
# HAPL Concrete Shielding Requirements

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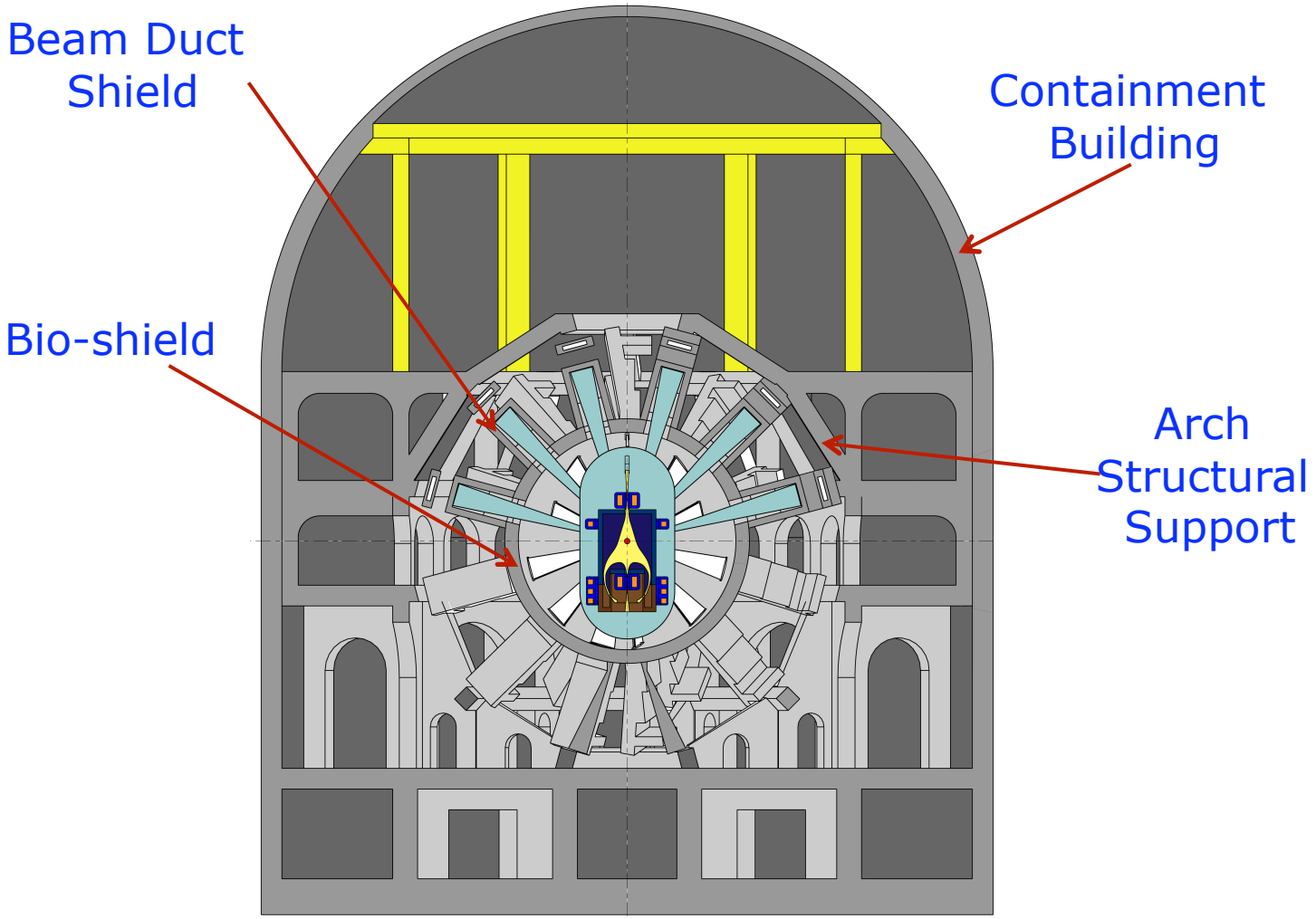
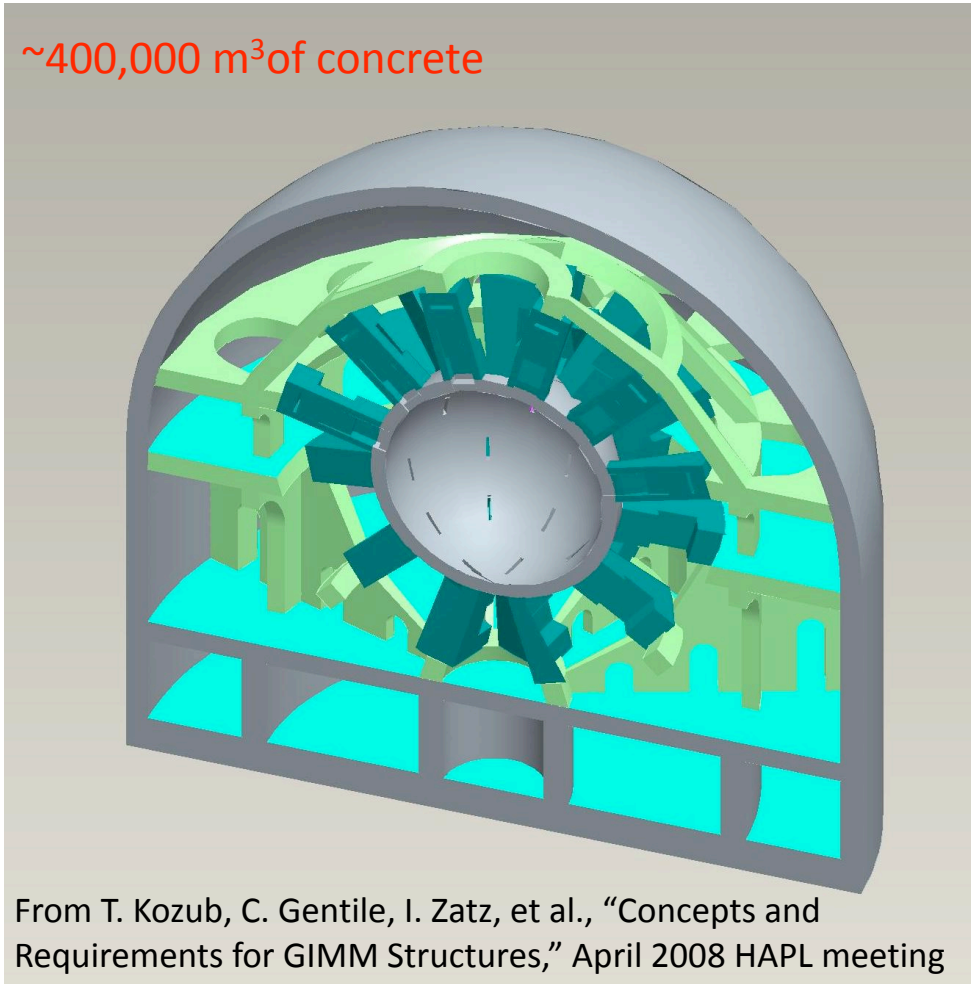
# Concrete Shielding Configuration



