ATLAS detector performance status and operations, improvements during shutdown, and 2011 data taking

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On behalf of the ATLAS Collaboration

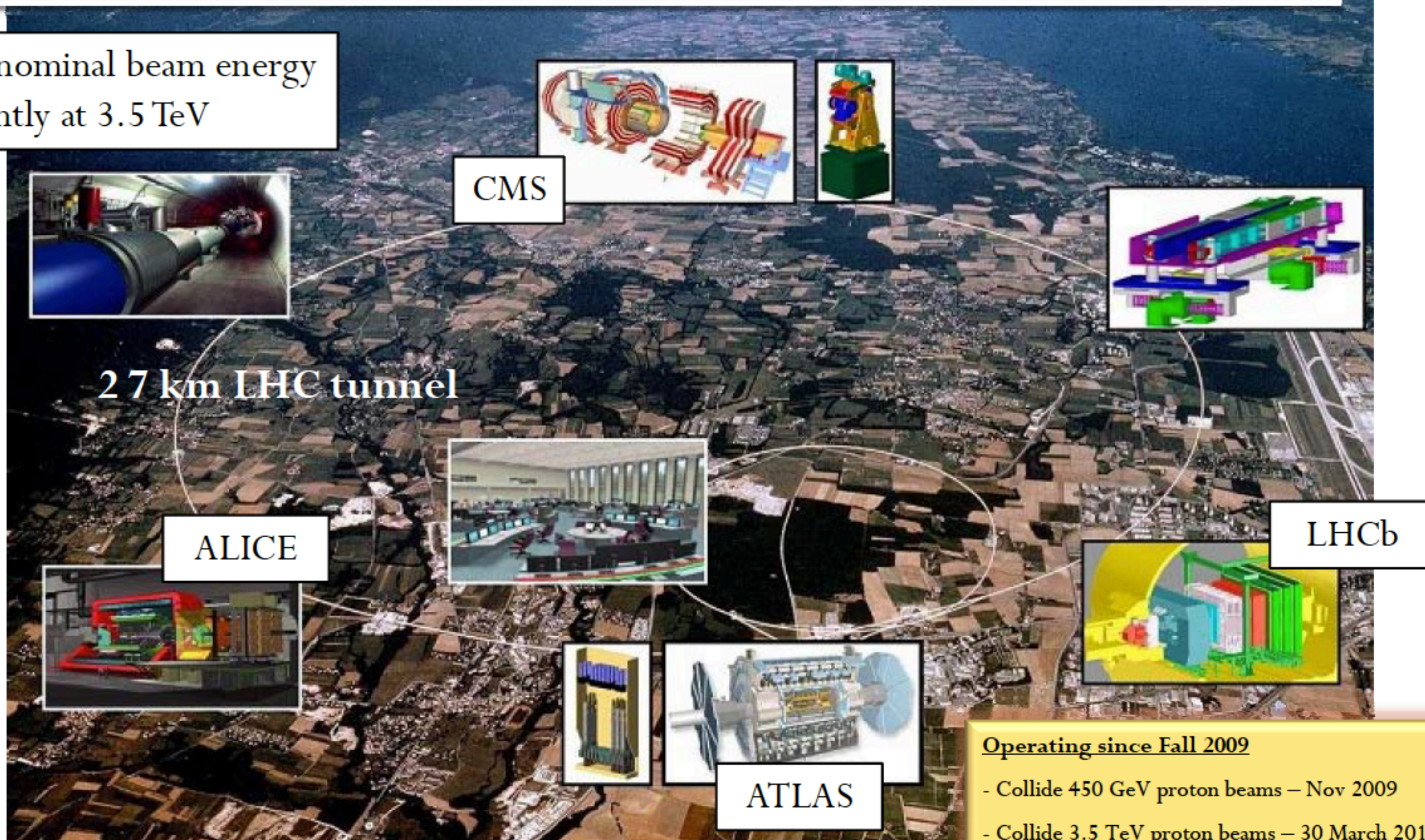
2nd International Conference on Particle Physics
in Memoriam Engin Arık and Her Colleagues

Content
- ATLAS Detector Overview and Data Taking
- Highlights of 2010 Detector Performance
- Recent hardware improvements
- Physics Results in early 2011 data
- Prospects and Conclusion

It is a great privilege and pleasure to present such a talk

A proton-proton collider located on the France-Switzerland border outside of Geneva

7 TeV nominal beam energy
Currently at 3.5 TeV



Operating since Fall 2009

- Collide 450 GeV proton beams – Nov 2009
- Collide 3.5 TeV proton beams – 30 March 2010
- Collide Pb ion beams – Nov 2010

Accelerates both protons and Pb ions

The LHC Challenges

The LHC surpasses existing accelerators/colliders in 2 aspects :

- The energy of the beam of 7 TeV that is achieved within the size constraints of the existing 26.7 km LEP tunnel.

LHC dipole field	8.3 T
HERA/Tevatron	~ 4 T

A factor <u>2</u> in field

A factor <u>4</u> in size

- The luminosity of the collider that will reach unprecedented values for a hadron machine:

LHC	pp	10^{34} cm^{-2} s^{-1}
Tevatron	pp	3×10^{32} cm^{-2} s^{-1}
SppS	pp	6×10^{30} cm^{-2} s^{-1}

A factor <u>30</u> in luminosity

Very high field magnets and very high beam intensities:

- Operating the LHC is a great challenge.
- There is a significant risk to the equipment and experiments.

The Physics

General event properties

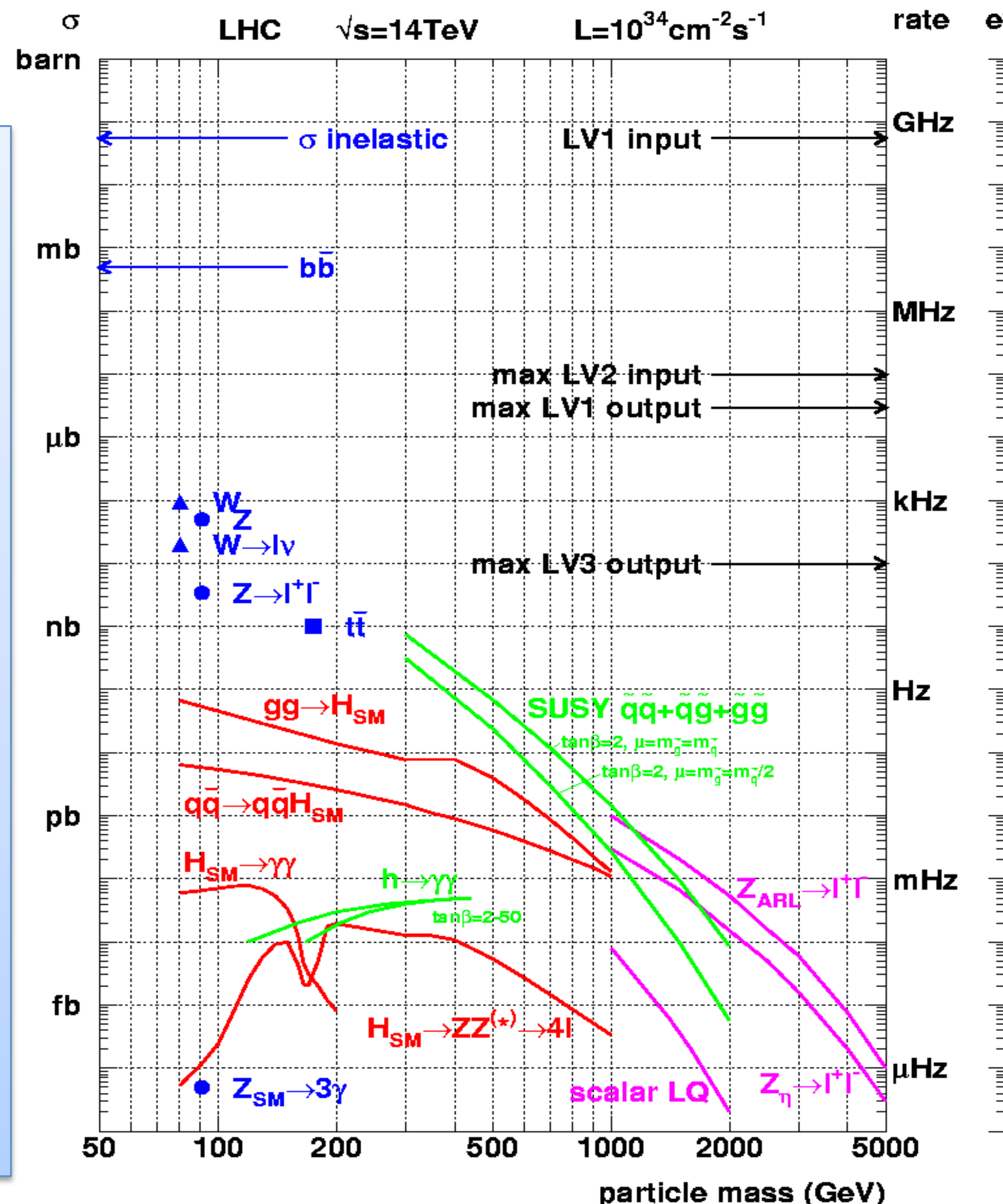
Heavy flavour physics

Standard Model physics including QCD jets

Higgs searches

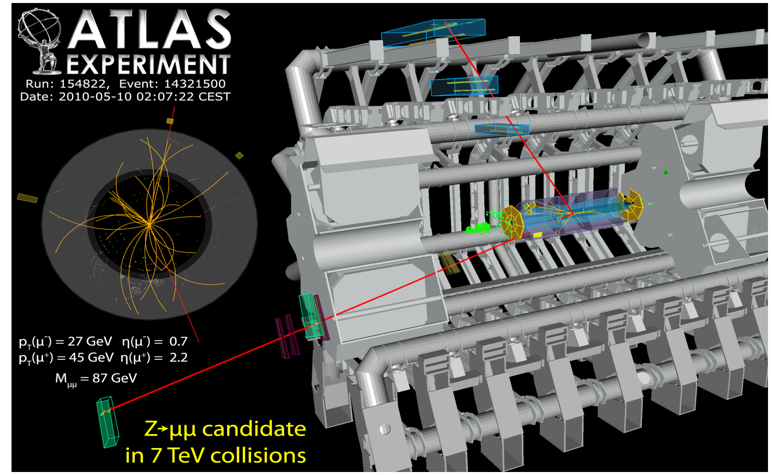
Searches for SUSY

Examples of searches for ‘exotic’ new physics

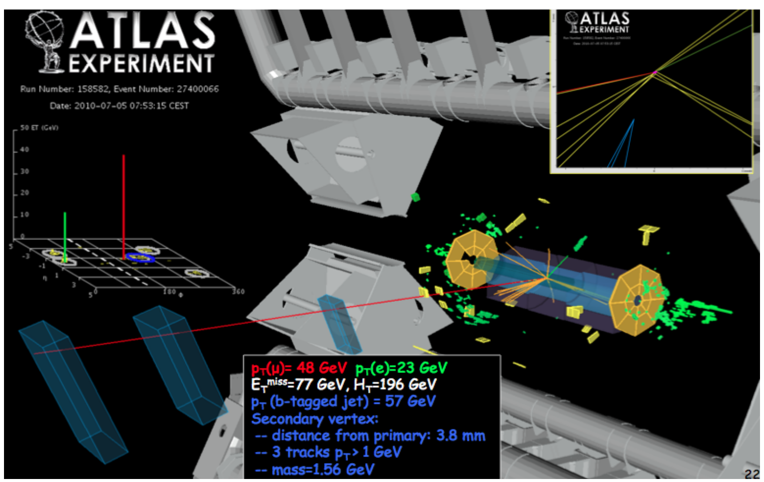


The most exciting LHC year so far: 2010

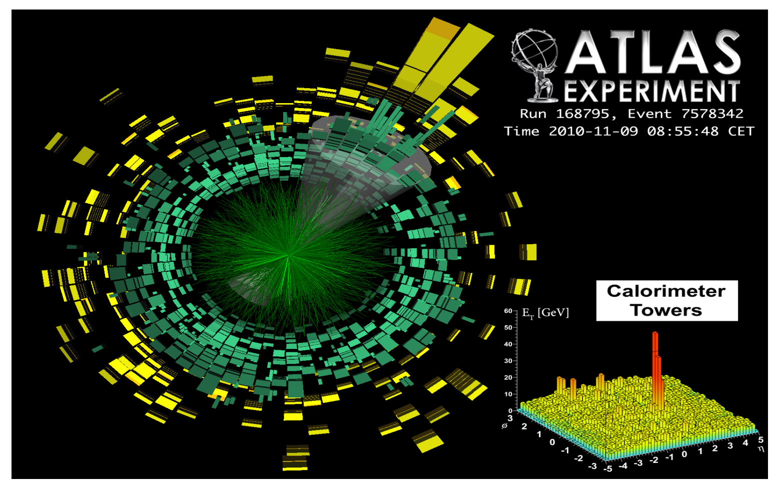
March 2010: ATLAS Control Room



May 2010: First Z Candidate



July 2010: First Top Candidate



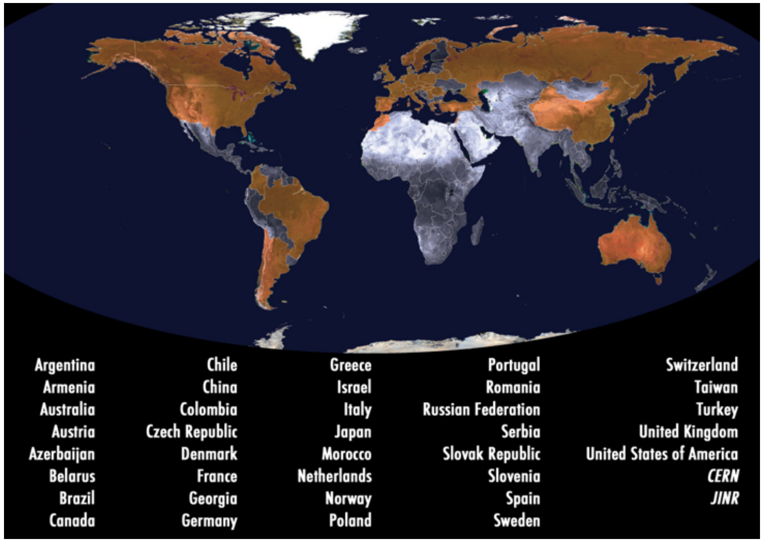
November 2010: Pb-Pb collision

The ATLAS Collaboration

- 3000 scientists
  - 174 institutes
  - 38 countries
  - all continents

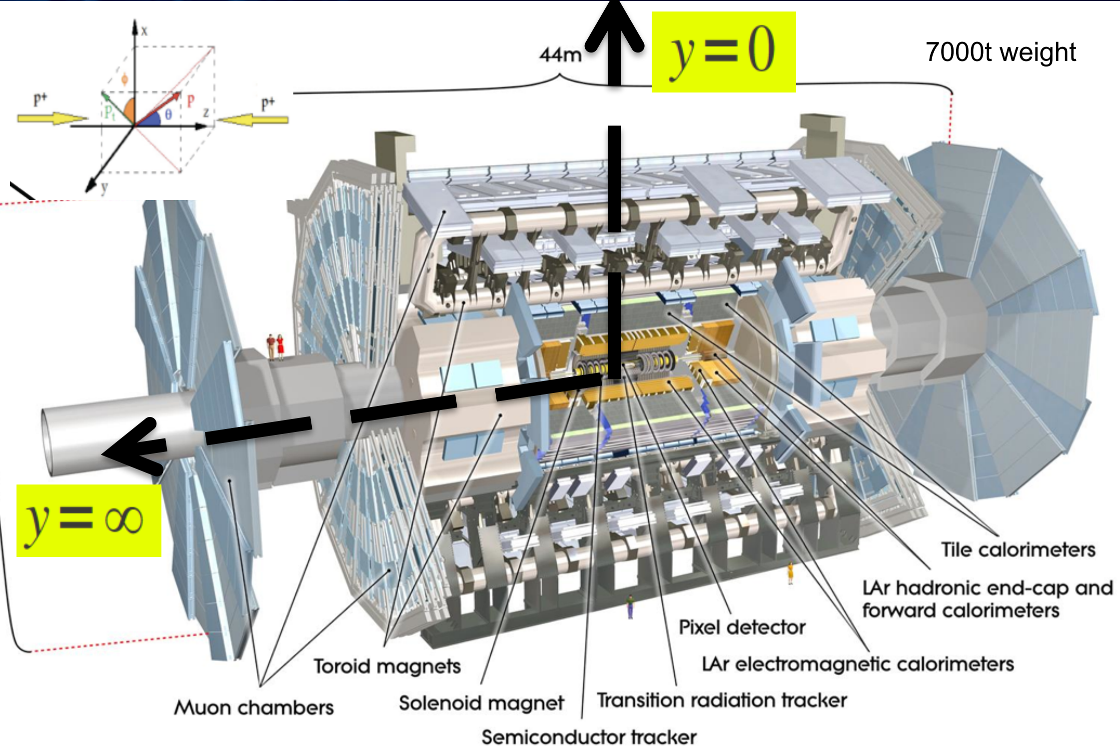
- More than 1000 PhD students

- More than 1.200 working meetings each month
  - Increased by factor of 3 compared to pre-data period



The ATLAS Detector (in 1 slide)

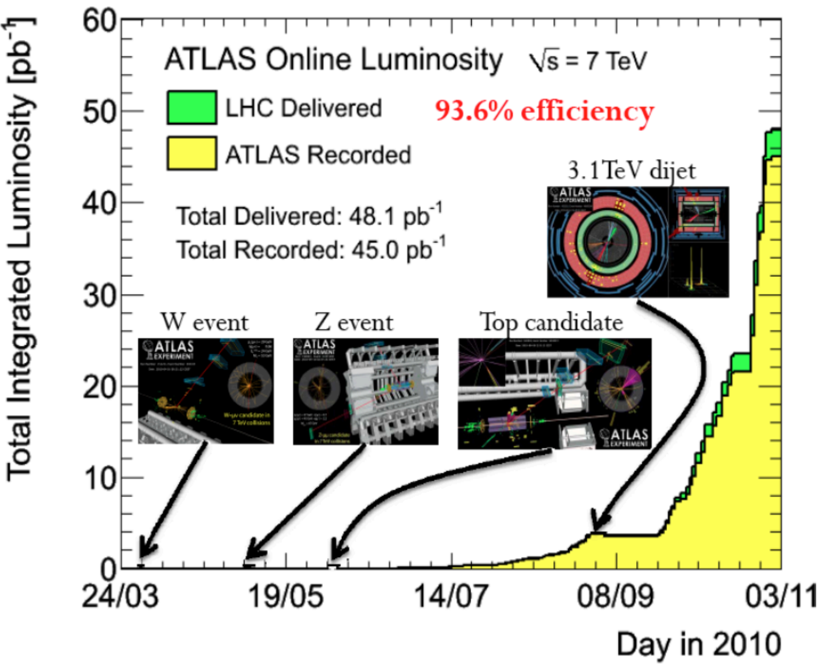
- Inner Detector
  - $|\eta|<2.5$, solenoid B=2T
  - 10^8 Si Pixels, ~ 10^6 Si strips, TRT – Xe filles straw tubes interleafed with PP/PE foil for Cherenkov light:
  - Tracking and vertexing
  - e/π separation
  - Resolution: $\sigma/p_T \sim 3.8\times10^{-4} p_T[\text{GeV}] \oplus 0.015$
- EM calorimeter
  - $|\eta|<3.2$
  - LAr/Pb accordion structure e/γ trigger, id + measurement
  - E-resolution: $\sigma/E \sim 10\%/\sqrt{E} \oplus 0.7\%$ (noise substracted)
- HAD calorimeter
  - $|\eta|<3.2$ (Forward Calo. $|\eta|<4.8$)
  - Scint./Fe tiles in the central, W(Cu)/LAr in fwd region
  - Trigger, jets + missing Et
  - E-resolution: $\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$

