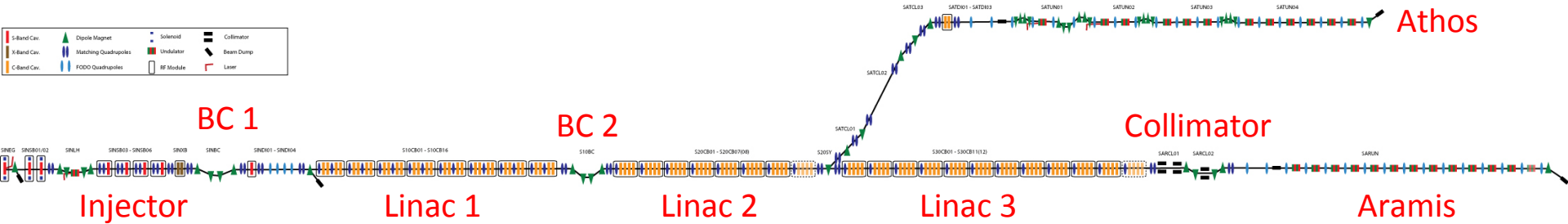

SwissFEL Project

CANDLE Workshop – July 1, 2010

Mode of Operation for the SwissFEL Facility

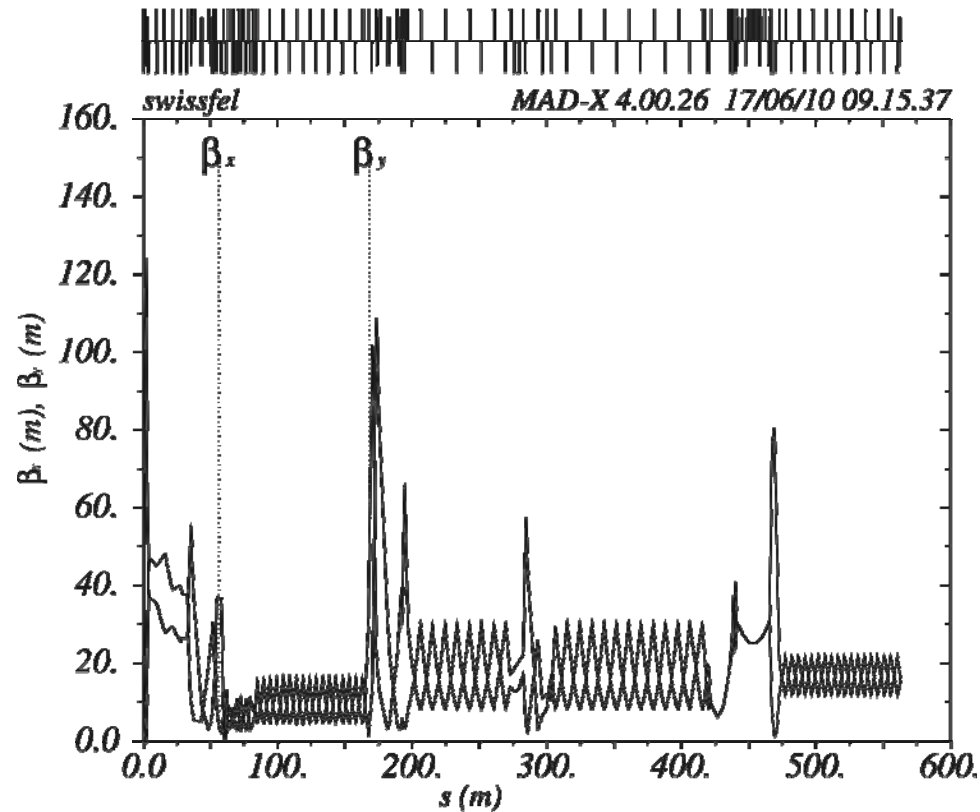
Sven Reiche



- Turning Knobs:
 - RF Phase of Injector
 - R56 of BC 1
 - RF Phase of Linac 1
 - R56 of BC 2
 - Collimator (see later slices)

Keep machine modular, using only one or two tuning knobs to change main configuration:

- RF Phase of Linac more on-crest for less compression
- Increase bending angle of BC 2 for more compression



Wakefield
Limited



Charge



Diagnosti
c Limit

- Standard operation
- 200 pC
- Maximum FEL pulse energy
- Longest FEL pulse length

- Lowest charge operation
- 10 pC
- Short FEL pulse length
- Single-spike in soft X-ray



