QA Plots for Diffractive ϕ Analysis

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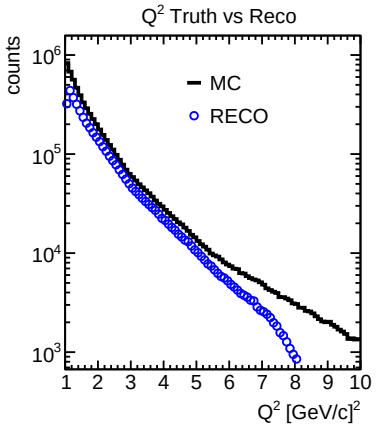
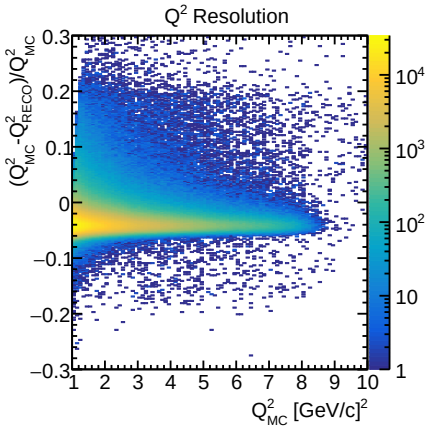
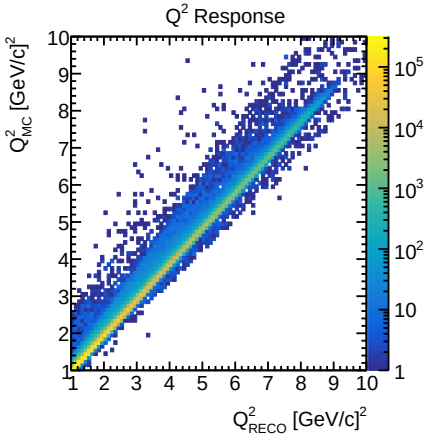
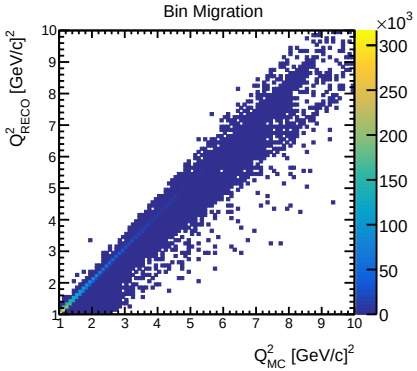
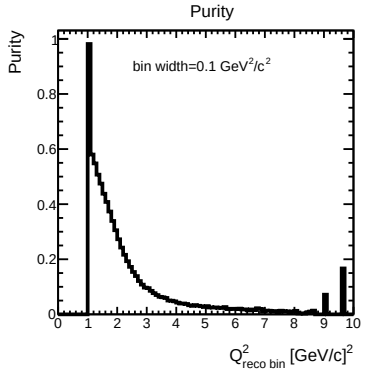
Q^2

