MPI - Halbleiterlabor für Physik
und für extraterrestrische Physik

PNSensor

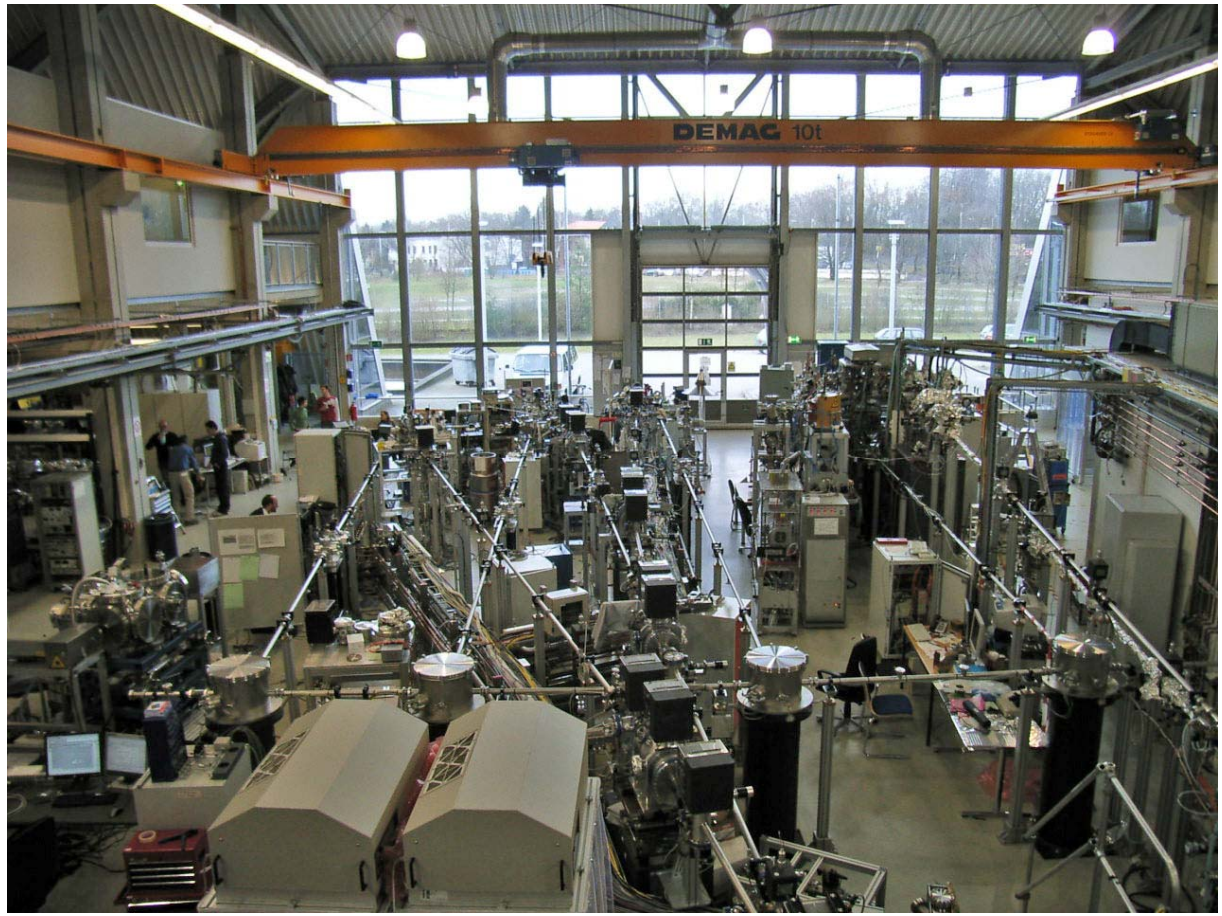
pnCCD at FLASH

Christian Reich

Collaboration PNSensor/MPI-HLL with cluster physics group Th. Möller, TU Berlin

Ringberg Meeting / April 23 – 25, 2007

VUV-Free Electron Laser at DESY: FLASH



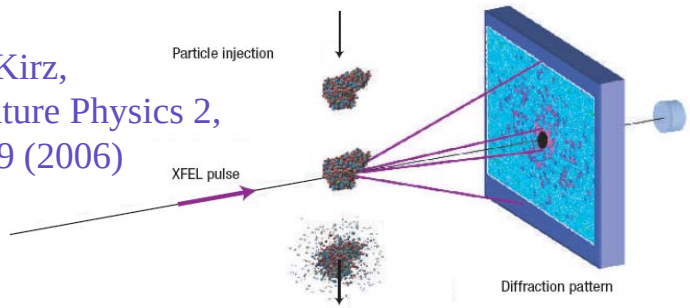
- high intensity coherent light: 10^{12} photons/pulse
- short pulses: 100 fs
- short wavelength: λ = 100nm (2002), 13 nm (now, 2006/7), 0,1 nm (future)

