EUROPEAN SPALLATION SOURCE

Lund, 15 April 2024

High Pressure Systems

Update

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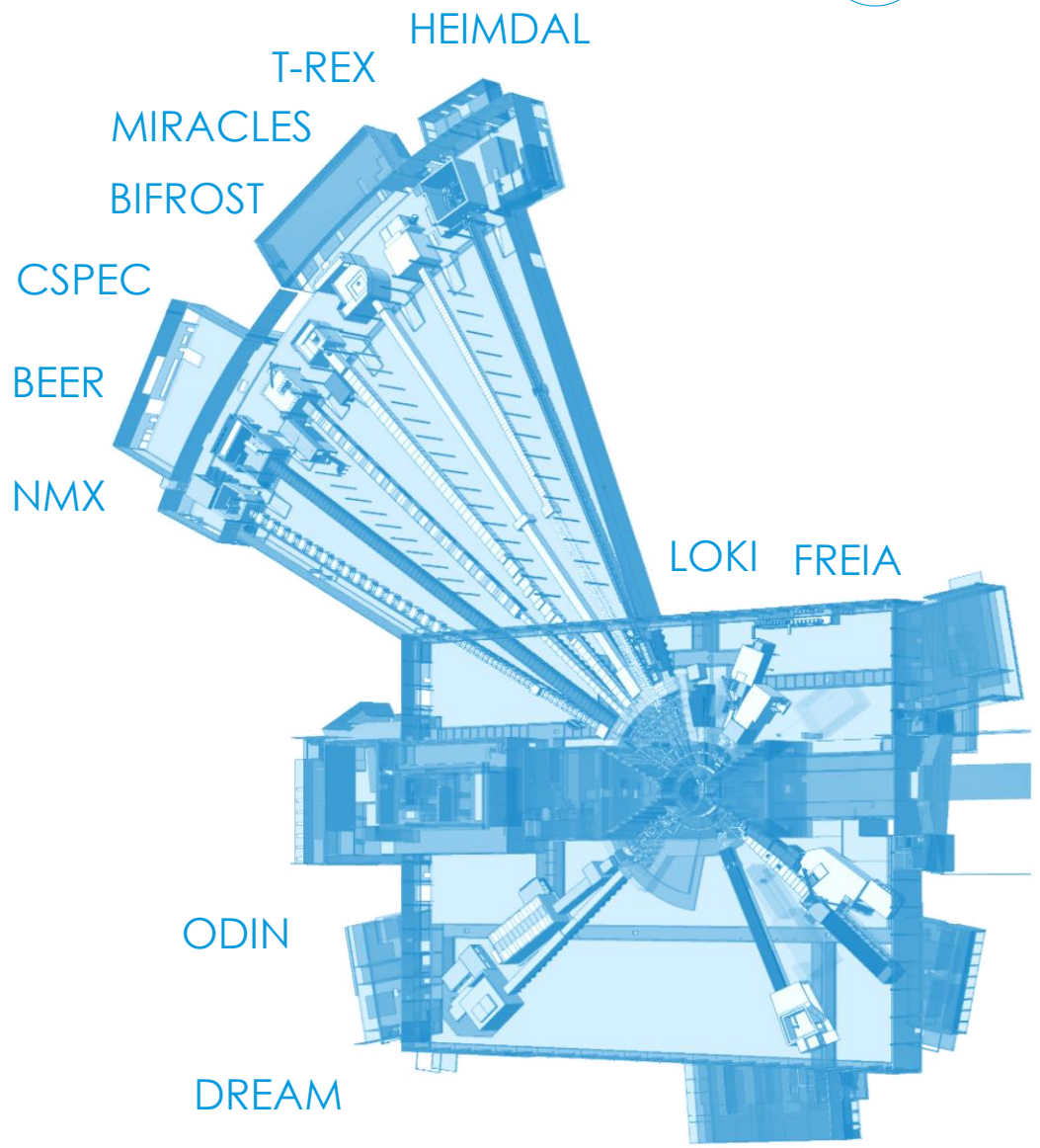
Lund, 15 April 2024

High-Pressure Experiments at ESS

ESS has now 15 instruments under construction

The MSPS Group aims to provide high pressure sample environment capable for achieving pressures from atmospheric up to tens of GPa.
Our approach is to enable high-pressure experiments on various ESS instruments, supporting traditional diffraction and spectroscopic measurements, small-angle scattering and imaging experimental techniques and combining high pressures with extreme low and high temperatures.

