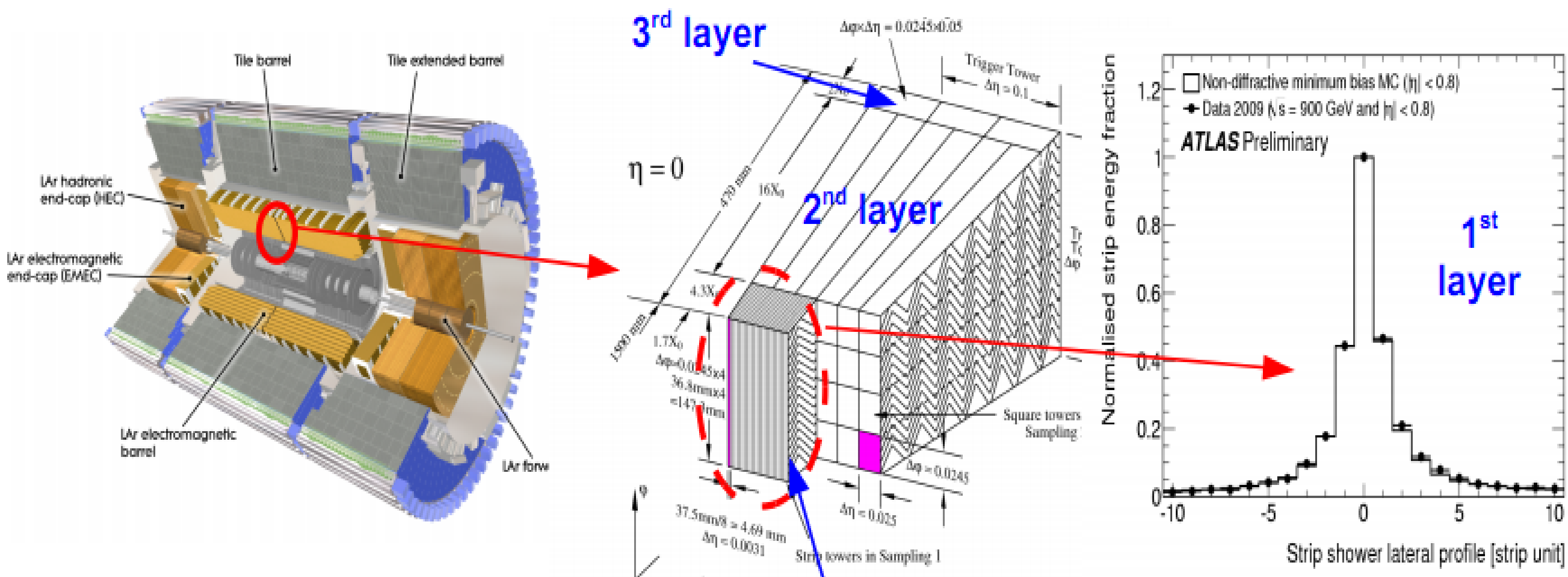
Electron ID efficiency measurement in Atlas

Bo Li CPPM/Shandong University

ATLAS EM Calorimeter

- Liquid Argon EM Calorimeter with accordion geometry covers | η |< 3.2. The fine granularity for | η |< 2.5 allows precision measurements of EM objects.
- Four layers perform energy/position measurements and provide information for particle identification

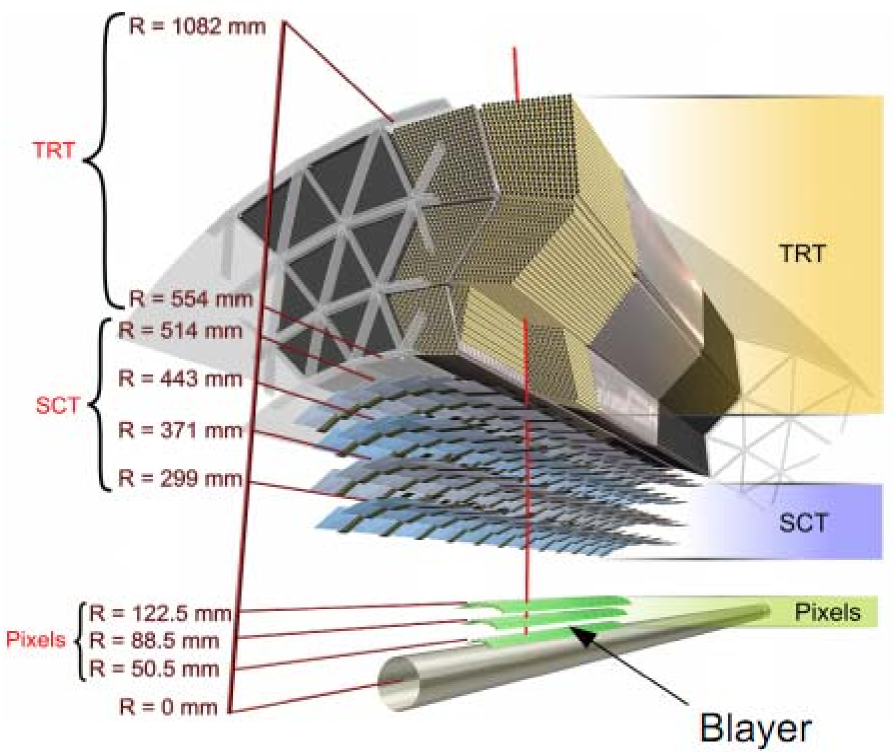


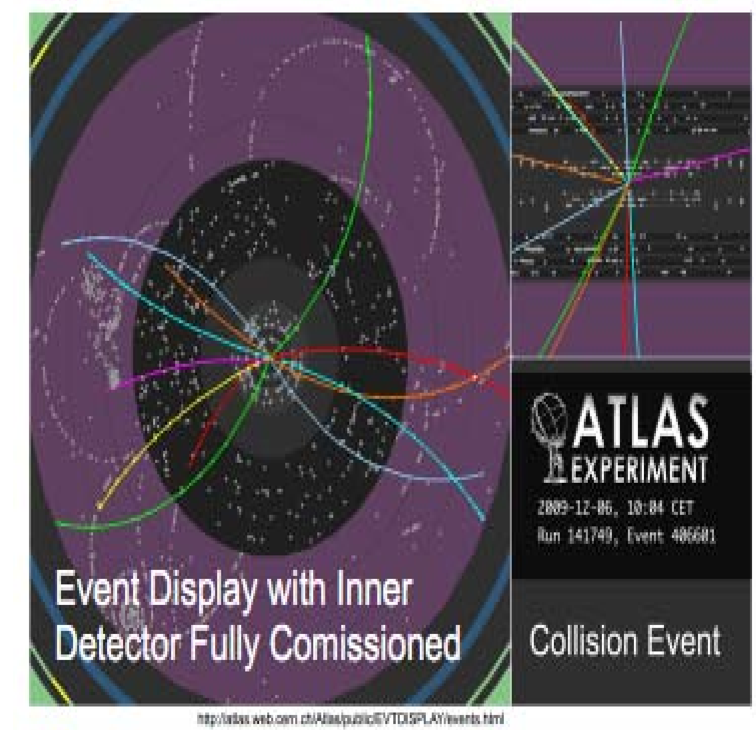
Pre-sampler

1st layer, finely segmented in η, precision measurement and rejection against pion.

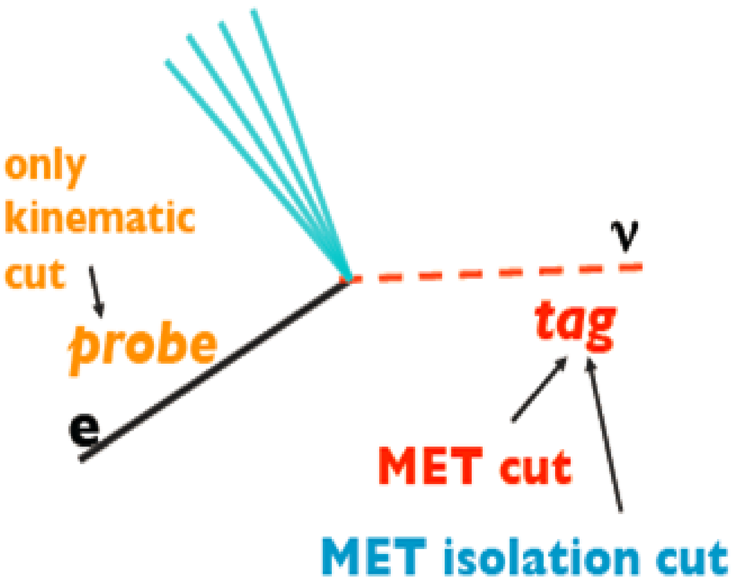
ATLAS Inner Detector Tracking System

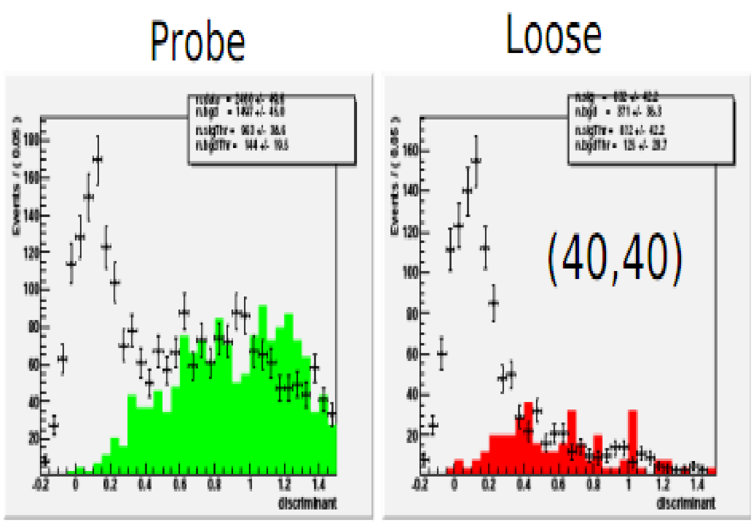
- Inner Detector consisting of PIXEL, SCT, and TRT trackers, provides precision measurements of momentum and direction of tracks with | η |< 2.5, and identification information





Introduction





- Electron identification efficiency measured by tagging missing E_T of neutrino in $W \rightarrow e\nu$ to select a sample of probe electrons.
- Create data-driven isolation template to subtract background from signal region, for probes and probes with ID.
- **Simple template subtraction method:**

•Probe "container" electron candidates and estimate background using an isolation template (obtained by reversing ID cuts).

• First perform background subtraction using isolation templates on probe (denominator) and probe+IDcut (numerator).

