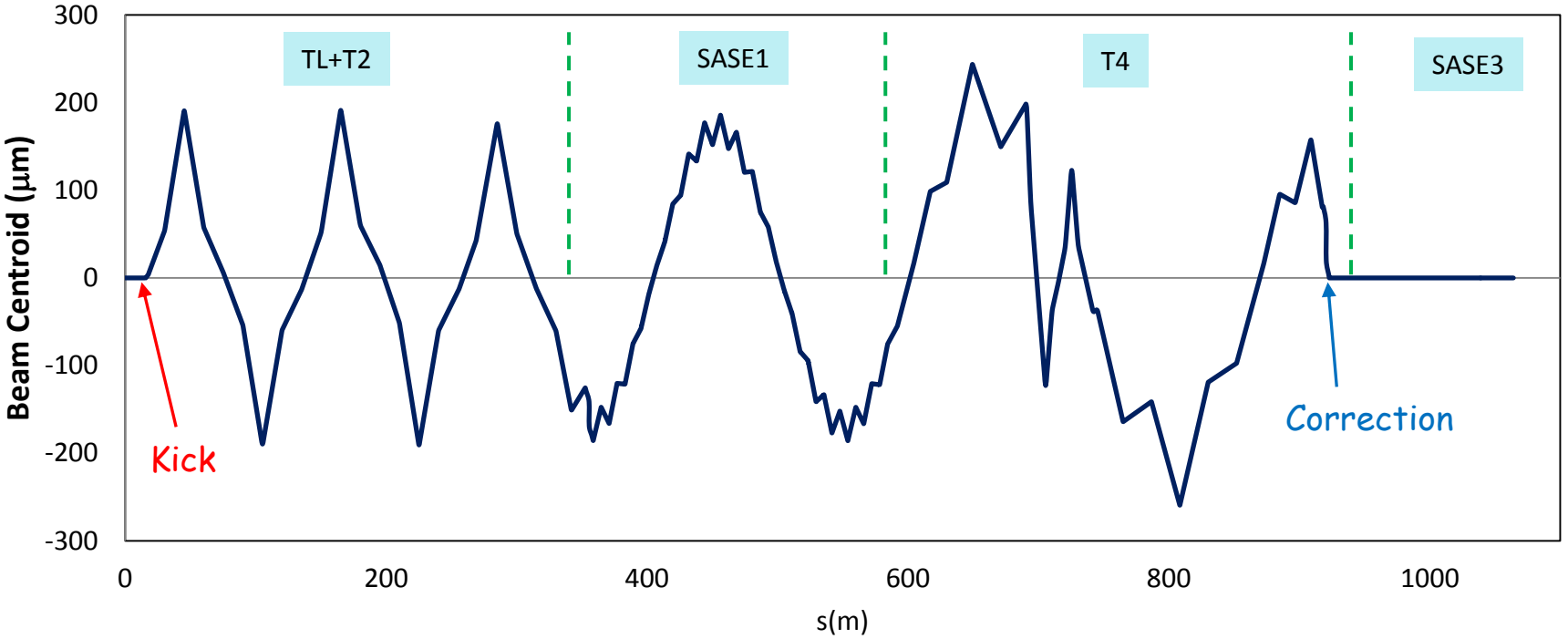
N_p -particles per slice

I_i -current of i-th slice

$I_{\max}$ -max. current

Numerical simulations

Kick by KFBX.1893.TL fast kicker and correction by CEX.2795.T4 and CEX.2799.T4 correctors



Beam centroid for 17,5 GeV case when kick is equal to 4 μrad

Considered cases for kick values

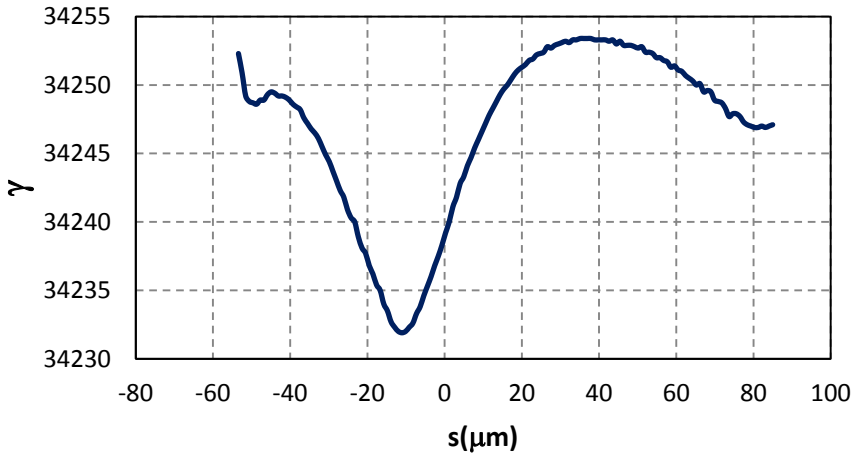
17,5 GeV
- 2 μrad kick
- 4 μrad kick
- 6 μrad kick

