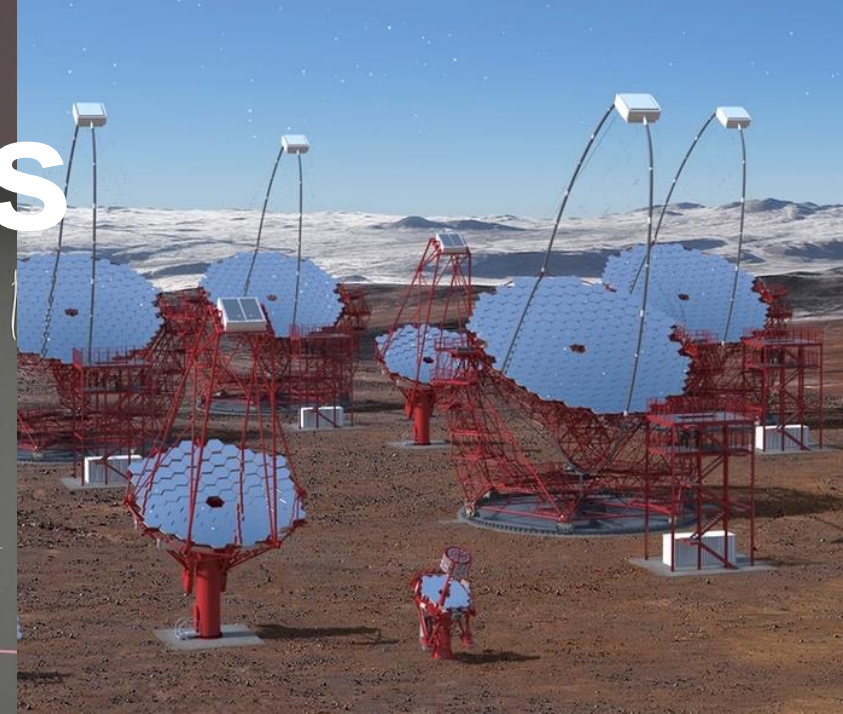
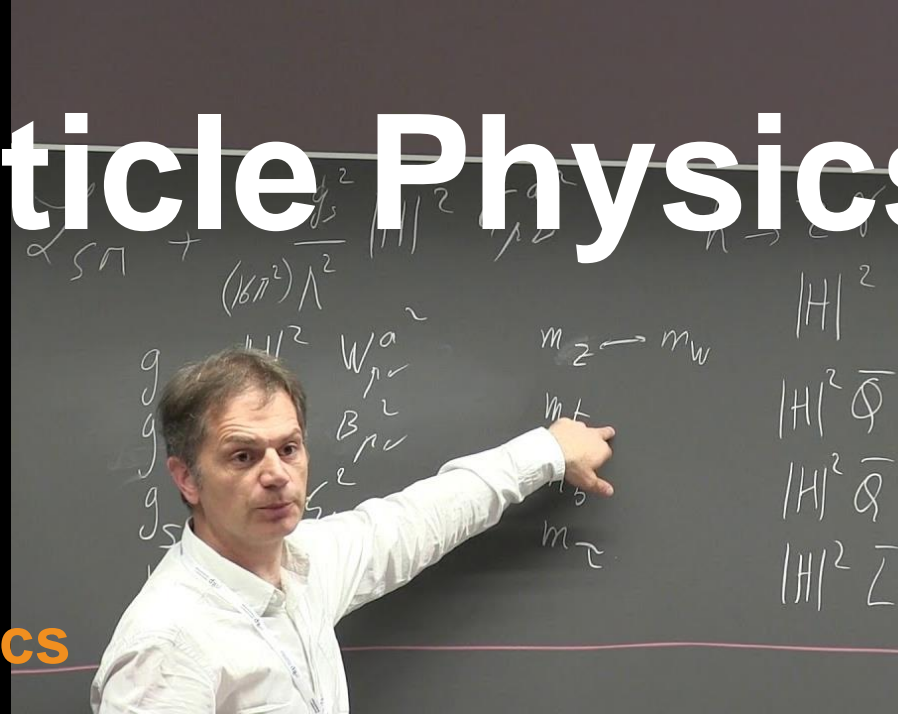


DESY Particle Physics

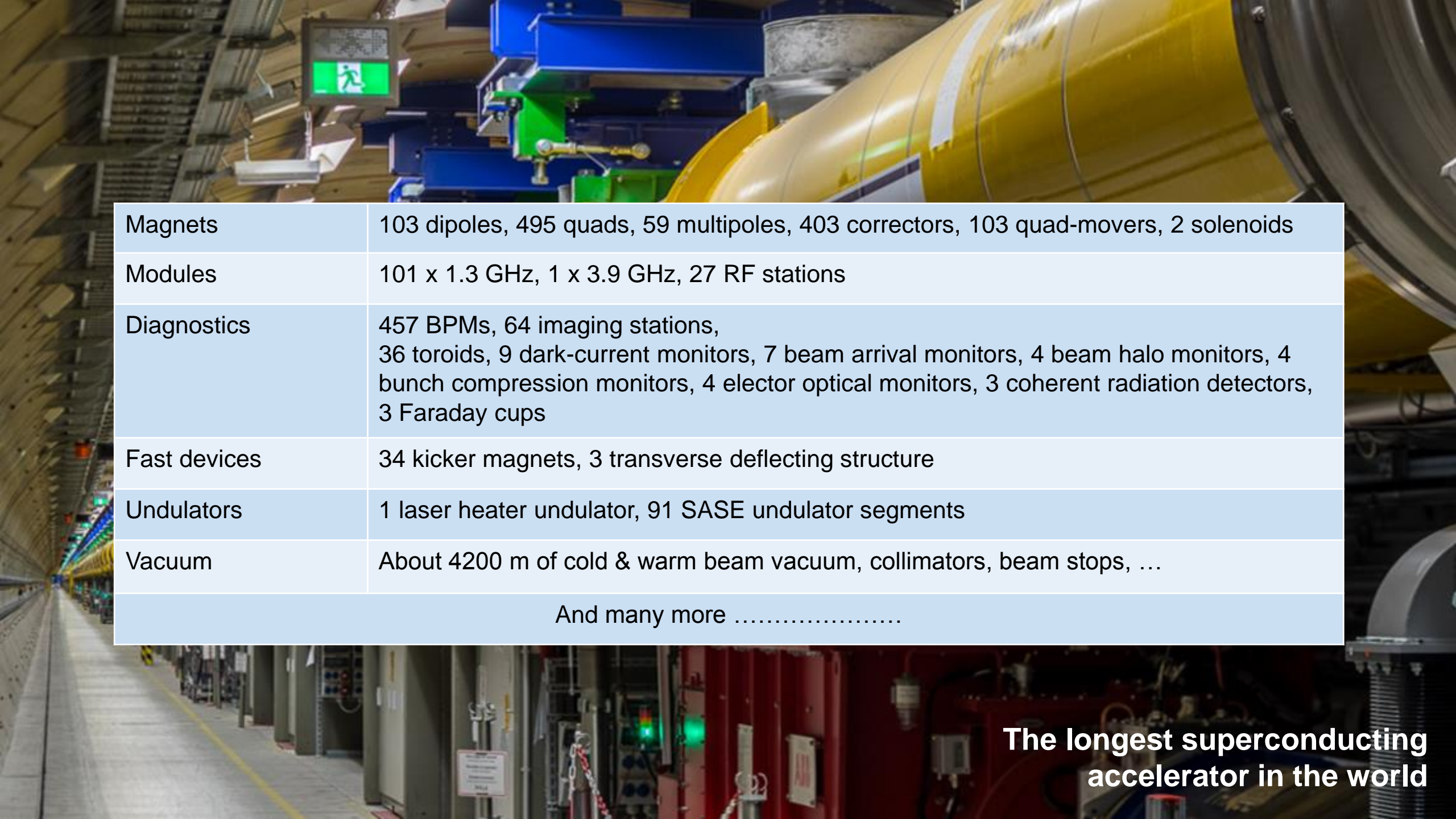
Status and selected topics



Joachim Mnich (DESY)
Plenary ECFA Meeting
15/16 November 2018

The European XFEL

entering routine user operation



Magnets	103 dipoles, 495 quads, 59 multipoles, 403 correctors, 103 quad-movers, 2 solenoids
Modules	101 x 1.3 GHz, 1 x 3.9 GHz, 27 RF stations
Diagnostics	457 BPMs, 64 imaging stations, 36 toroids, 9 dark-current monitors, 7 beam arrival monitors, 4 beam halo monitors, 4 bunch compression monitors, 4 electro optical monitors, 3 coherent radiation detectors, 3 Faraday cups
Fast devices	34 kicker magnets, 3 transverse deflecting structure
Undulators	1 laser heater undulator, 91 SASE undulator segments
Vacuum	About 4200 m of cold & warm beam vacuum, collimators, beam stops, ...
And many more	

