ATLAS Performance and Searches

NON-EXTENSIVE

João Firmino da Costa
DESY-LHC Physics Discussion, 26 July 2010

OUTLINE

Performances

Jets :

Inputs,shapes,structure ATLAS-CONF-2010-053
Jet calibration, uncertainties ATLAS-CONF-2010-056

MET

Reconstruction & calibration ATLAS-CONF-2010-057

Photons

Evidence for prompt photon production ATLAS-CONF-2010-077

Searches

SUSY with jets & MET ATLAS-CONF-2010-065
SUSY with jets & MET & leptons ATLAS-CONF-2010-066

Jet reconstruction, properties and calibration

Goals :

1. Study inputs to jet reconstruction and calibration
2. Study charged tracks in jets and internal structure
3. Validate jet calibration schemes

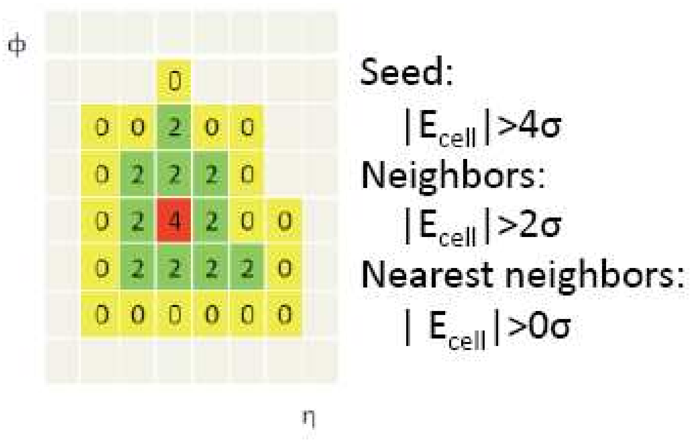
ICHEP: Ariel Schwartzman's talk

Study done with:
Minimum-bias triggered events (0.4 nb^{-1})
Jets reconstructed with anti-k_t algorithm (R=0.6)

Inputs :

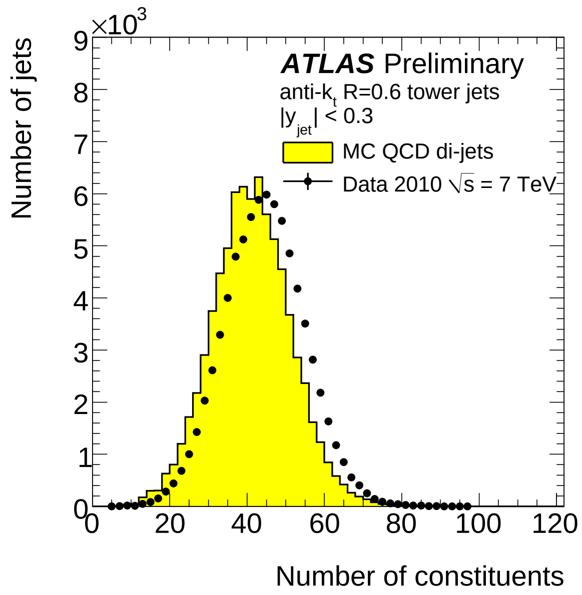
Topological Clusters :

Dynamically formed three-dimensional objects optimized to follow the shower development



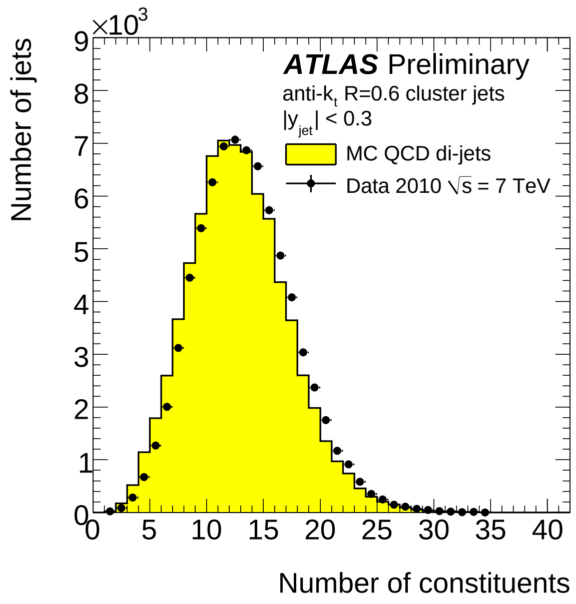
Noise suppressed towers :

Fixed geometry grid using cells belonging to topological clusters

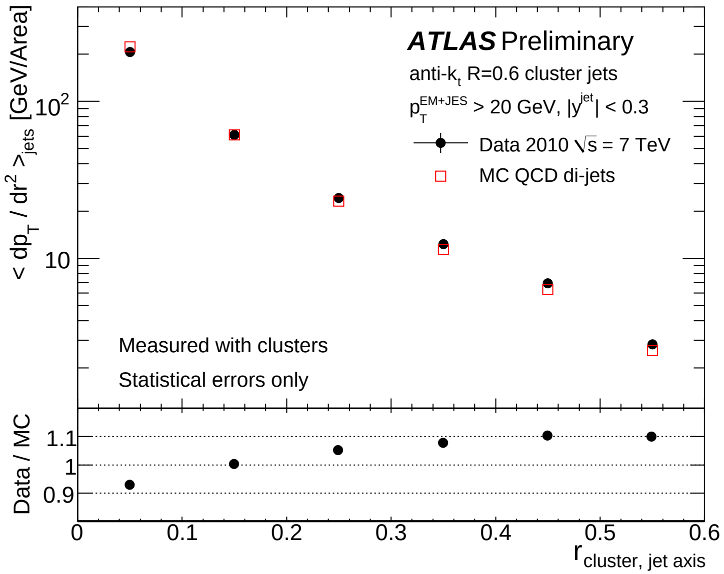


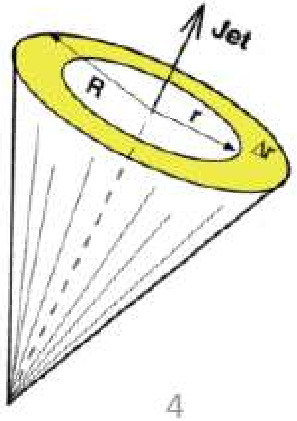
Tracks :

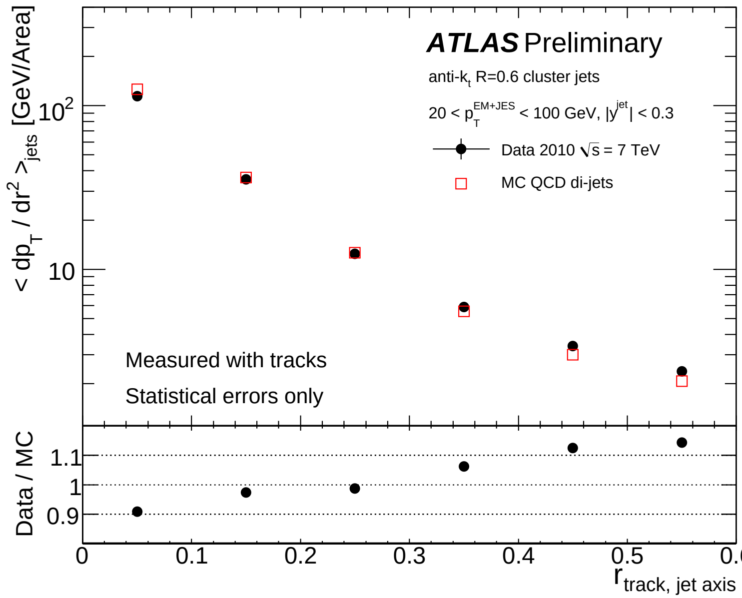
Independent from calorimeter measurements
Provide additional z-vertex information



Jet shape



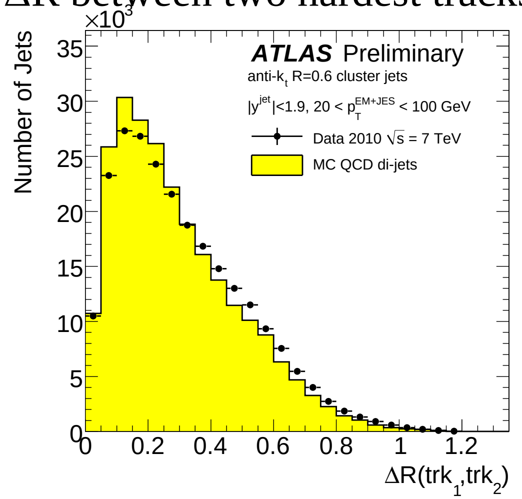




Measurements of jet shapes and properties are used to test how well the simulation models physics and detector effects

