V. FORMATO

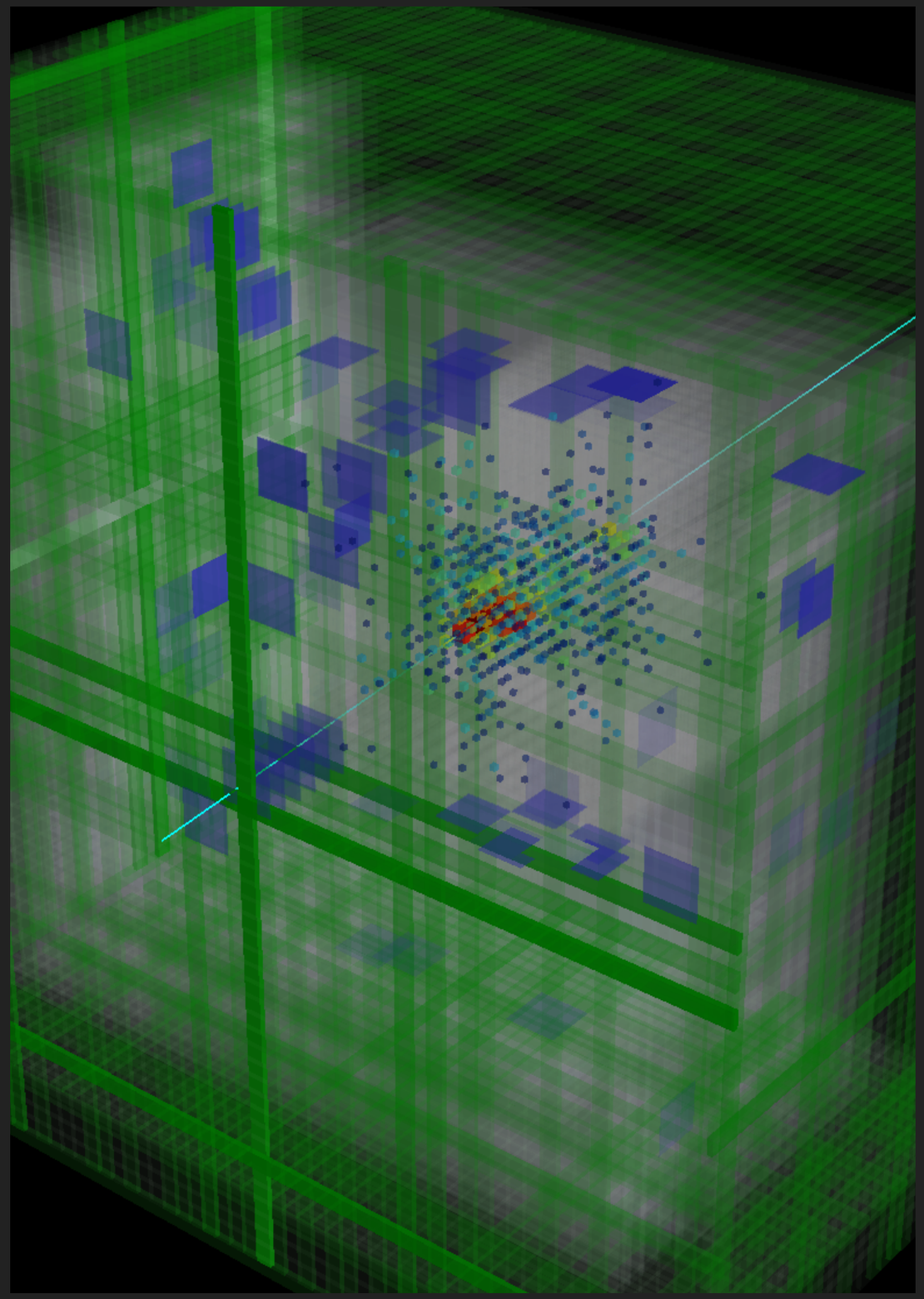
ON BEHALF OF THE HERD MC GROUP

27/03/18, BEIJING - 6TH HERD WORKSHOP

STATUS OF THE HERD MC SIMULATION

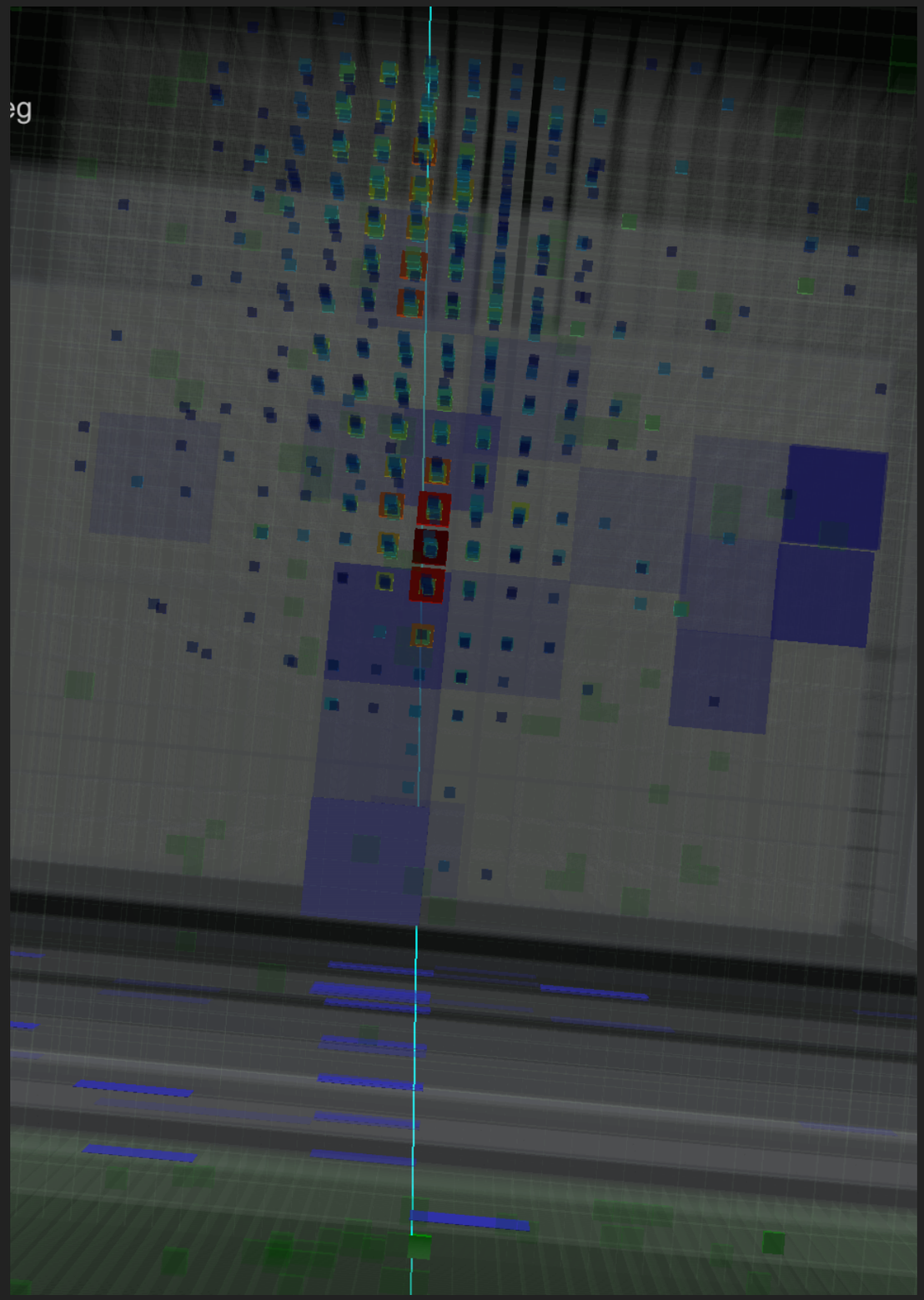
OUTLOOK

- GGS
- Baseline geometry
- Event generation



HERD MC GROUP

- Bari: F. Gargano
- Beijing: M. Xu, Z. Quan
- Florence: S. Bottai, N. Mori
- Lecce: A. Surdo
- Madrid: J. Casaus, A. Oliva
- Perugia: V. Formato
- Geneva: C. Perrina, J. Wang