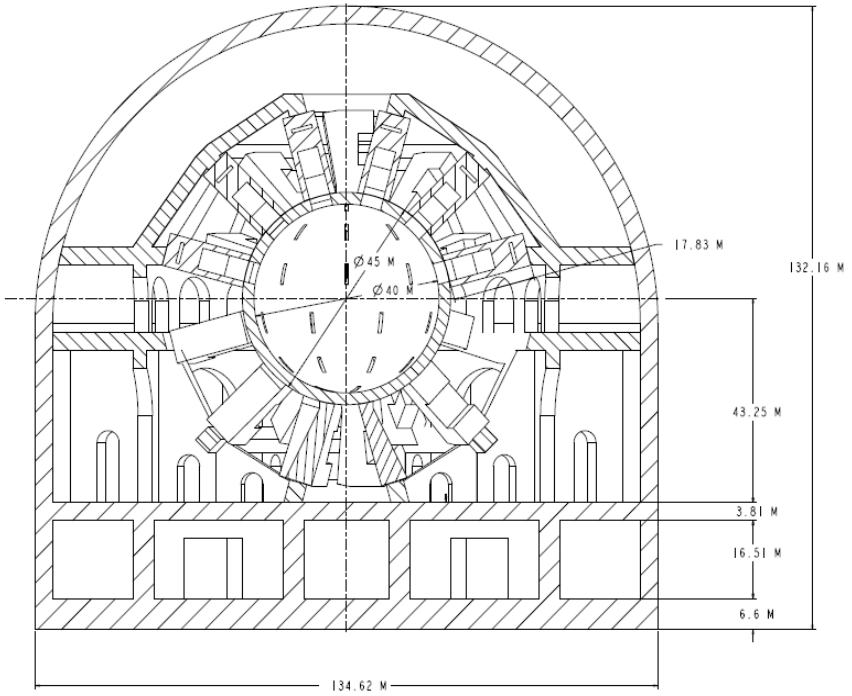
# Past HAPL Concrete Shielding Approach

- Concrete bio-shield around final optics and chamber was determined previously assuming that access is allowed outside it during operation
- This led to a sizable bio-shield
- Adding the concrete containment building and concrete arch structural support results in significant amount of concrete

