Taking a quick look at SPINE for atmospheric neutrinos

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DEEP UNDERGROUND NEUTRINO EXPERIMENT

CERN

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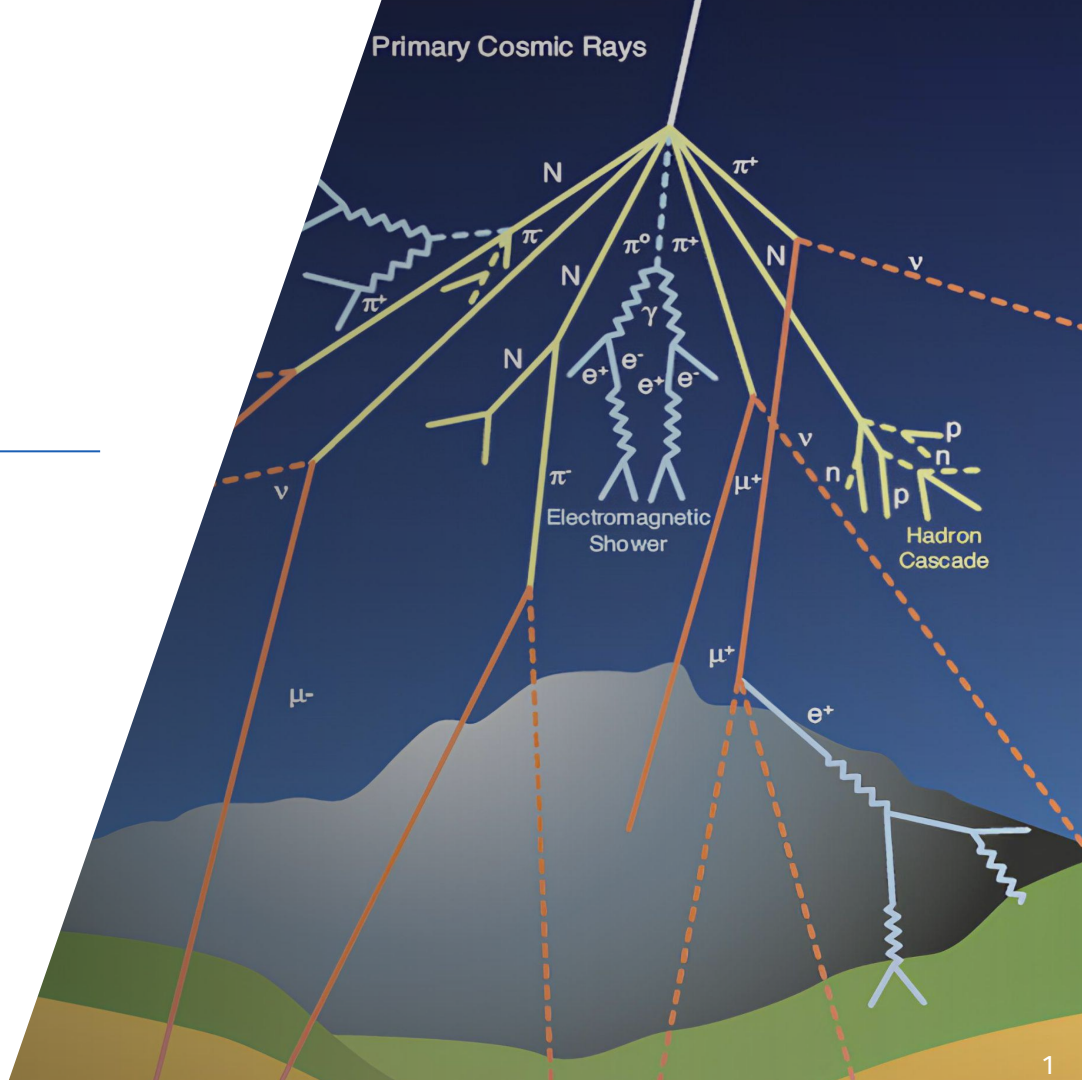
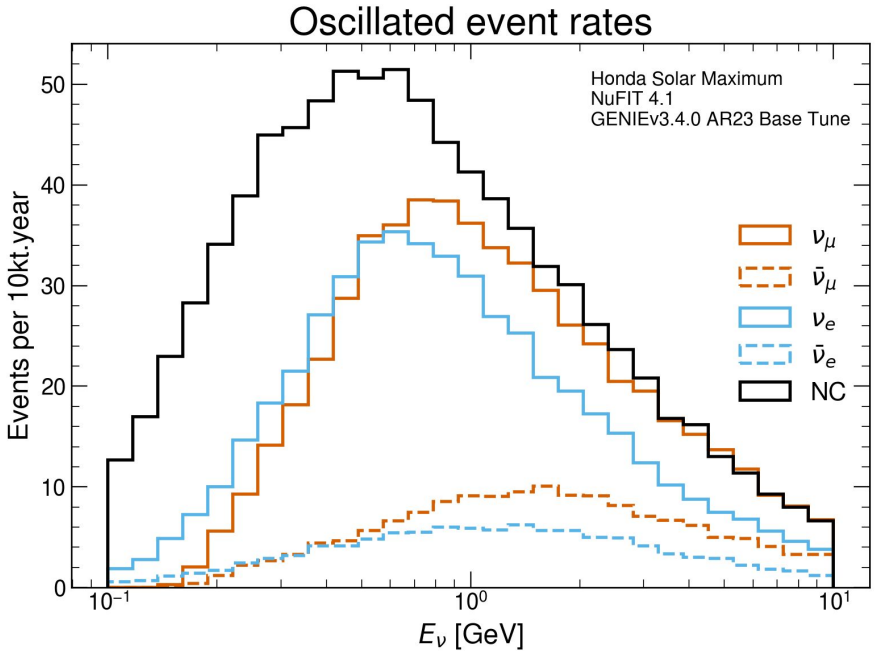


