

Heimdal Instrument ESS Review

Dan Mannix

Lead Scientist Heimdal Instrument ESS, Lund Sweden

ESS - June 27th 2022

Agenda



Part I

10:00 - 10:10 Welcome/intro (Rob)

10:10 - 10:30 Brief Overview of HEIMDAL (Dan)

- a. Science case
- b. Components
- c. Scope and in-kind partner responsibility
- d. Overall schedule and budget distribution

10:30 - 11:30 Project reporting

- a. Progress of each component/part: one slide per item
- b. Budget overview of all WPs
- c. Schedule and schedule uncertainties
- d. Risks (incl staffing)

11:30 - 12:30 Lunch

Part II

12:30 - 13:00 Project scope discussion

- a. Current plan for upgradability
- b. HEIMDAL team view
- c. ESS view (Andrew)

13:00 - 13:30 Overview of the Collaboration

- a. How is the collaboration organized
- b. How often the collaboration meets
- c. Challenges within the collaboration

13:30 - 14:00 Wrap up and conclusions

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Slides: 1-15

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The Heimdal Team



Isabel Llamas (IFE)



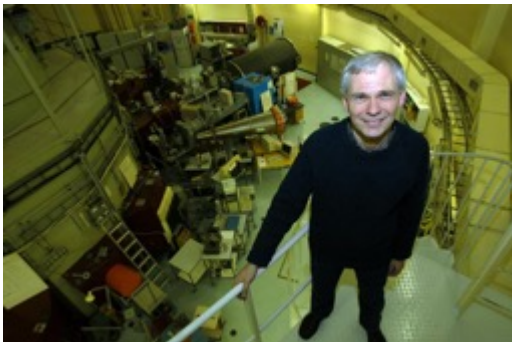
Dan Mannix (AU)
Lead Scientist



Kåre Iversen (AU)
Lead Engineer



Rodion Kolevatov (IFE)
Neutronics



Bjørn Hauback
IFE



35%



Mogens Christensen (PI)
AU



30%



Vladimir Pomjakushin
PSI

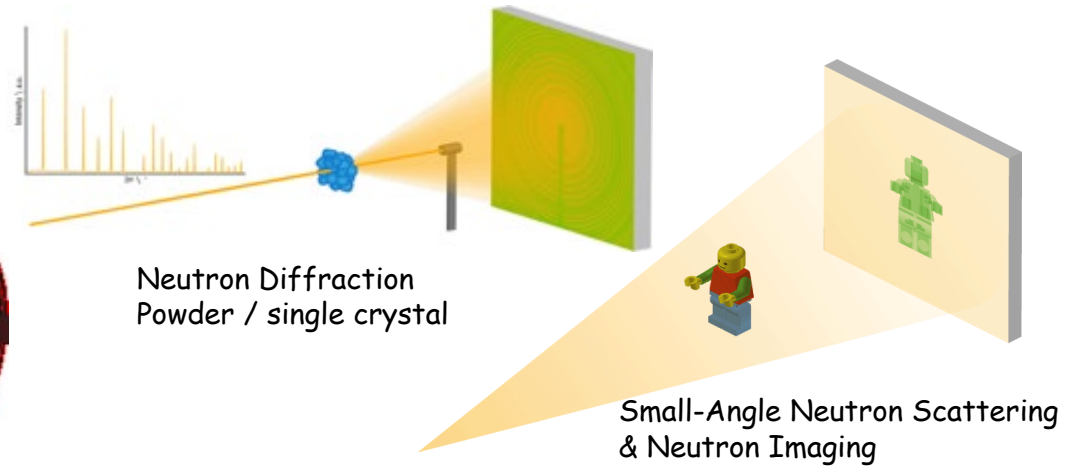
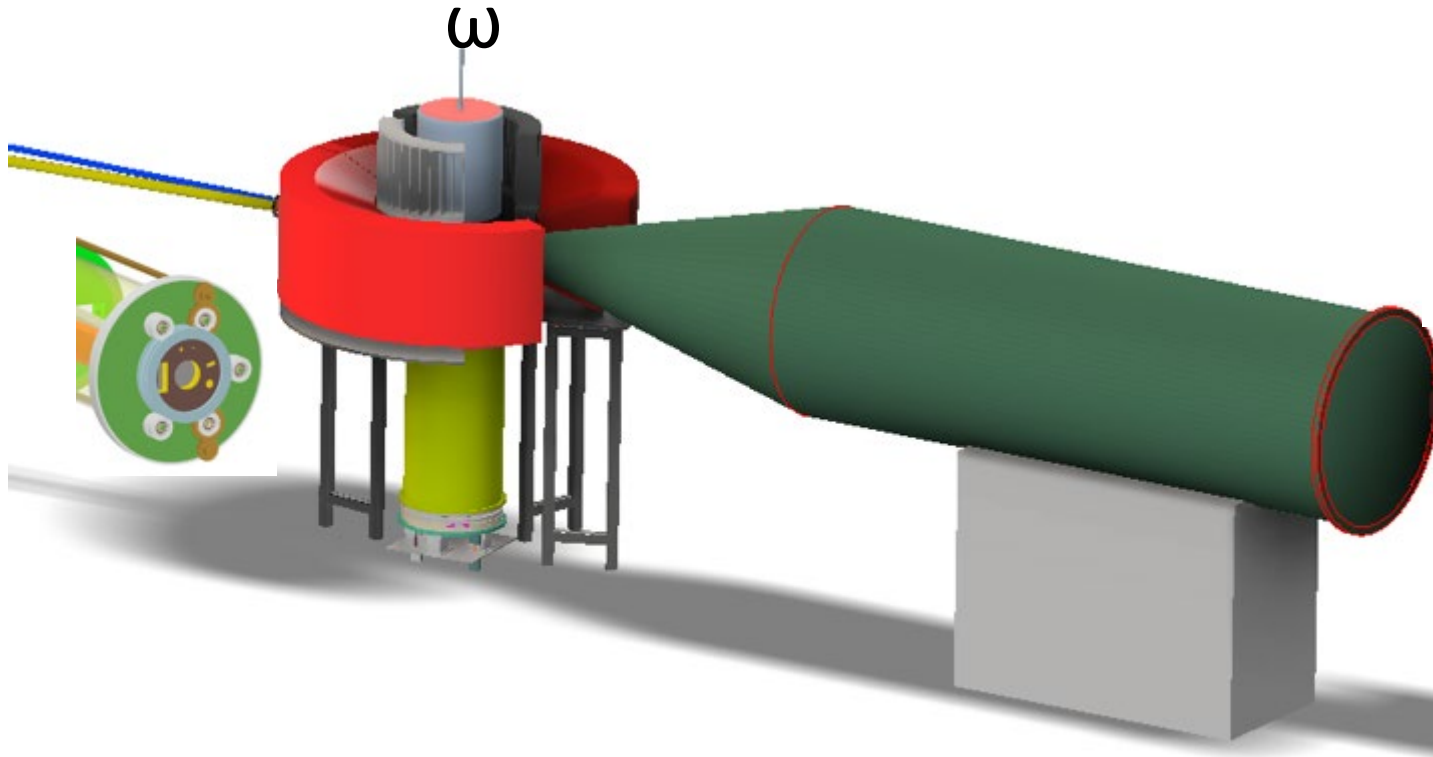


35%



HEIMDAL – Hybrid Diffraction

Multi Length Scale Neutron Scattering Instrument:
 $10^{-2} - 10^8$ nm

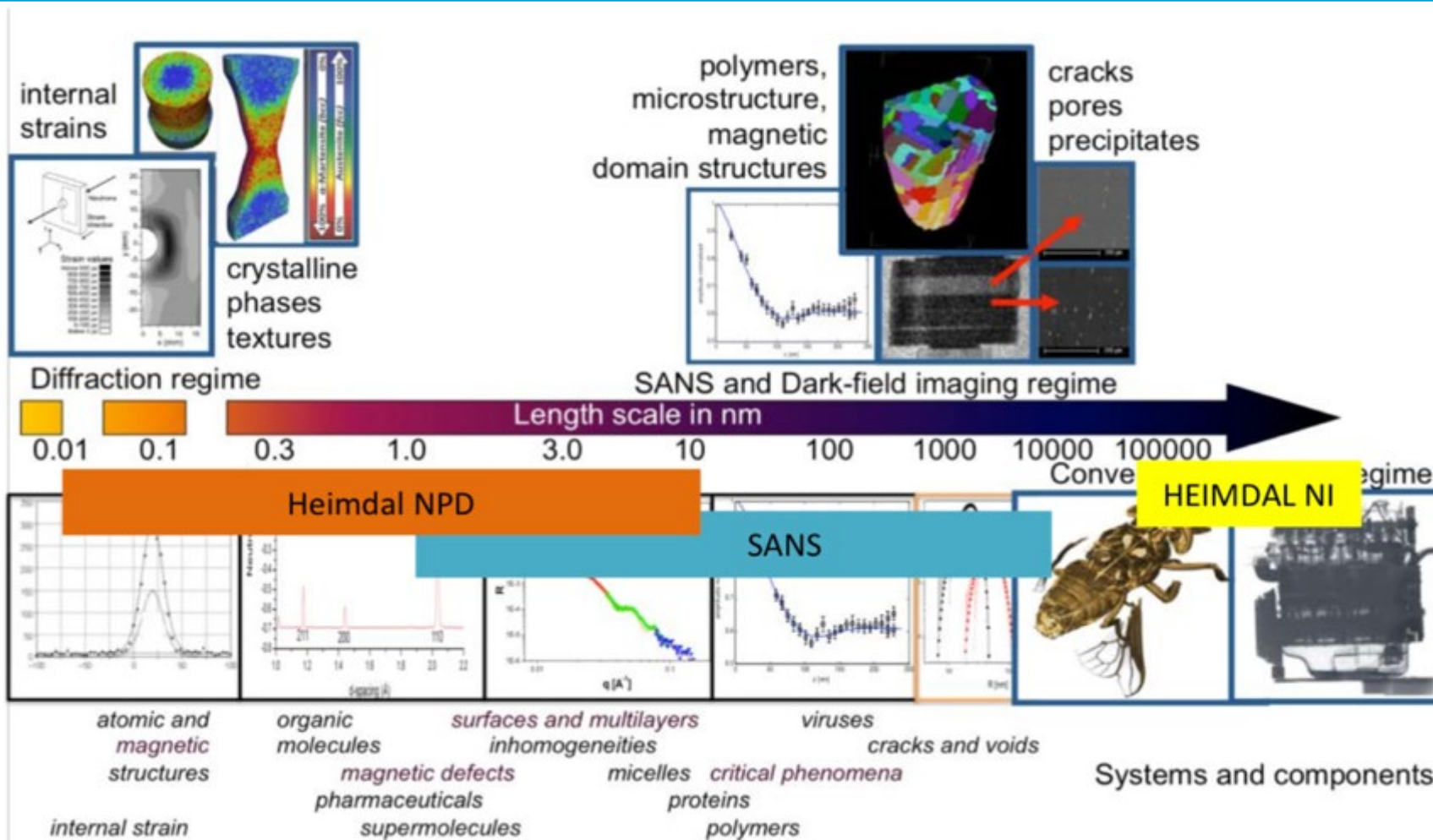


Diffraction + SANS + Imaging

- (1) Thermal Diffraction (SOUP ~2028)
- (2) Cold Guide - SANS (upgrade)
- (3) Neutron Imaging (upgrade)

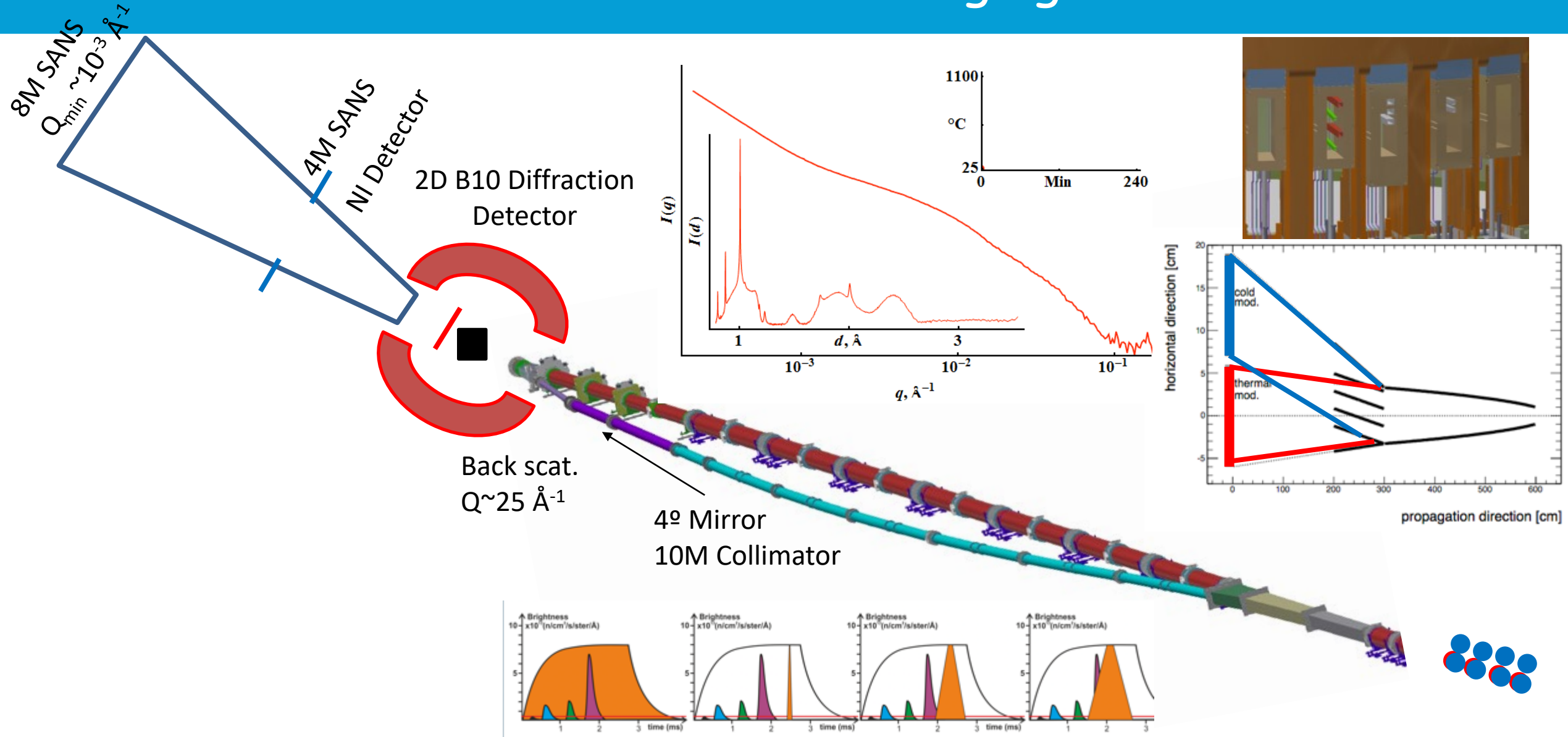
Thermal Neutron Diffraction + Cold Neutron SANS
Powder / Texture / Single Crystal
2D Rietveld Refinement
2D / 3D Cold Neutron Imaging

