XFEL HEDS Workshop

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The XFEL HEDS Workshop

- What?
- When?
- Where?
- Why?
- Who?
- Wallet
- Website

What

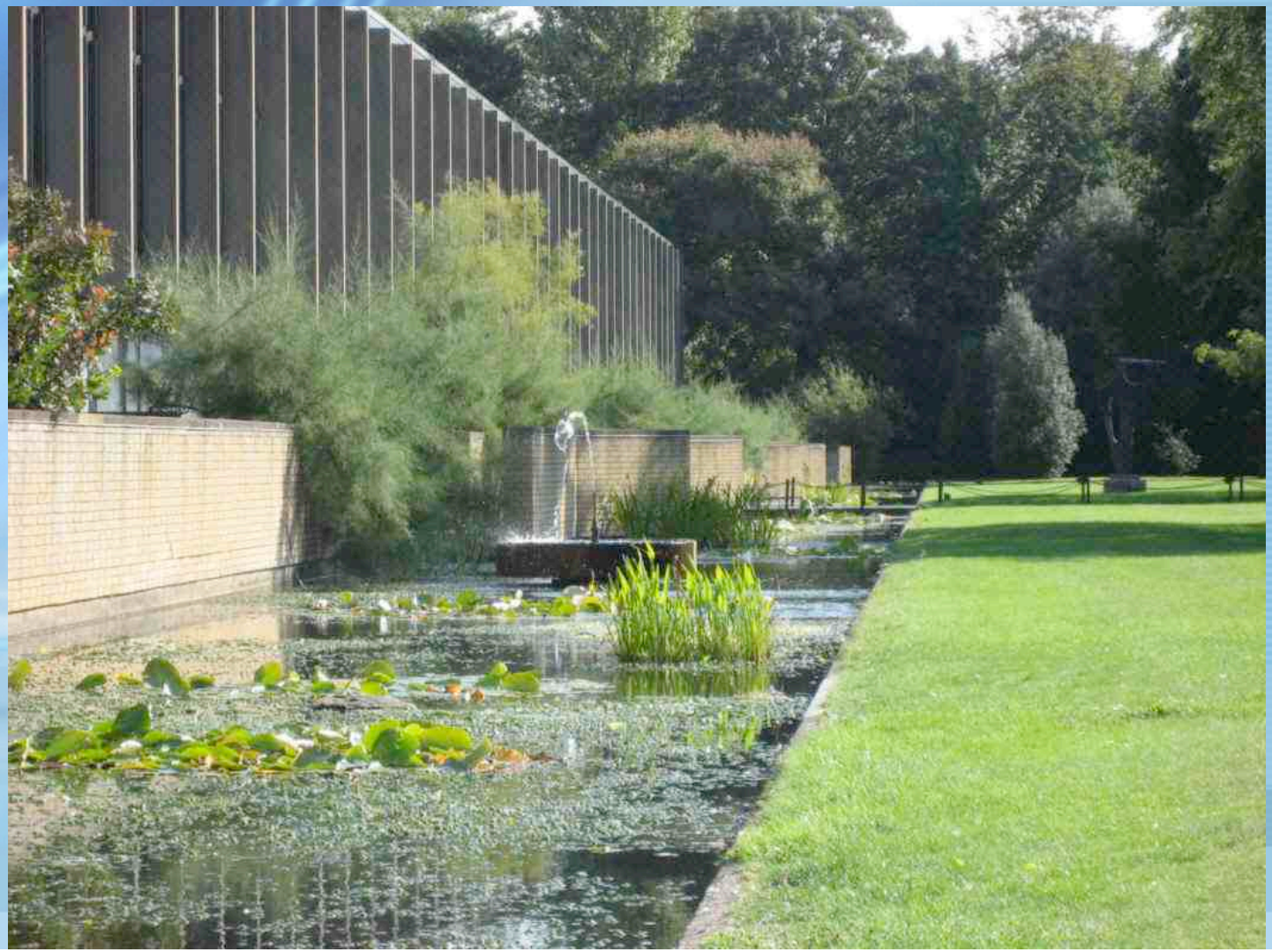
- One in a whole series of workshops organized and sponsored by XFEL to help in the design of end-stations for XFEL.
- The UK is honoured and pleased to be hosting the workshop on High Energy Density Science.

When?

- From lunchtime Monday 30th March until lunchtime Wednesday 1st April.

Where

St. Catherines College, University of Oxford.

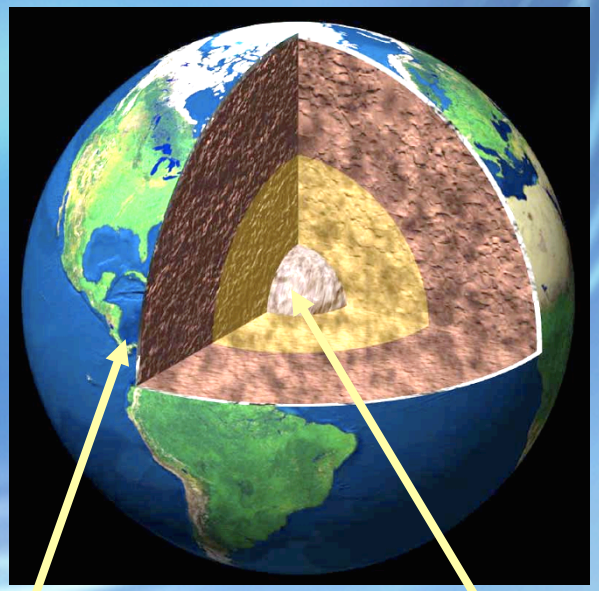


Why?

- The aim of the workshop is to bring together scientists from across Europe who are working in the HEDS area - i.e. dense plasmas, warm dense matter, x-ray and laser created plasmas, shock wave physics, and astrophysically relevant plasmas and other areas of extreme condition science, to consider current developments and the future possibilities for using the XFEL system for this burgeoning area of research.
- Start to develop concrete plans for the endstation.

