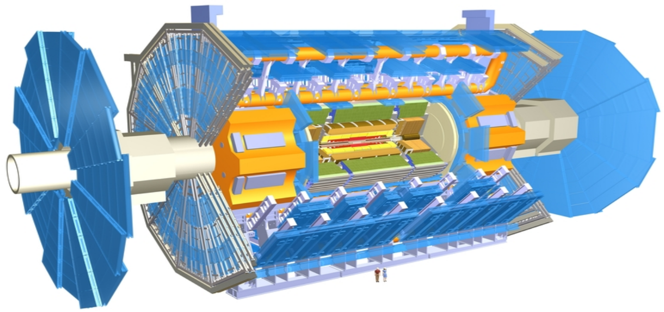
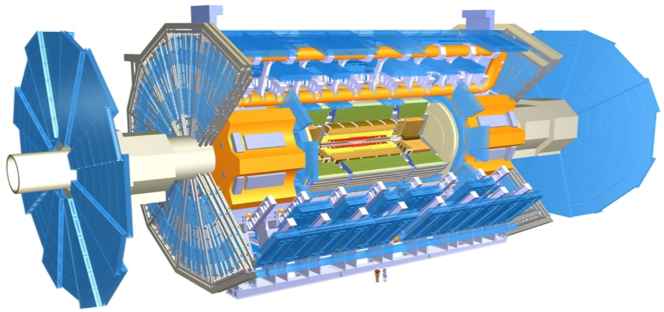


ATLAS Detector Status and Performance

Evangelos N. Gazis
NTUA/CERN

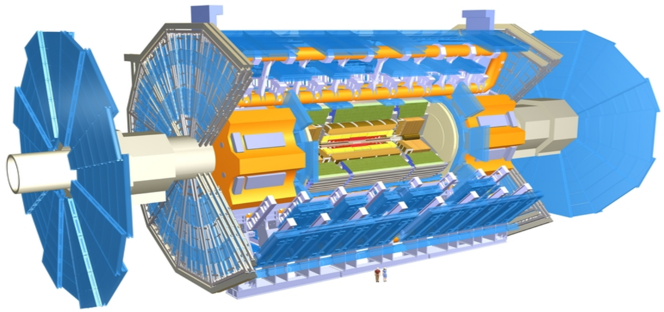
on behalf of the ATLAS collaboration

1st ICFP Crete,
10-16 June 2012



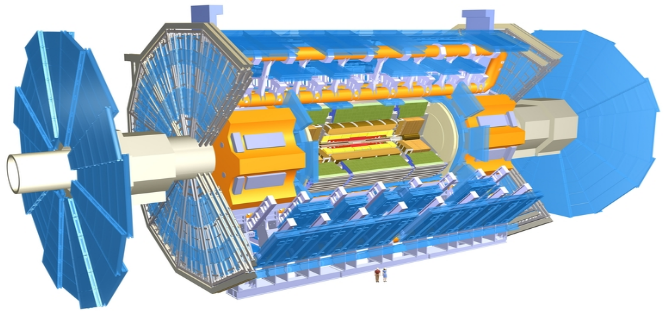
Many thanks to the ATLAS Colleagues:

Fabiola Gianotti
Maria Curatolo
Ana Henriques
Sandro Palestini
Michael Kobes
Guillaume Unal
Richard Hawkings
Francesca Pastore
Christoph Rembser
David Storm
Chiara Roda
Stephanie Zimmermann



Many talks to ICFP 2012 from our ATLAS Colleagues:

- *Sally Seidel : Highlights of ATLAS Experiments*
- *Lucio Cerrito: Top*
- *Stephanie Adomeit: QCD*
- *Nick Charles Edward: W, Z, and diboson physics*
- *Visili Mitsou: SUSY*
- *Serhan Mete: New physics searches*
- *Steve Hillier: Upgrade*



Outline:

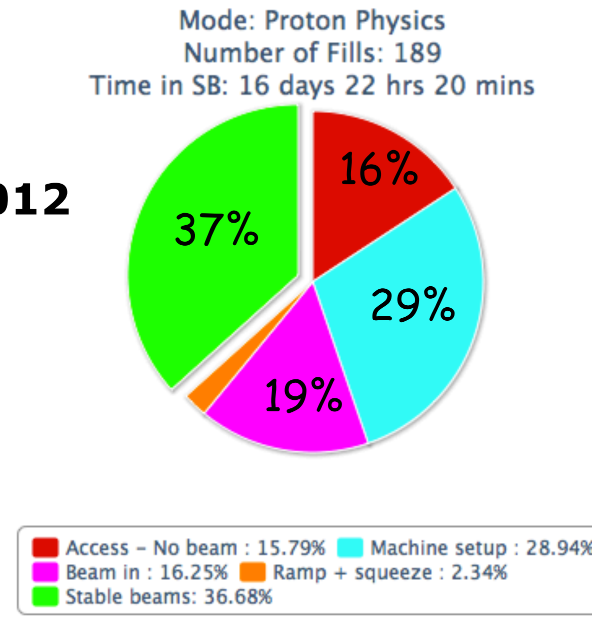
1. LHC @ CERN
2. ATLAS Detector – Hardware Status
3. ATLAS Readiness
4. Luminosity
5. Pile-up 2011/2012
6. Trigger – DAQ – Computing
7. Inner Detector
8. Calorimeters
9. Muon Systems
10. Plan for Upgrade
11. Conclusions

LHC @ CERN

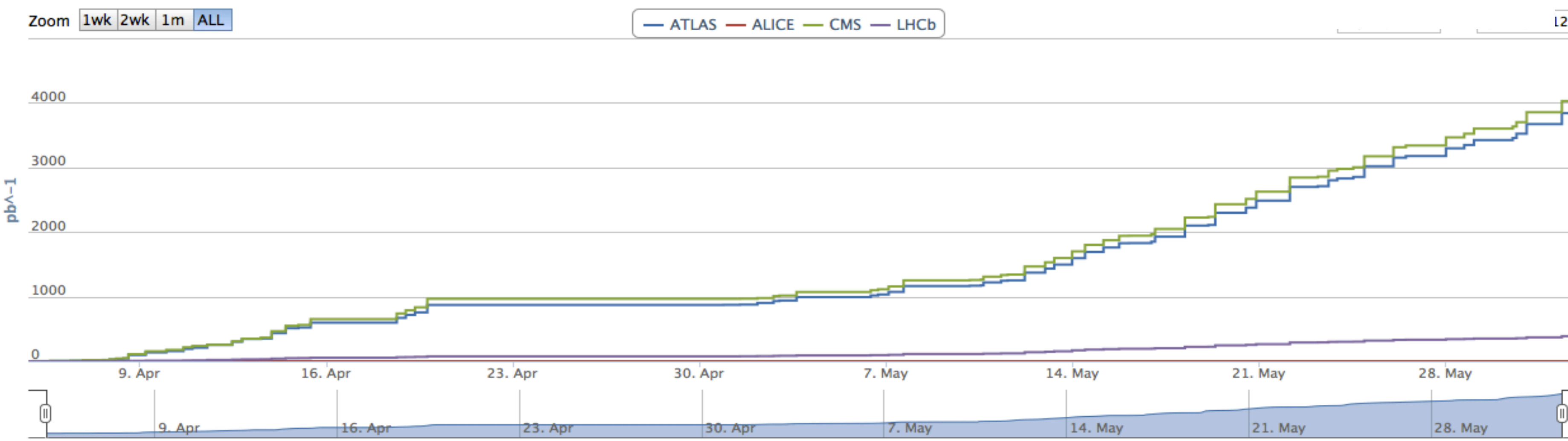
LHC Efficiency and Availability

LHC Run Efficiency

2012



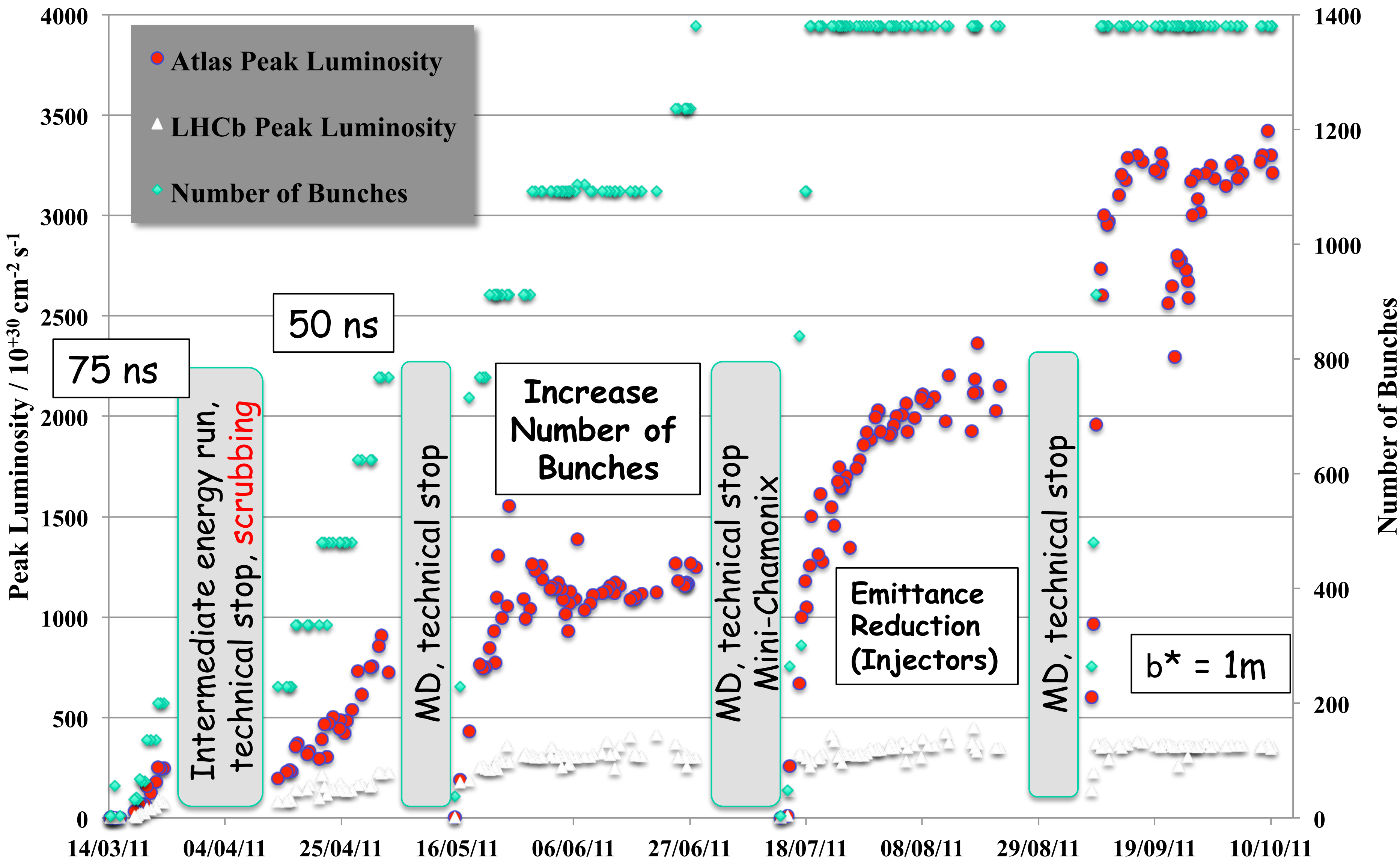
Integrated Luminosity Evolution



Online Integrated Luminosity

ALICE: 692.59 nb^{-1} | ATLAS: 4.08 fb^{-1} | CMS: 4.27 fb^{-1} | LHCb: 418.81 pb^{-1}

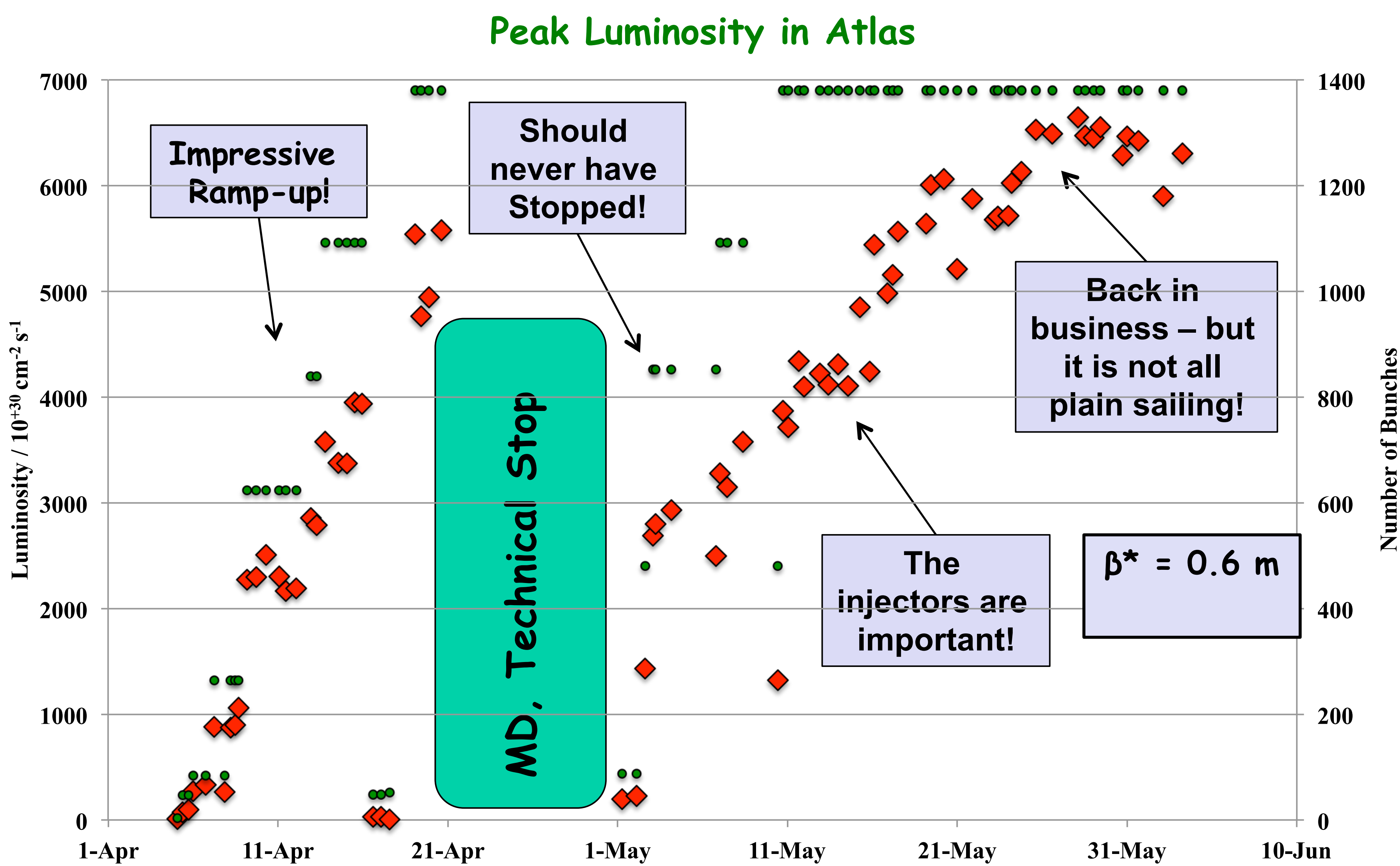
A quick look back: 2011 at a glance



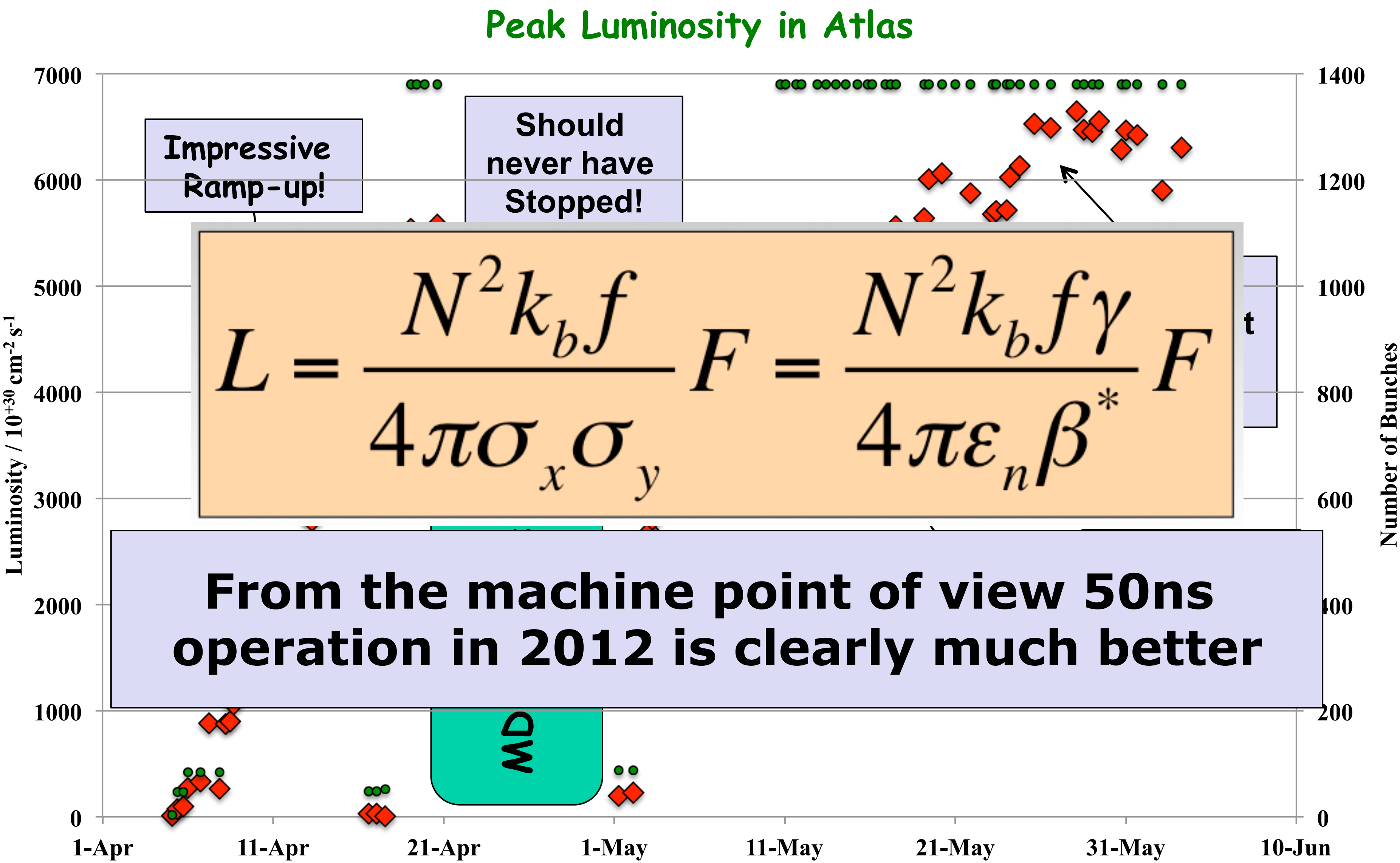
2011 to 2012

- Well organized, productive Xmas technical stop
  - Lot of R2E related work
  - Plus consolidation and improvements of many systems
- Vacuum consolidation to address successfully diagnosed causes of instabilities in 2011
- Injection collimators issues diagnosed and understood - spare in preparation - fingers crossed in the meantime
- Cool-down of machine exactly on schedule
- Very smooth hardware commissioning including careful quench-less commissioning of main circuits to 4 TeV
- Well oiled Machine checkout final tests and preparation for beam

Peak Luminosity Evolution (so far)



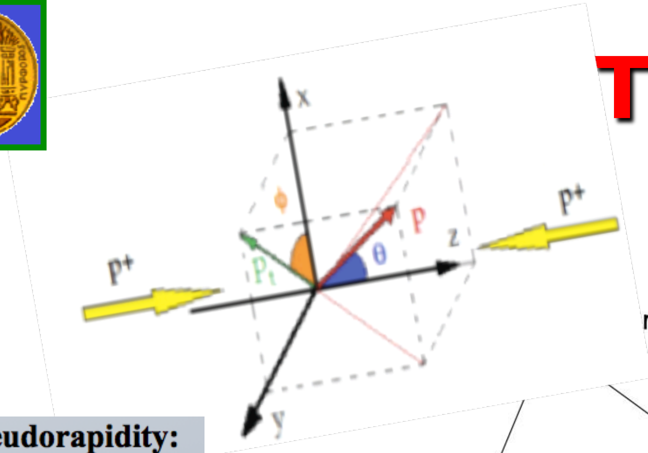
Peak Luminosity Evolution (so far)



$$L = \frac{N^2 k_b f}{4\pi\sigma_x\sigma_y} F = \frac{N^2 k_b f \gamma}{4\pi\varepsilon_n \beta^*} F$$

From the machine point of view 50ns operation in 2012 is clearly much better

The ATLAS detector

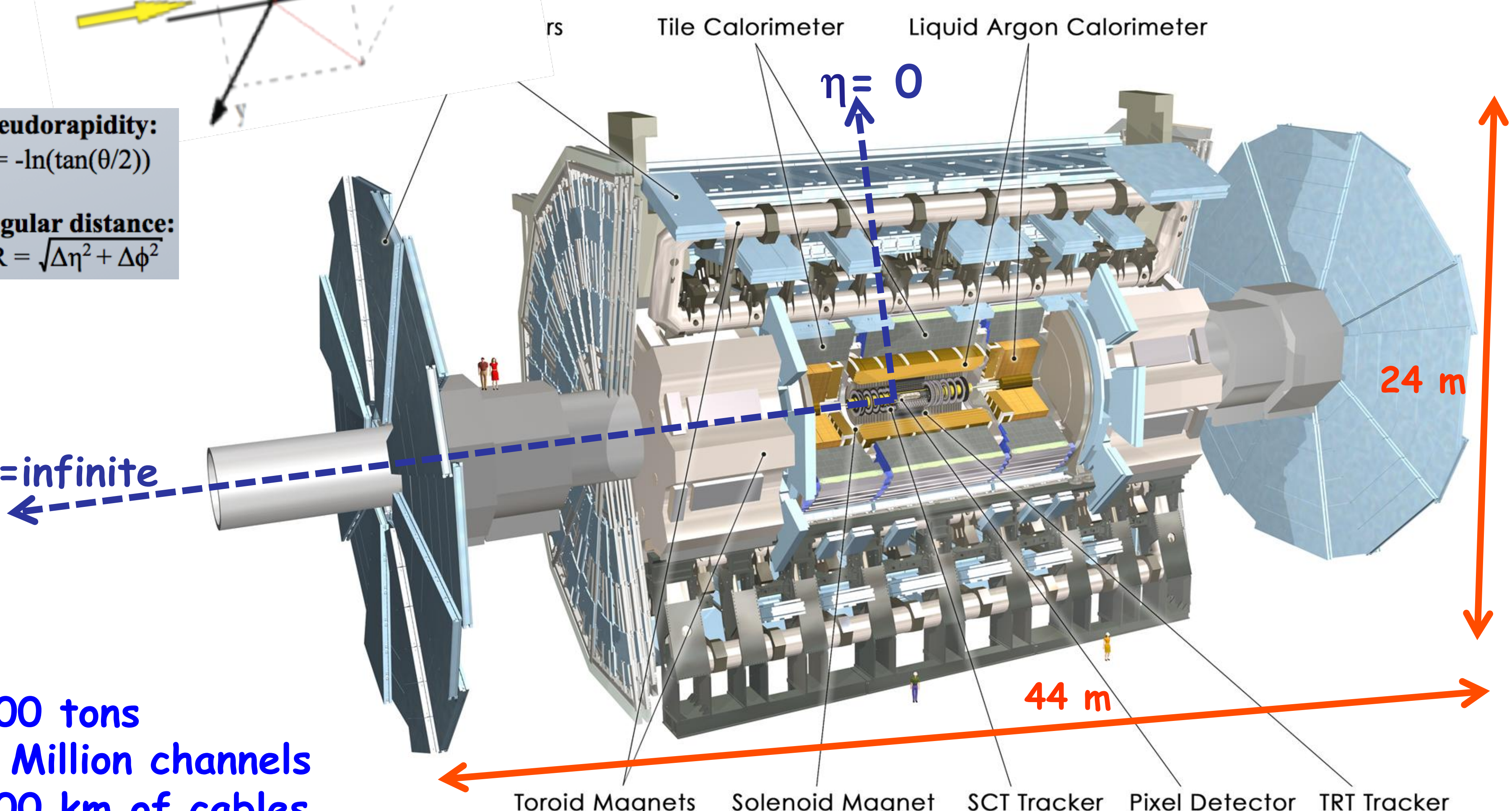


pseudorapidity:

