GEANT4 Simulation of background radiation study for APEX

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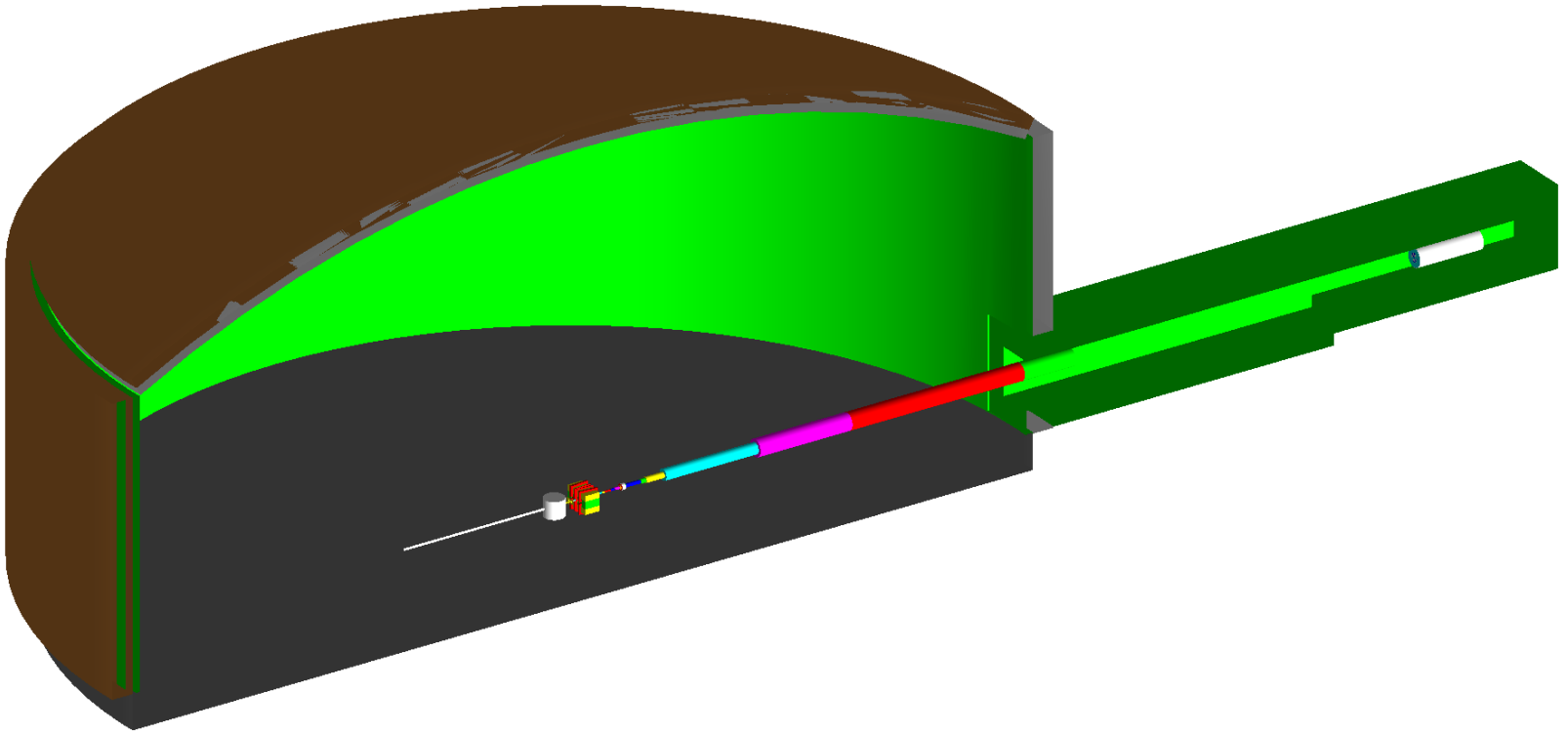
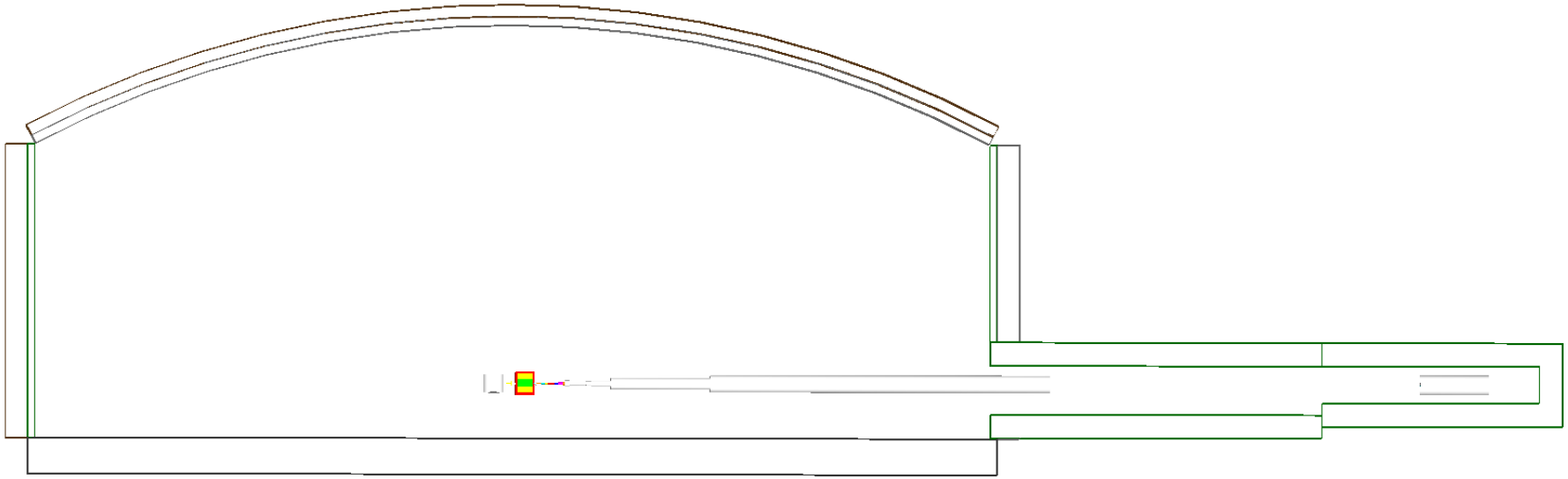
Tasks

- Septum geometry in G4: done
- Septum magnetic field: in progress
- Hall A geometry in G4: done
- Model of the radiation detector.
- Verification of background simulation: in progress
- Analysis of radiation sources: in progress
- Development of shielding.

