



**ENDURANCE**  
**Instruments and Guides**

Charles Dewhurst

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ILL 1999 → 2023 : Celebrating 25 years of making ‘stuff’ work at ILL

- Leeds BSc Physics → Cambridge PhD Superconductivity → Warwick Post-Doc – introduced to Neutrons



**D33**

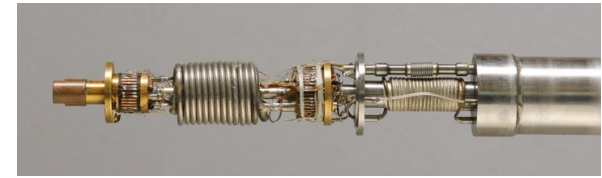
- ILL:

- 1999 → 2011 : D22 – Small-Angle Neutron Scattering
- 2005 → 2014 : D33 – Scientific project leader  
..... A millennium project
- 2015 → : Scientific Assistant to DPT  
.....Endurance
- 1999 → : Software – Data treatment, instrument & guide simulations

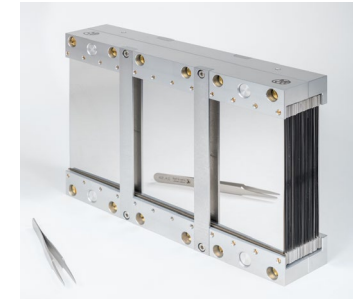
# Enabling Millennium & Endurance

## Technological developments:

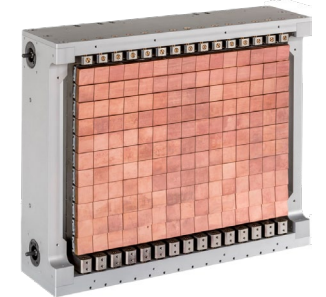
- Supermirrors
  - Large detectors
  - Precision optics
  - Polarised  $^3\text{He}$  technologies
  - Sample environment
  - Software
- Guides, polarisers, analysers
  - Position sensitive, size, resolution, count rate
  - Monochromator materials processing & mechanics
  - Optical pumping, cells, rf-flipper, magic-box
  - Extreme conditions: precise, reliable, autonomous
  - Instrument control, data analysis, simulations



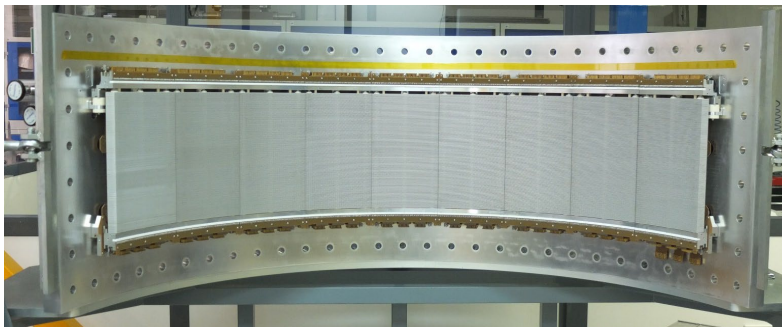
Dilution refrigerator



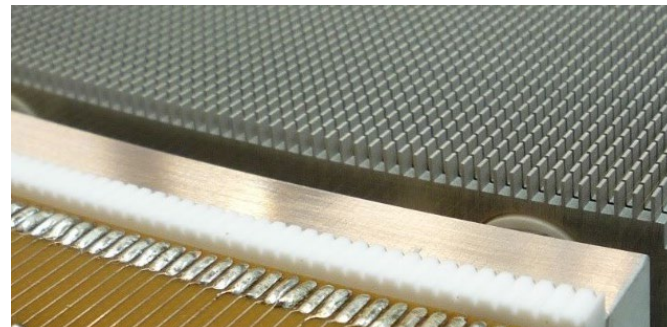
WASP analyser



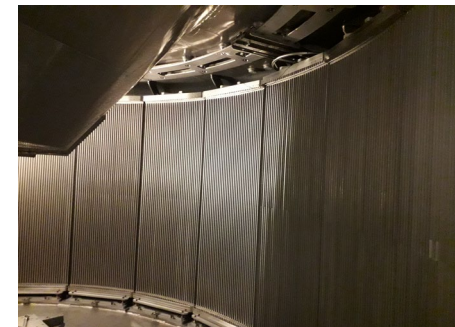
Panther Cu double-focus



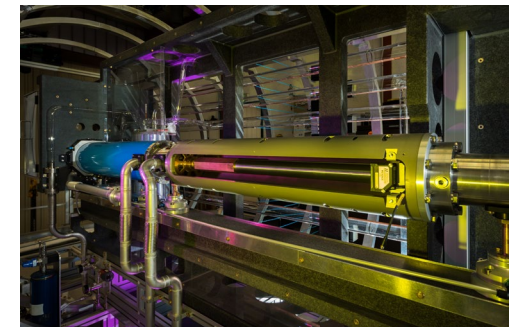
Trench-MWPC detector (XtremeD, D16, D20)



In-house precision manufacturing



Multi-tube detector (Panther)



Tyrex 2  $^3\text{He}$  station



## ENDURANCE:

Phase 1 (2016 – 2018), Phase 2 (2019 – 2023)

- More than 30 instrument projects – financial envelope ~ 55 M€
- Independent projects – easily rolled out
- Interdependent projects – require large infrastructure (guides) replacement



- H24 Guide (2023)
- D10+
- IN13
- XtremeD
- CT2

### Ongoing Projects:

- D20 Detector (2024)
- MARMOT (Thales) (2024/5)
- WASP (2024/5)

