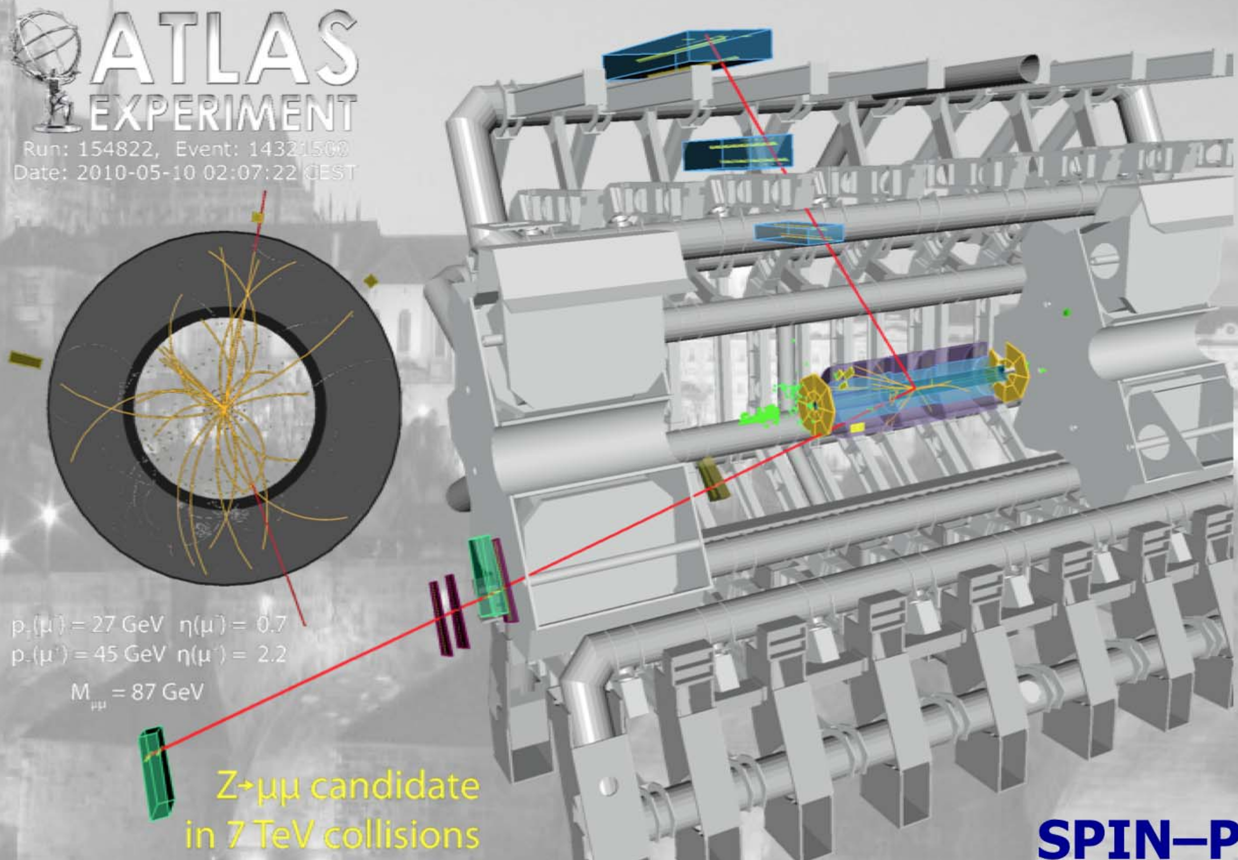
ATLAS – Status & First Results



SPIN–Praha–2010
Advanced Studies Institute – Symmetries and Spin
18 - 25 July, 2010
Prague

Hans Peter Beck
On behalf of the ATLAS Collaboration

LABORATORIUM FÜR HOCHENERGIEPHYSIK
LHEP
UNIVERSITÄT BERN

Outline

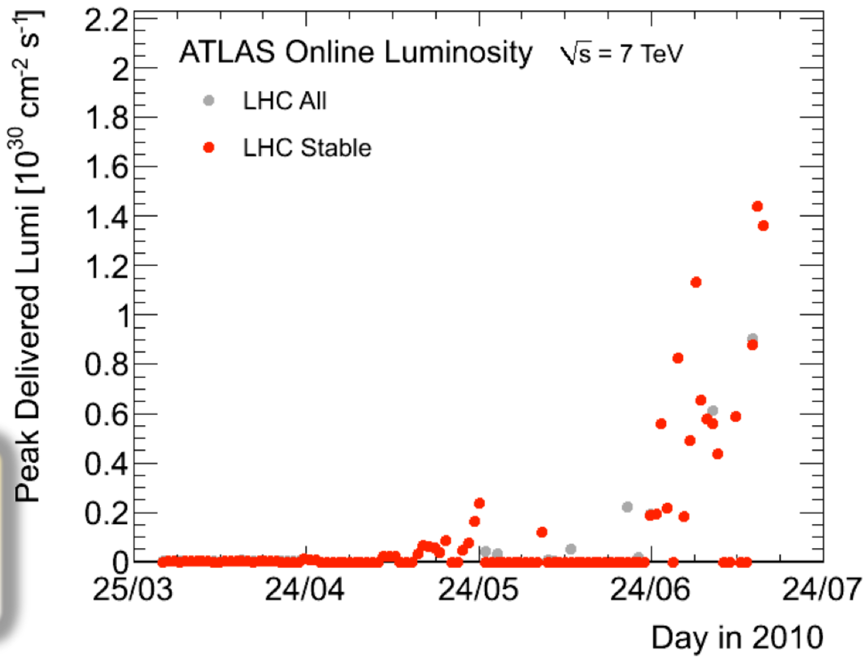
- **The Large Hadron Collider**
  - **Status & Roadmap for 2010—2011**
- **ATLAS detector overview**
  - **20 years of technological, human and financial efforts of a world-wide scientific community**
- **ATLAS status, data taking & trigger**
  - **Detector performance with 7 TeV collision data**
- **Rediscovery of the Standard Model with ATLAS**
  - **W and Z; (top takes a bit more)**
- **Looking forward**
  - **top, Higgs, SUSY, Z', W', …**
- **Conclusions**

The Large Hadron Collider

Status & Roadmap for 2010—2011

After 20 years of planning, R&D, installation & commissioning

The LHC is operational providing collisions at √s = 7 TeV



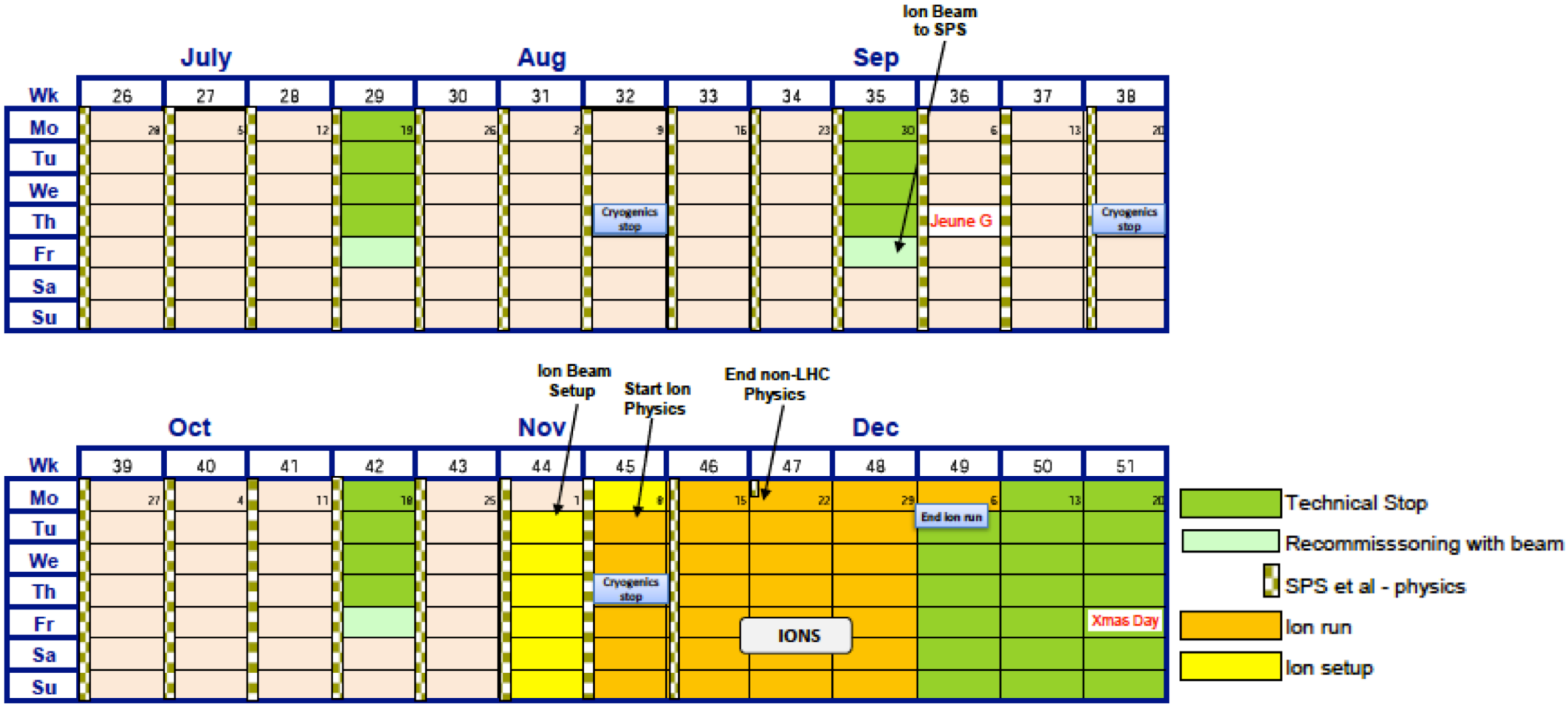
- ✓23 Nov-23 Dec: 12 μb^{-1} at 900 GeV
- ✓8 Dec: collisions at 2.36 TeV
- ✓30 March: colliding beams at 7 TeV

- ✓23 April: 10x increase in luminosity: = ×2 protons per bunch; β* = 5m↘ 2m
- ✓22 May: 3 colliding bunches, $\mathcal{L}=6.3\times10^{28}$ cm^{-2}s^{-1}, 2.3x10^{10} protons/bunch
- ✓26 May: design intensity per bunch (10^{11} protons/bunch) at 3.5 TeV
- ✓27 May: 8 bunches, 2×10^{10} protons/bunch

- ✓12 July: peak luminosity $\mathcal{L}=1.44\times10^{30}$ cm^{-2}s^{-1}, with 8 colliding bunches

peak luminosity rising exponentially (in these early days)!

LHC planning till end of 2010



✓p-p physics till 1 Nov: **plan to reach** $\mathcal{L}=10^{32}$ cm^{-2}s^{-1},
432+432 bunches, 10^{11} protons/bunch, 10 pb^{-1}/day

✓One week for ion beam setup in November

✓Four weeks of ion physics till technical stop end of 2010

LHC roadmap for the not too far future

Reach 1 fb^{-1} at $\sqrt{s}$ = 7 TeV by end of 2011

Followed by ~1 year shutdown to

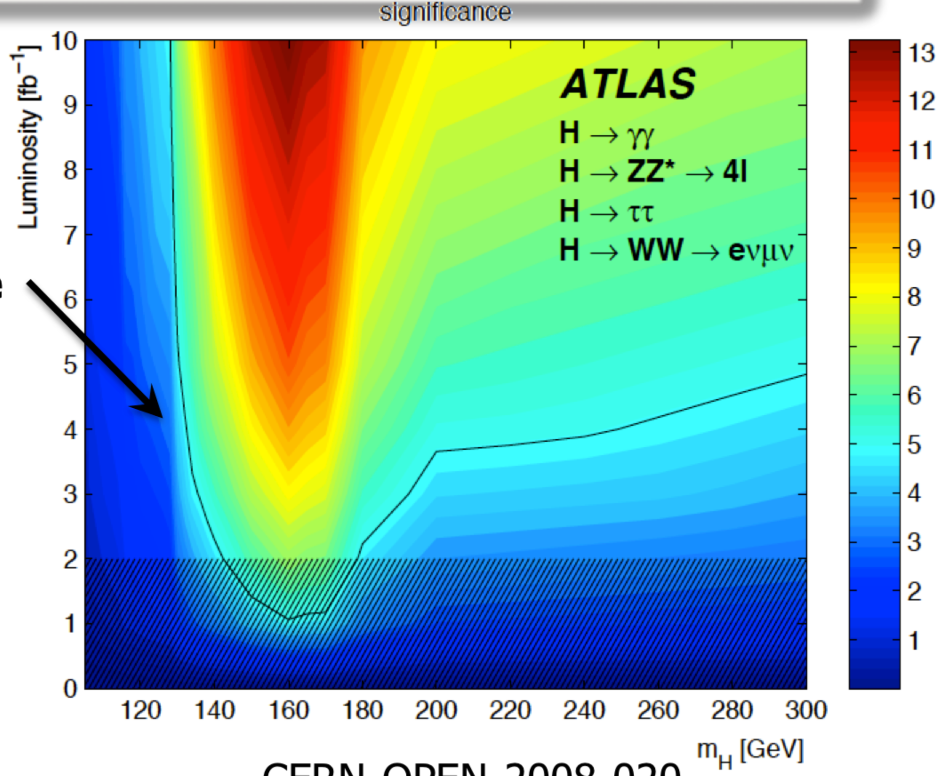
repair the splices between LHC magnets (quench protection)
get ready for providing collision at $\sqrt{s}$ = 14 TeV by 2012.

Collect 10 fb^{-1} at 14 TeV till end of 2014

as this is required, to settle the case for a light Higgs m_H=115 GeV

preliminary planning

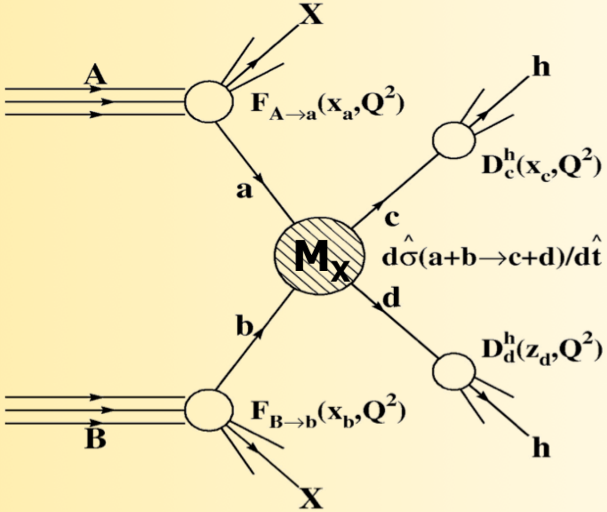
5σ Higgs discovery line



CERN-OPEN-2008-020

Tevatron @ 1.96 TeV vs. LHC @ 7 TeV

Ratios of parton luminosities allow to estimate physics yield of LHC @ 7 TeV



ttbar: (85% qq, 15% gg at Tevatron; mainly gg at LHC)

- factor ~70 in ttbar production

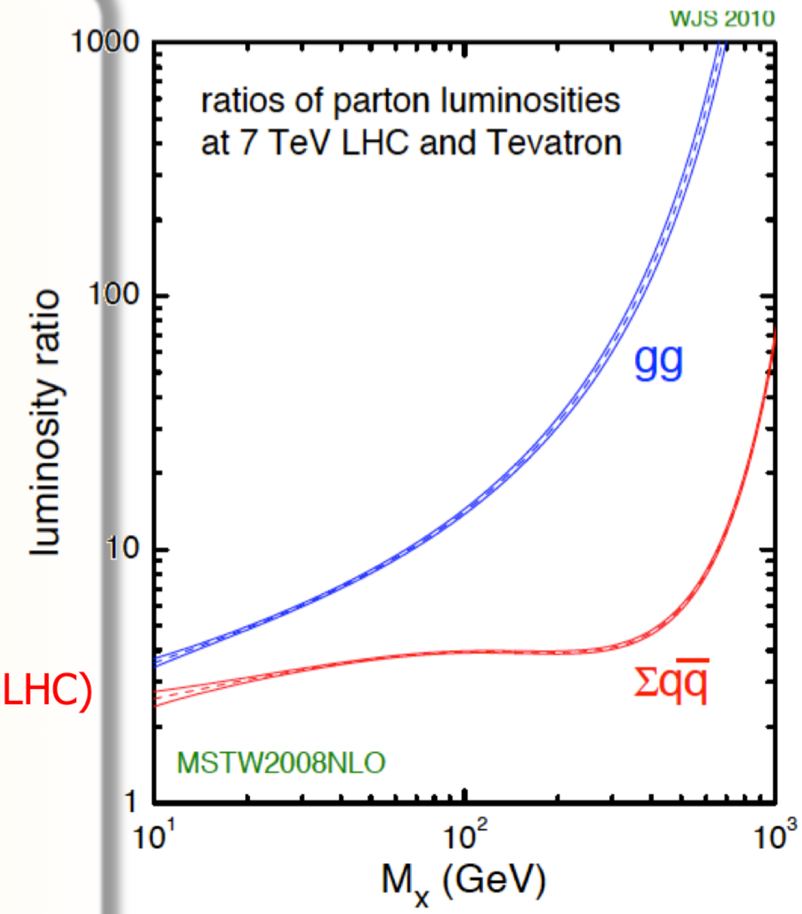
Higgs: (115 to 200 GeV; mainly gg)

- factor ~15

biggest gain from parton luminosities for large M_X :

Z′: ~1 TeV (qq)

- factor: ~ 50 to 100



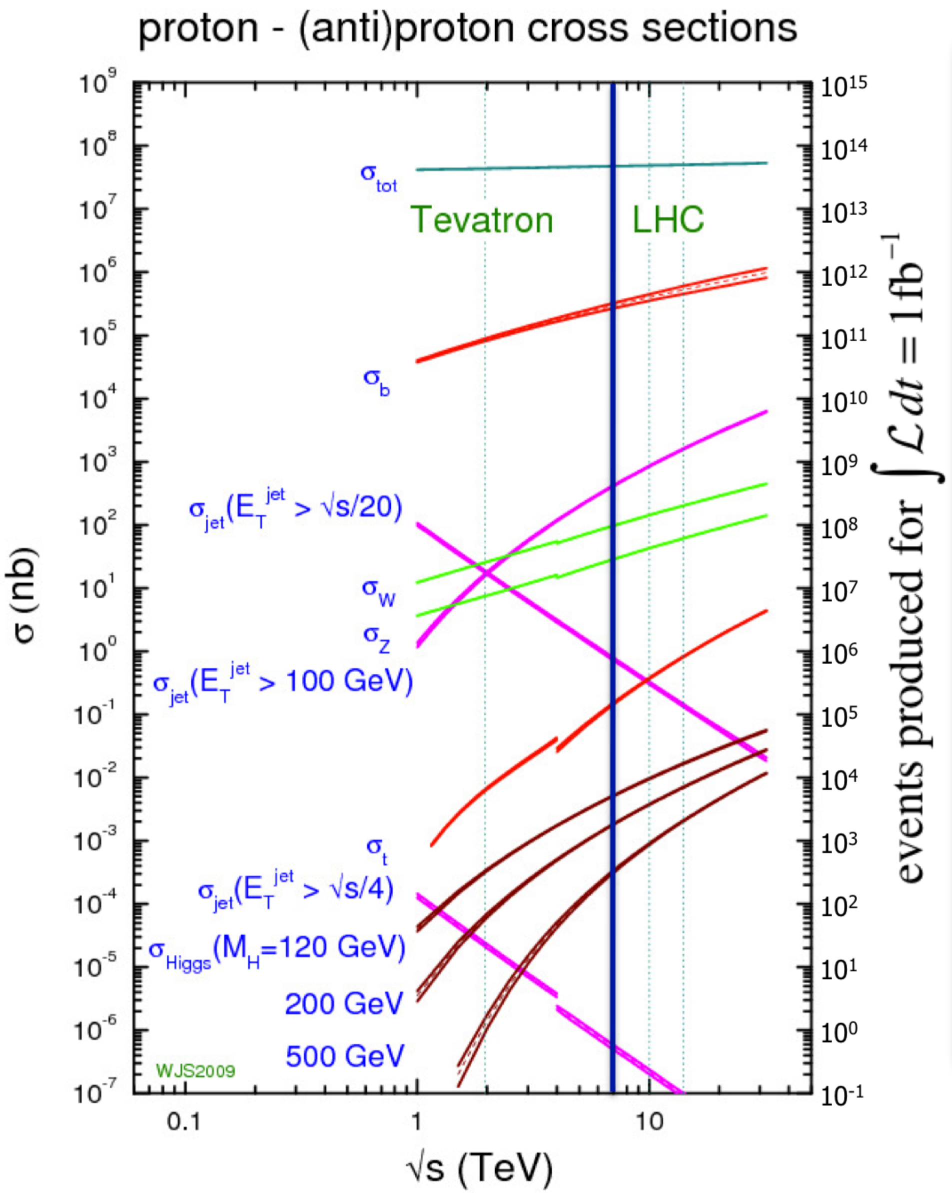
W.J. Stirling, private communication

1 fb^{-1} at 7 TeV:

>10 fb^{-1} at 2 TeV for Higgs searches

>50 fb^{-1} at 2 TeV for ttbar, Z′

Cross sections and expectations for 1 fb^{-1}



By end of **2011**, LHC is expected to have delivered **1 fb^{-1} per experiment**.