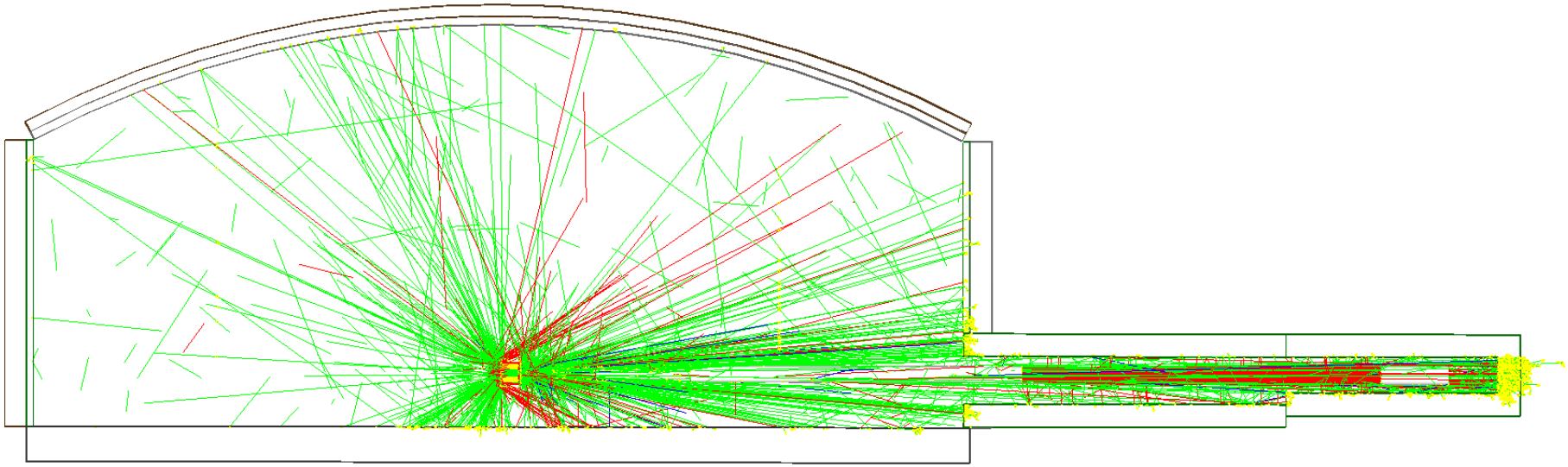
Hall A Geant4 geometry



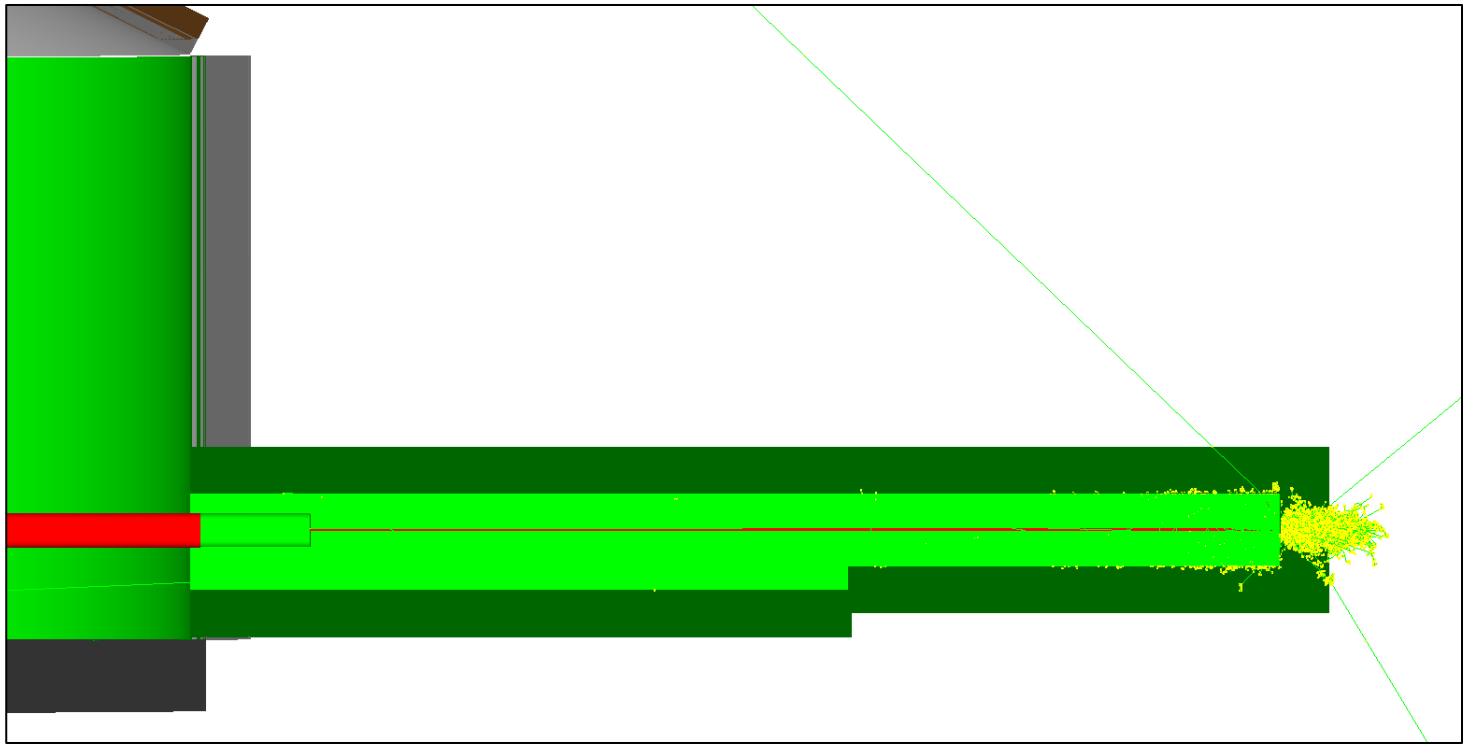
Hall A Geant4 geometry



Hall A Geant4 geometry

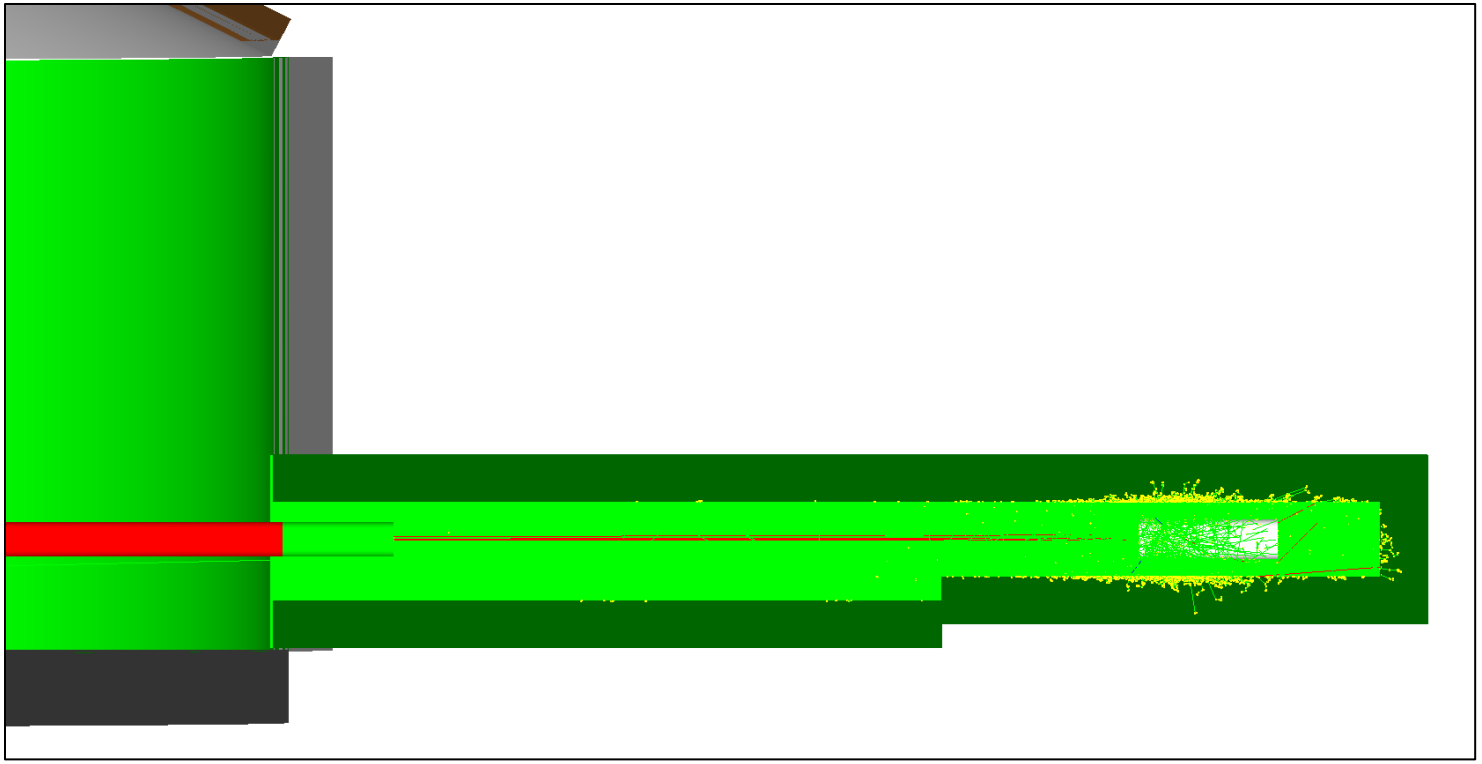


Beam dump with/without water tank