$\eta = -\ln(\tan(\theta/2))$

angular distance:

$\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$



7000 tons
88 Million channels
3000 km of cables
2T solenoid
Toroid (B ~ 0.5T in barrel;~1T end-cap)

ATLAS Status in Brief

	Jan 2012	Today
Recorded luminosity (pp)	5.2 fb^{-1} @ 7 TeV	+ 3.9 fb^{-1} @ 8 TeV
Peak luminosity	3.6×10^{33}	6.6×10^{33}
Max pile-up	~ 24	~ 38
Data-taking efficiency (pp)	~ 93.5 %	~ 94.5 %
DQ (all CP flags good)	~90% (after reprocessing)	~ 90%
N. of submitted collision-data papers	105	156
N. of CONF-notes	266	318
Talks at conferences since beg year	18	~ 230

In addition: lot of progress on Upgrade; process to prepare ATLAS input to ES in place

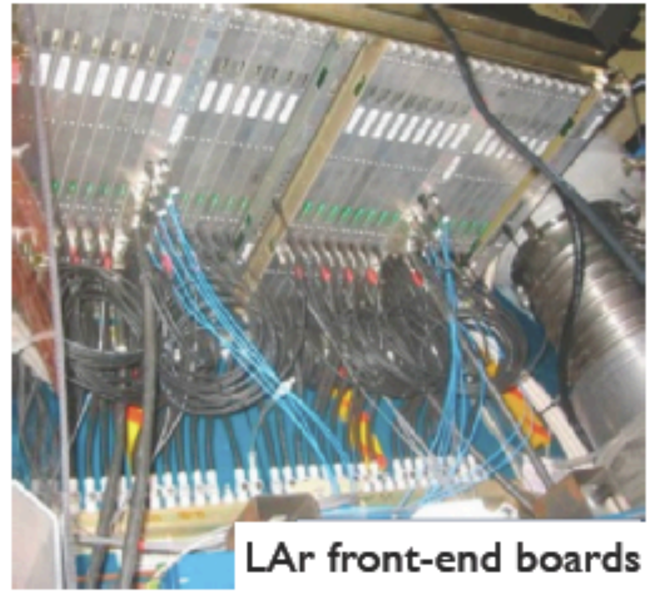
- Hope to record ~ 5 fb^{-1} by next MD +TS (19 June)
  → to be used (as much as possible) for Higgs and other results for ICHEP
- ATLAS and CMS luminosities seem to be ~ similar in 2012
  CMS got ~ 8% more integrated luminosity in 2011

The ATLAS Hardware status

Sub-dectector	Number of Channels	Appr. Operational Fraction
Pixels	80M	95.9%
SCT Silicon strips	6.3M	99.3%
TRT Transition Radiation Tracker	350k	97.5%
LAr EM Calorimeter	170k	99.9%
Tile Calorimeter	9.9k	99.5%
Hadronic Endcap LAr Calorimeter	5.60k	99.6%
Forward LAr calorimeter	3.50k	99.8%
LVL1 Calo Trigger	7.15k	100%
LVL1 Muon RPC Trigger	370k	99.5%
LVL1 Muon TGC Trigger	320k	100%
MDT Drift Tubes	350k	99.7%
CSC Cathode Strip Chambers	31k	97.7%
RPC Barrel Muon Chambers	370k	97.1%
TGC Endcap Muon Chambers	320k	99.7%

98.94% !!

ATLAS Readiness after 2011-12 Shutdown

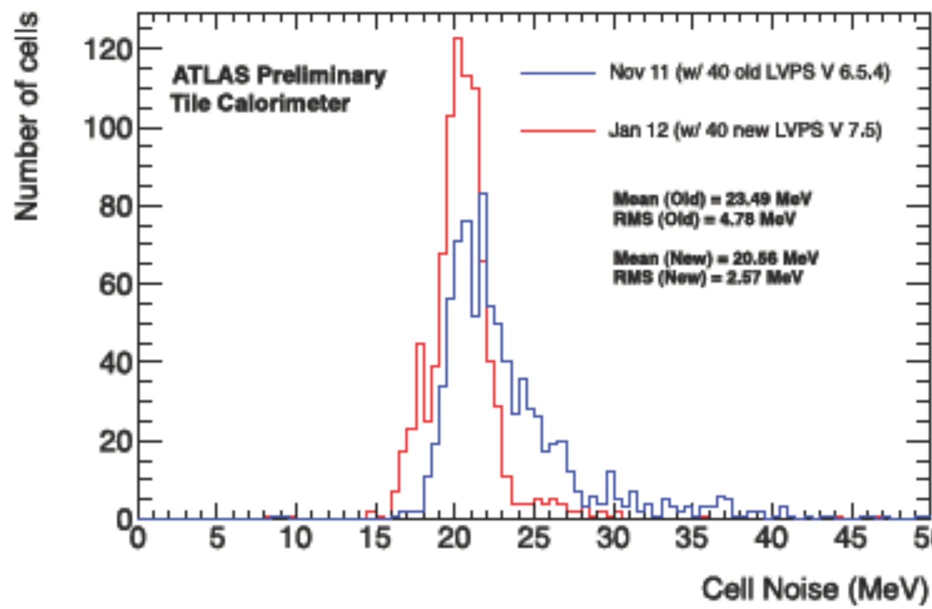

LAr front-end boards

Example **Liquid-Argon calorimeter**:
- 10 front-end boards repaired and 12 new LVPS installed:

➡ bad channels decreased from 385/182468 to 106/182468 (0.06%)

Example **Tile Hadronic calorimeter**:
- 45/256 on detector "drawers" opened for refurbishment
- 40/256 new low voltage power supplies replaced, reduce trip rates and noise

➡ bad cells: before shutdown 5% to 0.5% today



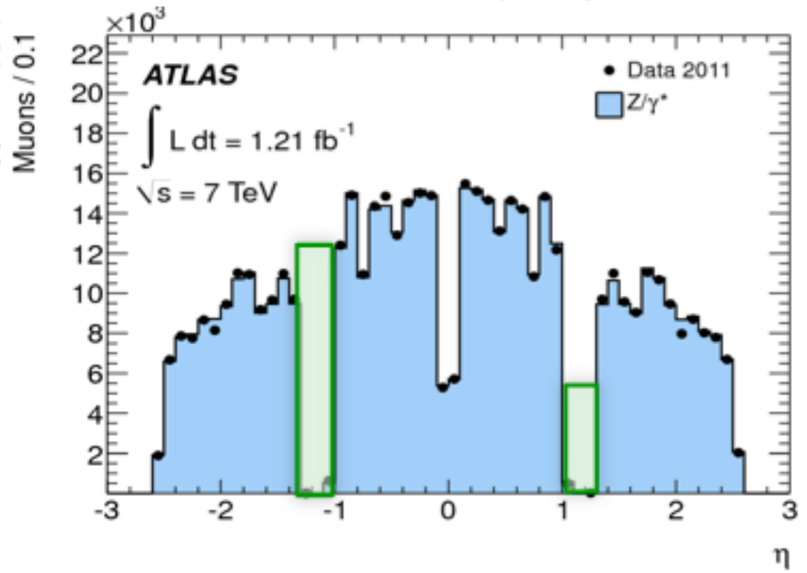
Example **infrastructure**:
- Cryogenics: NEW main compressor
- Maintenance cryogenics, gas, cooling, access systems and consolidation of the electrical system

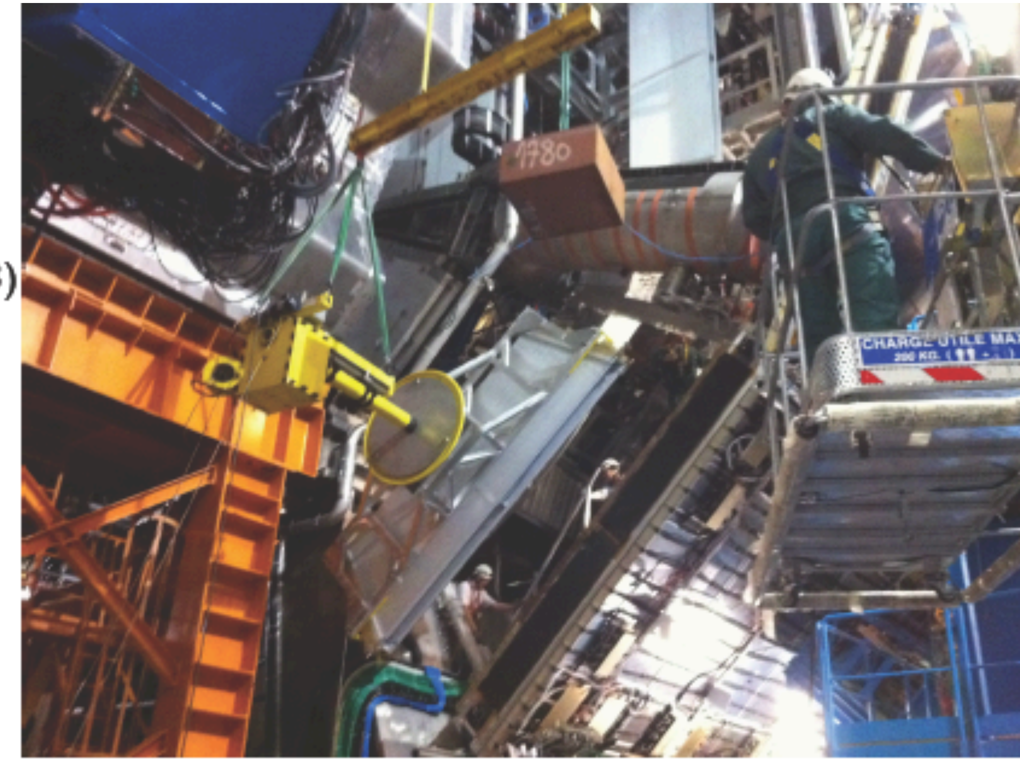
ATLAS Readiness after 2011-12 Shutdown

NTUA participated

Muon Spectrometer:

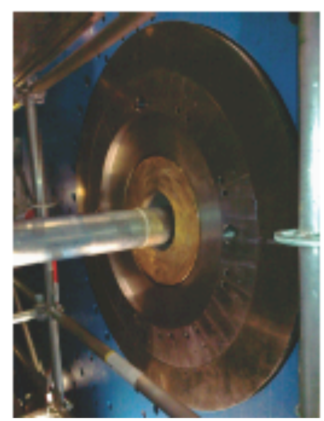
- Installation MDT EE (precision MS tracking at $|\eta|\sim 1.2$):
  - ➡ Side C: completed, 31 modules
  - ➡ Side A: 7 EELs (completion 2013)



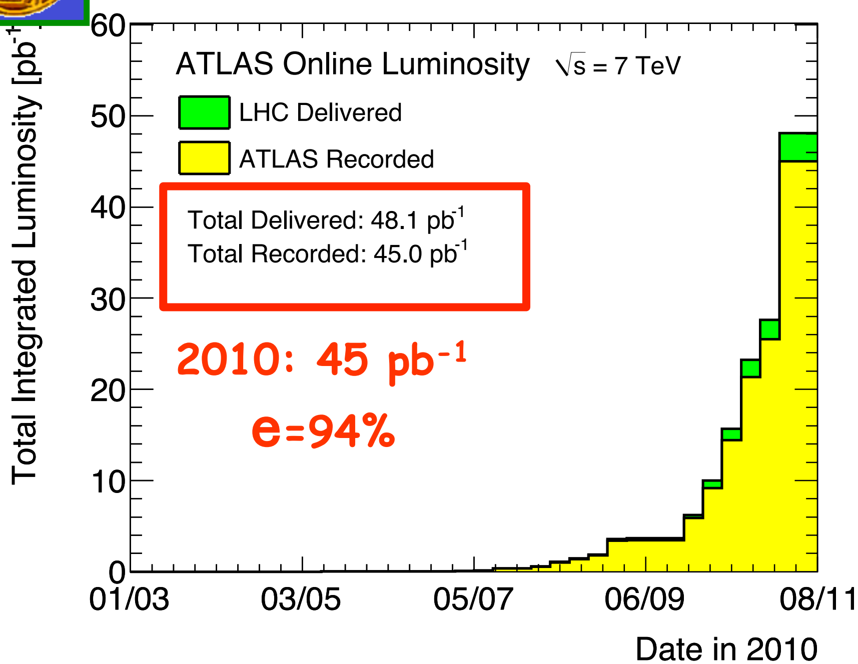


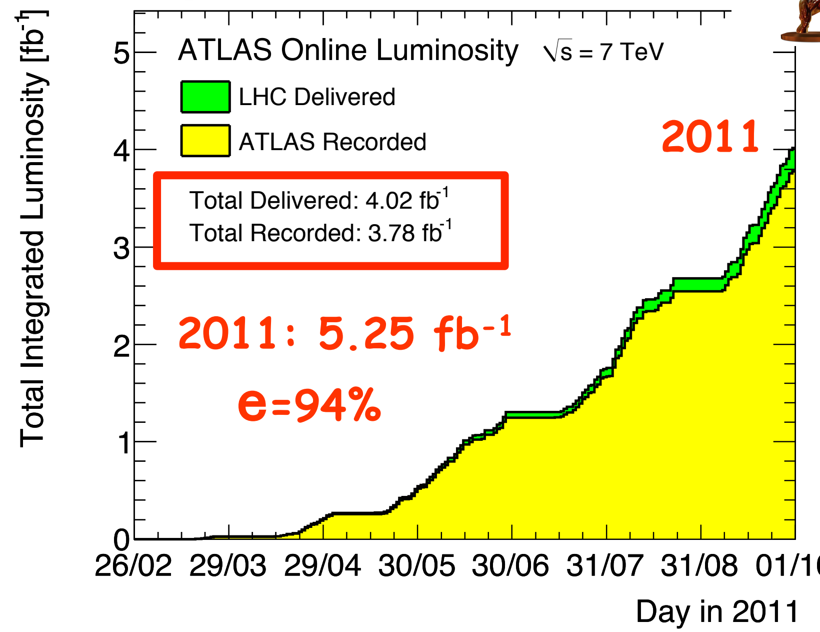
New shielding at $|Z|\sim 7$ m:

- reduction of large plume of photons in Muon Spectrometer

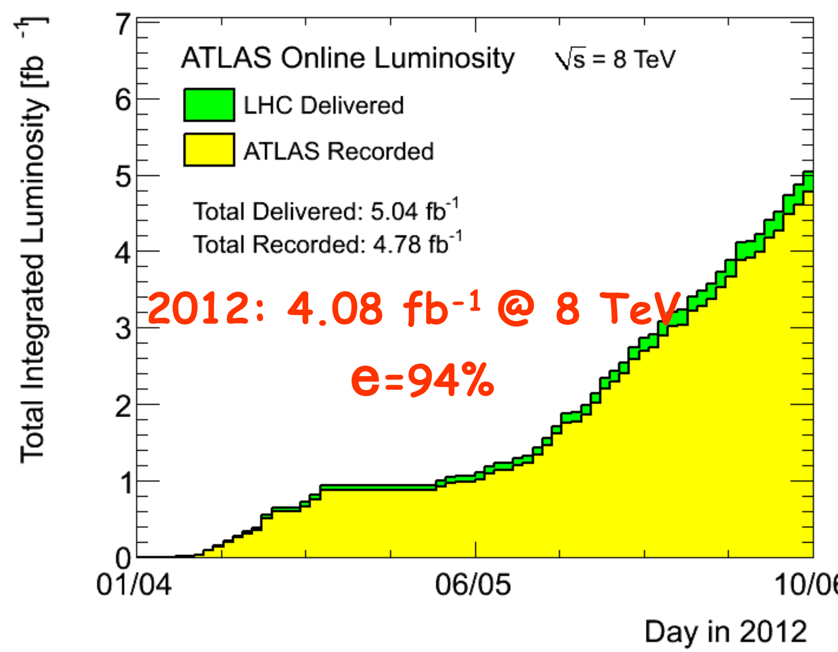


ATLAS Data Taking





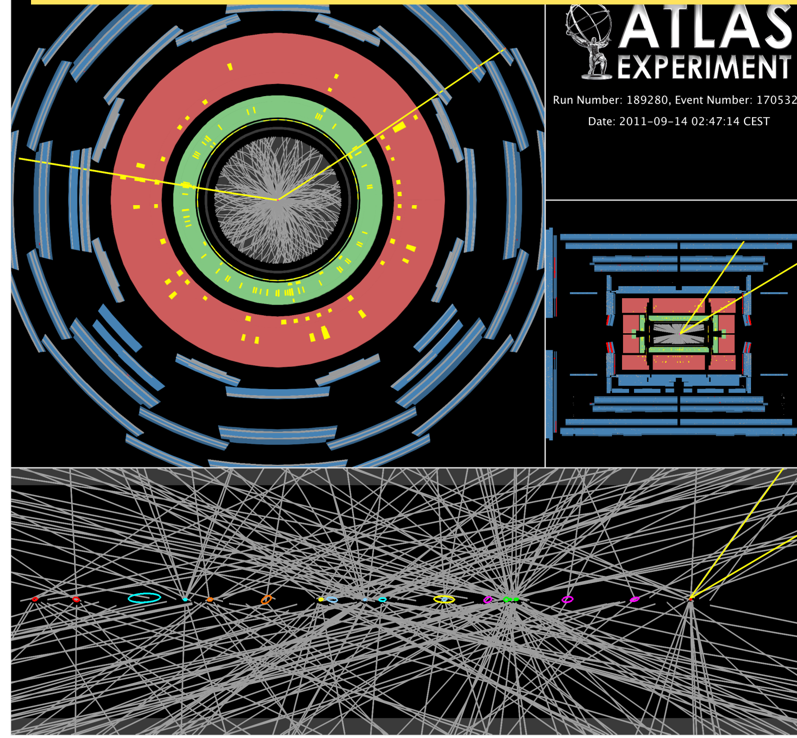
- $4.08\ fb^{-1}$ pp @ 8 TeV in 2012, $L=6.6\times10^{33}$
- $5.25\ fb^{-1}$ pp data in 2011 ($45.0\ pb^{-1}$ 2010)
- Up to $110\ pb^{-1}$ /day (x2 more than all 2010)
- $9.2\ mb^{-1}$ Pb-Pb in 2010
- 94% efficiency (94% in 2010)
- Max peak L $=3\times10^{33} cm^{-2}s^{-1}$ (>10 times more than in 2010)



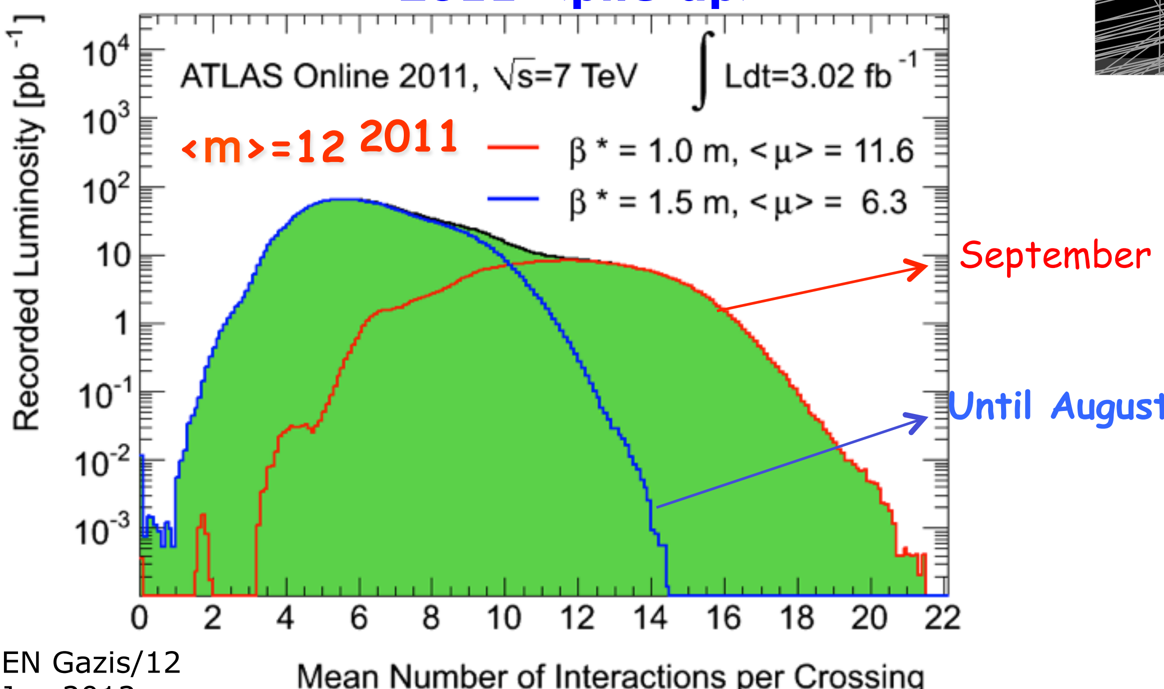
Pile-up challenge 2011

- ~x2 lower than LHC design
- 2011 <pile-up> =12 (up to 22 max)
- In September increasedx1.5 (β*=1.5m→1m)
- 2010 <pile-up> =1.3
- A potential issue for: Lepton Isolation, Vertexing, CPU time/event size, t, Jet Energy Scale/resolution, E_{Tmiss}.