**The longest superconducting
accelerator in the world**

The European XFEL

The longest SC linac in the world

Soft and hard X-ray light experiments

~800 TESLA-type cavities

Resonance frequency 1.3 GHz

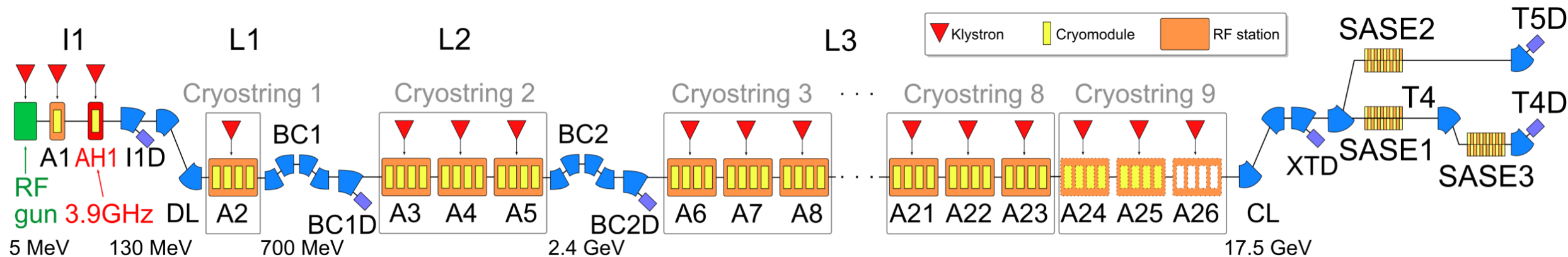
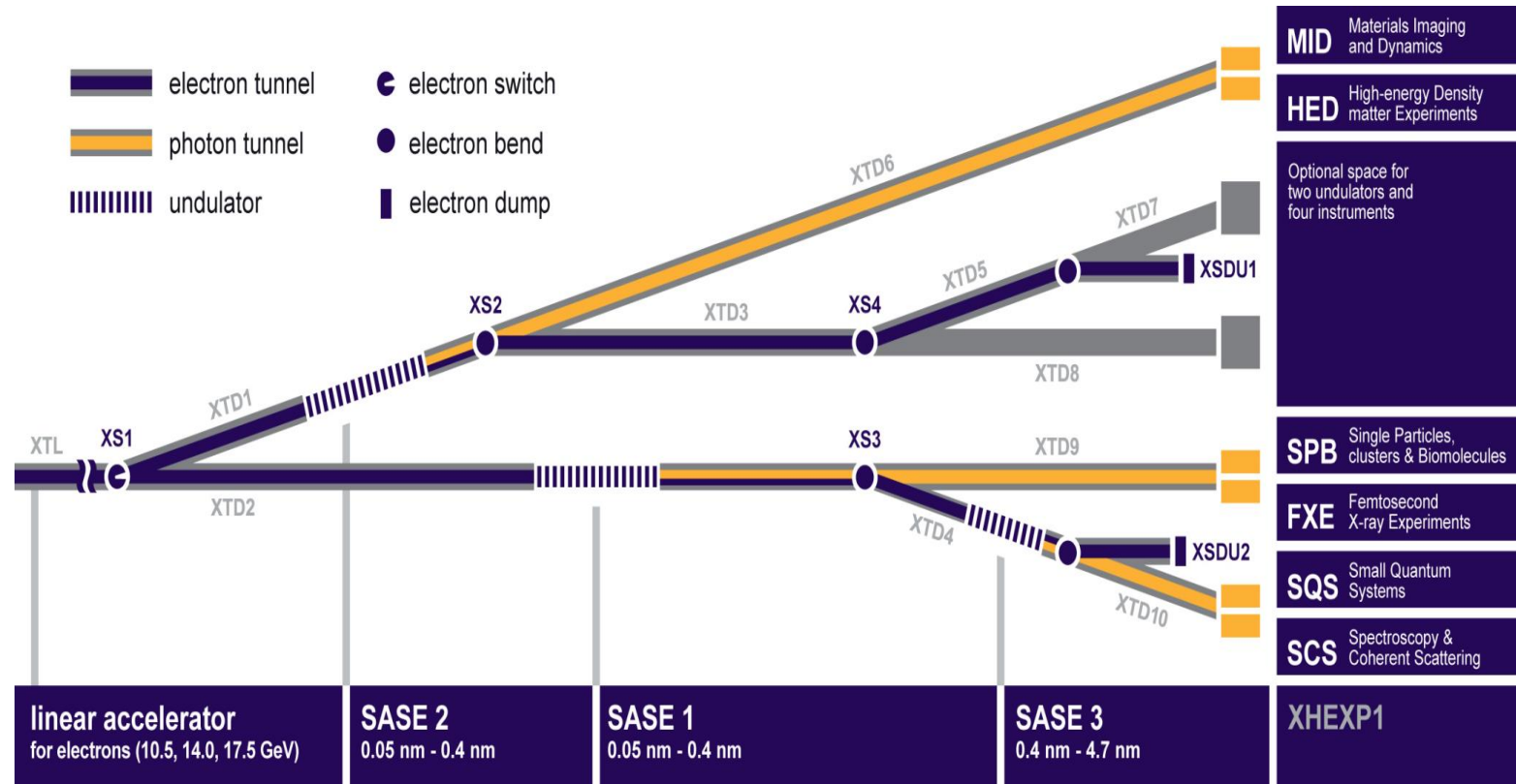
32 cavities per XTL RF station

Design energy 17.5 GeV

Pulsed operation 10 Hz

Routine user operation at several stations

Reached 17.6 GeV and 2700 bunches!



Particle Physics Activities

DAF and LHC Upgrades

Belle II

ALPS et al.

LHC Upgrades

At DESY and in Germany

Germany has significant and diverse contributions to the HL-LHC upgrades, with large Helmholtz involvement

- For many subdetectors for all four LHC experiments
- Most complex and challenging components to be built: tracker end-caps for ATLAS and CMS

Funding:

- 90 MEUR from BMBF for universities
- 15,7 / 4,3 MEUR for DESY / KIT from Helmholtz
- 10 MEUR from DESY for detector assembly facility (DAF)

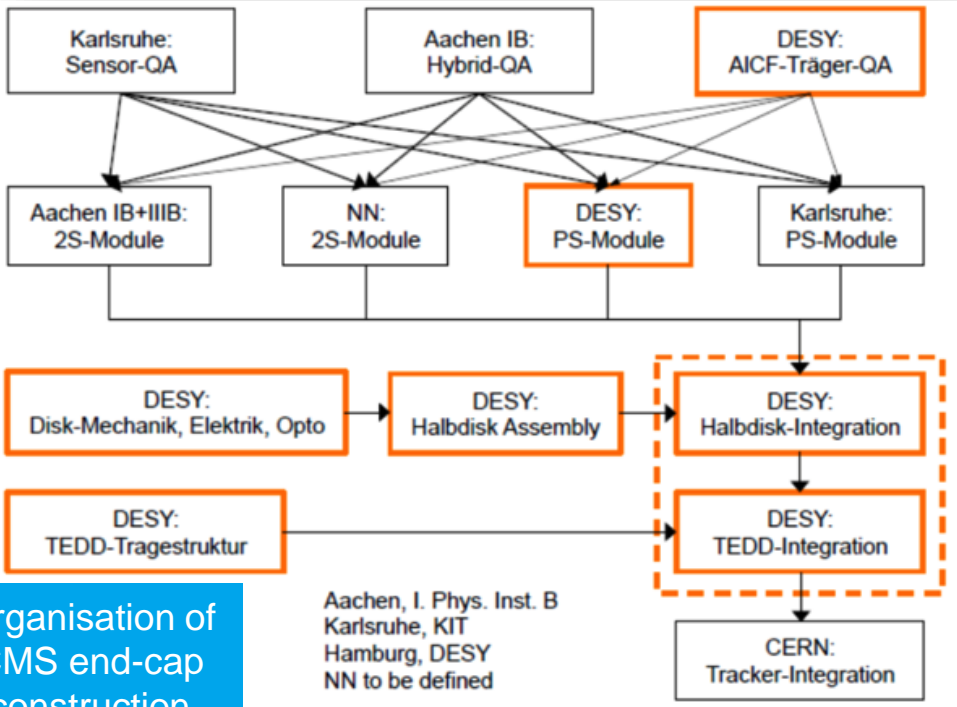
Central role of DESY:

- Complex organisation of tracker end-cap construction
- Strong collaboration between DESY and German universities
- DESY also organises controlling and reporting of BMBF funds for universities

German ATLAS & CMS ugrade involvement

CMS	Pixel detector	Hamburg
	Outer tracker	Aachen, DESY, KIT
	Myon system	Aachen

ATLAS	Pixel detector	Bonn, Dortmund, Göttingen, Siegen, Wuppertal
	Strip tracker	Berlin, DESY, Dortmund, Freiburg
	LAr calorimeter	Dresden, MPI
	Myon system	Freiburg, Mainz, München, MPI, Würzburg
	TDAQ	Heidelberg, Mainz



Organisation of CMS end-cap construction (ATLAS similar)

Detector Assembly Facility (DAF) - I

DESY Building 25c

Remember: DAF a 10 MEUR investment for LHC upgrades

- Buildings 25c and hall 1

Building 25c infrastructure & cleanroom (ISO-6) ready

- Commissioning almost done. R&D activities started



View of the ATLAS area of the cleanroom with microscopes and probe station. Gantry system for automated module assembly will be installed in November



View of the CMS area of the cleanroom with microscopes and automated module assembly system. All major devices are installed and are being commissioned

Detector Assembly Facility (DAF) - II

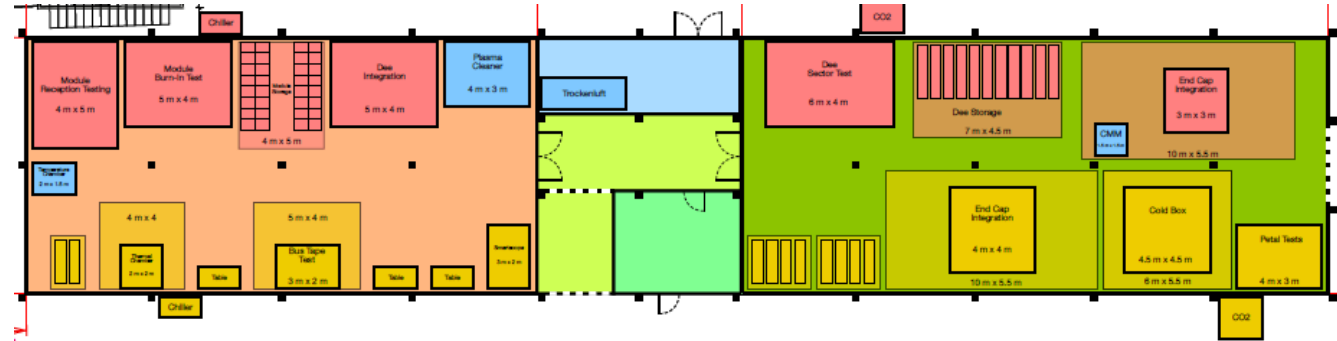
DESY Building 26 – hall 1

Building infrastructure is refurbished.

- Cleanroom (ISO-7) construction finished.
- Commissioning will start Jan 2019.



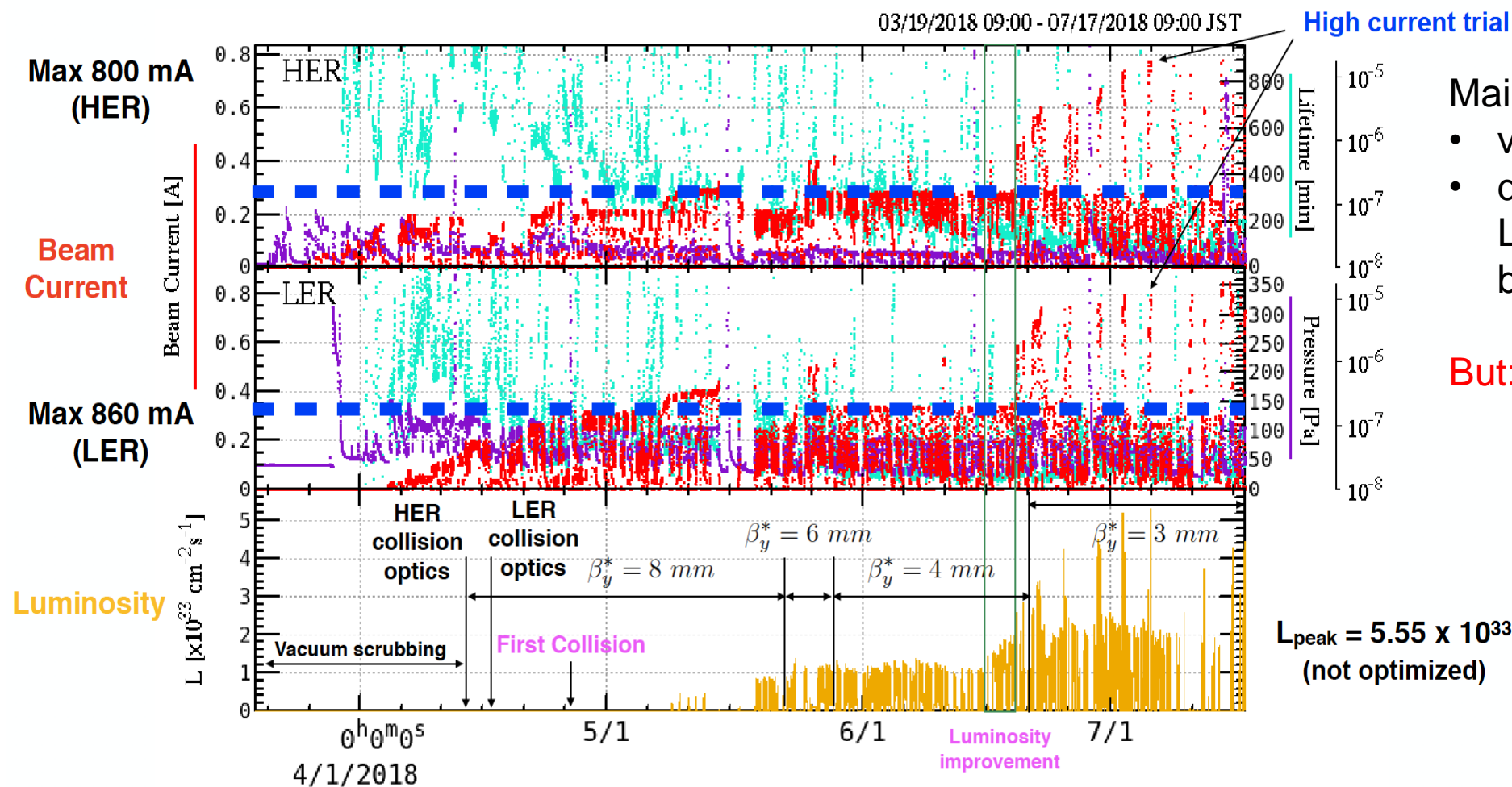
View from the endcap integration area side with air conditioning and filter units on top. Construction and commissioning of cleanroom is finished, final tests are being done now. Expect hand over beginning of December.



