Study the Radiation for CPS with Polarized Target Using FLUKA

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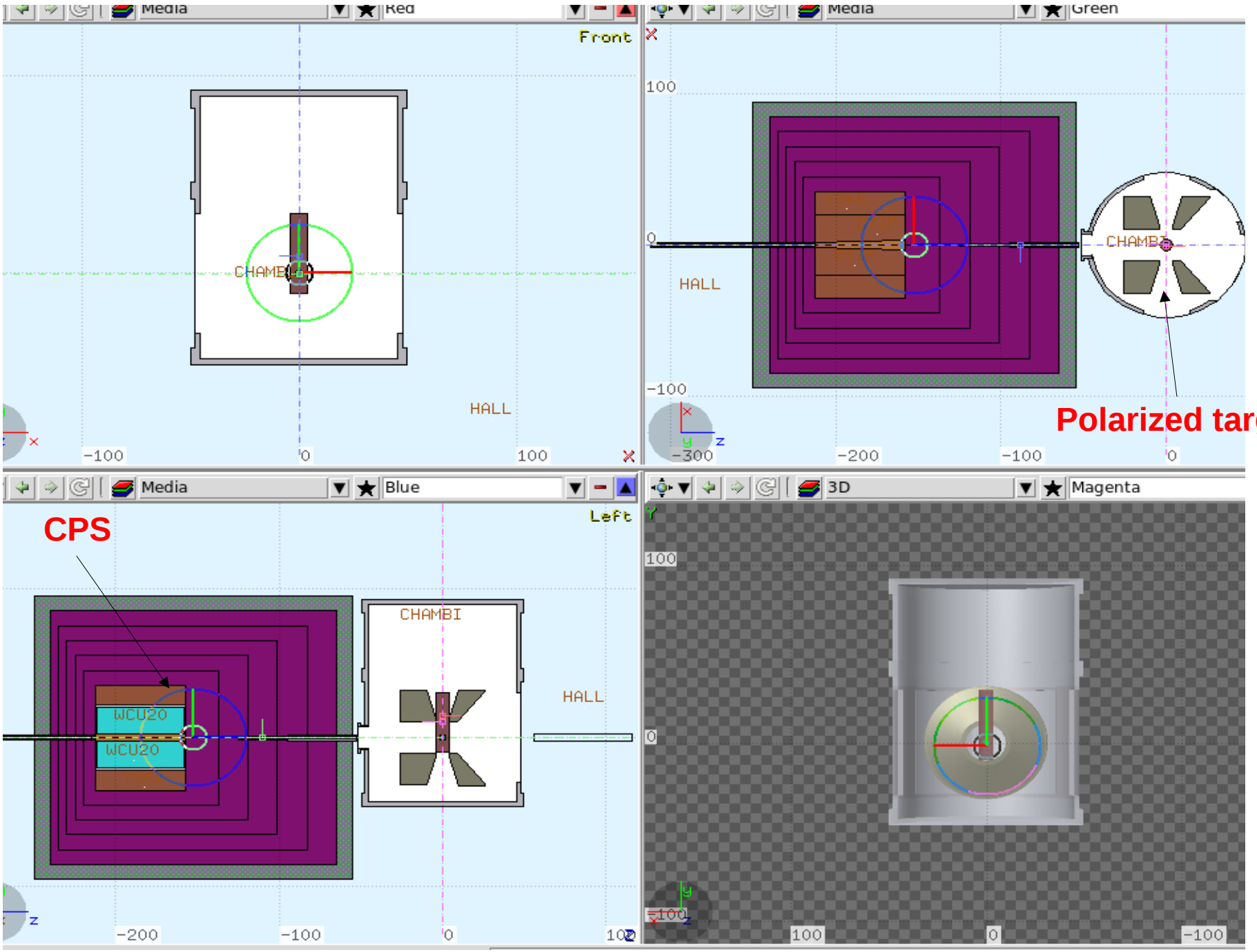
Outline

1) Geometry
   – adding the polarized target system to the CPS beamline
   – some small change in the target geometry

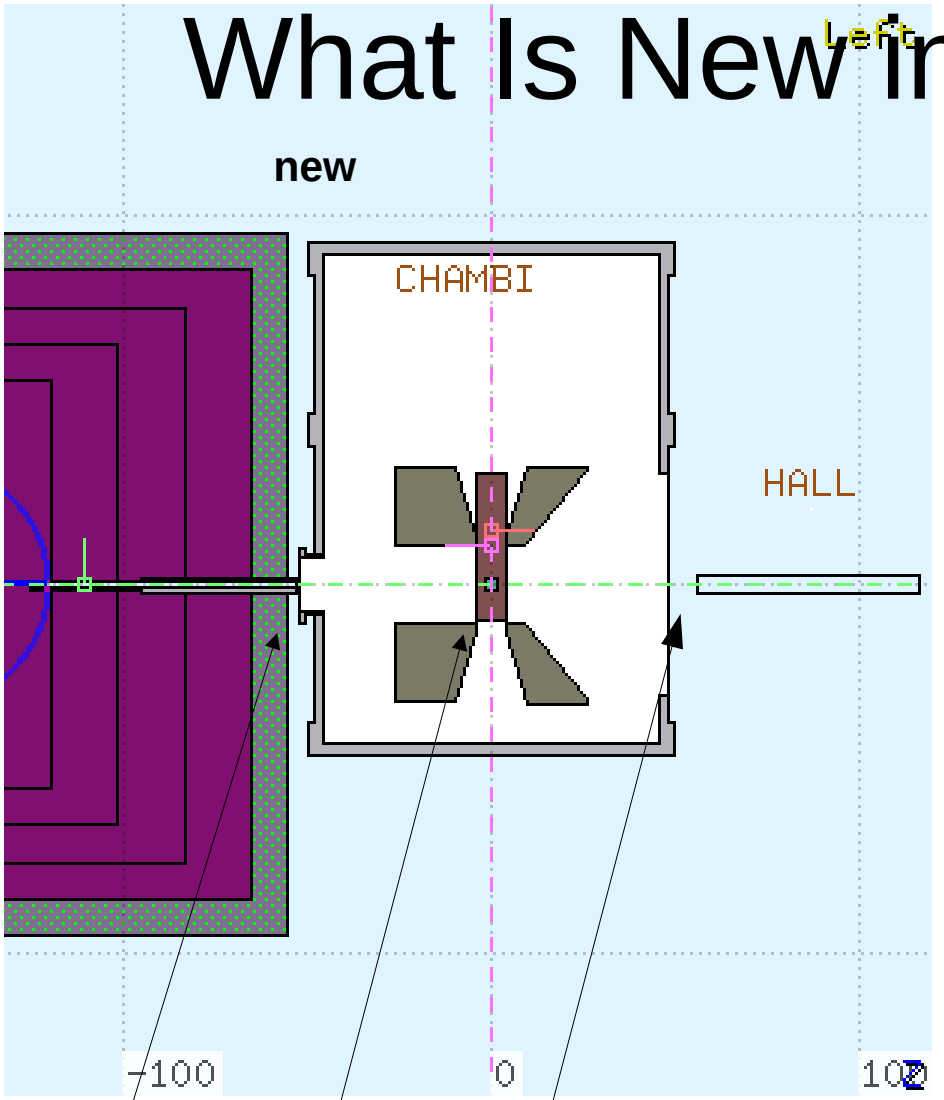
2) FLUKA simulation result

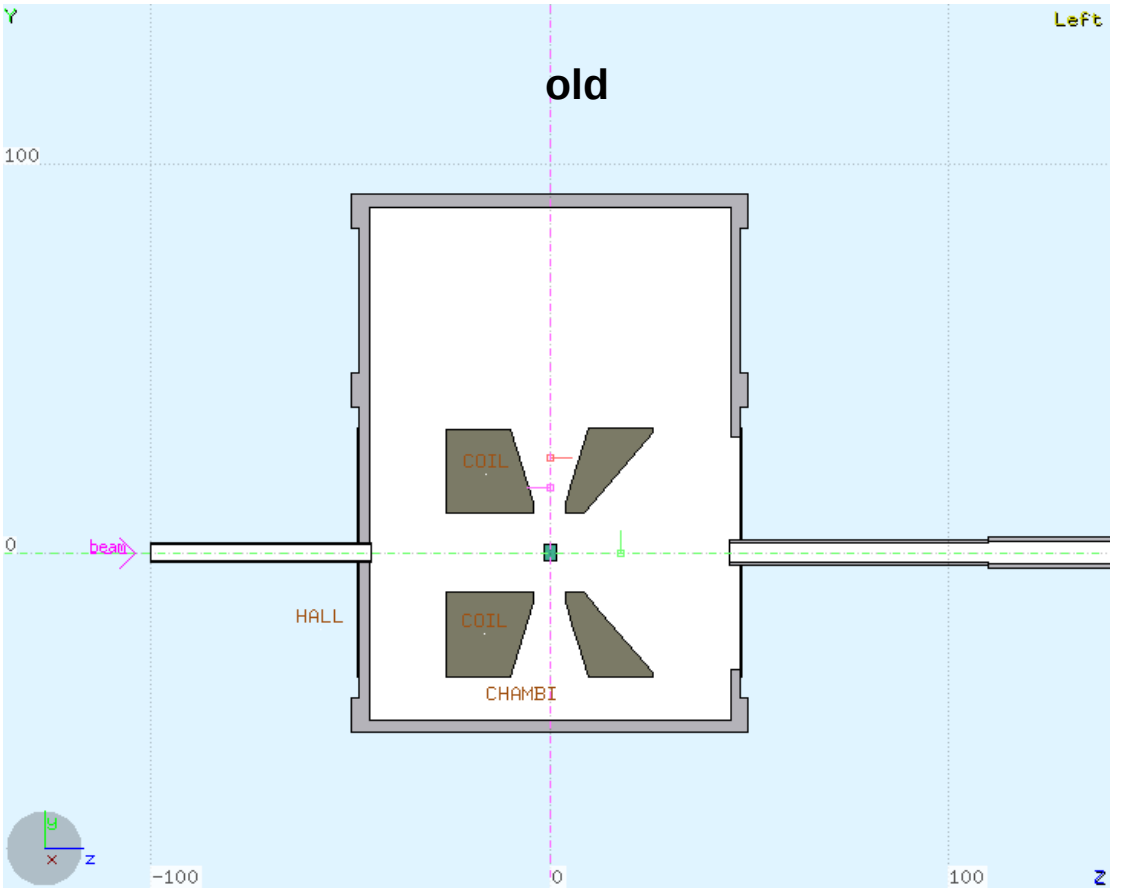
3) Summary

Geometry


Media
Red
Front
CHAMBI
HALL
-100
0
100
Media
Green
100
0
-100
HALL
CHAMBI
-300
-200
-100
0
Polarized target
Media
Blue
Left
CPS
CHAMBI
HALL
WCU20
WCU20
-200
-100
0
3D
Magenta
100
0
-100
100
0
-100

