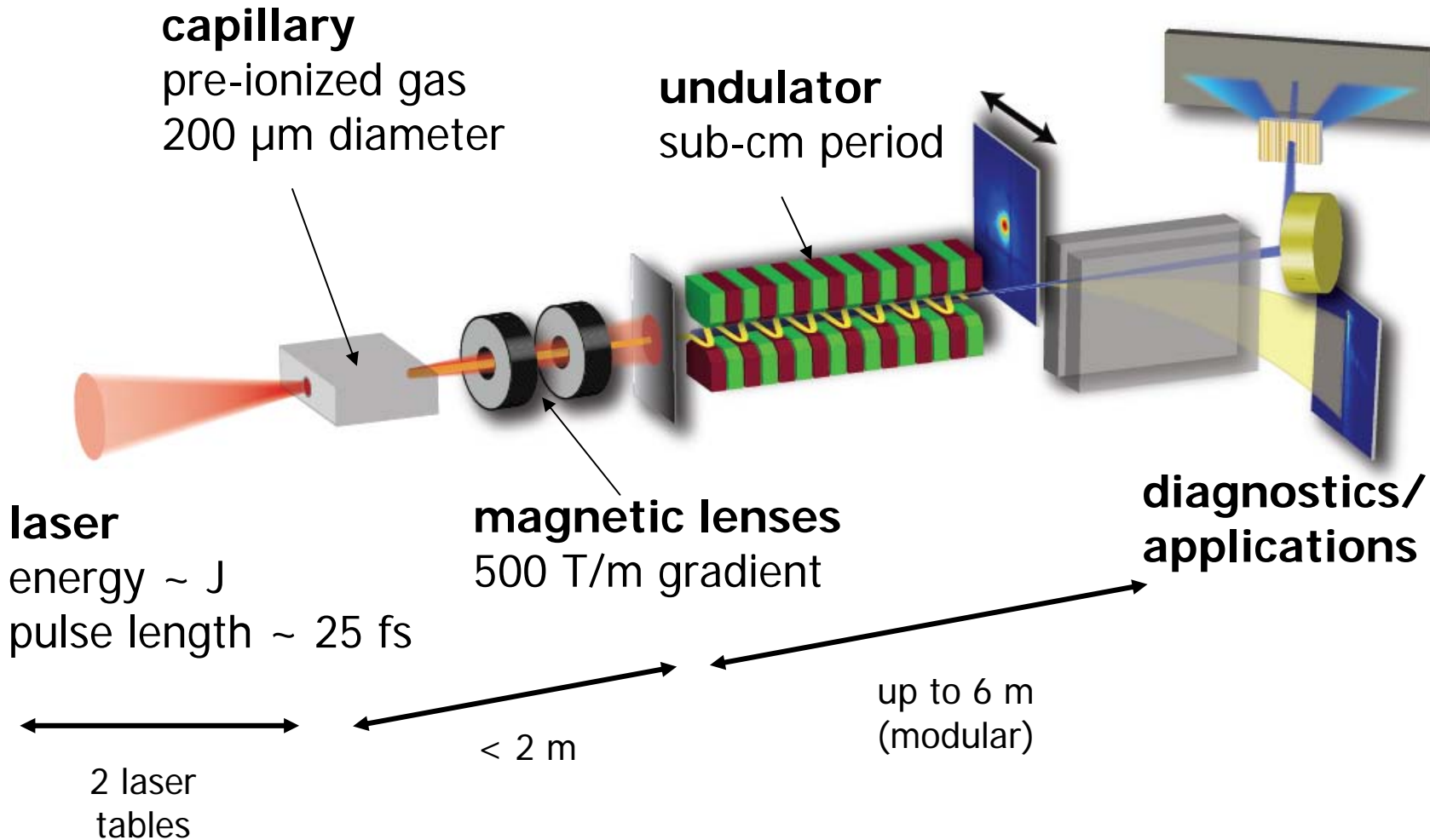
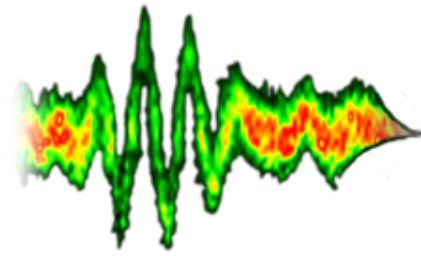


