K^0L CPS Meeting Dec 12, 2022

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Original Features

- First magnet is away from high radiation
- Distance to allow main beam to get away from the photon line
- Beam entry chamber, direct cascade products not visible in the photon line
- Second magnet not used
- Essentially full energy absorption in the dump
- Dense CuW shielding material to minimize total weight

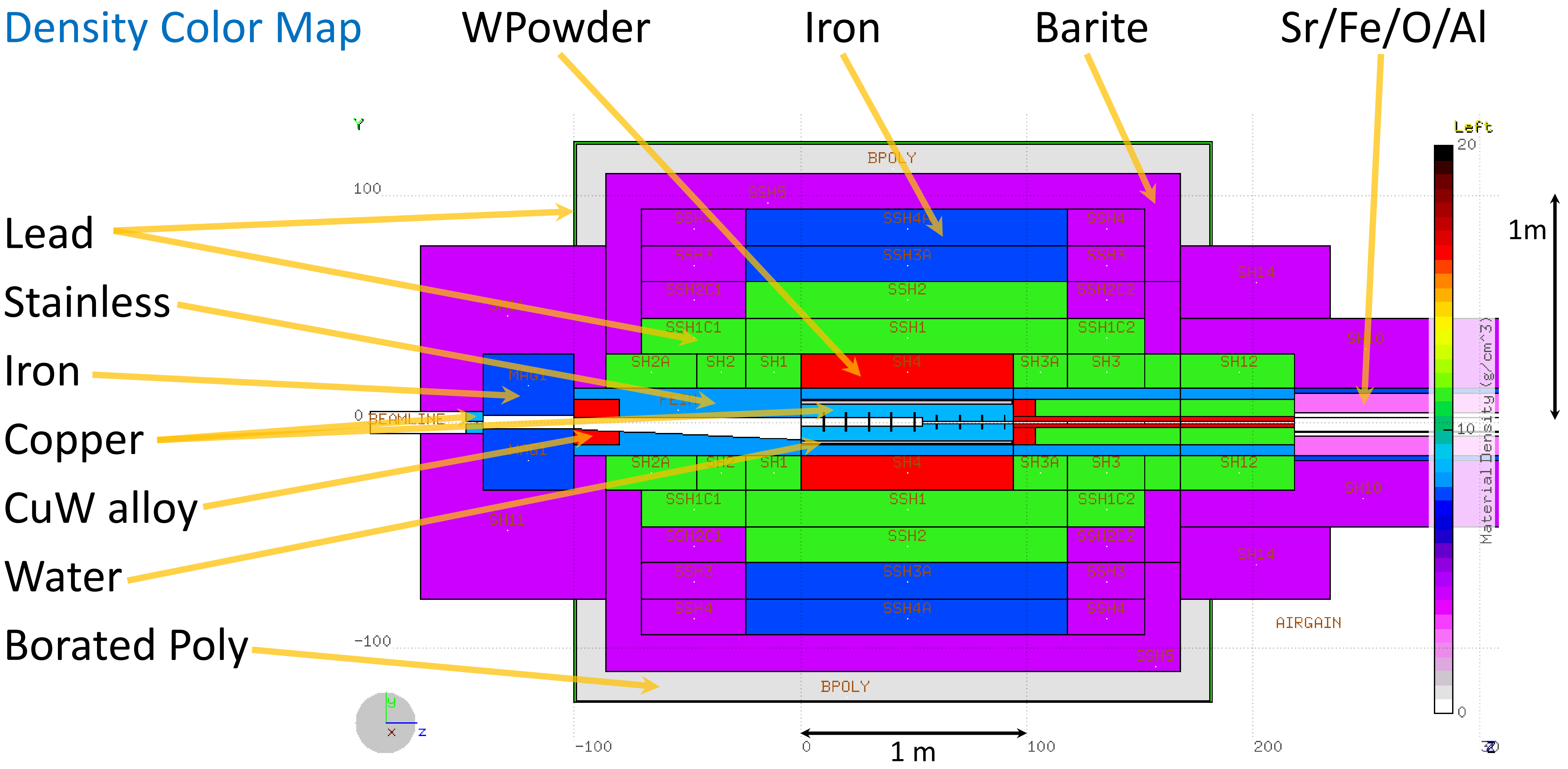
New Features

- Shorter design with higher BdL in the first magnet
- Wedge shape of the beam entry chamber to better dissipate beam power
- Combination of the shielding materials to optimize between the cost and weight (lower densities result in larger total weight)

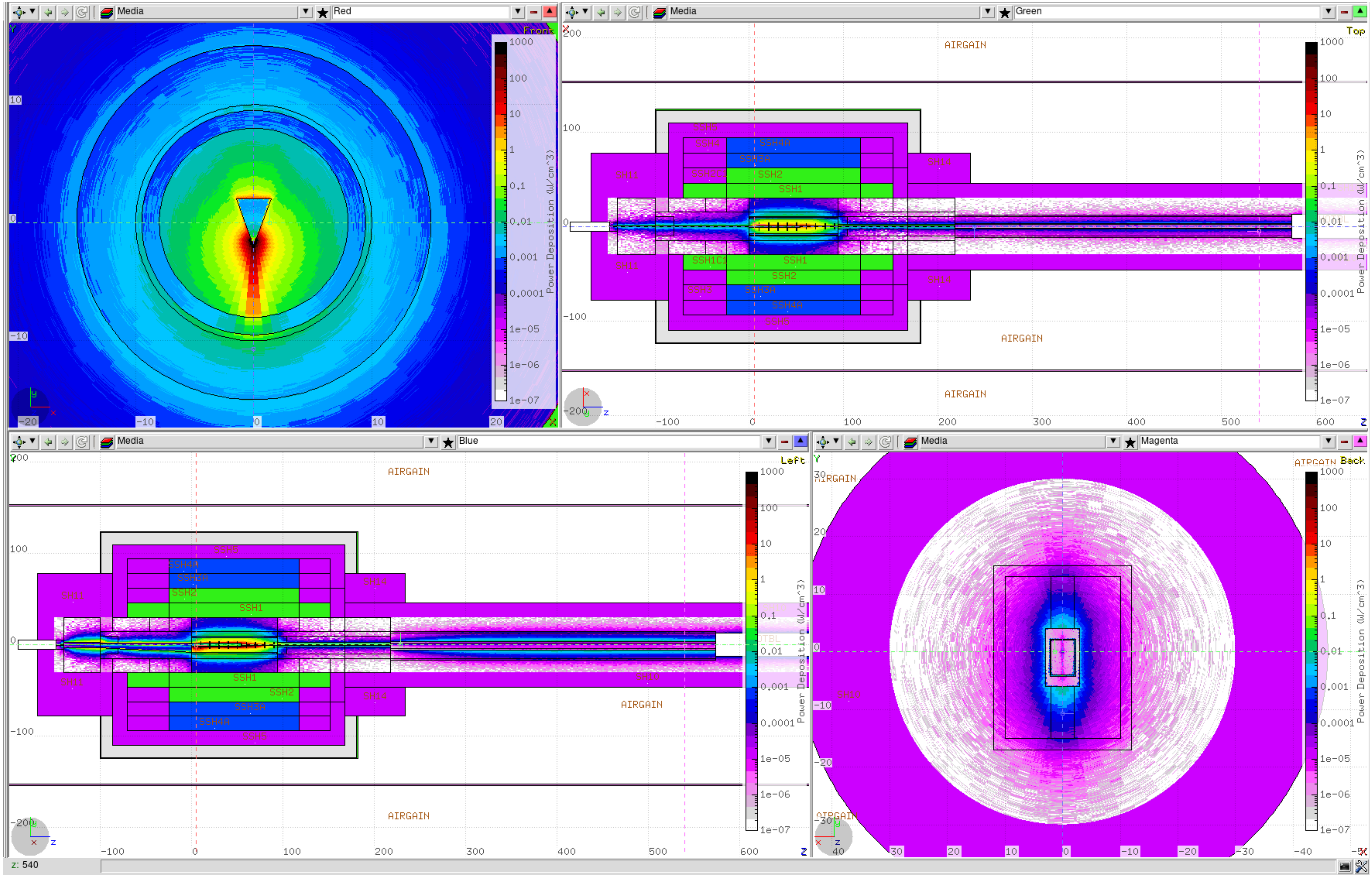
Absorber Design Update

- The proposed solution for the Absorber combines:
  - The entrance chamber in the shape of a wedge
  - The main beam energy deposition is along the tip of the wedge
  - The first part of the photon beam channel follows the wedge chamber
  - First-order E-M cascade products in the dump chamber cannot go along the photon channel, limiting the radiation streaming along the channel
- Suggested to be built out of two left/right symmetric half-cylinders
- The entrance cavity and the photon line machined out of flat surfaces
- When assembled, the absorber operates similarly to JLab beam dumps
- Absorbs bulk of the power (currently over 98% of all CPS power)

