# DREAM update for STAP

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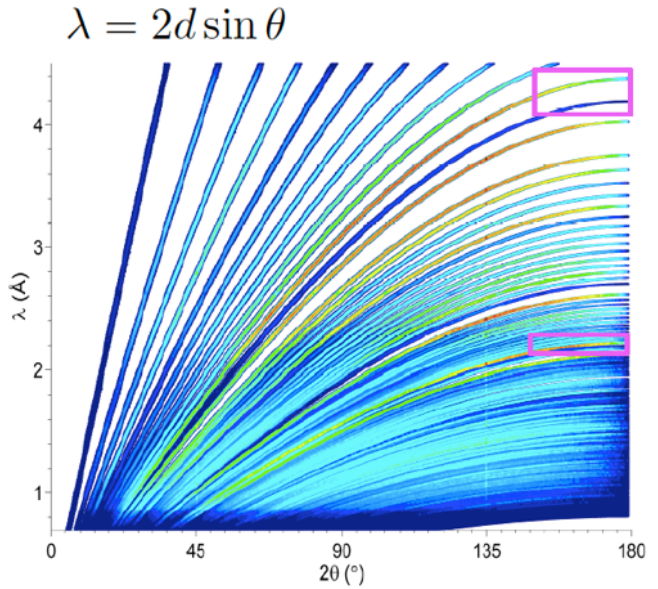
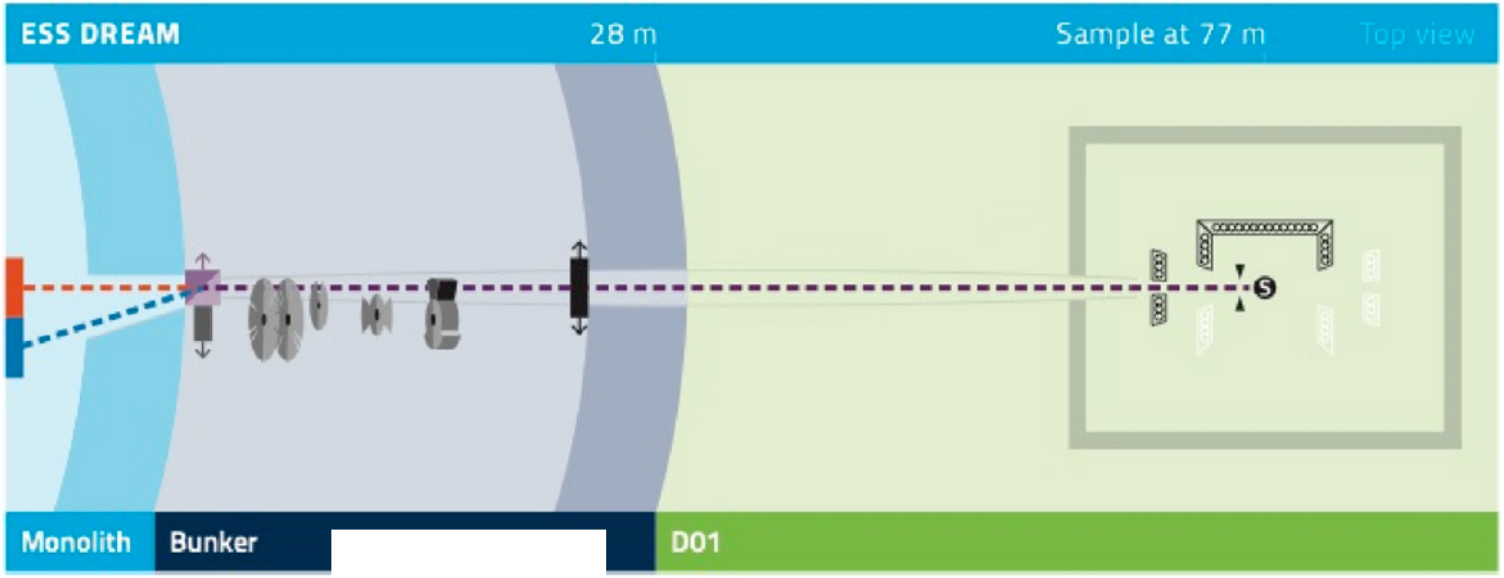
# Welcome new STAP members!

- **D**iffraction **R**esolved by **E**nergy and **A**ngle **M**easurements
- General use powder diffractometer with novel capabilities, which will outperform in its first stage existing instruments by factor of 2 on day one
- In-kind contribution to ESS from Germany (FZJ – 76 %) and France (LLB – 24 %)
- One of the first three instruments at ESS
- Upgradable: full detector coverage

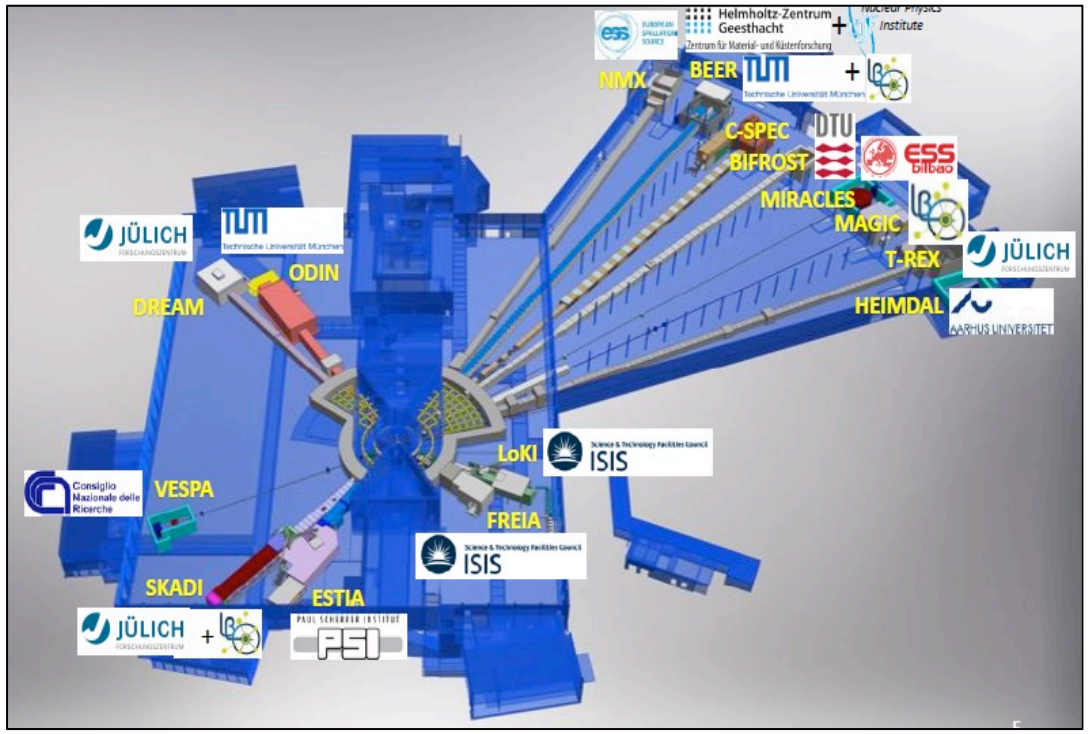


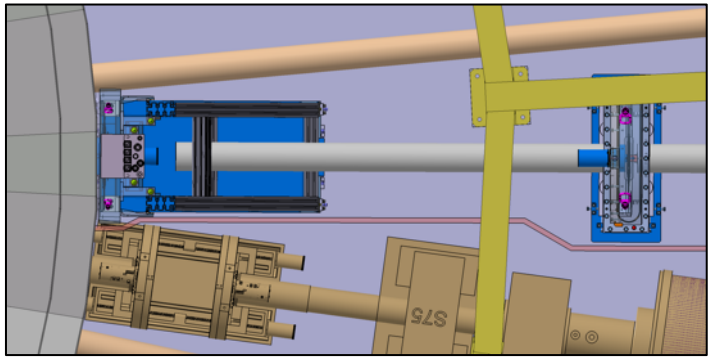

DREAM Quick Facts.