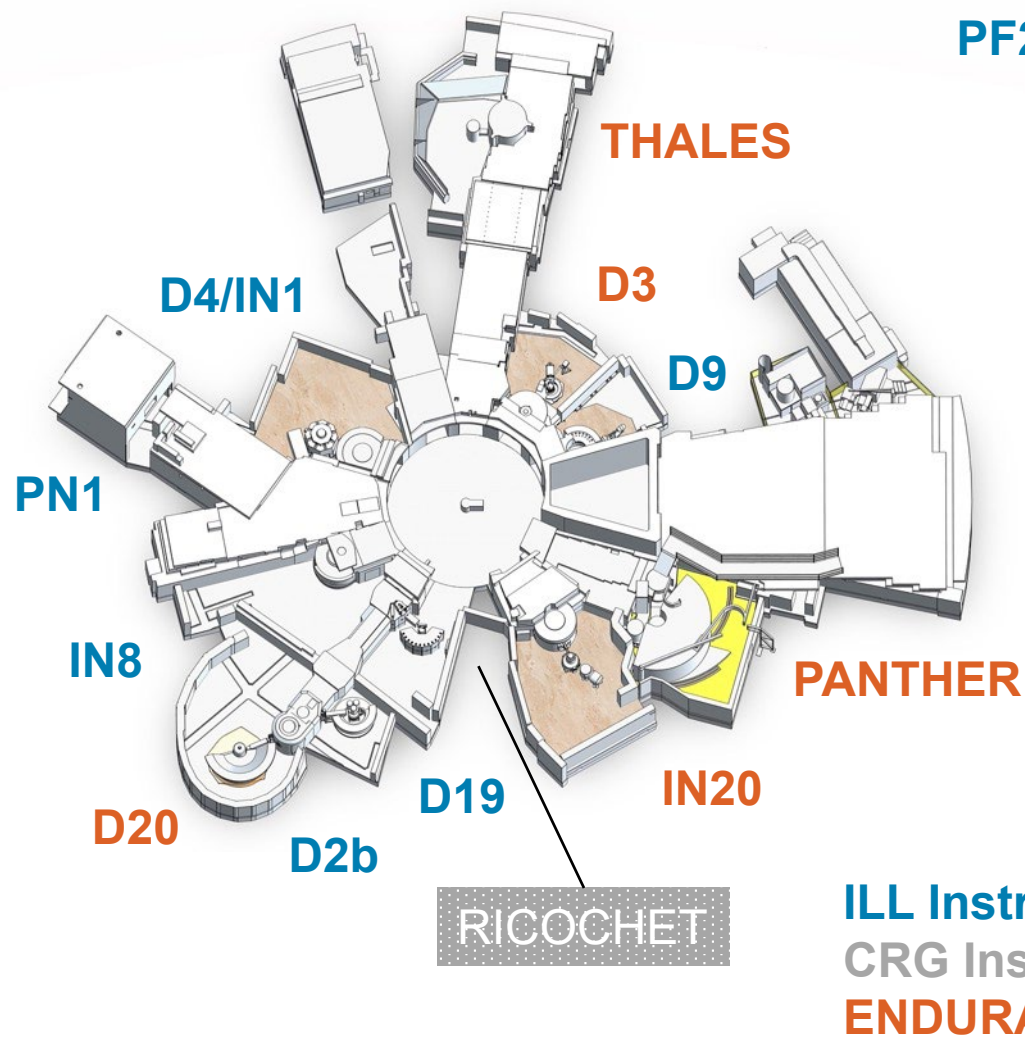
- H15 Guide (2024)
- T3
- D(00)7
- D11
- SAM
- SHARP+

**H1-H2 Shutdown  
(Oct. 2021 – Feb. 2023)**

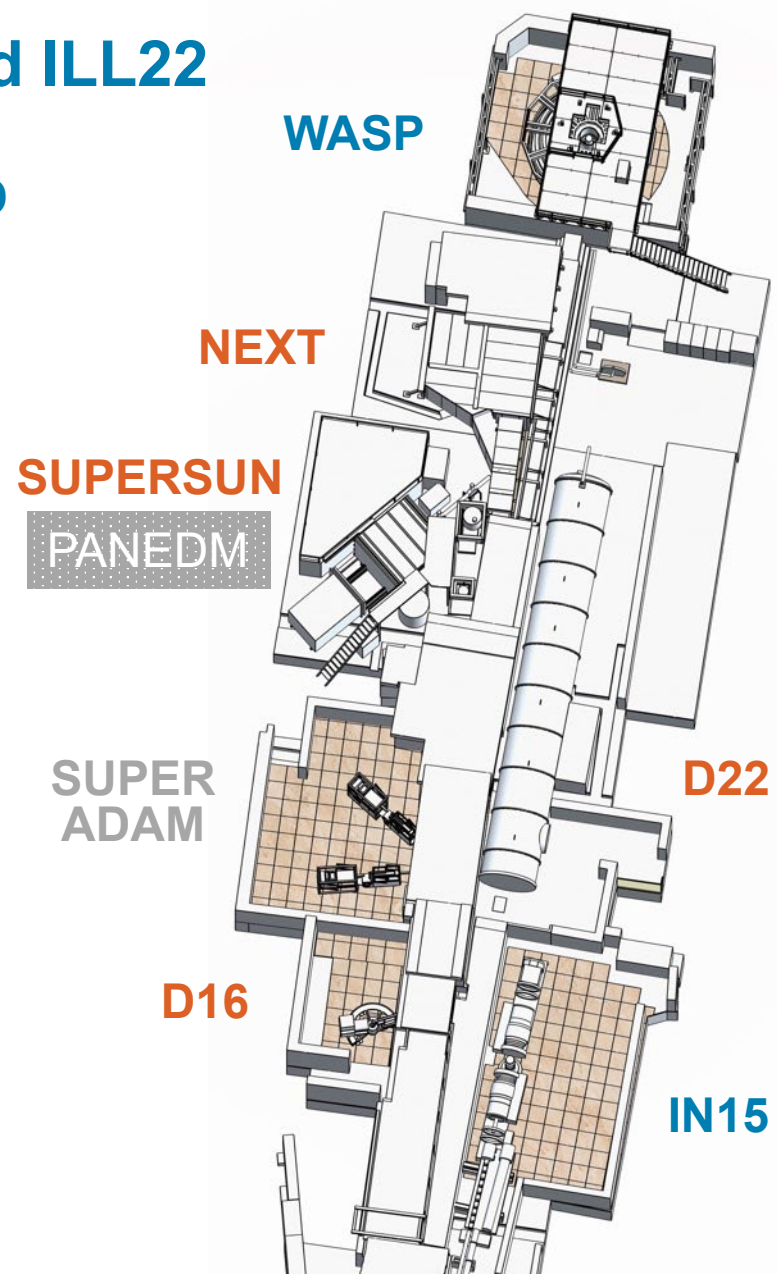
interdependent projects: H24, H15 - major infrastructure & civil works