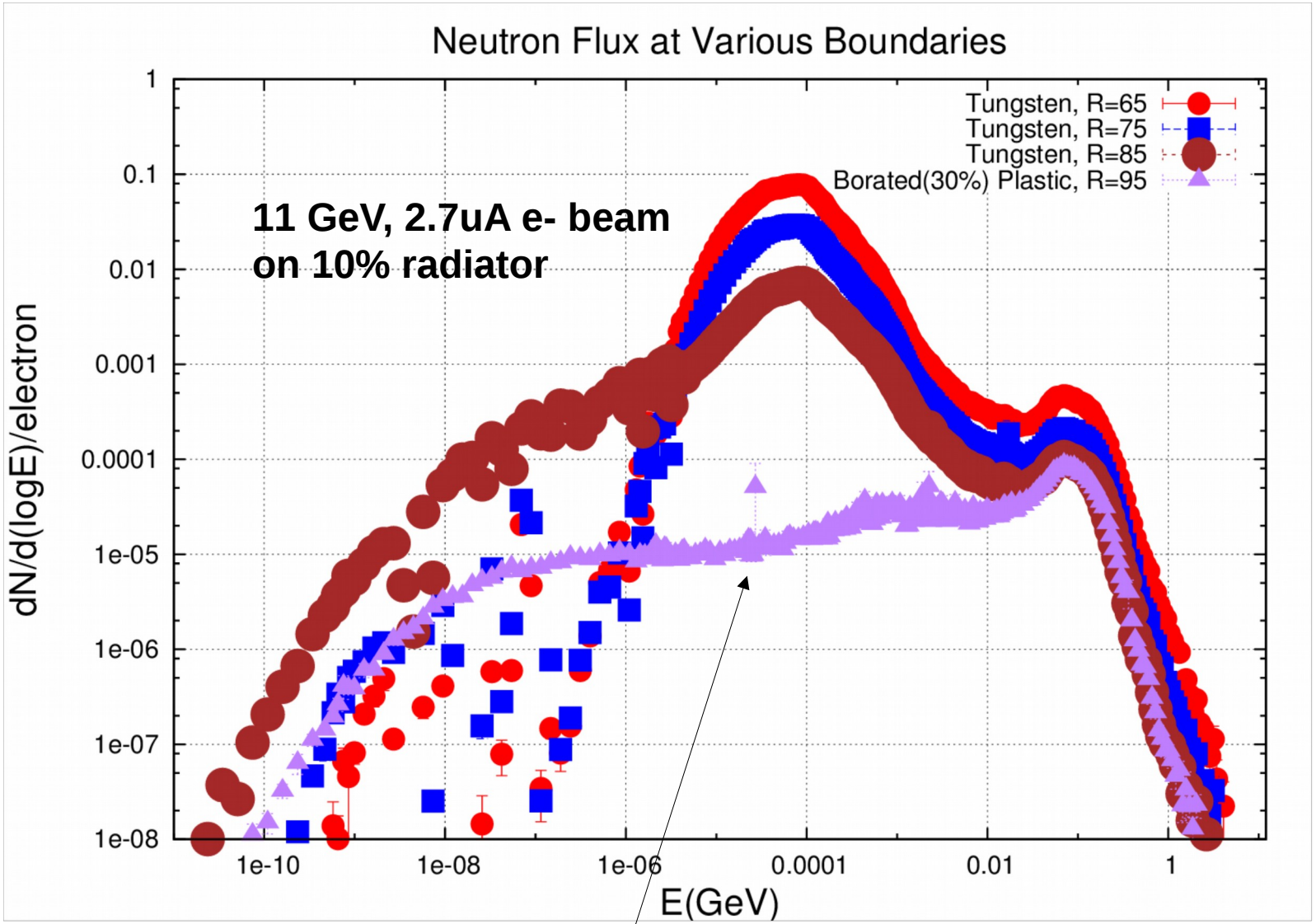
What Is New in Target Geometry





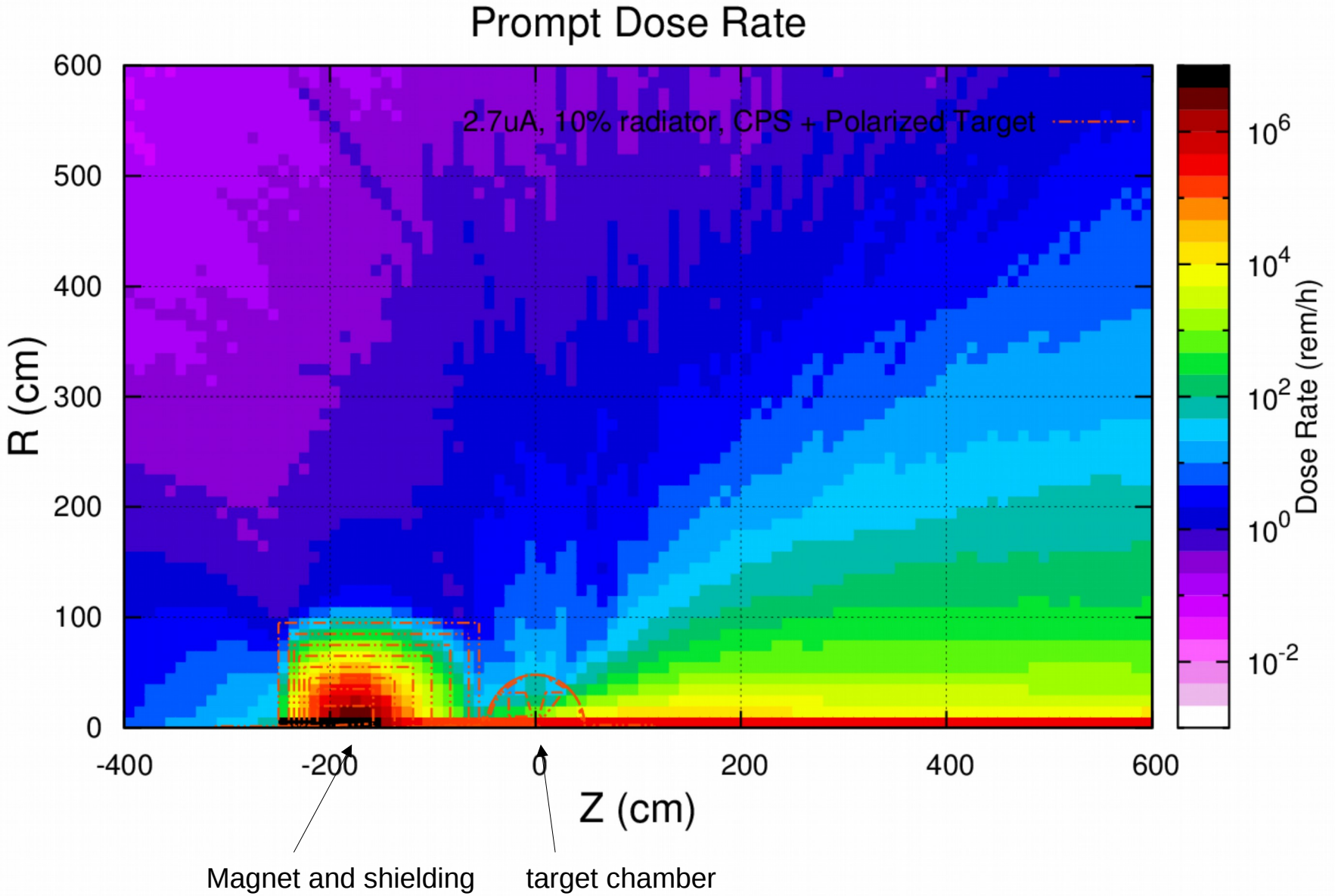
1) Add entrance flange. Beam pipe exit window is 4 mil aluminum. Target chamber entrance window is 8 mil aluminum. (Need to verify with Chris Keith if these two part are joined without windows.)
2) Add target nose, which is 4 mil thick aluminum. R=3.8 cm (in G2p, it is R=1.664”). Place liquid helium inside target nose.
3) Move down stream beam pipe a little bit down stream. Target chamber exit window is 20 mil plastic (it should be aluminum). Beam pipe window is 4 mil aluminum.

