ANN RECONSTRUCTION AT ALICE

Maria Paula Palhares[1, 2], **Alexandre Suaide**[2], **Maximiliano Puccio**[1], **Francesco Mazzaschi**[1]

VII Reunião Geral - Projeto Especial FAPESP “Física e Instrumentação de Altas Energias com o LHC-CERN”

[1] CERN

[2] Universidade de São Paulo

OUTLINE

Λnn context

HypHI report and phenomelogical studies

Analysis strategy

Goals

Dataset and event selection

Selections: tracks and V0

PID: (Anti)Tritons

TPC & TOF information

Λnn reconstruction

efficiency

pT and invariant mass

On going

new flag for LnnCand.isMatter

Outlook and next steps

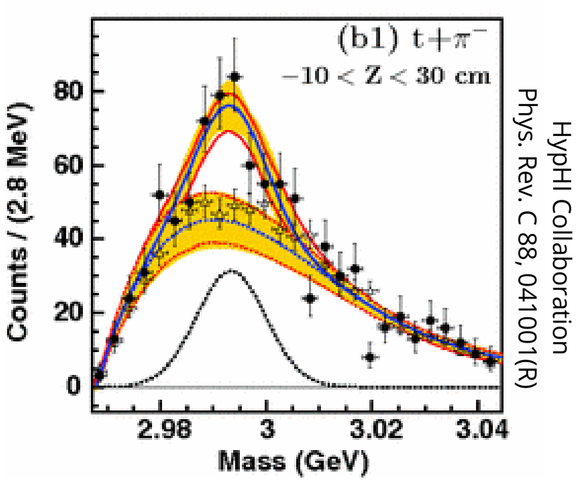
CONTEXT

Λnn context

Hypernuclei: Bound-states of ordinary nucleons and strange baryons. The characterisation of the interaction that binds strange matter to ordinary nucleon is one of the missing pieces to understand the EOS of NS.

Observation reported for Λnn by HypHI Collaboration (Phys. Rev. C 88, 041001(R)):

- Channel decay: 3H + π-
- Invariant mass [2993.7 ± 1.3 ± 0.6 MeV/c2] and lifetime estimation [190 ± 36 ps] .



HypHI Collaboration
Phys. Rev. C 88, 041001(R)

Theorical predictions:

- Unbound
  - Physics Letters B, v. 736, p. 93-97, 2014 | Phys. Rev. C 89, 061302 (R) | Phys. Rev. C 89, 057001
- Low-lying Λnn resonant state
  - Phys. Rev. C 92, 054608 | arXiv:0712.1911 | arXiv:2211.01693

ANALYSIS STRATEGY

GOAL

Experimental characterization of Λnn hypernucleus

- Reconstruction of 3H + π- channel decay with Run3 data in PbPb collisions at s_NN = √5.36 TeV.

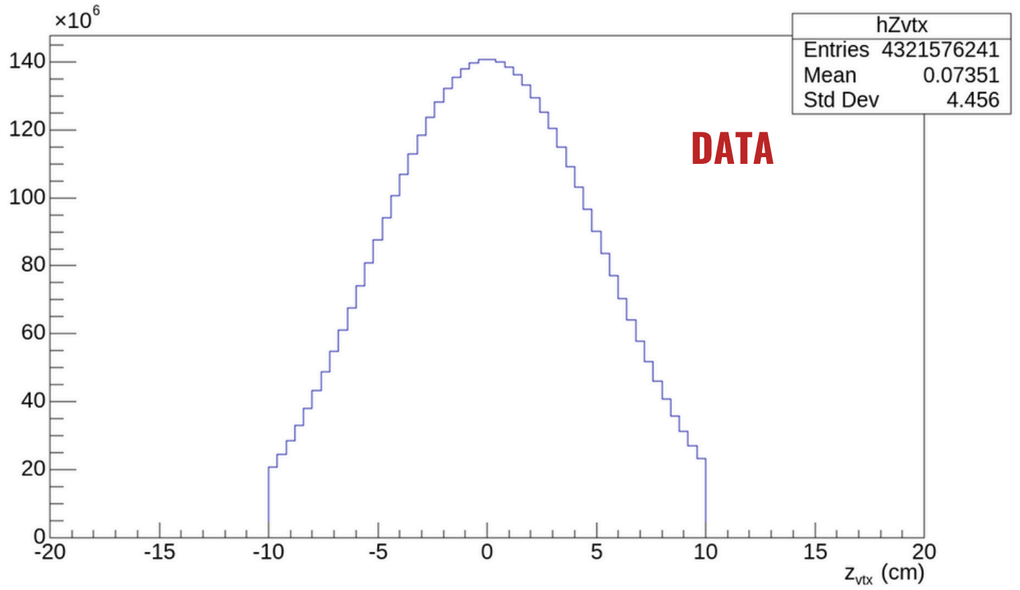
DATASET

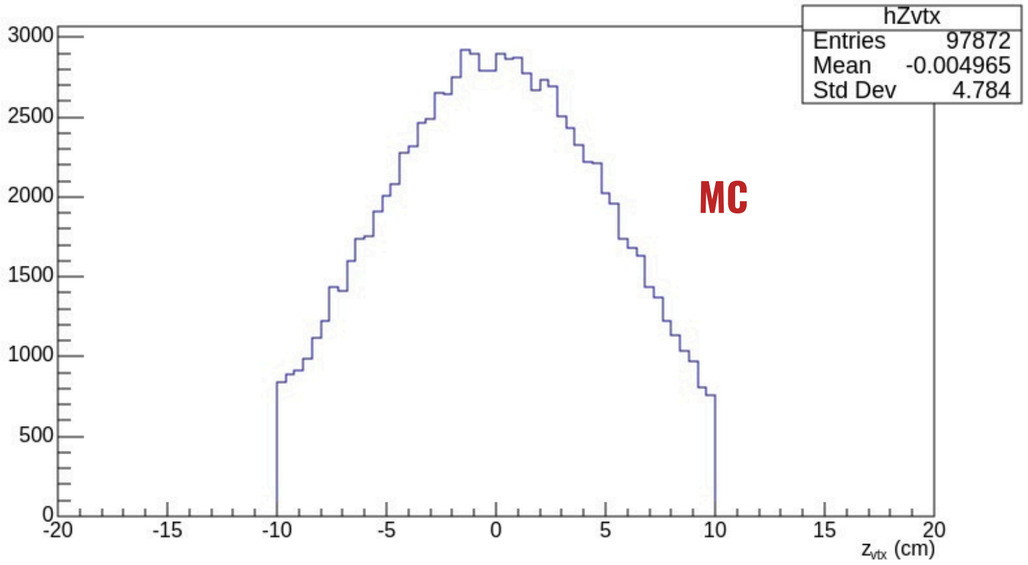
LHC23_PbPb_pass4:

- Run list:
  - 544028,545367,545345,545332,545311,545289,545262,545246, 545222,545184,545103,545086,545060,545004,544991,544963, 544947,544931,544911,544813,544767,544754,544739,544693, 544674,544672,544652,544640,544614,544582,544580,544567, 544564,544548,544508,544491,544490,544474,544389,544184, 544123,544121,544116,544095
  - 4.3 billion events

MC:

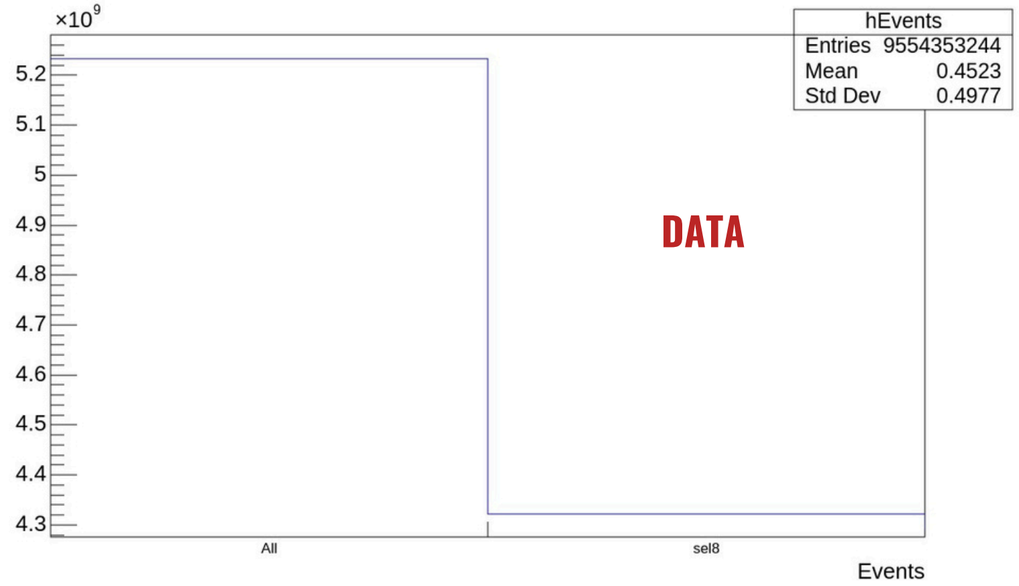
- Locally: 1 Λnn generated each 400 events signals
  - pp collisions
  - ~1.2 million events generated
  - without background signal

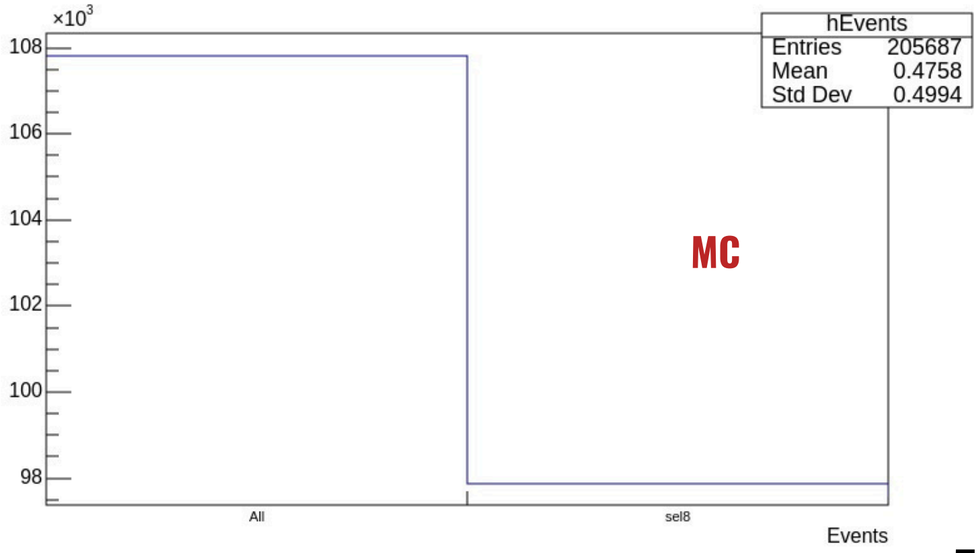




EVENT SELECTION

- **SEL8**: Event selection decision based on TVX



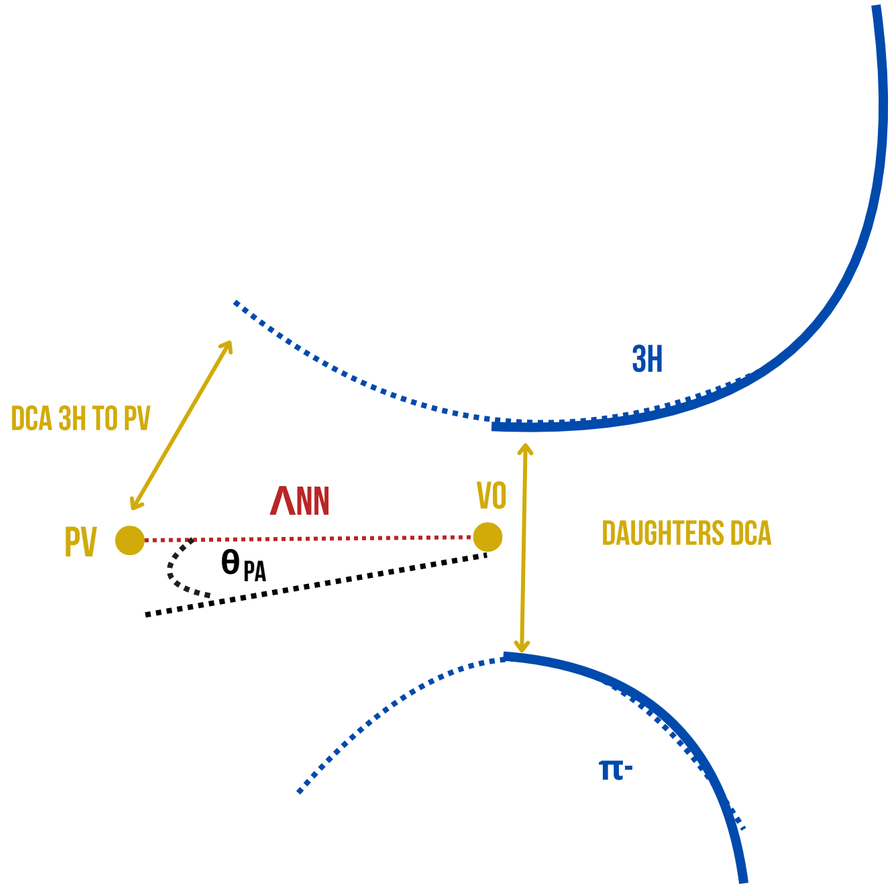


TRACK SELECTION

Variable	Requirement
hasTPC	True
hasTOF	True
Pseudorapidity (η)	< 0.8
χ2/nClusTPC	< 4
χ2/nClusITS	< 36
nσTritonTPC	[-5, 5]
nTPCClusMin3H	120
TPCRigidityMin3H	0.5

V0 SELECTION

VARIABLE	Requirement
cosPA	> 0.995
DCAv0	< 0.6
pT Min	> 0.5



PID

TPC: (ANTI)TRITONS

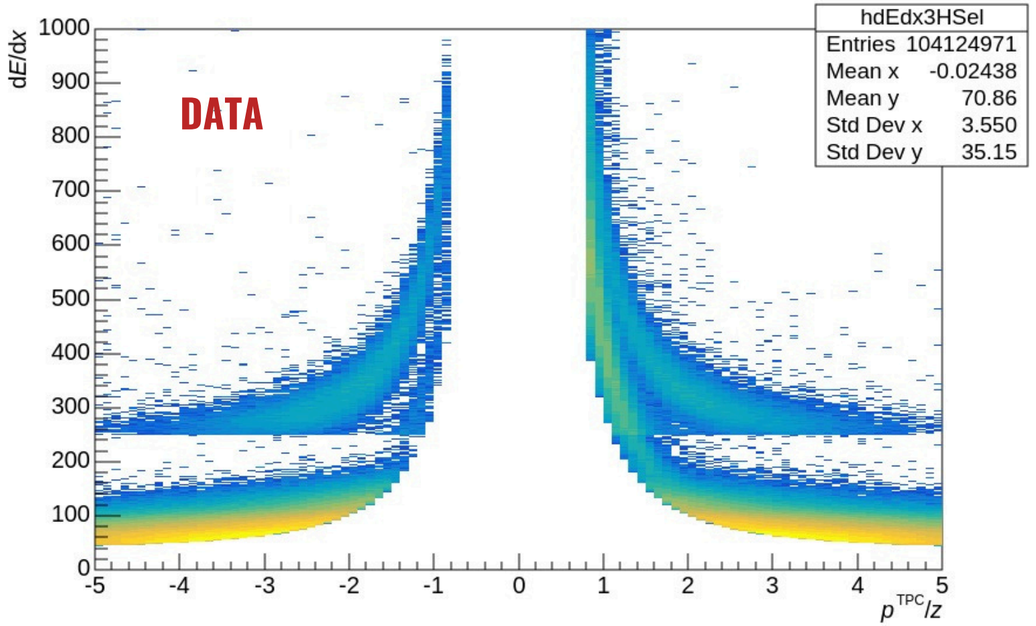
3H Parametrization via Bethe-Bloch curve