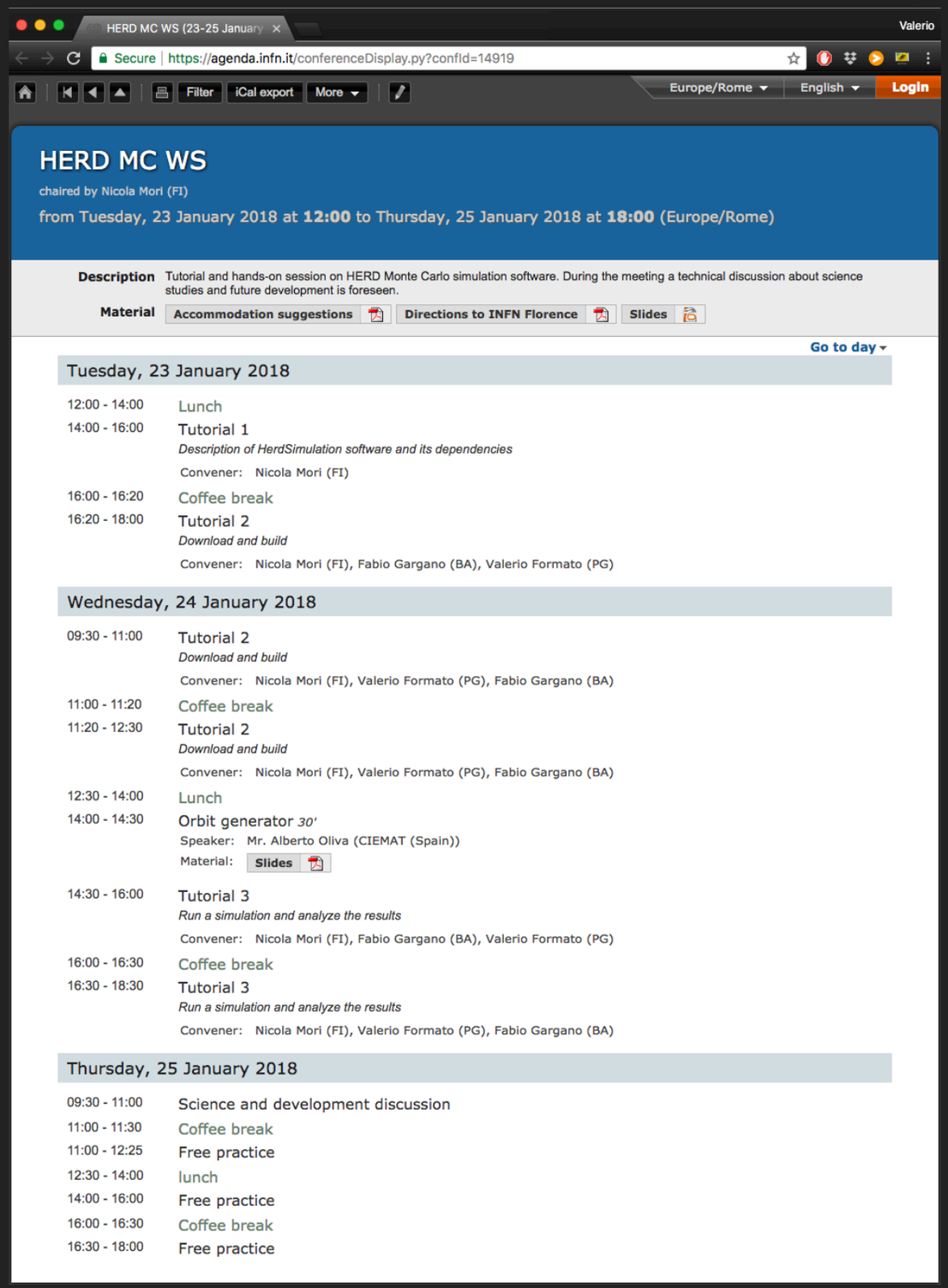


HERD MC GROUP

We just had a MC tutorial workshop in Florence

Focused on:

- Installing and using the GGS framework
- Using and contributing to the HERD simulation packages
- Ideas discussion, and further development for the HERD geometry