Neutron Fluence at Various Boundaries



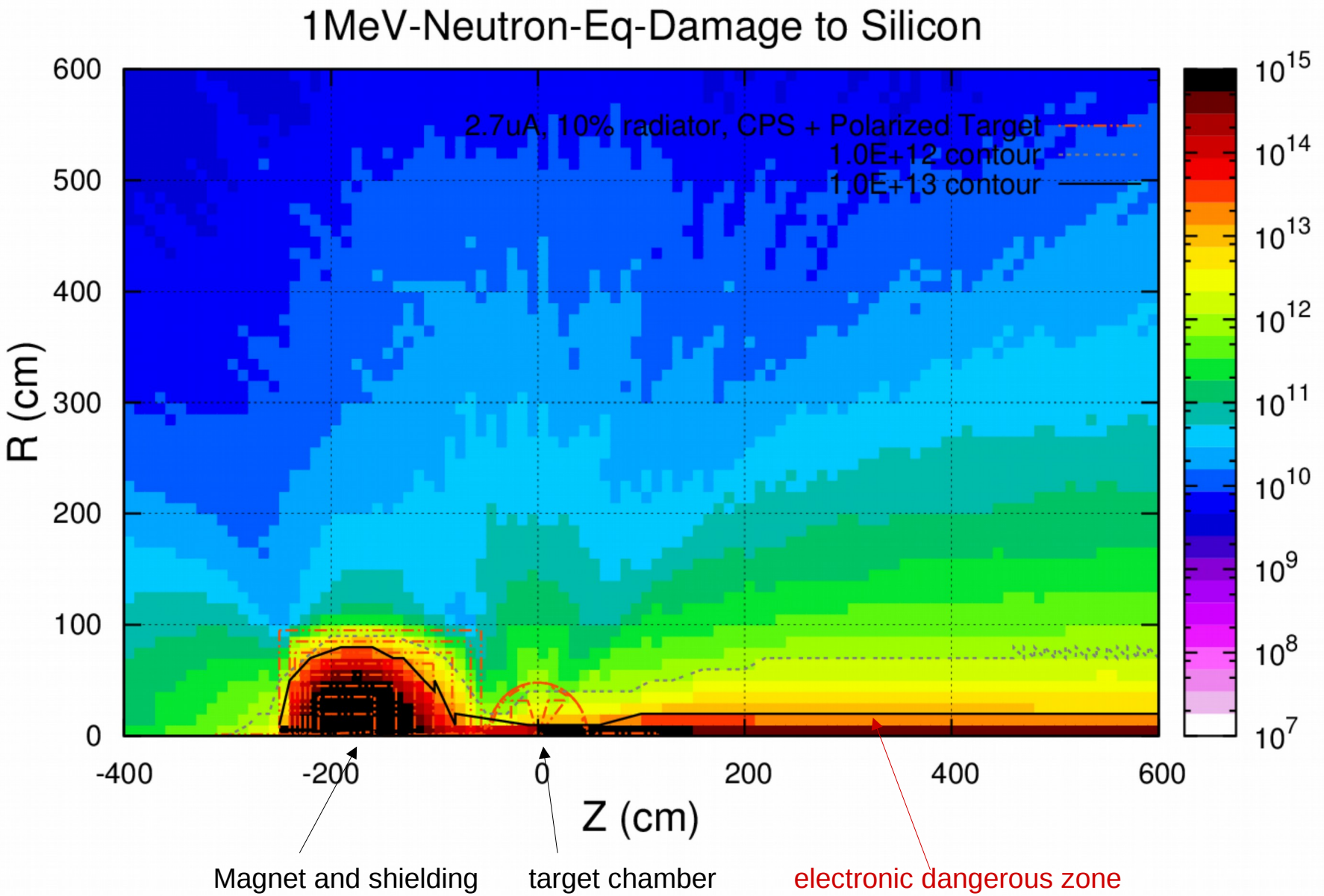
10cm thick 30% borated plastic layer reduces neutron flux a lot. Very helpful.

