# Electron and Photon Reconstruction and Identification with the ATLAS Detector

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on behalf of the ATLAS Collaboration

International Conference on Particle Physics in Memoriam Engine Arik and her Colleagues

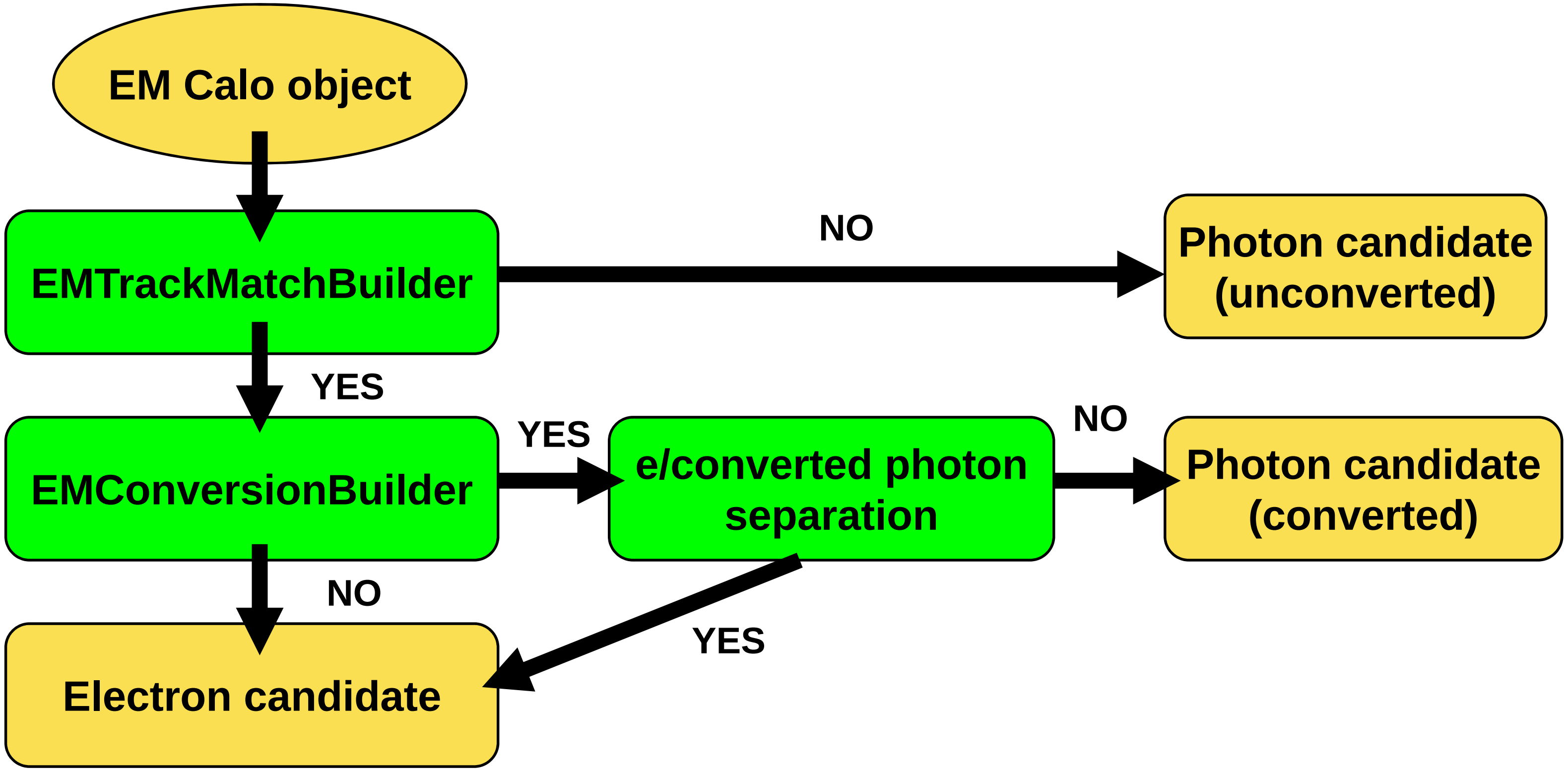
# Outline

- Introduction
- Electron and photon reconstruction
- Electron and photon identification
- Calibration with early data
  - Efficiency measurement is already discussed by M.Flowerdew
- Measurements with early data
  - W/Z cross-section measurement is already discussed by M.Flowerdew

