Update for QCD Background Estimation (W'->enu Search)

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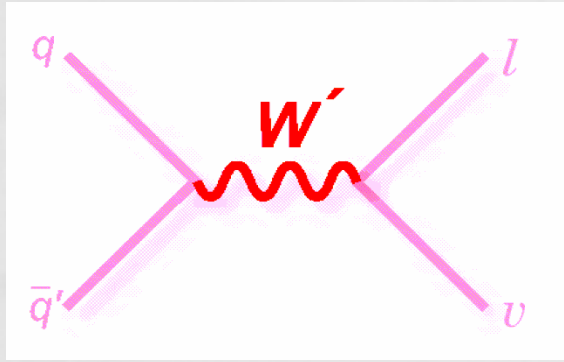
Introduction

W' Production & Decay

- **W' can be produced in proton-proton collisions through qq' annihilation**
- **Following reference model [Altarelli] assume W' as a carbon copy of Standard Model Wboson with suppression of W'→WZ decays**



Decay channels :

- A lepton–neutrino pair ($M_{\nu R} < M_{W'}$)

  $W' \rightarrow l\nu$ ($l = e, \mu, \tau$)
- A quark pair

  Light quarks: two jets

  A top and bottom pair

Contents

- Trigger Study (L1 & HLT)
  - HLT_Ele15_LW_L1R,
  - HLT_LooseIsoEle15_LW_L1R,
  - HLT_Photon15_L1R,
  - HLT_Photon25_L1R,
  - HLT_EM80,
  - HLT_EM200
- Electron ID and Isolation (updated with HEEP ID v2.0pre1)
- QCD Background Estimate (Matrix Method)

CMSSW_2_1_X : $\sqrt{s} = 10\,TeV,\ B = 3.8T$

Summer08 MC Samples

- W' ->enu Signal : (~ 100,000 events for each mass)

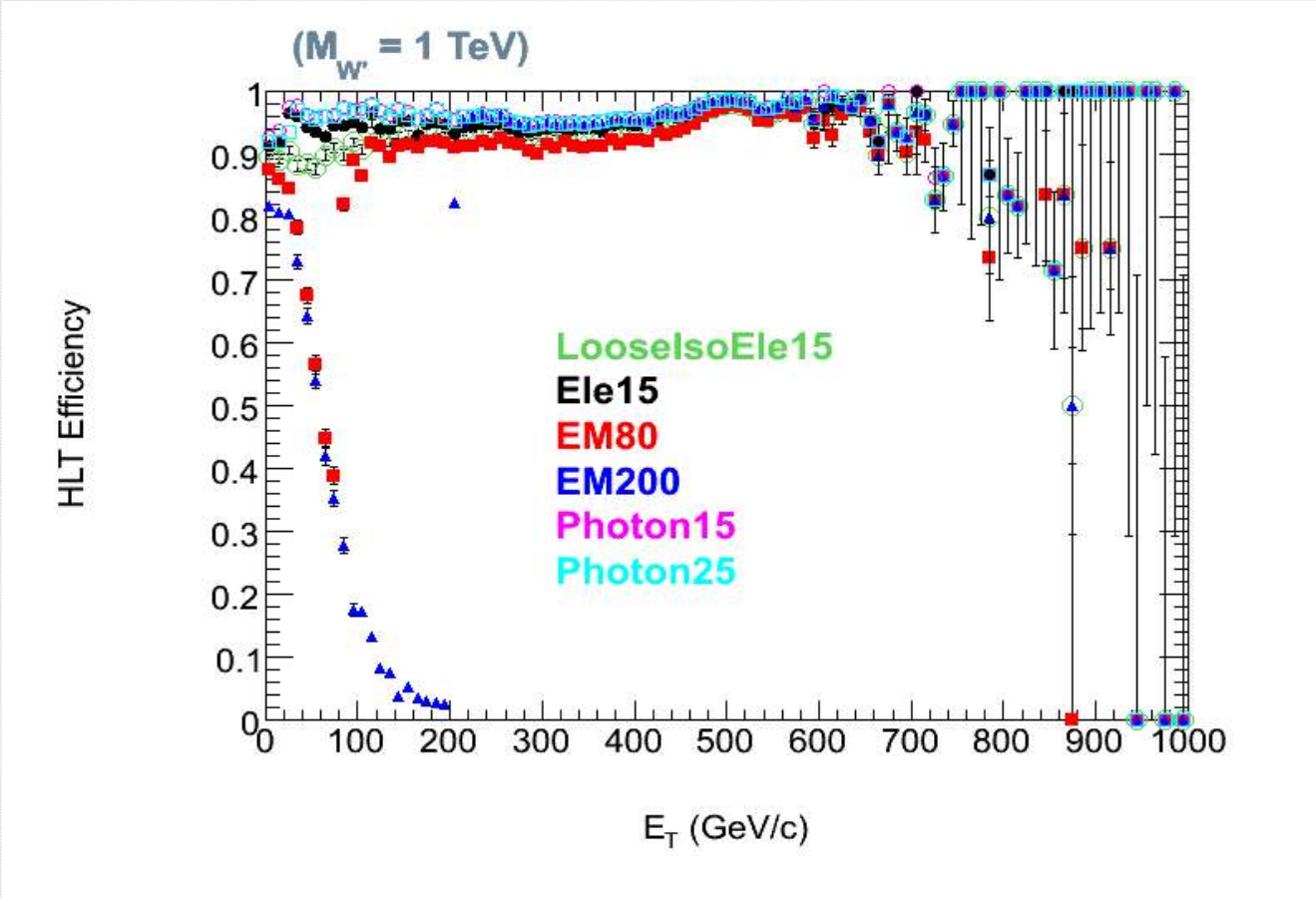
  /Exotica_WPrimeENuM1000/Summer08_IDEAL_V9_v1/GEN-SIM-RECO
  /Exotica_WPrimeENuM1500/Summer08_IDEAL_V9_v1/GEN-SIM-RECO
  /Exotica_WPrimeENuM2000/Summer08_IDEAL_V9_v1/GEN-SIM-RECO

- QCD Dijet Background : (~ 1,000,000 events in total)

  (Pt-hat range : 0 - 3500 (Inf) GeV)
  /QCDDiJetPtXtoY/Summer08_IDEAL_V9_v1/GEN-SIM-RECO

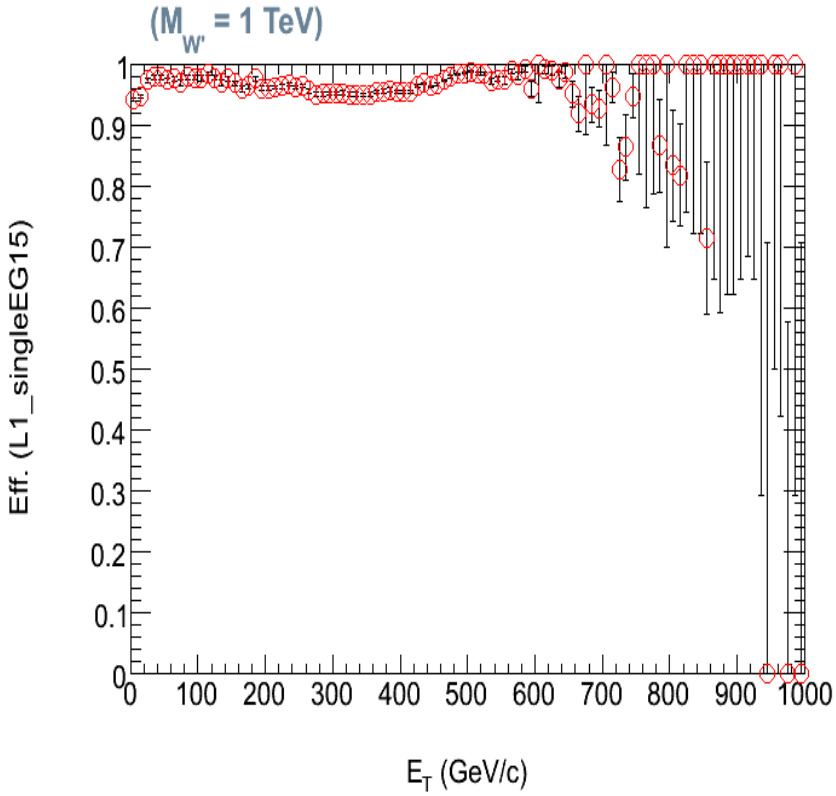
HLT eff.

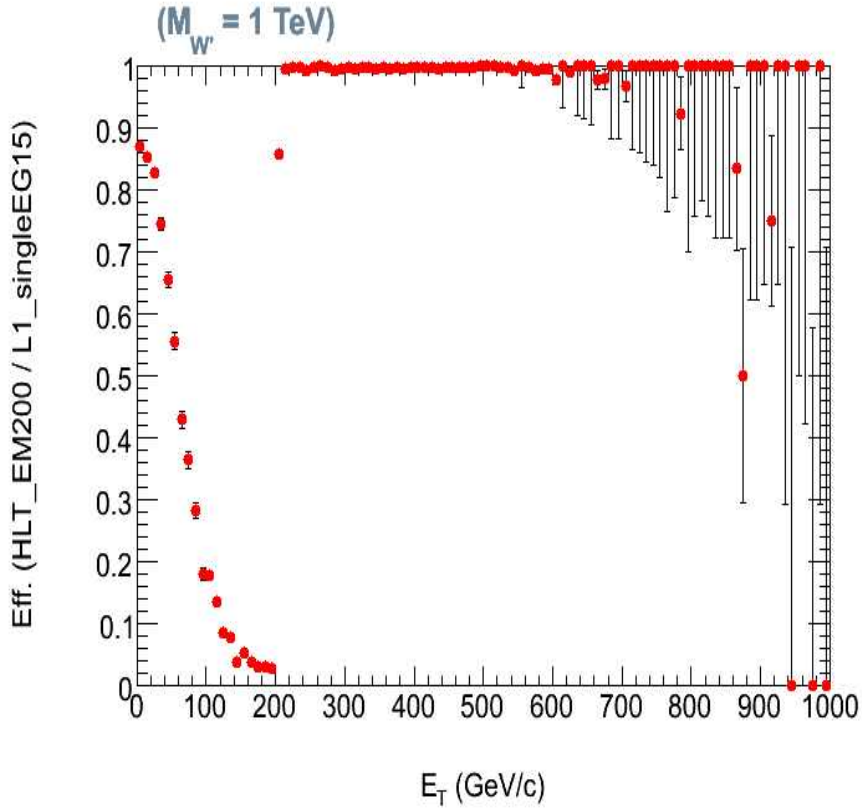
For all the electron candidates



Eff checking for “L1”, “HLT”

