Physics Areas at ATLAS

- **Minimum Bias Physics**
  - "soft QCD events", several per bunch crossing (underlaying event)
- **Standard Model measurements**
  - W,Z bosons and other electro weak processes
  - Jet physics and soft QC, Direct photons
- **Top-Quark Physics**
  - Top reconstruction, properties, mass and cross section
  - Single top
- **Higgs Searches**
  - Standard model Higgs ($\gamma\gamma$, ZZ, WW, $\tau\tau$, bb)
  - SUSY MSSM Higgs (charged and neutral)
- **SUSY Searches**
  - Searches in many channels (high pT leptons, MET, jets, …)
- **Exotics Searches**
  - Lepton + X, Jet +X, Dibosons and multilepton, long lived particles
  - Top and 4^{th} generation
- **Heavy Ions**

ATLAS Object reconstruction Groups

- Electron / photon reconstruction
  - Performance and isolation studies
- Flavour tagging
  - Tagging algorithms, calibrations
- Jet and missing transverse energy
  - Calibrations and jet energy scale, uncertaities
- Tau reconstruction
  - Hadronic tau algorithms and reconstruction efficiencies
- Muon reconstruction
  - Definition of muon objects
- Inner tracker and track reconstruction
- Trigger Menus
  - List of physics triggers for all physics and performance analyses

The Standard-Modell

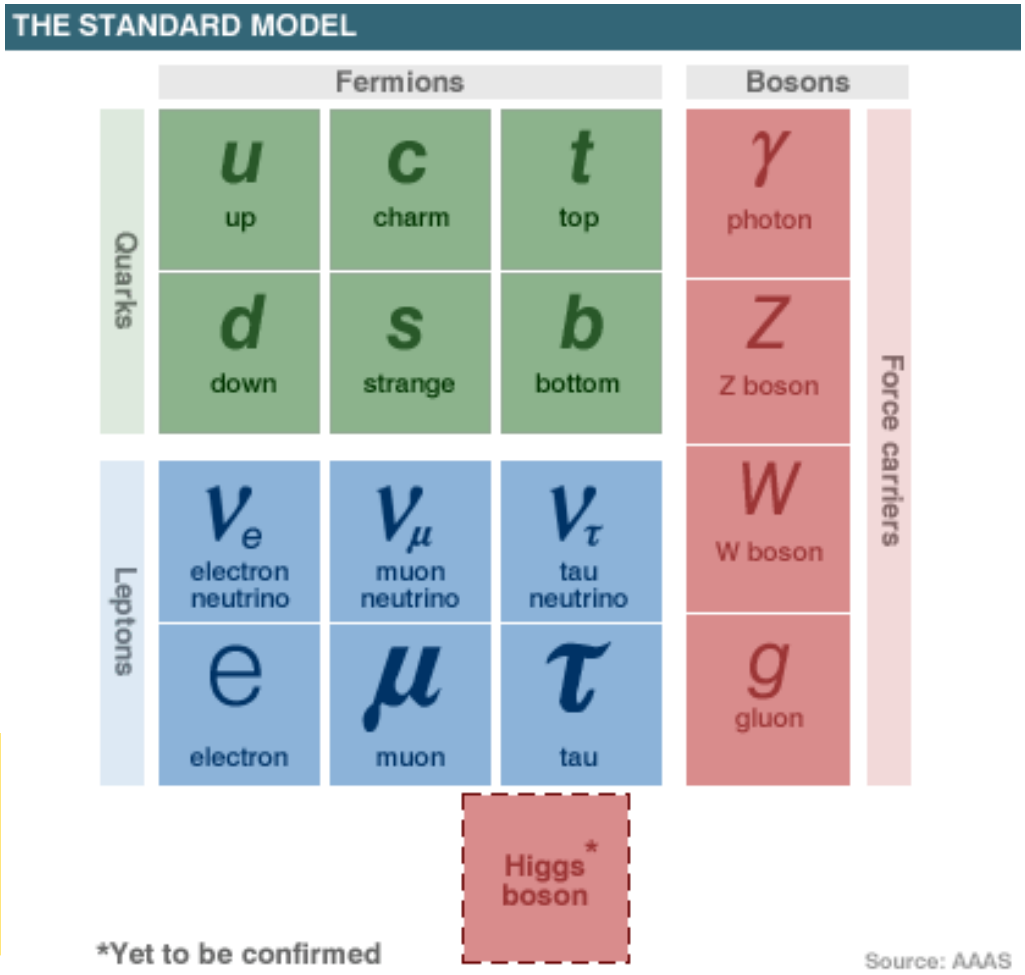
Fundamental particles:

6 Quarks (u, d, c, s, t, b)
6 Leptonen (e, μ, τ, ν_e, ν_μ, ν_τ)

Fundamental forces:

Strong interaction (g)
Weak interaction (W,Z)
Electromagnetic interaction (γ)

