PETRA IV.
NEW DIMENSIONS

Work Package Group 3

Photon Science Project

Kai Bagschik on behalf of the Project Team
Hamburg, 27th November 2023

PETRA IV - Progress Review Meeting

HELMHOLTZ

DESY.

Work Package Group 3

General Items and Updates

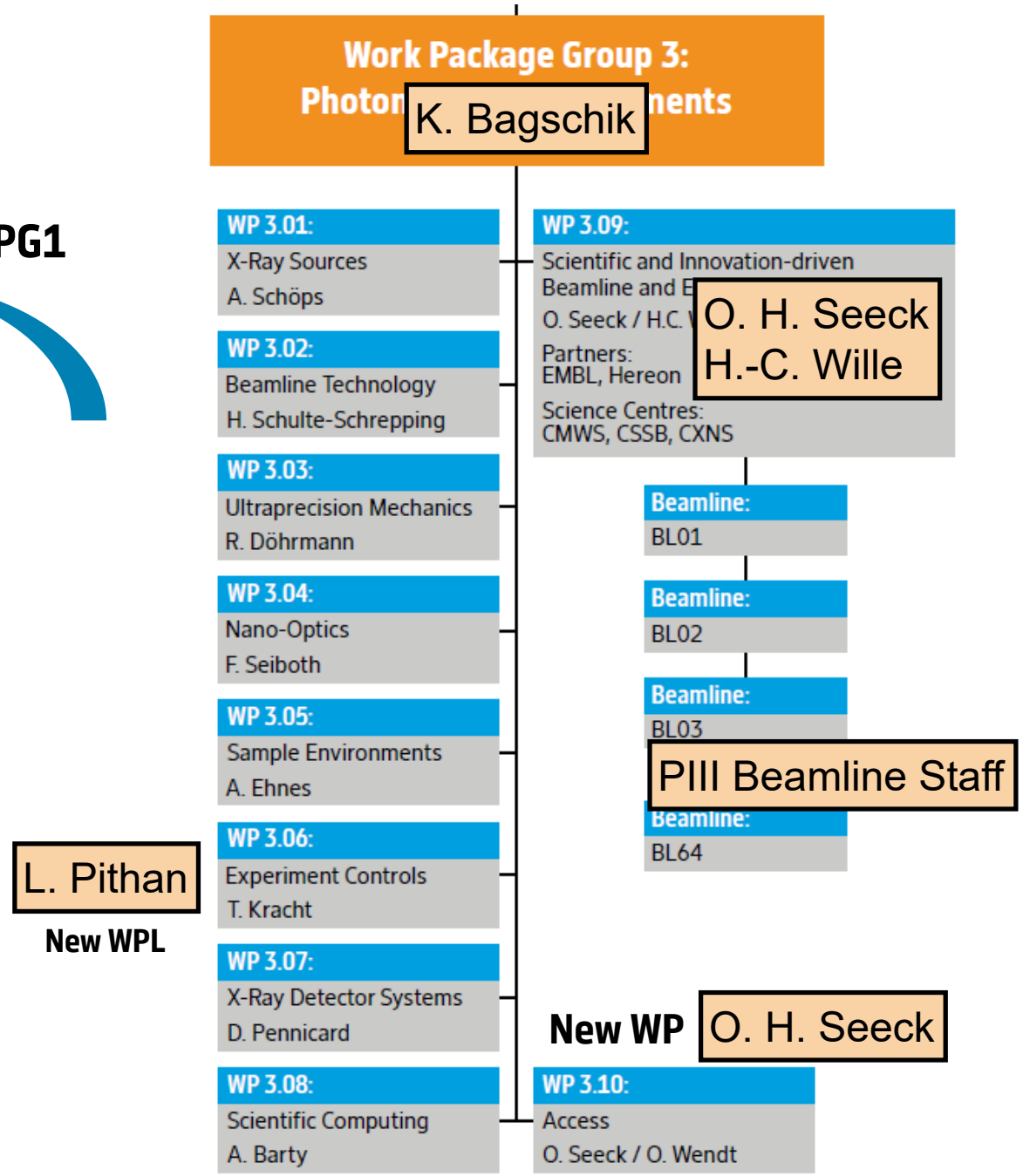
WP 1.09:
- Beamline Infrastructure
J. Müller-Dieckmann

WP 1.11:
- User Laboratories
M. Lippmann

2 WPs moved to WPG1

- WP3.01 - J. Abenhaim left (CPMU Project)
- WP3.03 – S. Starlinger leaves to industry (SPIDER setup)
- WP3.03 – H. Gülzow moved to ZM1 (30% PIV)

