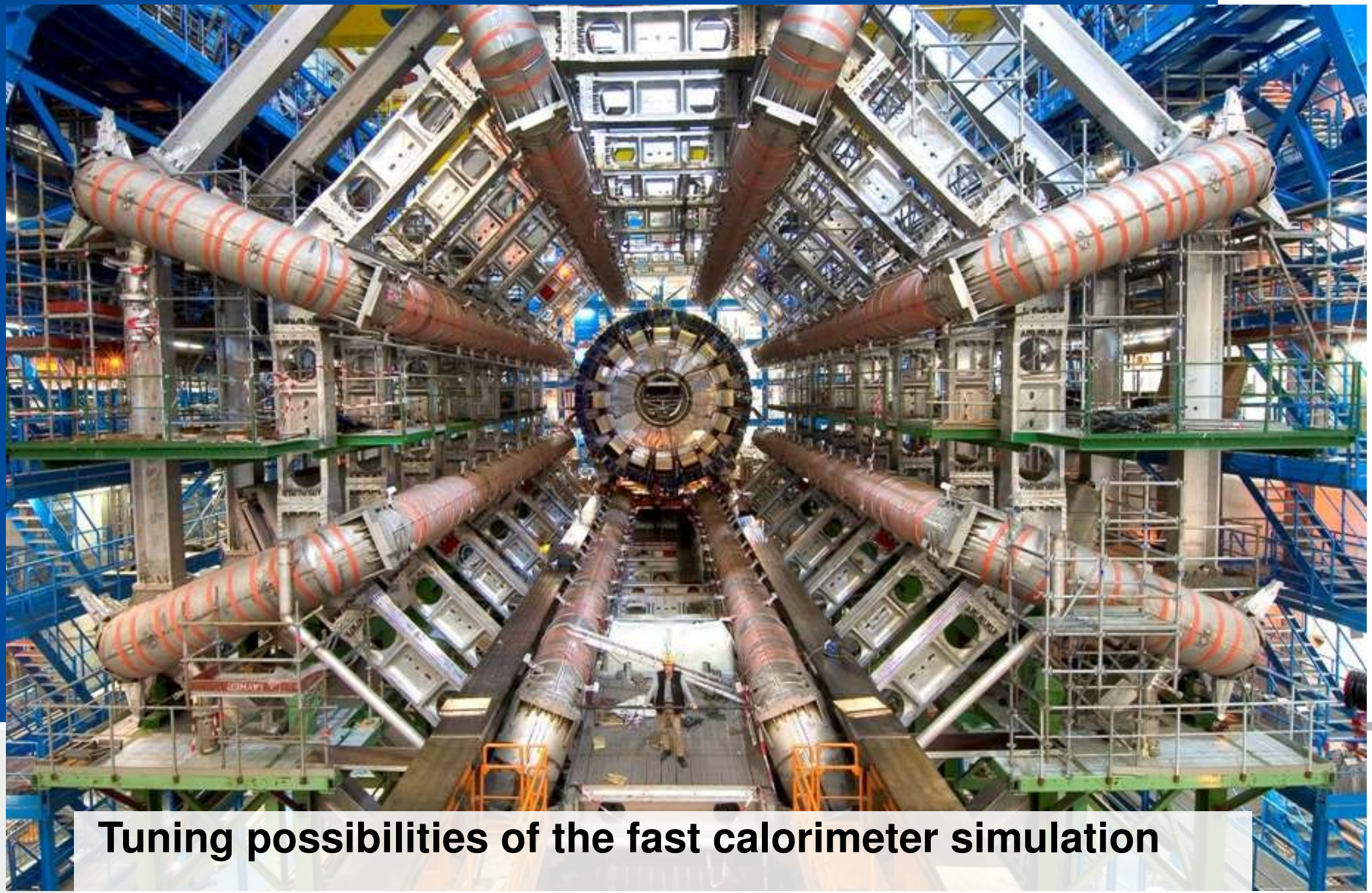


# Tuning possibilities of the fast calorimeter simulation with single photons and $J/\Psi \rightarrow e^+e$ events

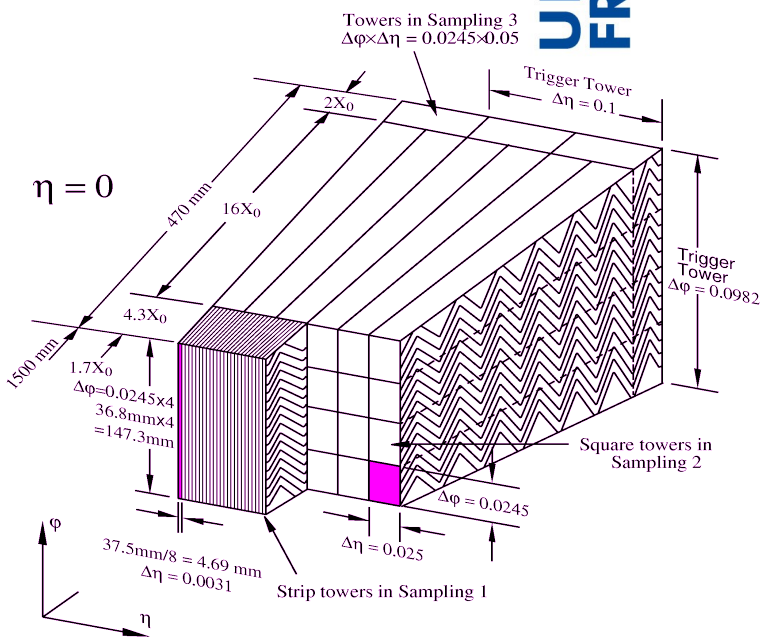
Karl Jakobs, Michael Dührssen, Marthe Teinturier, *Evelyn Schmidt*

# Calorimeter simulation



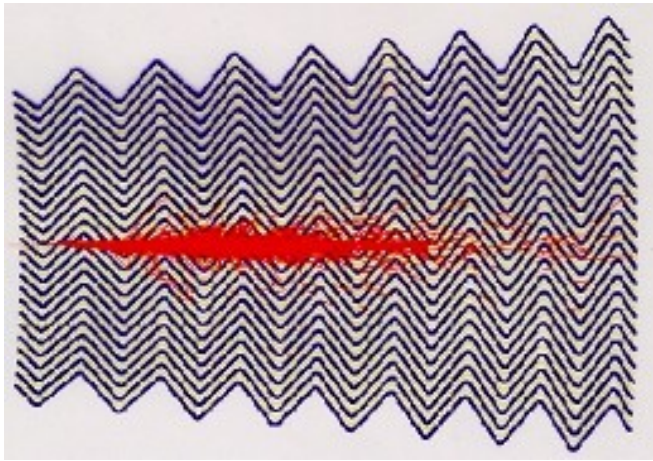
## Motivation:

- Compare Monte Carlo simulation with data
- Measured in calorimeter: energy in cells → ' shape '