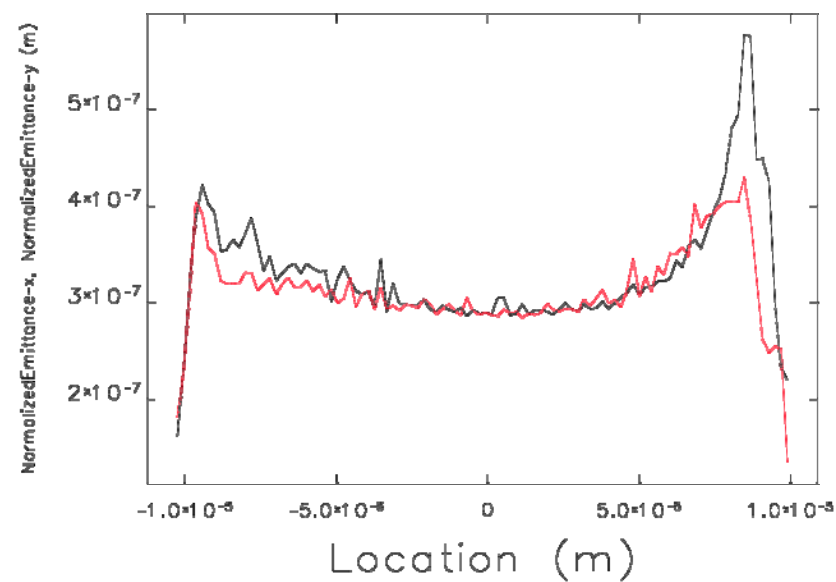
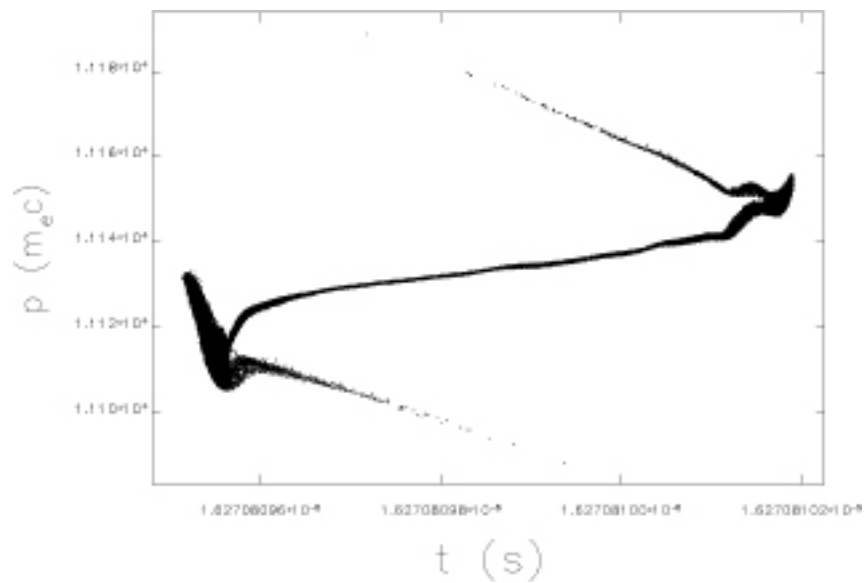
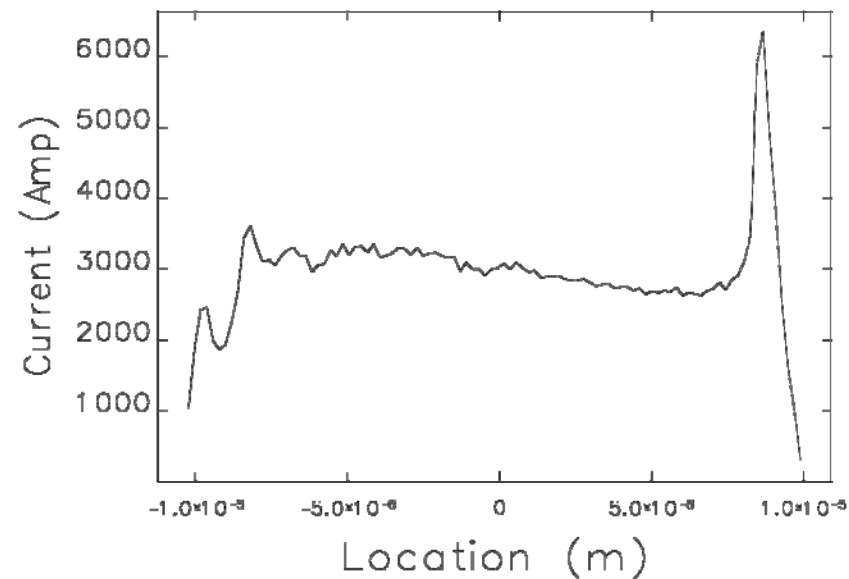
Special Cases



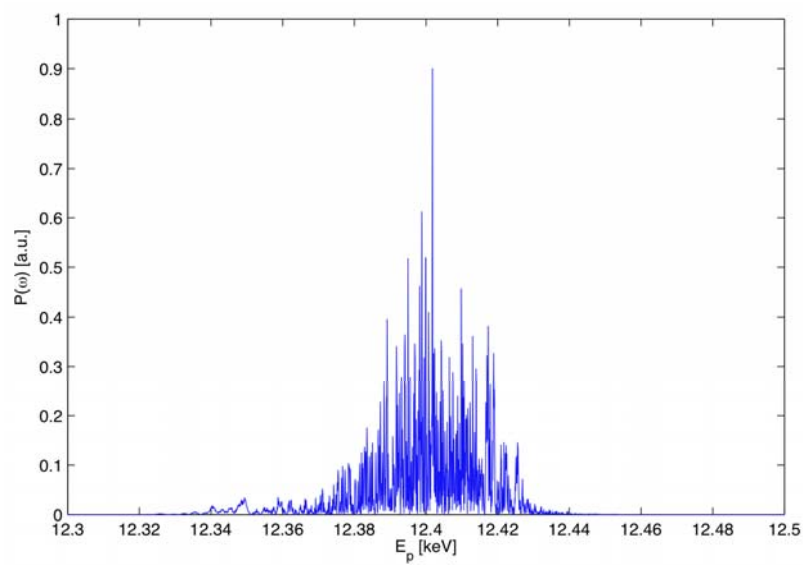
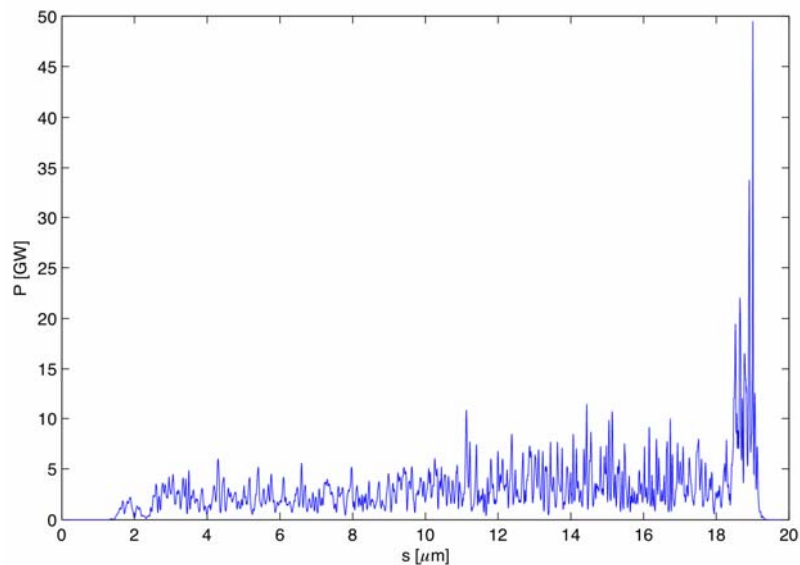
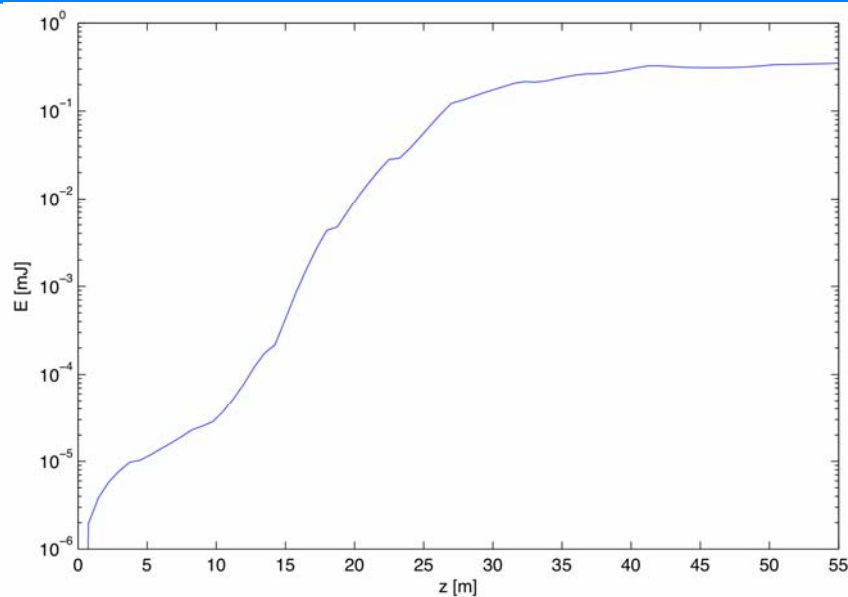
- Strong residual energy chirp
- 200 pC
- Large FEL Bandwidth (>1%) for single short Absorption spectroscopy.

