Seeking beam bunch with special properties for FLASHII HGHG option

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Purpose

As for the requirements for FLASHII HGHG option, seeking the special beam bunch with*:

(1) Beam current: higher than 1kA

(2) Bunch length: FWHM 200 fs

RMS ~80 fs

(3) Slice energy spread: <120keV

* From Igor's email

Restrictions

- From the RF power supplies

Maximum energy gain for each accelerating module

ACC1	**165 MeV**
ACC39	**22 MeV**
ACC2/3	**345 MeV**
ACC4/5	**320 MeV**
ACC6/7	**430 MeV**

- From the rules of the machine operation

E=145MeV Beam energy after ACC39
E=450MeV Beam energy after ACC3

Start to end simulation for FLASHII

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**

- SC, CSR and Wake field effects are included

* Elegant lattice file for FLASHII comes from Matthias Scholz.

- **RF parameters optimization**

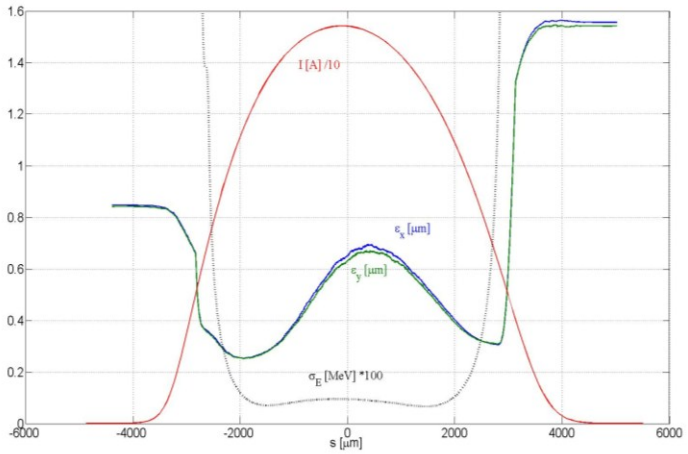
Q=0.25nC, 300000 particles

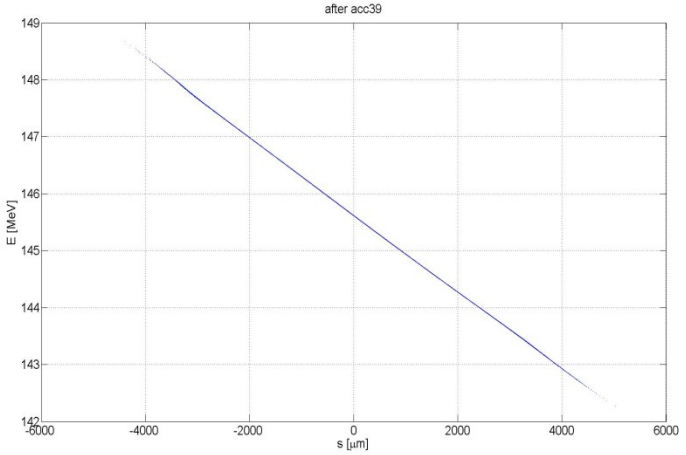
Element	Phase shift	V_{max}
RF Gun	2.00°	
ACC1	-0.158°	159.61MV
ACC39	155.017°	21.0994MV
ACC2/3	25.00°	337.302MV
ACC4/5	0.0°	320.0MV
ACC6/7	0.0°	230.0MV

E=1.0GeV at the end of the Linac.

