EUROPEAN
SPALLATION
SOURCE

Sample Environment at ESS

STAP meeting

PRESENTED BY CAROLINE CURFS, TOBIAS QUISPE,, ALEXANDER HOLMES, MALCOLM GUTHRIE, ALICE CORANI AND HARALD SCHNEIDER

2021-04-26

Agenda

1. General presentation and updates
2. Updates on mechanical interface and other mechanical development by Tobias
3. Updates on helium management, magnets, cryo and furnaces by Alex
4. Updates on high-pressure and mechanical engineering by Malcom
5. Updates on fluids and electrochemistry by Alice and Harald

1
General presentation and updates

PRESENTED BY CAROLINE CURFS

26-04-2021

Sample Environment group

Objectives

Enable to perform neutrons experiments with multiple parameters such as temperature, pressure, fields, mechanical constraints, humidity, gas loading and fluid control:

- **Provide** a suite (instrument specific and pool) of Sample Environment Systems (SES) for the ESS instruments
- **Maintain** and **evolve** the suite of SES incl. provision of spare SE devices
- Operate SE **labs**
- Coordinate **liquid helium** cycle
- **Integrate SES** for rapid change over and standardised control (mechanical and control)
- **Support users** of SES during operation
- **Develop** and **procure** new SES

Sample Environment group

Team

- **Alexander Holmes**: Magnetic and electric fields, low and high temperature
- **Alice Corani:** Electrochemistry + SULF
- **Anders Pettersson** (ECDC): Control integration
- **Andreas Hagelberg**: 3D printing, electronics and control integration
- **Caroline Curfs**: Group leader
- **Harald Schneider:** Fluids and soft matter + SULF
- **Lauritz Saxtrup:** Scientific instrumentation
- **Malcolm Guthrie:** High pressure and mechanical engineering
- **Niklas Ekström:** Electronics and control integration
- **Richard Ammer:** Precision mechanics
- Alejandro **Tobias Quispe** Mamani (NSS): Mechanical design

Sample Environment group

Collaborative projects

Accelerating knowledge transfer within ESS and external partners, and developing common approaches around concrete projects beneficial to all.

- **SEMCA**: Sample Environment and Motion Control and Automation (MCA)
- **Pumping Cart** for cryostats : Vacuum, Sample Environment and ISIS
- **Sample changer for low temperature**: Sample Environment and instruments
- **Sample holders**: Sample Environment and instruments
- **Guide for top loading equipment**: Sample environment and instruments

Sample Environment group

Organisation and documentation

Project planning
Jira Big Picture

- *Steps*
- *Deadlines*
- *Resources*
  - *Budget*
  - *Internal manpower (SE)*
  - *External manpower (ESS and In Kind partners)*
- *Planning and prioritisations*

Implemented soon

Project reporting:

CHESS and Confluence

- Follow the ESS engineering handbook (ESS-0092276)
- 6 steps/documents for each project required
  - PDR : Preliminary Design Review
  - CDR : Critical Design Review
  - TRR : Test Readiness Review
  - SAR : System Acceptance Review
  - SRR : Safety Readiness Review
  - ORR : Operational Readiness Review

To be updated

Safety :

To provide SE systems which are safe to use or/and whose risks are identified and communicated

Documents needed:

- A manual including installation and operation of the system
- A maintenance manual
- A risk assessment including residual risks
- A directory with all the technical files
- Hazard Identification (HAZID) Checklist

To be done for each system

Sample Environment Systems

Planning for delivery

Prior delivery to instruments:

- Test, calibration, mechanical and control integration of each Sample Environment System (pool and instrument specific)
- No priority : done as soon as they arrive

Delivery to instruments :

- 6 months before the date they are needed on the instrument (Hot Commissioning, First Science or SOUP) to enable commissioning and tests in real conditions

Prioritisation:

In case of lack of resources, priority will be given

1- to the SES absolutely needed

2- to the SES which can be slightly postponed (if needed in HC, delivery in FS)

3- to the SES which would be nice to have later during operation

Sample Environment Systems

Prioritisation for Hot Commissioning – Instrument specific

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Sample Env. Systems		Instrument	Control integration	ORR planned	On Track	Status	Remarks
SANS Sample Changer with same temperature per row		LOKI	Julabo: EPICS done	Q4/22	yes	Design	Judith Houston leads the project
SANS Sample changer with tumbler		LOKI	SEMCA Project	Q4/22	yes	Design	Judith Houston leads the project
Flow cells		LOKI	HPLC: About to start Syringe pumps: EPICS (2/3)	??	Yes	Const. & Comm	System already functioning at ISIS
Cryofurnace 20 changer		DREAM	TBD		no		2nd Call for Tender received no bid - SE group will procure a standard cryofurnace to fill the gap
Flow Cryostat		ESTIA	Lakeshore: EPICS	?	yes	Const.	Commercial system – Prototype available at PSI to start integration
Solid-Liquid Cells + Changer		ESTIA	SEMCA Project- HPLC: about to start- Julabo: EPICS Hydraulic valves	?	yes	Not started	SRESS grant awarded – not started
Sample changer solid-air		ESTIA	SEMCA Project	?	yes	Not started	
Wet Cryostat		BIFROST	Pumping cart	?	yes	Const.	Procurement completed – CDR 12.03
Cryofurnace		CSPEC	Pumping cart	?	?	Design	CTV nearly finished
Sample changer (6 positions)		CSPEC	SEMCA Project	?	?	Not started	
He3 Sorption Insert		CSPEC		?	?		
Wet cryostat		MAGIC	Pumping cart	Q4/22	yes	2nd hand	Refurbishment of an old cryostat (MLZ)

Sample Environment Systems

Prioritisation for Hot Commissioning - Pool

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Sample Env. Systems		Control integration	ORR planned	On Track	Status	Remarks	Budget
6.5 T Magnet			Q3/22	yes	2nd Hand	Contract signed	TEFI PCC
14 T magnet				No		Magnet strategy	??
2.5 T Warm Bore Cryomagnet		Can start before arrival of device	Q1/22	yes	Design	Call for Tender nearly finalized – Waiting for additional simulation (on going)	IK NIK3.8
8T Magnet		TBD	Q1/23	yes	Design	Call for tender published	IK NIK3.8
Wet Cryostat		Pumping Cart				TA in preparation - Possible 2nd hand	IK NIK3.8
Sample rotation stick		SEMCA Project		yes	Design		TEFI PCC
Heatgun-Cryojet		TBD		yes	Design	Nordforsk project started 01.21 – Quotation ongoing	SE OCC
Induction furnace		TBD		yes	Design	Nordforsk project started 01.21 – Quotation ongoing	SE OCC
Vacuum Furnace		TBD		yes	2nd hand?	TA in preparation - Possible 2nd hand from LLB	IK NIK3.8
100 kN Stress-Strain rig		On going	Q2/22	yes	Comm	Integration at NPI in progress Mechanical and control Integration	Ext. funding NPI
50KN Stress rig with Torsion-rotation		TBD	TBD	yes	Design	Specifications nearly finished- Discussions with instruments – Commercial system planned	PREMP PCC

Sample Environment Systems

Prioritisation for First Science

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Sample Env. Systems		Instrument /pool	Control integration	ORR planned	On Track	Status	Remarks
HT option for flow cryostat		ESTIA	TBD	?	?	?	
HV electrodes and PS for flow cryostat		ESTIA	TBD	?	?	?	
Fluorescence & UV (In situ)		LOKI	?	?	?	Const.	Judith Houston leads the project – Tests of setup planned at ILL in June
Electrochemical Cells		DREAM	?	?	?	?	SRESS project – no info
Dilution fridge/He3 insert		Pool	TBD	Q1/23	yes	Design	Waiting for 8T magnet dimensions
5 T Warm Bore		Pool	?	?	No		pending magnet strategy review
Rheometer		Pool	Waiting for HW delivery	Q4/22	yes	Const	Commercial system
Gas Processing		Pool	TBD	Q2/21	yes	Const & Comm	System #1 on its way – integration to be planned
Stopped flow Cell		Pool	HPLC-Syringe pumps	Q2/21	yes	Comm	On its way – Commercial system with modifs
Humidity Chamber		Pool	TBD	Q2/22	Yes	Const.	Construction planned at ESS Delivery at ESS Q3/21
PE HP cells		Pool	Vinci EPICS Compressor TBD	Q4/22	yes	Design	TA signed – KO meeting done
HP Gaz cells and Clamps		Pool	Vinci EPICS Compressor TBD	Q4/22	yes	Design	TA signed – KO meeting done
Dilatometer		Pool	TBD	TBD	Yes	Spec	Under discussion – Commercial system – Might be replaced by Gleeble

Sample Environment Systems

Prioritisation for SOUP

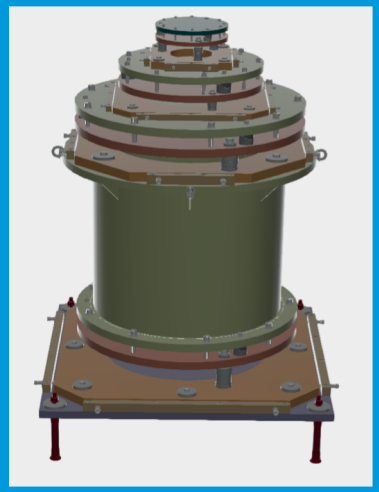
Absolutely needed

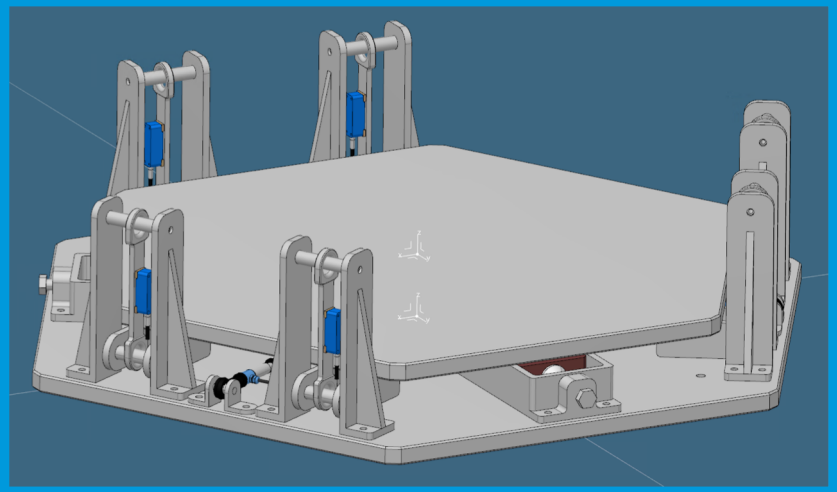
Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Sample Env. Systems		Instrument/ pool	Control integration	ORR planned	On Track	Status	Remarks
Sample changer with individually thermalized cuvettes		LOKI	On hold	No plan yet	On hold		TBD
TGA		DREAM		Q1/23	yes	Design	ISTAN project (VR grant) - Waiting for test and commissioning
Cryostat – Dilution Fridge		Pool		TBD	On hold		Pool equipment
Wet cryostat		Pool	Pumping Cart	TBD	On hold		Pool equipment
Very High Horizontal Field 17T		Pool					Can be borrowed ?
Electrochemical cell		Pool			yes	Design	Discussion with instruments for specifications
Laser Pump and Probe		Pool	TBD	Q2/22	yes	Const.	Waiting for delivery
Diamond Anvil Cells		Pool	PACE, Vinci EPICS	Q4/22	yes	Comm	Hot commissioning done at SNS – Mechanical and control integration nearly finished
Dilatometer		Pool	TBD	TBD	Yes	Spec	Under discussion – Commercial system – Might be replaced by Gleeble
Furnace for Rig 1		Pool	?	TBD		Comm	
Ultra-High T furnace for rig		Pool	?	TBD		Comm	Project with Chalmer Uni
5-10 KN Stress Rig		Pool	On hold	TBD	On hold		Under discussion – Borrowed from MAX IV? Or Robin's rig?

2
Update on mechanical interfaces and other mechanical developments





PRESENTED BY ALEJANDRO TOBIAS QUISPE MAMANI

26-04-2021

Summary

1 Introduction: Principles of SE equipment interface

2 Bottom loading – status update

3 Top Loading – status update

4 Other Developments: Rig for Magnetic Force Testing

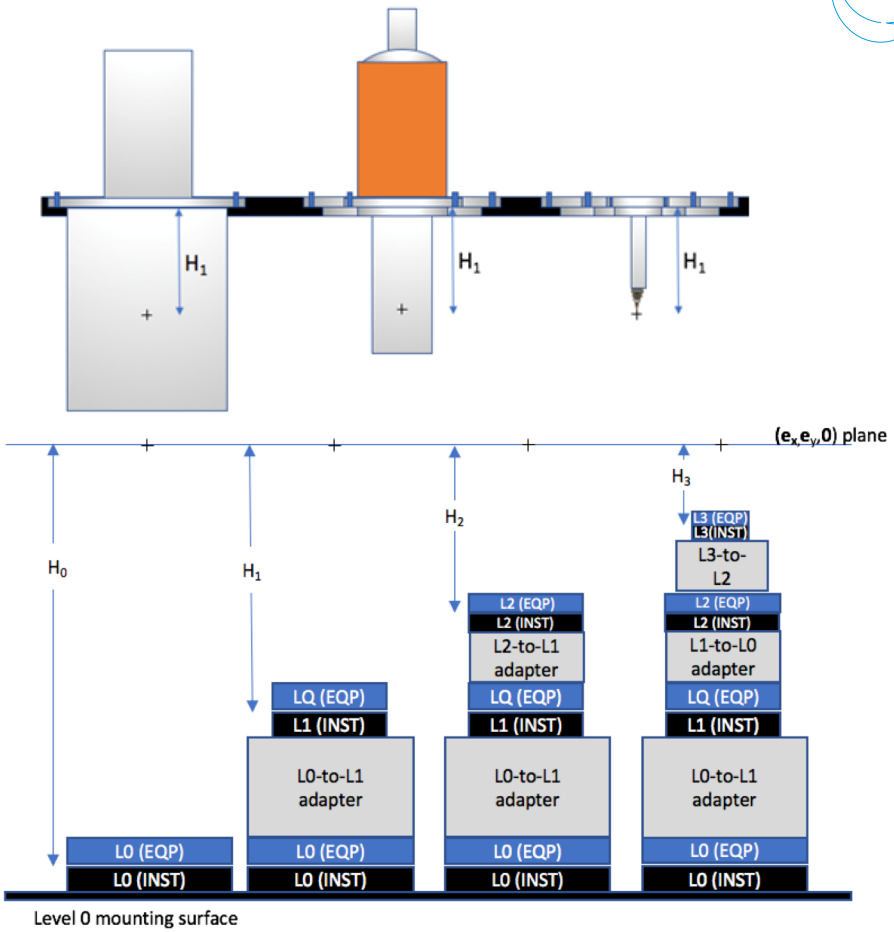
Principles of SE equipment interface

The main objective is to enable fast, accurate and standard installation of equipment for the sample environment.