Christian Reich
Ringberg
24.04.2007

Structure determination with a FEL

Molecules atomic resolution

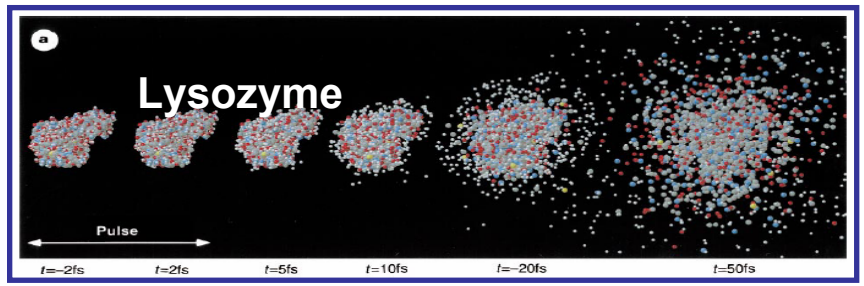
J. Kirz,
Nature Physics 2,
799 (2006)



Important FEL goal:
time-resolved single biomolecule imaging

- **new techniques for single shot imaging**
- **ionisation and explosion dynamics**

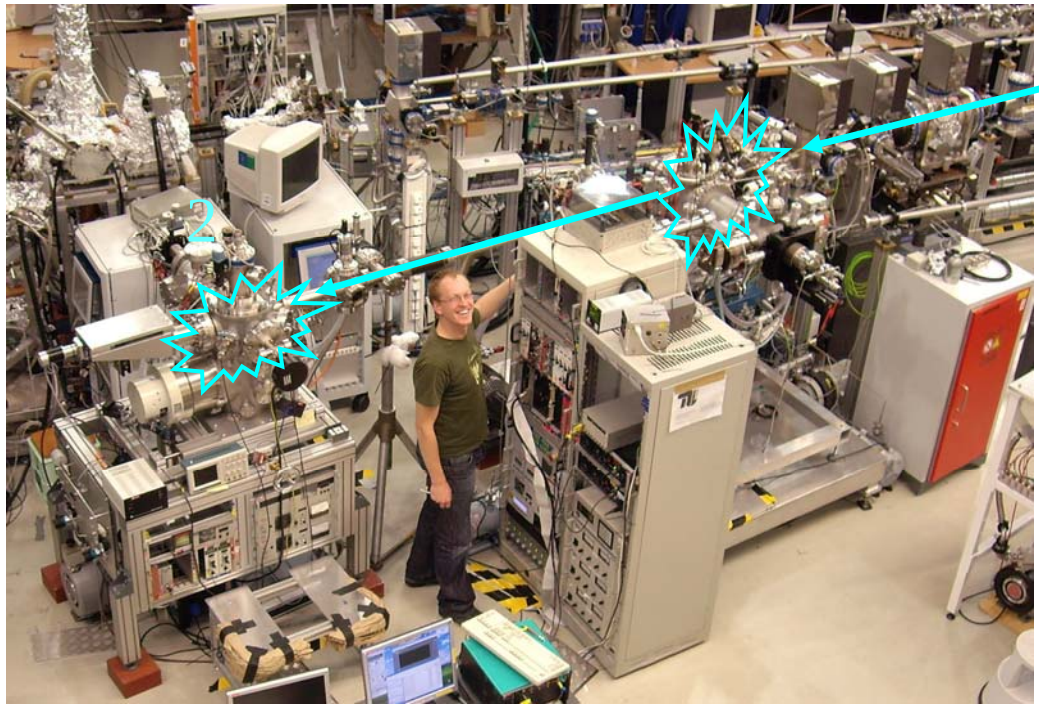
⇒ clusters as model systems
- **easy to make from different materials**
- **different sizes**
- **high symmetry**