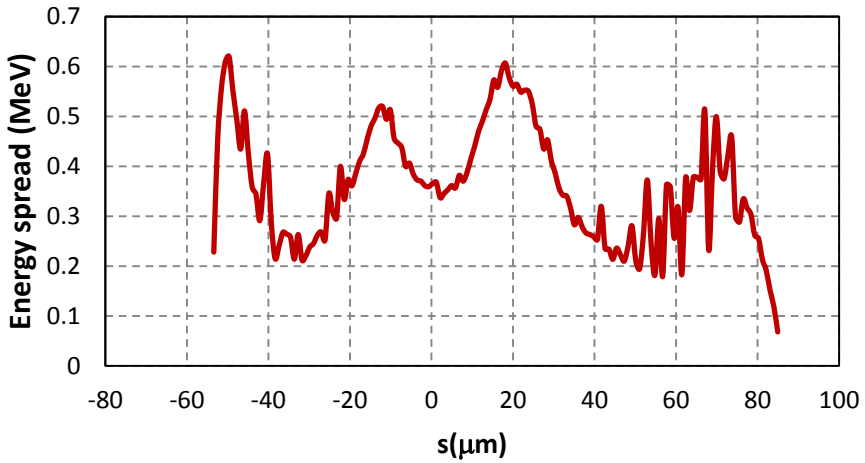
14 GeV
- 4 μrad kick
- 6 μrad kick
- 8 μrad kick

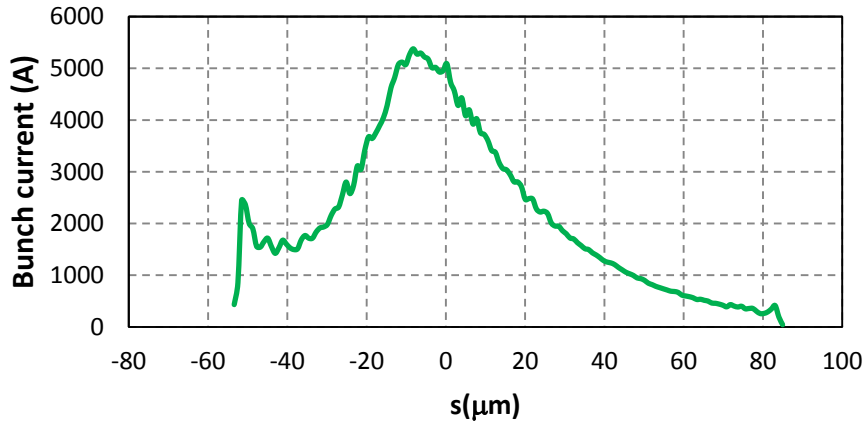
Max. traj. deviation	500 μm
Corrector max. kick	20 μrad

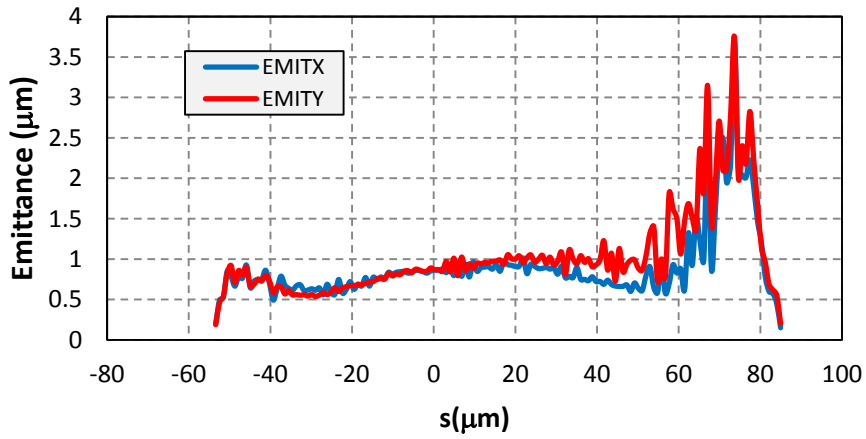
Numerical simulations (E=17,5 GeV, Q=1nC)

