Status report on

DNN ROI in PD-HD

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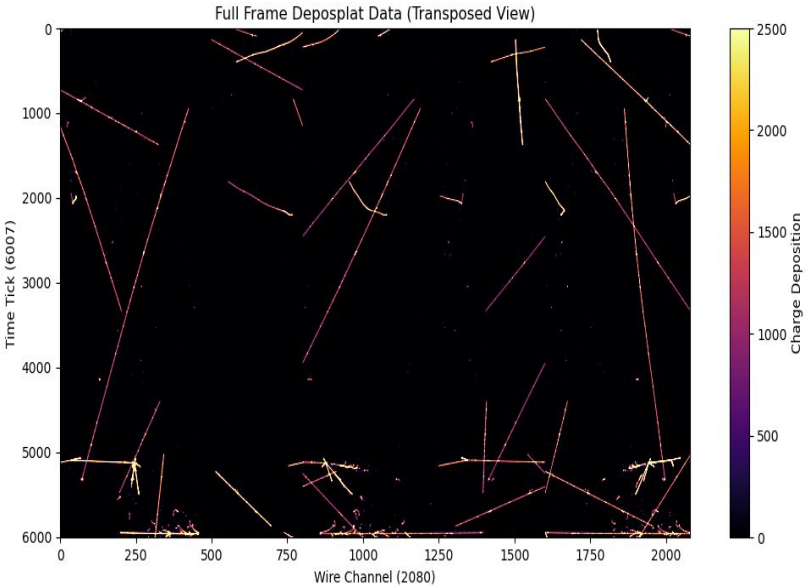
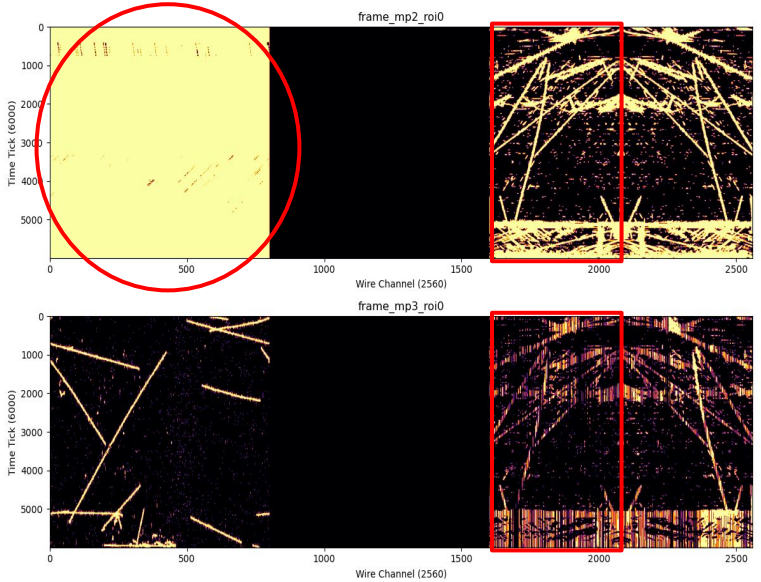
Outline

- Current Challenges for the PD-HD APA1
- DNN ROI performance evaluation
  - Single track simulation with varying ThetaXZ angle
- Summary & Plan

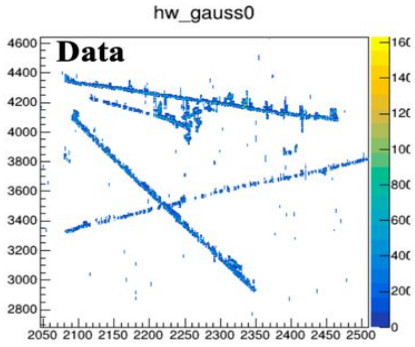
MP2 ROI Anomalies



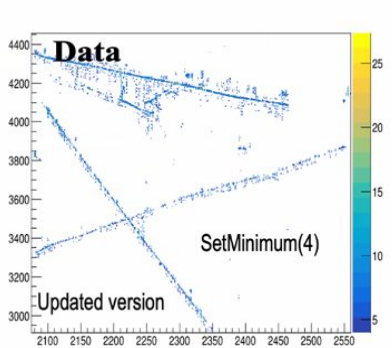


- Cosmic-ray simulation using Xuyang's field response for APA1
- Wire Channel: U (induction) 800 + V (collection) 800 + W 480
- MP3 ROI shows symmetry about wire channel 2080
- The MP2 ROI needs correction: poor S/N ratio → MP2/3 thresholds should be optimized