Not yet found:
Higgs-Boson
explains the mass of the particles

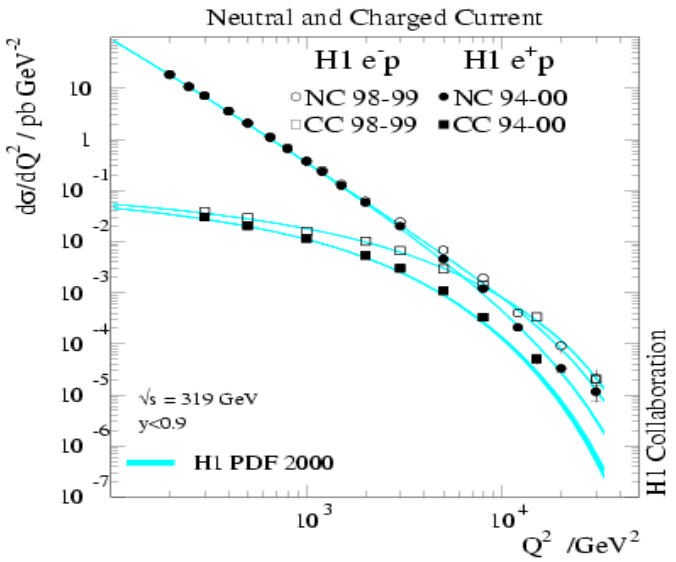


Very successful model, confirmed in many experimental tests, good prediction power

