

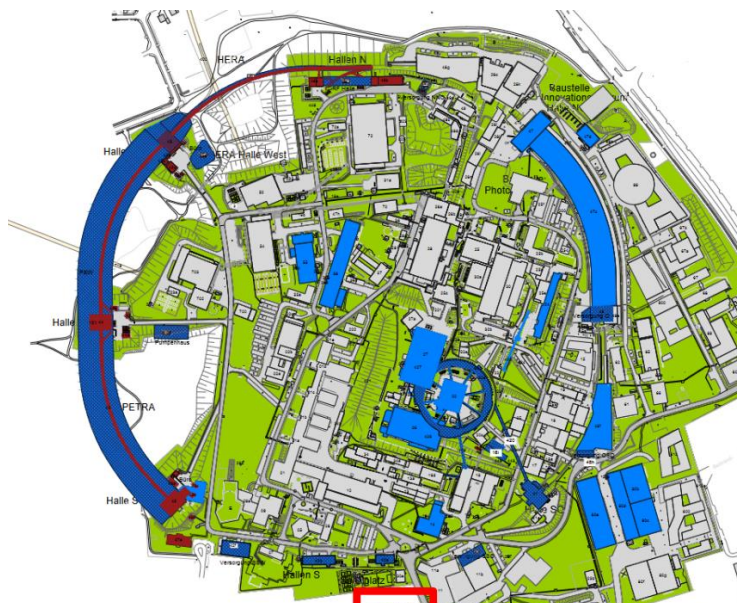
PETRA IV.

NEW DIMENSIONS



PETRA IV planning

Timeline (updated)

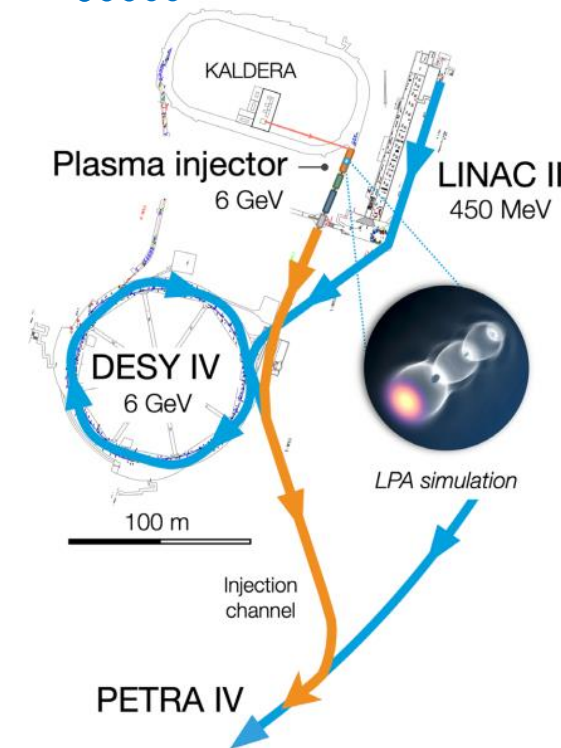


Start date, t_0 is **not confirmed** until Project Approval from Federal Govt, anticipated by mid-2024.

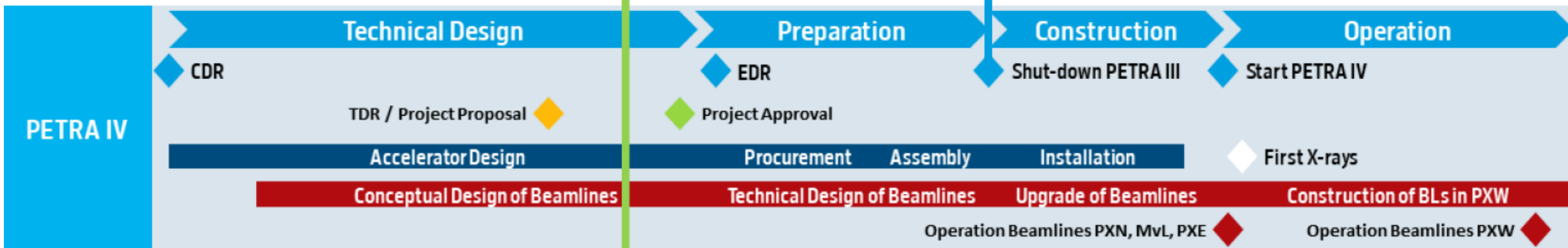
Today

The development of an **energy-saving plasma accelerator** likely not ready as an **injector** at projected start of PIV operation.

