STAR backgrounds for pp 510 GeV, run XII (3-rd round)

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Outline

- Neutron background.
- Upgrade of y2012 geometry.
- Comparison results of background calculation for two geometries (B and G). In geometries C -F it was a bug due to a feature of mortran geometry description. The CAVE tracking media Air had parameters of concrete. Thus results:
  - http://drupal.star.bnl.gov/STAR/blog/fisyak/2012/oct/24/estimation-neutron-flux-star-wah-second-round
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  Reported early has this problem and this is a reason for this note where the geometry with proper CAVE Air has been used.
- Conclusions

Neutron background

It would be useful to know what kind of background conditions we do have in STAR Wide Angle Hall. It is interesting from point of view of

- expected Silicon damage by neutrons (especially Pixel detector),
- Expected irradiation of different STAR detector components, and,
- for example, effects of background on TPC space charge distribution, especially, via processes like n ➔ γ ➔ e.

I have made a preliminary estimation of neutron flux in WAH based on existing geometry for WAH (Jason, version B, low statistics ~5 k events, see http://drupal.star.bnl.gov/STAR/blog/fisyak/2012/oct/15/estimation-neutron-flux-star-wah-first-round).

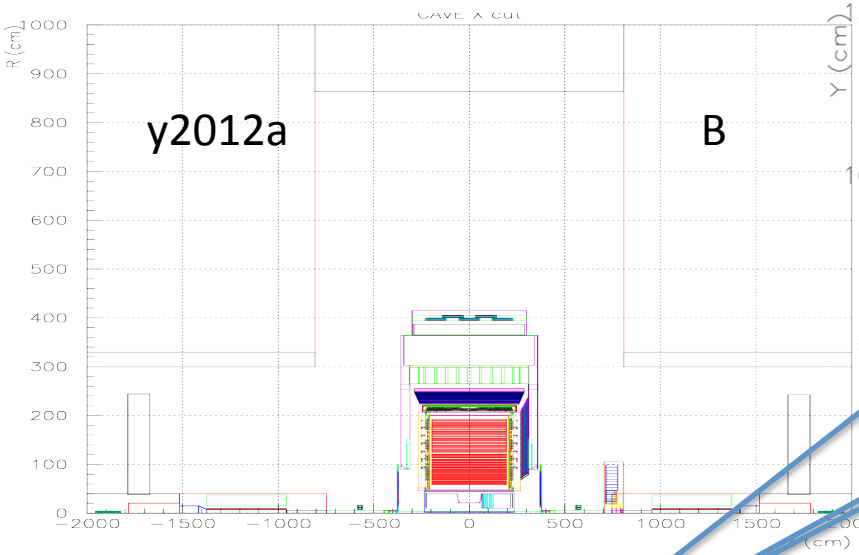
In this note I am presenting results (version D, statistics 50 k events) based on updated WAH geometry using the same as before GEANT/ GCALOR versions with low kinematical cuts:

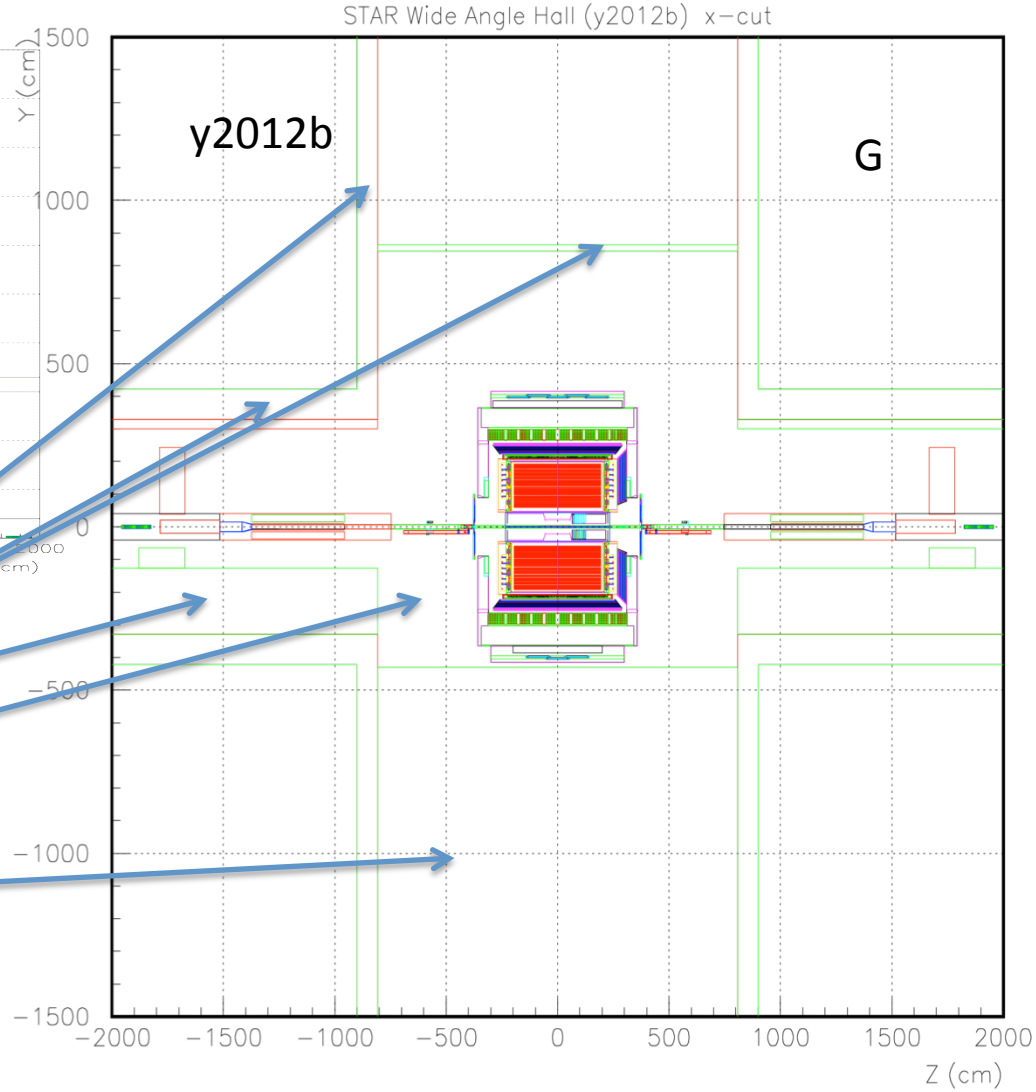
- Outline the differences in geometries for version B and D,
- Compare results obtained in D with B,
- Give estimation for fluxes and ionization due to background.

Definitions

- GEANT cuts:
  - e, γ = 10 keV,
  - neutron = 1e-13 GeV,
  - charged hadrons = 1 MeV.
- Flux is the sum of particle lengths in unit volume ($1/cm^2$)
- Deposited energy is sum of deposited energies in unit volume (keV/cm^3).
- Pythia has been used as event generator. It is assumed (Jamie) that BBC measures about 60% of total inelastic cross section.
- The fluxes have been calculated for pp 510 GeV (Run XII) and BBC rate 2 MHz.

Geometries

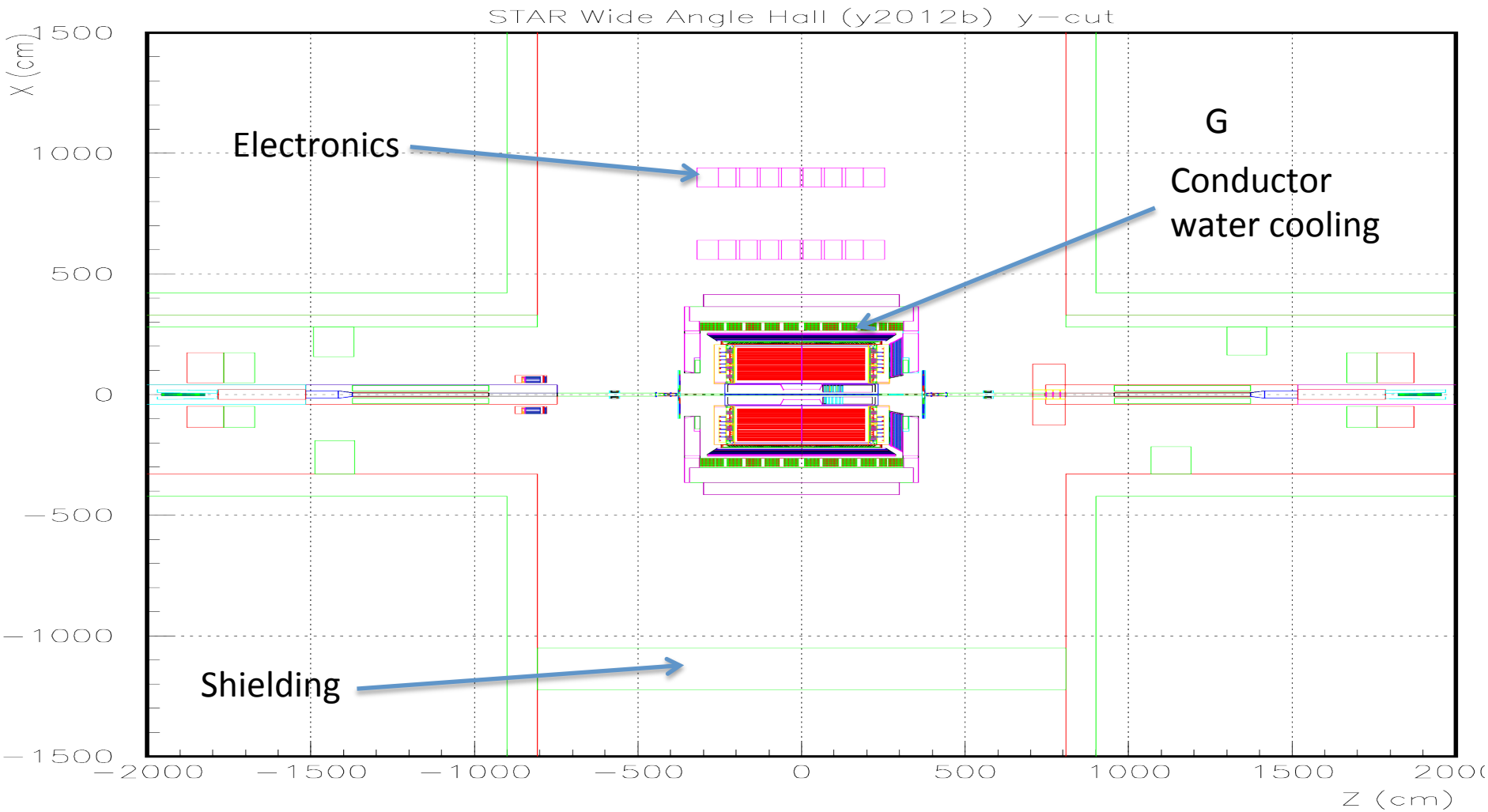




Geometry updates:

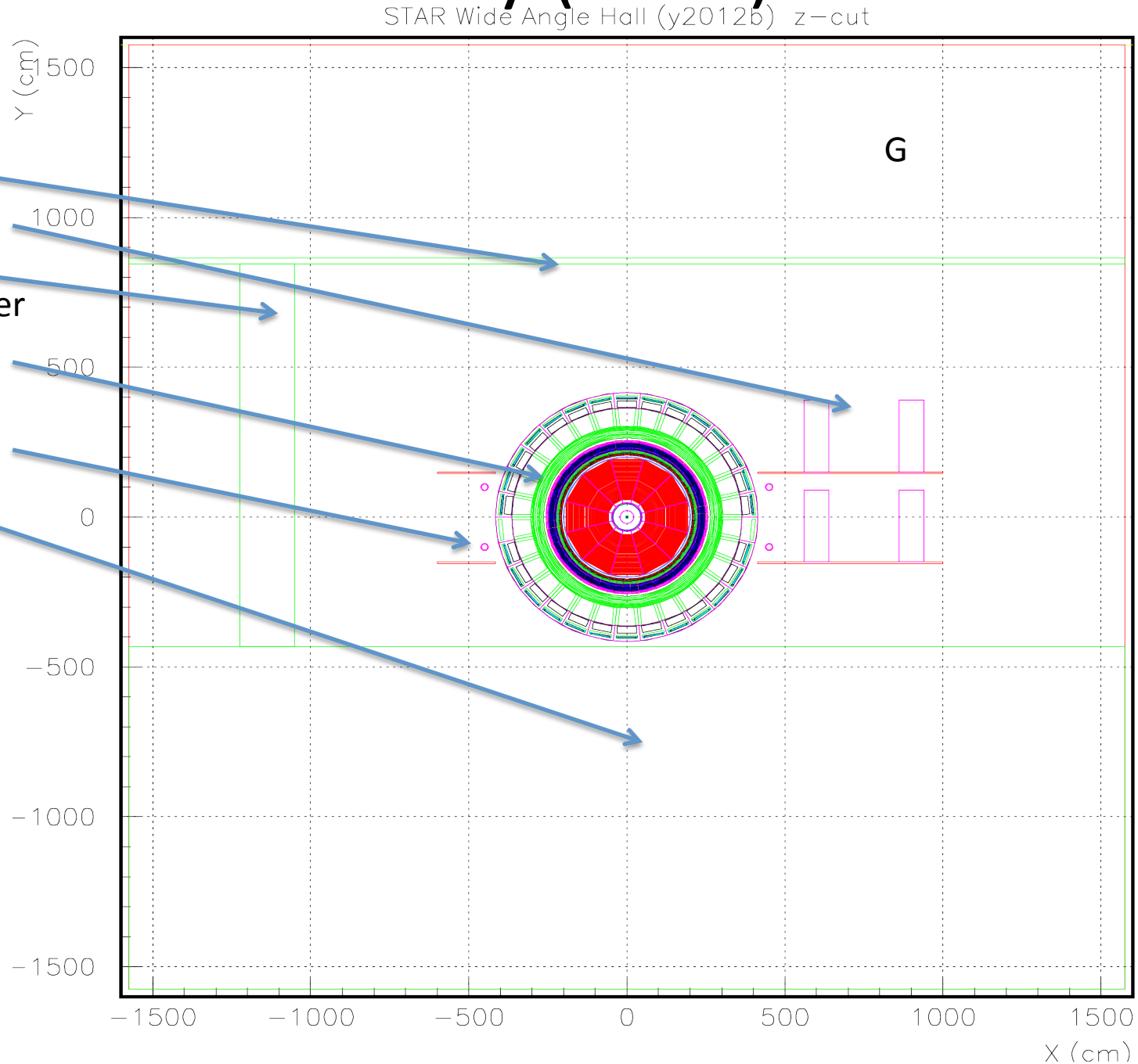
- Concrete walls
- Ceiling
- Air
- Floor

Geometry (cont.)

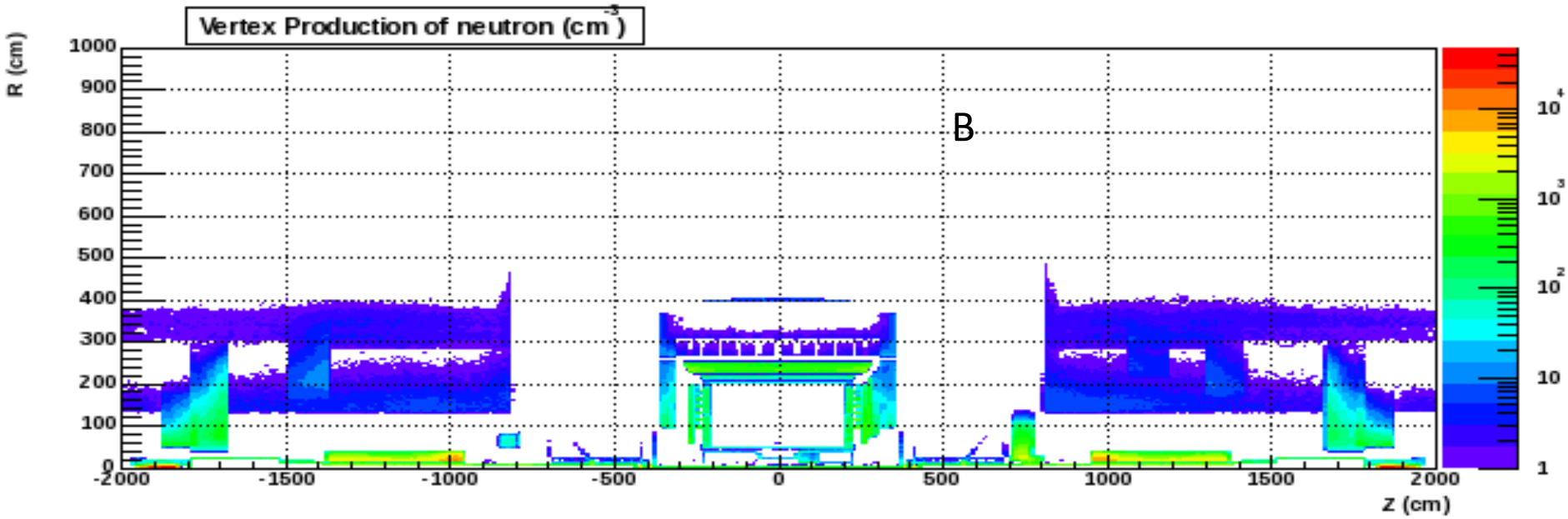


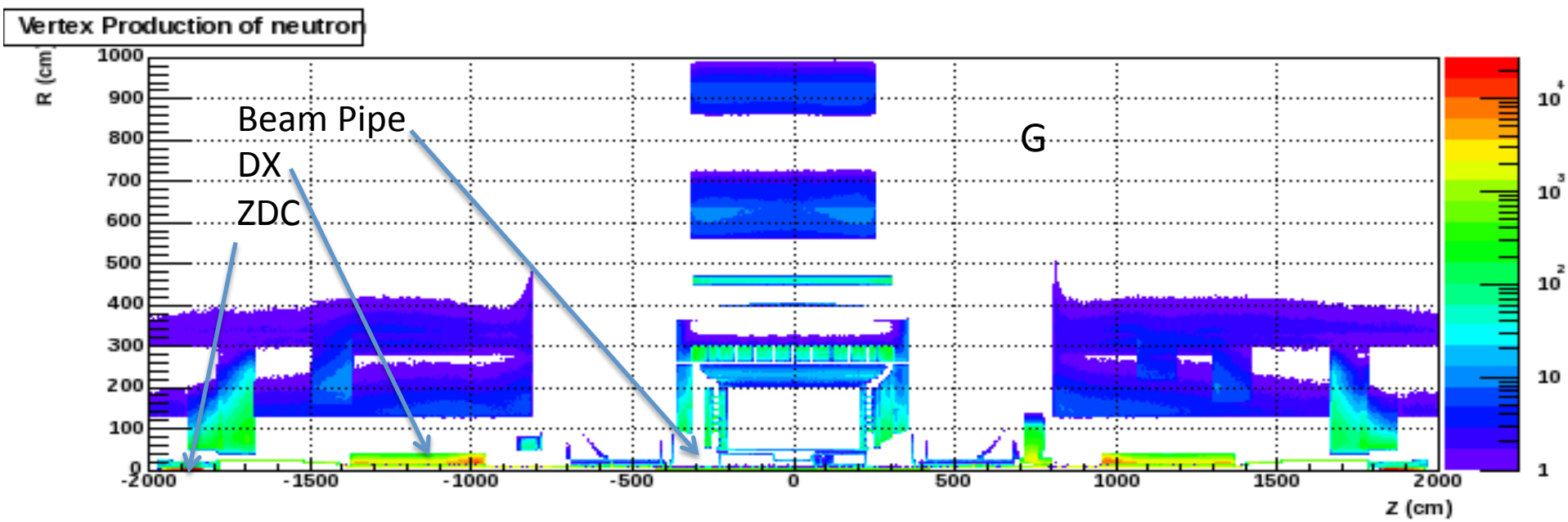
Geometry (cont.)