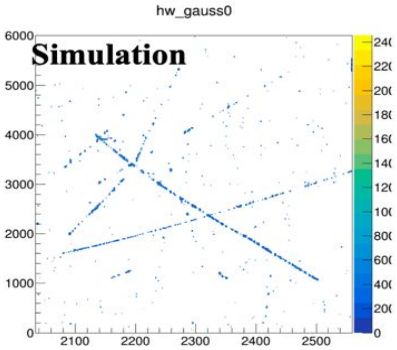
Discrepancies Between Data and Simulation



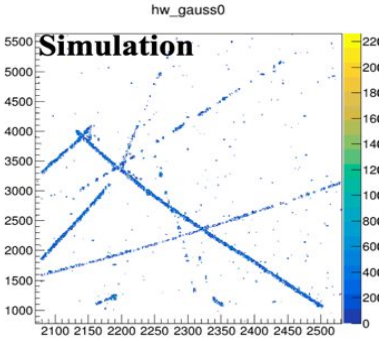
By Wenqiang with hard filtering on FR



By Xuyang with soft filtering

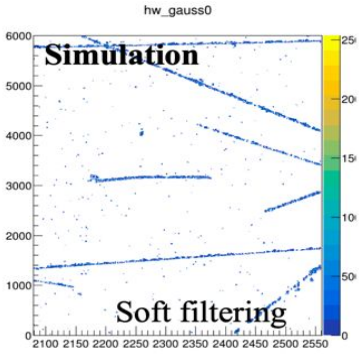


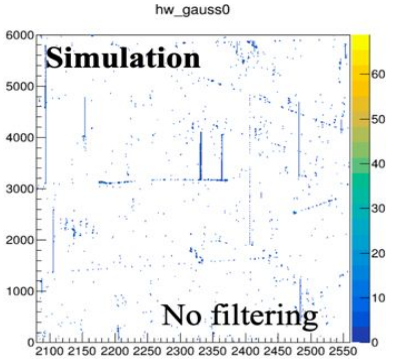
Hard filtering



Soft filtering

- There are spikes and scattered patterns along the tracks
- Hard filtering improves reconstruction in data, but not in simulation
- This contrast reveals a mismatch between data and MC





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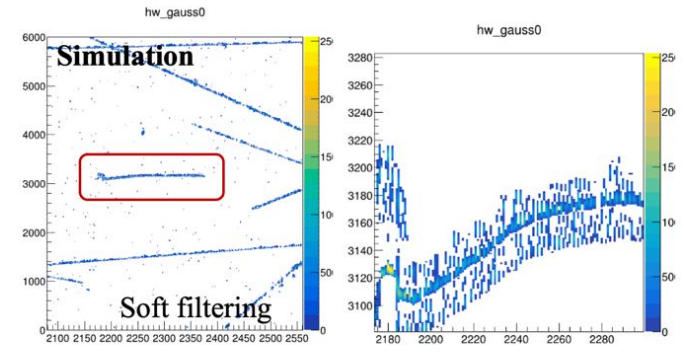
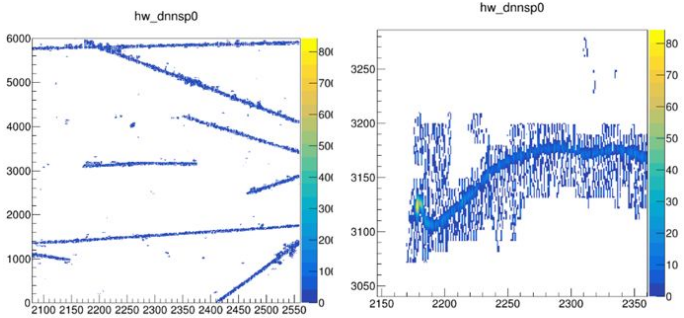
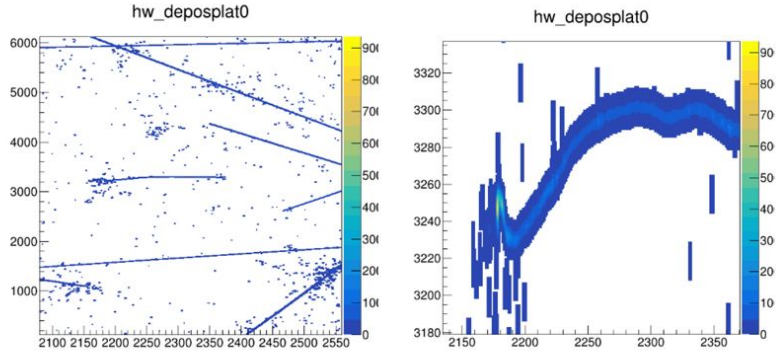