Towards Table-Top FELs

F. Grüner, A. Maier, M. Fuchs, C. Schroeder, et al.

- basic concept
- laser-plasma accelerator
 - physics
 - state-of-the-art
- critical issues
- first experiment: laser-driven soft x-ray undulator radiation
- outlook
 - towards a first table-top FEL demonstration
 - near-future experiment with spontaneous emission

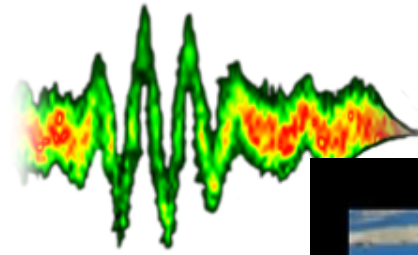
basic concept



laser-plasma accelerator: basics



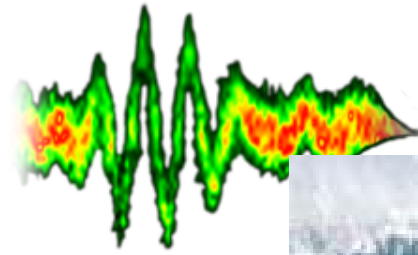
LMU
www.attoworld.de



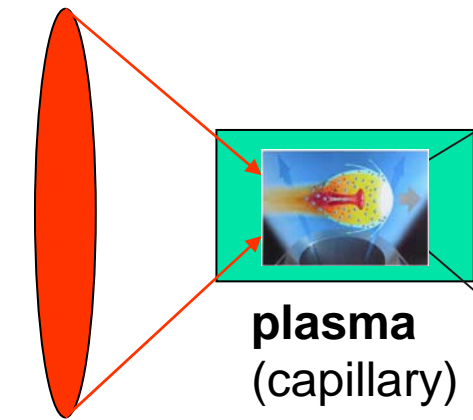
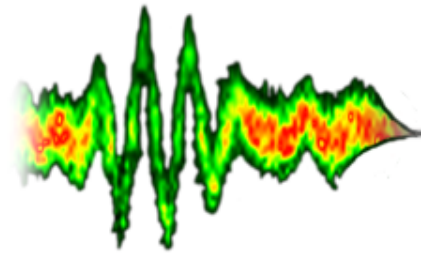
laser-plasma accelerator: basics



