O2DQ Tutorial

J/ψ->ee

— A simple example for new members of the Jpsi2ee analysis group

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Work environment

1. **Lxplus** working environment
    1. Lxplus is the cern farm server
    2. One can easily use daily updated O2Physics with the cvfms (CernVM File System)
2. Work with your **locally** installed O2Physics
    1. You can also install the O2Physics on your local machine (Linux, MacOS, WSL)
    2. Develop and test your new code, make a PR to commit to O2Physics
3. Work on **Hyperloop**
    1. Hyperloop is a tool to run and manage analysis trains on AliEn
    2. You can easily deploy (create, copy, compare, update,…), test, and submit your wagons

Enlarge your space on lxplus

With cern logged–in in your browser open the link:

https://account.cern.ch/account/

-> click on web-page (under the title ´Authorization, Resources and CERN applications´) on ´Resources and Services´, click on ´List services´, click on ´AFS Workspaces´, click on Settings tab on the left hand side

-> Increase workspace to 5 GB to have sufficient space for testing (in our case, it is the workfolder)

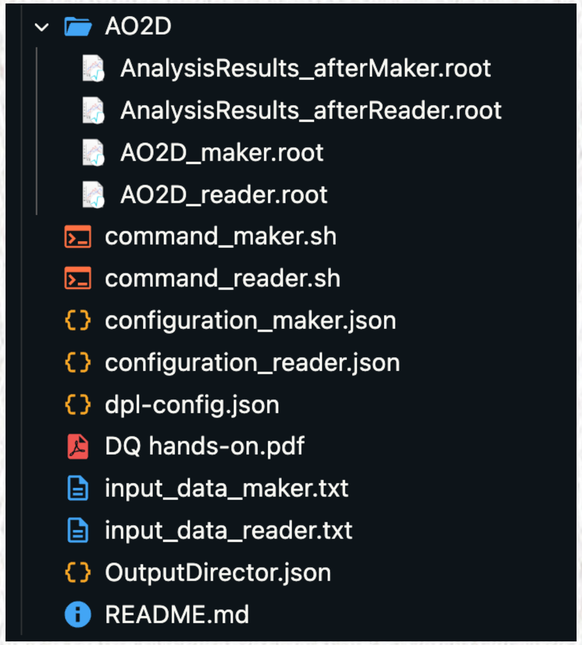
Lxplus working environment

Connect via ssh to lxplus: ssh -X name@lxplus.cern.ch

- name and password: your cern account
- make sure that you have a valid grid certificate
- cd $HOME directory

Download materials for this tutorial:
https://cernbox.cern.ch/index.php/s/3GN7NFOuCmzUQpl

Cross check you have the following materials



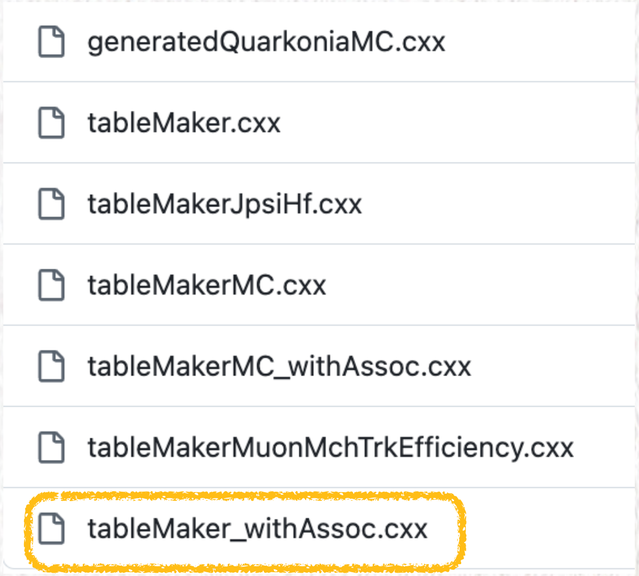
Software version to use

/cvmfs/alice.cern.ch/bin/alienv enter VO_ALICE@O2Physics::daily-20251106-0000-1

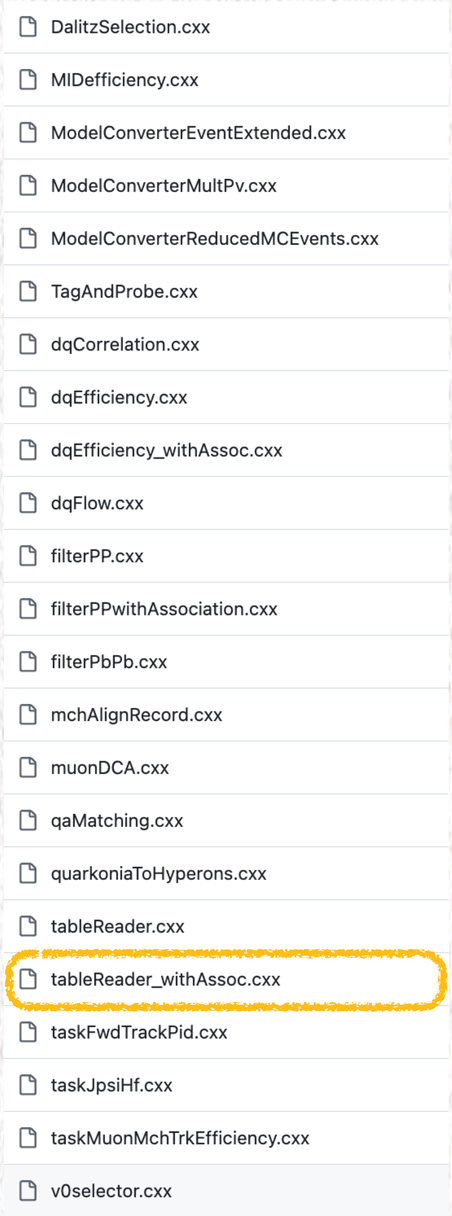
Older or newer versions may not be compatible, as O2Physics is updated daily. The provided configuration.json and command.sh may not work with other versions of O2Physics.

Tasks used today

PWGDQ/TableProducer



PWGDQ/Task



Task Selection: Focus on the two most commonly used tasks for most analyses:

[o2-analysis-dq-table-maker-with-assoc]

[o2-analysis-dq-table-reader-with-assoc]

Other tasks are for different purposes and are not included.

How to run tasks

Workflow Options:

o2-analysis-dq-table-maker-with-assoc and o2-analysis-dq-table-reader-with-assoc can be run in the same workflow.

Alternatively, run o2-analysis-dq-table-maker-with-assoc first to produce the so-called reducedAO2D files, and then use o2-analysis-dq-table-reader-with-assoc on the reducedAO2D files.