- **Bending angles**

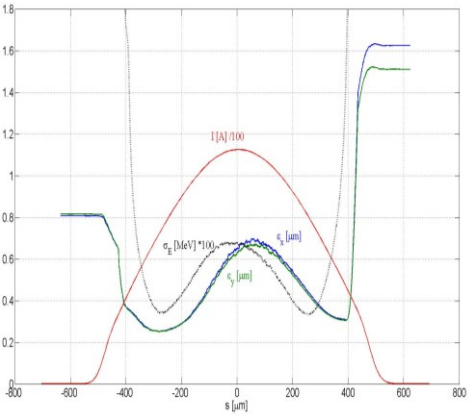
BC2 18°
BC3 3.72°

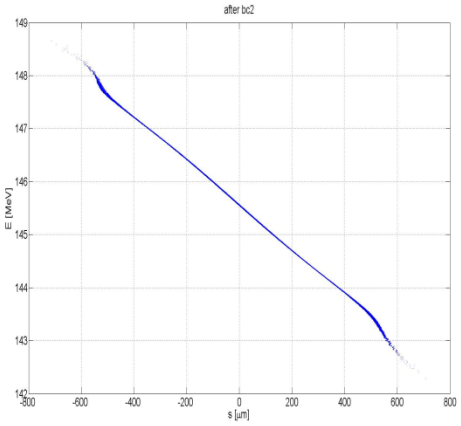




$\varepsilon_x{}^{proj}$=0.654μm , $\varepsilon_y{}^{proj}$=0.648μm

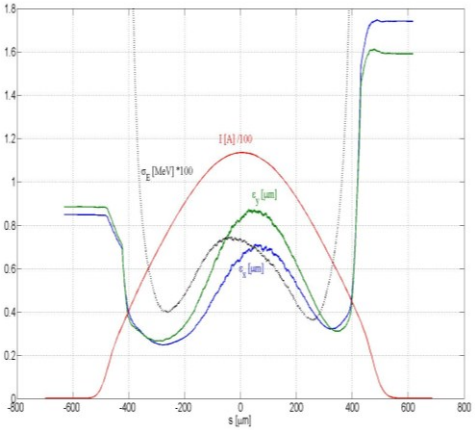
After ACC39

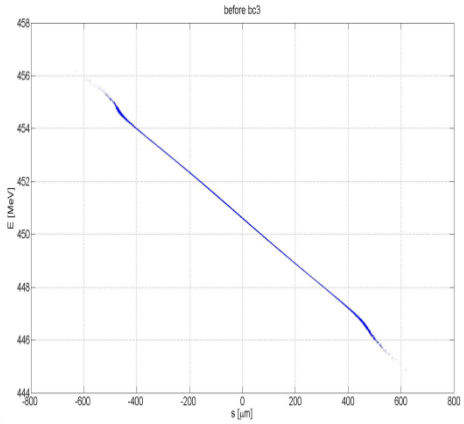




$\varepsilon_x{}^{proj}$=0.654μm , $\varepsilon_y{}^{proj}$=0.654μm

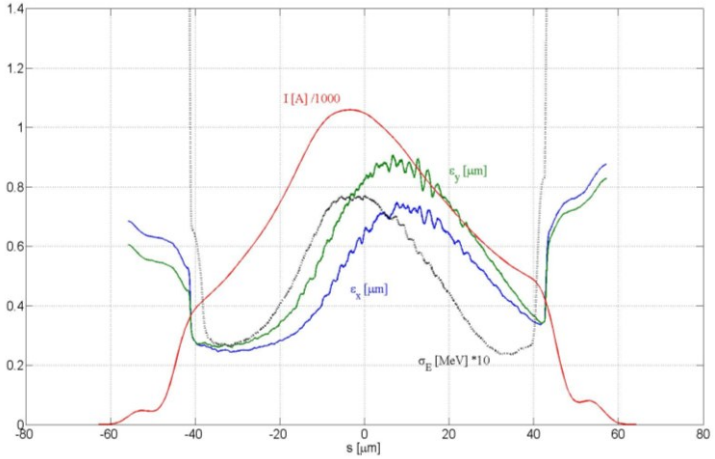
After BC2

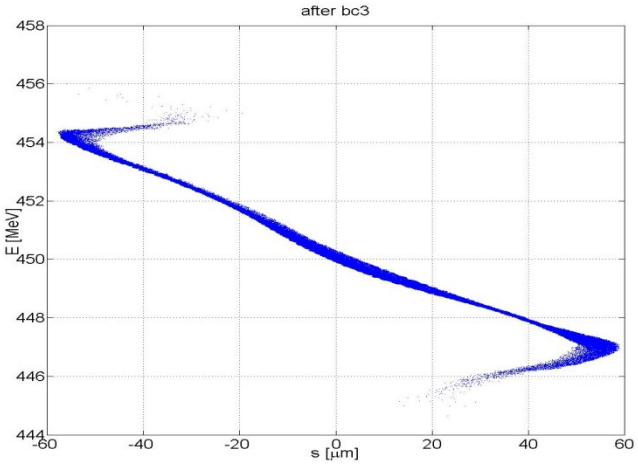




$\varepsilon_x{}^{proj}$=0.695μm , $\varepsilon_y{}^{proj}$=0.684μm

