

ATLAS-D Meeting
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Electron Trigger efficiencies from $Z \rightarrow ee$ in data



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- **Introduction:**
 - The ATLAS Trigger
 - Trigger efficiencies from data (Tag & Probe)
- **Results without background**
 - Comparing Tag & Probe with MC truth
 - Application to other physics processes
- **Including background (first approach...)**
- **Summary**

The 3 Level Trigger System of ATLAS :

LVL1:

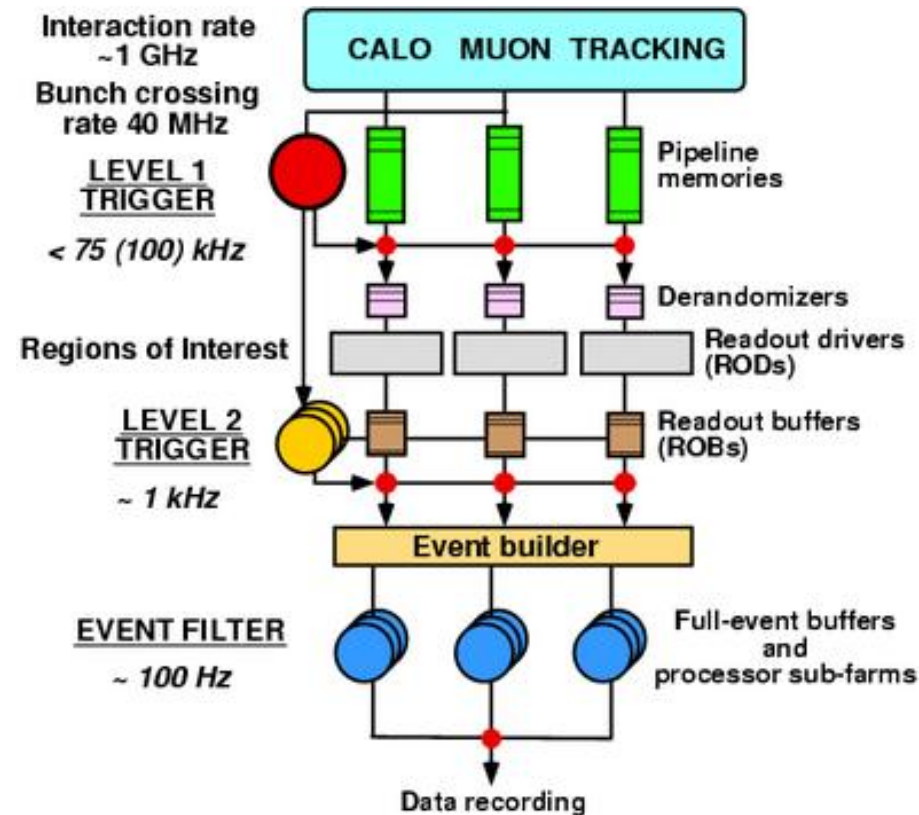
- Hardware based.
- Coarse Information from calorimeters and muon trigger chambers.
- Identifies Regions of Interest (RoIs).

LVL2:

- Based on optimized software algorithms.
- Full granularity data in RoIs.

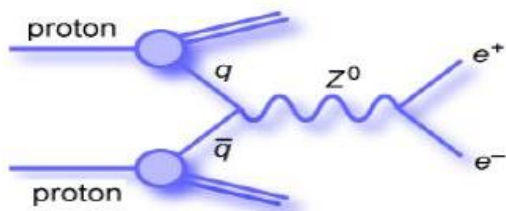
Event Filter:

- Uses complex software algorithms
- Performs its task after whole event has been assembled in the Event builder.