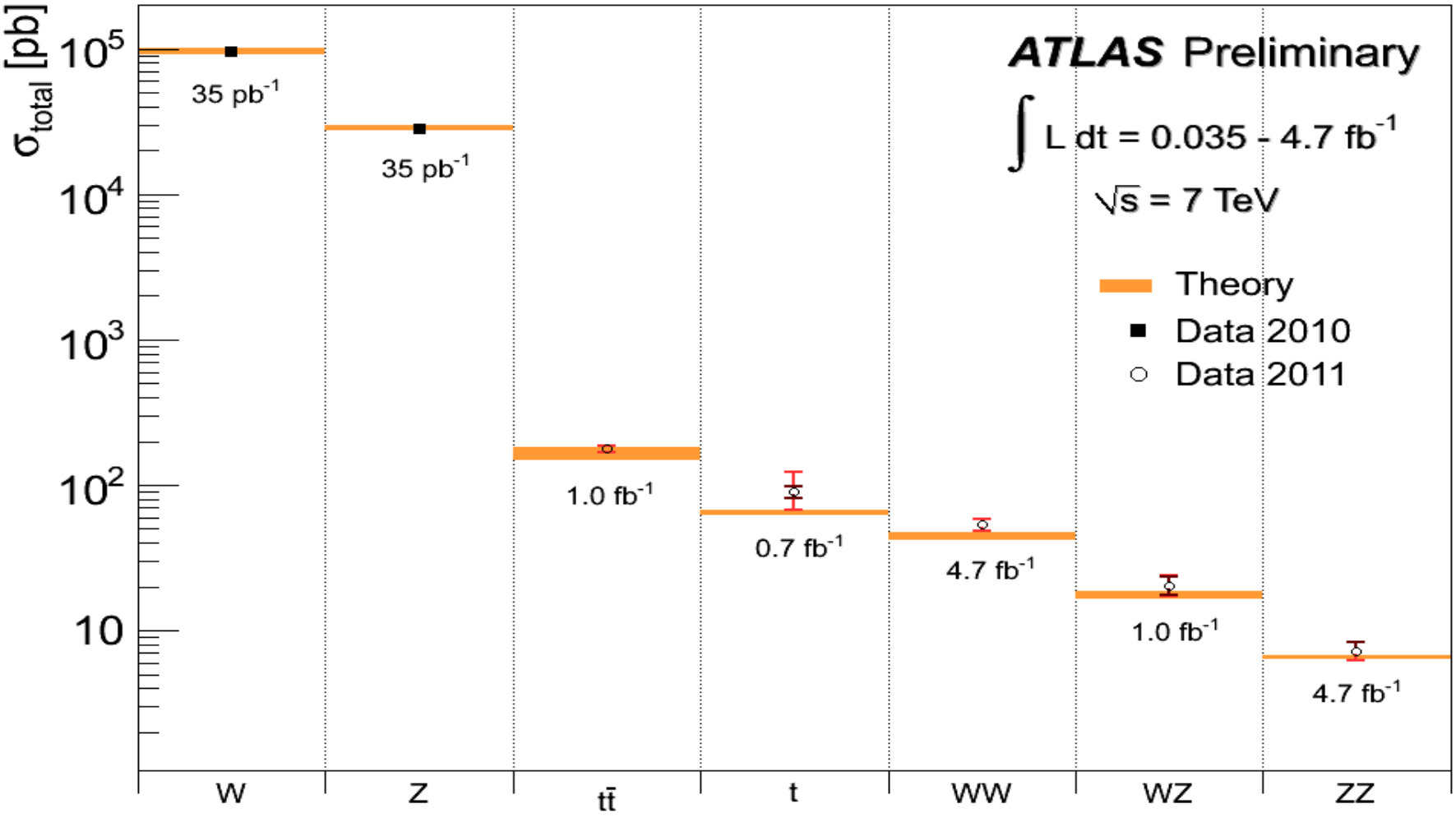
Standard Model forces

- All forces very precisely measured
- Even unification of electromagnetic and weak interaction measured
- Dynamics well measured up the several 100 GeV

$$\alpha_{em} = 1/137.03599976(50)$$
$$G_\mu = 1.16639(1) \cdot 10^{-5} \quad \text{GeV}^{-2}$$
$$M_Z = 91.1882(22) \quad \text{GeV}$$

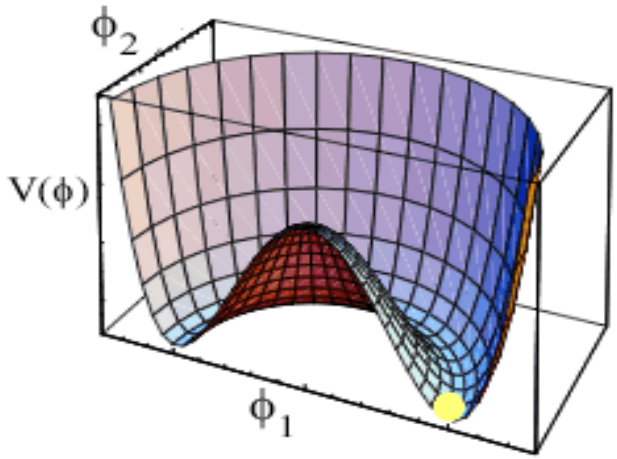


ATLAS Standard Model Measurements



Higgs still missing

- Important part of the standard model to explain the electro weak symmetry breaking
- Gives mass to bosons and fermions
- Standard moddel higgs: four higgs fields
  - three give mass to W/Z bosons
  - One well defined in physical properties (scalar boson), but mass not predicted

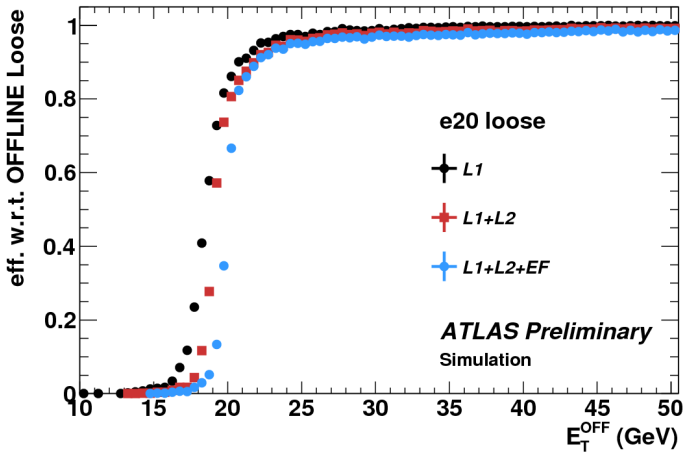


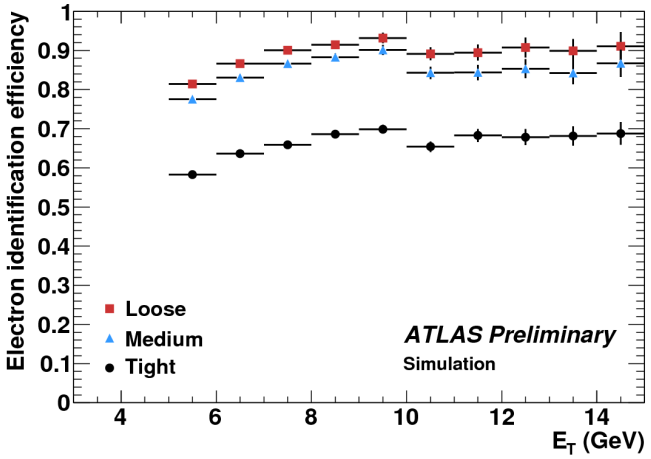
Event reconstruction: Physics Objects

- translation from measurement (detector) to full event
- main possible physics objects to be reconstructed:
  - electrons, muon, taus
  - photons
  - jets and b-jets
  - missing transverse energy (neutrinos and others)
- definitions of reconstruction algorithms
  - performance and efficiencies
  - calibrations and rescaling factors
- description of physics objects in Monte Carlo simulations
- each physics objects needs a trigger correspondence

