Z(ee)+Jets Analysis

- data vs MC comparisons
- Z(ee) + ≥n Jets xsections
- EM, Trigger, ... efficiencies

Samples

- **Data**:
  - EM1TRK skim
  - Single EM triggers
  - Run range: 20 April 2002 - 28 June 2004 (Runs 151,817 - 194,566)
  - Rejecting bad runs (CAL, SMT, CFT, Jet/Met, Lumi)
  - 336.838 pb^{-1} (Pass1 325.213 pb^{-1})
  - Pass 2 (T42 enabled)
  - JES 5.3
  - Processed with ATHENA (p16-br-03)
- **MC:**
  - Z/Gamma* > e^+e^- +X: 400k Pythia
  - Zj -> eej: 150k Alpgen + Pythia
  - Zjj -> eejj: 180k Alpgen + Pythia
  - Zjjj -> eejjj: 15k Alpgen + Pythia
  - Processed with ATHENA (p16-br-03)

Selection Criteria

- Removing bad runs/LBNs & dupli events
- PVX cut: |z|<60cm
- Using unprescaled single EM triggers
- Electron selection:
  - |ID|=10,11
  - EMF>0.9
  - Iso<0.15
  - HMx(7)<12
  - p_T>25GeV
  - |det_eta|<1.1
  - Including phi cracks
- Z selection:
  - 75GeV < M_{ee} < 105GeV
  - At least one trackmatched electron
  - At least one electron needs to fire the trigger
- Jet selection:
  - 0.05 < EMF < 0.95
  - HotF < 10
  - N90>1
  - CHF<0.4
  - L1conf
  - JES corrected p_T>20GeV
  - |det_eta|<2.5
  - Removal of jets overlapping with electrons from Z within dR of 0.4

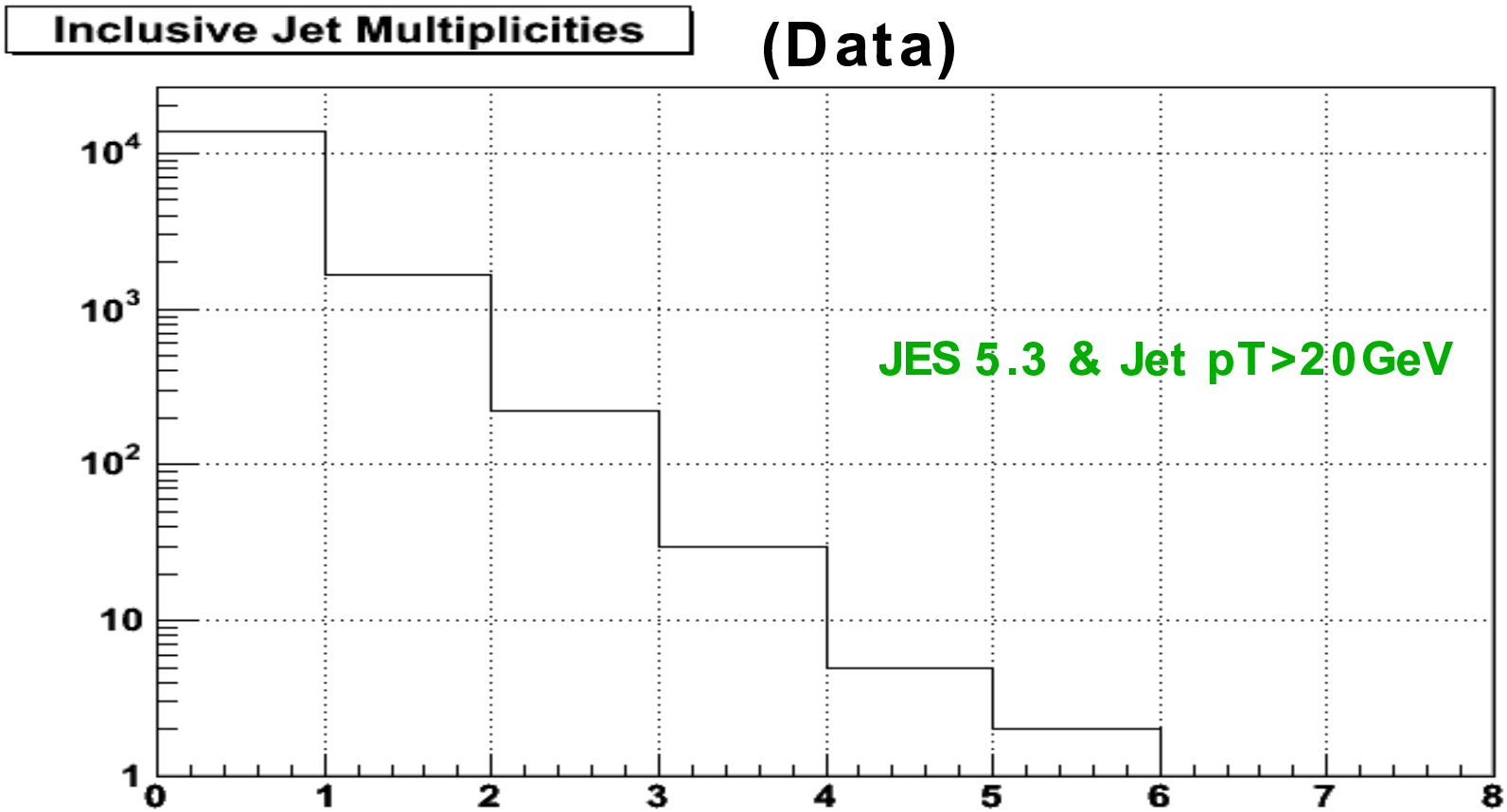
Data vs MC

(normalization wrt area)

Data & MC tuning

	Electrons	Jets
Data	- Correct for data EM inefficiencies - Correct for trigger inefficiencies - Correct for data tracking inefficiencies	- JES 5.3
MC	- Electron smearing - Correct for MC EM inefficiencies - Correct for MC tracking inefficiencies - Correct for difference in Z pT between data and MC (only for inclusive sample!)	- JES 5.3 - Jet smearing - Jet reco scaling factor

Jet Multiplicities

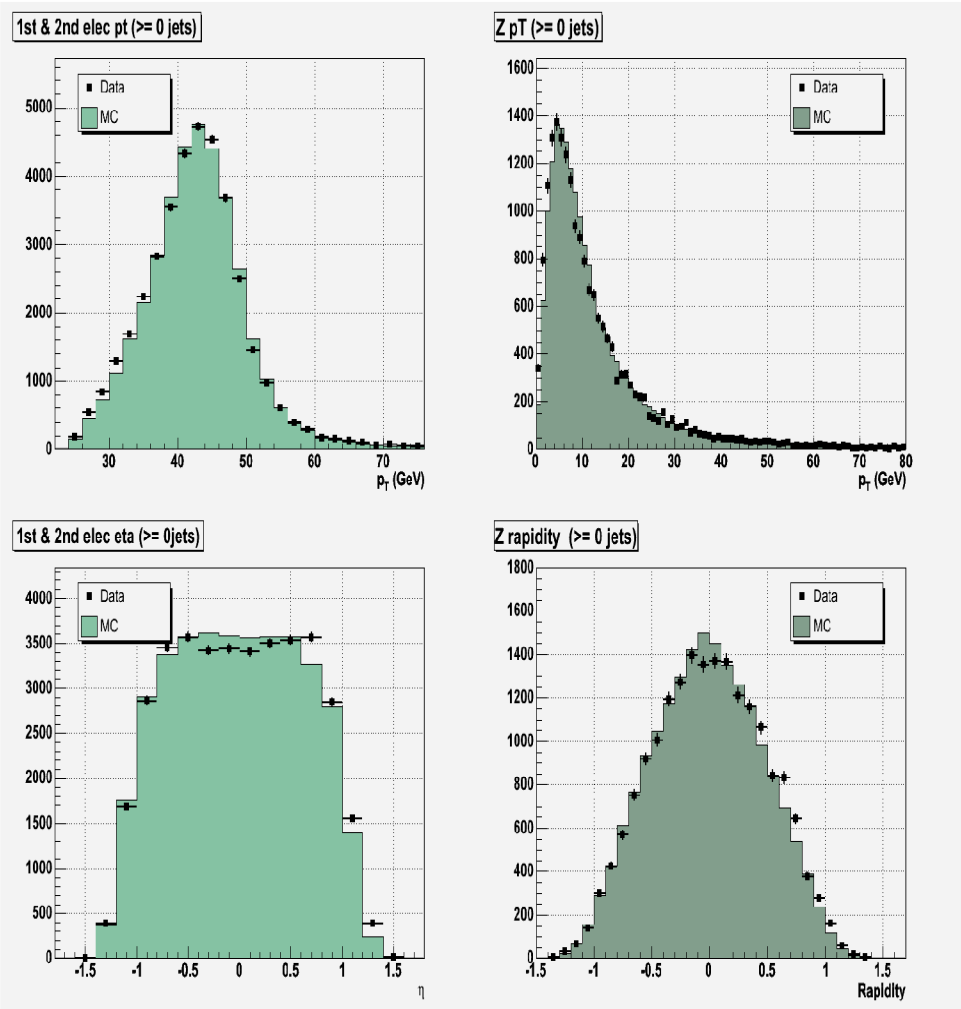


Inclusive # of jets	0	1	2	3	4	5	6
# events Pass 2	13,912	1,652	219	30	5	2	0
# events Pass 1	12,718	2,033	327	63	14	3	1