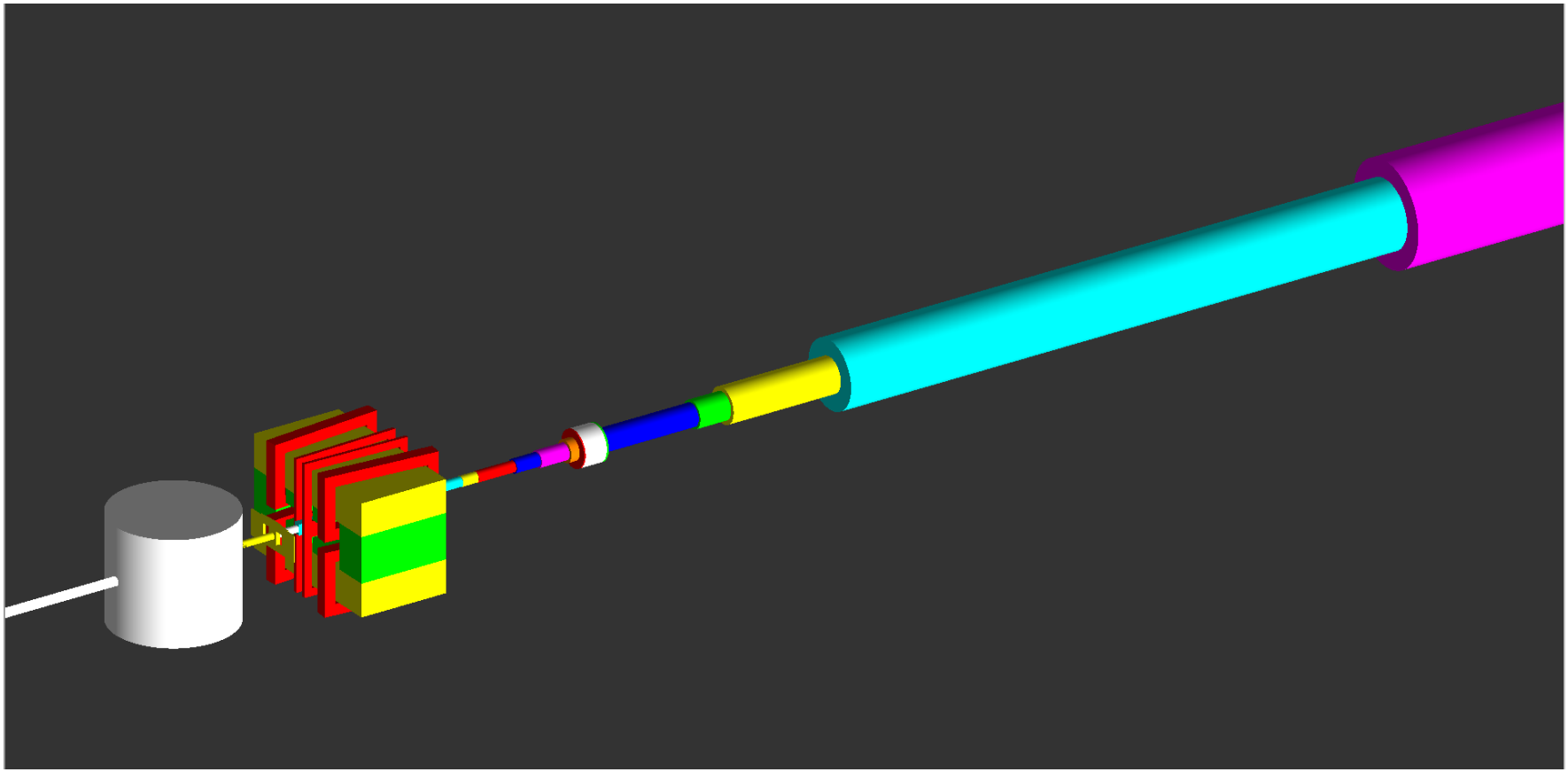
- Without water tank for 100 electrons

Beam dump with/without water tank

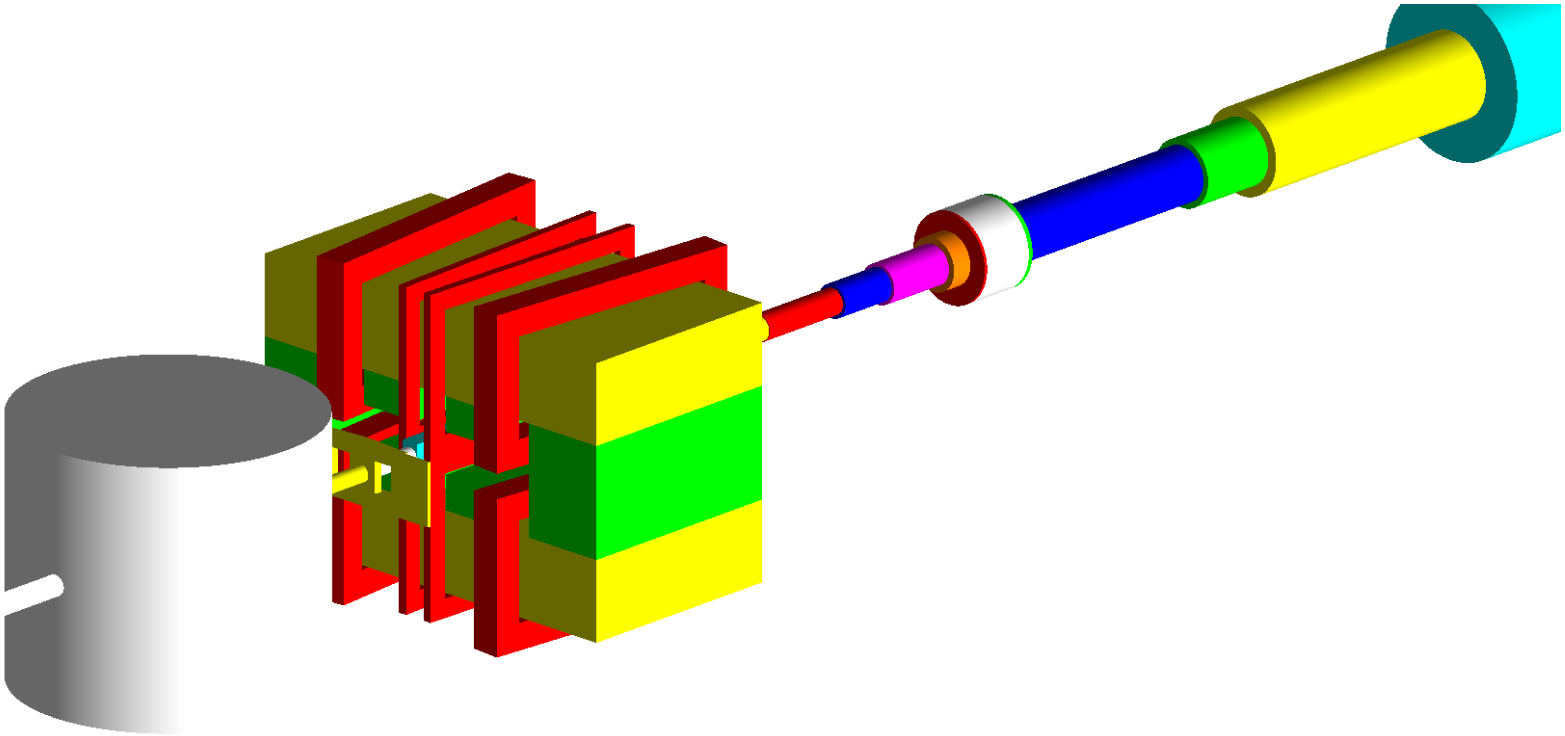


- With water tank for 100 electrons

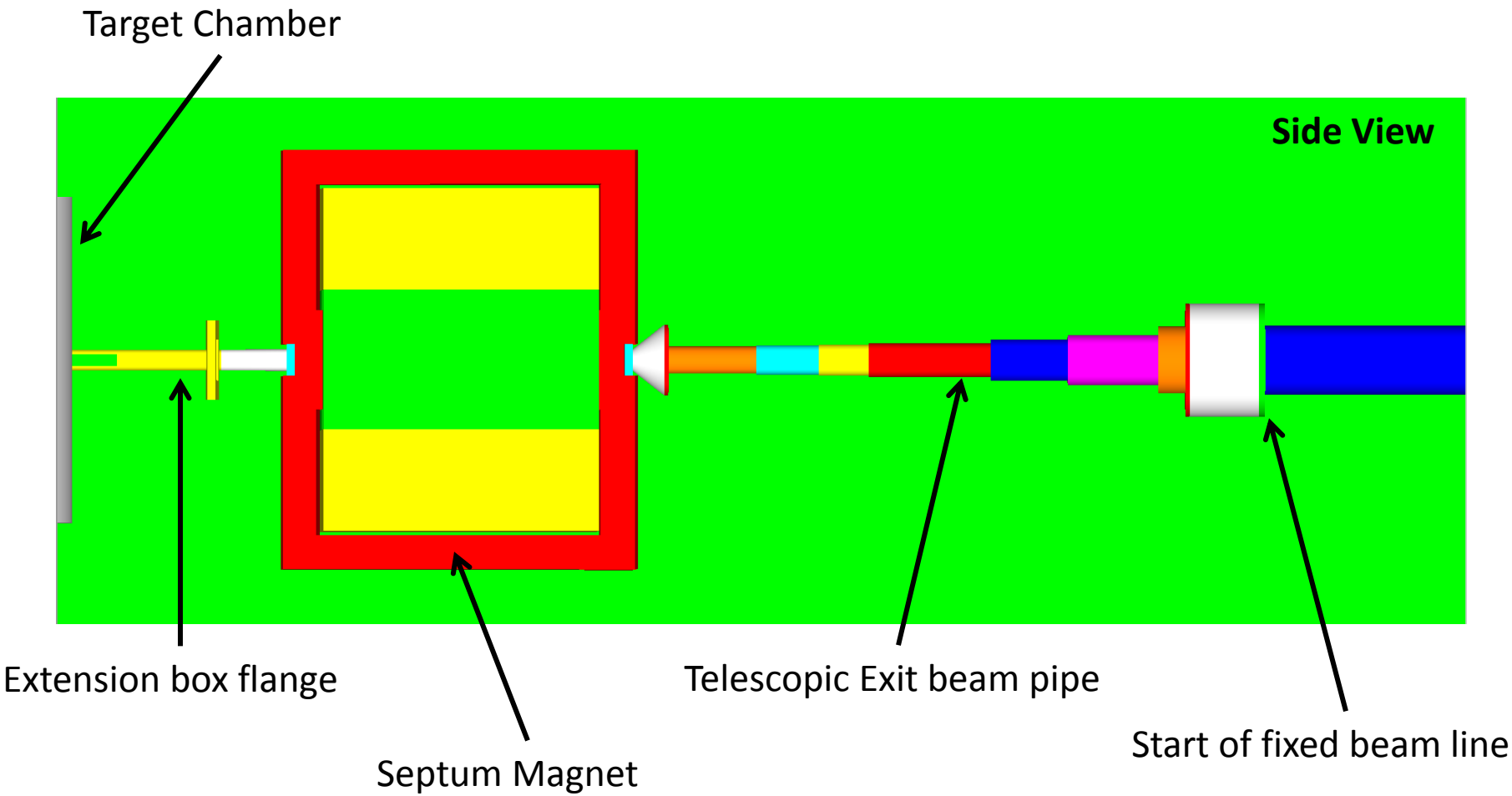