# Previous HAPL Concrete Shield Dimensions




From T. Kozub, C. Gentile, I. Zatz, et al., "Concepts and Requirements for GIMM Structures," April 2008 HAPL meeting




- 2.5 m inner spherical bio-shield around chamber
- 3.8 m containment building

# Current HAPL Bio-Shielding Strategy

- Access inside containment building allowed only for maintenance during shutdown periods
- Inner bio-shield around chamber and final optics sized to yield acceptable dose of ~2.5 mrem/h about one day after shutdown
- Containment building sized to yield an acceptable occupational dose to workers of ~0.5 mrem/h during operation
- Even with these conservative dose limits significant reduction in amount of concrete can be achieved

# Required Inner Bio-Shield

- Past experience showed that if fast neutron flux (E>0.1 MeV) is limited to ~$5x10^5$ to $3x10^6$ n/$cm^2$s during operation, dose rate levels of ~2.5-10 mrem/h after 1-10 day cool down period will result from decay gamma of activated shield and outlying equipments allowing for hands-on maintenance
- To get conservative estimates we use $5x10^5$ n/$cm^2$s fast neutron flux limit during operation to determine required inner bio-shield thickness that allows for hands-on maintenance

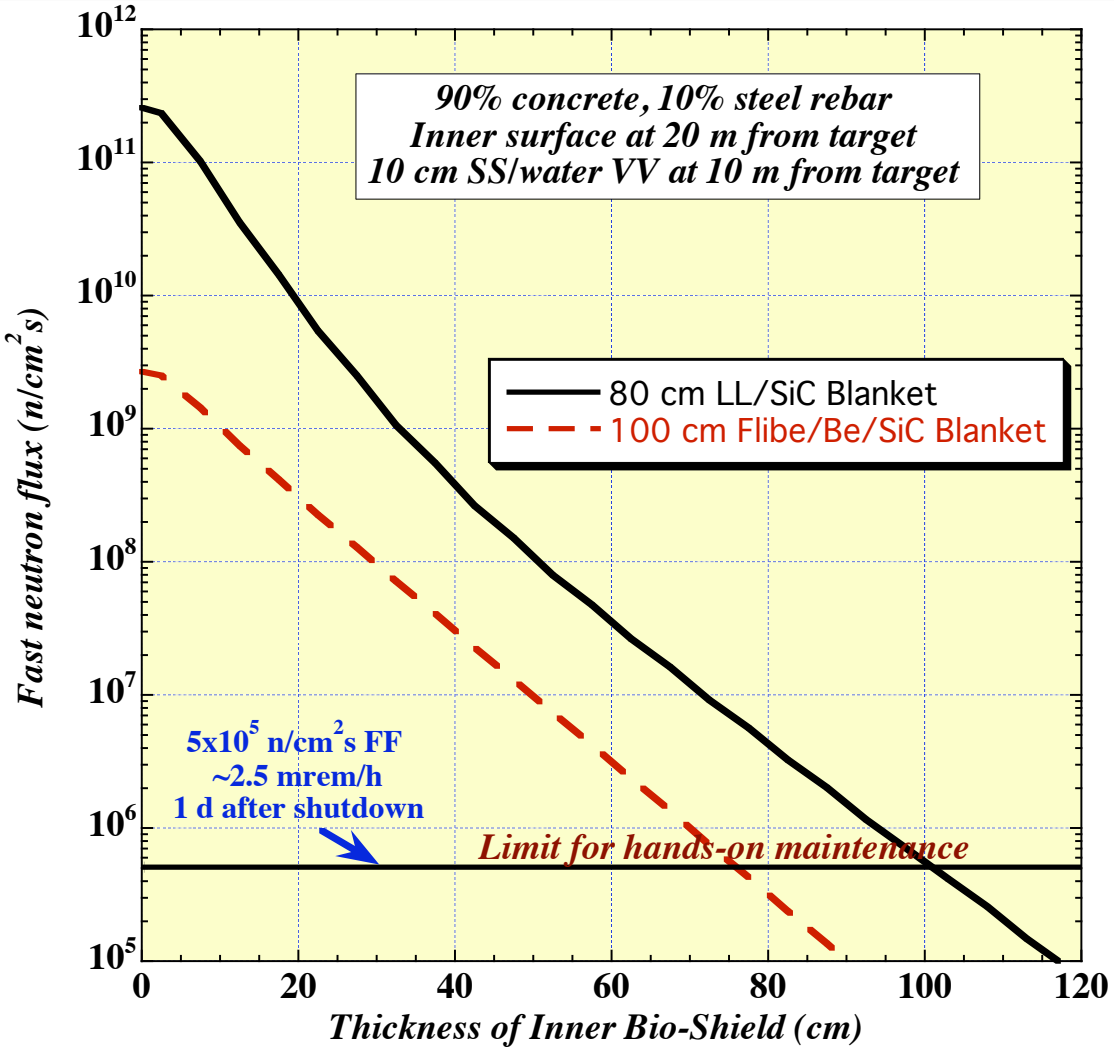
# Required Inner Bio-Shield (Cont.)