- Ceiling
- Electronics
- Wall
- Cooling water in magnet conductor
- Water pipes
- Floor

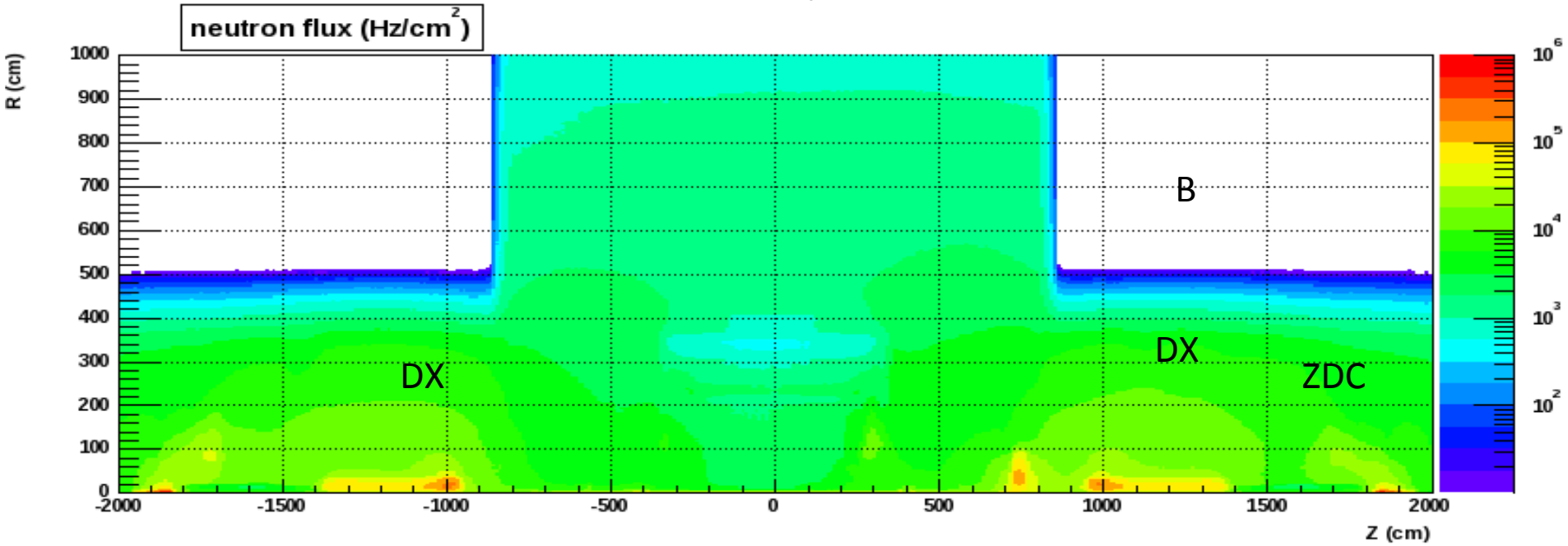


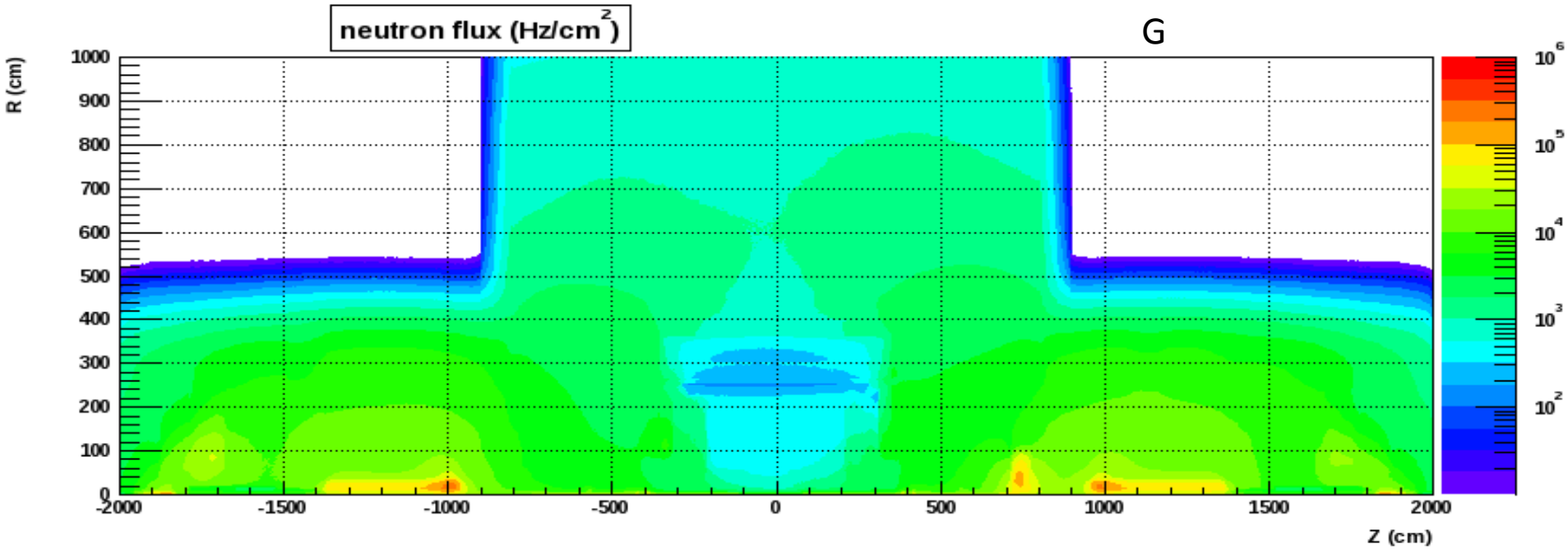
Neutron production vertex density (1/cm^3)