# Electrons and Photons in ATLAS

- High identification efficiency and high jet rejection
- Early and late $\gamma$ – conversion reconstruction
- Bremsstrahlung recovery
- Soft - e identification

# Reconstruction of high-$p_T$ electrons and photons (Calo - based)



# Low-$p_T$ electron reconstruction (track based algorithm)

- Selection of good tracks – cuts on $p_T$ and number of Silicon hits are applied.
- Selection of tracks using TRT – at least one TR hit and >20 TRT hits are required.
- Clusterisation
- Shower shapes
- Preselection using the electromagnetic calorimeter – E/p and energy depositions in the first, and third sampling are used.

All these cuts reduce the amount of candidates per jet from 9 to 0.4. But the cuts also affect the signal electrons, removing about 10% of reconstructed soft electrons.

# Identification

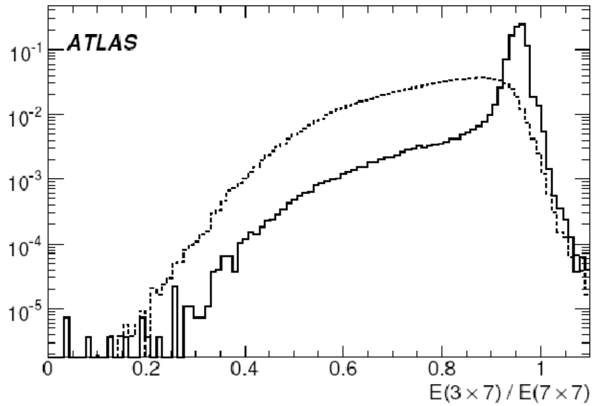
- Cut based algorithm (more robust, used initially)
- Multivariate methods
  - Likelihood ratio and BDT for electrons
  - H-matrix and Likelihood for photons

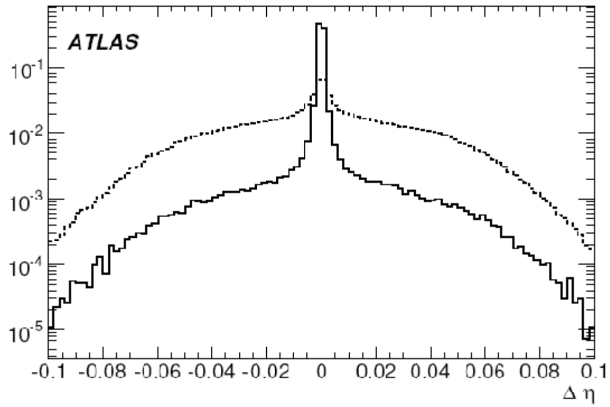
# Identification (cut based)

- Two identification procedure are available. The first one is the standard method optimized for isolated electrons. The second one is optimized for electrons originating from a b-quark, namely either from bb->J/ψ or electrons in jets (e.g WH->bb). It should be noticed that electrons can be identified by each method whatever reconstruction algorithm is used. Obviously not all combinations are "optimized", but the main use cases are:
- **electrons from Z are best reconstructed by the cluster-based reconstruction algorithm and identified by the procedure optimized for isolated electrons;**
- **electrons from pp->J/ψ (i.e below 10 GeV) are best reconstructed by the track seed algorithm and identified by the procedure optimized for isolated electrons;**
- **electrons in jets are best reconstructed by the track seed algorithm and identified by the procedure optimized for non-isolated electrons.**

# Identification of Isolated Electron (I)

- **Hadronic leakage**
- **Second compartment of the ECAL**
- **The first compartment of the ECAL**
- **Cluster Isolation**
- **Track quality cuts**
- **Inner Detector/calorimeter spatial matching information**
- **Inner Detector/calorimeter energy matching information**
- **transition radiation information in the TRT**