Key elements:

- Shared coordinate system
- Based on principles of kinematic constraint
- Separate standard for Top loading and Bottom loading instruments
- Quantised mounting levels (L0,L1,L2 etc)
- Interface comprises an “instrument” part and an “equipment” part

ESS-0038078 (last release Dec 2019)

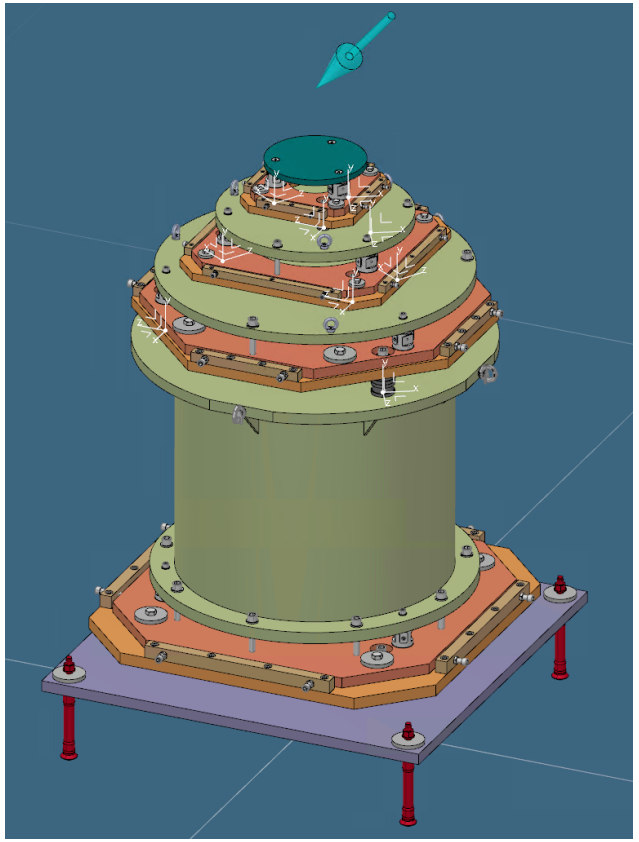


Bottom loading- Overview

- Mass of equipment rests on the ground
- Most common interface: 73% of initial suite (15)
- 4* quantised mounting levels

Level	Distance to beam (mm)	Weight max. (kg)	Interface dim. (mm)*	Positioning tolerance at sample position (mm)
0	1300	2000*	Ø 800	±2.500 (TBC)
1	500	1000*	Ø 800	*±0.02 (act.)*
2	350	300	Ø 500	*±0.02 (act.)*
3	200	10	Ø 250	±0.01 (TBC)

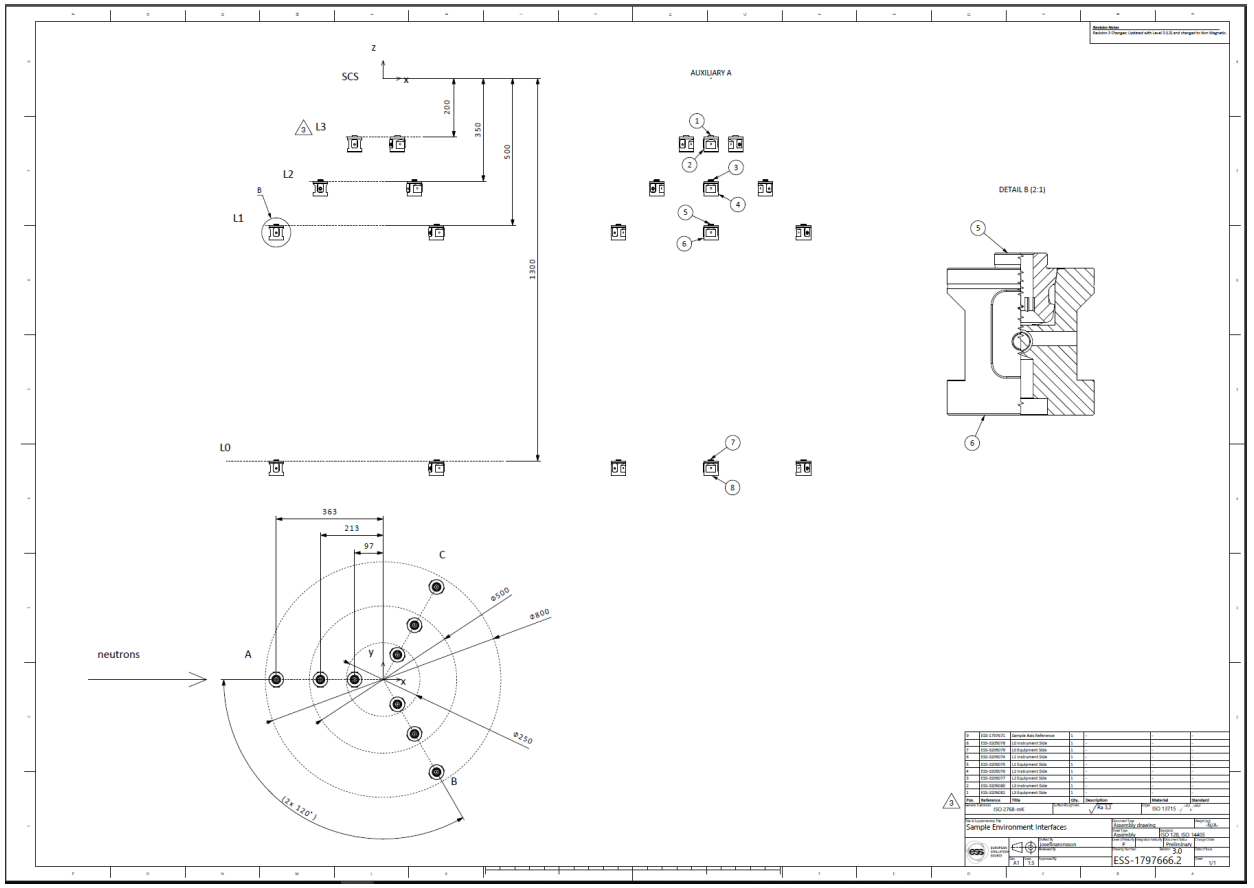
- Current Design (*April 2021*)



Bottom loading- Kinematic Mounts

Kinematic mounts and their arrangement in space

Kipp components: instrument part (left) equipment part (right). Each interface consists of three pairs



ESS-1797666.2

Bottom Loading – Magnetic Issues

Non Magnetic Kinematic Mounts

- Stock Kipp components are hardened steel (magnetic)
- Problem for to HF magnets and He^3 analyzers

Initial requirements from instruments:

Instrument	Max rel. μ
CSPEC	1.01
BIFROST	1.1
MAGIC	Equiv to BIFROST OK

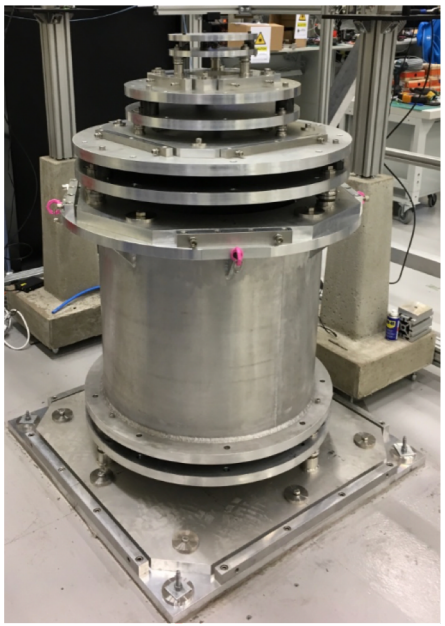
- Customized Development by Kipp ongoing
- First prototype successfully tested at rated loads
- Premature wear and tear due to usage, and some galling was observed.

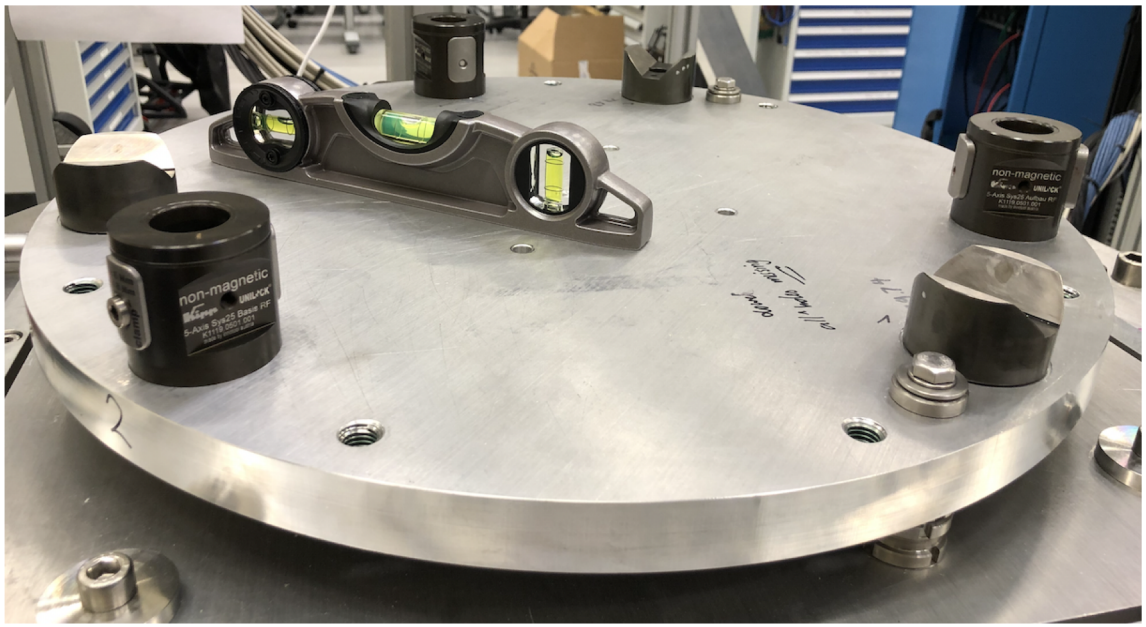
Materials considered:

Material	comments	Rel. μ	Hardness*	Activation
316/L steel	Machining/heat treatment can induce magnetism. As can stray field from magnet	1.01-1.06	80 HRB	16-18% Cr
Ti		1.00005	36 HRC	None
Al		1.000022	60 HRB	None
Inconel 718		1.0011	30-40 HRC	17-21% Cr;<1% Co

Bottom Loading - Update

- Kipp is slightly modifying the design of its mounts. A new prototype is expected in the coming weeks.
- The existing model of “TORTA” in our laboratories is being modified to adapt the non-magnetic mounts.