Analysis setup

- Using the official atmospheric neutrino sample (0.1 – 10 GeV ; isotropic ; no oscillation ; CC & NC)

- Re-running hit finding, cluster3D and supera with the newest settings (e.g. long hits modifications) on a sub-sample (~100k events)

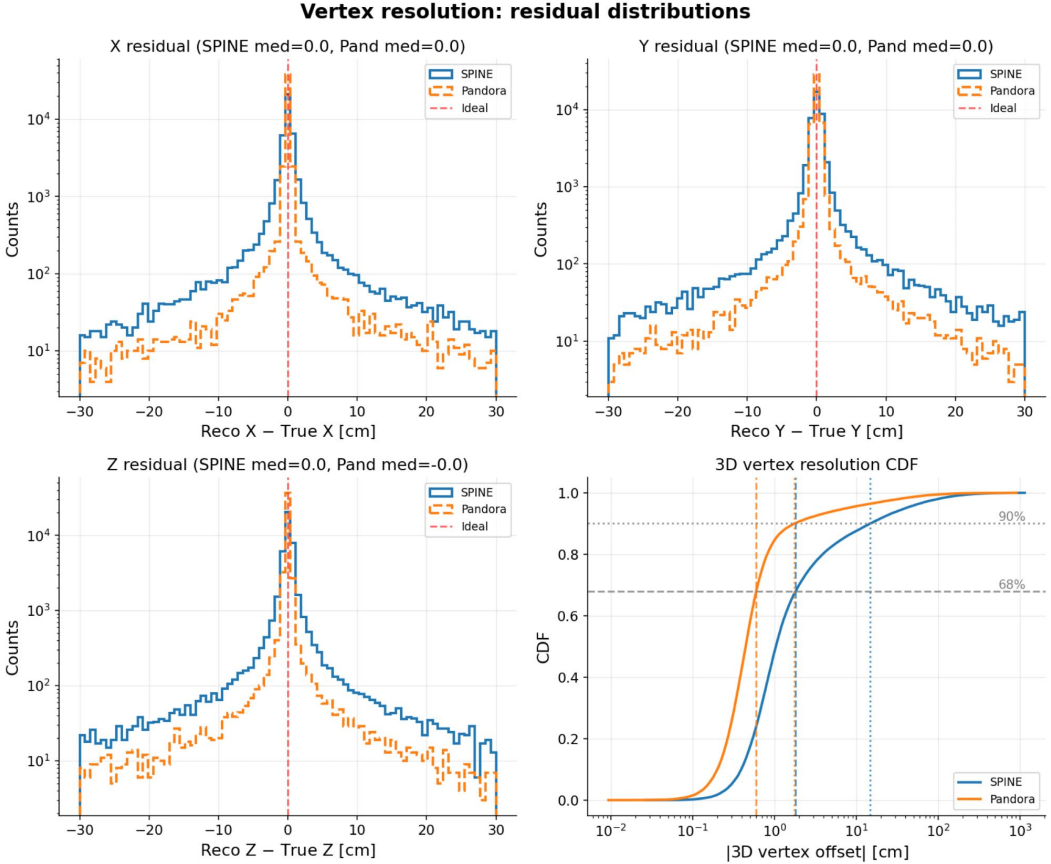
- Running SPINE inference with the newest weights *full_chain_260510.yaml*



Vertex resolution: global results

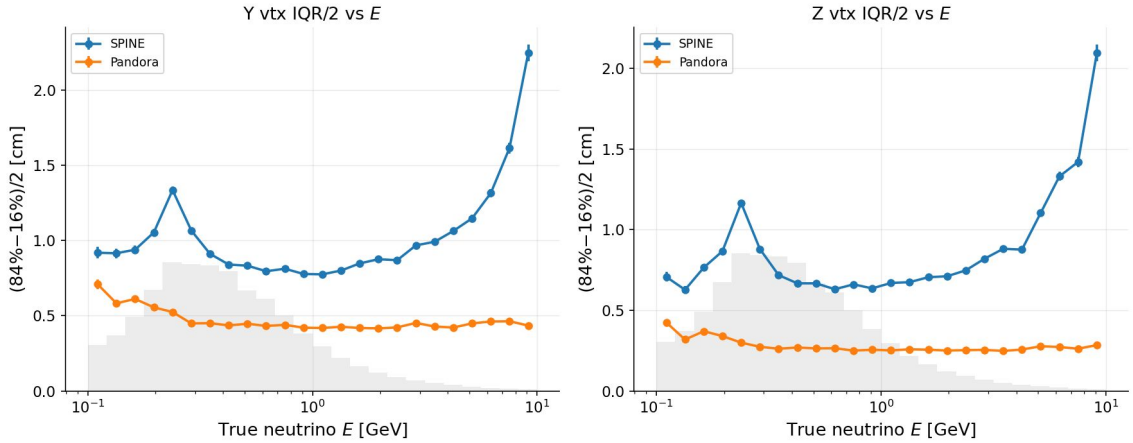
- Worse vertex resolution compared to Pandora
- Some small bias too (Y-axis)
- Note that Pandora is really fine-tuned to very well reconstruct the vertex