DREAM: Bispectral Powder Diffractometer
BIFROST: Extreme Environment Spectrometer
MAGIC: Magnetism, Single Crystal Diffraction
CSPEC: Cold Chopper Spectrometer
ODIN: Multi-Purpose Imaging
LoKI: Broadband SANS
BEER: time-of-flight diffractometer



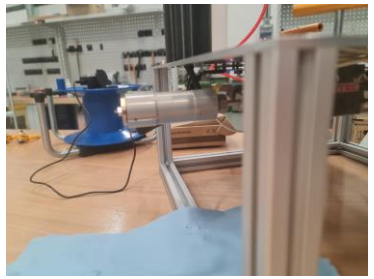
High-Pressure Systems at ESS

- Gas, liquid and clamp cells
- PE presses, PE press gas loader and PE Press CCR
- Diamond Anvil Cells
- Gas and liquid compressors
- High Pressure Laboratory Spaces and Test Bunker
- Summary and Next Steps
- LENS and 2024 IUCr HP Meetings

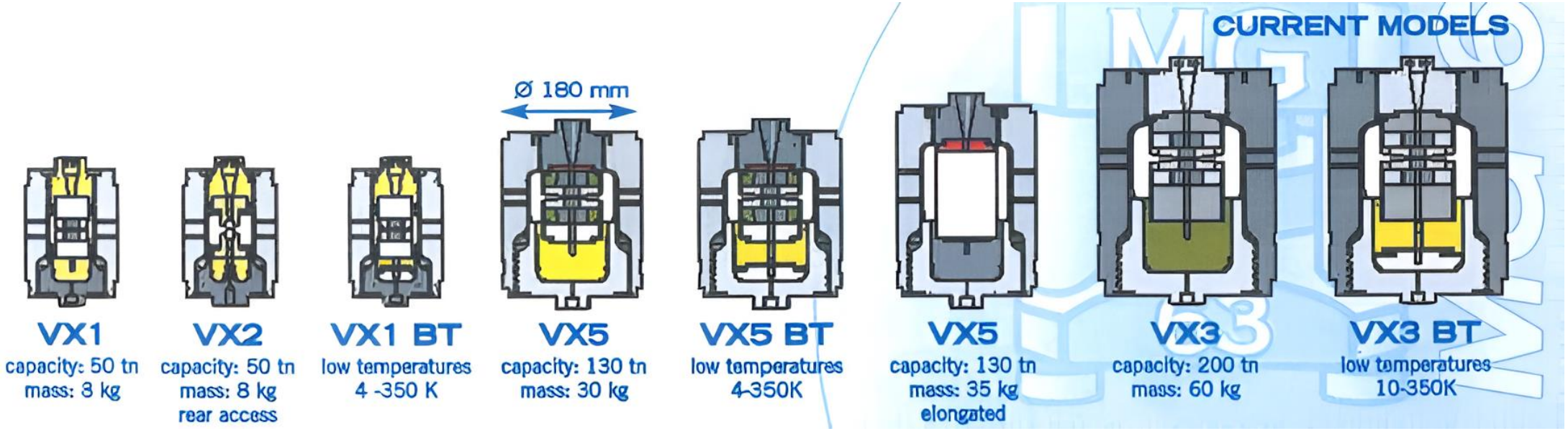
Gas, liquid and clamp high-pressure cells

- 5 gas cells*
  _2 x Al (max. pressure 4000 bars, diam. 5 and 7 mm)
  _2 x TiZr (max. pressure 5000 bars, diam. 5 and 7 mm)
  _1 x CuBe2 (max. pressure 7000 bars, diam. 7 mm)
- 4 liquid cells*
  _2 x Al (max. pressure 4000 bars, diam. 5 and 7 mm)
  _2 x TiZr (max. pressure 5000 bars, diam. 5 and 7 mm)
- 1 clamp cell* (CuBe, 15000 bars, diam. 5 mm)