ASTRA beam before TL section







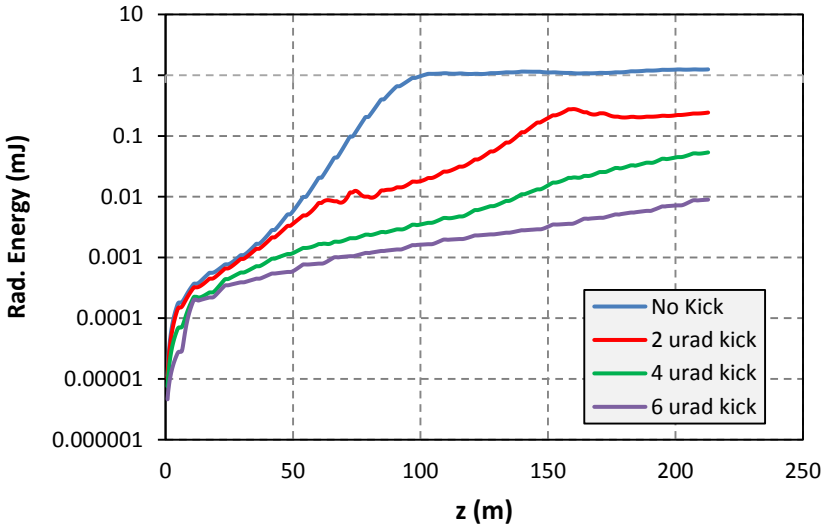


ε_x = 0,9 μm, ε_y = 1,08 μm

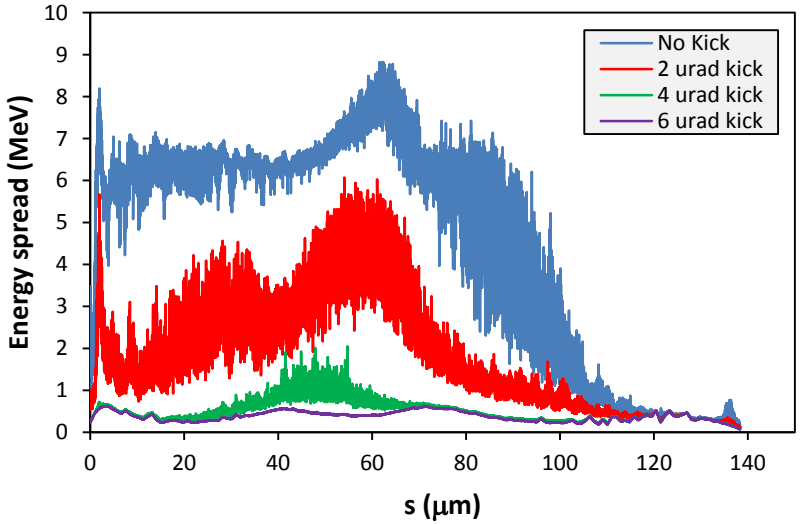
Beam file provided by Guangyao Feng

Numerical simulations (E=17,5 GeV, Q=1nC)

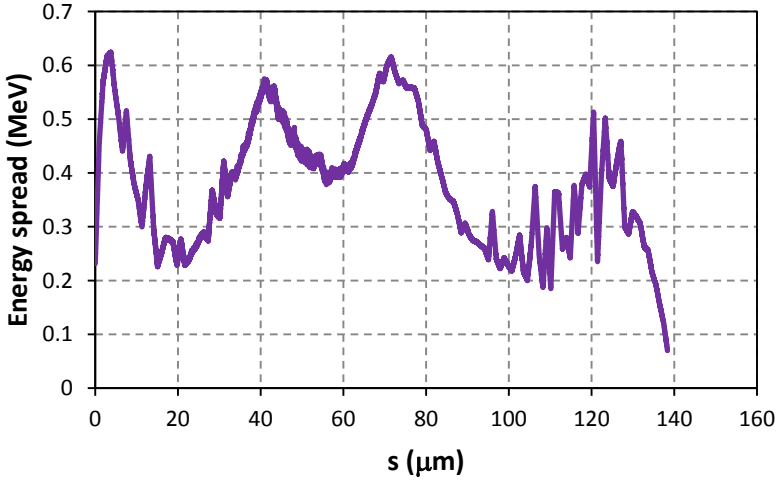
Rad. energy along SASE1 (0,1 nm)



