NSS Project update

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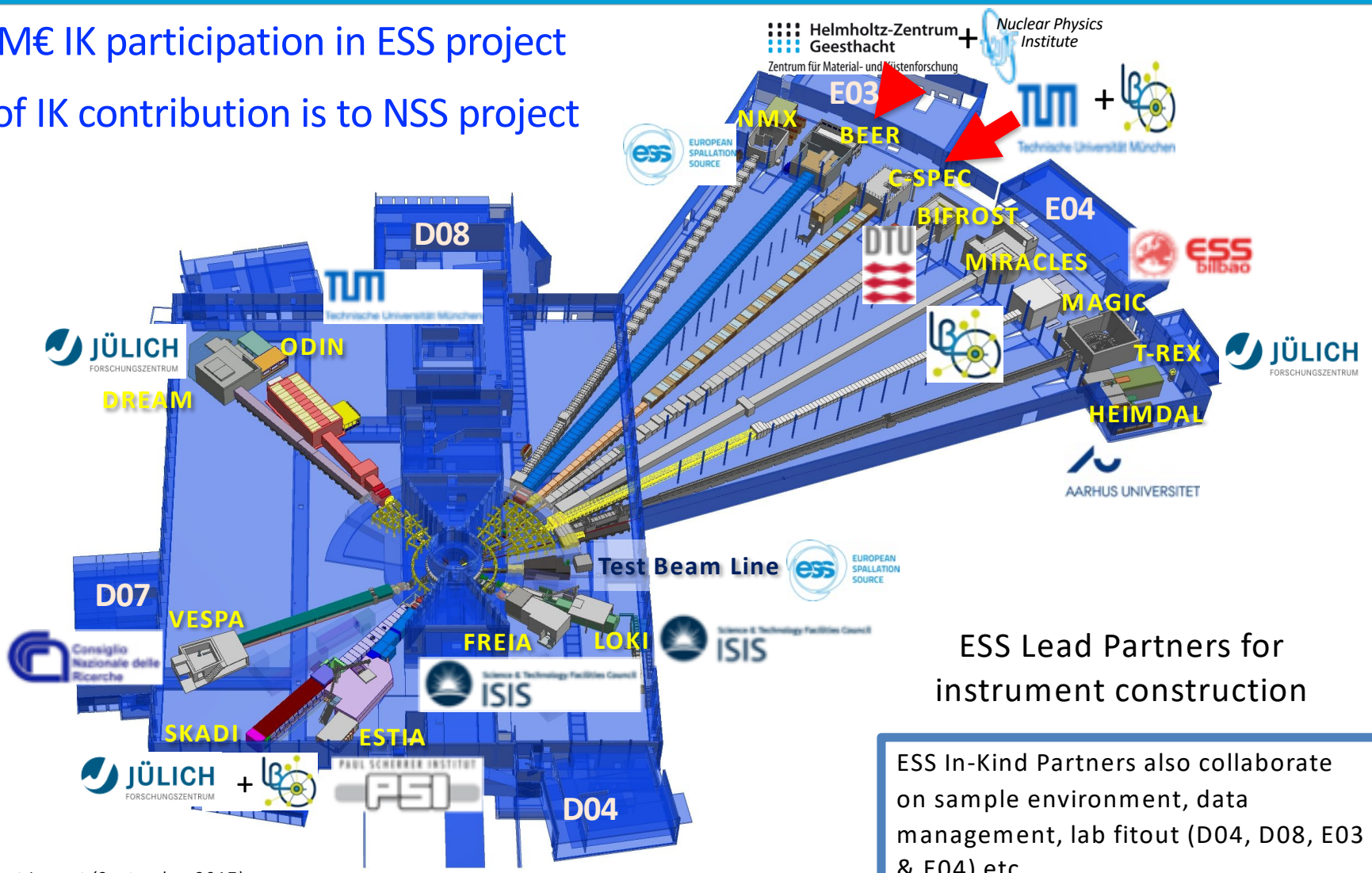
www.europeanspallationsource.se

IKON 15, 10 September 2018

NSS Project scope: *15 neutron instruments + test beamline + support labs*

~ 700 M€ IK participation in ESS project

~ 1/3 of IK contribution is to NSS project



ESS Instrument Layout (September 2017)

ESS Lead Partners for instrument construction

ESS In-Kind Partners also collaborate on sample environment, data management, lab fitout (D04, D08, E03 & E04) etc.

Schedule Rebaselining Overview

Delays from SEC/CF in various areas

12th April 2018

- Agreed on new dates with CF (April 12th), basis for this presentation
- Delays in the order of 12-17 months compared with current baseline

Building	Typ		Description	Building Lvl	2018-03-12, rev 4
D01	n/a	Level 1b	Bunker Crane operational (access to be coordinated)		15/Dec/19
	PA	Level 1b	Parallel Access Experimental Hall - weathertight building		17/Nov/20
	PA	Level 1b	Parallel Access Experimental Hall - Bunker Access		25/Feb/21
	PA	Level 1b	Parallel Access Experimental Hall - Instrument Access		3/Jun/21
	n/a	Level 1b	Experimental Hall Overhead Crane operational		26/Jul/21
D03	n/a	Level 1b	Bunker Crane operational (access to be coordinated)		15/Dec/19
	PA	Level 1b	Parallel Access Experimental Hall - weathertight building		5/Aug/20
	PA	Level 1b	Parallel Access Experimental Hall - Bunker Access		3/Nov/20
	PA	Level 1b	Parallel Access Experimental Hall - Instrument Access		18/Jan/21
	n/a	Level 1b	Experimental Hall Overhead Crane operational		15/Feb/21
D08	PA	Level 1b	RML Lab Access	Level 1	21/Aug/20
D01	SH	Level 1	Sectional Handover D01		25/Jan/22
D02	SH	Level 1	Sectional Handover D02		28/Jan/22
D03	SH	Level 1	Sectional Handover D03		16/Aug/21
D04	SH	Level 1	Sectional Handover D04		04-May-20
D05	SH	Level 1	Sectional Handover D05		1/Apr/19
D06	SH	Level 1	Sectional Handover D06		14/Aug/20
D07	SH	Level 1	Sectional Handover D07 Basement		15/Aug/19
D08	SH	Level 1	Sectional Handover D08		26/Feb/21
E02 part 1	PA	Level 1b	Parallel Access E02 part 1		15/Aug/19
E02 Part 2	PA	Level 1b	Parallel Access E02 part 2		10-May-21
E03 Lab	PA	Level 1b	Parallel Access Sample Environment lvl 110	lvl 110	19/Mar/19
E03 Lab	PA	Level 1b	Parallel Access Optics	lvl 100	28/Nov/16
E03 Lab	PA	Level 1b	Parallel Access Sample Environment lvl 100	lvl 100	21/Feb/19
E04 Lab	PA	Level 1b	Parallel Access Chem/Phys lvl 110	lvl 110	19/Sep/16
E04 Lab	PA	Level 1b	Parallel Access LS & SCM Basic prep	lvl 100	18-Oct-18
E04 Lab	PA	Level 1b	Parallel Access LS & SCM Instrument mgm	lvl 100	25-Oct-18
E04 Lab	PA	Level 1b	Parallel Access Physical C Room	lvl 100	7/Nov/18
E01	SH	Level 1	Sectional Handover E01		15/Aug/19
E02	SH	Level 1	Sectional Handover E02		13/Sep/21
E03	SH	Level 1	Sectional Handover E03		16/Dec/19
E04	SH	Level 1	Sectional Handover E04		2/Dec/19
E05	SH	Level 1	Sectional Handover E05		15/Aug/19

Pictorial interpretation of NSS dependencies on following slides

Science Directorate re-baseline major MS

(based on CF building access dates of 12th April)

Hot commissioning MS

NSS ready for Beam on Target (BOT) on 7 July 2022, with Test beam line and 1 or more user instruments ready for hot commissioning

User operations MS

A. Three user instruments be ready to start operation by end of 2023.

B. First eight instruments ready to start operation by end of 2024.

C. All fifteen instruments ready to start operation by end of 2026.

Major schedule delays compared to 2016 Baseline:

Beam on Target (BOT)	= 21 months
Beam on 1st Instrument	= 17 months
Eight Instrument into User Program	= 16 months
NSS project completion	< 12 months

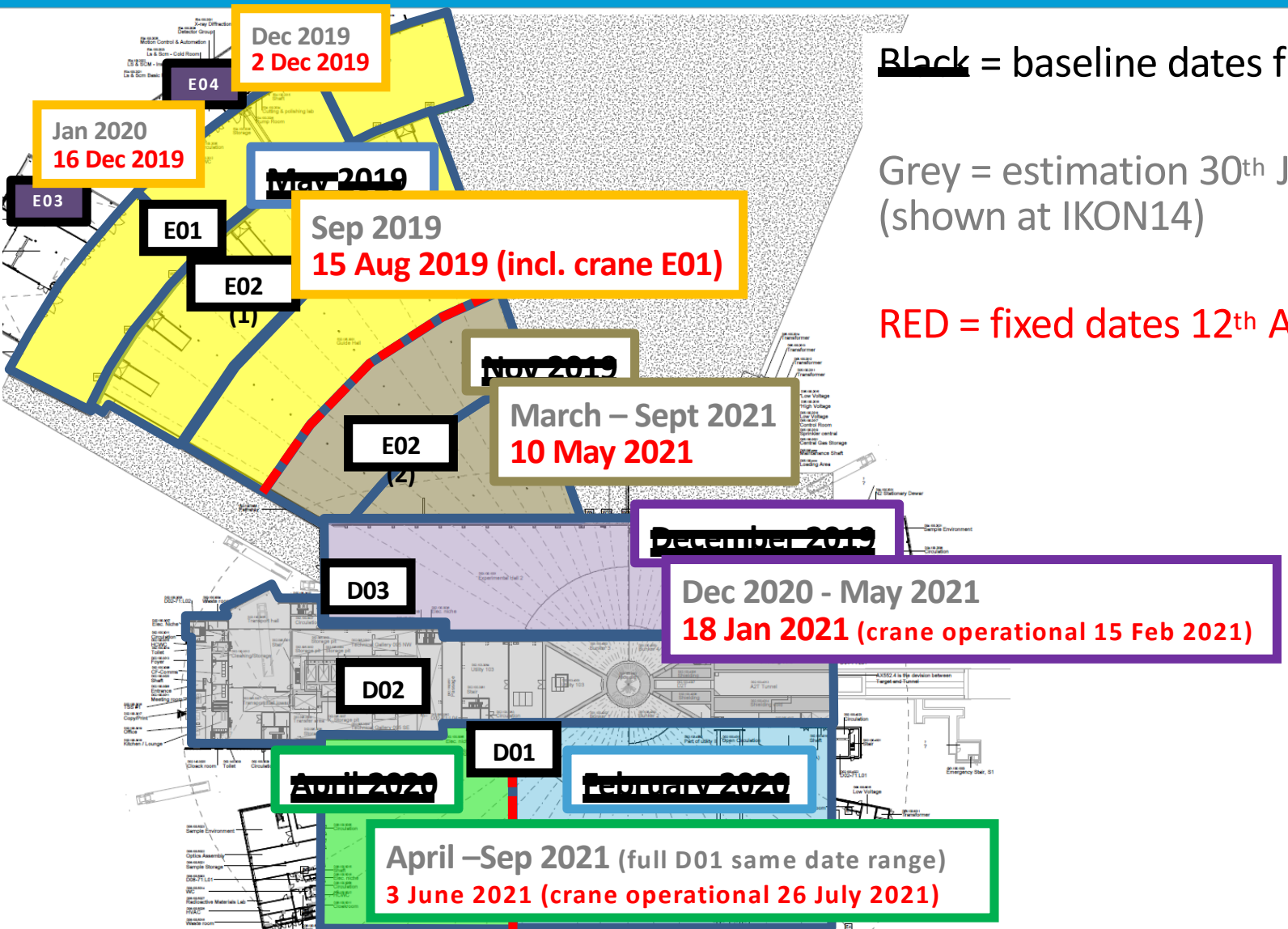
Preserved milestones:

Start of user program (SOUP) in 2023	*(with zero float)*
NSS project completion in 2025	*(also with zero float).*

Key Schedule dependencies & assumptions – Bunker & TD/CF interface

- CF & Target dependencies from agreed dates with CF/SEC (on 12th April)
- Majority of work in instrument hall (Bunker and instruments) will be done before Full Access, with reduced (80%) efficiency, but without increase in timeline b/c this is on critical path for SOUP (planning extra funds for mitigation)
- High degree of parallel work with Skanska & TD – shifts will most likely be needed between projects, and high degree of safety coordination will be required.
- NSS to work through summer holidays for anything on the critical path (i.e. bunker installation + installation and commissioning of early instruments)
  - otherwise assume normal working hours and standard ESS calendar
- Wait for weather tight buildings and floor treatments
- Don't wait for T&C of MEP, but start a bit before (schedule mitigation)

First *out-of-bunker* access dates for Instrument Installation

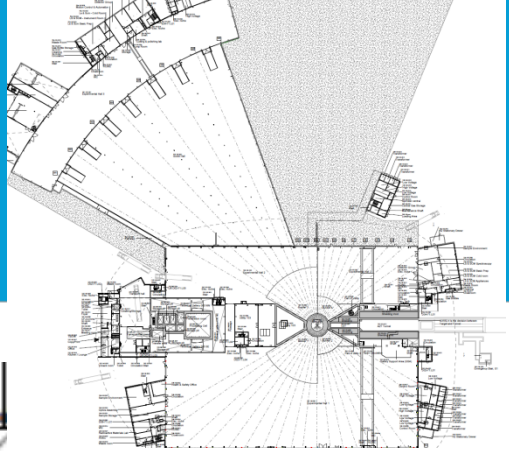


~~Black~~ = baseline dates from 2016

Grey = estimation 30th Jan 2018 (shown at IKON14)