Close view of the beamline



Close view of the beamline

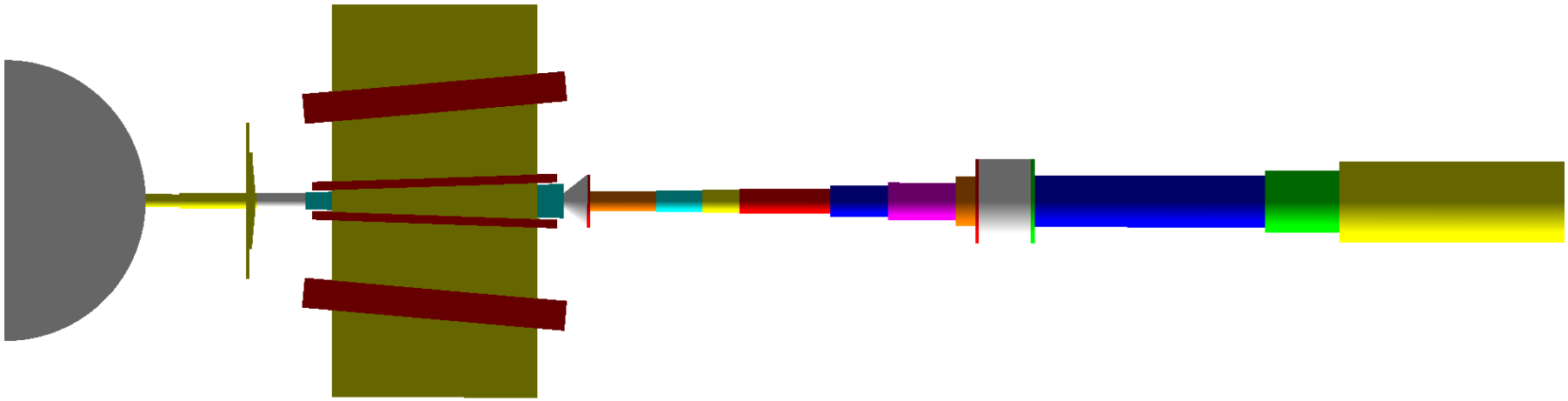


Close view of the beamline

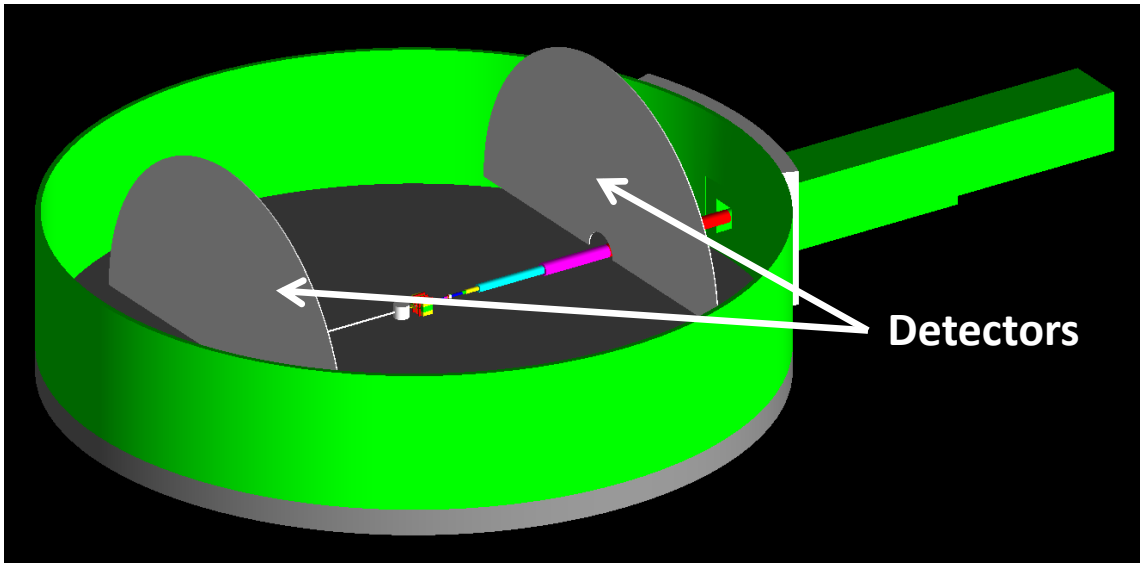


Close view of the beamline

Top View

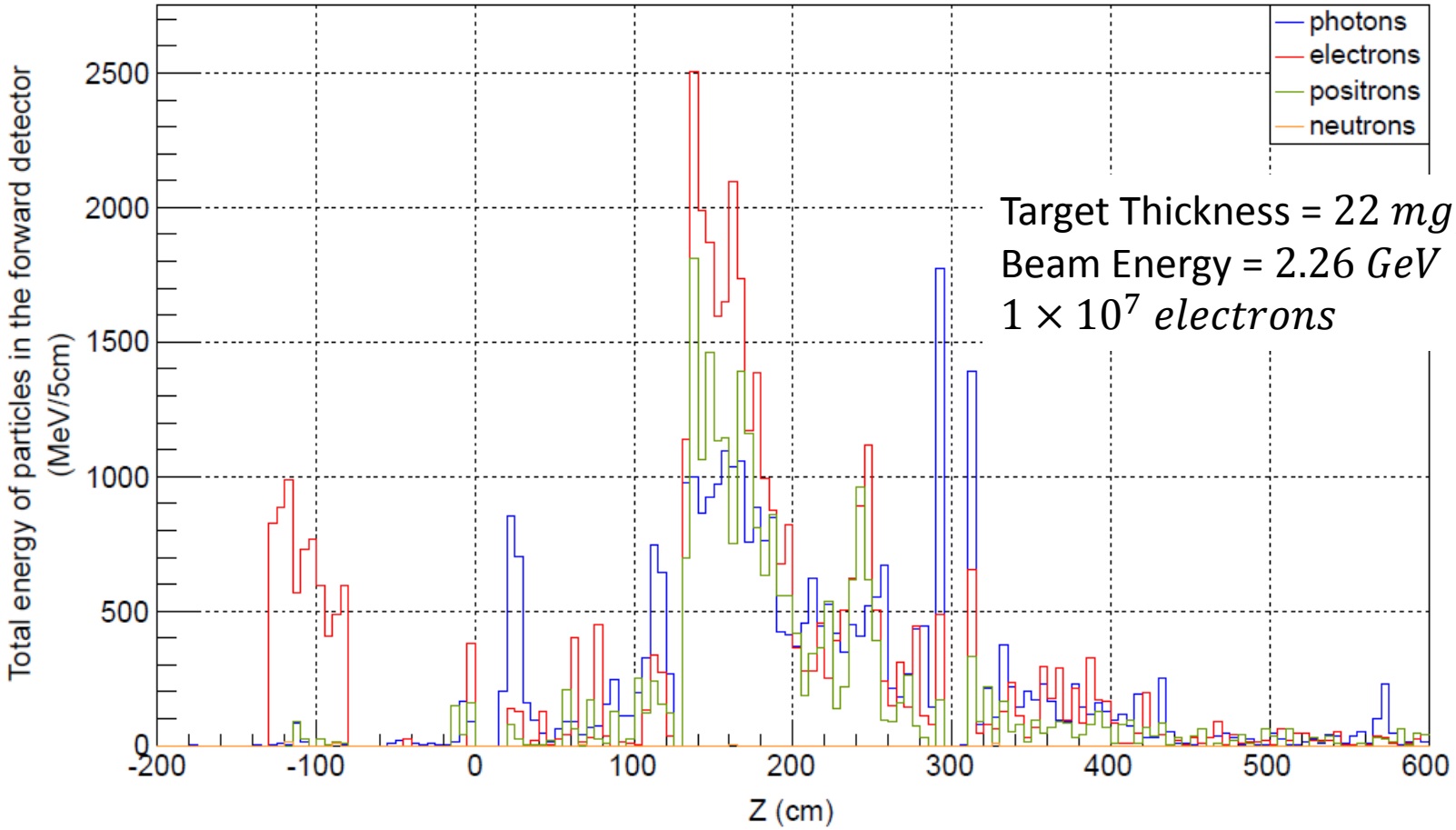