HEIMDAL: Science Case

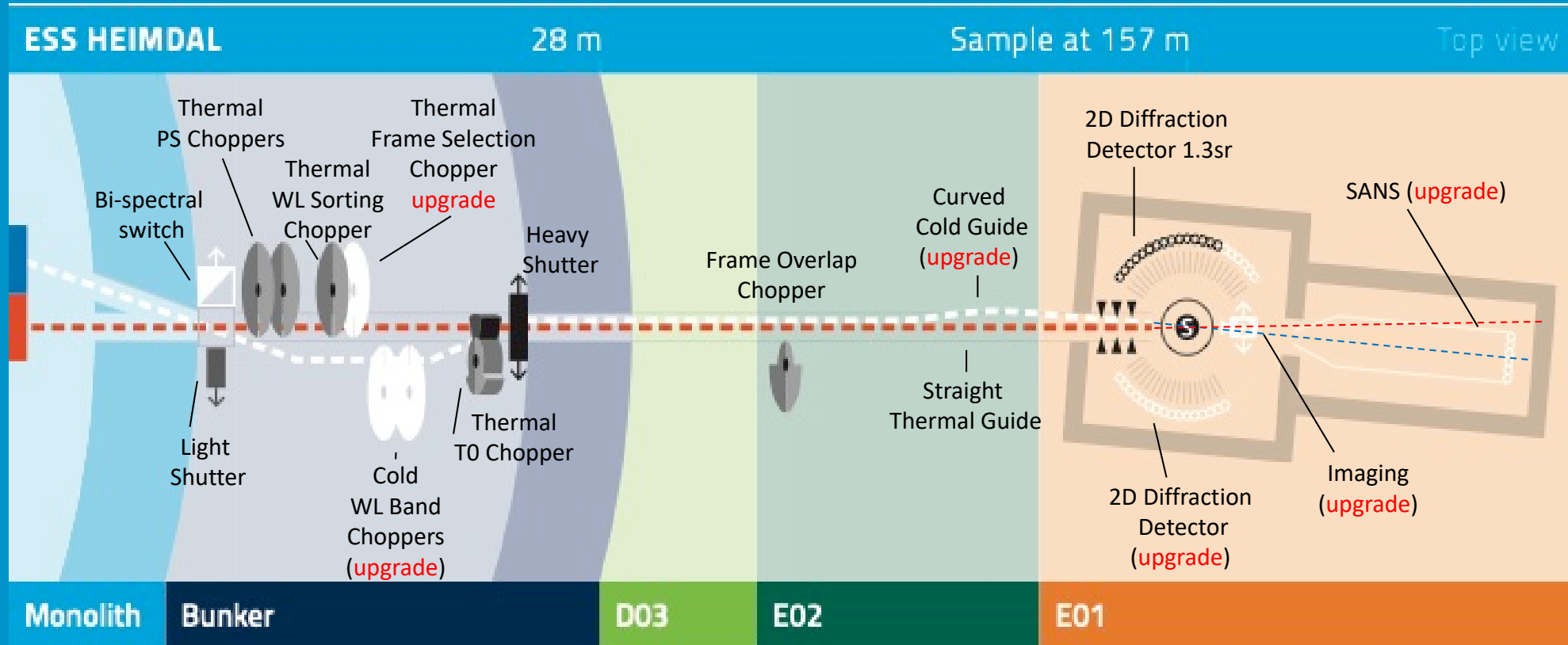


Powder Diffraction + SANS + Neutron Imaging

Heimdal - Bi-spectral Hybrid Diffractometer Diffraction - SANS - Imaging



Components



Descoped Items: TNPD:
Full Diffraction Detectors
Backscattering detectors (PDF)
2nd Detector collimator
Frame Selection chopper

Descoped Items: SANS:
Cold Guide (Except NBOA, BBG, BWI)
Cold Choppers
SANS Tank & Detectors

Descoped Items: Imaging
Imaging Detector

Heimdal Technical Scope (setting)

Scope Setting Report

Instrument : HEIMDAL

Date	2016-10-19
Revision	1.0
State	Released

Option 1 cost category B (**12 M€**) is an instrument with one backscattering detector module with an area of 0.5 m^2 resulting in coverage of $\sim 0.2 \text{ sr}$. The instrument is not upgradable to full scope. Upgrade to reasonable diffraction performance with 1.3 sr coverage is presented.

Option 2 World leading powder diffractometer, here the cost is **14.9 M€** and the instrument has all the necessary cold guide components installed in the monolith and bunker area, for upgrading the instrument to full scope and the diffraction detector coverage reaches 1.3 sr (2.1 m^2). The upgrade to full scope is presented.

Option 3 World leading multi-length scale instrument, cost is **18.6 M€** and it encompasses the full instrument scope with diffraction, SANS and imaging options. The diffraction detector coverage reaches 2 sr (3.2 m^2). The SANS detector is placed 10 m from sample and covers 0.5 m^2 and the imaging detector has a coverage of $28 \times 28 \text{ mm}^2$, with resolution of $55 \times 55 \mu\text{m}^2$.

Heimdal Technical Scope (Setting)

Scope Setting Report
Instrument : HEIMDAL

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It was agreed that the instrument presented as configuration 2 in the scope-setting report will form the basis of the scope and budget for HEIMDAL. A detailed comparison with other diffraction instruments shows a world-leading performance at 2 MW beam power.

- A number of cost adjustments were proposed by NSS management, resulting in an agreed cost book value of 13.553 M€. Starting from the configuration 2 instrument in the scope-setting report, with an initial budget of 14.938 M€, the adjustments were as follows:

Partner Budget (k€)		
IFE	PSI	AU
4630 (35%)	4752 (35%)	4171 (30%)

13553 = Cost Book Value

Partner	Fund allocated (€)	Phase 1	Phase 2-4
PSI	4.743.550 €	2.500 €	4.025.502 €
IFE	3.453.550 €	45.700 €	3.098.552 €
AU	4.065.900 €	279.000 €	3.521.033€
ESS	1.290.000 €	0	1.290.000 €
Total	13.553.000€	327.200€	11.935.087€

Heimdal In-Kind Contributions

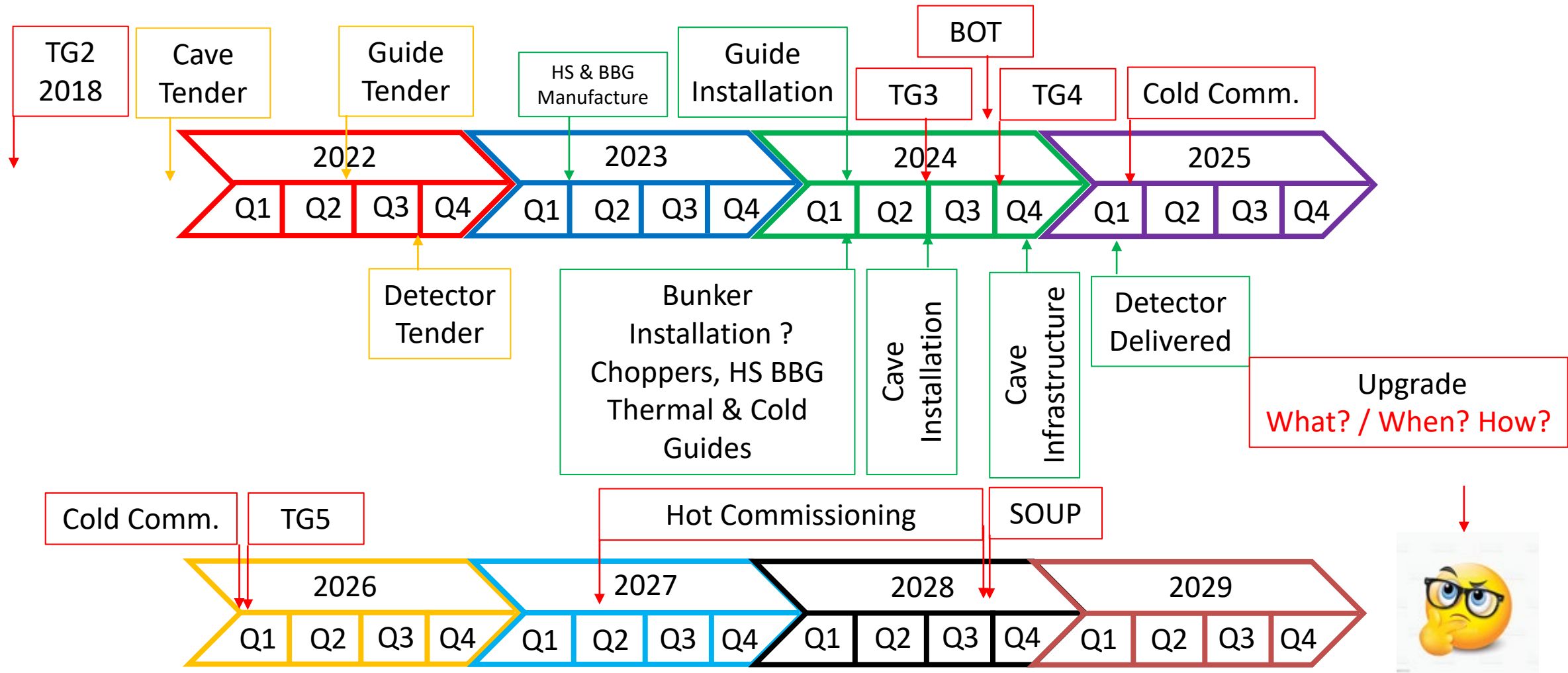


- Guide Shielding (ESS)
- Chopper Systems (ESS)
- T0 Chopper (ESS)
- Cave Shielding (Mirrotron)
- Utility & Electrical inf. (CEP CUP?)
- Experiment Cabin
+ sample prep. (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT)

- Neutron Guides + Housings
- 2/3 2D Detector (CDT)
- 2 x Monitors (CDT?)

- Salary Scientist + Engineer
7 Years 2018-2025
- Inner Cave, floors, stairs, detector support,
- Detector collimator
- Sample x,y,z omega table
- Heavy + Light shutter
- Divergence slits
- Collimator slits
- Beamstop
- Control Racks
- Sample environment control box

Heimdal Timeline & Milestones



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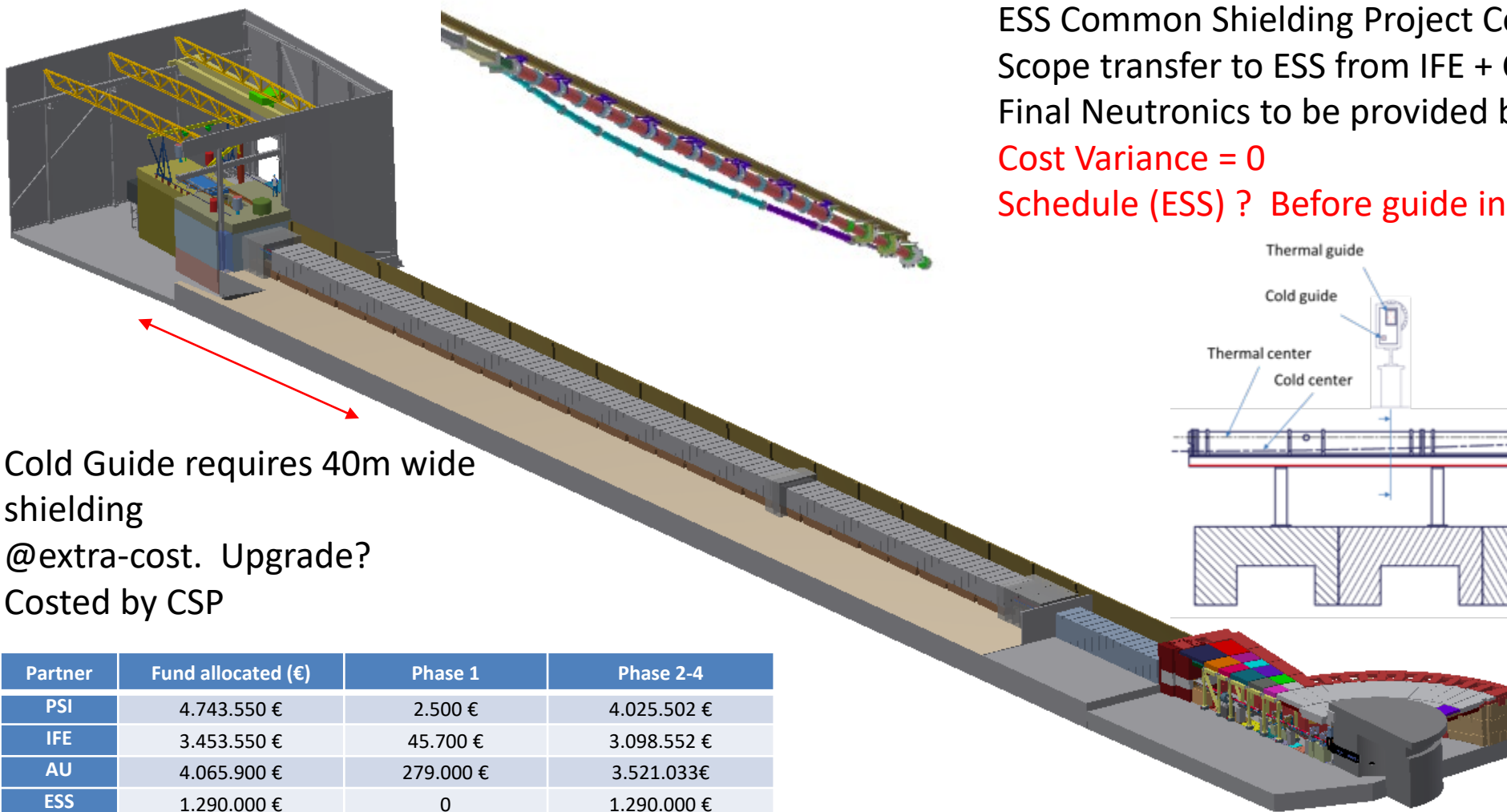


➤ Guide Shielding (ESS)

- Chopper Systems (ESS)
- T0 Chopper (ESS)
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- Cabin Infrastructure (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT)

