

Update on SAND reconstructed samples

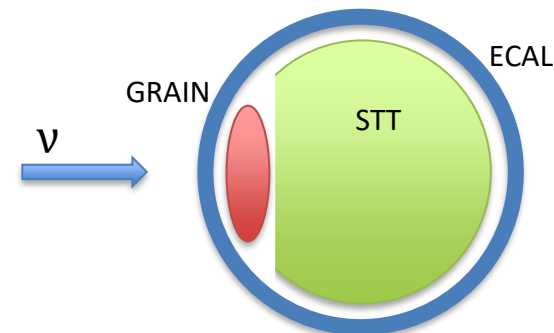
Matteo Vicenzi

LBL WG Meeting

July 25th, 2022

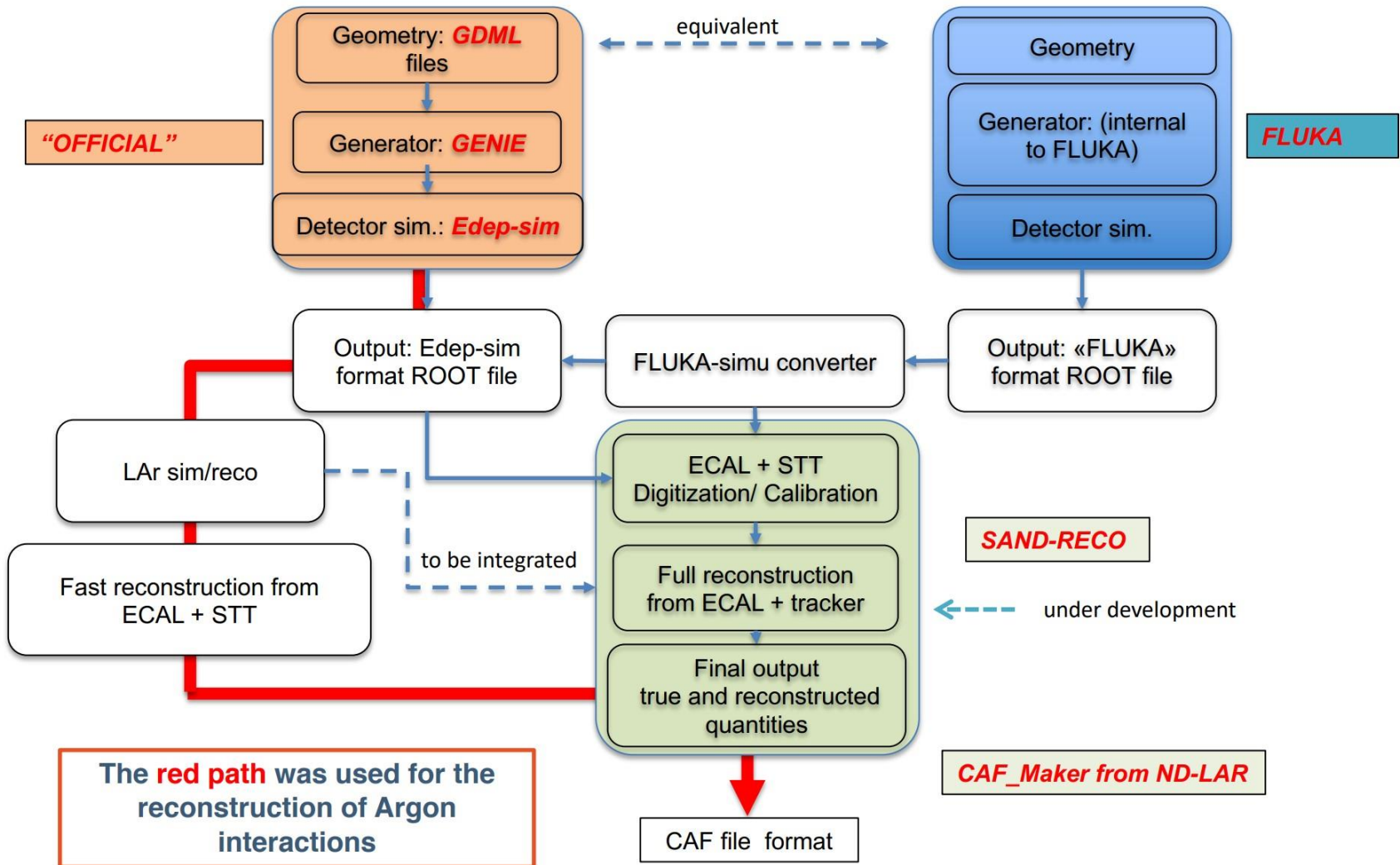


Samples in LAr



- FHC neutrino interactions in GRAIN.
- Moderate statistics ($\sim 10^5$ events) [1 yr. FHC $\sim 12 \cdot 10^6$ evts]
- Exclusive ν_μ channels extracted at GENIE-level, according to true charged pion multiplicity
 - $0\pi Np$
 - $1\pi Np$
 - $2\pi Np$
 - $>2\pi Np$
- Propagation: EDepSim + OptMen
- Reco: GRAIN reco (lar-lenses) + FastReco w/ GRAIN input

Software flowchart

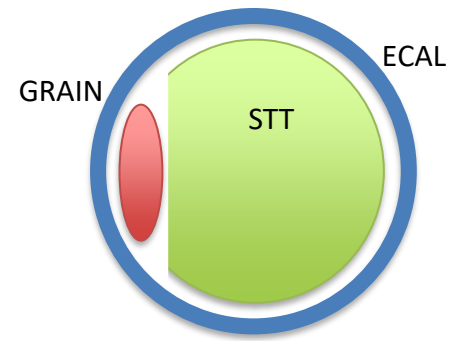


Reconstruction

- For charged particles, information from GRAIN, STT and ECAL depending on what is available.
 - **GRAIN**: image-based reco w/ lenses for vertex and 3D direction, 20% smear on true energy deposit.
 - **STT**: min 6 hits in ZY planes, Gluckstern formula on momentum at STT entrance.
 - **ECAL**: 100 KeV threshold for cell, smear according to KLOE published performance.
- Loops through primary particles, summing up their 4-momentum to compute back E_ν .
- Event reconstructed → at least one of two conditions:
 - Vertex is found in GRAIN reco (w/ images)
 - At least 2 tracks in STT
- No particle identification.