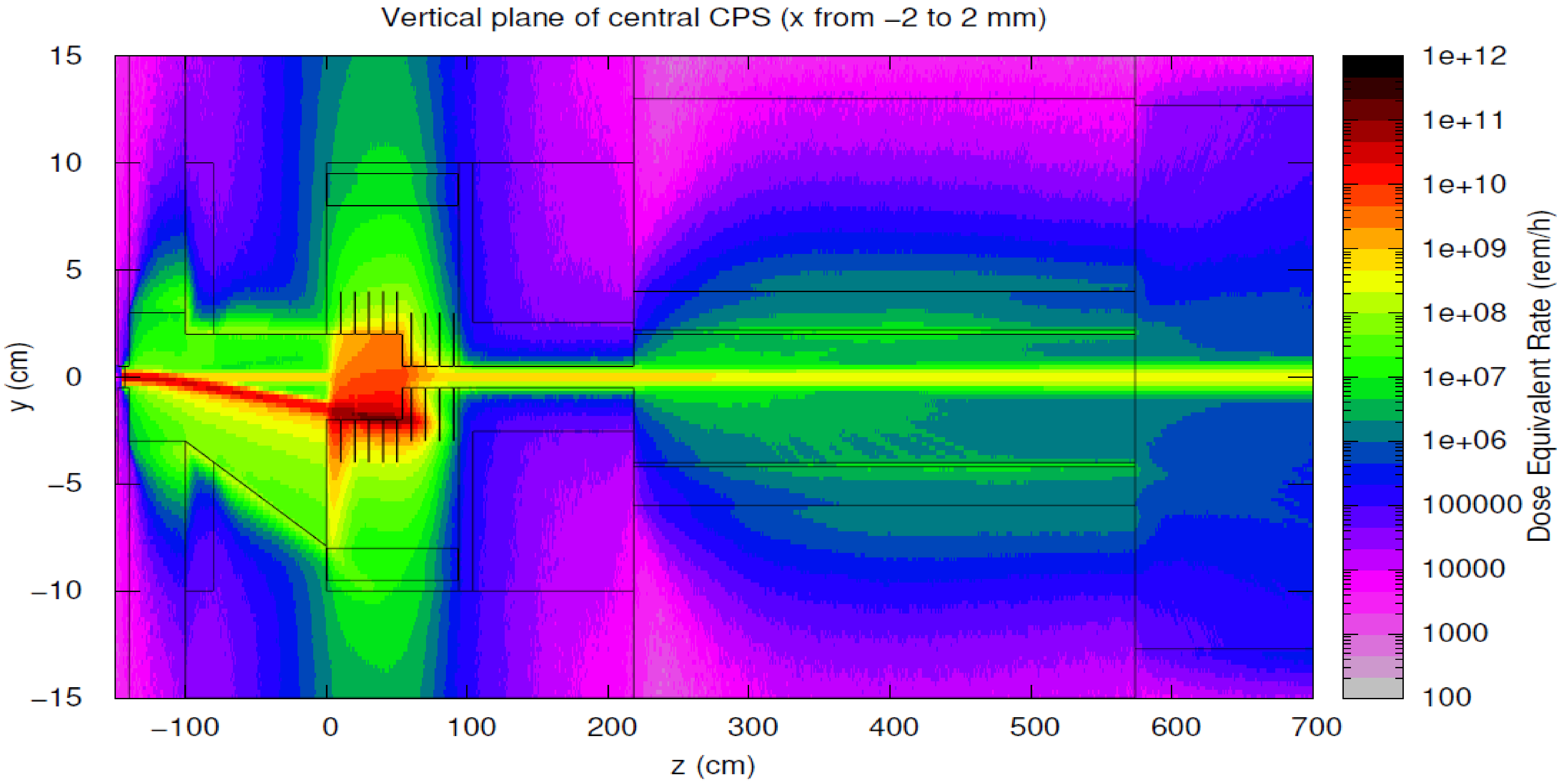
Conceptual Design Update: CPS Shorter by ~50%