View of endcap integration area just before final cleaning. Cleanroom is ready for installation of equipment now. Installations will start mid of November Commissioning until mid 2019

Belle II: Phase 2 Commissioning

25 April 2018; SuperKEKB ramping up towards design lumi



Main phase 2 goals reached:

- verified nano-beam concept
- demonstrated feasibility of $L = 1 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ at 1A beam current

But: Background issue

Belle II Pixel Detector (PXD)

Main German contribution to Belle II

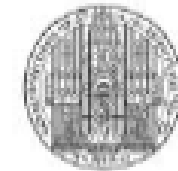
- German consortium consisting of 12 institutes (Universities, Max-Planck, Helmholtz)



GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN



JOHANNES GUTENBERG
UNIVERSITÄT MAINZ



UNIVERSITÄT
HEIDELBERG
ZUKUNFT
SEIT 1386



De-Scoping of PXD for Phase 3

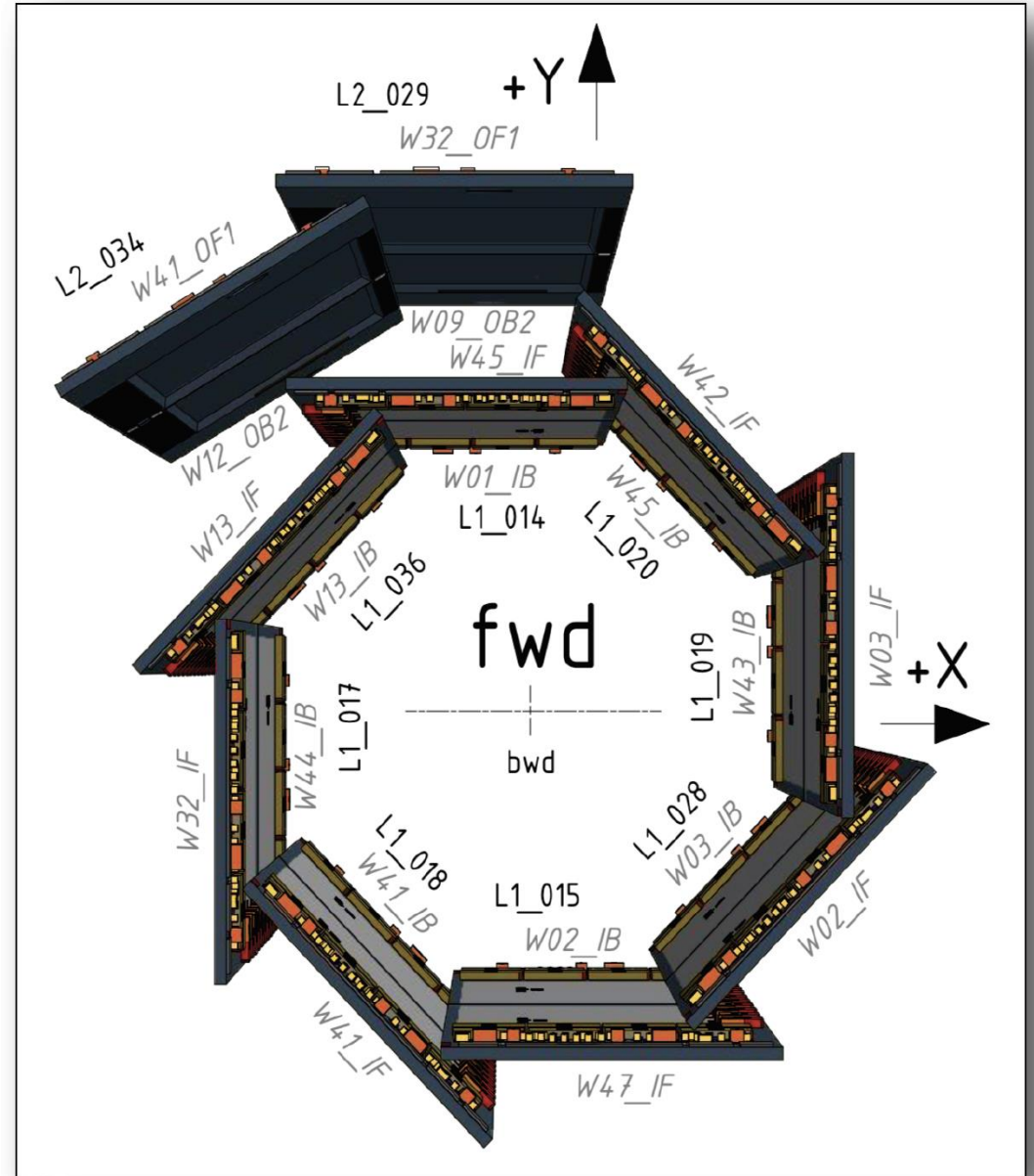
Too high failure rate during ladder assembly step

- Opted to proceed with a de-scoped version of PXD in 2018: L1 complete with 8 ladders, L2 only partial with 2 out of 12 ladders

After pre-commissioning in Germany half shells were transported to KEK, mounted and combined with SVD

Next steps:

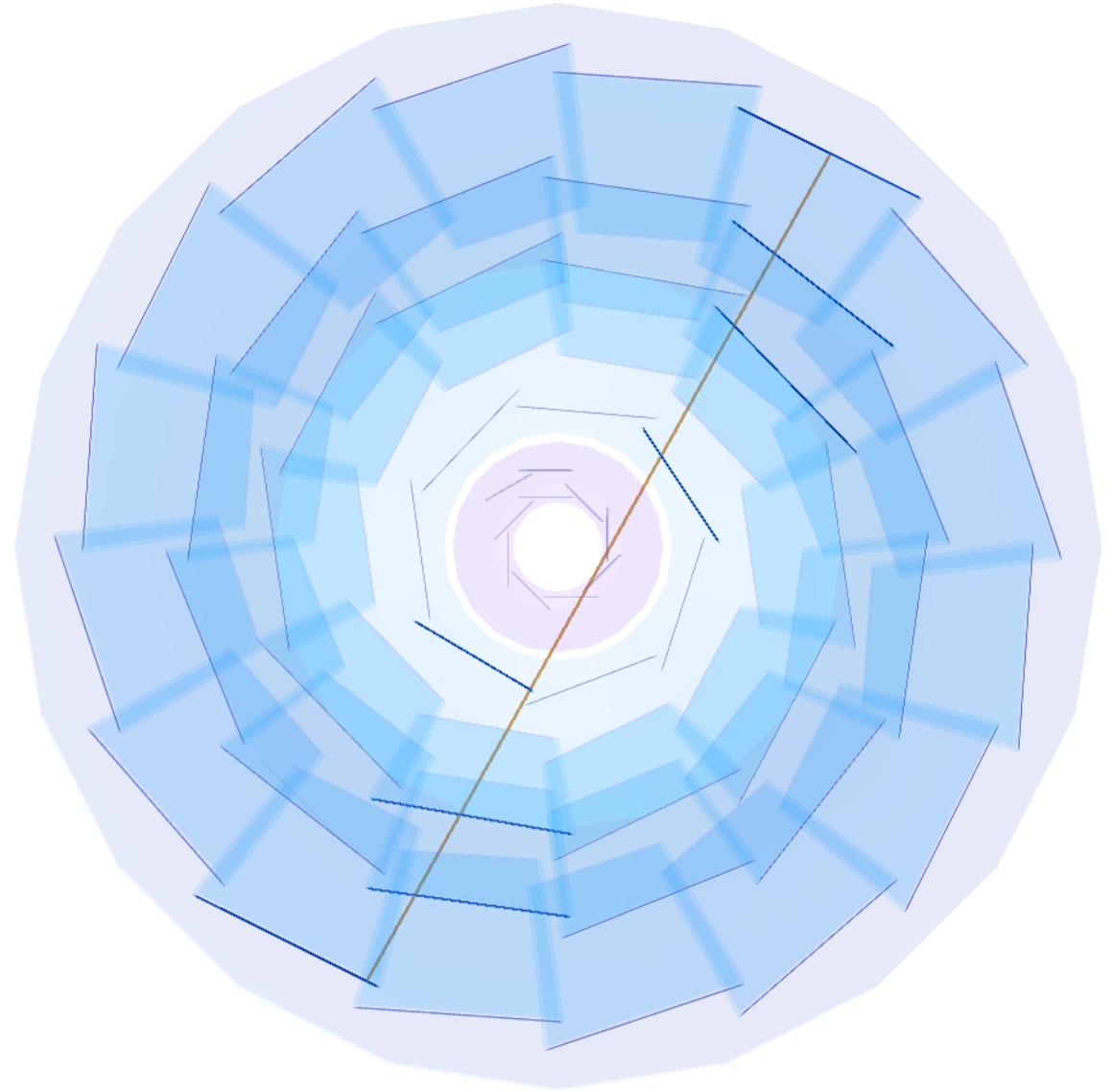
- VXD commissioning Oct 15 - Nov 09
- VXD installation in Belle II: end of Nov
- Ongoing studies to determine the impact on track/vertex resolutions
- "PXD 2020": Installation planned for a future extended shutdown