Neutron dose rate calculation



- Placed 2 semi circle shaped detectors 16m away from center.
- Area $\sim 350\ m^2$ each.

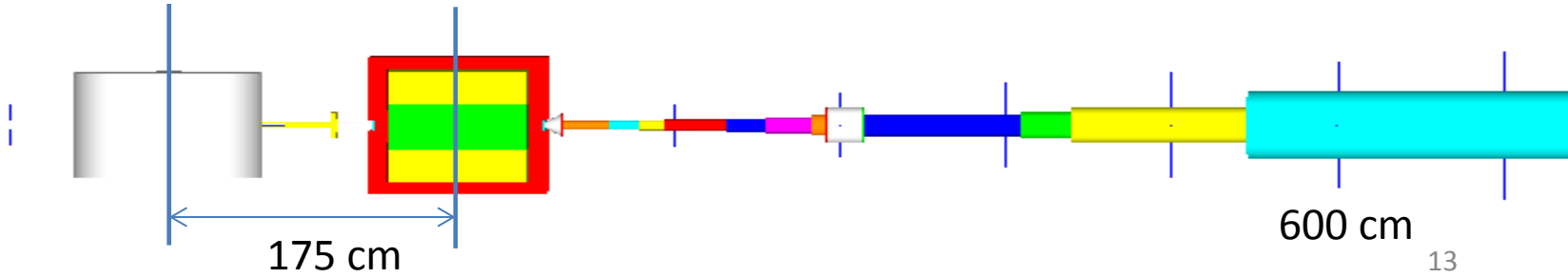
Distribution of energy sources along the Hall-A beamline