RED = fixed dates 12th April 2018

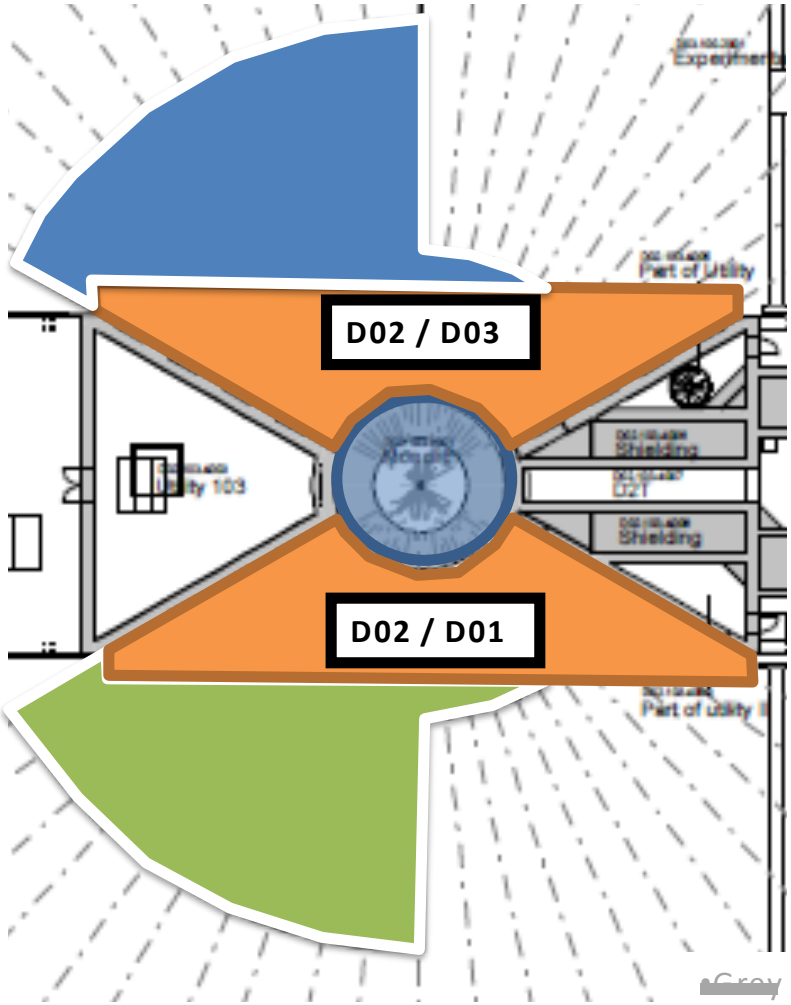
Work area
Access dates - Construction



D03
~~Jun 2019~~ > 3 Nov 2020
Bunker construction

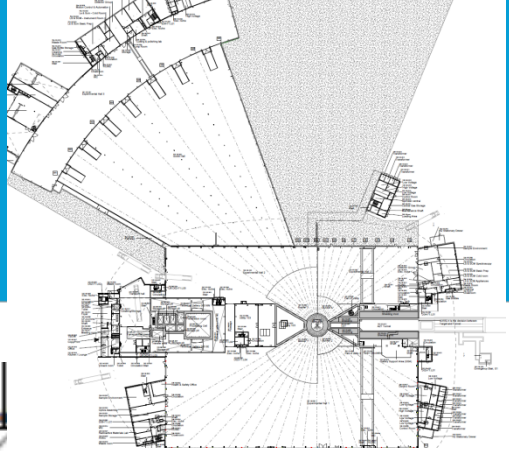
D02
~~Feb 2019~~ > 28 Feb 2020
Start of joint work
(R6, NBOA & LS etc.)

D01
~~Aug 2019~~ > 25 Feb 2021
Bunker construction

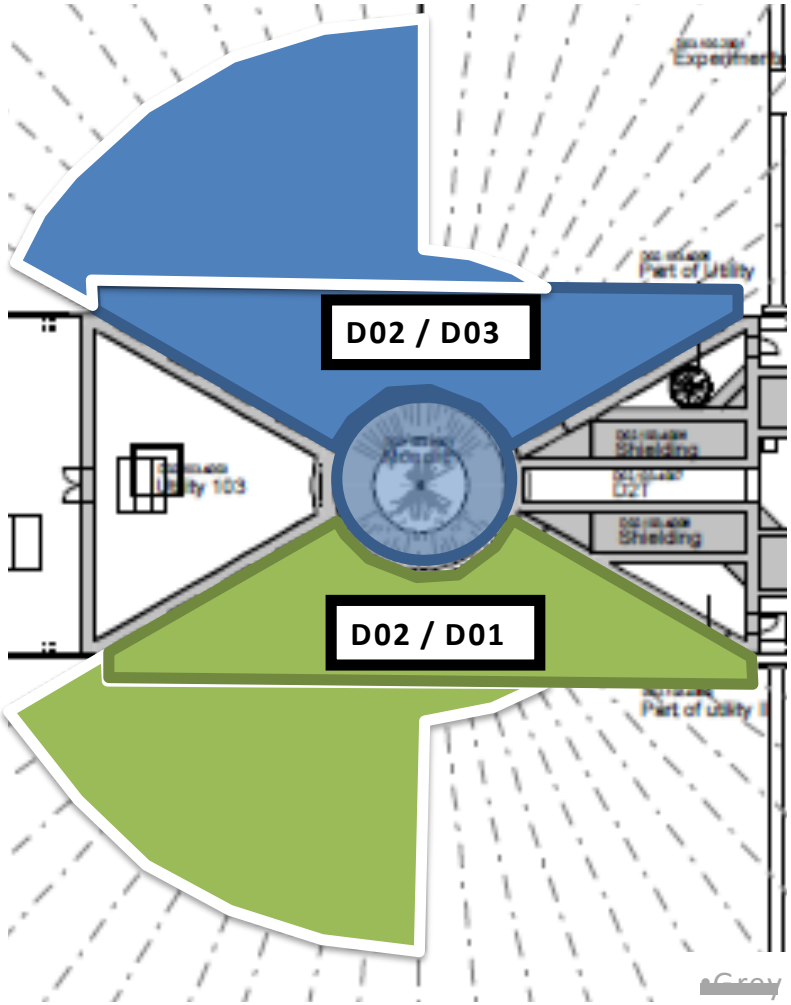


- ~~Grey~~ = baseline dates from 2016
- Black = fixed dates 12th April 2018

Work area
Access dates - Instrument builds



D03 bunker
~~Dec 2019~~ > 9 July 2021

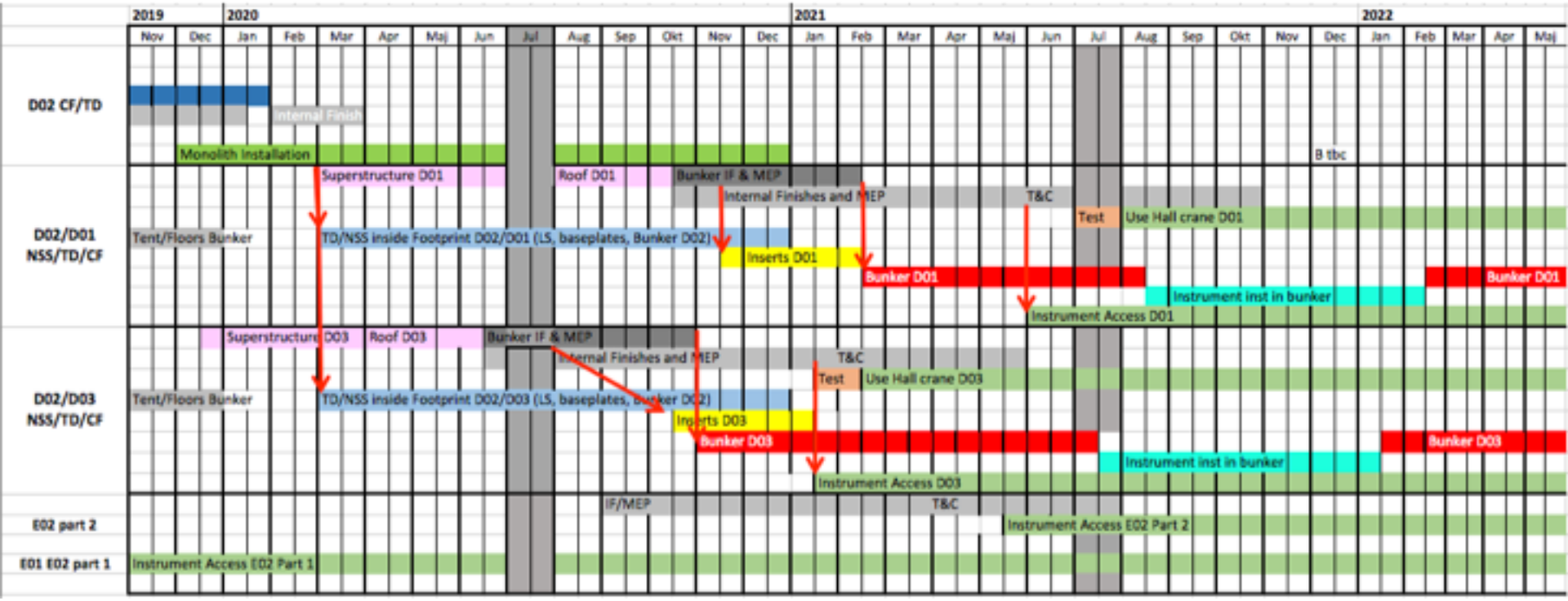


D01 bunker
~~Dec 2019~~ > 25 Aug 2021

- ~~Grey~~ = baseline dates from 2016
- Black = fixed dates 12th April 2018

Planning status – overview CF, TD & NSS

- *parallel work in D & E buildings (Ref: Sofie Ossowski, June 2018)*



Overview illustrating the ongoing work from the SEC, TD and NSS in the main areas D02, D03, D01 and E01/E02.

Red arrows indicates key dependencies/predecessors.

