Search for

$H \to ZZ \to \ell^-\ell^+\ell^-\ell^+$ ($\ell = e, \mu$)

at the ATLAS Detector

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The Higgs Boson

- The Standard Model predicts the existence of a particle called Higgs Boson needed to explain many observed particle properties and processes (mass problem and divergences)

- Direct searches have already been performed at the LEP e^+e^- collider (CERN), and at the Tevatron $p\bar{p}$ collider (Fermilab), but no final conclusions could be drawn

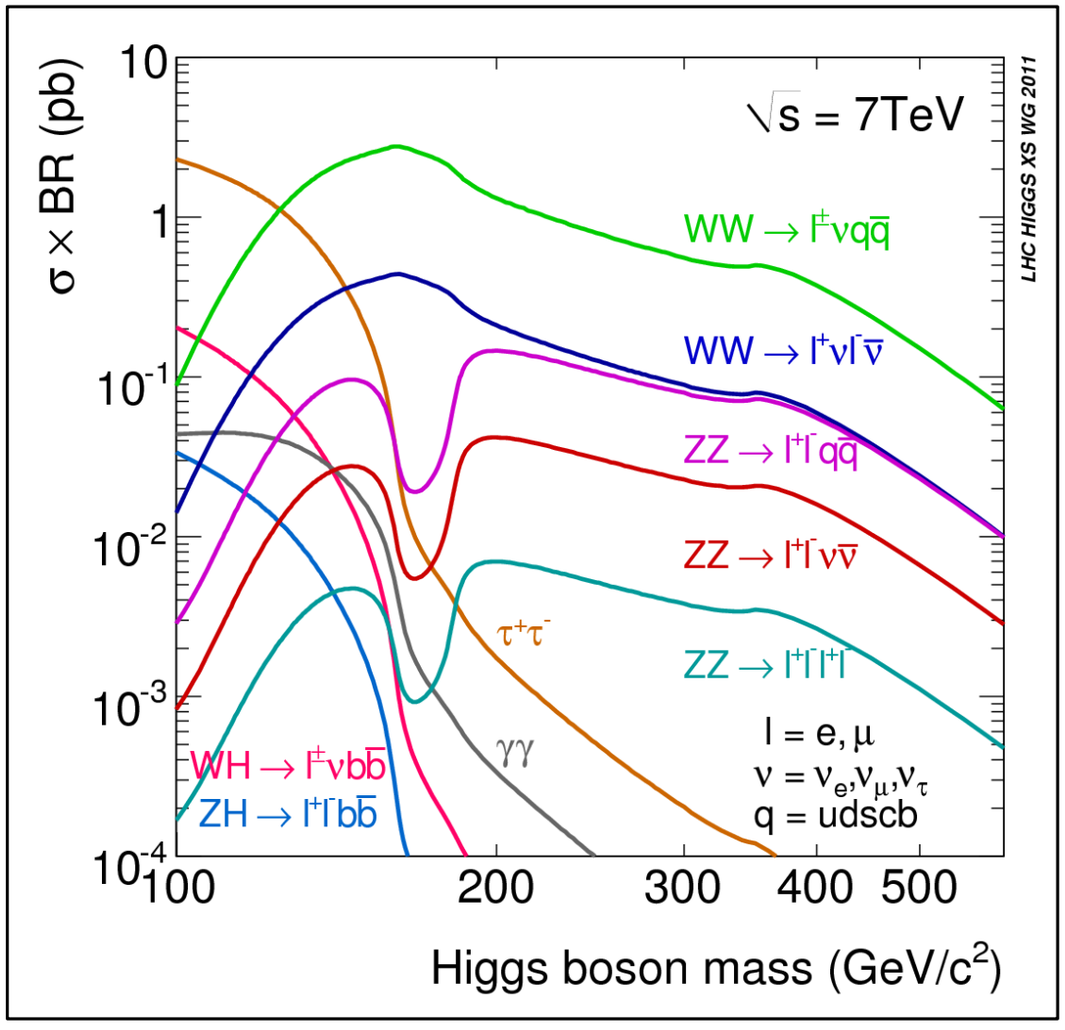
- The discovery or the final exclusion of the Higgs boson is a major goal of the Large Hadron Collider programme

$H \rightarrow ZZ \rightarrow \ell^- \ell^+ \ell^- \ell^+$

- The search for the SM Higgs in the decay channel $H \rightarrow ZZ \rightarrow 4l$ provides good sensitivity in a wide mass range