Big question. Invest in **DESY-IV booster**, or handicap P IV initially with the current DESY-II booster?



Projected PIII shutdown



PETRA IV *In situ* Large Volume Press Beamline

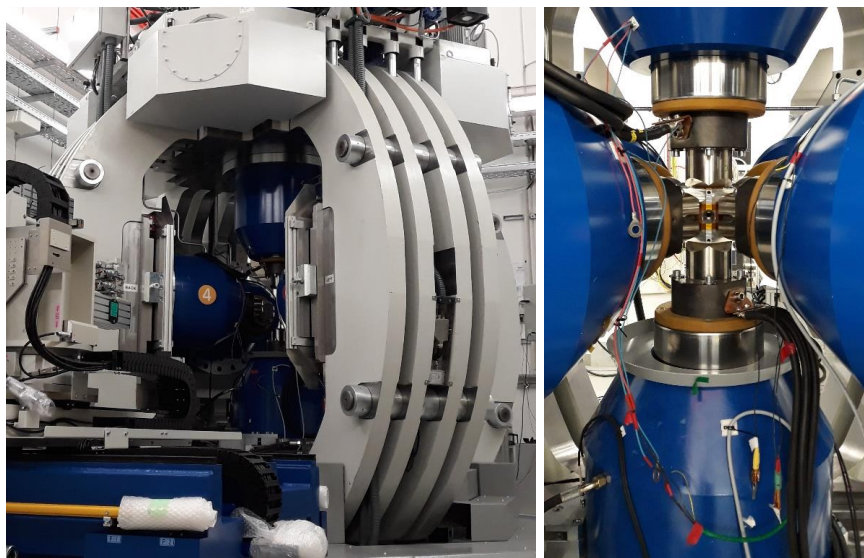
PETRA IV statement

Keywords: high flux/brilliance, high-resolution, large time/length scales, beam focus/expansion

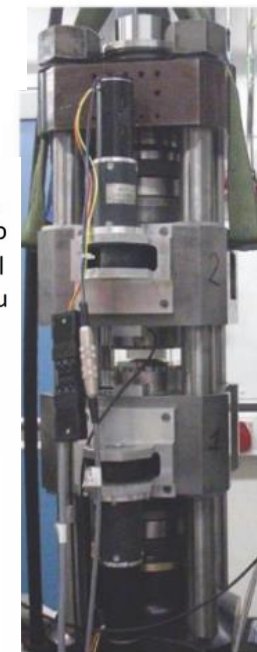
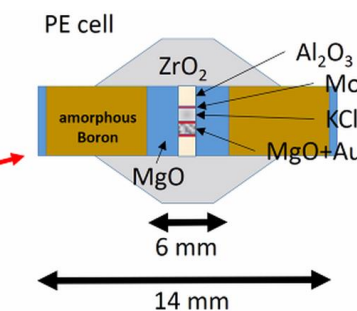
The new '*In situ* Large Volume Press Beamline' at PETRA IV will accommodate **multiple LVPs** for *in situ* studies at extreme pressures and temperatures.