- Required inner bio-shield around chamber determined for two blanket options:
  - 80 cm LiPb/SiC blanket, 10 cm SS/water VV
  - 100 cm Flibe/Be/SiC blanket, 10 cm SS/water VV

- Largest shield required at the neutron trap behind the GIMM where no shielding credit is provided by blanket and VV

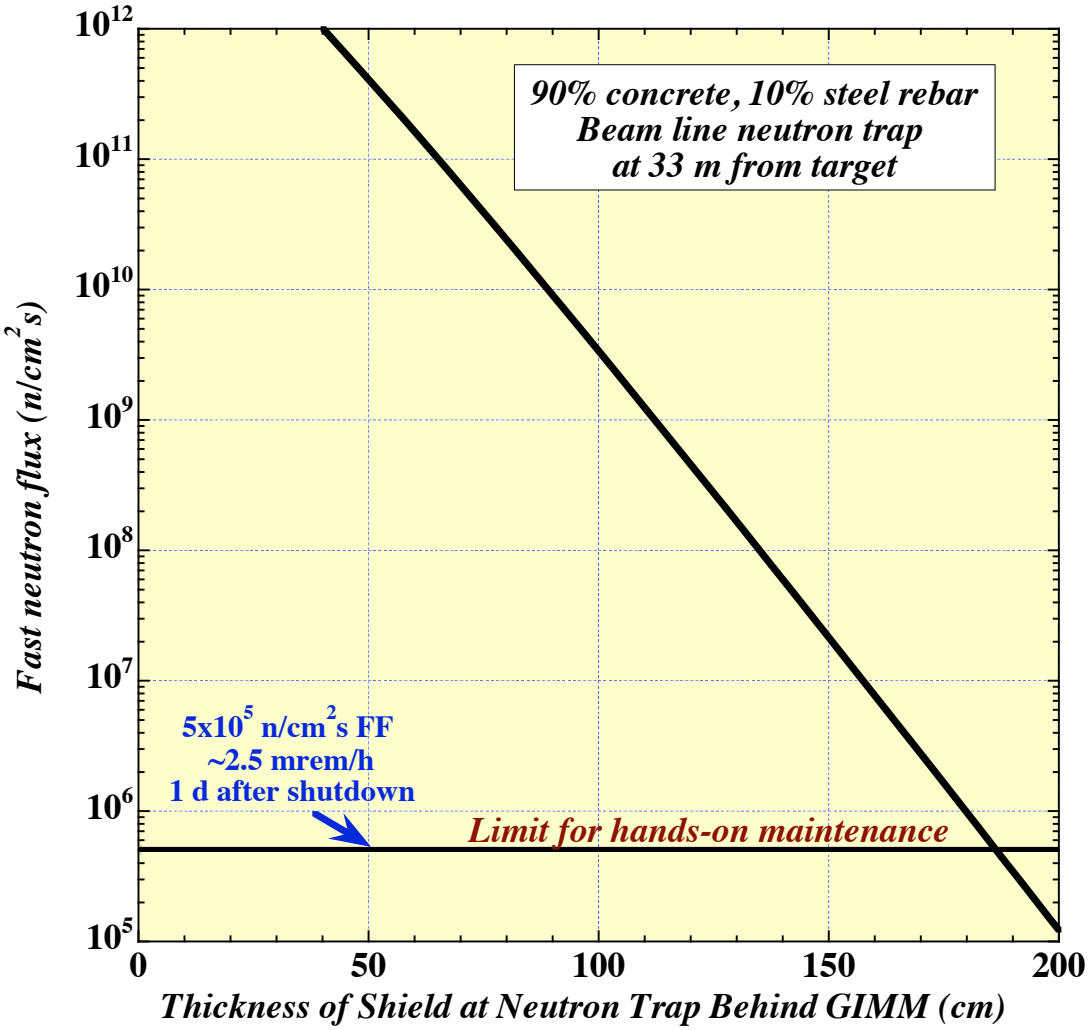
- Required shielding around final optics estimated from map of fast neutron flux around laser beam line