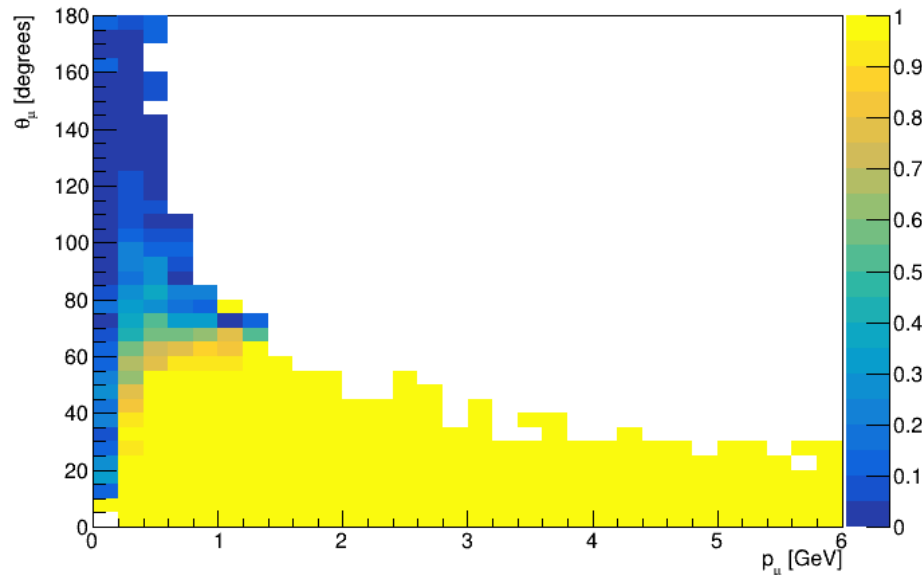
Muons

- Total reconstruction efficiency: 99.6%

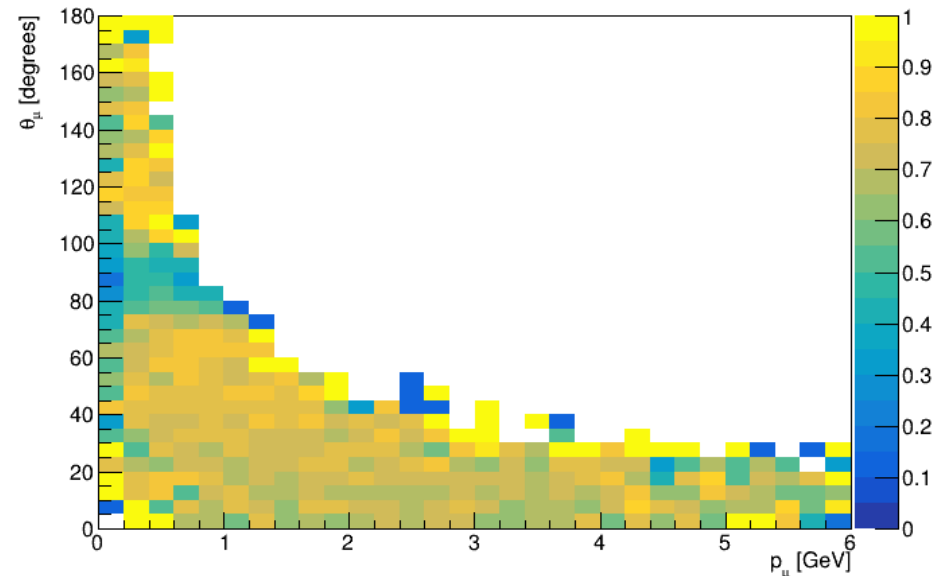


STT	GRAIN vis	GRAIN reco	ECAL
91%	80.7%	71.9%	98%

Muon reconstruction efficiency STT



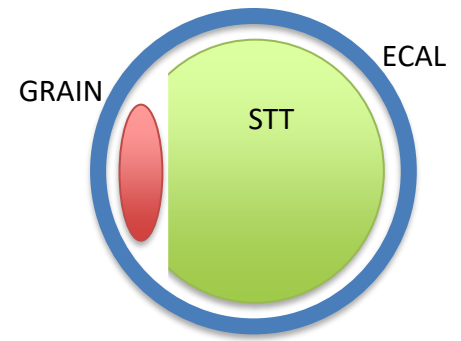
Muon reconstruction efficiency GRAIN



*Issue at 90° is a current limitation of the reconstruction algorithm in GRAIN

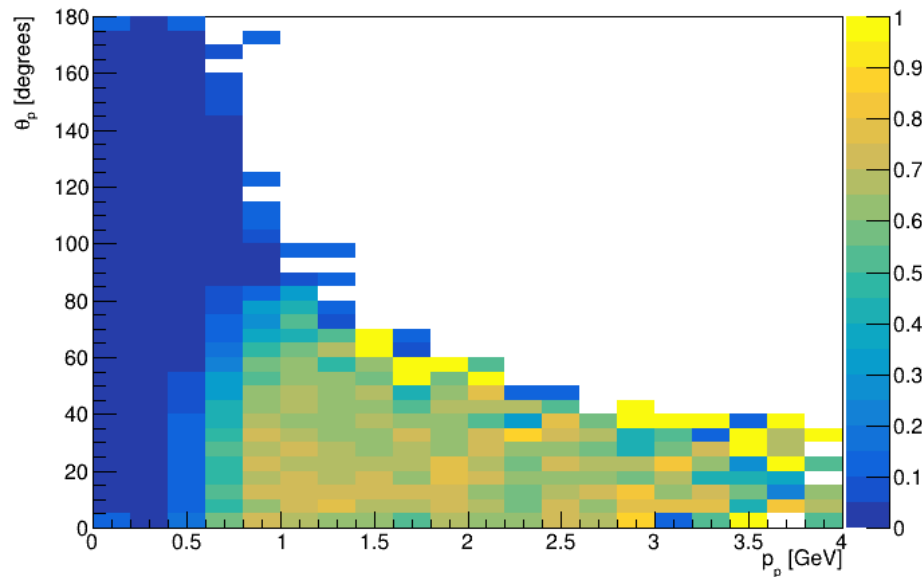
Protons

- Total reconstruction efficiency: 67.5%

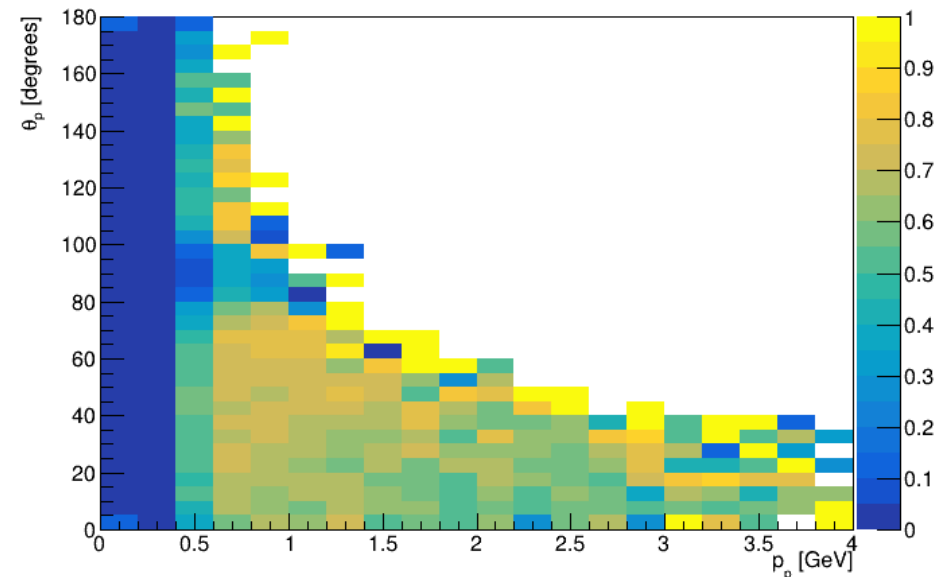


STT	GRAIN vis	GRAIN reco	ECAL
31.7%	53.2%	47.1%	38.2%

Proton reconstruction efficiency STT



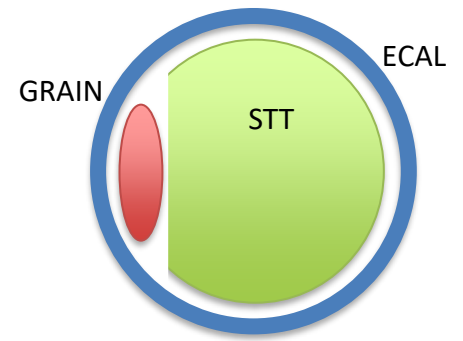
Proton reconstruction efficiency GRAIN



*Issue at 90° is a current limitation of the reconstruction algorithm in GRAIN