| DREAM Quick Facts | |
|---|---|
| Instrument Class | Diffraction |
| Moderator | Bispectral |
| Primary Flightpath | 76.5 m |
| Secondary Flightpath | 1.1 m (end-cap and mantle detectors)<br>2.5 m (high-resolution and low-angle detectors) |
| Wavelength Range | 0.5–4.1 Å |
| Flux at Sample at 2 MW | $1.4 \times 10^7$ n $s^{-1}$ $cm^{-2}$ ($\Delta d = 3 \times 10^{-4}$ Å)<br>$1.0 \times 10^9$ n $s^{-1}$ $cm^{-2}$ ($\Delta d = 2.5 \times 10^{-2}$ Å) |
| Q-Range | 0.2 (0.01[a])–25 $Å^{-1}$ |
| Detector Coverage | 1.82 (5.12[a]) sr |
| d-spacing Resolution $\Delta d$ | Adjustable $3 \times 10^{-4}$–$2.5 \times 10^{-2}$ Å |

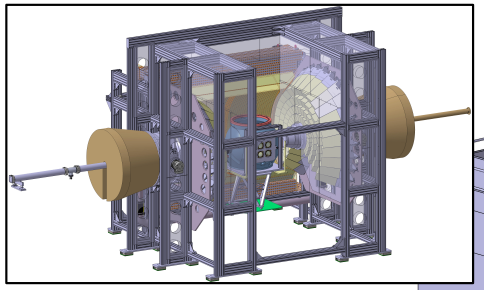
[a]Available as a foreseen upgrade.



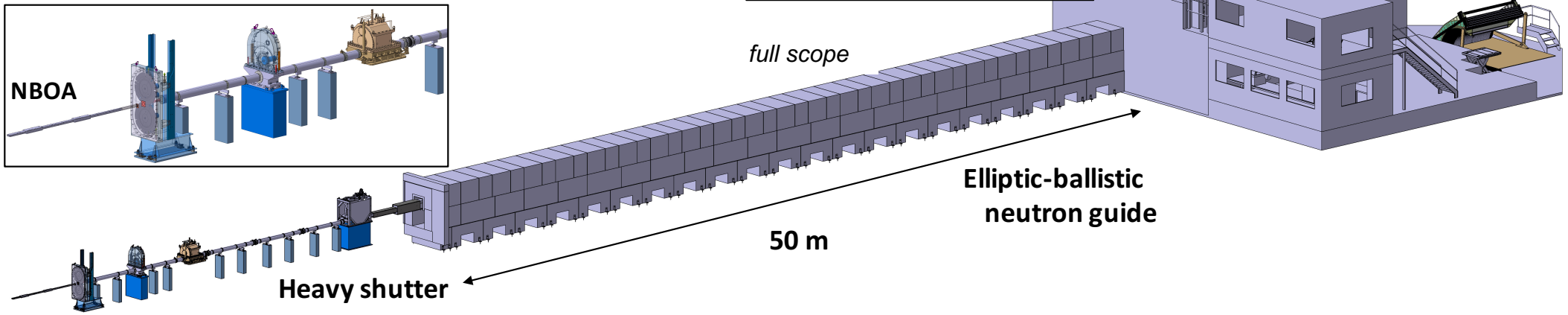

## Interface with ODIN inside the bunker



## Detectors



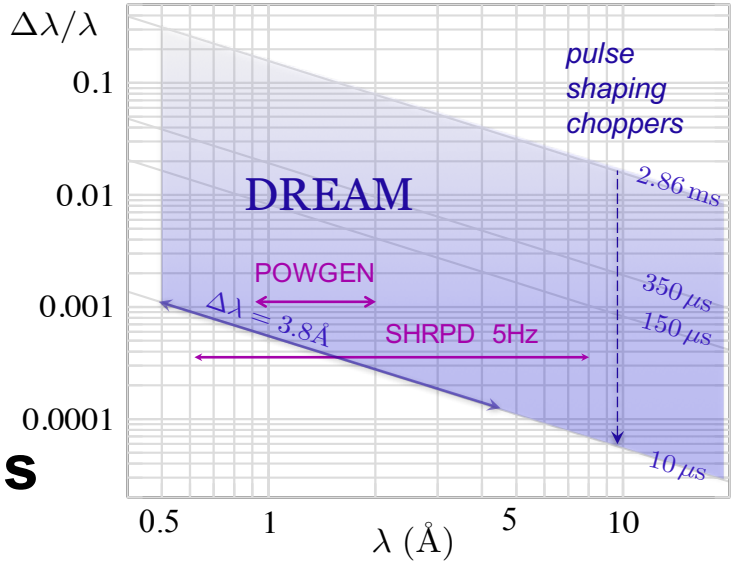
## Experimental cave



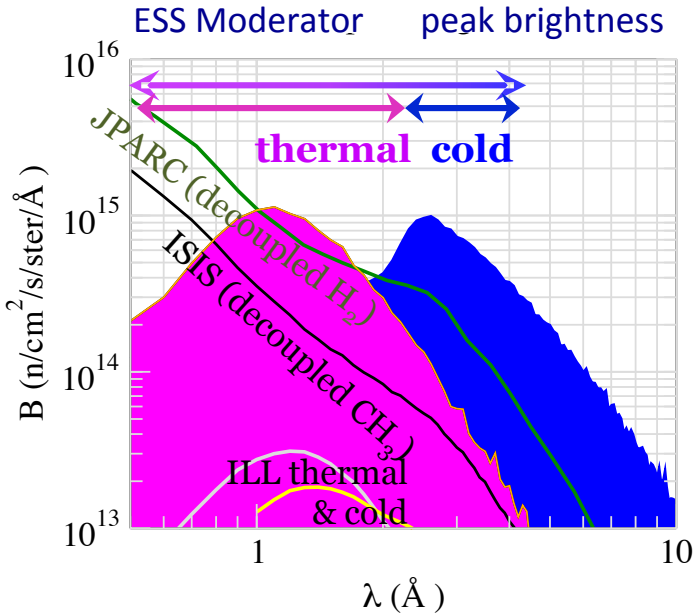
# Design features

## Pulse-shaping: high flux & high resolution flexibility

- Large bandwidth (3.6 Å)
- Broad Q-range in one setting
  0.3 $Å^{-1}$ (0.01 $Å^{-1}$) < Q < 25 $Å^{-1}$
  (SANS / ND / PDF)
- Highest resolution in neutron powder diffraction




## Combination of thermal and cold neutrons




- Superior peak brightness (cold neutrons!)
- Low Q: magnetism and large unit cells
- High Q: Pair-distribution function
- High intensity: small samples & fast in-situ measurements

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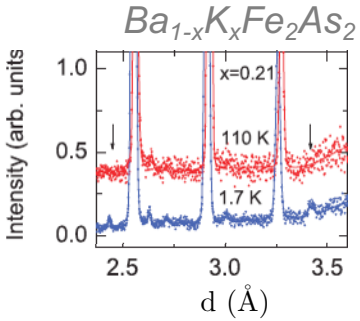
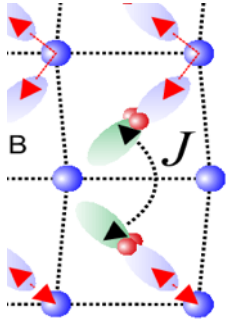
# Versatility