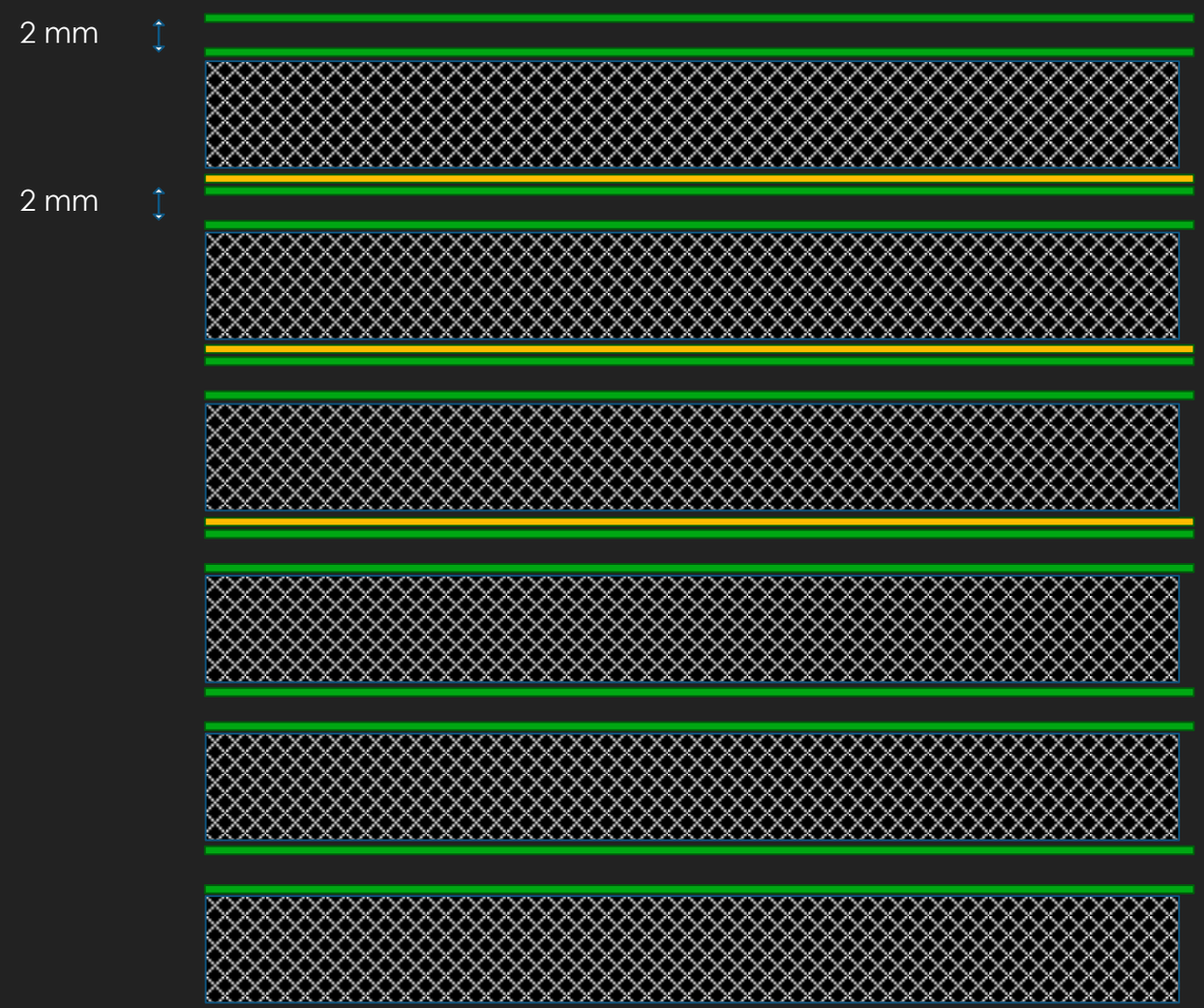


BASELINE GEOMETRY

- Based on the original Geant4 code already available
- STK and PSD updated
  - STK: Defined a tray structure with Carbon-fiber honeycomb, tungsten and two silicon planes
  - PSD: Two options: either two layers of bars or a single layer made of tiles.

STK STRUCTURE

- Tray structure
  - Si plane (X view) - 300 um
  - Carbon fiber honeycomb - 3 cm
  - W plane - 1 mm
  - Si plane (Y view) - 300 um
- STK module structure:
  - 6 Trays
  - First 2 Si planes without W for good charge measurement



STK STRUCTURE

- Top STK
  - 14 ladders, 14 wafers each
  - Total weight: 15 Kg (Si) + 100 Kg (W)
- Side STK
  - 6 ladders, 12 wafers each
  - Total weight: 5.5 Kg (Si) + 38 Kg (W)