R. Neutze, J. Haidu et al., Nature 406, 752 (2000)
Radiation damage and Coulomb explosion

Christian Reich
Ringberg
24.04.2007

Tandem setup: running two experiments at a time



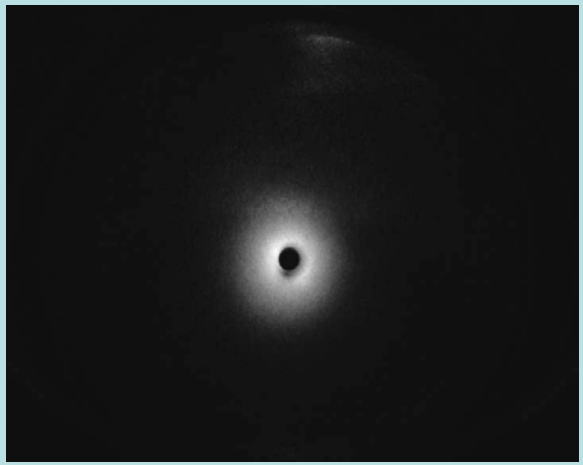
FLASH:
90 eV, 13 nm,
100 fs, 5 Hz
10^{12} photons/pulse

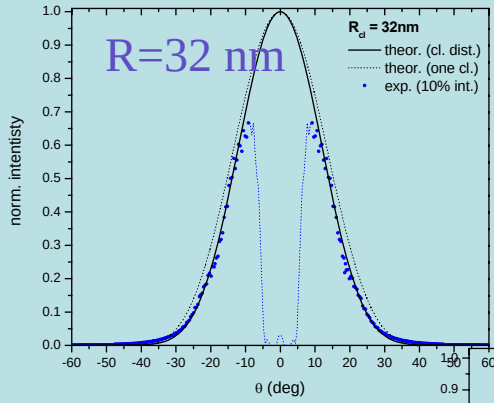
- 2 vacuum chambers with 2 noble gas cluster sources.
- FLASH beam is focused into 1. chamber (TOF).
- Refocused by multilayer mirror into 2. chamber (Scattering experiment).