*powders*
*single-crystals*
*nanoparticles*
*alloys*
*liquids*

# Magnetism

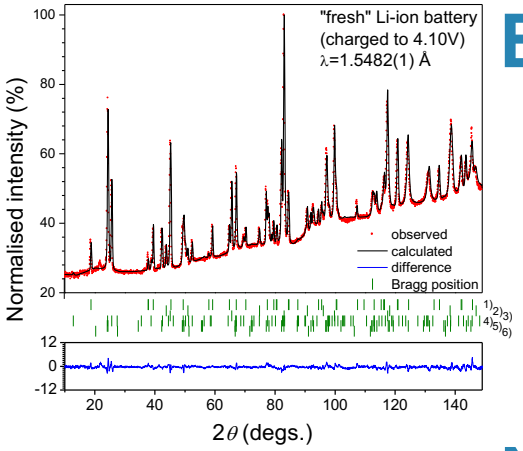



*weak moments*
*phase diagrams of*
*superconductors*
*multiferroics*




*orbital ordering*
*charge ordering*
*distortion*
*magnetic exchange*

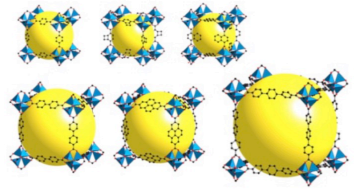
# Energy Materials

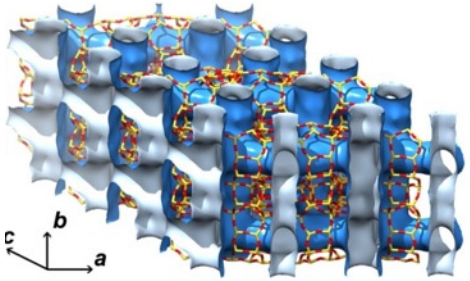



*multiphase*
*catalysts*
*in-operandi*
*batteries*

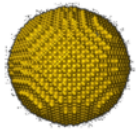
# Large Unit Cells

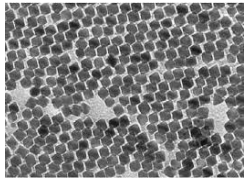
*MOFs*
*thermoelectrics*
*molecular sieves*
$H_2$ *- storage*






# Nanostructures





*many novel samples come in np*
*magnetic nanoparticles*
*core-shell structures*
*self-assembly*
*synthesis*

Dedicated SANS detector and
polarized neutrons are funded by RAC grant



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# Schedule update

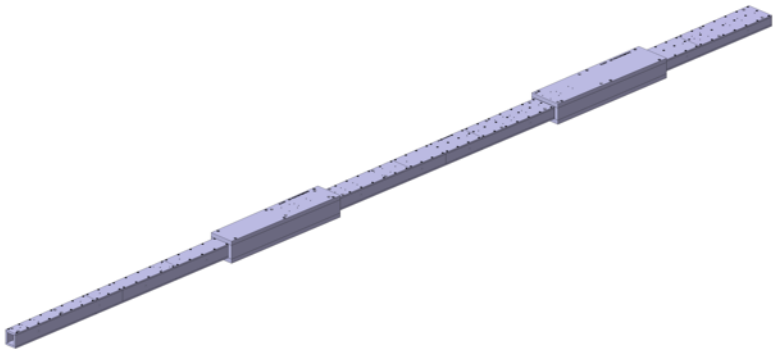
**DREAM will be ready for first neutrons in Sept. 2023:**

- Completion of the final design phase (TG3) is expected this year
- Access date to the bunker is delayed to Feb. 2022
- Access to experimental hall is on schedule June 2021
- Instrument construction is completed by Sept. 2022
- Beam-on-target is on Sept. 2023

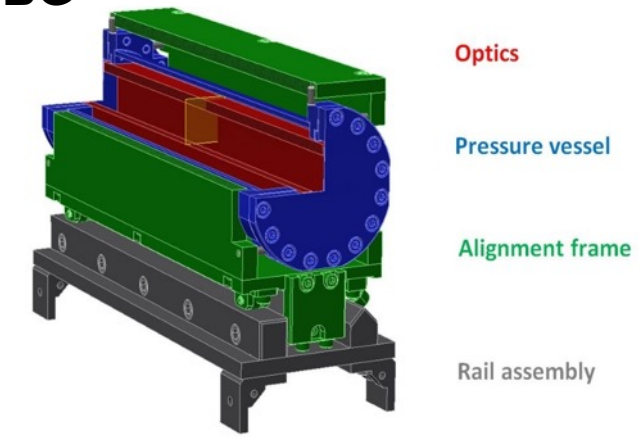
| Installation complete | Date |
|---|---|
| NBOA | Q1/Q2 2022 |
| Bi-spectral switch + BBG | |
| Neutron guides inside the bunker | |
| Heavy Shutter | |
| Choppers | |
| Caves | March - 22 |
| Hutch + sample prep. lab | April - 22 |
| Sample Vessel | June - 22 |
| Detector Support | |
| Neutron guides outside the bunker | July - 22 |
| Guide shielding | |
| Detectors / Utilities / PSS | Sept. – 22 |
| Beam on Target / Hot commissioning | Sept. - 23 |

# Neutron Beam Optics Assembly / Bridge Beam Guide / Bi-spectral Switch

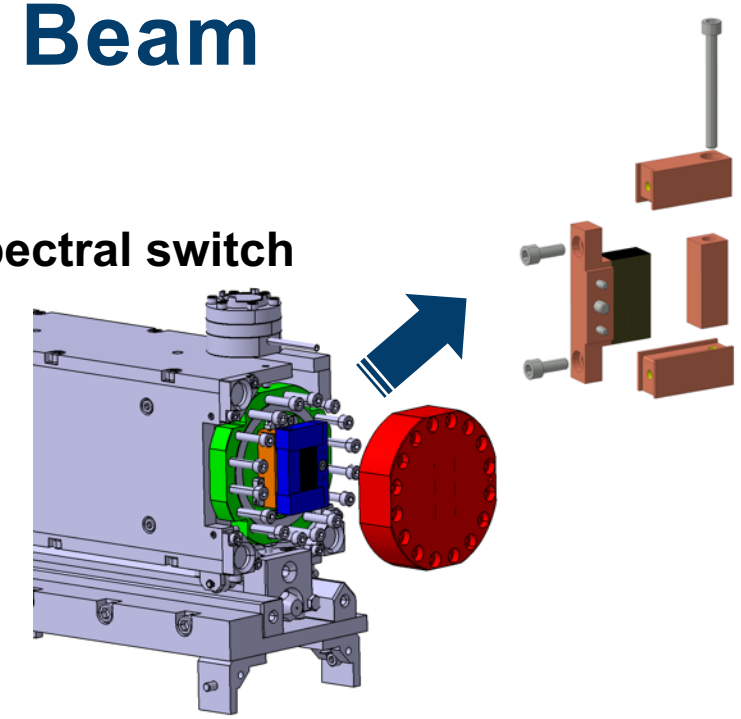
**NBOA**



**BBG**




**Bi-spectral switch**



- NBOA manufacturing is ongoing
- Neutron tests of NBOA mirrors are complete at ILL (March 2021)
- BBG kick-off meeting (26.11.2020)
- Si wafers are delivered to FZJ
- Neutron tests of Si wafers of bi-spectral switch are scheduled (May 2021)

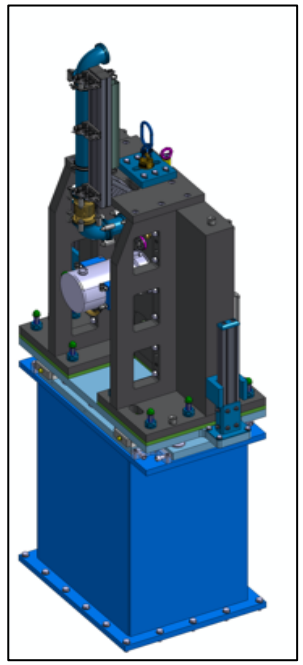
| Bi-spectral switch manufactured | NBOA delivered to ESS | BBG installed | Bi-spectral switch installed |
|---|---|---|---|
| Q2 2021 | May – 2021 | Q1/Q2 - 2022 | |