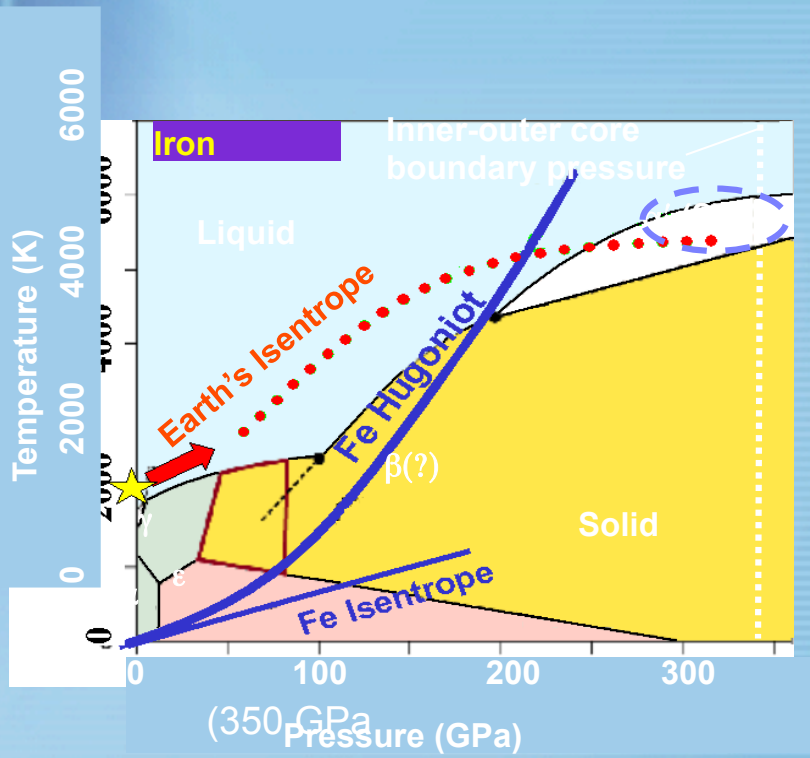
Science Examples

Phase Transitions in Iron - so far only resolved with nsec resolution

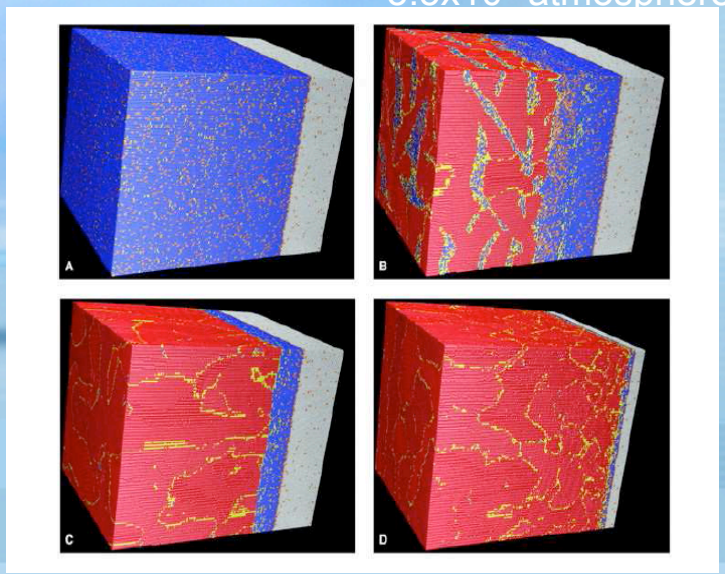


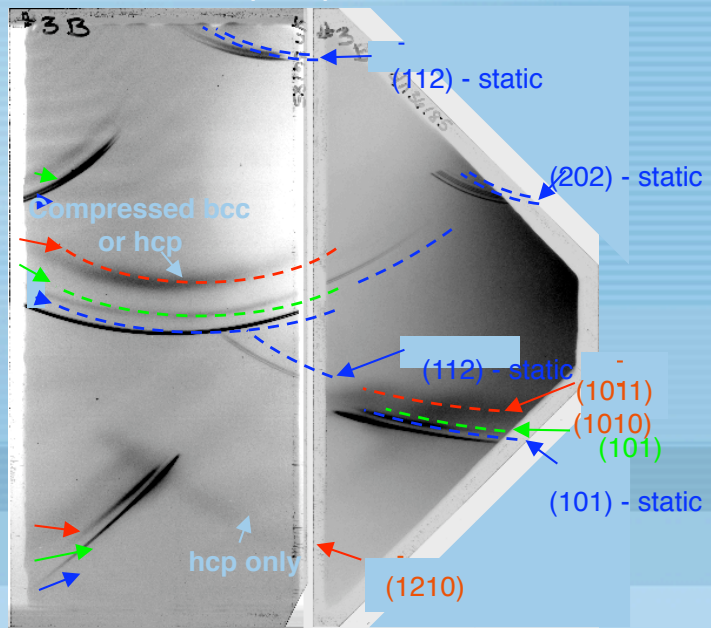
Outer liquid core

Inner solid core
= 3.5x10^6 atmospheres)

