# Work progress in February 2013

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MPY, DESY

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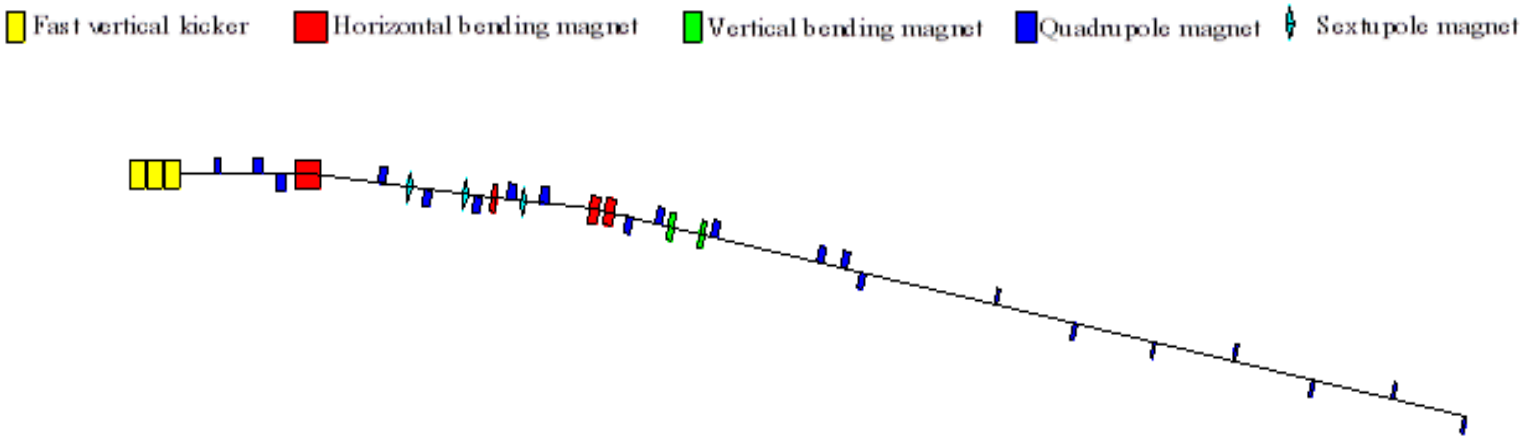
# The plan for last month

- Start to end simulation for FLASHII with low bunch charge (25%)
- Writing an elegant lattice file for EXFEL based on the Mad8 files (100%)
- Start to end simulation for SASEII (25%)
- Internal report about ACC1 gradient studies (50%)

# Achieved progress

1. Start to end simulation for FLASHII with low bunch charge (100pC) (70%)

**Purpose**: Investigating the CSR effects and the impact from the chromatic aberrations in the extraction arc on SASE for the low bunch charge case.



# Start to end simulation for FLASHII with low bunch charge

(1) The input files conversion from Elegant to Astra and CSRTrack based on Matthias's Elegant lattice file.

| | |
|---|---|
| **RF Gun** | **ASTRA** |
| **ACC1** | **ASTRA** |
| **ACC39** | **ASTRA** |
| **BC2** | **CSR-TRACK** |
| **ACC2/3** | **ASTRA** |
| **BC3** | **CSR-TRACK** |
| **ACC4/5/6/7** | **ASTRA** |
| **Extraction arc** | **CSR-TRACK** |
| **Straight section before undulator** | **ASTRA** |

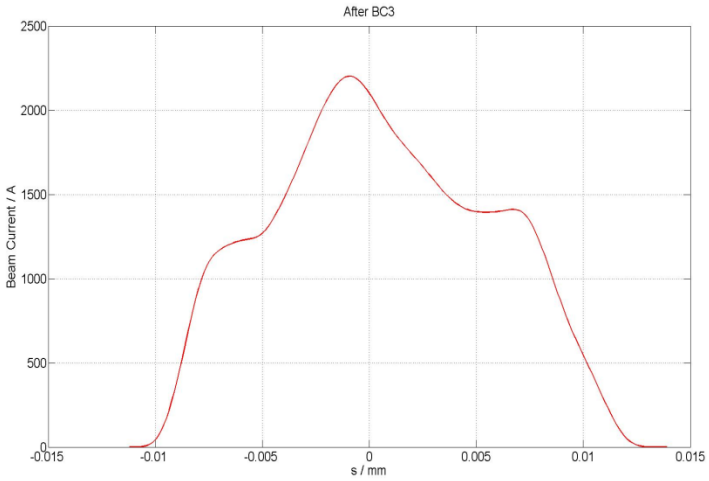
# Start to end simulation for FLASHII with low bunch charge