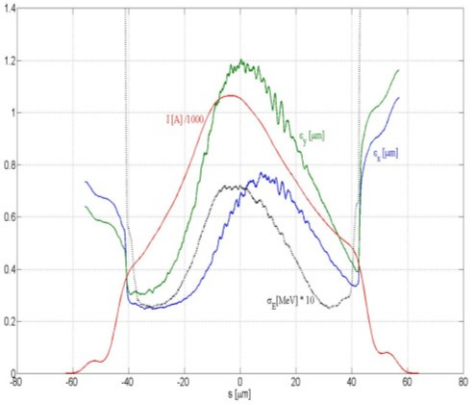
Before BC3

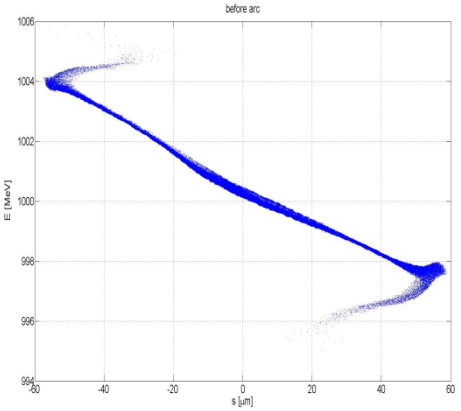




$\varepsilon_x{}^{proj}$=0.659μm , $\varepsilon_y{}^{proj}$=0.684μm

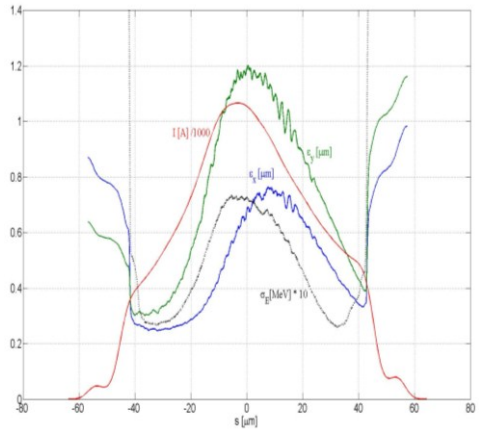
After BC3

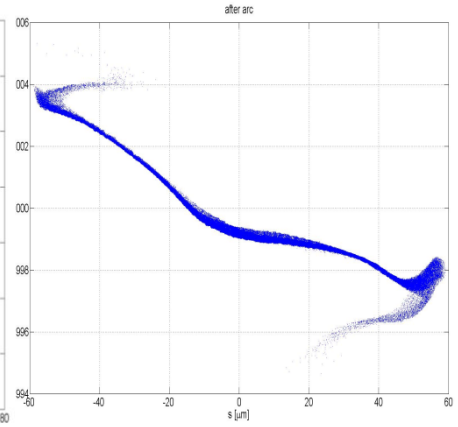




$\varepsilon_x{}^{proj}$=0.66μm , $\varepsilon_y{}^{proj}$=0.88μm

Before Arc

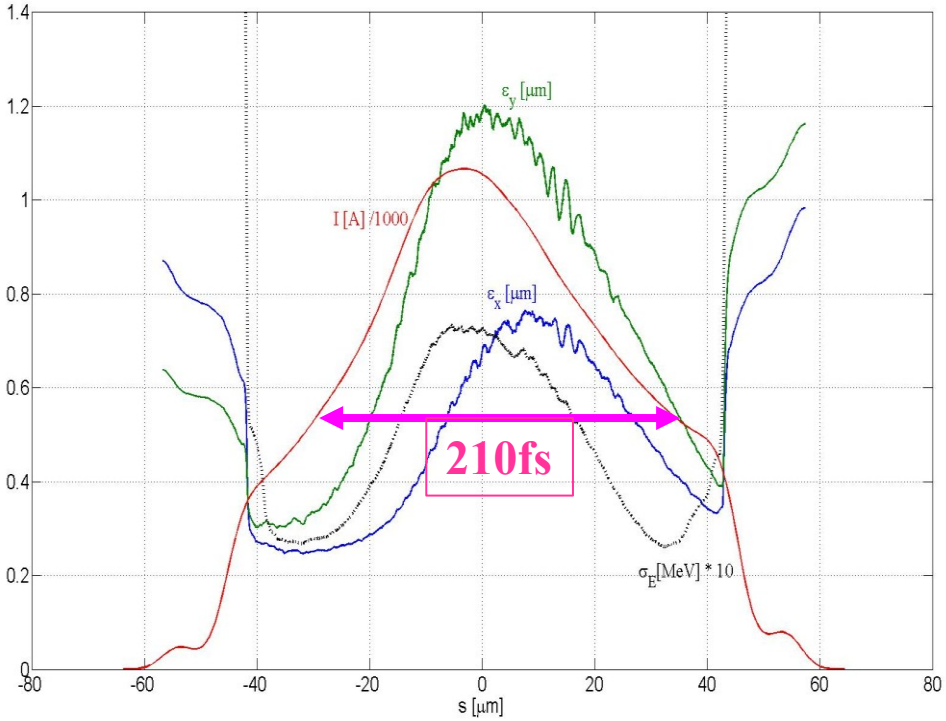


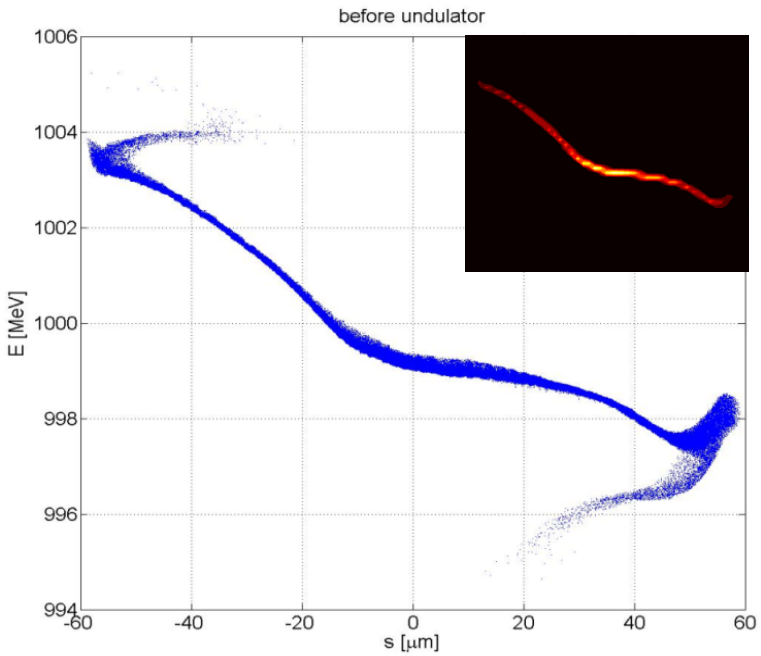


$\varepsilon_x{}^{proj}$=0.66μm , $\varepsilon_y{}^{proj}$=0.88μm

After Arc

