Generation of attosecond X-ray pulses with slotted foil in the XFEL

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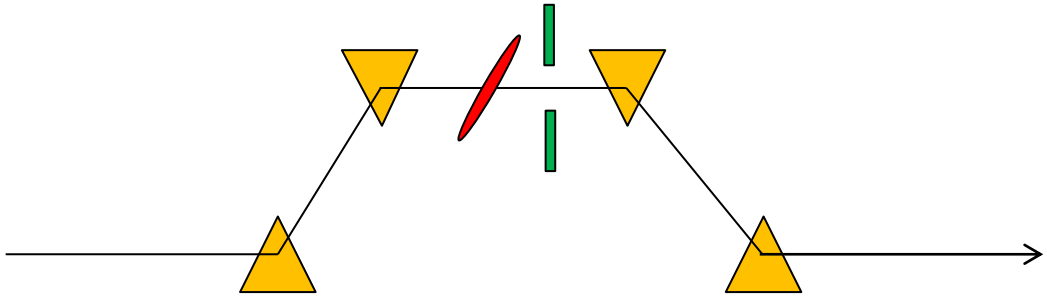
DESY

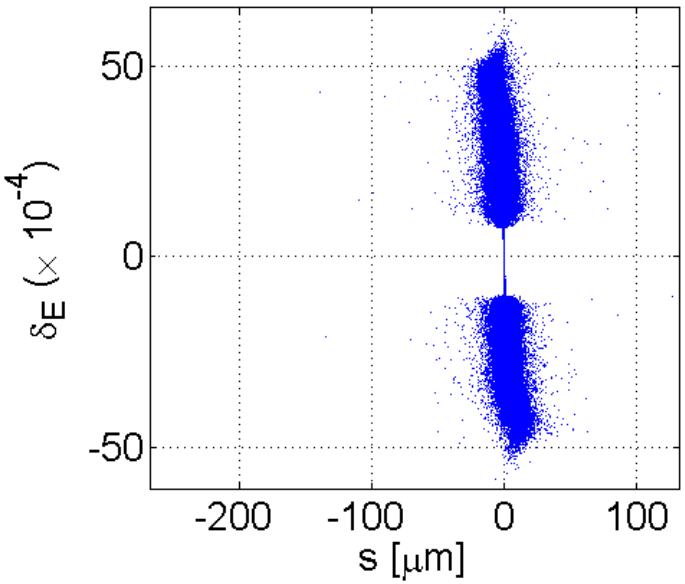
Setup

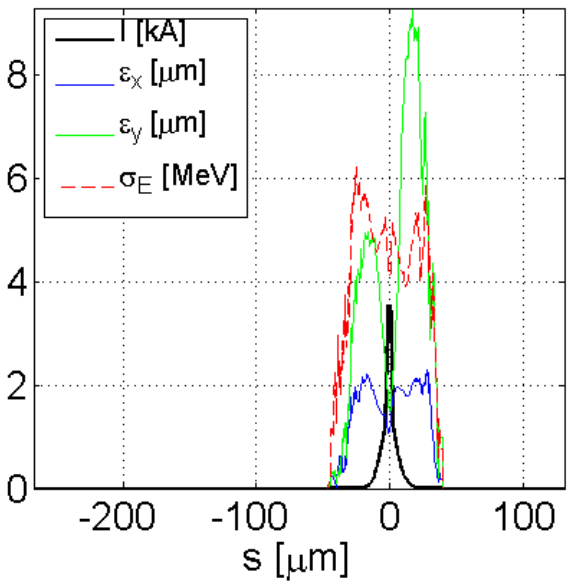
- Slotted foil in the middle of BC2
  - Metal : aluminum
  - Thickness : 2.0 μm
  - Gap : 0.7 mm