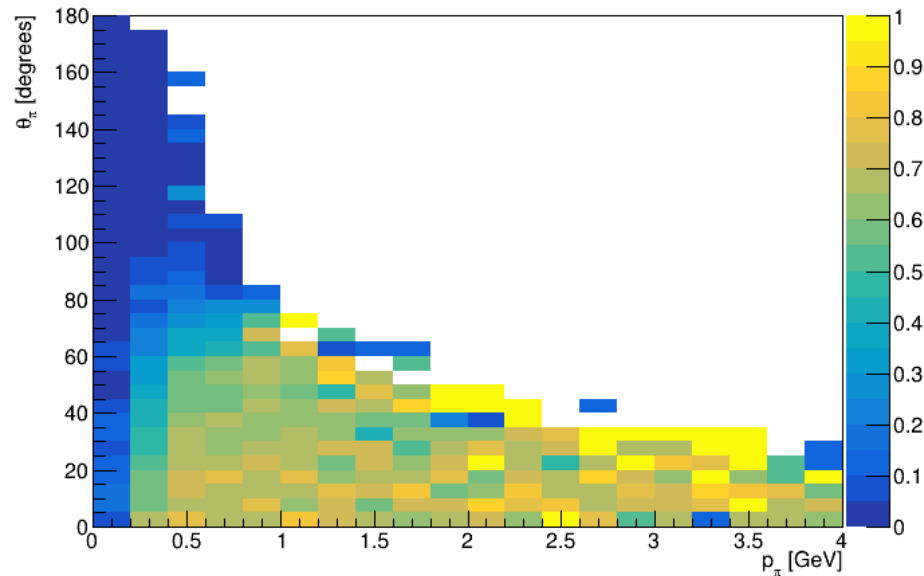
Pions

- Total reconstruction efficiency: 89%

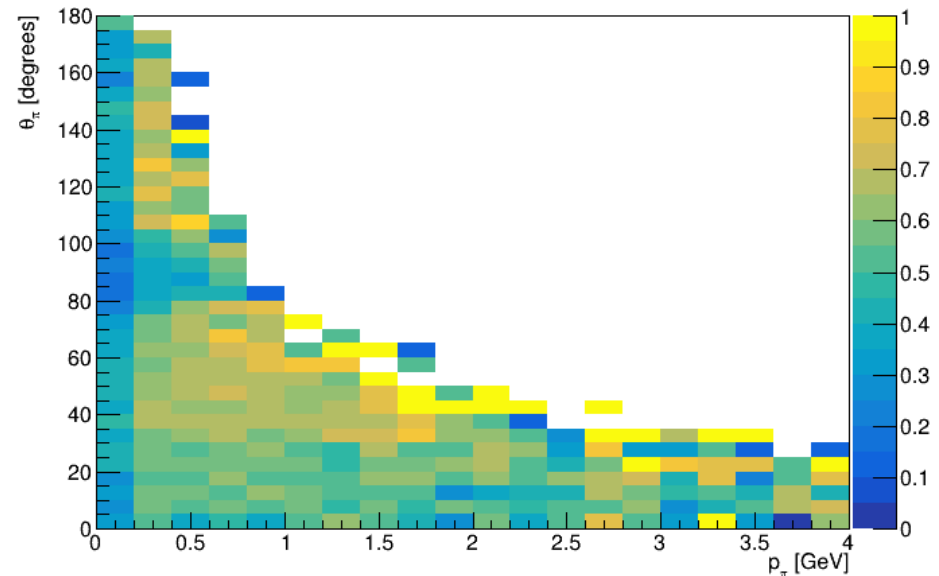


STT	GRAIN vis	GRAIN reco	ECAL
39.2%	66.1%	52.8%	71.7%

Pion reconstruction efficiency STT



Pion reconstruction efficiency GRAIN

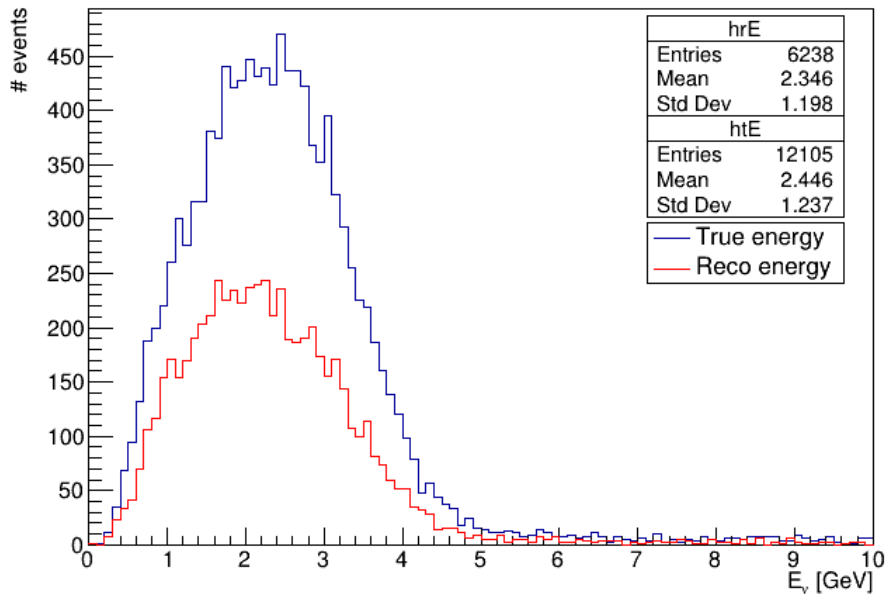


*Issue at 90° is a current limitation of the reconstruction algorithm in GRAIN

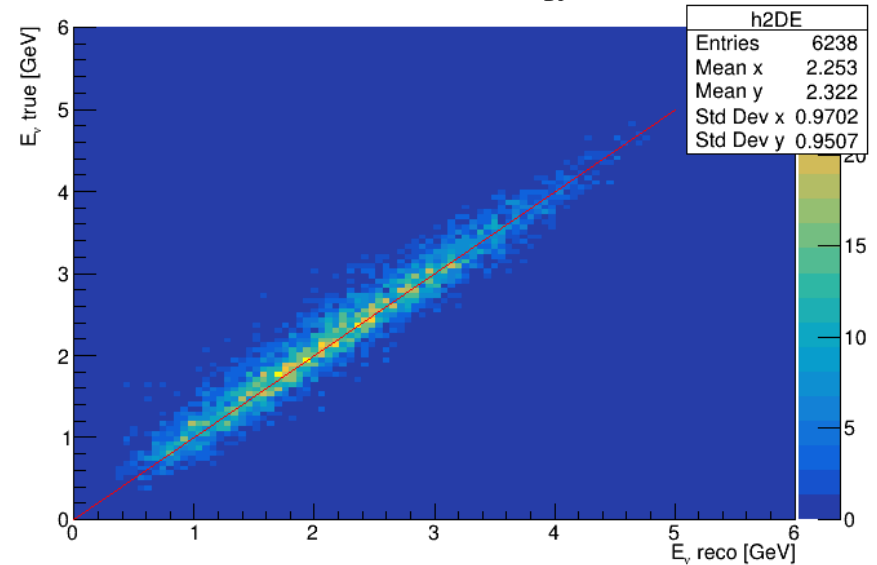
$0\nu N\rho - E_\nu$

- Events: 20k \rightarrow **12105** in fiducial volume
- Reco events: 6238 (51%)

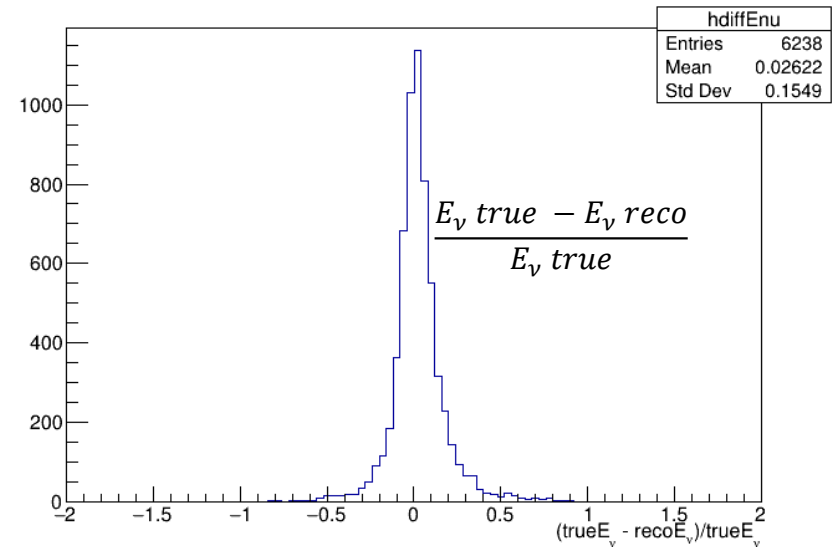
Neutrino energy



True vs Reco energy

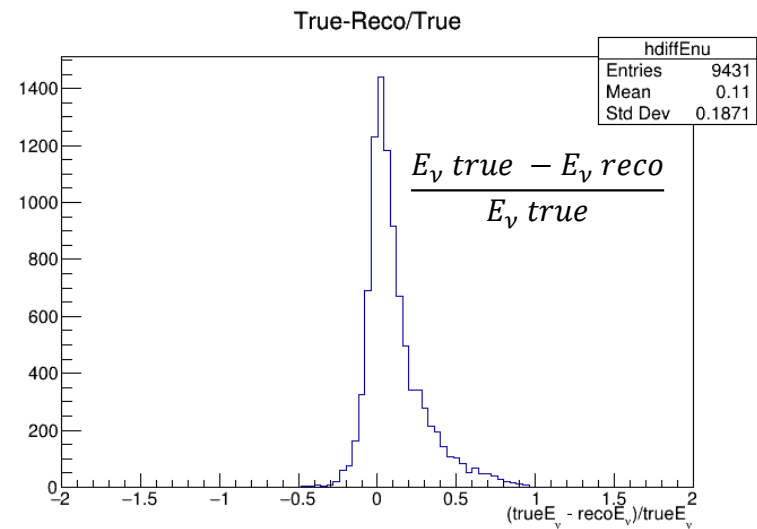
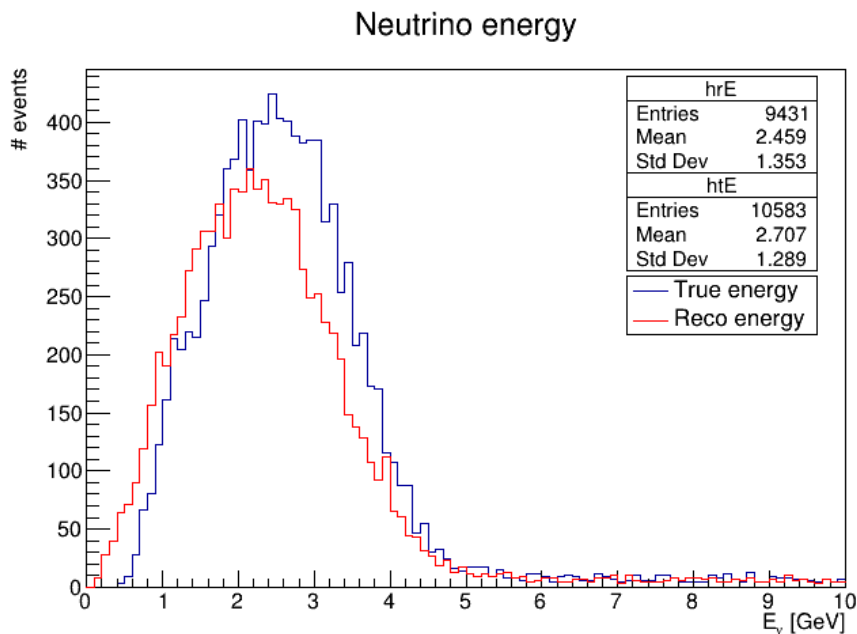
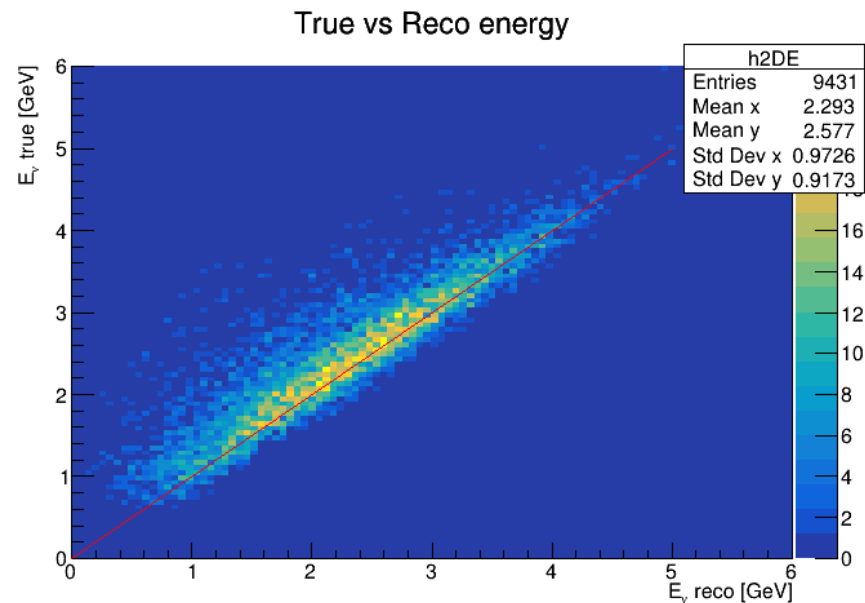