Prompt Dose Rate



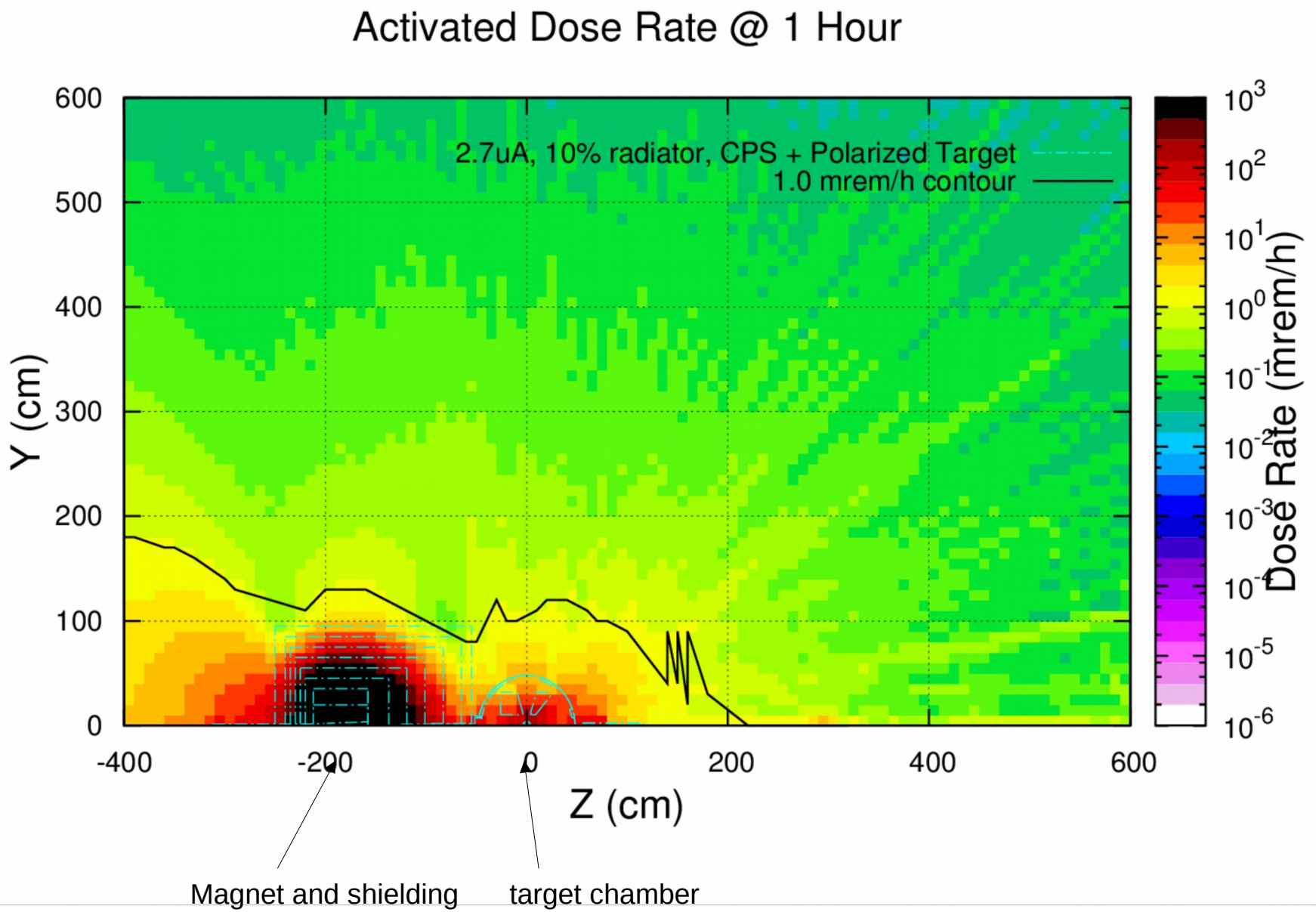
2.7uA beam @ 11 GeV

1 MeV Neutron Equivalent Damage



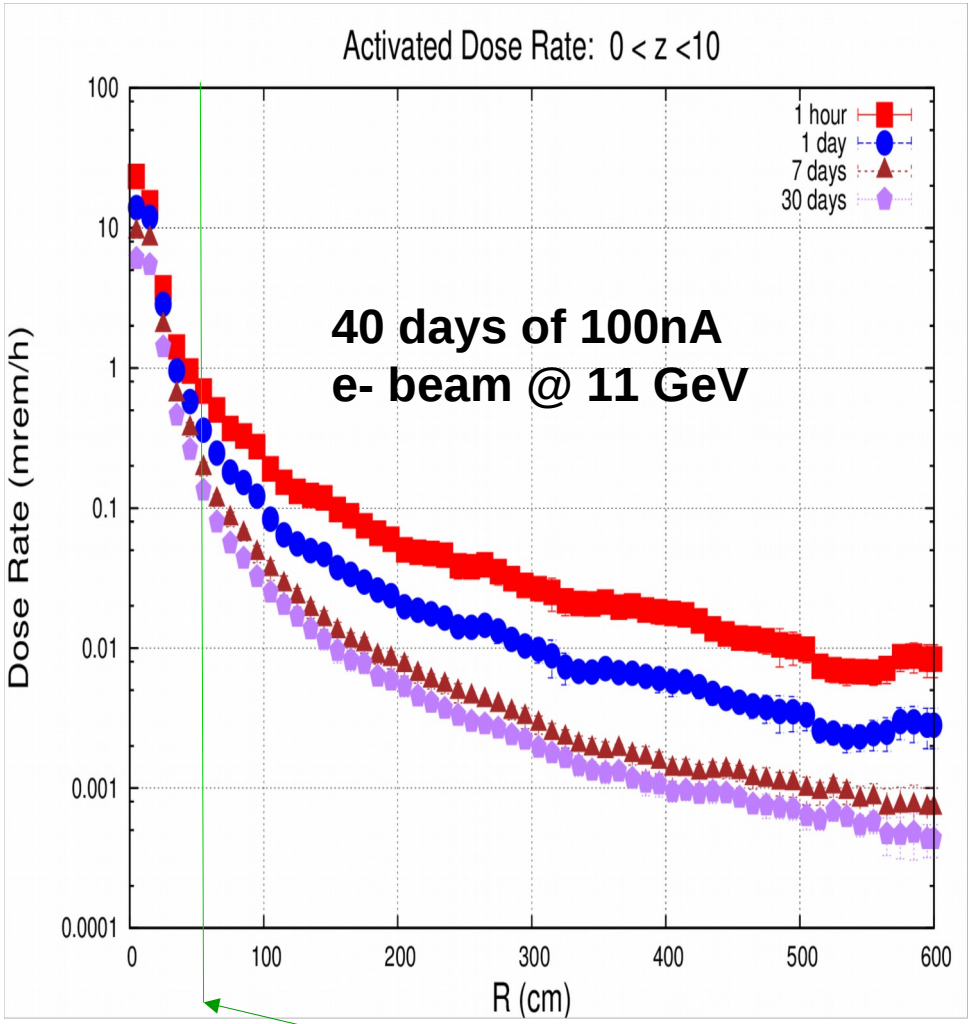
1000 hours of 2.7uA beam @ 11 GeV

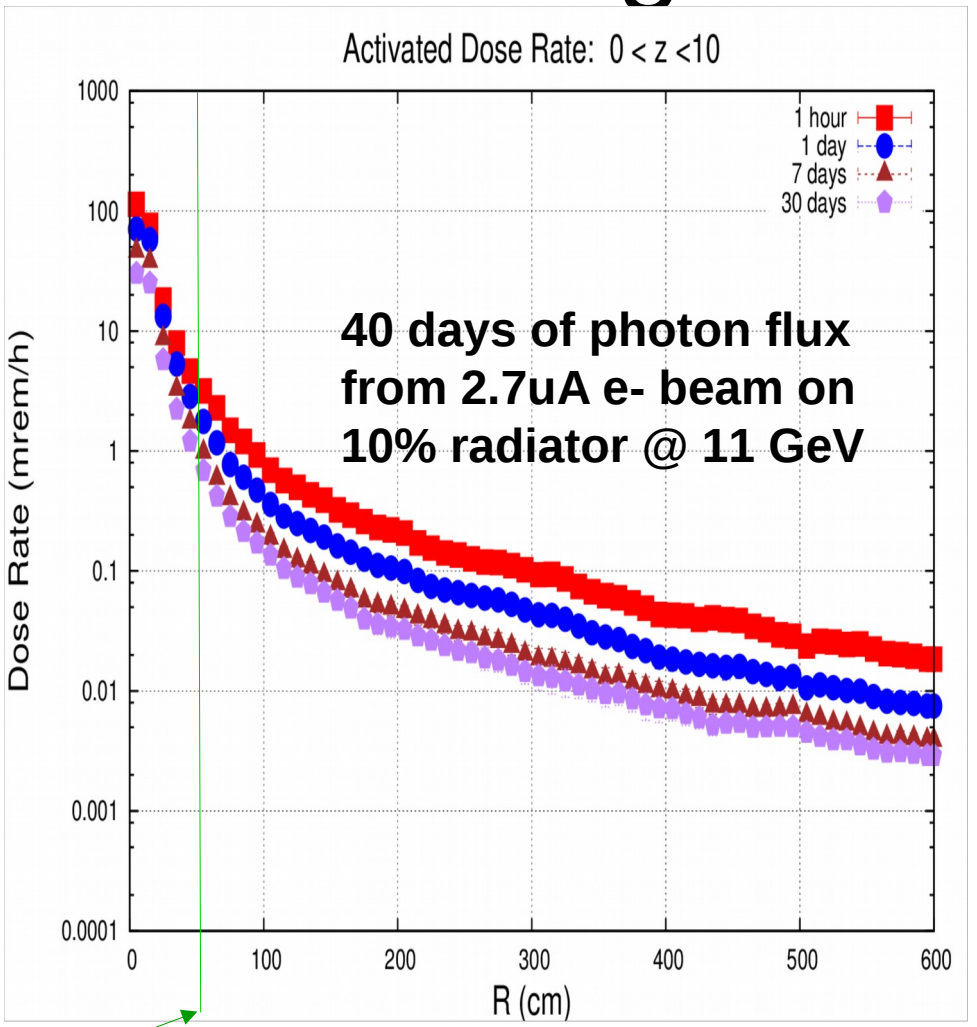
Dose Rate from Activation



1000 hours of 2.7uA beam @ 11 GeV

Activated Dose Rates in Target



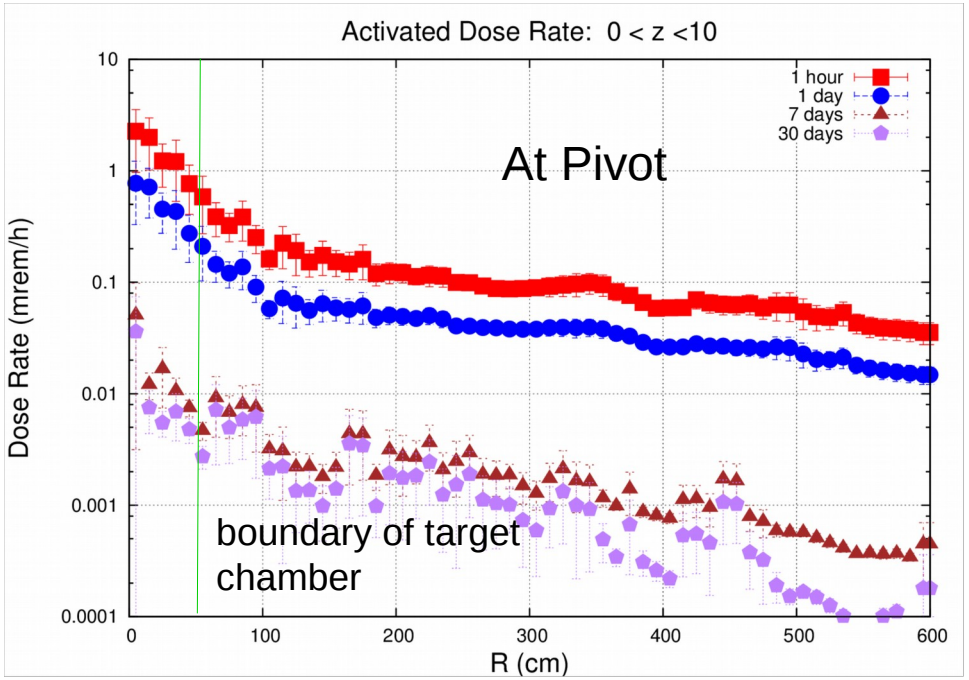


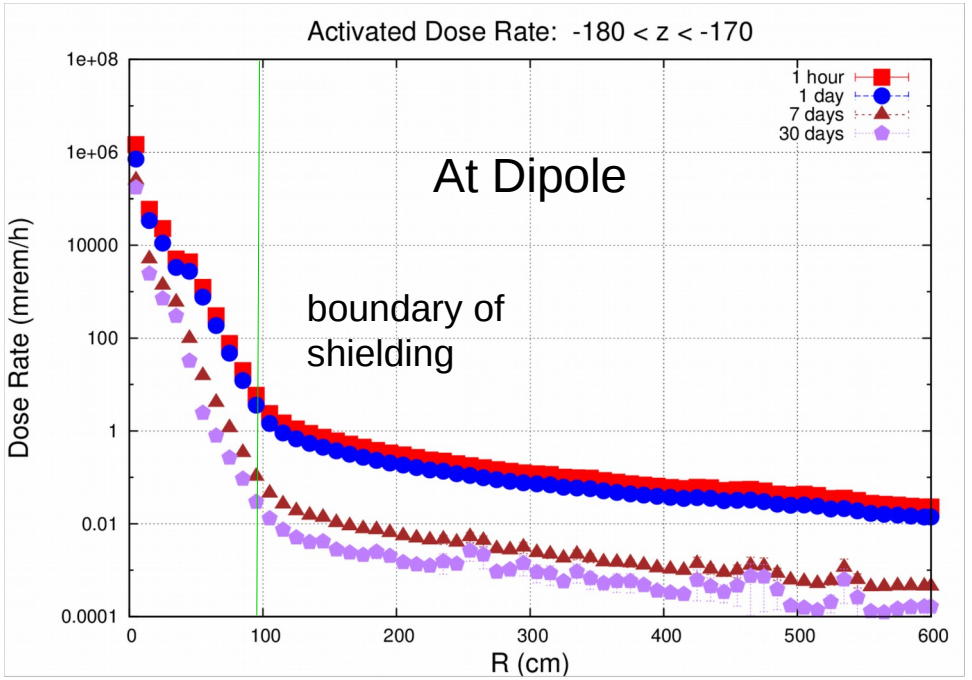
target chamber boundary

Only with UVA|JLab target, no CPS

A Bremsstrahlung photon beam created from 2.7uA 11GeV electron beam on 10% radiator will always have more activated dose in the target than a 100 nA electron beam as one has more photons activating.