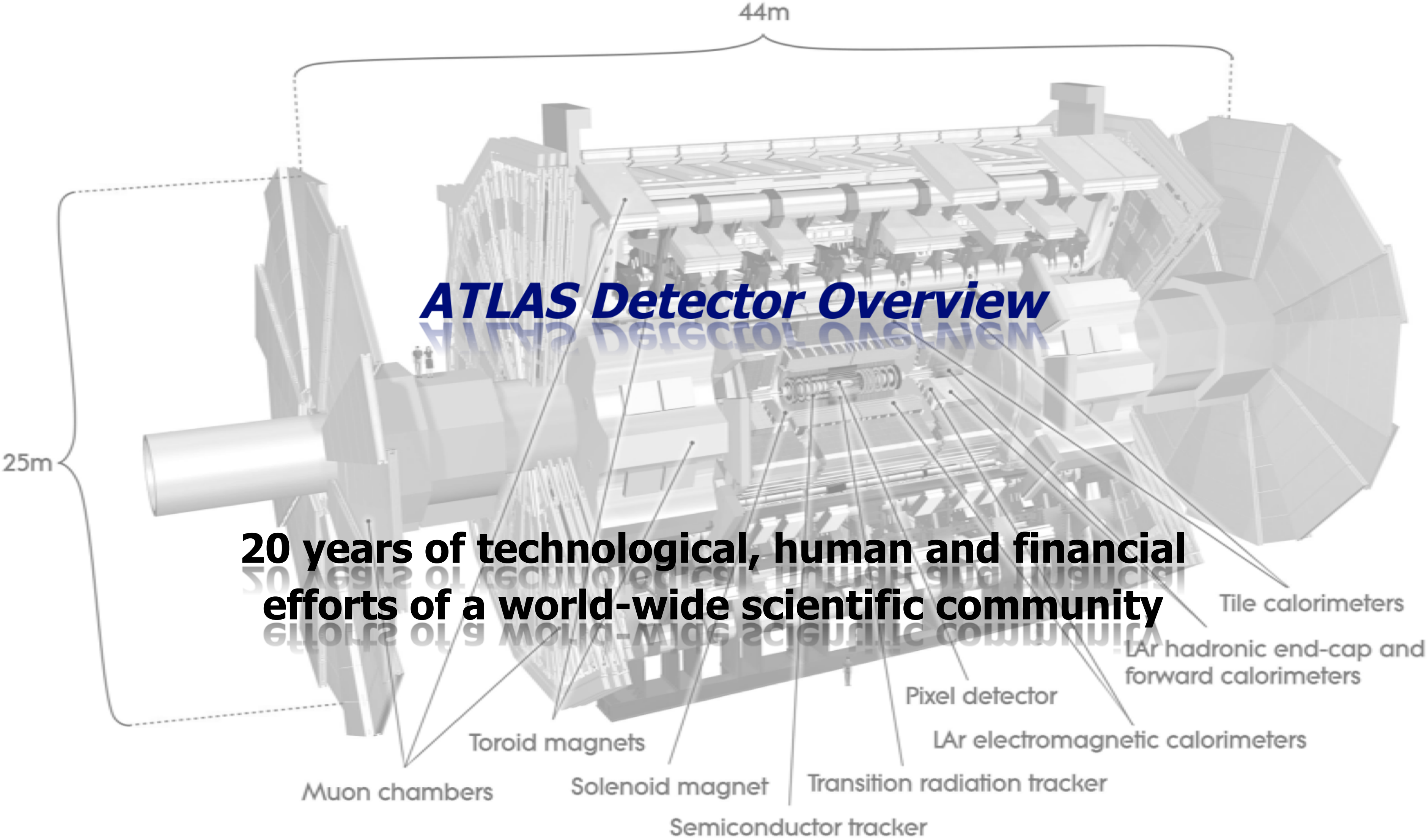
To be compared with **~10 fb^{-1} collected at Tevatron by end of 2011**.

Although, finding a low-mass Higgs will take more time, by end of 2011 ATLAS and CMS are expected to have collected substantially larger samples of **t-tbar events**, than CDF and DZero.

This will allow to study top mass, single top, rare top decays,...

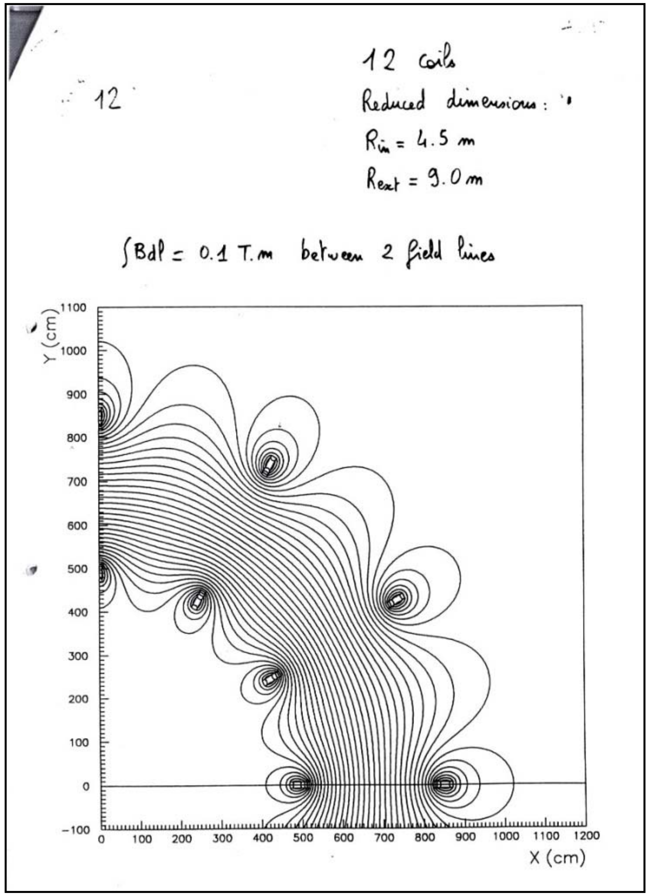
Expect also new bounds for searches for **new physics**: W', Z', SUSY, black hole events – and with some luck: **discoveries are not excluded**

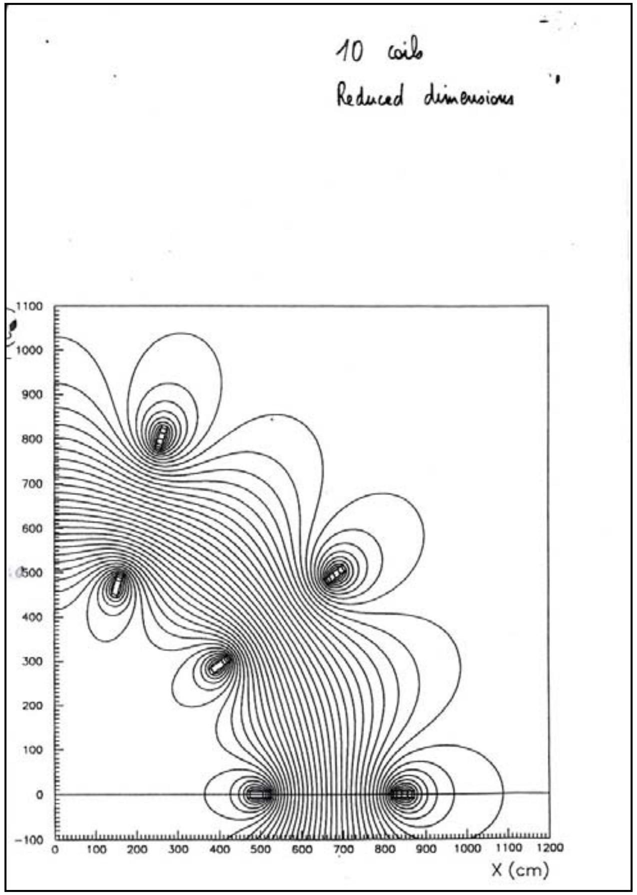
ATLAS Detector Overview

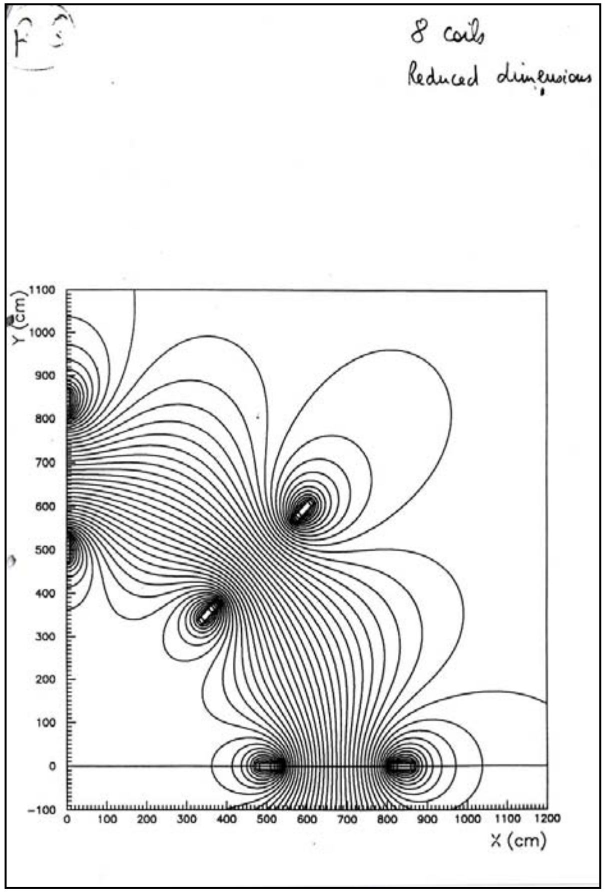


20 years of technological, human and financial efforts of a world-wide scientific community

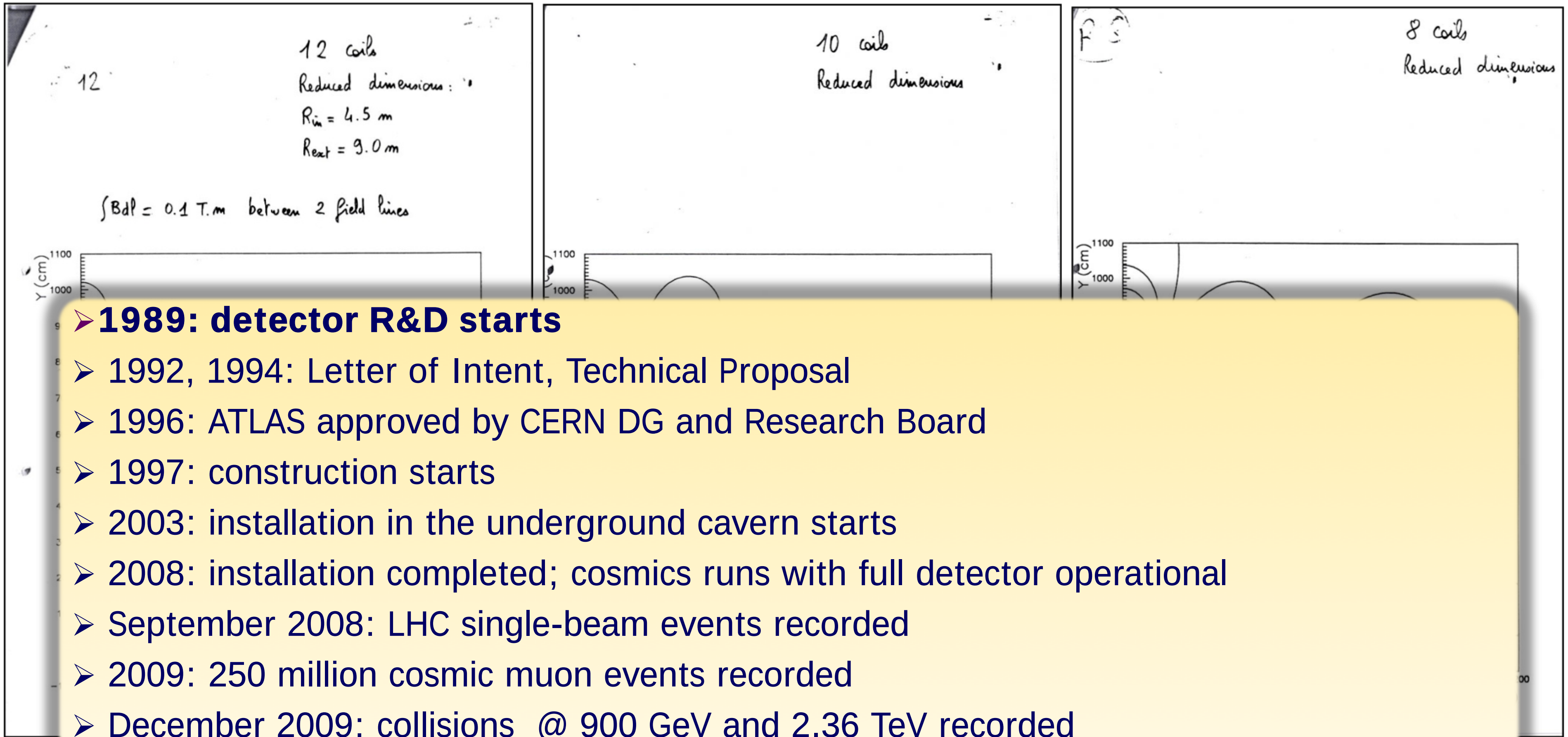
ATLAS history (briefly ...)







ATLAS history (briefly ...)



- **1989: detector R&D starts**
- 1992, 1994: Letter of Intent, Technical Proposal
- 1996: ATLAS approved by CERN DG and Research Board
- 1997: construction starts
- 2003: installation in the underground cavern starts
- 2008: installation completed; cosmics runs with full detector operational
- September 2008: LHC single-beam events recorded
- 2009: 250 million cosmic muon events recorded
- December 2009: collisions @ 900 GeV and 2.36 TeV recorded
- Since March 2010: collisions @ 7 TeV – collecting data

And ... **15 years of test-beam activities**, over **20 years of simulations of detector performance and physics potential**, 8 years of world-wide computing data challenges, 17 Technical Design Reports , education and outreach ...

and... ~3000 physicists from 173 Institutions and 37 Countries

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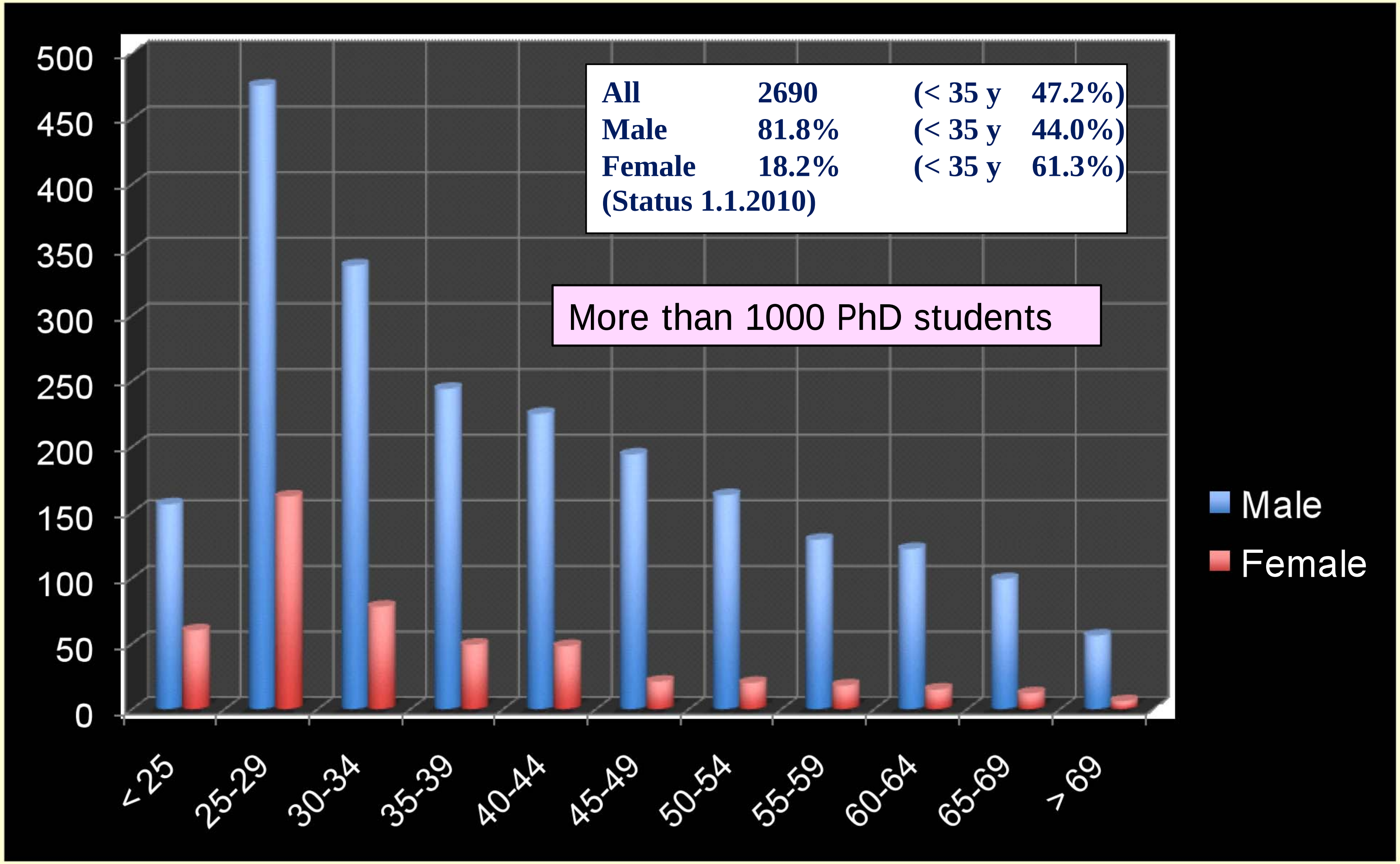
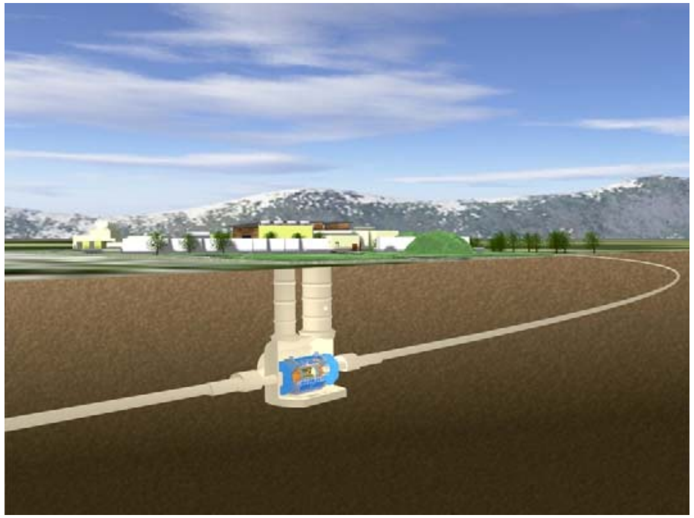


The ATLAS Detector



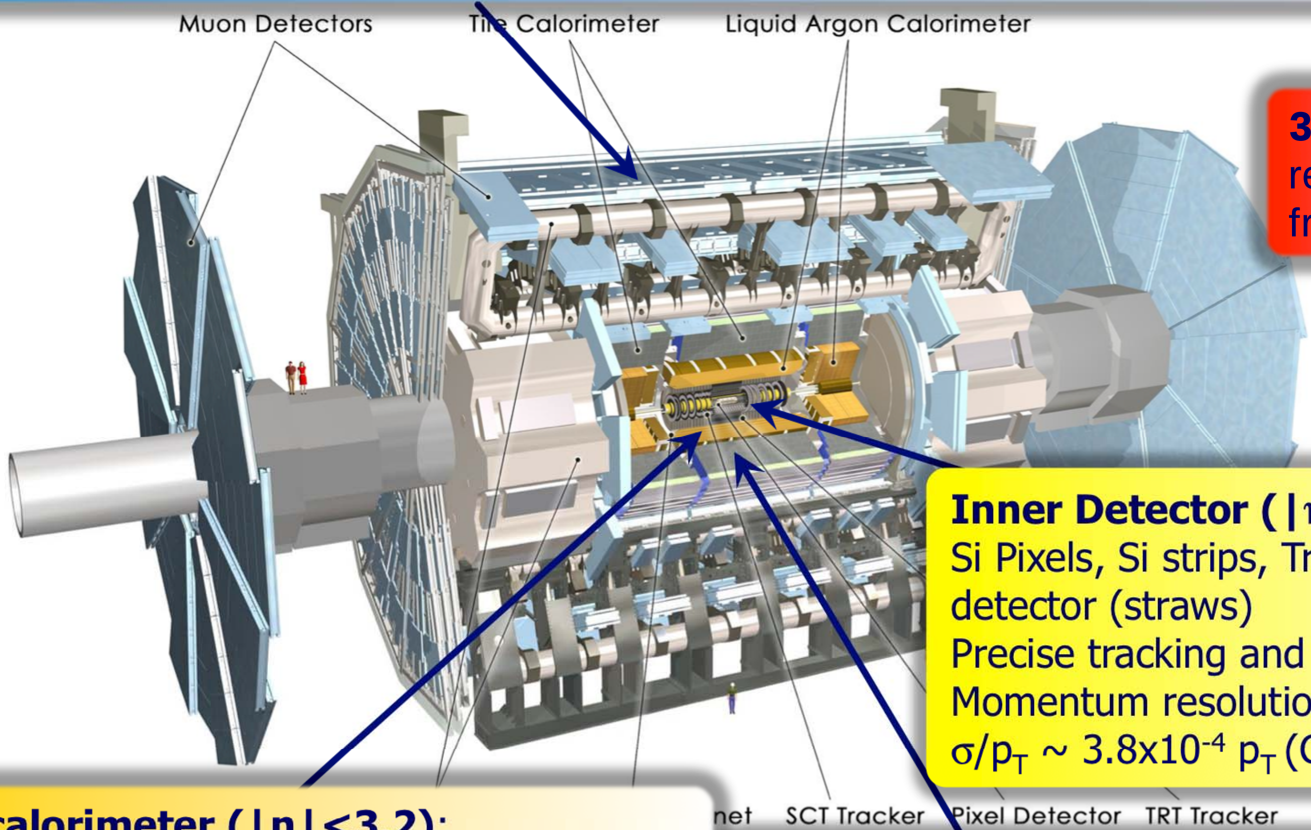
ATLAS looks like a small component in the overall LHC complex

ATLAS is as huge as the five story building 40 at Cern

Length:	**~ 44 m**
Height:	**~ 25 m**
Weight:	**~ 7000 tons** (compare with Eiffel tower, Paris: 10´000 tons)
	~ 10^8 electronic channels
	~ 3000 km of cables

The ATLAS Detector

Muon Spectrometer (|η|<2.7): air-core toroids with gas-based muon chambers
Muon trigger and measurement with momentum resolution $\sigma/p < 10\%$ up to $p_\perp \sim 1$ TeV



