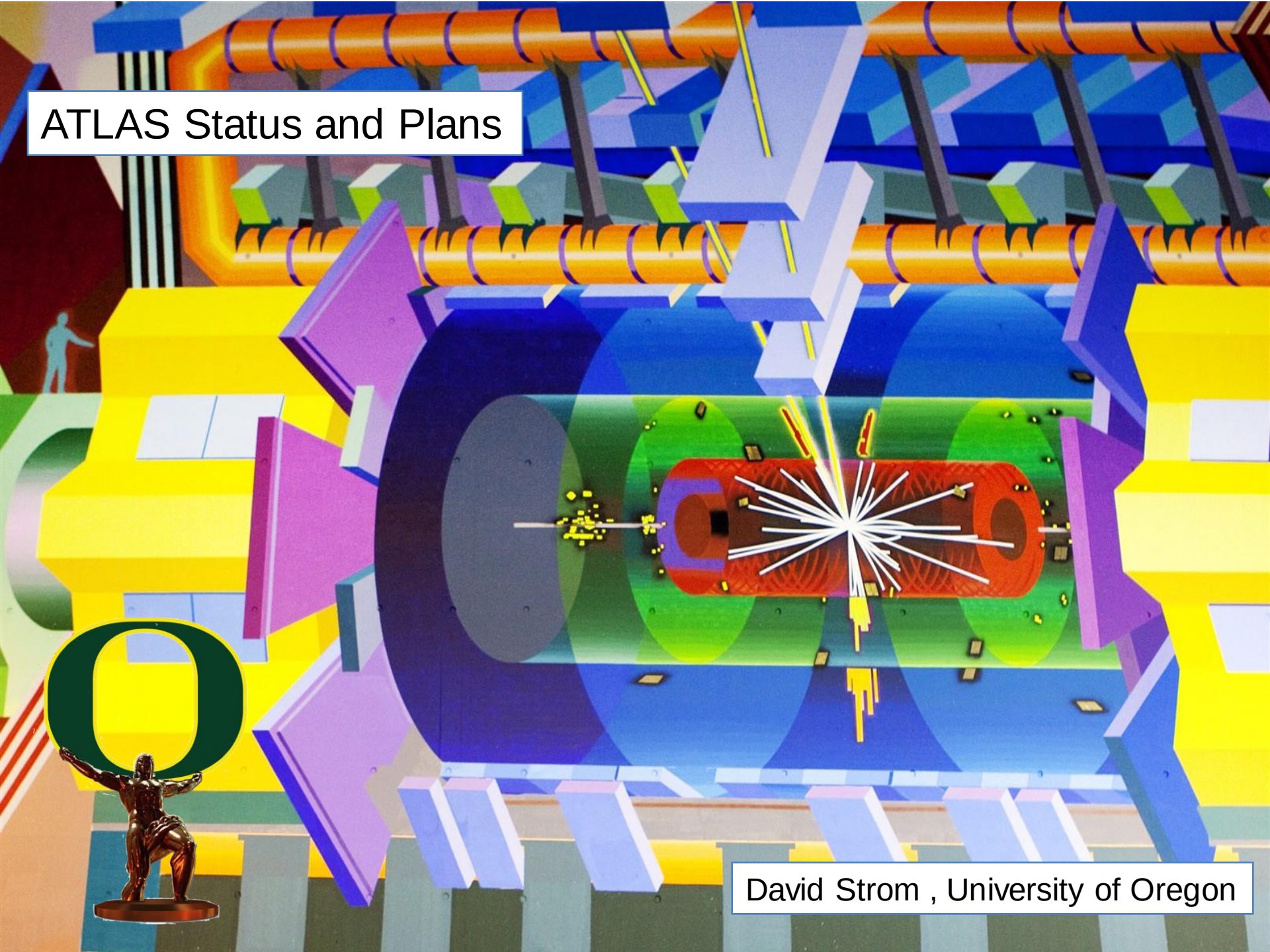
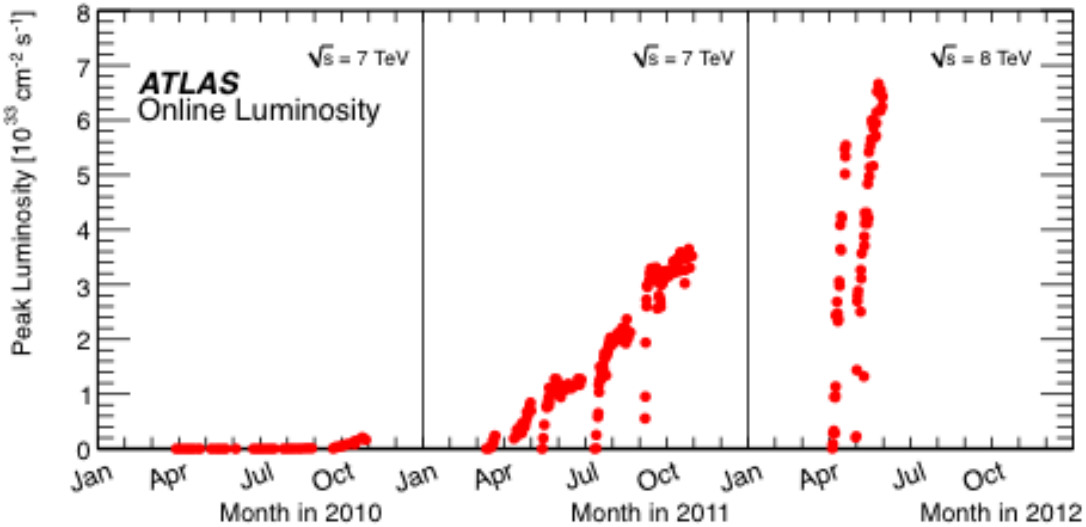
ATLAS Status and Plans