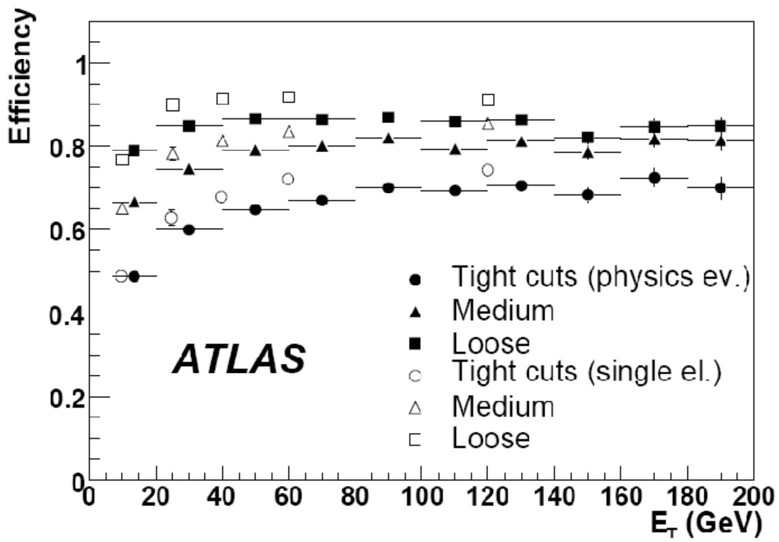


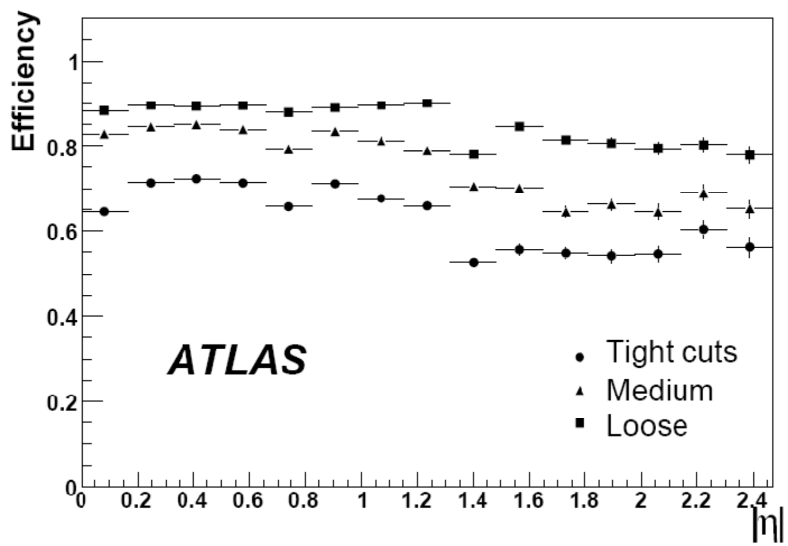
Istanbul, 28 October, 2008
e/gamma identification, V.Maleev

# Identification of Isolated Electron (II)

| | cuts | $\varepsilon_e$ | $R_{jet}$ |
|---|---|---|---|
| **Loose** | **HLeak + middle** | **88%** | **570** |
| **Mediu m** | **Loose+ STRIPS+ cl.isolation + track quality** | **77%** | **2200** |
| **Tight** | **All cuts including TR** | **64%** | $10^5$ |

