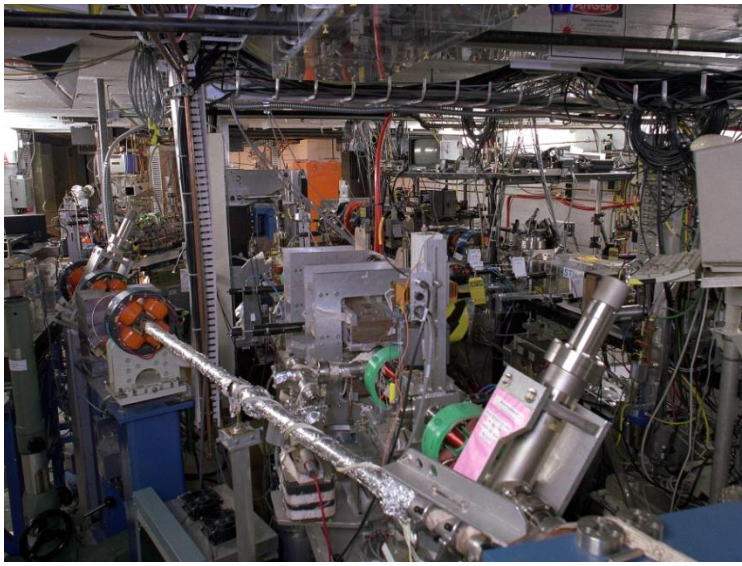
Very recent results from ATF

Vitaly Yakimenko

11/10/2009

Accelerator Test Facility

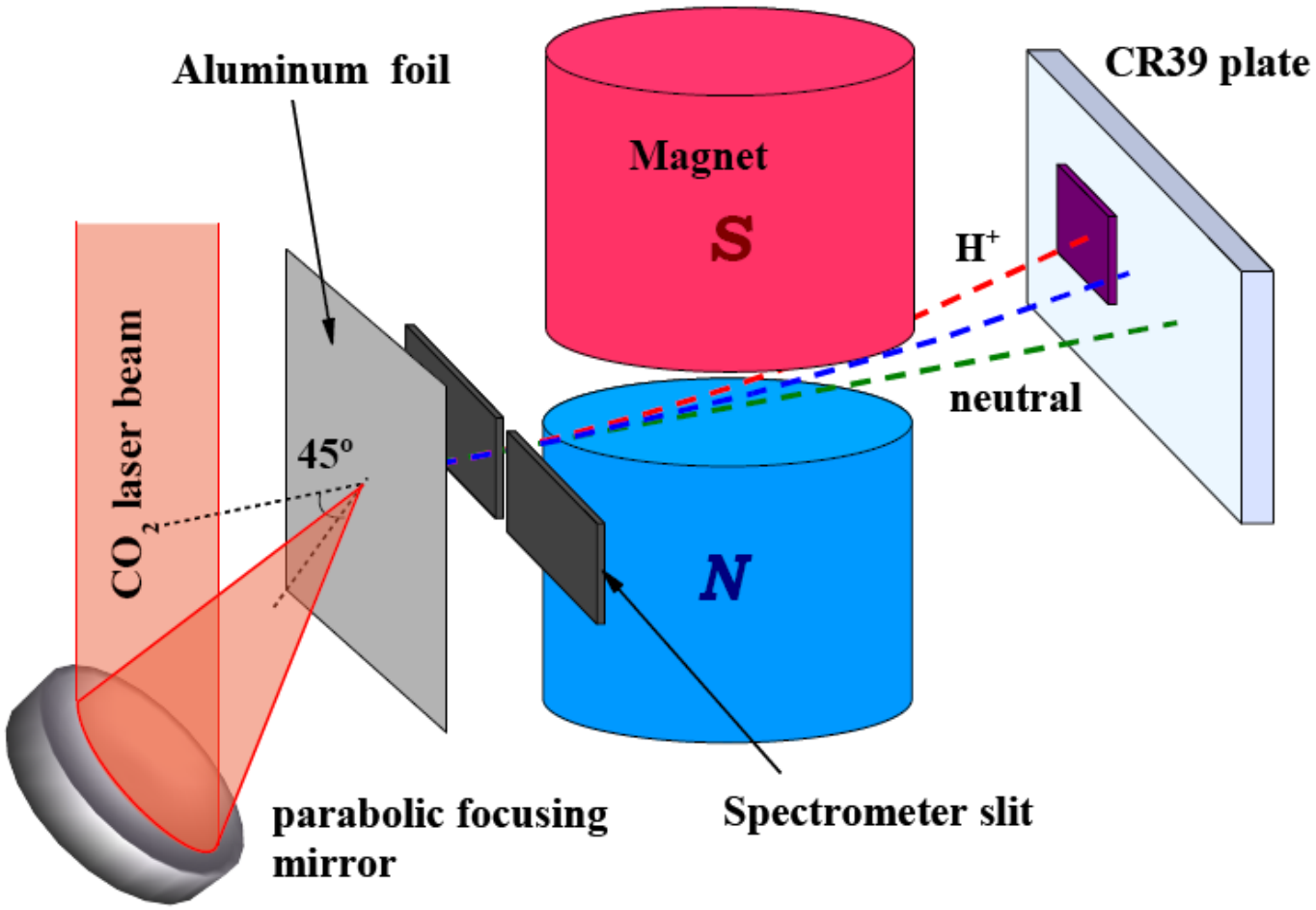
- The ATF is the only proposal-driven, advisory committee reviewed, USER FACILITY for long-term R&D into the Physics of Beams in the world.
- The ATF features:
  - High brightness e^- gun, 85 Mev Linac
  - High power lasers beam-synchronized at the picosec level (Unique TW CO2)
  - High brightness X ray source
  - 4 beam lines + controls
- The ATF serves the whole community: National Labs, universities, industry and international collaborations.
  - ATF contributes to Education in Beam Physics. (~2 PhD / year)
- In-house R&D on photoinjectors, lasers, diagnostics, computer control and more (~3 Phys. Rev. X / year)



ATF: A Unique resource world-wide in the comprehensive nature of the facilities. Supported by both HEP and BES.

