EUROPEAN SPALLATION SOURCE

Science Update

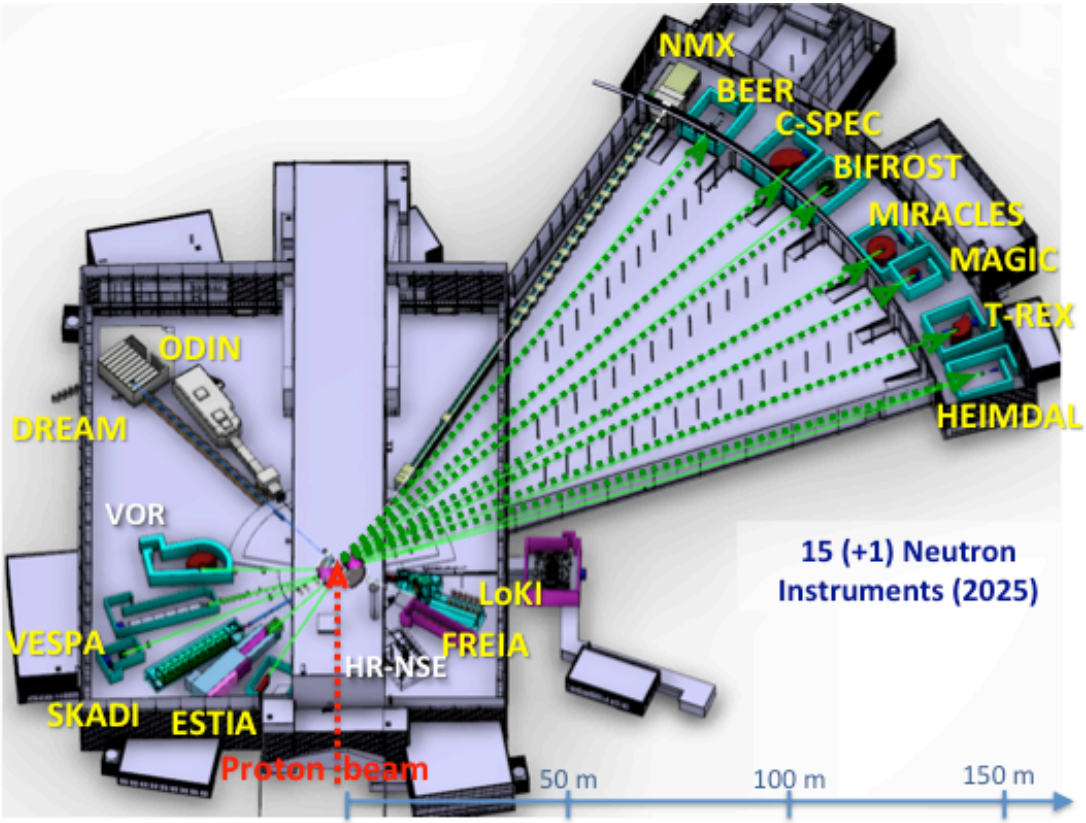
Andreas Schreyer

Director for Science

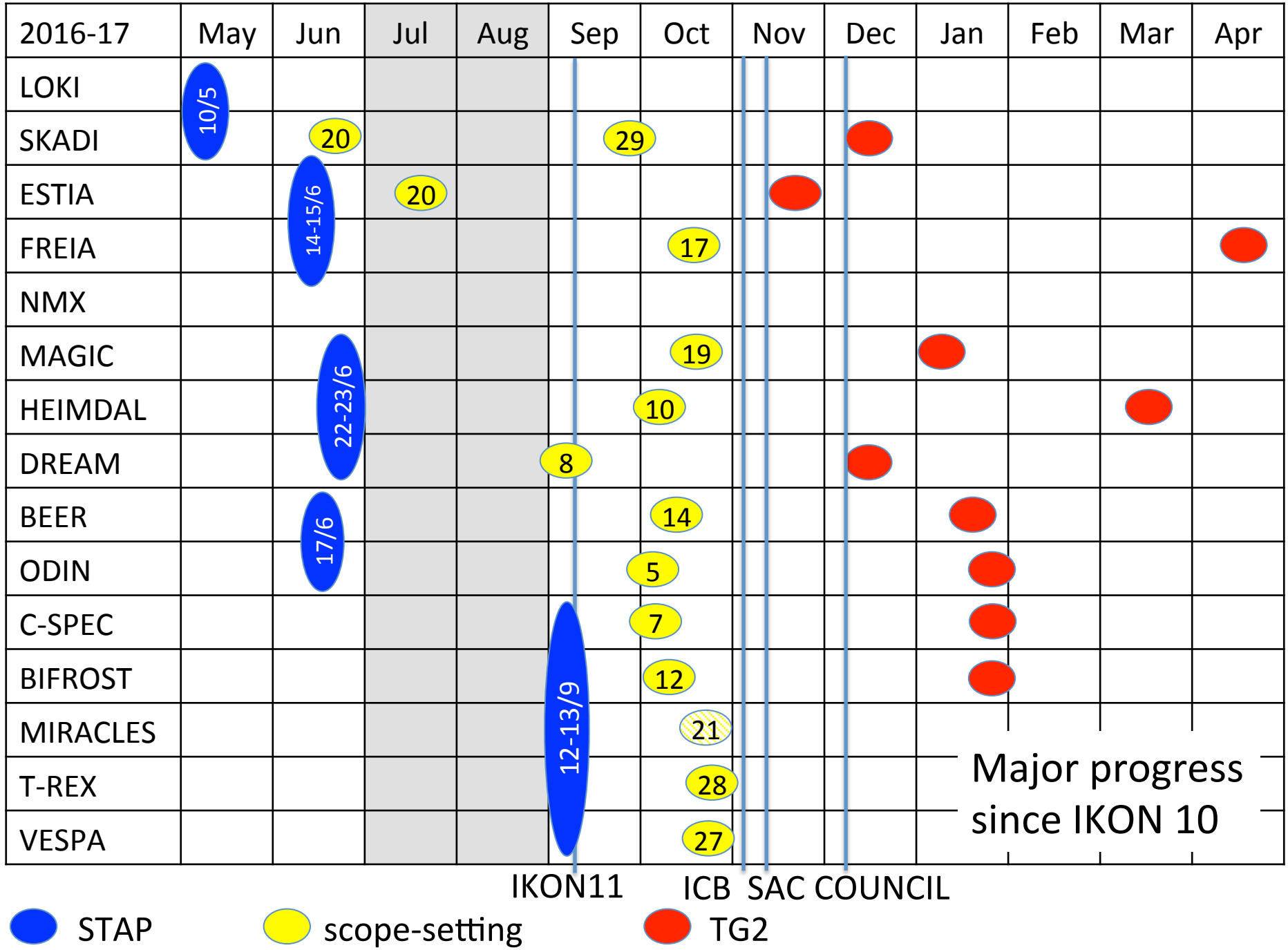
IKON 11, 14th September 2016

Priorities for 2016 concerning instruments

- Scope setting for 13 further instruments
- Realign NSS budget



- Develop a realistic schedule for all instruments **ensuring early science success** in line with available in-kind resources and partner capabilities
- Propose which instruments are to be operational first
- Proposal to Council in December 2016 on how to fund instruments plus everything else **required for early science success** within budget of 350 MEUR
- Operations budget


2016-17
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
LOKI
SKADI
ESTIA
FREIA
NMX
MAGIC
HEIMDAL
DREAM
BEER
ODIN
C-SPEC
BIFROST
MIRACLES
T-REX
VESPA
10/5
20
29
20
14-15/6
17
19
22-23/6
10
8
17/6
14
5
7
12
12-13/9
21
28
27
Major progress since IKON 10
IKON11
ICB
SAC
COUNCIL
STAP
scope-setting
TG2

Mon	Tue	Wed	Thu	Fri	Sat	Sun
2016 October					1	2
3	4	5 ODIN	6	7 C-SPEC	8	9
10 HEIMDAL	11	12 BIFROST	13	14 BEER	15	16
17 FREIA	18	19 MAGIC	20	21 MIRACLES	22	23
24 Operations Review	25	26	27 VESPA	28 T-REX	29	30