Technical documentation delivered by IK LLB partner.
Liquid cells commissioned with manual 7kbar compressor without beam, gas cells to be tested with SITEC compressor in the future.
* Cells height: 25 mm, temperature > 1 K



Paris-Edinburgh Presses, Gas Loader and CCR



Initial demand for PE systems

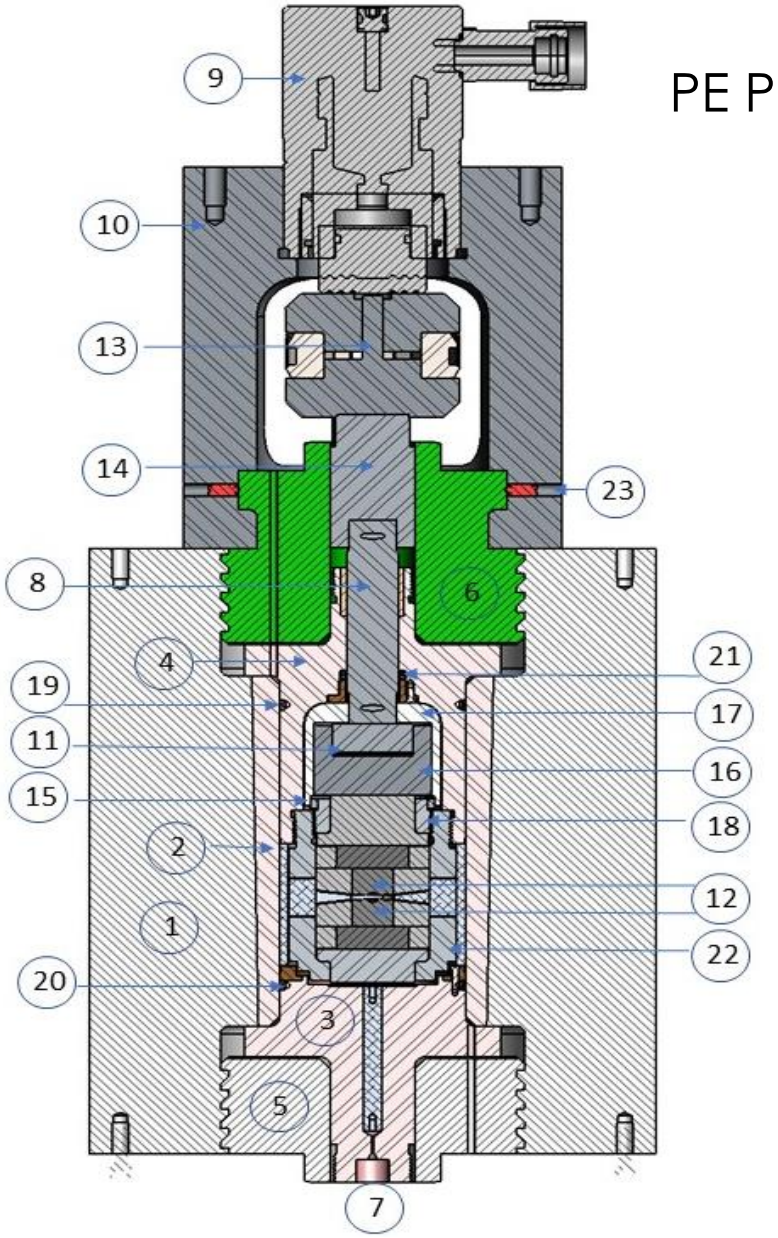
Instrument	Class	Primary geometry[3]	Demand for PE systems (3=high, 1=low,0=none)
MAGIC	DIFF (SXL)	L	2
DREAM	DIFF (PWD)	T or L	3
CSPEC	SPECT	L	2
BIFROST	SPECT	L	3
BEER	ENGINEERING	T or L	1
ODIN	IMAGING	L	1
LOKI	SANS	L	1
ESTIA	REFLECT	NA	0

[3] Transverse (T) means beam enters along load axis; Longitudinal (L) means beam enters perpendicular to load axis

Current Status

- 1 V3 PE (Press on-site, preliminary tests performed)
- 1 VX6 PE Press (Press on-site)
- 2 VX1 Presses (of which one CuBe, presses to be delivered soon by IK LLB Partner)
- PE Press for low temperature measurements will be delivered to ILL for CCR construction

