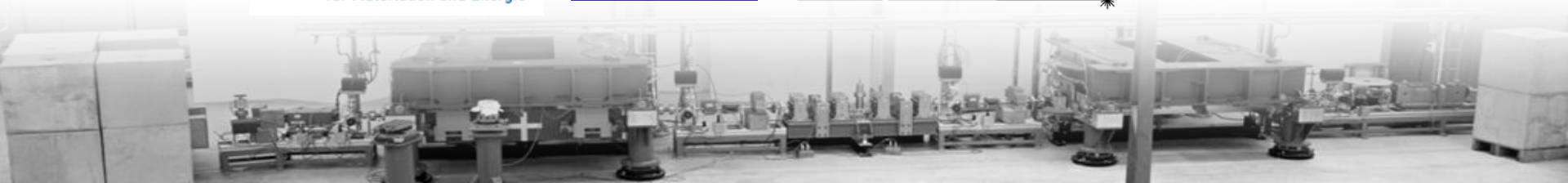


First results of Coherent Harmonic Generation at the MAX-lab test FEL

N. Cutic, F. Lindau, S. Thorin, S. Werin, Max-lab, Lund University, Sweden,
C. Erny, A. L'Huillier, E. Mansten, Dep. of Atomic Physics, Lund University,
Sweden, J. Bahrdt, K. Holldack, Helmholtz Zentrum Berlin, Germany



12th FEL Conference, París 1990

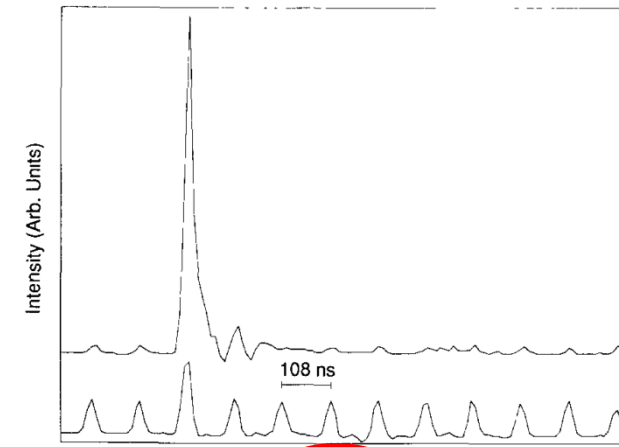
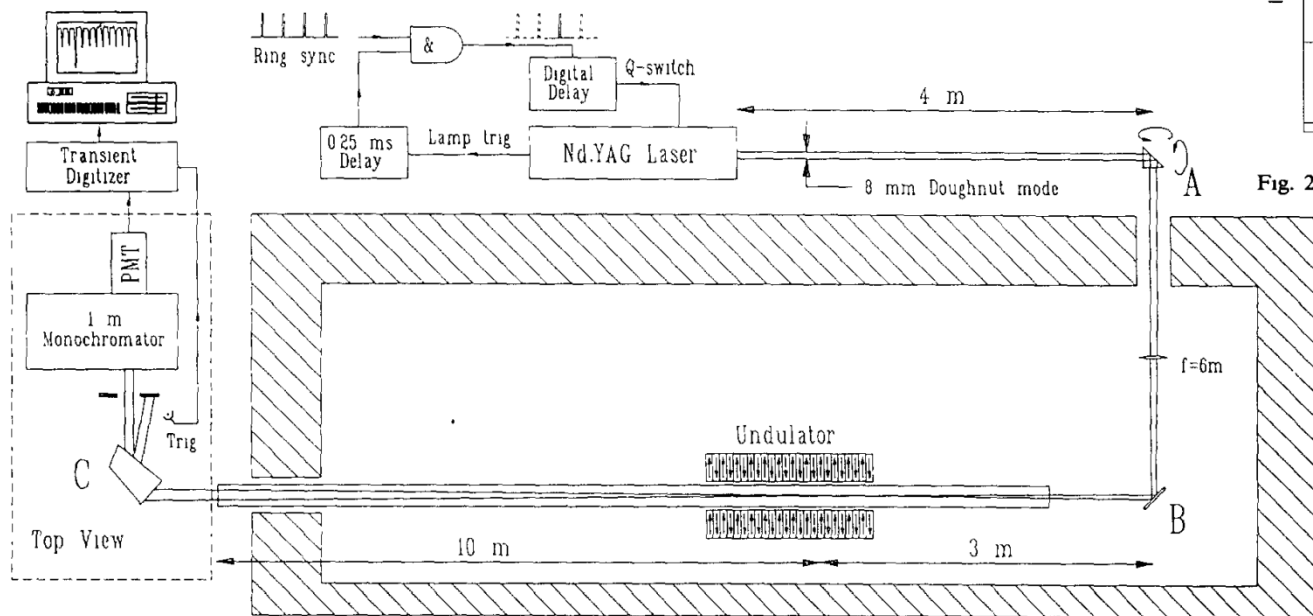


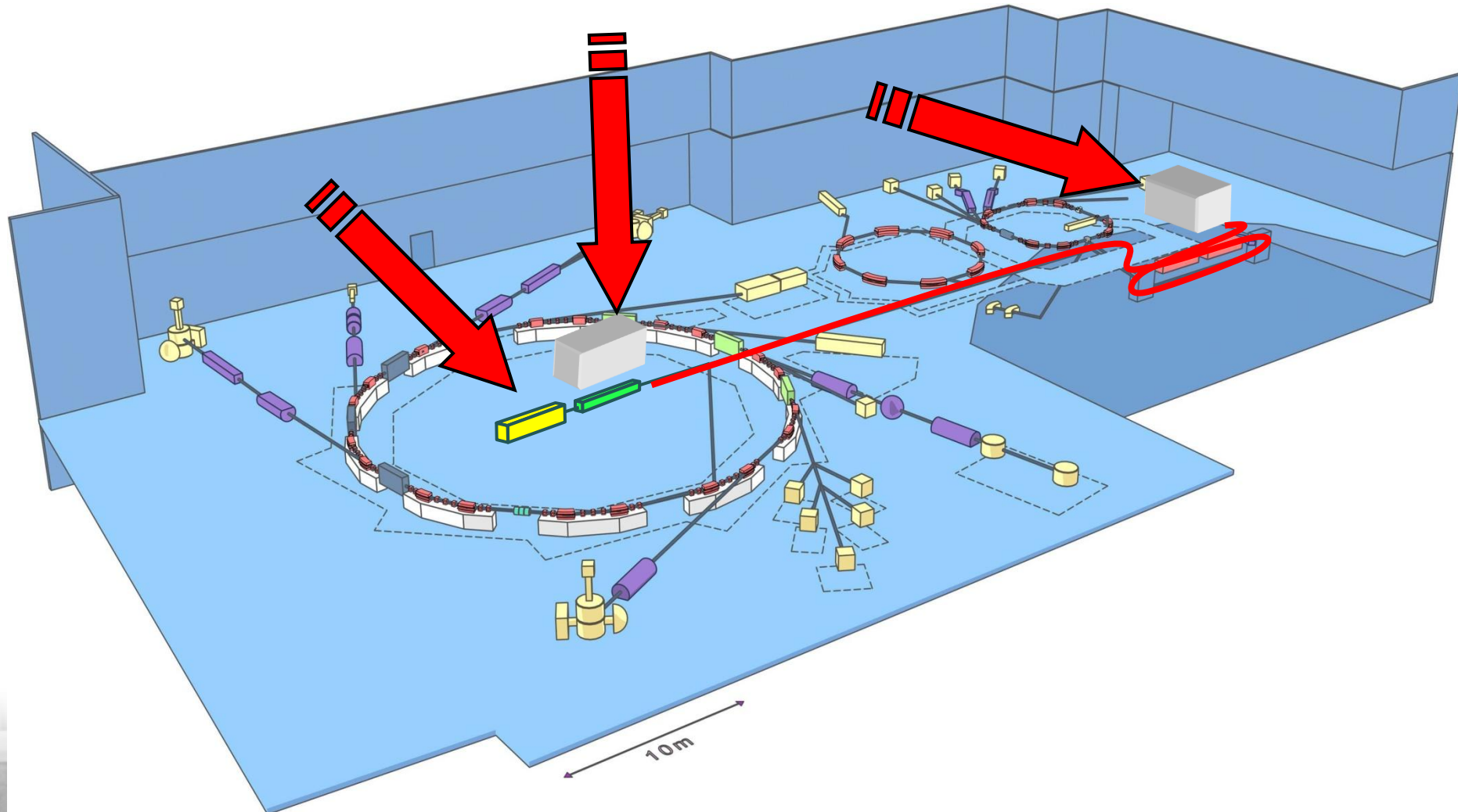
Fig. 2. Spectra (intensity at 355 nm as a function of time) as