Power deposition along the CPS core

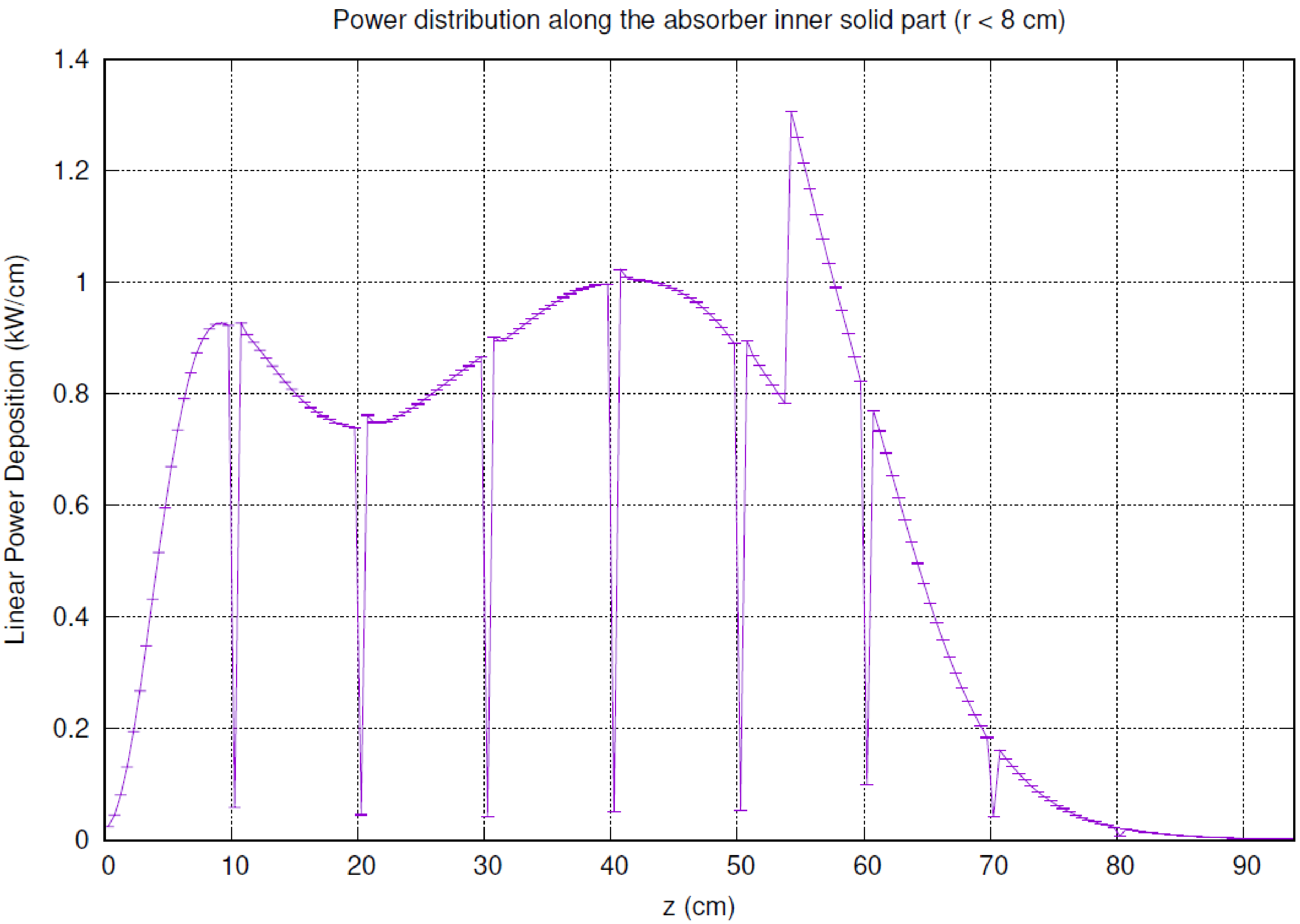


Dose Rates inside the CPS along Beam



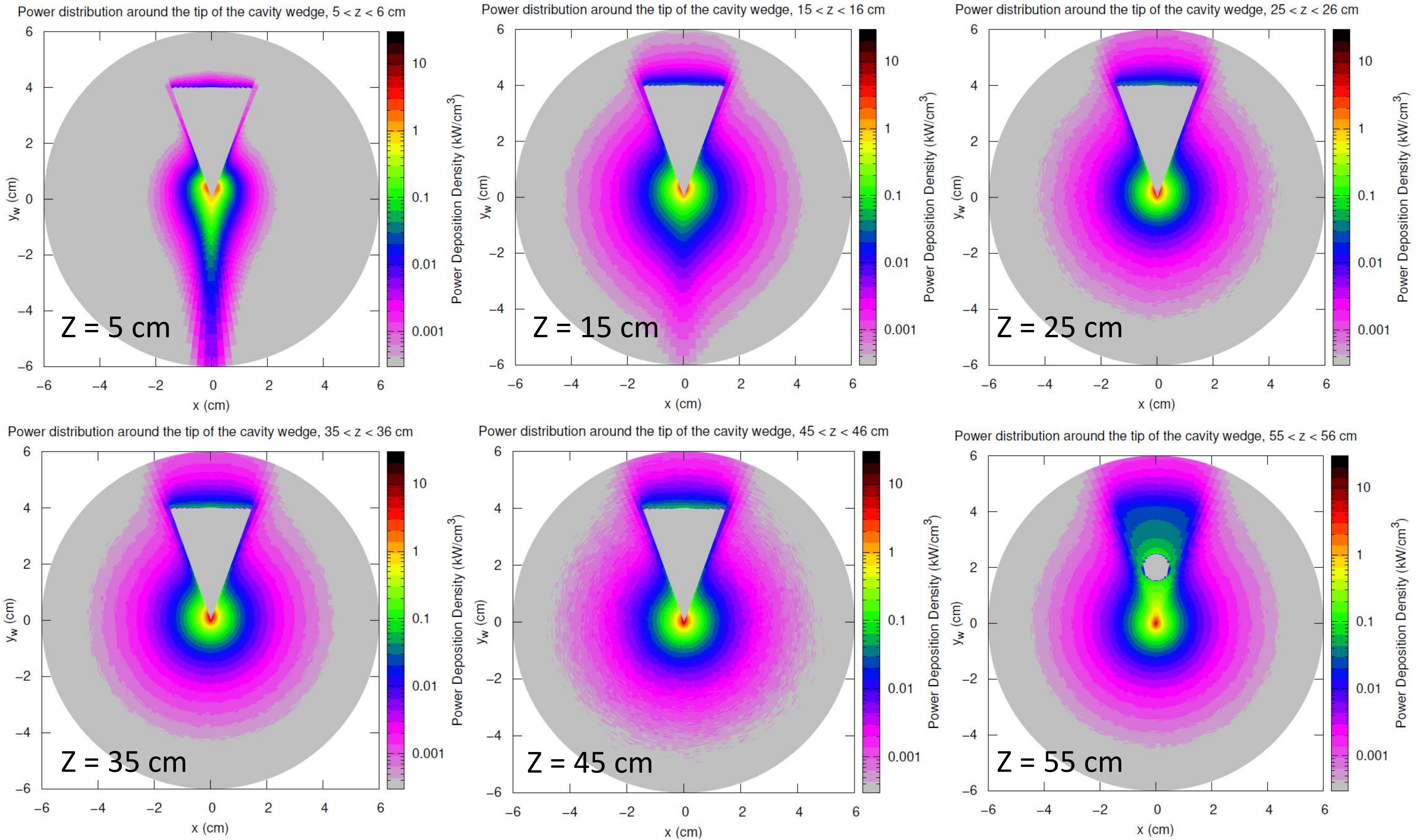
Over 98% of the full CPS power left in absorber

- ~Uniform along z
- Concentrated at the wedge tip
- No first-order cascade products go along the photon beam line
- Symmetric power deposition in x,y below and around the tip



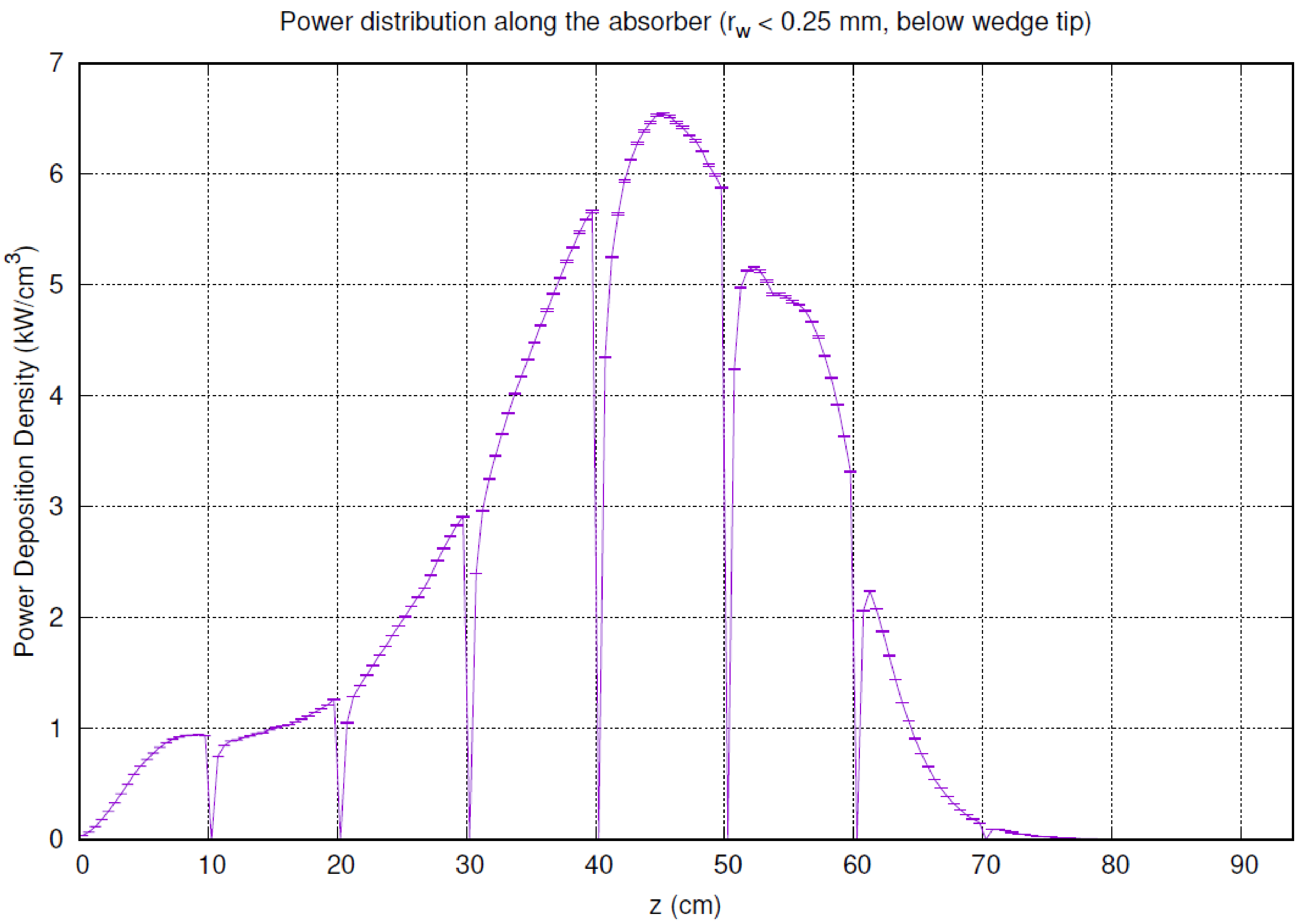
Power density around the tip of the wedge