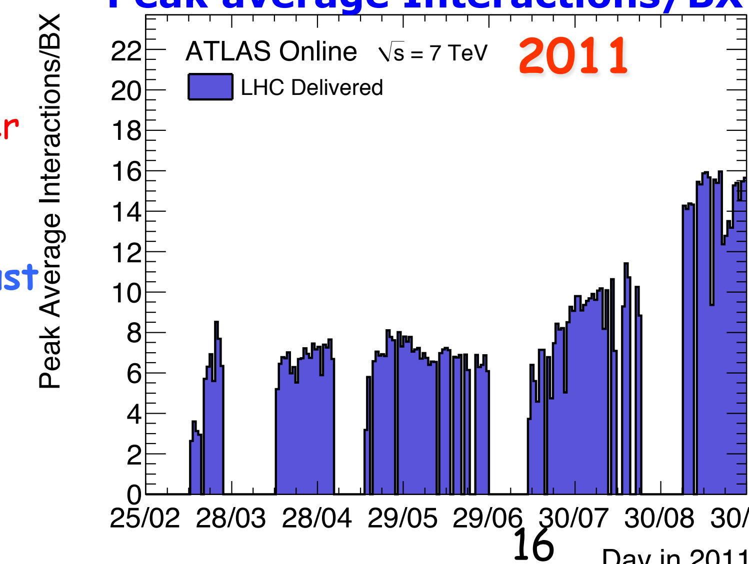
Z->mm with 20 reconstructed vertices



2011 <pile-up>

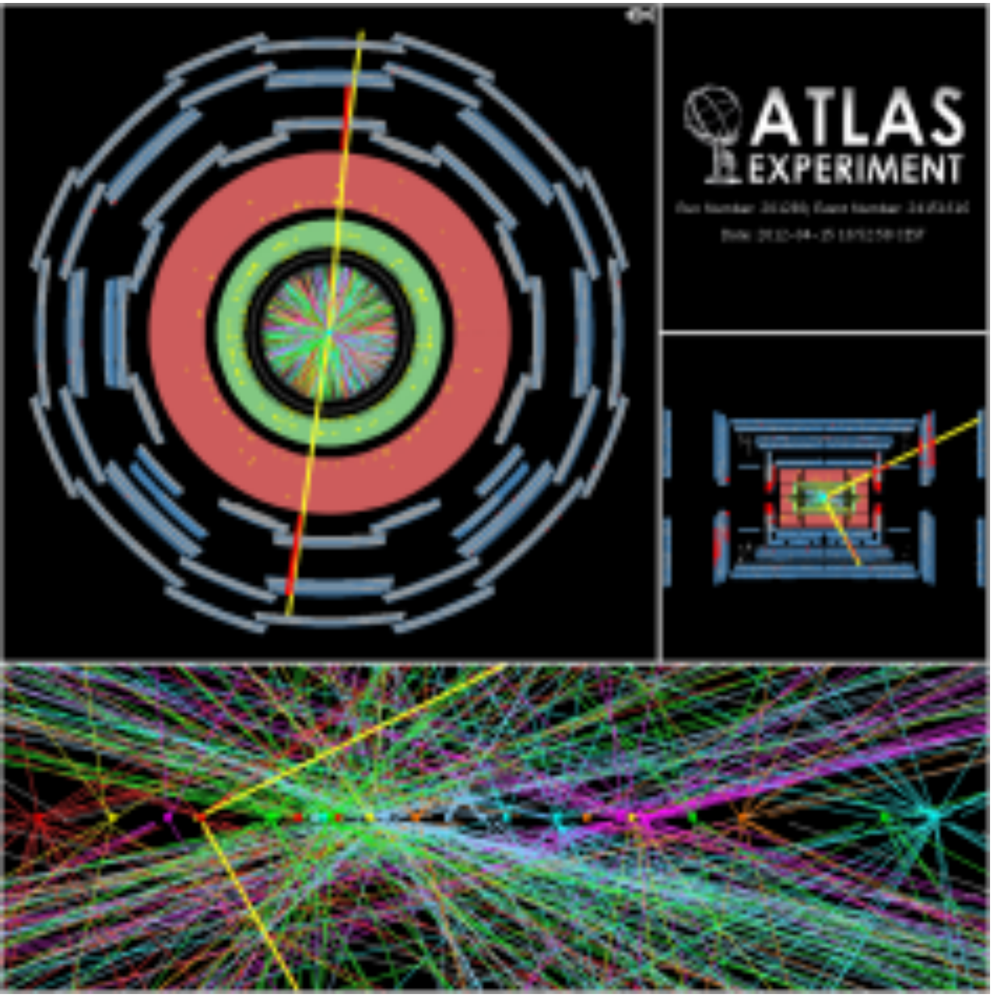


Peak average Interactions/BX

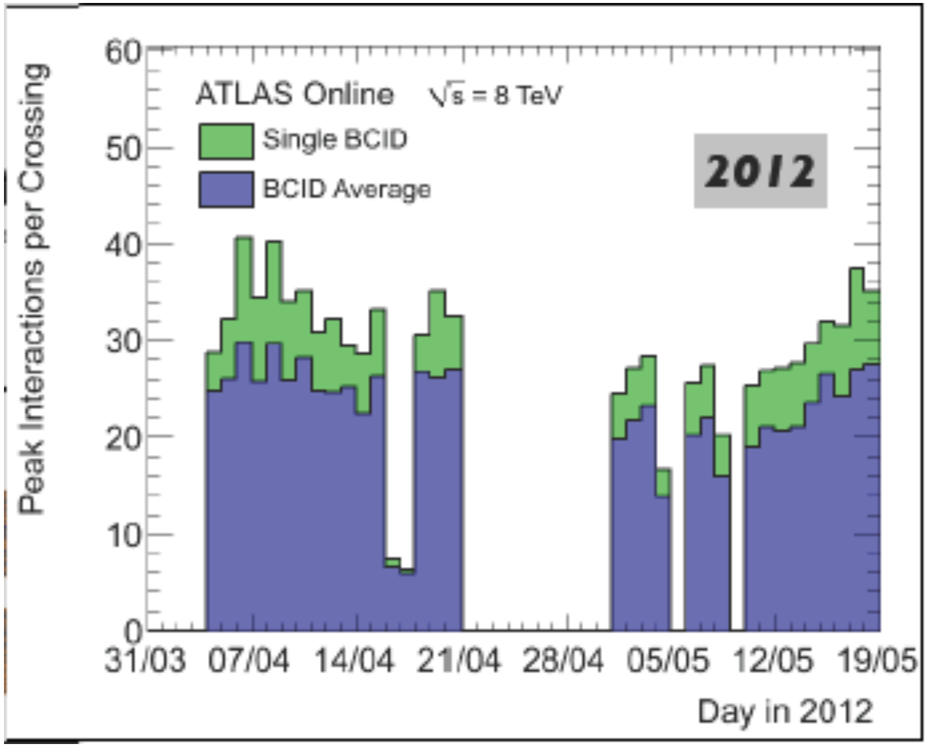


HIGH Pile-up 2012

Z->mm with 25 reconstructed vertices

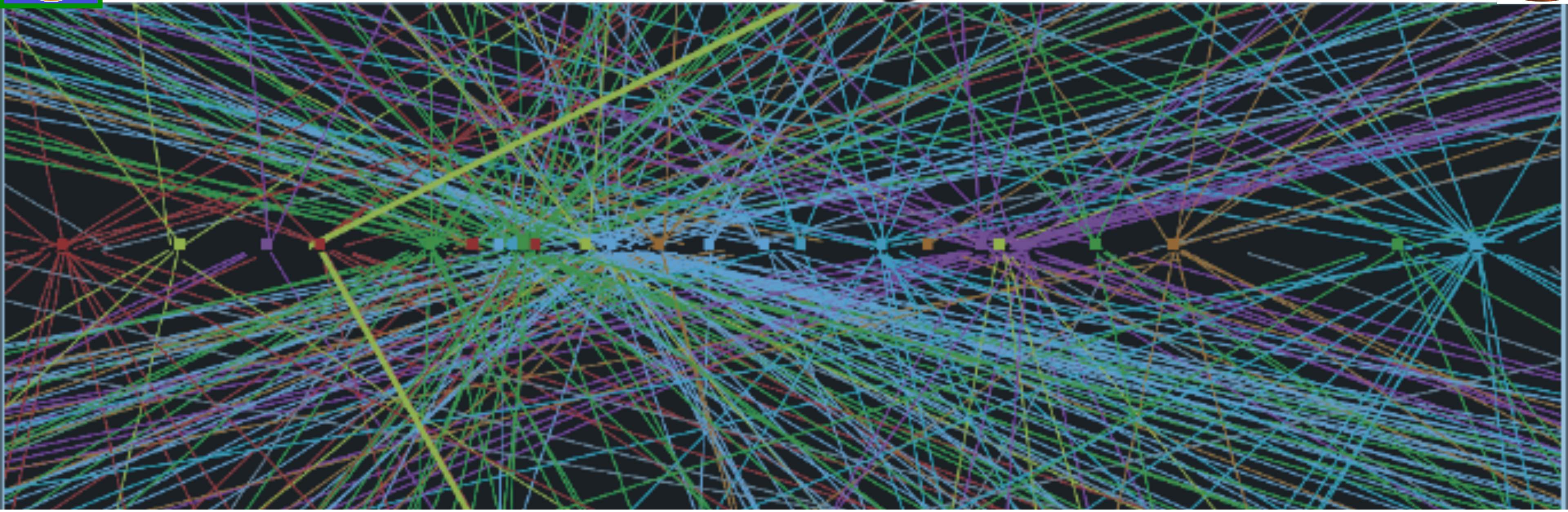


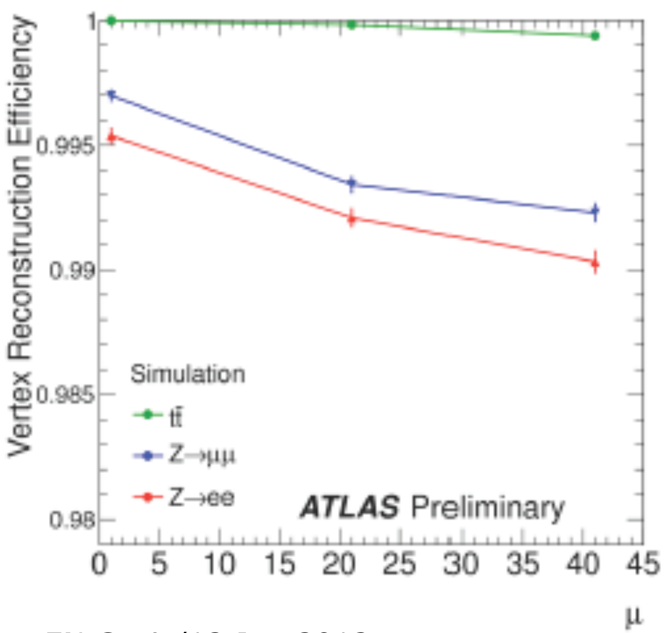
Peak average Interactions/BX



$\beta^* = 0.6m$

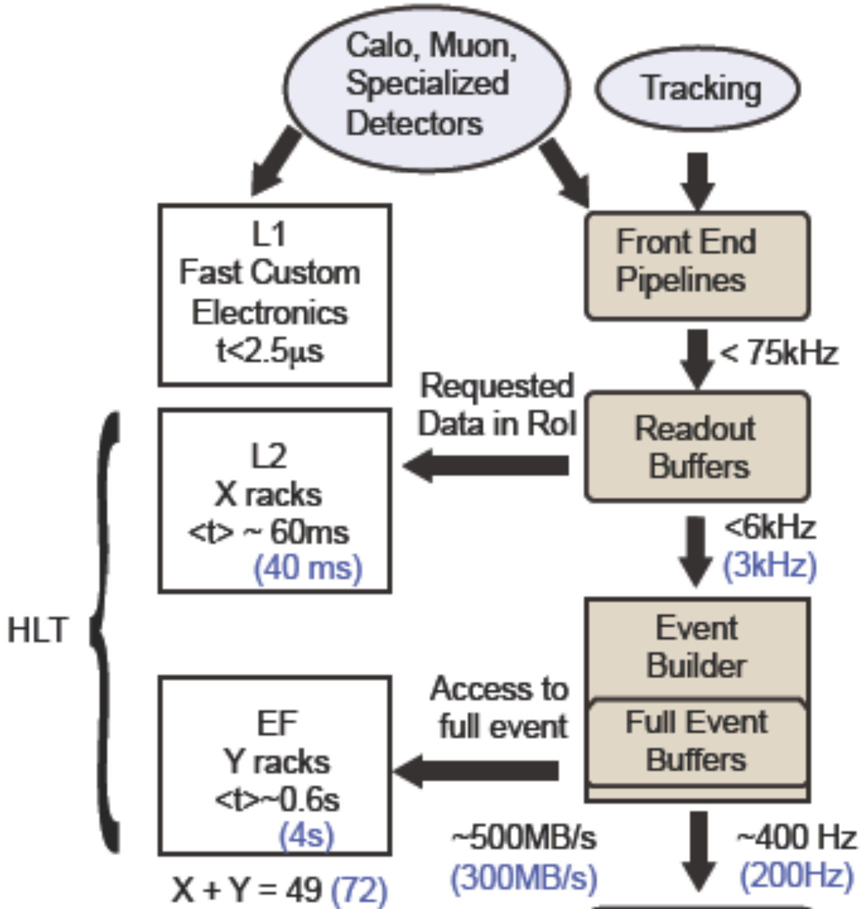
Vertexing





- Vertex reconstruction in the high track density environments is a challenging task
- Current reconstruction is performing well
  - Our vertex reconstruction efficiency remains very high
- The challenge is to:
  - Cleanly reconstruct each vertex
  - Select the correct vertex for your each analysis

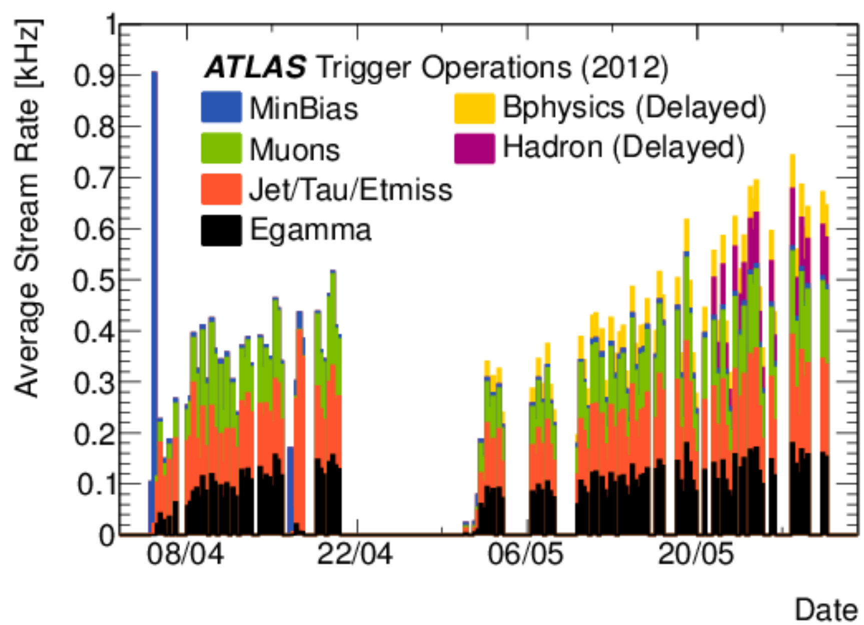
Trigger and DAQ



ATLAS 2011 Trigger, end of run
(ATLAS Design)

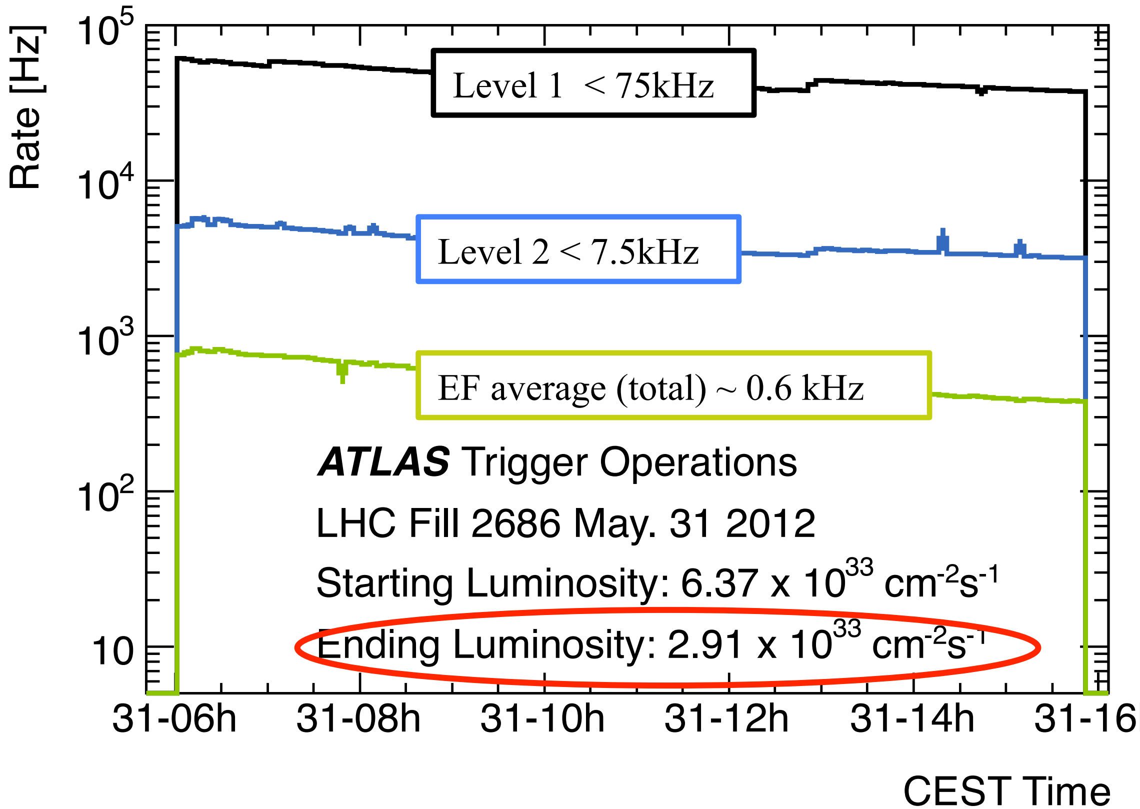
arXiv:1110.1530

- DAQ readout rate significantly beyond design (lower thresholds)
- Expect that system is adequate for the 2012 run



Trigger and DAQ

Trigger: pile-up robust algorithms and optimization of selections (e.g. isolation) to keep low un-prescaled thresholds (e.g. inclusive e, μ) in spite of x2 larger L and pile-up than in 2011



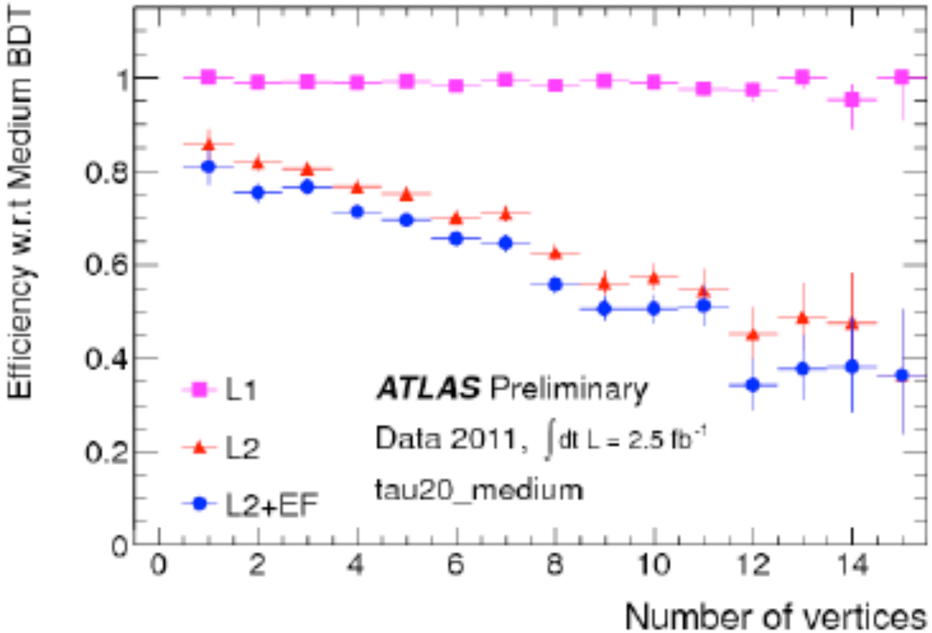
- Trigger Menu is largely driven by level 1 constraints (75kHz max)
- Average prompt EF output rate (0.4kHz) is driven by offline processing and storage
- Excess bandwidth used by temporary "priority items"
- The EF delayed stream (2012 only, mainly B physics and extra jets) can be up to 0.2kHz

Trigger during 2012

- Level-1 menu: defined at L= $8x10^{33}$ $cm^{-2}s^{-1}$ (8 TeV) for 75kHz with (~10KHz contingency)
- Level-2:

  ➡ **Pile-up insensitive selections for tau and e implemented in Level-2**

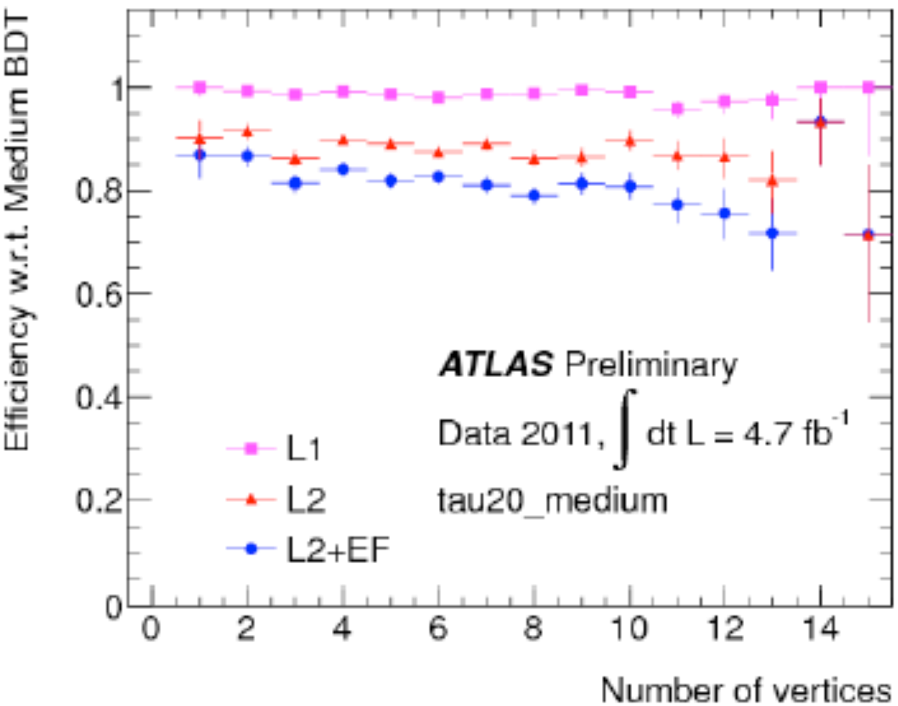
__Example tau trigger:__ *efficiency with respect to the offline identified tau candidates as a function of number of vertices measured in* ***2011****...*



... and as ***expected for 2012***

(the τ trigger is rerun on 2011 dataset from unbiased Z → ττ → μh events,

μ trigger is used to collect Z → ττ → μh data).