Experiments are funded by HEP, BES, SBIR, NSF, DOD …

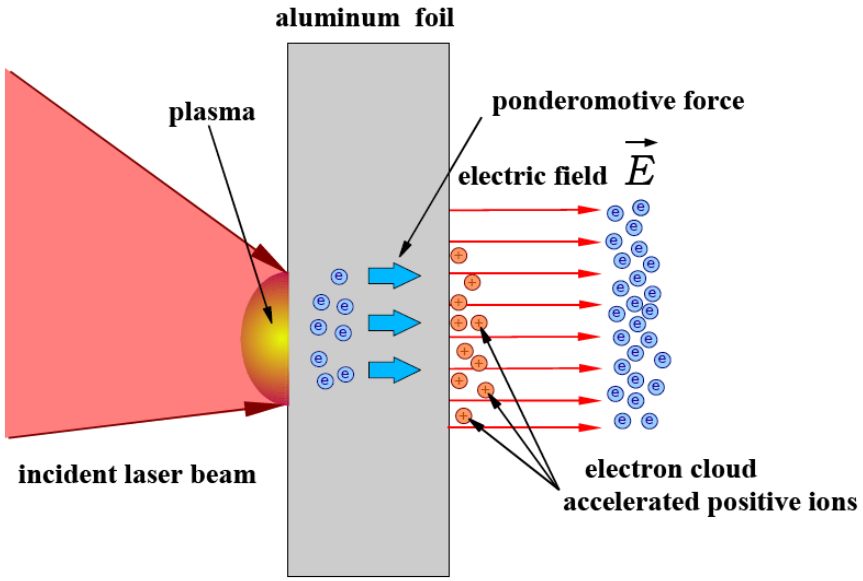
Principle setup for BNL experiment



Scaling proton acceleration with CO_2 lasers

- Electron heating and ponderomotive acceleration are defined by

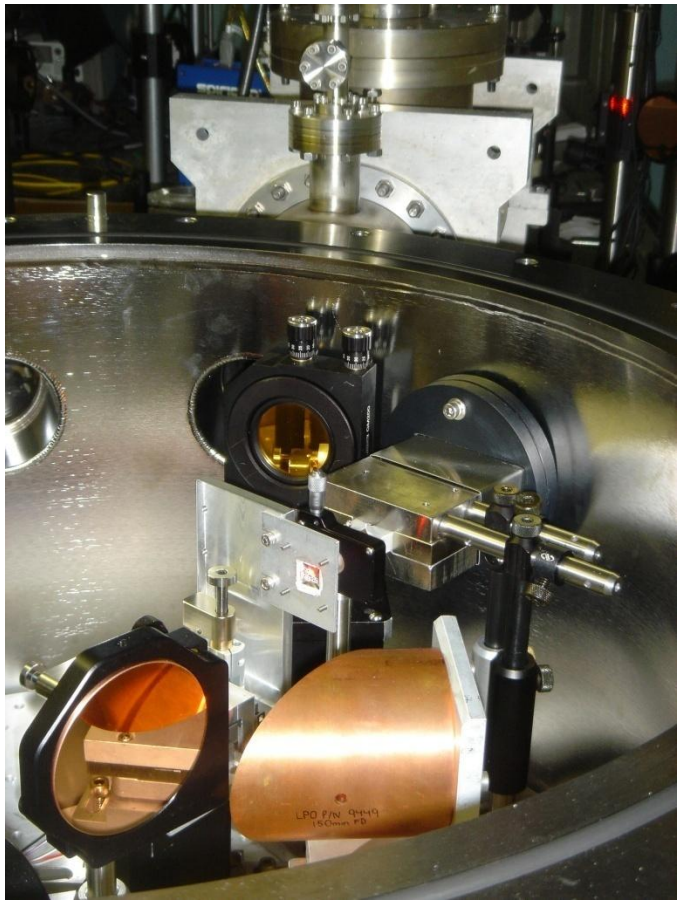
$$a_0 = 1 \quad \leftrightarrow \quad I \times \lambda^2 = 1.38 \times 10^{18} \left[W / cm^2 \times \mu m^2 \right]$$

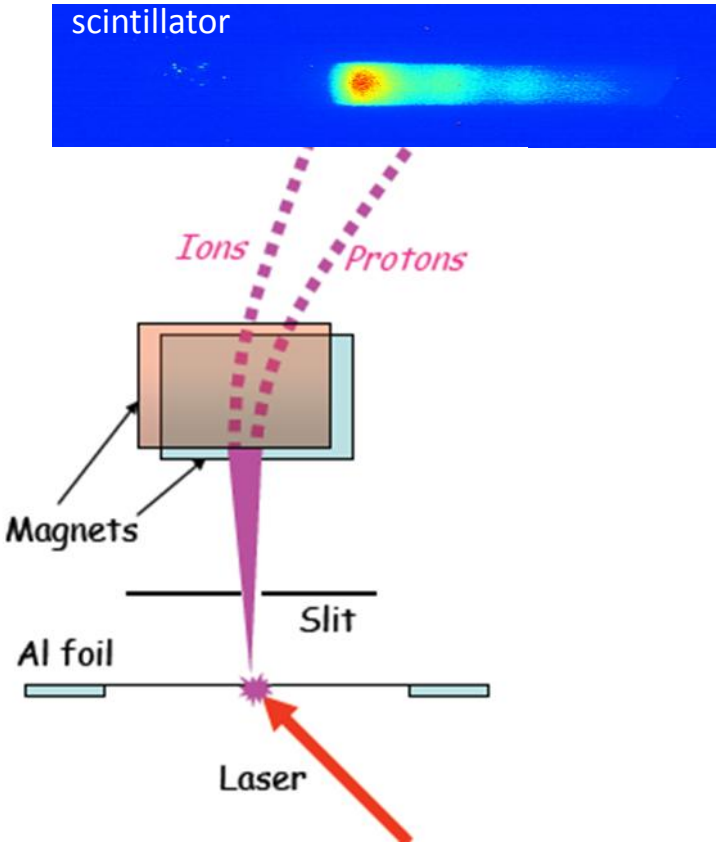


- At the same power and energy, 10-μm CO_2 laser will provide the same action within ~λ^2 (100 times) bigger area or ~λ^3 (1000 times) bigger volume than a 1-μm laser.

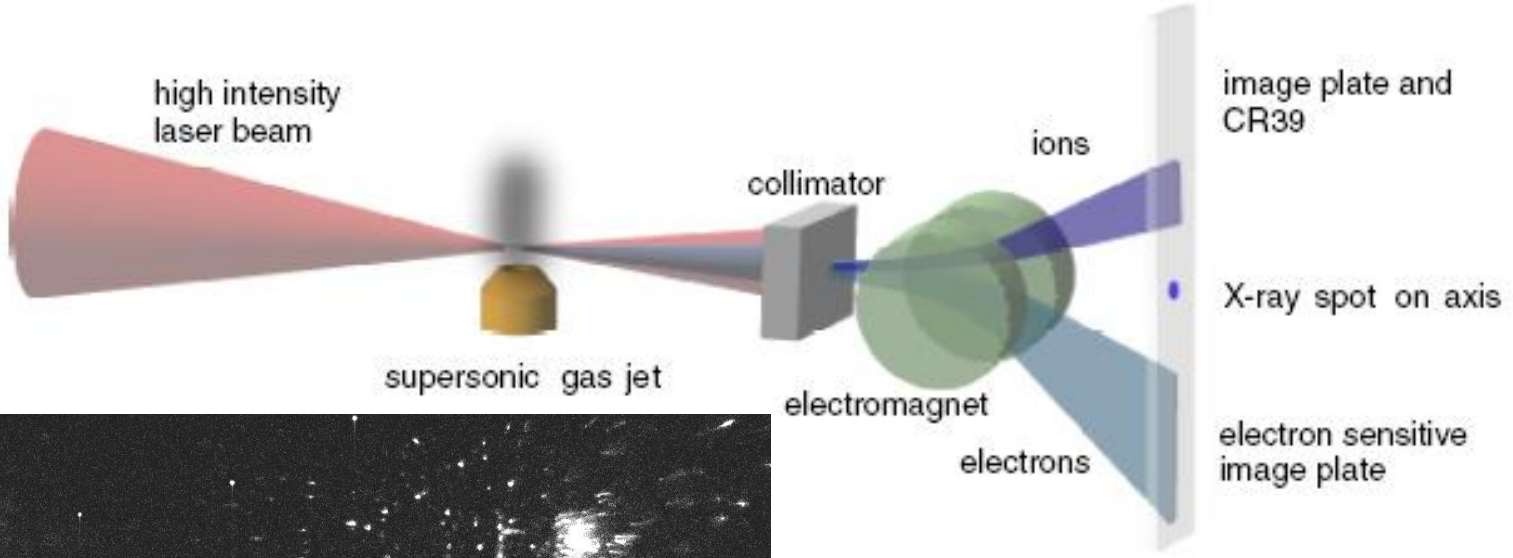
- Accordingly, we expect that the number of accelerated ions would grow with λ.