Max power density at the tip ~7 kW/cm^3



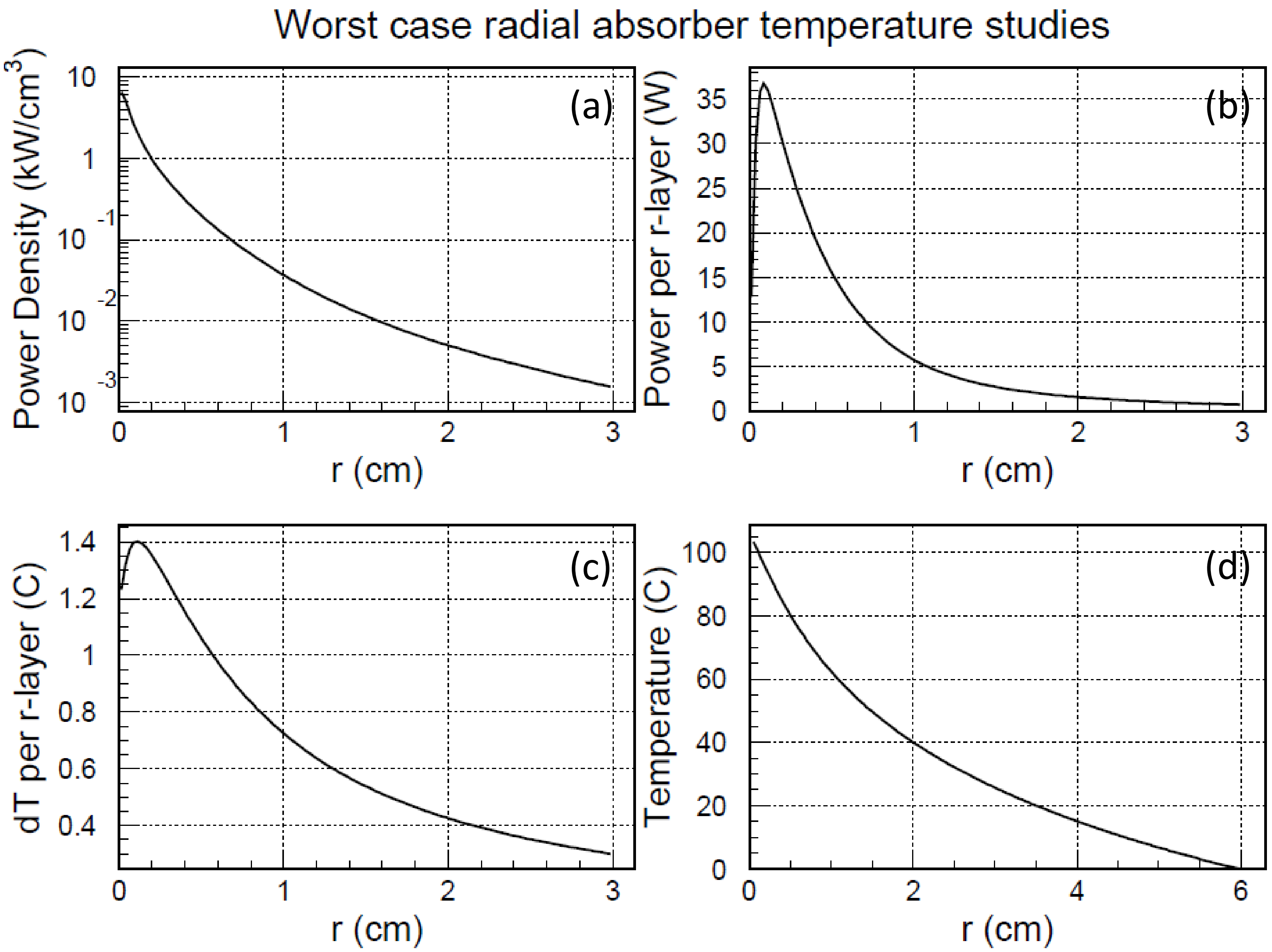
Maximum power density, y < -2 cm , $r_w < 0.25$ mm

- Max ~7 kW/cm^3
- Location z ~45 cm
- Radial (around the wedge tip) distribution can be used for the temperature evaluation



Worst case temperature evaluation

- (a) Radial power density distribution
- (b) Power per radial layer of 1 cm length
- (c) Change in temperature in the neighboring layers assuming cumulative power inside
- (d) Full temperature rise from outside to the center

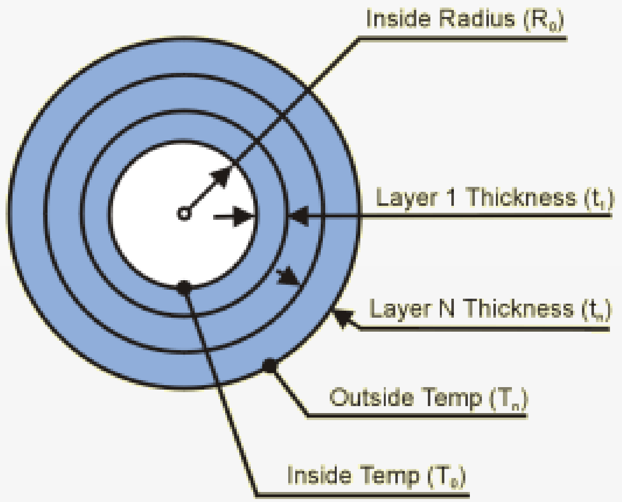


Online tool at https://thermal.mayahtt.com

- Using the thermal conductivity of copper:

  k = 385 W/(m K)

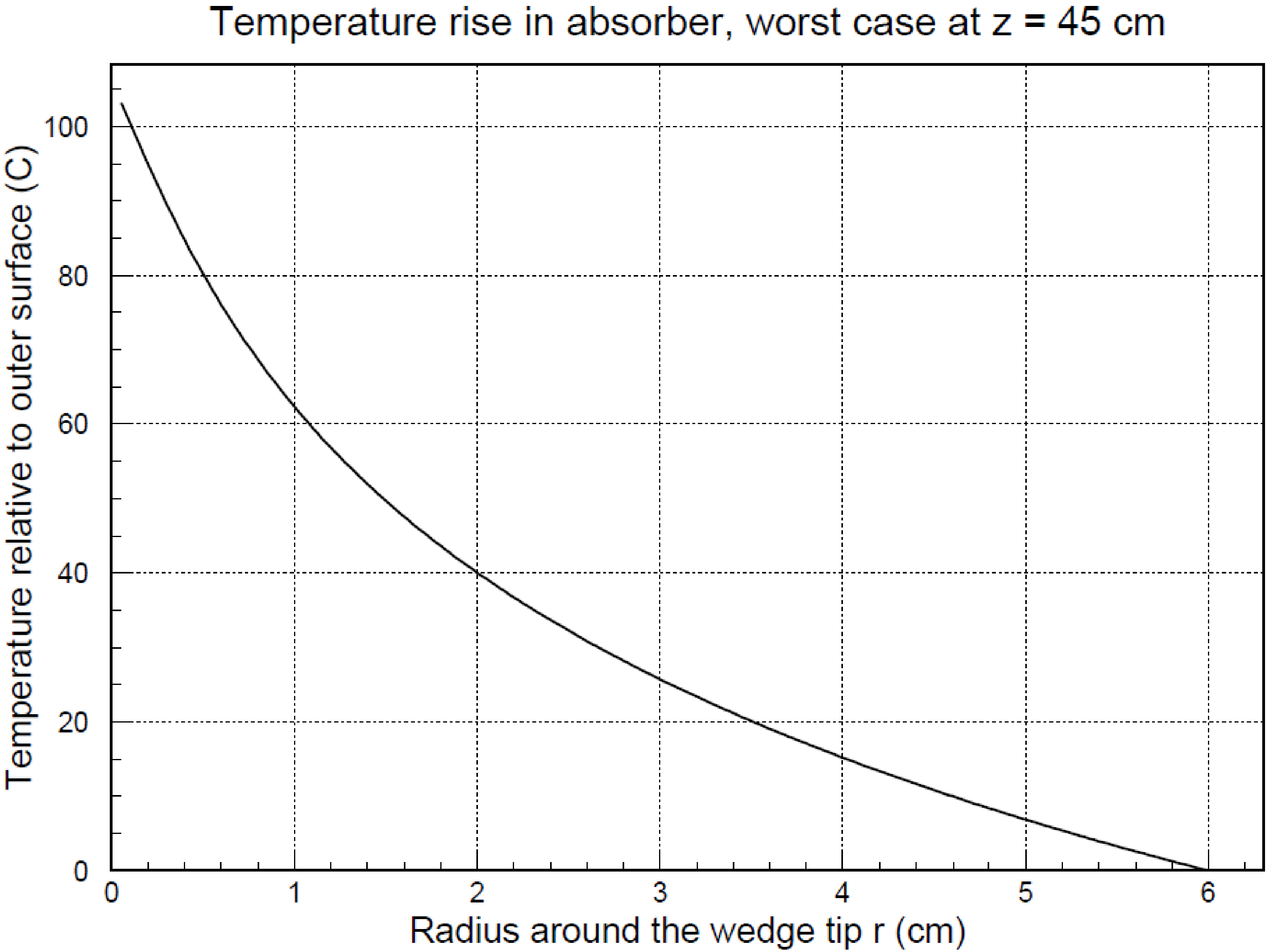
Conduction Across Multilayered Isothermal Cylinder