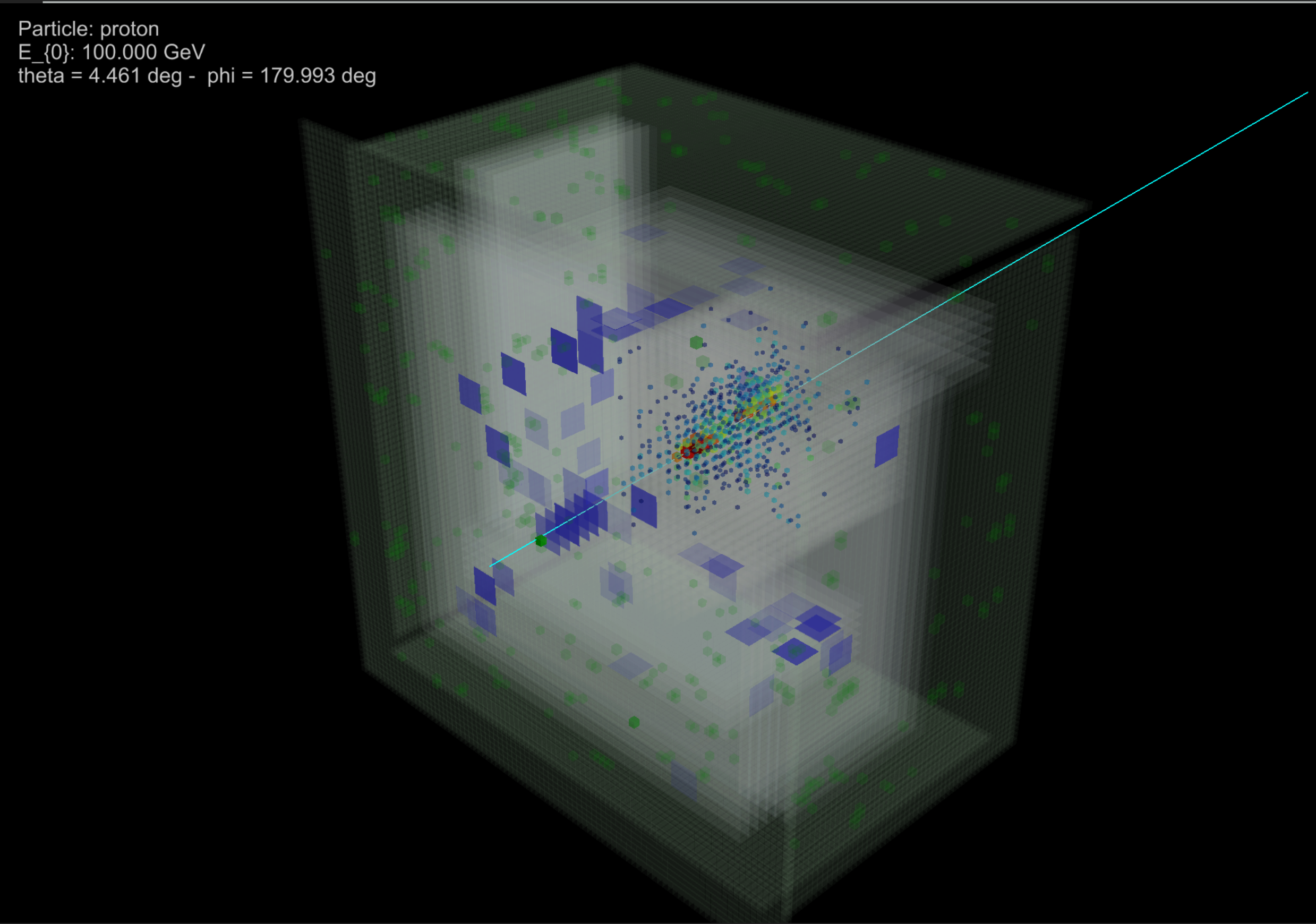
STK STRUCTURE

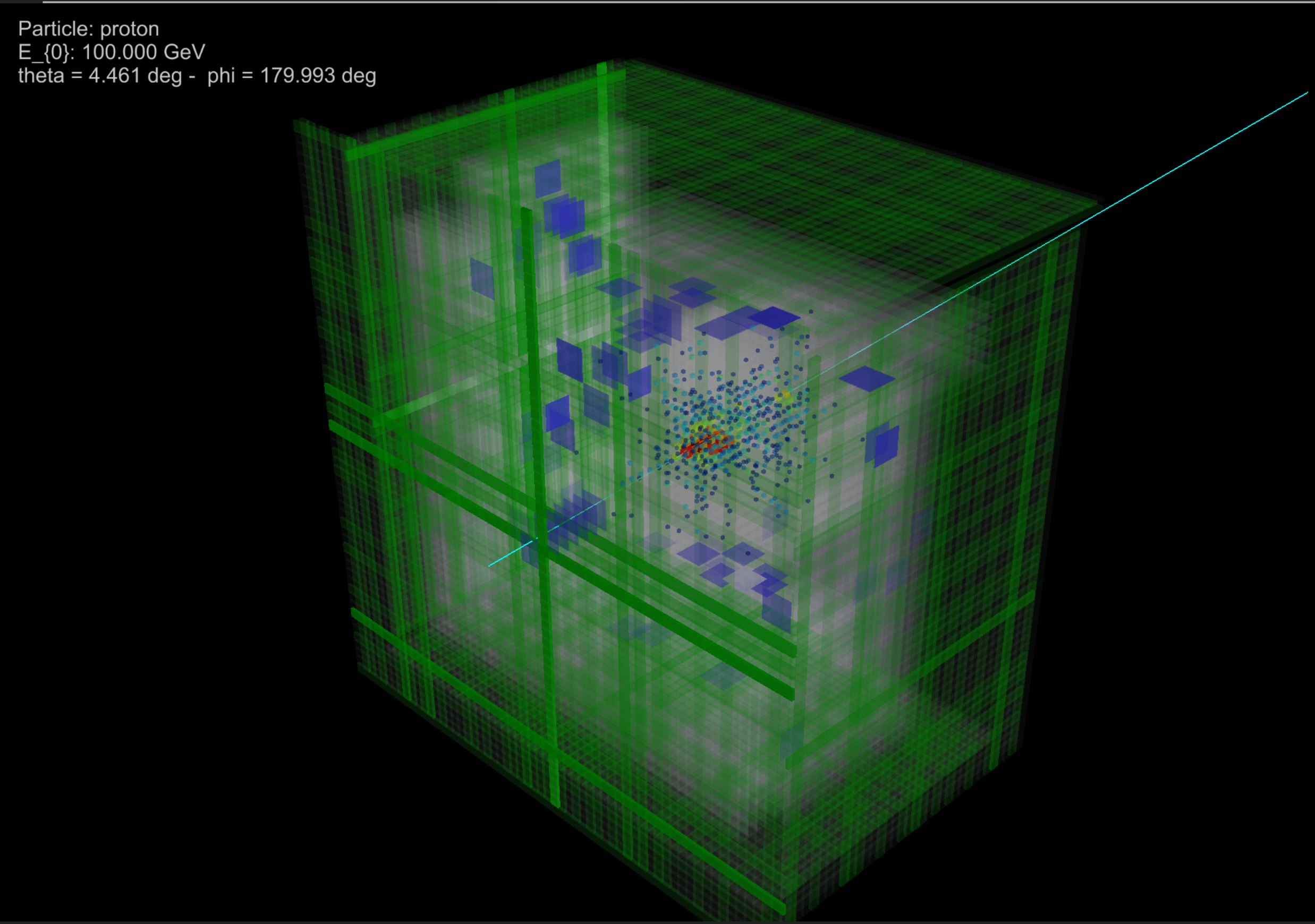
We have used the official geometry already implemented in Geant4 but some very preliminary test show that is possible to reduce STK by 20% both in weight and in readout channels.

- Top STK
  - 14 ladders, 14 wafers each
  - Total weight: 15 Kg (Si) + 100 Kg (W)
- Side STK
  - 6 ladders, 12 wafers each
  - Total weight: 5.5 Kg (Si) + 38 Kg (W)

PSD

- Tile option:
  - Both top and side PSD split into 2x2x2 cm3 tiles (180x180 on top, 160x100 on side)
  - Real life tiles will be bigger but this allows us to simulate different sizes by grouping smaller tiles
    - Total weight: 67 Kg top, 33 Kg side
- Bar option:
  - We implemented two layers of 3 cm wide bars (X and Y view)
  - 60x60 on top, 54x34 on side
  - Total weight: 67 Kg top, 35 Kg side


Particle: proton
E_{0}: 100.000 GeV
theta = 4.461 deg - phi = 179.993 deg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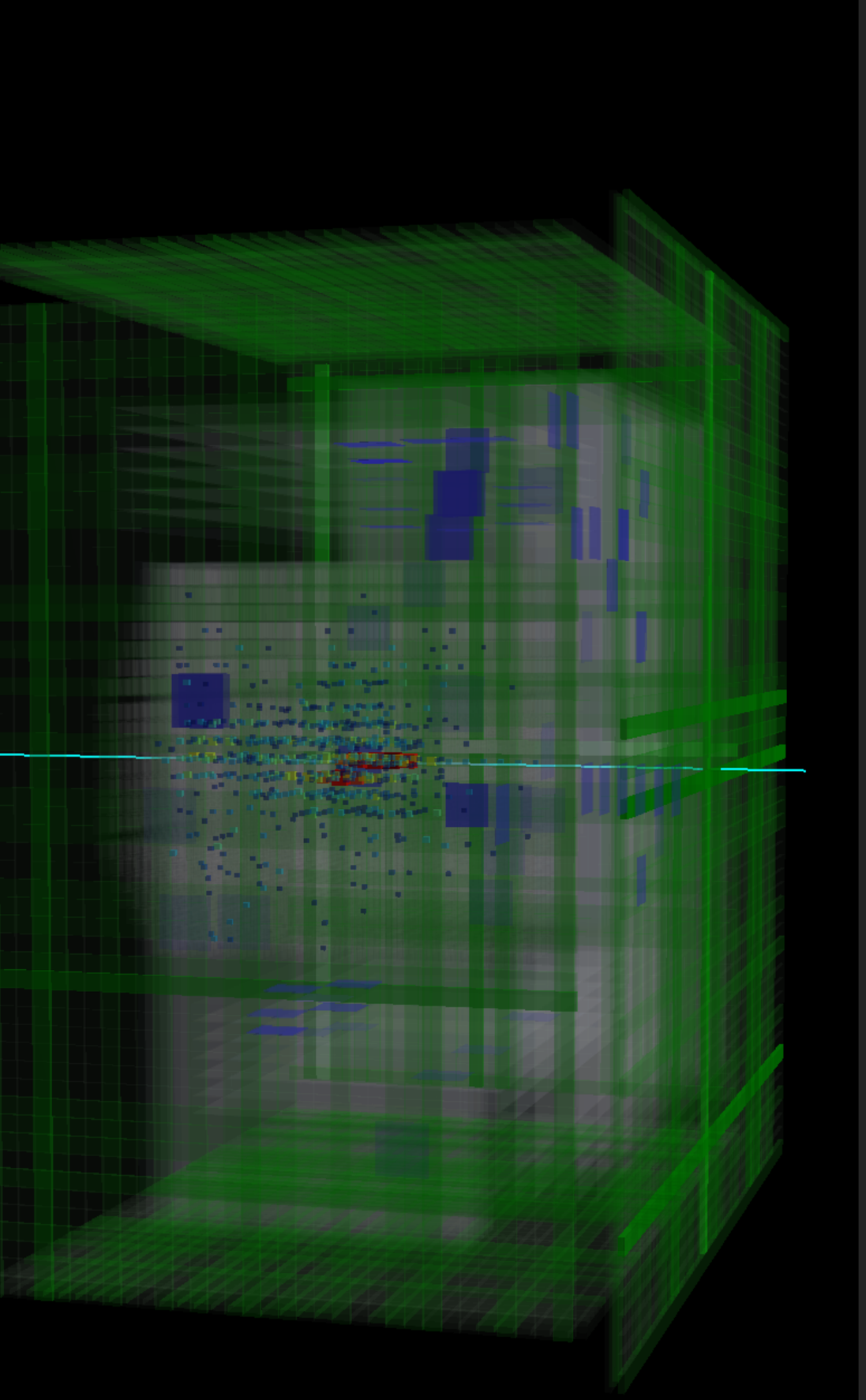