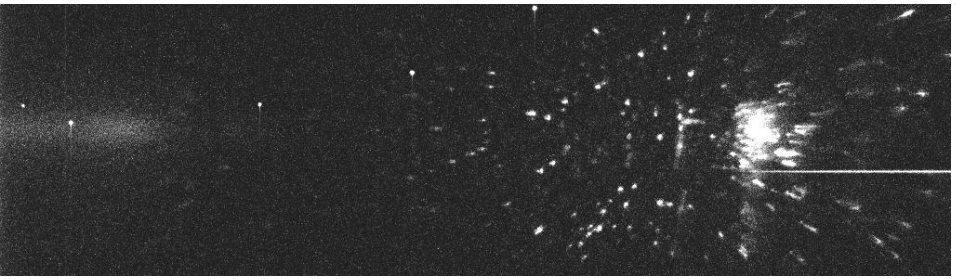
BNL experiment with circularly polarized laser beam



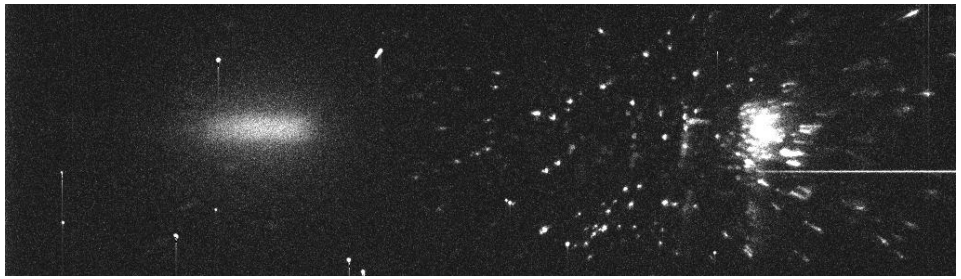


Ion beams produced from gas jets



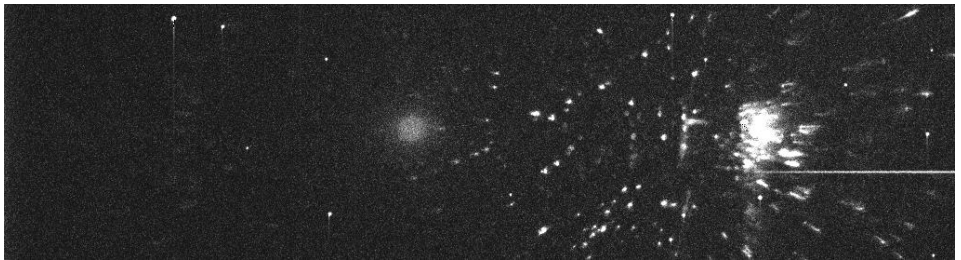


0.5 MeV protons



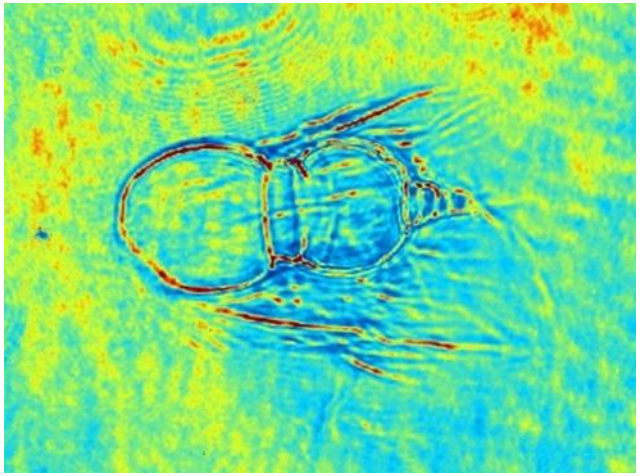
0.8 MeV protons
$\Delta E/E \sim 10\%$ RMS

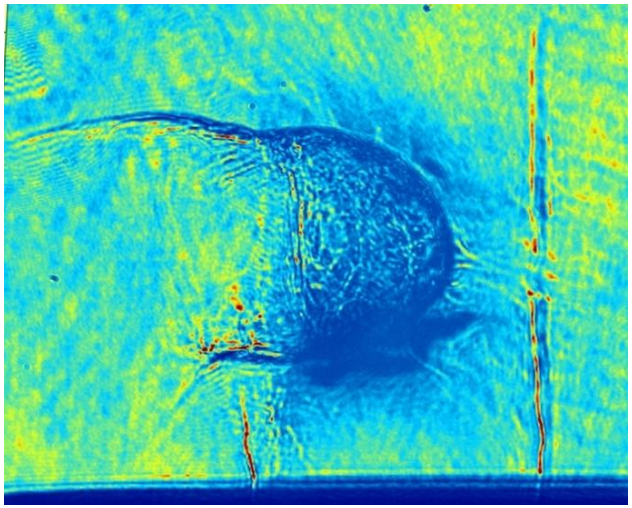
1.6 MeV protons
$\Delta E/E \sim 1\%$ RMS