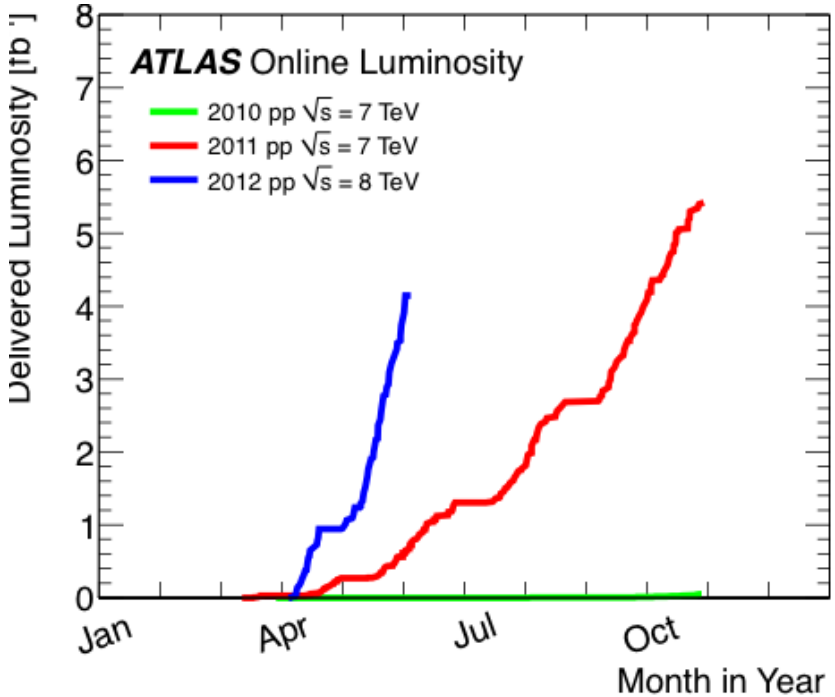


David Strom , University of Oregon

Thanks LHC!