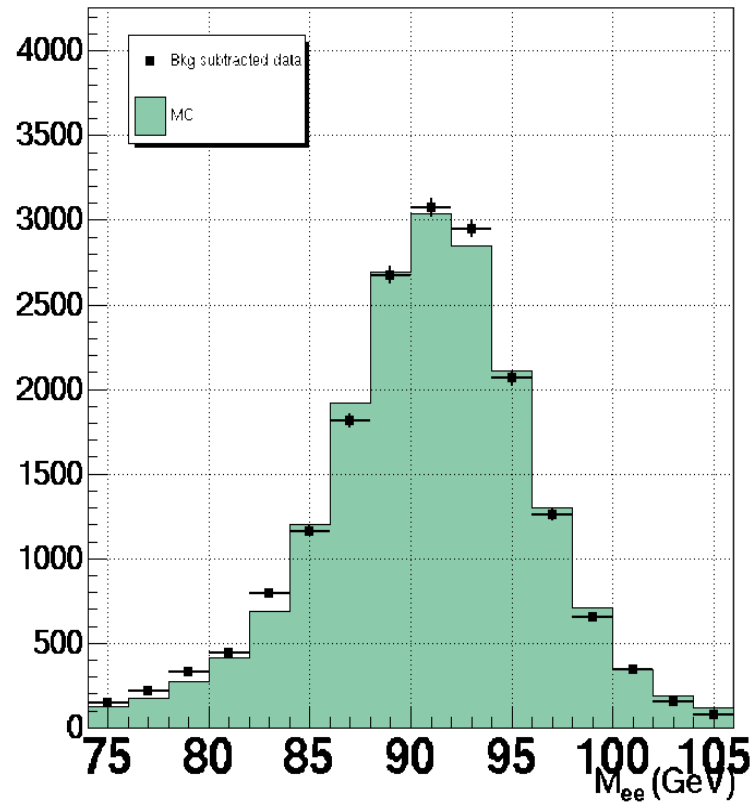
Z(ee)+X: Electrons and Zs

Sample size ≈ 14k events

MC = Pythia



Z peak



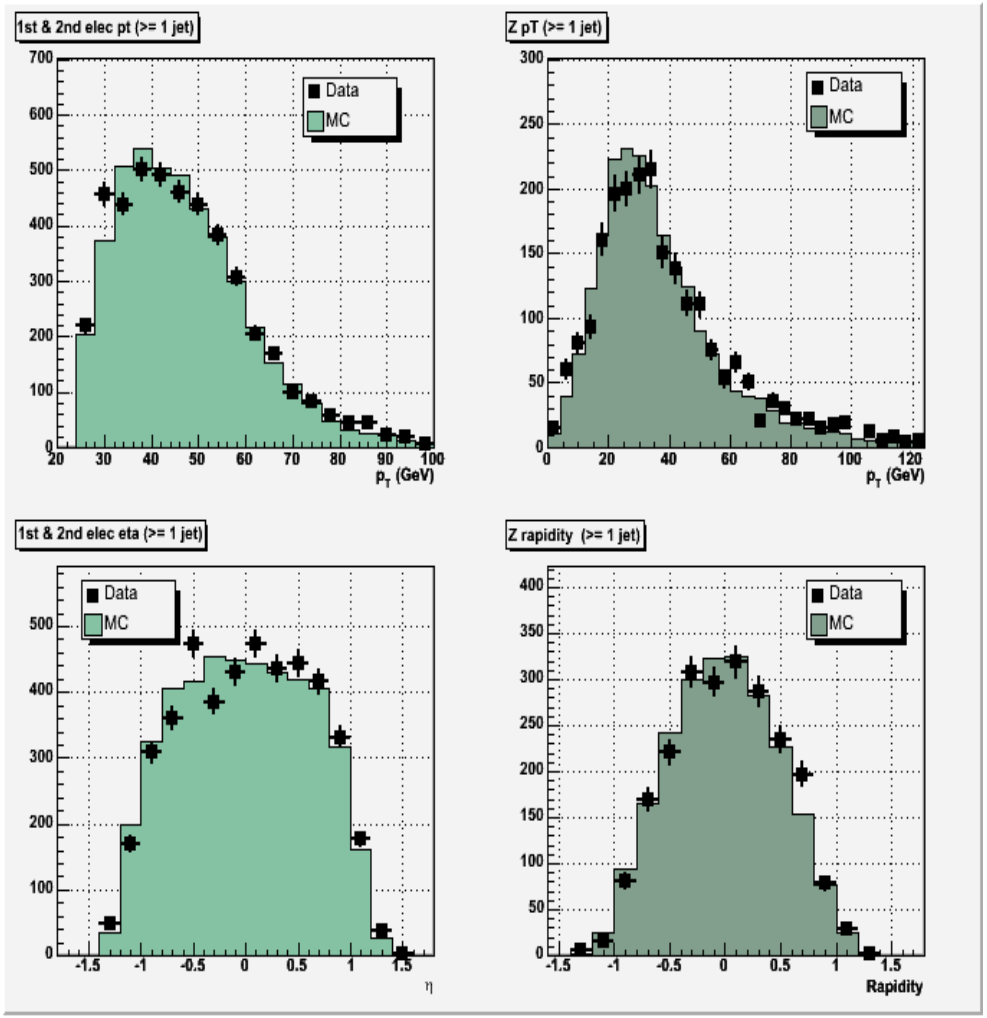
Mass = 91.02 GeV

Width = 4.03 GeV

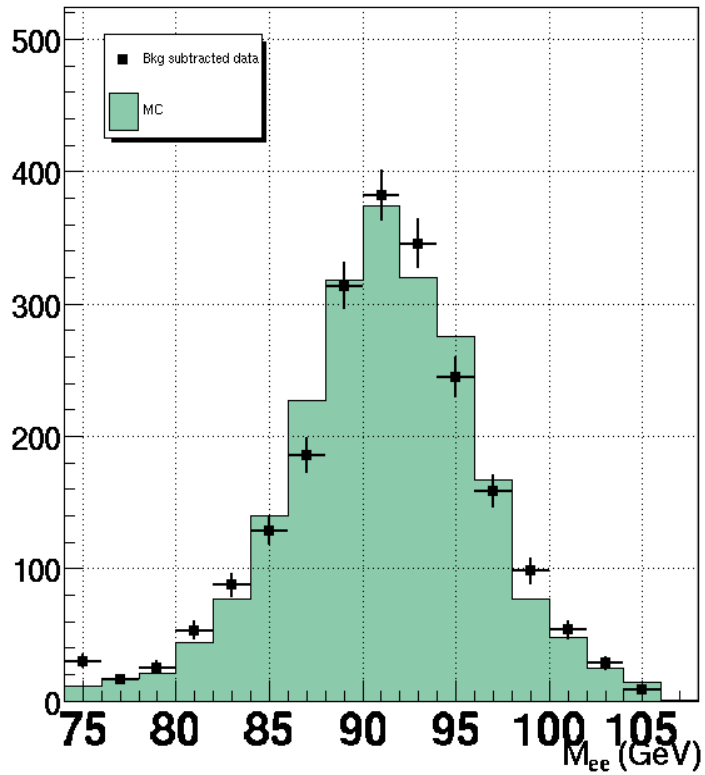
Z(ee) + ≥1jet(s): Electrons and Zs

Sample size ≈ 1.7k events

MC = Zj Alpgen



Z peak

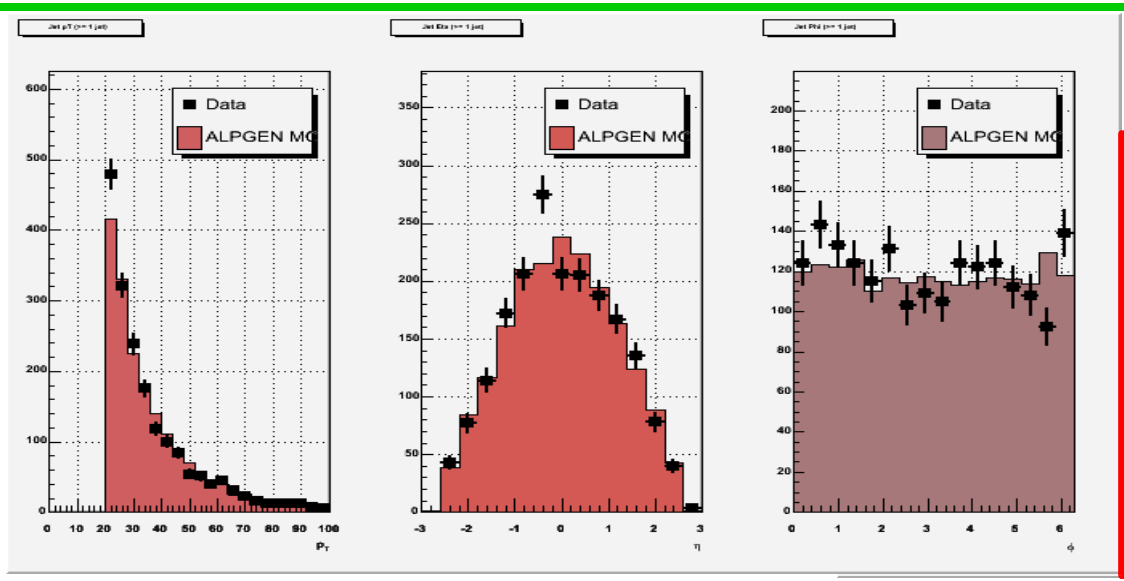


Mass = 91.40 GeV

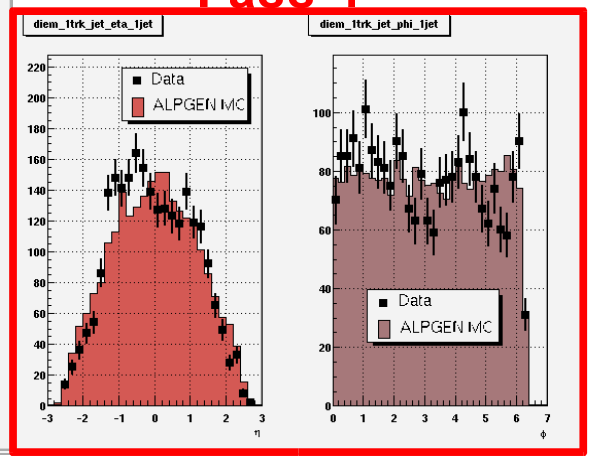
Width = 4.09 GeV

Z(ee) + ≥1jet(s): Jets

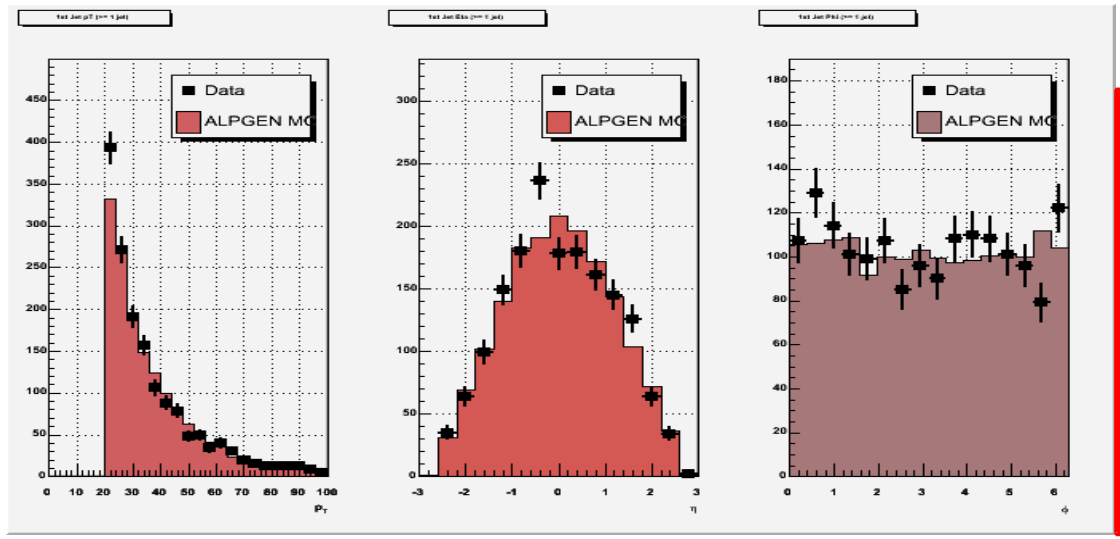
All Jets



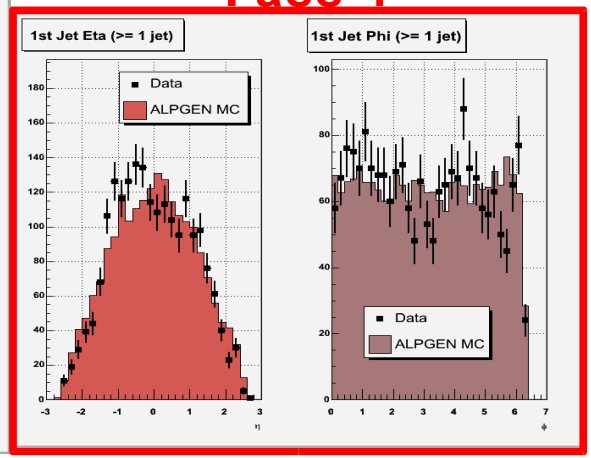
Pass 1



Lead Jet



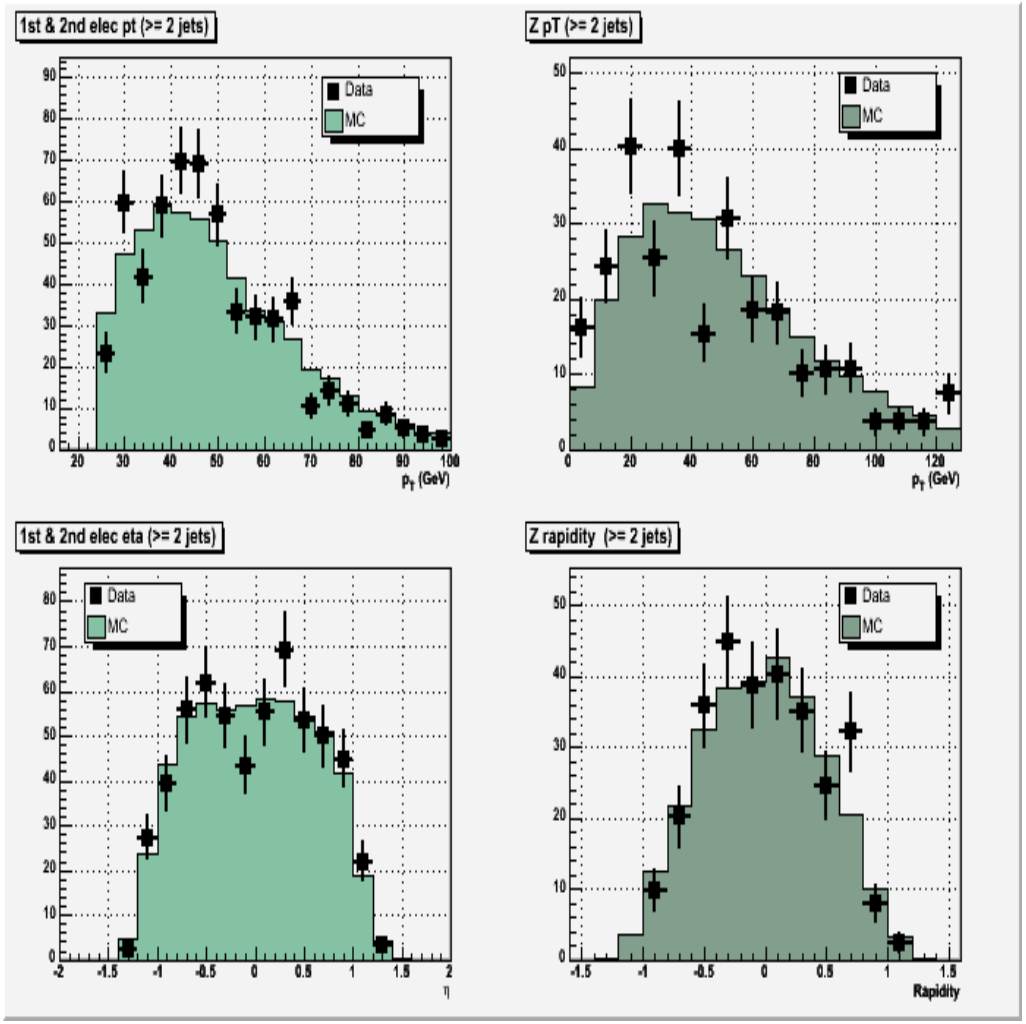
Pass 1



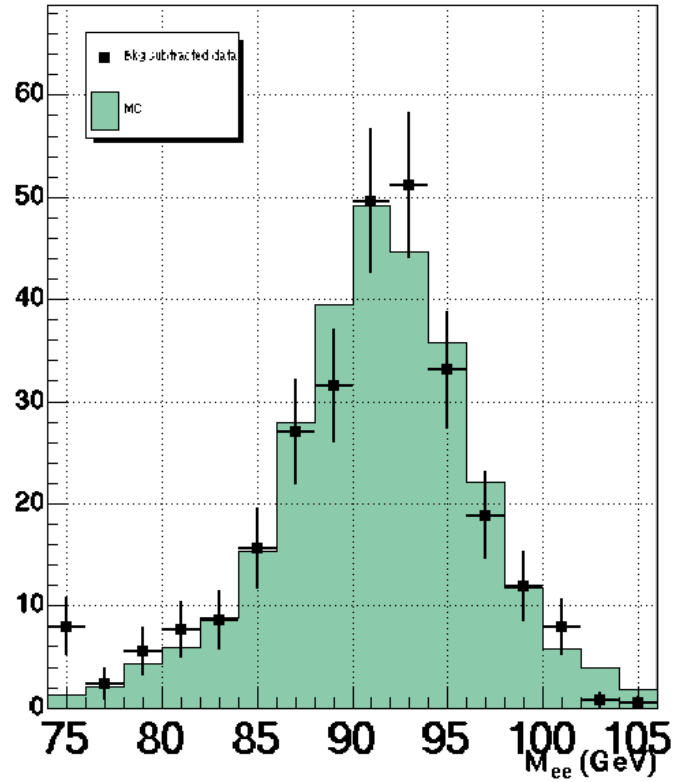
Z(ee) + ≥ 2 jet(s): Electrons and Zs

Sample size ≈ 200 events

