Electron Trigger Efficiency measurement and Lepton Early Running Triggers

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Introduction and definitions

•This talk will deal with electron trigger efficiency measurement in a 14TeV SUSY context

•Then introduce the proposed 10^{31} lepton triggers

•Discuss acceptance vs P_t threshold

•Discuss electron trigger efficiency measurement for 10^{31} triggers

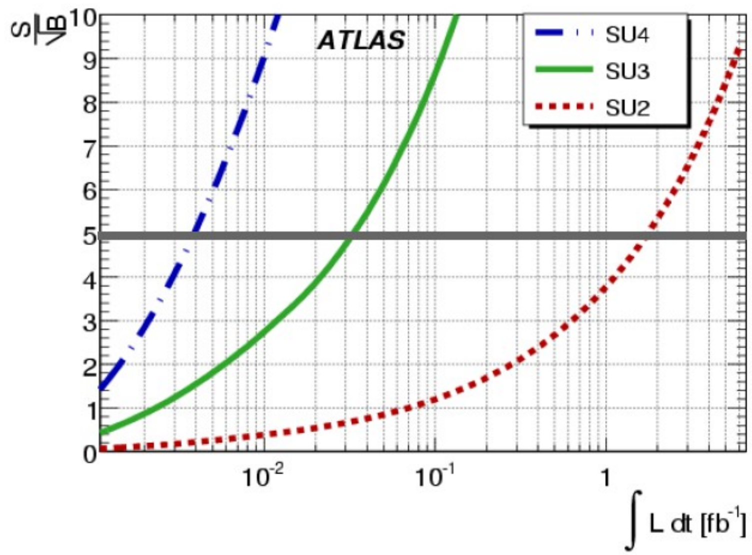
•Samples, all rel 13 14TeV samples

- 494k $Z \rightarrow ee$, σ = 1.68nb, $\int \mathscr{L}$ 294pb^{-1}
  trig1_misal1_mc12.005144.PythiaZee.recon.ESD.v13003004
- 450k semi-leptonic ttbar, σ = 234pb, $\int \mathscr{L}$ 1.9fb^{-1}
  trig1_misal1_mc12.005205.AcerMCttbar.recon.ESD.v13003004
- 98k SU3, σ = 18.59pb, $\int \mathscr{L}$ 5.2fb^{-1}
  trig1_misal1_csc11.005403.SU3_jimmy_susy.recon.ESD.v13003003
- 198k SU4, σ = 262pb, $\int \mathscr{L}$ 755pb^{-1}
  trig1_misal1_mc12.006400.SU4_jimmy_susy.recon.AOD.v13004005

• Object definitions are from the SUSY CSC notes, leptons are normalised to triggerable electron definitions and matched to truth electrons except where stated otherwise

Multi-lepton SUSY at 14TeV

- inclusive 3-lepton with 14TeV data.
  - SU2 : S /√B = 3.8 for 1 fb^{-1} of data
  - SU3 : S /√B = 27.3 for 1 fb^{-1} of data
  - SU4 : S /√B = 90.3 for 1 fb^{-1} of data



- Susy multilepton search systematics from CSC note 10fb^{-1} at 14TeV

Source	Uncertainty No jet veto	Uncertainty With jet veto
Background production rates	0.8%	1.9%
Lepton Efficiency	2.3%	2.3%
Fakes ($R_{b\to\ell}$)	4.0%	1.2%
Hadronic energy scale	–	1.8%
Missing energy scale	1.5%	1.0%
Total systematic	4.9%	3.8%
Statistical	3.7%	6.9%
Statistical + Systematic	6.2%	7.9%

Source	Tag-and-probe [7] ($1\ell^{\pm}$, $1fb^{-1}$)	This analysis ($10\ fb^{-1}$) $1\ell^{\pm}$	This analysis ($10\ fb^{-1}$) $3\ell^{\pm}$
e (trigger)	$\ll 1\%$	} 0.5 %	} 2.3%
μ (trigger)	0.4 %		
e (reco)	0.5 %	1 %	
μ (reco)	$\ll 1\%$	$\ll 1\%$	

- Uncertainties scaled from EW boson cross section measurement CSC note.
  - Uses tag and probe to determine the **0D trigger efficiency** ie independent of P_t and η.

EF_e25i_tight Efficiencies

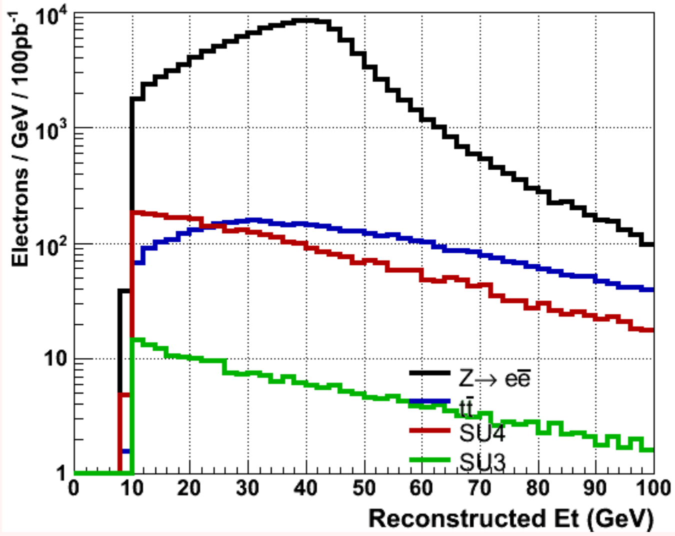
- Plateau Efficiencies
  - $E_t > 40$ GeV

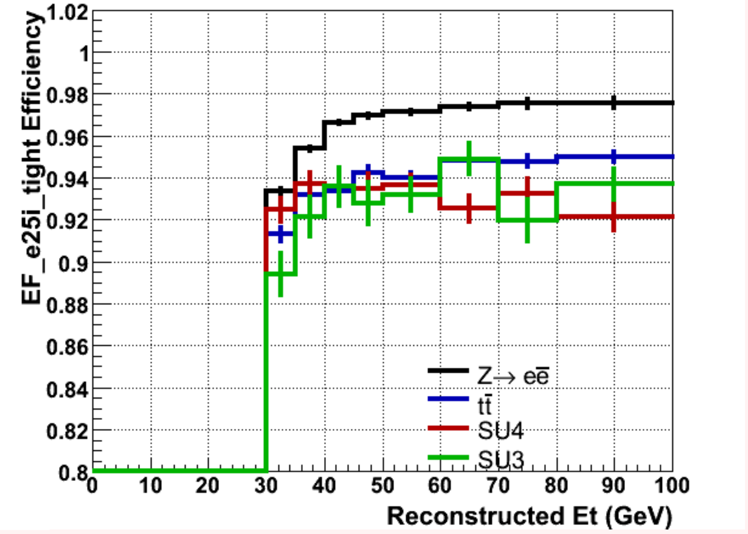
Sample	Efficiency	error
Z→ee	96.91	0.04
ttbar	94.02	0.09
SU3	92.43	0.23
SU4	91.95	0.31

