Results from the Optical Replica Synthesizer at FLASH

Shaukat Khan, University of Hamburg

FEL 2008, Gyeongju, Korea

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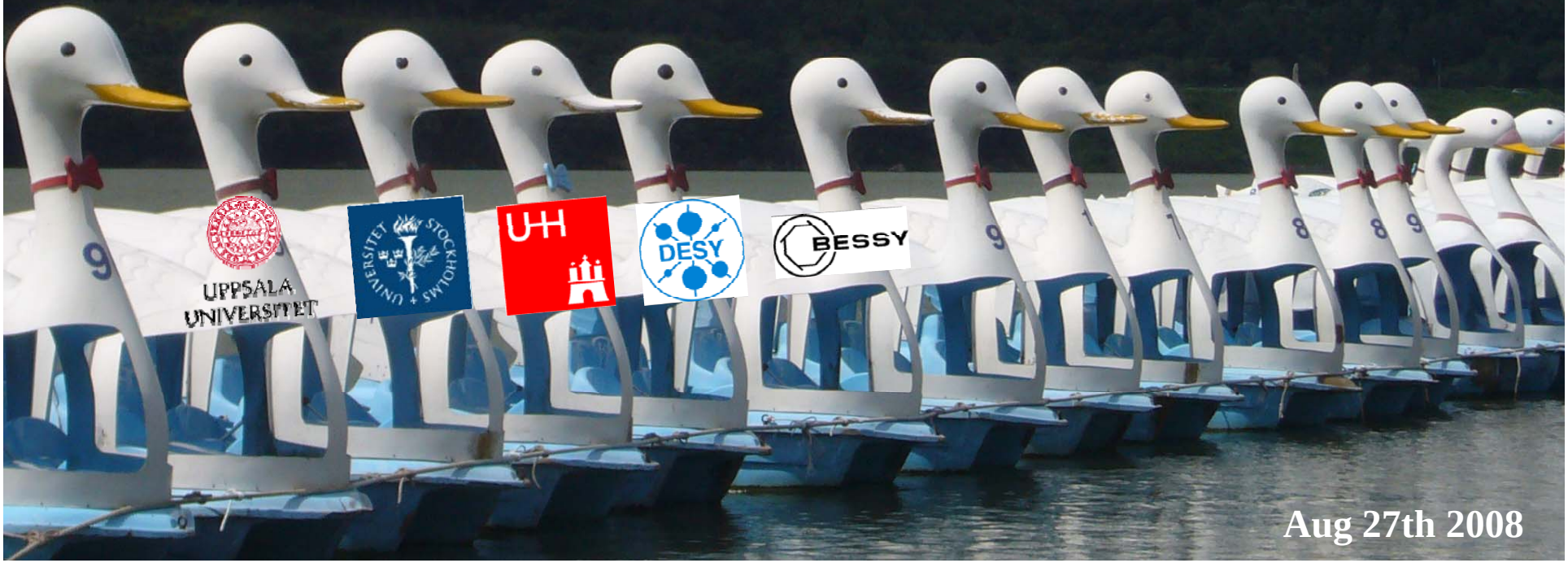
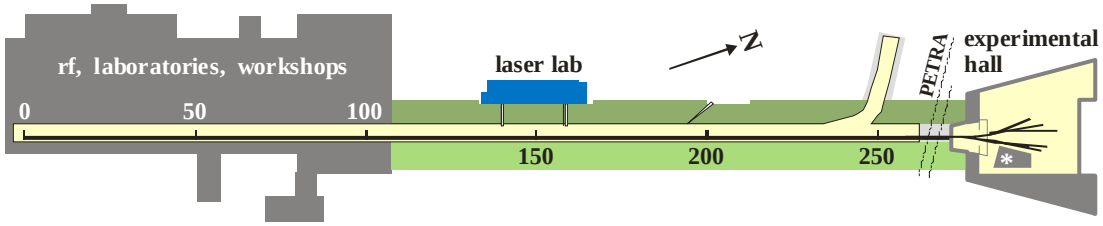
M. Larsson, P. van der Meulen, P. Salén (FYSIKUM, Stockholm, Sweden)
J. Bödewadt, S. Khan (University of Hamburg, Germany)
F. Löhl, E. Saldin, H. Schlarb, E. Schneidmiller, A. Winter, M. Yurkov (DESY, Hamburg, Germany)
A. Meseck (BESSY, Berlin, Germany)