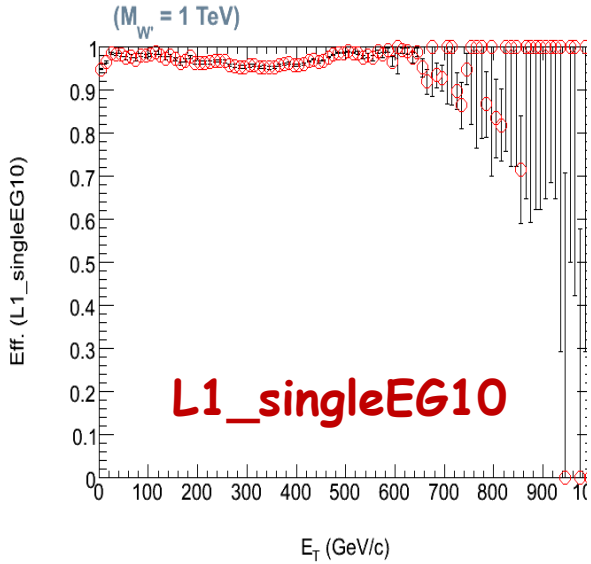
For all the electron candidates

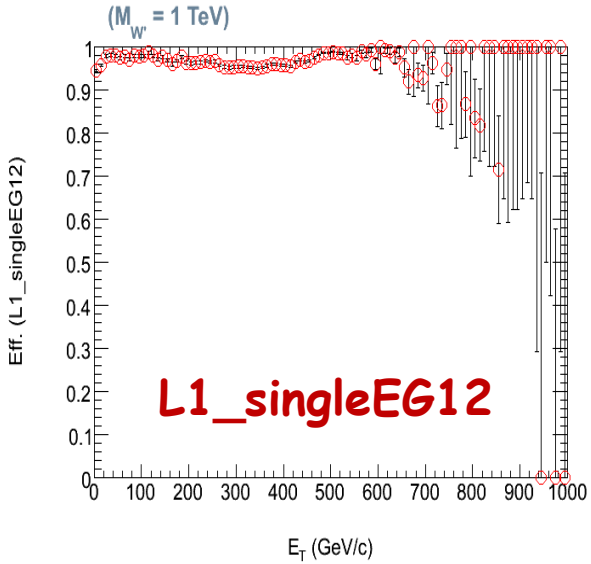


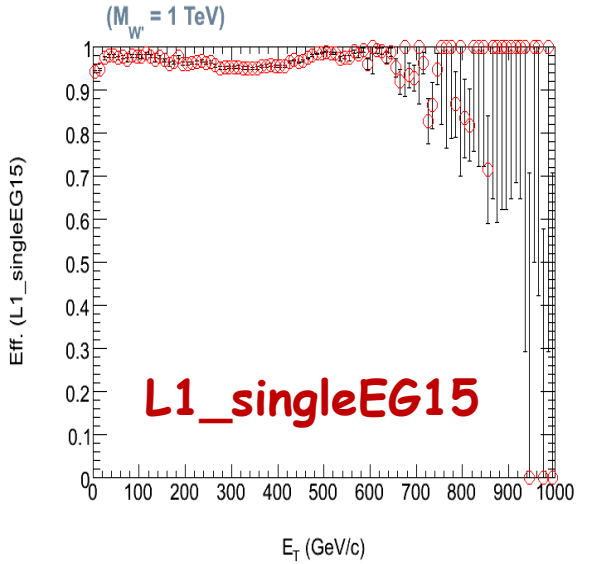


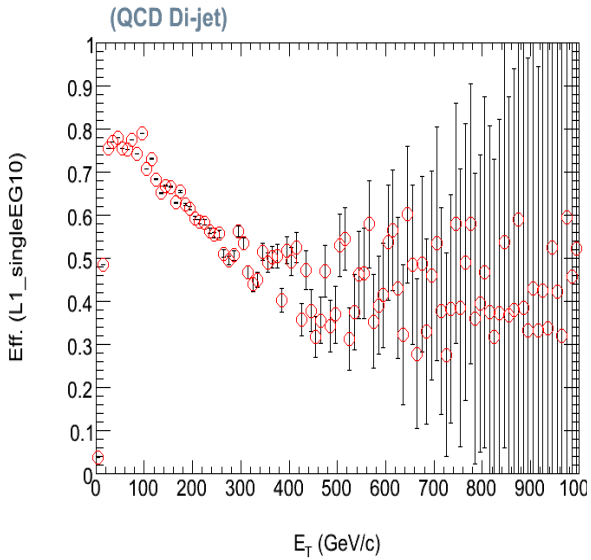
Eff. For "L1"

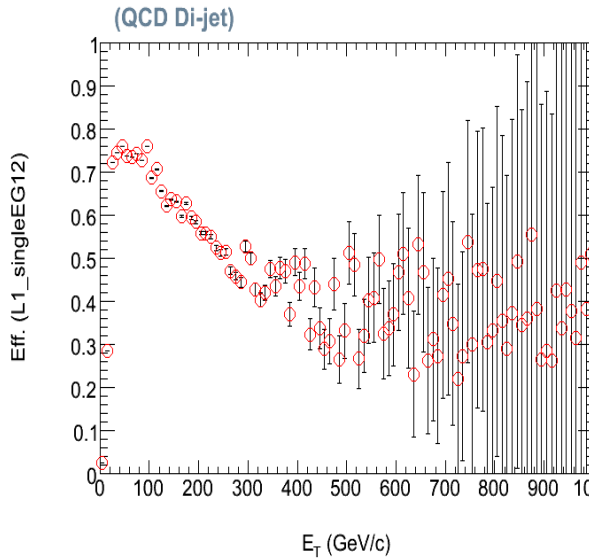
(W' = 1 TeV & QCD Di-jet)