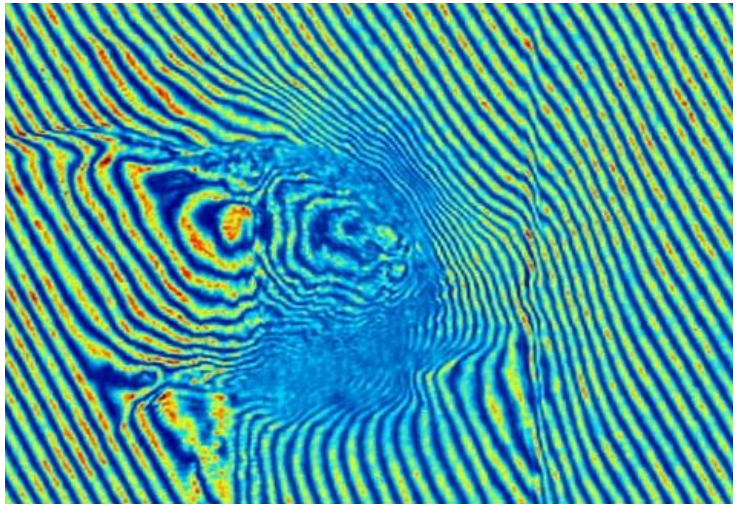


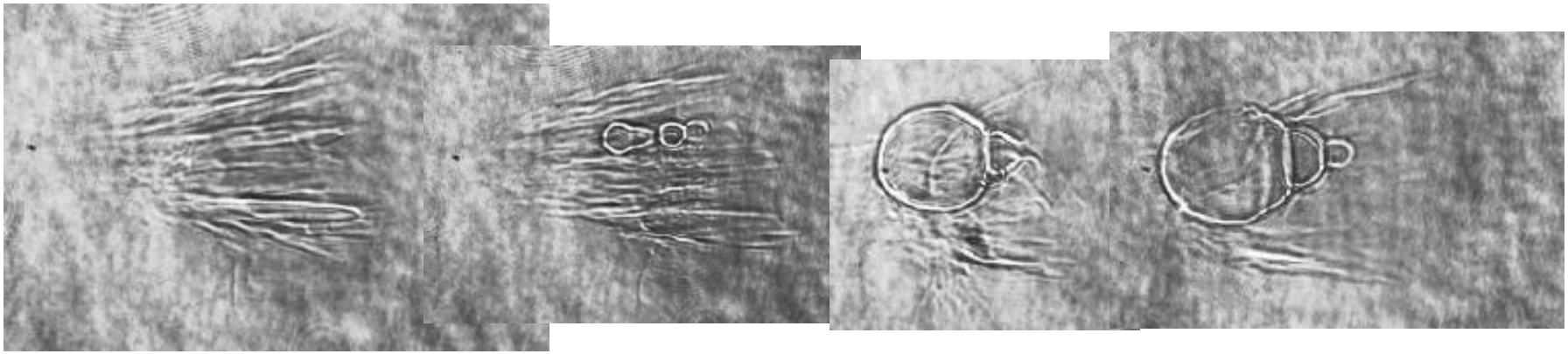
Measured on 10/19/09

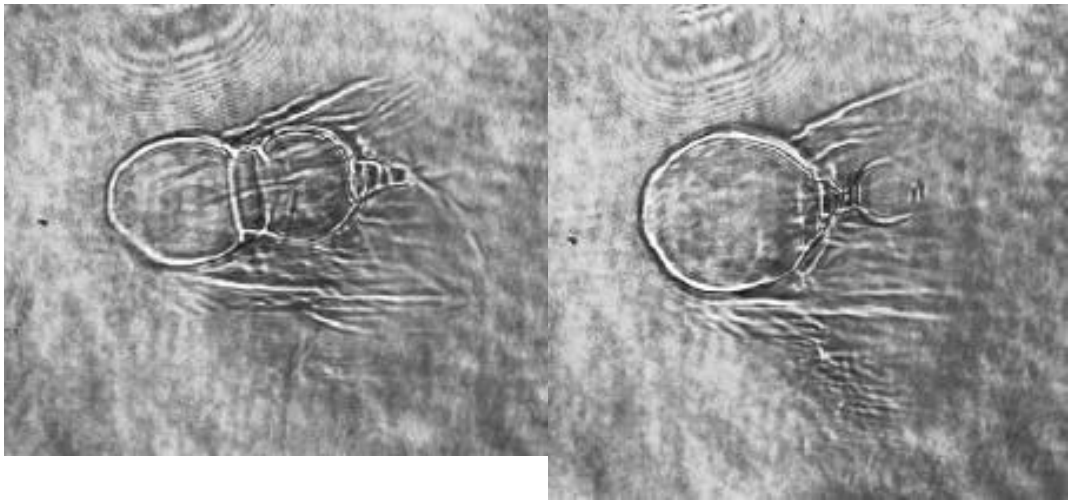
Interferometer probing of CO_2 laser strongly over-critical plasma with YAG 2nd harmonic