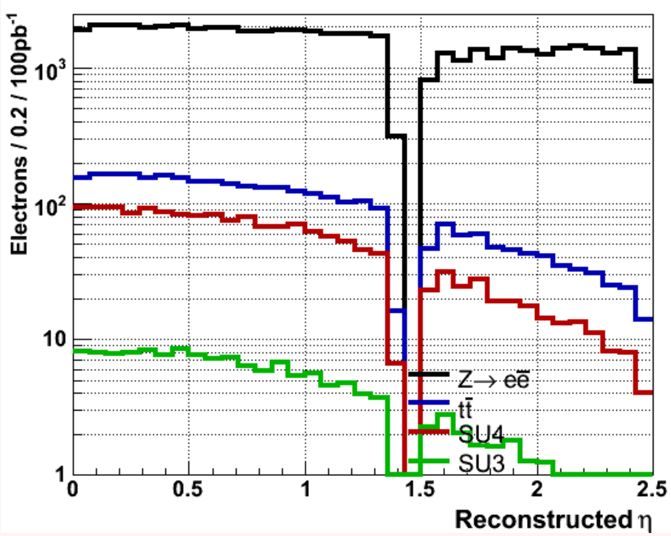
- Errors from Full MC stats

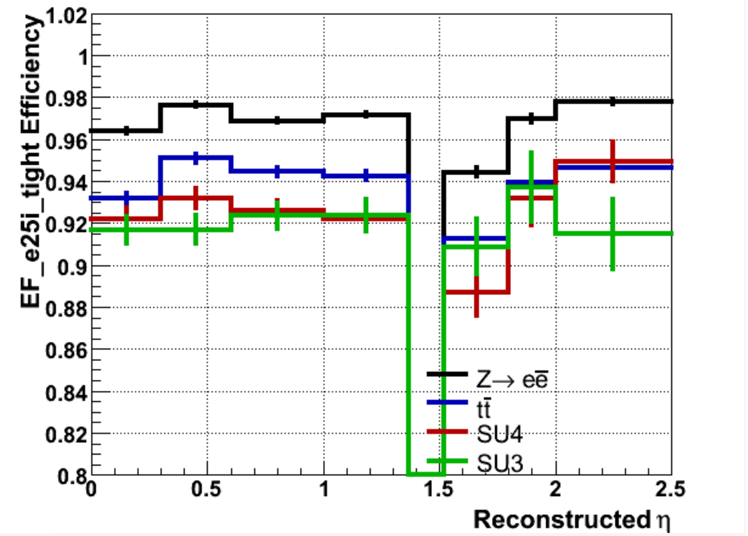
1D and 0D efficiencies in Z→ee samples are not the same as SUSY or ttbar samples

Differences O(5%)







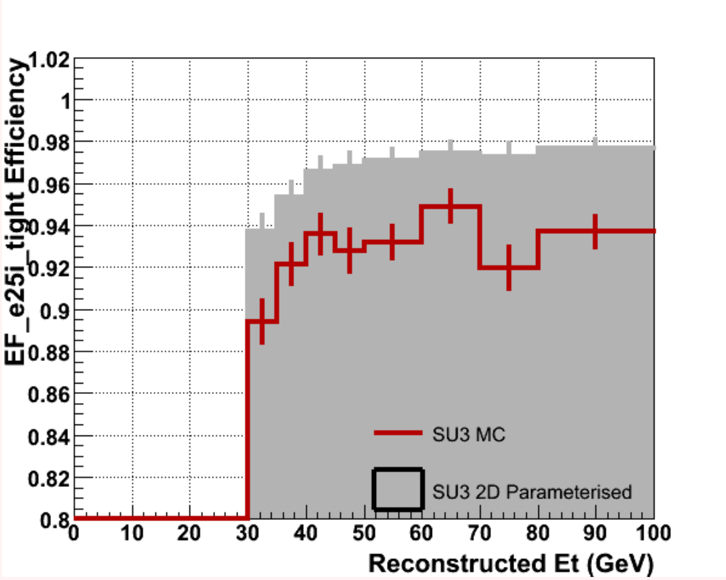


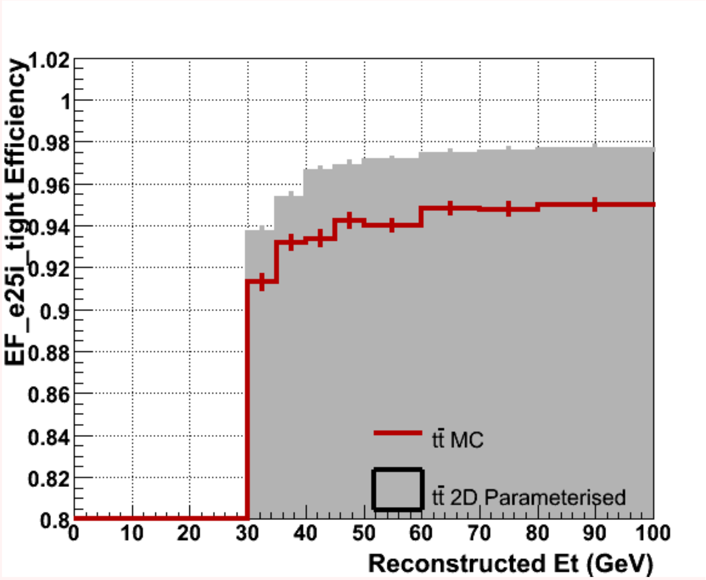
- Take Z→ee MC, work out 2D (E_t vs η) efficiency then compare to Monte Carlo.
  - Parameterisation made from all Z→ee MC data
  - Plateau Efficiencies (40 < E_t < 100 GeV)

Sample	Monte Carlo	error	2D parameterised	error
Z→ee	96.94	0.04		
ttbar	94.39	0.10	97.19	0.07
SU3	93.40	0.34	97.18	0.23
SU4	93.11	0.25	97.15	0.16

- **Differences O(4%)**

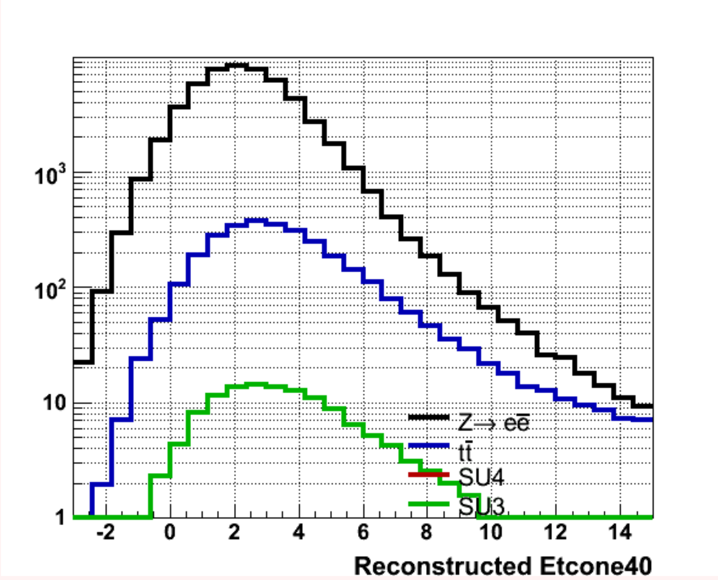
- 2D efficiencies in Z → ee samples are not the same as SUSY or ttbar samples