- WP3.06 – L. Pithan new WPL
- WP3.10 – New Work Package



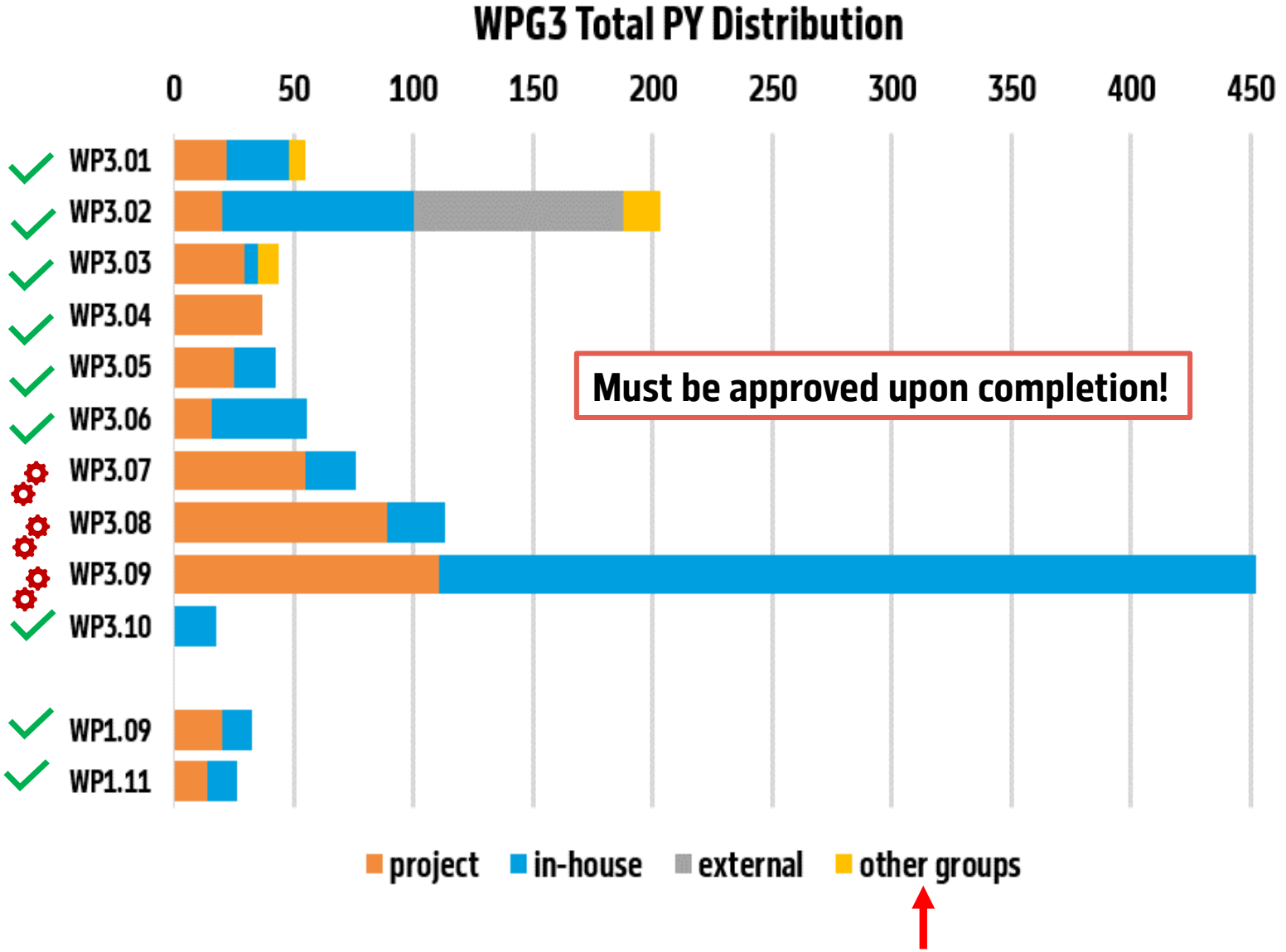
PETRA IV. Project

WPG3 – Status of 1st Change Management

- Most of the work packages have gone through the process.
- ZM1 requests and required work from other groups are now listed separately

→ Important requests to ZM1 discussed with J. Leichnitz (will be coordinated centrally in the future by plVpo)

- Change management of the 31 beamlines still in progress (further iterations are required)
- Change management to be completed by the end of the year



PETRA IV. Project

WPG3 – Priority Personnel

If we receive the 44 million € pre-financing:

- **WP3.02 Design Engineer Preparation and Models (2x) (*Start FE design*)**
- **WP3.02 Scientist Optics Technology (*New WP3.02 lead*)**
- **WP3.09 Engineer / Leader TechTask (*Management of Developments*)**
- **WP3.01 Engineer Mechanical Design (Start ID re-design)**
- **WP3.06 Software Engineers (2x) (Evaluate Control System)**
- **WP3.09 Mechatronic Engineer (Urgent Support for Automation)**

+ Extension of running fixed-term contracts!