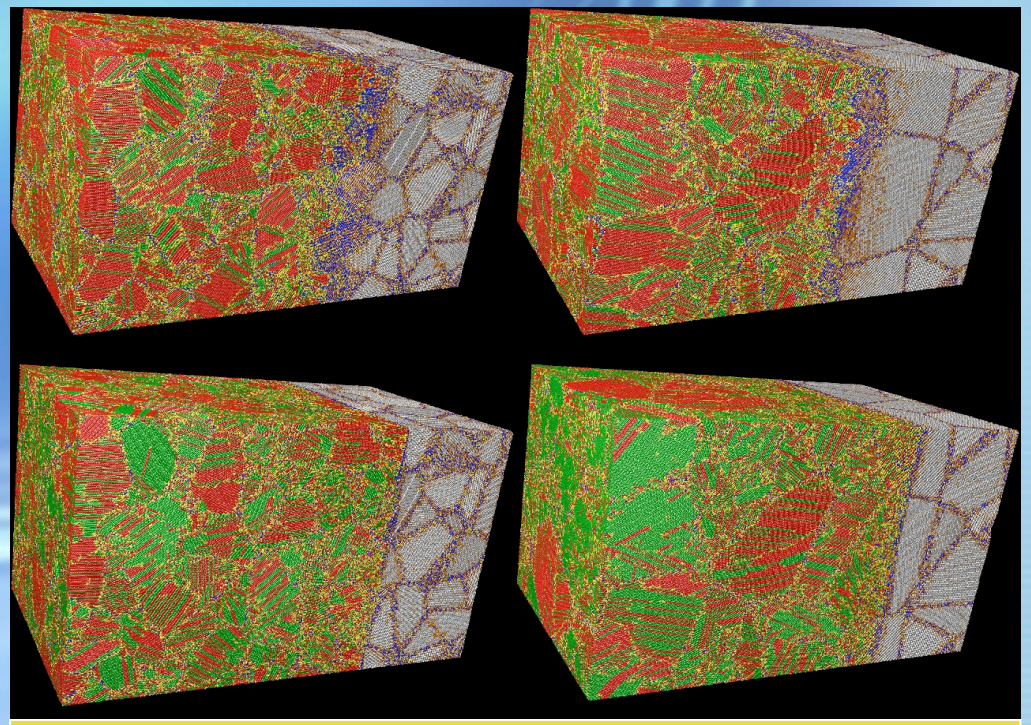


(350 GPa

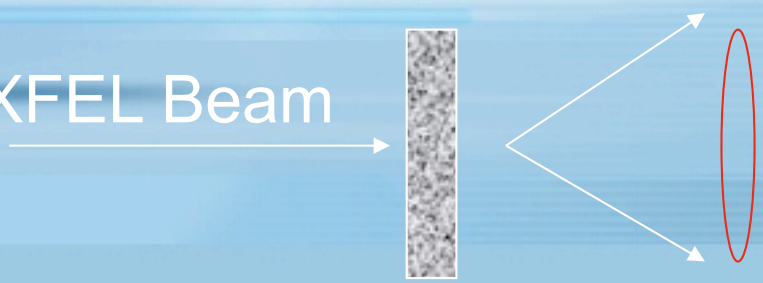


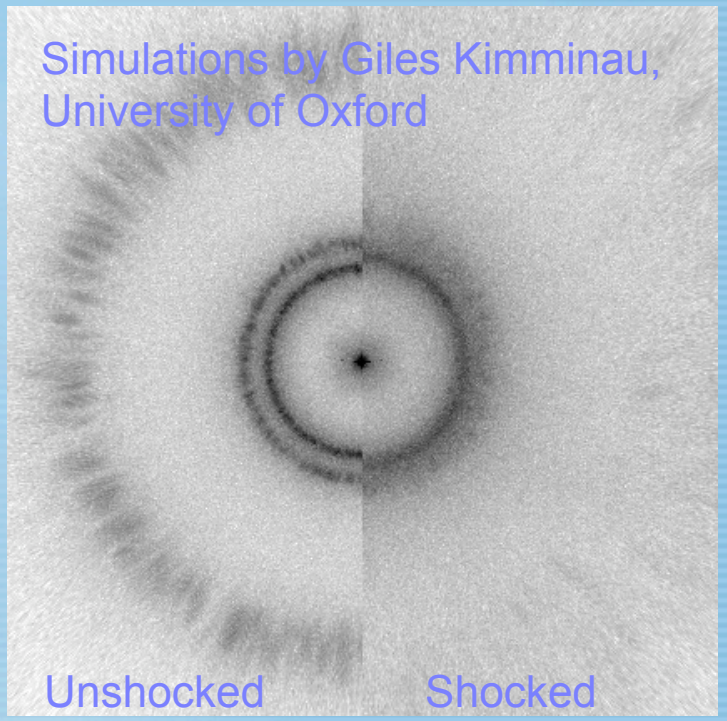


XFEL bright enough to allow powder diffraction of shocked samples



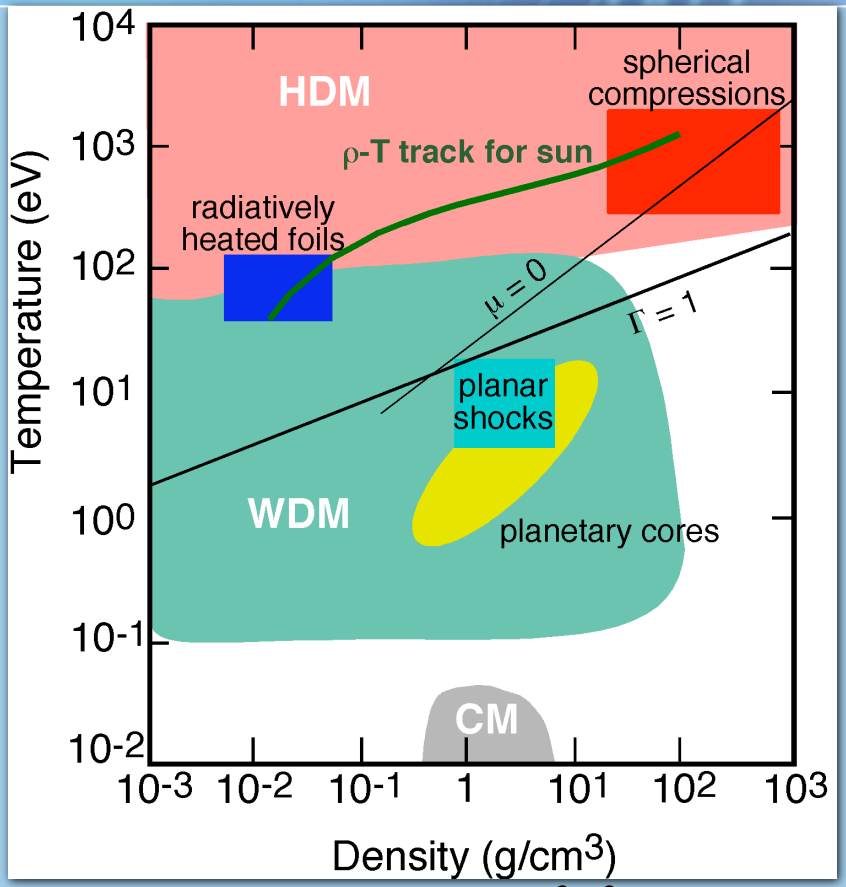
Investigate elastic-plastic response and phase transitions at the granular level in polycrystalline materials.





- MD Simulations of powder diffraction fro unshocked and shocked polycrystalline copper (NB MD shown left is polycrystalline *Iron*).
- 30 million atoms (72nm^3)
- 3000 grains
- Calculate 'absolute' intensities

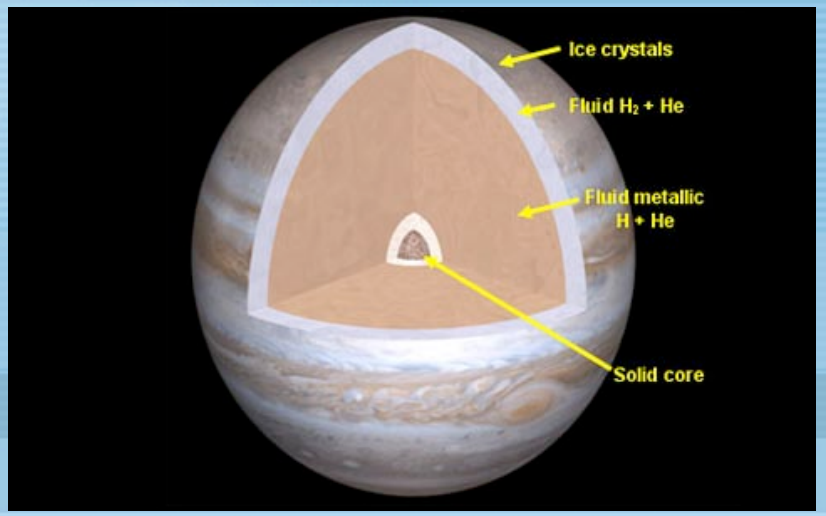
High Energy Density Matter



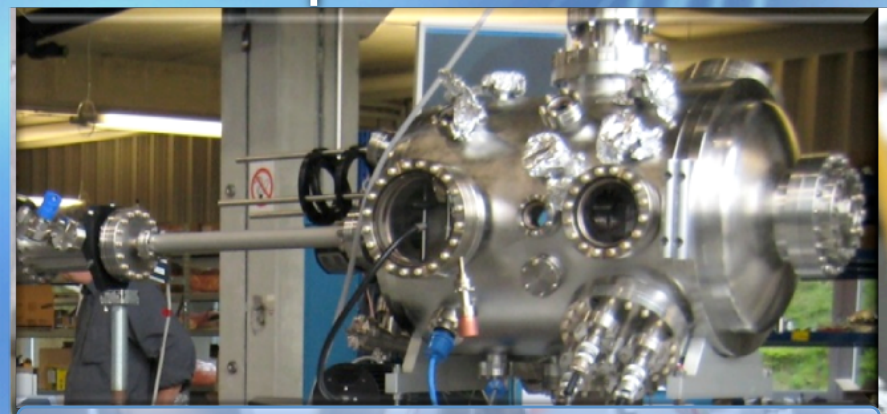
$$\Gamma = \frac{V_{ii}}{T} = \frac{Z^2 e^2}{r_o T}$$

$$\text{where } r_o \propto \frac{1}{\rho^{1/3}}$$

- Warm Dense Matter is notoriously hard to model (pressure predictions vary by factors of 2).
- WDM is automatically produced (isochorically) in 4th generation source interactions. 'Structure' probed via Thomson Scattering.
- Also require 'high rep-rate' (10Hz) high-energy optical laser to form other (compressed) states.