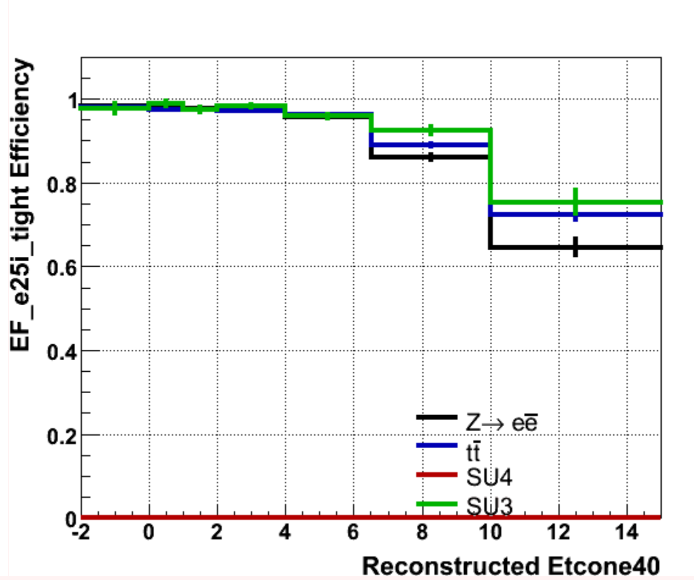


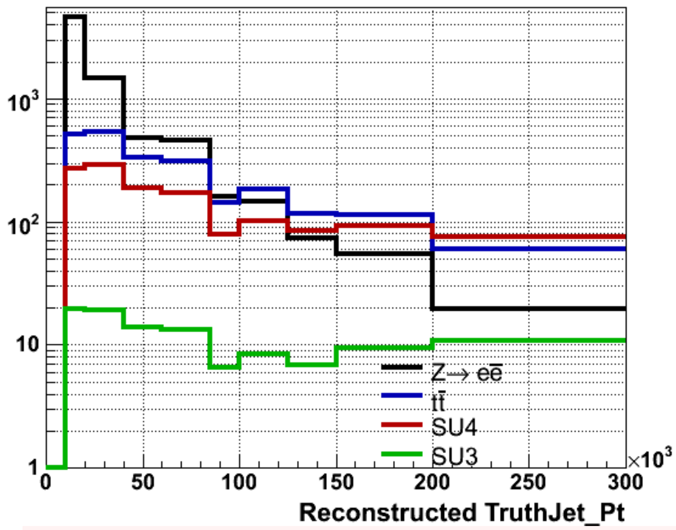


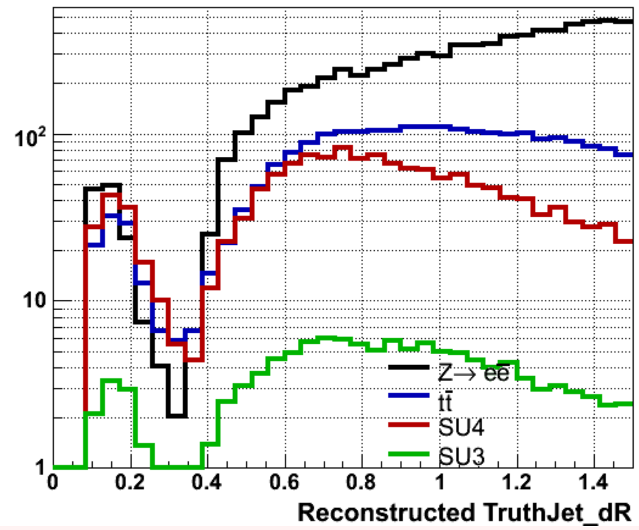
More 1D Efficiencies

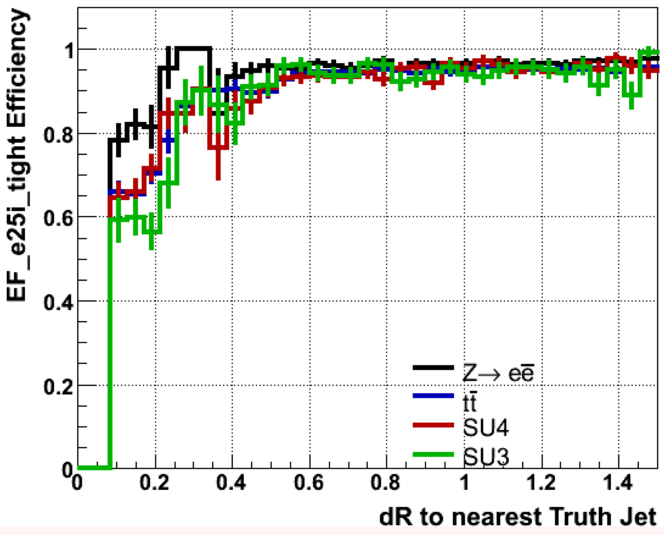
- E_t and η are not the only variables that affect trigger efficiency.
- Isolation variables;
  - Etcone40
  - ΔR & P_t of Jets
- Strange shape in jets caused by electron/jet overlap removal











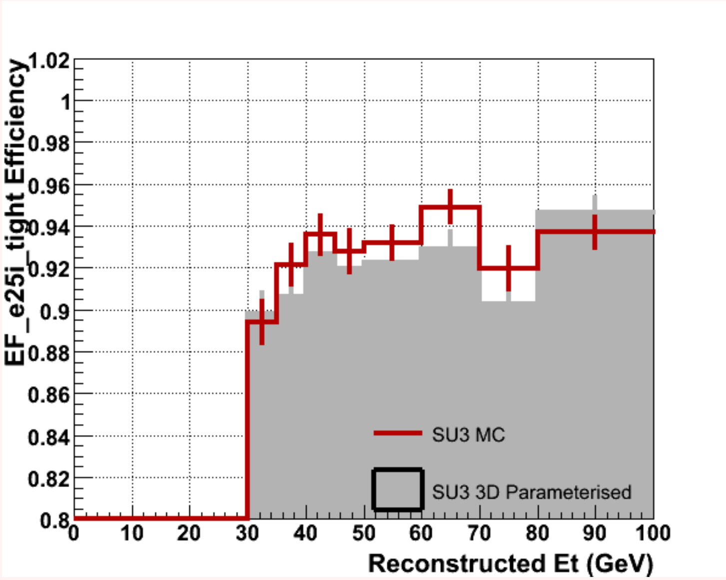
3D Parameterised Efficiencies E_t vs η vs Etcone40

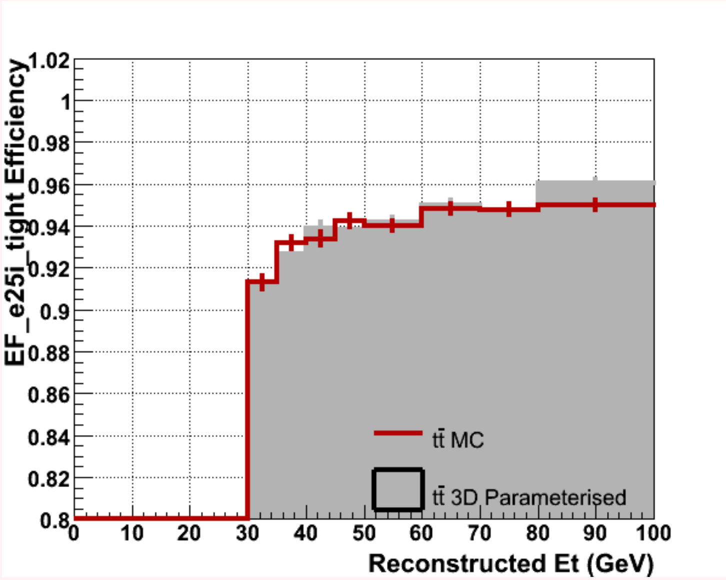
- Take Z→ee MC, work out 3D (E_t vs η vs Etcone40) efficiency then compare to Monte Carlo.
  - Parameterisation made from all Z→ee MC data
  - Plateau Efficiencies ($40 < E_t < 100$ GeV)

Sample	Monte Carlo	error	3D parameterised	error
Z→ee	96.94	0.04		
ttbar	94.39	0.10	94.64	0.10
SU3	93.40	0.34	92.59	0.36

- **Differences < 1%**

- To determine electron trigger efficiency to <1% then we need to parameterise in 3D.