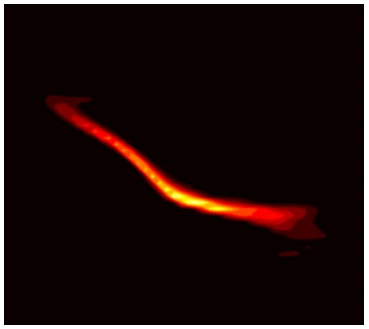
(2) RF parameters optimization for accelerating modules in order to get the current profile with good symmetry. (Considering space charge, CSR and wake field effects)

## Restrictions:

- Q=100pC, $\sigma_t$=4.4ps, $\sigma_x$=$\sigma_y$=0.286mm Initial description of the bunch
- $I_{peak}$=2.5kA Compression ratio in the bunch compressors
- E=1.0GeV Beam energy at the end of the Linac
- $E_1$=150MeV Beam energy after ACC39
- $E_2$=450MeV Beam energy after ACC3

| Element | Phase shift | $V_{max}$ |
|---|---|---|
| **RF Gun** | 2.00° | |
| **ACC1** | **-11.838°** | **168.586MV** |
| **ACC39** | **132.935°** | **28.651MV** |
| **ACC2/3** | **25.00°** | **331.565MV** |
| **ACC4/5** | 0° | 275.0MV |
| **ACC6/7** | 0.0° | 275.0MV |

