MARS15 studies of the radiation quantities for the carbon bent target

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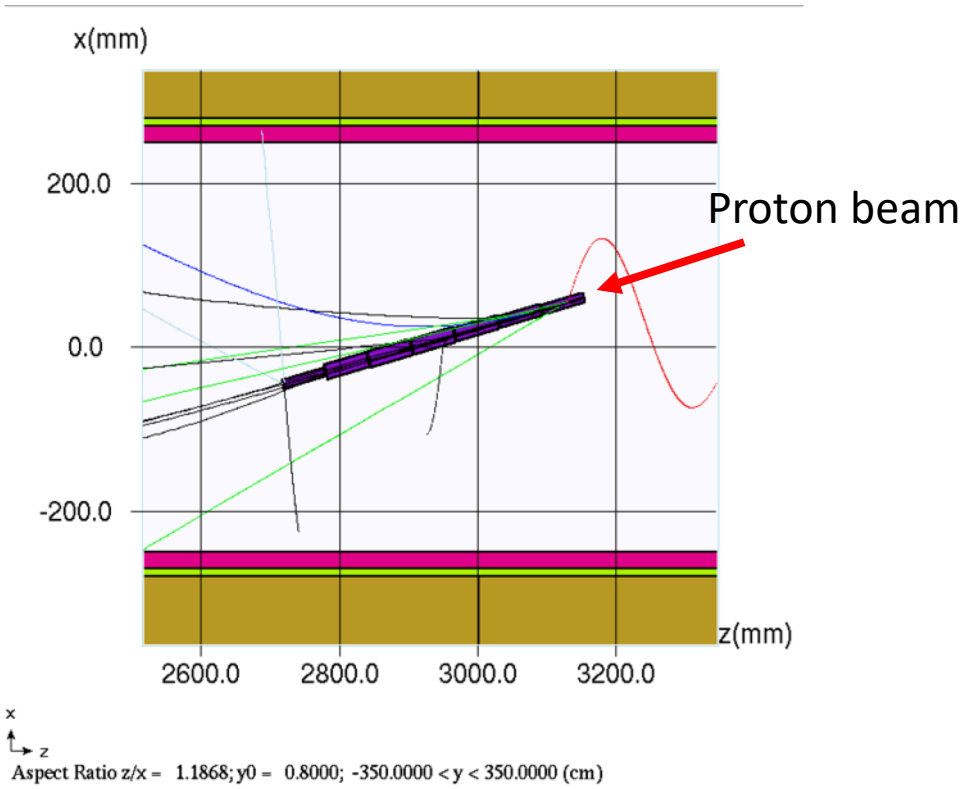
Mu2e-II Workshop