Energy spread after SASE1



Energy spread after SASE1 for 6 μrad kick

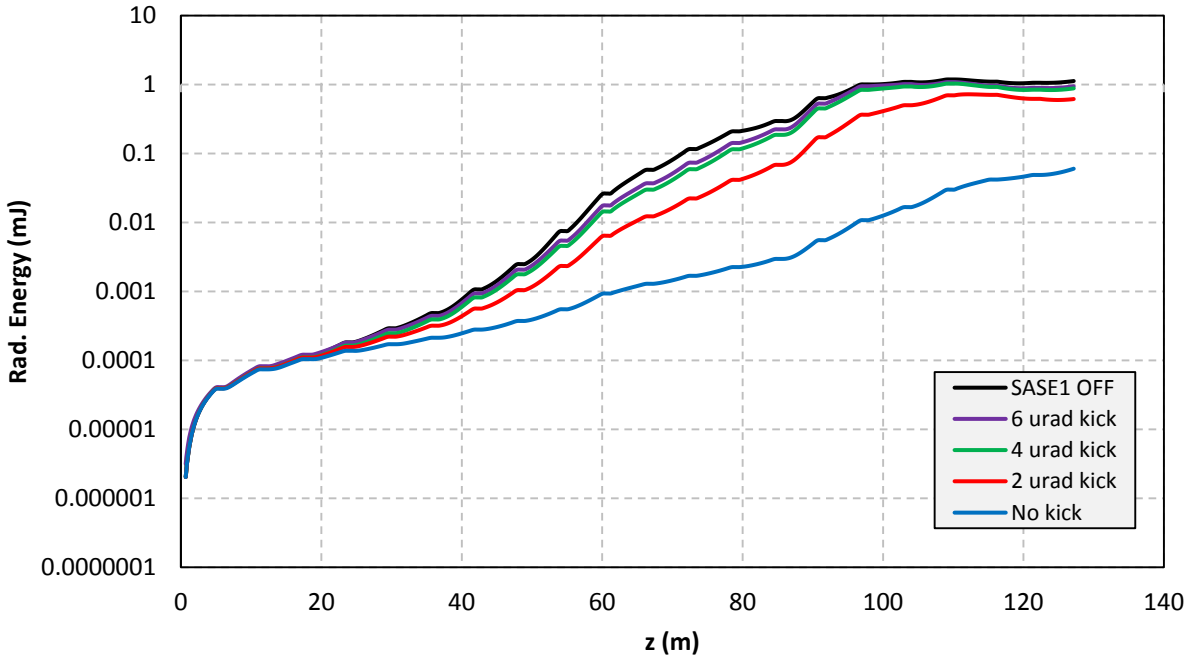


Rel. changes of sat. length and rad. energy at sat.

Kick value	L_{sat}	E_{sat}
No kick	1	1
2 μrad	1,75	0,43
4 μrad	-	-
6 μrad	-	-

Numerical simulations (E=17,5 GeV, Q=1nC)

Rad. energy along SASE3 (0,4 nm)