True-Reco/True

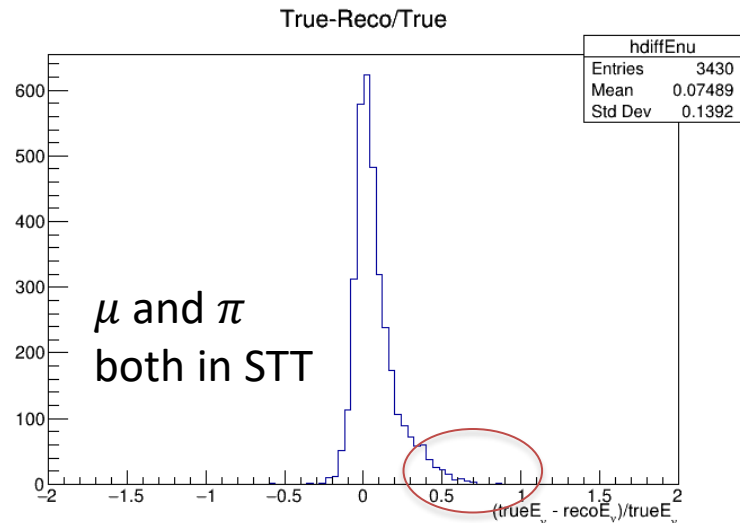
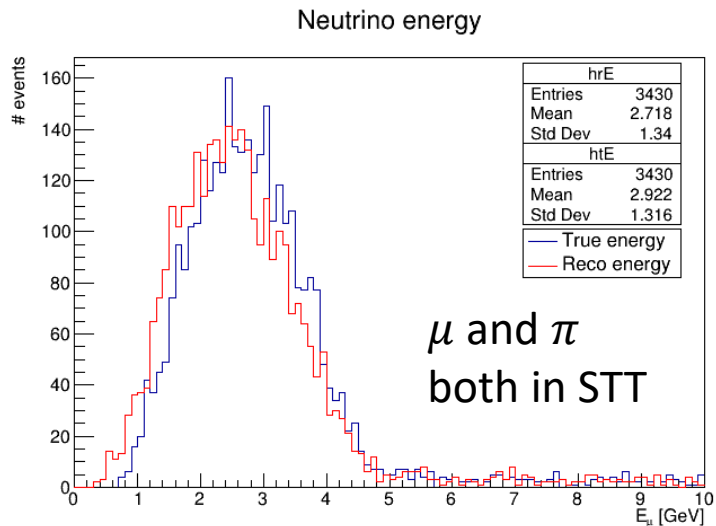
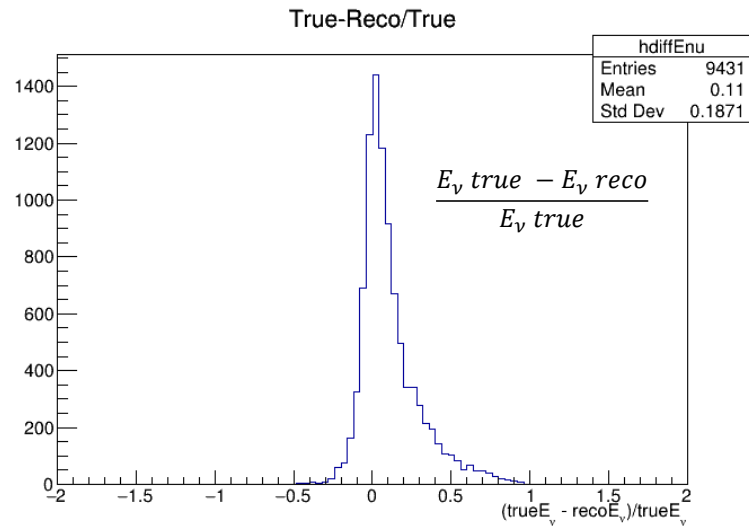
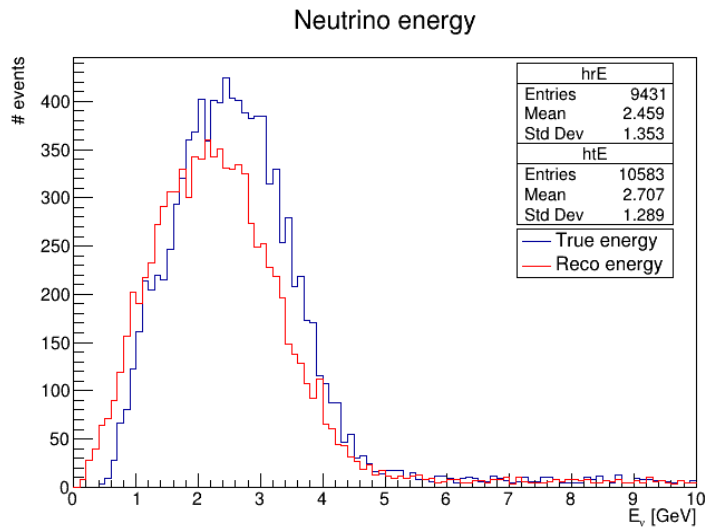


$1\pi N\rho - E_\nu$

- Events: 17.7k \rightarrow **10583** in fiducial volume
- Reco events: 9431 (89%)