- Jet fragmentation, detector response to low energy particles, inputs to jet reconstruction, soft underlying event, pile-up
- Calorimeter and track measurements are independent and can be used to disentangle physics and detector effects

ΔR between two hardest tracks



Conclusion :

Jets are observed to be broader in data than in the simulation

Jet calibration

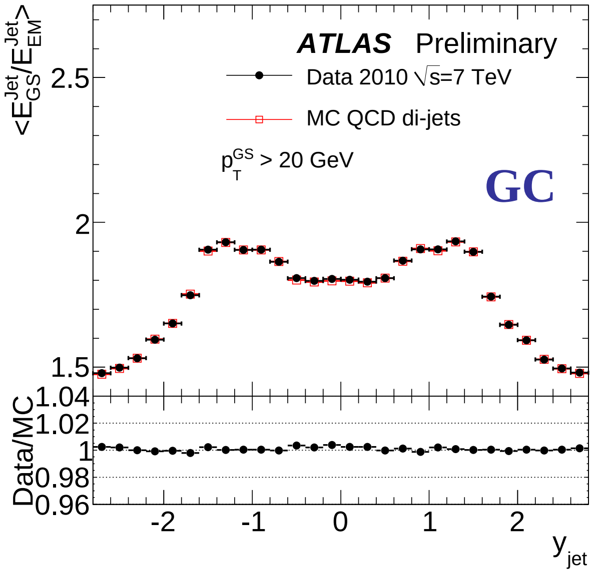
Correct jet energy for calorimeter non-compensation, energy looses in dead material, shower leakage, pile-up

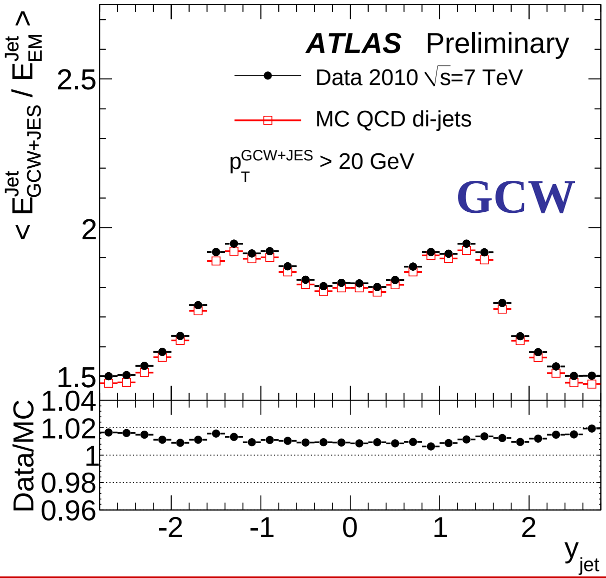
Standard calibration (EM+JES) : Simple pT- and η-dependent correction applied to jets measured at the EM scale

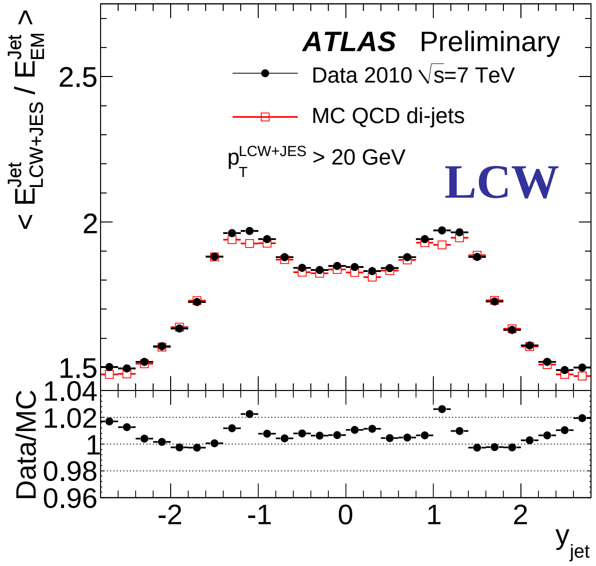
Global sequential calibration (GS):
Add jet-by-jet information about the longitudinal and transverse properties of the jet

Global cell weighting (GCW):
Use cell weights based on cell energy density to compensate for the different calorimeter response to hadronic (low E-density) and electromagnetic depositions

Local cluster weighting (LCW):
Use properties of topological clusters to calibrate them individually
Cluster calibration derived from Monte Carlo simulations of single charged and neutral pions





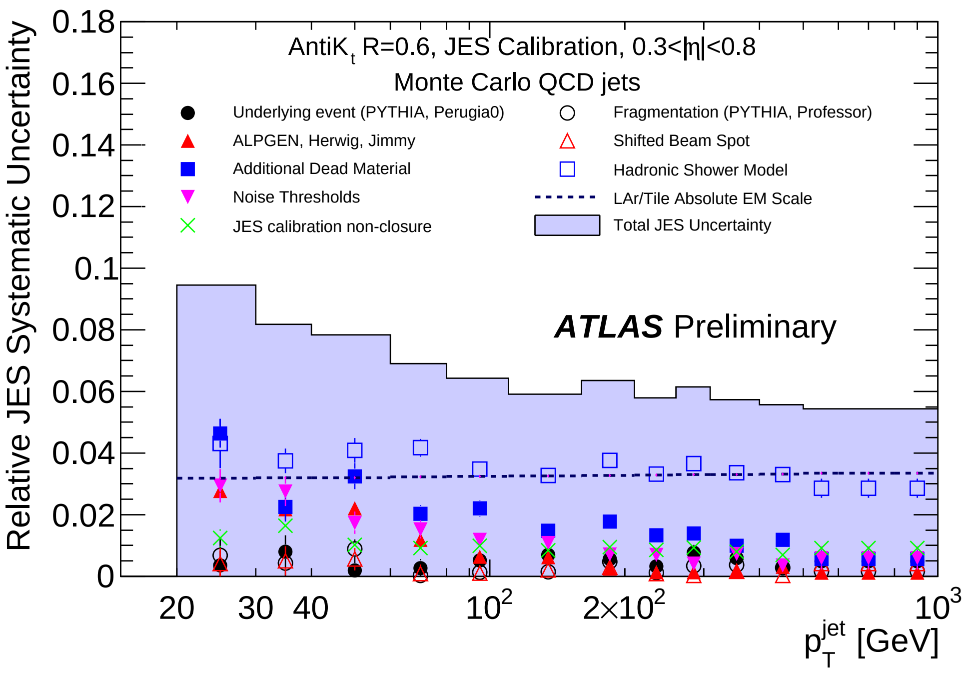


Conclusion : All calibrations apply same correction on average;
Agreement data-MC over all rapidity range to better than 2%

Jet uncertainty

JES uncertainty evaluated by comparing Monte Carlo simulations using various detector configurations and hadronic shower and physics models:

Dominant sources of uncertainty are due to:
- dead material (5%)
- noise description (3%)
- hadronic shower model (5%)
- LAr/Tile absolute EM scale (3%)
- η inter-calibration (3%)



Conclusion :

Jet energy scale uncertainty smaller than 7% for jets with p_T>100GeV
Expect reduction of the systematic uncertainty in the near future by propagating single particle response measurements in data to jets

Missing Transverse Energy Performance

Goals :