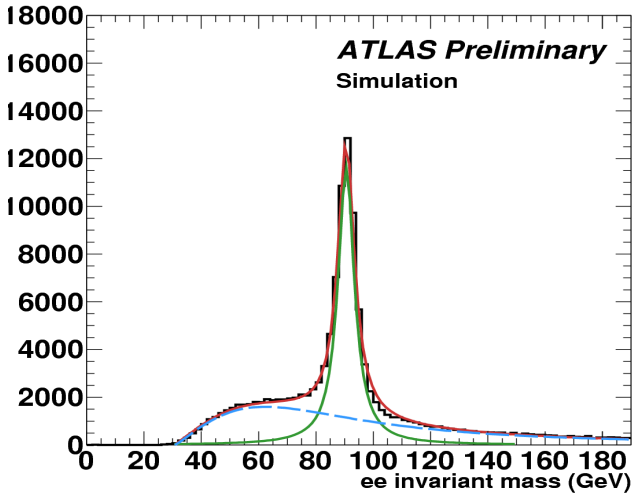
Electron Object Performance

Trigger efficiencies



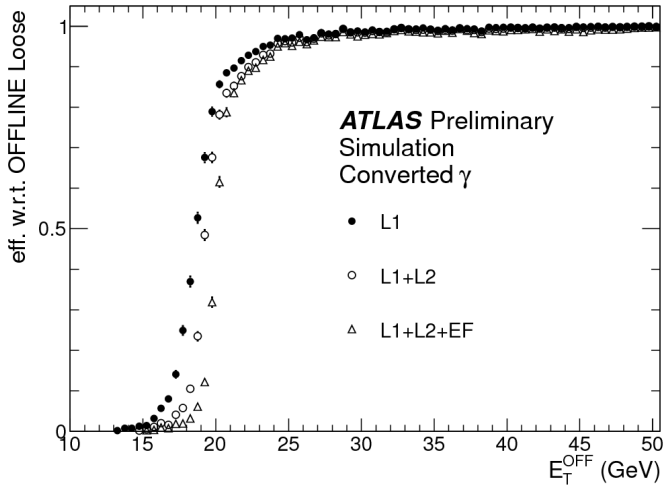


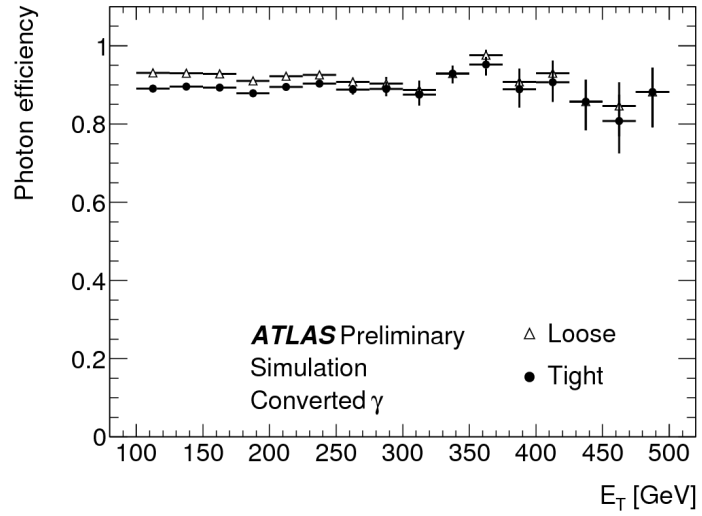
Electron identification as a function of the cluster transverse energy in J/Psi events