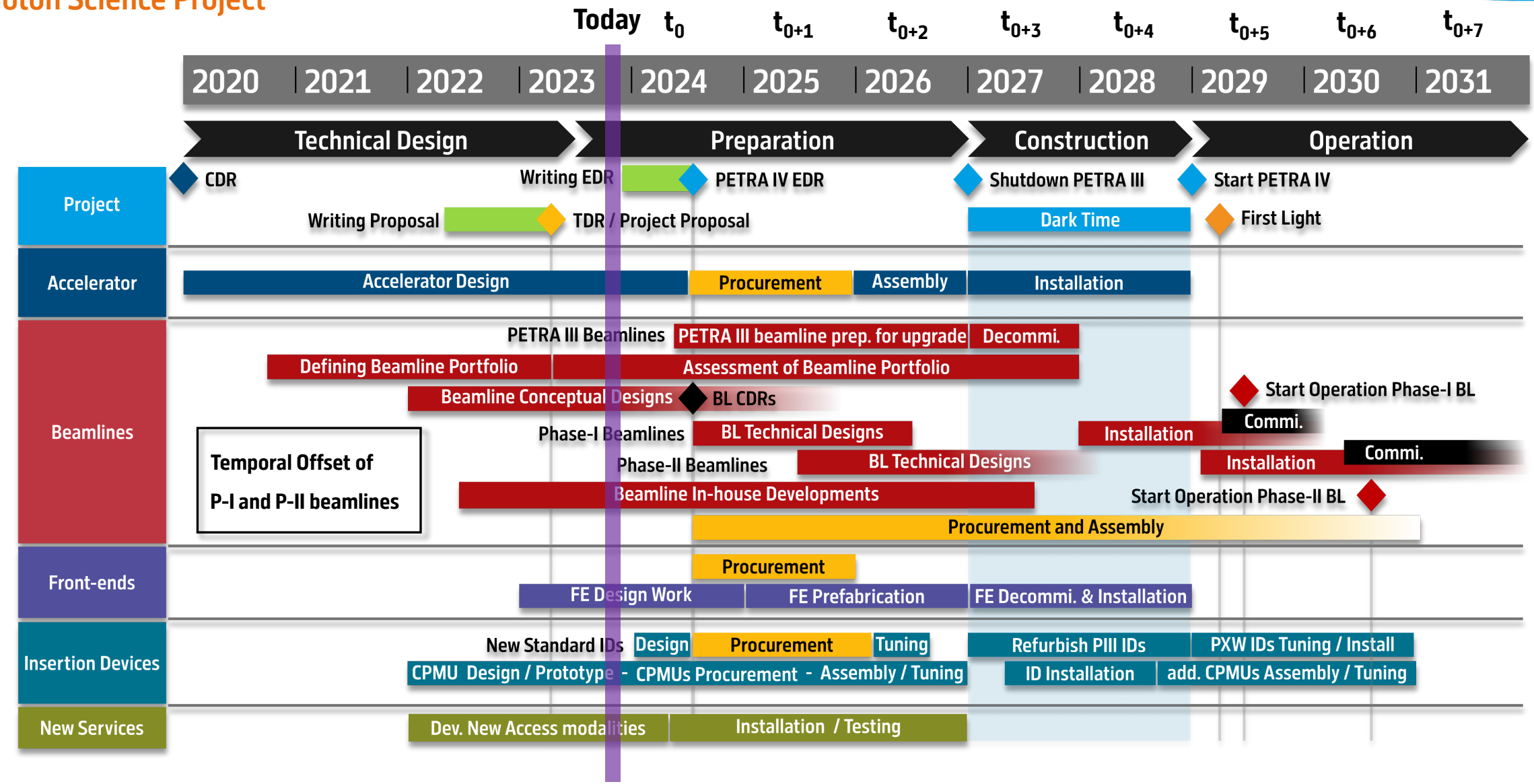
+ Replacement of lost WPG3 personnel

Priority Personnel / batch01 (version 005)

Rank	Work Package		Position	DESY Group	ID
1	WPG1	Civil Construction and Infrastructure	Work Package Group Leader	MPY	P.101.5
2	WP 1.01	Civil Construction	Civil Construction Engineer	MPY	P.101.6
3	pso01	Schedule and Campus Coordination	Schedule Manager	MPY	P.pso01.1
4	pso04	Procurement	Procurement (Construction)	V4	P.pso04.2
5	WP 1.02	Main Power Supplies / MKK	Engineer	MKK1	P.102.3
6	WP 1.03	Water Cooling / MKK	Engineer	MKK2	P.103.3
7	WP 1.04	Air Conditioning / MKK	Engineer	MKK3	P.104.3
8	WP 1.01	Civil Construction	Civil Construction Engineer	MPY	P.101.7
9	WP 1.01	Civil Construction	Civil Construction Engineer	MPY	P.101.8
10	WP 1.01	Civil Construction	Civil Construction Engineer	MPY	P.101.9
11	WP 2.10	Machine Controls	High-Level Software	MCS	P.210.38
12	pso02	Recruitment	Recruiter	V2	P.pso02.1
13	WP 3.02	Beamline Technology / ZM1	Design Engineer Preparation and Models	ZM1	P.302.5
14	pso08	Documentation and Change Management	Junior Scientfic Manager	MPY	P.pso08.1
15	pso04	Procurement	Procurement (EKM)	V4	P.pso04.4
16	WP 2.05	Diagnostics	Scientist	MDI	P.205.8
17	WP 2.05	Diagnostics	Engineer (Racks)	MDI	P.205.25
18	WP 1.03	Water Cooling	Engineer / CAD designer	MKK2	P.103.4
19	WP 1.03	Water Cooling	Engineer / CAD designer	MKK2	P.103.5
20	WP 1.04	Air Conditioning	Engineer / CAD constructeur	MKK3	P.104.4
21	WP 3.06	Experimental Control System	General purpose GUIs	FS-EC	P.306.13
22	WP 4.01	Assembly, Integration, Test	CAD engineer	MPY	P.401.5
23	WP 3.09	Beamline and Experiment Design	Engineer / Leader TechTask		P.309.12
24	WP 1.01	Civil Construction	Civil Construction Engineer	MPY	P.101.3
25	WP 1.01	Civil Construction	Civil Construction Engineer	MPY	P.101.1
26	pso03	Budget Controlling	Accountant	MPY	P.pso03.1
27	WP 3.02	Beamline Technology	Design Engineer Preparation and Models (located in ZM1)	ZM1	P.302.18
28	WP 2.06	Girders	Engineer	MEA	P.206.3
29	WP 2.02	Magnets	Engineer	MEA	P.202.5
30	WP 4.05	Quality Management	WPL	MPY	P.405.2
31	WP 2.03	Magnet Testing	Measurement engineer	MEA	P.203.5
32	WP 2.10	Machine Controls	High-Level Software	MCS	P.210.39
33	WP 2.08	Feedbacks	SW programmer 2	MSK	P.208.10
34	WP 4.01	Assembly, Integration, Test	Requirements Engineer	MPY	P.404.2
35	WP 3.09	Beamline	Mechatronic Engineer		P.309.7
36	WP 3.02	Beamline Technology	Mechanical Engineer Optics	FS-BT	P.302.5
37	WP 2.01	Accelerator Physics	Physicist (replacement)	MPY	P.201.2
38	WP 3.01	X-Ray Sources	Engin. Mech. Design	FS-US	P.301.3
39	pso03	Budget and Controlling	Project budget manager	V3	P.pso03.3
40	WP 4.04	Systems Engineering	CAD integrator		P.404.4
41	WP 4.04	Systems Engineering	BIM integrator		P.404.5
42	WP 3.06	Experimental Control System	General purpose GUIs	FS-EC	P.306.17
43	WP 2.02	Engineer for Damping Wiggler Design		FS-US	

