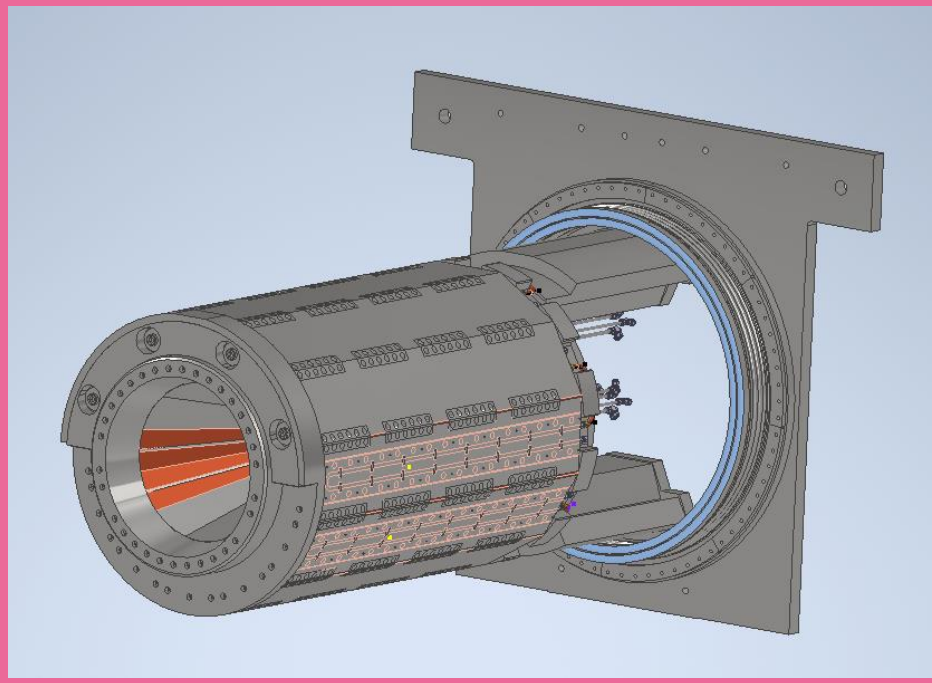
Capture Solenoid Inner Shield

Heat & Radiation Shield



Yusuke UCHIYAMA

Feb 19, 2024

COMET-Mu2e target collaboration @Fermilab

The CS inner shield

To shield radiation from the target

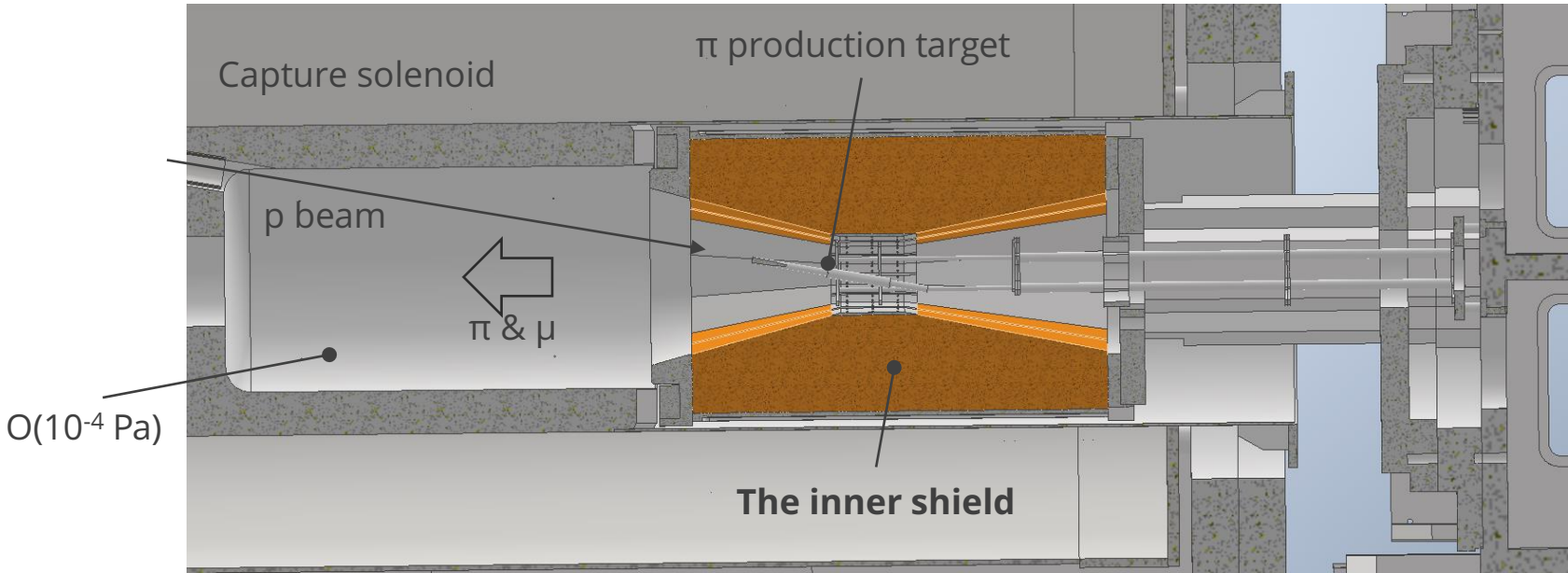
- especially to protect the SC coil of CS from quench by heat load and from radiation damage.

