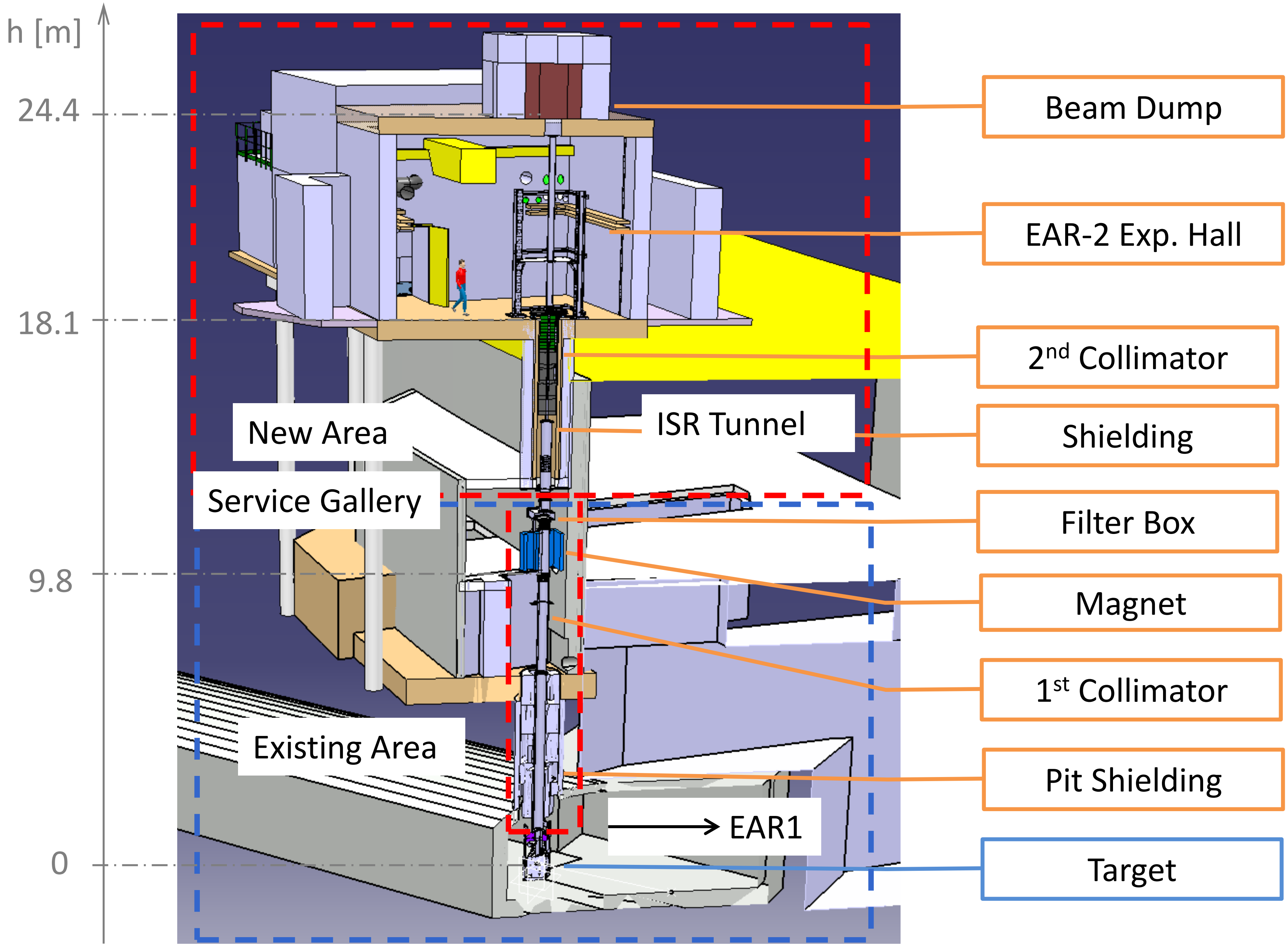
EAR2 Beam Line

Report on the Status

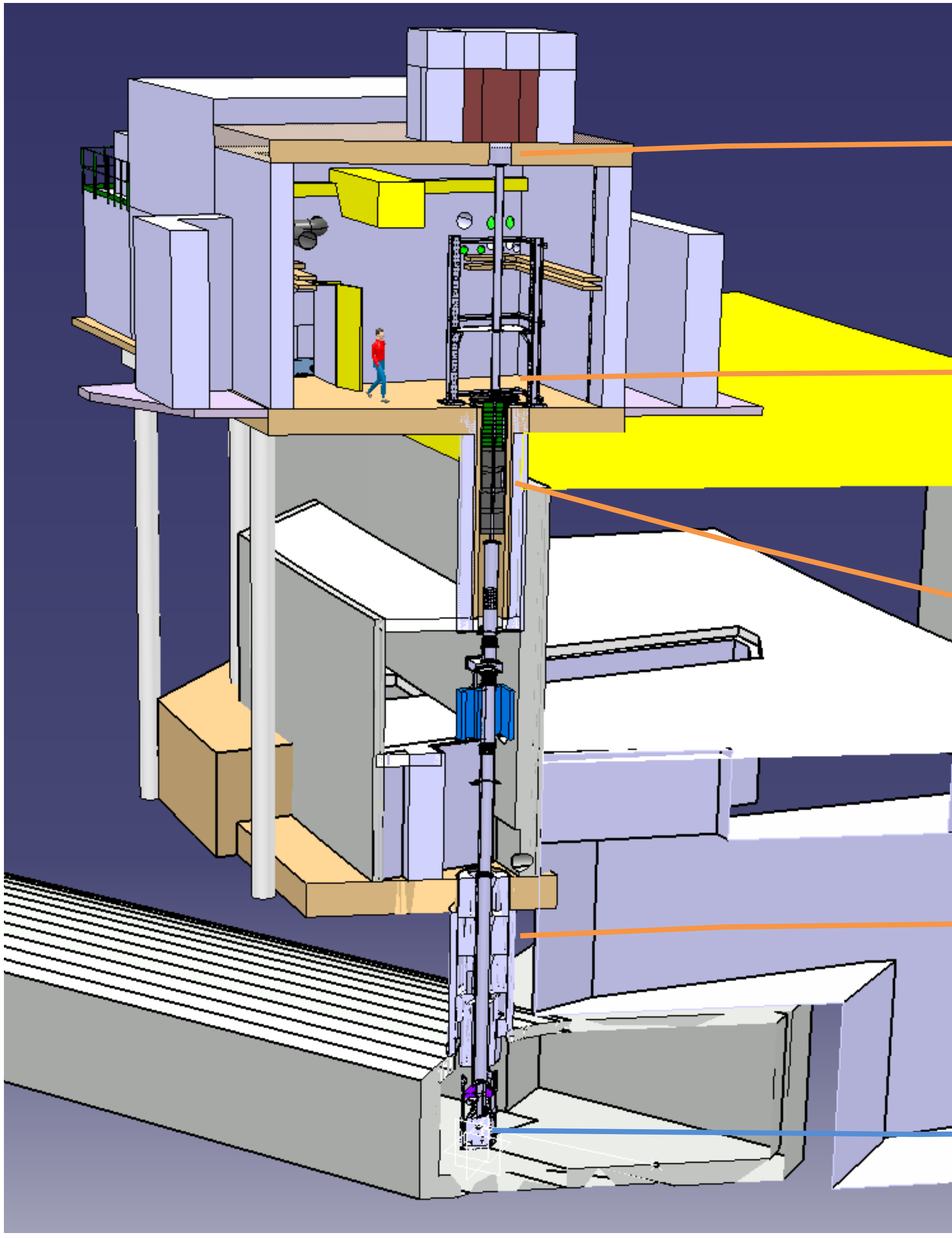
C. Weiss


h [m]
24.4
18.1
9.8
0
Beam Dump
EAR-2 Exp. Hall
2nd Collimator
Shielding
Filter Box
Magnet
1st Collimator
Pit Shielding
Target
New Area
ISR Tunnel
Service Gallery
Existing Area
EAR1

Beam Line - Design Considerations

1. Exchangeable components in order to allow new target installation (2018).
2. Minimum background to the experiment.
3. Maximum neutron fluence to the experiment.
4. Acceptable dose rate in working area close to beam line (0.5 μSv/h in ISR).
5. Maximum flexibility for experiment installation (capture & fission setup).
6. Automatic alignment with neutron beam.
7. Feasibility :-)!

VACUUM CHAMBERS



Special vacuum chamber at the beam dump with inserted shielding material (avoid backscattered neutrons).

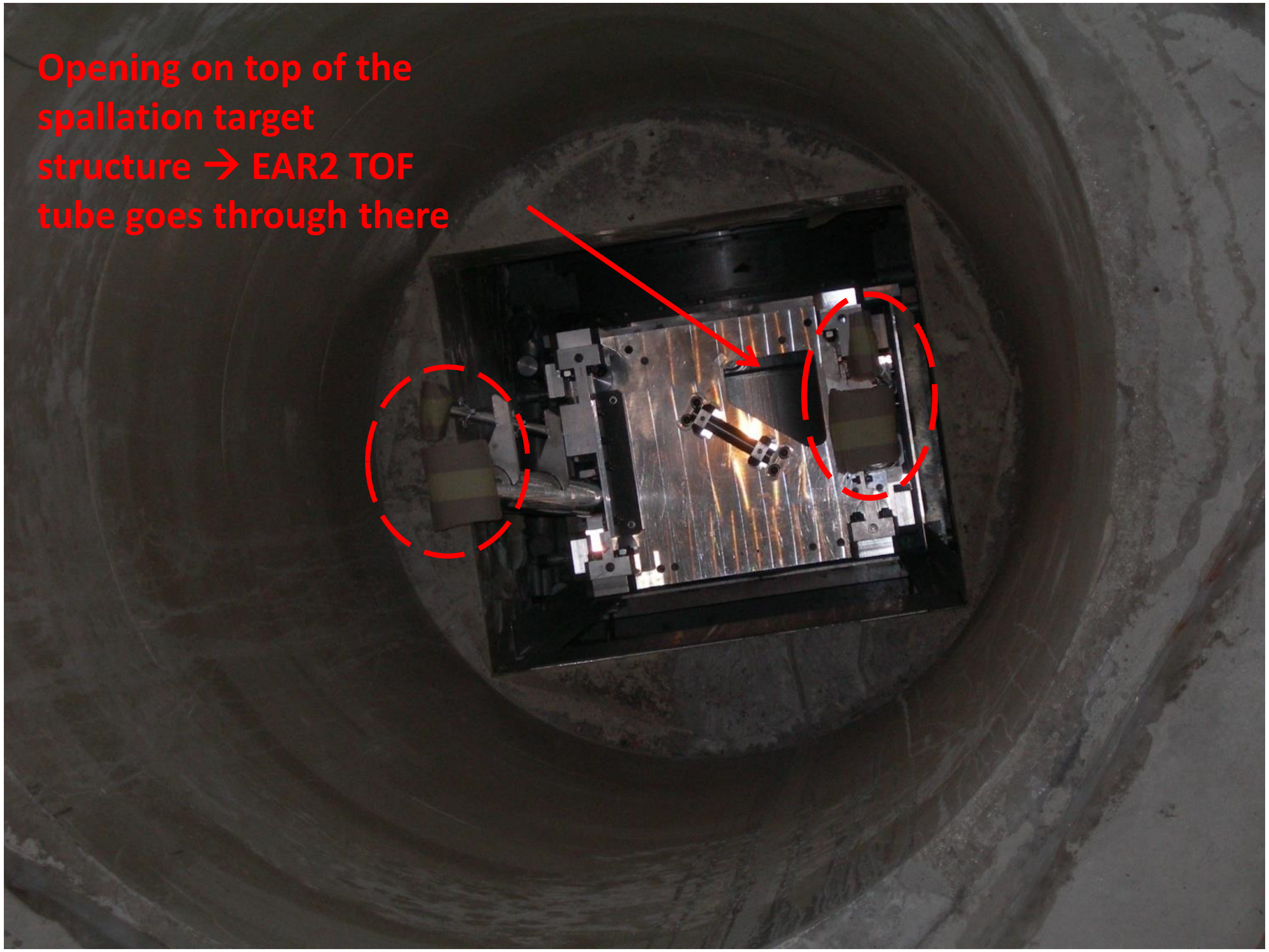
SiMon: carbon fibre vacuum chamber (LNS / INFN).