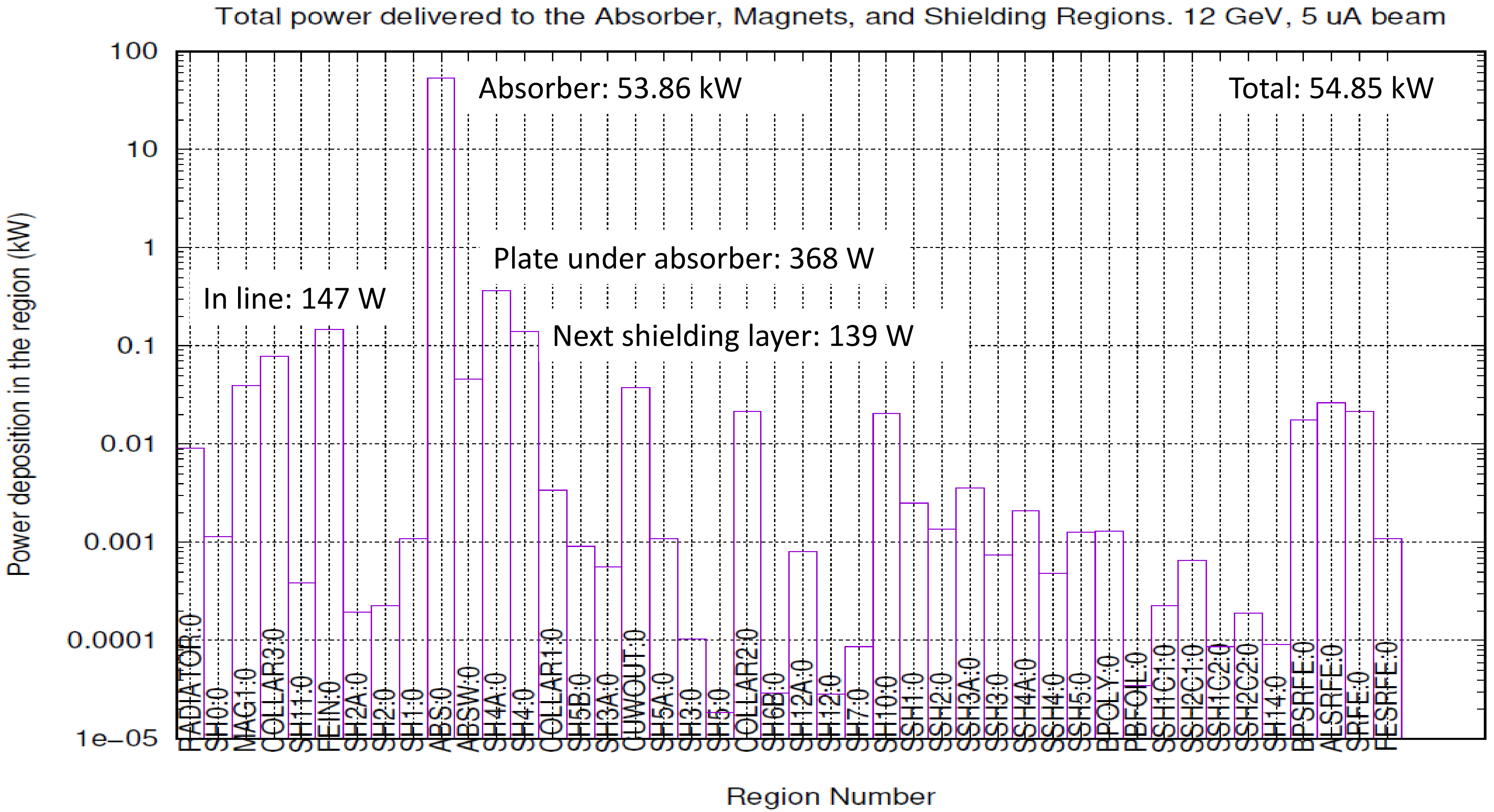
Outer Temperature = $T_0 - T_n = q * (\sum (ln(r_i/r_{i-1}))/(2 * \pi * k_i * L))$

Worst case temperature evaluation

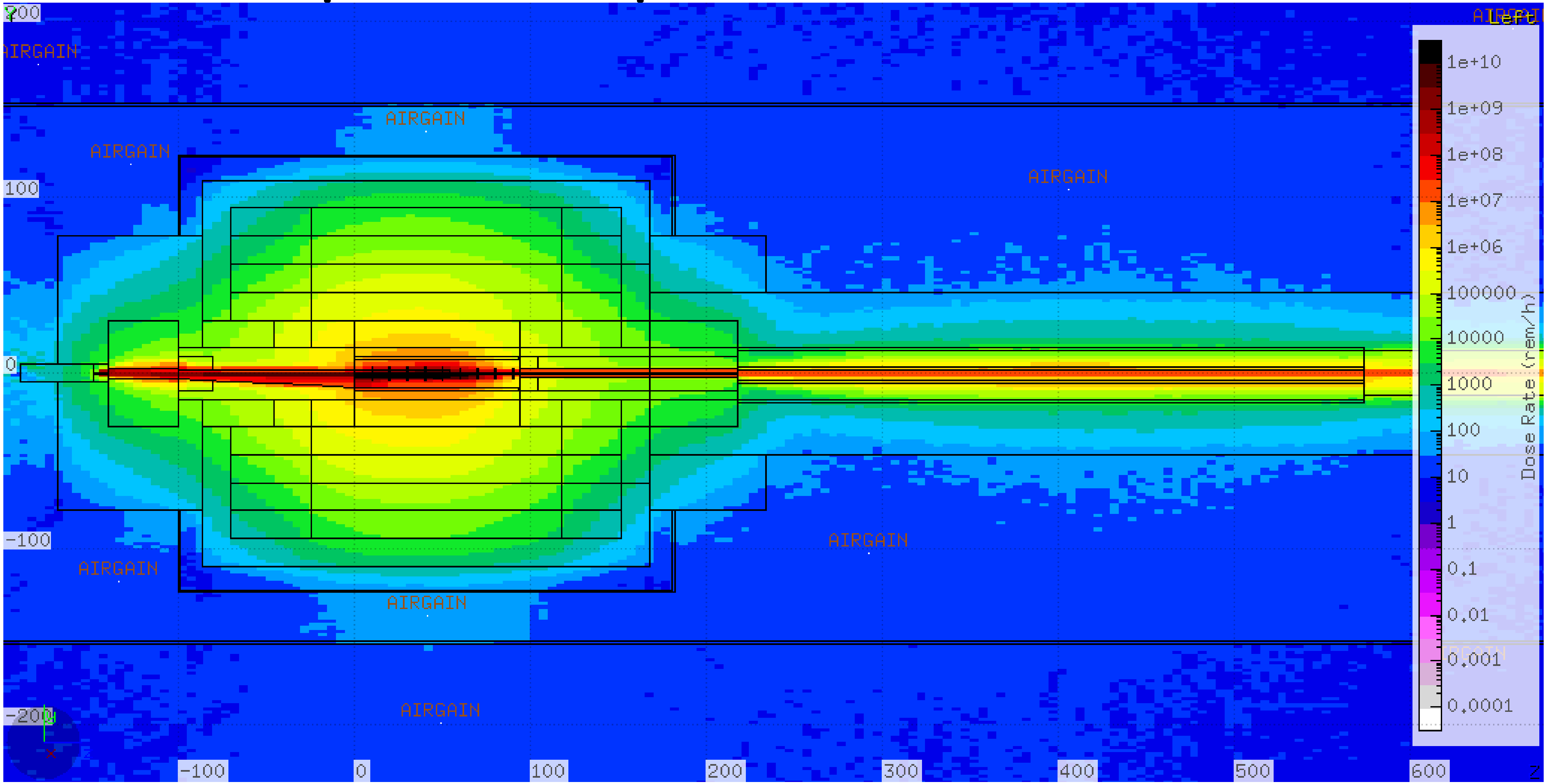
- Full temperature rise from outside to the center