MC = Zjj Alpgen



Z peak



Mass = 91.47 GeV

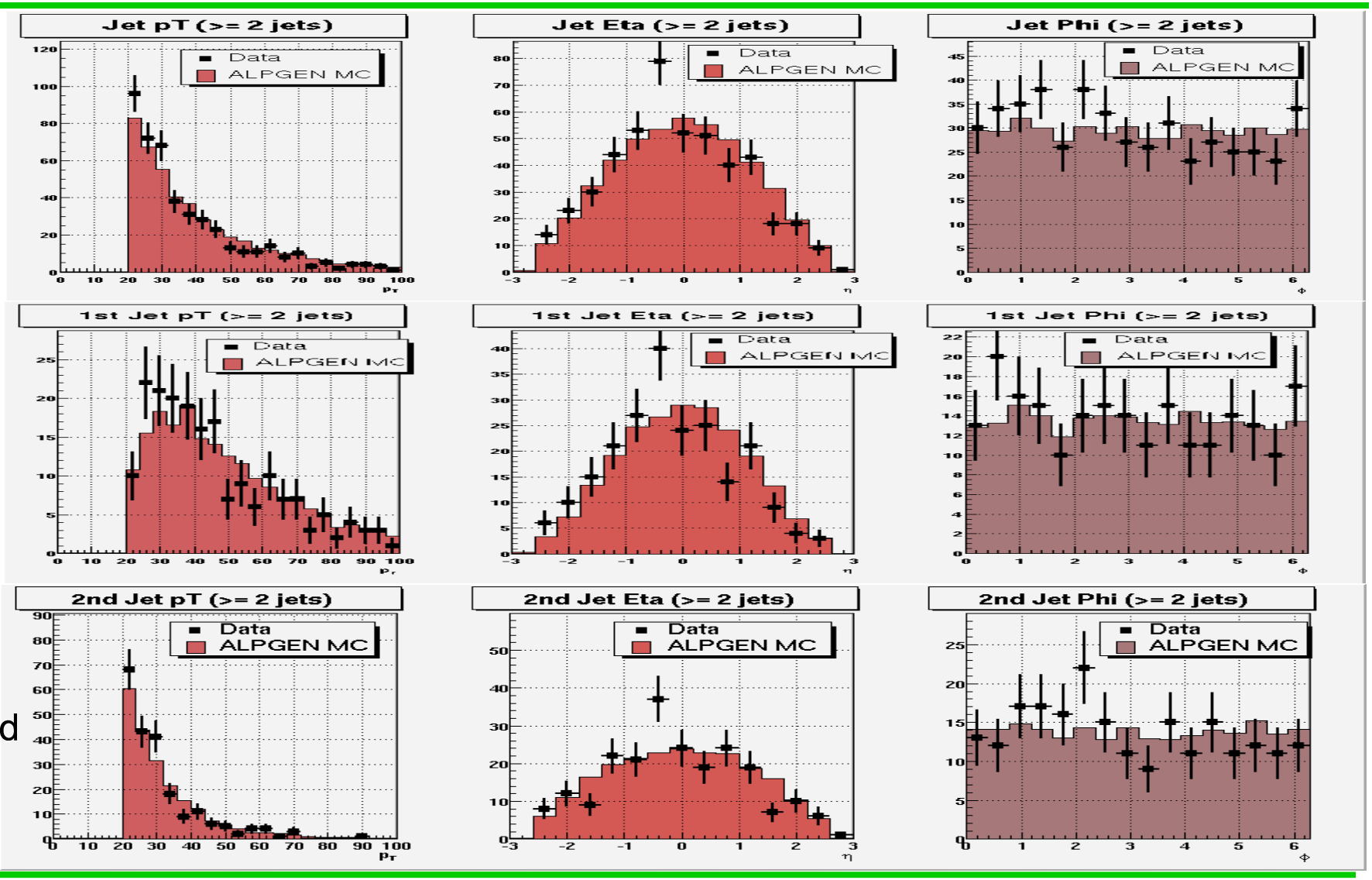
Width = 3.72 GeV

Z(ee) + ≥ 2 jet(s): Jets

All

1st

2nd



Cross sections

Xsection calculation

Xsection x BR = (# of signal events) / (Lumi x Acceptance)

Corrected for EM, Track, Trigger, Jet reco inefficiencies

336.838 pb^{-1}

kinematic and geometric, PVZ, M_{ee}

Jetmult	# of signal events	Acceptance	xsection
0	18,551	21.0%	262 pb
1	2,207	23.7%	28pb
2	286	25.4%	3.3pb
3	37	27.8%	0.4pb
4	7	28.6%	0.07pb
5	2	30.9%	0.02pb

todo

- Jet reco efficiency correction
- MC closure test
- Acceptance correction for jet removal cut
- Vertex efficiency
- MC background estimation
- Extra jets/'jet promotion'
- Unsmear xsection
- Update analysis note