Special vacuum chamber at the 2nd collimator, to allow the insertion of the collimator and to optimize shielding.

Special vacuum chamber to get as close as possible to the target and allow material irradiations close to target.

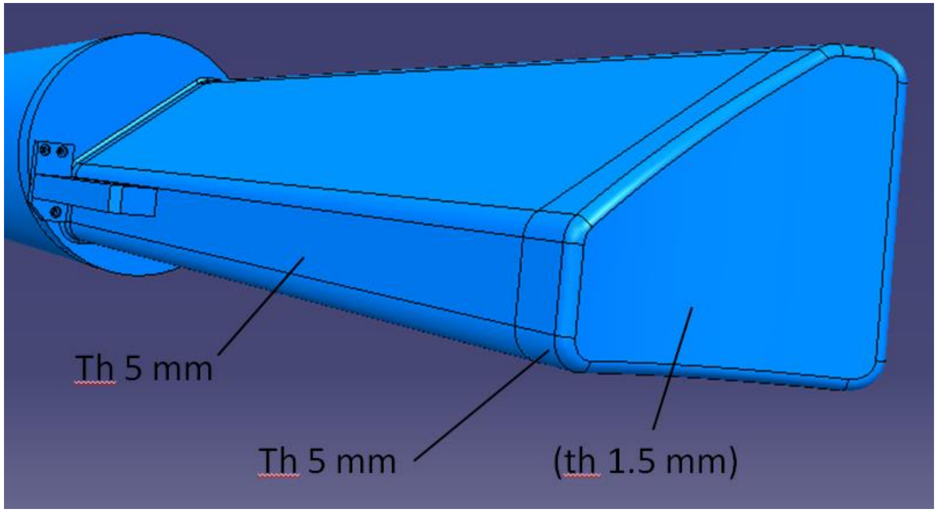
Target

n_TOF Target from the Top



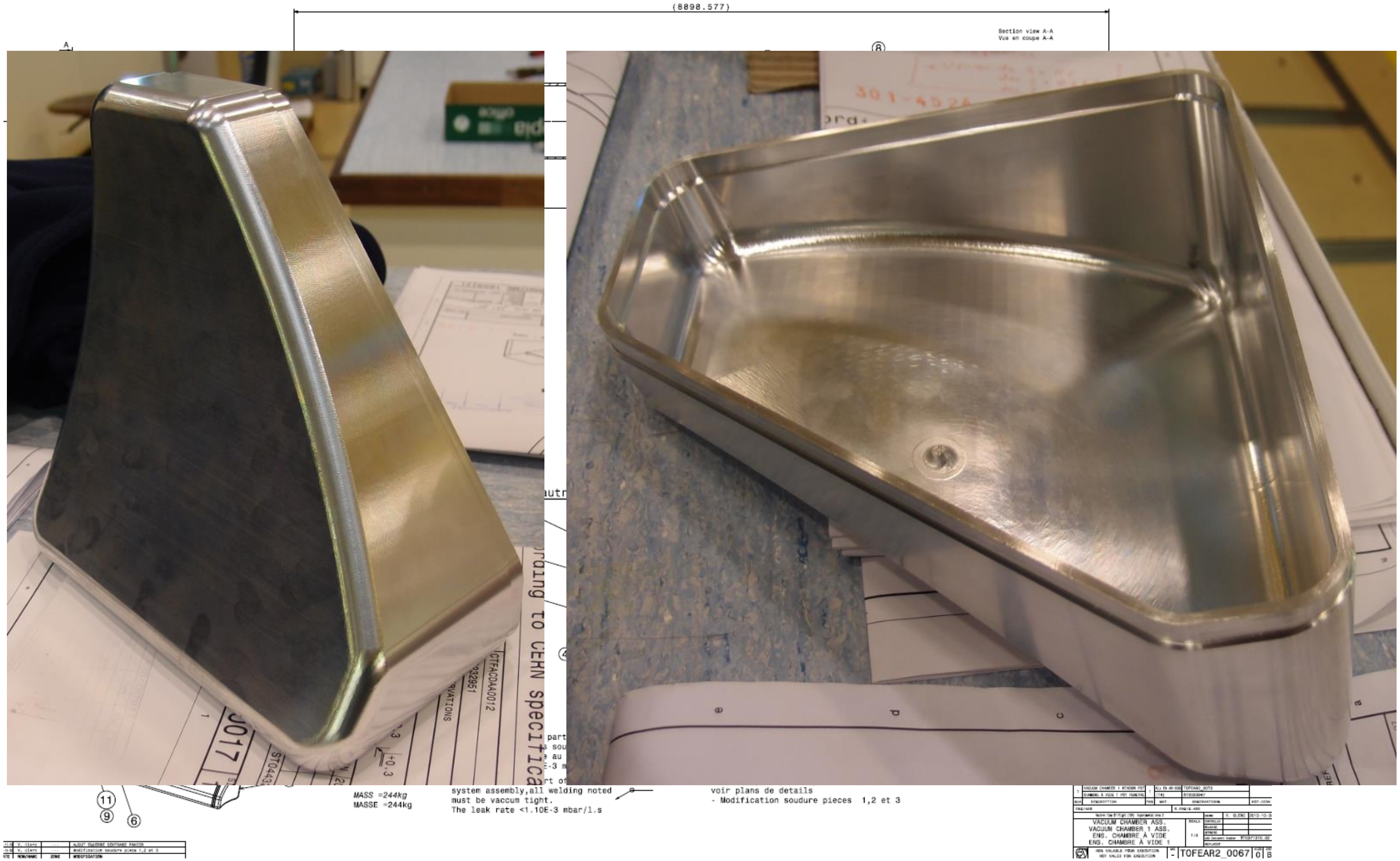
Vacuum Chamber 1

- 8.9 m total length:
  - 'Triangular' shape for the first 1.1 m
  - Cylindrical shape (d = 317.9 mm) from top of target onwards
- Window: 1.5 mm Al, concave shape
- 12 mm gap of air btw. target and window

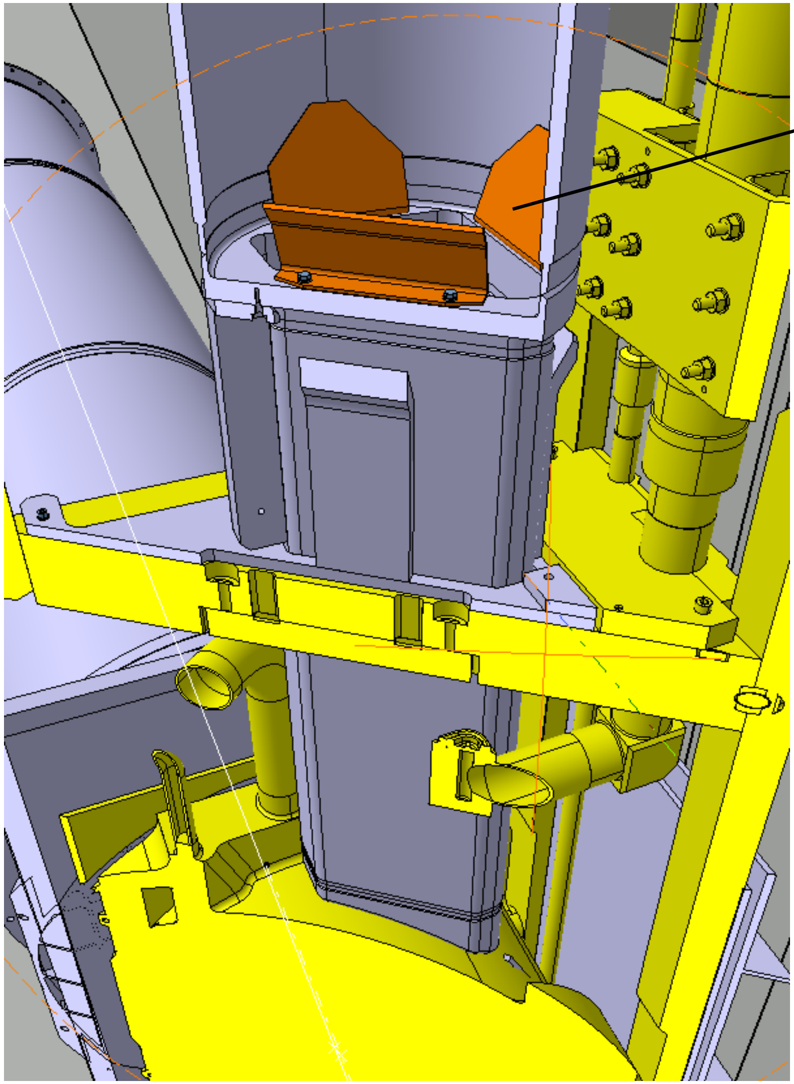


Vacuum chamber 1

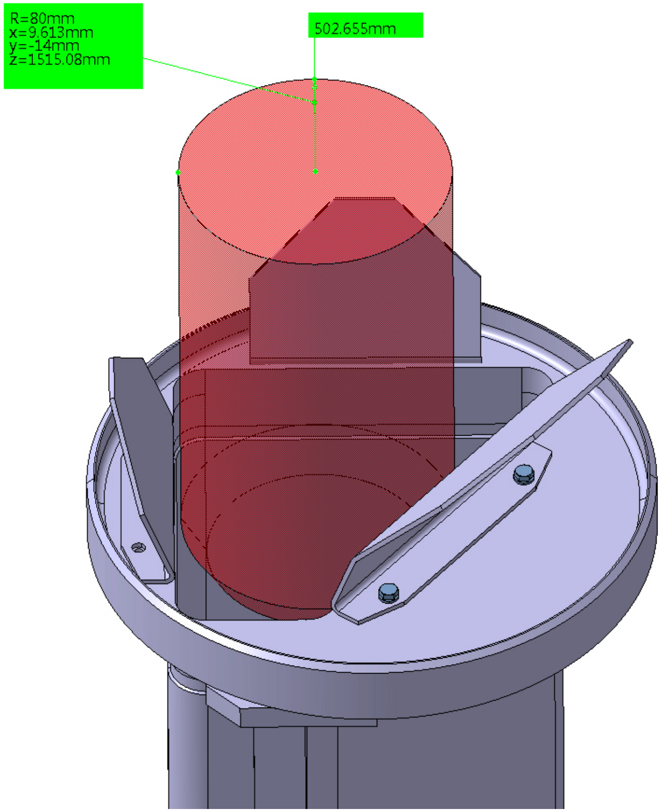
Production on-going



Vacuum chamber 1



New guidings for irradiation on target Basket Ø160



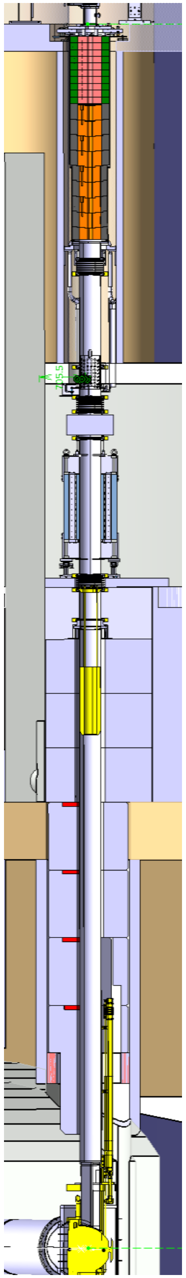
COLLIMATORS

Collimators

- Decisions on beam parameters:
  - n_TOF coll. meeting May – capture beam
  - n_TOF tech. meeting in Sept. – fission beam