Necessary shielding power depends on the beam power.

- ⇔ Its shielding power would determine the available beam power in the experiment.
- Two-step strategy of COMET → upgrade in the 2nd phase
  ⇒ must be exchangeable after Phase I (radio-activated).

Is placed in the target volume (vacuum), provides interface for target system, and supports it

Top view



Shield

Base design for Phase I is w/ SST.

- An option to use **Cu** for high-rad region, depending on available budget.
- For Phase II, **W** is necessary, which costs too much and has many technical challenges.

Start production of SST part in FY2024

- Its design is almost fixed.
- Now we are finalizing the design of interface and exchange scenario.

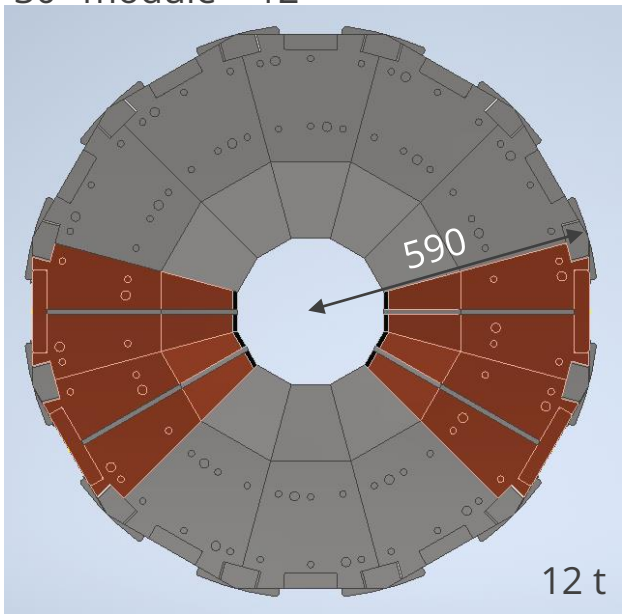
Beam Power Limitation by Energy Deposit to CS Coil

Rad. Shield	Neutron Fluence [10^{20} n/m^2]	Energy Deposit [kGy]	DPA [10^{-7} DPA]	Energy Deposit (local max) [mW/kg]	Beam Power Max [kW]
Threshold	10	1000	4000	4.0	
W	11	52	0.8	4.0	16.52
Cu	3.4	52	34	4.0	2.02
S316	3.1	52	35	4.0	1.53
No shield	0.1	52	2.3	4.0	0.12

Threshold : n<10^{21} n/m2, ED<<1MGy, 4mW/kg, DPA<4x10^{-4}
Note1 : Above numbers are picked up from maxmum area.
Note2 : Due to beam spill structure, heat generation (energy deposit [mW/kg]) becomes instantaneously 5 times larger.