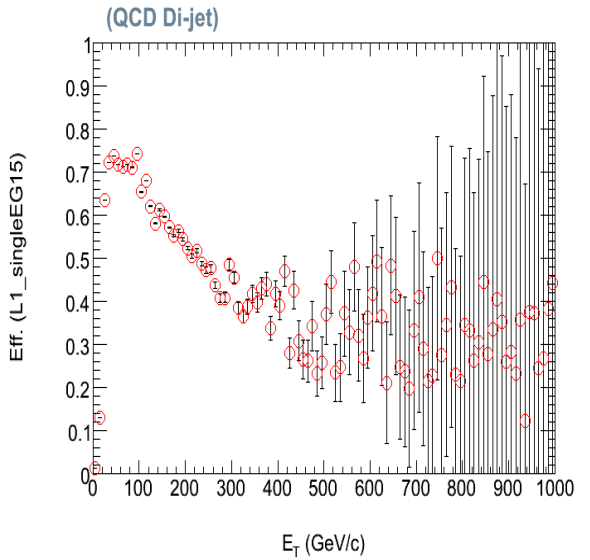




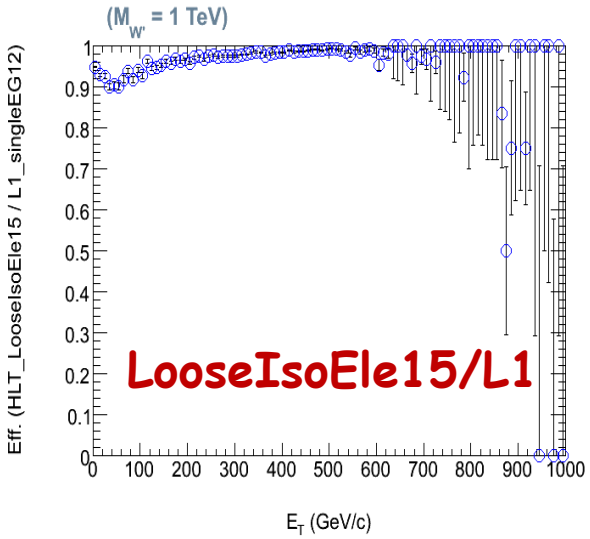


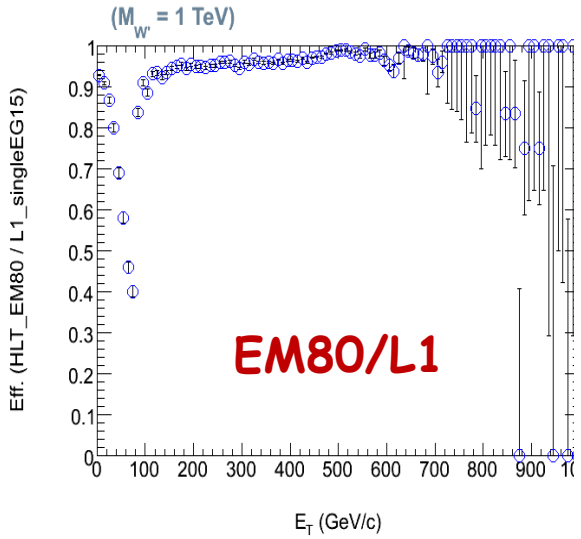


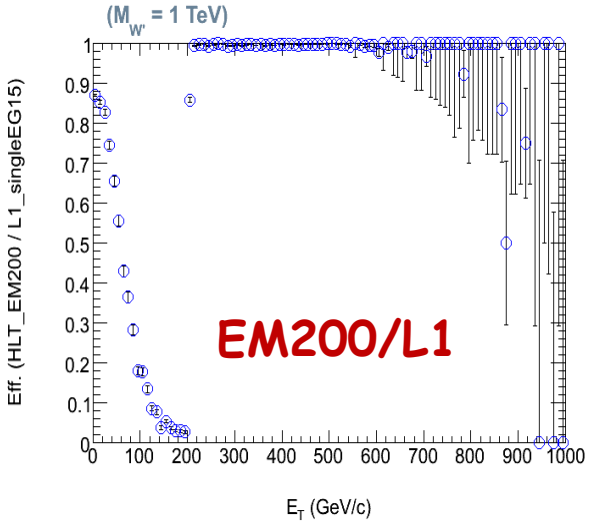


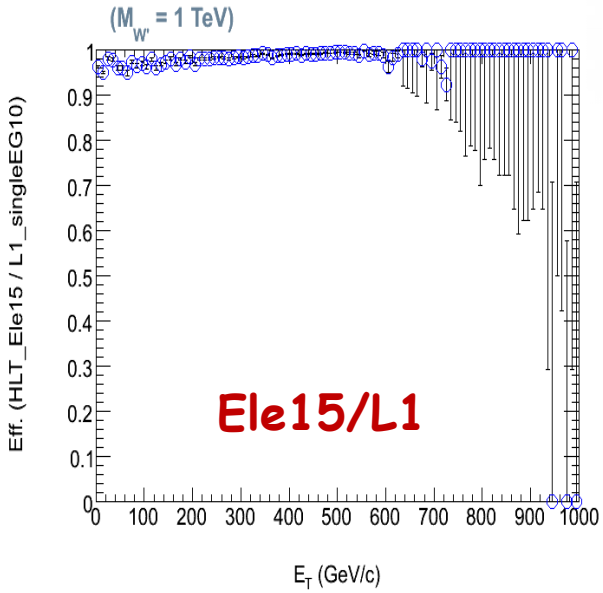


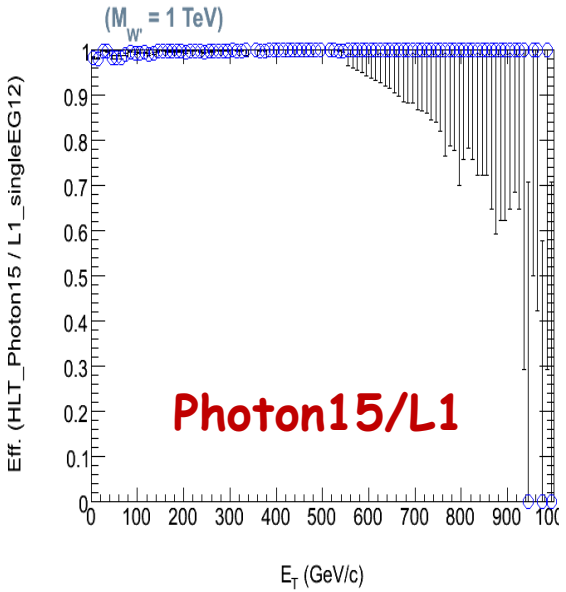
Eff. For "HLT/L1" (W' = 1 TeV)

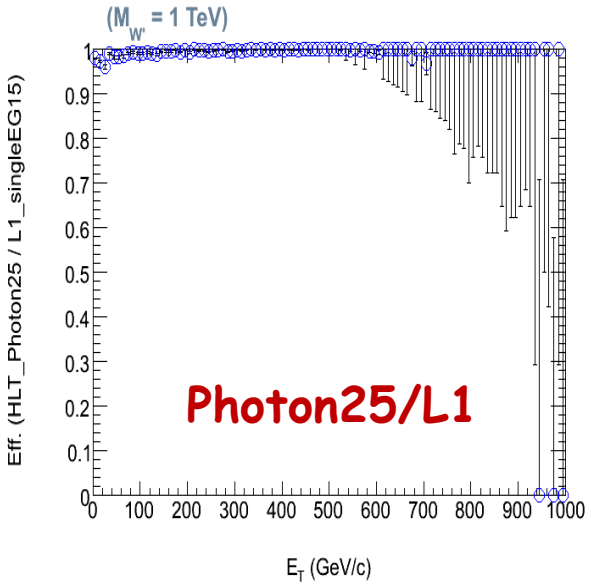




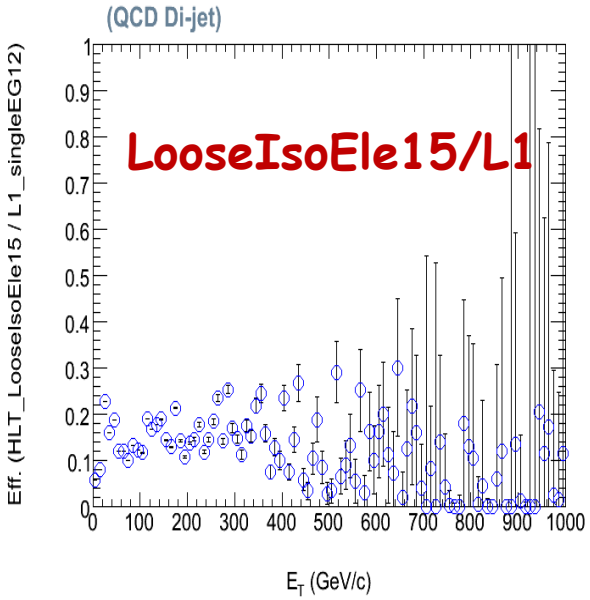


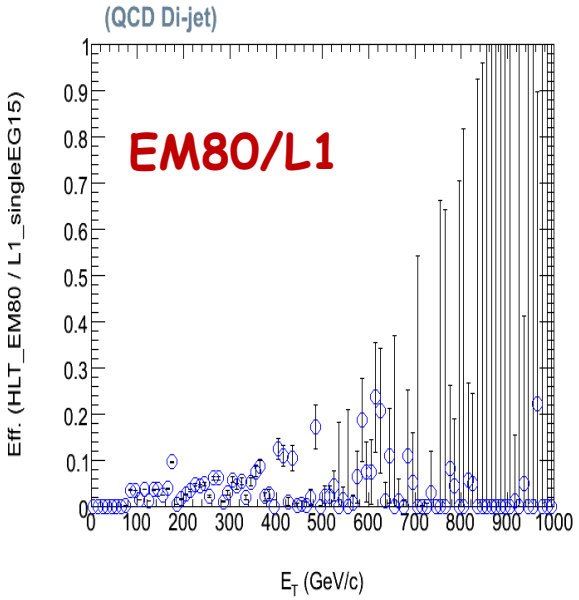


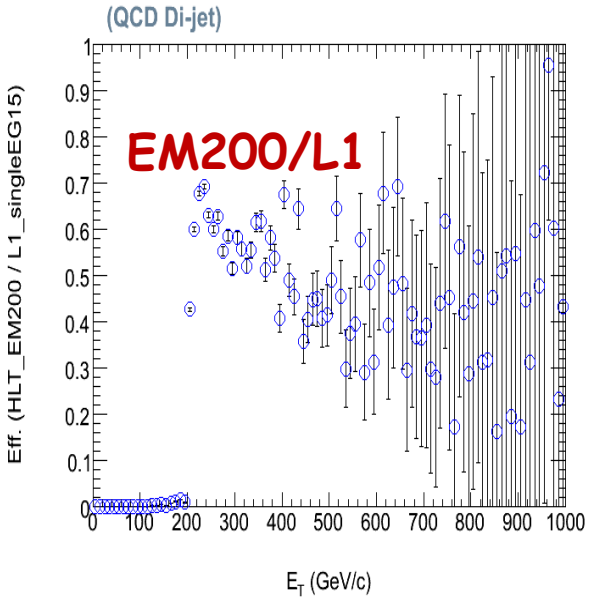


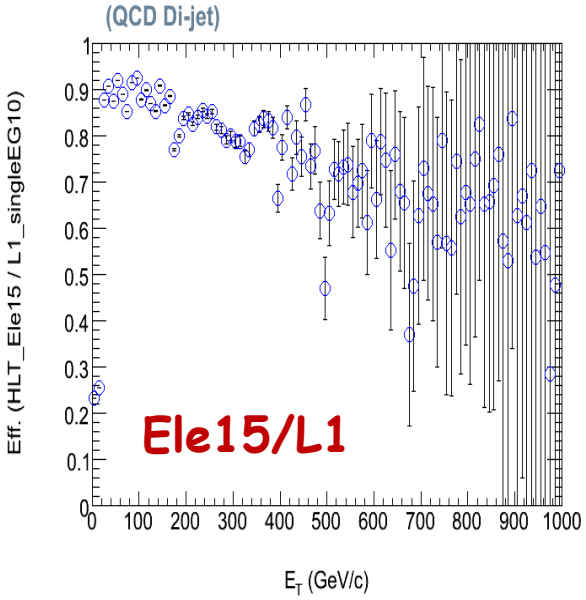


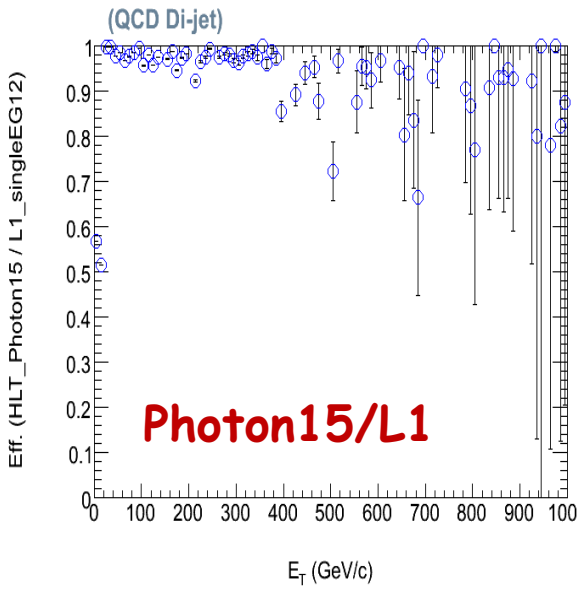
Eff. For "HLT/L1" (Di-jet)