Dose Rate from Activation - I



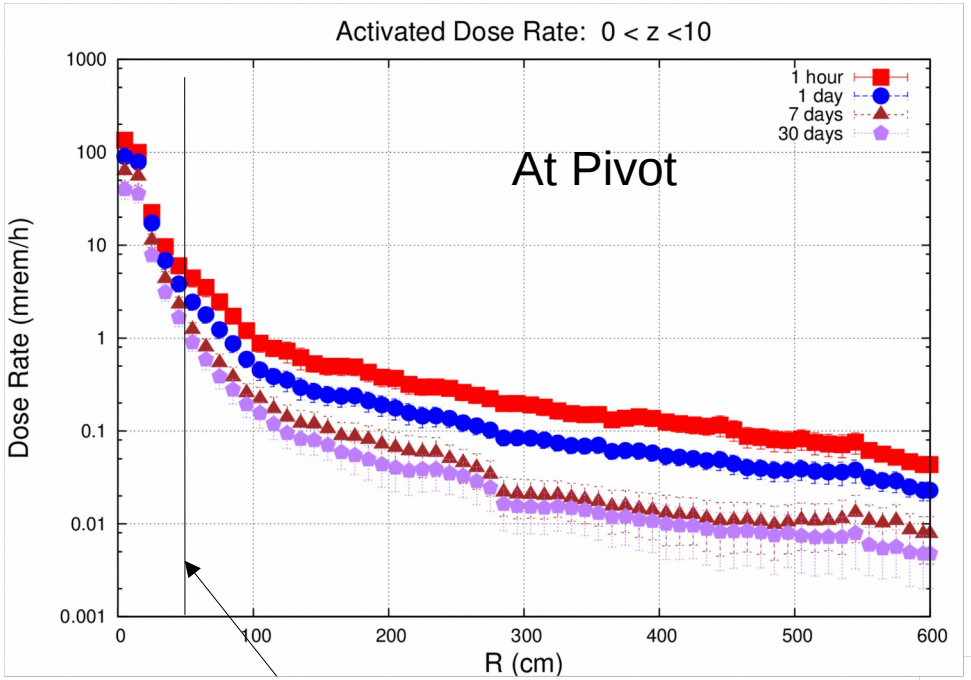


1000 hours of 2.7uA beam @ 11 GeV

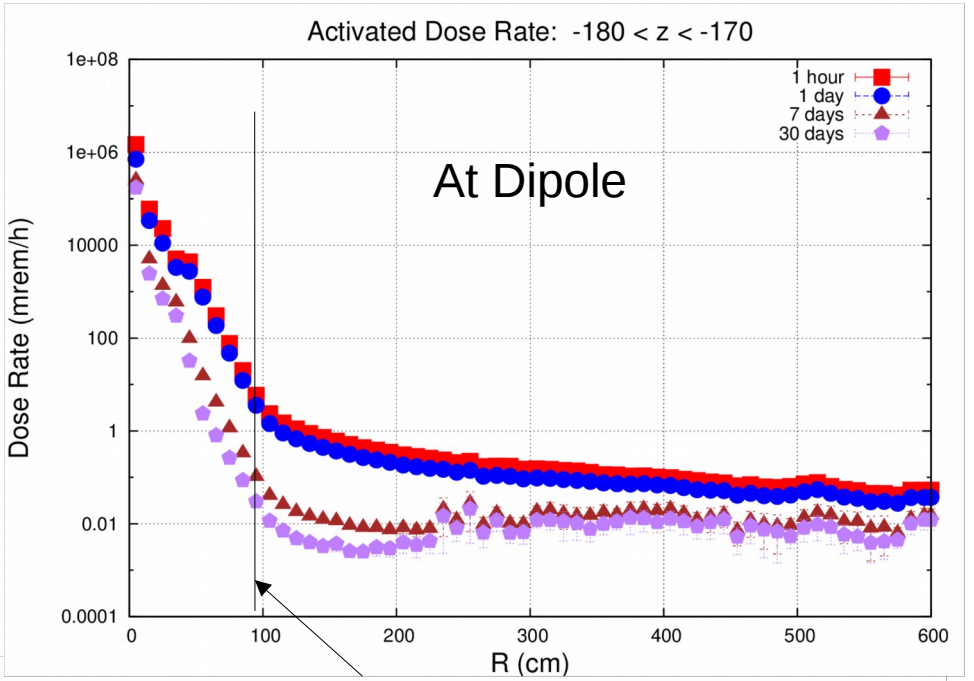
Only with CPS, no UVA|JLab target

Dose rate from activation after 1 hour the beam is shut down: at the target chamber boundary is ~1 mrem/h, at 1.0m away from the dipole is ~6 mrem/h.