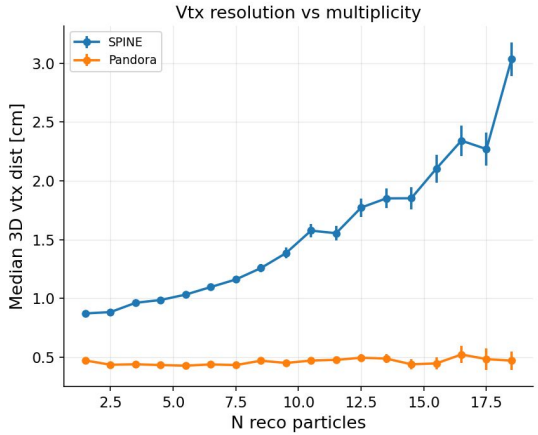
Metric	SPINE	Pandora
3D 68% [cm]	1.82	0.60
3D 90% [cm]	14.80	1.76
X residual med [cm]	-0.13	-0.03
Y residual med [cm]	0.57	0.29
Z residual med [cm]	0.45	0.17



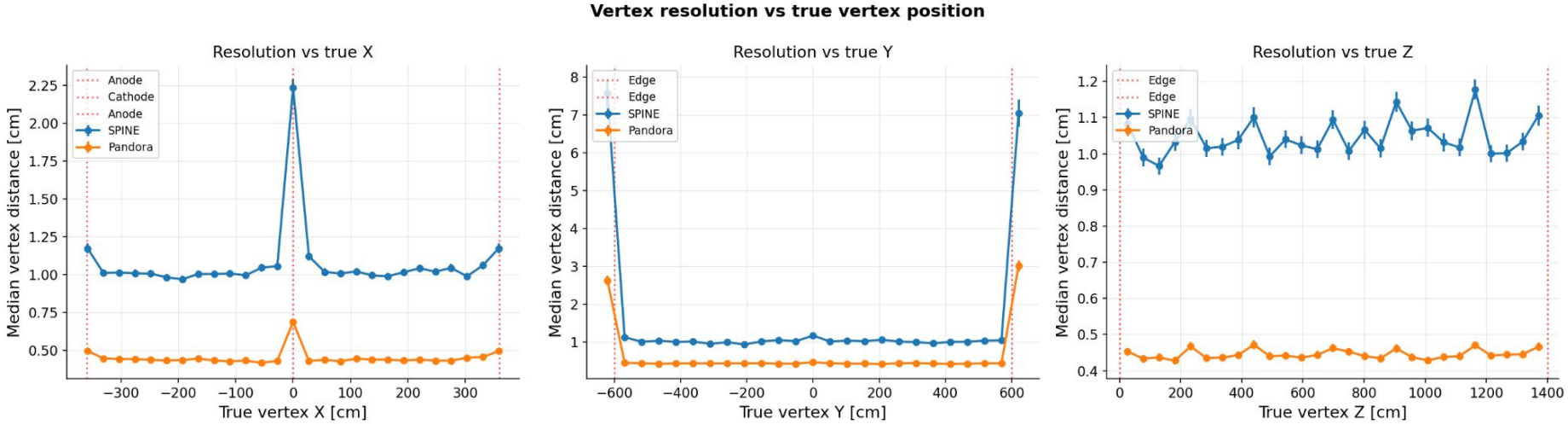
Vertex resolution: looking in details

- While Pandora vertex resolution is relatively flat with energy, SPINE doesn't like low-E and high-E
- Vertex resolution seems totally correlated to the number of particles for SPINE. Actually how is the vertex reconstructed?
- Funny peak ~200MeV, which seems link to the start of ν_μ CC.





Vertex resolution: looking in details

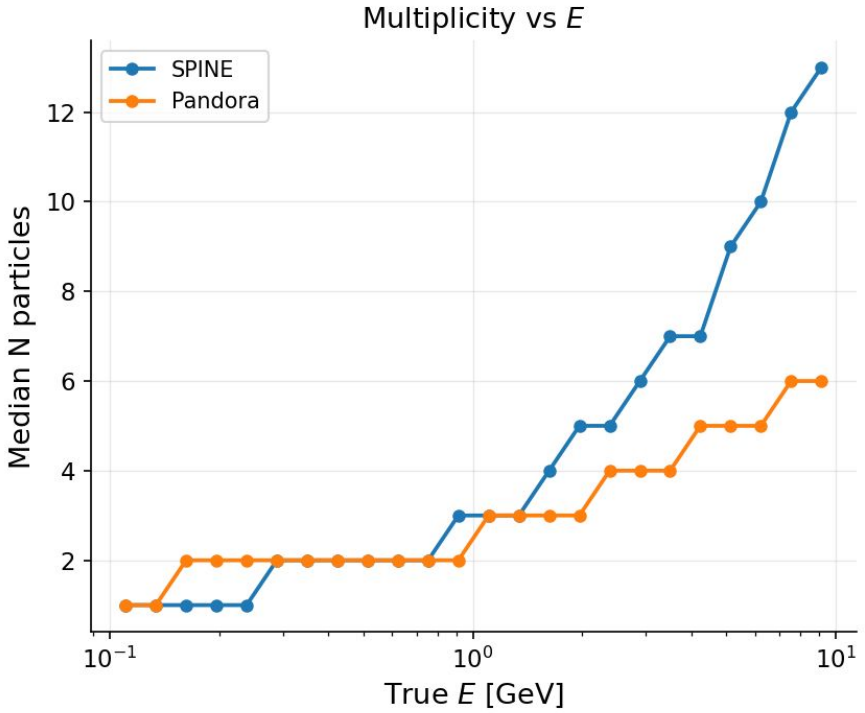


- Position dependence as expected, worsens more near the edges than Pandora
- Relative worsening seems more important than Pandora
- NB: Pandora knows that the vertex is inside the cryostat (no cosmic option)