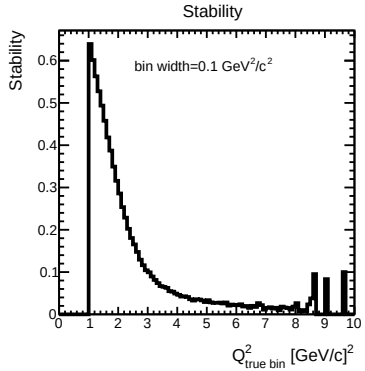

Q² Truth vs Reco
counts
MC
RECO
Q² [GeV/c]²

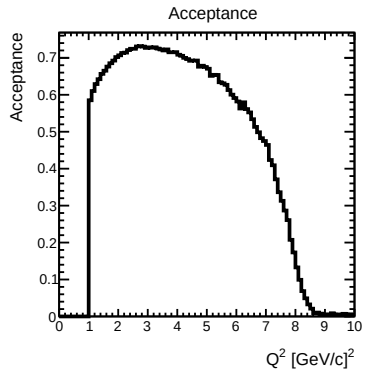

Q² Resolution
(Q²MC -Q²RECO)/Q²MC
Q²MC [GeV/c]²

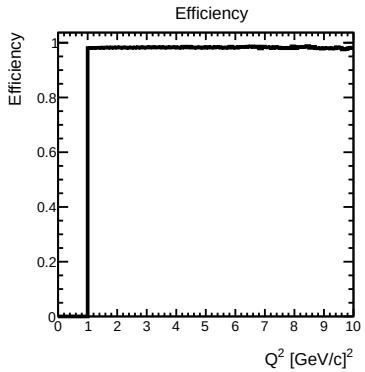

Q² Response
Q²MC [GeV/c]²
Q²RECO [GeV/c]²

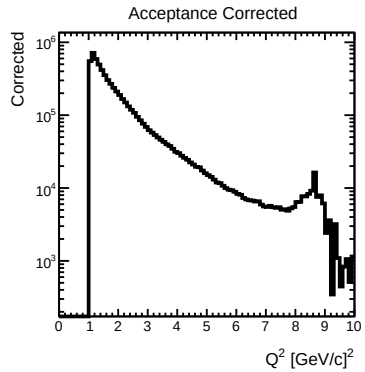

Bin Migration
Q²RECO [GeV/c]²
Q²MC [GeV/c]²


Purity
bin width=0.1 GeV²/c²
Q²reco bin [GeV/c]²

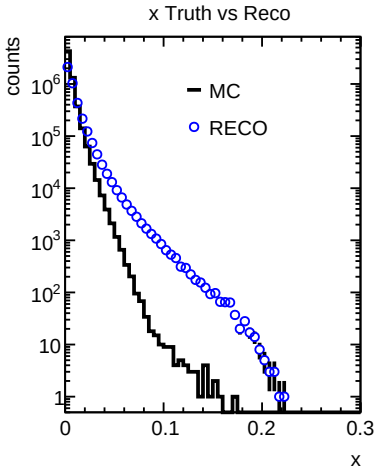

Stability
bin width=0.1 GeV²/c²
Q²true bin [GeV/c]²

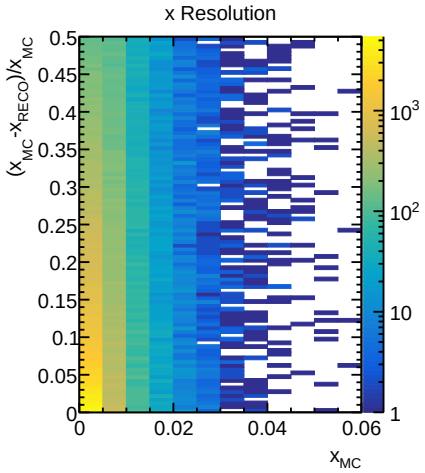

Acceptance
Q² [GeV/c]²

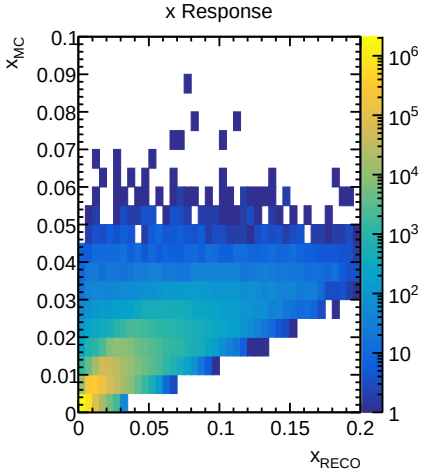

Efficiency
Q² [GeV/c]²

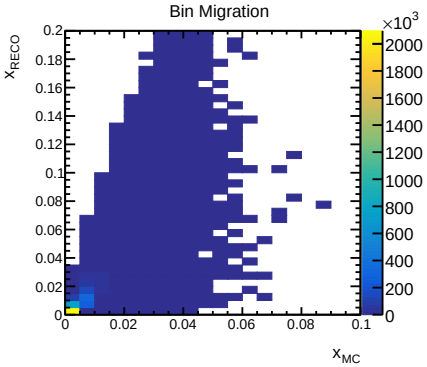

Acceptance Corrected
Corrected
Q² [GeV/c]²

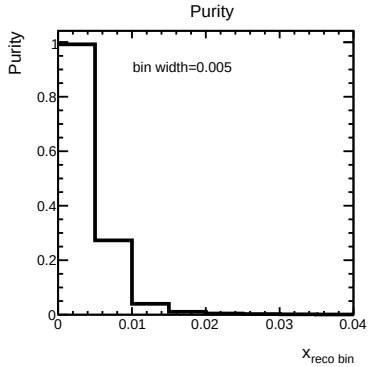
X

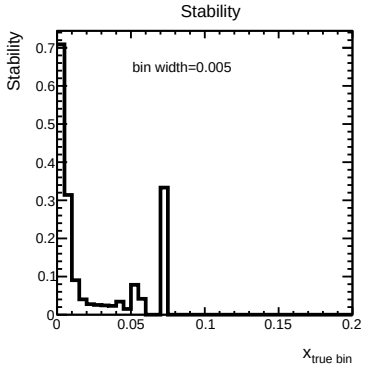

x Truth vs Reco
counts
MC
RECO
x

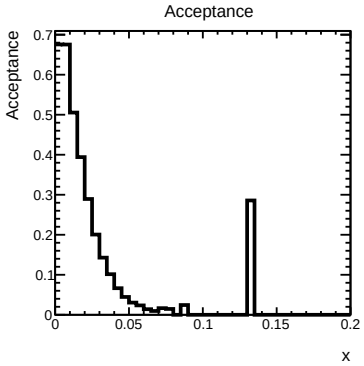

x Resolution
$(x_{MC}-x_{RECO})/x_{MC}$
x_{MC}

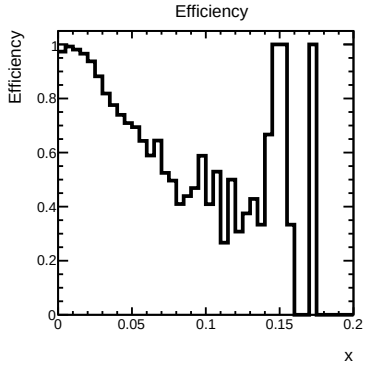

x Response
x_{MC}
x_{RECO}

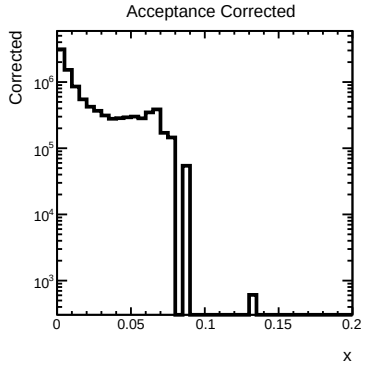

Bin Migration
x_{RECO}
x_{MC}


Purity
Purity
bin width=0.005
$x_{reco\ bin}$

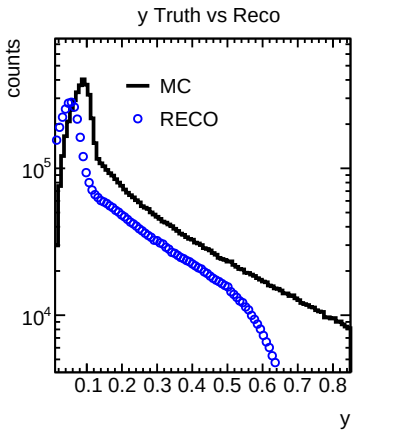

Stability
Stability
bin width=0.005
$x_{true\ bin}$

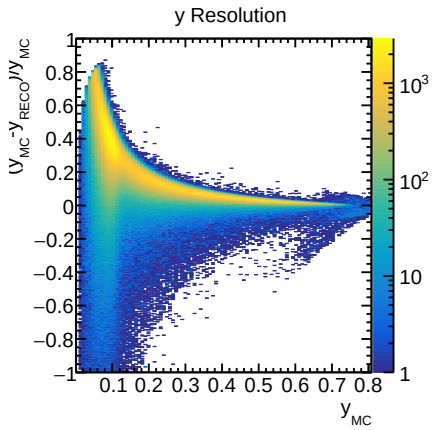

Acceptance
Acceptance
x

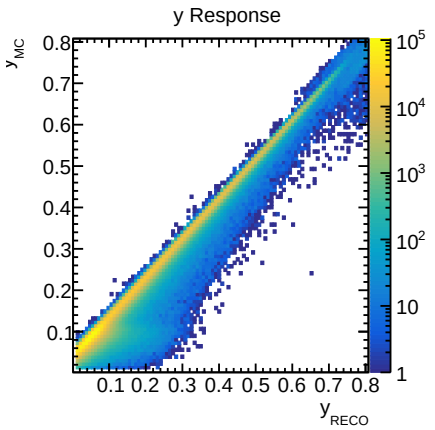

Efficiency
Efficiency
x

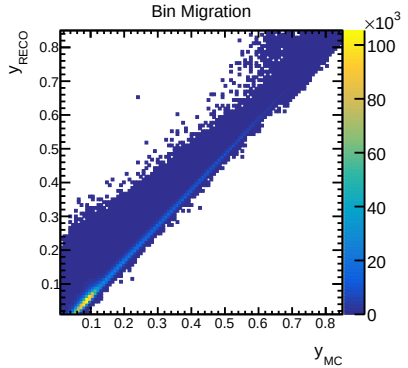