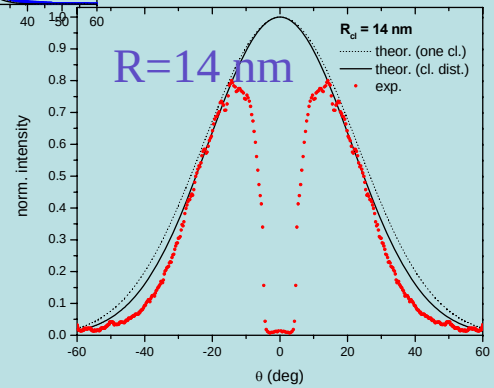
Christian Reich
Ringberg
24.04.2007

Single shot scattering possible

Ar clusters , radius R = 32 nm



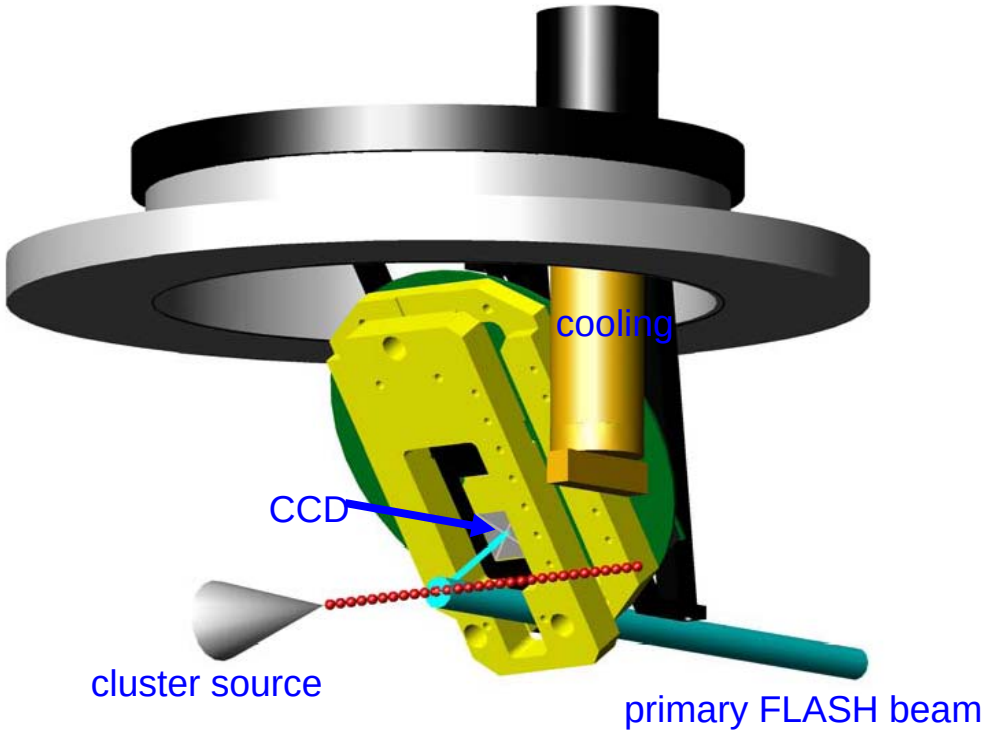




by Th. Möller, Ch. Bostedt, TU Berlin, 2006

- Previous scattering experiment with MCP detector at FLASH
- Charged particles pose problems
- Greater dynamic range needed