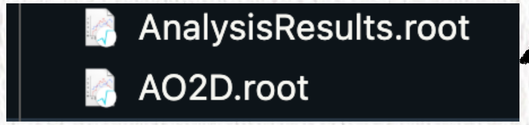
To run o2-analysis-dq-table-maker-with-assoc:

./command_maker.sh

```
o2-analysis-pid-tof-merge -b --configuration json://configuration_maker.json | o2-analysis-ft0-corrected-table -b --configuration json://configuration_maker.json | o2-analysis-tracks-extra-v002-converter -b --configuration json://configuration_maker.json | o2-analysis-multcenttable -b --configuration json://configuration_maker.json | o2-analysis-dq-table-maker-with-assoc -b --configuration json://configuration_maker.json | o2-analysis-event-selection-service -b --configuration json://configuration_maker.json | o2-analysis-propagationservice -b --configuration json://configuration_maker.json | o2-analysis-pid-tpc-service -b --configuration json://configuration_maker.json | o2-analysis-track-to-collision-associator -b --configuration json://configuration_maker.json | o2-analysis-trackselection -b --configuration json://configuration_maker.json --aod-file @input_data.txt --aod-writer-json OutputDirector.json
```

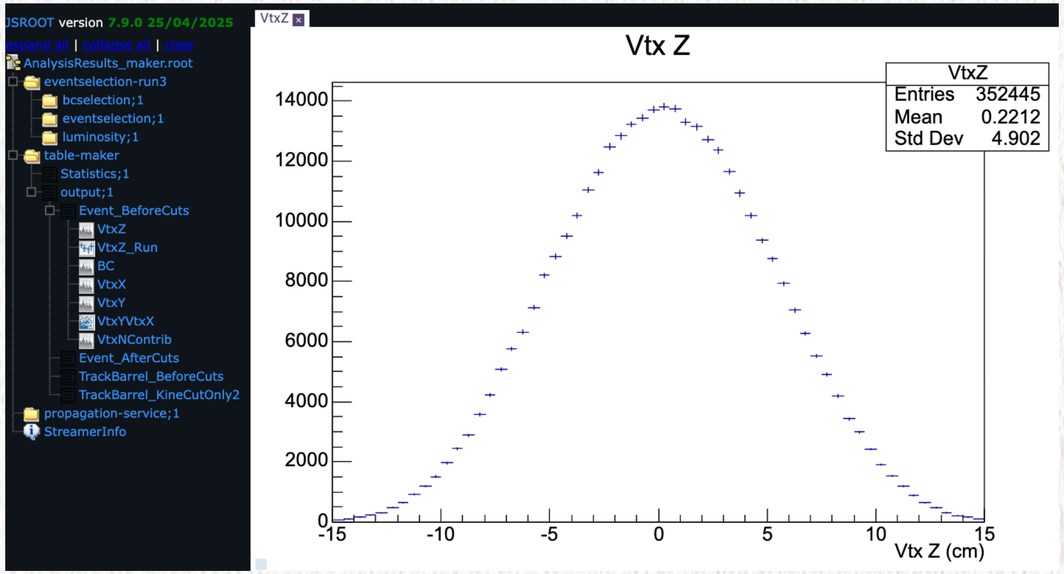
o2-analysis-task -b -- configuration json://configName.json
-- aod-file @input_data.txt
-- aod-writer-json OutputDirector.json