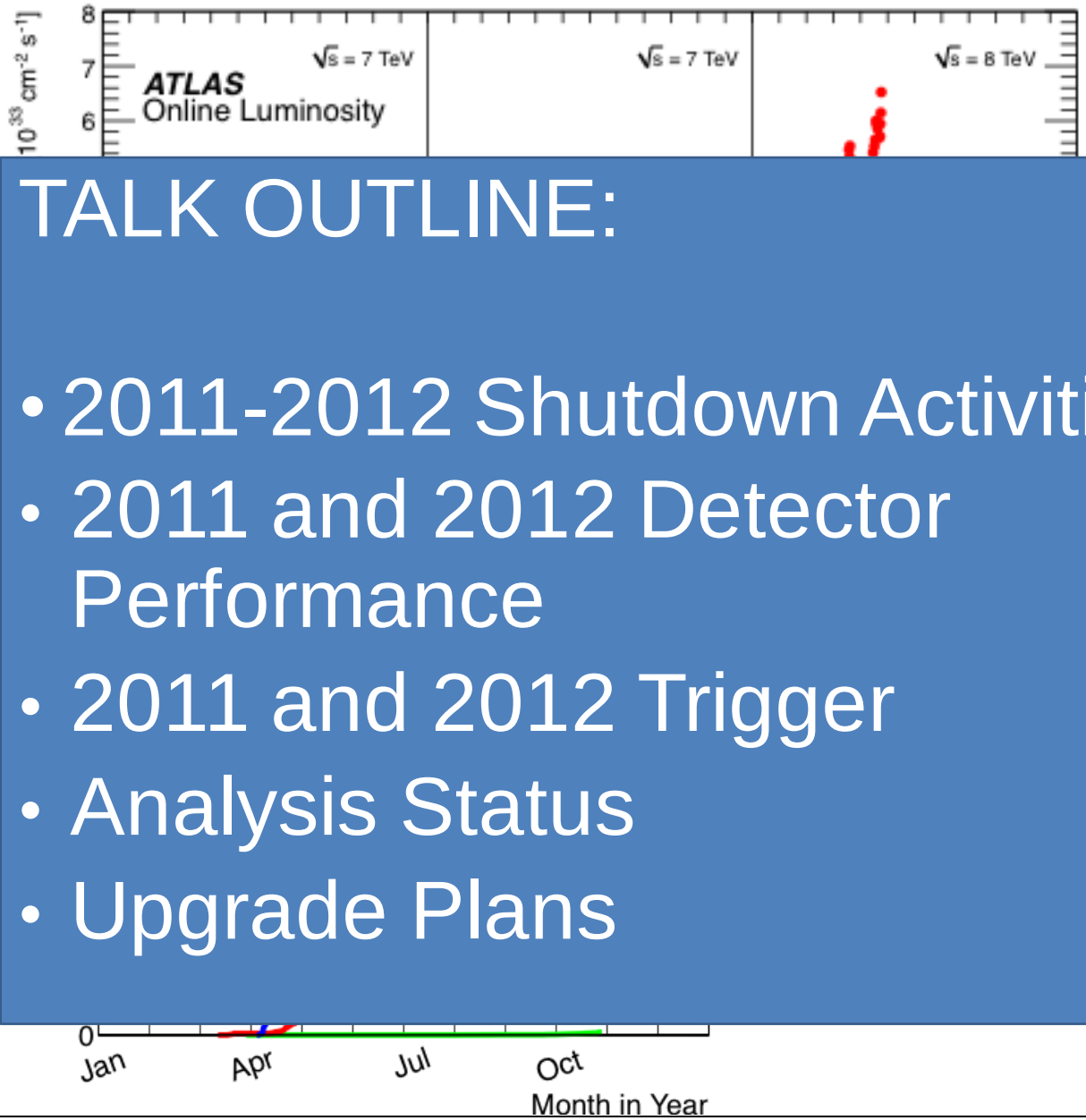
Very rapid rise in luminosity



Hope to be off the plot soon

Good machine stability leads to high integrated luminosity

Thanks LHC!