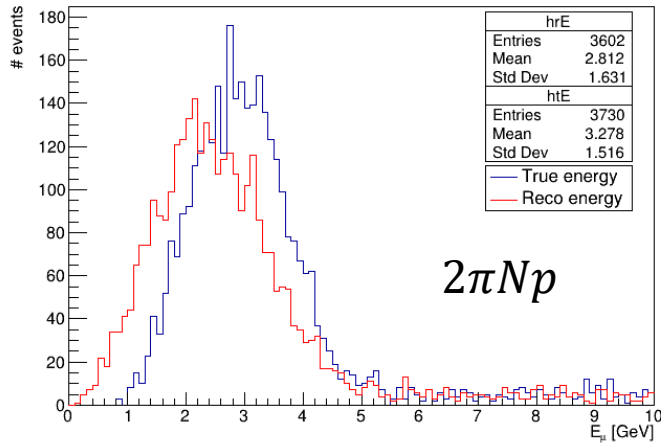


$1\pi N\rho - E_\nu$

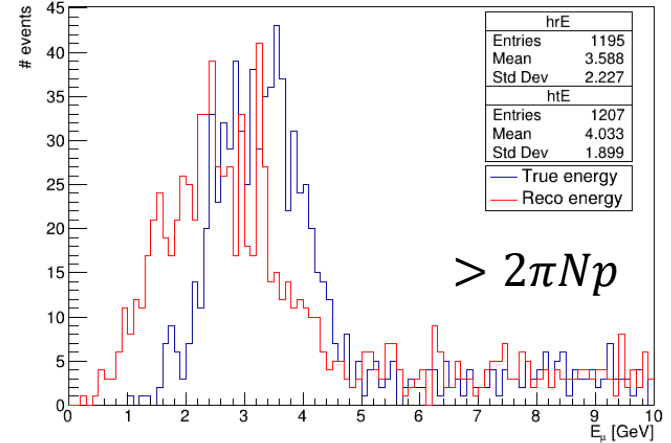


($>$) $2\pi Np - E_\nu$

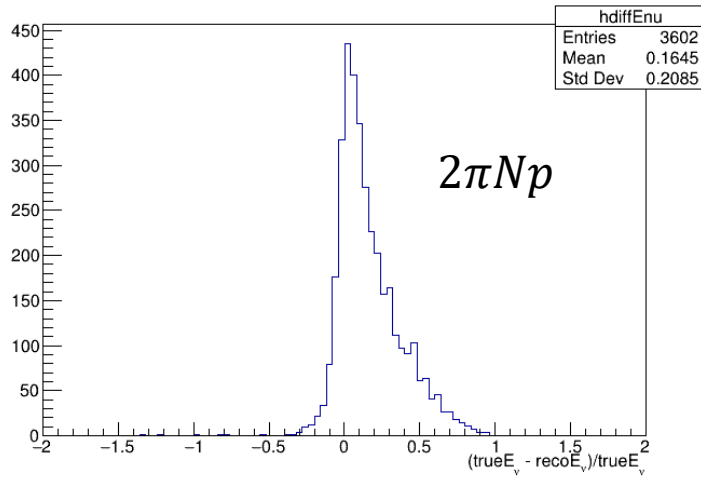
Neutrino energy



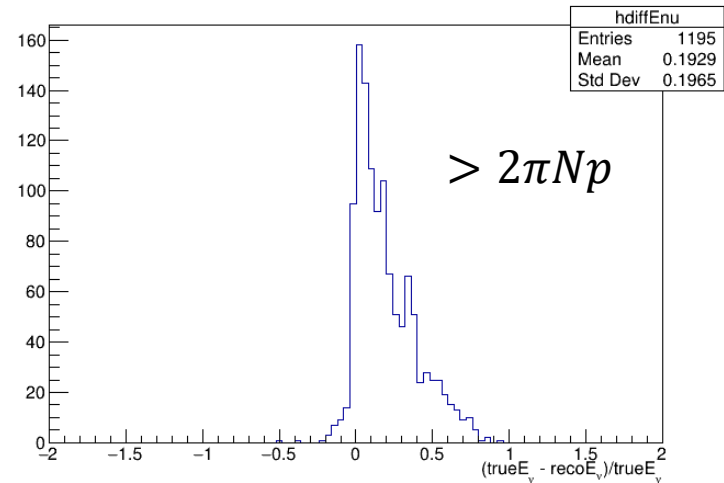
Neutrino energy



True-Reco/True



True-Reco/True



CAF format

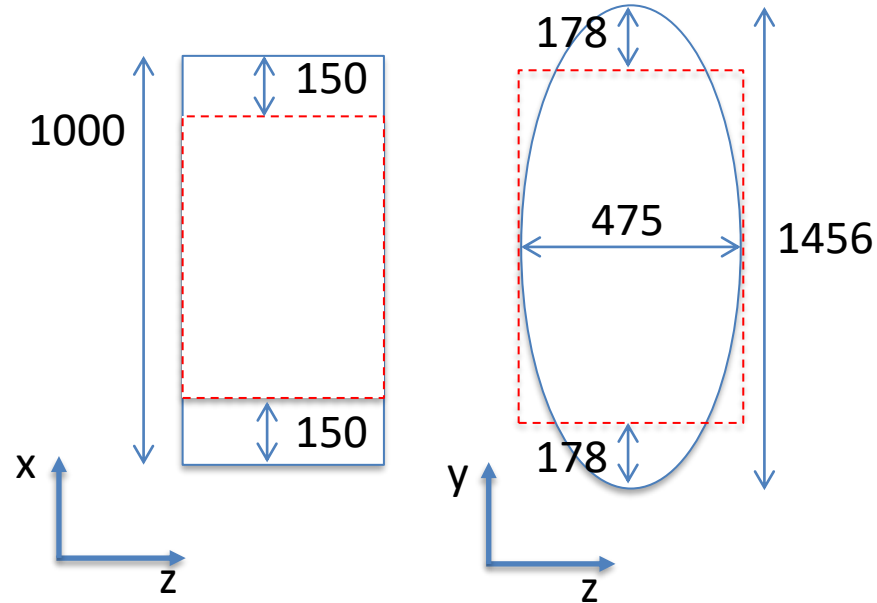
- As of today, we have a branch within ND_CAFMaker.
- https://github.com/DUNE/ND_CAFMaker/tree/sandcaf
- Currently only filling some of the truth/reco variables already present for ND-LAr (if available for SAND).
- These samples are CAF-ready, will be converted soon.

Summary

- $\sim 10^5$ events FHC interactions in GRAIN
- Reconstruction still evolving, currently fast/parametrized version putting together subdetector info.
- Studied performance for some specific channels at increasing π multiplicity.
- Still a long way before a proper LBL sample, but these are now CAF-ready and can be played with for higher-level analysis.

Backup

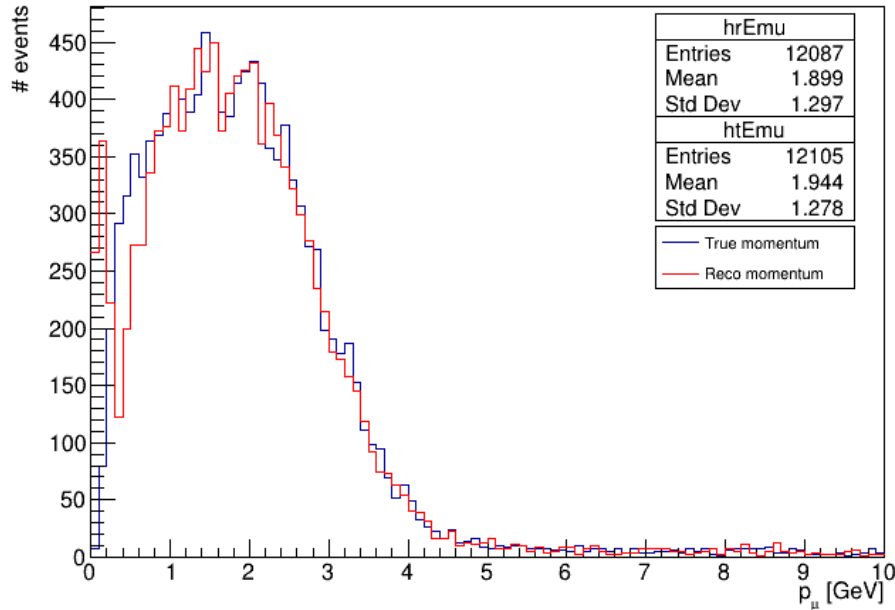
GRAIN fiducial volume



- $|x - x_{GRAINcenter}| < 350$ mm
- $|y - y_{GRAINcenter}| < 550$ mm
- No cut on Z

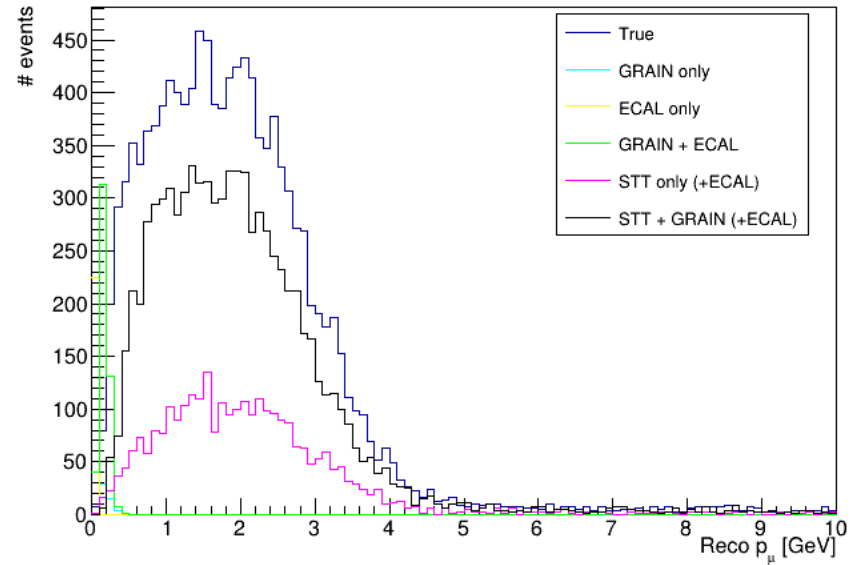
$0\pi Np - p_\mu$

Muon momentum

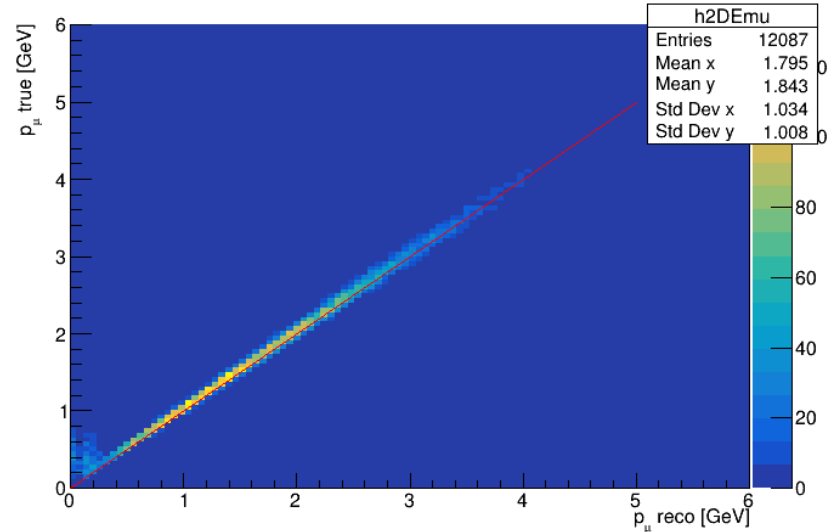


- Reconstructed muons:
 - ecal only: 2%
 - grain+ecal: 4%
 - stt only (or stt+ecal): 24 %
 - stt+grain (or stt+grain+ecal): 70%