3rd harmonic
355 nm
MAX I storage ring

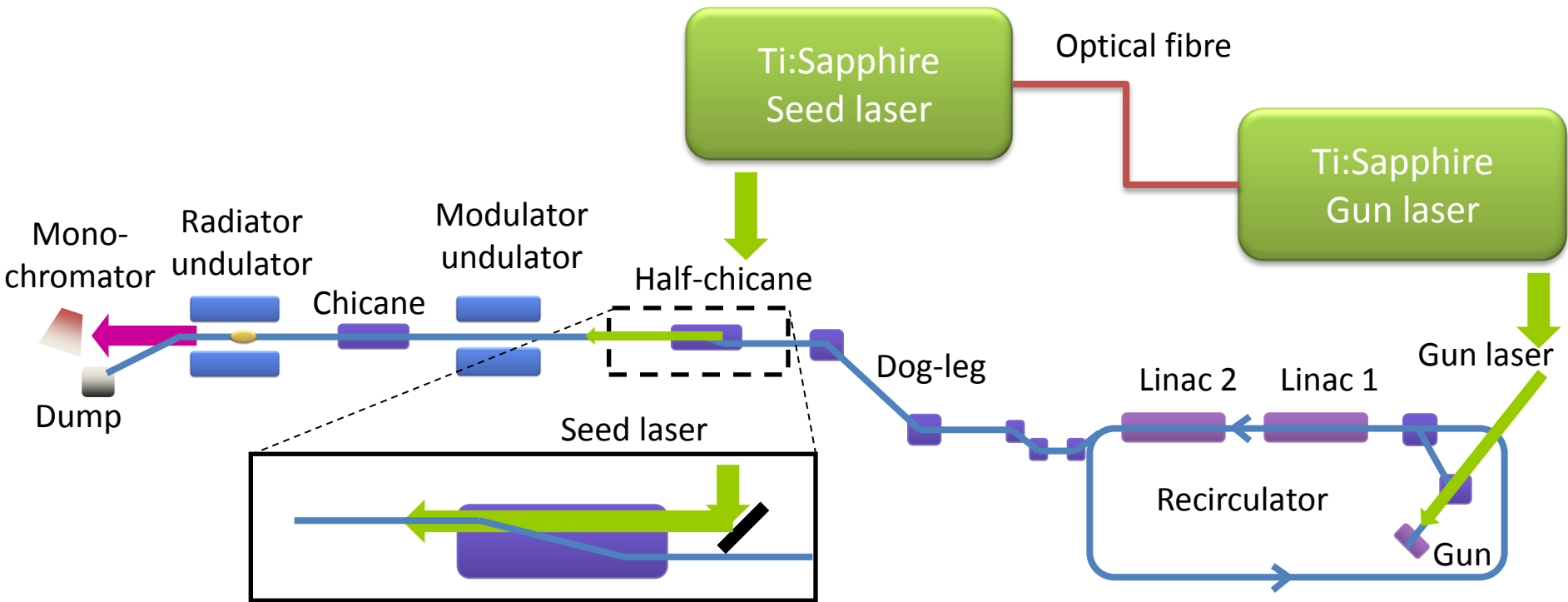


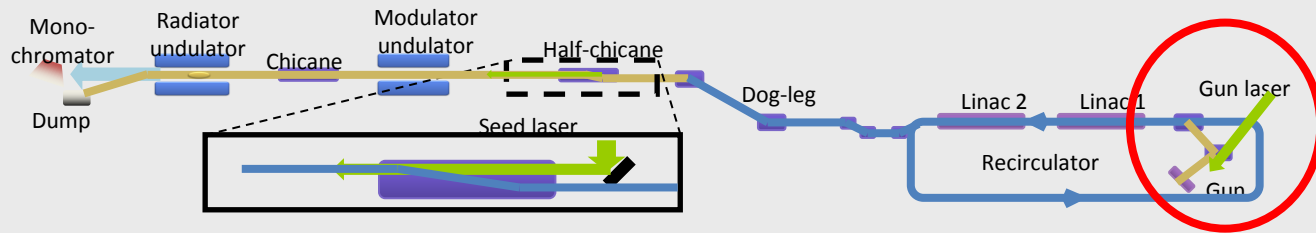
Free Electron Laser Test facility

Main installations

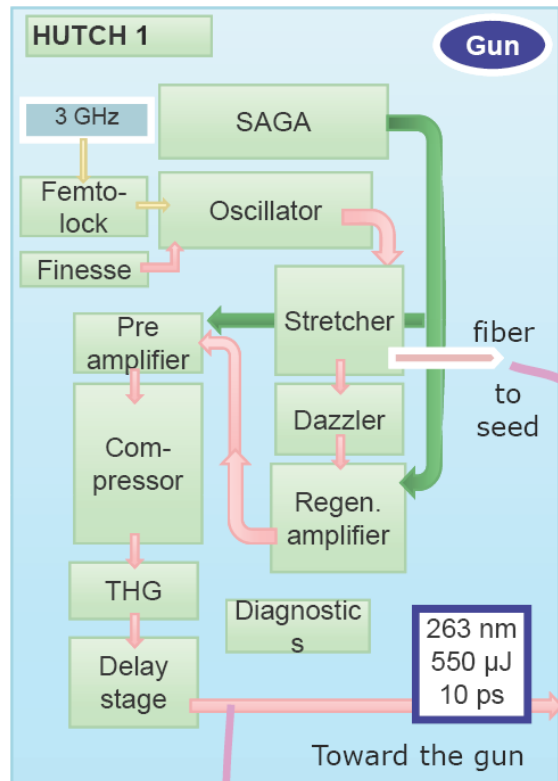


FEL test facility





Gun and gun laser

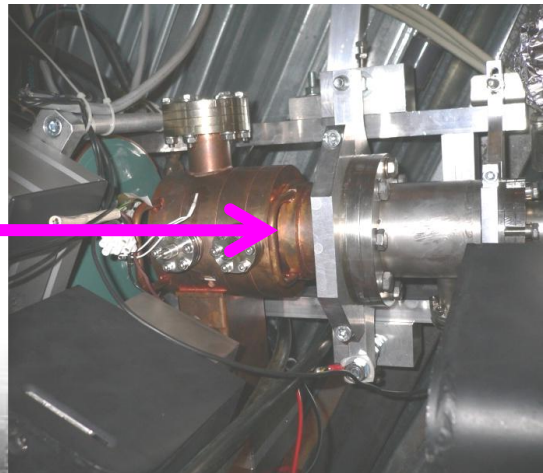
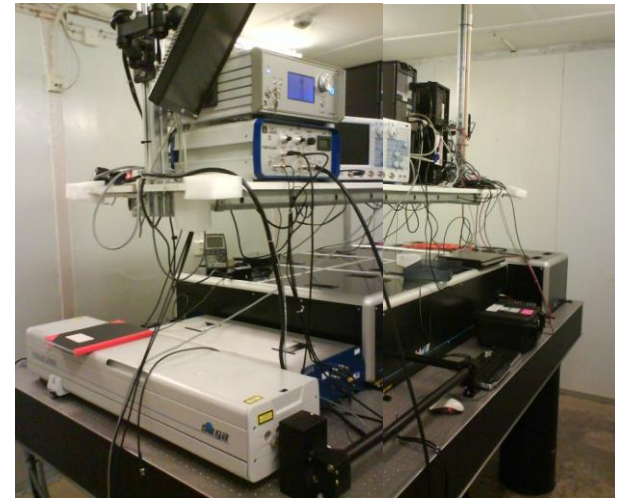


Gun

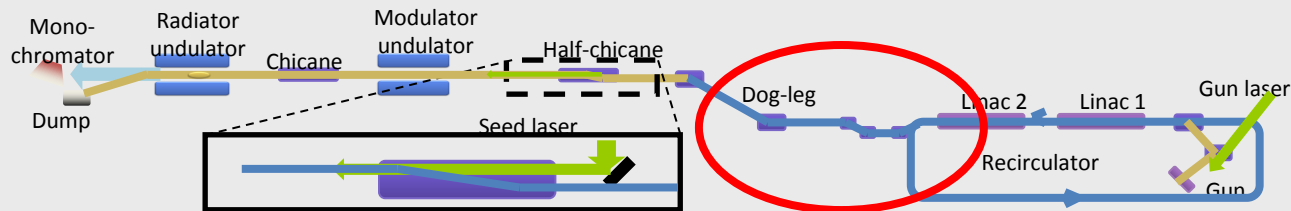
Ti:Sapphire
Jitter < 300 fs
Pulse length 10 ps