• Then calculate efficiency:

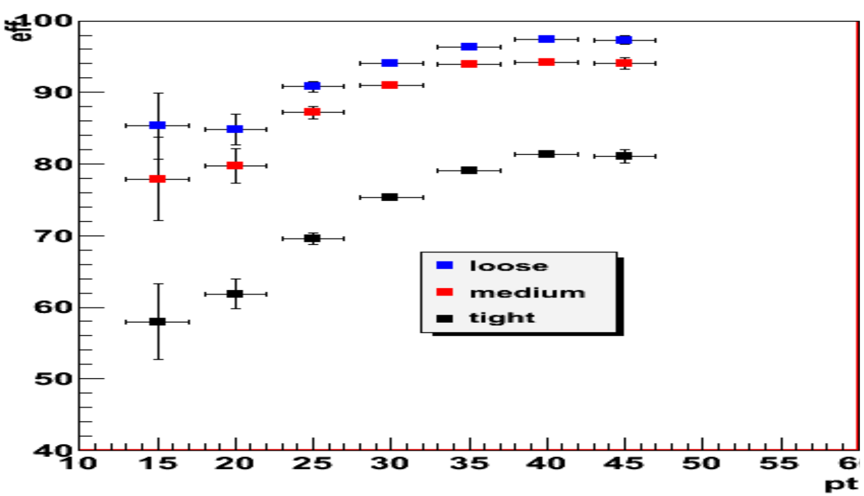
$$\varepsilon(e) = \frac{\texttt{N(probe electrons passed ID cuts)}}{\texttt{N(all probe electrons)}}$$

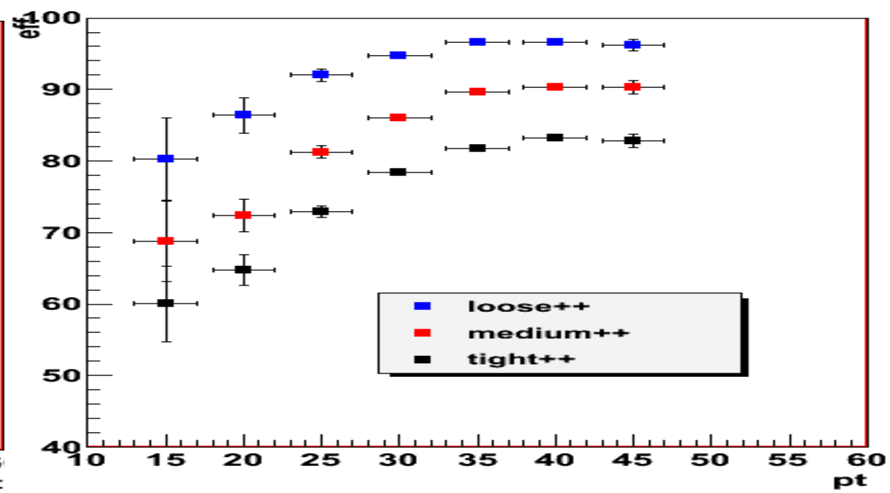
definition

Loose cuts		
Acceptance of the detector Hadronic leakage	$\|\eta\| < 2.47$ Ratio of E_T in the first sampling of the hadronic calorimeter to E_T of the EM cluster	
Second layer of EM calorimeter.	Ratio in η of cell energies in 3×7 versus 7×7 cells. Ratio in ϕ of cell energies in 3×3 versus 3×7 cells. Lateral width of the shower.	R_η R_ϕ
Medium cuts (includes loose cuts)		
First layer of EM calorimeter.	Difference between energy associated with the second largest energy deposit and energy associated with the minimal value between the first and second maxima. Second largest energy deposit normalised to the cluster energy. Total shower width. Shower width for three strips around maximum strip. Fraction of energy outside core of three central strips but within seven strips.	ΔE_s $R_{\max 2}$ w_{stot} w_{s3} F_{side}
Track quality	Number of hits in the pixel detector (at least one). Number of hits in the pixels and SCT (at least nine). Transverse impact parameter (<1 mm).	
Tight (isol) (includes medium cuts)		
Isolation	Ratio of transverse energy in a cone $\Delta R < 0.2$ to the total cluster transverse energy.	
Vertexing-layer	Number of hits in the vertexing-layer (at least one).	
Track matching	$\Delta\eta$ between the cluster and the track (< 0.005). $\Delta\phi$ between the cluster and the track (< 0.02). Ratio of the cluster energy to the track momentum.	E/p
TRT	Total number of hits in the TRT. Ratio of the number of high-threshold hits to the total number of hits in the TRT.	
Tight (TRT) (includes tight (isol) except for isolation)		
TRT	Same as TRT cuts above, but with tighter values corresponding to about 90% efficiency for isolated electrons.	

++menu

- **Loose++:** efficiencies close to Loose , rejection close to Medium
  - Shower Shapes: rEta, rHad, wEta2, Eratio, wstot
  - nPix+nPixOutliers >=1 and nSi+nSiOutliers >= 7
  - loose trk-cluster matching in eta (|deltaeta| < 0.015)
- **Medium++:** efficiencies lower than of Medium, rejection close to Tight
  - tighter delta-eta track-cluster matching (|deltaeta|<0.005)
  - stricter bLayer and Pixel hit requirements, (bL + bLOutlier > 0 for |eta| < 2.01 and nPix+nPixOutliers > 0; nPix + nPixOutliers > 1 for |eta| > 2.01),
  - loose TRT HT Fraction cuts
  - tighter shower shapes for |eta| > 2.01
- **Tight++:** slightly better efficiency and rejection
  - No substantial gains were made in Tight++ over Tight



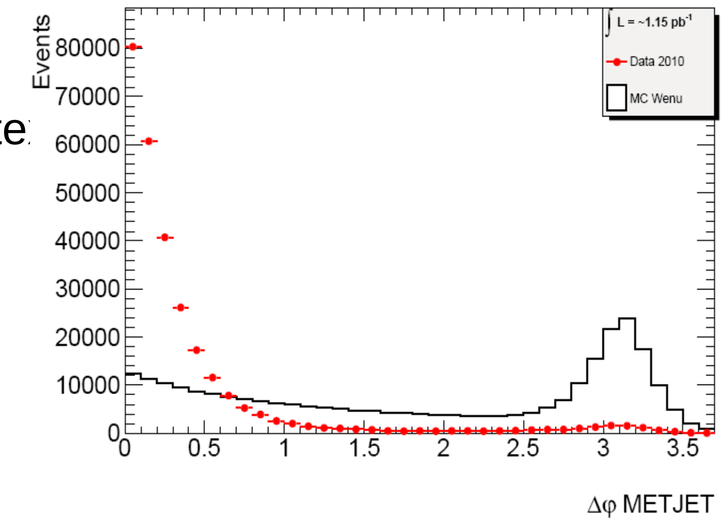


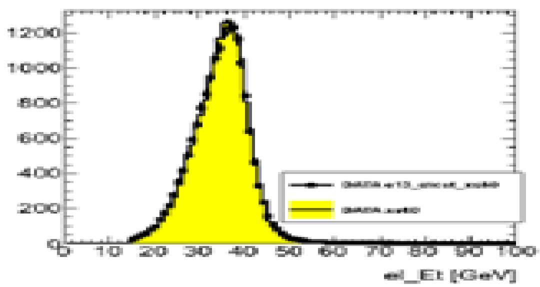
selection

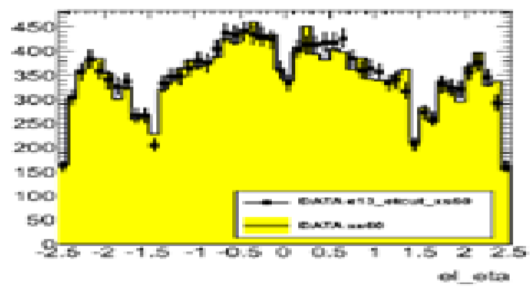
- DATA Period 2011, MC11
- Preselection

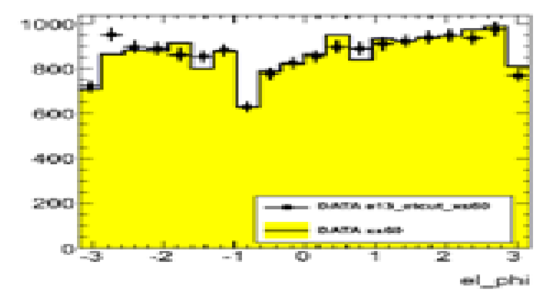
  GRL,MET trigger, MET clean, OTX ,primary verte
  electron Et>15GeV, |eta|<2.47
  MET_Lochad_Topo_Et>30GeV
- MET isolation cut:

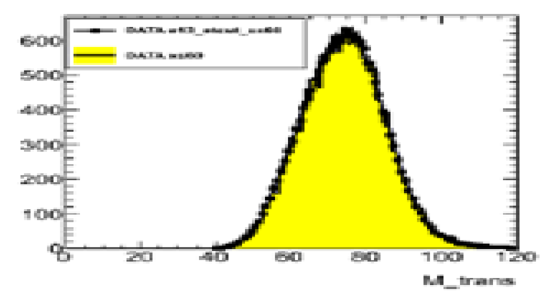
  $$Min(|\phi(j)-\phi(Etmiss)|) > 2.0$$
- W mass>50GeV

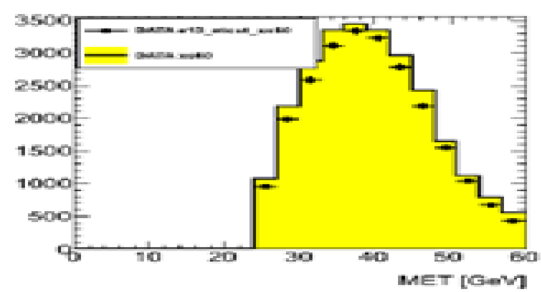












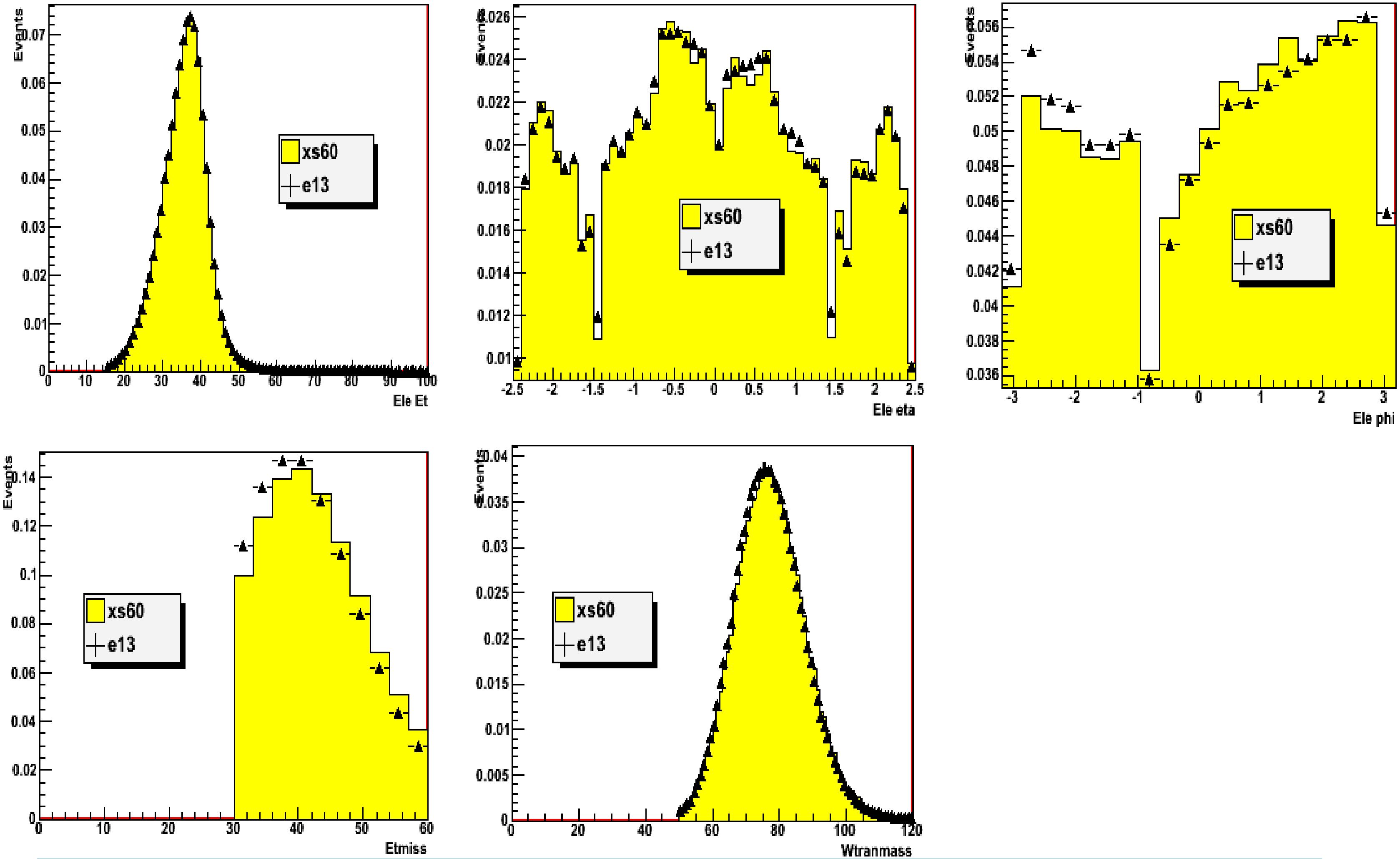
Efficiency dependence on trigger

Trigger	Period D	Period E	Period F	Period G	Period H
EF_xs60_noMu_L1EM10XS45	209×10^3	61×10^3	119×10^3	31×10^3	--
EF_xs75_noMu_L1EM10XS50	112×10^3	28×10^3	--	--	--
EF_g20_etcut_xe30_noMu	33×10^3	1×10^3	2×10^3	3×10^3	1×10^3
EF_e13_etcut_xs60_noMu	--		--	444×10^3	205×10^3
EF_e13_etcut_xs60_noMu_dphi2j10xe07	--	--	--	--	--