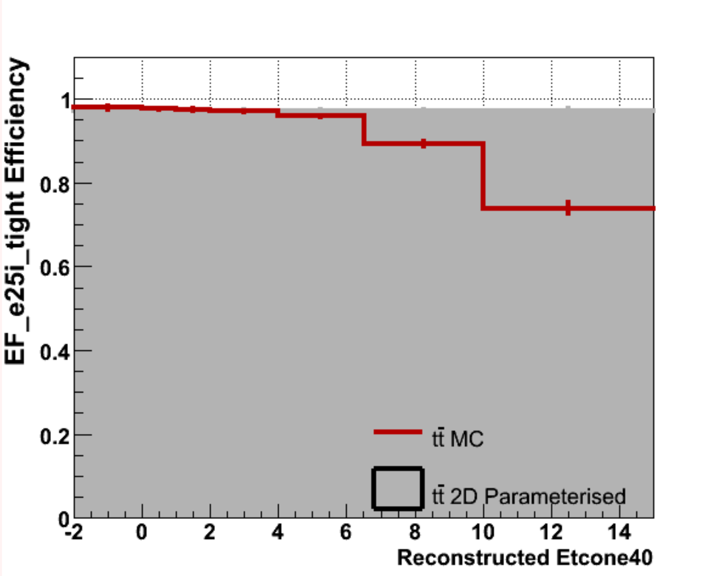


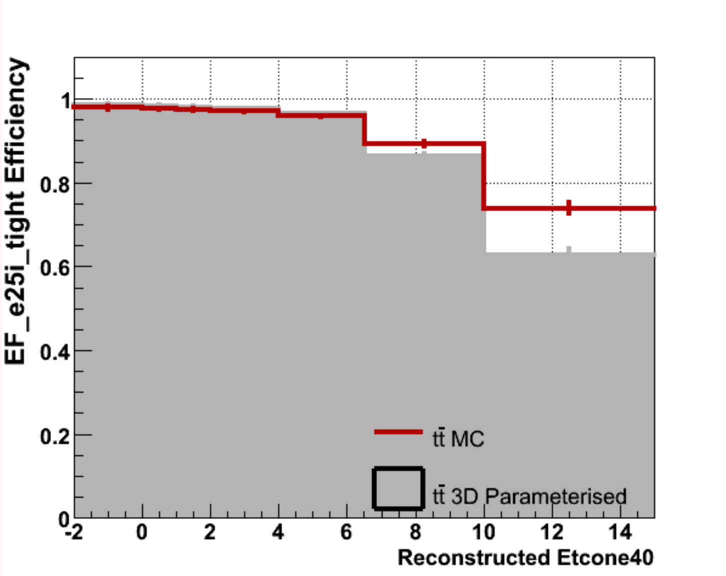


Parameterisations – other variables

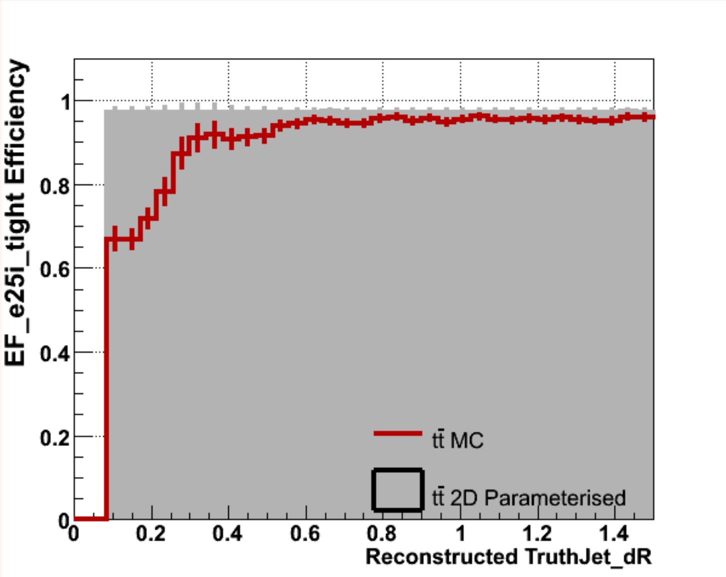
2D ttbar

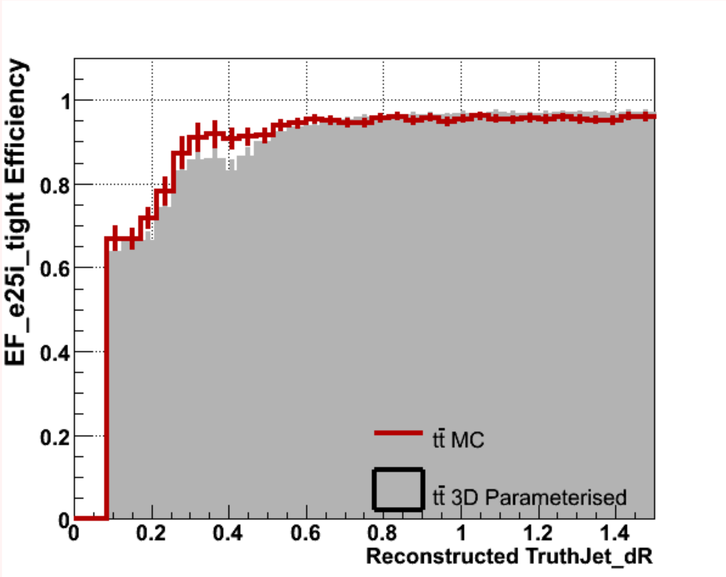
3D ttbar





Etcone40





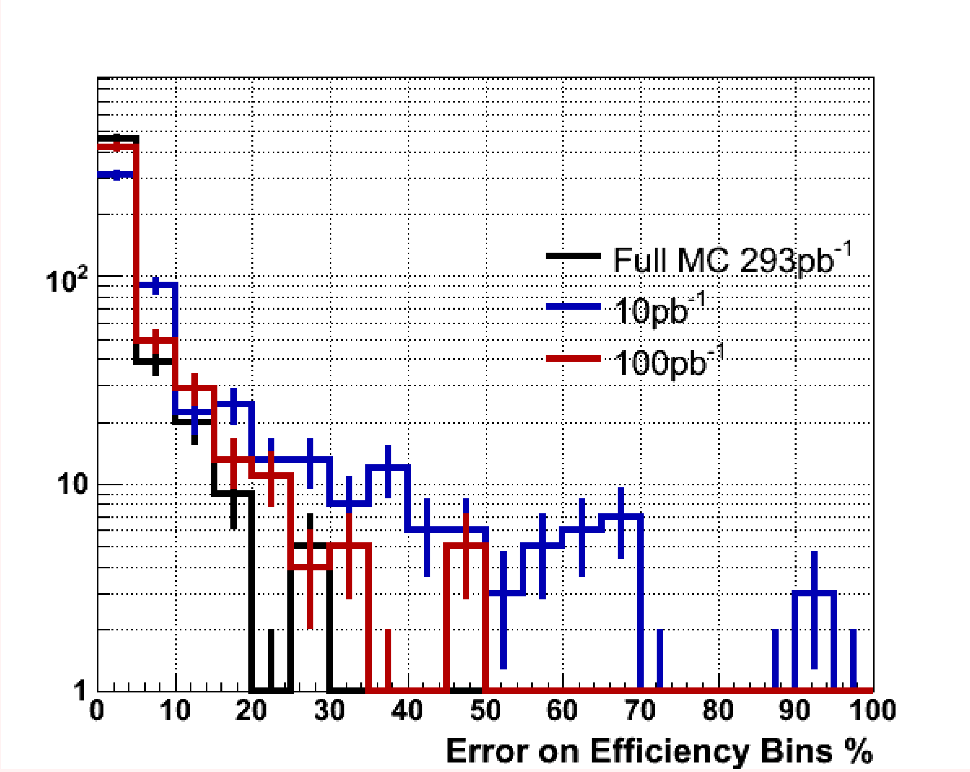
ΔR to nearest Truth Jet

3D efficiency Matrix errors

p_t (GeV) = [0, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 100]