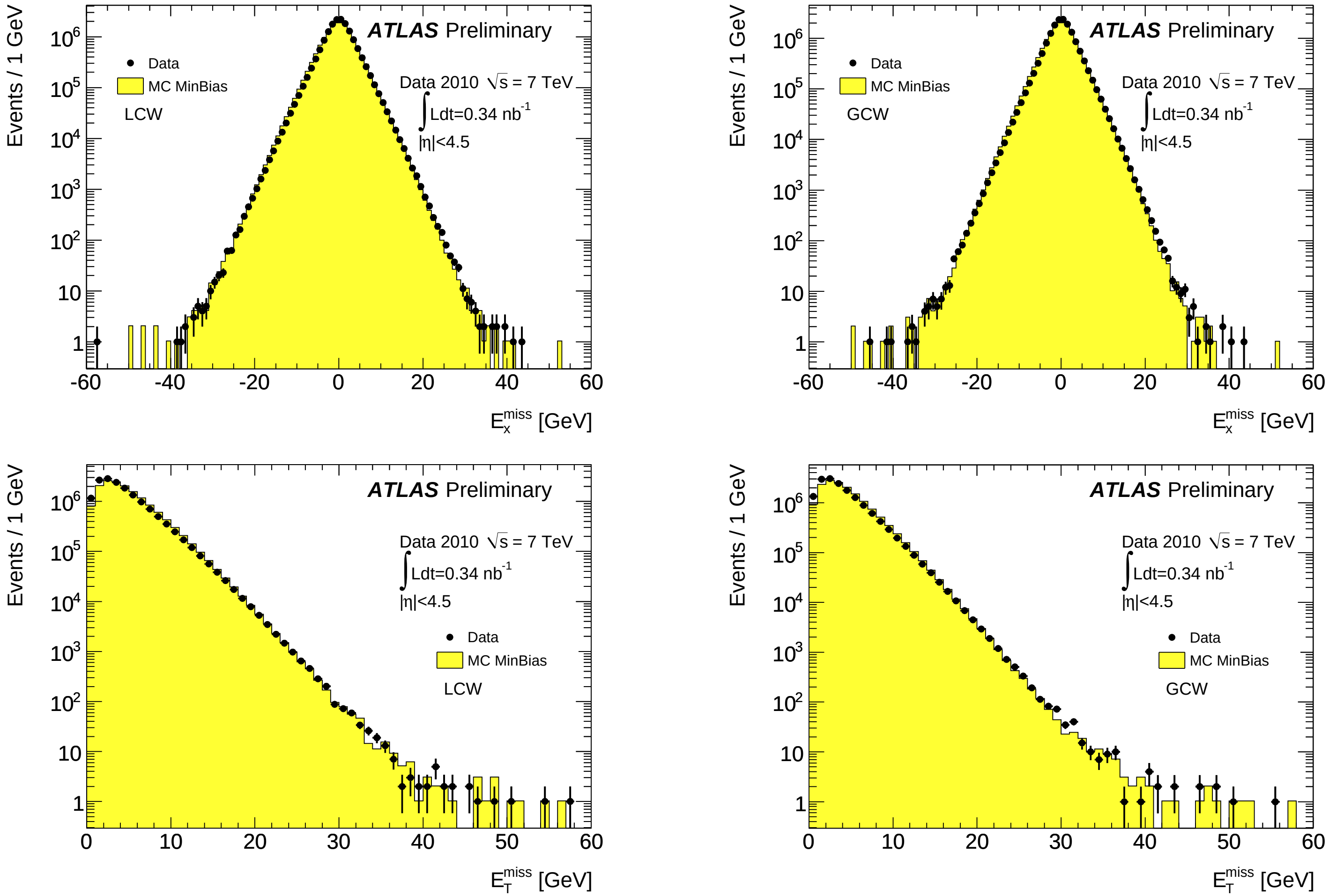
1. Test different calorimeter cell calibration
2. Test refined E_T^{miss} reconstruction

ICHEP: Ariel Schwartzman's talk

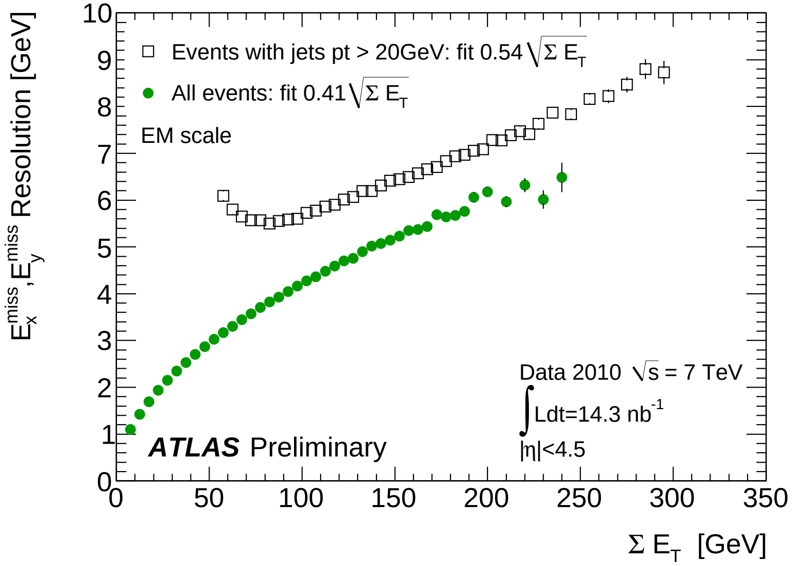
Study done with:

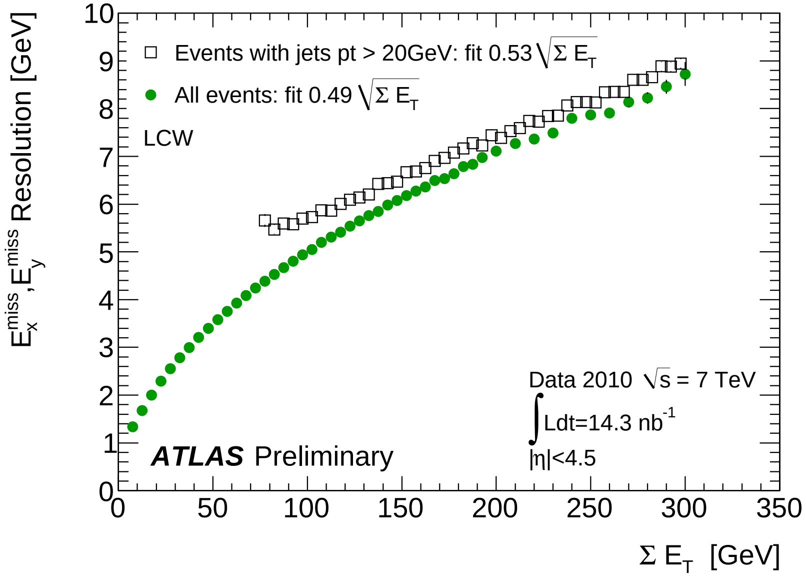
Minimum-bias events (15.2M evts, 0.34 nb^{-1})

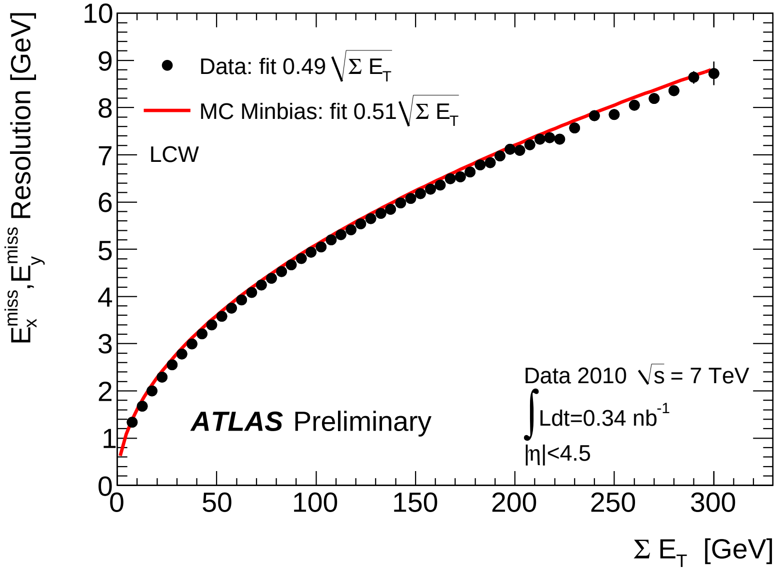
Level-1 Calo events (4.3M evts, 14.3 nb^{-1})