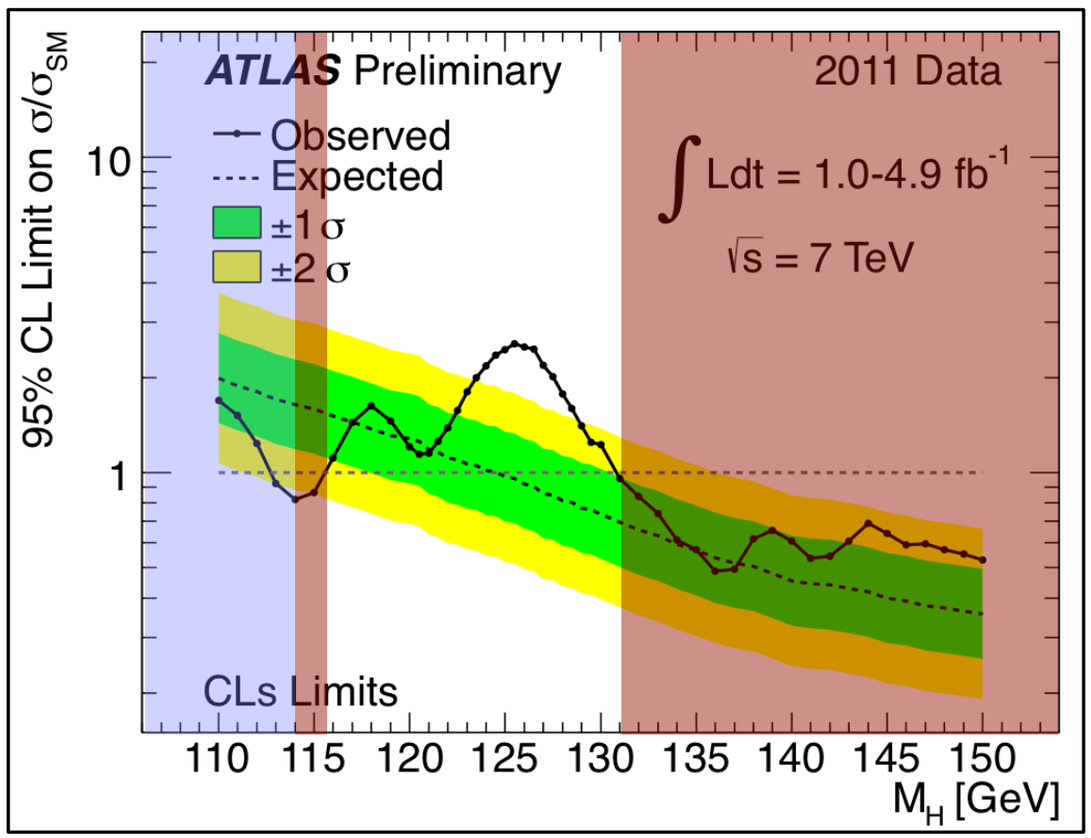
- Mass can be fully reconstructed, events would cluster in a (narrow) peak

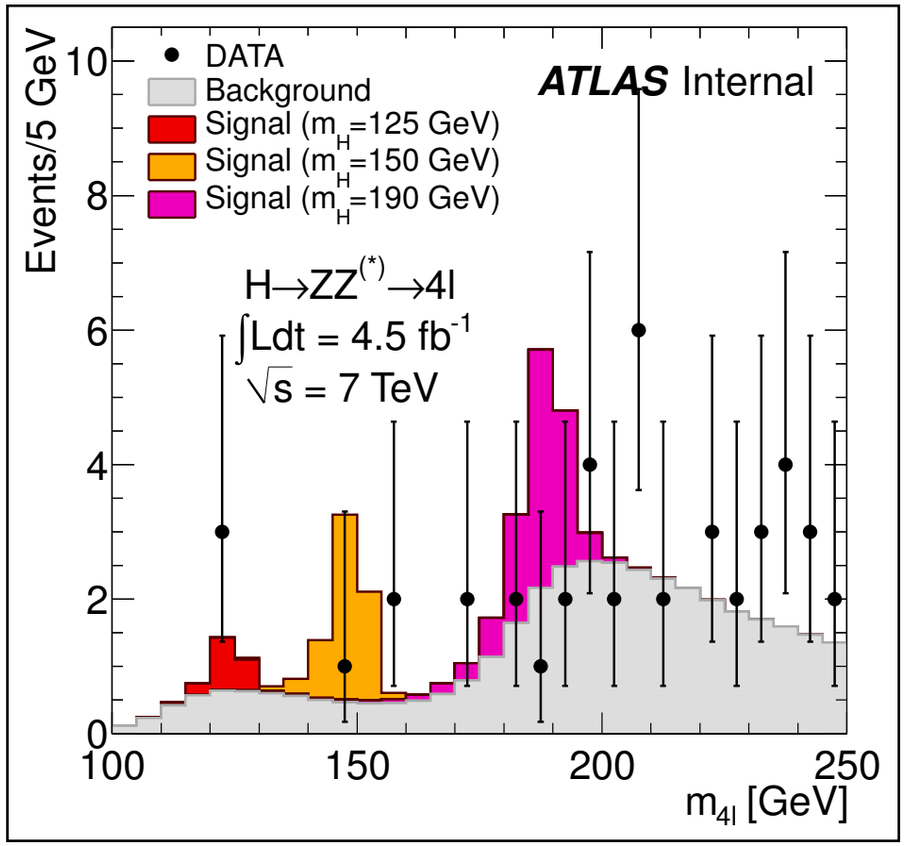
- Pure channel: Signal/Background ~ 1



Higgs Searches Status

- We observe an excess of events around M_H~126 GeV
- The global significance is 2.3 σ with contributions from the $H\to\gamma\gamma$, $H\to ZZ^*\to 4\ell$, $H\to WW^*\to \ell\nu\ell\nu$ analysis