$|\eta|$ = [0, 0.3, 0.6, 1.0, 1.37, 1.52, 1.8, 2.0, 2.5]

etcone40 (GeV) = [-2, 0, 1, 2, 4, 6.5, 10, 15] **616 bins**



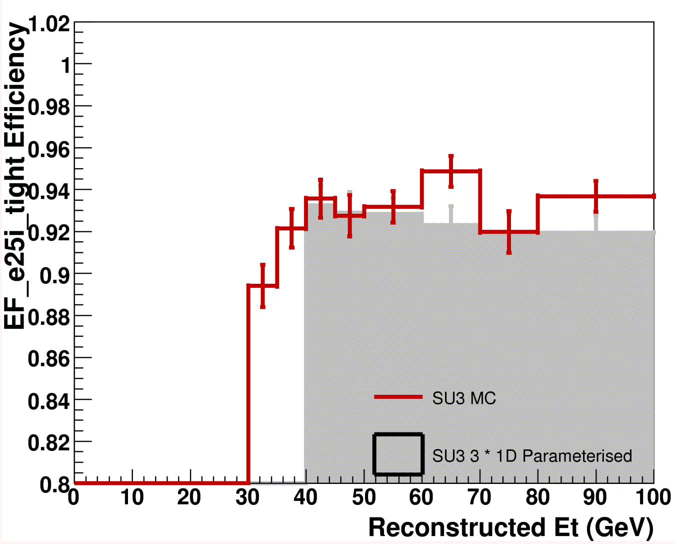
- **Errors can be very high**, especially at high values of Etcone.
- For **first data need to check for obvious 1% effects**. Is it therefore acceptable to factorize our 3D matrix into a lower dimensionality?
- When using tag and probe we can expect loss of statistics.

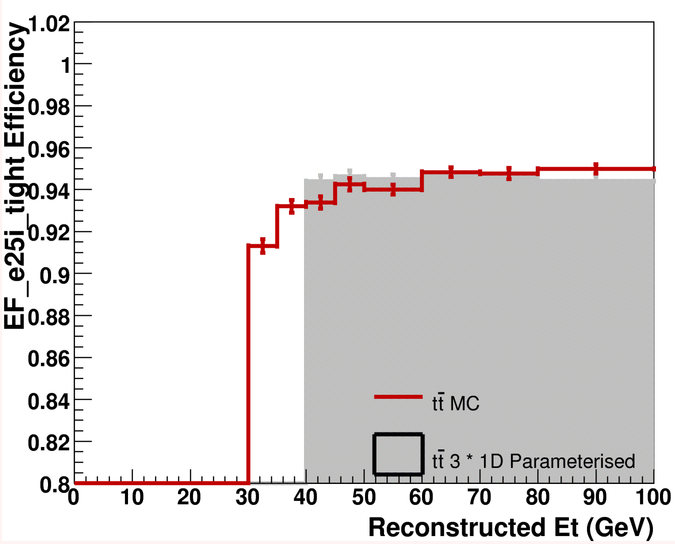
- Apply E_t efficiency, then η, then etcone40.
  - Reduces binning
  - Doesn't account for correlations between variables
- All efficiencies are correlated with E_t pre-turn on. Therefore look at plateau efficiencies.

$$\mathbf{Eff}(et,\eta,etcone40) = (\mathbf{Eff}(et) * \mathbf{Eff}(\eta) * \mathbf{Eff}(etcone40)) / ((\int \mathbf{Eff})^2)$$

Sample	Monte Carlo	error	3*1D parameterised	error
$Z \rightarrow ee$	96.94	0.04		
ttbar	94.39	0.10	94.52	0.10
SU3	93.40	0.34	92.49	0.36

- **Differences O(%)**
- Same O() of agreement as 3D.
- Systematics need study.
- **Prelimenary**





Parameterised Efficiencies Conclusions

- 0D and 1D trigger efficiency is not the same in Z→ee and SUSY events.
  - Systematic O(5%) reduction for EF_25i_tight in SUSY events.

- Trigger efficiency determined in E_t, η and Etcone40 removes systematic reduction caused by isolation and determines efficiency to within 1%.

- Prelimenary work indicates that 3*1D parameterisation can be used instead of 3D to reduce binning.
  - Needs further study.

Lepton Triggers for Early running (10^{31})

- '*10^{31} Menu:* the menu to be used in the first 2009/2010 physics run taking few pb^{-1} to 100's of pb^{-1} of 10TeV collisions with all backup items'

- Electron information from Andrew Hamilton TAPM egamma 19/01/09

- Triggers from;
  - https://twiki.cern.ch/twiki/bin/view/Atlas/L31TriggerMenu

- Rates for 10^{31} menu at 14 TeV with 14.4.0
  - http://www-hep.uta.edu/~brandta/ATLAS/Rates/Rates-14p4p0-1031.html

Trigger	Rate	Prescaled	Motivation
2e5_medium	~2Hz	no	J/Ψ, Υ, Drell-Yan
e10_medium	~27Hz	no	e from b,c for E/p studies. DY.
e20_loose	~6Hz	no	W, Z, top
em105_passHLT	~1Hz	no	exotics
mu10	~21.8Hz	no	W, Z, top
2mu6	~14.8Hz	no	B, DY, J/Ψ, Υ, Z, ttbar
e10_mu6	~0.3Hz	no	WW, leptonic Z→$\tau\tau$

Lepton Triggers for Early running (10^{31})

- George has put together a list of triggers listed in https://twiki.cern.ch/twiki/pub/AtlasProtected/SusyTrigger/susy_analyses_and_trigger.

Signature	Trigger	Notes
trilepton	EF_e10_medium	
	EF_2e5_medium	
	EF_mu10	
	EF_2mu4	
	EF_e10_mu4	
trilepton + Jet	Same as trilepton	Which Jet triggers?

- Backups in case of high rate.

Combined Jet Triggers
- No electron + jet triggers
- mu6_j18 (~7.3Hz)

Combined MET Triggers
- e10_xe30 (~0.3Hz)
- e15_xe20 (~1.44Hz)
- e20_xe15 (~1.75Hz)
- mu15_xe15 (~0Hz)

CSC Note trilepton triggers
- mu20 || e22i (~95%)
- 2mu10 || 2e15i (~50%)

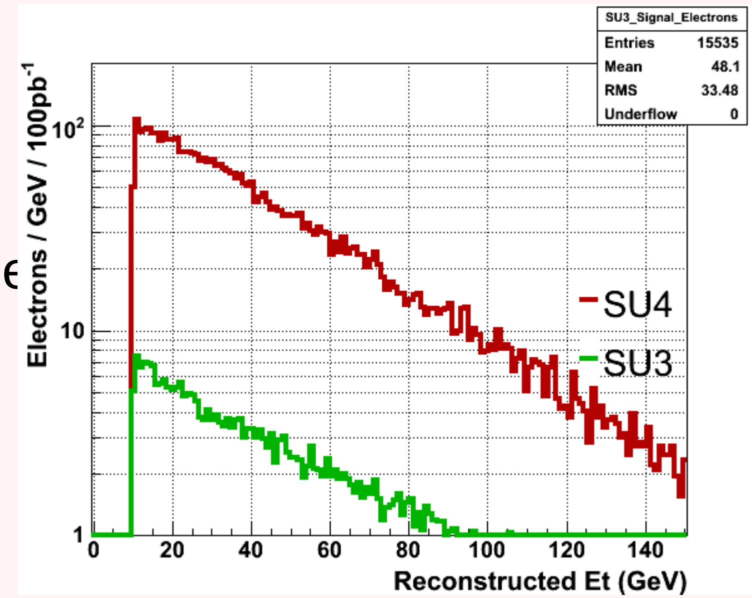
Primary Trigger	Backup Triggers
2e5_medium (~2Hz)	2e5_medium1 (~1Hz) 2e6_medium (~1Hz) e5_e7_medium (~13Hz) (e5_e10)
e10_medium(~27Hz)	e12_medium (~13Hz)
e20_loose (~6Hz)	none
em105_passHLT (~1Hz)	none
mu10 (~22Hz)	mu15 (~6.7Hz)
2mu6 (~14Hz)	2mu10 (~0.1Hz)
e10_mu6 (~0.3Hz)	none (raise thresholds)