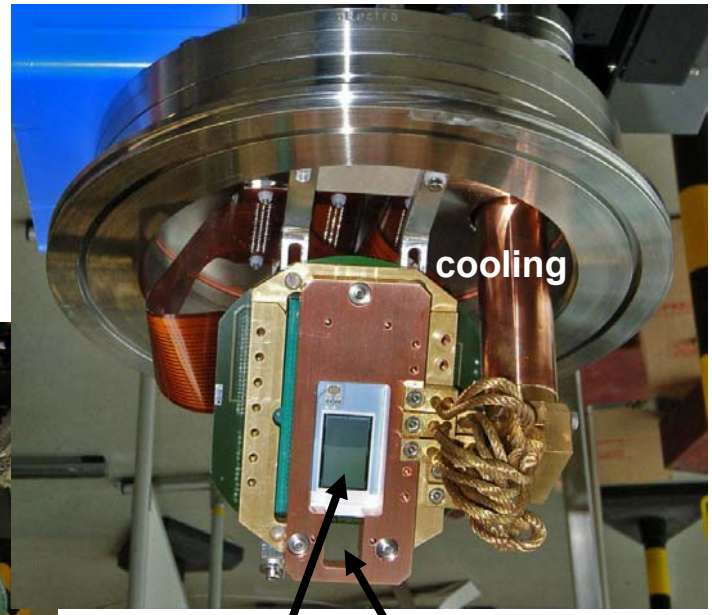
Setup of pnCCD at FLASH

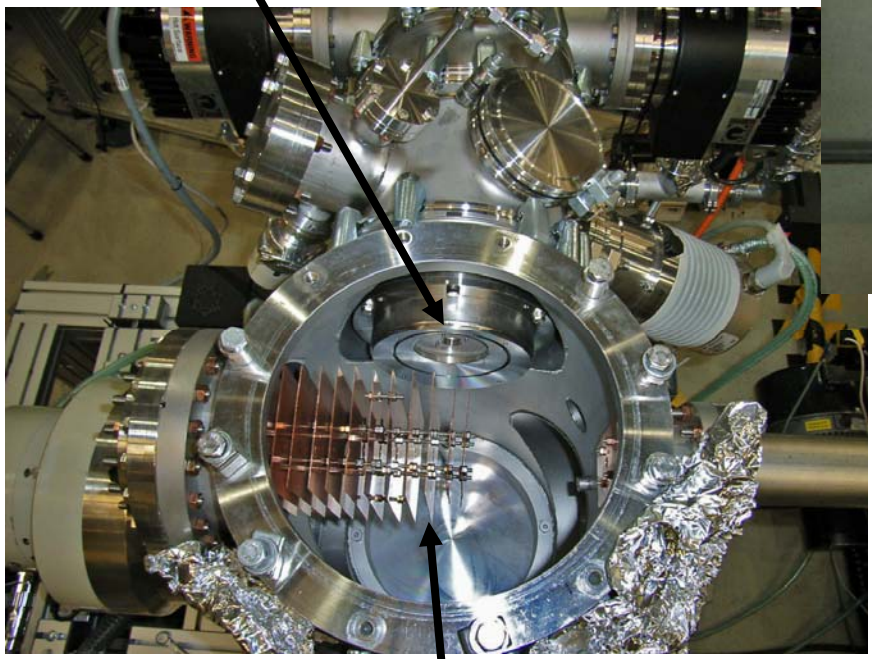


- The primary FLASH beam passes through the cluster beam and is focused back on the cluster beam by a multilayer mirror.
- Observation angle: 35° (22° - 50°)
- Pixel size: 75 µm x 75 µm
- Operating temperature: -70°C

Christian Reich
Ringberg
24.04.2007

Setup of pnCCD at FLASH





Christian Reich
Ringberg
24.04.2007

First pnCCD Spectrum at 90 eV

Recombined spectrum from 4000 frames
with 0.005 photons/pixel/frame

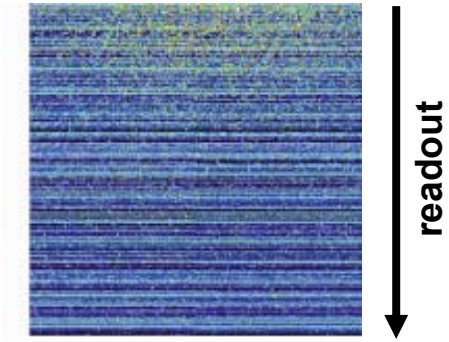
T = -70° C

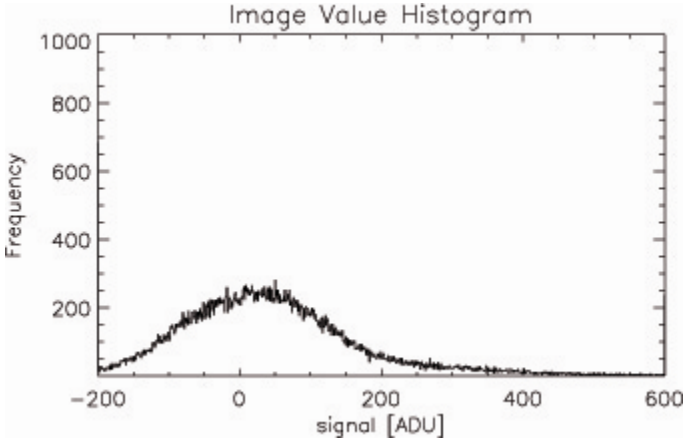
The signal is clearly seperated from
noise and higher harmonics.
FWHM: 38.9 eV

