

October Update

Liverpool FASER Meeting

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October 3, 2025



Outline

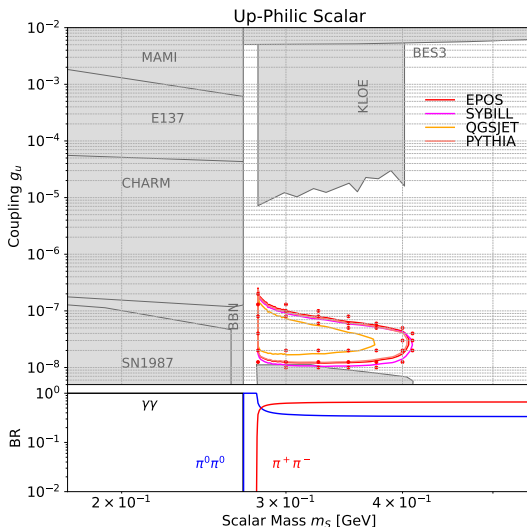
- Monte Carlo Production
- Neutrino Background for A' – Update

Monte Carlo Production

- Large Number of Samples pending
 - Flat A' samples
 - New Dark Photon Grid ($2 \times 90 = 190$ samples)
 - New Up-Philic Grid ($2 \times 30 = 60$ samples)
 - ALPs Samples

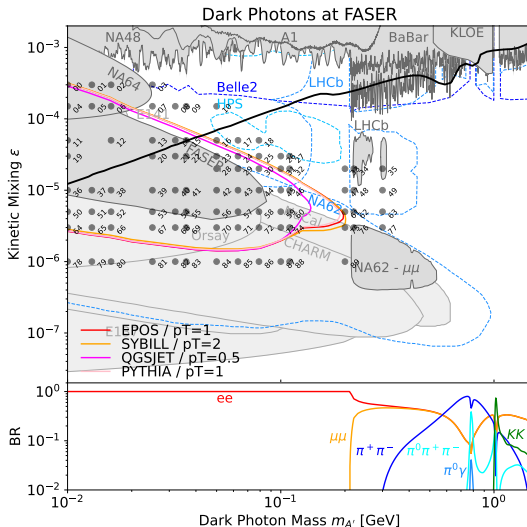
Monte Carlo Production

- Previously showed Up-Philic cutflows – Possible sensitivity
- Needed a new Grid for the Contours



Monte Carlo Production

- Updated Dark Photon Grid



Neutrino Background for A' – Recap

- Old Analysis used Genie-200005 Sample
 - High luminosity of 300 iab
 - But only contained interactions in the Timing/Trackers & $R < 100\text{mm}$
- Analysis with Default samples
 - Larger interaction volume but low luminosity of 10 iab
 - Showed that signal region could have events not seen by Genie'05
 - But did not have enough statistics to be sure
- New 100 iab Neutrino samples now produced
 - Similar interaction volume to Default sample
 - But smaller interaction volume $z > -2.2\text{m}$, $x,y < 250\text{ mm}$

Recap – Continued

Neutrino Cutflow for Two Track Analysis

Cut	Genie '05 [300 iab]		Genie Default [10 iab]		Genie 100 iab	
	Pass	Yield	Pass	Yield	Pass	Yield
Colliding BCID	30653	19.41	2784869	52912.51	10550908	20046.73
Timing Trigger	30653	19.41	2784869	52912.51	10550908	20046.73
Timing Not Saturated	29734	18.83	2513863	47763.40	8265696	15704.82
VetoNu_raw.charge $\leq$ 40	29728	18.83	1718872	32658.57	8184523	15550.59
Veto1_raw.charge $\leq$ 40	29584	18.74	1187065	22554.24	6232168	11841.12
Timing_raw.charge $>$ 70	7841	4.97	175653	3337.41	1191378	2263.62
Preshower_raw.charge $>$ 2.5	7508	4.76	68338	1298.42	586956	1115.22
At least one good track	673	0.43	2895	55.00	69139	131.36
At least two good tracks	142	0.09	39	0.74	691	1.31
Exactly two good tracks	95	0.06	29	0.55	538	1.02
Track_R $<$ 100	50	0.03	1	0.02	25	0.05
Track_R $<$ 95	45	0.03	1	0.02	19	0.04
Calo_E_EM.fudged $>$ 0 GeV	43	0.03	1	0.02	18	0.03
Calo_E_EM.fudged $>$ 50 GeV	35	0.02	1	0.02	13	0.02
Calo_E_EM.fudged $>$ 100 GeV	29	0.02	1	0.02	9	0.02
Calo_E_EM.fudged $>$ 250 GeV	16	0.01	0	0.00	6	0.01
Calo_E_EM.fudged $>$ 500 GeV	11	0.01	0	0.00	2	0.00
Calo_E_EM.fudged $>$ 1 TeV	6	0.00	0	0.00	1	0.00

