EUROPEAN SPALLATION SOURCE

LoKI Optics & Shielding

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www.europeanspallationsource.se
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LoKI

SANS for Soft Matter, Materials and Bio-Science

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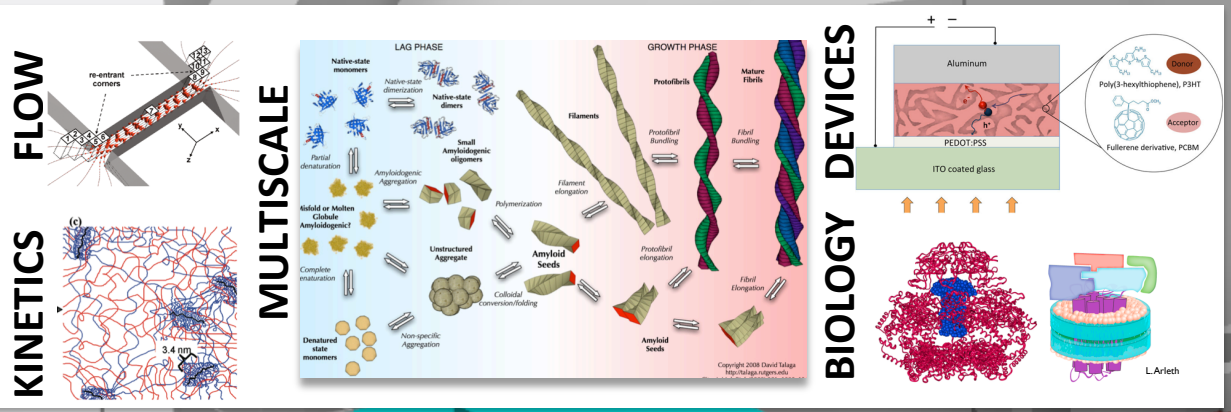
The combination of a **large solid angle** of detectors and a **broad wavelength band** will provide a **world leading** SANS instrument for the ESS.

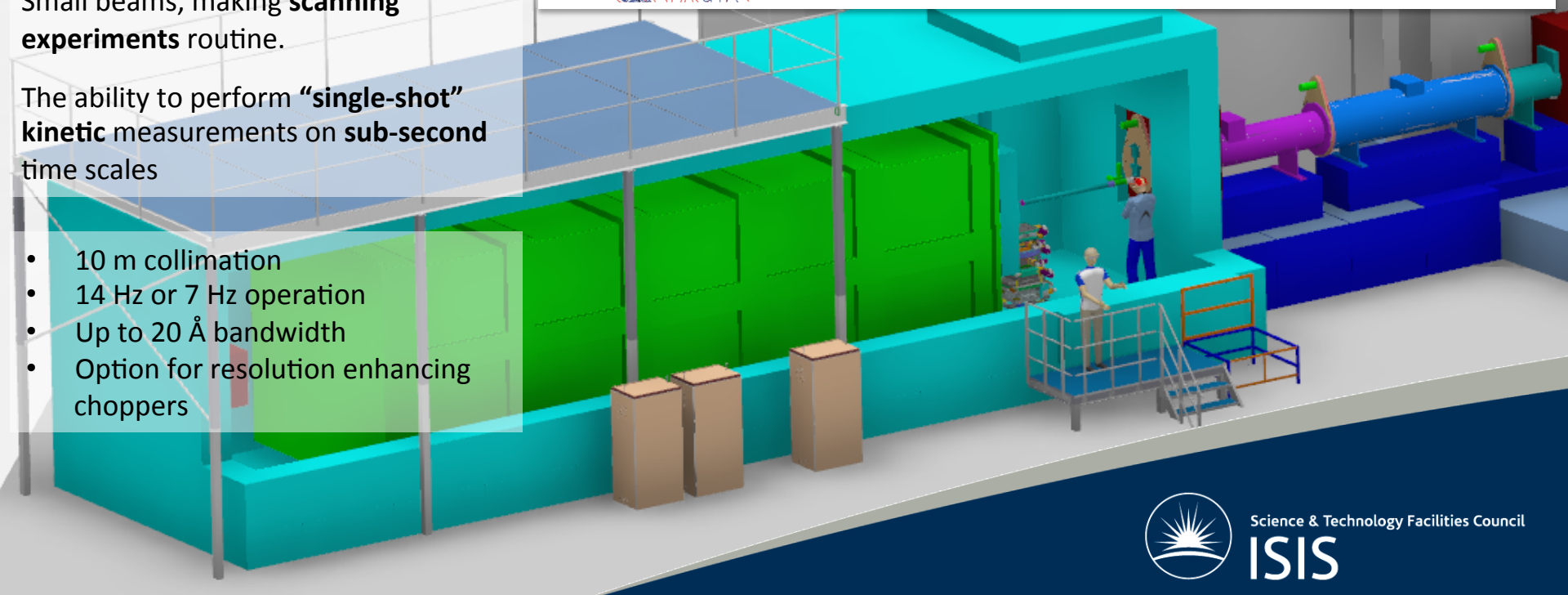
LoKI will have **high flux**, **wide simultaneous size range**, and a **flexible sample area**.

Small beams, making **scanning experiments** routine.

The ability to perform **"single-shot" kinetic** measurements on **sub-second** time scales

- 10 m collimation
- 14 Hz or 7 Hz operation
- Up to 20 Å bandwidth
- Option for resolution enhancing choppers





Science & Technology Facilities Council
ISIS

Requirements

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A broad Q range, high flux SANS instrument for soft matter, materials & bio-science

High-level Scientific Requirements for the Instrument

- The instrument shall allow data to be collected to a Q_{min} of < 0.001 $Å^{-1}$.
- The instrument shall allow data to be collected to a Q_{max} of > 2 $Å^{-1}$.
- The instrument shall allow data to be collected simultaneously over a continuous Q range with Q_{max}/Q_{min} > 1000.
- The instrument shall match the size of the neutron beam to the size of the sample.
- The instrument should allow the Q resolution (dQ/Q) to be optimised for the experiment.
- The instrument should be capable of providing a Q resolution < 10% dQ/Q over the whole Q range.
- The instrument should allow data collection from samples < 8 mm^3 volume

Optics / Shielding Philosophy

- Following NOSG advice
- 2 x line of sight before collimation
- Combination of
  - Close shielding
  - Collimation collars
  - Open space (chopper pits originally, now whole bunker)