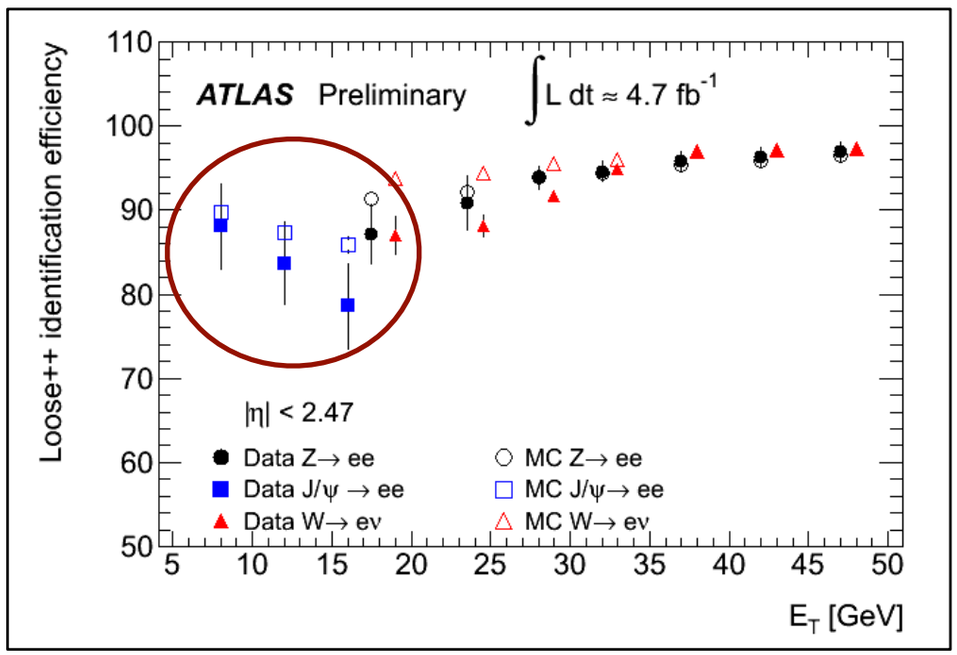


Crucial Experimental Aspects

- High lepton reconstruction and identification efficiency down to lowest p_T
  - It is crucial to understand low p_T electrons, strongly affected by material effects
- Good lepton energy/momentum resolution
- Good control of reducible backgrounds (Z+bb, Z+jets, $t\bar{t}$) in low-mass region

My Contribution

- We performed truth vs reco studies using J/ψ to validate the new brem refitting alghoritm
- We are using the “Tag and Probe” method with J/ψ to calculate our electron identification efficiency
- We are performing H→4e background studies to reduce the systematics on fake electrons