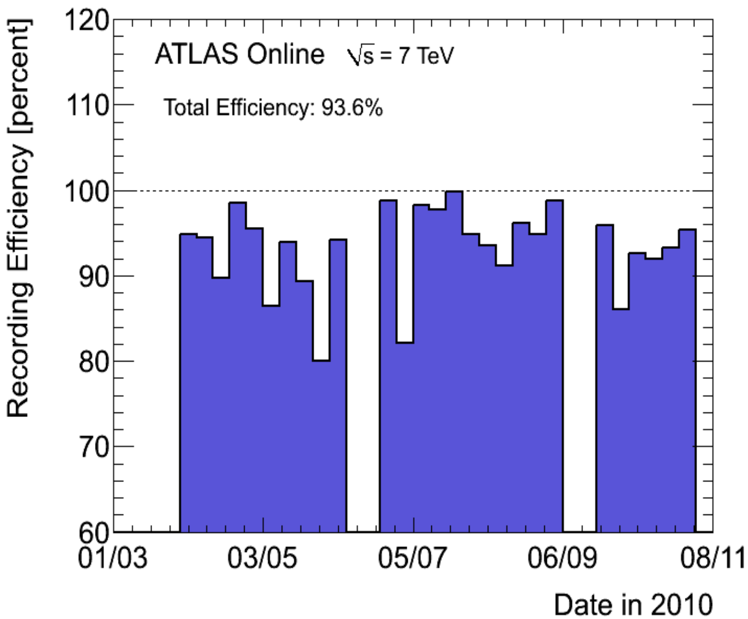


- StandAlone Muon Spectrometer
  - $|\eta|<2.7$
  - 3 layers gas based muon chambers
  - Muon trigger and muon momentum determination
  - Muon Momentum resolution < 10% up to ~ 1 TeV

4 Superconducting magnets: Central Solenoid (B= 2T, 7.6 kA)
3 Air core Toroids (22kA, peak field strength up to 4T)

Peak integrated luminosity = 2.1X10^{32} cm^{-1}s^{-1}





Data Taking in 2010(1/2)

$$l = \int L \cdot dt = \int R/\sigma \cdot dt$$

R = event rate
σ = event cross section

- 48.1pb^{-1} delivered integrated luminosity
  - Many thanks to a fantastic LHC team, also for responding fast to any feedback from ATLAS

Overall data taking efficiency (with full detector on): ~ 94% constantly

- Luminosity detectors (LUCID) calibrated with van der Meer scans
  - Luminosity known today to 4% (error dominated by knowledge of beam currents)
  - Will go down significantly after the analysis of last van der Meer scan
  - ALFA detector in place for 2011
    - elastic scattering in Coulomb-Nuclear interference region

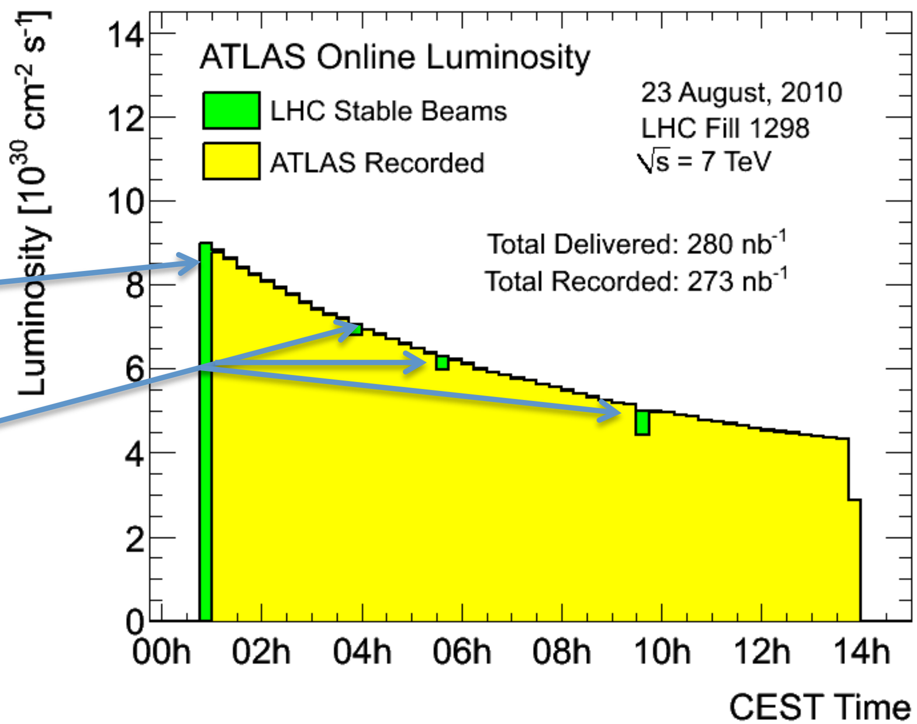
Data Taking in 2010 (2/2)

- For all systems > 97% of channels are operational
  - in addition have built-in redundancy in most systems: Overall detector is performing very well, but a few issues with component failures to watch out for…
    - LAr calorimeter data quality inefficiency will largely be recovered in reprocessing by Fall 2011
- Typical LHC Fill
  - Few minutes needed for tracking detectors (silicon and muons) to ramp HV when LHC declares stable beams
  - Short 'dips' in recorded rate: recover "on-the-fly" modules which would otherwise give a BUSY blocking further events

Total fraction of good quality data (green "traffic light")

Inner Tracking Detectors			Calorimeters				Muon Detectors			
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC
99.0	99.9	100	90.5	96.6	97.8	94.3	99.9	99.8	96.2	99.8

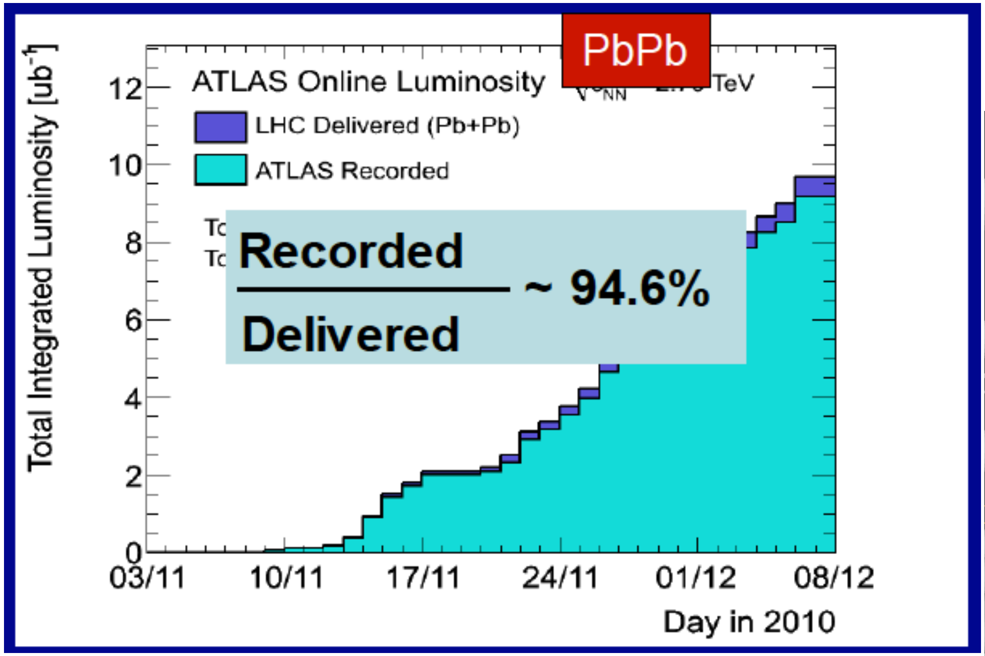
Luminosity weighted relative detector uptime and good quality data delivery during 2010 stable beams in pp collisions at √s=7 TeV between March 30th and October 31st (in %). The inefficiencies in the calorimeters will largely be recovered in a future data reprocessing.

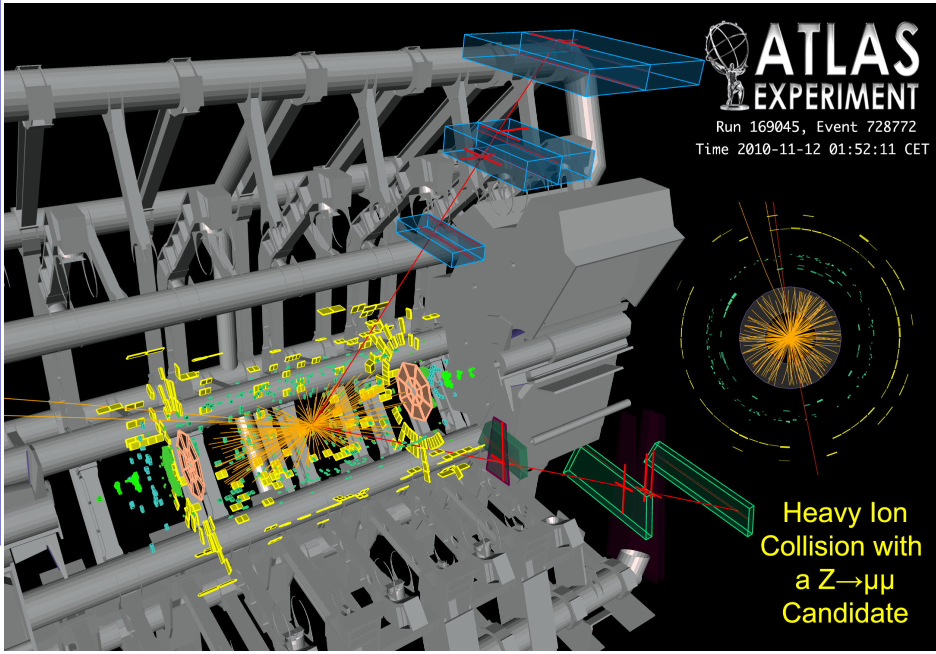


Heavy Ion Run

LHC HI running started on Nov 4, ended on Dec 6.

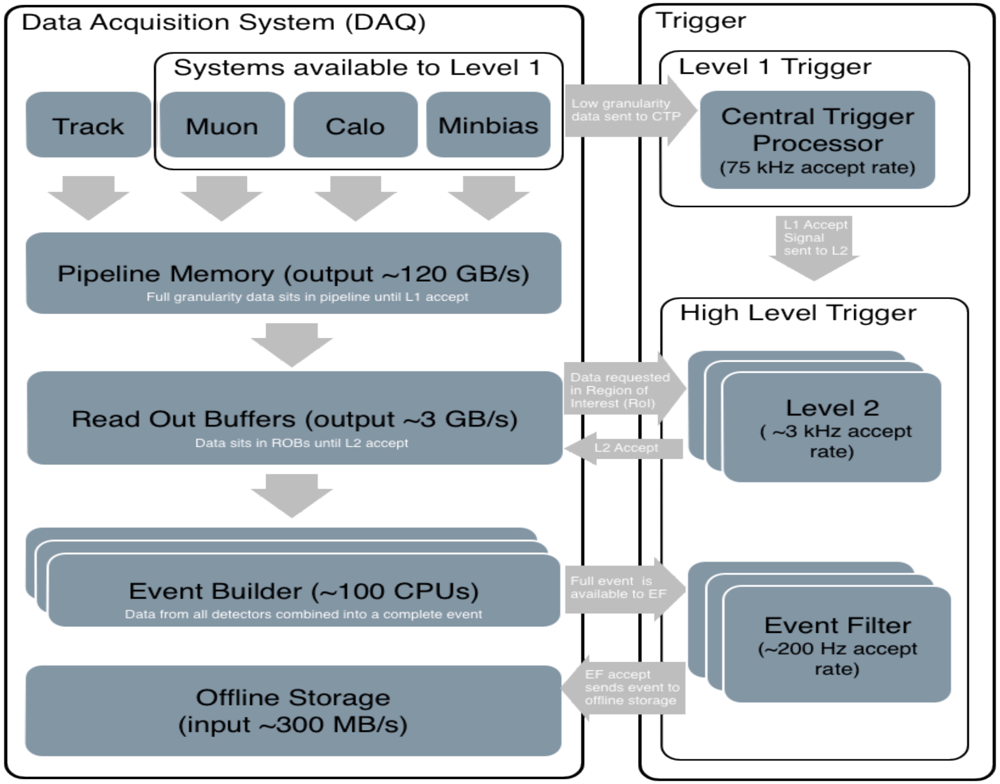
- $\sqrt{S_{NN}}$=2.76 TeV, 14x higher in energy compared to RHIC
- Up to 129 bunches, 500 ns bunch spacing
- First observation of HI events on Nov 7, jet events shortly after
- Total recorded Lumi = 9.17 **μ**b^{-1} (95% efficient!)
- Peak luminosity = 3X10^{25}/cm^2/s





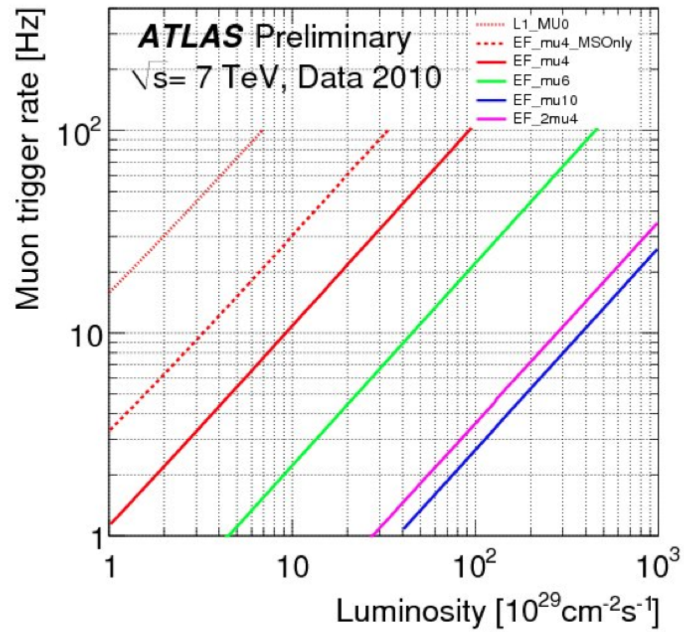
- Level-1:
  - Implemented in hardware
  - Muon + Calo based
  - coarse granularity
  - e/γ, μ, π, τ, jet candidate selection
  - Define regions of interest (ROIs)
- Level-2:
  - Implemented in software
  - Seeded by level-1 ROIs, full granularity
  - Inner Detector – Calo track matching
- Event Filter:
  - Implemented in software
  - Offline-like algorithms for physics signatures
  - Refine LV2 decision
  - Full event building

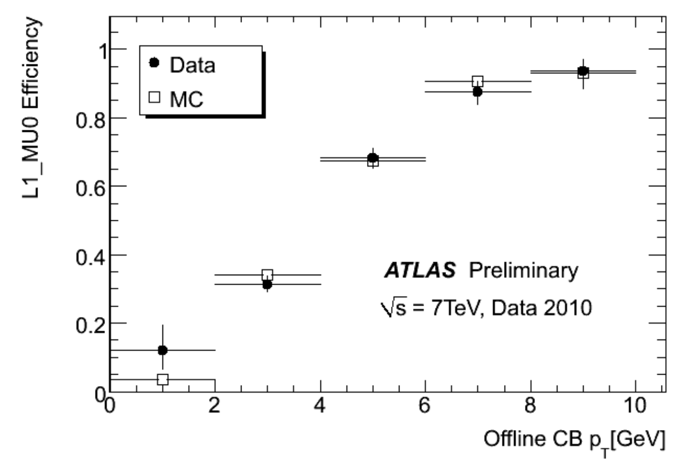
The ATLAS Trigger and Data Acquisition System (TDAQ) is designed to reduce the event (data) rate from 40MHz (1PB/s) to 200Hz (300MB/s) by selecting only interesting collision events for offline storage, splitting data into several different streams for use in physics analysis.