Number of reconstructed particles

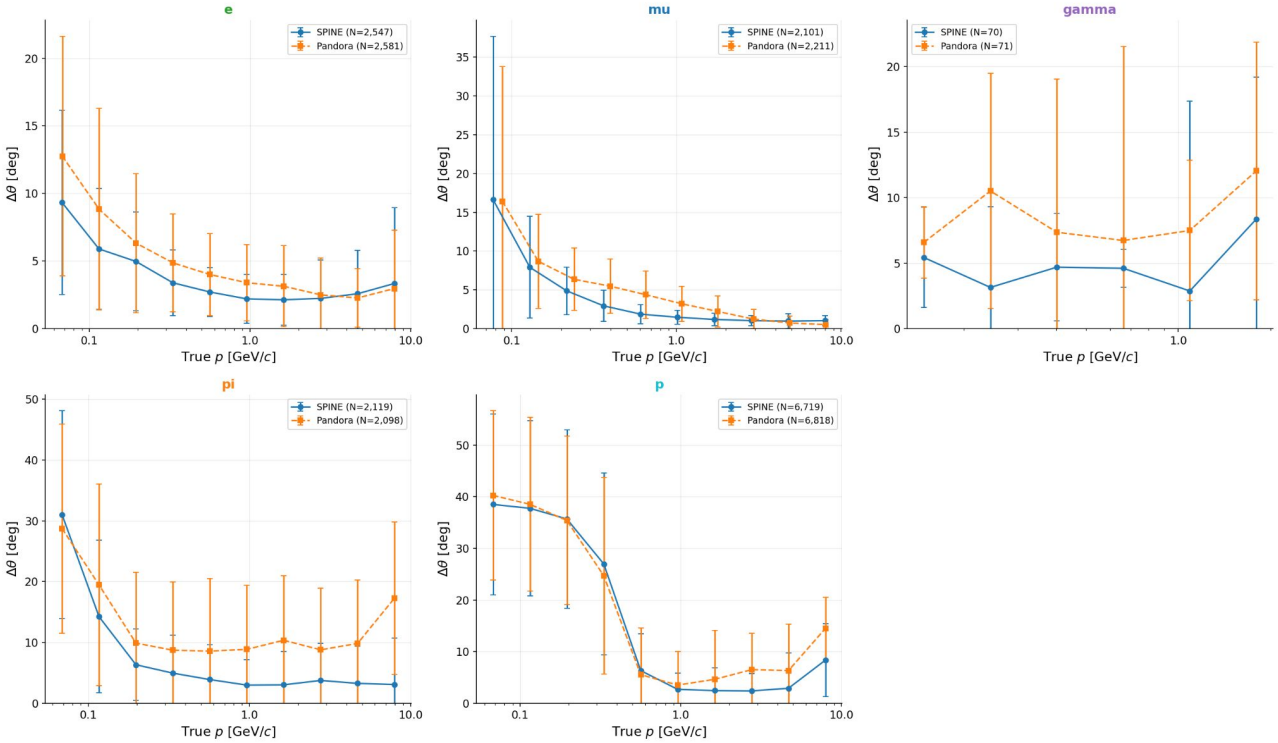
- SPINE seems to reconstruct more particles at higher energies (known blobification effect from Pandora)