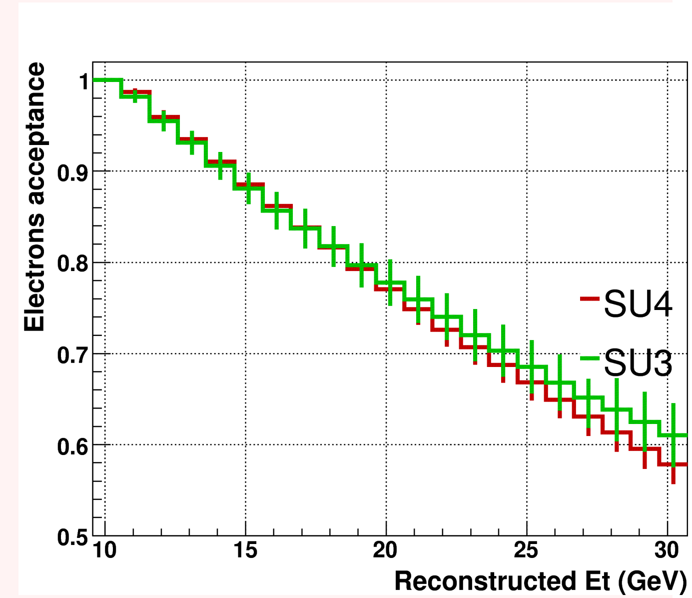
- Thresholds must be increased and/or cuts tightened as instantaneous luminosity increases.

Lepton Acceptance vs P_t Cut

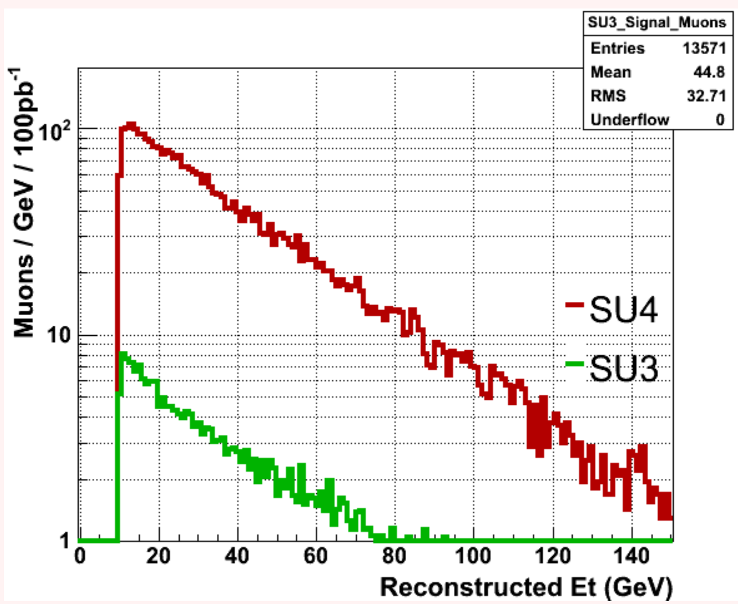
- What is the effect of raising the P_t threshold of the lepton triggers on SUSY signal?

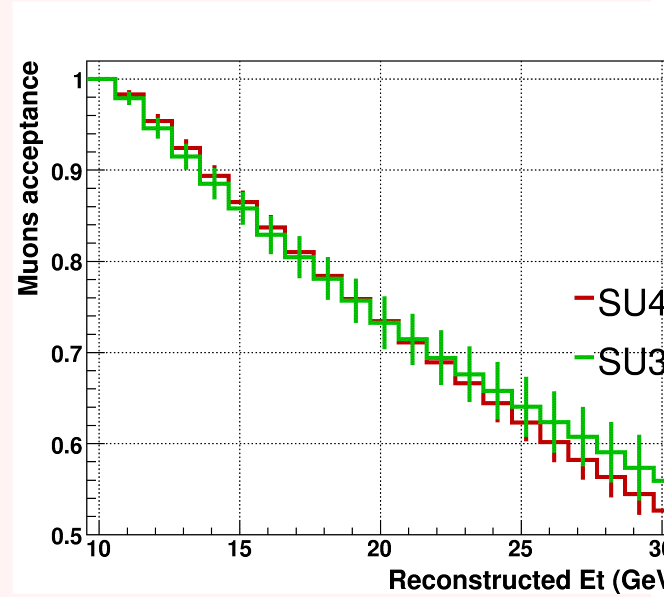
- 10 GeV lepton inserter cut.
- For **electrons** raising the offline P_t cut to **12 GeV** reduces acceptance to around **96%**





- For **muons** raising the offline P_t cut to **15 GeV** reduces accepectance to around **86%**





- **This doesn't account for Trigger resolution.**

Trilepton Acceptance vs P_t Cut

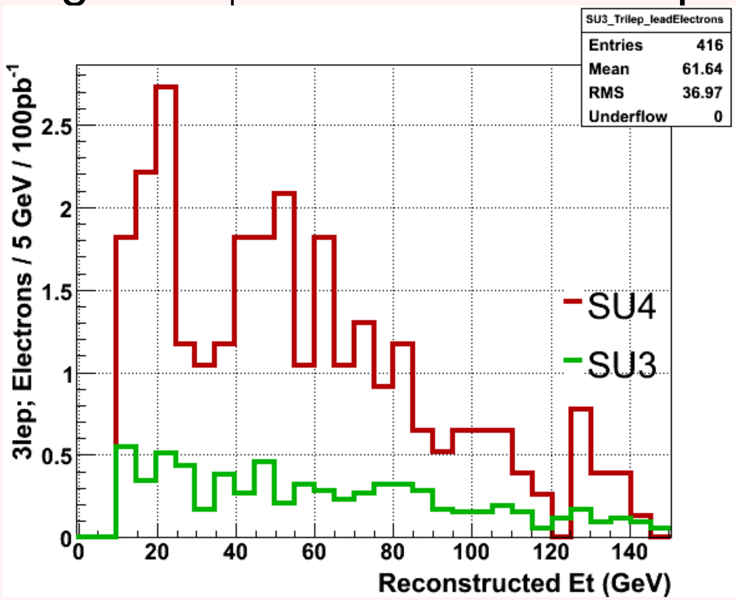
- What is the effect of raising the P_t threshold of the lepton triggers on SUSY inclusive trilepton signal?