By MARS simulation

30° module × 12



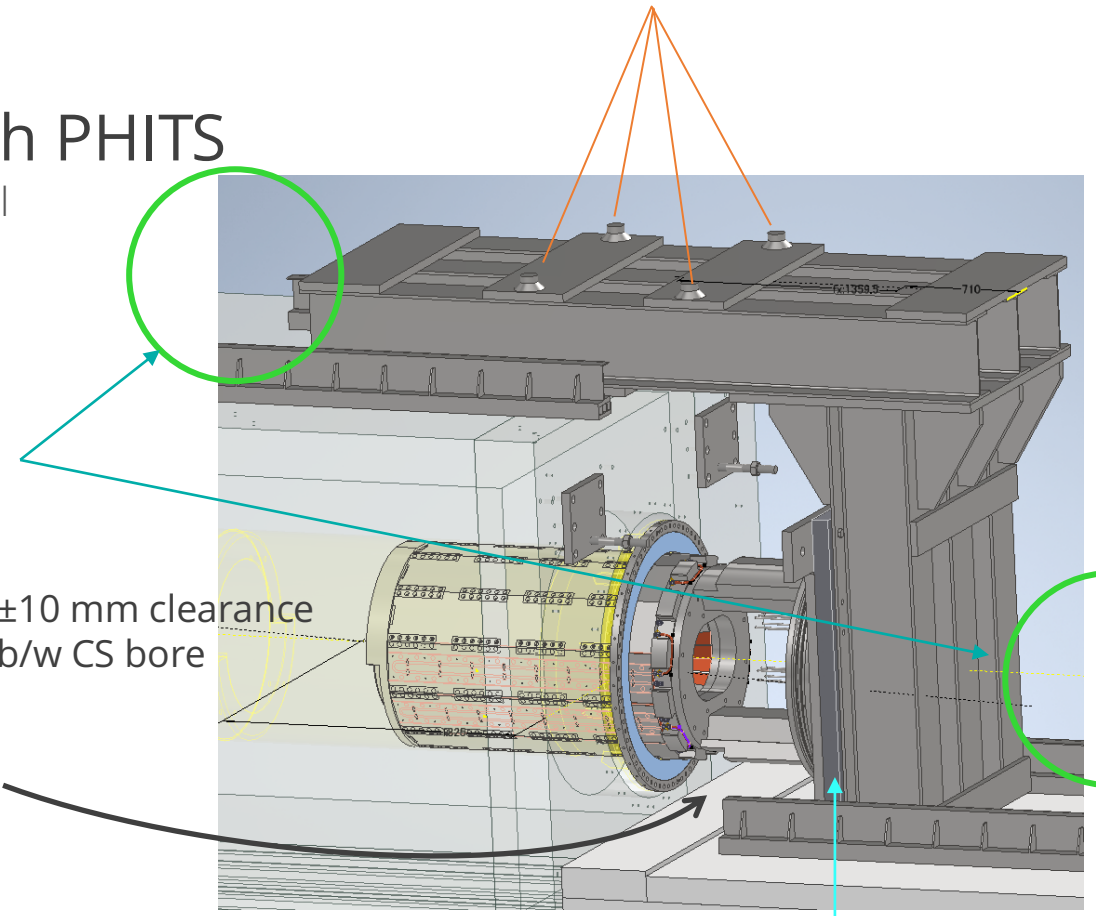
Installation/extraction method

Design the system to be exchangeable after irradiation

- Minimize radiation exposure to people
- with space limitation in the area
- & minimizing the cost