Trigger (2/2)

- Validation of trigger algorithms with data is a crucial step before chains become actively rejecting
  - first chains to activate are low-pT electromagnetic, followed by taus and muons
- Trigger configuration infrastructure is very flexible
- Coping very well with rapidly increasing luminosity by adjusting prescales/menus
- ~10 different inclusive streams written out during the run
- Challenges
  - optimize sharing of the bandwidth for physics
  - Determination of trigger efficiencies in data
    - Level-1 Muon Trigger efficiency determined with 'tag-and-probe' method on J/Psi candidates



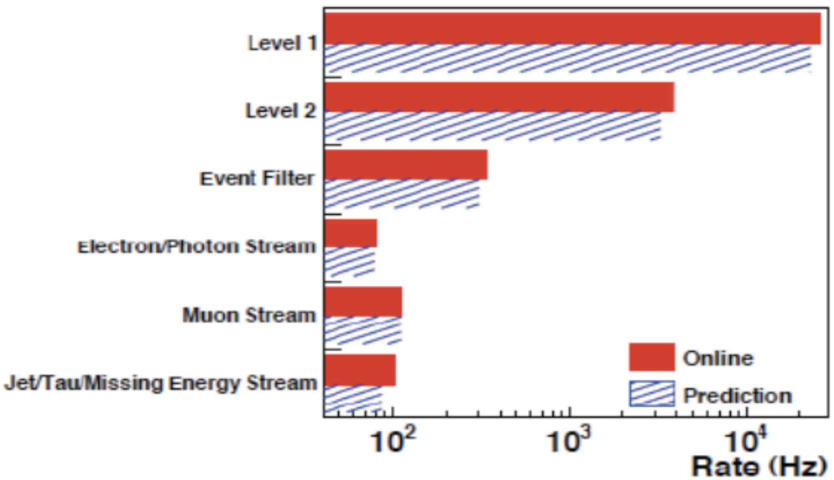


Trigger Menu in 2011

- Trigger menu kept stable for primary triggers
  - Primary triggers are never prescaled
  - Supplement by supporting and monitoring triggers
    - Increased fraction in early 2011 runs and at end of runs
- Typical Rates:
  - L1: 60 kHz, L2: 5 kHz, EF: 300-400 Hz
    - EF output rate constrained by offline resources
  - Can predict rates with ~20% accuracy
- Performance of trigger well understood
  - Detailed paper on 2010 data in preparation

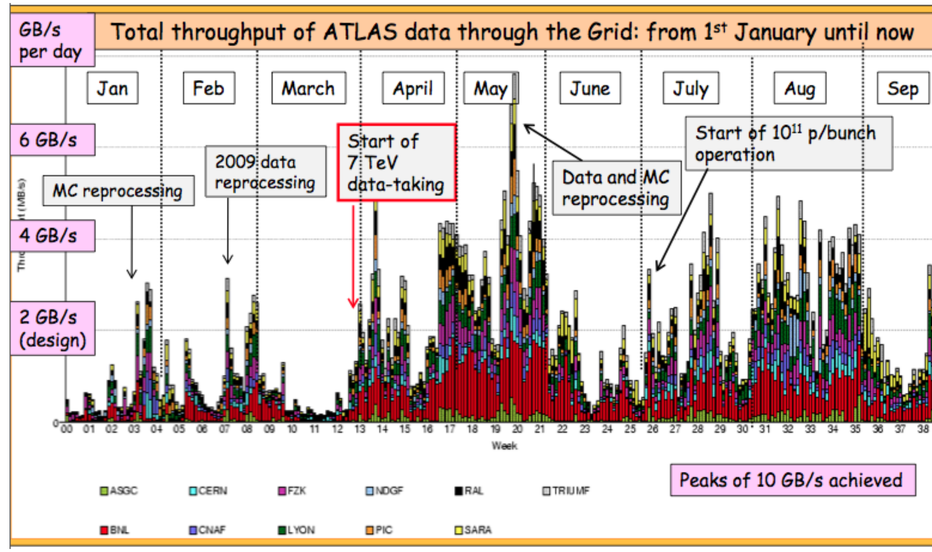
Unprescaled trigger rates at $L=1x10^{33}$ $cm^{-2}s^{-1}$

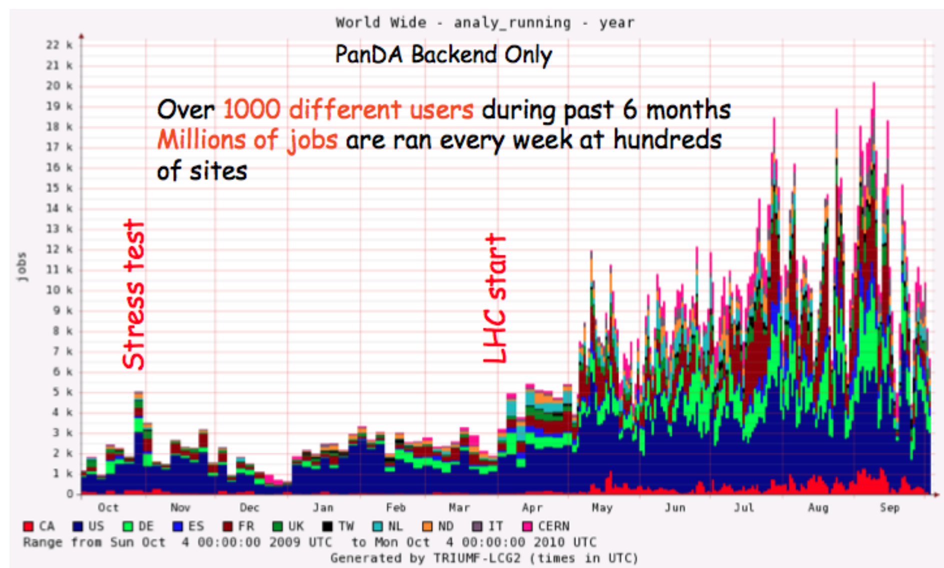
trigger	L1 item	L1 Rate (Hz)	EF Rate (Hz)
E20_medium	EM14	8500	50
2e12_medium	2EM7	5700	1
g80_loose	EM30	700	3
2g20_loose	2EM14	750	2
mu18	MU10	5300	40
2mu10	2MU10	100	1
xe60	XE40	300	4
J180	J75	200	6
Tau29medium_xe35	TAU11_XE20	3800	6
Tau16_e15	TAU6_EM10	7500	6
J75_xe45	J50_XE20	500	10



Data Processing

- Tier0 capacities sufficient to cope with current data volume
- Reprocessing of all MC and Data during LHC data taking
  - Tier1 and Tier2 centres process ~70k jobs per day
- 10 GB/s peak rate during data and MC processing
  - Design was 2GB/s
- Over 1000 different users during past 6 months
  - Millions of jobs are ran every week at hundreds of sites
- Data distribution on the Grid
  - Constant impressive duty cycle !





Content

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- Physics Results in early 2011 data
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Only some highlights of recent physics results can / will be shown in this talk.

- **Results on ATLAS Physics was shown in the talk of Reiner Hauser**
- **Full list of ATLAS public results in https://twiki.cern.ch/twiki/bin/view/AtlasPublic**

Overview

- Discussion of the individual sub-detectors of ATLAS along their corresponding physic objects
    - Inner Detector
    - Electrons and Photons
    - Jets and Missing Energy
    - Muons

Current ATLAS Activities…….

- Understand in detail the detector and reconstruction performance
- Comparison between data and Monte Carlo simulations
- With increasing statistics using more and more data driven methods
- Use standard model 'candles' like J/Ψ, Z ->μμ, ee, …. to precisely determine resolution, momentum scale, energy scale etc.

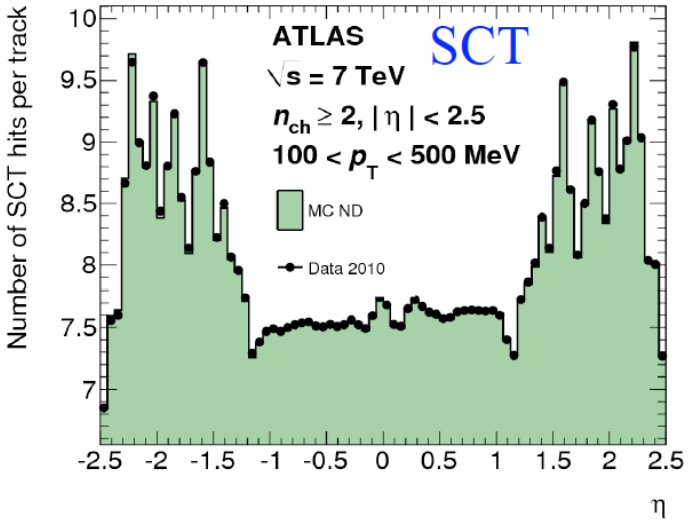
Cross section measurements, soft QCD Processes, Jet Physics, Searches …

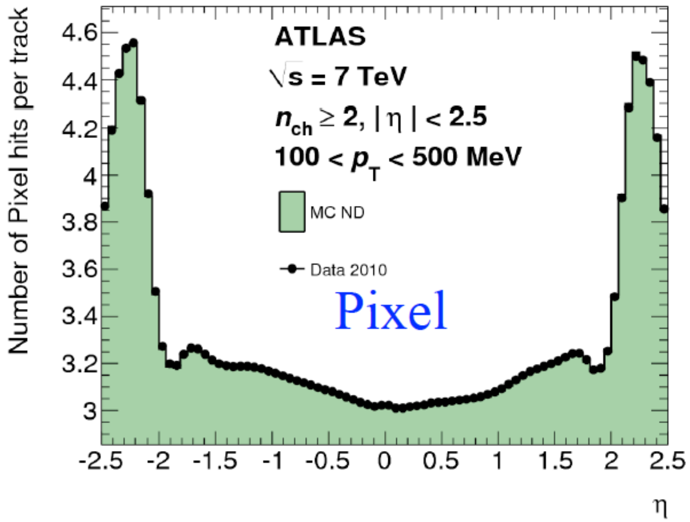
More ATLAS Results and topics:
Reiner Hauser: "ATLAS physics results with 2010 data and preliminary results with 2011 data"→ Mon pm
Lidia Dell'Asta: "Electroweak results with 2010 ATLAS Data" → Tue am
Marcello Barisonzi: "QCD and Top physics results with the 2010 ATLAS Data" →Fri am
Taiki Yamamura: "Early Higgs searches with the ATLAS Data" → Mon am
Gokhan Unel: "Eraly Higgs searches with the ATLAS Data" → Mon am
Thijs Cornelissen: "ATLAS ID performance at LHC" → Tue am
Ahmet Bingul: "ATLAS TRT and its performance at LHC" → Thu am

Tracks

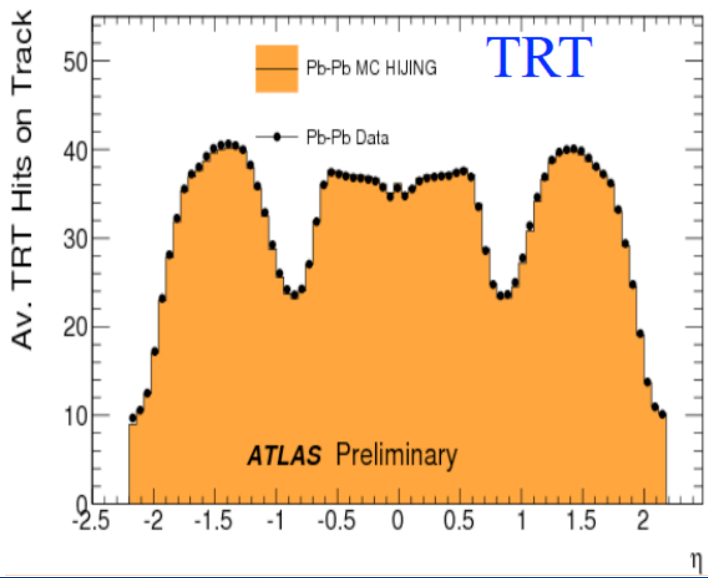
The tracking detector simulations are in a mature state, charged track measurements are well understood

Acc. by New J. Phys. arXiv:1012.5104[hep-ex]



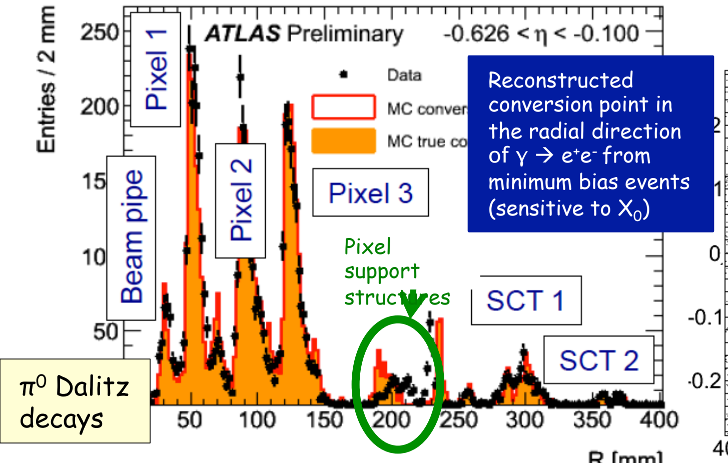


PbPb MC events weighted to measured pT and z-vertex distributions



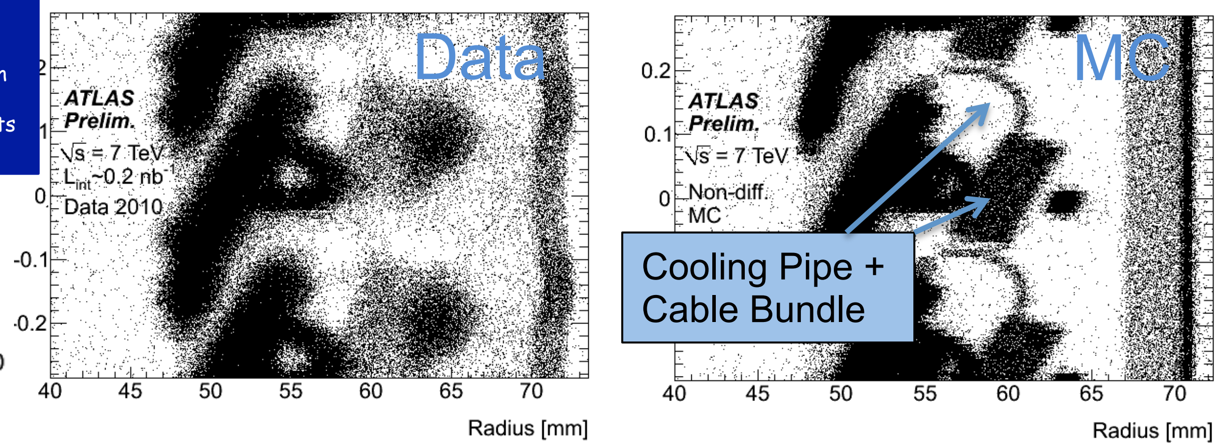
Tracking very well understood

Inner Detector Performance (1/3)

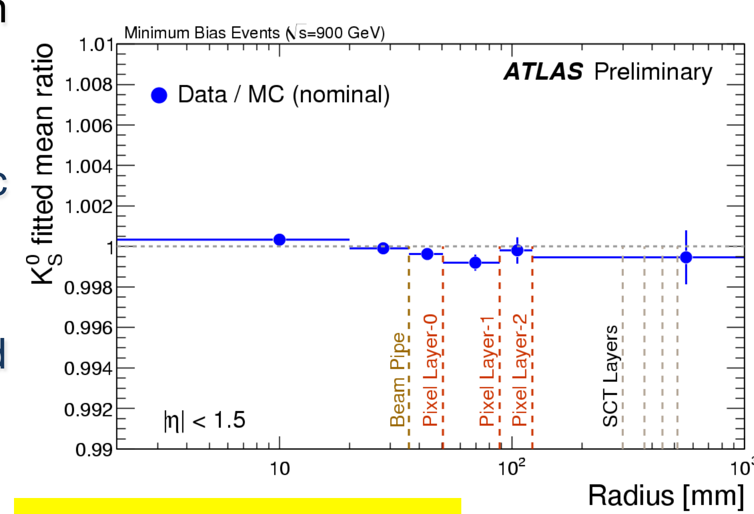


Amount of material gamma conversions data-MC

ϕ vs. radius of reconstructed secondary vertices in the first Pixel layer after photon/Ks/ Lambda veto



- Today know detector material distribution to better than 10%.
- Estimation via e.g.
  - Reconstructed secondary vertices due to hadronic interactions,
  - K_S mass
  - Use γ-ee conversion for mapping, already spotted few inconsistencies between data and MC
- Already very good, but can be improved
  - Aim to achieve a level of 5%
    - (e.g. for W-mass measurement)



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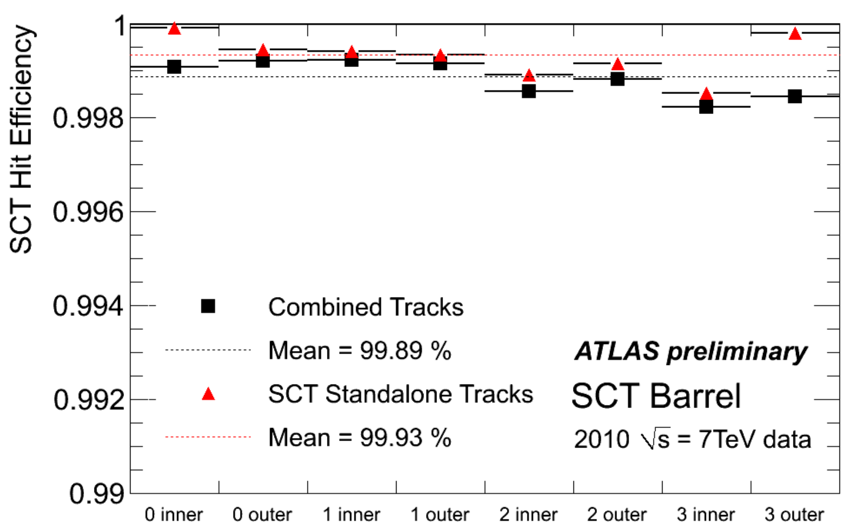
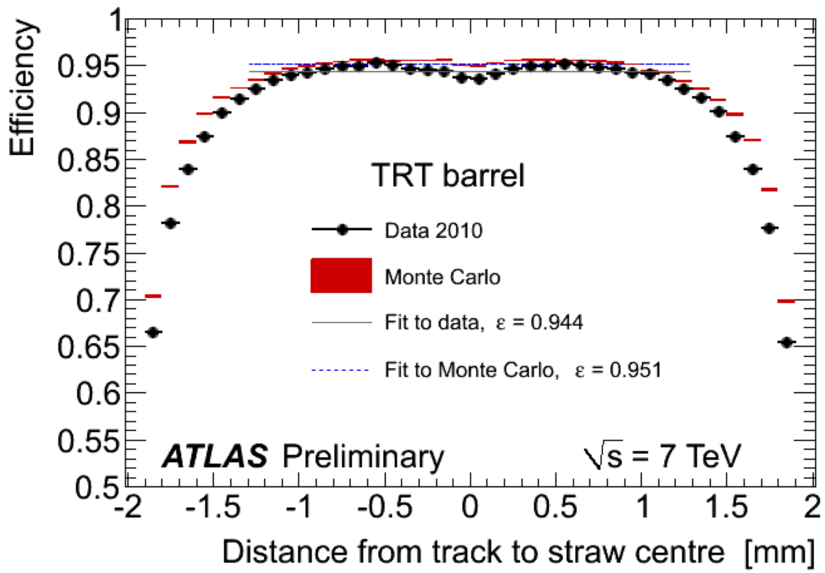
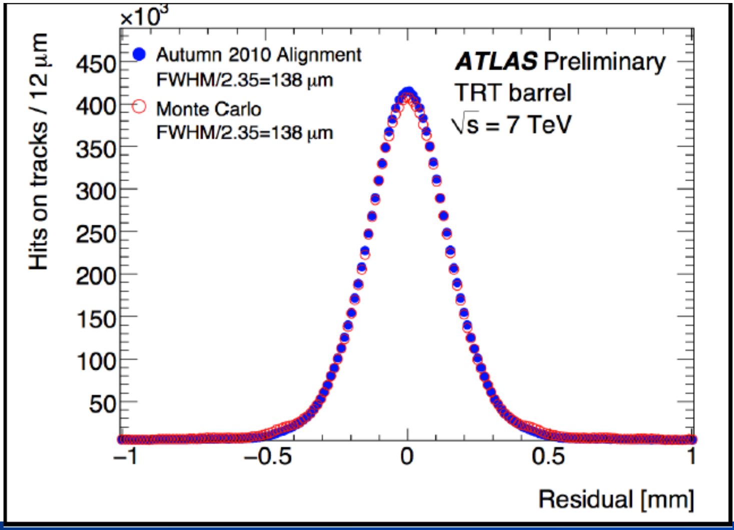
Reconstructed conversion point in radial direction