Effect of more elaborate calibration procedures on MET resolution

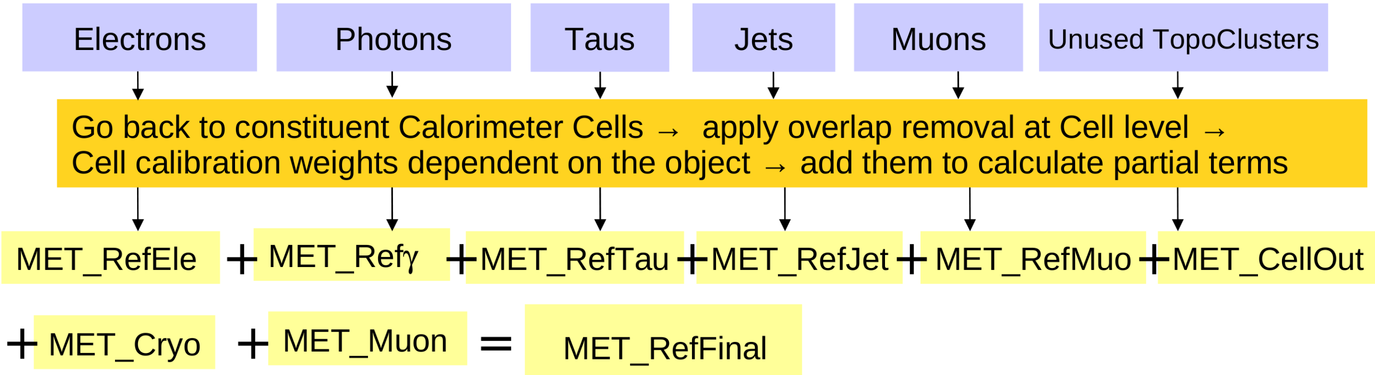




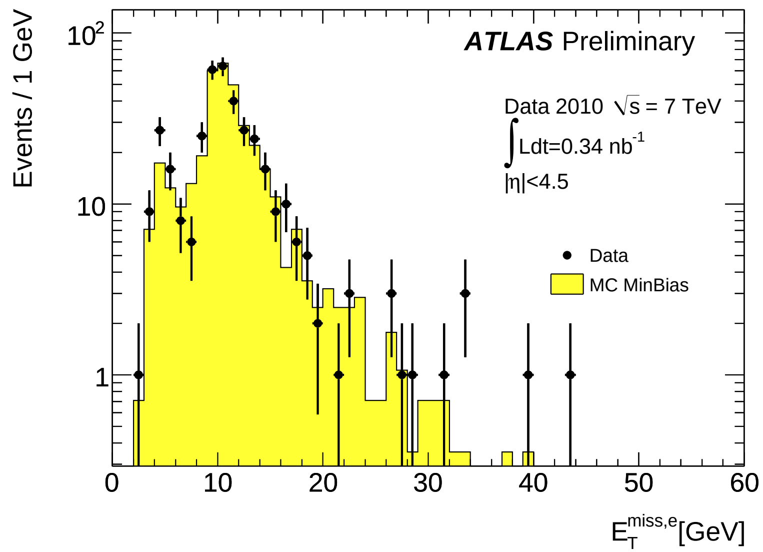


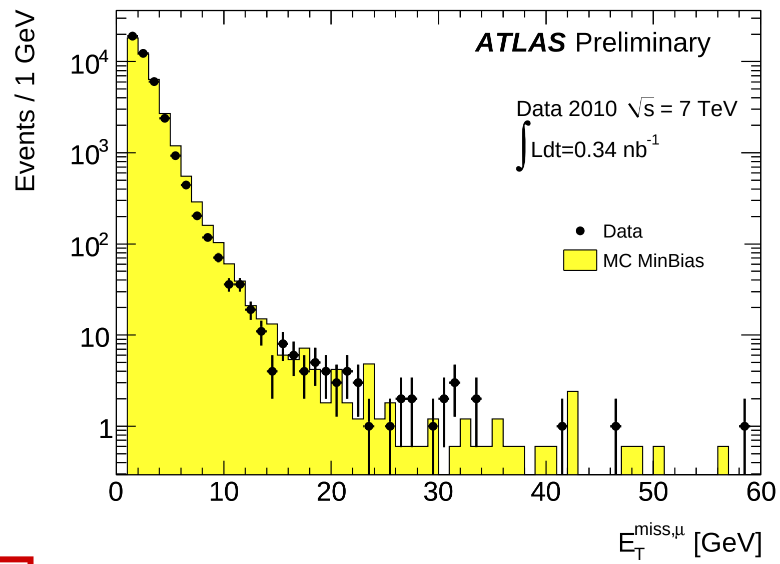
Refinement of Missing Transverse Energy calibration

Calorimeter cells associated with corresponding parent reconstructed object.
Separate and independent calibration for each cell.



Evaluation of E_T^{miss} reconstruction associated with each object:





Conclusion : E_T^{miss} distribution well reproduced by MC
Prepared to look for physics with E_T^{miss} →

W→ l ν (Ivana's talk)
Search for NP with non interacting particles

Prompt photon production

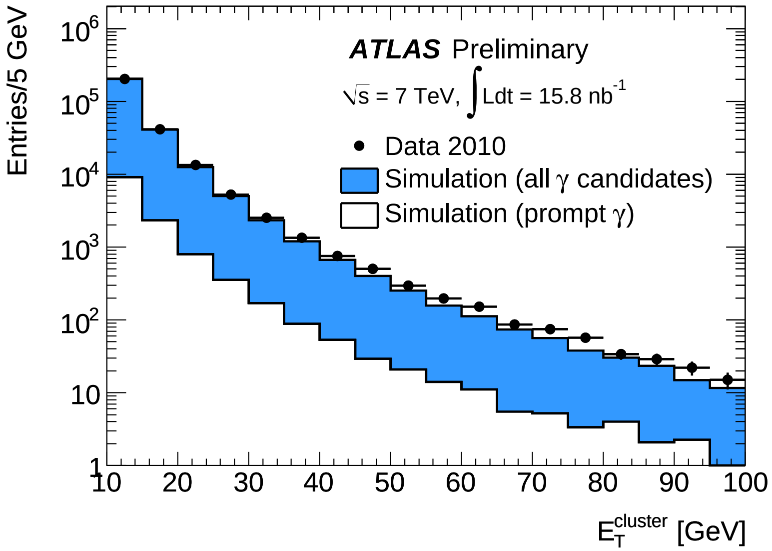
Goal :
Extract the contribution of isolated photons with a significant signal and evaluate the purity of the sample

ICHEP: Scott Snyder's talk

Expect high production rate
Study done with only **15.8 nb^{-1}**
Main bkg : π^0/η decays

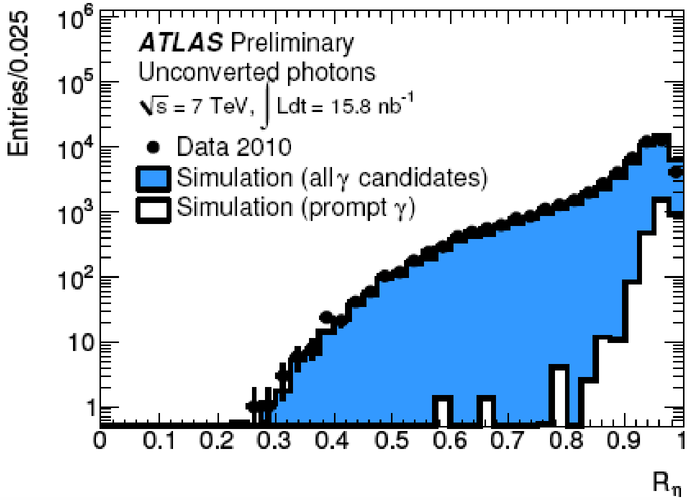
Preselection:

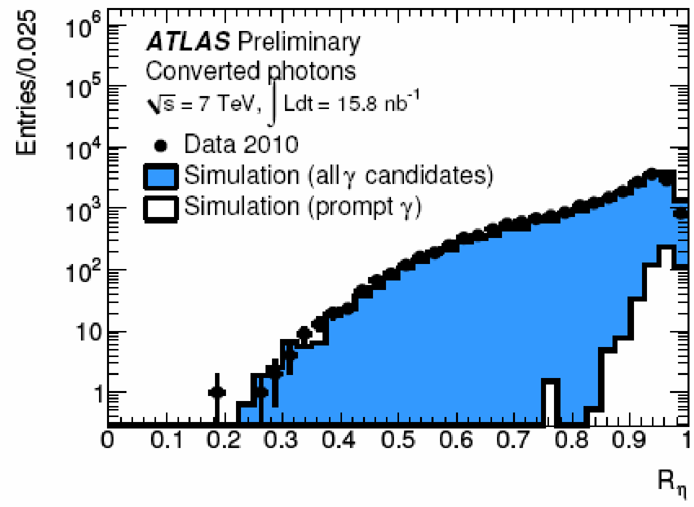
-$|\eta|$< 2.37 without crack regions
-E_T > 10 GeV
-Only clusters in fully working calo regions