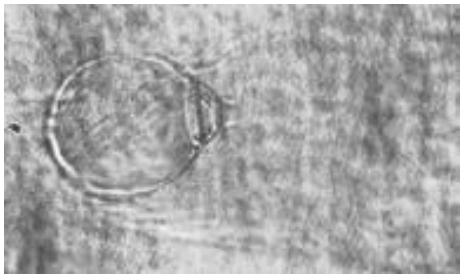


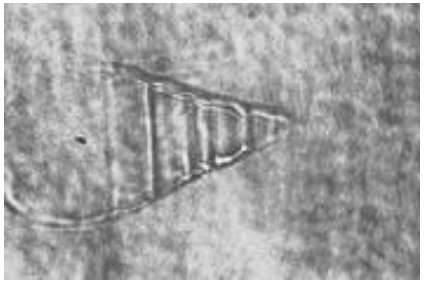


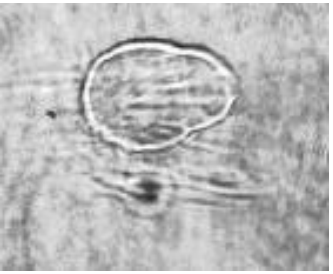


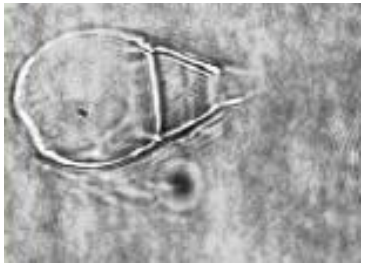


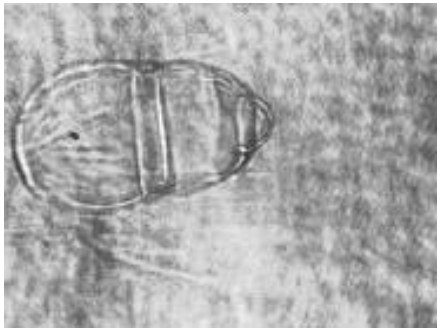


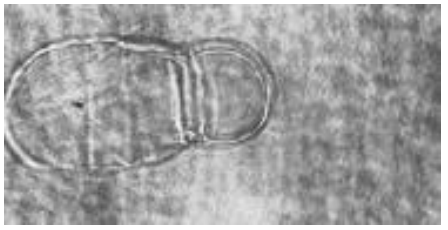




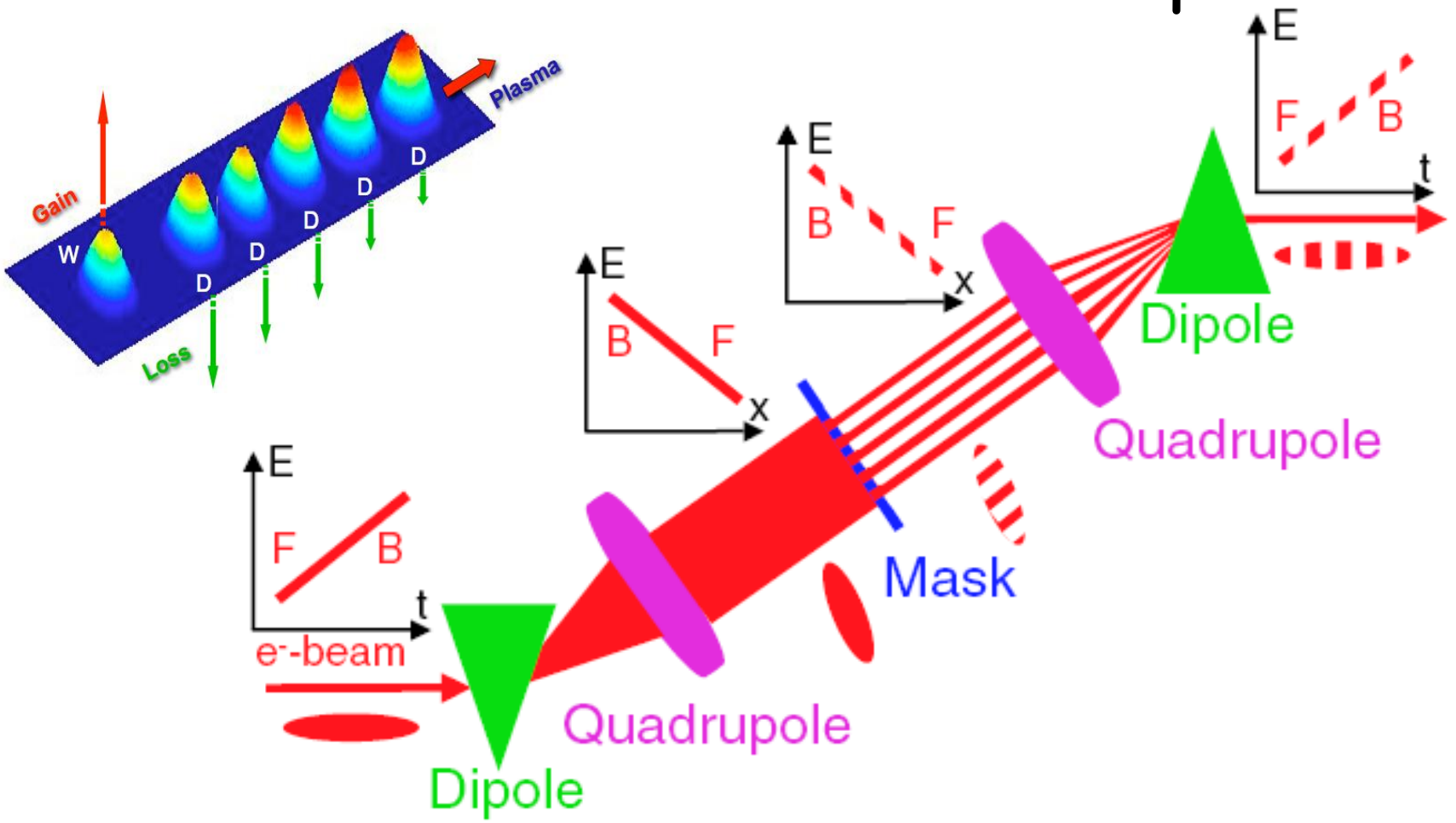






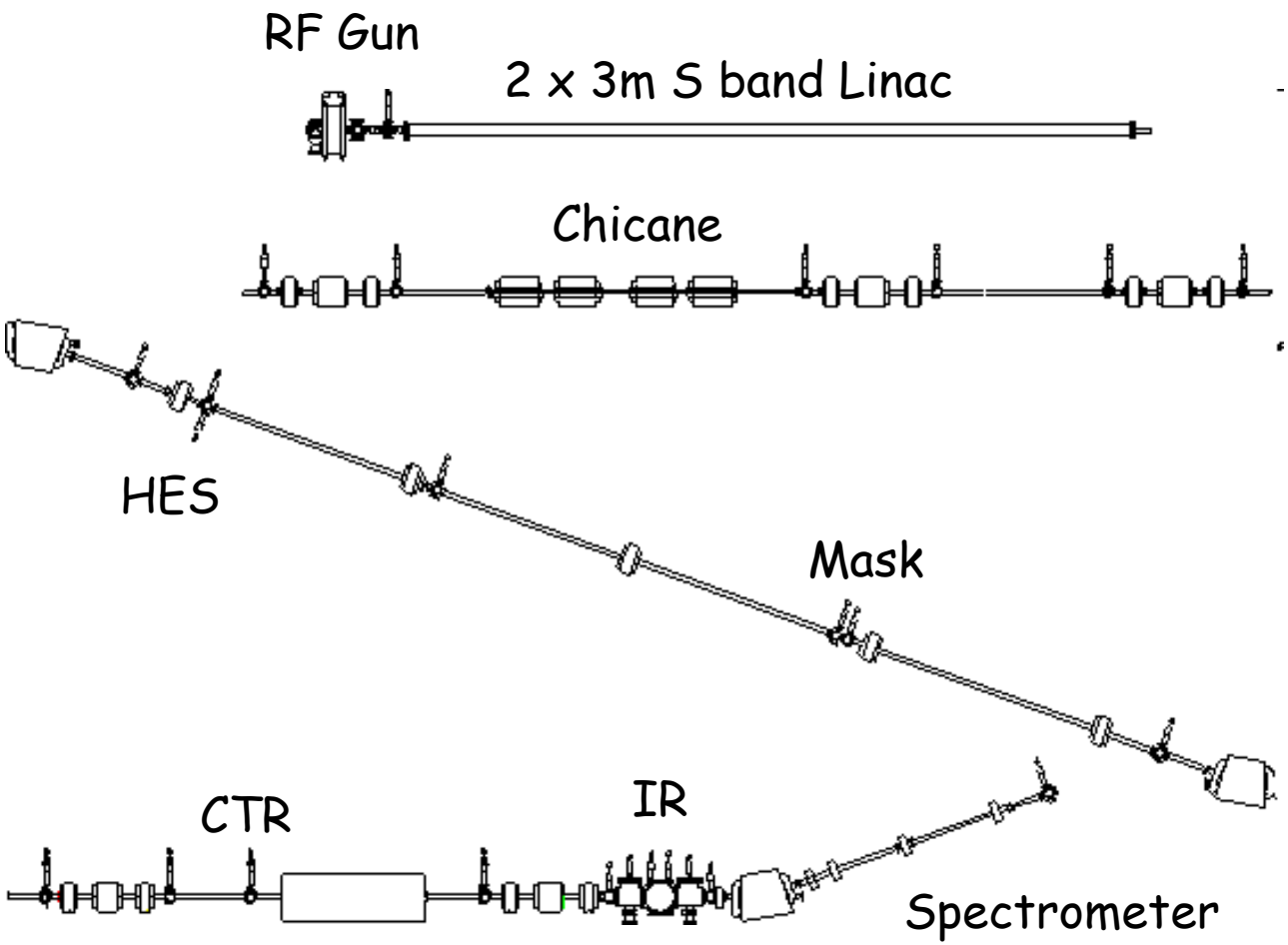


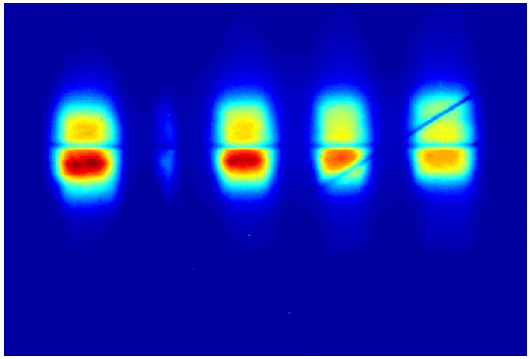
Idea of the train of macro particles



Simplified schematic of the mask principle. Only the dogleg section of the beam line is depicted (not to scale), and three quadrupole magnets are omitted. The side graphs represent the beam energy correlation with the beam front labelled by "F" and the back by "B."