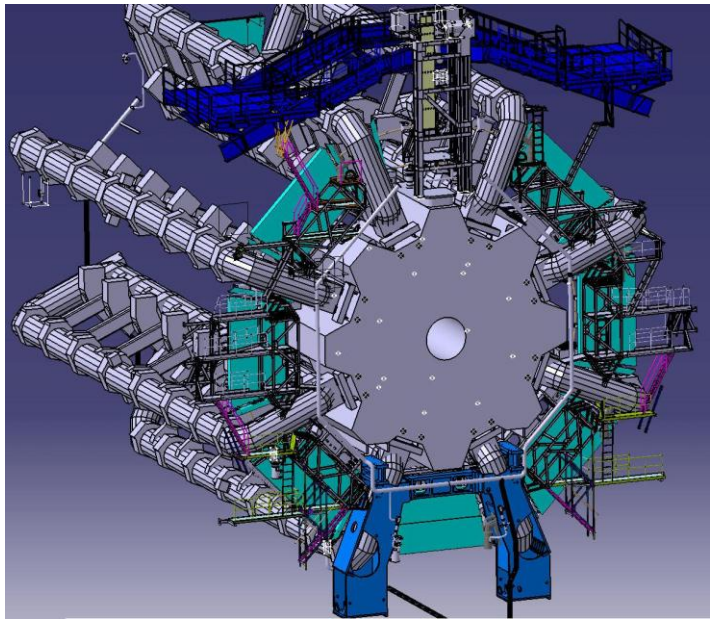
Very rapid rise in osity

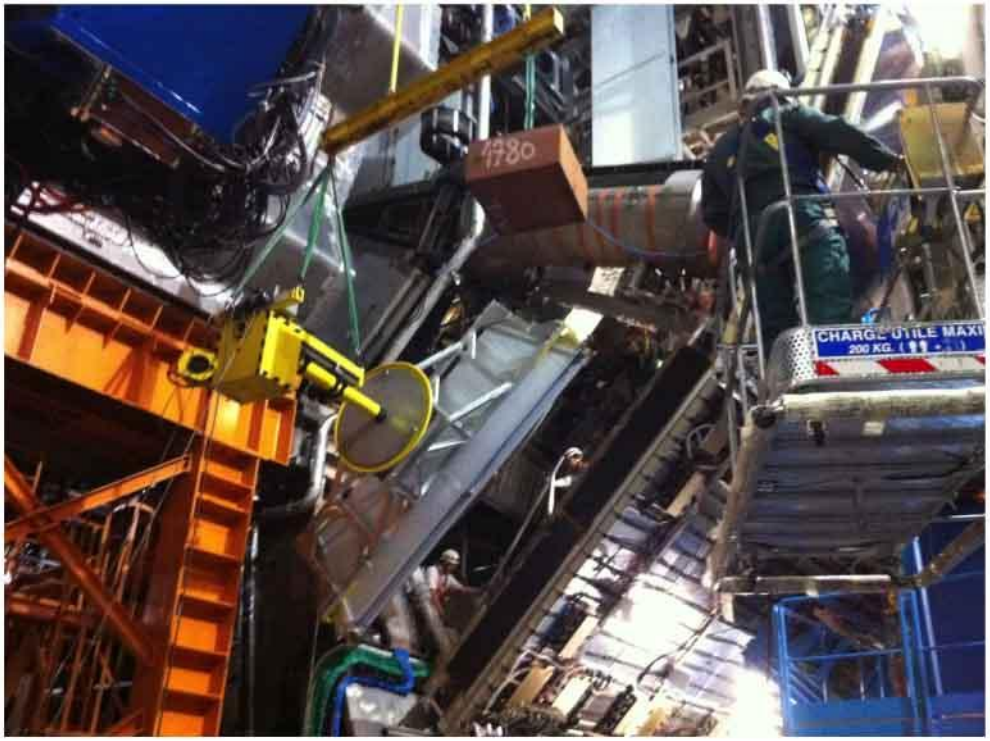
Hope to be off the plot soon

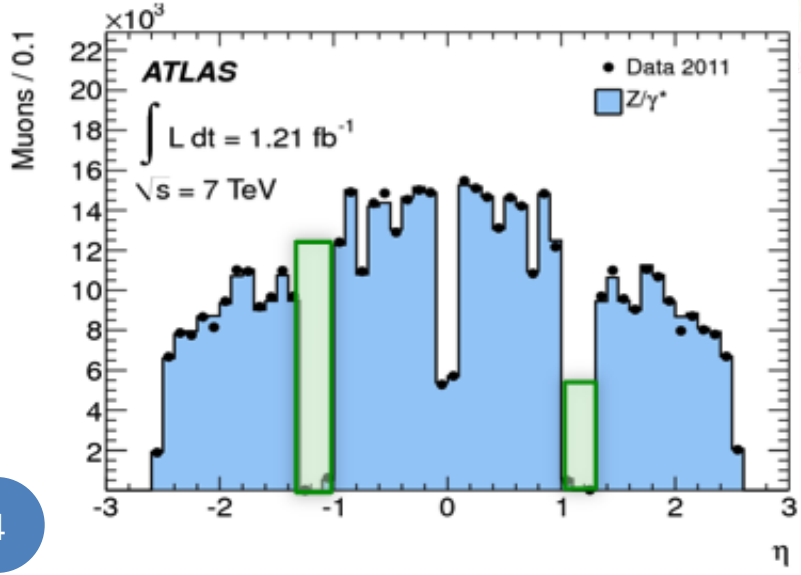
TALK OUTLINE:

- 2011-2012 Shutdown Activities
- 2011 and 2012 Detector Performance