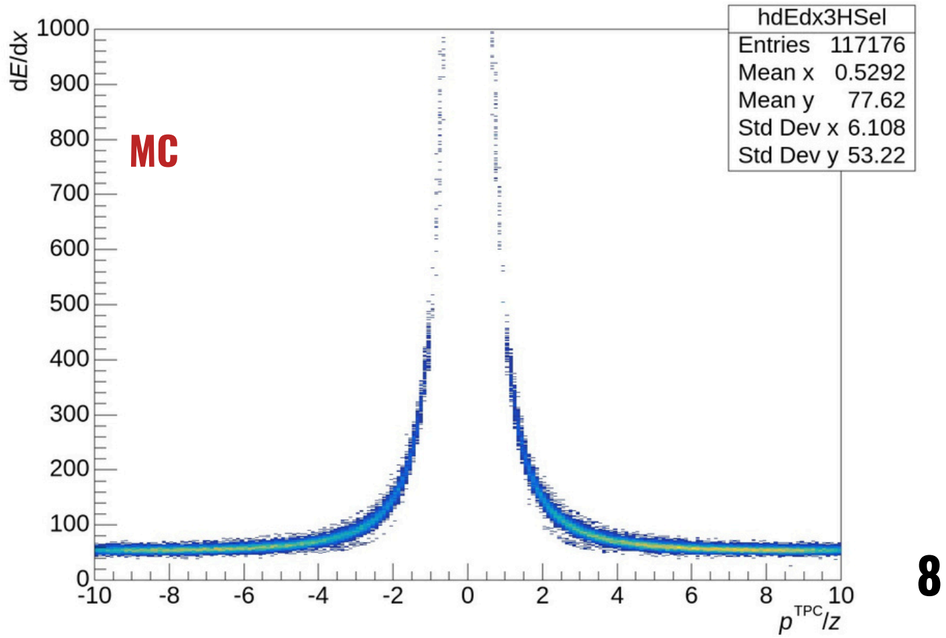
- proportional to Z
- **Selected triton parametrization values from ccdb base.**

3He considered as triton. Why?

- is3H and isAnti3H = hasTPC() & **nSigmaTPC > NSigmaTPCMinCut.**
  - InnCand.IsMatter = is3H and isAnti3H ?
    - h3track = InnCand.IsMatter ? posTrack : negTrack.
- Plot filled after the massLnn hypothesis which is close to hypertriton mass.

above 1.5 GeV: mismatch TPC-TOF tracks signal

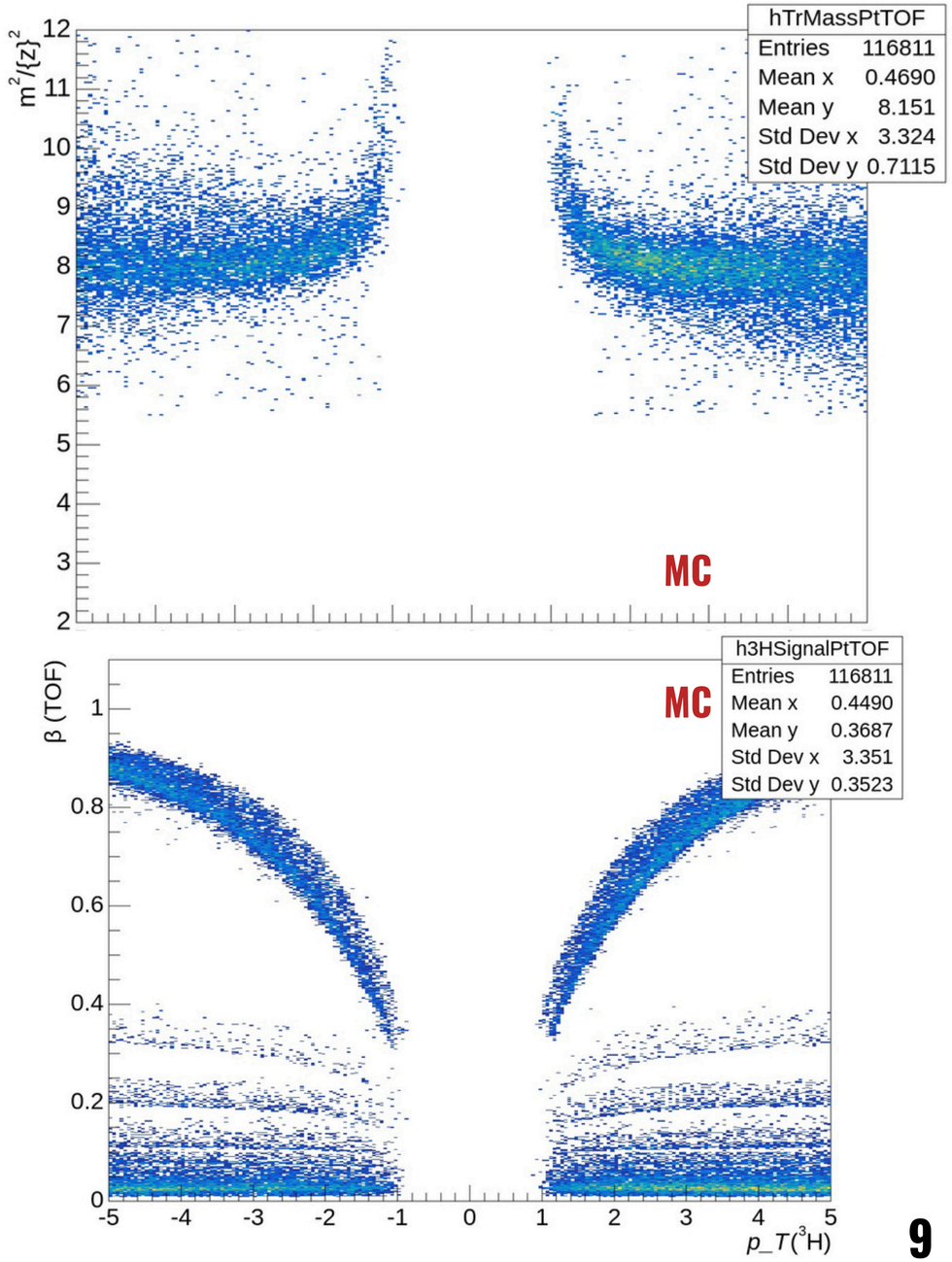




TOF: (ANTI)TRITONS

Get (anti)triton signal information above the TPC limit via time of flight

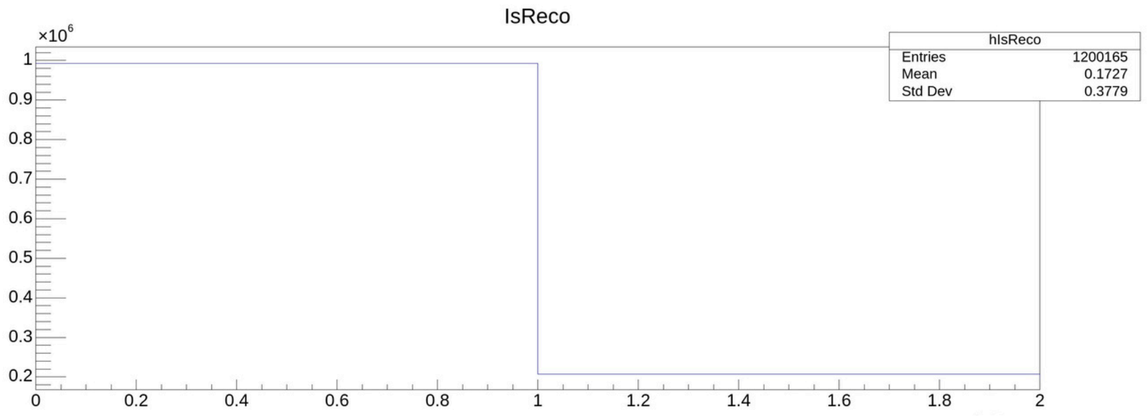
- β = L/tTOFc with L = track lenght
  - **m=(√(1 - β)/β) * p**
- if pTMinTOF > 1.5 and SquareTritonMassTOFMin > 5.5: continue
  - Fill hdEdx3HSel and NSigma3H