Aug 27th 2008

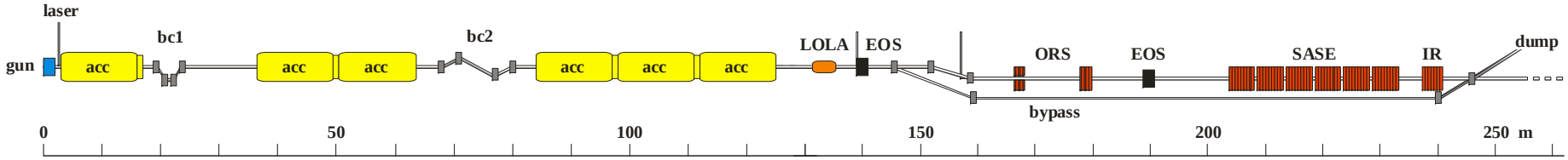
FLASH at DESY / Hamburg

FLASH at DESY / Hamburg

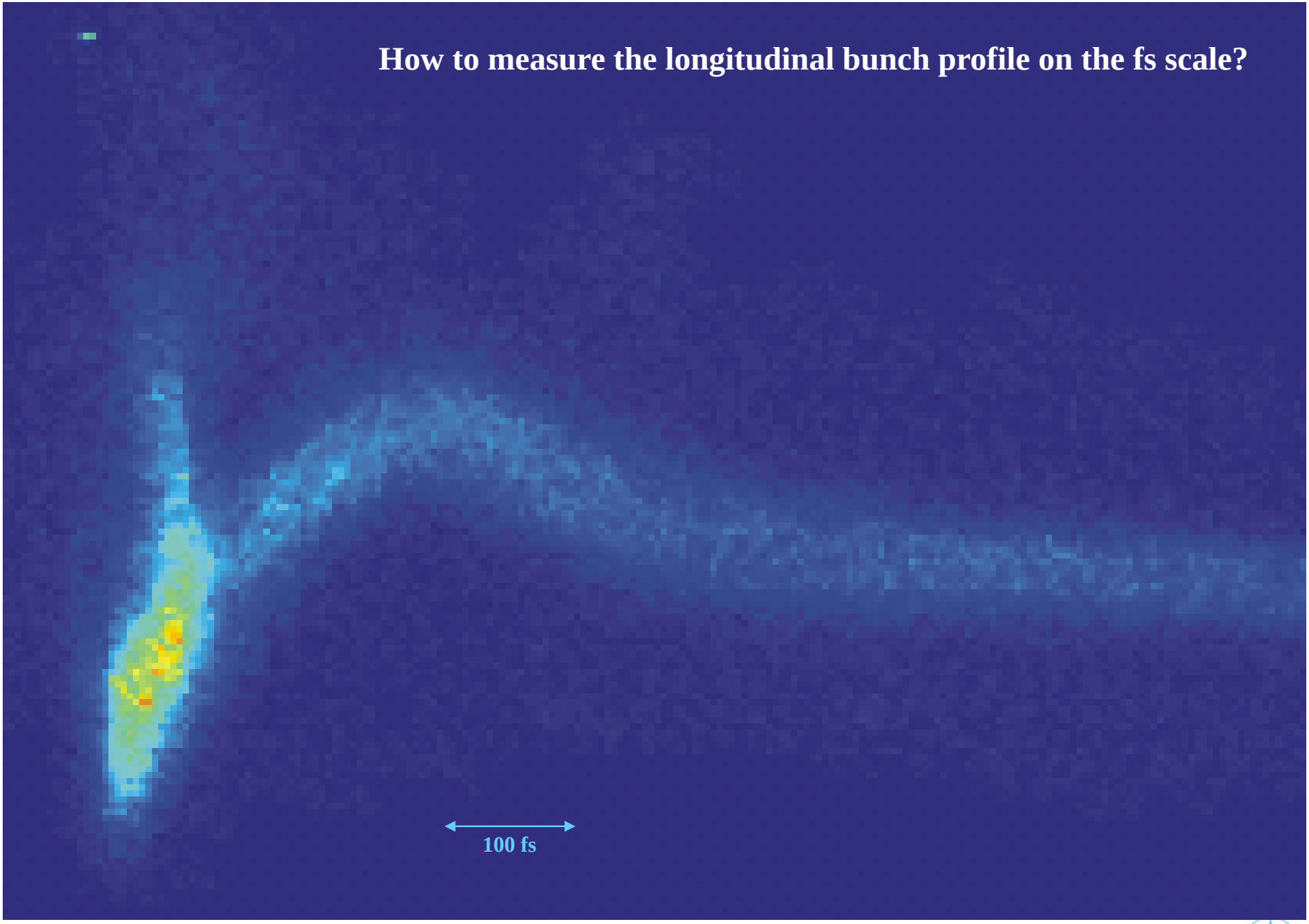


acceleration & bunch compression

SASE

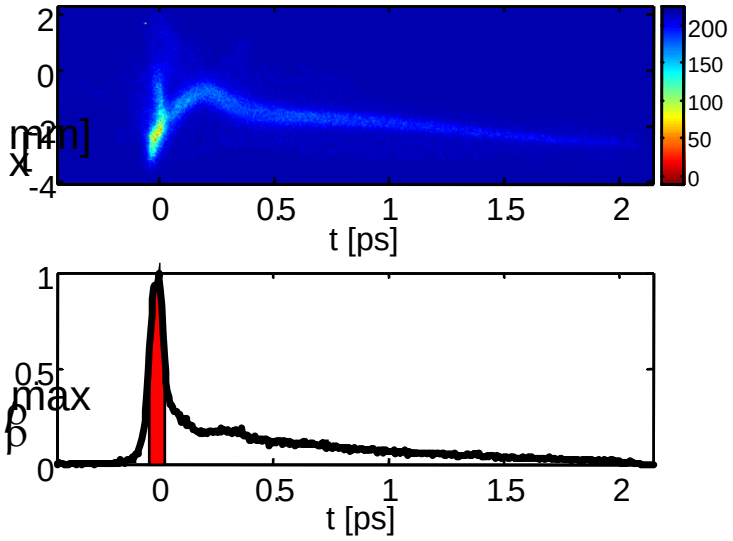


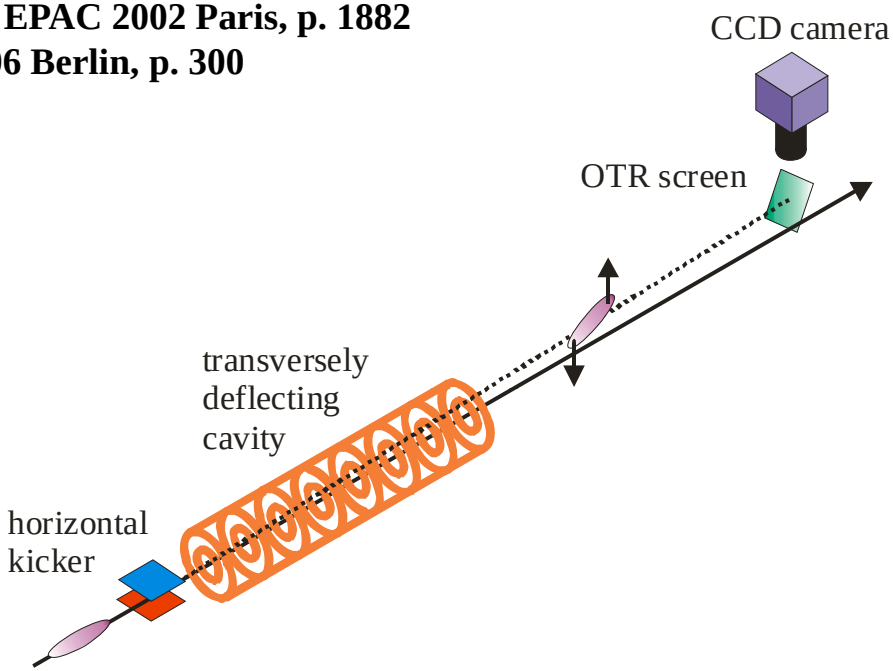
How to measure the longitudinal bunch profile on the fs scale?



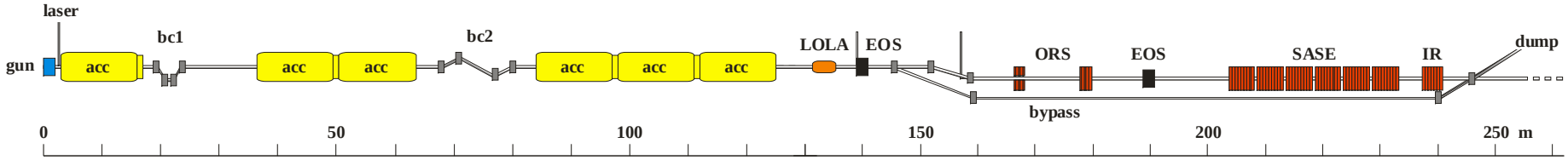
1. Transversely deflecting rf structure („LOLA“)

R. Akre, L. Bentson, P. Emma, P. Krejick, Proc. EPAC 2002 Paris, p. 1882
M. Roehrs, C. Gerth, H. Schlarb, Proc. FEL 2006 Berlin, p. 300
M. Roehrs, PhD thesis Hamburg 2008





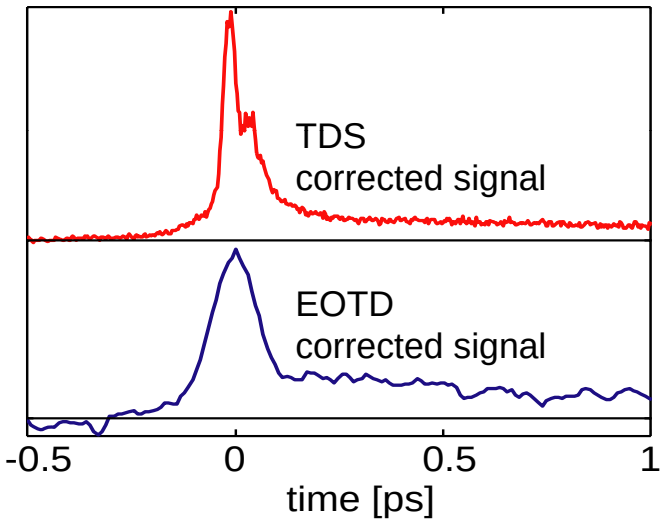
time resolution ~30 fs

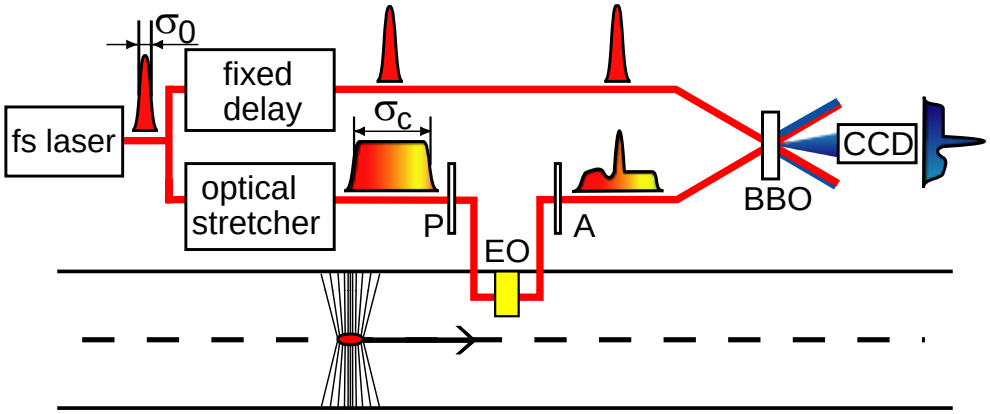


2. Electro-optical sampling (EOS)

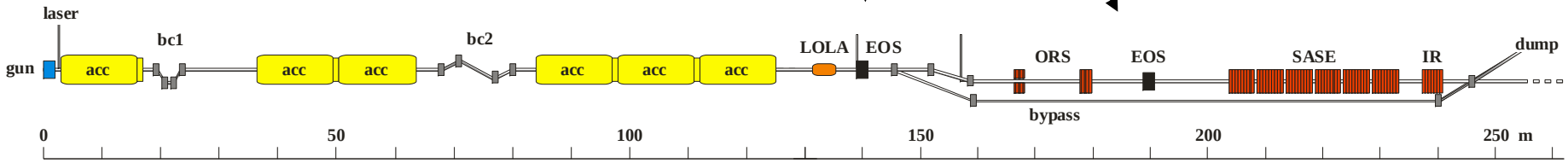
B. Steffen et al. Proc. FEL Novosibirsk 2007, p. 310
B. Steffen, PhD thesis Hamburg 2007