EM inefficiency corrections:

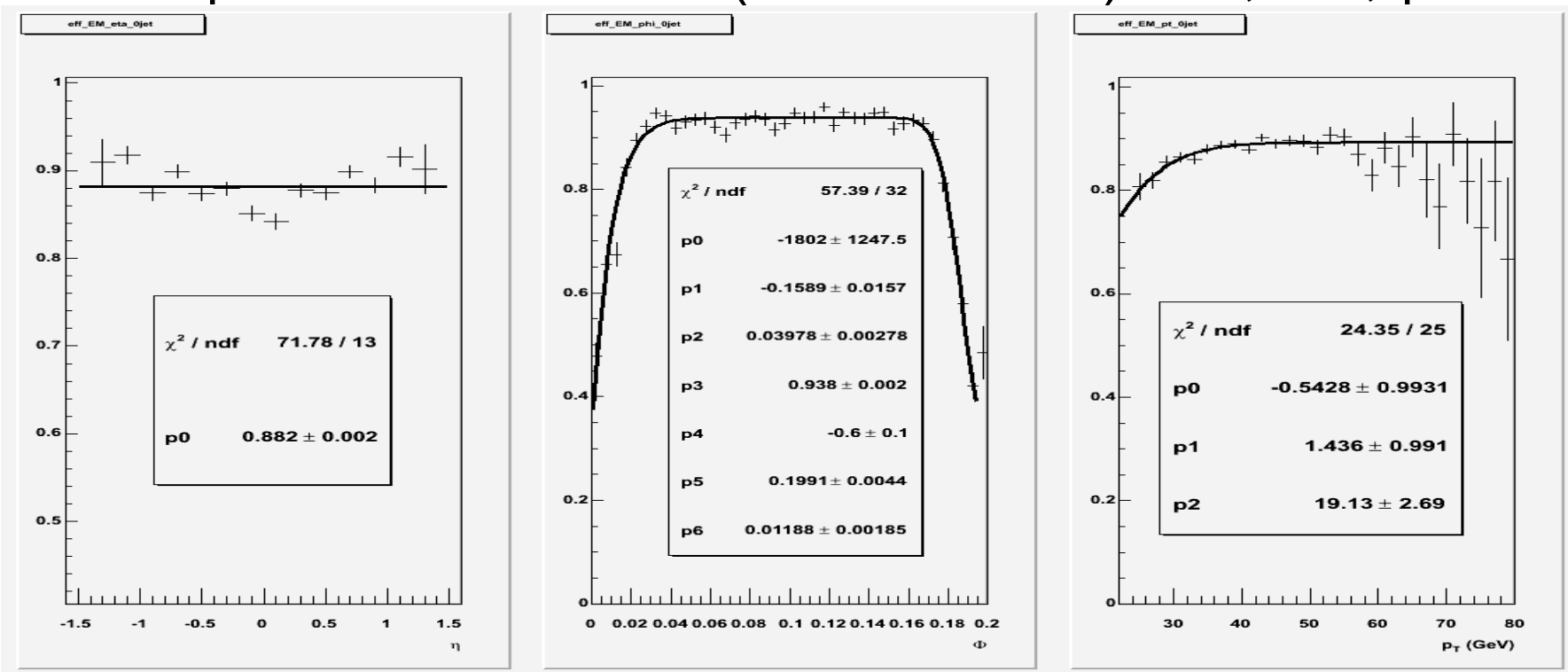
- Reco x ID efficiencies in data & MC for xsection and data vs MC comparisons (all jet multiplicities)
- Reco efficiencies in MC for acceptance (all jet multiplicities)

Z(ee) + X: Reco x ID (data)

Averaged efficiency **w/ o** SB subtraction = **88.2** +- 0.2 P2 (**88.0%** P1)

Averaged efficiency **with** SB subtraction = **88.9** +-0.3 P2 (**88.6%** P1)

1D parameterizations (w/o SB subtr): Eta, Phi, pT



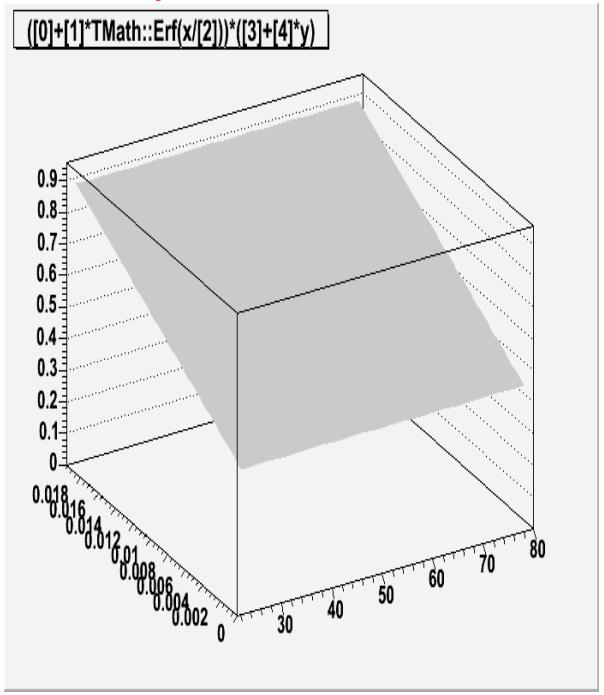
Flat eta

2D parameterization for pT and phi needed (next slide)

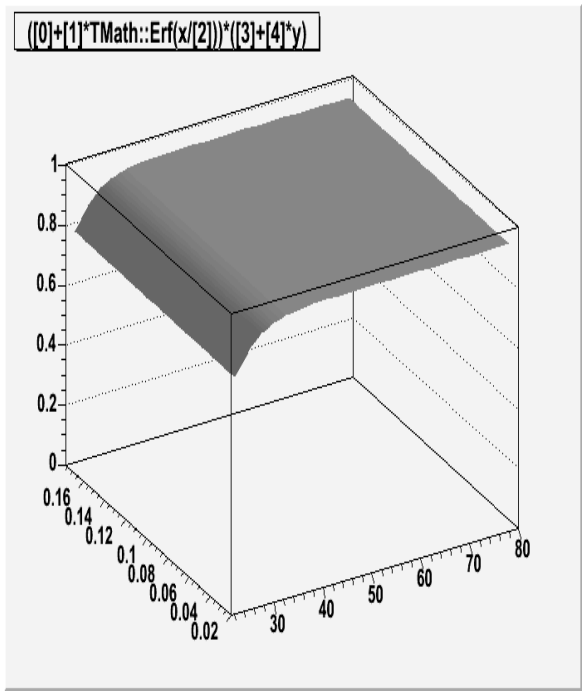
Z(ee) + X: Reco x ID (data)

2D parameterization (w/o SB subtr): pT vs Phi

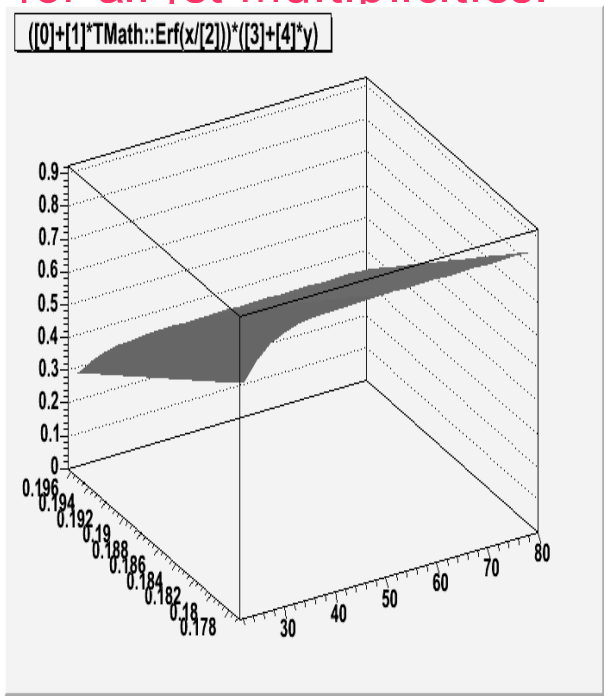
These plots are used to correct for EM inefficiencies for all jet multiplicities!



p0= -7.14878e-02
p1= 9.69166e-01
p2= 4.16703e-01
p3= 4.94640e-01
p4= 2.58078e+01



p0= -1.47044e+00
p1= 1.97746e+00
p2= 1.60416e+01
p3= 1.87097e+00
p4= 2.58628e-02



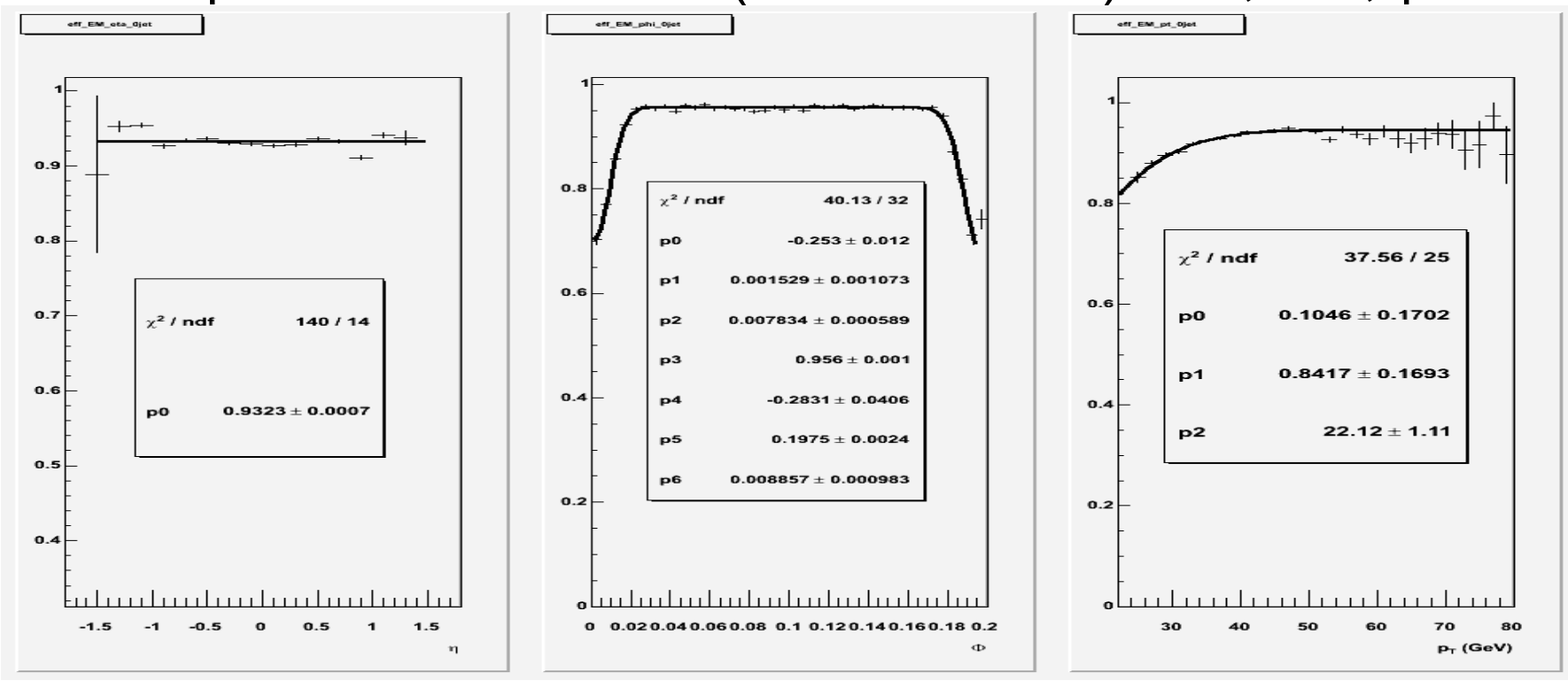
p0= -5.62633e-01
p1= 8.34205e-01
p2= 1.67582e+01
p3= 2.03739e+01
p4= -9.73265e+01