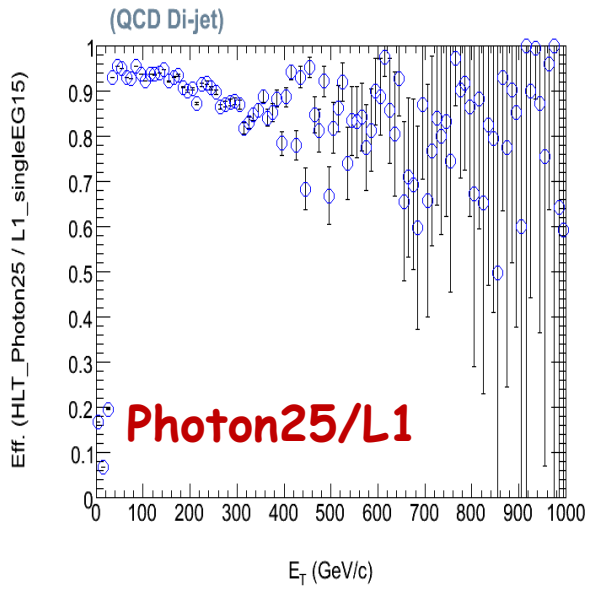












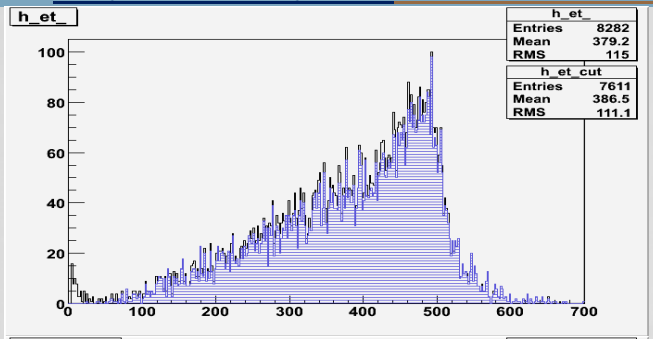
HEEP Selections (v2.0pre1)

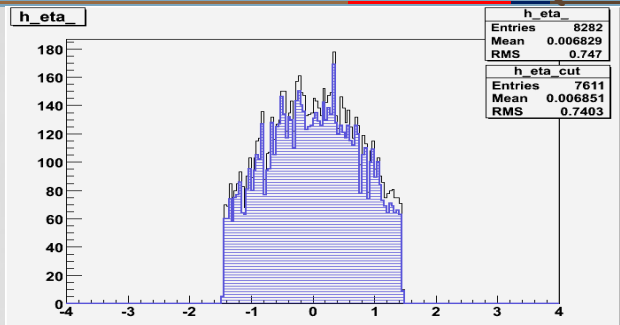
Official HEEP Selection v2.0pre1 (Current Version)		
Variable	Barrel	Endcap
E_T	> 25 GeV	> 25 GeV
$\lvert\eta_{sc}\rvert$	< 1.442	1.560 < $\lvert\eta_{sc}\rvert$ < 2.5
classification	< 100	≥100
$\lvert\Delta\eta_{in}\rvert$	< 0.005	< 0.007
$\lvert\Delta\phi_{in}\rvert$	< 0.09	< 0.09
H/E	<0.05	<0.05
$\sigma_{i\eta i\eta}$	n/a	<0.0275
E^{2x5}/E^{5x5}	>0.94 OR E^{1x5}/E^{5x5} > 0.83	n/a
EM + Had Depth 1 Isolation	<3+0.02*Et	<5.5 for Et<50 else
		<5+0.05*(Et−50)
Had Depth 2 Isolation	n/a	<0.5
Track Isol: Trk Pt	<7.5	<15

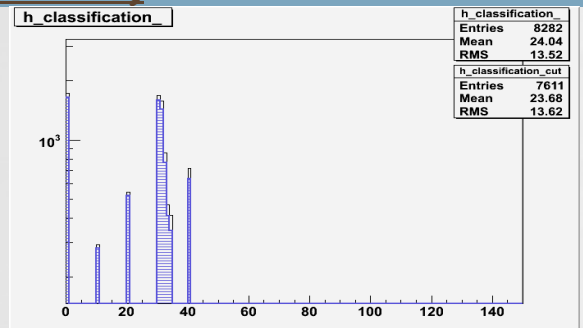
(New Variable)

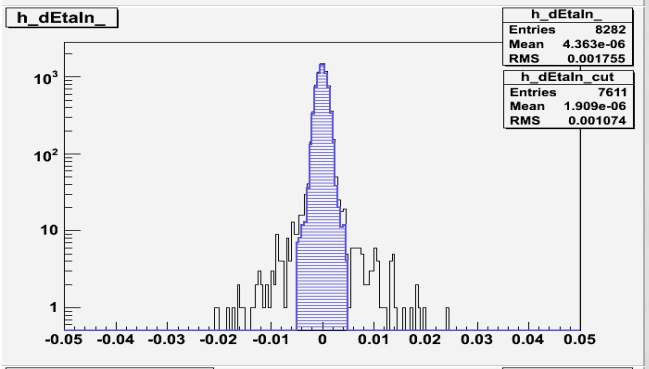
changed since v1.2

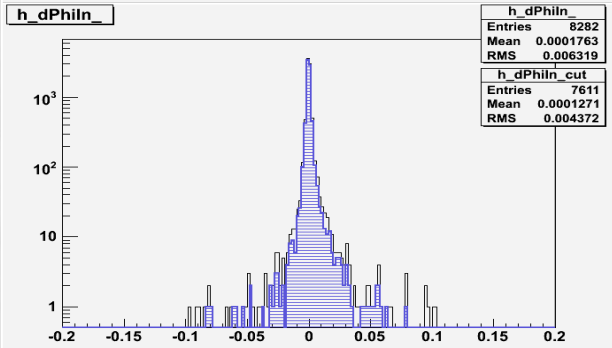
Before & After All HEEP ID selection cuts - "Barrel" (W'=1TeV)