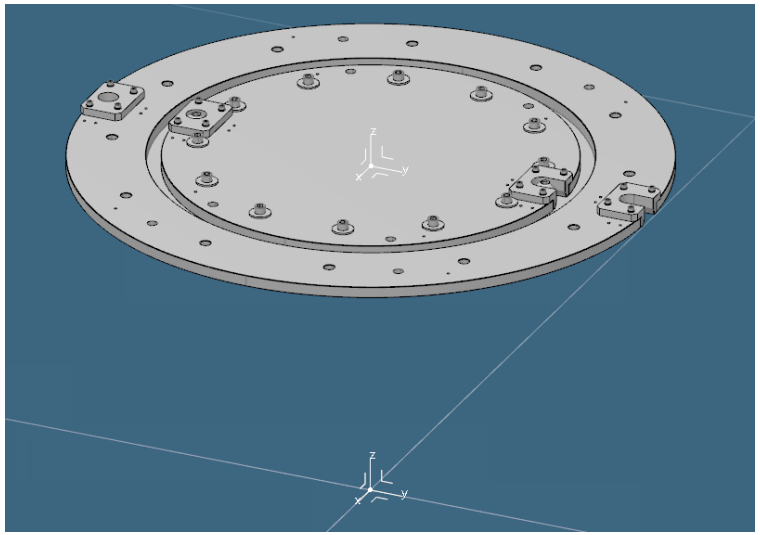




Top loading- Overview

- Mass of equipment hangs from above (usually tank)
- Less common interface: 33% of initial suite (15)
- 3 quantised mounting levels

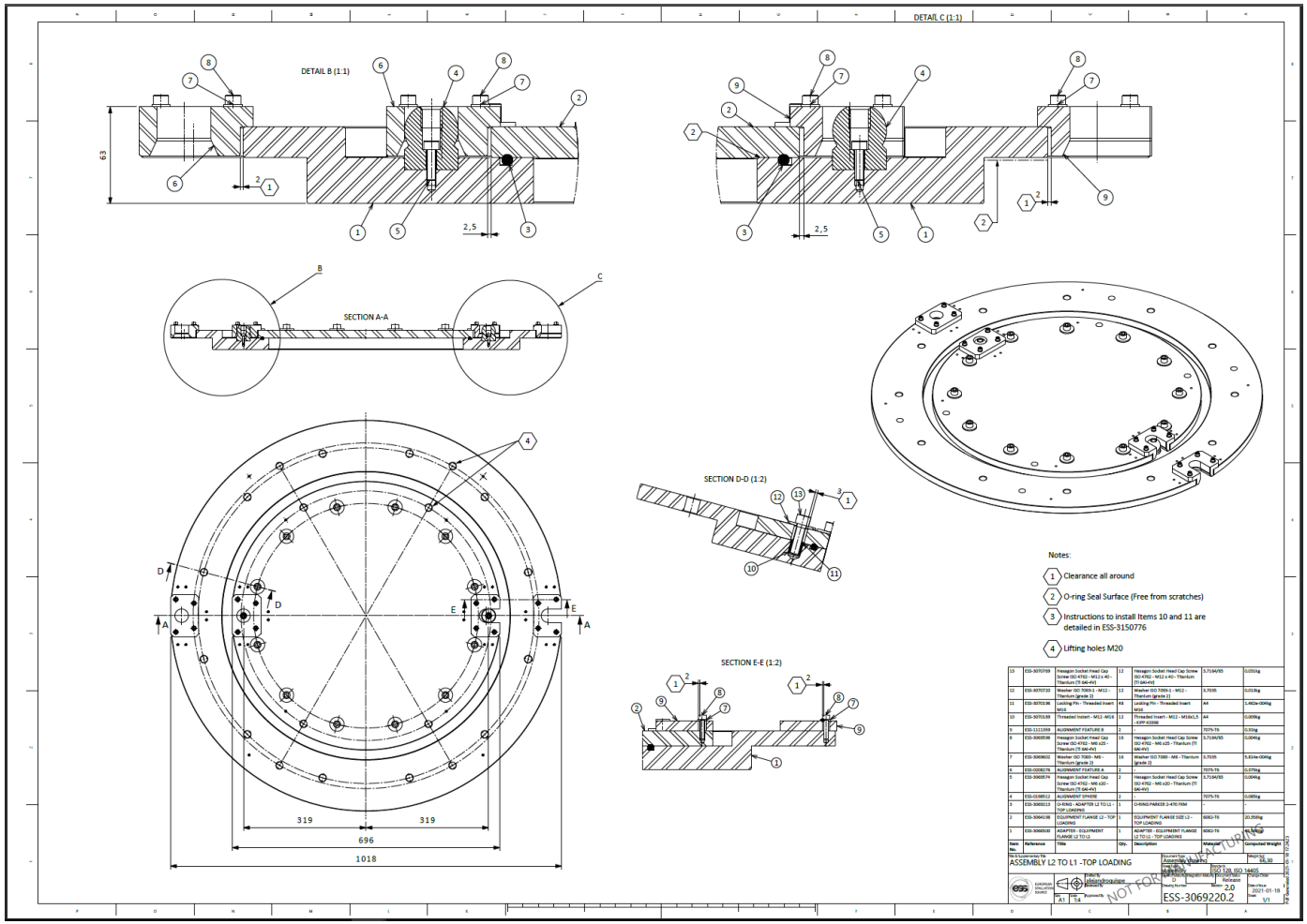
Level	Distance to beam (mm)	Weight max. (kg)	Interface opening. (mm)	Positioning tolerance at sample position (mm)
1	600	1000*	Ø 805	*±1-2 (TBC)*
2	600	300	Ø 505	*±0.25 (TBC)*
3	600	5	Ø 255	±0.01 (*TBC*)



- **Possible for equipment to simultaneously have both type of mounts!**

Top Loading- Overview

The pins and alignment blocks

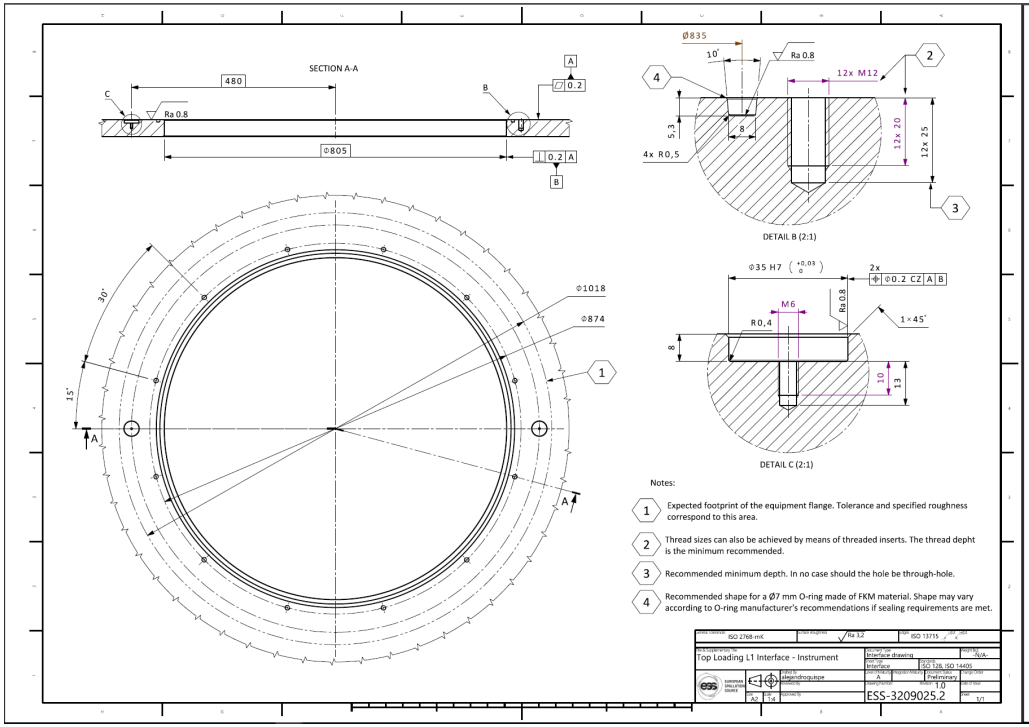


ESS-3069220.2

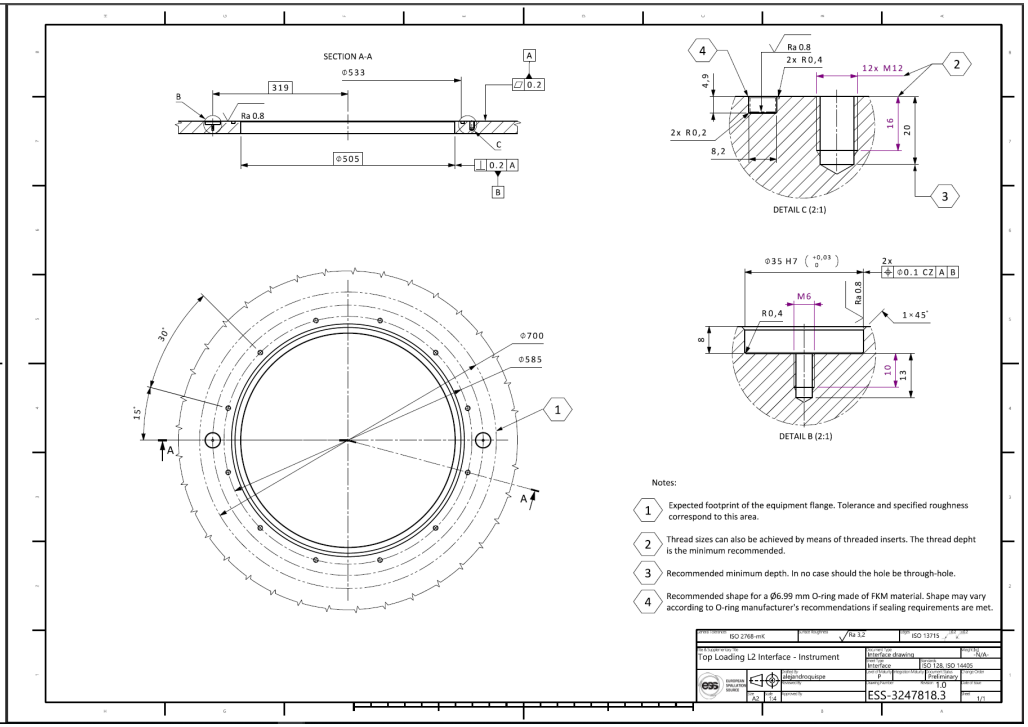
Top Loading- Update

Frozen interfaces for the instruments

L1: ESS-3209025.2



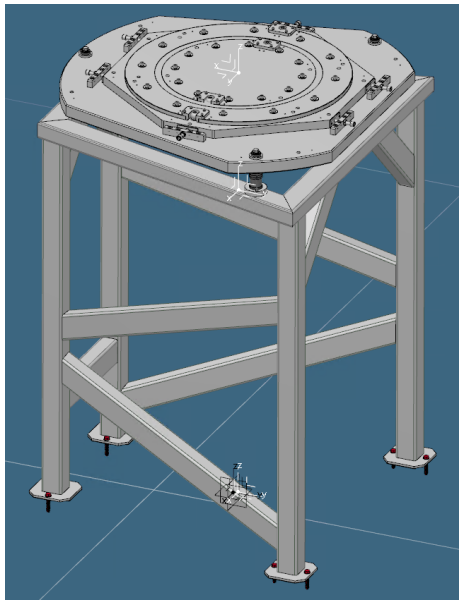
L2: ESS-3247818.2

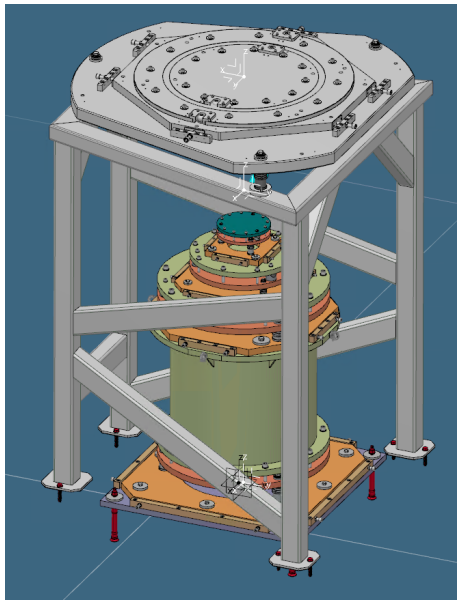


Top Loading- Update

Prototypes

- A prototype top-loading structure has been manufactured and installed. Mainly steel was used.
- Flanges and interface elements made of non-magnetic materials have been designed.

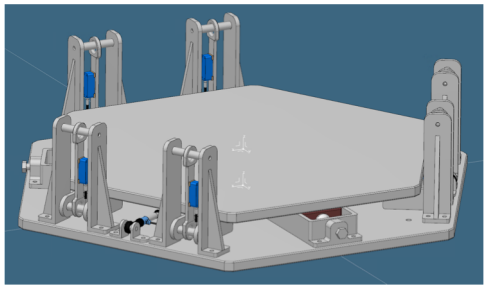




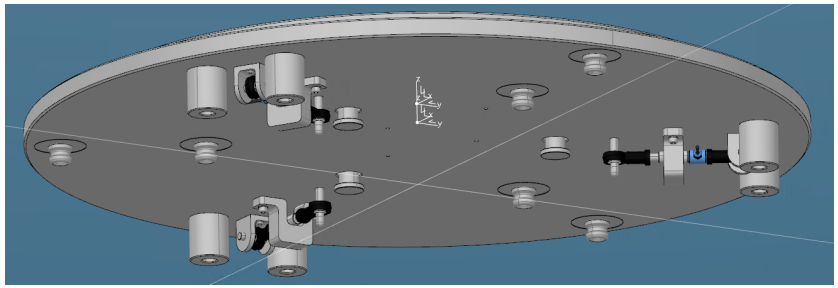
Rig For Magnetic Force Testing

Ongoing conceptual ideas

- Measurement in X, Y and Z. With dedicated sensors for each direction



- Measurement in X and Y. Measurement in Z is done using the crane (Not recommended)



- Measurement in X, Y and Z. With triaxial sensors (non-magnetic options are being sought).

3
Updates on helium management, magnets, cryo and furnaces

PRESENTED BY ALEXANDER HOLMES

26-04-2021

Agenda

1. Helium & Nitrogen
2. Latest news
3. TEFI systems update
4. Pumping cart
5. Magnet strategy
6. Pool Cryostats & furnaces

1

Helium & Nitrogen update

Helium recovery

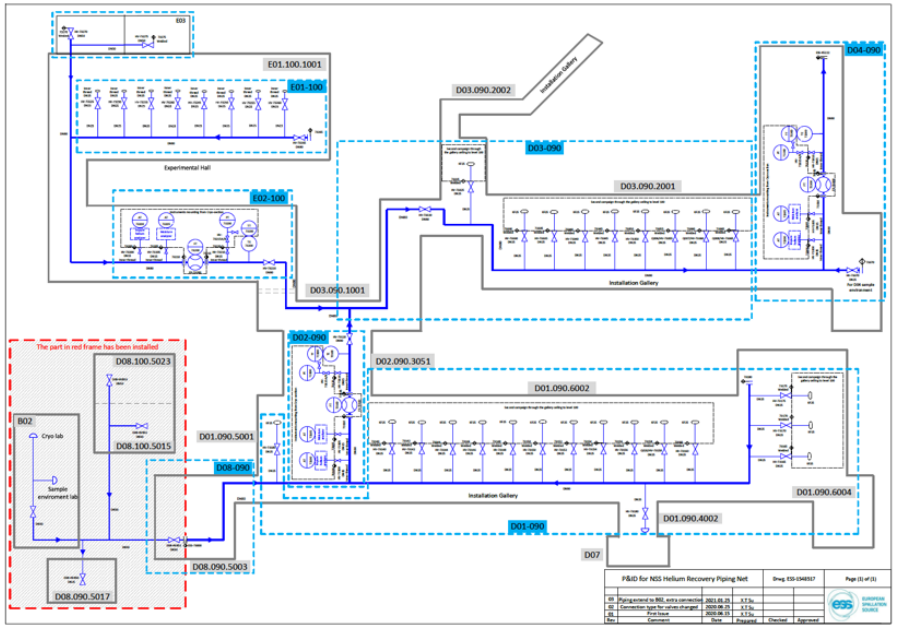
Multi-stakeholder system spanning enitre ESS, a complex challenge!