Paris-Edinburgh Presses, Gas Loader and CCR



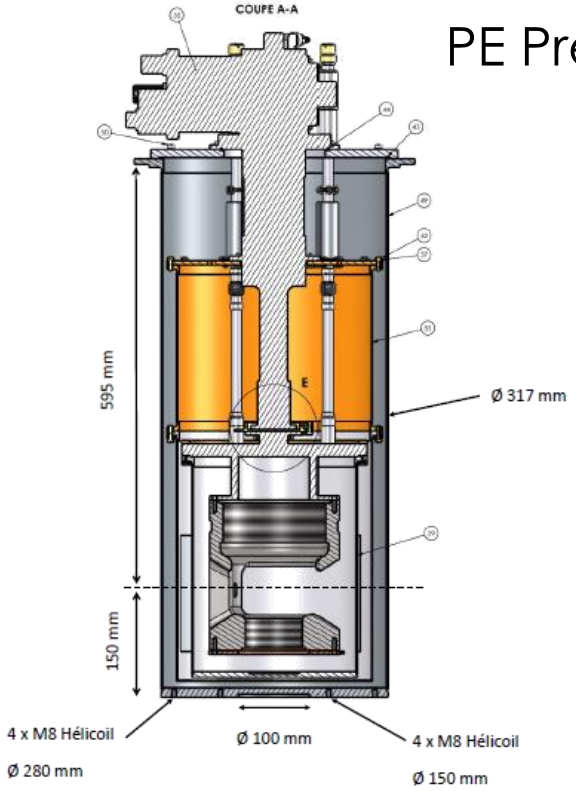
PE Press Gas Loader

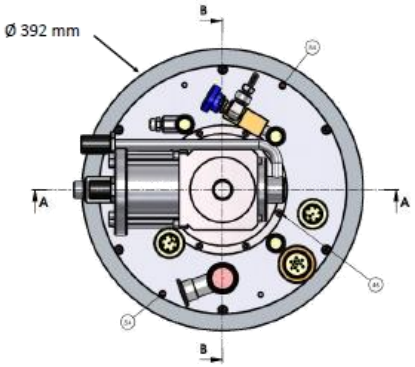
Project in cooperation with In-Kind Partner from Laboratoire Léon Brillouin (LLB) / CEA / Paris Saclay and Stefan Klotz (Université Sorbonne)

- Possible hydrogen loading / safety regulations and procedures to be created in the near future
- Successful FAT test performed by the end of 2023 with Helium. The gas loader together with 2 VX1 Presses is now being shipped from LLB to ESS. Delay due to the shipment issues
- SAT to be performed on 24th of September 2024

Paris-Edinburgh Presses, Gas Loader and CCR

PE Press Cryostat





Project in cooperation with In-Kind Partner from Laboratoire Léon Brillouin (LLB) / CEA / Paris Saclay

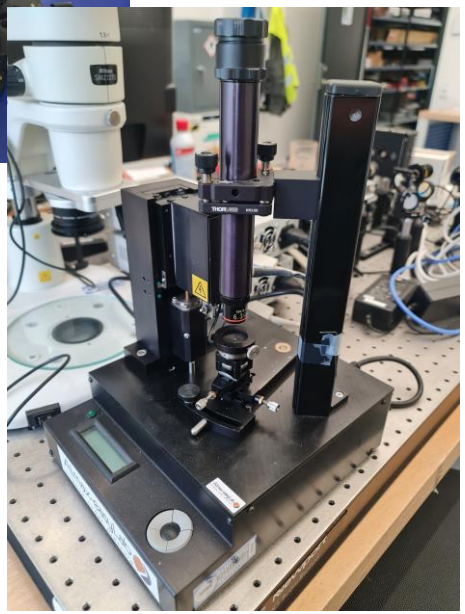
- HP CCR to be assembled at ILL in the fall 2024
- Some parts have been delivered by AS Scientific. AS Scientific has damaged one component during welding, they will deliver new one in May. This should not cause further delays in the assembly.