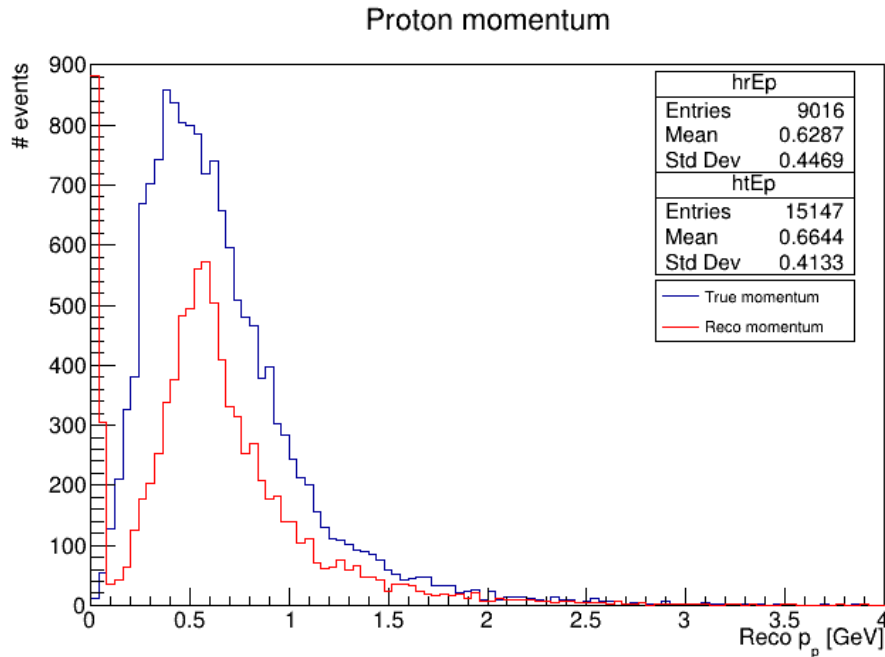
Muon momentum



True vs Reco muon momentum

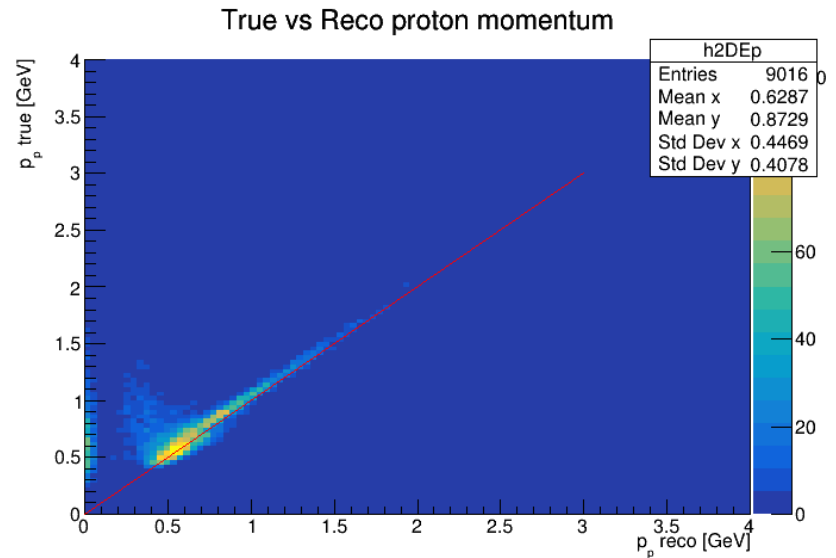
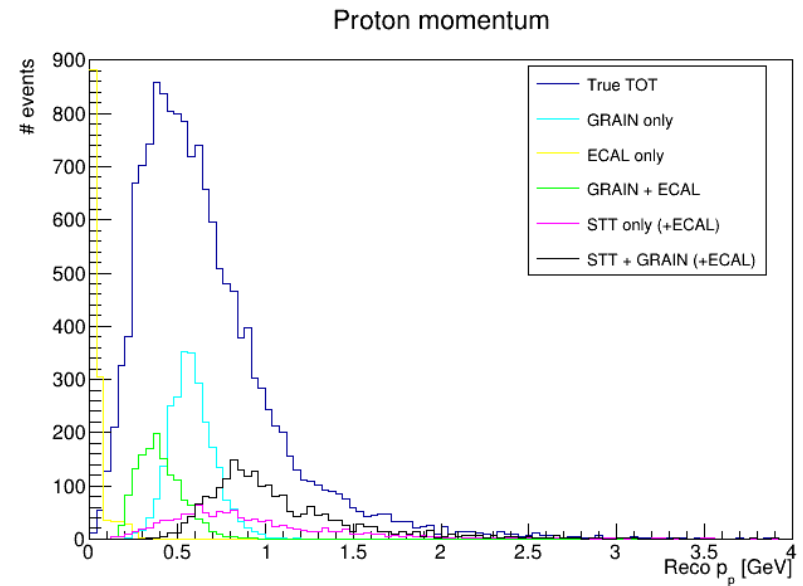


$0\pi Np - p_p$

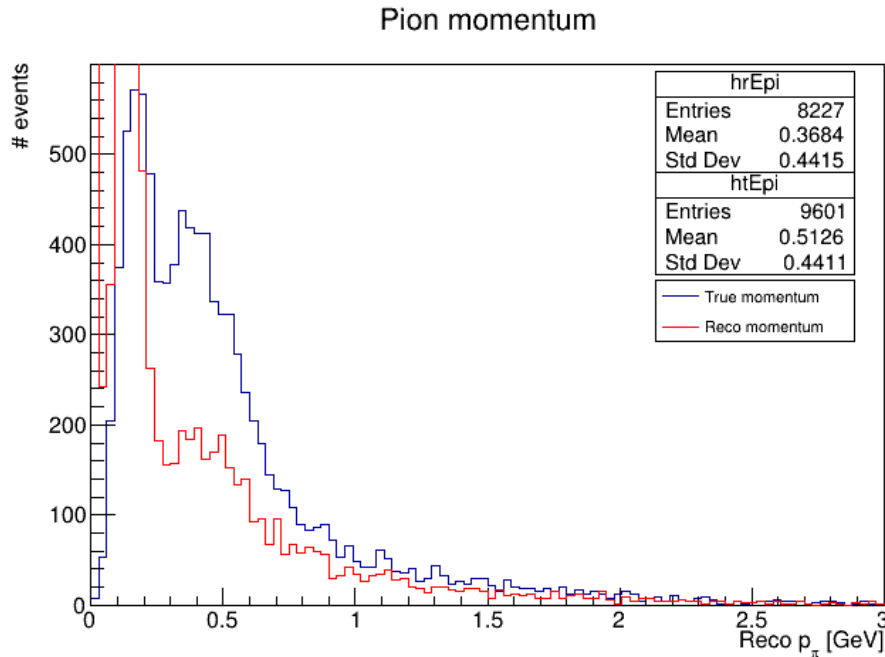


- Reconstructed protons:

- grain only: 28%
- ecal only: 15%
- grain+ecal: 16%
- stt only (or stt+ecal): 13%
- stt+grain (or stt+grain+ecal): 23%