LMU
www.attoworld.de

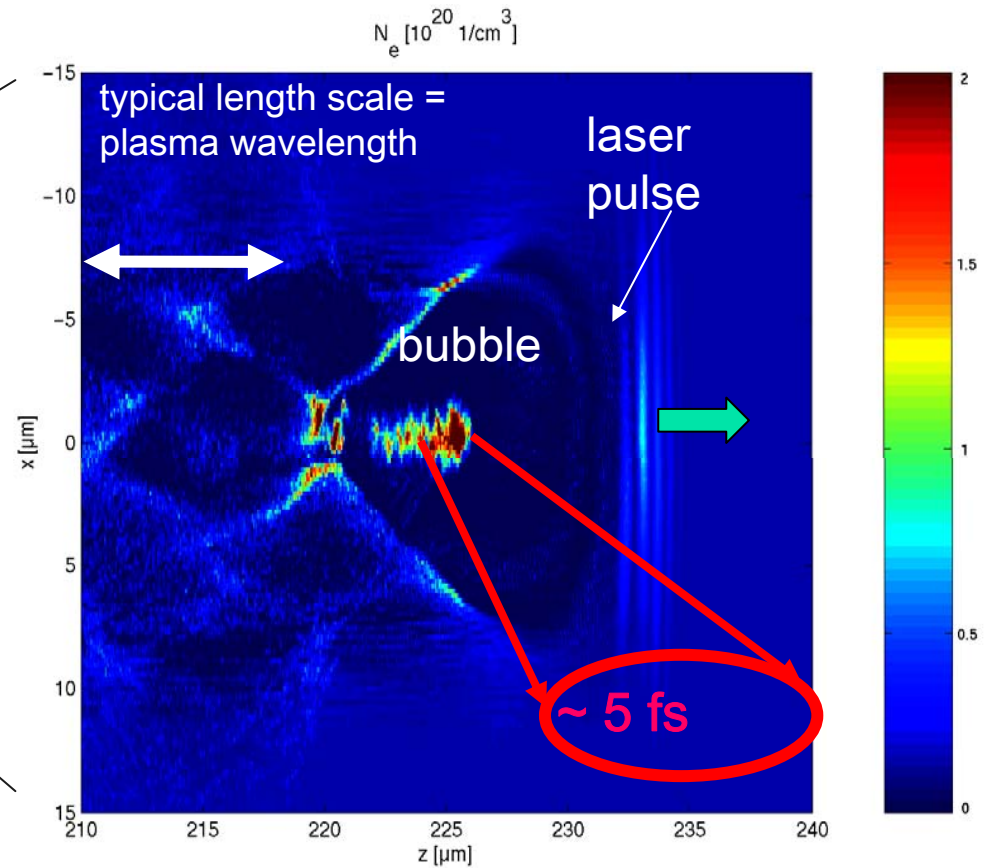


laser-plasma accelerator: basics



high-intensity
laser

plasma
(capillary)

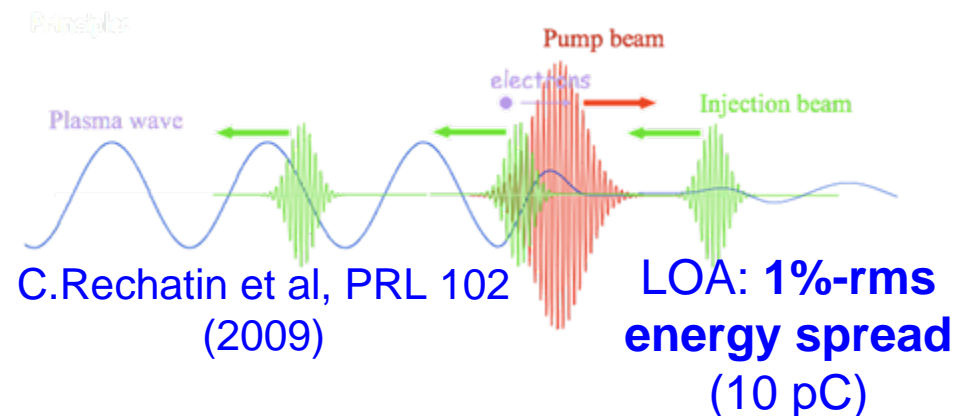
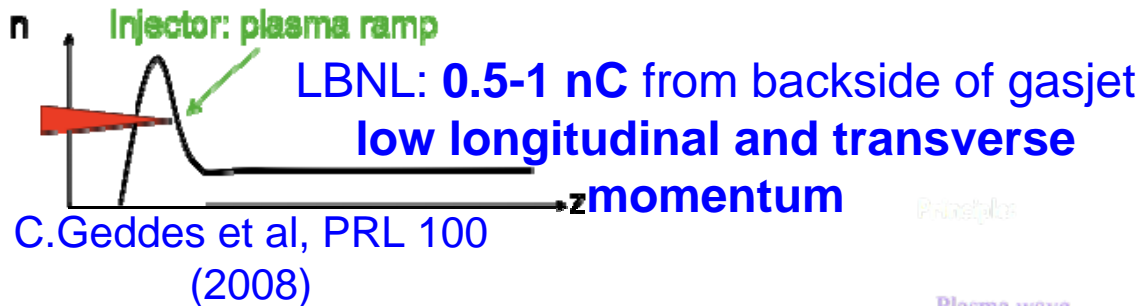
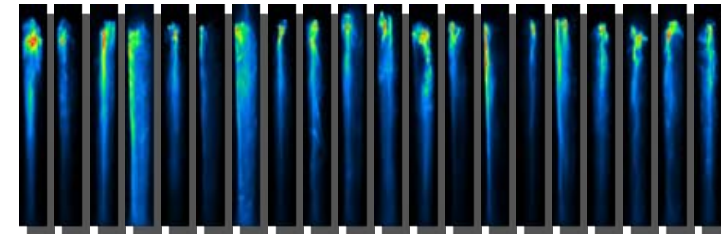


PIC simulation (M. Geissler)