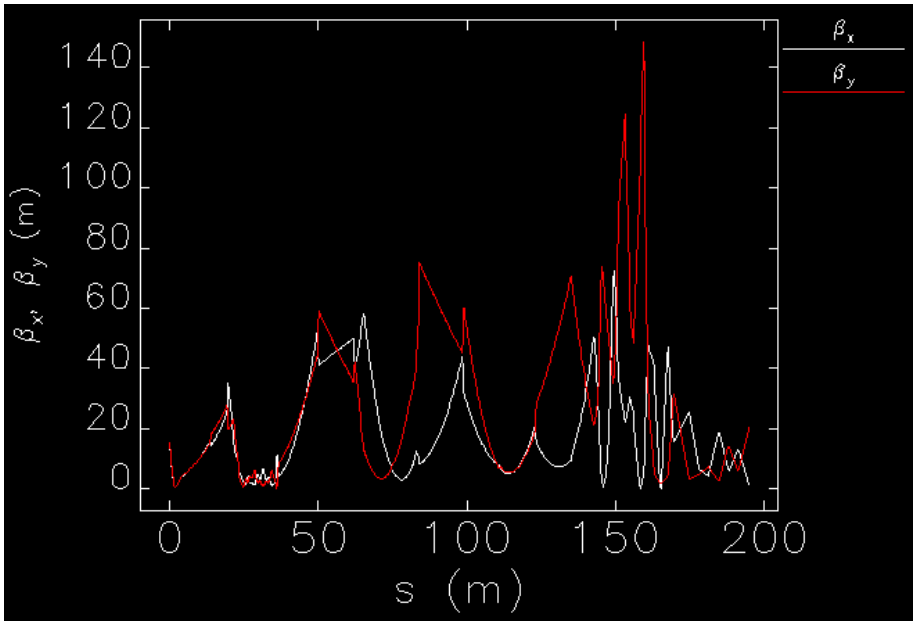


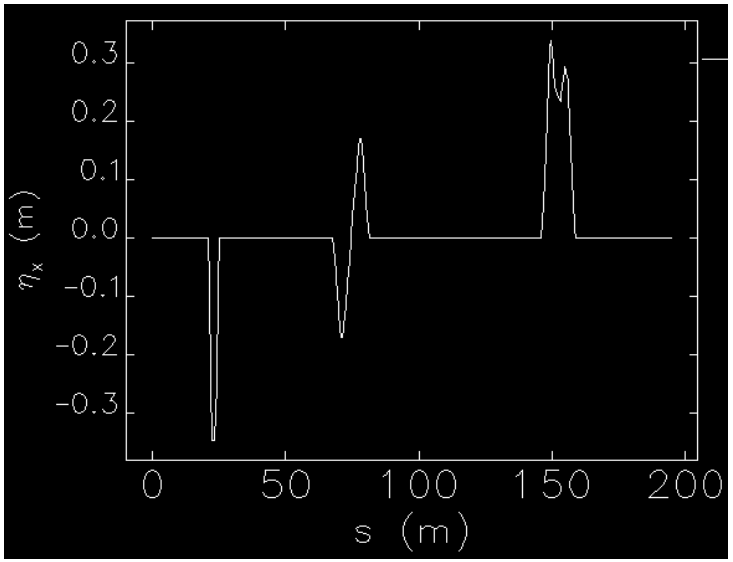



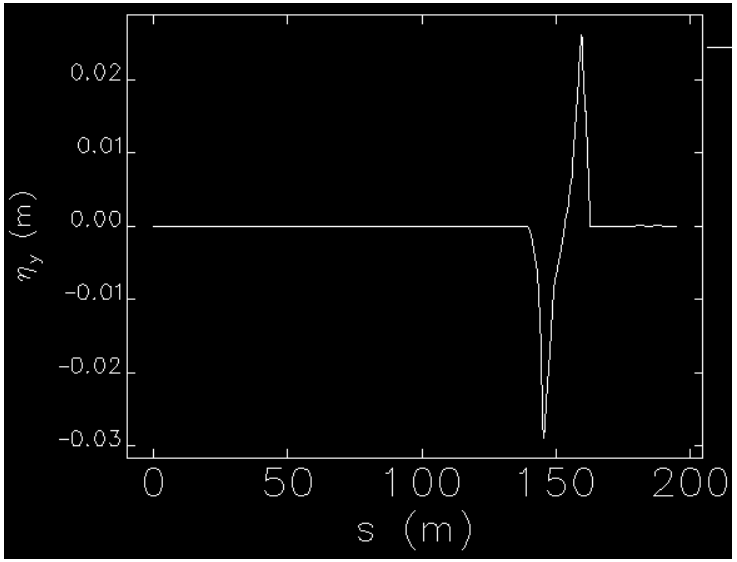
**After BC3**

# Start to end simulation for FLASHII with low bunch charge

(3) Design optics calculation using the optimized RF parameters for FLASHII with Elegant



# Start to end simulation for FLASHII with low bunch charge

(4) Beam dynamics simulation from start to the entrance of the undulator system (300000 particles)

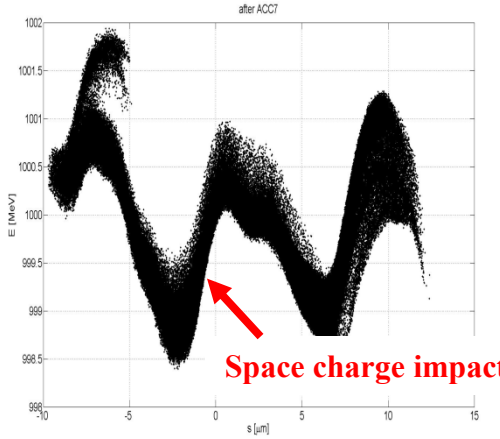
| Extraction arc | | Angles | |
|---|---|---|---|
| Horizontal bending magnets | (4) | 6.5°, -0.9°, 3.2°, 3.2° | |
| Vertical fast kickers | (3) | $7.35\times10^{-4}$ , $7.35\times10^{-4}$ , $7.35\times10^{-4}$ | [rad] |
| Vertical bending magnets | (2) | $1.21\times10^{-2}$, $-1.21\times10^{-2}$ | [rad] |

(1) The vertical deflection angles are too small to concern the CSR effects.

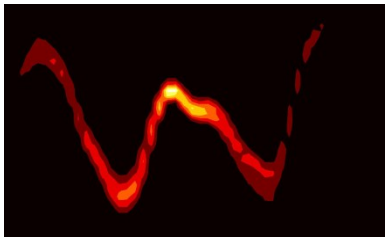
(2) There will be a vertical misalignment (2-3.6cm) of the dipoles and quadrupoles in the arc. During the **CSRTrack** calculation, horizontal and vertical bending magnets can't be defined at the same time. The calculation should be done in one plane.

Ignoring the CSR effects and the chromatic aberration impact in **the vertical plane** during the CSRTrack calculation.