Trigger during 2012 Improvements

•Pileup robust electron selection, based on 2012 offline selection

•Pileup robust tau selection (see slides)

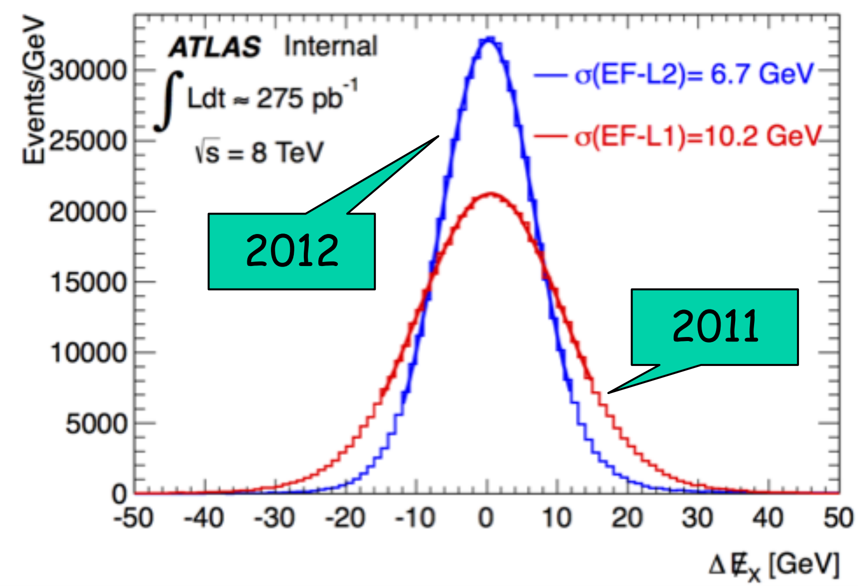
•Use both inside-out and outside-in muon selections in the EF

•Missing E_t (MET) improvements (threshold now lower than in 2011) :
- •Optimize L1 noise cuts to match 2012 pileup
- •Fast Front End Board sums at Level 2
- •Use offline clustering for EF

•New LT jet finding based on trigger tower information

Item	Lowest unprescaled EF threshold (GeV)	Rate (Hz) @ $5x10^{33}$
Incl. e	24	60
Incl. μ	24	45
ee	12	8
μμ	13	5
ττ	29,20	12
γγ	20	10
E_T^{miss}	80	17
5j	55	8

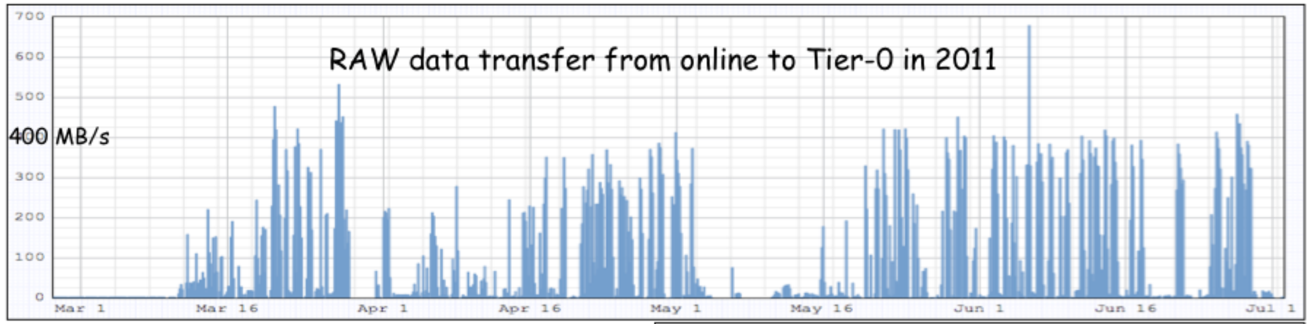
E_T^{miss} now re-calculated at LVL2 using calo FEB sums → sharper turn-on than in 2011



ATLAS Worldwide GRID Computing

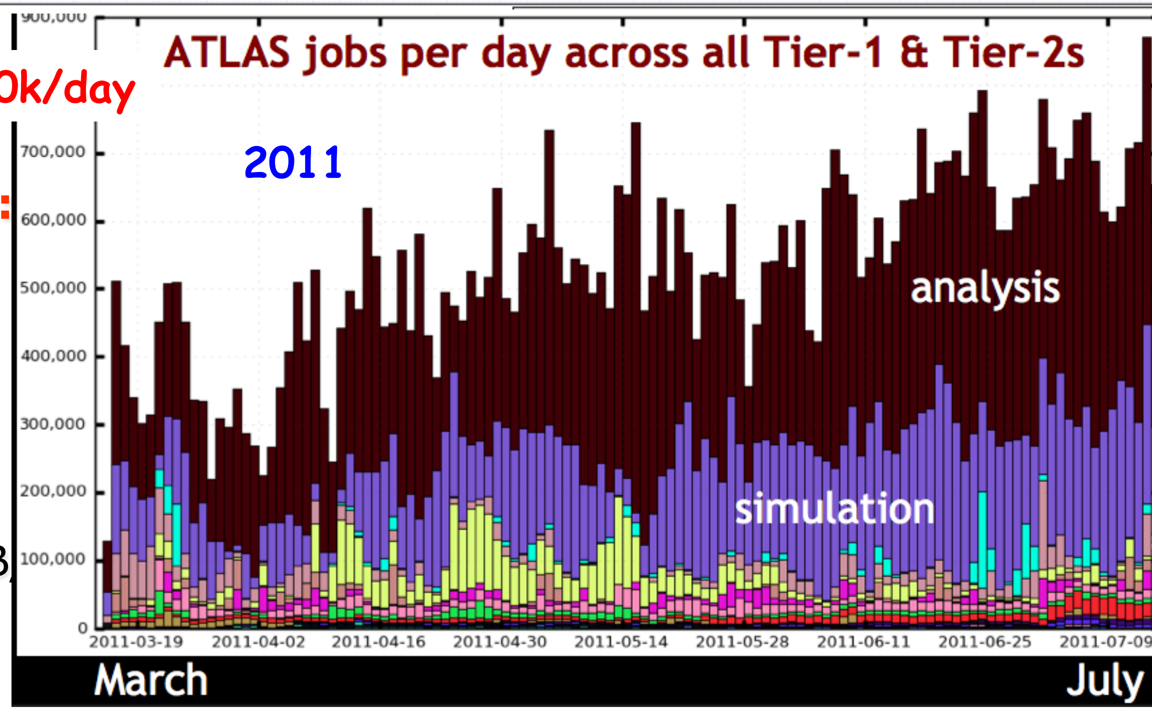
Tier0 at CERN:

- First raw data processing ~48h after data taking:
  - Calibration/DQ/mask bad channels.
  - Data used for physics analysis on GRID in ~ 1 week



Tiers1/Tier2 (~10+~70 sites):

- Simulation
- Re-processing of data and MC
- Physics analysis
- up to 800k jobs/day
- More than 1000 users
- 10 GB/s peak rate (Design 2GB
- ~66 PetaBytes since LHC start

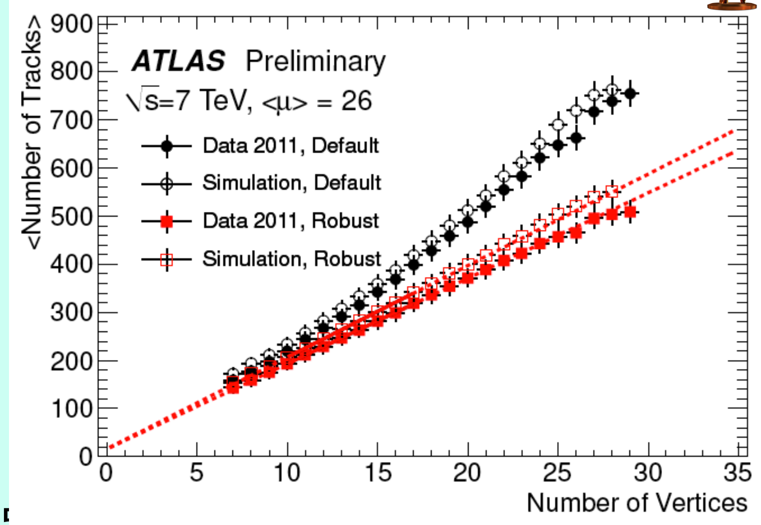


Excellent computing performance allow results shortly after data taking

Reconstruction software has been improved to deal with higher pileup in 2012

ATLAS Inner detector

- Precise tracking and vertexing,
- e/π separation; coverage: $|\eta|<2.5$
- B (solenoid) =2T
- <hits> in barrel ~ 3/8/30 pixel/SCT/TRT;
- $0.5X_0$ at $\eta=0$; $1.1\ X_0$ at $\eta=1.8$
- $\sigma_{pT}/p_T = 0.05\%\ pT \oplus 1\%$



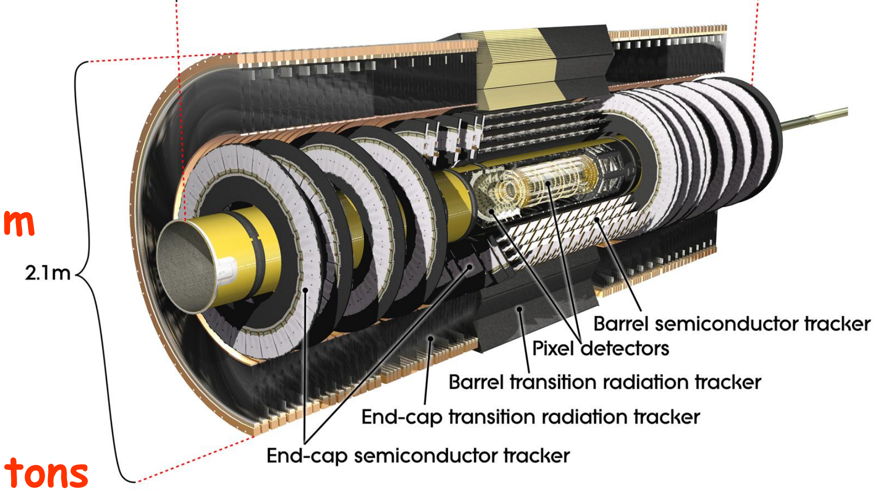
3 Sub-detectors

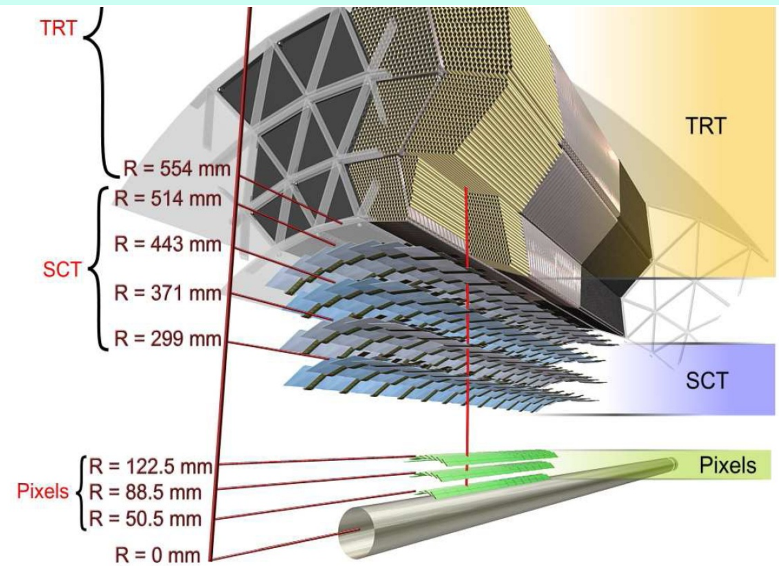
- **Si Pixels**: 80M channels ; 3 layers and 3 disks ; $|\eta|<2.5$
- **10^6 Si strips (SCT)**: 6M channels; 4 layers and 9 disks ;
- **Transition Radiation Tracker(TRT)** : 350k channels ; $|\eta|<2.0$

6.2 m

2.1 m

4.5 tons



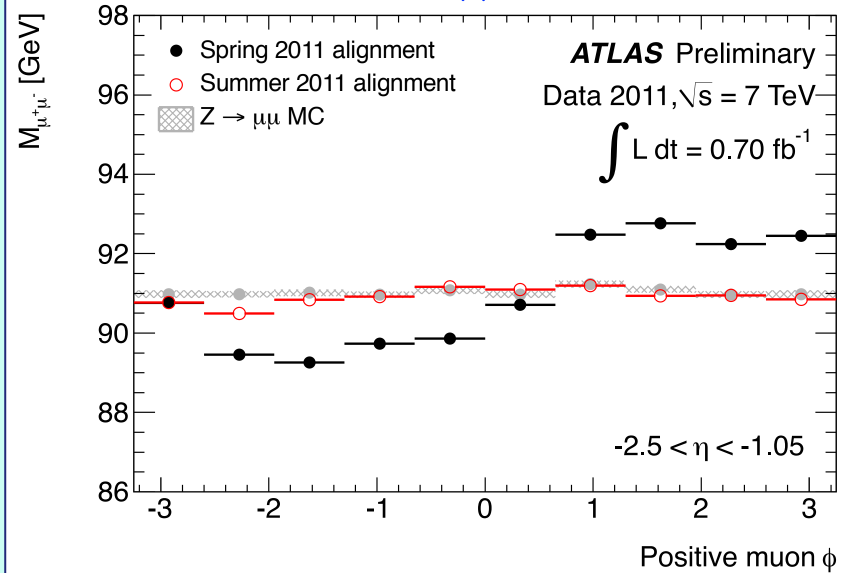


Inner detector performance (1)

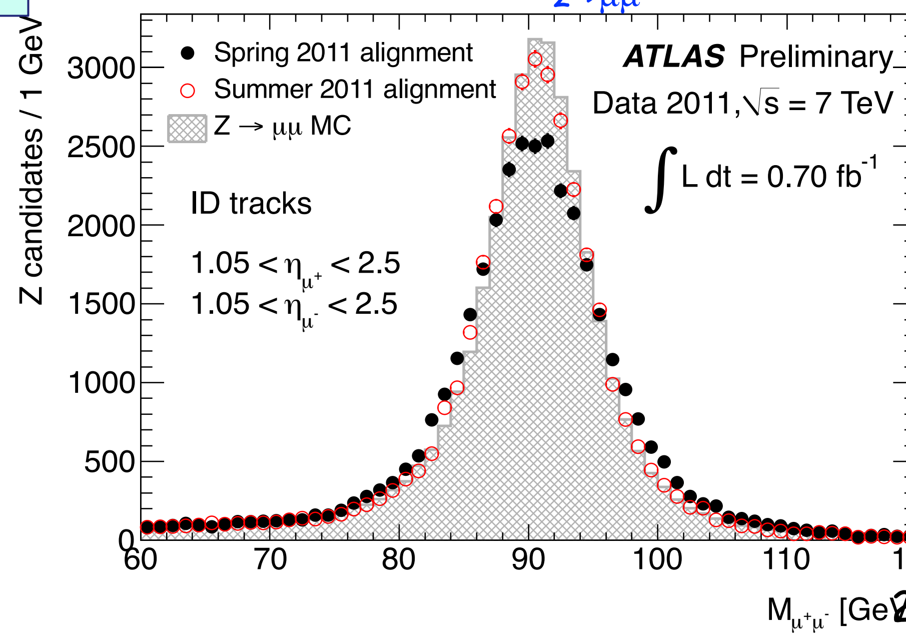
- **P_t scale determined at ‰ level at low P_t and at % level at P_t~100 GeV**
- σ/p_T much improved in summer 2011, in particular in the high p_t region (low p_T region dominated by multiple scattering):
- Increased statistics
- B field–ID tilt correction in y (0.55 mrad)
- Constrain E/p measurement for e^+ and e^-

Data close to MC and close to design
Response independent of φ
(e.g. σ_Z improvement in end-cap by factor 3)

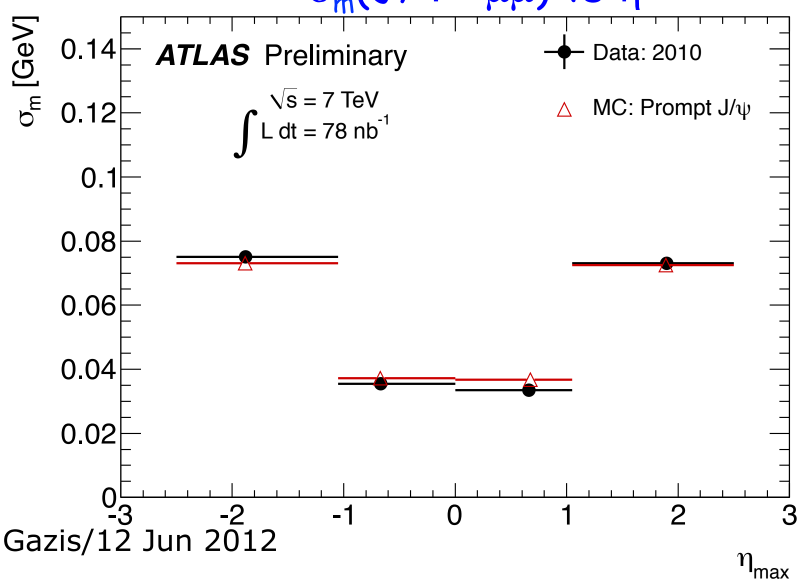
$M_{Z\to\mu\mu}$ vs ϕ



$M_{Z\to\mu\mu}$



$\sigma_m(J/\Psi\to\mu\mu)$ vs η



Inner detector performance (2)

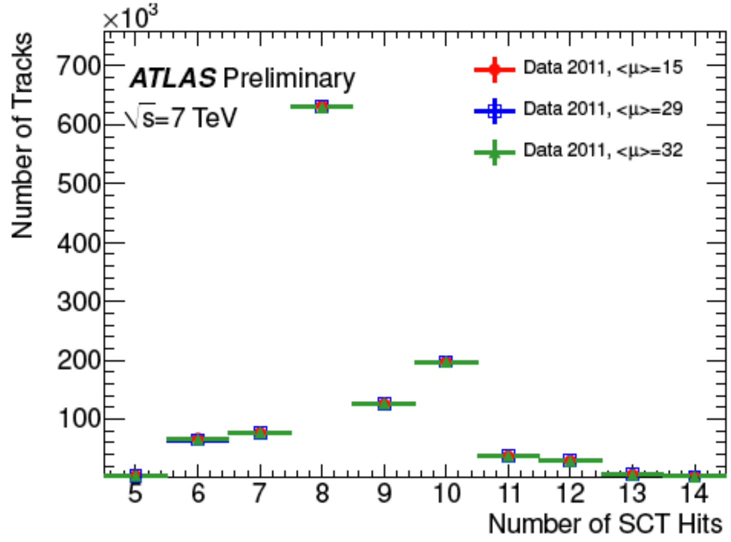
Noise occupancy and hit efficiency exceed the design specifications:
- Hit efficiency: Pixels/SCT>>99% ; TRT >95%
- Noise Occupancy: Pixel< 10^{-9}; SCT<5×10^{-4}, TRT~ 2%.

- Good TRT particle identification over all η

Number of pixel, SCT and TRT hits for tracks meeting the robust requirements in data taken at medium and high pile-up.

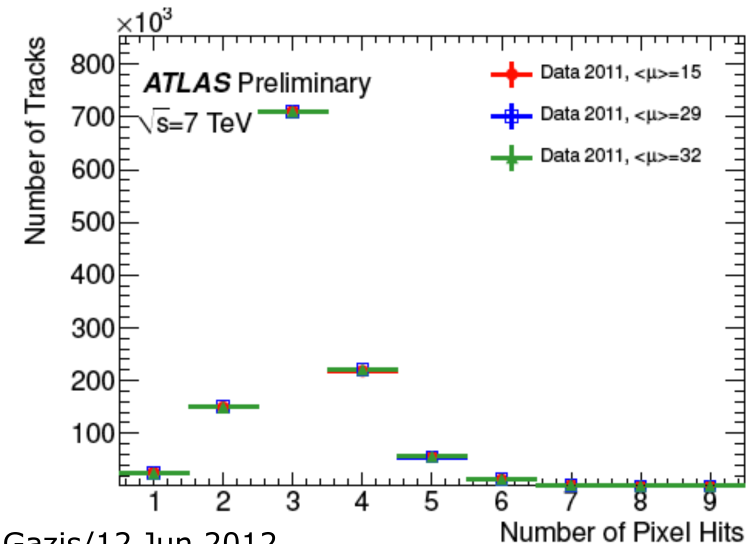
The distributions are normalized to the same number of reconstructed tracks.