NN RECONSTRUCTION

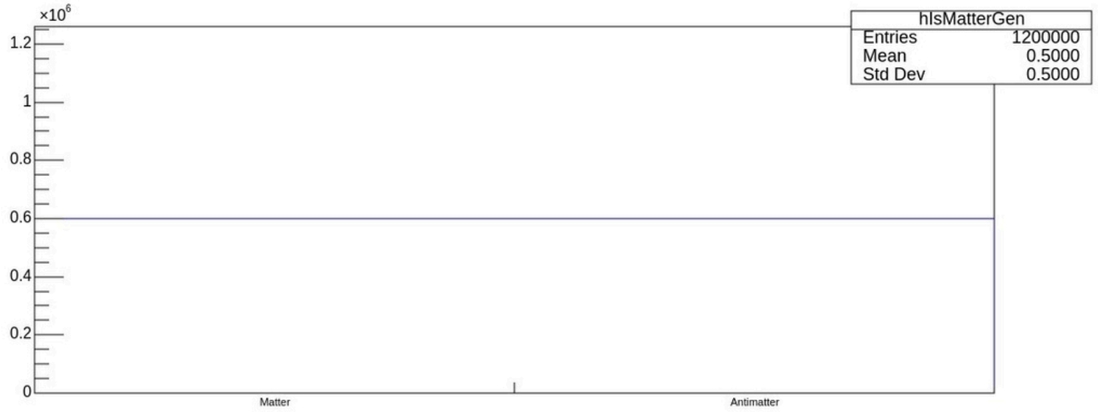
MC

IsReco:
207.210 reconstructed candidates



0: False | 1: True

IsMatterGenerated:
1.200000 generated candidates

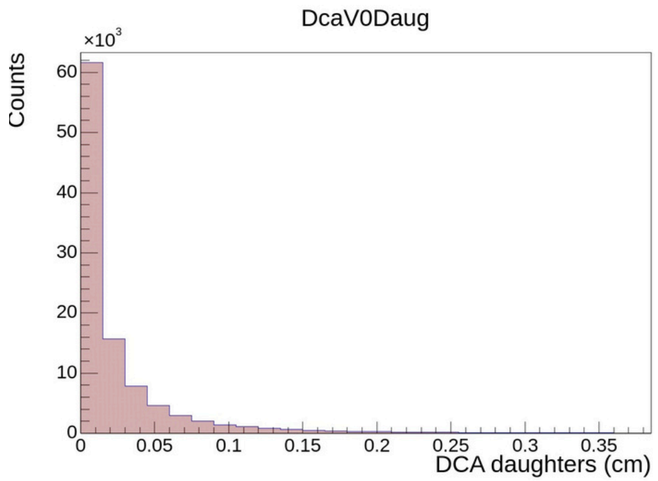


0: Matter | 1: AntiMatter

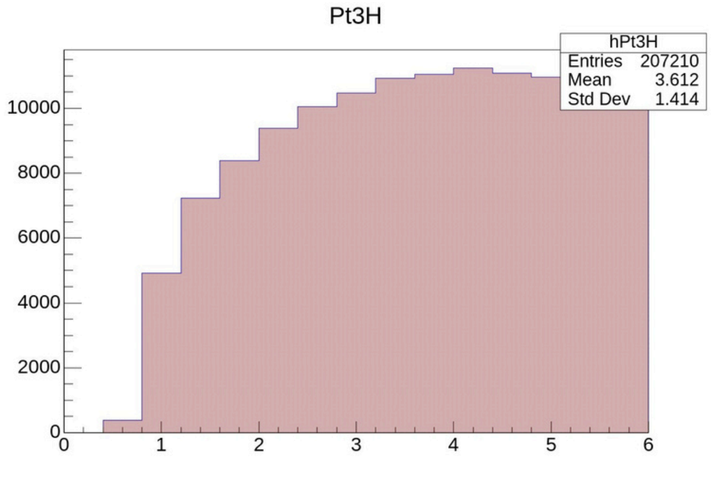
MC: INFORMATION

Examples for reconstructed topologial, kinematic and PID variables

TOPOLOGICAL

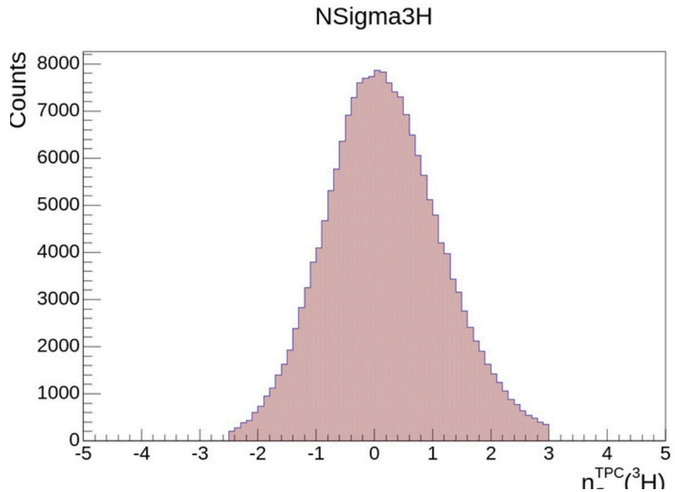


KINEMATIC



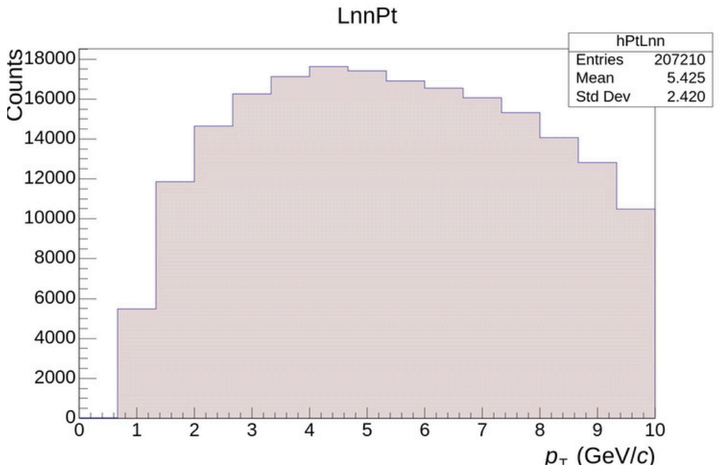
Global propagation

PID

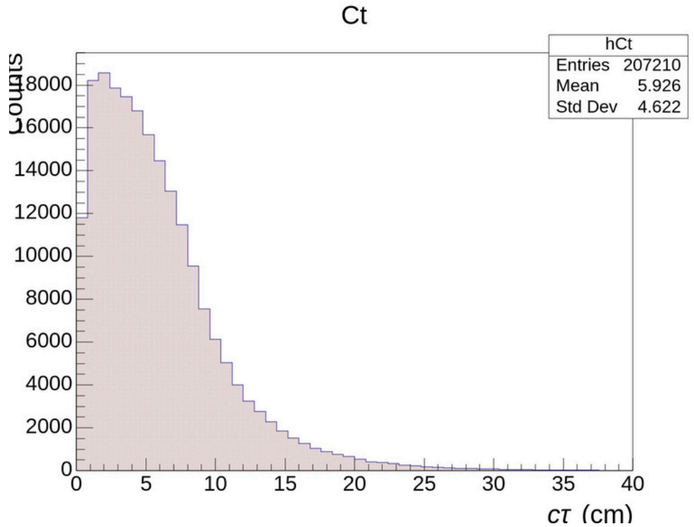


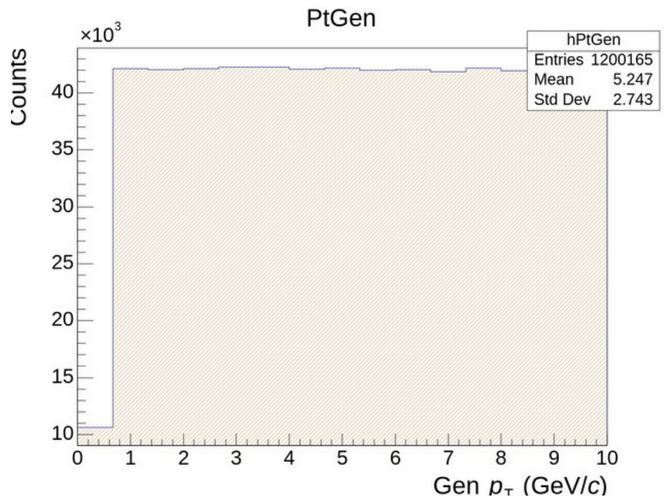
$n\sigma TPC = dEdx - \langle dEdx \rangle / \sigma_{dEdx}$