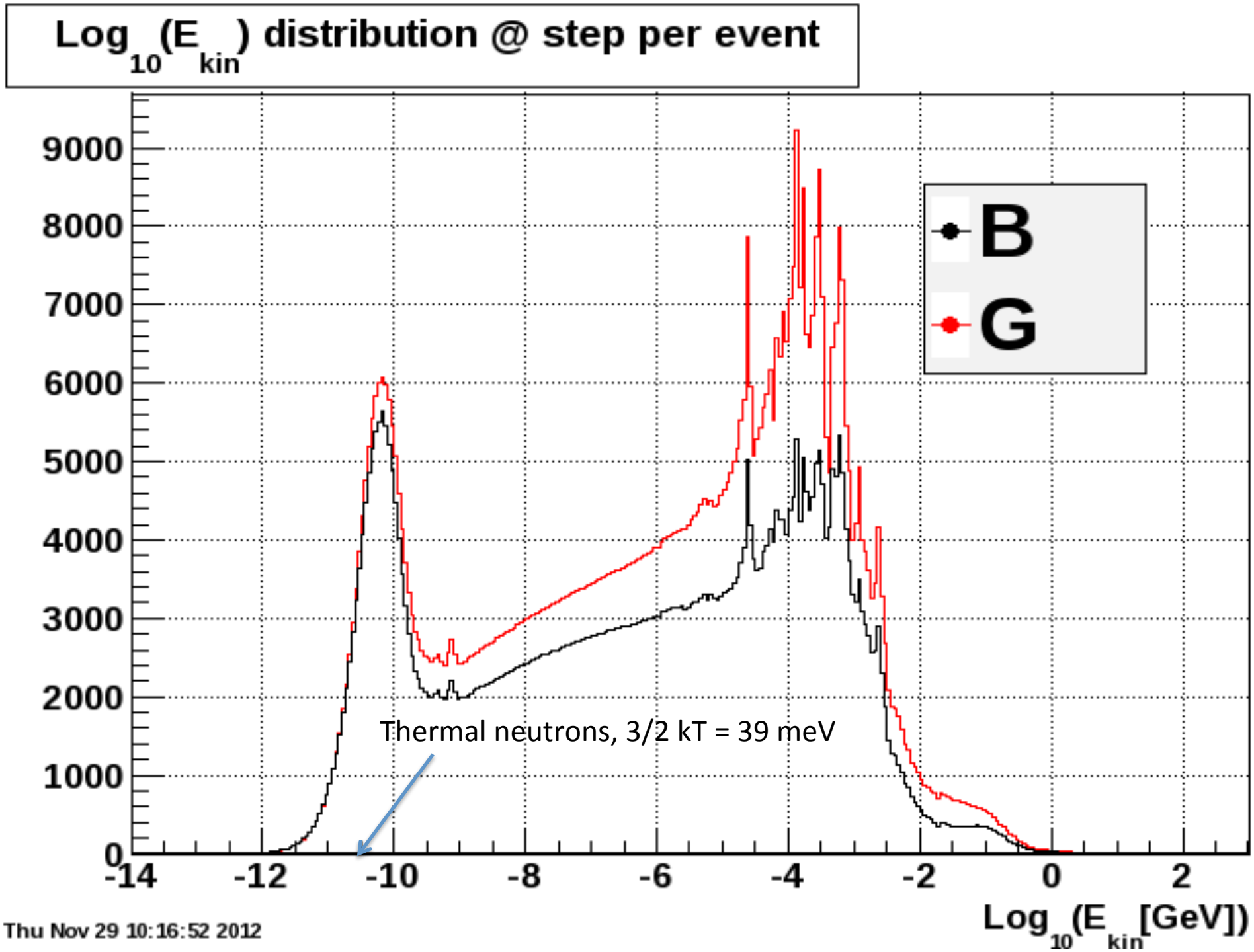




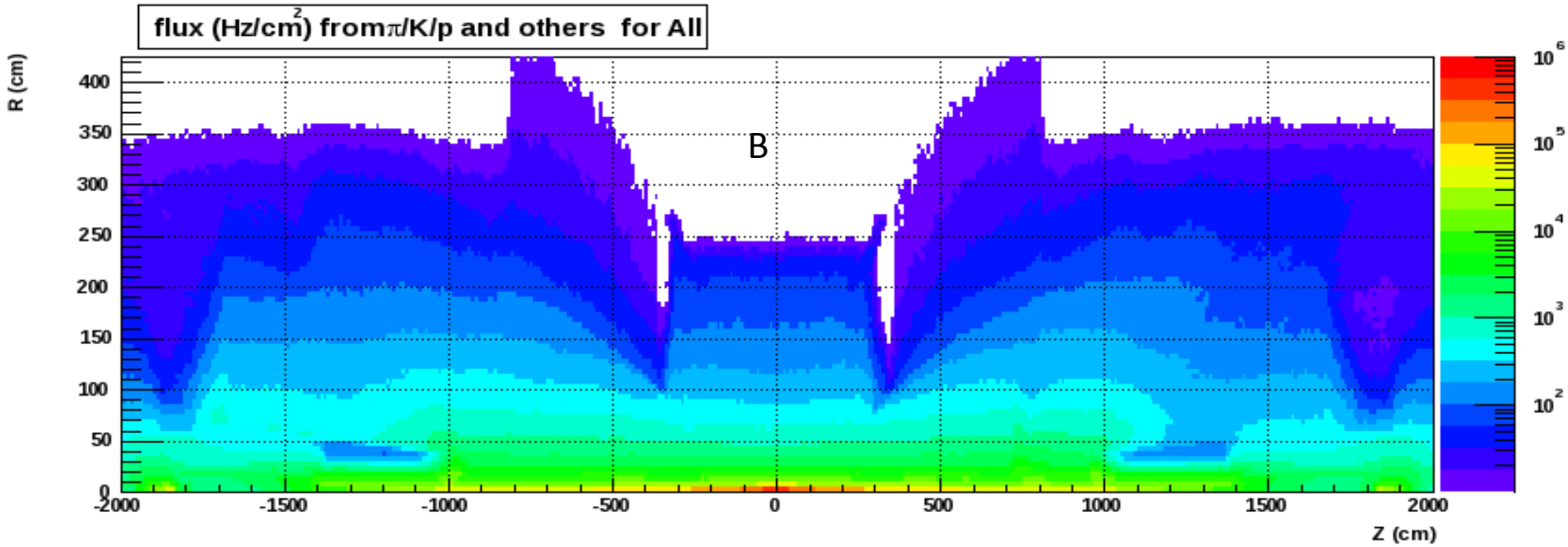
Neutron flux, B versus G

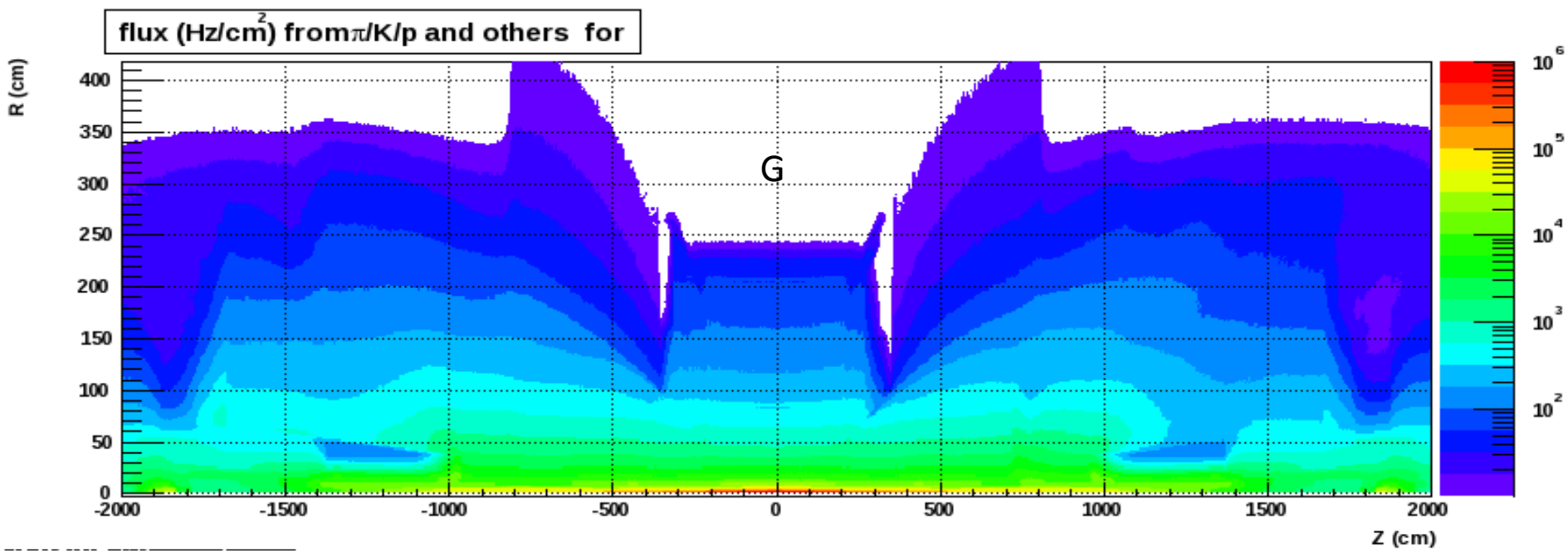




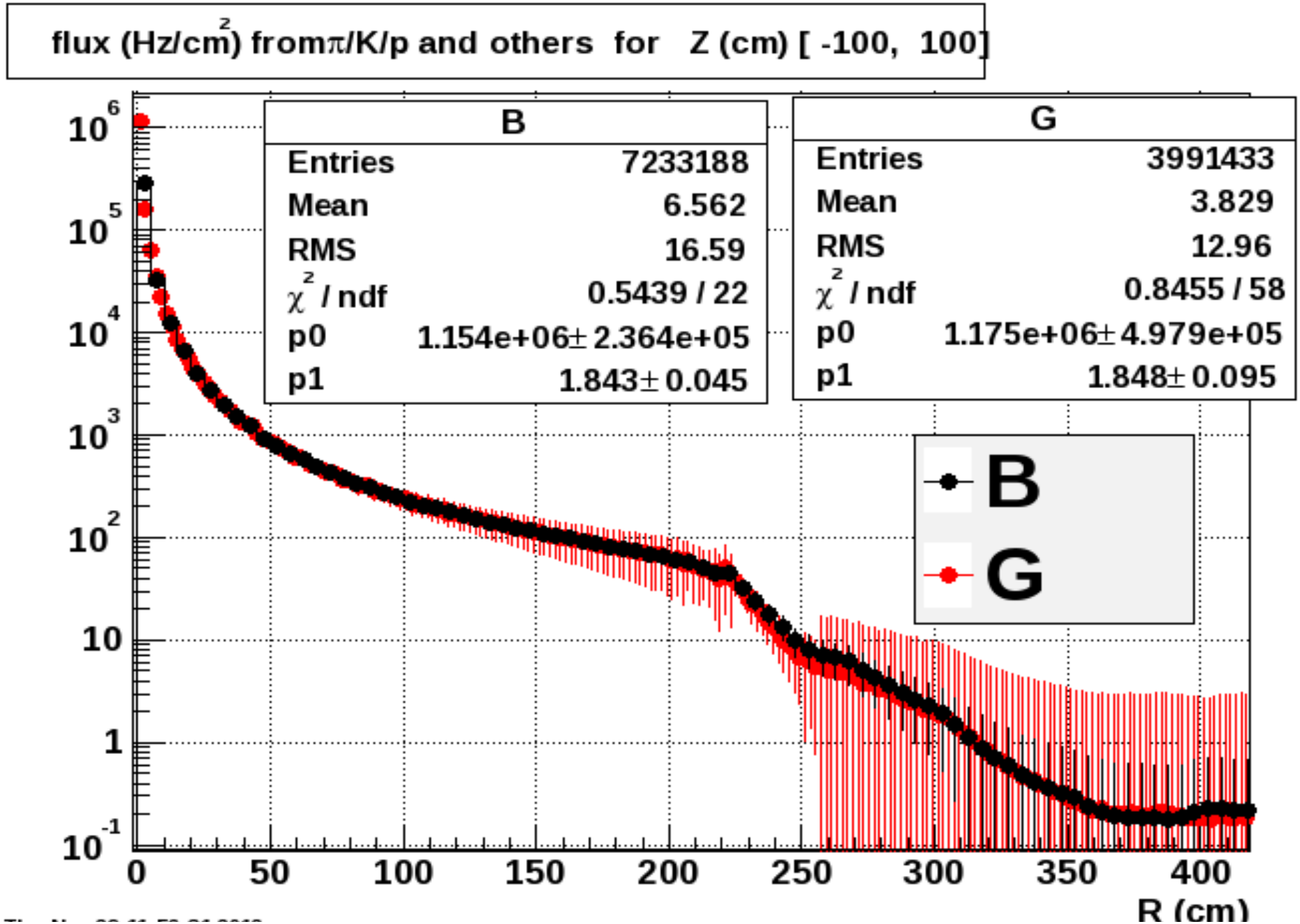

Log10(Ekin) distribution @ step per event
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-14
-12
-10
-8
-6
-4
-2
0
2
B
G
Thermal neutrons, 3/2 kT = 39 meV
Thu Nov 29 10:16:52 2012
Log10(Ekin[GeV])