Radiation calculation with PHITS

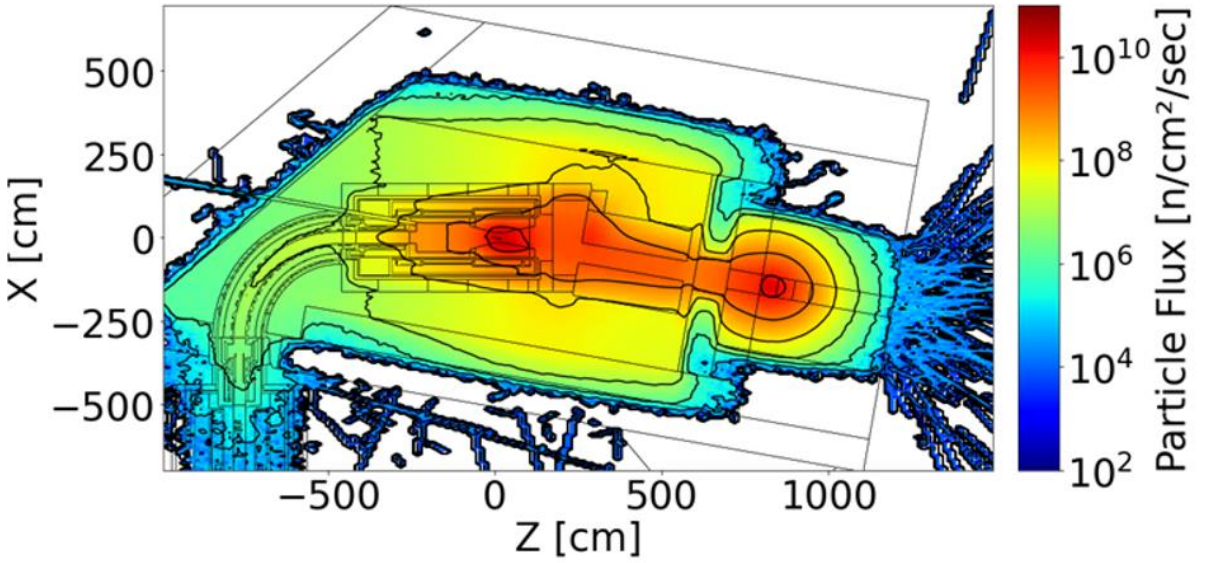
- Evaluate residual dose after Phase I



Dose calc.