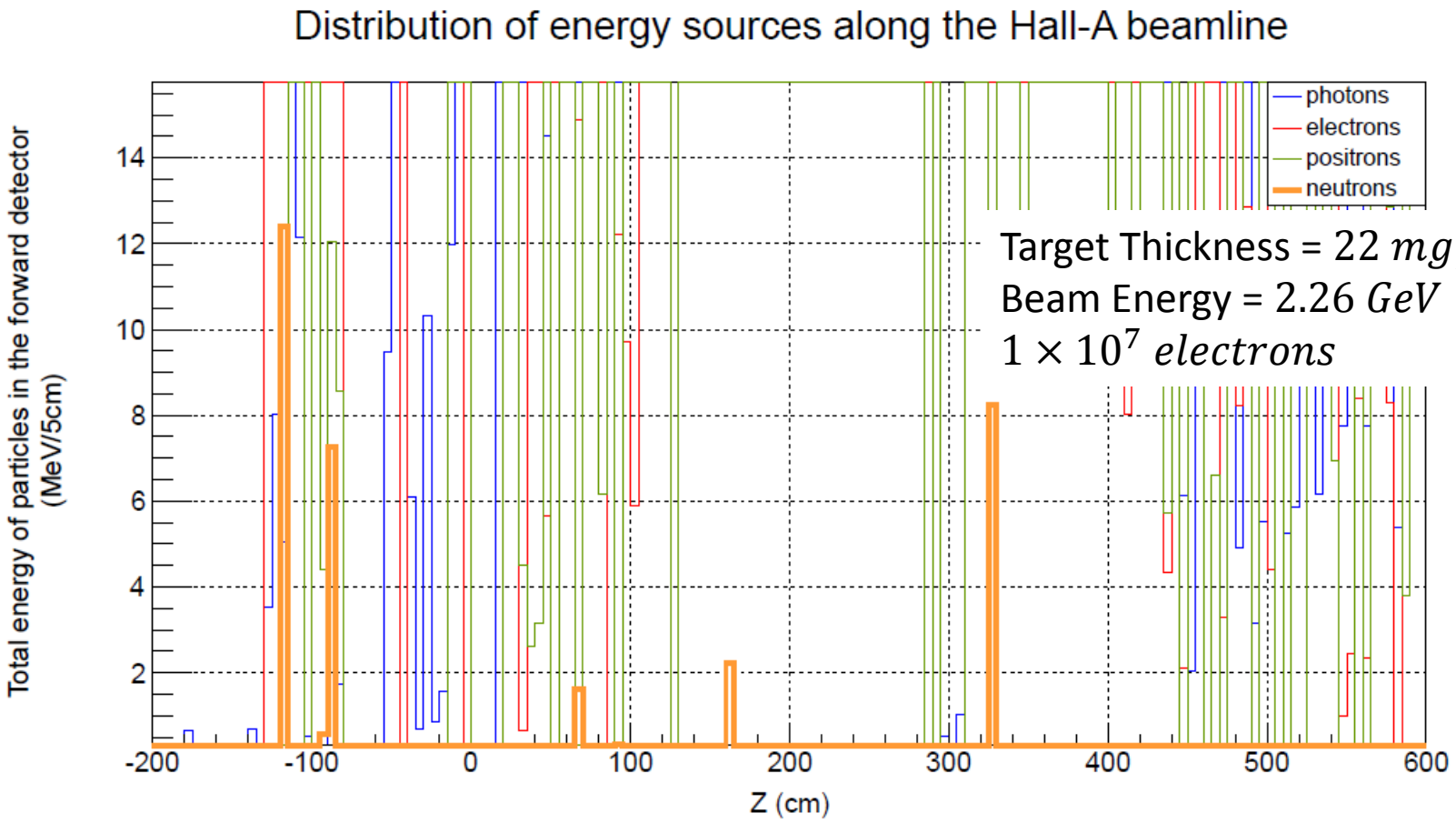


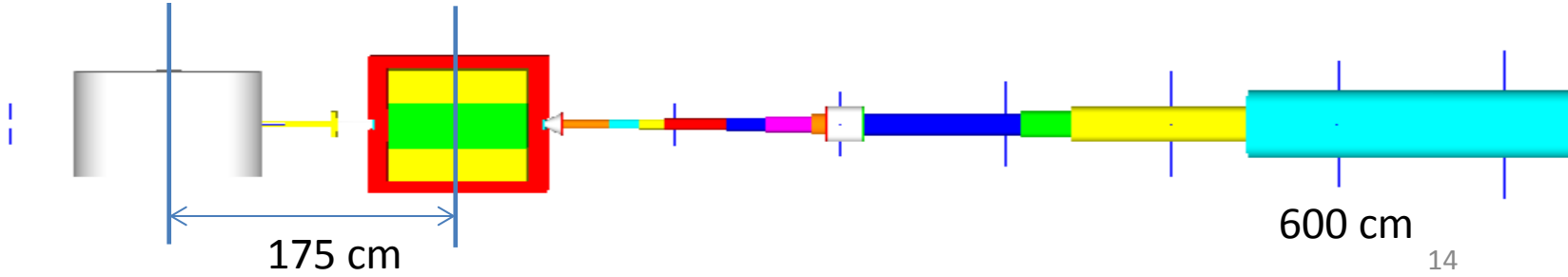
Target Thickness = 22 mg/cm^2 (W)