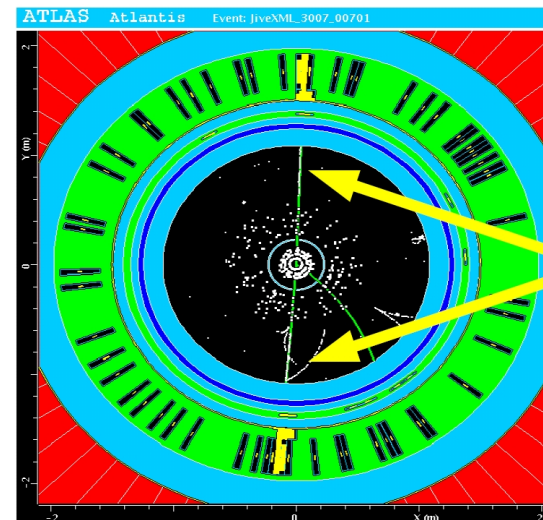


The trigger rejects 99.9995% of the events!
Crucial for data taking to know its (in-) efficiencies!

- In general: trigger efficiencies should be extracted from data, not from MC!
- One method to do this is the so called tag & probe method:



e25i: Isolated electron
with a P_T of at least 25GeV



- In an offline analysis require:
two reconstructed electrons with $M_{inv} = M_Z \pm 20\text{GeV}$
- Require that event has been triggered by "Tag" electron (e25i)
- Determine trigger efficiency with "Probe" electron (2e25i)

Does this method introduce a bias?
Compare with truth matched electrons:

Ntuples produced with **HighPtView**

Dataset used: trig1_misal1_csc11.005144.PythiaZee.recon.AOD.v12000601_tid00599

● selection offline:

- isEM==0, tight
- $1.37 < |\eta| < 1.52$ (Barrel/endcap crack excluded)
- $|\eta| < 2.4$ (electrons in inner detector acceptance)
- $70\text{GeV} < |M_{\text{inv}}| < 110\text{GeV}$

● selection MC gen ("truth"):

- 2 offline reconstructed electrons matched to a truth electron

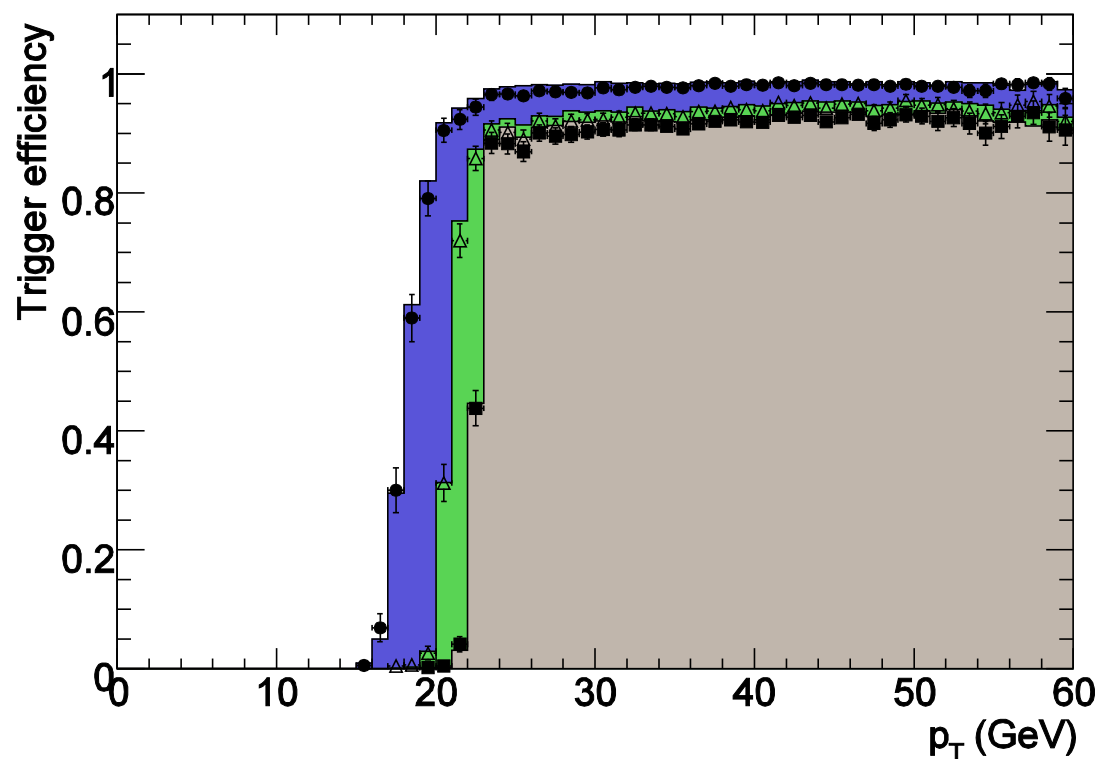
$$\epsilon_{MC} = \frac{\# \text{ triggered truth matched reco electrons}}{\# \text{ all truth matched reco electrons}}$$

