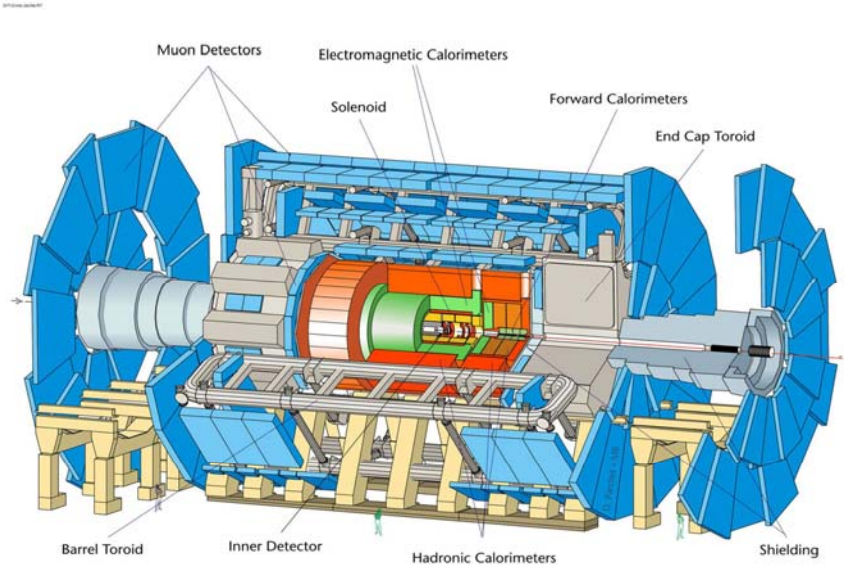
First physics with the ATLAS detector

Dirk Zerwas
LAL Orsay
On behalf of the ATLAS Collaboration

Physics at LHC 2008
Split, Croatia
October 2, 2008

- Introduction
- expected performance
- first physics
- conclusions



Introduction

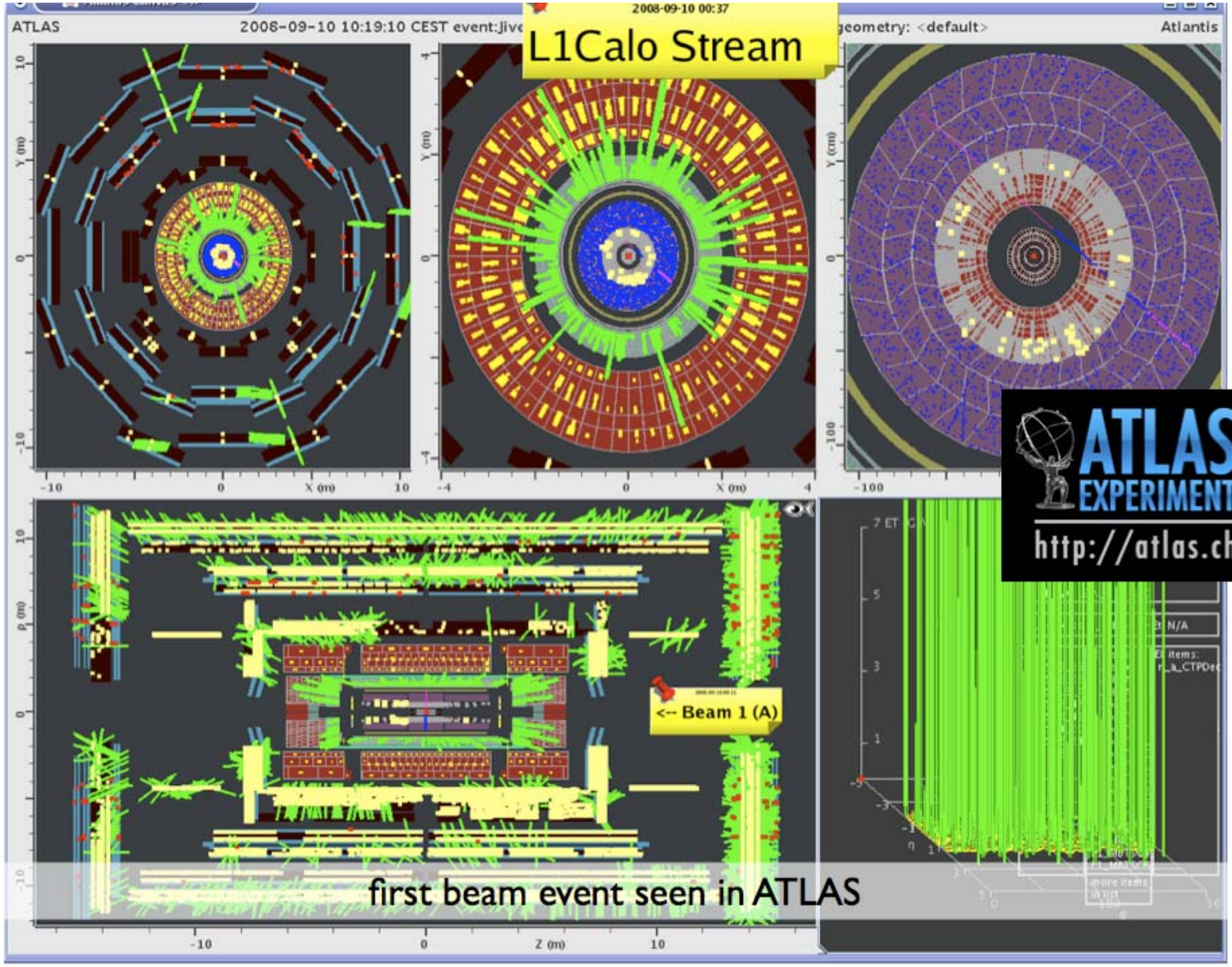
- Status of the ATLAS detector → Peter Jenni
- Commissioning of the ATLAS detector → Manuella Vincter