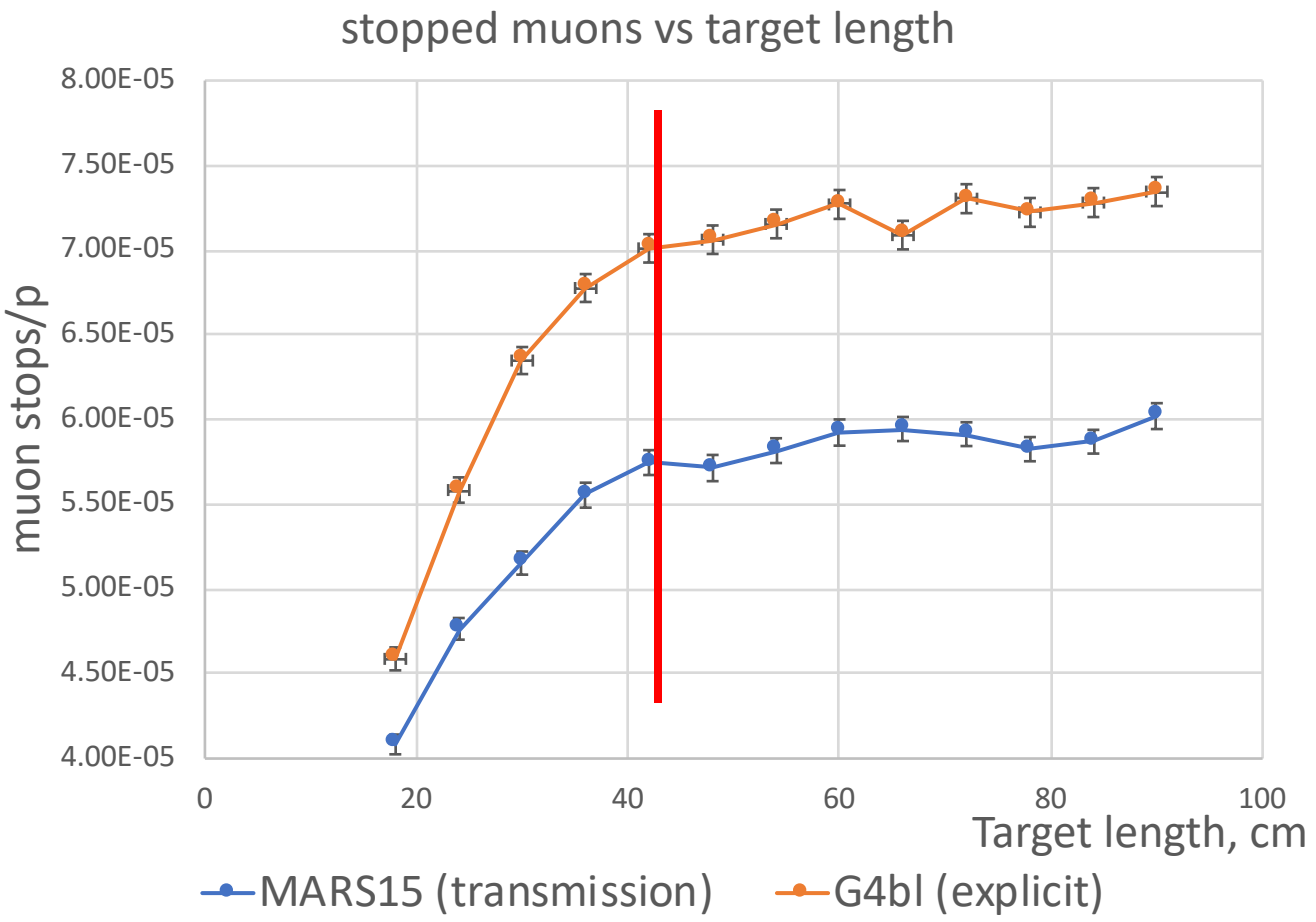
Radiation simulations progress

- Since the last workshop:

- Michael MacKenzie: implementation of the carbon bent target in framework
- Stefan Mueller: FLUKA simulations for the carbon bent target, energy deposition, particle fluxes (next talk)
- Vitaly Pronskikh: MARS15 simulations for the carbon bent target, energy deposition, muon/pion fluxes, power density and DPA in the production target and SC coils. Results are based on LDRD: I.Fang, K.Lynch, D.Neuffer, J.Popp, V.Pronskikh, D.Pushka