- 2011 and 2012 Trigger
- Analysis Status
- Upgrade Plans

2012 shutdown activities



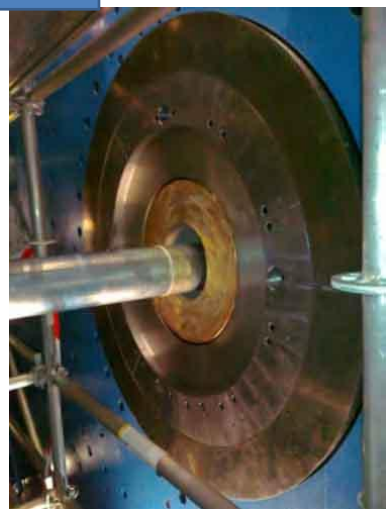


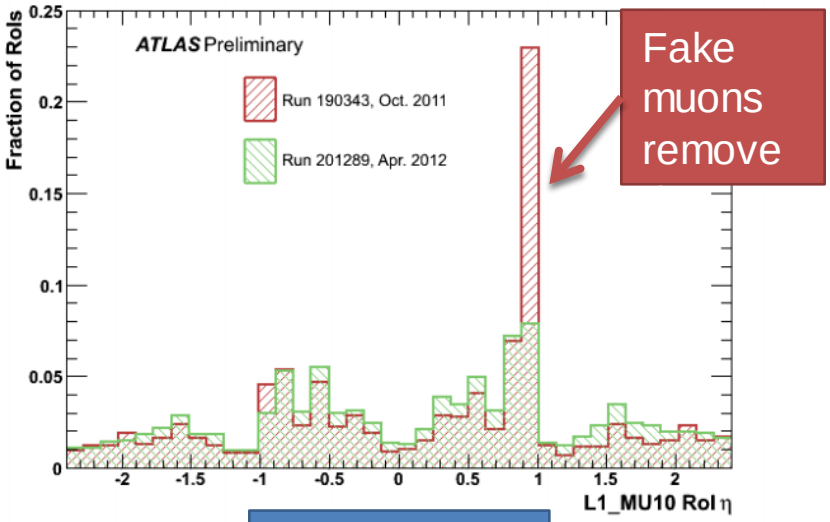


- Completely installed “EE” muon chambers on side C
- About ½ of chambers on side A installed

