TECHNISCHE UNIVERSITÄT MÜNCHEN

Orphée Laboratoire Léon Brillouin

CSPEC

EUROPEAN SPALLATION SOURCE

CSPEC: The cold chopper spectrometer of the ESS

Lead Scientist: P.P.Deen (TUM)
Lead Engineer: Joseph Guyon le Bouffy (LLB)

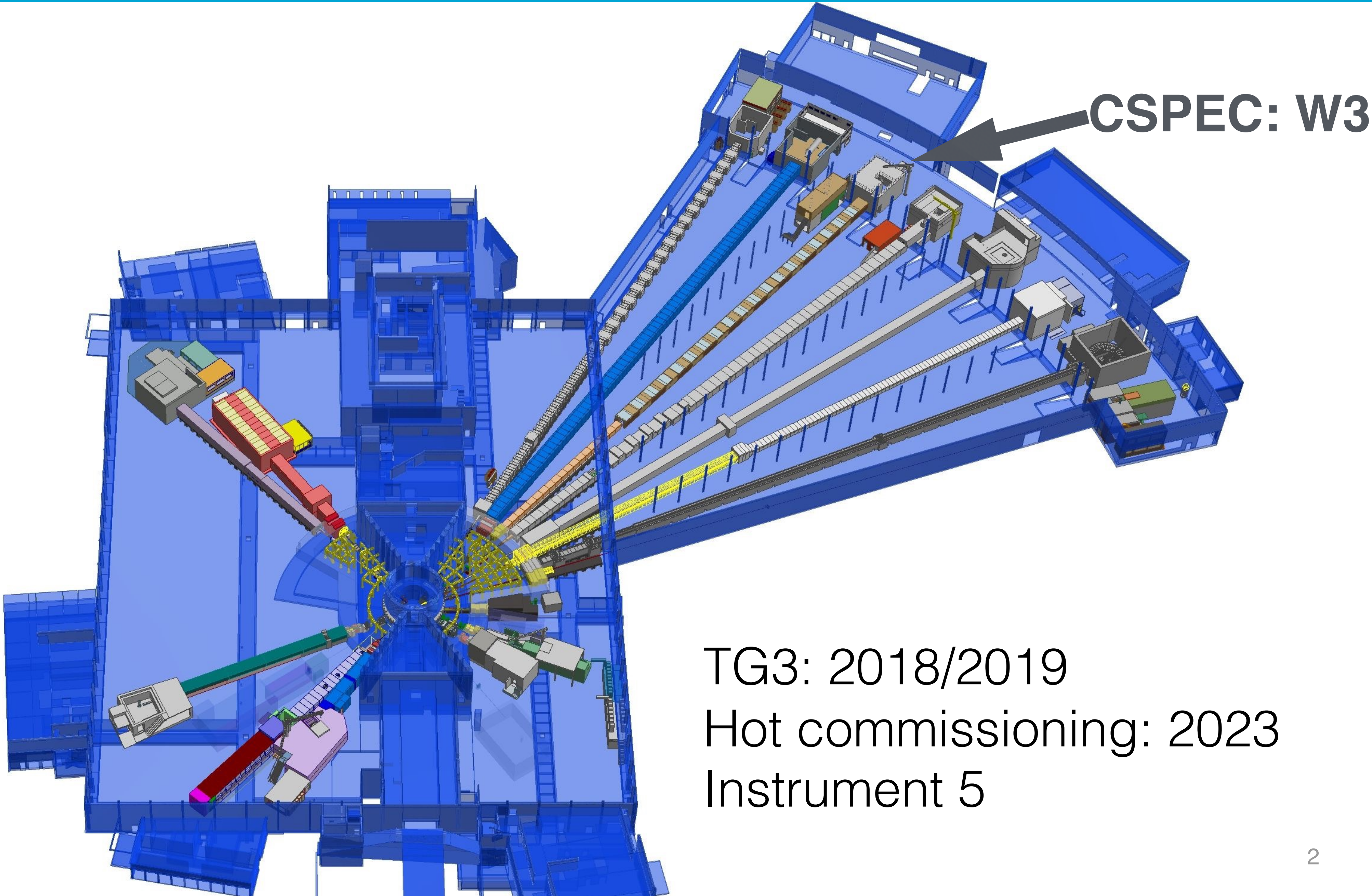
TUM (50%): W. Lohstroh, L. Laoiza, J. Neuhaus, W. Petry
LLB (50%): S. Longeville, G. Fabrèges, E. Elliot, Alba-Simionesco






& N. Tsapatsaris (ESS), D. DiJulio (ESS), D. Rodriguez(ESS), H. Schneider(ESS), A. Holmes (ESS), A. Sandstrom(ESS), M. Anastasopoulos (ESS),G. Laszlo (ESS), C. Lopez, P. Link (TUM) H. Meier(TUM), J. Huber (TUM), A. Cazenave (LLB), S. Desert(LLB).

CSPEC



TG3: 2018/2019

Hot commissioning: 2023

Instrument 5

CSPEC

CSPEC: The cold chopper spectrometer of the ESS

measure low lying dynamics in materials

Develop instrument to enable the study of time dependent & in-operando phenomena

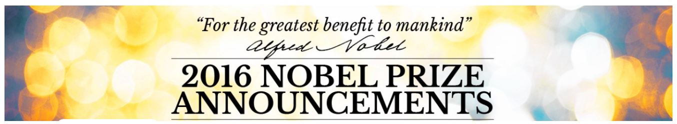
Grand challenges & CSPEC Science case:

Energy: Solar cells, batteries, thermoelectric materials, hydrogen storage

Climate: CO_2 capture and storage (carbon nanotubes) Low carbon technologies in cement, steel and chemical industries

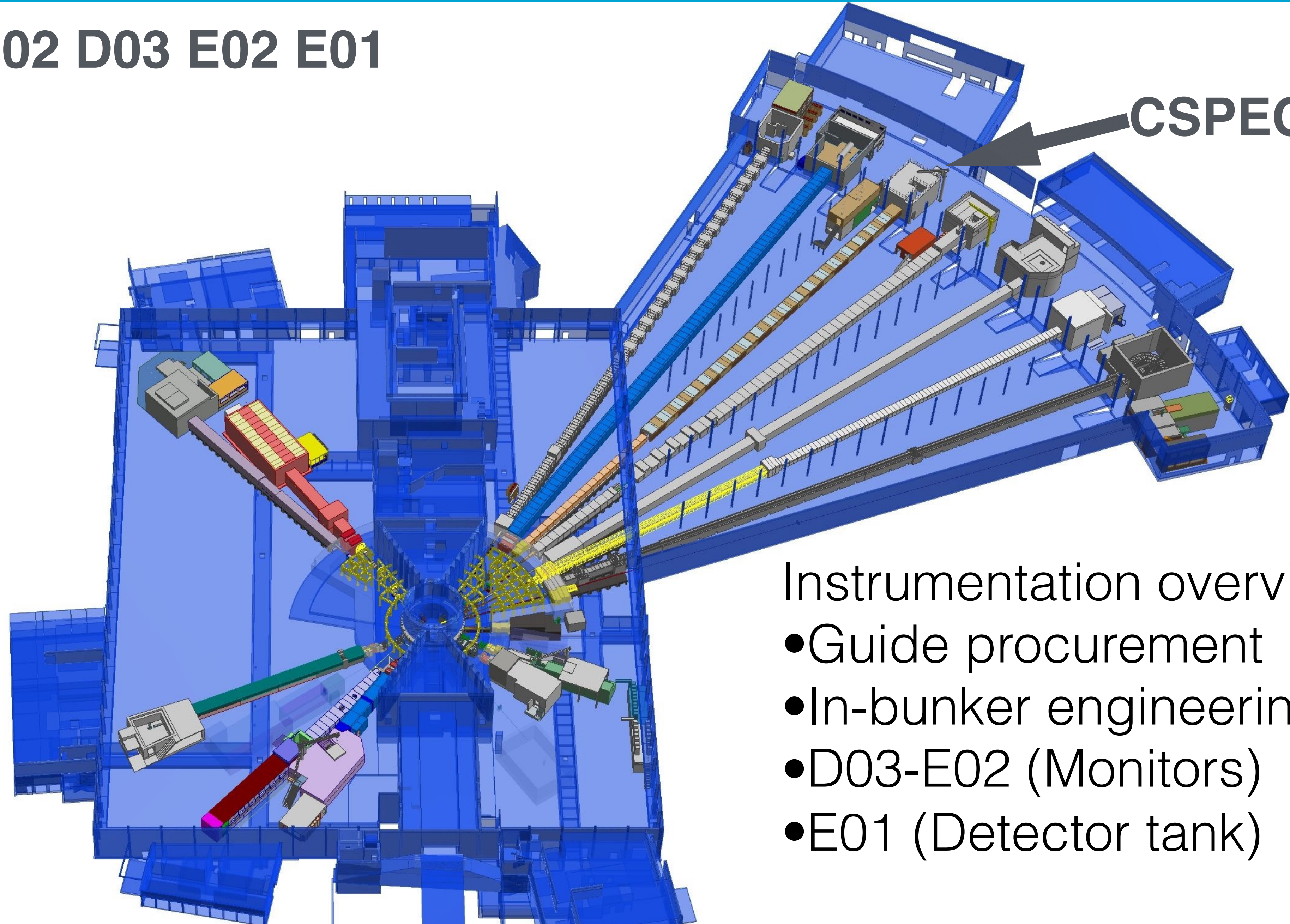
Health: Drug delivery, proteins dynamics, hydrogen bonding, quantum effects in the origin of life

Digital Society: Magnetic storage, Spin liquids, novel magnetic behaviour (Topology!)



CSPEC

D02 D03 E02 E01



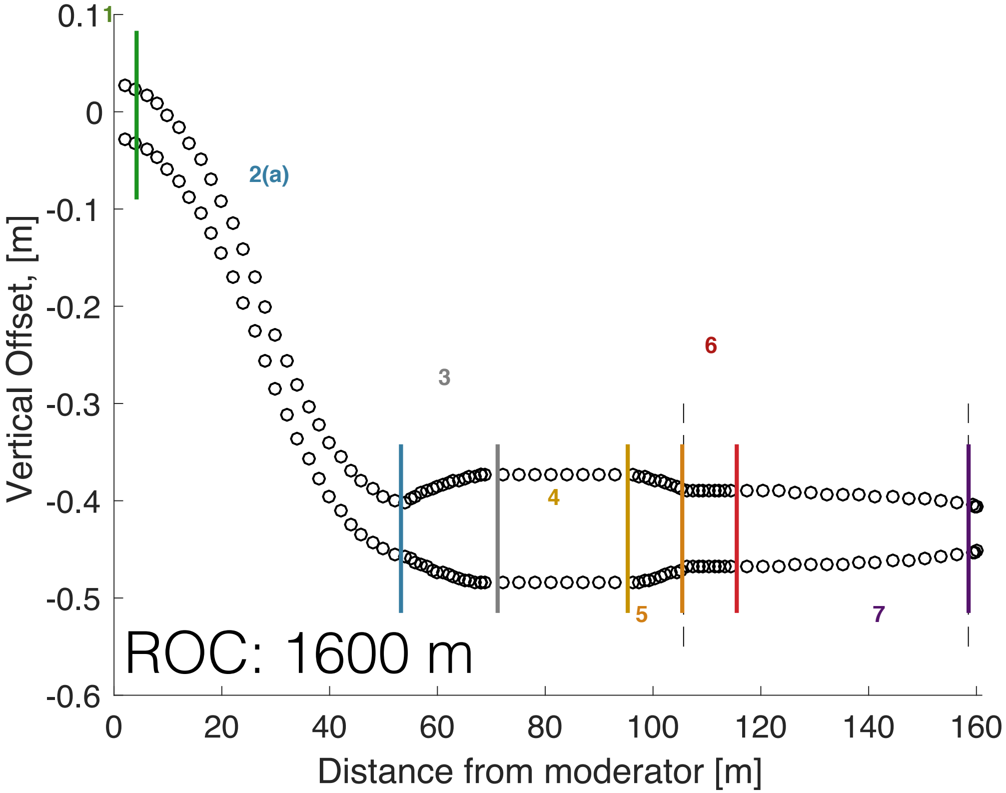
Instrumentation overview:

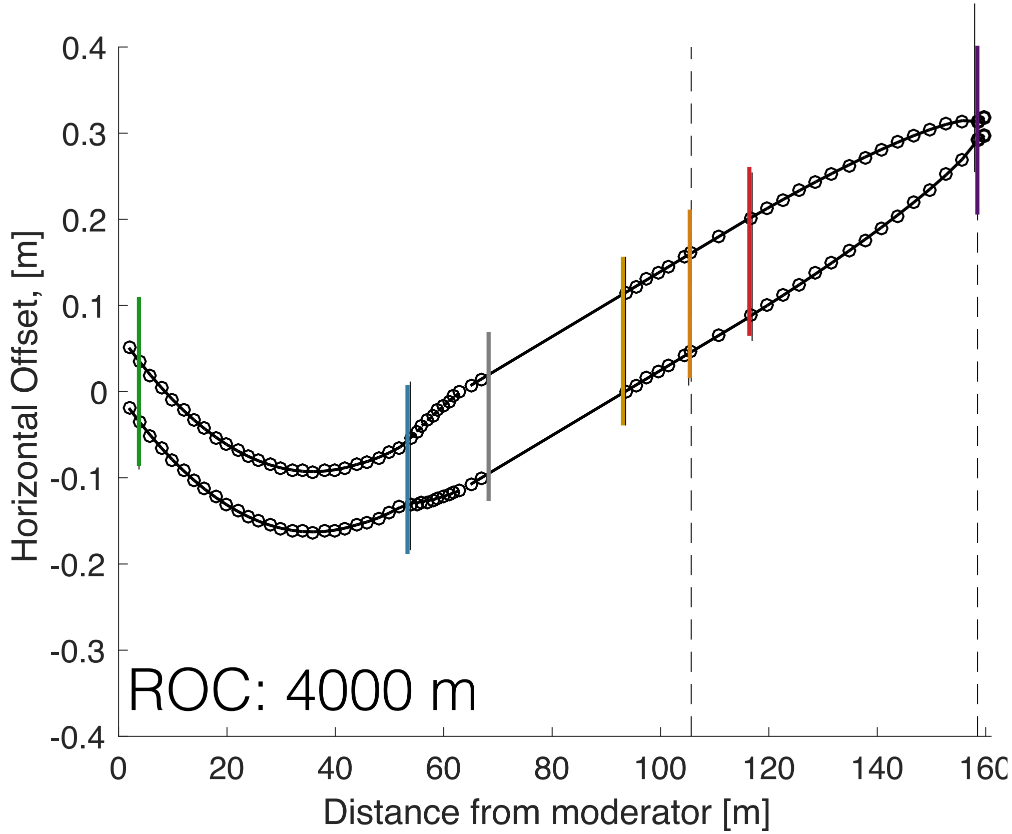
- Guide procurement
- In-bunker engineering
- D03-E02 (Monitors)
- E01 (Detector tank)