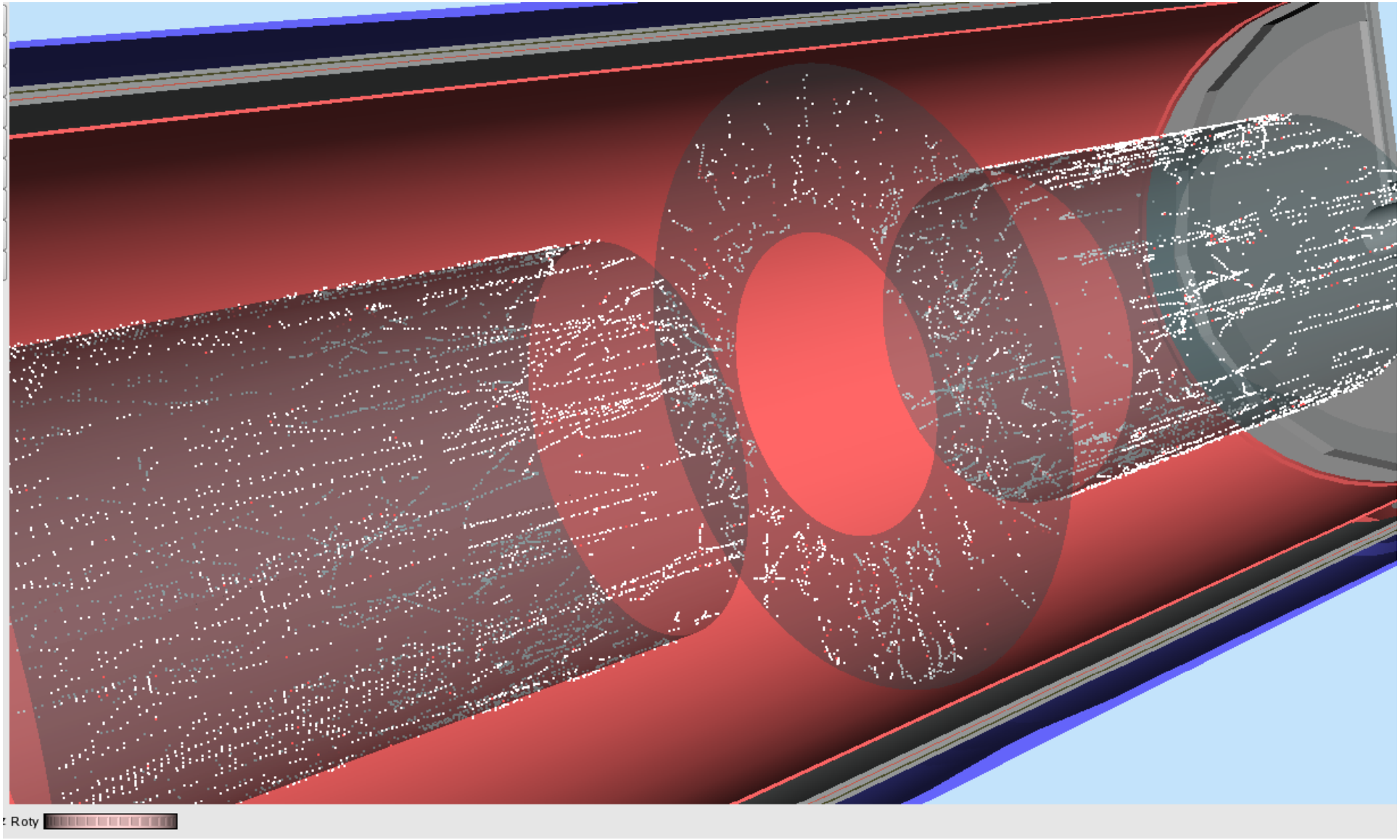
First physics = performance and calibration
Highlight expected performance:
- electrons, muons, jet/ETmiss, tau, b-tagging, trigger
- low-mass resonances, Z → ee,μμ,ττ Z+jets, tt

First physics beyond performance:
- new physics in autocalibrated/large cross section signals

EW: Z/W cross sections
→ Lucia di Ciaccio (LHC)
→ Kristin Lohwasser (ATLAS)
QCD/top:
→ Frank-Peter Schilling

Basis of the studies: CSC
- large scale production
- simulation and reconstruction of more than 25 million events
- single particles to complex physics signatures
- most precise detector description
- volontary introduction of imperfections (alignment+additional material)
- test of analysis model


ATLAS
2008-09-10 10:19:10 CEST event:Jive
2008-09-10 00:37
L1Calo Stream
geometry: <default>
Atlantis
<-- Beam 1 (A)
ATLAS EXPERIMENT
http://atlas.ch
first beam event seen in ATLAS

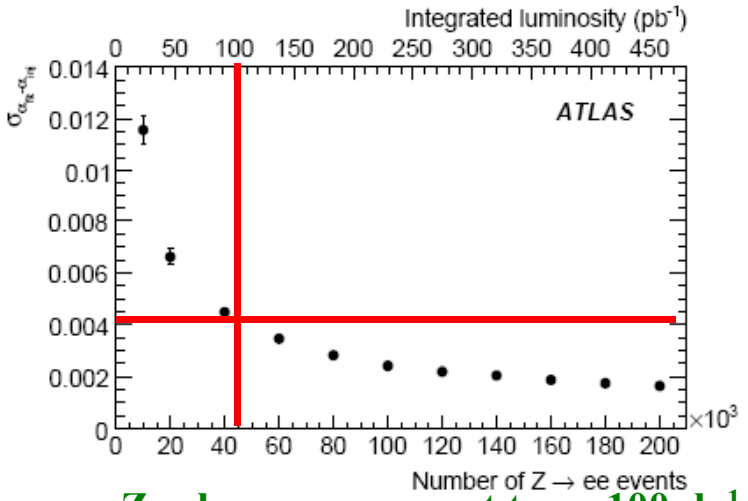

Roty

Expected performance: Electrons

talk by Emmanuel Turlay, September 30

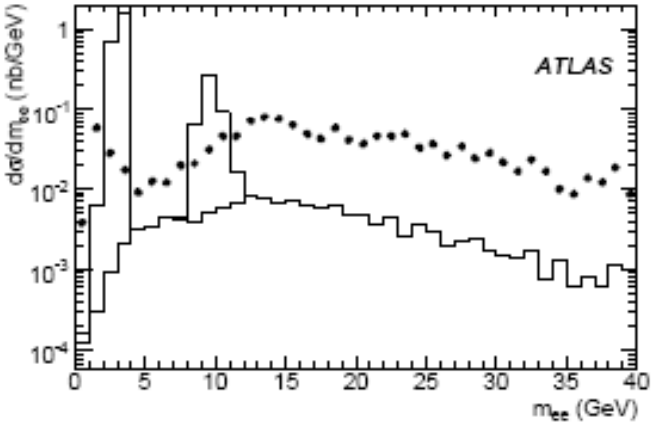
Cuts	$E_T > 17$ GeV		
	Efficiency (%)		Jet rejection
	$Z \rightarrow ee$	$b,c \rightarrow e$	
Loose	87.96 ± 0.07	50.8 ± 0.5	567 ± 1
Medium	77.29 ± 0.06	30.7 ± 0.5	2184 ± 13
Tight (TRT.)	61.66 ± 0.07	22.5 ± 0.4	$(8.9 \pm 0.3)10^4$
Tight (isol.)	64.22 ± 0.07	17.3 ± 0.4	$(9.8 \pm 0.4)10^4$