Trigger	Period I	Period J	Period K
EF_xs60_noMu_L1EM10XS45	--	--	--
EF_xs75_noMu_L1EM10XS50	--	--	--
EF_g20_etcut_xe30_noMu	1×10^3	0.5×10^3	1×10^3
EF_e13_etcut_xs60_noMu	93×10^3	30×10^3	75×10^3
EF_e13_etcut_xs60_noMu_dphi2j10xe07	268×10^3	138×10^3	329×10^3

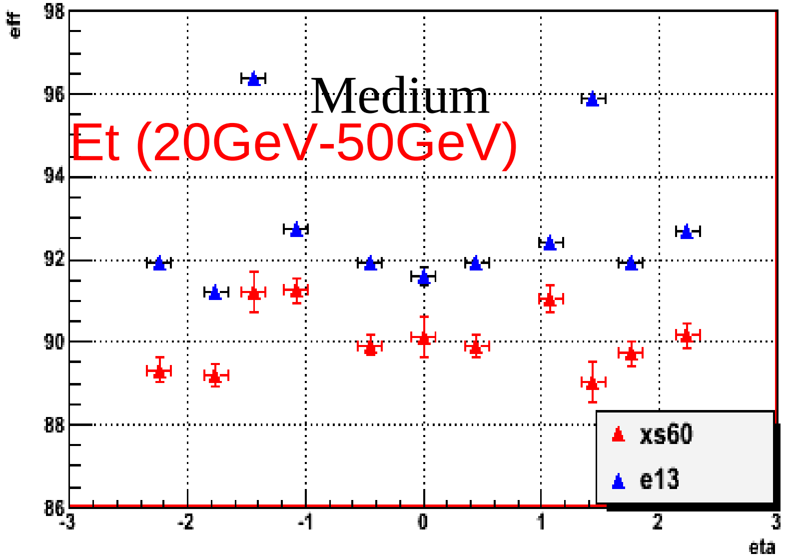
- Compare two triggers in the same period
  - EF_xs60_noMu_L1EM10XS45 and EF_xs75_noMu_L1EM10XS50 in periods D
  - EF_xs60_noMu_L1EM10XS45 and EF_e13_etcut_xs60_noMu in period E-H
  - EF_e13_etcut_xs60_noMu and EF_e13_etcut_xs60_noMu_dphi2j10xe07 in periods I+J+K

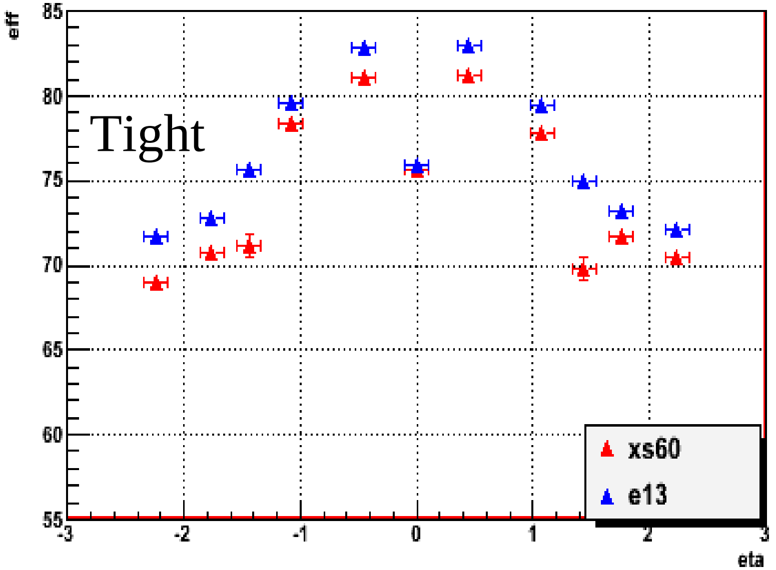
xs60 vs e13_etcut kinematics

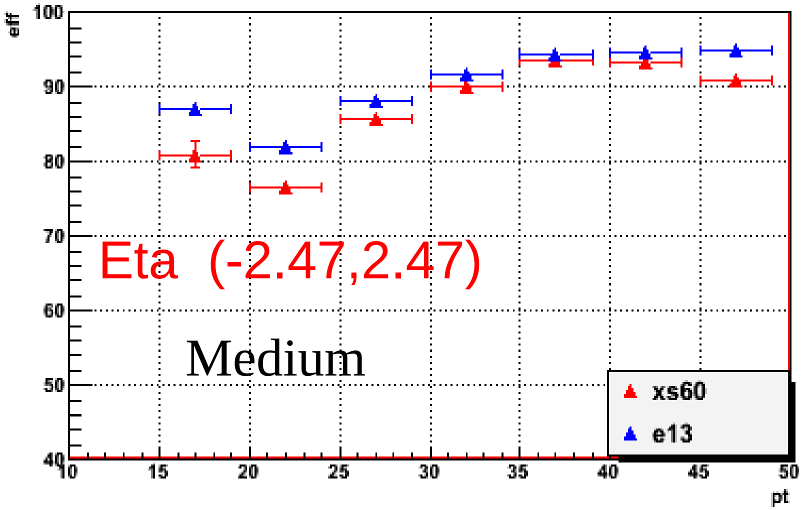


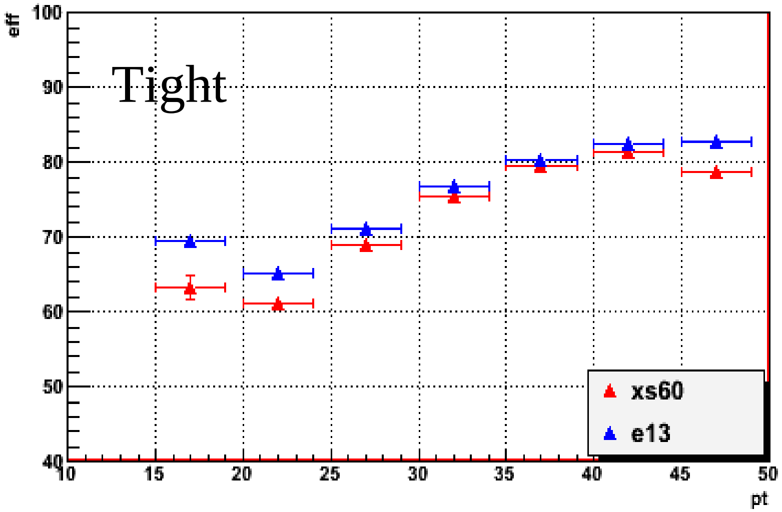
- Good agreement in Et and W transverse mass
- Different in Etmiss and eta , phi