3-level trigger
reducing the rate
from 40 MHz to ~200 Hz

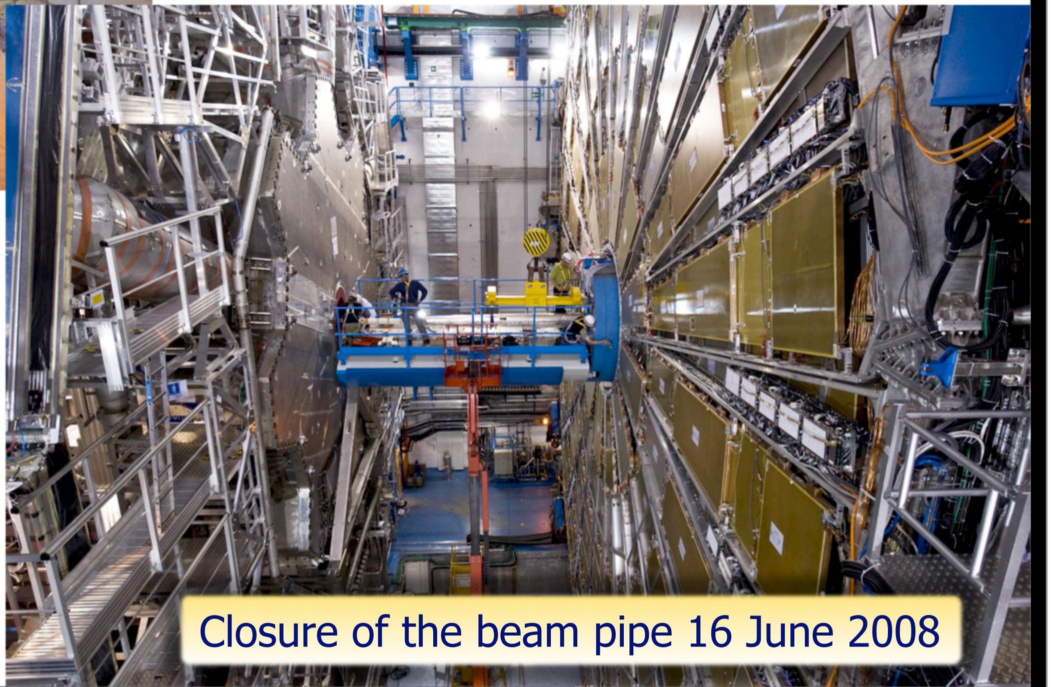
Inner Detector (|η|<2.5, B=2T):
Si Pixels, Si strips, Transition Radiation detector (straws)
Precise tracking and vertexing, e/π separation
Momentum resolution:
$\sigma/p_T \sim 3.8\times10^{-4}\, p_T(\mathrm{GeV}) \oplus 0.015$

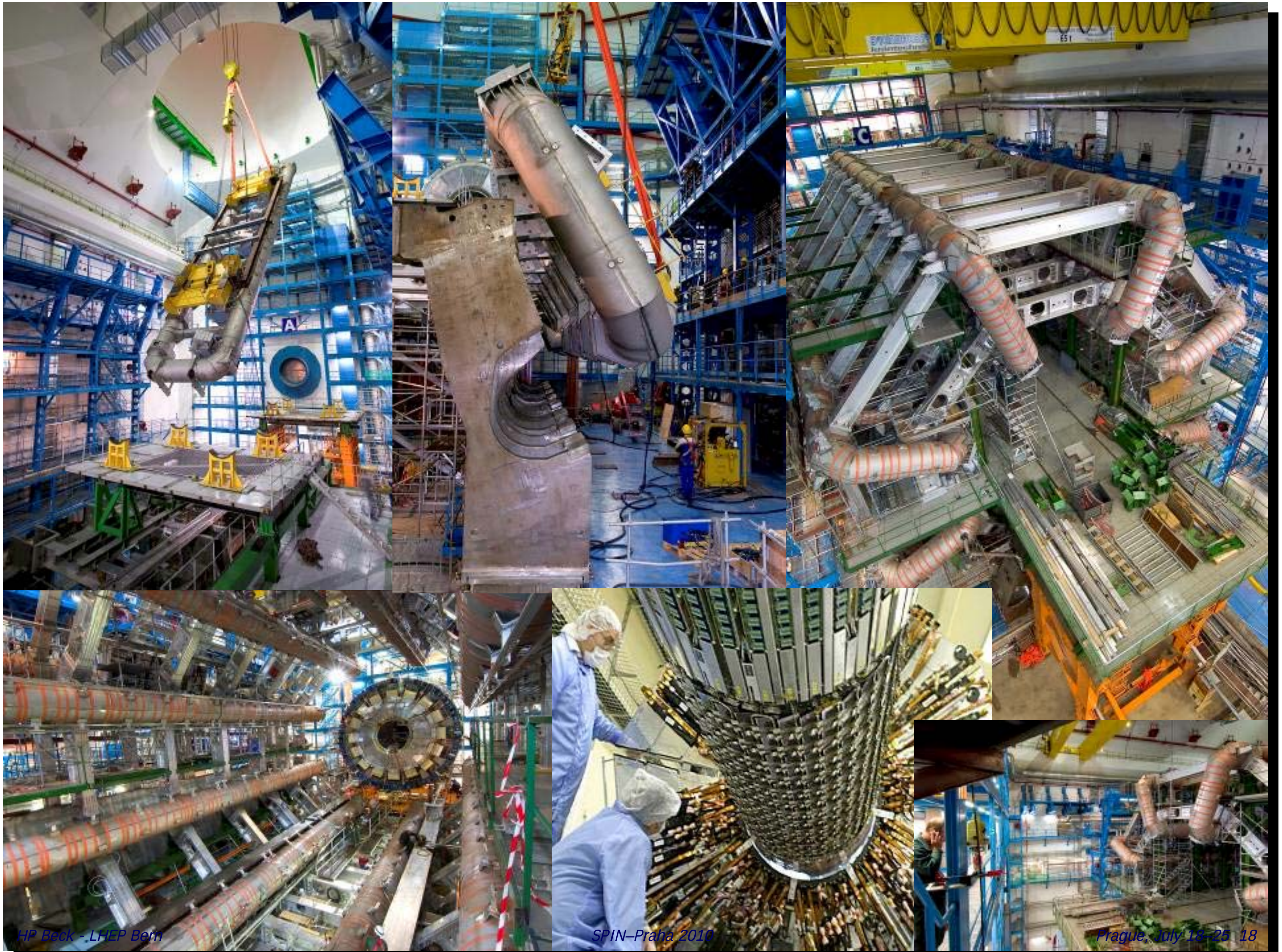
EM calorimeter (|η|<3.2):
Pb-LAr Accordion
e/γ trigger, identification and measurement
E-resolution: $\sigma/E \sim 10\%/\sqrt{E}$

HAD calorimetry (|η|<5):
segmentation, hermeticity, Fe/scintillator Tiles (central), Cu/W-LAr (fwd), Trigger and measurement of jets and missing E_T
E-resolution: $\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$

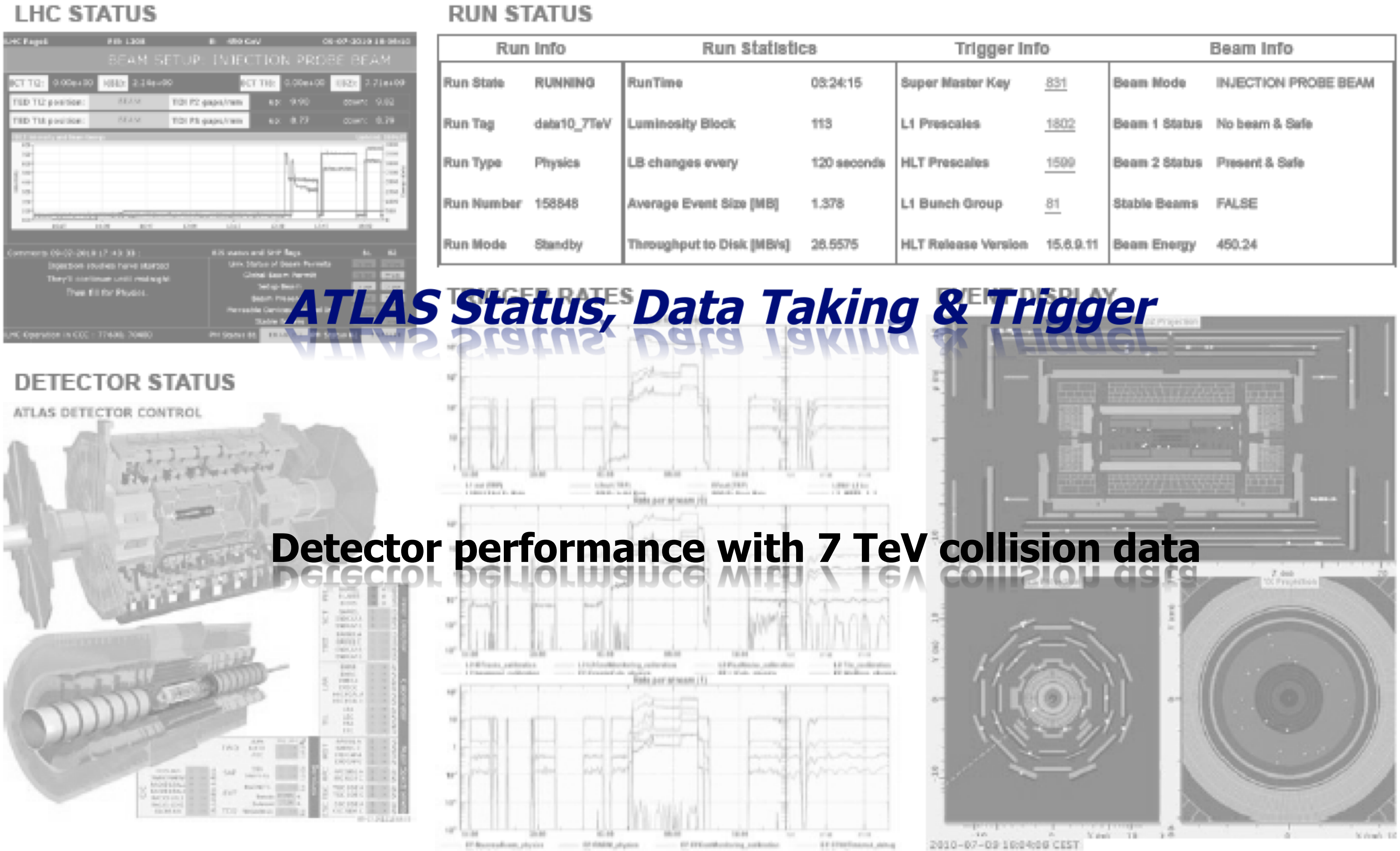
ATLAS Installation (2003 – 2008)


ATLAS cavern (-100 m) in June 2003


Closure of the beam pipe 16 June 2008



ATLAS Status, Data Taking & Trigger



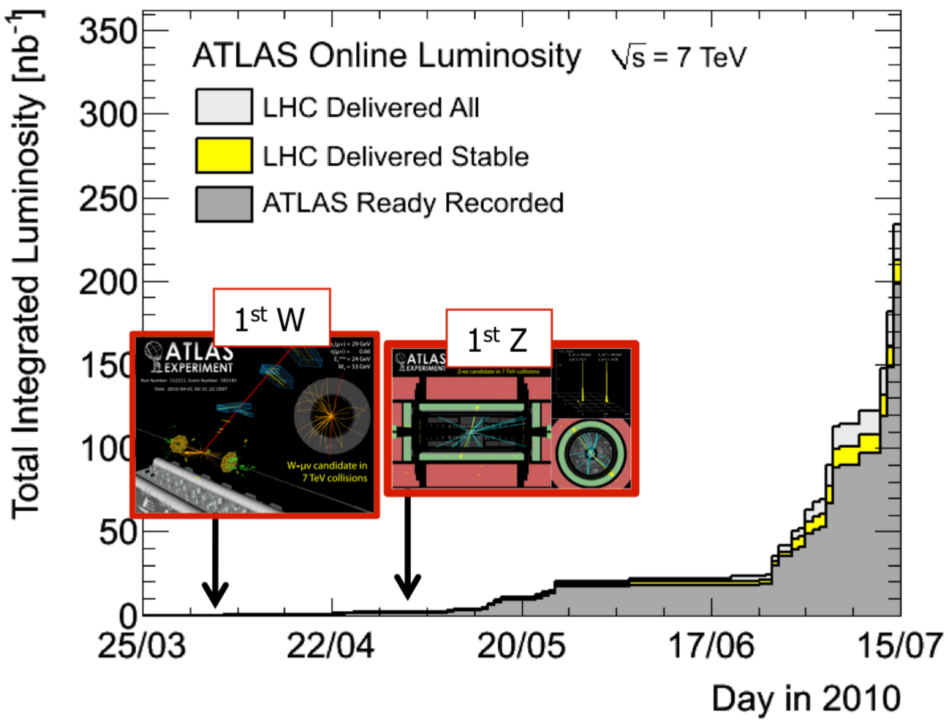
Detector performance with 7 TeV collision data

Detector Status as of July 2010

Sub-detector	# channels	Fraction working (%)
Pixels	80×10^6	97.4
Silicon strip detector (SCT)	6.3×10^6	99.2
Transition Radiation Tracker (TRT)	3.5×10^5	98.0
LAr electromagnetic calorimeter	1.7×10^5	98.5
Fe/scintillator (Tilecal) calorimeter	9800	97.3
Hadronic end-cap LAr calorimeter	5600	99.9
Forward LAr calorimeter	3500	100
LVL1 Calo Trigger	7160	99.9
LVL1 Muon RPC Trigger	3.7×10^5	99.5
LVL1 Muon TGC Trigger	3.2×10^5	100
Muon Drift Tube chambers (MDT)	3.5×10^5	99.7
Muon Cathode Strip chambers (CSC)	31000	98.5
Barrel muon trigger chambers (RPC)	3.7×10^5	97.0
End-cap muon trigger chambers (TGC)	3.2×10^5	98.6

Achieved: Detector and trigger working very well
Data taking efficiency ~96% (~ 93% including warm-start)
Concerns: long-term reliability of some components: low-voltage power supplies LAr and Tile calorimeters, Pixle, SCT, LAr readout optical links, inner detector cooling.
Back-up solutions being prepared for installation in at end of year technical stop and in future shut-down.

Data sample at √s = 7 TeV



As of **15 July 2010**:

200 nb^{-1} recorded

Results for **up to 17** nb^{-1} available for detector performance and first physics results.

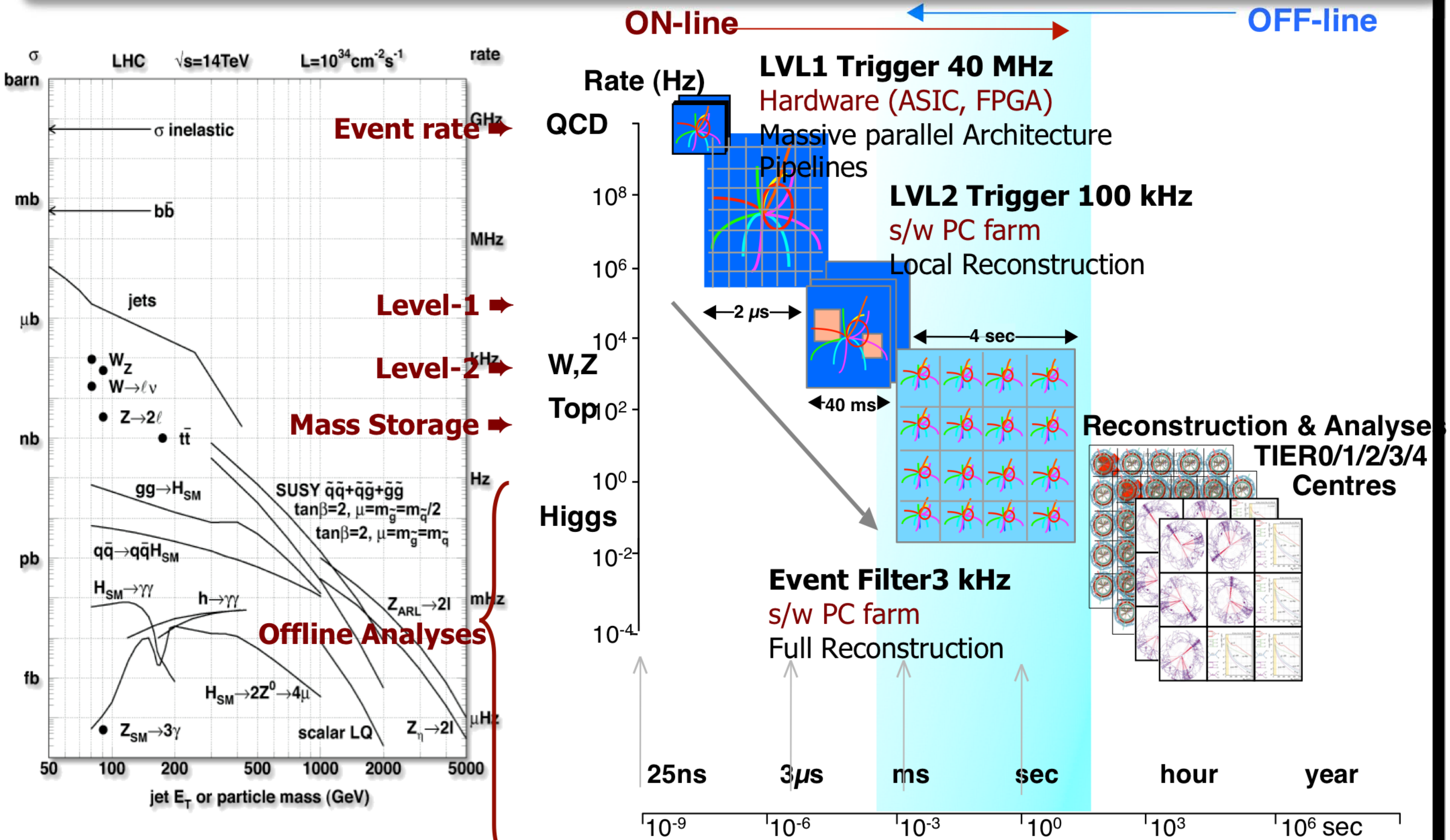
1st W and Z events seen
1st top in Europe expected ~now

~10% accuracy for luminosity measurement achieved using van der Meer beam separation scans

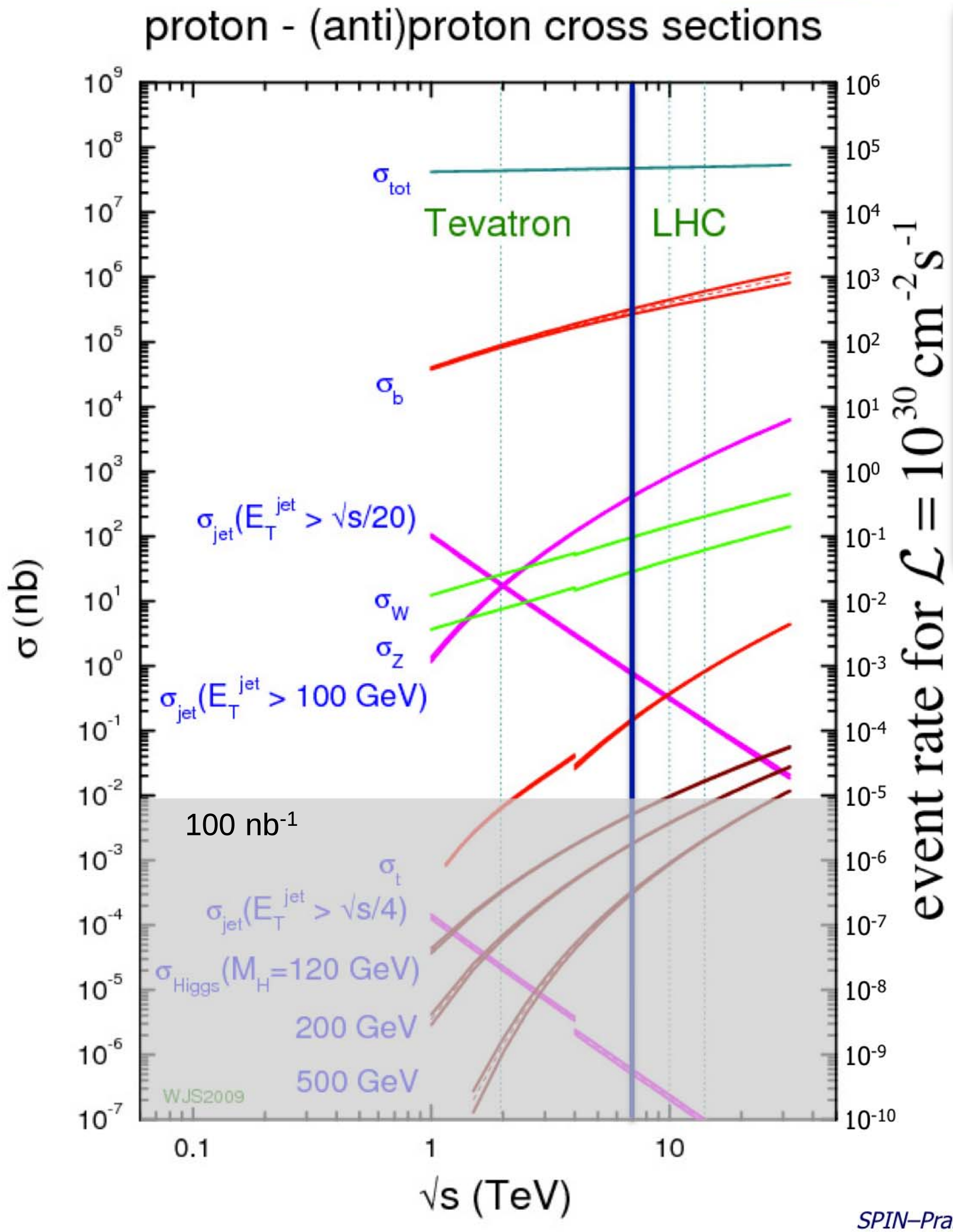
$\mathcal{L}$=1.44×10^{30} $cm^{-2}s^{-1}$ record peak luminosity on 12 July 2010

Trigger system overview

A three level trigger system reduces the initial event rate of 1 GHz (25 pile-up × 40 MHz BC rate) down to ~200 Hz output rate for storage and offline analysis.



Trigger operation at initial luminosities

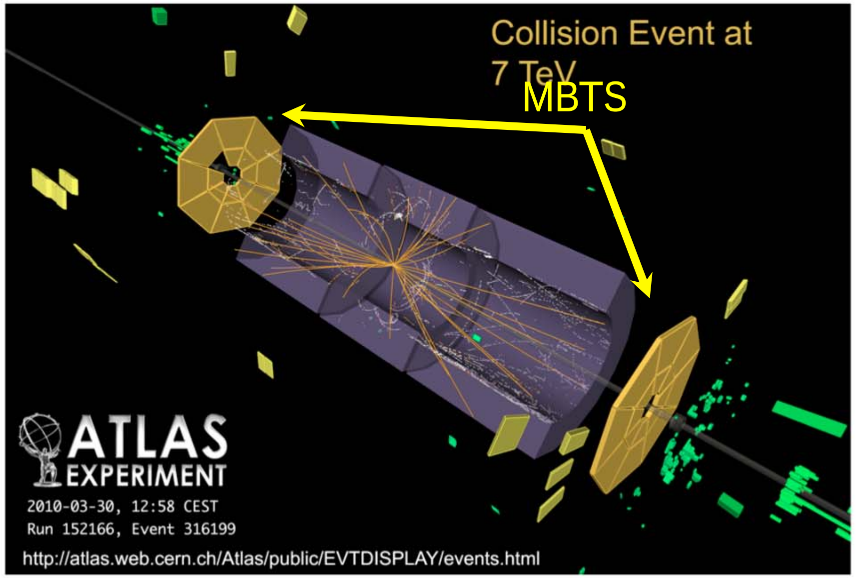


Commissioning at $\mathcal{L} \leq 10^{27}$ cm^{-2}s^{-1}

Collision rate ~100 Hz → take all events triggered by minimum bias trigger scintillators (**MBTS**) on LAr EC ± 3.5m from IP.

