THE UNIVERSITY OF WARWICK

# FLUKA Power Deposition for IDS120f Geometry

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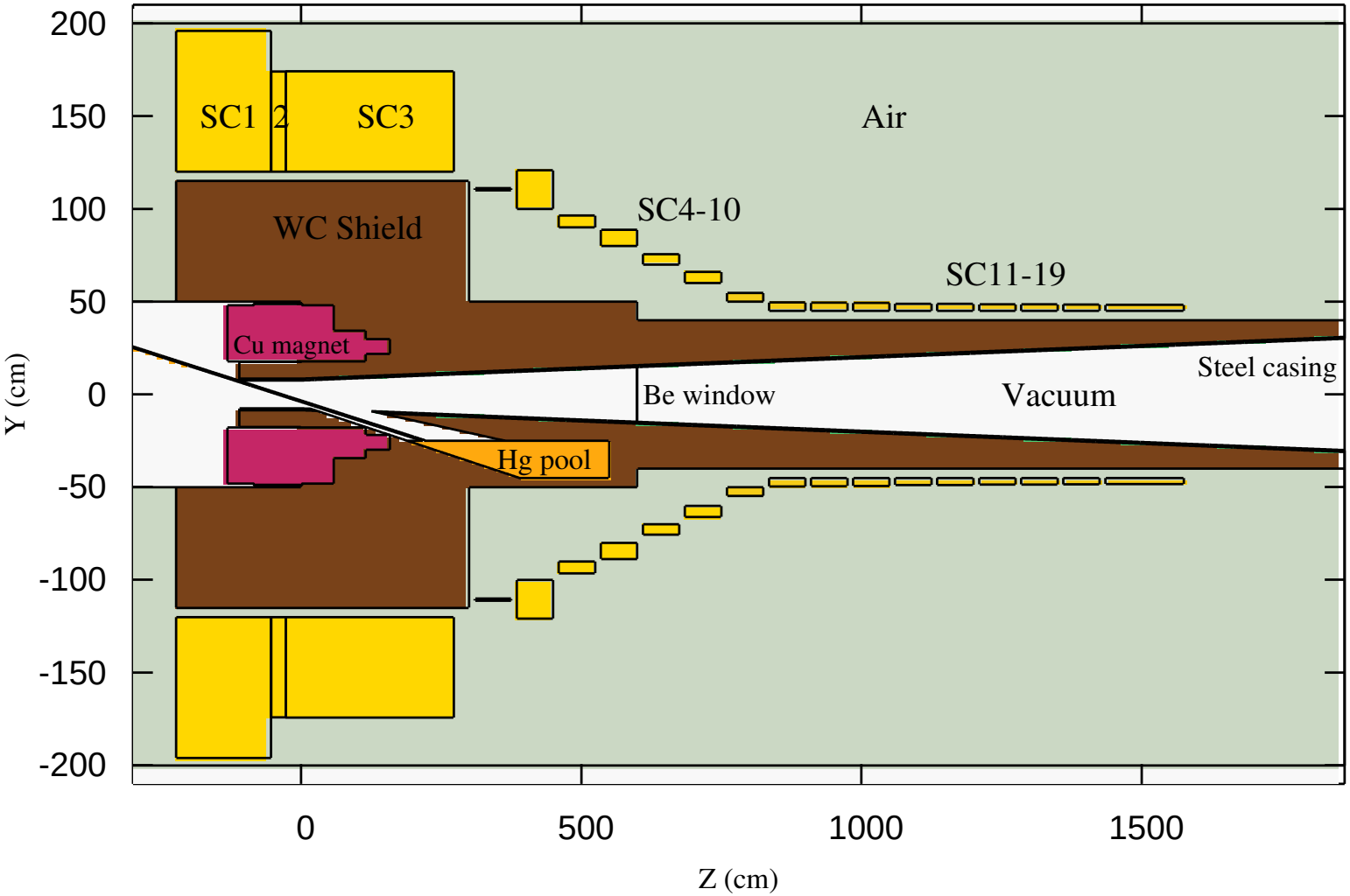
8th February 2011