e.g. temporal decoding



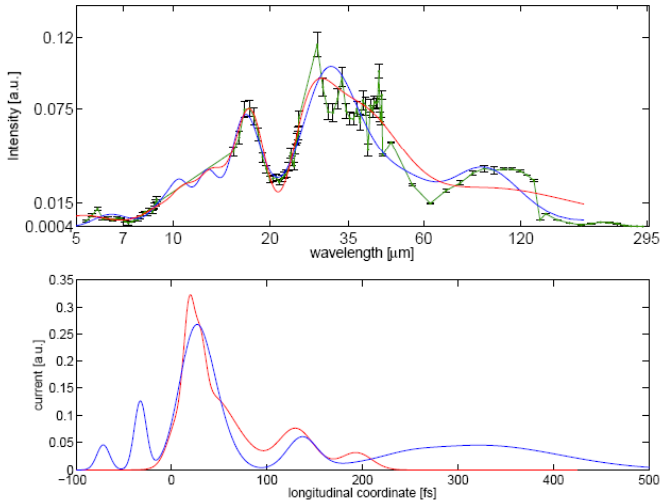


time resolution
~55 fs achieved

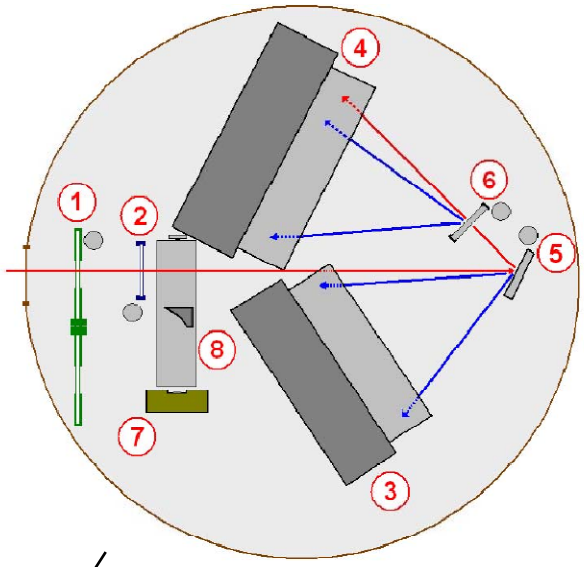


3. Coherent transition radiation (CTR)

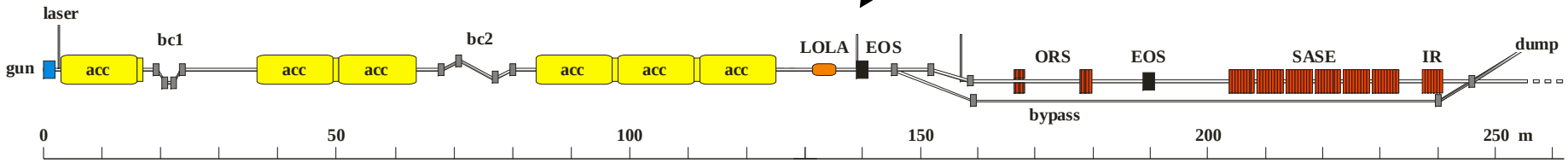
H. Delsim-Hashemi et al. Proc. FEL 2006 Berlin, p. 594
H. Delsim-Hashemi, PhD thesis Hamburg 2008



2-stage single-shot spectrometer

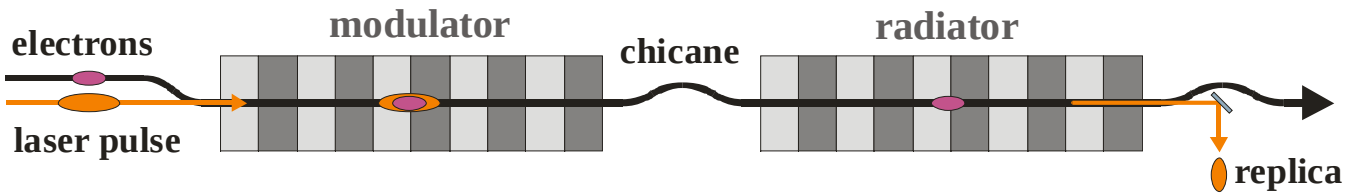


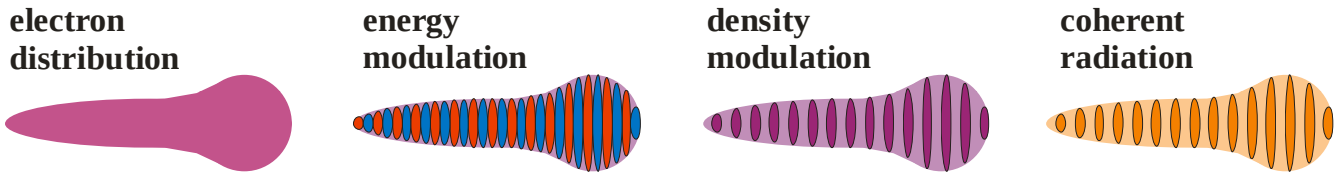
no intrinsic resolution limit,
but result ambiguous

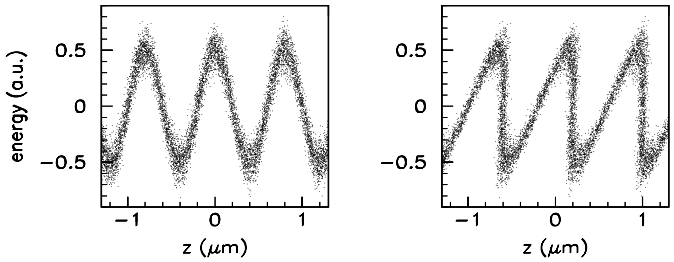


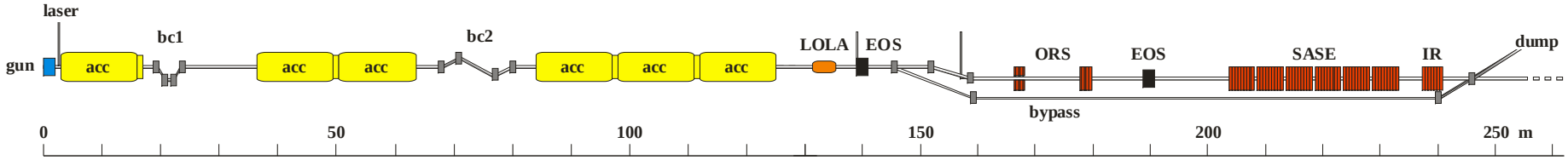
4. Optical-replica synthesizer (ORS)