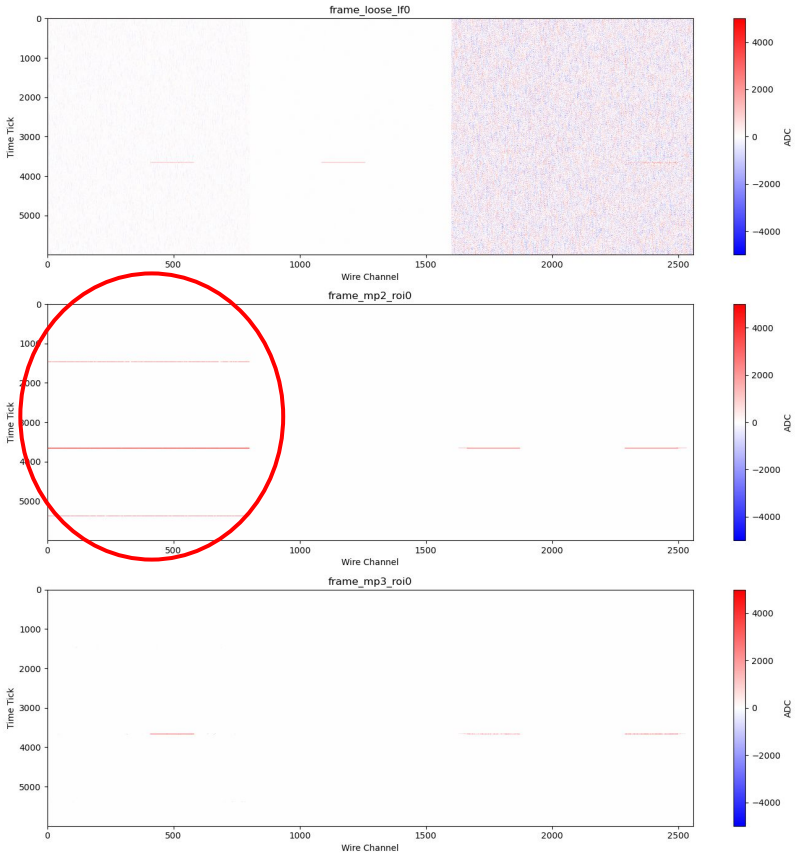




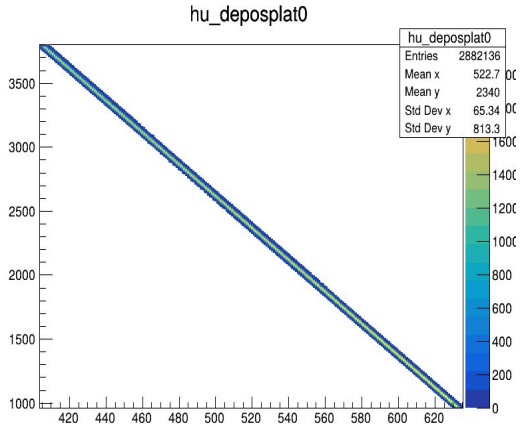
- Compared to the truth, the decon shows disconnections and scatters along the track
- The DNN reduces the disconnections but retains the surrounding spread
- These findings complicate a direct comparison of DNN SP performance in data and simulation