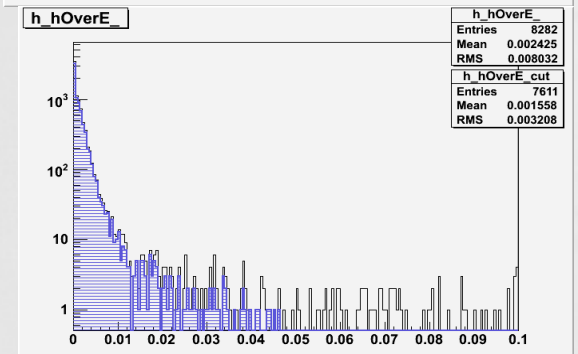


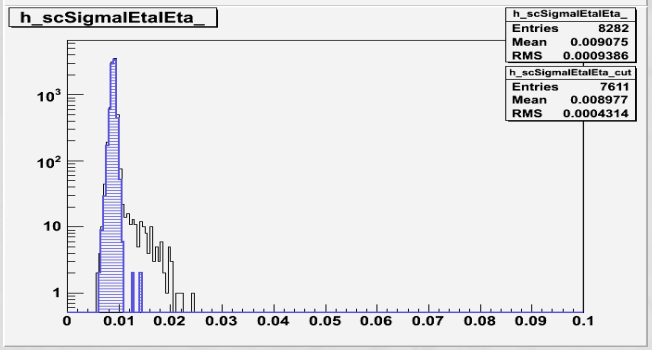


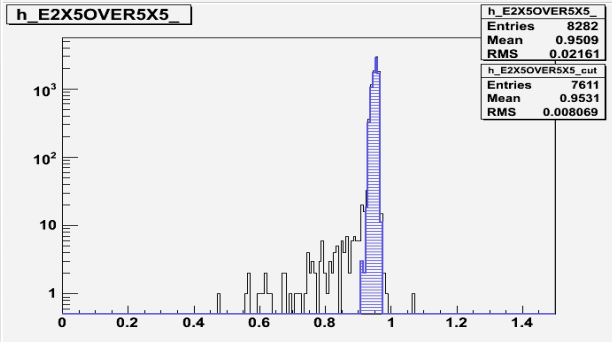


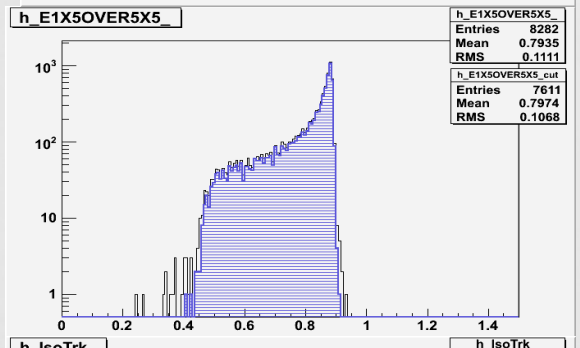


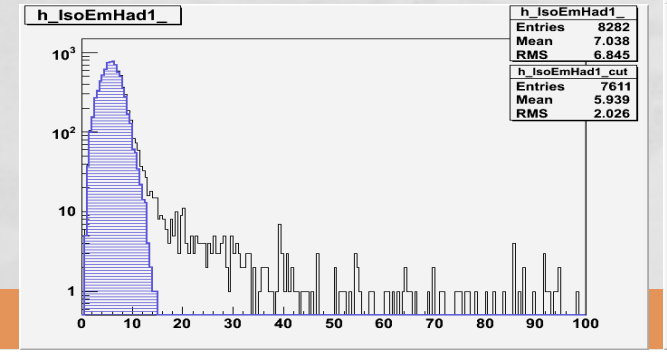


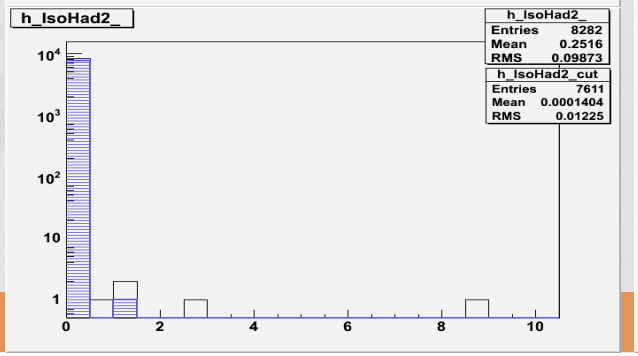


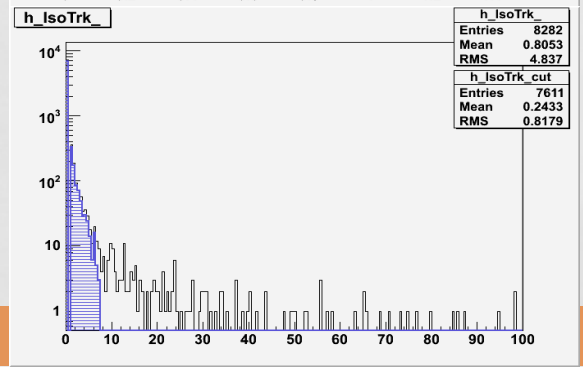








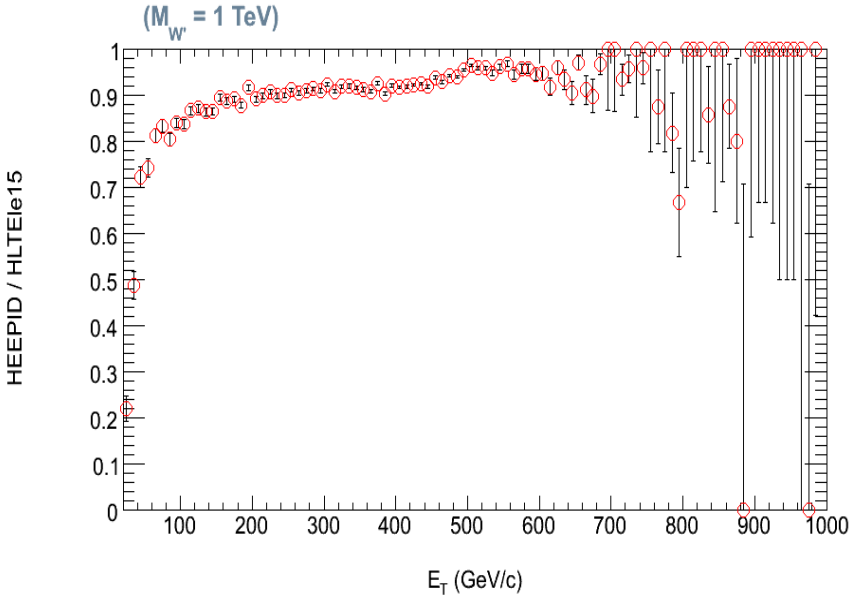


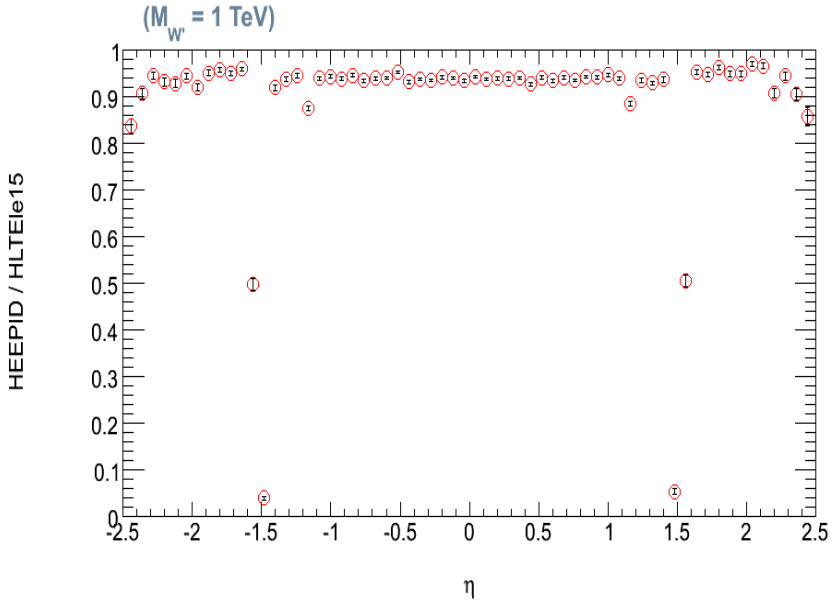


Before & After All HEEP ID selection cuts – "Endcap" (W'=1TeV)

Efficiency (Summary)

- W' = 1 TeV :
  - HLT_Ele15 = 89.9%
  - RobustHighEnergy eID = 94.5%
  - RobustHighEnergy eID / HLT_Ele15 = 96.2%
  - HEEP ID (with Isolation) / HLT_Ele15 = 91.5%





QCD Estimate

- Check the isolation efficiency in QCD sample made with the inversion of isolation after requiring HLT, electron ID (Isolation efficiency of fake electrons is a function of transverse mass. Study this dependence)

- "matrix method" for the QCD number of events : isolation vs. missing E_T

  https://twiki.cern.ch/twiki/pub/CMS/TWikiEWKelectron/EWK_electrons_AN_10jan08.pdf

- Remove the contamination of real electrons from the source of W->enu and Z->ee in the sample with inverted isolation (or other electron ID variables also).

Event Selection

- Summer08 MC Samples
  - QCD Dijet Background
  - (Pt-hat range : 0 - 3500 (Inf) GeV)
  - /QCDDiJetPtXtoY/Summer08_IDEAL_V9_v1/GEN-SIM-RECO
- High Level Trigger
  - HLT_Ele15_LW_L1R
- Electron ID and Isolations
  - HEEP ID v2.0pre1

QCD Estimate (Matrix Method)

- Using the same electron HLT sample we apply the HEEP ID but no Isolation, no Missing Et cut, it's to make an anti-isolated sample and extract the number of QCD events in the signal region (the isolated and high Met >25 GeV region)
- The assumption that the isolation in QCD events is independent of the Met so can relate the number of QCD events with D="BC/A"
- Another assumption for today's results is that EWK real electron source already properly removed in the QCD sample (Later we can think of subtracting with MC expectation)
- Some checks from QCD Di-Jet MC Sample before calculating,
  - Total N. of events = 1.1e+06
  - Sum of the weighted N. of events by their cross sections & Luminosity (100pb-1) = 5.3e+12
  - HLT_Ele15 = 1.4e+09
  - HEEP ID (w/o Isolation) = 3.7e06 in Barrel
    = 4.2e06 in Endcap

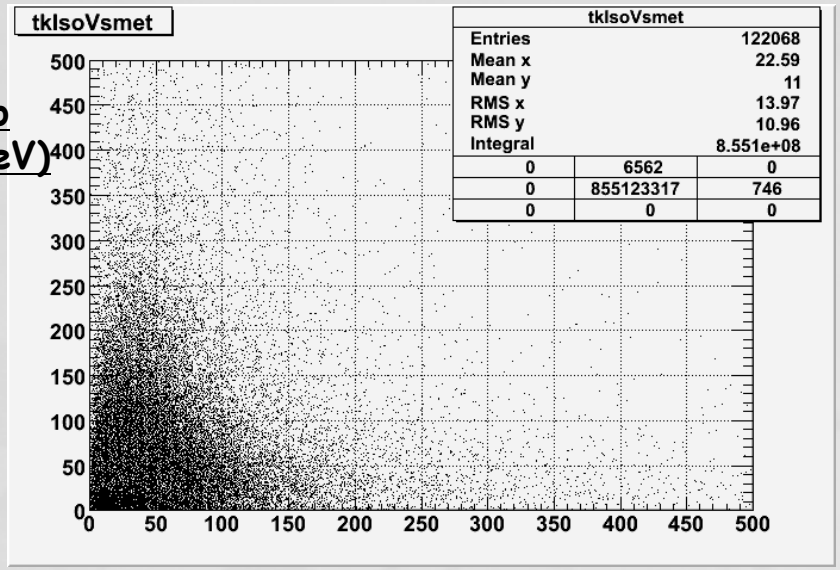
HEEP Selection cuts (v2.0pre1)

Official HEEP Selection v2.0pre1 (Current Version)		
Variable	Barrel	Endcap
E_T	> 25 GeV	> 25 GeV
$\lvert\eta_{sc}\rvert$	< 1.442	1.560 < $\lvert\eta_{sc}\rvert$ < 2.5
classification	< 100	≥100
$\lvert\Delta\eta_{in}\rvert$	< 0.005	< 0.007
$\lvert\Delta\phi_{in}\rvert$	< 0.09	< 0.09
H/E	<0.05	<0.05
$\sigma_{i\eta i\eta}$	n/a	<0.0275
E^{2x5}/E^{5x5}	>0.94 OR E^{1x5}/E^{5x5} > 0.83	n/a
EM + Had Depth 1 Isolation	<3+0.02*Et	<5.5 for Et<50 else
		<5+0.05*(Et−50)
Had Depth 2 Isolation	n/a	<0.5
Track Isol: Trk Pt	<7.5	<15