Christian Reich
Ringberg
24.04.2007

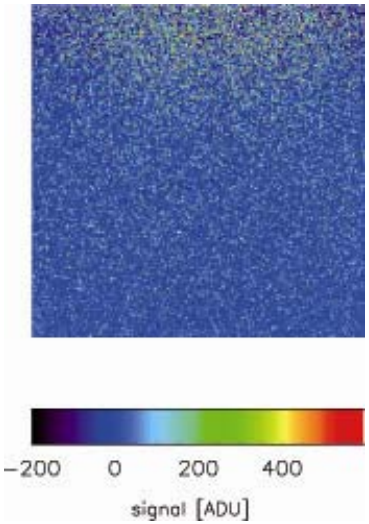
Correction of Common Mode I

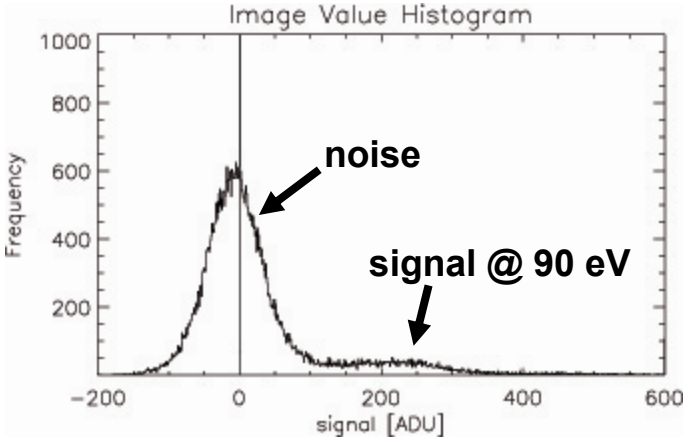
Common mode
varation of about
± 0.5 photons





Median correction
of common mode



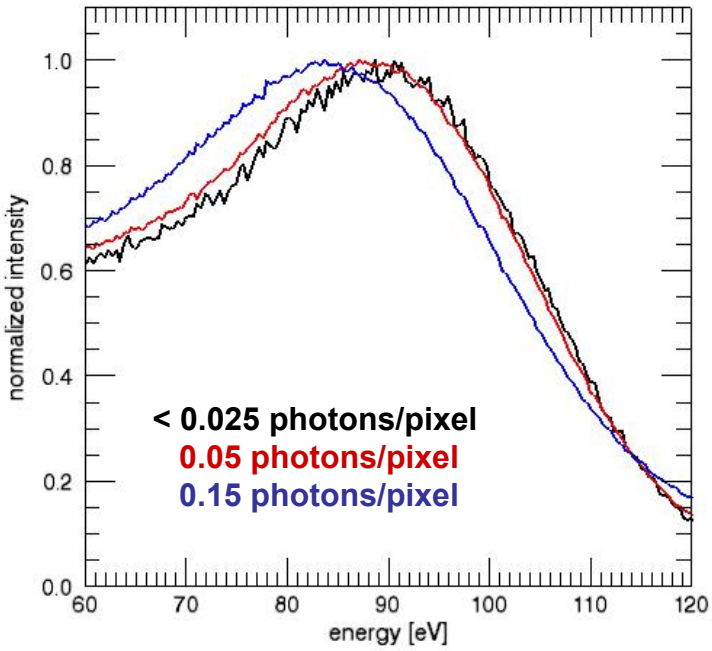


Spectrum shifted to lower values.
Shift depends on photon density.