E. Saldin, E. Schneidmiller, M. Yurkov, Nucl. Inst. Methods A 539 (2005), p. 499









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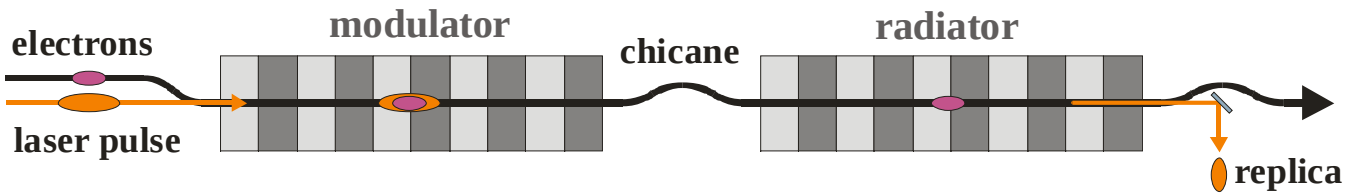

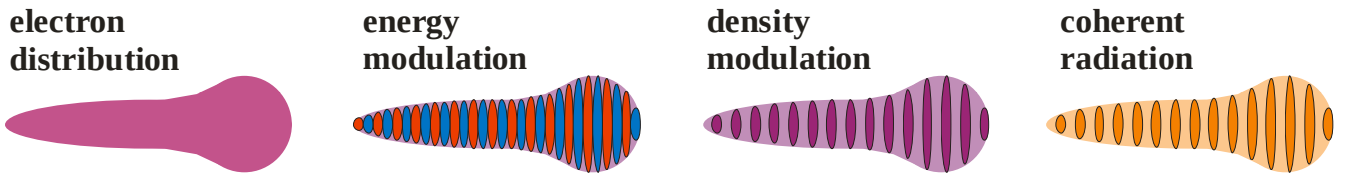

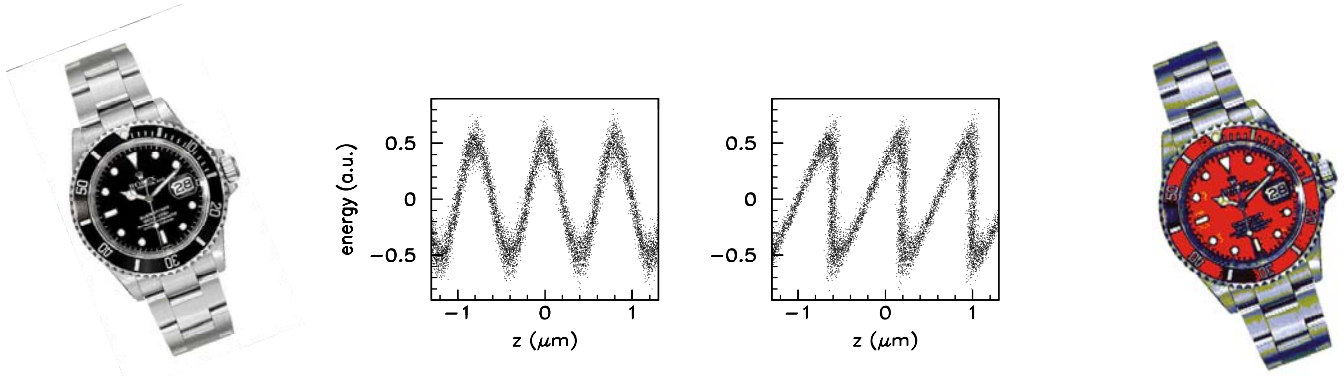

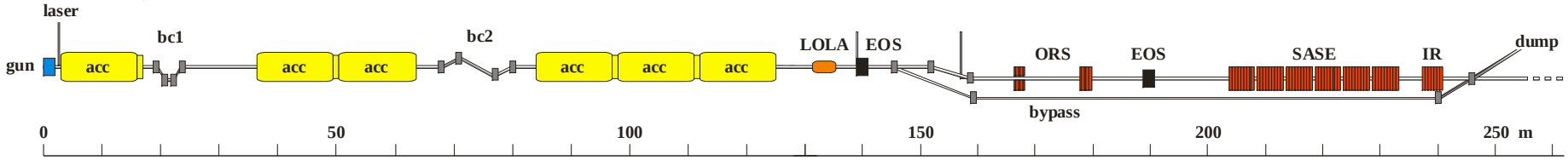

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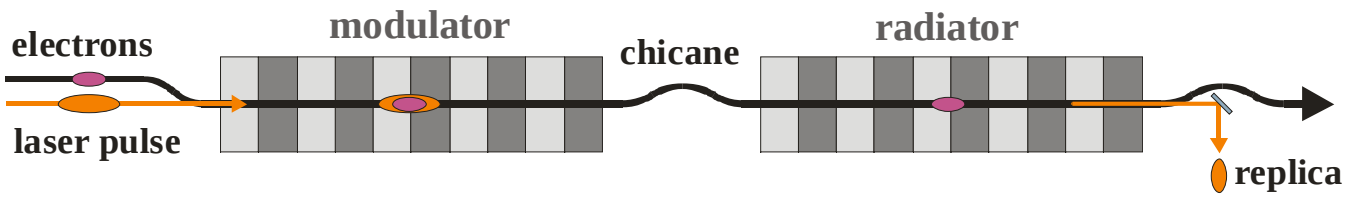
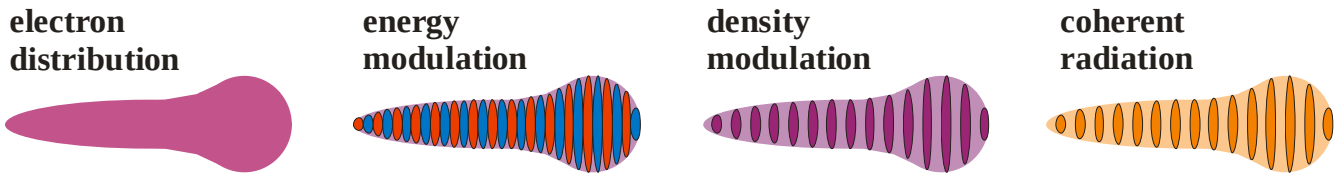
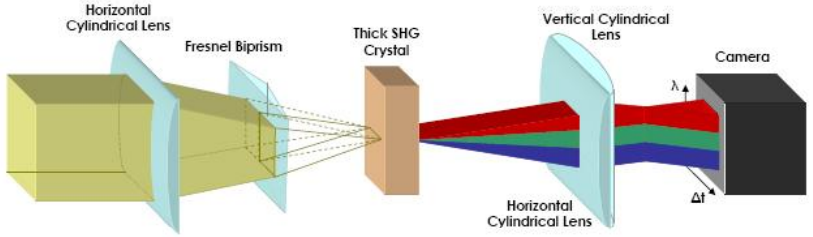
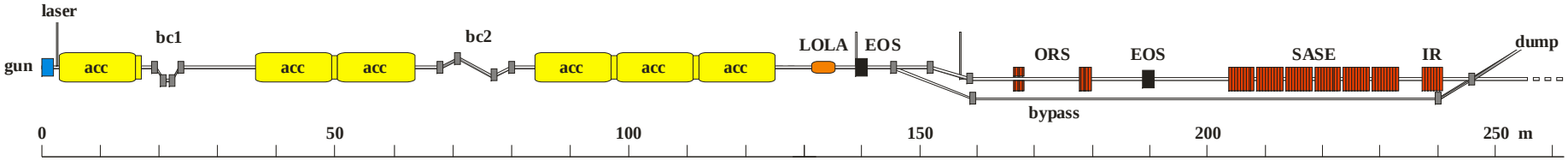




FROG = Frequency-Resolved Optical Gating (GRENOUILLE)

time resolution given by wavelength (2.6 fs)
plus slippage of electrons w.r.t. laser field