RobustHighEnergy eID

Choosing Track Isol for anti-isolated QCD sample

• Only after HLT_Ele15

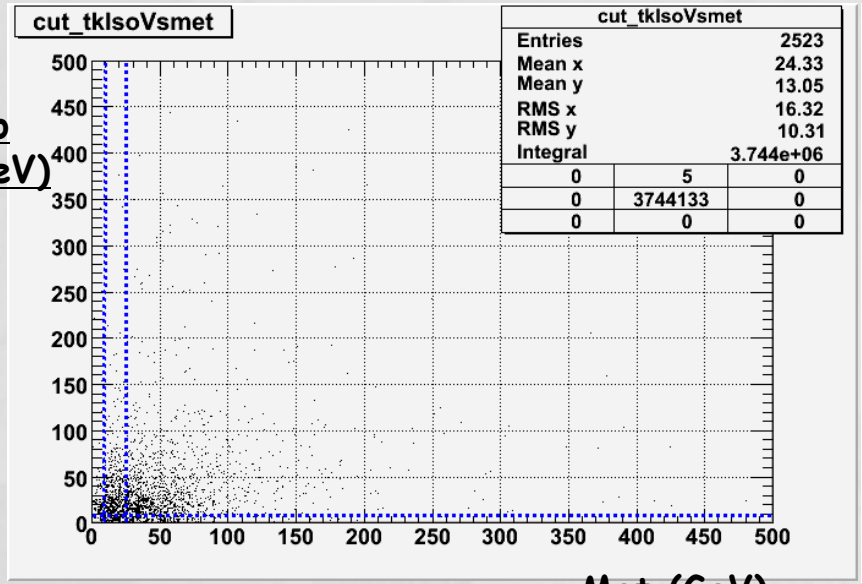


1. look at after HEEP ID w/o Iso & Met cut (Barrel, Endcap separately)

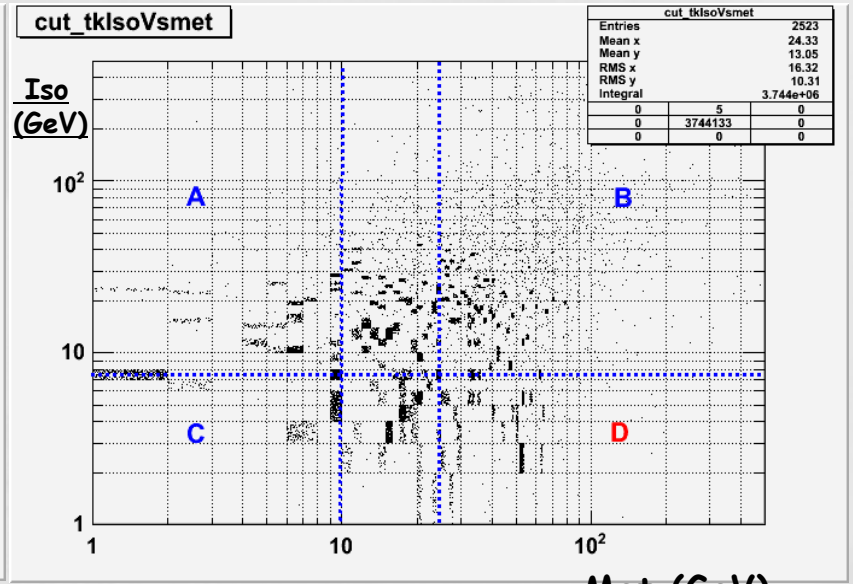
2. Obtain the N. of QCD events with D=BC/A relation

A : Iso>7.5 & Met<10
B : Iso>7.5 & Met>25
C : Iso<7.5 & Met<10
D : Iso<7.5 & Met>25

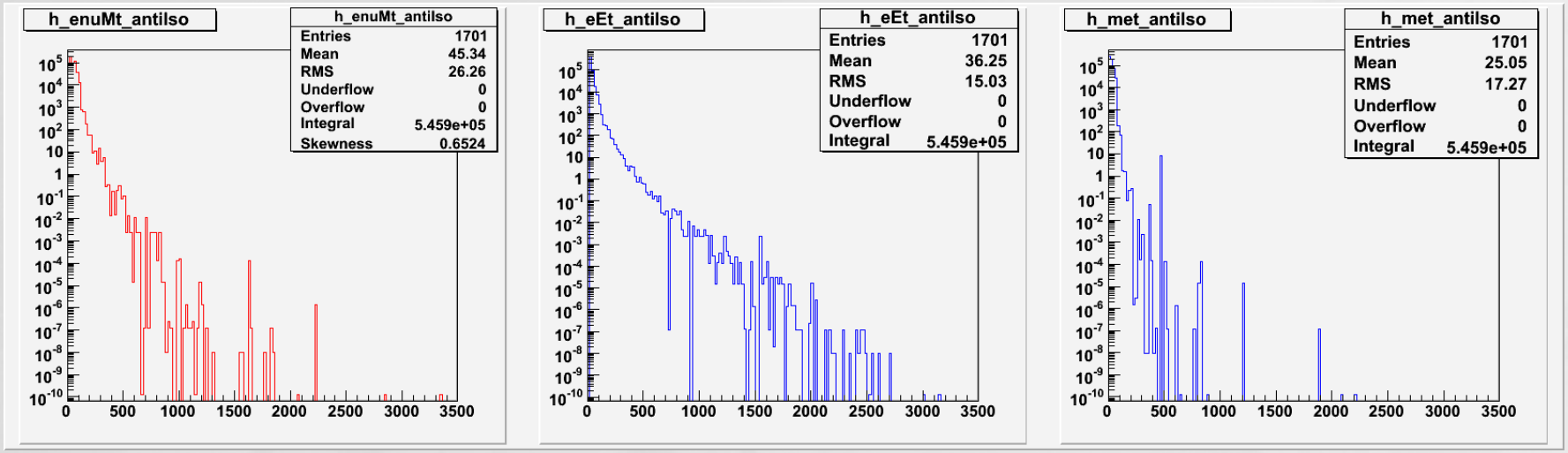
• after HLT_Ele15 & HEEP w/o Iso & MEt



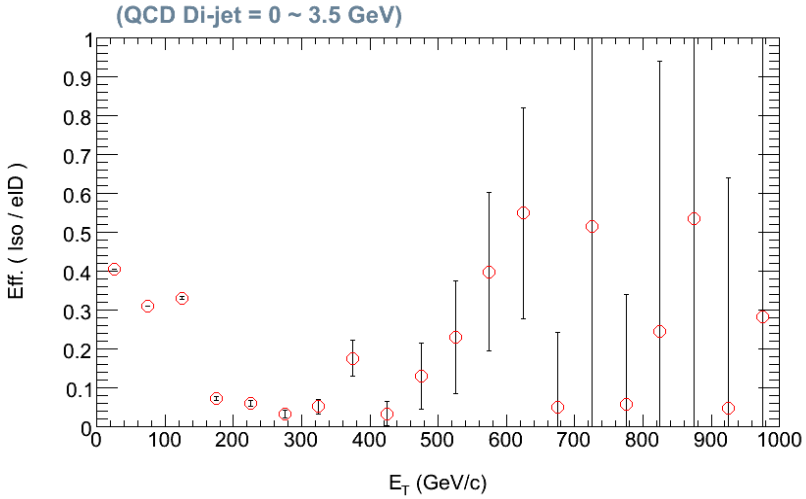
• after HLT_Ele15 & HEEP w/o Iso & Met (Log Scale)

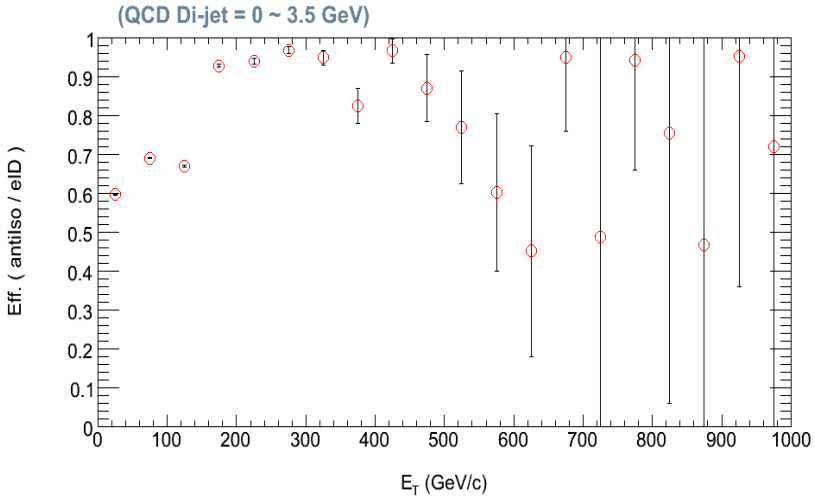


- **Get the QCD Mt (Et, MEt) in the anti-isolated sample (Barrel) (scaled to the estimated QCD BG number of events)**