Main header pipework Critical Design Review in progress, passed main steps.

Cost pressures on installation – no chance for additional expenditure if budget exceeded.

Prioritising SE E03 workshop, E01 long experimental hall. Can be expanded over time as funds allow.

ESS is part of Helium management collaboration with HZB, ILL, ISIS – access software development (mobile Dewar tracking, He inventory management…) and cost-price hardware.



Cryogen delivery

Liquid nitrogen and helium

Automatic LN2 filling station tested on site.

First delivery of Nitrogen and Helium to ESS achieved (from site to Utgård workshop)

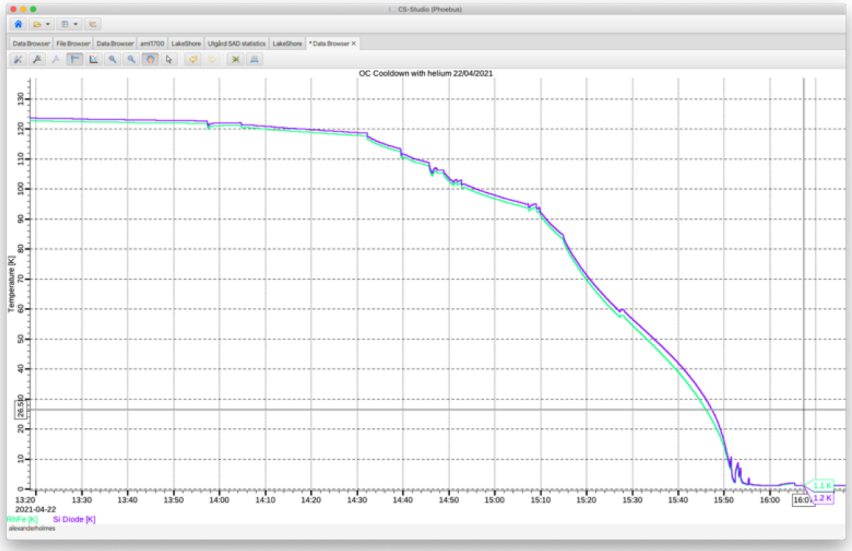
2

Newsflash!

Orange Cryostat cooldown to <1.5K

Update from last week!

Coldest temperature achieved so far at ESS!



Thanks to Richard Ammer, Alice Corani, Lauritz Saxtrup, Andreas Hagelberg (SAD), Romain Goncalves (Cryo), Ralf Huber (Vacuum), Douglas Beniz (ICS) Cassandra Waad (Logistics), Anders Månsson (MAX IV)

3

TEFI systems - update

8T Magnet for MAGiC, DREAM, *HEIMDAL*

Providing 8T, 1.6K (or 50/300 mK with ULT inserts)

1. System Overview and Deliverables

+15°/-35° asymmetric 8T vertical field wet cryomagnet

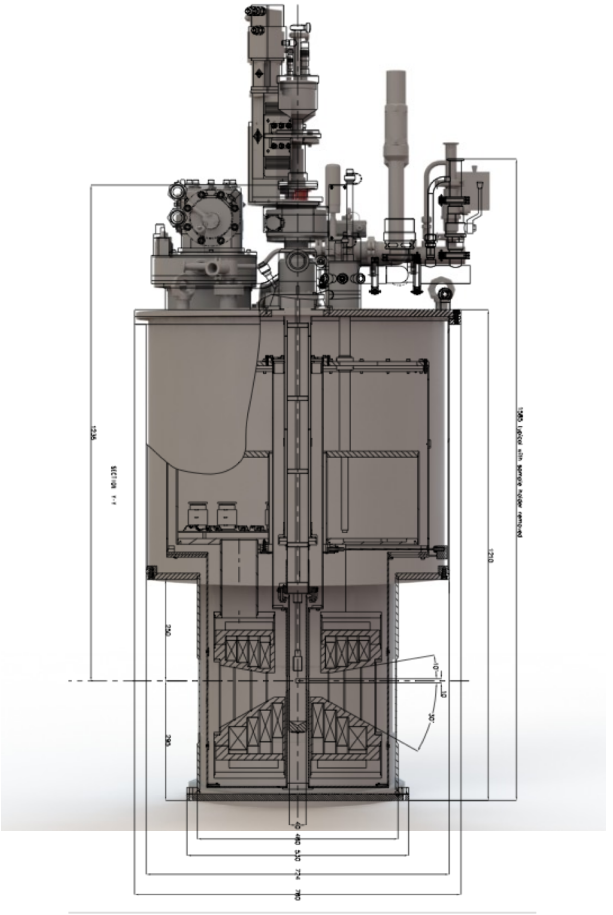
2. Schedule, Milestones and Reviews

Call for tender review (CTV) completed more than 1 year ago. Preliminary offers from 2 vendors received.

Tender publication delayed but finally published via CNRS 3 April. Selection round ends 29 Apr.

Mechanical integration – L1 mounts specified

Control integration - ESS pumping cart, standard pumps, specified temperature controllers.



New ULT systems for ‘8T magnet + OC’

Providing ‘parameter range’ 50/300mK – 300K

FR In-kind contribution:

- 2 dilution systems
- 1 ^{3}He sorption

Matched to 8T magnet, usable in wet cryo.

Specifications to be set when dimensions of 8T magnet are fixed (after magnet CDR)

- Additional dilution system coming from HZB (compatible with 15T+6.5T magnets, wet cryostats)
- CSPEC inst. Spec. ^{3}He insert

Temperature controller device integration:
2 x Lakeshore 350 & 2 x Lakeshore 372 have been purchased and are available to start early integration (*Command set is almost identical to already EPICs – integrated LS336)*

Warm bore for ESTIA, LOKI

Providing 2.5T magnetic field FR in-kind via LLB

1. **System Overview and Deliverables**

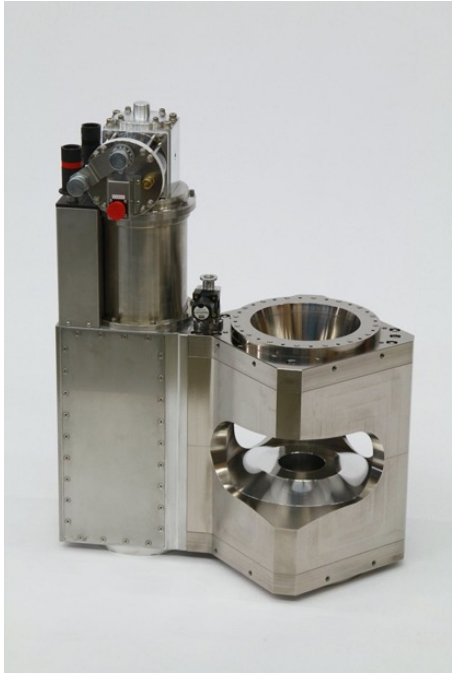
- Based on TOFTOF HTS110 magnet with minor modifications.

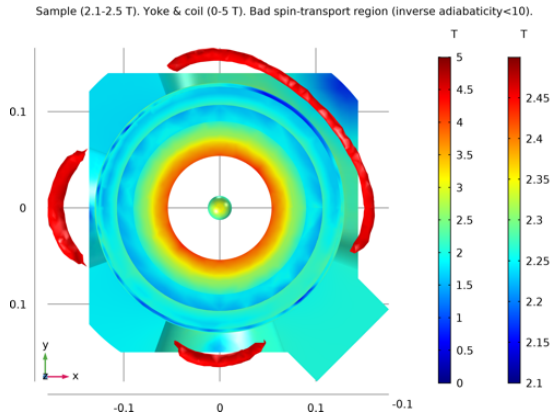
2. **Schedule, Milestones and Reviews**

- CTV carried out – identified need for further calculations by Hal Lee (ESS polarisation responsible) to ensure compatibility with polarisation. Results to be discussed ASAP with instrument teams and vendor. Possible solution: asymmetric current with existing coil design? Priority is open geometry vs max field.

3. **Integration:**

- L2 Mounting & interfaces agreed with LOKI and ESTIA
- Control integration – manuals received from HTS110

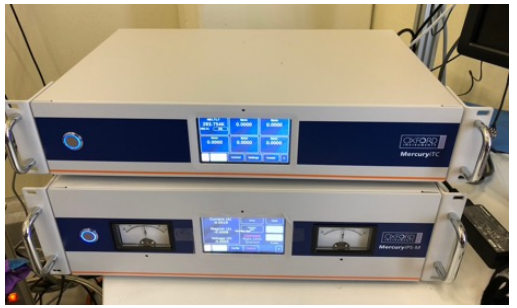


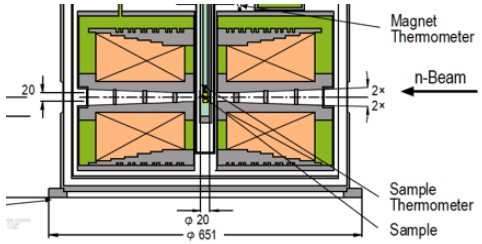


'15T magnet' for BIFROST

Second hand magnet

1. **System Overview and Deliverables**
   - 15 T magnet 'VM1B' formerly from HZB+ original electronics
   - 15 T magnet 'VM1' formerly from HZB
2. **Schedule, Milestones and Reviews**
   - Due for delivery as COVID19 lockdown started, requires trained personnel for packing/unpacking
3. **Integration**
   - BIFROST team designing mechanical integration for L1 kinematic mount
   - Purchased updated control hardware (OxInst Mercury iTC/iPS)
   - ESS pumping cart

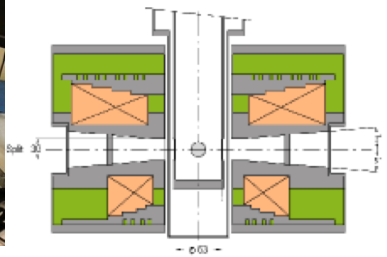


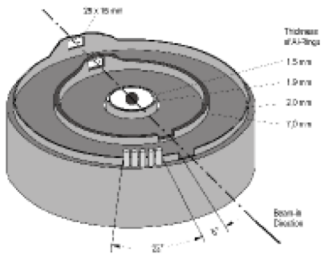


6.5T Cryomagnet for CSPEC, *TREX*

Second hand assymetric cryomagnet from HZB

1. **System Overview and Deliverables**
   - 6.5T Cryomagnet + original electronics
2. **Schedule, Milestones and Reviews**
   - Signed contract with HZB, delivery summer 2021 (pandemic permitting)
3. **Integration, Safety, Verification, Validation**
   - Working with Tobias Q for mechanical integration into top loading L1 vacuum interface.
   - ESS pumping cart, standard controllers

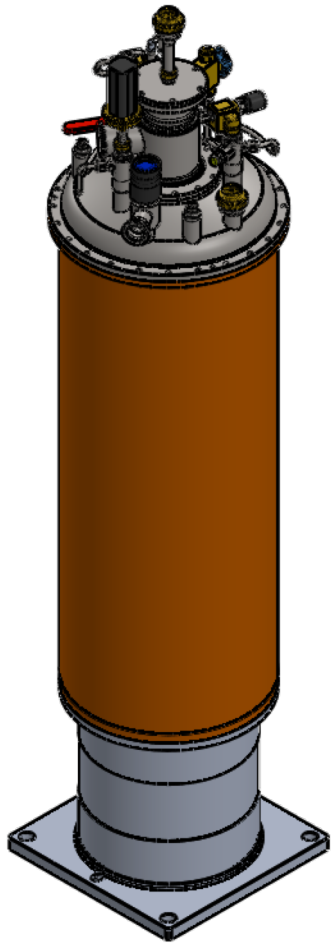




‘Wet cryostat’ for BIFROST

Instrument specific cryostat 1.5 K - 300 K

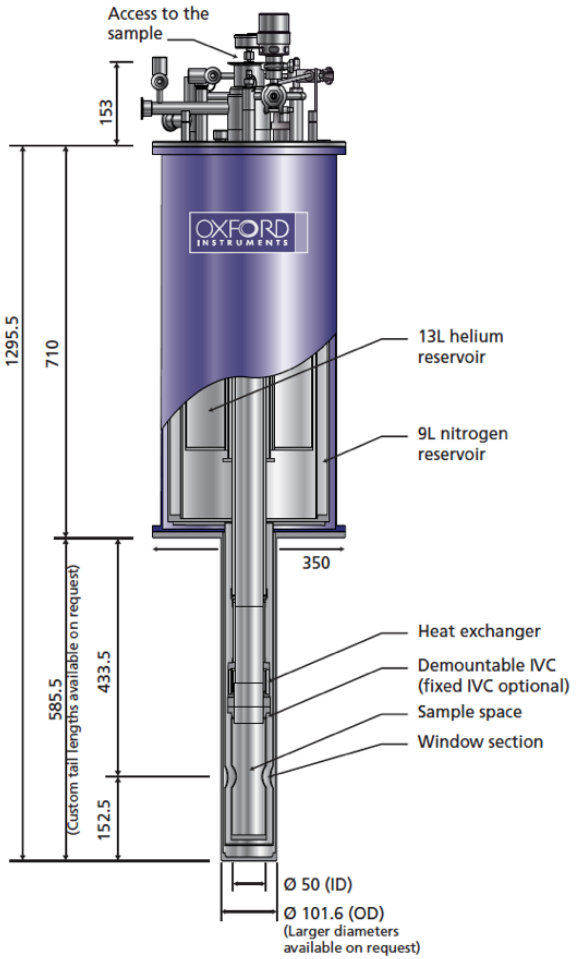
1. **System Overview and Deliverables**
   - Wet orange type-cryostat 70mm VTI
   - 1200mm stick length (set as new standard)
2. **Schedule, Milestones and Reviews**
   - CDR passed, equipment in manufacturing
   - Delivery Jul/21, SAR Aug/21
3. **Integration**
   - Mech. integration to instrument sample stack (KM used for goniometer, not cryostat)
   - ESS pumping cart, standard Lakeshore controllers