Acceptance Corrected
Corrected
x

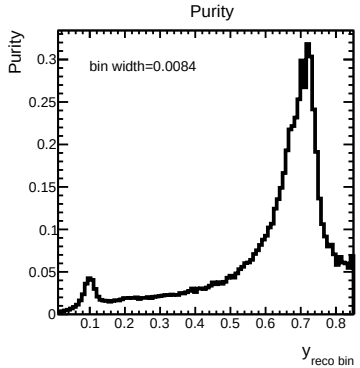
y

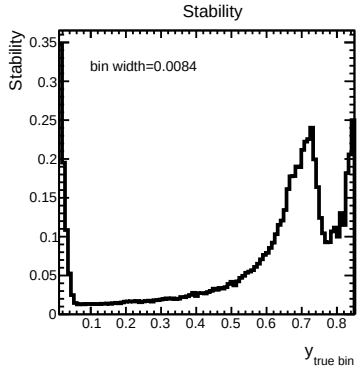

y Truth vs Reco
counts
MC
RECO
y

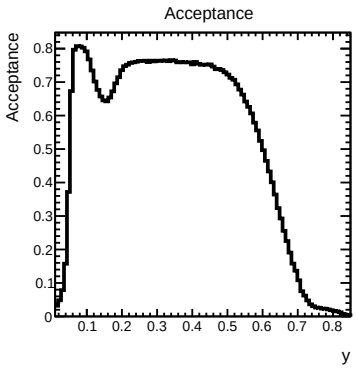

y Resolution
$(y_{MC}-y_{RECO})/y_{MC}$
y_{MC}

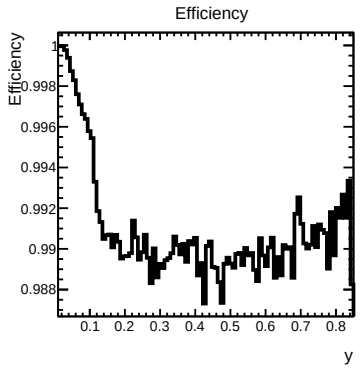

y Response
y_{MC}
y_{RECO}

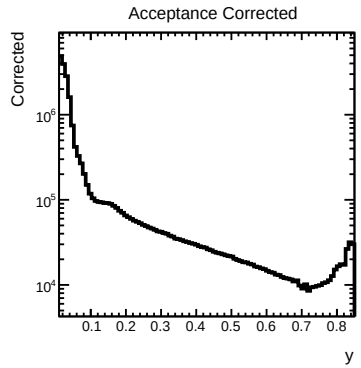

Bin Migration
y_{RECO}
y_{MC}


Purity
Purity
bin width=0.0084
$y_{reco\ bin}$

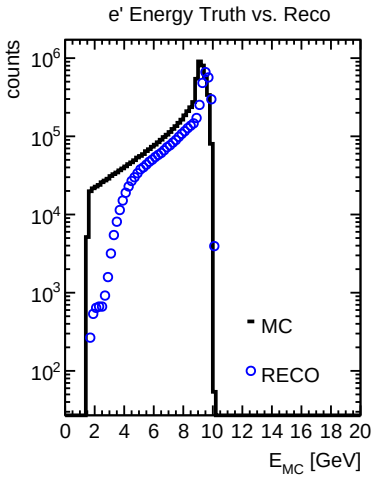

Stability
Stability
bin width=0.0084
$y_{true\ bin}$

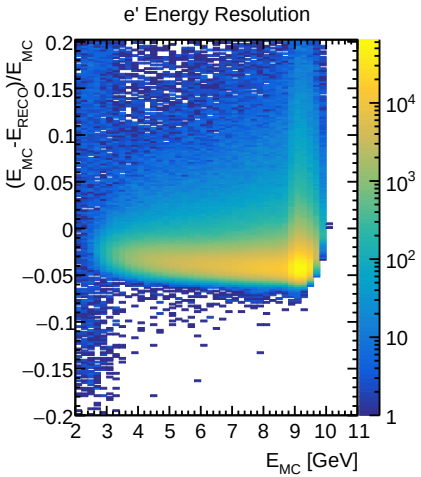

Acceptance
Acceptance
y

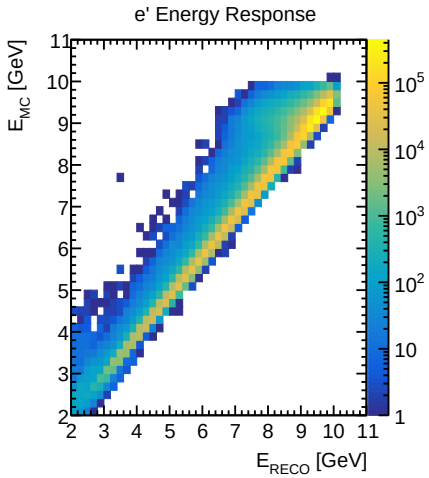

Efficiency
Efficiency
y

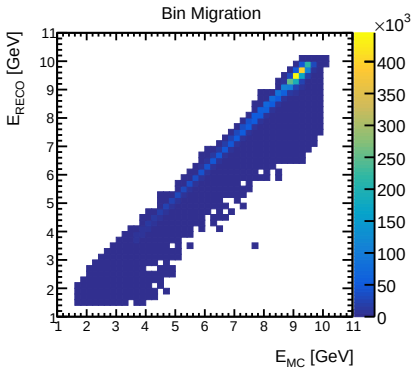

Acceptance Corrected
Corrected
y

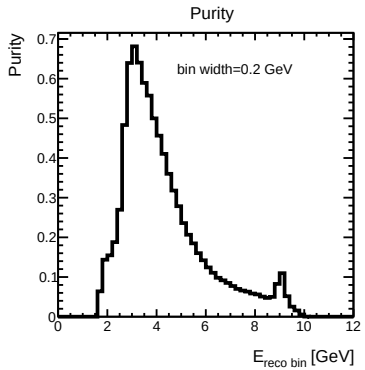
$E_{e'}$

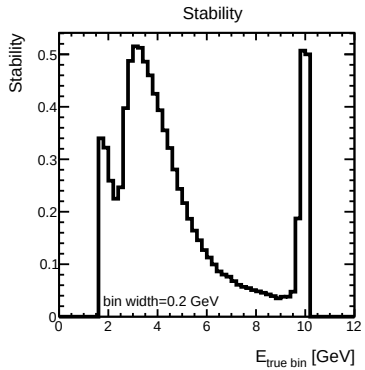

e' Energy Truth vs. Reco
counts
MC
RECO
E_MC [GeV]

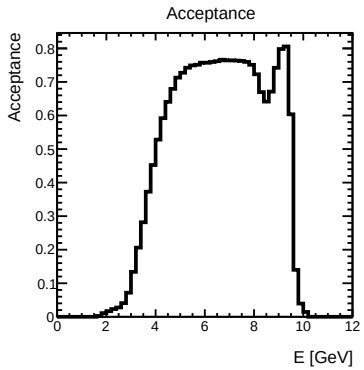

e' Energy Resolution
(E_MC-E_RECO)/E_MC
E_MC [GeV]

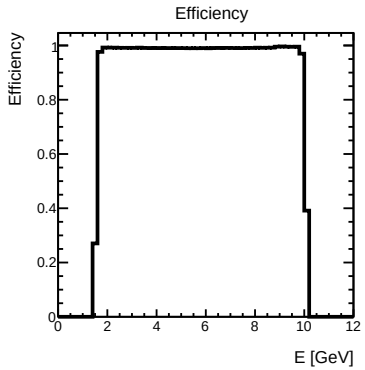

e' Energy Response
E_MC [GeV]
E_RECO [GeV]

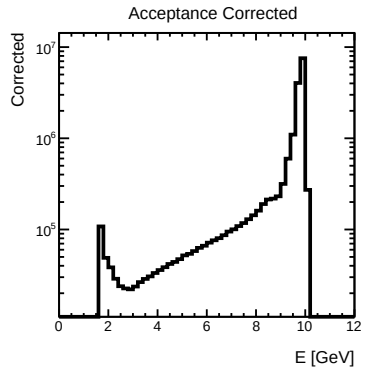

Bin Migration
E_RECO [GeV]
E_MC [GeV]


Purity
Purity
bin width=0.2 GeV
E_reco bin [GeV]

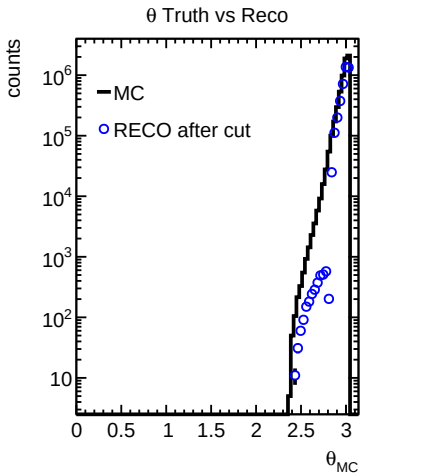

Stability
Stability
bin width=0.2 GeV
E_true bin [GeV]

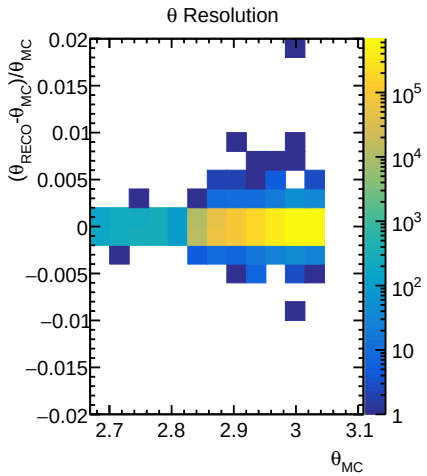

Acceptance
Acceptance
E [GeV]