Micro-focusing at FLASH: experimental setup



CHAMBER ATTACHED TO FEL BEAMLINE

Focusing optic:
multilayer coated off-axis parabola

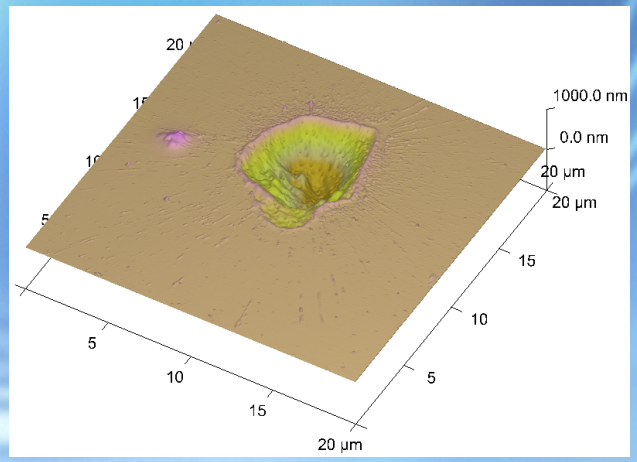
Position of a ToF
or alternatively a
VUV spectrometer

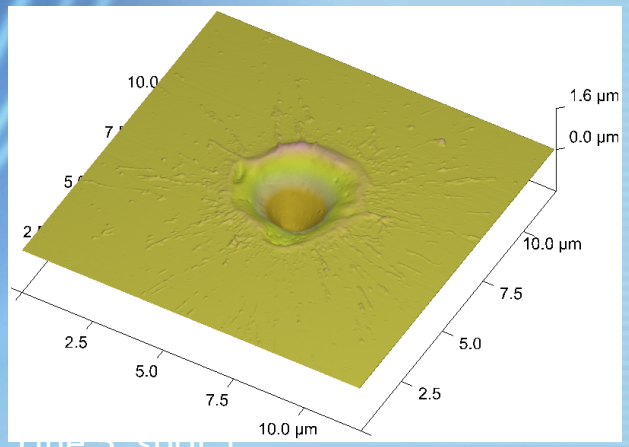
FLASH Beam
15 fs, 13.5 nm

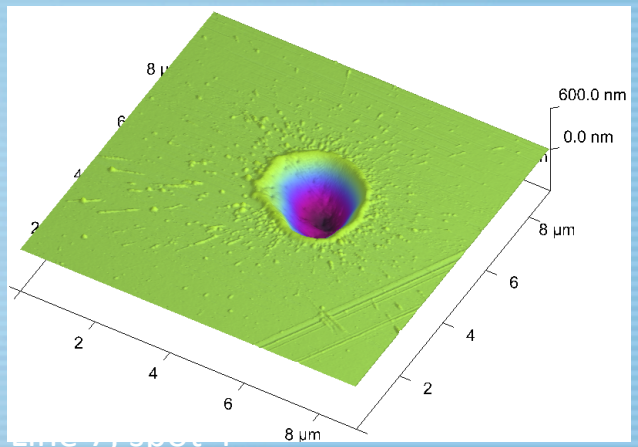
Focused on Targets:
PMMA, Ce:YAG, Al, SiN, etc.

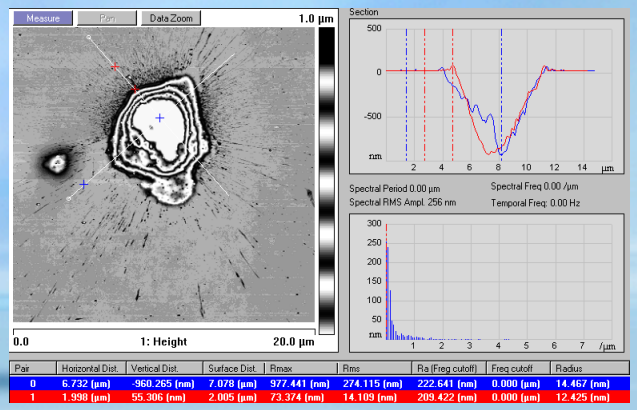
Micro-focusing at FLASH: results

microscopy analysis (Czech IOP):