Shutdown activities – a few more examples

Improved muon shielding

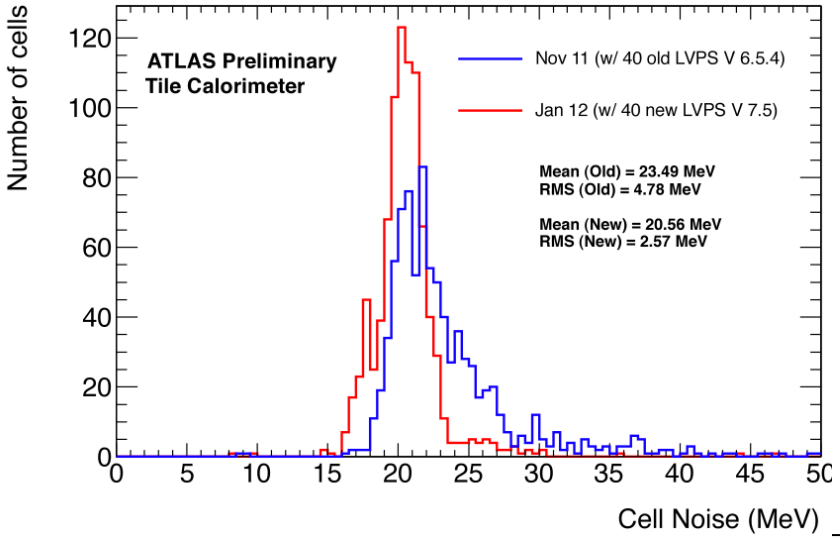




P_t > 10 GeV

Calorimetry improvements

- Tile hadron calorimeter
  - 45/256 on detector tile "drawers" refurbished
  - 40/256 new low voltage supplies improves SEUs and noise
- Liquid Ar calorimeters
  - 10 FEB and 12 low voltage supplies replaced
  - Bad channels decrease385/182468 to 106/182468 (0.06%)



Working channels in 2012

Subdectector	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%

ATLAS Detector Status in 2011

Overall data taking efficiency
93.5% (**94.7%** w/o warm-start)

Similar Efficiency in 2012

Cause	Inefficiency
Dead time	1.0
Warm-start	1.2
DAQ Actions	1.2
Equipment Failure (incl. Human Resp.)	2.8

Fraction of data after data quality cuts used for analysis:

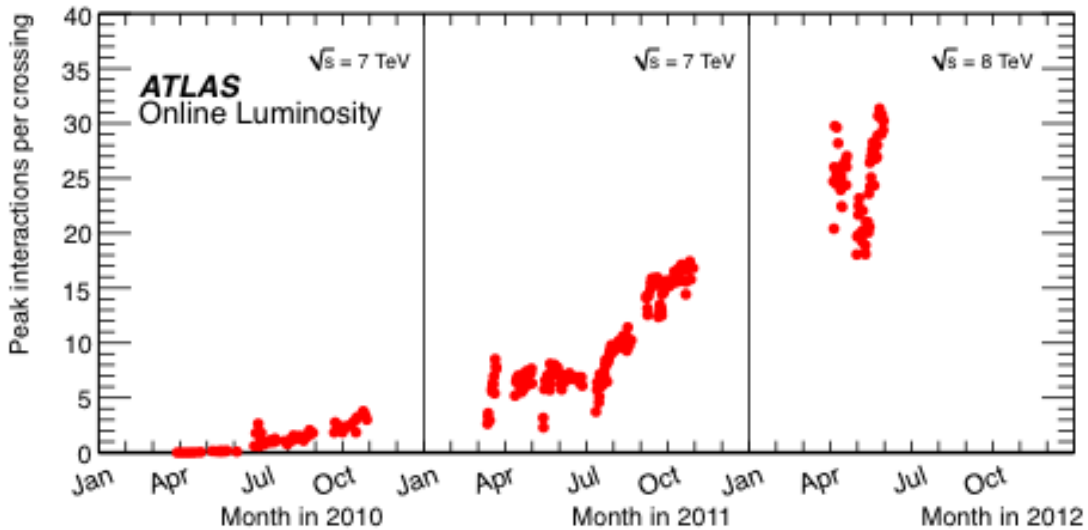
Inner Tracking Detectors			Calorimeters				Muon Detectors				Magnets	
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.8	99.6	99.2	97.5	99.2	99.5	99.2	99.4	98.8	99.4	99.1	99.8	99.3