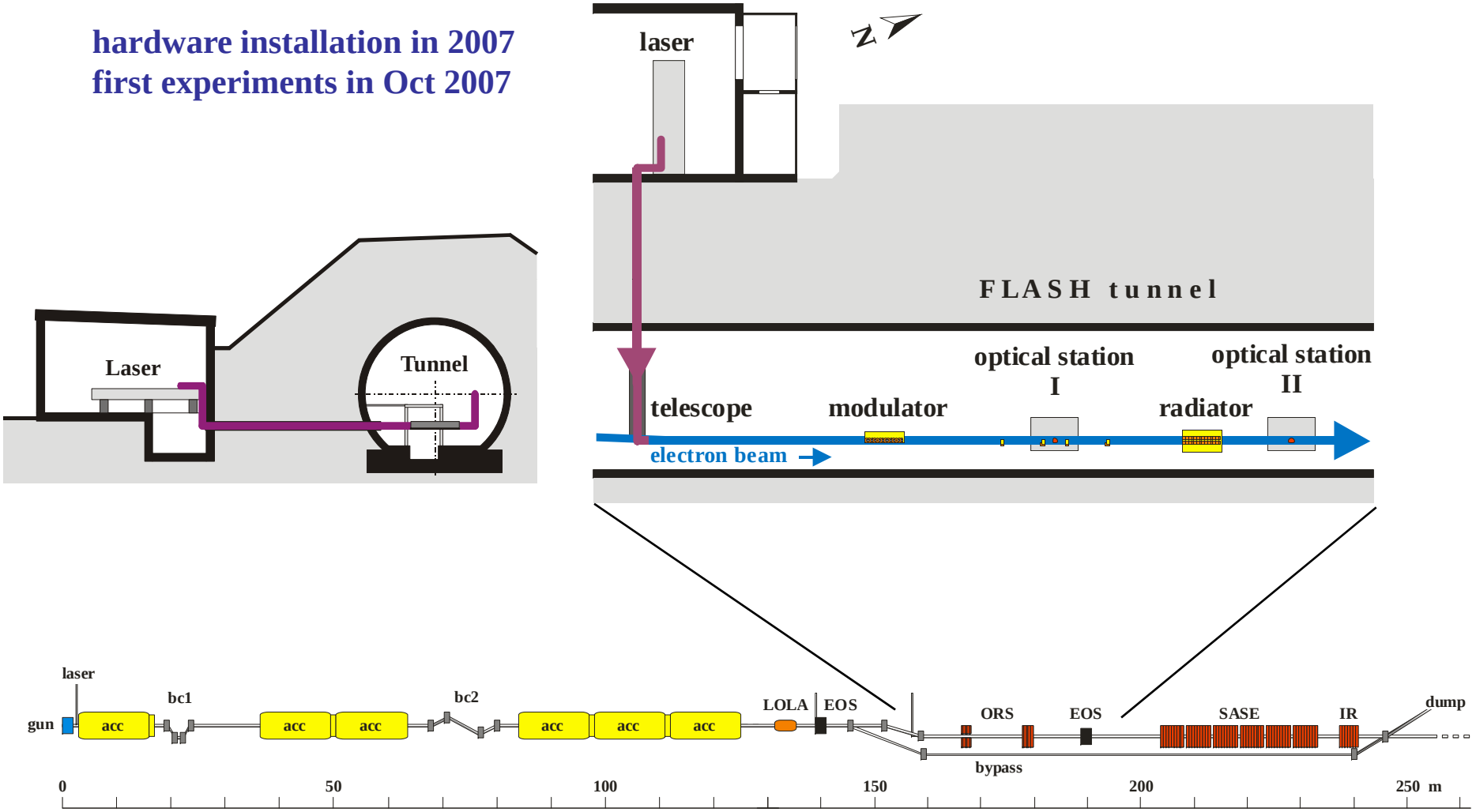




4. Optical-replica synthesizer (ORS)

G. Angelova et al., Phys. Rev. ST Acc. Beams 11 (2008), 070702.

hardware installation in 2007
first experiments in Oct 2007



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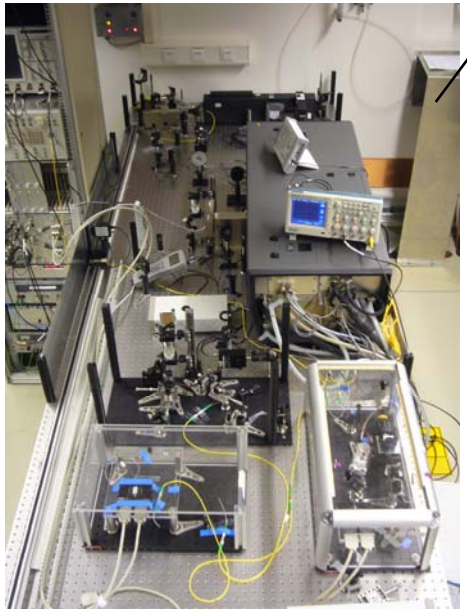

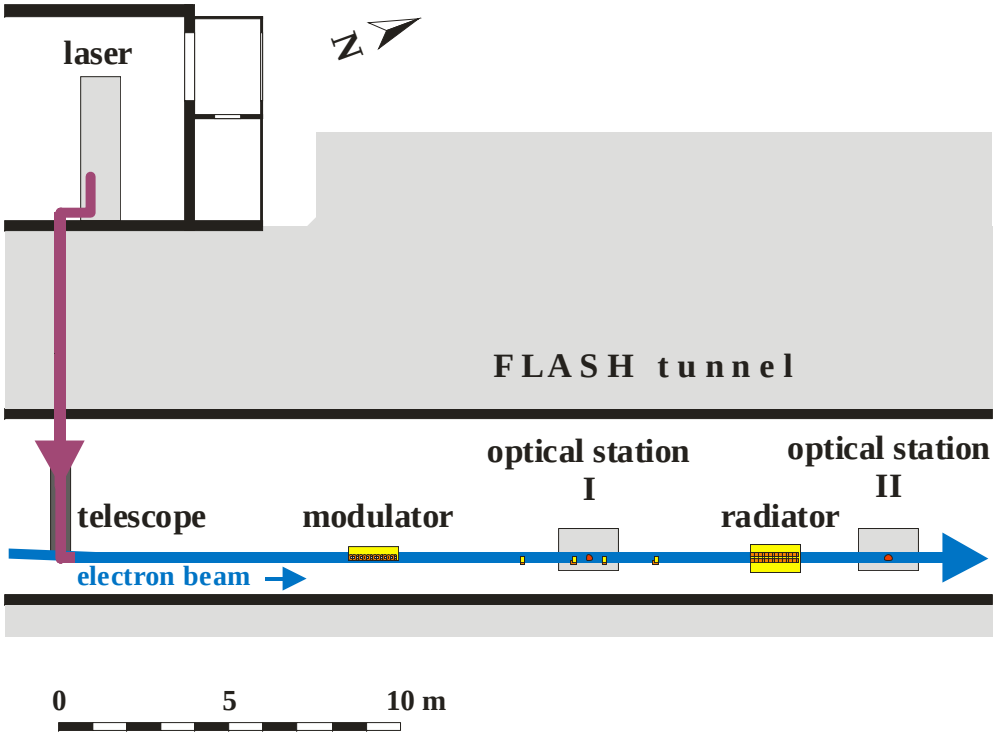

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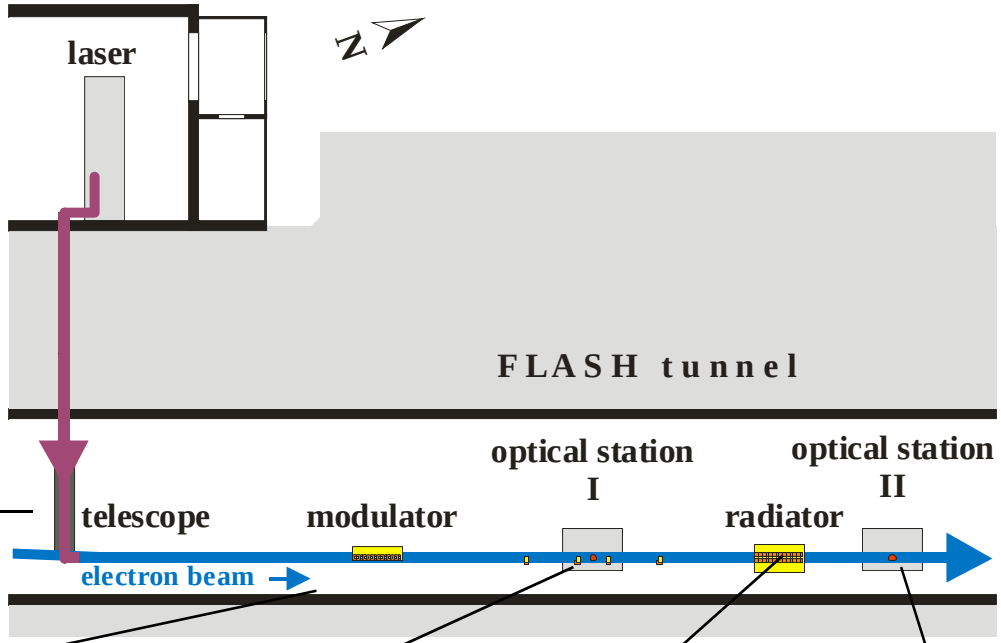