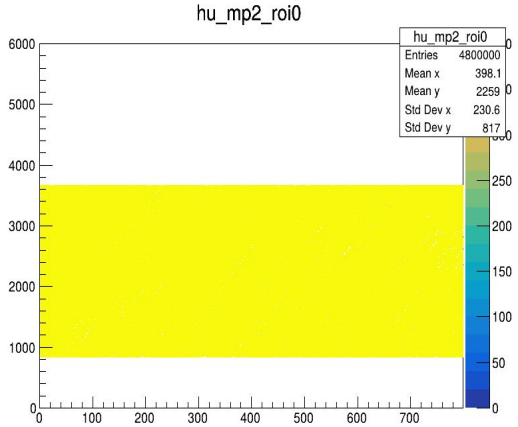
Evaluating DNN SP sensitivity to track angle

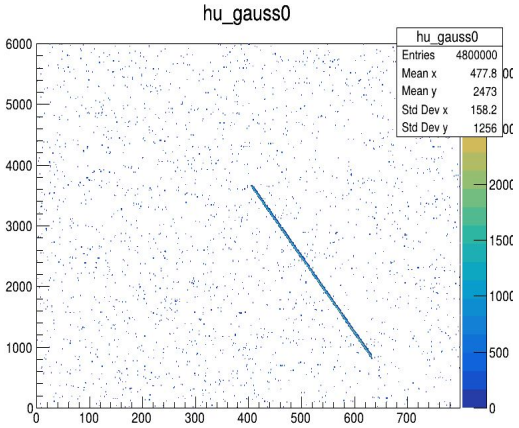
- Performed single track simulations to investigate how the DNN SP performance depends on the track angle ThetaXZ
- Weight file: unet-cosmic390-newwc-depofluxsplat-pdhd.ts
- ThetaXZ =
  0 °, 10 °, 20 °, 30 °, 40 °, 50 °, 60 °, 70 °, 80 °, 85 °
- elecGain = 14 mV/fC
- The MP2 ROI problem is more clearly seen the horizontal track (ThetaXZ = 0) case

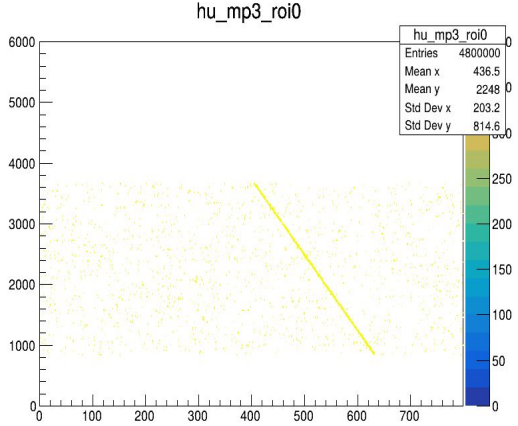


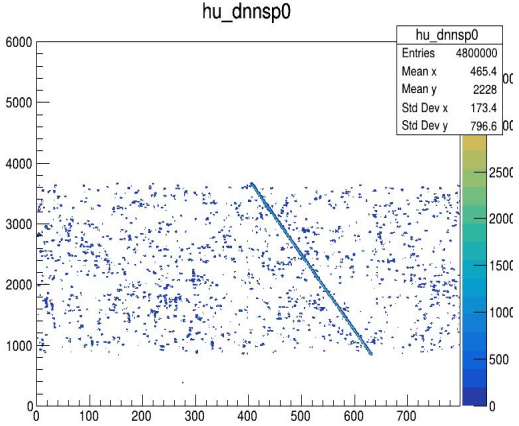
Evaluating DNN SP sensitivity to track angle