Backup

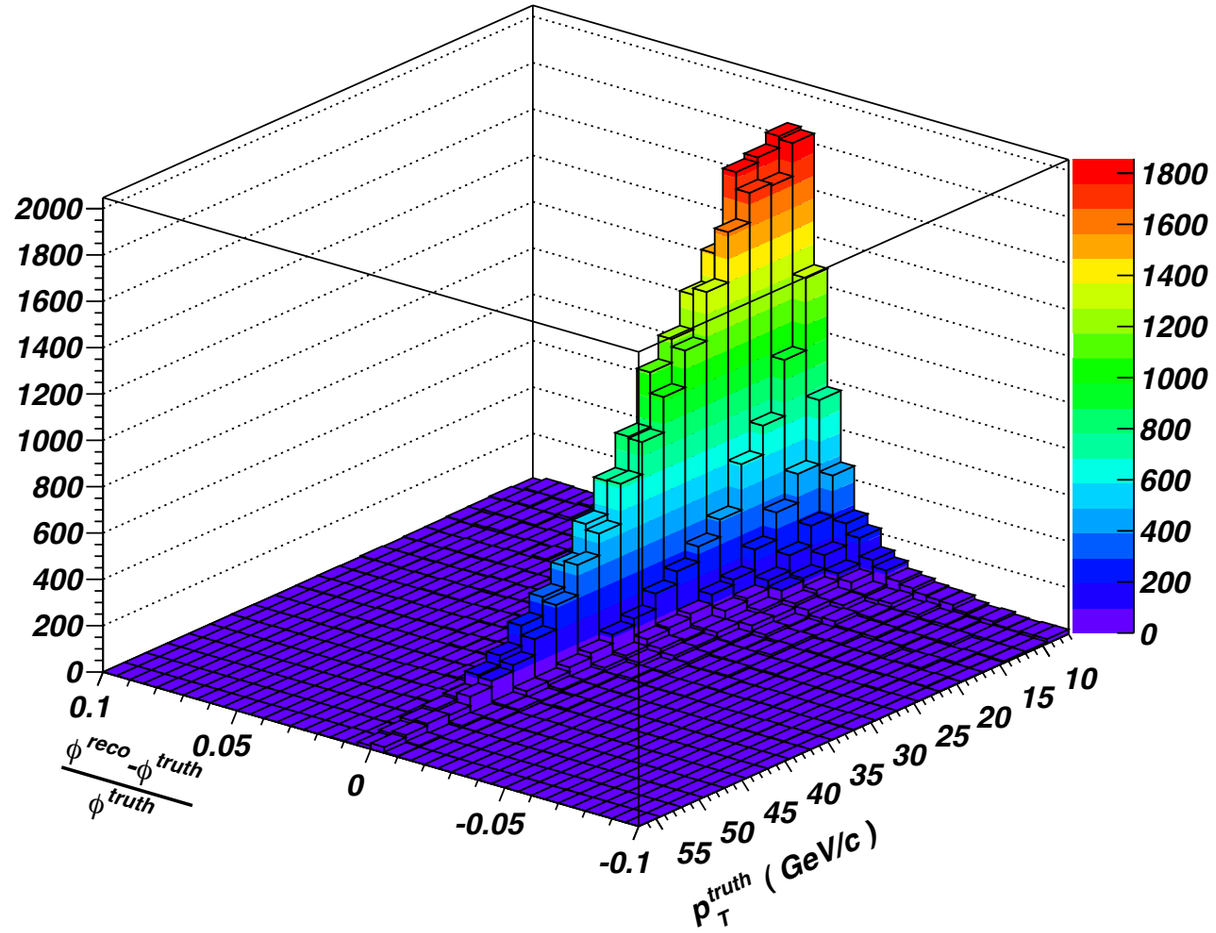
Procedure

- I have studied the following parameters: d_0/σ, φ, q/p, θ, $z \sin\theta$

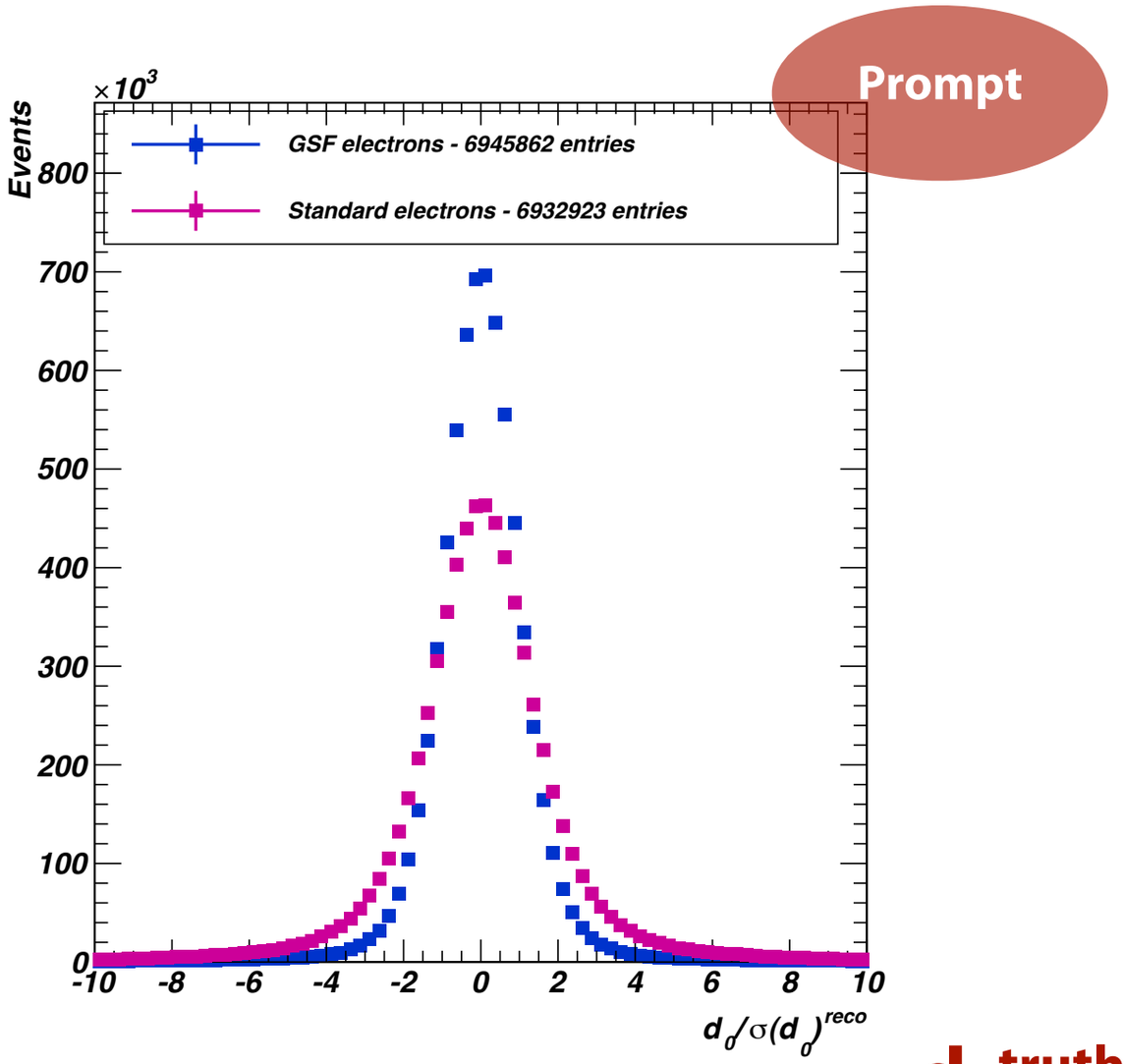
- For each of them, I have built $(X_{reco}-X_{truth})/X_{truth}$ and taken a look at its behaviour as a function of η^{truth} and p_T^{truth}

