ENERGY DEPOSITION WITHIN SUPERCONDUCTING COILS OF A 4-MW TARGET STATION

(PAC11, TUP179)

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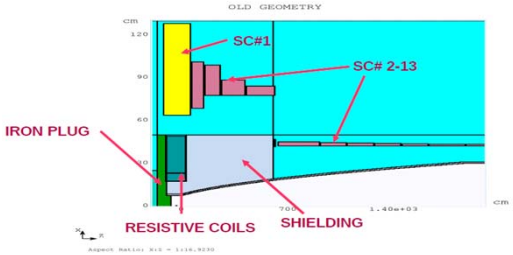
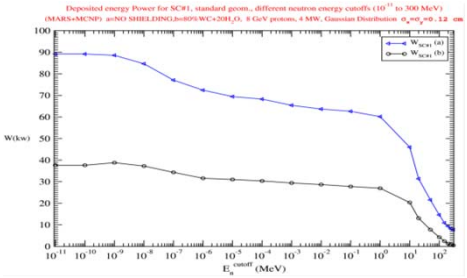
A series of studies was performed by using the MARS15+MCNP code to optimize the tungsten-carbide + water shielding of superconducting magnets for the target station at a Muon Collider or Neutrino Factory. The goal is to provide a 10-year lifetime of these magnets against radiation damage due to secondary particles from the target. For this, the peak density of deposited power can be no more than 0.15 mW/g.

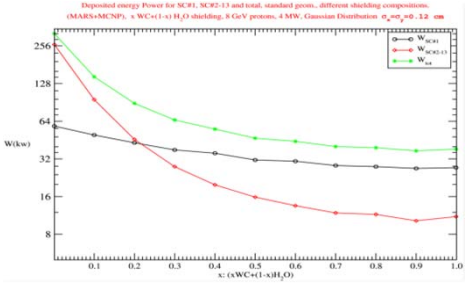
Study II Geometry (2001)
ID=126.6 cm



SC1 : 37.6 kW
TOTAL: 50.1 kW
Peak SC1: 5.5 mW/g

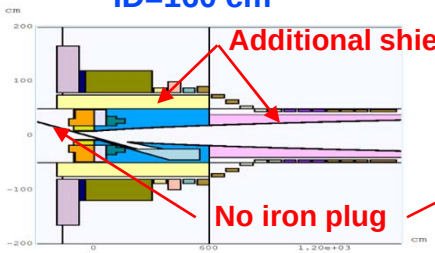


MeV neutrons more trouble than thermal neutrons



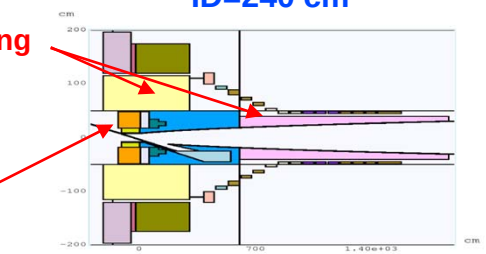
More W-C shielding is better

IDS80f Geometry
ID=160 cm

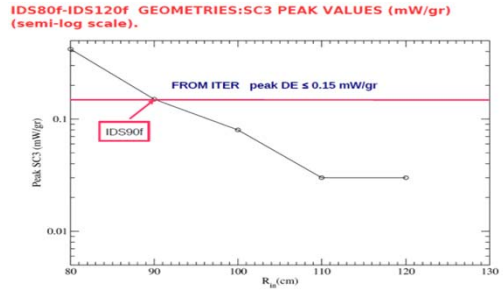


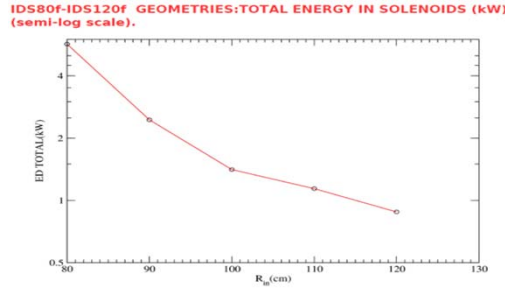
SC3 : 4.2 kW
TOTAL : 5.7 kW
Peak SC3: 0.42 mW/g
Stored energy: 2 GJ

IDS120f Geometry
ID=240 cm

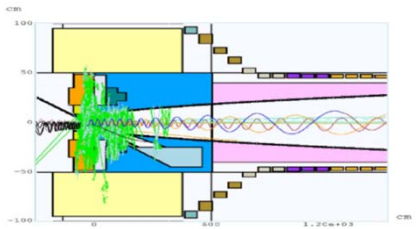


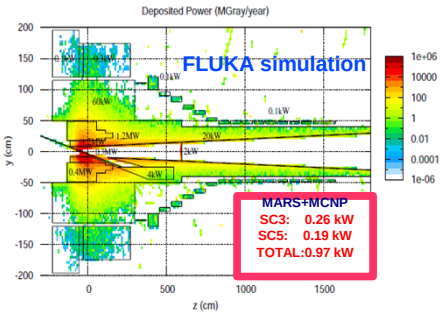
SC3 : 0.26 kW
SC5: 0.19 kW
TOTAL : 0.97 kW
Peak SC3: 0.03 mW/g
Stored energy: 4 GJ





PARTICLE TRACKS FOR 9 EVENTS





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

CONCLUSIONS

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

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

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