Inner Detector Performance (2/3)





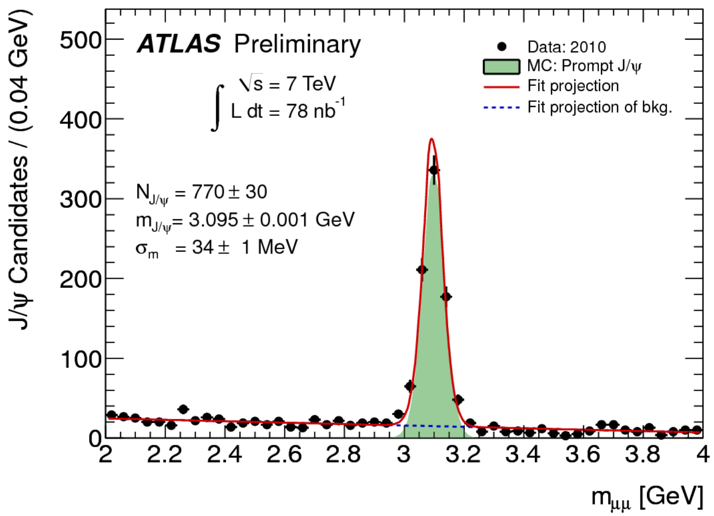
Hit efficiencies: nearly 100% for pixel & SCT, ~95% for TRT



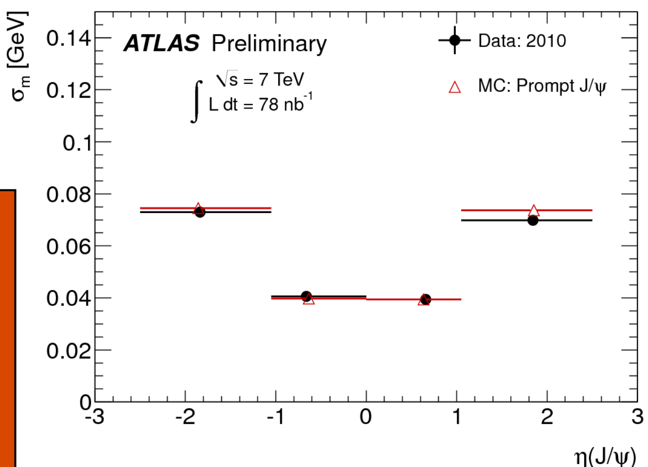
Alignment with collision tracks and improved calibration resulted in a hit resolution of 138 μm in the barrel, comparable to both design performance and results achieved in the combined test beam

Inner Detector Performance (3/3)

- Particles with higher masses (e.g. J/ψ, Z) are used to assess momentum scale and resolution in higher energy regimes
  - Example: J/ψ mass resolution
  - Mean and resolution of J/ψ mass consistent with expectation
  - Momentum scale known to 1% level up to ~100GeV



- Offline reconstruction efficiencies determined e.g. via 'tag and probe' techniques
  - ID reconstruction efficiency for muons above 20GeV confirmed to be better than 99%

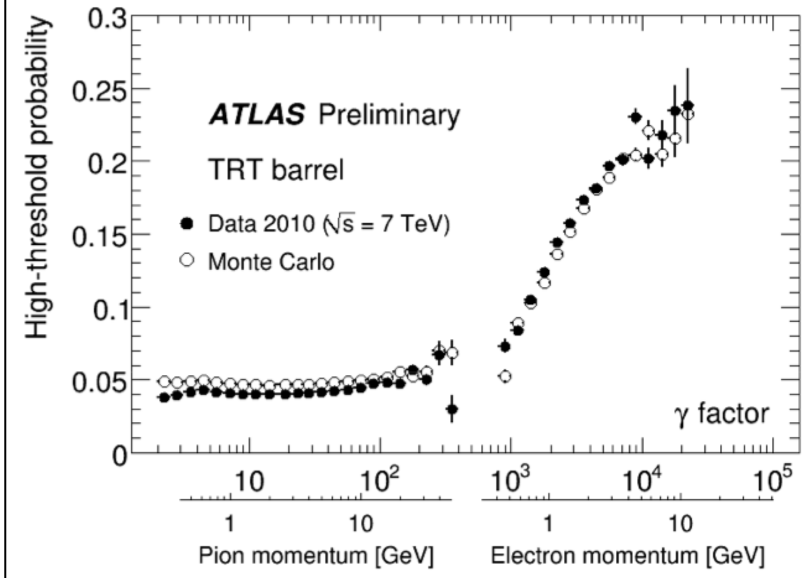


From these early studies:
- ❑ Momentum scale known to few permil in this range
- ❑ Resolution as expected (dominated by multiple scattering)
- ❑Good performance of ATLAS tracker and tracking/vertexing algorithm
- ❑ Complex algorithms (cascade decays, b-tag, …) worked well right from the beginning

Now working on material, refining alignment, …

Electrons and Photons (1/3)

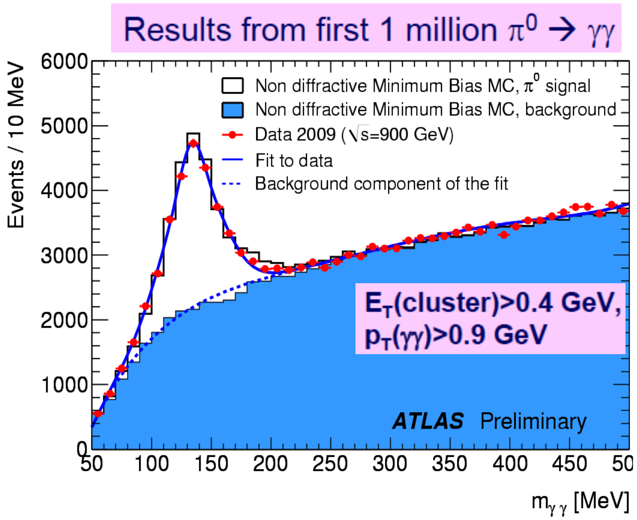
- Main electron selection based on EM calorimeter:
  - purely electromagnetic shower
  - shower shapes
  - matched pointing track at the ID
  - Refinement via Inner Detector
    - Conversion detection via inner most pixel layer
    - e/π_0 separation via TRT (upper left plot)

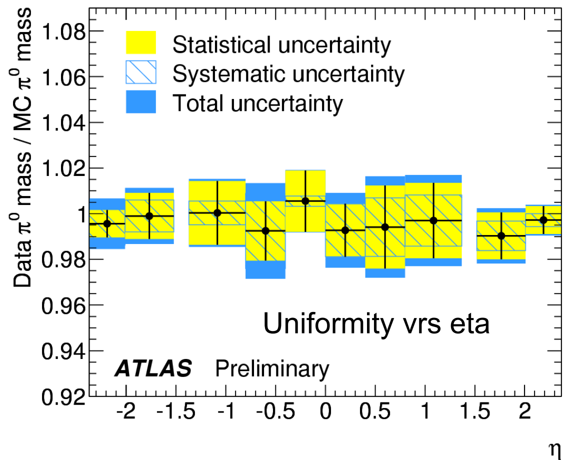


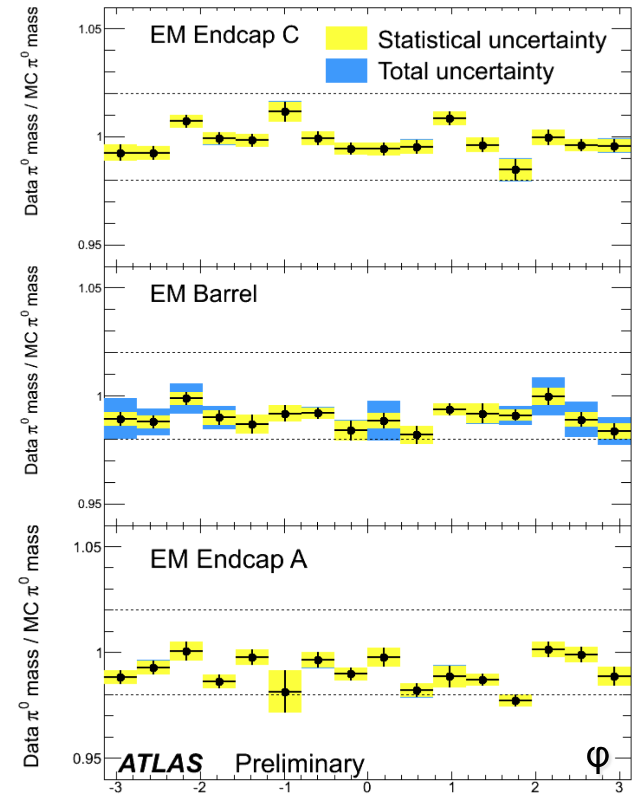
- 3 levels of electron ID:
  - loose(rough shower shape and track)
  - medium: ref shower shape, pixel hit,a0
  - tight: track match, TRT, E/P
  - Tight (>20 GeV)rejection/jets up to 10^5

ELECTRON E-SCALE
The EM E-scale has been determined through in situ calibration of constraining the di-electron invariant mass distribution to follow the well known Z line shape derived from MC.
The distributions are fitted with a Breit-Wigner convoluted with a Crystal Ball function.
The method has been applied to multiple regions of the EM calorimeter, both central and forward.
The resulting energy scale is determined to a high precision level; **of the order of 0.5% in the central region**.

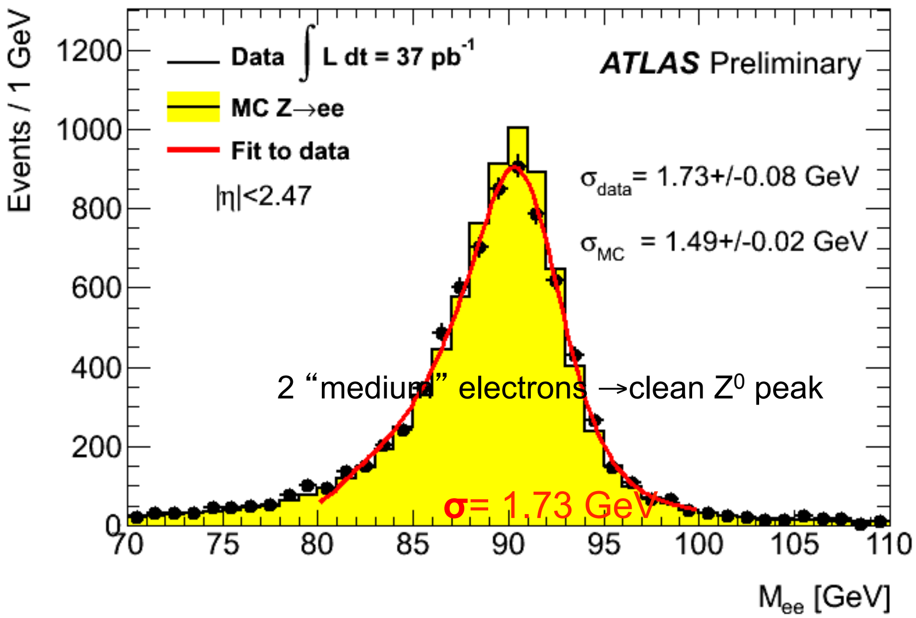
Electrons and Photons (2/3)

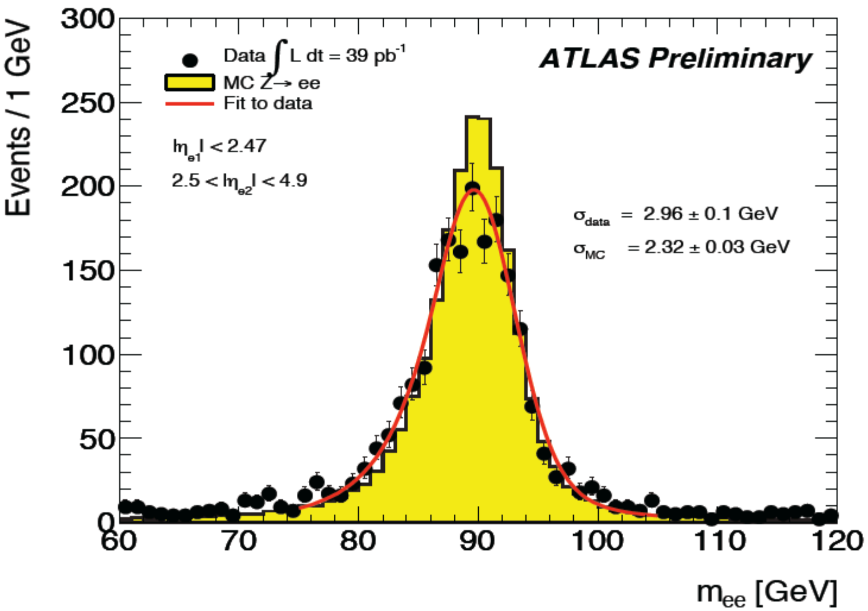






- Neutral pions provide handle for measuring EM energy scale and response uniformity
  - ~2% in overall η range
  - <0.7% in φ



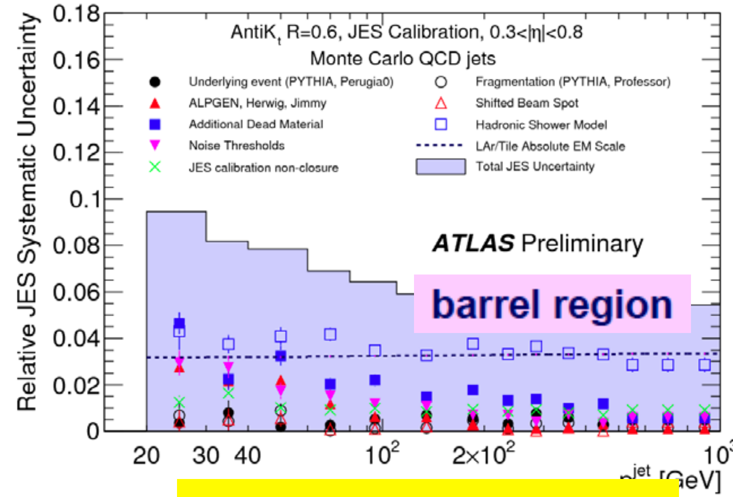


- Good agreement of Z-Boson line shape
  - Autumn reprocessing
  - Energy Scale uncertainty <1%
  - Aim for electron identification efficiency determination for 2010 data: 1%

Electrons: Excellent resolution (1.9% @ Z) and linearity down to very low Pt

Jets and Missing Energy (1/3)

- Jet Energy Scale (JES) and Resolution : A considerable effort went into understanding the JES, the dominant source of uncertainties for most jet measurements
- JES : current calibration and uncertainties:
  - MC studies
  - many years of detailed test beam studies + huge effort of validation of all ingredients for JES from collision data
    - Single hadrons: $E_{calo}/p_{tracker}$: Use isolated tracks, determine calorimeter response for single particles



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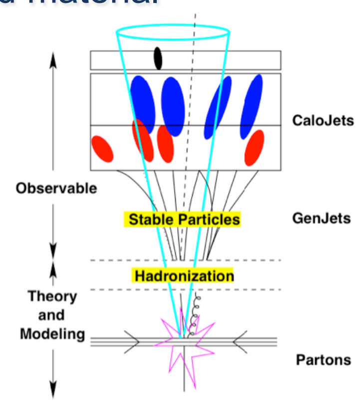
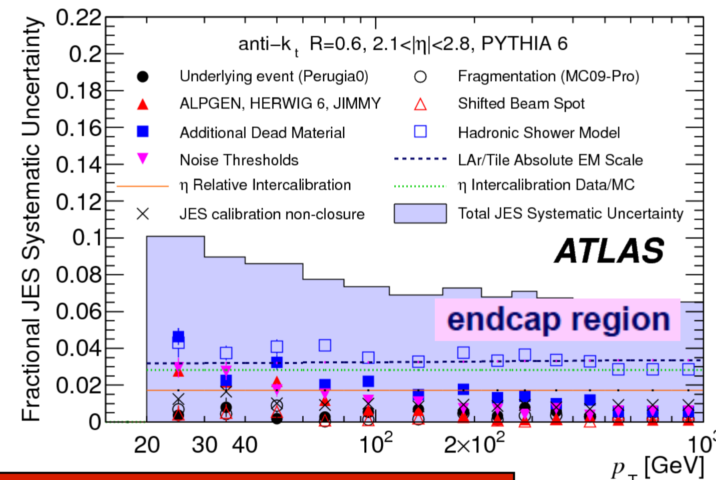
- Dominant contributions to current uncertainties:
  - Detector descriptions/additional dead material
  - Detector noise description
  - Hadronic model shower
    - **Aim to reach 1%**