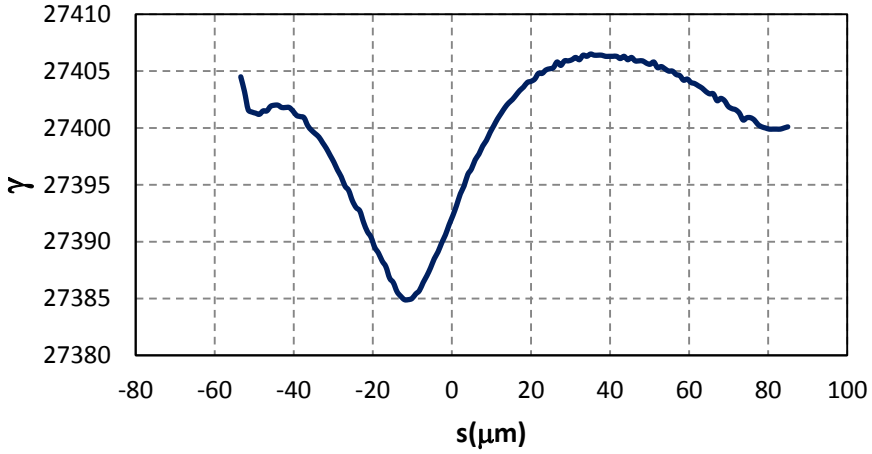


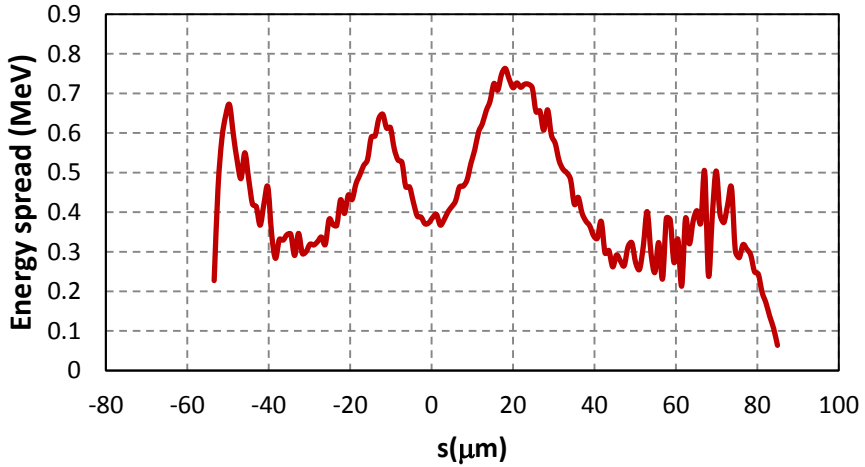
Rel. changes of sat. length and rad. energy at sat.

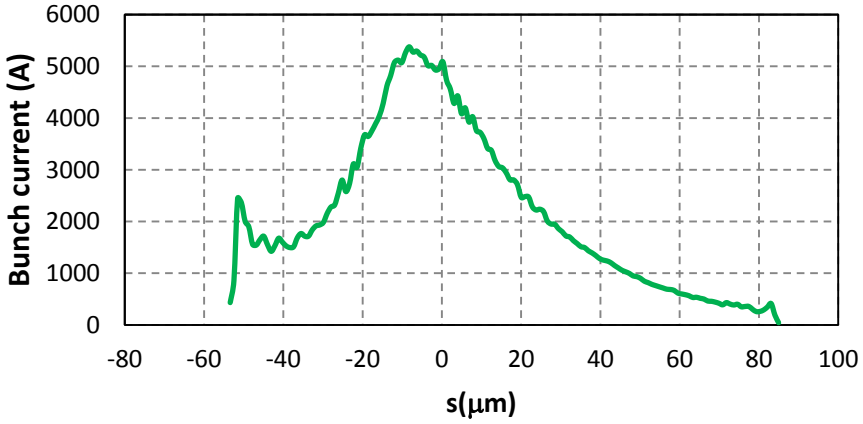
Kick value	L_{sat}	E_{sat}
SASE1 OFF	1	1
6 μrad	1,02	0,95
4 μrad	1,04	0,91
2 μrad	1,12	0,7
No kick	-	-

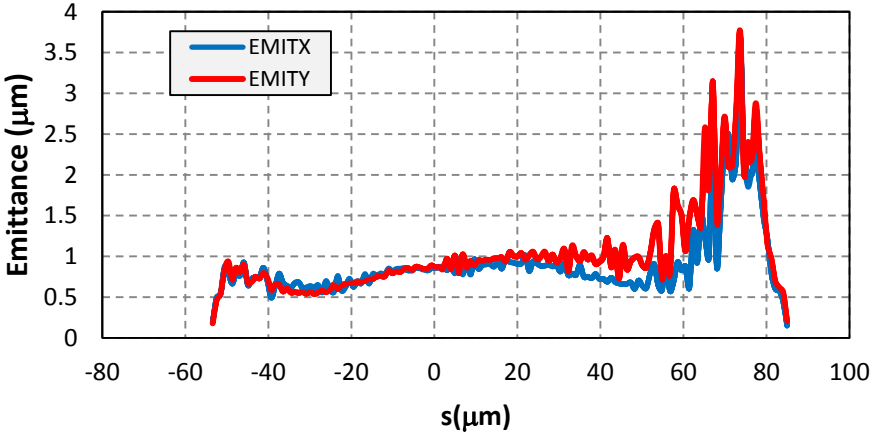
Numerical simulations (E=14 GeV, Q=1nC)