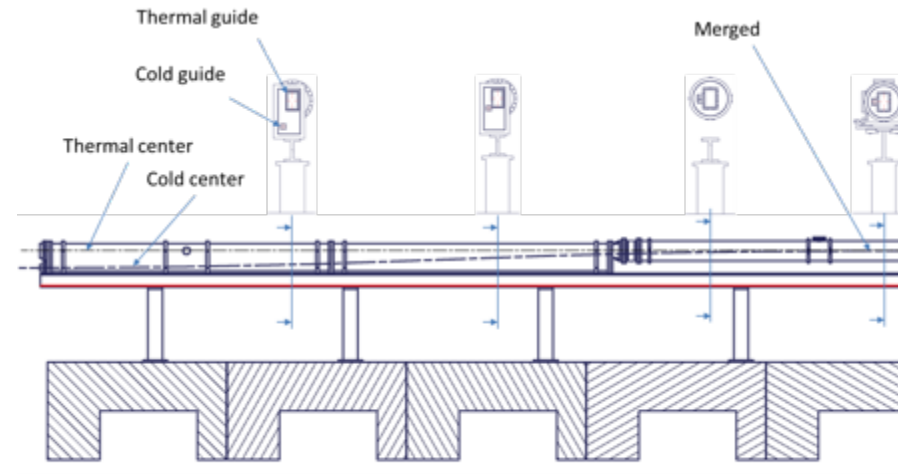
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Cold Guide requires 40m wide shielding
 @extra-cost. Upgrade?
 Costed by CSP

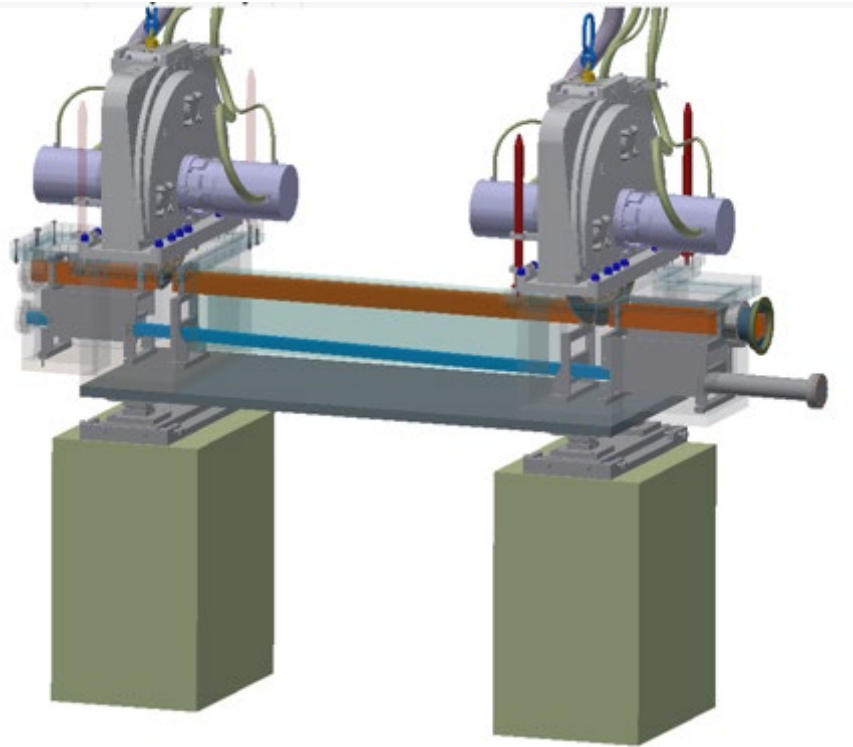
ESS Common Shielding Project Costed in 2018 1290k€
 Scope transfer to ESS from IFE + CR.
 Final Neutronics to be provided by ESS
Cost Variance = 0
Schedule (ESS)? Before guide installation Q2 2024.



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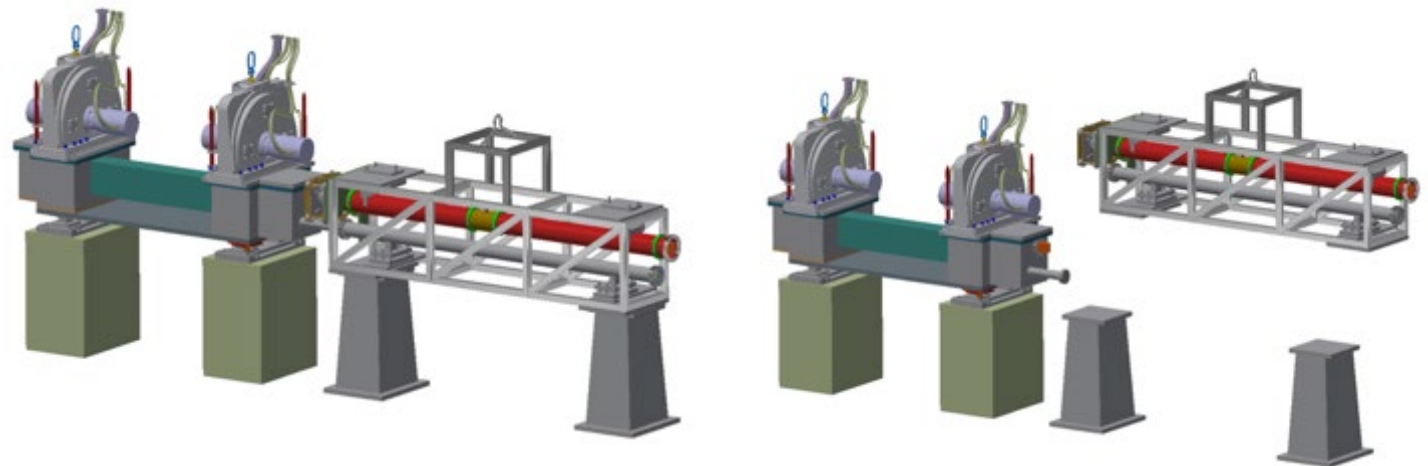
Heimdal In-Kind Contributions

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ESS Common Chopper Project
Costed 840 k€ - Budget 840k€
Scope transfer to ESS from IFE + CR.
Cost Variance = 0

**Delivery expected before BOT
Installation in bunker (2024)**



Heimdal In-Kind Contributions



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- **T0 Chopper (ESS)**
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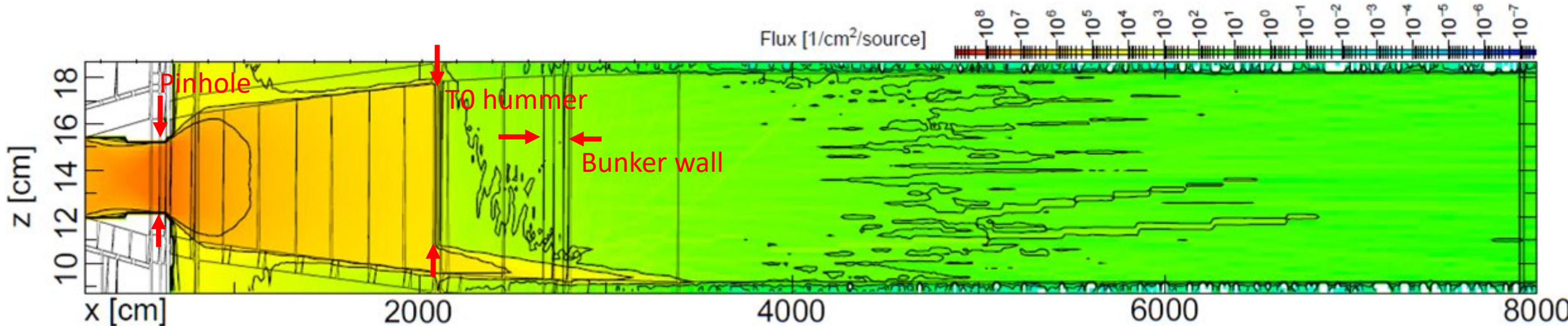
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T0 Chopper



ESS Common T0 Chopper Project
DREAM Modified prototype
No streaming from neutronics calculations
Costed 350 k€ - Budget 350k€
Scope transfer to ESS from IFE + CR.
Cost Variance = 0

Delivery Not expected before BOT
Installation later (2026?) & vacuum tube installed for HC



Heimdal In-Kind Contributions

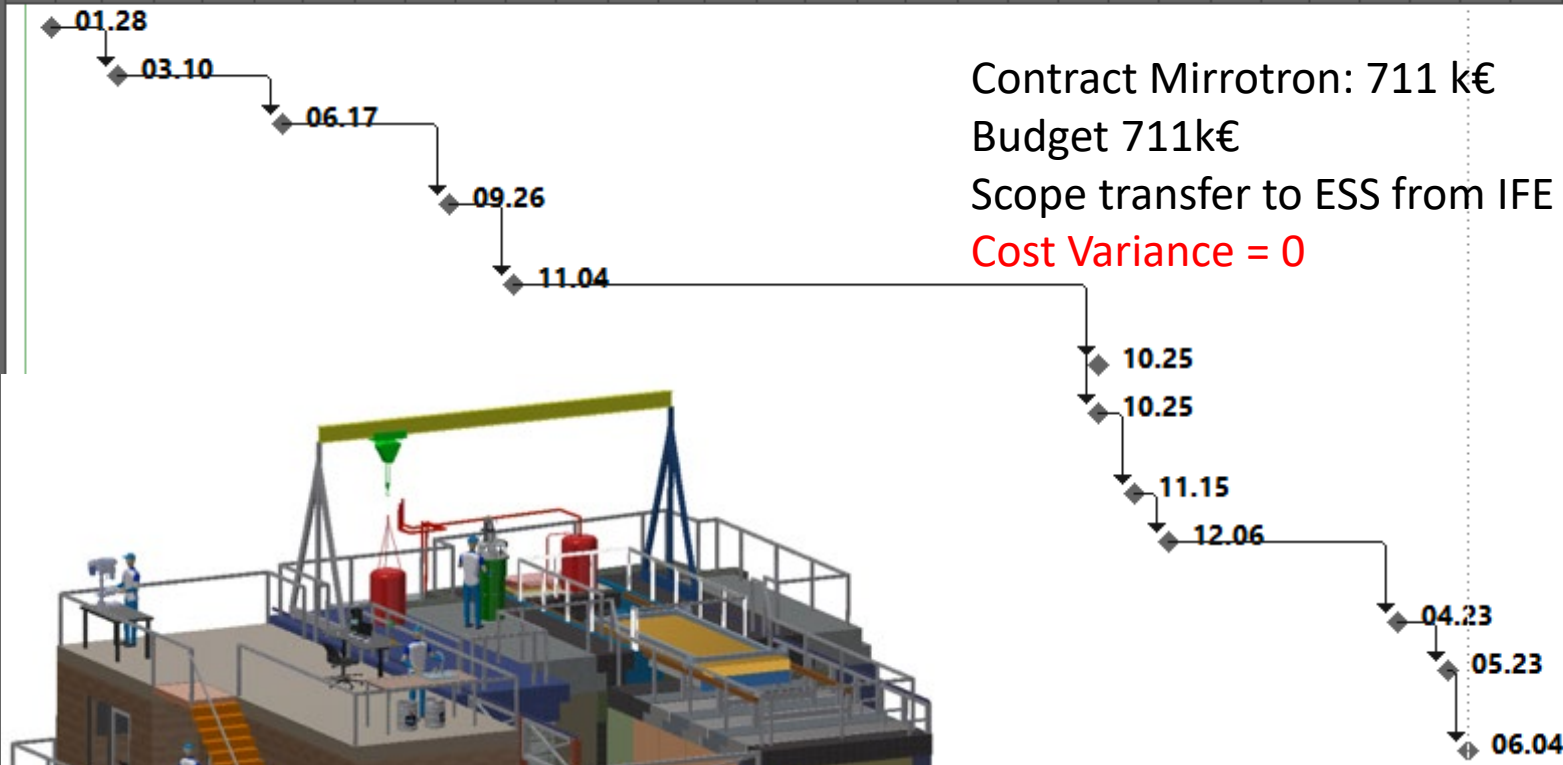


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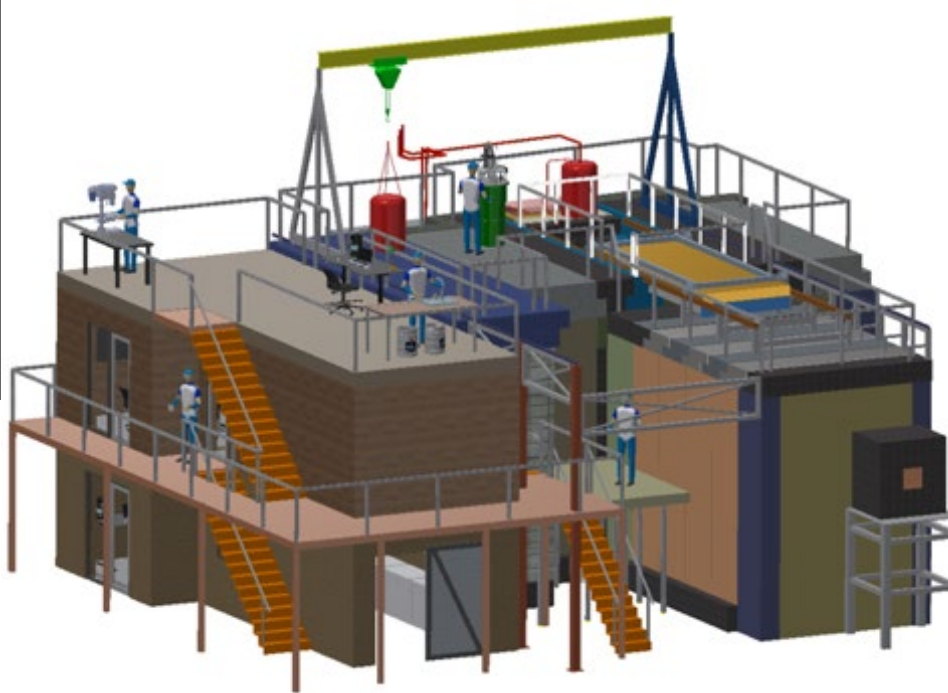
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Task Name	Start	Finish	2022, Half 1					2022, Half 2					2023, Half 1					2023, Half 2					2024, Half 1					2024, Half 2									
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S		
Signed Agreement	Fri 22.01.28	Fri 22.01.28																																			
Kick-Off Meeting	Thu 22.03.10	Thu 22.03.10																																			
PDR - Preliminary Design Review	Fri 22.06.17	Fri 22.06.17																																			
CDR - Detailed design to AU	Mon 22.09.26	Mon 22.09.26																																			
TG3 - Detailed design to ESS	Fri 22.11.04	Fri 22.11.04																																			
MAT	Wed 23.10.25	Wed 23.10.25																																			
FAT - Factory Acceptance Test	Wed 23.10.25	Wed 23.10.25																																			
RFD - Ready For Delivery	Wed 23.11.15	Wed 23.11.15																																			
IGC - Incoming Goods Check	Wed 23.12.06	Wed 23.12.06																																			
INST - Installation	Tue 24.04.23	Tue 24.04.23																																			
SAT - Site Acceptance Test	Thu 24.05.23	Thu 24.05.23																																			
COM - Project complete	Tue 24.06.04	Tue 24.06.04																																			



Contract Mirrotron: 711 k€
 Budget 711k€
 Scope transfer to ESS from IFE + CR.
Cost Variance = 0



Extra costs:
 Gantry Crane ?
 Sliding Hatch Mechanism
 Cost request to Mirrotron.
 Cost Overrun 100k€ ?