Planned order of commencement of operation of first 8 instruments

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).

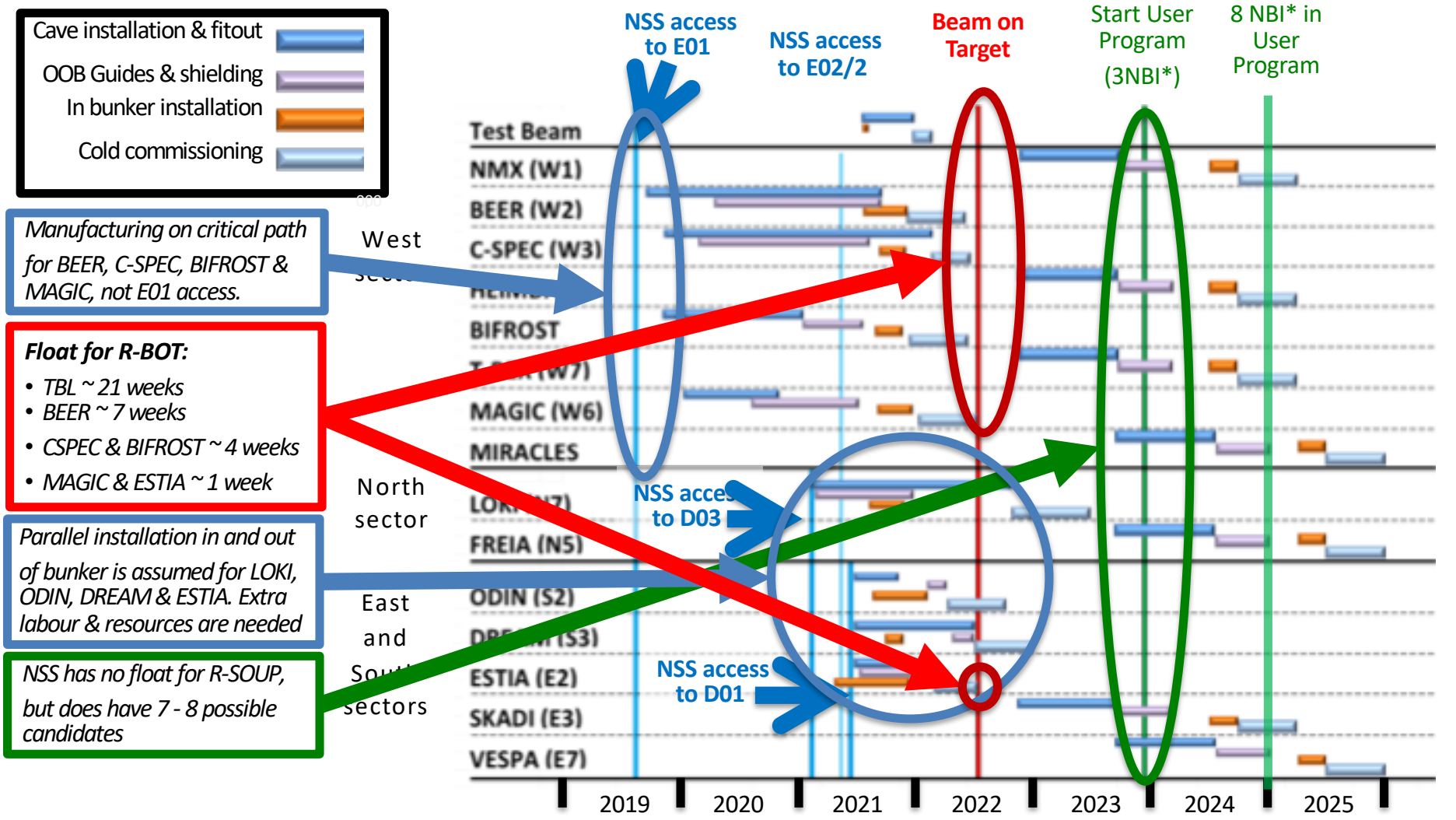
Instruments in **bold type** to be operational by ~~Aug 2023~~ Dec 2024
Italic type indicates backups in case of delays to those in bold type

PRIORITIES UNCHANGED SINCE 2016

Instrument Class	Sub-class	Candidates
Large Scale Structures	Small Angle Scattering	**LOKI (ISIS)** or *SKADI* (FZJ/LLB)
	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/LLB)** or *T-REX* (FZJ)
	Indirect Geometry	**BIFROST (DTU)**, MIRACLES (Bilbao), VESPA (CNR)

Rebaseline schedule for NBI* Installation (TG4 –> TG5) (V4.0, 11th May 2018)

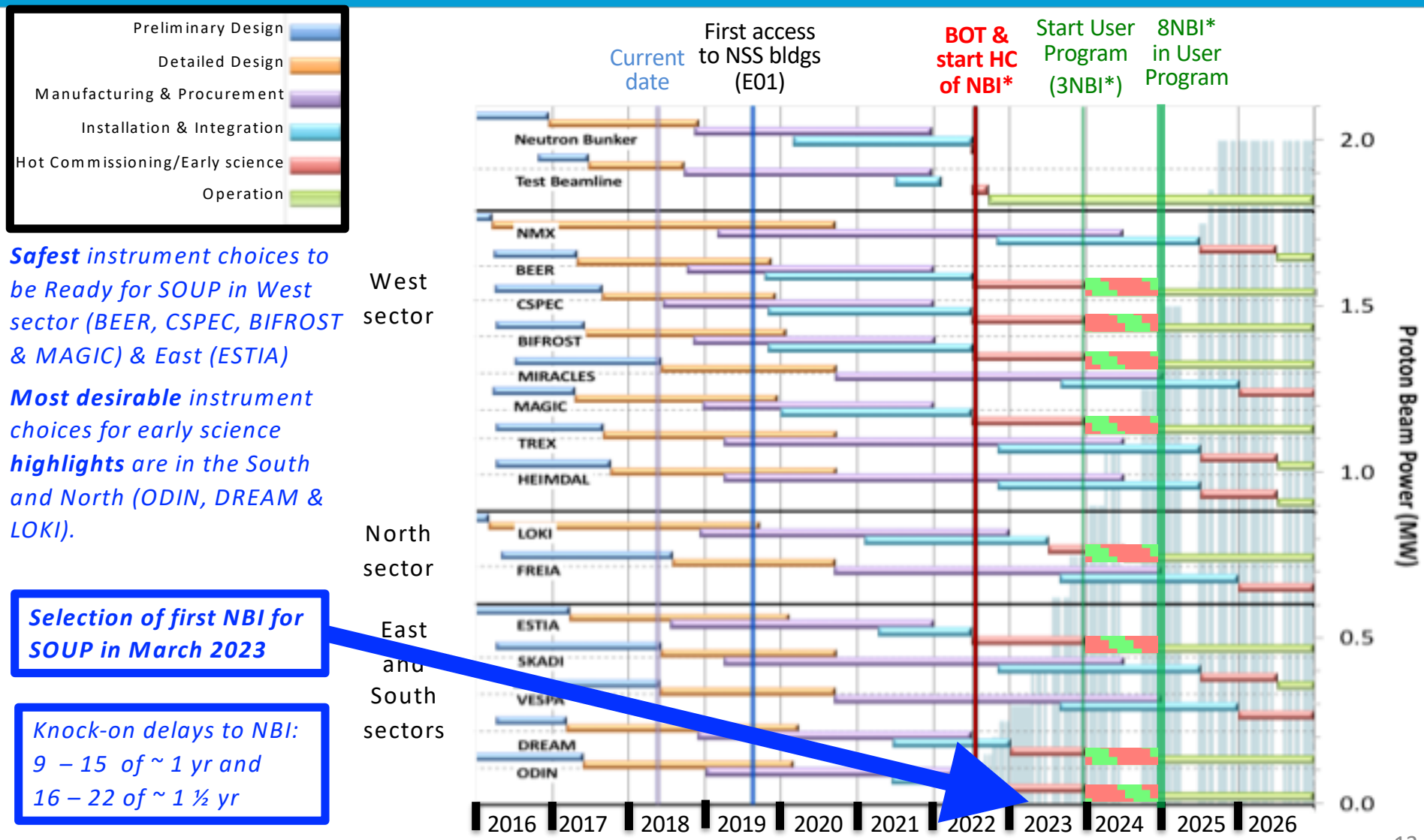
from Installation workshop with teams building first 8 Instruments (8th May)