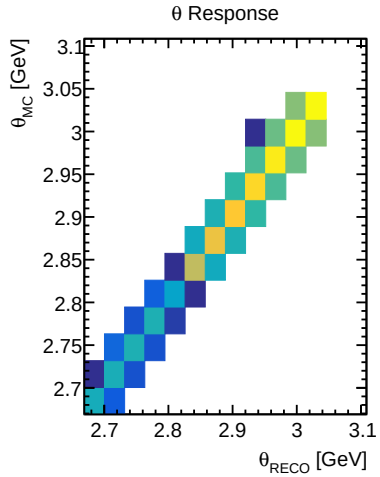

Efficiency
Efficiency
E [GeV]

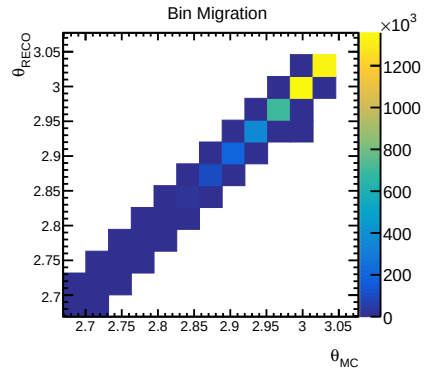

Acceptance Corrected
Corrected
E [GeV]

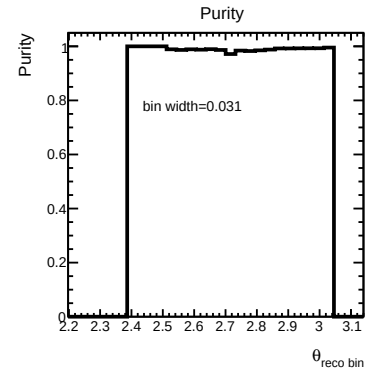
$\theta_{e'}$

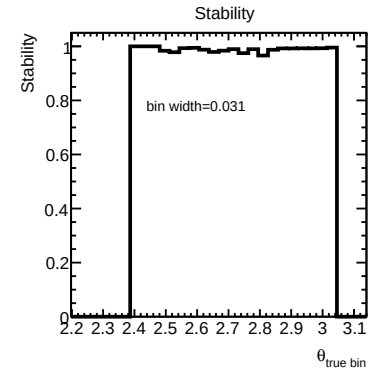

θ Truth vs Reco
counts
MC
RECO after cut
θMC

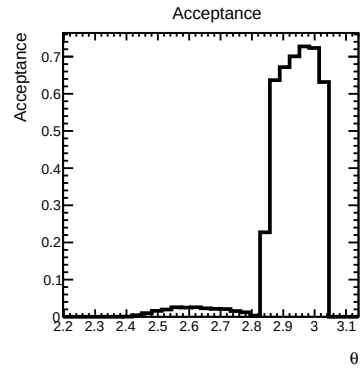

θ Resolution
(θRECO-θMC)/θMC
θMC

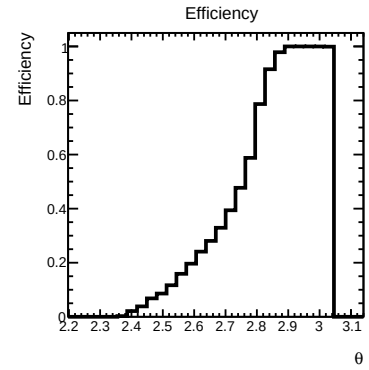

θ Response
θMC [GeV]
θRECO [GeV]

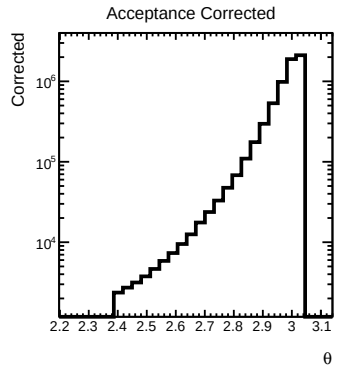

Bin Migration
θRECO
θMC


Purity
bin width=0.031
θreco bin

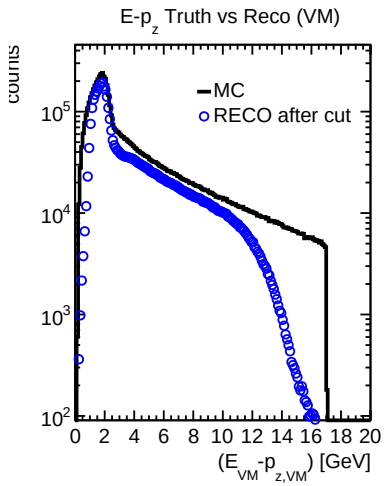

Stability
bin width=0.031
θtrue bin

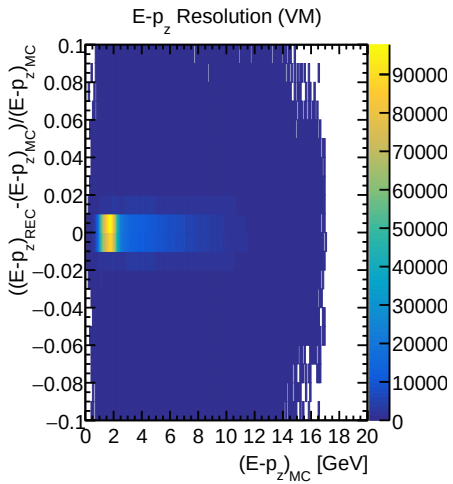

Acceptance
Acceptance
θ

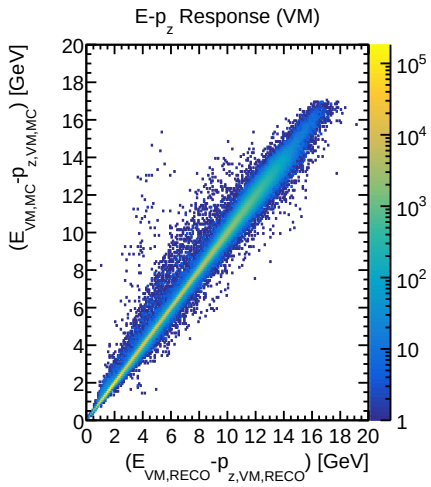

Efficiency
Efficiency
θ

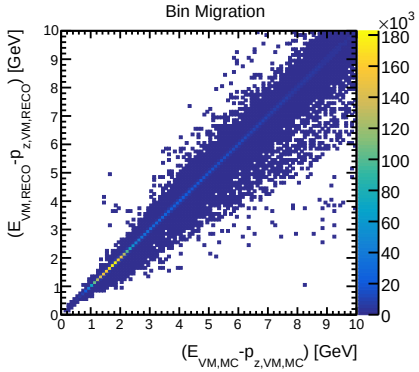

Acceptance Corrected
Corrected
θ

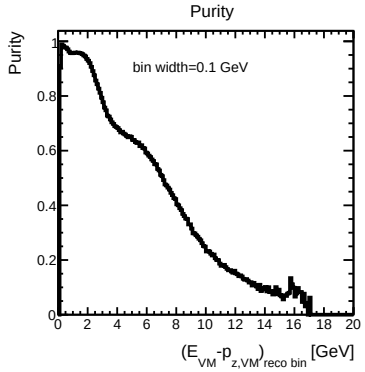
VM ($E - p_z$)

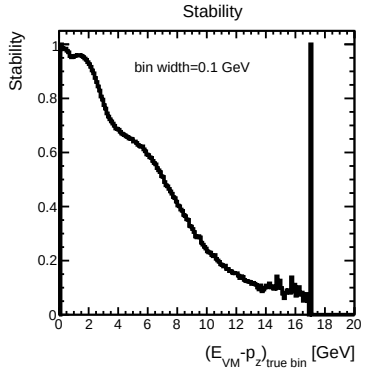

E-p$_z$ Truth vs Reco (VM)
counts
MC
RECO after cut
(E$_{VM}$-p$_{z,VM}$) [GeV]