MC: ΛNN KINEMATICS

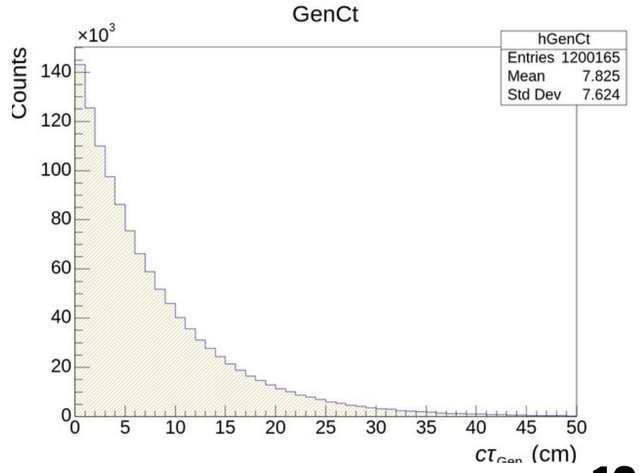


RECO





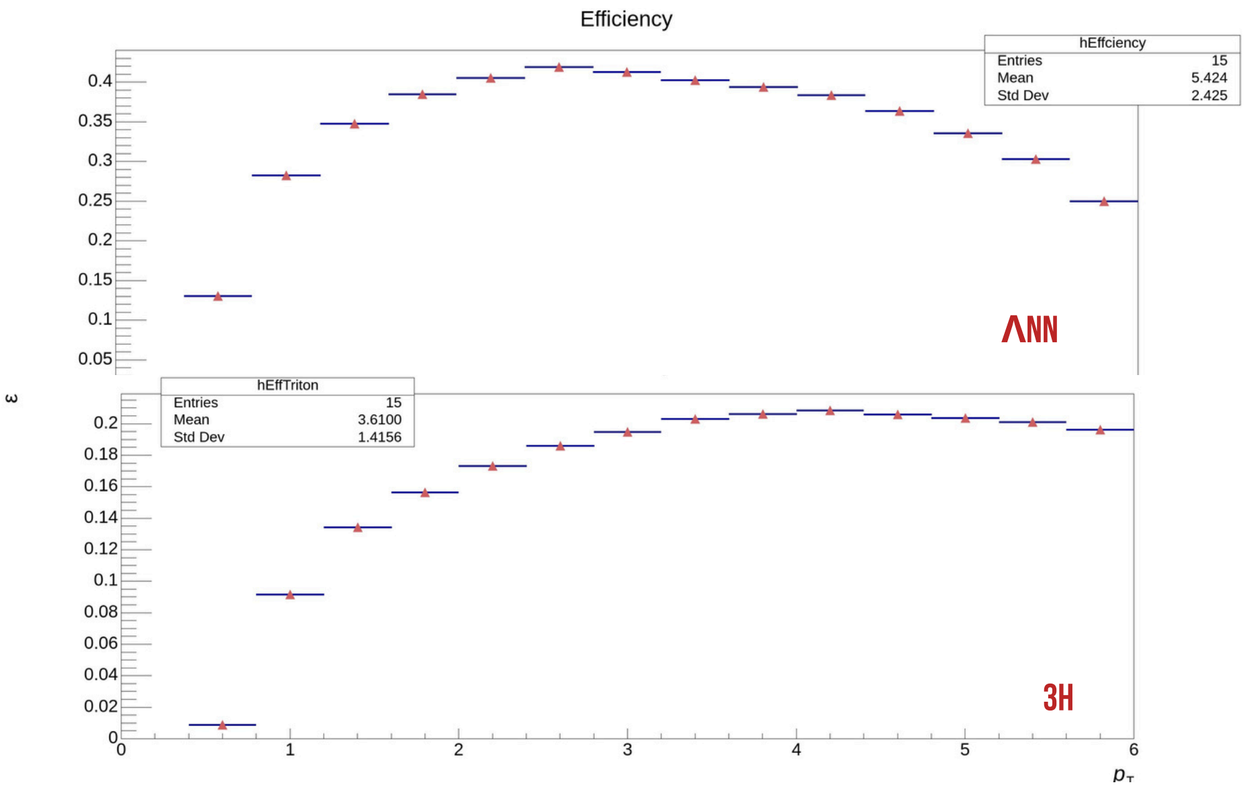
GEN



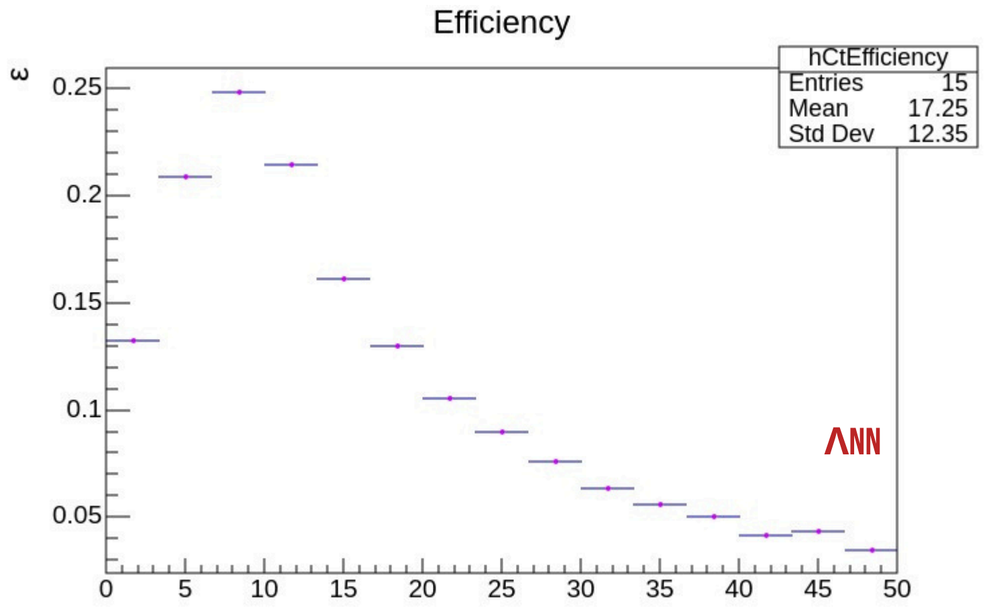
EFFICIENCY

$$\text{EFF} = \frac{\text{NUMBER OF PARTICULES RECONSTRUCTED}}{\text{NUMBER OF PARTICULES GENERATED}}$$