‘Wet cryostat’ for ‘MAGiC’

Instrument specific cryostat providing 1.5K-300K

1. **System Overview and Deliverables**
   - Variox wet cryostat system from JCNS/MLZ
2. **Schedule, Milestones and Reviews**
   - Existing system at MLZ.
3. **Integration, Safety, Verification, Validation**
   - Desired reduction of tail diameter to fit smaller coils (by JCNS).
   - Mechanical integration with XYZ coils and kinematic mount under way by instrument team in consultation with Tobias Q.
   - ESS pumping cart, standard controllers



Variox

Flow cryostat for ESTIA

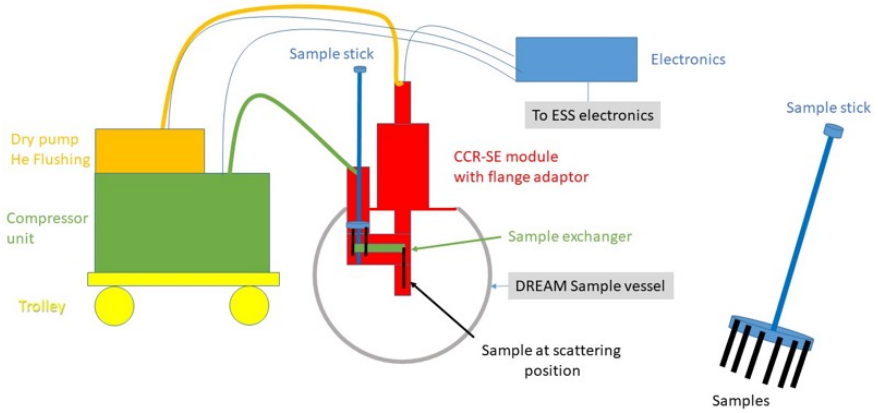
Instrument specific flow cryostat 5-300K

1. **System Overview and Deliverables**
   - Helium flow cryostat
   - JANIS model selected by ESTIA
2. **Schedule, Milestones and Reviews**
   - To be purchases shortly by PSI
   - Specs reviewed by TEFI
3. **Integration, Safety, Verification, Validation**
   - Integrated with hexapod, used with 2.5T warm bore magnet
   - Standard Lakeshore 336 temperature controller

'20 position Cryofurnace' for DREAM

Providing 20 samples, 4 K-800 K at measurement position, sample storage at 90 K

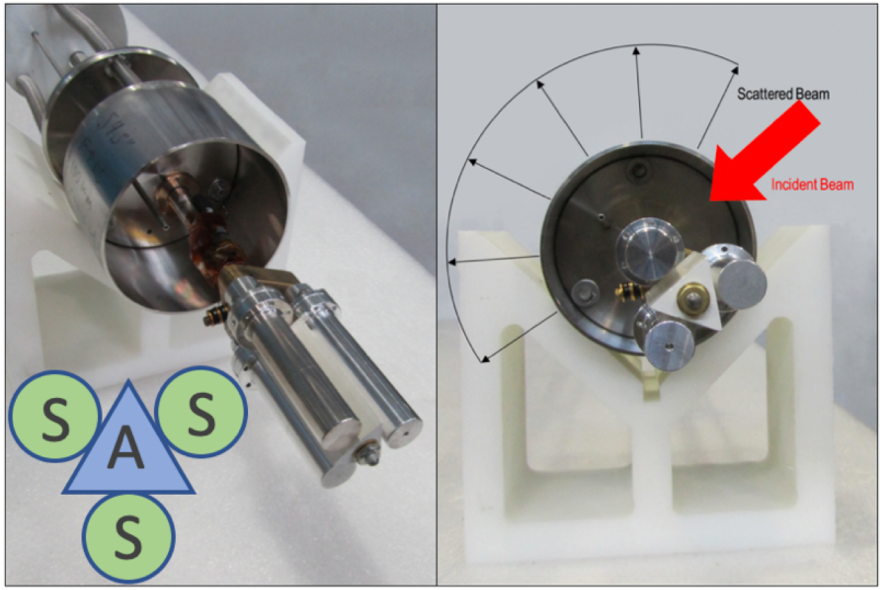
1. **System Overview and Deliverables**
   - Instrument specific multi position dry cryofurnace
2. **Schedule, Milestones and Reviews**
   - CTV complete
   - Tender failed twice, specs simplified in discussion with vendors.
3. **Integration, Safety, Verification, Validation**
   - Top loading L2 interface



‘Cryofurnace changer’ for ‘CSPEC’

Instrument specific providing ‘parameter range’ 1.5-700K

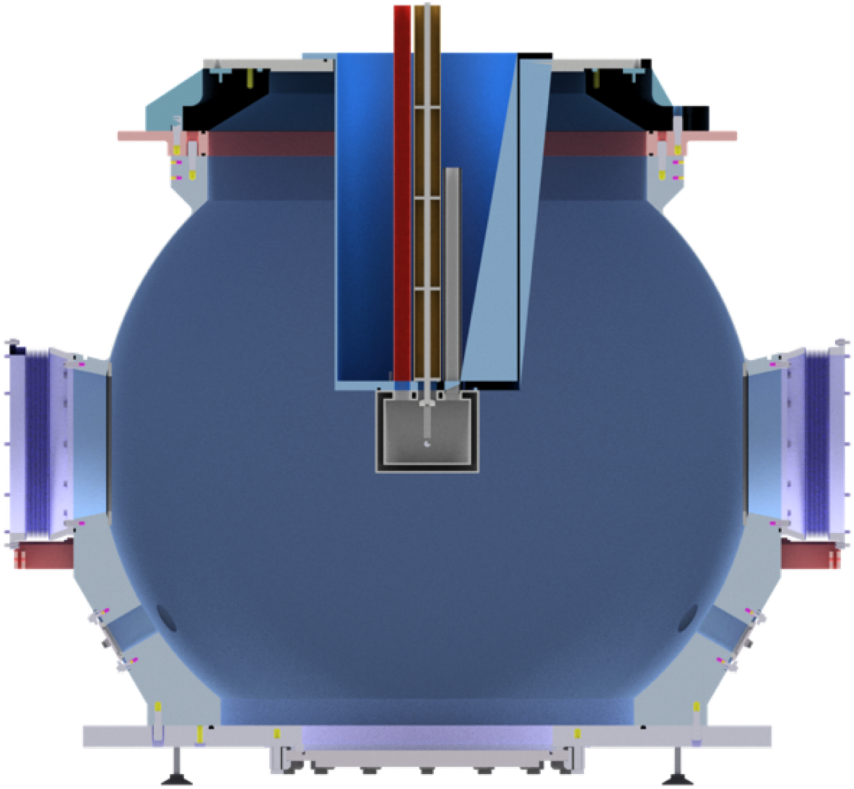
1. System Overview and Deliverables
   - 70mm Cryofurnace
   - 6 position changer
2. Schedule, Milestones and Reviews
   - Cryofurnace specifications reviewed with CSPEC team
   - Sample changer part of joint project with instruments (HS)



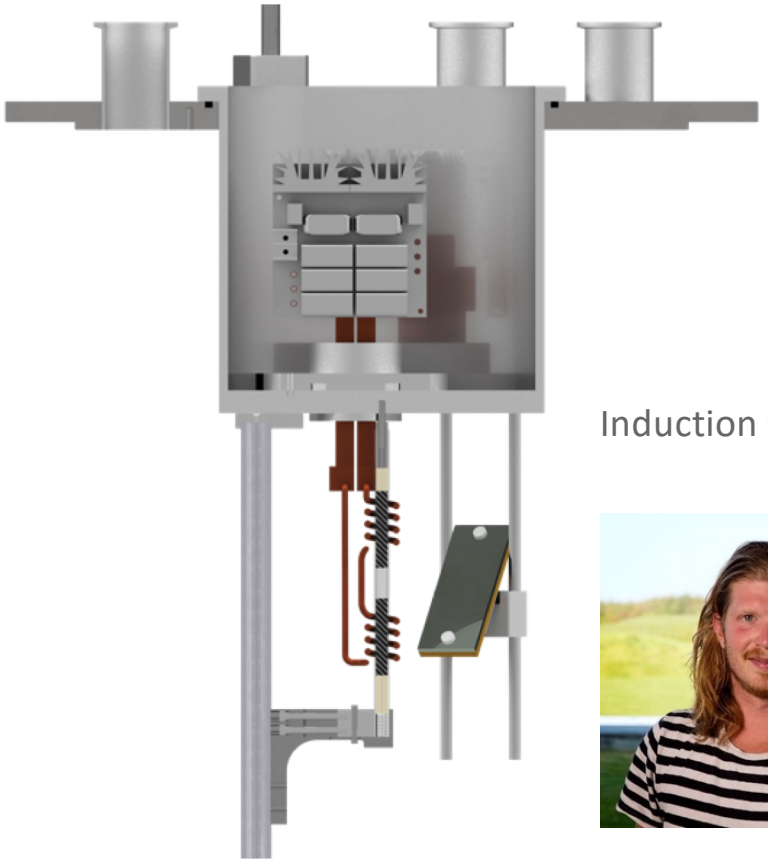
SNS

Ultra fast furnaces for DREAM/HEIMDAL

Nordforsk postdoc project – JAKOB VOLDUM AHLBURG (Aarhus)



Hot air gun/cryostream



Induction furnace

Pumping cart

Joint project SAD, Vacuum group

All wet systems need pump(s), cold valve controller, level meter(s), temperature controller.

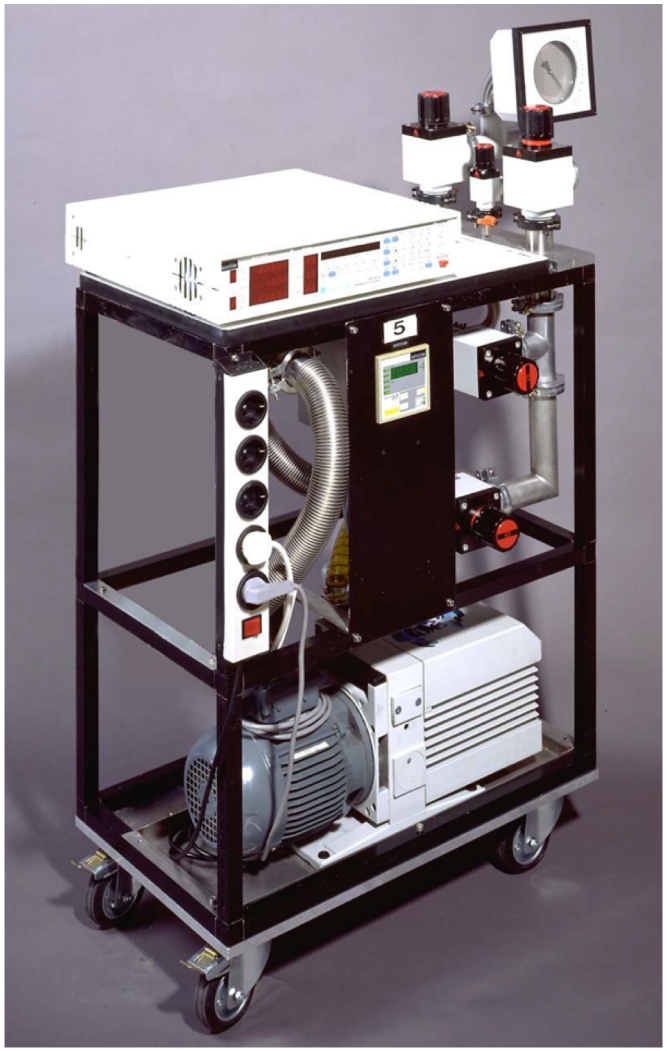
Beckhoff PLC + fitlet PC + touchscreen selected by MESI for hardware control. Octopy software allows python scripting.

Enables a great deal of automation and flexibility, more than in traditional pumping carts.

Automatic sample space flushing sequence already implemented and tested at 300 K.

Cooperating with ISIS though opportunities for common hardware is limited.

To be discussed in breakout session



Breakout sessions - TEFI

Topics for breakout session

Helium management

Pumping cart feedback

Magnetic force testing

Magnet strategy

Pool cryostats & Furnaces

Breakout topic - Pool cryostats & (cryo)furnaces

Generics to specifics

Most instruments in first 8 have instrument specific cryostats/cryofurnaces, except LOKI, ODIN, BEER.

Requirements especially on tails, detector coverage, mounting is rather different for each instrument, no such thing as ‘standard cryostat’.

Most obvious option – prioritise standard wet cryofurnace and ILL furnace for DREAM (top loading with vanadium tails). 2nd hand available from LLB.

Other possibilities:

Backup cryostat for MAGiC (with tail sized for XYZ coils)

SANS compatible tail for LOKI (silicon/sapphire windows).

