THE UNIVERSITY OF WARWICK

Power Deposition in νFact Target Front-End

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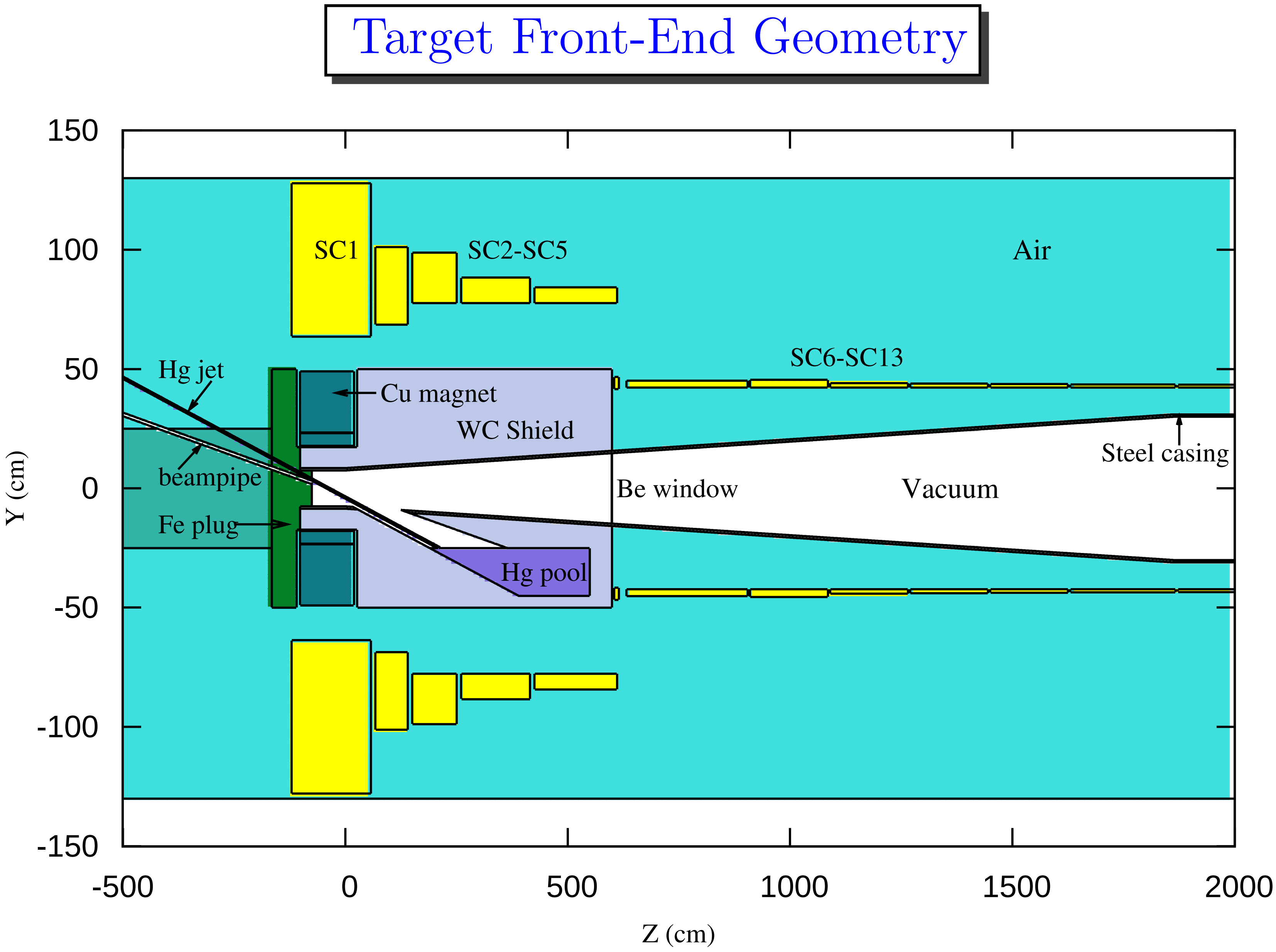
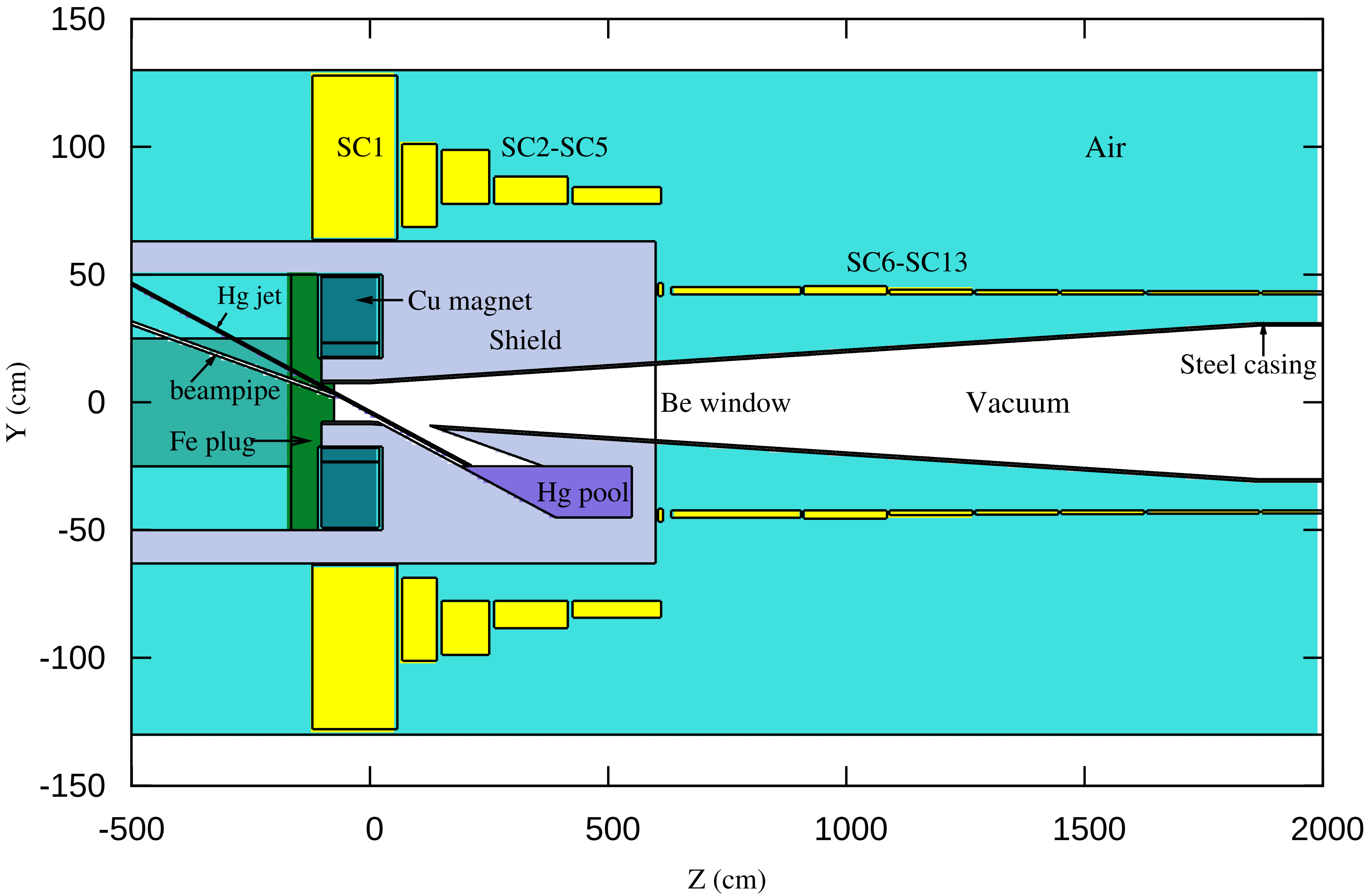
Introduction