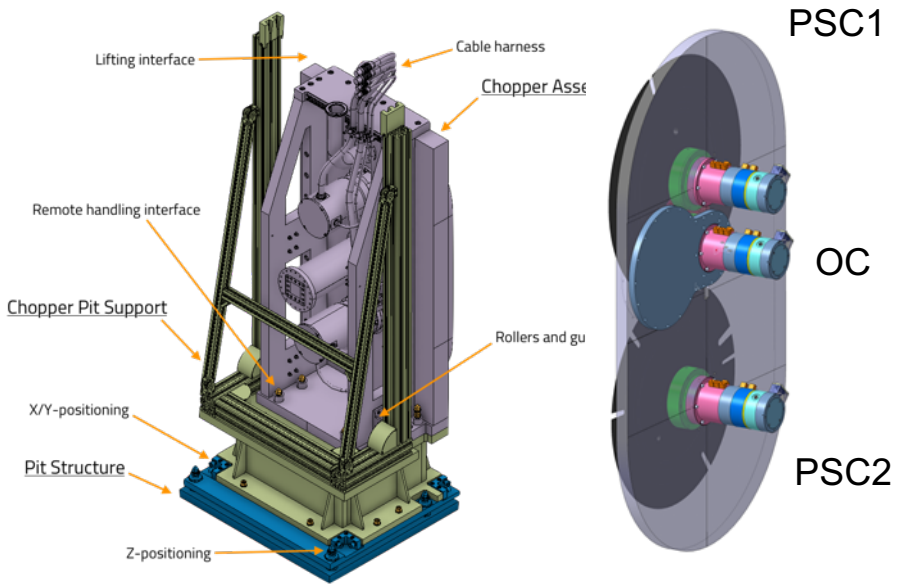
# Chopper system

## Pulse Shaping Chopper (308 Hz) & Overlap Chopper (14 Hz)

## Band Control Chopper (112 Hz)

- Vendor: Jülich Chopper Group
- Disks from Airbus are manufactured
- SubTG3 review is complete
- Manufacturing is ongoing at FZJ

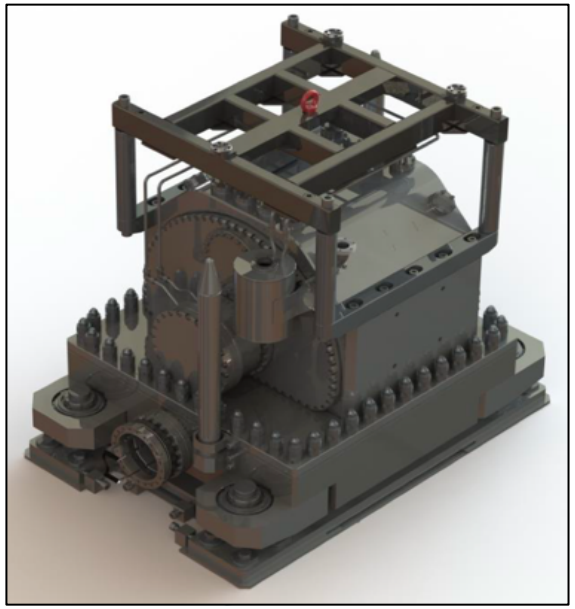





## T0-Chopper

- Design by ESS is ready and approved by FZJ
- T0 chopper prototype with DREAM specs was manufactured and awaits FAT
- DREAM-specific offer was unacceptable
- Solution: use T0 chopper prototype for the DREAM instrument

*T0 prototype (ESS)*



# PSC, OC and BC installation schedule

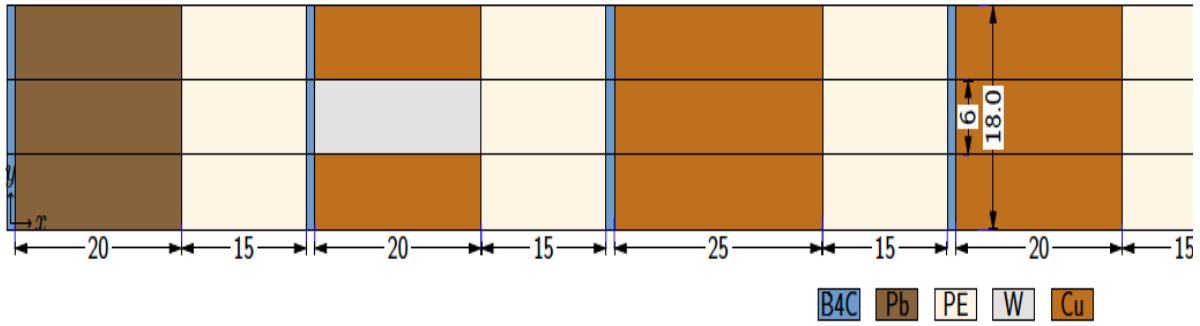
| Nr. | Vorgangsname | Dauer | Arbeit | Anfang | Fertig stellen |
|---|---|---|---|---|---|
| 1 | Projekt start DREAM Choppers | 0 Tage | 0 Std. | Di 01.10.19 | Di 01.10.19 |
| 2 | Finalize and agree specs | 2 Wochen | 0 Std. | Di 01.10.19 | Mo |
| 3 | Verify concept design vs specs | 2 Monate | 0 Std. | Di 15.10.19 | |
| 4 | Procure Disks | 9 Monate | 0 Std. | Di 10.12.1 | |
| 5 | Procure 3 SKF spindles | 9 Monate | 0 Std. | Di 24.12 | |
| 6 | Concept design OC 14 Hz spindle | 2 Monate | 0 Std. | Di 07.0 | |
| 7 | Update Concept design incl handling | 2 Monate | 0 Std. | Do 02 | |
| 8 | **PSC + OC Chopper (750 mm / 308 Hz + 300 mm 14H** | **300 Tage** | **1.363,2 Std.** | **Do 18** | |
| 25 | **Bandwidth Chopper BC (750 mm / 112 Hz)** | **240 Tage** | **240 Std.** | **Do 08** | |
| 30 | **Base frame and handling unit** | **280 Tage** | **304 Std.** | **Do 27** | |
| 33 | **Electronics** | **457 Tage** | **2.320 Std.** | **Di 01.** | |
| 41 | **Lab Commissioning and Testing** | **210 Tage** | **1.632 Std.** | **Do 12.0** | |
| 52 | **Shippment to ESS** | **200 Tage** | **0 Std.** | **Do 09.09** | |
| 53 | Base frame | 2 Wochen | 0 Std. | Do 07.10.21 | |
| 54 | BC lower housing | 2 Wochen | 0 Std. | Do 09.09.21 | |
| 55 | PSC / OC Chopper | 2 Wochen | 0 Std. | Do 02.06.22 | Mi 15. |
| 56 | BC Chopper | 2 Wochen | 0 Std. | Do 02.06.22 | Mi 15.06.22 |
| 57 | Installation choppers on site | 2 Wochen | 160 Std. | Do 16.06.22 | Mi 29.06.22 |