- 2nd collimator: 2 m Fe + 1 m PE (with B or Li)
- 1st collimator: 1 m Fe

Measurement	Collimator & Shape	Inner Diameter [mm]
Capture	2nd: conical	d_2 = 20 d_1 = 69
	1st: cylindrical	d_0 = 200
Fission	2nd: conical	d_2 = 85.6 d_1 = 124.6

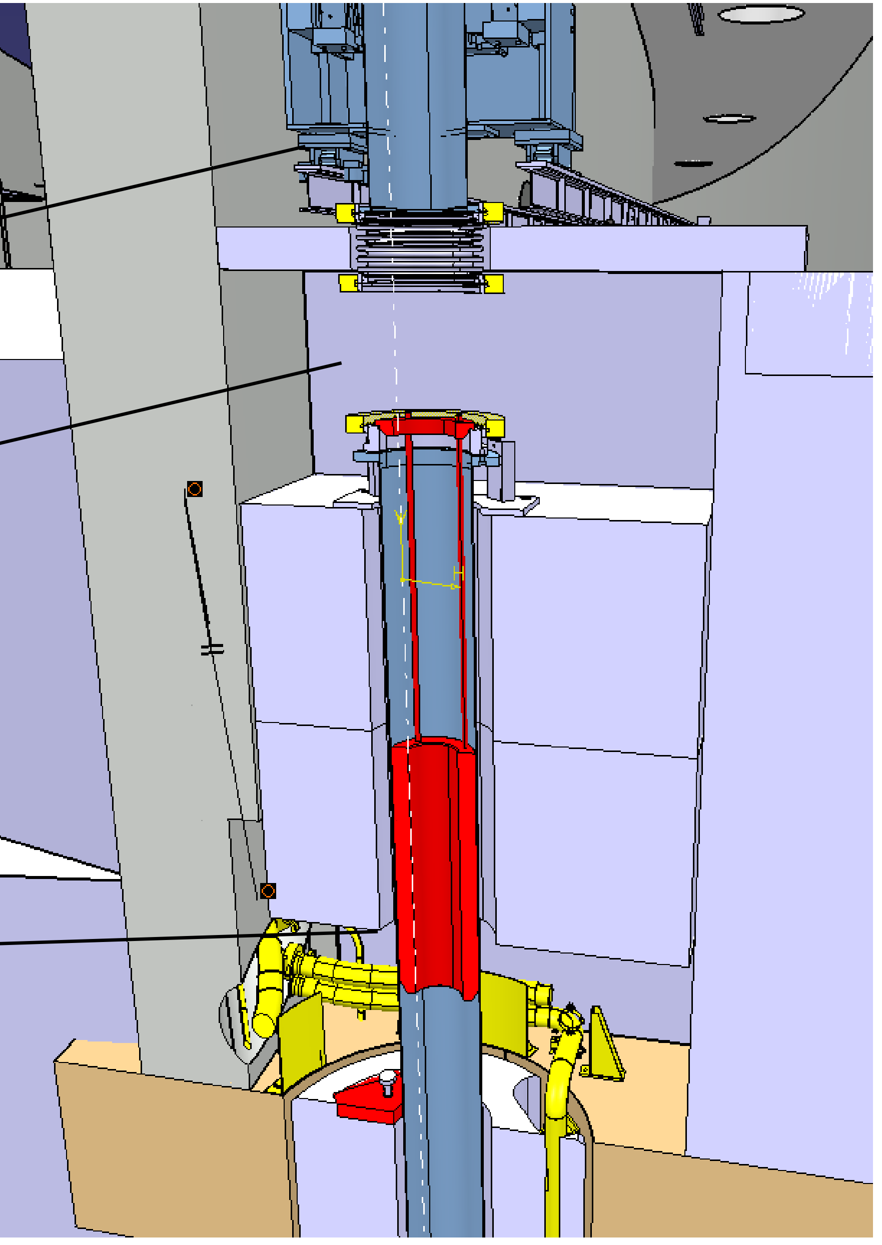


1st Collimator

Magnet

Shutter replaced with vacuum chamber

Collimator 1:
1 m Fe
d_{inner} = 200 mm
(will be inserted in vacuum chamber 1)

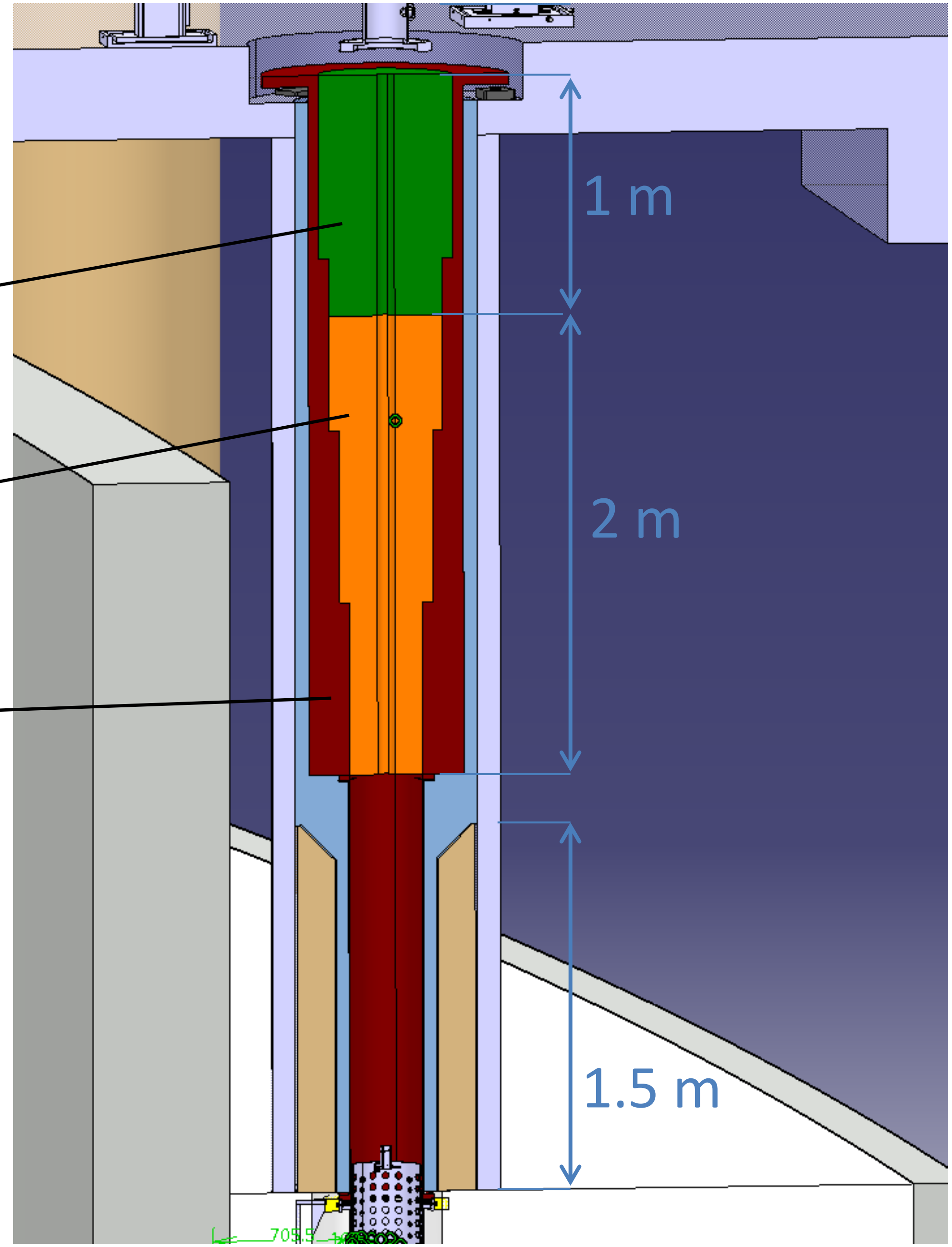


2nd Collimator

PE (+B or Li) core
260 kg

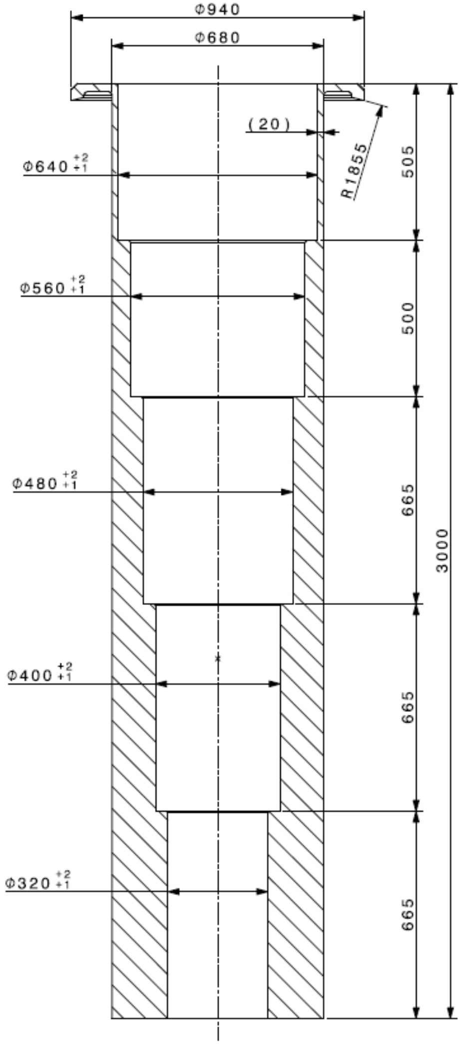
Steel core
2 t

Steel vacuum vessel
5 t



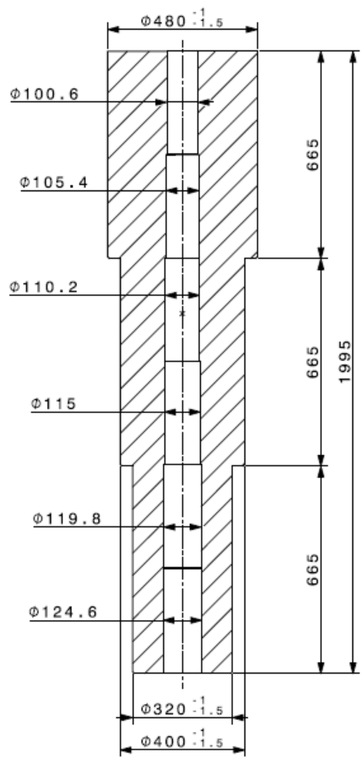
2nd Collimator

Multiple-step design as conical is not machinable!