- Collimator drums with laminate structure to reduce background

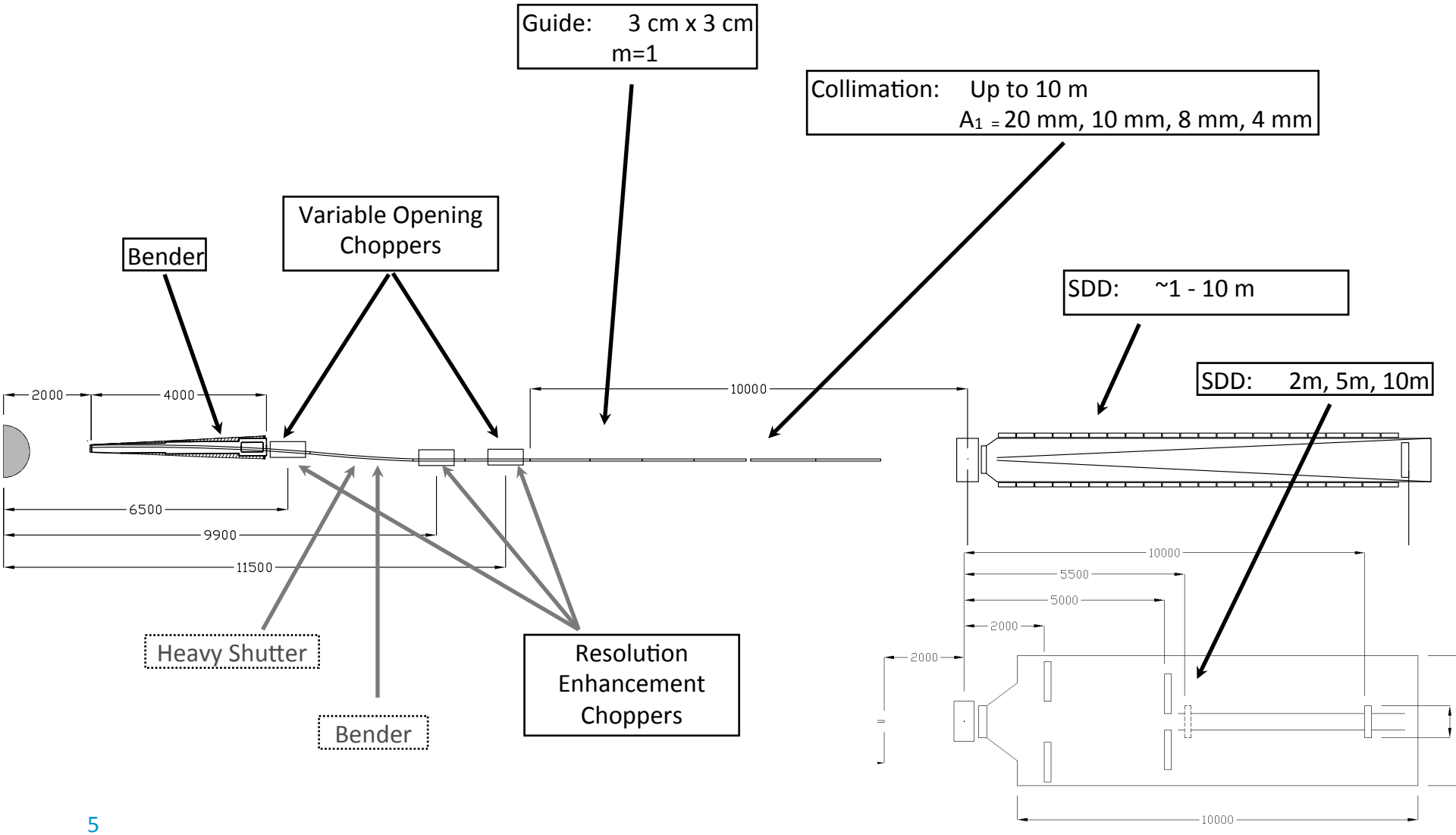
- Concrete + Steel over collimators

- Steel + Wax cave

- Lead as needed

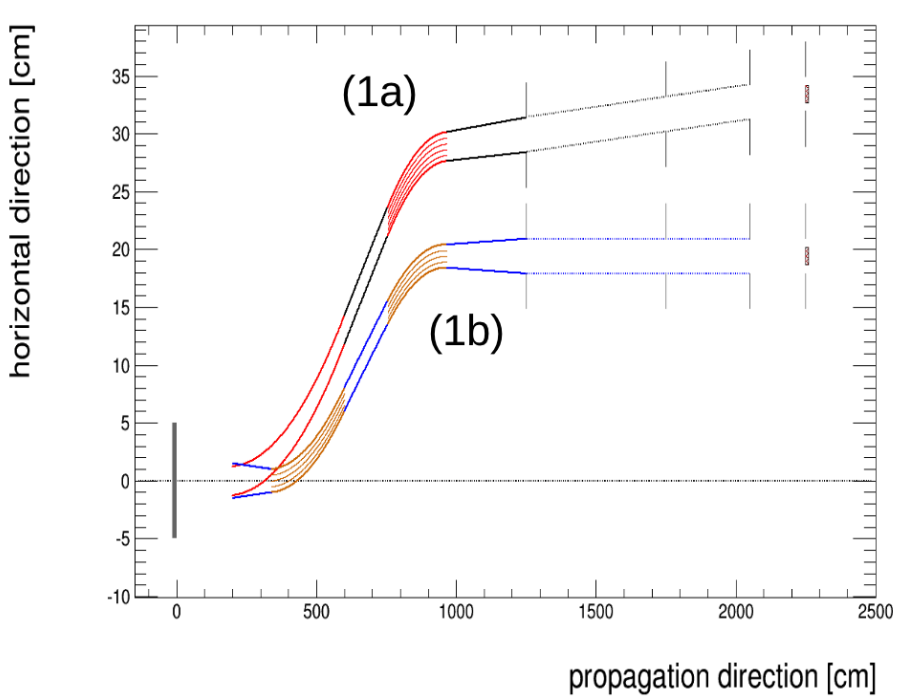
- Iterate through neutronics simulations and engineering design