- It might struggle a bit more at lower energies to see some low-E particles

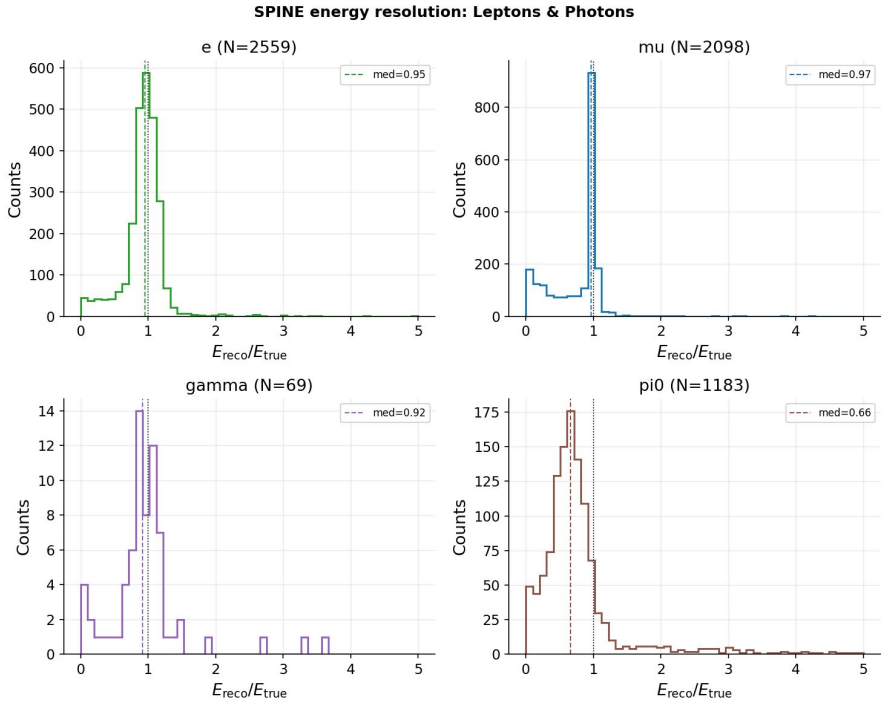


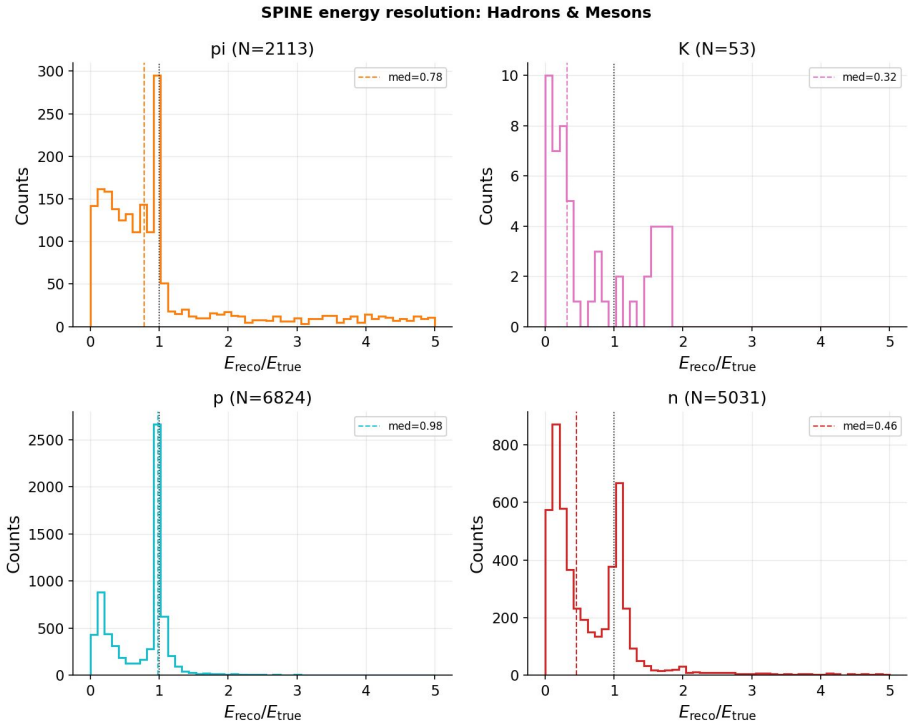
Particle-level angular resolution

Consistently outperforming Pandora for particle direction



Particle's energy resolution

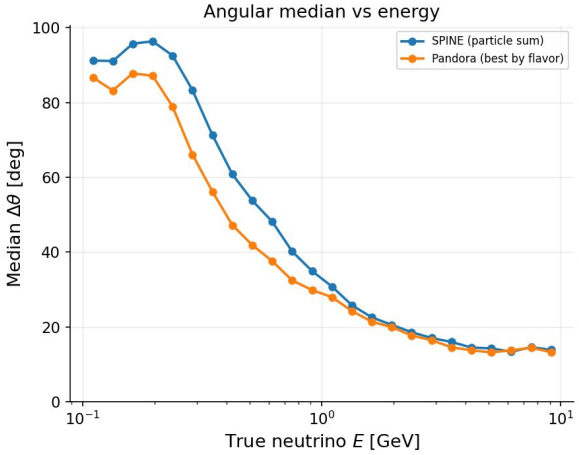


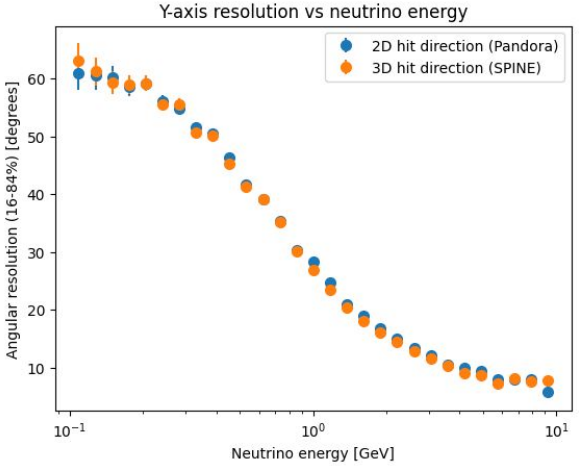


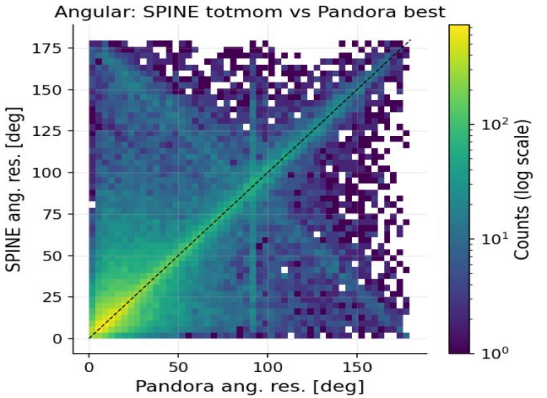
Neutrino direction

Reco methods:

- “Pandora”:
  - Sum of momenta (with some specific selection, see backup)
  - “Energy direction” fits in 2D hit views
- SPINE:
  - Sum of momenta, taken as they are from SPINE
  - “Energy direction” from 3D reconstructed voxels