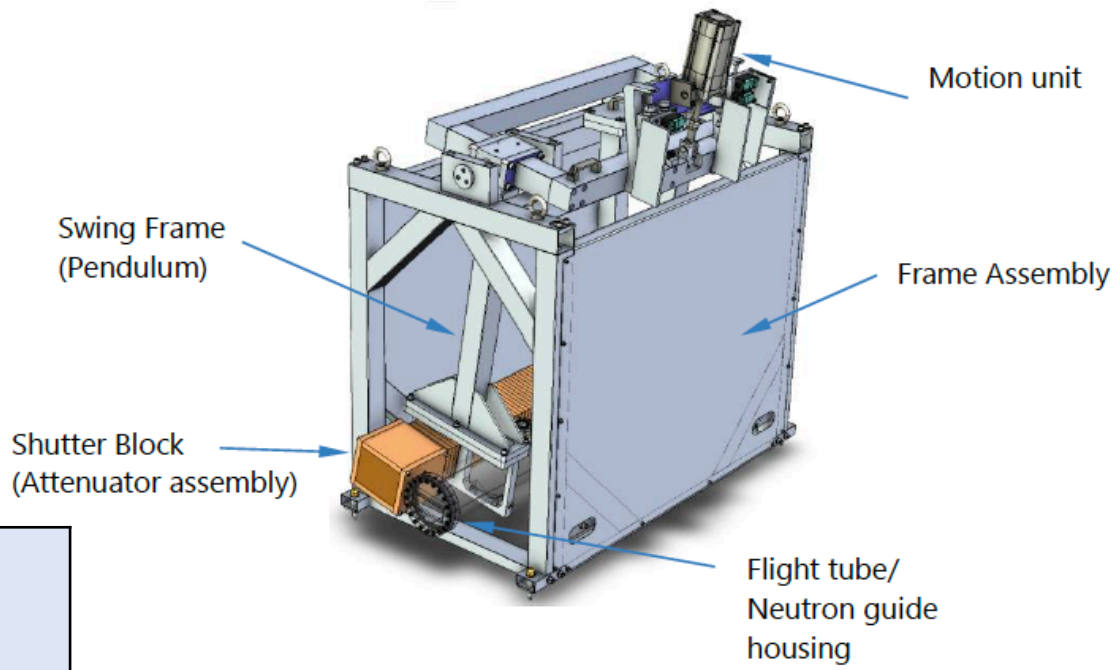
- Still need access to the bunker in June 2022 for 2 weeks to finish PSC, OC and BC installation
- Original date of bunker access of Aug. 2021 is being used for installation planning

- Later bunker access dates  (Feb – Aug 2022) solve the problem with installation dates
- Still going full speed with production to mitigate any possible covid delays

# Heavy shutter (ESS)

*Shutter block composition*



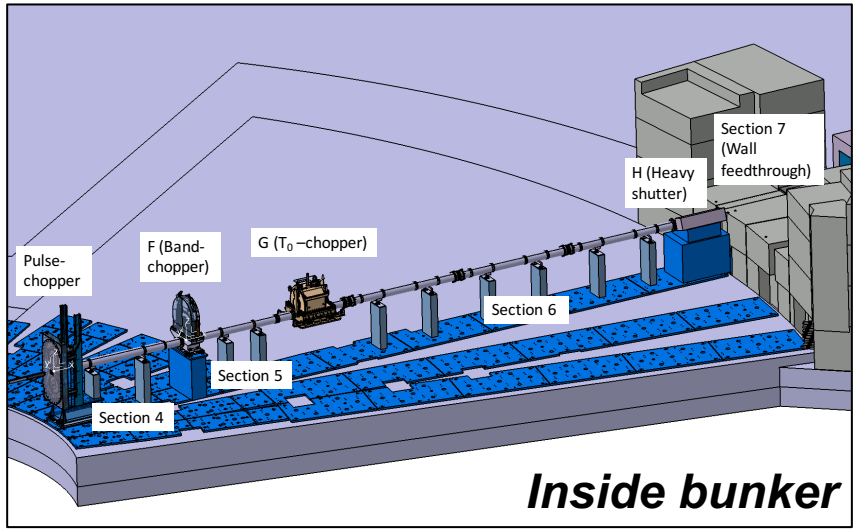



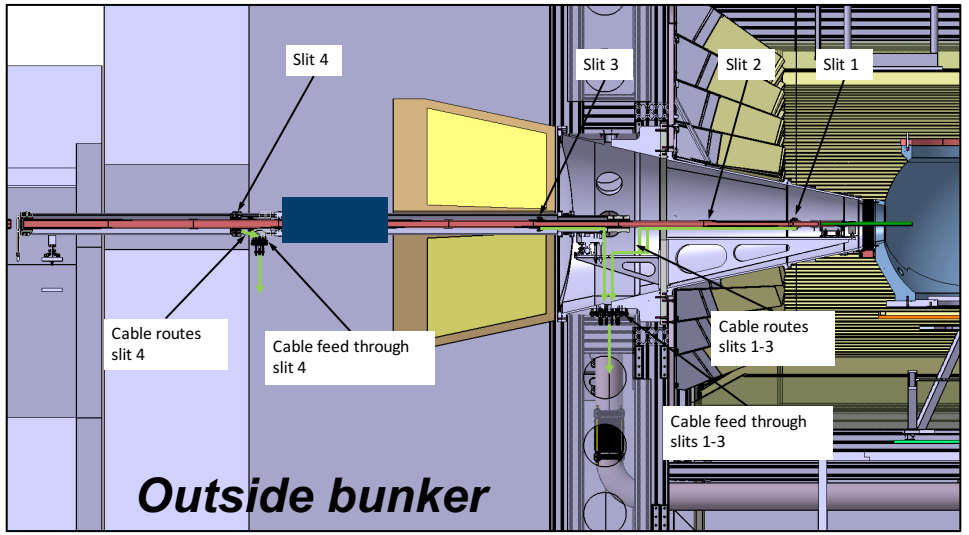

| Bunker access | Delivered (ESS) | Installed |
|---|---|---|
| Feb 2022 | May 2021 | Feb 2022 – Aug 2022 |

- Neutronics simulations are done by FZJ
- Interface between shutter and guides was discussed between ESS, FZJ and SwissNeutronics
- ESS offer was accepted

# Neutron guides

- SwissN will deliver in- and out-bunker guides
- Installation for in-bunker guides is prioritized
- Kick-off meeting for in-bunker guide took place 26.11.2020
- Kick-off meeting for out-bunker guide is planned for Q1 2021
- Out-bunker guides will be delivered later, but installation is still on time




| Bunker access | Chopper base | In-bunker guides |
|---|---|---|
| Feb. 22* Aug. 22 | Q1/Q2 2022 | |

*latest ESS estimate

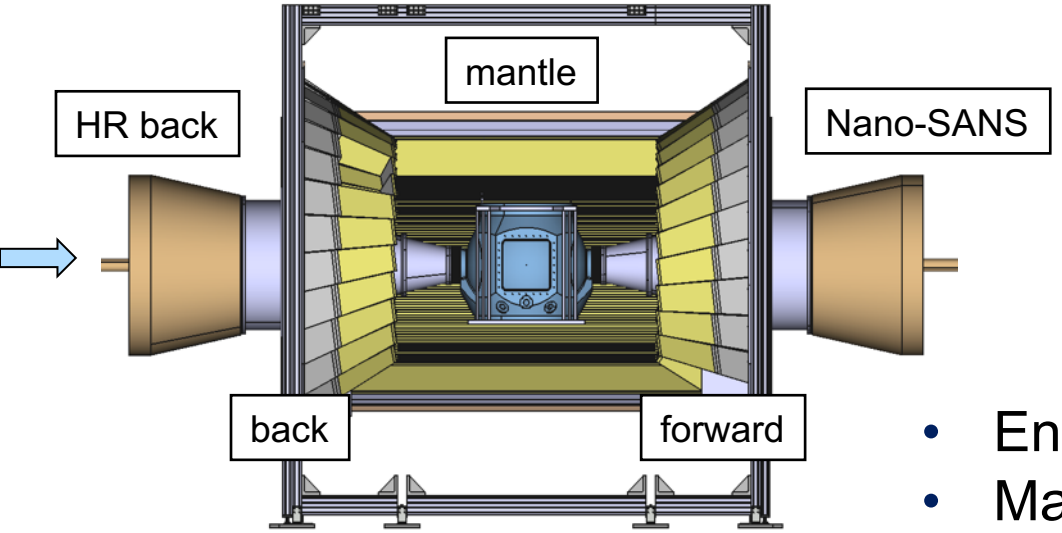
| D01 available to Partners | Out-bunker guides | Guide shielding installed | Cave installed |
|---|---|---|---|
| 03.06.2021 | Apr. 22 - Jul. 22** | Jul. 22 | March 22 |