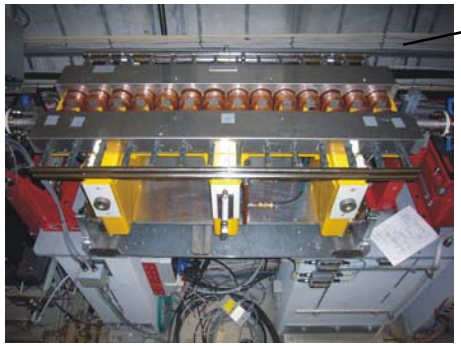

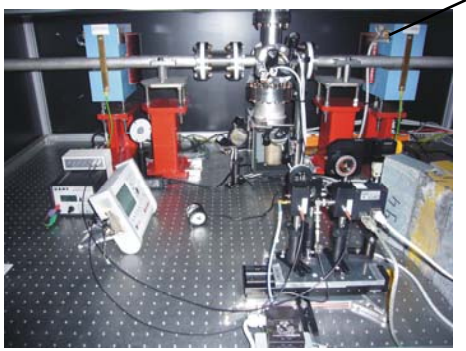

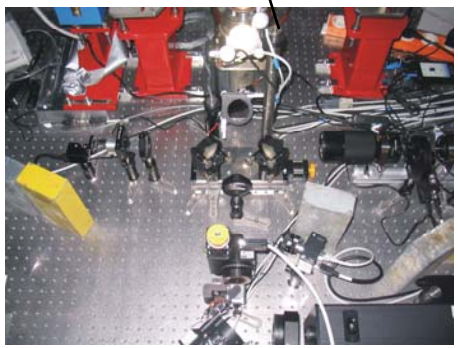

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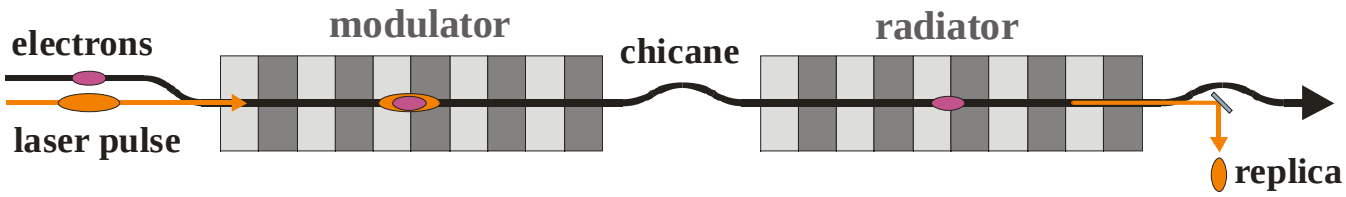
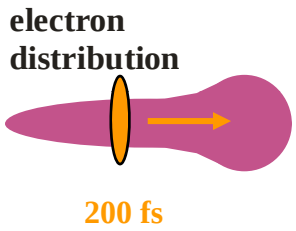
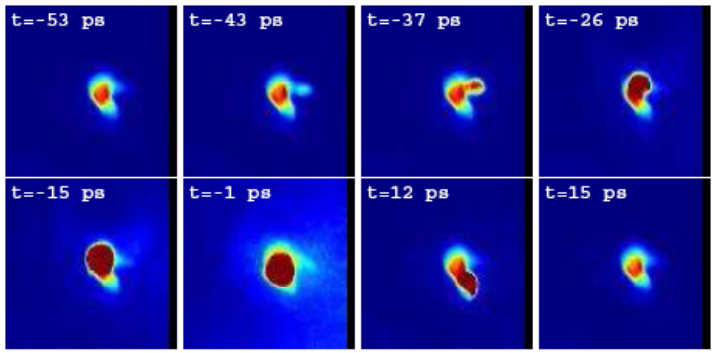
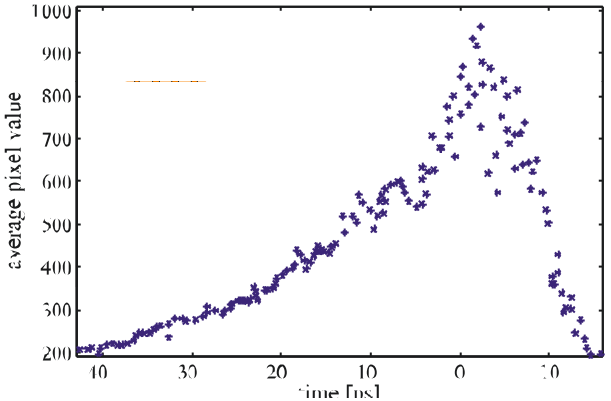
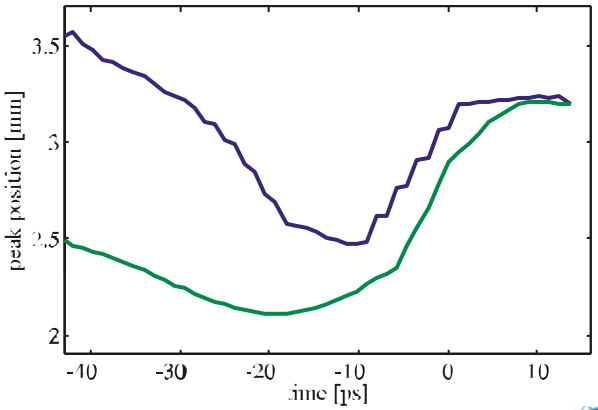








optical transtion radiation at 400 nm



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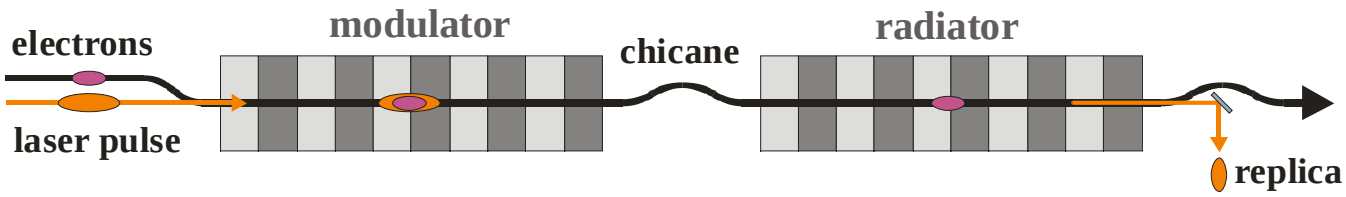