263 nm
550 μ J
10 ps

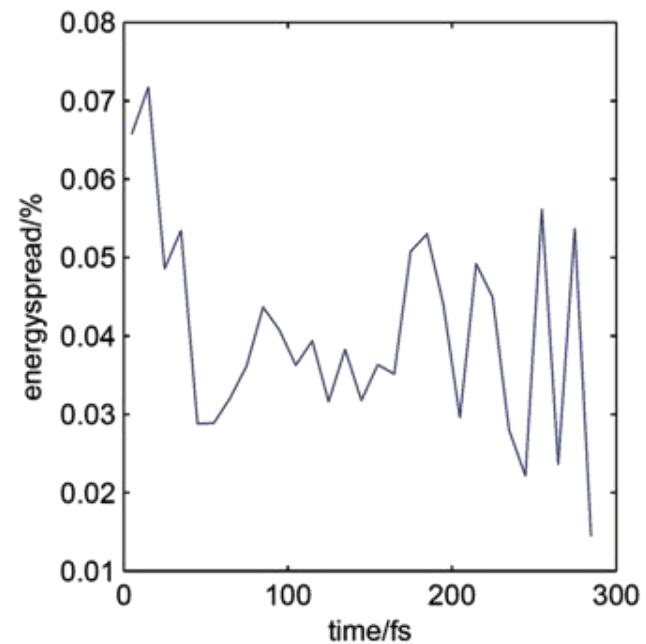
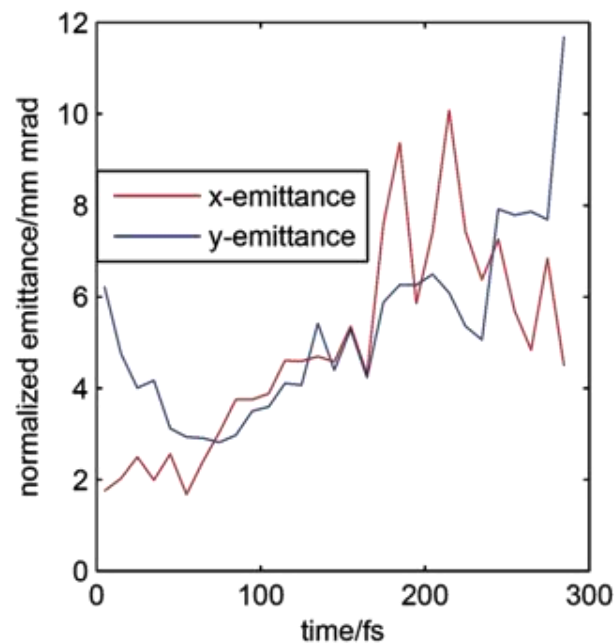
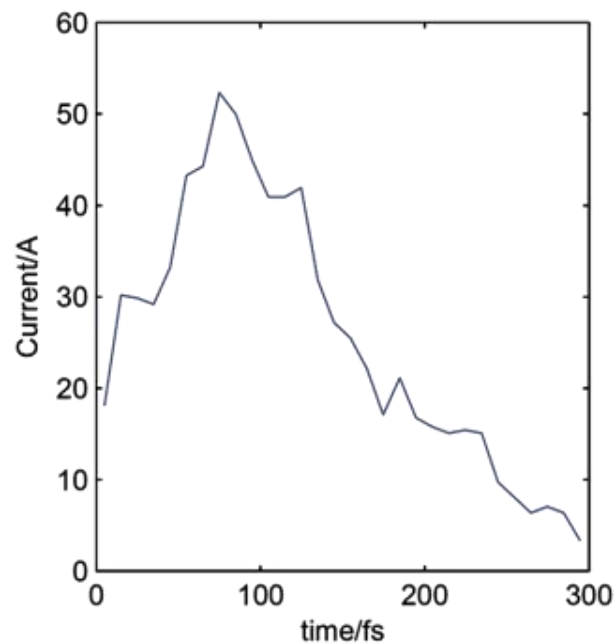
Test of
FERMI@Elettra gun



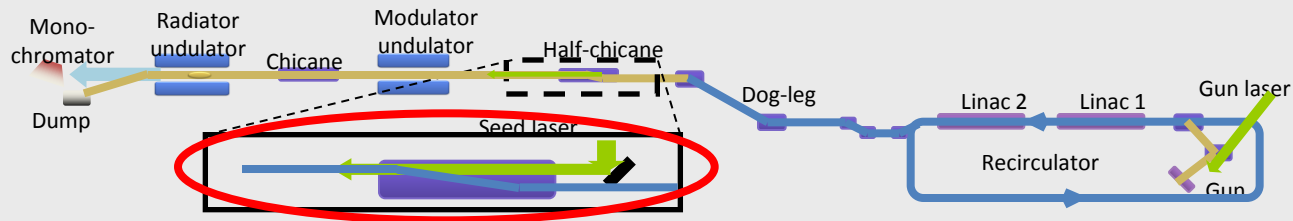
Energy 1.6 MeV
RF 3 GHz
Pulse length 10 ps
Phase $\approx$ 25 deg
Charge 100 pQ
Emittance 4 mm mRad
Rep rate 2 Hz



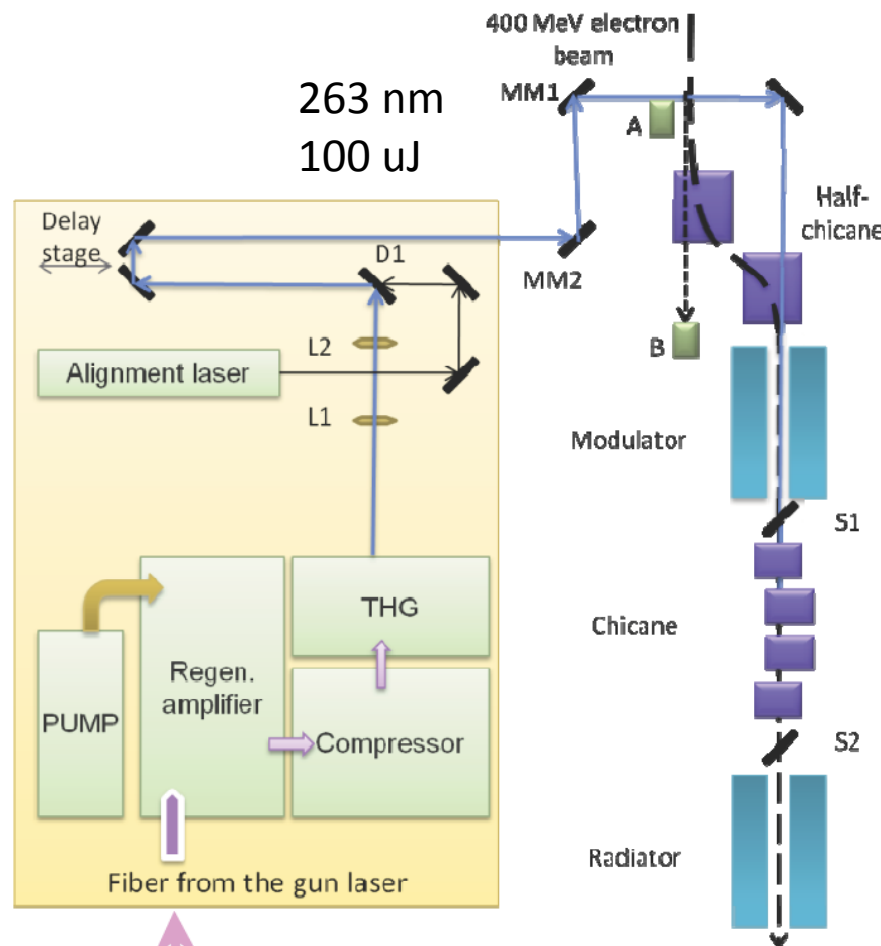
Bunch compression

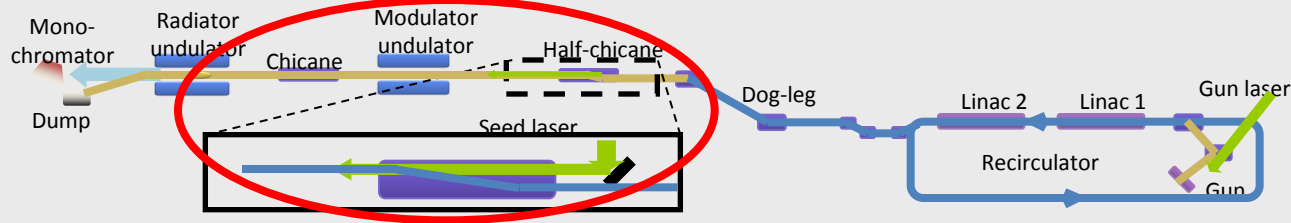


$Q = 0.01 \text{ nC}$

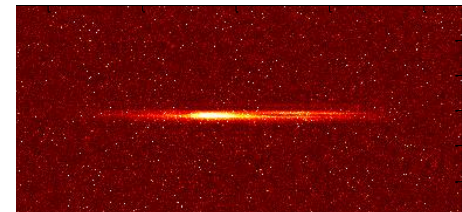
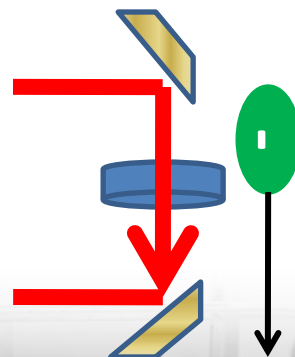
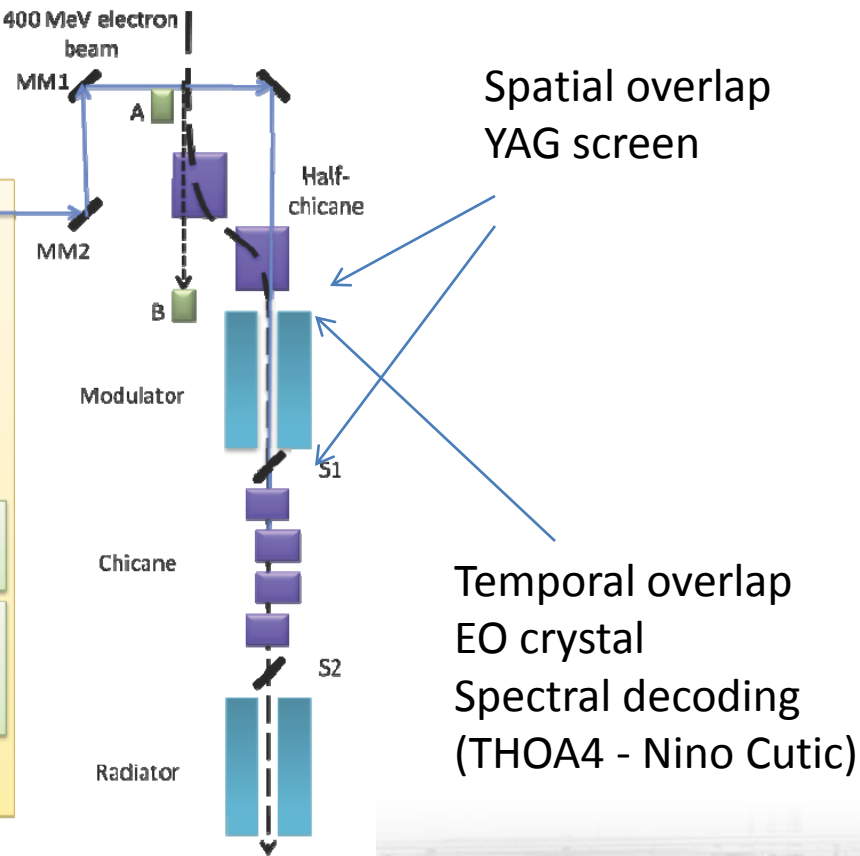