ASTRA beam before TL section





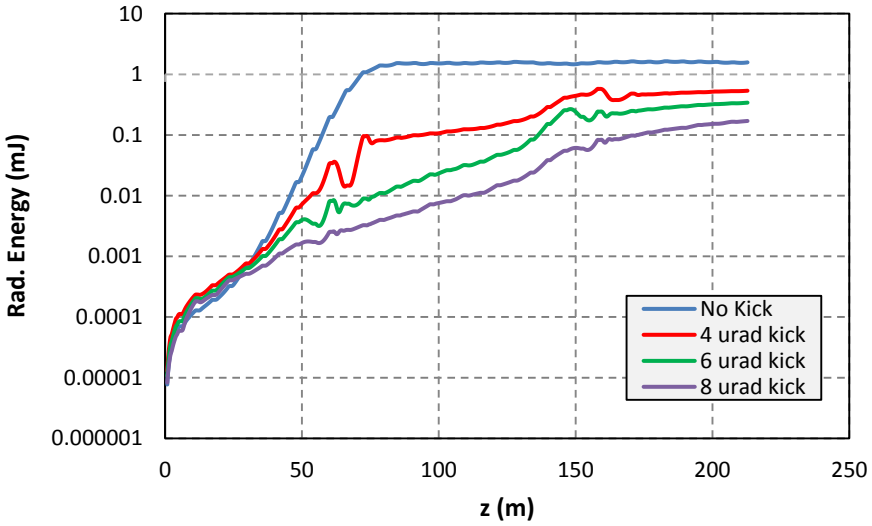




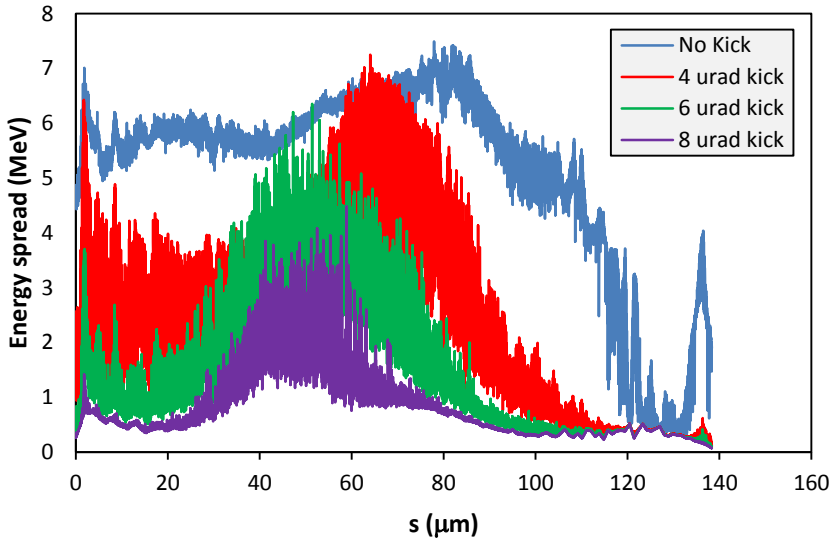
ε_x = 0,91 μm, ε_y = 1,08 μm

Numerical simulations (E=14 GeV, Q=1nC)