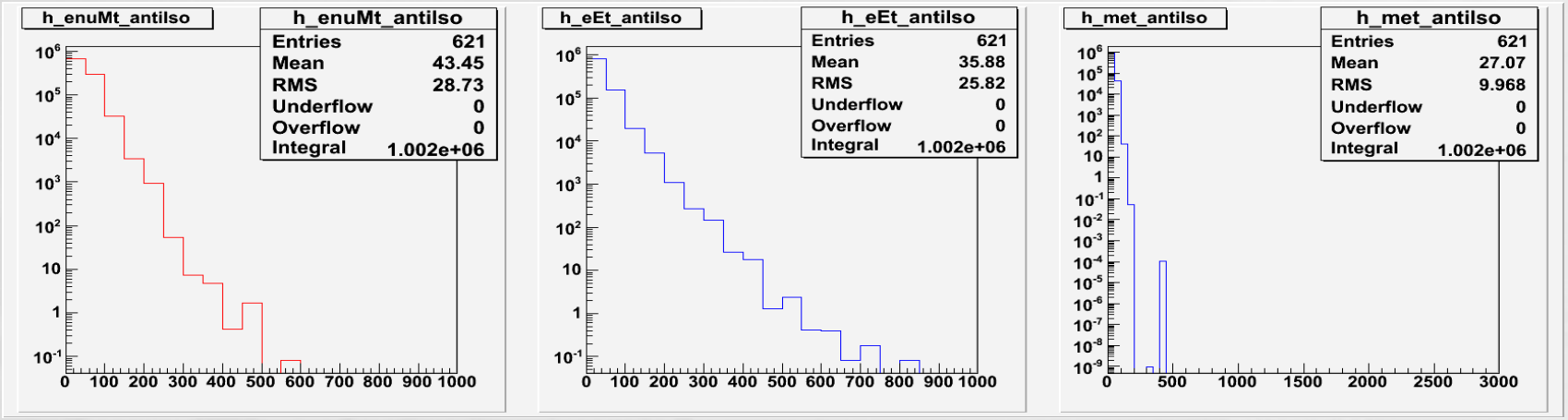


- **Check efficiency (isolation & anti-isolation)**

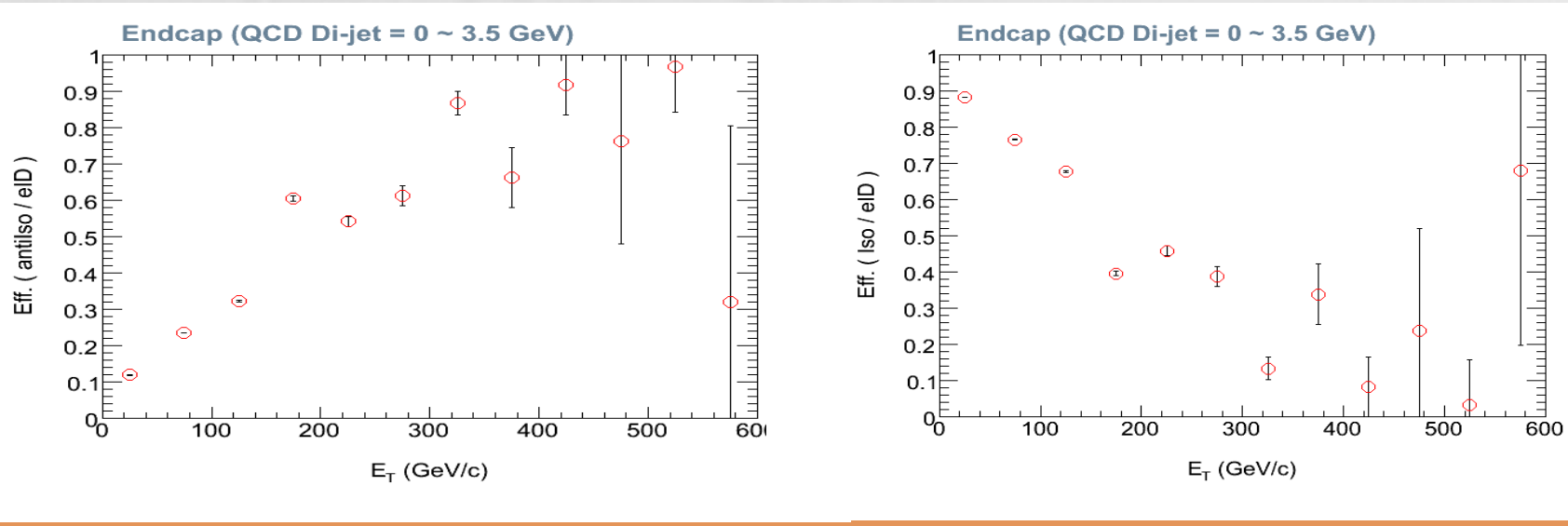




- **Get the QCD Mt (Et, MEt) in the anti-isolated sample (Endcap) (scaled to the estimated QCD BG number of events)**



- **Check efficiency in Endcap (isolation & anti-isolation)**



QCD Di-Jet MC sample (N. of Events Comparison)

"Data-driven"	Barrel	Endcap
From "BC/A" relation (using only Track Isolation)	(5.5 +/- 1.7) x 10^5	(1.0 +/- 0.2) x 10^6
From "D" region (using only Track Isolation)	(4.3 +/- 1.1) x 10^5	(1.0 +/- 0.2) x 10^6

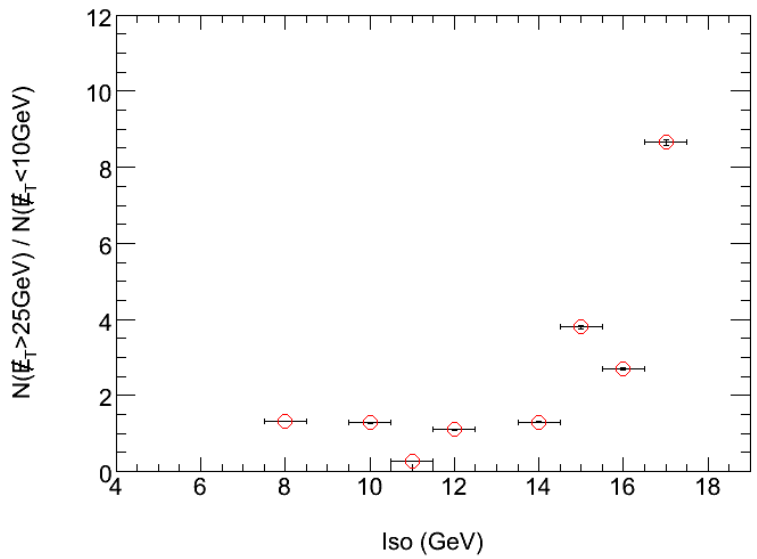
"MC"	Barrel	Endcap
HLT_Ele15	5.4e+08	3.1e+08
HEEPID w/o Iso	3.7e+06	4.2e+06
HEEPID w/ Iso (track isolation only)	1.5e+06	3.6e+06
HEEPID w/ Iso (applying all the three isolation variables)	4.9e+05	1.9e+06
Met > 25 GeV	(5.0 +/- 2.2) x 10^4	(6.7 +/- 1.7) x 10^5

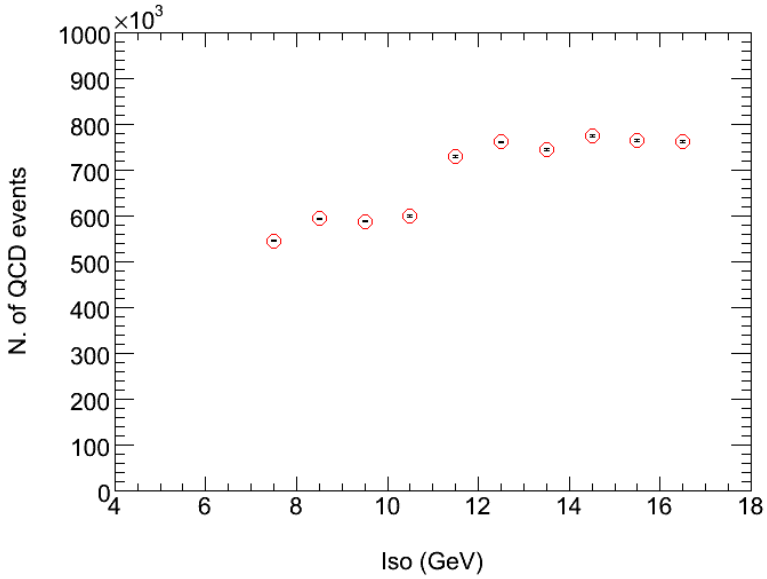
Summary

- Matches for the results from Data-driven and MC (in region “D”)
- After requiring Isolations (track and calorimeters) much more QCD BG are survived in Endcap (~4 times more than in the Barrel)

* Slightly alternative change (1)

- We can take an account for the correlation from the isolation cuts by fitting in these below plots and extract the N. of QCD events in the signal region