# Introduction

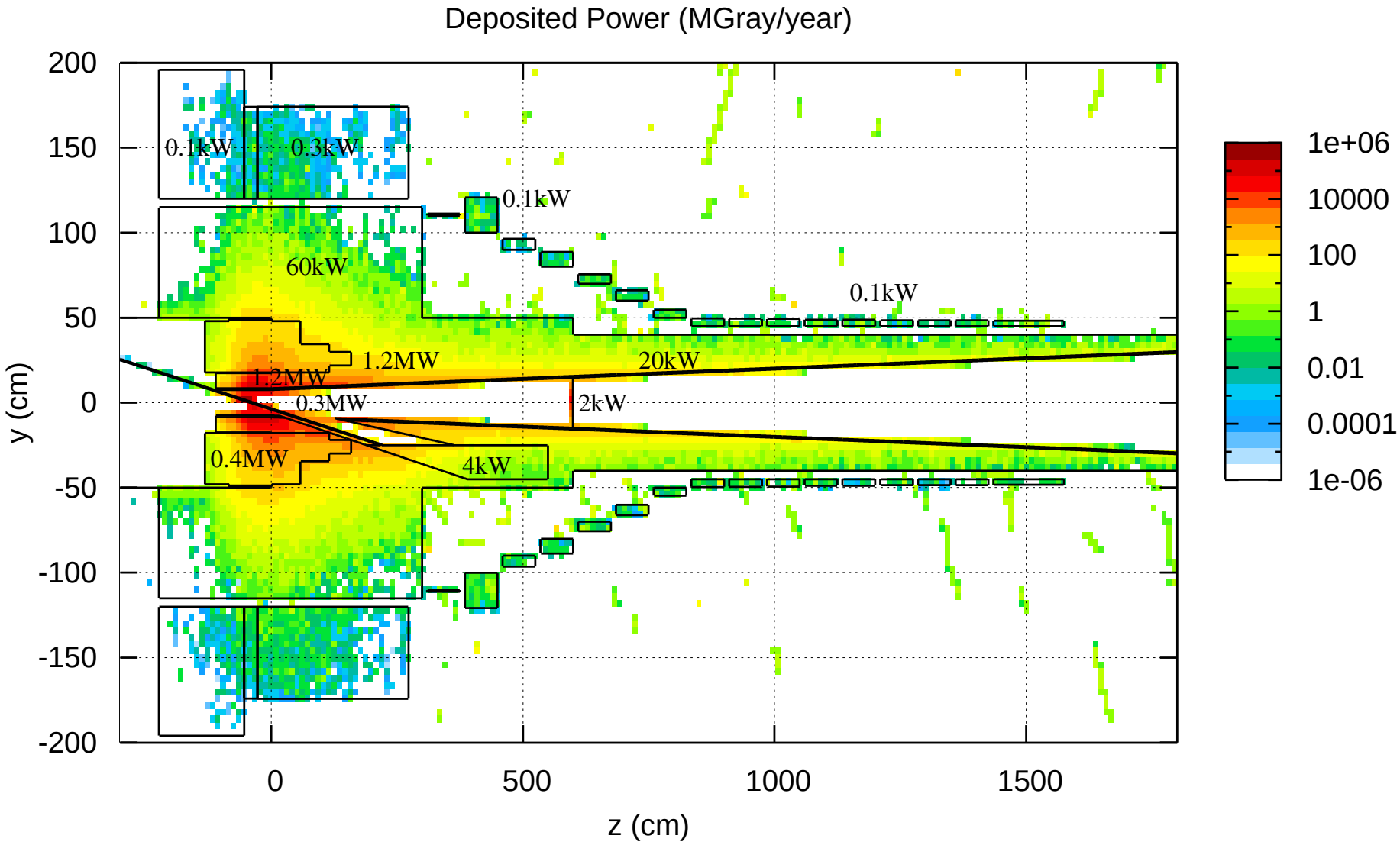
- Using FLUKA 2008.3c to estimate energy deposition for Hg jet target
- "IDS120f" geometry parameters (N. Souchlas) and $\underline{B}$ field map (R. Weggel)
  - MARS+MCNP: less than 1 kW power in each SC coil (N. Souchlas)
- Hg jet: $r = 0.4\,\text{cm}$, tilt $\theta = 97\,\text{mr}$. Modelled as a cylinder.
- Gaussian proton beam $\sigma_x = \sigma_y = 0.12\,\text{cm}$, KE $= 8\,\text{GeV}$,
  $\Delta\theta = 27\,\text{mrad}$ at $z = -37.5\,\text{cm}$ (from optimisation study by X. Ding)
  - Proton rate $= 3.125 \times 10^{15}\ \text{s}^{-1}$ for 4 MW (8 GeV, 50 Hz)
  - Multiply (average) energies by proton rate to get deposited power
- Also looked at energy deposition vs neutron min energy cut-off
  - Default neutron energy cut-off of $10^{-14}\,\text{GeV}$ seems good enough
- Different random number runs (100k events each) to estimate uncertainties