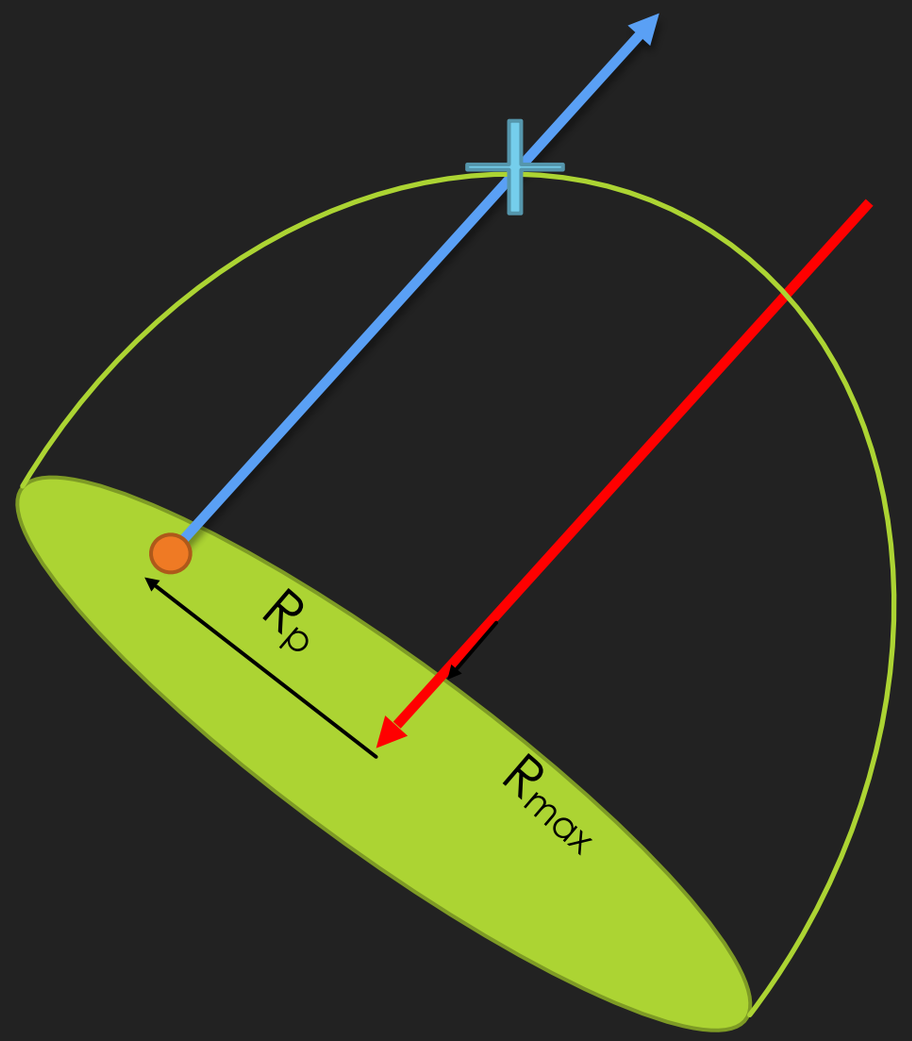
PARTICLE GENERATION

MOTIVATION

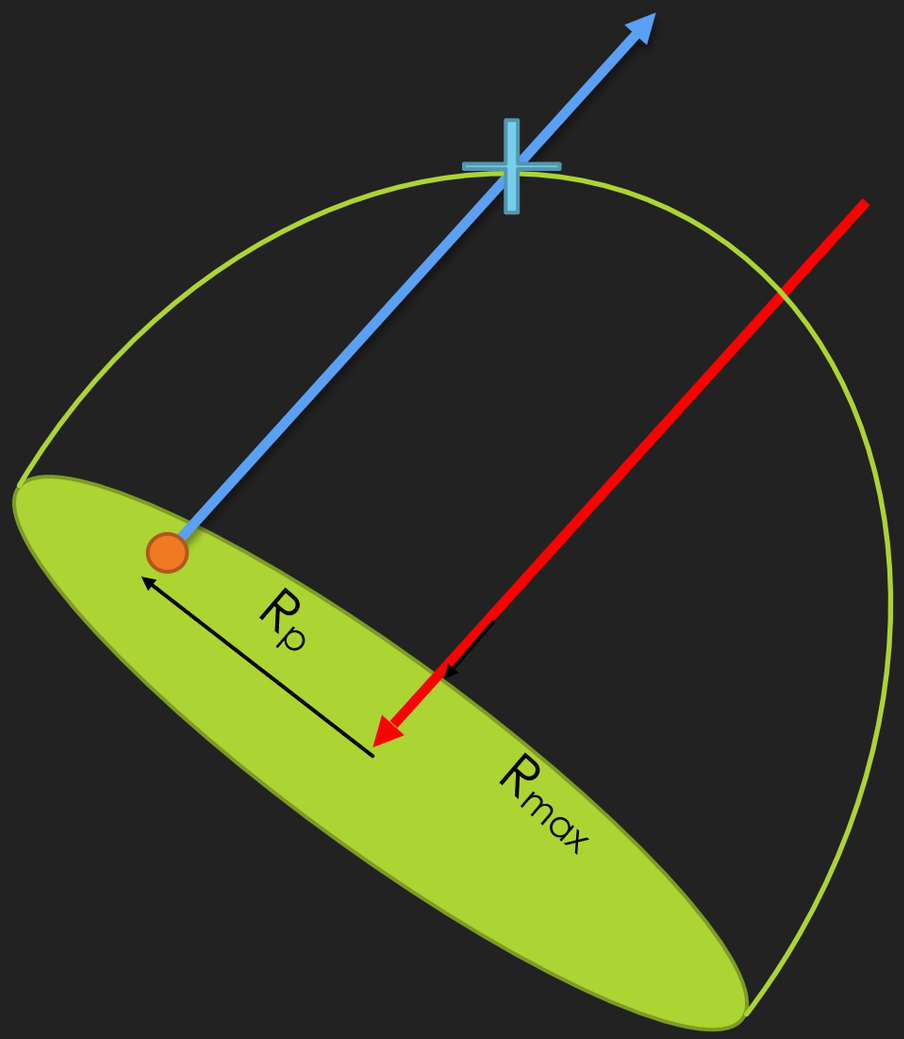
- We have in place a GEANT4 simulation based on GGS tool developed by Nicola Mori.
- At the moment we have done preliminary studies using particles beam, but if we want to perform more detailed simulation we have to simulate particles coming from all directions as it is in a space environment.
- We need a generation engine that can provide an uniform and isotropic distribution of particles in a sphere (half-sphere) surrounding our detector.
- We will test a set of GPS commands and a custom generator engine (hereafter called ISO)
- In all the tests (GPS and ISO) we use muons of fixed monochromatic energy (1GeV) since we are interested only in the generation geometry.