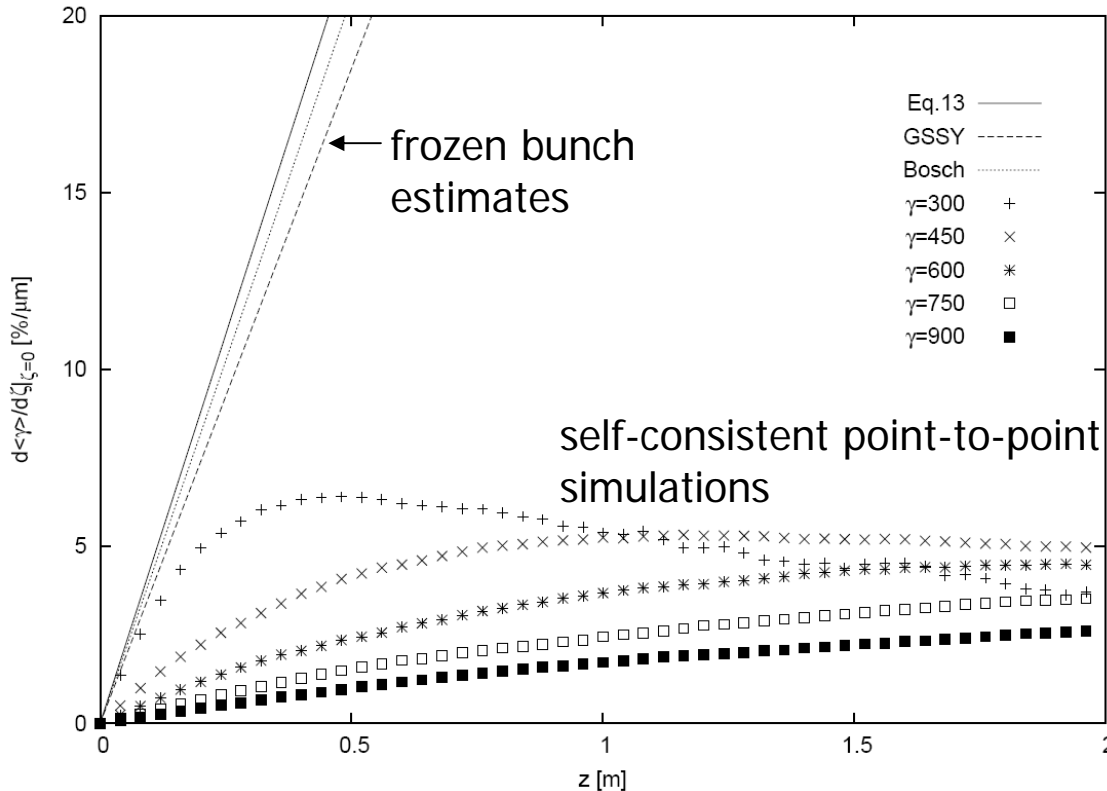
laser-plasma accelerator: state-of-the-art

J. Osterhoff, et al., *PRL* **101**, 085002 (2008)

- 2000, theory of bubble acceleration (Meyer-ter-Vehn, MPQ)
- 2004, first experimental results (Nature cover issue)
- 2006, Berkeley lab reaches 1.0 GeV (W. Leemans et al., Nature Physics)
- 2008, stability improvement (e.g., J. Osterhoff et al., PRL)
- 2008/09, new schemes:



- space-charge issues (case study: 0.4 nC, $\sigma_z = 1.0 \mu\text{m}$, 150 MeV)