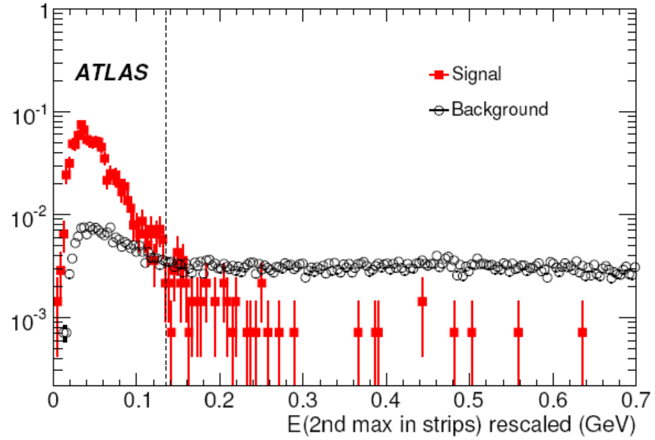
**S/B ~3/1 for $E_T$> 20 GeV**

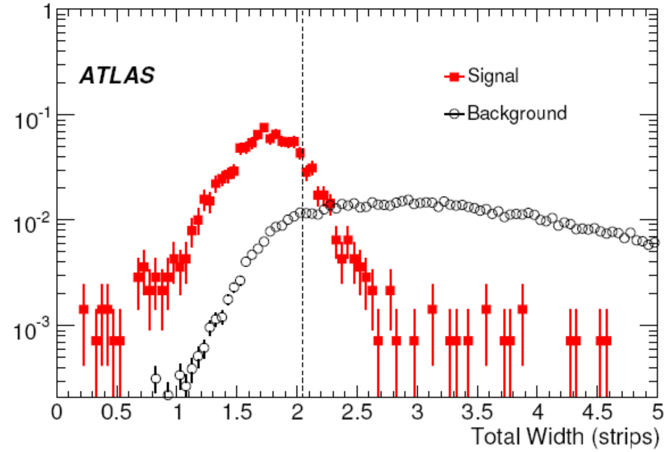


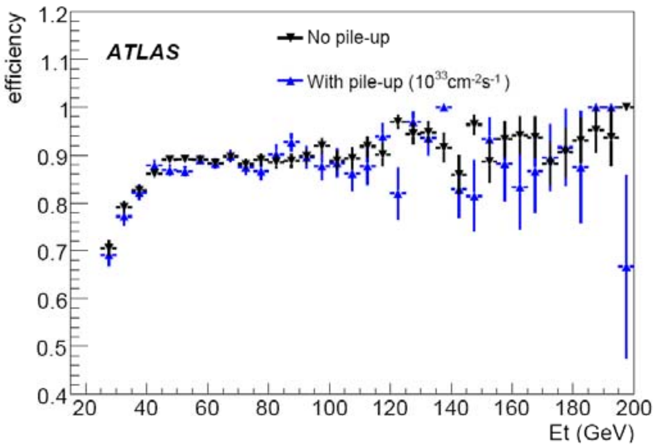



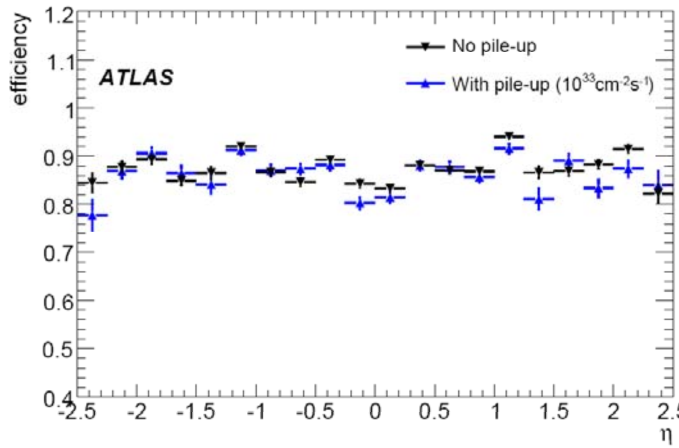
# Identification of Isolated Photon

- Algorithm is the same as for Isolated Electron except tracking

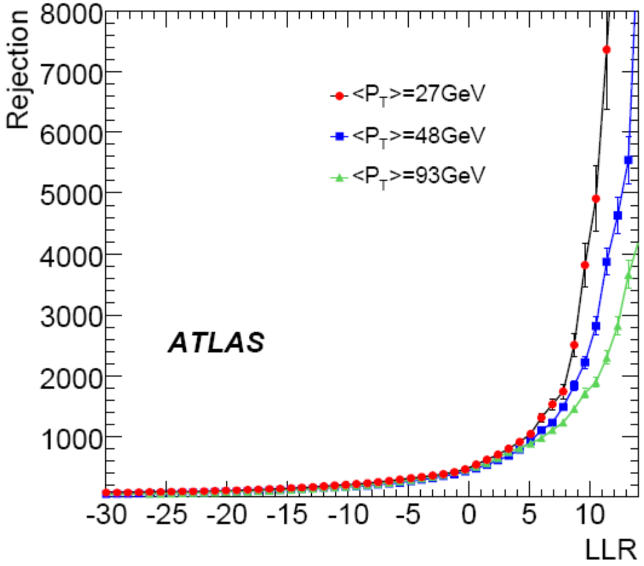


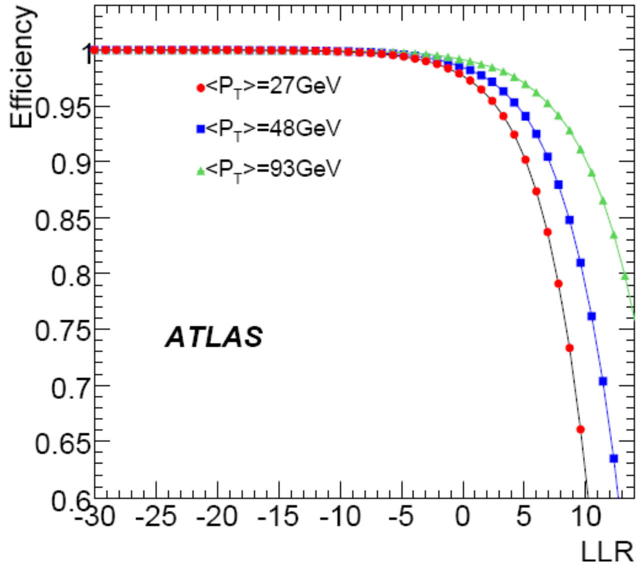



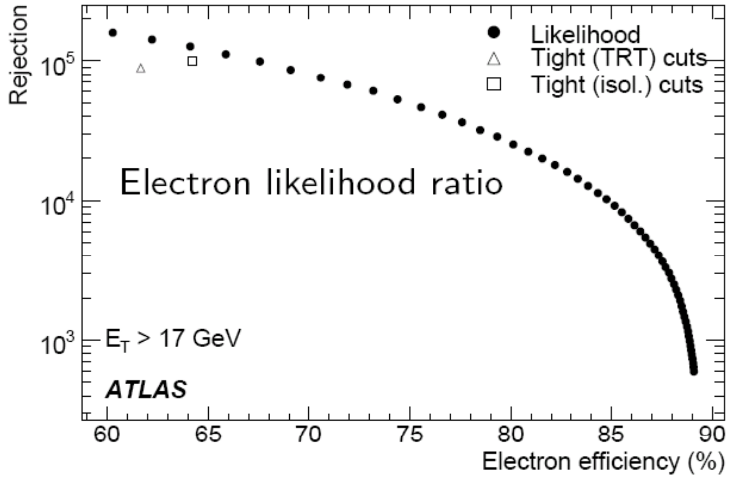



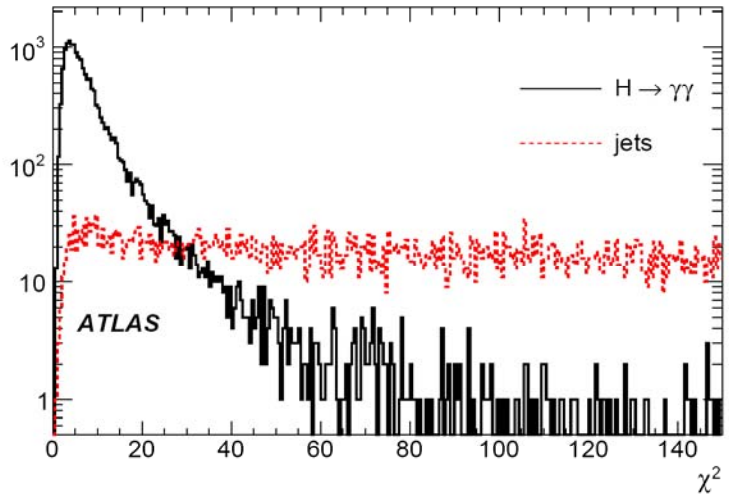