provisional:	STAP	Scope-Setting	TG2 Review
agreed:	STAP	Scope-Setting	TG2 Review

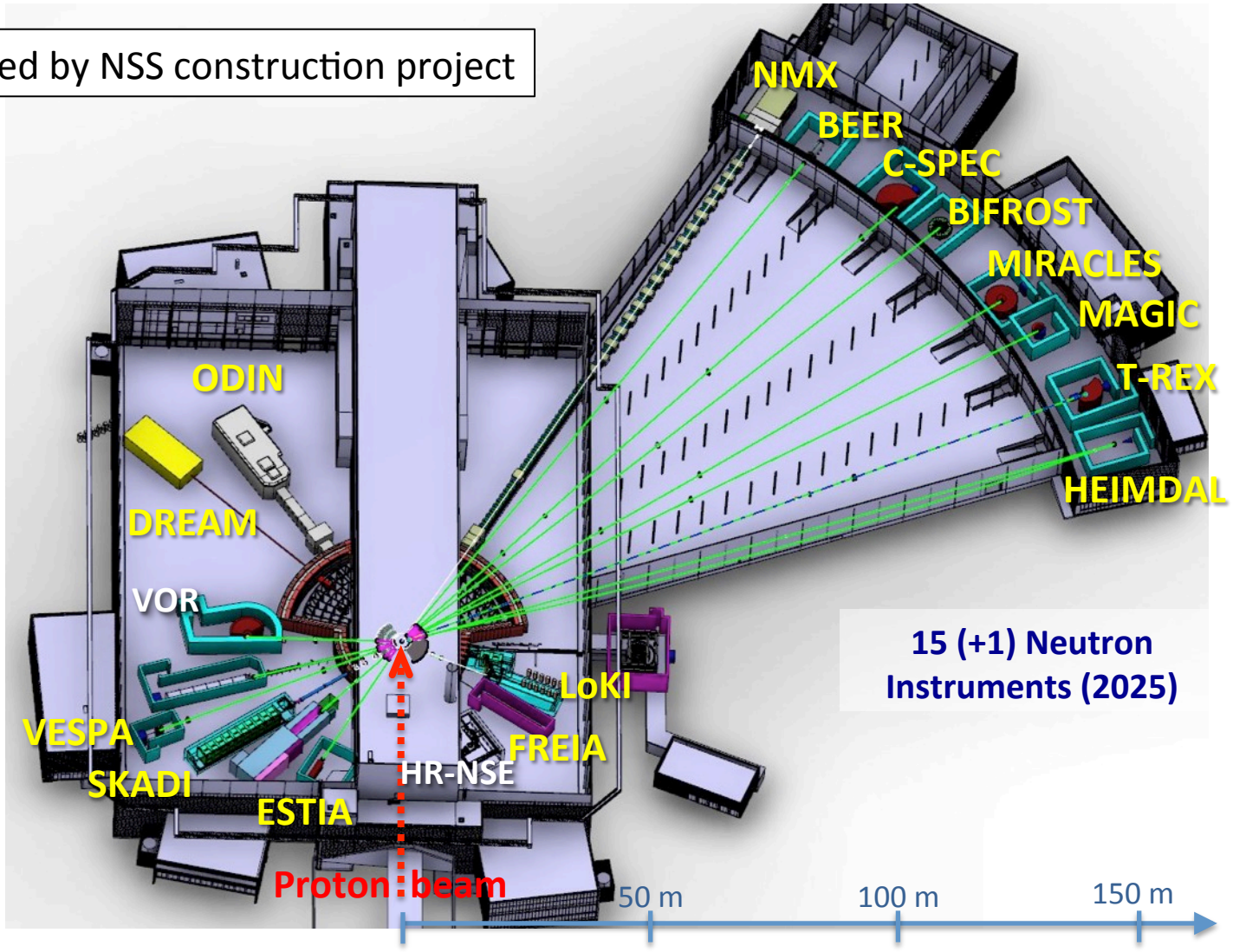
Instrument Beamports Allocated

Instruments 1-16; funded by NSS construction project

Two instruments have moved;

- ESTIA; E1 -> E2 – for cleaner view of source
- SKADI ; E8 -> E5 – for more space (= lower technical risk)

- DREAM; S4 -> S3 – change request received for more space and gain of additional useable beamport



Instrument Layout (Jun 2016)

New Procedure for Decisions on Construction of Instruments (June Council)

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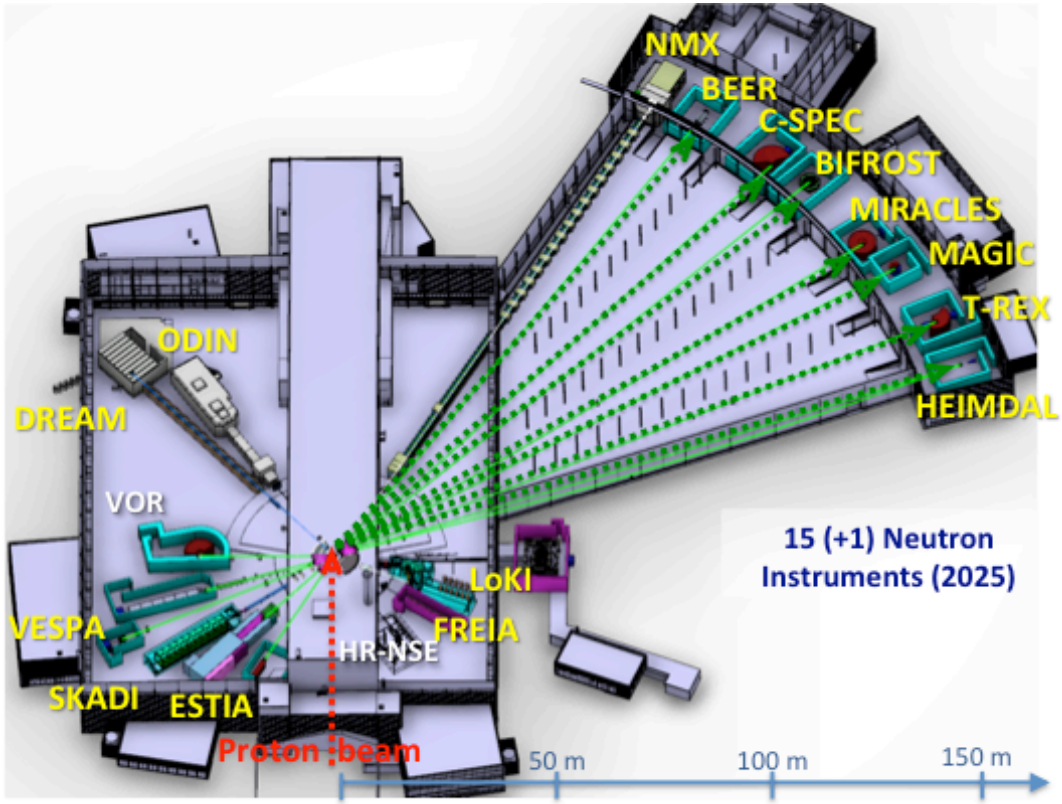
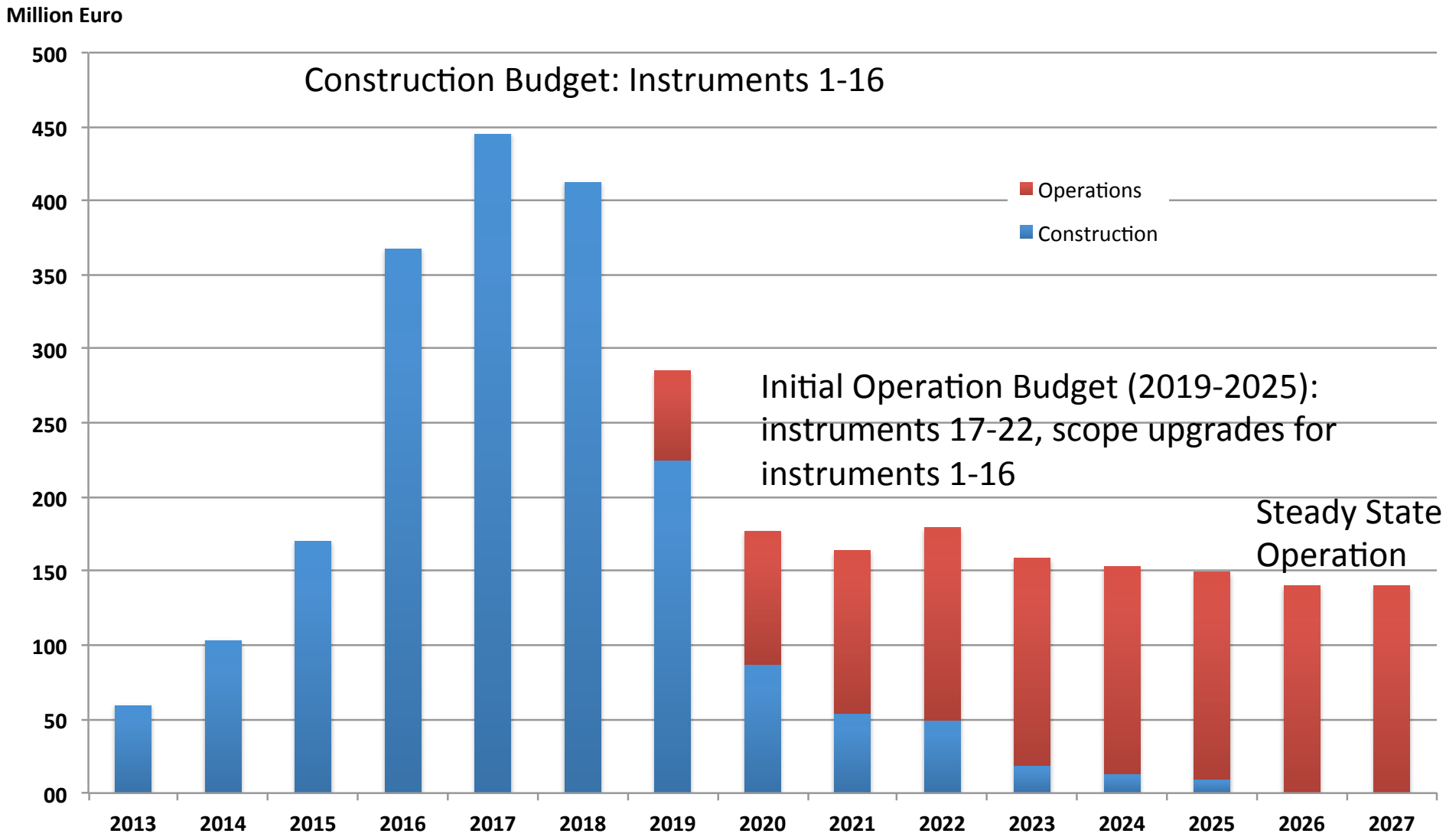
- New procedure **allows the provision of a cost book value before the completion of phase 1 (Tollgate 2)** to allow an overall view and alignment of the NSS construction budget. The final Council decision to construct an instrument will take place after Tollgate 2 as agreed previously.