Z(ee) + X: Reco x ID (MC)

Averaged EM efficiency **w/ o** SB subtraction = **93.3%**+-0.1 P2 (**93.2%** P1)

Averaged EM efficiency **with** SB subtraction = **93.4%** +- 0.1 P2 (**93.3%** P1)

1D parameterizations (w/o SB subtr): Eta, Phi, pT



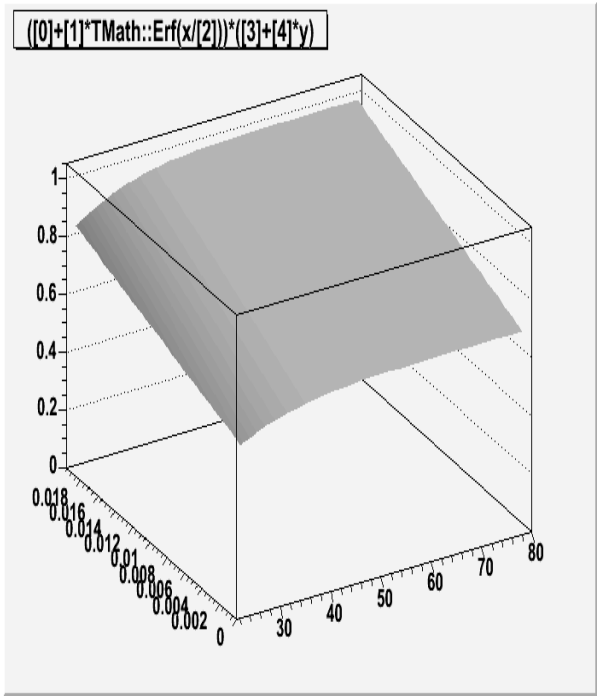
Flat eta

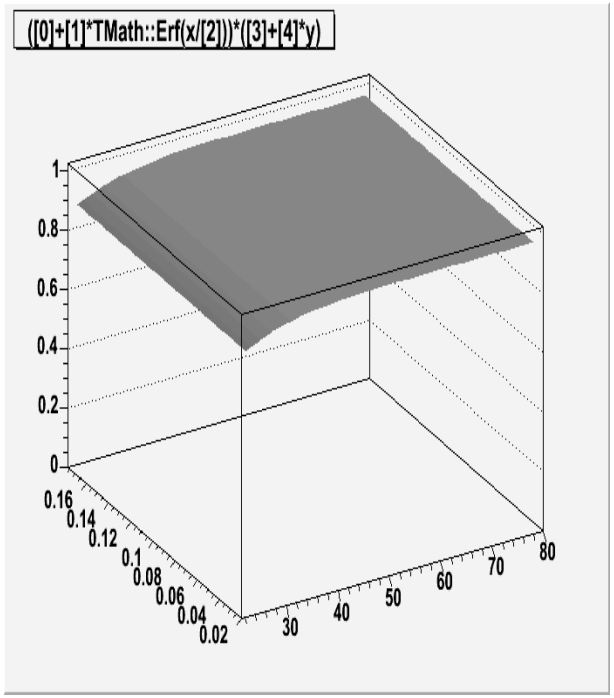
2D parameterization for pT and phi needed (next slide)

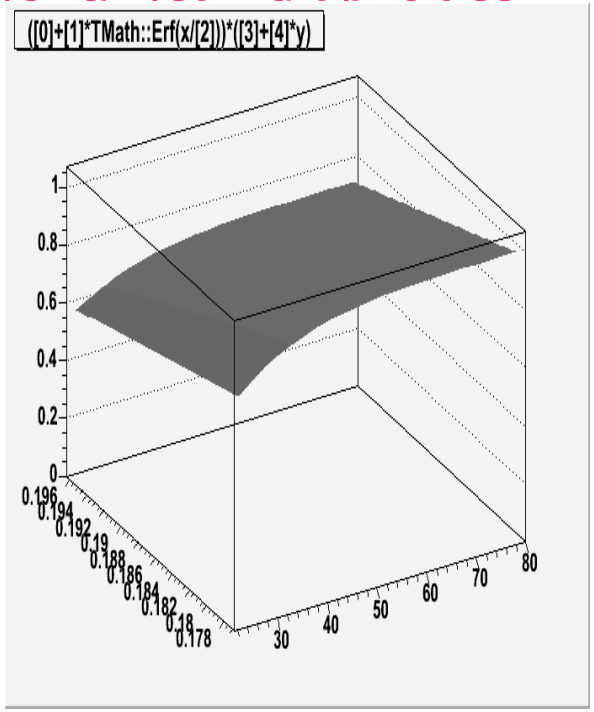
Z(ee) + X: Reco x ID (MC)

2D parameterization (w/o SB subtr): pT vs Phi

These plots are used to correct for EM inefficiencies for all jet multiplicities!

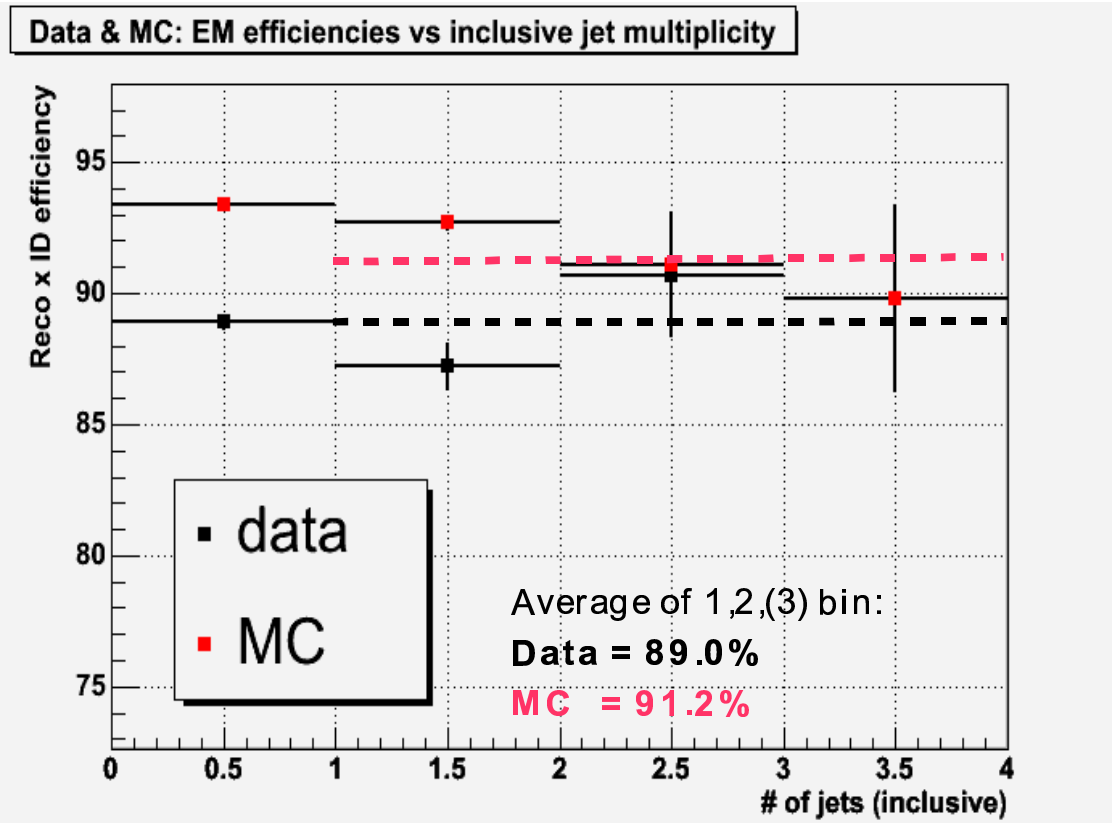






p0= 5.01462e-01	p0= 7.67718e-01	p0= 4.21768e-02
p1= 8.63779e-01	p1= 7.11170e-01	p1= 9.81402e-02
p2= 2.70382e+01	p2= 2.39058e+01	p2= 3.02860e+01
p3= 5.03853e-01	p3= 6.58444e-01	p3= 2.54832e+01
p4= 1.12603e+01	p4= -8.66241e-03	p4= -1.03648e+02

Z(ee) + n Jets: Reco x ID (data & MC)



After applying the pt/phi parameterized efficiency correction to all samples the following ratio is supposed to take care of the residual inefficiencies due to jet activity:

EM_jet_corr (data) ≈ 1.0

EM_jet_corr (MC) = 93.4%/91.2%

= 1.02

Jet mult	0	1	2	3
Data	88.9+-0.3	87.2+-0.9	90.7+-2.4	-
MC	93.4+-0.1	92.7+-0.3	91.1+-1.0	89.8+-3.6

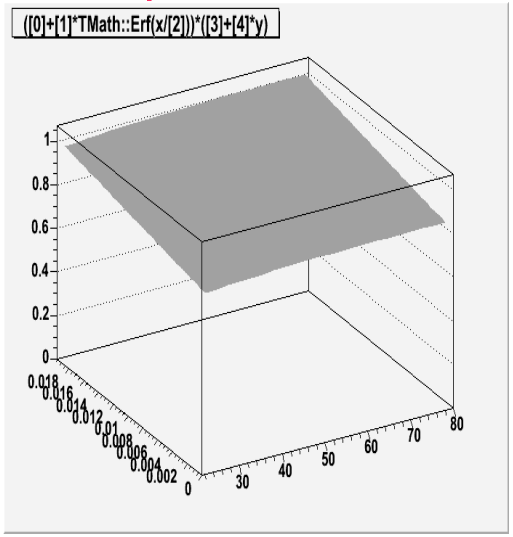
Z(ee) + X: Reco (MC)