- Attosecond FEL pulse
- 10 pC
- Strongest compression
- Single-spike in hard X-ray

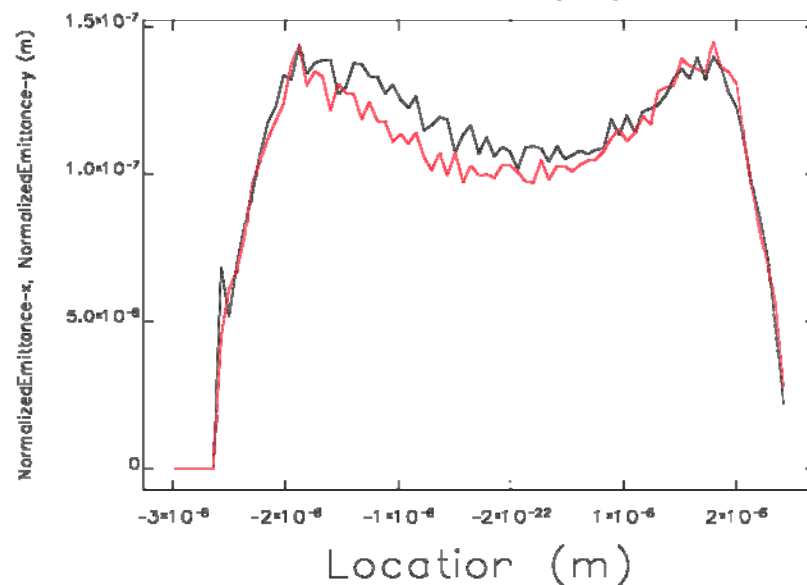
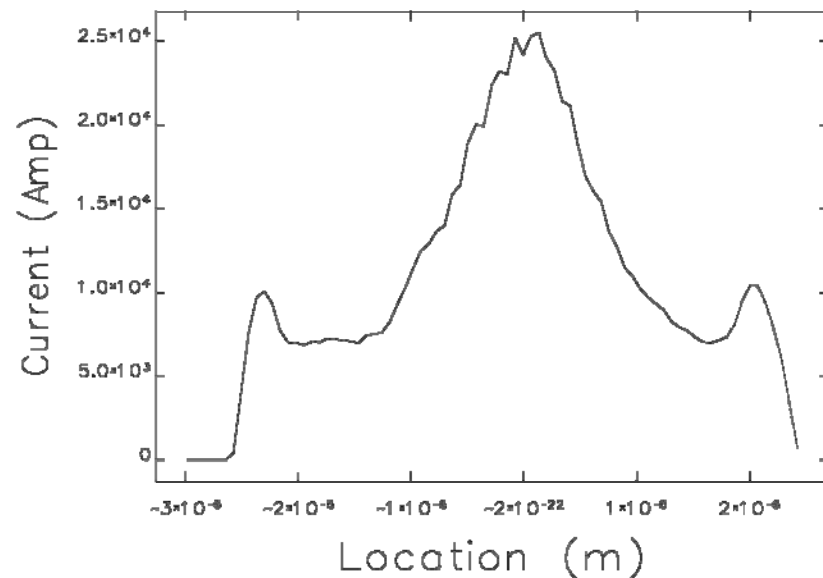
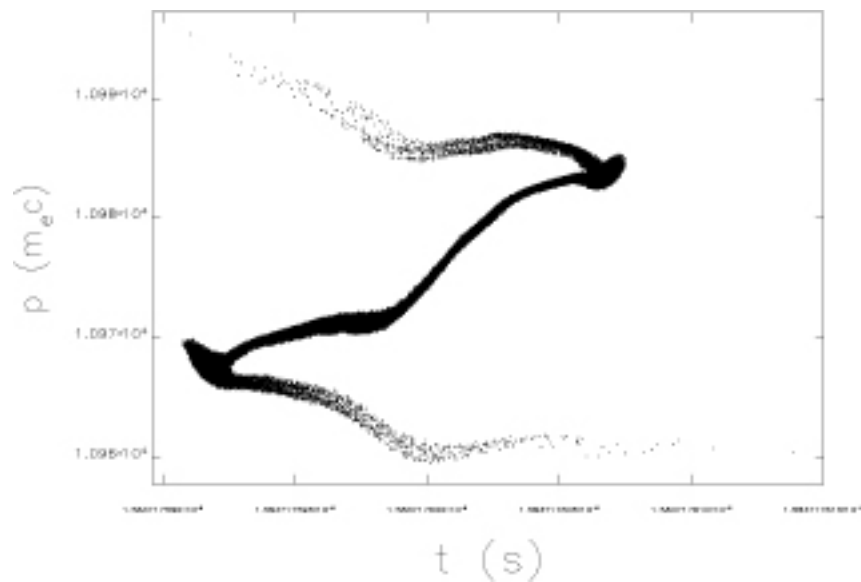
ϕ_{inj}	-17°
θ_{BC1}	4.2°
ϕ_{L1}	20.8°
θ_{BC2}	2.15°