Table-maker outputs

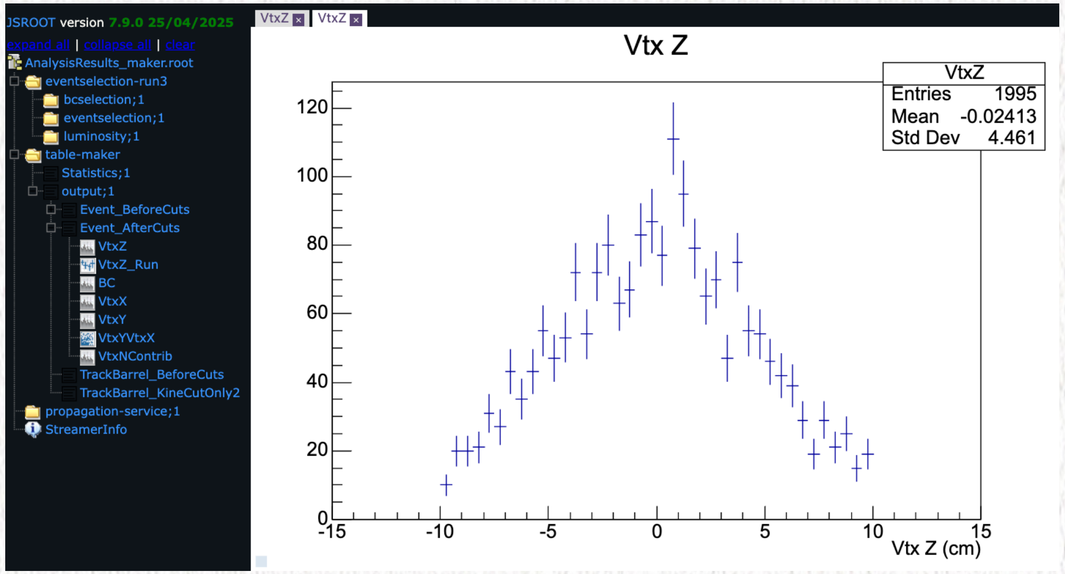


The outputs after tableMaker workflow

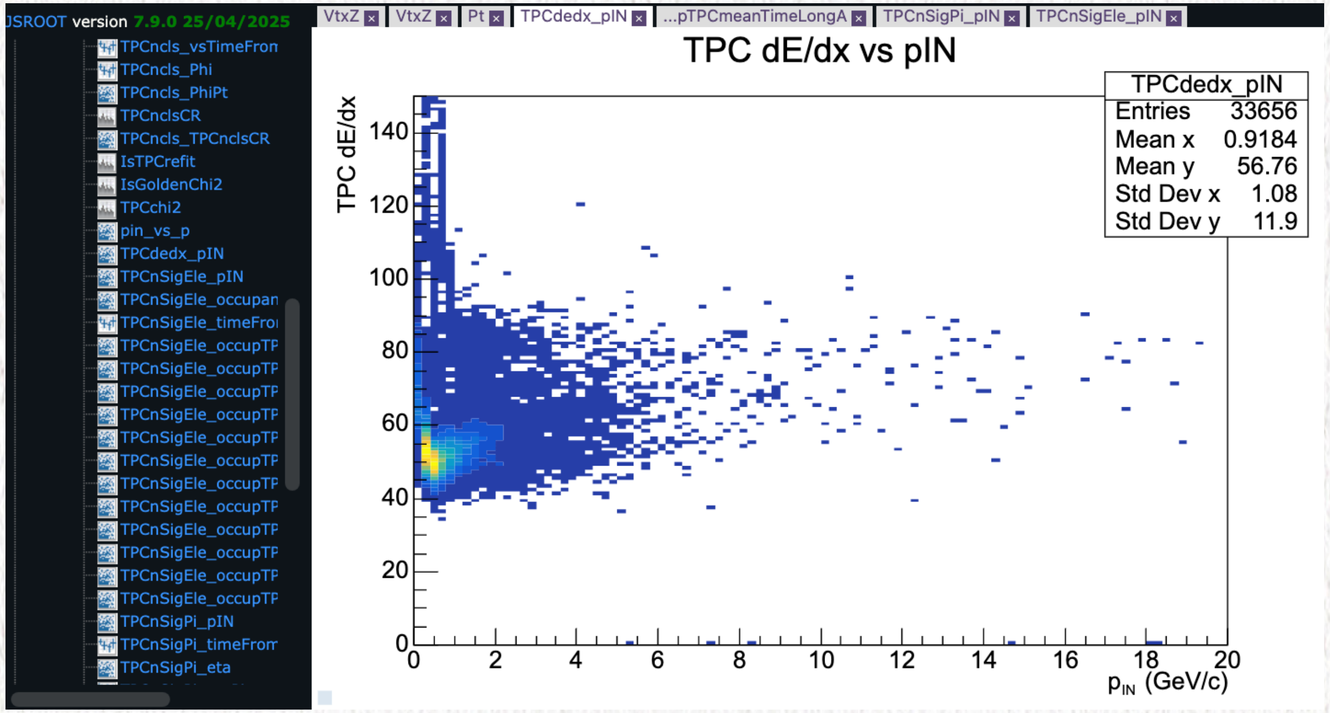
Event before cuts



Event after cuts



Tracks after cuts



Understand the table-maker outputs (I)

```
"aod-file-private": "@input_data_maker.txt",
```

The file includes the lists of the input AO2D path

```
    "processPPWithFilter": "false",
    "processPPWithFilterBarrelOnly": "false",
    "processPPWithFilterMuonOnly": "false",
    "processPPWithFilterMuonMFT": "false",
    "processPPBarrelOnly": "true",
    "processPPBarrelOnlyWithV0s": "false",
    "processPPMuonOnly": "false",
    "processPPRealignedMuonOnly": "false",
    "processPPMuonMFT": "false",
    "processPPMuonMFTWithMultsExtra": "false",
    "processPbPb": "false",
    "processPbPbBarrelOnly": "false",
    "processPbPbBarrelOnlyNoTOF": "false",
    "processPbPbWithFilterBarrelOnly": "false",
    "processPbPbBarrelOnlyWithV0Bits": "false",
    "processPbPbBarrelOnlyWithV0BitsNoTOF": "false",
    "processPbPbMuonOnly": "false",
    "processPbPbRealignedMuonOnly": "false",
    "processPbPbMuonMFT": "false",
    "processOnlyBCs": "true"
```

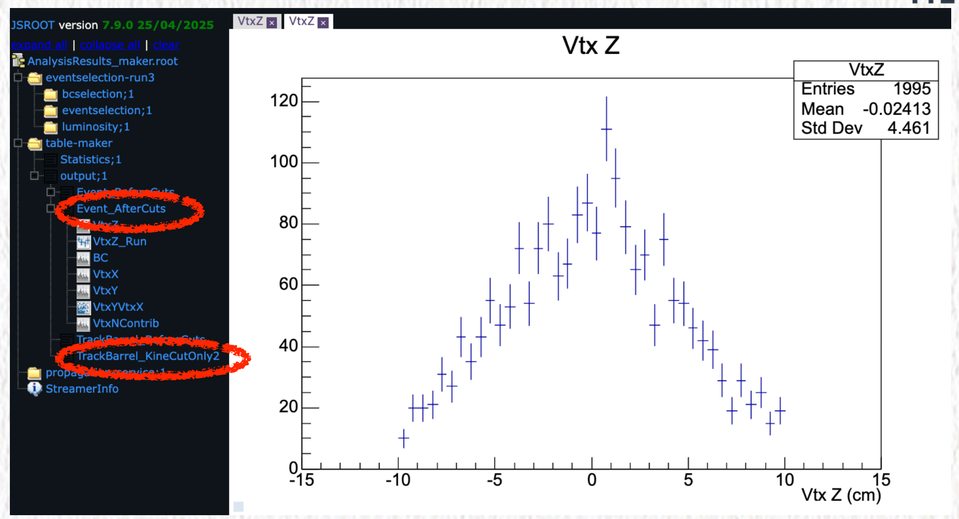
The process to run

- Muon for forward rapidity
- WithFilter for unskimmed pp data
- PbPb for AA collisions

Understand the table-maker outputs (II)

What selections (events, tracks) were used?

```
"table-maker": {
    "cfgEventCuts": "eventStandardSel8",
    "cfgBarrelTrackCuts": "KineCutOnly2",
```



Where to find the contents of these tags?

[O2Physics/PWGDQ/Core/CutsLibrary.cxx]

```
if (!nameStr.compare("eventStandardSel8")) { // kIsSel8 = kIsTriggerTVX && kNoITSROFrameBorder && kNoTimeFrameBorder
  cut->AddCut(VarManager::kVtxZ, -10.0, 10.0);
  cut->AddCut(VarManager::kIsSel8, 0.5, 1.5);
  return cut;
}
```

```
if (!nameStr.compare("KineCutOnly2")) {
  cut->AddCut(GetAnalysisCut("PIDStandardKine2")); // standard kine cuts usually are applied via Filter in the task
  return cut;
}
```

```
if (!nameStr.compare("PIDStandardKine2")) {
  cut->AddCut(VarManager::kEta, -0.9, 0.9);
  cut->AddCut(VarManager::kPt, 0.1, 1000.0);
  return cut;
}
```

Understand the table-maker outputs (III)

Where were the histograms defined?

```
"cfgQA": "true",
"cfgDetailedQA": "true",
"cfgAddEventHistogram": "vtxpp",
"cfgAddTrackHistogram": "tpcpid,itsvspt,dca",
```

Where to find the contents of these tags?