Heimdal In-Kind Contributions



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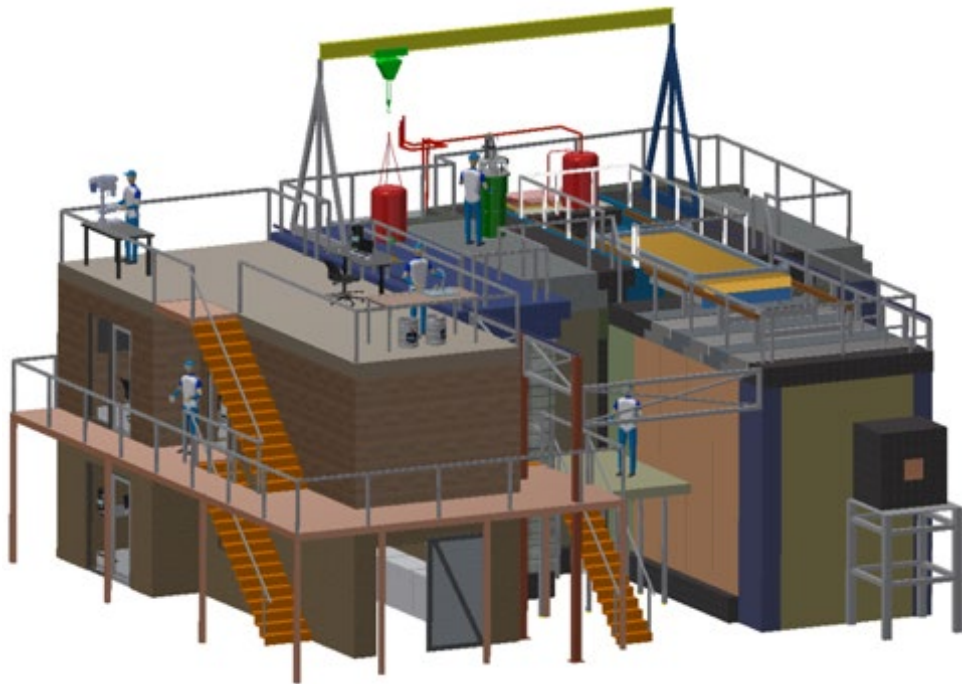
Compare to ESS common projects:

- Electrical: 258 kEUR
- Utilities: 250 kEUR

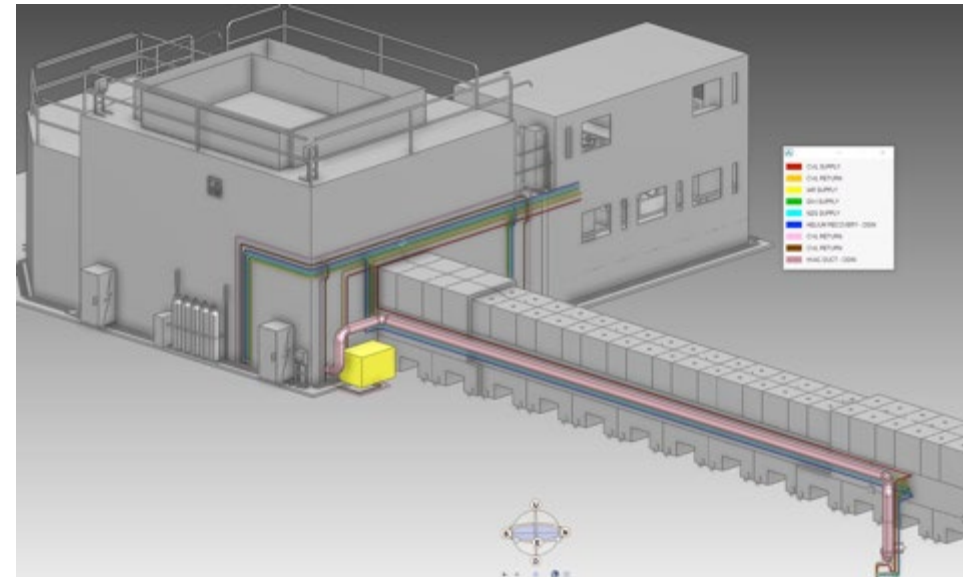
CEP + CUP ~ 500 k€
Budget 200 k€ (IFE)
Control Racks (AU) 75 k€
SE control box (AU) 100 k€
Total 375 k€

Cost Variance = -125 k€

Discussions started with Anton Lundmark & Stuart Birch
Installation after cave Q2 2024



Dream Instrument Utilities



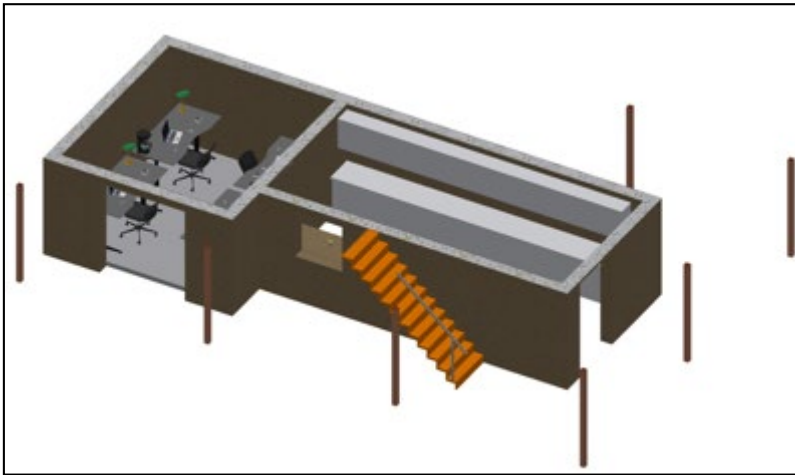
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- **Cabin Infrastructure (ESS?)**
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- 1/3 2D Detectors (CDT) with PSI

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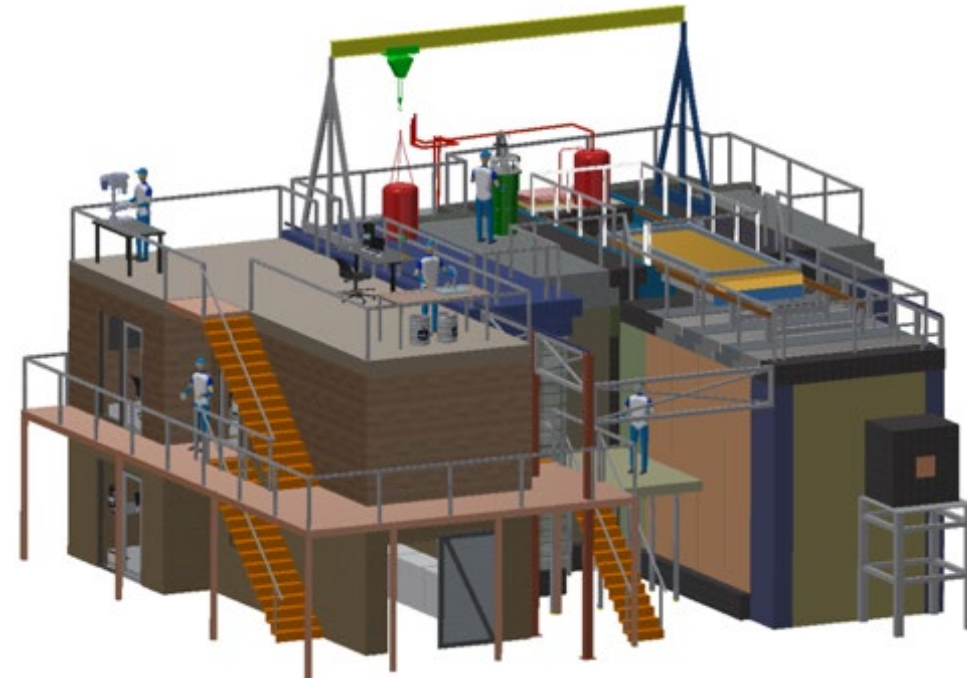
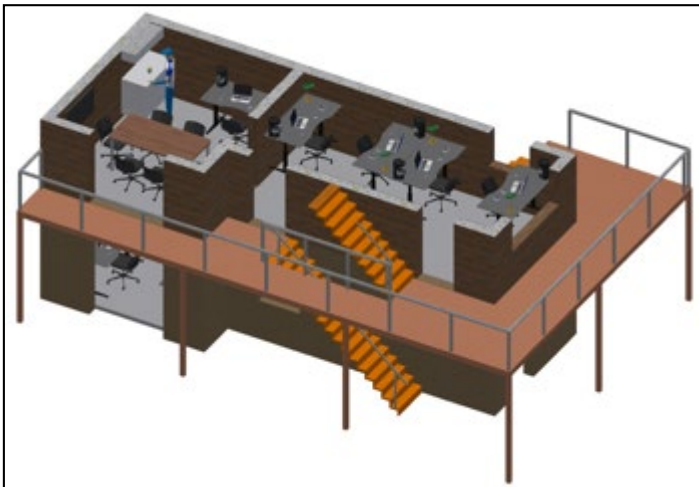


Estimated structure costs ~ 100 k€
+ Infrastructure (doors, windows,
tables chairs etc)

Budget 184€

Discussions with Philip Astrand &
Irina @ Facility Management ESS

Cost Variance = 0 k€ ?



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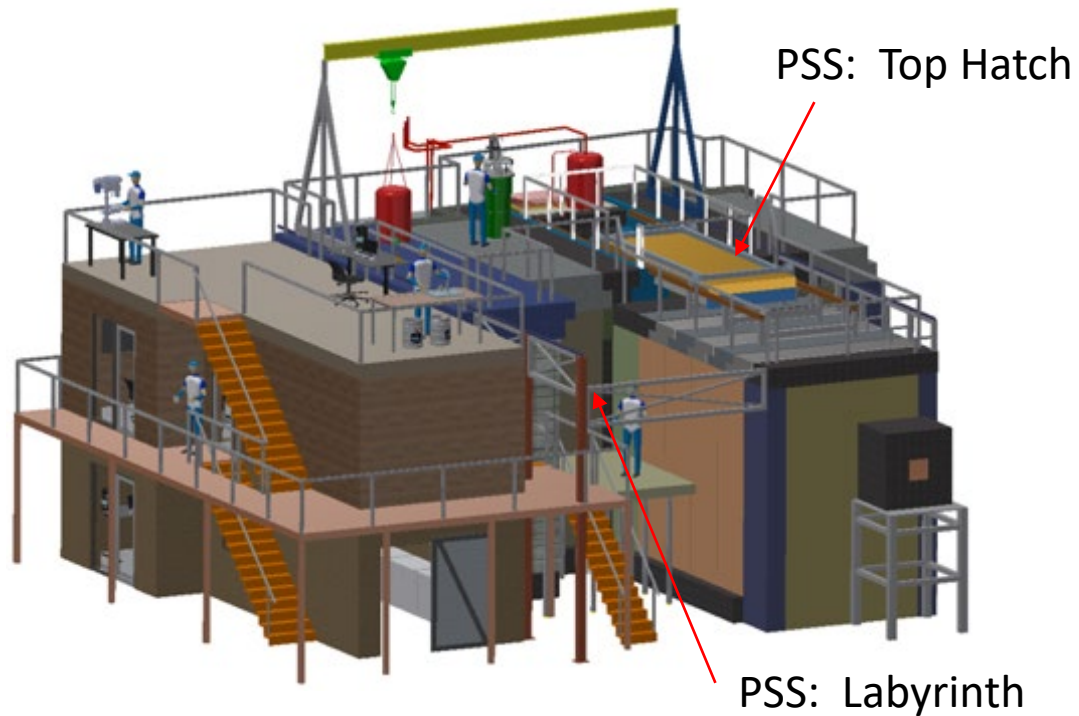
Little Known about PSS at the moment ?

Estimated costs <100 k€ (BiFrost)

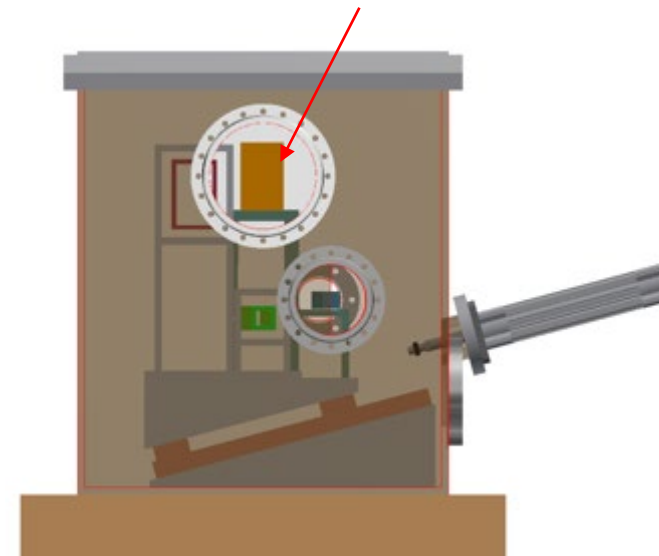
Budget 160 k€

Cost Variance = +60 k€ ?