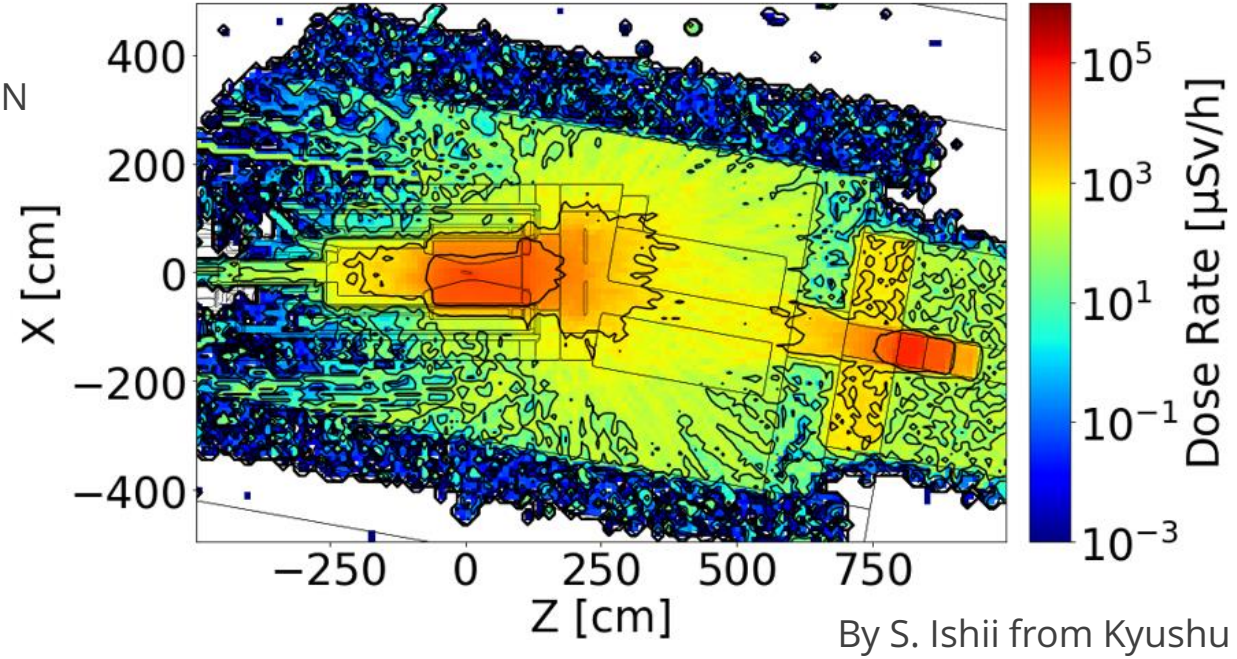
[PHITS](#) simulation

During Phase I beam operation



Residual dose after 180 d cooling (150 d beam)

PHITS + DCHAIN



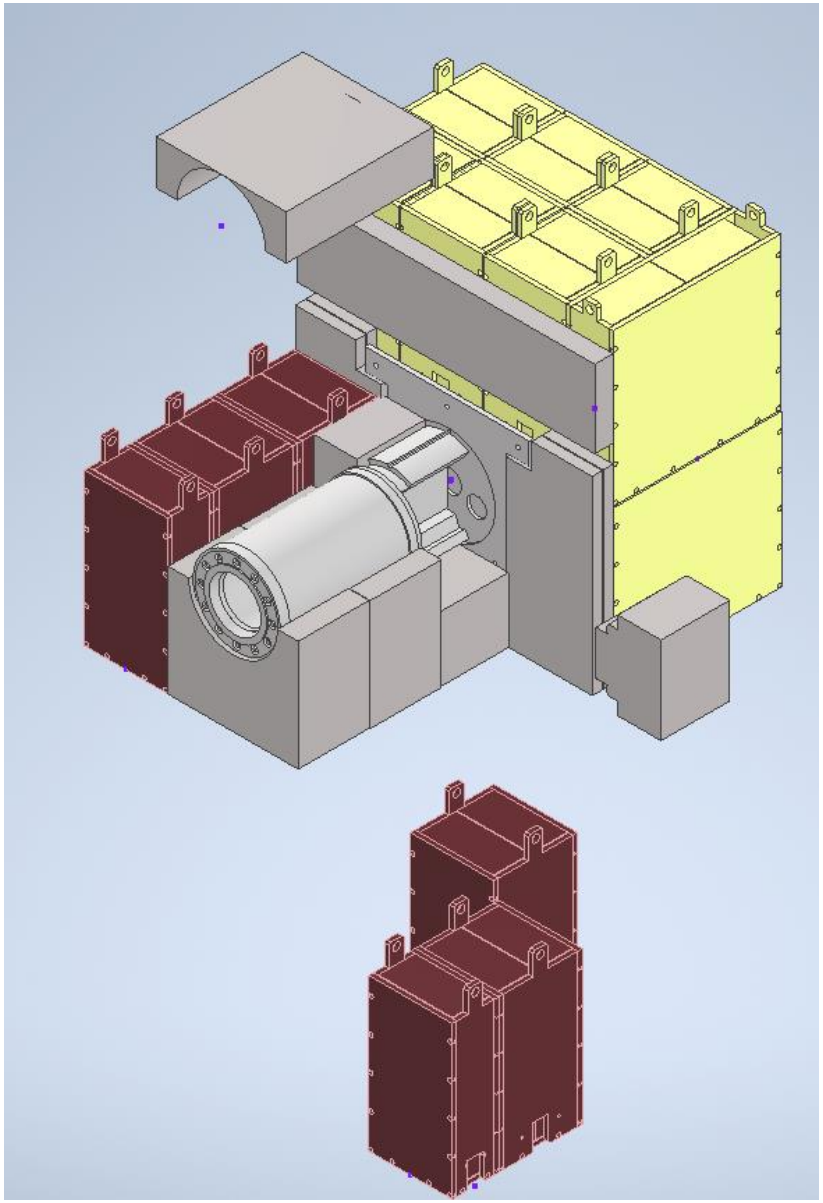
By S. Ishii from Kyushu U.