- Beam
  - 100 pC
  - 200,000 macro-particles
  - 5kA peak current

Beam profile after BC2





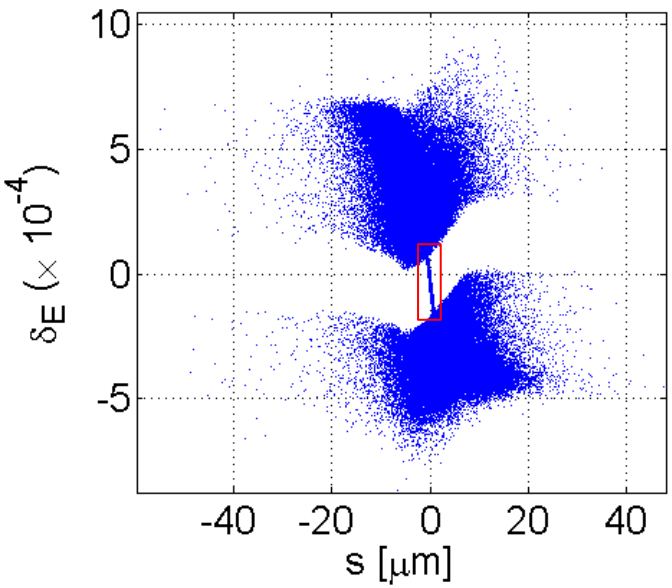
Remove about 6% bad particles in the analysis

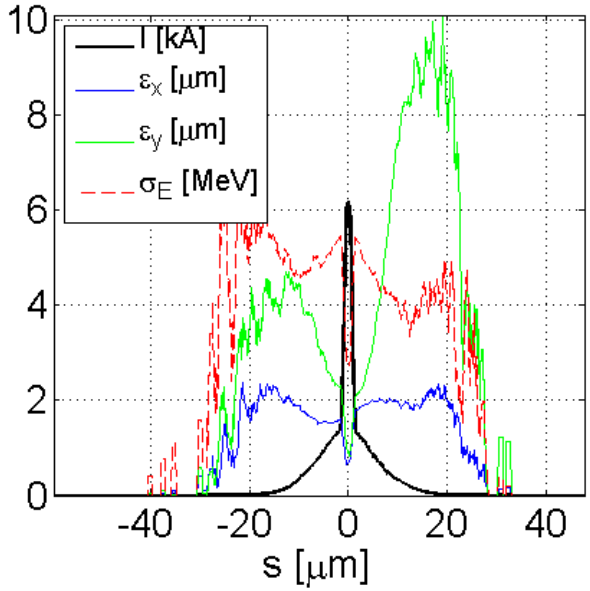
$\varepsilon_{proj,x}$ = 1.4 μm

$\varepsilon_{proj,y}$ = 4.6 μm

FWHM = 5.92 fs

Beam profile before SASE1





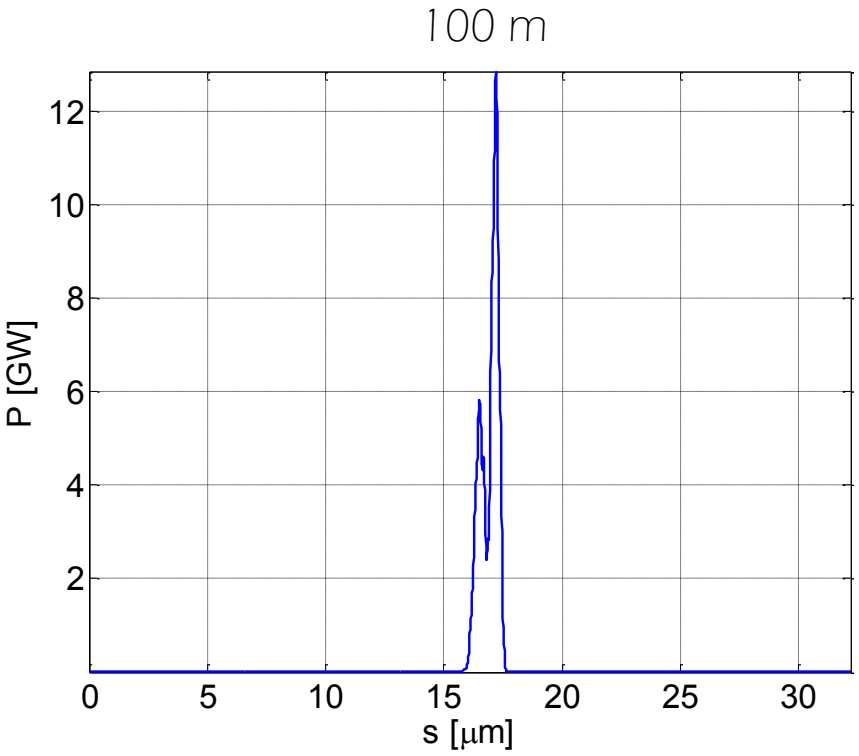
Remove about 6% bad particles in the analysis