Seed laser





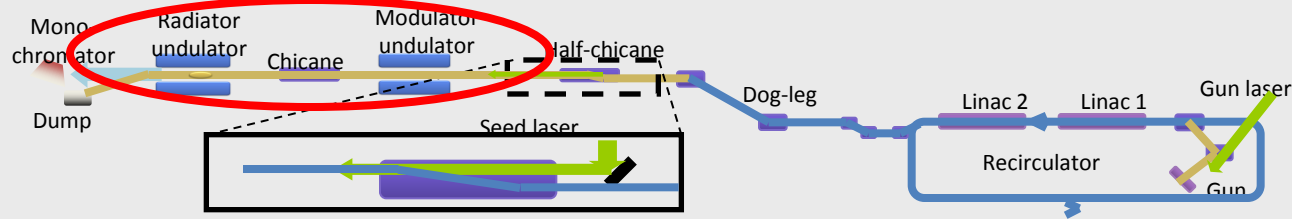
Overlap in time and space



← →

≈ 2 ps





Optical klystron

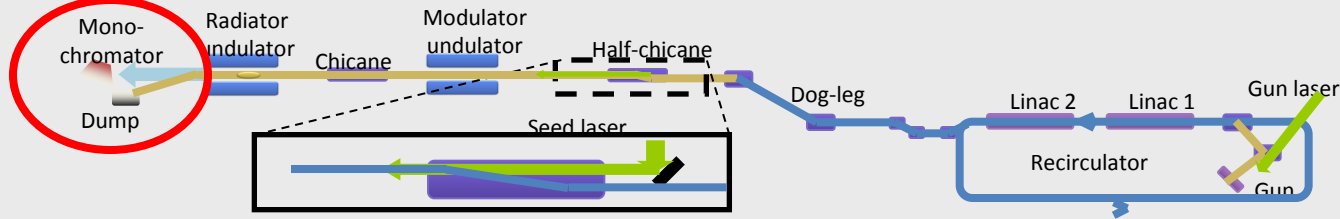


Radiator	Apple II (BESSY)
Period	56 mm
# of periods	30
Min. gap	12 mm
K max	4.3

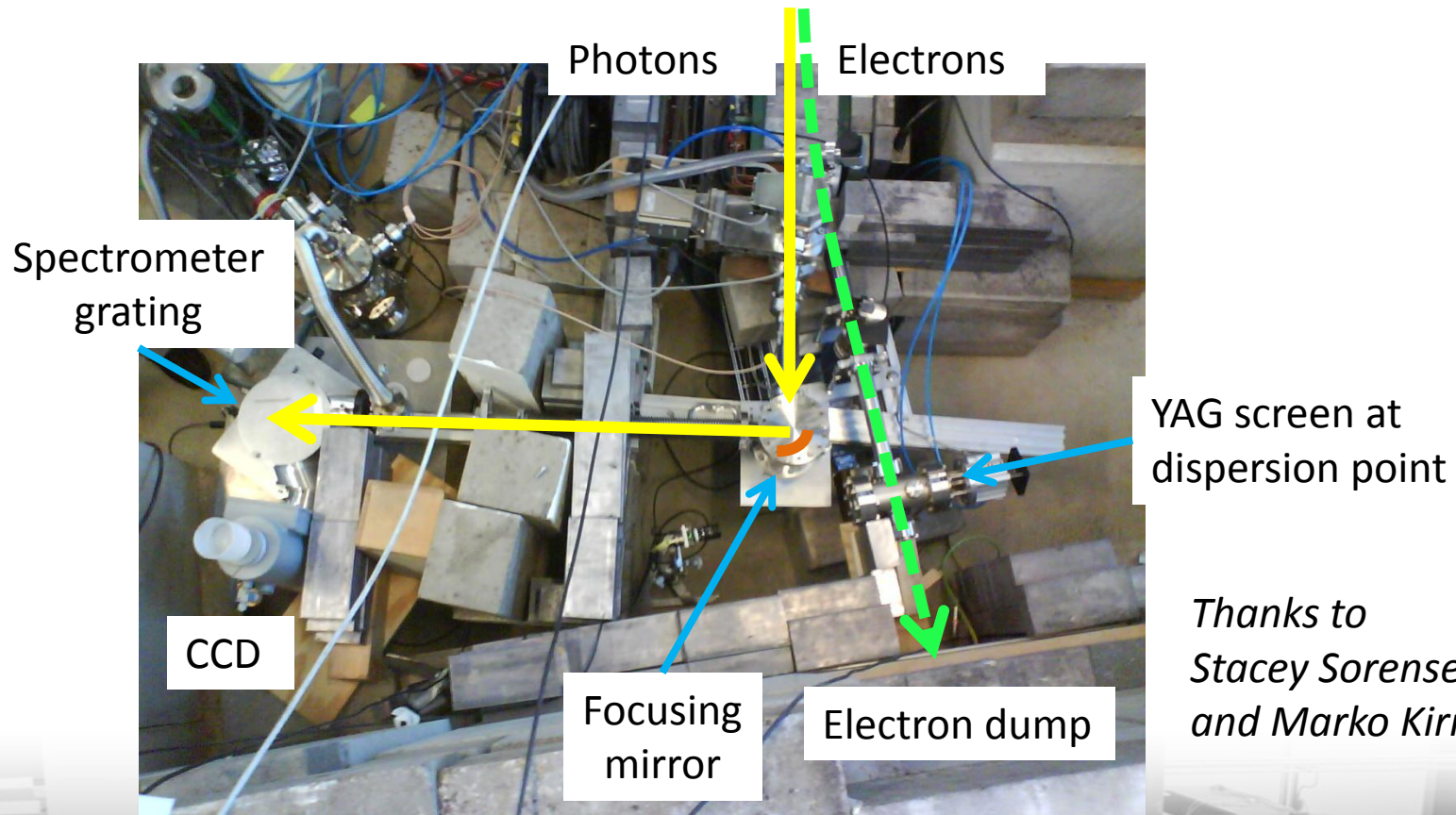
Chicane	
# of magnets	4
Gap	15 mm
B max	0.2 T