X-ray diffraction (PXRD), Absorption & Contrast imaging, μ -tomography, & other techniques (e.g. time-resolved)

1. Aster-15 LVP: 6-ram press at P61B for isotropic and anisotropic, high-pressure generation (at high T).



2. Purchase of new PE press: moderate pressures (15 GPa) on liquid/solid samples.



Tomography in the PE press

Photo of the ROTOPEC (J.P. Perrillat)

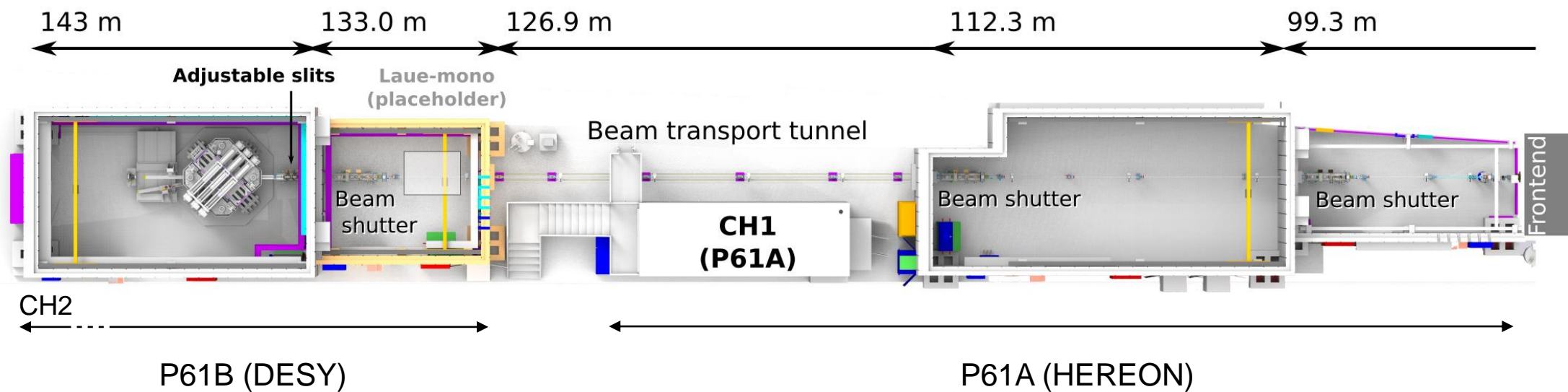
See Philippe *et al.* HPR 2016

PETRA IV proposed beamline layout

PETRA III – P61



PXN hall
Sector 1



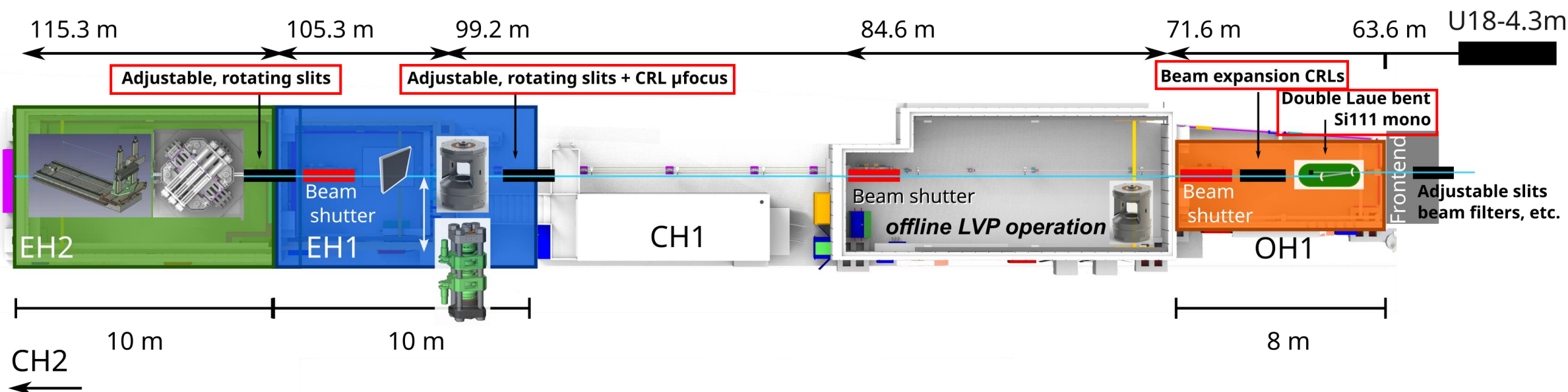
PETRA IV proposed beamline layout

PETRA IV – *In situ* LVP beamline concept



PXN hall
Sector 1

The new U10 source will be closer to Aster-15 (~110 m) than the current PETRA III 10 wiggler array (~136 m)