# Instruments in User Program – ILL5-C and ILL22

PF2 in ILL5-D

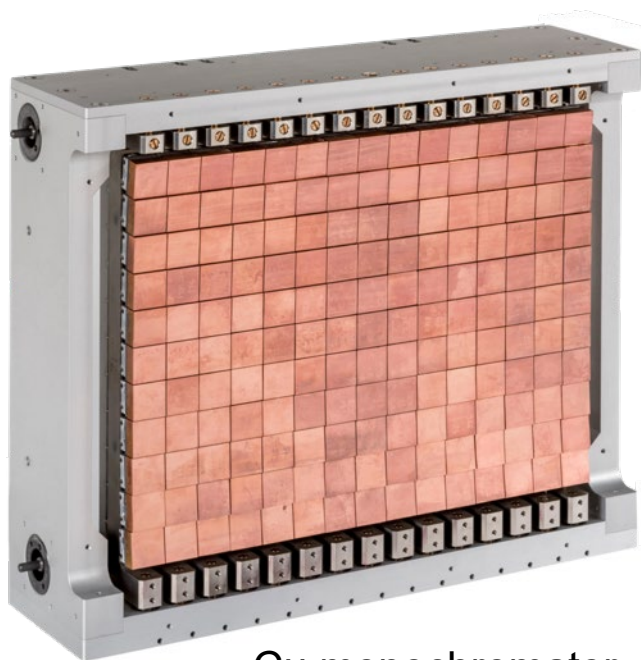


WASP

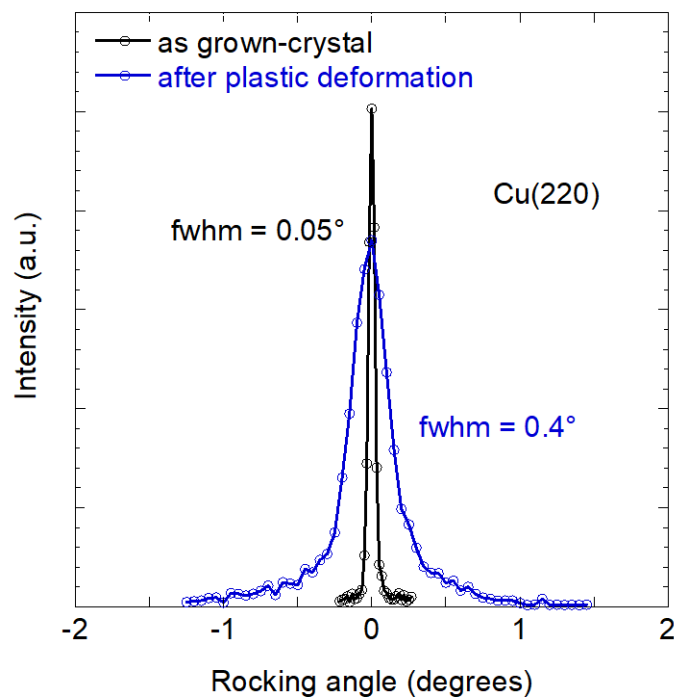


# Endurance Instruments

## PANTHER: thermal neutron time-of-flight spectrometer (x60 IN4)



Cu monochromator



position-sensitive detector

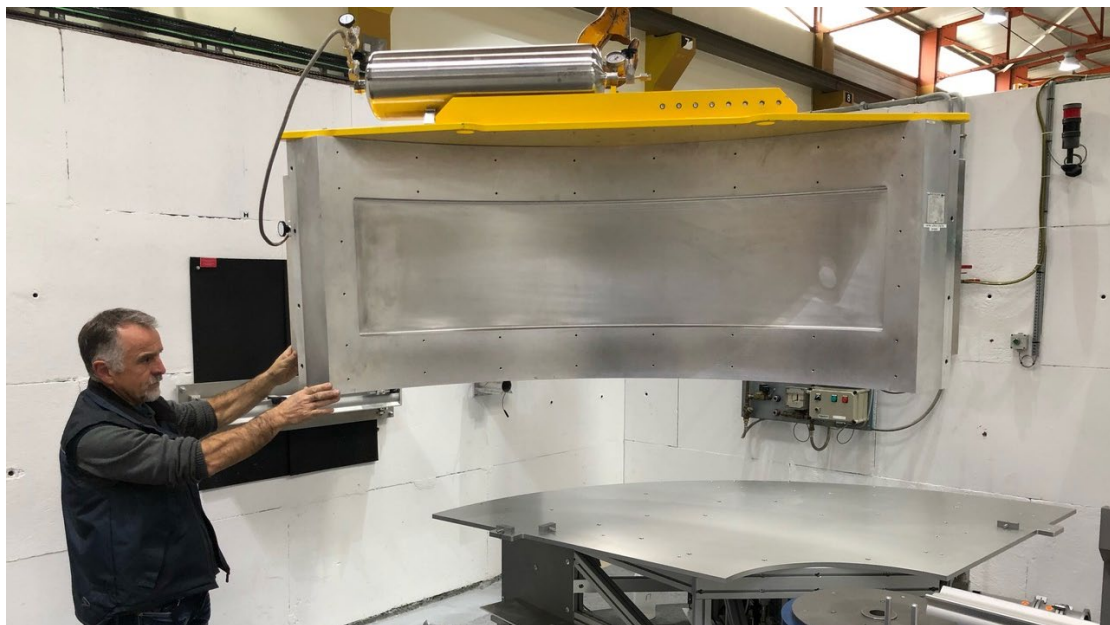
- large performance increase (to IN4): detector area, monochromator size and matching beam divergence, (commissioned in 2020)
- installation of the new chopper system (in commissioning): further reduction in background
- Endurance project of polarisation-analysis using [PASTIS-3 relaunched](#)

B. Fak, M. Koza, G. Manzin



# Endurance Instruments

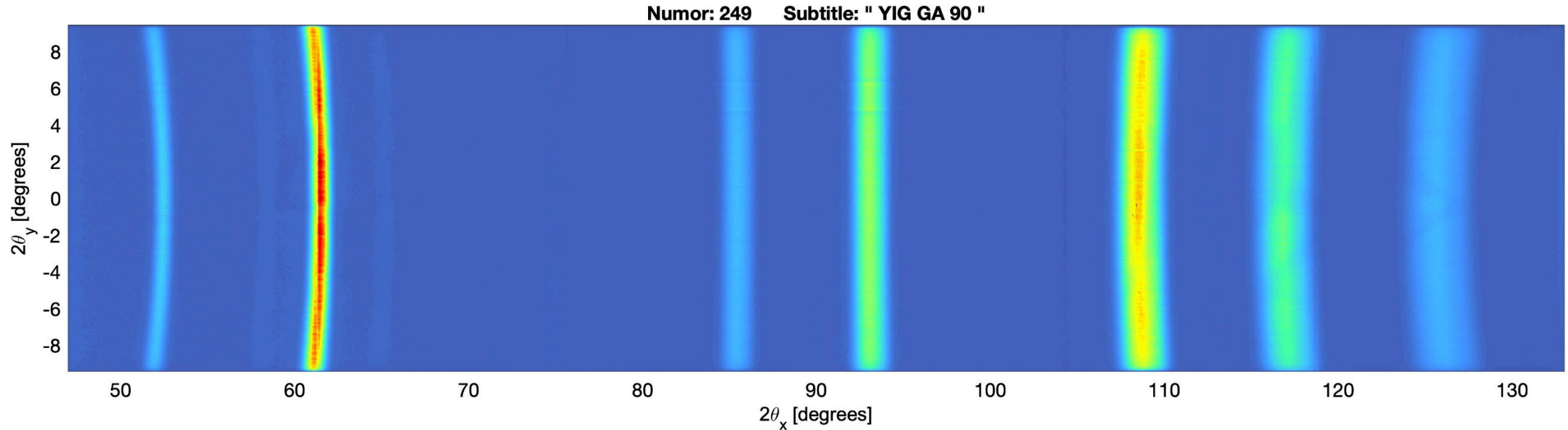
## D16: cold neutron diffractometer



- the new D16 instrument:
  - Helium filled flight box and compatibility with large sample environments, e.g. cryomagnet
- new wide-angle detector, 85° coverage (c.f. 25° previously) based on ILL's trench Multi Wire Proportional Counter (MWPC) technology
- $R = 1.15 \text{ m}$ , 1152 x 192 pixels @ 1.5 mm x 2 mm