O2Physics/PWGDQ/Core/HistogramsLibrary.cxx

```
if (subGroupStr.Contains("vtx")) {
  hm->AddHistogram(histClass, "VtxX", "Vtx X", false, 200, -0.1, 0.1, VarManager::kVtxX);
  hm->AddHistogram(histClass, "VtxY", "Vtx Y", false, 200, -0.1, 0.1, VarManager::kVtxY);
  hm->AddHistogram(histClass, "VtxYVtxX", "Vtx Y vs Vtx X", false, 200, -0.06, 0.0, VarManager::kVtxX, 200, -0.03, 0.03, VarManager::kVtxY);
}
if (subGroupStr.Contains("vtxpp")) {
  hm->AddHistogram(histClass, "VtxNContrib", "Vtx n contributors", false, 100, 0.0, 100.0, VarManager::kVtxNcontrib);
}
```

There are also some histograms were defined in the task.cxx

O2Physics/PWGDQ/TableProducer/tableMaker_withAssoc.cxx

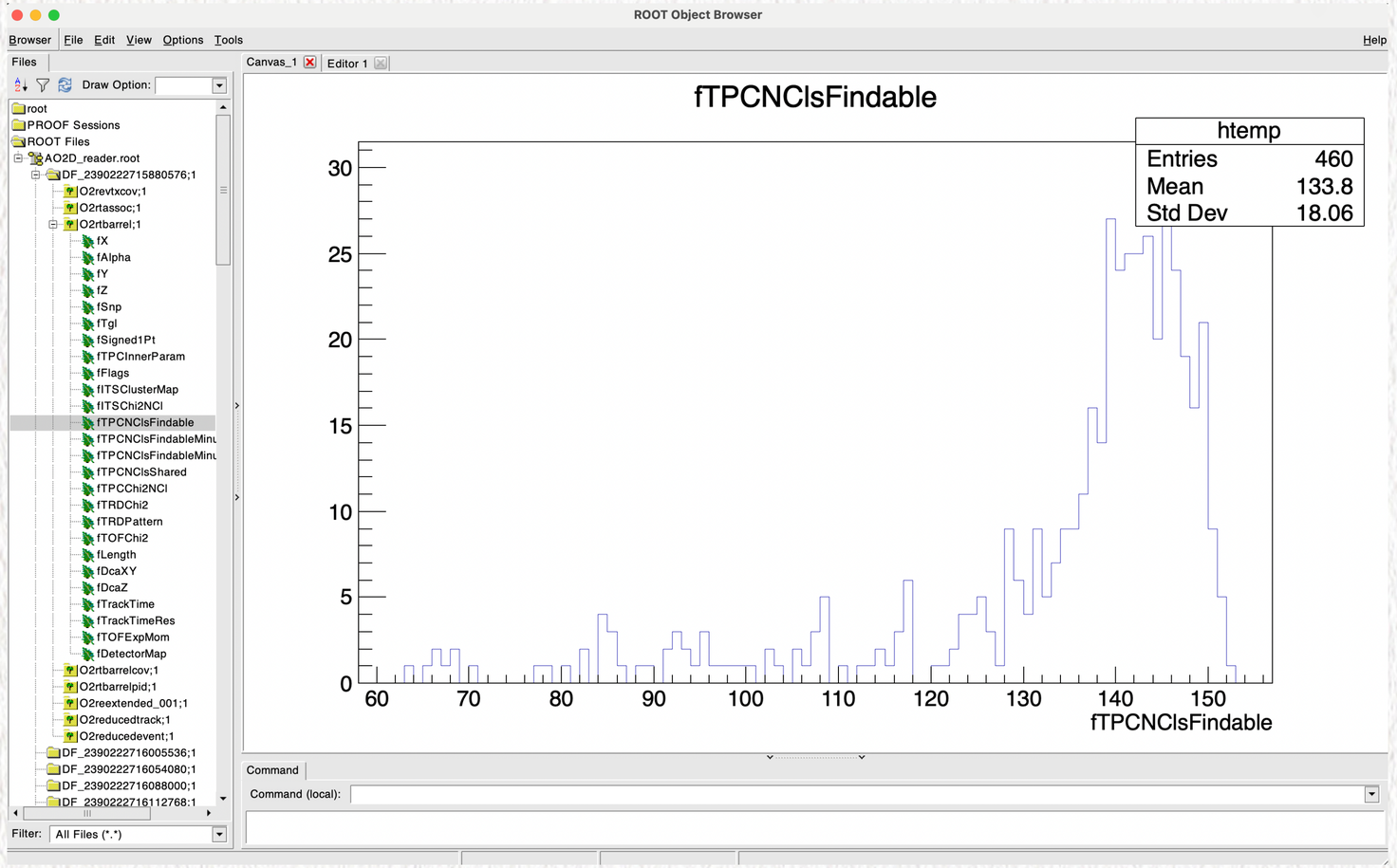
```
if (classStr.Contains("Track") && !classStr.Contains("Pairs")) {
  if (classStr.Contains("Barrel")) {
    dqhistograms::DefineHistograms(histMan, objArray->At(iclass)->GetName(), "track", histName);
    if (classStr.Contains("PIDCalibElectron")) {
      dqhistograms::DefineHistograms(histMan, objArray->At(iclass)->GetName(), "track", "postcalib_electron");
    }
    if (classStr.Contains("PIDCalibPion")) {
      dqhistograms::DefineHistograms(histMan, objArray->At(iclass)->GetName(), "track", "postcalib_pion");
    }
    if (classStr.Contains("PIDCalibProton")) {
      dqhistograms::DefineHistograms(histMan, objArray->At(iclass)->GetName(), "track", "postcalib_proton");
    }
  }
```

Find the content of the tags

Understand the table-maker outputs (IV)

The tables included in the reducedAOD file were defined in the OutputDirector.json

```
{ "OutputDirector": {
    "debug_mode": true,
    "resfile": "AO2D",
    "OutputDescriptors": [
      {
        "table": "AOD/REEXTENDED/1"
      },
      {
        "table": "AOD/REDUCEDEVENT/0"
      },
      {
        "table": "AOD/REDUCEDTRACK/0"
      },
      {
        "table": "AOD/RTBARRELPID/0"
      },
      {
        "table": "AOD/RTBARREL/0"
      },
      {
        "table": "AOD/RTASSOC/0"
      },
      {
        "table": "AOD/REVTXCOV/0"
      },
      {
        "table": "AOD/RTBARRELCOV/0"
      }
    ],
    "ntfmerge": 1
  } }
```



Find the table you want in the [PWGDQ/DataModel/ReducedInfoTables.h]

Run table-reader on the reducedAO2D files

The script to run:
./command_reader.sh

```
o2-analysis-dq-table-reader-with-assoc -b --configuration json://configuration_reader.json --aod-file
@input_data_reader.txt
```

The input_data_reader.txt is the path to the output AOD files from tableMaker task

```
./AO2D/AO2D_reader.root
```

analysis-event-selection	→	Further event selections
analysis-muon-selection	→	Further selections on muon
analysis-track-selection	→	Further selections on central barrel tracks
analysis-asymmetric-pairing	→	Run pairing for resonance with legs fulfilling separate cuts
analysis-prefilter-selection	→	Prefilter tracks to be able to provide a reasonable inv. mass
analysis-same-event-pairing	→	Do the e^+ and e^- or μ^+ and μ^- pairing in same event or mixed-event
analysis-dilepton-track	→	For analysis needs a dilepton and a track, such as $B^+ \to J/\psi + K^+$, J/ψ-hadron correlation
analysis-dilepton-track-track	→	For analysis needs a dilepton and two tracks, such as $\psi(2S)/X(3872) \to J/\psi + \pi^+ + \pi^-$

Run table-reader on the reducedAO2D files

The script to run:

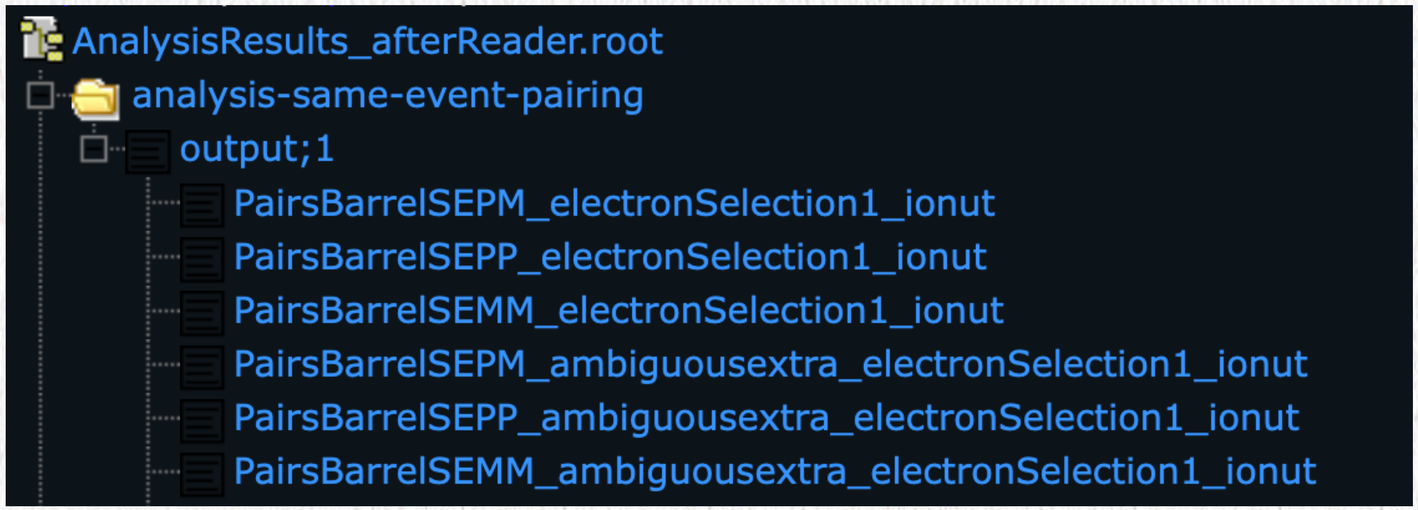
./command_reader.sh

```
o2-analysis-dq-table-reader-with-assoc -b --configuration json://configuration_reader.json --aod-file
@input_data_reader.txt
```

The input_data_reader.txt is the path to the output AOD files from tableMaker task

```
./AO2D/AO2D_reader.root
```

The output from the tableReader



“Which pair” + “trackSelections”

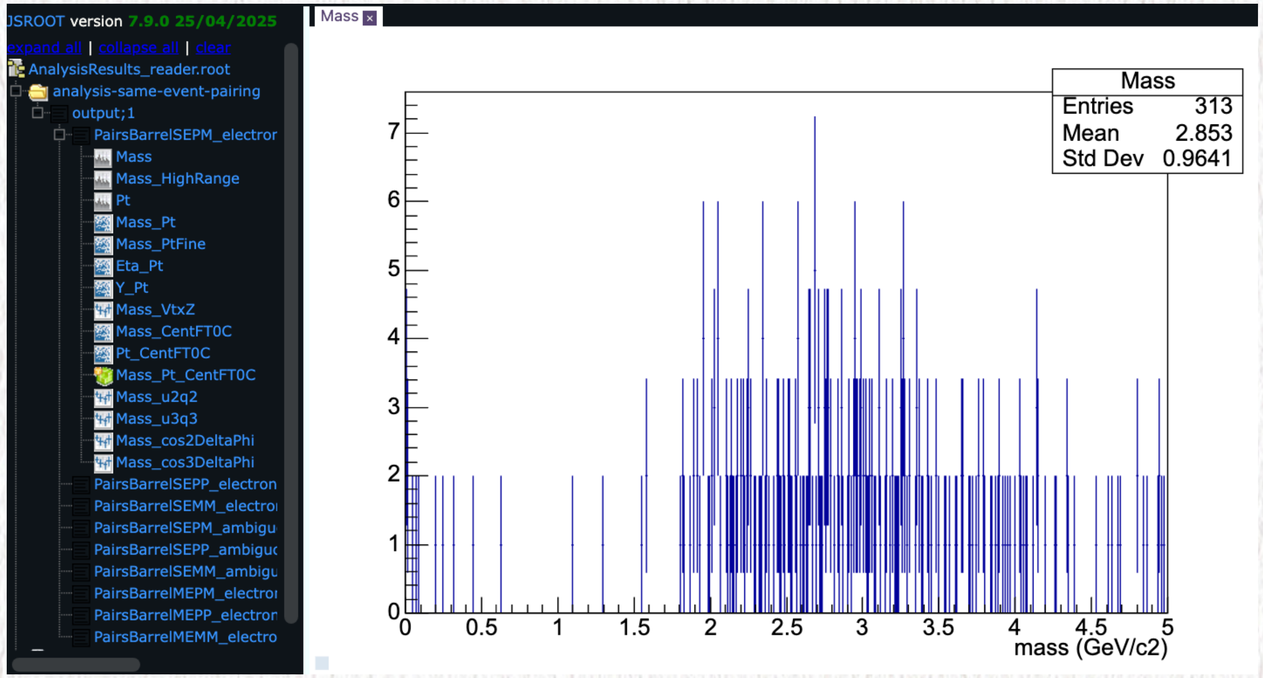
“ambiguousextra” is to subtract due to the double counting

Run table-reader on the reducedAO2D files

The script to run:

./command_reader.sh

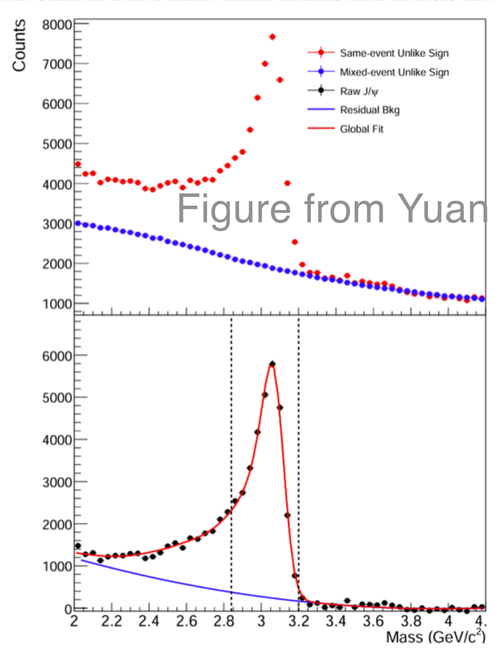
```
o2-analysis-dq-table-reader-with-assoc -b --configuration json://configuration_reader.json --aod-file
@input_data_reader.txt
```