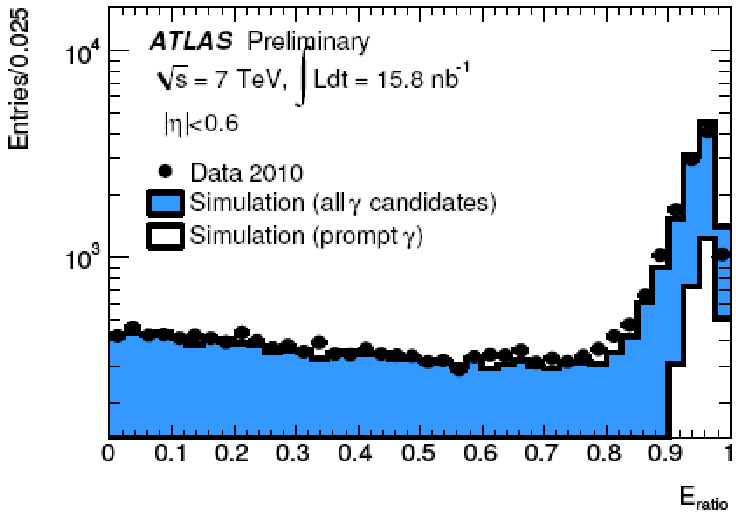
Background suppression
(Loose selection)

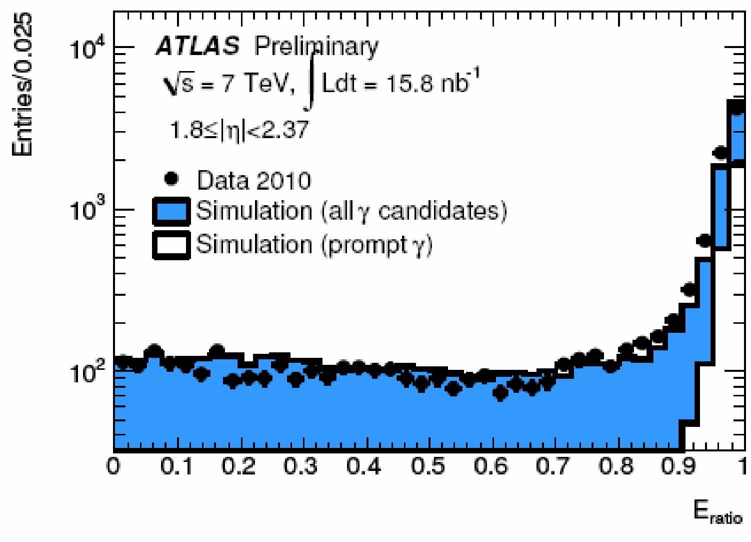
-Energy leakage into the TileCal
-Cluster width in eta (2nd layer)
-R_η = E(3 x 7)/E(7 x 7) (2nd layer)





Prompt photon production (enhancement)





Tight selection variables

Cluster shape/width in layer 1 (π^0 rejection).

E_{ratio}: asym. btw 1st two maxima in layer 1

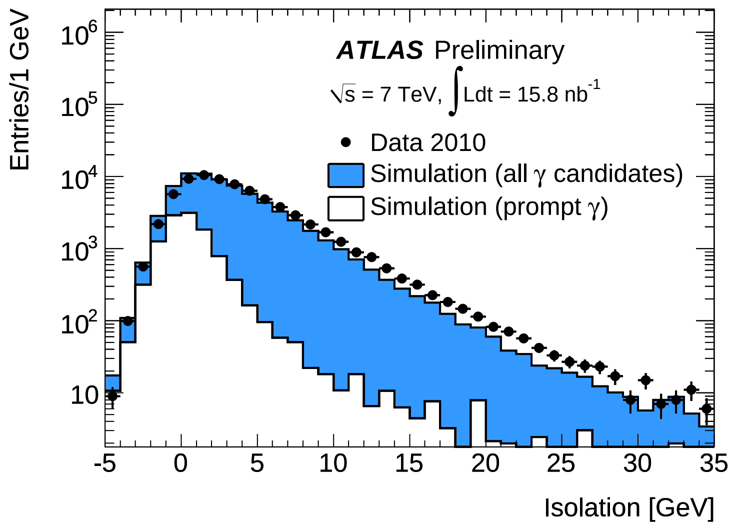
F_{side} : E(7 x 7) - E(3 x 7) (1st layer)

Isolation

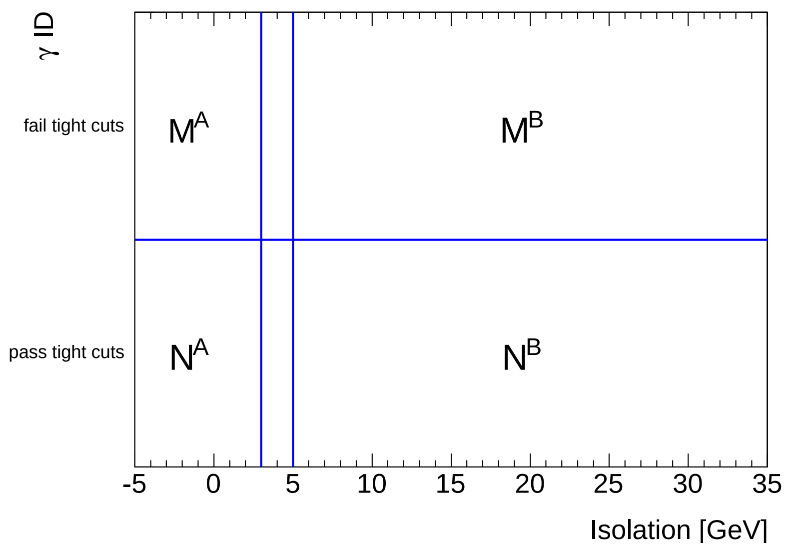
Sum calorimeter energy within R < 0:4 around the candidate.

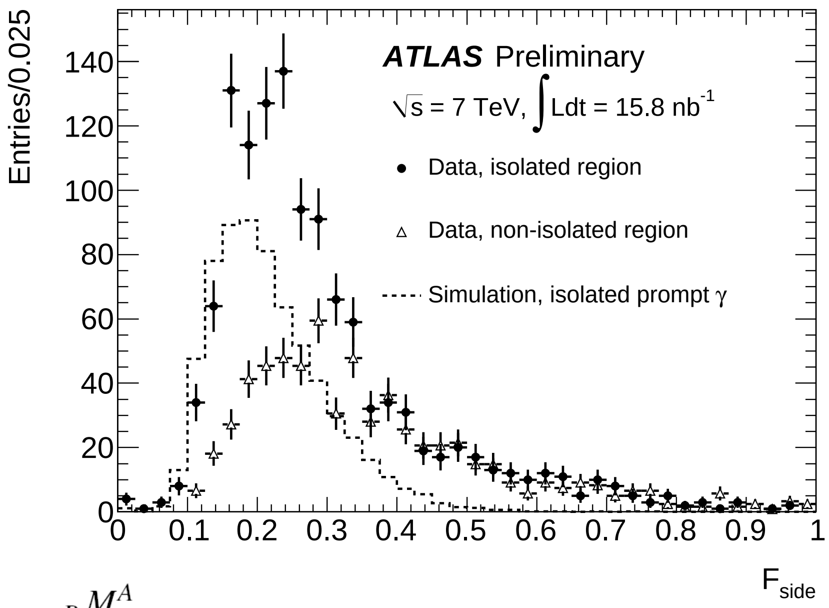
Exclude the candidate itself and subtract expected underlying event contribution.

Signal region: < 3 GeV.



Prompt photon production (Evidence)





$$N^A_{\mathrm{sig}} = N^A - N^B \frac{M^A}{M^B}$$

$$P = 1 - \frac{N^B}{N^A}\frac{M^A}{M^B}$$

E_T interval [GeV]	$10 \leq E_T < 15$	$15 \leq E_T < 20$	$E_T \geq 20$
Number of candidates	5271	1213	864
Estimated purity P [%]	24 ± 5	58 ± 5	72 ± 3
Systematic uncertainty on P [%]	24	8	6
Estimated signal yield N^A_{sig}	1289 ± 297	706 ± 69	618 ± 42
Systematic uncertainty on N^A_{sig}	1362	86	59

Conclusion : Good agreement data-MC. Promissing for physics with photons

SUSY with jets+E_T^{miss}+0 leptons

Goal :
1. Test SM background prediction
2. Get lucky ?