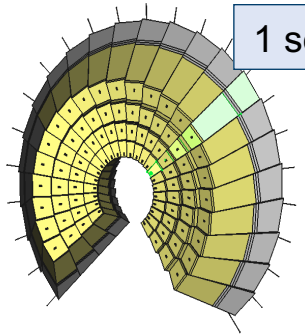
**last piece inside the cave

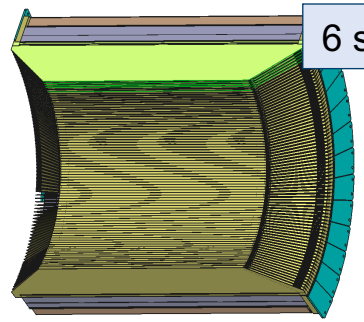
# Detectors

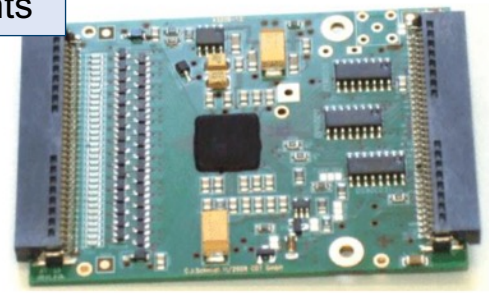
- Development of first modules and readout electronics (Sept. 2017)

*Complete detector coverage*



- End-cap is successfully tested with neutrons (July 2019)
- Mantle detector is successfully tested with neutrons (Nov 2020)
- Production of mantle & end-cap is ongoing
- Finalizing design of HR & Nano-SANS dectors

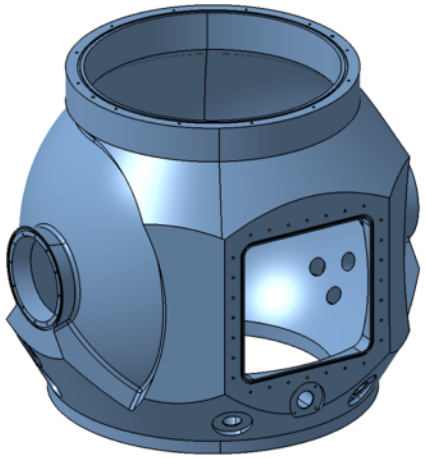
| | back/forward | mantle | HR back | Nano-SANS* |
|---|---|---|---|---|
| Manufactured | March - 2022 | Aug. - 2021 | Apr. - 2022 | Q3 - 2023 |

** not part of the scope, external funding*

| Cave installed | Detector support installed | SubTG4 | Detectors installation completed | Hot commission/ First science |
|---|---|---|---|---|
| Mar. - 2022 | Jun. - 2022 | Jun. - 2022 | Sept. - 2022 | Sept. - 2023 |

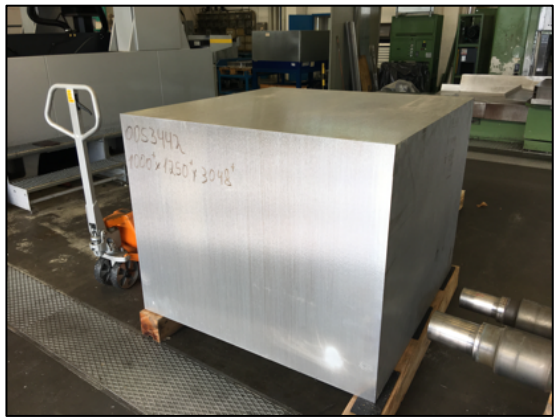
# Sample vessel

*IDR, Dec 2018*

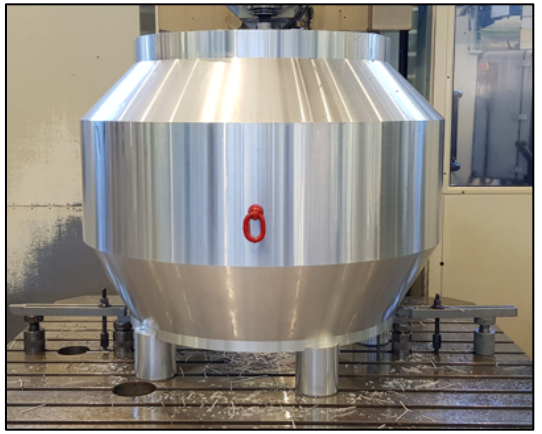


*Scale-down prototype, Dec 2018*

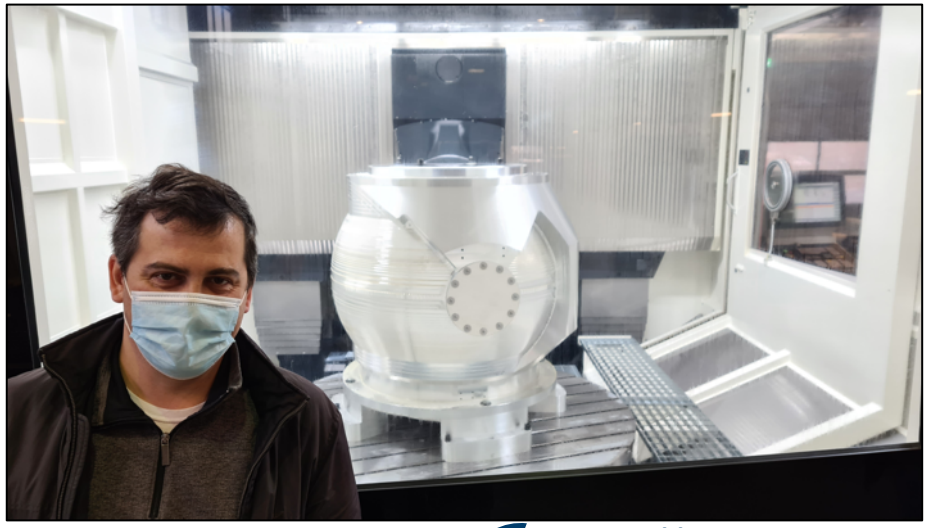
*Al proto-material, Apr 2020*



*Measured & wax-filled Sept 2020*



*Milling is ongoing now!*



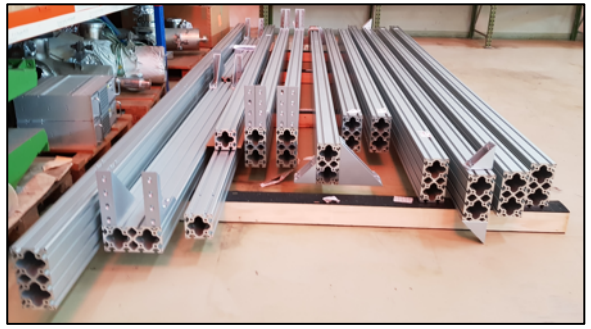
| Cave installed | Detector support installed | Sample vessel & support installed | Detectors installation starts | Detectors installation completed |
|---|---|---|---|---|
| Mar. - 2022 | Jun. - 2022 | Jun. - 2022 | Jun. - 2022 | Sept. - 2022 |

- Standard flange L2 is being manufactured
- Installation of the vessel with the support and vacuum testing are planned for Q2 2021