SCT #Tracks vs # Hits

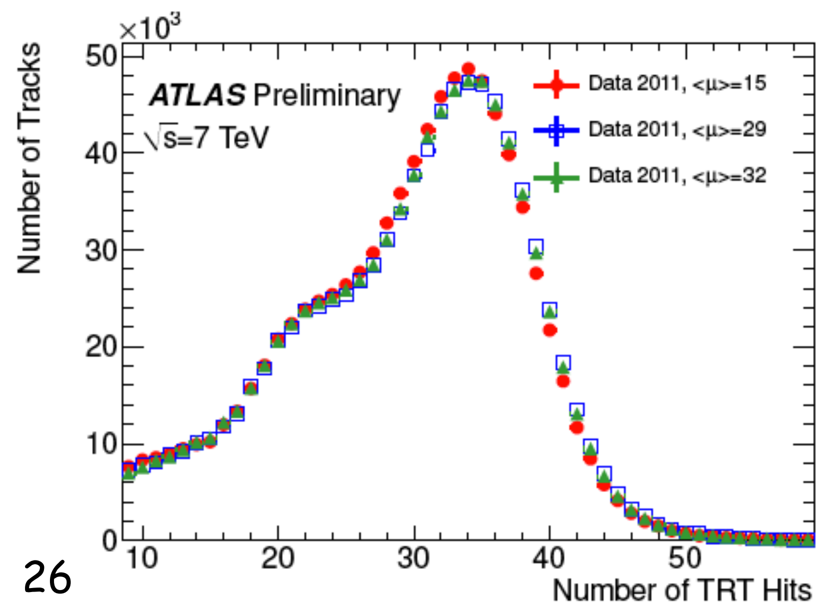


SCT

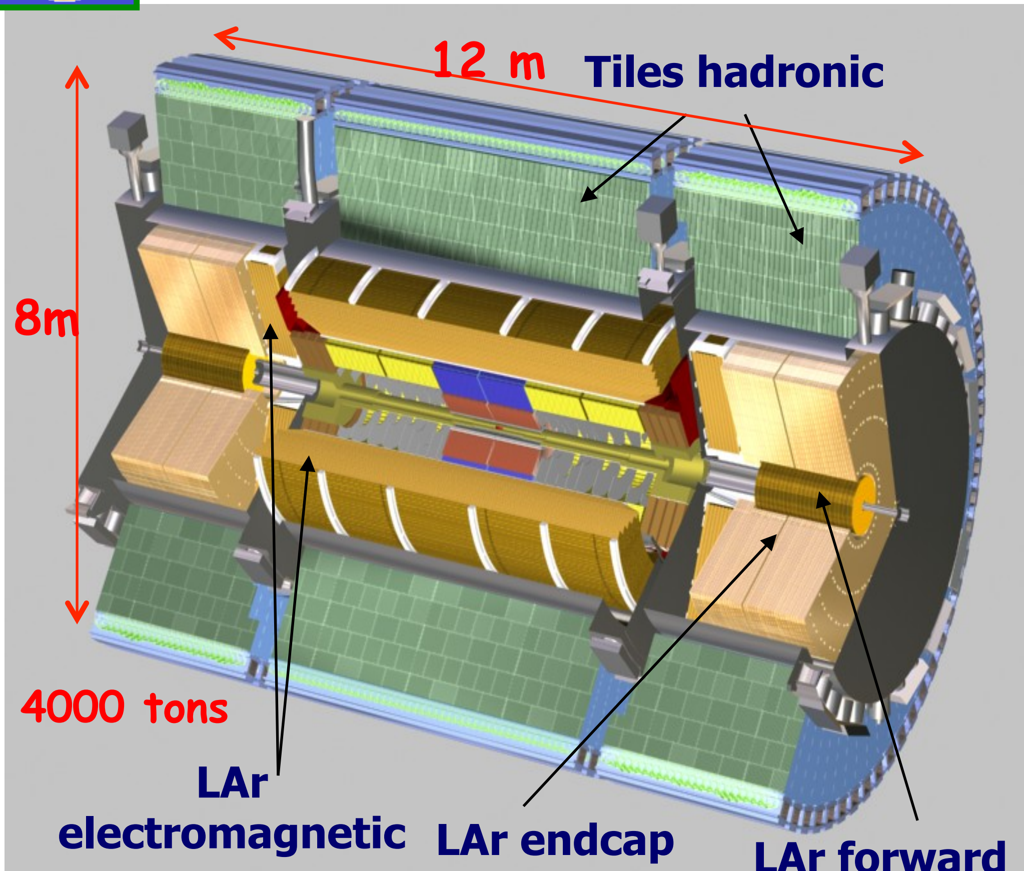
TRT



Pixel



The Atlas calorimeter (|η|<4.9)



Hadron calorimeter

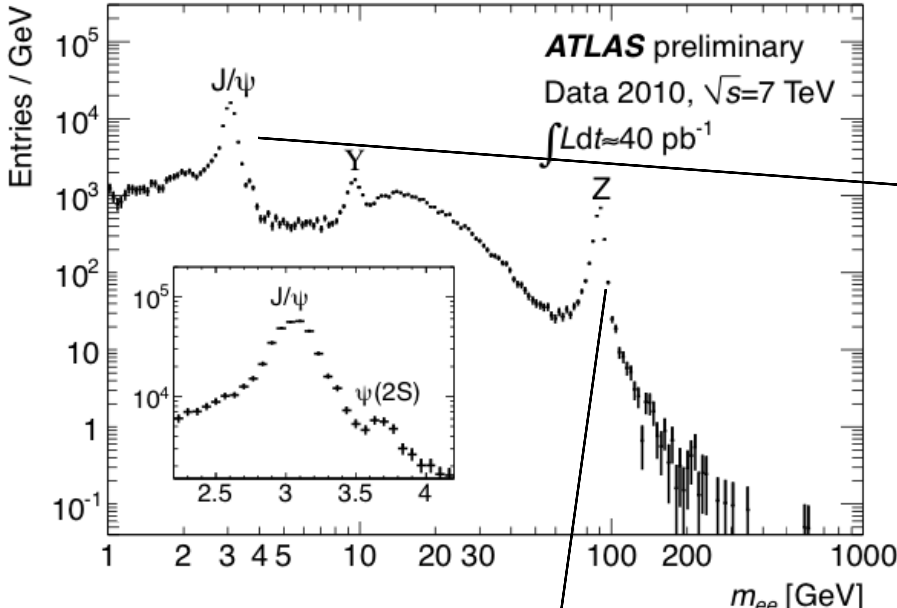
- Trigger, jet measurement E_t^{miss}
- σ/E ~ 50%√E⊕0.03
- |η|<1.7: Fe/scint. Tiles (Tilecal)
- 3.2 <|η|<1.5: Cu-Lar (HEC)
- 3.1<|η|<4.9: FCAL Cu/W-Lar

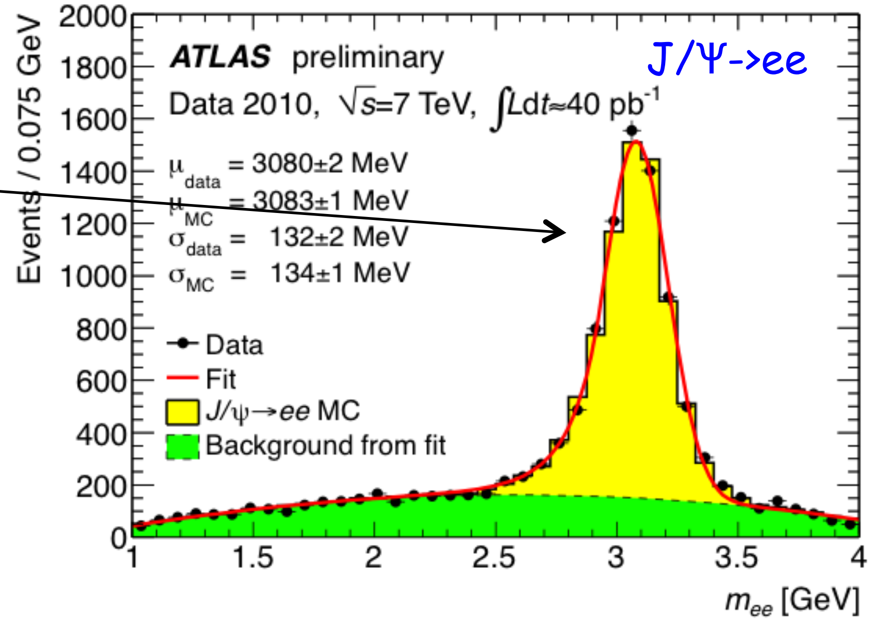
- |η|<4.9
- 10l at |η|=0
- 3-4 Longitudinal layers
- $20x10^3$ channels

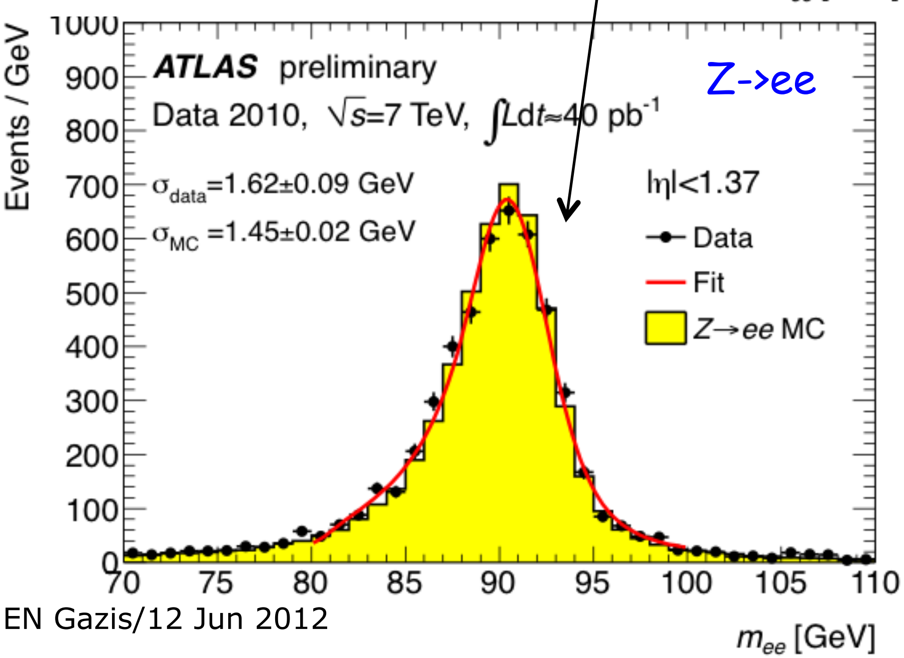
Lar-Pb EM calorimeter:
- e/γ trigger, identification; measurement

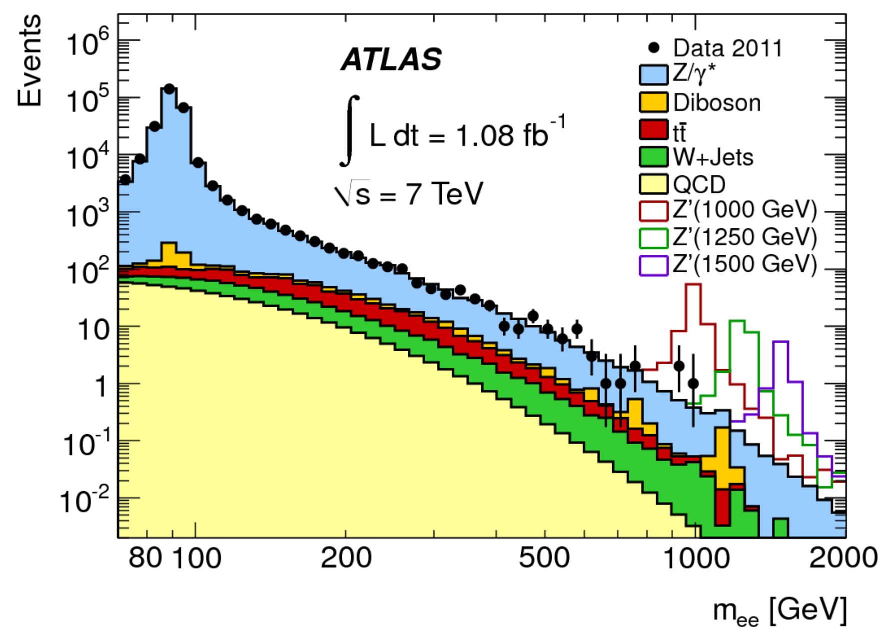
3 longitudinal layers with different granularity: 2.5 <η<3.2 only 2 layers, extra presampler layer for η<1.8, σ/E ~ 10%√E
- Barrel **|η|<1.475,** End-cap **1.375<|η|<3.2**
- 173k channels

EM-Calo Performance-Resonances with known particles and searching for new ones







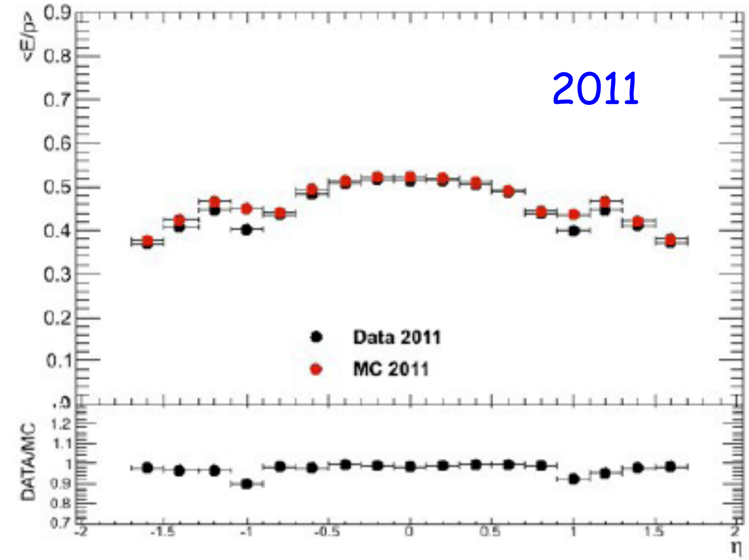


Hadron calorimeter performance

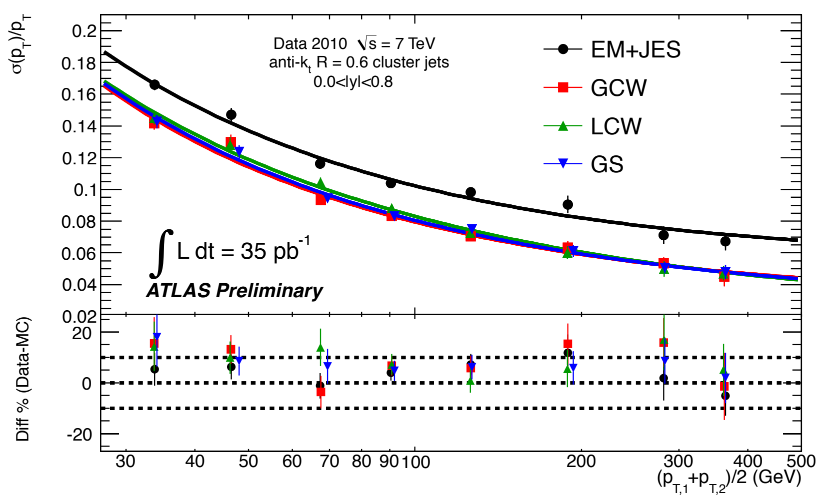
- Good performance, agreement with MC (within 10%) thanks to >10 years test-beam, cosmics.
Resolution close to design:
 - constant term ~3% at ~2TeV (GCW/LCW/GS calibrations)
 - Further improvement of 10% on resolution using track-jet based calibration method (TBJC) .

-2011: Pile-up worsen low pt resolution by ~20%. Improvements expected after pile-up corrections for in-time/out-time bunches/noise threshold tuning (LAr drift time ~500ns ; bipolar shaping designed for $<E_T>$~0 at 25ns bunch spacing)

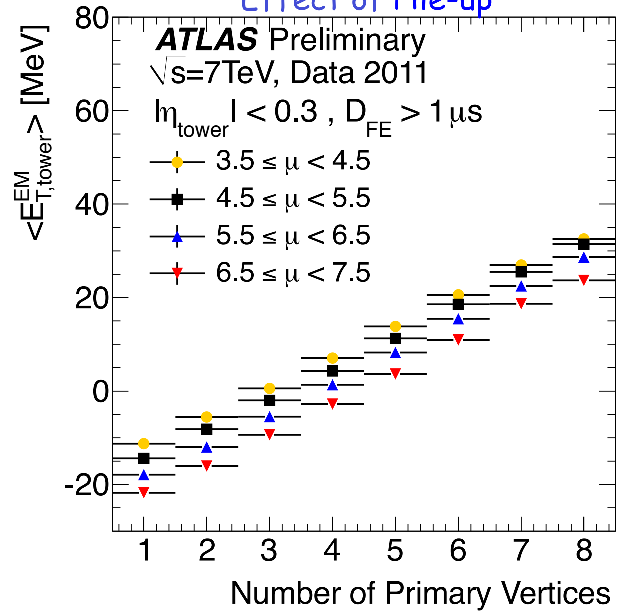
E/p response in Tile had. calorimeter



Jet resolution (Lar+Tilecal (|η|<0.8)



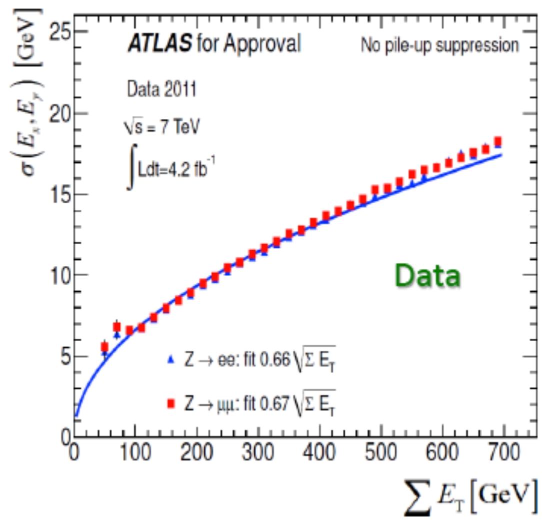
Effect of Pile-up

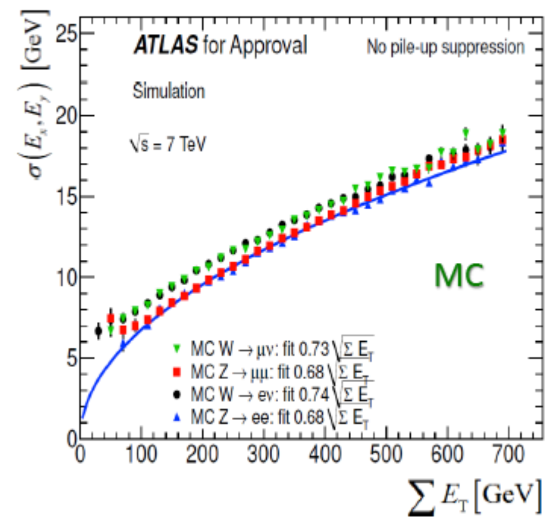


E_t^{miss} Performance

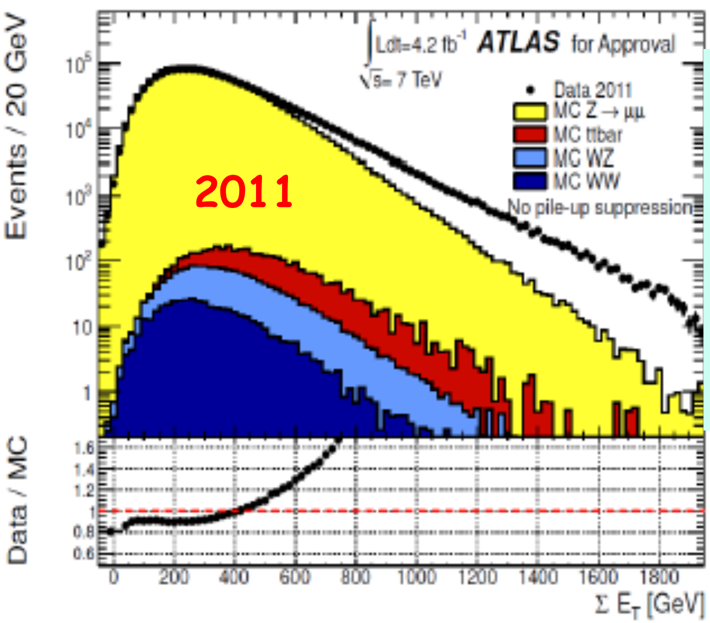
- Key element for many searches and precise measurements (SUSY, top,…)
- Sensitive to calorimeter performance
- Good resolution in p and Pb collisions:
- $\sigma(E_T)=0.48 X \Sigma E_T$
- Good data-MC agreement
- No tails in min.bias sample
- Scale precision ~2% (W->eν ;W->μν)

MET Resolution in data & MC:



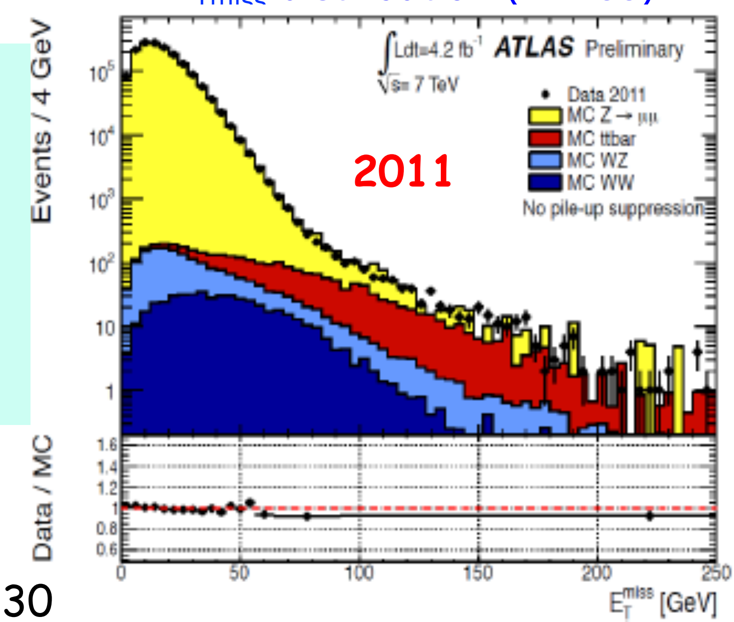


sum E_T distribution with di-jets



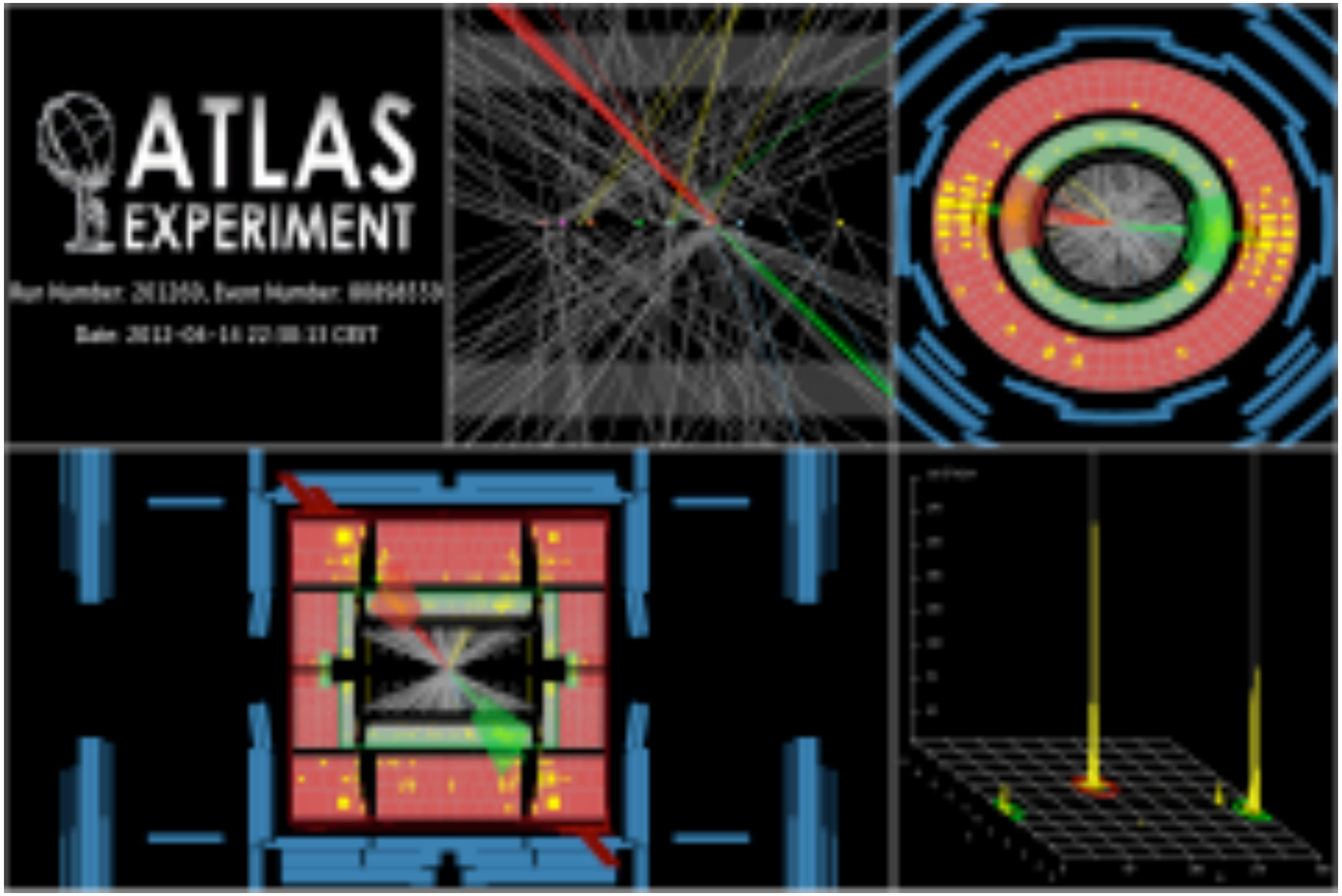
In 2011: Optimal performance require pile-up/noise tuned corrections vs Luminosity in LAr cells to set $< E_T > \sim 0$ independently of L (being done)