Christian Reich
Ringberg
24.04.2007

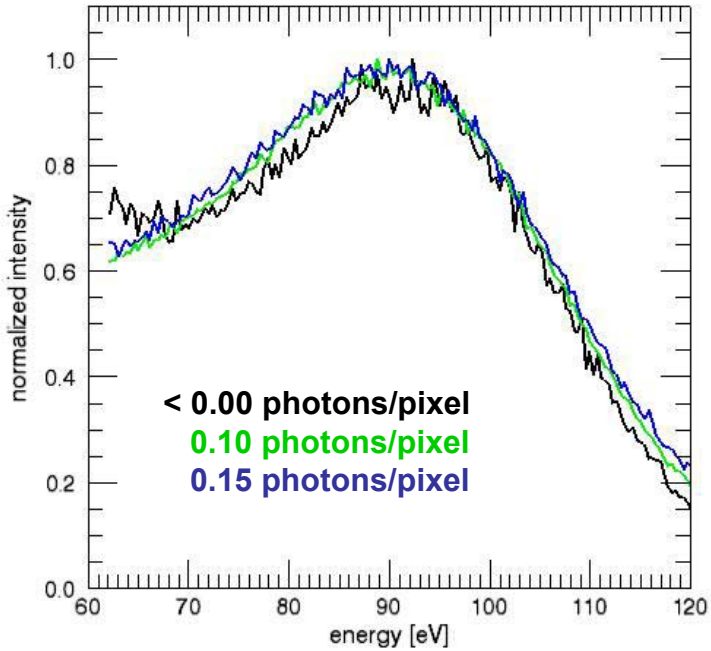
Correction of Common Mode II

median subtracted



Even at low photon densities the median correction induces an error of several eV (≈ 7 %).

mean of lowest values subtracted

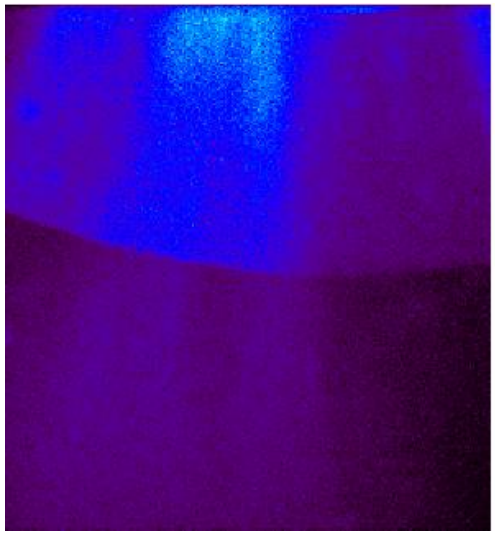


When subtracting the mean of the 10 lowest values in each row, the signal peak position is independent of photon density up to 0.2 photons/pixel (constant offset of 16 eV).