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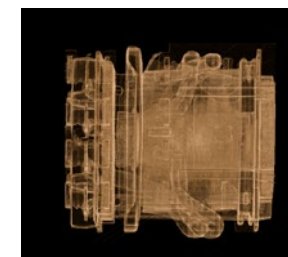
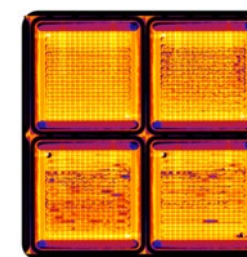
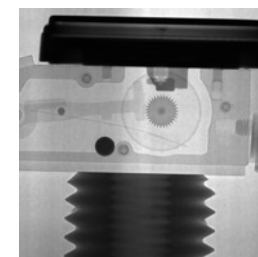
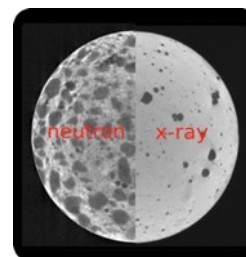
# Endurance Instruments

## NeXT: Neutron & X-ray Imaging and Tomography

April 1<sup>st</sup> 2022

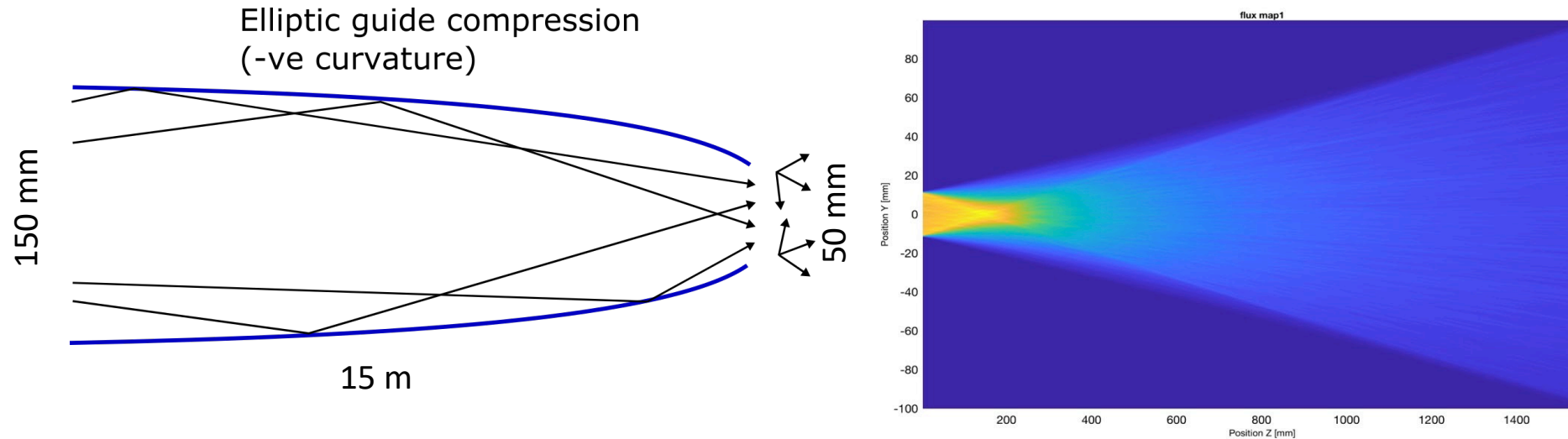


- NeXT: public imaging instrument with participation of UGA Grenoble & HZB Berlin
- major expansion in exp. capabilities: gratings interferometry, polarized neutrons
- monochromatic tomography MoTo station (2024)



imaging materials for science & engineering

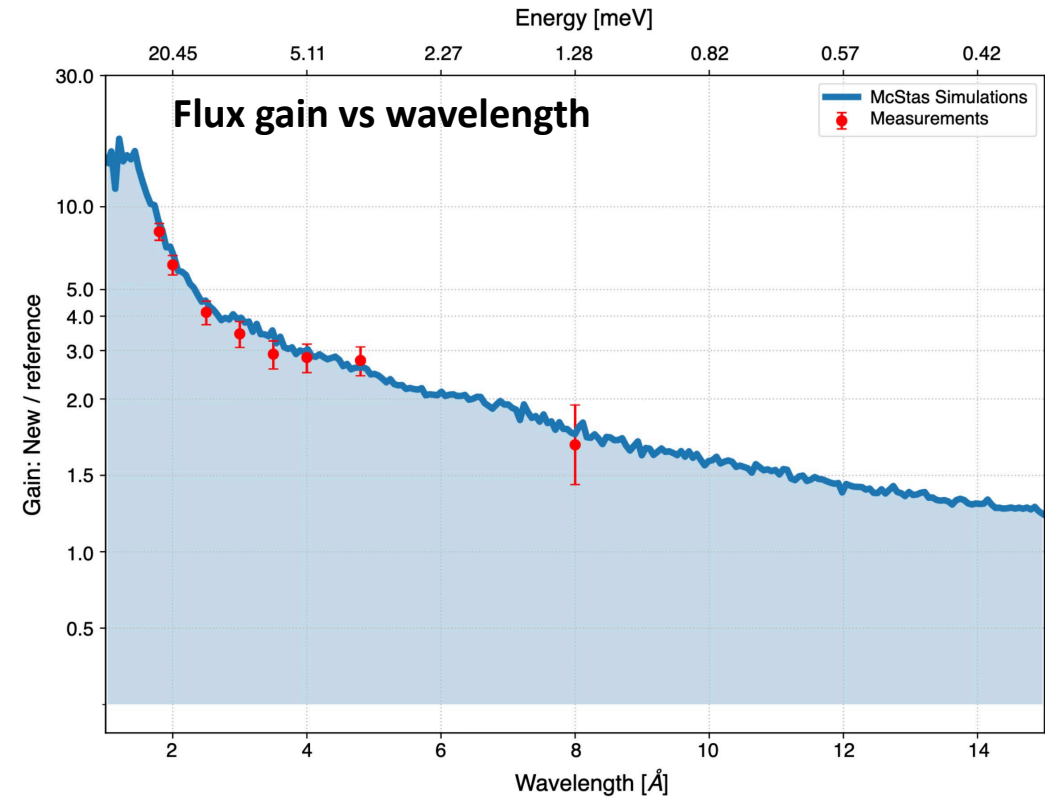
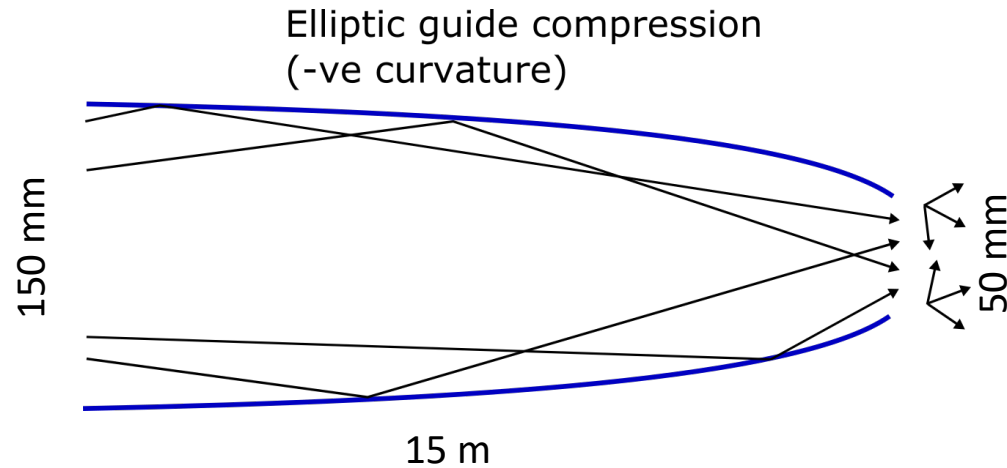
# IN5 – H16 double elliptical focusing guide



- cold TOF spectrometer (2019): new elliptically focussing neutron guide
- best use of phase space; huge gains in intensity – in particular at short wavelengths; focussing onto much smaller samples.