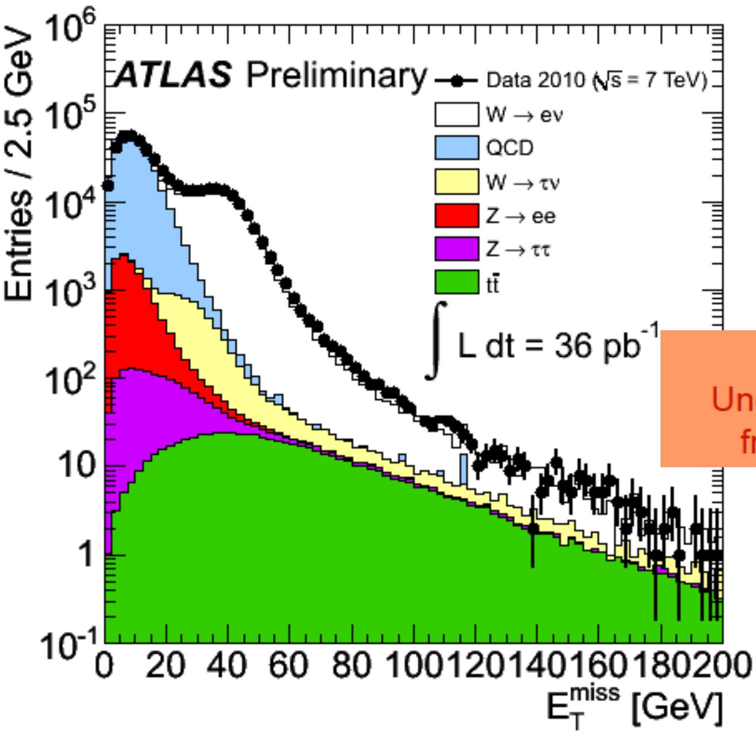




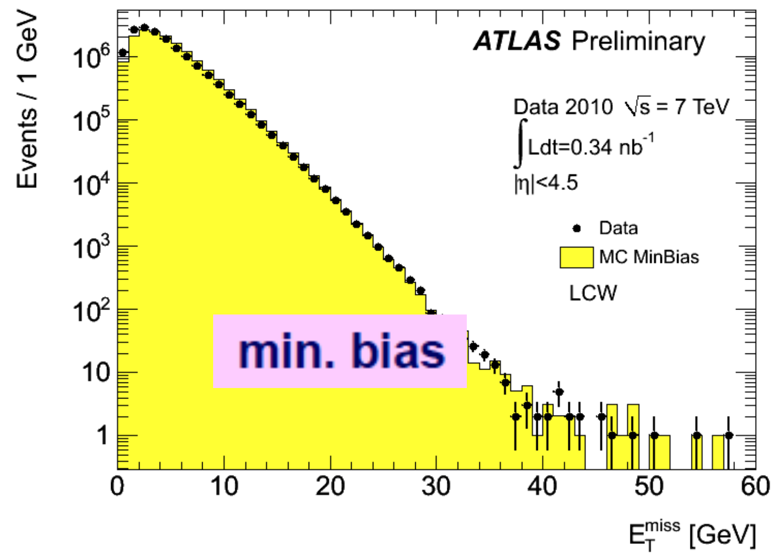
JES: systematic uncertainty <3% in a large pt range (2010 data no pile-up)
JES systematic uncertainty: ≈10% for low pt, 6.5% (barrel)/ 7% (endcap) for pt> 100 GeV

Jets and Missing Energy (2/3)

- Missing transverse energy is key element for many searches and precision measurements
  - Governed by strong performance of the ATLAS calorimeter
  - Sensitive to calorimeter performance (noise, coherent noise, dead cells, mis-calibrations, cracks, etc.), and cosmics and beam-related backgrounds



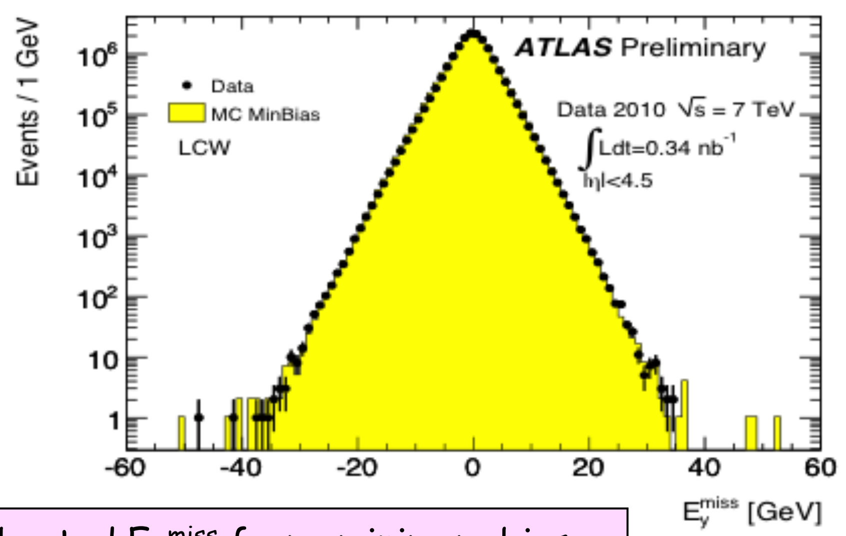
Detailed Understanding from W's ..



- Jet cleaning cuts to remove fake jets from noisy cells: no tails introduced into the distribution
- No tails introduced by improved calo calibration

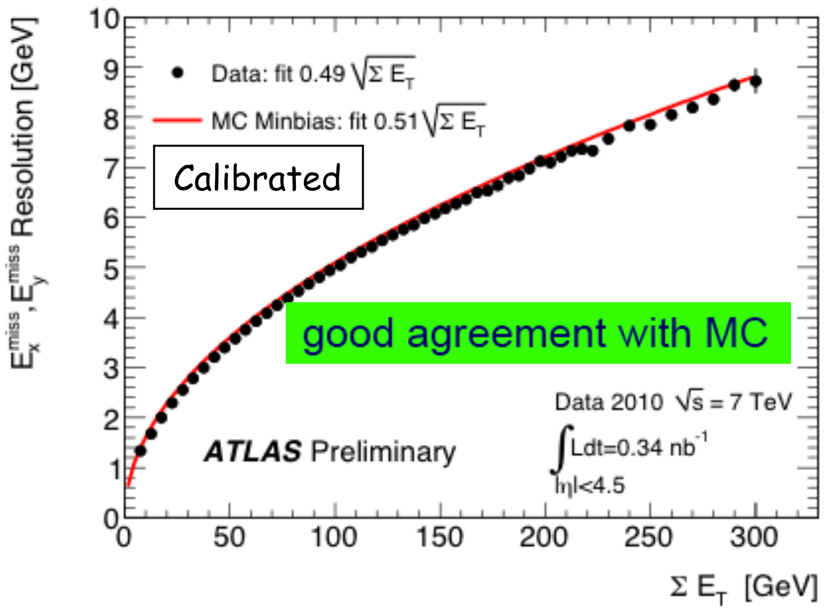
Jets and Missing Energy (3/3)

- Best resolution needed to detect presence of neutrinos/non-interacting particles from new physics
- Using topological clusters of calorimeter cells, with calibration determined for each component based on estimate of hadronic component

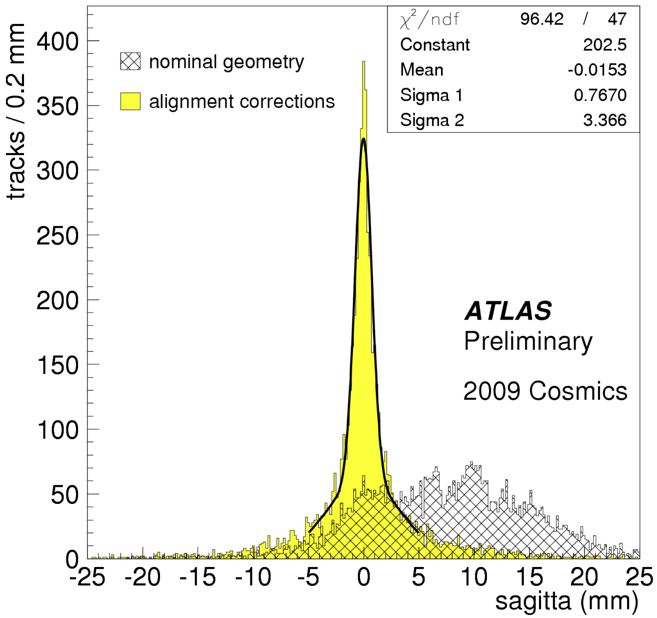


Calibrated E_T^{miss} from minimum-bias events (component on vertical axis)

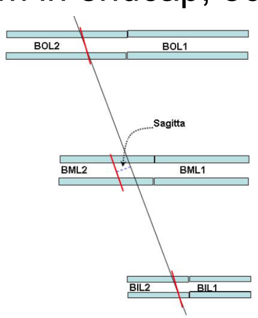
Measured over ~ full calorimeter coverage (360^0 in φ, |η| < 4.5, ~ 200k cells)

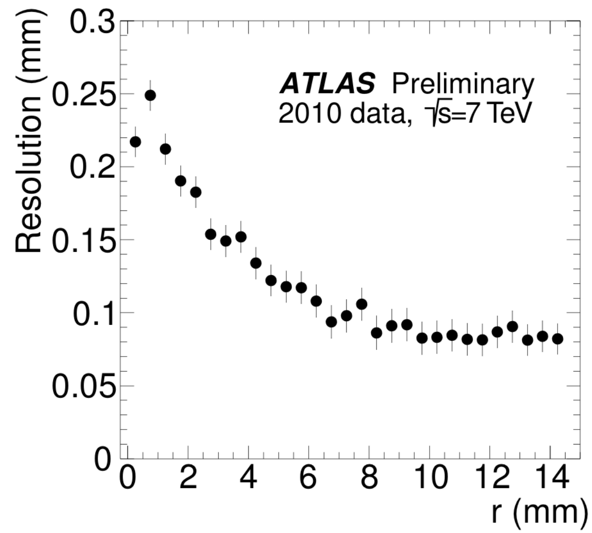


Performance Muon Systems(1/3)



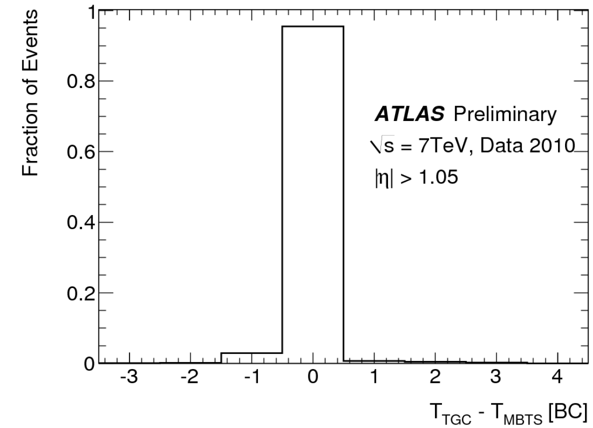
Striving for 10% resolution at momentum of 1 TeV, achieved good alignment precision for MDT: 50 μm in endcap; 80 μm in barrel



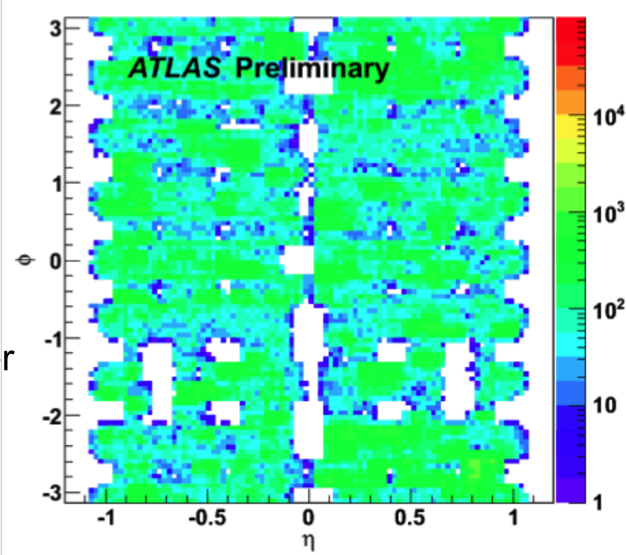


Single MDT hit resolution of 80 μm at 12 mm separation: a value near that of results with TB

RPC ensured 100% barrel trigger coverage within the geometrical acceptance.

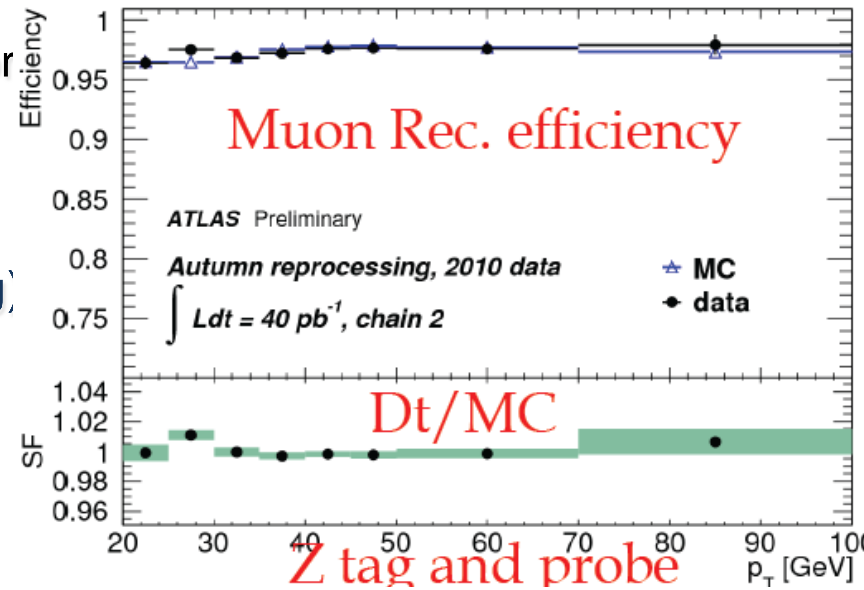


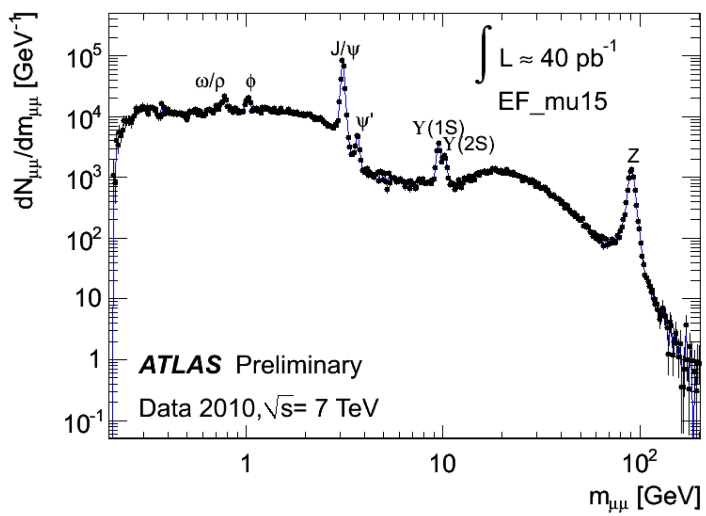
TGC is timed in and performs well, providing triggering of forward muons



Performance Muon Systems(2/3)

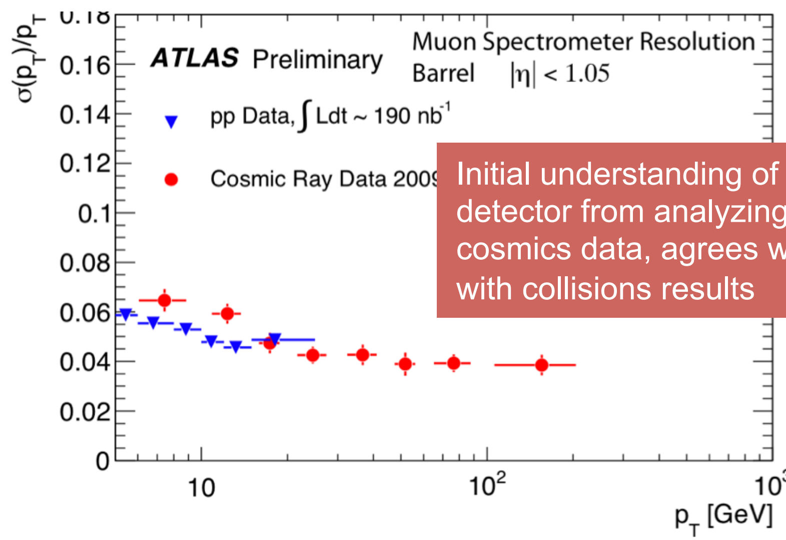
- Good performance of combined Inner Detector and Muon Spectrometer reconstruction
  - At low pt, Inner detector is dominating overall muon momentum resolution (~2% resolution, dominated by multiple scattering)
  - Transition at ~50GeV
- Muon Spectrometer Performance can be assessed via
  - Cosmic muons
  - Di-muon decays of known particles
    - Momentum scale known to 1%
    - Momentum resolution known to rel. 10%
    - Reconstruction efficiency known to 1-2%
      - Aim is to reach <1%





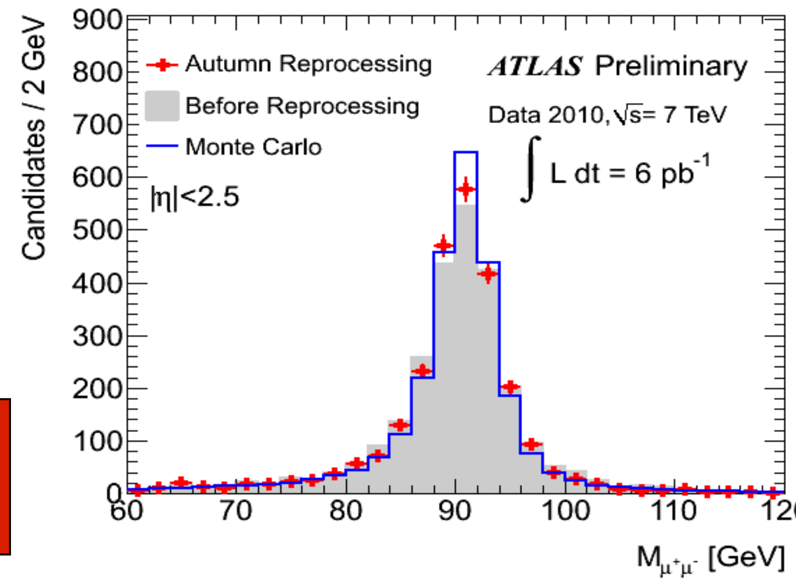
Performance Muon Systems(3/3)

- Example: First studies of Momentum resolution of MS standalone
  - cosmics: resolution from splitting muon tracks crossing the detector from top to bottom
  - muons from collisions: resolution from comparing MS with ID measurement (ID resolution not subtracted, negligible at low p)



Initial understanding of the detector from analyzing cosmics data, agrees well with collisions results

- Z-Boson resonance appeared wider in data, due to:
  - Alignment, magnetic field uncertainties
  - Expected improvement for reprocessing campaign
    - Available for analysis in fall 2011



Muons: high and well understood reconstruction efficiency, Excellent resolution: (@Z: 2 % in Barrel, 3% in EndCap) and scale <1%