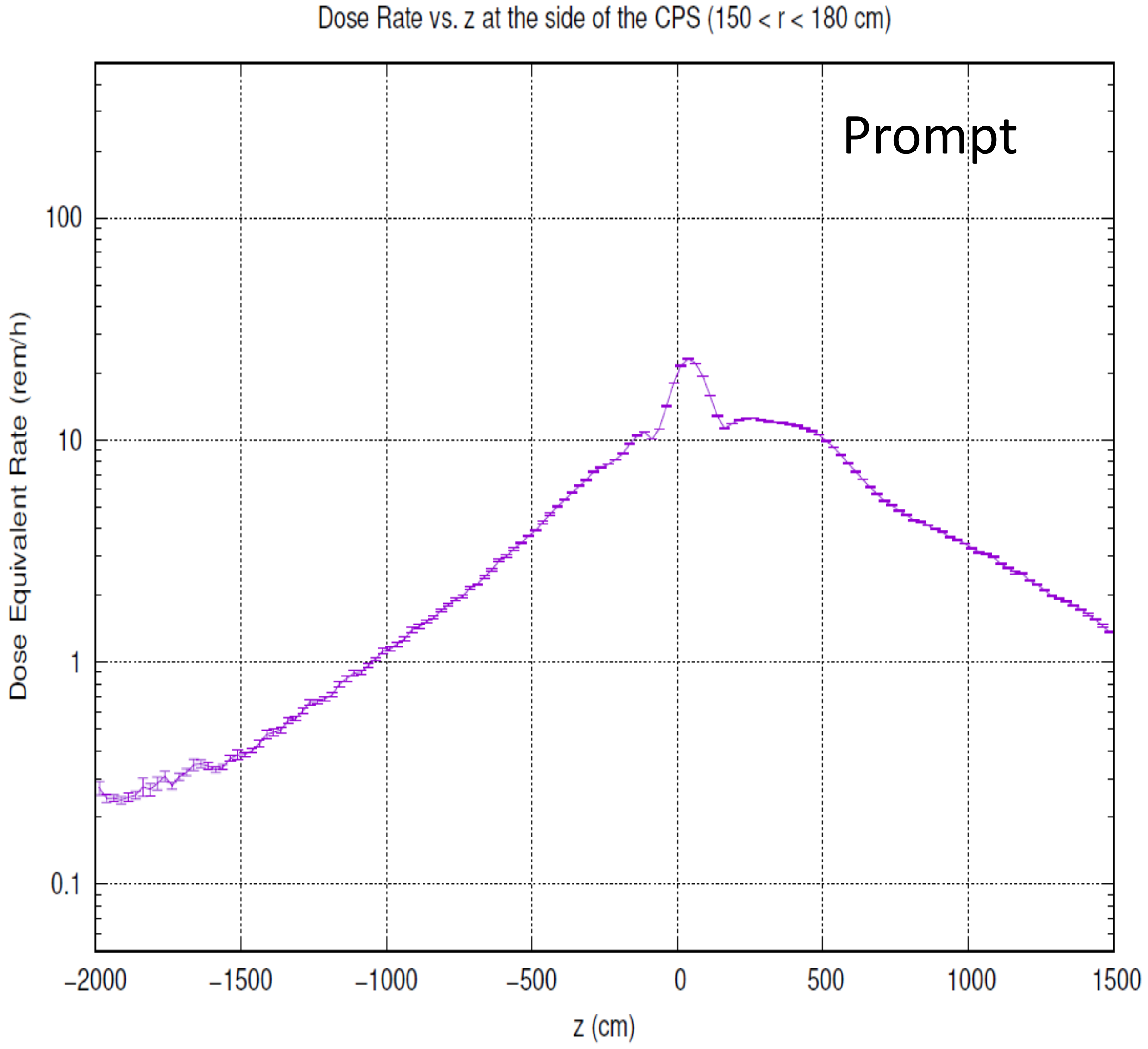
Bulk of power in CPS stays in Absorber (98%)