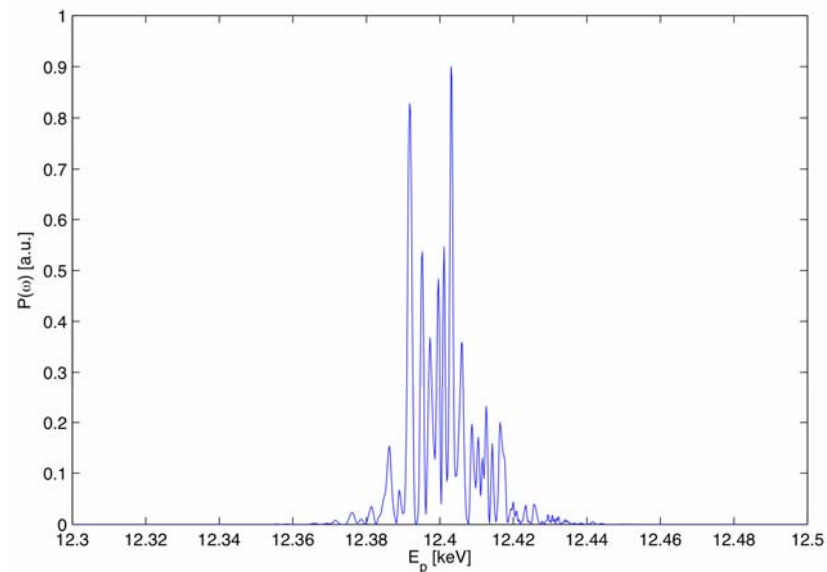
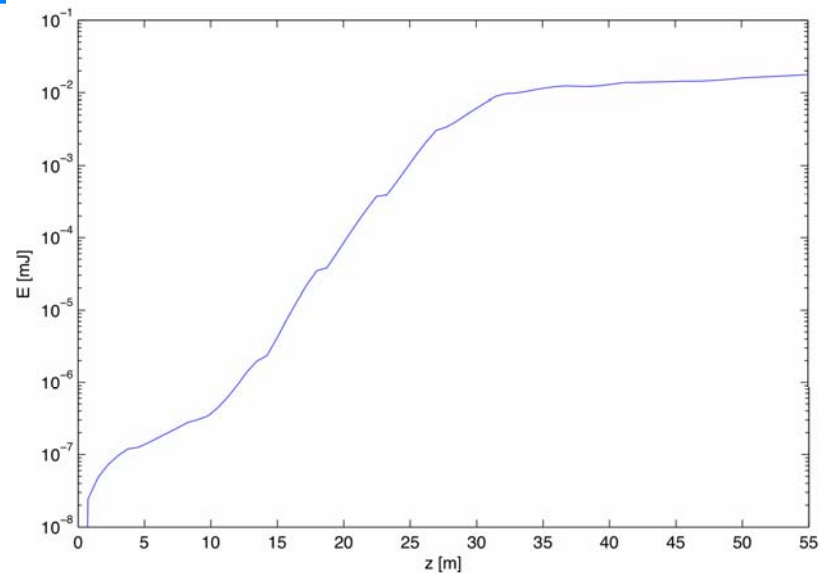
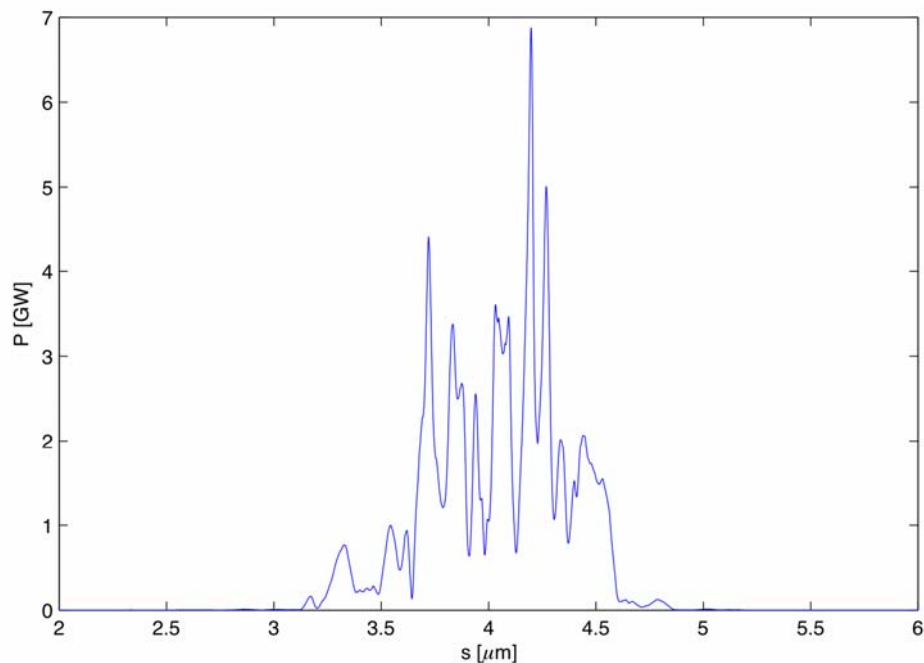
- Residual Chirp, not removed by wakes, increases the bandwidth of the FEL pulse.
- Saturation length at around 30 m though somehow reduced coherence.