ICHEP: Marija Milosavljevic's poster

Study done with only **70±8 nb^{-1}**
Main bkg : QCD jets,W/Z+jets, top pairs
Study made for different jet multiplicities
Signal = mSUGRA SU4

BKG normalization :
Using dijet cuts selection (dominated by QCD production). Overall normalization applied for all multiplicity channels

Event Selection :

Number of jets	Monojets	≥ 2 jets	≥ 3 jets	≥ 4 jets
Leading jet p_T (GeV) Subsequent jets p_T (GeV)	> 70 veto if > 30	> 70 > 30	> 70 > 30 (Jets 2 and 3)	> 70 > 30 (Jets 2 to 4)
E_T^{miss} $\Delta\phi(\mathrm{jet}_i, \vec{E}_T^{miss})$	> 40 GeV no cut	> 40 GeV $[> 0.2, > 0.2]$	> 40 GeV $[> 0.2, > 0.2, > 0.2]$	> 40 GeV $[> 0.2, > 0.2, > 0.2, > 0]$
$E_T^{miss} > f \times M_{eff}$	no cut	$f = 0.3$	$f = 0.25$	$f = 0.2$

Systematic uncertainties :
The calorimeter energy scale uncertainty was estimated using a parameterisation of this scale as a function of jet pT and η.
The resulting systematic uncertainty on the number of expected events was found to be **>25%** for the monojet analysis and 2-jet analysis, **> 40%** for the 3-jet analysis and **> 50%** for the 4-jet analysis.

The uncertainty in the integrated luminosity is estimated to result in an overall normalization error of **11%** for the $W^{\pm}$ + jets, Z^0 + jets and ttbar production.

SUSY with jets+E_T^{miss}+0 leptons

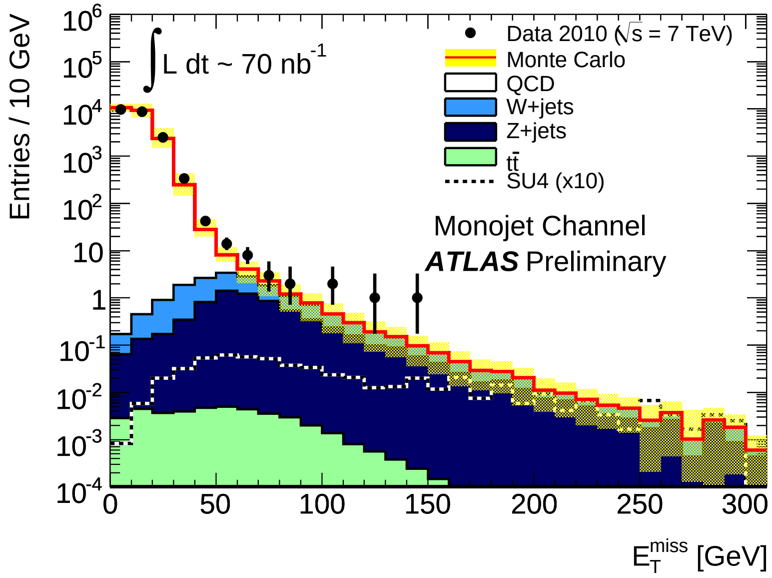
Monojet channel :

Bkg dominated by QCD,
W/Z relevant for E_T^{miss} > 50 GeV

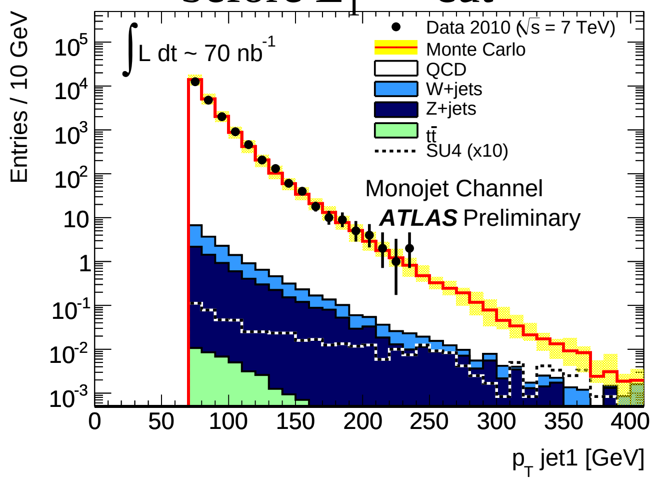
Signal region : E_T^{miss} > 40 GeV

4 events in the signal region are candidates for beam-halo interactions

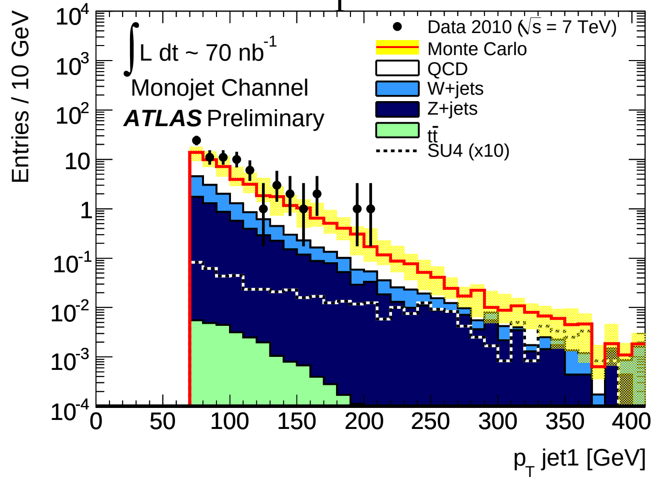
JES systematic uncertainty for number of events > **25%**



before E_T^{miss} cut



after E_T^{miss} cut



Agreement within systematic uncertainties

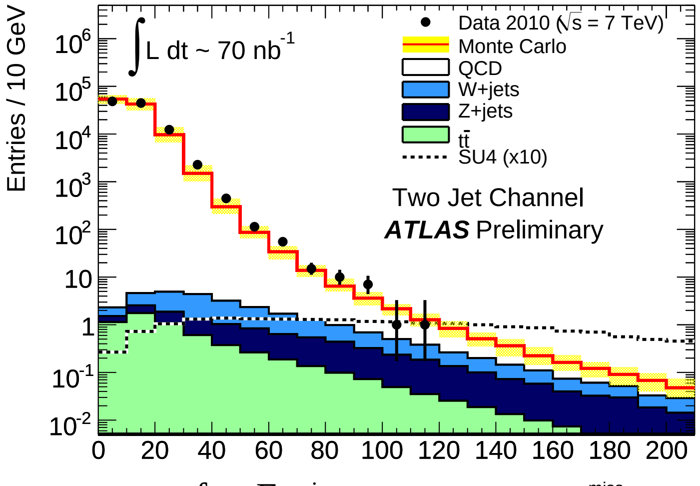
SUSY with jets+E_T^{miss}+0 leptons

Two jet channel :

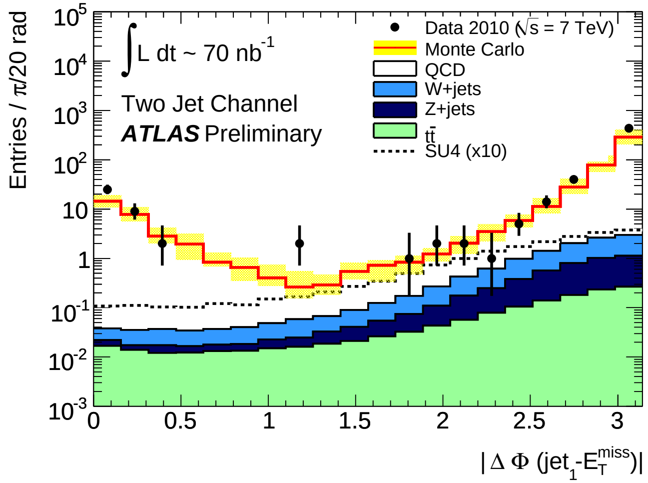
Bkg = QCD dijets

Extra-handle : Check angular correlations between the two jets

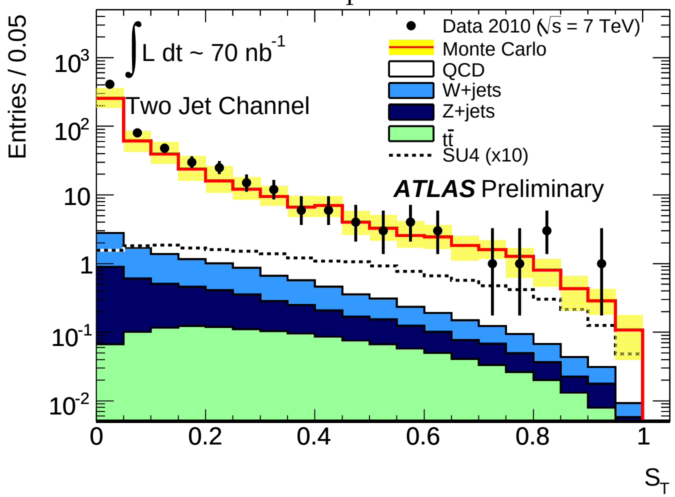
JES systematic uncertainty for number of events > **25%**



after E_T^{miss} cut



after E_T^{miss} cut



transverse sphericity

Conclusion :

- Agreement with Standard Model expectations for 1,2 jet channel (also for 3,4 not shown) up to E_T^{miss} ≈ 100 GeV, M_{eff} ≈ 1500 GeV (not shown)
- Need to refine/reduce systematic uncertainties in order to provide increased sensitivity to new physics.

