MATHUSLA Simulation Discussion/Update

29 August 2018
MATHUSLA Workshop Simons Center

John Paul Chou, David Curtin, Brandon Gomes,
Abhishek Rajput , Martin Subieta

Current simulation status

We are close to first quantitative results for **Cosmic Rays** as Signal and Background

We already havehave reasonable estimate of **Muon BG from LHC**, but it needs to be augmented by full GEANT in detector.

We have analytical over-estimates of neutrino background, but need GENIE simulations to confirm & narrow down.

Cosmic Rays

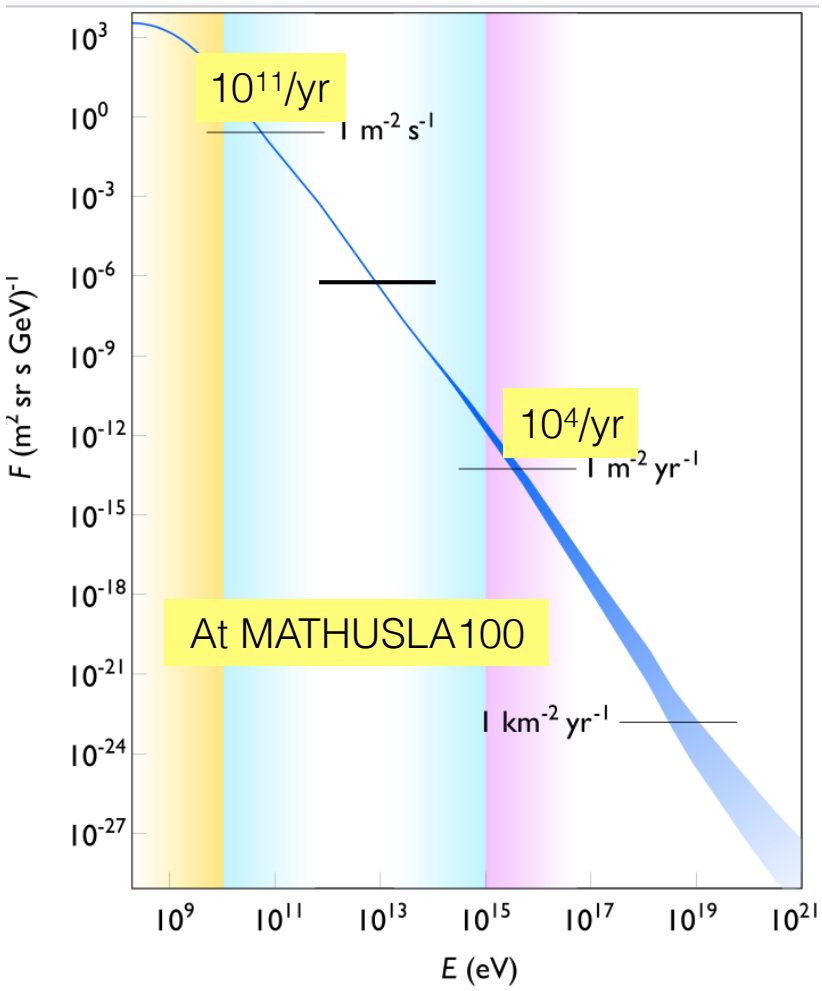
We have CORSIKA simulations for H, He, C, Si, Fe primaries in:

high energy range 10^{14} - 10^{17} eV
(2M events per each species
~ 2 years of MATHUSLA exposure)

and separate samples for

low-energy range 10^{8} - 10^{14} eV, which numerically dominates but may not give individually distinguishable showers

(5M events per species, compare to flux ~ 10^{14}/yr . We can't simulate full flux, but can translate [not rotate, earth B field] & reuse events & do FASTSIM, see next slide).)



Cosmic Rays

These Corsika events can be piped through toy-detector-sim (Brandon) with tracking & vertexing afterwards (can change # layers, resolution, etc afterwards).

This is ready to go, just transferring files now and writing adapter scripts to read Corsika events into detector sim.

LLP Outcome: run tracking & vertexing for different possible detector configs on LLP signal and background and confirm zero CR fakes hopefully (at our level of statistical power).

To overcome statistical limitations, full CORSIKA events will be used to calibrate FASTSIM for CR events. Muon fastsim is done, electron fastsim in progress.

Cosmic Rays

CR outcome:

1) take detector sim output WITHOUT tracking, and just do old-school hit position & timing in in top layer only. With that info ONLY, confirm that you can reconstruct spatial/temporal shower profile and #hits to diagnose energy/composition.

2) adapt tracking for high multiplicity situations.
   Repeat (1), how much better do you do for EAS reconstruction/information extraction.

3) Investigate effect of analog RPC pads.

4) Tie the above into CR physics case.

Cosmic Ray Backsplatter

Hard to estimate, neutrinos kicked out of floor by CR muons etc.

First toy investigation: 10^6 muons with energy 5 GeV hitting floor of detector in GEANT. DONE!

Next: play with events, run tracking and find DVs. Also isolate neutrinos and see if any of them look dangerous (e.g. show up withou charged particle friends etc)

QUESTION: is this reliable, does GEANT do the relevant interaction properly, if not, how do we find out?

Muons

DONE: GEANT propagation of muons in rock as transfer function is done. Used this for analytical estimate of background in MATHUSLA using various known decay/scattering rates of muons.

Next: propagate muons within MATHUSLA in Geant. Should give “final” numbers on muon background, and inform veto strategies beyond floor veto.

Neutrinos

In progress: GENIE simulations for neutrinos hitting air-mix of nuclei, for different neutrino energies.

Once that's done, can convolve with known neutrino flux (Frejus data) and MATHUSLA geometry to get accurate rates of "irreducible" neutrino scattering background, and estimate of veto efficiencies for geometric & timing cuts.

This should give smaller results than initial overestimates, which gave ~ few/year. So we hope once we have the above, we can lay neutrinos to rest until we do fully detailed propagation of final staten in GEANT detector sim.