P. Dijkstal, E. Prat :: FEL Beam dynamics :: Paul Scherrer Institut
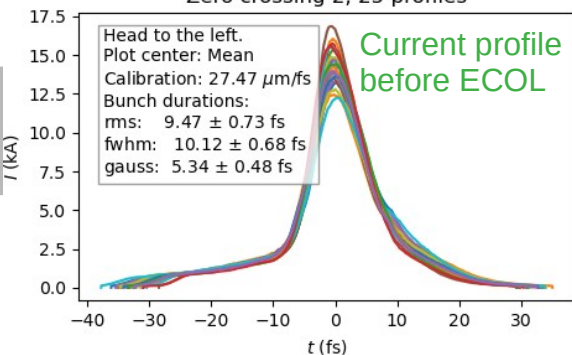
Sub-fs hard X-ray FEL pulses from dispersive beam tilt
2024-05-18

SwissFEL Progress Meeting 2024-06-08

Previous results from March MD week

Zero crossing 2, 25 profiles

Head to the left.
Plot center: Mean
Calibration: 27.47 μm/fs
Bunch durations:
rms: 9.47 ± 0.73 fs
fwhm: 10.12 ± 0.68 fs
gauss: 5.34 ± 0.48 fs

Current profile before ECOL

- We set up extreme compression with over 15 kA peak current.
- ~~Single spike spectral analysis: upper limit of 1 fs fwhm duration for spike width of 2.5 eV.~~
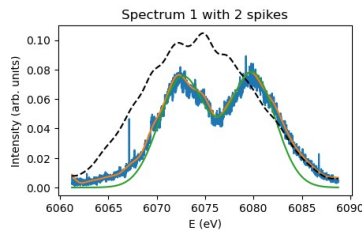- ~~Here: avg 6.3 eV fwhm spike widths (<400 as), over 50% single spikes, and 11 uJ avg pulse energy.~~

fel_spectra_20240218_202236.h5
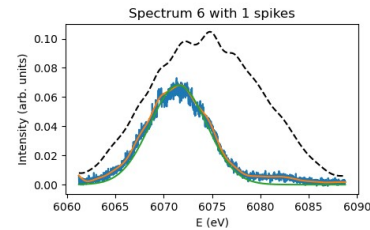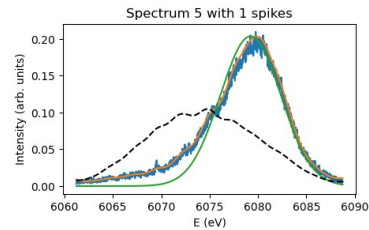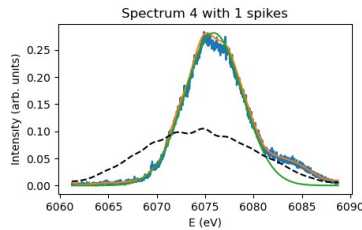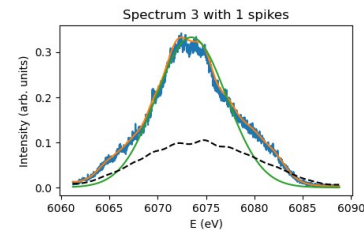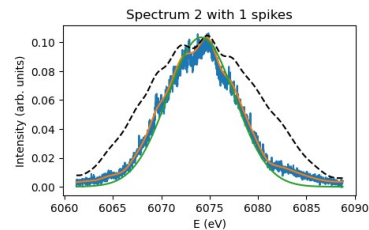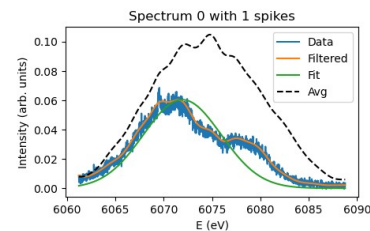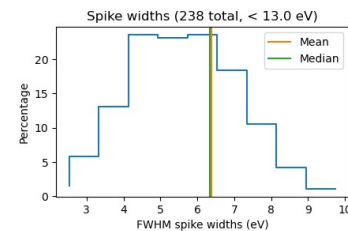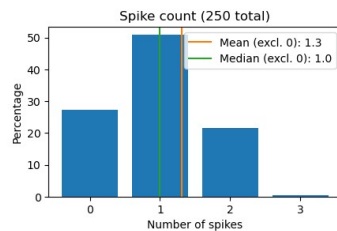
- **Spike widths seemed too good to be true.**
- **We wanted to make sure the results are true.**

# Results from May MD shift

Setting 1

- Current profile FWHM around 20 fs
- Peak current of 6 kA
- Single spike ratio of up to 12%
- Few tens of uJ
- Ratio of single spikes goes up if larger tilts are generated.
- Spikes are wide, indicating short pulse durations.
- Problem: we probably did not align the center of mass, given that the mean pulse energy is shifted.