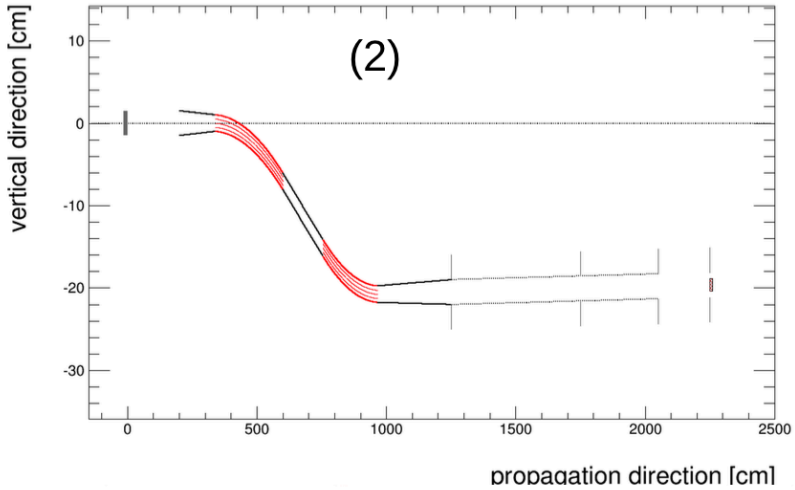
2014 – TG2 – Pre Bunker Redesign

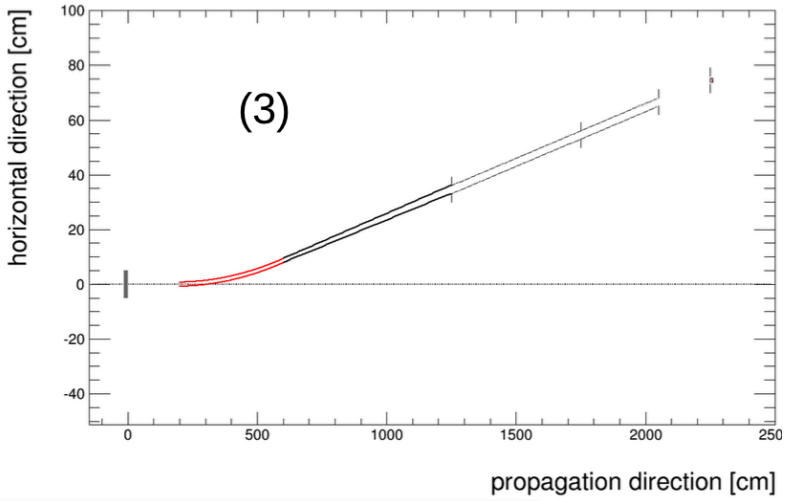


Optics Optimisation

Optics TAP advised that we should take 2x line-of-sight as our baseline and use integrated optics/shielding simulations next year to see if we can relax that requirement





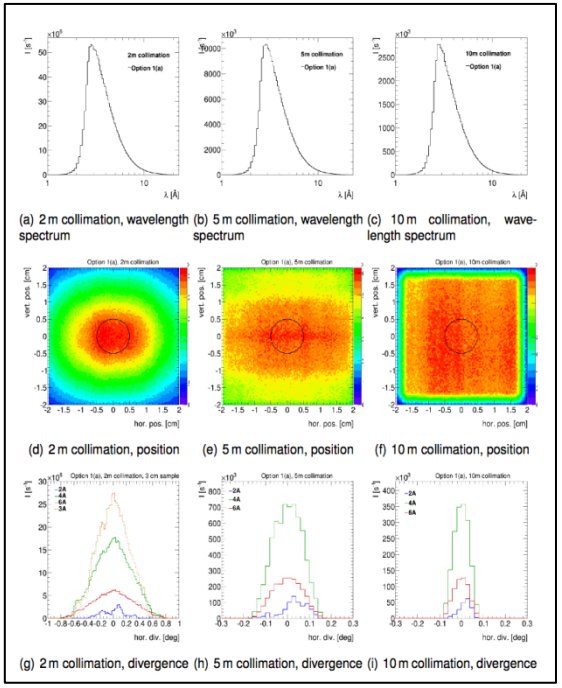


3 options considered :
horizontal 2x LOS, vertical 2x LOS
and horizontal 1x LOS (proposal)

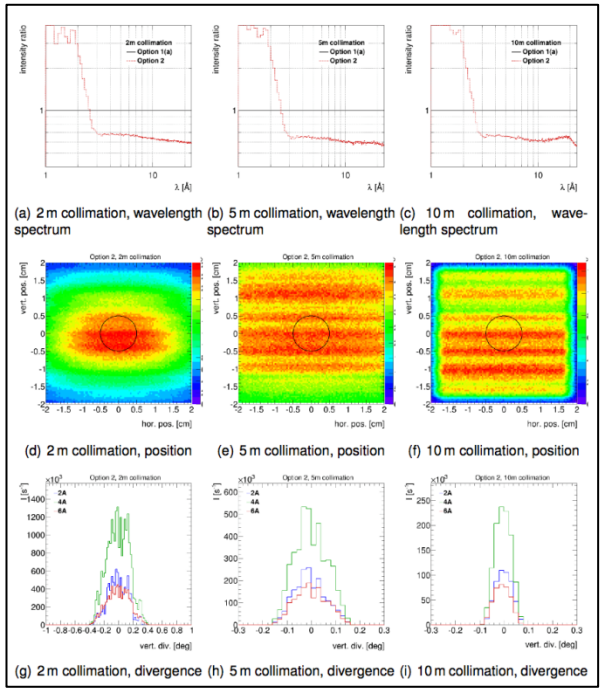
Optics Optimisation

Optics TAP advised that we should take 2x line-of-sight as our baseline and use integrated optics/shielding simulations to see if we can relax that requirement

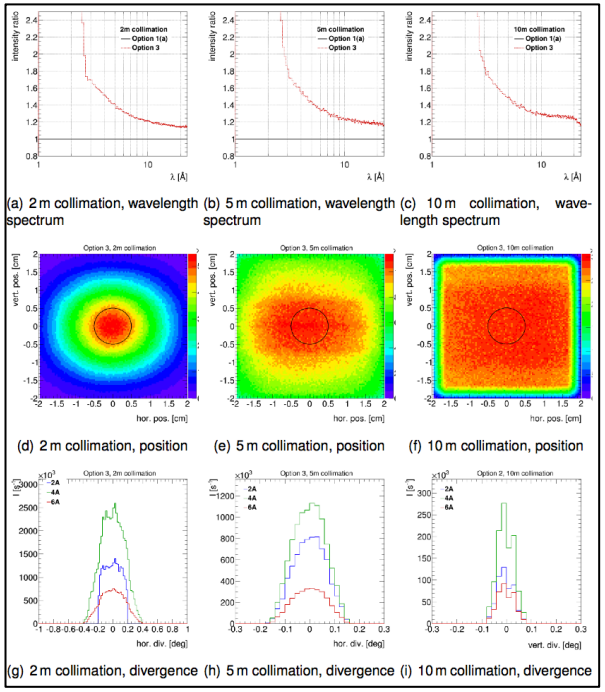
Option 1 (a) & (b)
Horizontal s-bender
2x LOS