# Multivariate techniques



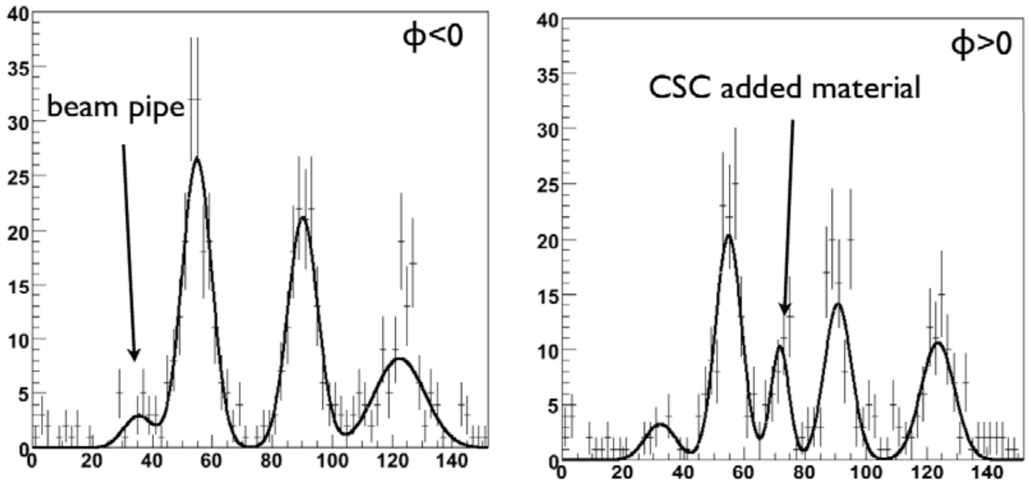



# Calibration with data

- It is possible to correct some Calo parameters using reconstructed Z mass:
  - cell calibration – correction for electronics nonlinearities and non-nominal high voltage
  - cluster position calibration
  - cluster energy calibration
- This requires a good knowledge of material before calorimeter what can be achieved with photon conversion reconstruction (see next slide)