$\varepsilon_{proj,x}$ = 1.5 μm

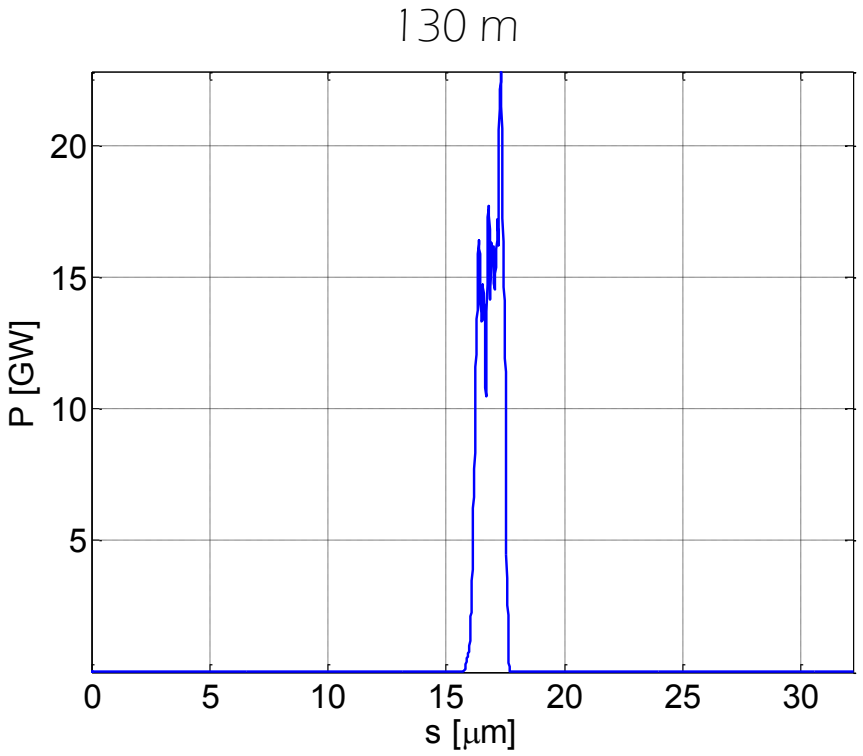
$\varepsilon_{proj,y}$ = 4.5 μm

FWHM = 5.57 fs

Radiation power at 100 & 130 m – SASE1

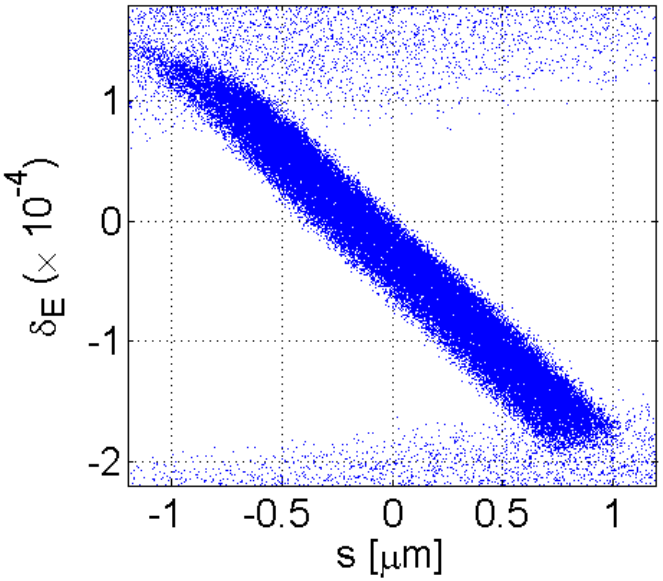


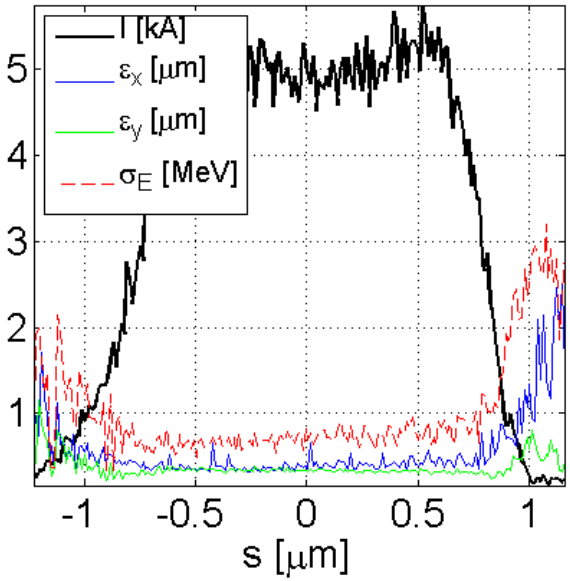
FWHM = 0.86 fs



FWHM = 2.4 fs

Beam profile before SASE1