Experimental Layout

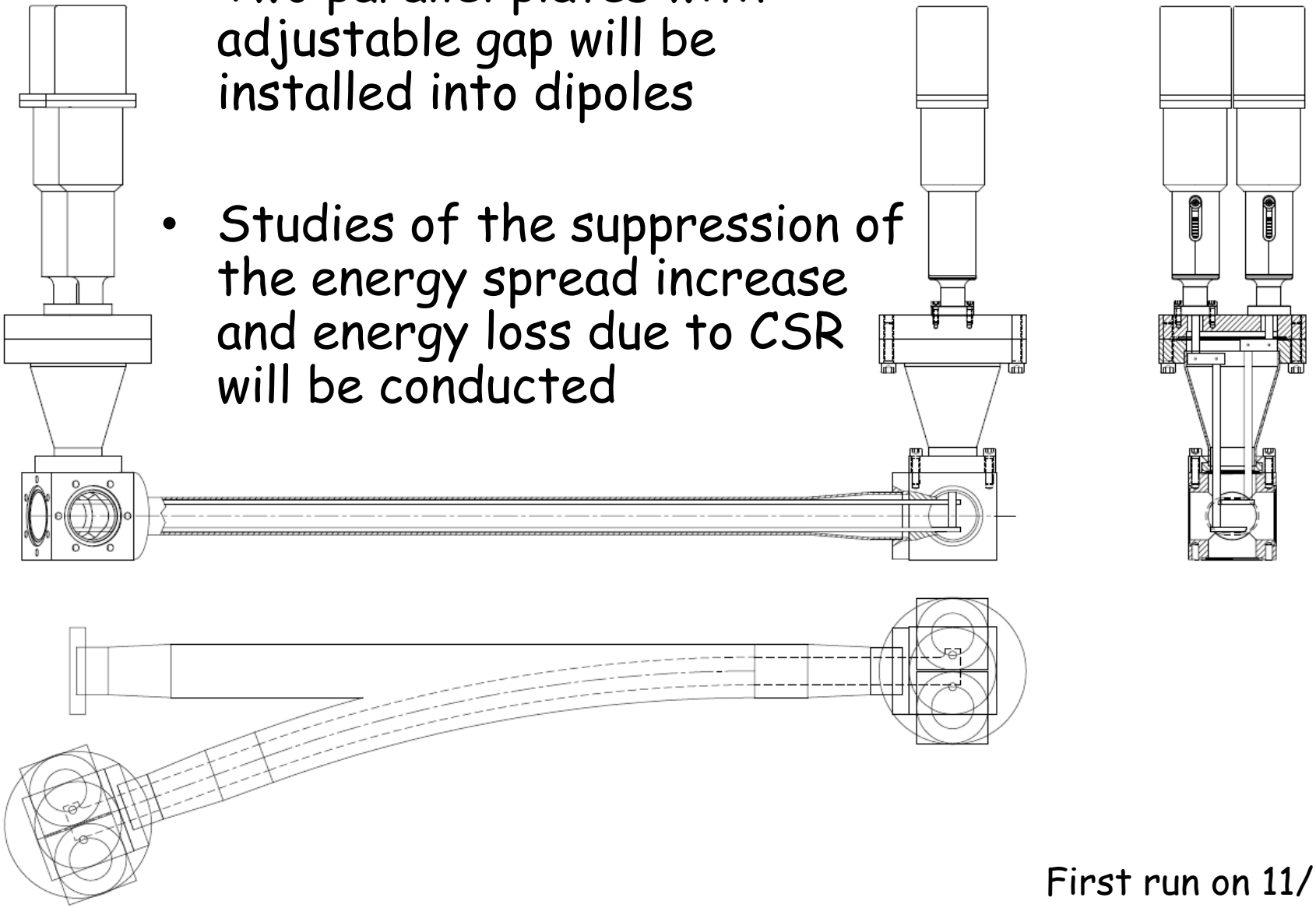




Measured microbunches

CSR shielding test

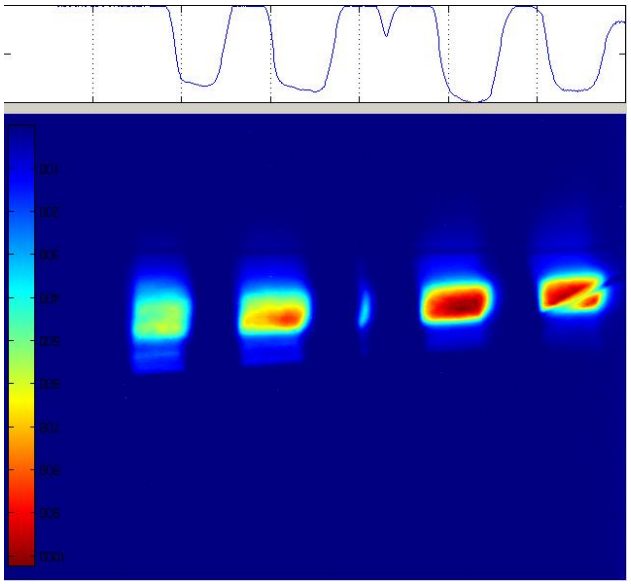
- Two parallel plates with adjustable gap will be installed into dipoles
- Studies of the suppression of the energy spread increase and energy loss due to CSR will be conducted



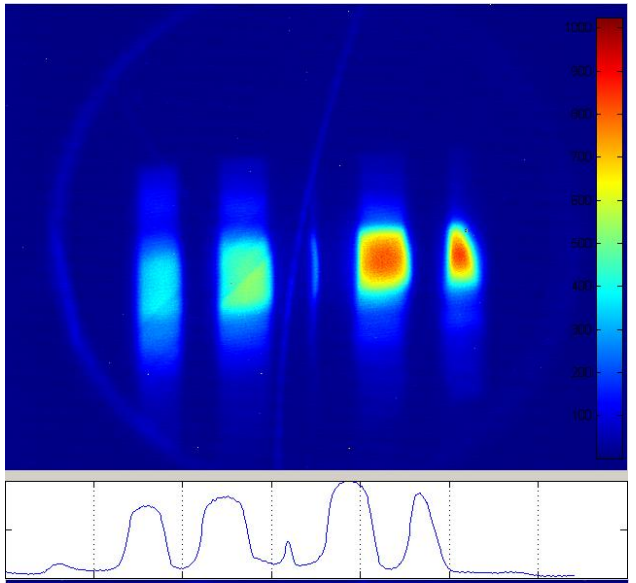
First run on 11/5/09

Experimental setup is ready

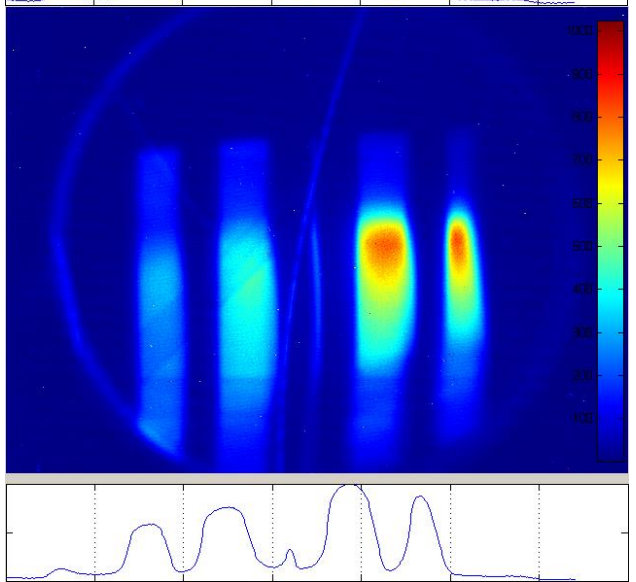
Before dipole



After dipole



400 pc



750 pc

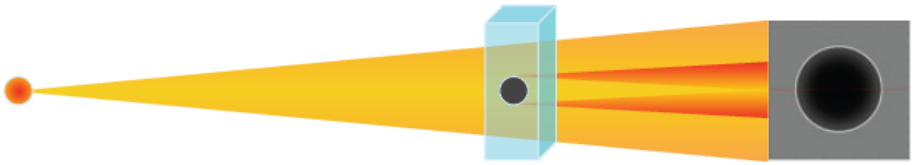
- Change of energy and spread of individual beamlets lead to experimental verification of CSR