- Cross-check with W and J/ψ data

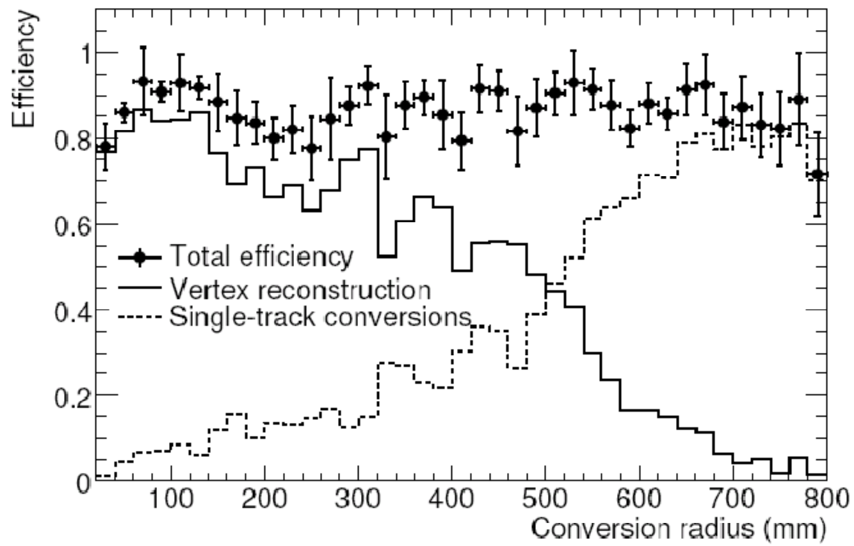
# Conversion Reconstruction




| Layer | Nc/350k | x/X0(%) | Δx/x |
|---|---|---|---|
| Beam pipe | 11 | 0.45 | - |
| B-layer | 127 | 5.3±1.6 | 31% |
| Extra material | 16 | 0.7±0.2 | 35% |
| Pixel 1 | 103 | 4.3±1.3 | 31% |
| Pixel 2 | 76 | 3.1±1.0 | 31% |

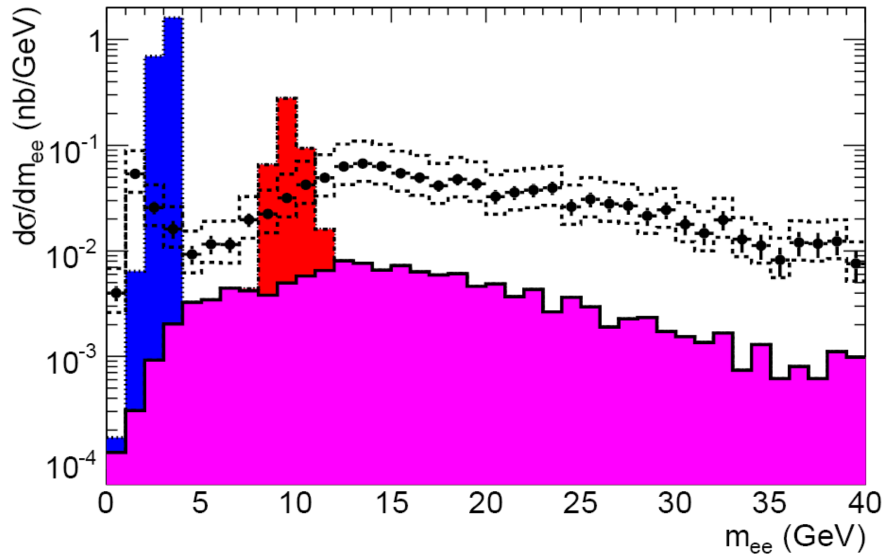
Low-$p_T$ γ-conversions from min.bias ($p_T$ > 1 GeV) (upper row)