- Using Mars & Fluka to estimate energy deposition for νFact Hg jet target
  - all Mars results courtesy of Xiaoping Ding (UCLA)
- Study II geometry and magnetic field map
- Hg jet: $r = 0.5\,\mathrm{cm}$, tilt θ=100 mr
- Gaussian proton beam $r_{\mathrm{beam}} = 0.15\,\mathrm{cm}$, tilt θ=67 mr; KE= 8 GeV
- Looking at deposited power in different regions, specifically in the shielding and the superconducting coils (SC)
  - Proton rate $= 3.125 \times 10^{15}\ \mathrm{s}^{-1}$ for 4 MW (8 GeV, 50 Hz)
  - Multiply deposited energies by proton rate to get power

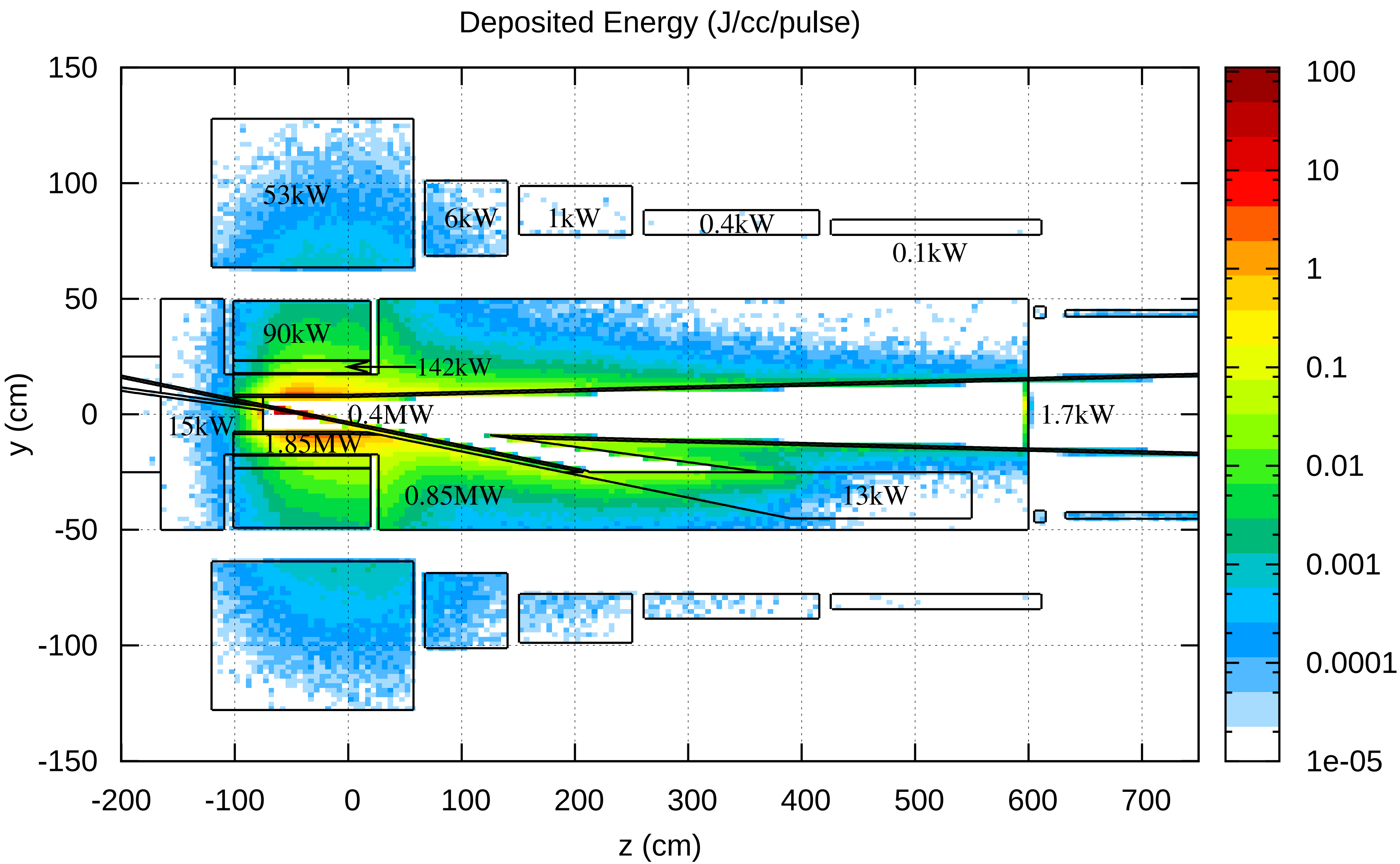

Target Front-End Geometry
150
100
50
0
-50
-100
-150
-500
0
500
1000
1500
2000
Y (cm)
Z (cm)
SC1
SC2-SC5
Air
Hg jet
SC6-SC13
Cu magnet
WC Shield
Steel casing
beampipe
Be window
Vacuum
Fe plug
Hg pool