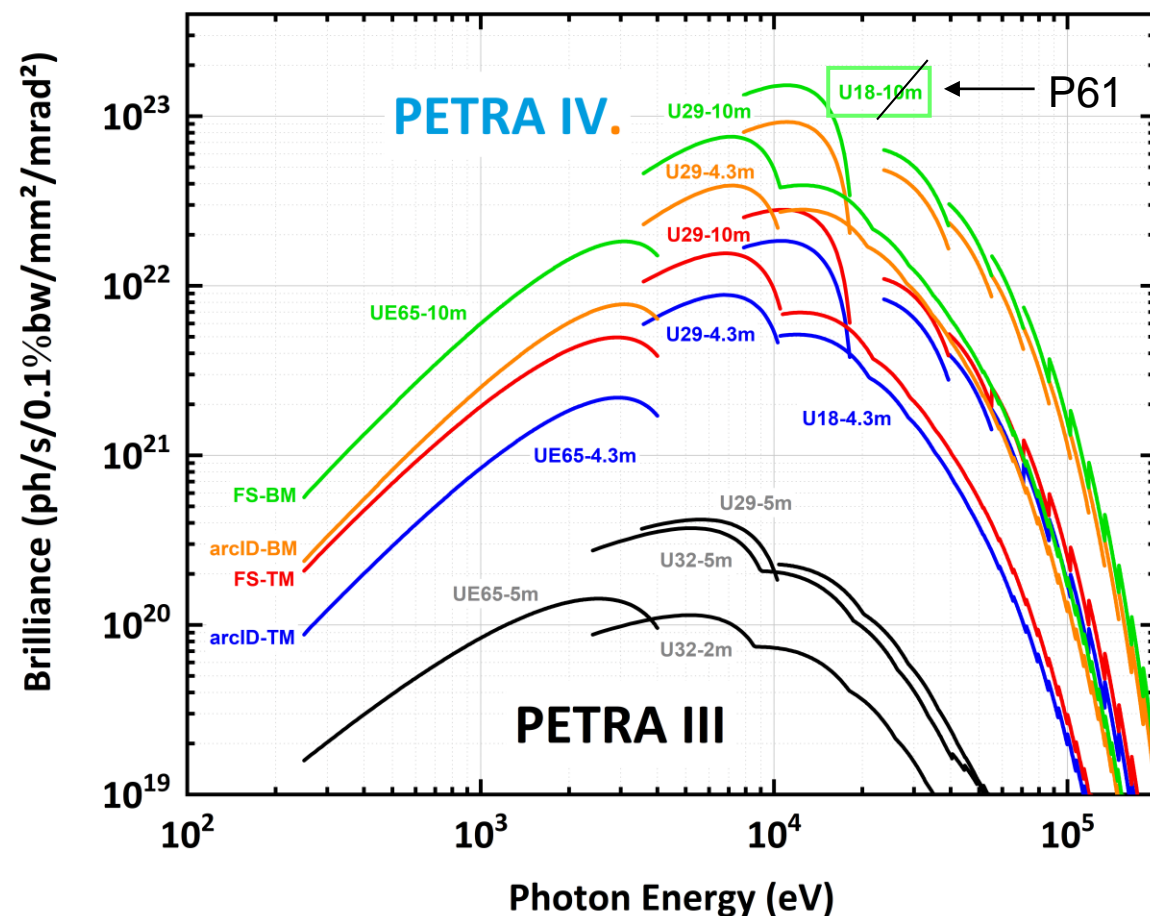


> Beam energies: 30, 40, 55, 70, 90 keV

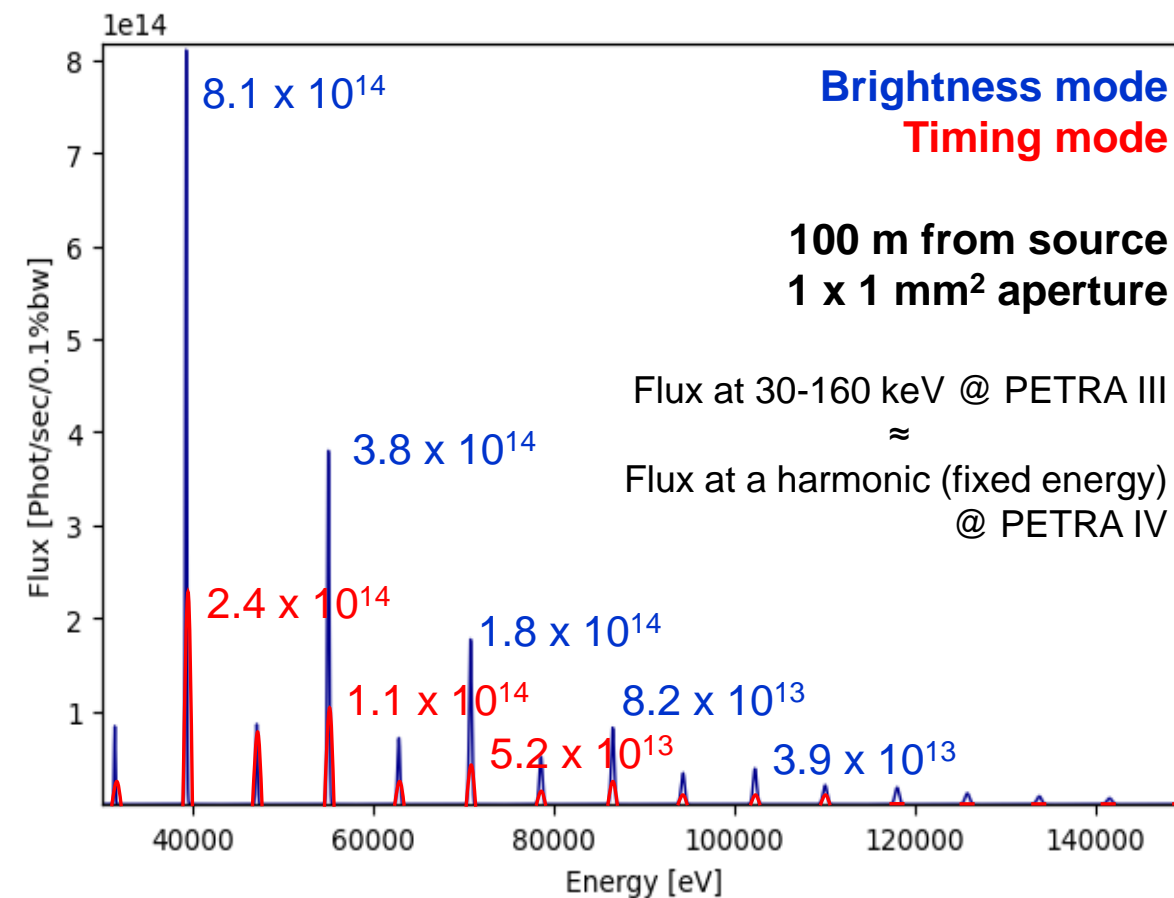


PETRA IV source flux

Brilliance and flux curves



At PXN (P.P. Ewald hall) – Sector 1, P61
U18 – 4.3 m cryogenically cooled undulator



