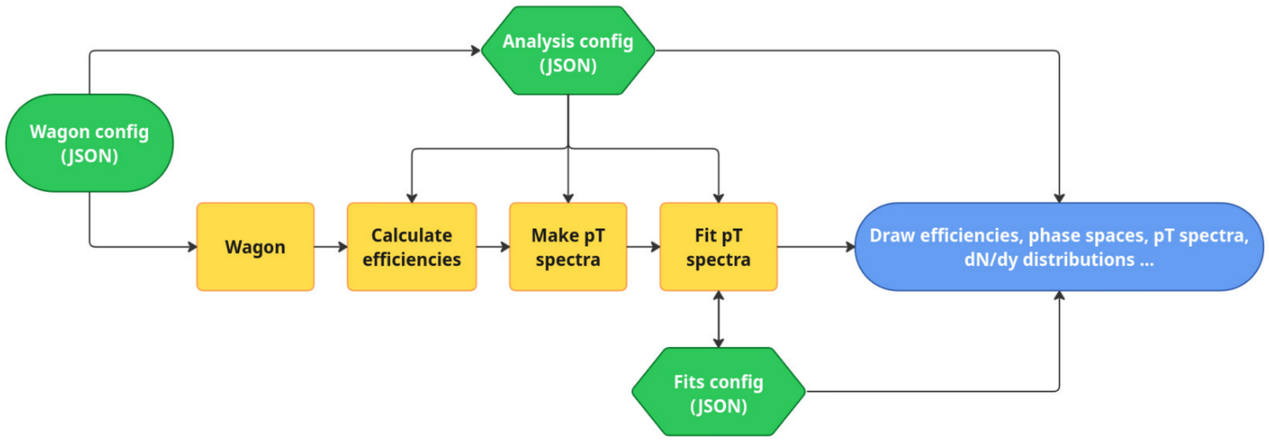
«Nuclei» wagon

Update



V. Kireyeu 17.06.2025

Summary from 03.06.2025

https://indico.jinr.ru/event/5454/contributions/31566/attachments/22421/39618/nuclei-wagon.pdf

- Despite the right approach used within the «nuclei» wagon, there is room for improvement:

Done • ~~PID part in the wagon C++ part must be refactored (reduce the code).~~

Done • ~~More options must be added to the analysis configuration file (post-processing analysis).~~

Done • ~~Small refactor of the post-processing programs for the heavies usage of the configuration file — it is a must.~~

Took 2 days ~~**~1 month to implement and test**~~

Done **Fully config-driven approach**

PID modes

- MpdPid class, max probability: dE/dx only
- MpdPid class, max probability: combined dE/dx and m^2

Old and known

- MpdPid class, «Veto PID»: TPC-TOF
- MpdPid class, «Veto PID»: TOF-TPC
- evPID wagon, «Veto PID»: TPC-TOF
- evPID wagon, «Veto PID»: TOF-TPC

New

New configuration options for analysis

```
"Efficiencies": [
  {"numerator": "h__eff_counter_3",   "denominator": "h__eff_counter_0",
      "output": "efficiency_tpc",            "type": "efficiency"},
  {"numerator": "h__eff_counter_4",   "denominator": "h__eff_counter_1",
      "output": "contamination_secondaries", "type": "contamination"},
  {"numerator": "h__eff_counter_5",   "denominator": "h__eff_counter_2",
      "output": "efficiency_tof",            "type": "none"},
  {"numerator": "h__eff_counter_6",   "denominator": "h__eff_counter_2",
      "output": "efficiency_pid",            "type": "sigma"},
  {"numerator": "h__eff_counter_7",   "denominator": "h__eff_counter_6",
      "output": "purity_pid",                "type": "none"},
  {"numerator": "h__eff_counter_8",   "denominator": "h__eff_counter_6",
      "output": "contamination_pid",         "type": "none"}
],
```

Efficiencies and contaminations are applied automatically relying on the «type» field:

efficiency: $\times \frac{1}{\varepsilon}$

contamination: $\times (1 - C)$

sigma: $\times \frac{1}{\sigma}$

New configuration file for «merging»

```
{
  "System": "Xe+W, E_{kin} = 2.5 A.GeV",
  "JSON_analyses":[
    "settings/match2sigma/analysis_xew_2.5agev_evpid_tpctof.json",
    "settings/match2sigma/analysis_xew_2.5agev_evpid_toftpc.json"
  ],
  "ROOT_ptspectra": "output/match2sigma/evpid-merged/ptspectra.root",
  "Rapidity": [
    [0.0, 0.1],
    [0.1, 0.2],
    [0.2, 0.3],
    [0.3, 0.4],
    [0.4, 0.5],
    [0.5, 0.6],
    [0.6, 0.7],
    [0.7, 0.8],
    [0.8, 0.9],
    [0.9, 1.0]
    ],
  "Particles": {
    "p": {
      "0": [
        [0, 5, 6, 30],
        [0, 5, 6, 30],
        [0, 5, 6, 30],
        [0, 6, 7, 30],
        [0, 6, 7, 30],
        [0, 8, 9, 30],
```

Define the configuration files for the spectra to merge

Rapidity intervals

Histograms bins to merge

Written in the way so it can handle more than 2 spectra: you can merge 2, 3, 4, …, **N** histograms.

«Veto» PID: TPC-TOF

- TPC-TOF
  - TPC 2σ PID selection for a given specie (π, p)
  - If track is 2σ-matched to TOF then TOF 2σ PID selection for a given specie (π, p)

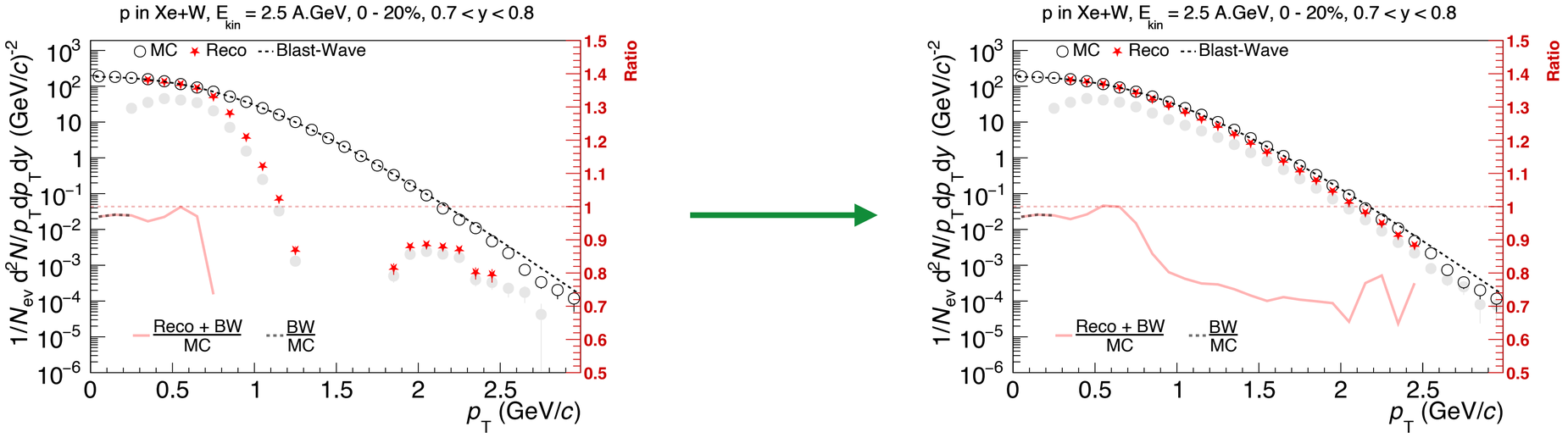
- TPC-TOF
  - TPC 1σ PID selection for a given specie (K)
  - If track is 2σ -matched to TOF then TOF 1σ PID selection for a given specie (K)
  - TPC 3σ veto-PID for other species (for K: e/π/p veto)