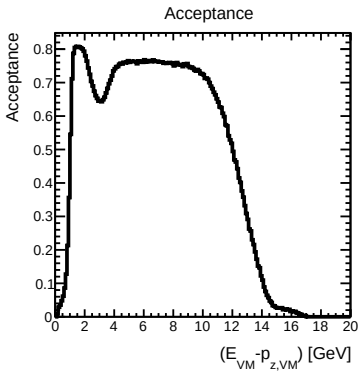

E-p$_z$ Resolution (VM)
((E-p$_z$)$_{REC}$-(E-p$_z$)$_{MC}$)/(E-p$_z$)$_{MC}$
(E-p$_z$)$_{MC}$ [GeV]

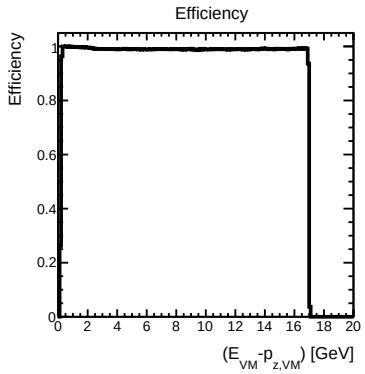

E-p$_z$ Response (VM)
(E$_{VM,MC}$-p$_{z,VM,MC}$) [GeV]
(E$_{VM,RECO}$-p$_{z,VM,RECO}$) [GeV]

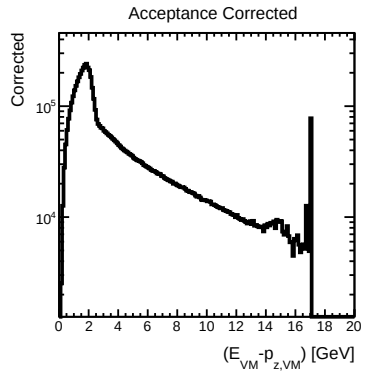

Bin Migration
(E$_{VM,RECO}$-p$_{z,VM,RECO}$) [GeV]
(E$_{VM,MC}$-p$_{z,VM,MC}$) [GeV]


Purity
bin width=0.1 GeV
(E$_{VM}$-p$_{z,VM}$)$_{reco\ bin}$ [GeV]

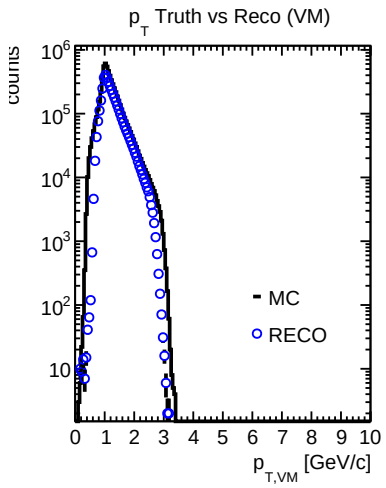

Stability
bin width=0.1 GeV
(E$_{VM}$-p$_z$)$_{true\ bin}$ [GeV]

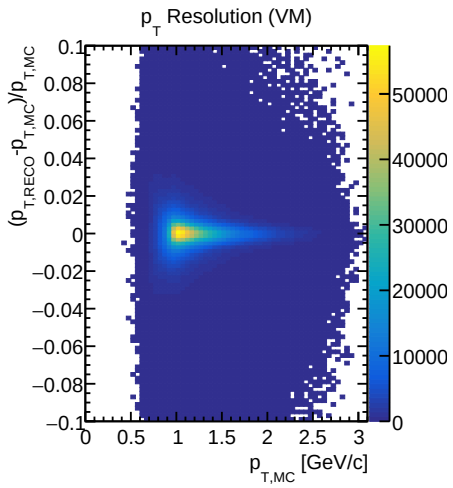

Acceptance
(E$_{VM}$-p$_{z,VM}$) [GeV]

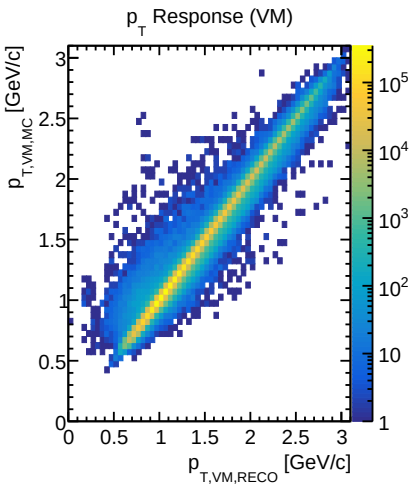

Efficiency
(E$_{VM}$-p$_{z,VM}$) [GeV]

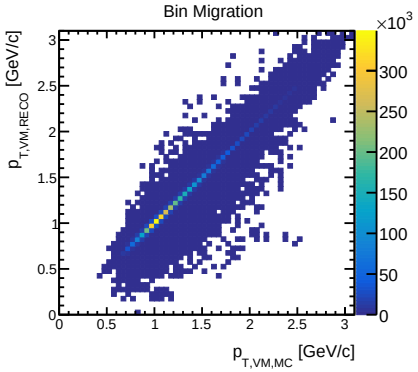

Acceptance Corrected
Corrected
(E$_{VM}$-p$_{z,VM}$) [GeV]

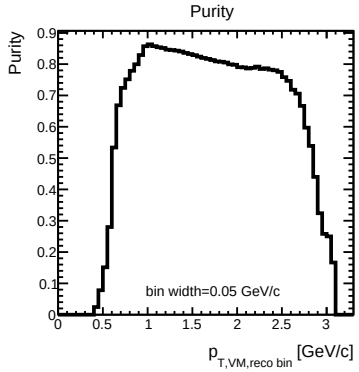
VM p_T

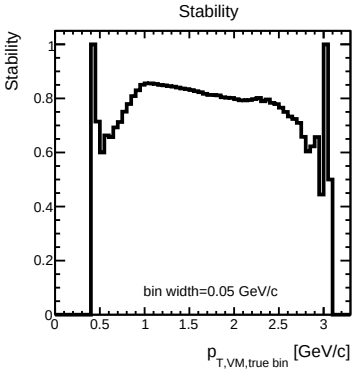

p_T Truth vs Reco (VM)
counts
MC
RECO
p_T,VM [GeV/c]

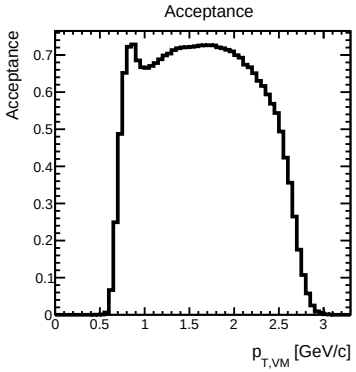

p_T Resolution (VM)
(p_T,RECO-p_T,MC)/p_T,MC
p_T,MC [GeV/c]

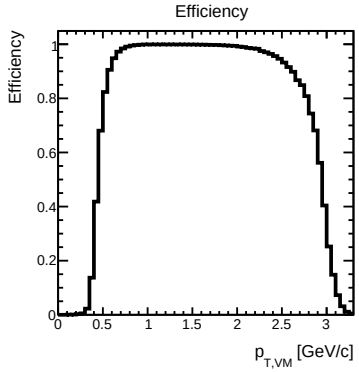

p_T Response (VM)
p_T,VM,MC [GeV/c]
p_T,VM,RECO [GeV/c]