High-$p_T$ photon conversion from H→γγ ($m_H$ = 120 GeV)



# Measurements with early data

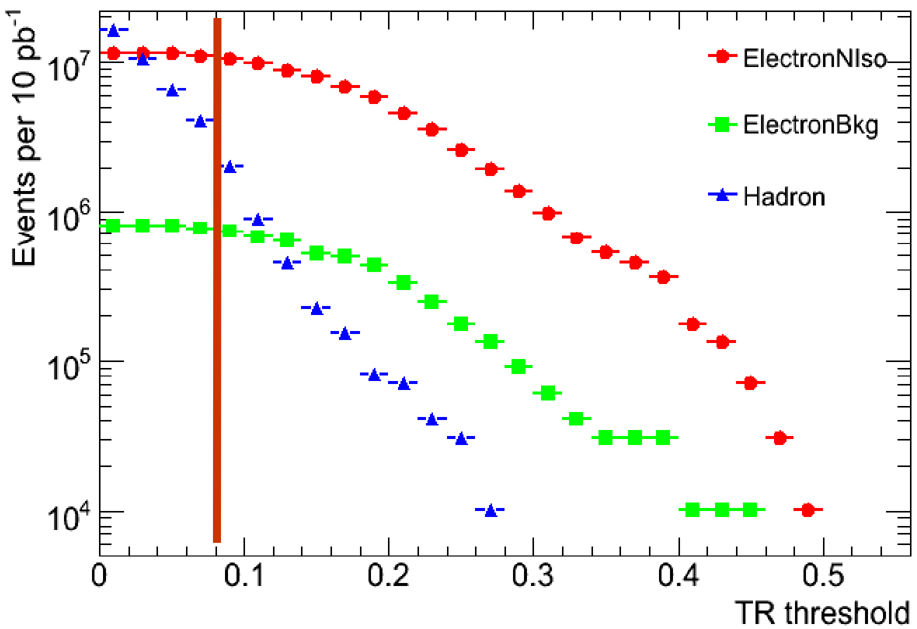
- W/Z cross-section measurement is already discussed by M.Flowerdew
- Low mass electron pairs