Large aperture pillow seal

After Phase I

Bury the shield in the dump

- Reuse the shielding material
- which are highly radio-activated.



Summary

Presented our design of CS inner shield

- An important vicinity of high-power targetry in both Mu2e & COMET

We plan to start construction in this year

- Final engineering design is underway
- considering the given budgetary constraint

Any collaborations are welcome

- starting with exchanging information.
- We need an upgrade towards Phase II.

Mu2e Heat & Radiation Shield in TDR

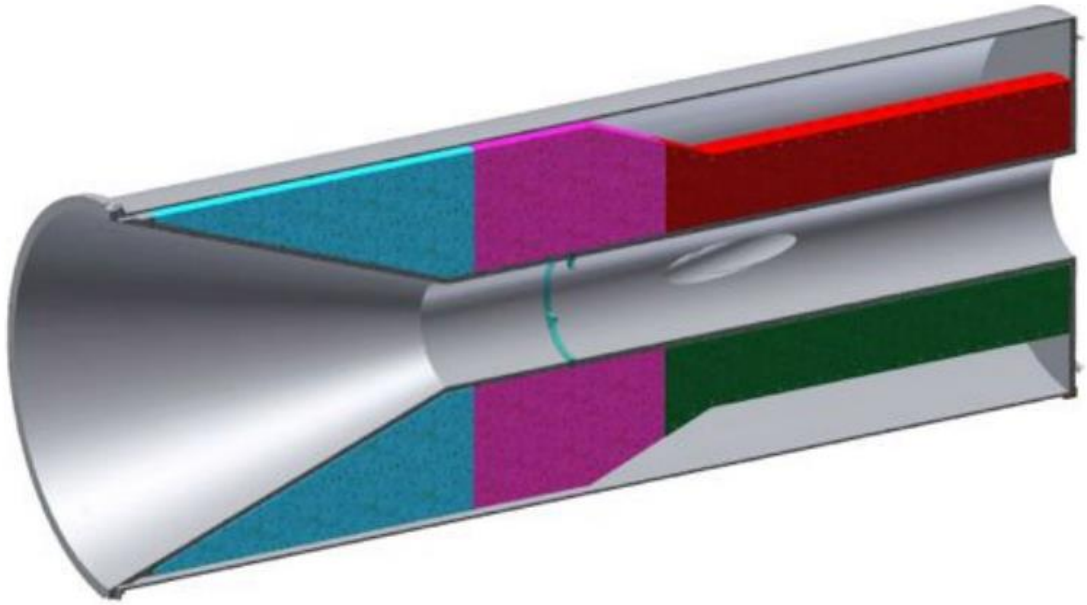


Figure 4.167. Section view of the HRS. Bronze pieces are shown in light blue, purple and red. A stainless steel liner surrounds the bronze on all sides and the vessel holds 600 gallons of water.