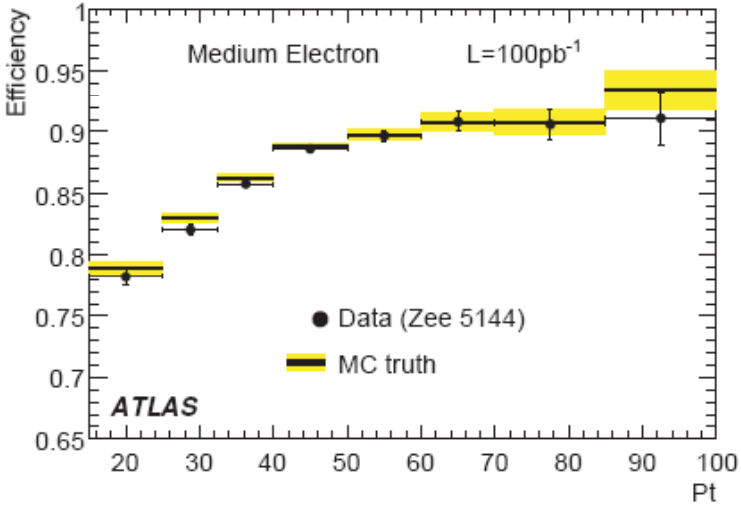
Large QCD cross section at LHC:
10^5 rejection reached for 64% efficiency: ok



Zee long range const term 100pb^{-1} :
0.4% (⊕ 0.5%) OK

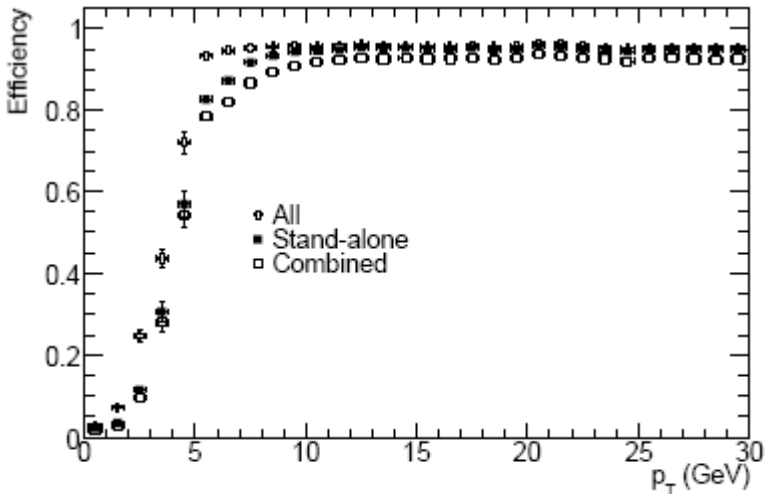
First physics for electrons:
- **copious source of low-PT electrons: J/ψ/Upsilon**
- **100pb^{-1}: Z→ee for intercalibration and tag&probe**





Efficiency Z→ee tag& probe:
Good agreement with MCtruth (±0.1%, ±1.5%)

Expected performance: Muons

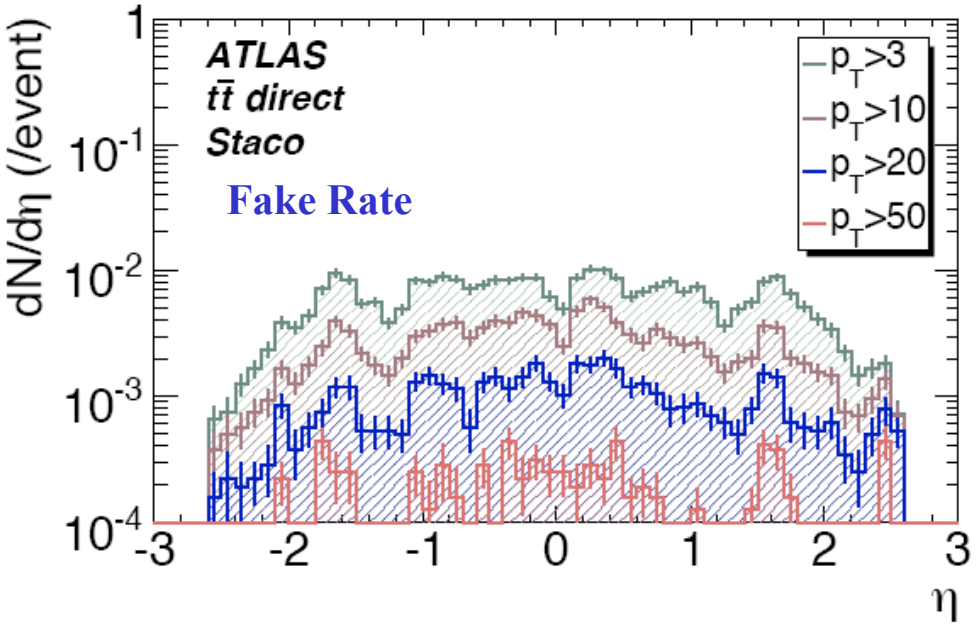


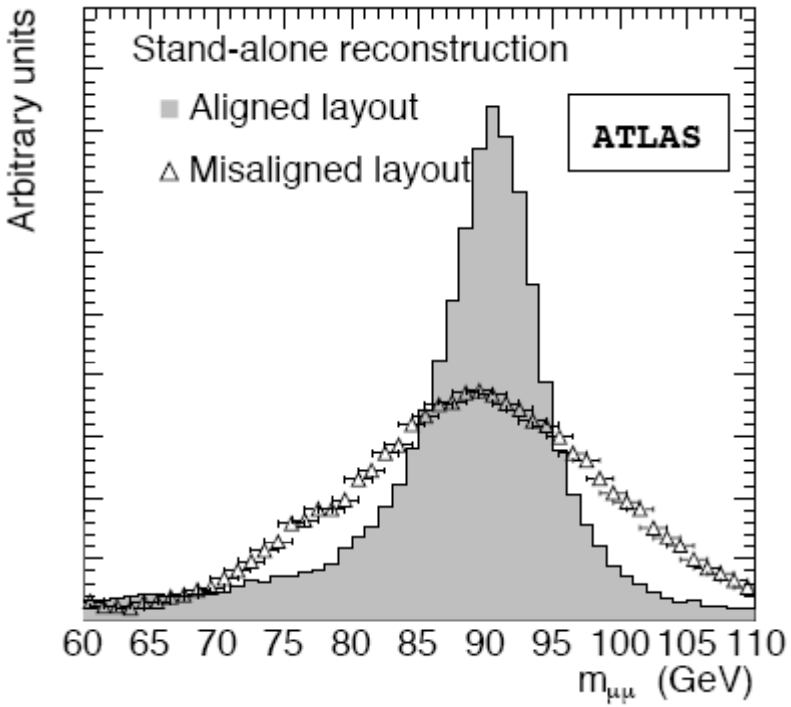
Combination of ID and MuonSpectrometer tracks

- **Good efficiency PT>=4GeV with low fake rate**
- **Good coverage in η**

First physics:

- **Z→μμ tag&probe**
- **100pb^{-1} → ε ±0.08% (stat) ±1% (syst)**
- **energy scale with 50pb-1: ±0.5GeV (50GeV muons)**
- **initial misalignment 1mm and 1 mrad, no bias but 3x broader distribution (after aligment: 50μm)**





Expected performance: jets

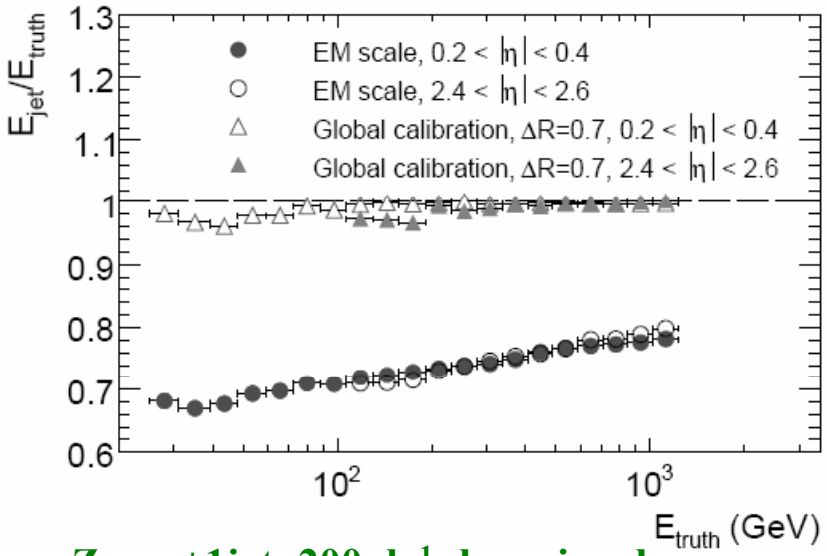
talk by Damir Lelas September 30

Calorimeter based jets:
- **Topological clustering**
- **Calibration (local)**
- **Jet finding kt/cone**
- **Jes corrections (noise/pileup)**
- **Refined jets (underlying event)**

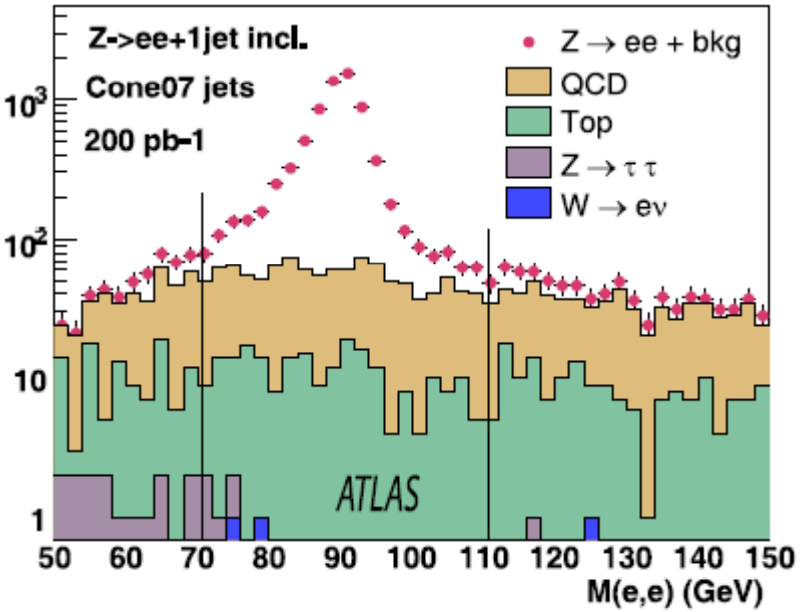
Jet energy scale ~ % in the barrel

Photon + jets: large statistics
~% scale precision

p_T low edge	Error for 10 pb^{-1}
20 GeV	0.2%
30 GeV	0.2%
45 GeV	0.4%
67.5 GeV	0.4%
101 GeV	0.7%
152 GeV	0.4%
228 GeV	1.7%
342 GeV	4%
513 GeV	19%