CSPEC

EUROPEAN SPALLATION SOURCE

Guide overview

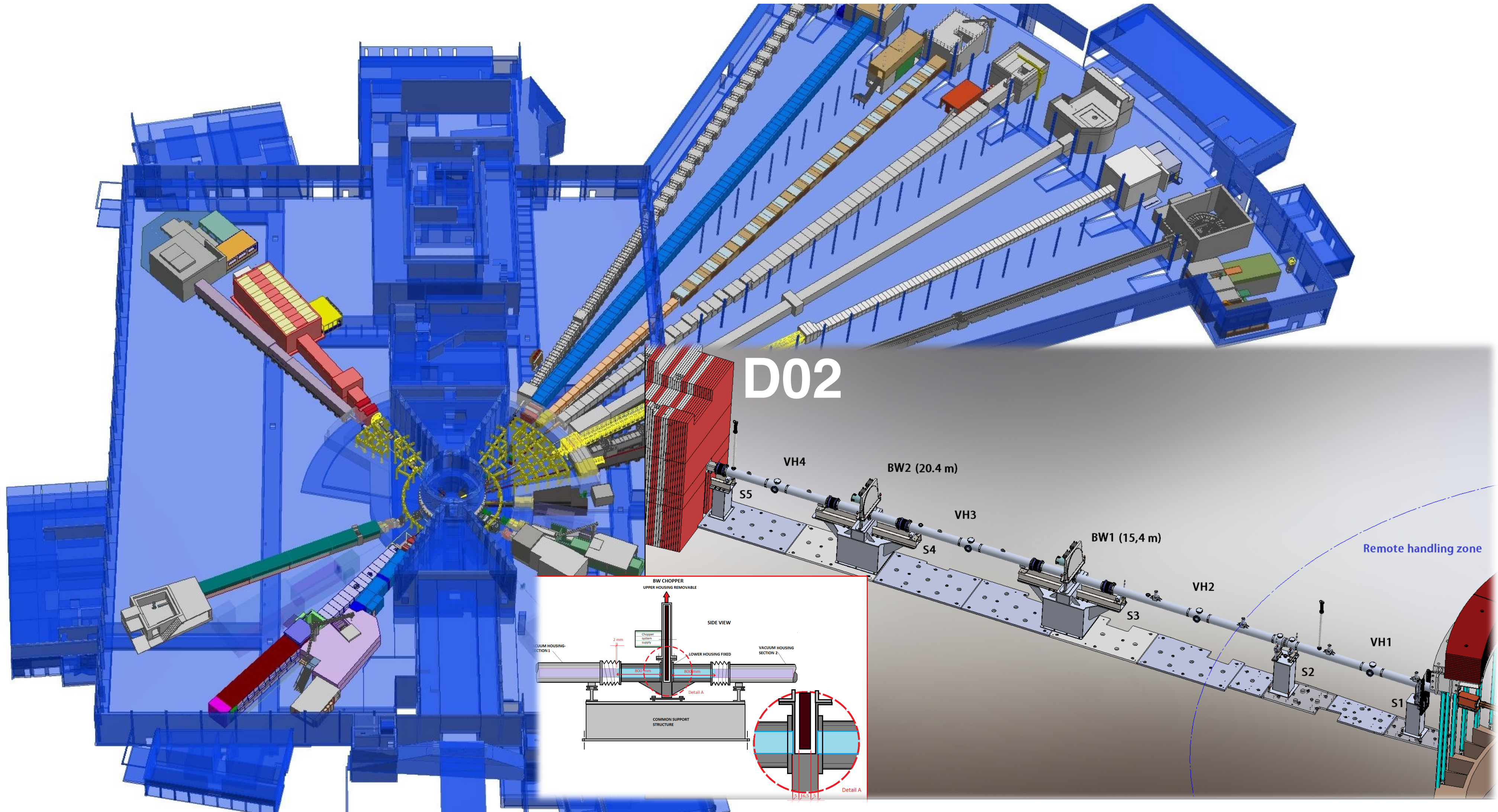




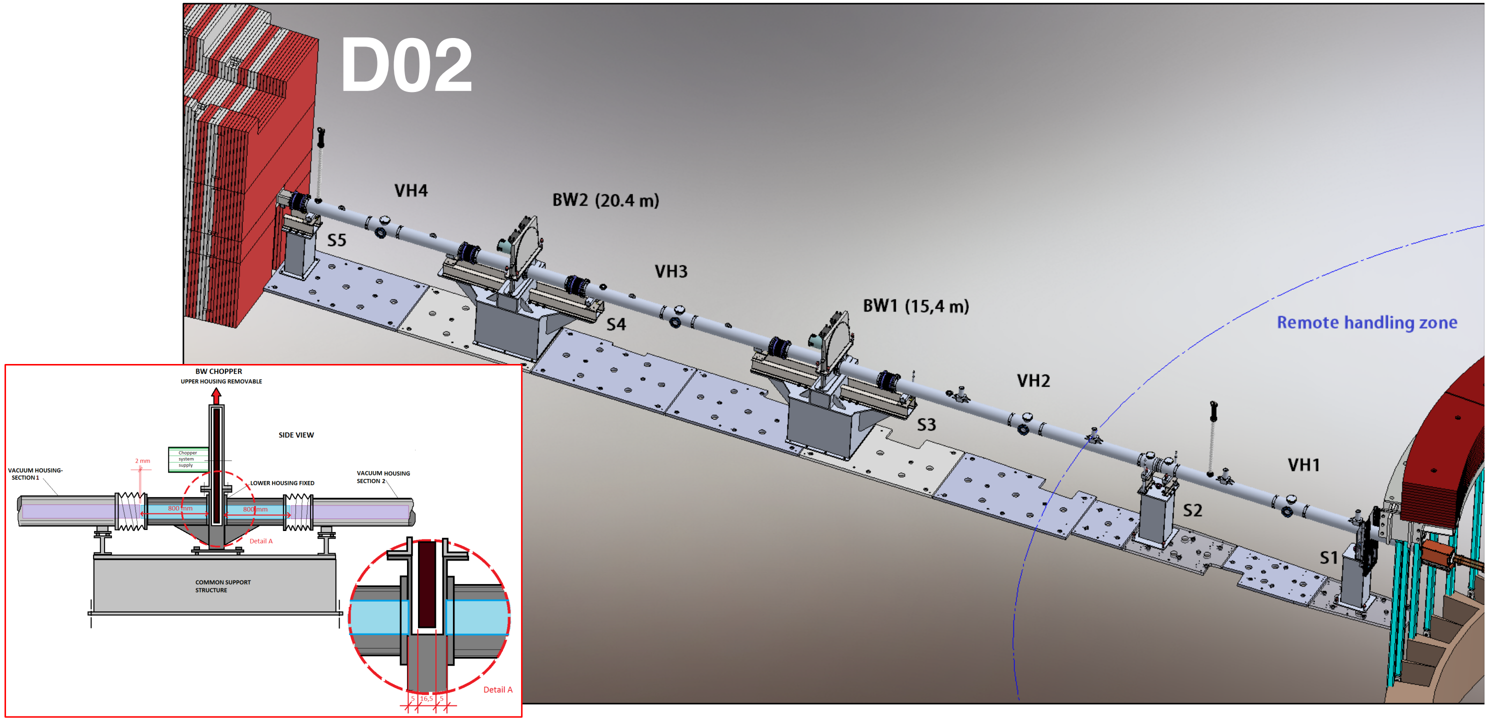
CSPEC

D02 D03 E02 E01

D02: NBOA, Light shutter, BW1, BW2, Remote handling & bunker feedthrough



CSPEC



In-Bunker: high radiation zone, special precautions.

- *“Within the first 25 m of radius, all substrates must be made from super polished copper or aluminium. “*
- *“Sodium glass will not be used at ESS (hard gamma emission on neutron capture.)”*

ESS guide lines

CSPEC

18m of guide made with aluminium 132m of guide made with borkron glass	18m of guide made with Na float glass 132m of guide made with borofloat glass

Components	Price (in k€)
NBOA	120
BBG	20
In bunker guide (manufactured by Swiss Neutronics)	390
Bunker feedthrough	140
Out of bunker guide (manufactured by Swiss Neutronics)	1680
Guide exchange	150
Vacuum housing and mechanical support	600
Total	3100

Components	Price (in k€)
NBOA	120
BBG	20
In bunker guide (manufactured by the TUM)	185
Bunker feedthrough	140
Out of bunker guide (manufactured by the TUM)	1300
Guide exchange	150
Vacuum housing and mechanical support	600
Total	2515

Difference in cost

In bunker: 205 000 €

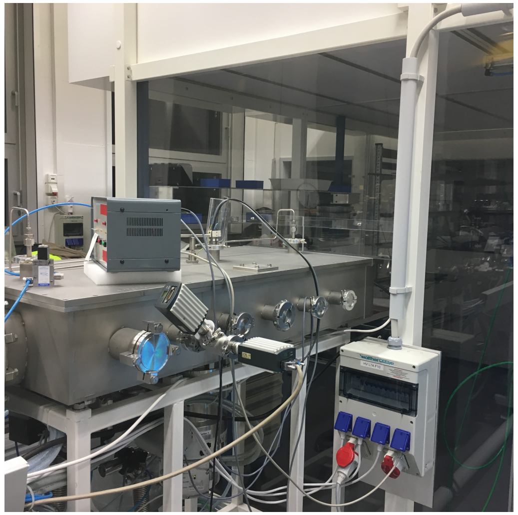
Out of bunker: 380 000 € (Accepted ESS-020606)

= 585 000 €

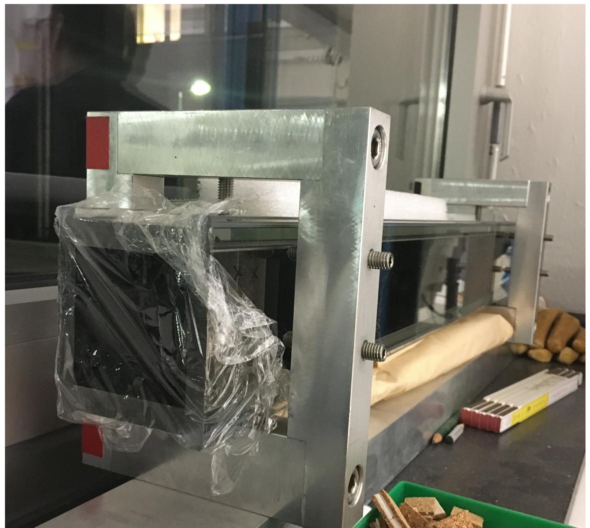
CSPEC

Neutron Optics

Optics will be housed in vacuum housing developed by TUM



Guides, if possible, will be manufactured at the Optics lab, TUM. Optimise Time & Money.



Optics will be aligned using alignment procedure developed by TUM (with help of NSOG)

CSPEC

IAEA.org
International Atomic Energy Agency

Thermal neutron capture γ

Hard γ:

^{23}Na = 0.09, 0.472, 0.8 & 6.395 MeV.
^{27}Al = 0.0306, 3 & 7 MeV.

Activation issue:

Same as Cu.

Loss of performance: see SNS

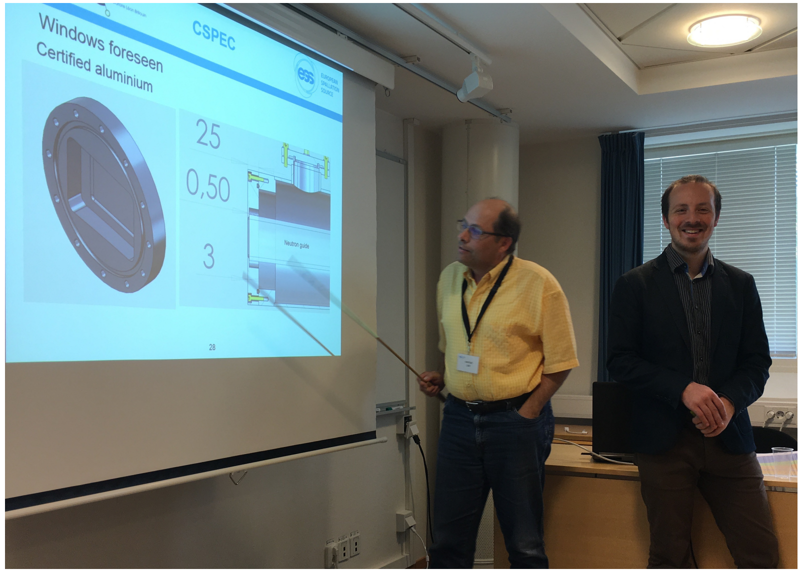
(private communications. G. Ehlers, K. Herwig).

CSPEC documentation to ESS (February 2018 & May 2018)
BIFROST change request

CSPEC Guide Review meeting, mini-TG3, May 2018

The purpose and scope of the meeting:

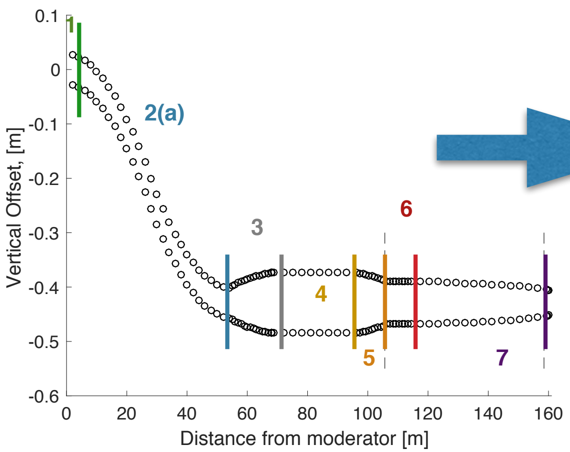
- Verification of the CSPEC **optics** system to deliver the CSPEC high level optics requirements.
- Overview of the interfaces: vacuum, ICS, handling.
- Overview of design considerations: materials, installation, handling and transport, maintenance, survey, ES&H.



Enable the CSPEC team to procure the raw materials for the guides.

Provide an overview of vacuum housing & Clarify uncertainties for all.