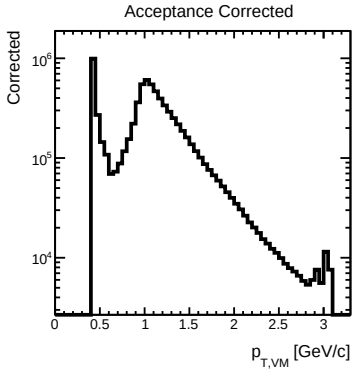

Bin Migration
p_T,VM,RECO [GeV/c]
p_T,VM,MC [GeV/c]


Purity
Purity
bin width=0.05 GeV/c
p_T,VM,reco bin [GeV/c]

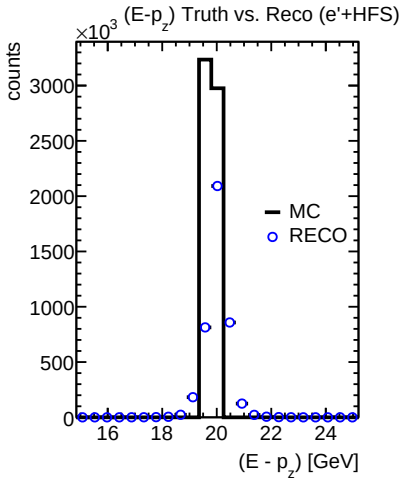

Stability
Stability
bin width=0.05 GeV/c
p_T,VM,true bin [GeV/c]

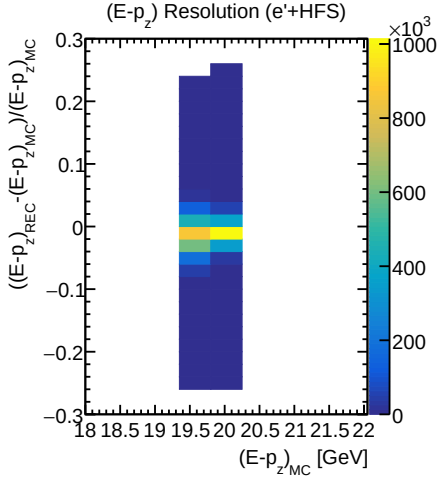

Acceptance
Acceptance
p_T,VM [GeV/c]

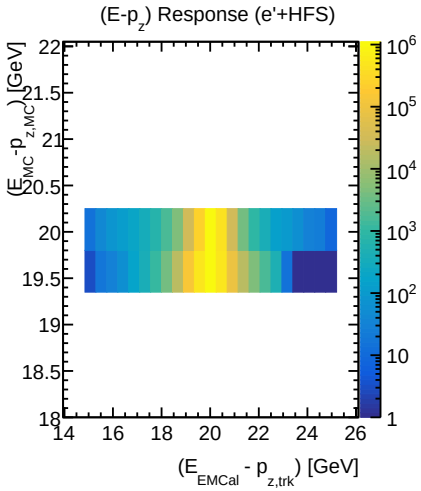

Efficiency
Efficiency
p_T,VM [GeV/c]

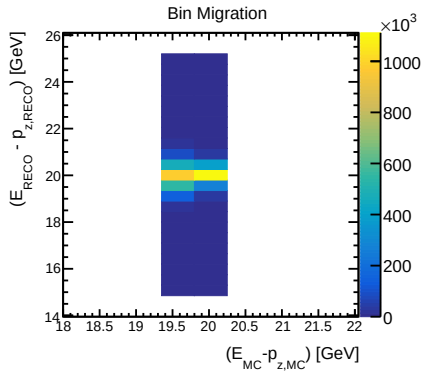

Acceptance Corrected
Corrected
p_T,VM [GeV/c]

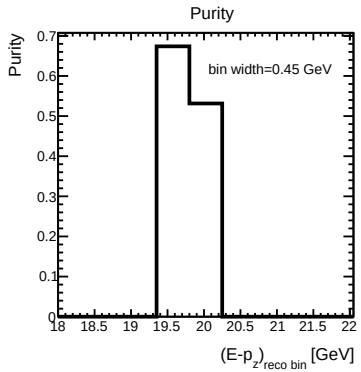
$(E - p_z)$ for $(e' +$ HFS$)$

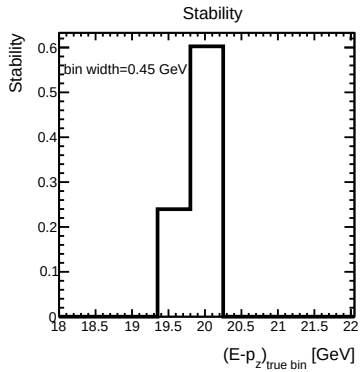

(E-p$_z$) Truth vs. Reco (e'+HFS)
counts
MC
RECO
(E - p$_z$) [GeV]

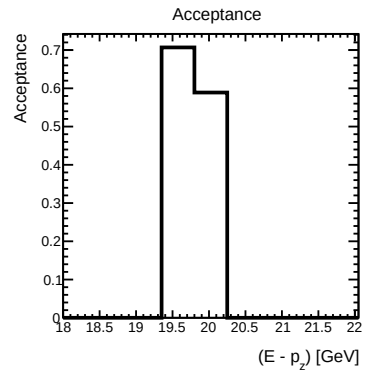

(E-p$_z$) Resolution (e'+HFS)
((E-p$_z$)$_{REC}$-(E-p$_z$)$_{MC}$)/(E-p$_z$)$_{MC}$
(E-p$_z$)$_{MC}$ [GeV]

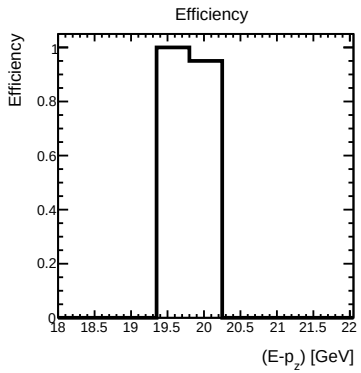

(E-p$_z$) Response (e'+HFS)
(E$_{MC}$-p$_{z,MC}$) [GeV]
(E$_{EMCal}$ - p$_{z,trk}$) [GeV]

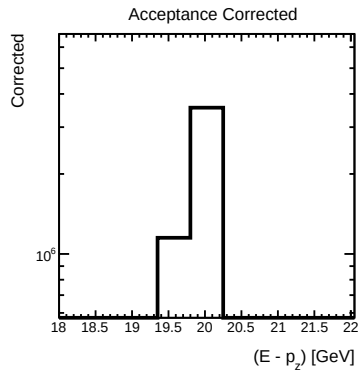

Bin Migration
(E$_{RECO}$ - p$_{z,RECO}$) [GeV]
(E$_{MC}$-p$_{z,MC}$) [GeV]


Purity
Purity
bin width=0.45 GeV
(E-p$_z$)$_{reco\ bin}$ [GeV]

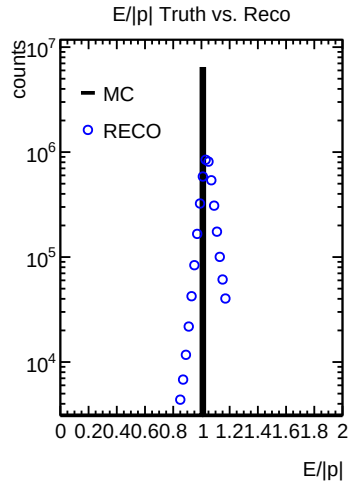

Stability
Stability
bin width=0.45 GeV
(E-p$_z$)$_{true\ bin}$ [GeV]

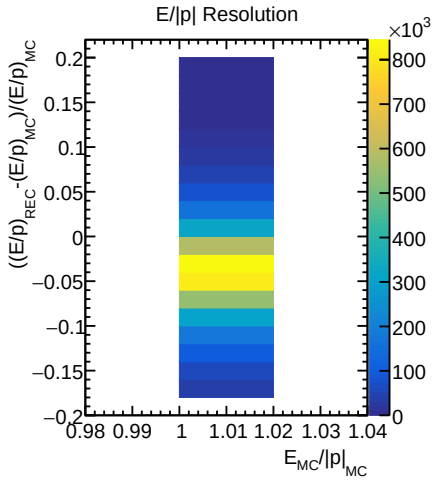

Acceptance
Acceptance
(E - p$_z$) [GeV]