ISO GENERATOR

- To simulate a uniform and isotropic distribution at detector in space, we use a sphere of radius R_{max} surrounding the detector. R_{max} is the maximum value of impact parameter (R_p) and should be greater than the maximum distance from the coordinate origin (which could be the center of detector or any specific points). This sphere is called “detector sensitive region” (DSR) from now on.
- The requirement of “uniform” means uniform probability of impact points on any plane slicing through the DSR. In a 3-D coordinate, this condition can be parameterized as dN/dV = const
- The requirement of “isotropic” means uniform probability of unit vectors of velocity of any events. This means dN/dΩ =const where dΩ is the solid angle



ISO GENERATOR

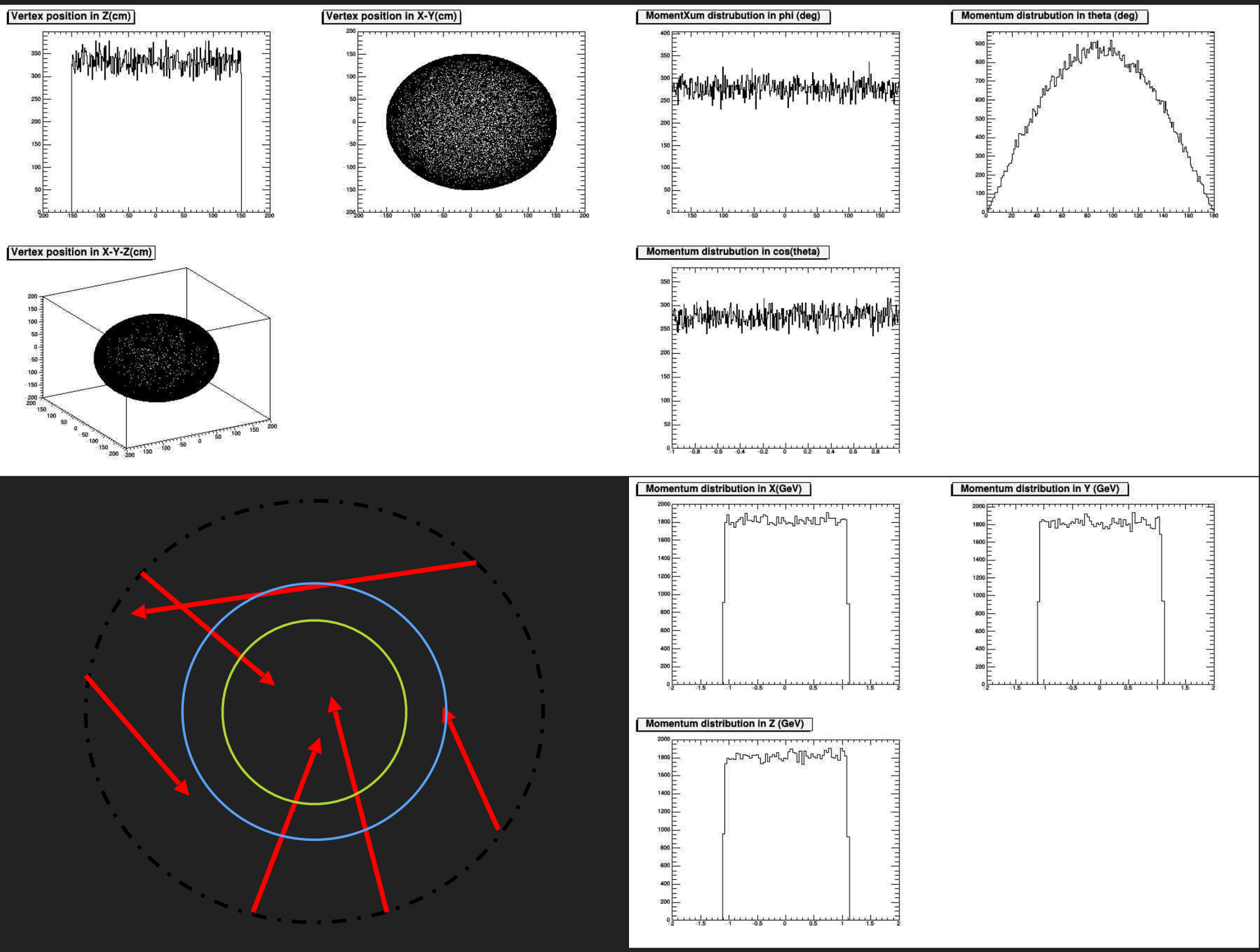


1. Generate of a direction
   - Distribution flat in cos(theta)
2. Define a disc perpendicular to the direction and fixed radius
3. Select a random point on the disk
   - Distribution flat in R^2
4. Find the intersection between the line starting form the point with fixed direction and a sphere of radius R_{max}

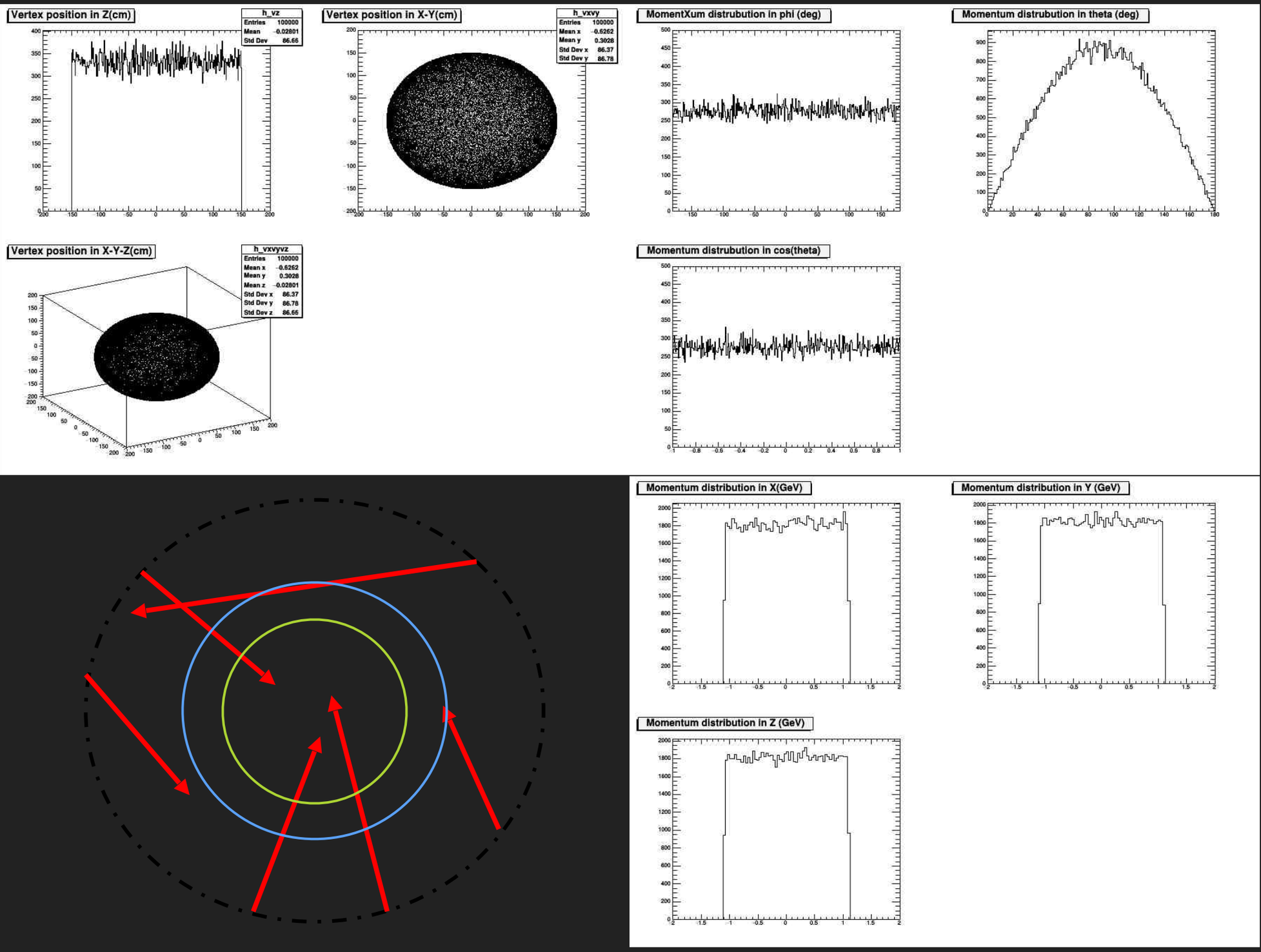
This engine is now available as plugin in GGS