Enhanced Target Front-End Geometry



Extra shielding below SC1: $r_{\max} = 50 \rightarrow 63\,\mathrm{cm}$

Approximate distribution of power deposition



Power Deposition - Standard Shielding

Power deposition in the SC coils & the shielding for Mars & Fluka

Shielding Material	SC1	(kW)	SC1-SC13	(kW)	Shielding	(kW)
0.8 WC + 0.2 Water	24.9	53.5	36.1	64.3	1839	2293
100% W	20.9	57.0	30.8	69.8	1826	2231
0.8 W + 0.2 Hg	22.6	62.5	33.2	79.7	1860	2199
0.6 W + 0.4 Hg	23.7	68.6	35.1	90.7	1892	2171
100% Hg	32.5	86.7	61.1	133.9	1651	2083

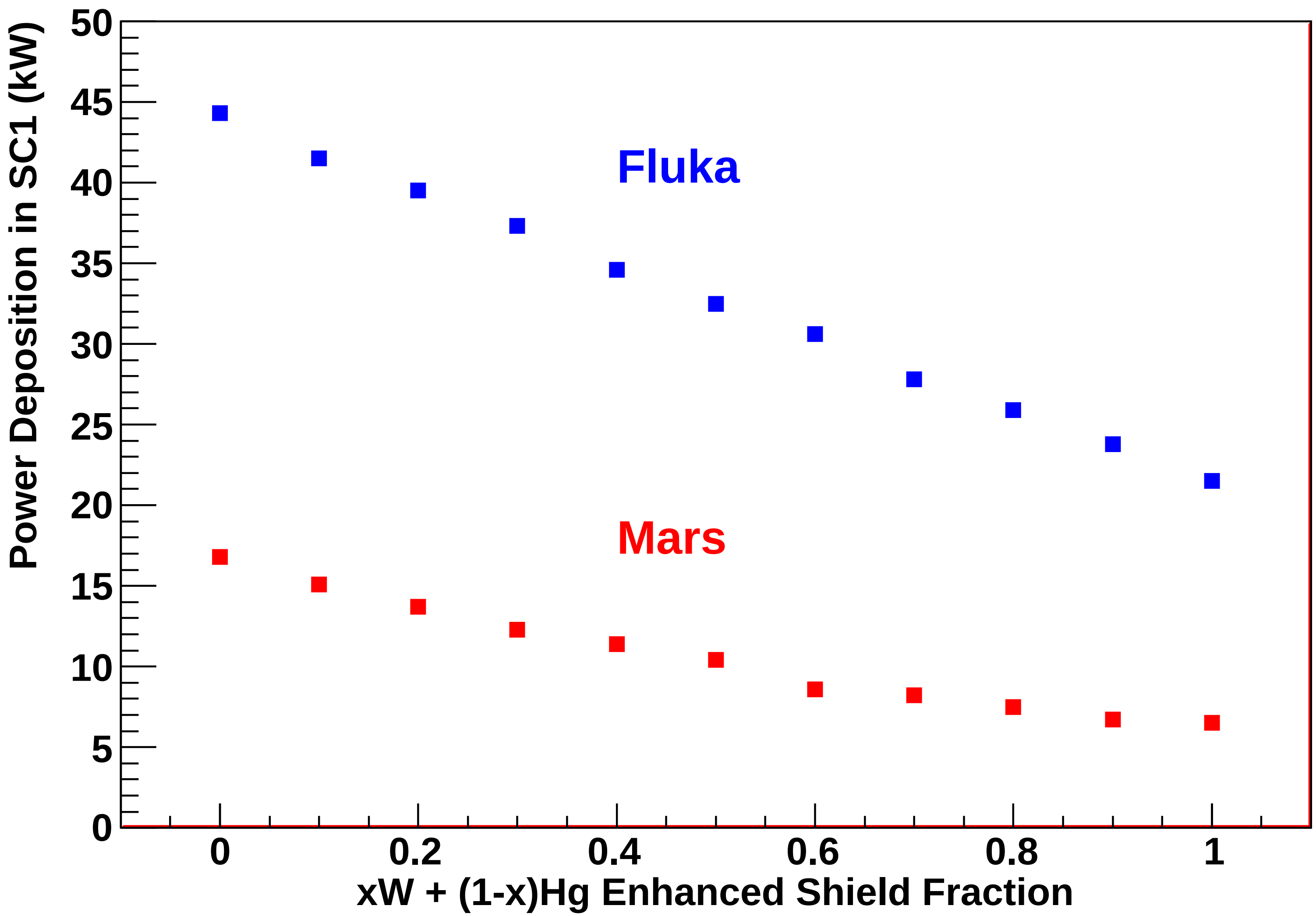
Similar results using Ta instead of W for composite shielding material.