- Are electron, photons, jets etc. modeled correctly ?




## Current (sophisticated) simulation:

- Simulation of particle interactions with detector material
- Complicated structure of ATLAS calorimeter → **SLOW**



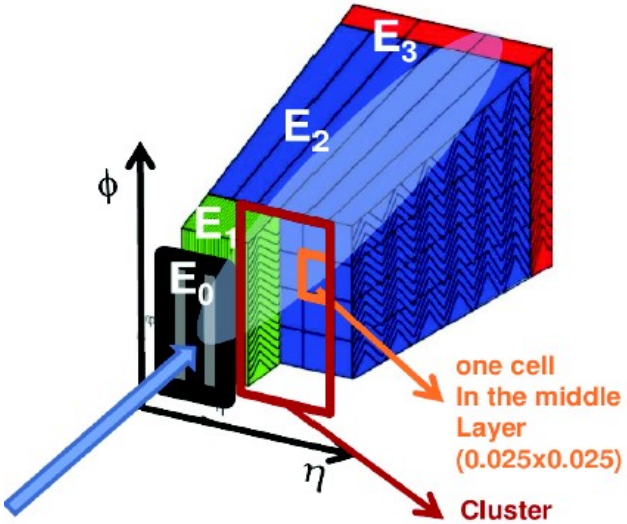
## To save time and allow for high statistic productions:

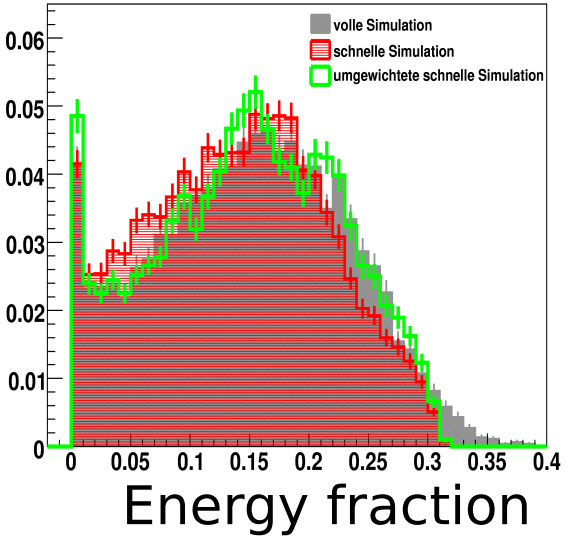
- Parametrization of energy response and resolution
- Parametrization of average lateral shower shape