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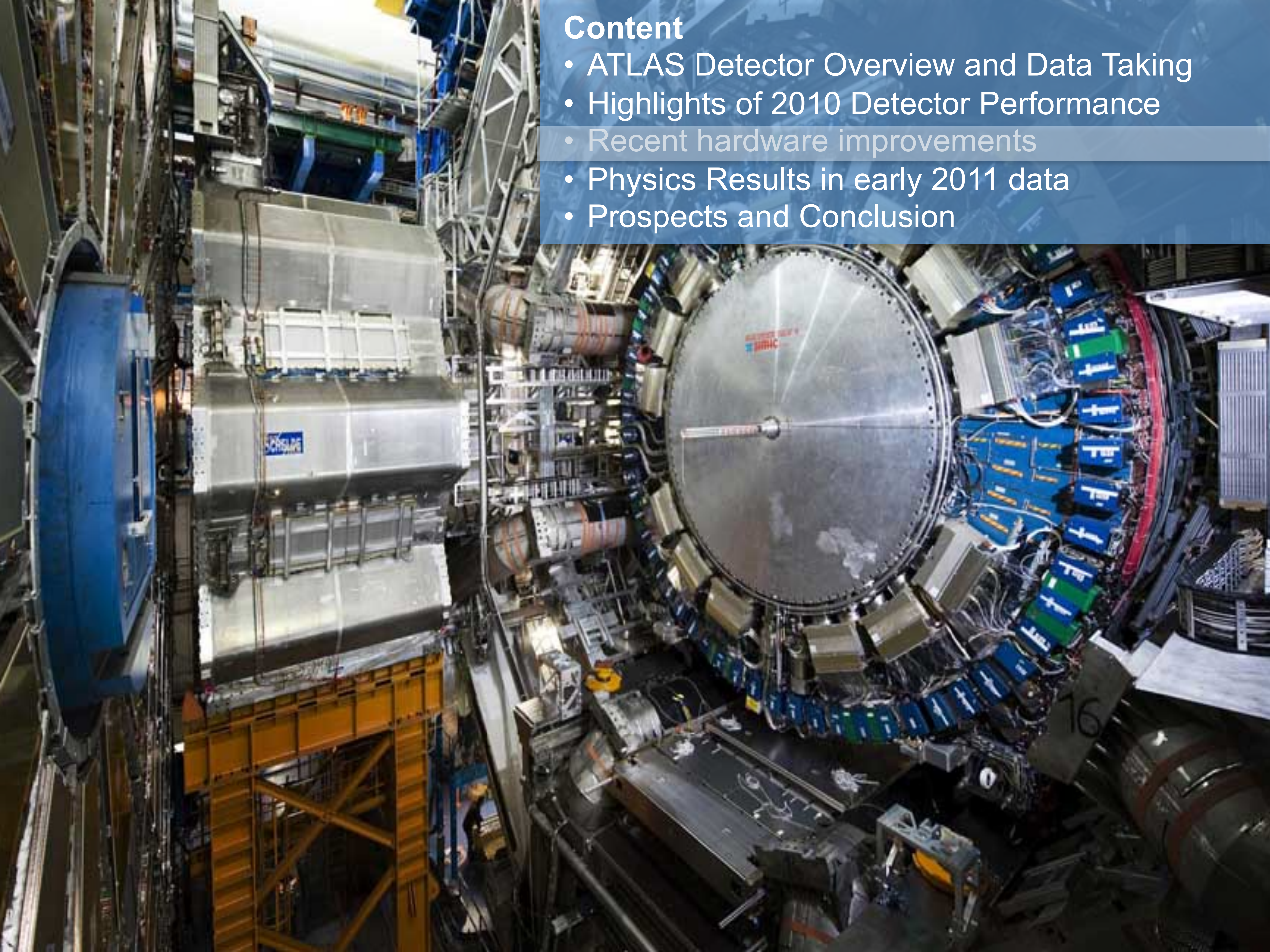
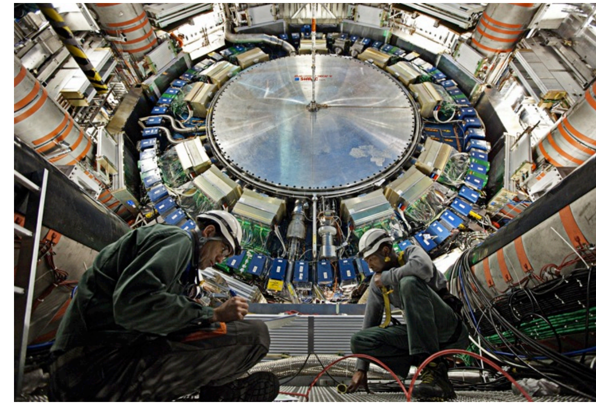
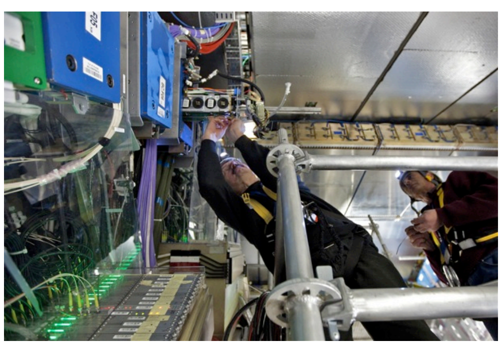


Activities during 2010/2011 Technical Stop



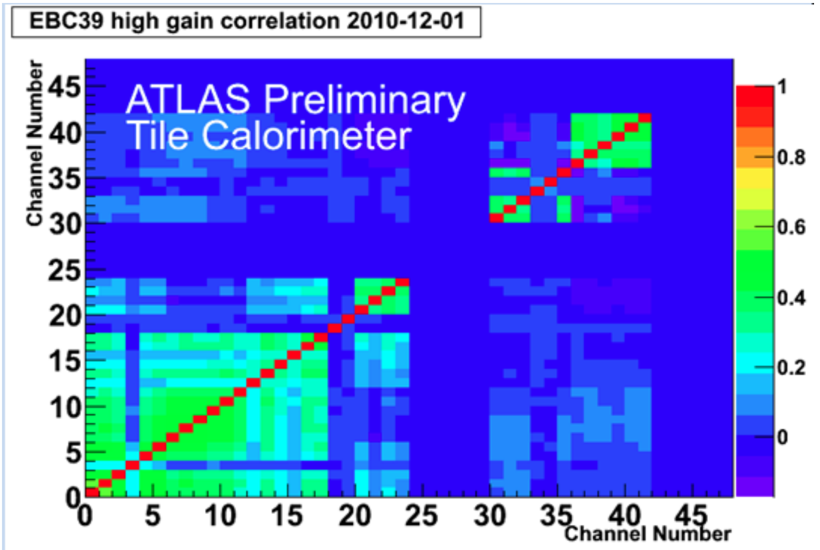
The main steps are :

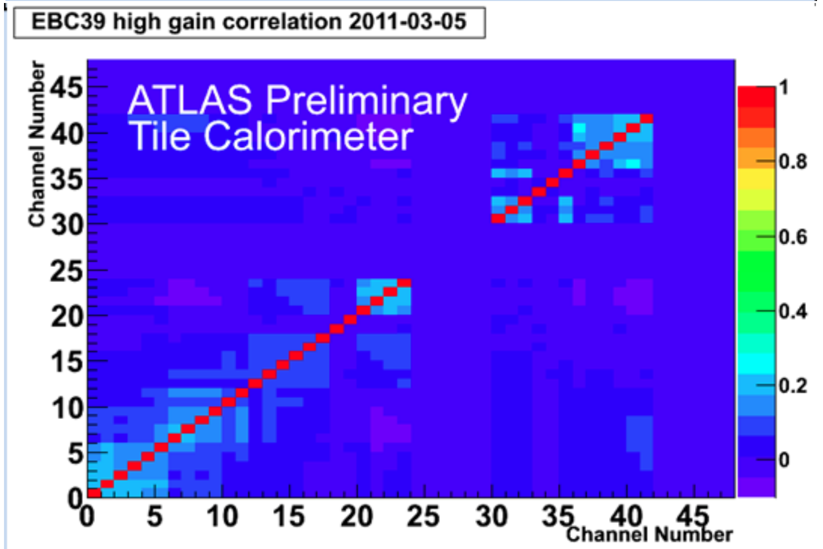
- ✓ Shaft opening and equipment installation
- ✓ Forward shielding removal including Big Wheels movement
- ✓ Detector movement according Standard Opening scenario
- ✓ Access installation
- ✓ Detectors back to Run position
- ✓ Forward shielding installation, including Big Wheels movement
- ✓Shaft closing, including removal of equipment
- ✓ Cleaning



Activities during 2010/2011 Technical Stop: TileCal

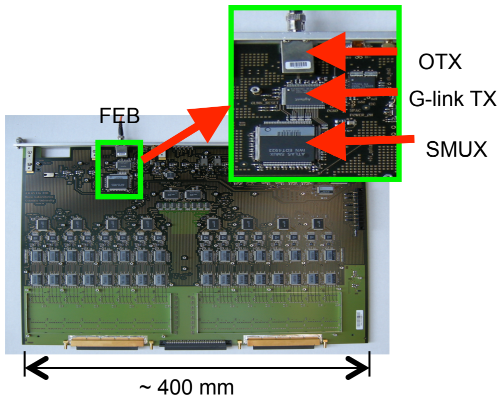
- Replaced 23 LVPS with 18 refurbished LVPS (more robust against trips) and 5 LVPS of the new production
- Reduced the number of dead cells from 3.81% to 0.19%
- The new LVPS shows much less correlated noise than the current LVPS and the noise is more Gaussian.

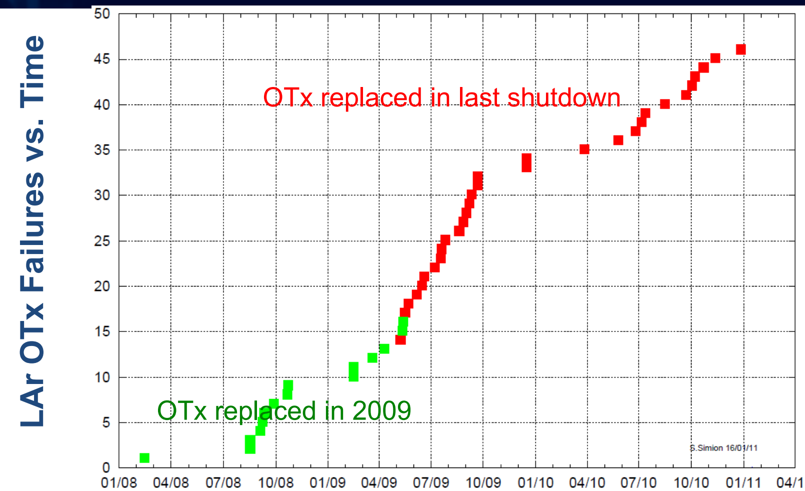


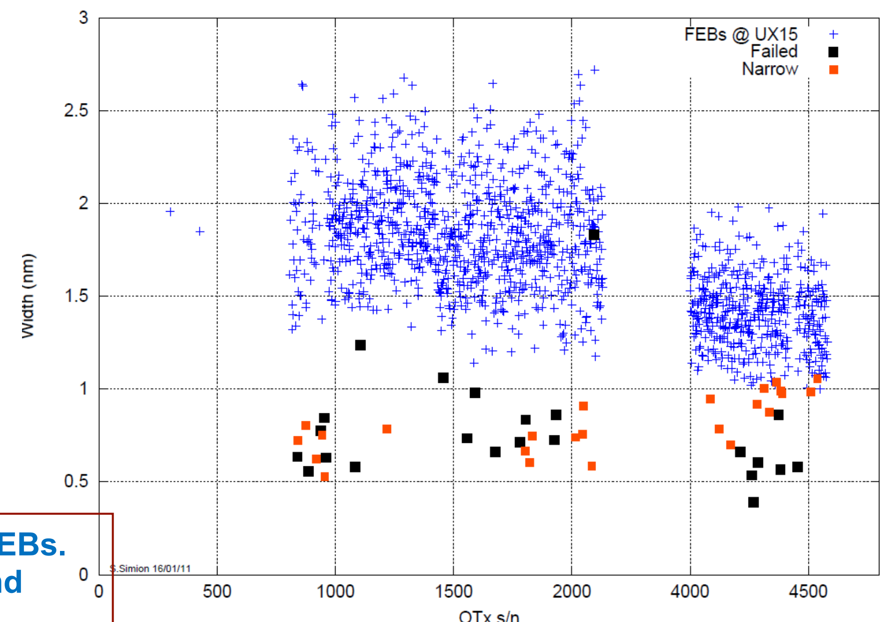


Activities during 2010/2011 Technical Stop
LAr front electronics

- ❑ Optical transmitter (OTx) on the 1532 front-end boards (FEB) have been failing since January 2008.
- ❑ Fragile OTx are identifiable by their narrow optical spectrum.







Winter 2010 replacements:

- ❑ 30 FEB with failed optical links (Otx)
  - ❑ no data for ~4K channels (~5% of acceptance / electron,photon
- ❑ 24 FEB with narrow spectrum
- ❑ 11 boards (FEB, TBB, CTL) replaced for other reasons

OTx optical spectrum was measured a few times for the ~ 1500 FEBs. The spectrum width is reasonably stable with time for “good” and “bad” OTx and is good parameter to define suspect ones

Activities during 2010/2011 Technical Stop: Muons

RPC Shutdown interventions:

- replacement of HV connectors faulty batch of connectors
  - caused on average a failure every 10 days, have been replaced
- gas leak repairs
  - 22 leaks detected in December survey: all repaired
  - 10 more leaks found at end of shutdown clearly correlated with cavern activities
- replacement of optical links
  - 14 out of 60 optical links with truncated spectrum replaced in trigger boxes with most difficult access
  - remaining 46 optical links can be replaced during technical stops
    - (no impact on RPC muon trigger and readout)

TGC Shutdown interventions:

•Replace fan trays modules for TGC M1, M3 wheels

•Replace 1 (TGC-1 side C) + 5 (TGC-3 A+C) TGC chambers

•New LV, HV DCS implementation

•Upgrade ROD firmware (new data format) towards 75 kHz rate capability, tests with ATLAS DAQ are successful

Activities during 2010/2011 Technical Stop: Muons

MDT Shutdown interventions:

- **Revise HV mapping (rack side connections) to have chamber multilayers no longer on the same board → reducing chamber failure due to HV**
- **Change of H2O concentration of MDT gas mixture**
- **Annual leak test and leak repair (dominated by EO, 59 out of 81 ML fixed, worst one was not fixed due to no access)**
- **Fix several readout, LV, HV problems (~10) scattered around the detector**
- **Update of MROD firmware: trailer suppression mode under certifications**

CSC Shutdown interventions:

- **Repair temperature readout Small Wheel side A**

Status: 50KHz no problem, 98.5% alive strips

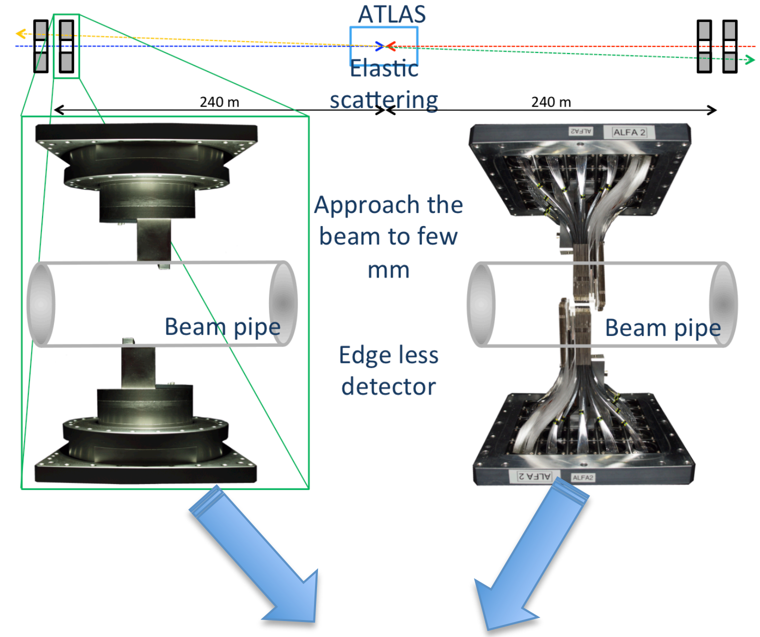
Open Issues:

- **Major problem : can run at 75KHz, but it is not 100% reliable still under investigation;**
- **Include CSC to muon calibration stream;**
- **Understand CSC internal alignment and strip resolution**

Activities during 2010/2011 Technical Stop: ALFA

ABSOLUTE LUMINOSITY FOR ATLAS (ALFA)

- ❑ aims at the LHC absolute luminosity at Point 1 analyzing the elastic scattering of protons at small angles.
- ❑ All Roman Pot stations installed
- ❑ the detector consists of scintillating fibers
  - ❑ spatial resolution of ~30 microns
  - ❑ robust technical design
- ❑ Electronics installed
- ❑ Detector Control System (DCS) fully operational
- ❑ The ALFA system is now getting its very first physics data after a final commissioning period with the beam.
- ❑ Integration into ATLAS CTP and DAQ
- ❑ 2011: Determination of total cross section to about 5% uncertainty
- ❑ 2012 - : Absolute determination of luminosity to about 3% uncertainty