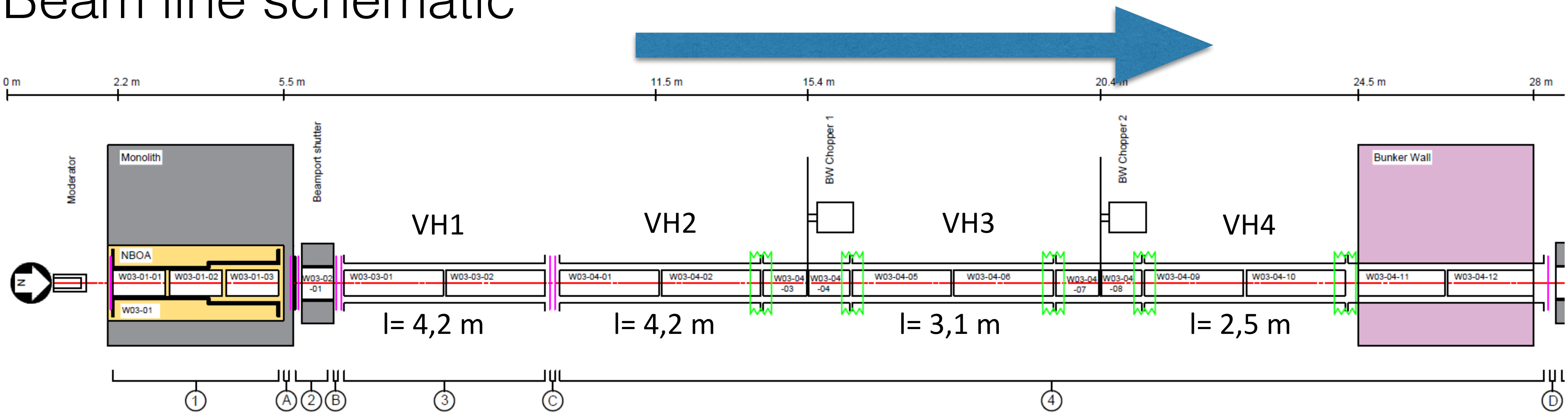
McStas to Engineering reality: ISCS to CATIA

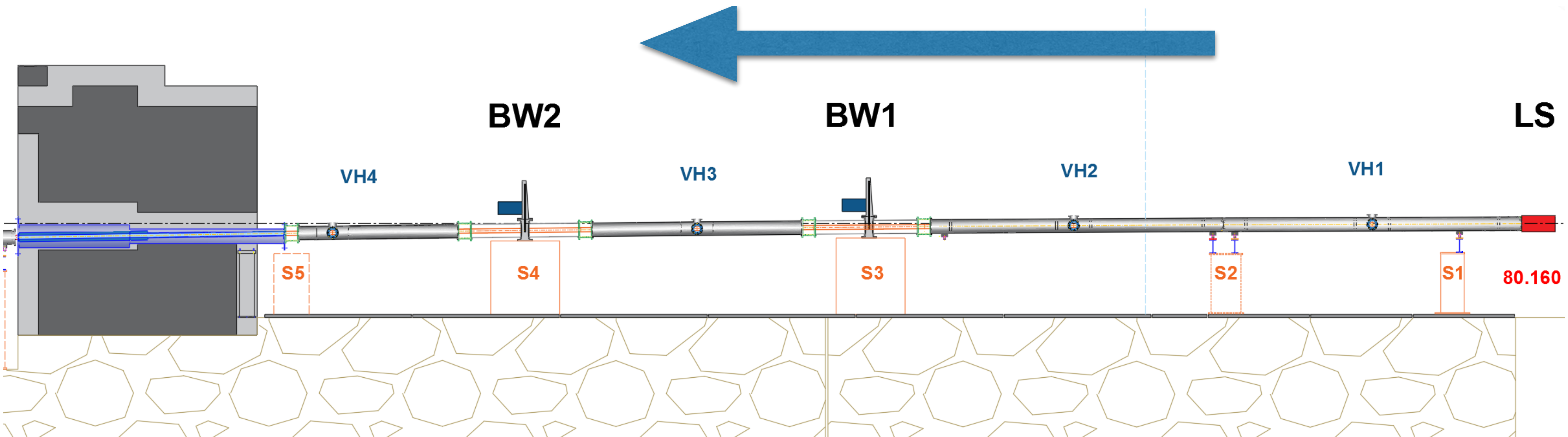


Section PD	Element #	chi(x)	phi(y)	x start	ISCS [mm] y start	z start	x end	ISCS [mm] y end
1	W03-01-011	0,000	0,500	1879,94	-0,0050	0,00	2379,44	-0,0050
1	W03-01-012	-0,009	0,496	2379,44	-0,0050	0,00	2878,94	0,0262
Gap		-0,018	0,493	2878,94	0,0262	-0,08	2879,94	0,0263
1	W03-01-021	-0,027	0,489	2879,94	0,0263	-0,08	3379,44	0,1200
2	W03-01-022	-0,045	0,482	3379,44	0,1200	-0,31	3878,94	0,2760
Gap		-0,054	0,479	3878,94	0,2760	-0,70	3879,94	0,2764
2	W03-01-031	-0,063	0,475	3879,94	0,28	-0,70	4379,94	0,50
2	W03-01-032	-0,081	0,468	4379,94	0,50	-1,25	4879,94	0,78
2	W03-01-033	-0,098	0,461	4879,94	0,78	-1,95	5359,94	1,11
GAP LS	W03-02-01	-0,116	0,454	5359,94	1,11	-2,78	5877,94	1,52
2	W03-03-01	-0,164	0,434	5877,94	1,52	-3,82	8056,29	4,02
NO-Gap		-0,203	0,419	8056,29	4,02	-10,07	8057,29	4,02
2	W03-03-02	-0,242	0,403	8057,29	4,02	-10,07	10235,63	7,71
NO-Gap		-0,282	0,387	10235,63	7,71	-19,29	10247,63	7,73
2	W03-05-13	-0,044	-0,227	51892,69	306,46	-420,57	54376,49	337,98
NO-Gap		0,000	-0,245	54376,49	337,98	-422,50	54377,49	337,99
3	W03-05-14	0,000	-0,245	54377,49	337,99	-422,50	56377,33	363,99
NO-Gap		0,000	-0,245	56377,33	363,99	-422,50	56379,32	364,02
3	W03-05-15	0,000	-0,245	56379,32	364,02	-422,50	58379,16	390,02
NO-Gap		0,000	-0,245	58379,16	390,02	-422,50	58380,16	390,03
3	W03-05-16	0,000	-0,245	58380,16	390,03	-422,50	60379,99	416,03
NO-Gap		0,000	-0,245	60379,99	416,03	-422,50	60381,99	416,05
3	W03-05-17	0,000	-0,245	60381,99	416,05	-422,50	62381,82	442,05
NO-Gap		0,000	-0,245	62381,82	442,05	-422,50	62382,82	442,07
3	W03-05-18	0,000	-0,245	62382,82	442,07	-422,50	64382,65	468,07
NO-Gap		0,000	-0,245	64382,65	468,07	-422,50	64384,65	468,09
3	W03-05-19	0,000	-0,245	64384,65	468,09	-422,50	66384,48	494,09
NO-Gap		0,000	-0,245	66384,48	494,09	-422,50	66385,48	494,10
3	W03-05-20	0,000	-0,245	66385,48	494,10	-422,50	68385,31	520,10
NO-Gap		0,000	-0,245	68385,31	520,10	-422,50	68387,31	520,13
4	W03-05-21	0,000	-0,245	68387,31	520,13	-422,50	70387,14	546,13
NO-Gap		0,000	-0,245	70387,14	546,13	-422,50	70388,14	546,14
4	W03-05-22	0,000	-0,245	70388,14	546,14	-422,50	72387,97	572,14
NO-Gap		0,000	-0,245	72387,97	572,14	-422,50	72389,97	572,17
4	W03-05-23	0,000	-0,245	72389,97	572,17	-422,50	74389,80	598,17
NO-Gap		0,000	-0,245	74389,80	598,17	-422,50	74390,80	598,18
4	W03-05-24	0,000	-0,245	74390,80	598,18	-422,50	76390,63	624,18

CSPEC

CSPEC in bunker area
Beam line schematic





CSPEC

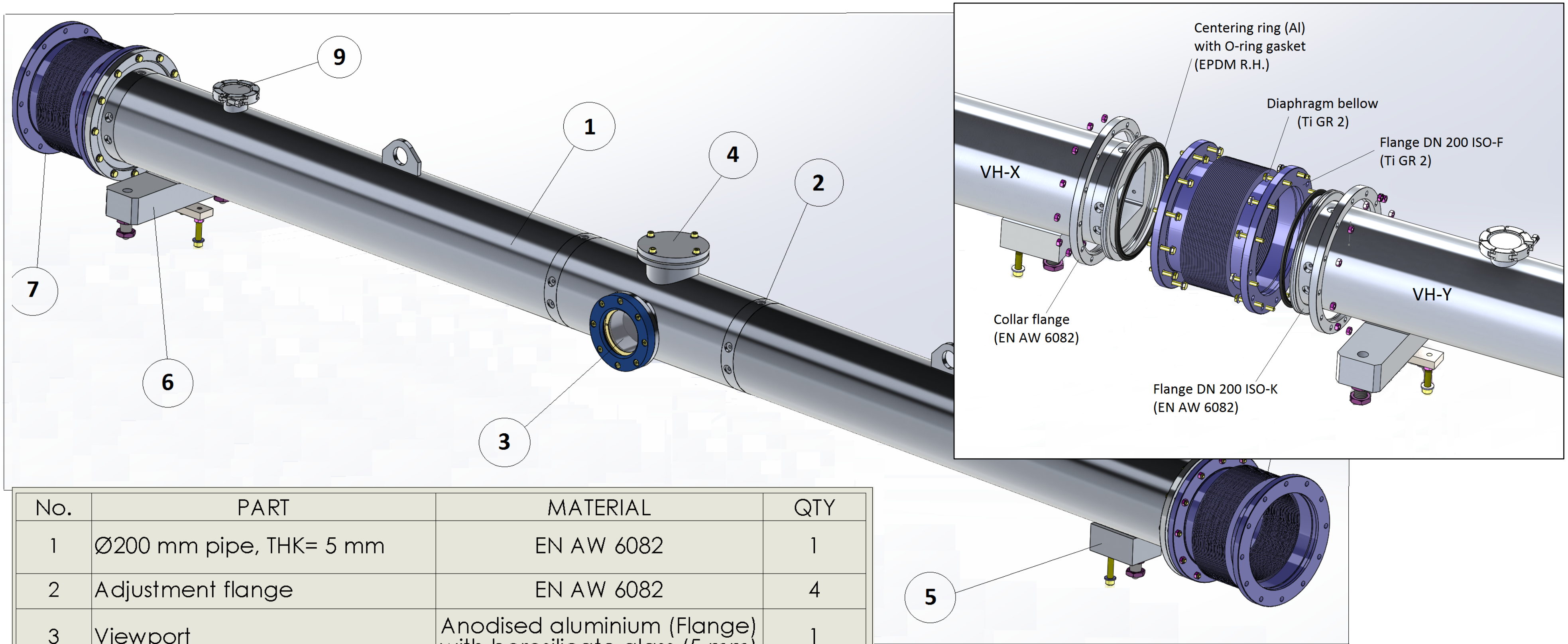
TECHNISCHE UNIVERSITÄT MÜNCHEN

Orphée Laboratoire Léon Brillouin

EUROPEAN SPALLATION SOURCE

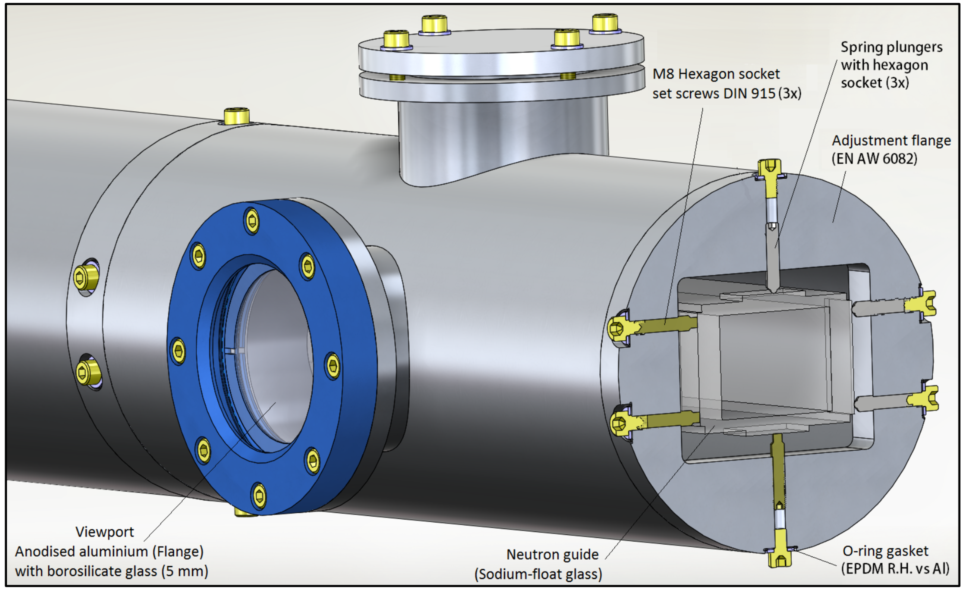
Vacuum housing: Careful consideration of materials (Ti bellows)

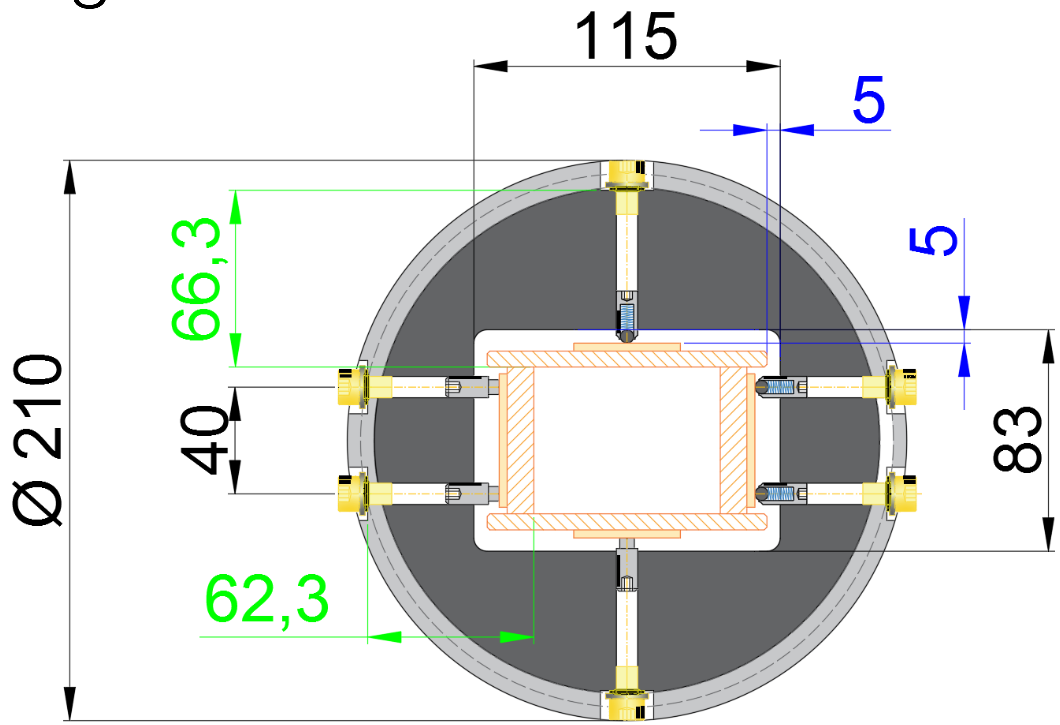
Laser tracking ports: Borosilicate glass, Alignment procedures: 3 point positioning.