Warm bore insert cryostat (dry/wet?).

Breakout topic - Magnet strategy

Revised magnet prioritisation.

System	Instruments **OPTIMISED,** Suitable, *Possible*	Cost (€)	Status	Notes
8 T verti. field diffraction cryomagnet	**MAGiC**, DREAM, HEIMDAL, *BIFROST*	1M	FR IK Draft TA/tender Waiting for IKA	Large aperture
15 T HZB	**BIFROST**, *DREAM*, *MAGiC, HEIMDAL*	~~1M~~	Agreement from HZB	Horizontal scattering only
2.5 T Warm bore #1	**ESTIA,** LOKI, *MAGiC, BIFROST, SKADI, HEIMDAL, DREAM*	335k	Planned FR IK. Specs as TOFTOF	
6.5 T Vertical field	**CSPEC**, **TREX**	~~300k~~	Agreement from HZB	
Warm bore #2,3	General purpose	680k	Planned	
14T spectroscopy	**CSPEC**, **TREX,** *MAGiC, DREAM, HEIMDAL, BIFROST*	800k	Initial ops	Low background
11T Horizontal	**SKADI,** ESTIA	500k	Initial ops	Split coil

4
Updates on high-pressure and mechanical engineering

PRESENTED BY MALCOLM GUTHRIE

26-04-2021

SES for first 8 Instruments

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Instr.		Sample Env. Systems	Needed for	Control integration	ORR planned	On Track	Status
LOKI		5-10 KN Stress Rig	SOUP	On hold	TBD	On hold	
ODIN		50KN Stress rig with Torsion-rotation	FS	TBD	TBD	yes	Design
		100 kN Stress-Strain rig	SOUP	On going	Q2/22	yes	Comm
DREAM		PE HP cells	FS	Vinci EPICS, Compressor TBD	Q4/22	yes	Comm
		HP Gas cells and Clamps	FS	PACE, Vinci EPICS	Q4/22	yes	Comm
		Diamond Anvil Cells	SOUP	Vinci EPICS, Compressor TBD	Q4/22	yes	Design
BIFROST		HP Gas cells	FS	Compressor TBD	Q4/22	yes	Design
		HP Clamps	FS	NA	Q4/22	yes	Design
		PE HP cells	FS	Vinci EPICS, Compressor TBD	Q4/22	yes	Comm
		Diamond Anvil Cells	SOUP	PACE, Vinci EPICS	Q4/22	yes	Design
CSPEC		PE HP cells, HP Gas and Clamps	FS	Vinci EPICS, Compressor TBD	Q4/22	yes	Design
		Diamond Anvil Cells	SOUP	PACE, Vinci EPICS	Q4/22	yes	Comm
MAGIC		PE HP cells, HP Gas and Clamps	SOUP	PACE, Vinci EPICS, Compressor TBD	Q4/22	yes	Comm
BEER		100 kN Stress-Strain rig	HC	On going	Q2/22	yes	Comm
		50KN Stress rig with Torsion-rotation	FS	TBD	TBD	yes	Design
		Dilatometer	SOUP	TBD	TBD	Yes	Spec
		Furnace for Rig 1	SOUP	?	TBD		Comm
		Ultra-High T furnace	SOUP	?	TBD		Comm

Pressure systems: overview

System		Instruments	EARLIEST NEEDED	Status
Gas cells (<1 GPa)		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design
Clamp cells		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design
PE cells		***DREAM,BIFROS,CS PEC***,MAGIC	FS	Comm
Diamond Anvil cells		***DREAM,BIFROSTCS PEC***	SOUP	Comm

- Clear consensus on priorities and urgency
- Emphasis on traditional equipment
- Combined LT and HP is essential for all

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Pressure systems: overview

System		Instruments	EARLIEST NEEDED	Status	System Hardware				
Gas cells (<1 GPa)		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells	He comp	Fluid pump		
Clamp cells		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells				
PE cells		***DREAM,BIFROS,CS PEC***,MAGIC	FS	Comm	cells	hyd pump	He comp	gas loader	CCR
Diamond Anvil cells		***DREAM,BIFROSTCS PEC***	SOUP	Comm	DACs	anvils	XYZ	gas loader	CCR

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Not started

Underway (design, manufacture, or testing)

Complete (with some small further work

Pressure systems: overview

System		Instruments	EARLIEST NEEDED	Status	System Hardware					Control integration			
Gas cells (<1 GPa)		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells	He comp	Fluid pump			He Compressor			
Clamp cells		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells					NA			
PE cells		***DREAM,BIFROS,CS PEC***,MAGIC	FS	Comm	cells	hyd pump	He comp	gas loader	CCR	2 kbar hyd. pump	He Comp	CCR	
Diamond Anvil cells		***DREAM,BIFROSTCS PEC***	SOUP	Comm	DACs	anvils	XYZ	gas loader	CCR	2 kbar hyd. pump	PACE	XYZ	CCR

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Not started

Underway (design, manufacture, or testing)

Complete (with some small further work

Pressure systems: overview

System	Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration
Gas cells (<1 GPa)	***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells | He comp | Fluid pump	He Compressor	Cryostat stick
Clamp cells	***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells	NA	Cryostat Stick
PE cells	***DREAM,BIFROS,CS PEC***,MAGIC	FS	Comm	cells | hyd pump | He comp | gas loader | CCR	2 kbar hyd. pump | He Comp | CCR	BL-L2 (including XYω trans) | TL-L2
Diamond Anvil cells	***DREAM,BIFROSTCS PEC***	SOUP	Comm	DACs | anvils | XYZ | gas loader | CCR	2 kbar hyd. pump | PACE | XYZ | CCR	BL-L2 (including XYZ trans) | TL-L2

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Not started

Underway (design, manufacture, or testing)

Complete (with some small further work

Pressure systems: overview

System	Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration	ES&H Quality Integration
Gas cells (<1 GPa)	***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells | He comp | Fluid pump	He Compressor	Cryostat stick	RA, design safety aspects, manual
Clamp cells	***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells	NA	Cryostat Stick	RA, design safety aspects, manual
PE cells	***DREAM,BIFROS,CS PEC***,MAGIC	FS	Comm	cells | hyd pump | He comp | gas loader | CCR	2 kbar hyd. pump | He Comp | CCR	BL-L2 (including XYω trans) | TL-L2	RA, design safety aspects, manual
Diamond Anvil cells	***DREAM,BIFROSTCS PEC***	SOUP	Comm	DACs | anvils | XYZ | gas loader | CCR	2 kbar hyd. pump | PACE | XYZ | CCR	BL-L2 (including XYZ trans) | TL-L2	RA, design safety aspects, manual

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Not started

Underway (design, manufacture, or testing)

Complete (with some small further work

Pressure systems: gas & liquid cells

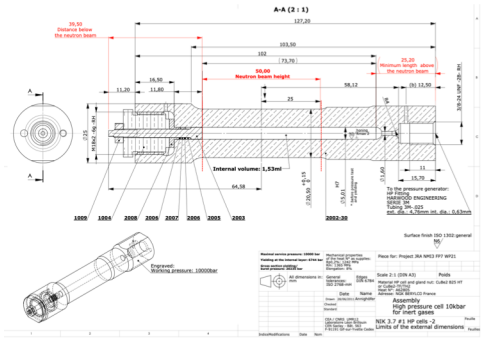
System		Instruments	EARLIEST NEEDED	Status	System Hardware			Control integration	Mech. Integration	ES&H Quality Integration
Gas cells (<1 GPa)		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Design	cells	He comp	Fluid pump	He Compressor	Cryostat stick	RA, design safety aspects, manual

Achievements

- Signed and kicked off in-kind agreement with CEA (Feb 2021)
- First detailed design of gas cell
- Started assembly of 7 kbar fluid pump

Challenges

- Compressor: Sitec 10 kbar model (ILL, PSI, ORNL) more expensive than expected by (~80%)

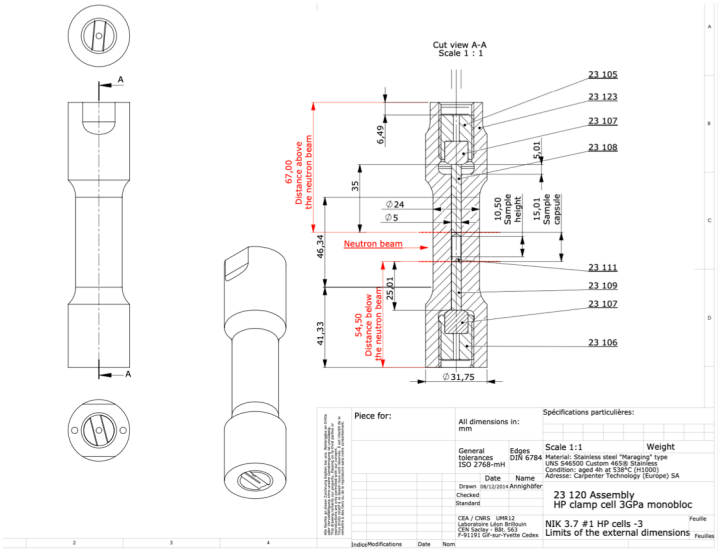


Pressure systems: clamp cells

System		Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration	ES&H Quality Integration
Clamp cells		***DREAM,BIFROSTCS PEC,***MAGIC	FS	Design	cells	NA	Cryostat Stick	RA, design safety aspects, manual

Achievements

- Signed and kicked off in-kind agreement with CEA (Feb 2021)
- First detailed design of clamp cell



Pressure systems: PE cells

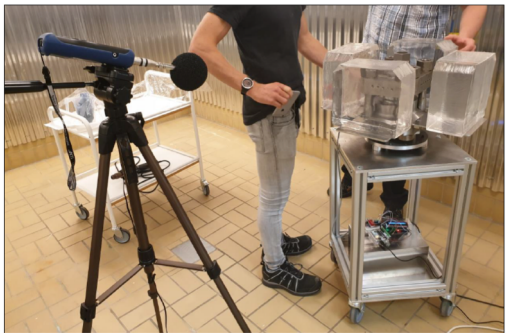
System		Instruments	EARLIEST NEEDED	Status	System Hardware					Control integration			Mech. Integration		ES&H Quality Integration
PE cells		***DREAM,BIFROSTCS PEC***,MAGIC	FS	Comm	cells	hyd pump	He comp	gas loader	CCR	2 kbar hyd. pump	He Comp	CCR	BL-L2 (including XYω trans)	TL-L2	RA, design safety aspects, manual

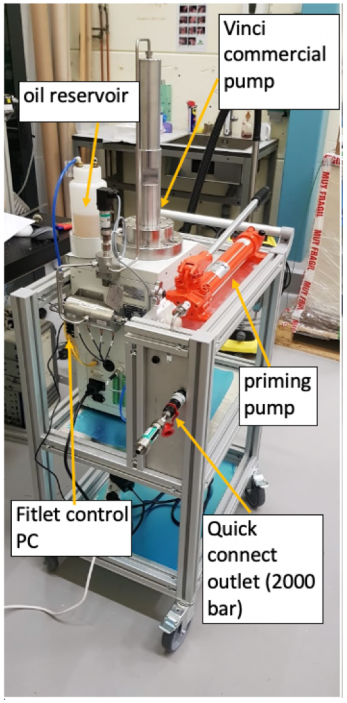
Achievements

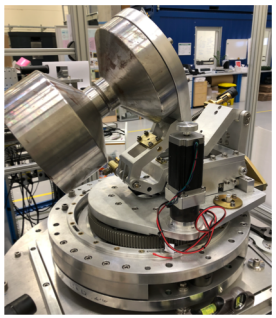
- Signed and kicked off in-kind agreement with CEA (Feb 2021)
- 2000 bar hydraulic pump, built, tested and integrated (EPICS)
- mech. integration (DREAM, MAGIC & BIFROST) *almost* complete
- In house ZTA anvils and gaskets successful

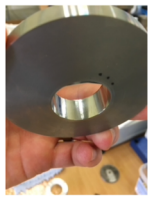
Challenges

- Low temp operation requires He compressor
- Projected delivery of CCR (Q2/23) means integration may be an issue
- Anvil development project (SAKURA) stalled.