Diamond Anvil Cells

- A set of DACs with ±15° aperture perpendicular to load axis;
- x-y-z scannable translation mount;
- pressure callibration *via* ruby fluorescence; PRL ready for use
- operating temperatures from 2 to 300K;
- typical sample size: sample diam.= 1.5mm, height = 0.1mm;
- max. pressure ~40 GPa

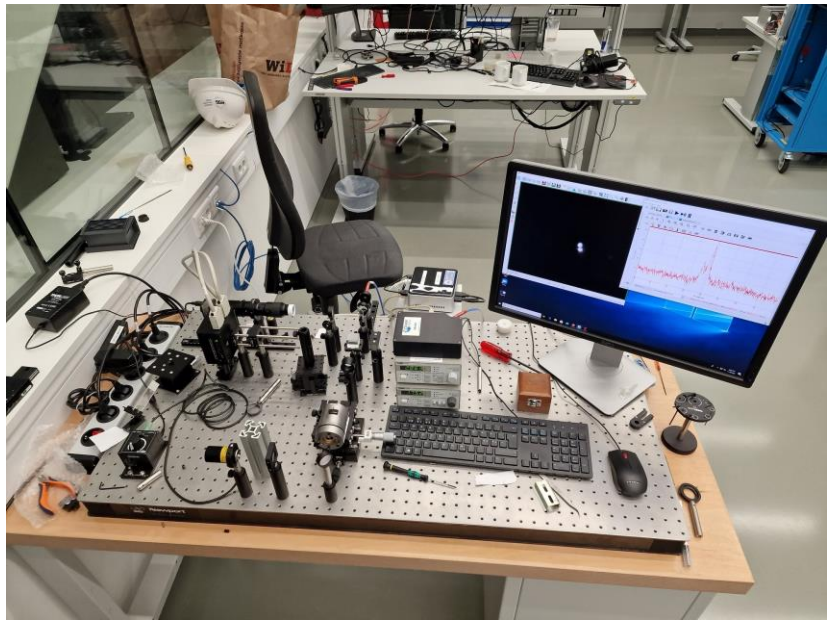
Diamond Anvil Cells and gas membrane

XRD One20DAC for preliminary HP studies ready for measurements using Single Crystal 4-circle diffractometer