More on «veto» PID:
https://indico.jinr.ru/event/4928/contributions/28804/attachments/20329/35316/Signed_piKp_PID_BiBi92.pdf
https://indico.jinr.ru/event/5313/contributions/30786/attachments/21958/38740/PiKP_MalaevM_010425.pdf
https://indico.jinr.ru/event/5424/contributions/31340/attachments/22339/39461/PiKP_MalaevM.pdf

«Veto» PID: TPC-TOF

- TPC-TOF in «nuclei» wagon
  - TPC ***N***σ PID selection for a given specie
  - If track is 2σ-matched to ToF then ToF ***N***σ PID selection for a given specie
  - TPC ***N***σ veto-PID for other species
  - ToF ***N***σ veto-PID for other species if track is 2σ-matched to ToF

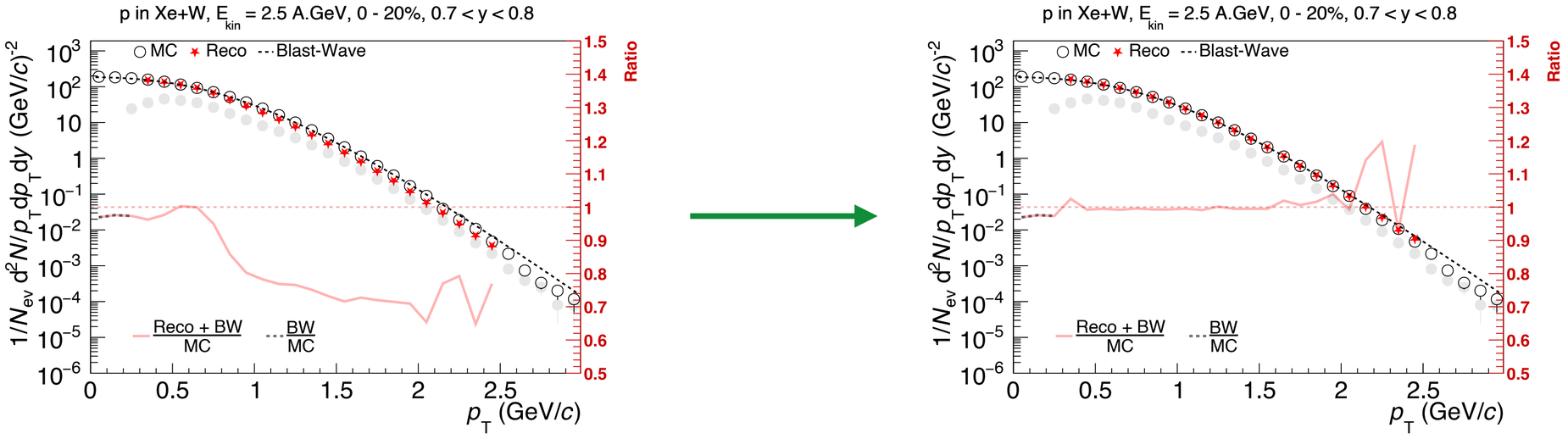
evPID wagon



«Veto» PID: TPC-TOF

- PID efficiency correction
  - ***N***σ correction does not count particles rejected by the «veto»
  - Use the «standard» MpdPid class way to calculate «Veto PID» efficiency?