No.	PART	MATERIAL	QTY
1	Ø200 mm pipe, THK= 5 mm	EN AW 6082	1
2	Adjustment flange	EN AW 6082	4
3	Viewport	Anodised aluminium (Flange) with borosilicate glass (5 mm)	1
4	Access flange for Laser Tracker	EN AW 6082	1
5	Load attachment plate	EN AW 6082	1
6	Load attachment plate	EN AW 6082	1
7	Diaphragm bellow	Titanium grade 2	2

Radiation Hard EPDM or metallic gaskets?





Rad hard EPDM: tested up to 1.6MGray (10 % loss of functional parameters)

1.6 MGray = 15 m on CSPEC (10 yrs), 6.6 MGray @ 9.9 m (10 yrs).
5-10 cm away from direct beam, Remains functional?

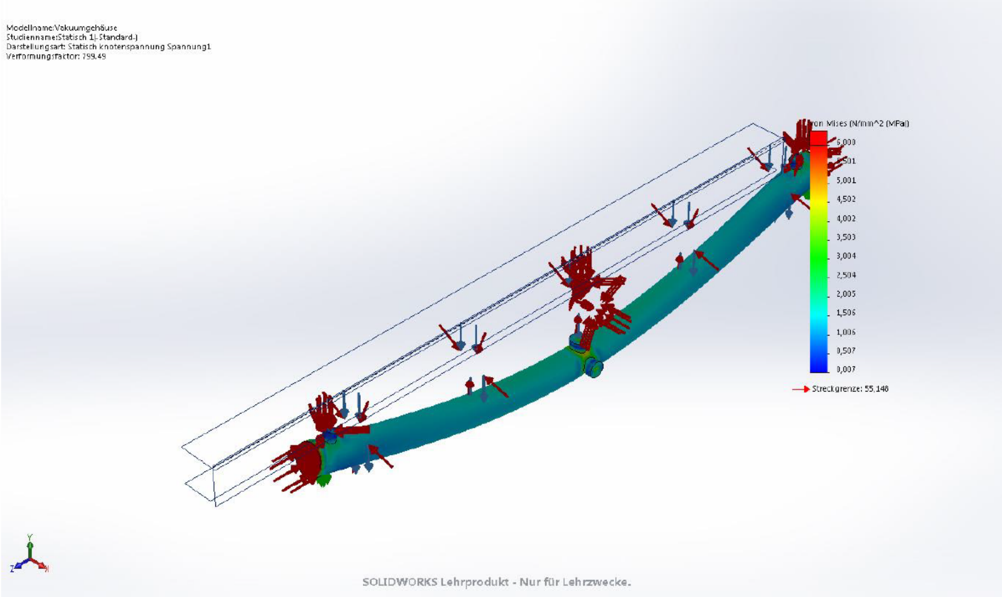
ESS: Beyond 61 mm from beam - hard rad EPDM allowed.

CSPEC

Vacuum housing (4.2 m): EN AW 6082

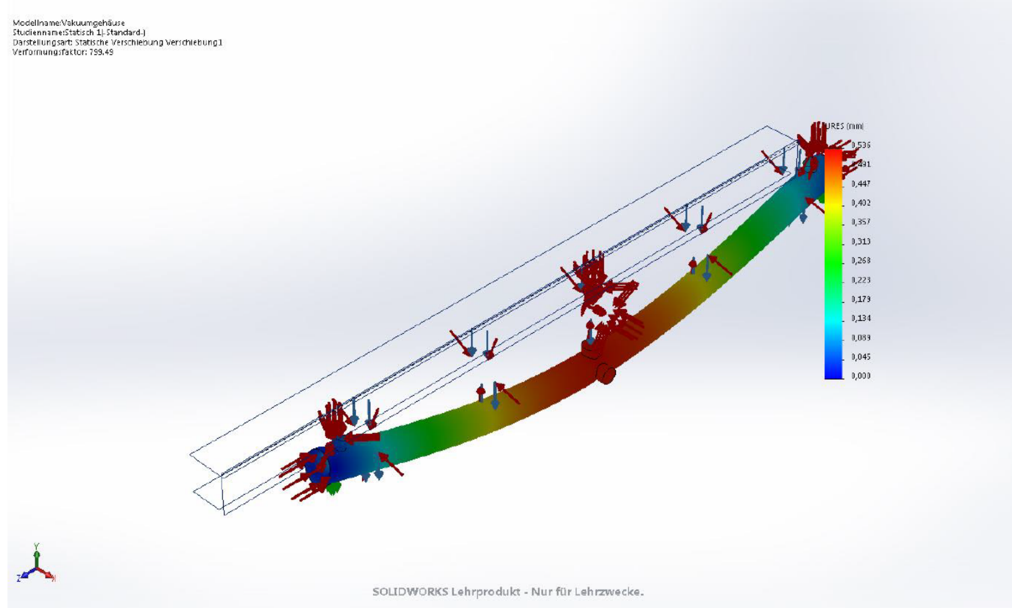
Strength/deformation calculations:
Tube transportation?

Ergebnisse untersuchen



Vakuumgehäuse-Statisch 1-Spannung-Spannung1

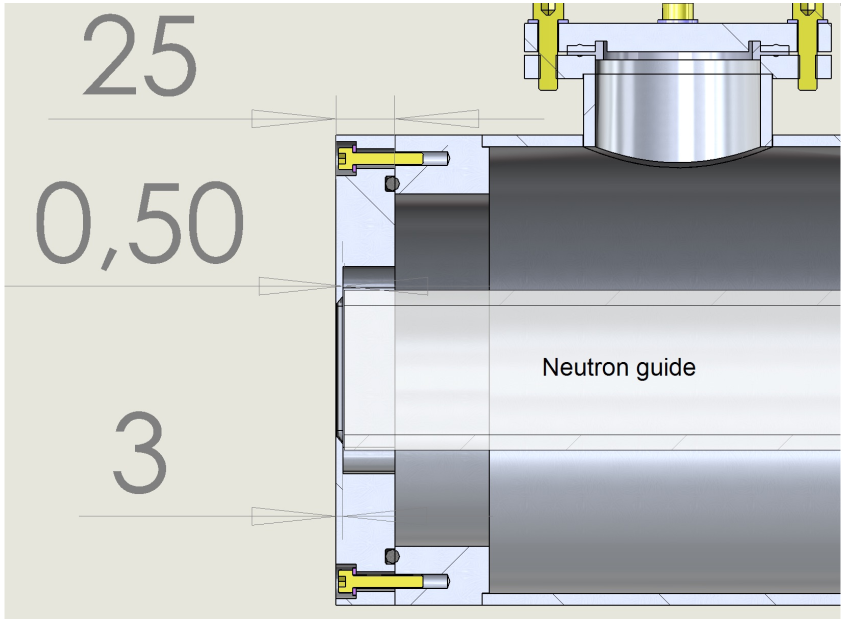
Name	Typ	Min.	Max.
Spannung1	VON: Von-Mises-Spannung	0,007 N/mm^2 (MPa) Knoten: 27925	18,648 N/mm^2 (MPa) Knoten: 5393

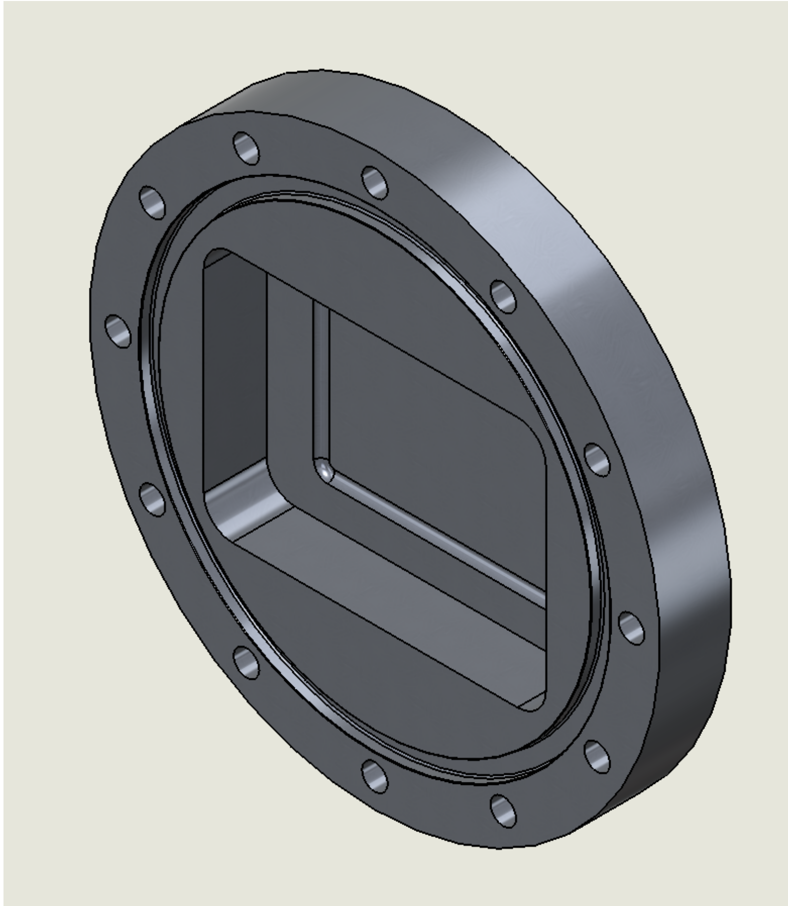


Vakuumgehäuse-Statisch 1-Verschiebung-Verschiebung1

Name	Typ	Min.	Max.
Verschiebung1	URES: Resultierende Verschiebung	0,000 mm Knoten: 3721	0,536 mm Knoten: 9142

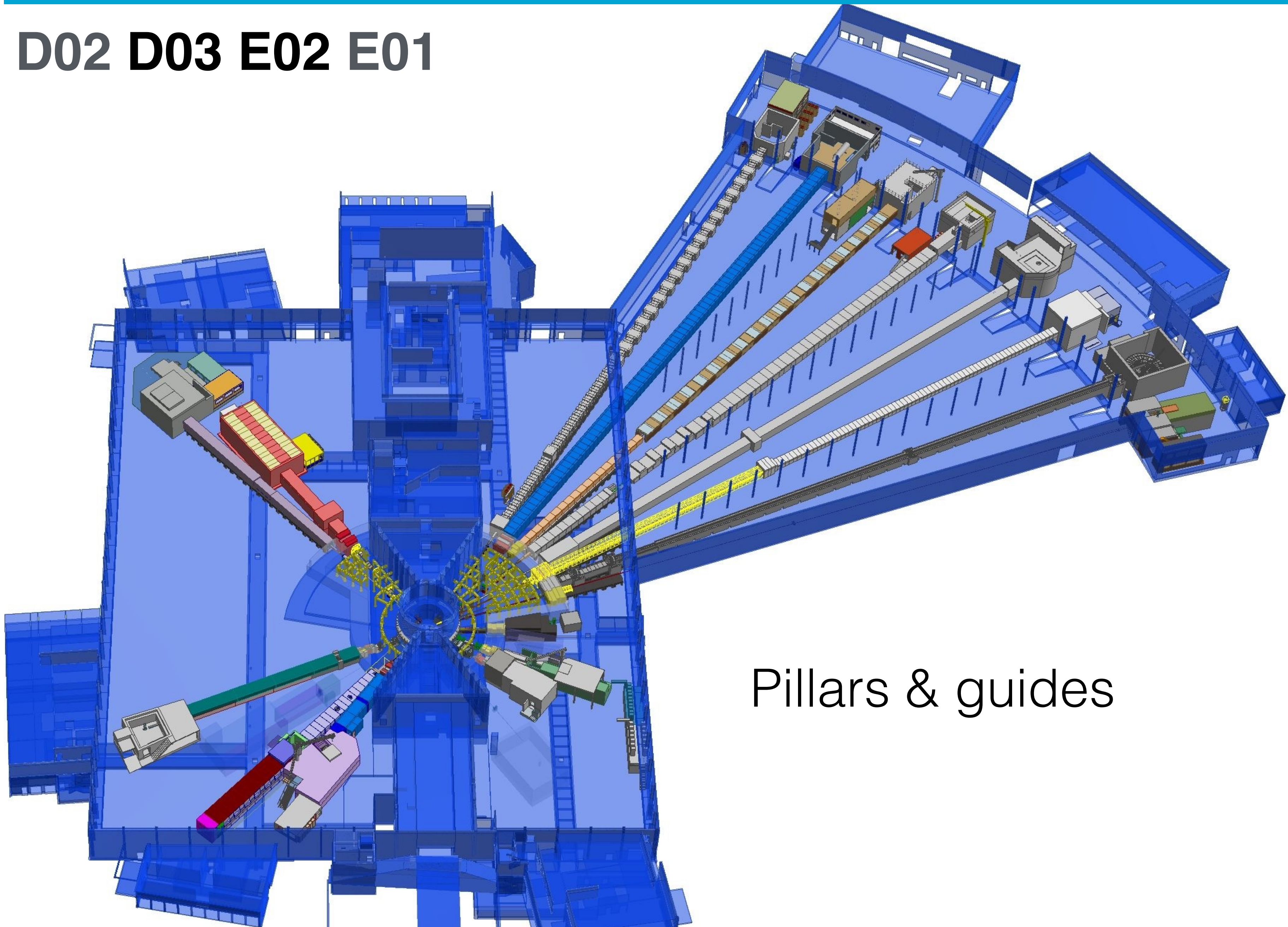
Minimise guide windows.





0.5 mm Al windows (Al 2024) FEA calculation show failure
Yet in operation at ISIS.
CSPEC will develop & test prototype.