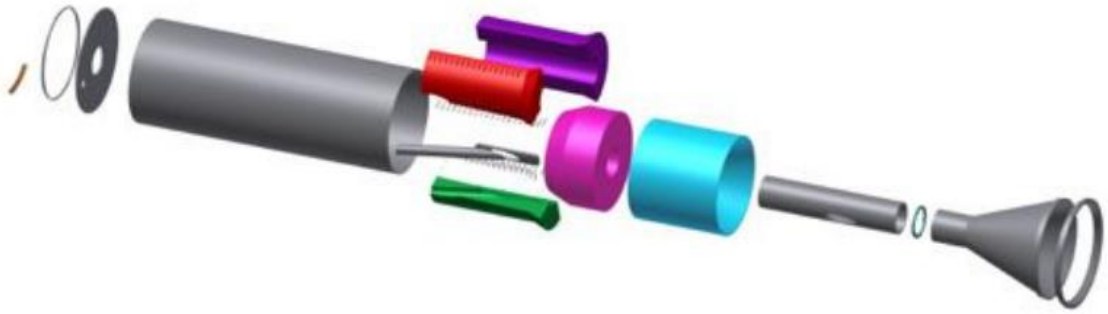
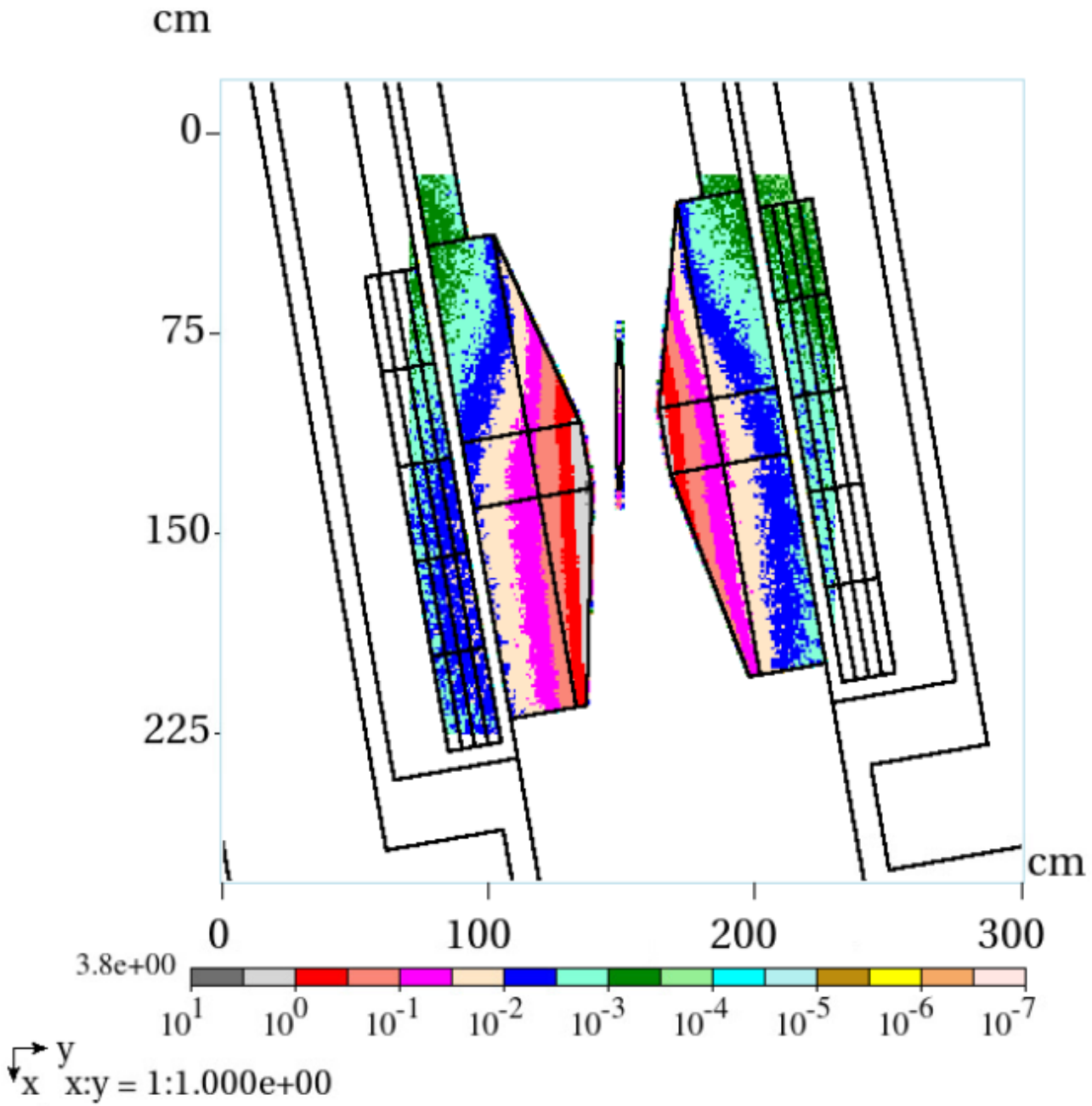


Figure 4.168. Exploded view of the HRS showing the stainless steel liner.



mW/g@2.75e+12 p/s(3.52kW)