Belle II: PXD Impressions

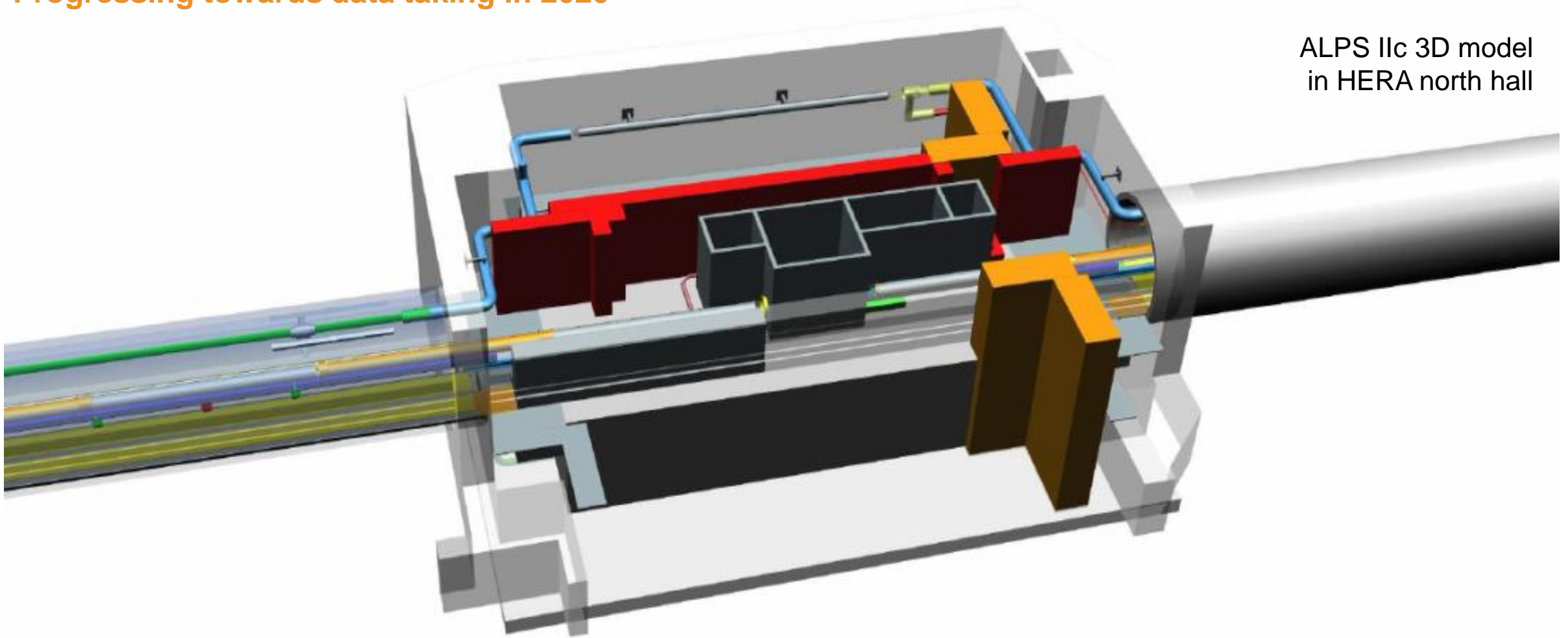


Cosmic track in PXD



ALPS II Progress at DESY

Progressing towards data taking in 2020



ALPS IIc 3D model
in HERA north hall

A company has been hired to review the safety concept for the operation in the HERA tunnel.

ALPS II Progress at DESY

Progressing towards data taking in 2020

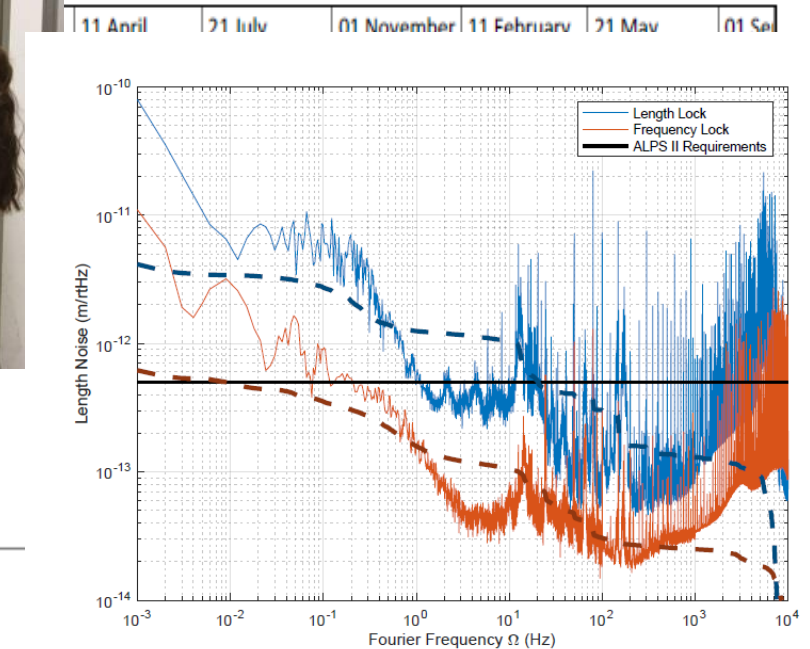
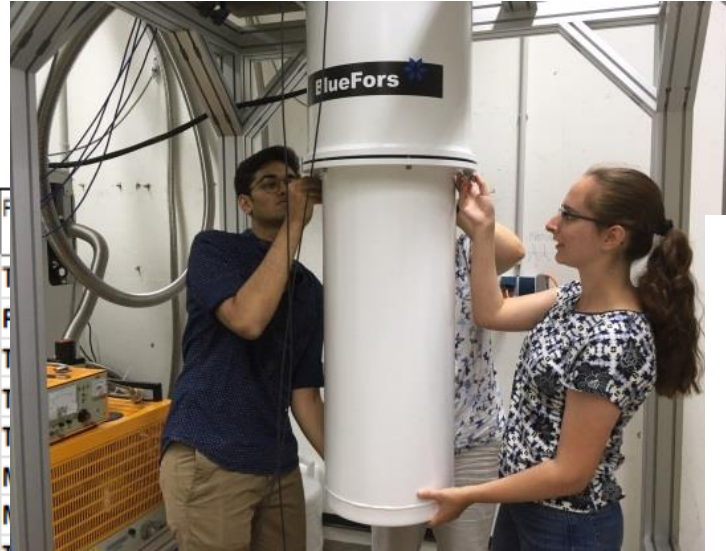


ALPS II Progress at DESY

Achievements and schedule

ALPS IIc could start data taking in 2020:

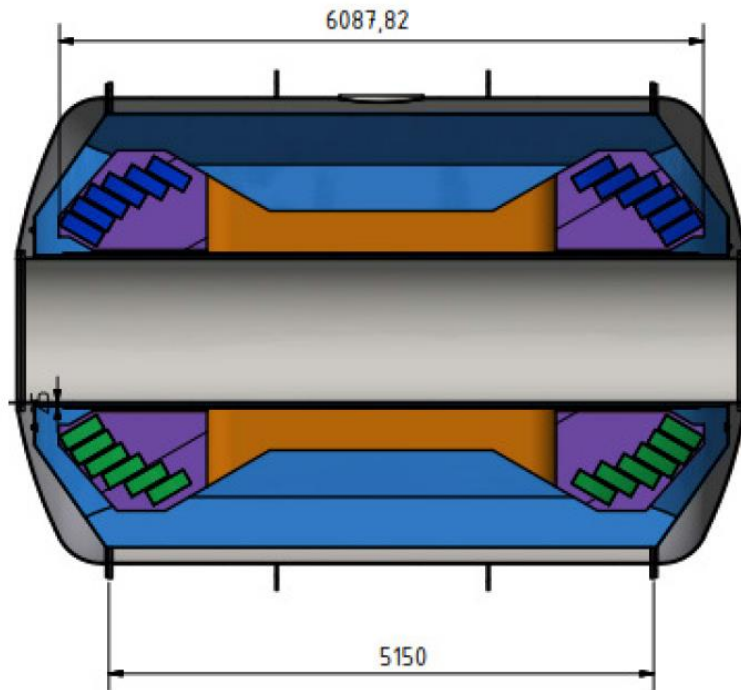
ID	Task Name	Duration	Start	End
0	Arbeiten ALPS setup	1215 dys?	Fri 11.12.15	Tue 12.05.20
1	Dipole	723,5 dys	Tue 20.09.16	Fri 11.12.15
47	West	614 dys	Thu 05.01.17	Tue 12.05.20
51	Halle Nord	44 dys	Thu 08.02.18	Tue 12.05.20
58	NR Abbau	90 dys	Wed 21.03.18	Tue 12.05.20
102	NL Abbau	84 dys	Wed 28.03.18	Tue 12.05.20
142	Aufbau NORD	714 dys	Wed 01.11.17	Tue 12.05.20
257	Einbau Dipole	200 dys	Wed 07.08.19	Tue 12.05.20
326	TUEV Pruefung	38 dys	Wed 22.04.20	Fri 11.12.15
334	Abschluss Halle Nord	97 dys	Wed 25.03.20	Thu 06.08.20
337		1 dy?	Fri 11.12.15	Fri 11.12.15
338		1 dy?	Fri 11.12.15	Fri 11.12.15



- The ALPS IIc site in HERA North has been cleared.
- A new dilution cryostat BF-SD (67 μ W at 50 mK) for the TES detector has been put into operation successfully.
- 13 (out of 20) HERA proton dipoles have been straightened without any problems.
- Locking the regeneration cavity via 532 nm light and keep it resonating to 1064 nm with a length noise rms of 0.5 pm demonstrated.

On-Site Experiments – Future

MADMAX – search for dark matter axions

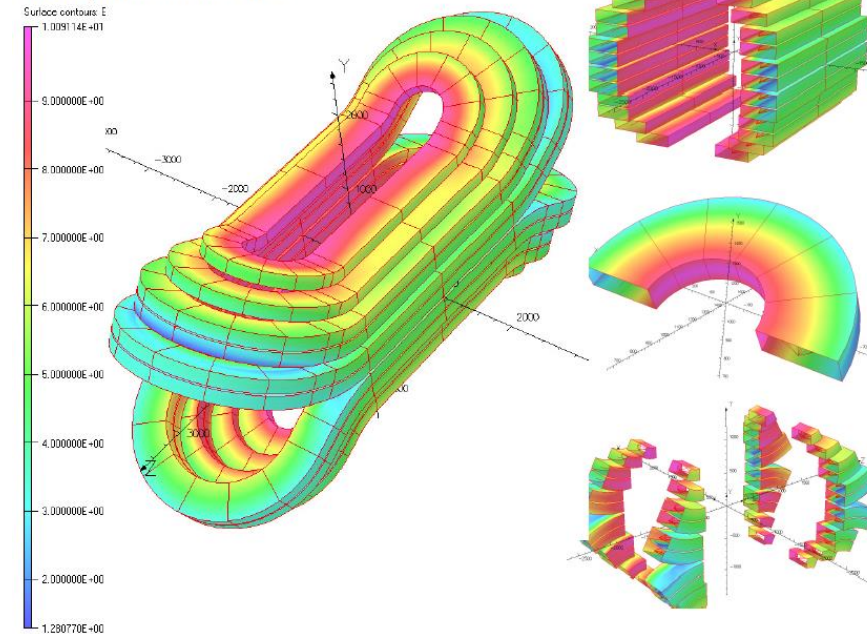


MADMAX (dark matter)

- Conversion of axion to microwave in 10T B field; 80 dielectric discs made of LaAlO_3 with $\epsilon = 25$
- Aachen, DESY, Hamburg, MPI Munich, Saclay, Tübingen, Zaragoza

Magnetic Design

Field profile in the coils



MADMAX collaboration

- Collaboration founded at DESY in 2017; selected DESY site: north hall (H1) area
- Site now being prepared
- Magnet studies by Bilfinger-Noell and CEA Saclay, aim for magnet decision in late 2018