You can add further event-level and track-level selections at this stage

```
"cfgTrackCuts": "electronSelection1_ionut",
"cfgMuonCuts": "",
"cfgPairCuts": "",
"cfgRemoveCollSplittingCandidates": "false",
"cfgMixingDepth": "100",
"cfgAddSEPHistogram": "barrel,flow,pbpb,dimuon,cumulant,metest,flow-ccdb",
```

The invariant mass distribution already allows for the start of J/ψ candidates reconstruction



Something more

Are there alternative ways if the histograms/selections are not compiled in the DQ framework

Yes! We can do it in the json level 👍


```
"cfgAddJSONHistograms": "{\"Histo_test\":{\"type\":\"THn\",\"histClass\":
[\"PairsBarrelSEPM_electronSelection1_ionut\",\"PairsBarrelSEPM_Electron_test\"] \"title\":\"Something2Test\",\"nDimensi
ons\":4,\"vars\":[\"kPt\", \"kEta\",\"kVtxZ\",\"kMass\"],\"binLimits\":[[0.0,1.0,2.0,4.0,6.0,8.0,10.0,14.0,24.0],[-0.9,
-0.72, -0.54, -0.36, -0.18, -5.55112e-17, 0.18, 0.36, 0.54, 0.72, 0.9],[-15, -13, -11, -9, -7, -5, -3, -1, 1, 3, 5, 7,
9, 11, 13, 15],
[4.00,4.02,4.04,4.06,4.08,4.10,4.12,4.14,4.16,4.18,4.20,4.22,4.24,4.26,4.28,4.30,4.32,4.34,4.36,4.38,4.40,4.42,4.44,4.46
,4.48,4.50,4.52,4.54,4.56,4.58,4.60,4.62,4.64,4.66,4.68,4.70,4.72,4.74,4.76,4.78,4.80,4.82,4.84,4.86,4.88,4.90,4.92,4.94
,4.96,4.98,5.00,5.02,5.04,5.06,5.08,5.10,5.12,5.14,5.16,5.18,5.20,5.22,5.24,5.26,5.28,5.30,5.32,5.34,5.36,5.38,5.40,5.42
,5.44,5.46,5.48,5.50,5.52,5.54,5.56,5.58,5.60,5.62,5.64,5.66,5.68,5.70,5.72,5.74,5.76,5.78,5.80,5.82,5.84,5.86,5.88,5.90
,5.92,5.94,5.96,5.98,6.00,6.02,6.04,6.06,6.08,6.10,6.12,6.14,6.16,6.18 ]],\"useSparse\":true}}",
```


"cfgAddJSONHistograms" to add self-defined histograms

- **Histogram name**: "Histo_test"
- **Histogram type**: "THnSparse"
- **Which HistClass**: "PairsBarrelSEPM_electronSelection1_ionut" and "PairsBarrelSEPM_Electron_test"
- **Histo definition**: 4D, (p_T, η, VtxZ, m), binLimits


```
"analysis-track-selection": {
    "cfgTrackCuts": "electronSelection1_ionut",
    "cfgBarrelTrackCutsJSON": "{\"Electron_test\":
{\"type\":\"AnalysisCompositeCut\",\"title\":\"Electron_test\",\"useAND\":true,\"AddCut-jpsiStandardKine\":
{\"type\":\"AnalysisCut\",\"library\":\"jpsiStandardKine\"},\"AddCut-electronStandardQualityForO2MCdebug\":
{\"type\":\"AnalysisCut\",\"library\":\"electronStandardQualityForO2MCdebug\"},\"AddCut-dcaCut1_ionut\":
{\"type\":\"AnalysisCut\",\"library\":\"dcaCut1_ionut\"},\"AddCut-nSigmaEl\":
{\"type\":\"AnalysisCut\",\"title\":\"nSigmaEl\",\"AddCut-nSigmaEl\":
{\"var\":\"kTPCnSigmaEl\",\"cutLow\":-4.0,\"cutHigh\":4.0}}}}",
```


"cfgBarrelTrackCutsJSON" to add self-defined barrel track selections

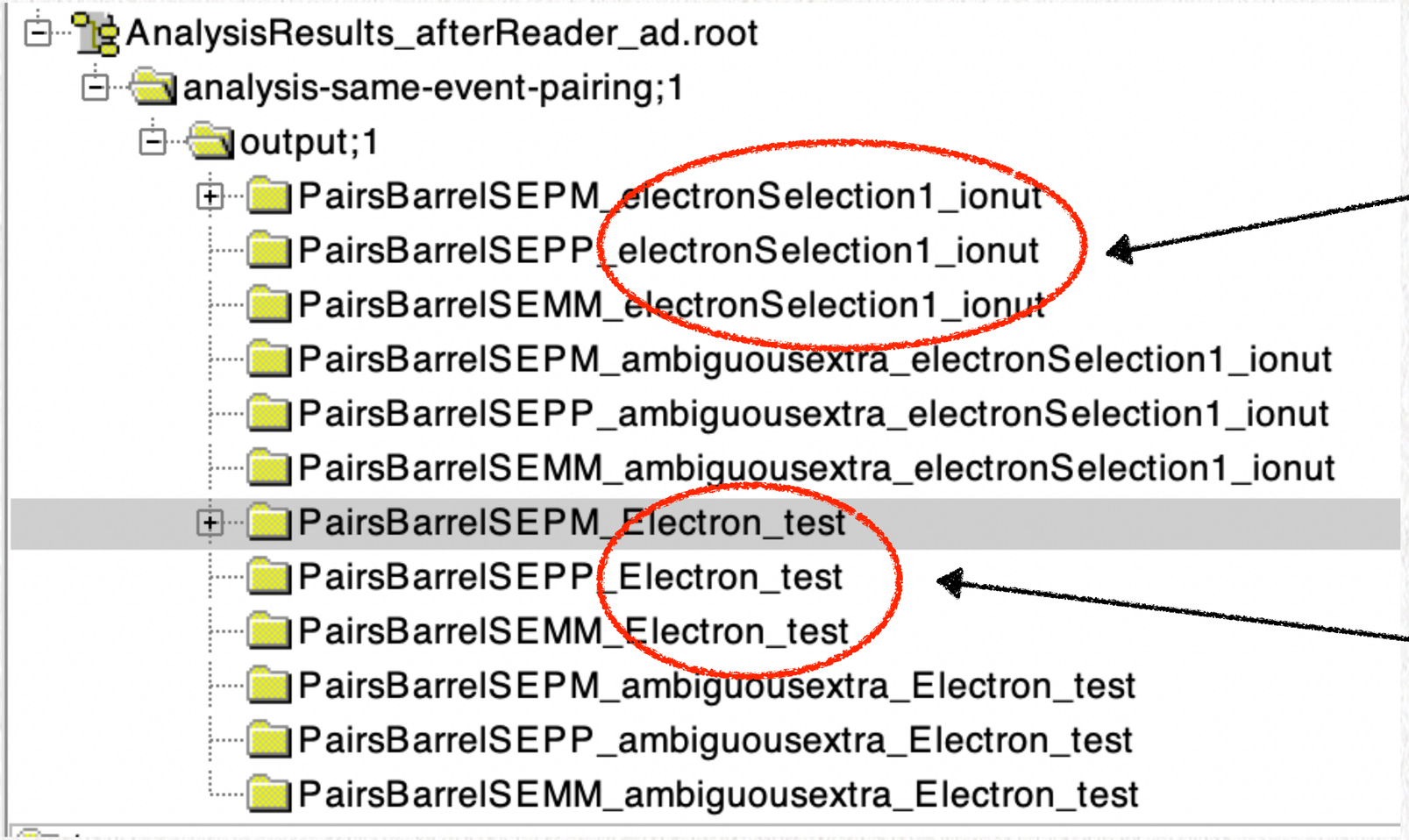
- **Selection name**: "Electron_test"
- You can use AND or OR to combine many sub-selections
- Sub-selections can be the selection library already defined in the CutLibaraty.cxx
- Sub-selections can also be a self-defined cut based on variables defined in the VarManager.h


```
"cfgEventCutsJSON": "",
"cfgPairCutsJSON": "",
"fConfigBdtCutsJSON": "",
"cfgMCsignalsJSON": "",
```