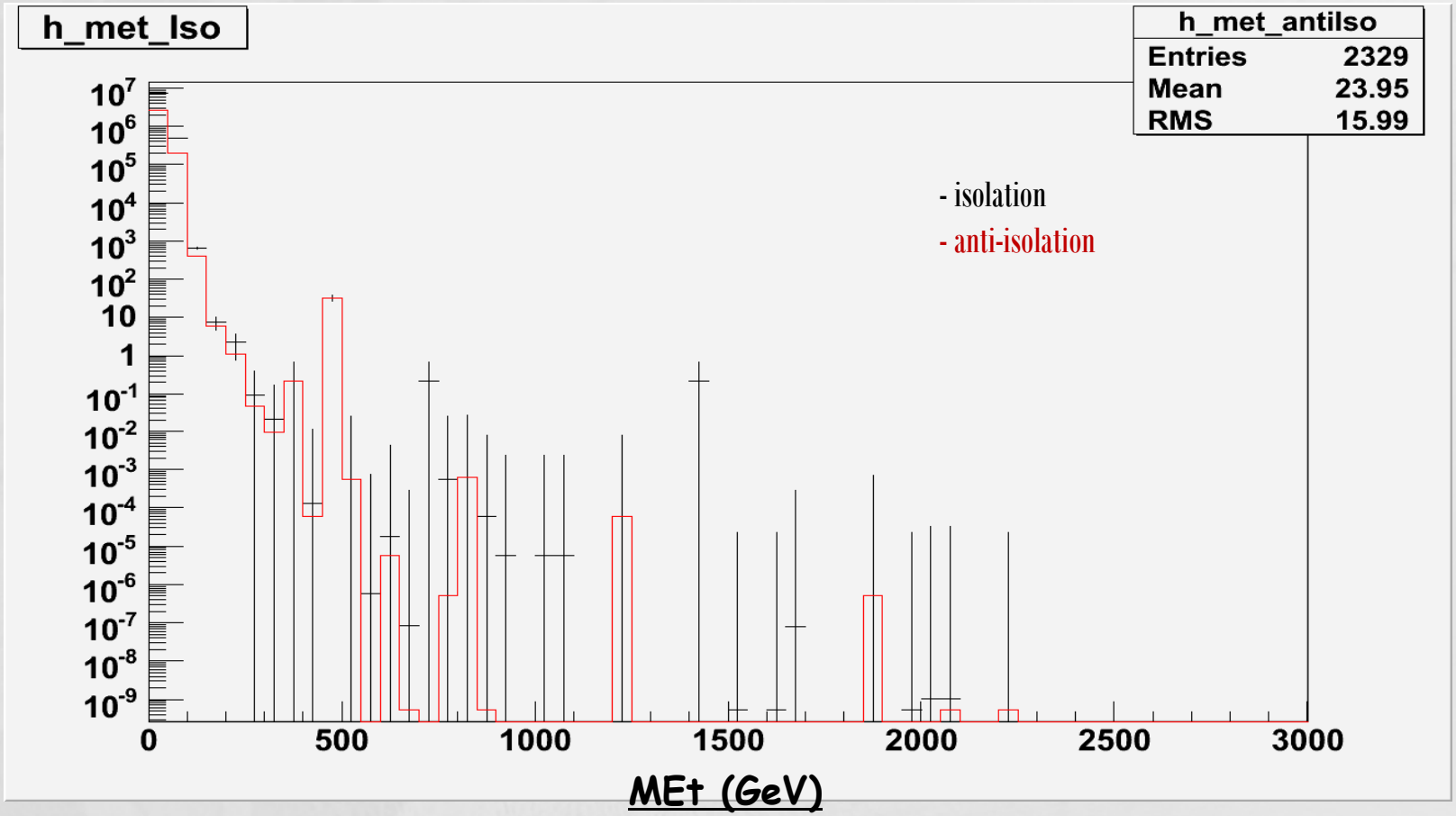




Varing arbitrarily
Iso cut regions (Left) & upper Iso cut for the region "A","B" (Right)

* Slightly Alternative change (2)

- we can think of the fit the anti-isolated (QCD BG) to the isolated which can be Data we search for in Missing Et Dist. and get the integral of Met>25GeV for the QCD Estimate.



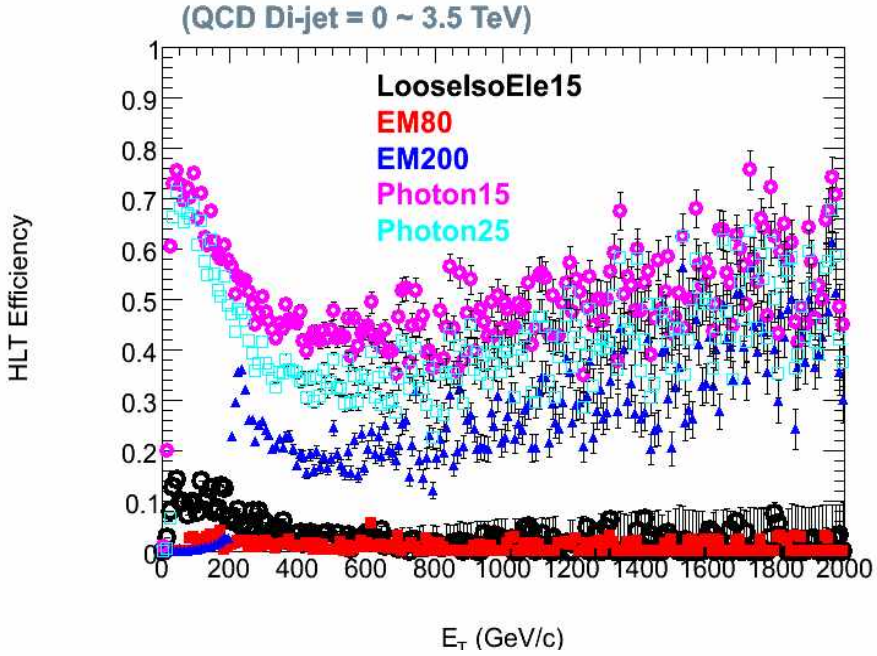
More Further looks…

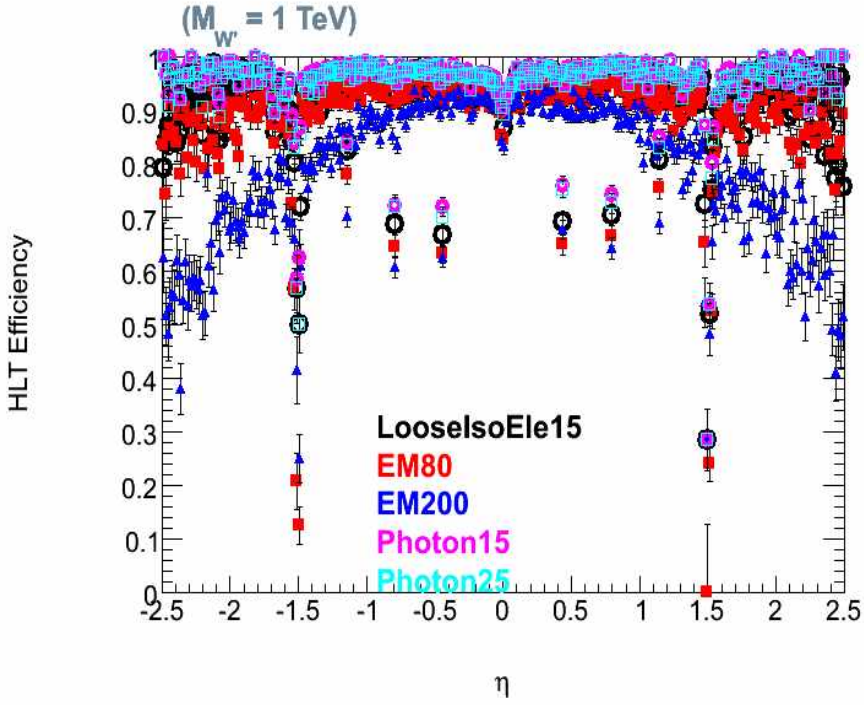
- Matches in the Missing Et Dist. by Jet Correction
- Removing real electron sources in the anti-isolated sample (Maybe with MC expectation?)
- Systematic uncertainty consideration for the QCD Mt shape by the chosen isolation cut

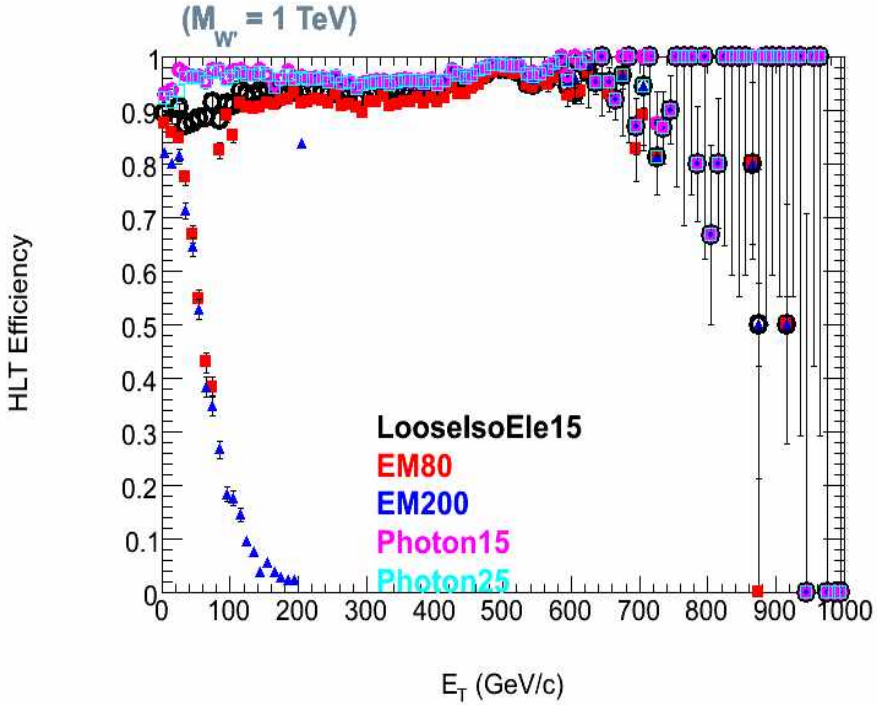
Back-up

HLT eff.

- W' = 1 TeV & QCD Di-jet,
- For all the electron candidates







HEEP ID & Isolation

Variable	Barrel	Endcap
E_T	> 30 GeV	> 30 GeV
η^{sc}	$\lvert\eta^{sc}\rvert \leq 1.442$	$1.560 \leq \lvert\eta^{sc}\rvert \leq 2.5$
classification	< 40	≥ 100
H/E	< 0.05	< 0.1
$\sigma_{\eta\eta}$	< 0.011	< 0.0275
$\lvert\Delta\eta_{in}\rvert$	< 0.005	< 0.007
$\lvert\Delta\phi_{in}\rvert$	< 0.09	< 0.09
isol EM + Had Depth 1	< 5 GeV for $E_T < 65$ GeV else $< 5 + 0.02 \times (E_T - 65)$ GeV	< 4 GeV for $E_T < 65$ GeV else $< 4 + 0.04 \times (E_T - 65)$ GeV
isol Had Depth 2	-	$< 1 + 0.0005 \times E_T$ GeV
isol Trk p_T	< 7.5 GeV/c	< 15 GeV/c

changed since v1.1

The standard HEEP selection cuts v1.2

1TeV Wprime MC sample (N. of Events Check)

"MC"	*Barrel*	*Endcap*
Total N. of Events (not weighted for the cross section & Lum.)	106,196	
HLT_Ele15	84,294	14,057
HEEPID w/o Iso	82,813	13,660
HEEPID w/ Iso (track isolation only)	81,830	13,598
HEEPID w/ Iso (applying all the three isolation variables)	78,866	13,156
Met > 25 GeV	78,838	13,130