BEAM-POWER DEPOSITION IN A 4-MW TARGET STATION FOR A MUON COLLIDER OR A NEUTRINO FACTORY

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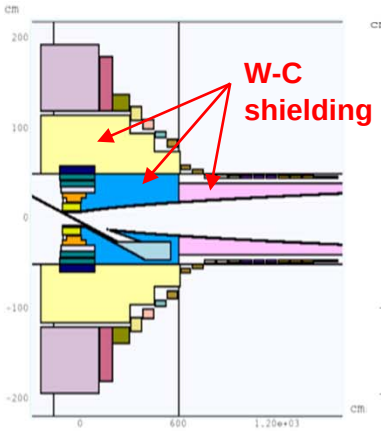
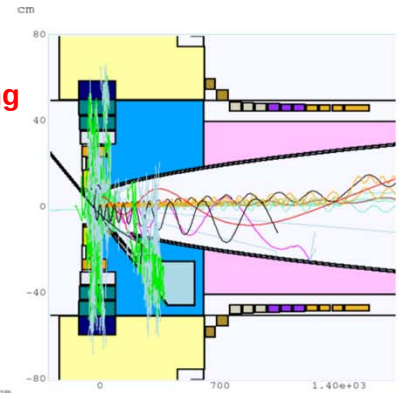
A series of studies was performed using the MARS15+MCNP code to optimize the tungsten-carbide + water shielding of superconducting magnets for the target station at a Muon Collider or Neutrino Factory. The goal is to provide a 10-year lifetime of these magnets against radiation damage due to secondary particles from the target. For this, the peak density of deposited power can be no more than 0.1 mW/g.

IDS120h Geometry ID=240 cm

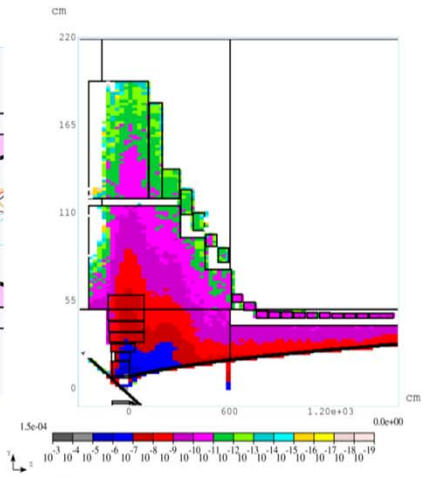


SC3 : 0.26 kW
SC5: 0.19 kW
TOTAL : 0.86 kW
Peak SC3: 0.045 mW/g
Stored energy: 3 GJ

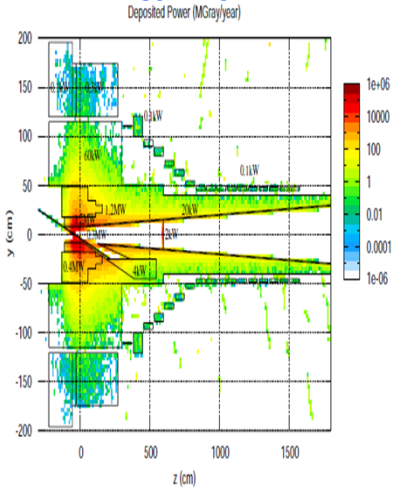
PARTICLE TRACKS FOR 9 EVENTS

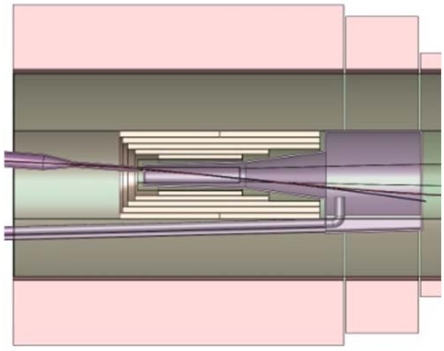


MARS15 simulation of energy deposition



FLUKA simulation of energy deposition



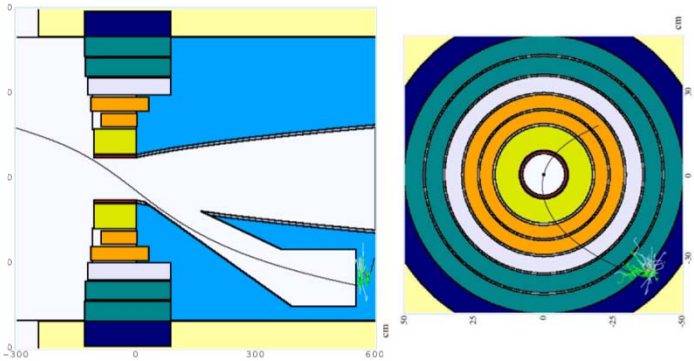


Above: section of the target system near the interaction region, sketching the mechanics of the Hg collection pool.

MARS+MCNP vs. FLUKA FOR IDS120f GEOMETRY (Power deposited in kW):

TOTALS	MARS	FLUKA
SC#1-19	0.97	0.56
SH#1-4	2020.06	2148.9
RS#1-5	329.55	405.1
BP#1-3	458.39	482.8
Hg TARG.	376.5	319
Hg POOL	10.16	4.4
Be WIND.	0.53	2.1
TOTAL	3196.16	3362.86

POWER DENSITY PEAK VALUES:
MARS/MCNP < 0.08 mW/g
FLUKA < 0.05 mW/g



Proton-beam trajectory in the 20-T field is curved, and the Hg collection pool, which also serves as the beam dump, must be suitably wide.

CONCLUSIONS

W-C+water shielding out to 1 m radius inside central superconducting magnets provides > 10-year lifetime against radiation damage.

MeV neutrons more trouble than thermal neutrons.

More W-C shielding is better.

Thermal load at 4K remains high: ~ 1 kW even with shielding out to 1.2 m radius.

W-C shielding likely needed beyond the target station, where ~ 800 kW power must be dissipated.