The High Energy Materials Science Beamline (HEMS) at PETRA III

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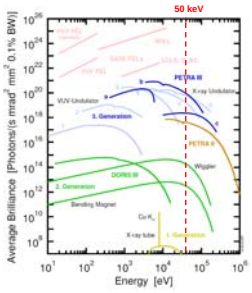
High Energy Experiments at PETRA III

Refurbished for operation with 6 GeV @ 100 mA, the storage ring PETRA III on the DESY site in Hamburg will be one of the most brilliant 3rd generation x-ray sources with first users already in autumn 2009.

PETRA III: A Low Emittance Synchrotron Radiation Source, Technical Design Report, ed. K. Balewski *et al.*, Hamburg, DESY, 2004

Aerial photo of PETRA site.



Comparison of PETRA III with 2nd and 3rd generation synchrotron radiation and FEL sources.

The **H**igh **E**nergy **M**aterials **S**cience Beamline **HEMS** is ***fully tunable in the range 30-250 keV*** and optimized for ***sub-µm focusing*** with **C**ompound **R**efractive **L**enses and Kirkpatrick-Baez ML mirrors. Design, construction, operation and main funding is the responsibility of GKSS. 2/3 of the beamtime will be dedicated to materials research, 1/3 to "general physics" experiments covered by DESY.

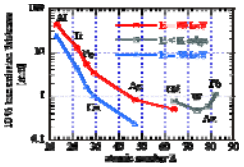
→ **Fundamental research** encompassing metallurgy, physics, chemistry, biology with investigations of the *relation between macroscopic and micro-structural properties of polycrystalline materials*, *grain-grain-interactions*, *re-crystallisation processes*, and the *development of new & smart materials or processes.*

→ **Applied research** for manufacturing process optimisation, *complex and highly dynamic in-situ studies of micro-structural transformations,* e.g. during friction stir welding, easy accommodation of large and heavy user provided equipment up to 1 t.

→ Targeting of the **industrial user community** based on well established techniques with standardised evaluation and "*full service" measurements* for strain mapping, texture determination and tomography.

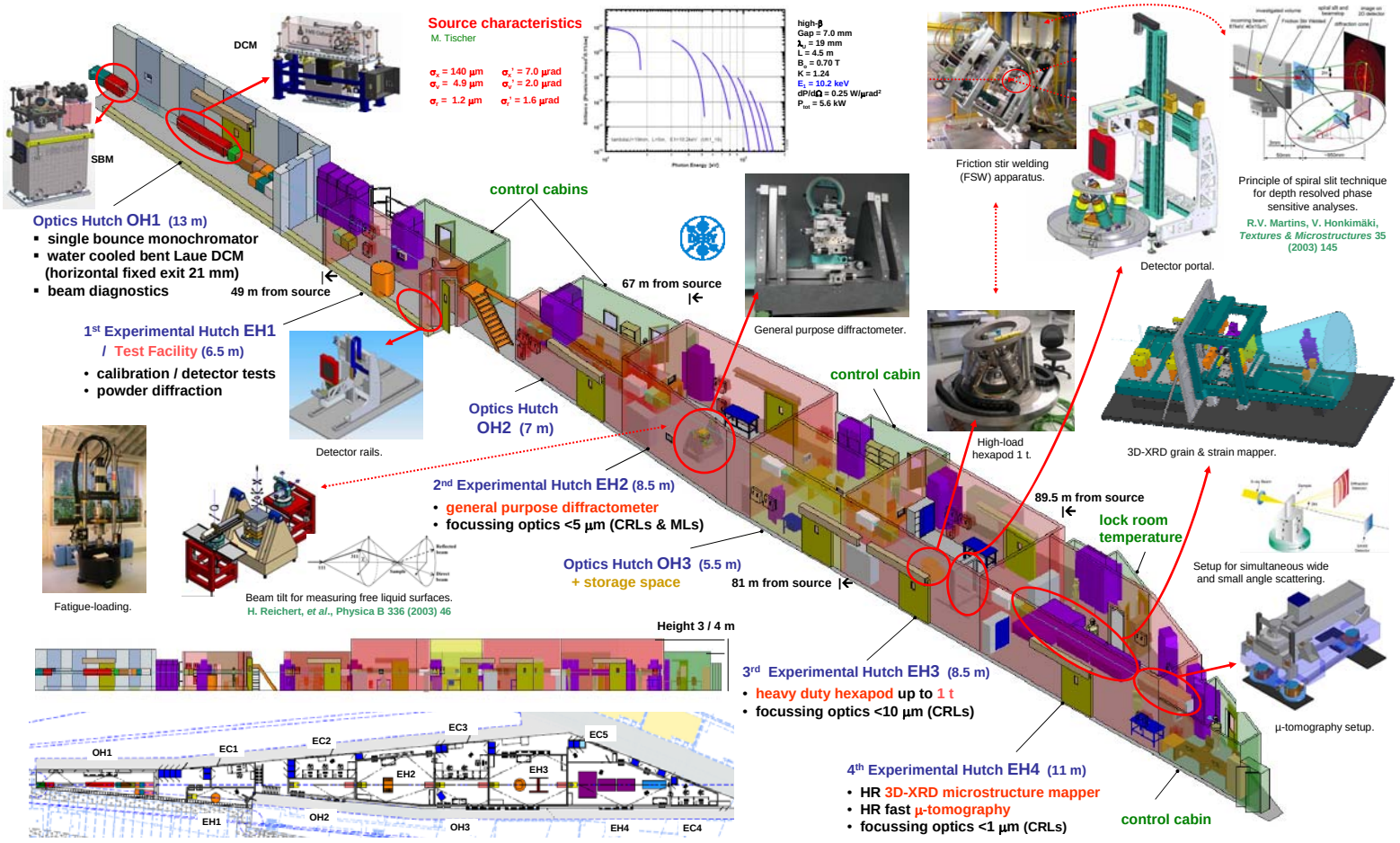
Key Properties of High Energy X-Rays

- **High penetration depth**
  - → non-destructively bulk properties measurable
  - → deeply buried structures accessible
- **Large Ewald Sphere**
  - → lines and planes in reciprocal space can be imaged
  - → small Bragg angles (typically 5° to 15°), monitoring of complete diffraction rings with area detectors possible
- **Extinction and multiple Bragg scattering negligible**
- **Focussing to spot sizes in nm range possible**
  - → combination of high penetration depth and high flux
  - → very short data acquisition times possible (< 1 s)
  - → non-destructive observation of highly dynamic processes
  - → high spatial resolution narrowing the gap to electron microscopy



10% transmission thicknesses of technologically relevant metals for different x-ray energies.

Beamline Layout and Instrumentation



Fatigue-loading.

Beam tilt for measuring free liquid surfaces.
H. Reichert, *et al.*, Physica B 336 (2003) 46

General purpose diffractometer.

Friction stir welding (FSW) apparatus.

Detector portal.

Principle of spiral slit technique for depth resolved phase sensitive analyses.
R.V. Martins, V. Honkimäki, *Textures & Microstructures* 35 (2003) 145

High-load hexapod 1 t.

3D-XRD grain & strain mapper.

Setup for simultaneous wide and small angle scattering.

µ-tomography setup.

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