Modulator	Planar (ESRF)
Period	48 mm
# of periods	30
Min. gap	10 mm
K max	4.3



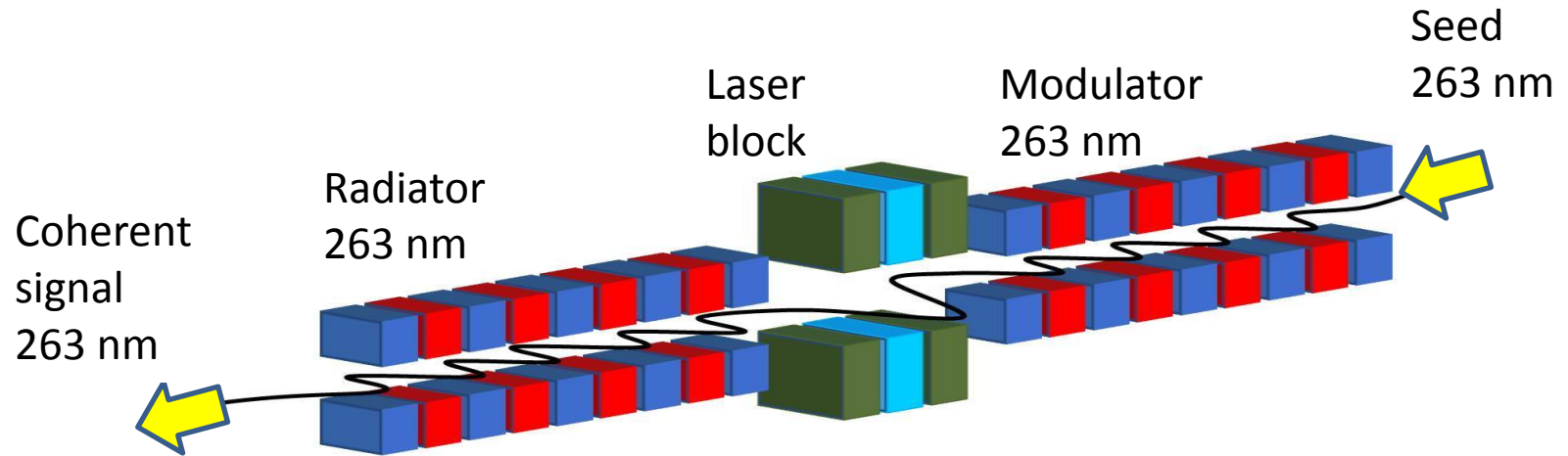


Spectrometer system

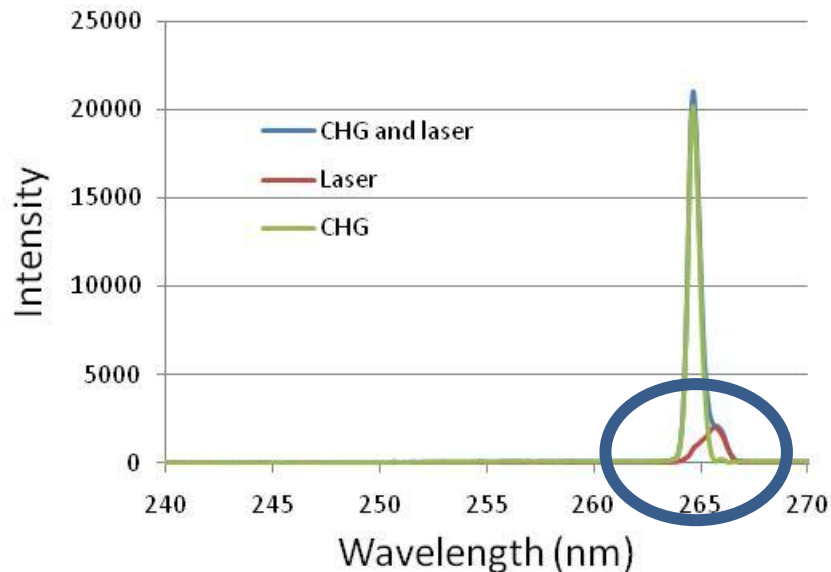


*Thanks to
Stacey Sorensen (Lund)
and Marko Kirm (Tartu)*

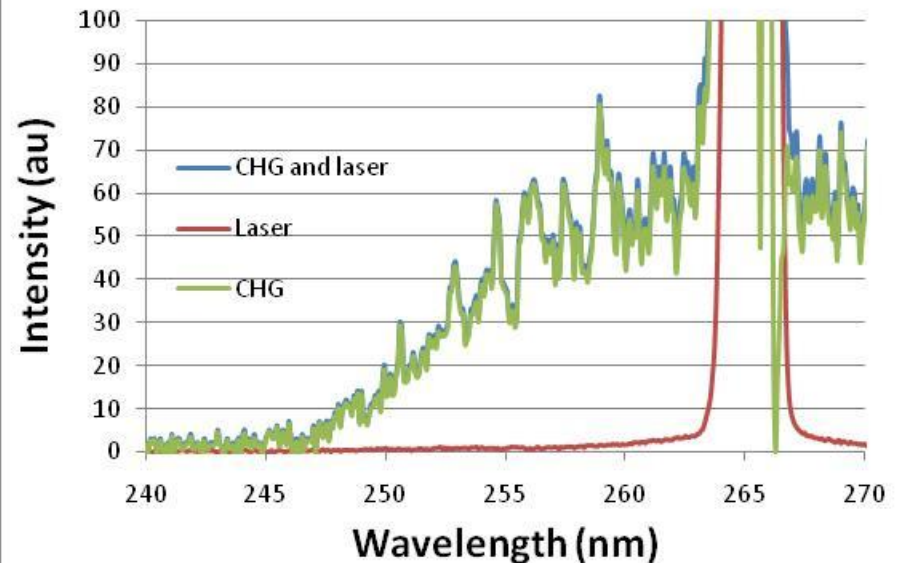
Results – fundamental 263 nm



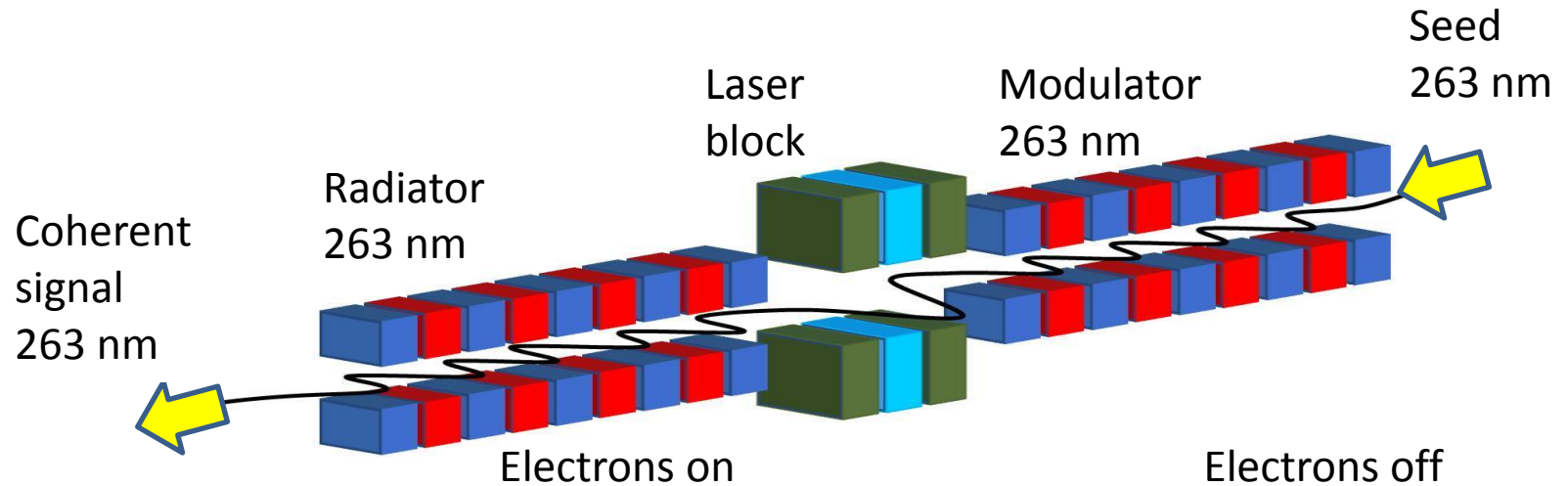
Fundamental



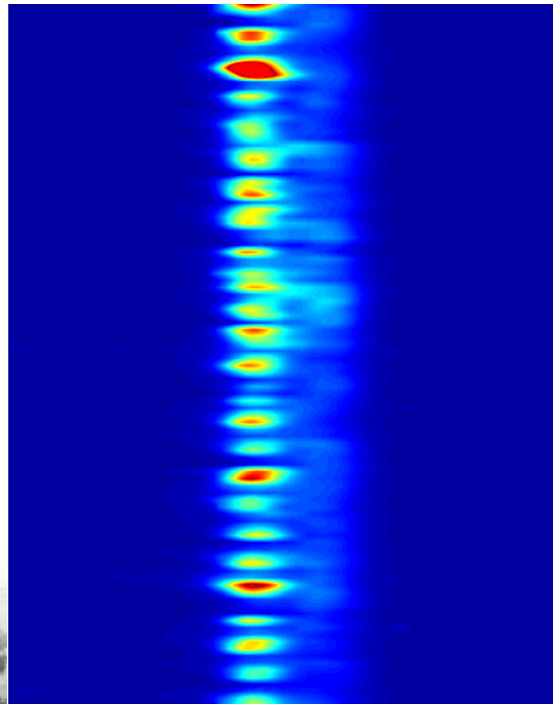
Fundamental



Results – fundamental 263 nm