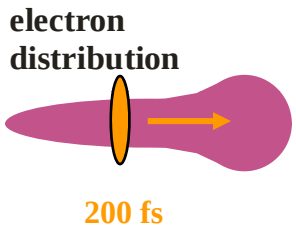

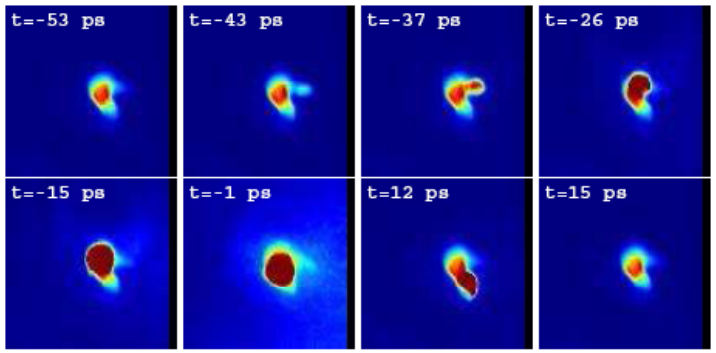

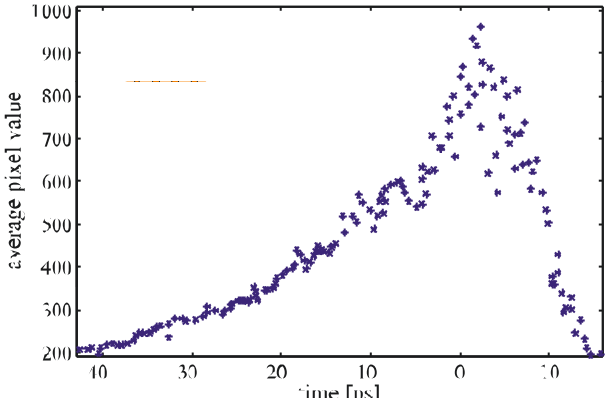

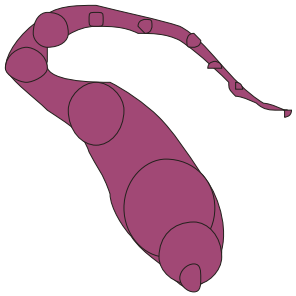

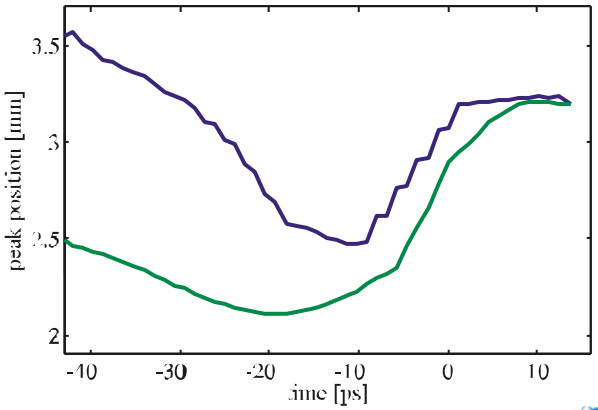

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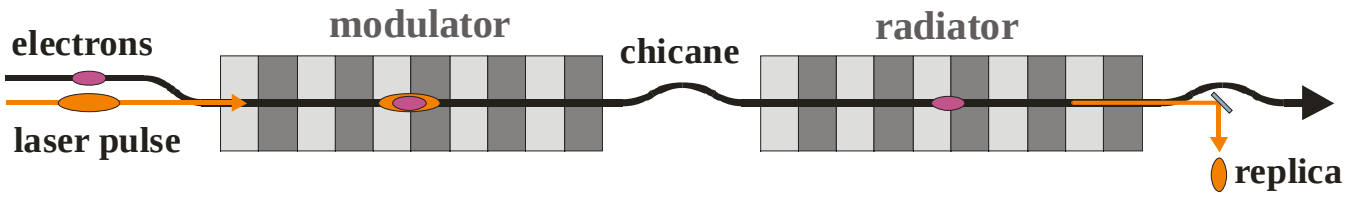

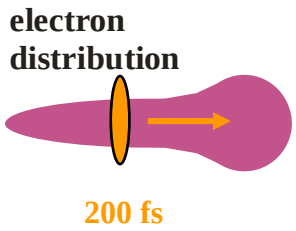

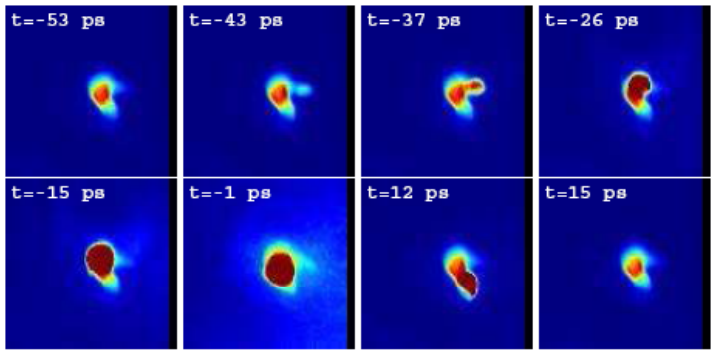

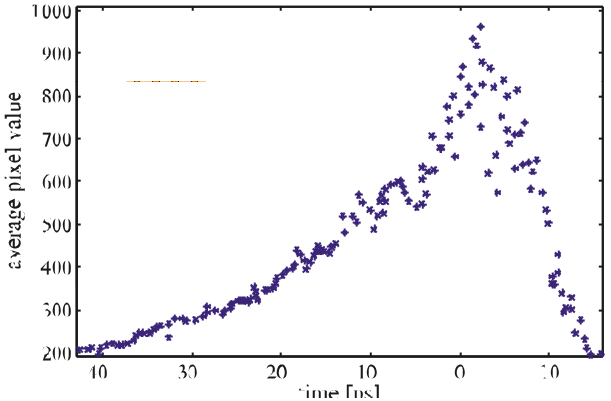

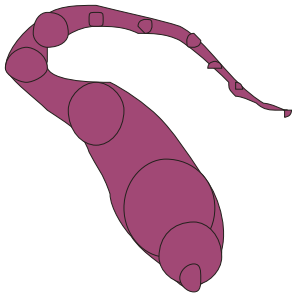

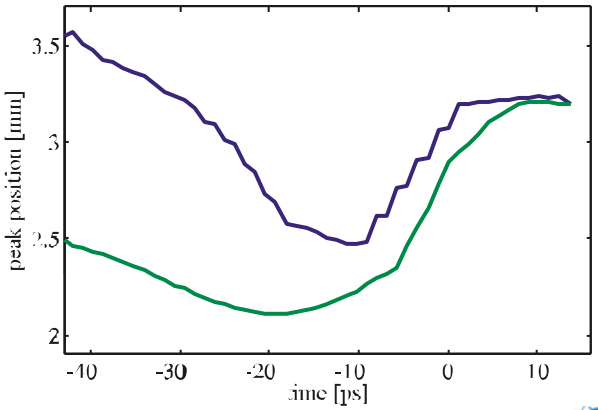

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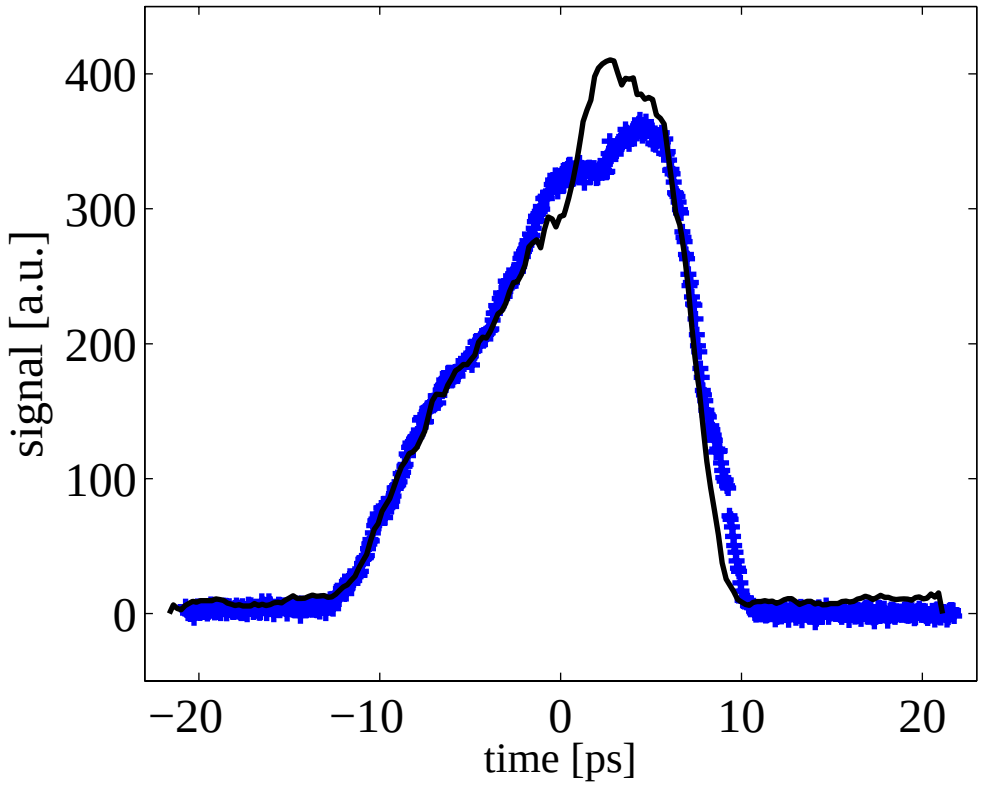
Comparison: OTR from modulated bunches (black line)
transversely deflecting cavity (blue dots)