* NBI = Neutron Beam Instrument

Rebaseline schedule for Neutron Beam Instruments (V4.0, 11th May 2018)

from Installation workshop with teams building first 8 Instruments (8th May)



***Safest** instrument choices to be Ready for SOUP in West sector (BEER, CSPEC, BIFROST & MAGIC) & East (ESTIA)*

***Most desirable** instrument choices for early science **highlights** are in the South and North (ODIN, DREAM & LOKI).*

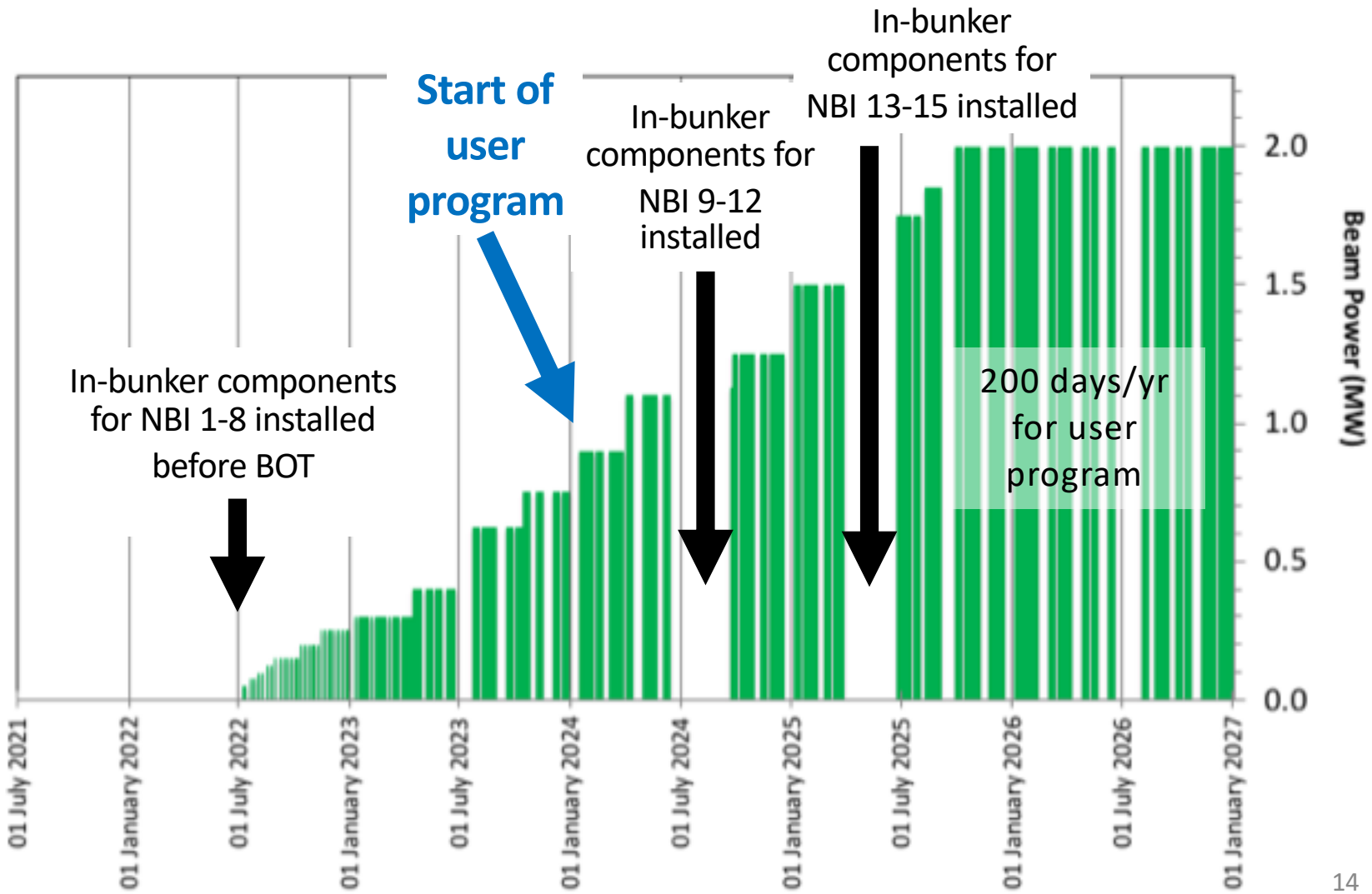
Selection of first NBI for SOUP in March 2023

Knock-on delays to NBI:
9 – 15 of ~ 1 yr and
16 – 22 of ~ 1 ½ yr

* NBI = Neutron Beam Instrument

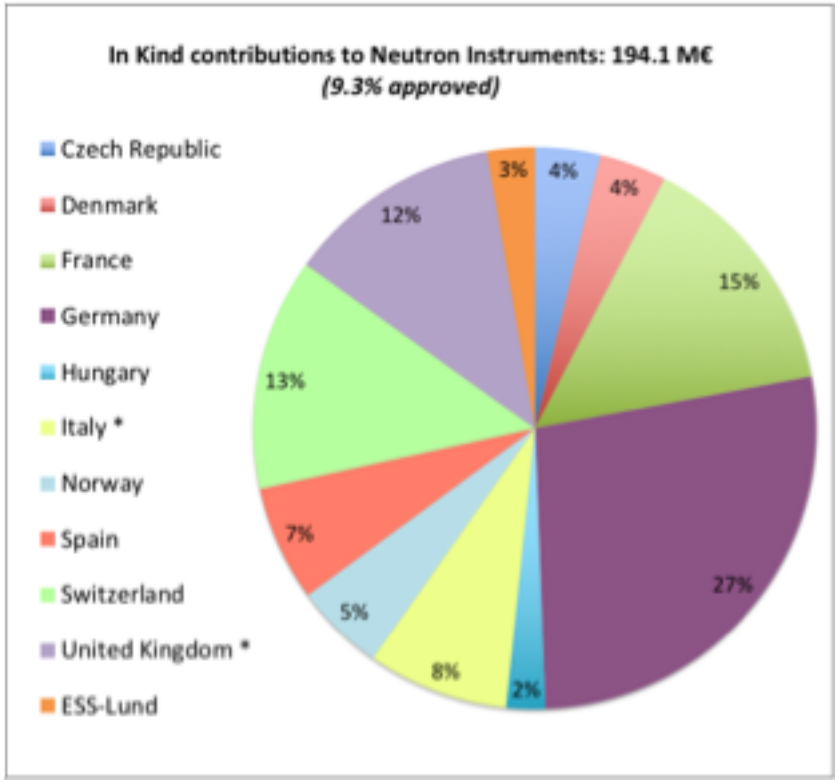
Source Power ramp up *from NSS Master Schedule (V4.0 – 11th May 2018)*