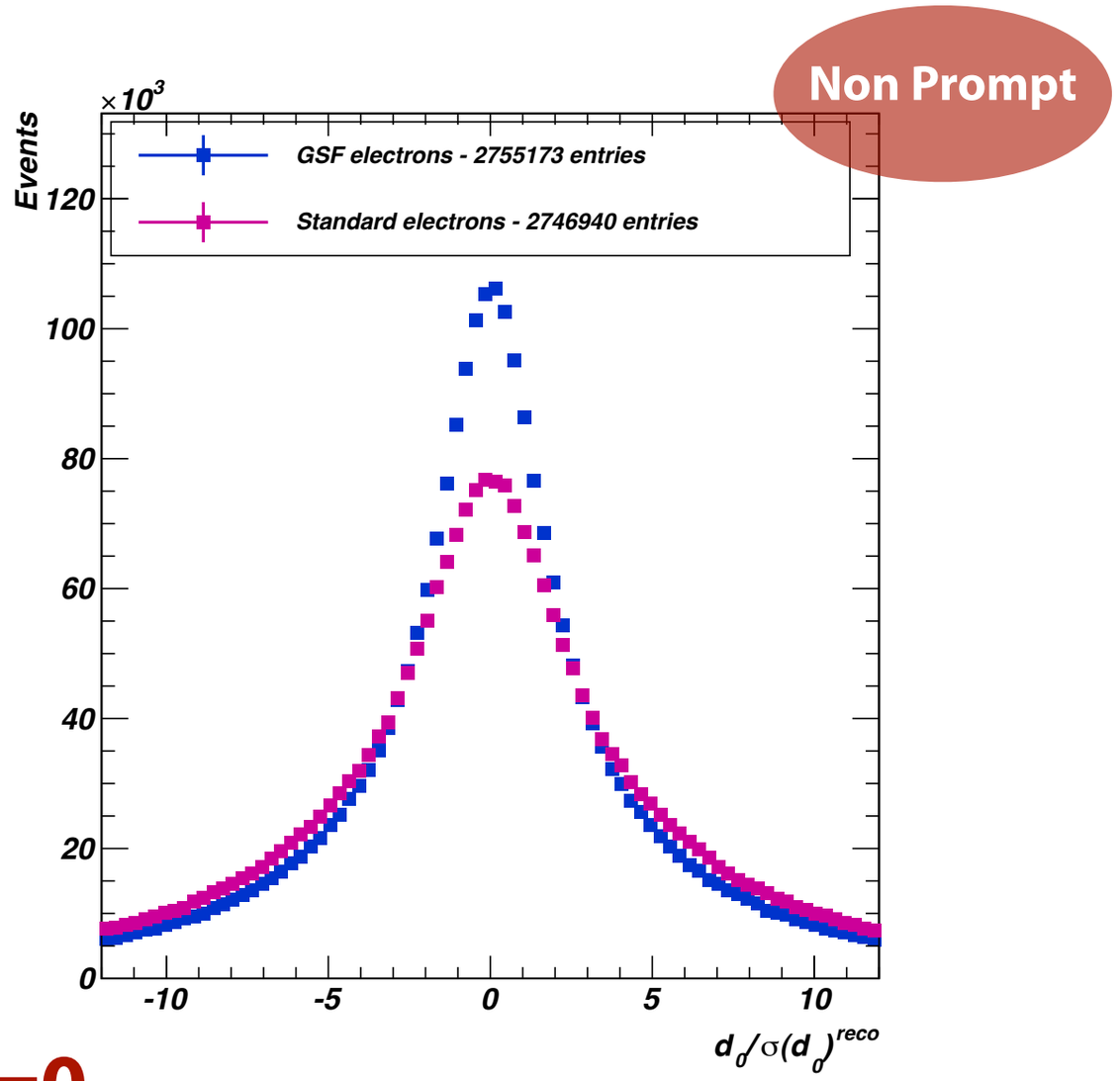
- Fitting each bin in η^{truth} and p_T^{truth} we extract σ and mean value of the distributions

- Studies done for all the isEm menus, here I will show only loose++ results.