evPID wagon

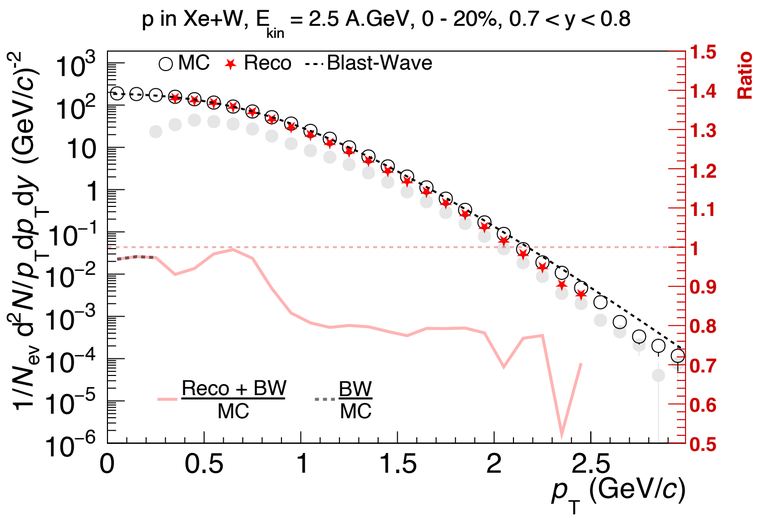


«Veto» PID: merging

- The idea is to merge TPC-TOF and TOF-TPC spectra

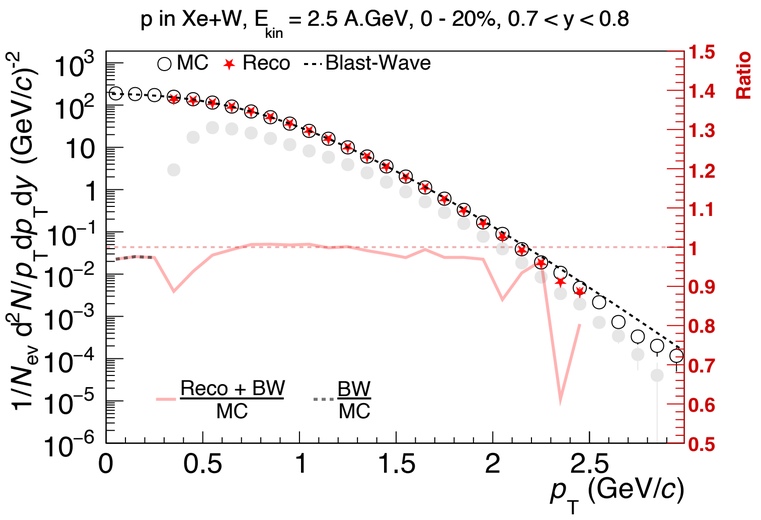
MpdPid class

TPC-TOF



+

TOF-TPC

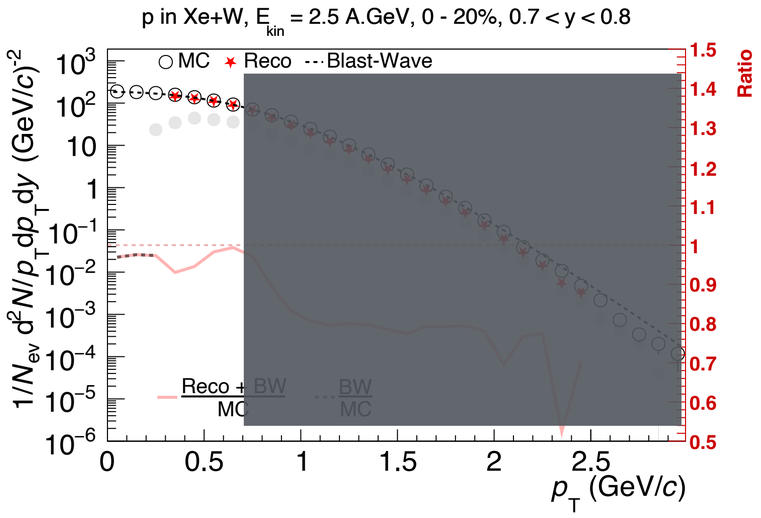


«Veto» PID: merging

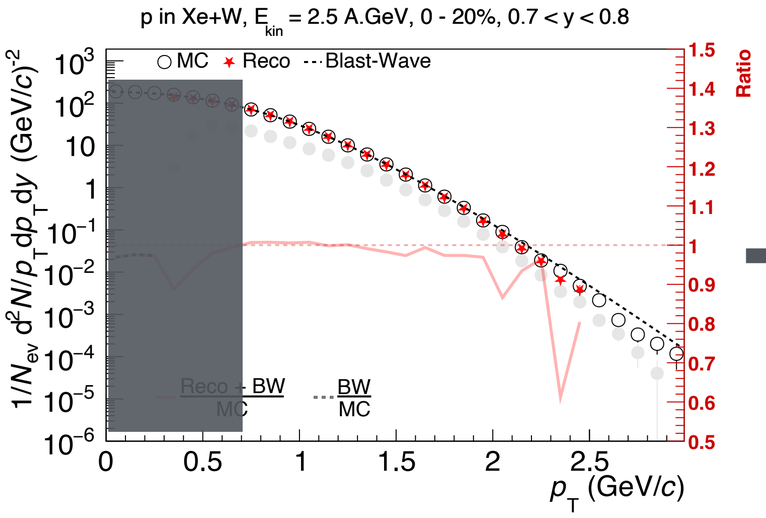
- The idea is to merge TPC-TOF and TOF-TPC spectra

MpdPid class

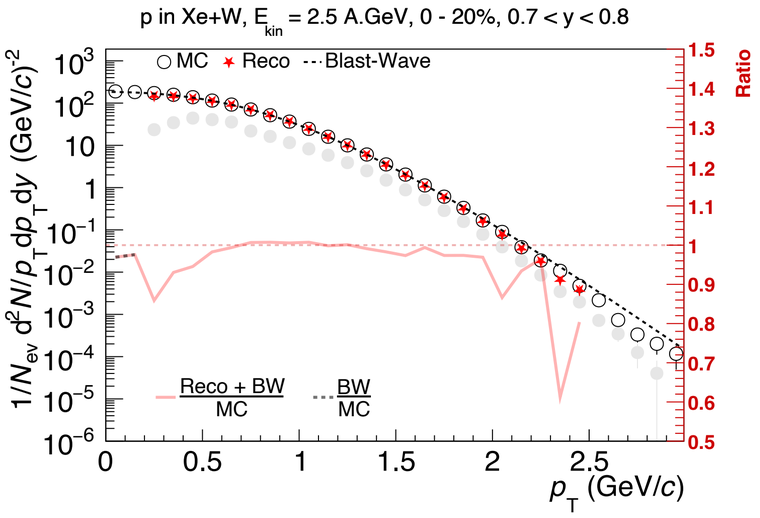
TPC-TOF



TOF-TPC



Merged

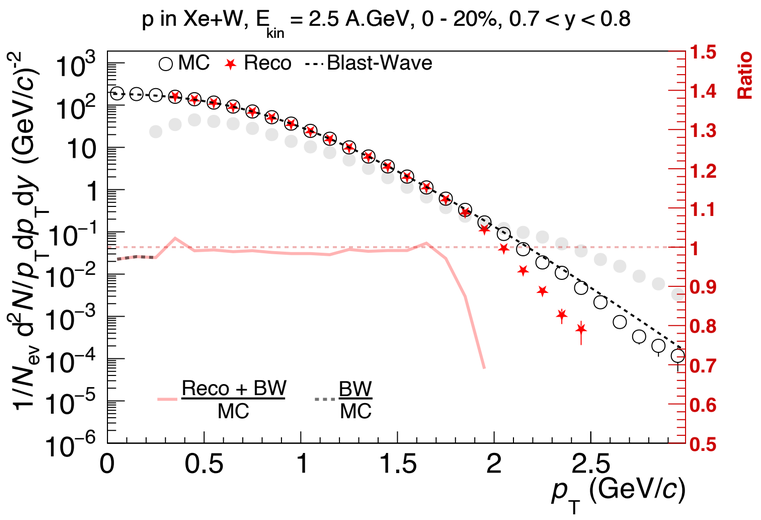


dE/dx + Combined PID: merging

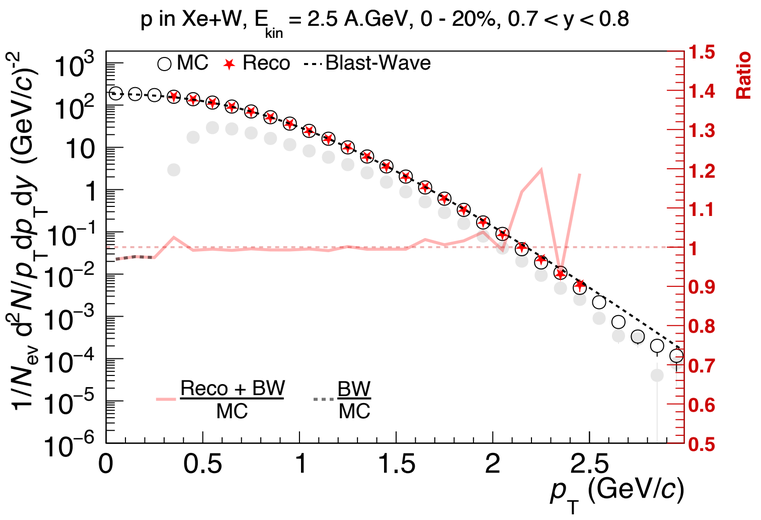
- Same idea for «dE/dx only» and «Combined PID» spectra