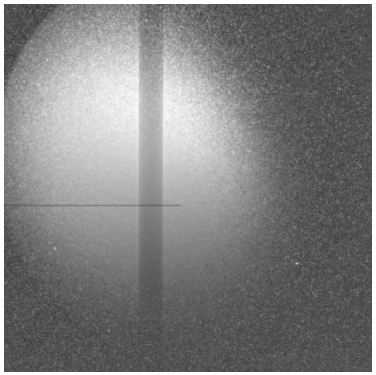
Images taken 11/10/2009

Phase contrast imaging using Compton X ray beam

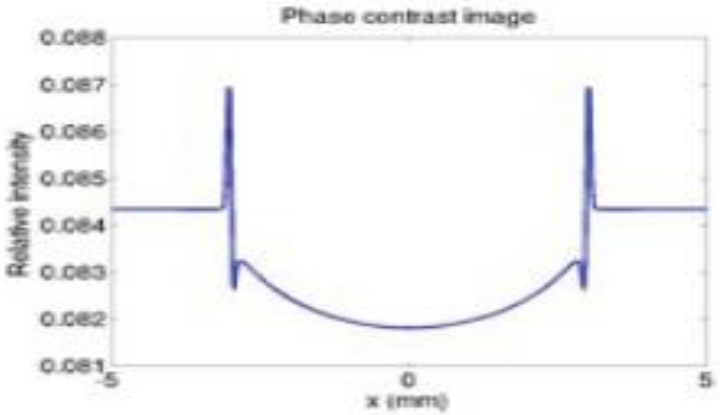
Phase contrast imaging (IFN),

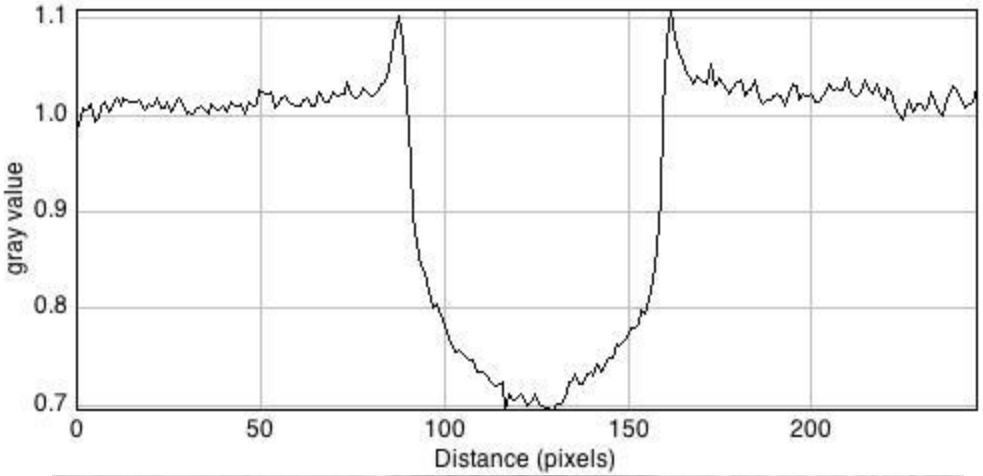
First proposed by Snigirev (1995)