Dose Rate from Activation - II



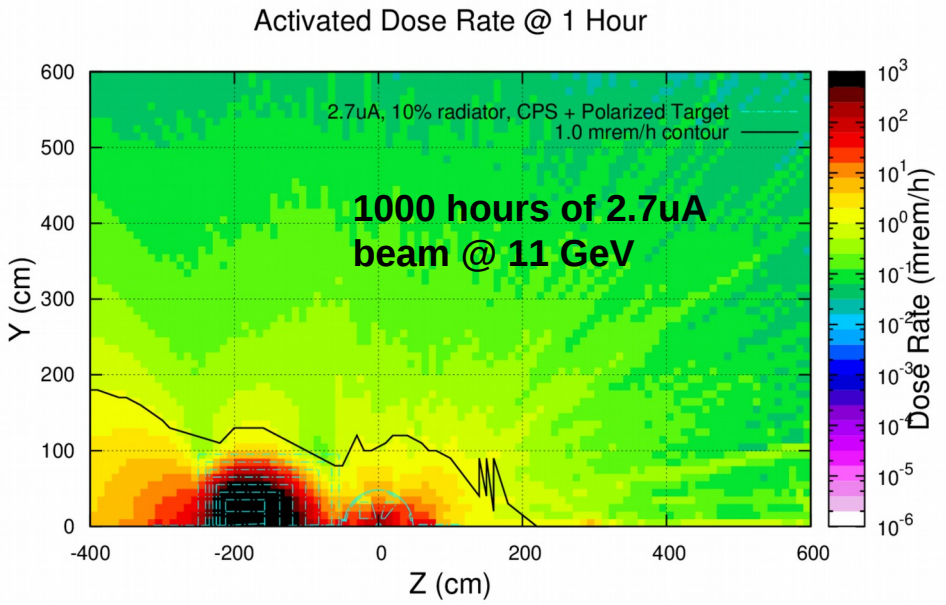
target chamber boundary



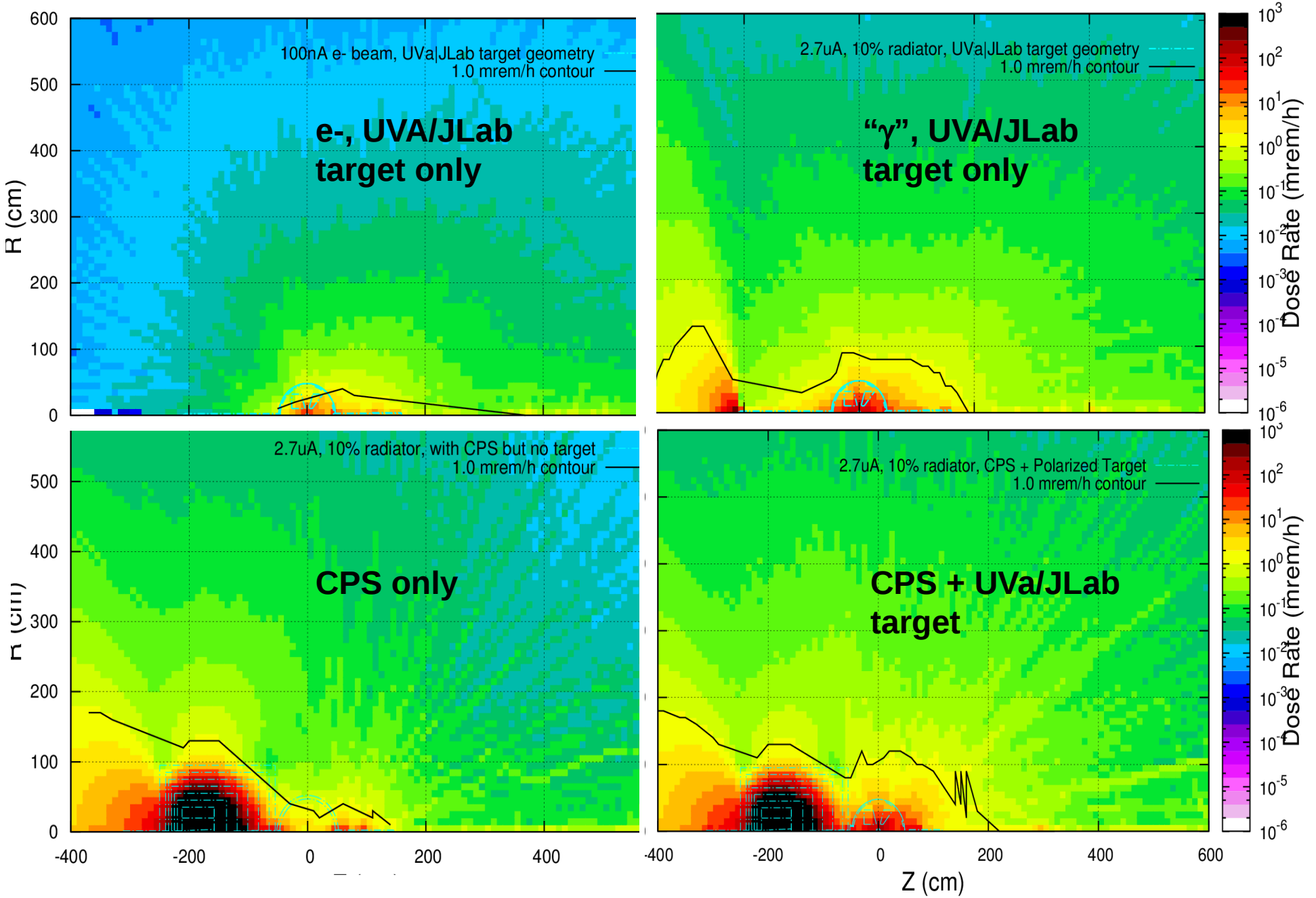
CPS plastic shielding boundary

With CPS and UVA|JLab target

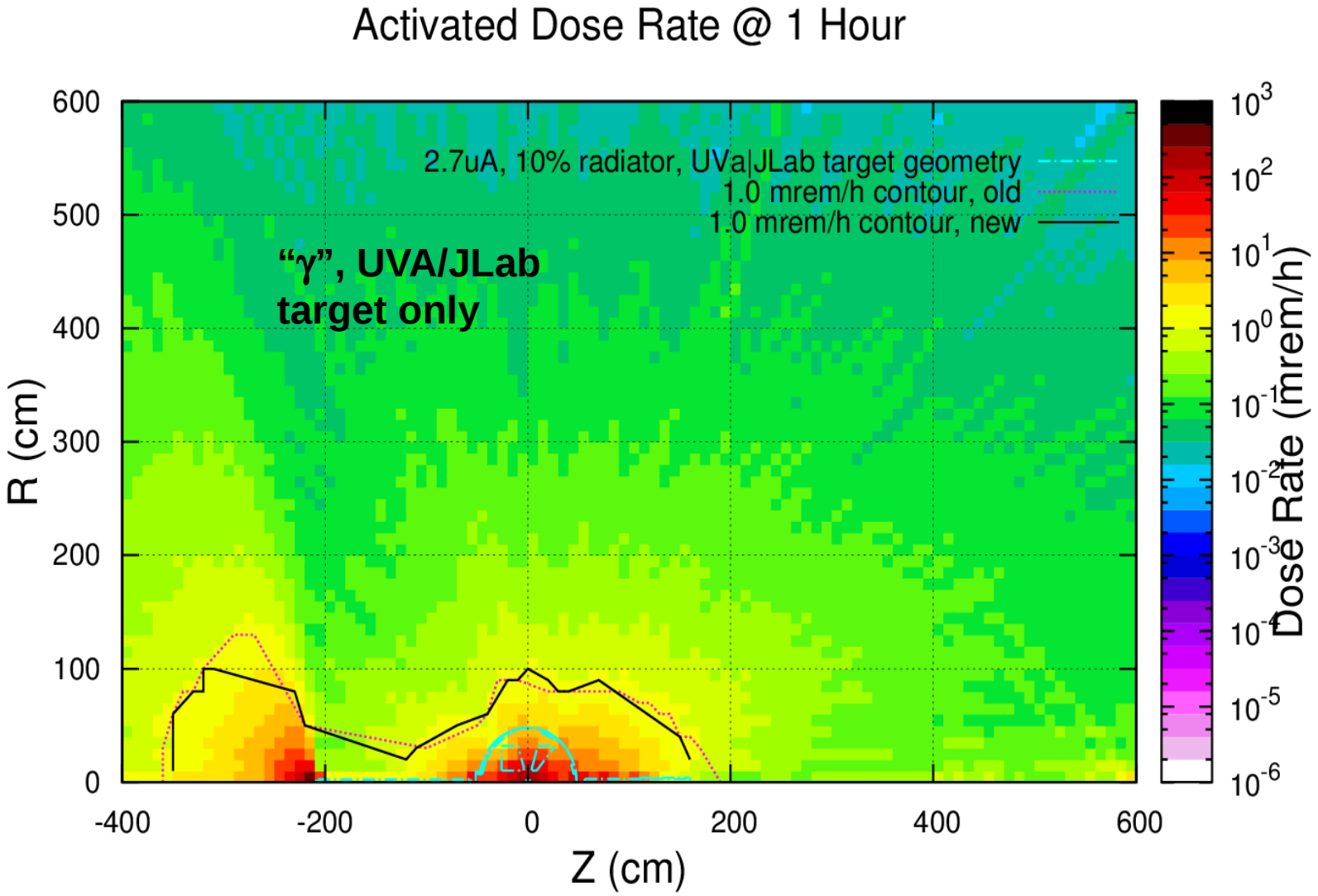
Dose rate from activation after 1 hour the beam is shut down: at the target chamber boundary is ~5 mrem/h, at 1.0m away from the dipole is ~6 mrem/h.



Compare Activated Dose Rate



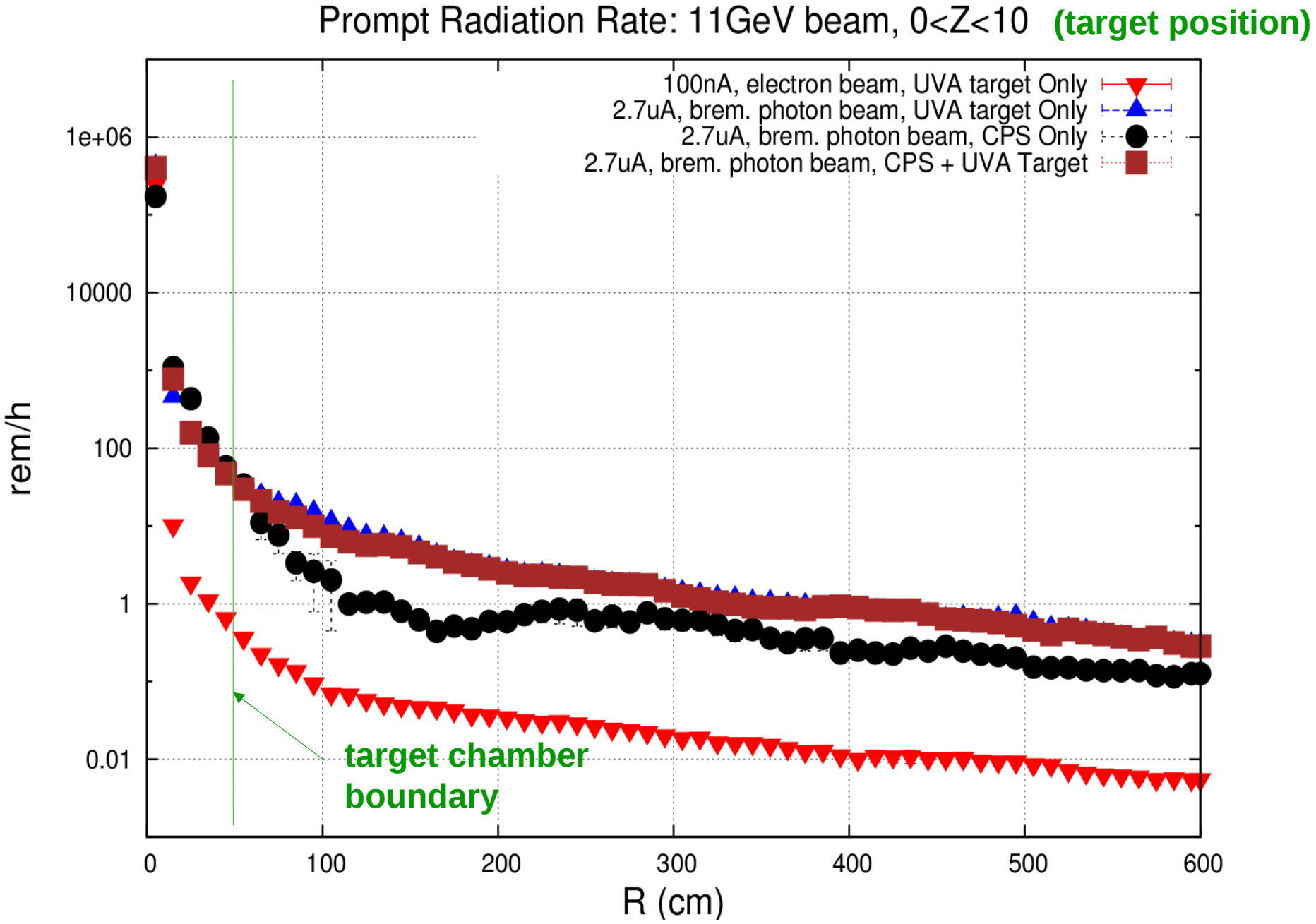
Contribution from New Target Geometry



Only with UVA|JLab target, no CPS

Those windows and liquid helium have some but not too much contribution.

Compare Prompt Dose Rate



Summary

1) CPS and polarized target geometry have been merged. FLUKA simulation has been performed for 1000 hours of 2.7 uA electron beam at 11.0 GeV.

2) 10 cm borated plastic shielding is added to reduce neutron flux.

3) After 1000 hours, the accumulated 1-MeV-Nu-Eq damage to silicon at target area (z=0) is less than 10^12 at 40cm away from beam line, down stream of the beam pipe is hot. Outside the borated plastic layer is about 7x10^11.

4) Dose rate from activation after 1 hour the beam is shut down at the target chamber boundary is ~5 mrem/h, outside the borated plastic layer at 1.0 m from the dipole it is ~6 mrem/h.

5) **Note that the 5 mr/hr is equivalent to the dose rate from any equivalent photon flux beam, i.e., it does not get enhanced by the CPS.**

Geometry (continue)

1) CPS magnet is centered at z=-185 cm. Radiator (10%) islocated at z=**-215** cm.

2) Pure copper core, dig 3mm(width) x 3mm(height) slot through it.

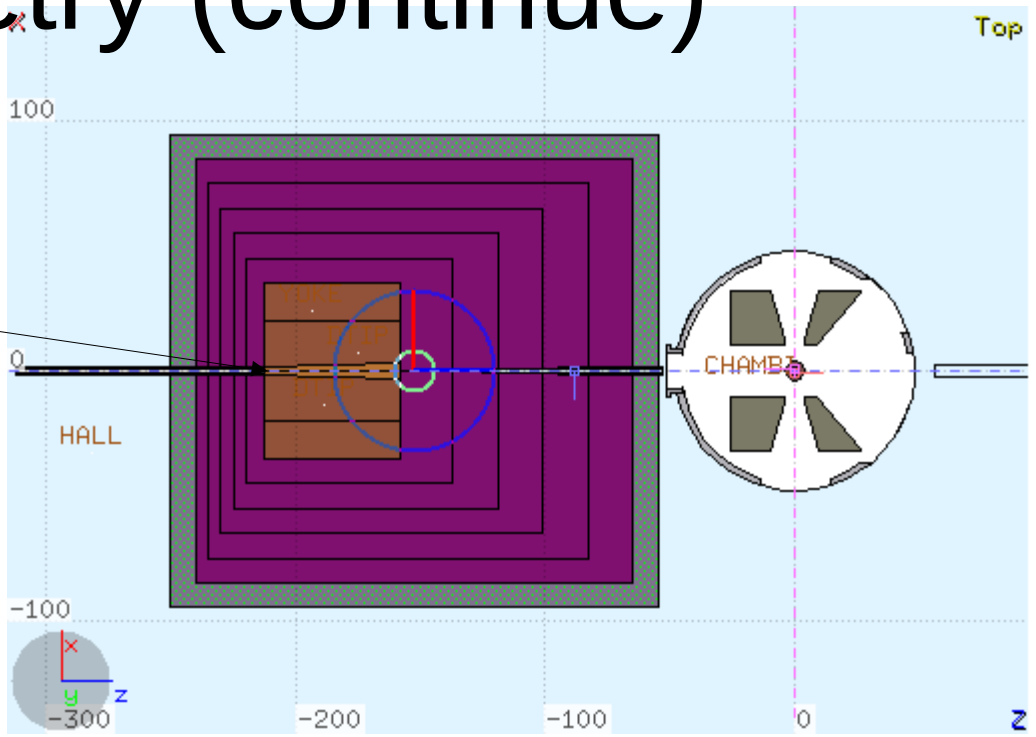
3) Fill W(80%)-Cu(20%) alloy between coils.