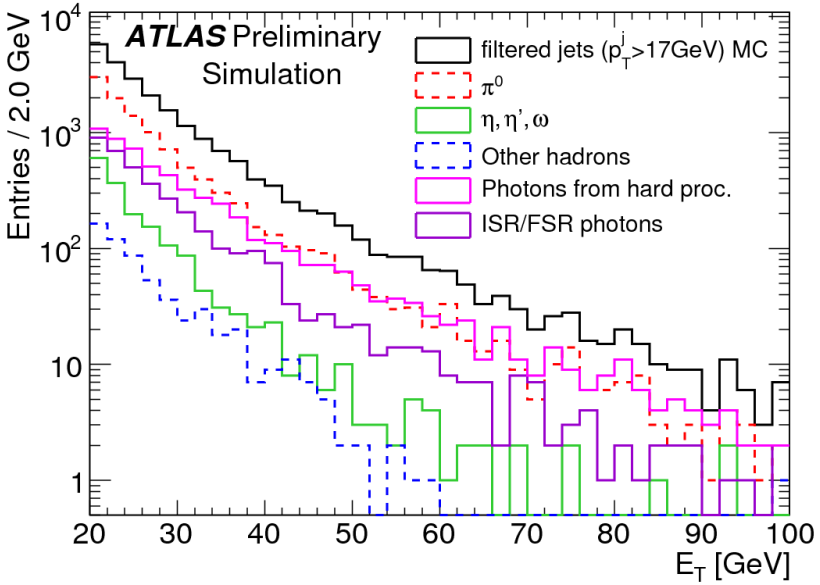
Z-Mass resolution

Photon Object Performance



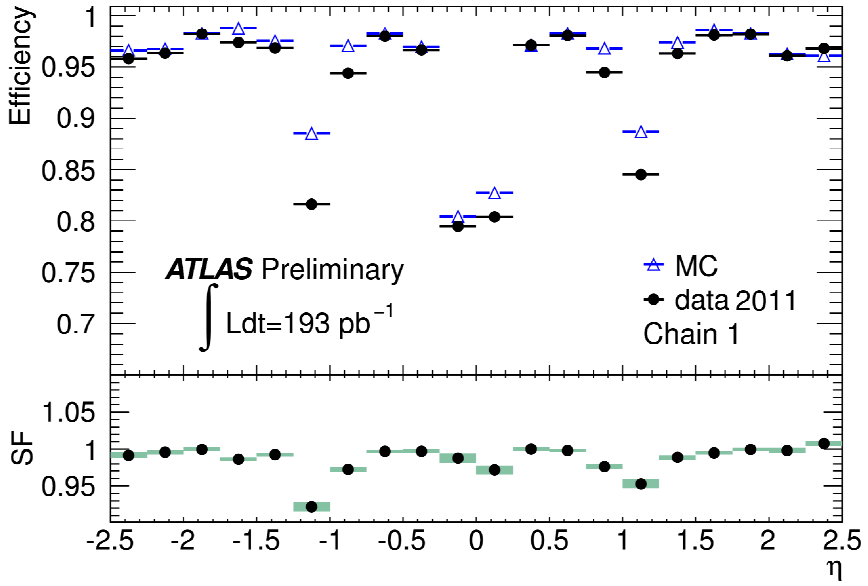


E_T spectra for the photon candidates in the background jet sample passing the tight selection. The different components are shown.



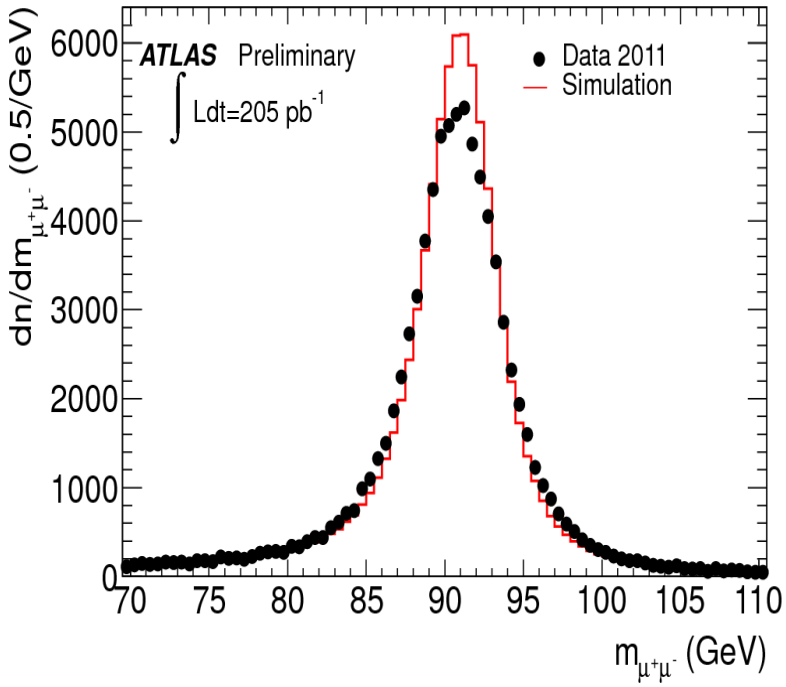
Expected total photon efficiency (reconstruction + identification) vs true E_T for loose and tight selection criteria and for converted photons in the high E_T range