There are some more JSONs, such as on event-selections, pair-selections, Bdt-selections, MCsignals,…

- feel free to play around with it

Outputs with self-definition in JSON



PairsBarrelSEPM_”selections”

Compiled selections
in the CutLibrary.cxx

Self-defined track
selections

ROOT Object Browser

Browser File Edit View Options Tools Help

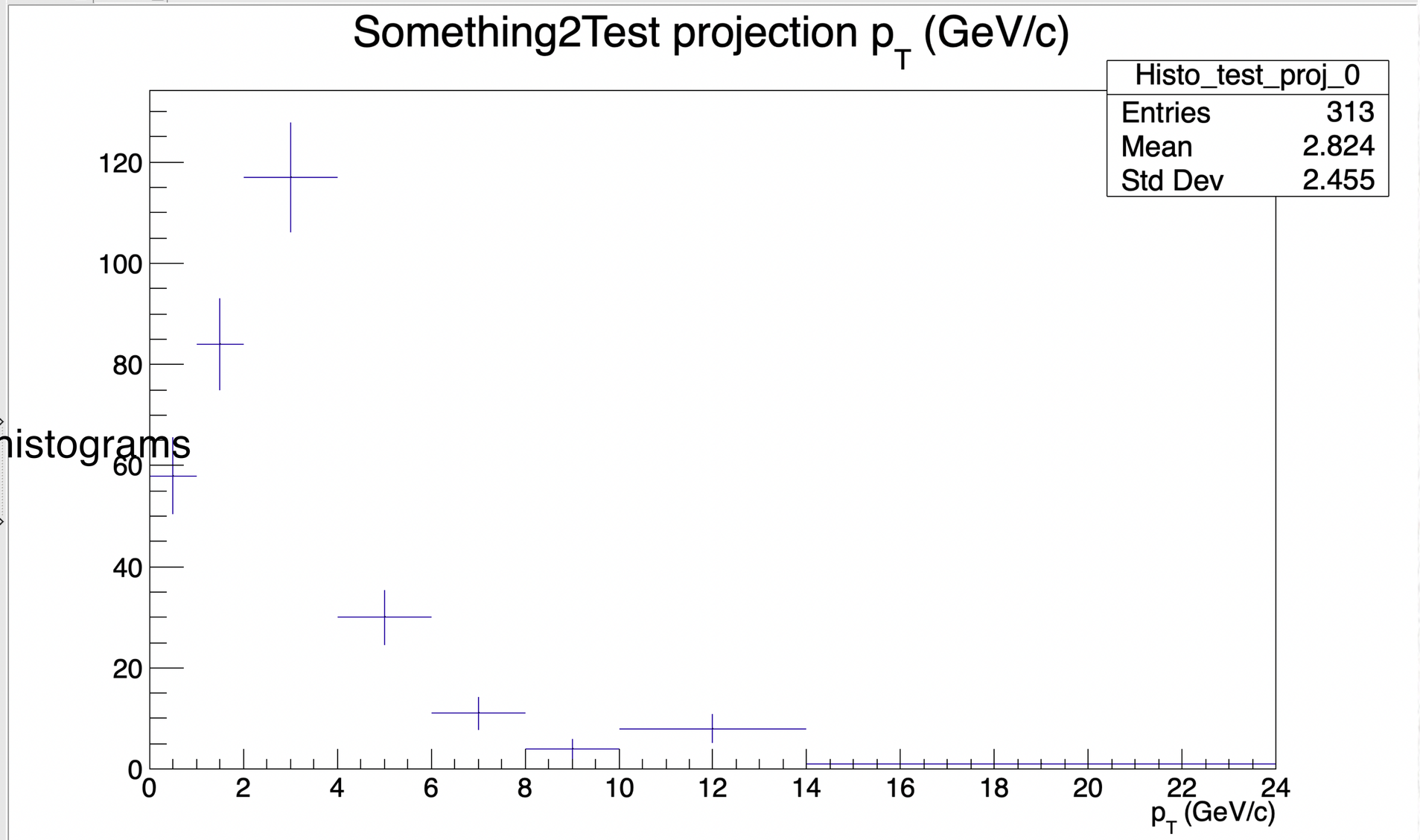
Files

Draw Option:

- root
- PROOF Sessions
- ROOT Files
  - AnalysisResults_afterReader_ad.root
    - analysis-same-event-pairing;1
      - output;1
        - PairsBarrelSEPM_electronSelection1_ionut
          - Mass
          - Mass_HighRange
          - Pt
          - Mass_Pt
          - Mass_PtFine
          - Eta_Pt
          - Y_Pt
          - Mass_VtxZ
          - Mass_CentFT0C
          - Pt_CentFT0C
          - Mass_Pt_CentFT0C
          - Mass_u2q2
          - Mass_u3q3
          - Mass_cos2DeltaPhi
          - Mass_cos3DeltaPhi
          - Histo_test
            - axis0
            - axis1
            - axis2
            - axis3
        - PairsBarrelSEPP_electronSelection1_ionut
        - PairsBarrelSEMM_electronSelection1_ionut
        - PairsBarrelSEPM_ambiguousextra_electronSelection1_ionut
        - PairsBarrelSEPP_ambiguousextra_electronSelection1_ionut
        - PairsBarrelSEMM_ambiguousextra_electronSelection1_ionut
        - PairsBarrelSEPM_Electron_test
          - Mass
          - Mass_HighRange
          - Pt
          - Mass_Pt
          - Mass_PtFine
          - Eta_Pt
          - Y_Pt
          - Mass_VtxZ
          - Mass_CentFT0C
          - Pt_CentFT0C
          - Mass_Pt_CentFT0C
          - Mass_u2q2
          - Mass_u3q3
          - Mass_cos2DeltaPhi
          - Mass_cos3DeltaPhi
          - Histo_test
        - PairsBarrelSEPP_Electron_test