PETRA IV. Timeline

Photon Science Project

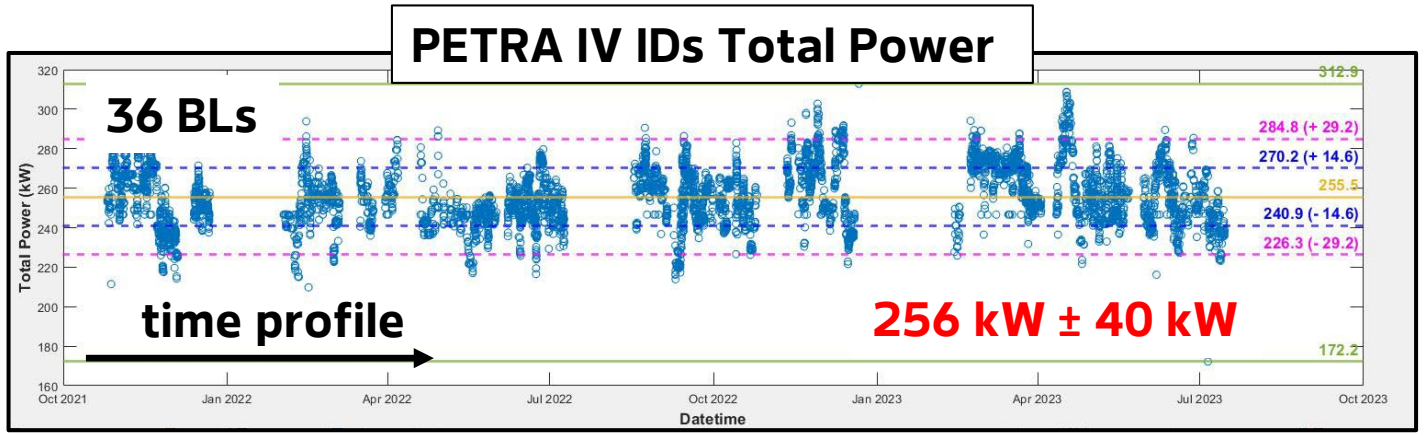


WP3.01 – X-ray Sources

Status of the Work Package

Insertion Device Portfolio:

- First draft of ID Portfolio according to "Spec Sheets A" provided by the individual beamlines → Already made adjustments
- Agreed with WP2.04 on key parameters for standard IDs (minimum gap and device length)
- Detailed plan for refurbishing and reusing components of existing 2m IDs
- Special 5m ID (UE65 Apple II) can be reused in long straight
- Total Power of PETRA IV Insertion devices calculated (to be used for damping wiggler / emittance control concept)



CPMU18 →

U32-4.3m →

U32-4.3m →

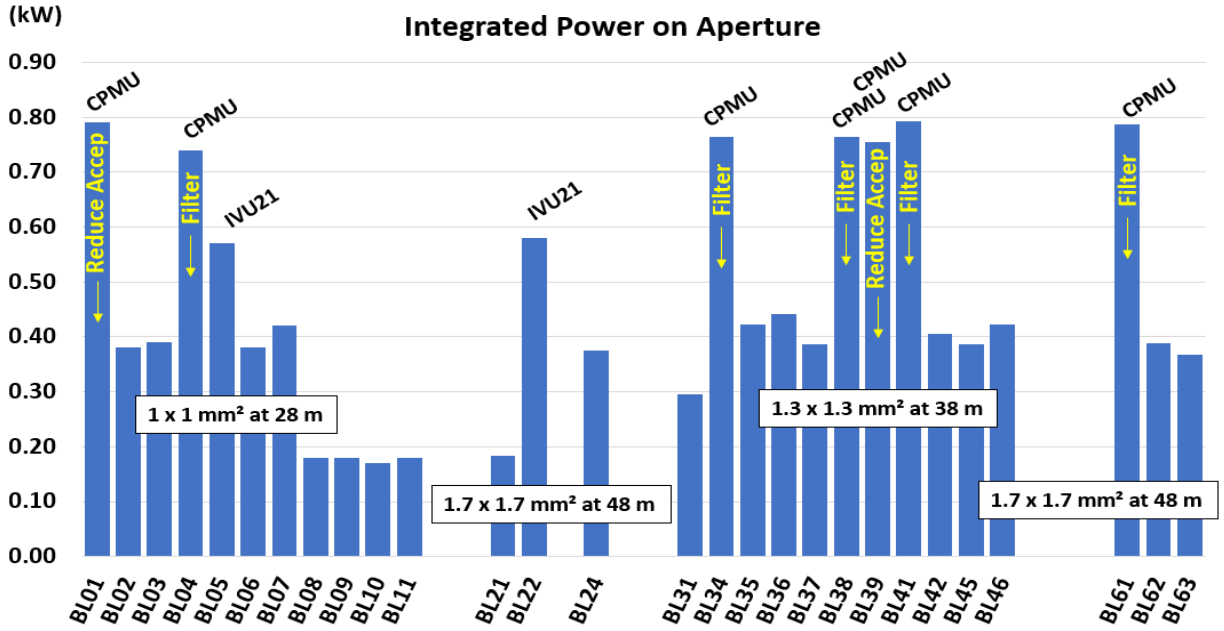
Beamline	ID	K_{max} (Gap_{min})	Type
Max von Laue (MvL) Experimental Hall:			
BL01 Nuclear Resonance and X-ray Raman Scattering	CPMU19~4.0 m	1.95 (6 mm)	new
BL02 AdMiNaXS Beamline	2× U29-2 m	2.2 (9.5 mm)	refurbished
BL03 Hard X-ray Photoelectron Spectromicroscopy	U34-4.3 m	2.9 (9.5 mm)	new
BL04 High-Energy Scatt. and Diff. Tomography	U29-4.3 m	2.2 (9.5 mm)	new
BL05 High-Energy Mater. Sci. Beamline (HEREON)	IVU21-4.0 m	1.8 (6 mm)	refurbished
BL06 Surface and Interface Dynamics Beamline	2× U29-2 m	2.2 (9.5 mm)	refurbished
BL07 *In-situ* Bragg Microscopy Beamline	U30-4.3 m	2.4 (9.5 mm)	new
BL08 High-Thru. MX	U29-2 m	2.2 (9.5 mm)	refurbished
BL09 BioSAXS Beamline (EMBL)	U29-2 m	2.2 (9.5 mm)	refurbished
BL10 High Performance and Microfocus MX (EMBL)	U23-2 m	1.3 (9.5 mm)	ref./new mag.
BL11 Bio Diffraction and Imaging (EMBL)	U29-2 m	2.2 (9.5 mm)	refurbished
Ada Yonath (PXE) Experimental Hall:			
BL21 High-Energy Beamline for Phys. and Chem.	U29-2 m	2.2 (9.5 mm)	refurbished
BL22 Swedish High-Energy Mater. Sci. Beamline (SE)	IVU21-4 m	1.8 (6 mm)	refurbished
BL23 HIKA Beamline (KIT)	tbd.	tbd.	tbd.
BL24 Chemical Crystallography Beamline	U25-4.3 m	1.55 (9.5 mm)	new
New PXW Experimental Hall:			
BL31 HRHS Soft X-ray Beamline	UE65-5m	6.3 (11 mm)	refurbished
BL34 Multiscale Mater. Microscope (DESY/HEREON)	CPMU18~3.8 m	1.76 (6 mm)	new
BL35 Materials Scanning Nanoscope	U34-4.3 m	2.9 (9.5 mm)	new
BL36 In-Situ/High-Resolution 3D Nanoprobe	U32-4.3 m	2.7 (9.5 mm)	new/ref. mag.
BL37 Full-Field Imaging for Mater. Sci. (HEREON)	U25-4.3 m	1.55 (9.5 mm)	new
BL38 CryoBio Nanoprobe Beamline	CPMU18~3.8 m	1.76 (6 mm)	new
BL39 Coherent Applications Beamline	CPMU18~3.8 m	1.76 (6 mm)	new
BL41 ExTReM	CPMU18~4.0m	1.76 (6 mm)	new
BL42 Resonant X-ray Scattering Beamline (MPG)	2× U32-2 m	2.7 (9.5 mm)	refurbished
BL45 Powder Diffraction and Total Scattering	U25-4.3 m	1.55 (9.5 mm)	new
BL46 SAXSMAT II Beamline	U30-4.3 m	2.4 (9.5 mm)	new
BL48 Applied Analytical XAFS and Q-EXAFS Beamline	3PW	tbd.	new
Paul P. Ewald (PXN) Experimental Hall:			
BL61 *In-situ* Large Volume Press Beamline	CPMU18~4.0 m	1.76 (6 mm)	new
BL62 Materials Science Lab Beamline (MPG)	U32-2 m/U23-2 m	2.7/1.3 (9.5 mm)	ref./new mag.
BL63 X-ray Absorption & Emission Spec. Beamline	U29-2 m/U33-2 m	2.2/2.7 (9.5 mm)	refurbished
BL64 Time-Resolved VUV Spectroscopy Beamline	3PW	tbd.	new