E_{Tmiss} distribution (Z->ee)



Highest-mass dijet event taken on 14 April 2012

M_{jj} = 4.23 TeV



Mjj = 4.23 TeV
Jet 1: p_T = 1.36 TeV, η = -1.02, φ =3.01
Jet 2: p_T = 1.29 TeV, η = 1.06, φ = 0.09
Etmiss = 125 GeV, φ = -0.44
Sum Et= 3.33 TeV
p_T (cut) = 0.5 GeV

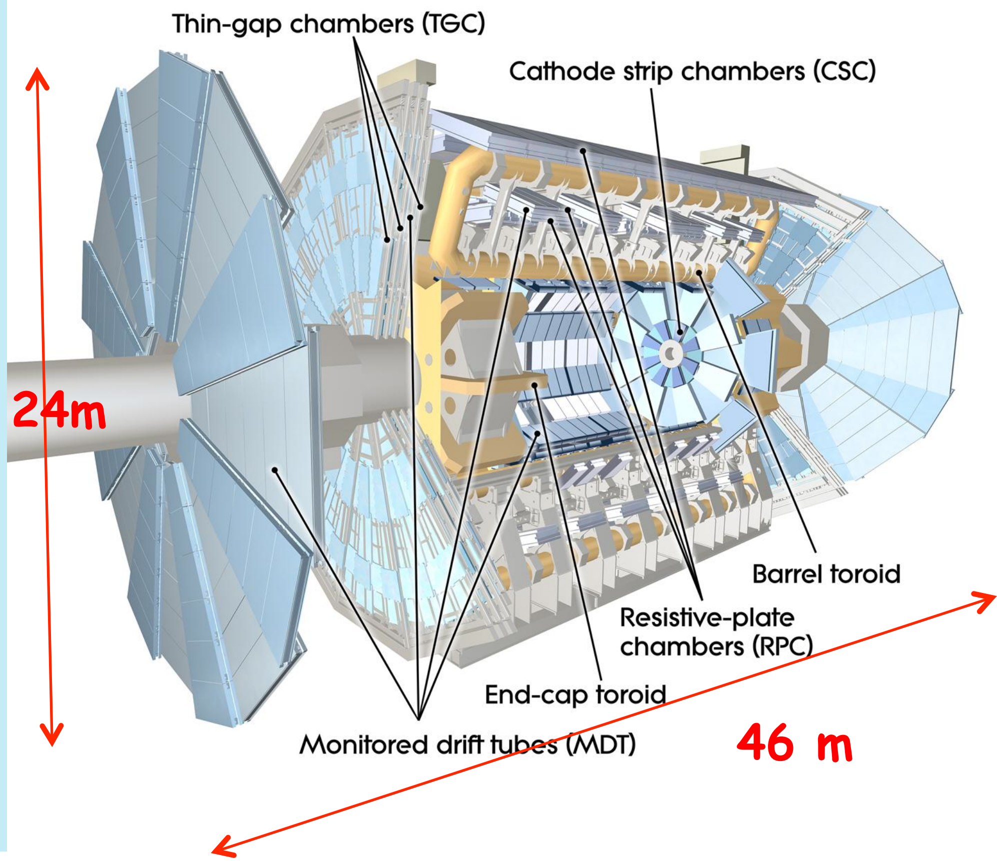
The Atlas Muon Spectrometer(MS)

4 chambers types gas based ($|\eta|<2.7$)
1.1×10^6 channels ; 12000 m^3

Precision chambers : MDT ; CSC Trigger chambers (LVL1): RPC ; TGC

Muon trigger and measurement
Alignment accuracy: ~ 30-40 μm
MDT resolution = 80 μm ($|\eta|<2$)
CSC resolution =60 μm ($2<|\eta|<2.7$)

Momentum resolution (ID+MS) $|\eta|<1.1$:
$\sigma p_T/p_T$ ~10% (p_T ~ 1 TeV)
$\sigma p_T/p_T$ ~2% (p_T =50 GeV)

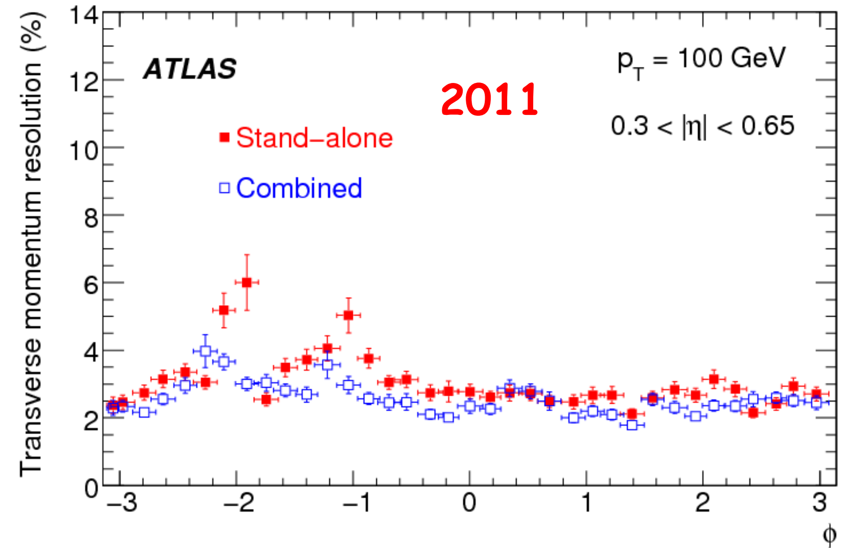


ATLAS MAGNET SYSTEM

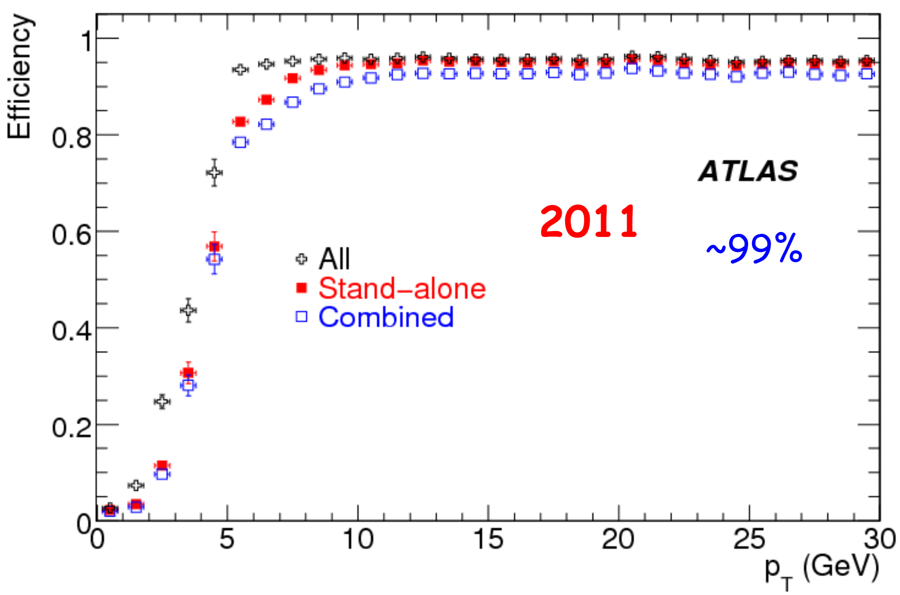
4 Superconducting magnets:
- **Solenoid around ID (B=2T;7.6 kA)**
- **3 Air core Toroids (with 8 coils each: 22.0 kA)**
- **B_{toroid} ~0.5-1T**

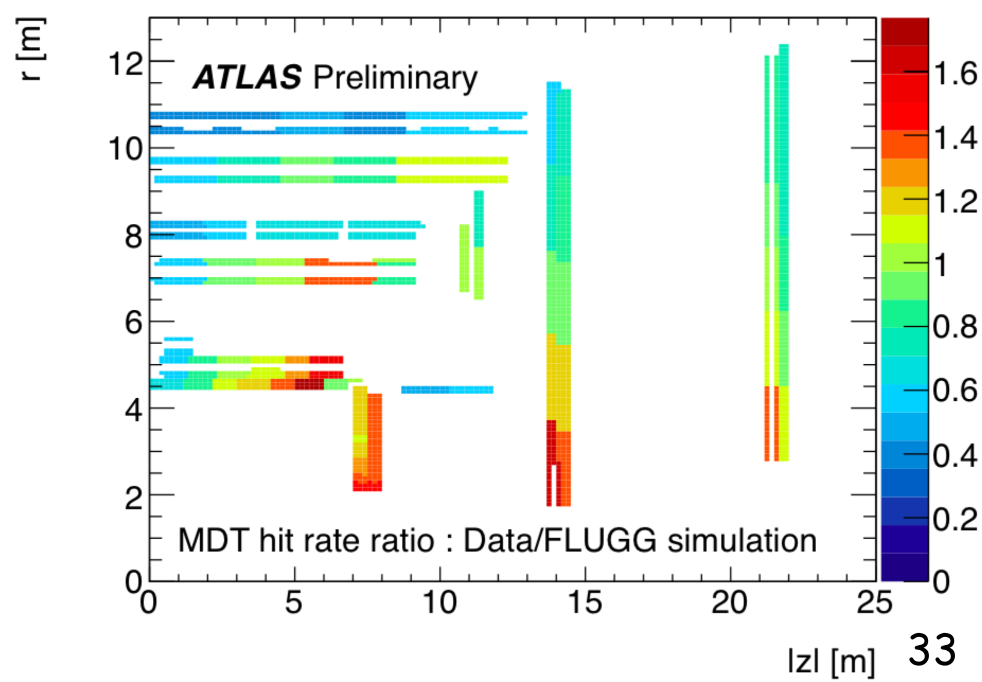
Muon Spectrometer performance (1)

- Alignment precision continuously been improved:
  - **barrel: cosmics->collisions (60μm->50μm).**
  - **End-cap: collisions with B_{off} (180μm ->100μm)**
  - Goal is 30-40 mm with more calibration runs (B_{off})
- $\sigma p_T/p_T$ close to design up to ~100GeV:
  - At low P_t mult. scattering in ID dominate (~2%)
  - TeV region improvement after better alignment
- 99% reconstruction efficiency (pt>20GeV)
- Good agreement data-MC



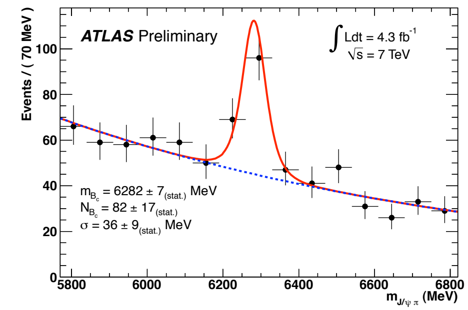
Muon reconstruction efficiency vs p_T

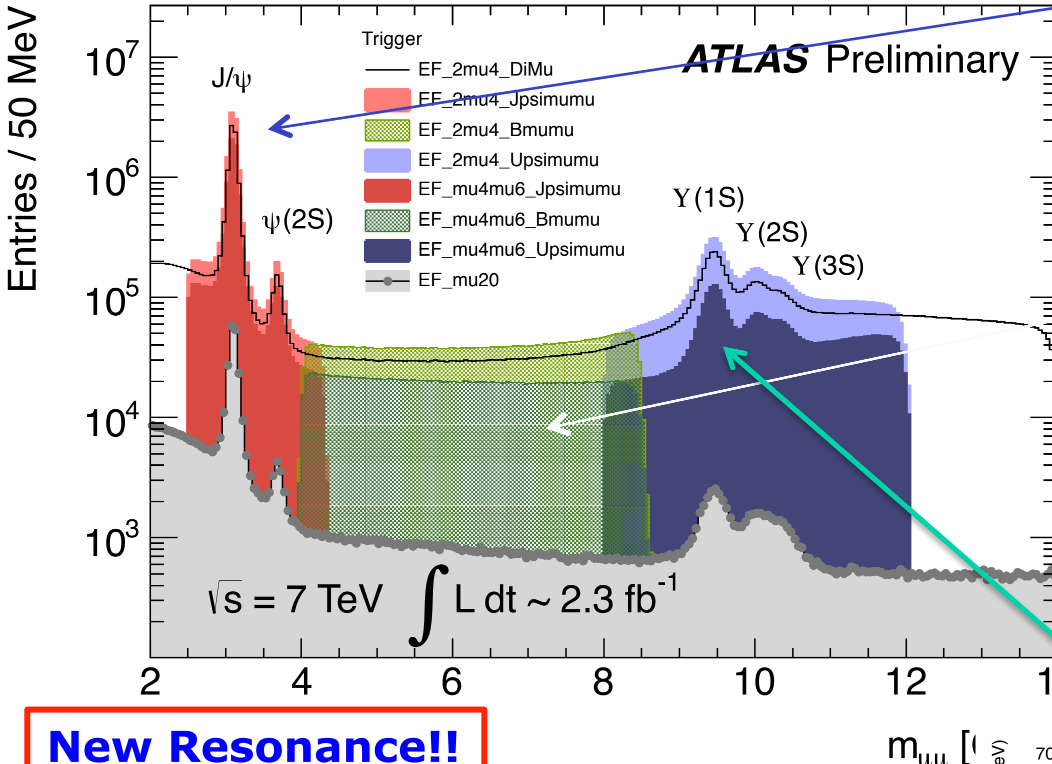




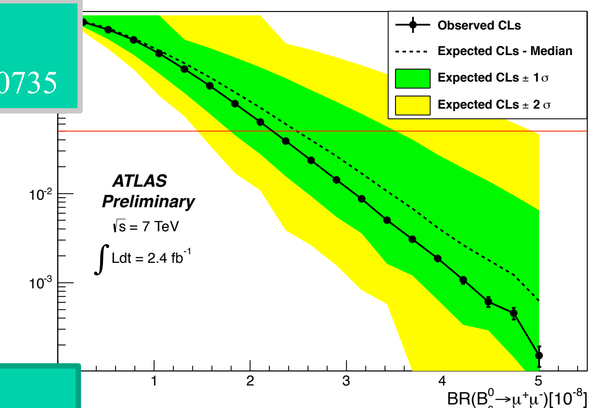
Muon Resonances searches for discoveries

B_c observation
ATLAS-CONF-2012-028
Also λ_b lifetime





B->μμ
arxiv:1204.0735

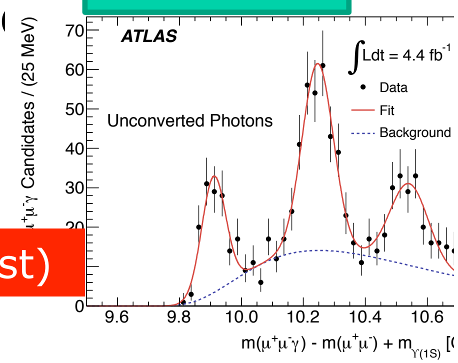


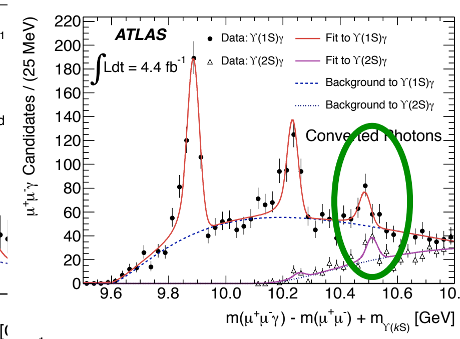
X_b
arxiv:1112.5154

New Resonance!!

$X_b(3P) \to \Upsilon(1s, 2s)\ \gamma$

$M[X_b(3P)] = 10.539 \pm 0.004\ (stat) \pm 0.008\ (syst)$

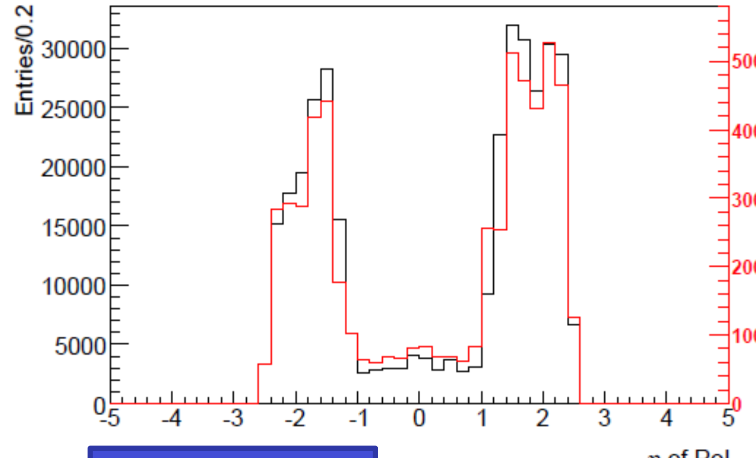




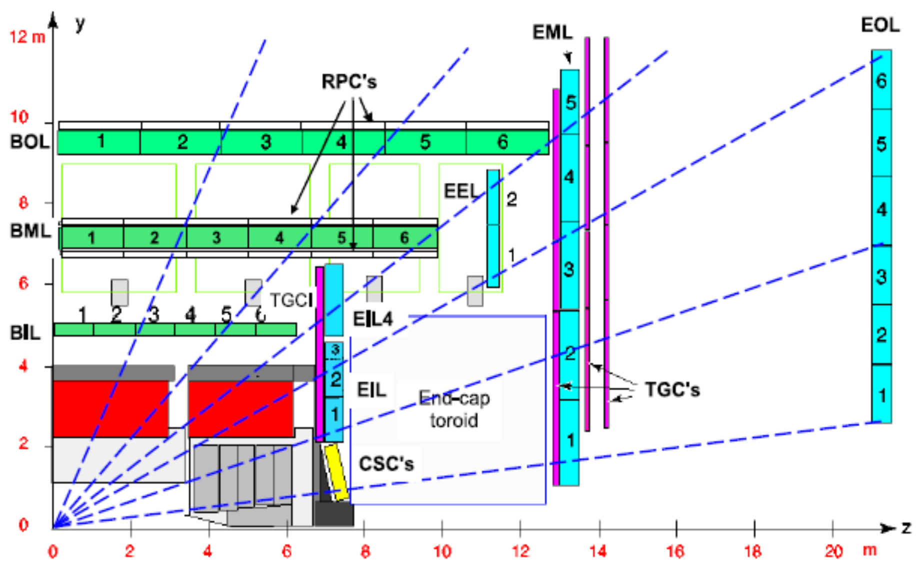
MUON Upgrade

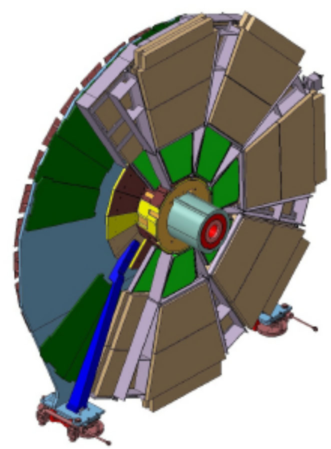
To improve the high-rate trigger efficiency at the S-LHC phase and to avoid fake triggers

Background for 20 GeV muons all in endcap



P_t> 20 GeV





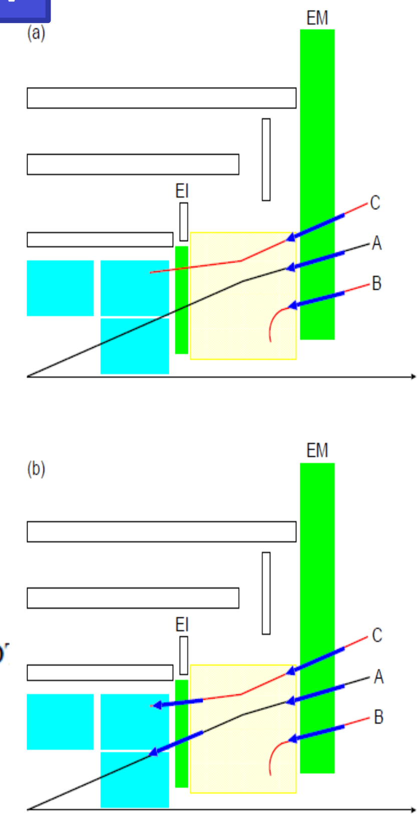


Figure 2.1. Left: A z-y view of 1/4 of the ATLAS detector. The blue boxes indicate the end-cap MD' chambers and the yellow box CSC. Right: A view of a small wheel mounted on the JD disk shielding.