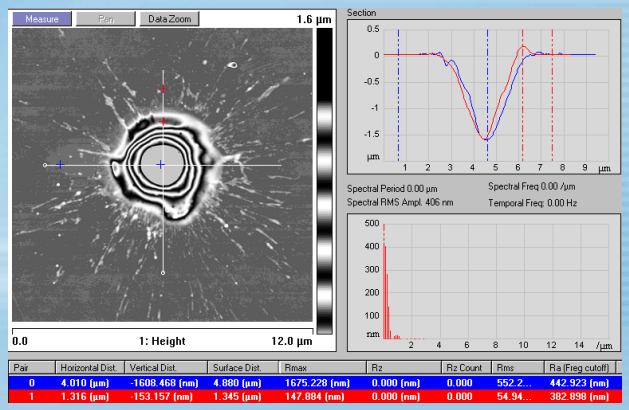




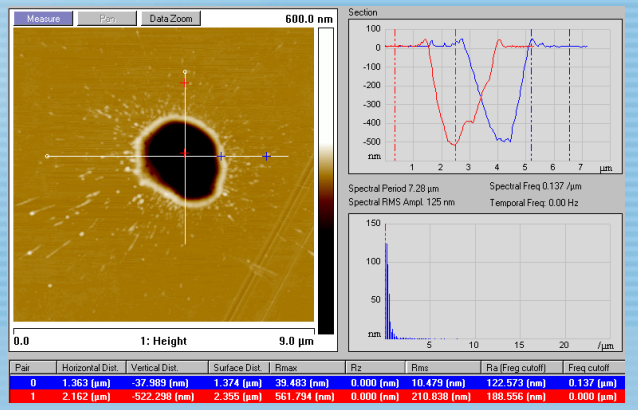




FWHM ≈ 4 µm

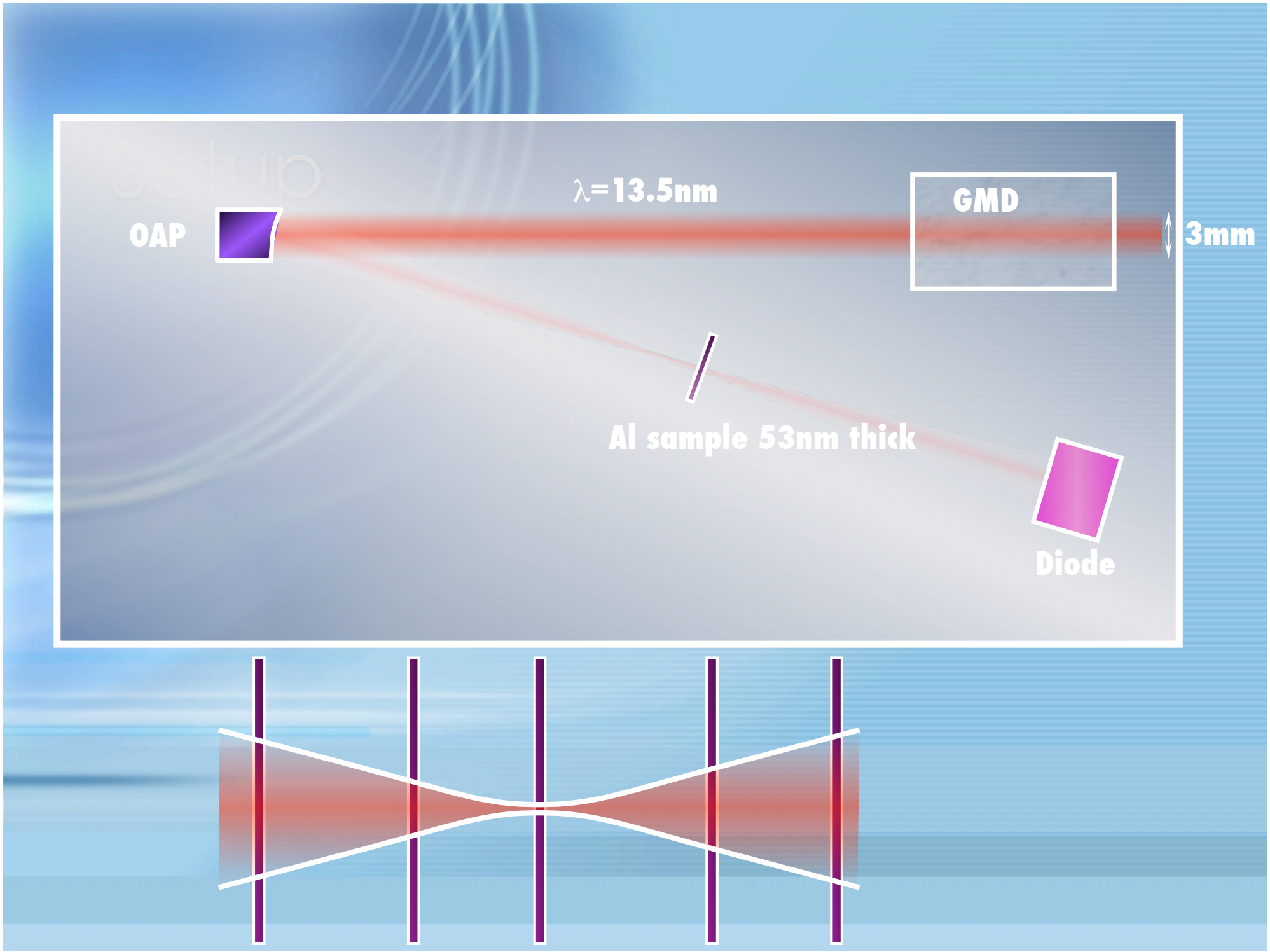


FWHM ≈ 1.5 µm

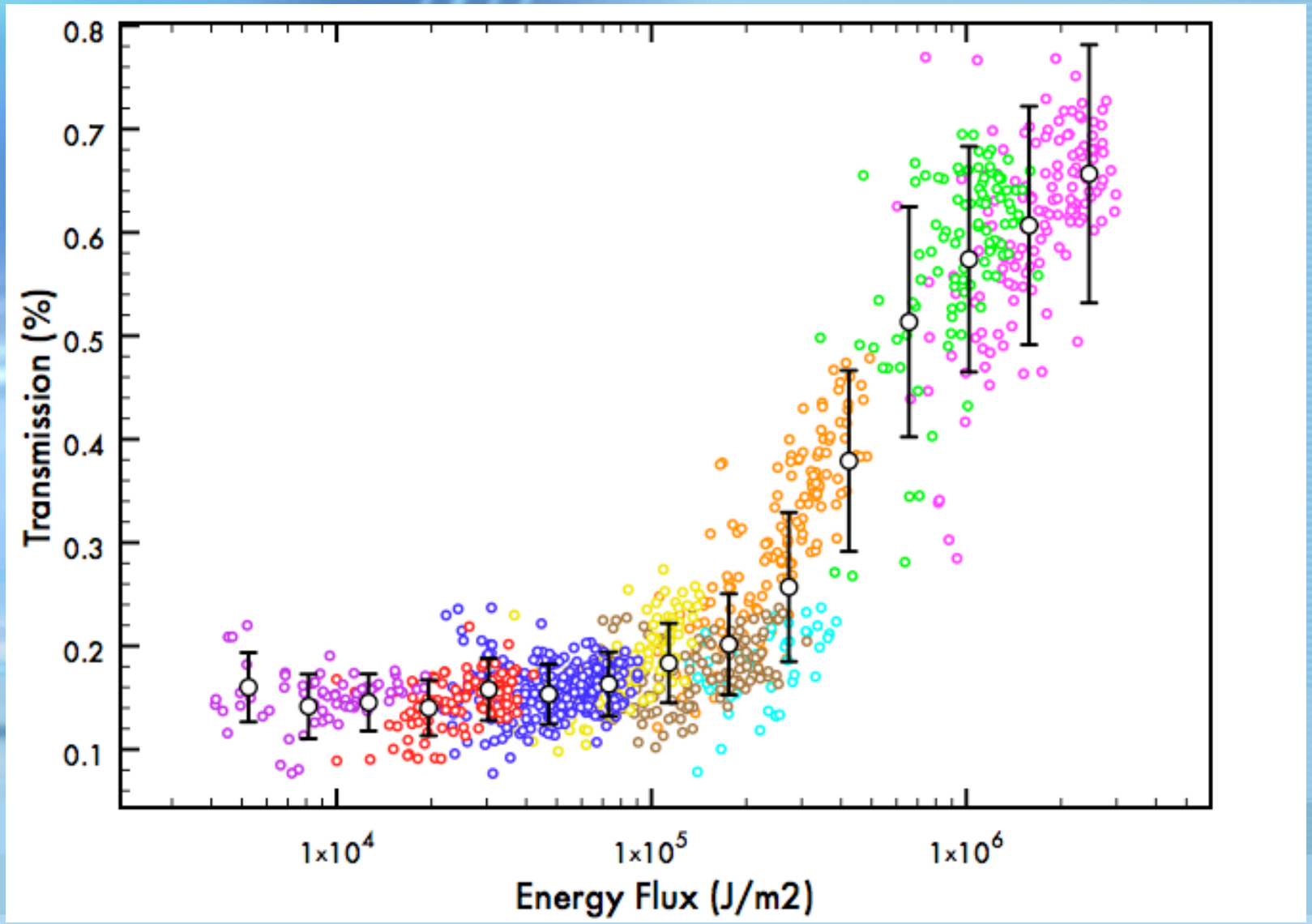


FWHM ≈ 1.5 µm

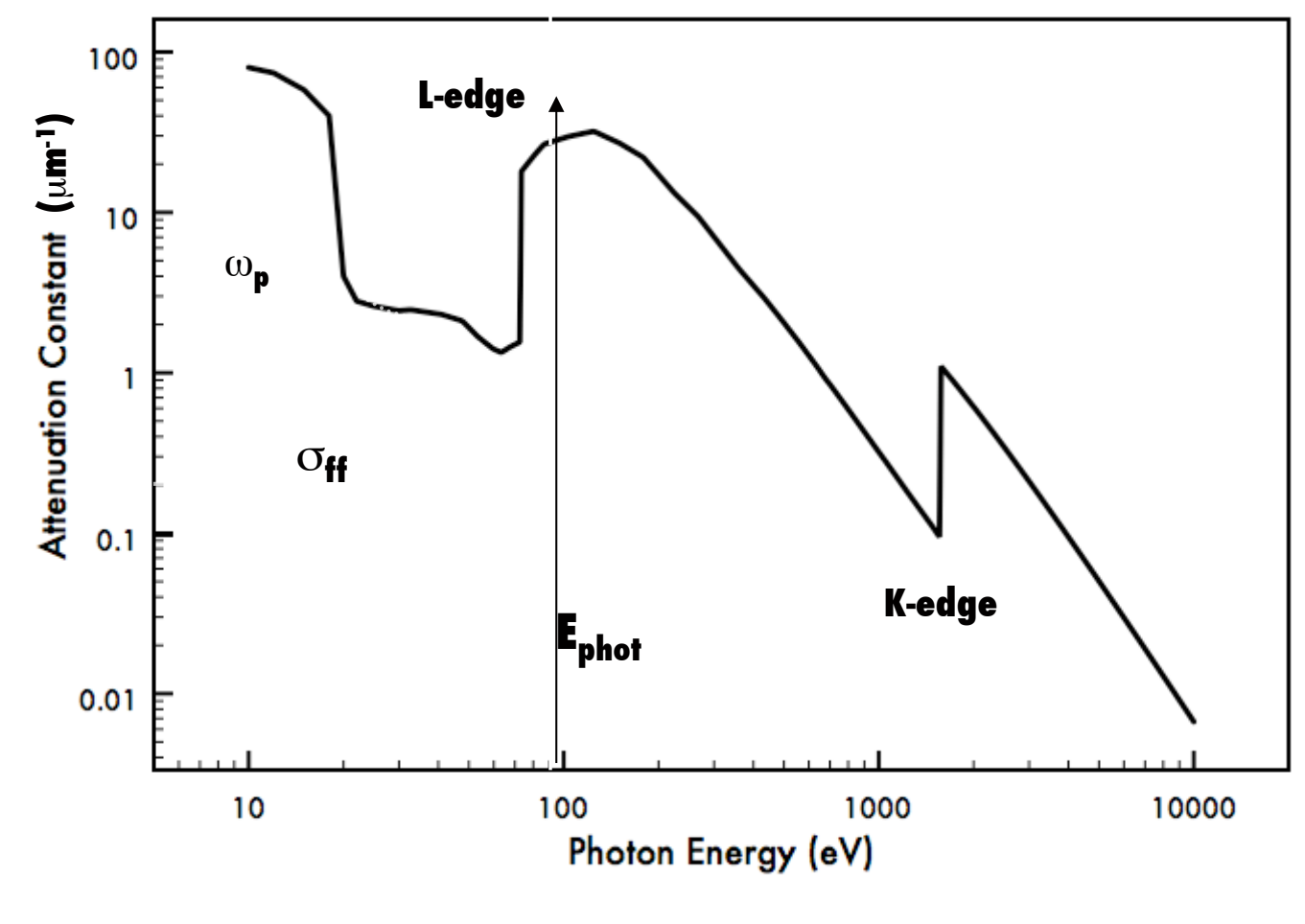
- Assuming the average energy on target (10 µJ) this corresponds to ≈ 4 10^{16} W/cm^2.
- Peak energies of 2-3 times higher also observed – intensities in the 10^{17} W/cm^2 range!


Setup
λ=13.5nm
OAP
GMD
3mm
Al sample 53nm thick
Diode

Aluminium Transmission data



Al absorption coefficient



Atomic Aluminium:

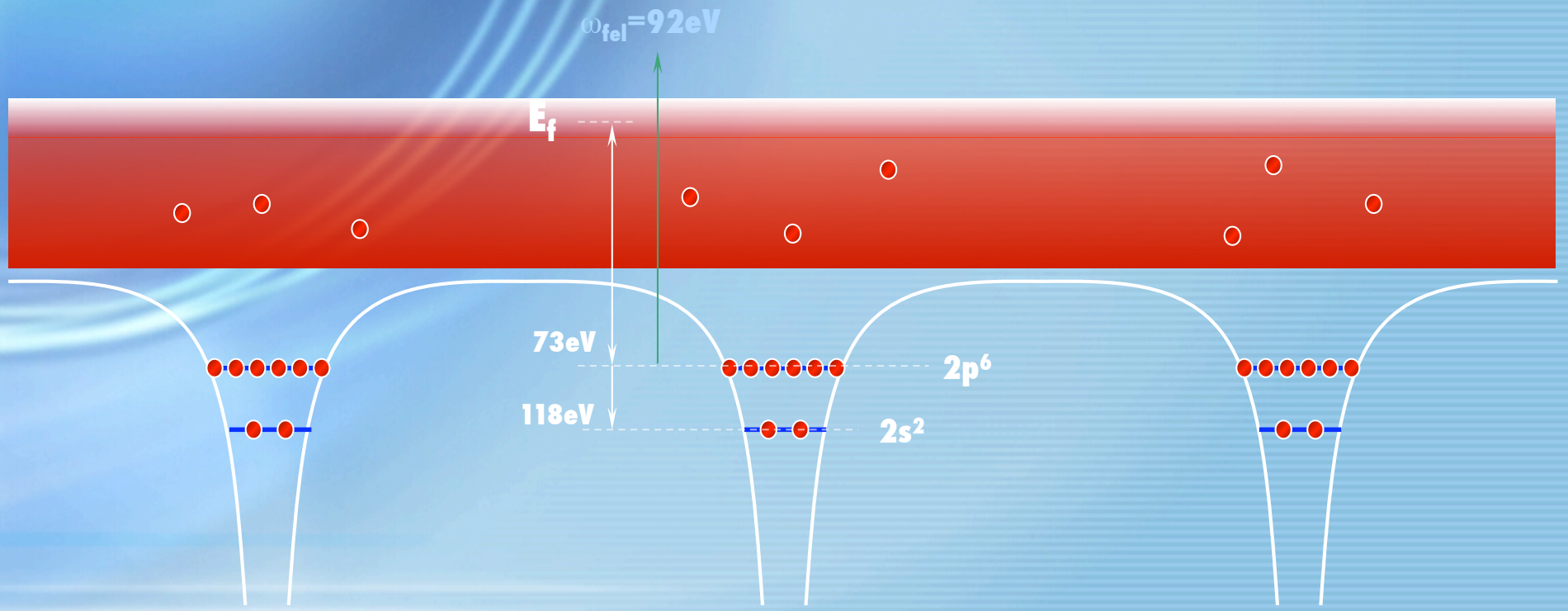
$1s^2$	$2s^2 2p^6$	$3s^2 3p^1$
K	L	M

$$\sigma = \sigma_{ff} + \sigma_{bf}$$

$$\sigma_{ff} = 0.2\,\mu m^{-1}$$

$$\sigma_{bf} = 27\,\mu m^{-1}$$

L-edge shift



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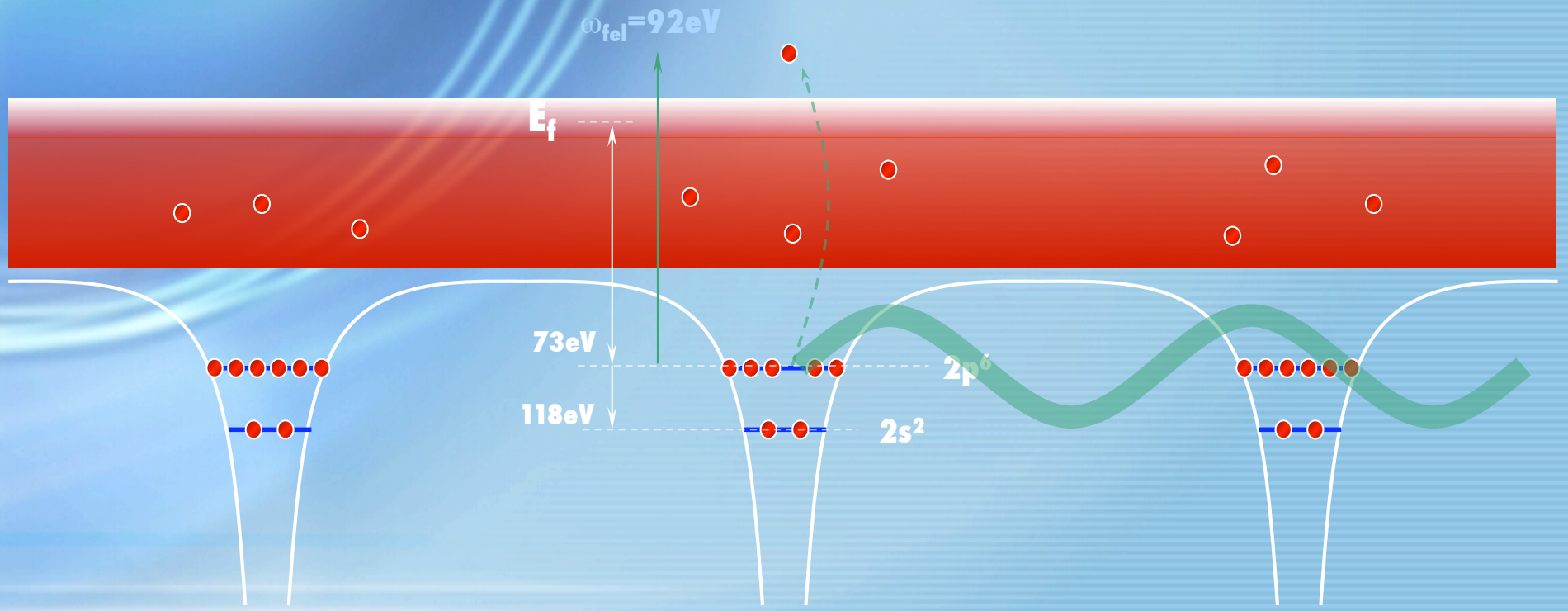

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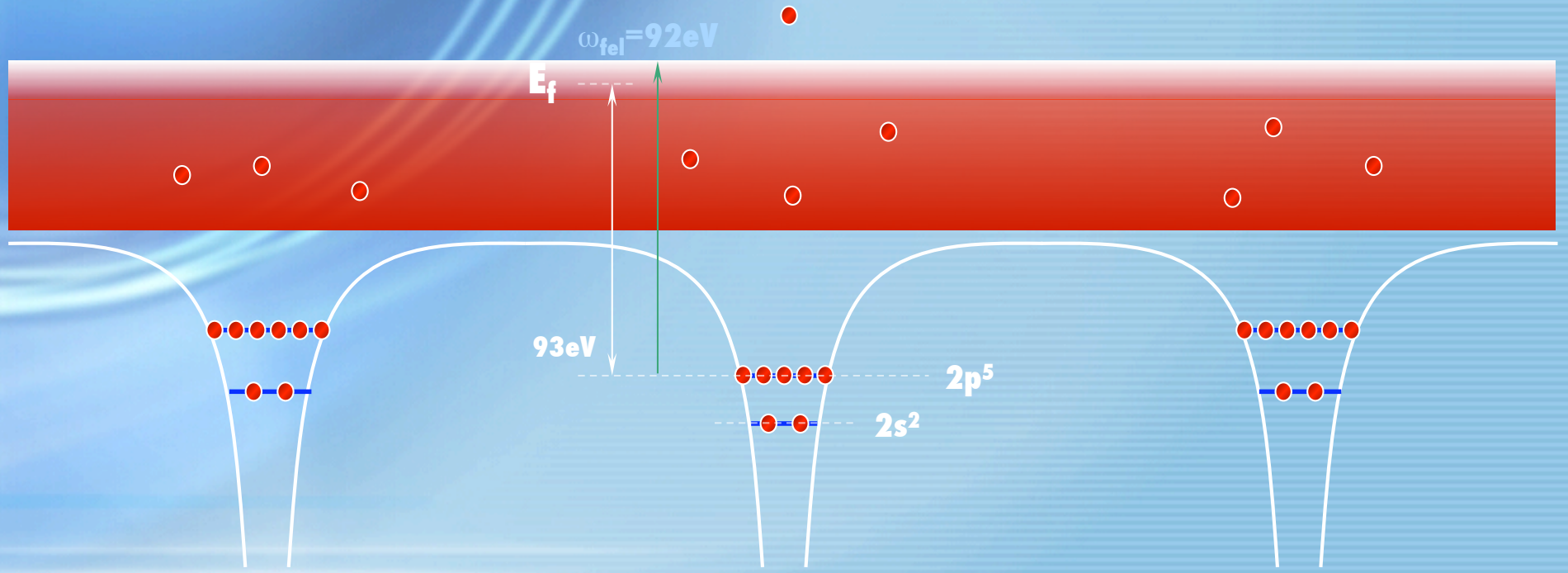
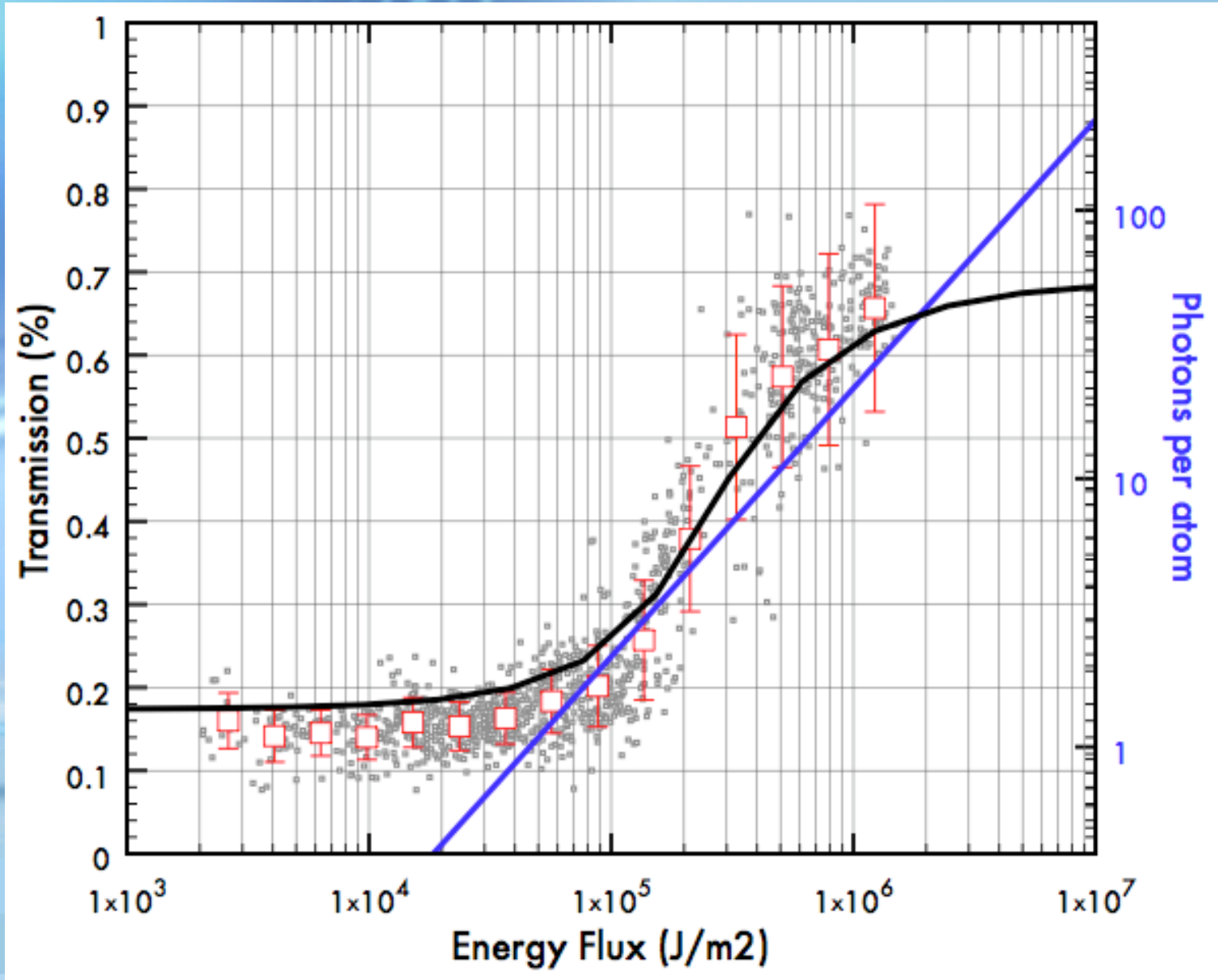