- New approach has the great advantage that it will be possible to propose an overall strategy and close to complete view for the 16 instruments which are in the scope of NSS within the ringfenced NSS construction budget.



Construction and operations budget profiles



NSS achievement based transition milestones to operations

based on draft schedule of instruments

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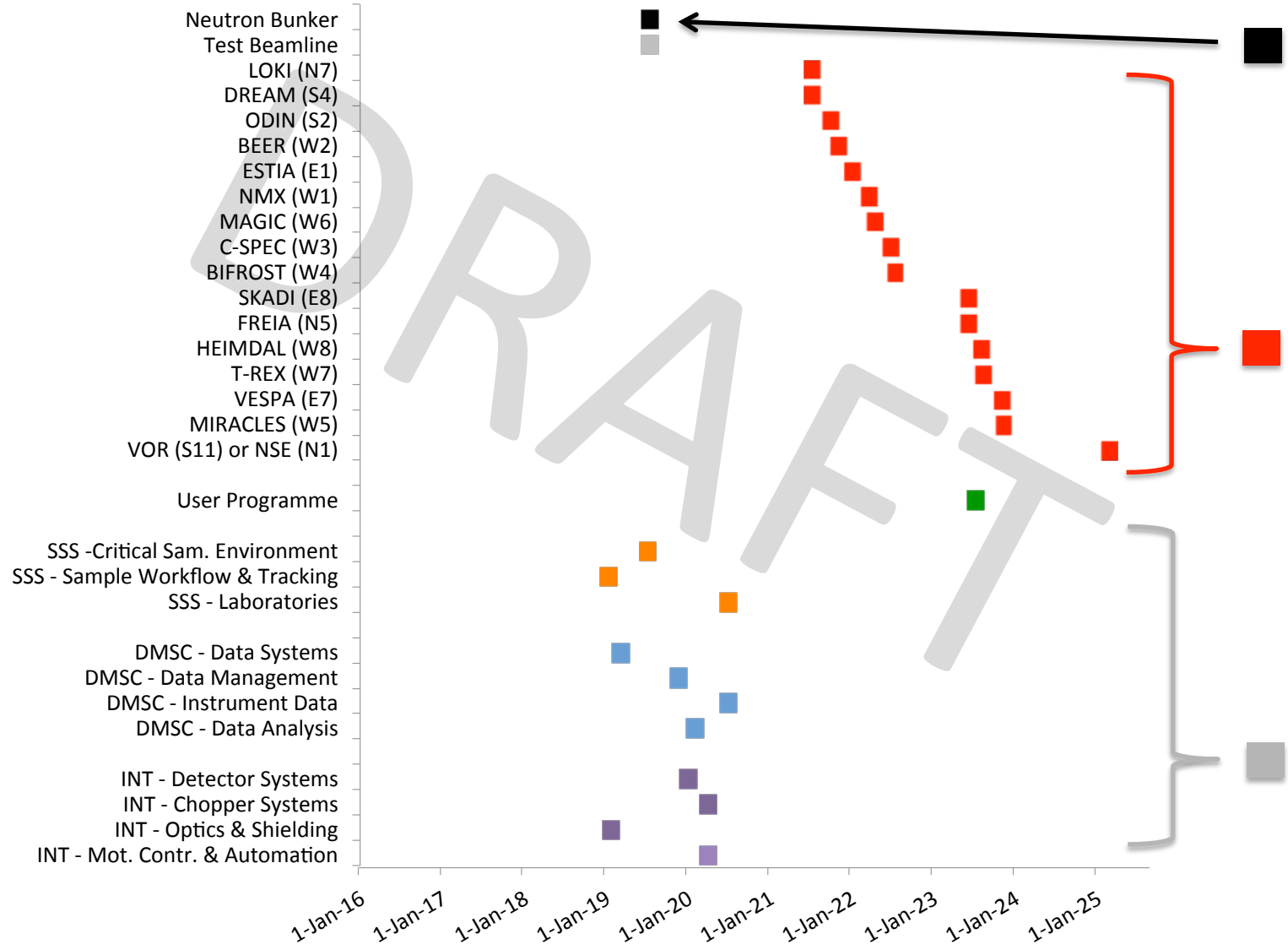

Bunker needs to be ready for Hot Commissioning to allow ESS to start producing neutrons

Start of Hot Commissioning activities on instruments using neutrons

Scope delivered to enable cold commissioning of instrument construction projects

Potential order of commencement of operation of first 8 instruments (August 2023)

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2nd Annual Review Recommendation (0.5)

Prioritisation of instruments within budget must ensure that the first tranche of instruments (8) is ready to deliver world-class science at the start of user operations (2023)

Matching early success in delivery of scientific outputs with the capacity of Lead In-Kind partners to deliver on schedule (ISIS, PSI, FZJ, LLB, HZG/NPI, TUM/PSI, TUM/LLB & DTU lead consortium).

Instrument Class	Sub-class	Candidates
Large Scale Structures	Small Angle Scattering	**LOKI (ISIS)** or **SKADI** (FZJ)
	Reflectometry	**ESTIA (PSI)** or FREIA (ISIS)
Diffraction	Powder Diffraction	**DREAM (FZJ)** or HEIMDAL (ÅU)
	Single crystal diffraction	**MAGIC (LLB)** or NMX (ESS)
Engineering	Strain scanning	**BEER (HZG/NPI)**
	Imaging and tomography	**ODIN (TUM/PSI)**
Spectroscopy	Direct Geometry	**C-SPEC (TUM)** or T-REX (FZJ)
	Indirect Geometry	**BIFROST (DTU)**, MIRACLES (Bilbao), VESPA (CNR)