LHC plans (LS1, LS2, LS3)

LS = Long Shutdown

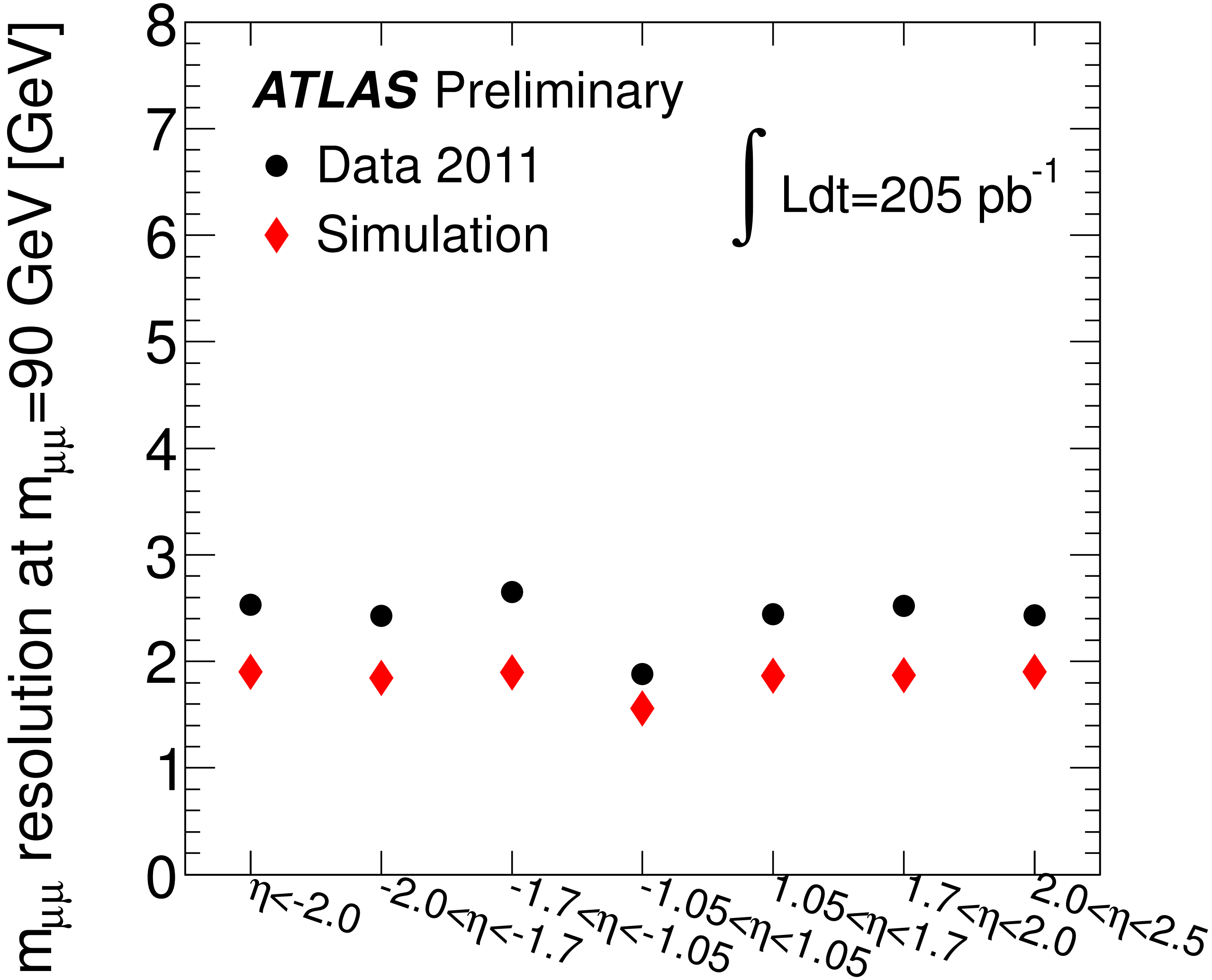
2009		LHC start up, $\sqrt{s}$ = 900 GeV	
2010–2012		$\sqrt{s}$ = 7-8 TeV, $L = 6 \text{ to } 8 \cdot 10^{33} cm^{-2}s^{-1}$, bunch spacing **50 ns**	~25 fb^{-1}
2013–2014	LS1	Go to design energy, nominal luminosity	
2015–2017		$\sqrt{s}$ = 13-14 TeV, $L = 1 \cdot 10^{34} cm^{-2}s^{-1}$, bunch spacing **25 ns** **(likely to be more)**	~50 fb^{-1}
2018	LS2	Injector & LHC Phase I upgrade to full design luminosity	
2019–2021		$\sqrt{s}$ = 14 TeV, $L = 2 \cdot 10^{34} cm^{-2}s^{-1}$, bunch spacing **25 ns** **(likely to be more)**	~300 fb^{-1}
2022	LS3	HL-LHC Phase-2 upgrade, crab cavities?, IR	
2023–2030?		$\sqrt{s}$ = 14 TeV, $L = 5 \cdot 10^{34} cm^{-2}s^{-1}$, bunch spacing **25 ns** **Plan for 50% more**	~3000 fb^{-1}

Conclusions

- ATLAS had an excellent year in 2011 due to the high luminosity delivered by LHC and the hard work of the collaboration to deal with high pileup. ATLAS is exploiting the full physics potential of LHC.
- Many excellent physics results based on the 2011 run are presented in detail to the summer conferences
- Data taking in 2012 is proceeding smoothly and improvements for high pileup have been largely successful
- ATLAS is working diligently to design and build upgrades to cope with the high luminosities expected after LS1, LS2 and LS3
- The upgrade R&D and projects are getting at full speed.

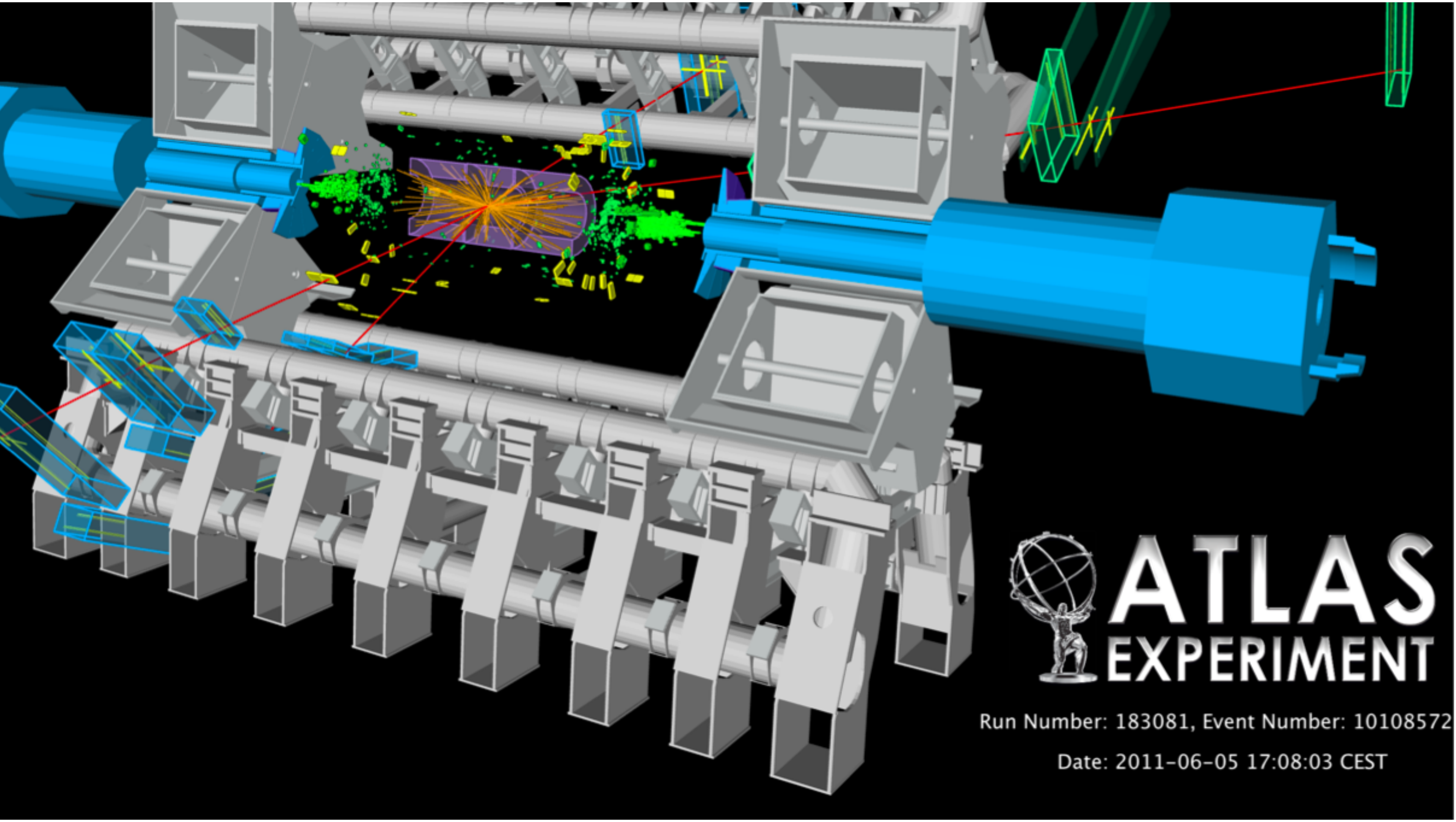
Many thanks to LHC machine for it's excellent performance!

Backup slides

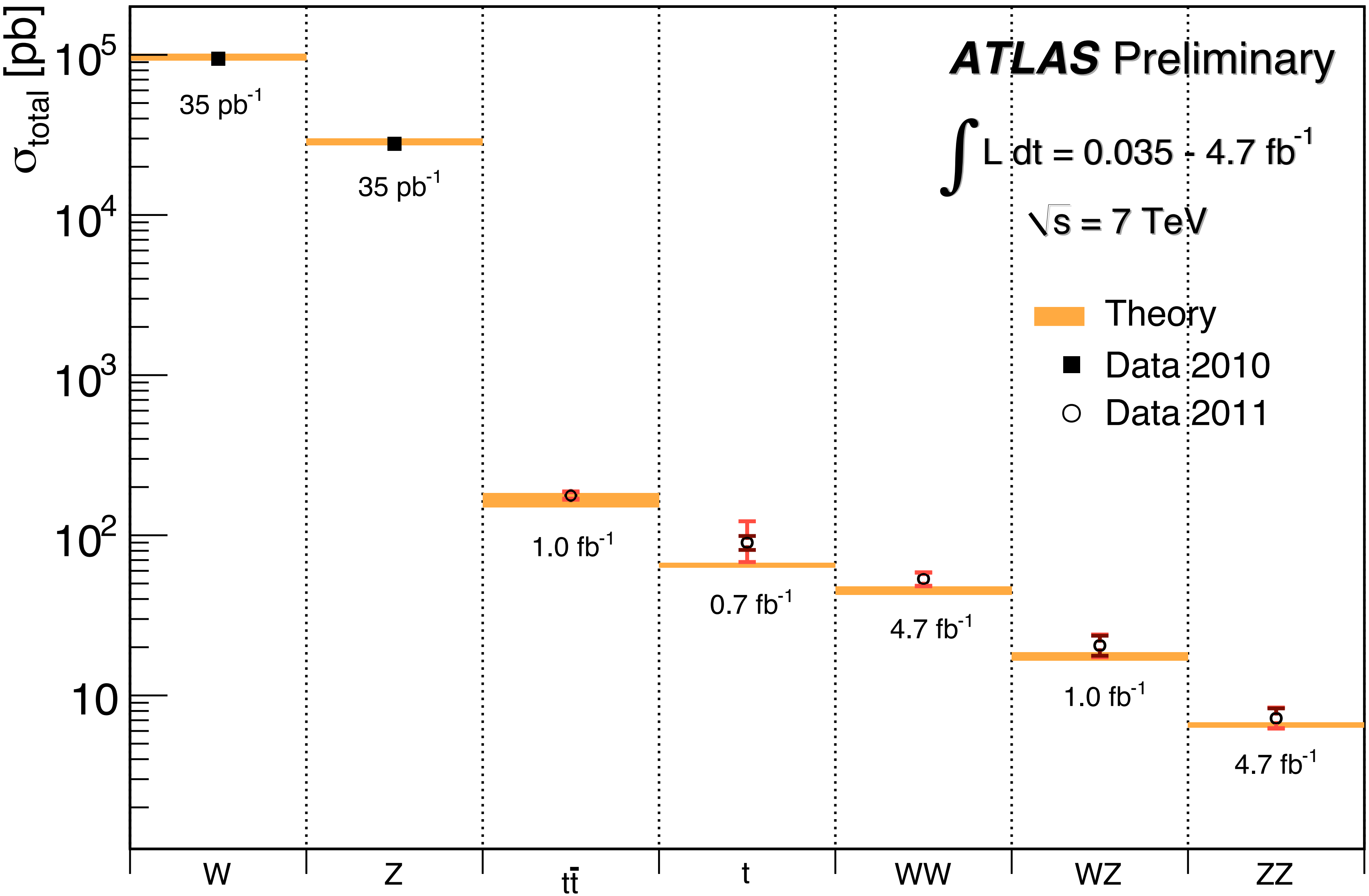


ZZ* ->4m candidate

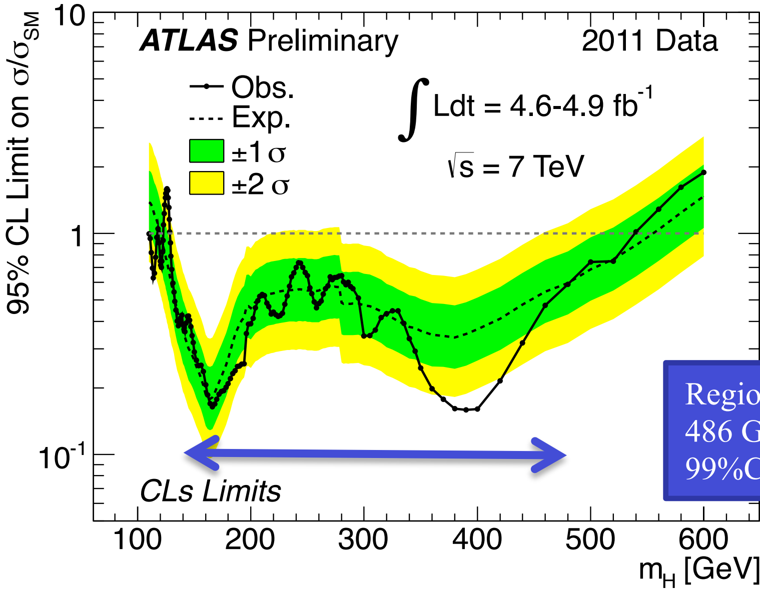
$M_{Z,1}$=90.6GeV ; $M_{Z*,2}$=47.4 GeV; M_{4m}=143.5GeV



Standard Model

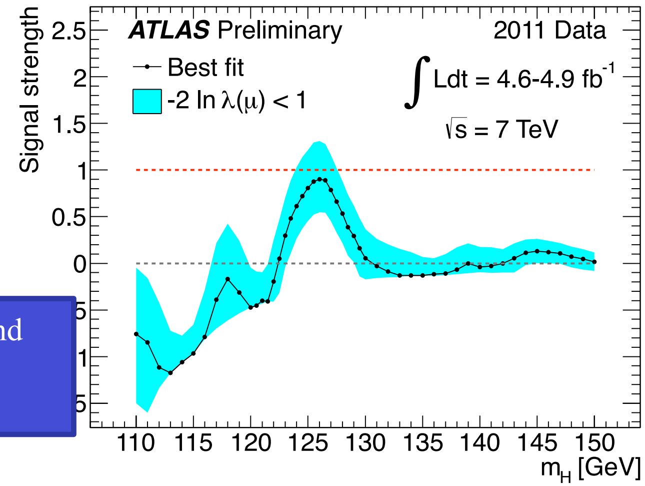


Higgs



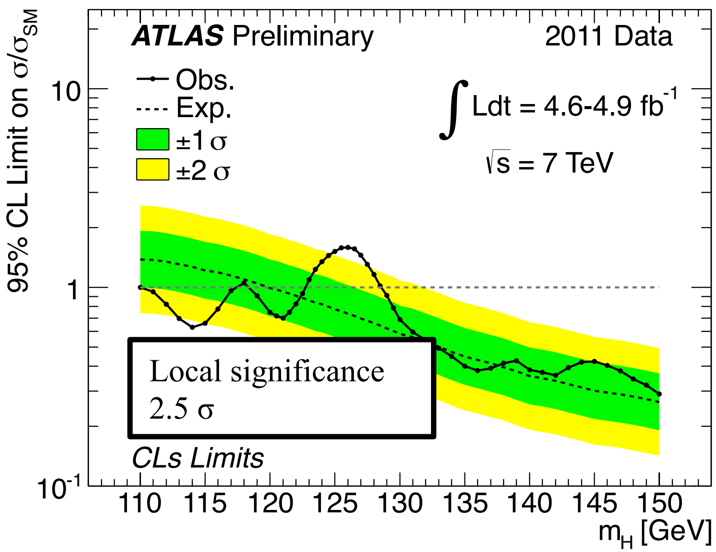
Region between 130 and 486 Gev excluded at 99%C.L

Excess seen in the low mass region:



Excess consistent with SM cross section

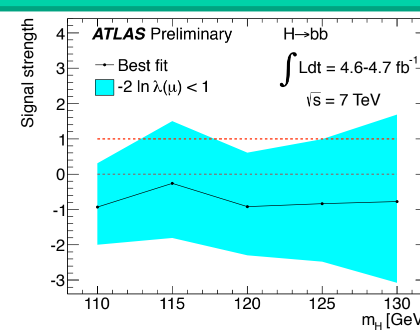
Global probability for such an excess on this plot is ~10%



Local significance 2.5 σ

Many interesting Higgs questions:

- Is there more than one Higgs?
- Are the couplings what one expects?



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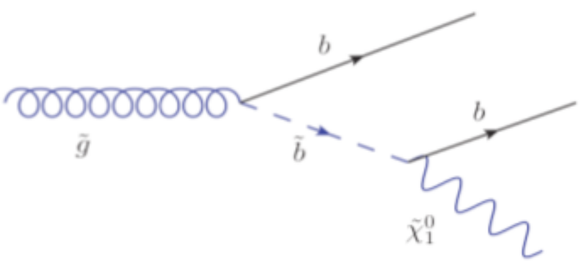
SUSY

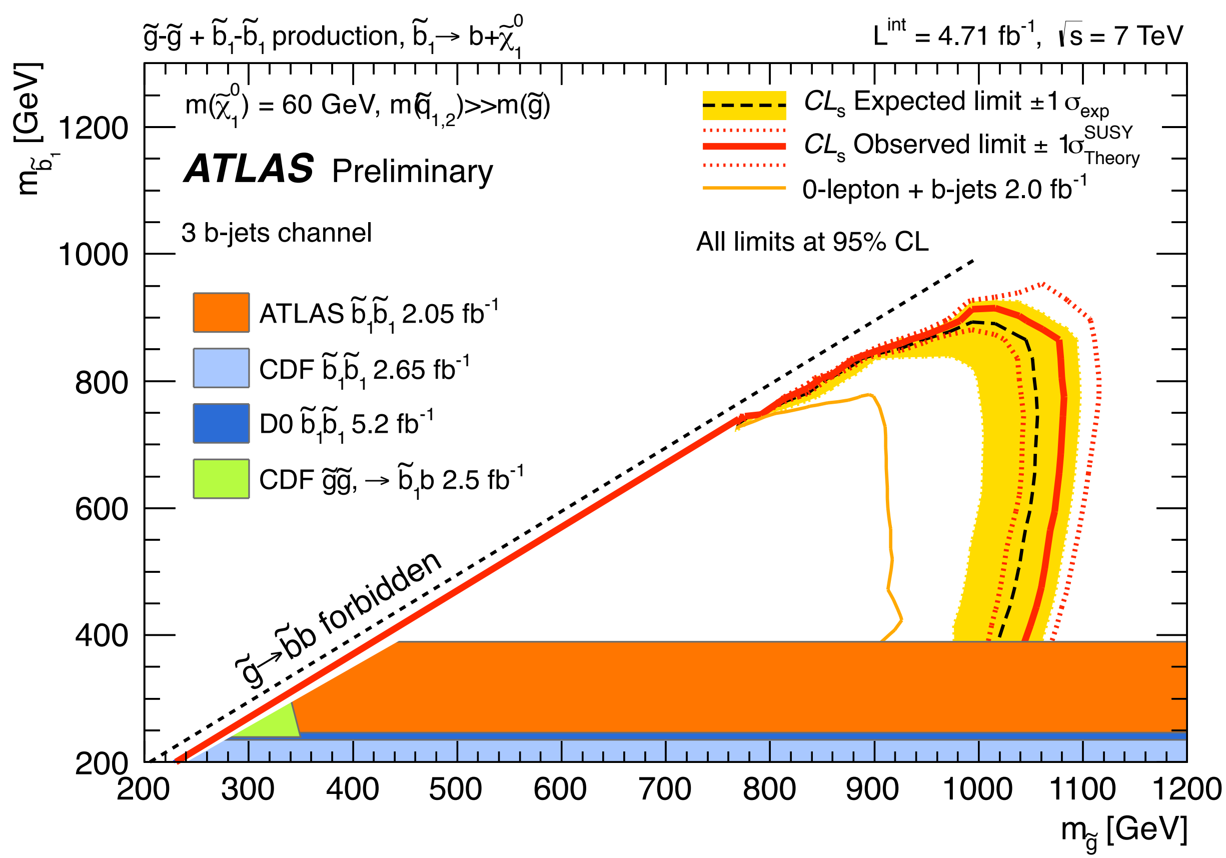
New conference notes on lightest third generation scenarios:

•ATLAS-CONF-2012-058: Search for gluino-mediated scalar top and bottom quark production in final states with missing transverse energy and at least three *b-jets*

•ATLAS-CONF-2012-059: Search for light scalar top quark pair production in final states with two leptons