MpdPid class

dE/dx



Combined

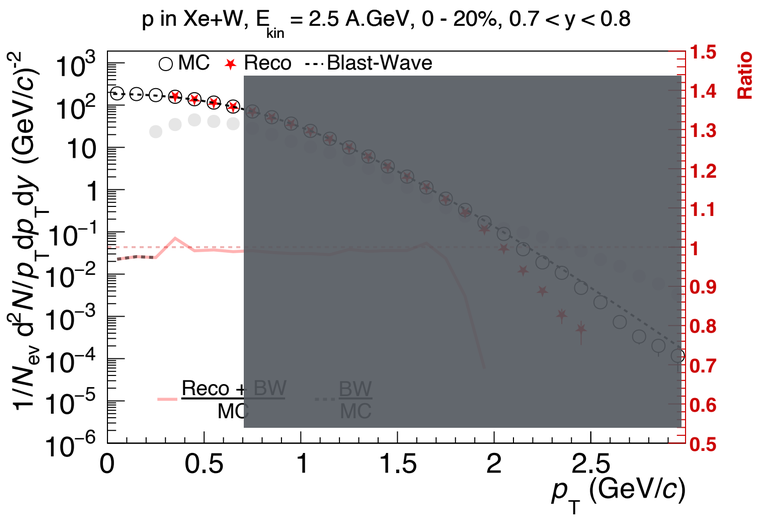


dE/dx + Combined PID: merging

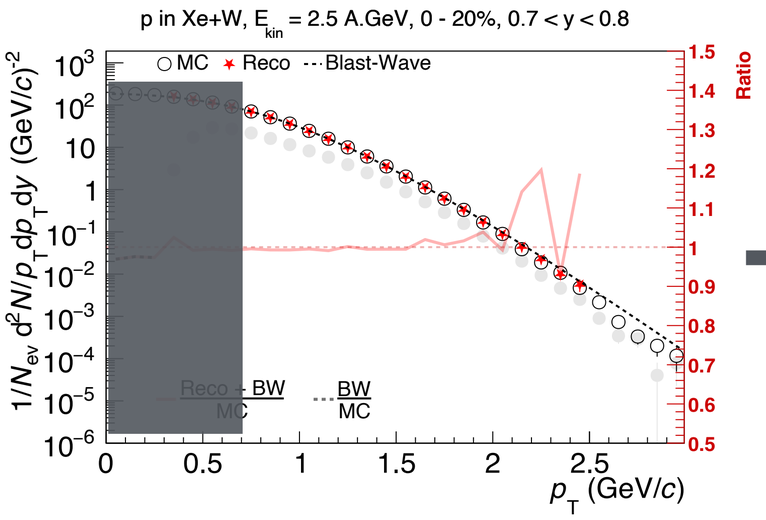
- Same idea for «dE/dx only» and «Combined PID» spectra