Z→ee+1jet: 200pb^{-1} clear signal
→ Z+jet calibration

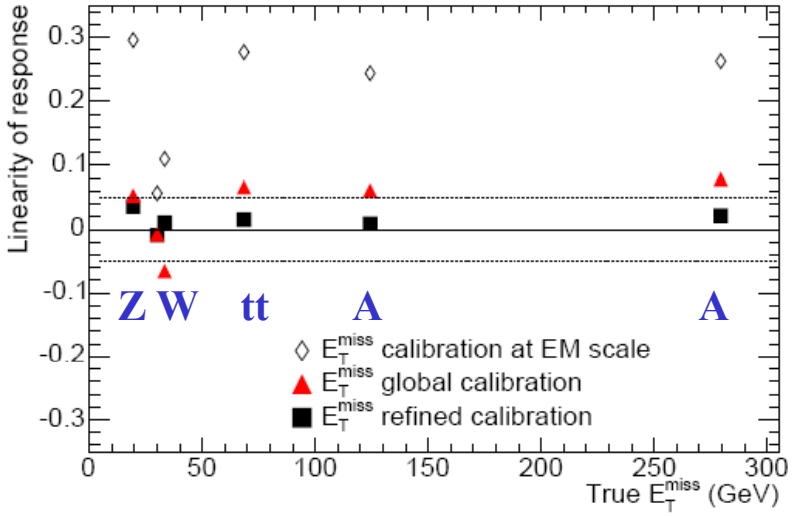


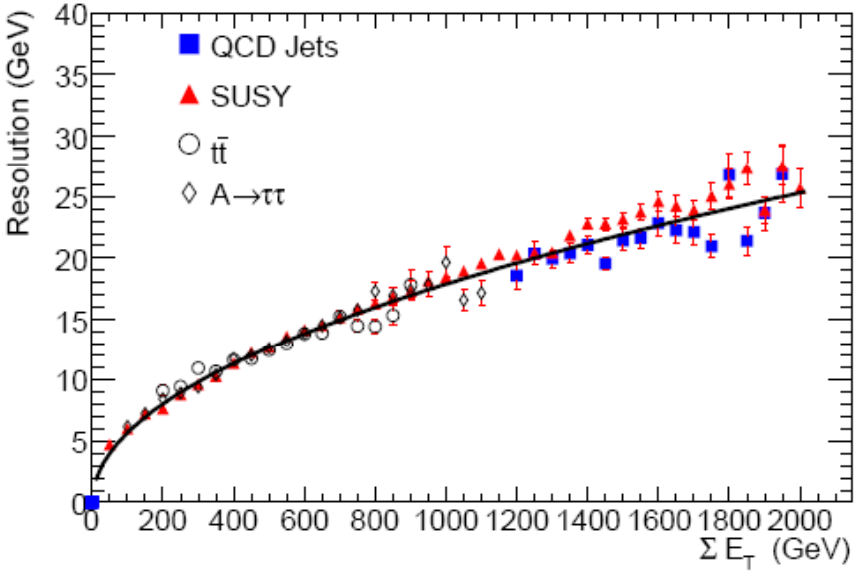
Expected performance: ETmiss

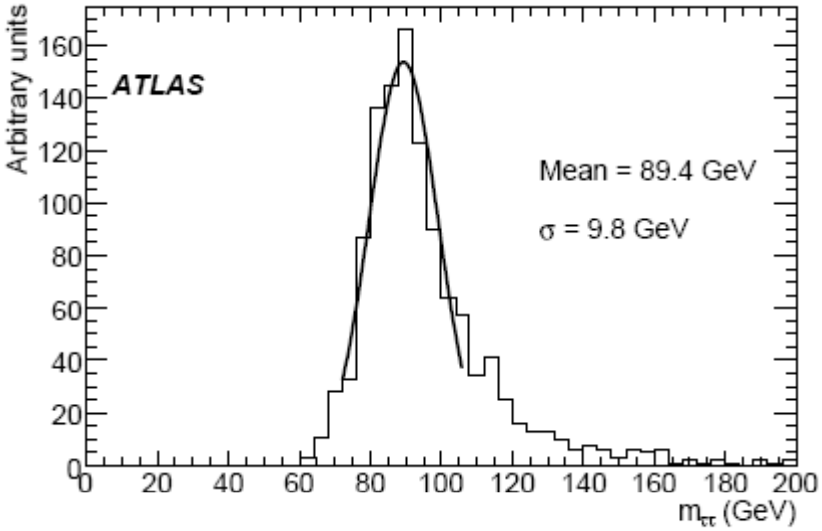
ETmiss at EM energy scale ~30%
refined with
- **muons**
- **electrons**
- **jets**

ETmiss scale ~ 5%
ETmiss resolution 0.57√E

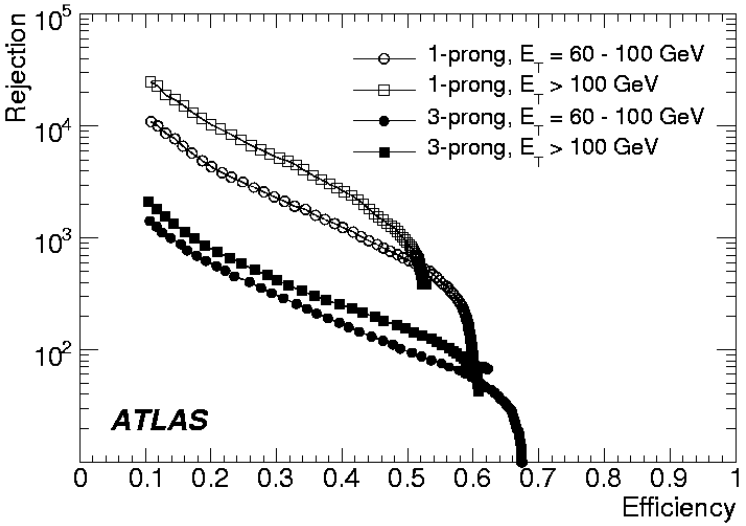
First check: Z→ττ
energy scale 2%



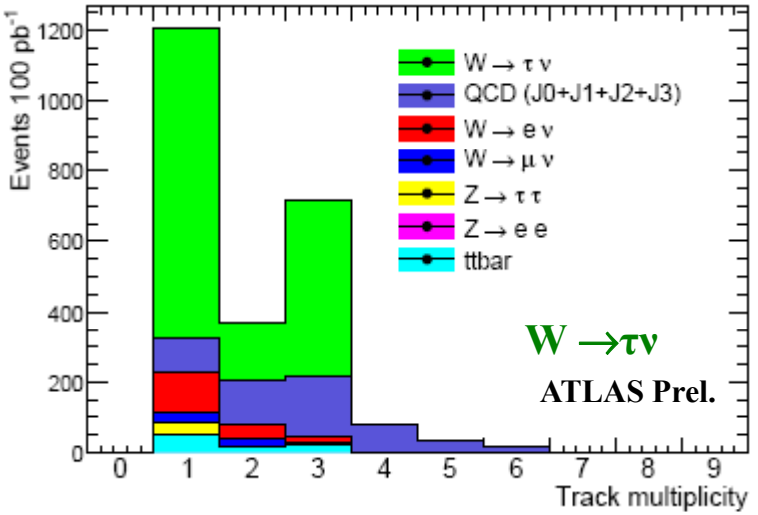




Expected performance: Taus



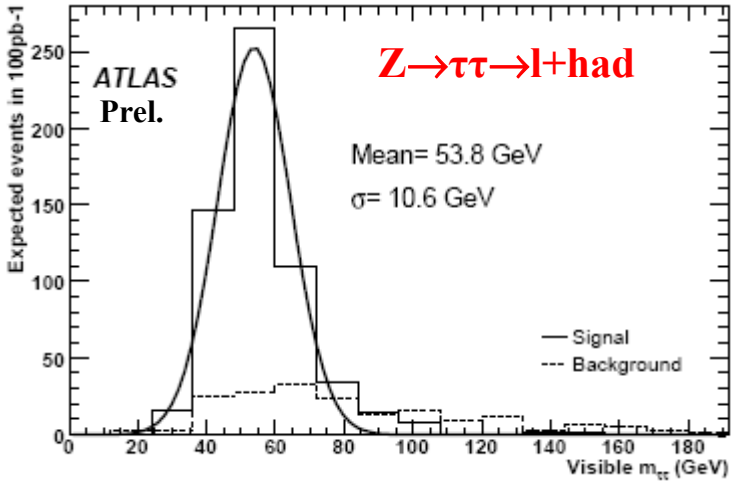
calorimeter based tau-ID



ETmiss > 60GeV

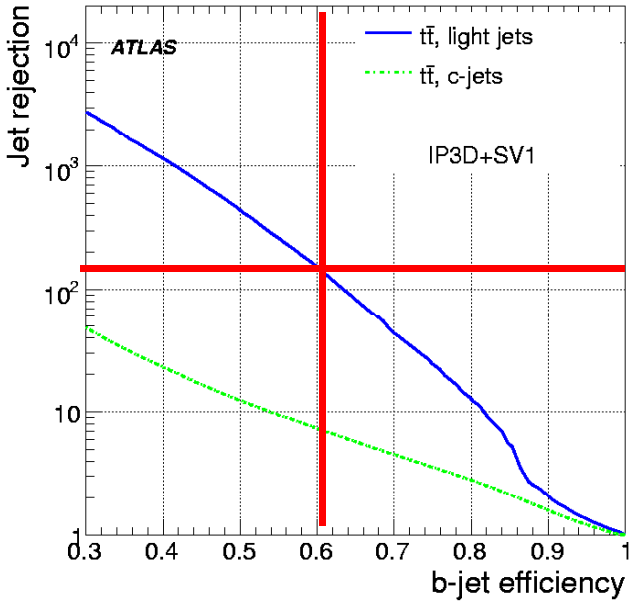
Two approaches:
- **calorimeter based**
- **track based**
- **efficiencies: 30% for jet-rejection ~10^3**