# Fluka Geometry (IDS120f)




Shielding (brown area): 60% WC + 40% Water
SC coils (yellow areas): 1-9 are $Nb_3Sn$, 10-19 are NbTi

# Typical distribution of beam power



# Power deposition in SC coils

| Region | P (kW) |
|---|---|
| SC Coil 1 | $0.052 \pm 0.008$ |
| SC Coil 2 | $0.032 \pm 0.006$ |
| SC Coil 3 | $0.261 \pm 0.058$ |
| SC Coil 4 | $0.004 \pm 0.002$ |
| SC Coil 5 | $0.066 \pm 0.012$ |
| SC Coil 6 | $0.014 \pm 0.004$ |
| SC Coil 7 | $0.013 \pm 0.002$ |
| SC Coil 8 | $0.017 \pm 0.004$ |
| SC Coil 9 | $0.017 \pm 0.006$ |
| SC Coil 10 | $0.014 \pm 0.006$ |

| Region | P (kW) |
|---|---|
| SC Coil 11 | $0.011 \pm 0.002$ |
| SC Coil 12 | $0.011 \pm 0.004$ |
| SC Coil 13 | $0.007 \pm 0.002$ |
| SC Coil 14 | $0.006 \pm 0.002$ |
| SC Coil 15 | $0.008 \pm 0.004$ |
| SC Coil 16 | $0.007 \pm 0.006$ |
| SC Coil 17 | $0.005 \pm 0.004$ |
| SC Coil 18 | $0.005 \pm 0.002$ |
| SC Coil 19 | $0.010 \pm 0.004$ |
| All Coils | $0.560 \pm 0.062$ |