Option 2
Vertical s-bender
2x LOS

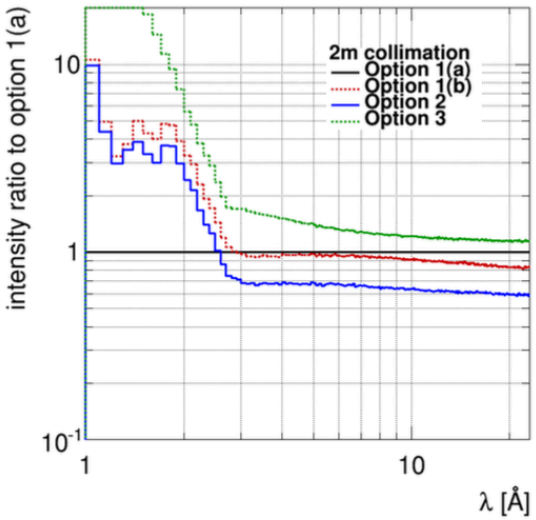


Option 3
Horizontally curved
1x LOS

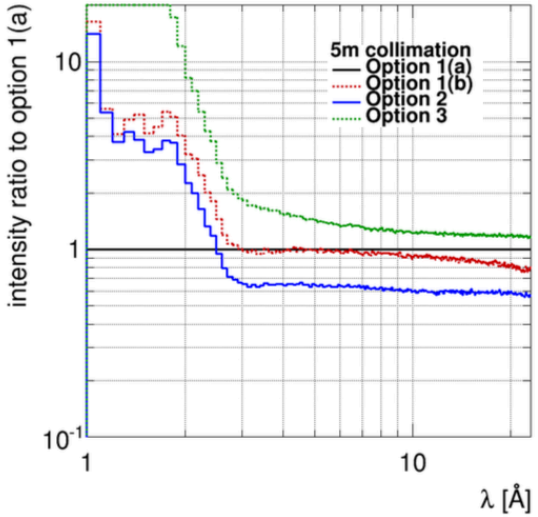


Optics Optimisation

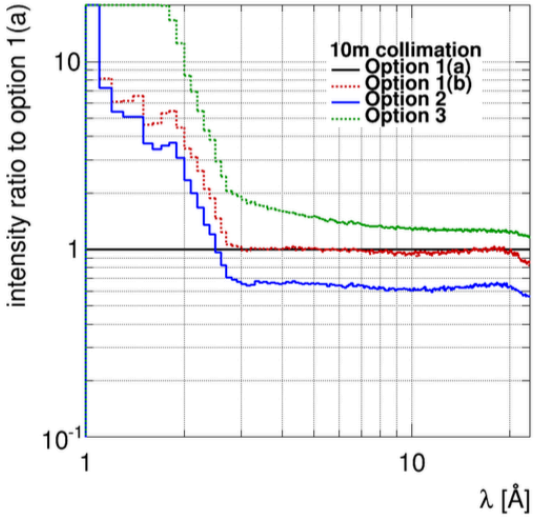
Spectrum: 2m collimation



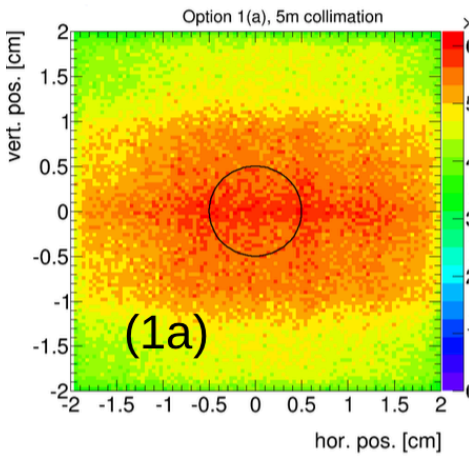
5m collimation

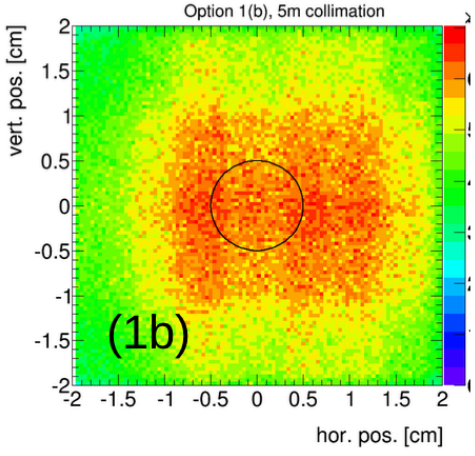


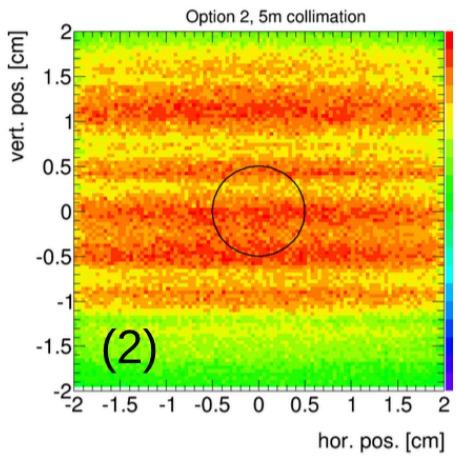
10m collimation

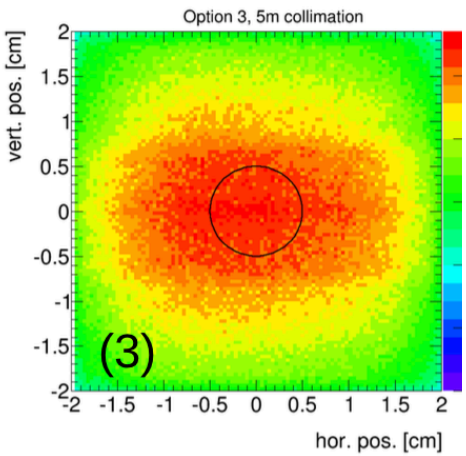


Beamspot at sample position, 5m collimation:









Optics Optimisation

Option	bender 1					bender 2				
	L	w	R	N_{ch}	m	L	w	R	N_{ch}	m
Option 1(a)	4.0 m	2.5 cm	66.0 m	1	6	2.1 m	2.5 cm	36.8 m	5	3
Option 2 and 1(b)	2.6 m	2.0 cm	53.6 m	4	4	2.1 m	2.0 cm	43.3 m	4	4
Option 3	4.0 m	1.5 cm	100.0 m	1	6	-	-	-	-	-