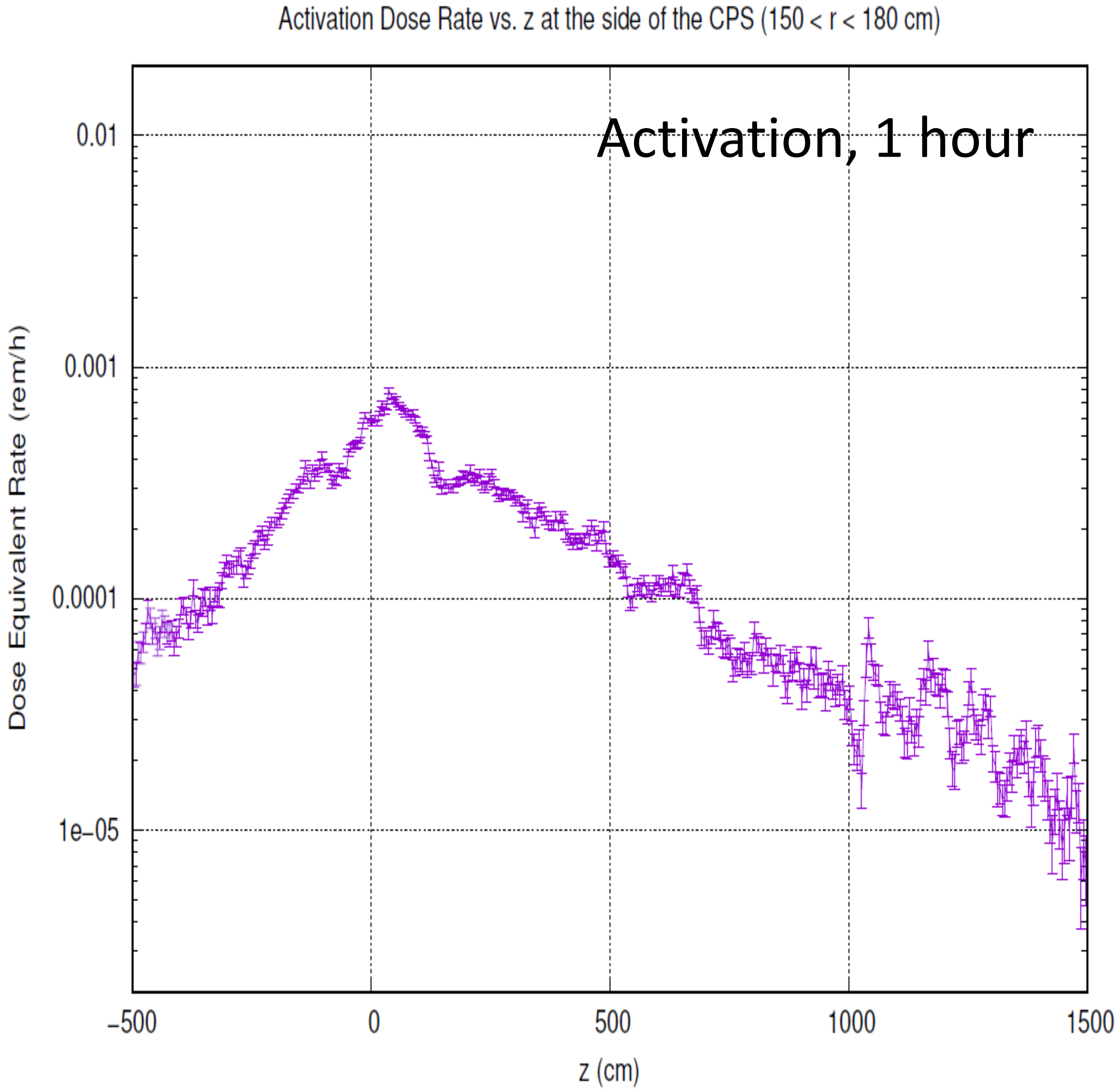


Prompt Dose Eq. Rates around the CPS



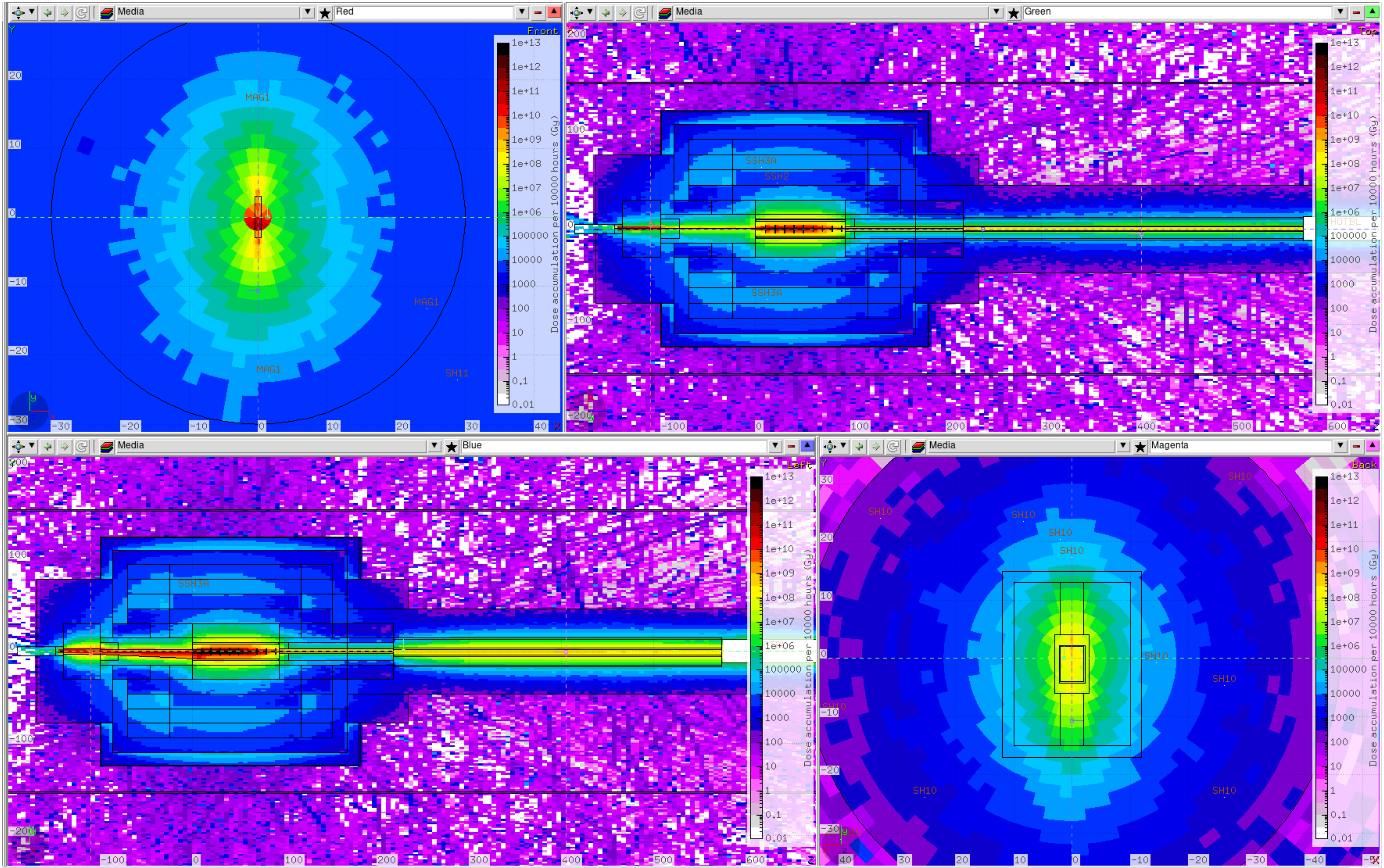
Dose Eq. Rates around the CPS



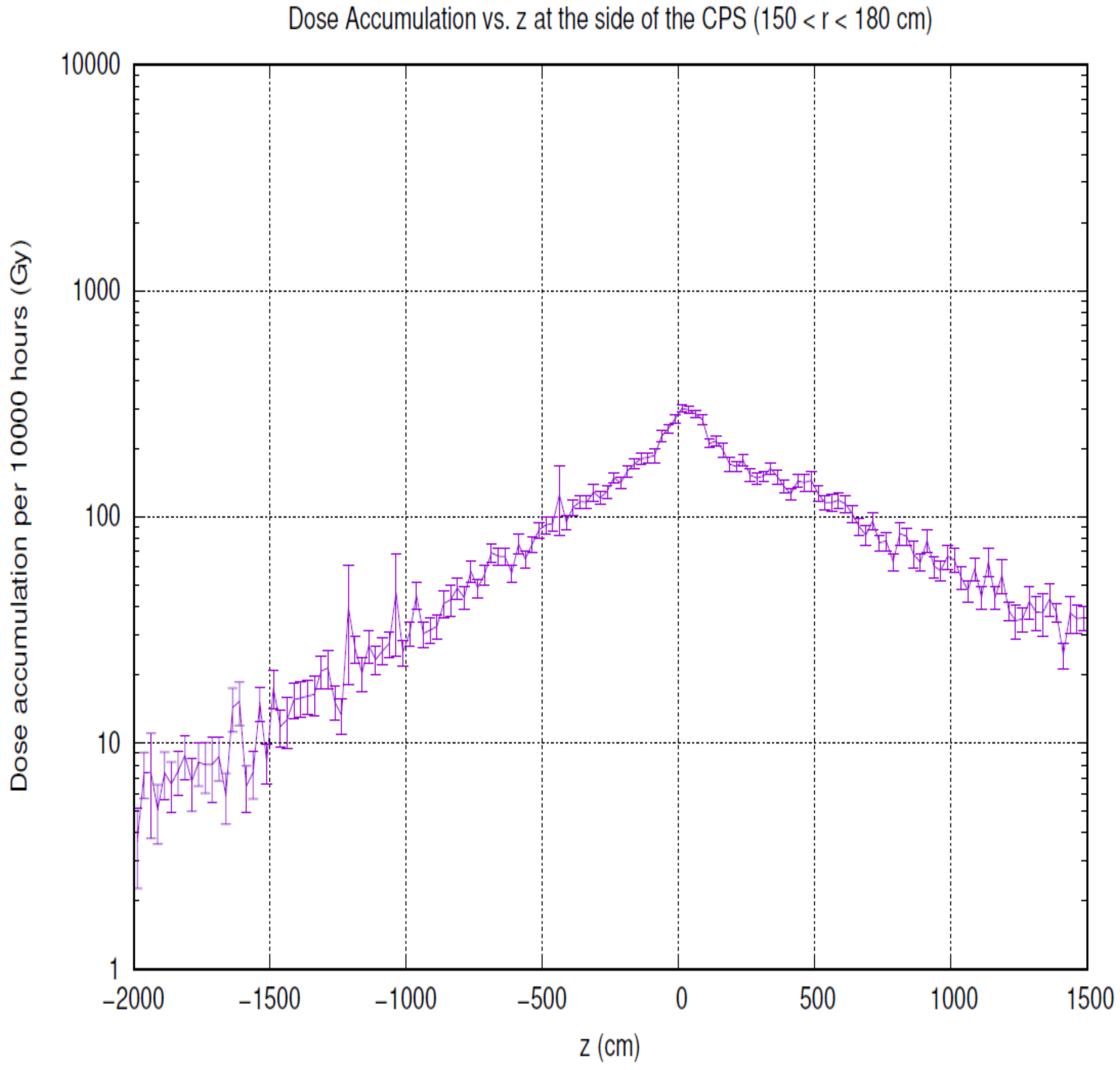


Accumulated Doses around the CPS (10000 h)

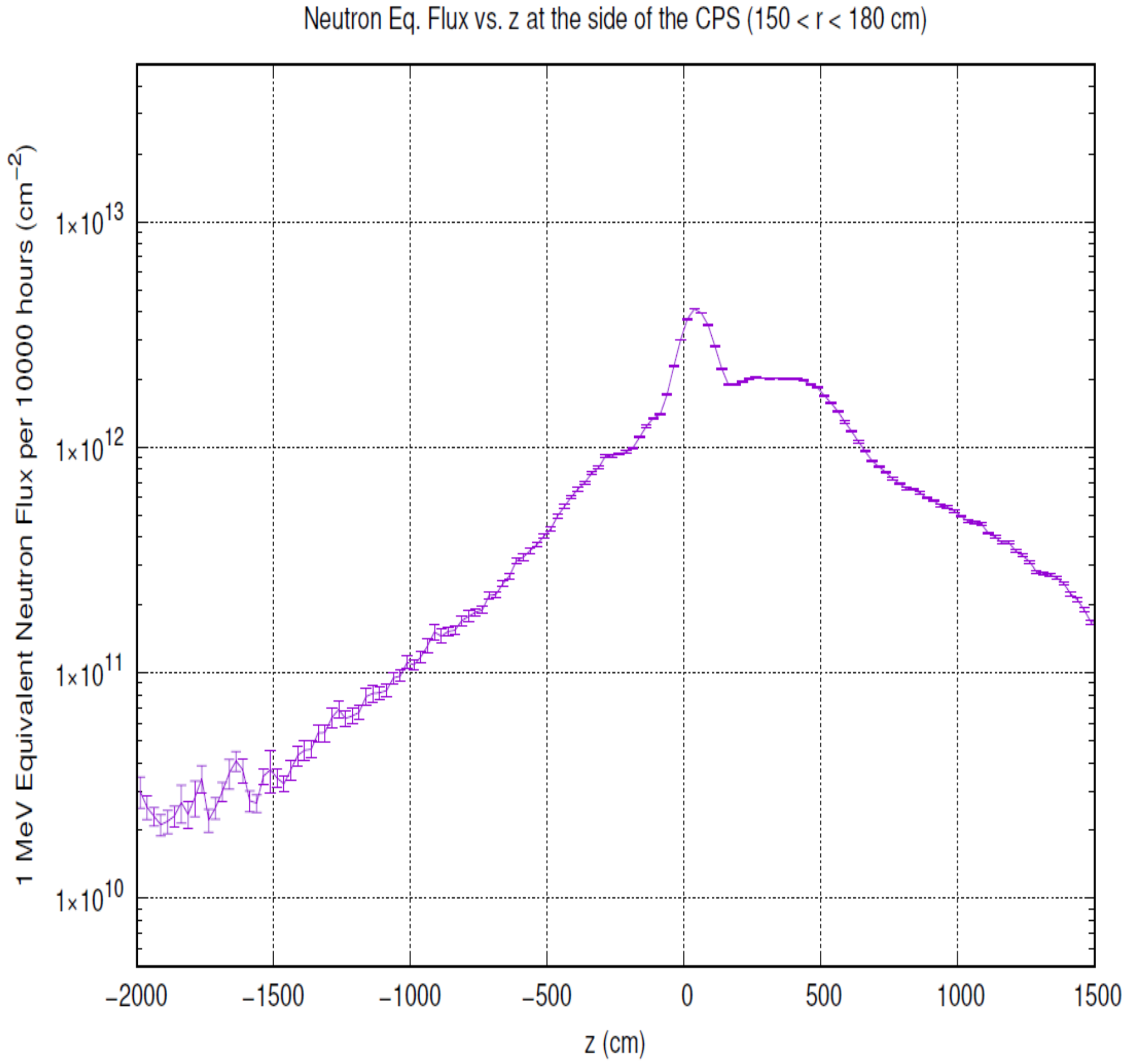
- Under 10^5 Gy at 10 cm from the beam, first magnet
- Under 10^7 Gy at the strontium ferrite for the permanent magnet