LVL1 calo & **LVL1 muon** also active.

LVL2 & Event Filter operational in **pass-through** mode.

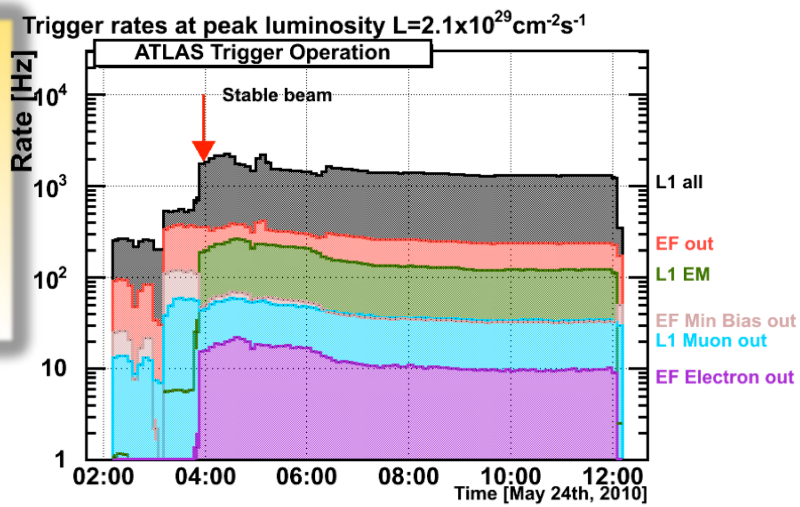


Trigger efficiencies

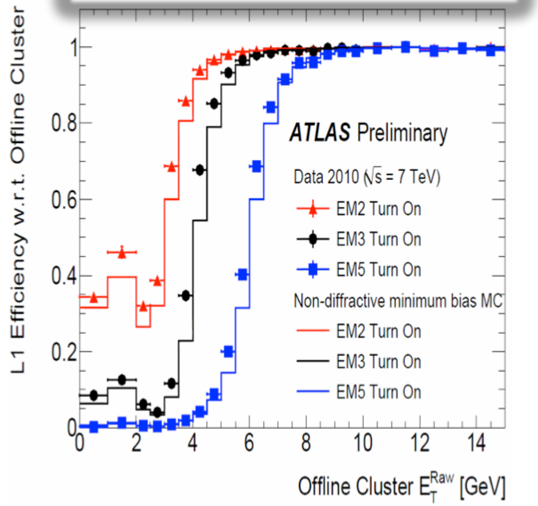
For $\mathcal{L} \geq 10^{27}$ cm^{-2}s^{-1} the MBTS trigger is prescaled

For $\mathcal{L} \geq 10^{29}$ cm^{-2}s^{-1} the HLT e/γ selection is active

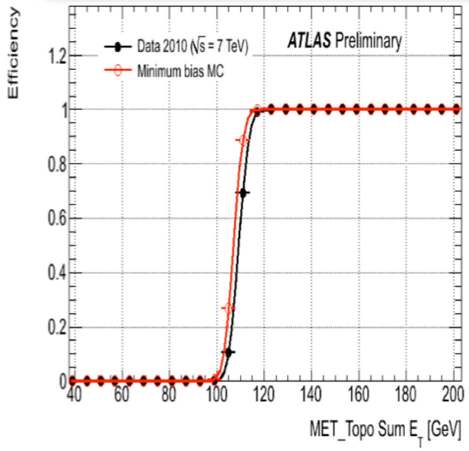
Trigger menu for $\mathcal{L} = 10^{32}$ cm^{-2}s^{-1} is prepared
(needs to be ready for late summer)



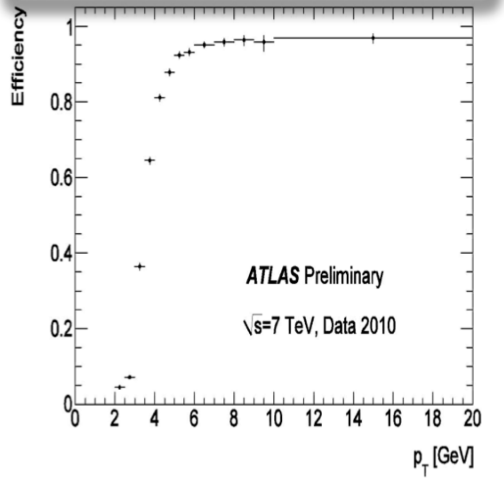
L1 EM trigger efficiencies
for $E_\perp$=2, 3 and 5 GeV



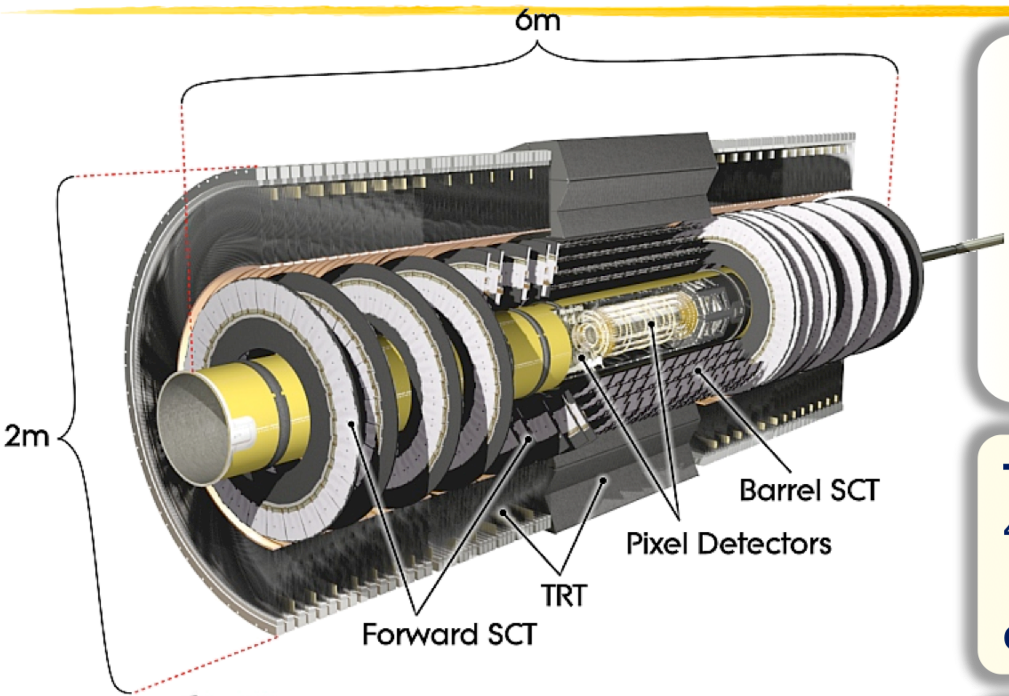
L1 calo trigger efficiency
for $\Sigma E_\perp$ = 100 GeV

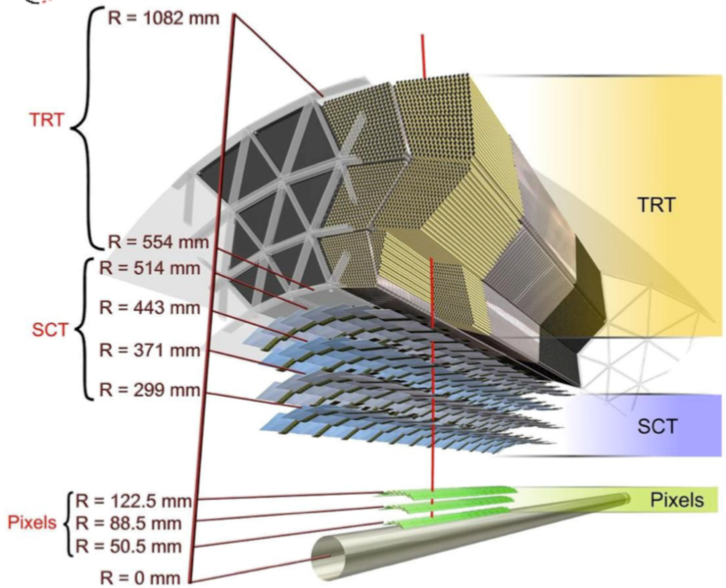


L2 muon trigger efficiency
for $p_\perp$ = 4 GeV



Inner Detector





Immersed in **2T solenoid field**
coverage **|η|<2.5** (2.0 for TRT)

$$\frac{\sigma_{p_\perp}}{p_\perp} \approx 3.4\times10^{-4}\, p_\perp[\mathrm{GeV}] \oplus 0.015$$

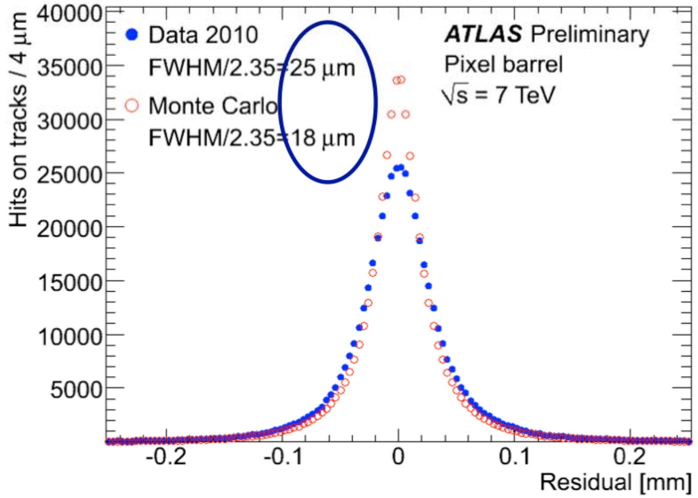
$$\sigma_{d_0} \approx 10\,\mu\mathrm{m} \oplus \frac{140}{p_\perp[\mathrm{GeV}]}\mu\mathrm{m}$$

Transition Radiation Tracker (TRT)
4×10^5 straw tubes:
150 cm (barrel); 40 cm (endcaps)
$\sigma_{r\varphi}$ = 130 μm

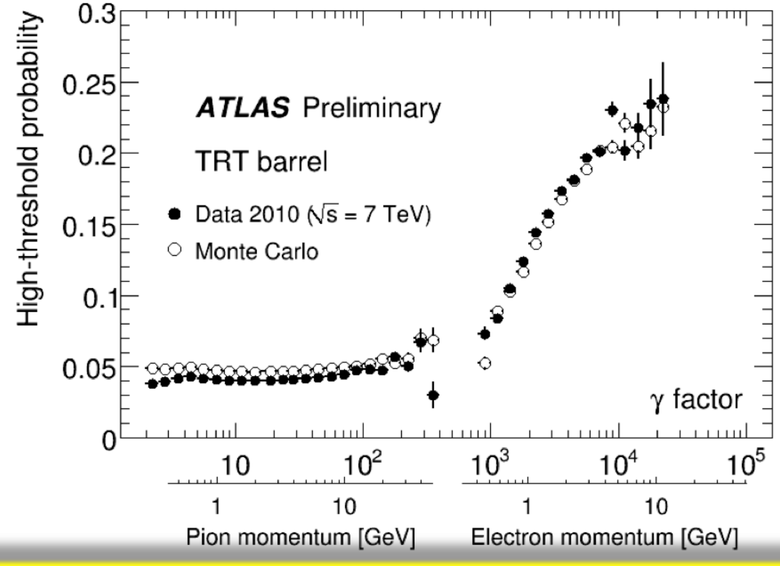
Silicon strips (SCT)
4 barrel layers, 2×9 disks
6.2×10^6 Si strips: 70-90μm×12cm
$\sigma_{r\varphi}$ = 16 μm; σ_z = 580 μm

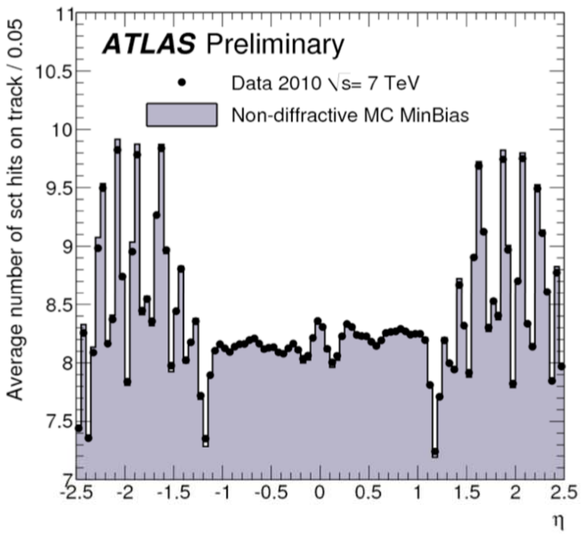
Pixel detector
3 barrel layers, 2×3 disks
~ 80 million Si pixels: 50μm×400μm
$\sigma_{r\varphi}$ = 10 μm; σ_z = 115 μm

Tracking performance @ $\sqrt{s}$ = 7 TeV



Inner Detector alignment close to ideal MC expectation.

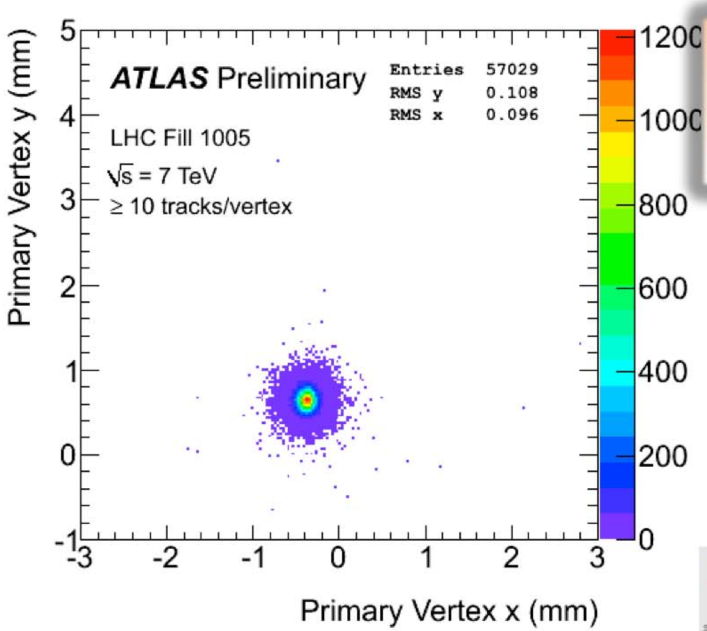




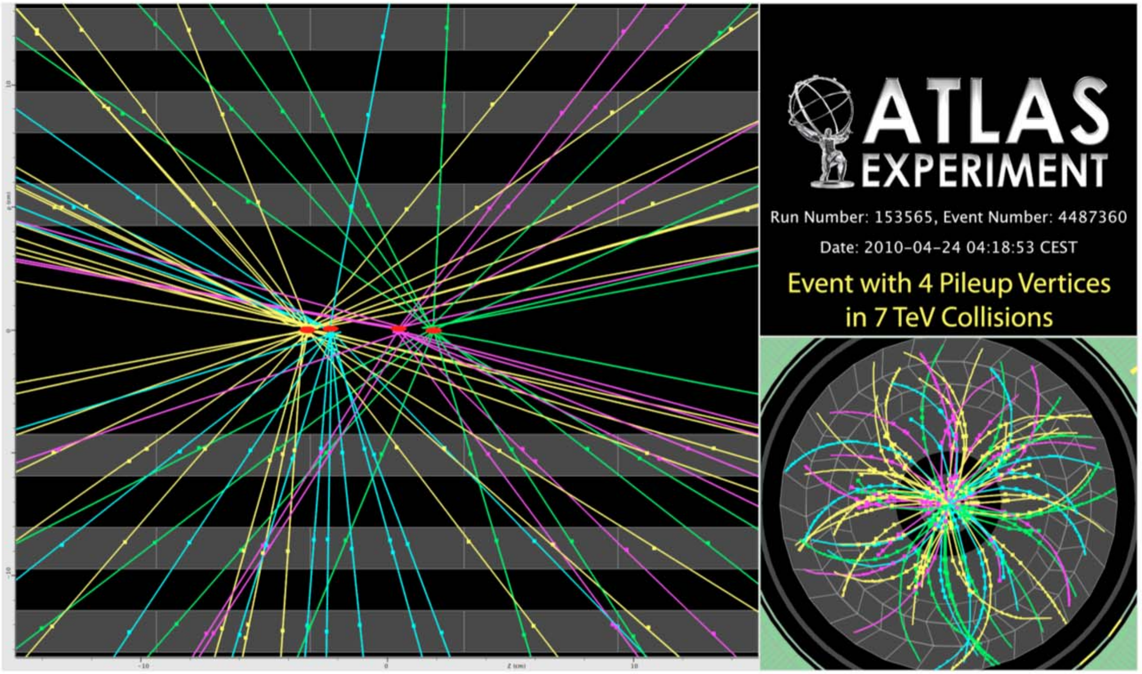
TRT e/π separation using transition radiation is working.

Track finding & reconstruction well understood.
Tracking down to $p_\perp$=100 MeV.

Vertex finding and pile-up events

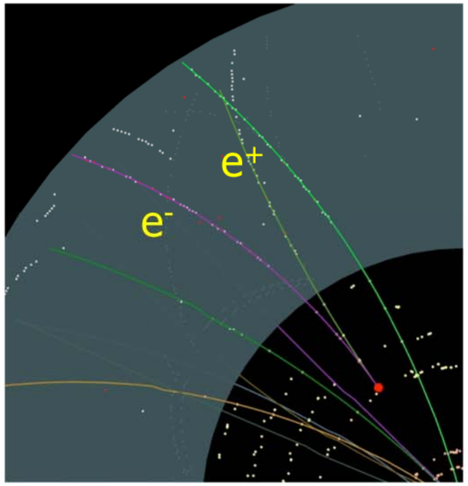


Beam spot measurement in xy-plane.
Luminous size of about 45µm in x and 70µm in y with errors that are completely dominated by systematics.

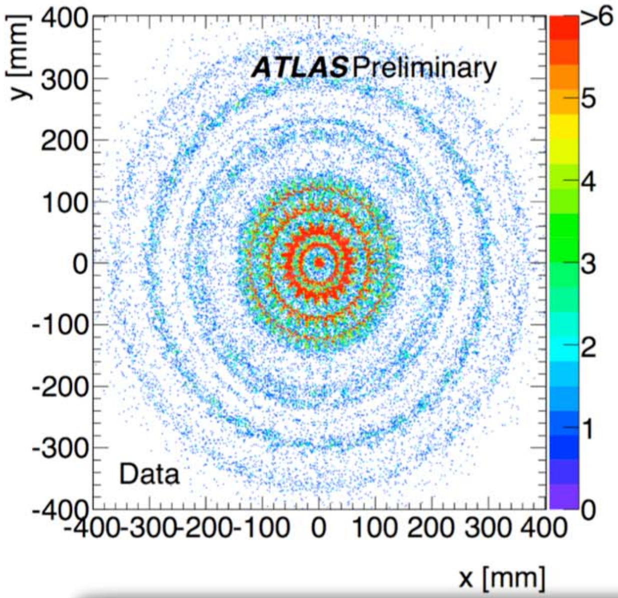


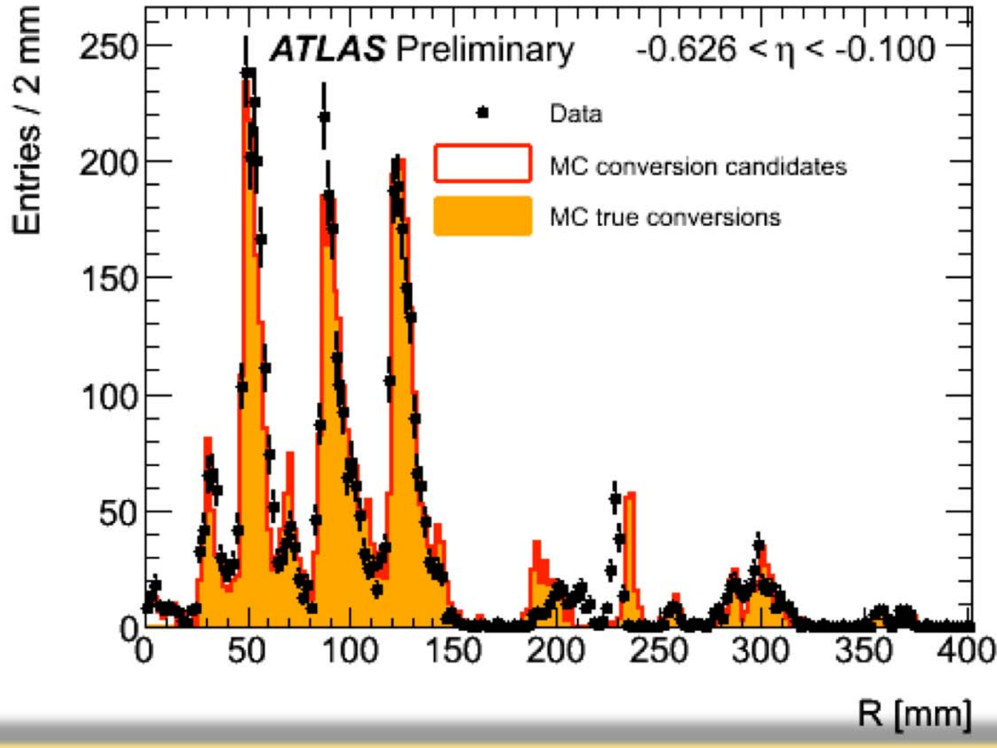
Event with four reconstructed primary vertices at z=−32.1, −22.9, 4.6, 18.8 mm.