DATA1D Efficiency xs60 vs e13_etcut



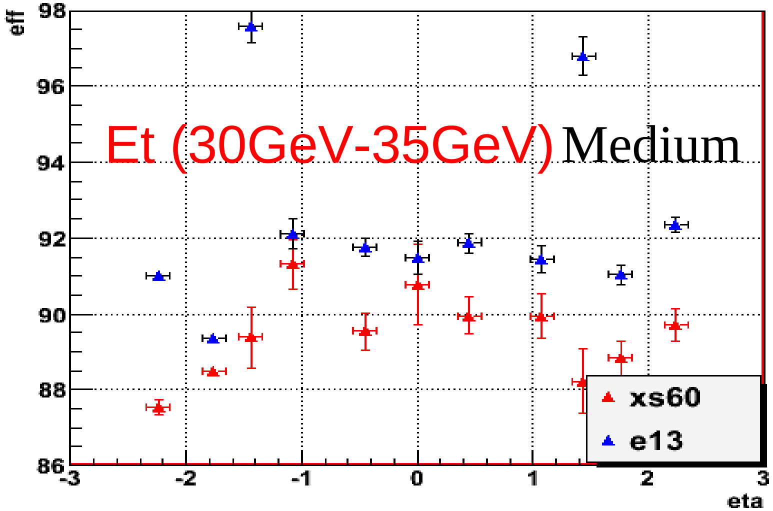


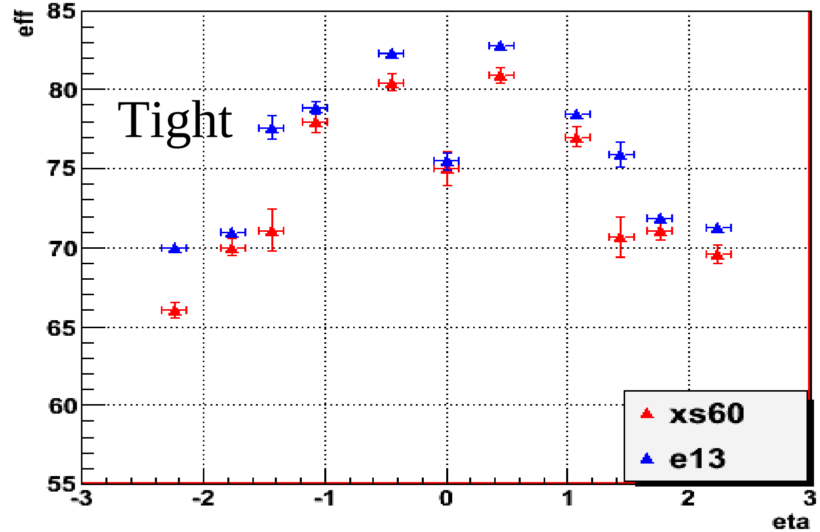


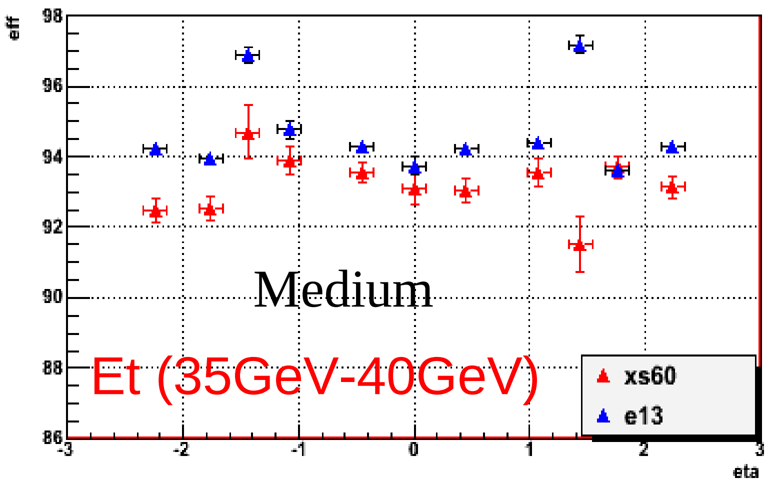


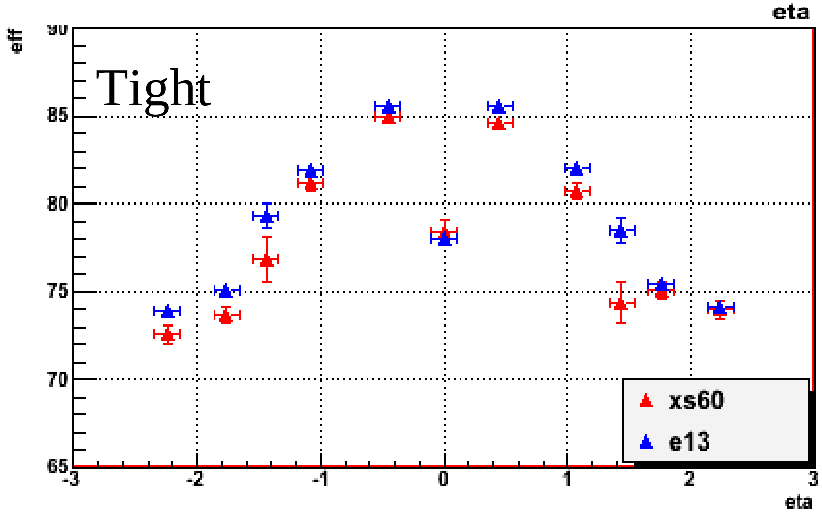
- 2% difference for whole Et region

DATA 2D Efficiency xs60 vs e13_etcut



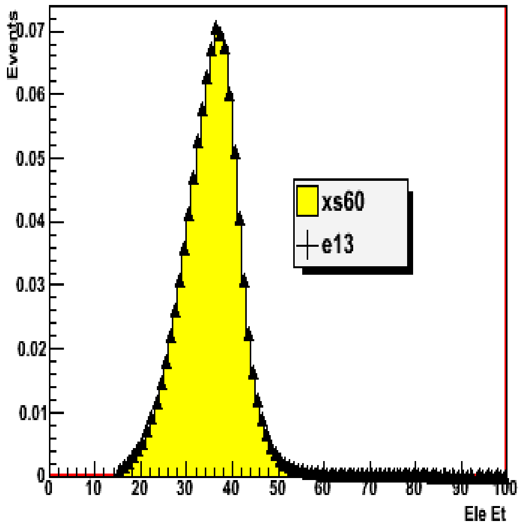


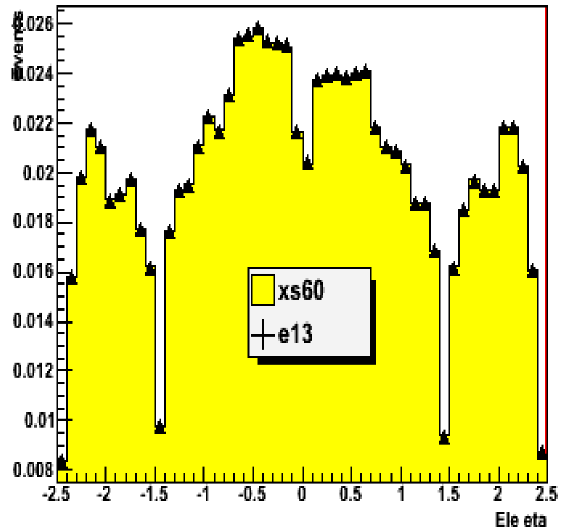


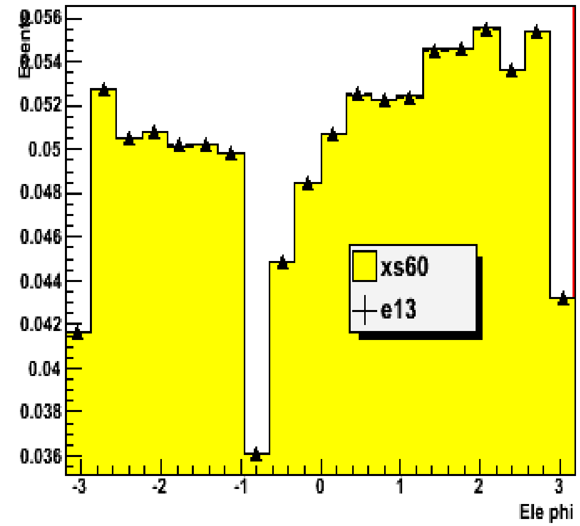


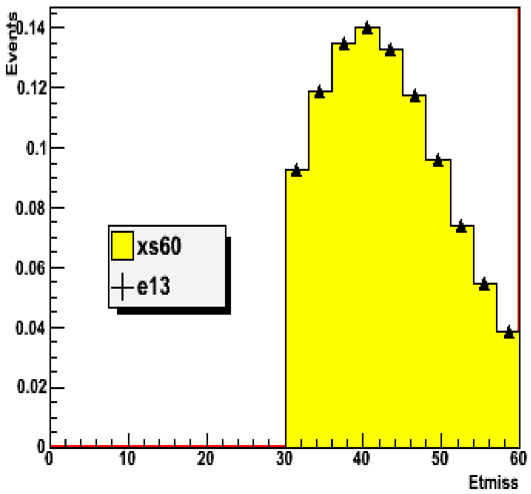
- More different for 30-35GeV than 35-40GeV