D02 D03 E02 E01

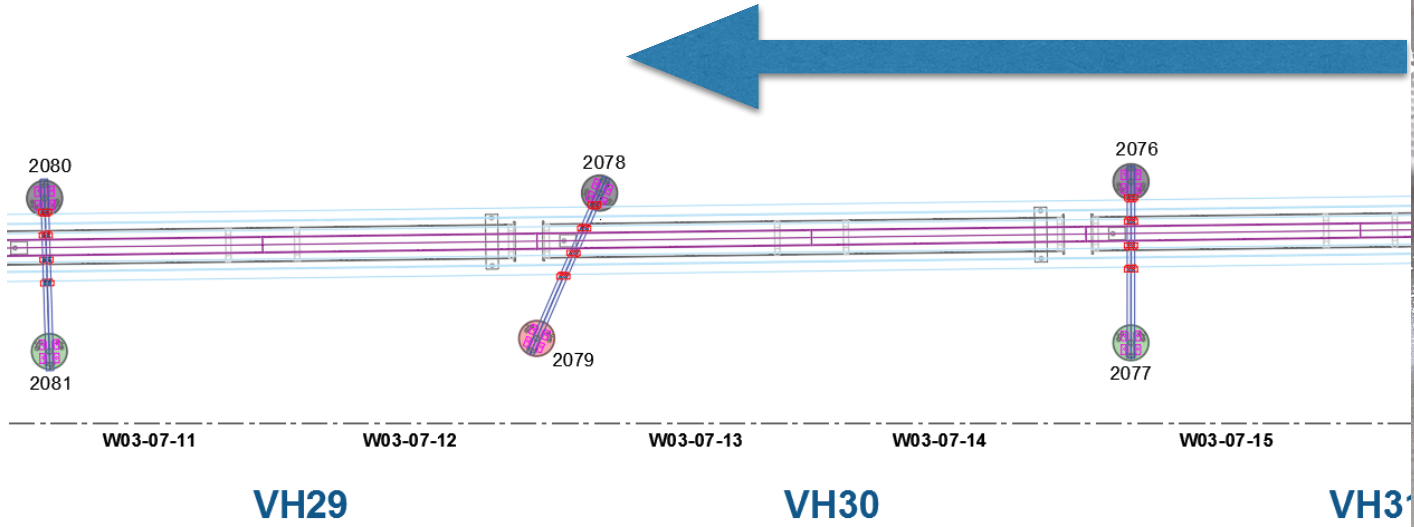


Pillars & guides

Guide & Vacuum system out of bunker

Pile positions

E02

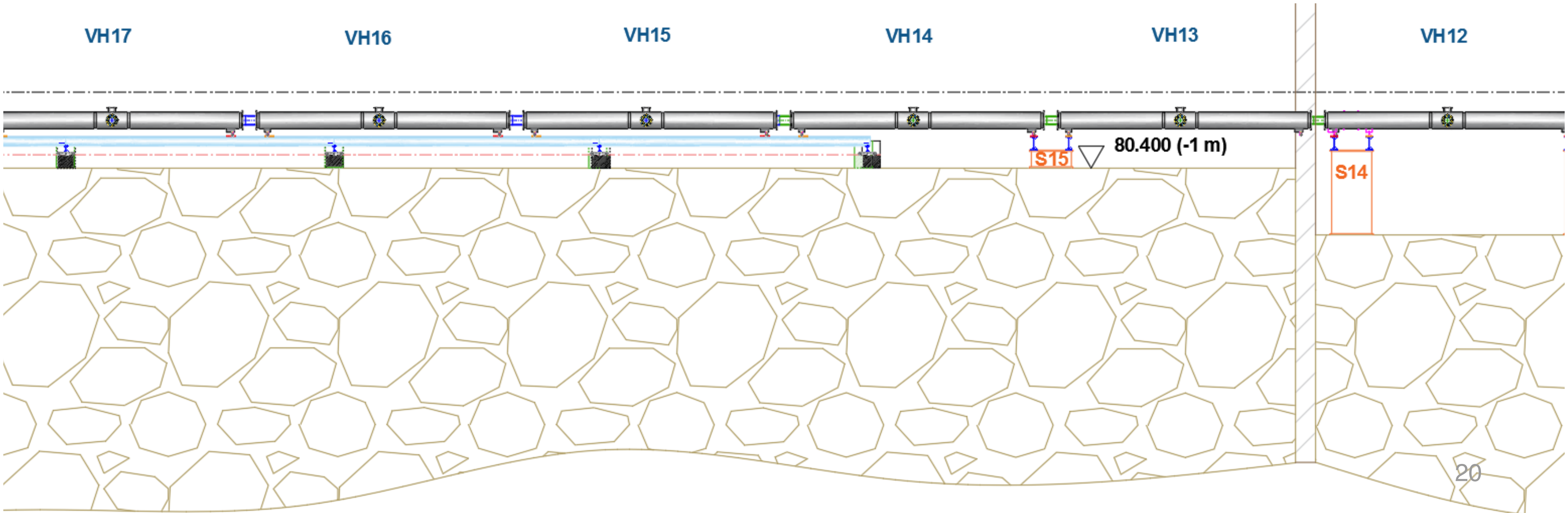


Supporting piles: need precise ISCS/ TCS positions
Working closely with F. Rey. (Skanska info not enough.)

Guide & Vacuum system out of bunker

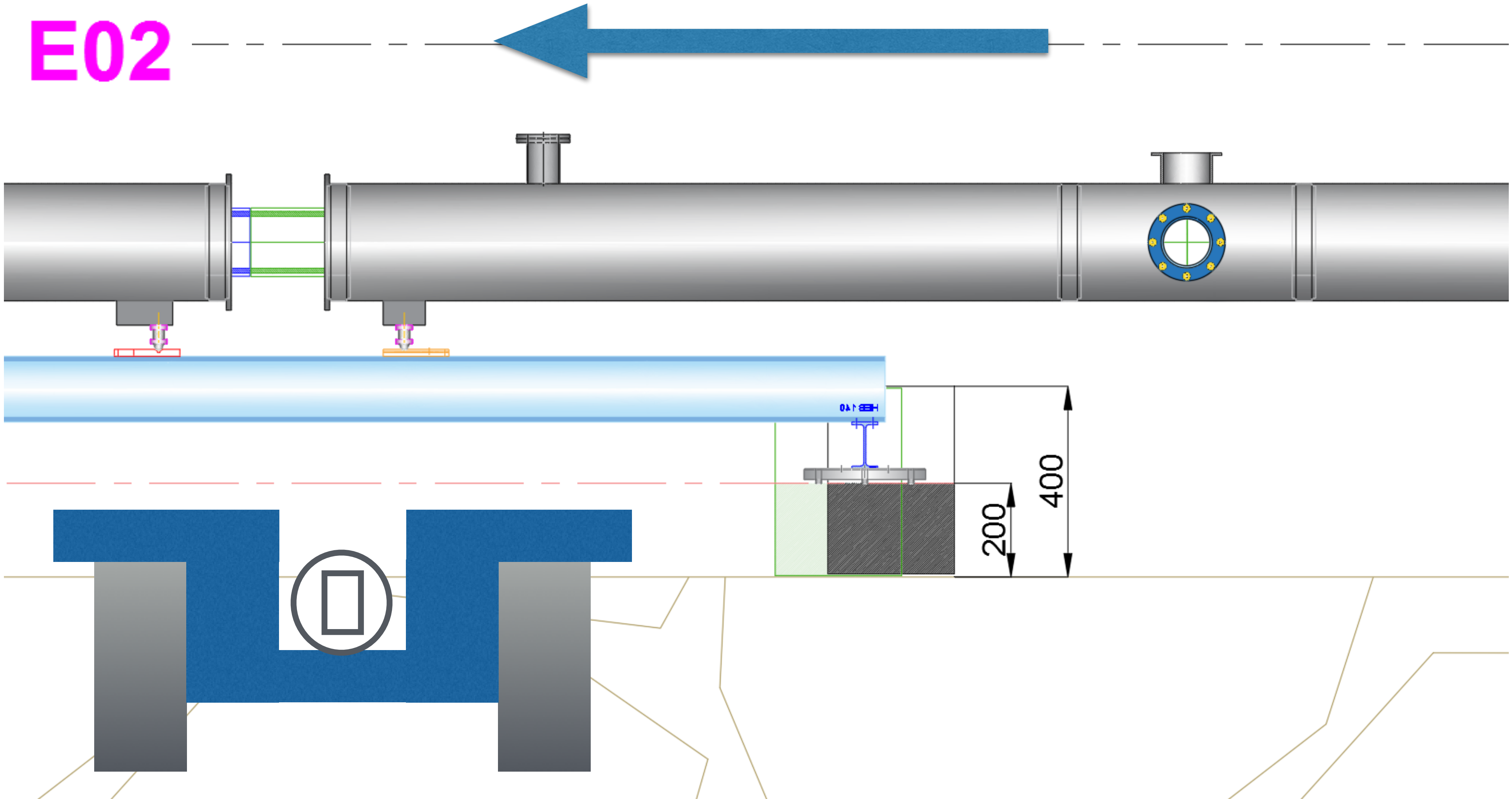
Pile heights: E02 (40 cm)

E02 ← D03



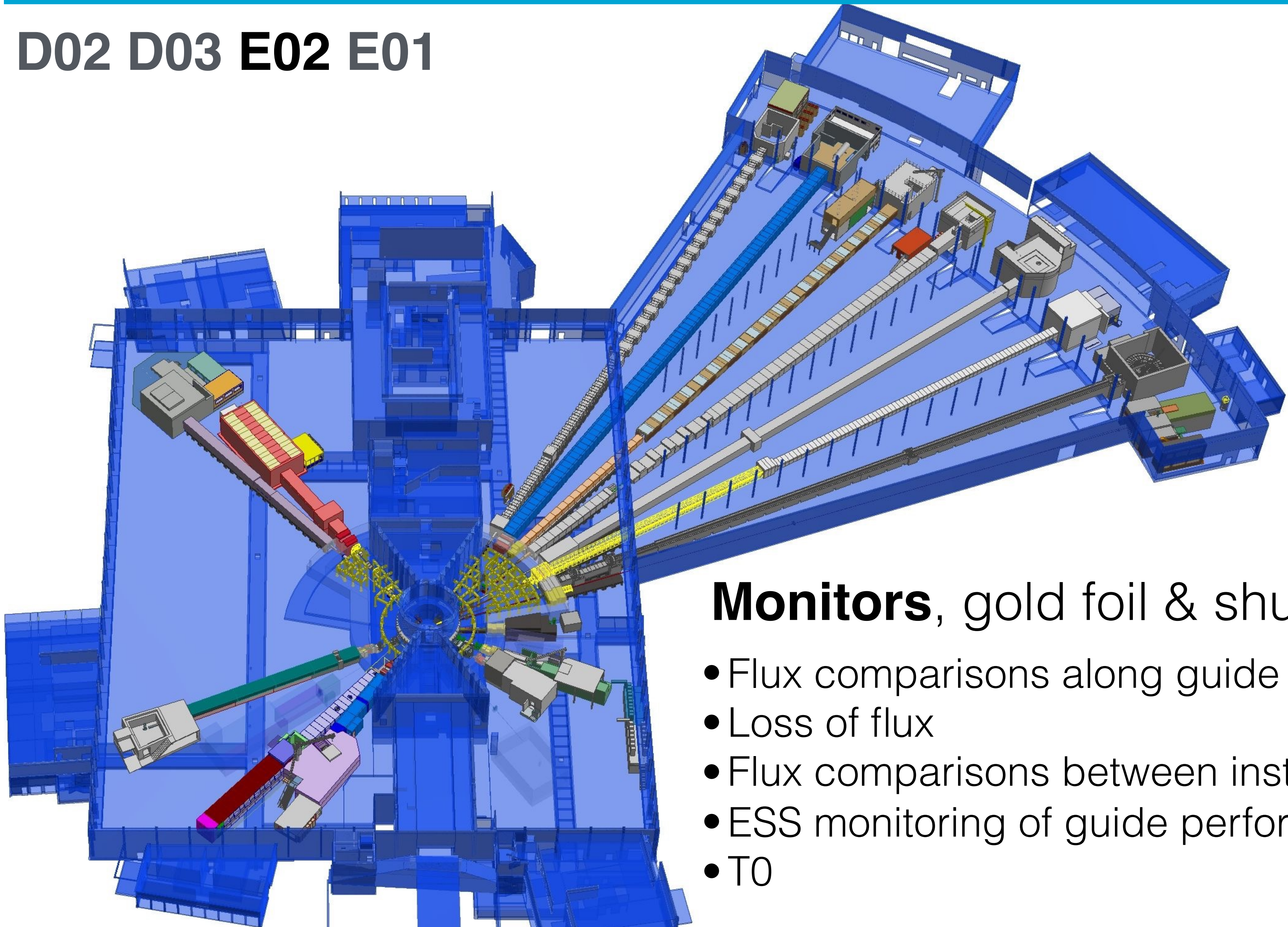
Guide & Vacuum system out of bunker

Supporting piles: E02 (currently 40 cm)



CSPEC

D02 D03 **E02** E01



Monitors, gold foil & shutters

- Flux comparisons along guide
- Loss of flux
- Flux comparisons between instrument
- ESS monitoring of guide performance
- T0