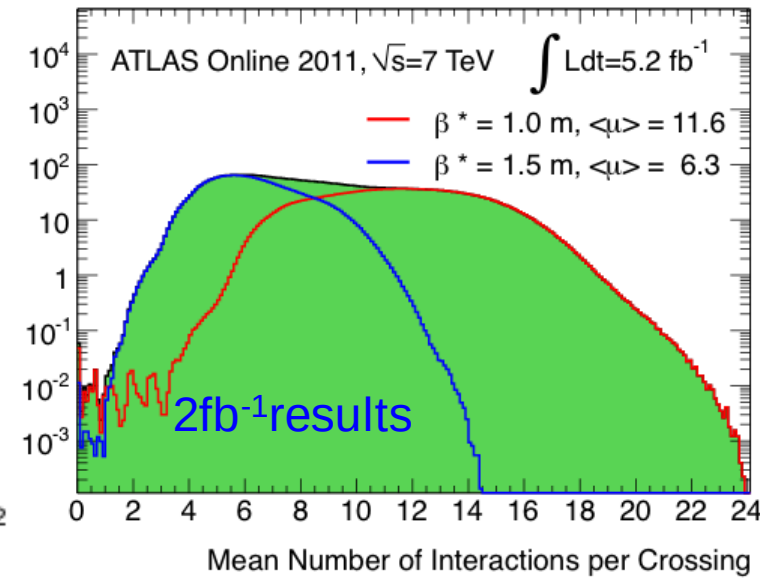
Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in pp collisions at $\sqrt{s}$=7 TeV between March 13th and October 30th (in %), after the summer 2011 reprocessing campaign