First physics:
- **100pb^{-1}**
- **W →τν**
- **Z→ττ→l+had**
- **clear signal for W and Z in tau channel!**

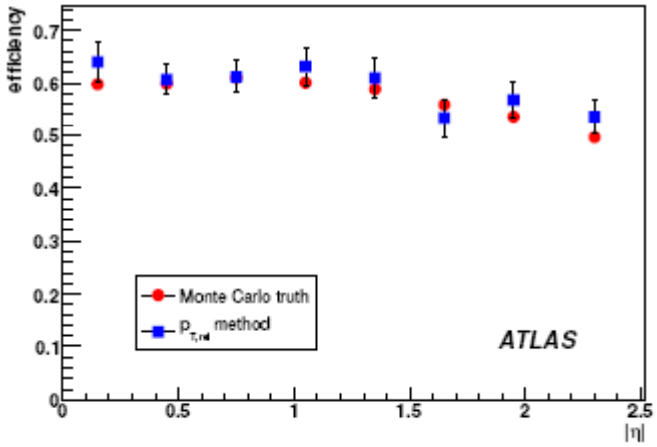


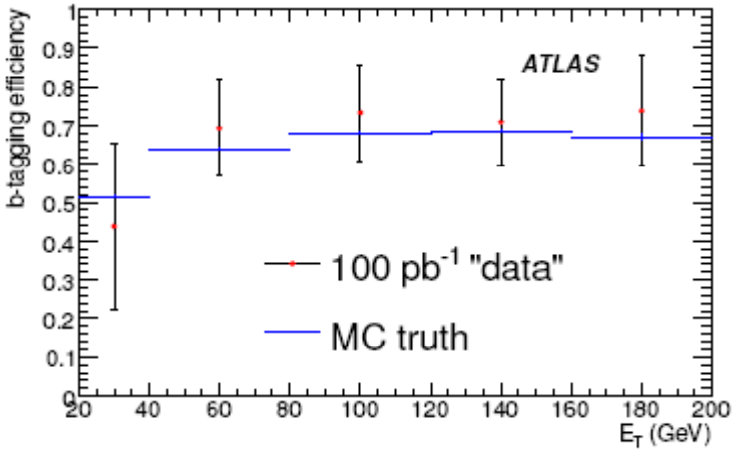
Expected performance: b-tagging

b-tagging:
- 60% efficiency
- JetProb: rejection at least 30
- soft-lepton tagging (later)
- IP3D (long. & transverse IP): rejection 60
- secondary vertex: rejection 150

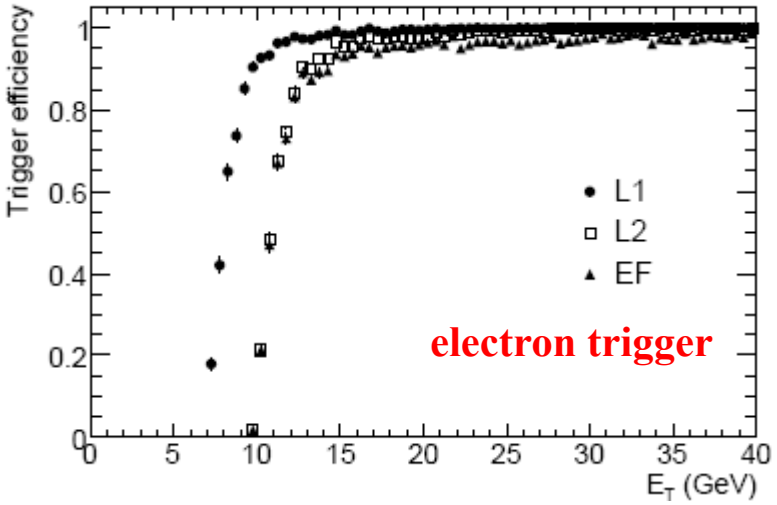


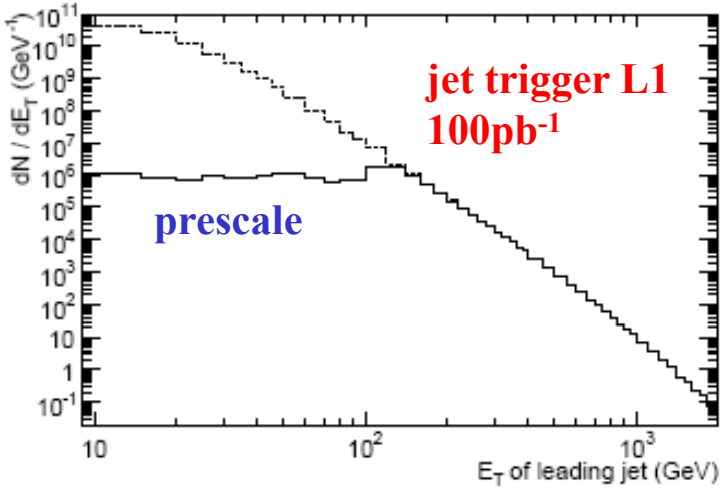
in-situ calibration of b-tagging:
- tt: good agreement MCtruth and "MCData"
- 5-10% precision
- muon+jets with trigger prescaled
- 50 pb^{-1} necessary, valid <80GeV





Expected performance: Trigger





- sharp turn-on curves
- differential cross section for jets

Subset of Trigger Menu for 10^{31} cm^{-2}s^{-1}

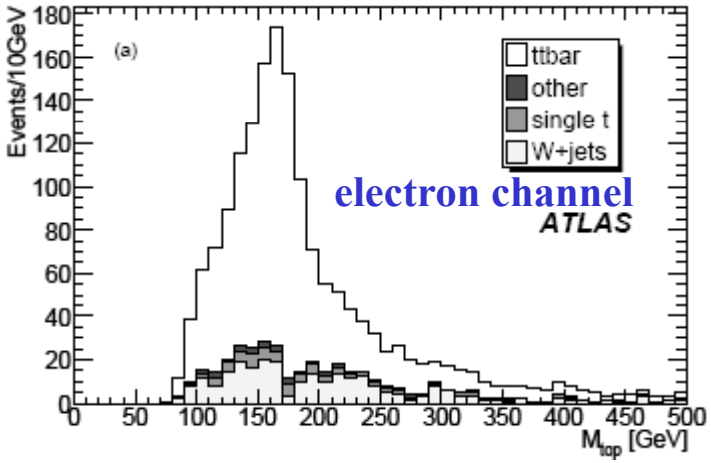
Signature	L1 rate (Hz)	HLT rate (Hz)	Comments
Minimum bias	Up to 10000	10	Pre-scaled trigger item
e10	5000	21	$b, c \rightarrow e$, W, Z, Drell-Yan, $t\bar{t}$
2e5	6500	6	Drell-Yan, J/ψ, Υ, Z
γ20	370	6	Direct photons, γ-jet balance
2γ15	100	< 1	Photon pairs
μ10	360	19	W, Z, $t\bar{t}$
2μ4	70	3	B-physics, Drell-Yan, J/ψ, Υ, Z
μ4 + J/$\psi(\mu\mu)$	1800	< 1	B-physics
j120	9	9	QCD and other high-p_T jet final states
4j23	8	5	Multi-jet final states
τ20i + xE30	5000 (see text)	10	W, $t\bar{t}$
τ20i + e10	130	1	$Z \rightarrow \tau\tau$
τ20i + μ6	20	3	$Z \rightarrow \tau\tau$