Material mapping using photon conversion



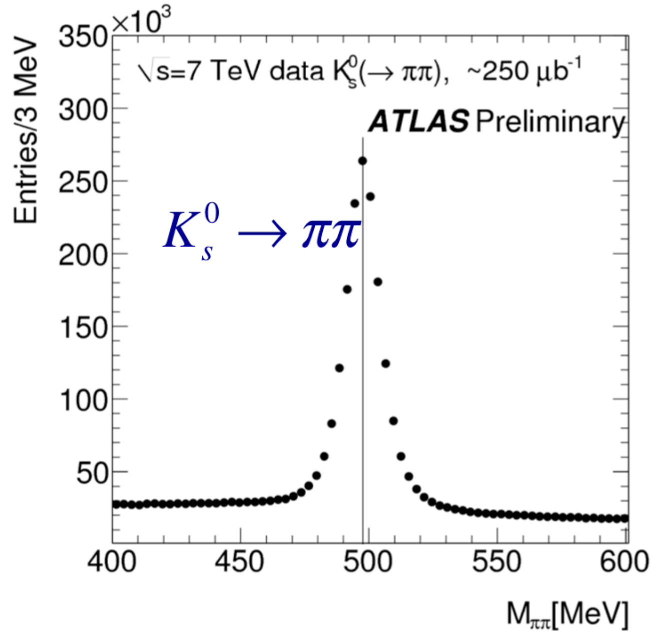
Secondary vertex finding:
Mapping the inner detector using photon conversion
$\gamma \rightarrow e^+e^-$

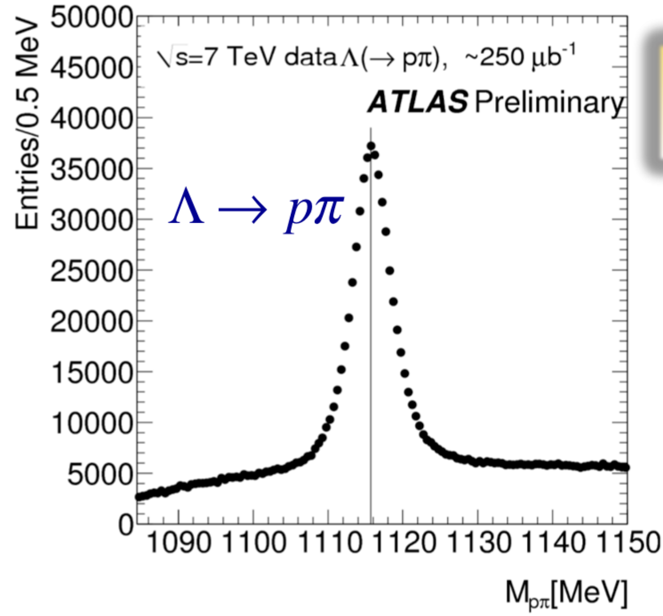




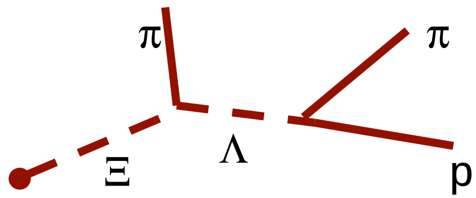
xy- and radial-distribution of reconstructed conversion vertices in the barrel tracker

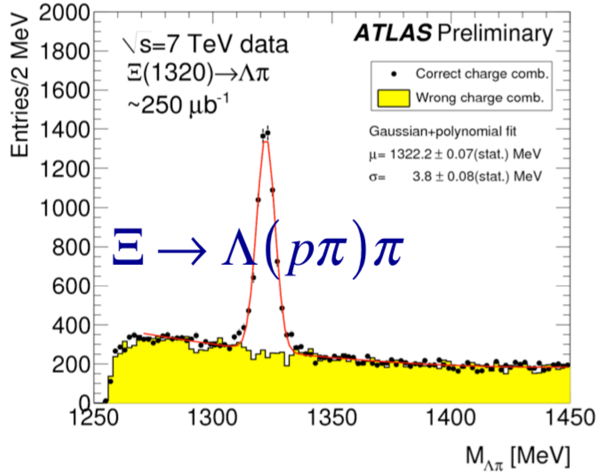
Rediscovery of mesons and hadrons

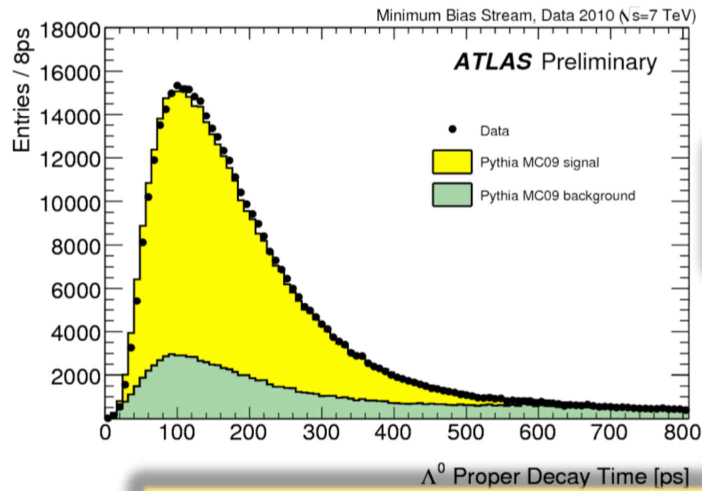




pdg value indicated by vertical line





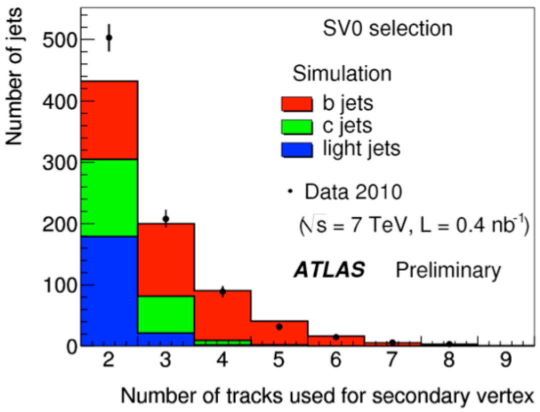


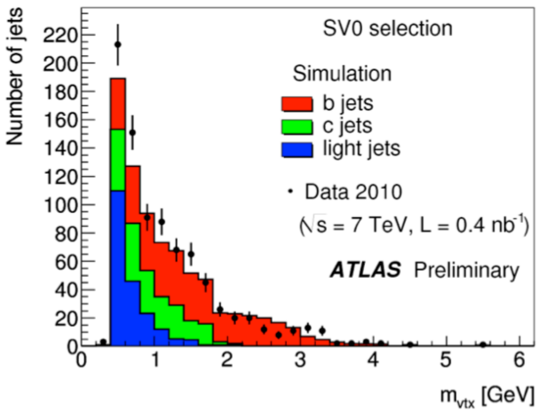
and also reconstruction of Ω, K*, D±,D⁰,…

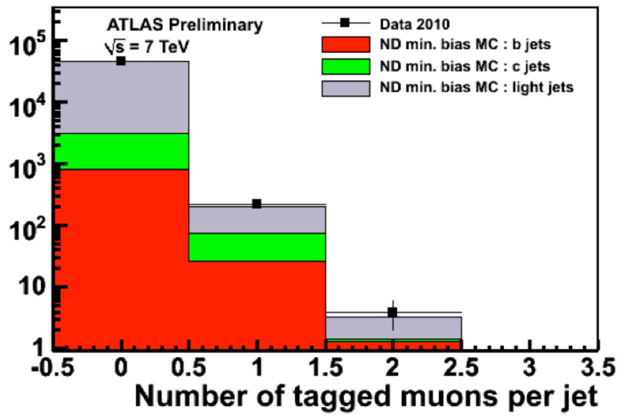
Decay time of lambda candidates for data and MC

b-tagging performance

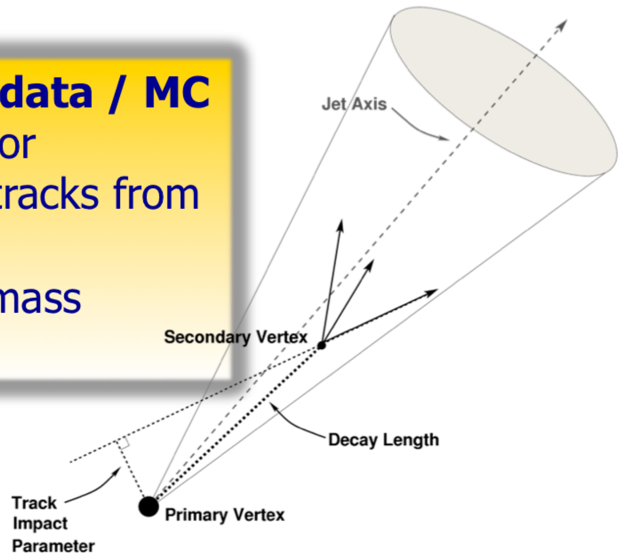
Several b-taggers exist using:
impact parameter, secondary vertex (number of tracks, 3D and 2D decay length, mass), probability of tracks to be compatible with prompt jets, muon tagging

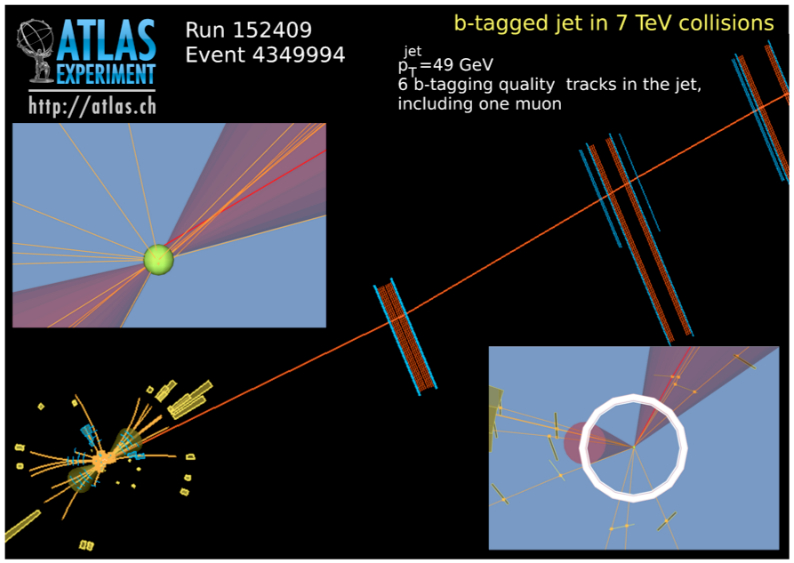






Good agreement data / MC
b-jets clearly seen for
high multiplicity of tracks from secondary vertices
as well as for high mass secondary vertices.





Charged particle multiplicities

First ATLAS physics paper (tracking only)

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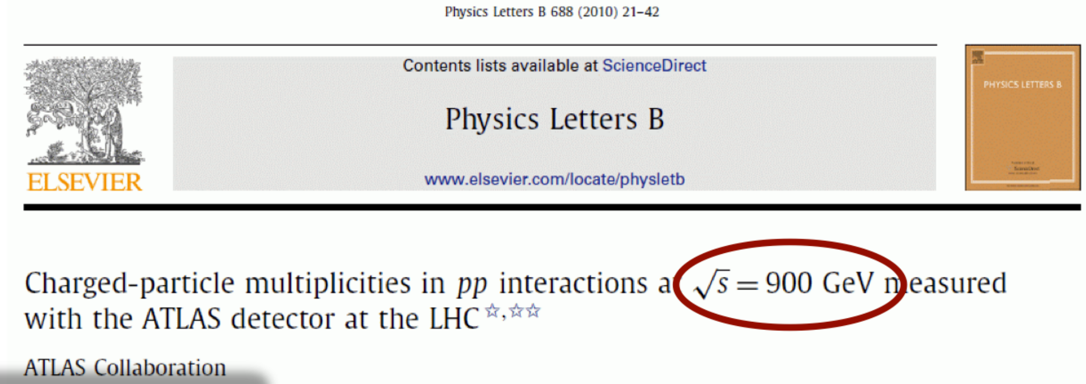
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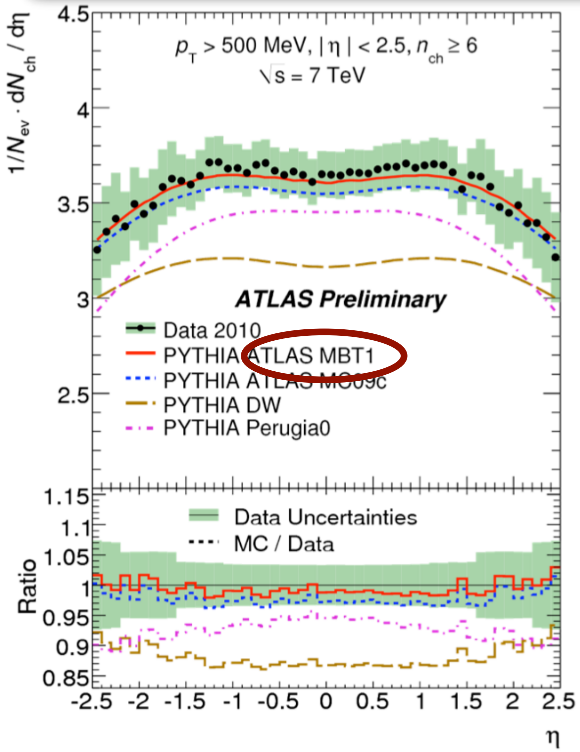
Charged-particle multiplicities in pp interactions at $\sqrt{s} = 900$ GeV measured with the ATLAS detector at the LHC ☆,☆☆

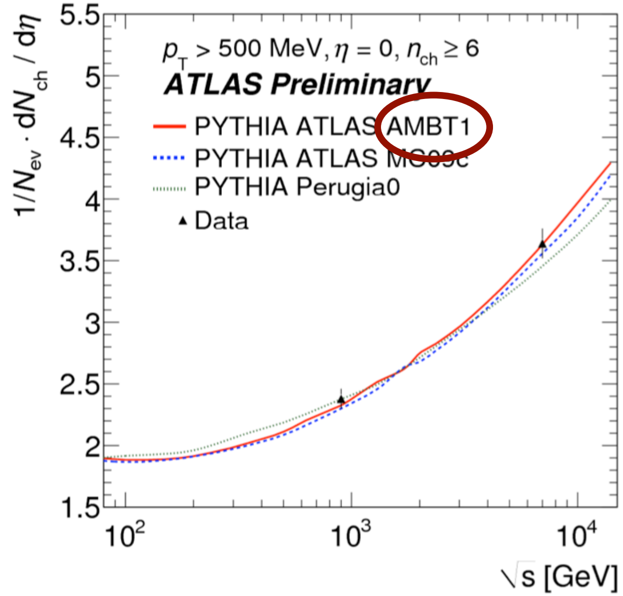
ATLAS Collaboration

In the mean time, analysis re-done at √s = 7 TeV



MC tunes to Tevatron data with PDFs for √s = 7 TeV predict 5-20% lower charged track multiplicities than observed.

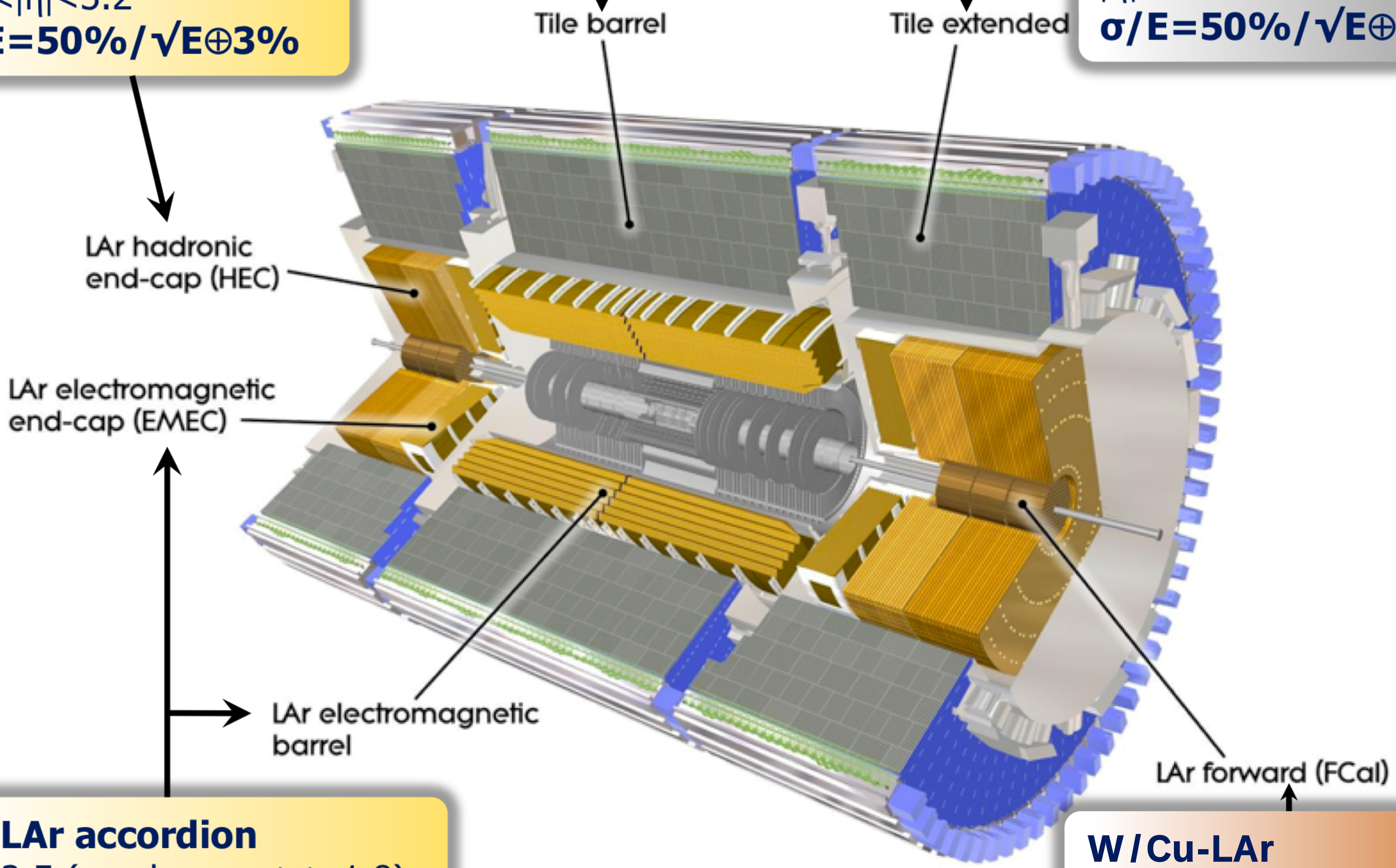
⇒ ATLAS tune to Pythia6: **AMBT1** to describe observed data.



Calorimeter

Cu-LAr
1.5<|η|<3.2
σ/E=50%/√E⊕3%

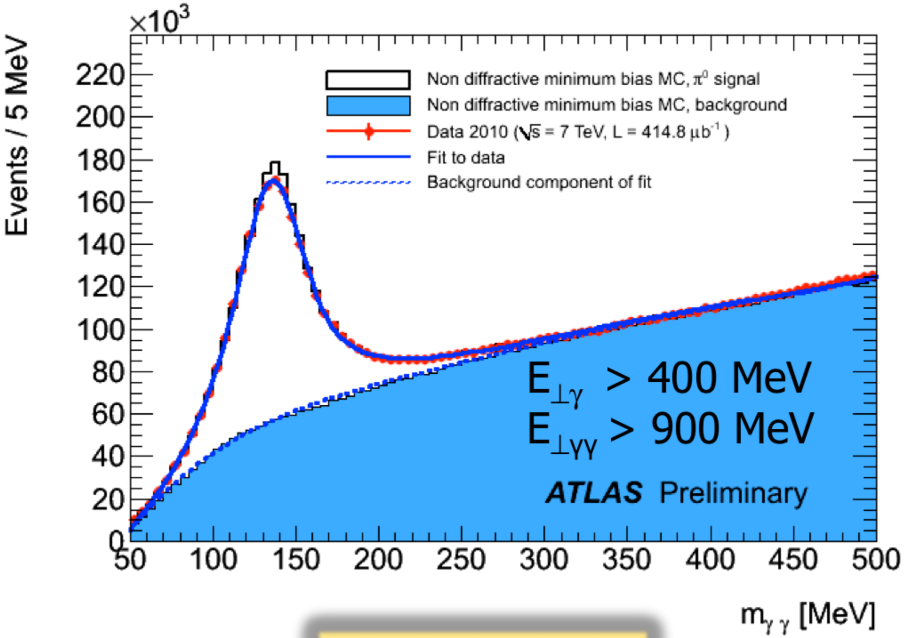
Fe-scintillating tiles
|η|<1.7
σ/E=50%/√E⊕3%



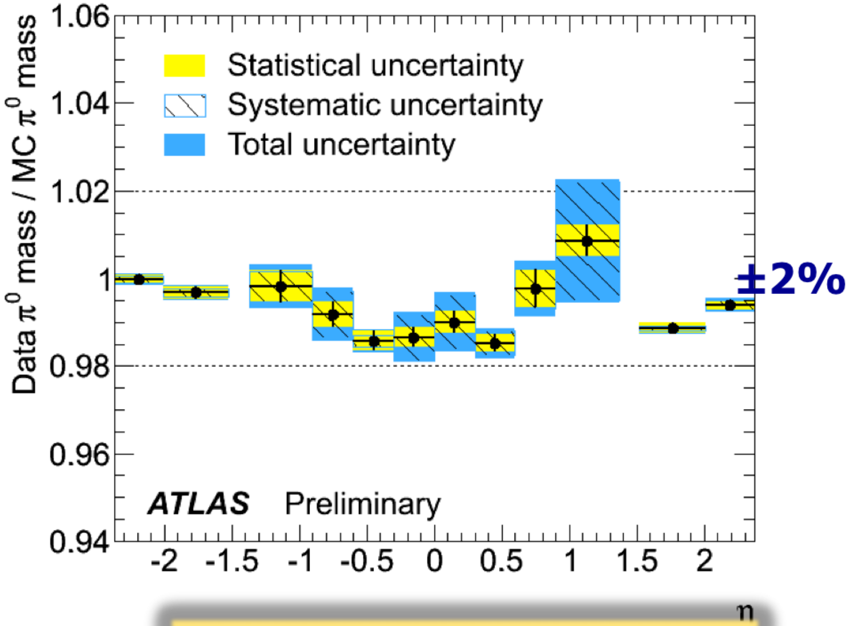
Pb-LAr accordion
|η|<2.5 (preshower: |η|<1.8)
σ/E=10%/√E⊕0.7%