pT



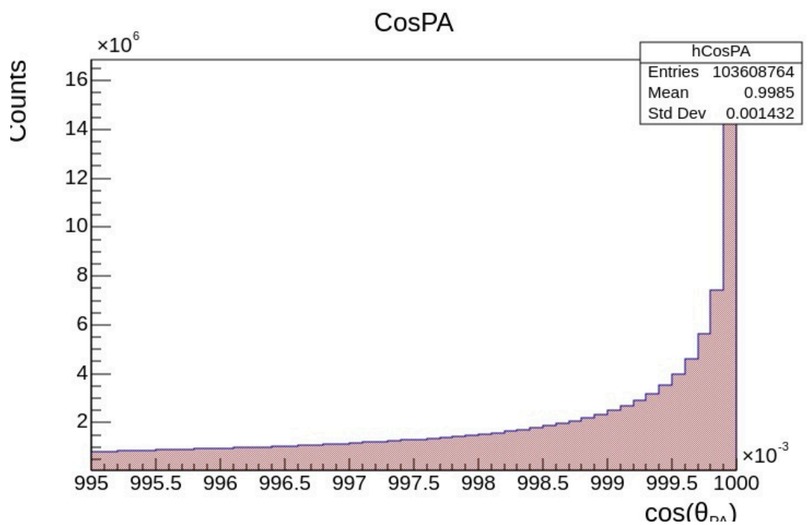
ct



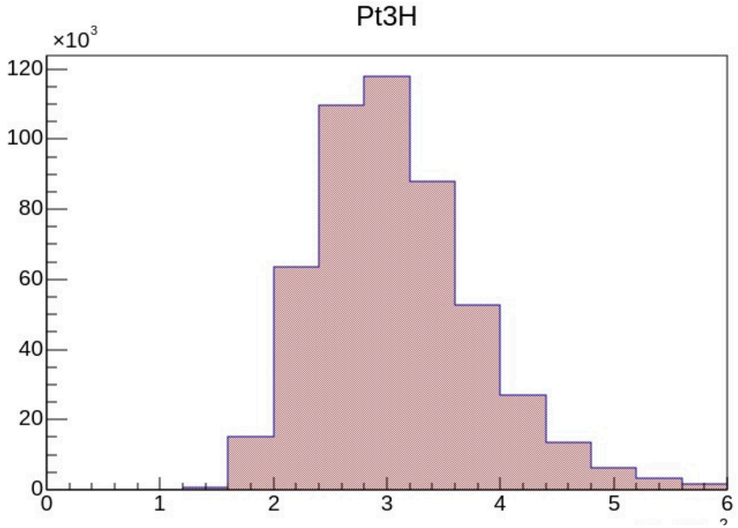
DATA: INFORMATION

Examples for topologial, kinematic and PID variables

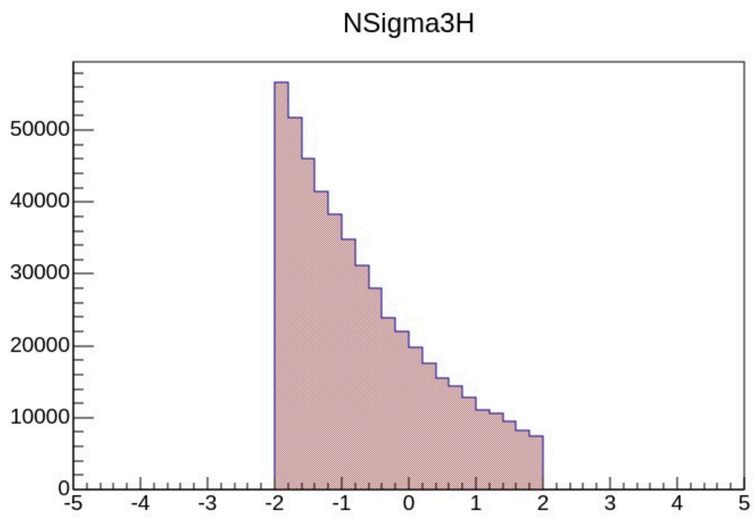
TOPOLOGICAL



KINEMATIC



PID

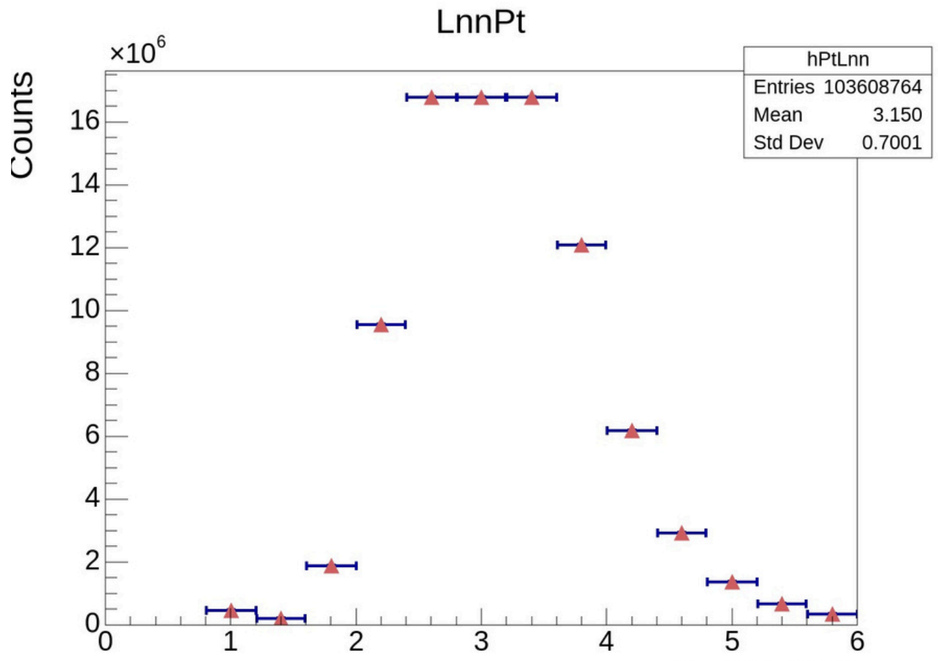


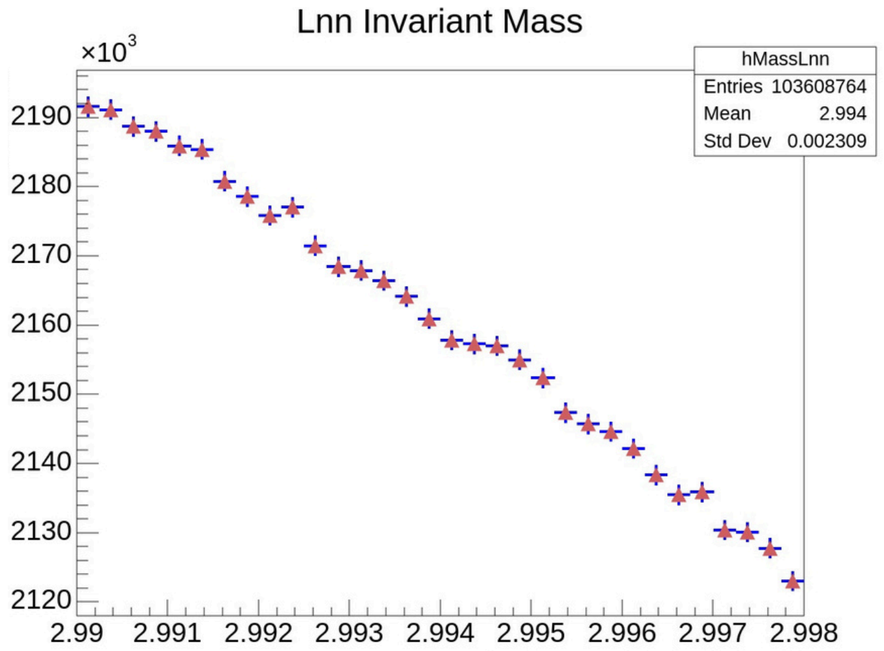
FIRST ΛNN DISTRIBUTIONS

Very raw preliminary results!

Cuts:

- cosPA > 0.995 and abs(nSigmaTPC) < 2





ON GOING

CURRENT WORK

New flag for InnCand.isMatter

- Old flag based only in nTPCSigmaCut, which works for 3He selection in TPC, where its energy loss curve is more descriminate than particles with Z = 1
- Armenteros Podolanski alpha