# Detector support

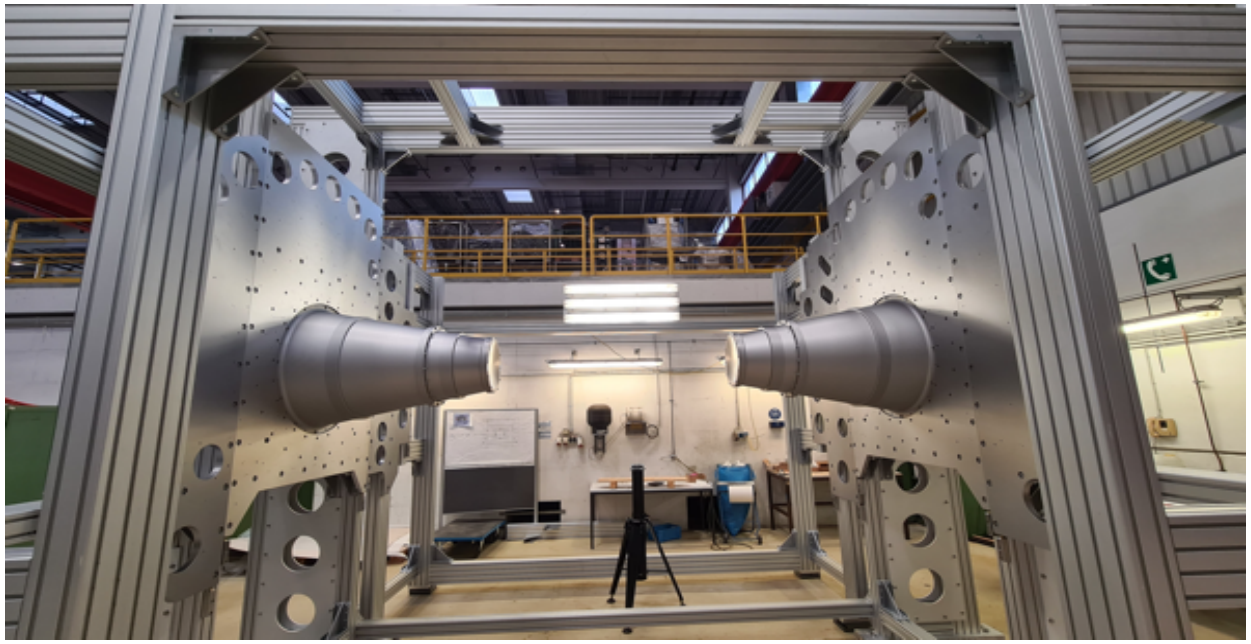
- Installation at FZJ is ongoing
- Still possible to work during lockdown
- Entire system with sample vessel and support will be pre-installed and tested
- Detailed installation plan, once cave supplier is chosen

*FAT at ITEMS, Jun. 2020*



*Frame is installed, Aug. 2020*

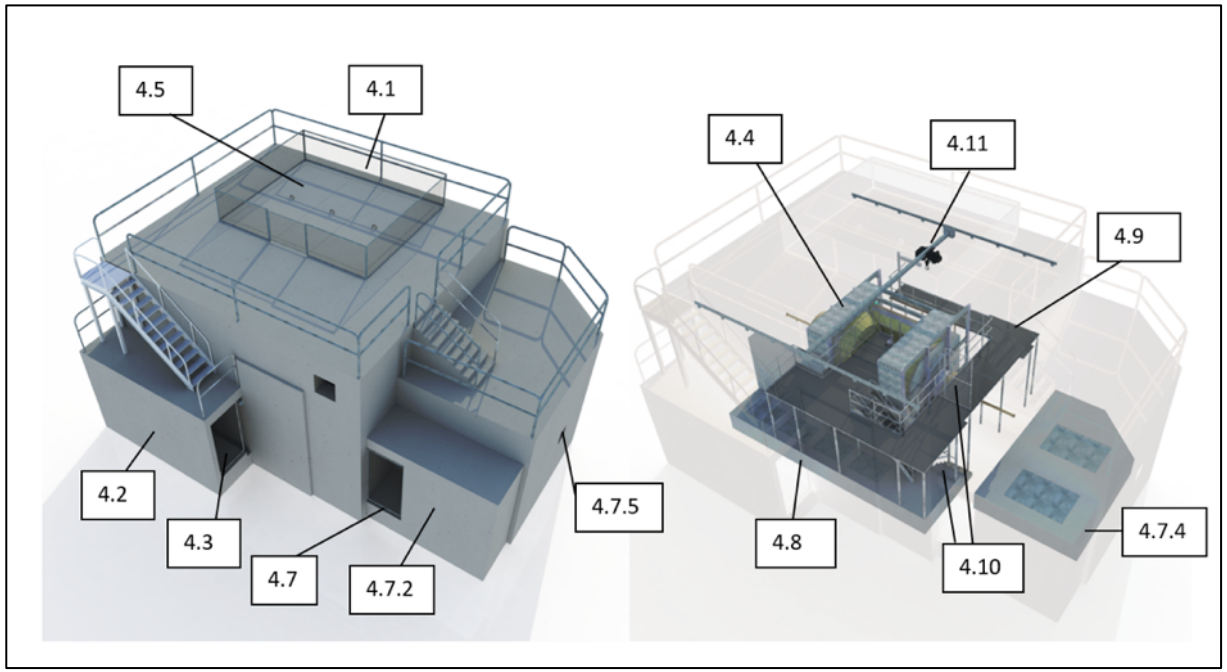
*End-cap det. plates & vacuum cones are installed, Jan. 2021*



*Vessel support (LLB)*

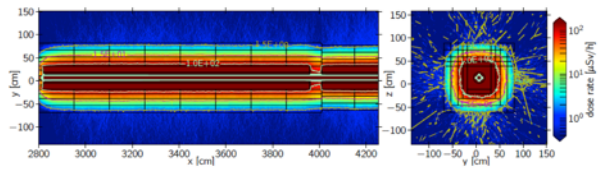
# Experimental caves

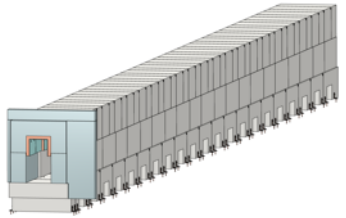
- Procurement is complete (MICo)
- 2 caves will be built
- ESS Common Electrical Project
- ESS Common Utility Project




# Neutron guide shielding

- Final design was accepted (SubTG3)
- Interactions between SN, ESS and FZJ





# Personnel Safety System

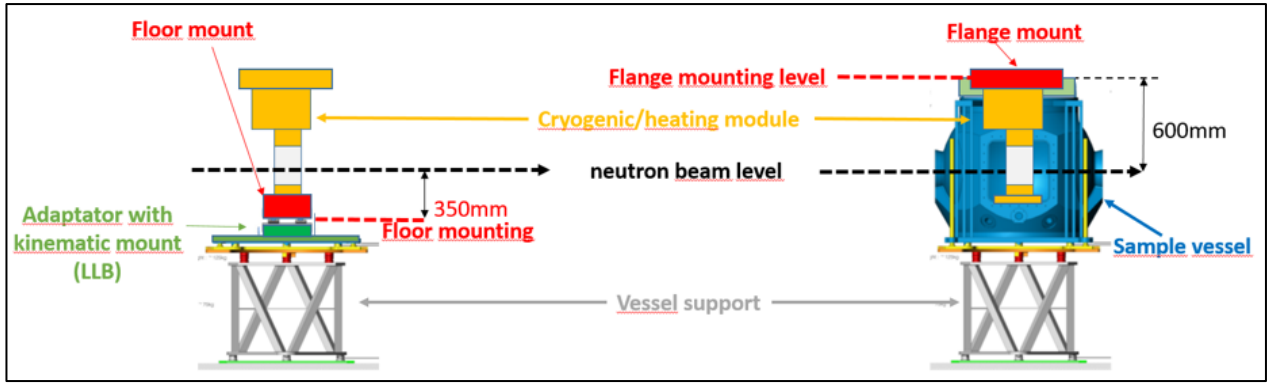
- Regular meetings with PSS team
- Draft of PSS ConOps
- Developed for 1st cave