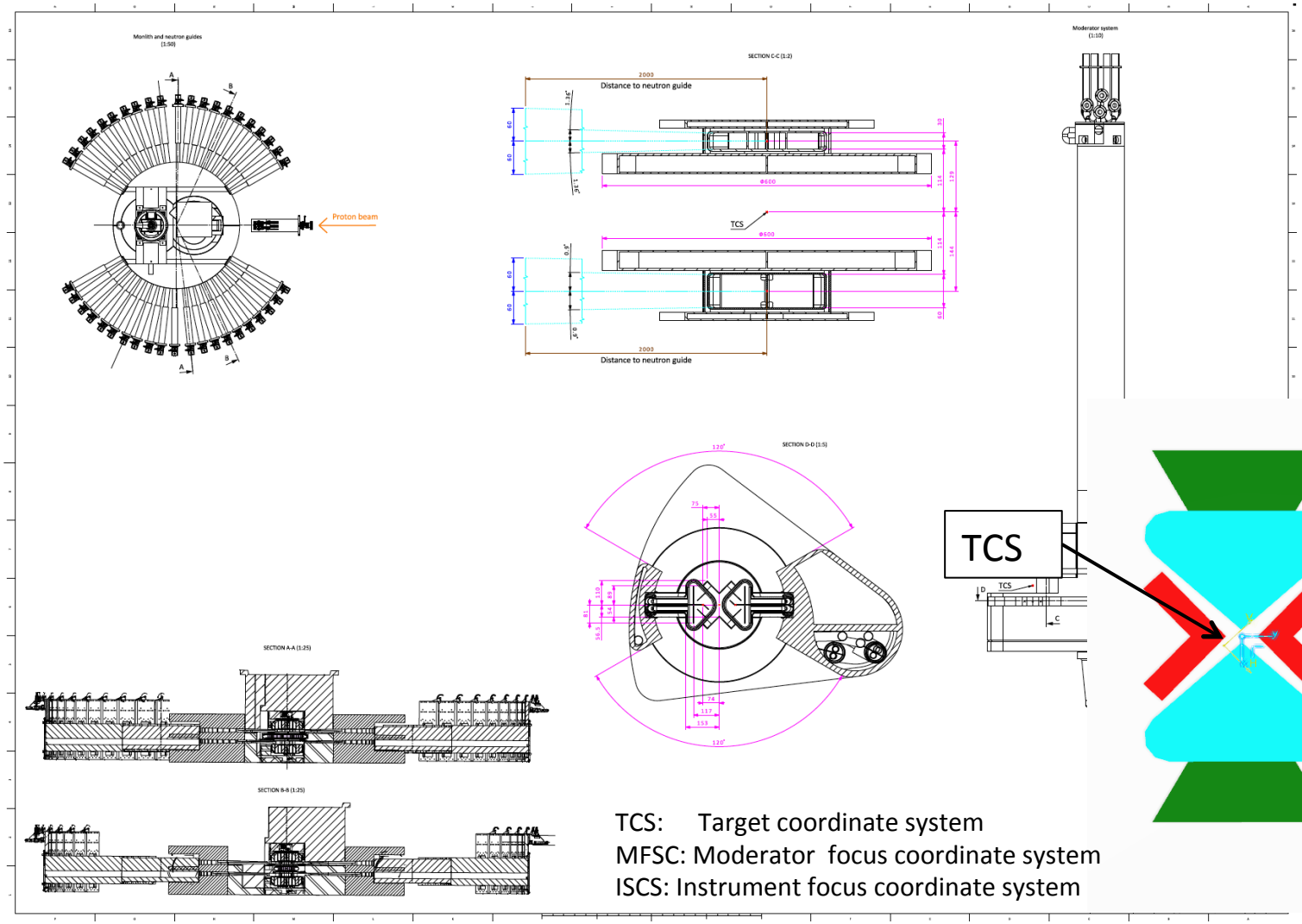
Option	Flux (2-22 Å)			guide	displacement	
	2 m coll.	5 m coll.	10 m coll.	cost	spatial	angular
Option 1 (a)	1.00	1.00	1.00	314 k€	34 cm (h)	0.3°
Option 1 (b)	1.03	1.06	1.09	333 k€	19 cm (h)	0°
Option 2	0.74	0.70	0.71	333 k€	19 cm (v)	0°
Option 3	1.62	1.79	1.84	249 k€	72 cm (h)	2.24°

Cost breakdown [kEUR]:

option	bender 1	bender 2	total
1a	58	84	314
1b, 2	87	70	333
3	57	-	249

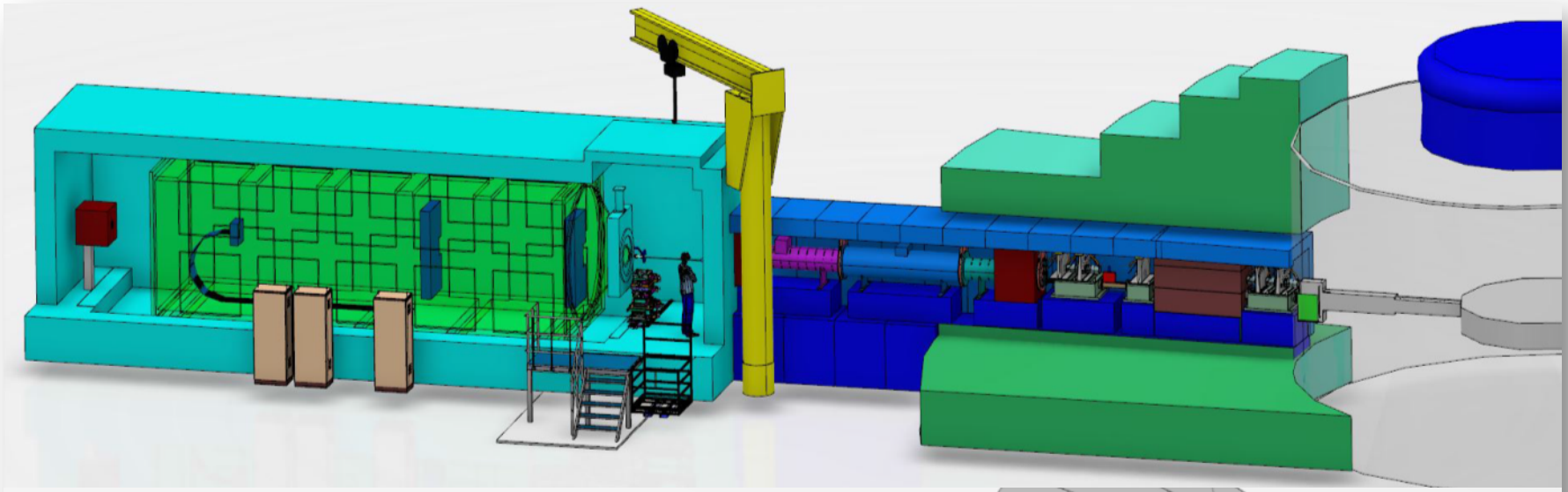
Recommendation: option 1

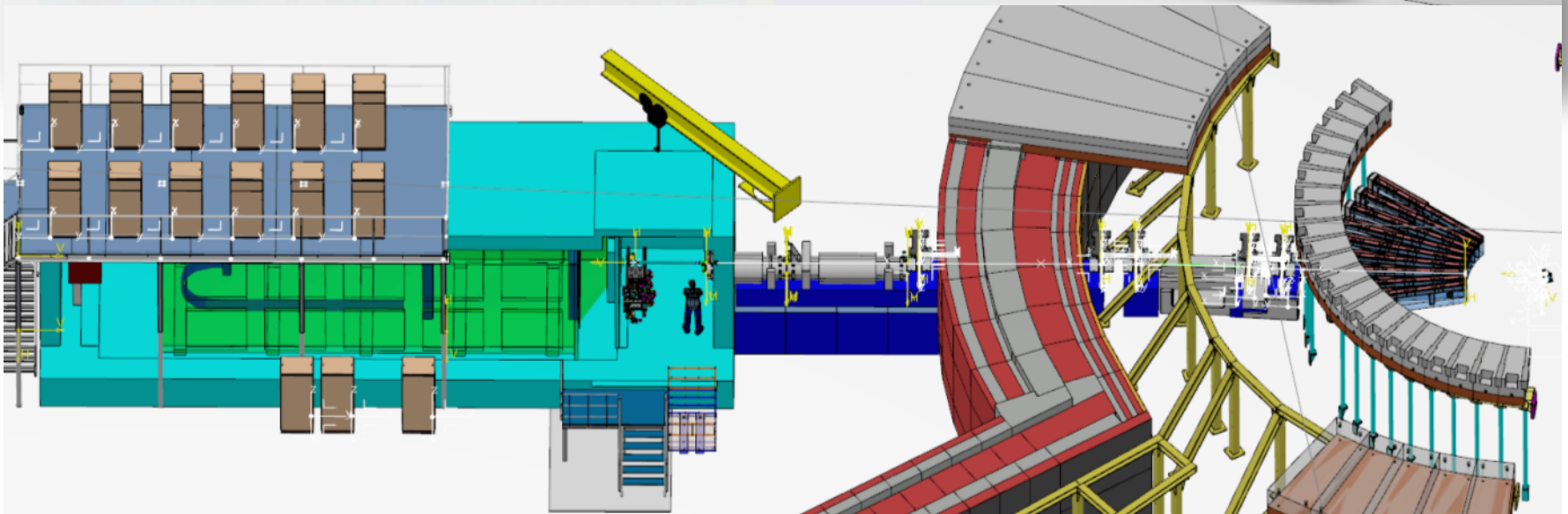
Moderator Change …



TCS: Target coordinate system
MFSC: Moderator focus coordinate system
ISCS: Instrument focus coordinate system