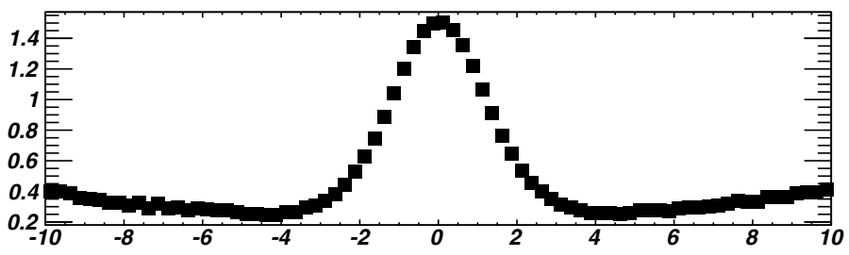


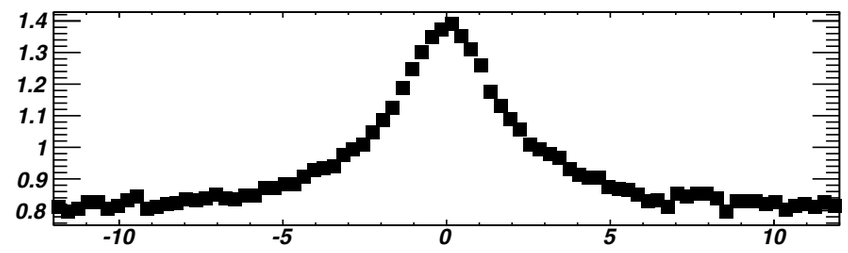
d_0/σ overall distribution



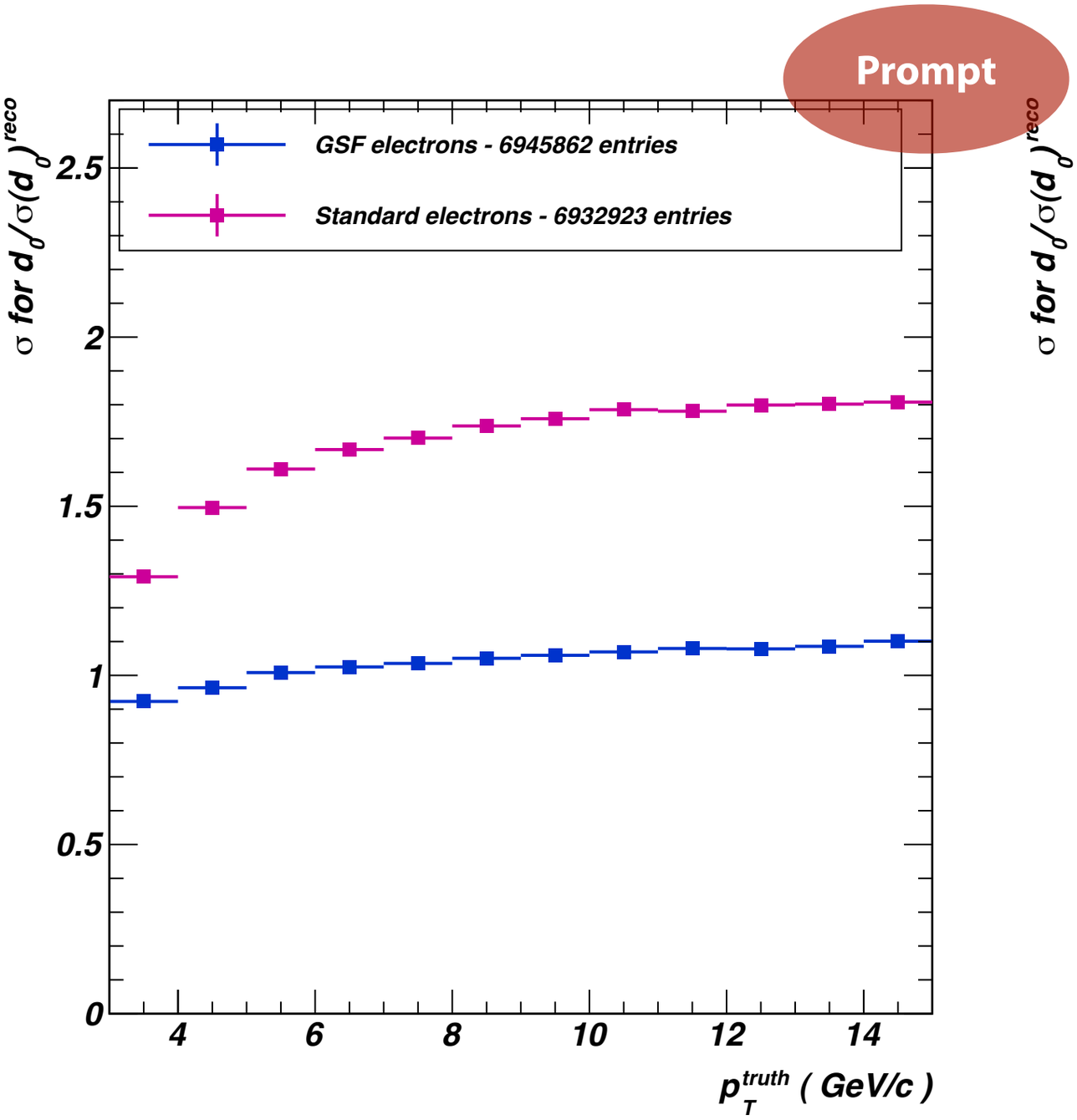


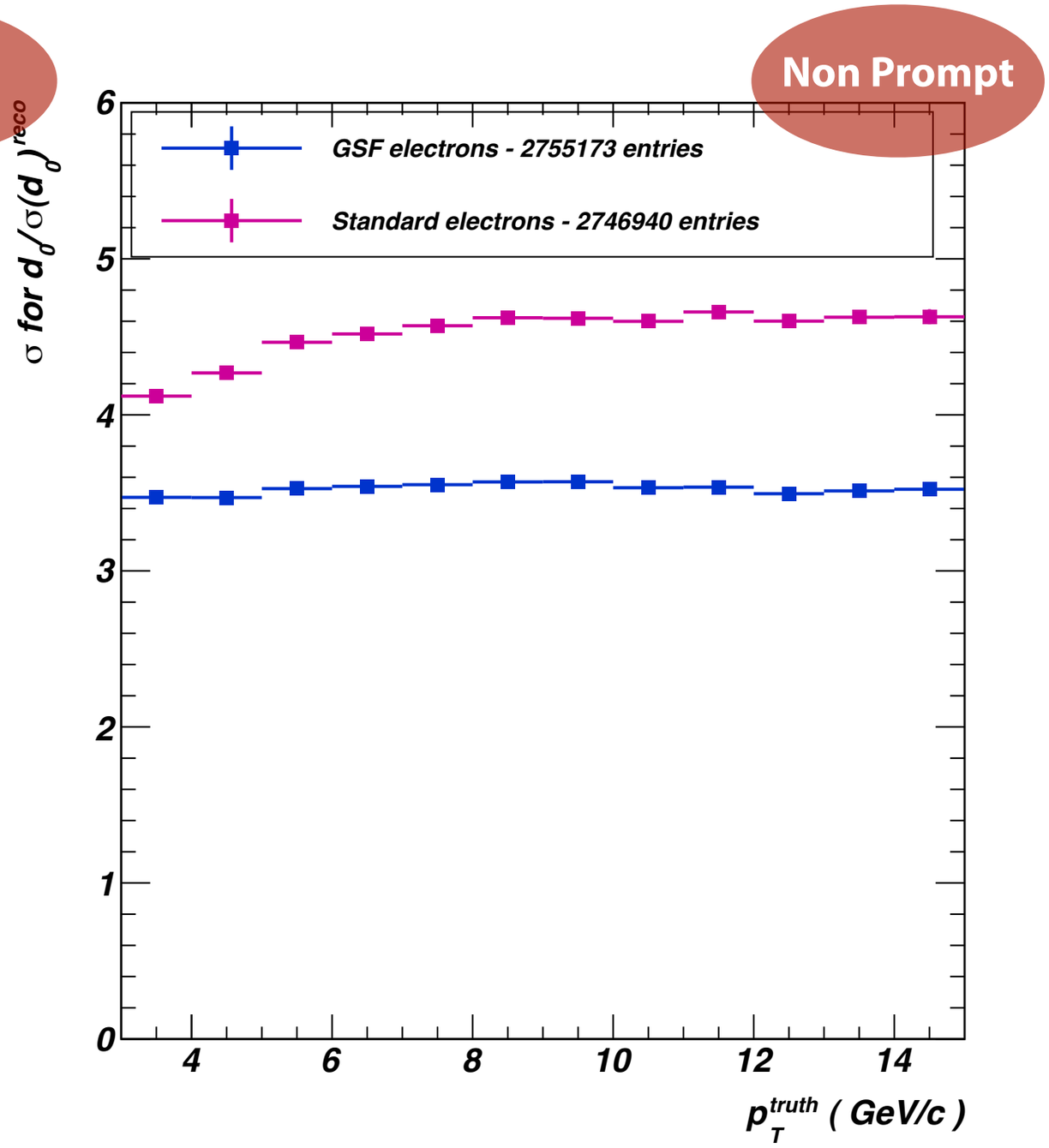
$d_0^{truth}=0$