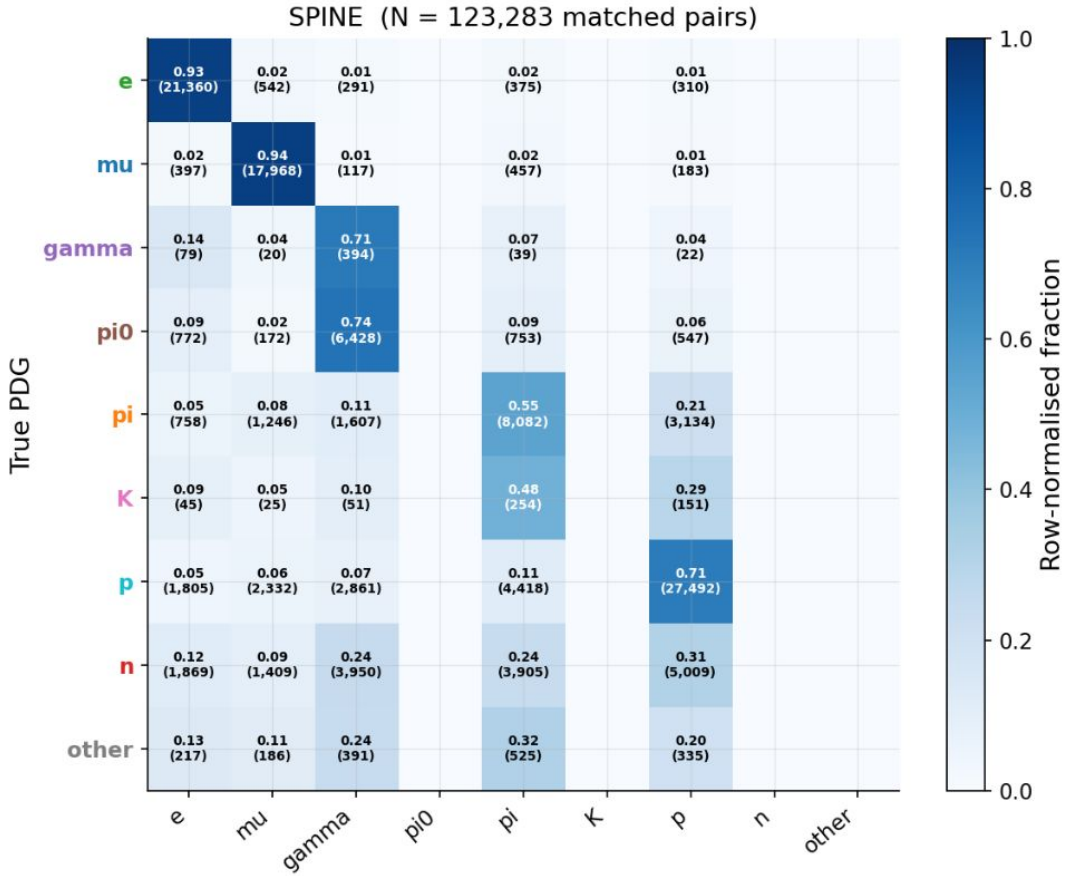


Conclusions:

- Sum of momenta is better with Pandora (why?)
- 3D “energy direction” seems better -> good!

Particle-level PID

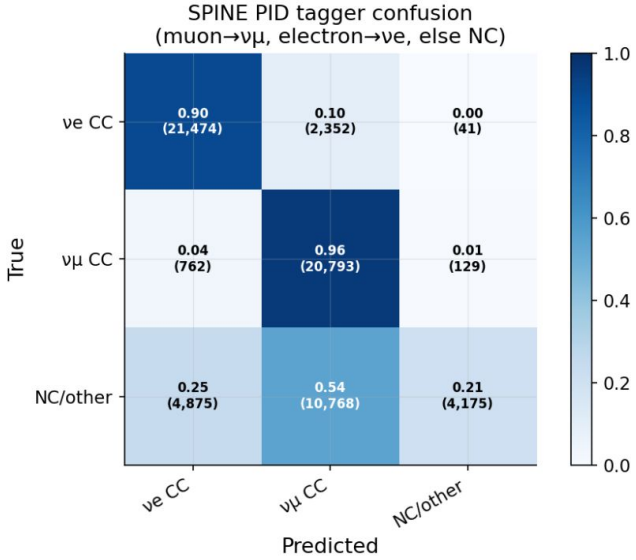
Very good PID!