# Start to end simulation for FLASHII with low bunch charge

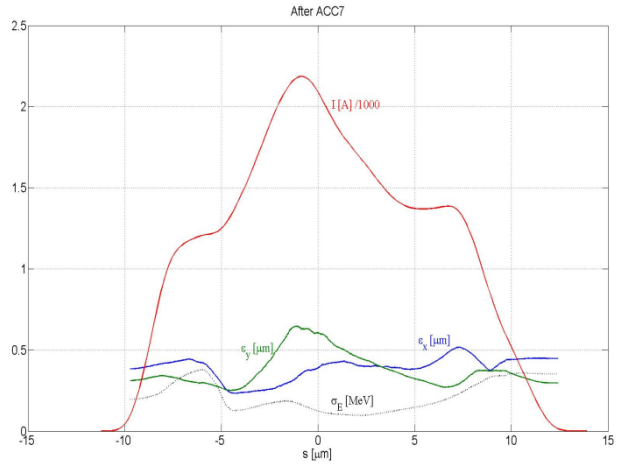


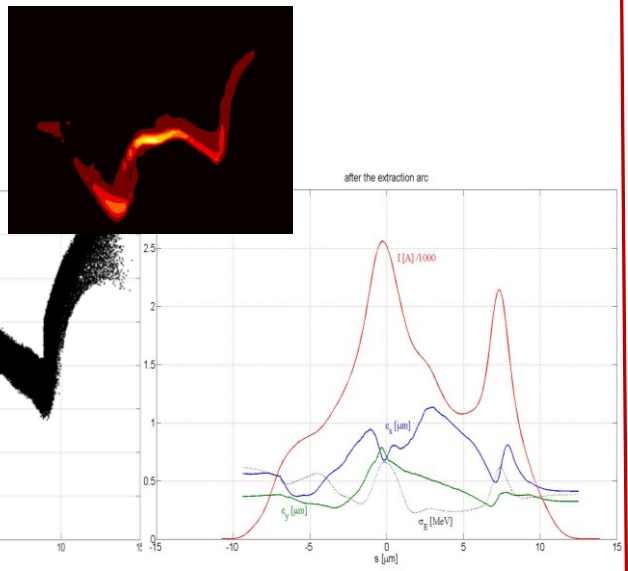

Space charge impact



$\varepsilon_x{}^{proj}$=1.2$\mu m$ , $\varepsilon_y{}^{proj}$=0.6$\mu m$

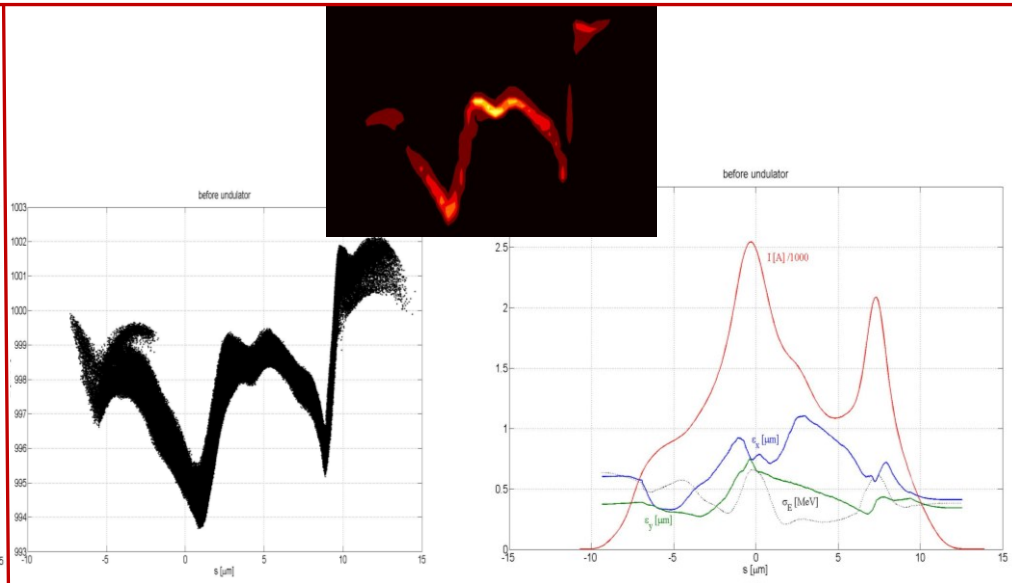
**After ACC7**




$\varepsilon_x{}^{proj}$=1.6$\mu m$ , $\varepsilon_y{}^{proj}$=0.6$\mu m$

**After extraction arc**




$\varepsilon_x{}^{proj}$=1.6$\mu m$ , $\varepsilon_y{}^{proj}$=0.6$\mu m$

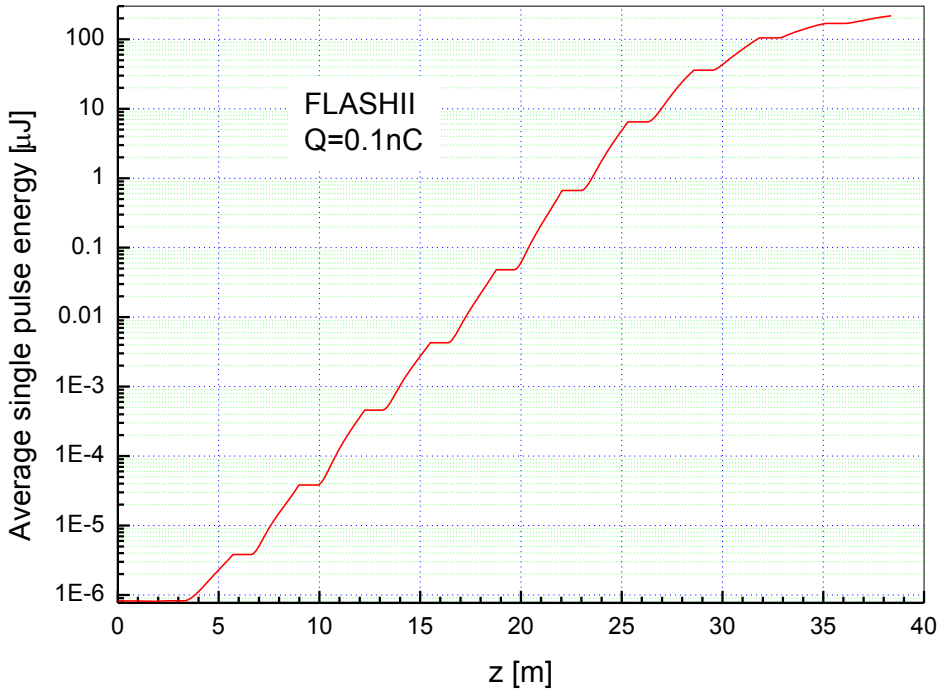
**Before undulator**

# Start to end simulation for FLASHII with low bunch charge

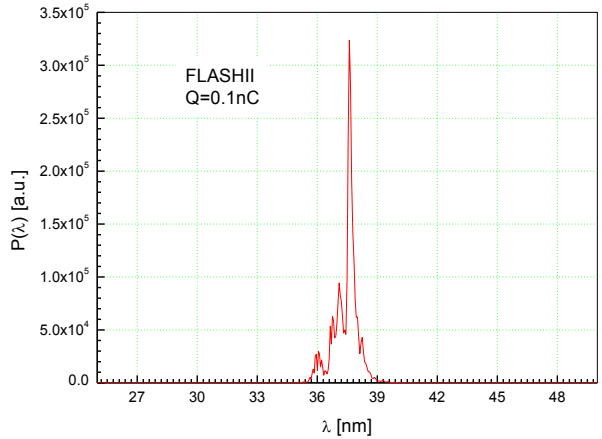
(5) SASE FEL simulation* Going forward … …

Slice parameters are extracted from s2e simulations for SASE simulation

$$\gamma \quad \Delta\gamma \quad \varepsilon_x \quad \varepsilon_y \quad \beta_x \quad \beta_y \quad \langle x \rangle \quad \langle y \rangle \quad \langle x' \rangle \quad \langle y' \rangle \quad \alpha_x \quad \alpha_y \quad I$$




**Q=0.1nC**
**E = 220μJ**




6 random seeds for shot noise

* The magnet description file for the undulator system comes from Matthias

**Other work progress**

- Input files conversion from Mad8 to Elegant for EXFEL (100%)
- Start to end simulation for SASEII (0%)
- Internal report for the completed work (50%)

**Difficulties**

Understanding some details about the calculation results

(1) the beam optics impact on CSR related emittance growth
(2) high order momentum compaction impact on the current profile
(3) Micro bunching in the bunch compressors
(4) …

# The plan for this month

1. Completing the start to end low bunch charge simulation for FLASHII with Astra, CSRTrack and Genesis (100%)

2.

- The beam dynamics simulation for FLASHII extraction arc will be done with Elegant after getting the particle distribution file at the end of ACC7 from Astra. During the calculation, the chromatic aberrations impact in the vertical plane should be included.
- Doing beam dynamics simulation for the last straight section (before undulator) with Astra.
- The radiation calculation with Genesis (100%)

3. Making a comparison between 1 and 2 (50%)

4. Doing the start to end simulation for FLASHII with other bunch charge (0.25nC, 0.5nC, 1.0nC) if necessary (20%)

5. Begin to do the input files conversion from Elegant to Astra and CSRTrack for SASEII. (10%)

6. Continue writing the internal report for the completed work (75%)