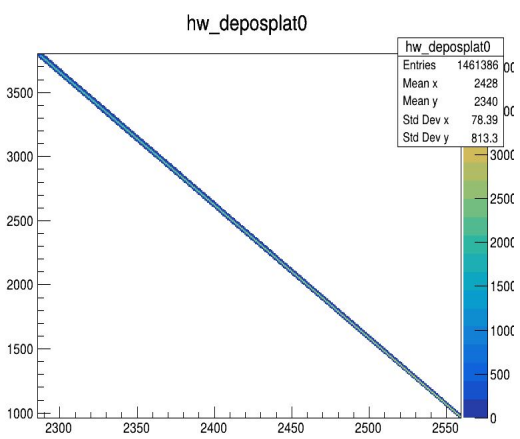


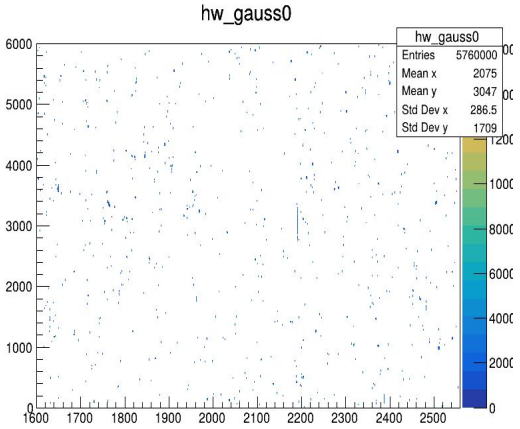


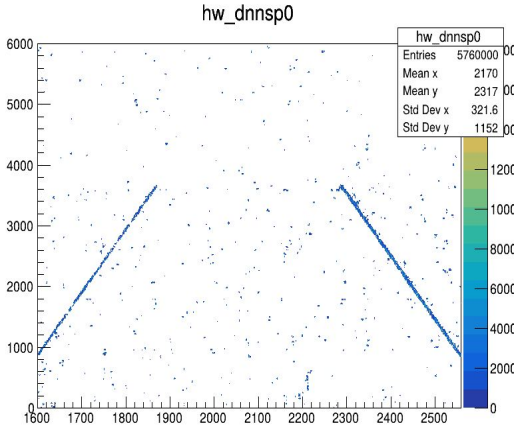


- U plane, thetaXZ= 60
- The covered region in MP2 affects the noise level in specific areas of hu_dnnsp