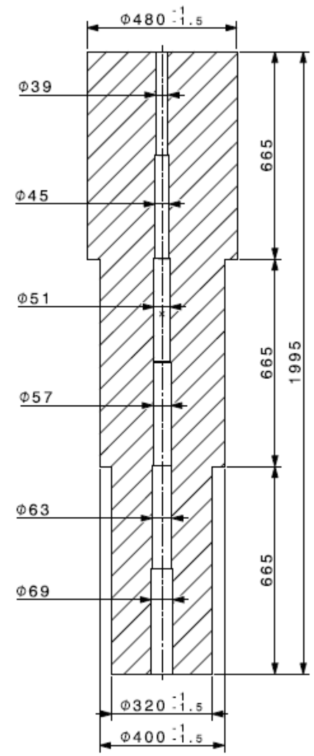
Masse: 4400 kg
1 piece acier
ou inox

Fission



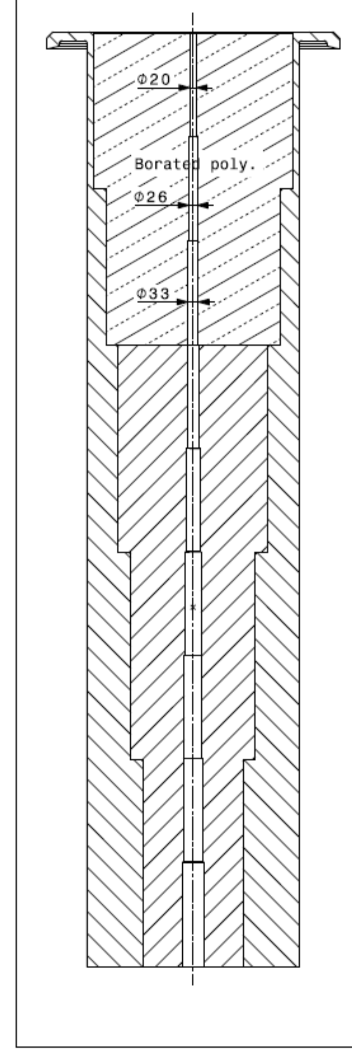
Core 1: 1850kg
1 piece acier

Capture

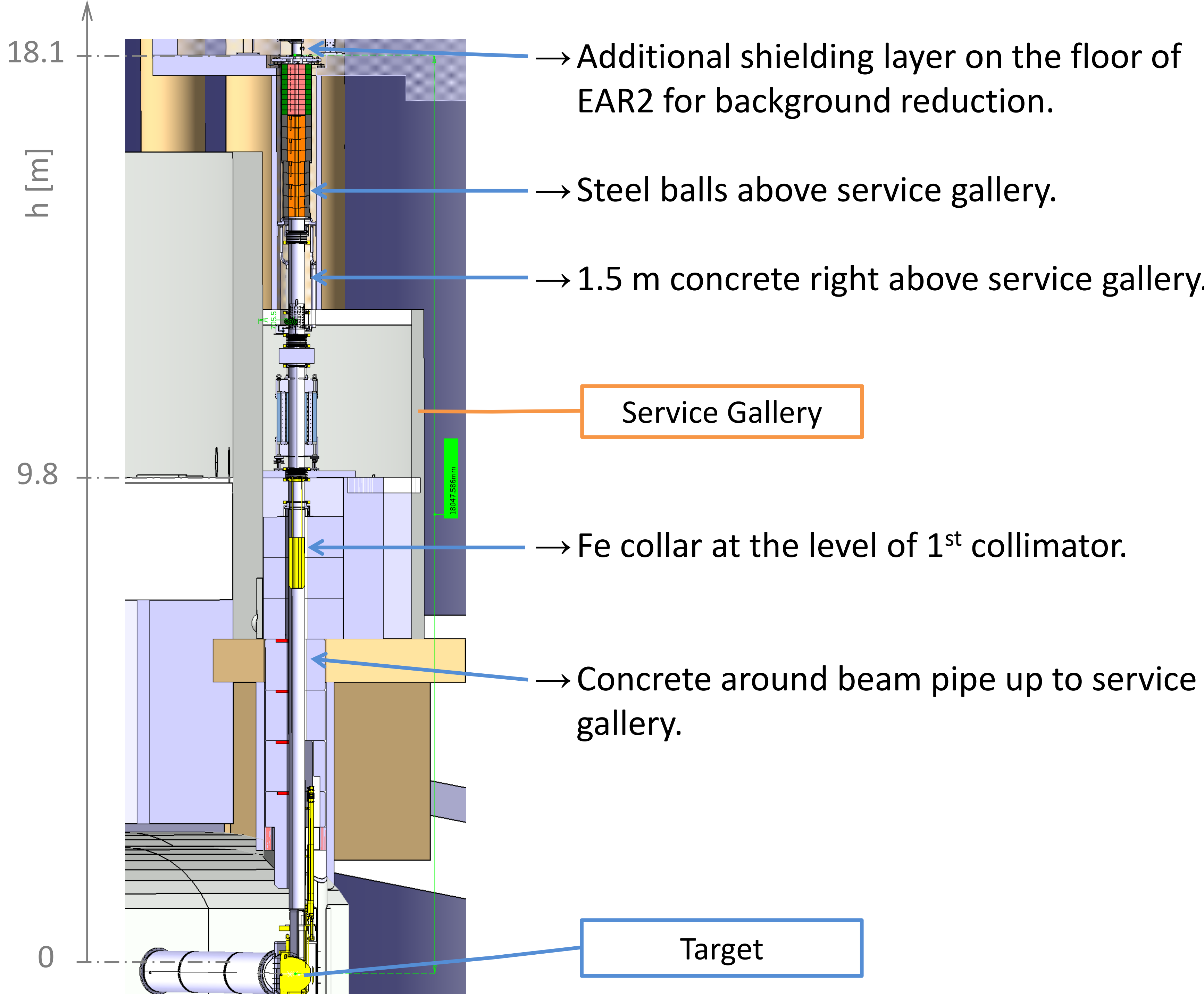


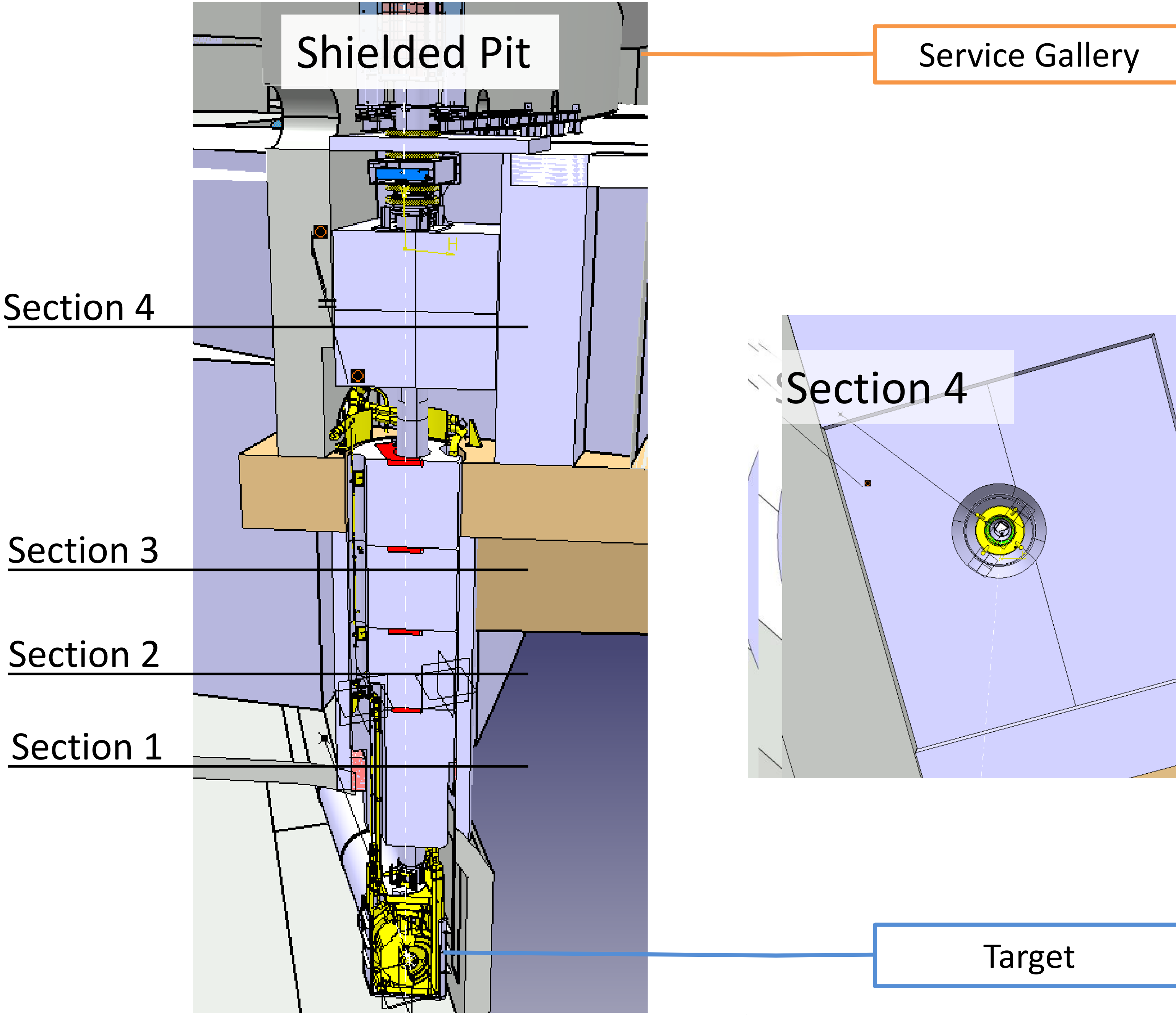
Core 2: 1900 kg
1 piece acier

Assembly

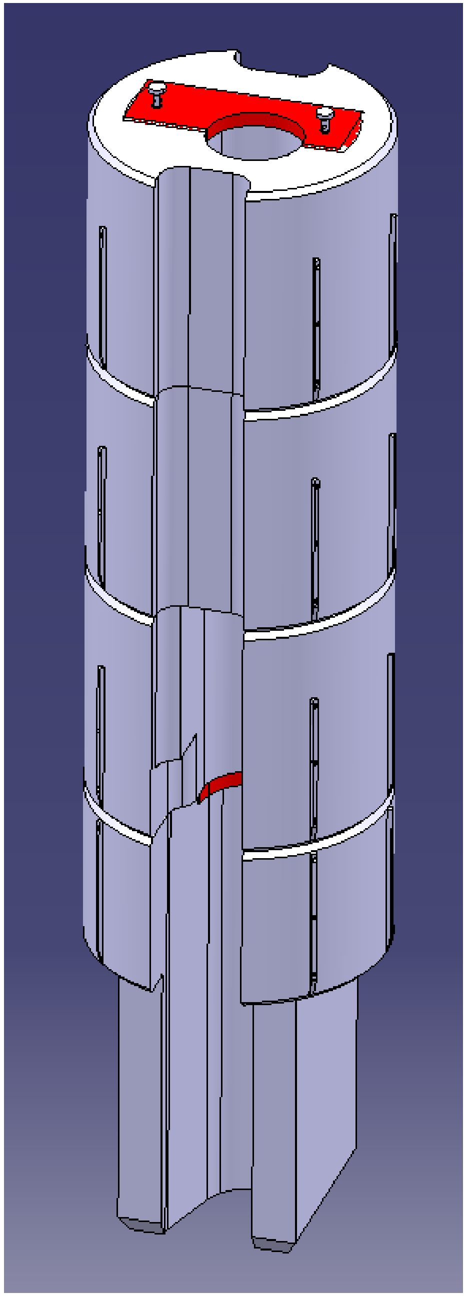


BEAM LINE SHIELDING


h [m]
18.1
9.8
0
→ Additional shielding layer on the floor of EAR2 for background reduction.
→ Steel balls above service gallery.
→ 1.5 m concrete right above service gallery.
Service Gallery
→ Fe collar at the level of 1st collimator.
→ Concrete around beam pipe up to service gallery.
Target