- Intermediate experimental stage before IAXO

BabyIAXO	BabyIAXO: a first stage towards IAXO Letter of Intent to DESY PRC	Version: 1.2 Date: October 7, 2018 Page 3 of 38
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final IAXO bores
final ones.
igation for full IAXO

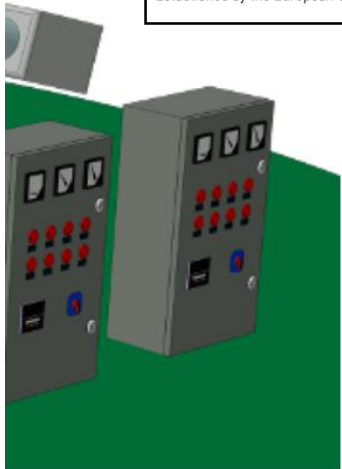
Letter of Intent to the DESY PRC

BabyIAXO: a first stage of the
International Axion Observatory IAXO

: CERN

Free bore [m]
Magnetic length [m]
Field in bore [T]
Stored energy [MJ]
Peak field [T]

E. Armengaud¹, D. Attie¹, S. Basso², P. Brun¹, N. Bykovskiy³, J. M. Carmona⁴, J. F. Castel⁴, S. Cebrián⁴, M. Civitani², C. Cogollos⁵, D. Costa⁵, T. Dafni⁴, A.V. Derbin⁶, M.A. Descalle⁷, K. Desch⁸, B. Döbrich³, I. Dratchnev⁶, A. Dudarev³, E. Ferrer-Ribas¹, J. Galán¹, G. Galanti², D. Gascón⁵, L. Gastaldo⁹, L. Garrido⁵, C. Germani⁵, G. Ghisellini², M. Giannotti¹⁰, I. Giomataris¹, S. Gninenko¹¹, N. Golubev¹¹, R. Graciani⁵, I. G. Irastorza^{4,*}, K. Jakovčić¹², J. Kaminski⁸, M. Krčmar¹², C. Krieger⁸, B. Lakić¹², T. Lasserre¹, P. Laurent¹, I. Loms kaya⁶, E. Unzhakov⁶, O. Limousin¹, A. Lindner¹³, G. Luzón⁴, F. Mescia⁵, J. Miralda-Escudé⁵, H. Mirallas⁴, V. N. Muratova⁶, X.F. Navick¹, C. Nones¹, A. Notari⁵, A. Nozik¹¹, A. Núñez⁴, A. Ortiz de Solórzano⁴, V. Pantuev¹¹, T. Papaevangelou¹, G. Pareschi², E. Picatoste⁵, M. J. Pivovarov⁷, K. Perez¹⁴, J. Redondo⁴, A. Ringwald¹³, J. Ruz⁷, E. Ruiz-Chóliz⁴, J. Salvadó⁵, T. Schiffer⁸, S. Schmidt⁸, U. Schneekloth¹³, M. Schott¹⁵, H. Silva³, G. Tagliaferri², F. Tavecchio², H. ten Kate³, I. Tkackev¹¹, S. Troitsky¹¹, P. Vedrine¹, J. K. Vogel⁷, A. Weltman¹⁶.



Strategy DESY-2030

For particle physics

Explore the LHC and beyond

- Upgrade ATLAS and CMS for HL-LHC
- Prepare leading participation in future global collider project; eagerly awaiting ILC decision from Japan

Harvest at Belle II

- Data taking and analysis until ~2027

On-site experiments

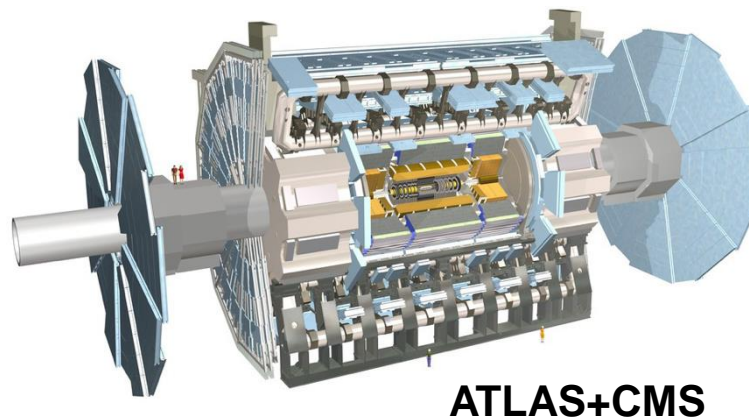
- Prepare a future on-site experiment after ALPS-II
- Detector R&D & testbeam operation

Theory:

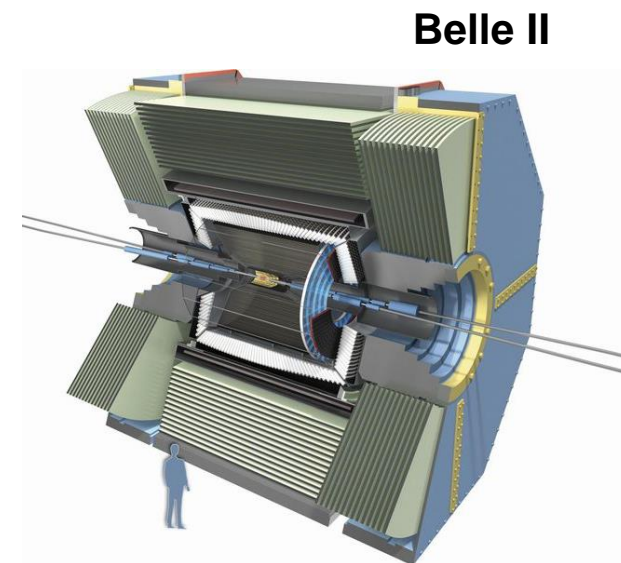
- Maintain broad spectrum of research topics and world-leading expertise

DESY as a “hub”:

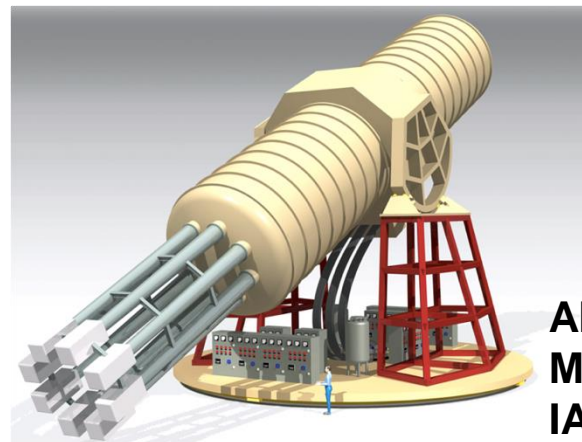
- Support projects with large German participation