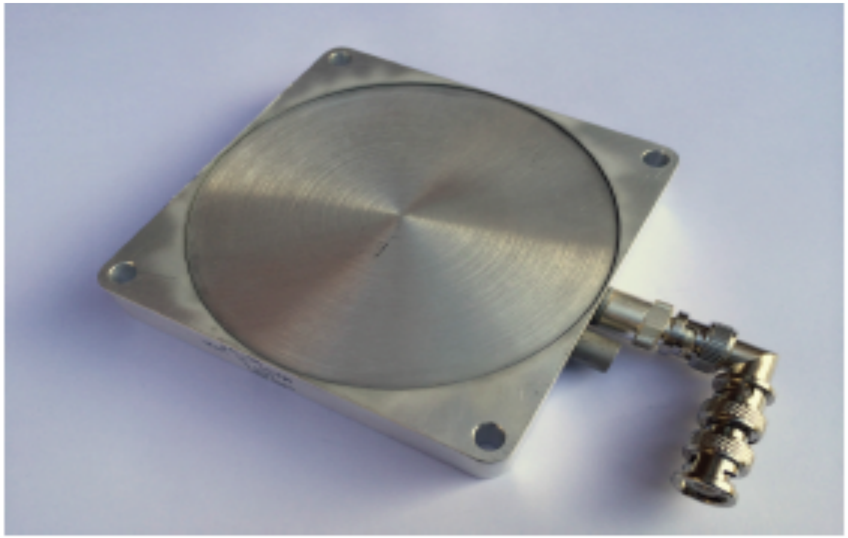
CSPEC: Monitors

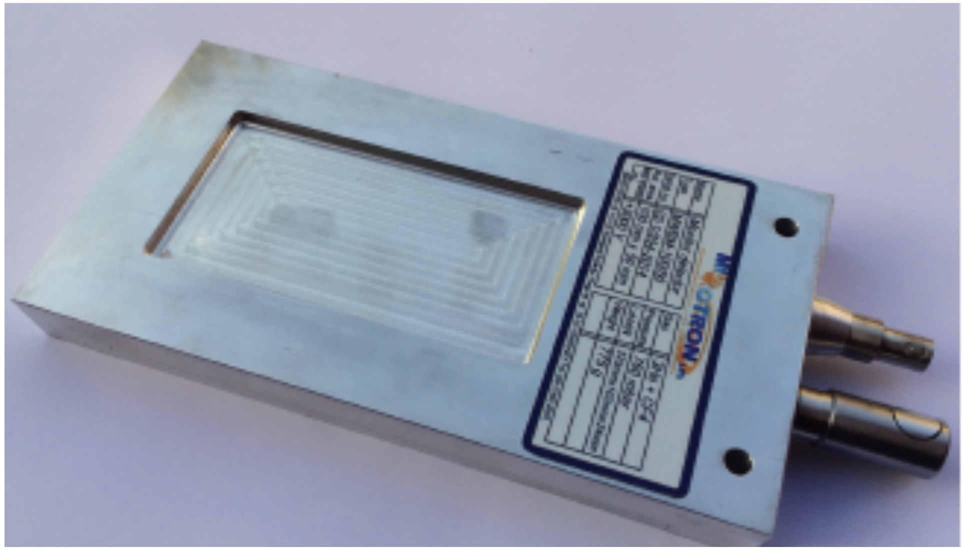
Component	Position from moderator (m)	Guide Dimensions (Height x Width) (cm)	Monitor Type	Removeable	Time resolution	Spatial resolution	Vacuum	Flux n/s Max flux (3 Å) BW only on
BW1	15.2	7x5.5						2.7e11
BW2	20.4	7x5.5						1.9e11
End of bunker wall	28m	7x**5.5**	Scintillator/ MWPC/ Fission Gold Foil	Yes	10 muS	No	No	
BW3/PS	105.667	11.467x**7.39**	Scintillator/ MWPC/ Fission Gold Foil	Yes	10 muS	No	No	2.9e10
M	158.5	4x**2.148**	Li Scintillator	No	1 muS	No	Yes	1e10
Sample	160	5 x 3	MWPC	Yes	1 muS	Yes	No	9e9

CSPEC

Monitor Manufacturer	Scintillator QD	Fission chamber LND
Active element	^{6}Li	^{235}U
Active area (mm)	28x42	100x100
Window thickness (mm)	0.1	1

Monitor Manufacturer	MWPC ORDELA	MWPC ORDELA	MWPC Mirrotron	2D-MWPC Mirrotron
Active element	^{3}He	^{14}N	^{3}He	^{3}He
Active area (mm)	114x51	114x51	100x50	100x50
Window thickness (mm)	2	2	1	1





Efficiency: 1e-04

Scattering:3.8% - tests more

Measured Attenuation at 2.4 Ang: 3.8%

Monitors for ESS

Efficiencies too low (Saturation).
Attenuation too high (Loss of flux).

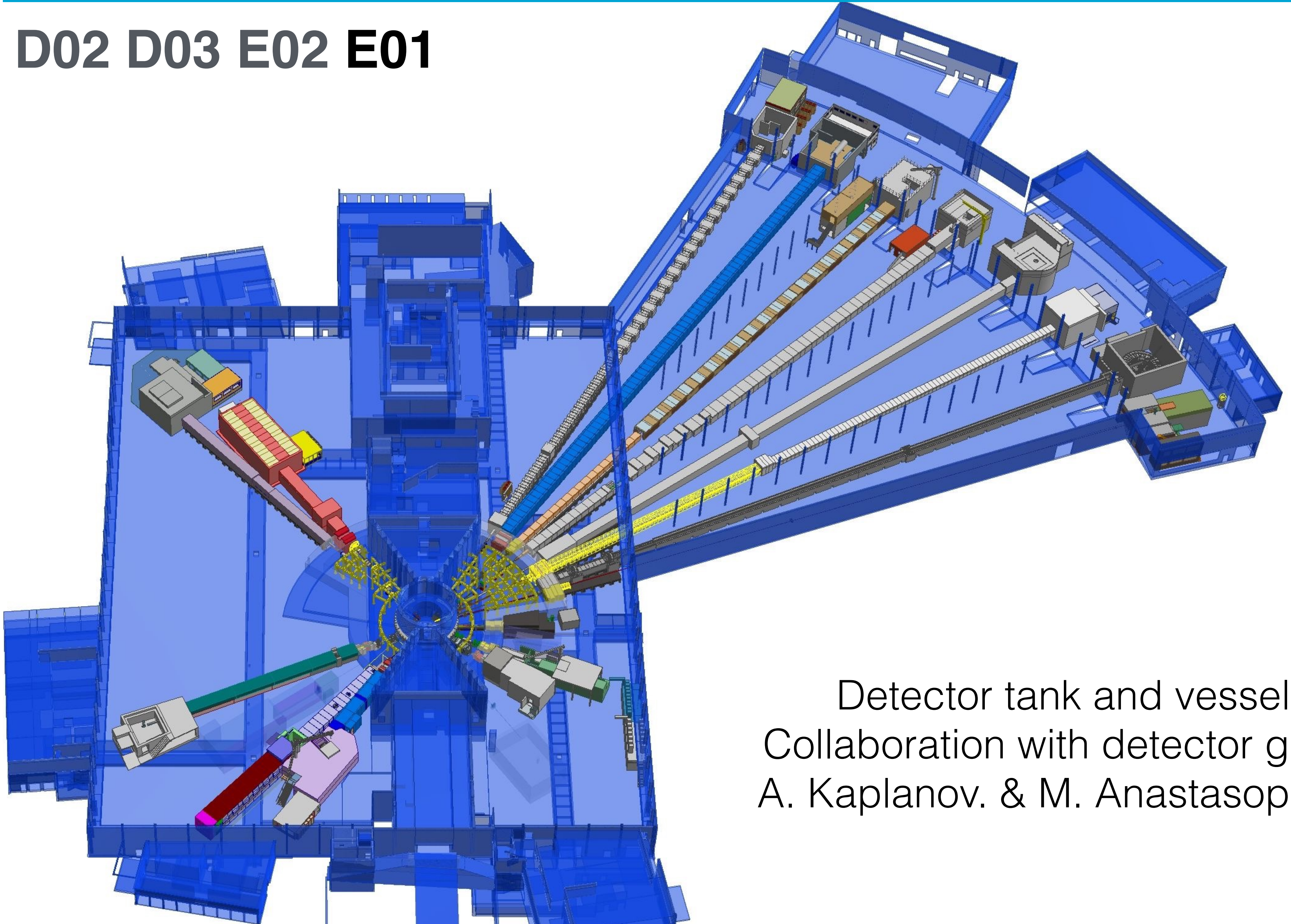
No solution for in-bunker monitors @ SNS
New technologies: CASCADE detectors, ISIS Scintillators, gamma monitors ??

Flux comparisons along the guide/between instruments?
ESS monitoring of guide systems?
Timing?

"Spectroscopy STAP : STAP recommends to ESS management that extra resources are urgently needed in the area of monitors."

CSPEC

D02 D03 E02 **E01**



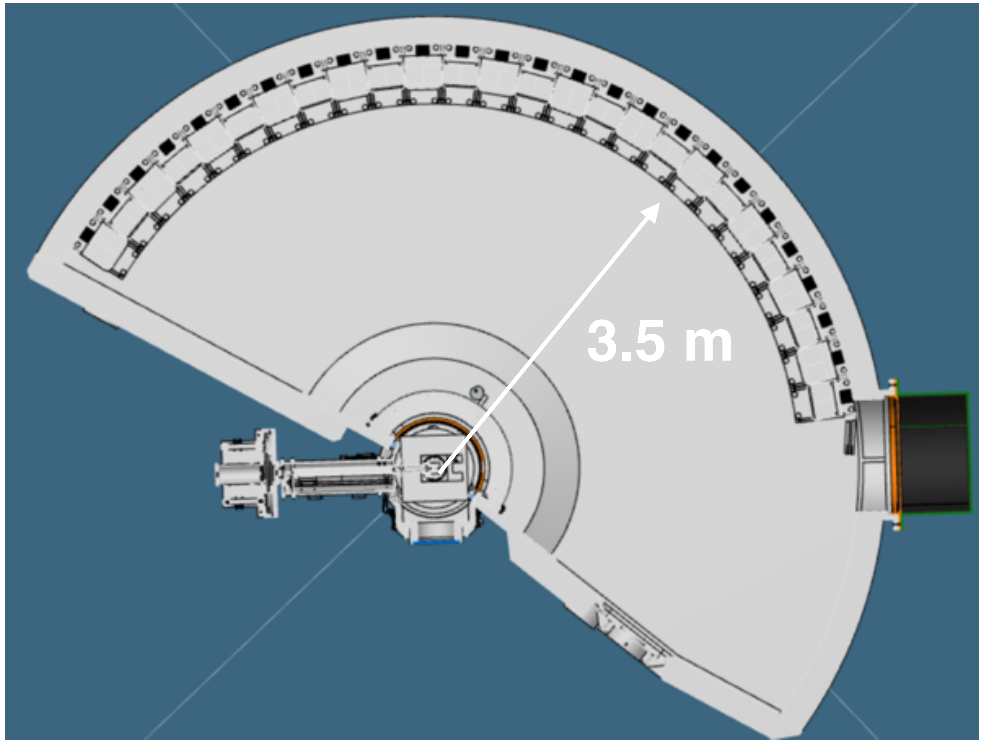
Detector tank and vessels
Collaboration with detector group:
A. Kaplanov. & M. Anastasopolous

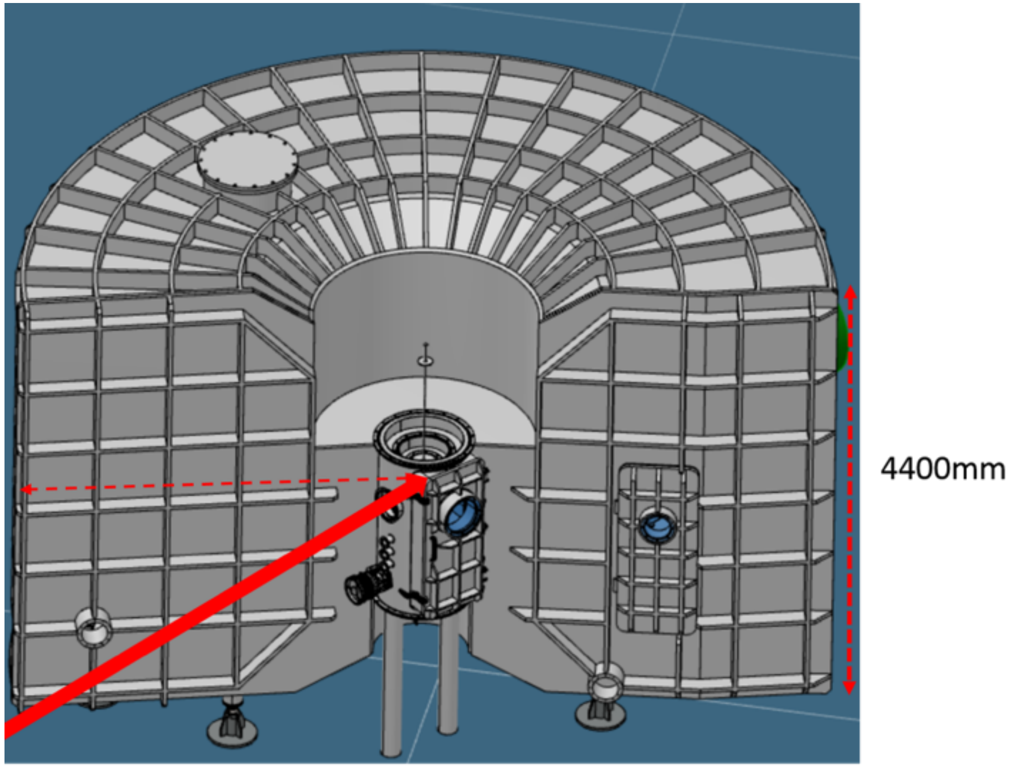
Al Detector tank

Det. Angular range: -30 + 140°, +/- 26.5°

Sample - Detector = 3.5 m

Pressure = 10^{-3} mbar

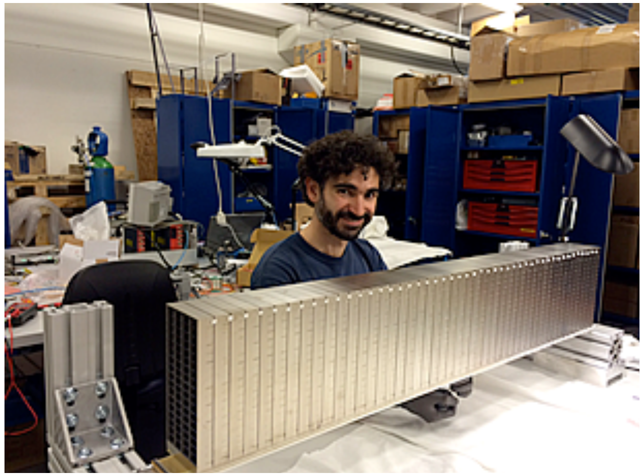


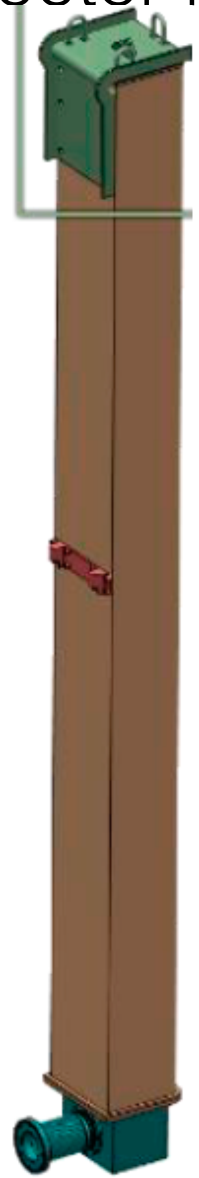


Last window: Monochromatic chopper
Guide exit within sample environment area

Implementation of B^{10} detector array
Sample environment
Optimised for science case.