Setting 2

- Current profile FWHM around 14 fs

- Peak current of 8 kA

- Single spike ratio of up to 9%

- Few tens of uJ

- Ratio of single spikes does not go up if larger tilts are generated.

- Again we probably did not align the peak of the current profle.

Summary
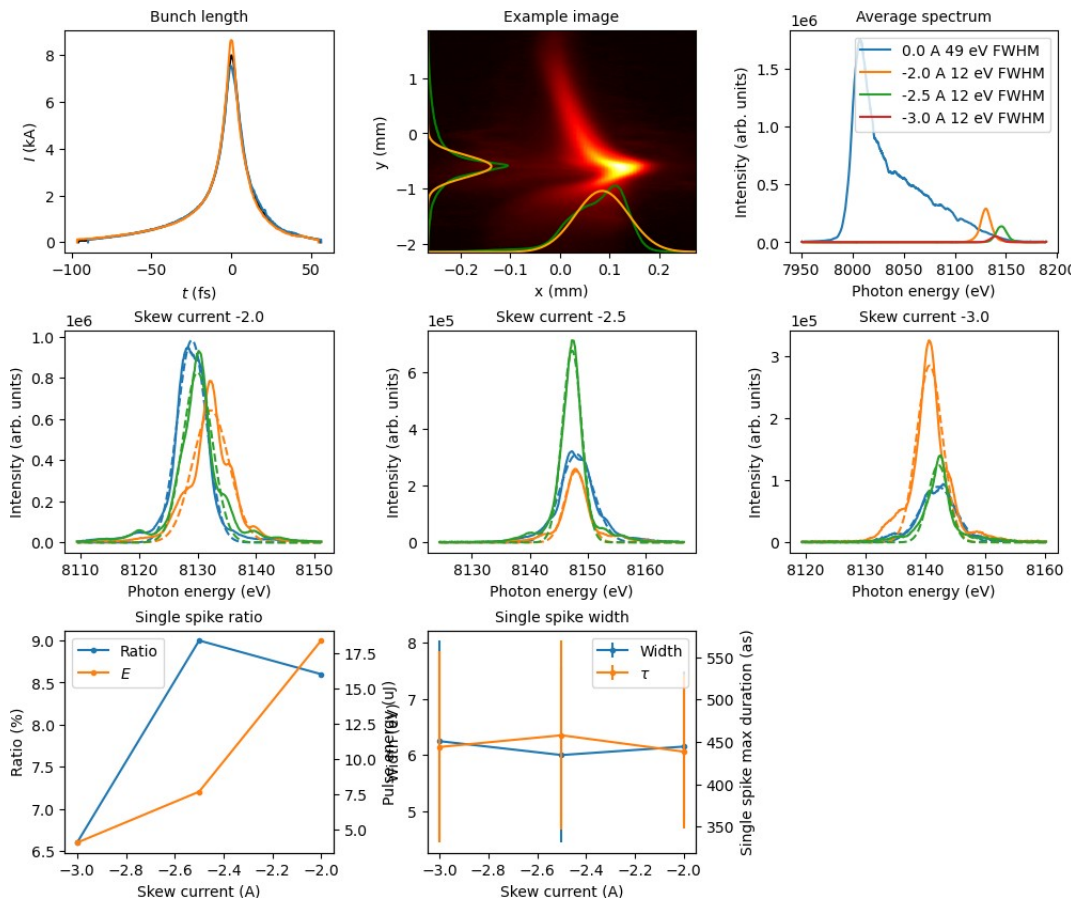
- Managed to generate sub-fs pulses at 200 pC of charge
- Problems:
  - Could only run at 10 Hz due to loss issues, resulting in not ideal readings from the gas detector.
  - We did not have a procedure ready to align the peak of the bunch. We expected that the adaptive orbit tool could do it but it seems not the case.
  - As per Eduard's simulations, much better performance should be possible from this.
- Orbit snail scan to find best lasing orbit? I once wrote such a tool for EuXFEL, but never managed to try it there.
- Also need better spectrum data acquisition that records the pulse energy synchronous to each shot. Before last shift I tried to implement this but there were problems with bsread and the combinations of channels I requested (PSSS and uncalibrated/calibrated fast gas detector signals).