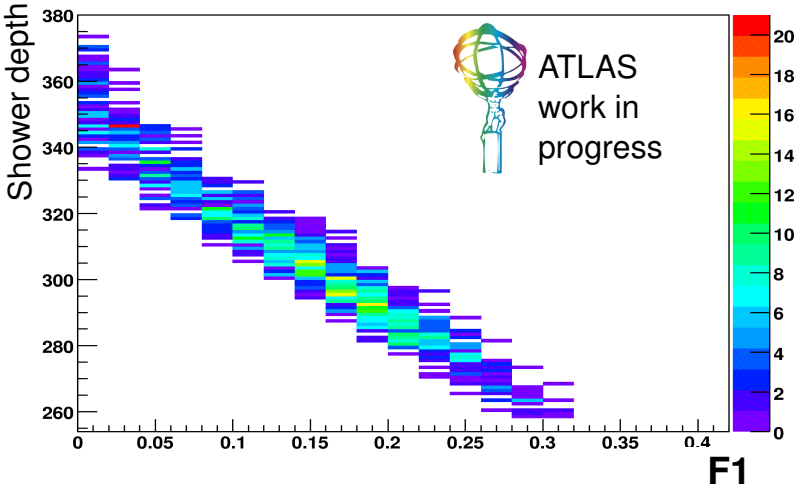
# Tuning possibilities

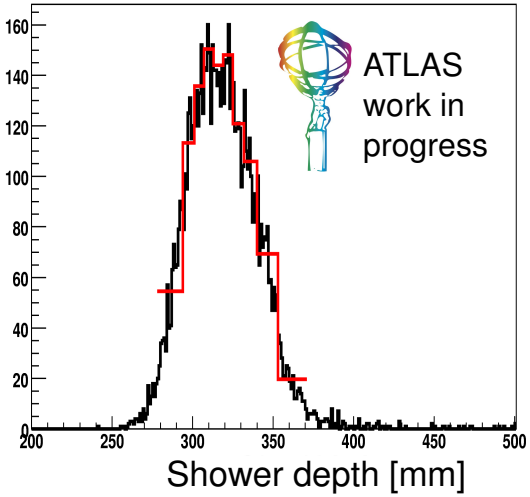


- Shower depth $d = 1/E \times \sum E_i \times d_i$ is internal parameter of fast simulation
- Strong anticorrelation of shower depth and fraction of energy in first layer (F1 )
- F1 distribution can be used to evaluate necessary changes of shower depth



# $J/\Psi \rightarrow e^+e^-$



$J/\Psi$ : charm quark resonance with mass ( $J/\Psi(1S)$) = 3097 MeV

Motivation:

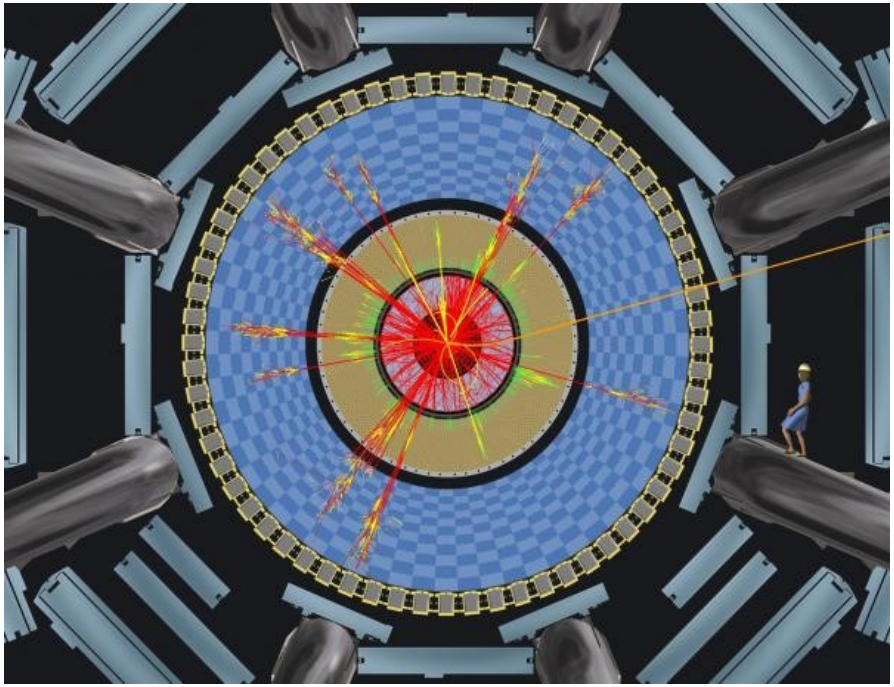
- How do REAL electrons look like in the ATLAS detector ?
- Is the energy and shape well described by our simulation ?