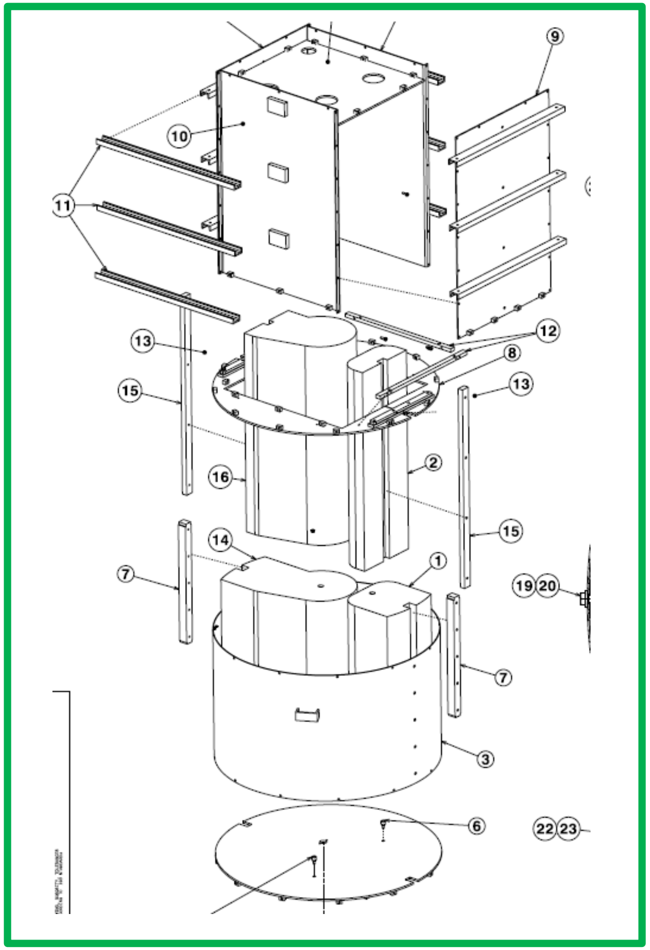

Shielded Pit
Service Gallery
Section 4
Section 3
Section 2
Section 1
Section 4
Target

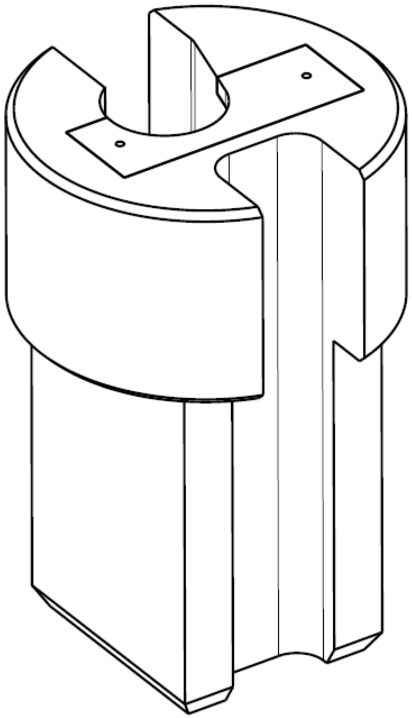
New Concrete Shieldings



Concrete Tap Blocks

Steel forms for concrete taps → Green light for production

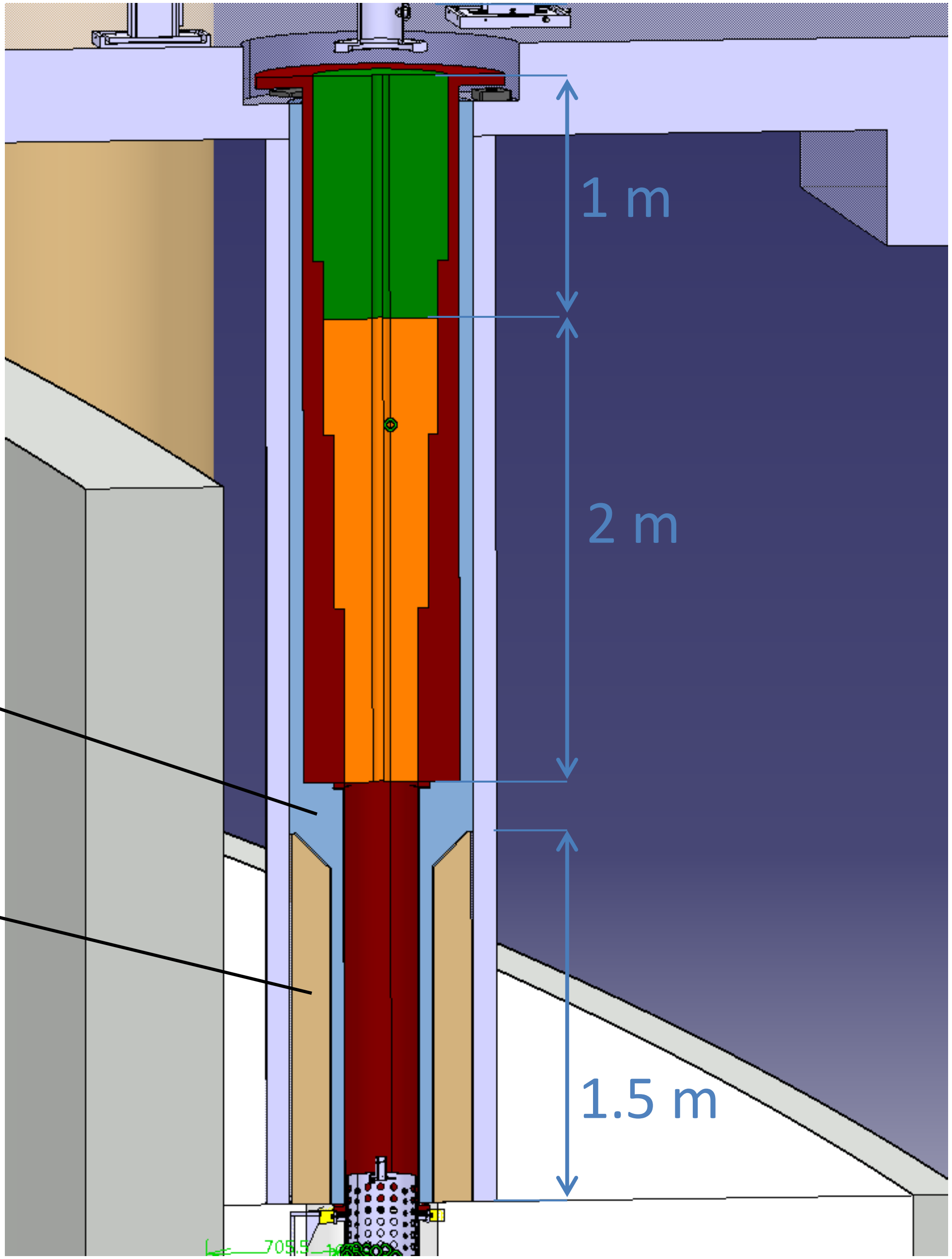




Shielding above Service Gallery

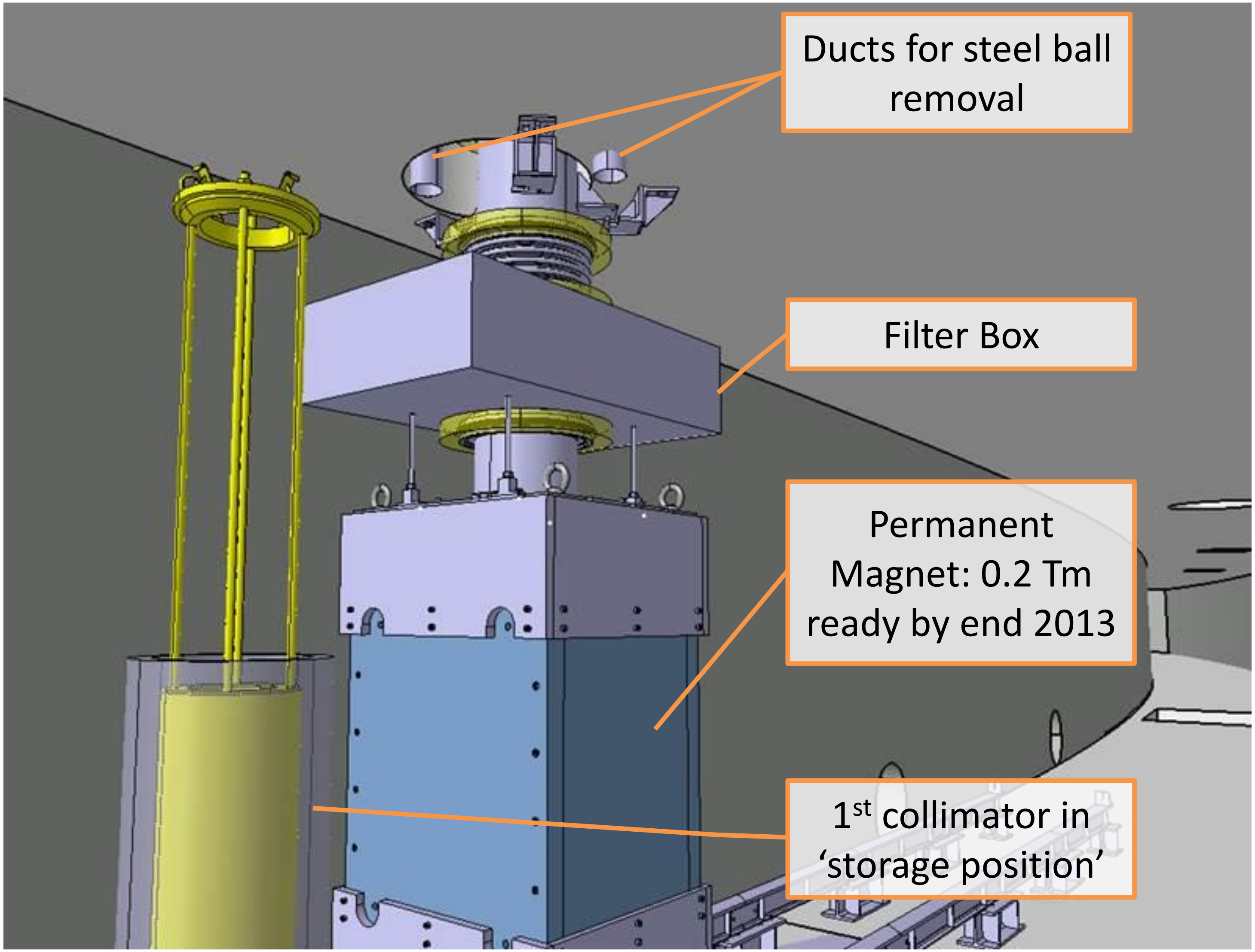
St steel balls 3 t ($0.6 m^3$)

Concrete 1.1 t



SERVICE GALLERY
- MAGNET AND FILTER BOX

Magnet and Filter Box



Filter Box

Filter	EAR1 Available	EAR2 Proposed	d [mm]
Cd*	✗		0.5
Ag	✔		0.5
W*	✔		0.8
Mo*	✔		1
Co*	✔		0.25
Na*	✗		10
Al*	✔ / ✔		30 / 80
S*	✗		80
C	✔		60