W/Cu-LAr
3.2<|η|<4.9
σ/E=100%/√E⊕10%

EM Calorimeter: $\pi^0 \to \gamma\gamma$



Di-photon mass



π^0 mass uniformity vs. η

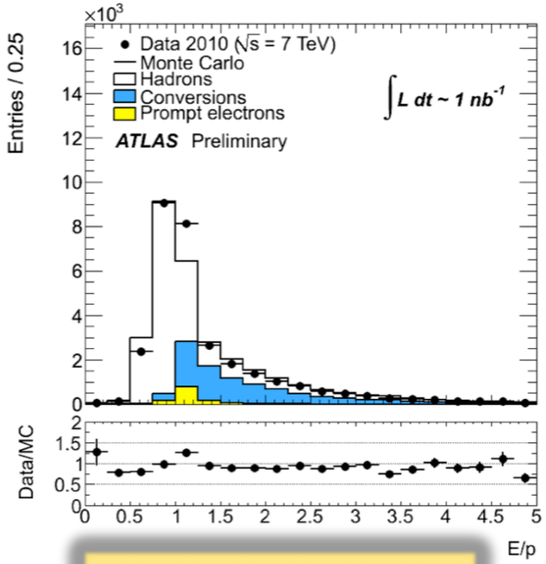
data / MC ratio shown

systematic error dominated by material description in MC

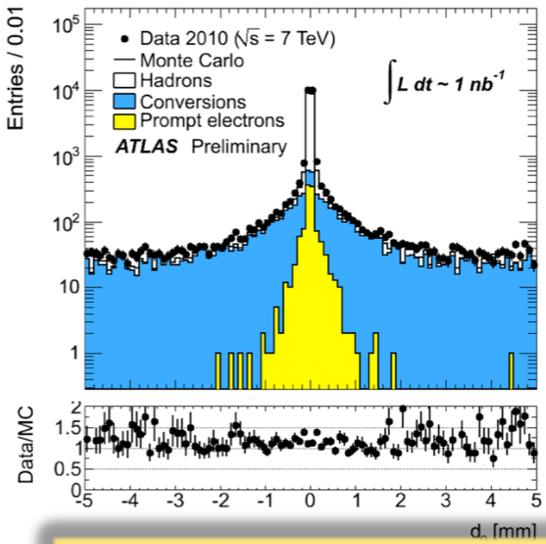
Mass 135.04 ± 0.04 MeV
Width 20.11 ± 0.05 MeV

PDG Mass: 134.9767 MeV
Expected resolution: 19.09±0.04 (MC)

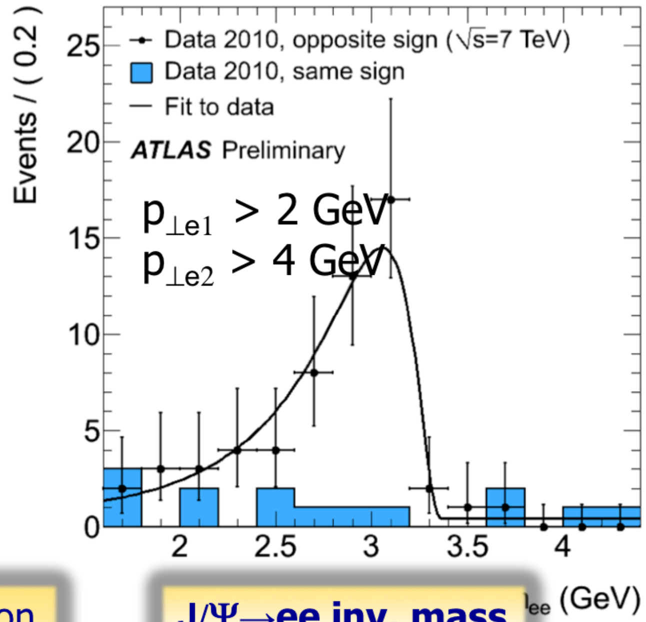
EM Calorimeter: Electrons



E/p electron energy over momentum ratio



Impact parameter resolution for prompt electrons measured from EM shower shapes.



$J/\Psi \to ee$ inv. mass

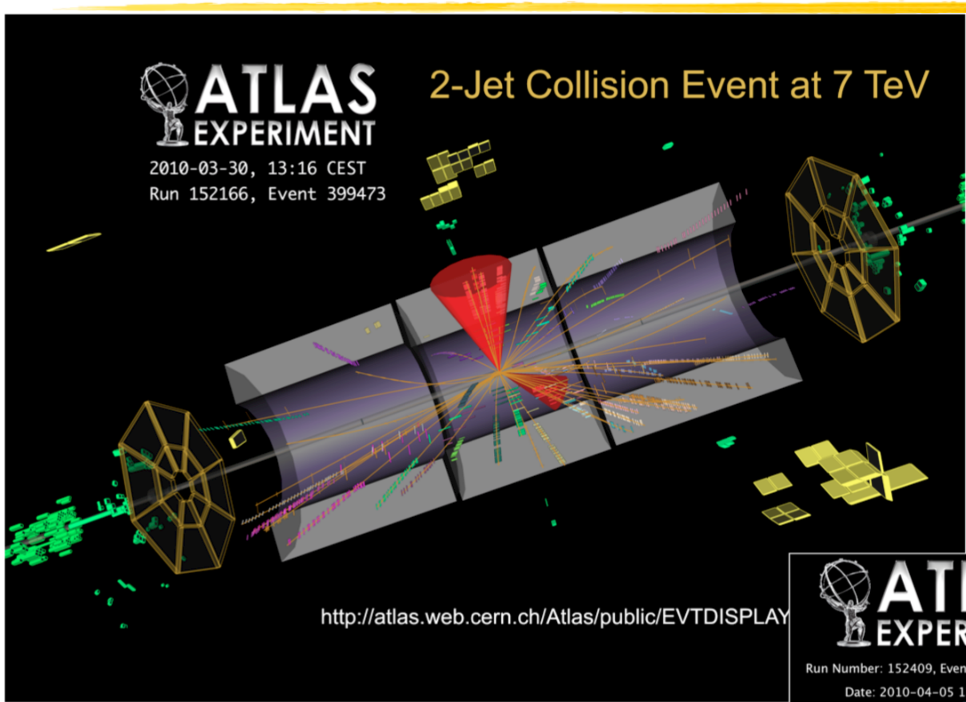
For **$\int \mathcal{L}$ dt=13.8±1.5 nb^{-1}**

~70k electron candidates
with $E_\perp$>7 GeV and $|\eta|$<2

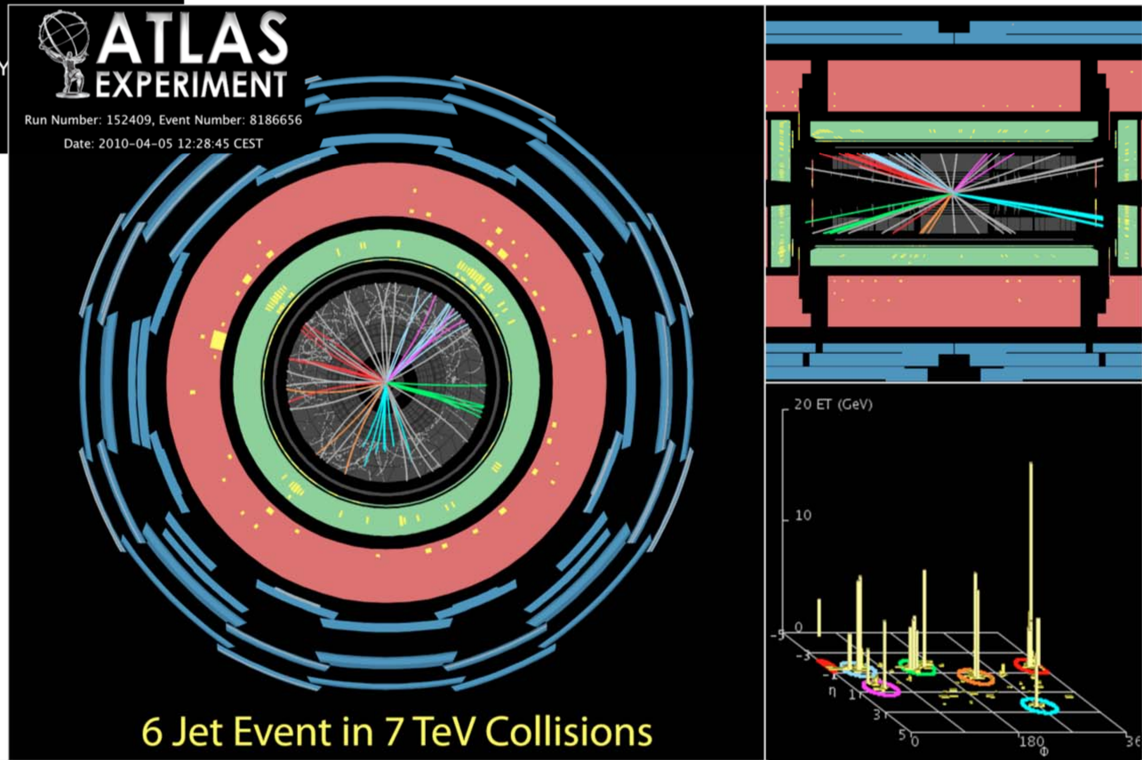
~10k prompt electrons
electrons from heavy flavour decay, $W \to e\nu$, $Z \to ee$

d_0 from hadrons faking electrons **100 μm**
larger d_0 for prompt electrons due to bremsstrahlung
broad distribution for electrons from photon conversions

Jets



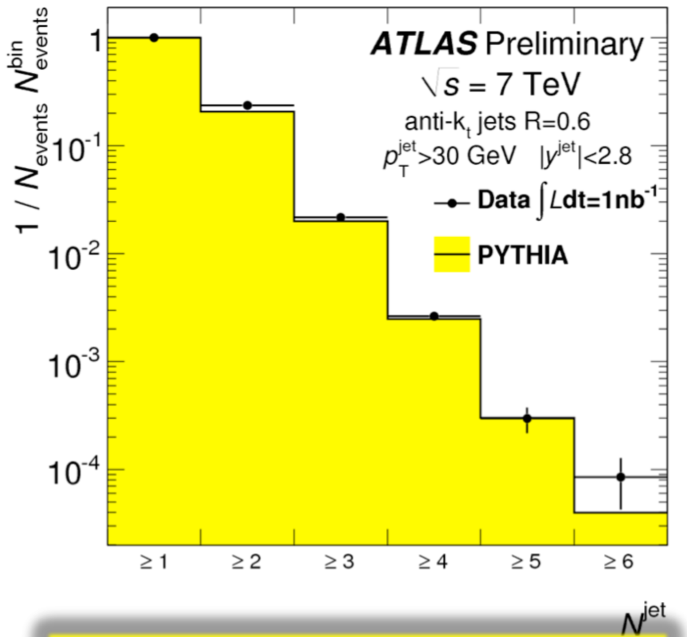
Di-jet event



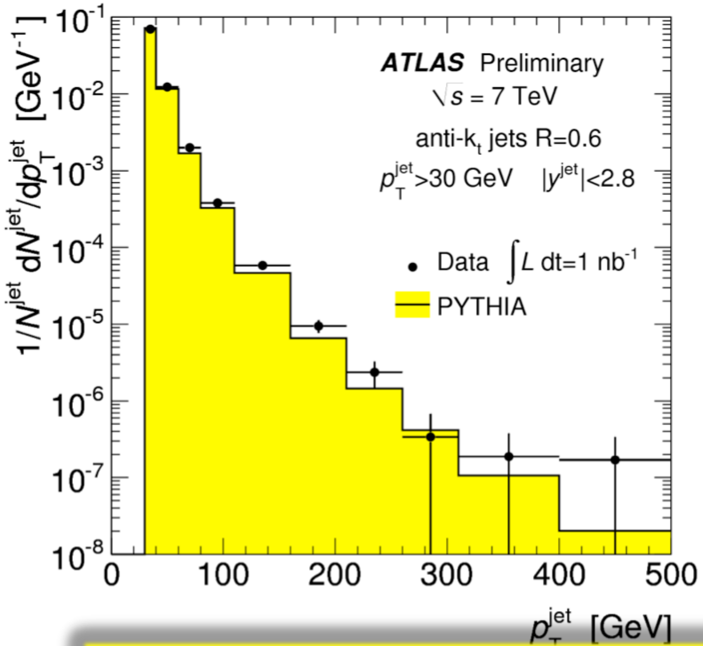
6-jet event

Jet-$E_{\perp}$ between 30 and 70 GeV (after calibration)

Jets with $p_\perp$ >30 GeV @ $\sqrt{s}$= 7 TeV



Inclusive jet multiplicity distribution



Jet transverse momentum distribution

Jet reconstruction:

Anti-k⊥ jets with R=0.6
→ recursive recombination of proto-jets

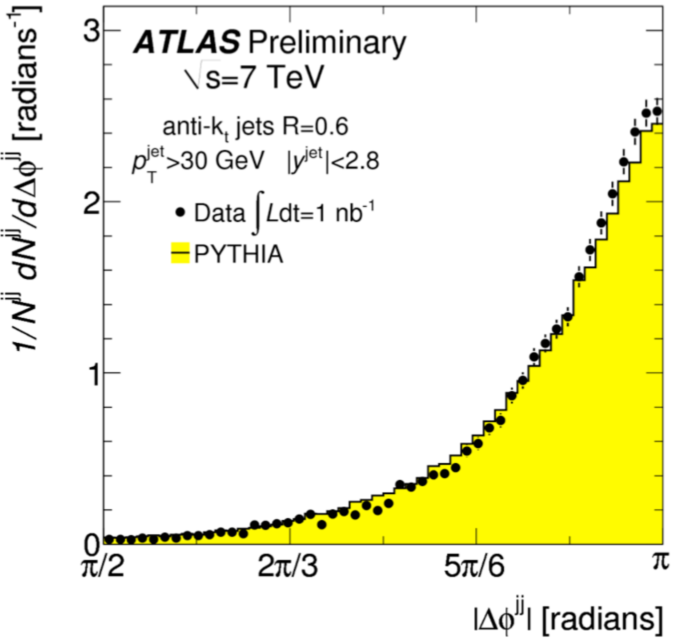
$p_{\perp jet}$ > 30 GeV
$|\eta_{jet}|$ < 2.8

JES from EM scale & global factor for hadronic correction
only statistical uncertainties shown

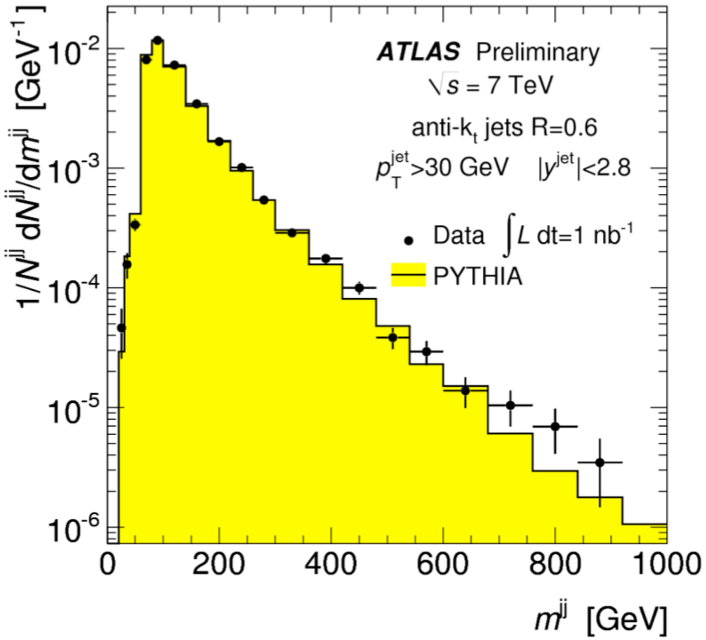
Events with up to six jets,
and up to $p_{\perp jet}$ ~500 GeV have been observed

MC describes data fairly well

Di-Jets with $p_\perp$ >30 GeV @ $\sqrt{s}$= 7 TeV



$|\Delta\varphi^{jj}|$ of the two leading jets



Invariant mass m^{jj} of the two leading jets

only statistical uncertainties shown

Jet reconstruction:

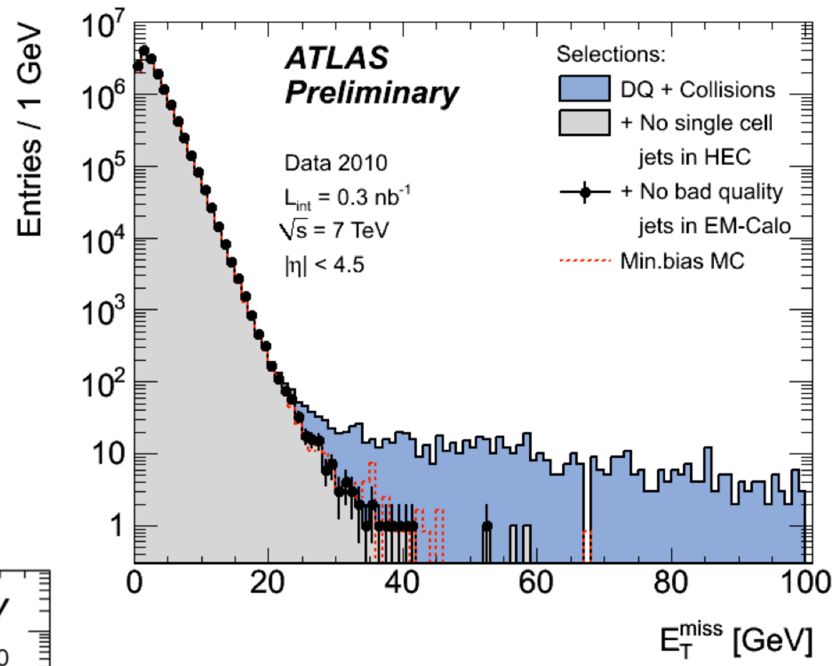
Anti-k⊥ jets with R=0.6
$p_{\perp jet}$ > 30 GeV
$|\eta_{jet}|$ < 2.8

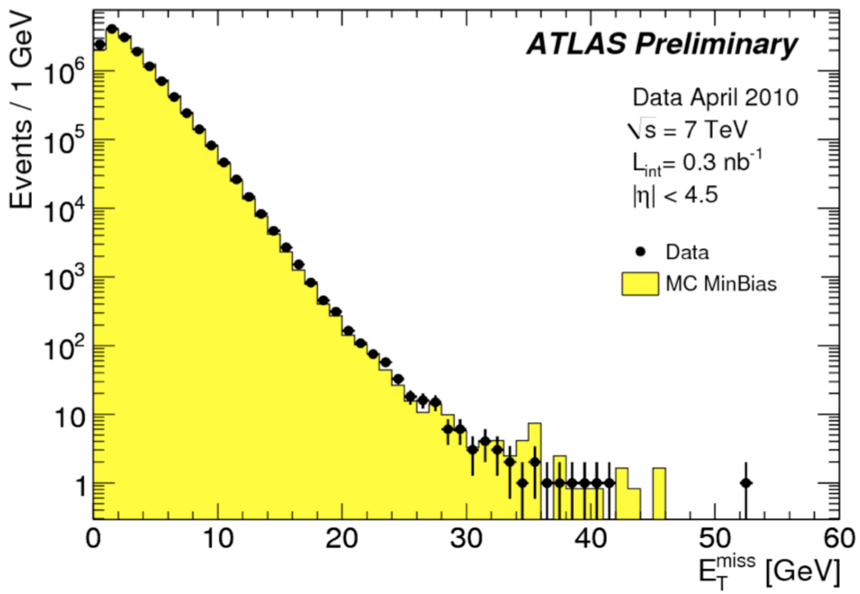
Di-jets peak in a back-to-back configuration
Up to 900 GeV of di-jet mass observed

MC describes data fairly well

Missing transverse energy $E_\perp^{miss}$

Distribution of $E_\perp^{miss}$
before and after cleaning cuts:
-Dataquality flags
-removal of single cell jets

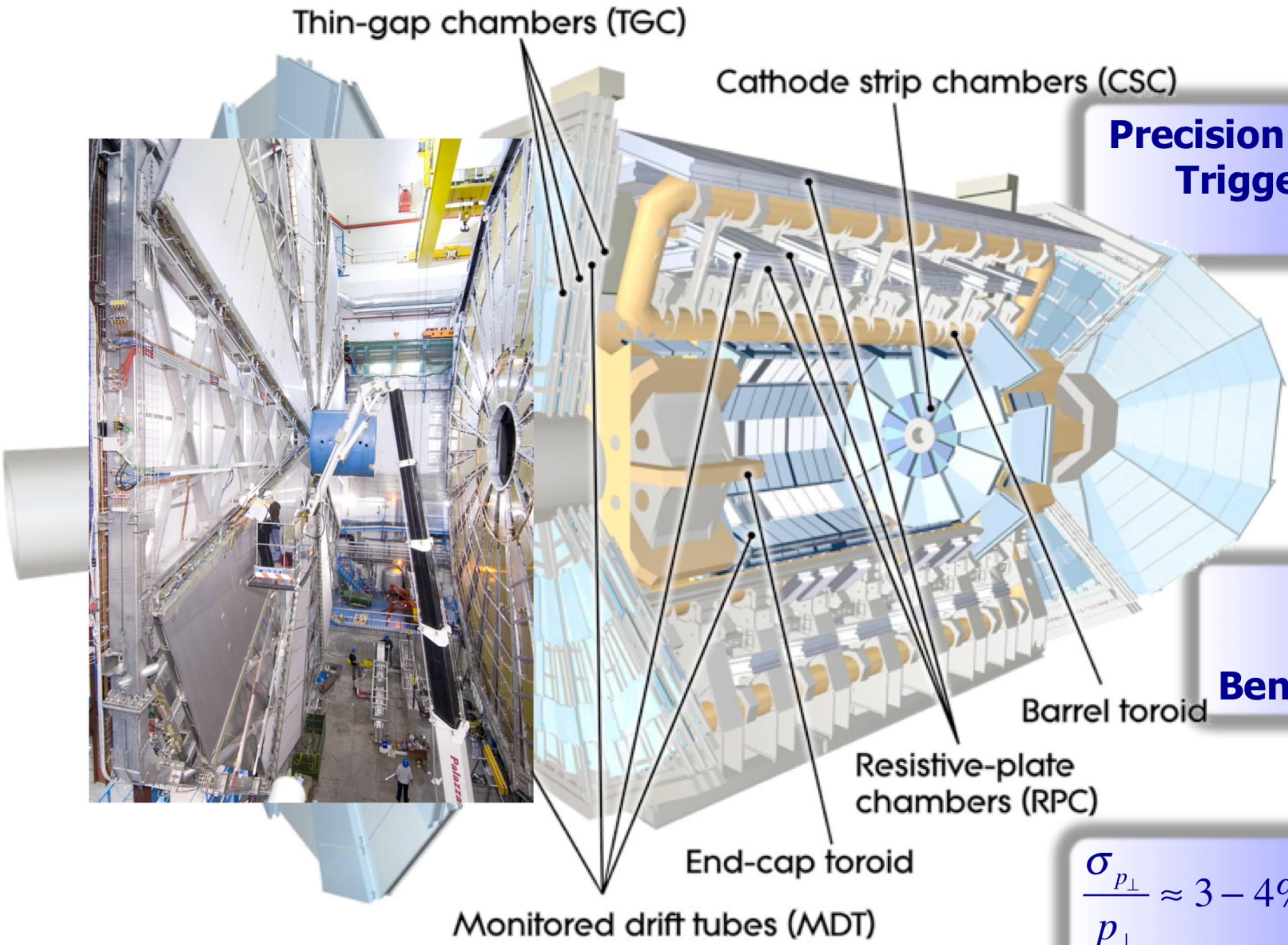




Distribution of $E_\perp^{miss}$
for events triggered with
the MBTS minimum bias scintillator planes.
All cleaning cuts applied.