Muon Object Performance

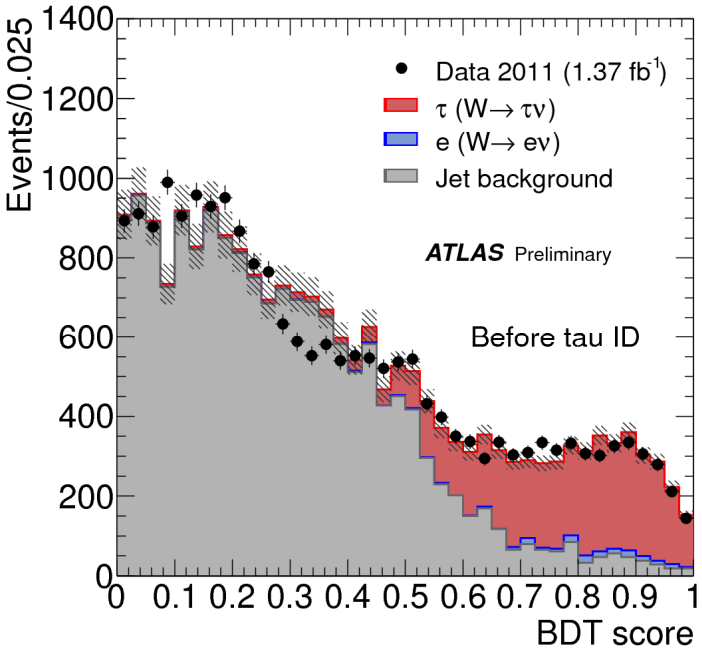


Combined muon reconstruction efficiency with respect to the inner tracking efficiency as a function of the η(μ) with pT(μ) > 20 GeV. The panel at the bottom shows the ratio between the measured and predicted efficiencies (Scaling Factor).

Di-muon invariant mass distribution for oppositely charged muon pairs with transverse momentum above 20 GeV and calorimeter isolation (sum of calorimeter cell energies <2 GeV in a cone of ΔR=0.3.).