Instruments in Bold type to be operational by Aug 2023

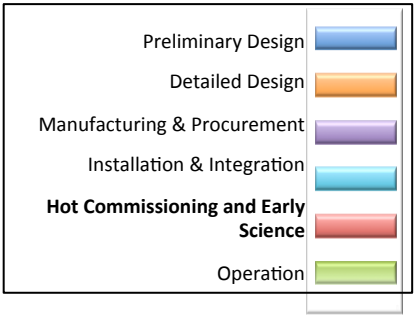
Neutron Beam Instrument Draft Schedule

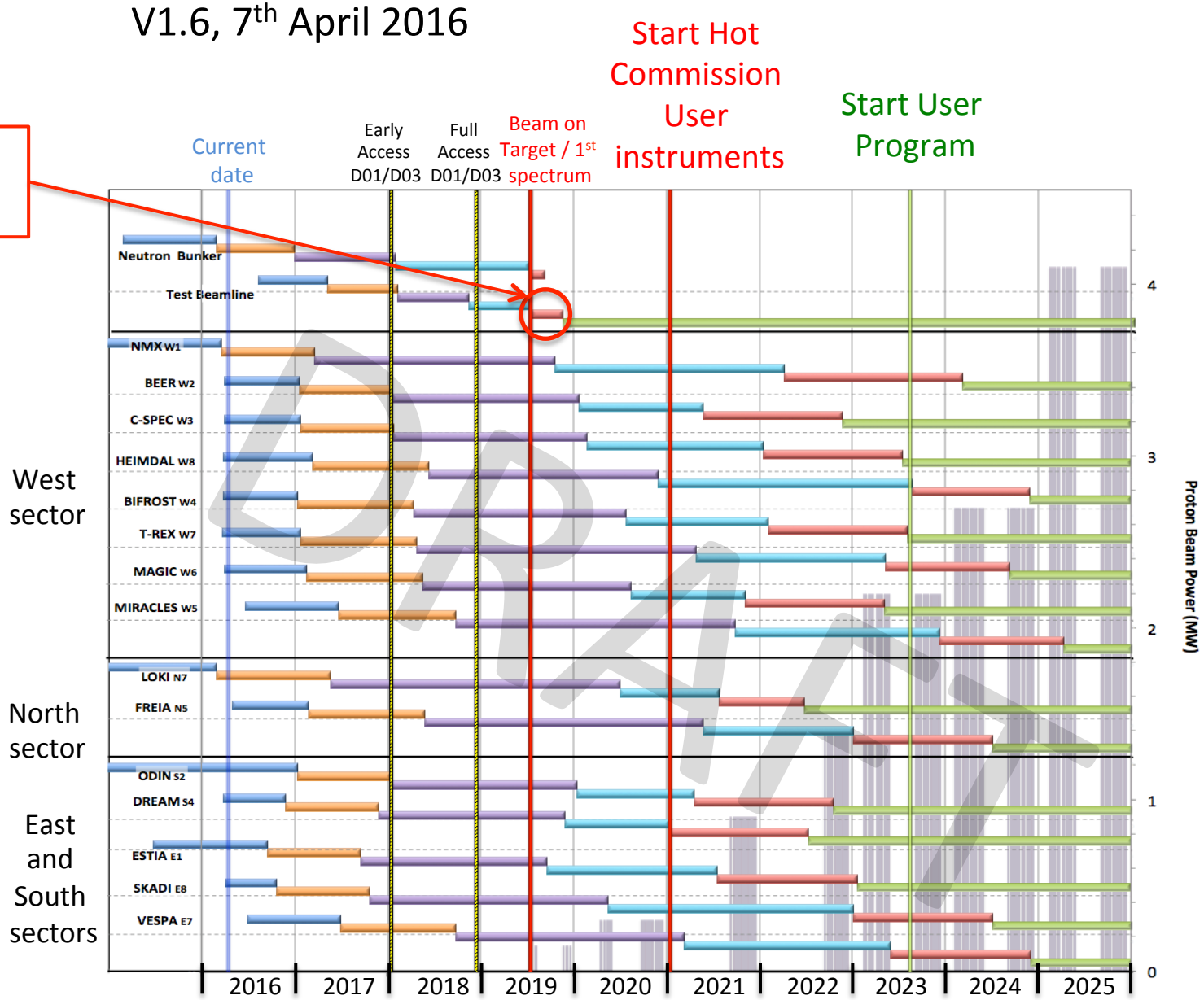
V1.6, 7th April 2016

Commissioning of test beam – to demonstrate performance and inform instrument projects

Notes;

- The order of completion 1- 8 chosen for science and deliverability
- Shift 9-16 to focus on 1-8 for early science success
- Hot Commissioning start;
  - E ≥ 200 MeV
  - P ≥ 200 kW
  - January 2021





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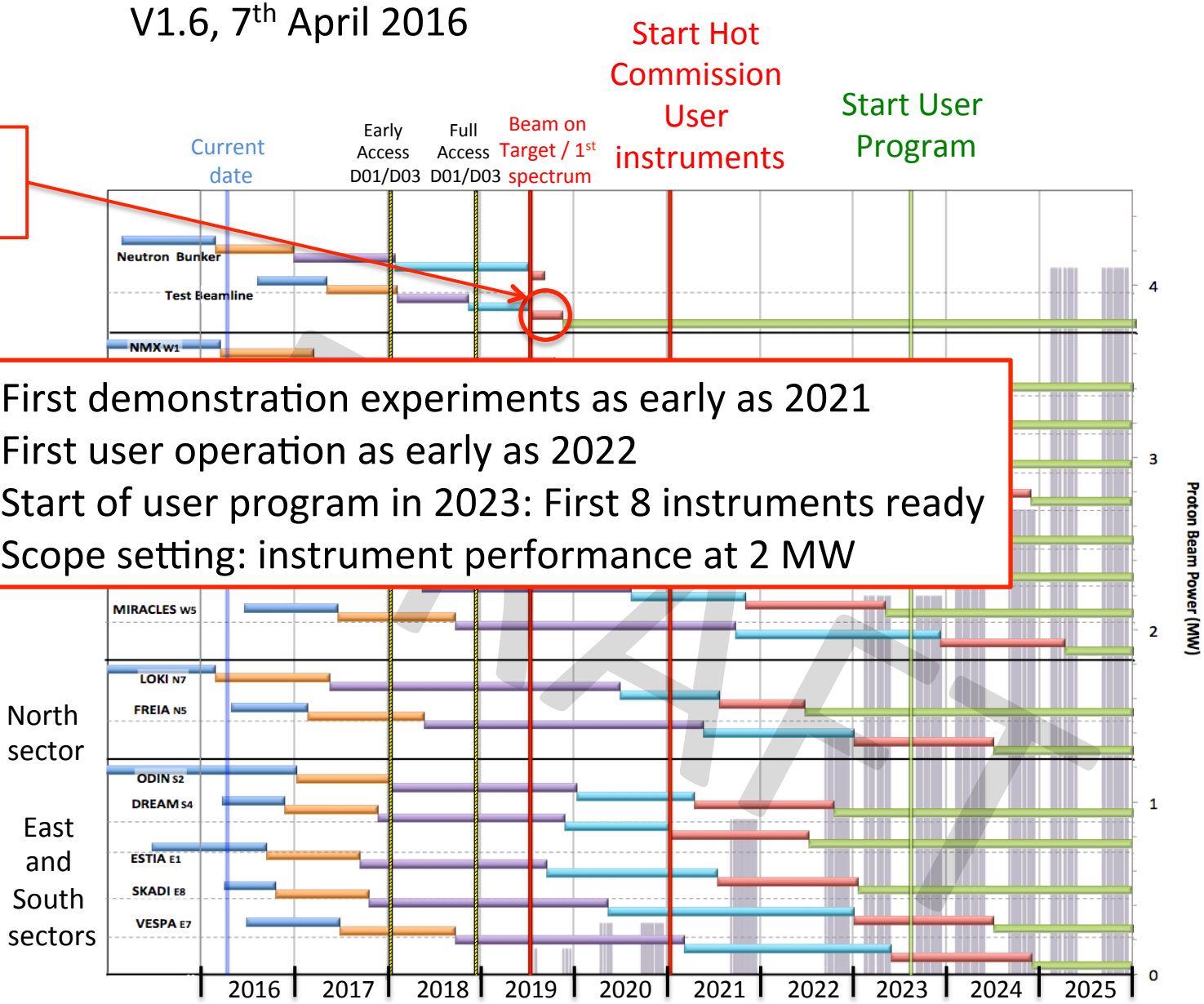

First demonstration experiments as early as 2021
First user operation as early as 2022
Start of user program in 2023: First 8 instruments ready
Scope setting: instrument performance at 2 MW

Notes;

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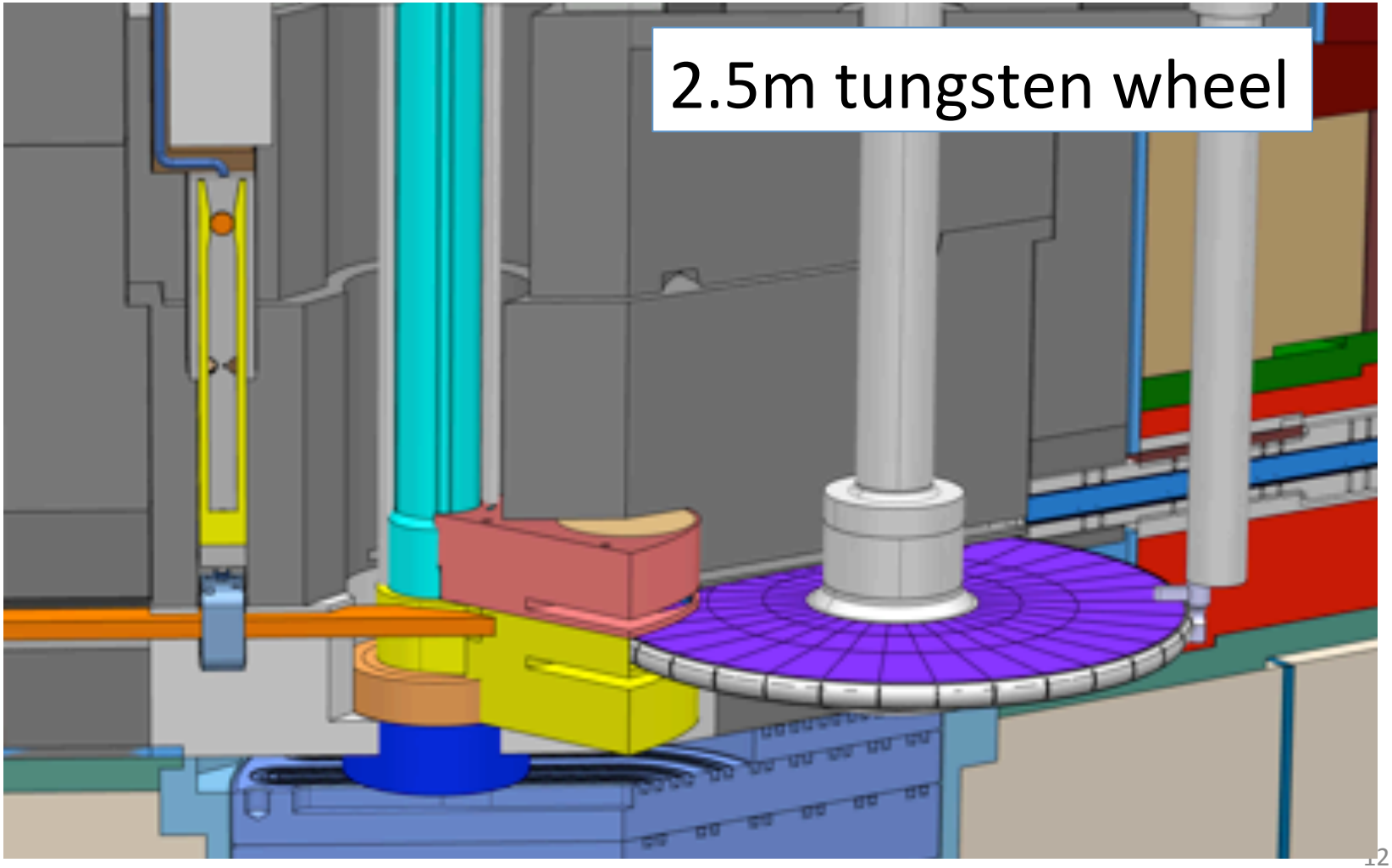
- Shift 9-16 to focus on 1-8 for early science success
- Hot Commissioning start;
  - E ≥ 200 MeV
  - P ≥ 200 kW
  - January 2021