Almax-EasyLab EDM machine

Diamond Anvil Cells

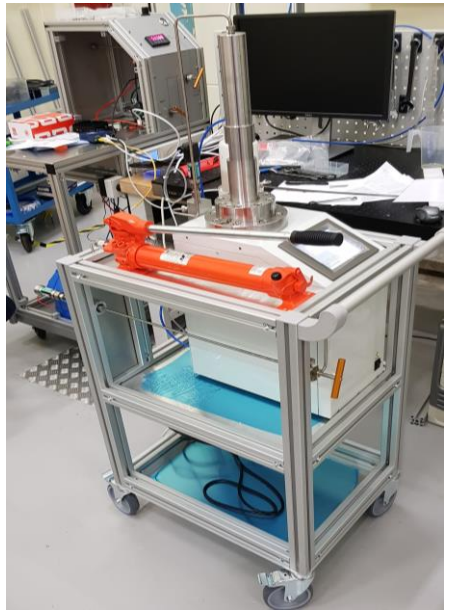


PRL system

Water crystallization within DAC

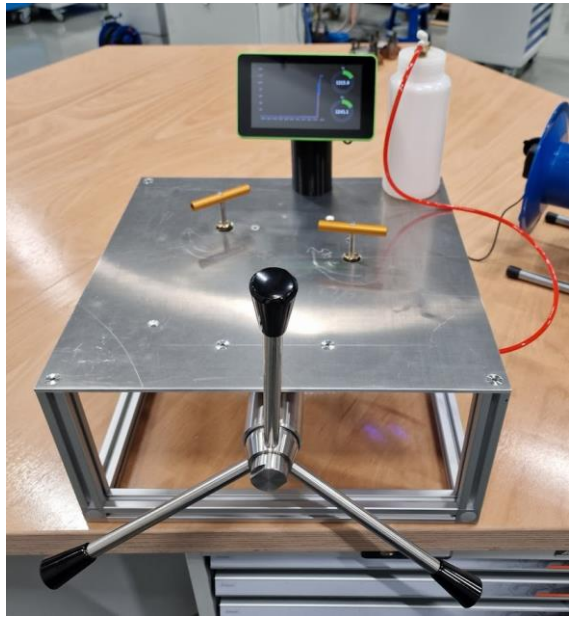
Gas and Liquid Compressors

Gas Loading, Sample Preparation



Vinci Pump

PACE5000



Manual 7kbar
liquid compressor

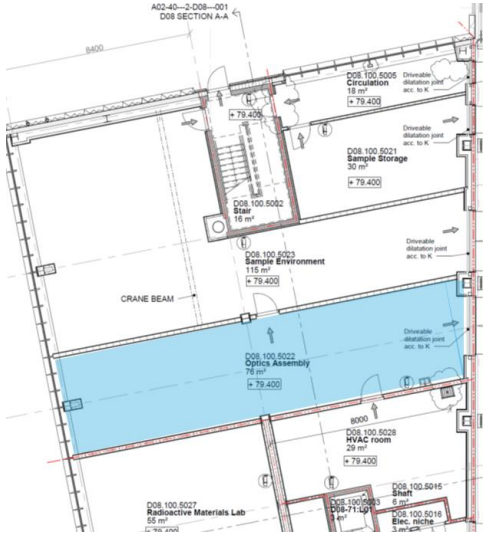
SITEC 10 kbar He gas pressure generator

- Vinci Pump, PACE5000 gas pressure controllers for PE presses and membrane DACs, respectively – integrated with Phoebus (remote control) and NICOS (remote control and scripting possibilities);
- In-house built (Lauritz Saxtrup) manual 7kbar liquid compressor for liquid HP cells in operation;
- SITEC 10 kbar He gas pressure generator: 2 approaches for Site Acceptance Tests in 2023, Successful SAT performed in September 2023. Later tests revealed a major problems with Top Industrie 2 stage compressor unit. Same problem in other facilities. Unit modified by manufacturer and sent back to ESS on April 11th 2024.