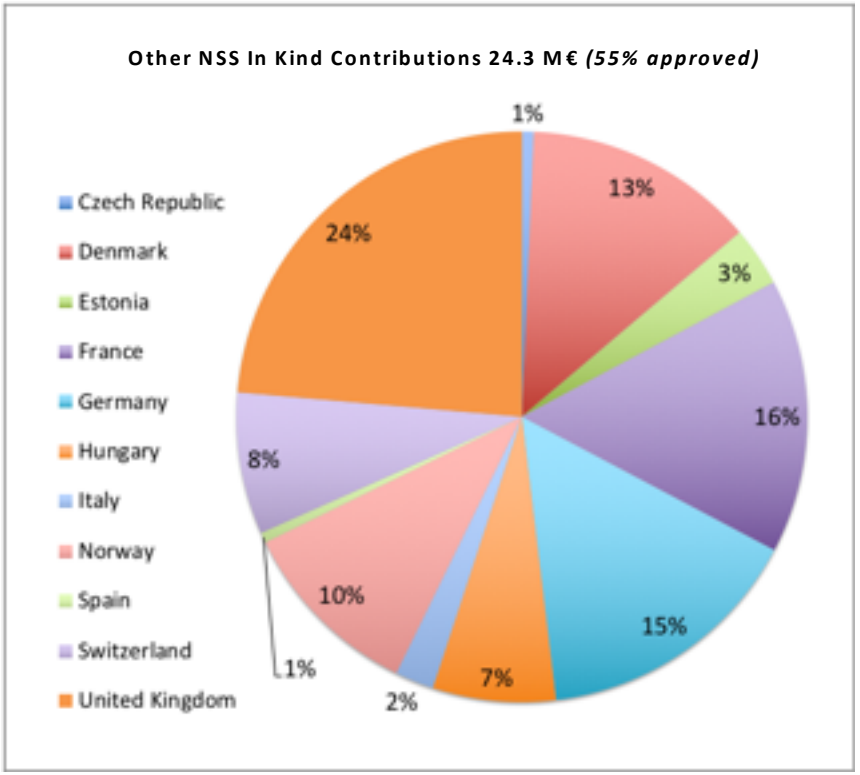
(Work in progress: - discussion with Accelerator & Target Project teams is ongoing)



Budget Overview

NSS In-Kind Contributions
Country Summary





Total IK contributions (approved, planned & potential): 218.4 M€ (96 % of NSS target)

** Split of IT & UK contributions to LOKI, FREIA & VESPA to be determined*

The NSS Project Neutron Instruments

Instrument Class	Neutron Instrument	Costbook Value (M€)	Partners
Large Scale Structures	LOKI (Broad band SANS)	12.19	ISIS (94%) + ESS(6%)
	SKADI (General Purpose SANS) *(+SONDE funds)*	11.50	FZJ (50 %) & LLB (50 %)
	ESTIA (Focusing Reflectometer)	**11.80**	**PSI (100%)** ***TA signed & approved***
	FREIA (Liquids Reflectometer)	13.20	ISIS (100%)
Diffraction	DREAM (Bispectral powder diffractometer)	13.66	FZJ (76 %) & LLB (24 %)
	HEIMDAL (Hybrid diffractometer)	13.55	Åarhus U. (30%), PSI (35%), IFE (35%)
	MAGIC (magnetism single crystal diffractometer)	13.10	LLB (61%), FZJ (24%) & PSI (15%)
	NMX (Macromolecular crystallography)	11.67	ESS (33%), WI/IER(38%), Bergen (22%), LLB (7%)
Engineering & Industrial	BEER (Engineering diffractometer)	14.99	NPI (50%) & HZG (50%)
	ODIN (multi-purpose imaging)	11.60	TUM (61%), PSI (33%) & ESS (6%)
Spectroscopy	BIFROST (extreme environment spectrometer)	13.45	DTU/KU (26%), PSI (32%), IFE(22%), LLB (20%)
	C-SPEC (cold chopper spectrometer)	16.50	TUM (50%) + LLB (50%)
	T-REX (bispectral chopper spectrometer)	16.85	FZJ (75%) & Perugia U. (25%)
	VESPA (vibrational spectroscopy)	12.00	CNR (100%)
	MIRACLES (backscattering spectrometer)	13.53	ESS-Bilbao (98%), KU (1%), ESS (1%)
	Total cost book value (M€)	**199.59**	

NSS budget status & forward projection

RED = Updated through rebaselining

NSS Project Budget Item	Budget (M€)
Neutron Beam Instruments (NBI)	199.98
Instrument Technologies	48.39
Science Support Systems	25.44
Data Management & Software Centre	20.67
Neutron Bunker (excl. floor)	18.00
NSS Integration/management	14.81
Instrument Concepts	5.97
Science Directorate Management	5.20
Polarization Analysis System [2]	0.25
ESS - Test Beamline[1]	0.93
Forecast increases *(10% c2c + emerging scope)*	*6.35*
Total contingency	21.35
Estimated cost at completion (EAC)	**367.35**

NSS Project is 22 % complete

Projected IK value is 218.3 M€

EAC – BAC = 6.35 M€ (2% of c2c)

Contingency split
(as % of cost to complete):
10 % for non-NBI, 7,2% for NBI

[1]Test Beamline; excludes BrightnESS (0,9 M€)

[2]PA systems, project descoped - shift major investment to initial operations

Source: ESS PR 20 Aug 2018)

Recent & upcoming activities

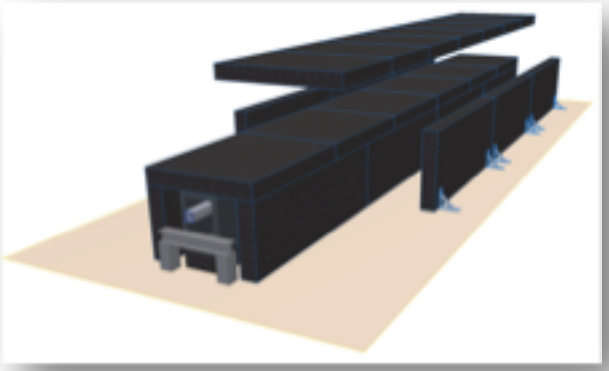
Bunker construction Schedule

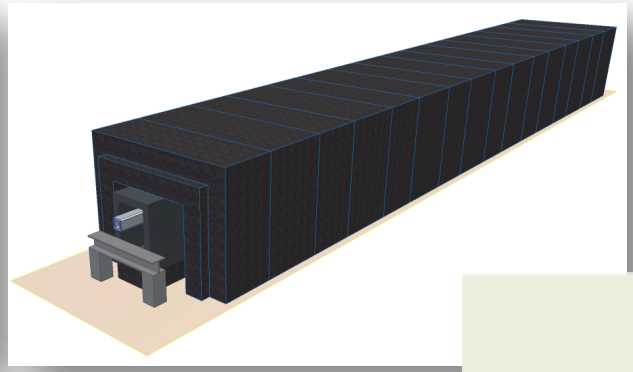
milestone	New date
Document fire safety requirements	March 2018 ✓
Agree & document seismic requirements	February 2018 ✓
Complete requirements	March 2018 ✓
Complete Value Engineering	August 2018 ✓
Release manufacturing tender*	July 2018 ✓
Complete mechanical design	September 2018
Critical Design Review	October 2018
Award manufacturing contract	December 2018
Ready to start assembly of bunker (R6)	October 2019

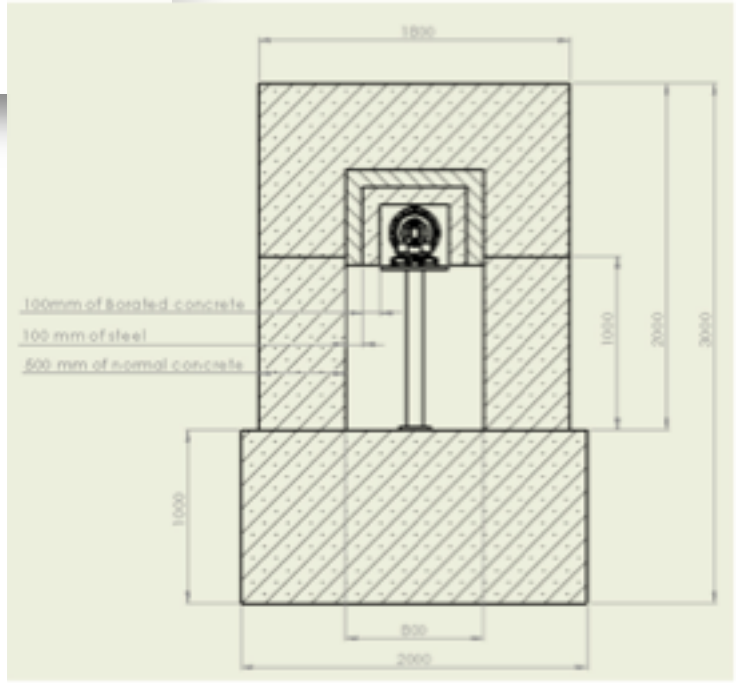
After Rebaselining:
Bunker design & manufacturing has 88 days float for R-BOT;
Bunker installation is on critical path for R-BOT