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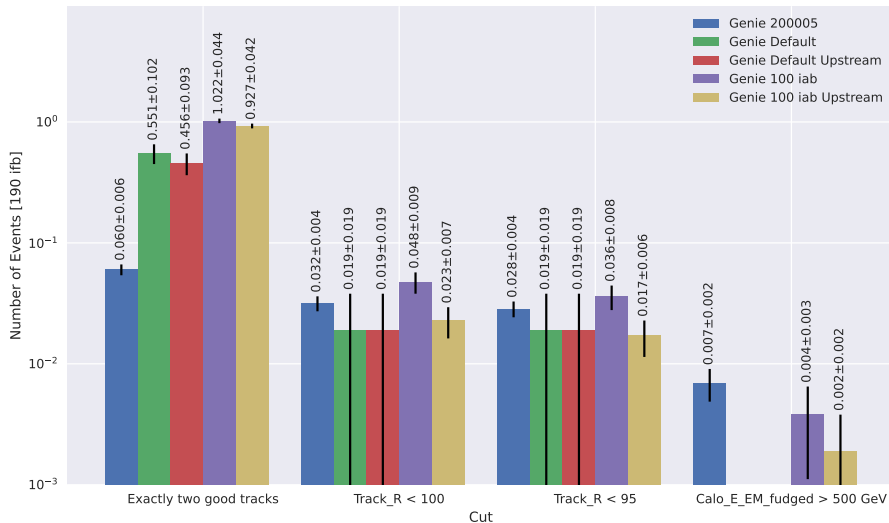
- Yield significantly different between samples – Difference in volume?
 - Genie '05 – Timing/Trackers & $R < 100\text{mm}$
 - Genie Default/100iab – More tracks from interactions in magnet
 - Not sure why Genie Default has less tracks than 100 iab sample?
 - Mostly mitigated by Track_R cut

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Calo_E_EM_fudged > 500 GeV	11	0.01	0	0.00	2	0.00(4)
Calo_E_EM_fudged > 1 TeV	6	0.00	0	0.00	1	0.00(2)

- Genie 100 iab has low stats after 250 GeV cut.
- Genie '05 sample predicts 11 events in the SR (18 with correction)
- Genie 100 iab seems to underpredict? – Low stats?
- Even if we simulate a 300 iab sample we would expect around 6 events?

Neutrino Cutflow for Two Track Analysis



Neutrino Cutflow for One Track Analysis

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Timing_raw_charge $>$ 70	7841	4.97	175653	3337.41	1191378	2263.62
Preshower_raw_charge $>$ 2.5	7508	4.76	68338	1298.42	586956	1115.22
At least one good track	673	0.43	2895	55.00	69139	131.36
Track_R $<$ 100	399	0.25	33	0.63	289	0.55
Track_R $<$ 95	363	0.23	31	0.59	240	0.46
Calo_E_EM.fudged $>$ 0 GeV	333	0.21	25	0.47	239	0.45
Calo_E_EM.fudged $>$ 50 GeV	186	0.12	17	0.32	117	0.22
Calo_E_EM.fudged $>$ 100 GeV	158	0.10	15	0.28	94	0.18
Calo_E_EM.fudged $>$ 250 GeV	103	0.07	5	0.10	52	0.10
Calo_E_EM.fudged $>$ 500 GeV	58	0.04	3	0.06	25	0.05
Calo_E_EM.fudged $>$ 1 TeV	26	0.02	1	0.02	6	0.01

Neutrino Cutflow for One Track Analysis

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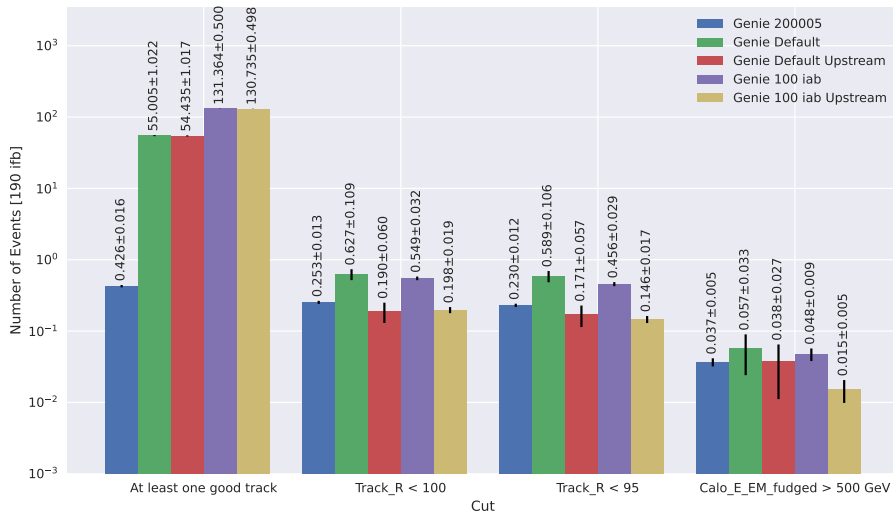
- Similar to two track case
 - Difference in volume probably leads to a difference in number of tracks
- Suprisingly not mitigated by Track_R cut
 - Genie Default/100iab seem to overpredict the number of fiducial tracks
 - Interactions in decay volume magnets can give good fiducial tracks
 - Not sure if the difference between Default and 100 iab is significant.