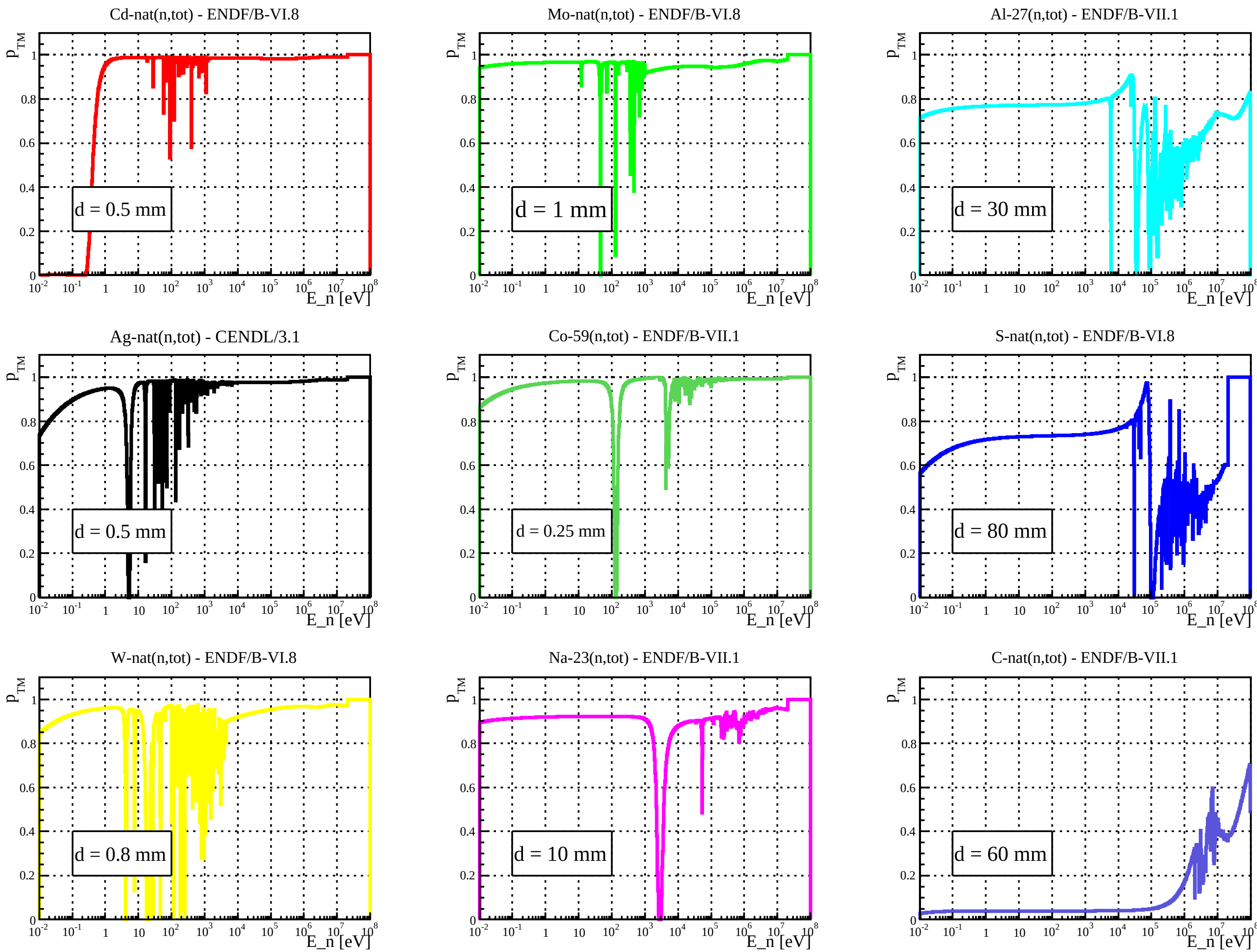
*Proposed by E. Berthoumieux, F. Gunsing and C. Lederer

Filter Box

Filter	EAR1 Available	EAR2 Proposed	d [mm]
Cd*	✗	?	0.5
Ag	✔	✔	0.5
W*	✔	✔	0.8
Mo*	✔	✔	1
Co*	✔	✔	0.25
Na*	✗	✔	10
Al*	✔ / ✔	✔ / ✗	30 / 80
S*	✗	✔	80
C	✔	?	60

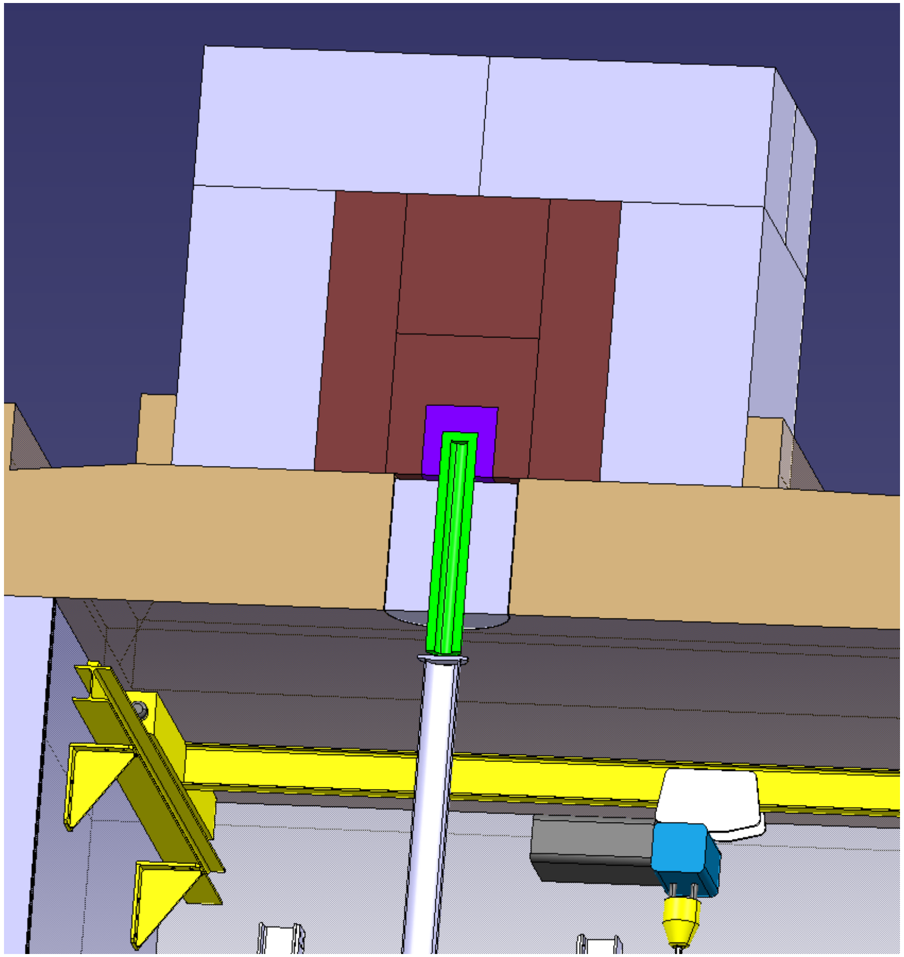
EAR2: 276 mm available length, each filter: 350 x 350 mm^2

Filters: Transmission Probabilities



BEAM DUMP

Beam Dump



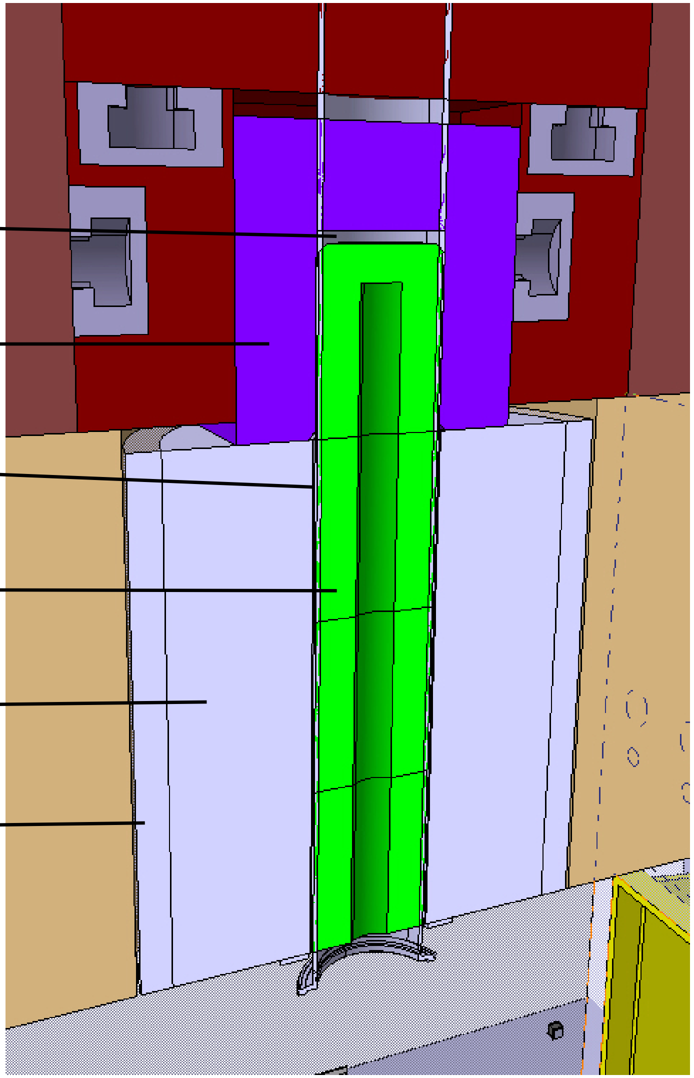
Design constraints:

- Background situation in EAR2 (n_TOF)
- Dose rate outside (Radioprotection)
- Maximum weight (Civil Engineering)

Outer dimensions (to be confirmed by RP):

1. Concrete: 3.2 x 3.2 x 2.4 m^3
2. Iron: 1.6 x 1.6 x 1.6 m^3

Beam Dump Entrance



Alignment accuracy to be defined!

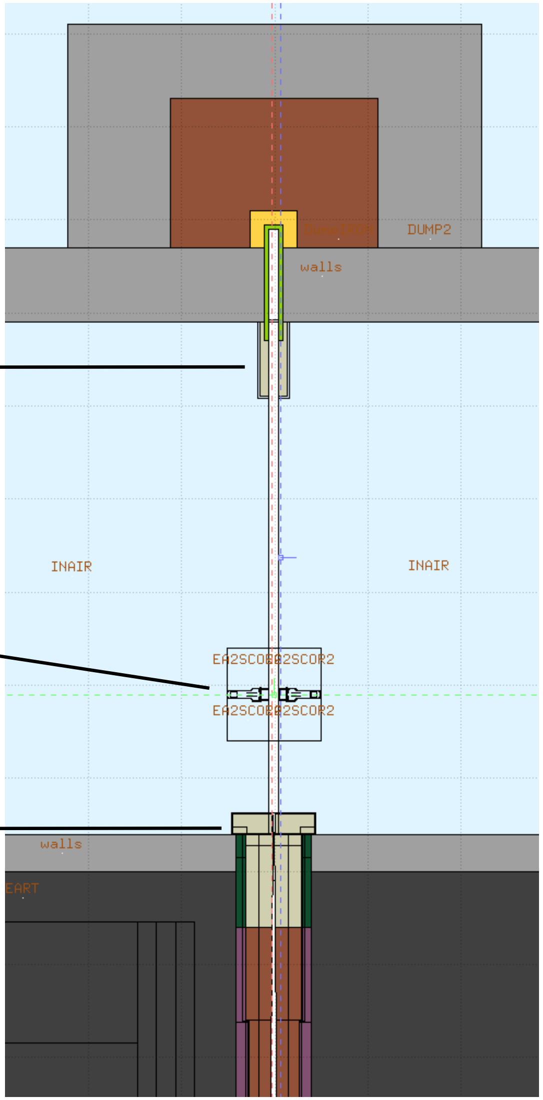
EXPERIMENTAL AREA

Additional Shielding in EAR2

Additional shielding below beam dump.