# Hutch & Prep lab

- Procurement is complete (MICo)
- Synergy with caves construction

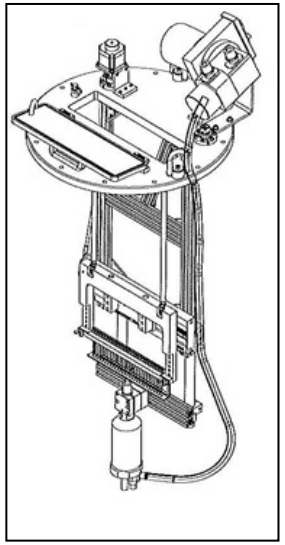
# DREAM Specific SEE: Cryofurnace with Sample Changer

- T = 4 - 800K
- 20 samples
- Flange & floor mounts




| SEE delivered to ESS | Sample vessel & support Installed | Detectors Installation completed |
|---|---|---|
| Apr. - 2023 | Jun. - 2022 | Sept. - 2022 |

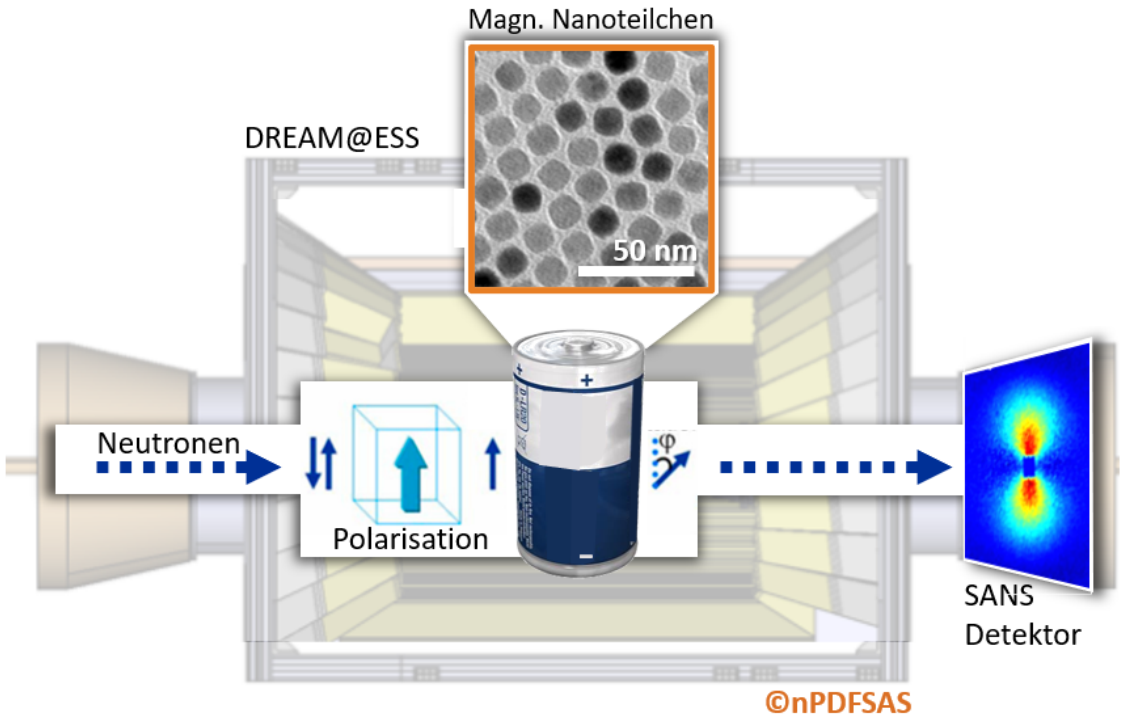
- Two unsuccessful tenders
- 2 requirements were relaxed, schedule was relaxed
- New tender will be open soon
- Fallback option: simple stage with cryo-jet and/or heat gun
- Sample changer capability is crucial for a fallback option

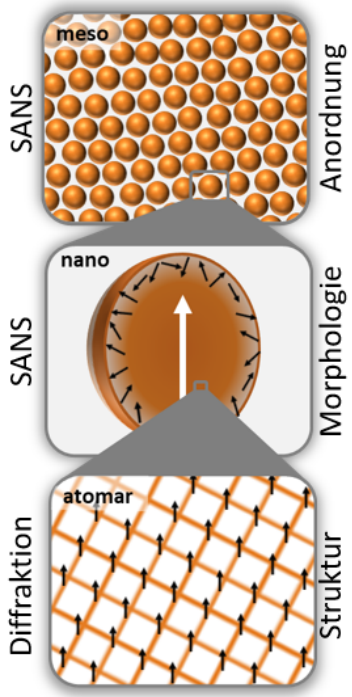


*NOMAD @ SNS*

# Going toward First Science Milestone: RAC funding

*nPDFSAS: Simultaneous polarized SANS and NPDF methods to study novel electrode nanomaterials*




UPPSALA UNIVERSITET

MAX IV

JÜLICH Forschungszentrum

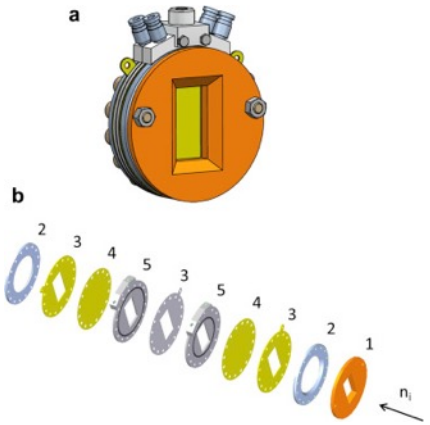
Universität zu Köln

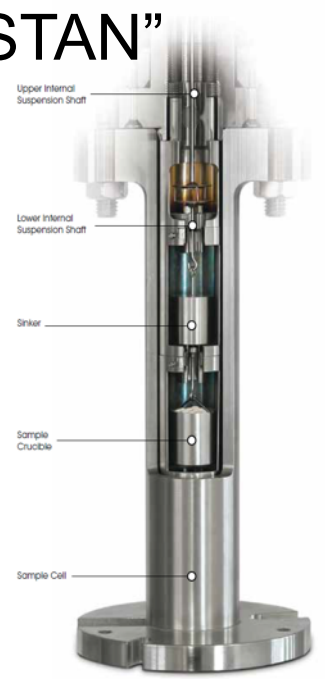
- Funds Nano-SANS detector and polarizer + students and postdocs for preparing samples, carrying out feasibility measurements and developing software tools with DMSC
- Participants: Mikhail Feygenson (FZJ)
  Sabrina Disch (UzK)
  Earl Babcock (FZJ)
  Tomas Plivelic (MAX IV)
  German Salazar-Alvarez (UU)
  Mario Valvo (UU)
  Peter Svedlindh (UU)

# Other funding for First Science Milestone

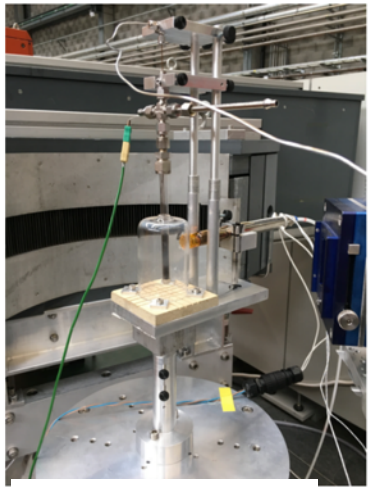
VR grant: “In situ Studies using Thermal Analysis in Neutron scattering, ISTAN”

SreSS3 funding to develop electrochemical cell




Nordforks postdoc to develop combined airgun-heater and cryo-cool setup (10 - 1000 K) for DREAM and HEIMDAL



*hot-airgun*

+

*cryostream*