...if event is triggered by the 'tag' electron:

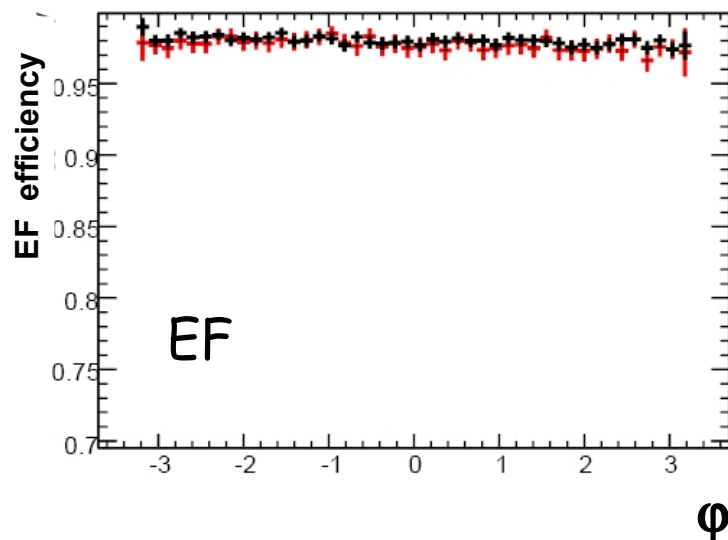
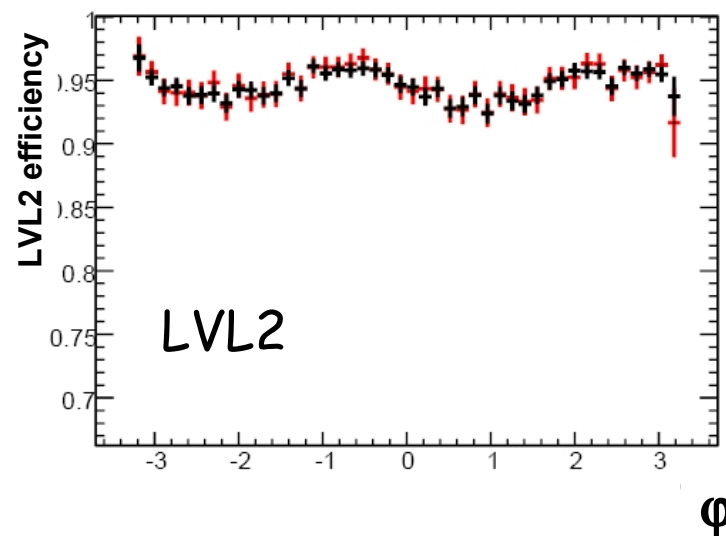
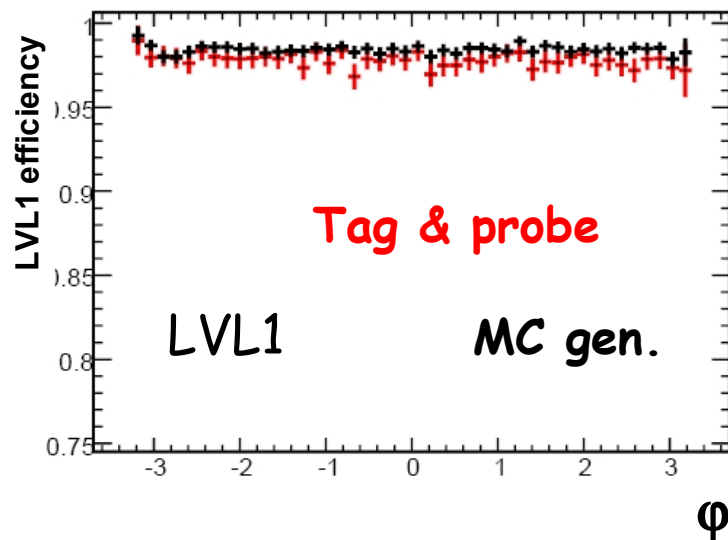
$$\epsilon_{T\&P} = \frac{\# \text{ triggered reco 'probe' electrons}}{\# \text{ all reco 'probe' electrons}}$$