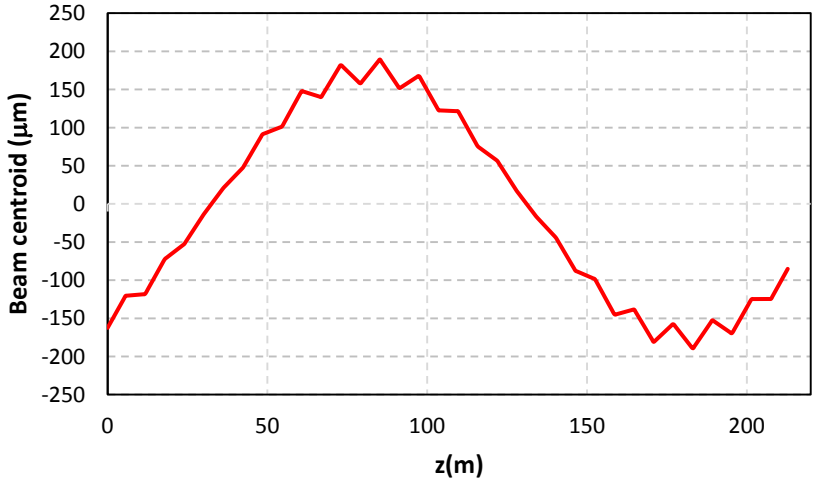
Rad. energy along SASE1 (0,23 nm)



Energy spread after SASE1



Beam centroid along SASE1 for 4μrad kick

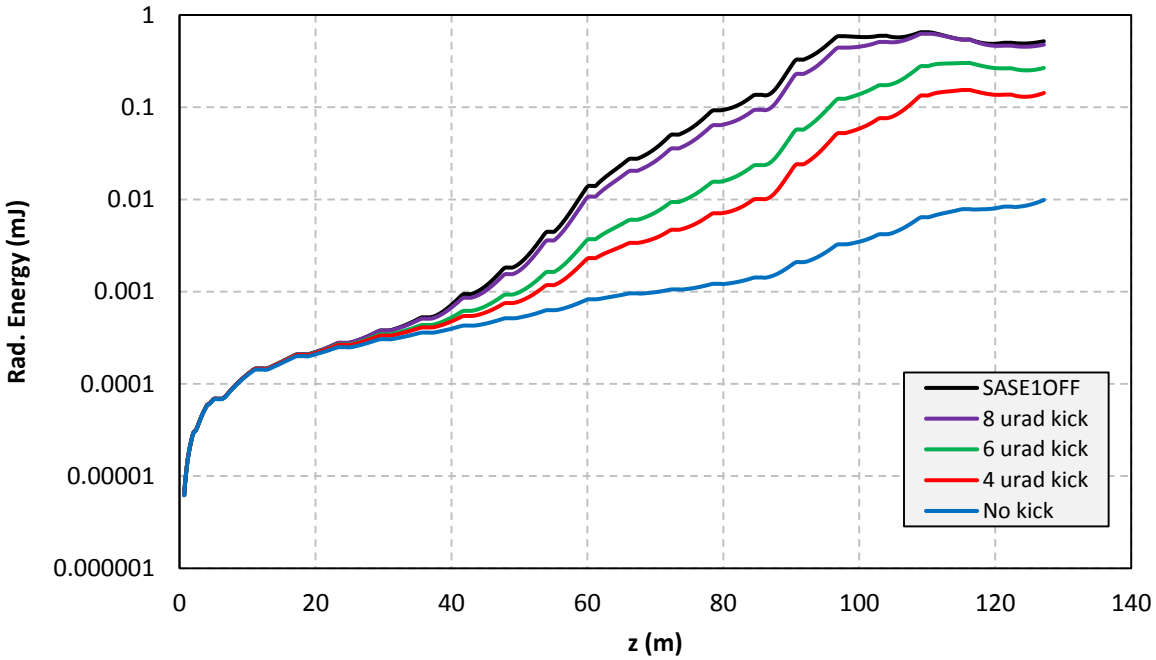


Rel. changes of sat. length and rad. energy at sat.

Kick value	L_{sat}	E_{sat}
No kick	1	1
4 μrad	1,95	0,35
6 μrad	-	-
8 μrad	-	-

Numerical simulations (E=14 GeV, Q=1nC)

Rad. energy along SASE3 (0,4 nm)



Rel. changes of sat. length and rad. energy at sat.

Kick value	L_{sat}	E_{sat}
SASE1 OFF	1	1
8 μrad	1,02	0,78
6 μrad	1,12	0,5
4 μrad	1,14	0,23
No kick	-	-

Next steps

- Study the case when:

  E=8.5 GeV,

  λ_{SASE1} = 0.62 nm $K_{SASE1} \in [1.65, 3.9]$

  λ_{SASE3} = 1,1 nm $K_{SASE3} \in [4, 9]$

- Study the impact of the kick position (different betatron phases at the entrance of SASE1)

THANK YOU FOR ATTENTION