Remove about 72% bad particles in the analysis

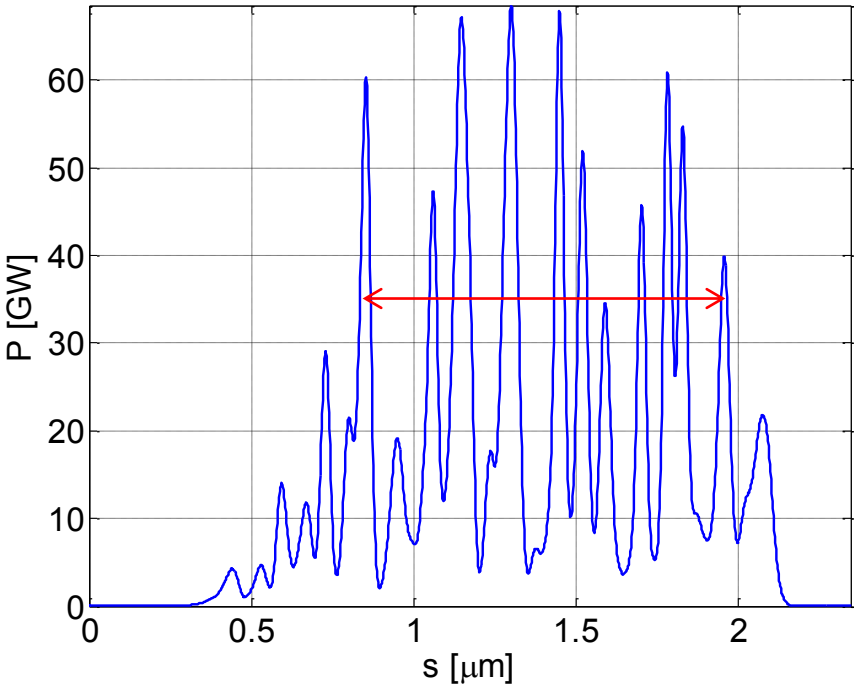
$\varepsilon_{proj,x}$ = 0.51 μm

$\varepsilon_{proj,y}$ = 0.41 μm

FWHM = 5.12 fs

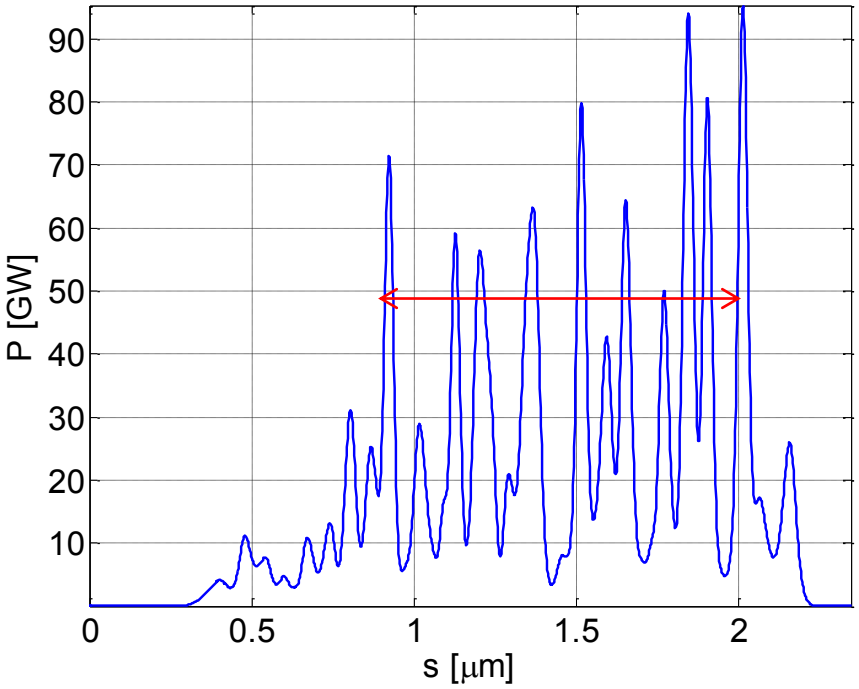
Radiation power at 100 & 130 m – SASE1

100 m



FWHM = 3.75 fs

130 m



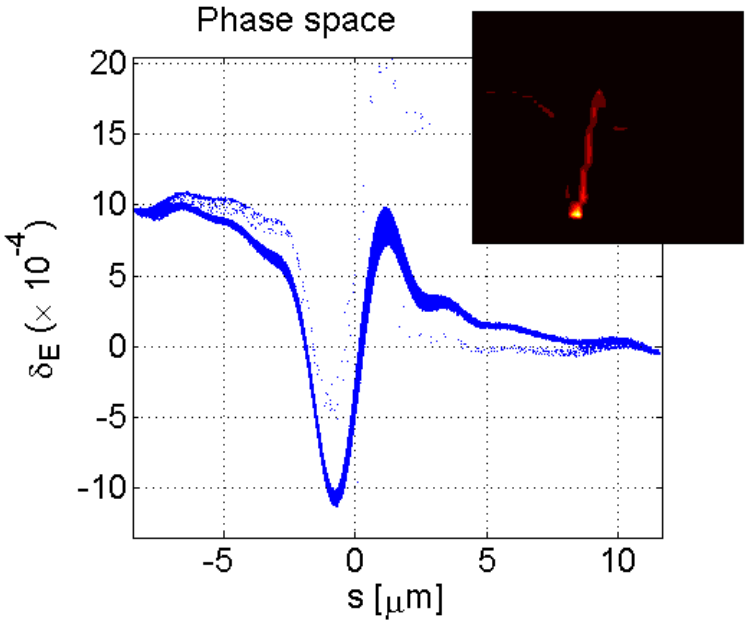