Carbon bent target for 800 MeV@100 kW beam

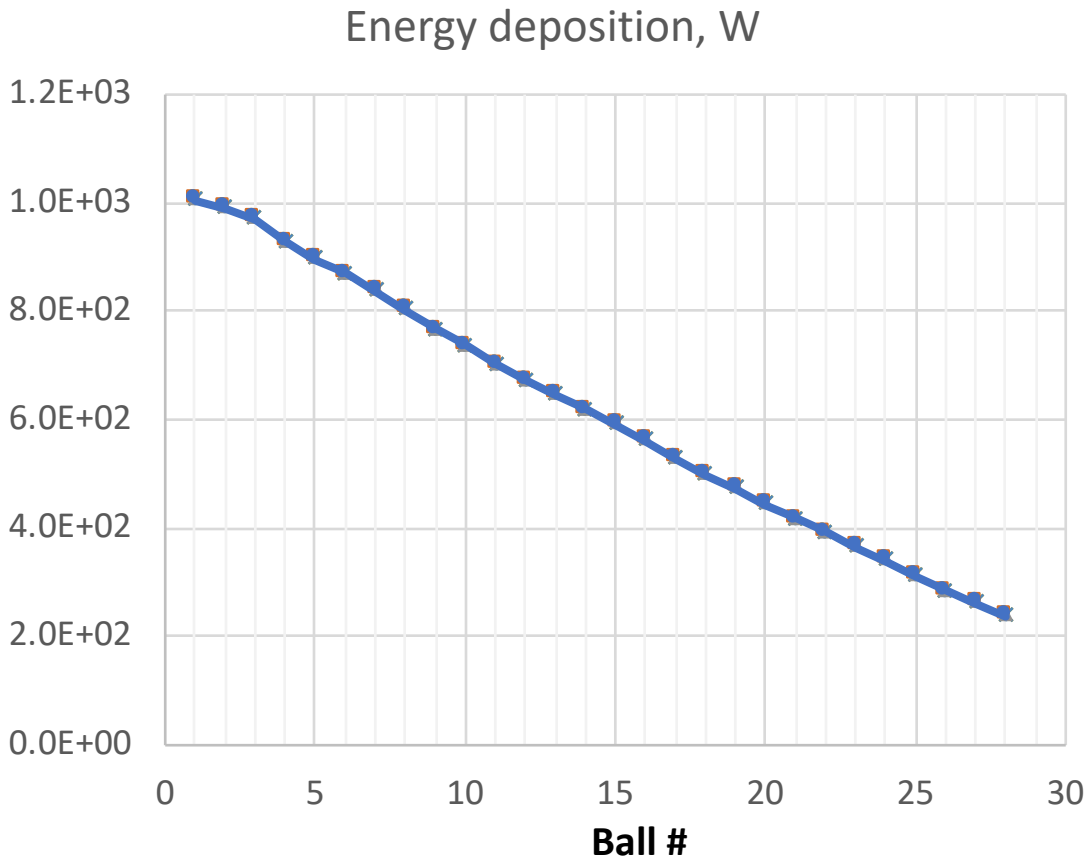


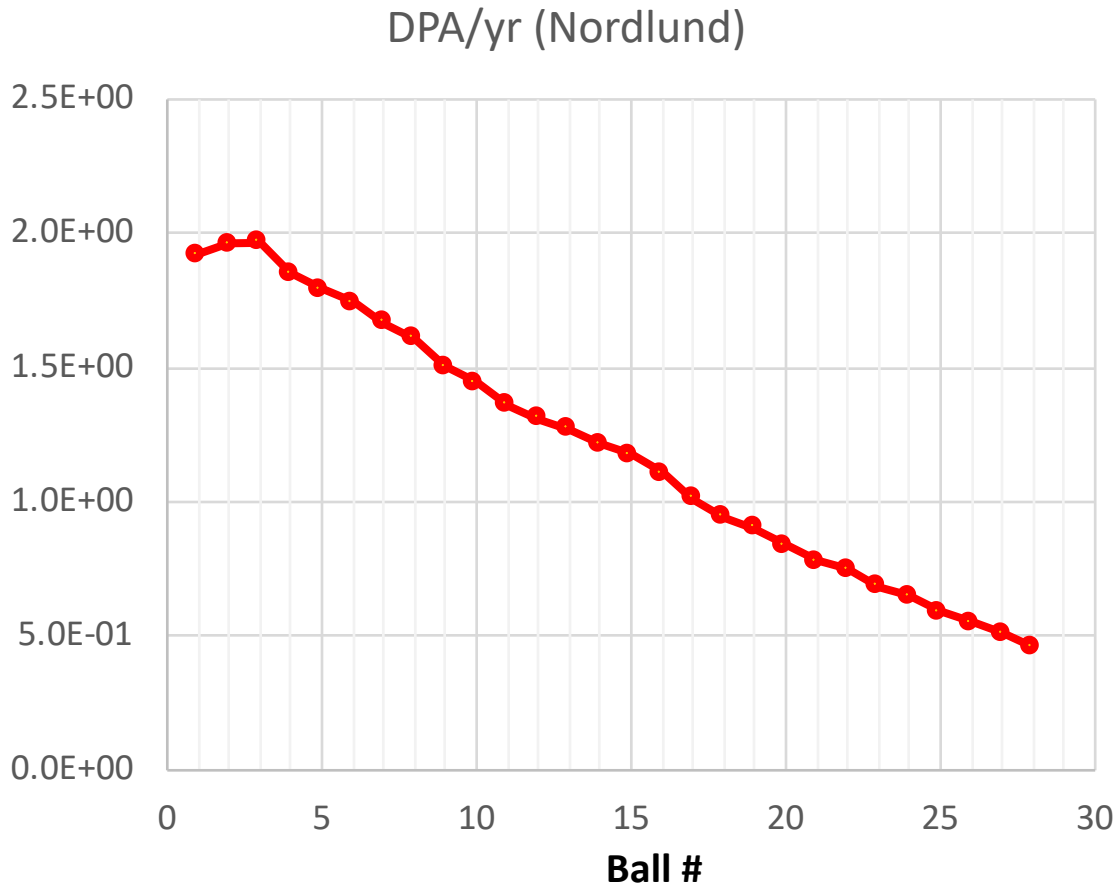


2. Carbon bent target optimal length has been determined Rball=0.75 cm; σ= 0.1 cm (~28 spherical elements) for the conveyor target option.