WP3.02 – Beamline Technology

Status of the Work Package

Front-ends and Optics – Power Analysis:

- Calculation of partial power and power density based on ID portfolio performed
- First estimation of absorbed power and power density of HHL DCM (filters for high-energy beamlines!)
- PETRA IV allows smaller/symmetric front-end mask aperture (fixed apertures needed)
- Re-evaluation of Front-end thermal design needed!



Current ver. HHL DCM Design: max. 1000 W and 150 W/mm²

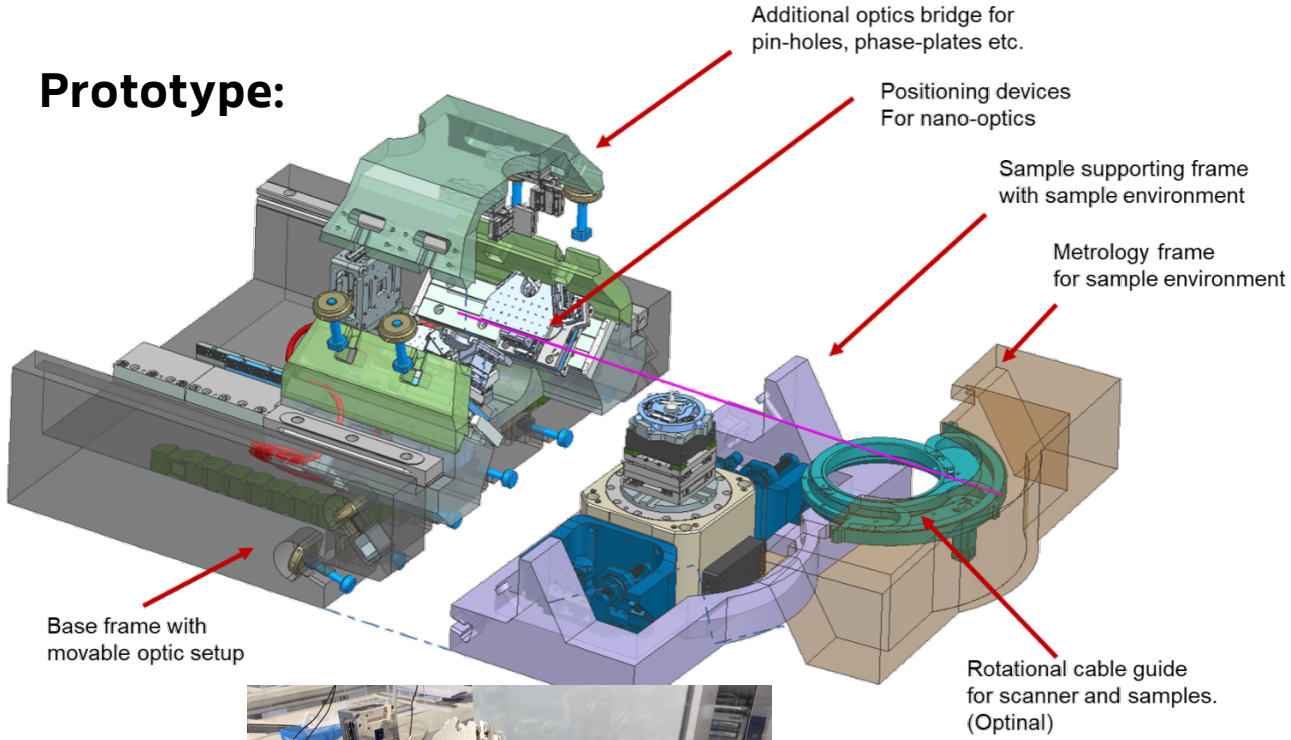
Source	Max. K	Min. Energy (keV)	Power (W) 2x2 mm² at 28 m	Beam size (µm) FWHM at 28 m	Power (W) 0.7x0.7 mm² at 28 m	Power Desity (W/mm²)	Power Density (W/mm²) at DCM
U29-5m (**PIII**-HB)	2.2	3.5	1093	735 x 449	147 (Flux 66%)	304	120 (θ_B = 34°)
U29-4.3m (**PIV**-BM)	2.2	3.5	1481 ✗	443 x 426	200 (Flux 92%) ✓	412	160 (θ_B = 34°) ✓
CPMU18-3.8m (**PIV**-BM)	1.76	7.3	2813 ✗	363 x 333	380 (Flux 95%) ✓	353	143 (θ_B = 16°) ✓