Dose Accumulation

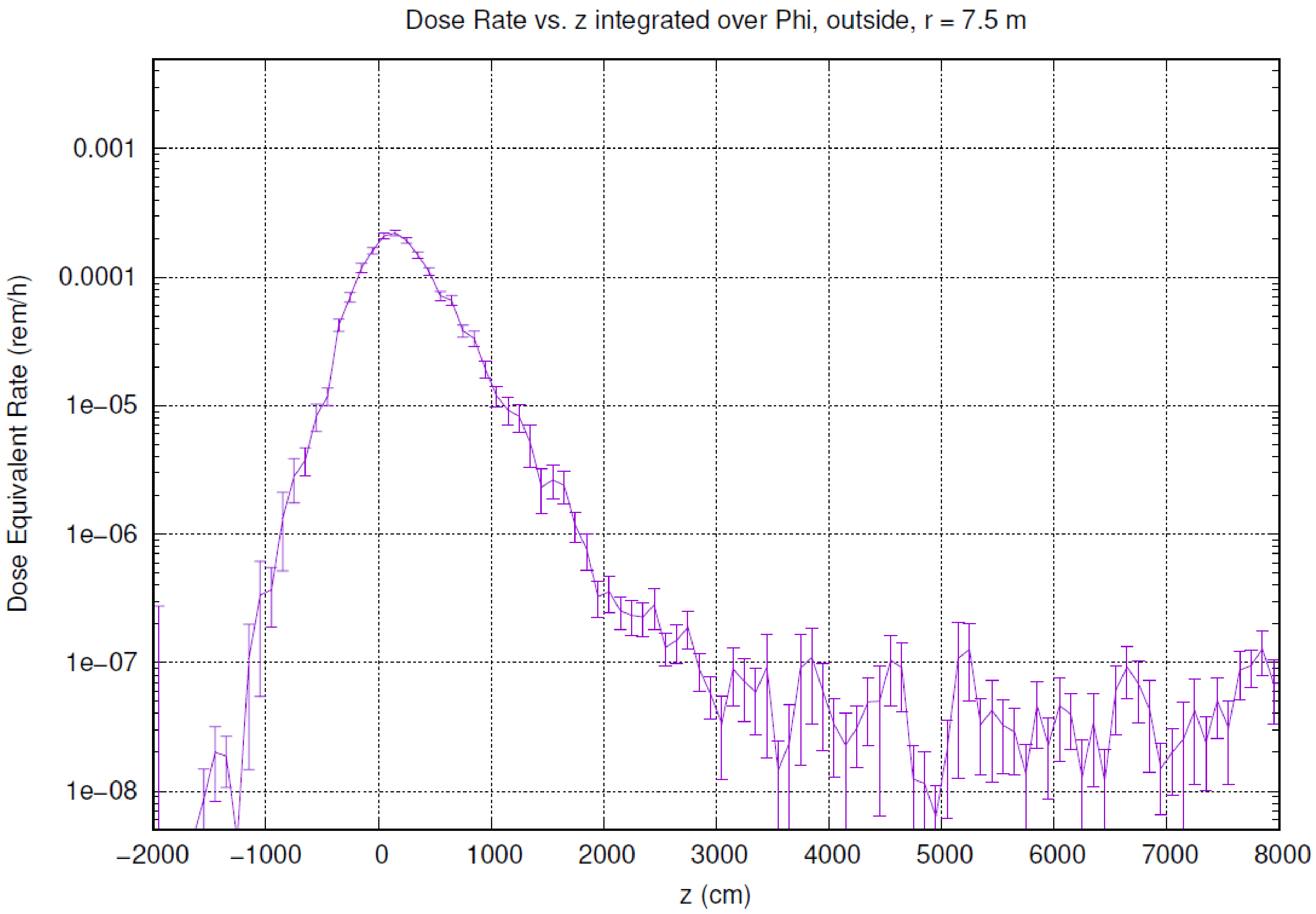


1-MeV Neutron Eq. Flux



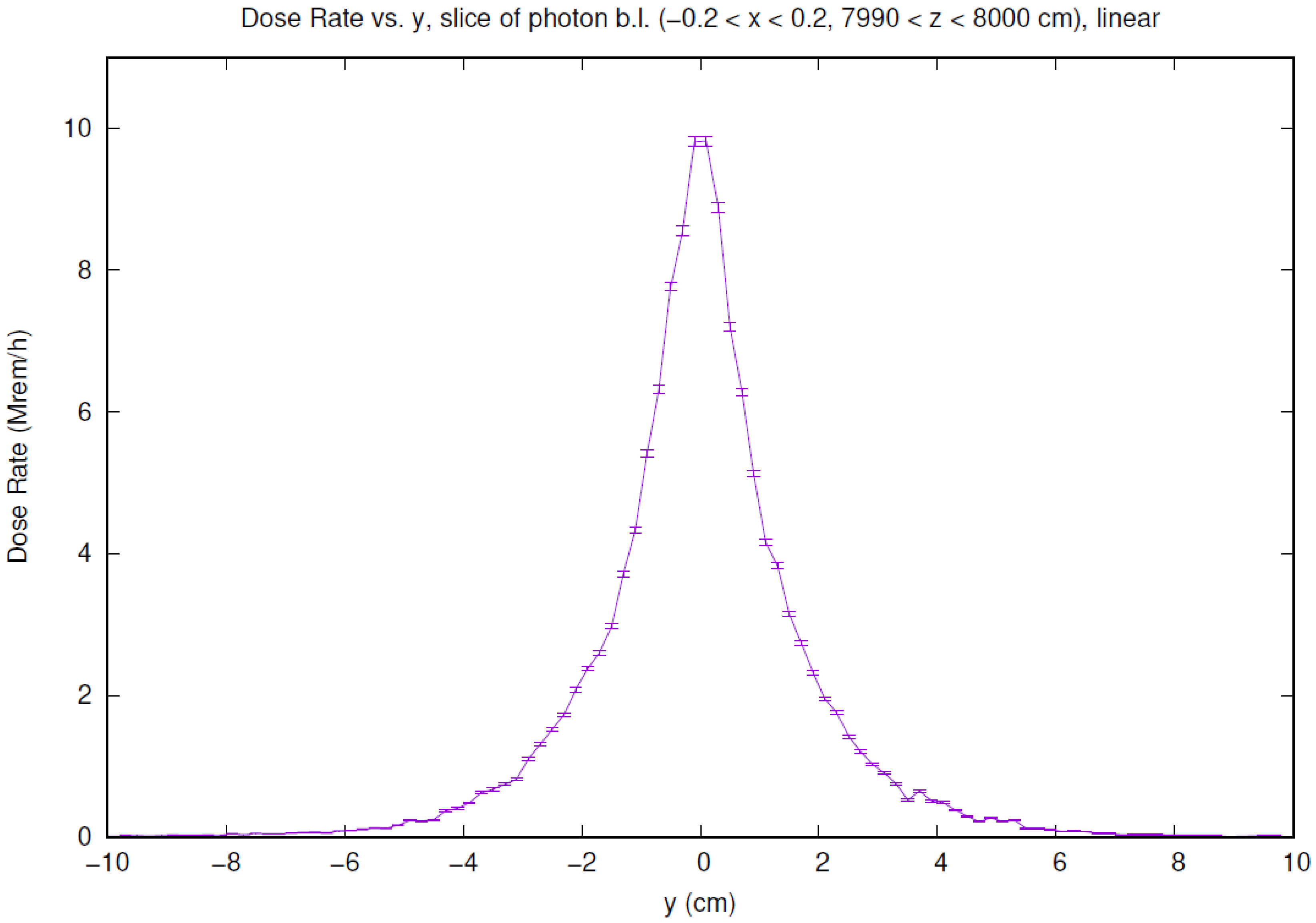
Prompt Dose Eq. Rates Outside

- Very approximate model for the berm above the photon pipe



Photon Beam Quality at 80 m

- Presented as the dose eq. rate function of Y in a slice of X



Energy-weighted spectra of photons and e^+/e^-