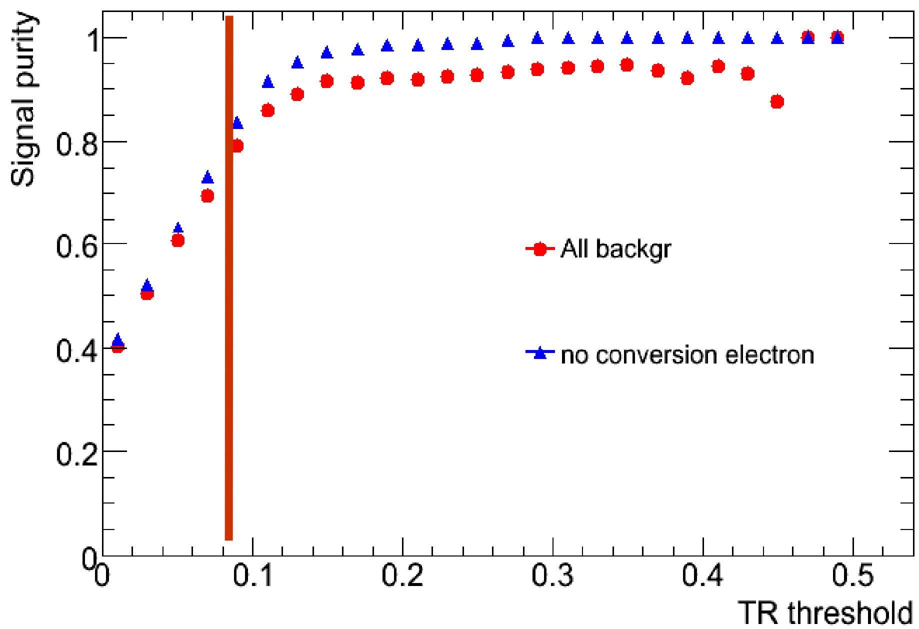



| $k/100pb^{-1}$ | J/ψ | Υ(1S) | Drell-Yan | Bkg |
|---|---|---|---|---|
| 2se5 | 230 | 43 | 13 | 116 |
| se5se10 | 72 | 12 | 8 | 27 |
| 2se10 | 10 | 3.4 | 2.9 | 1.7 |

# Measurements with early data

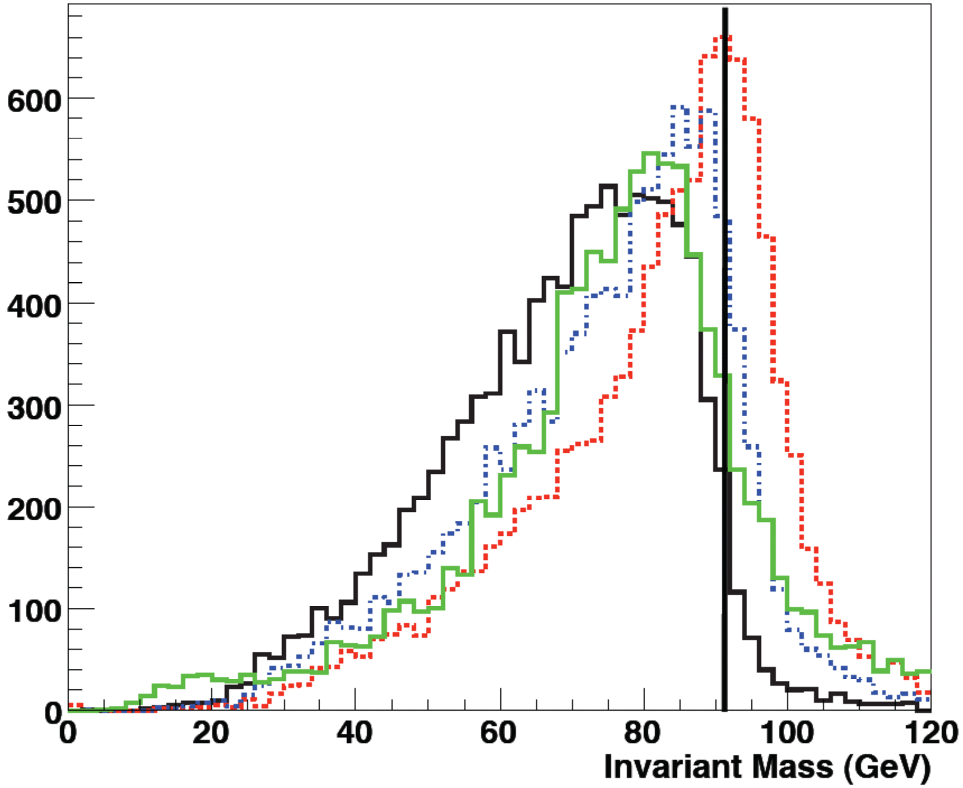
- Measurement of cross-section b/c→e +X (benefit from TRT)




Sample content and signal purity after all cuts except TRT

# Brem recovery




Different Brem recovery tools are available

Z mass reconstruction with tracking only. Black – no Brem recovery, green – CaloBrem, blue – DNA (dynamic noise adjastment), red – GSF (Gaussian summ filters)

# CONCLUSION

- **High ID efficiencies for high jet rejection achieved in ATLAS**
  - **Combination of Calo and track information**
  - **Various ID algorithms (simple cuts, likelihood ratio, BDT, H-matrix) available**
- **Efficient conversion reconstruction allows material mapping**
- **Brem recovery improves tracking resolution**
- **Tools for inter-calibration with data available**
- **Trigger very important for early physics with electrons!**

| Menu | rate |
|---|---|
| 2EM3 | 10 kHz at L1 |
| 2e5 | 10 Hz after EF |
| EM8 | 10 kHz at L1 |
| e10 | 20 Hz after EF |