- Linac 1 Phase: $-17^\circ \rightarrow -13.8^\circ$
- RF gun laser dimension scaled by $20^{-1/3} \sim 36\%$
- Lower values of the β -function matched by laser heater optics into regular lattice.

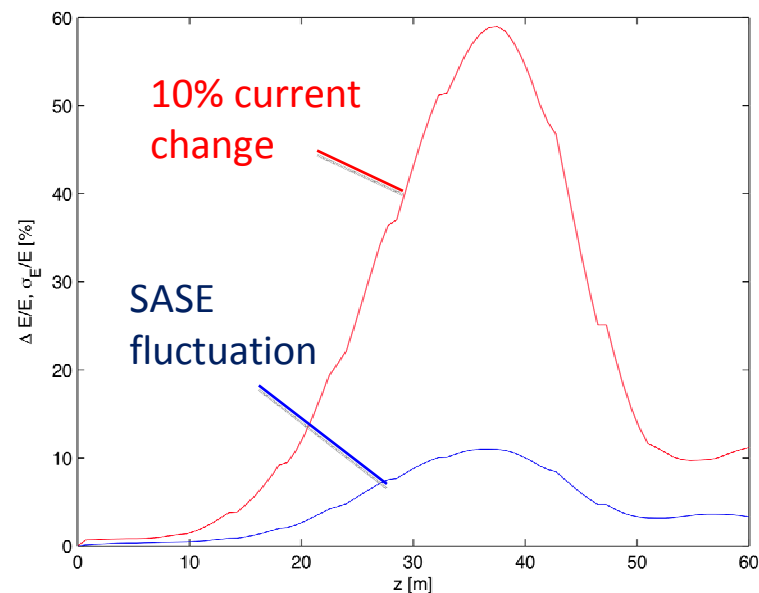


- Compression configured to obtain same saturation length as at 200 pC (conform with extracted power).
- Pulse length as short as 1 fs

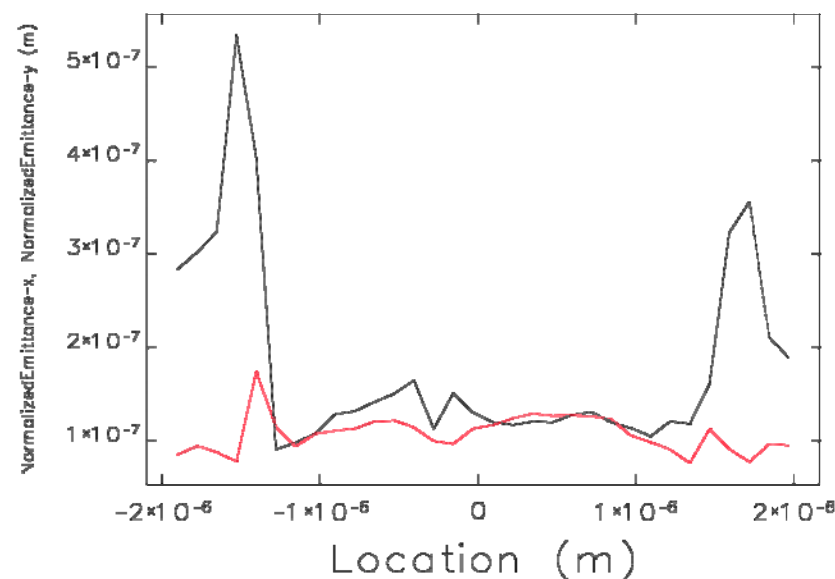
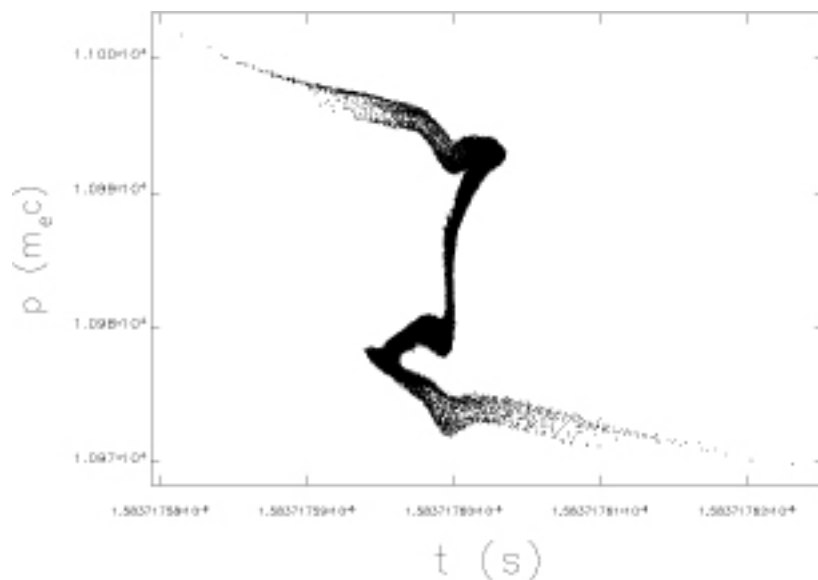
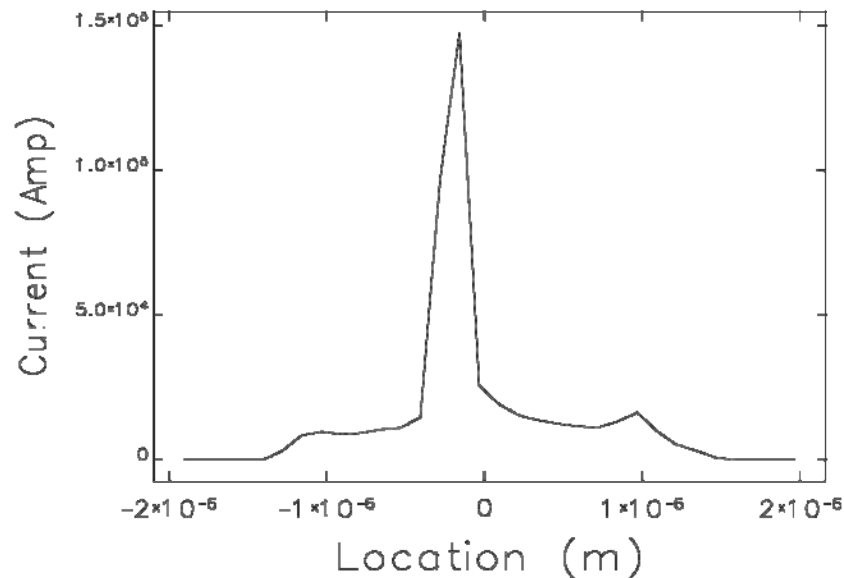