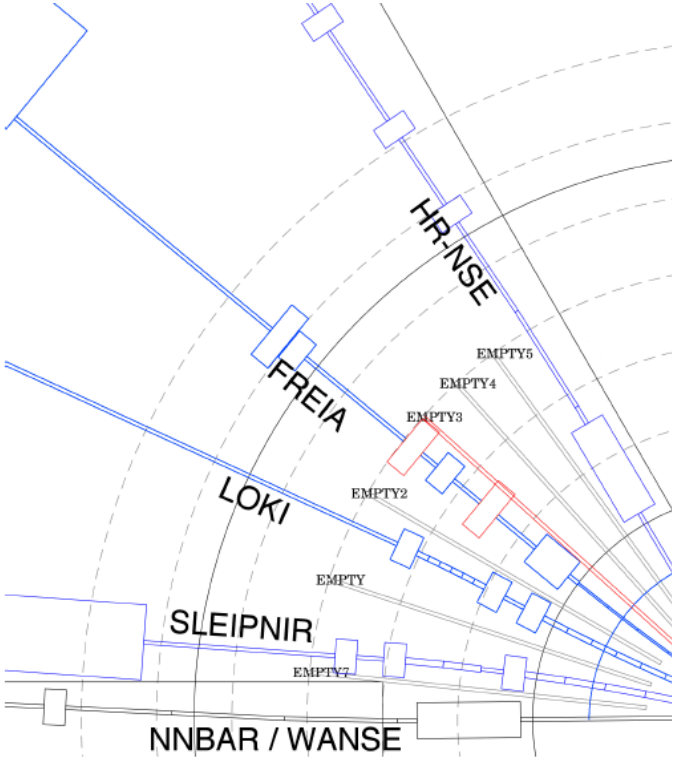
New Bunker Design

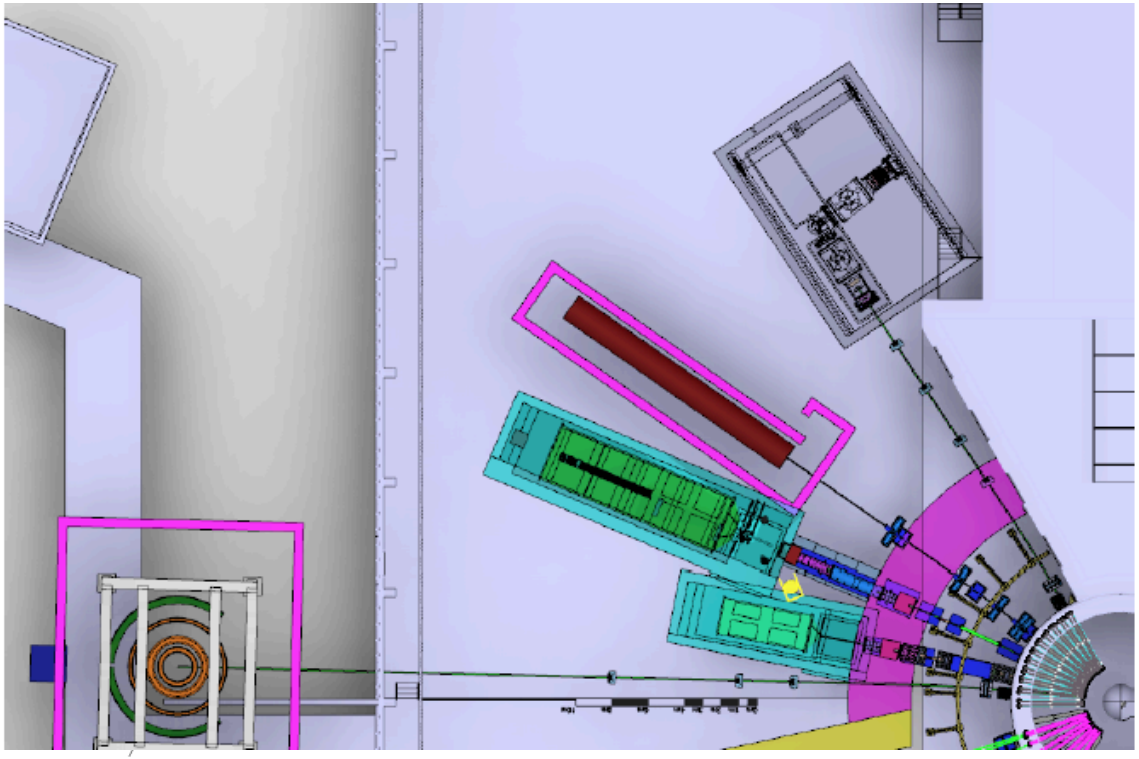




Beamport Allocation

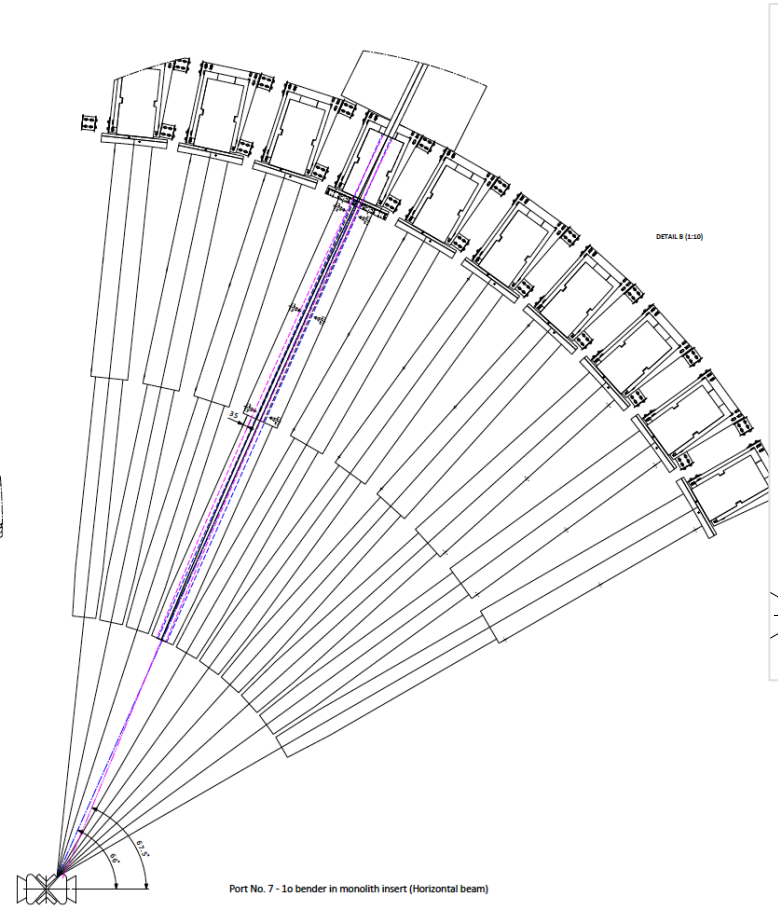
- Hall 2 – North sector: Port allocation ESS-0047786