Challenges:

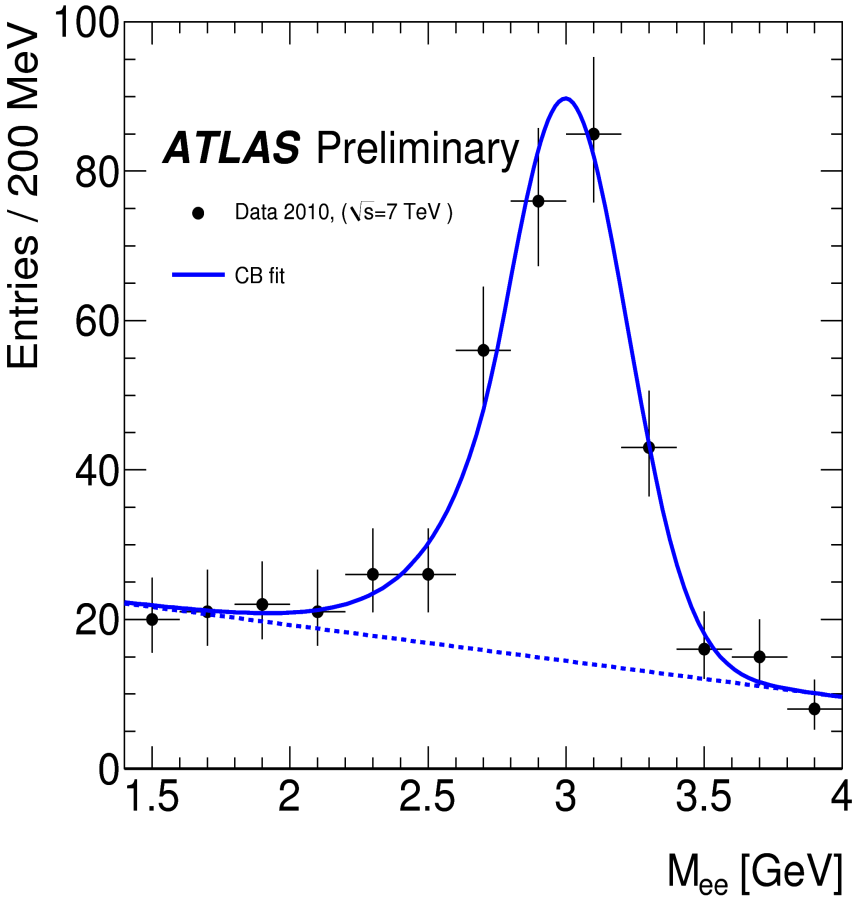
- Electrons have 'low' energy ( ~ 3 GeV )
- Can we trigger these electrons ?
- Can we reconstruct them ?

Advantages:

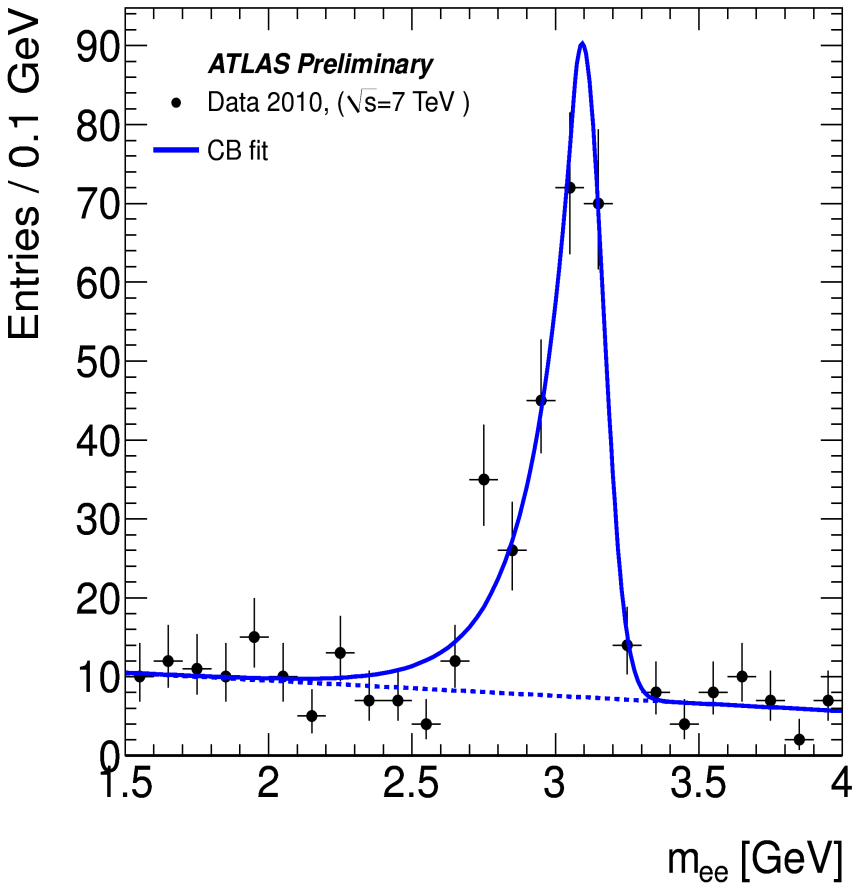
- 'tag & probe' possible:
- One electron with 'tight' cuts
- Second electron with track cuts only