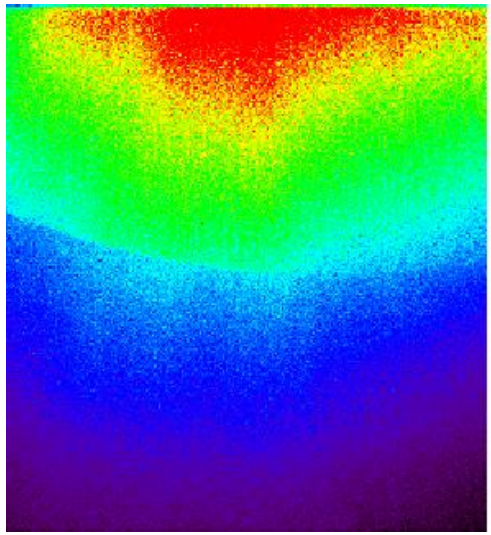
Christian Reich
Ringberg
24.04.2007

Scatter Images

cluster source off



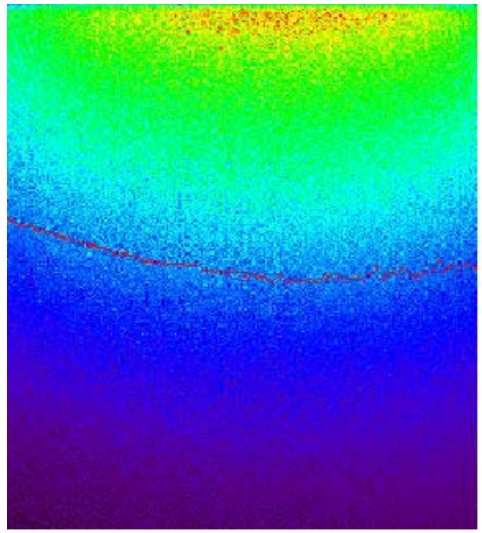
with Xe clusters, 21 nm



- 5000 frames with 10 pulses
- Intensity: 0.1-0.2 ph/pixel/frame

subtraction

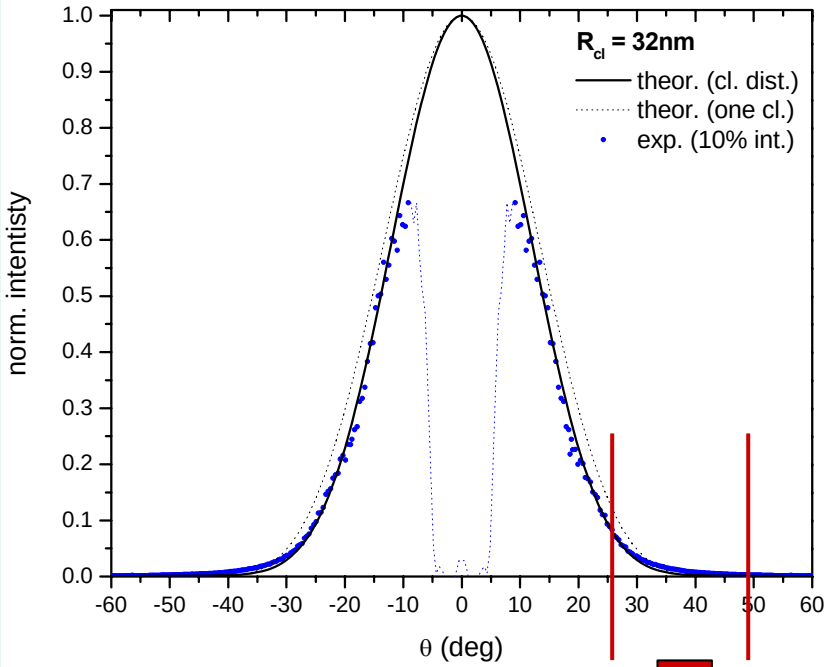
scattering image from
Xe clusters



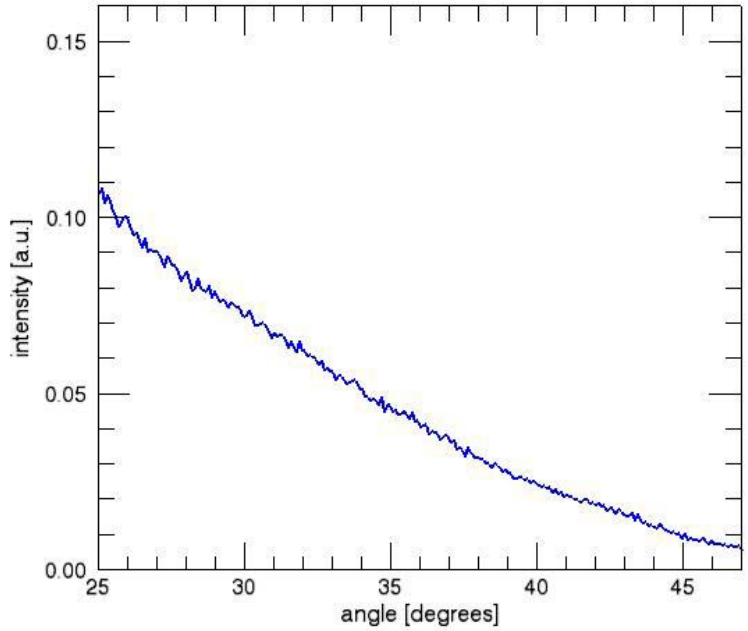
Christian Reich
Ringberg
24.04.2007

Scattering Profiles

MCP measurement, Mie scattering on single Ar cluster, d = 64 nm



pnCCD, Summed scattering on few Xe clusters



⇒ **similar pattern**
details need to be analyzed

Christian Reich
Ringberg
24.04.2007

Summary And Outlook

- Signal from 90 eV photons is clearly seperable from noise and higher harmonics. FWHM = 38.9 eV.
- Different types of common mode correction were tested.
- Scattering images from Xe clusters agree with previous measurements.

- Single shot imaging successful?
- Common mode detection on hardware