FWHM = 3.73 fs

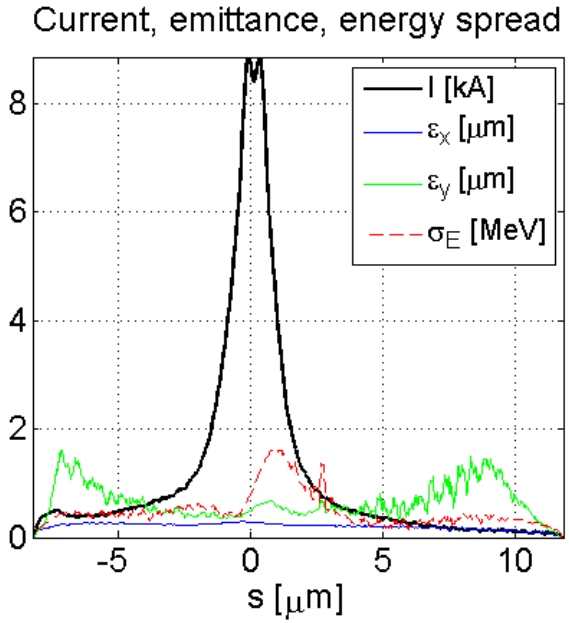
- Radiation pulse is larger than attosecond scale.

  - Decrease gap : 0.7 → 0.3 mm

  - Increase peak current : 5k → 10k

Beam profile before SASE1 without foil





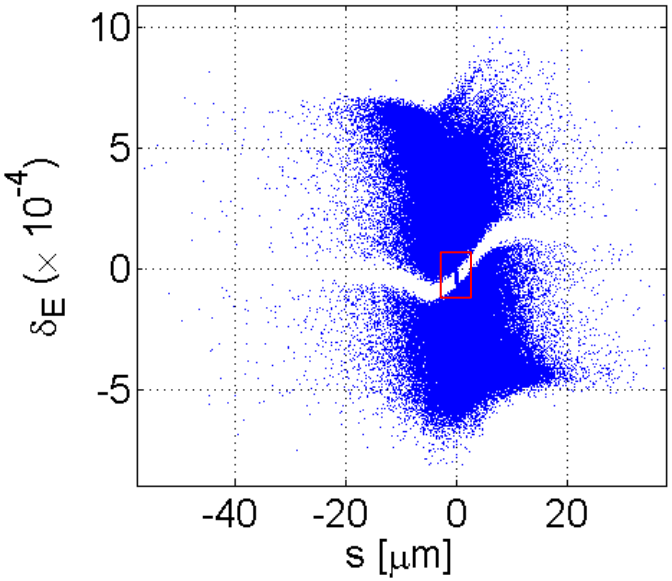
Remove about 20% bad particles in the analysis