Heat map has been produced, radiation quantities determined, thermal analysis started

Energy deposition and DPA in the target

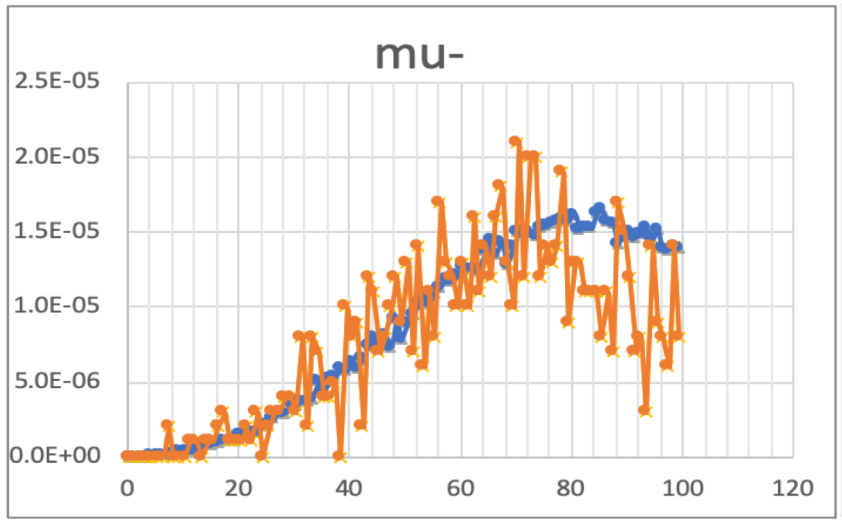


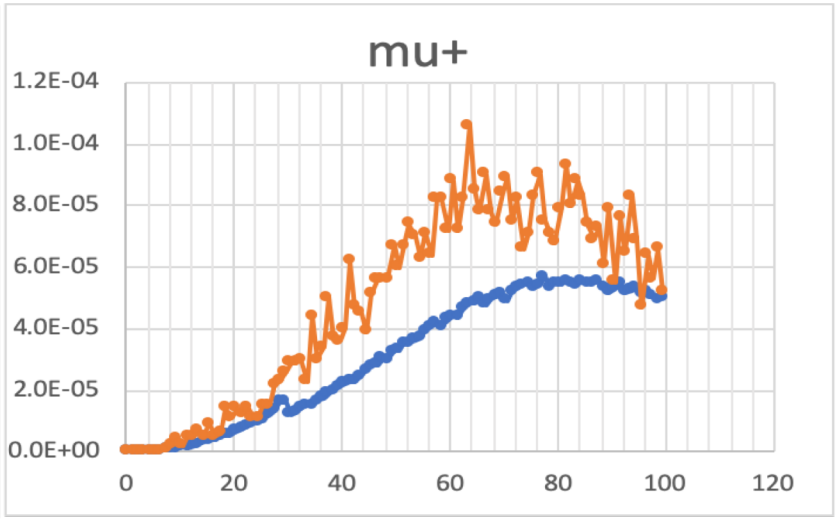


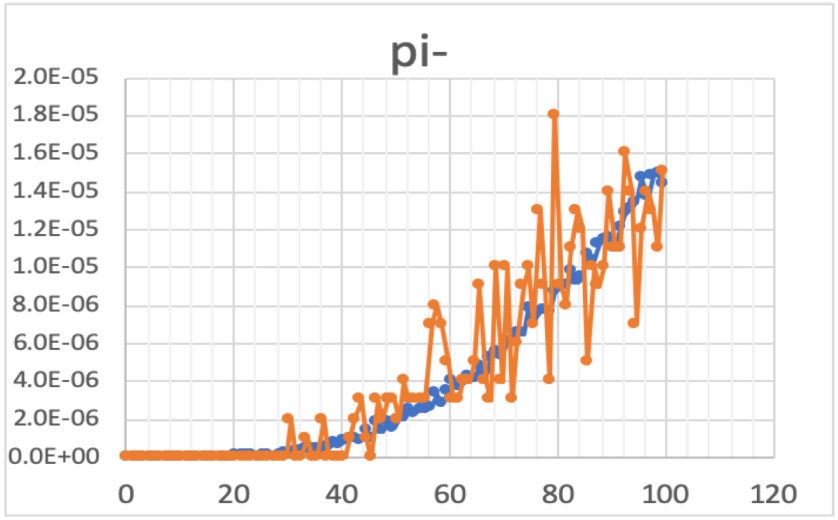
Total in target Edep = 17.1 kW

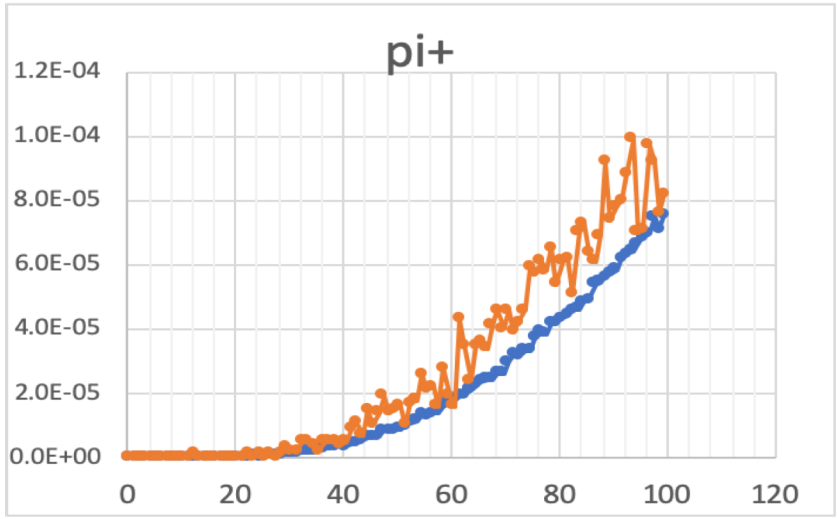
Critical DPA for carbon is ~ 1 DPA

Muon/pion yields at TS1







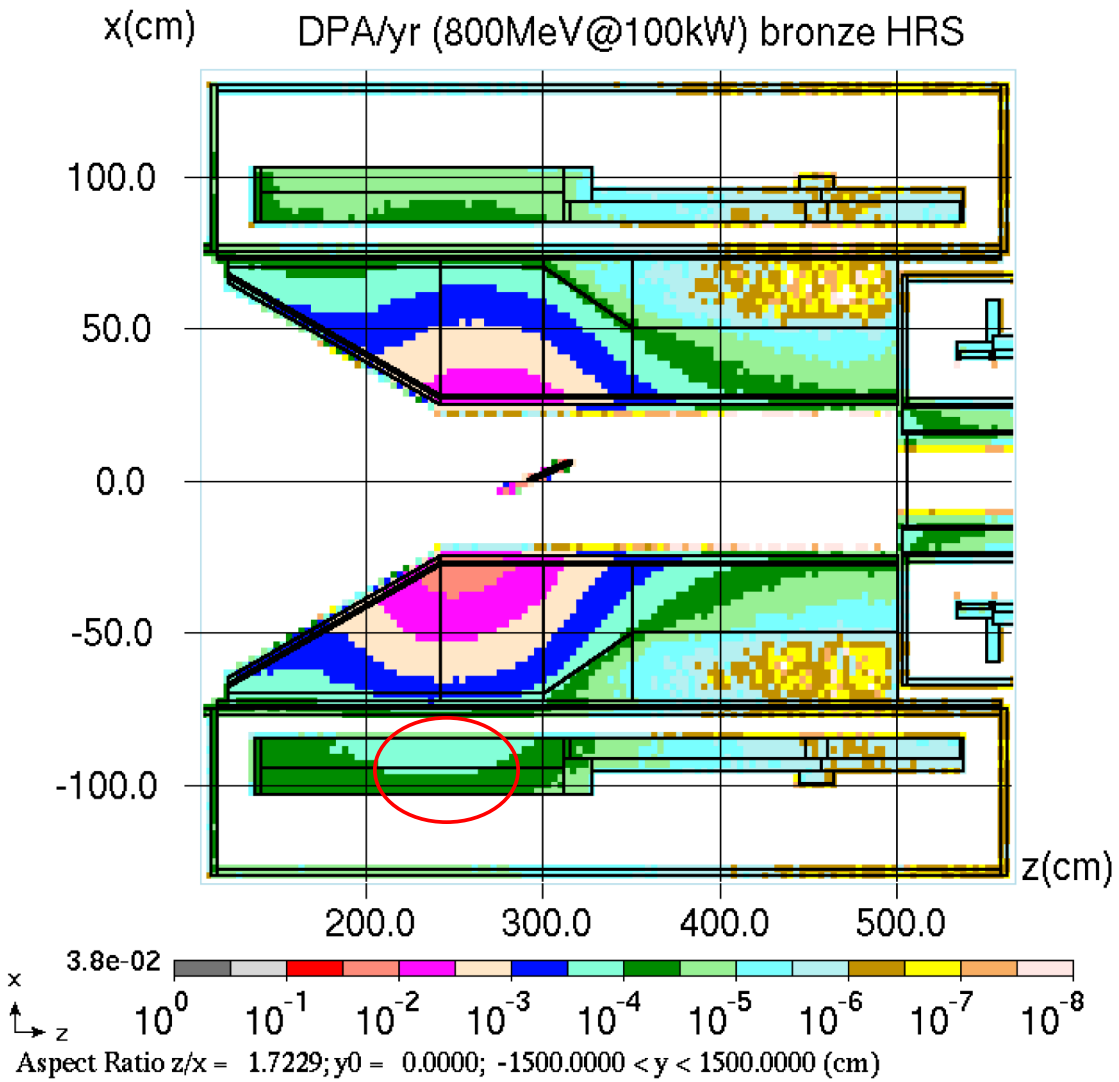