# $J/\Psi \rightarrow e^+e^-$




Mass from calo energy/track direction
mean = 3.00 +/- 0.03
sigma = 0.22 +/- 0.03
signal = 229 +/- 24
bkg = 96 +/- 22

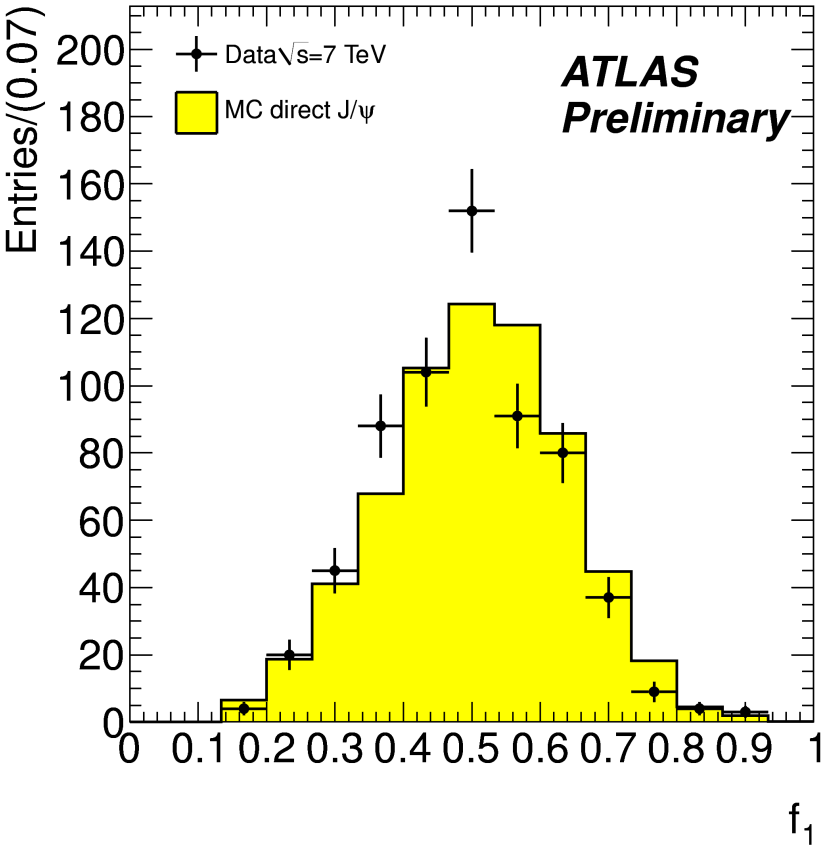


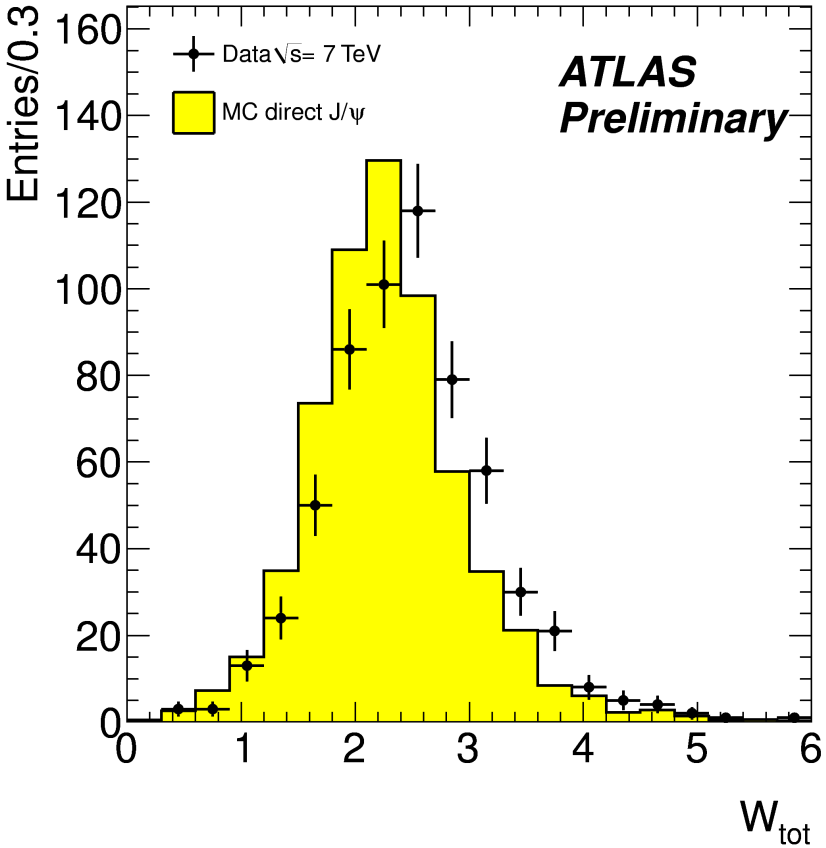

Mass from tracks (GSF)
mean = 3.09 +/- 0.01
sigma = 0.07 +/- 0.01
signal = 222 +/- 11
bkg = 28 +/- 2