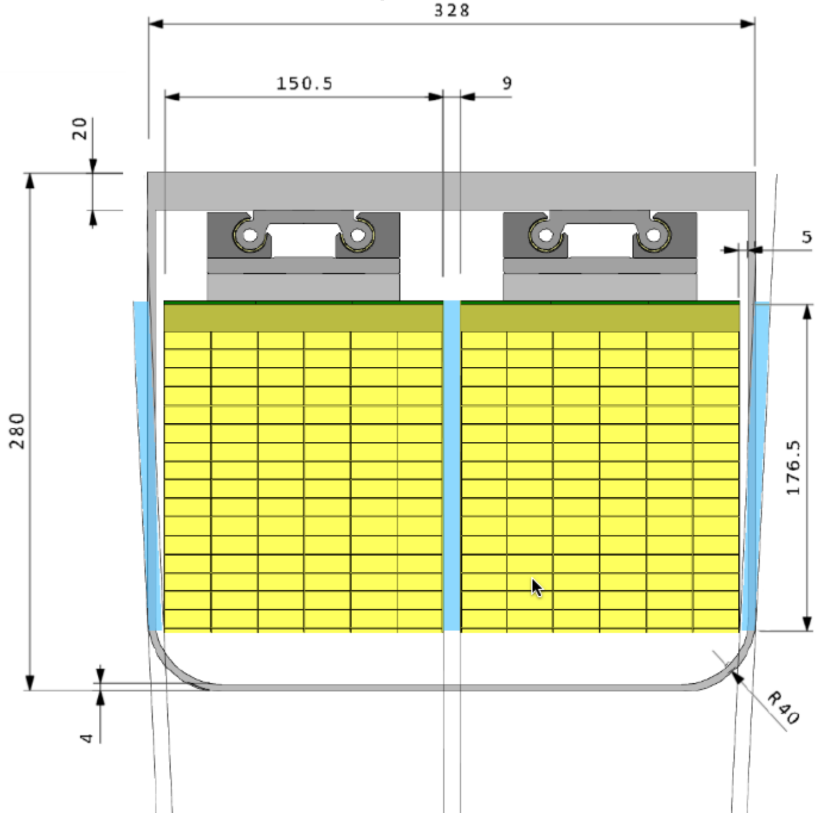
Detector vessels: detector housing of B^{10} detectors





Active height: 3.5 m

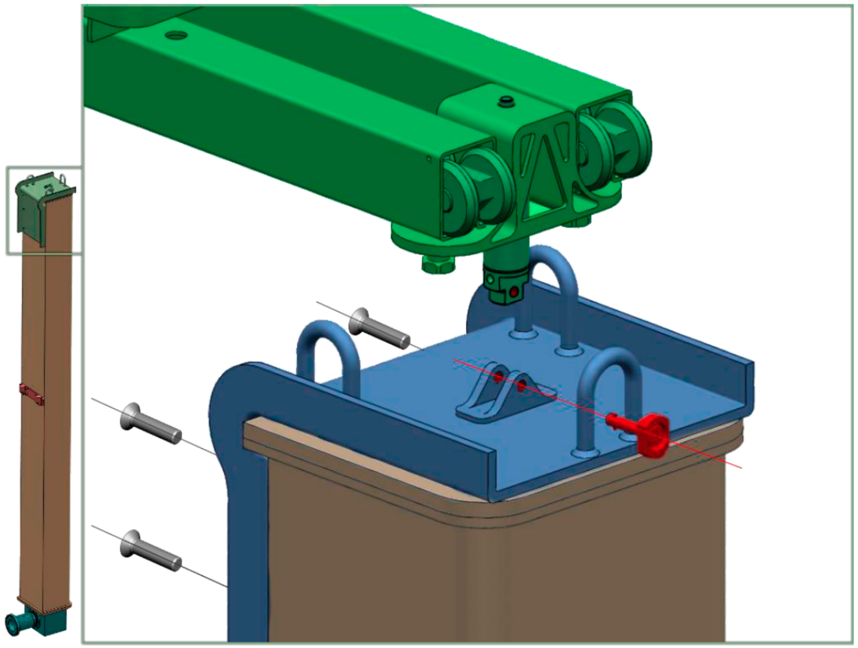
Top view

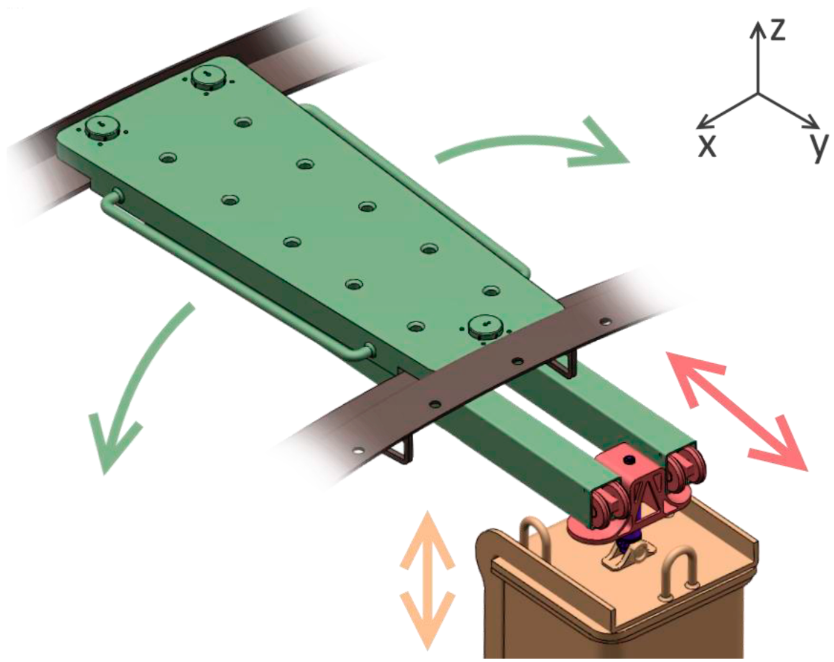


Al window(4 mm)

Detector vessel: Introduction & extraction

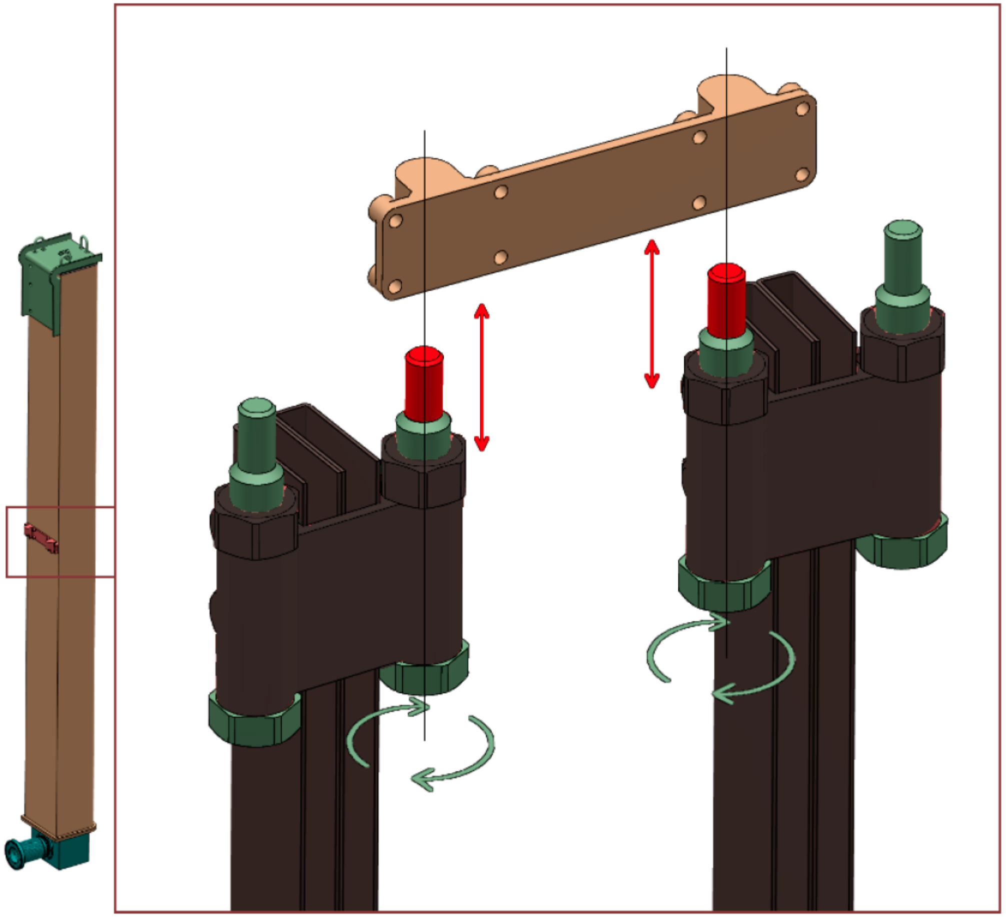
1- Mounting the integration plate onto the detector
2- Mount the integration plate and its detector onto the motion cart
3- Radial, axial positioning by the operator
4- Height adjusting to mount on the detector support with an actuator
5- Custom flange mounting at the back of the vacuum tank for cables feedthrough
6- Front screw tuning to get the detector straight