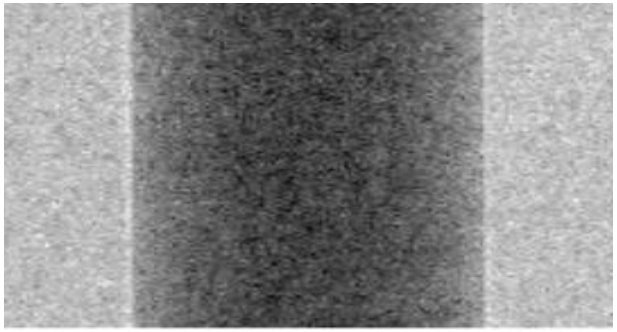


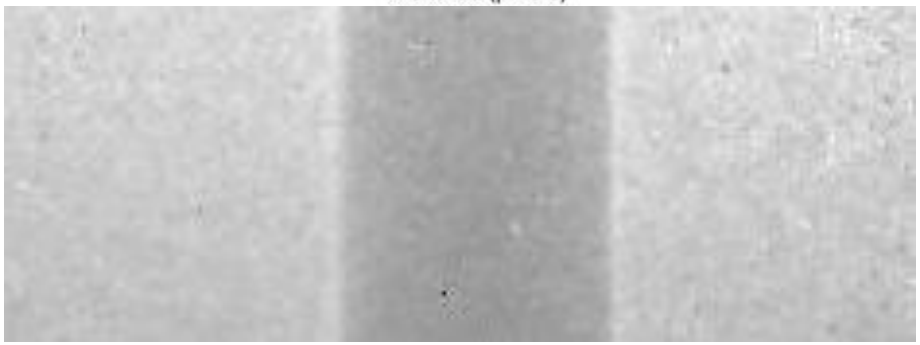


Single shot measurements at ATF 10/27/09

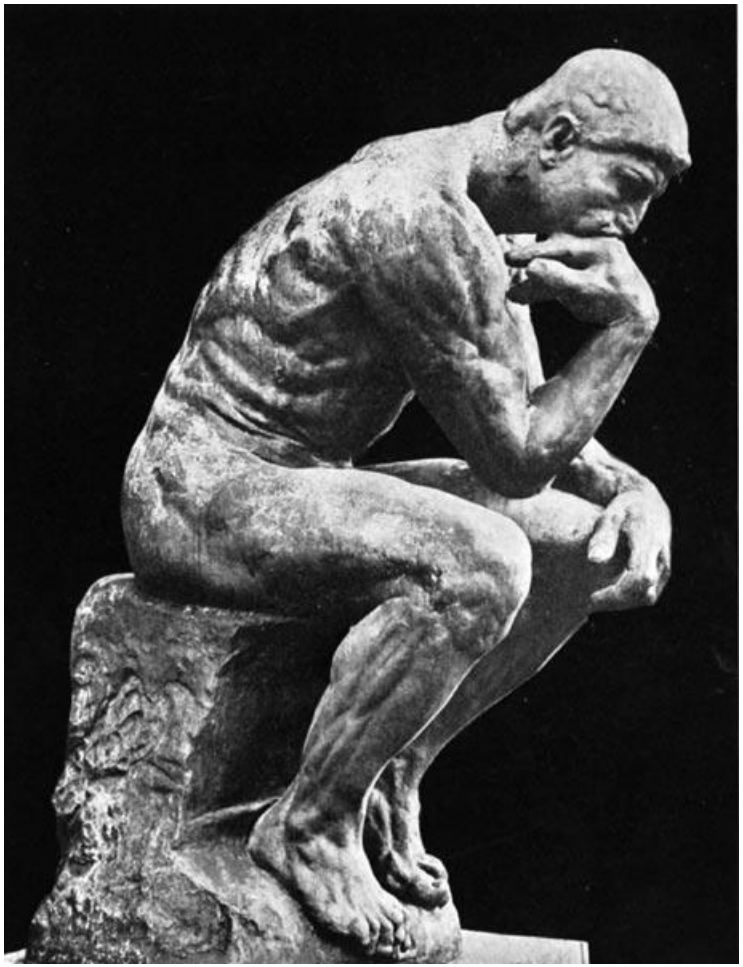


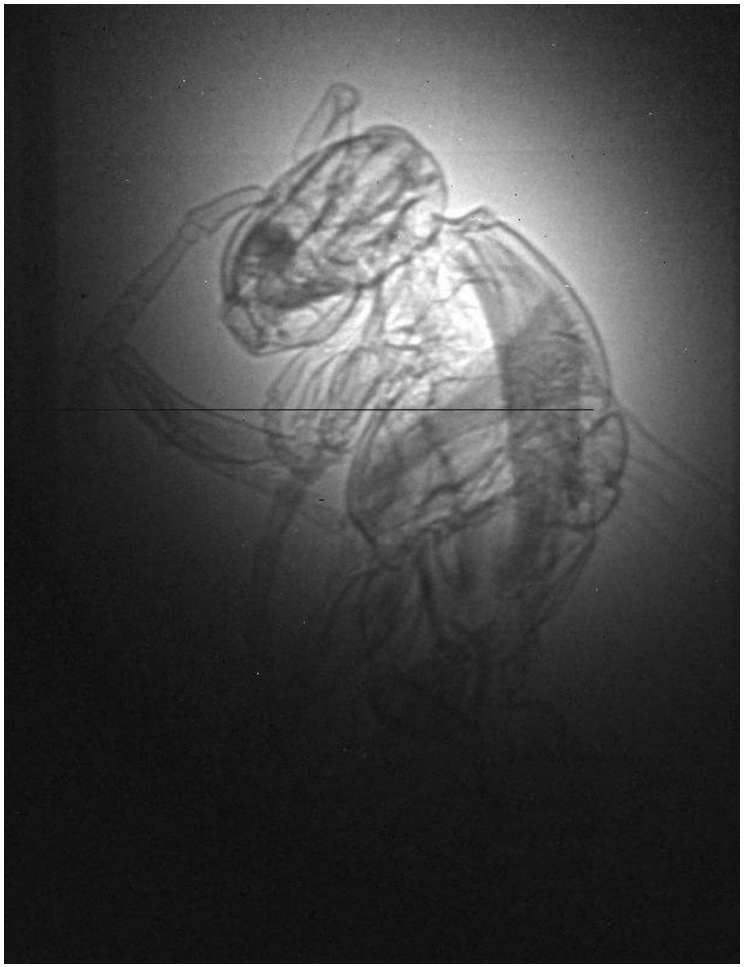






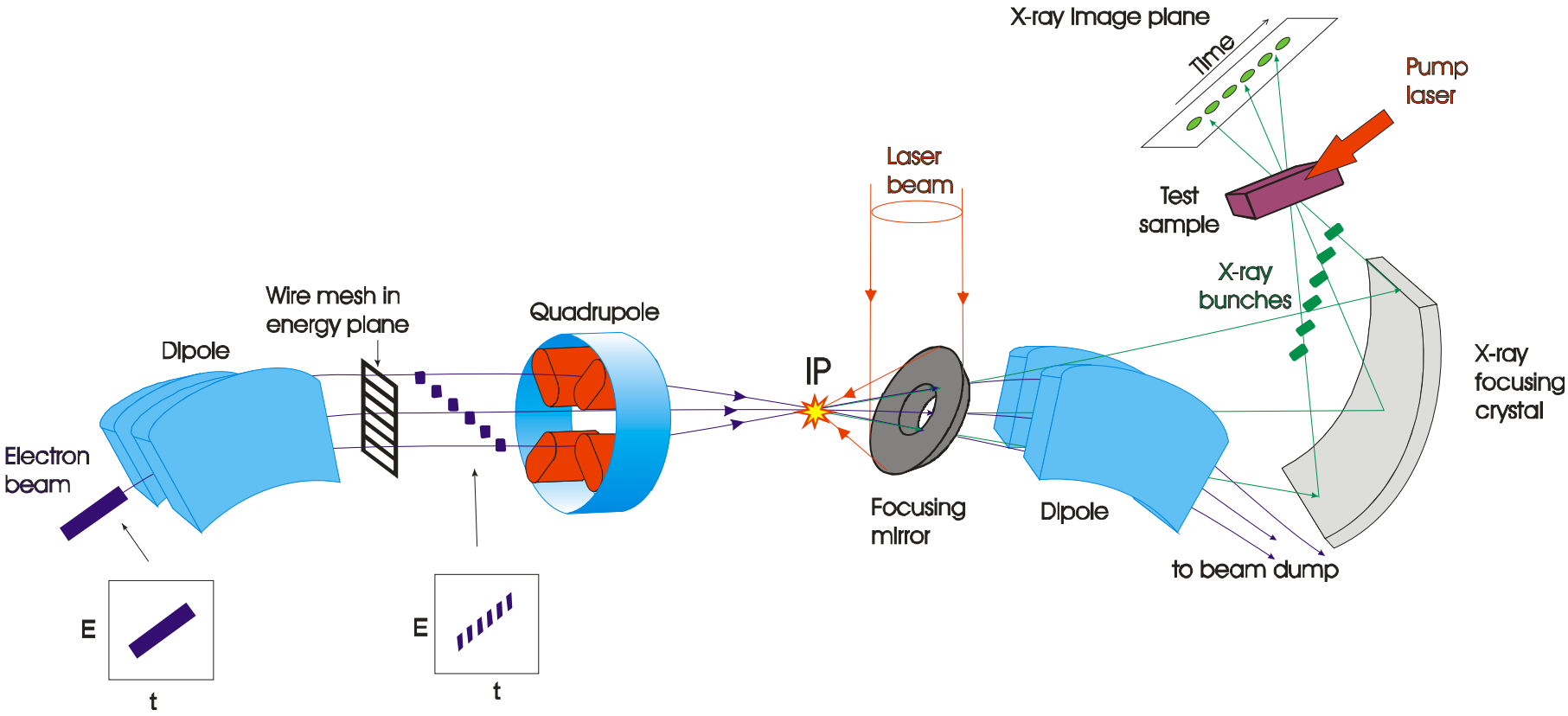
Picture of bee taken with a single picosecond X ray pulse





Taken on 10/28/09

Idea of X ray camera



10^7 X-rays per beamlet are expected with 1% energy spread with 0.3 mrad divergence, 35μm source size and 100fs RMS duration. This correspond to peak brightness of 10^{23} ph/sec/mm^2/mrad^2/0.1%

Waiting for LDRD decision