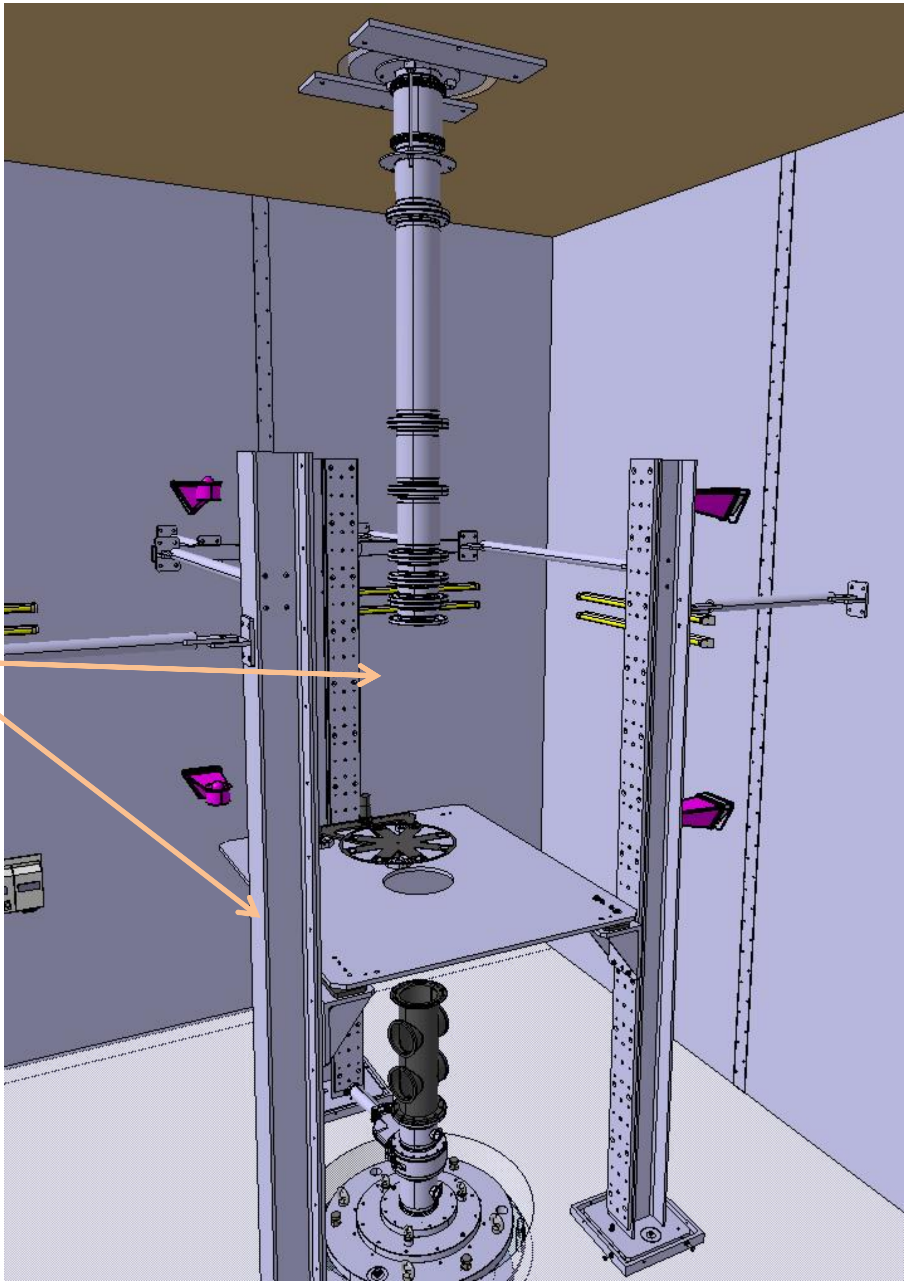
C6D6 detectors in FLUKA.

Additional shielding above 2nd collimator = false floor (20 cm).

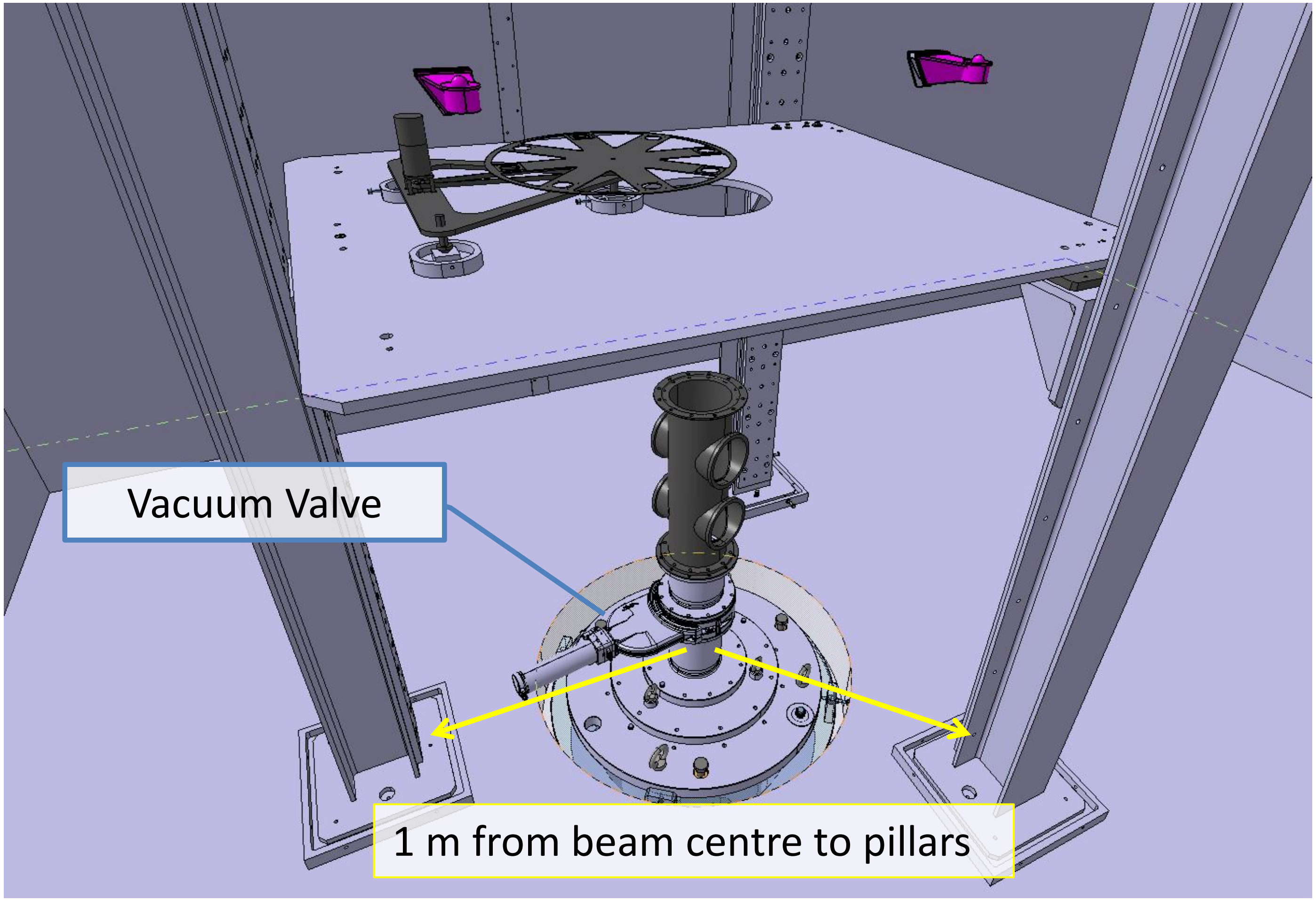


Capture Setup

- SiMon and sample exchanger (INFN) included in model.
- Support for sample exchanger to be modified (less material, detector closer to sample).
- Beam-line reductions before and after sample not included yet.
- Small Kapton windows planned before and after sample (like in EAR1).
- Valve below SiMon (vacuum + safety).
- Additional shielding not included yet (false floor + below beam dump).