Power Deposition - Enhanced Shielding

Power deposition in the SC coils & the shielding for Mars & Fluka

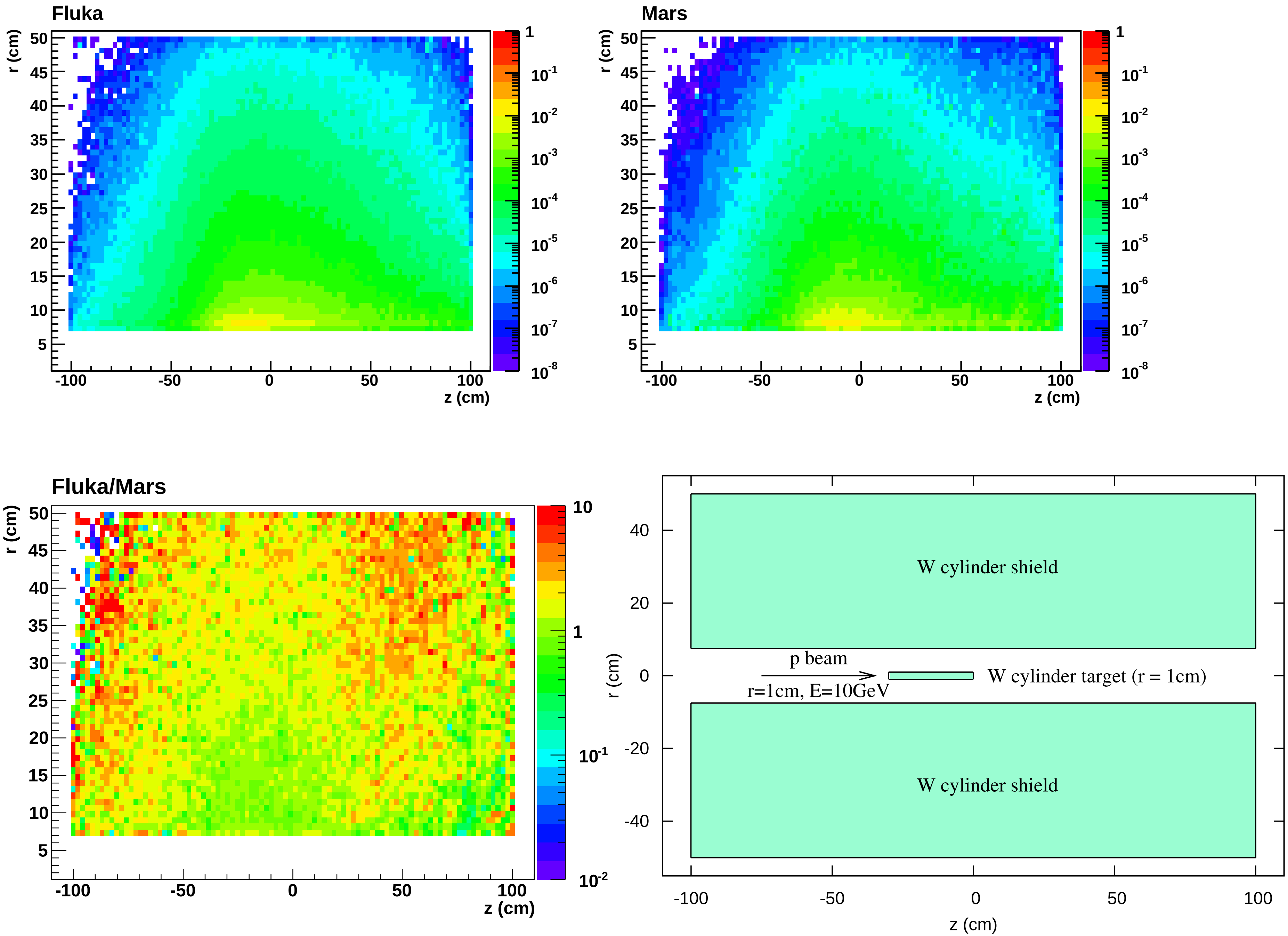
Shielding Material	SC1	(kW)	SC1-SC13	(kW)	Shielding	(kW)
0.8 WC + 0.2 Water	8.6	18.6	16.8	23.7	1866	2347
100% W	6.5	21.5	14.0	26.8	1934	2280
0.9 W + 0.1 Hg	6.7	23.8	14.3	29.6	1833	2267
0.8 W + 0.2 Hg	7.5	25.9	15.0	32.3	1817	2259
0.7 W + 0.3 Hg	8.2	27.8	15.9	35.0	1805	2249
0.6 W + 0.4 Hg	8.6	30.6	16.4	38.9	1794	2231
0.5 W + 0.5 Hg	10.4	32.5	21.1	42.5	1796	2220
0.4 W + 0.6 Hg	11.4	34.6	23.2	46.0	1776	2208
0.3 W + 0.7 Hg	12.3	37.3	25.4	50.7	1752	2194
0.2 W + 0.8 Hg	13.7	39.5	28.0	55.1	1741	2188
0.1 W + 0.9 Hg	15.1	41.5	31.7	59.9	1710	2176
100% Hg	16.8	44.3	35.9	66.1	1683	2166