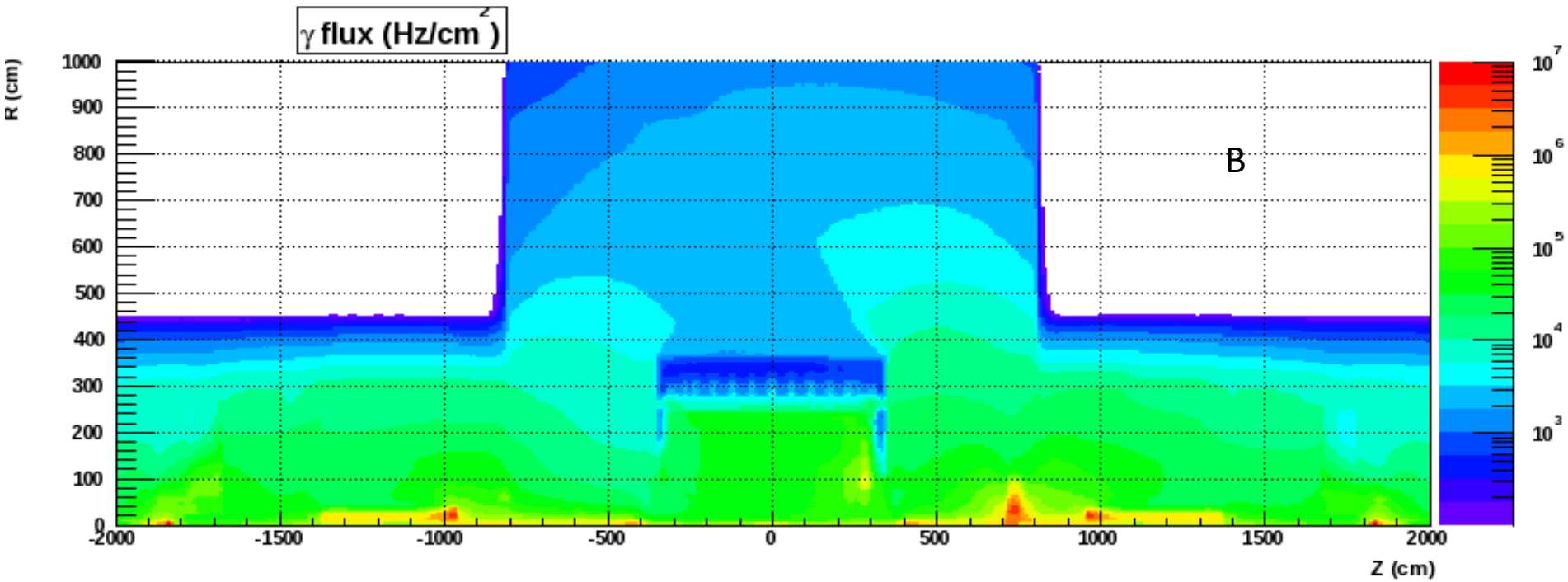
Charged hadron fluxes

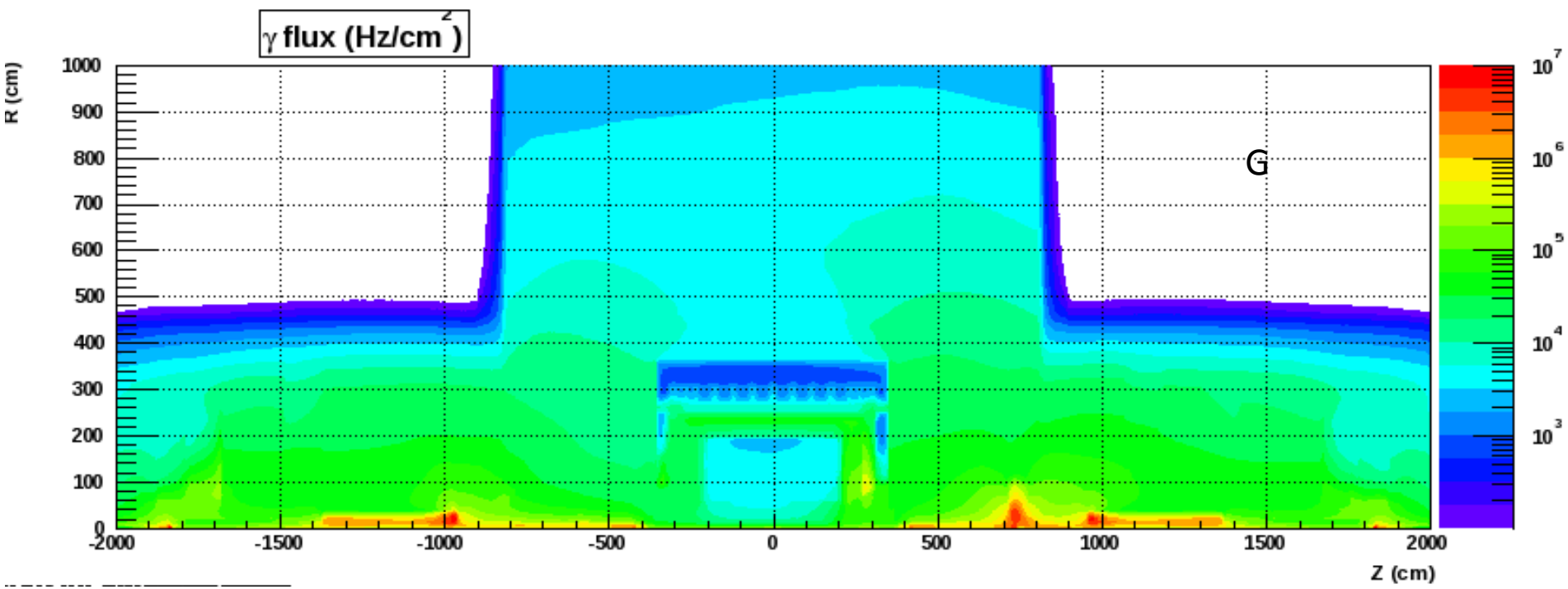




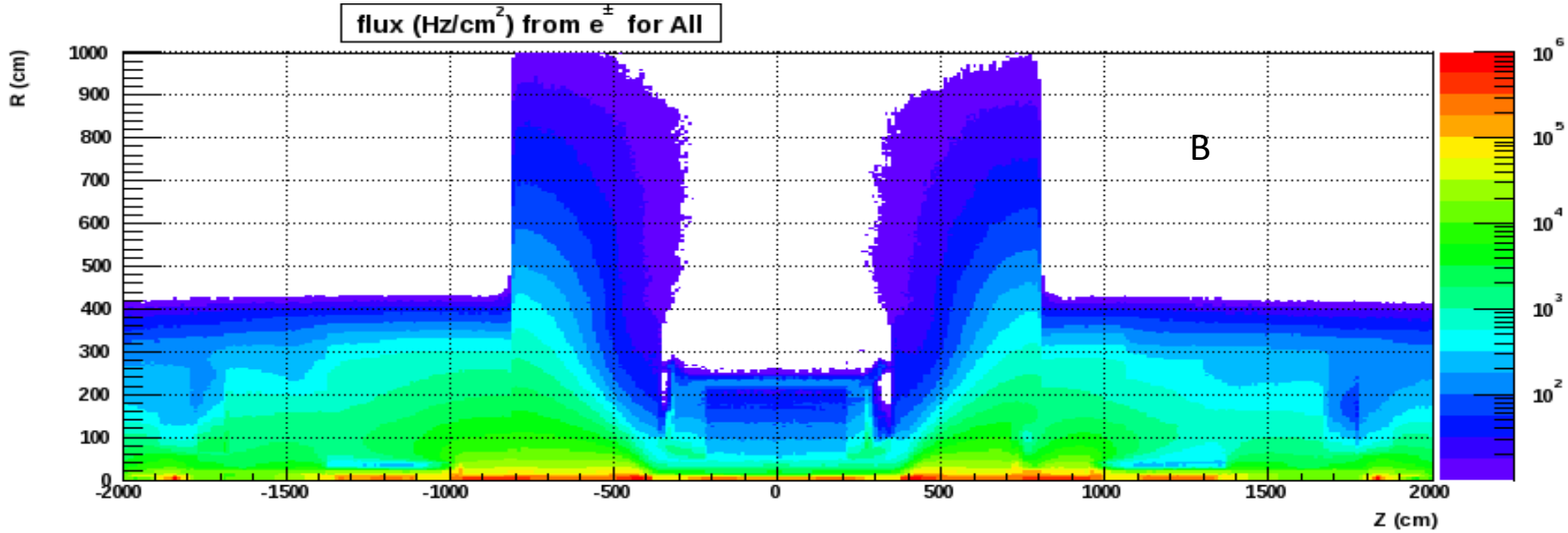
R dependence of charged hadron flux integrated in |z| < 100 cm