d_0/σ resolutions vs p_T^{truth}





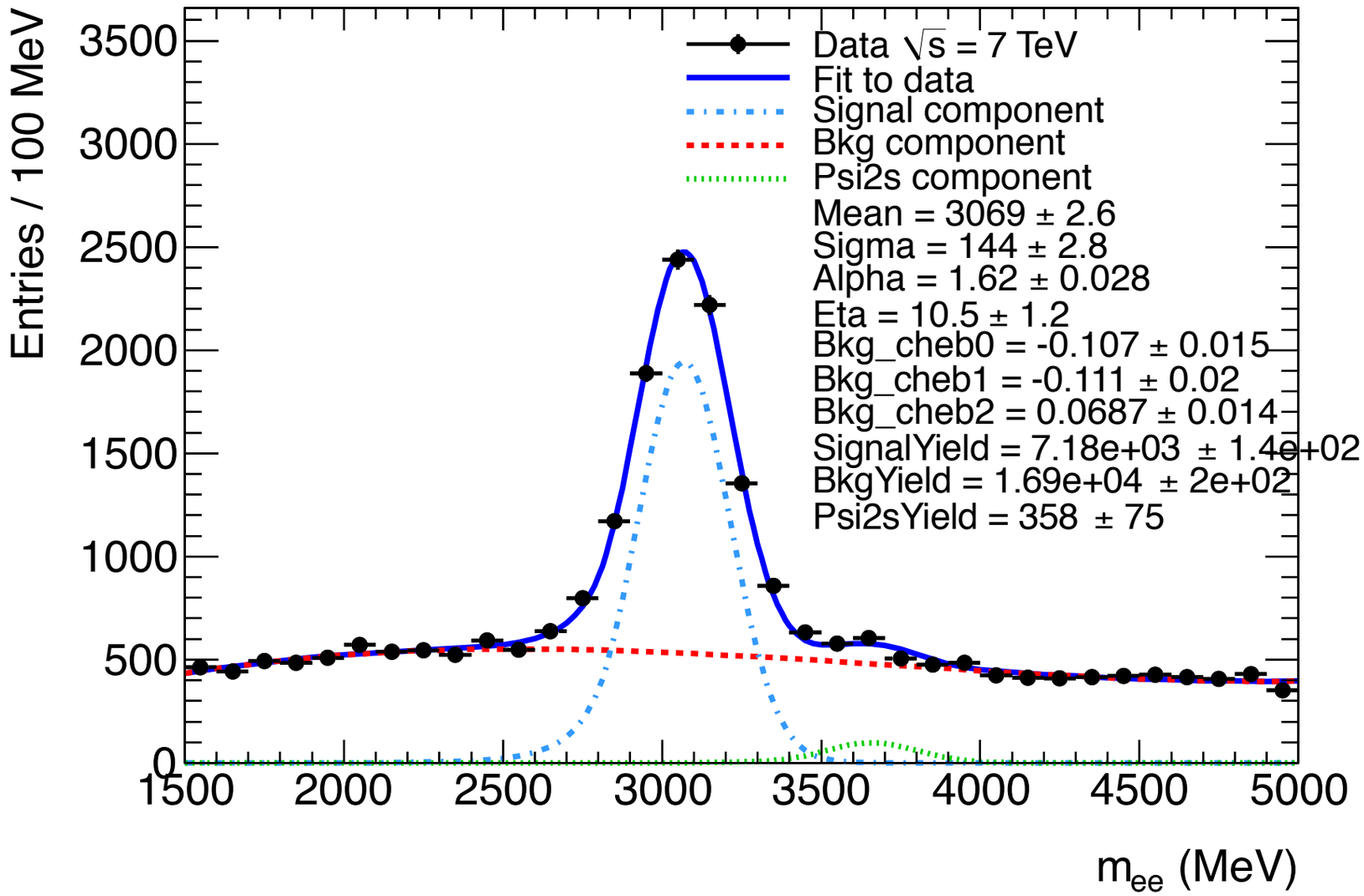
J/ψ Tag and Probe

- J/ψ Tag and Probe is extremely challenging:
  - high background contamination
  - contribution from both prompt and non-prompt J/ψ