Averaged reco efficiency **w/ o** SB subtraction = **98.0%**+-0.04

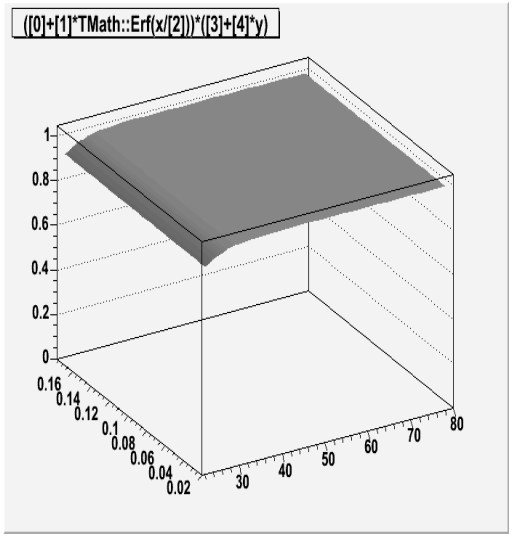
Averaged reco efficiency **with** SB subtraction = **98.0%** +- 0.04

2D parameterization (w/o SB subtr): pT vs Phi

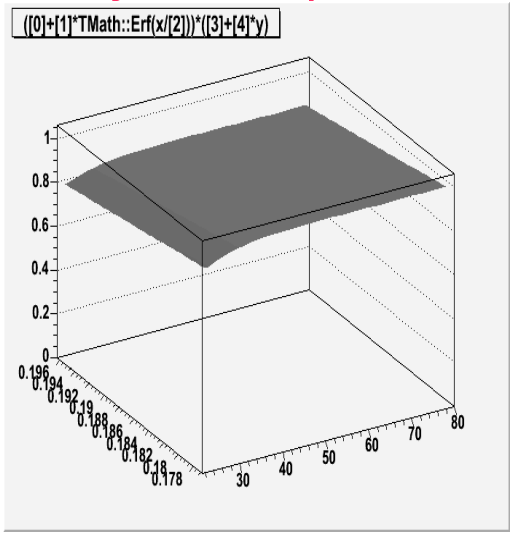
These plots are used to correct for EM inefficiencies for all jet multiplicities!



p0= 1.15666e+00
p1= 1.13930e-01
p2= 3.75039e+01
p3= 6.68515e-01
p4= 6.69022e+00

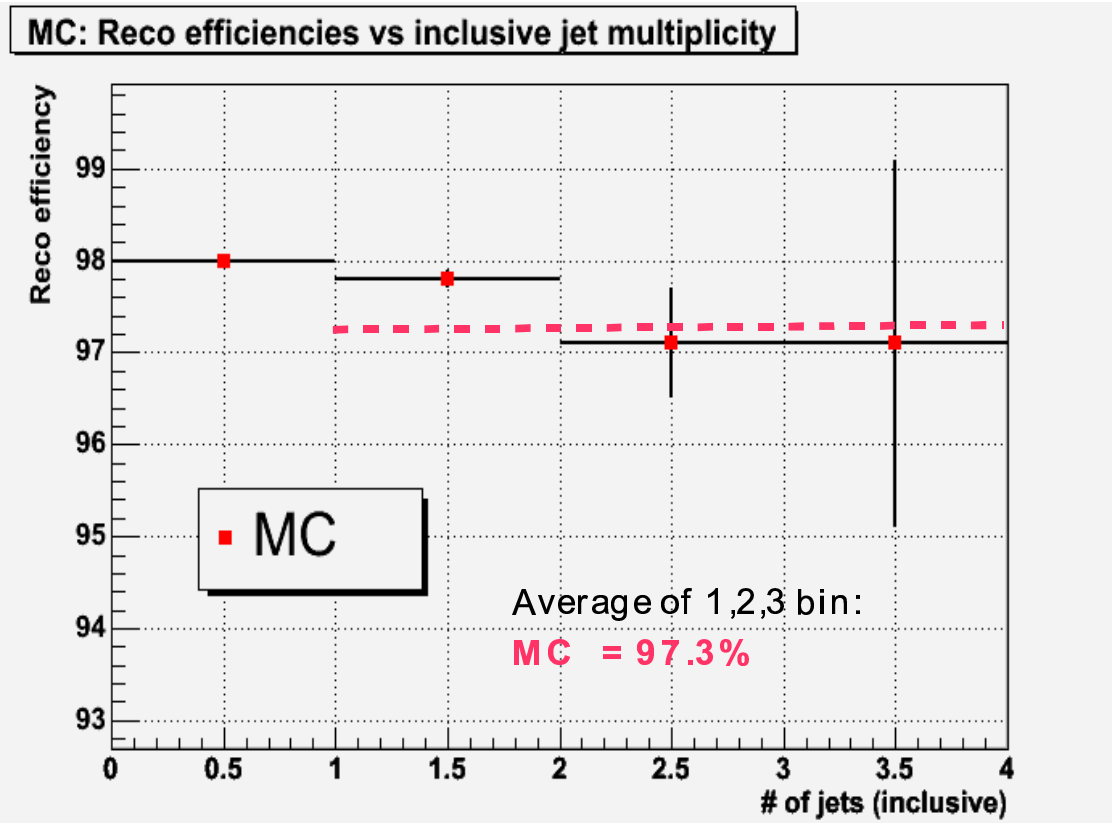


p0= -6.61249e-01
p1= 1.55326e+00
p2= 1.58091e+01
p3= 1.11574e+00
p4= 3.66837e-03



p0= 2.93278e-02
p1= 4.08735e-02
p2= 2.15278e+01
p3= 3.30752e+01
p4= -1.06148e+02

Z(ee) + n Jets: Reco (MC)



After applying the pt/phi parameterized efficiency correction to all samples the following ratio is supposed to take care of the residual inefficiencies due to jet activity:

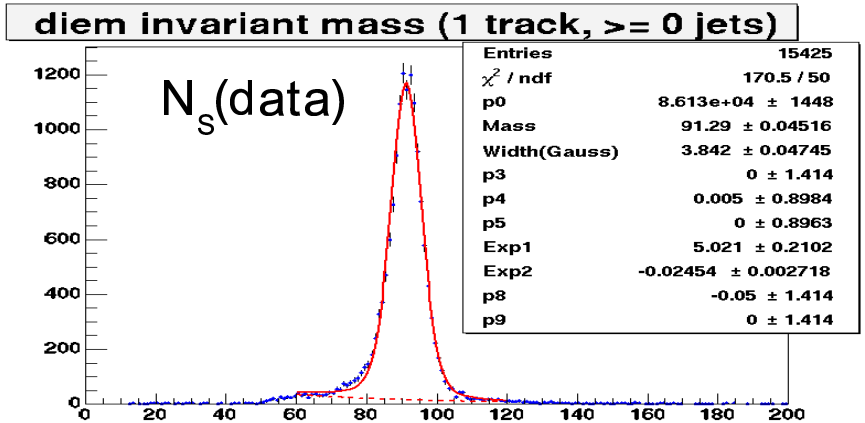
EM_jet_corr (MC) = 98.0%/97.3%
= 1.01

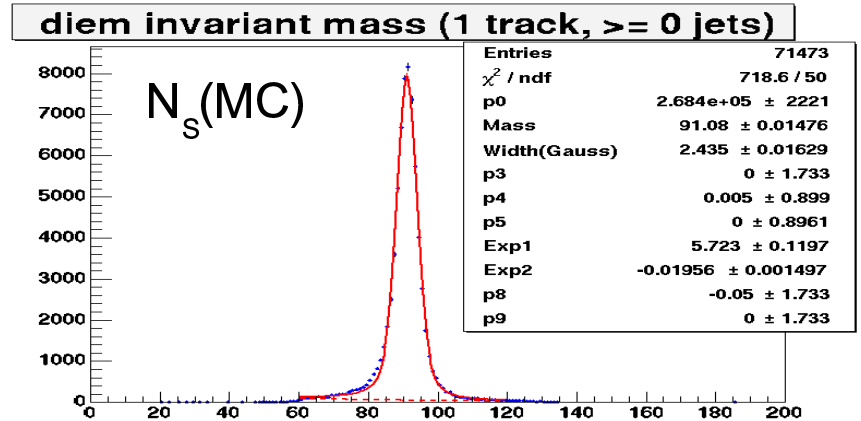
Jet mult	0	1	2	3
MC	98.0+-0.04	97.8+-0.1	97.1+-0.6	97.1+-2.0

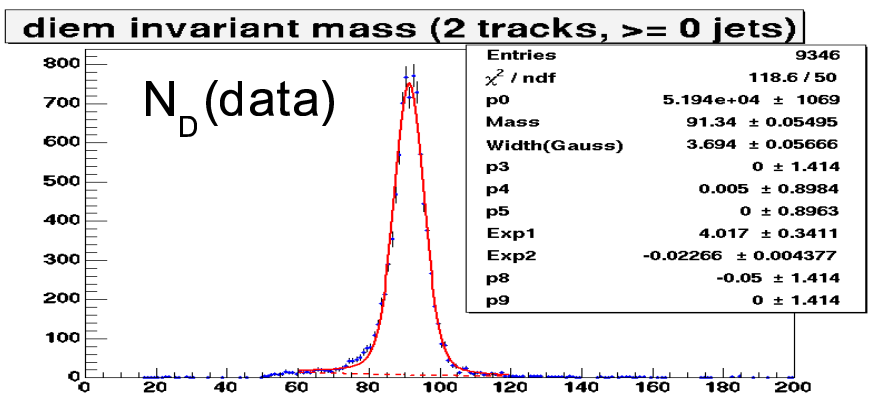
Tracking inefficiency corrections

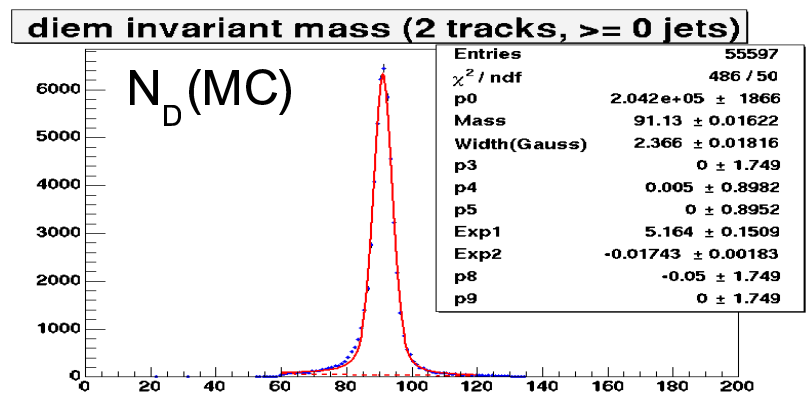
Z(ee)+X: Track (data & MC)