# Required Inner Bio-Shield behind Blanket/VV



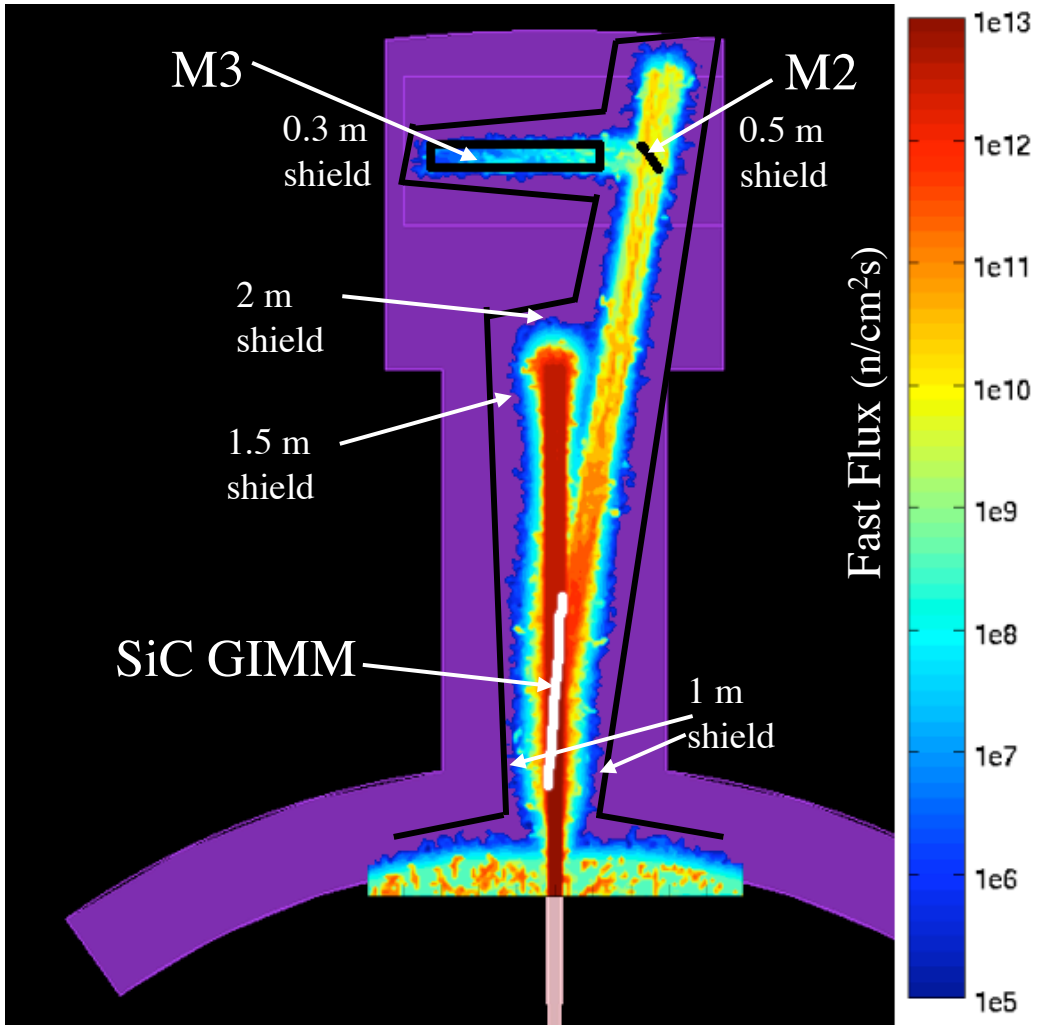

- Assumed inner surface at 20 m from target
- Type 04 ordinary concrete used with SS316 rebar
- Required inner bio-shield thickness behind LiPb blanket is ~1 m and reduces to only ~0.75 m with Flibe blanket
- A conservative 1 m thickness is recommended