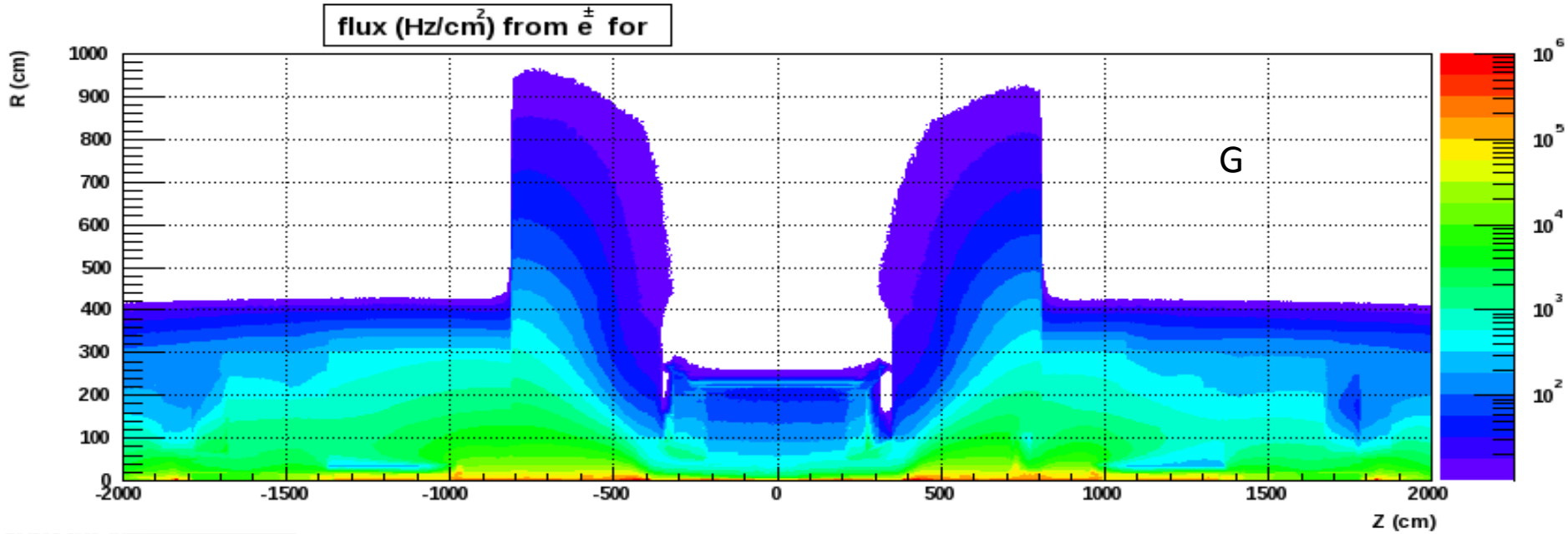



γ flux (Hz/cm²)
R (cm)
Z (cm)
B

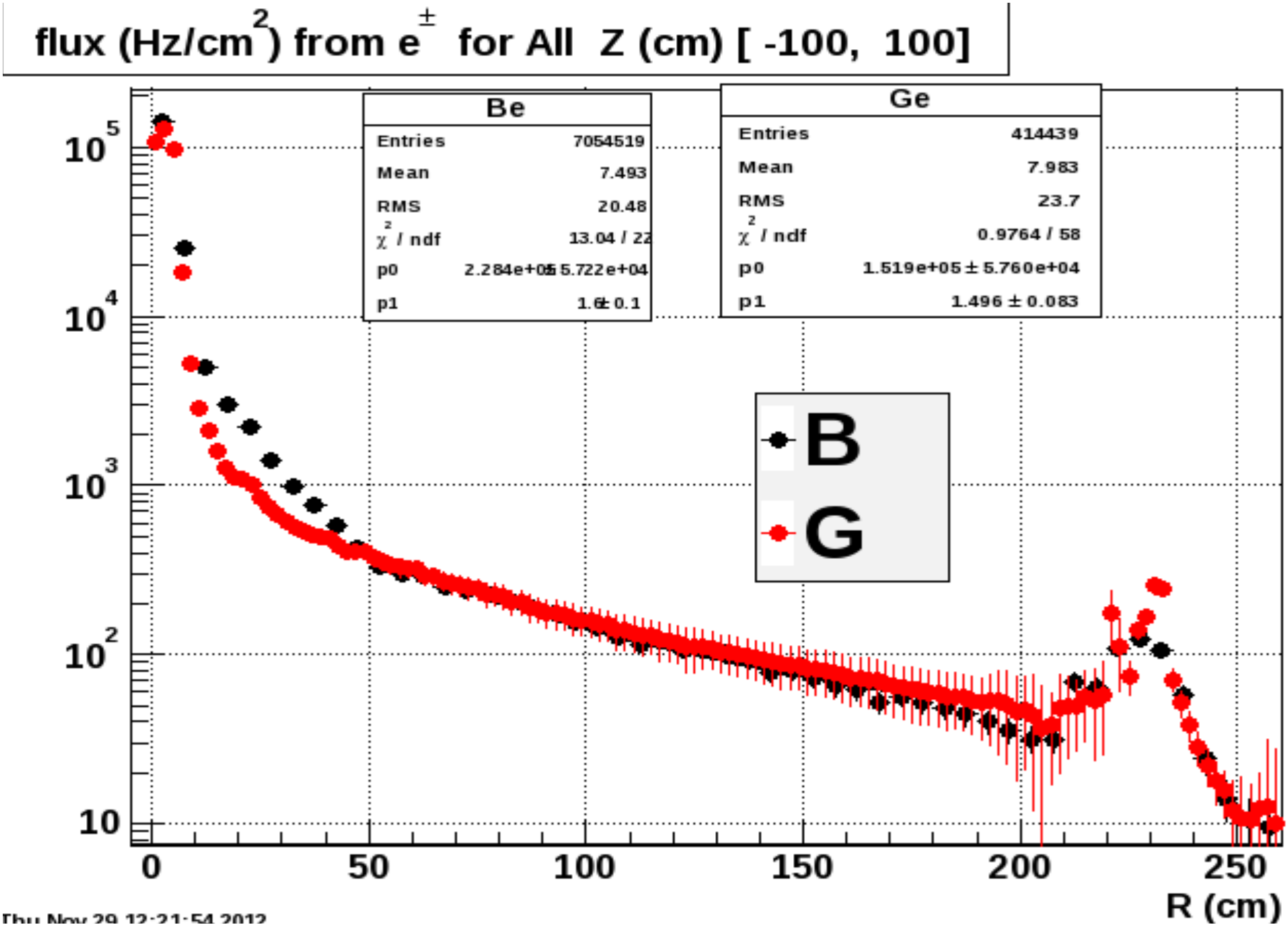

γ flux (Hz/cm²)
R (cm)
Z (cm)
G

Flux from $e^{\pm}$

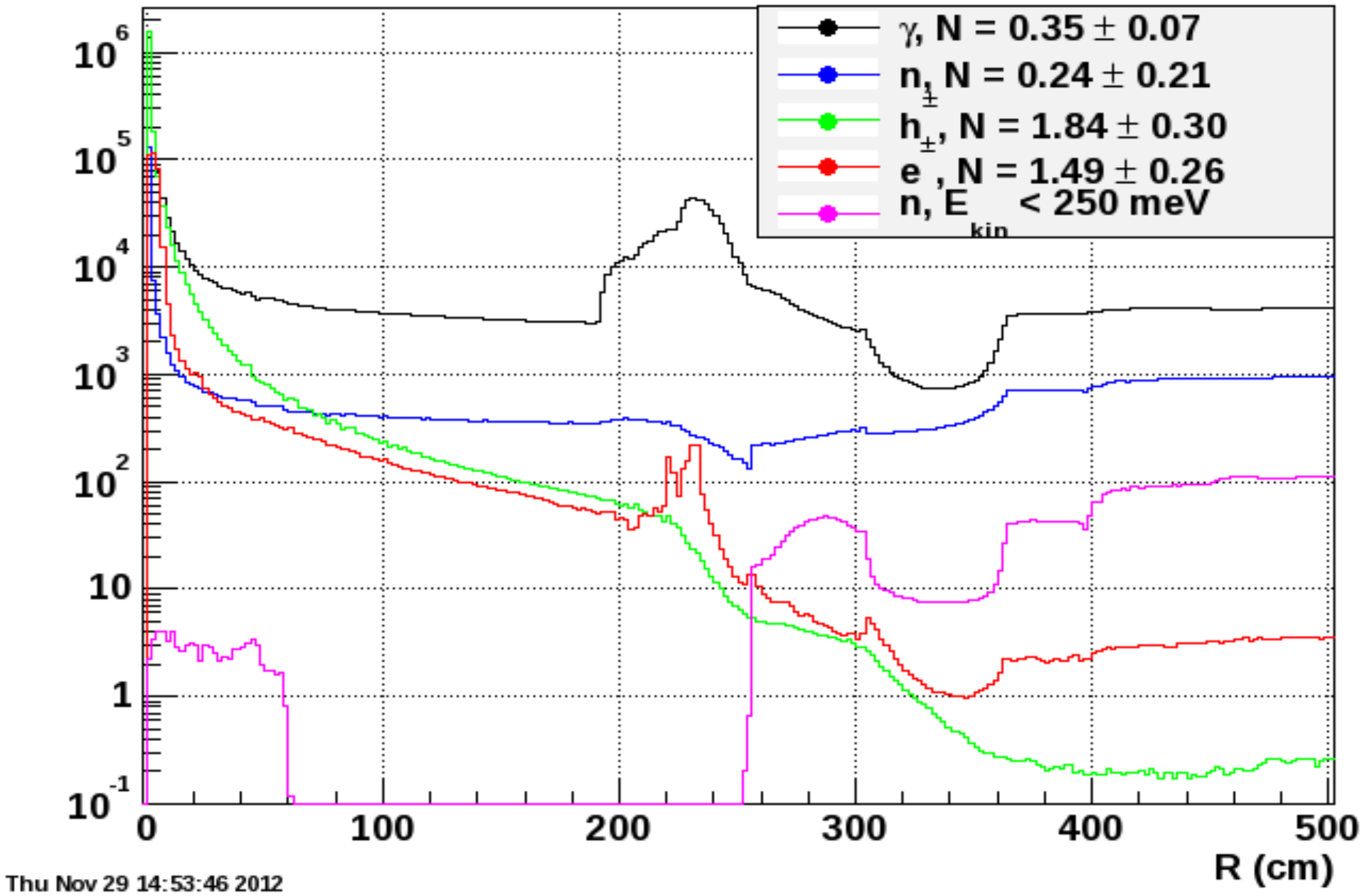


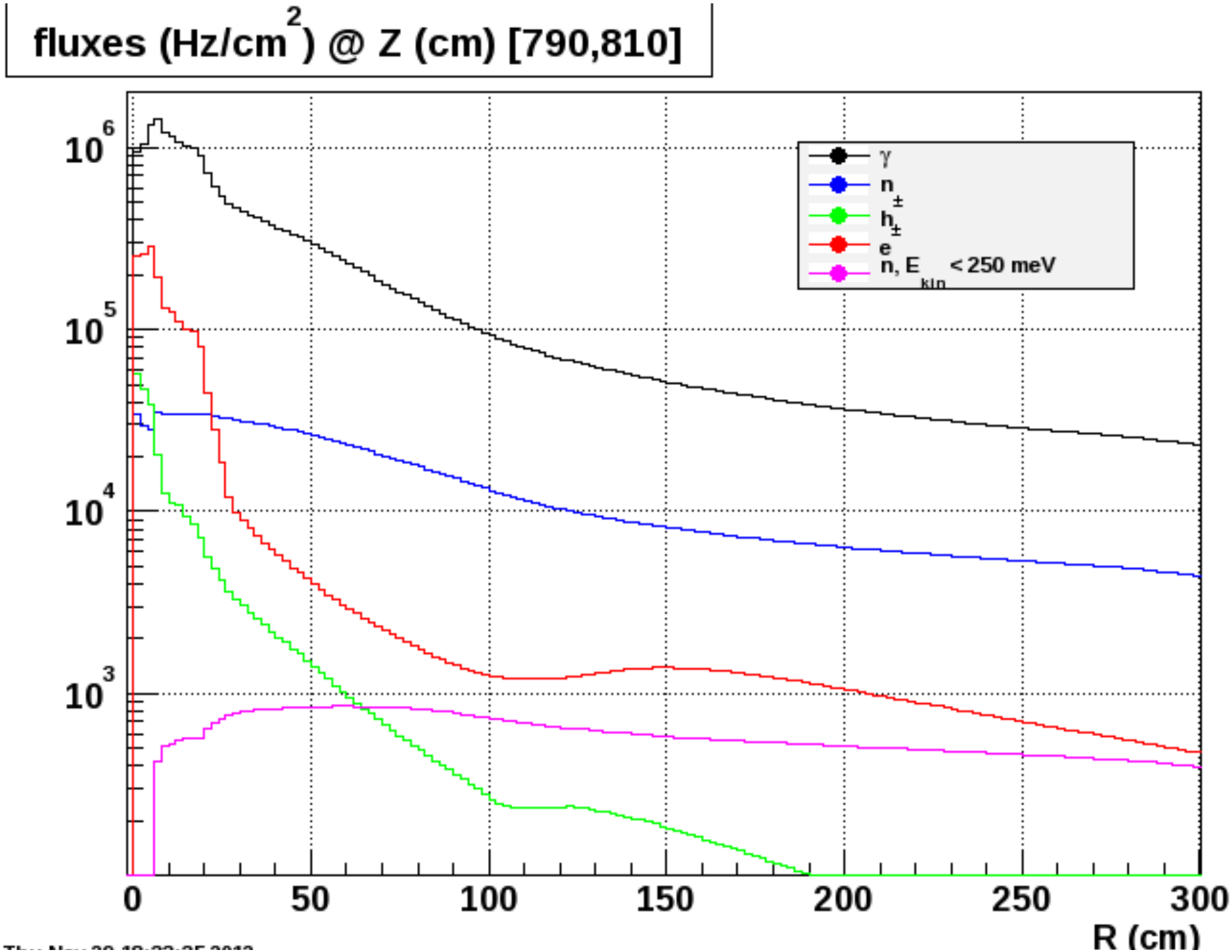


R dependence of charged hadron flux integrated in |z| < 100 cm