Our contribution to the detector paper:

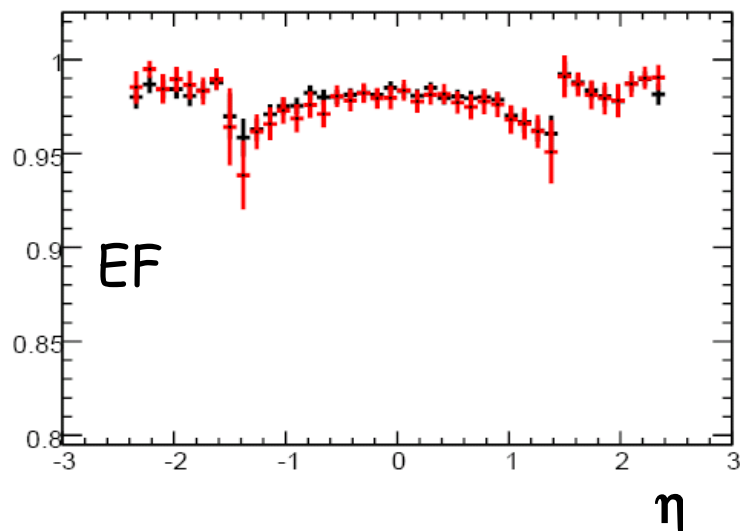
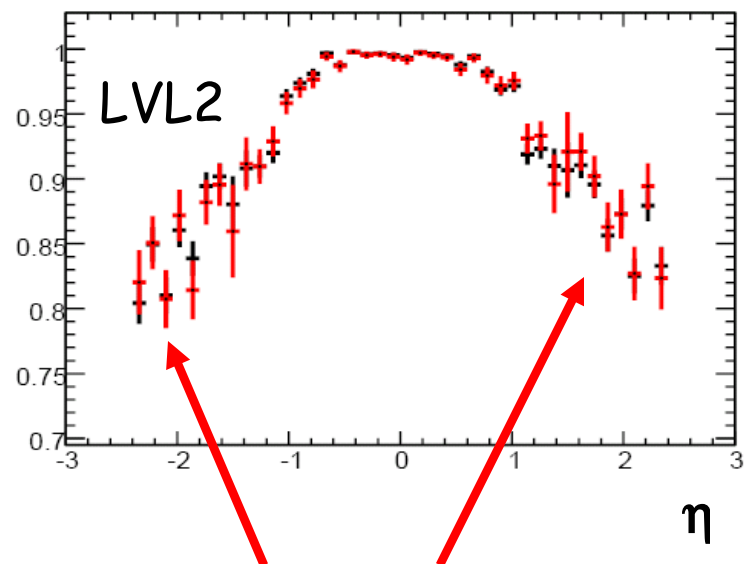
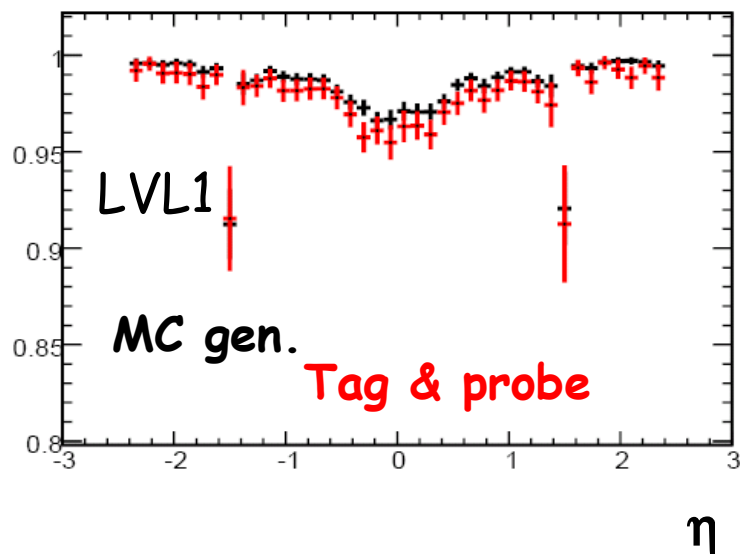
- Normalized to offline selection.
- plotted: $P_{T,REC}$
- Histograms: MC
- Dots: Tag & Probe
- e25i efficiency for
 - L1
 - L1 + L2
 - L1 + L2 + EF
- loss in L2 due to L2 tracking bug in Rel 12. (fixed in Rel 13)