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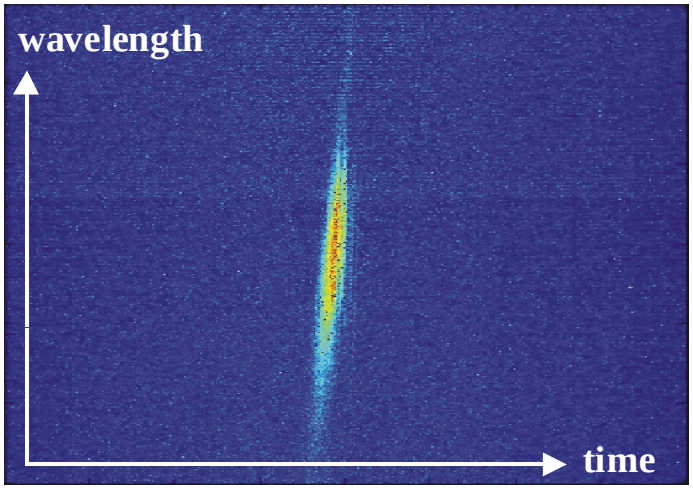
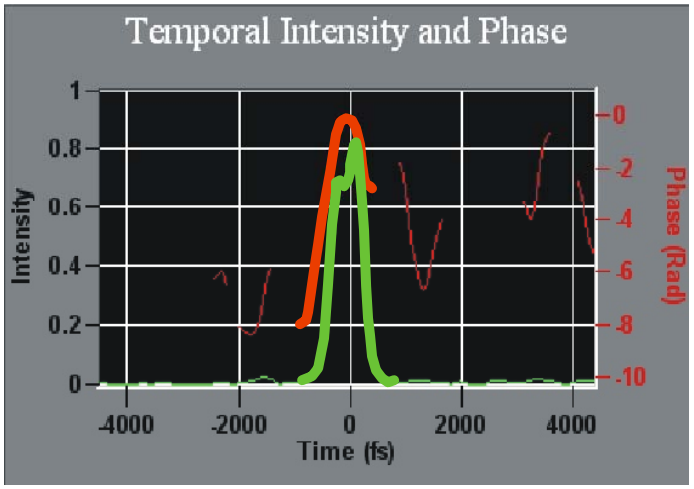
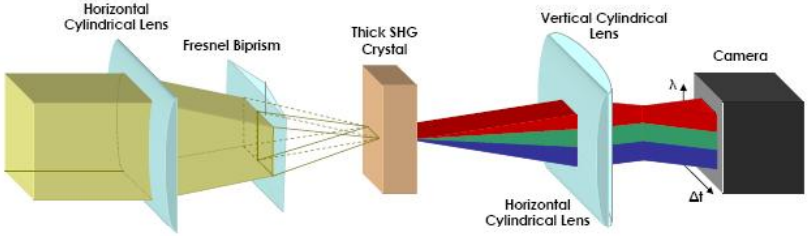
G. Angelova et al., EPAC 2008, Genova/Italy



latest experiment:
200 fs laser pulse
and moderately
compressed (100 fs)
electron bunch

FROG =
Frequency-Resolved
Optical Gating
(GRENOUILLE)





presently using a
GRENOUILLE 8-500USB
optimized for 500 fs pulses

Summary

Commissioning

- 200 fs laser pulse (800 nm) with uncompressed bunch, observing
  ... coherent optical transition radiation at 400 nm
  ... coherent synchrotron radiation from the radiator at 400 nm

- 200 fs laser pulse with moderately compressed bunch, observing
  ... first FROG traces with 500 fs resolution

Next steps (Oct 08)

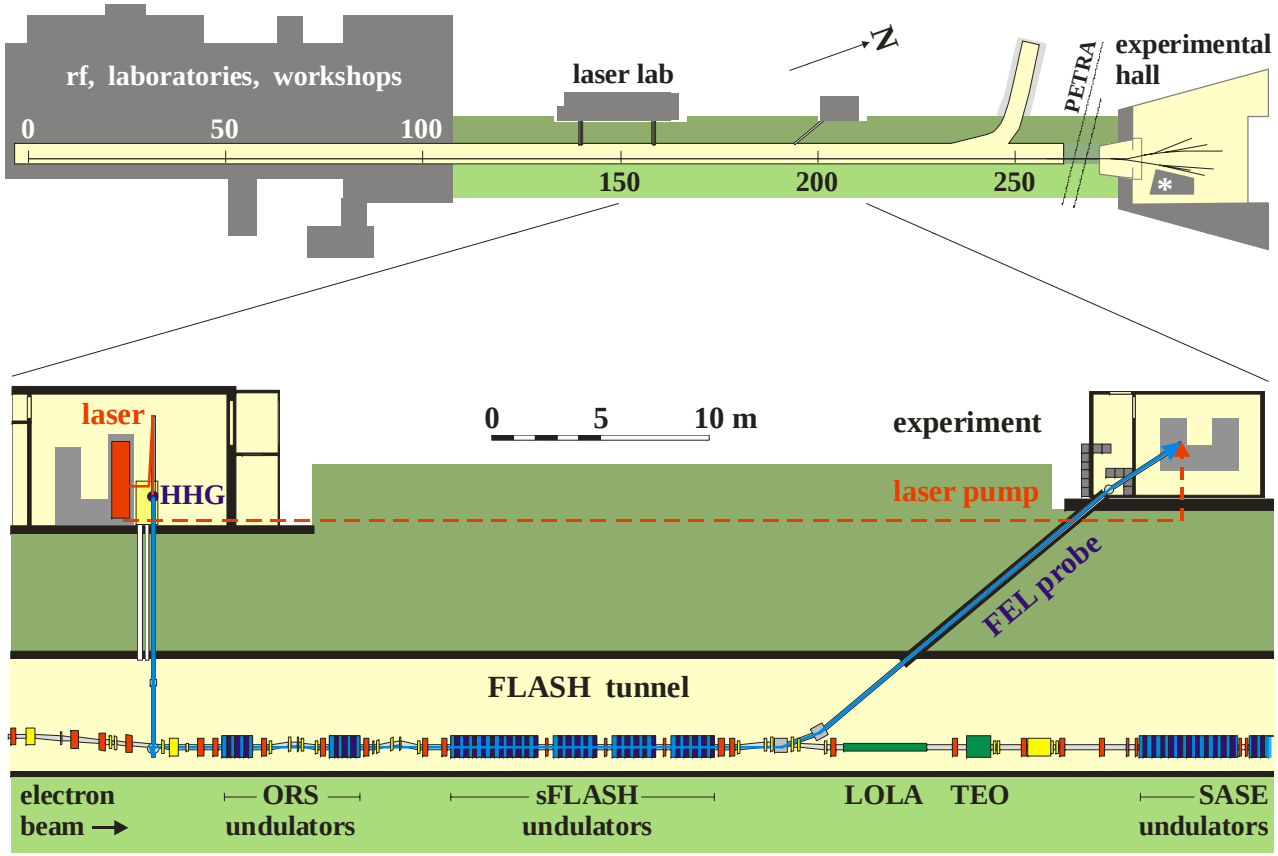
- FROG traces with better resolution (replace GRENOUILLE)
- look at fully compressed bunches

Goals

- measure longitudinal bunch profile with sub-10 fs resolution
- prepare the ground for other laser-based applications
  (e.g. HHG seeding)

sFLASH: an experiment for seeding VUV radiation at FLASH

(this conference TUPPH072)




Thank you