- Due to the stochastic nature of the SASE process, the FEL output fluctuates shot-shot.
- In the linear regime of the FEL the fluctuation is proportional to the number of spikes in the profile:

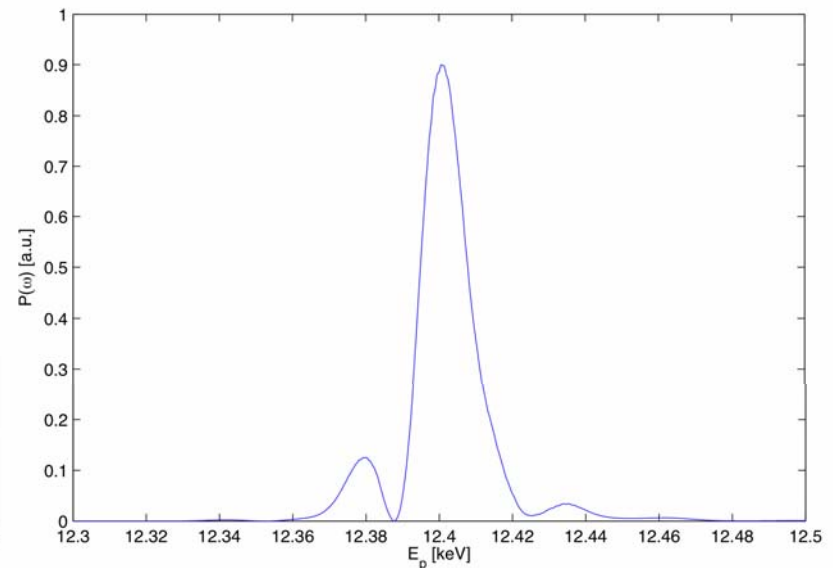
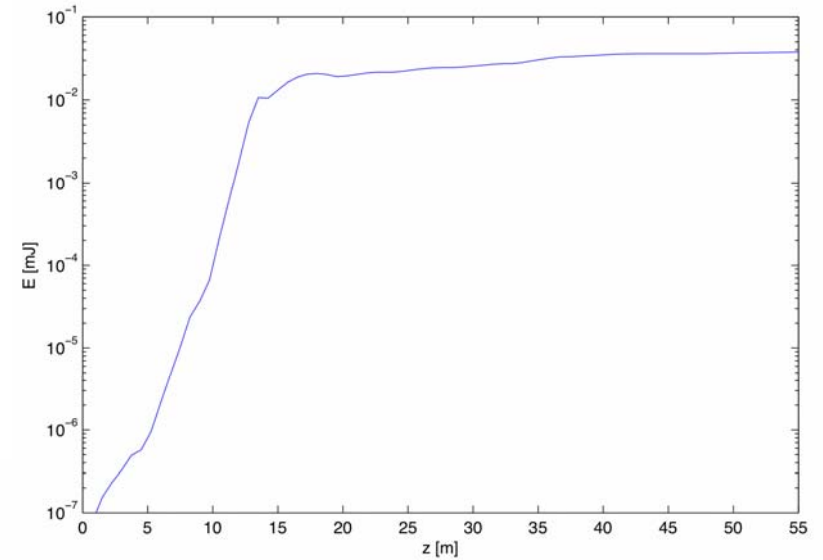
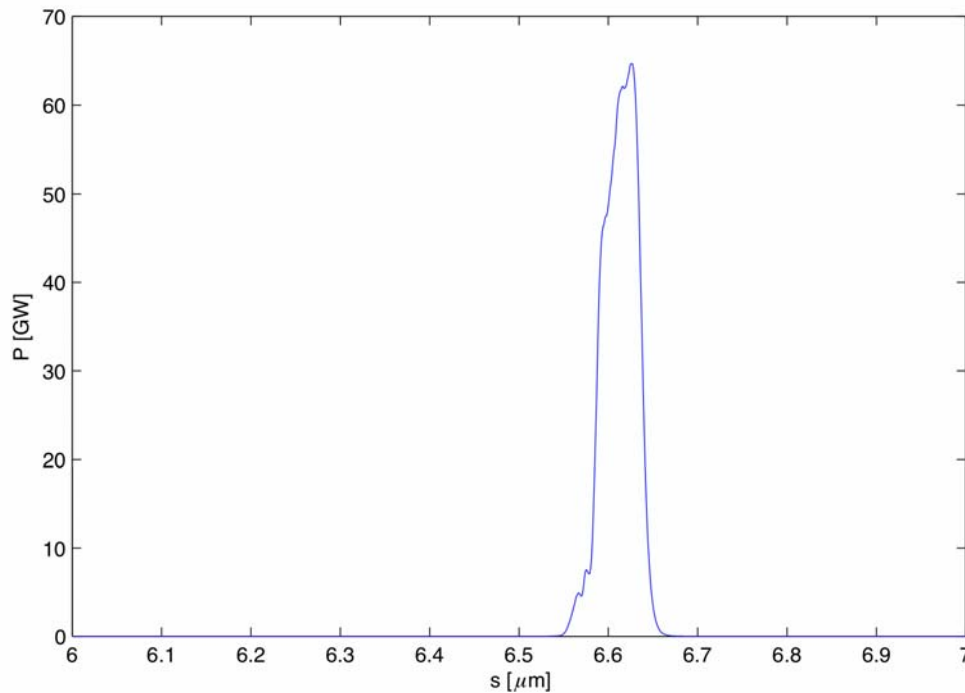
$$\frac{\sigma_E}{E} = \frac{1}{\sqrt{N}}$$
- At saturation the spikes slip into the gaps between the spikes thus reducing the fluctuation.
- The fluctuation allows for some fluctuation in the beam current, defining the stability tolerance of the linac.
- The low charge exhibits larger fluctuation due to the reduced number of spikes.