PETRA IV key beamline components

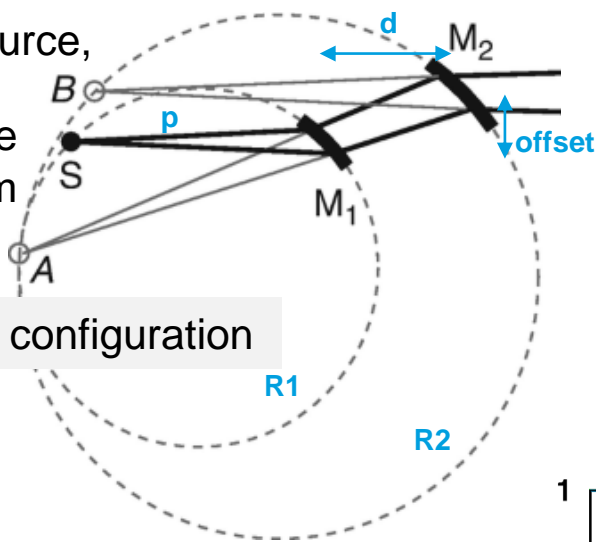
Bent crystal Laue Monochromator

for AD-XRD at 30 – 120 keV

Virtual source,

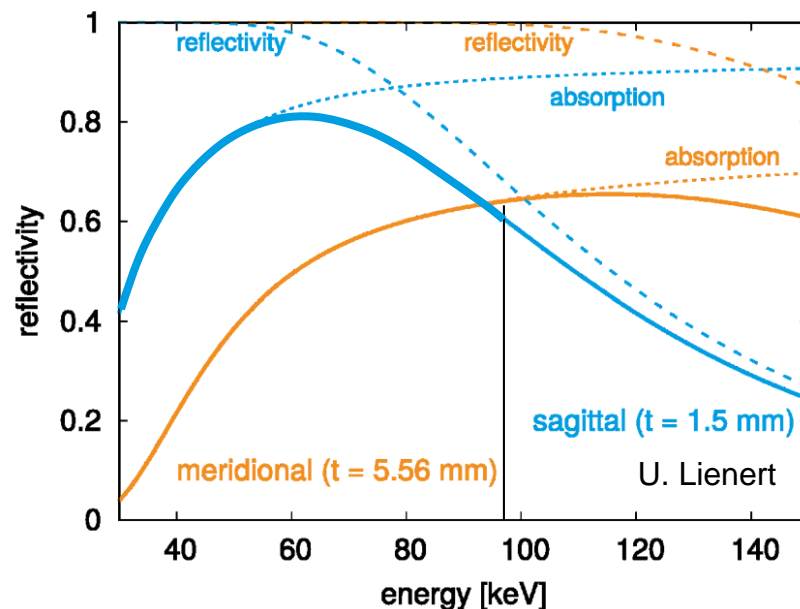
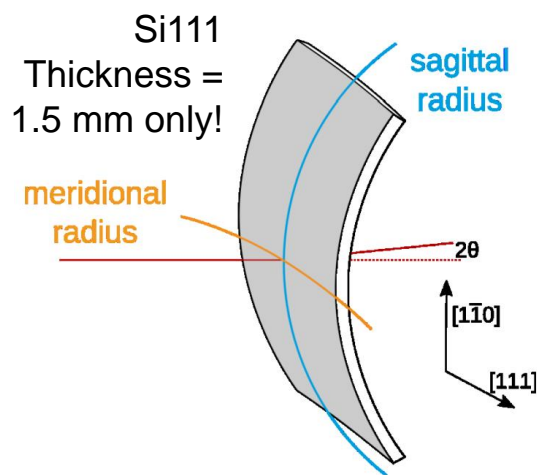
Source
S ≈ 65 m

Rowland configuration



Meridional bending insufficient to target harmonics in energy range ~30 – 100 keV.