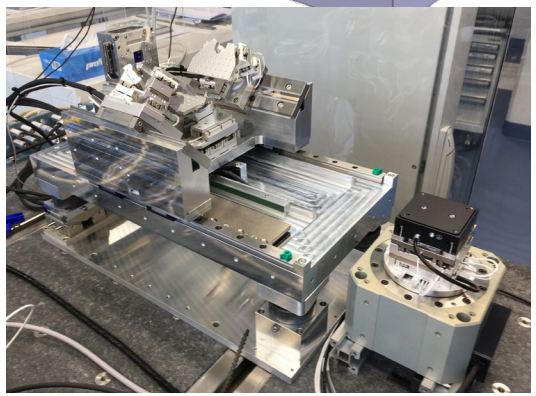
PETRA III: 6.08 GeV, 120 mA PETRA IV: 6.0 GeV, 200 mA

WP3.03 – Ultra-Precision Mechanics

Status of the Work Package

Prototype:





SPIDER Project:

- The final design concept is currently being fine-tuned.
- A prototype set up in the lab for positioning and stability studies.
- Critical components are continuously tested for vibrations, stability and accuracy.
- Studies of the control and system performance of mechatronic components are underway.

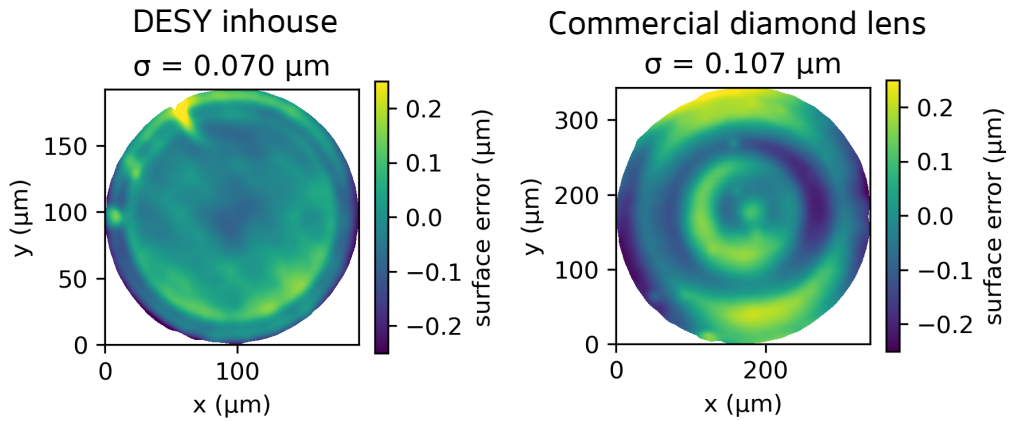
Scanning **P**latform for **I**mage **D**etection with **E**xtreme **R**esolution

WP3.04 – Nano-Optics

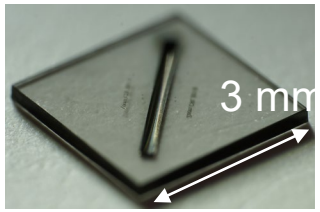
Status of the Work Package

Diamond X-ray lenses:

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

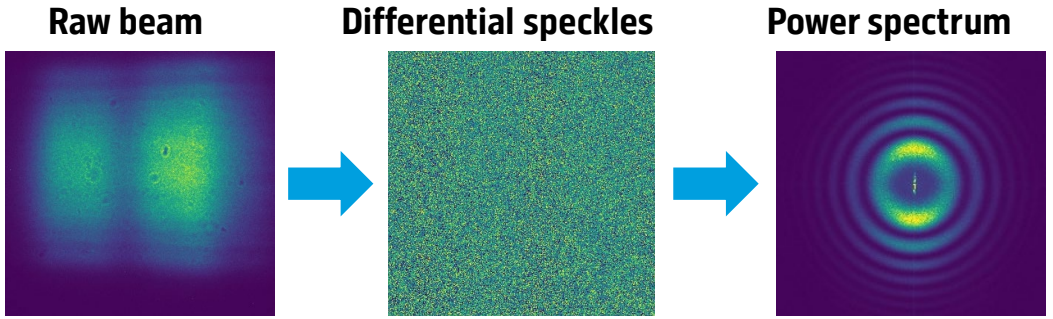


  - Capability for large lenses to capture full PETRA IV beam



Combined coherence and wavefront sensor:

- First coherence measurement using colloidal solution and near-field speckle analysis



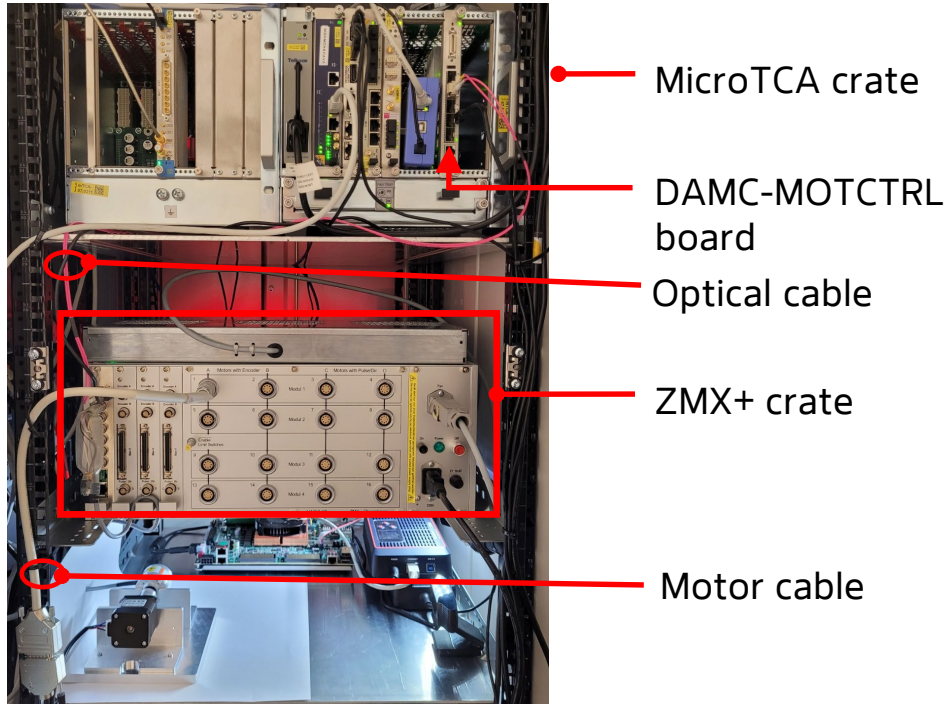
- Contrast decay in power spectrum → lateral coherence
- Test case: Effect of horizontal pre-focusing with 1D lens
  - Reduced horizontal coherence
  - Preserved vertical coherence