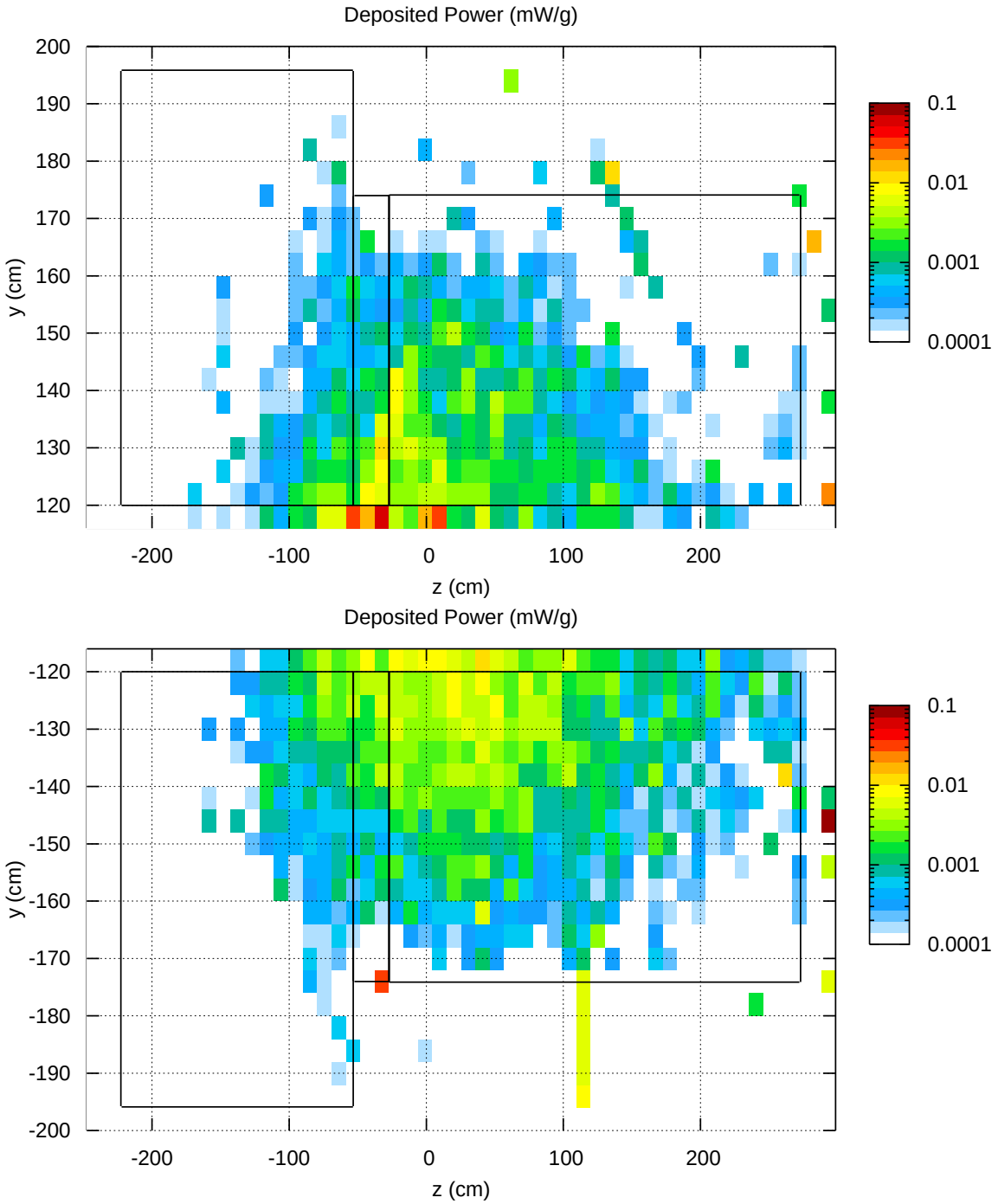
All SC power deposition results significantly below 1 kW

# Power deposition in other regions

| Region | P (kW) |
|---|---|
| Inner shielding $r < 17.5\,\text{cm}$, $z < 0\,\text{m}$ | $1050 \pm 10$ |
| Shielding $0 < z < 6\,\text{m}$, $r < 50\,\text{cm}$ | $1018 \pm 10$ |
| Downstream shielding $z > 6\,\text{m}$ | $20.0 \pm 0.4$ |
| SC shield $r > 50\,\text{cm}$, $z < 0\,\text{m}$ | $60.9 \pm 0.6$ |
| Inner shield casing 1 $z < 0\,\text{m}$ | $237.6 \pm 1.0$ |
| Inner shield casing 2 $z > 0\,\text{m}$ | $245.2 \pm 1.2$ |
| HgJet | $319 \pm 2$ |
| HgPool | $4.4 \pm 0.4$ |
| Cu Magnet $-131.3 < z < -84.0\,\text{cm}$ | $2.1 \pm 0.2$ |
| Cu Magnet $-84.0 < z < 2.2\,\text{cm}$ | $188 \pm 5$ |
| Cu Magnet $2.2 < z < 58.4\,\text{cm}$ | $140 \pm 4$ |
| Cu Magnet $58.4 < z < 115.4\,\text{cm}$ | $59 \pm 3$ |
| Cu Magnet $115.4 < z < 158.9\,\text{cm}$ | $16 \pm 2$ |
| Be window at 6 m | $2.1 \pm 0.2$ |