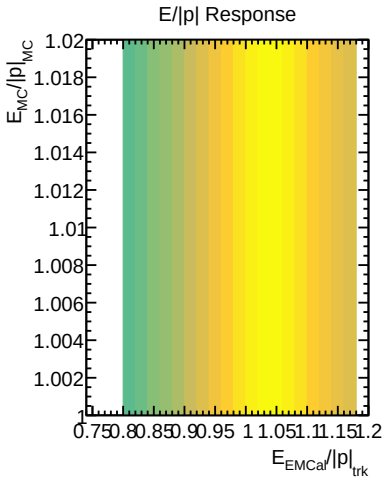

Efficiency
Efficiency
(E-p$_z$) [GeV]

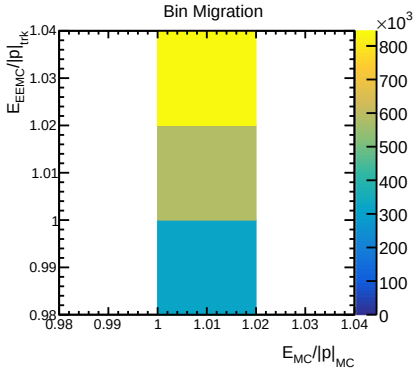

Acceptance Corrected
Corrected
(E - p$_z$) [GeV]

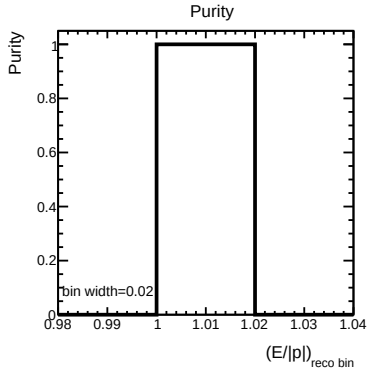
E/p

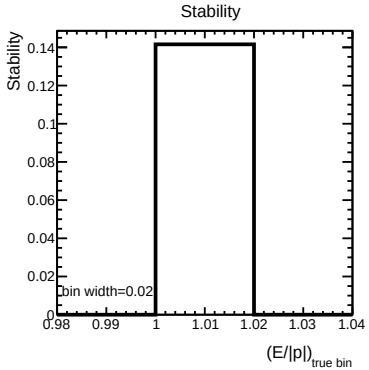

E/|p| Truth vs. Reco
counts
MC
RECO
E/|p|

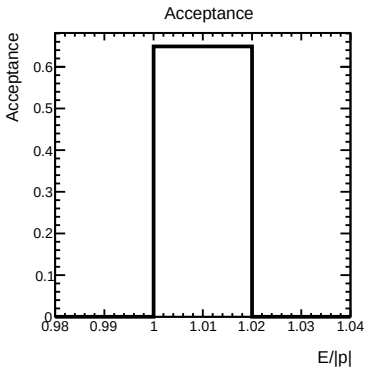

E/|p| Resolution
$((E/p)_{REC}-(E/p)_{MC})/(E/p)_{MC}$
$\times 10^3$
$E_{MC}/|p|_{MC}$