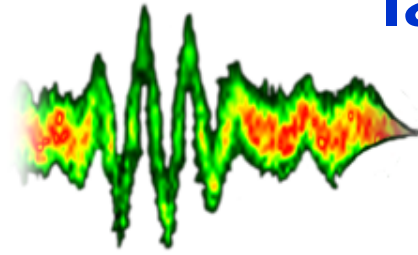


F. Grüner, et al., Phys. Rev. STAB 12, 020701 (2009)

- wakefields

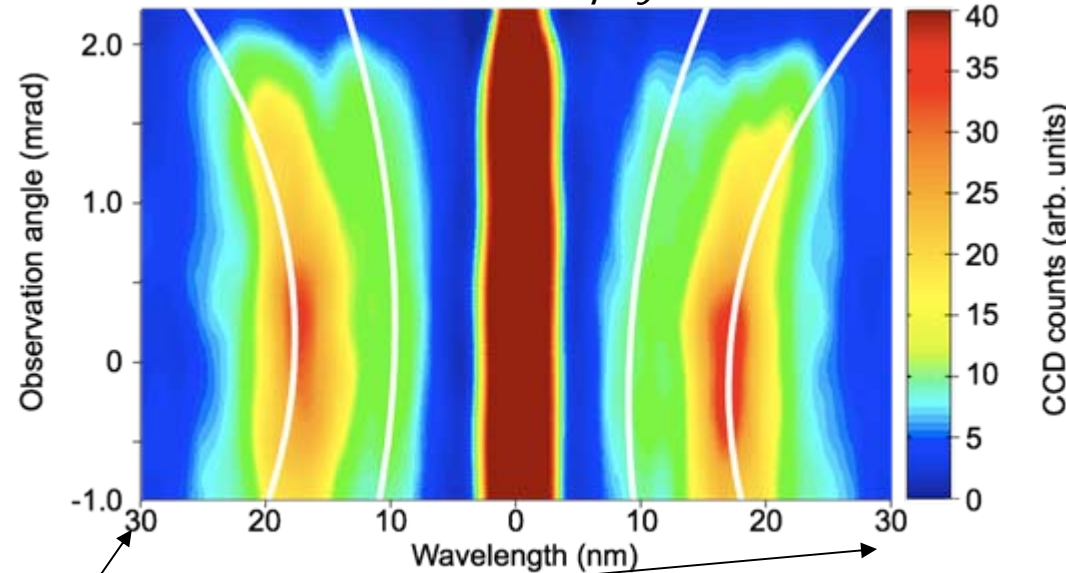
- cryogenic undulator (cooperation with BESSY)
- superconducting undulator (coop. w/ FZK)

laser-driven soft x-ray undulator radiation

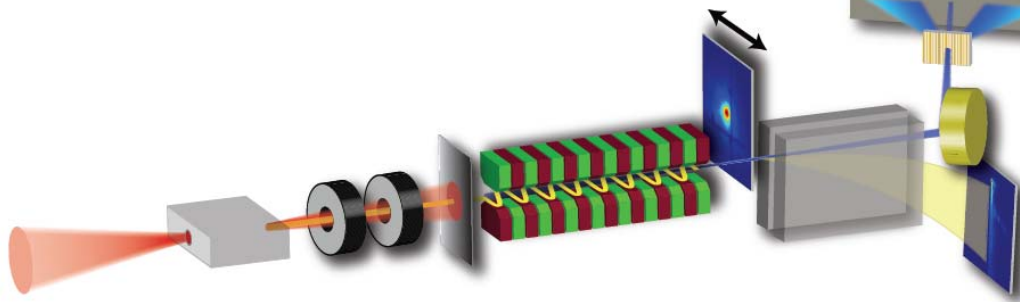


M. Fuchs et al., submitted to
Nature phys.

first experiment at MPQ



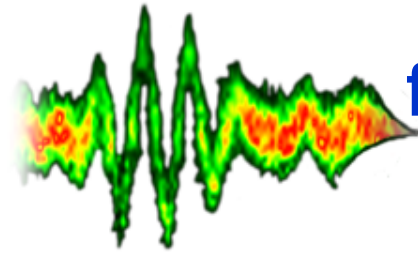
200 MeV, 5 pC
undulator: 30 cm, 5 mm period



- spectrum in 70% of all laser shots
- hints for normalized emittance of $\sim 0.8 \text{ mm.mrad}$

outlook I:

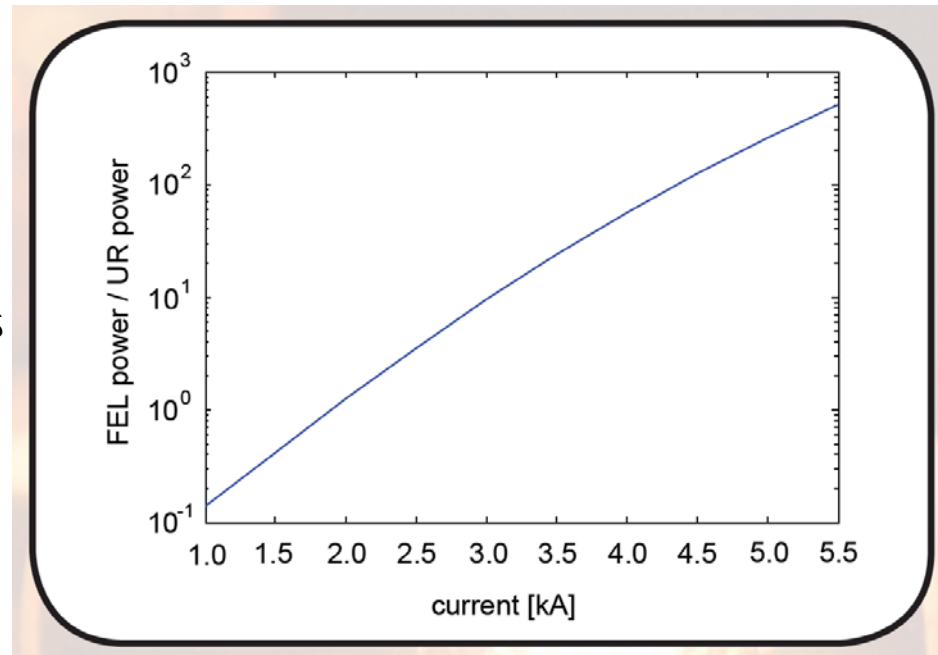
first demonstration experiment



- today's experimental parameters don't allow FEL process
- solution 1: improve beam quality (long way)
- solution 2: design „minimal demonstration“:

GENESIS simulations including:

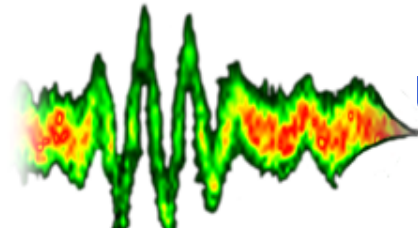
space-charge
wakefields
beam transport



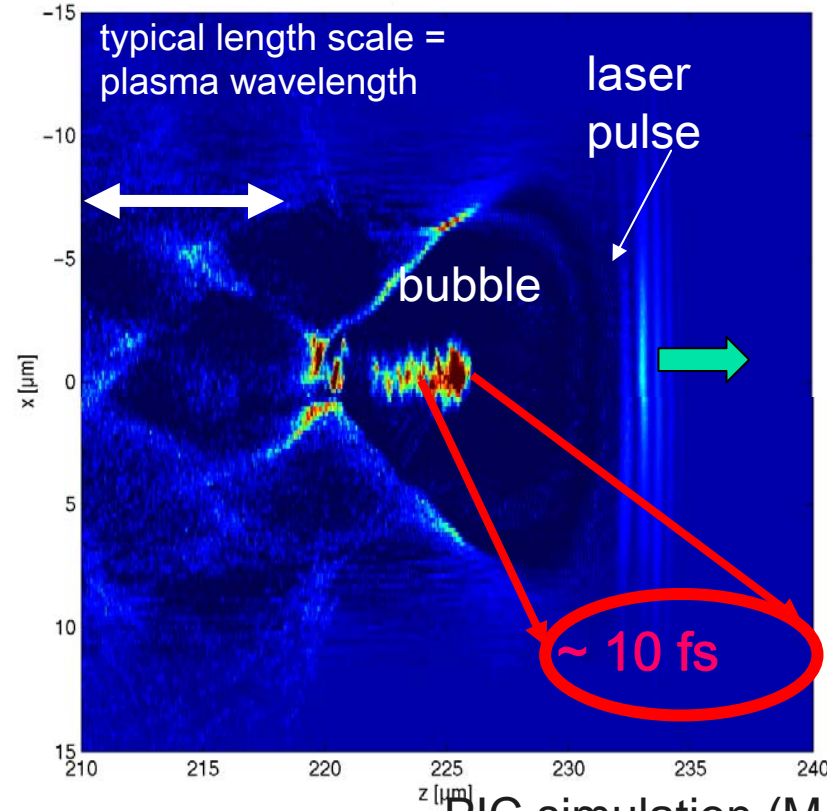
paper in preparation

outlook II:

ultra-short spontaneous emission



$$N_e [10^{20} \text{ 1/cm}^3]$$



PIC simulation (M. Geissler)

on axis peak intensity:

10,000 photons/(shot mrad² 0.1% bw)

in 10 fs

[*femtoslicing*:

flux of 1,000 photons in 100 fs, 0.1% bw]

near-future goal:

x-ray pump-probe experiments

5 keV, 10 fs (with 2 GeV electrons)

conclusion



- basic concept
- laser-plasma accelerators: state-of-the-art
- critical issues (space-charge, wakefields)
- minimal demonstration experiment
- first laser-driven x-ray undulator source