Evaluating DNN SP sensitivity to track angle

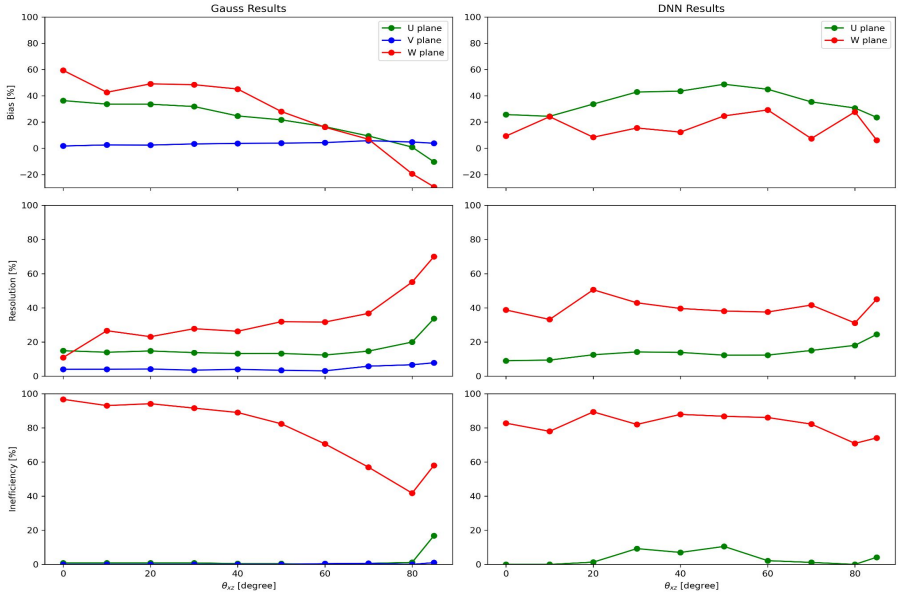




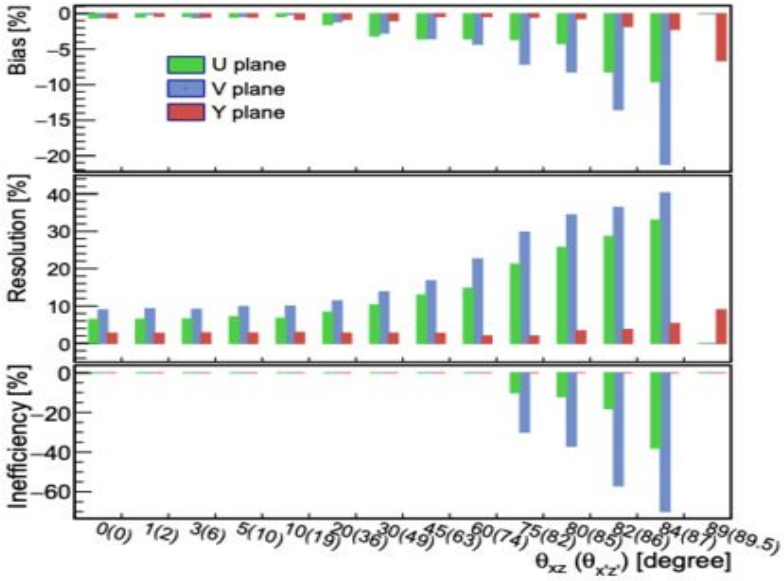


- W plane, thetaXZ= 60
- A “Fake” track in red circle affects the inefficiency

Evaluating DNN SP sensitivity to track angle



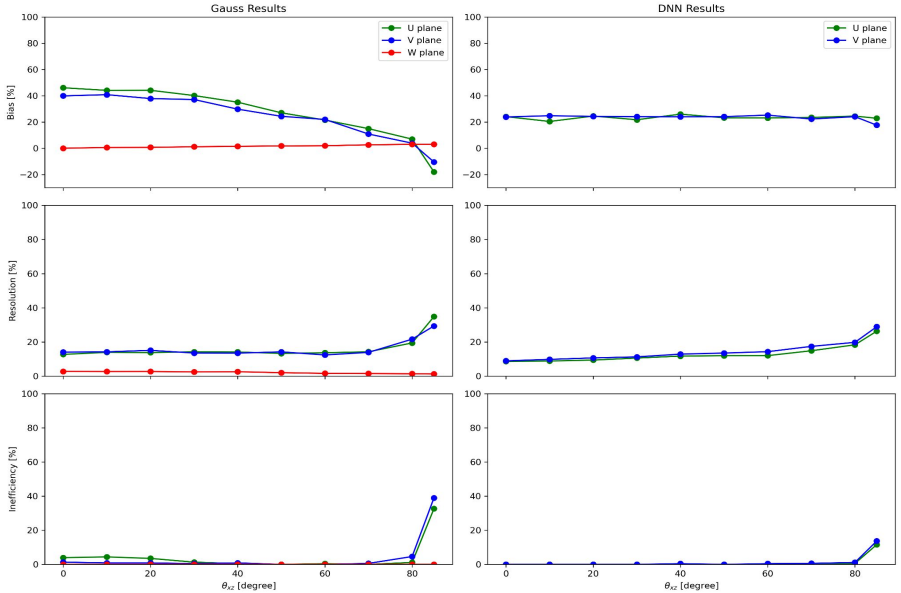
❑ PD-HD APA1



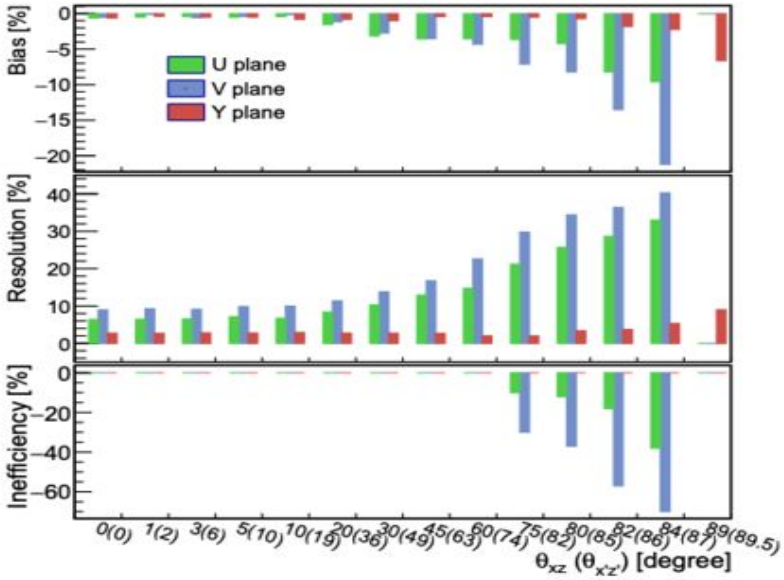
❑ MicroBooNE
https://arxiv.org/pdf/1802.08709

- Gaussian Bias is getting lower as the ThetaXZ increases
- More samples in high ThetaXZ are needed to check if DNN SP performs better than Traditional SP
- For W plane, the fake tracks should be removed to have better performance

Evaluating DNN SP sensitivity to track angle



❑ PD-HD APA2



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Summary & Plan

- MP2 ROI anomalies such as poor S/N ratio and asymmetry were identified, requiring threshold tuning

- Gaussian bias decreases with increasing ThetaXZ, but more high-angle samples are needed to confirm whether DNN SP consistently outperforms traditional SP

- Train DNN models using samples generated with APA1 field response

- Evaluate DNN SP performance on both cosmic-ray simulation and real data

Back Up

DNN SP evaluation w/ single track simulation (WCT standalone)

Plane	Eval	Type	ThetaXZ in Degree									
			0 (%)	10 (%)	20 (%)	30 (%)	40 (%)	50 (%)	60 (%)	70 (%)	80 (%)	85 (%)
U	Bias	Gau.	36.36	33.68	33.62	31.85	24.69	21.71	16.51	9.42	0.96	-10.26