High Pressure Laboratory Spaces and Test Bunker

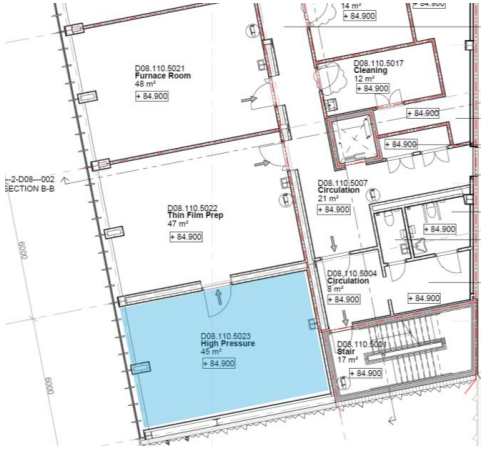
D08

Ground floor

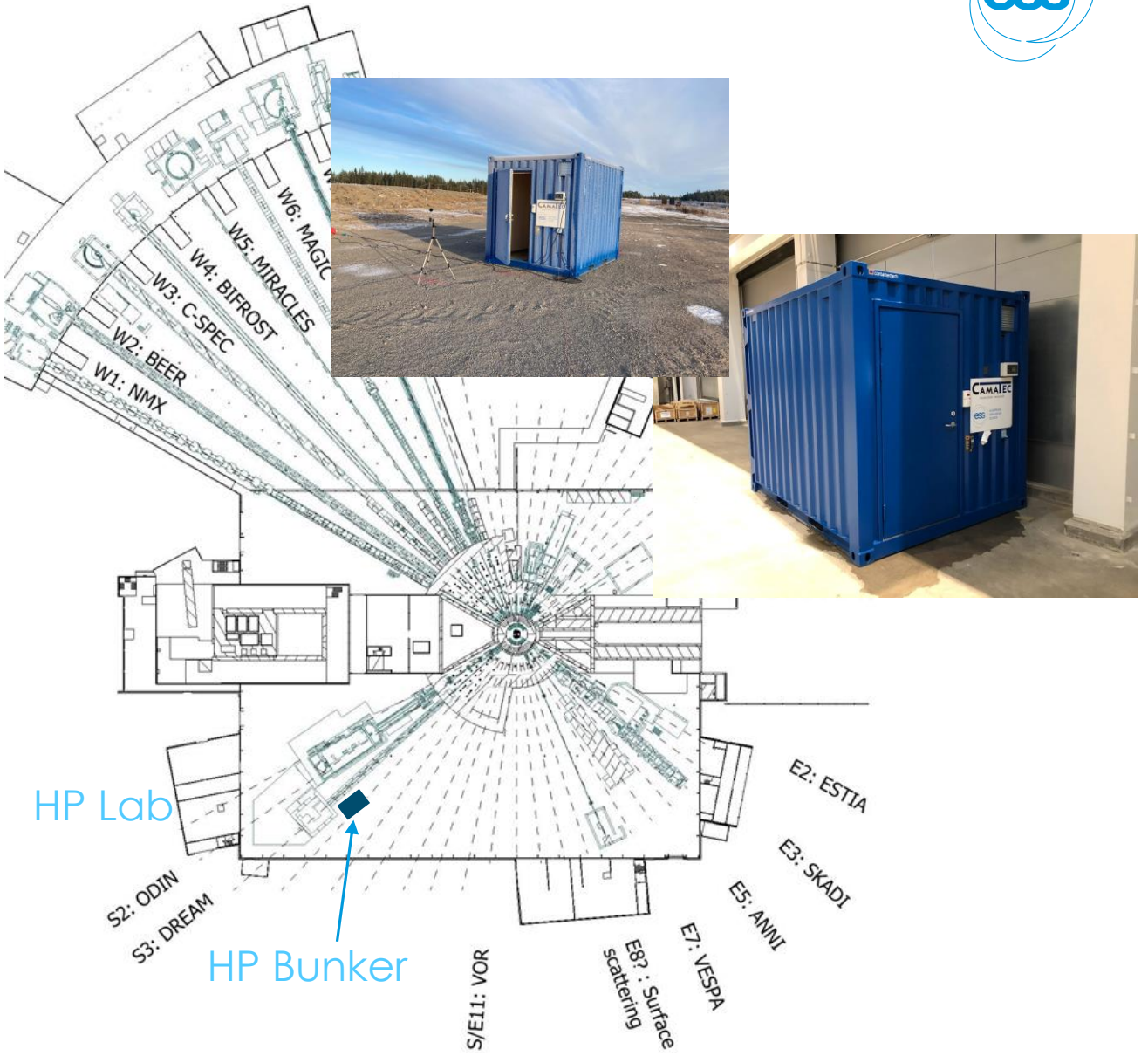


High Pressure
PE presses, Liquid, gas and clamp cells
Compressors

First floor



High pressure
DAC
RAMAN



Ready to move in by the end of 2024

Summary and Next Steps

Project	Status	Next step
Gas, liquid and clamp cells	5 gas (2 Al-alloy, 2 TiZr and 1 $CuBe_2$), 4 liquid (2 Al-alloy and 2 TiZr) and 1 clamp ($CuBe_2$) cells + technical documentation delivered by IK LLB partner. Liquid cells commissioned with manual 7 kbar compressor without beam	Commissioning of gas cells with SiTEC 10 kbar He gas pressure generator. Design of "sample sticks" and its integration within cryostats
PE presses and PE press gas loader	V3 and VX6 PE presses on site and tested. VX1 PE presses (one $CuBe_2$) to be delivered together with PE press gas loader in April 2024	Testing and commissioning of PE presses, Site Acceptance Test of PE press gas loader to be performed on September 24th 2024 Request for HTHP experiments within PE presses from user community.
PE Press CCR	CCR parts delivered to IK Partner by AS Scientific	Assembly of the CCR to be done in the fall at ILL
DAC Pool	Pressure Ruby Luminescence (PRL) spectrometer ready for use, High Pressure Diamond Anvil Cell lab under construction	Upgrade of PRL to Raman system

Summary and Next Steps

Project	Status	Next step
SITEC 10 kbar He gas pressure generator	2 approaches for Site Acceptance Tests in 2023, Successful SAT performed in September 2023. Later tests revealed a major problems with Top Industrie 2 stage compressor unit. Same problem in other facilities. Unit modified by manufacturer and sent back to ESS on April 11th 2024.	Integration of compressor unit into the pressure generator and tests to be done in the second half of April 2024.
Vinci Pump and PACE5000 Compressor	Vinci Pump and PACE5000 Compressor integrated with Phoebus (remote control) and NICOS (remote control and scripting possibilities)	Task completed
HP SANS	Discussion with Instrument Scientists, and other facilities initiated	Need for additional resources, experience with FEA (final element analysis) needed