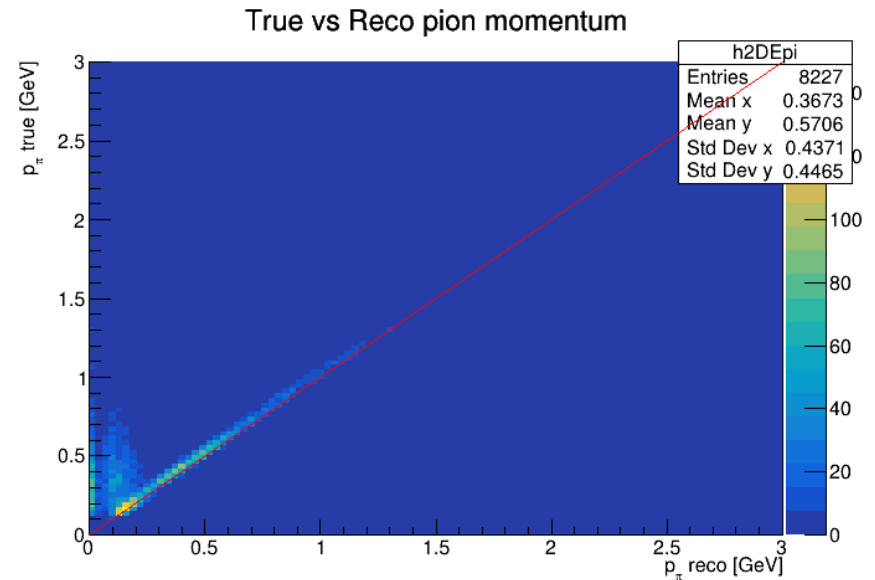
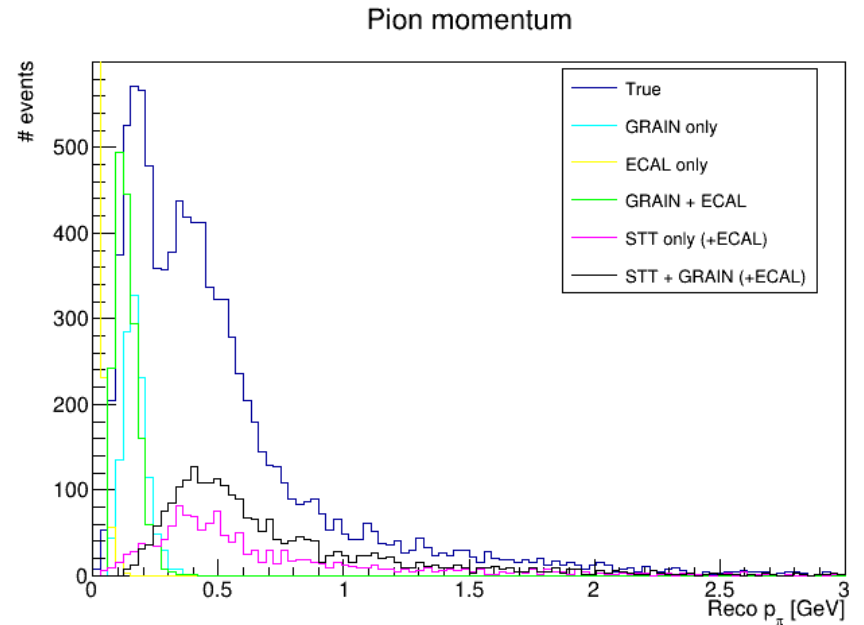


$1\pi Np - p_\pi$



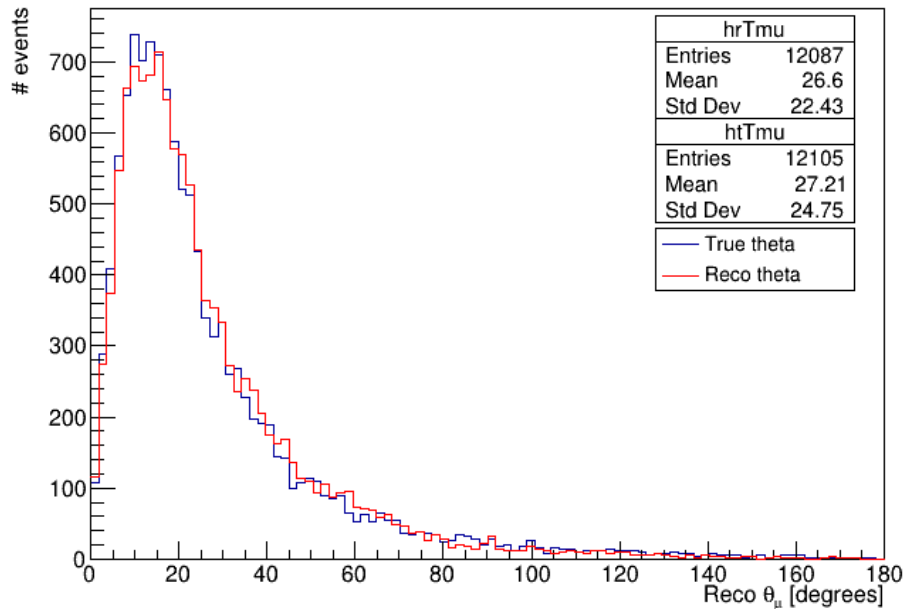
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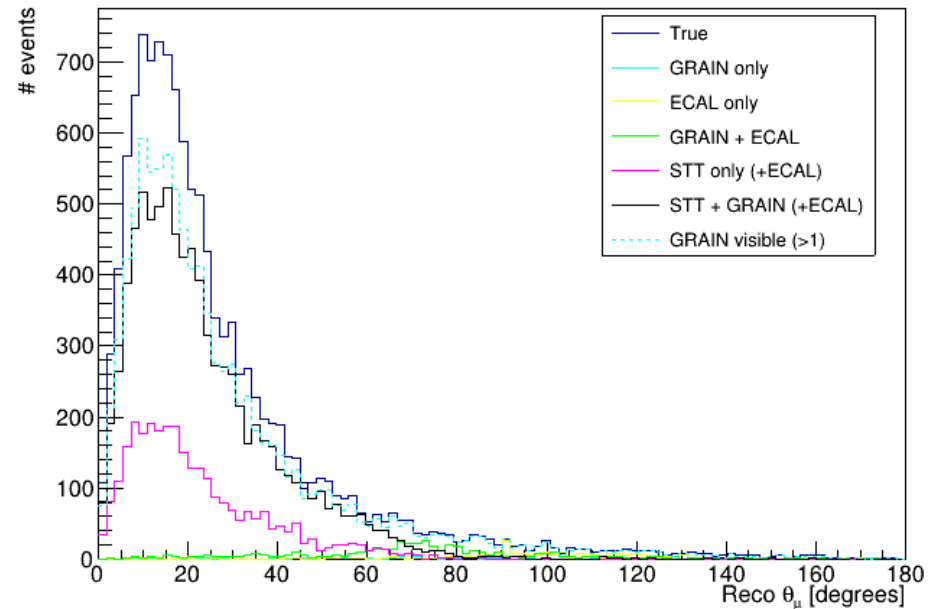


$0\pi Np - \theta_\mu$

Muon theta

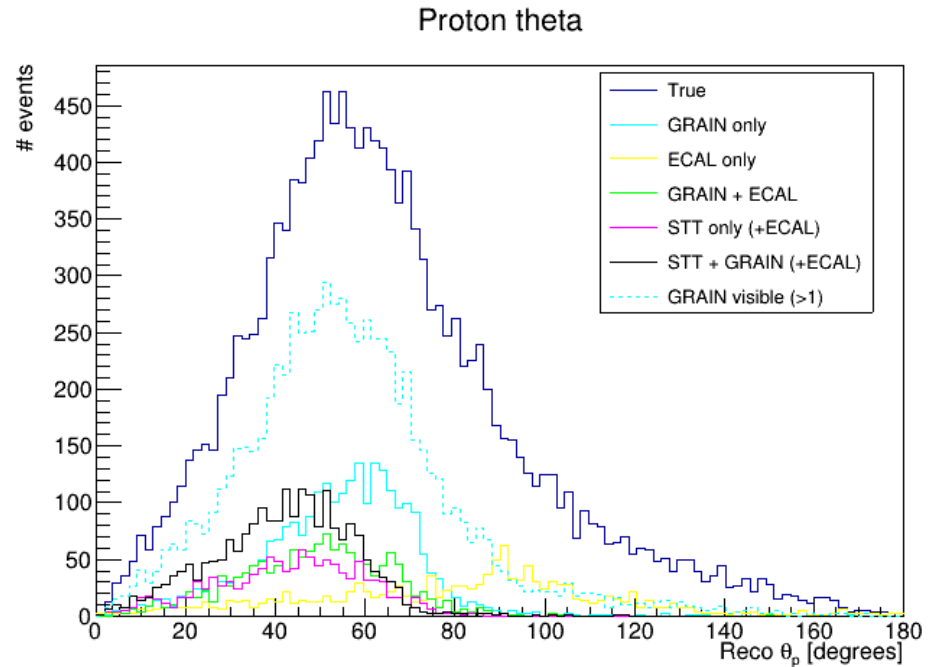
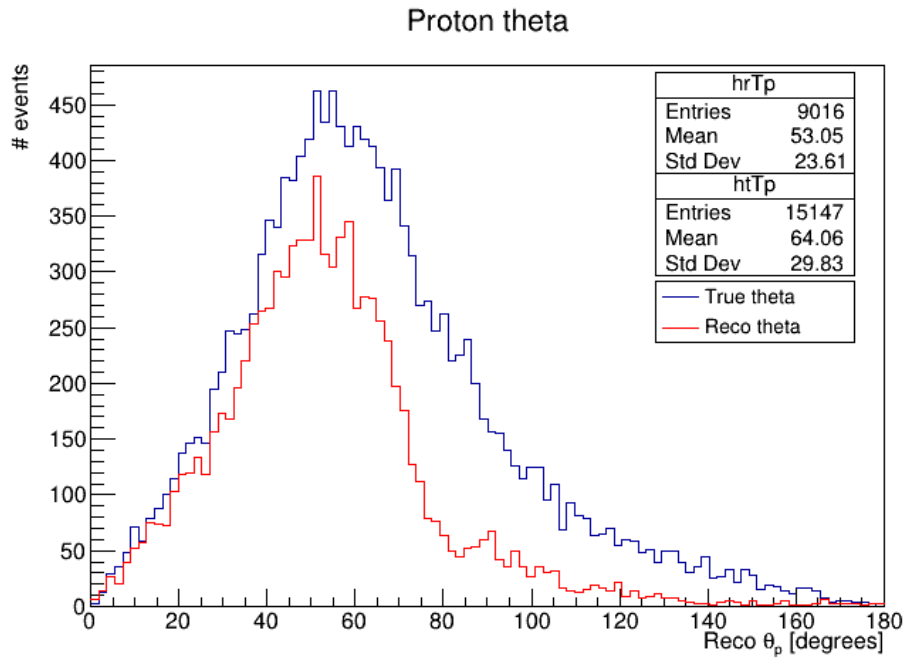