/generators/isosphere/Radius 150 cm
/generators/isosphere/MinTheta 0 deg
/generators/isosphere/MaxTheta 180 deg
/generators/isosphere/Center 0 0 0 cm

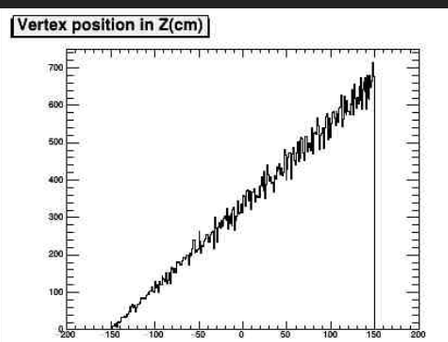
ISO GENERATOR

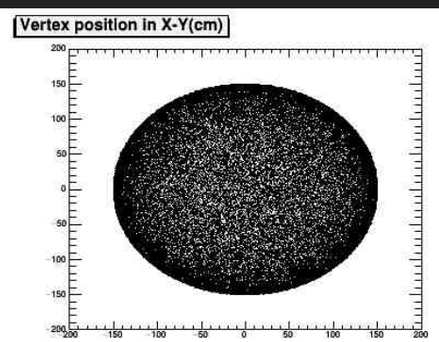


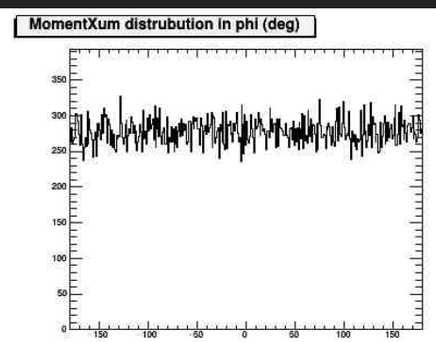
GPS GENERATOR

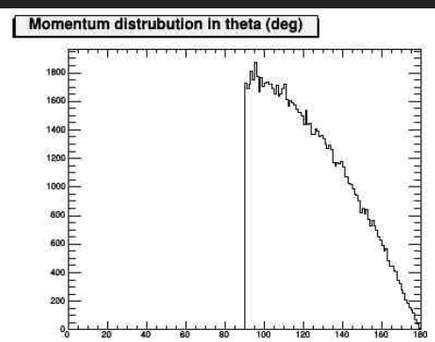


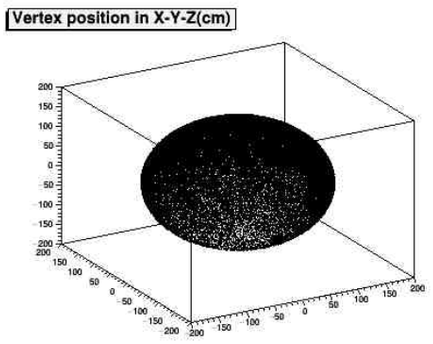
ISO GENERATOR – HALF SPHERE

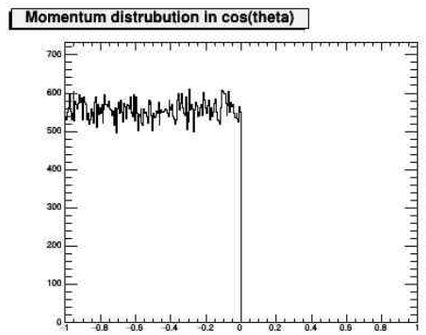


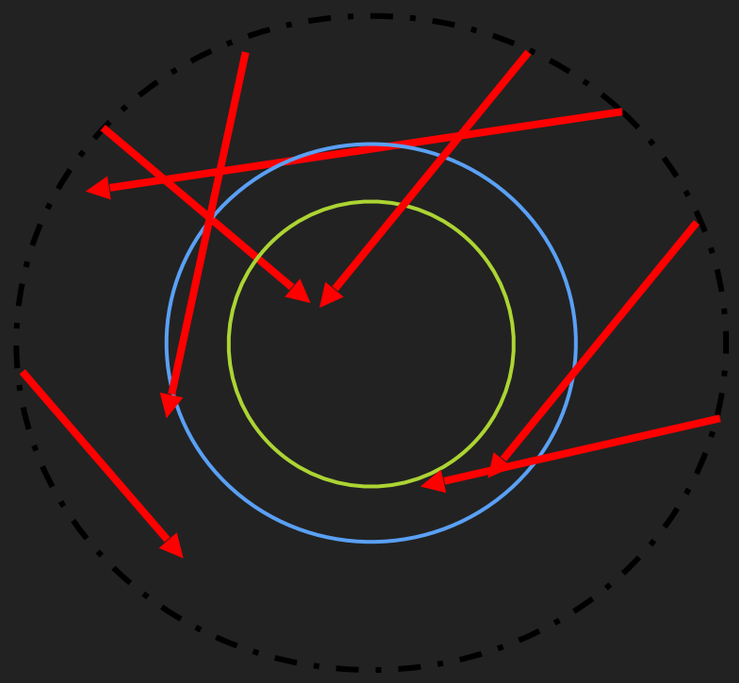


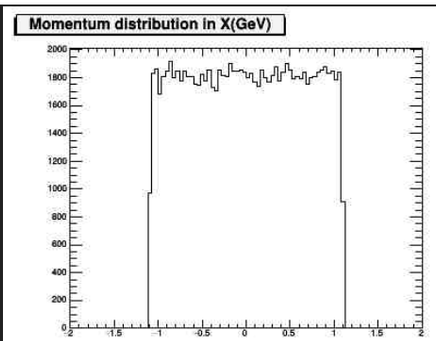


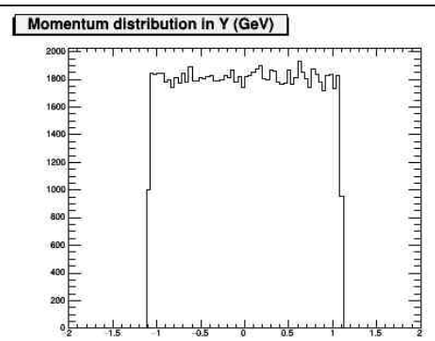


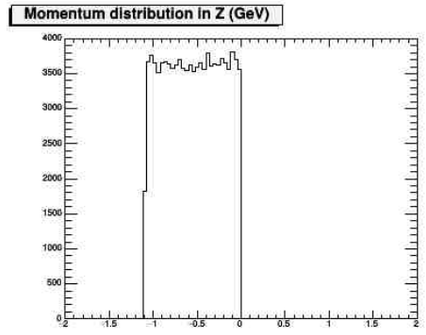




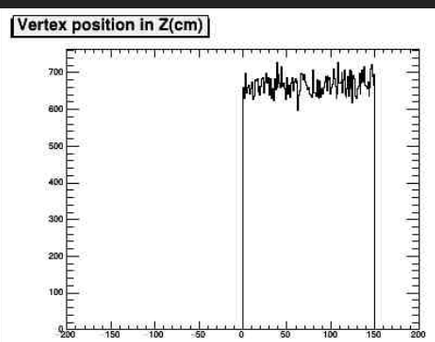


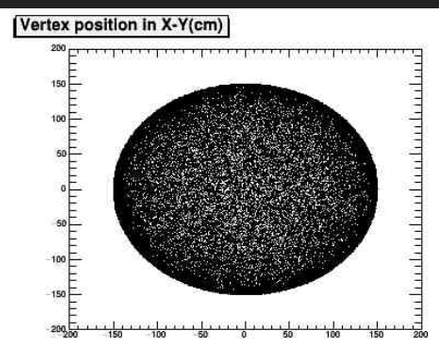


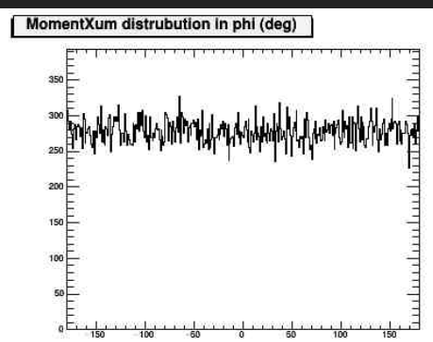


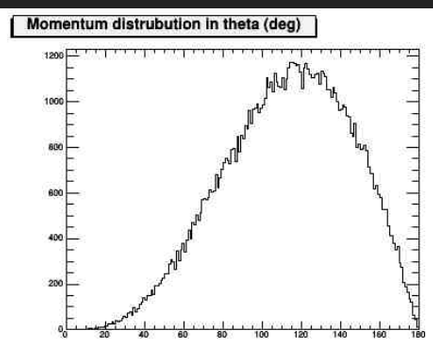


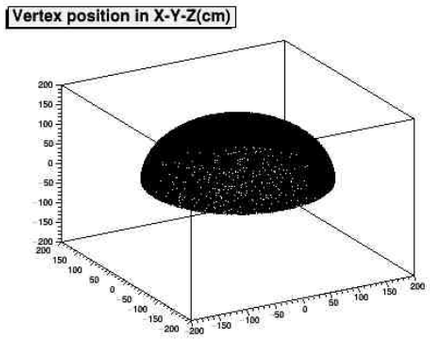
GPS GENERATOR – HALF SPHERE

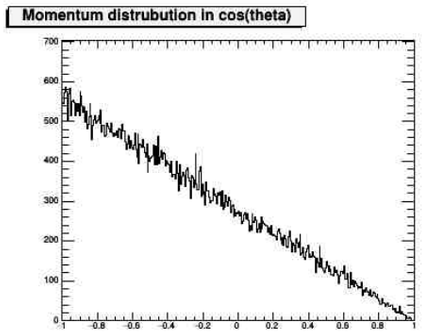


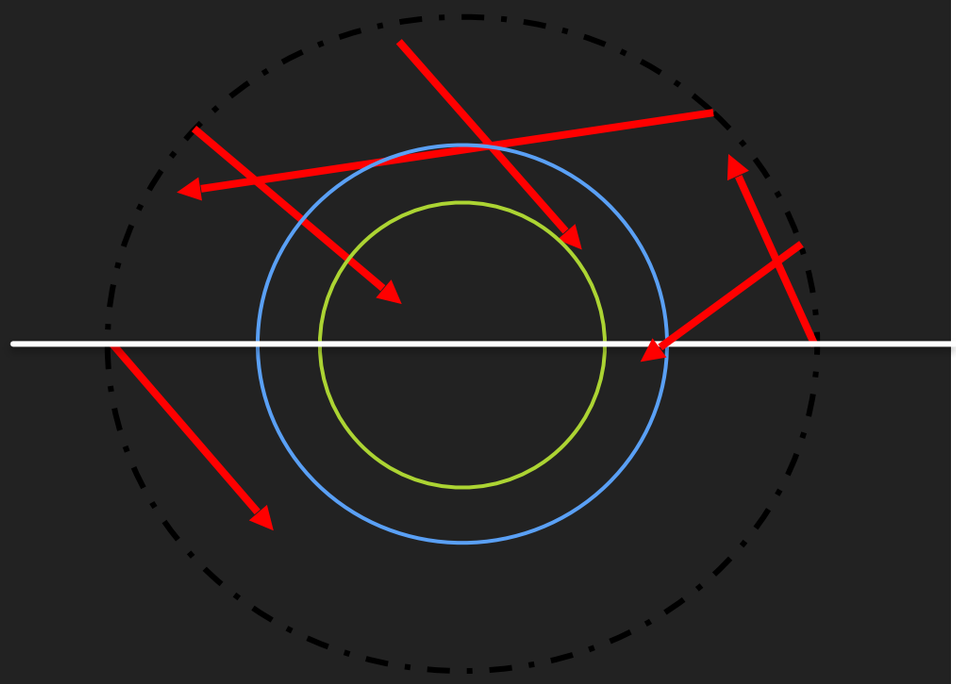


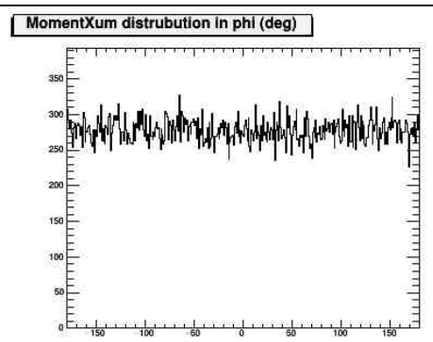


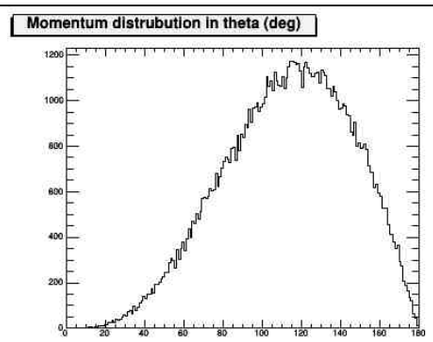


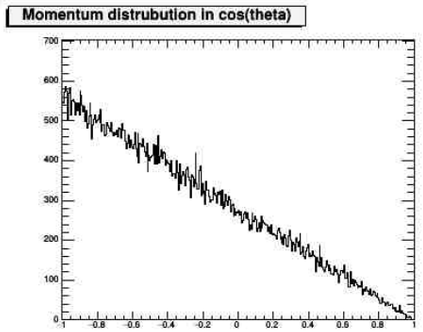












GENERATOR COMPARISON

- We have compared the ISO engine with the standard GPS tool of GEANT4
- The two generator engines are identical if a FULL sphere generation in considered
- The differences are in the HALF sphere generation:
  - GPS: The generation engine starts form the position and then a direction is added. In this way the position is uniform in half-sphere
  - ISO: The generation engines start from the direction and then a position is added. In the way the angular cos(theta) distribution is uniform.
- Both *FERMI* and *DAMPE* collaborations use the ISO generator engine

CONCLUSIONS

- Development of the HERD MC simulation is ongoing
- Two new geometries have been implemented, based on the original baseline specifications. (eventually we need to go through the proposal and update a few parameters)
- A new CR generation engine has been added to simulate a uniform and isotropic flux.
- We are preparing for a mass production of simulated events: p, He, e^-, gamma, with various energies using both geometries. The resulting files will be available for the whole collaboration to analyse via XROOTD access. Stay tuned!