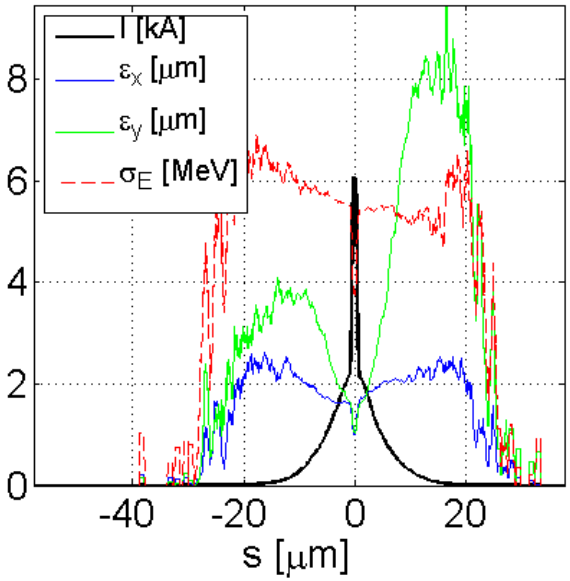
$\varepsilon_{proj,x}$ = 0.4 μm

$\varepsilon_{proj,y}$ = 2.2 μm

FWHM = 5.42 fs

Beam profile before SASE1





Remove about 6% bad particles in the analysis

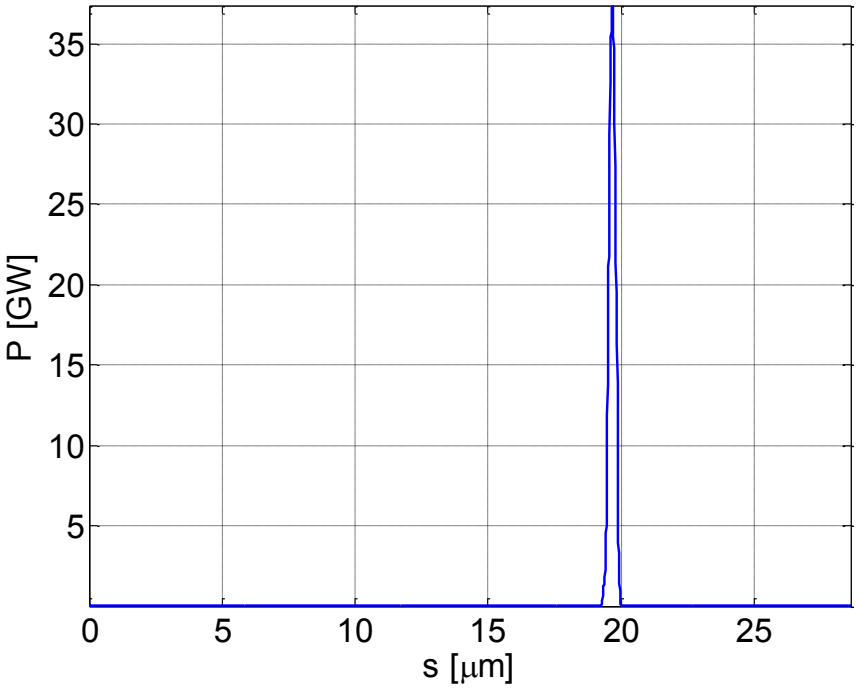
$\varepsilon_{proj,x}$ = 1.7 μm

$\varepsilon_{proj,y}$ = 4.9 μm

FWHM = 1.46 fs

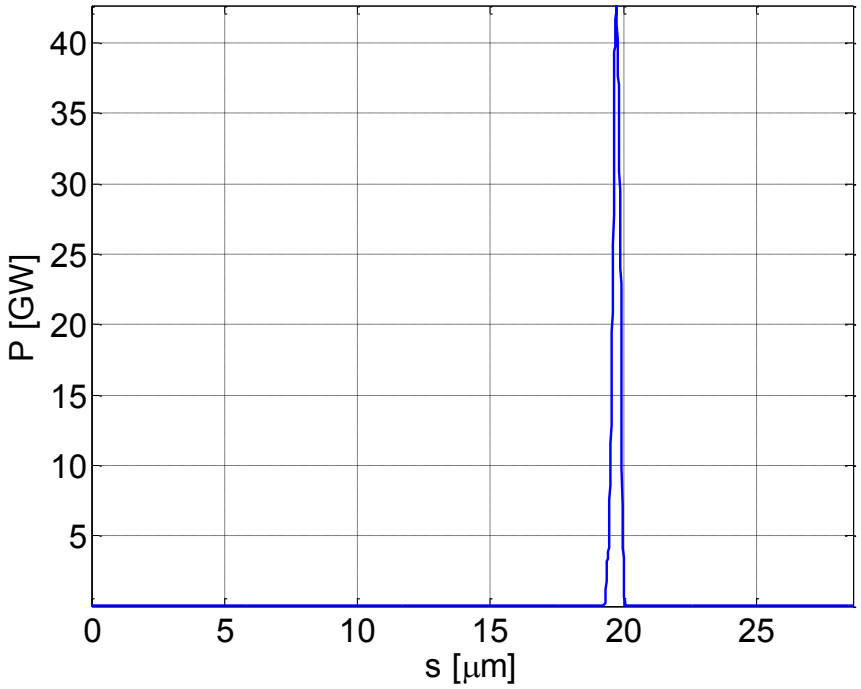