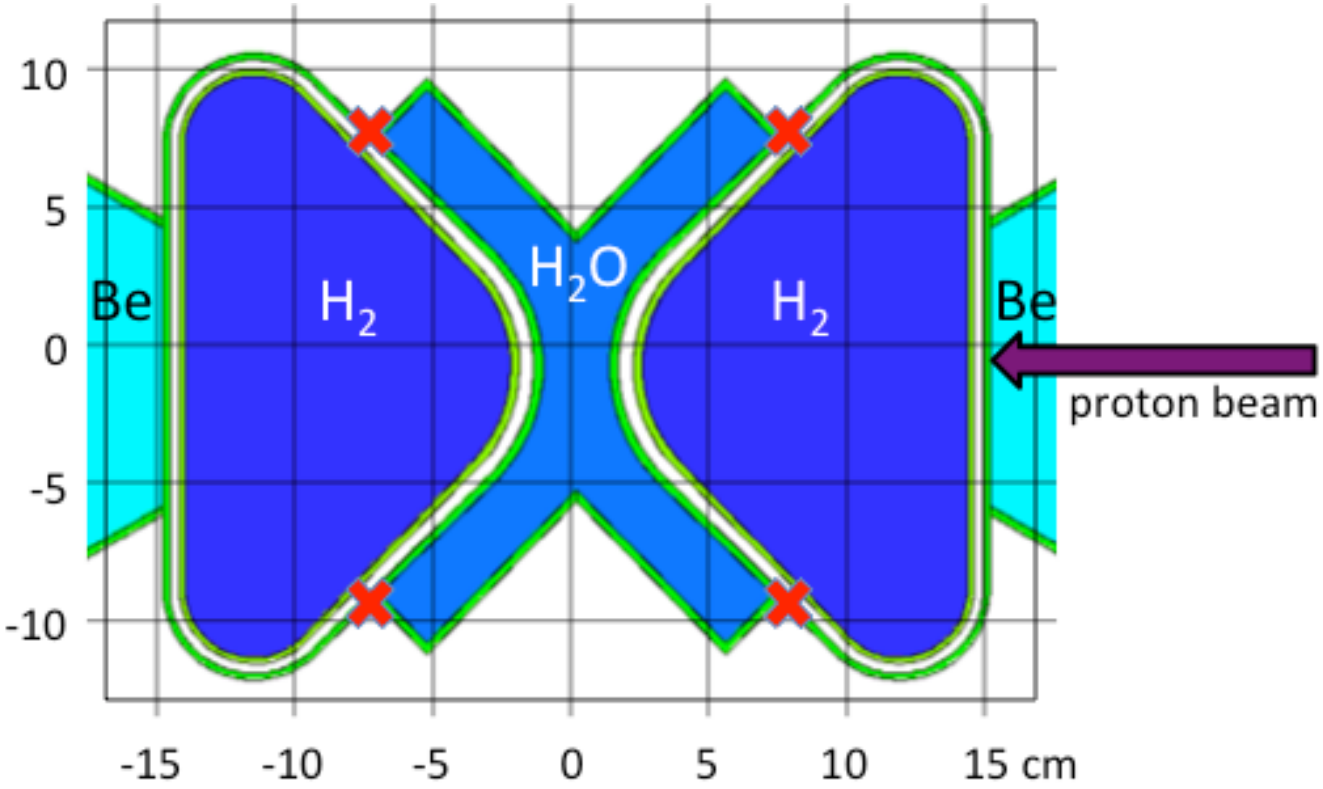
Preliminary Design
Detailed Design
Manufacturing & Procurement
Installation & Integration
Hot Commissioning and Early Science
Operation