WP3.06 – Experimental Control

Status of the Work Package

Hardware:

- MicroTCA for Beamline Control & Synchronization
- MicroTCA motion controller developed at DESY
- PiLC for continues scans



Software:

- Evaluation of BlueSky and Bliss as alternatives to Saradana

  → Workshops together with Soleil, Max IV, ESRF, HZB
- Tests of BlueSky and Bliss at PETRA III Beamlines
- ROCK-IT project to explore options
- MicroTCA - Tango server under development

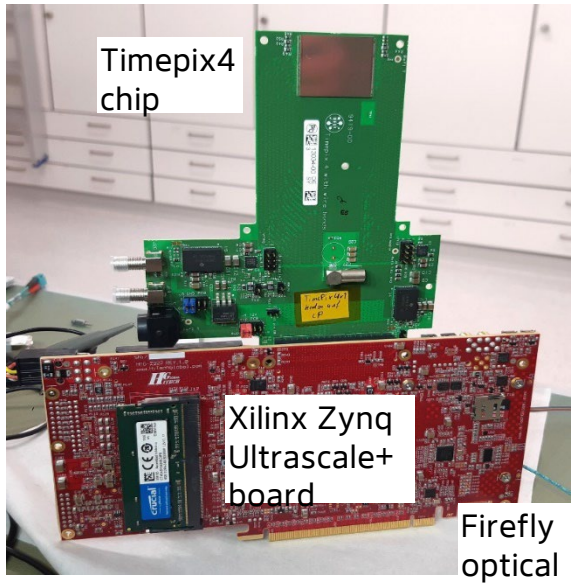
WP3.07 – X-ray Detector Systems

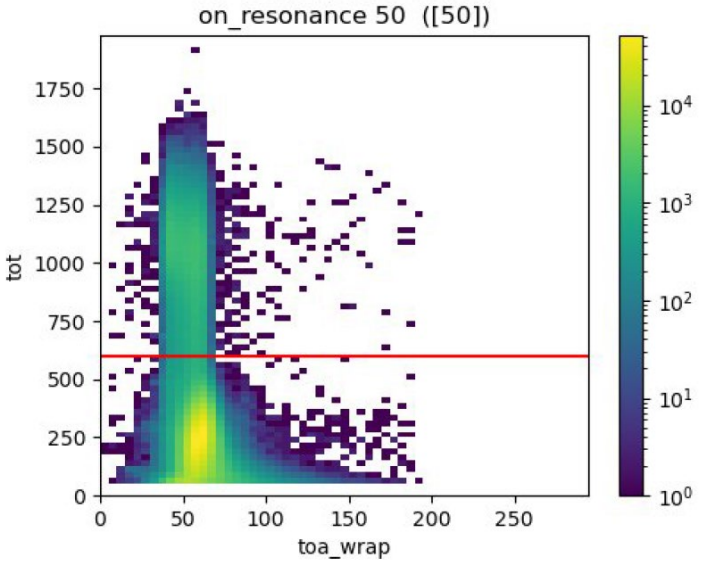
Status of the Work Package

Detector Developments and Prototyping:

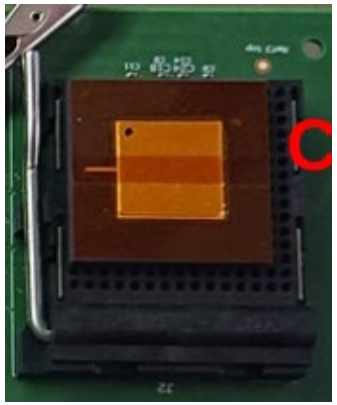
- TEMPUS system prototype tested at P01 – observed expected time structure in Nuclear Resonant Scattering
- New high-speed transceivers demonstrated
- CoRDIA pixel array prototyped – pixels function as expected
- Working on I/Os and full chip design
- CZT sensors produced and bonded to existing AGIPD chip

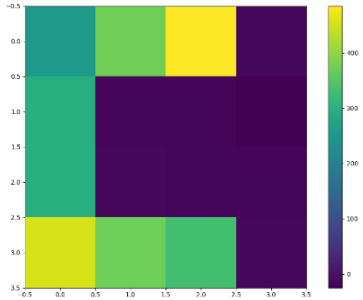
TEMPUS prototype (512 x 448)



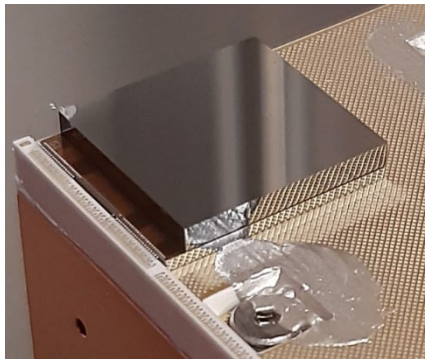


CoRDIA 4x4 pixel – Test pattern





CZT AGIPD



WP3.08 – Beamline and Experiment Design

Status of the Work Package

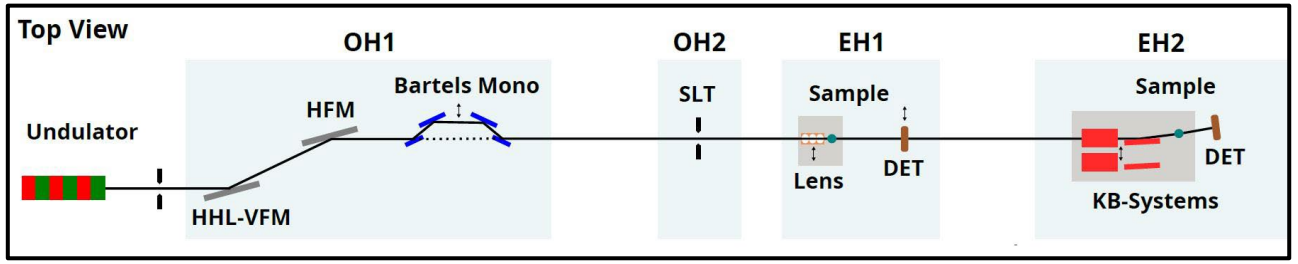
Beamline Conceptual Designs:

- 2-day internal beamline optical layout review performed
- Template for beamline CDRs in preparation
- Start of the CDR Process Jan 2024
- Preparation of beamline TDR process

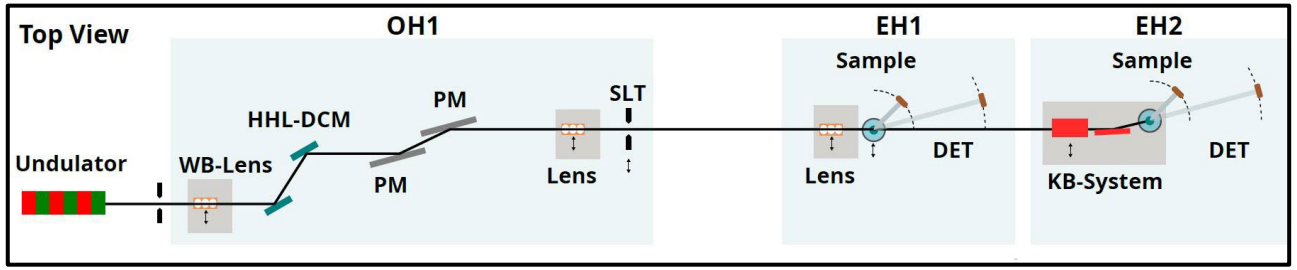
Generic Optical Components:

- Working Groups to compile optics requirements/specifications including FEM simulations, heatload calculations and ray-tracing

Example: CryoBio Nanoprobe Beamline



Example: In-Situ Bragg Microscopy Beamline

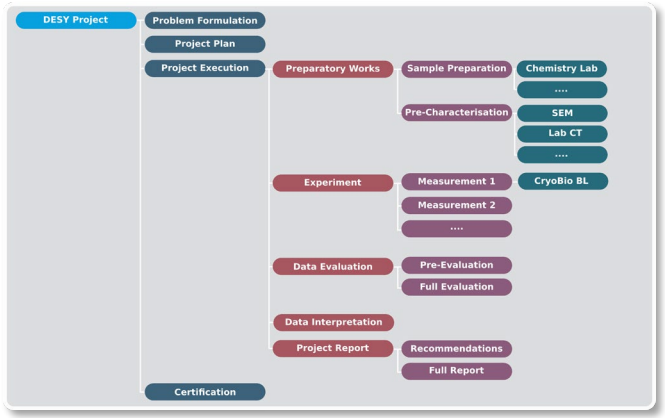


In-House Developments:

- Reorganised TechTask to manage in-house projects, including reviews and beamline prototype testing
- Project format for all developments - staffed by beamline engineers and WP3.08 staff

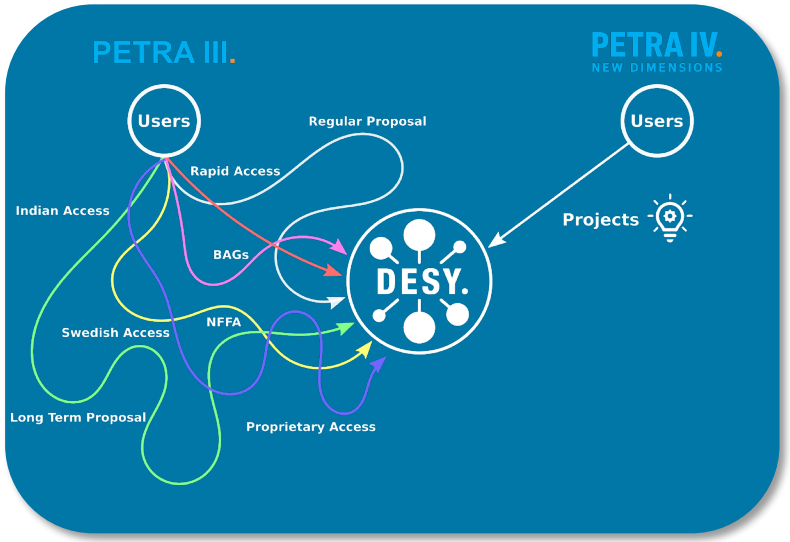
WP3.10 – Access

Status of the Work Package

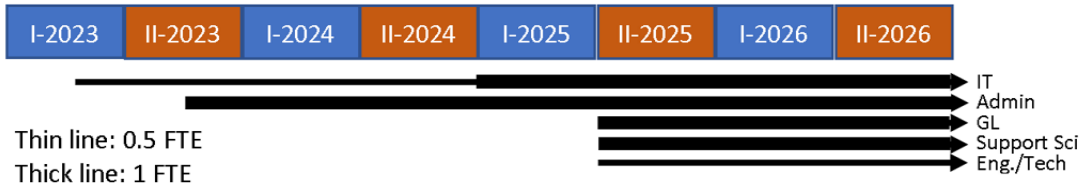


Rolling Access at PETRA III and PETRA IV:

- New access model (rolling access) worked out
- Beamlines in the test phase (starting spring 2024):
  - P08 & P23 (Diffraction, Reflectivity, Liquid Scattering, Langmuir)
  - P11 (Macromolecular Crystallography)
  - P24 (Chemical Crystallography)
  - P22 (HAXPES)
  - Chemical and biological laboratories, clean rooms
  - NanoLab (AFM, SEM, FIB etc.)
- 0.5 FTE working on software implementation
- 1.0 FTE working on administration and development
- Proposal reviewers informed at PRP (Nov 6th and 7th, 2023)
- Satellite workshop planned at Photon Science Users Meeting Jan 2024



Timetable new FTE. The administrating person can be also a support scientist, at the same time



Many people are involved into the PETRA IV WPG3 activities and writing of the PETRA IV Project Proposal

Thank you !!