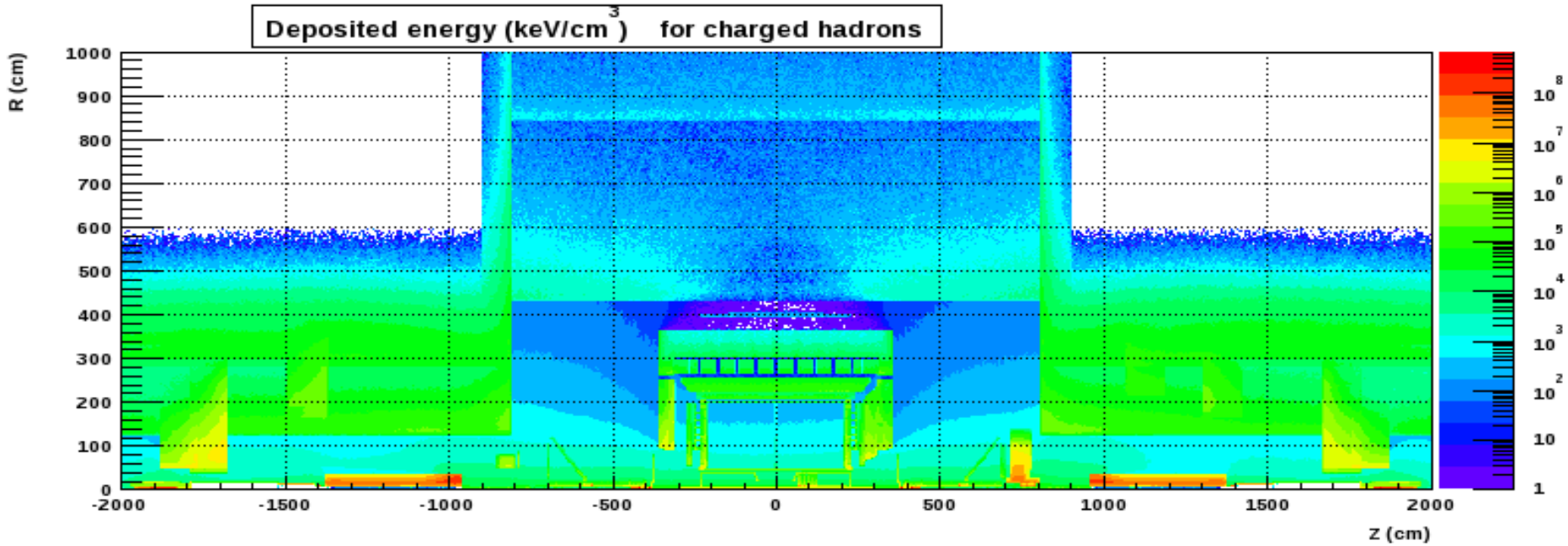


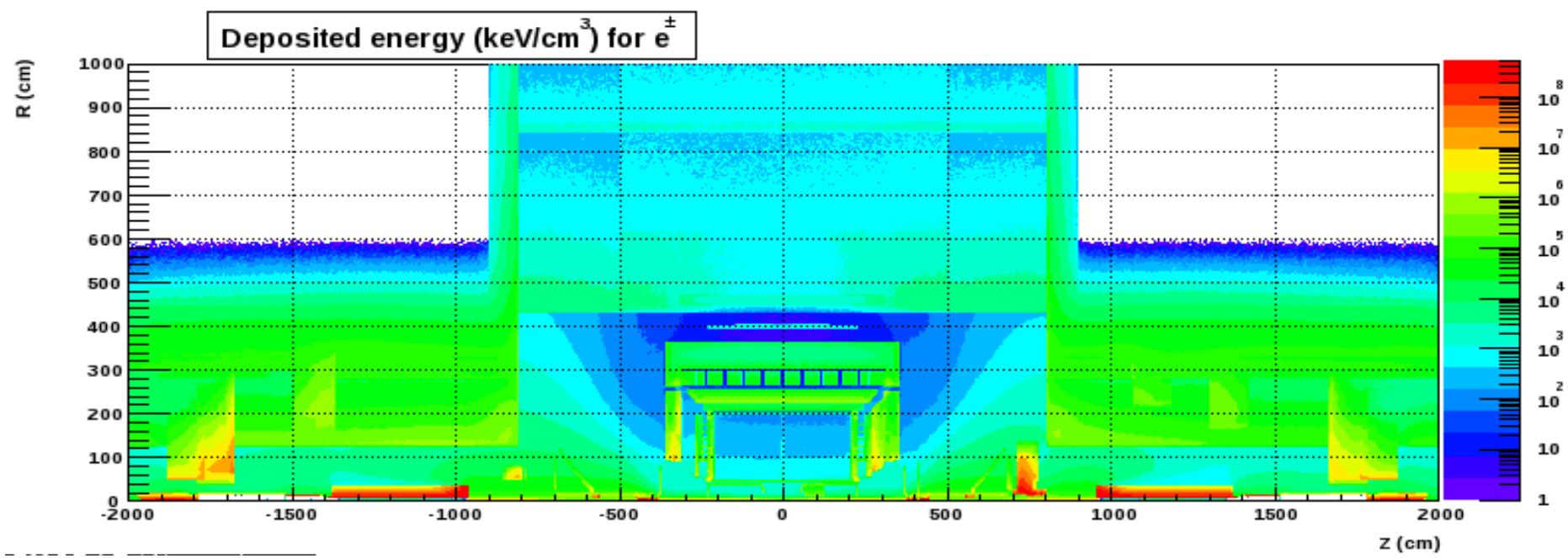
Fluxes (Hz/cm^2) @ |z| < 10 cm



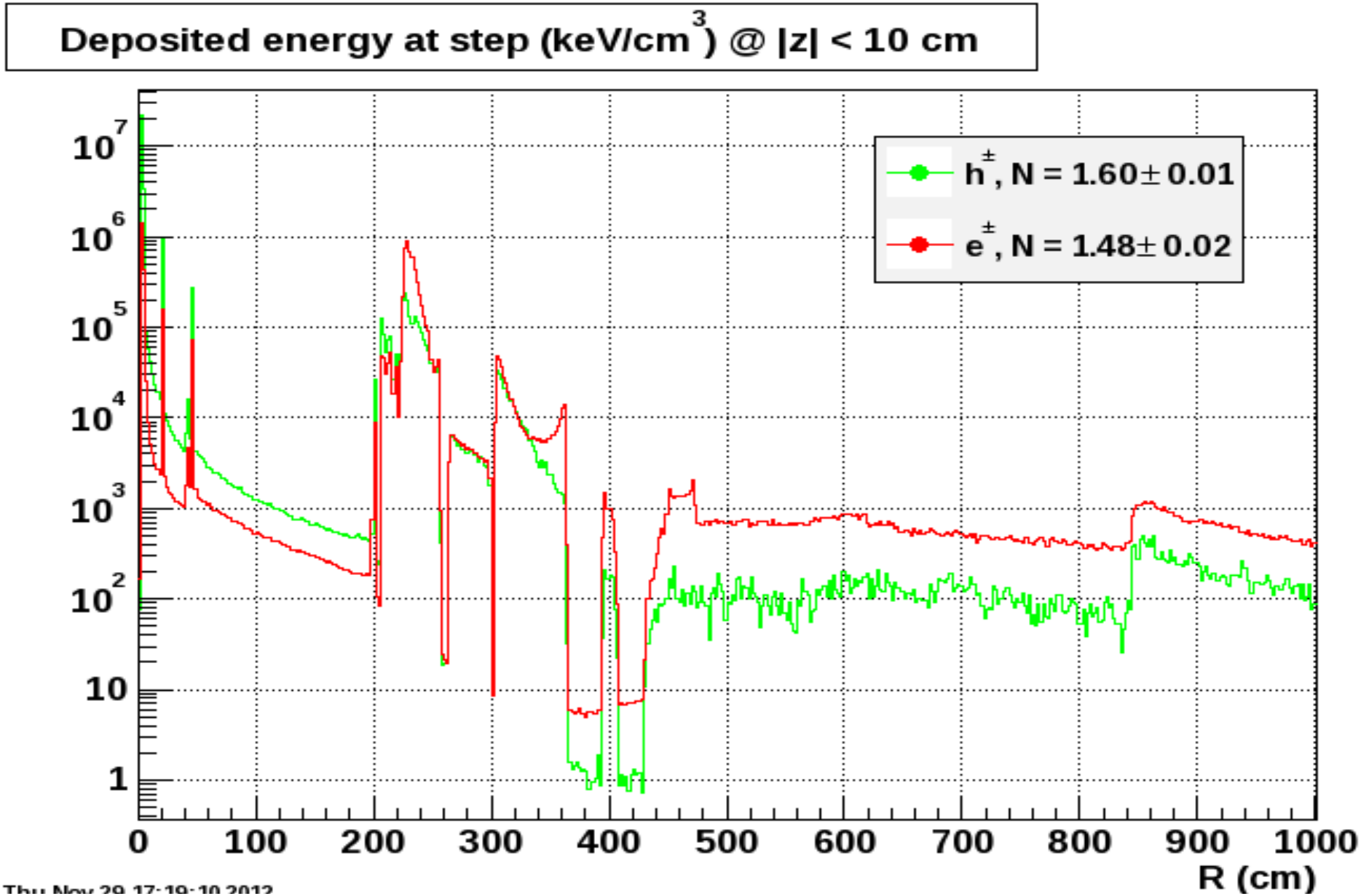

fluxes (Hz/cm^2) @ Z (cm) [790,810]
10^6
10^5
10^4
10^3
0
50
100
150
200
250
300
R (cm)
γ
$n_\pm$
$h_\pm$
e
n, E_{kin} < 250 meV