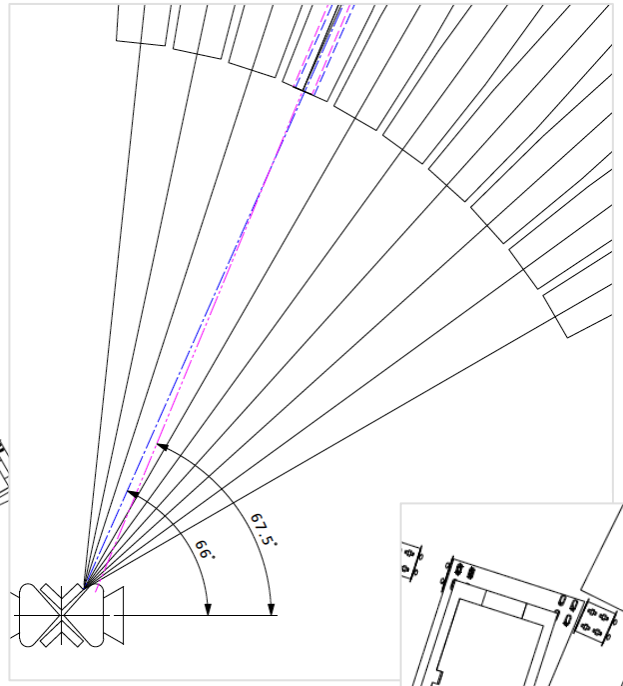


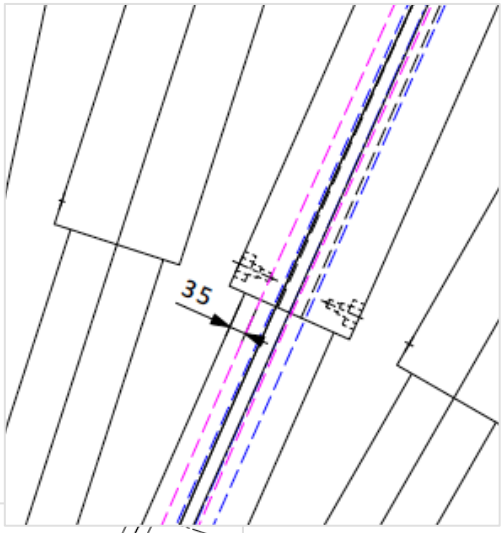


TG2 geometry

- LoKI in port 7 – Bending horizontally

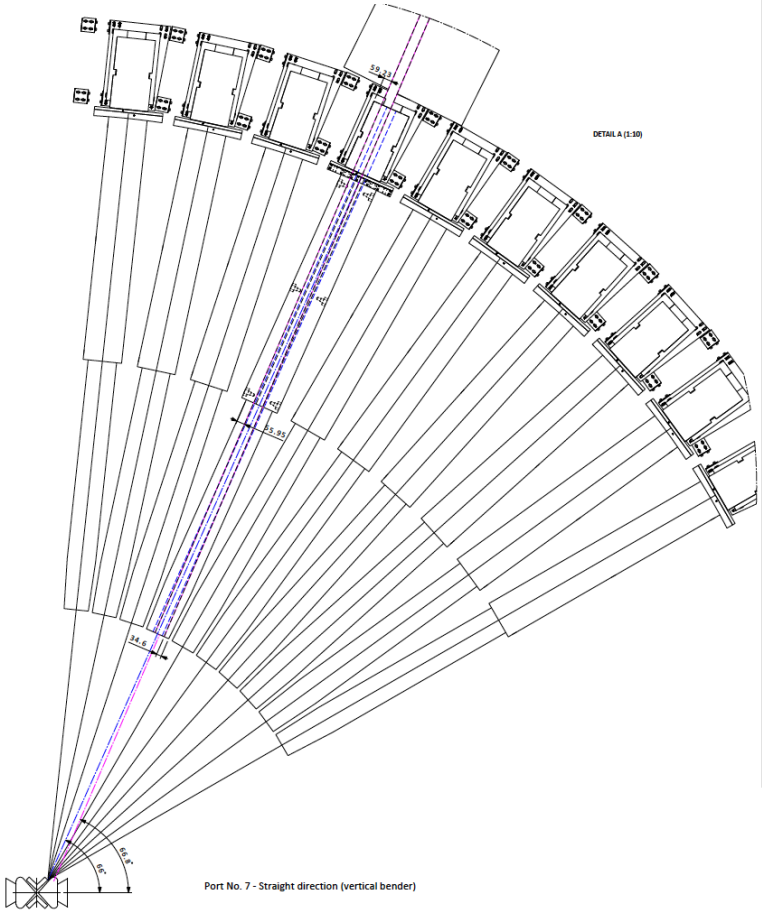


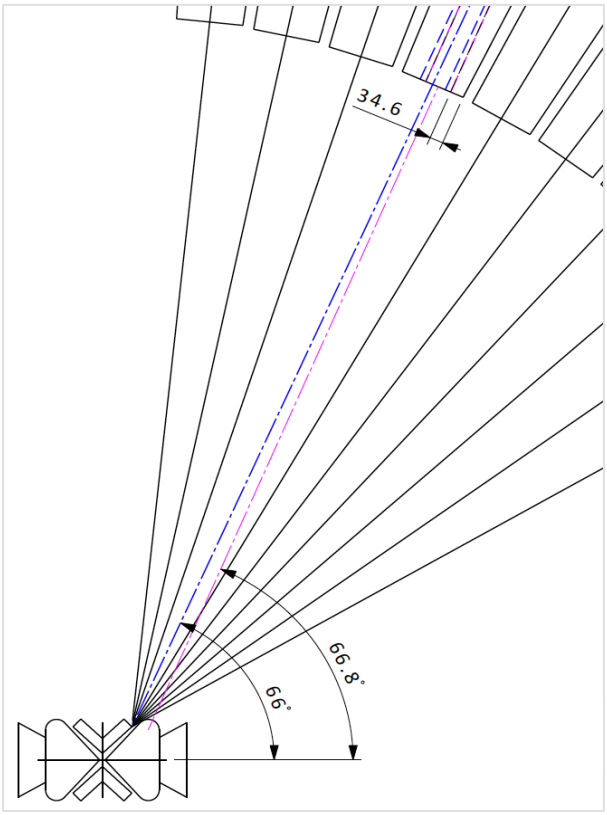


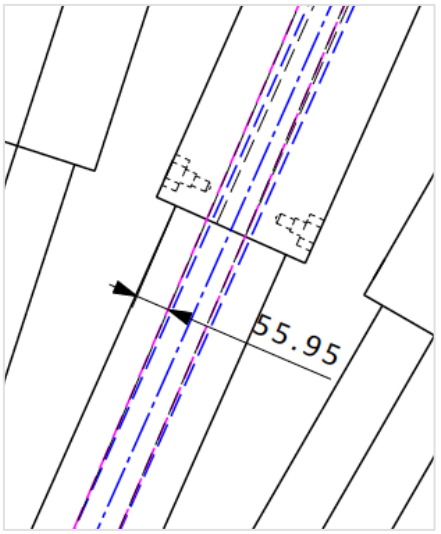


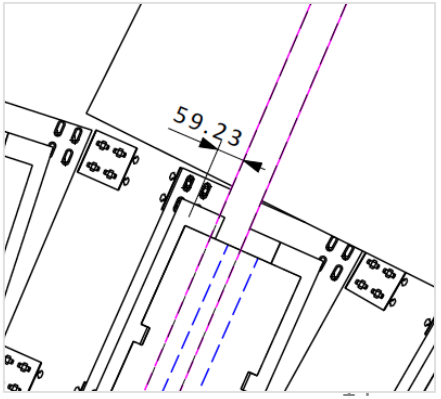
Alternative vertical bend

- LoKI in port 7 – Bending vertically (top view-straight)

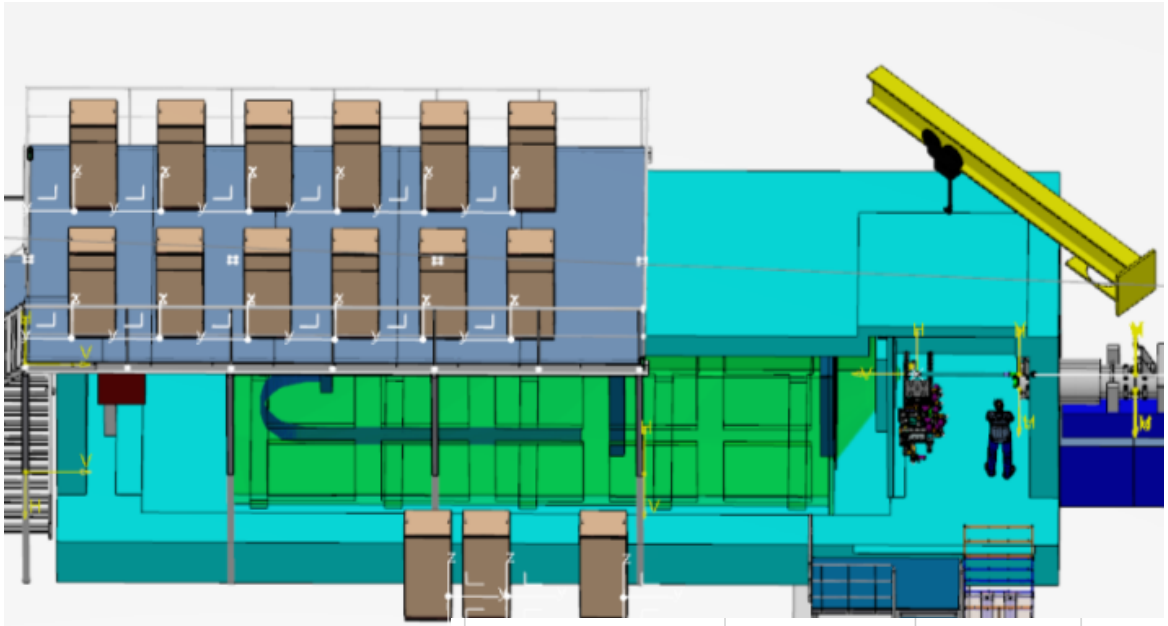




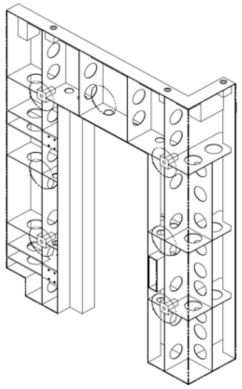


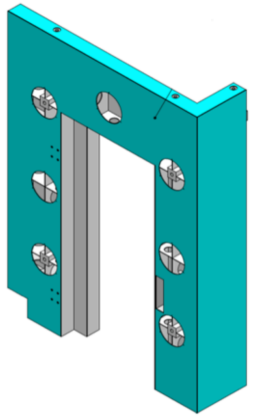


Instrument Cave



Wax tank walls





Material	Density kg/m3	T=500mm Volumen (m3)	T=750 mm Volumen (m3)	T= 500 mm Weight (kg)		T=750 mm Weight (kg)	
Wax	860	160	240	137600		206400	
Light concrete	1750	160	240	280000		420000	
Heavy concrete	2400	160	240	384000		576000	
Carsten concrete	2200	160	240	352000		528000	
Steel	7860	7,4	8,96	58164		70425,6	
					ton/m2		ton/m2
Steel + Light concrete				338164	15,0	490425,6	14,5
Steel + Heavy concrete				442164	19,7	646425,6	19,2
Steel + Carsten concrete				410164	18,2	598425,6	17,7
Steel + Wax				195764	8,7	276825,6	8,2

Work now …

- Updating guide design to incorporate new information about bunker
- Likely will go to vertical bend to offset below beam centre (background, size of shutter)
- Removed all components from in bunker wall – smallest possible hole in wall (background)

- Natasha has begun work on the MCNP model of LoKI

- Plan is
  - Initial round of simulations at ESS to iron out bugs and get first answers
  - Hand the model to ISIS neutronics group to do the iterations with engineering.
  - Final check for licensing & validation done by ESS NOSG