**Tendering before CDR to maintain schedule*

Standard guide shielding by NSS core team
(with partner participation in neutronics design)







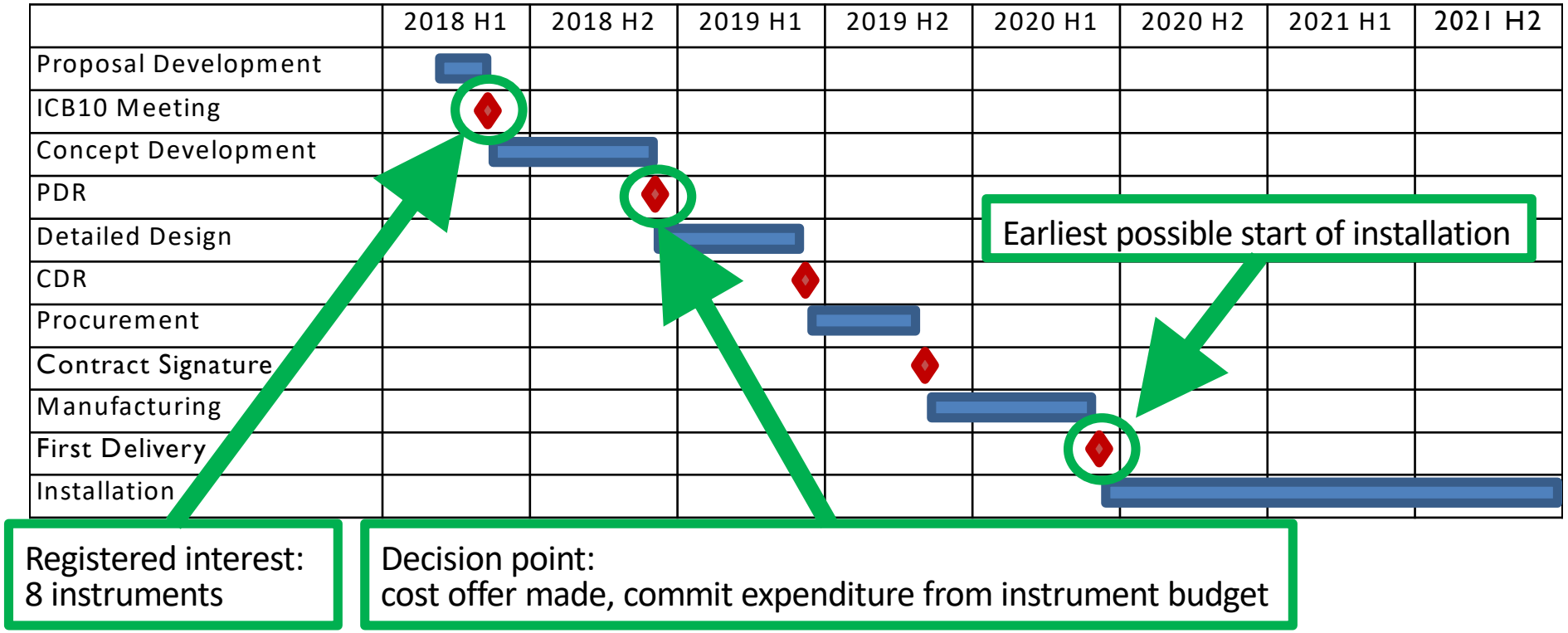
Phase 1: Concept development (mechanical & neutronics), costing & delivery plan

Phase 2: Manufacturing and delivery to ESS

Instrument teams participating in phase 1:
BIFROST (IFE), CSPEC (TUM), DREAM (FZJ), HEIMDAL (IFE), MAGIC (LLB), ODIN (TUM), T-REX (CNR) & VESPA (CNR). Potential value ~ 12 M€

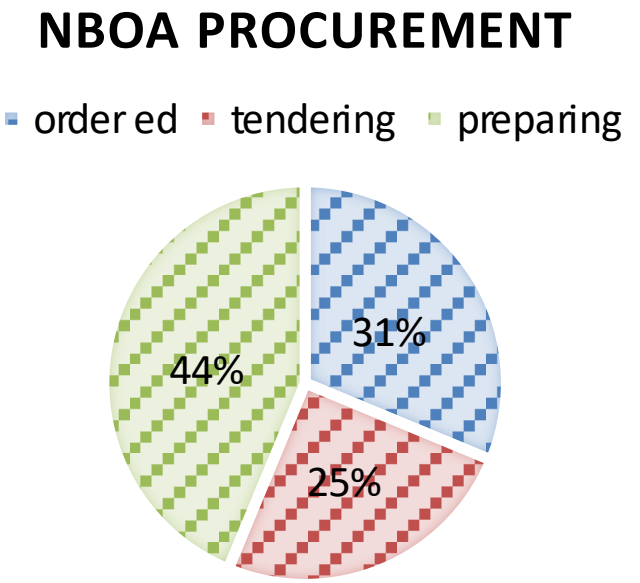
Phase 1 PDR scheduled for December 2018
- Instrument teams decide whether to participate in phase 2

Standard guide shielding: for 8 Instruments (~ 750 metres)



NBOA manufacturing is go !

Kick off meet of first NBOA's (June 2018)



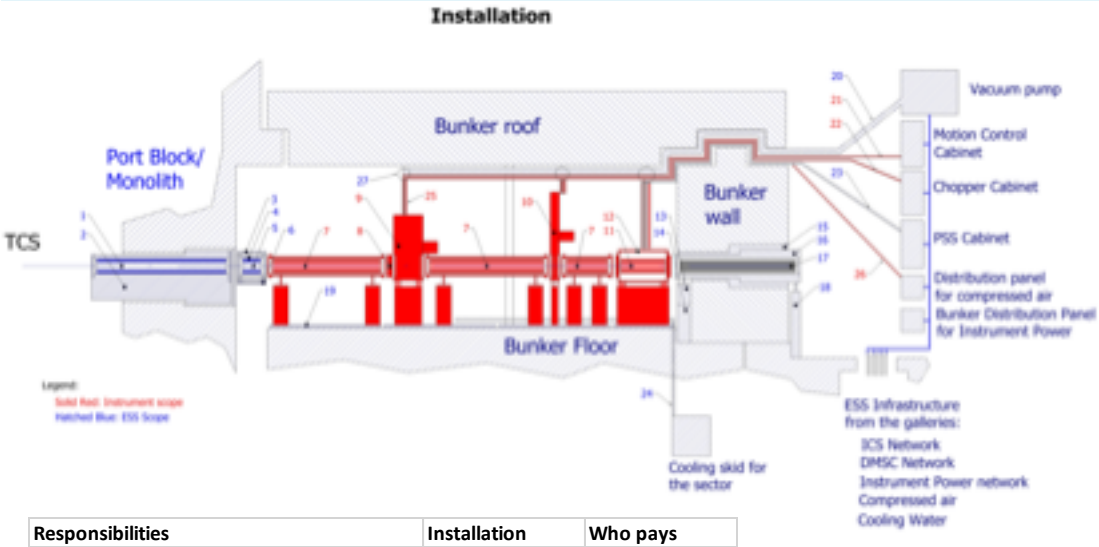
By end of Q4 2018

- All teams should have placed orders
- Completion of detailed design first 8 instruments

Installation planning:
Division of labour for instrument installation inside the neutron bunker