Pressure systems: DACs

System		Instruments	EARLIEST NEEDED	Status	System Hardware					Control integration				Mech. Integration		ES&H Quality Integration
Diamond Anvil cells		***DREAM,BIFROSTCS PEC***	SOUP	Comm	DACs	anvils	XYZ	gas loader	CCR	2 kbar hyd. pump	PACE	XYZ	CCR	BL-L2 (including XYZ trans)	TL-L2	RA, design safety aspects, manual

Achievements

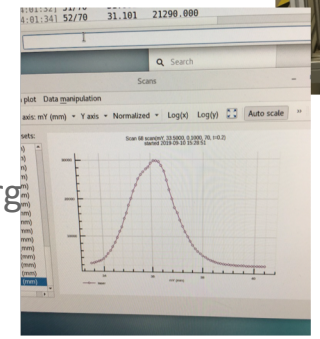
- Successful collaboration with SNS to develop and hot commission new DAC designs (for powder and SXL diffraction)
- Fully integrated (NICOS) and hot-commissioned mechanical integration (inc x,y,z alignment stage)
- Integrated (EPICS) gas-control system (can also use VINCI system)
- portable ruby system built and tested

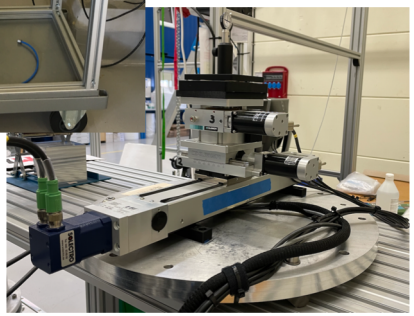
Challenges

- Procurement of cells and diamonds postponed

Mitigation

- Older cell designs available through collab. with university of Edinburg





Pressure testing facility

- Extensive work has been done on defining safety requirements for HP equipment
- On going consultation with Swedish Defense Research Agency (FOI) to independently review risks and the ESS approach.
- Approach to HP safety requires regular pressure testing, including burst testing (also done at ISIS and ILL).
- Also developed specification and published tender for physical construction of a pressure testing facility.

one concept is a modified 8’ shipping container

Engineering systems: overview

System	Instruments	EARLIEST NEEDED	Status	System Hardware			Control integration			Mech. Integration		ES&H Quality Integration
Rig 1 (100 kN)	ODIN, **BEER**	HC	Comm	Rig	Furnace	Ultra high T Furnace (external)	Rig	Furnace	UHTF	BL-L1 (horiz)		RA, design safety aspects, manual
Rig 2 (50 kN torsion-rotation)	***ODIN BEER***	FS	Design	Rig			Rig			BL-L2 (horiz)	BL-L2 (vert)	RA, design safety aspects, manual
Rig 3 (5-10 kN)	***LOKI***	SOUP	On Hold	Rig			Rig			BL-L2 (vert)		RA, design safety aspects, manual
Rig 4 (2nd hand)	**LOKI**	SOUP	Comm	Rig			Rig			BL-L2 (vert)		RA, design safety aspects, manual
Dilatometer	***BEER***	SOUP	Design	Dilatometer (commercial)			Dilatometer			BL-L2		CE-marked

Absolutely needed

Can be postponed (HC to FS, FS to SOUP)

Can be postponed for later during operation

Not started

Underway (design, manufacture, or testing)

Complete (with some small further work

Engineering systems: Rig 1

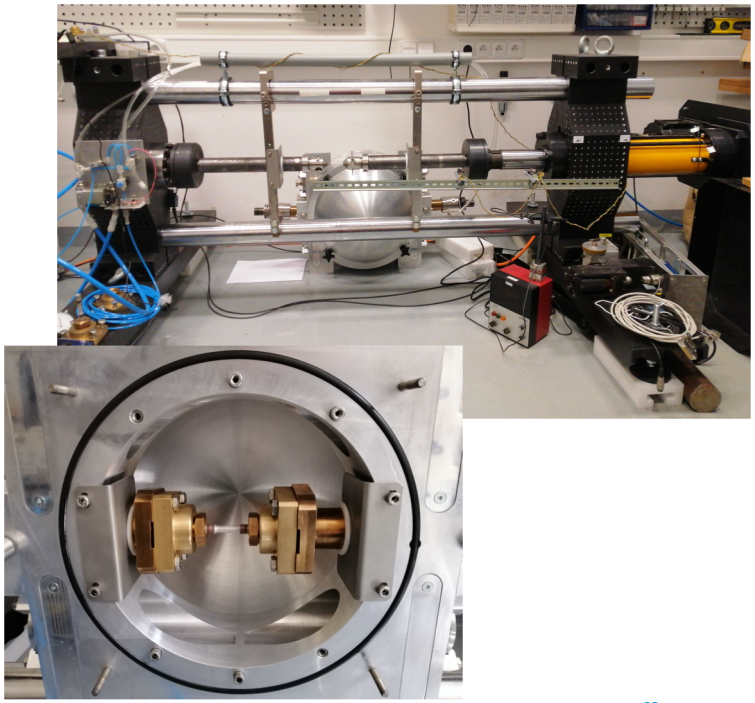
System		Instruments	EARLIEST NEEDED	Status	System Hardware			Control integration			Mech. Integration	ES&H Quality Integration
Rig 1 (100 kN)		ODIN, **BEER**	HC	Comm	Rig	Furnace	Ultra high T Furnace (external)	Rig	Furnace	UHTF	BL-L1 (horiz)	RA, design safety aspects, manual

Achievements

- Rig hardware inc. furnace constructed by partners at NPI
- Initial review of safety/quality for rigs conducted
- Partial integration via MQTT

Challenges

- Lack of resources on partner side for control integration
- labview interface not currently supported by ICS
- UHT Furnace project delayed by legal issues with ISIS



Engineering systems: Rig 2

System		Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration		ES&H Quality Integration
Rig 2 (50 kN torsion-rotation)		***ODIN BEER***	FS	Design	Rig	Rig	BL-L2 (horiz)	BL-L2 (vert)	RA, design safety aspects, manual

Achievements

- Requirements and specification defined
- Draft tender document written

Challenges

- Undecided on whether a commercial or non-commercial system

Engineering systems: Rig 3

System		Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration	ES&H Quality Integration
Rig 3 (5-10 kN)		***LOKI***	SOUP	On Hold	Rig	Rig	BL-L2 (vert)	RA, design safety aspects, manual

Challenges

- on hold for now

Engineering systems: Rig 4

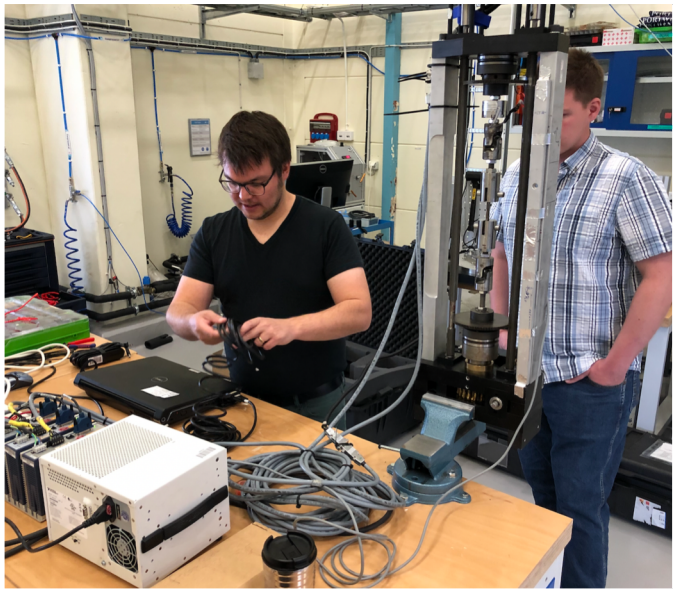
System		Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration	ES&H Quality Integration
Rig 4 (2nd hand)		**LOKI**	SOUP	Comm	Rig	Rig	BL-L2 (vert)	RA, design safety aspects, manual

Achievements

- System (2nd hand, developed by R. Woracek) has been operated in Lund
- Used rig as test bed to define safety/quality requirements for non-CE marked rigs
- preliminary concepts for mechanical integration

Challenges

- Lack of integration resources
- Labview interface not currently supported by ICS



Engineering systems: Dilatometer

System		Instruments	EARLIEST NEEDED	Status	System Hardware	Control integration	Mech. Integration	ES&H Quality Integration
Dilatometer		***BEER***	SOUP	Design	Dilatometer (commercial)	Dilatometer	BL-L2	CE-marked

Project not yet started

5
Updates on fluids and electrochemistry

SE
Soft matter & Electrochemistry

PRESENTED BY ALICE CORANI AND HERALD SCHNEIDER

26-04-2021

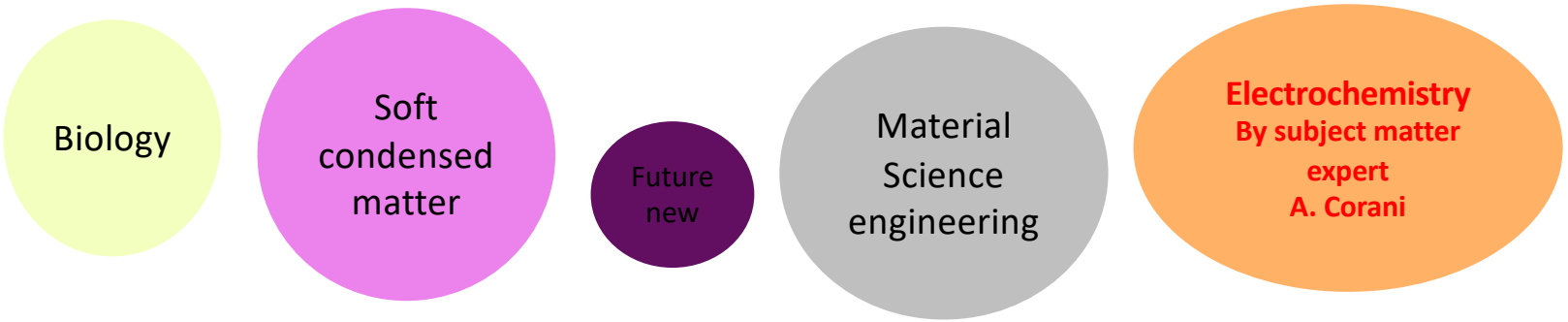
SE

Soft matter & electrochemistry

- A. Corani / H. Schneider -

EUROPEAN SPALLATION SOURCE

SE provides Sample Environment Systems (SES)* and devices* for :



SES →

- **Main usage at large scale instruments**
  - **SANS { LOKI , SKADI }**
  - **Reflectometer { ESTIA , FREIA }**
  - **Spectrometer { CSPEC , MIRACLES , VESPA }**
  - **But , if needed also at other instruments**

Devices →

- **Useful for all instruments, e.g. gas manifolds, water bath circulators**

* SES = Humdity chamber , devices = humidity cell, humidity generator, temperature controller, gas supply
* SES = Orange cryostat , devices = cryostat mech. , temperature controller, pumping unit, level meter, Lhe/LN_2

SE

Soft matter & electrochemistry

- A. Corani / H. Schneider -

The team is active part of the E03/E04 installation team

- **Participating in the shift operation on support of external technicians**
- **A. Corani takes part in characterization measurements on target materials**
- **Also A. Corani starts collaborations with Tartu, Univ. Uppsala , FZ-Juelich on cell development on in situ measurements with electrochemistry cells.**
- **H. Schneider electrical operations leader for the E03/E04 building**
- **Working on reliable sample changer options for various instrument types**
- **The team is moved to the “On-Site-Offices” at E04, temporary lab.in E04**
- **Hand over of D04 lab in Q1/22**
- **Meanwhile start working in temporary lab in E04**

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Planned suite of sample environment systems & devices, ESS/construction

- Humidity Chamber(s), preparing for integration
- Rheometer (RheoSANS), Shear cells, Cuette cells, procured-delivery in june
- Stopped Flow devices , preparing for integration
- Syringe Pumps , Peristaltic Pumps, first are base line integrated
- Gas Process Handling (arrived), Manifolds, waiting for installation support
- Water (Oil) bath circulating devices, 7 available, base line integration done
- Rotating cells, finalizing installation
- Thermalizing gas blower, later planned
- Liquid-Solid-Cells, Electro-chemistry cells for ”In Situ” /”operando” measurements, on going

Provided as part of instrument budgets :

• Sample changer , multiple samples, on going	CSPEC/MIRACLES	TUM, Ger, Esp.
• Troughs, Langmuir troughs, trough changer,later	FREIA	STFC, GB /NN
• SANSMAG, stopped	LOKI/SKADI/ESS	STFC/FZJ ; GB/Ger
• Sample changer, later	VESPA	STFC , GB
• HPLC Pump, done , preparing for integration	LOKI/FREIA/ESTIA	STFC/PSI ; GB/CH
• Liquid-Solid-Cells , planned	FREIA/ESTIA	STFC/PSI ; GB/CH
• Cryo stream instrument	NMX	ESS , DK, FR
• Humidifier instrument	NMX	ESS , DK, FR

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Gas process handling system

P < 200 bar

Flushing, pressurising, filling

Simple adsorption measurement

T <= 773 K

N_2, O_2, H_2, D_2 He, Ne, Ar, CO, CO_2

expandable

InKindPartner, Univ Tartu, Est

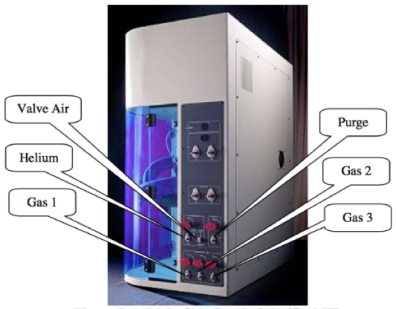
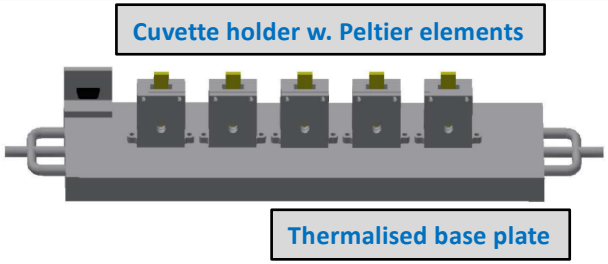


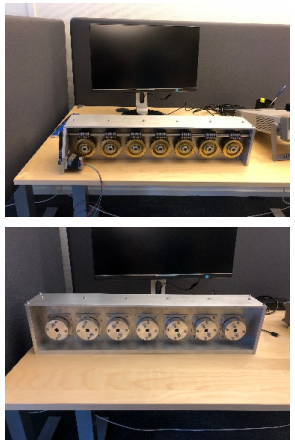
Figure D.1, Right Side Panel of the iSorbHP

Principle sketch of the device



IK Partner: B Jakobson, C Niss, RUC

Tumbler, Basque interns/ESS



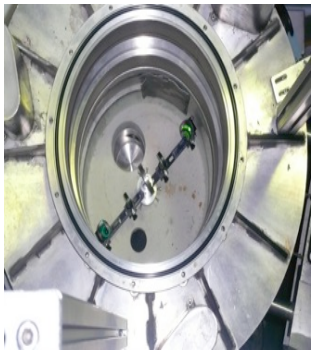
Laser pump probe

Optical trigger

for photosynthesis

Laser pump probe II

Thermal stimuli of sample



InKindPartner, Prof. J. PieperUniv Tartu, Est

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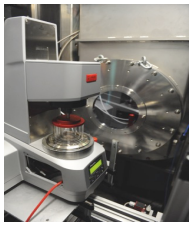
Both , moved to OPS