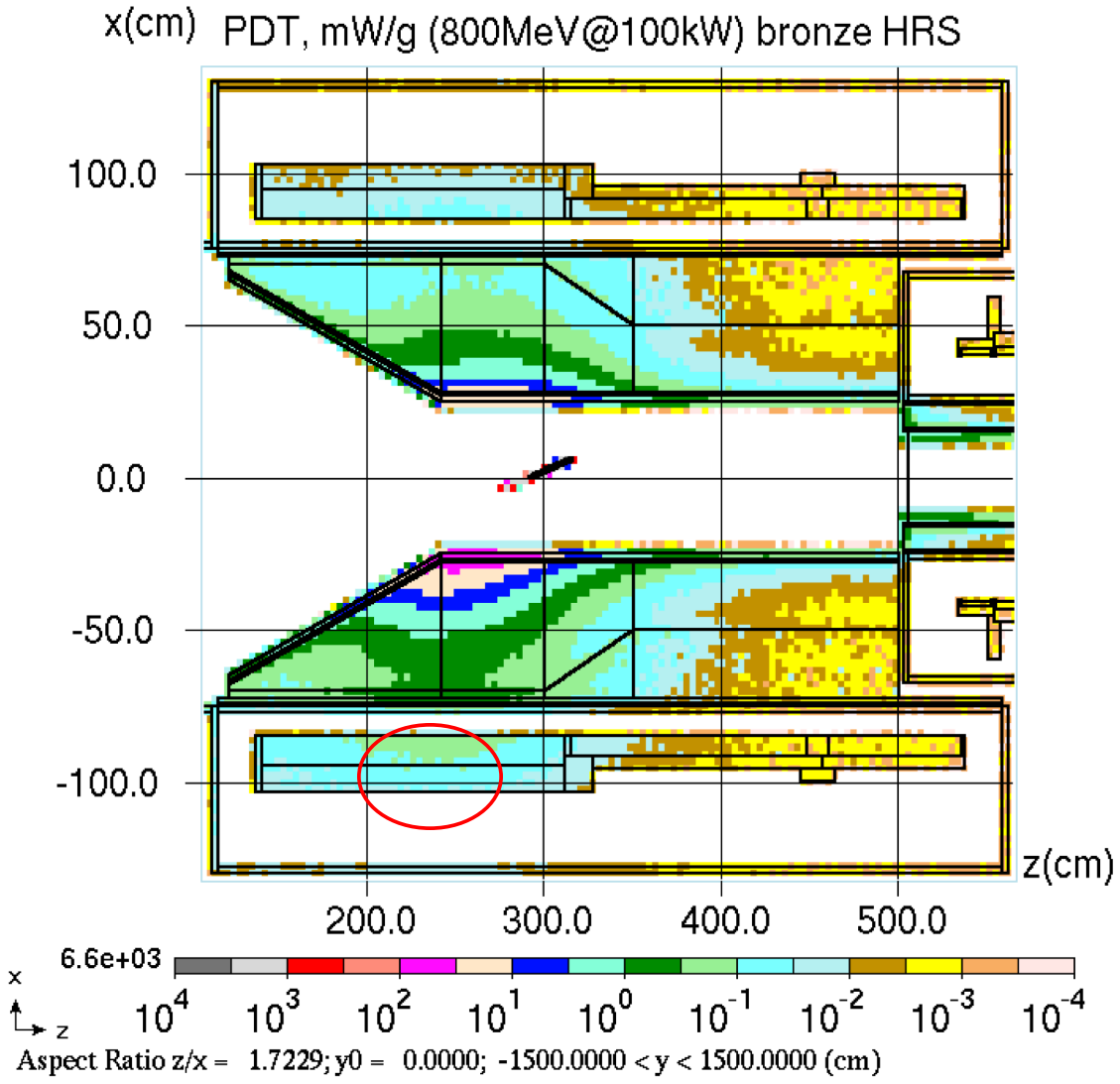
G4beamline

MARS15

- Reasonable agreement for pi-/mu-; disagreement for pi+/mu- is larger

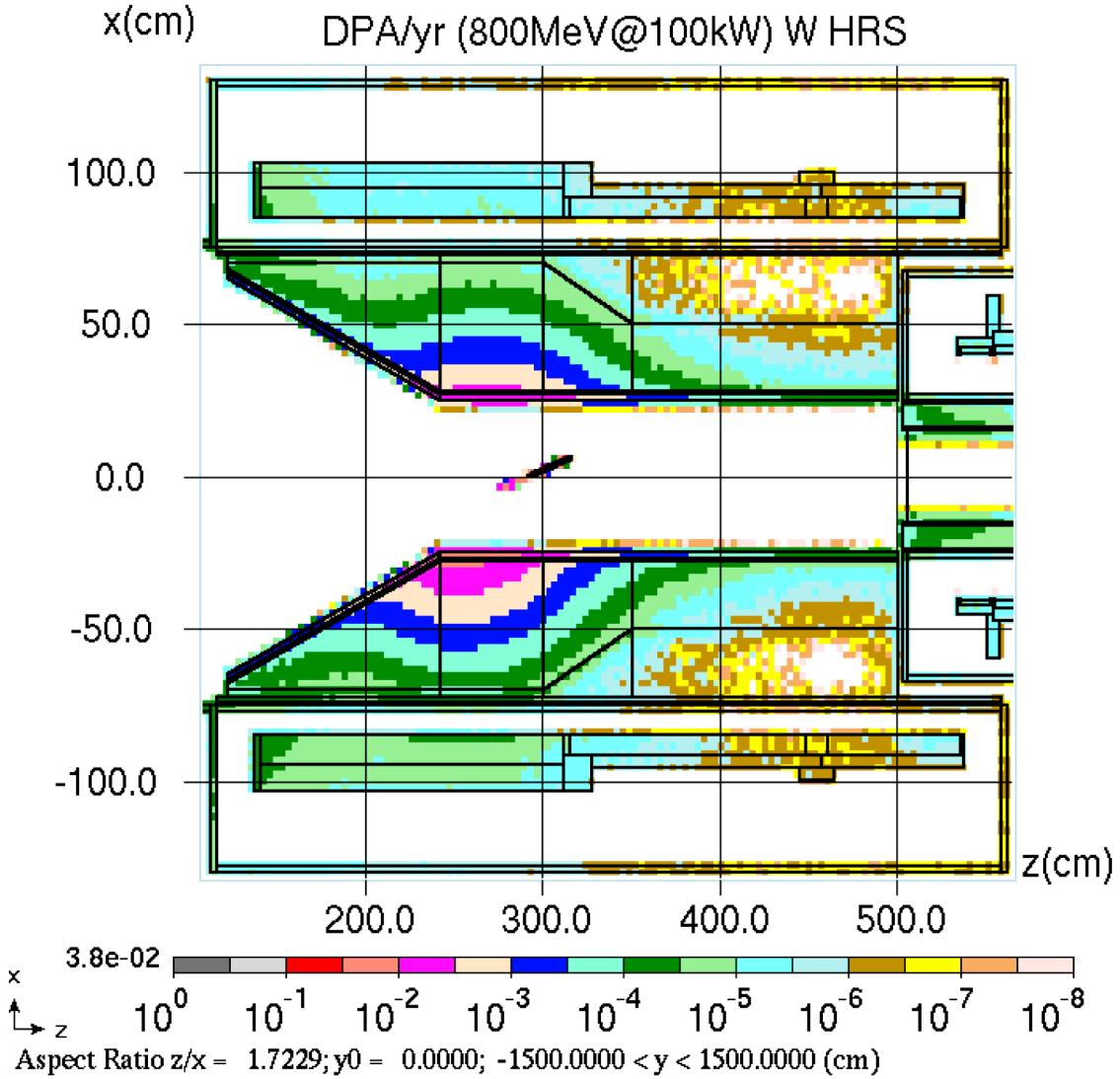
Bent target w/bronze HRS

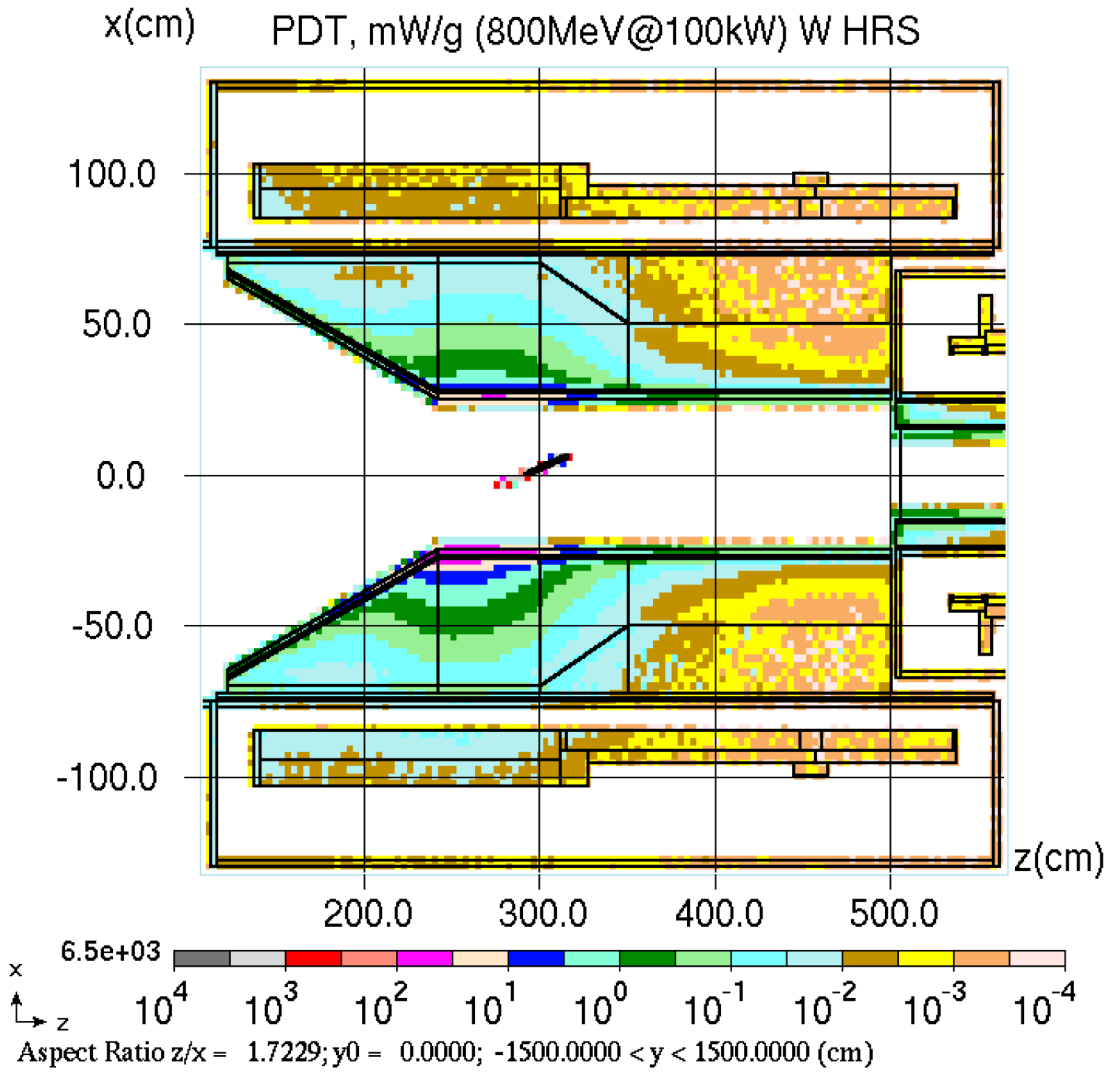




Peak DPA 1.5E-4 DPA/yr (Mu2e limits 4-6E-5 DPA before annealing); peak power density 0.14 mW/g (limit ~30 uW/g)
4-month runs before shutdown and another cooling scheme (conduit)

Bent target w/W HRS