→ Sagittal ‘mediated-meridional’ bending is preferred solution with cryo-cooling (already implemented at P21)



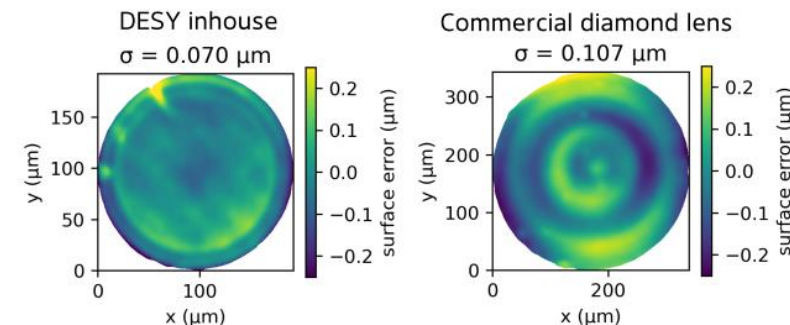
Movable CRLs

for large-beam imaging and μ-focusing

→ Fast switching between different modes

Diamond X-ray lenses:

- > Improved diamond X-ray lens manufacturing
- > Lens surface error < 200 nm, **better than commercially available**



- > Capability for large lenses to capture full PETRA IV beam

Target beam size for imaging

→ 3 mm (h) x 4 mm (v)
and intensity loss < factor 4 (@ 56 keV)

Target beam size for μCT/DSCT

→ < 2 μm (h & v) at < 1 m with DOF > 10 mm
and intensity loss < factor 6 (@ 56 keV)