Filter: All Files (*.*)

Canvas_1 Editor 1



Self-defined histograms

Command

Command (local):

An example configuration to use this feature:

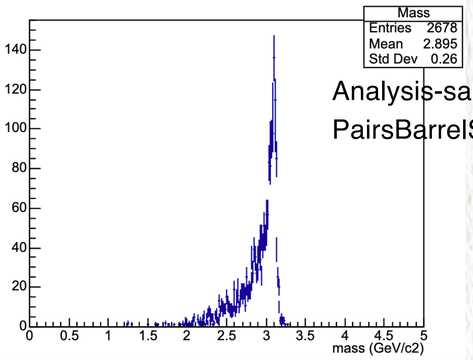
https://cernbox.cern.ch/index.php/s/3IlMHKiXjW8RbSq

Run MC

We apply the same selections used in the Data to the MC for the efficiency calculation

Workflow used for MC samples:

o2-analysis-dq-efficiency-with-assoc -b --configuration json://configuration.json | o2-analysis-mccollision-converter -b --configuration json://configuration.json | o2-analysis-bc-flags-creator -b --configuration json://configuration.json | o2-analysis-ft0-corrected-table -b --configuration json://configuration.json | o2-analysis-pid-tof-merge -b --configuration json://configuration.json | o2-analysis-tracks-extra-v002-converter -b --configuration json://configuration.json | o2-analysis-multcenttable -b --configuration json://configuration.json | o2-analysis-dq-table-maker-mc-with-assoc -b --configuration json://configuration.json | o2-analysis-event-selection-service -b --configuration json://configuration.json | o2-analysis-pid-tpc-service -b --configuration json://configuration.json | o2-analysis-track-to-collision-associator -b --configuration json://configuration.json | o2-analysis-propagationservice -b --configuration json://configuration.json | o2-analysis-trackselection -b --configuration json://configuration.json | o2-analysis-mccollisionextra -b --configuration json://configuration.json --aod-file @input_data.txt



Analysis-same-event-pairing/output/PairsBarrelSEPM_jpsiO2MCdebugCuts2_eeFromJpsi/Mass

The materials to run MC samples:

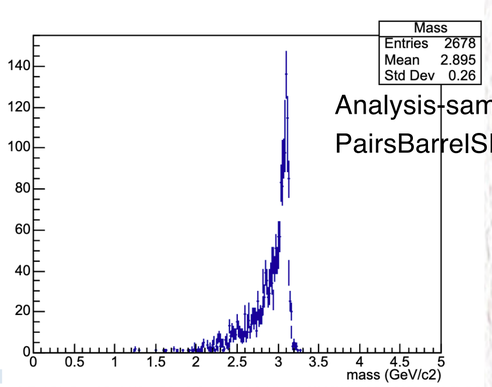
https://cernbox.cern.ch/index.php/s/PEjQMs1S2OkrCOk

Run MC

We apply the same selections used in the Data to the MC for the efficiency calculation

Workflow used for MC samples:

o2-analysis-dq-efficiency-with-assoc -b --configuration json://configuration.json | o2-analysis-mccollision-converter -b --configuration json://configuration.json | o2-analysis-bc-flags-creator -b --configuration json://configuration.json | o2-analysis-ft0-corrected-table -b --configuration json://configuration.json | o2-analysis-pid-tof-merge -b --configuration json://configuration.json | o2-analysis-tracks-extra-v002-converter -b --configuration json://configuration.json | o2-analysis-multcenttable -b --configuration json://configuration.json | o2-analysis-dq-table-maker-mc-with-assoc -b --configuration json://configuration.json | o2-analysis-event-selection-service -b --configuration json://configuration.json | o2-analysis-pid-tpc-service -b --configuration json://configuration.json | o2-analysis-track-to-collision-associator -b --configuration json://configuration.json | o2-analysis-propagationservice -b --configuration json://configuration.json | o2-analysis-trackselection -b --configuration json://configuration.json | o2-analysis-mccollisionextra -b --configuration json://configuration.json --aod-file @input_data.txt



Analysis-same-event-pairing/output/
PairsBarrelSEPM_jpsiO2MCdebugCuts2_eeFromJpsi/Mass

This tutorial provides a simple example of how to run the Jpsi2ee framework.

Many other processes are not covered here, such as flow, polarization, event mixing, AA, …

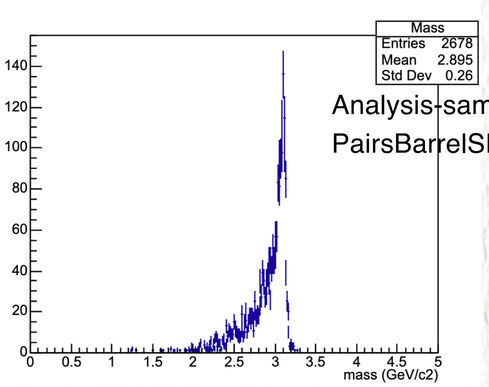
Explore and Enjoy!

Run MC

We apply the same selections used in the Data to the MC for the efficiency calculation

Workflow used for MC samples:

o2-analysis-dq-efficiency-with-assoc -b --configuration json://configuration.json | o2-analysis-mccollision-converter -b --configuration json://configuration.json | o2-analysis-bc-flags-creator -b --configuration json://configuration.json | o2-analysis-ft0-corrected-table -b --configuration json://configuration.json | o2-analysis-pid-tof-merge -b --configuration json://configuration.json | o2-analysis-tracks-extra-v002-converter -b --configuration json://configuration.json | o2-analysis-multcenttable -b --configuration json://configuration.json | o2-analysis-dq-table-maker-mc-with-assoc -b --configuration json://configuration.json | o2-analysis-event-selection-service -b --configuration json://configuration.json | o2-analysis-pid-tpc-service -b --configuration json://configuration.json | o2-analysis-track-to-collision-associator -b --configuration json://configuration.json | o2-analysis-propagationservice -b --configuration json://configuration.json | o2-analysis-trackselection -b --configuration json://configuration.json | o2-analysis-mccollisionextra -b --configuration json://configuration.json --aod-file @input_data.txt



Analysis-same-event-pairing/output/
PairsBarrelSEPM_jpsiO2MCdebugCuts2_eeFromJpsi/Mass

Thank you for your attention!

This tutorial provides a simple example of how to run the Jpsi2ee framework.

Many other processes are not covered here, such as flow, polarization, event mixing, AA, …

Explore and Enjoy!