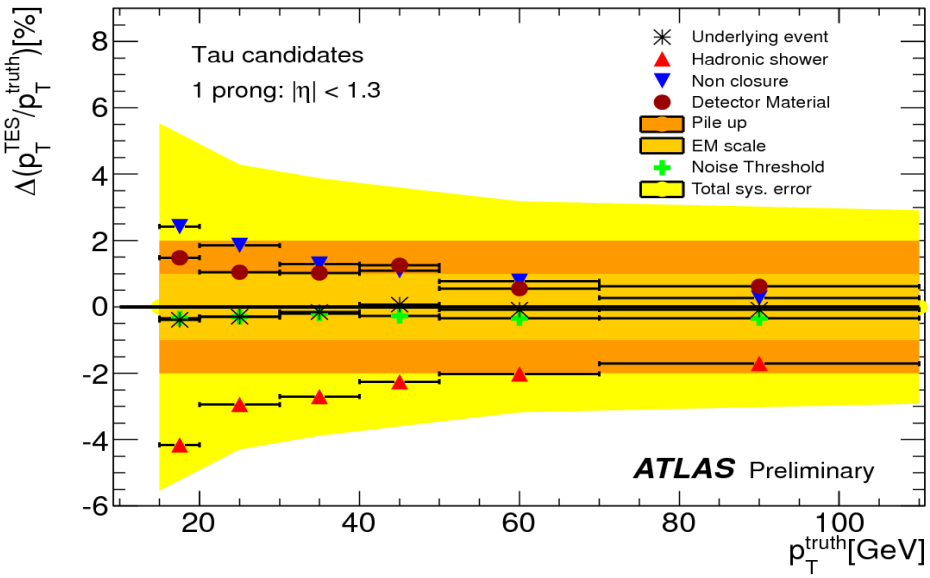


Tau Object Performance

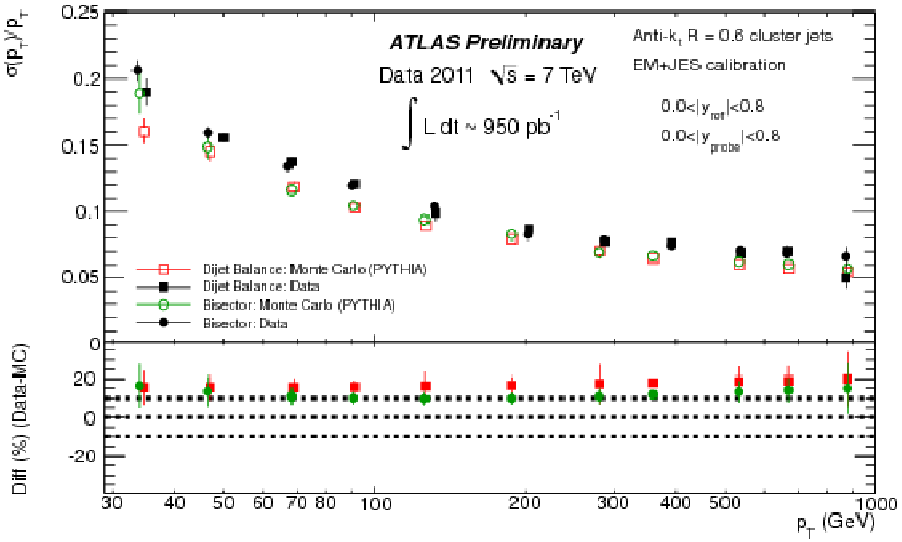


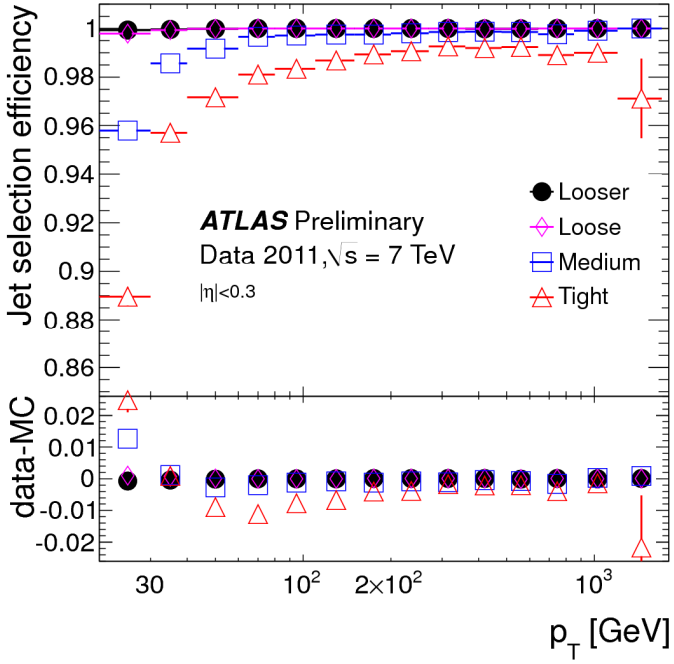
Boosted decision tree output
For tau selection before the indentification

Final systematic uncertainty on the tau energy scale for 1-prong candidates in the barrel region. Each different marker represents a separate source of uncertainty as indicated in the legend. The yellow band shows the combined uncertainty from all sources.



Jet Object Performance

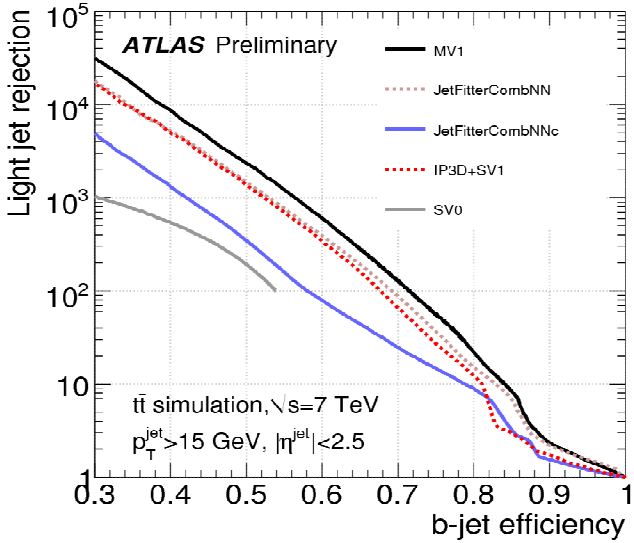




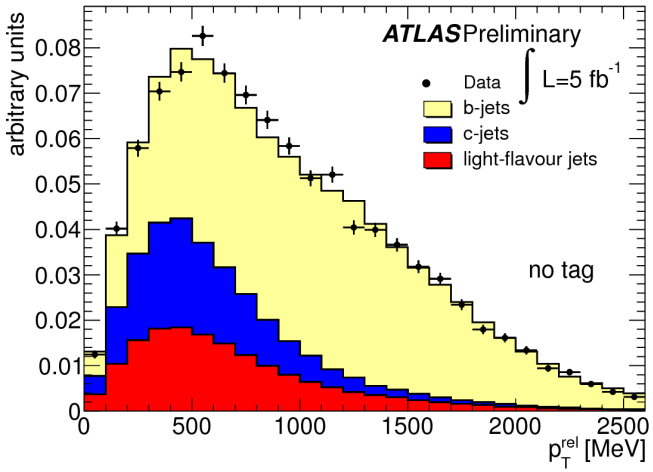
[Jet resolution EM+JES jets] Fractional jet energy resolution as a function of the average jet transverse momenta for the di-jet balance (squares) and bi-sector (circles) in-situ techniques using EM+JES calibrated jets.

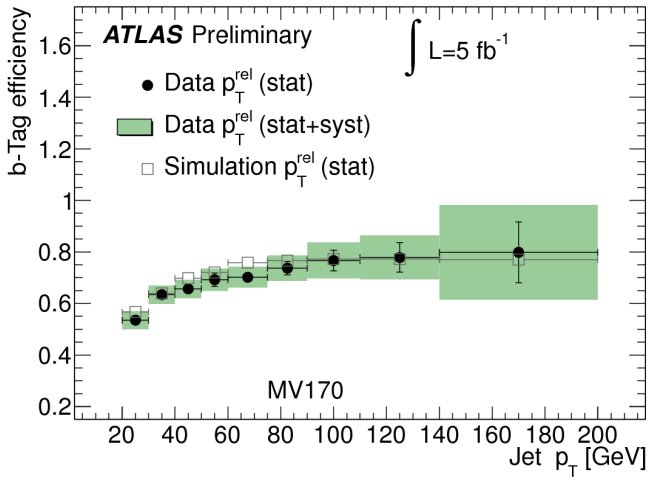
Jet quality selection efficiency for Anti_kt jets with R = 0.4 measured with a tag-and-probe technique as a function of pT in eta ranges, for the four sets of selection criteria.