$$Eff = 2N_D / (N_D + N_S)$$





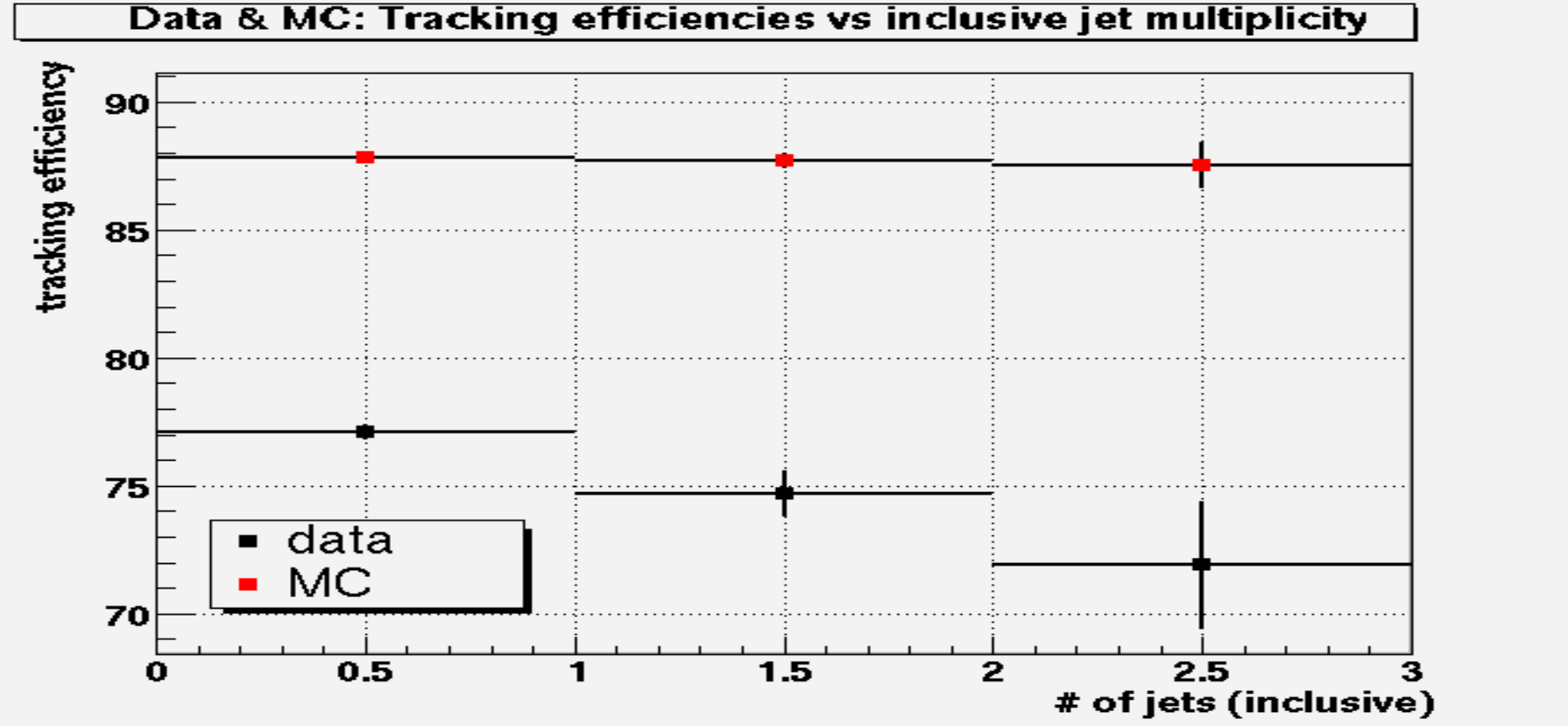




Eff(data) = **77.1%** +- 0.3

Eff(MC) = **87.8%** +- 0.03

Z(ee)+n Jets: Track (data & MC)



Jet mult	0	1	2
data	77.1+-0.3	74.7+-0.9	71.9+-2.5
MC	87.8+-0.03	87.7+-0.3	87.5+-0.9

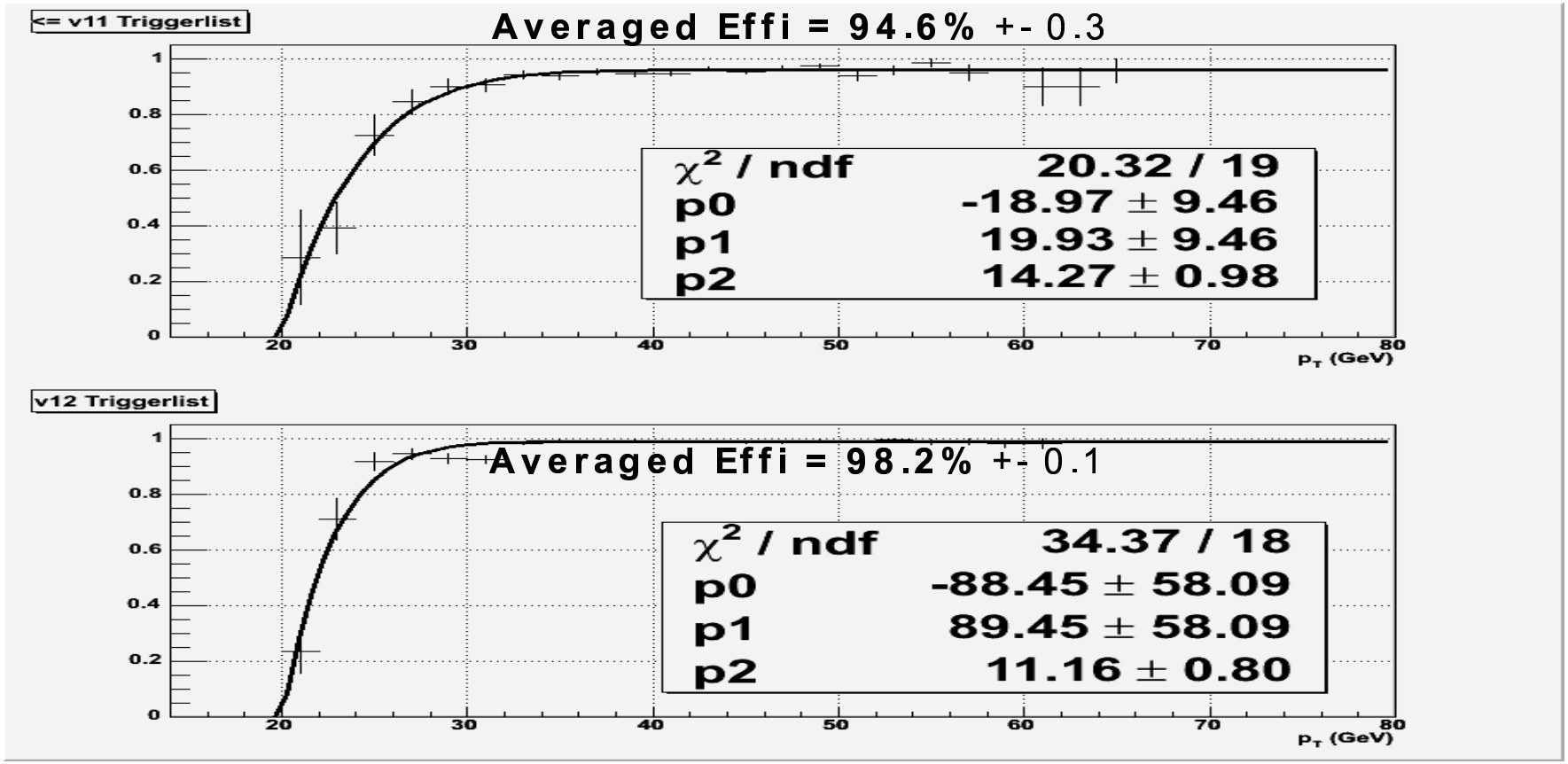
Average (data) = 74.6%

Average (MC) = 87.7%

Trigger inefficiency corrections

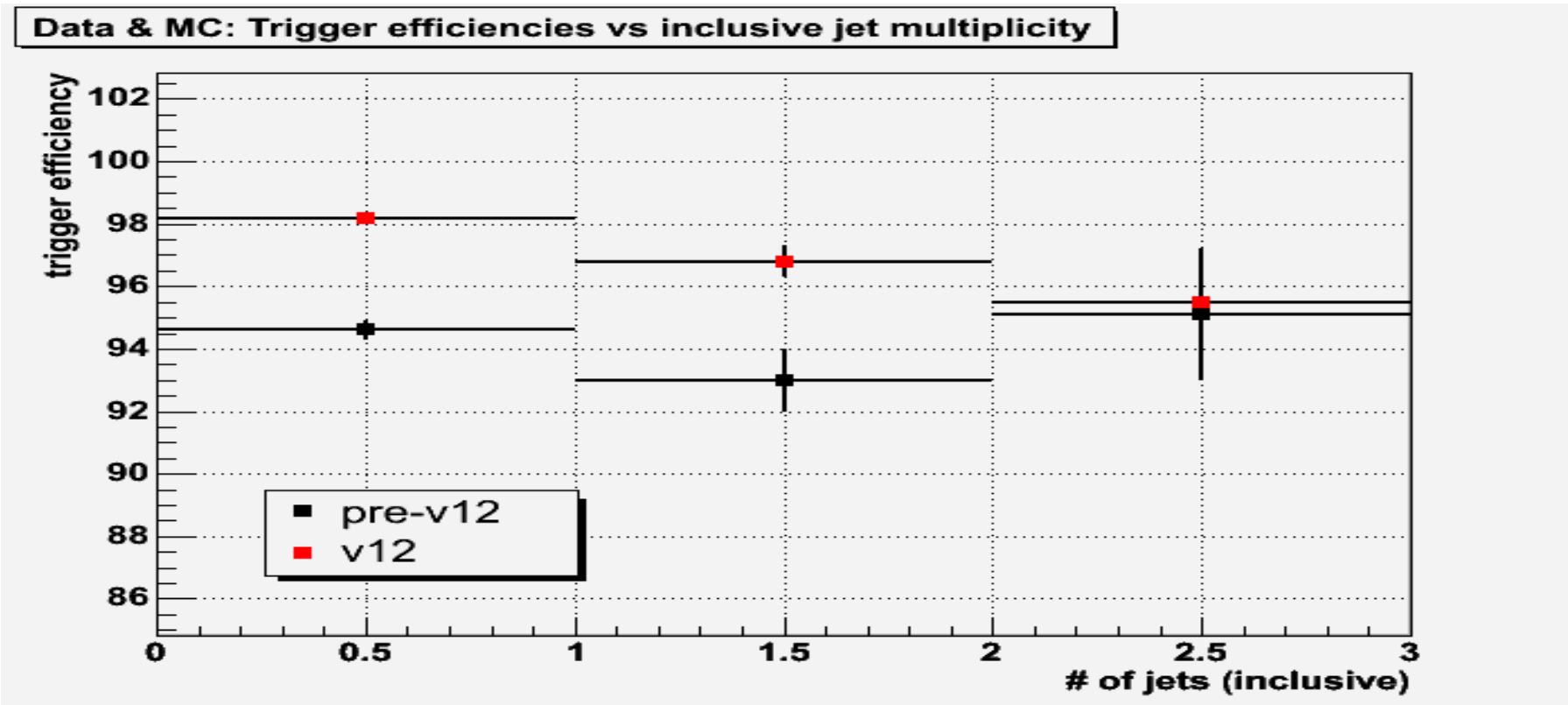
Z(ee)+X: Trigger

Eff(pt) = p0 + p1 * Erf(pt/ p2)



Assuming no dependence of trigger efficiency wrt jet multiplicity (next slide), these curves are used for all jet multiplicities to correct for trigger inefficiencies.