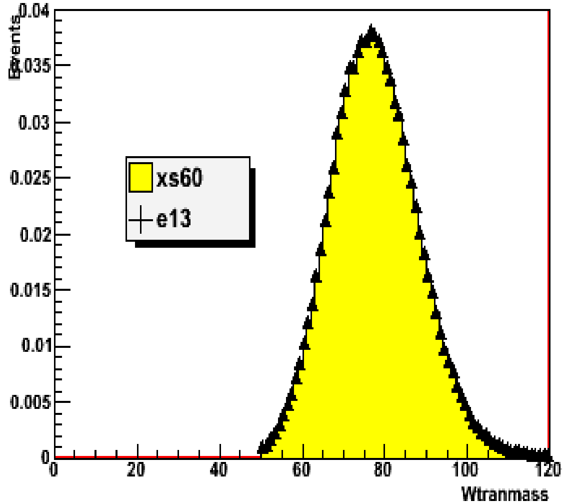
xs60 vs e13_etcut kinematics in MC11





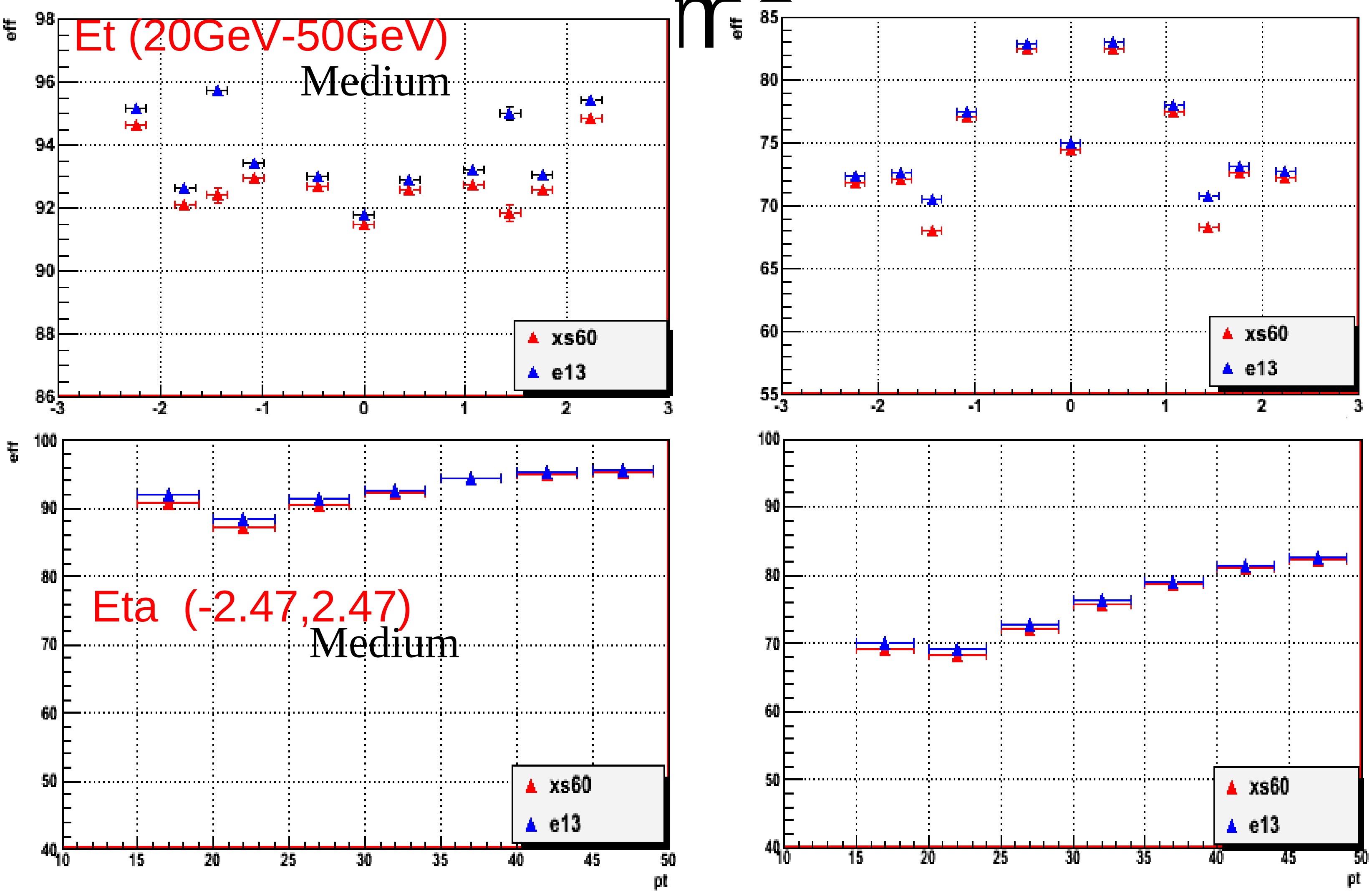






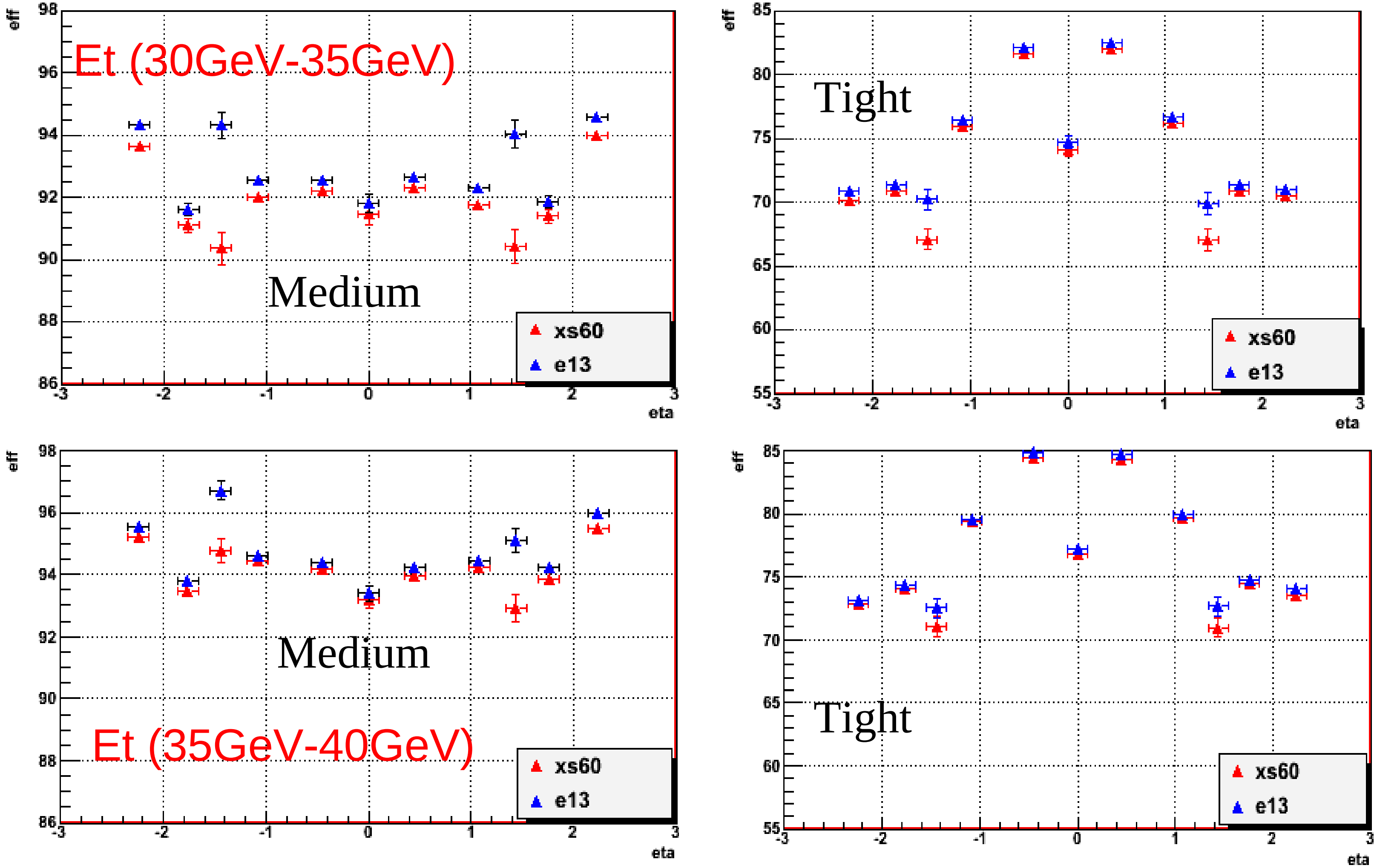
- Good agreement for all performance

MC11 1D Efficiency xs60 vs e13_etcut me



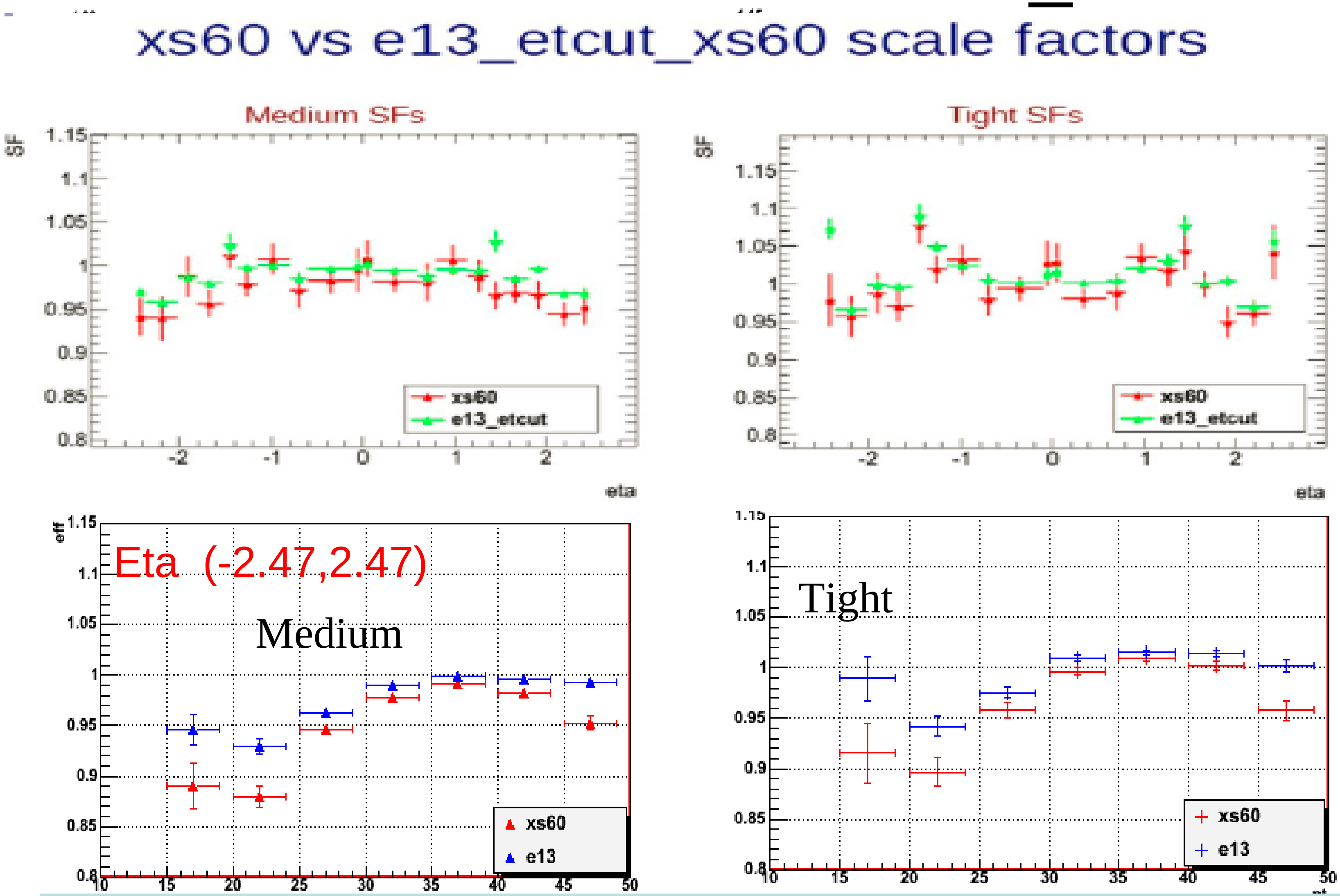
- 0.5% difference for whole Et region

MC11 2D Efficiency xs60 vs e13_etcut



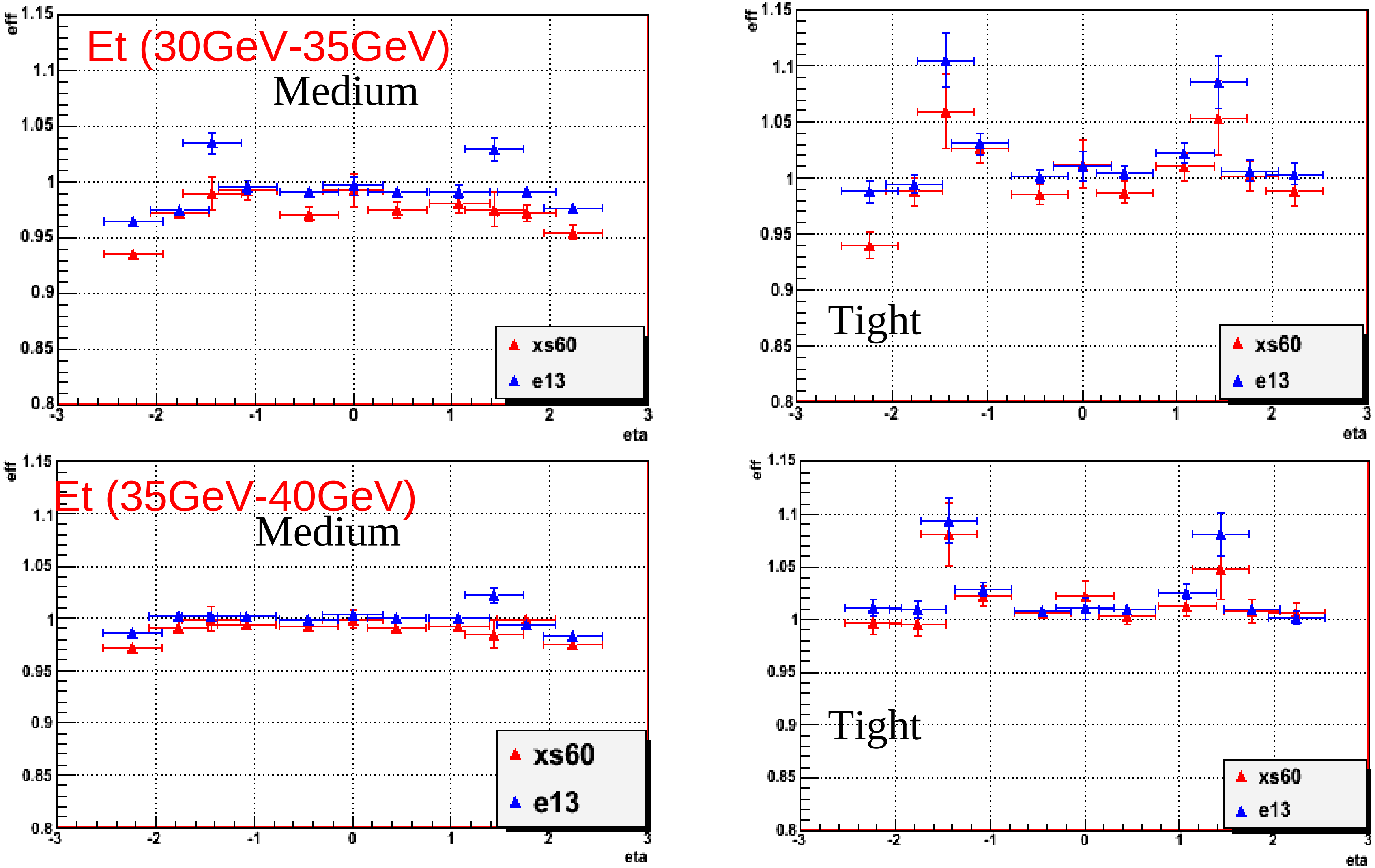
- little different both in (30-35)GeV and (35-40)GeV

1D Scale F xs60 vs e13_etcut



- 2% difference in whole Et region
- Lower for xs60 in whole Eta region

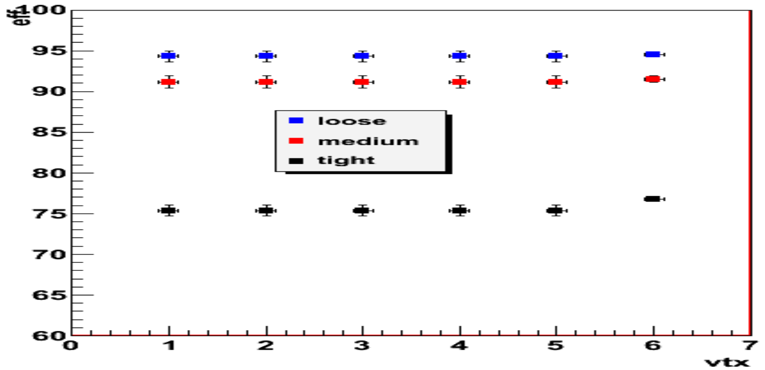
2D Scale F xs60 vs e13_etcut



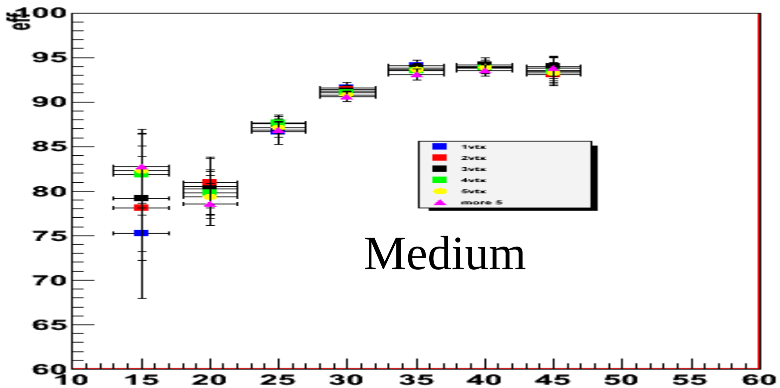
- 1% difference for Et (35-40) GeV
- 2% difference in Et(30-35)GeV