ESS target assembly



Moderator Baseline: Butterfly

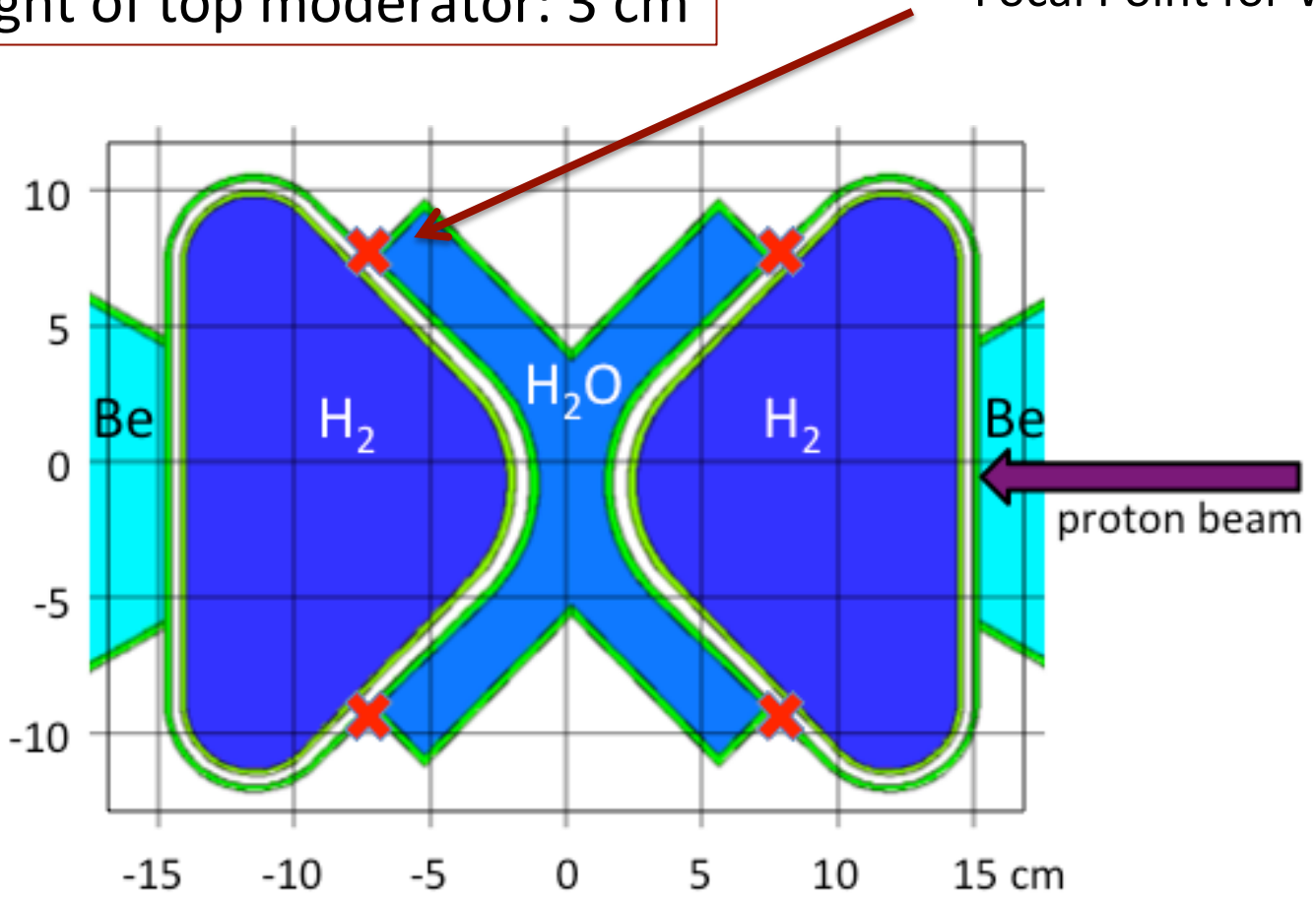
Height of top moderator: 3 cm



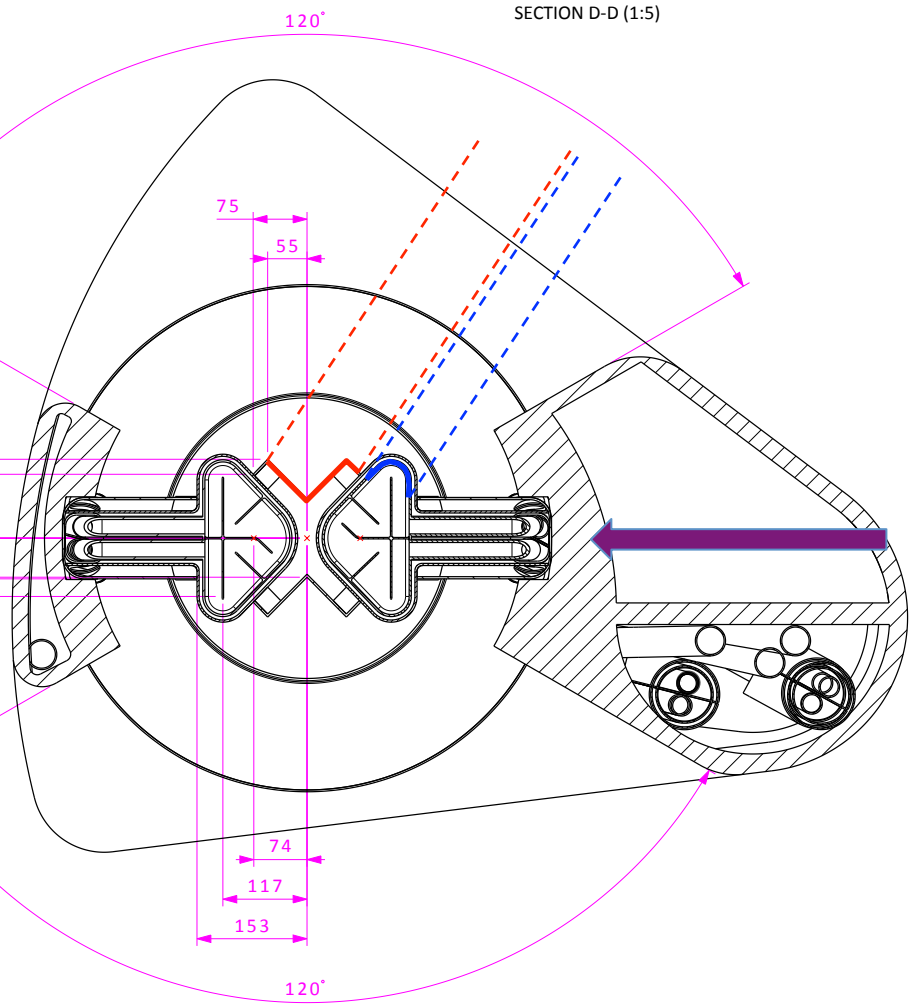
Moderator Baseline: Butterfly

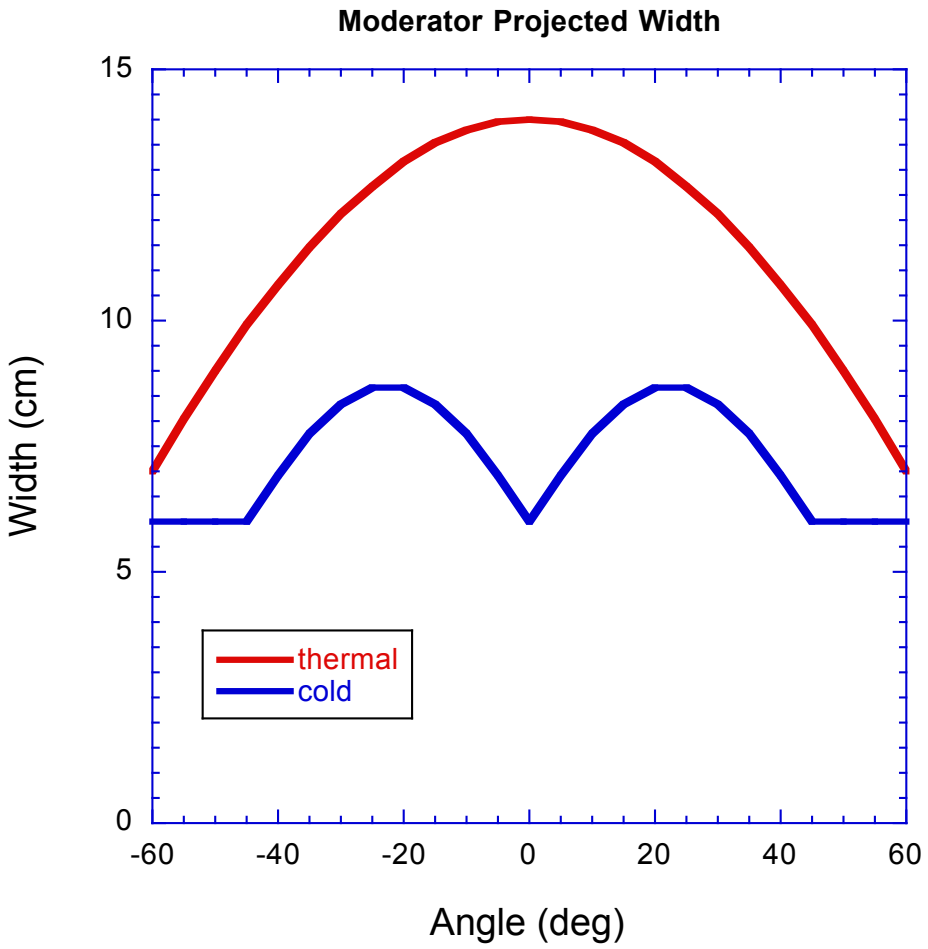
Height of top moderator: 3 cm

Focal Point for West sector

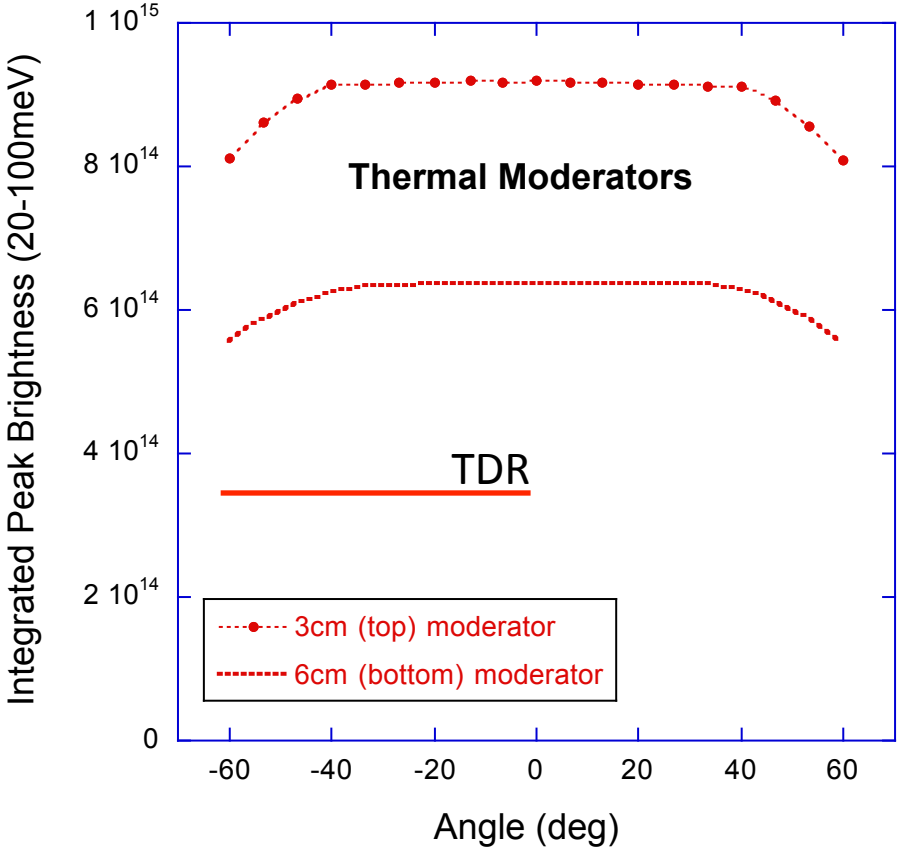


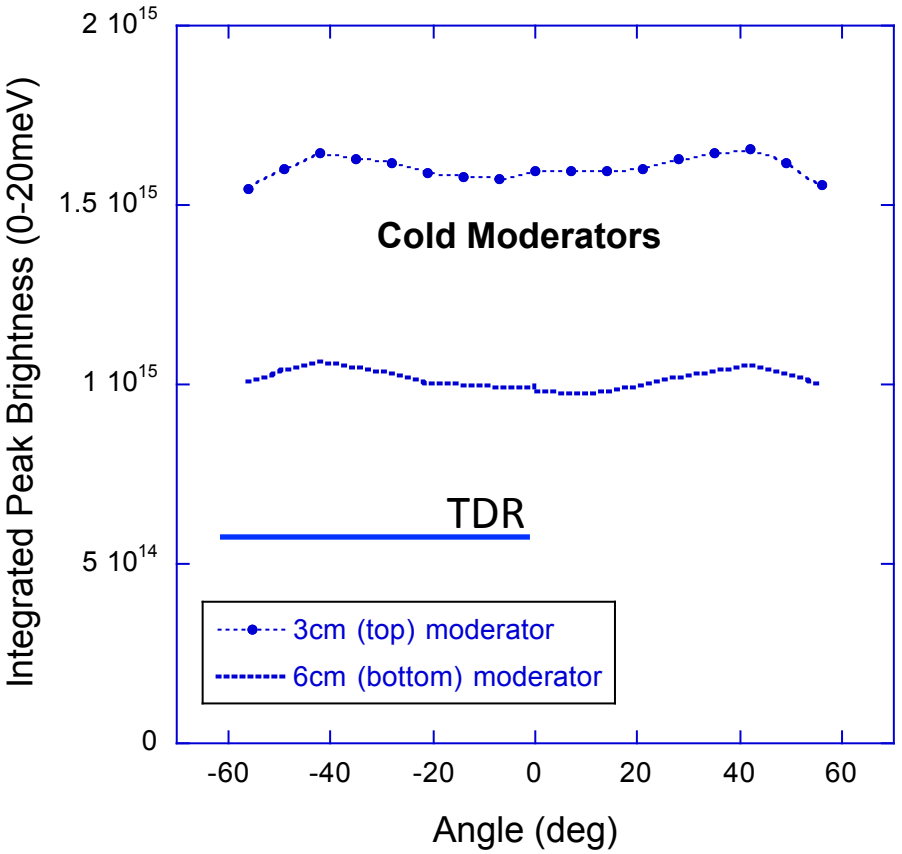
Moderator Baseline: Butterfly





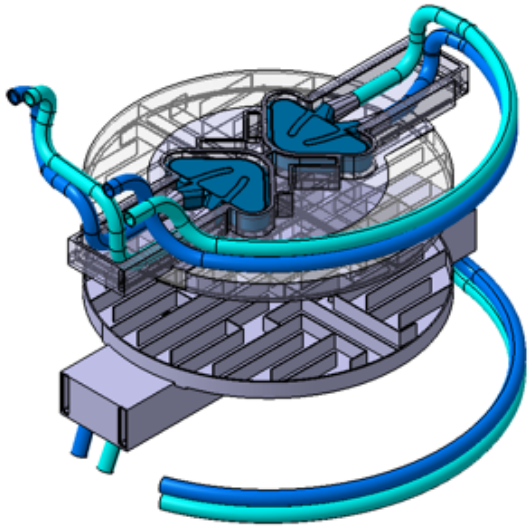
Moderator Brightness





Comparison of ESS moderator options

- ESS concept includes an upper 3 cm high and lower 6 cm high version of the butterfly moderator
- Most (~80 %) of funded neutron instruments plan to view top moderator, due to its higher brightness
- The other instruments plan to use lower moderator due to its higher area-integrated brightness



Could the neutron instruments perform as well (or better) viewing the upper moderator?

Comparing moderator options;