Earlier Study 2 geometry results had $\sim 60\,\text{kW}$ in SC coils

SC shield for $r > 50\,\text{cm}$ stops energy getting to SC3 & other SC coils

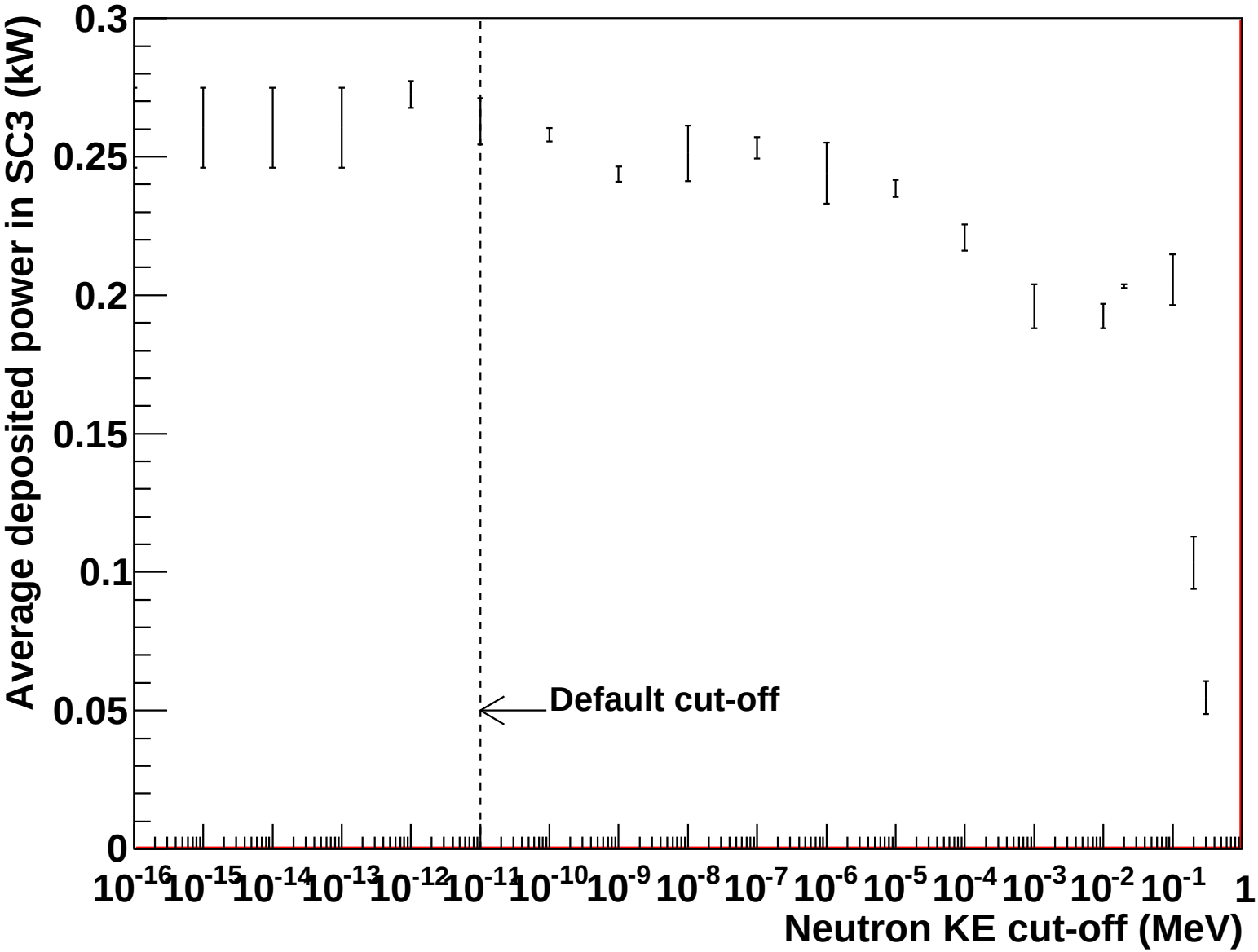



Specific power deposition in SC coils 1, 2 & 3

$P_{\text{peak}} < 0.05\,\text{mW/g}$ for SC3

ITER requirement:
$P_{\text{peak}} < 0.17\ \text{mW/g}$

# Effect of neutron cut-off energy for power in SC3



# Summary

- FLUKA results for IDS120f geometry confirms MARS+MCNP results
  - Same power deposition for SC3 (0.3 kW)
  - Average power in SC coils all significantly less than 1 kW
  - Power in SC coils meets ITER requirement ($< 0.17\,\mathrm{mW/g}$)
- Default neutron energy cut-off: does not underestimate $E_n$ contributions