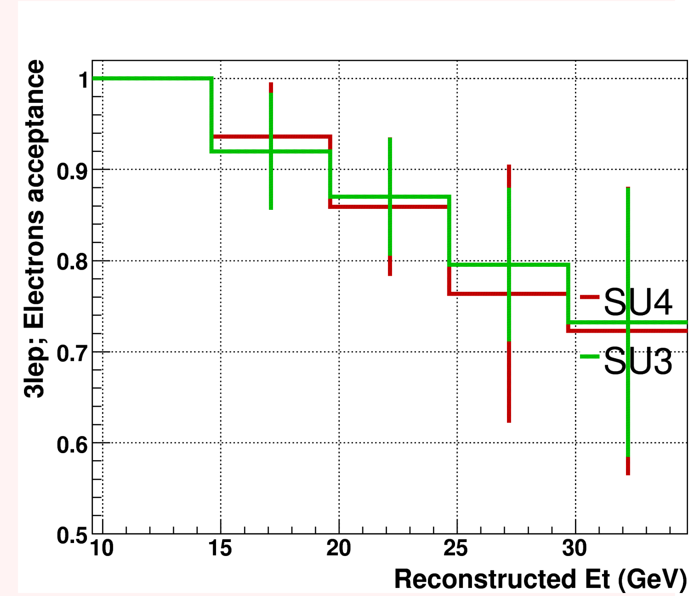
- 3 lep, 1 jet P_t > 200GeV
- No truth or trigger normalisation

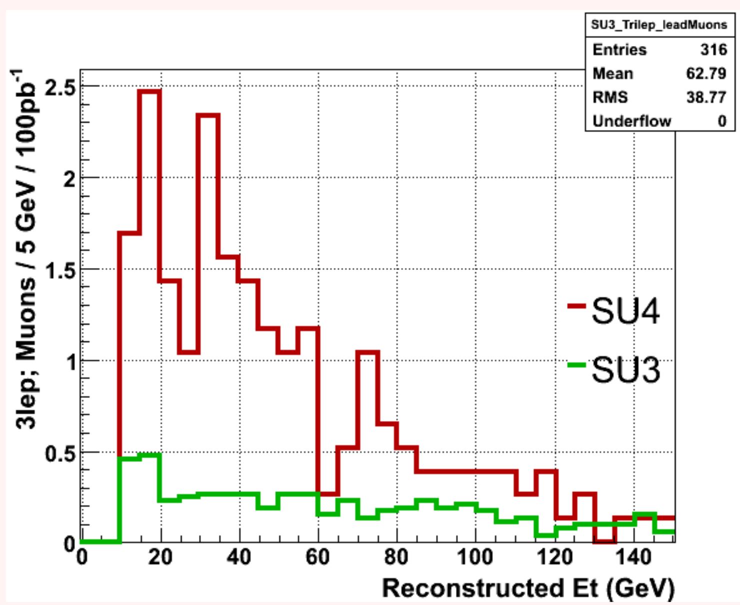
- **Electrons** raising the offline P_t cut to **12 GeV** reduces **leading electron** acceptance to ~ **96%**

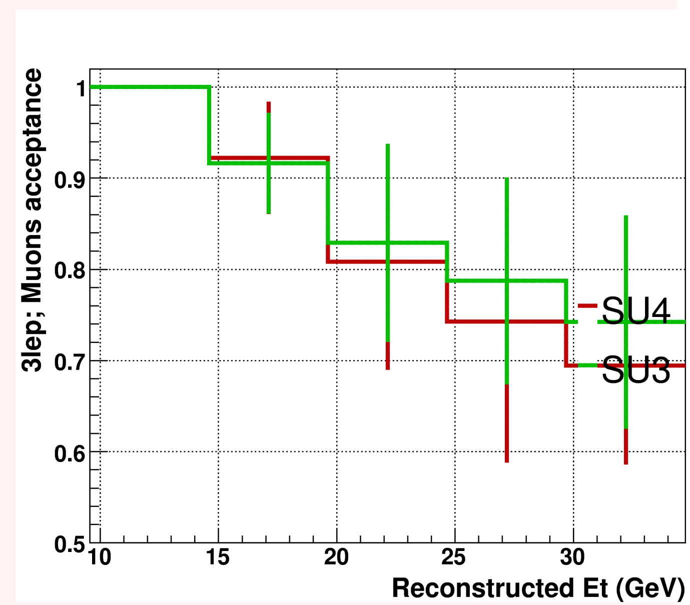
- For **muons** raising the offline P_t cut to **15 GeV** reduces **leading muon** accepectance to ~ **92%**

- **This doesn't account for Trigger resolution.**







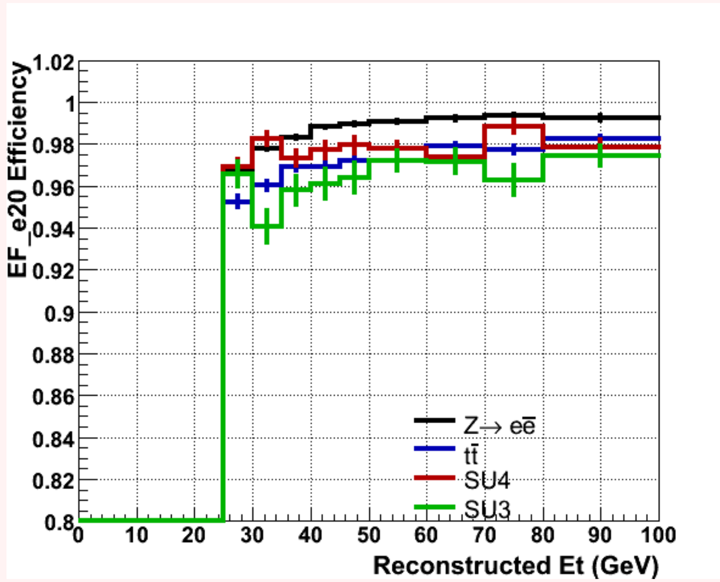


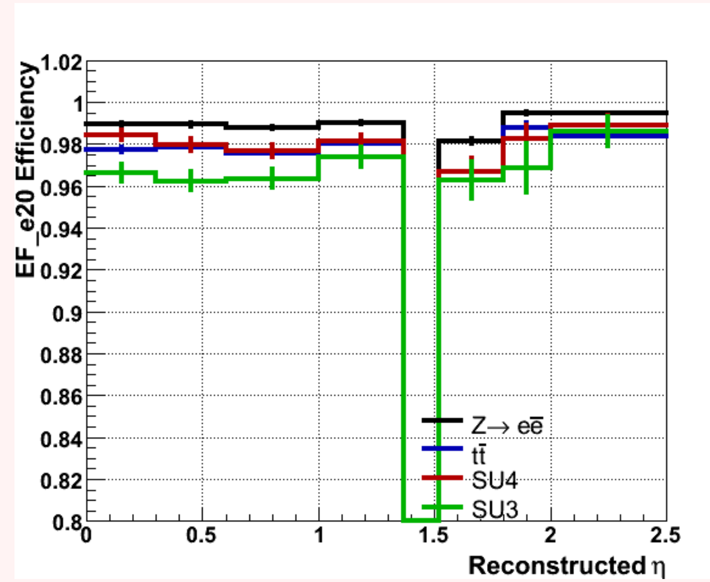
1D Efficiencies EF_e20 (EF_e20_loose in 14)

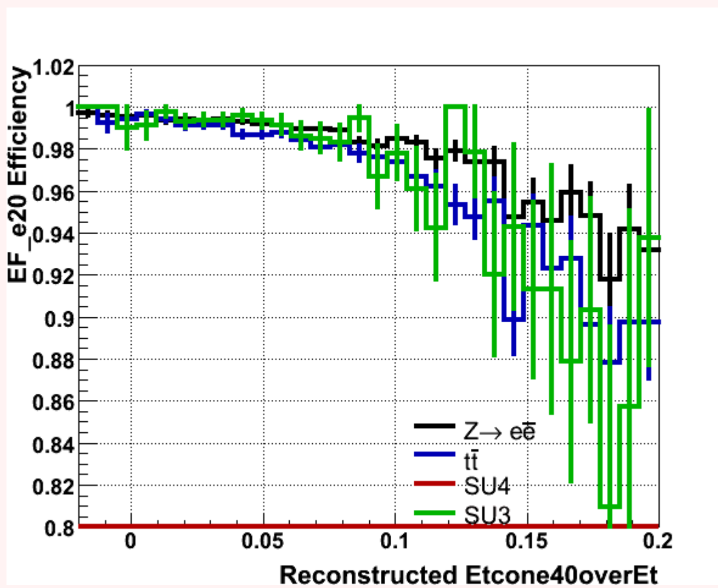
Sample	Efficiency	error
$Z\rightarrow ee$	98.98	0.03
ttbar	97.73	0.06
SU3	98.00	0.12
SU4	96.65	0.21