MpdPid class

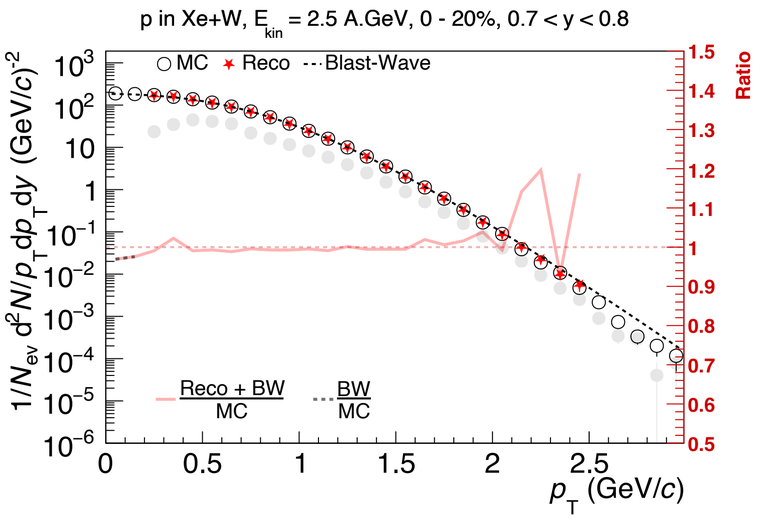
dE/dx



Combined

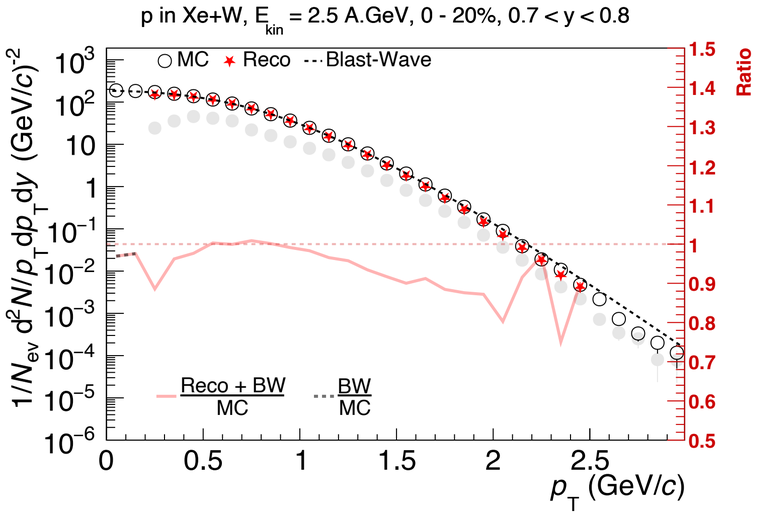


Merged

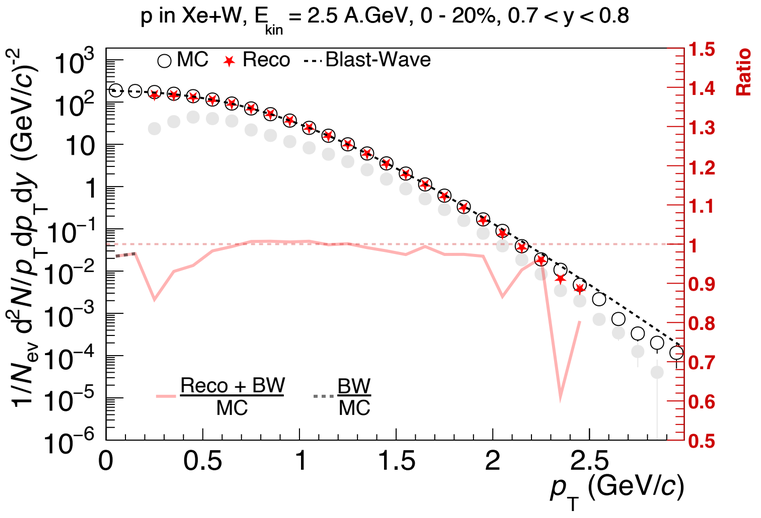


«Merged» spectra for all PID: protons

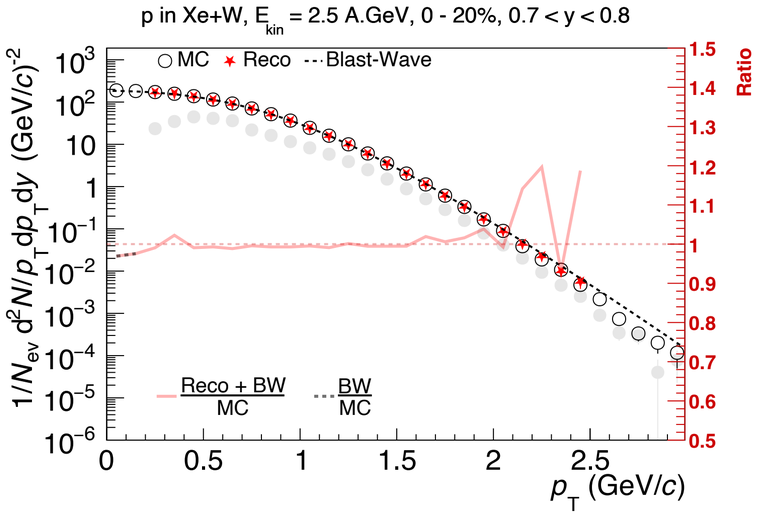
evPID: Veto



MpdPid: Veto

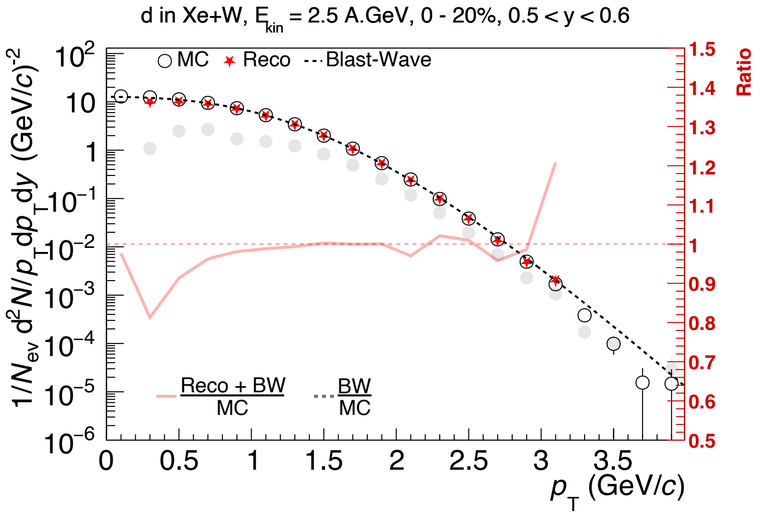


MpdPid: MaxProb

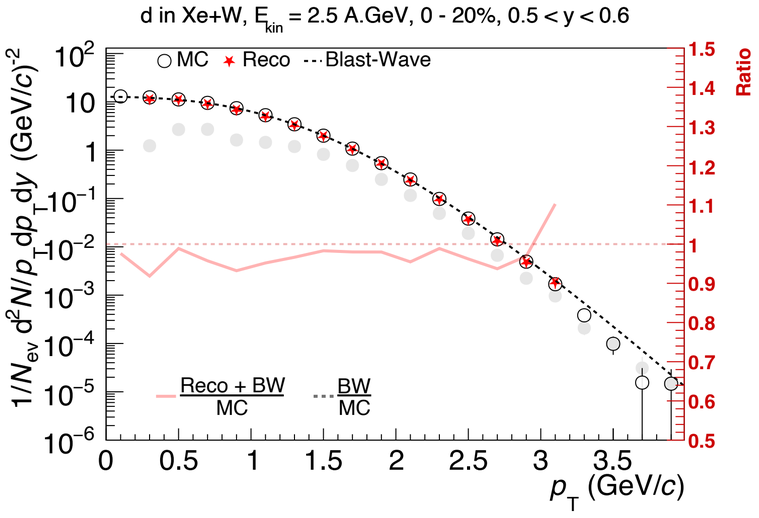


«Merged» spectra for all PID: deuterons

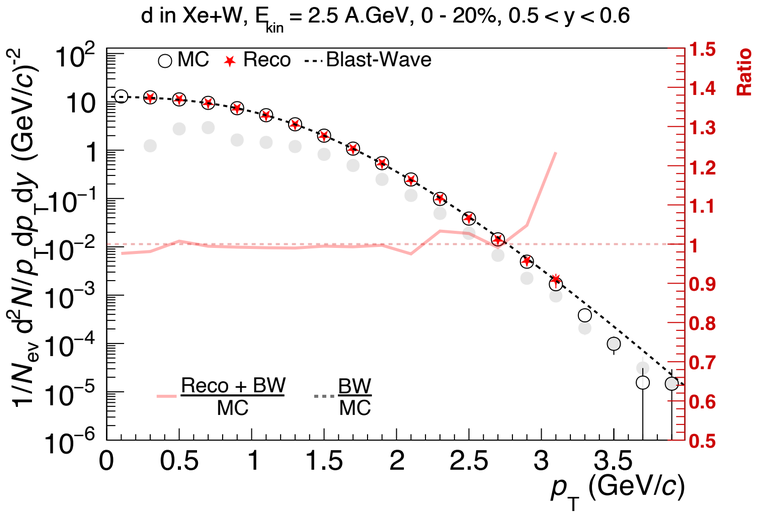
evPID: Veto



MpdPid: Veto