# $J/\Psi \rightarrow e^+e^-$



2.7 GeV < Mee < 3.2 GeV
Have a look at 'probe' electron:




f1: fraction of energy in the first layer relative to all three layers of the EM calorimeter

Wtot: shower width in the $\eta$ direction of the first layer of the EM calorimter (in units of strips)

# Summary:

- Tuning of fast simulation technically possible
- Adjust amount of energy deposited in calorimeter layers and shower shapes

- Possible to extract electron shower shapes in data
- Careful checks of background subtraction necessary
- More statistics needed ( ~ 2000 events) but this should be available soon

# Summary:

- Tuning of fast simulation technically possible
- Adjust amount of energy deposited in calorimeter layers and shower shapes

- Possible to extract electron shower shapes in data
- Careful checks of background subtraction necessary
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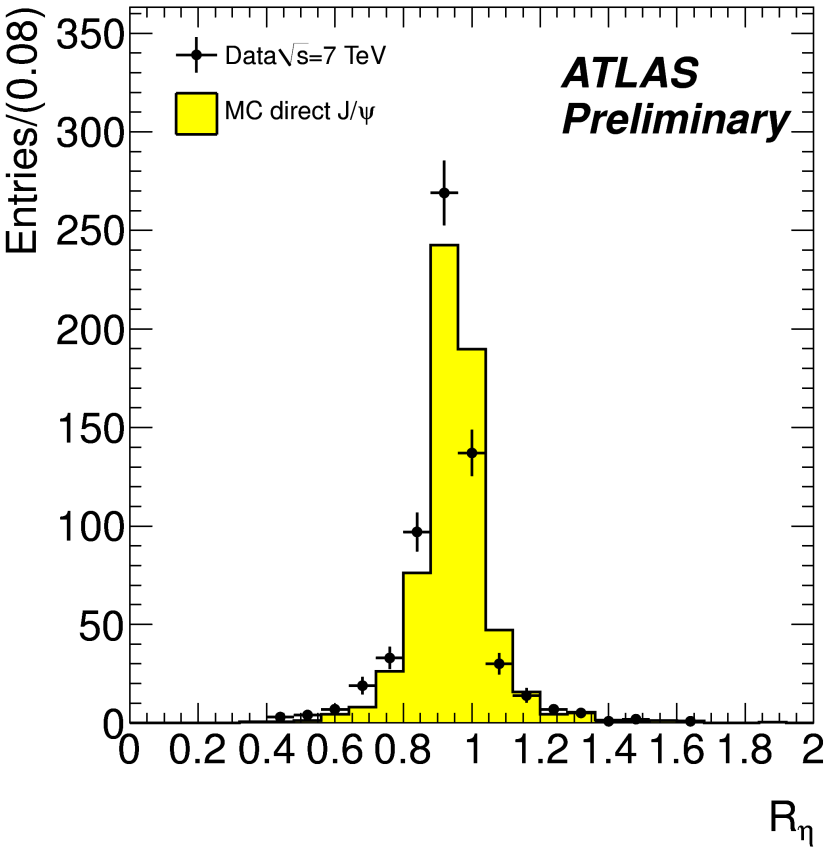
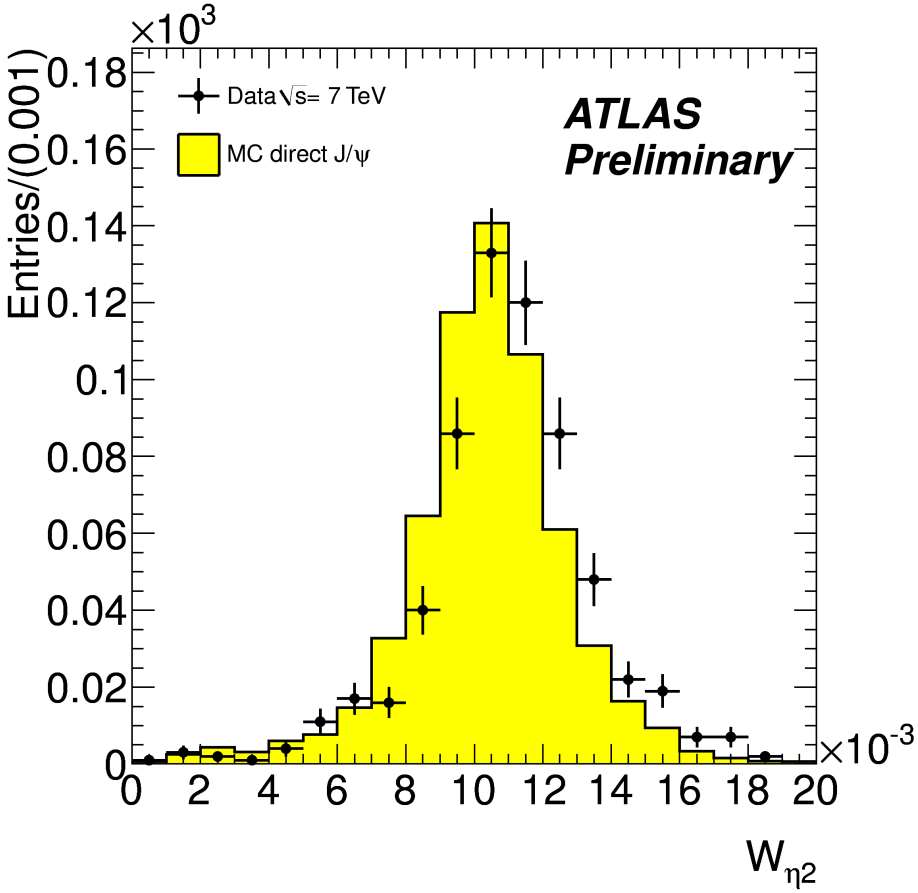
- Tuning of detector simulation seems possible