Schedule after cave installation Q2 2024



PSS Heavy Shutter



Heimdal In-Kind Contributions



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- PSS (ESS)
- **1/3 2D Detectors (CDT) with PSI**
TAKE THIS WITH PSI LIST

- Neutron Guides + Housings (?)
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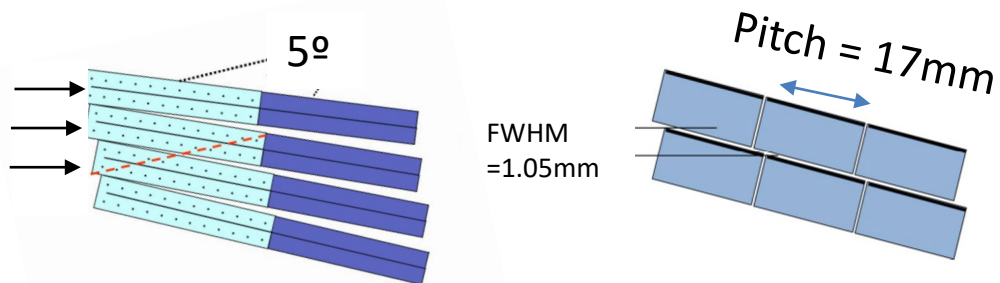
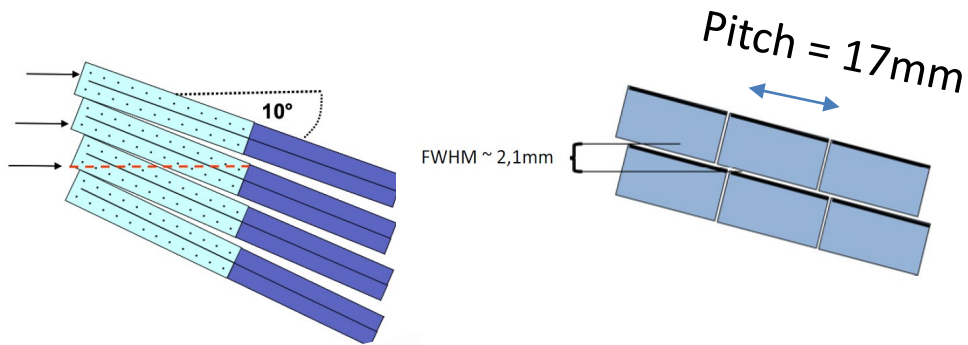
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2D Detector



¹⁰B Based Jalousie Detector

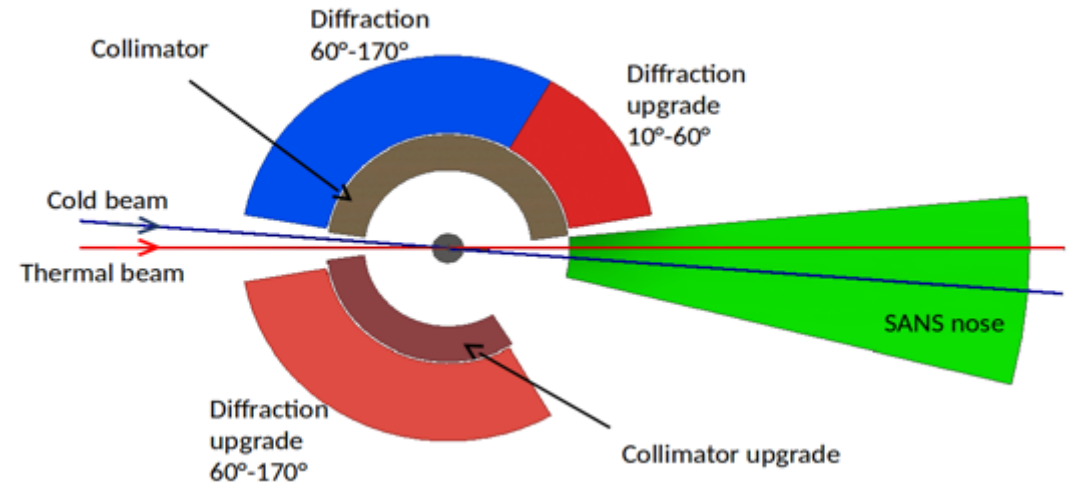


Estimated cost 1.3sr 1673 k€ (Quote 2018)
 + Backend electronics 150 k€ (estimate)
 Total = 1823
 Budget 598.9k€ (IFE) + 1317.5 k€ (PSI) = 1916,4
 Cost Variance = + 93,4 k€ ?

Add on? Gas mixing system CDT scope from utilities ?

Note: 1.3sr costed and 1.0sr is scope.

Schedule: Tender Q3 2022 -> SAT Q4 2024.



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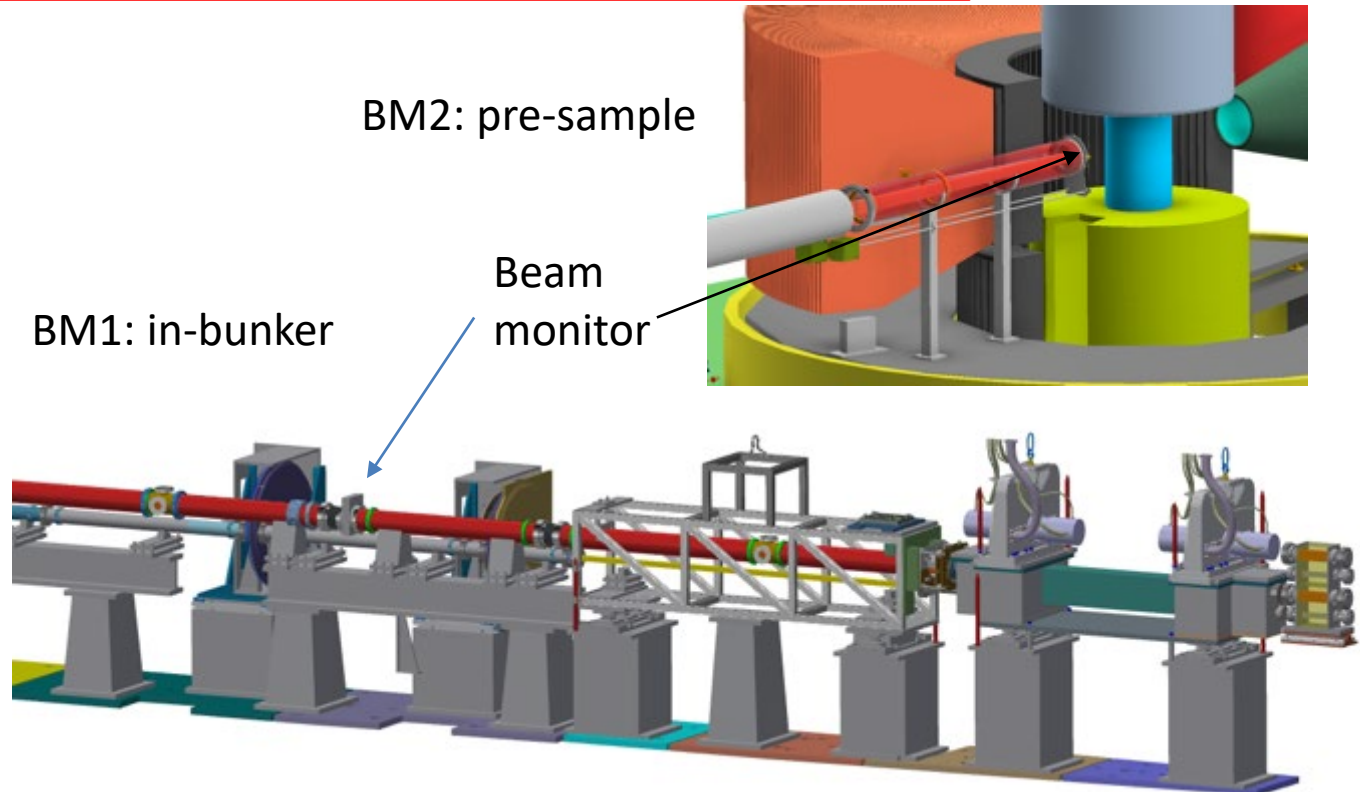
Beam Monitors



Estimated <30K per monitor (common monitors?)
 Total < 60k for 2 monitors
 Budget 77k€ (IFE)
 Cost Variance = + 17 k€ ?
 Schedule: Delivery Q1 2024.



Manual for I-BM and TIA-DAQ
 21.03.2018



Heimdal In-Kind Contributions



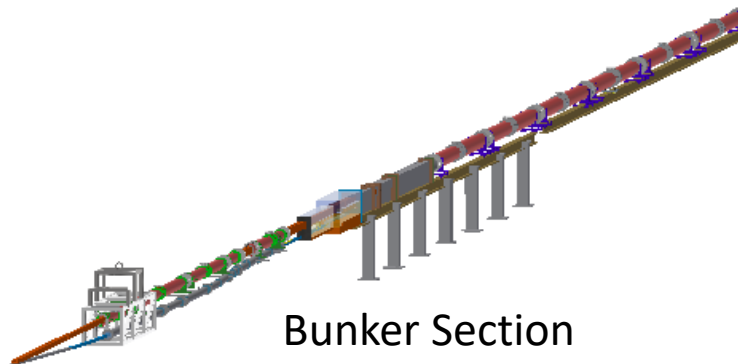
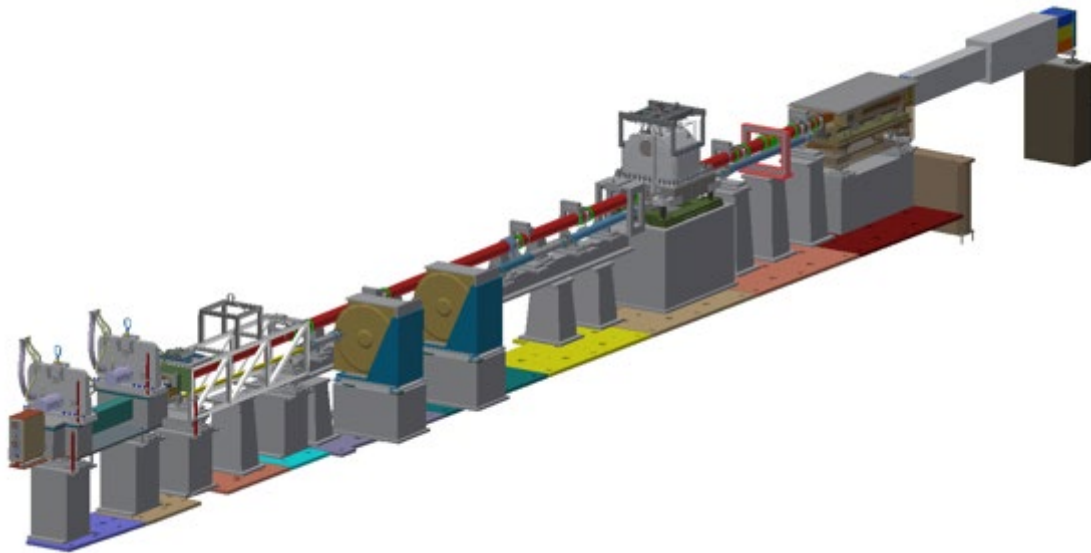
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- **Neutron Guides + Housings (?)**
- 2/3 2D Detector (CDT)
- 2 x Monitors (CDT?)

- Salary Scientist + Engineer
7 Years 2018-2025
- Inner Cave, floors, stairs, detector support,
- Detector collimator
- Sample x,y,z omega table
- Heavy + Light shutter
- Divergence slits
- Collimator slits
- Beamstop
- Control Racks
- Sample environment control box

Neutron Guide + Housings

In-bunker



Estimated 1300k€ Thermal Guide (Quote)
 Estimated 1500k€ Vacuum Housing (Quote)
 Estimated 140k€ Installation + alignment (Quote)
 Total: 2940 k€. (Note Bifrost ~3000k€ Guide + Housings)
 Budget 2686 k€ (IFE)

Cost Variance = -254 k€ ?

Schedule: WTO Tender Q2 2022 -> SAT Q3 2023.

+BWI housing 24,9 k€ (AU)

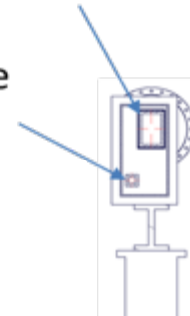
Estimated cold guide: (quote):

In-Bunker (28M) 193,2k€ Guides + 280k€ Vacuum housings?

Long straight (80M) 390k€ - no extra vacuum housings

Thermal guide

Cold guide



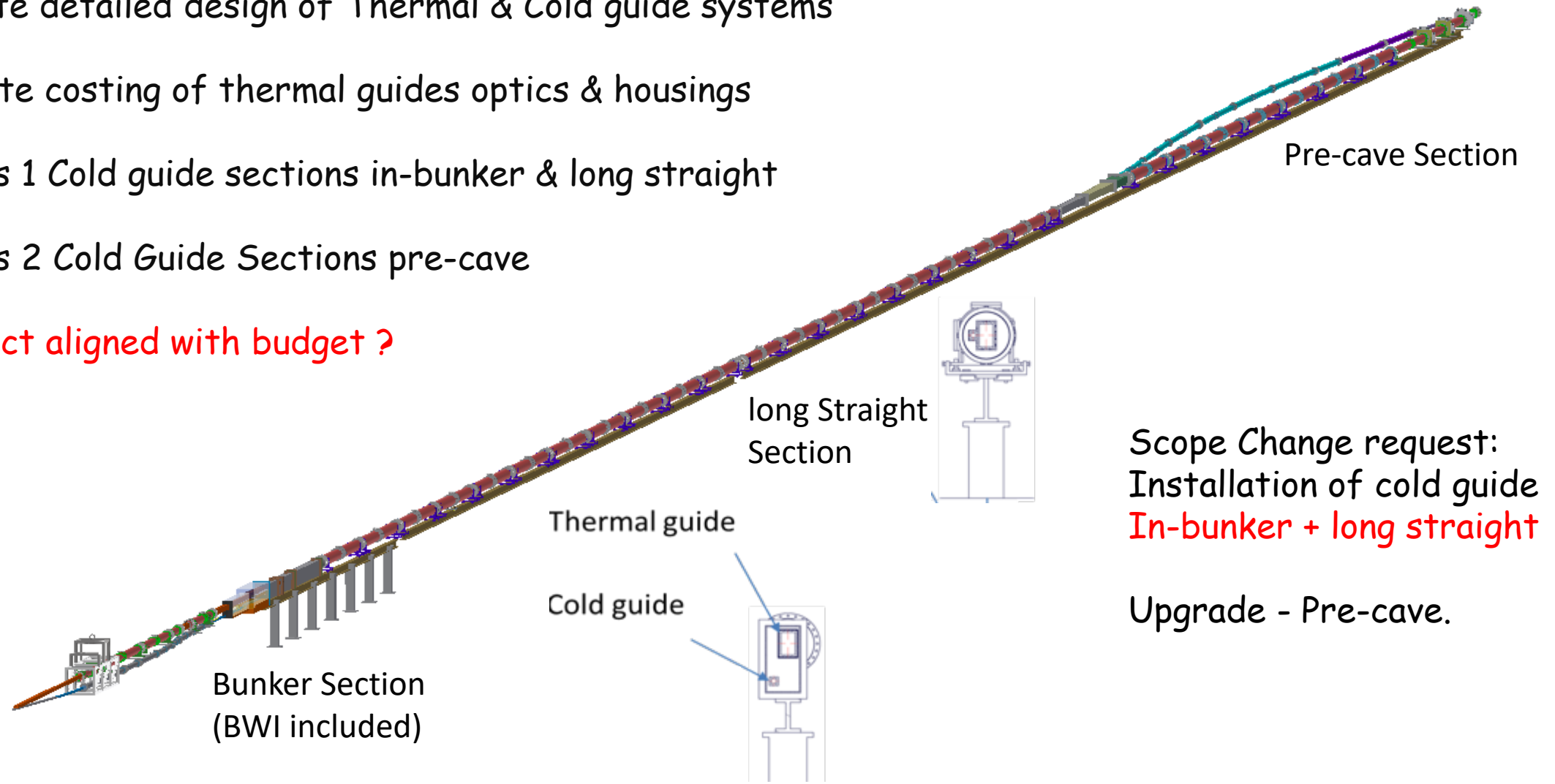
We should have contractual costing in Q3 2022 for thermal & cold guides

Heimdal Guide (PSI) WTO Tender

Published 23 June 2022

- (1) Complete detailed design of Thermal & Cold guide systems
- (2) Complete costing of thermal guides optics & housings
- (3) Options 1 Cold guide sections in-bunker & long straight
- (4) Options 2 Cold Guide Sections pre-cave

Final project aligned with budget ?