J. Ollivier

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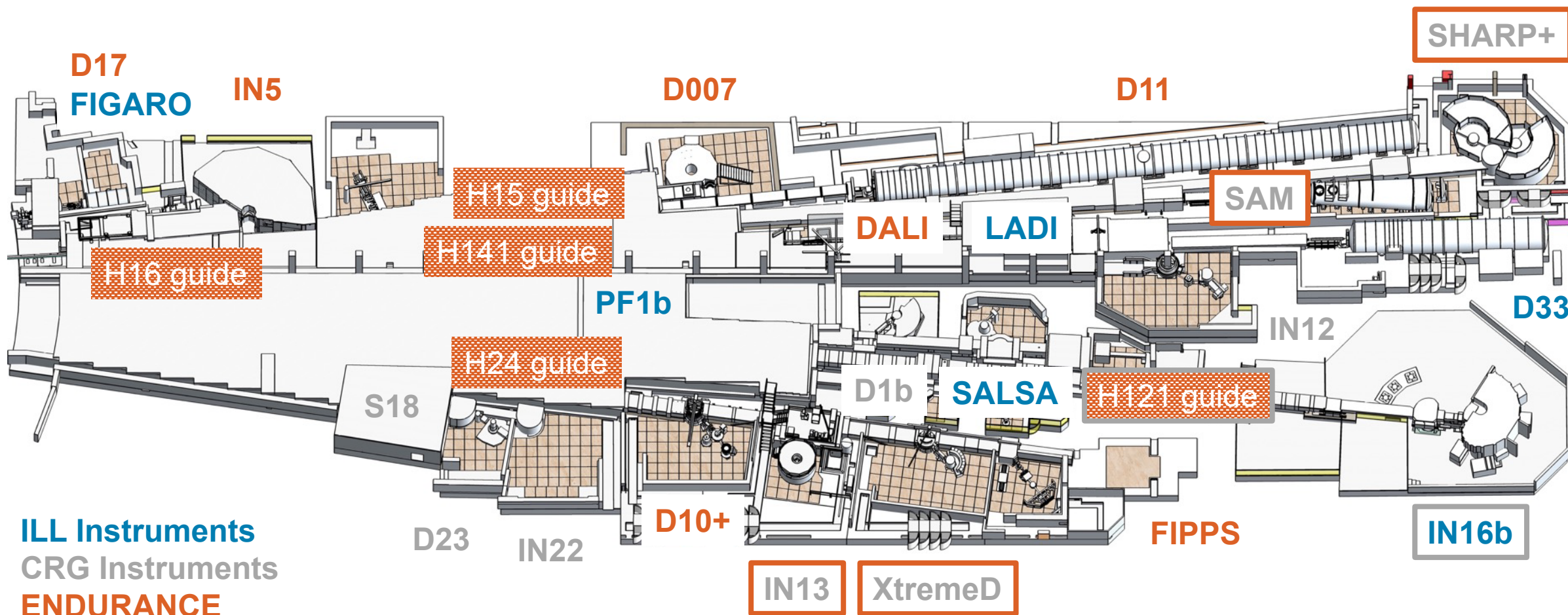


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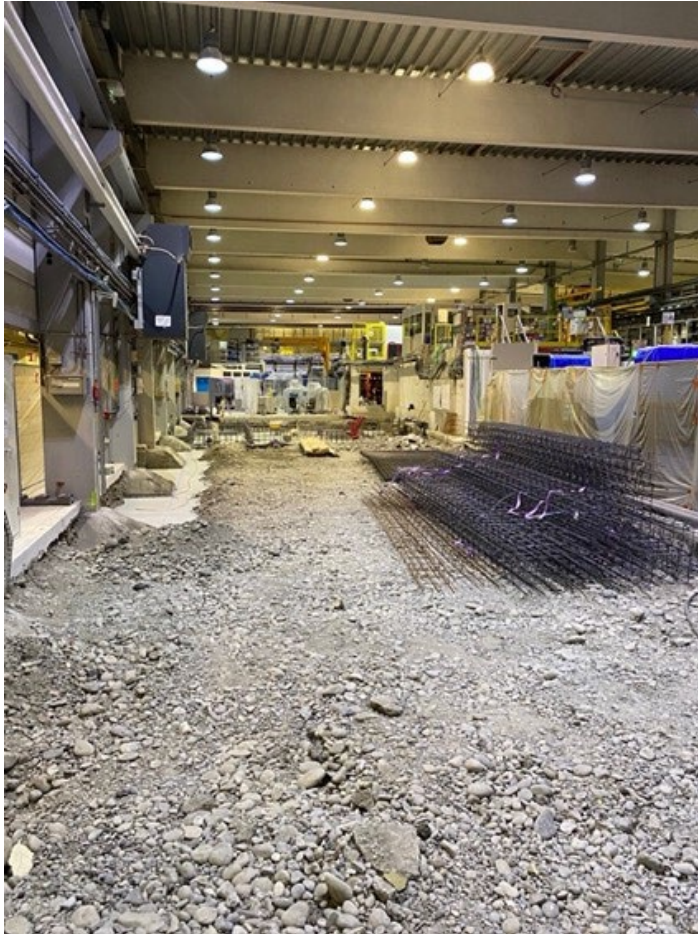
# Instruments in User Program – ILL 7 Guide Hall