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- Not so much struggle for stats here – 25 events in SR
- Overall Genie '05 underpredicts – Probably from the mismodelling(?)

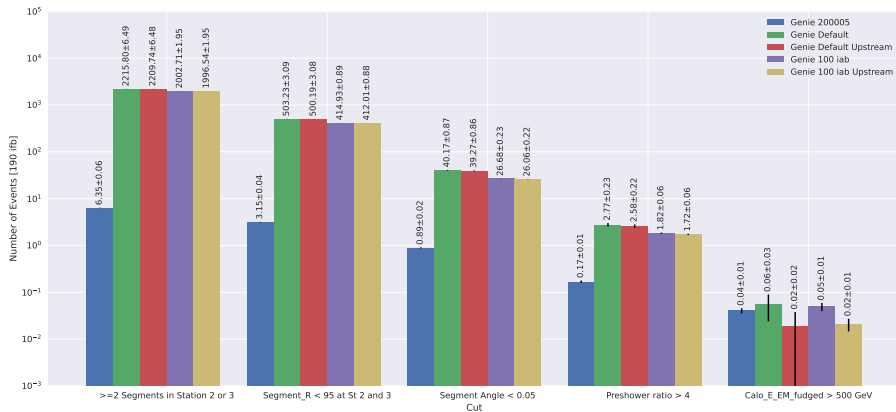
Neutrino Cutflow for One Track Analysis



Neutrino Cutflow for Segment Analysis

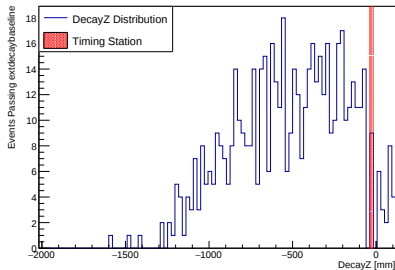
Cut	Genie '05 [300 iab]		Genie Default [10 iab]		Genie 100 iab	
	Pass	Yield	Pass	Yield	Pass	Yield
Colliding BCID	30653	19.41	2784869	52912.51	10550908	20046.73
No long tracks	28916	18.31	2626138	49896.62	10018552	19035.25
VetoNu_raw_charge ≤ 40	28910	18.31	1870717	35543.62	9901747	18813.32
Veto1_raw_charge ≤ 40	28753	18.21	1328451	25240.57	7499809	14249.64
≥ 2 Segments in Station 2 or 3	10021	6.35	116621	2215.80	1054059	2002.71
Segment_R < 100 at St 2 and 3	6016	3.81	32081	609.54	267645	508.53
Segment_R < 95 at St 2 and 3	4969	3.15	26486	503.23	218384	414.93
Segment Angle < 0.05	1405	0.89	2114	40.17	14043	26.68
Preshower ratio > 4	265	0.17	146	2.77	959	1.82
Calo_E_EM_fudged > 0 GeV	262	0.17	134	2.55	948	1.80
Calo_E_EM_fudged > 50 GeV	220	0.14	25	0.47	148	0.28
Calo_E_EM_fudged > 100 GeV	194	0.12	14	0.27	95	0.18
Calo_E_EM_fudged > 250 GeV	113	0.07	7	0.13	49	0.09
Calo_E_EM_fudged > 500 GeV	64	0.04	3	0.06	26	0.05
Calo_E_EM_fudged > 1 TeV	35	0.02	0	0.00	10	0.02

Neutrino Cutflow for Segment Analysis

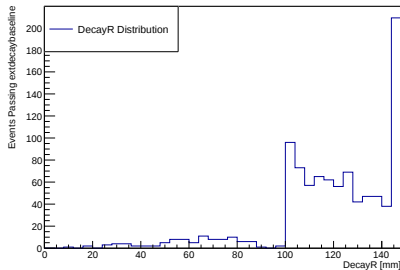


Segment Analysis w/o Calo Cut

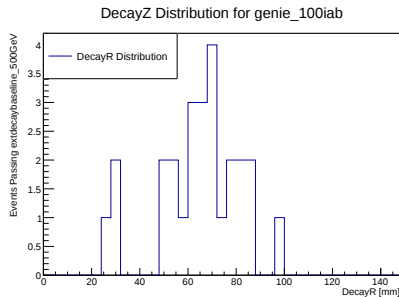
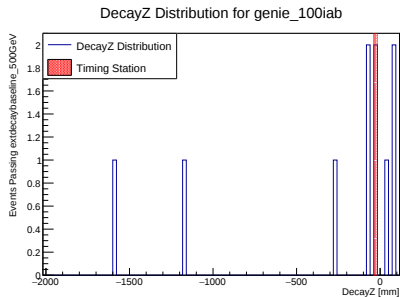
DecayZ Distribution for genie_100iab



DecayZ Distribution for genie_100iab



Neutrino Cutflow for Segment Analysis



Summary and Next Steps

- First look at Neutrino Background for A' with new sample
 - Overall better statistics than 10 iab samples
 - Some differences with the previous samples to be investigated
 - Make event displays to investigate
- Monte Carlo Production
 - Slow but steady
 - New samples being produced

Backup