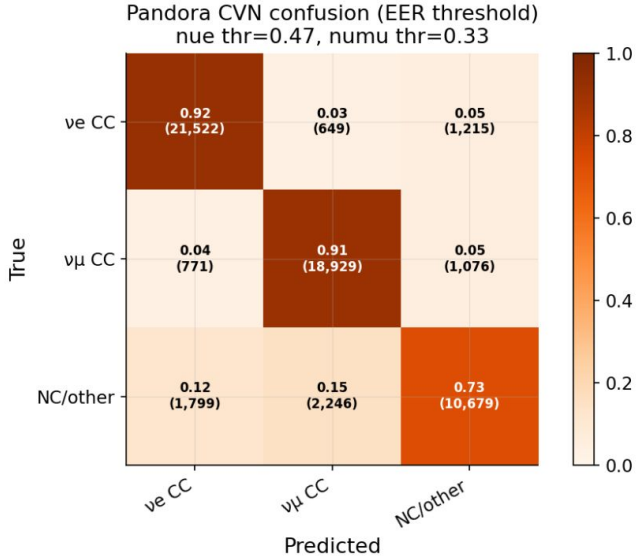


Neutrino flavour ID

SPINE seems to want to see a muon in many NC interactions

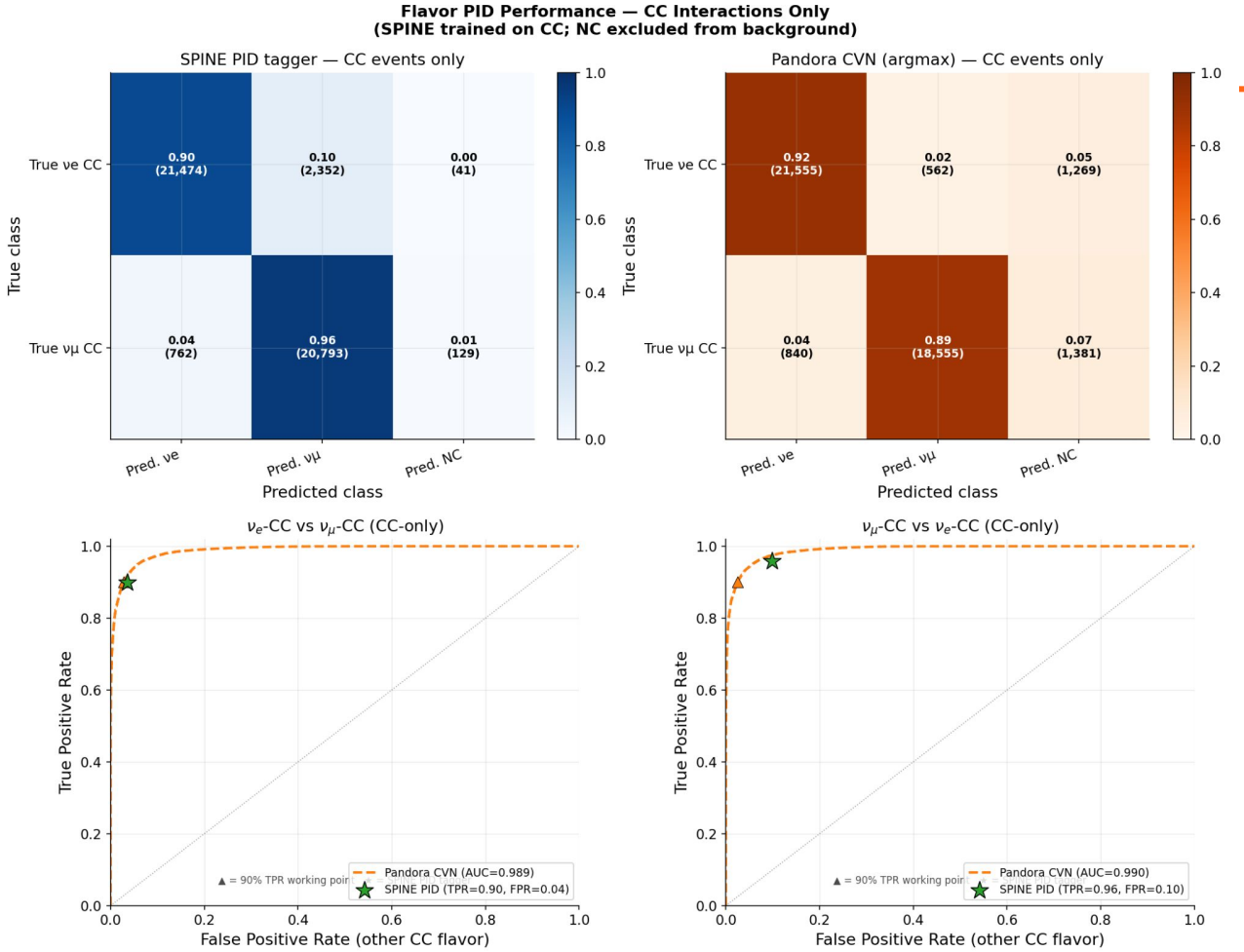
-> Very likely linked to the training sample not including any NC-like interaction (w.o. any lepton)