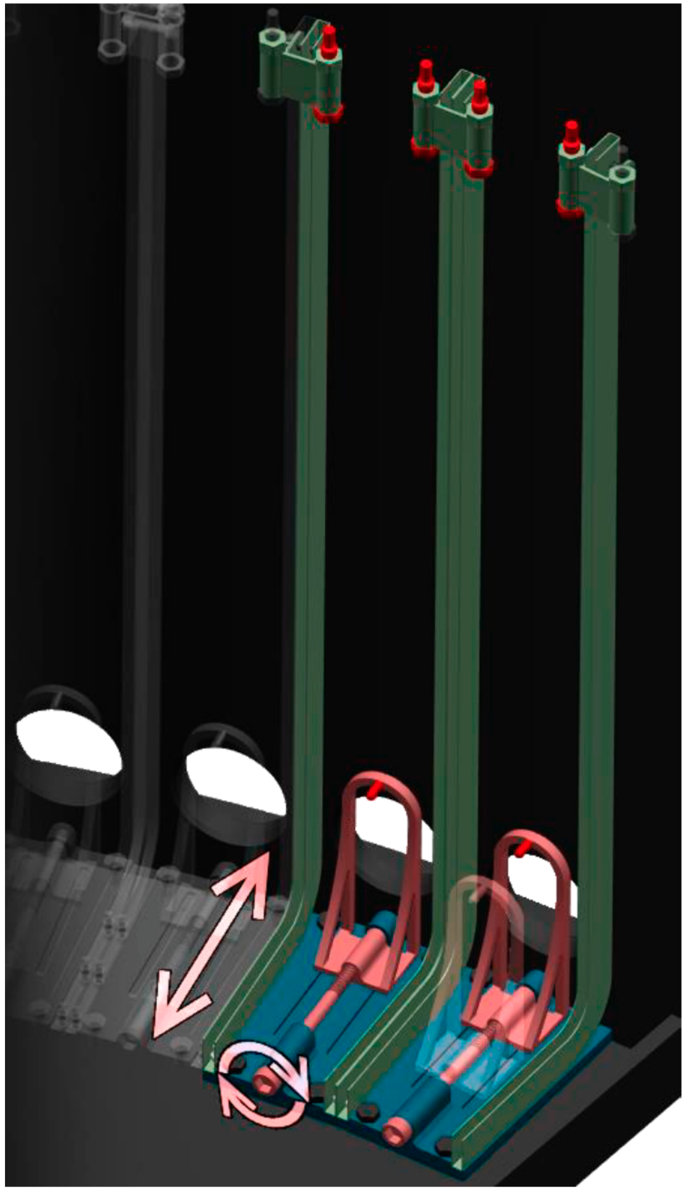
CSPEC

Support at the back

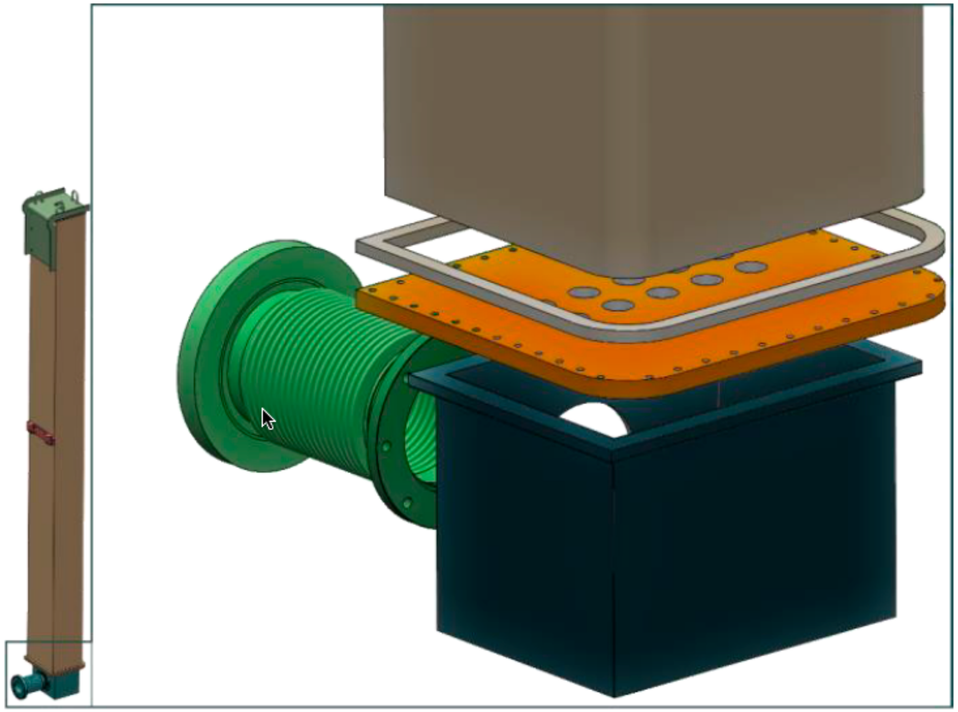


Simple to extract.
More difficult to reposition

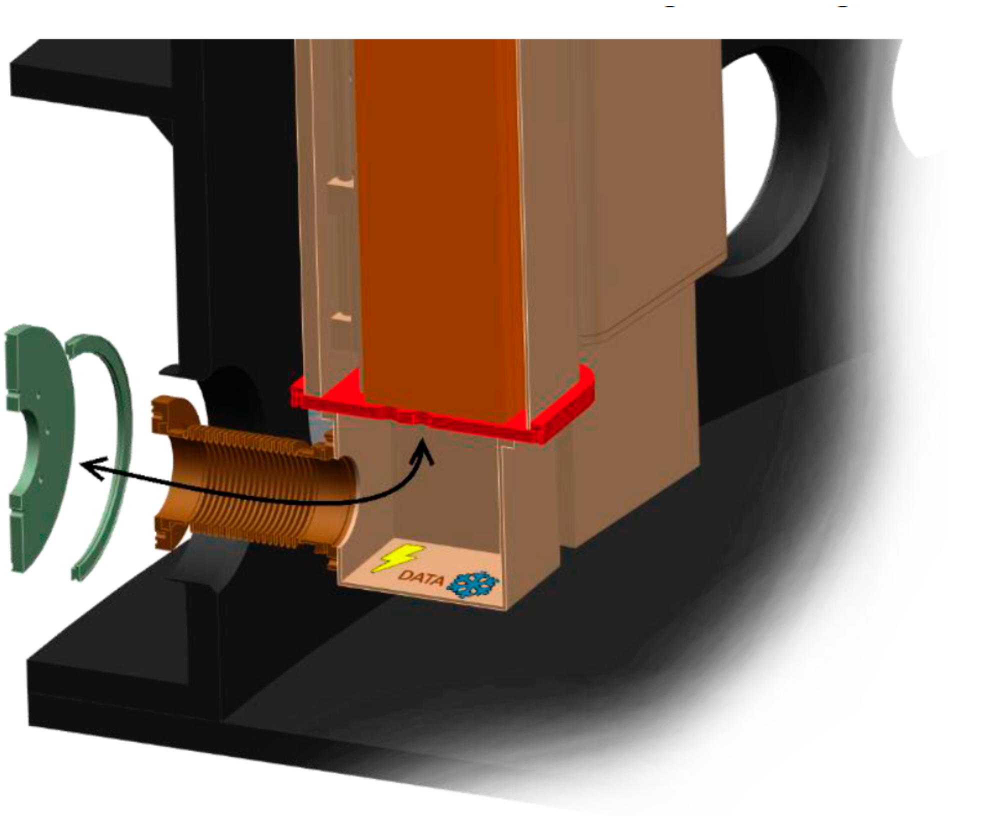
Further alignment



Electronics box



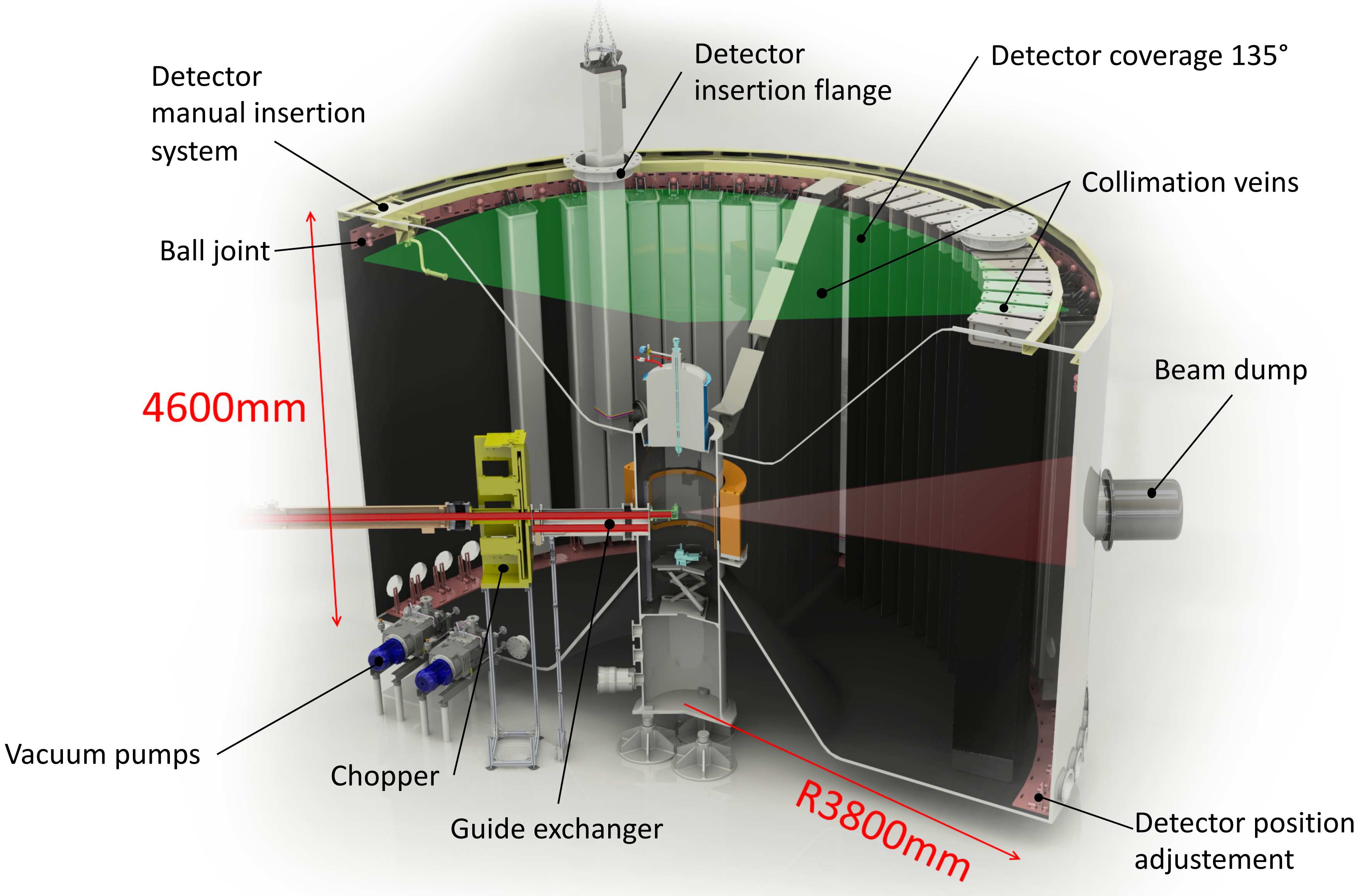
Utilities



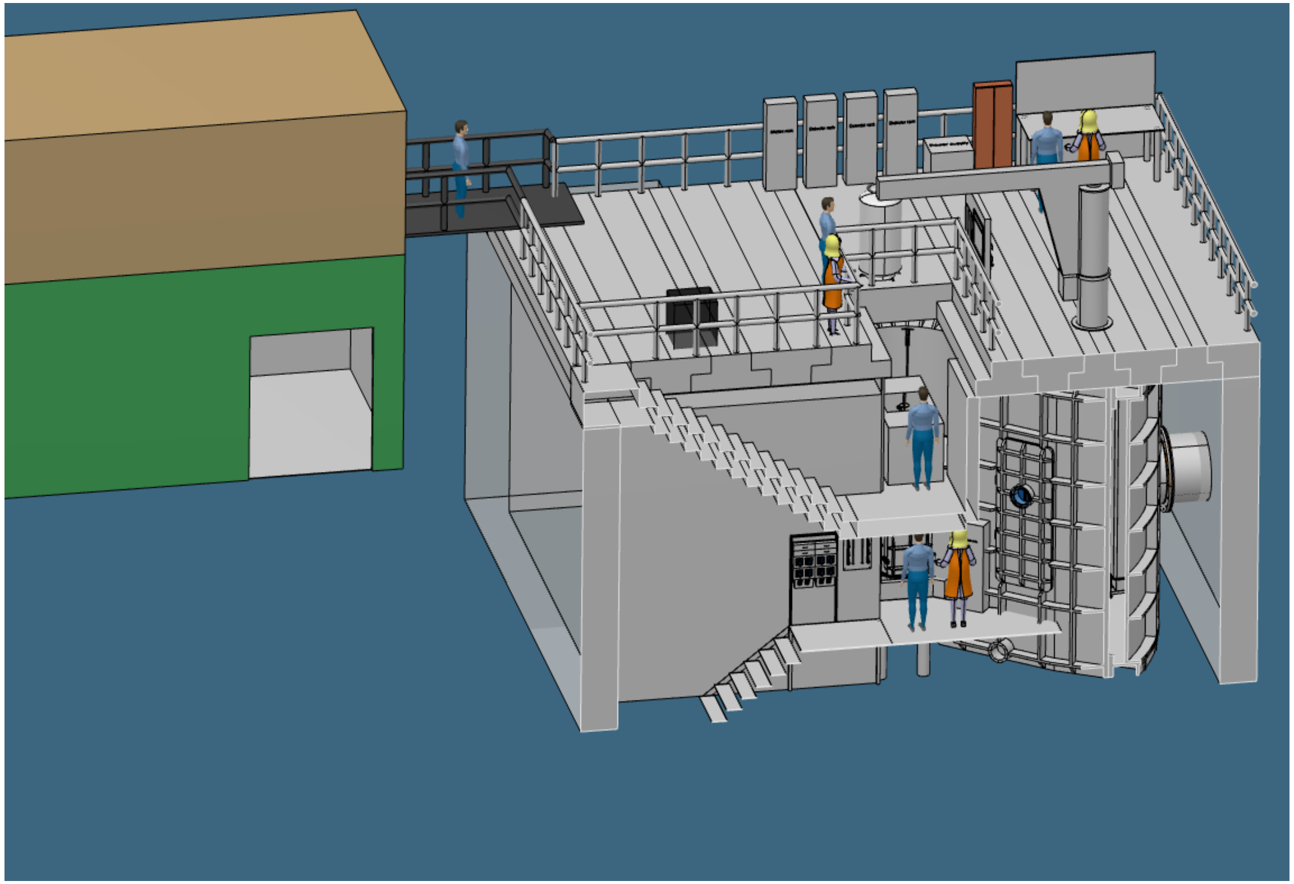
Utilities: optic fibres are required to read out a detector. The fibres, low voltage, high voltage and gas flow cables will be delivered to the detector via the bellows.

mini-TG3 expected in the next few months

Detector vessels in detector tank:



Small comment on shielding for spectrometers



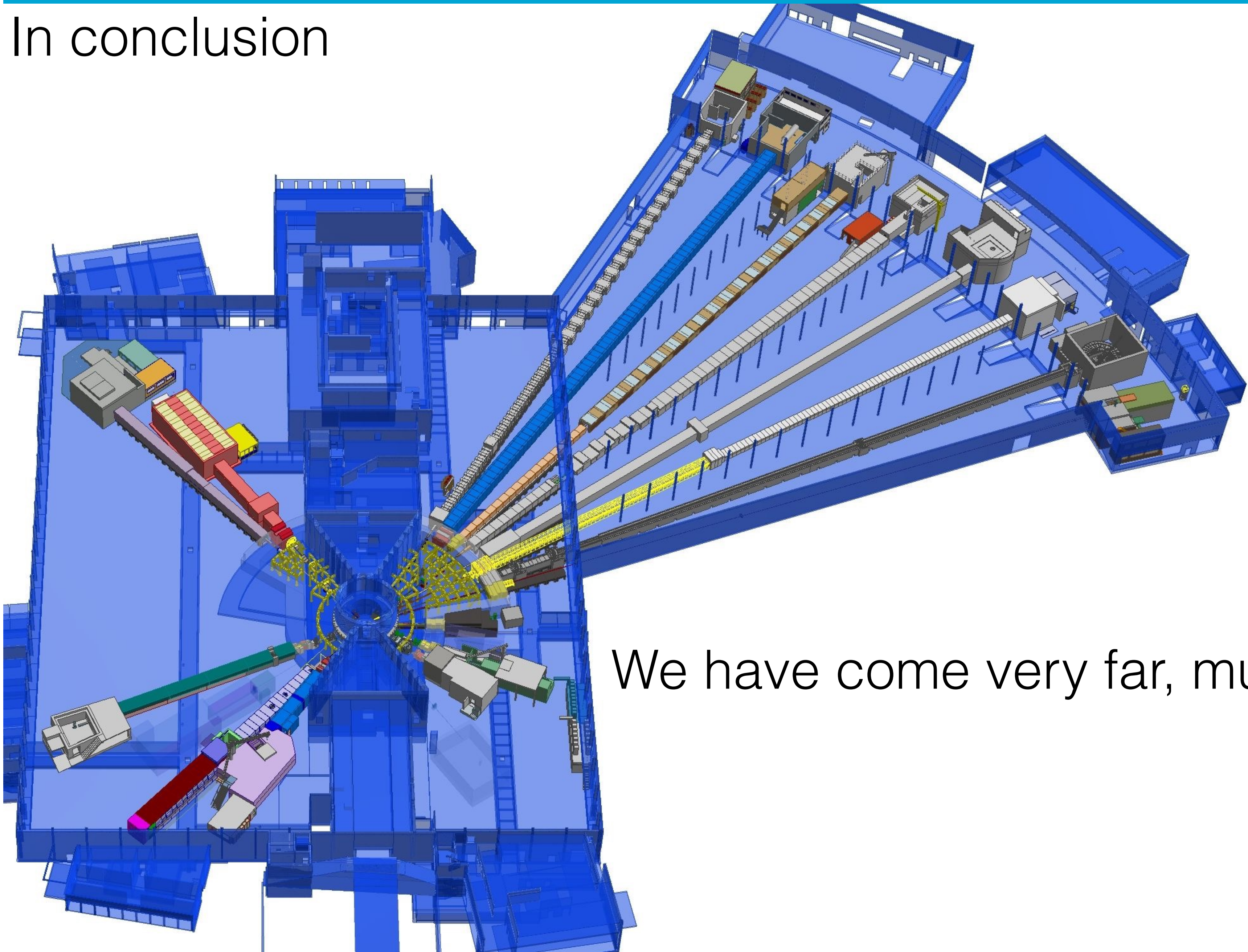
Above & around sample environment: no access during operation.
TG2: opening above sample space accepted - 10 mSv/hr >>>>> 3μSv/hr.
31st May 2018: Bifrost request for official change of requirement.

Some instrument topics

Monolith insert
Guide
Guide alignment
Choppers
Detector
Detector vessel
Sample environment pot
Sample environment
Control cabin
Shielding
Crane coverage
Floor loading …..

PSS
Electrical engineering
Risk assessment
Hazard analysis
Procurement
Assembly
Installation
In-kind consideration …….€

In conclusion



We have come very far, much to do …

CSPEC

- Change of boundary conditions common, need even more effective communication.

- Completed documentation.

- Timely answers and continued discussion.

CSPEC

CSPEC: The cold chopper spectrometer of the ESS

Lead Scientist: P.P.Deen (TUM)
Lead Engineer: Joseph Guyon le Bouffy (LLB)

TUM (50%): W. Lohstroh, L. Laoiza, J. Neuhaus, W. Petry
LLB (50%): S. Longeville, G. Fabrèges, E. Elliot, Alba-Simionesco






& N. Tsapatsaris (ESS), D. DiJulio (ESS), D. Rodriguez(ESS), H. Schneider(ESS), A. Holmes (ESS), A. Sandstrom(ESS), M. Anastasopoulos (ESS),G. Laszlo (ESS), C. Lopez, P. Link (TUM)
H. Meier(TUM), J. Huber (TUM), A. Cazenave (LLB), S. Desert(LLB).