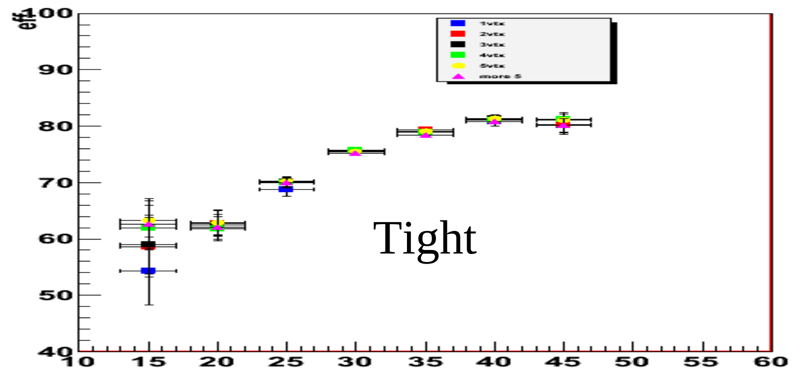
Efficiency dependence on vtx

- Measure the efficiency in vtx =1,2,3,4,5, >=5

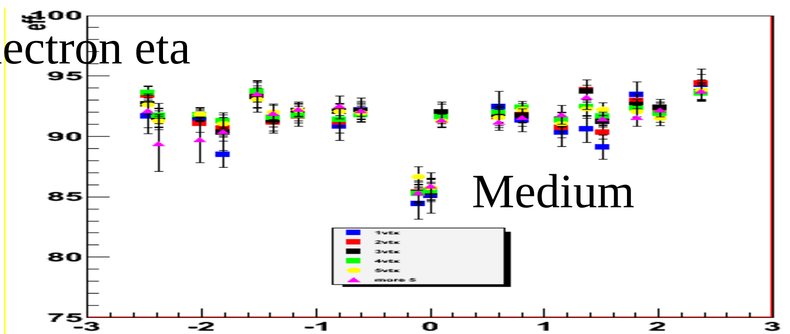


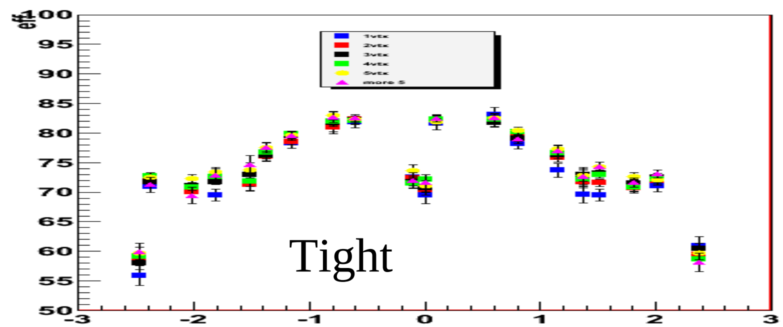
Electron Et





Electron eta

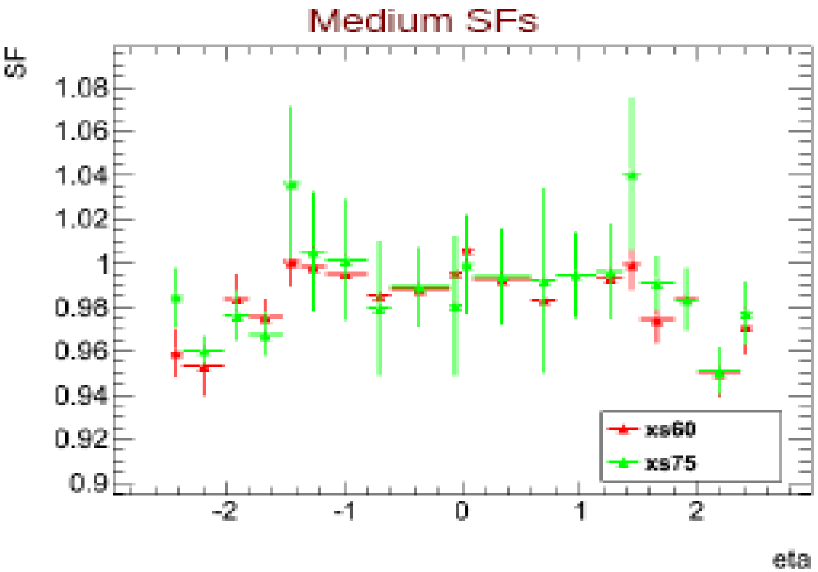


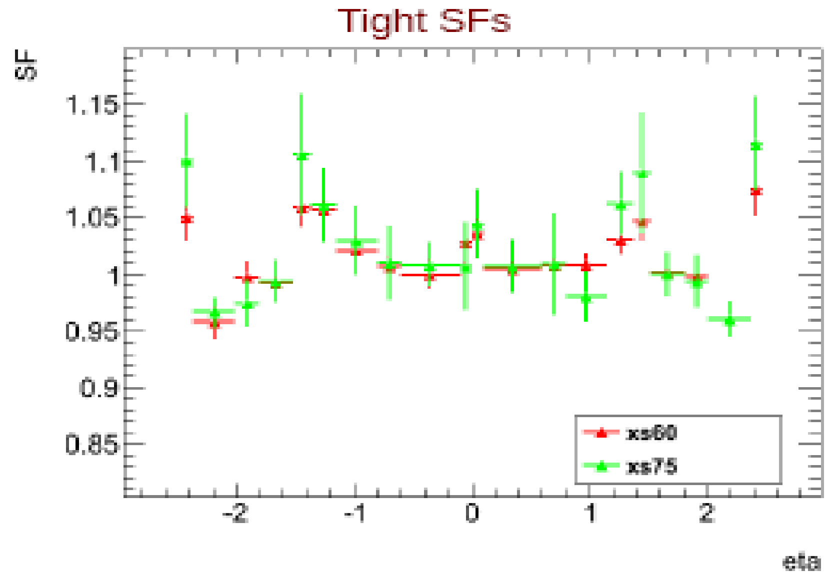


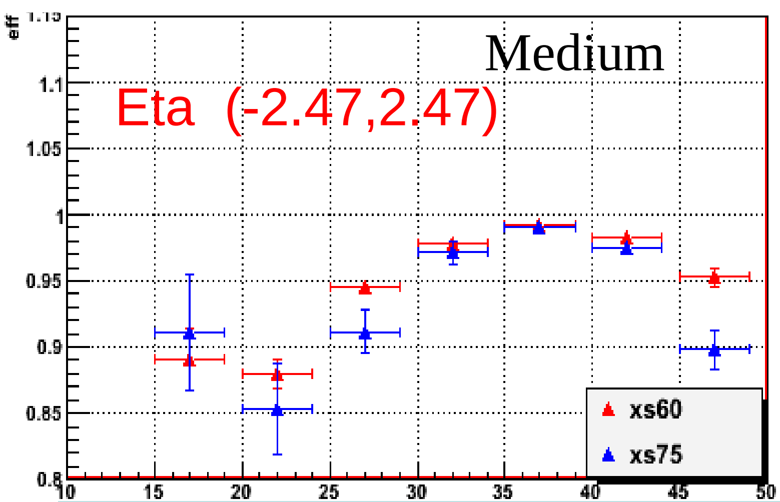
Conclusion

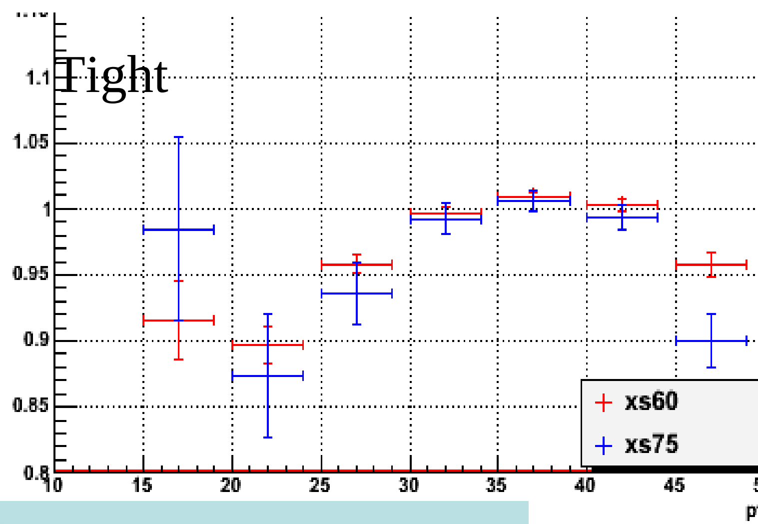
- ID efficiencies
  - Loose++ efficiencies close to Loose
  - Medium++ efficiencies lower than of Medium
  - Tight++ slightly better efficiencies
- ID efficiencies vs trigger
  - **smaller** difference in **high Et** region compare to low Et region
  - efficiency and Scale factors for xs60 is slightly different with e13_etcut
  - efficiency and Scale factors for e13_etcut and e13_etcut_dphi are almost the same
- ID efficiencies vs vtx
  - difference in vtx number are not obviously

1D Scale F: xs60 vs xs75



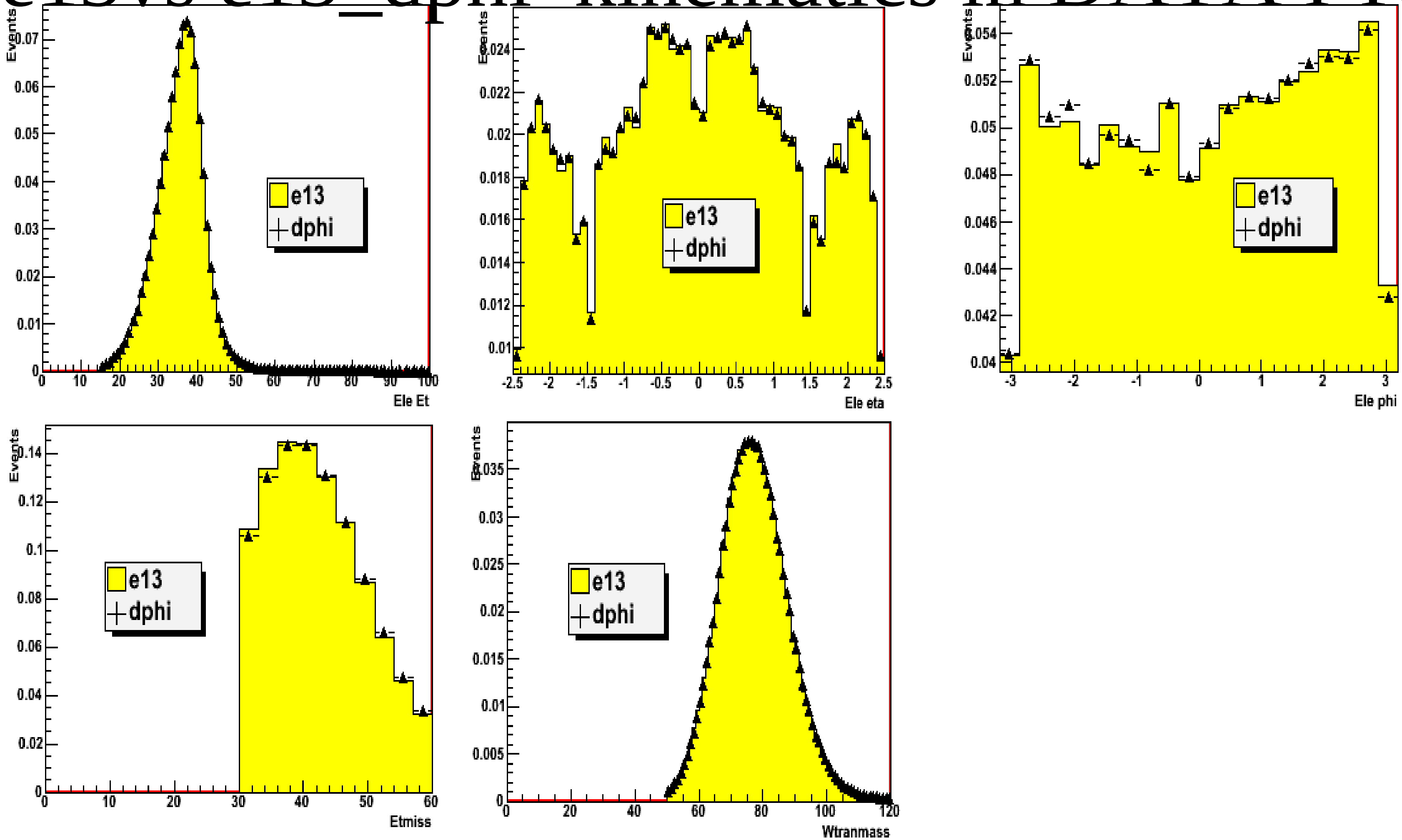






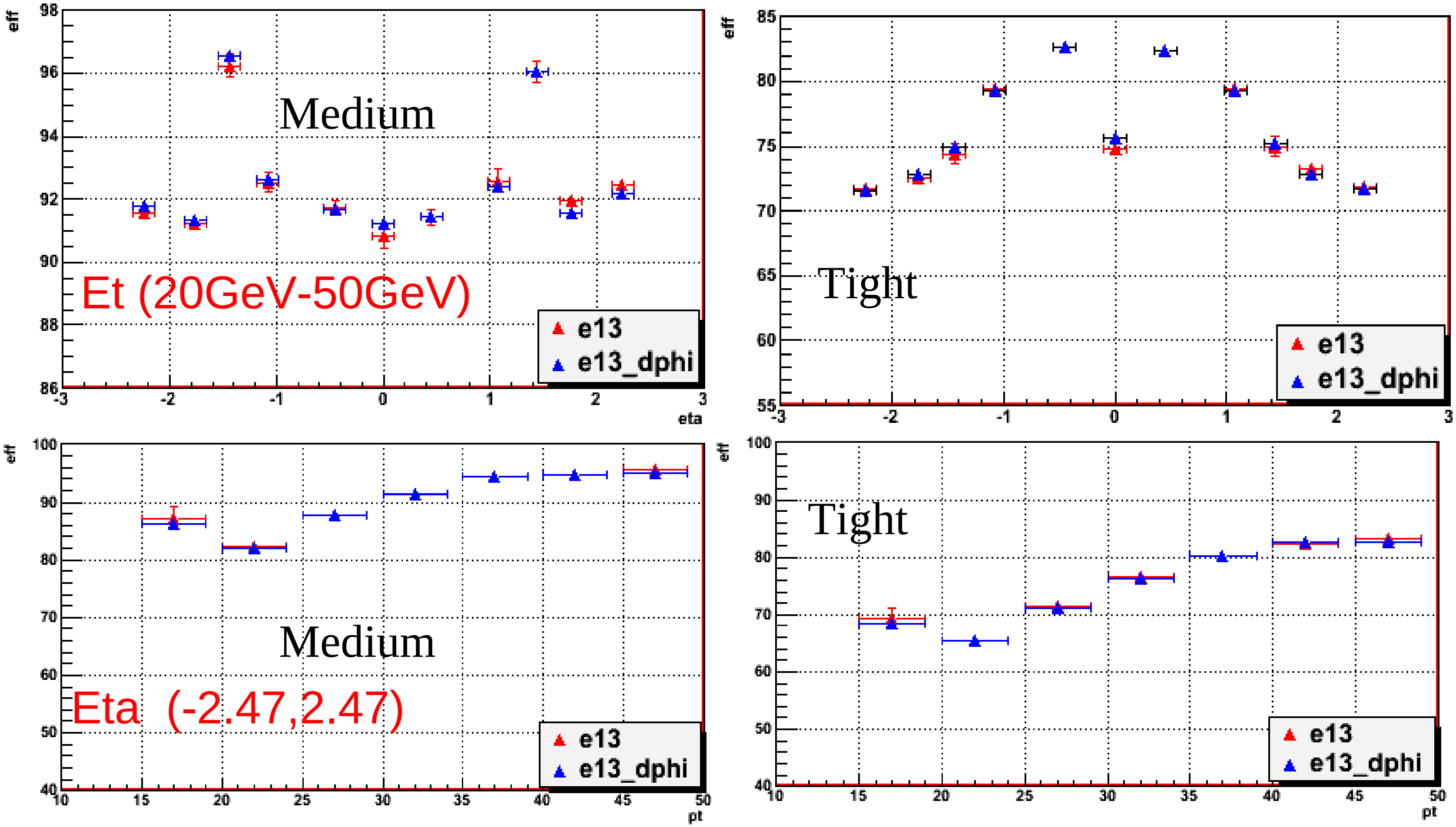
- Scale F agree in whole Et region
- More different in low Et region

