# STATUS OF THE HERD MC Simulation

V. FORMATO ON BEHALF OF THE HERD MC GROUP 27/03/18, BEIJING - 6<sup>TH</sup> HERD WORKSHOP

## 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

	MC WS (23-25 January X	Valerio
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HERD M	C WS	
haired by Nicola N		
rom Tuesday,	7, 23 January 2018 at <b>12:00</b> to Thursday, 25 January 2018 at <b>18:00</b> (Europe/Rome)	
Descriptio	on Tutorial and hands-on session on HERD Monte Carlo simulation software. During the meeting a technical discussion about science	
Materi	studies and future development is foreseen.	
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Tuesday.	. 23 January 2018	iy <del>-</del>
12:00 14:00		
14:00 - 16:00	Unch	
	Description of HerdSimulation software and its dependencies	
	Convener: Nicola Mori (FI)	
16:00 - 16:20	Coffee break	
16:20 - 18:00	D Tutorial 2	
	Download and build	
	Convener: Nicola Mori (FI), Fabio Gargano (BA), Valerio Formato (PG)	_
Wednesd	day, 24 January 2018	
09:30 - 11:00	D Tutorial 2	
	Download and build	
11.00 - 11.20	Convener: Nicola Mori (F1), Valerio Formato (PG), Fabio Gargano (BA)	
11:20 - 12:30	Corree break	
11120 12100	Download and build	
	Convener: Nicola Mori (FI), Valerio Formato (PG), Fabio Gargano (BA)	
12:30 - 14:00	D Lunch	
14:00 - 14:30	Orbit generator 30'	
	Speaker: Mr. Alberto Oliva (CIEMAT (Spain))	
	Material: Slides 7	
14:30 - 16:00	D Tutorial 3	
	Run a simulation and analyze the results	
16:00 - 16:30		
16:30 - 18:30	Contee break	
	Run a simulation and analyze the results	
	Convener: Nicola Mori (FI), Valerio Formato (PG), Fabio Gargano (BA)	
Thursday	y, 25 January 2018	
09:30 - 11:00	Science and development discussion	
11:00 - 11:30	Coffee break	
11:00 - 12:25	5 Free practice	
12:30 - 14:00	D lunch	
14:00 - 16:00	<sup>D</sup> Free practice	
16:00 - 16:30	Coffee break	
16:20 19:00		

# **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.

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## **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

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Particle: proton E\_{0}: 100.000 GeV theta = 4.461 deg - phi = 179.993 deg



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Particle: proton E\_{0}: 100.000 GeV theta = 4.461 deg - phi = 179.993 deg





# 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<sub>max</sub> surrounding the detector. R<sub>max</sub> is the maximum value of impact parameter (R<sub>p</sub>) 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<sup>2</sup>

4.Find the intersection between the line starting form the point with fixed direction and a sphere of radius R<sub>max</sub>

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!