# ENDURANCE Modernisation Program – H1-H2 Long Shutdown

maximum destruction February 2022



ILL7 guide hall - Chartreuse



ILL7 guide hall - Vercors

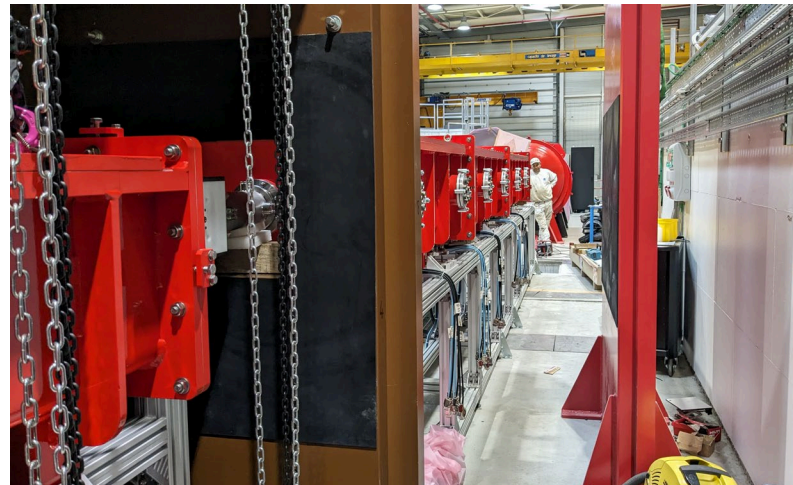


ILL22 guide hall - NEXT



# ENDURANCE Modernisation Program – H1-H2 Long Shutdown

## H24 & Instruments rebuilt by February 2023



**ILL7 – H24: D10+ & XtremeD**

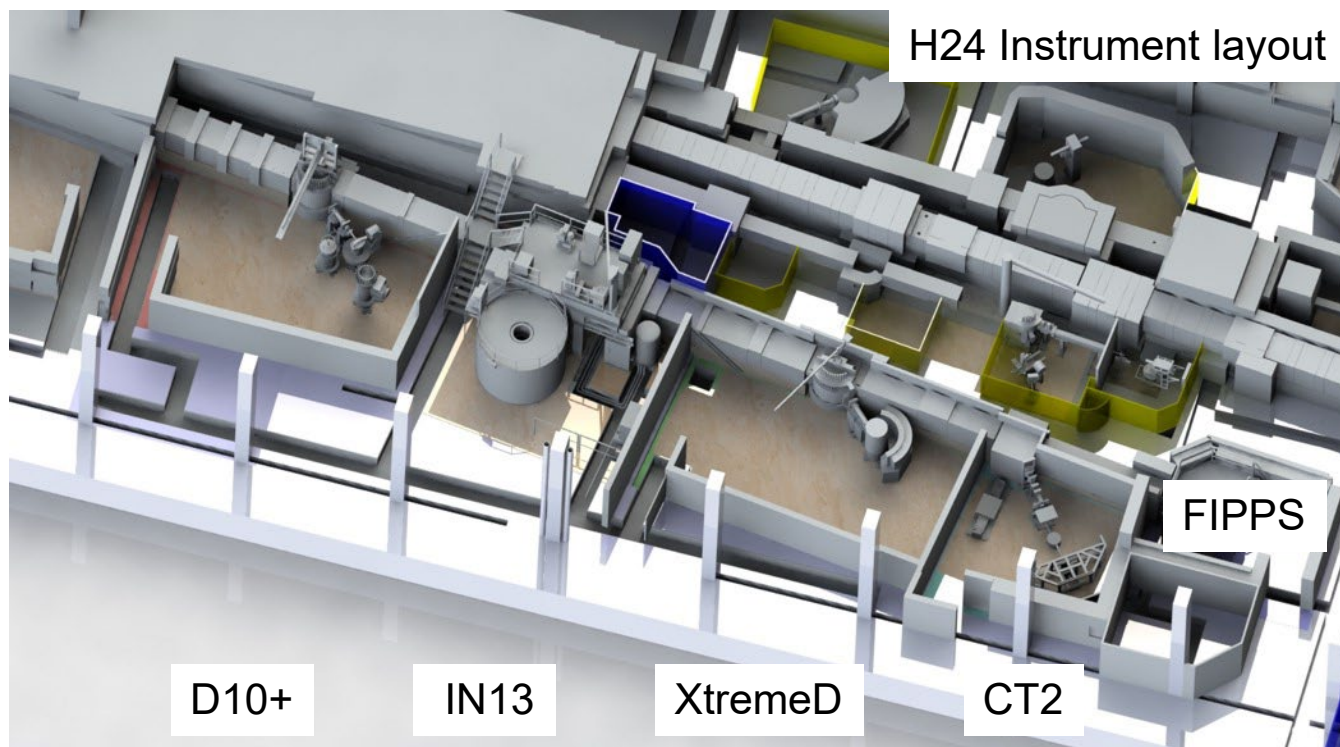
**ILL7 – H15: D11 & SAM**

**ILL22: NeXT & D16**



## Endurance Instruments

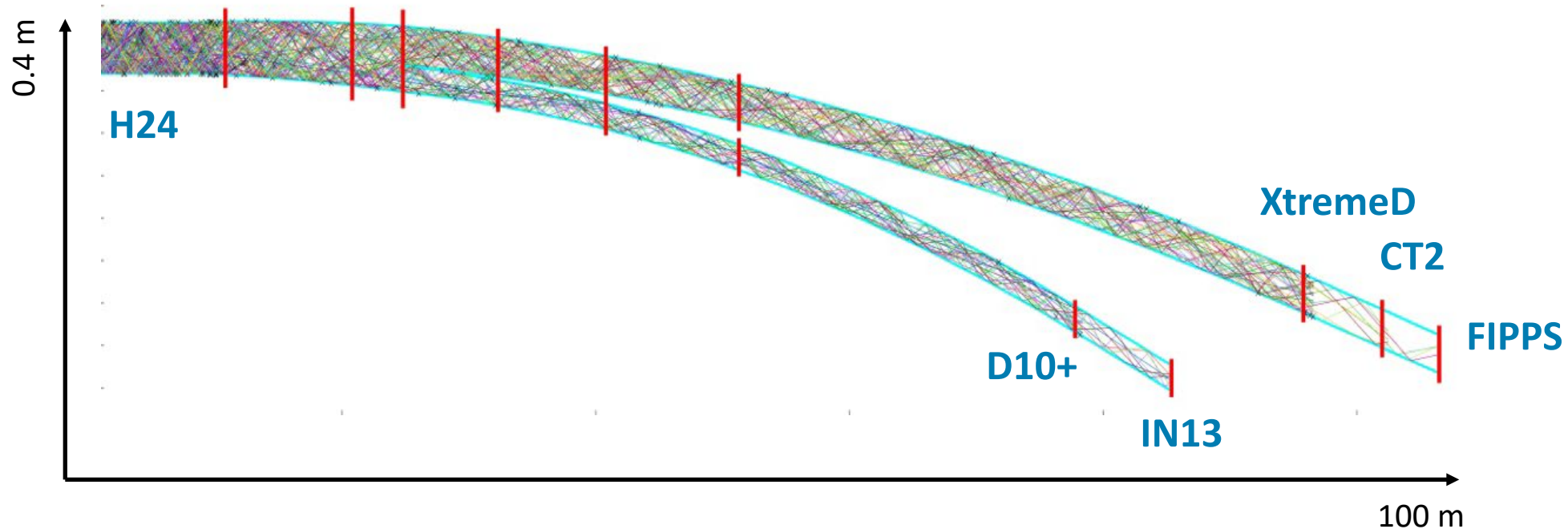
H24 thermal-neutron guide + instruments: D10+, IN13+, XtremeD, CT2, FIPPS



- common-curved-trumpet design exploiting two radii of curvature expanding the guide over 22m
- split into two branches H241 ( $R=14000\text{m}$ ), H242 ( $R=8000\text{m}$ ); high critical angle  $m=3$  coating
- **dedicated end-of-guide positions** for instruments with  $m=2$  divergence

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## H24 Endurance Instruments

in commissioning: thermal single-crystal diffractometer D10+



- four-circle diffractometer with optional energy analysis
- larger high-efficiency PSD detector
- ~ x10 performance of D10