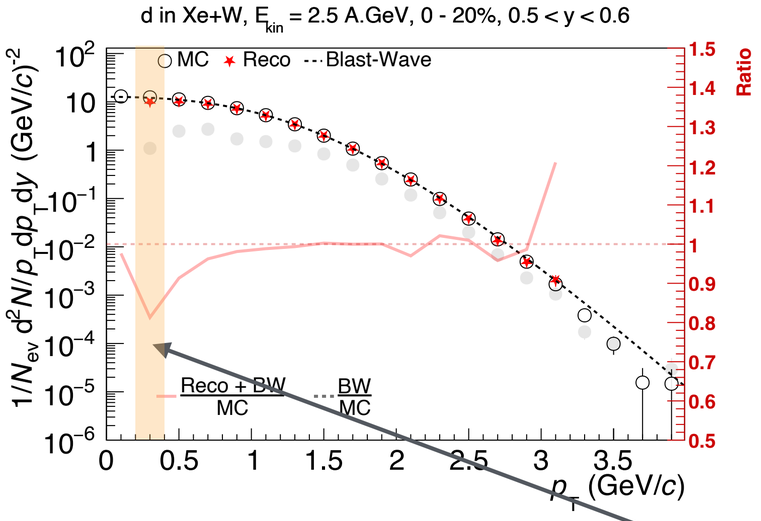


MpdPid: MaxProb

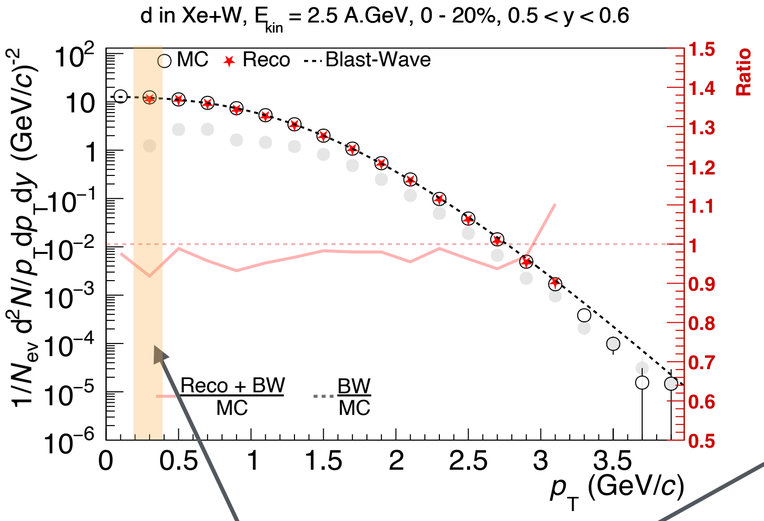


«Merged» spectra for all PID: deuterons

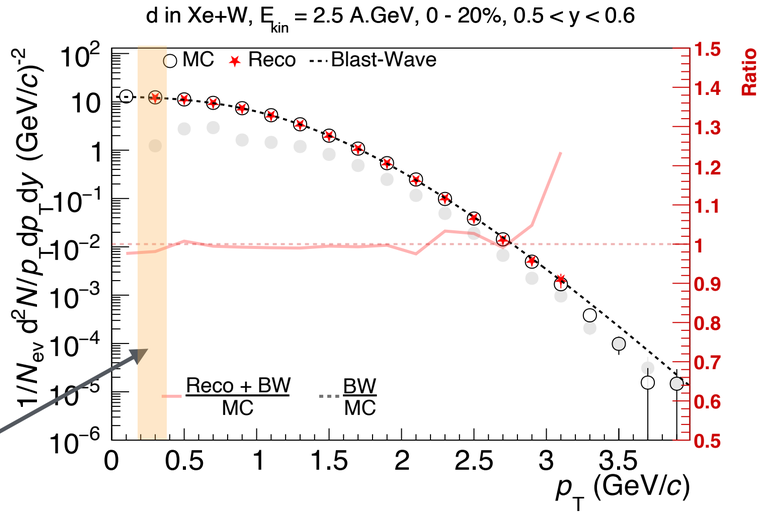
evPID: Veto



MpdPid: Veto



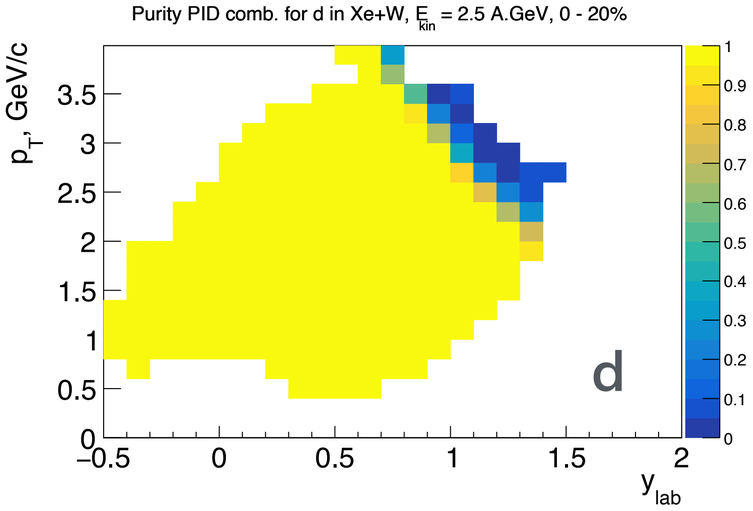
MpdPid: MaxProb

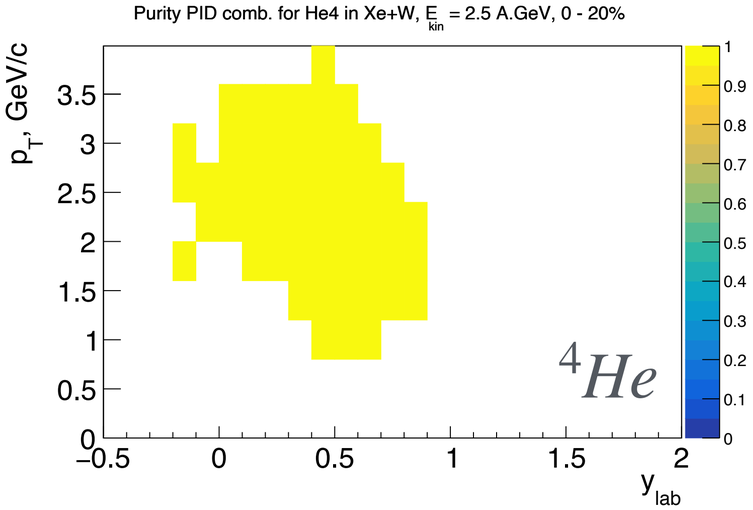


Overall correction ~ $\times 10$

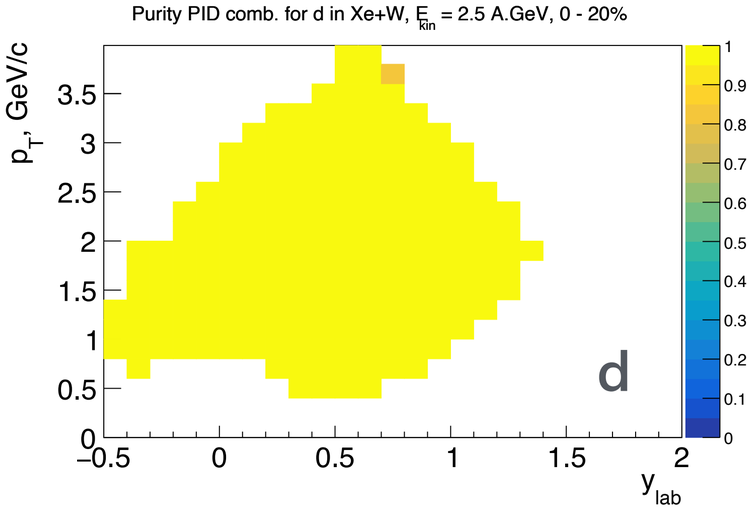
A bit on purity

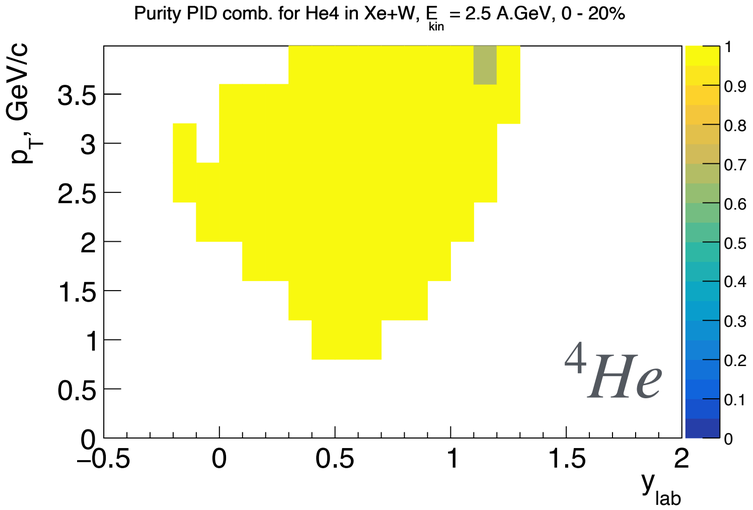
evPID: TOF-TPC



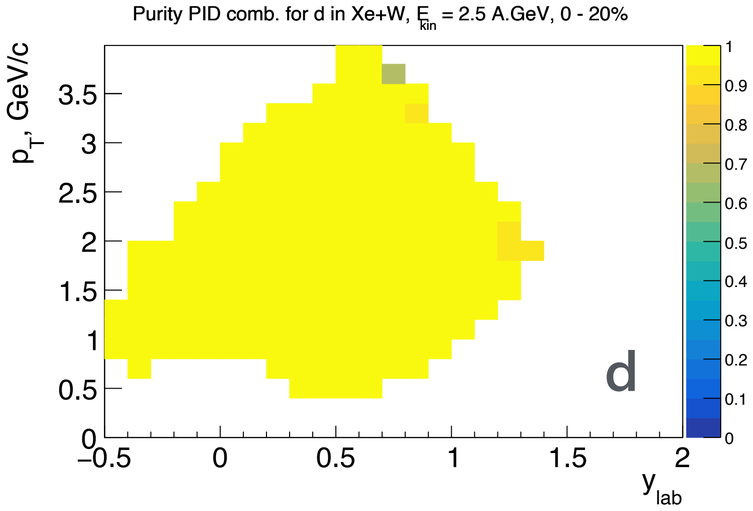


