



Work Summary

Liverpool FASER Meeting

Pawan

June 13, 2025



- Submitted First Year Report !
- Validation of MC Simulation in Alma9
 - Finished first round of validation
 - No major issues found some event level disparities
- Looking at Genie Samples
- Finishing up Alma9 validation

Submitted First Year Report !

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MC Simulation Validation

Validation of MC Simulation in Alma9



Tracking and Energies look good



- Some variables are not filled in the ntuples Mostly related to the truth-level information Should be easy to track down and fix
- Some issues with individual calo/preshower vars Fixed in newer release



Event Level Mismatches

- Overall, the aggregate metrics look same !
- However, there are some discrepancies at the event level
 - Events with different number of tracks : 1597 (31% of 5k)
 - Events where al9-simulation has more tracks than sl7-simulation: 835 (16%)
 - Events where sl7-simulation has more tracks than al9-simulation: 762 (15%)
 - Looking at event-displays, it seems to be from noise or difference in random seed

Number	of	entries in al9 chain: 5000
Number	of	entries in sl7 chain: 5000
Number	of	entries in combined chain: 5000
Number	of	tracks in combined chain: 8520.0
Number	of	tracks in combined chain: 8418.0
Number	of	<pre>events where al9.longTracks != sl7.longTracks: 1597</pre>
Number	of	events where al9.longTracks > sl7.longTracks: 835
Number	of	events where al9.longTracks < sl7.longTracks: 762

Did Some Fixed Seed Testing

- Results were inconclusive some differences still here
- Seed seems statically initialized Or I missed something
- Eric thinks could be from G4-Simulations...

<pre></pre>		
37 sample1/feet.similate.log.Reway from G4/estralg string used to set Bardom Seed is : "BardomStreamName": SeartA	39	

Briefly Brought Down Production

Intern: I fixed the bug and pushed the code to production



Me watching senior dev fixing my mistakes that took down production



GENIE Detour

GENIE Detour

Calorimeter Energy Distribution



• Saw some significant differences in the Calorimeter energy distribution and cut flows between the Default Genie Samples and the GENIE Samples used in the old analysis (Genie 200005).

Pawan (University of Liverpool)

Work Summary

Interaction Volume



- Mostly boiled down the difference in the interaction volume.
- Genie Default were simulated with a very large volume.
- Genie 200005 was simulated inside the detector only. Most of FaserNU/Magnets/preshower/calorimeter were excluded.
- Filtering the Genie Default to the same volume as Genie 200005 (denoted Genie Default Downstream), much of the differences go away.

One Track Cutflow scaled to 190 ifb



Two Track Cutflow scaled to 190 ifb



Event Display from Genie Default



- The Genie Default picks up a lot of extra events that come from the magnets and outside the detector. Fiducial requirements usually take care of this, but does have non-"zero" impact...
- Figure out in what volume to simulate future GENIE Samples Tobias already did?

Track pT – once a "promising" variable



I thought we found the signal discrimiant to be within the Track Kinematics
And Track pT was a "promising" variable. (said this 5 times in my report)

Track pT – once a "promising" variable



• Turns out if you add the underflows, we realise everything was at zero all along – Neutrino interactions rarely produce tracks as evident in the cutflow

Track pT – once a "promising" variable



(a) Track pT distribution with atleast 1 good fiducial track.

(b) Track pT distribution with 2 good fiducial tracks.

• With the baselines the statistics are low.

Charge Distribution



- Overall, Alma9 sees more tracks in general
- Thus a cut like Sum(Track_charge) == 0 improves just based on the increased number of tracks

Tracks with Misldentified Charge



- charge_misid is defined as (Track_charge != TrackChargeFrom(t_pdg))
- Alma9 sees less tracks with misidentified charge but slightly more misidentified good-tracks – Not really too different

Misldentified Charge as a function of TrackR



- The y-axis is the fraction of tracks with misidentified charge
- We generally misidentify the charge of tracks with large R
- ALMA9 does see improvements in the early bins.

Misldentified Charge as a function of TrackP



- ALMA9 seems to misidentify more at low momenta.
- ALMA9 does better at moderate momentum
- ALMA9 consistently bad as CENTOS7 at high momentum

Momentum Distribution



We see a 25% difference in the reconstructed momentum distribution
Sinead also saw this with the single muon samples

Momentum Residual



• I do not see enough in the residuals to explain the differences in the momentum distribution in the previous slide

Momentum Residual Fractional



- The residual ratio can be -1 when $Track_p 0 = 0$ or $Track_p 0 \ll t_p$
- Alma9 seems to be underestimating the momentum of tracks much more than CENTOS7





- Simulation Validation Looks Okay?
- Genie Detour Finished. Roughly understood.
- Alma9 Validation Issues nothing too major?
- HistFitter Not working. Need time to understand and detangle the existing code.