B-Jet Objects Performance

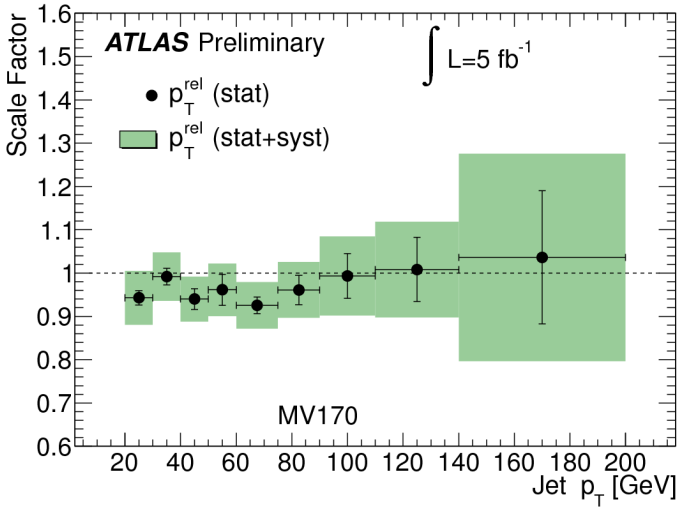


B-tagging bench Mark measurement An comparison of Tagging algorithms; Distribution of pTrel (separation variable)





B-tagging performance measurement: (calibration) Efficiencies and Scaling factors



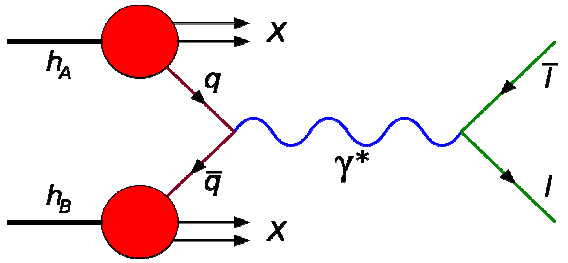
Measurement of the Standard Model

- One of the best measured theories ever
- Large prediction power shown in the past
- Very good measured at earlier experiments
- Clear an well known signatures (W, Z, J/Psi) of invariant masses
- Ideal benchmark processes to understand an to calibrate a new detector
- important basis for searches / measurements for new physics
- Many background processes can be studied with Standard Model processes
- Standard Model processes are the background of the searches

Production of Vector Bosons

- **Z-boson:** Drell Yan Process in leading order
- steeply falling cross section

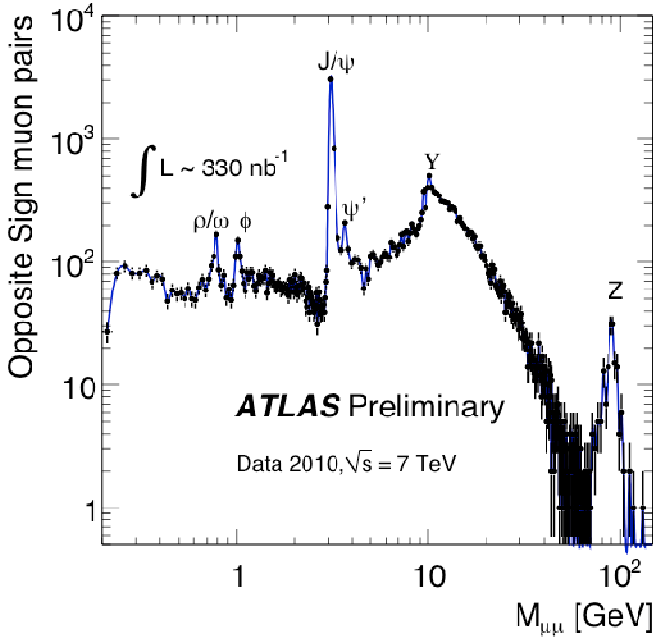
$$\sigma \propto \frac{1}{M^2} \times \mathcal{L}_{q\bar{q}}$$



- **W-Boson:** very similar to Z-Boson (Drell Yan process), but different initial quarks (flavours)

$$u\bar{d} \rightarrow W^+ \rightarrow \mu^+ \nu_\mu$$

- Sensitive to different quark content in proton,
  - Important calibration point for PDfs



- Drell-Yan: lots of structures, measured with di-muon events with ATLAS
- Decays: into e / μ / τ: reconstruction of final state objects