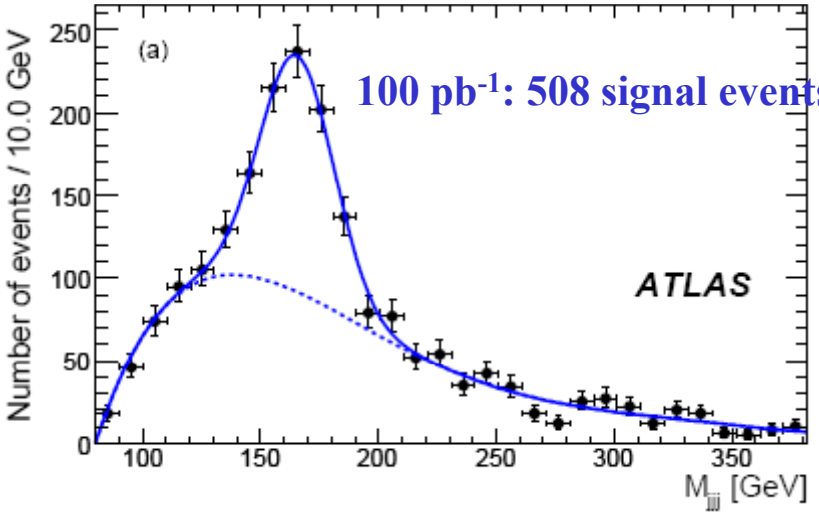
Total rates in budget !

Standard model: top quark

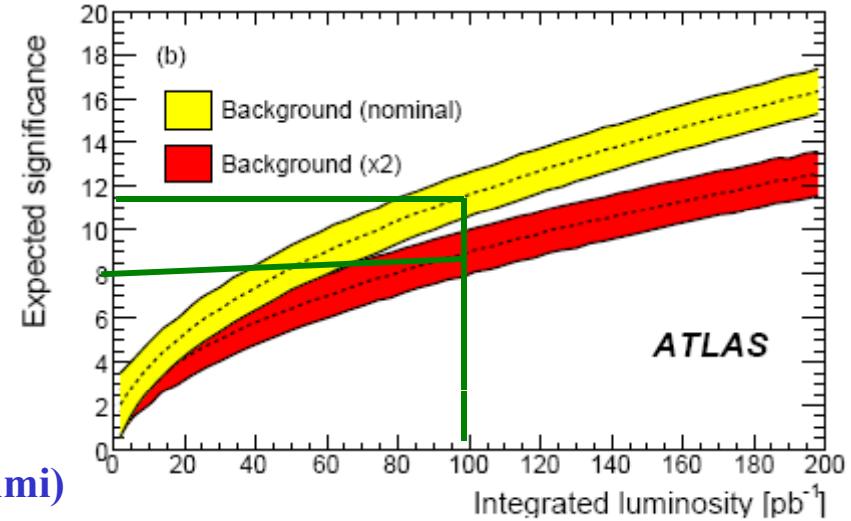
The LHC top quark factory
→semi-leptonic top quark events
no b-tagging used

First physics:
- **100 pb^{-1} clear signal even with QCD bg x2**
- **signal purity for the muon/electron channel 80%**





100 pb^{-1}: 508 signal events (muon channel)



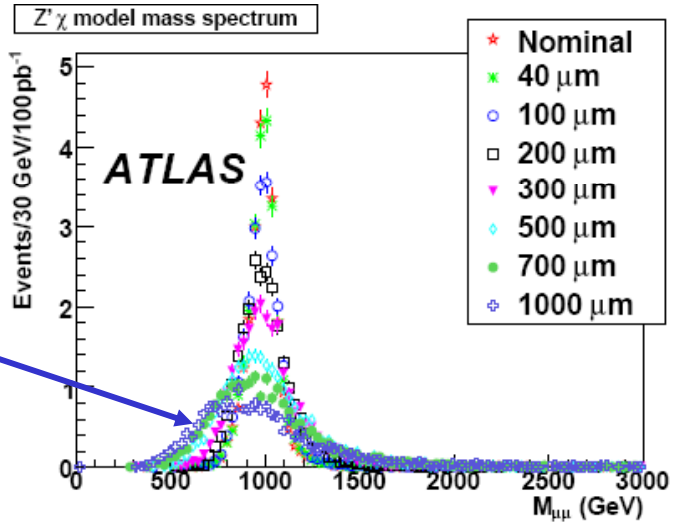
$\Delta\sigma/\sigma$ = 7% (stat) ± 15% (syst) ± 3% (pdf) ± 5%(lumi)