		DNN	25.75	24.39	33.72	42.89	43.59	48.81	45.00	35.38	30.70	23.58
	Resol	Gau.	14.88	13.96	14.70	13.74	13.22	13.26	12.33	14.62	19.94	33.64
		DNN	9.00	9.37	12.49	14.14	13.86	12.26	12.30	15.01	18.00	24.43
	Ineffi	Gau.	2/227	2/227	2/227	2/227	1/228	1/228	0/228	1/170	2/174	16/95
		DNN	0/227	0/227	3/227	2/227	16/228	24/228	5/228	2/170	0/174	4/95

$$\text{Bias}_{\text{method}} = 100 \times (\text{Mean}(Charge_{\text{method}}/Charge_{\text{truth}}) - 1.0)$$

$$\text{Resolution} = 100 \times \frac{\text{RMS}(Charge_{method}/Charge_{truth})}{\text{Mean}(Charge_{method}/Charge_{truth})}$$

DNN SP evaluation w/ single track simulation (WCT standalone)

Plane	Eval	Type	ThetaXZ in Degree									
			0 (%)	10 (%)	20 (%)	30 (%)	40 (%)	50 (%)	60 (%)	70 (%)	80 (%)	85 (%)
W	Bias	Gau.	59.37	42.70	49.11	48.47	45.16	28.04	16.11	6.92	-19.36	-29.27
		DNN	9.35	24.12	8.47	15.51	12.39	24.71	29.25	7.44	27.77	6.20
	Resol	Gau.	10.88	26.58	23.07	27.75	26.26	31.86	31.63	36.73	55.06	69.98
		DNN	38.72	33.15	50.56	42.93	39.60	38.11	37.53	41.60	31.12	45.05
	Ineffi	Gau.	263/272	253/272	256/272	249/272	242/272	224/272	192/272	115/202	86/206	65/112
		DNN	225/272	212/272	243/272	223/272	239/272	236/272	234/272	166/202	146/206	83/112

- Gaussian Bias is getting lower as the ThetaXZ increases
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Discrepancies Between Data and Simulation