Trigger

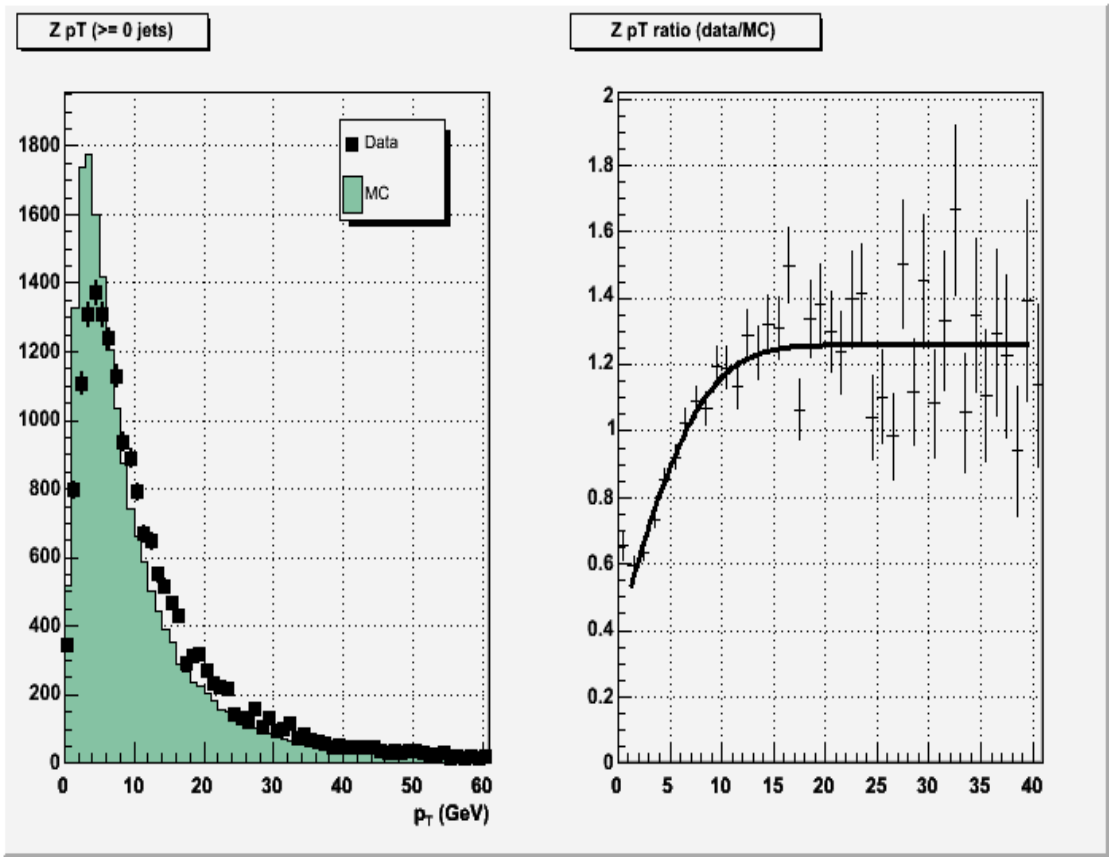


Jet mult	0	1	2
pre-v12	94.6+-0.3	93.0+-1.0	95.1+-2.1
v12	98.2+-0.1	96.8+-0.5	95.5+-1.6

Z pt corrections

Z(ee)+X: Z pt correction

After applying all of the corrections from the previous slides we compare the Z pT distribution between data and MC and derive an additional Z pT correction. This correction is then applied to the MC to take care of residual kinematic differences between data and MC (NLO effects).



Error function parameterization for Z pT ratio:

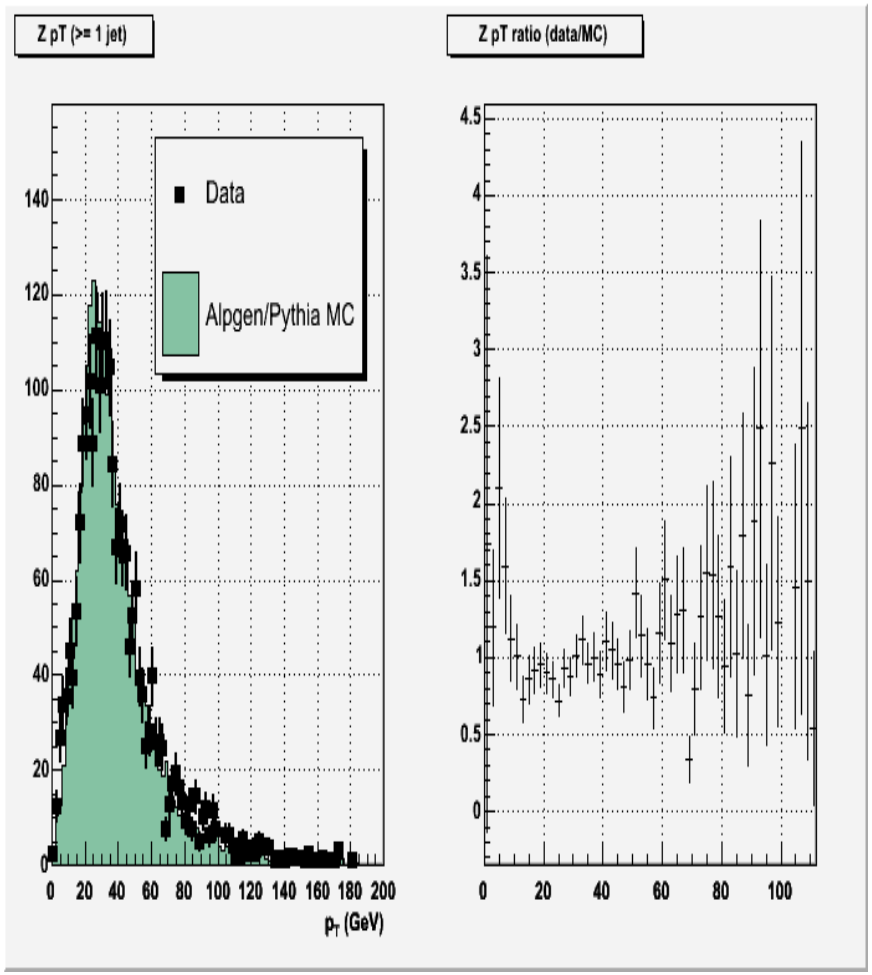
Ratio(Z pt) = p0 + p1 * Erf(pt/ p2)

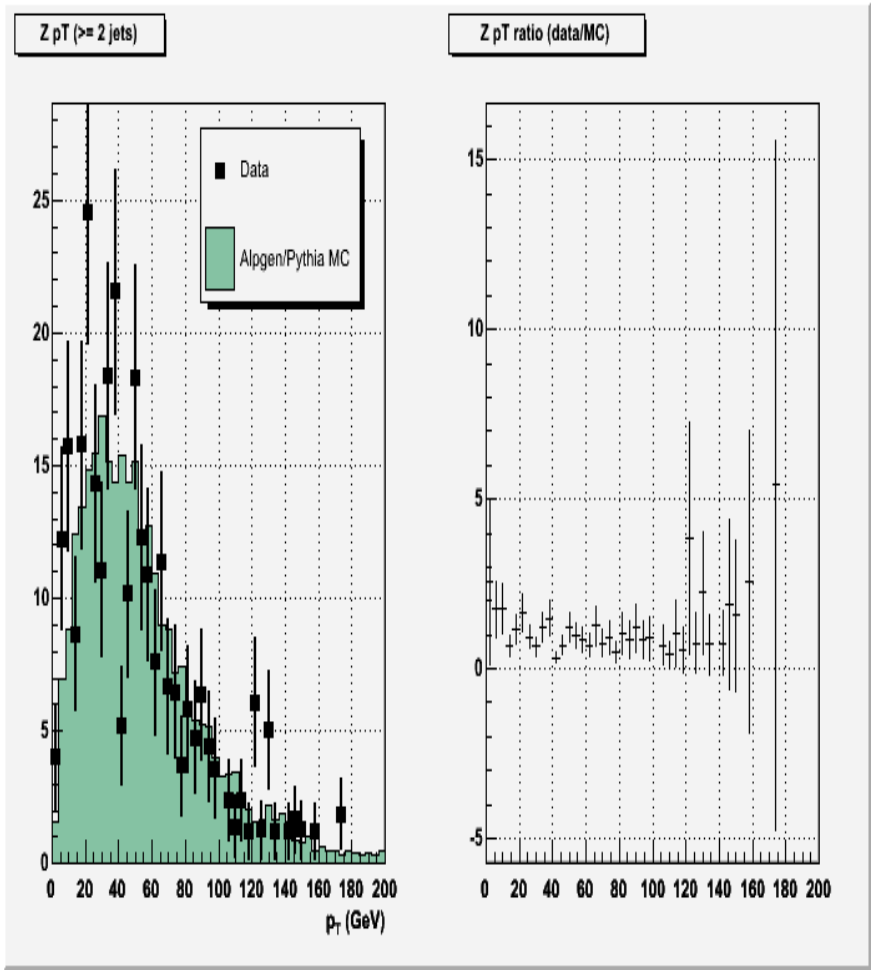
p0 = 3.98765e-01

p1 = -8.61209e-01

p2 = -8.95334e+00

Z(ee)+ ≥1 & 2 jet: Z pt correction





No Z pT correction for ≥ 1, 2, ... samples are being applied.

Jet reco efficiencies (J.Heinmiller)

Scale factor (data vs MC):

1.00 * Erf(0.02852 * Z_pt + 0.2623)

Cal_jet_pt = 71/80 * Z_pt + 5.25

Jet reco efficiencies (data & MC):

p0 * Erf(p1 * x + p2 * x^(1/2) + p3 * x^(1/4)

	P0	P1	P2	P3
MC CC	0.9814	5.838*10^-2	3.759*10^-3	-0.2370
Data CC	0.9814	4.283*10^2	7.623*10^-2	-0.3541
MC ICR	0.9551	0.2199	-1.8440	2.1650
Data ICR	0.9454	7.321*10^-2	-0.2149	-1.161*10^-2
MC FWD	0.9739	0.1754	-1.6480	2.1030
Data FWD	0.9739	0.1041	-0.7919	0.8777

(CC= -.7 < eta < .7 - ICR=.7 < |eta| < 1.5 - FWD=1.5 < |eta| < 2.5)