# Required Bio-Shield at Neutron Trap behind GIMM



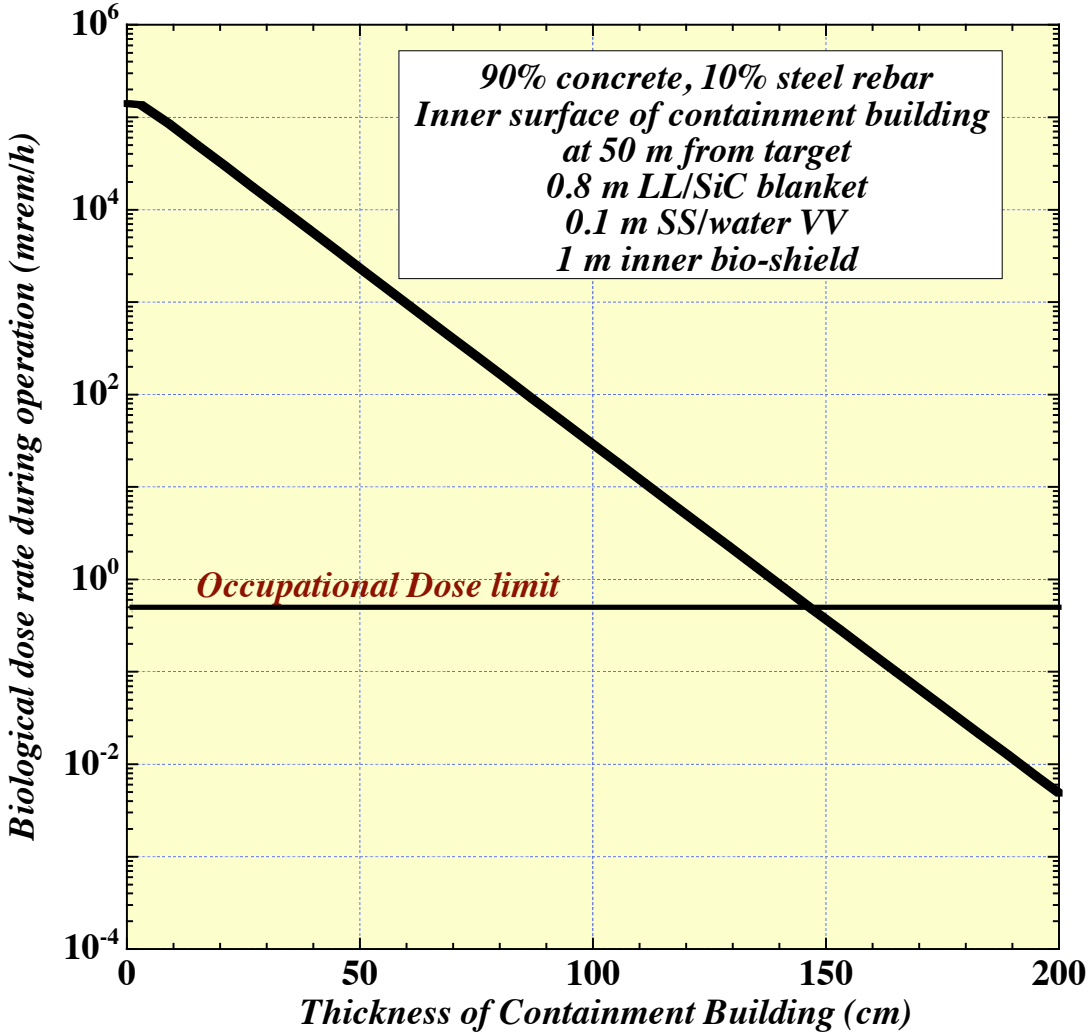

- Required bio-shield thickness at neutron trap (@33 m from target) behind GIMM is ~1.85 m
- Conservative thickness of 2 m is recommended

# Required Bio-Shield Around Final Optics




- Bio-shield thickness at GIMM is 1 m and reduces to 0.5 m around M2 and 0.3 m around M3
- Shield at neutron trap should be 2 m at back and 1.5 m at side

# Required Containment Building Thickness




- Assumed inner surface of containment building at 50 m from target
- Type 04 ordinary concrete used with carbon steel C1070 rebar
- Required containment building thickness is ~1.5 m
- Since no credit is taken for added shielding by concrete arch structure, we can use thinner containment building

# Summary and Conclusions

- Amount of concrete required for bio-shield and containment building can be reduced significantly (by at least a factor of 2) based on shielding requirements
- Considerations for structural support might dictate using thicker bio-shield and containment building than required for radiation shielding