Scope Change request:
Installation of cold guide
In-bunker + long straight

Upgrade - Pre-cave.

Heimdal In-Kind Contributions



- Guide Shielding (ESS)
- Chopper Systems (ESS)
- T0 Chopper (ESS)
- Cave Shielding (Mirrotron)
- Utility & Electrical inf. (CEP CUP?)
- Experiment Cabin
+ sample prep. (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT) with PSI

- Neutron Guides + Housings (?)
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- Sample environment control box

Personnel



Dan Mannix (ESS)
Lead Scientist

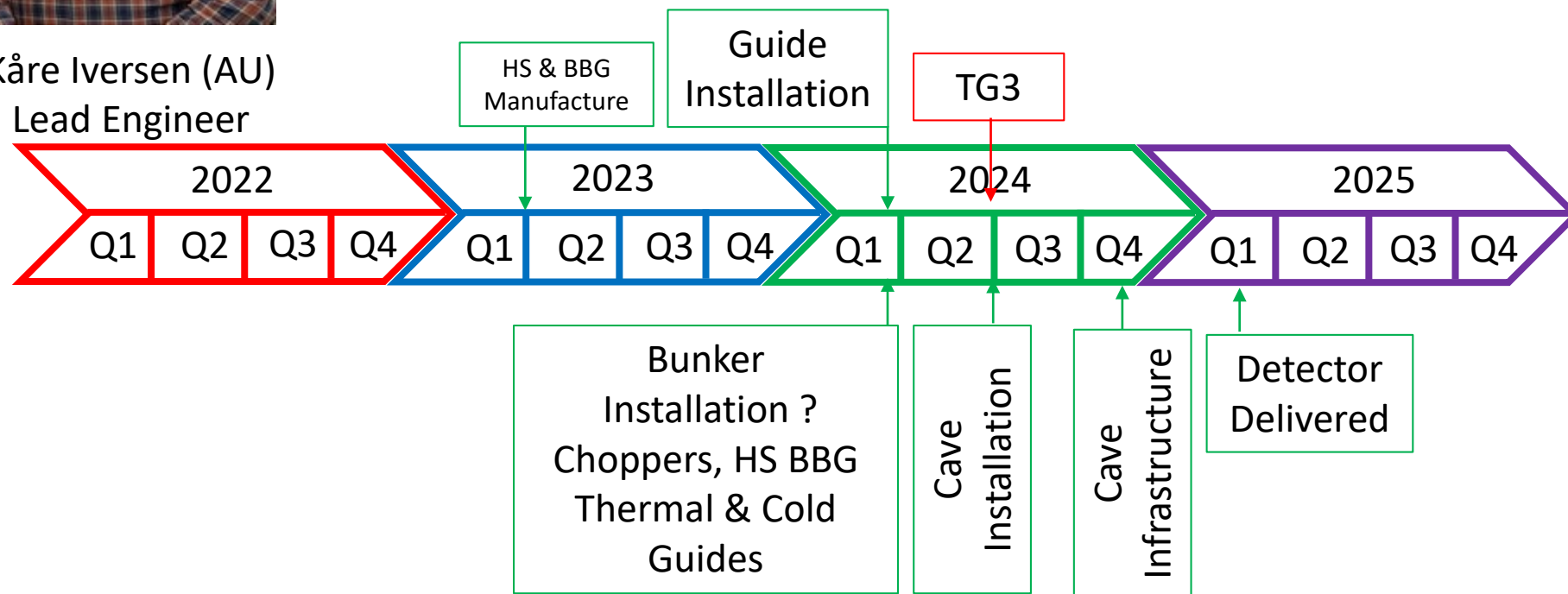


Kåre Iversen (AU)
Lead Engineer

Salary:

- 1 Lead Scientist 7 Years 2018 - 2022
- 1 Lead Engineer 7 Years 2018 – 2022

Lower Engineering support than other instruments.
Additional Engineer @ ESS fixed period ~2 years



Heimdal In-Kind Contributions

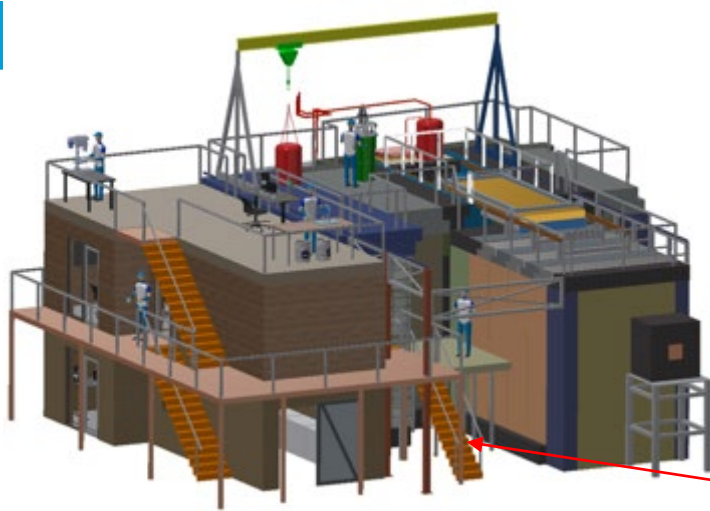


- Guide Shielding (ESS)
- Chopper Systems (ESS)
- T0 Chopper (ESS)
- Cave Shielding (Mirrotron)
- Utility & Electrical inf. (CEP CUP?)
- Experiment Cabin
+ sample prep. (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT) with PSI

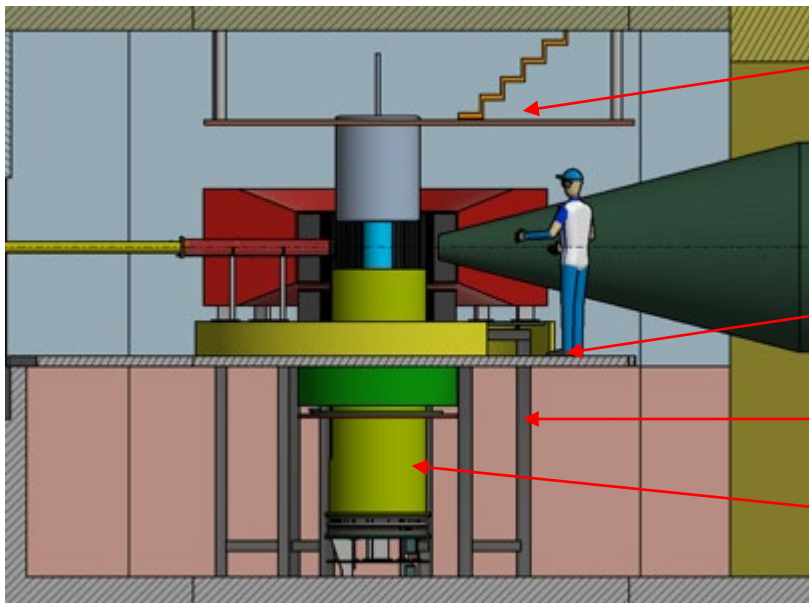
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- 2/3 2D Detector (CDT)
- 2 x Monitors (CDT?)

- Salary Scientist + Engineer
7 Years 2018-2025
- Inner Cave, floors, stairs, detector support.
- Detector collimator
- Sample x,y,z omega table
- Heavy + Light shutter
- Divergence slits
- Collimator slits
- Beam Stop
- Control Racks
- Sample environment control box

Inner Cave, stairs, Detector Table



stairs



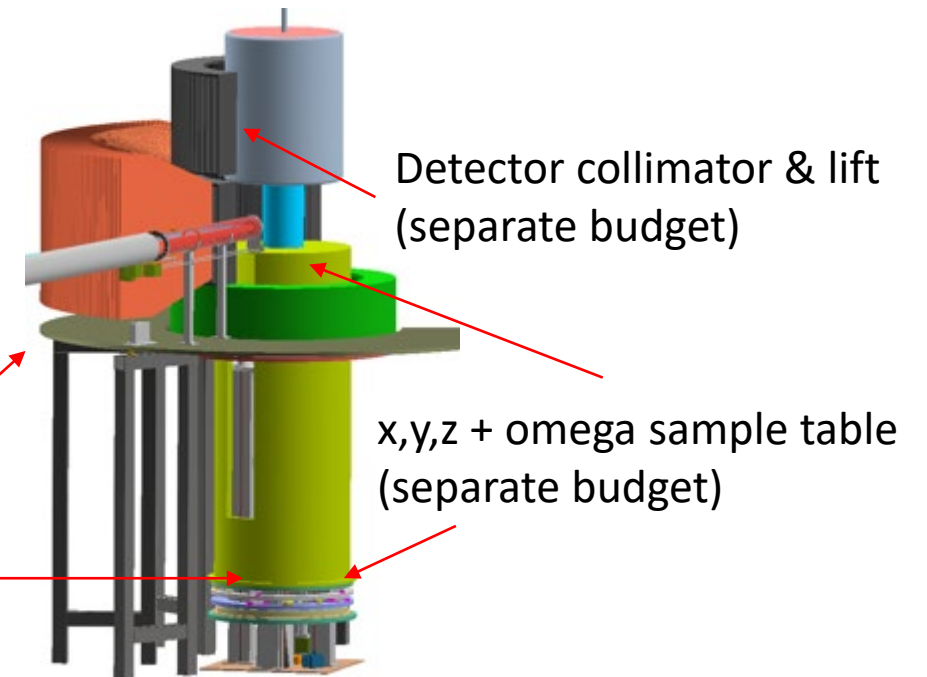
suspended floor

False floor

Detector Table

Sample table lift

- (1) Table fabrication @ AU
Stairs & Floor FM?
Budget = 604 k€
 - (2) Detector collimator & lift
Budget 226.5 k€
 - (3) x,y,z sample table
Budget 163 k€
- Schedule delivery Q4 2024



Detector collimator & lift
(separate budget)

x,y,z + omega sample table
(separate budget)

Heimdal In-Kind Contributions



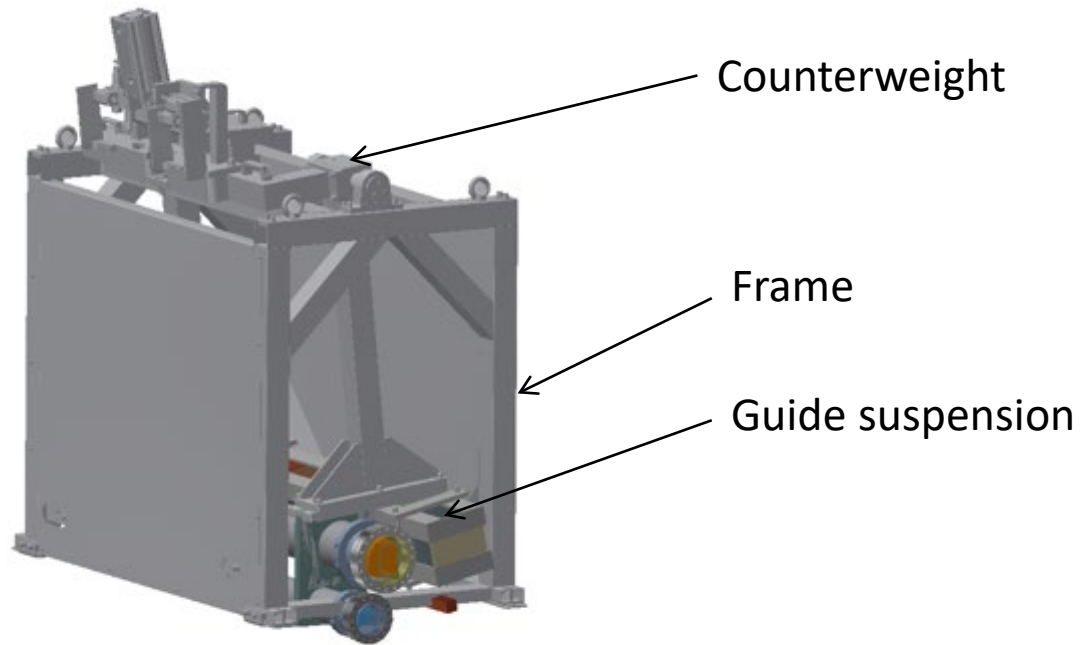
- Guide Shielding (ESS)
- Chopper Systems (ESS)
- T0 Chopper (ESS)
- Cave Shielding (Mirrotron)
- Utility & Electrical inf. (CEP CUP?)
- Experiment Cabin
+ sample prep. (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT) with PSI

- Neutron Guides + Housings (?)
- 2/3 2D Detector (CDT)
- 2 x Monitors (CDT?)