# BACKUP

# $J/\Psi \rightarrow e^+e^-$

2.7 GeV < Mee < 3.2 GeV
Have a look at 'probe' electron:



# $J/\Psi \rightarrow e^+e^-$

## Tag & Probe Selection:

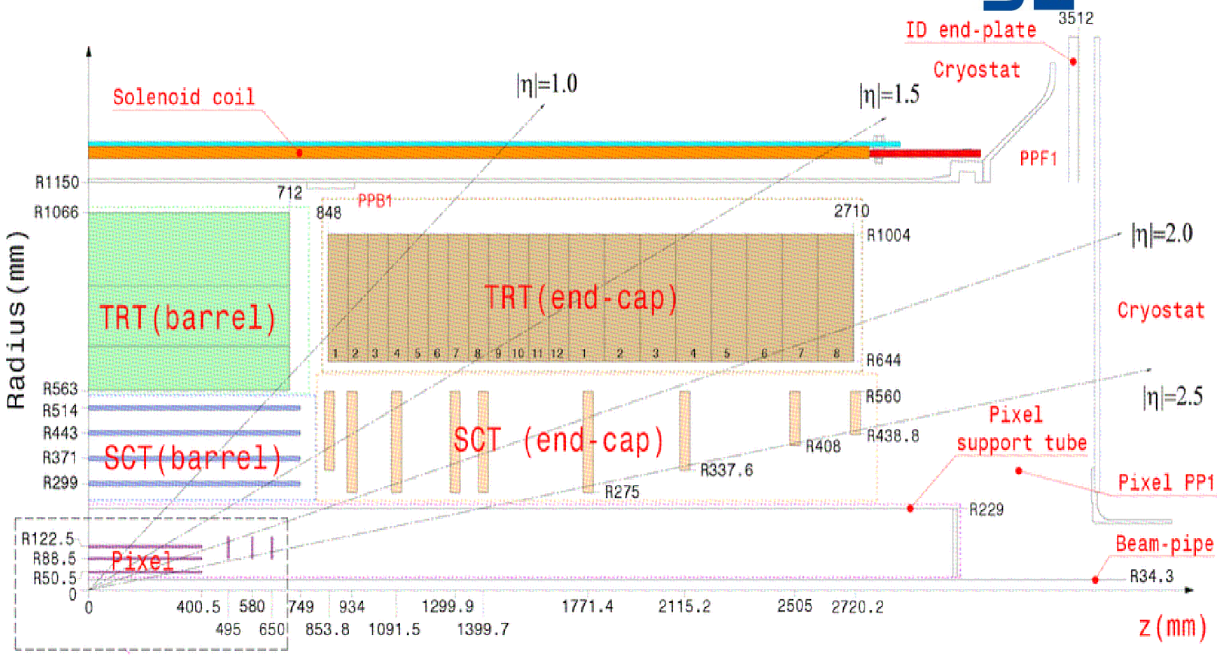
- 1 tight electron (tag electron)
- 1 loose electron (probe electron)

## Track requirements in selection:

- Track $|\eta| < 2.5$
- Track $p_T > 2$ GeV
- Number of BLayer Hits > 1
- Number of Silicon Hits > 8
- TRT frac > 0.12