Beam Energy = 2.26 GeV

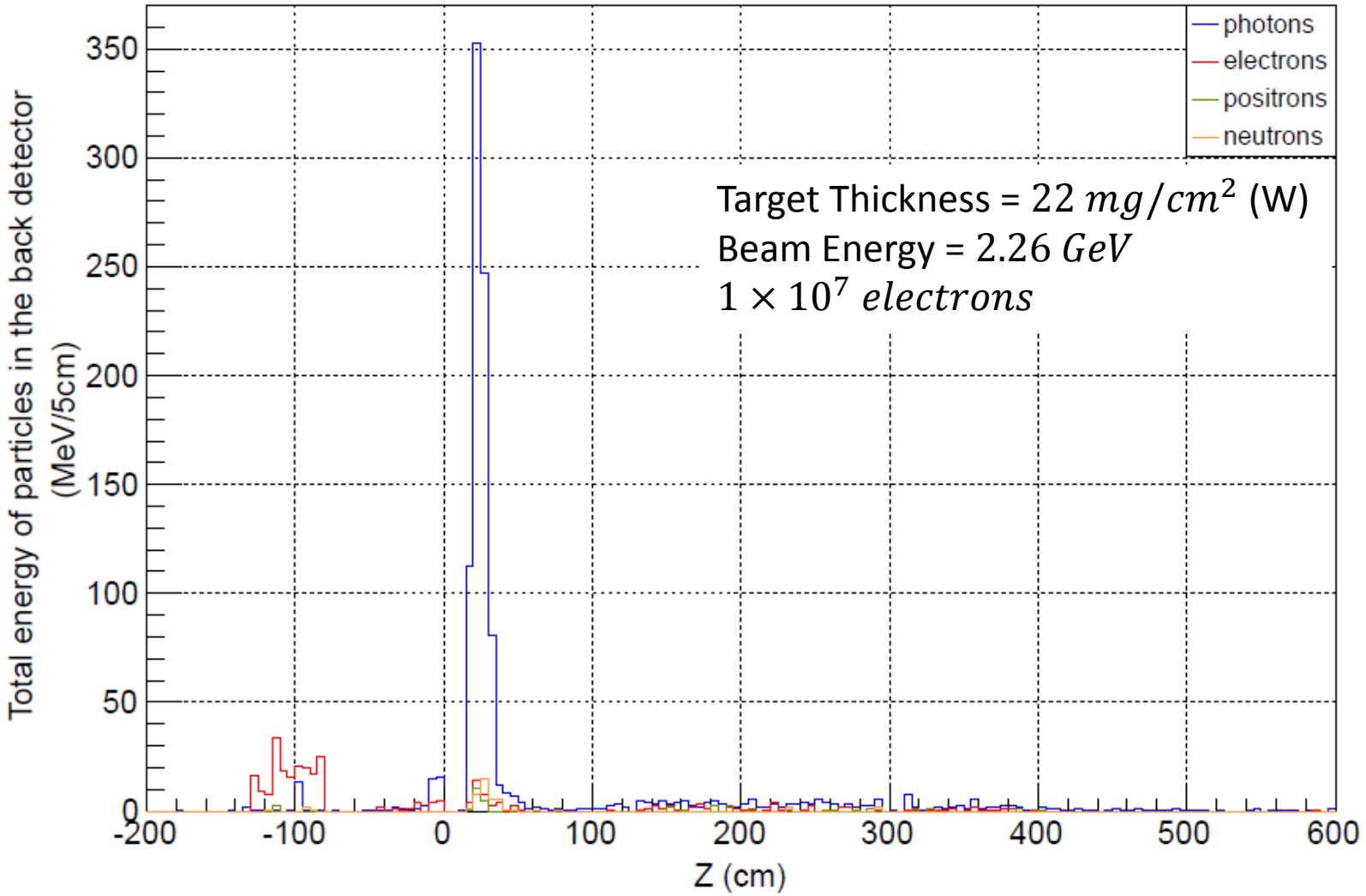
1×10^7 $electrons$

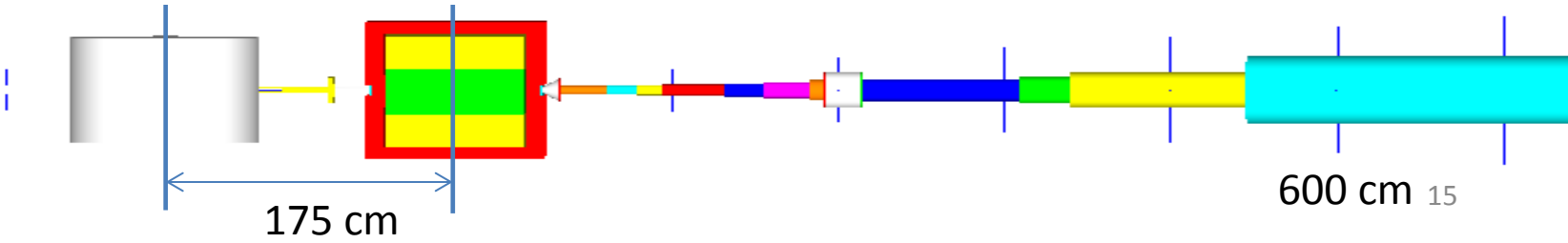



Distribution of energy sources along the Hall-A beamline
Total energy of particles in the forward detector (MeV/5cm)
Z (cm)
photons
electrons
positrons
neutrons
Target Thickness = 22 mg/cm^2 (W)
Beam Energy = 2.26 GeV
1×10^7 $electrons$

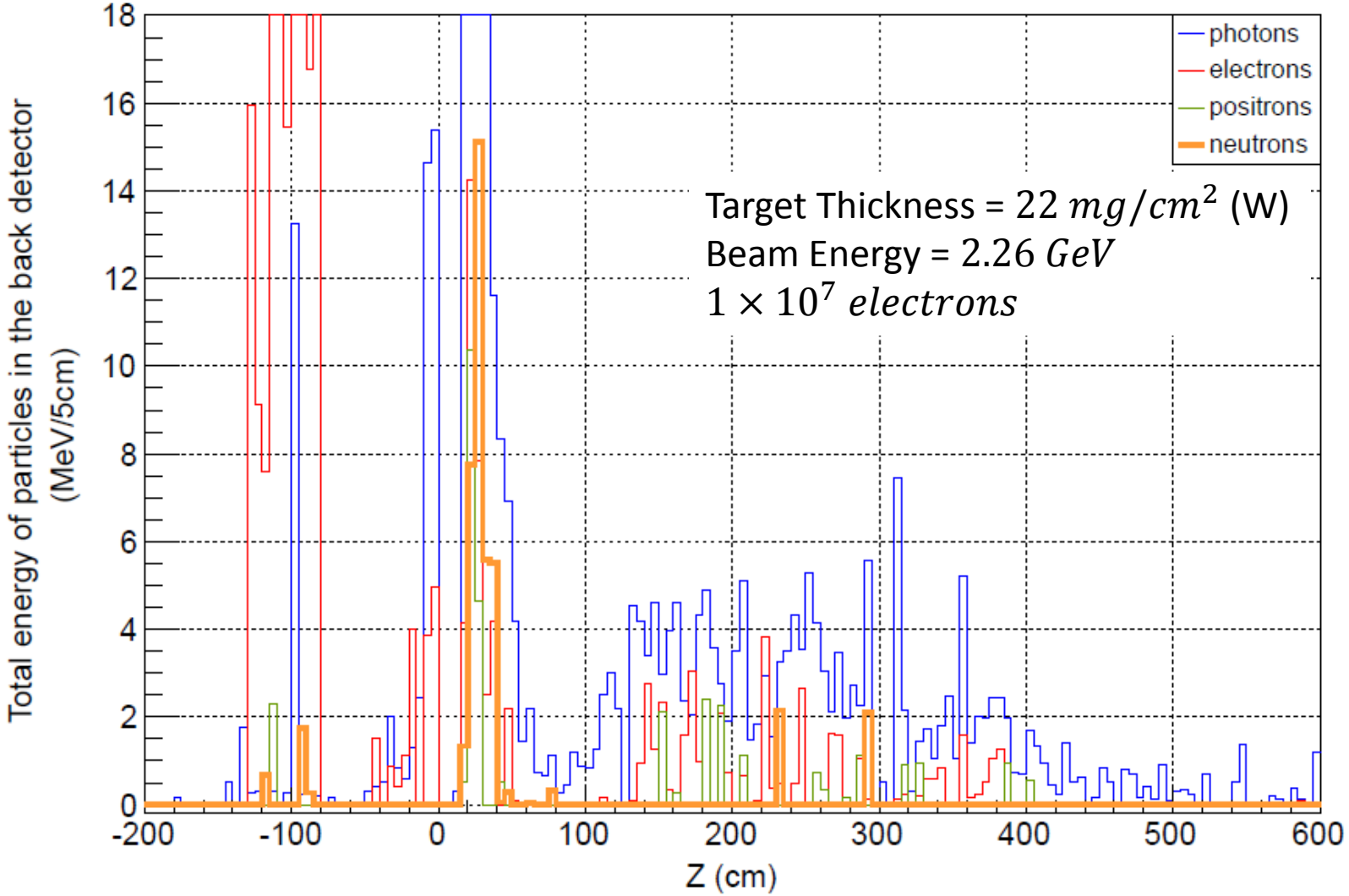

175 cm
600 cm

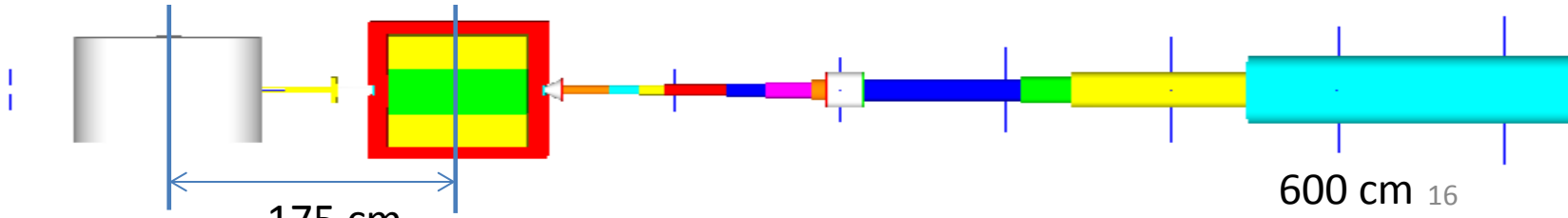
Distribution of energy sources along the Hall-A beamline





Distribution of energy sources along the Hall-A beamline





Neutron dose rate calculation

Target thickness = $22\ mg/cm^2$
Electron beam energy = $2.26\ GeV$
Number of Beam electrons = $1 \times 10^7\ electrons$

Total Energy of neutrons at the back detector = 46 MeV

Sum of dose equivalence of neutron energy = 1×10^{-3}
(sum of values obtained running Pavel's code)