ATLAS+CMS



Belle II



ALPS-II
MADMAX
IAXO



Backup

Schleswig-Holstein

Hamburg

The European XFEL

Schenefeld

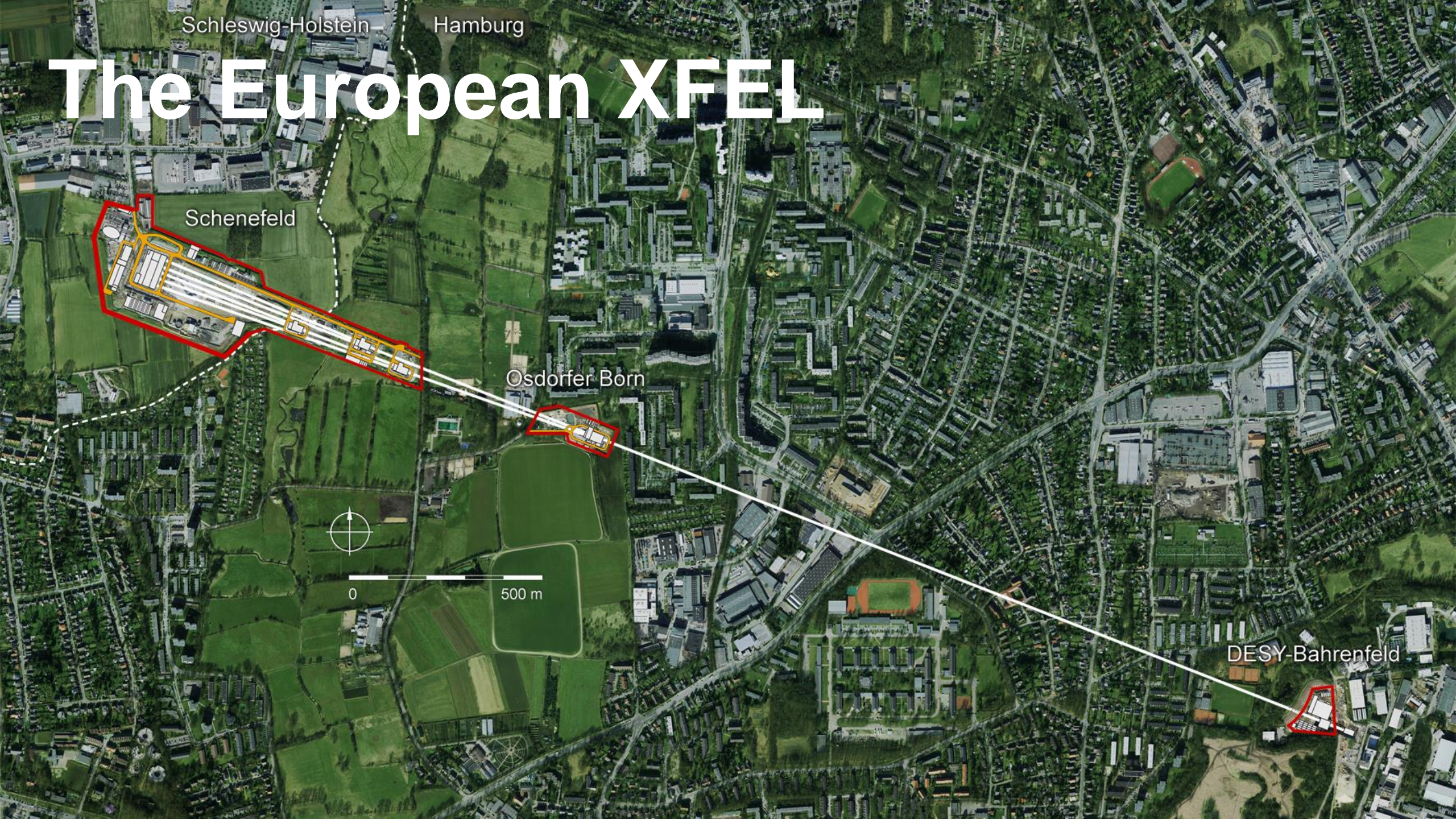
Osdorfer Born

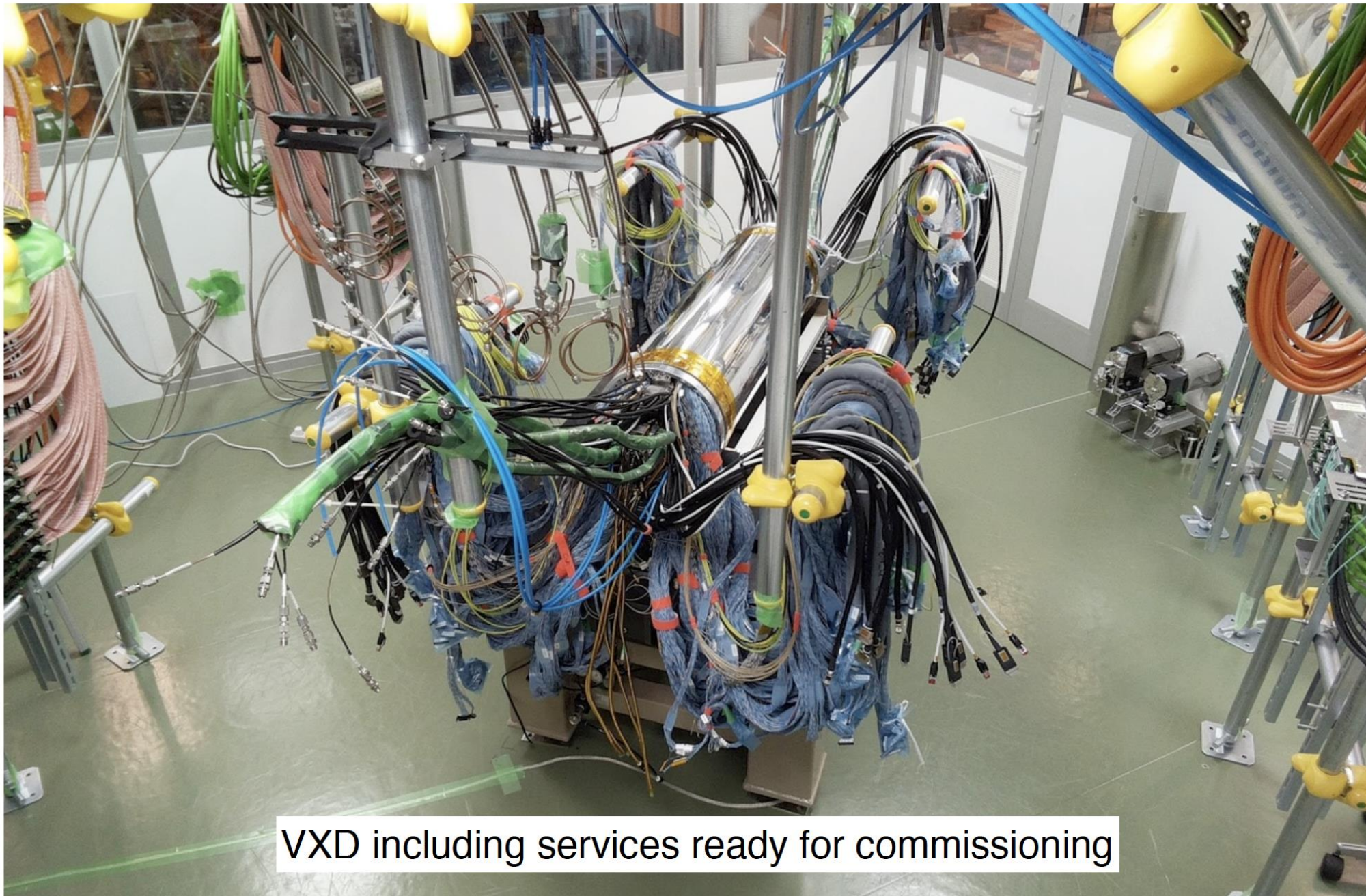
DESY-Bahrenfeld



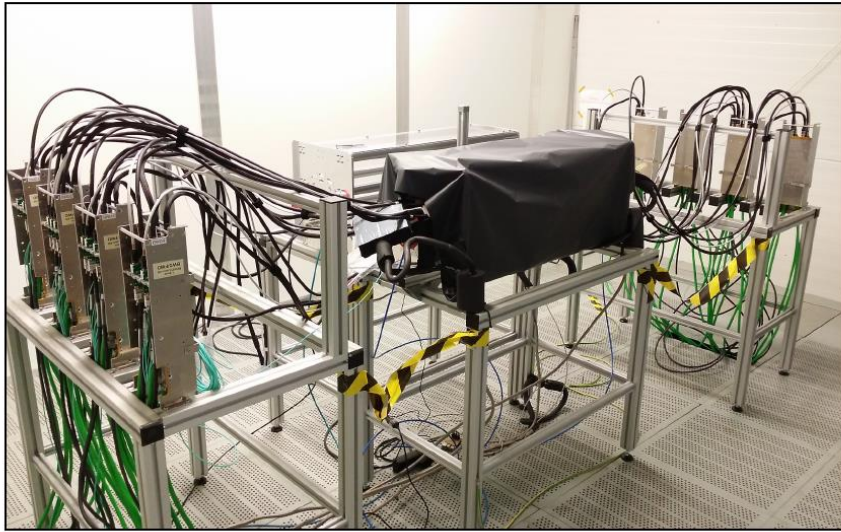
0

500 m

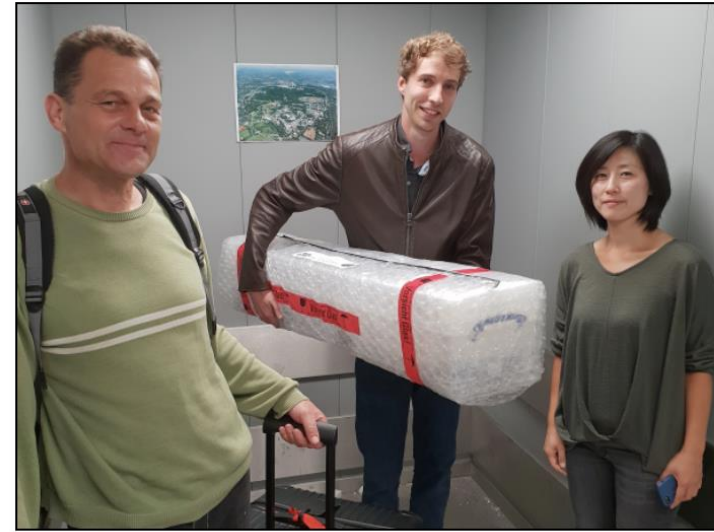




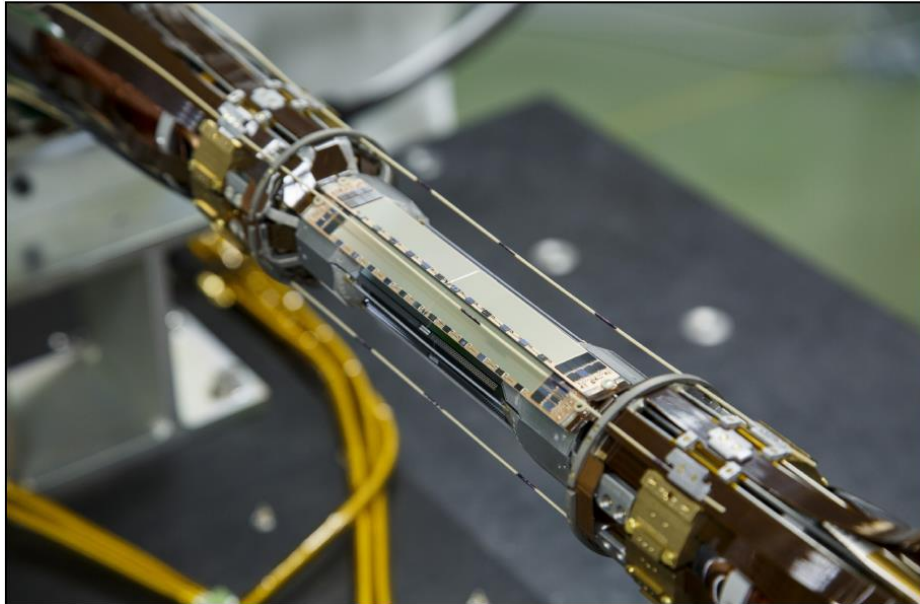
VXD including services ready for commissioning



PXD commissioning set-up at DESY



PXD half shell ready for transport to KEK



PXD mounted on beam pipe at KEK



PXD combined with one half of SVD

Clean Room in HERA West

CO₂ cooling

CO2lean
ETH zürich

Many thanks to ETHZ!

Data-handling units

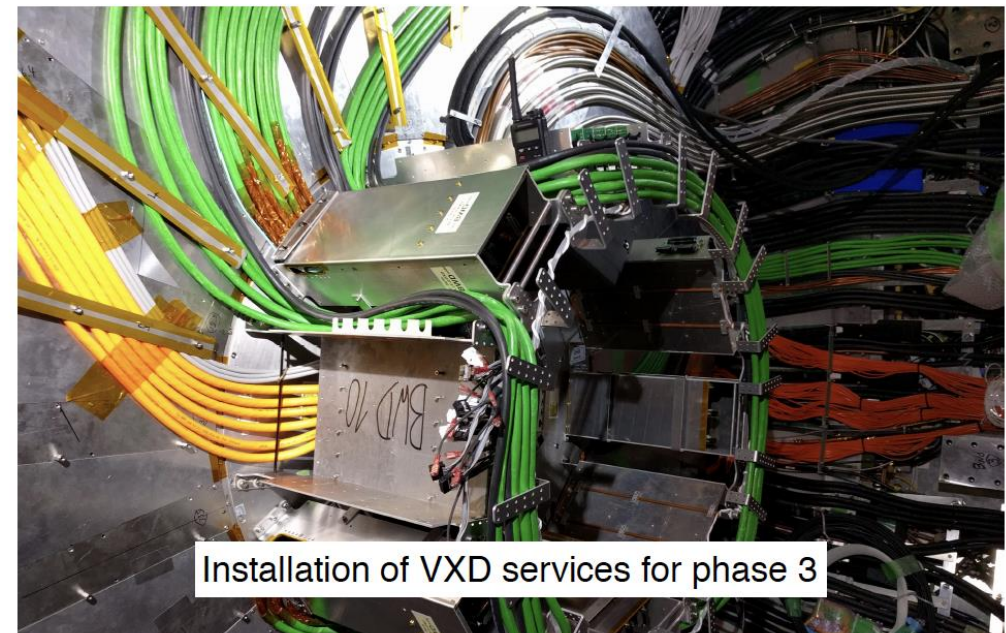
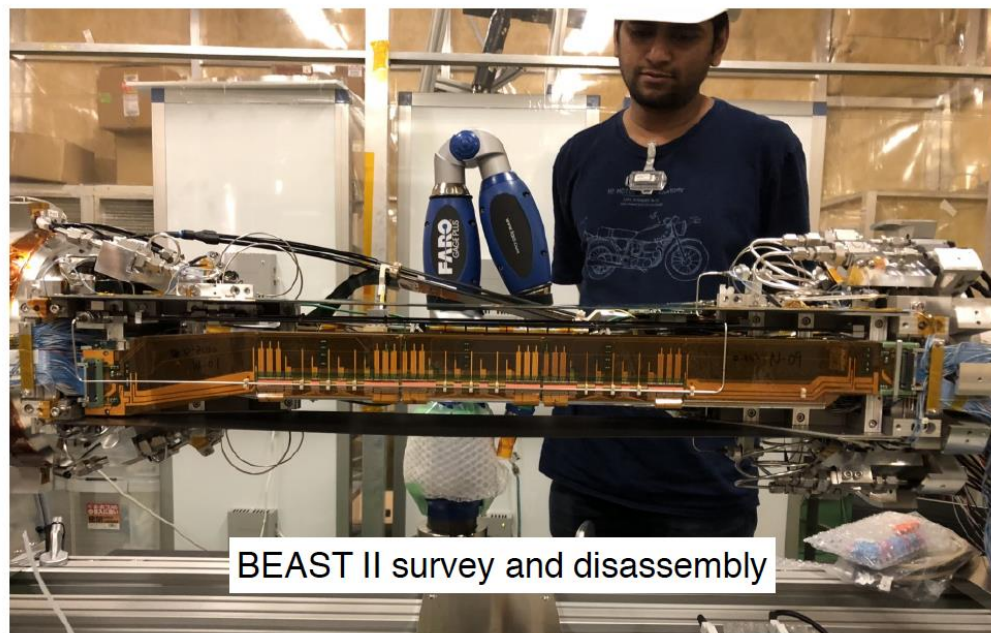
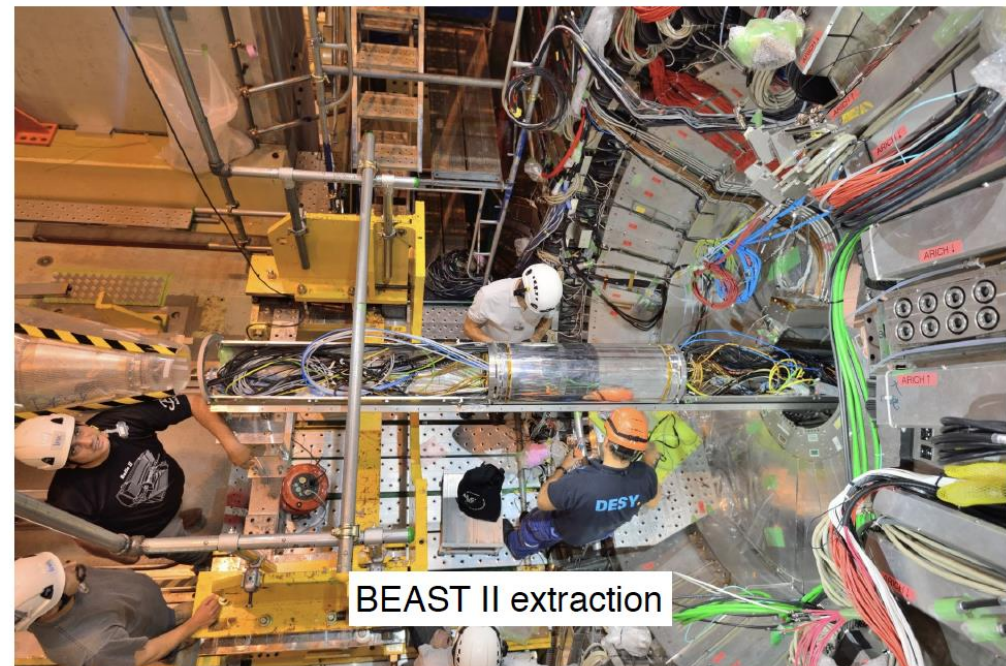
Power supplies