Muon theta



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$0\pi Np - \theta_p$

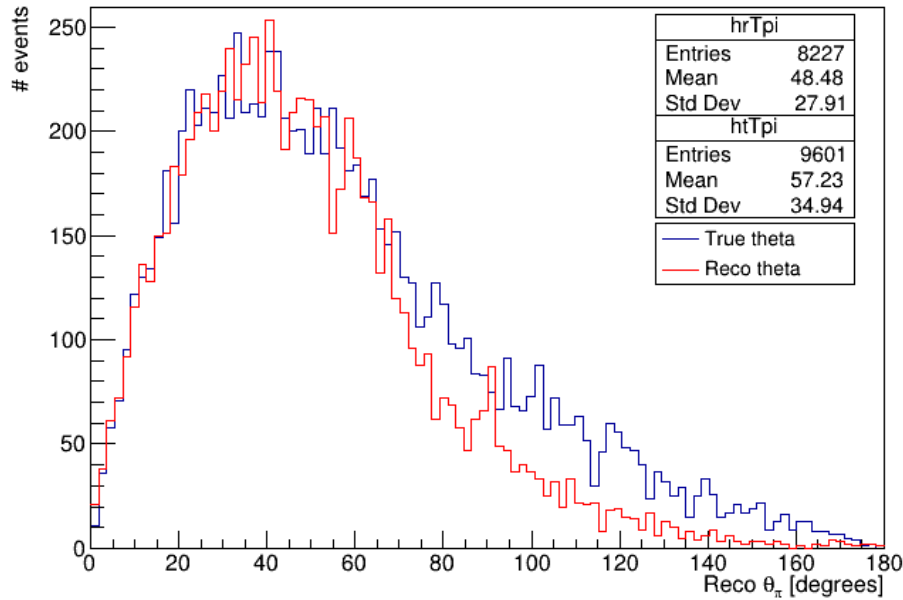


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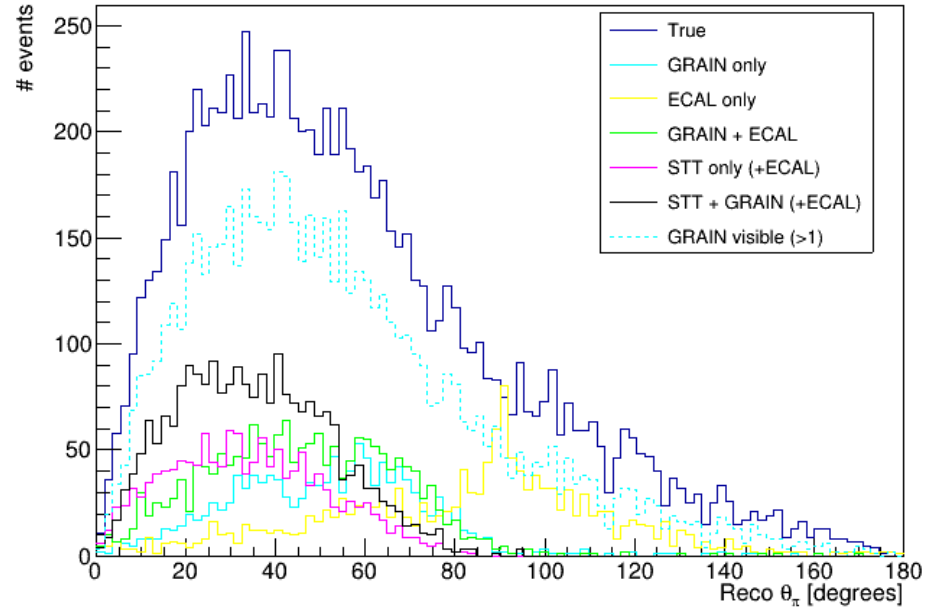
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$1\pi Np - \theta_\pi$

Pion theta



Pion theta

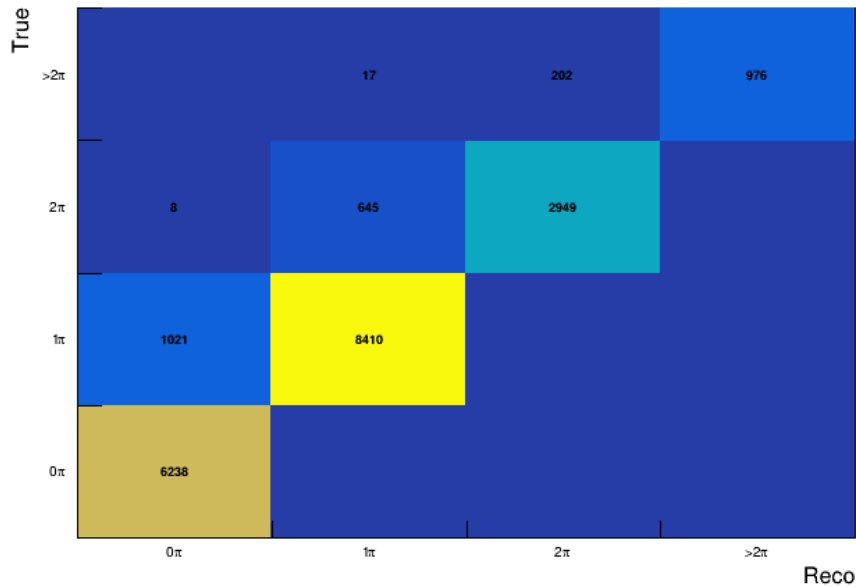


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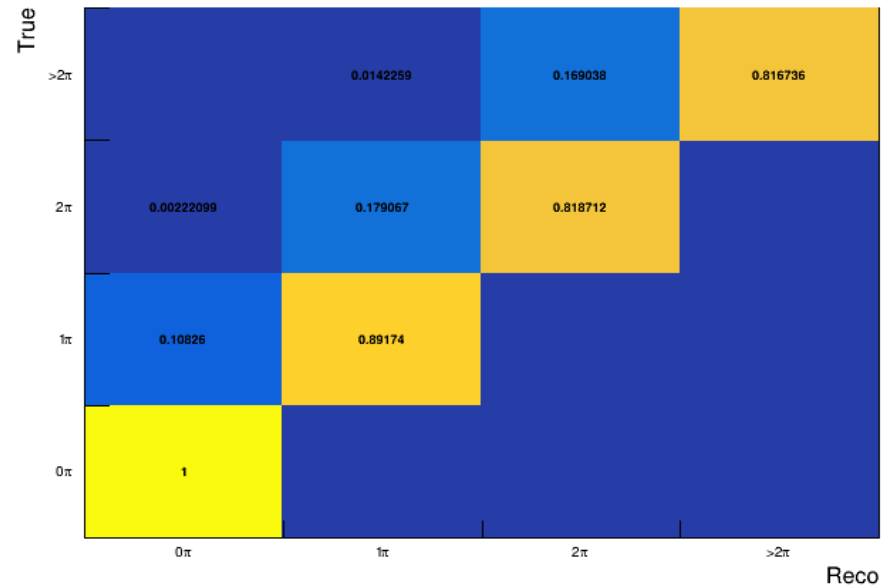
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Pion «migration»

Pion migration matrix



Pion migration matrix (row norm)



- **NOTE:** there is no particle identification. Pions are lost because they are not reconstructed