- Salary Scientist + Engineer
7 Years 2018-2025
- Inner Cave, floors, stairs, detector support.
- Detector collimator
- Sample x,y,z omega table
- **Heavy + Light shutter**
- Divergence slits
- Collimator slits
- Beam Stop
- Control Racks
- Sample environment control box

Heavy and Light Shutters

Heimdal heavy shutter



(1) Light shutter fabrication @ AU
+ bispectral switch (not scope)

Budget = 80 k€

(2) Heavy shutter fabrication @ AU

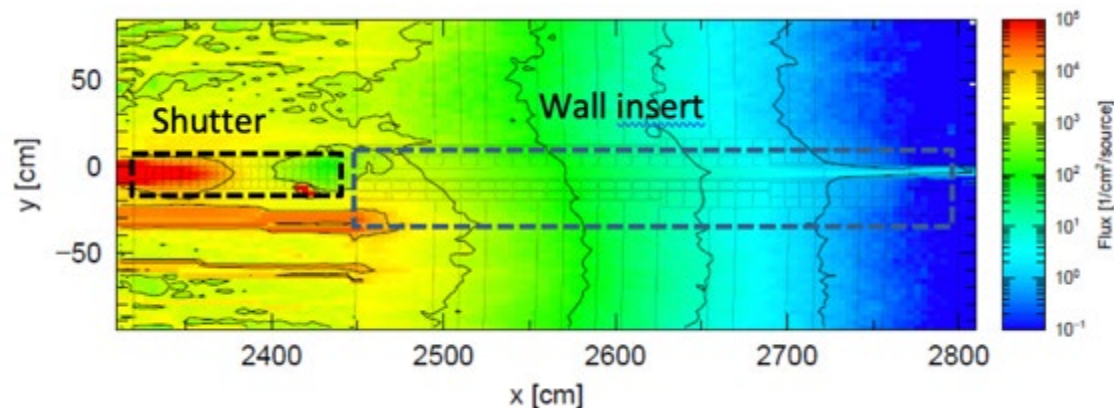
Budget 146.5 k€

Schedule

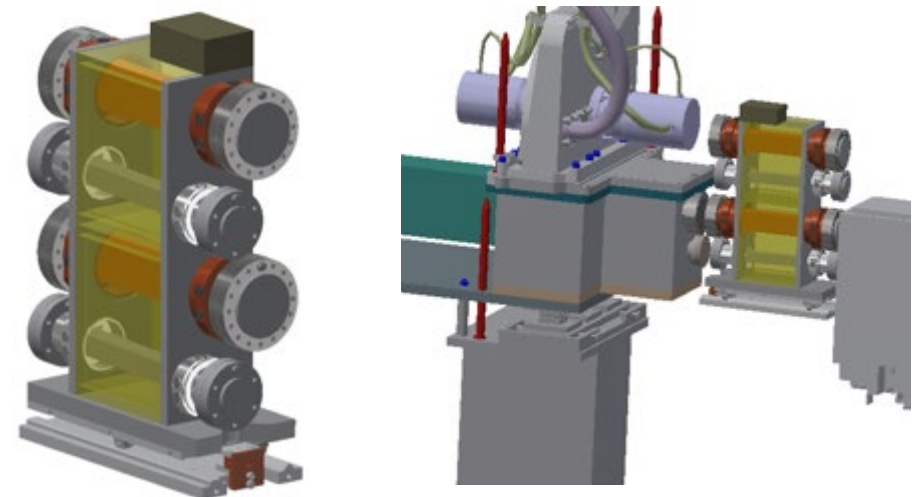
sTG3 Q1 2023

Manufacture Q1 2023

Delivery Q1 2024



Heimdal heavy shutter



Heimdal In-Kind Contributions



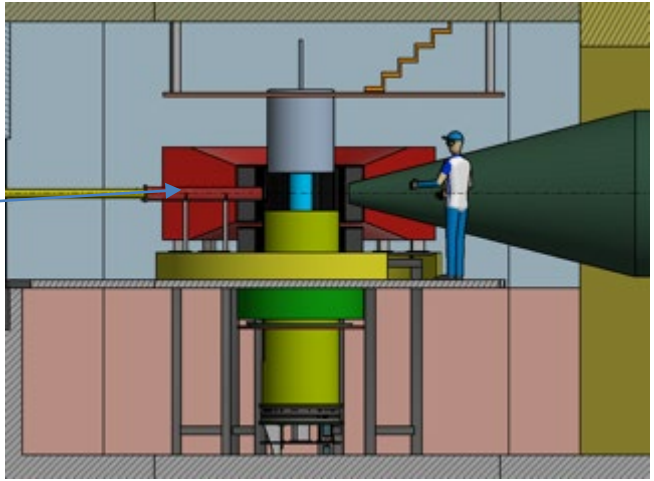
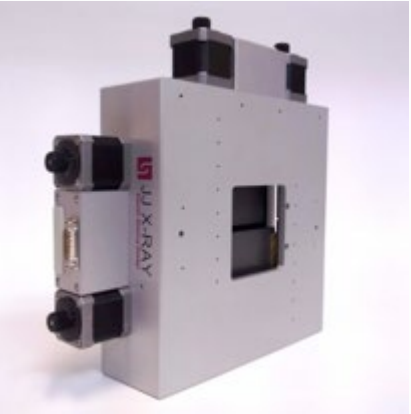
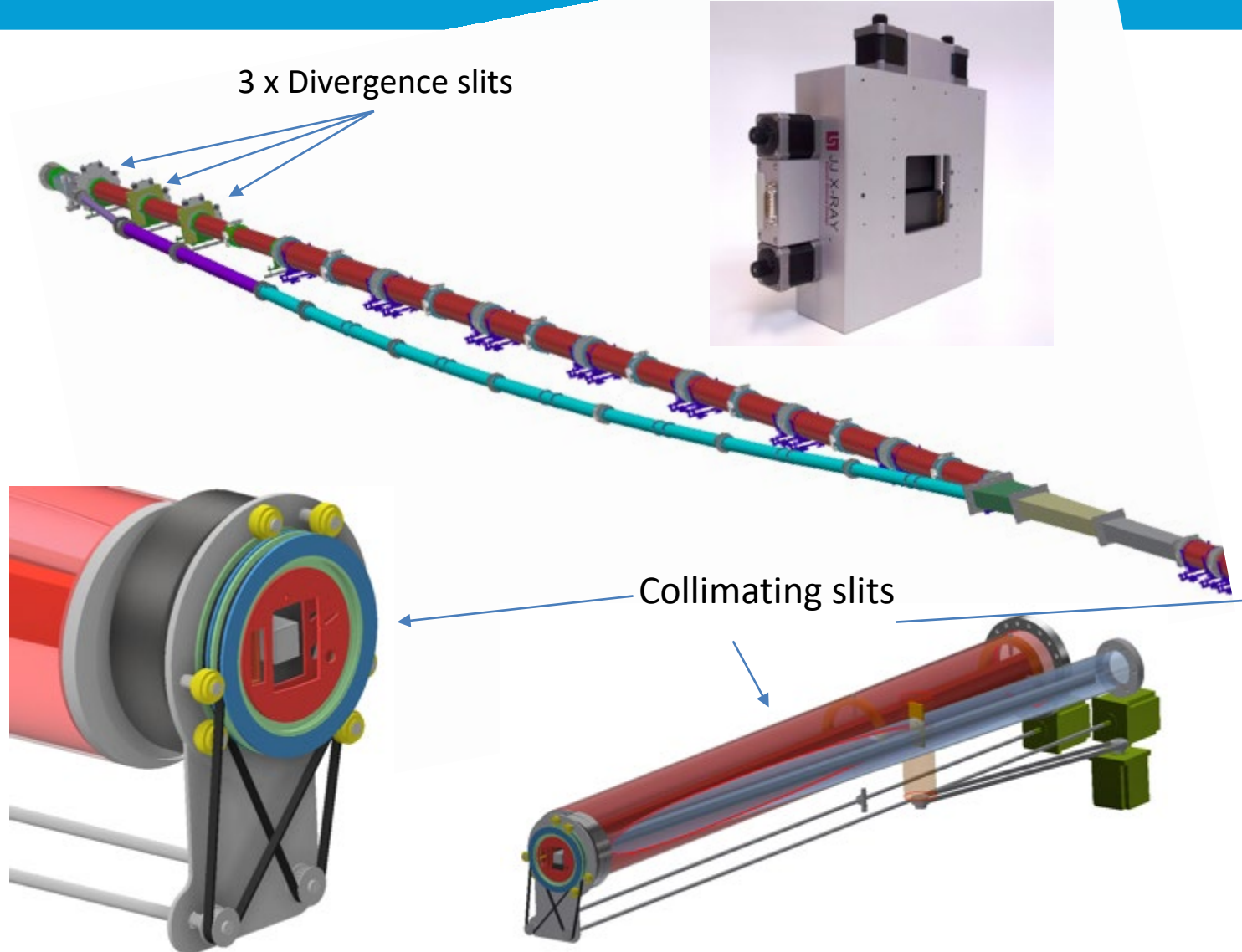
- Guide Shielding (ESS)
- Chopper Systems (ESS)
- T0 Chopper (ESS)
- Cave Shielding (Mirrotron)
- Cave Utility distribution (CEP CUP?)
- Experiment Cabin
+ sample prep. (ESS?)
- Cabin Infrastructure (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT) with PSI

- Neutron Guides + Housings (?)
- 2/3 2D Detector (CDT)
- 2 x Monitors (CDT?)

- Salary Scientist + Engineer
7 Years 2018-2025
- Inner Cave, floors, stairs, detector support.
- Detector collimator
- Sample x,y,z omega table
- Heavy + Light shutter
- **Divergence slits**
- **Collimator slits**
- Beam Stop
- Control Racks
- Sample environment control box

Divergence + Collimating Slits

(1) 3X Divergence slits JJ-X-ray
(2) Collimating slits fabrication @ AU
Budget 134.5 k€
Schedule
Delivery Q4 2024



Heimdal In-Kind Contributions

- Guide Shielding (ESS)
- Chopper Systems (ESS)
- T0 Chopper (ESS)
- Cave Shielding (Mirrotron)
- Utility & Electrical inf. (CEP CUP?)
- Experiment Cabin
+ sample prep. (ESS?)
- PSS (ESS)
- 1/3 2D Detectors (CDT) with PSI

- Neutron Guides + Housings (?)
- 2/3 2D Detector (CDT)
- 2 x Monitors (CDT?)

- Salary Scientist + Engineer
7 Years 2018-2025
 - Inner Cave, floors, stairs, detector support.
 - Detector collimator
 - Sample x,y,z omega table
 - Heavy + Light shutter
 - Divergence slits
 - Collimator slits
 - **Beam Stop**
- Scope transfer to ESS with cave (IFE)
- **Control Racks**
 - **Sample environment control box**
- Part of Utilities CEP CUP project (IFE)

IFE Budget Overview k€

Project	Budget	Estimated Cost	Contractual Cost	Cost Variance
Guide Shielding	1960		1290 (ESS)	0
Chopper Systems	840		840 (ESS)	0
T0 Chopper	350		350 (ESS)	0
Cave Shielding + Beamstop	711 (IFE + AU)		711 (Mirrotron)	0
Cave Top Sliding Hatch Mechanism	0	~ 100 ?		-100
Cave Gantry Crane (Not Scope)	0	~ 50 ?		-50
Utilities + Electrics (CUP + CEP)	375	~500 ? (ESS)		-125
Experimental Cabin + sample lab	184	~ 100 ? structure only		0
PSS	160	100 (Bifrost ?)		+60
1/3 2D Detector	598.9	cash transfer from IFE to PSI ?		0
2013 Euros Index			Shielding 129 Cave 90 Choppers 110	+329
Global IFE Budget				+114

PSI Global Budget

Note: many costs still non-contractual

PSI Budget Overview k€				
Project	Budget	Estimated Cost	Contractual Cost	Cost Variance
2D Detector 1.3sr (scope = 1.0sr)	1317.5 (PSI) + 595.9 (IFE)	1673 (CDT quote)	CDT	+93.4
Backend Electronics Total Project	Total=1916.4	150 (ESS Detector Group) 1823	ESS	
Monitors	76	~70 (ESS) x2 monitors		0
Thermal Guide Vacuum Housings Alignment Total Project	2686	1300 (quote) 1500 ?? (quote) 140 (quote) 2940		-254
Global PSI Budget				-160.6 ?

Guide tender published 20/06/2022: Should have accurate costs after summer
Large unknown for vacuum housings.

AU Global Budget

Note: many costs still non-contractual

AU Budget Overview k€				
Project	Budget	Estimated Cost	Contractual Cost	Cost Variance
Inside Cave: Detector Table False Floors Stairs	604	604 ? (Budget)		0
Sample translation x,y,z omega	163	163 ? (Budget)		0
Detector Collimator	226.5	226.5? (Budget)		0
Beam Stop	213.4	106.5 Cash Transfer to ESS (Cave Project)		+106.9
Light Shutter	80	80 (Budget)		0
Heavy Shutter	144	144 (budget)		0
Divergence Slits x3 Collimating slits	134.5	134.5 (budget)		0
Control Racks	75	Transfer to IFE for CUP & CEP		0
SE Control Box	100	Infrastructures		
Global AU Budget				+106.9 ?

Large amount of costs from internal manufacturing at AU.

Increased Scope & Engineering Costs ?

Increased Scope & Personnel Costs k€			
Project	Estimated Costs	Total Cost	Additional Costs
Additional Engineer 2 Years	110 / Yr	220	-220
Cold Guide: In-bunker (28M) Guide Optics Vacuum housings	193.2 280	~ 500 ?	-500
Cold Guide: Long Straight (80M) Guide Optics Vacuum Housings	390 0	390	-390
Total			- 1100

More accurate costs for guide after summer 2022.

Early upgrade not additional costs to final scope

Heimdal Committed Spend



Heimdal Budget Committed Cost per partner k€ CB=13553				
Project	Budget	Estimated Cost	Committed Cost	Cost Variance
IFE (CB=3453)				
Guide Shielding	1960 (IFE)		- 1290 (ESS)	0
Chopper Systems	840 (IFE)		- 840 (ESS)	0
T0 Chopper	350 (IFE)		- 350 (ESS)	0
Cave Shielding + Beamstop	711 (IFE + AU)		- 604 (Mirrotron)	0
Subtotal			3084	
2013 Index			+329	
AU (CB =4065)				
Salary 01/2018 - 06/2022			550 ?	
Beam Stop			107	
Subtotal			657	
PSI (CB=4065)				
Subtotal			0	
Total Committed spend			3741	

The Heimdal Risk Register

RISKS to Heimdal project: Delay, Quality & Costs	Lack of Engineering resources based at ESS. Lead Engineer is only Engineering resource, based in Denmark. Close to retirement age. No Engineering manpower based at ESS.	Heimdal cannot complete engineering documentation according to schedule. Lead engineer retiring and not enough overlap with replacement engineer. Risk of delay and quality of final instrument.	Delay in instrument schedule. Quality of Instrument delivered. Increased labor costs from delay.
RISKS to Heimdal project: Delay, Quality & Costs	20	Reduce	Allocation of Engineering resources to Heimdal and based at ESS. Best solution is reuse of engineering resources from earlier instruments with ESS instrument work experience.