DAQ & slow control

Goals:

- study systematic performance of PXD
- verify transport and mounting procedures
- pre-commissioning before final campaign at KEK

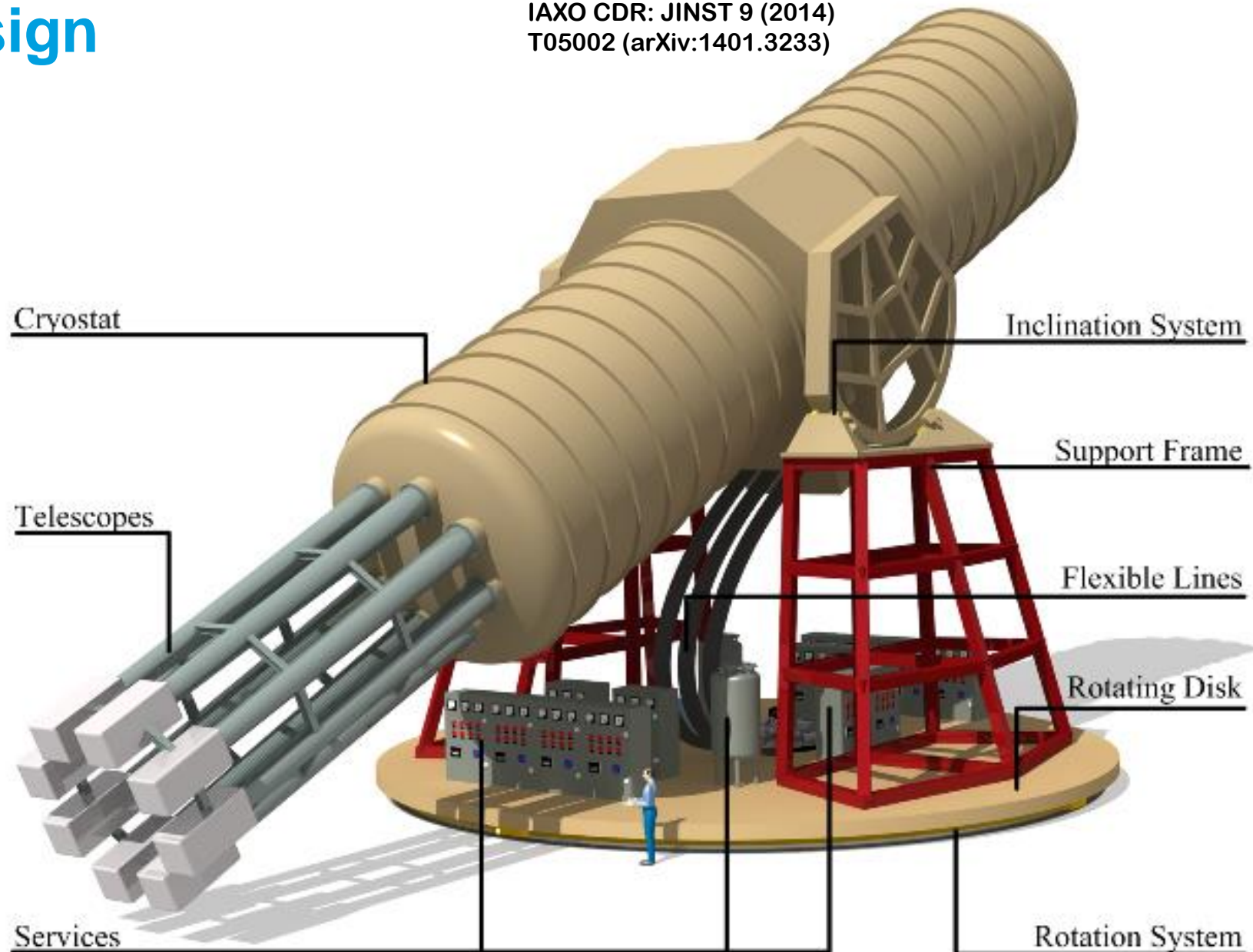
Belle II: Phase 3 preparations



IAXO Conceptual Design

IAXO CDR: JINST 9 (2014)
T05002 (arXiv:1401.3233)

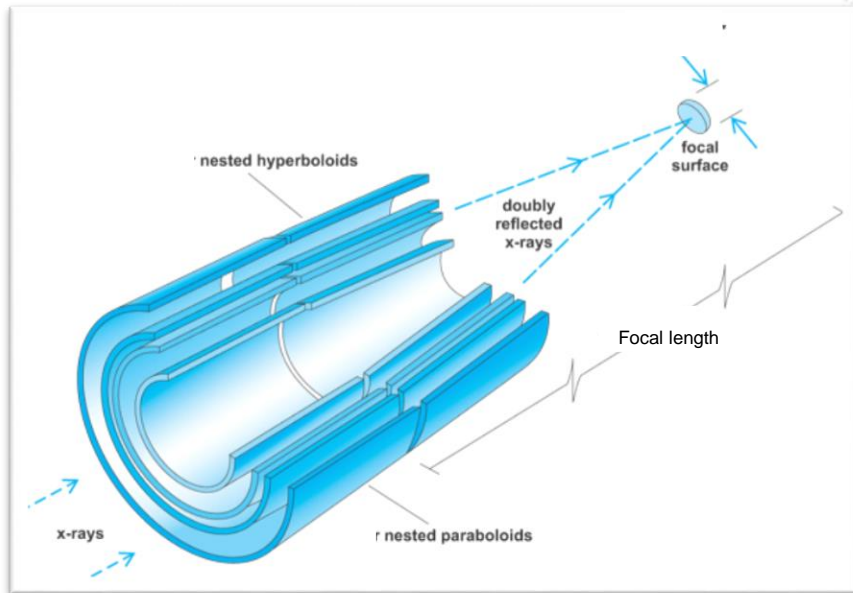
- Large toroidal 8-coil magnet
 $L \approx 20$ m
- 8 bores: 600 mm diameter each
- 8 x-ray telescopes + 8 detection systems
- Rotating platform with services



IAXO Magnet & Optics

IAXO telescopes

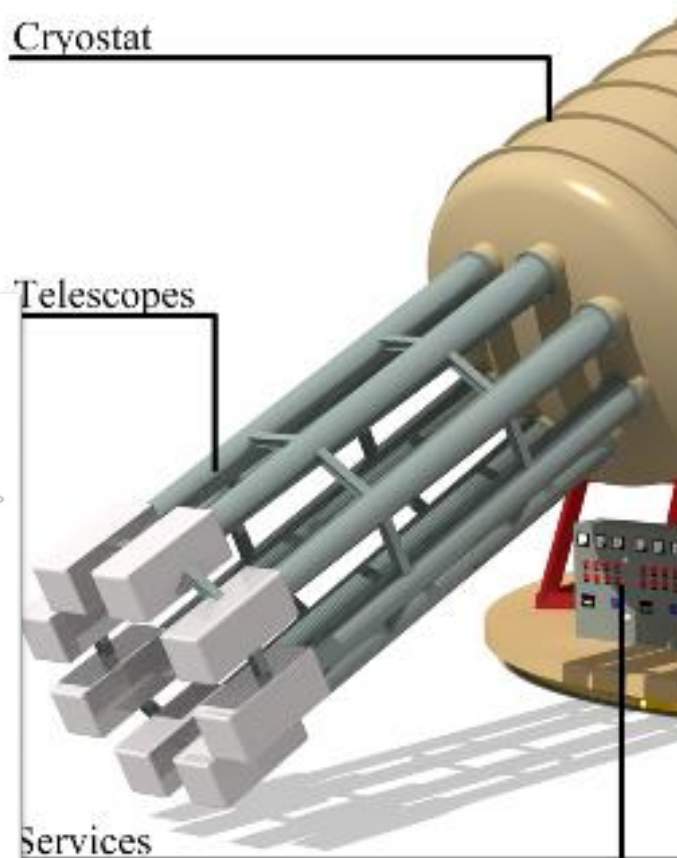
- Slumped glass technology with multilayers
- Cost-effective to cover large areas
- Similar to NuSTAR optics
- Focal length ~5 m
- 60-70% efficiency
- LLNL+UC+DTU
+ MIT + INAF