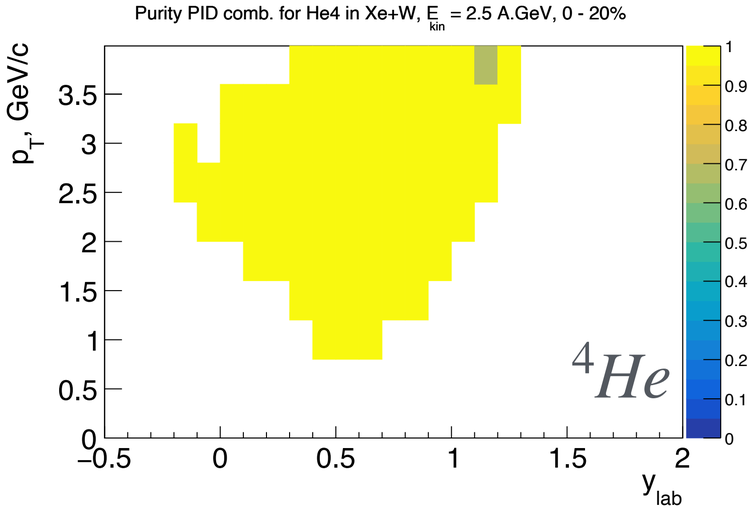
MpdPid: TOF-TPC





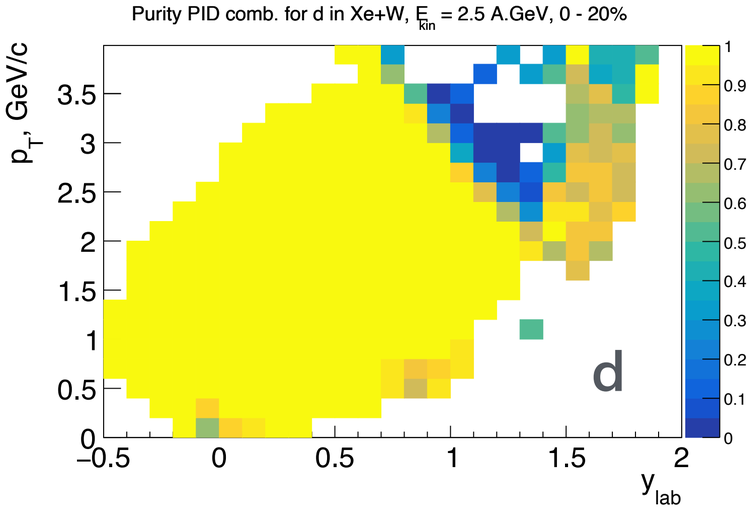
MpdPid: dE/dx + m²

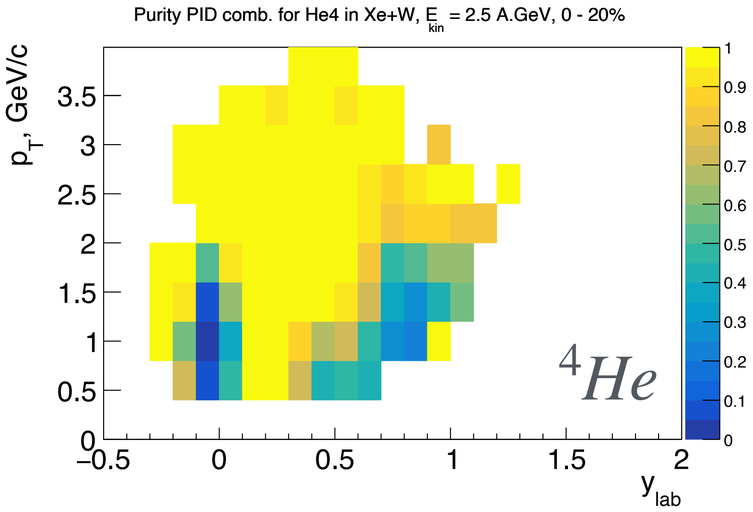




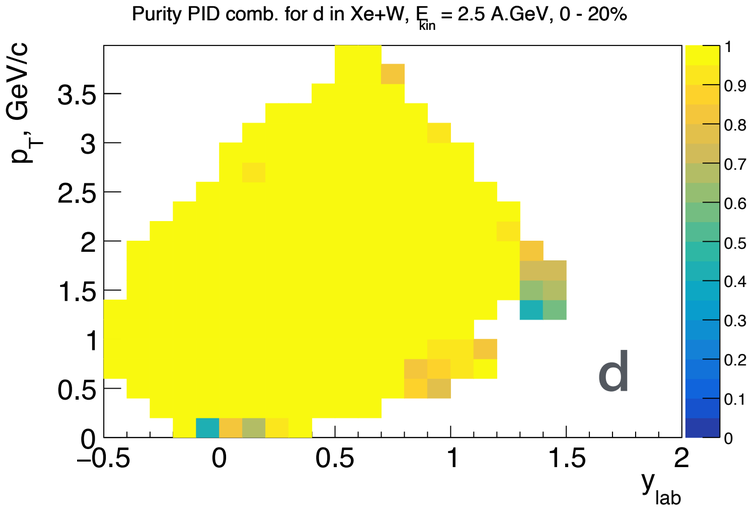
A bit on purity

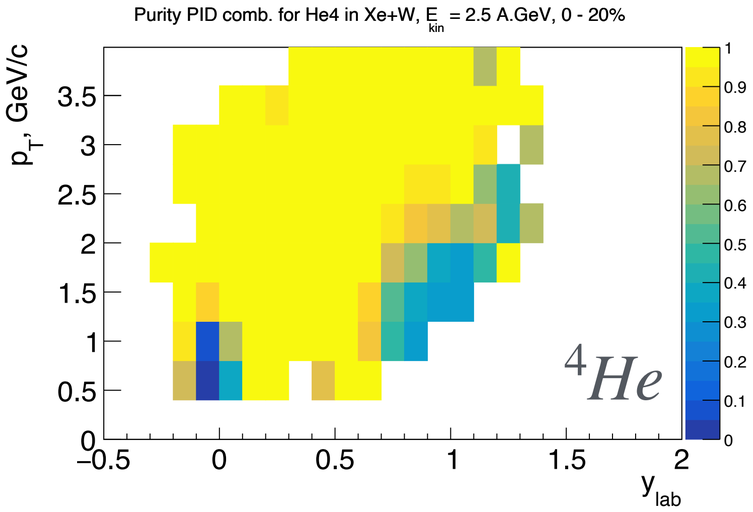
evPID: TPC-TOF



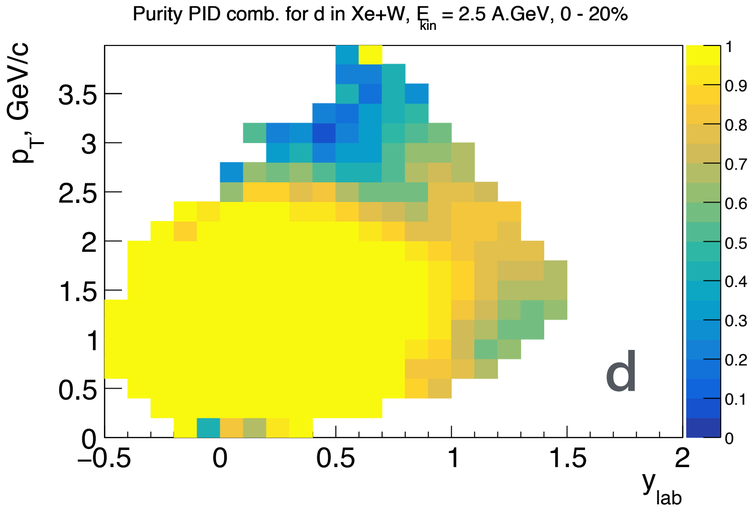


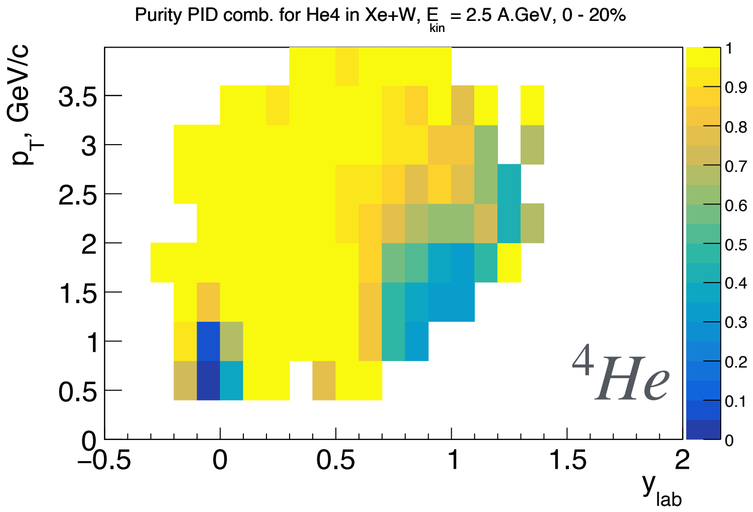
MpdPid: TPC-TOF





MpdPid: dE/dx





Summary

- «Nuclei» wagon can use any kind of the PID.
- For the «TPC-TOF» mode of the «Veto» PID additional ToF veto-cut in the case of the ToF-matching must be applied.
- No clear evidence on which PID type/mode is «better».
- No clear evidence on the spectra «merging» benefits.
- **Good news: any PID type and mode gives very similar results.**
- «Nuclei» wagon now if fully config driven: main part, post-processing, spectra merging.
- Another abstraction layer can be added to the configuration files part.

Backup slides

Efficiencies: TPC, ToF matching