PETRA IV detectors



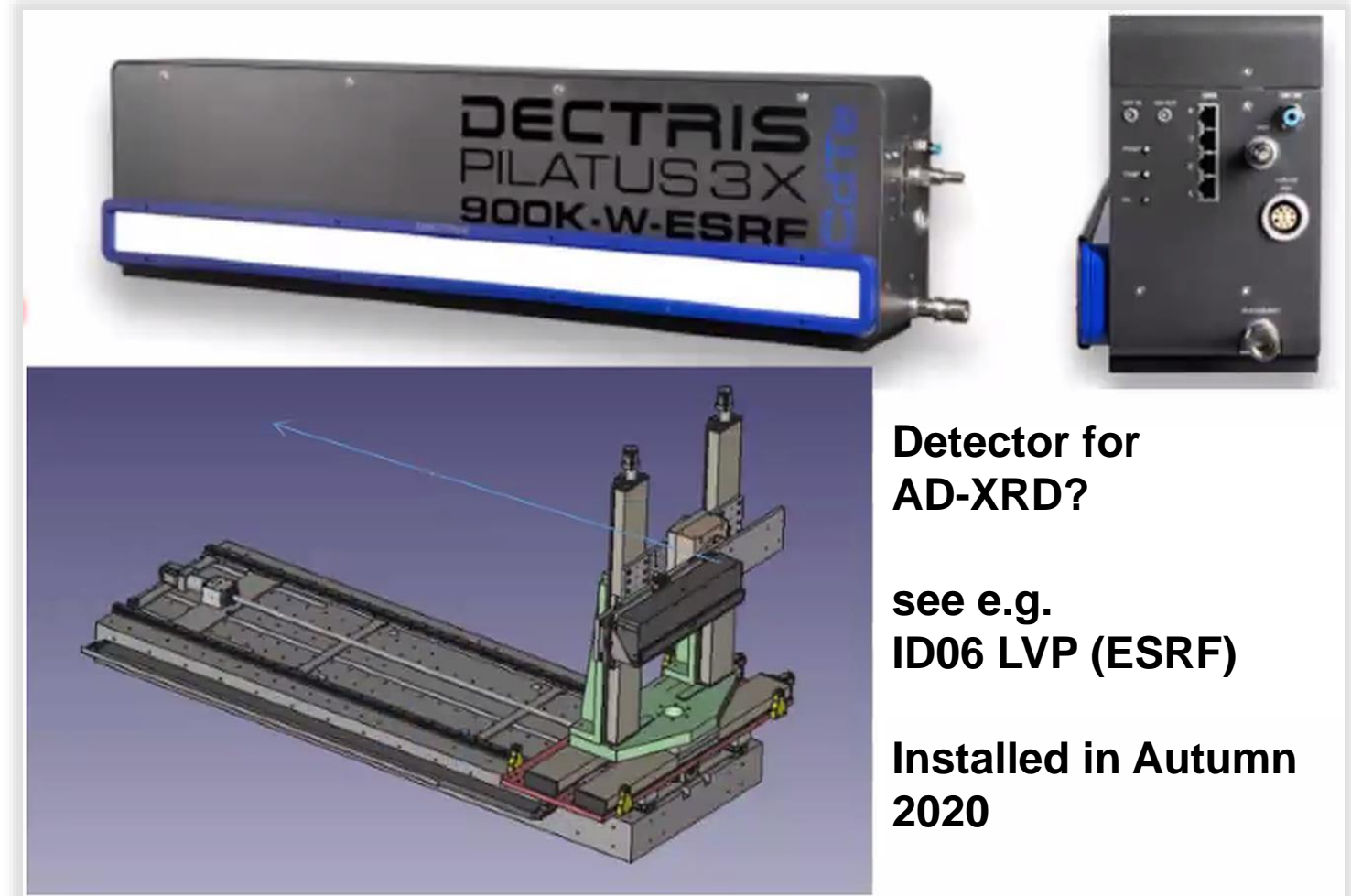
New detectors and stages/goniometers

Options for AD-XRD, DSCT, CDI

- A new large-radius linear detector for the Aster-15 LVP (see example on the right)
 - CdTe technology
 - Small pixel size (150 μm or less)
 - Gap-less (no gaps between modules)
 - High frame rate ($> 1\text{kHz}$)
 - Continuous readout/no deadtime
 - High quantum efficiency ($>50\%$) at 100+ keV
 - High counting depth (20 bit)
 - Large size $\geq 800\text{ mm}$
- Existing Varex 4343CT for smaller LVP

Options for Imaging (Abs/Phase contrast)

- Existing 2x obj. X-ray microscope
- New X-ray microscope with faster camera, optimized for PETRA IV beams



**Detector for
AD-XRD?**

**see e.g.
ID06 LVP (ESRF)**

**Installed in Autumn
2020**

Summary PETRA IV upgrade

New possibilities with AD-XRD

- Radial diffraction
- Crystallography (Rietveld ref.)
- Single crystal XRD
- Enhanced rock deformation
- PDF on melts/glasses,
- Melt density measurements
- New imaging techniques V
[Phase Contrast, μ CT tomography, DSCT, Bragg CDI]

PETRA IV will come...

- Phase 1 full beamline with an additional experimental hutch.
- Aster-15 LVP remains in place. Offline access still possible.
- Looking for support/ideas to buy a new LVP to take advantage of **new and emerging imaging techniques @ PETRA IV**
- Development of techniques and materials for AD-XRD in the LVP

Lets discuss your needs!

- How can we adapt your ED-XRD experiment to AD-XRD geometry?
- Is the lowest possible energy: 40 keV acceptable, or 30 keV required?
- What detector requirements do you have for XRD and Imaging?
- What should a new (portable) LVP be able to do for you that Aster-15 cannot?



Conference advertisement



SRI2024

15th International Conference on Synchrotron Radiation Instrumentation

26-30 August 2024 • Hamburg, Germany
save the date

- The latest in the world of synchrotron radiation and free-electron lasers
 - Presentations of high-pressure beamlines around the world
 - PETRA IV update and beamline CDR
- PETRA III tours!

Many thanks to those who helped with the Scientific Instrumentation Proposals (SIPs) for the new *In Situ* LVP beamline at PETRA IV

In particular (in no specific order):

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 - Dr. Keller (Freiberg)
 - Prof. Litasov (HPPI)
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 - Dr. Wiehl (Darmstadt)
 - Dr. Sieber (Potsdam)
 - Prof. Perrillat (Lyon)
- ...and the wider high-pressure communities in Germany and around the world!

Thank You for Your Attention!