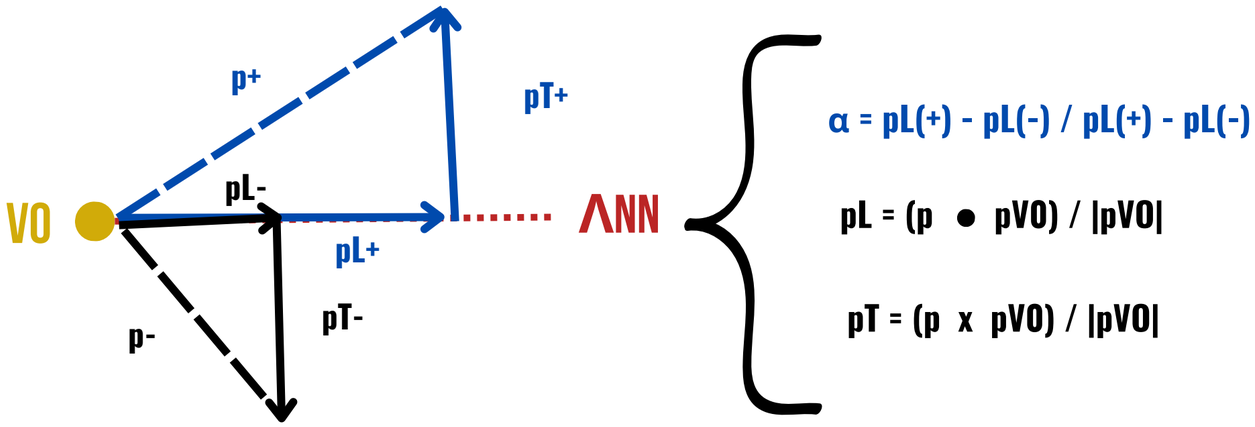
Corrections in TOF implementation

- discarted if !hasTOF
- pTminTOF, massTr2 variables
- if hasTOF
  - only fill TPC information afterwards

ARMENTEROS PODOLANSKI

Correlation between the pT of mother particle and the longitudinal momenta assymetry of daugthers particles (alpha)

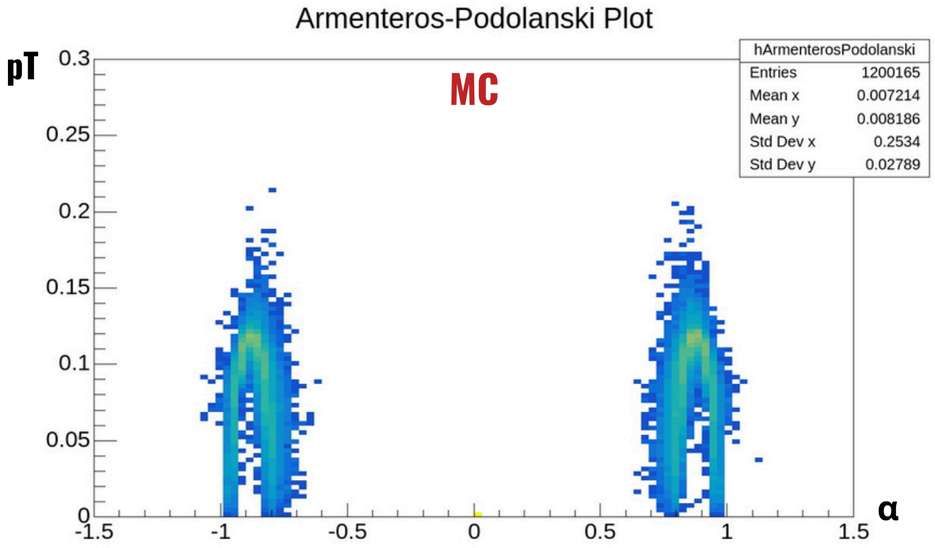
- Old:
  - is3H and isAnti3H = hasTPC() & **nSigmaTPC > NSigmaTPCMinCut.**
    - InnCand.IsMatter = is3H && isAnti3H?
    - h3track = InnCand.IsMatter? posTrack : negTrack;
- New flag:
  - **InnCand.isMatter = alpha > 0**
  - **auto& h3track = InnCand.isMatter ? posTrack : negTrack;**