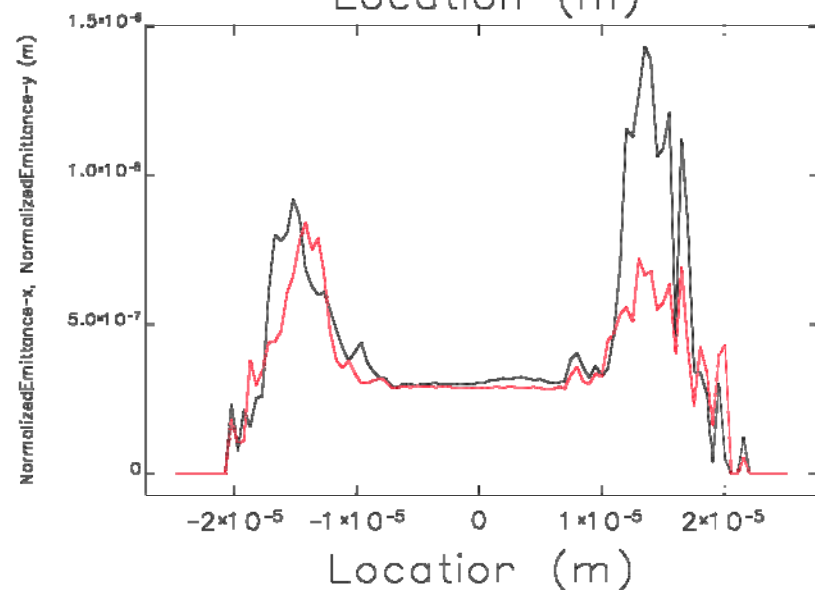
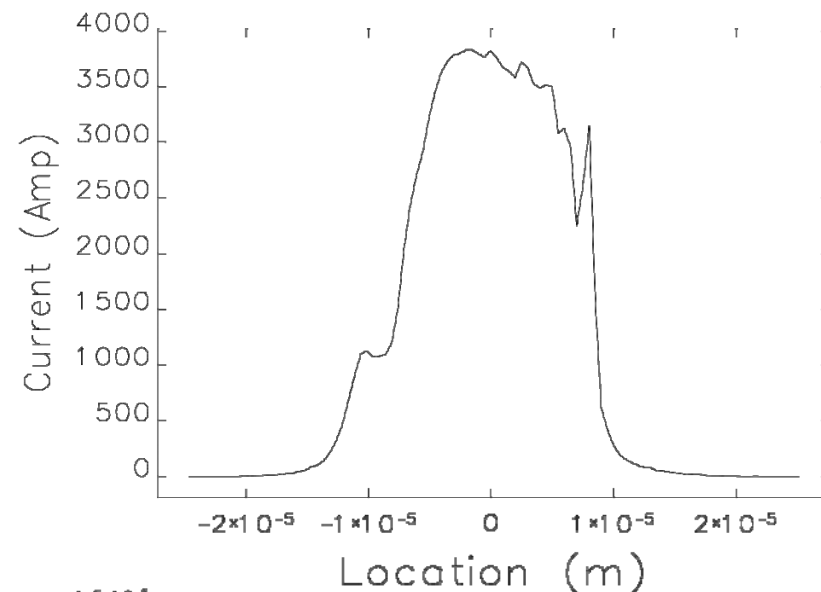
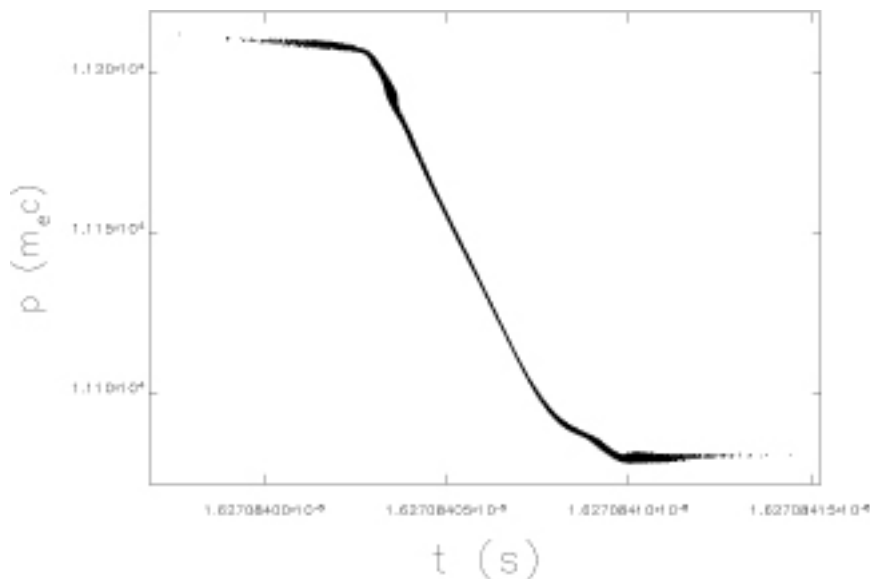
- Fully upright compression
- Linac 1 Phase: $-13.8^\circ \rightarrow -13.1^\circ$
- Reconfiguration of bunch collimator for additional compression (next slides)



- Significant enhancement of the current and thus increase of the FEL parameter.
- Single spike operation at one 1 Angstrom with an RMS pulse length of 60 as!