Cryostat

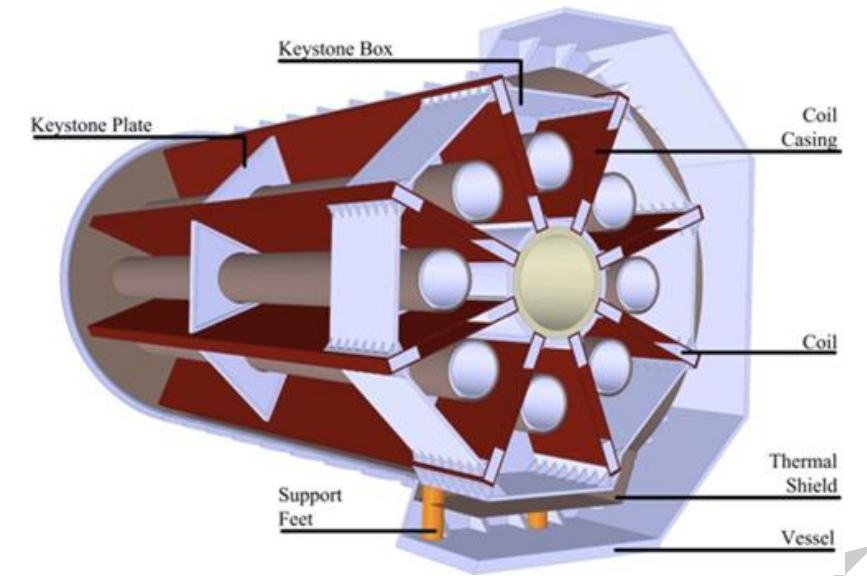
Telescopes

Services



IAXO magnet

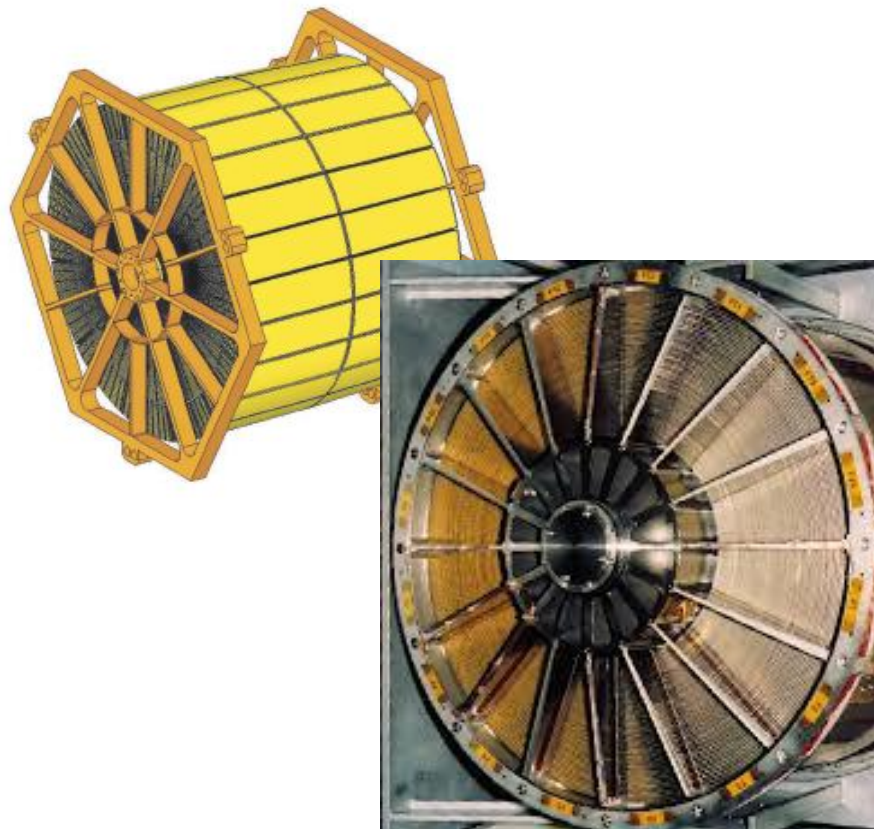
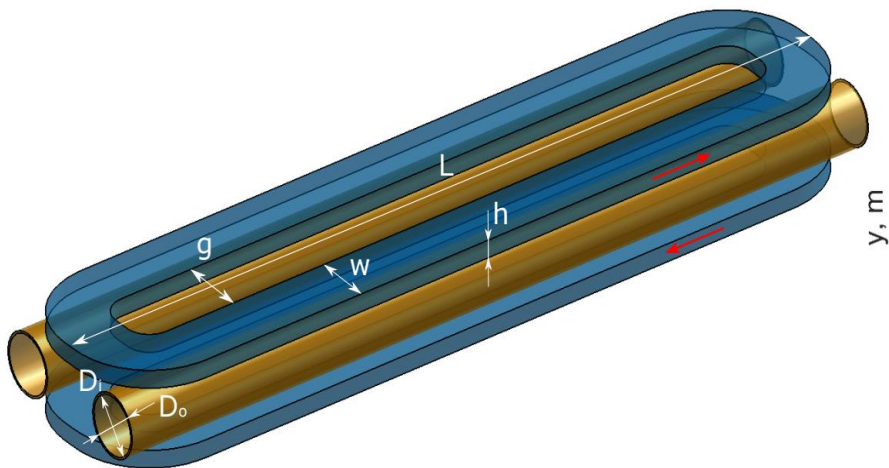
- Superconducting “detector” magnet.
- Toroidal geometry (8 coils)
- Based on ATLAS toroid technical solutions.
- CERN+CEA expertise
- 8 bores / 20 m long / 60 cm Ø per bore



Baseline developed at:
IAXO Conceptual Design: JINST 9 (2014) T05002
(arXiv:1401.3233)

BabyIAXO

Magnets optics detectors



“Common coil” configuration chosen
Minimal construction risk: move to construction asap
Cost-effective: Best use of existing infrastructure (tooling) at CERN
Winding layout very close to current IAXO toroidal design.

Optics - baseline option: Segmented-glass and flight spare XMM optics from ESA.
Minimal risk to the project
Risk reduction for final IAXO segmented-glass optics
XMM optics specs very close to IAXO optics design

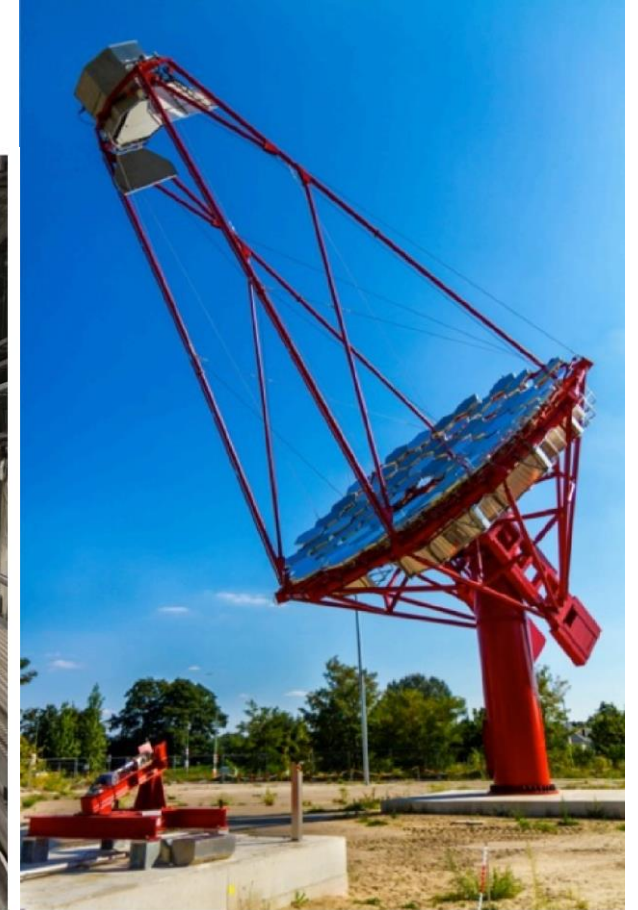
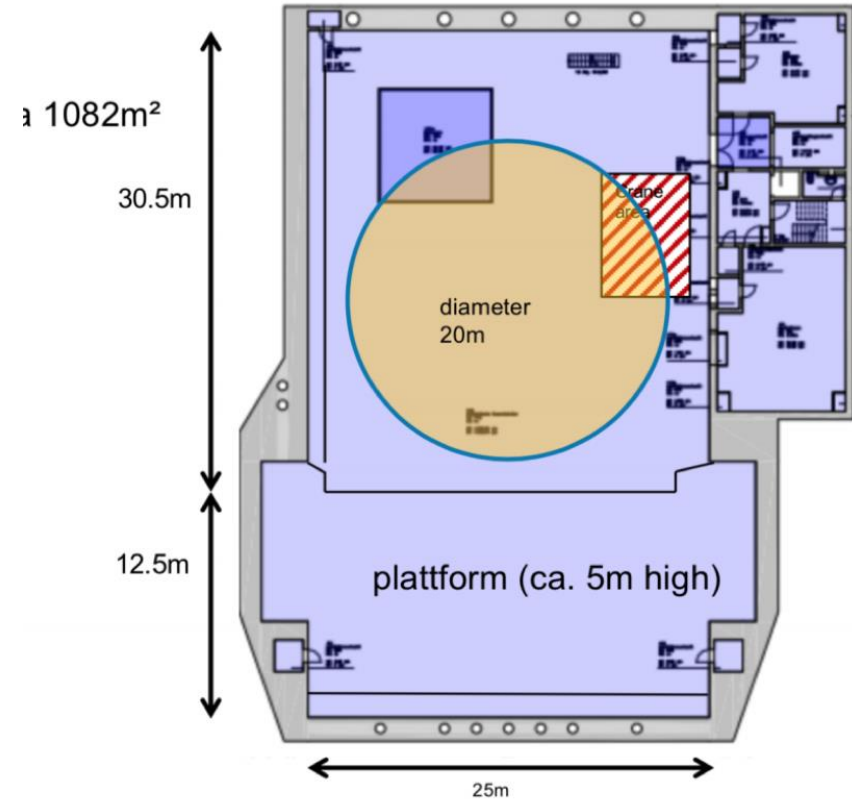
Detectors - baseline option: 2 Micromegas setups
In addition: a R&D generic platform to improve and tests all other detection technologies

IAXO and BabyIAXO

Milestones and plans

- First concept studies date back to 2011.
- CERN SPSC reviewed positively physics program of IAXO in 2014.
- IAXO progress is being followed by “Physics Beyond Colliders” process at CERN (to provide feedback for the European Strategy Part Phys)
- Collaboration formally established in last year’s collaboration meeting at DESY:
 - 17 institutions to sign IAXO bylaws
 - Management structure defined and operative.
- Near term goal defined for the collaboration: **BabyIAXO**
 - Full intermediate experiment with relevant physics potential
- BabyIAXO Magnet under design at CERN (Applied fellow)
- Important support decisions obtained recently: **ERC funding in 2018**. But also, preparatory IAXO projects granted in Germany, Croatia, Spain, US....
- Solid plans towards BabyIAXO. First physics could come in 3-4 years. Discussion started towards an MoU, detailed cost sharing and timetable.

BabyIAXO at DESY



HERA south hall (former ZEUS experiment hall): preferred site for BabyIAXO
BabyIAXO collaboration suggested review by DESY PRC by spring 2019
→ in-depth scrutiny (optics, magnet, cryo, infrastructure, physics, detector, ...)

DESY infrastructure & expertise very well suited to IAXO