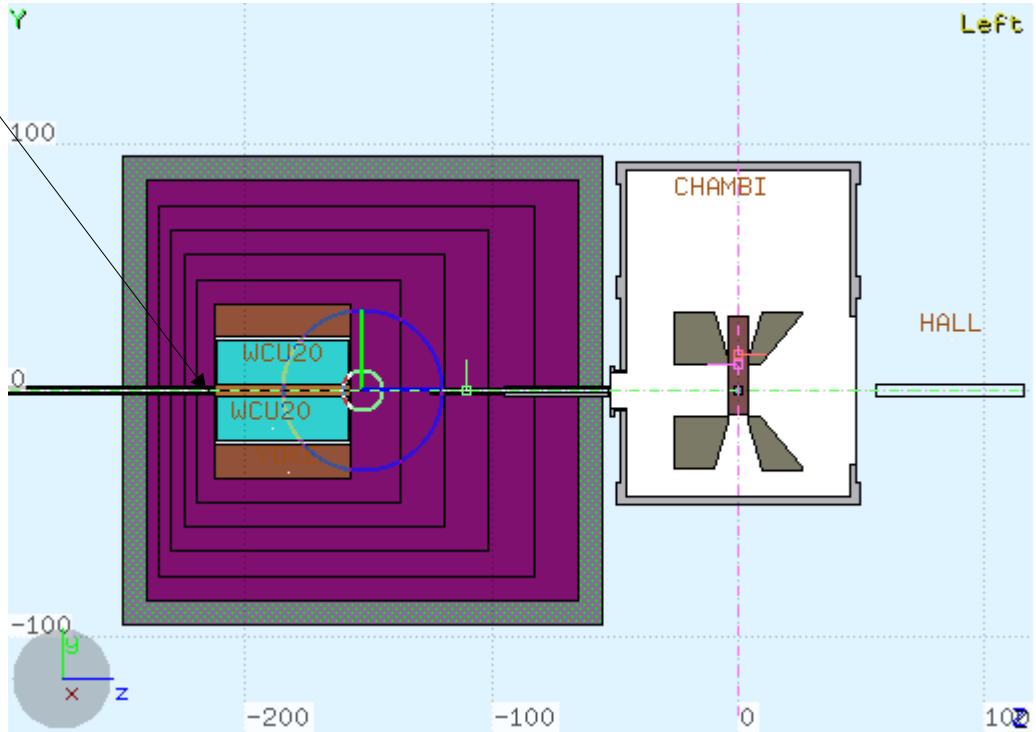
4) Shielding: tungsten powder, 16g/cm^3, (5 layers). Thickness: 92.75cm, 49.75cm and 27.75cm in downstream, side and upstream direction, respectively.

5) Add 10 cm 30% borated plastic to surround the tungsten powder

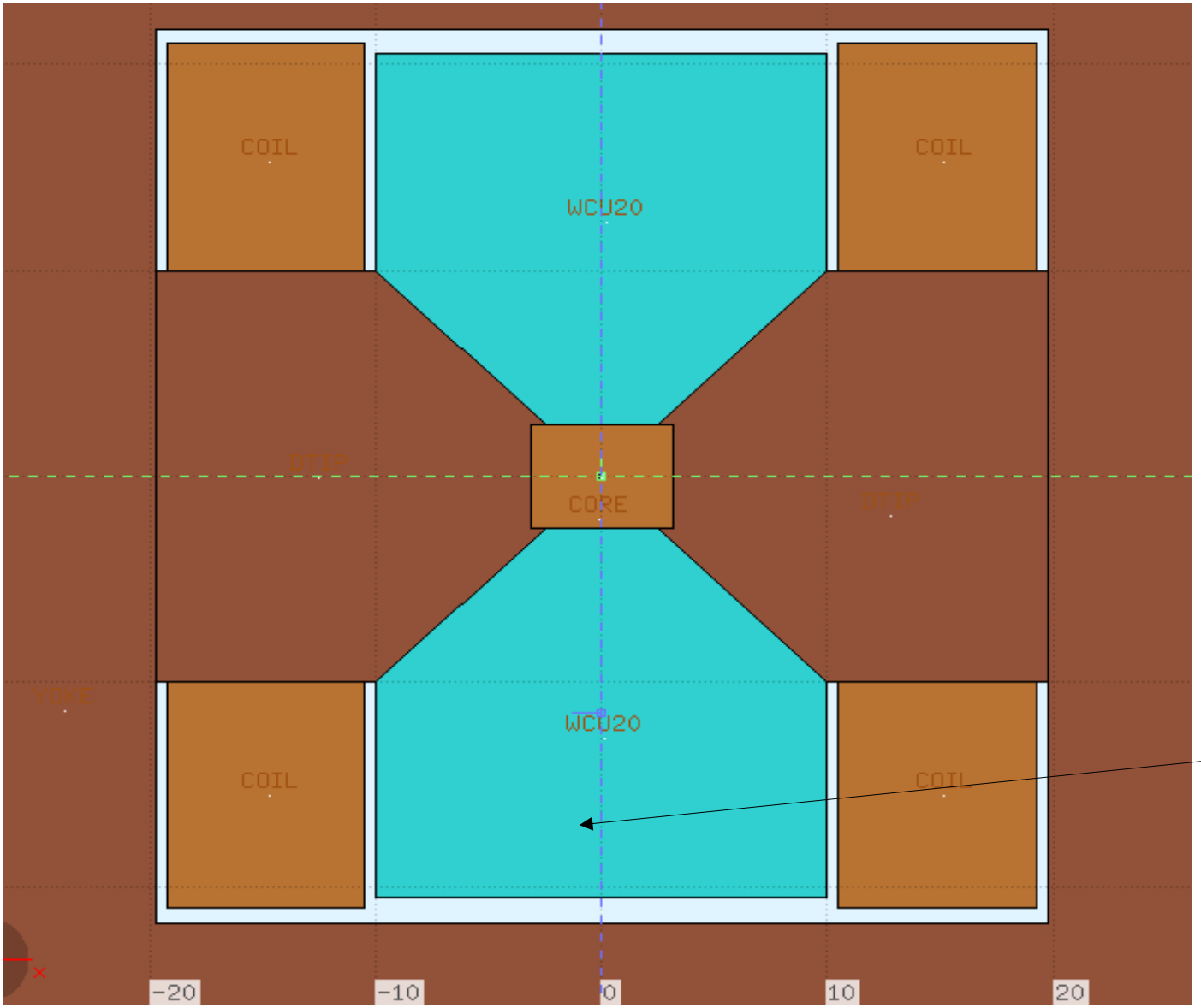
6) Polarized target built with helium bath, NH3, target chamber, windows, beam pine windows.