## Trigger requirement :

- One electron triggered by L1_EM2 trigger




## Conversion rejection:

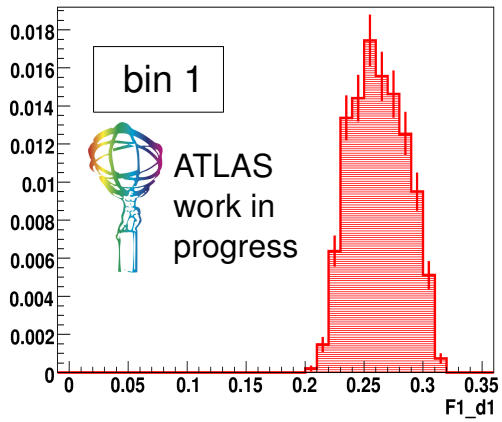
- Delta R(electron, photon) > 0.05
- Delta R(electron, electron) > 0.05

# First modification steps



## How to modify F1 in terms of the shower depth ?

- Earlier start of shower → higher fraction of energy in first layer
- Evaluate F1 histograms in bins of shower depth
- Total F1 histogram is sum of individual histograms
- Apply weights $a_1$, $a_2$, ... $a_{10}$ to bin probability

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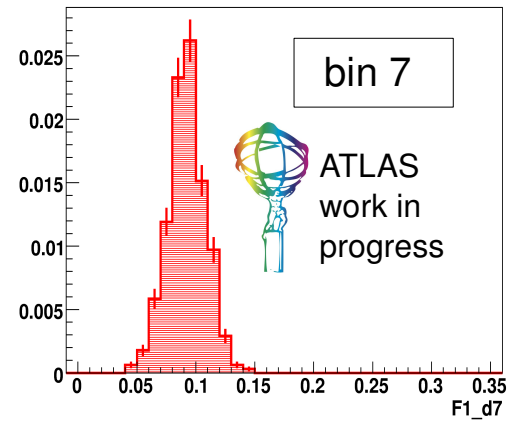
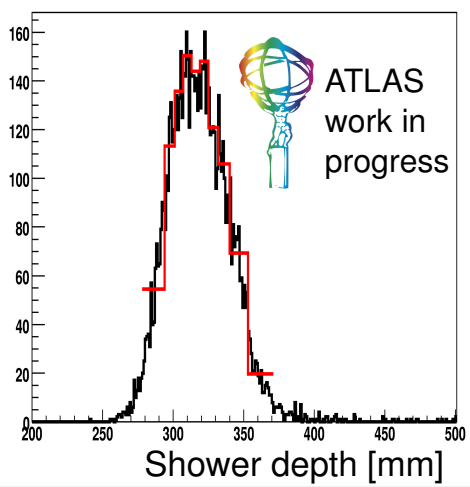
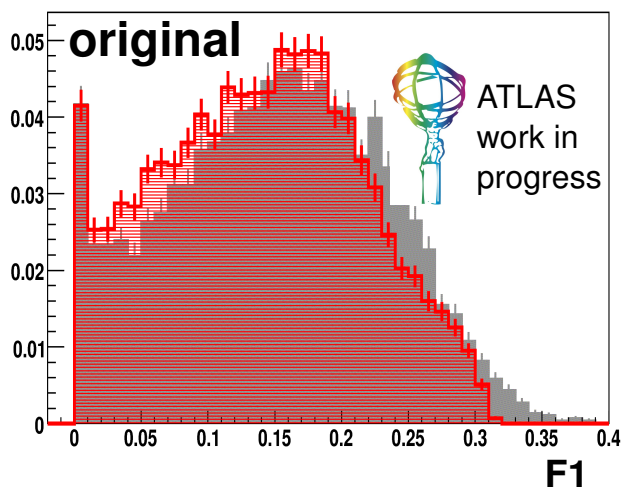
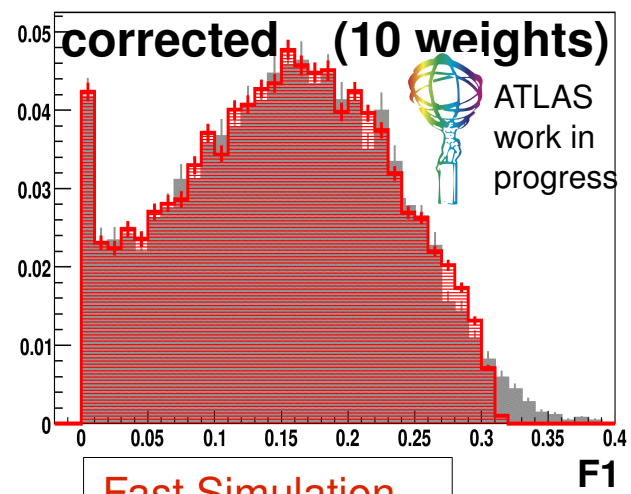



- Determine weights by $\chi^2$ – Fit using (F1 Full – F1 Fast) histograms




Fast Simulation
Full Simulation