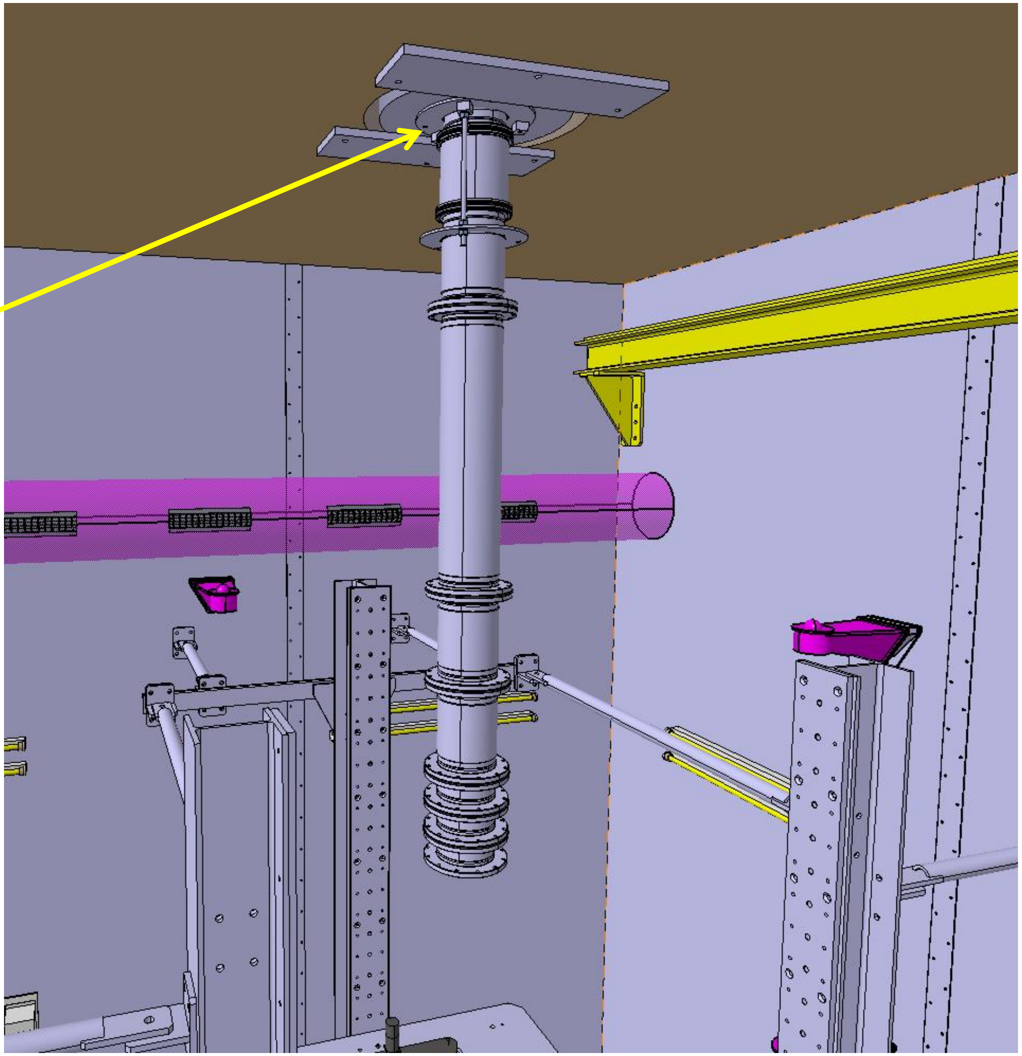
Capture Setup



Capture + Fission Setup

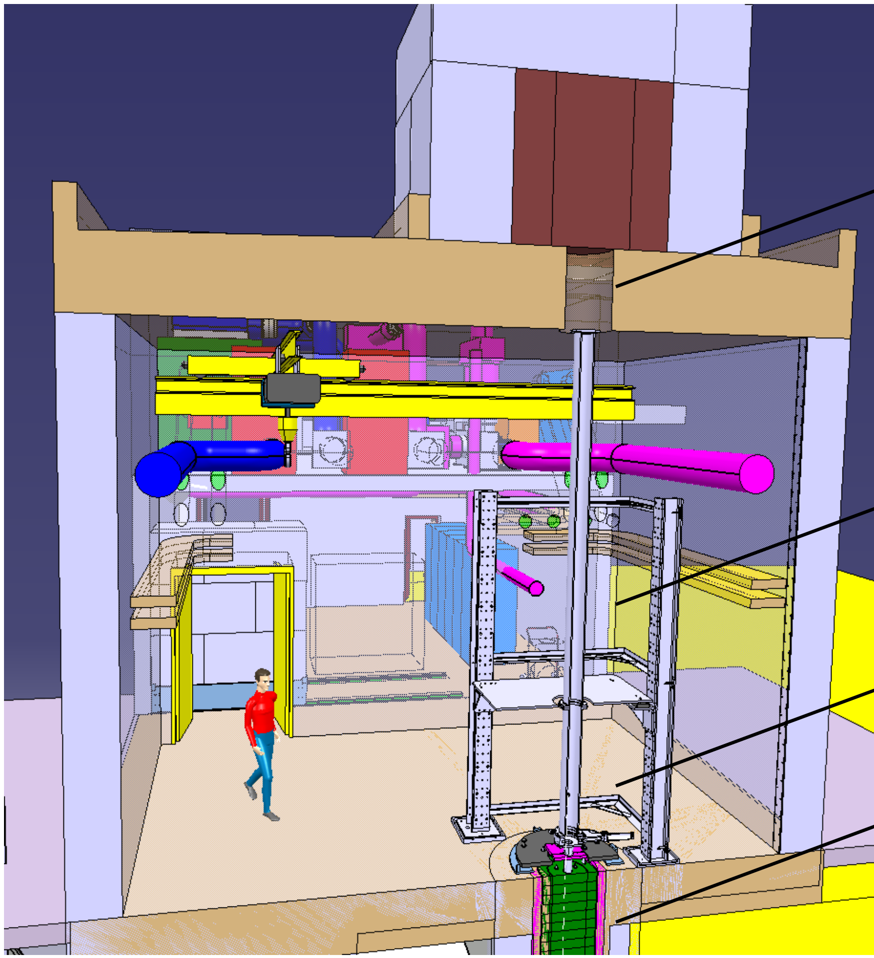
- Top part of the beam line will have to be dismantled before the crane can be used.

- Vacuum chamber with inserted shielding different for capture and fission => also needs to be removed when changing the collimators.



From Capture to Fission

(and reverse!)



To be dismantled and remounted:

- Vac. chamber + shielding in roof
- Beam Line + Detectors
- False Floor = Shielding
- 2^{nd} Collimator
- 1^{st} Collimator in Service Gallery!

4-5 days!

^{6}LI OR ^{10}B

Investigations

- Use $^{6}Li(n,\alpha)^{3}H$ instead of $^{10}B(n,\alpha)^{7}Li$ for 2nd collimator and all shielding material in EAR2.
- Cross-section of $^{6}Li(n,\alpha)^{3}H$ is 4 times smaller than $^{10}B(n,\alpha)^{7}Li$ – higher neutron background expected.
- See presentation of Silvia for details about the simulations.

- Available material:
  7.5% ^{nat}Lithium-Polyethylene.
- Material properties:
  machinable like normal PE,
  no safety issues reported.
- Budget: Approximately 10 000 Euros for 1 m^3.

CONCLUSIONS

Conclusions

- Production started for various elements:
  - Vacuum chamber 1
  - All needed bellows
  - Magnet (almost ready)
- To be decided:
  - ? Filters (proposed: Ag, W, Mo, Co, Na, Al, S)
  - ? ^{10}B or ^{6}Li
  - ? Monitoring system (capture)
  - ? Error margins for beam dump alignment
  - ? Safety margins for vacuum chambers inside EAR2
- To Do:
  - Supports (detectors, sample exchanger, etc.)
  - Equipment in EAR2 (tools, sources, etc.)

Master Mind Sylvain Girod

Thank you for your attention!

WHAT HAVE WE FORGOTTEN?

BACKUP

Collimator 2 Material

Thickness 20 mm

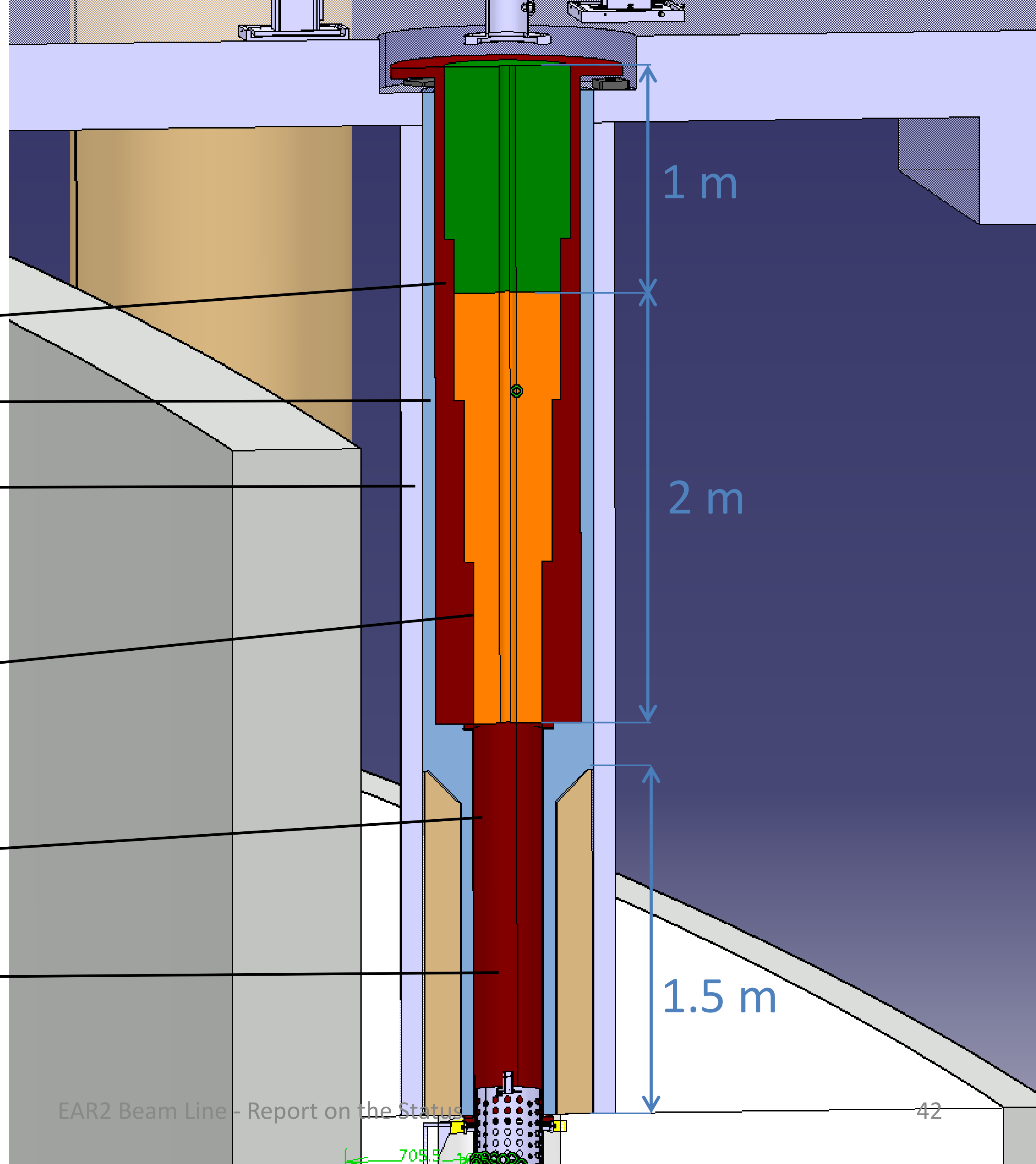
Gap 60 mm

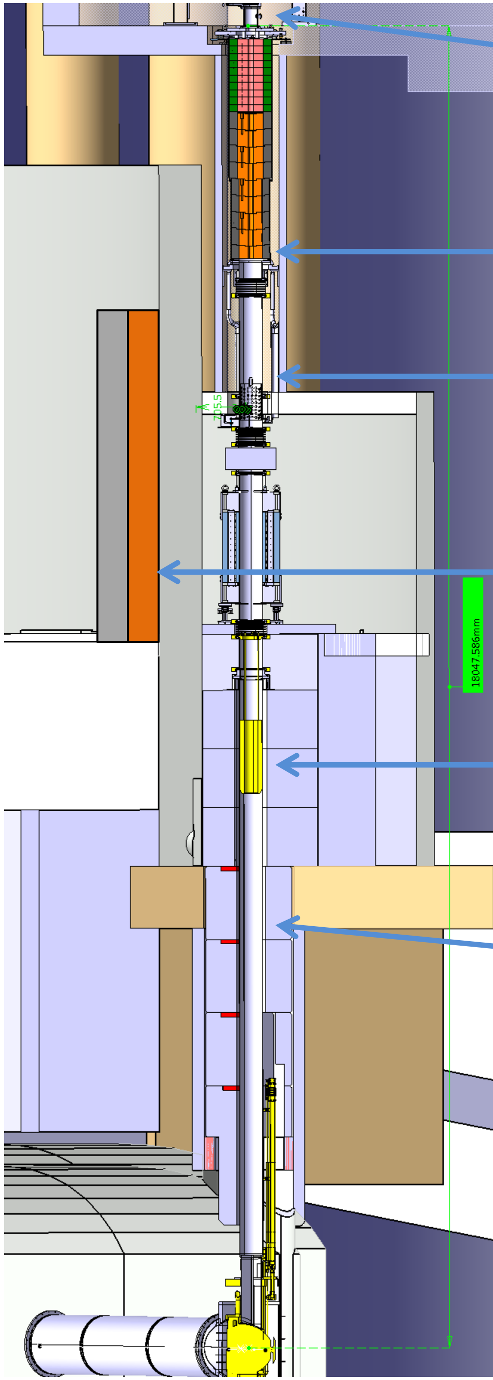
Pit Ø800 mm

175 mm available for chicanes on radius. (Here 3x58mm)

Maximum gap: 2mm

Minimum aperture Ø320 mm





→ Additional shielding layer at the floor of EAR2 for background reduction

→ Steel balls above service gallery

→ 1 m Concrete right above service gallery

→ Fe + Concrete wall in ISR tunnel

→ Fe collar at the level of 1st collimator

→ Concrete around beam pipe up to service gallery

1st Collimator: Removal

1. The green shielding is brought above the collimator with a trolley on the rails
2. The collimator is lifted inside the green shielding with a hoist
3. The rails guide the trolley to the storage position
4. The collimator is lowered in the storage pit