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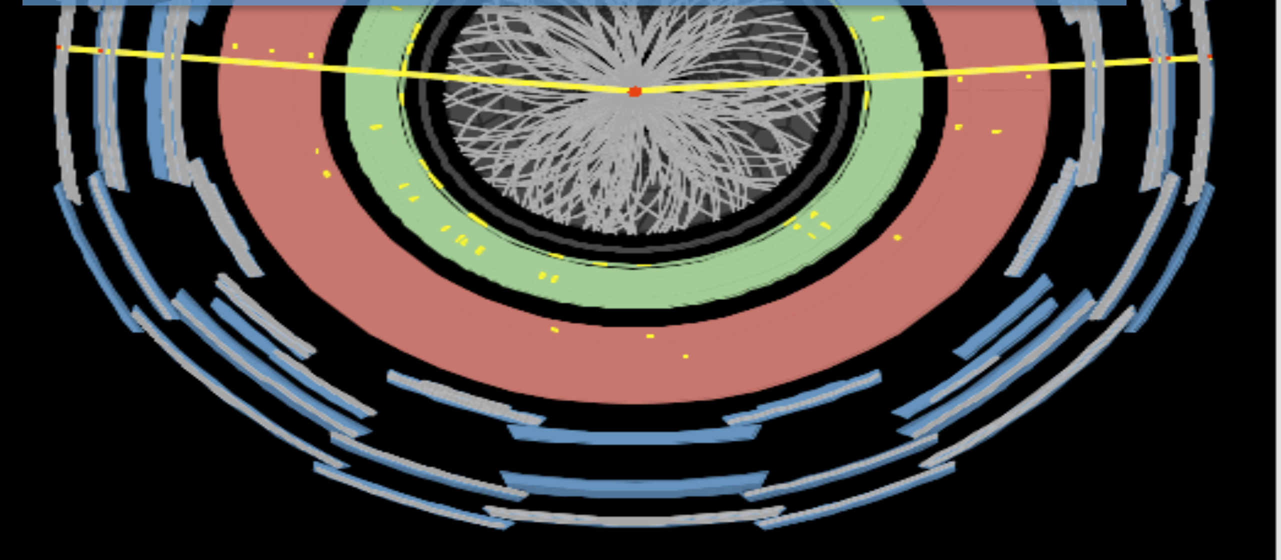
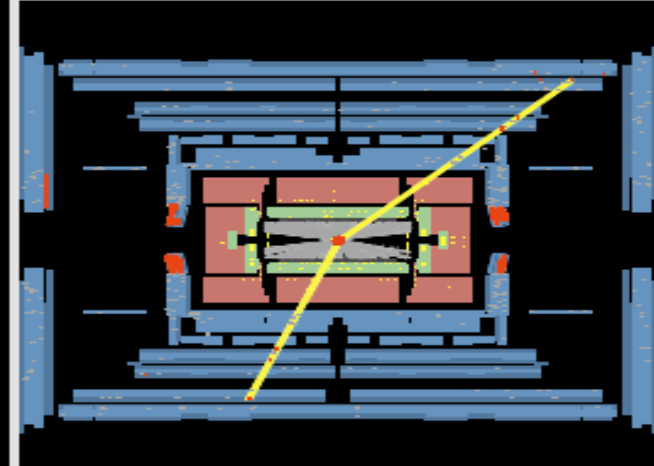
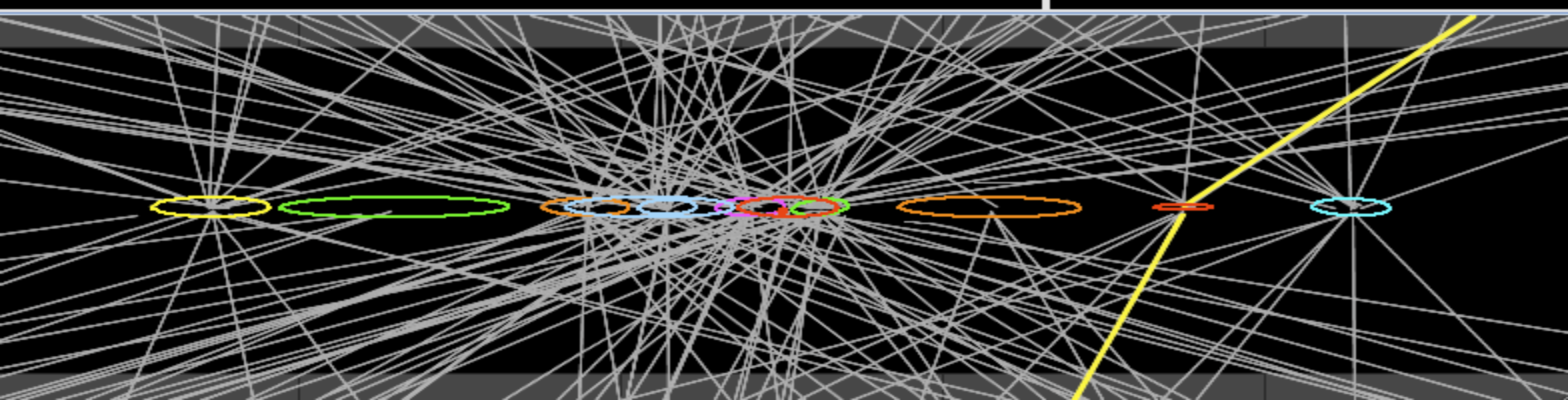


ATLAS EXPERIMENT

Run Number: 180164, Event Number: 146351094

Date: 2011-04-24 01:43:39 CEST

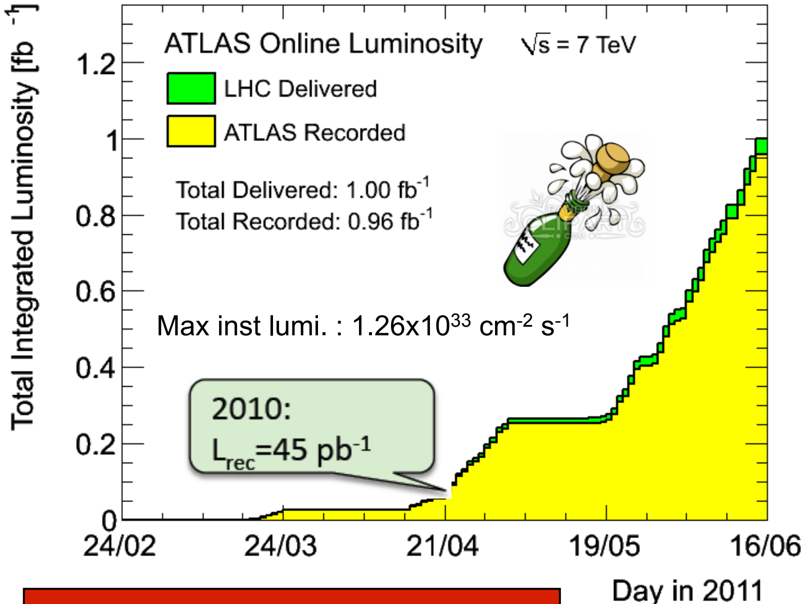




Data Taking in 2011(1/2)

- New trigger menu for 10^{33}
  - driven by Trigger with lot of iterations and discussions with full community
- New release for data-taking, new detector conditions after repairs
- Preparing for data processing, MC production, revised data distribution model, reprocessing
- Experiment is in an even better shape than last year
- Expected in 2011 (from Chamonix):
  - max peak luminosity : 1.3-2 x 10^{33}
    - note: average pile-up up to 15 evts/crossing
  - integrated luminosity : 2.7-3.7 fb^{-1}

Data taking in 2011(1/2)



Fraction of recorded data used for Top analysis : 83%

Overall data taking efficiency (with full detector on): > 95%

Inefficiency due to:
- Turn-on at start of stable beams: 1.6%
- Deadtime: 2.6%

- ATLAS is recording the amazing amount of LHC data efficiently:
  - It's great to have delivered this amount of data in time for the main summer conferences
- Delivered luminosity: 1 fb^{-1}
  - ~ 70x10^{12} collisions
- ATLAS ready recorded: 0.96 fb^{-1}
- Uncertainty on luminosity: 4.5%
  - Will improve with recent vdM scan data

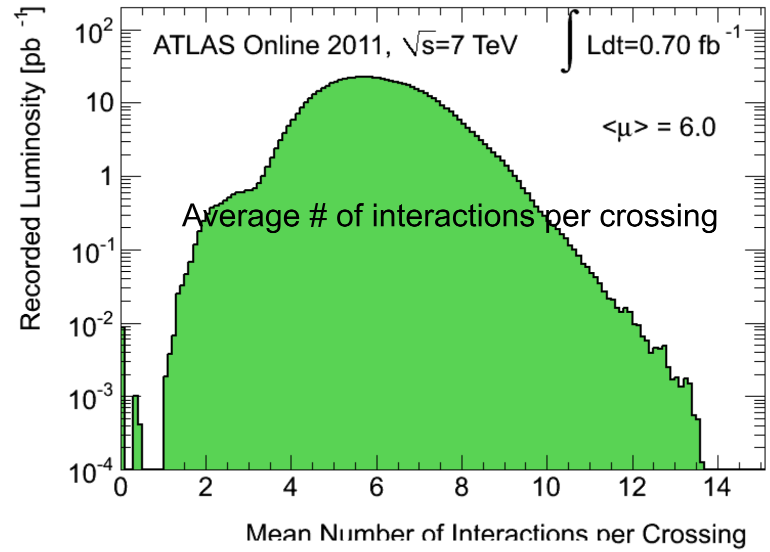
Fraction of good quality data per detector

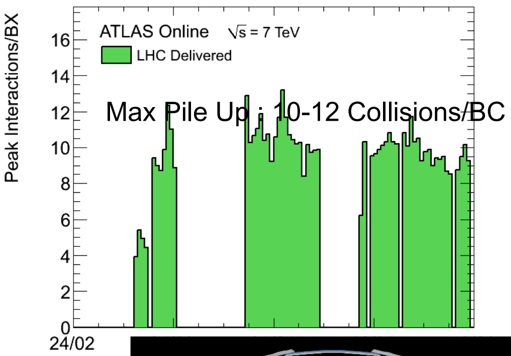
Inner Tracking Detectors			Calorimeters				Muon Detectors				Magnets	
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.8	99.5	100	89.3	92.7	94.3	99.5	100	99.5	100	99.9	98.5	97.9

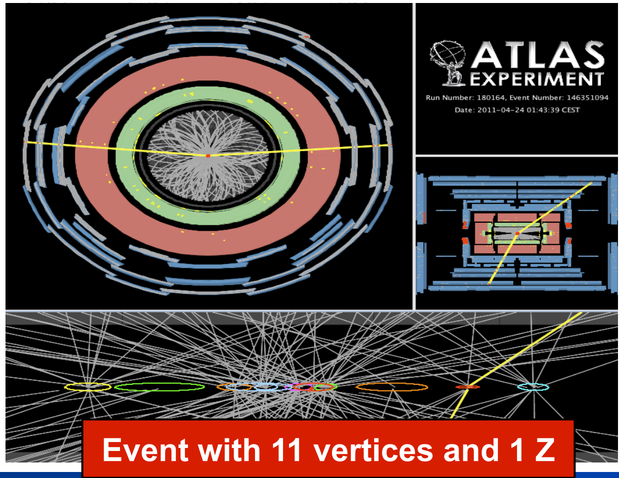
Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in pp collisions at √s=7 TeV between March 13th and June 6th (in %). The inefficiencies in the LAr calorimeter will partially be recovered in the future. The magnets were not operational for a 3-day period at the start of the data taking.

PileUp

- Average Pile Up in 2011 : 6.0 Coll/BC
- Significantly higher than 2010
  - And than originally anticipated in early LHC running
- Tails up to 14 interactions per crossing
  - Due to some bunches with much higher currents
- Causes challenges for physics and software:
  - Missing energy
  - Lepton Isolation (mainly calorimetric)
  - Jet Energy Scale and resolution
    - JES uncertainty temporarily increased for low pT jets
  - Vertexing
  - CPU time and event size
- Software performance significantly improved (recently) to accommodate Tier0 resources
  - reco time 11-13s/event
- Detailed simulation models both the <μ> and the bunch train structure
  - Reweighted according to data <μ> distribution

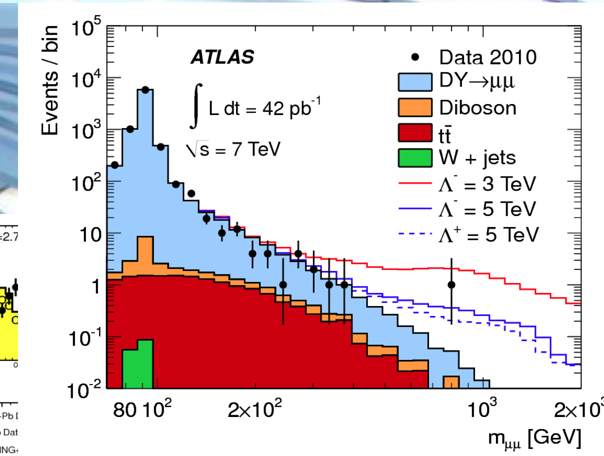


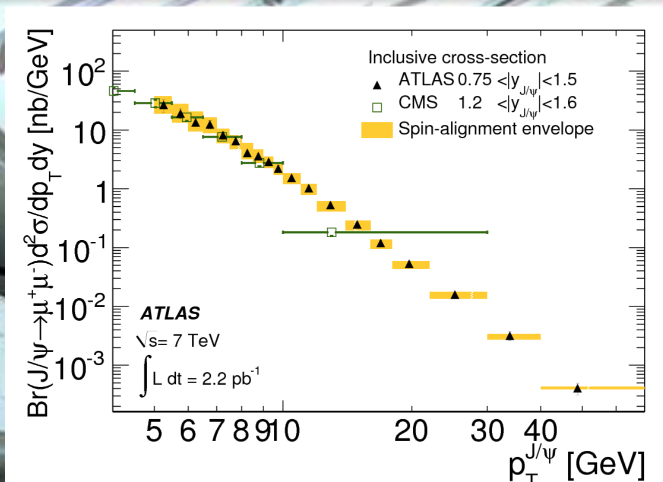


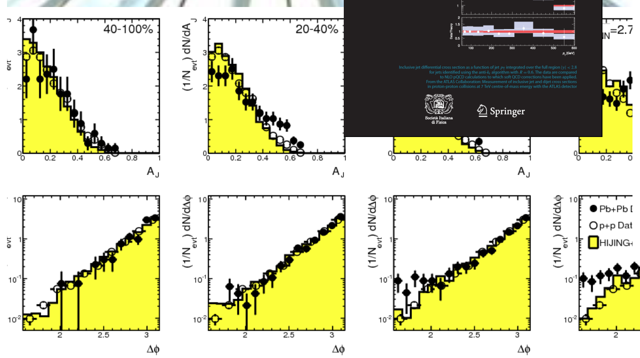


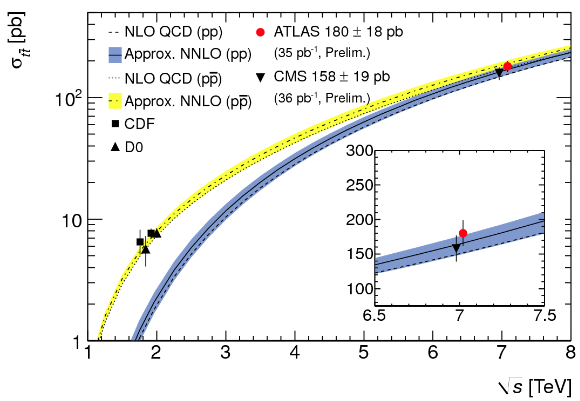
Summary

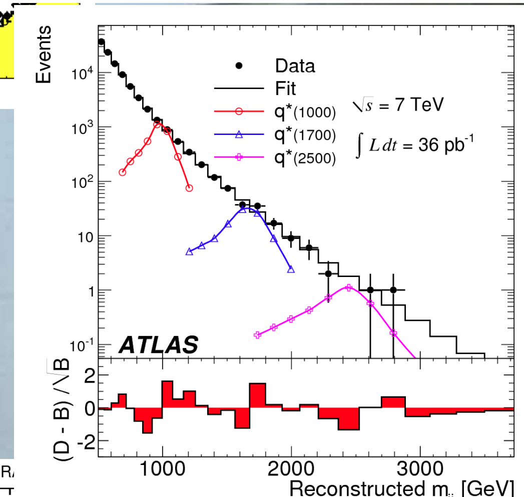
- 36 Physics papers published or submitted
- 88 conf notes published in 2011