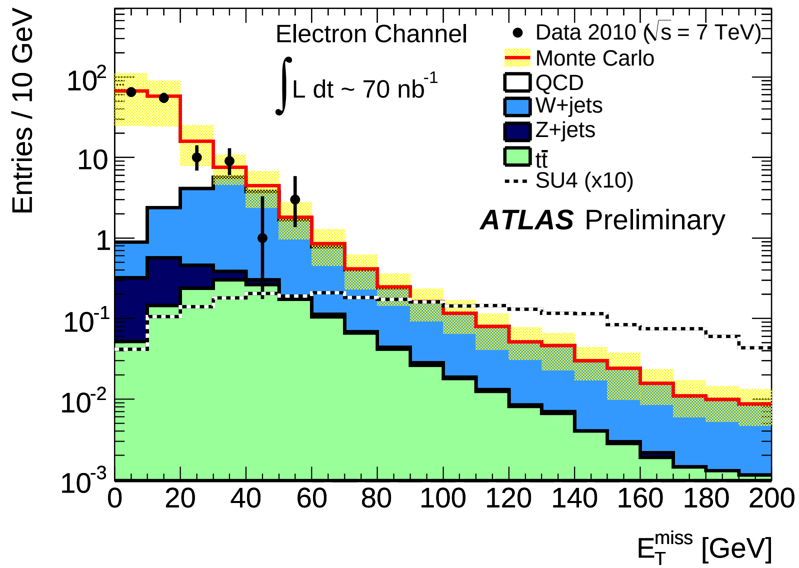
SUSY with jets+E_T^{miss}+1 lepton

Goal :
1. Test SM background prediction
2. Get lucky ?

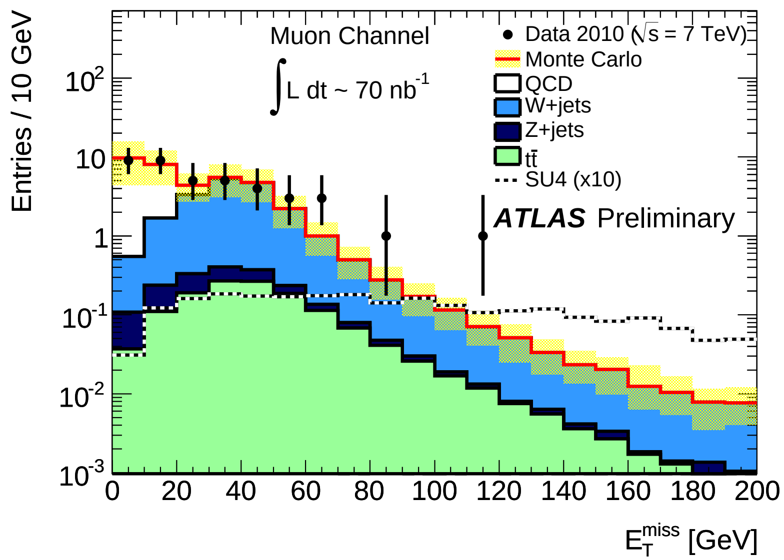
ICHEP: Dominique Fortin's talk

Study done with only **70±8 nb^{-1}**
Main bkg : QCD jets,W/Z+jets, top pairs
Signal = mSUGRA SU4

Search made for e/μ



Control regions used for normalizing MC expectations for single lepton channels



Pythia QCD:

MET < 40 GeV and mT < 40 GeV

QCD bkg. systematic uncertainty = **50%**

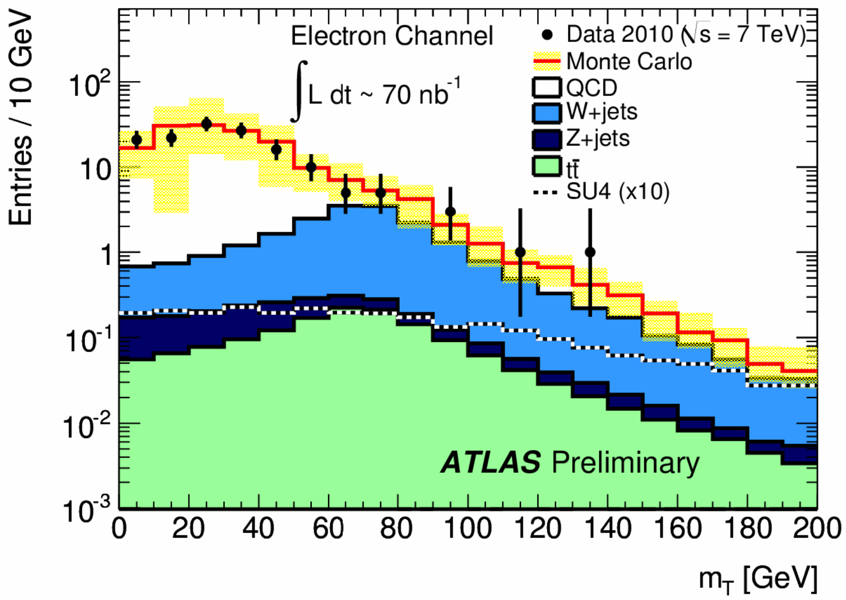
(**100%** for dilepton)

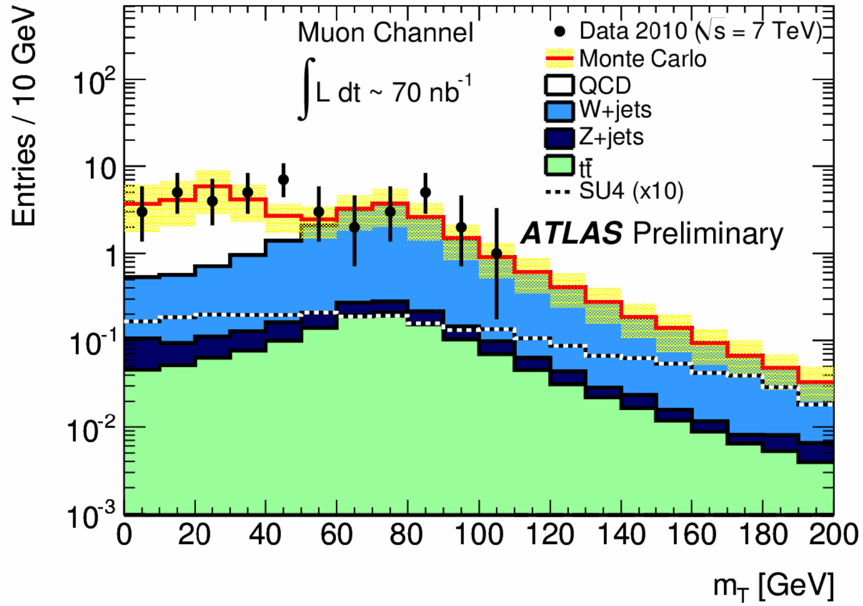
Alpgen W + jets:

30 GeV < MET < 50 GeV and
40 GeV < mT < 80 GeV

W-jet bkg. systematic uncertainty = **60%**

SUSY with jets+E_T^{miss}+1 lepton





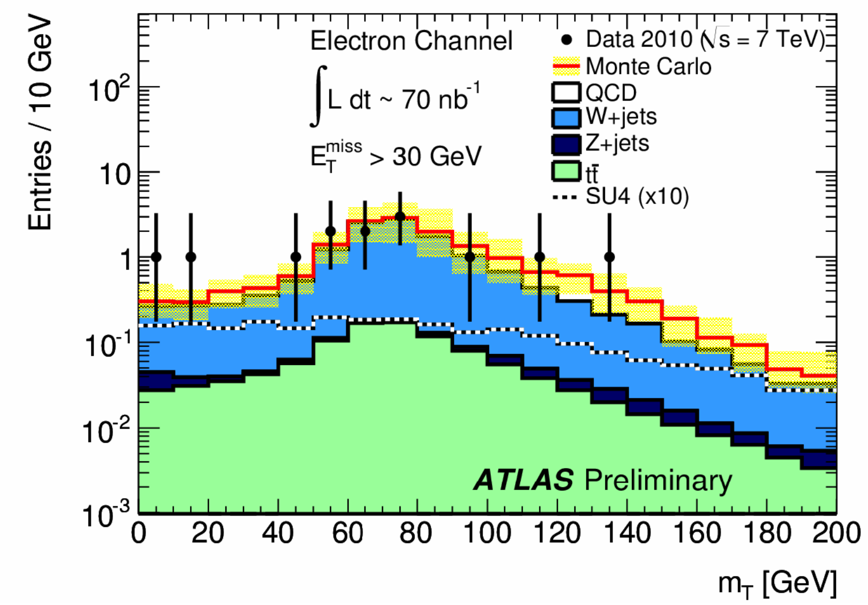
Required 1 lepton with p_T > 20 GeV and 2 jets with p_T > 30 GeV

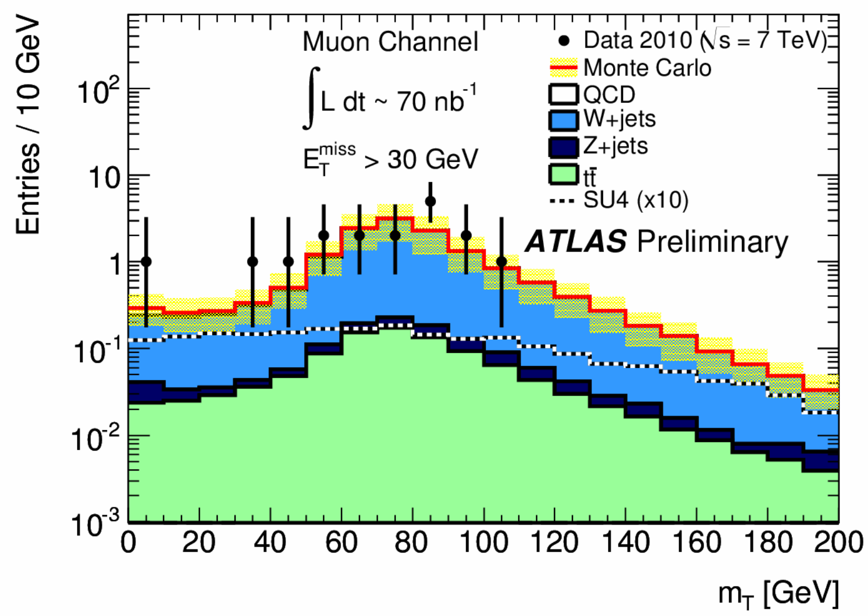
Normalized MC using control regions

Electron channel: 143 events in data compared to 157 ± 85 from MC

Muon channel: 40 events in data compared to 37 ± 14 from MC

SUSY with jets+E_T^{miss}+1 lepton





Required 1 lepton with p_T > 20 GeV and 2 jets with p_T > 30 GeV and MET > 30 GeV

Normalized MC using control regions

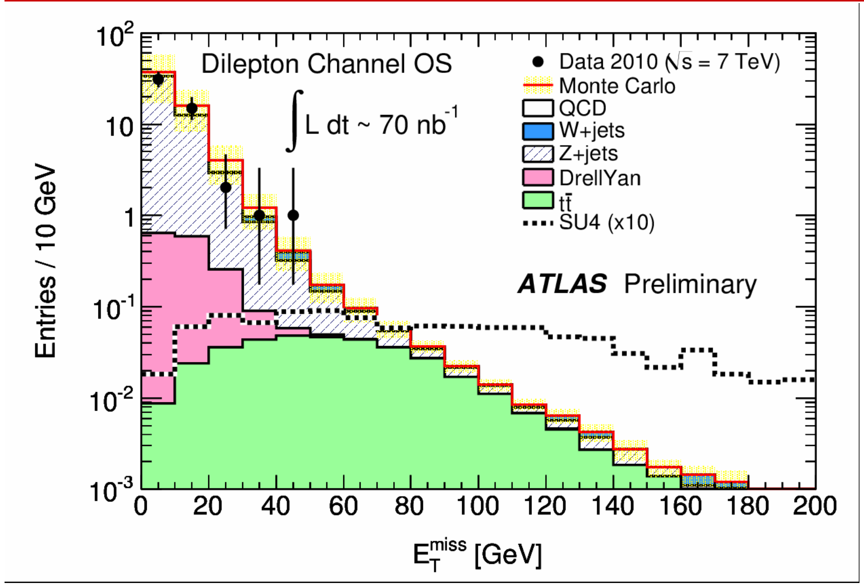
Electron channel: 13 events in data compared to 16 ± 7 from MC

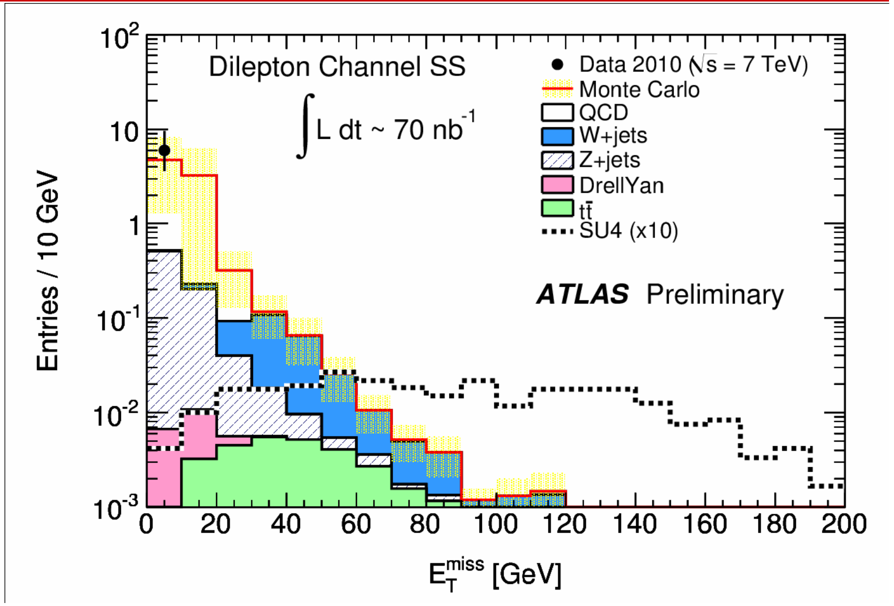
Requiring m_T > 100 GeV: 2 data events survive compared with 3.6 ± 1.6

Muon channel: 17 events in data compared to 15 ± 7 from MC

Requiring m_T > 100 GeV: 1 data event survives compared with 2.8 ± 1.2

SUSY with jets+E_T^{miss}+2 lepton





Require a 2nd lepton (electron or muon) with $p_T > 10$ GeV/c
MC Alpgen W + ≥2 jets normalized to QCD cross section

Checked rates consistent in QCD dominiated control region

5 GeV < m_{ll} < 15 GeV; MET < 15 GeV

Requiring MET > 30 GeV

Two event remains in OS channel, consistent with MC background predictions 2 ± 0.8

Back-up

The “top story”

http://www.bbc.co.uk/news/science-environment-10746900

23 July 2010 Last updated at 19:33 GMT [N.B. *ATLAS D. Fortin spoke at noon*]
LHC closes in on massive particle
By Paul Rincon Science reporter, BBC News, Paris

“Physicists at the Large Hadron Collider (LHC) have seen
several candidates for the heaviest elementary particle known to science.
If the observations are **confirmed**, ... could assist physicists in the hunt for the elusive Higgs boson, or "God particle".
Details of the top quark candidates were presented at a major particle physics conference in Paris....
'Striking event' Several possible detections of top quarks have been made recently by the LHC's Atlas and Compact Muon Solenoid (CMS) experiments.
Atlas has seen nine collision events compatible with the top quark; **CMS has observed 3-4 candidate events**...
But physicists stressed that more data was needed in order to support the conclusive observation of top quark production at the LHC.
... The top quark might also act as the progenitor for so-called "supersymmetric" particles.
These would represent an entirely new class of particles, predicted to exist by theorists,
but which have yet to be observed at particle accelerators.”

Conclusion : No need to read conf-notes from now on...

Jet properties