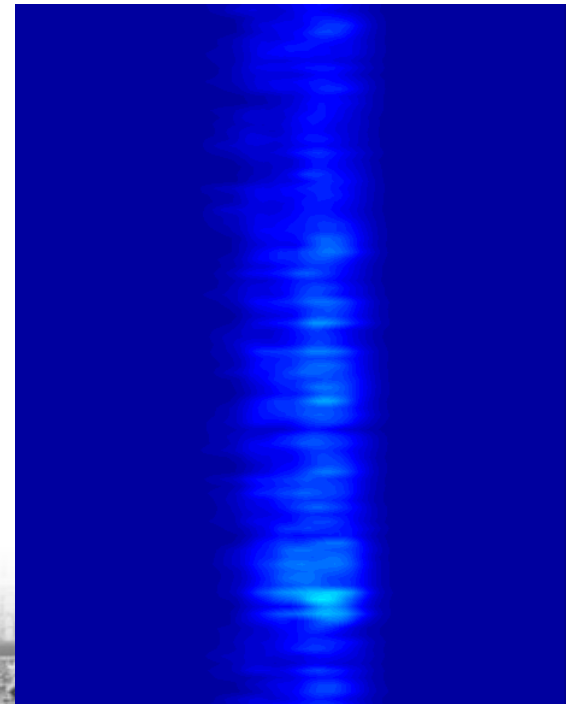


Sweep number



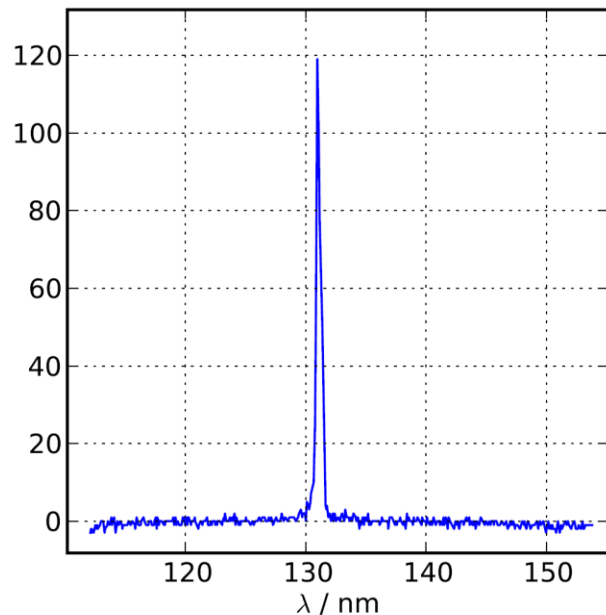
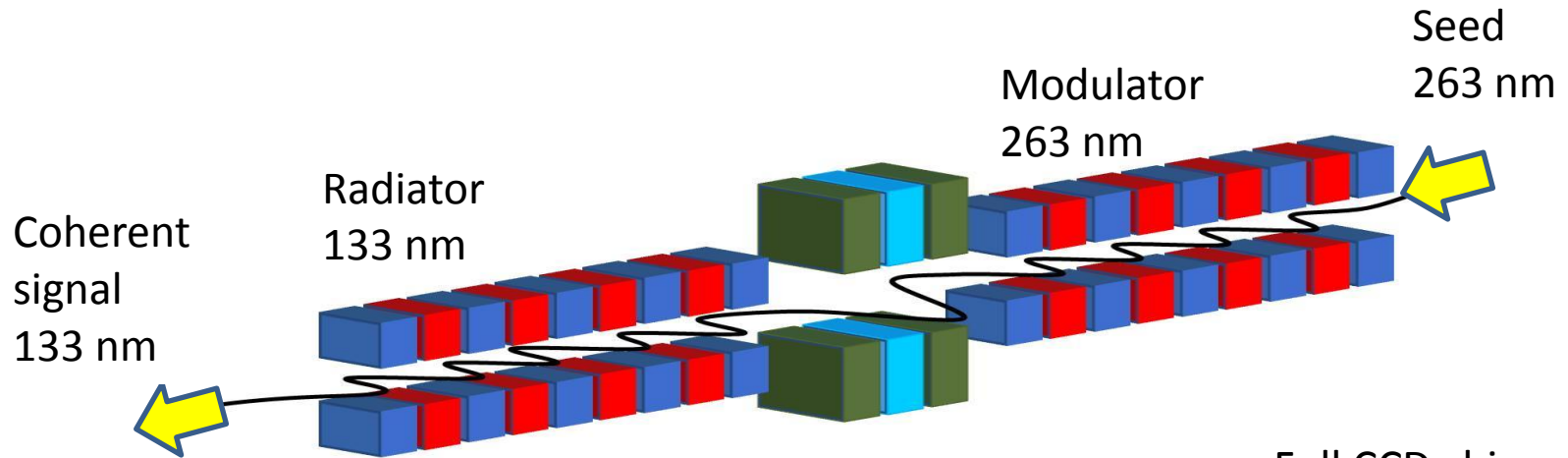
260 – 270 nm

Sweep number



260 – 270 nm

Results – 2nd harmonic 133 nm

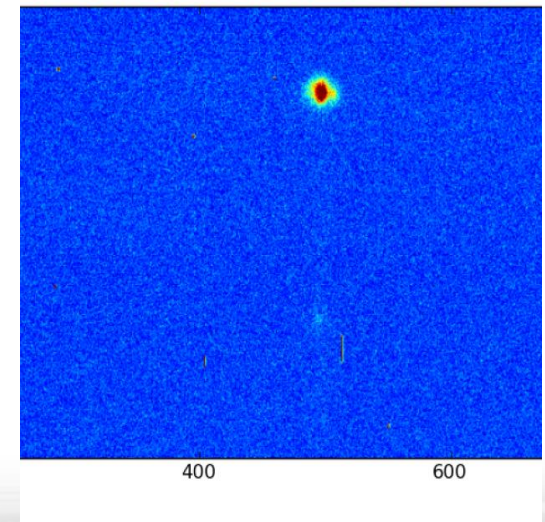


133 nm linear mode

($>$) 185 fs
<0.24% BW (=spectr.)
8e6 photons/pulse
11 pJ/pulse
0.2 mRad

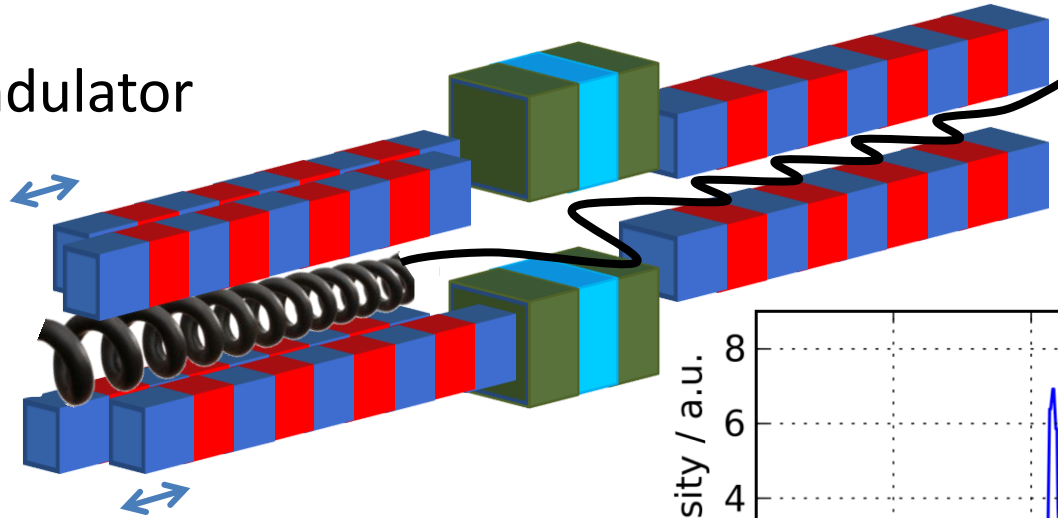
Full CCD chip
No trace of spontaneous signal