Area of the back detector = $3.5 \times 10^6\ cm^2$

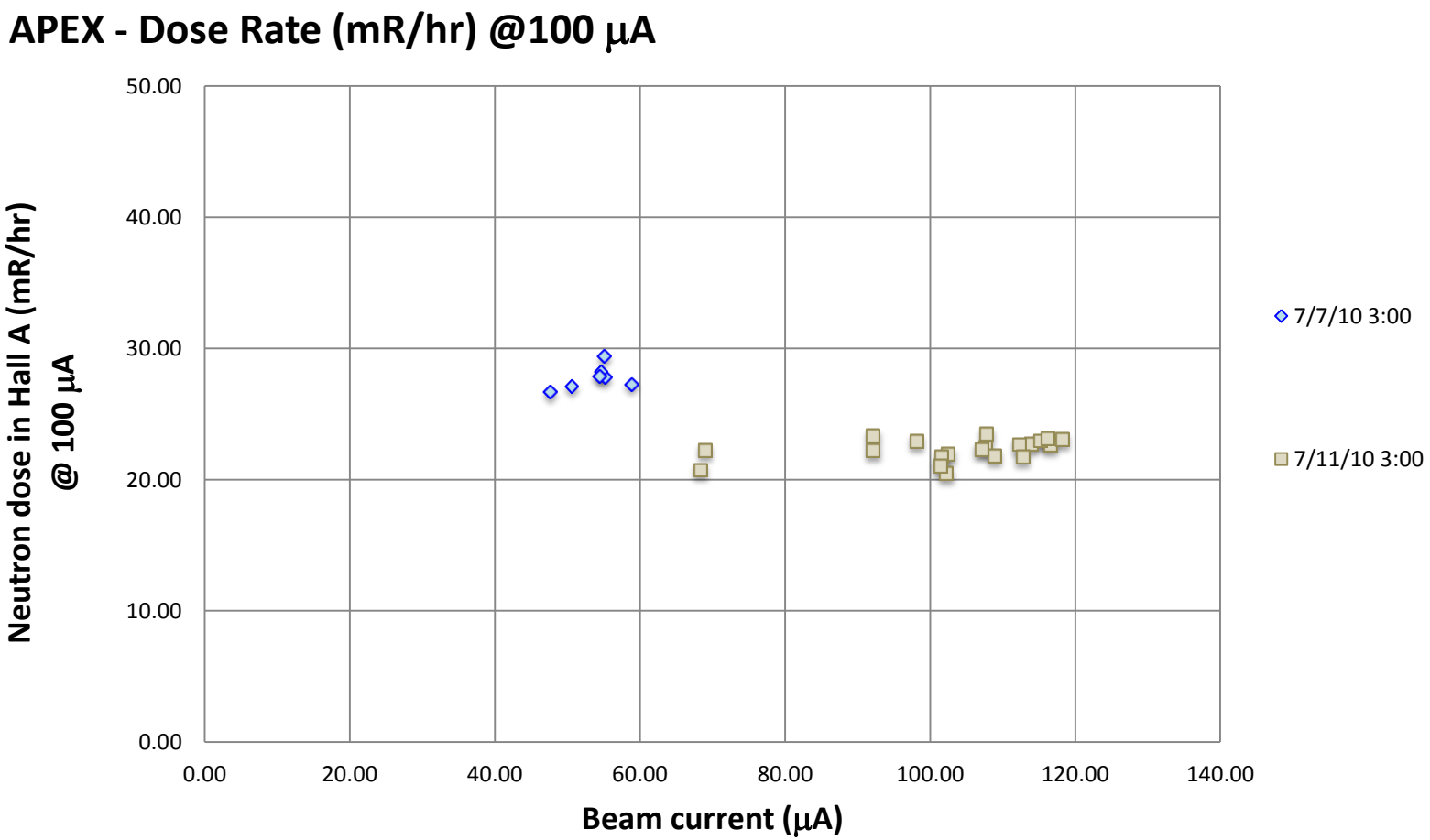
Total Dose = $\frac{dose\ equivalence}{Area\ of\ detector} = \frac{1\times10^{-3}}{3.5\times10^6\ cm^2} = 2.8 \times 10^{-10}$ mrem

Total dose for $100\mu A$ beam = $\frac{2.8\times10^{-10}\ mrem}{1\times10^7\ electrons} \times (6 \times 10^{14}\ \frac{electrons}{s})$
$= 17 \times 10^{-3}\ mrem/s$

For 1 hour of beam = $17 \times 10^{-3}\ \frac{mrem}{s} \times 3600\ s$
$= \underline{61\ mrem/hr}$

APEX (test) – July 2010: E_{e^-} = 2.26 GeV

J.Boyce, 2011



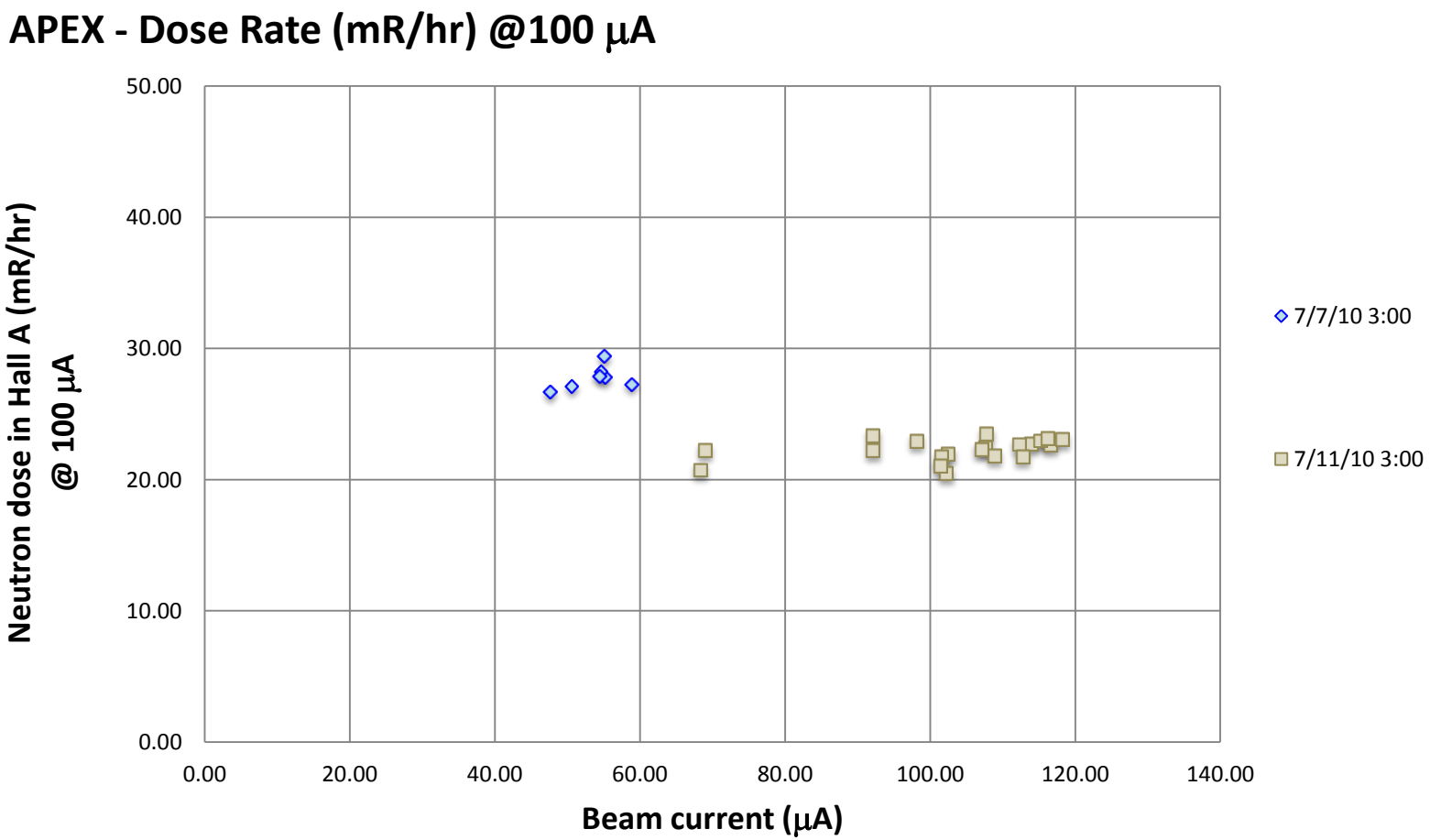
Target thickness = 22 mg/cm² (Ta)

Average Dose Rate = 24 mR/hr at 100 μA

APEX (test) – July 2010: E_{e^-} = 2.26 GeV

J.Boyce, 2011

● $61\ mrem/hr$



Target thickness = 22 mg/cm² (Ta)

Average Dose Rate = 24 mR/hr at 100 μA

Timeline

- Work started on September 30, 2014
- Described Project could be completed by 2/15
- Experimental test of shielding could be done during spring beam delivery.

Thank you Bogdan, Sergey, Seamus, Vladimir and Gordon for their support.