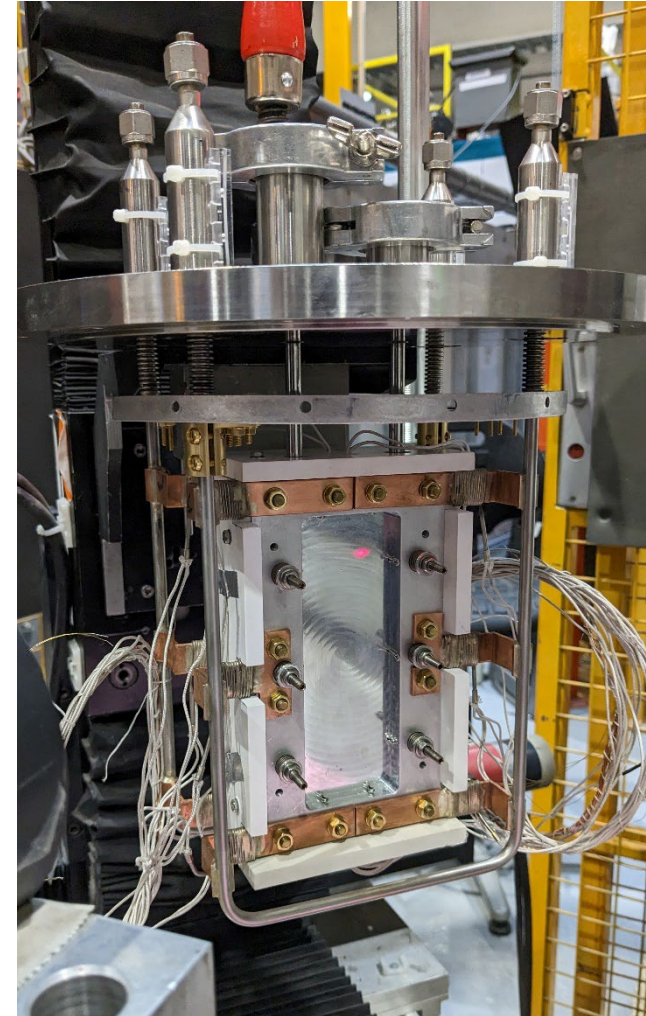


alignment of the double-faced Cu / HOPG monochromator with the first neutrons in 2023



## H24 Endurance CRG Instruments

in commissioning: XtremeD – IN13 backscattering



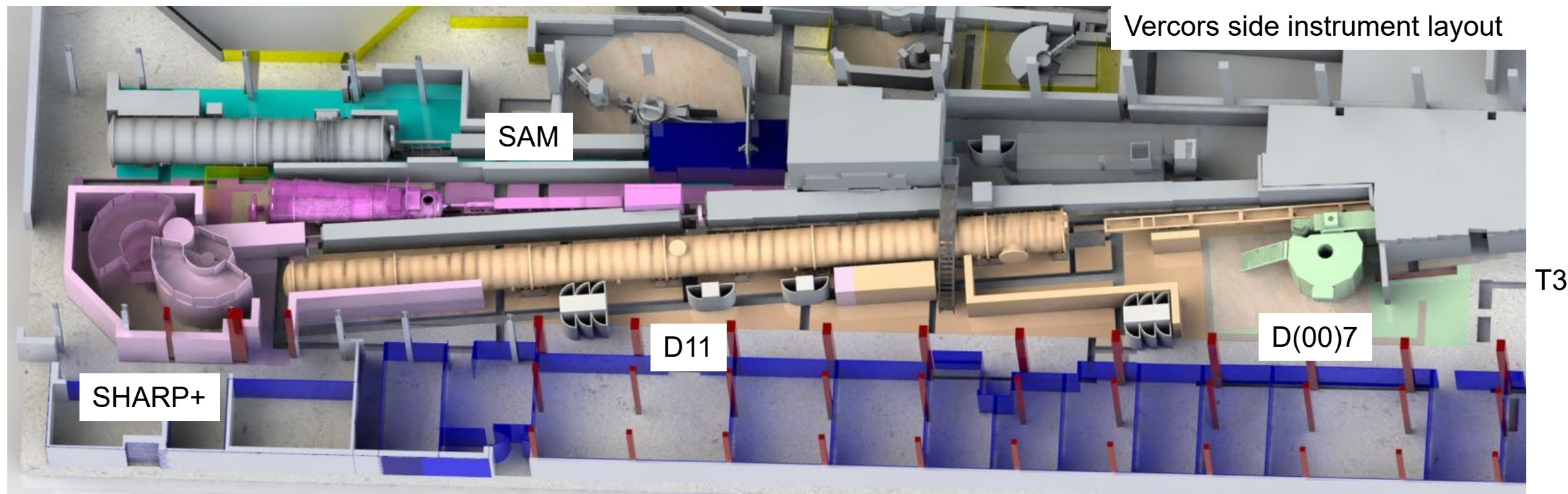
alignment of  
IN13 mono  
on T13c

- XtremeD: a new diffractometer for extreme sample environments: magnetic field, pressure, levitation, ...
- IN13: new temperature gradient monochromator at the thermal backscattering instrument



## Endurance Instruments

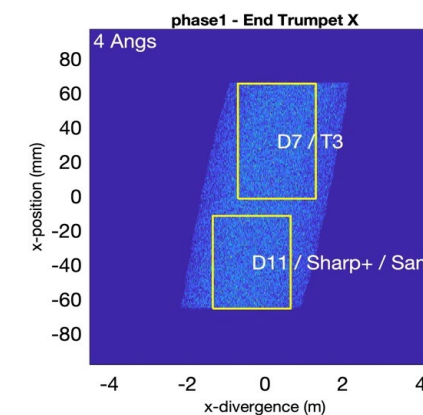
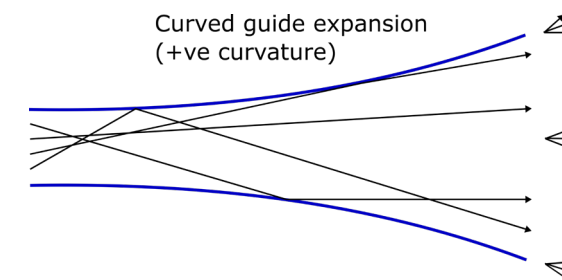
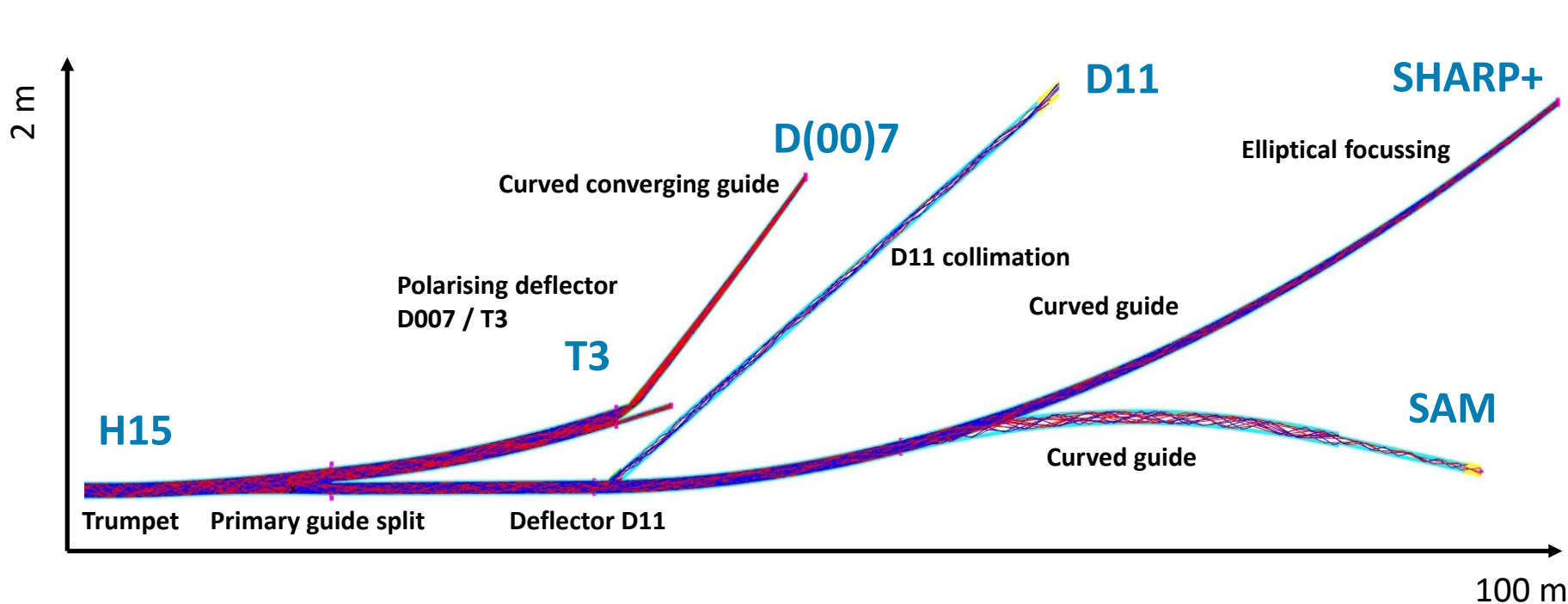
H15 cold-neutron guide + instruments: T3, D(00)7, D11+, SAM, SHARP+