(L. Zanini & F. Mezei)

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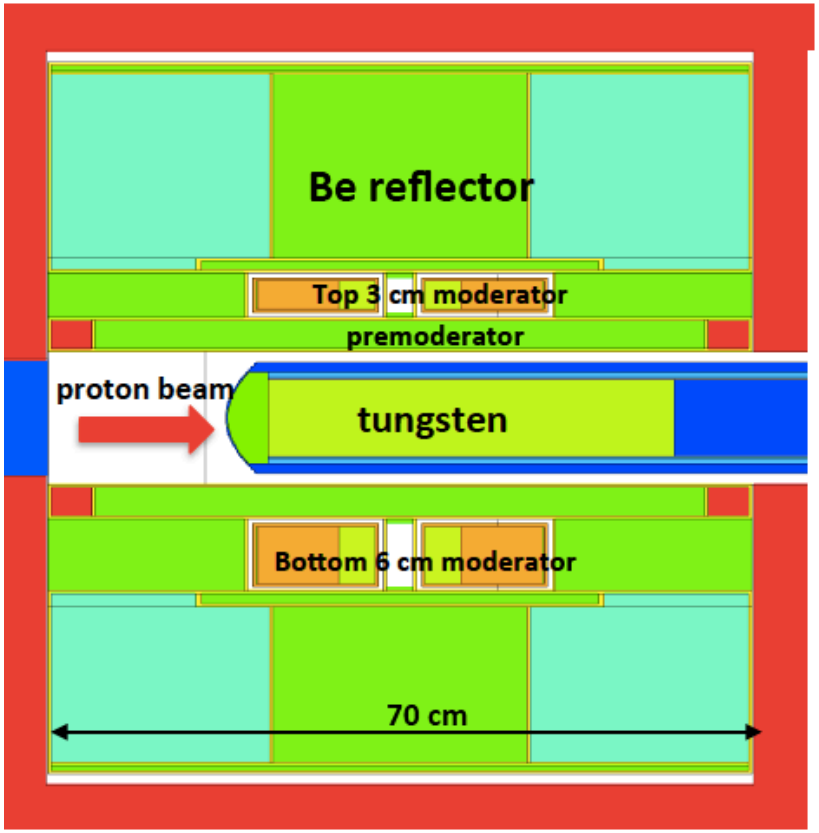
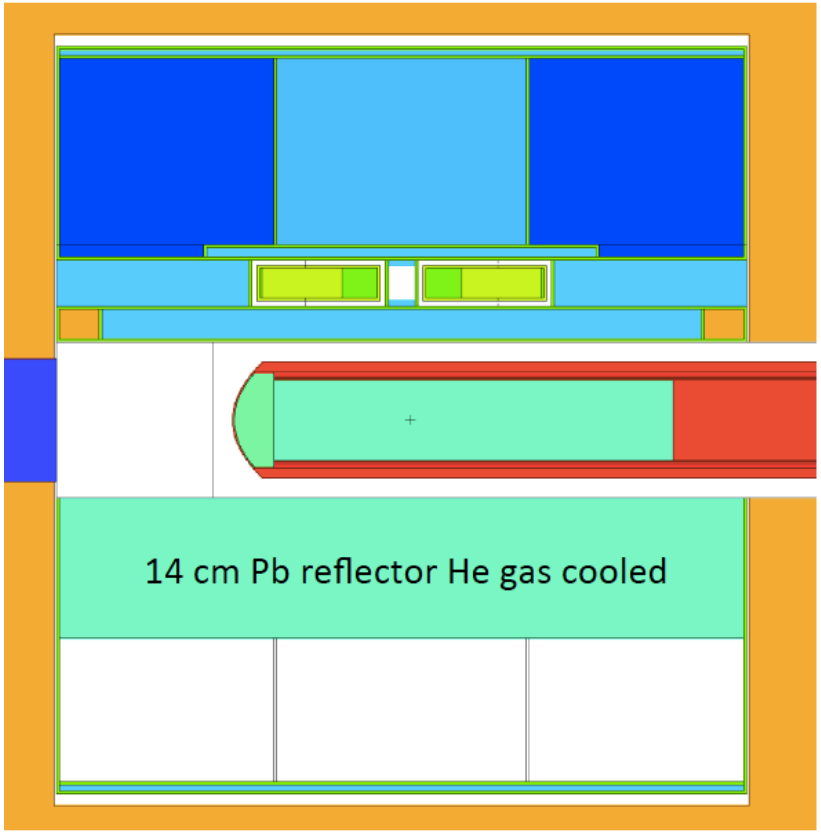


Current design;

3 cm upper + 6 cm lower moderator



Alternate design;

3 cm upper moderator + 14 cm lower reflector

Comparing calculated source brightness

Configuration	moderator	Relative brightness (n/cm²/s/sr/Å)	
		cold neutrons	thermal neutrons
Current design; 3 cm upper + 6 cm lower moderator	upper	1.00	1.00
	lower*	0.64	0.70
Alternate design; 3 cm upper moderator + lower reflector	upper	1.17	1.15

* Relative area-integrated brightness of the lower moderator scales in proportion to its height (x 2)

Can the beam transport system of the concerned neutron instruments be optimized to take advantage of the brighter single upper moderator?

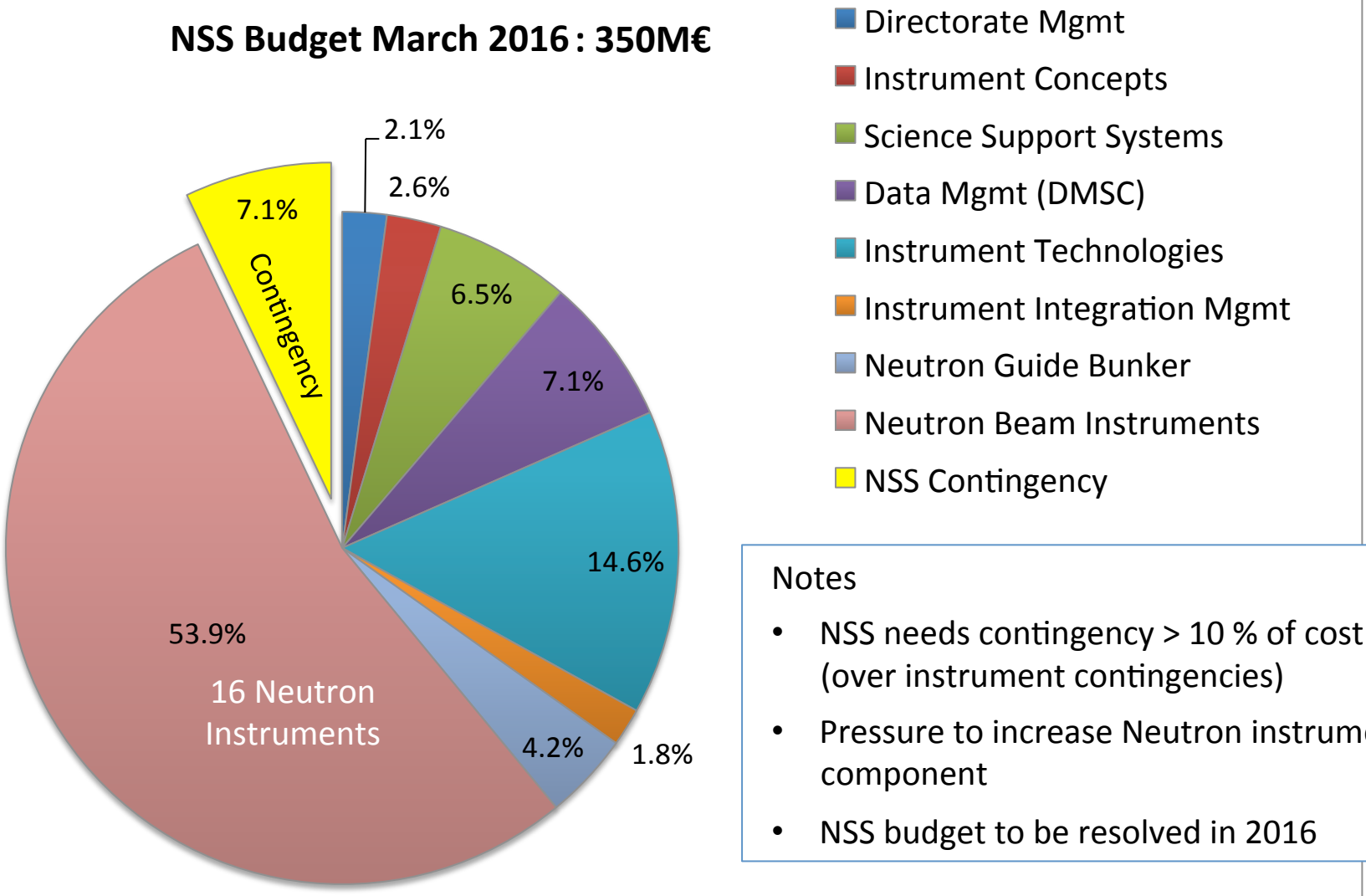
- For ODIN & HEIMDAL, the conclusion is Yes
- For MIRACLES, the conclusion is most probably