Example: 4b final state

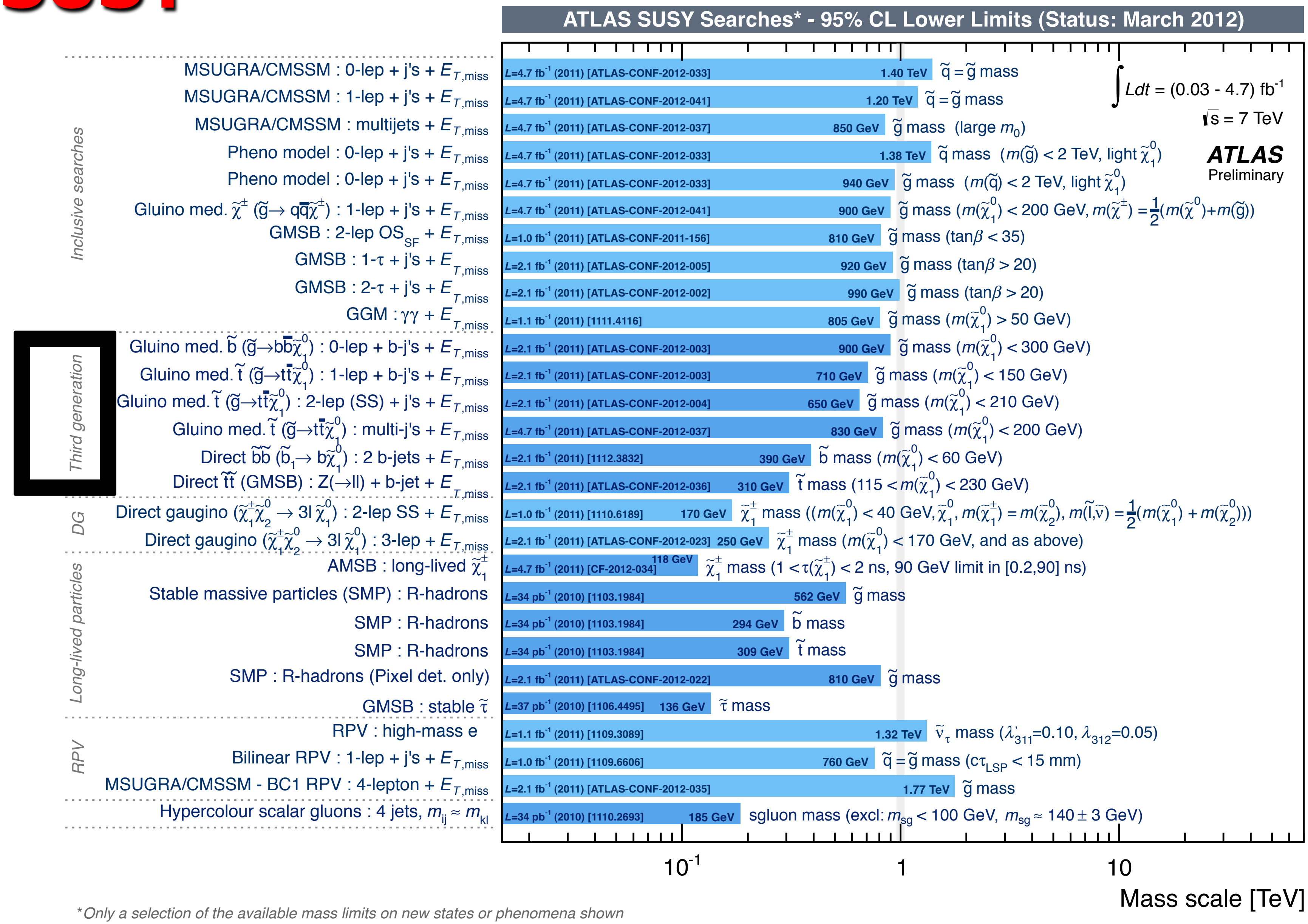




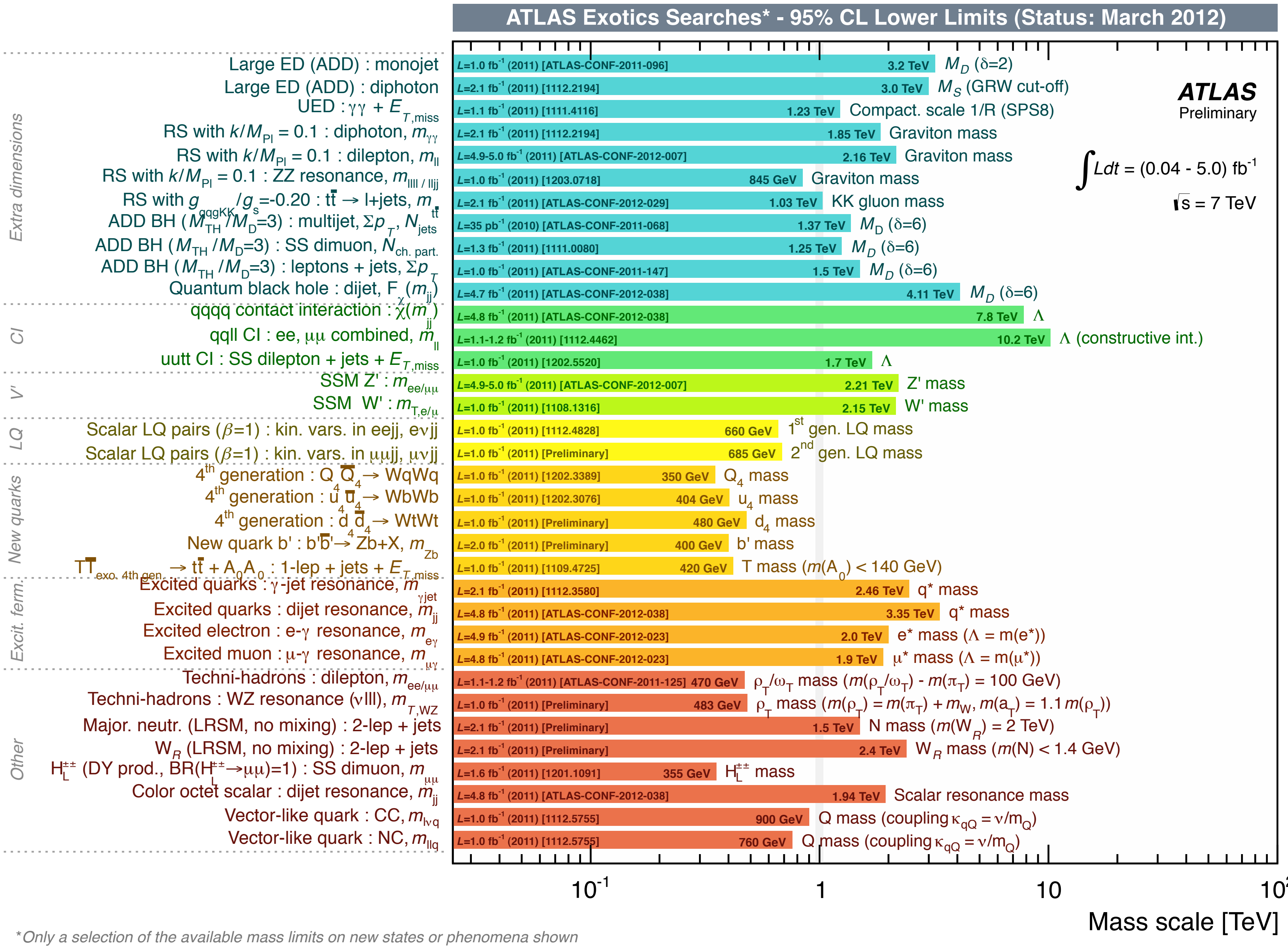
•T. EIFERT
SUSY and BSM searches in ATLAS (5B)

•J. MCFAYDEN
Search for supersymmetric gauginos and third generation squarks with the ATLAS detector (5E)

SUSY


ATLAS SUSY Searches* - 95% CL Lower Limits (Status: March 2012)
∫Ldt = (0.03 - 4.7) fb^-1
√s = 7 TeV
ATLAS
Preliminary
Inclusive searches
MSUGRA/CMSSM : 0-lep + j's + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-033] — 1.40 TeV — q̃ = g̃ mass
MSUGRA/CMSSM : 1-lep + j's + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-041] — 1.20 TeV — q̃ = g̃ mass
MSUGRA/CMSSM : multijets + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-037] — 850 GeV — g̃ mass (large m_0)
Pheno model : 0-lep + j's + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-033] — 1.38 TeV — q̃ mass (m(g̃) < 2 TeV, light χ̃_1^0)
Pheno model : 0-lep + j's + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-033] — 940 GeV — g̃ mass (m(q̃) < 2 TeV, light χ̃_1^0)
Gluino med. χ̃^± (g̃→qq̄χ̃^±) : 1-lep + j's + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-041] — 900 GeV — g̃ mass (m(χ̃_1^0) < 200 GeV, m(χ̃^±) = ½(m(χ̃^0)+m(g̃))
GMSB : 2-lep OS_SF + E_T,miss — L=1.0 fb^-1 (2011) [ATLAS-CONF-2011-156] — 810 GeV — g̃ mass (tanβ < 35)
GMSB : 1-τ + j's + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-005] — 920 GeV — g̃ mass (tanβ > 20)
GMSB : 2-τ + j's + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-002] — 990 GeV — g̃ mass (tanβ > 20)
GGM : γγ + E_T,miss — L=1.1 fb^-1 (2011) [1111.4116] — 805 GeV — g̃ mass (m(χ̃_1^0) > 50 GeV)
Third generation
Gluino med. b̃ (g̃→bb̄χ̃_1^0) : 0-lep + b-j's + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-003] — 900 GeV — g̃ mass (m(χ̃_1^0) < 300 GeV)
Gluino med. t̃ (g̃→tt̄χ̃_1^0) : 1-lep + b-j's + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-003] — 710 GeV — g̃ mass (m(χ̃_1^0) < 150 GeV)
Gluino med. t̃ (g̃→tt̄χ̃_1^0) : 2-lep (SS) + j's + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-004] — 650 GeV — g̃ mass (m(χ̃_1^0) < 210 GeV)
Gluino med. t̃ (g̃→tt̄χ̃_1^0) : multi-j's + E_T,miss — L=4.7 fb^-1 (2011) [ATLAS-CONF-2012-037] — 830 GeV — g̃ mass (m(χ̃_1^0) < 200 GeV)
Direct b̃b̃ (b̃_1→bχ̃_1^0) : 2 b-jets + E_T,miss — L=2.1 fb^-1 (2011) [1112.3832] — 390 GeV — b̃ mass (m(χ̃_1^0) < 60 GeV)
Direct t̃t̃ (GMSB) : Z(→ll) + b-jet + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-036] — 310 GeV — t̃ mass (115 < m(χ̃_1^0) < 230 GeV)
DG
Direct gaugino (χ̃_1^±χ̃_2^0 → 3l χ̃_1^0) : 2-lep SS + E_T,miss — L=1.0 fb^-1 (2011) [1110.6189] — 170 GeV — χ̃_1^± mass ((m(χ̃_1^0) < 40 GeV, χ̃_1^0, m(χ̃_1^±) = m(χ̃_2^0), m(l̃,ν̃) = ½(m(χ̃_1^0) + m(χ̃_2^0)))
Direct gaugino (χ̃_1^±χ̃_2^0 → 3l χ̃_1^0) : 3-lep + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-023] — 250 GeV — χ̃_1^± mass (m(χ̃_1^0) < 170 GeV, and as above)
Long-lived particles
AMSB : long-lived χ̃_1^± — L=4.7 fb^-1 (2011) [CF-2012-034] — 118 GeV — χ̃_1^± mass (1 < τ(χ̃_1^±) < 2 ns, 90 GeV limit in [0.2,90] ns)
Stable massive particles (SMP) : R-hadrons — L=34 pb^-1 (2010) [1103.1984] — 562 GeV — g̃ mass
SMP : R-hadrons — L=34 pb^-1 (2010) [1103.1984] — 294 GeV — b̃ mass
SMP : R-hadrons — L=34 pb^-1 (2010) [1103.1984] — 309 GeV — t̃ mass
SMP : R-hadrons (Pixel det. only) — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-022] — 810 GeV — g̃ mass
GMSB : stable τ̃ — L=37 pb^-1 (2010) [1106.4495] — 136 GeV — τ̃ mass
RPV
RPV : high-mass eμ — L=1.1 fb^-1 (2011) [1109.3089] — 1.32 TeV — ν̃_τ mass (λ'_311=0.10, λ_312=0.05)
Bilinear RPV : 1-lep + j's + E_T,miss — L=1.0 fb^-1 (2011) [1109.6606] — 760 GeV — q̃ = g̃ mass (cτ_LSP < 15 mm)
MSUGRA/CMSSM - BC1 RPV : 4-lepton + E_T,miss — L=2.1 fb^-1 (2011) [ATLAS-CONF-2012-035] — 1.77 TeV — g̃ mass
Hypercolour scalar gluons : 4 jets, m_ij ≈ m_kl — L=34 pb^-1 (2010) [1110.2693] — 185 GeV — sgluon mass (excl: m_sg < 100 GeV, m_sg ≈ 140 ± 3 GeV)
10^-1
1
10
Mass scale [TeV]
*Only a selection of the available mass limits on new states or phenomena shown

Exotics



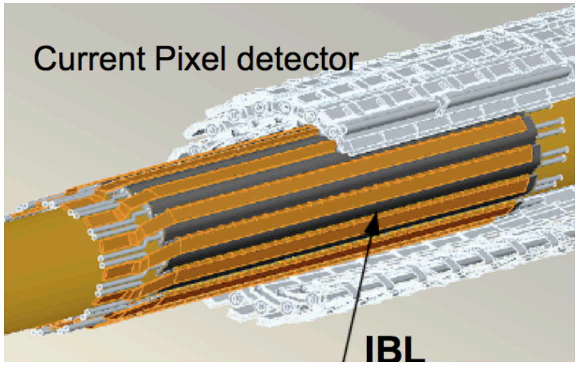
ATLAS Exotics Searches* - 95% CL Lower Limits (Status: March 2012)
ATLAS
Preliminary
∫Ldt = (0.04 - 5.0) fb⁻¹
√s = 7 TeV
Extra dimensions
CI
V'
LQ
New quarks
Excit. ferm.
Other
Large ED (ADD) : monojet
L=1.0 fb⁻¹ (2011) [ATLAS-CONF-2011-096] 3.2 TeV
M_D (δ=2)
Large ED (ADD) : diphoton
L=2.1 fb⁻¹ (2011) [1112.2194] 3.0 TeV
M_S (GRW cut-off)
UED : γγ + E_T,miss
L=1.1 fb⁻¹ (2011) [1111.4116] 1.23 TeV
Compact. scale 1/R (SPS8)
RS with k/M_Pl = 0.1 : diphoton, m_γγ
L=2.1 fb⁻¹ (2011) [1112.2194] 1.85 TeV
Graviton mass
RS with k/M_Pl = 0.1 : dilepton, m_ll
L=4.9-5.0 fb⁻¹ (2011) [ATLAS-CONF-2012-007] 2.16 TeV
Graviton mass
RS with k/M_Pl = 0.1 : ZZ resonance, m_llll / lljj
L=1.0 fb⁻¹ (2011) [1203.0718] 845 GeV
Graviton mass
RS with g_qqgKK/g_s=-0.20 : tt̄ → l+jets, m_tt̄
L=2.1 fb⁻¹ (2011) [ATLAS-CONF-2012-029] 1.03 TeV
KK gluon mass
ADD BH (M_TH/M_D=3) : multijet, Σp_T, N_jets
L=35 pb⁻¹ (2010) [ATLAS-CONF-2011-068] 1.37 TeV
M_D (δ=6)
ADD BH (M_TH/M_D=3) : SS dimuon, N_ch. part.
L=1.3 fb⁻¹ (2011) [1111.0080] 1.25 TeV
M_D (δ=6)
ADD BH (M_TH/M_D=3) : leptons + jets, Σp_T
L=1.0 fb⁻¹ (2011) [ATLAS-CONF-2011-147] 1.5 TeV
M_D (δ=6)
Quantum black hole : dijet, F_χ(m_jj)
L=4.7 fb⁻¹ (2011) [ATLAS-CONF-2012-038] 4.11 TeV
M_D (δ=6)
qqqq contact interaction : χ(m_jj)
L=4.8 fb⁻¹ (2011) [ATLAS-CONF-2012-038] 7.8 TeV
Λ
qqll CI : ee, μμ combined, m_ll
L=1.1-1.2 fb⁻¹ (2011) [1112.4462] 10.2 TeV
Λ (constructive int.)
uutt CI : SS dilepton + jets + E_T,miss
L=1.0 fb⁻¹ (2011) [1202.5520] 1.7 TeV
Λ
SSM Z' : m_ee/μμ
L=4.9-5.0 fb⁻¹ (2011) [ATLAS-CONF-2012-007] 2.21 TeV
Z' mass
SSM W' : m_T,e/μ
L=1.0 fb⁻¹ (2011) [1108.1316] 2.15 TeV
W' mass
Scalar LQ pairs (β=1) : kin. vars. in eejj, eνjj
L=1.0 fb⁻¹ (2011) [1112.4828] 660 GeV
1st gen. LQ mass
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj
L=1.0 fb⁻¹ (2011) [Preliminary] 685 GeV
2nd gen. LQ mass
4th generation : Q_4 Q̄_4 → WqWq
L=1.0 fb⁻¹ (2011) [1202.3389] 350 GeV
Q_4 mass
4th generation : u_4 ū_4 → WbWb
L=1.0 fb⁻¹ (2011) [1202.3076] 404 GeV
u_4 mass
4th generation : d_4 d̄_4 → WtWt
L=1.0 fb⁻¹ (2011) [Preliminary] 480 GeV
d_4 mass
New quark b' : b'b̄' → Zb+X, m_Zb
L=2.0 fb⁻¹ (2011) [Preliminary] 400 GeV
b' mass
TT̄_exo. 4th gen. → tt̄ + A_0A_0 : 1-lep + jets + E_T,miss
L=1.0 fb⁻¹ (2011) [1109.4725] 420 GeV
T mass (m(A_0) < 140 GeV)
Excited quarks : γ-jet resonance, m_γjet
L=2.1 fb⁻¹ (2011) [1112.3580] 2.46 TeV
q* mass
Excited quarks : dijet resonance, m_jj
L=4.8 fb⁻¹ (2011) [ATLAS-CONF-2012-038] 3.35 TeV
q* mass
Excited electron : e-γ resonance, m_eγ
L=4.9 fb⁻¹ (2011) [ATLAS-CONF-2012-023] 2.0 TeV
e* mass (Λ = m(e*))
Excited muon : μ-γ resonance, m_μγ
L=4.8 fb⁻¹ (2011) [ATLAS-CONF-2012-023] 1.9 TeV
μ* mass (Λ = m(μ*))
Techni-hadrons : dilepton, m_ee/μμ
L=1.1-1.2 fb⁻¹ (2011) [ATLAS-CONF-2011-125] 470 GeV
ρ_T/ω_T mass (m(ρ_T/ω_T) - m(π_T) = 100 GeV)
Techni-hadrons : WZ resonance (νlll), m_T,WZ
L=1.0 fb⁻¹ (2011) [Preliminary] 483 GeV
ρ_T mass (m(ρ_T) = m(π_T) + m_W, m(a_T) = 1.1 m(ρ_T))
Major. neutr. (LRSM, no mixing) : 2-lep + jets
L=2.1 fb⁻¹ (2011) [Preliminary] 1.5 TeV
N mass (m(W_R) = 2 TeV)
W_R (LRSM, no mixing) : 2-lep + jets
L=2.1 fb⁻¹ (2011) [Preliminary] 2.4 TeV
W_R mass (m(N) < 1.4 GeV)
H_L^±± (DY prod., BR(H_L^±±→μμ)=1) : SS dimuon, m_μμ
L=1.6 fb⁻¹ (2011) [1201.1091] 355 GeV
H_L^±± mass
Color octet scalar : dijet resonance, m_jj
L=4.8 fb⁻¹ (2011) [ATLAS-CONF-2012-038] 1.94 TeV
Scalar resonance mass
Vector-like quark : CC, m_lνq
L=1.0 fb⁻¹ (2011) [1112.5755] 900 GeV
Q mass (coupling κ_qQ = ν/m_Q)
Vector-like quark : NC, m_llq
L=1.0 fb⁻¹ (2011) [1112.5755] 760 GeV
Q mass (coupling κ_qQ = ν/m_Q)
10⁻¹
1
10
10²
Mass scale [TeV]
*Only a selection of the available mass limits on new states or phenomena shown

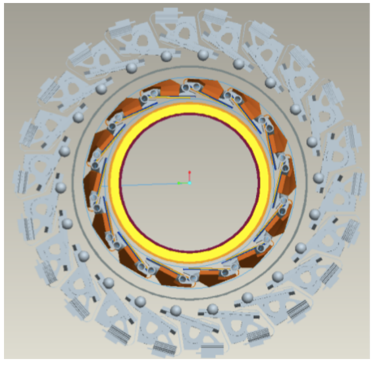
Phase-0 (installation 2013-14)

Main Improvements to Physics Capabilities

1. New small Be pipe
2. New insertable pixel b-layer (IBL) (drives shutdown schedule)
3. Finish the installation of the EE muon chambers staged in 2003 +additional chambers in the feet (new electronics) and elevators region
4. Add topological processing in level 1 of trigger
5. Improve L1 trigger readout rate to 100kHz

IBL preserves current physics performance at high pileup



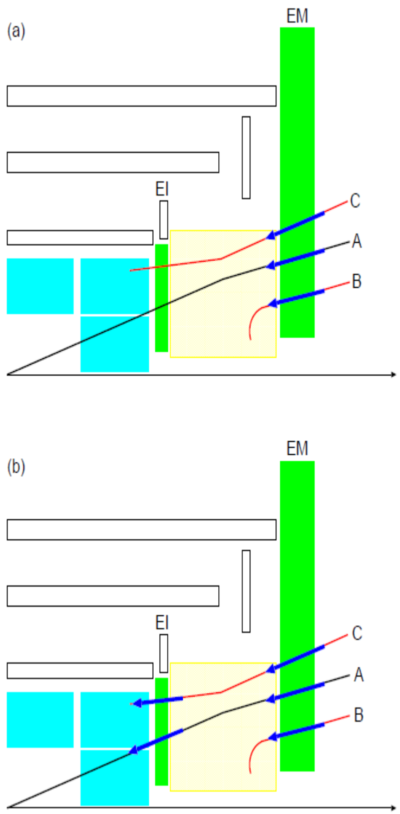


Phase-I (installation in or before 2018)

Major Projects

1. New muon small wheels with more trigger granularity and trigger track vector information
2. Higher-granularity calorimeter LVL1 trigger and associated front-end electronic
3. Fast track processor (FTK) using SCT and pixel hits (input to LVL2) expected installation before 2018
4. Forward physics detection station at 220m for new diffractive physics (full 3D edgeless and timing detectors, target 2017)
5. Topological trigger processors combining LVL1 information from different regions of interest (improvements starting well before 2018)

New muon small wheel



B and C background

Phase-II (installation 2022-23)

Likely upgrades:

1. New Inner Detector (strips and pixels)

Very substantial progress in many R&D areas

2. New LAr front-end and back-end electronics
3. New Tiles front-end and back-end electronics
4. TDAQ upgrade (add level 0 to the trigger?)

Under study:

1. LAr new FCAL
2. LAr HEC cold electronics consolidation
3. Muon Barrel and Large Wheel system upgrade
4. L1 track trigger
5. LUCID upgrade