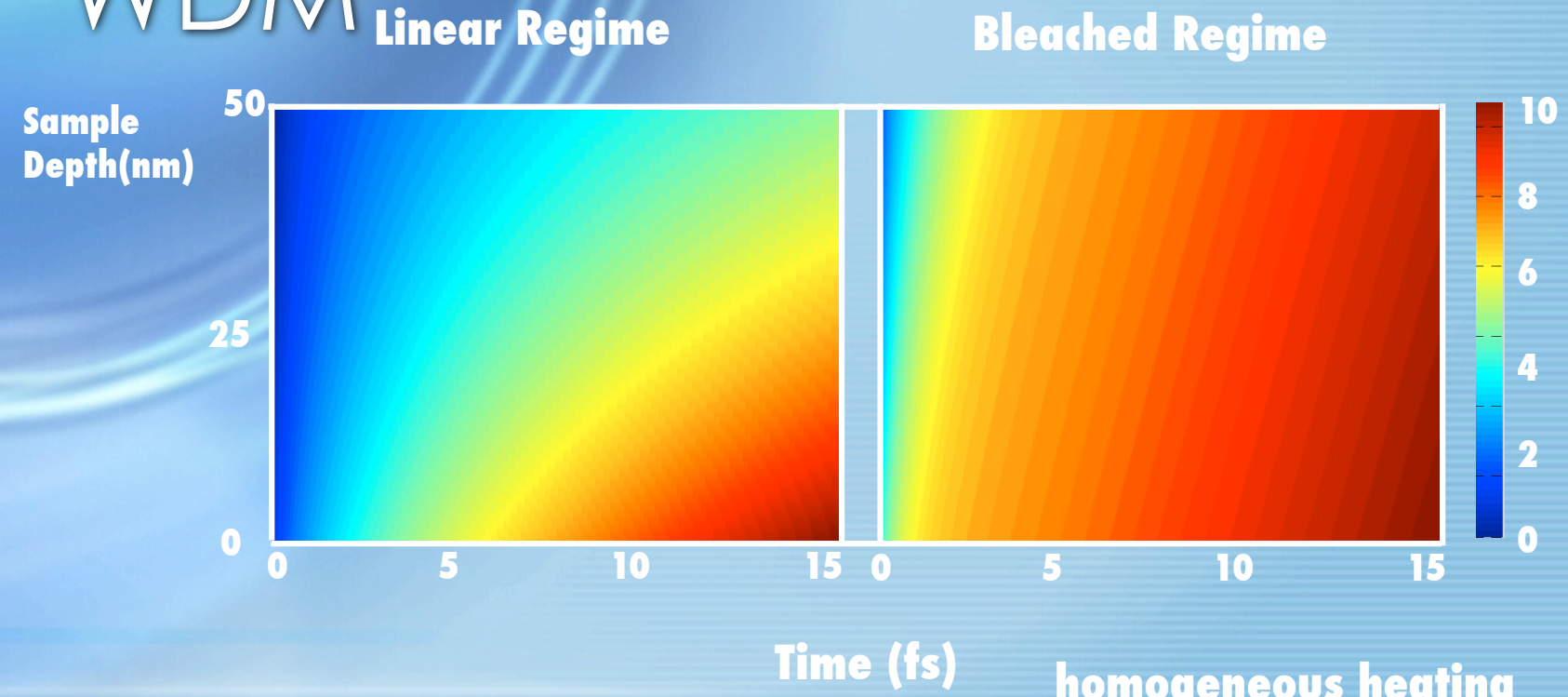
Simple Model

- The high saturable absorption indicates recombination probably takes longer than than the FEL pulse.
- Propagate the pulse through the foil, reducing the absorption coefficient due to the depletion of L-shell electrons, and shift of the edge beyond the photon energy.
- The increased transmission occurs when the edges move beyond the photon energy.

Transmission of 52nm Al with Oxide layer (10nm)



Homogeneously heated WDM



We are heating matter isochorically to tens of eV, resulting in multi-Mbar pressures

homogeneous heating an order of magnitude more efficient

Who?

- Conference Committee
  - Justin Wark - Oxford & STFC
  - Patrick Audebert, LULI
  - Marta Fajardo, IST, Portugal
  - Gyula Faigel, RISSP, Hungary
  - Gianluca Gregori, Oxford
  - Richard Lee, LLNL
  - David Riley, QUB
  - Thomas Tschenscher, XFEL
- Invited Speakers
  - List to be put on website soon.
- To whom to send registration forms andy.boyd@stfc.ac.uk

Wallet

- Subsidized by XFEL and by STFC.
- No attendance fee - all in accommodation + food cost of £180.
- Limited number of bursaries for young scientists upon application of upto 400 Euros (in most cases this will cover all costs).

Website

European XFEL

International workshop on the High Energy Density Science Endstation and associated instrumentation at the European XFEL

30 March – 01 April 2009

St Catherine's College
University of Oxford, UK

The capability to produce material at ultra high energy densities is one of the prioritized areas of science for the upcoming European XFEL facility as described in the Technical Design Report (available at www.xfel.eu). Matter at such energy densities is of relevance to a number of fields of science, including basic plasma physics, materials in extreme environments, and planetary physics and astrophysics.

The workshop will bring together scientists interested in using the HEDS instrument at XFEL in order to review the present state of the field, potential experiments on XFEL, and the requirements for the facility in terms of beam characteristics, chamber configuration, diagnostics, and associated instrumentation and data acquisition technology.

The workshop will feature a series of invited lectures providing an overview of scientific and technical ideas for the endstation. Group sessions will build on the ideas presented, providing the opportunity for specific input on endstation design and capability from potential users.

Young scientists bursaries
Deadline 06 February 2009
(for details see website)

The workshop is co-funded by the European Commission through the Pre-XFEL grant. This will allow free of charge access to the workshop.
Hosting the workshop and support by the Photon Science Research Institute of the UK Science and Technology Facilities Council is gratefully acknowledged.

Local Organizer

Science & Technology Facilities Council

Justin Wark
University of Oxford & STFC, UK

International programme committee

Patrick Audebert
LULI, Palaiseau, France
Marta Fajardo
IST, Lisbon, Portugal
Gianluca Gregori
University of Oxford, UK
Gyula Faigel
Research Institute for Solid State Physics and Optics, Budapest, Hungary
Richard Lee
Lawrence Livermore Laboratory, USA
David Riley
Queens University, Belfast, UK
Thomas Tschentscher
European XFEL Project Team, Germany

www.xfel.eu/hed-workshop-2009
Deadline 06 February 2009

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www.xfel.eu

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