Minimum bias MC describes data well
over six orders of magnitude.

Muon Spectrometer



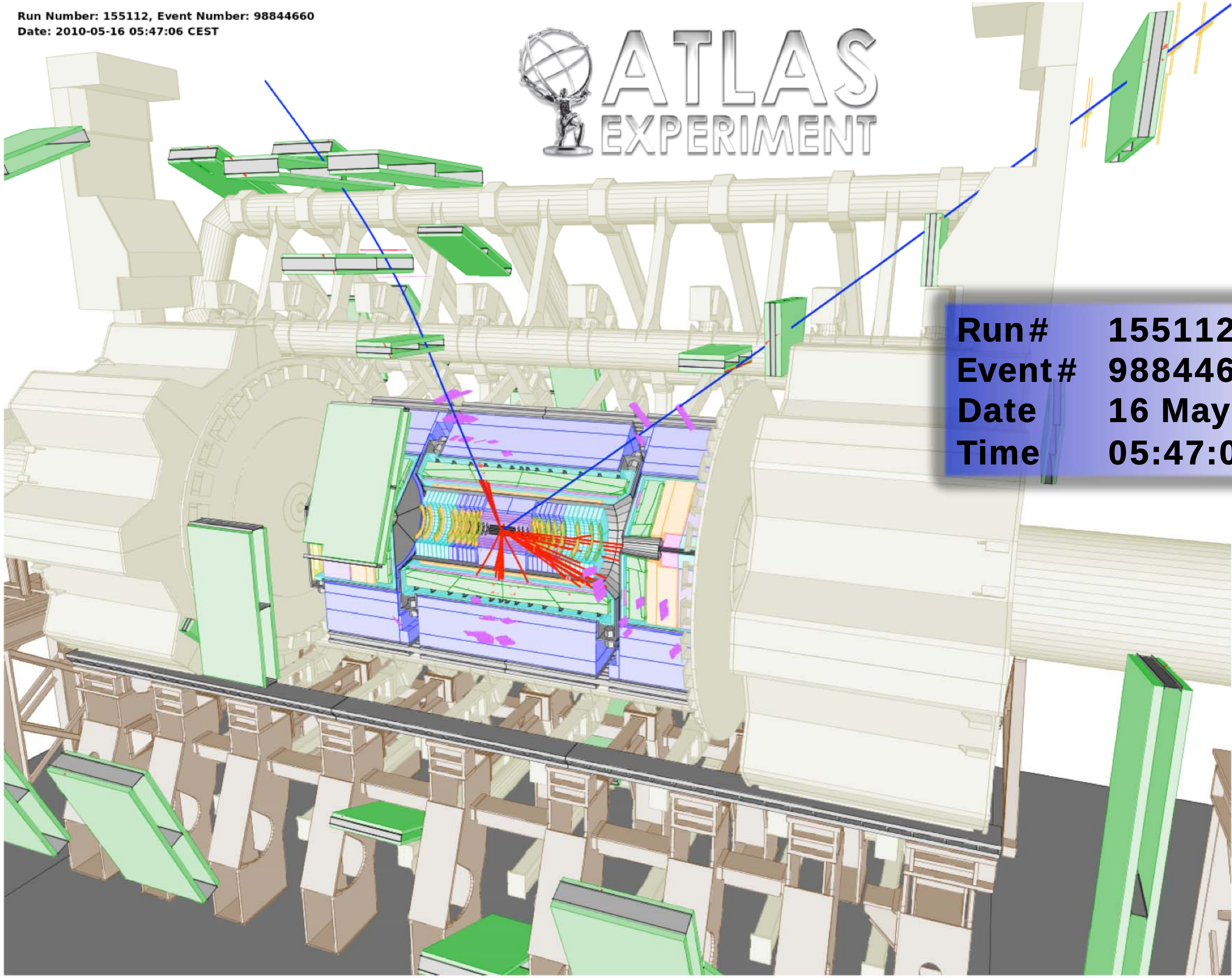
Precision chambers: MDT, CSC
Trigger chamers: TGC, RPC
coverage $|\eta|<2.7$

Magnetic field
0 – 4 T, $B_{avg} \approx 0.5$ T
Bendingpower: 2.5-6 Tm

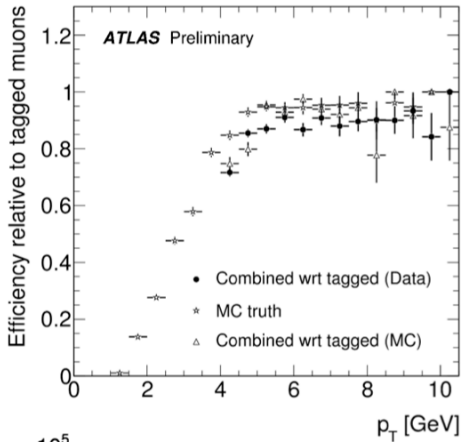
$$\frac{\sigma_{p_\perp}}{p_\perp} \approx 3-4\% \text{ for } 10 < p_\perp < 500\,\text{GeV}$$

$$< 10\% \text{ for } p_\perp < 1\,\text{TeV}$$

Event with isolated and contained muon

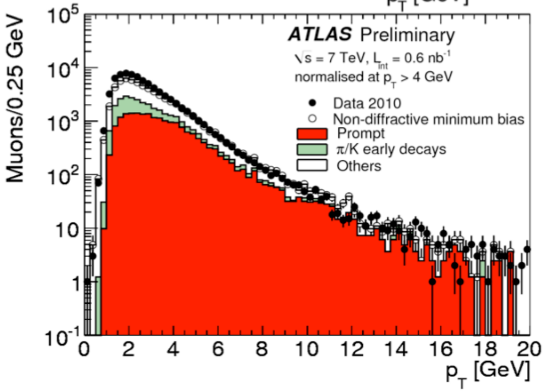


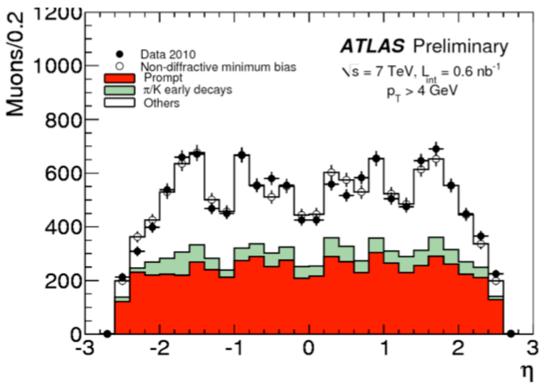
Muon spectrometer acceptance



Muon acceptance and reconstruction efficiency

At about $p_{\perp}$=5 GeV and above, the μ reconstruction efficiency reaches its plataeu value.





Muon $p_{\perp}$ and η distributions
for events triggered by minimum bias trigger scintillators

The minimum bias MC includes

- prompt muons (b and c decays)
- early π/K decays (track match in inner tracker)
- late π/K decays (no track match in inner tracker)
- fakes (muons from hadronic showers)
- mismatches (match with wrong track in inner detector)
- sail-through (non-muon traversing through the calorimeter)

MC normalized to data for $p_{\perp}$>4 GeV
MC describes data fairly well

Muon spectrometer : Rediscovery of J/Ψ

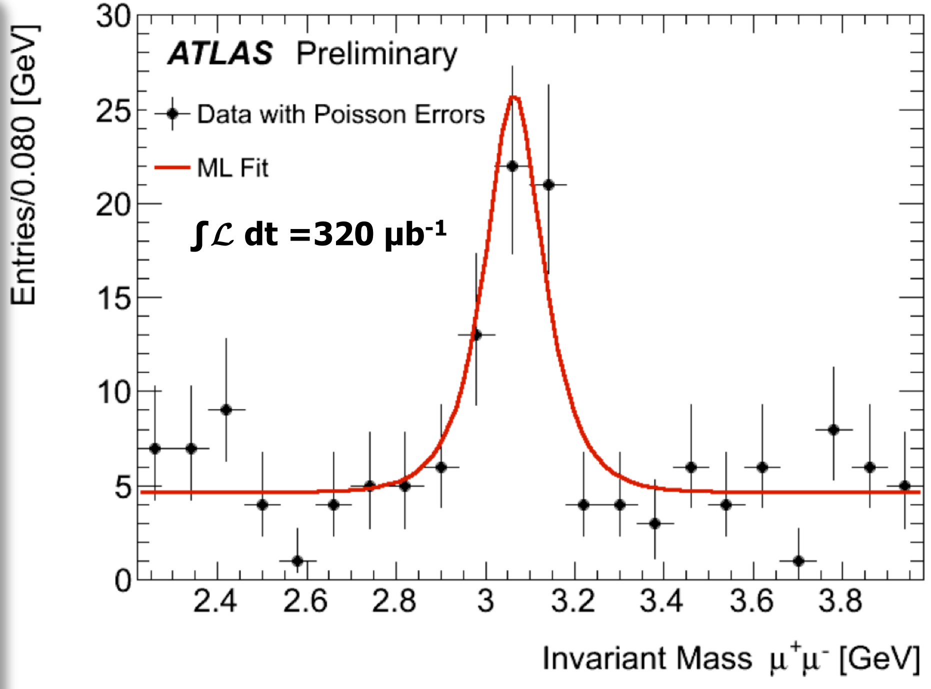
Di-muon invariant mass distribution

- oppositely charged muon pairs
- $p_{\perp\mu}$ > 3 GeV each
- use inner detector track parameters after fit to a common vertex.

- For **$\int\mathcal{L}$ dt =320 μb^{-1}**

  Number of signal events: 49±12
  Number of background events: 28±4

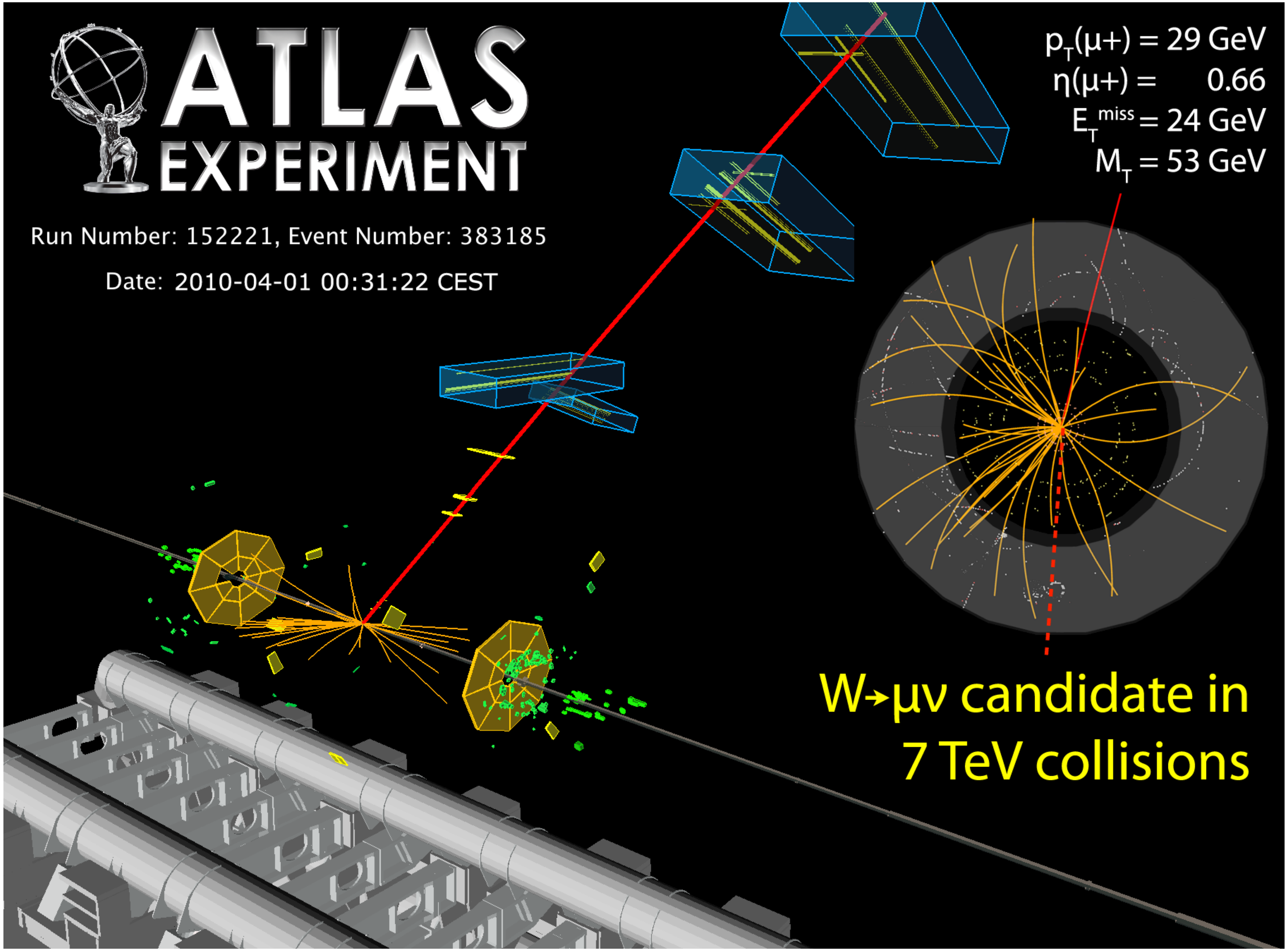
  Mass: 3.06±0.02 GeV
  Resolution: 0.08±0.02 GeV



Rediscovery of the Standard Model with ATLAS

W and Z
(top takes a bit more)

First $W^+ \rightarrow \mu^+ \nu$ candidate



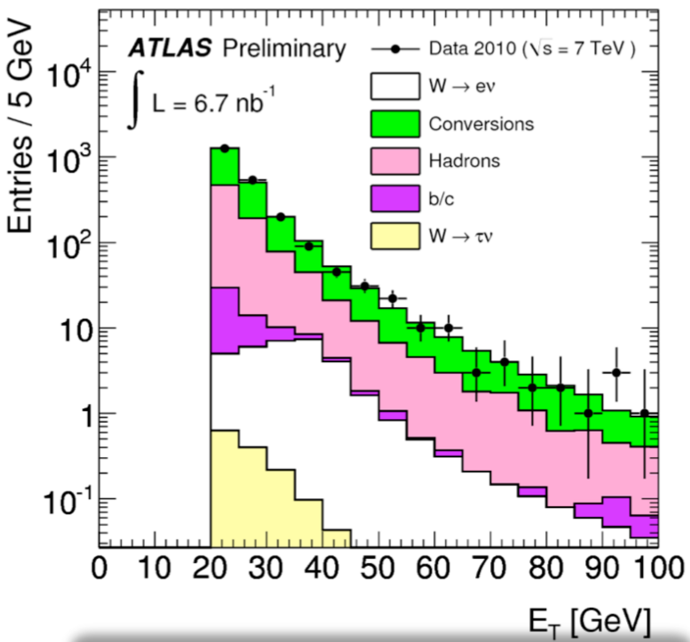
W preselection at √s = 7 TeV

W→eν

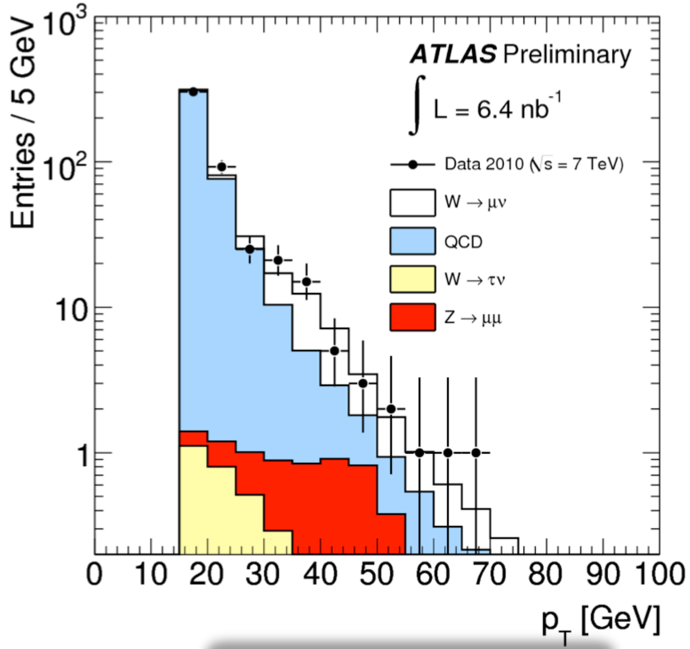
Primary vertex with ≥ 3 tracks
At least one 'loose' Electron
EM cluster-$E_\perp$ > 20 GeV, |η| < 2.47
Excluding region 1.37 < |η| < 1.52

W→μν

Primary vertex with ≥ 3 tracks
At least one muon with ID track match
$p_\perp$ > 15 GeV, |η| < 2.4



EM cluster-$E_\perp$ of selected electron



$p_\perp$ of selected muons

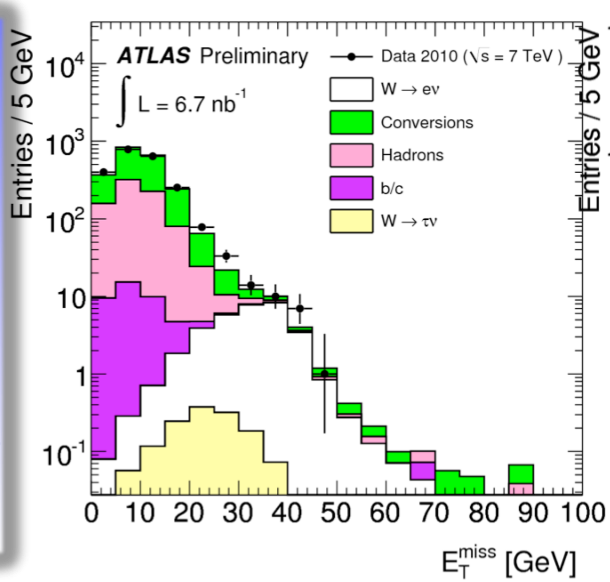
W candidates with $\int\mathcal{L}\,dt = 6.9\text{nb}^{-1}$

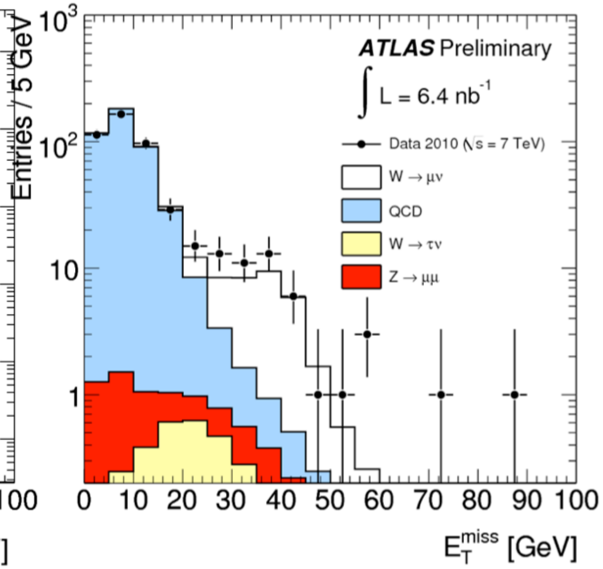
W→eν and W→μν

missing transverse energy
cut from escaping neutrino
$E_\perp^{miss} > 25$ GeV

transverse mass $m_\perp > 40$ GeV

$$m_\perp = \sqrt{2 p_\perp^\ell p_\perp^\nu \left[1 - \cos\left(\varphi^\ell - \varphi^\nu\right)\right]}$$

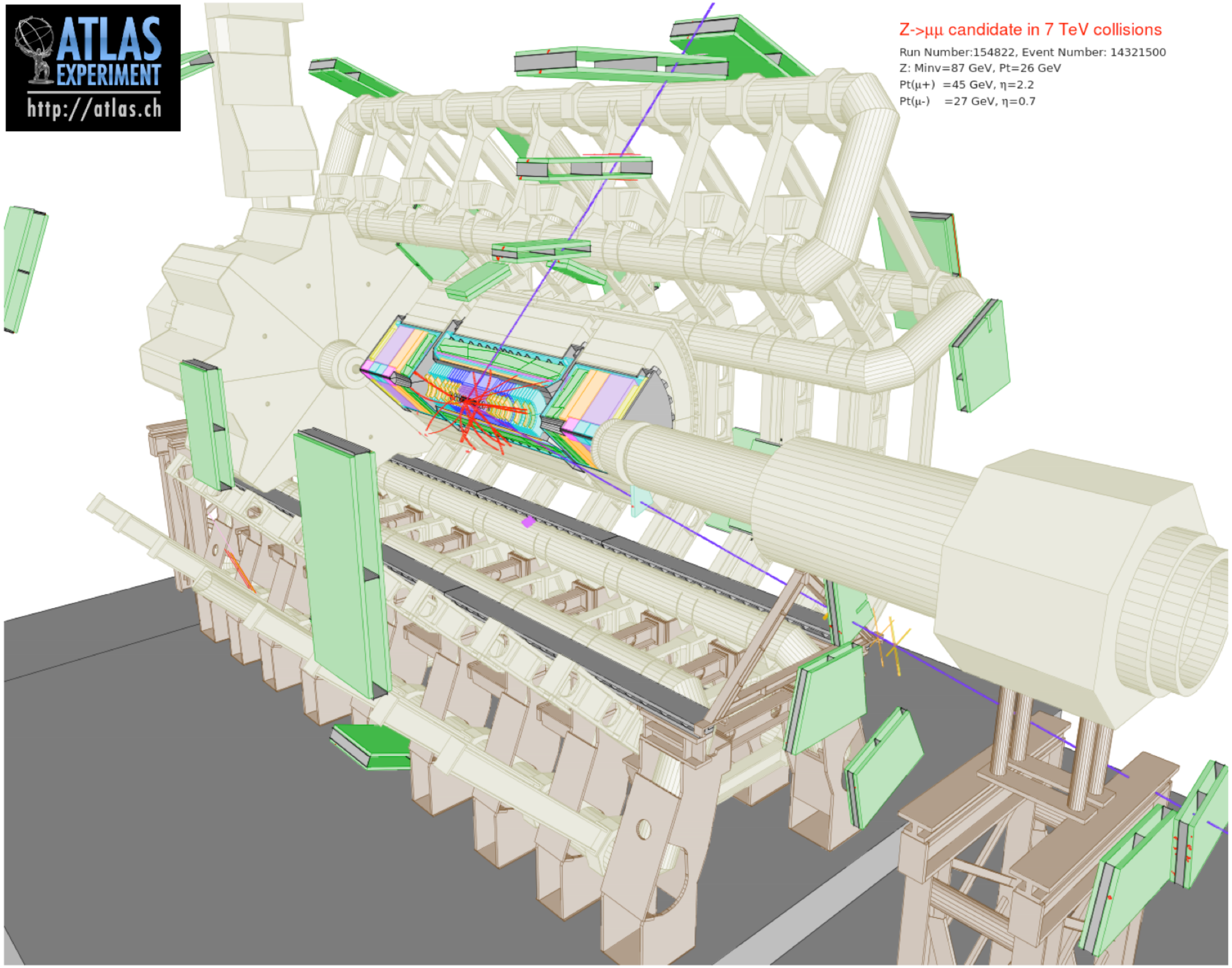




	W→eν	W→μν
Observed	17	40
Expected	23.1±1.2(stat)±1.7(syst)±4.6(lumi)	28.7±0.5(stat)±3.9(syst)±5.7(lumi)
Signal	20.7 ± 1.7(syst) ± 4.1(lumi)	25.9±3.6(syst)±5.2(lumi)
Background	2.4 ± 1.2(stat) ± 0.4(syst) ± 0.5(lumi)	2.8±0.5(stat)±0.8(syst)±0.6(lumi)