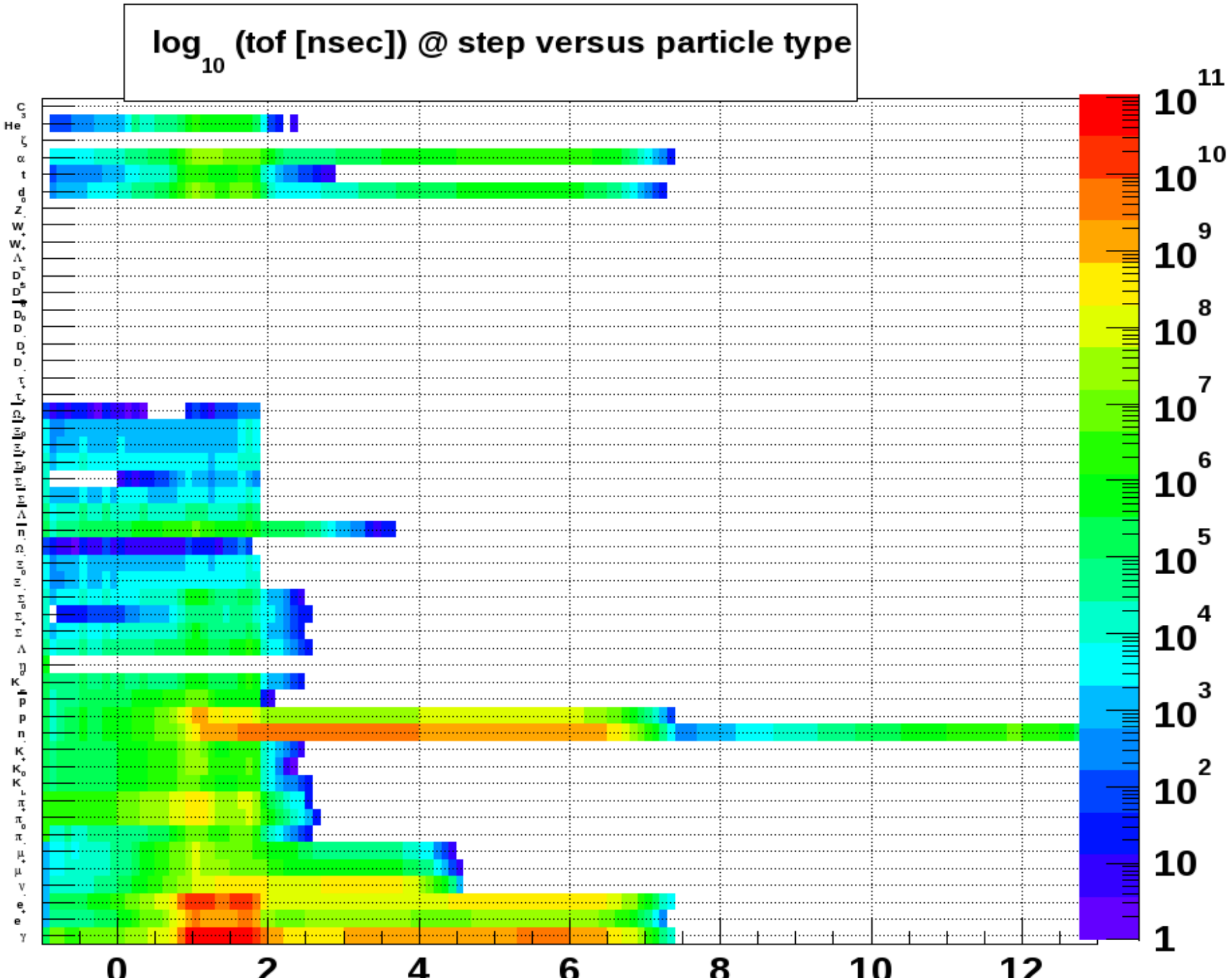
Deposited energy from charged hadrons and $e^{\pm}$

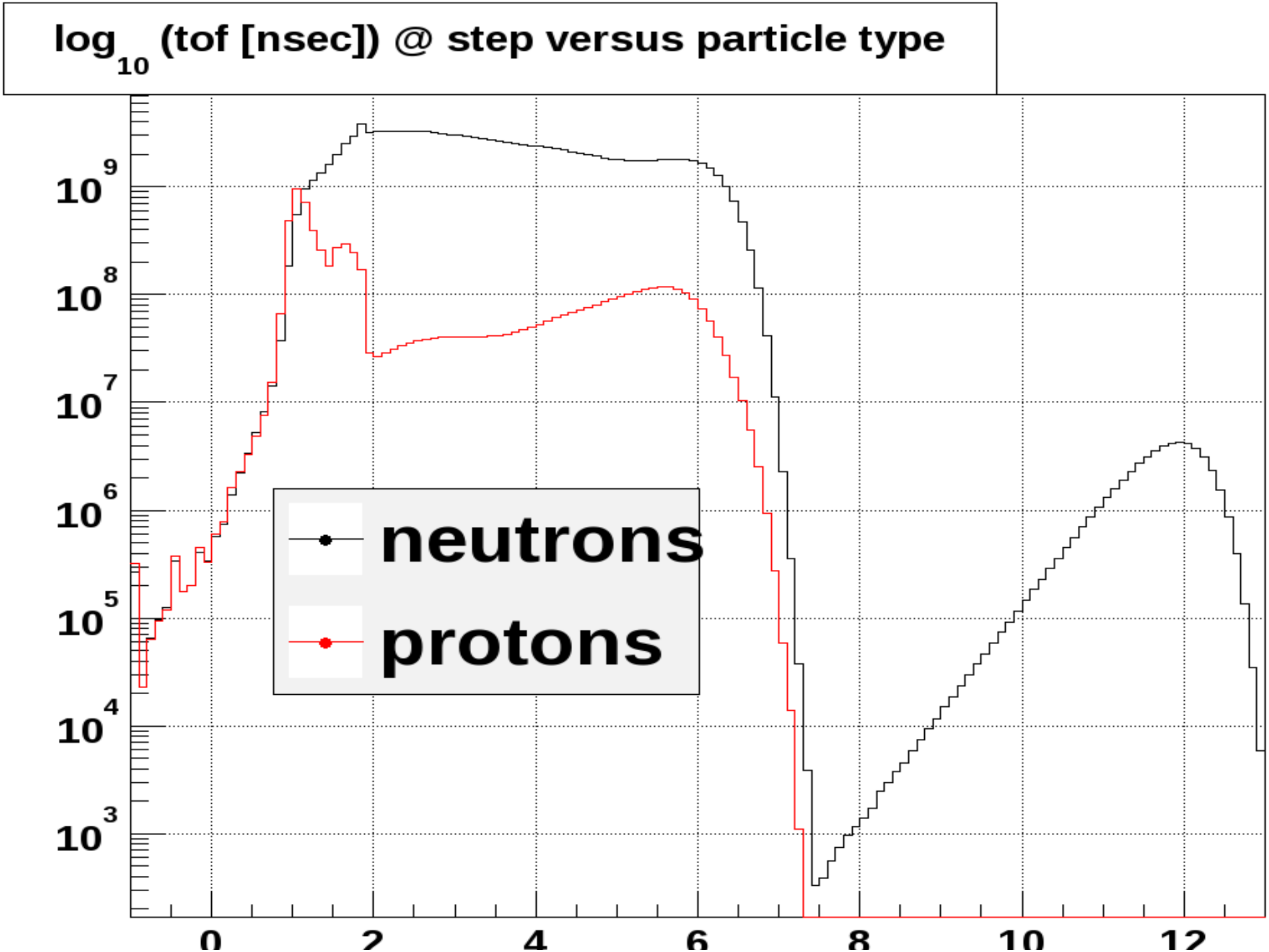




R dependence of deposited energy |Z| < 10 cm




log10 (tof [nsec]) @ step versus particle type
0
2
4
6
8
10
12
1
10
10^2
10^3
10^4
10^5
10^6
10^7
10^8
10^9
10^10
10^11


log10 (tof [nsec]) @ step versus particle type
10^9
10^8
10^7
10^6
10^5
10^4
10^3
0
2
4
6
8
10
12
neutrons
protons

Conclusions

- Geometry affects fluxes significantly.
- There are two components in radial dependence of deposited energy (~ space charge in TPC)
  - From charged hadrons (N = 1.60 in $1/R^N$ dependence), and
  - From electrons (N = 1.42)
- Expected fluxes:
  - of neutron @Z = 0 and R = 7.5 cm is ~10 kHz/cm^2.
  - of thermal neutrons @Z = 0 and R = 5m is ~100 Hz/cm^2.
  - of neutrons @Z = 8m and R = 1m is ~10 kHz/cm^2, and
  - thermal neutrons @Z = 8m and R = 1m is ~1 kHz/cm^2.
- To verify the presented calculation it is necessary to do a measurement of neutron fluxes in STAR WAH.