EUROPEAN SPALLATION SOURCE

Nr.	Responsibilities	Installation	Who pays
	In bunker components		
1	NBOA (Neutron Beam Optics Assembly)	NSS/Survey	Instrument
2	Monolith Insert Shielding, Beam windows	Target	Target
3	BBG (Bridge Beam Guide), Additional Optical units.	NSS/Survey	Instrument
4	Pressure vessel for BBG	NSS (Integration)	Instrument
5	BBG alignment frame	NSS (Integration)	NSS(Integration)
6	BBG rails	Target	NSS(Integration)
7	Neutron guide, housing, kinematic mounts, supports	Instrument	Instrument
8	Beam monitors	Instrument	Instrument
9	T0 chopper and support	Instrument	Instrument
10	Disk chopper and support	Instrument	Instrument
11	Heavy Shutter Optics	Instrument	Instrument
12	Heavy Shutter mechanics and support	Instrument	Instrument
13	BWI (Bunker Wall Insert Support) /upstream/	NSS (Bunker)	Instrument
14	Wall Block under the BWI Support	NSS (Bunker)	NSS (Bunker)
15	Filler plates around the BWI	NSS (Bunker)	Instrument NSS matching
16	BWI	NSS (Bunker)	Instrument
17	BWI Optics	NSS/Survey/ext.	Instrument
18	BWI Support /downstream/	NSS (Integration)	Instrument
19	Instrument Base-plates	NSS(Integration)	Instrument /Target/NSS
20	Temporary beam-stop	NSS (Bunker)	NSS(Bunker)
22	Collimator collar	Instrument	Instrument
21	Other Instrument components*	Instrument	Instrument
	In bunker Infrastructure		
20	Vacuum Manifold	ESS(Vacuum)	ESS(Vacuum)
21	Motion control cables (power & signal)	Instrument	Instrument
22	Chopper cables (power & signal)	Instrument	Instrument
23	PSS cables	ICS/PSS	Instrument
24	Cooling pipes	ESS(Cooling)	Instrument
25	Vacuum hoses between instrument components and the manifold	Instrument	Instrument
26	Pipes for compressed air	Instrument	Instrument
27	Cable trays	NSS(Integration)	NSS(Integration)
28	Lighting and power points	NSS(Integration)	NSS(Integration)
29	Cables For Beam Monitors	Instrument	Instrument



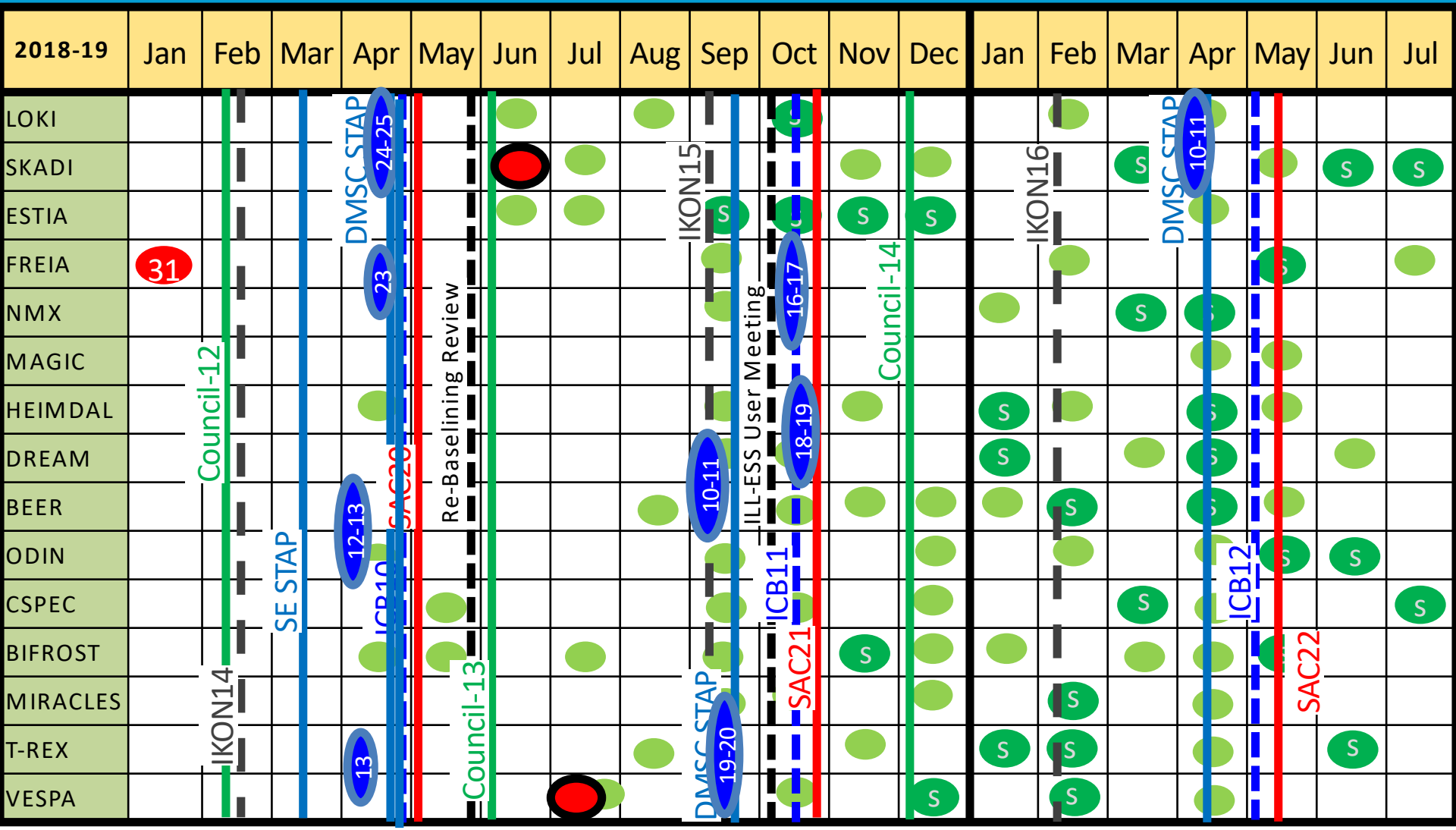
Responsibilities	Installation	Who pays
Bunker cabinets and panels (Out of bunker)		
Vacuum Pump	ESS(Vacuum)	ESS(Vacuum)
Motion Control Cabinet	NSS(Integration)	Instrument
Chopper Control Cabinet	NSS(Integration)	Instrument
Beam monitor electronics	NSS(Integration)	Instrument
PSS Panel	ICS/PSS)	Instrument
Distribution panel for compressed air	Instrument	Instrument
Instrument power distribution cabinet	NSS(Integration)	NSS(Bunker)
Central cooling skid , utility panel	ESS(Cooling)	Instruments
Infrastructure between gallery and cabinets		
ICS Network	ICS	ICS
DMSC Network	DMSC	DMSC
Instrument power	NSS(MCAG)	NSS(MCAG)
Compressed Air	Instrument	Instrument
Cooling water	ESS(Cooling)	ESS(Cooling)

**details in ESS-0063538 (Gabor Laszlo)*

Overview of NSS instrument meetings/milestones

EUROPEAN SPALLATION SOURCE

Version 10/9/2018



Instruments Installation planning

- Installation plans will comply Antonio's specifications (details in the specific session)
- Instruments installation plans (*BEER, C SPEC, BIFROST, MAGIC*) completely resource loaded for *E01* and *E02.1* tasks;
- **Deadline: end of October 2018**

- First 8 instrument installation plans completely resource loaded
- **Deadline: June 2019**

- *We plan to hold an installation workshop at the end of October 2018 focused on the resource loaded installation plan;*

NSS Project Summary

NSS major goal at this time is start build in E01 in Q3 2019

∴ Advancing detailed design & entering procurement for first 8 instruments is our top priority

- Successful Bunker CDR - October 2018
- Standard shielding design and costing - Q4 2018
- New accelerator ramp-up and operation plans updated *(jointly with Accelerator Target Division, ICS & ES&H)* - Q4 2018
- Signed TA's for first 13 instruments - Q1 2019
- Proposal for NSS central management of beam monitor scope - Q3 2018
- Complete resource loaded installation plan for first 8 instruments - Q2 2019
- Proposal for NSS central management heavy shutter scope under consideration

ESS Annual Review - 10-14 December 2018: major issues

- Schedules & resources for bunker & instrument installation,
- Integrated commissioning plan (all sub-projects)
- Ensuring early science success