Radiation power at 100 & 130 m – SASE1

100 m



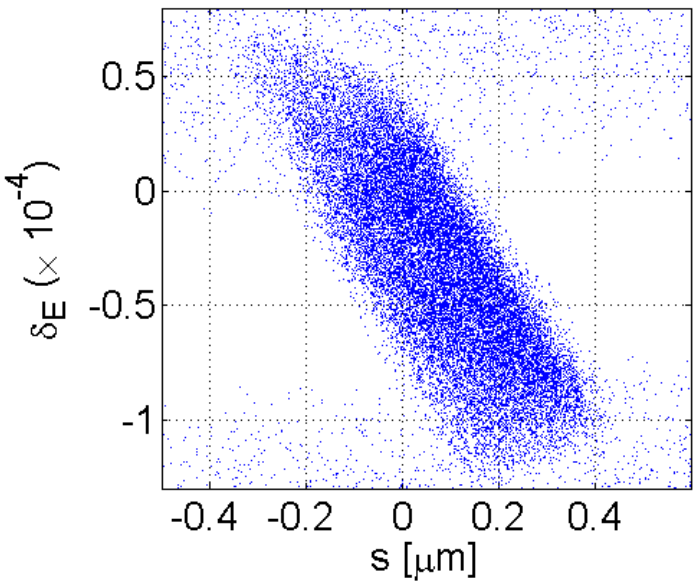
FWHM = 0.42 fs

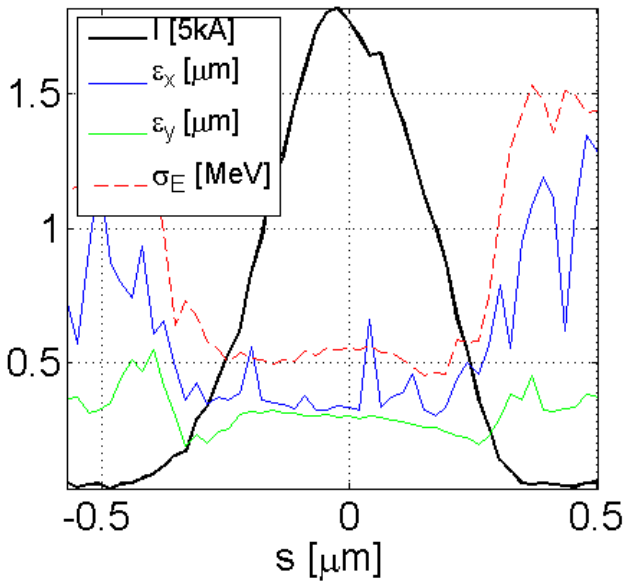
130 m



FWHM = 0.1 fs

Beam profile before SASE1





Remove about 88% bad particles in the analysis

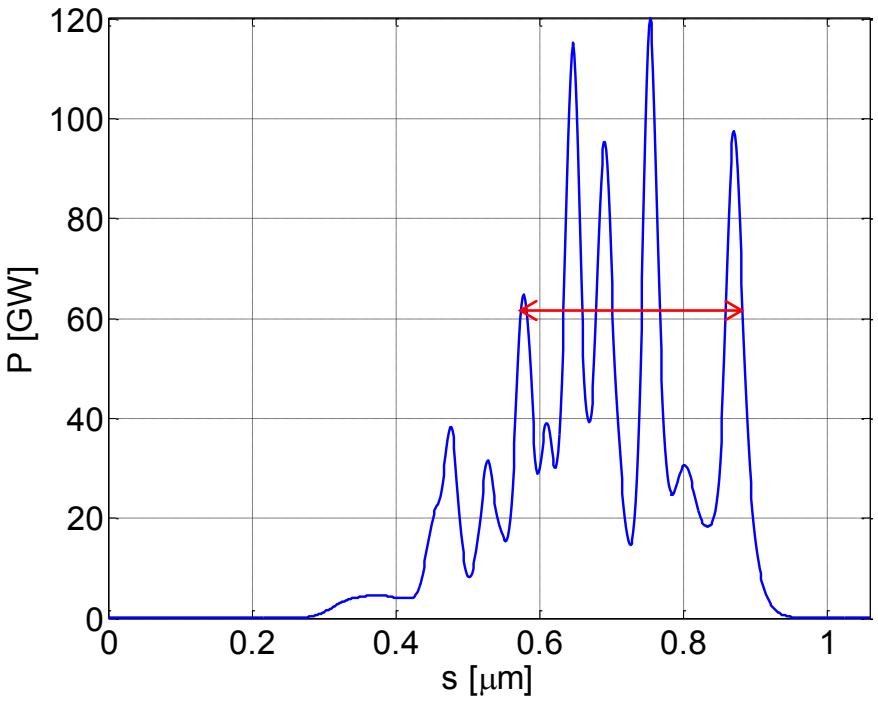
$\varepsilon_{proj,x}$ = 0.45 μm

$\varepsilon_{proj,y}$ = 0.34 μm