Undisturbed plane

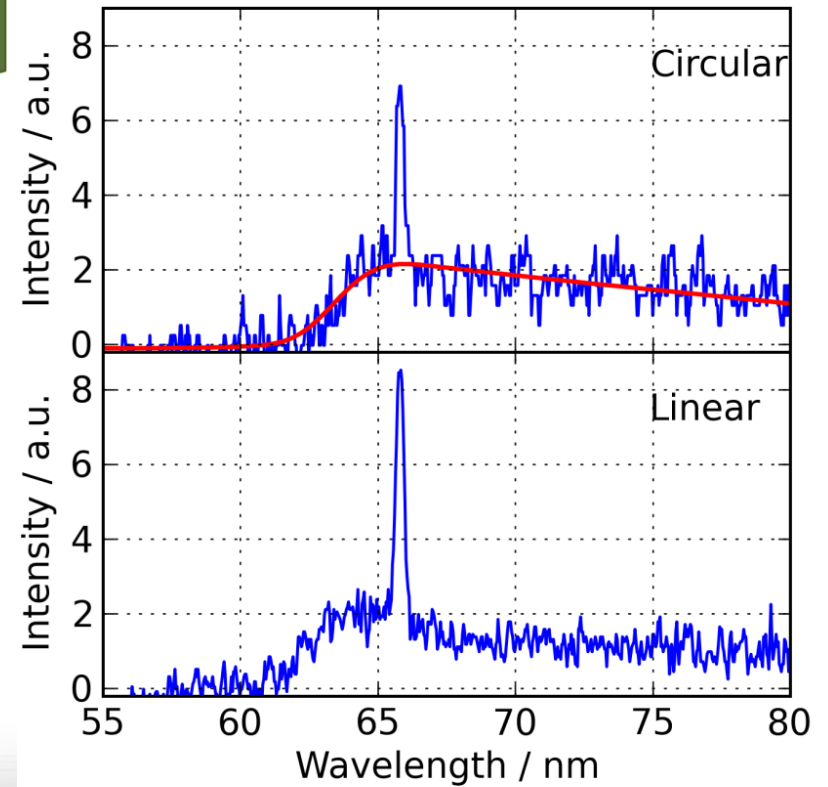


Results – 4th harmonic variable polarization

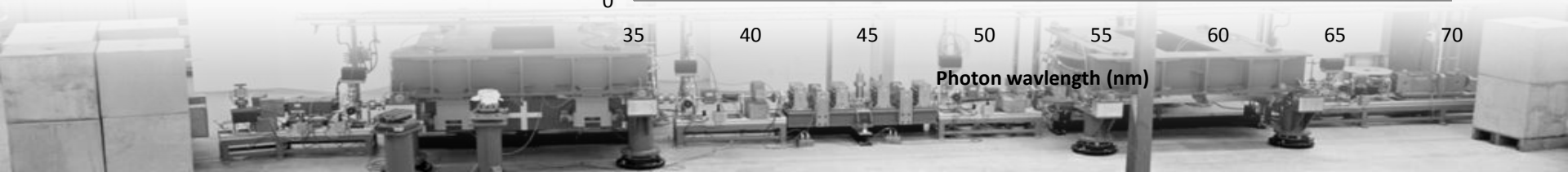
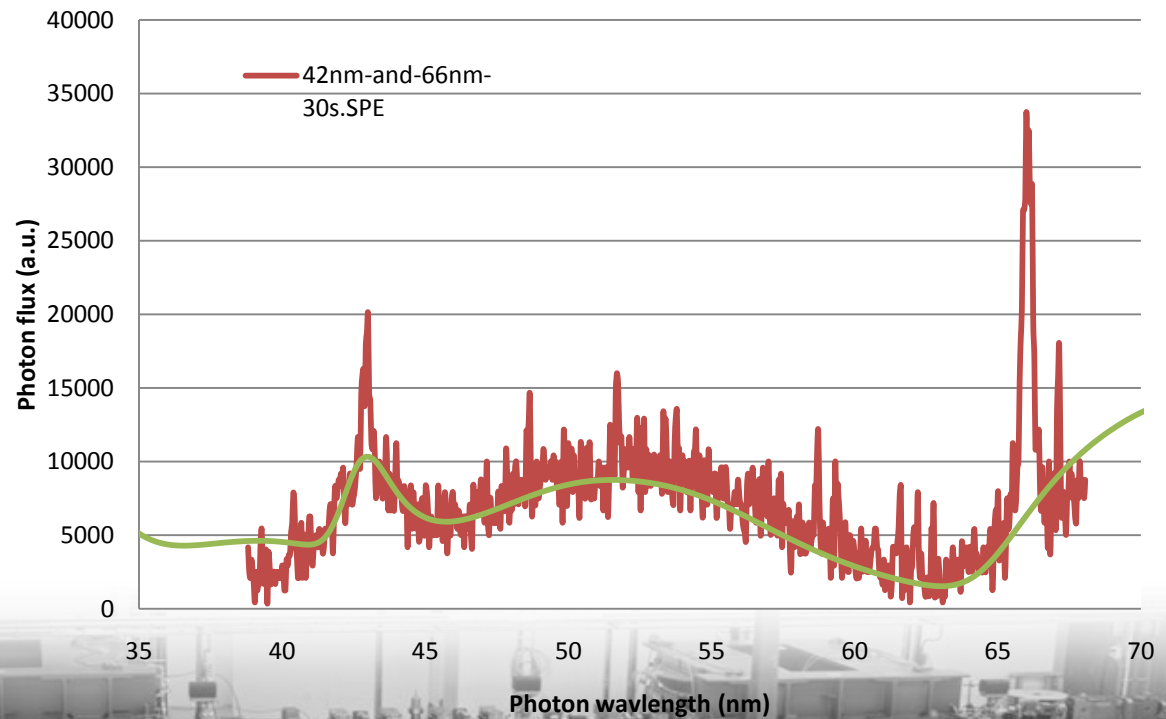
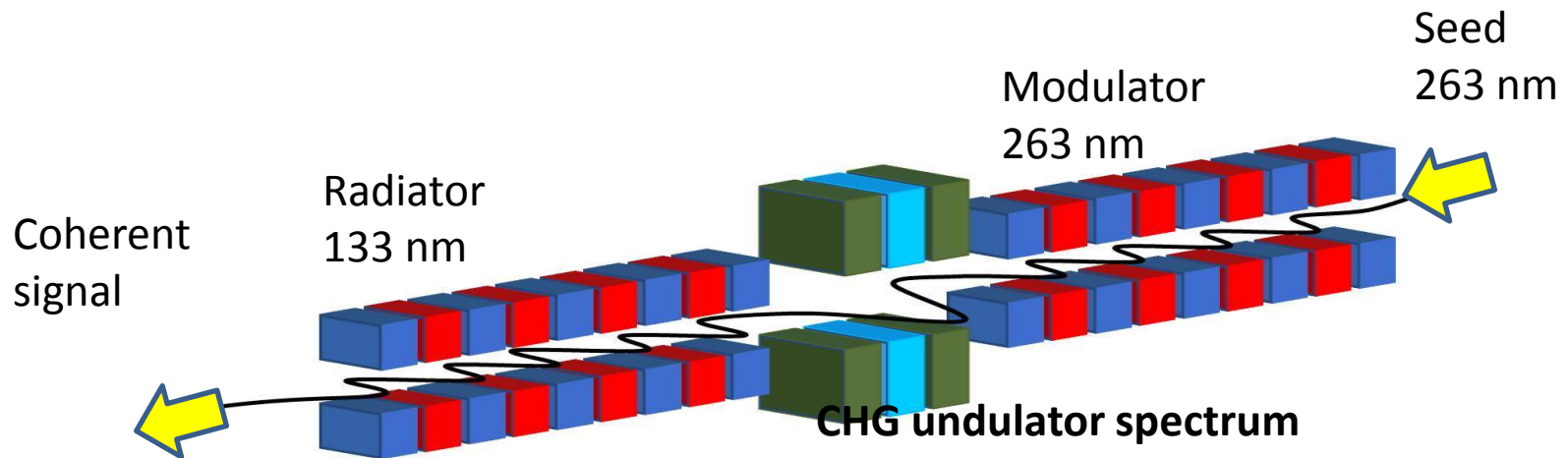
Apple II undulator
Helical



1-3 pJ/pulse



Results – 4th and 6th harmonic (66 & 42 nm)