Heimdal Requires more engineering support based at ESS to deal with large workload & installation

Kåre Iversen - Lead Engineer based at Aarhus University

Dan Mannix - Lead Scientist based at ESS

The Heimdal Risk Register

Risk of personnel leaving	Neutron instrument division has requested opening of Heimdal lead scientist position	Dec-20	Low	Unlikely	2	4	Falling
Delay of 2D Detector Procurement from PSI	Issue resolved and moving ahead in 2022. Guide procurement priority (Change in BOT ESS-MS). Detector procurement Q2 Q3 2022.	2020-12-01	Low	Moderate	4	6	Falling
Delay of Guide procurement from PSI	Issue resolved and moving ahead in 2022. PSI Guide tender publication expected Q2 2022. RISK Reduced	2020-12-01	Low	Moderate	4	6	Falling
SANS upgradability	Partners and ESS shall clarify the subject as soon as possible. If the proposed changes are not excepted there has to be some plan that allows a later upgrade with reasonable budget.	2022 Q2	High	Likely	16	15	Rising
TO Cost / High Background	Search new supplier of TO chopper. ESS to investigate if it can be built by ESS. Update Feb-22: ESS Chopper group scope. Risk		Very low	Moderate	2	15	Falling
delay to cave installation	Awaiting results of rebaseline	2020-12-15	Low	Moderate	4		New

Agenda



Part I

10:00 - 10:10 Welcome/intro (Rob)

10:10 - 10:30 Brief Overview of HEIMDAL (Dan)

- a. Science case
- b. Components
- c. Scope and in-kind partner responsibility
- d. Overall schedule and budget distribution

10:30 - 11:30 Project reporting: **Slides 15-50**

- a. Progress of each component/part: one slide per item
- b. Budget overview of all WPs
- c. Schedule and schedule uncertainties
- d. Risks (incl staffing)

11:30 - 12:30 Lunch

Part II

12:30 - 13:00 Project scope discussion **Slides 51-55**

- a. Current plan for upgradability
- b. HEIMDAL team view
- c. ESS view (Andrew)

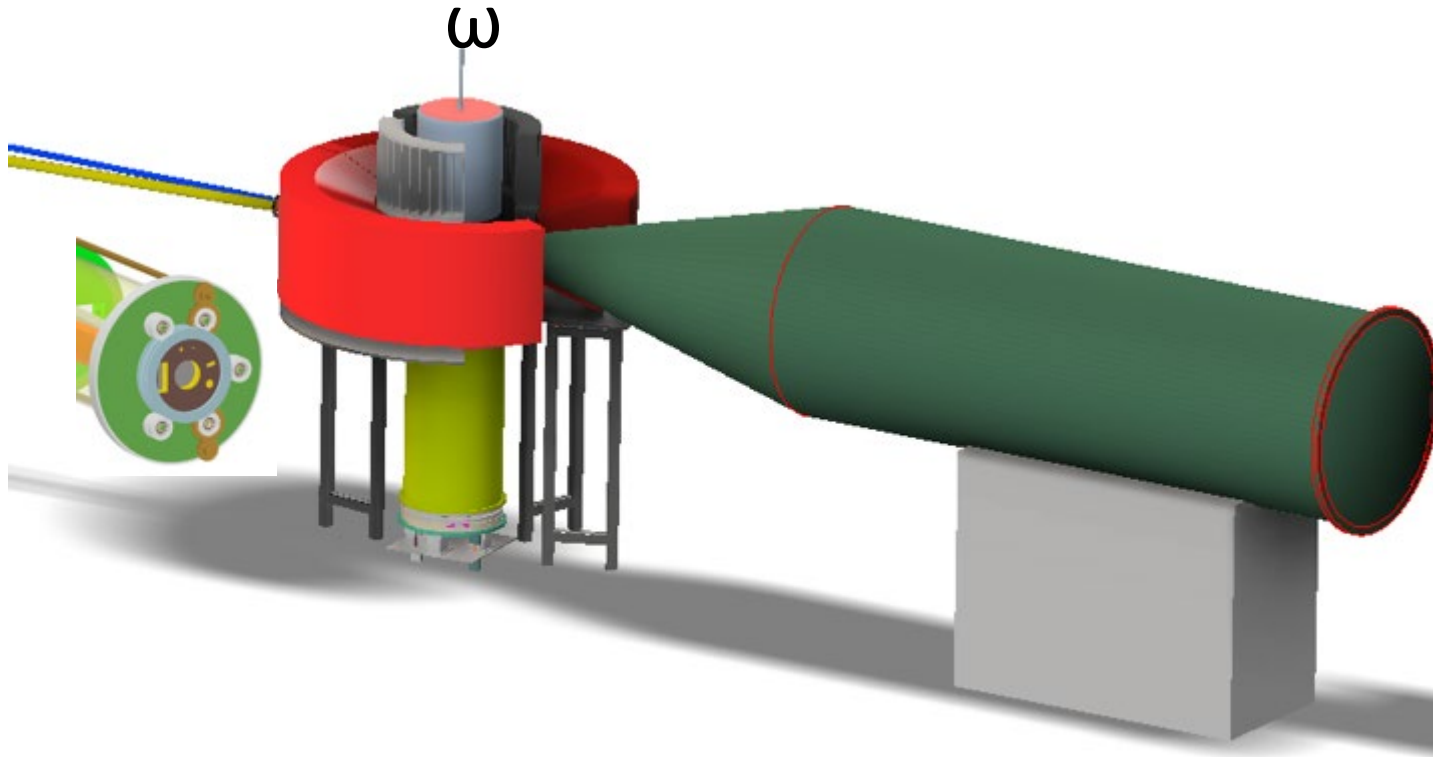
13:00 - 13:30 Overview of the Collaboration

- a. How is the collaboration organized
- b. How often the collaboration meets
- c. Challenges within the collaboration

13:30 - 14:00 Wrap up and conclusions

HEIMDAL – Hybrid Diffraction

Multi Length Scale Neutron Scattering Instrument:
 $10^{-2} - 10^8$ nm



Diffraction + SANS + Imaging

- (1) Thermal Diffraction (SOUP ~2028)
- (2) Cold Guide - SANS (upgrade)
- (3) Neutron Imaging (upgrade)

Upgradeability Plan ?

Retrofit of Cold Guide has implications:

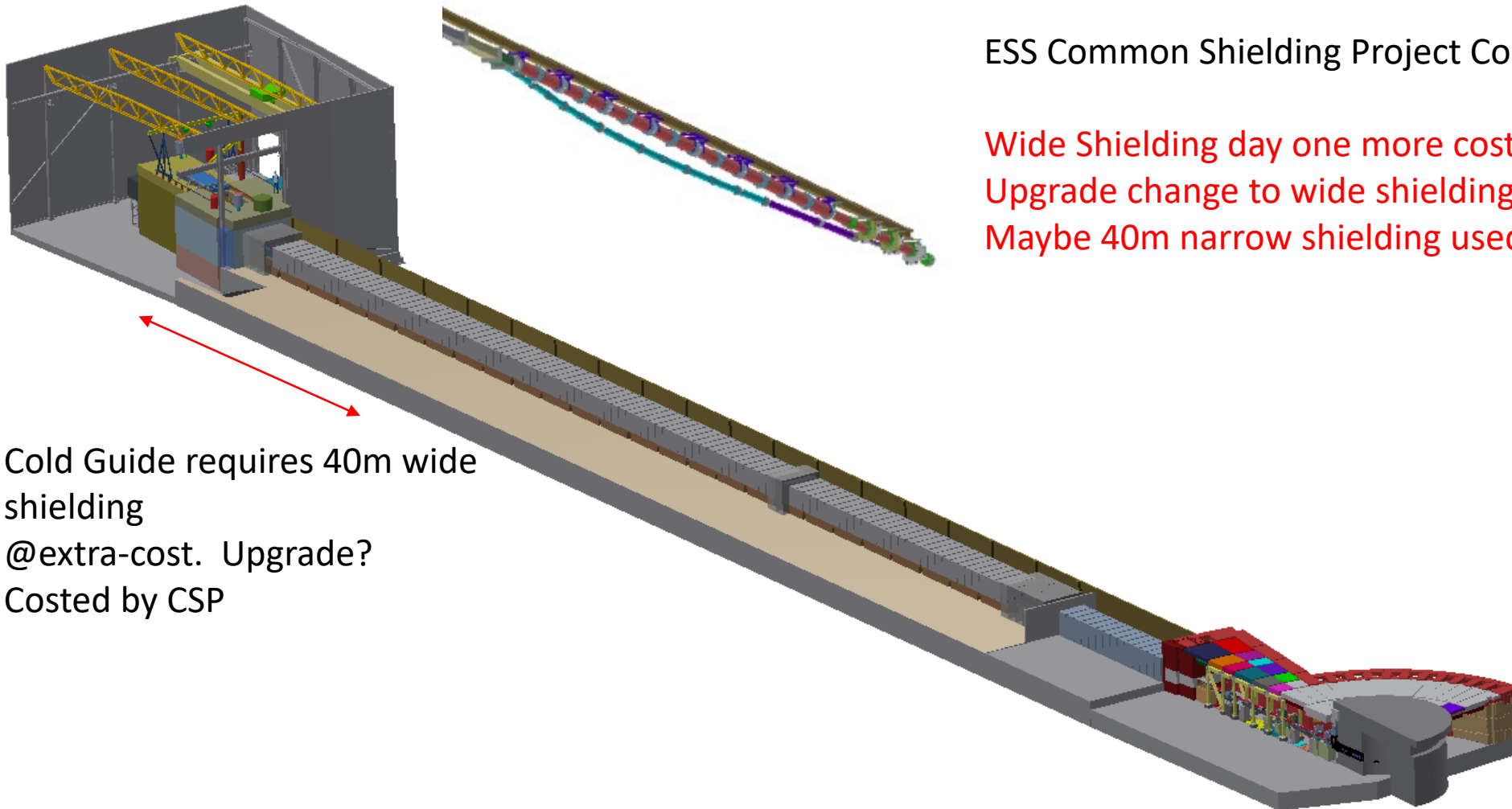
Bunker (28M):

Shutdown of ESS & Instrument.
Activity of components / remote handling ?
Safety work permits ?
Cramped workspace
Maybe low activation due to low power?
Feasibility study required?

Long Straight (80M):

Less activation issues than bunker
Shutdown of ESS not required
Instrument shutdown.
Dismantle / remove / glue cold guide /
reassemble / realign

Pre-cave section: Easier to upgrade.

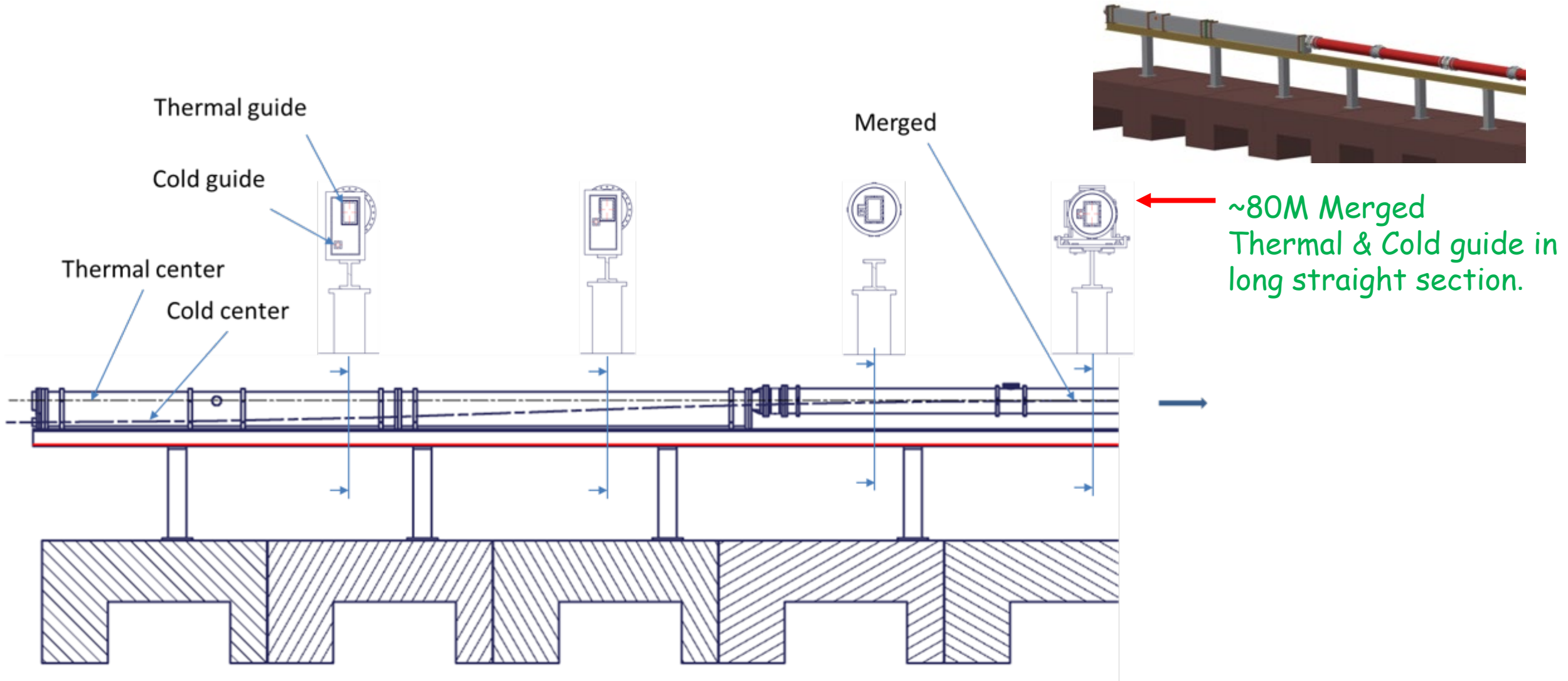


ESS Common Shielding Project Costed in 2018 1290k€

Wide Shielding day one more cost.
Upgrade change to wide shielding waste?
Maybe 40m narrow shielding used by instruments 16-22?

Cold Guide requires 40m wide shielding
@extra-cost. Upgrade?
Costed by CSP

Split and Merge vacuum chambers More expensive than D210 tube.



Upgradeability Plans

Access to earlier upgrade funding?

Option 1: Cheapest Day 1 costs / More complex & cost upgrade:

Day 1: No cold Guide in Bunker / long straight / Pre-cave sections. Narrow Guide shielding last 40m / No merge & split chambers.

Upgrade Plan: Shutdown (**ESS**) / Install Cold Guide in-bunker long straight (remove & glue) and pre-cave. Replace last 40m of guide shielding / Install SANS tank and detectors, cold choppers, Hot commissioning.

Option 2: Medium Day 1 costs / less complex & cost upgrade:

Day 1: Cold Guide in Bunker / No long straight / No Pre-cave sections. Narrow Guide shielding last 40m / No merge & split chambers.

Upgrade Plan: Shutdown / Install Cold Guide long straight (remove & glue) and pre-cave. Replace last 40m of guide shielding / Install SANS tank and detectors, cold choppers, Hot commissioning.

Option 3: High Day 1 costs / easy & lower cost upgrade:

Day 1: Cold Guide in Bunker & long straight / No Pre-cave sections. wide Guide shielding last 40m / merge & split chambers.

Upgrade Plan: Shutdown pre-cave. Install SANS tank and detectors, cold choppers, Hot commissioning.