FWHM = 1.38 fs

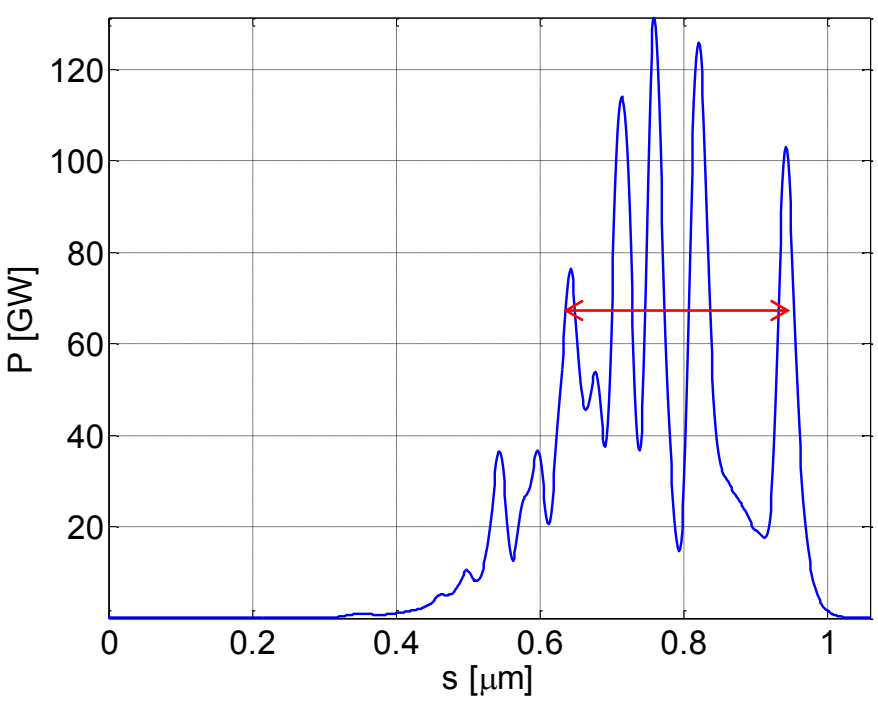
Radiation power at 100 & 130 m – SASE1

100 m



FWHM = 1.03 fs

130 m



FWHM = 1.06 fs

- Number of macro-particles which pass through the foil is small (about 20,000) → difficult to calculate the radiation power with genesis

  - Increase initial macro-particles : 200,000 → 1,000,000