LENS and 2024 IUCr HP Meetings

Topics

_Advances in High-Pressure Science Using Synchrotron X-rays
_Neutron Scattering in High-Pressure Research
_Crystallography at High Pressure
_Materials Behavior and Phase Transitions under High Pressure
_High-Pressure Studies of Earth and Planetary Materials
_High-Pressure Techniques and Instrumentation
_Computational Methods in High-Pressure Research
_Spectroscopy (Raman, IR and Brillouin) at high pressures
_Dynamic compression

Plenary Lectures
Prof. Karen Friese (Jülich Centre for Neutron Science, Germany)
Dr. Bianca Haberl (Oak Ridge National Laboratory, US)
Prof. Sebastien Merkel (Universite de Lille, France)

Invited Speakers
Dr. Malcolm Guthrie (Oak Ridge National Laboratory, US)
Dr. Stefan Klotz (Sorbonne Université, CNRS, France)
Prof. Sven Lidin (Lund University, Sweden)
Dr. Hanna Boström (Stockholm University, Sweden)
Dr. Umbertoluca Ranieri (University of Edinburgh, UK)
Dr. Florian Trybel (Linköping University, Sweden)
Dr. Vladimir Solozhenko (Laboratoire des Sciences des Procédés et des Matériaux, France)
Prof. Ronald Miletich (University of Vienna, Austria)
Dr. Anna Pakhomova (European Synchrotron Radiation Facility, France)
Prof. Natalia Dubrovinskaia (University of Bayreuth, Germany)
Dr. John Loveday (University of Edinburgh, UK)
Dr. Michael Hanfland (European Synchrotron Radiation Facility, France)
Dr. Ewa Patyk-Kazmierczak (Adam Mickiewicz University, Poland)
Prof. Katarzyna Jarzembska (University of Warsaw, Poland)
Kinga Potempa (University of Warsaw, Poland)
Dr. Boby Joseph (Elettra Sincrotrone Trieste, Italy)

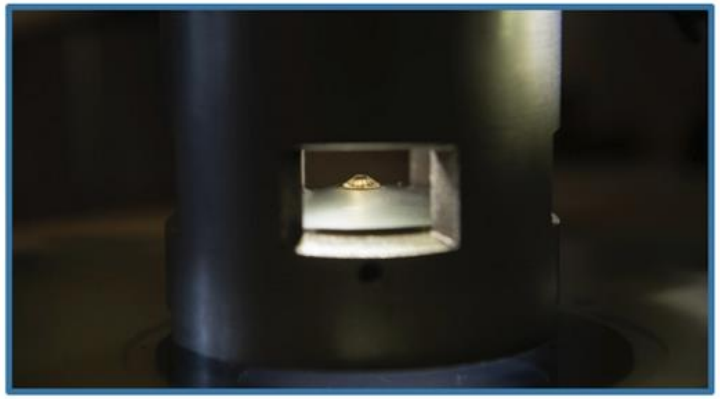
LENS and 2024 IUCr HP Meetings

LENS High Pressure Sub Working Group Meeting

24 September 2024
UTC timezone

Enter your search term

- Overview
- Timetable
- Registration
- Participant List



Date and Time: **24 September 2024, 12h00 - 18h00**

Venue: **European Spallation Source ERIC, Partikelgatan 2, Lund, Sweden (Tycho Brahe Auditorium)**

Tentative Agenda

- Networking and open forum discussion of latest developments in high pressure, developments at neutron sources across Europe with a view to enabling collaboration
- Discussion of the McWhan cell and issues across the facilities
- Discussion of a database that will collate the accumulated data on neutronic, muonic and chemical compatibility for materials which can be used as pressure devices

Thanks to

Caroline Curfs, Lauritz Saxtrup, Richard Ammer, Niklas Ekström, Andreas Hagelberg, Alexander Holmes, Yulia Pedersen, Luca Sagliano and Oleksiy Zadorozhko

and

you for your attention