Table derived from ESS internal report by F. Mezei, 18 Nov. 2015

Two-moderator decision

- The two moderators provide similar performance for the planned suite of instruments, offering limited flexibility
- Average performance of the facility increases by > 10 % by replacing the lower moderator by a neutron reflector (Ni, Pb or W),
- This change has been estimated to save >1.5 M€/year in operation
- Installation of the lower moderator now would block/Make expensive (20 – 40 M€ In repositioning/replacement of lower moderator Instruments) the life cycle flexibility of ESS benefitting from future moderator upgrades
  - Possible future developments: e.g. very cold neutrons, Maximum brightness moderator for small phase space instruments, more directional moderator…
  - Primary upgrade path is more instruments on the main target station

Neutron Scattering Systems Budget



Notes

- NSS needs contingency > 10 % of cost to complete (over instrument contingencies)
- Pressure to increase Neutron instrument component
- NSS budget to be resolved in 2016

NSS Internal WP scope setting (2015 & 2016) -changes

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NSS has worked hard to shift budget/ resources into priority areas for early science success;

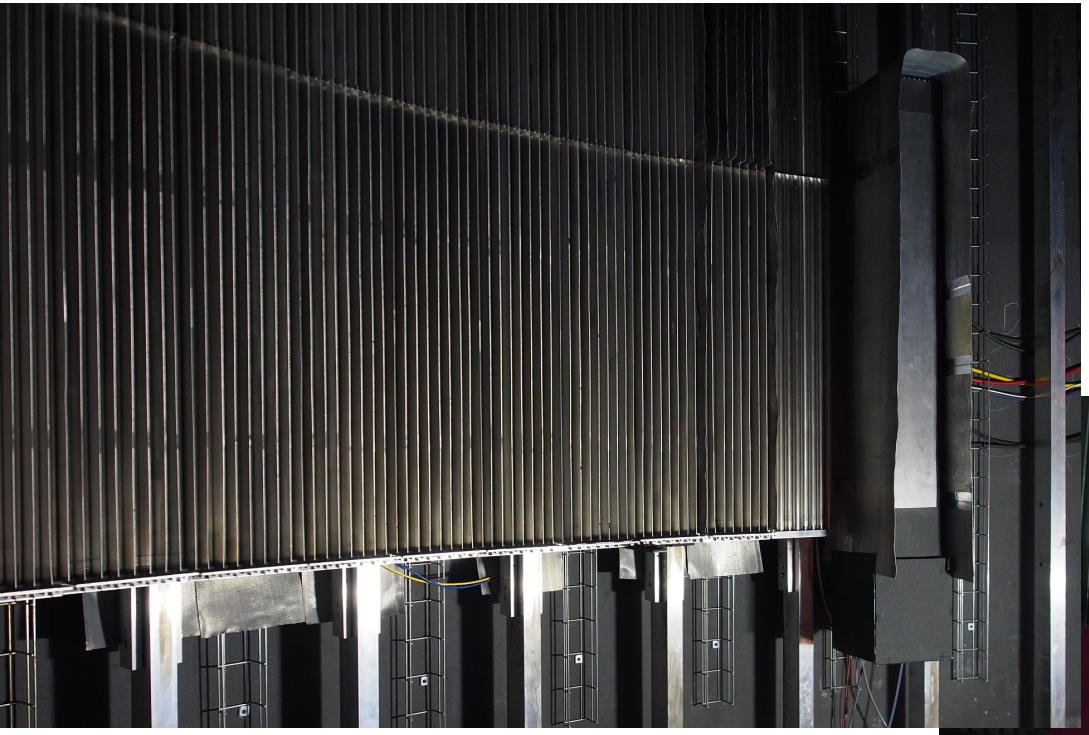
Work Package	Budget - Sept 2016 (k€)	*Change from 2014*
13.1 Management & Administration	**5,580**	*-11%*
13.2 Instrument Concepts	**6,167**	*-36%*
13.3 Science Support Systems	**20,569**	*-12%*
13.4 DMSC	**20,072**	*-25%*
13.5 Instrument Technology	**49,128**	*-27%*
13.6 Instrument Construction	**213,706**	*13%*
13.6.1 Management & Admin	**10,392**	*30%*
13.6.2 Guide Bunker	**14,600**	*N/A*
13.6.3-X Instruments 1-16	**188,714**	*4%*
13.7 NSS Contingency	**34,778**	*26%*
NSS Total	350,000	

- Notes;
  - 10.46 MEUR shifted to 13.7 and 13.6 in summer 2016
  - NSS contingency now at 11 % of cost to complete
  - Bunker provisional budget set in Aug 2015 – currently being re-costed

Publication of instrument papers

- All instrument designs should be published
- Proposal: special issue of Journal of Applied Crystallography
  - instrument description after phase 1 completion
    - basic science case
    - instrument design
    - performance calculations
    - comparison to other instruments
  - publication during 2017
  - feedback on Friday, please

$^{10}B_4C$ Multi-Grid detector test at CNCS (SNS)



Detector shielded with
boron and cadmium

Exciting results!
Talk on Thursday at 15:30

Installation completed!
Detector inaccessible
for next 6 months

Status of Neutron Scattering Systems

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- moved from instrument selection to construction
  - 15 instruments in construction
- all major in-kind partners now actively participating
- STAPs have been restructured
- beamport allocations made
- licensing application submitted
  - first step of process towards full operational license
- finalising key technical components
  - common shielding bunker
  - monolith beam extraction inserts
  - light shutters
  - civil engineering
- ramp-up of planning for operations
- John Womersley will replace Jim Yeck as Director General in November

Budget summary,
(with comparison to 2014 budgets)

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Work Package	Budget on 24 May (k€)	Change from 24 May Budget **(k€)**	**Budget at 6 Sept 2016 (k€)**	*Change from CURRENT Budget (%)*	*Change from 2014 (%)*
13.1 Management & Administration	7,448	-1,868	**5,580**	-25%	*-11%*
13.2 Instrument Concepts	6,167	0	**6,167**	0%	*-36%*
13.3 Science Support Systems	22,769	-2,200	**20,569**	-10%	*-12%*
13.4 DMSC	25,022	-4,950	**20,072**	-20%	*-25%*
13.5 Instrument Technology	51,228	-2,100	**49,128**	-4%	*-27%*
13.6 Instrument Construction	211,486	2,220	**213,706**	1%	*13%*
13.6.1 Management & Admin	8,172	2,220	**10,392**	27%	*30%*
13.6.2 Guide Bunker	14,600	0	**14,600**	0%	*N/A*
13.6.3-X Instruments 1-16	188,714	0	**188,714**	0%	*4%*
13.7 NSS Contingency	25,880	8,898	**34,778**	34%	*26%*
NSS Total	350,000	0	350,000		
Contingency as % of cost to complete		**11.2%**	Float (k€)	3,778	

Instrument Budgets

- 16-instrument budget: 188.9M€
  - sum of proposal budgets: 250M€
- day one scope < full scope
- increase budget per instrument?
  - cost savings in other parts of NSS: 1M€/instrument = 20% cut
  - (day one instruments need adequate sample environment,labs, software, detectors, etc.)
  - fewer instruments?
- better understanding of shielding cost
- day one version must allow early scientific success
- funding for upgrades will be included in initial operations budget (to be proposed to council)
  - 25M€ for upgrades + 17.5M€ for hot commissioning of instruments 1-16
  - 85M€ for construction + 6.4M€ for hot commissioning of instruments 17-22
  - 3.3M€/year for instrument spares