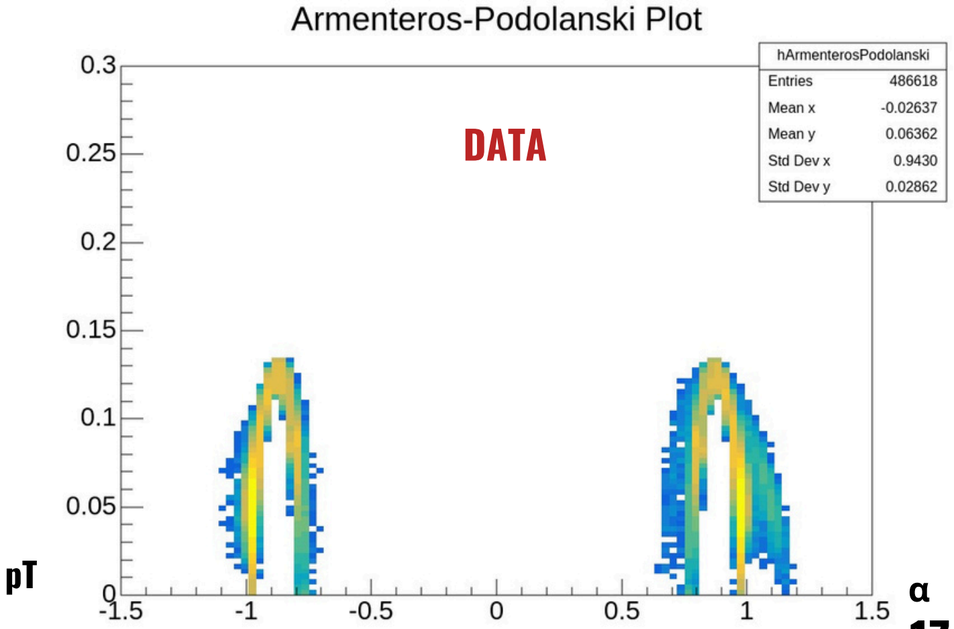


$$\alpha = pL(+) - pL(-) \,/\, pL(+) - pL(-)$$

$$pL = (p \bullet pV0) \,/\, |pV0|$$

$$pT = (p \times pV0) \,/\, |pV0|$$

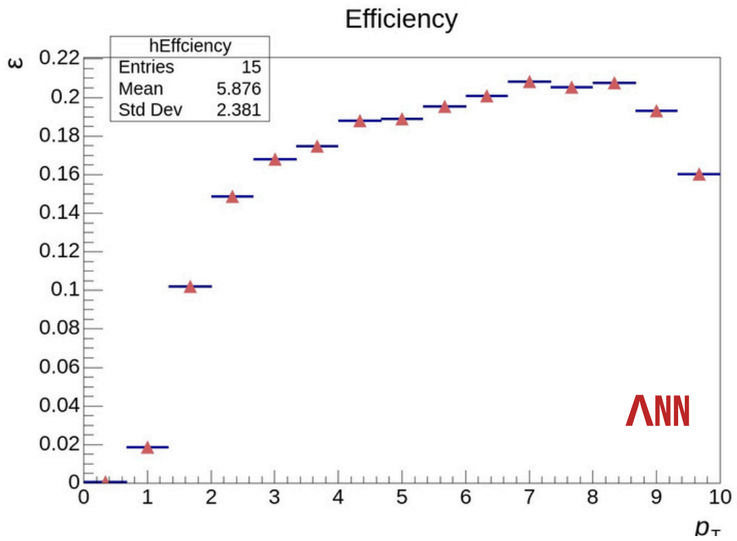


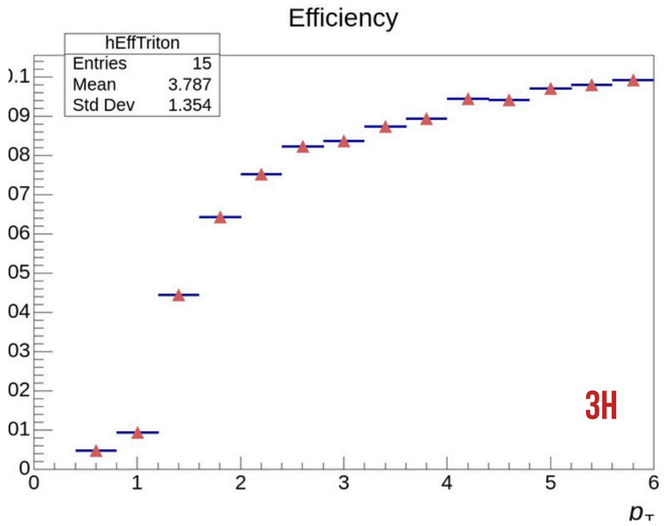


EFFICIENCY

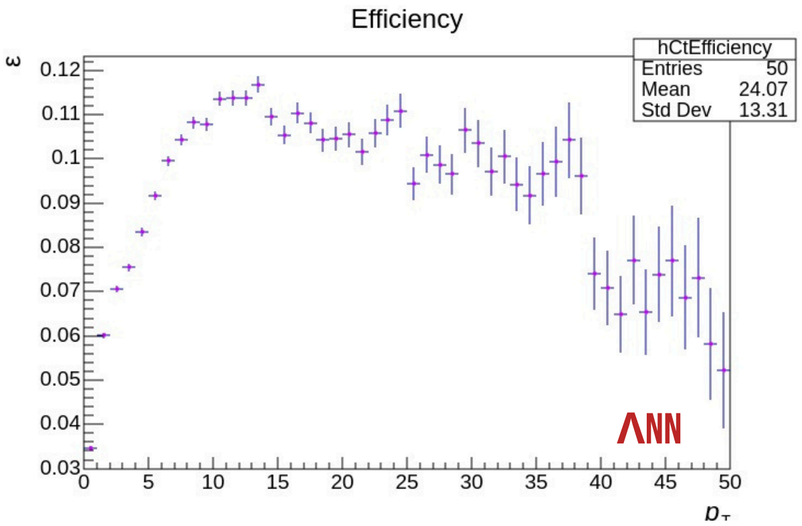
$$\text{EFF} = \frac{\text{NUMBER OF PARTICULES RECONSTRUCTED}}{\text{NUMBER OF PARTICULES GENERATED}}$$

pT





ct



OUTLOOK

These work was developped on the last six months when I started as PhD student by CERN Non-Member States doctoral program.

Reconstruction of triton + π- channel decay

- Task avaiable on O2Physics repository: InnRecoTask.cxx
- Data + MC
  - topologial, kinematics and PID information
    - ITS-TPC and TOF:
      - Detector operation
      - (Anti)tritons selections
  - Efficiency

Λnn candidates

- Preliminary invariant mass and transverse momentum distribution

NEXT STEPS

New resuts from AP alpha implementation for isMatter flag

Future steps:

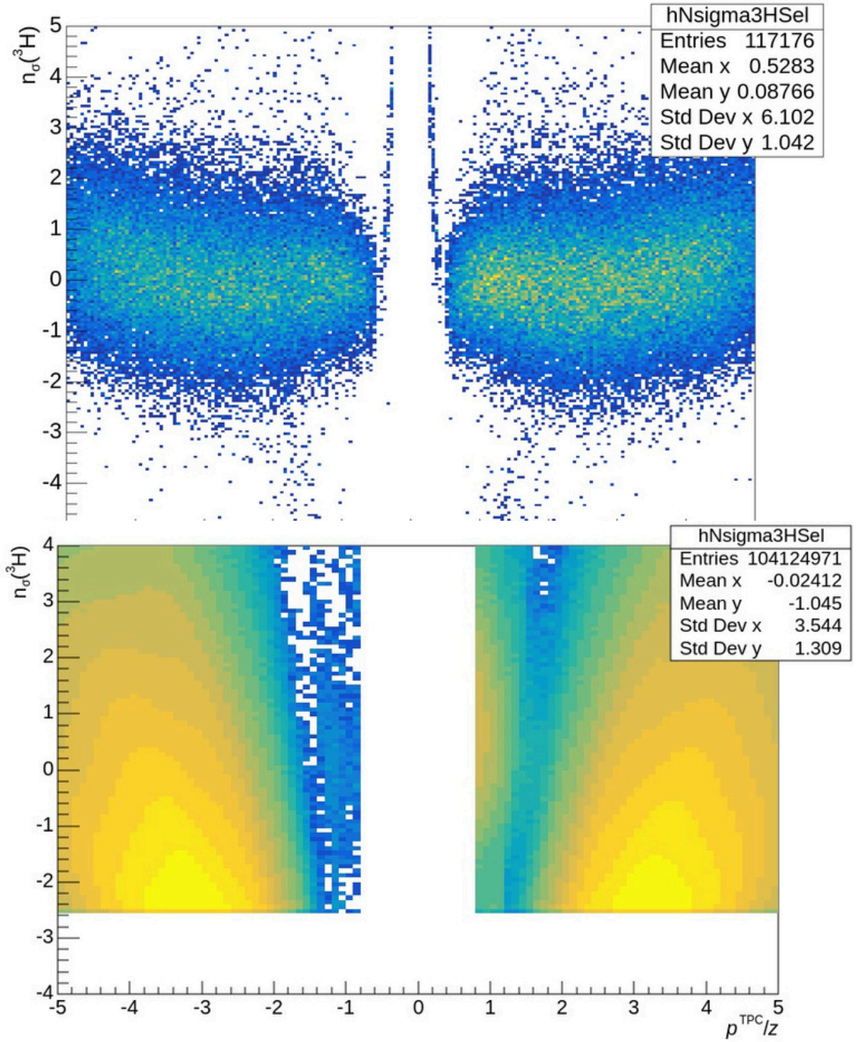
- VOcostum > secondary vertex pool with tracks selection
- Background study: purity
  - Fit invariant mass with crystall ball and remotion of background for Lnn invariant mass
- Start the ML approach to improve the LnnCandidates selection
  - Input: topologial variables + NSigma3H
- Run new MC -> for my datasample

OBRIGADA!

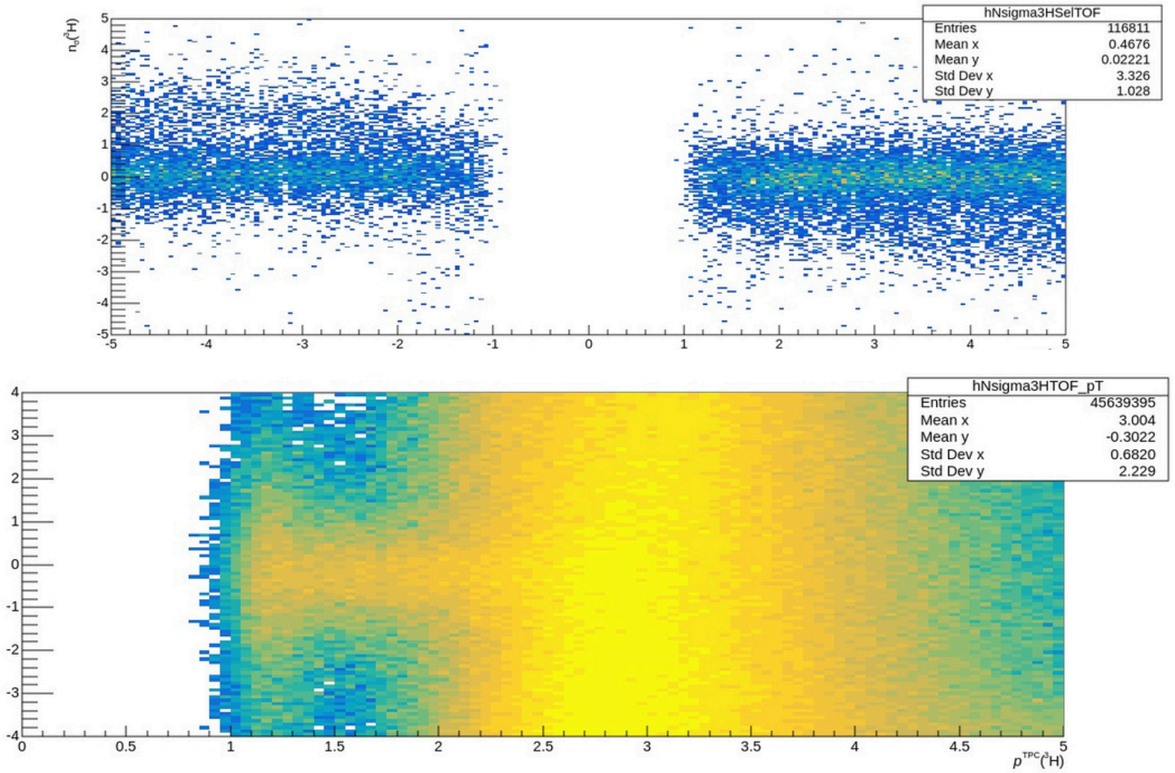
BACK UP

NSIGMA DISTRIBUTIONS

TPC



TOF



MC: PT CORRELATIONS