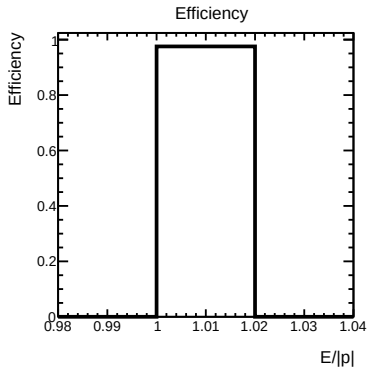

E/|p| Response
$E_{MC}/|p|_{MC}$
$E_{EMCal}/|p|_{trk}$

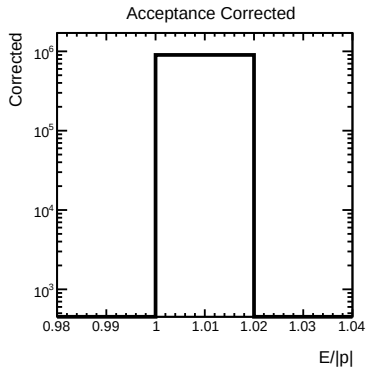

Bin Migration
$E_{EEMC}/|p|_{trk}$
$\times 10^3$
$E_{MC}/|p|_{MC}$


Purity
Purity
bin width=0.02
$(E/|p|)_{reco\ bin}$

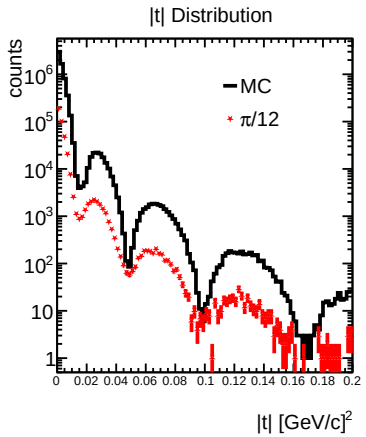

Stability
Stability
bin width=0.02
$(E/|p|)_{true\ bin}$

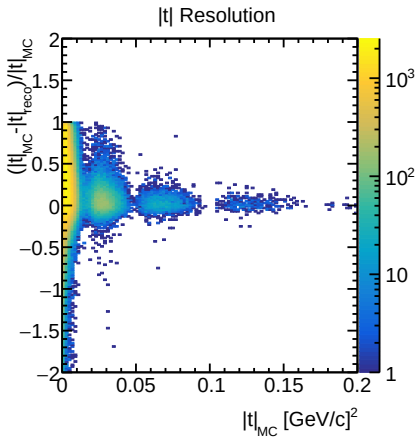

Acceptance
Acceptance
E/|p|

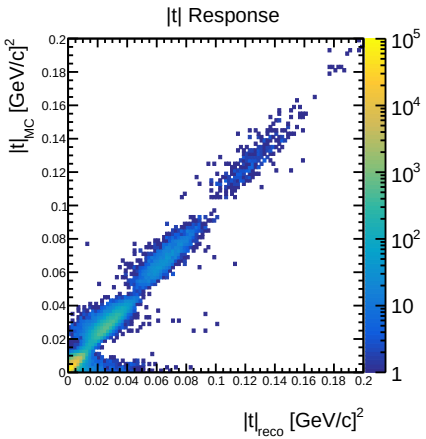

Efficiency
Efficiency
E/|p|

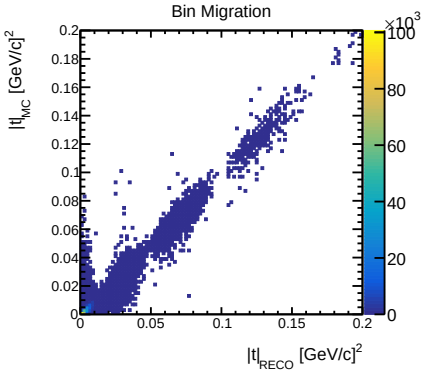

Acceptance Corrected
Corrected
E/|p|

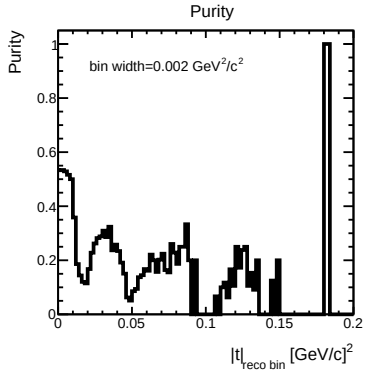
t

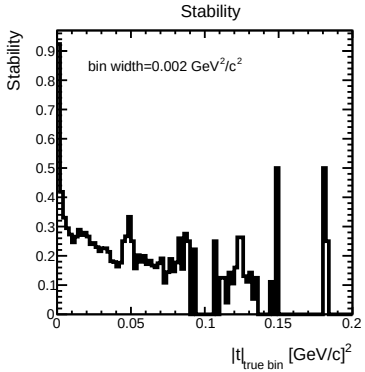

|t| Distribution
counts
MC
π/12
|t| [GeV/c]²

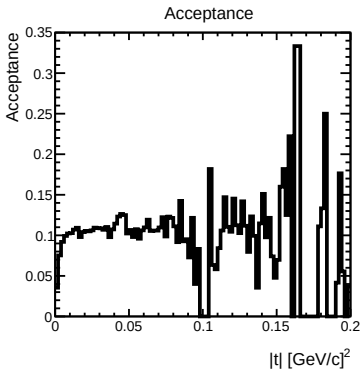

|t| Resolution
(|t|MC-|t|reco)/|t|MC
|t|MC [GeV/c]²

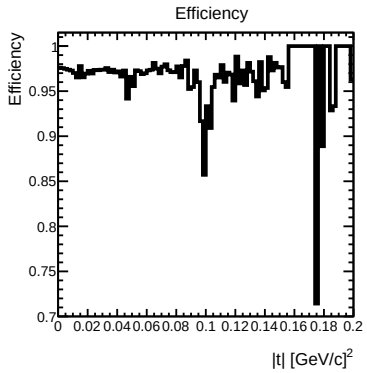

|t| Response
|t|MC [GeV/c]²
|t|reco [GeV/c]²

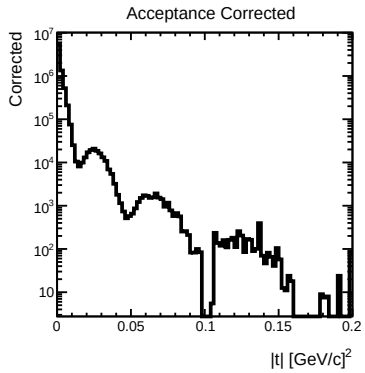

Bin Migration
|t|MC [GeV/c]²
|t|RECO [GeV/c]²


Purity
bin width=0.002 GeV²/c²
|t|reco bin [GeV/c]²


Stability
bin width=0.002 GeV²/c²
|t|true bin [GeV/c]²


Acceptance
|t| [GeV/c]²


Efficiency
|t| [GeV/c]²


Acceptance Corrected
Corrected
|t| [GeV/c]²

Calculations

QA Plots

Kinematic reconstructions	quantity	Reco	Truth	Response (2D)	Purity/bin migration	detector acceptance-only corrected	Unfolding/full correction
(electron,JB, DA,sigma, e-sigma)	Q2	☐	☐	☐	☐	☐	☐
	x	☐	☐	☐	☐	☐	☐
	y	☐	☐	☐	☐	☐	☐
	dQ2/Q2	☐	☐	☐	☐	☐	☐
	dx/x	☐	☐	☐	☐	☐	☐
	dy/y	☐	☐	☐	☐	☐	☐
	e' energy	☐	☐	☐	☐	☐	☐
	e' theta	☐	☐	☐	☐	☐	☐
	HFS (E-pz)	☐	☐	☐	☐	☐	☐
	HFS (pT)	☐	☐	☐	☐	☐	☐
Event level		☐	☐	☐	☐	☐	☐
	E-pz (e'+HFS)	☐	☐	☐	☐	☐	☐
	E/p for calorimeter	☐	☐	☐	☐	☐	☐
	Calo clusters	☐	☐	☐	☐	☐	☐
Observable of interest		☐	☐	☐	☐	☐	☐
	e.g., t,u,etc.	☐	☐	☐	☐	☐	☐
Detector specific variables	Depends	☐	☐	☐	☐	☐	☐
PID quantities:	Add when it comes	☐	☐	☐	☐	☐	☐

Bin Migration

- Events generated in bin i (x-axis)
  - MC
- Reconstructed in bin j (y-axis)
  - RECO

```
// Epz scat' e
double EpzREC = (scatClusEREC+hfs).E() - (scatMCmatchREC+hfs).Pz();
h_Epz_REC->Fill(EpzREC);
h_Epz_response->Fill(EpzREC,EpzMC);
h_Epz_migration->Fill(EpzMC,EpzREC);
```

Example of how I coded the bin migration

- Diagonal:
  - Good resolution $\rightarrow$ events reconstructed in correct bin
- Off diagonal:
  - Bad resolution $\rightarrow$ events reconstructed in wrong bin

Purity for RECO bin j

- Fraction of events in RECO bin j that came from same true bin j
- Loop over RECO bins from the bin migration
- Sum up events migrating from MC bin i to RECO bin j
- Get the diagonal $\rightarrow$ count of correctly reconstructed in the MC bin

```
int nx_Epz = h_Epz_migration->GetNbinsX();
int ny_Epz = h_Epz_migration->GetNbinsY();
for (int j=1; j<=ny_Epz; ++j)
{
    double recoColSum = 0;
    for (int i=1; i<=nx_Epz; ++i) recoColSum += h_Epz_migration->GetBinContent(i,j);

    double diag = h_Epz_migration->GetBinContent(j,j);
    if (recoColSum>0) h_Epz_purity->SetBinContent(j, diag / recoColSum);
}
```

Example of my code for purity.

Stability for MC bin i

- Fraction of events in MC bin i reconstructed in same bin i
- Loop over MC bins from bin migration
- Sum up events migrating from RECO bin j to MC bin i
- Get the diagonal $\rightarrow$ count of correctly reconstructed in the RECO bin

```
for (int i=1; i<=nx_Epz; ++i)
{
    double trueRowSum = 0;
    for (int j=1; j<=ny_Epz; ++j) trueRowSum += h_Epz_migration->GetBinContent(i,j);

    double diag = h_Epz_migration->GetBinContent(i,i);
    if (trueRowSum>0) h_Epz_stability->SetBinContent(i, diag / trueRowSum);
}
```

Example of my code for stability.

Bin by Bin Correction

- Estimate of true bin content

```
double Nreco_in_bin_i = h_Epz_REC->GetBinContent(i);
double corrected = (acceptance>0) ? Nreco_in_bin_i / acceptance : 0;
h_Epz_corrected->SetBinContent(i, corrected);
```

Example of my code for bin-by-bin correction.

Acceptance

- Fraction of MC events in a MC bin that survives cuts
- Measures how many events from MC bin were accepted by the detector and reconstruction

```
for (int i=1; i<=nb_Epz; ++i)
{
    double Ntrue = h_Epz_MC->GetBinContent(i);
    double Naccepted = 0;
    for (int j=1; j<=nb_Epz; ++j) Naccepted += h_Epz_migration->GetBinContent(i,j);
    double acceptance = (Ntrue>0) ? Naccepted / Ntrue : 0;
    h_Epz_acceptance->SetBinContent(i, acceptance);
```

Example of my code for acceptance. Note: i and j have same binning.

Efficiency

- Shows how well the detector reconstructs events that pass cuts

```
double Nreco_from_bin_i = h_Epz_MC_after->GetBinContent(i);
double efficiency = (Ntrue > 0) ? Nreco_from_bin_i / Ntrue : 0;
h_Epz_efficiency->SetBinContent(i, efficiency);
```

Example of my code for efficiency.

- h_Epz_MC_after: $(E - p_z)$ after MC level cuts
  - $1 < Q^2 < 10$
  - $0.01y < 0.85$
  - VM $|\text{Rapiduty}_\phi| < 3.5$