Cross-section measurements with more data in preparation

Z candidate


ATLAS
EXPERIMENT
http://atlas.ch
Z->μμ candidate in 7 TeV collisions
Run Number:154822, Event Number: 14321500
Z: Minv=87 GeV, Pt=26 GeV
Pt(μ+) =45 GeV, η=2.2
Pt(μ-) =27 GeV, η=0.7

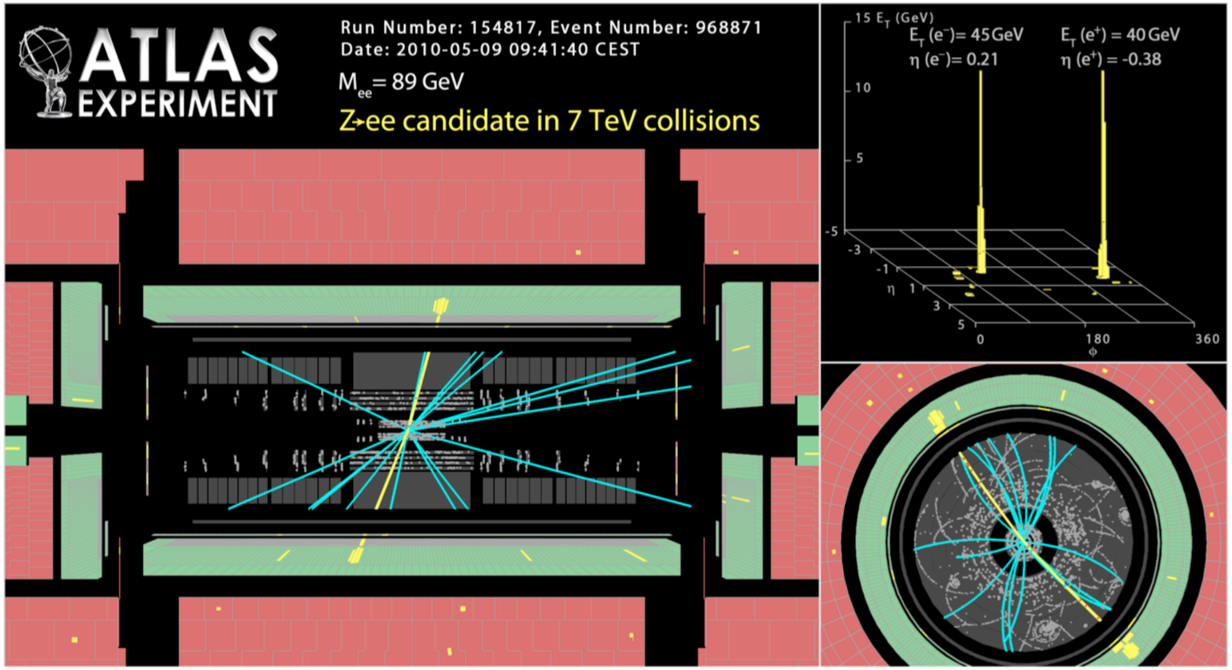
Z production at √s = 7 TeV

Z→ee $\int\mathcal{L}\,dt$ = 6.7nb^{-1}±20%

2 tracks with opposite charge pointing to EM clusters
$E_\perp$ > 20 GeV, |η| < 2.47
80 GeV < m_{ee} < 100 GeV
Observed 1, expected 1.6 ± 0.3
Reconstructed mass: 91.4 GeV

Z→μμ $\int\mathcal{L}\,dt$ = 7.9nb^{-1}±20%

2 isolated combined track (ID-MS) with opposite charge
$p_{\perp 1}$ > 20 GeV, $p_{\perp 2}$ > 15 GeV, |η| < 2.4
80 GeV < mμ μ < 100 GeV
Observed 2, expected 3.2 ± 0.9
Reconstructed mass: 87.6, 80.2 GeV



Looking forward

top, Higgs, SUSY, Z’, W’, …

With increasing luminosity…

top *already some hints of candidate events…*

- *top pair production cross section*
- *top mass*
- *single top*
- *top charge*
- *rare top decays*

Higgs

- ***with 1fb^{-1}*** *catch up with Tevatron on $H \rightarrow WW \rightarrow \ell\nu\ell\nu$*
- low mass Higgs will need $10 fb^{-1}$ @ 14 TeV (end of 2014 – preliminary)

Supersymmetry

- *inclusive searches: multi-jets + ETmiss (with leptons)*
- *with few 100 pb^{-1}*

W', Z'

- *if at TeV scale,* ***1 fb^{-1}*** *enough to extract clean signal*

Further looking for

- *Leptoquarks, heavy fermions, large extra dimensions, black holes*

…for later *with 14 TeV and ever increasing luminosities*

- *Higgsless models, technicolor, vector boson scattering, …*

Conclusions

After 20 years of preparation

the LHC accelerator is colliding protons

the ATLAS experiment [detector, trigger and data acquisition, data quality, calibration and alignment, data processing and world-wide distribution] is in excellent shape.

All subdetectors are operational at better than 98% level; some even at 100%.

Data taking efficiency > 90%

Remarkably good understanding of detector response
(Monte Carlo simulation effort and cosmic ray studies paying fruit)

First physics results

Charged track multiplicities and first MC tunes
Rediscovery of mesons and baryons

Rediscovery of weak vector bosons

The outlook for new physics is bright
Interesting times ahead → stay tuned

Back-up

Expected data samples (examples) with 100 pb^{-1}

Channels (examples)	Expected events in ATLAS after cuts $\sqrt{s} \to 10$ TeV, $100\ pb^{-1}$
$J/\Psi \to \mu\mu$	$\sim 10^6$
$\Upsilon \to \mu\mu$	$\sim 5\times10^4$
$W \to \mu\nu$	$\sim 3\times10^5$
$Z \to \mu\mu$	$\sim 3\times10^4$
$tt \to WbWb \to \mu\nu + X$	~ 350
QCD jets $p_T > 1$ TeV	~ 500
$\tilde{q},\tilde{g}$ $m_{SUSY} \sim 1$ TeV	5

Goals in 2010

1) Commission and calibrate the detector in situ using well-known physics samples

e.g. – $Z \to ee, \mu\mu$ tracker, ECAL, Muon chamber calibration and alignment, etc.

– $tt \to bl\nu\ bjj$ jet scale from $W \to jj$, b-tag performance, etc.

2) "Rediscover" and measure Standard Model at $\sqrt{s}$ = 7 TeV: W, Z, tt, QCD jets ...

(also because omnipresent backgrounds to New Physics)

3) Early discoveries ? Potentially accessible: Z', SUSY, ... surprises ?

Expectations for top quark in 2010 (1)

The golden channel

- Signature is 2 leptons, 2 jets + missing E_T.

  $t \rightarrow b\ W^+ \rightarrow b\ l^+\ n$

  $\bar{t} \rightarrow \bar{b}\ W^- \rightarrow \bar{b}\ l^-\ \bar{n}$

- With ~10 pb^{-1}, we expect a convincing signal
  - Each experiment will have ~30 events with an expected background of 5 or 6.

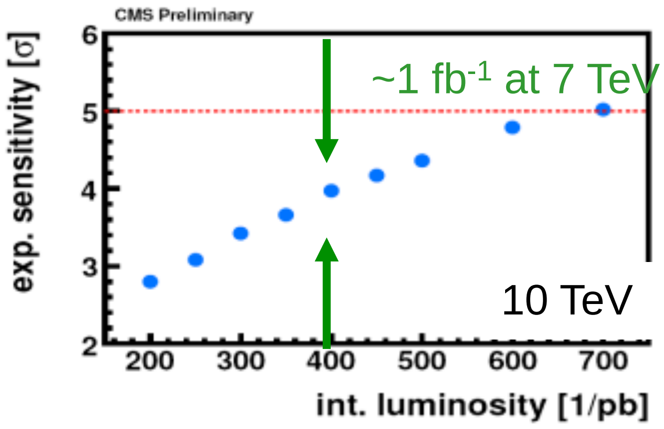
- Even with 5 pb^{-1}, many will find the signal plausible:
  - Each experiment will have ~15 events over a background of around 3.

Expected 10 pb^{-1} sensitivity

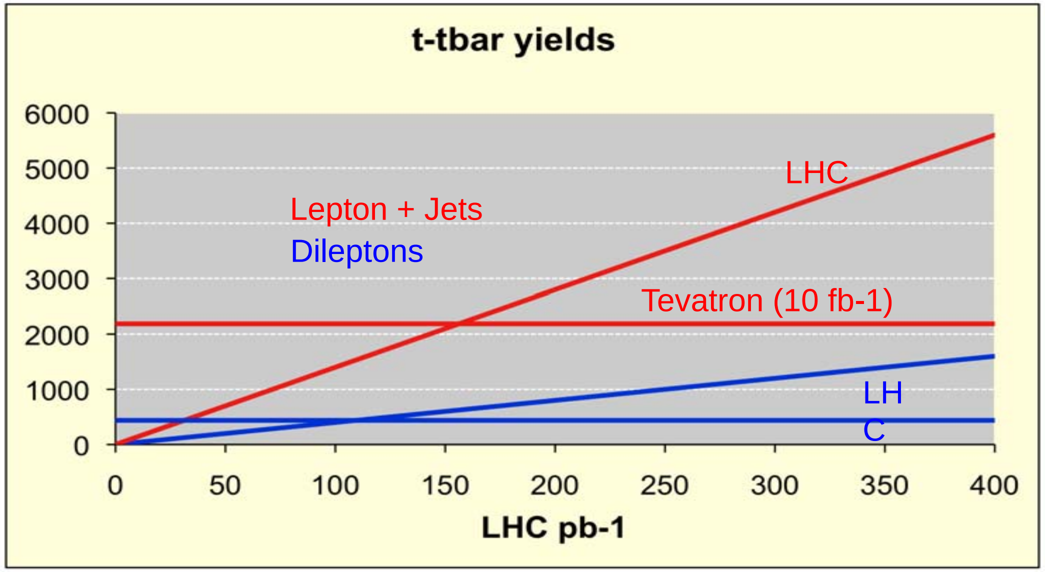
Channel	N(Signal)	N(background)
$e - \mu$	14	2.5
$e - e$	4.3	1.1
$\mu - \mu$	6.6	1.9
Total	25	5.5

Expectations for top quark in 2011

- By the end of 2011, the top samples will be substantially larger than at TeVatron
- Open possibility to study
  - Top mass
  - Single Top
  - Rare decays



Single top



Heavy Z's or W's

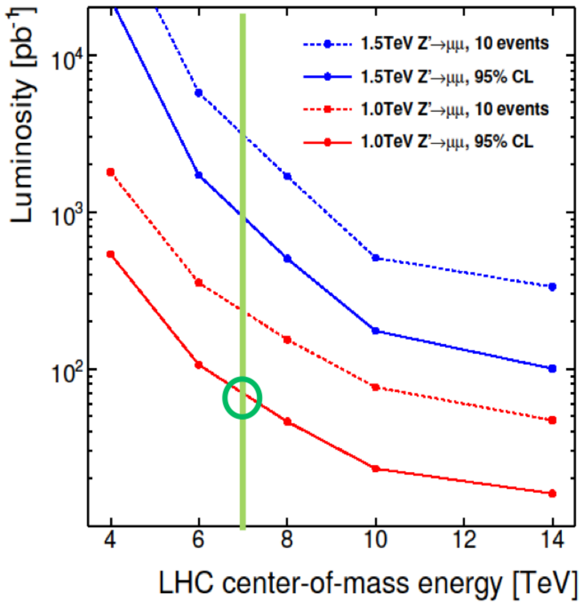
•Predicted in many SM extensions
(Extra Dimensions, Technicolor, Little Higgs)
Low, well understood background

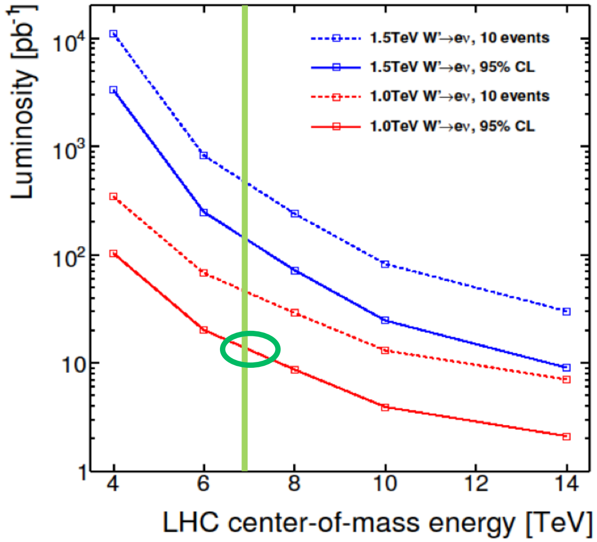
•Z'

- •Tevatron limit ~1 TeV
- •95% CL exclusion O(50pb^{-1}) at 1 TeV
- •Discovery up to 1.3 TeV at 100 pb^{-1}
- •Discovery up to 1.5 TeV at 1 fb^{-1}

•W'

- •Tevatron limit ~1 TeV
- •95% CL exclusion O(10pb^{-1}) at 1 TeV
- •Discovery up to 1.3 TeV at 100 pb^{-1}
- •Discovery up to 1.9 TeV at 1 fb^{-1}



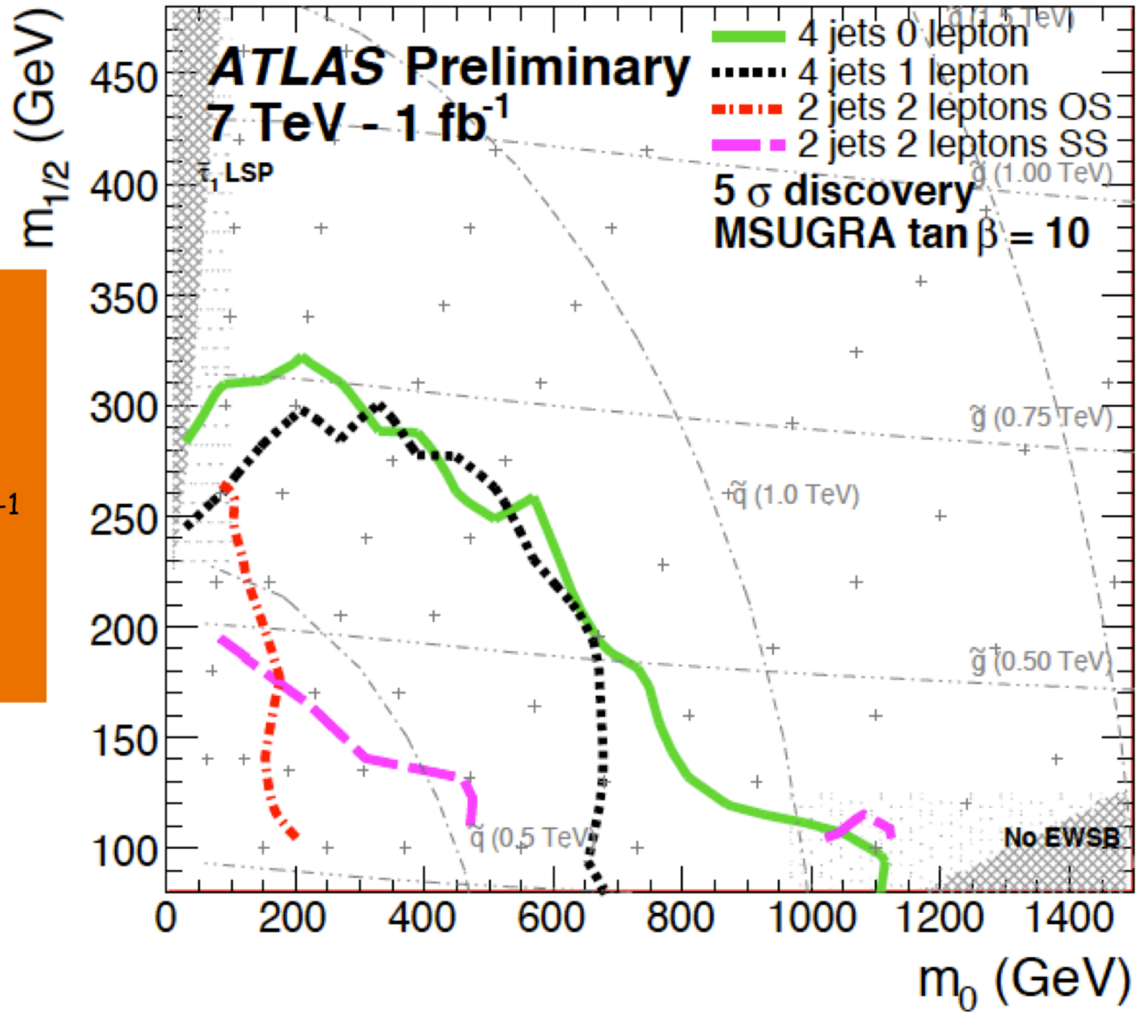


SUSY discovery limit

Search for squarks and gluinos

Tevatron limit ~ 400 GeV

Discovery up to 400 GeV at 100 pb^{-1}
Discovery up to 1000 GeV at 1 fb^{-1}

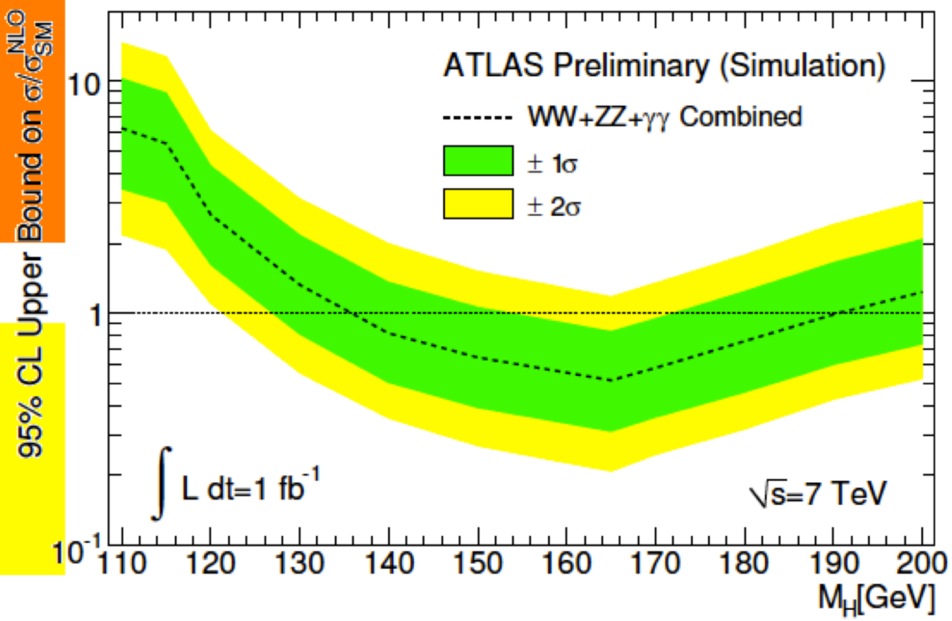


What about the SM Higgs ?

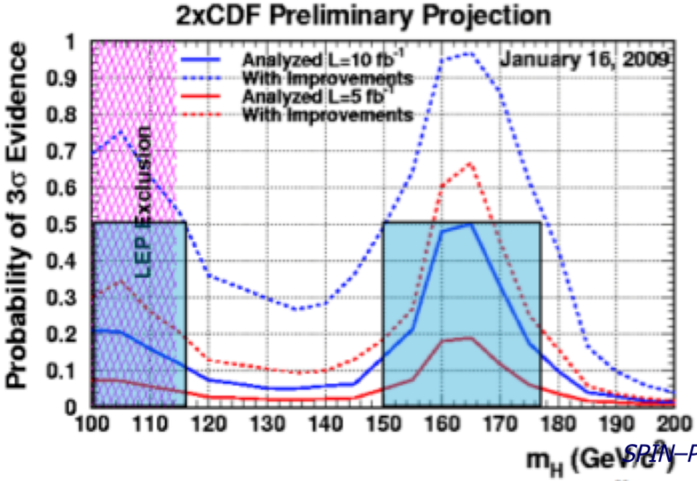
Tevatron today excludes 163-166 GeV/c^2

ATLAS can exclude 140-190 GeV/c^2 with 1 fb^{-1} , taking over from TeVatron above 140 GeV/c^2

Exclusion if the full mass range down to 115 GeV/c^2 requires 1.5 fb^{-1} at 14 TeV



Discovery at 115 GeV/c^2 requires 10 fb^{-1} at 14 TeV: a long way to go if the Higgs is just above LEP limit.



Importance of energy for Higgs search