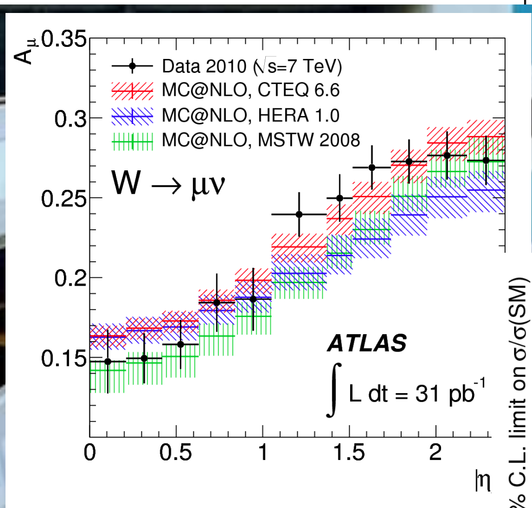


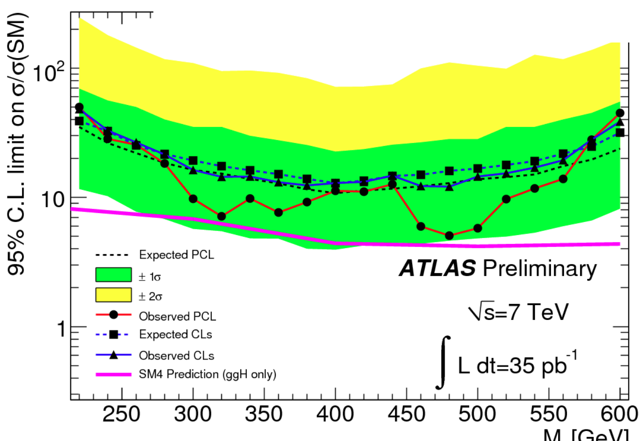


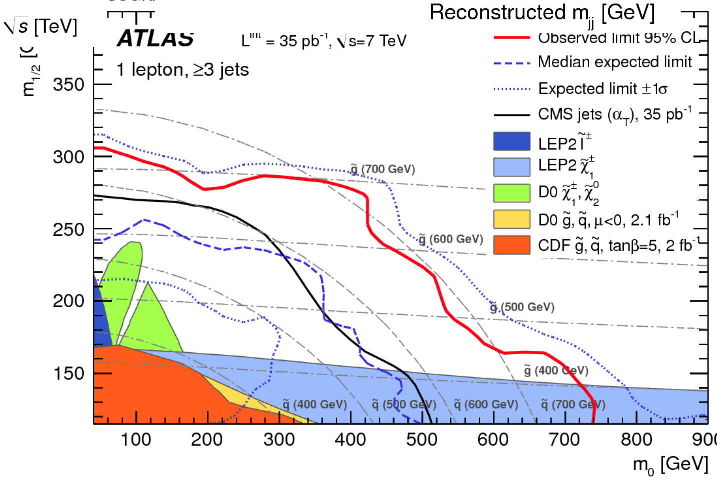


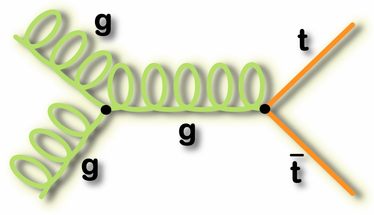




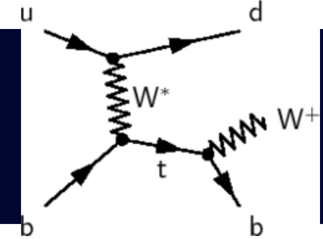




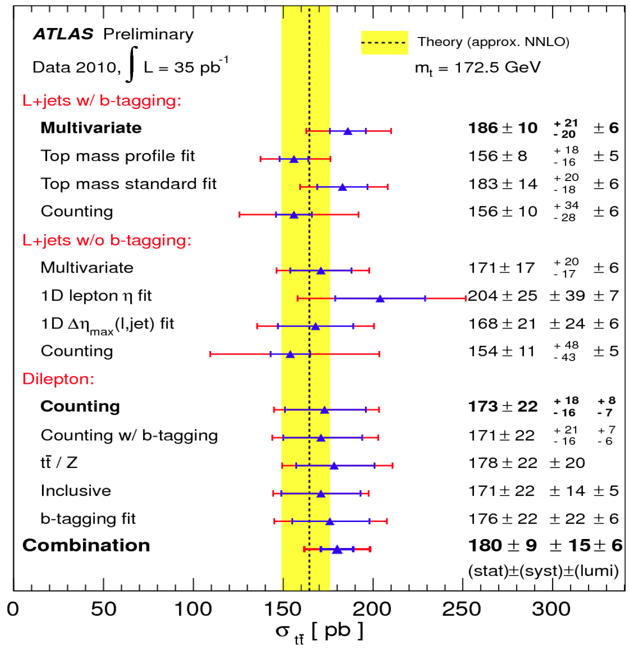




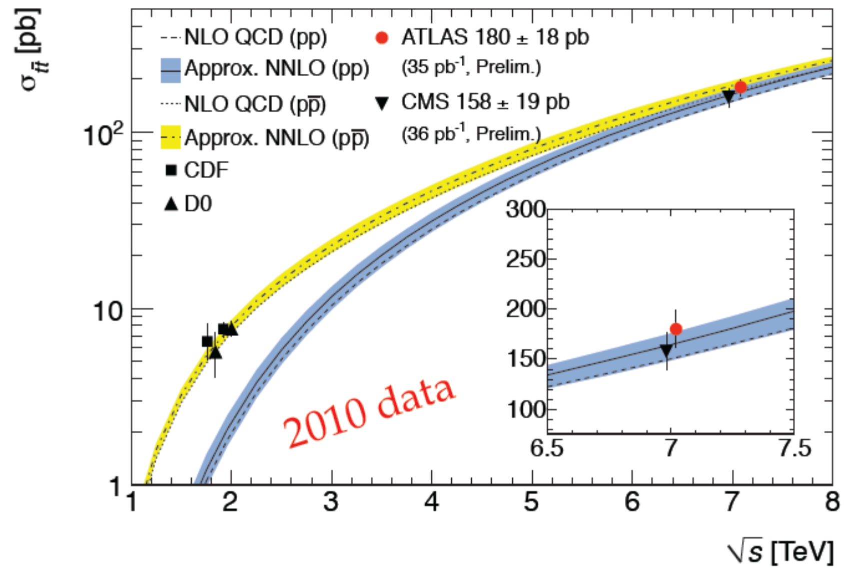
Top Cross-Section and Mass

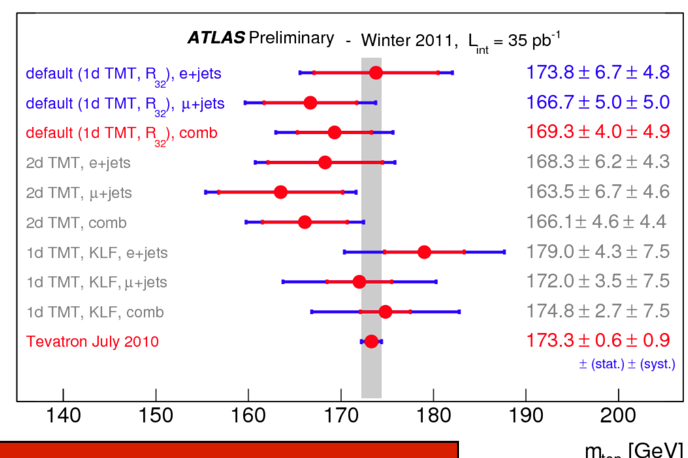


- Cross section measured in variety of channels with different techniques
- Lepton+jets: with and w/o b-tagging
- Dileptons: with and w/o b-tagging



ATLAS-CONF-2011-023
ATLAS-CONF-2011-034
ATLAS-CONF-2011-035
ATLAS-CONF-2011-066





Counting fit to all channels experiment, with simultaneous likelihood to derive the combined cross section

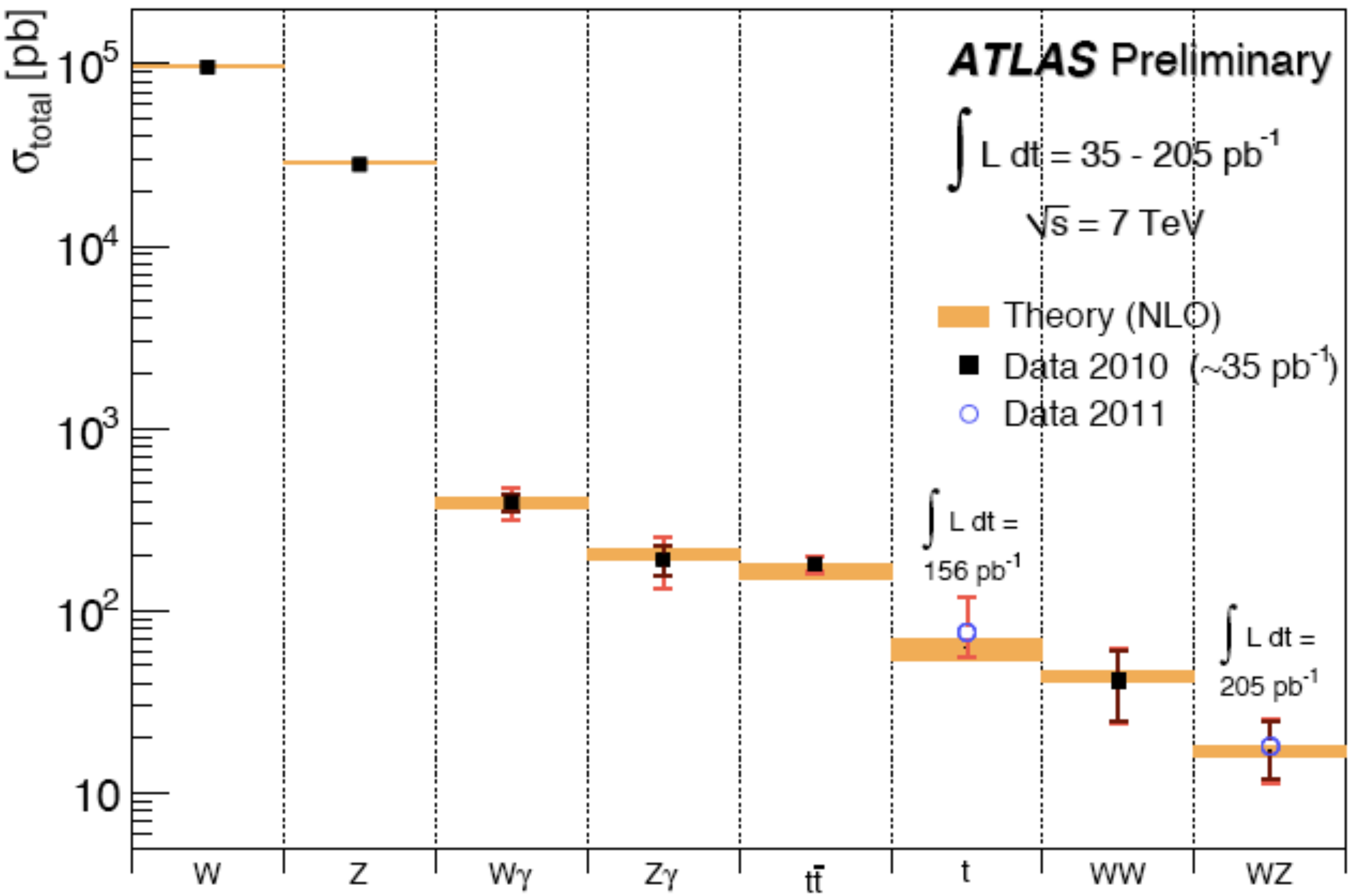
σ(tt) = 180 ± 18 pb
10% precision similar to theoretical precision

Mt = 169 ± 4.0 ± 4.9 GeV
in the l+jet channel

ATLAS-CONF-2011-033
ATLAS-CONF-2011-054

Summary of EW Boson and Top Quark Cross Sections

Main SM cross sections measured by ATLAS



- All measurements agree with SM expectation (so far)
- Probing cross sections of ~10 pb

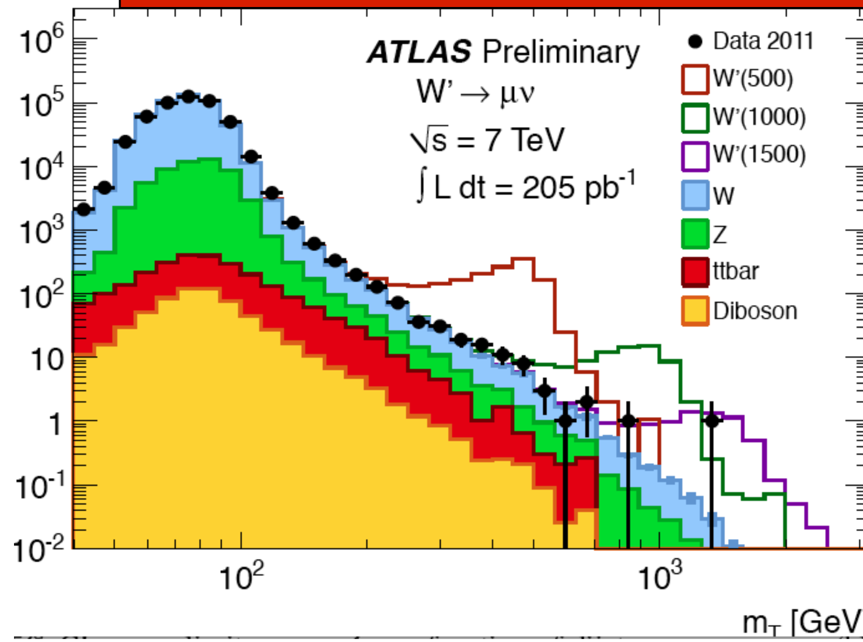
Searches – New Heavy Bosons: W'->μν

- W' search based on the transverse mass spectrum

$$m_T = \sqrt{2p_T^l E_T^{miss}(1-\cos\phi_{l\nu})}$$

- Need to understand Missing Et and Muons at very high momentum
- Main background:
  - W
  - Z (if one lepton is missed)
  - Top and Di-Boson

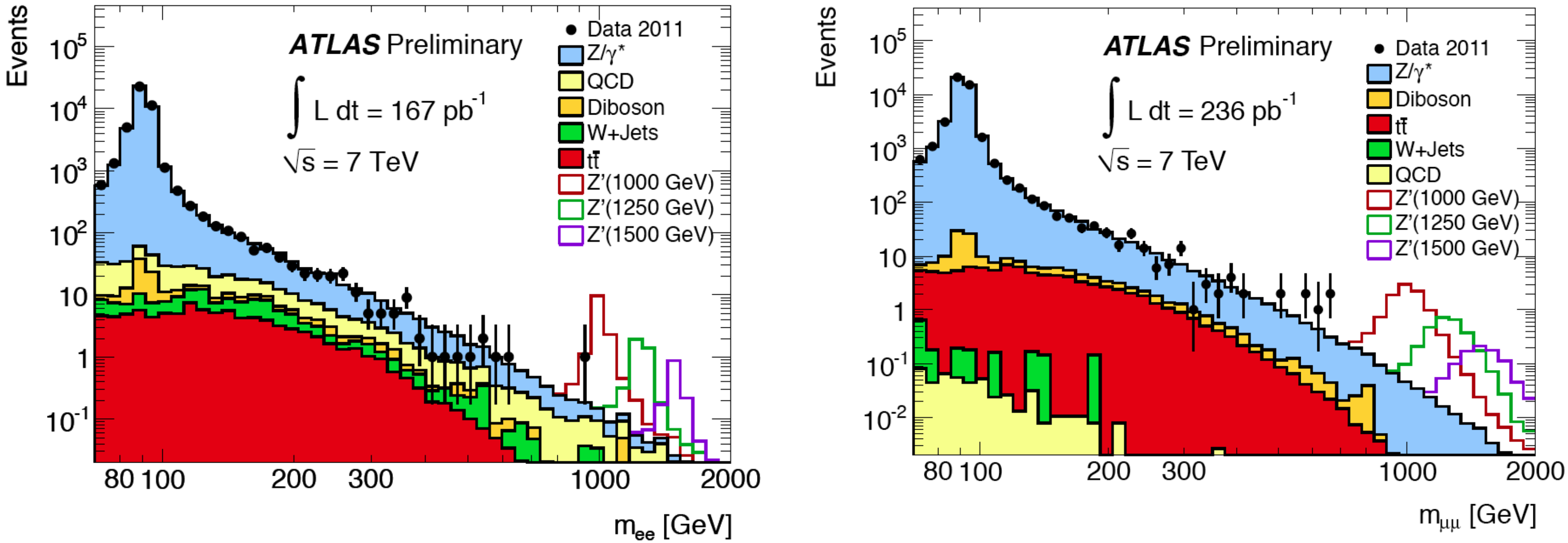
No significant excess over SM background
• Highest m_T 1.35 TeV



- **Data consistent with background expectation**
  - Use data to constrain W' bosons
- **Exclude m(W')<1.7 TeV for SM couplings**
  - combining eν and μν decay modes

ATLAS-CONF-2011-082

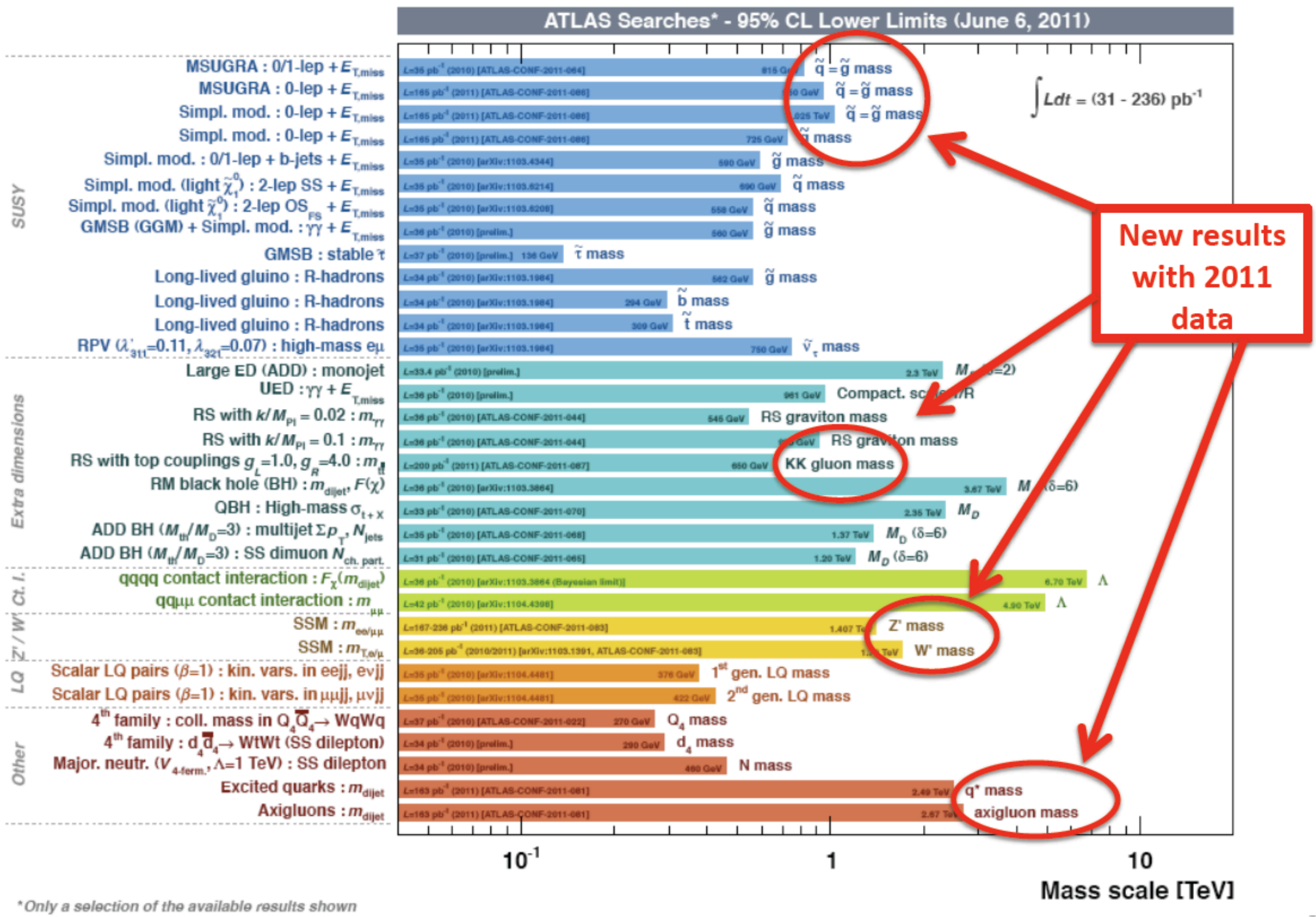
Search for peak in invariant mass of high P_T dilepton pairs
Main backgrounds: Drell-Yan, W, Top, QCD fakes



- **Data in good agreement with SM expectation**
  - No evidence for any peak structure
  - Use data to derive limits on Z' in various models
- **Exclude m(Z')<1.44 TeV with SM couplings**
  - combing ee and μμ channel

ATLAS-CONF-2011-083

Physics beyond Standard Model



Roadmap of Expected Hadron Collider Performances Model

P. Jenni slide

Now	Tevatron	2 TeV	7 fb^{-1} (analysed)
	LHC	7 TeV	45 pb^{-1}
End 2011	Tevatron	2 TeV	10 fb^{-1}
	LHC	7 TeV	2 fb^{-1}
End 2012	LHC	7 TeV	5 fb^{-1}
End 2015	LHC	14 TeV	30 fb^{-1}
End 2017	LHC	14 TeV	100 fb^{-1}
Early 2020s	LHC	14 TeV	500 fb^{-1}
2030	(s)LHC	14 TeV	3000 fb^{-1} (ultimately…)

(These are round numbers and estimates, just to give a rough idea…)

(1 fb^{-1} = 1000 pb^{-1})

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- ATLAS is taking very good quality Data with 95% Data taking efficiency
- Excellent performance of ATLAS detector
  - Subsystems operating according to design specifications
  - Monte Carlo simulation in good agreement with data
- Many very high-quality papers published, submitted or in the pipeline
- ATLAS is running on the exciting 2011-2012 period:
  - we should be able to close the SM Higgs question
  - sensitivity to new physics will extend in the multi-TeV region
- discoveries may well arrive in a few months………

Thank you