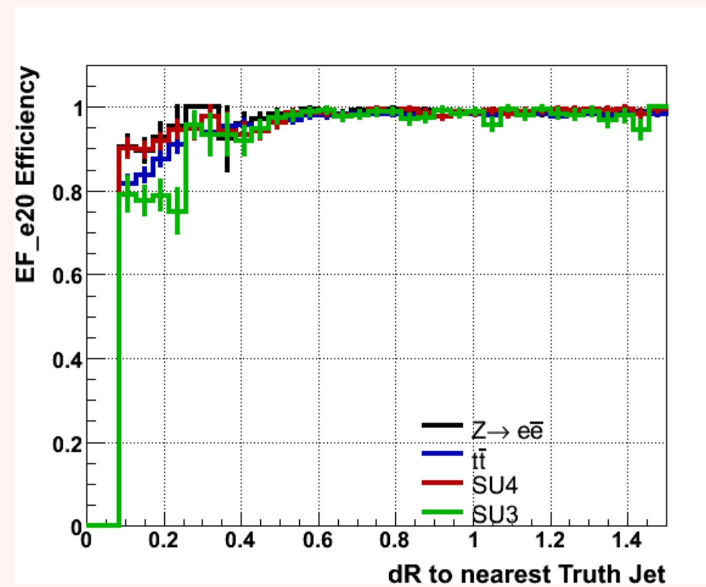
- 0D and 1D efficiencies show **1→2% differences**

- Much less difference than seen for e25i_tight as this is an unisolated trigger.









Parameterised Efficiencies

2D

Sample	Monte Carlo	error	2D parameterised	error
Z→ee	98.97	0.03		
ttbar	97.56	0.07	99.08	0.04
SU3	96.85	0.24	99.07	0.13
SU4	97.87	0.14	99.06	0.1

Differences 1→2%

3D

Sample	Monte Carlo	error	3D parameterised	error
Z→ee	98.97	0.03		
ttbar	97.56	0.07	98.16	0.06
SU3	96.85	0.24	97.57	0.21

Differences < 1%

3*1D

Sample	Monte Carlo	error	3*1D parameterised	error
Z→ee	98.97	0.03		
ttbar	97.56	0.07	98.08	0.06
SU3	96.85	0.24	97.36	0.22

Differences < 1%

Summary and Conclusions

- 0D and 1D trigger efficiency is not the same in Z→ee and SUSY events.
  - Systematic O(5%) reduction for EF_e25i_tight in SUSY events.

•Trigger efficiency determined in E_t, η and Etcone40 removes systematic reduction caused by isolation and determines efficiency to within 1%.

- Can be done in 3D or alternatively for low statistics 3*1D.
  - 3*1D needs further study.

- No issues with proposed 10^{31} lepton triggers.
  - As menu evolves to higher luminosities cuts will have to tighten.

- Prelimenary studies into acceptance effects of raising trigger Pt thresholds have begun.

- Non isolated triggers for use in the 10^{31} menu show smaller systematic deviations in 0D efficiency between Z→ee and SUSY events (O(1→2%)).

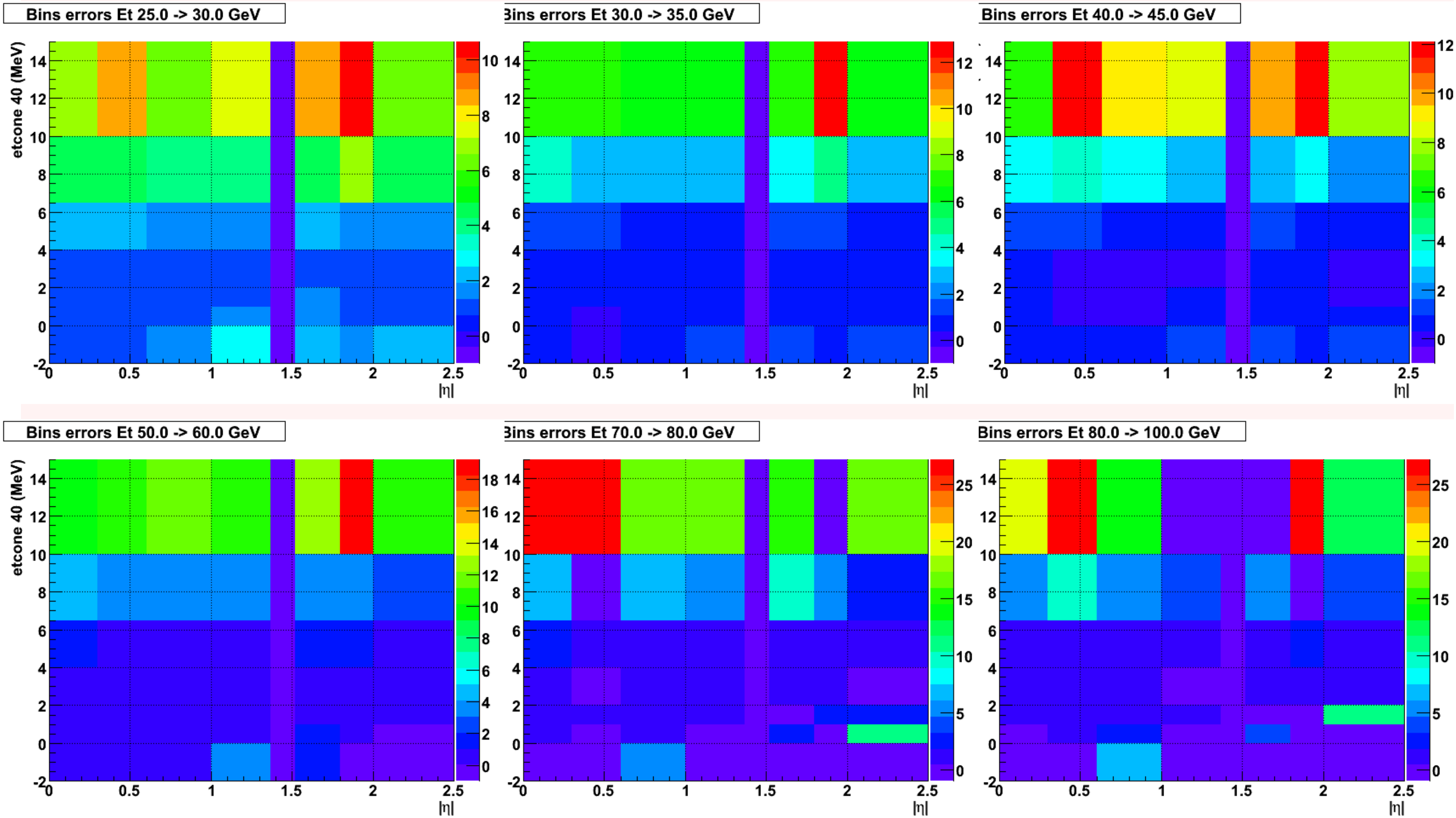
•Non isolated trigger efficiency can be determined to within 1→2% by 2D parameterisation or to within 1% using the 3D same methods as for isolated triggers.

•Alternative methods of efficiency determination should be considered such as bootstrap or orthoganal trigger methods.
  - Statistics needed (Rejection factors)?

Backup slides

3D Parameterised look at the efficiency Matrix

Zee full MC – look at Magnitude of error axis



Are Et, eta and etcone40 corrolated?

•A corrolated variables (in terms of trigger efficiency) are when efficiency is a simultaneous function of variables.