....Method seems to work fine!



- Efficiencies with respect to previous trigger Level output $P_T > 25$ GeV in plateau.
- small differences (0.5% level) in LVL1 to be investigated.



L2 Tracking bug in Rel 12 clearly visible
(efficiency loss in end-cap region)

→ Efficiencies obviously η dependent!

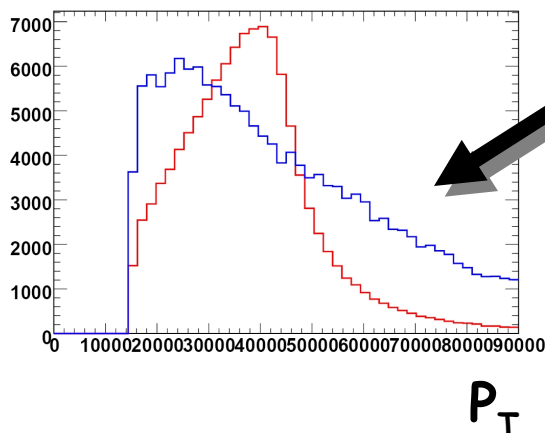
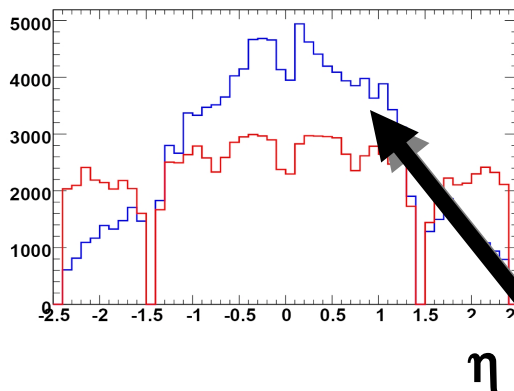
**Good agreement of both methods
on all Trigger levels!**

Application to other physics processes

Compare $t\bar{t}$ events to $Z\ell\ell$

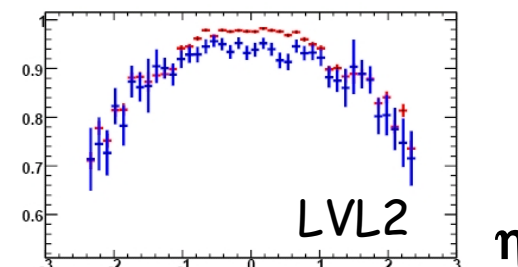
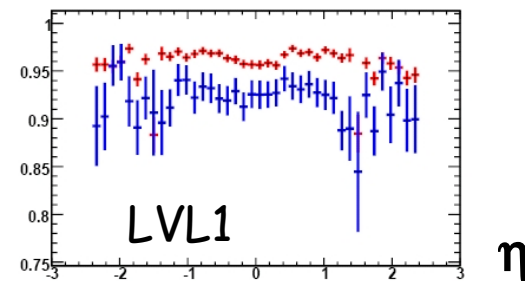
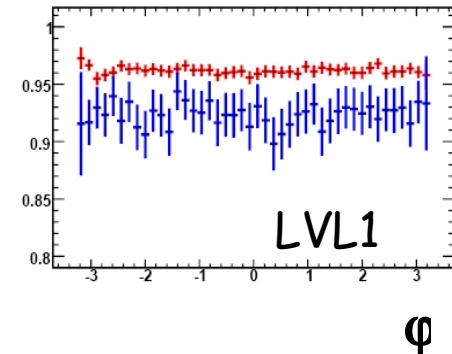
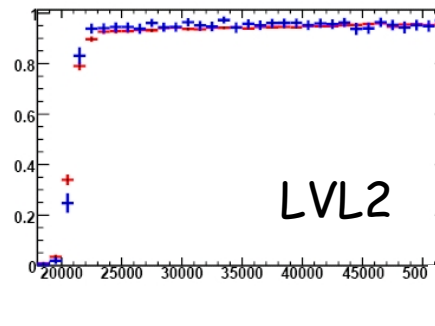
Distributions:

Inclusive efficiencies:



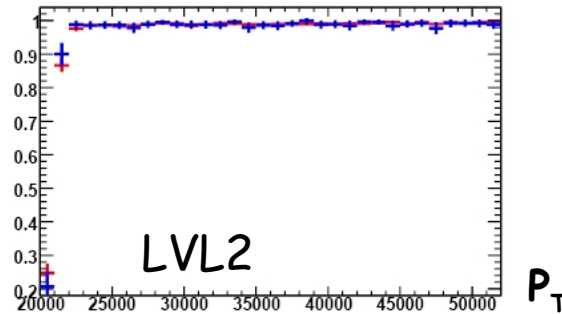
electrons from $t\bar{t}$:

- more central
- tail to higher P_T
- Considerably amount of electrons have low P_T .



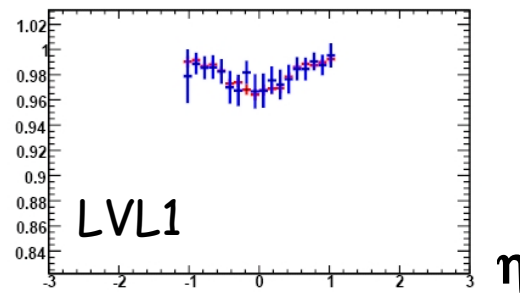
Idea: If the electron efficiency is properly parametrised as a function of the correct variables, then it should be independent of the physics process.

$$|n| < 1$$

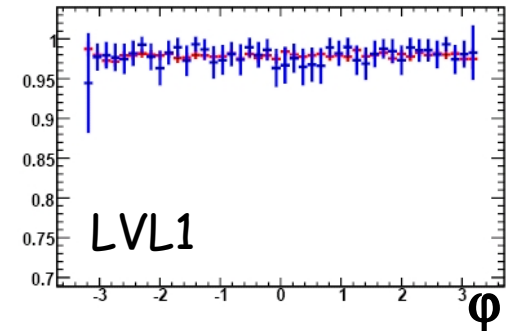


Further restriction:

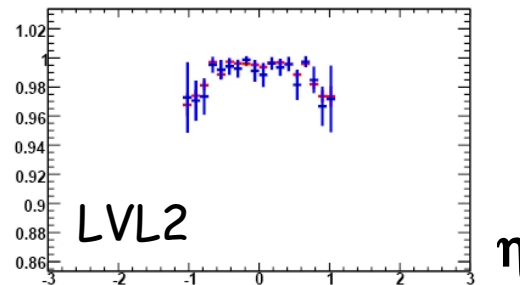
$$|n| < 1 \text{ and } 25. \text{ GeV} < P_T < 70. \text{ GeV}$$