- opposing-curved ‘trumpet’ ( $m=4$ ) spatially expands the guide to to split into multiple branches
- highly complex guide – both optically and engineering
- optimised end-of-guide positions for new instrumentation: T3, D(00)7, D11, SHARP+, SAM

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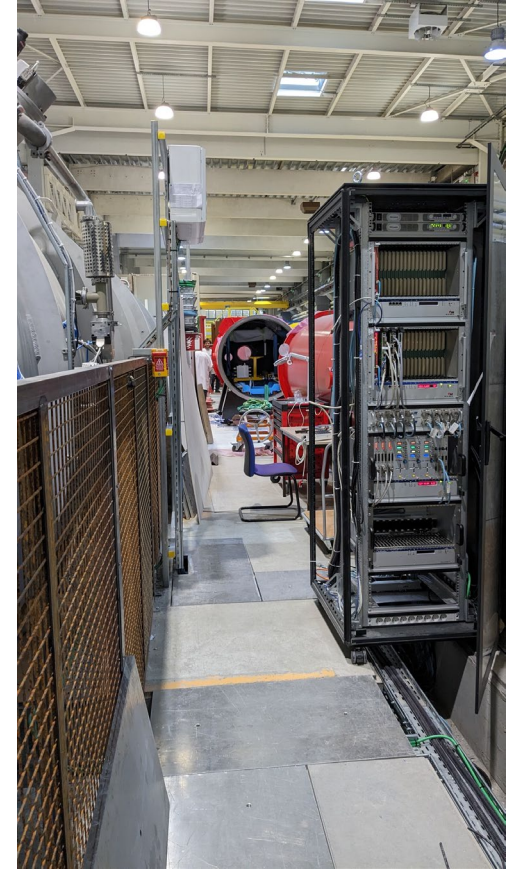
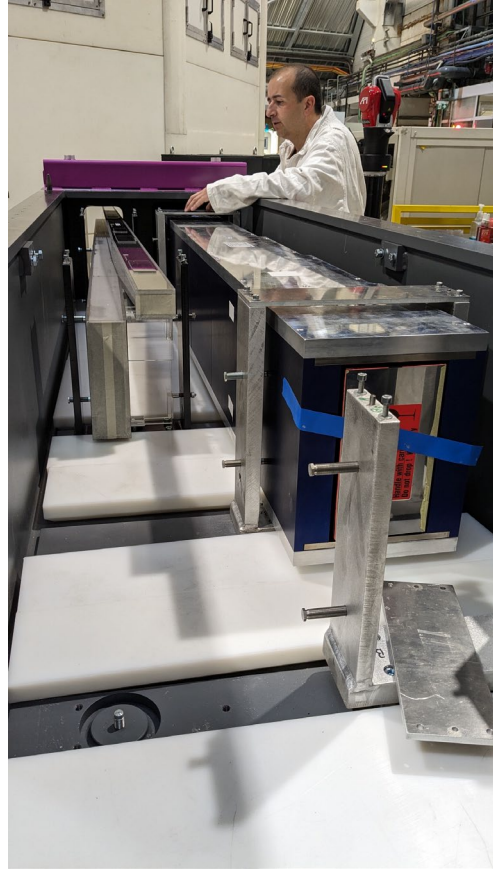


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H15 cold-neutron guide + instruments: T3, D(00)7, D11+, SAM, SHARP+



- H15 guide installation continues during 2023
- commissioning during 1<sup>st</sup> cycle in 2024; project proceeds as planned

November 2023



## H15 Endurance Instruments

SHARP+: crystal time-of-flight spectrometer with time and monochromatic focussing options



- brand-new primary spectrometer with a 60m long dedicated guide
- as compared to IN6: 5 times the flux, 3.7 times detector area, significantly lower background
- enhanced wavelength range from 2Å to 6Å

# H15 Endurance Instruments

D007: permanently-polarized diffuse-scattering diffractometer and spectrometer

new primary spectrometer with a dedicated guide

- in-guide polarizing deflector
- large focussing monochromator
- evacuated flight path

expected flux gain > x10 D7

will allow for polarisation-analysis TOF spectroscopy

- magnetic dynamics
- quasielastic scattering





# ENDURANCE

## Instruments and Guides

- Completion of Endurance upgrade program (>30 projects): *state-of-the-art facility for science and innovation*
- Cutting-edge neutron scattering capabilities at a safe and sustainable neutron source through the next decade
- Restart of the reactor operation on 27<sup>th</sup> February
- Restart of user program:
- Cycles 2023:
 

▪ 1st March – 8 March	[28 MW]*	[7 days]
▪ 29 <sup>th</sup> March – 18 <sup>th</sup> April	[44 MW]*	[20 days]
▪ 10 <sup>th</sup> May – 5 <sup>th</sup> July	[48 MW]	[56 days]
▪ 22 <sup>nd</sup> Aug – 27 <sup>th</sup> Sept	[44 MW]*	[36 days]
▪ 24 <sup>th</sup> Oct – 10 <sup>th</sup> Dec	[57 MW]	[47 days]
		[166 days]



thank you  
after