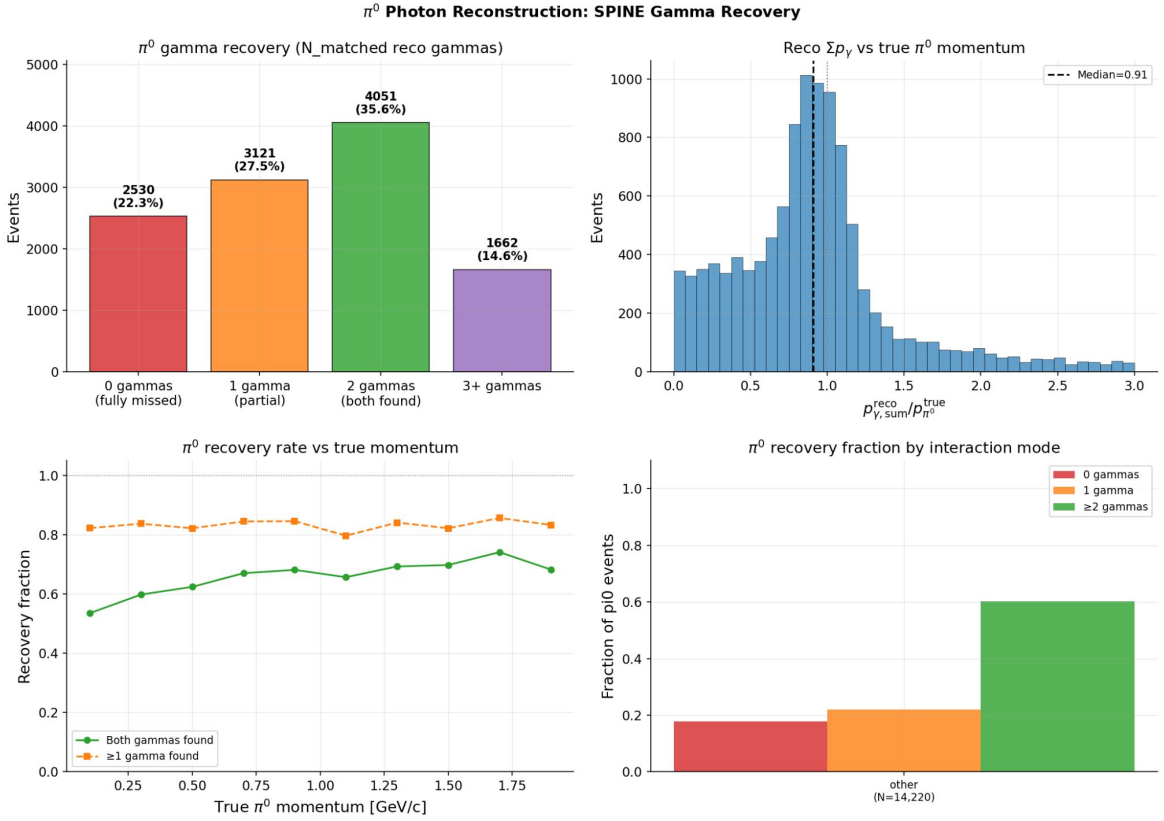
Neutrino flavour ID

Looking only at the CC cases seem quite convincing (comparison a bit unfair though)



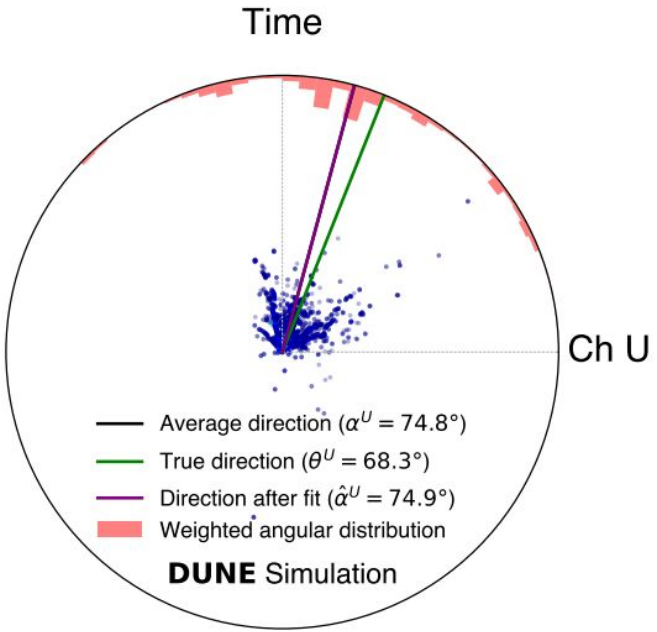
A quick look at π_0

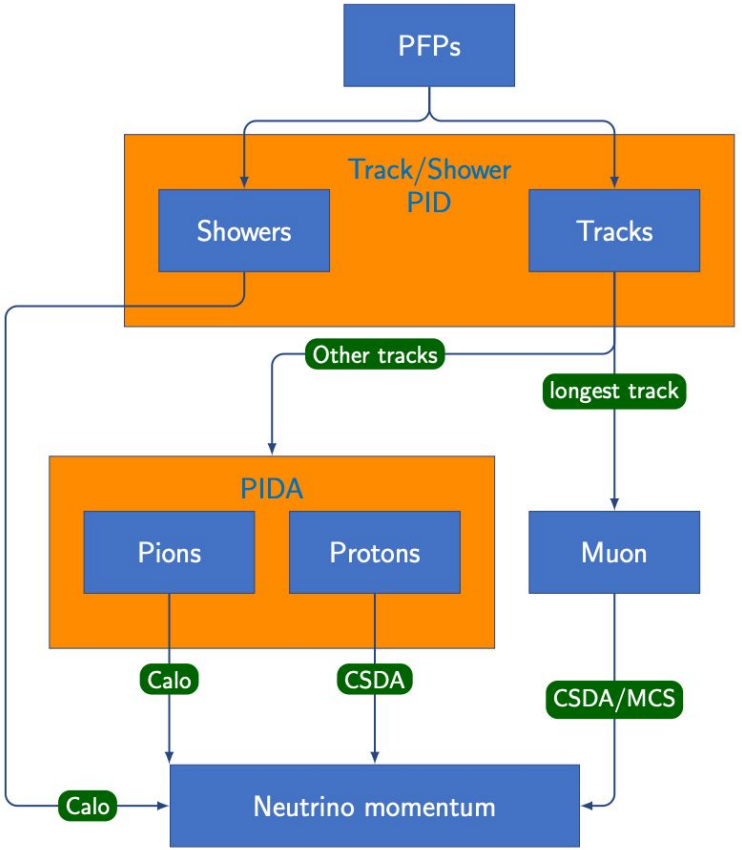
Looks decent while imperfect



BACKUP

Direction reconstruction with Pandora





Energy vs angular resolution