η



ϕ

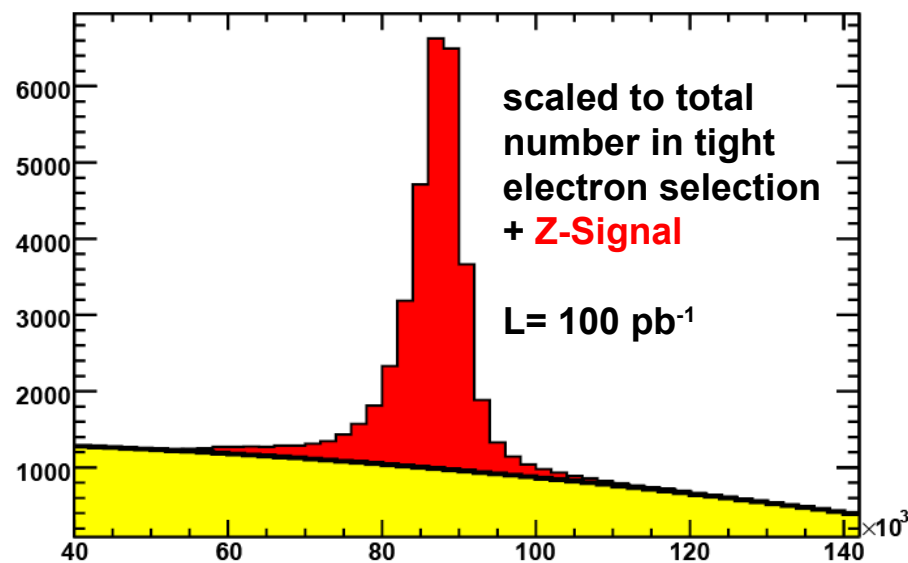
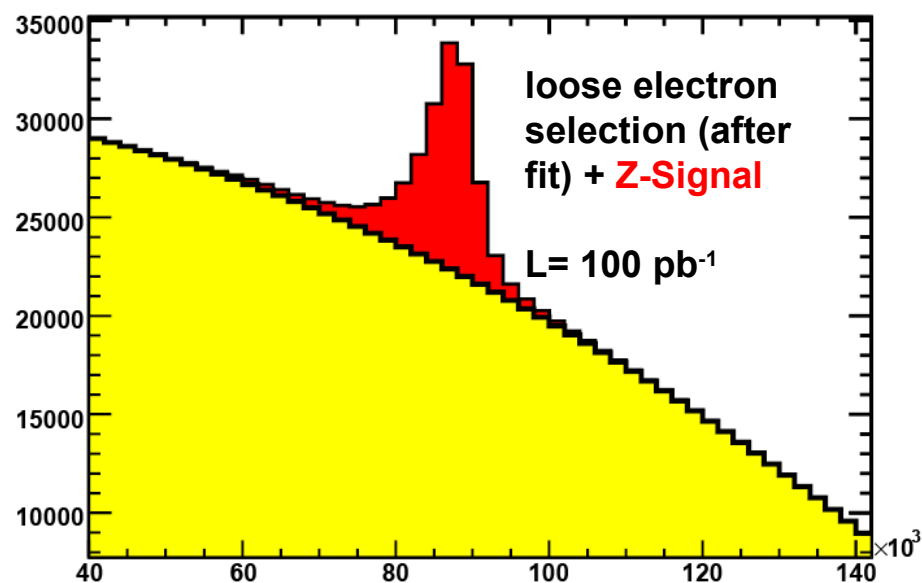


η

..the differential efficiencies from Zee and ttbar are in agreement!

- Main source of background: misidentified **di-jets**.
- Available simulated di-jet sample is by far not big enough for an estimate.
- a rough estimation of the background under the Z-peak is sufficient since we won't have this problem in data.
- Our method:
 - Use the invariant (jet-jet) mass spectrum of inclusive di-jets for the shape.
 - fit the spectrum
 - scale it to the number of events in the tight electron selection.

Next step: sideband subtraction of the background -> First results look promising!



Summary:

- One method to determine trigger efficiencies from data is the 'Tag & Probe' method.
- Results without background are promising and in good agreement with efficiency from generator matched electrons.
- Comparing 'inclusive' efficiencies of $t\bar{t}$ events shows deviations !
- A first step towards parameterization in one (η - p_T) bin shows that efficiency gained from $Z \rightarrow ee$ events is applicable to other processes.

Next Steps:

- Include background.
- Extend parameterization to full phase space (e.g. endcaps).
- Test method with SUSY events.