e13vs e13_dphi kinematics in DATA I-K

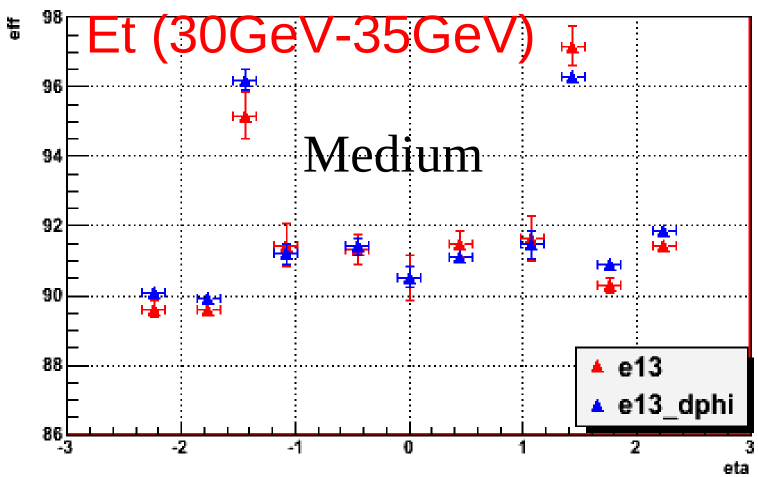


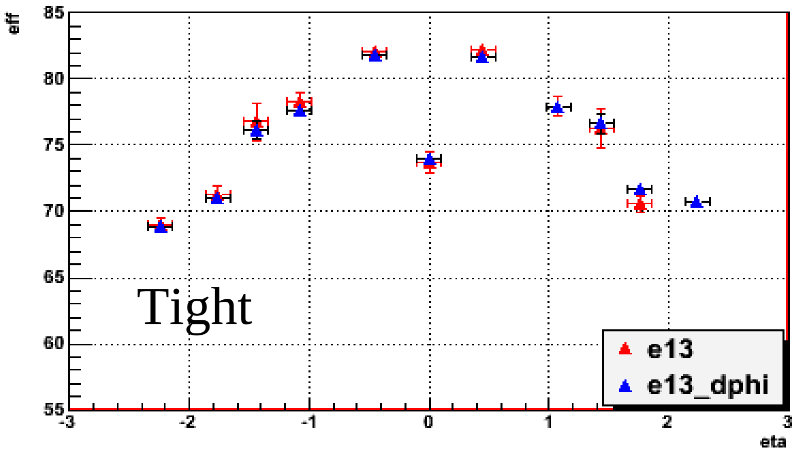
- Good agreement in performance

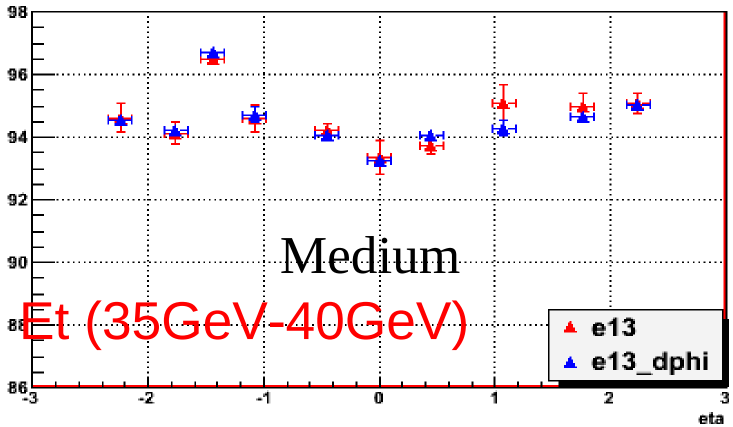
DATA1D efficiency e13vs e13_dphi

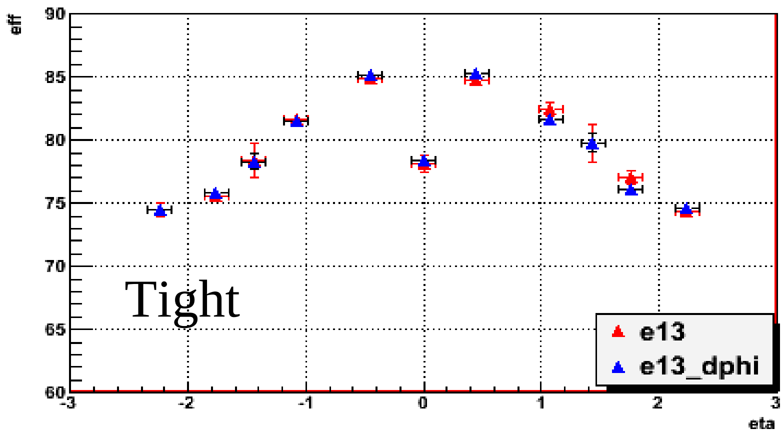


DATA2D efficiency e13vs e13_dphi

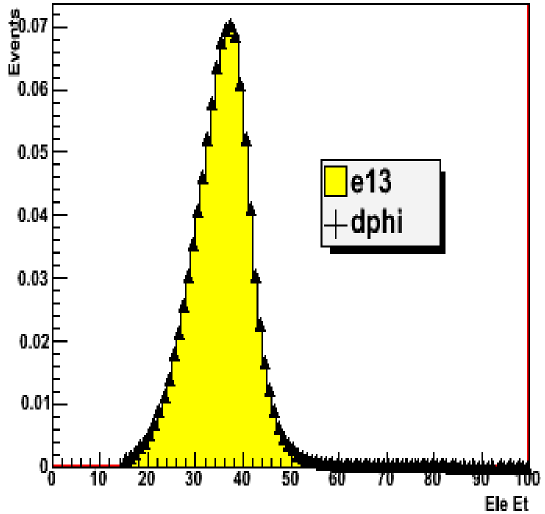


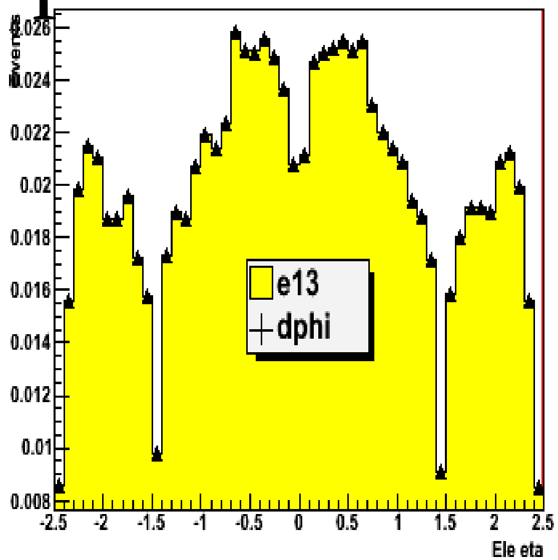


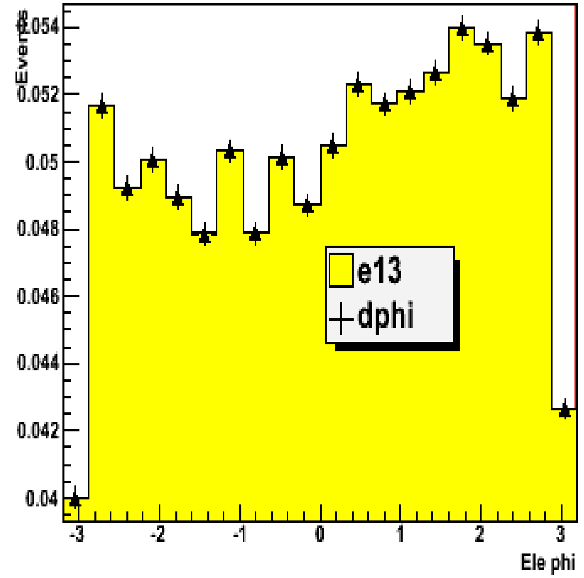


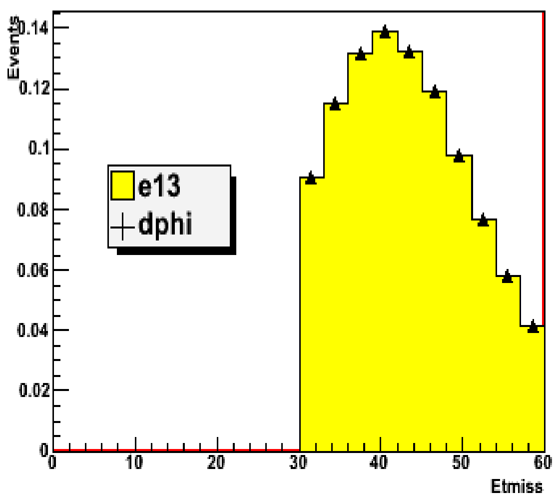


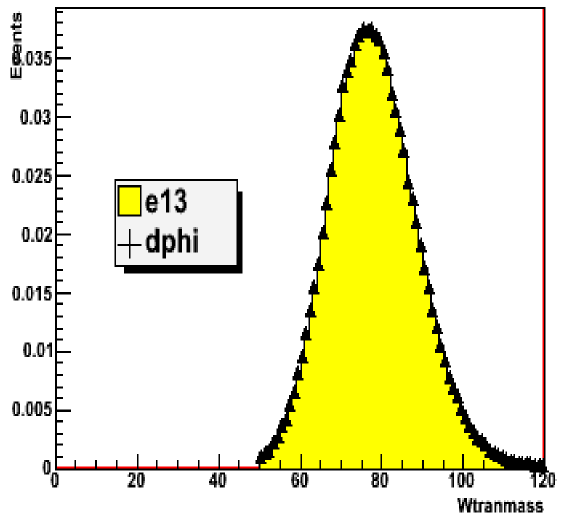