Peak DPA 4E-4 DPA/yr (Mu2e limits 4-6E-5 DPA before annealing); peak power density 33 uW/g (limit ~30 uW/g)
Standard one-year runs before shutdown and the Mu2e baseline cooling scheme

Conclusions

- 28 spherical element R=0.75 cm bent target option for 0.1-RMS beam is currently under study and thermal analysis
- Total Edep is ~17.1 kW (seems feasible), particular technology (cooling scheme, speed, mechanics) are under study
- Peak DPA is ~2 DPA/yr (critical ~1 DPA), balls can be replaced as necessary in conveyer (a half-year durability)
- Pi-/mu- yields are in a reasonable agreement with G4beamline
- Current HRS allows to anneal once ~4 months, a conduit cooling scheme for SC coils will be required
- Tungsten HRS of the same shape/dimensions would function with the same parameters (rad.damage, heat loads) at 800MeV@100kW beams as the Mu2e baseline HRS will at 8 GeV@8kW

Next steps

- MARS15 and FLUKA (and MCNP6 ?): comparisons of particle fluxes, energy depositions, radiation damage
- MARS15: simulations of W/WC bent (conveyor) target: DPA in target/SC coils, mu-/pi- yields, stopping rates; thermal analysis and feasibility studies
- MARS15: bent targets position in the HRS bore optimization
- MARS15: hardware in the bore modeling and simulation, studies of hardware effects on radiation quantities, activation, and muon stopping rates