- Over Compression between 3rd and 4th dipole in 2nd bunch compressor.
- BC2 angle : $2.15^\circ \rightarrow 2.245^\circ$
- Wakes of Linac 2 & 3 adds to chirp
- (no Genesis calculation yet)





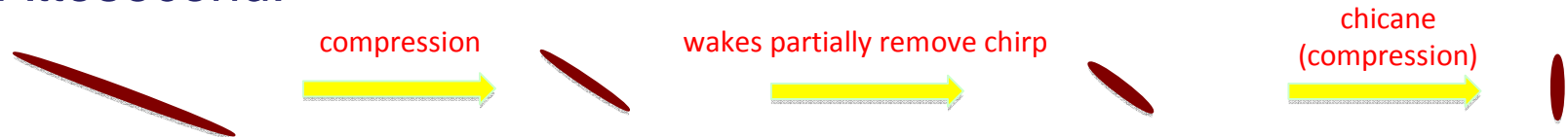
- *Normal:*



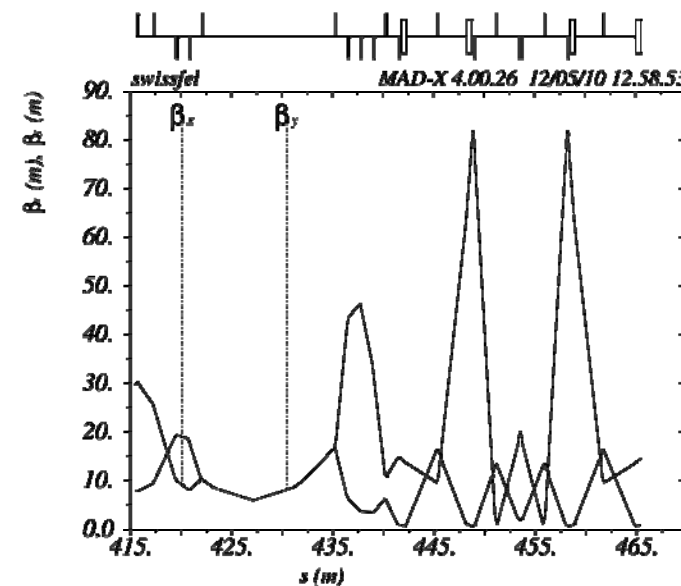
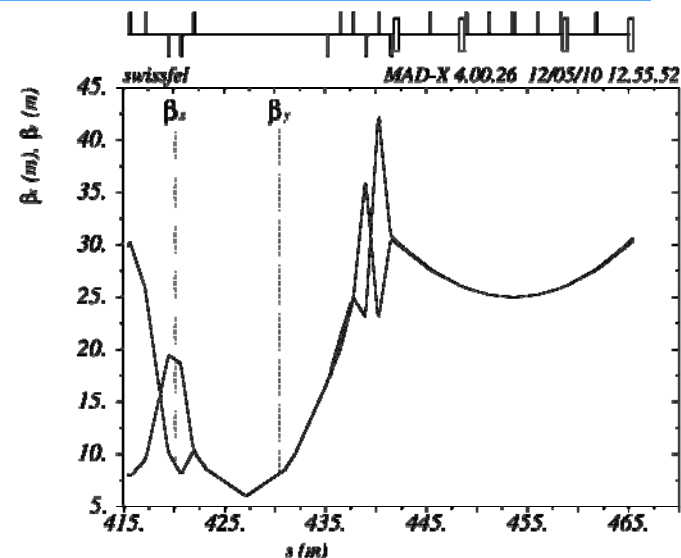
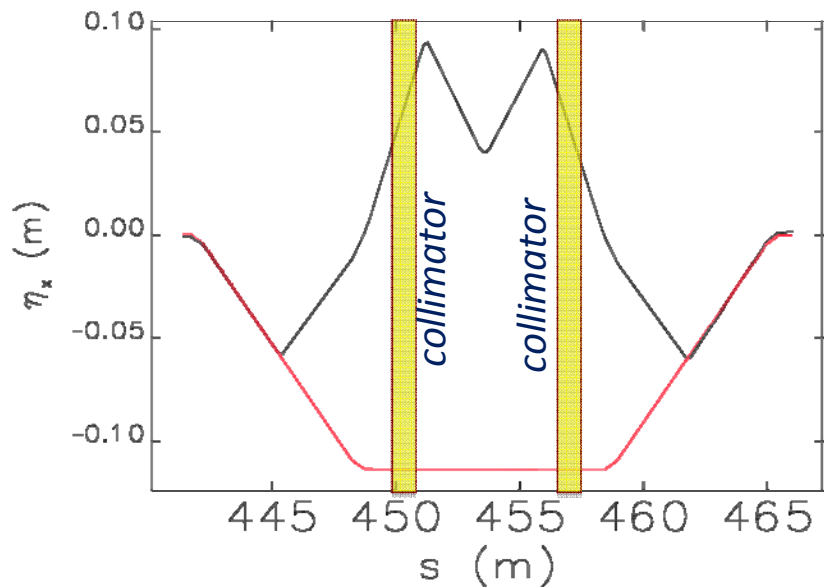
- **Large Bandwidth:**



- **Attosecond:**



- Energy collimator can act as a magnetic chicane or as a double dog-leg.
- Chicane is easier to operate but has the stronger R_{56} .
- Dogleg shows little impact of non-linear compression, though needs to be studied more (sextupoles)



- Almost fixed configuration for an operation between 200 to 10 pC, with the reference case optimized for 200 pC
- Beamline configuration modular:
 - Injector and BC 1 fixed for all operation modes
 - Tuning with RF phase of linac 1 and bending angle of BC 2
 - All modes require individual tuning of correction magnets.
- Extreme modes can be done with the given hardware though require careful tuning. Most likely they suffer from stronger fluctuation.
- CSR mitigation needs to be optimized and correlated transverse offset and momentum to be compensated in the magnetic chicanes.