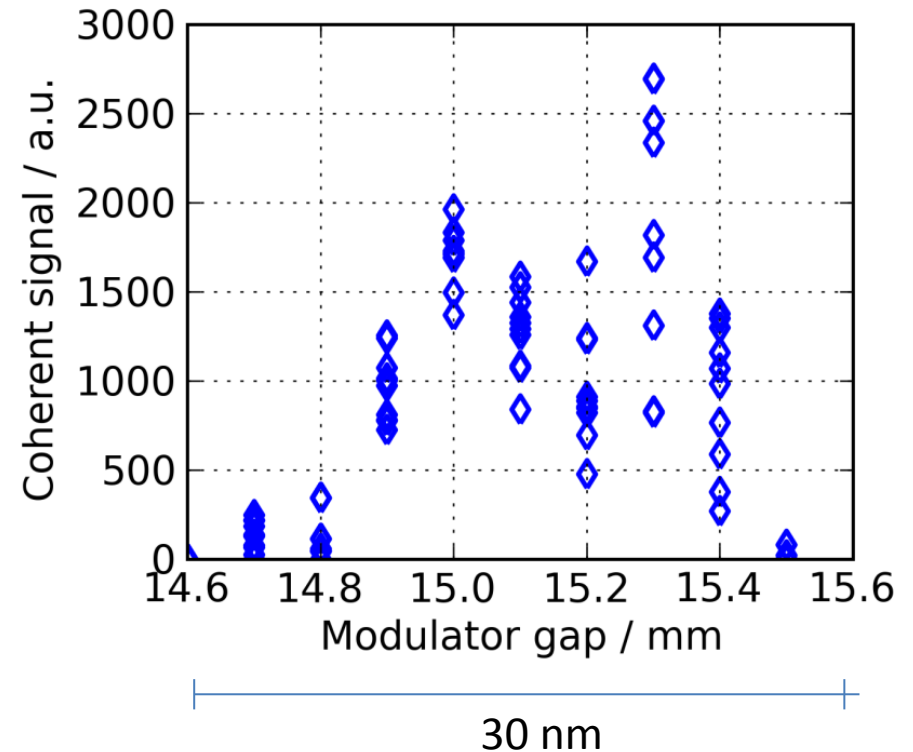


Modulator scan

Wider than modulator
linewidth

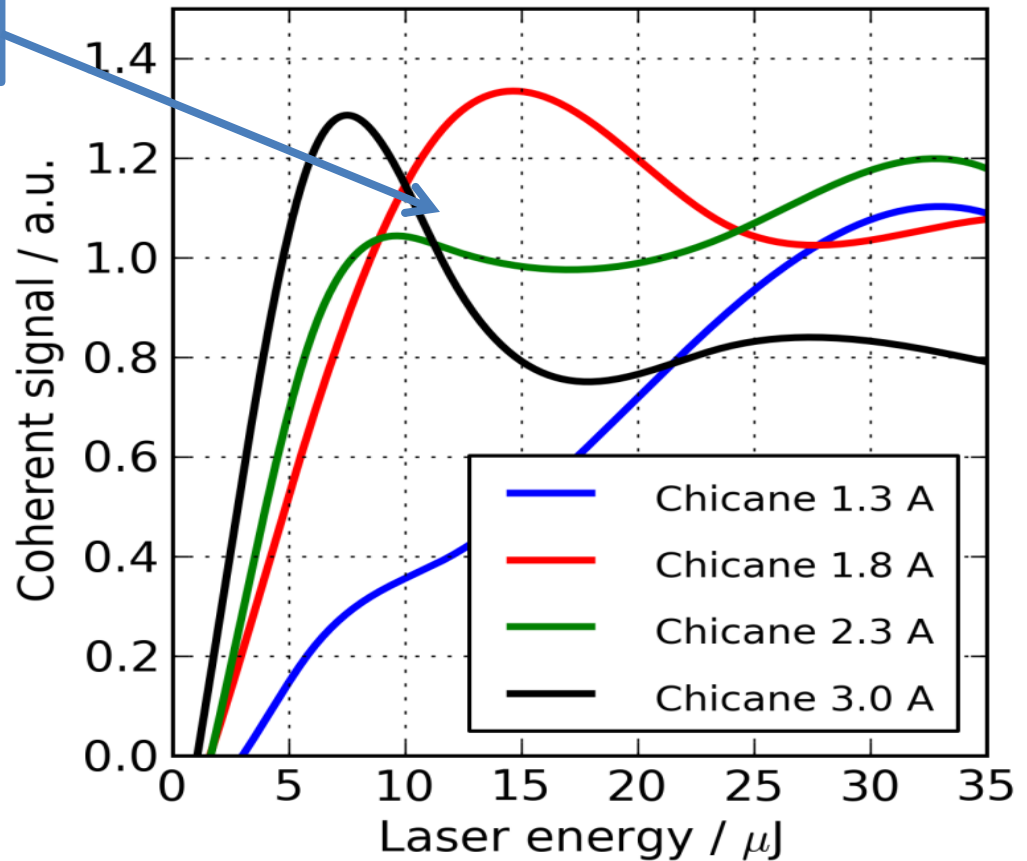
Energy jitter

Short laser focus



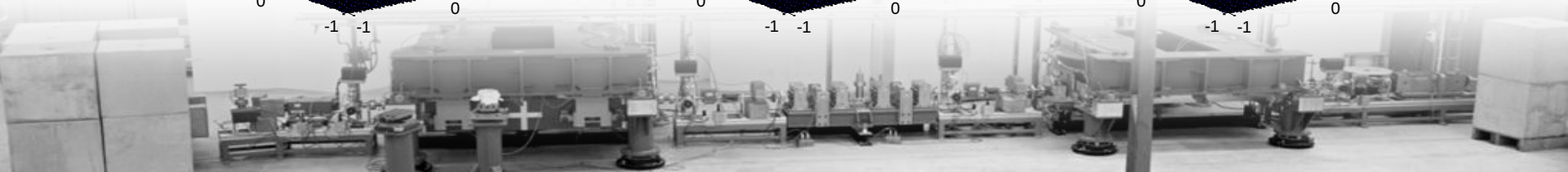
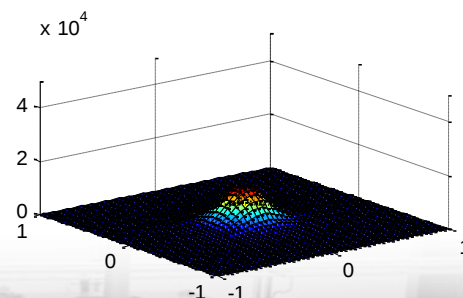
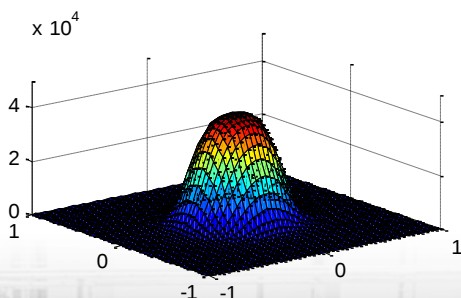
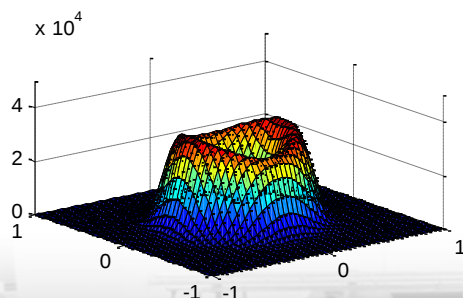
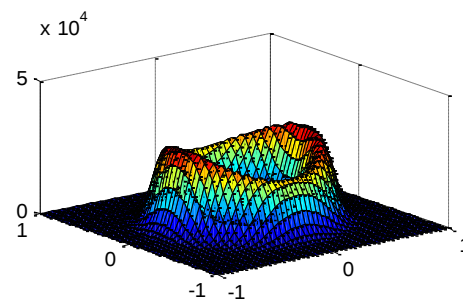
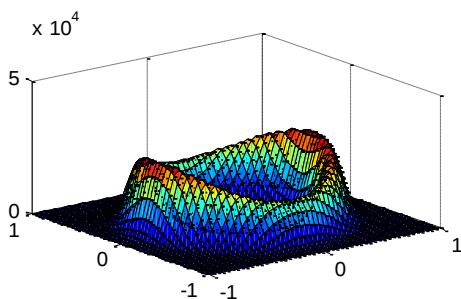
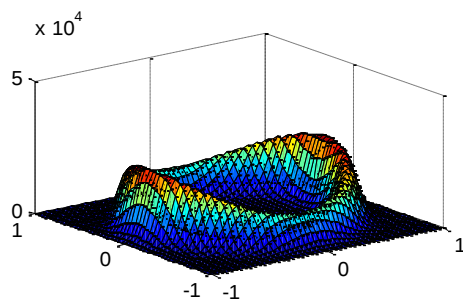
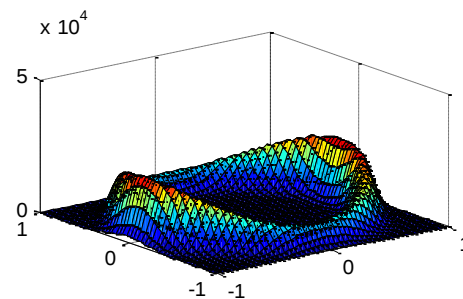
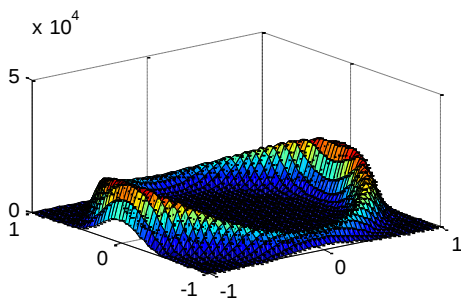
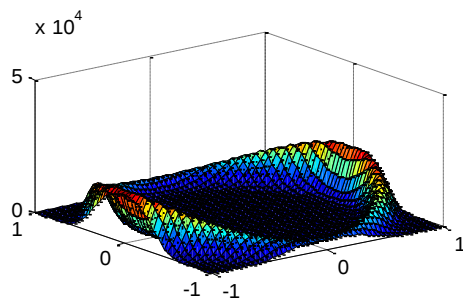
Chicane and laser energy (133 nm)

Overbunching



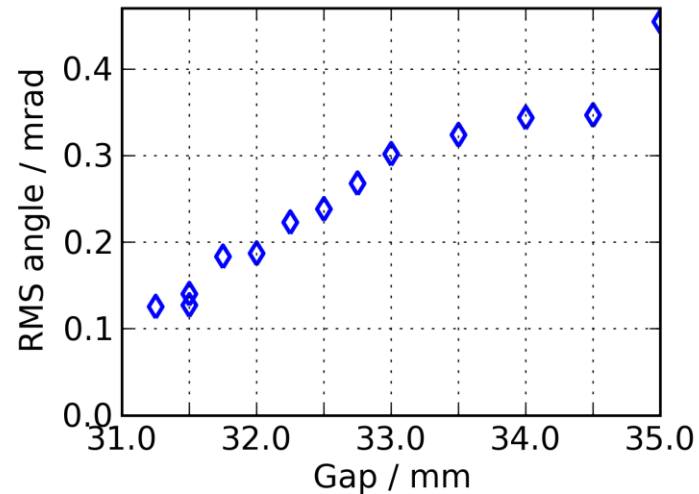
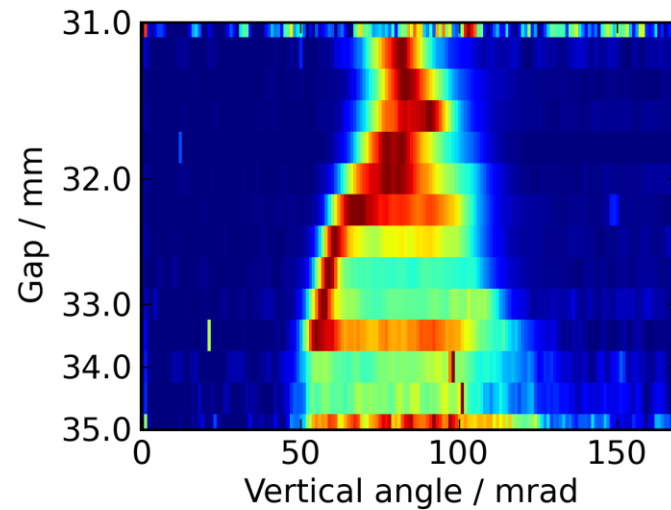
Scan radiator gap

Simulation in SPECTRA



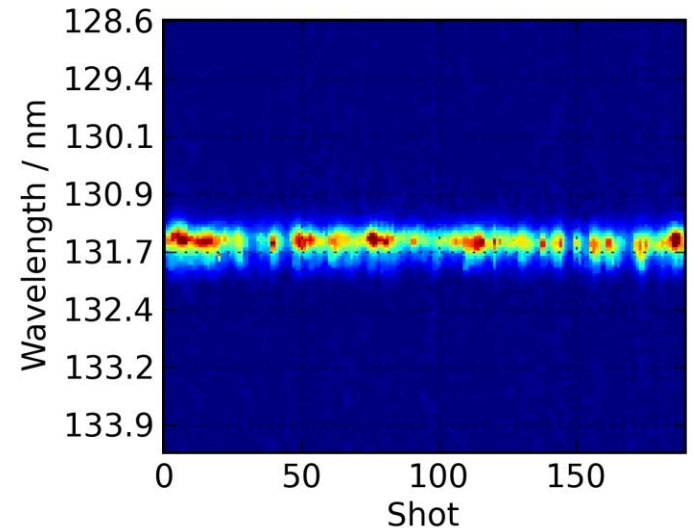
Scan radiator gap

- Optical mode increases (in fact becomes a circle)
- Focusing plane
- Cut and reflection?
- 133nm



Stability

- Jitter sources
- Laser 200-300 fs
- Klystron modulators lock to 50 Hz (ok)
- Jitter gun-linac klystron
- => Energy jitter => position jitter
- Feed back of laser delay on e-beam arrival (drift correction, OK)



Thank you!

THOA4 – EO

TUPB15 – HHG

WEPA11 – MAX IV FEL

WEPB34 – MAX IV Injector