Before the undulator system Q=0.25nC





$\varepsilon_x{}^{proj}$=0.66μm , $\varepsilon_y{}^{proj}$=0.88μm

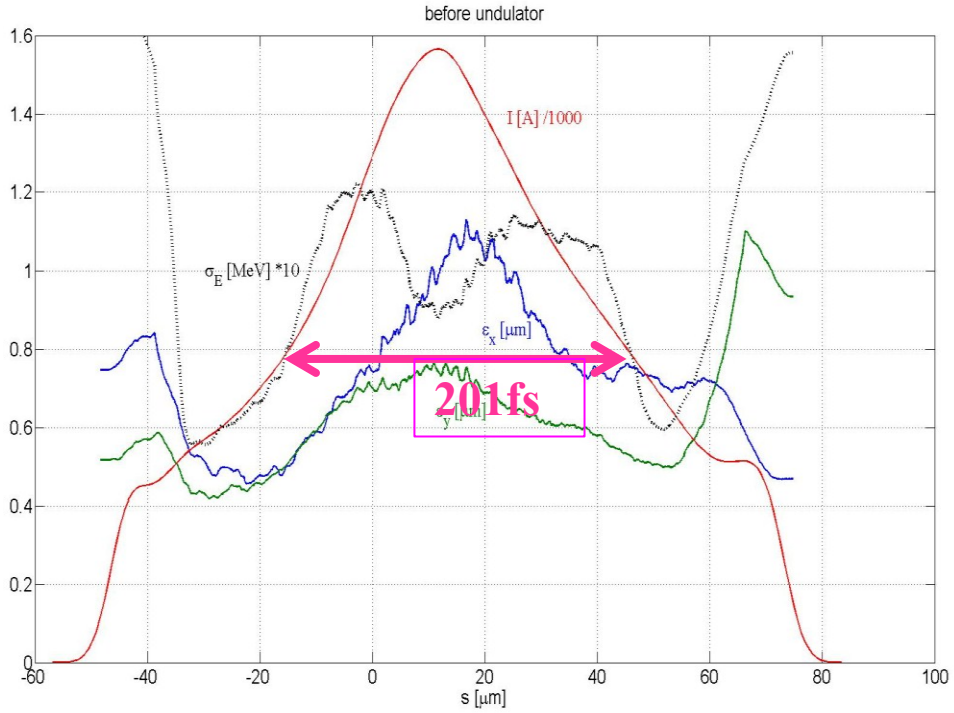
Peak current: higher than 1kA
Bunch length: FWHM ~210 fs (RMS ~78 fs)
Slice energy spread: less than 100 keV

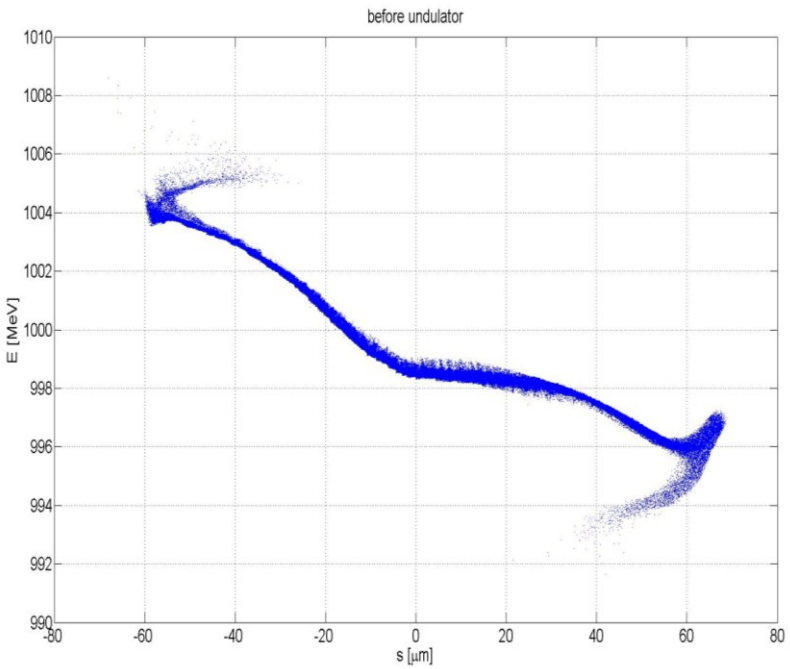
The other case

Q=0.4nC, 200000 particles

Element	Phase shift	V_{max}
RF Gun	2.00°	
ACC1	0.1866°	159.883MV
ACC39	157.588°	20.983MV
ACC2/3	24.50°	335.179MV
ACC4/5	0.0°	320.0MV
ACC6/7	0.0°	230.0MV

Before the undulator system Q=0.4nC





$\varepsilon_x{}^{proj}$=1.22μm , $\varepsilon_y{}^{proj}$=1.16μm

Peak current: **~ 1.6kA**
Bunch length: **FWHM ~201 fs**
Maximum slice energy spread: **~ 120 keV**

Work in the future

Reducing the transverse slice emittance

(1) Adjusting the compression in BC2 to reduce the space charge effects.
(2) Optimizing magnetic field of the solenoid after the gun to get lower initial emittance.
(3) The beam optics matching at some critical positions.
(4) Beam optics impacts on CSR related emittance growth.
(5) …