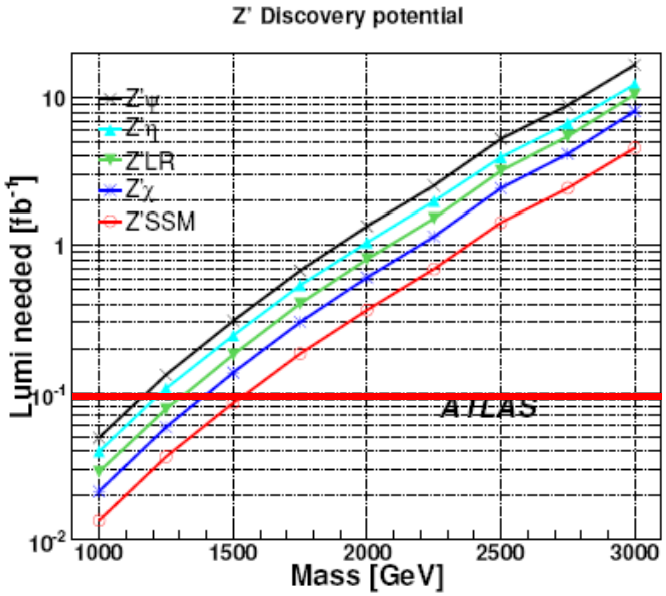
New physics: exotics

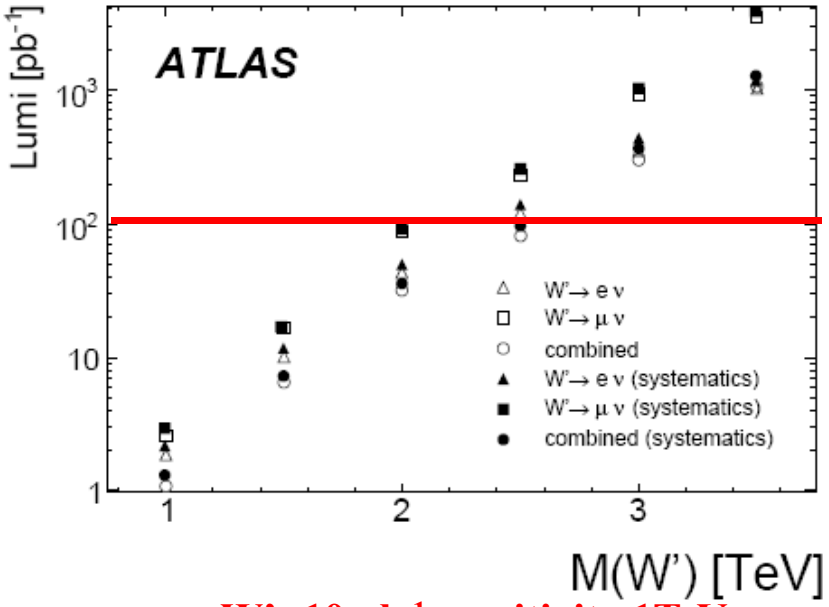
First discovery physics:

- extra gauge bosons eg. Z', W'
- necessitates electron/muon ID
- ETmiss (W')
- alignment (seen in Z already) 1mm
- typical limits currently 500GeV-1TeV

Z' : 100pb^{-1} ~1.2-1.5TeV
W': 100pb^{-1} ~2TeV







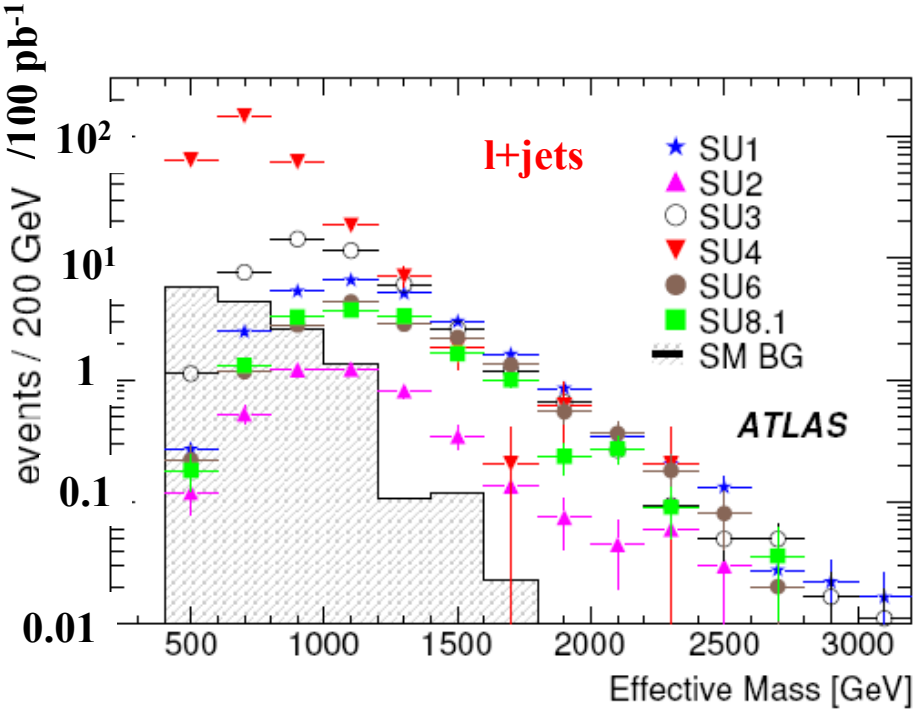
Electron channel alone: 100 pb^{-1} sensitivity 1TeV

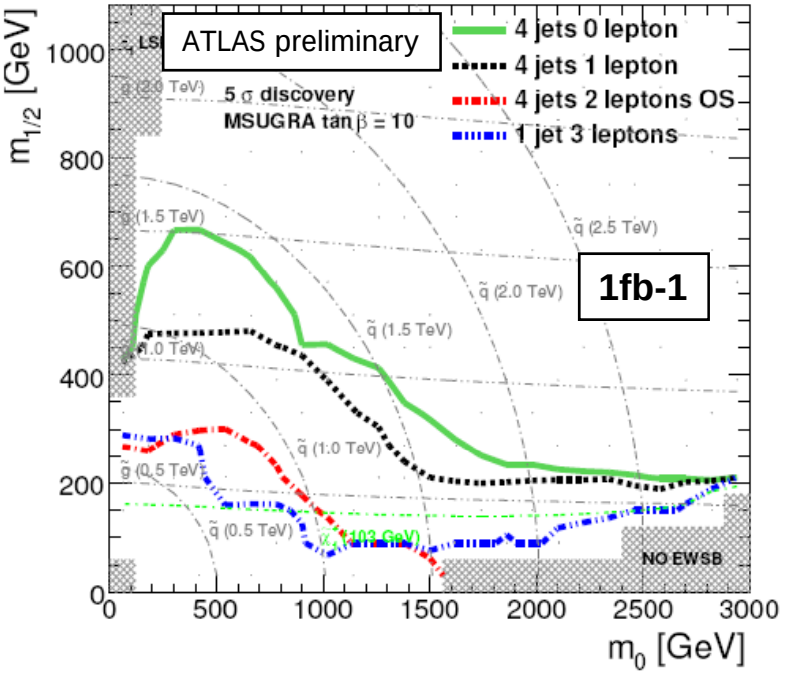
W': 10 pb^{-1} sensitivity 1TeV
Combines ETmiss and e/μ

New physics: Supersymmetry

Large cross sections for gluinos and squarks:
- multi-jet + large ETmiss (+leptons)
- necessitates understanding of all components

Define effective mass:
- sum of jet PT and ETmiss
- require one lepton
- less statistics, but cleaner





Sensitivity:
- 10pb^{-1} ~400GeV sensitivity=TeVatron
- 1 fb^{-1} ~ 1.5TeV (all jets)
- 1 fb^{-1} ~ 1TeV (1lepton + jets)

Conclusions

- ATLAS is well prepared for first physics
  - electrons (photons)
  - muons
  - jet
  - ETmiss
  - tau
  - b-tagging
- eagerly awaiting next year at 10 TeV (or more) to find:
  - the standard model
  - exotics
  - supersymmetry
  - or ?