Instrumentation for *in situ* high pressure and temperature studies on large samples at a concept beamline at PETRA IV.

Robert Farla[1], Melanie Sieber[2], Shrikant Bhat[1], Tomoo Katsura[3], Jean-Philippe Perrillat[4]

[1] Deutsches Elektronen-Synchrotron DESY, [2] Institute of Geosciences, University of Potsdam, [3] Bayerisches Geoinstitut (BGI), University of Bayreuth, [4] Laboratoire de Géologie de Lyon, UMR5276, Université Claude Bernard Lyon

Mission statement

To probe the structure and properties of materials *in situ* at high pressures and temperatures in a Large Volume Press (LVP) using X-ray diffraction and imaging techniques.

Applications in geo- and material sciences:

- Phase relations:
  - Transformation/nucleation
  - Melting curves (solidus/liquidus)
  - Equations of state
- Crystallography
- Controlled rock deformation
- Melt viscosity measurements
- Structure of amorphous materials
- MHz wave speed & acoustic emissions

Beam parameters for PETRA IV

- Large beam for imaging! (e.g. 2 x 2 mm^2)
- Pencil/focused beam for XRD! (e.g. 200 x 200 µm^2, or less)
- Energy range: 30 - 120 keV, $\Delta E/E \sim 10^{-4}$
- High flux/brilliance! At least 10^{14} ph/s/0.1% b.w. at 55 keV
- Energy scannable for ED-XRD

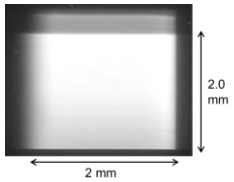
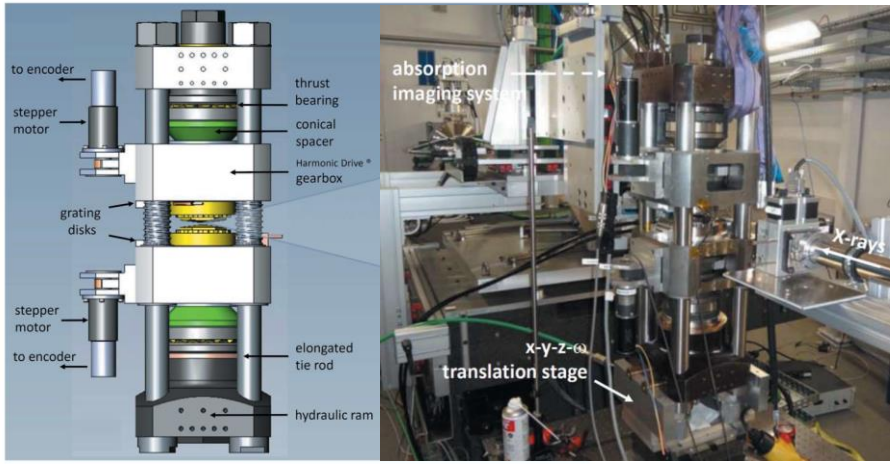


Fig 1. Voggenreiter 6-ram LVP
Max. load: 15 MN
Precision: 0.1 µm
5-axis press stages: x,y1,y2,z (± 100 mm), rotation: ± 11.5°

Combined with 1 or 2 HP Ge-SSD for ED-XRD or large-radius (600 mm) CdTe detector for AD-XRD, and X-ray microscope for radiography.

Ideal for:
- General purpose HP and Ultra-HP exps. 2 – 25 GPa, 25 – 60+ GPa, 100 K (cryo) – 3500 K
- Deformation exps.

Fig 2. The modified **Paris-Edinburgh press (RoToPEc)**
Near-full angular access: 360°/0.02° precision, *PT range*: 15 GPa/ 2500 K, *Max. load*: 4.5 MN, *torsional deformation by anvil rotation.*



Ideal for: (1) synchrotron X-ray absorption/phase contrast micro-tomography (2x2 mm^2 beam) at extreme conditions. (2) diffraction/scattering computed tomography, DSCT (e.g. 3x3 µm^2 focused beam) at extreme conditions.

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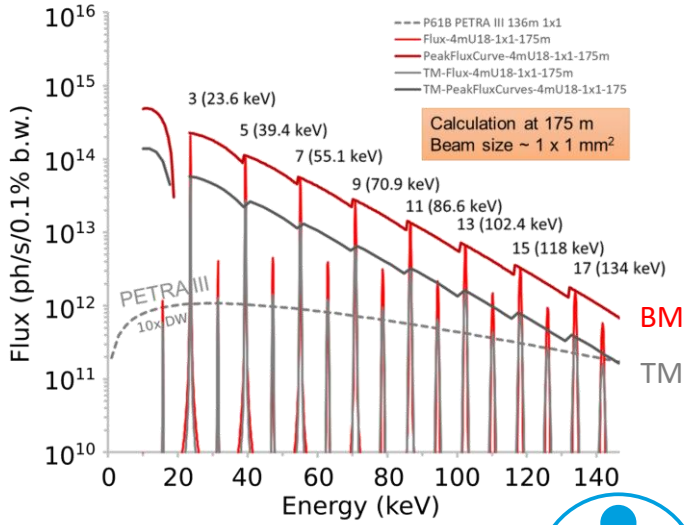
Fig 3. PETRA IV photon flux at 175 m distance in 1 x 1 mm^2 aperture. Brightness Mode (200 mA – 1600 bunch), Timing Mode (80 mA – 80 bunch). By tuning the undulator strength parameter, K the **peak flux curve** is obtained for each harmonic.



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