- Invariant Mass fit performed to separate signal from background

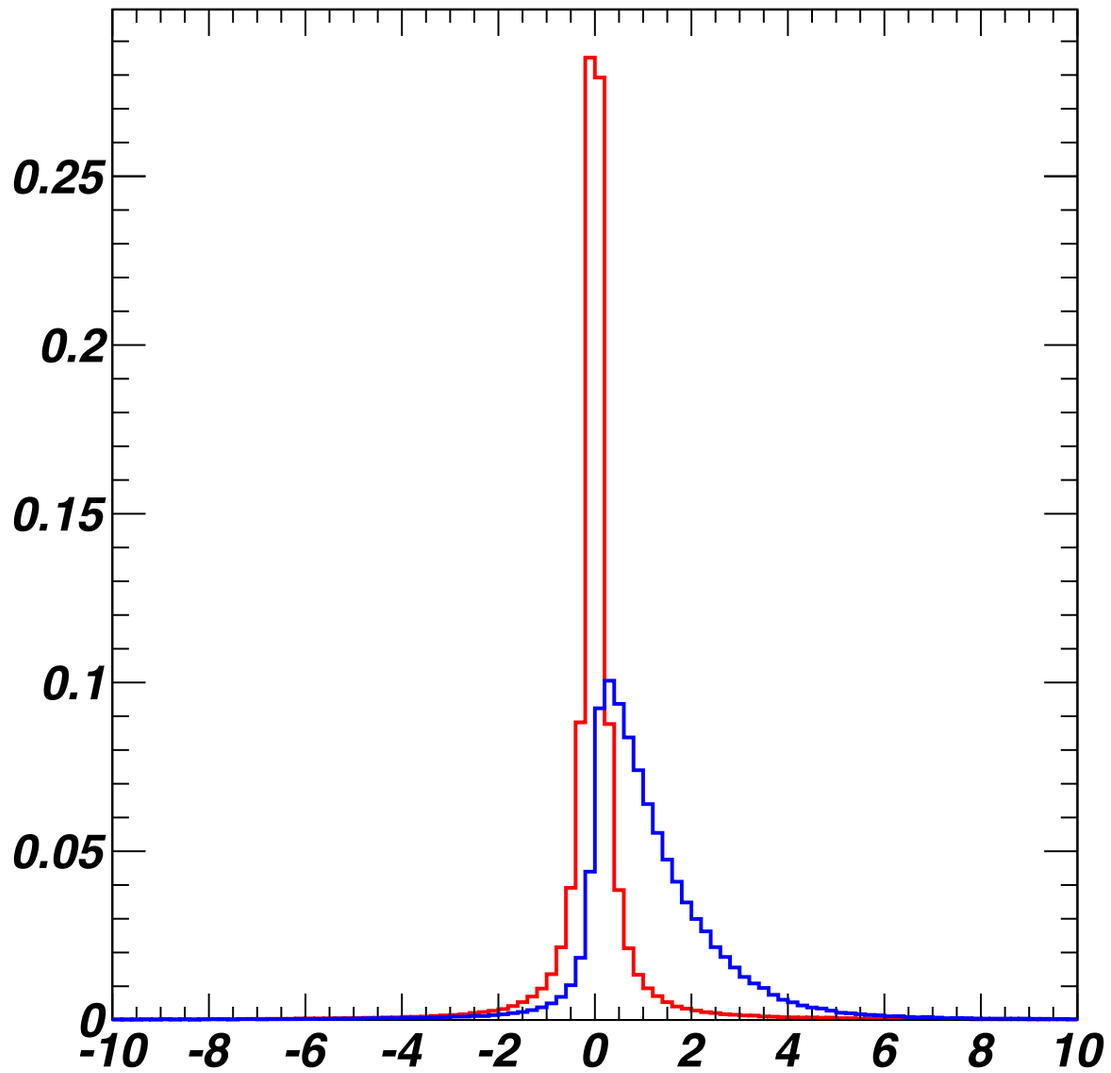
- In previous studies, cut on J/ψ pseudo proper time introduced to reduce non prompt contribution

J/ψ Invariant Mass



- J/ψ signal and ψ(2s) = Crystal ball
- Background = 3rd order Chebychev

J/ψ Pseudo-Proper Time (1)



$$\tau = L_{xy} \cdot m^{J/\psi} / c \cdot p_T^{J/\psi}$$

J/ψ Pseudo-Proper Time (2)

- Applying a cut on the pseudo-proper time helps to reject the non-prompt contribution, but it is not the best thing to do because it biases the efficiency and does not provide a pure sample

- We would like to perform a bi-dimensional fit on both the invariant mass and the pseudo-proper time, in order to extract the fraction of signal/background and the fraction of prompt/non prompt J/ψ

- This procedure was already follow for the muons, and that is our starting point

- Performing this fit for all the possible η and E_T bins is difficult, and work is still ongoing