7) Beam: 2.7uA, 11 GeV, raster size is 2mm x 2mm



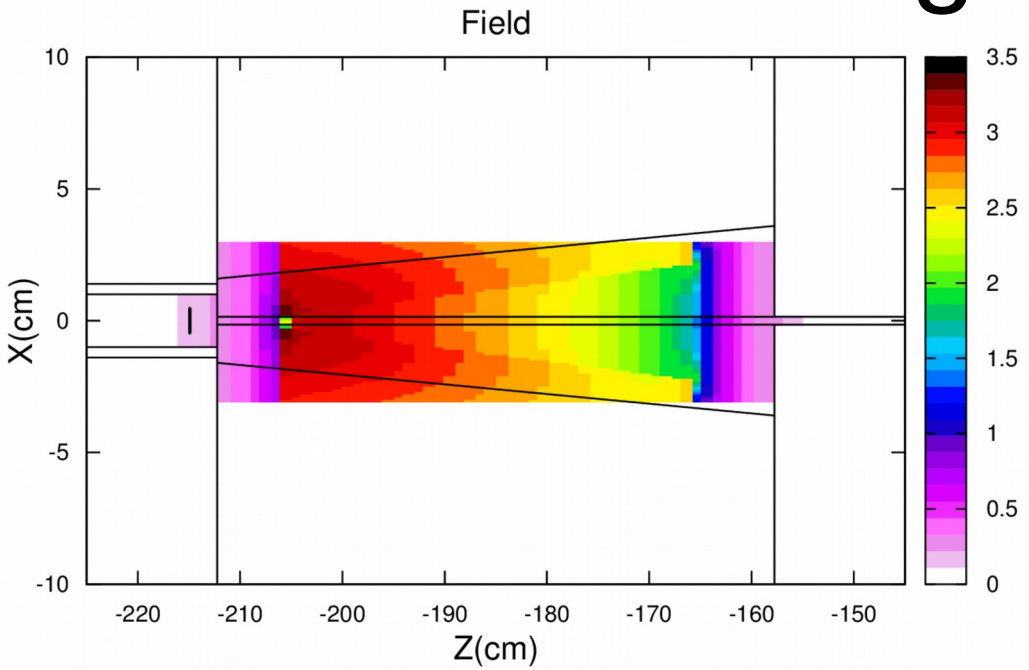


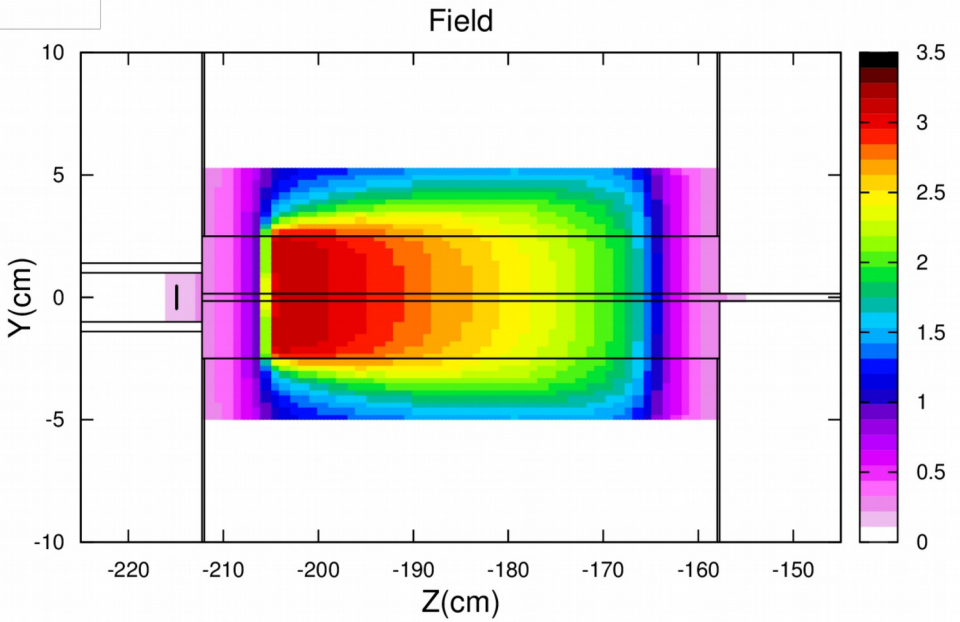
CPS Magnet Geometry: beamview



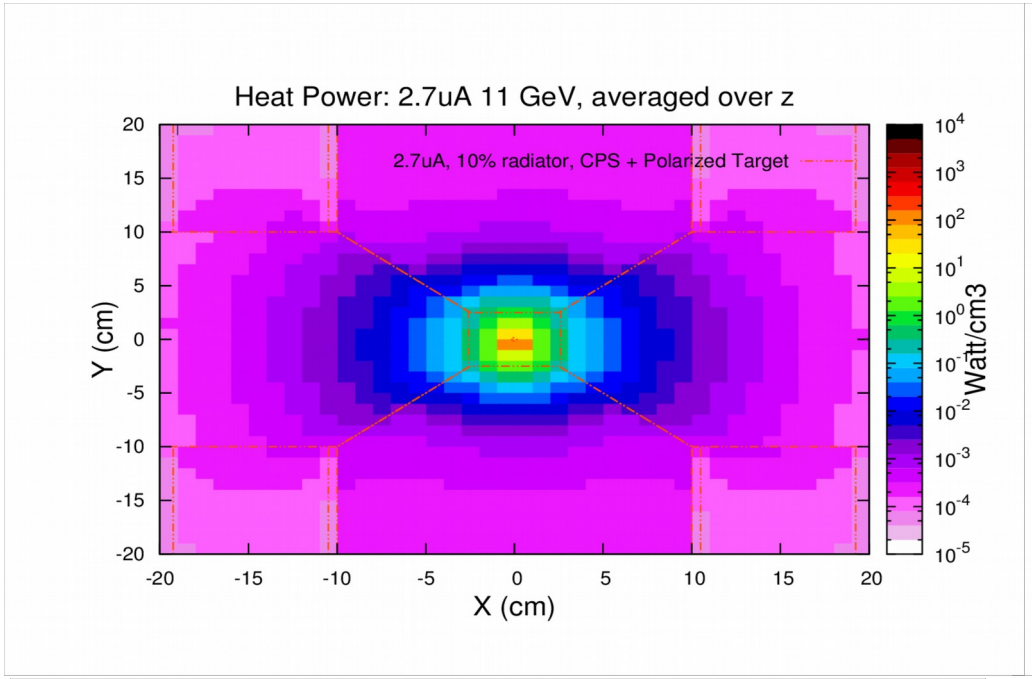
Place tungsten-copper alloy here (20% copper)

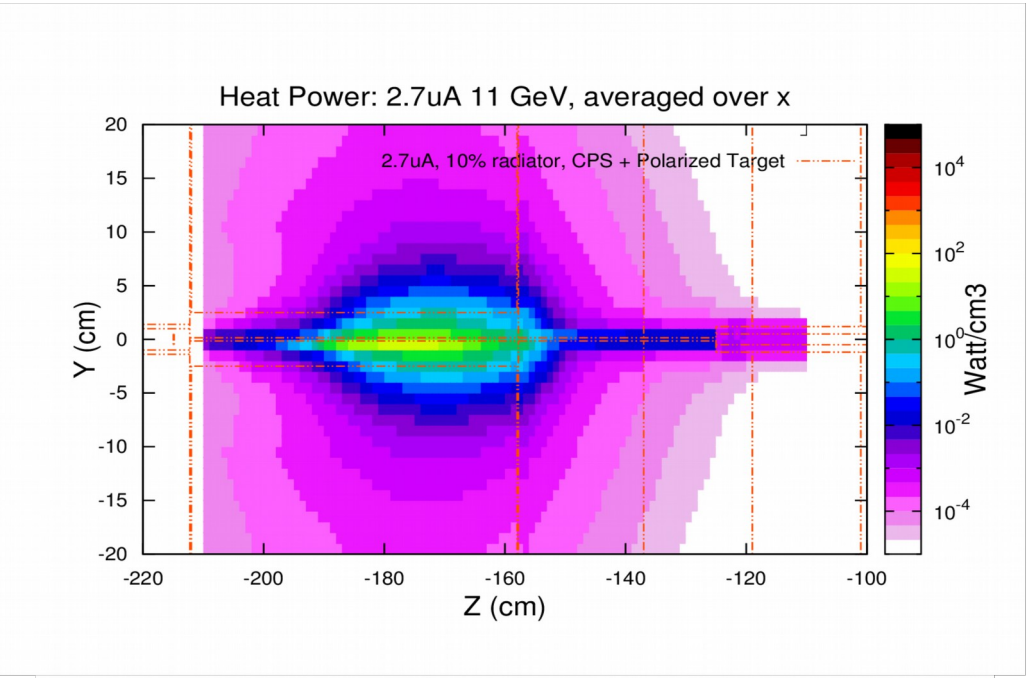
CPS Magnet Field

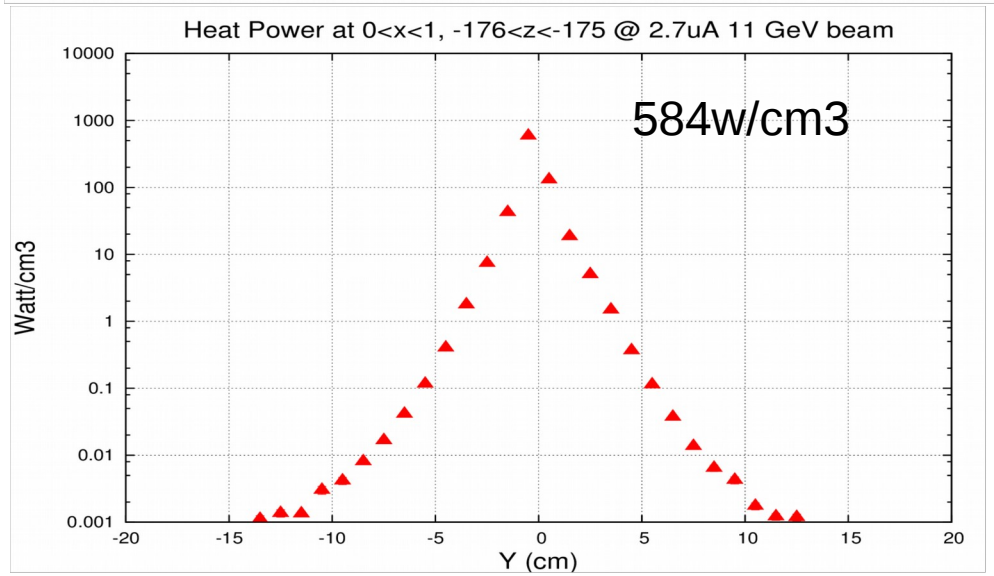


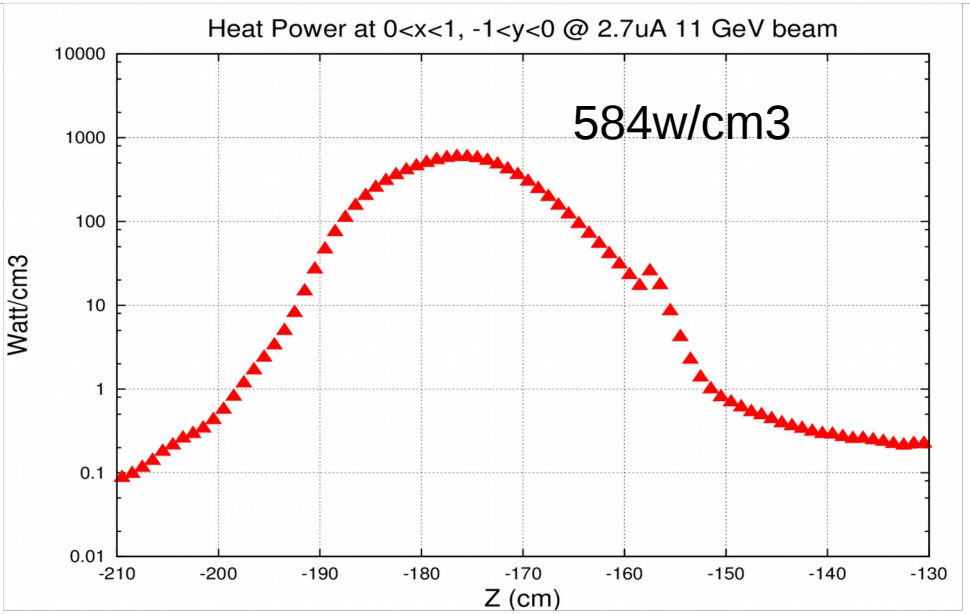


Heat Power









2.7uA beam @ 11 GeV