e13vs e13_dphi kinematics in MC11







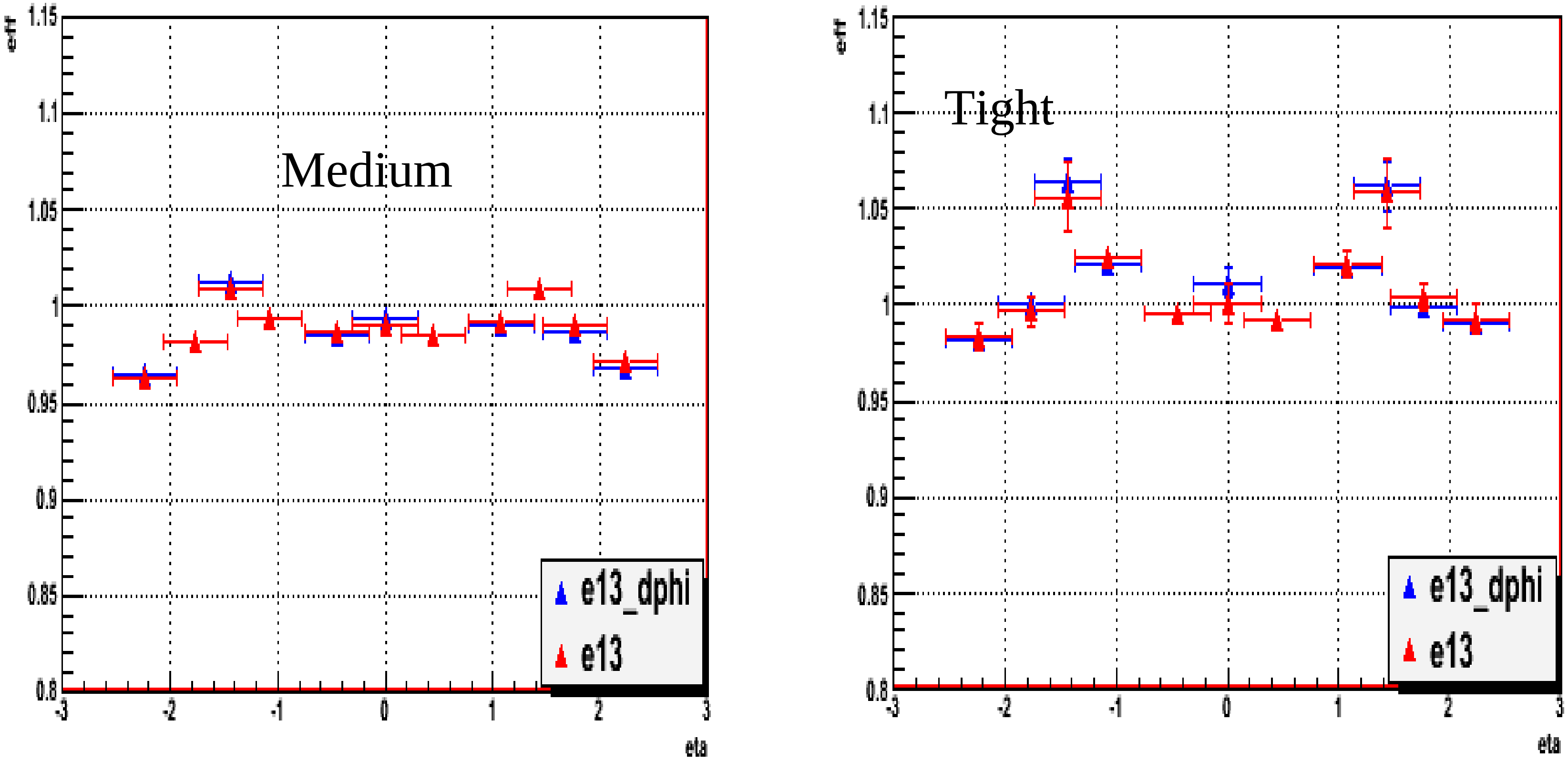




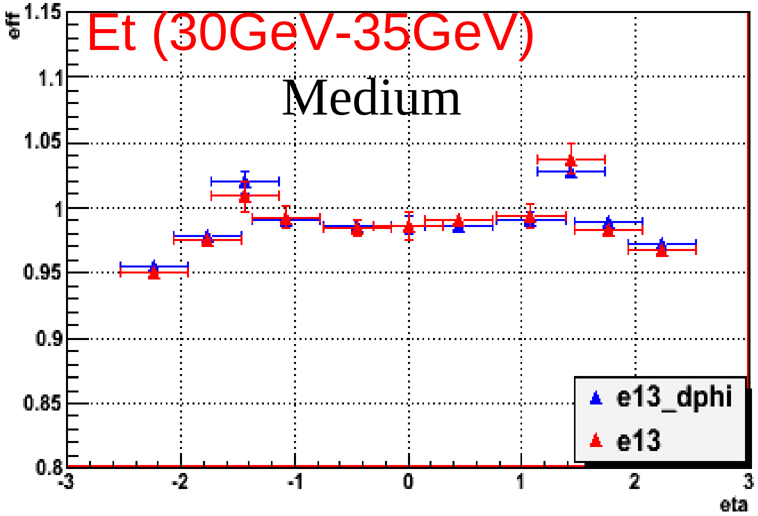
- No difference in performance

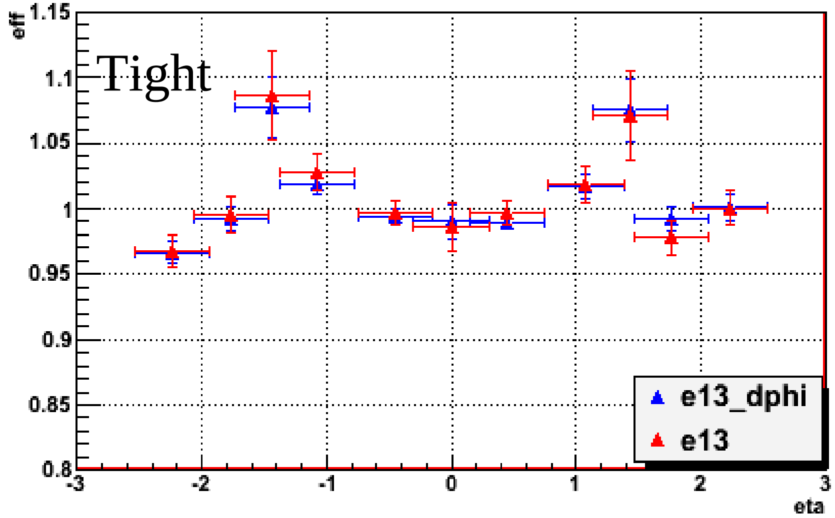
DATA1D Scale F for e13vs e13_dphi

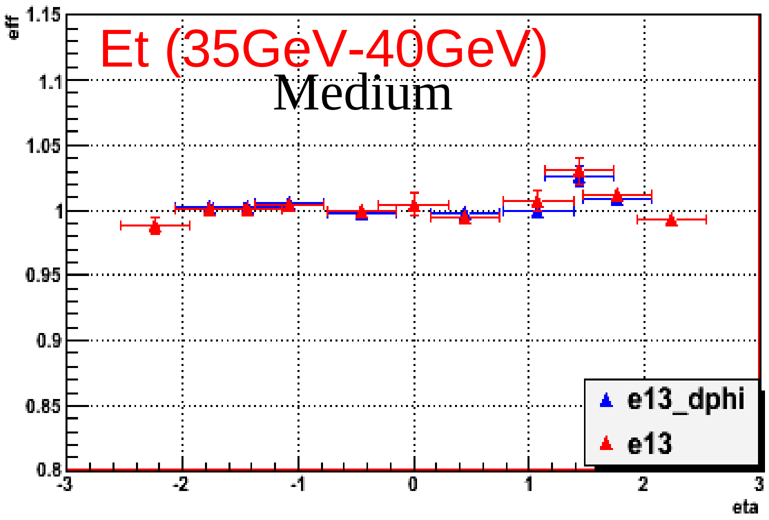
Et (20GeV-50GeV)

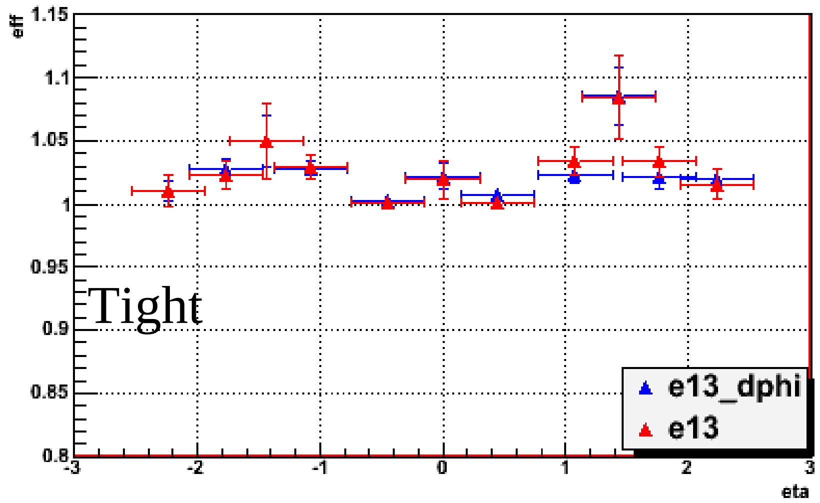


DATA 2D Scale factor e13vs e13_dphi



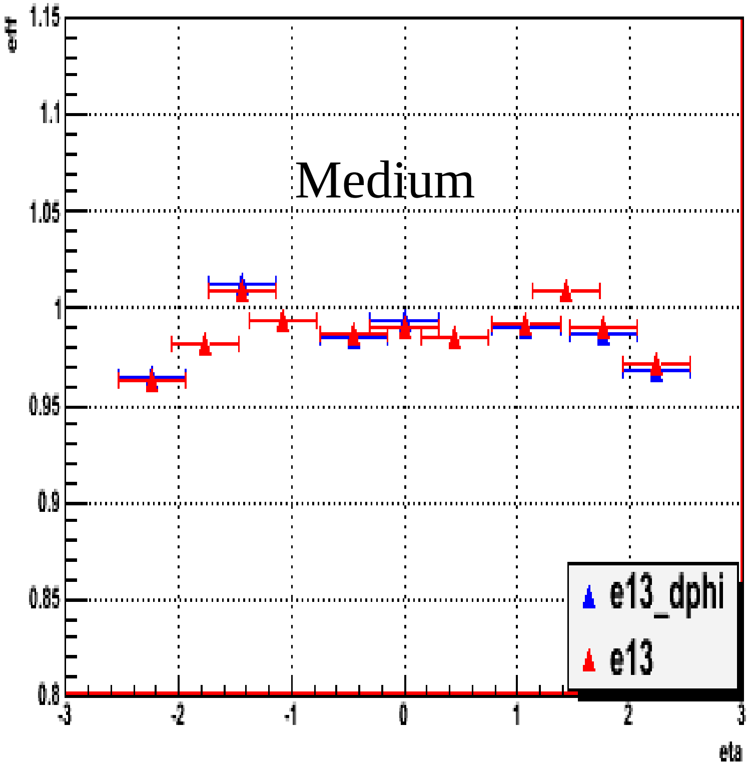


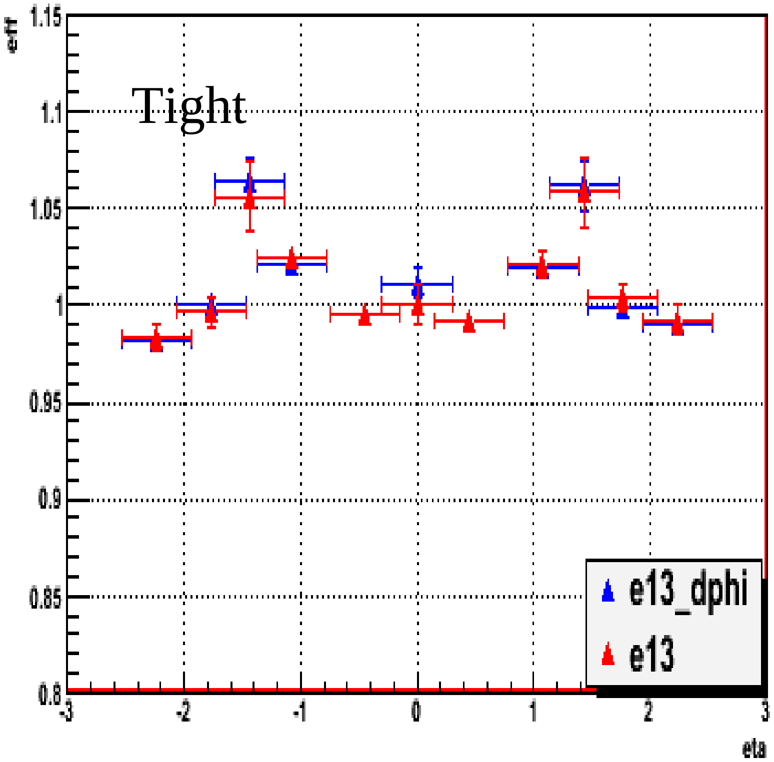




DATA1D Scale F for e13vs e13_dphi

Et (20GeV-50GeV)





Ele pt , eta distribution vs vtx