Rheometer
Various setups
e,.g shear cell
Taylor-Cuette cell
Quench technique



JCNS , Outstation at FRM2 , MLZ

Gas stream thermalizer

In Test thermal solutions

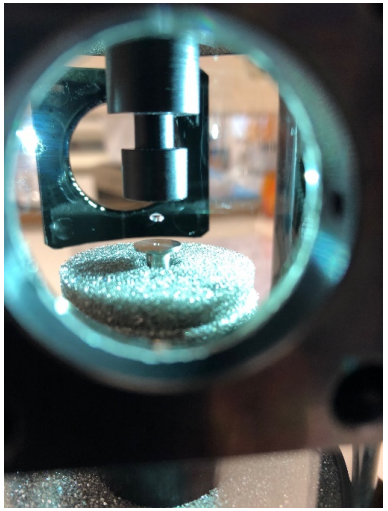
Potential InKindPartner, FZJ ,Ge

H2 gas manifold

Stopped flow cell
6 channels.
278 K – 368 K

In Kind with Univ. Tartu

Ultrasonic Levitator



Testoperation at MV Lab,
Collaboration with SULF

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FlexiProb , A german BMBF funded project

- **Additional equipment and methods available by FlexiProb project**

- **BMBF funded project by University of Bielefeld, TU-Darmstadt, TU-Muenchen**
- **FZ-Juelich incl. the SKADI team.**
- **Development of experimental setup's for ESS experiments at SANS instr.**
- **Some topics**
  - **Foams : Structure, dynamics/kinetics**
  - **Humidity cells + GISANS techniques, In Situ UV VIS, WL-Spectroscopy**
  - **In situ light scattering setup , DLS, SLS**

Partner : Prof. R. von Klitzing, Prof. Th. Hellweg, Prof. P. Mueller-Buschbaum

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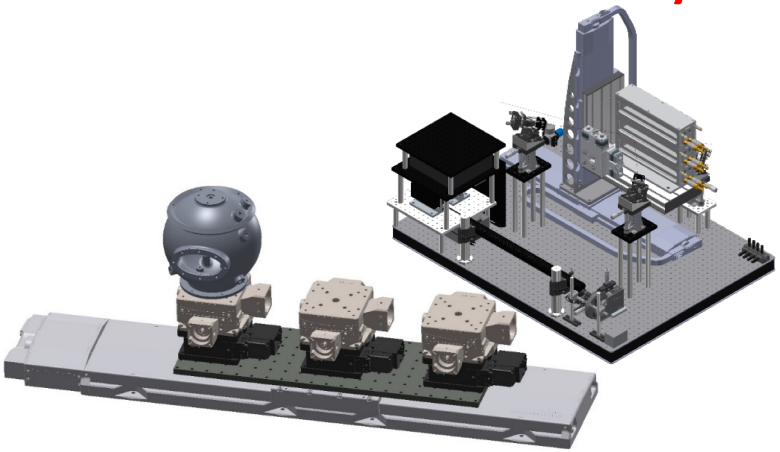
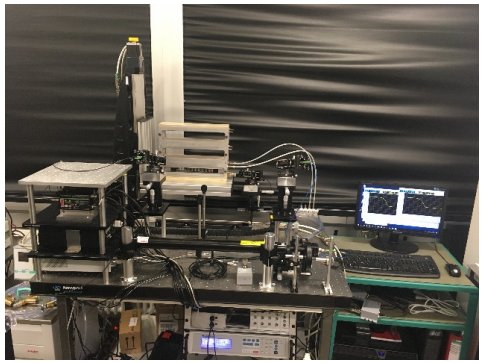
FlexiProb , A german BMBF funded project

- **Successful renewal for 3 more years (2019-2022)**





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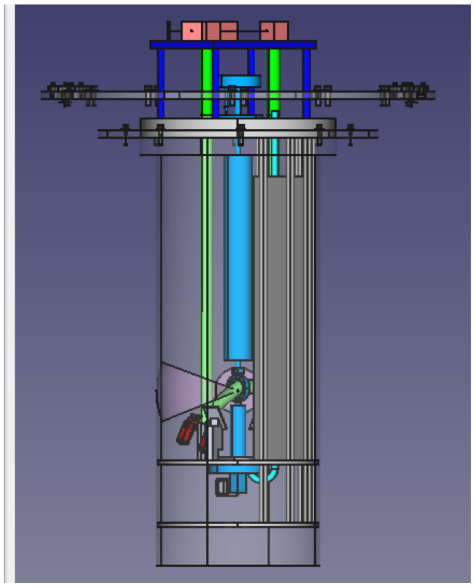
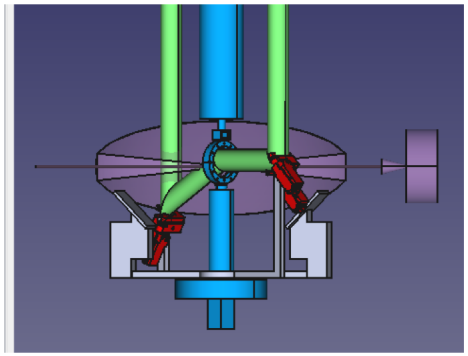
- PP full setup angle of orientation 135
  - PP_full_setup_angle_of_orientation_135
    - Origin
    - PP_prisma_orientation_135
    - PP_sample_holder
    - neutron_scattering
    - laser_mirrors
    - laser_beam
    - Oil_tubes_135_small_port
    - laser_table_PP
    - holders_of_mirrors_orientation_135
    - PP_miracles_Sample_Chamber
    - Nema_17



- PP full setup angle of orientation 135
  - PP_full_setup_angle_of_orientation_135
    - Origin
    - PP_prisma_orientation_135
    - PP_sample_holder
    - neutron_scattering
    - laser_mirrors
    - laser_beam
    - Oil_tubes_135_small_port
    - laser_table_PP
    - holders_of_mirrors_orientation_135
    - PP_miracles_Sample_Chamber
    - Nema_17



PP chamber is embedded into the Vessel of Miracles instrument, Production is on going@Tartu

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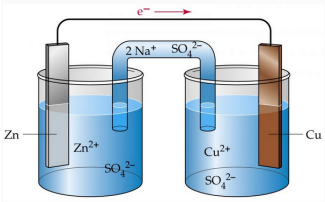
Electrochemistry

Not a new or modern technique

General analytical tool in a chemistry lab

- *Electrosynthesis*
- *Surface treatments*
- *Energy Storage and conversion*
- *Material Analysis*
- *Corrosion*



Increasing interest Energy Storage and Energy conversion

- Battery
- Reduce CO_2 emission

Scientific community challenges

- Interfaces/ Interphases charge transfer
- New material

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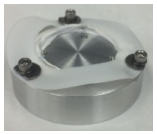
Electrochemistry

User Lab → **Sample Environment**

- Basic analytical tool
  - Wet chemistry
  - Polarography
  - Impedance measurement



- Sample preparation
  - Glove box
  - Clean area
  - Prepare charge/discharge

Developing Cells compatible with neutron experiment, In situ and operando in collaborations with:

- In kind with Tartu University
- Univ. Uppsala , FZ-Juelich

Provide infrastructure to perform exp.

- Temperature control (10 K to 500 K)
- Testing/cycling opportunity
- Potentiostats with FRA

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In Kind – Tartu University

WP	Partner	2020	2021	2022	
EC cell	Uni. Tartu (EE)	Selection/ definition of parameters, selection of material	Design of cells, CDR, Manufacture	Test of the cell, calibration, suitability for neutron scattering exp	Documentation, handover including CAT

- Cells compatible with neutron experiment, in situ and operando
  - Coin cell, SANS measurements.
  - Annular cell for inelastic, diffraction exp.
- Instruments
  - Structure and dynamic studies :

    DREAM, CSPEC, T-REX, VESPA, HEIMDAL and MIRACLE
  - Large scale structure experiments:

    LOKI, FREIA, ESTIA, SKADI

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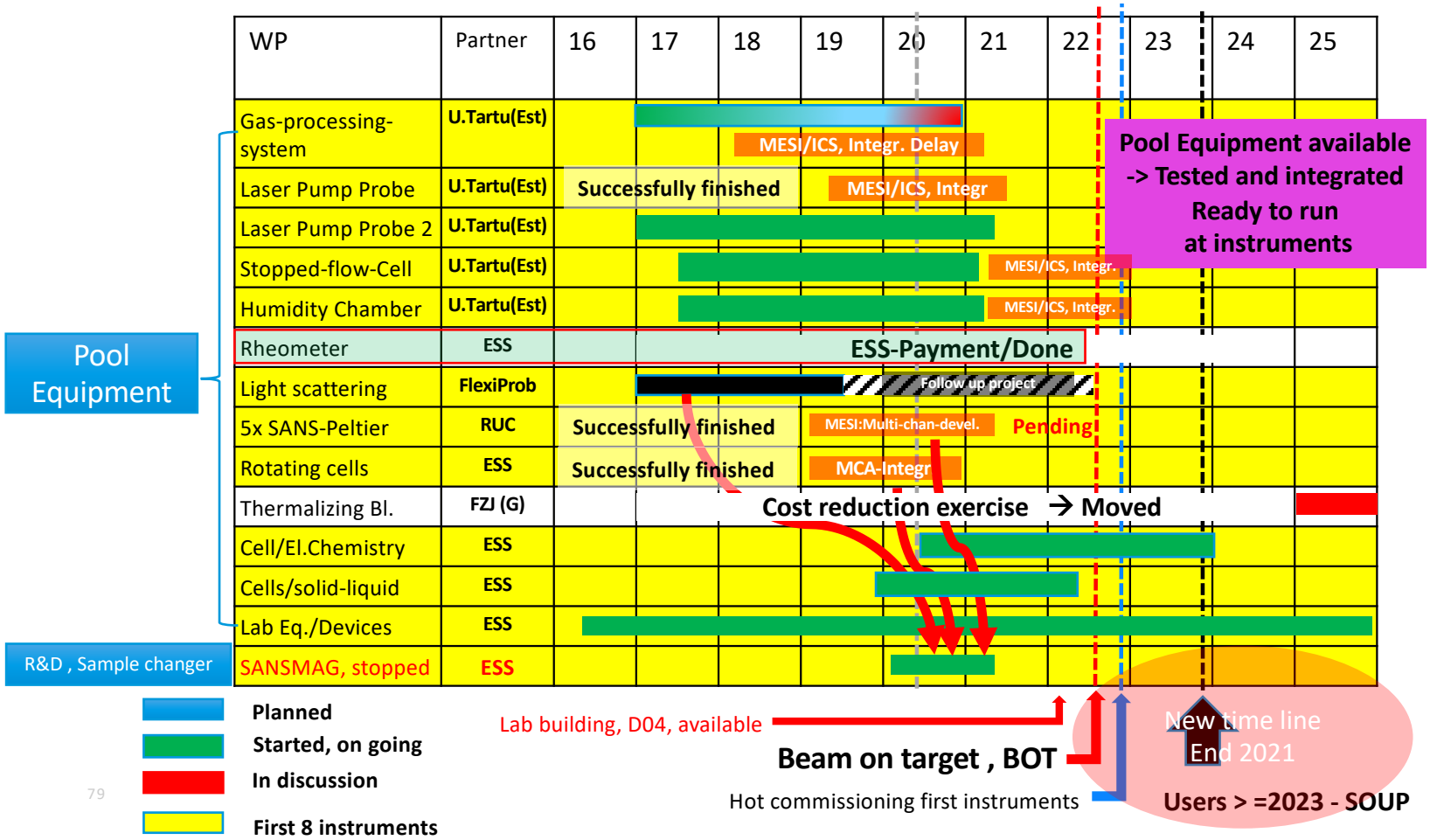

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Staffing development up to 2025 as envisaged start of steady state operation , First technician starts in 09/2019.

personnel	15	16	17	18	19	20	21	22	23	24	25
Scientific engineer	5/12	1	1	1	1	1	1	1	2	2	2
Technician 1	-	-	-	-	0.5	0.5	0.5	1	2	3	3

Actual line end 21 expected

Lab building available

Hot commissioning first instruments

Users >= 2023

Now , 2021, hiring freeze

FTE : 5 , (Full Time Equivalent)

Management	**0.3 FTE = 6%**
R & D	**1.0 FTE = 20%, or minimum 1 person**
FLUCO Infrastructure	**0.2 FTE = 4%**
User operation / support	**2.5 FTE = 50%**
Platform service	**1.0 FTE = 20%**

Leading , fixed No's are 20 % R & D and service providing 50 %.

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So ….

- **The most needed pool equipment is arrived and with In-Kind projects and ”Cash” on the way, to integration.**

- **The Gas-Process-Handling-System has arrived, after installation, the integration process will started with ECDC.**

- **Stopped flow still at RSS and Humidity chamber are on going**

- **Own developments are started and first low value devices are procured, thermalizers/syringe pumps/HPLC pump/ H_2 gas manifold (build), peristaltic pump, levitator (ultrasonic)**

- **Actually testing the possibilities of ultrasonic levitation as sample holder, in collaboration with SULF on going**

- **Also a approach to find Field Flow Fractionation using with Neutron scattering @ SANS/GISANS has started.- on going**

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Conclusions

- **For the hot commissioning of the first 8 instruments, the mandatory pool equipment will be available**
- **The BMBF Flexiprob project gives more features (DLS,SLS, humidity cells for vertical and SANS applications))**
- **Hopefully next year an other technician can be hired.**

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Thank you for your attention

Questions ?

Notes , Remarks, ...

Thank you

2021-04-26