Variation of SC1 power for W/Hg shield fraction



Fluka/Mars differences

- Fluka gives higher E_{dep} values
- Short study to investigate differences between the two codes:
  - Proton beam: $r = 1\,\mathrm{cm}$, $E = 10\,\mathrm{GeV}$
  - Simple tungsten target, no B field, nor complicated geometries
- Fluka/Mars E_{dep} ratio shows Fluka energy showers are more "penetrating"
  - Fluka E_{dep} higher as we move away from the initial proton beam
  - Explains higher E_{dep} values for SC coils in Fluka
- Following plots show normalised energy (per unit mass) deposition & the Fluka/Mars ratio


Fluka
Mars
Fluka/Mars
r (cm)
z (cm)
W cylinder shield
p beam
r=1cm, E=10GeV
W cylinder target (r = 1cm)
W cylinder shield

Summary

- Shown power deposition for νFact target front-end using Mars & Fluka
  - Most of power deposited in shield; about 10% in Hg jet
  - Fluka power values higher than Mars (showers more "penetrating")
- Best shielding solutions differ between Mars & Fluka
  - Mars suggests 100% W, whereas Fluka slightly prefers 80% WC + 20% H_2O
  - Differences in hadronic models/cross-sections for p & n reactions?
- Very high power deposition in the first superconducting coil (SC1): $P_{\mathrm{SC1}} > 20\,\mathrm{kW}$
  - Enhanced shielding ($r_{\mathrm{max}} = 50 \rightarrow 63\,\mathrm{cm}$) reduces SC1 power by $\sim \frac{1}{3}$
- Need more shielding to reduce this further
  - Need to know maximum allowed safe operating power for SC1
  - Need simulation results to be significantly lower than this to ensure safety case
  - Probably need to move the SC1 coil much further out, or replace with Cu coils
  - Implications for the SC magnetic field (14 T) $\Rightarrow \pi, \mu$ yield production