DQ efficiency for physics analysis ≥ 90% for recorded data

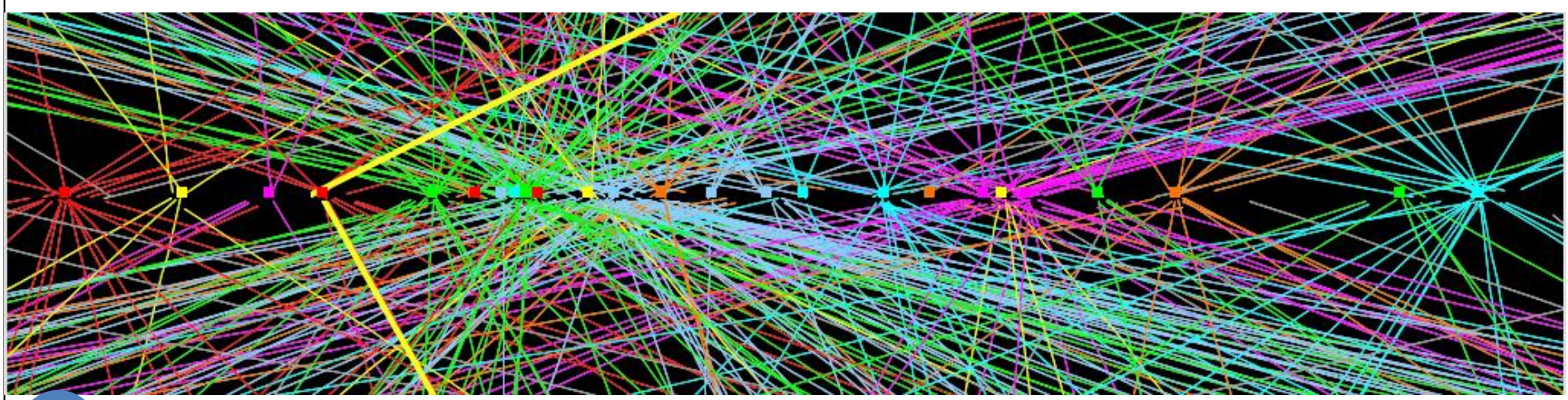
Similar DQ Efficiency in 2012

Data Taking Conditions in Proton Running



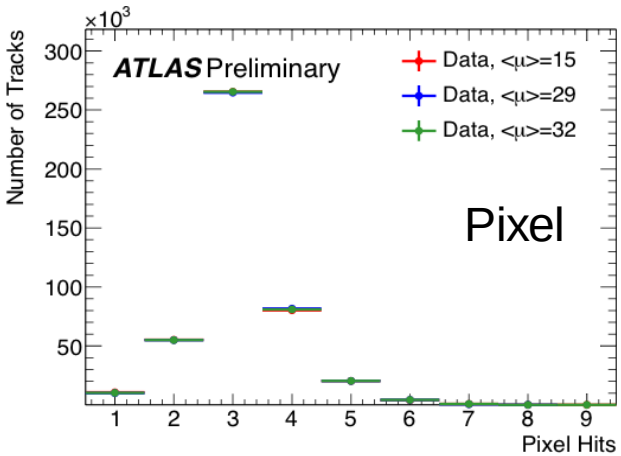


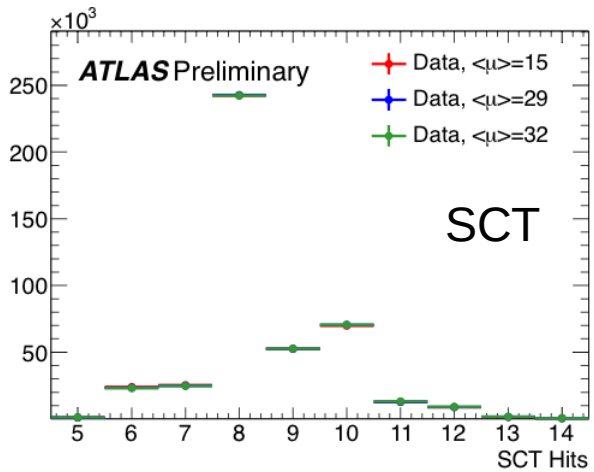
2012 pileup event

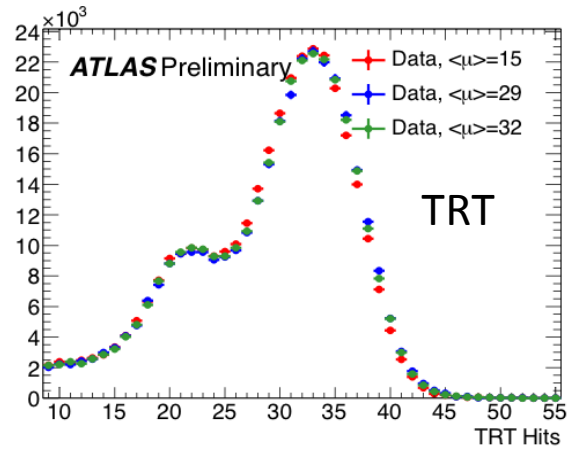


ATLAS definition of μ based on $\sigma_{inelastic}$

Tracking Performance



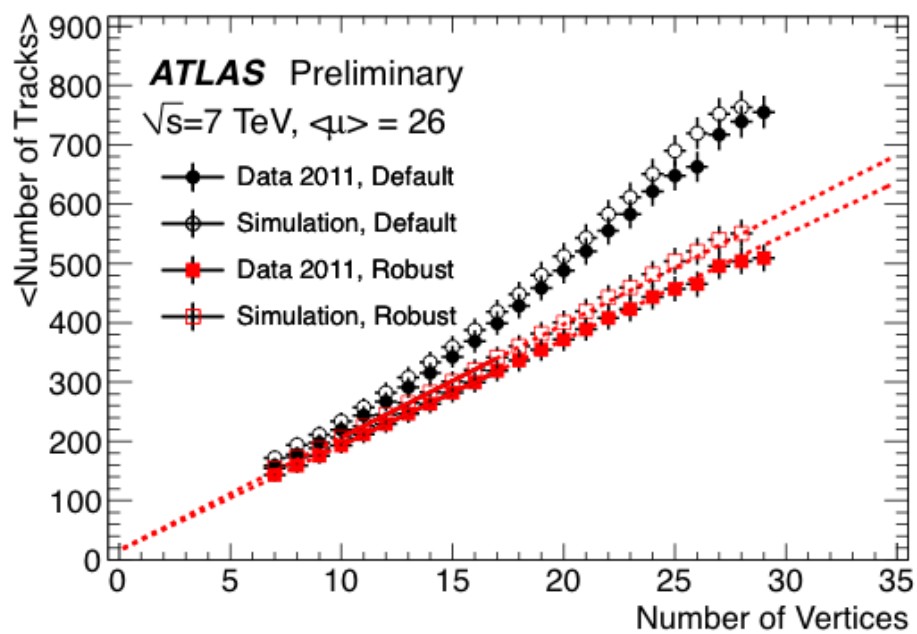




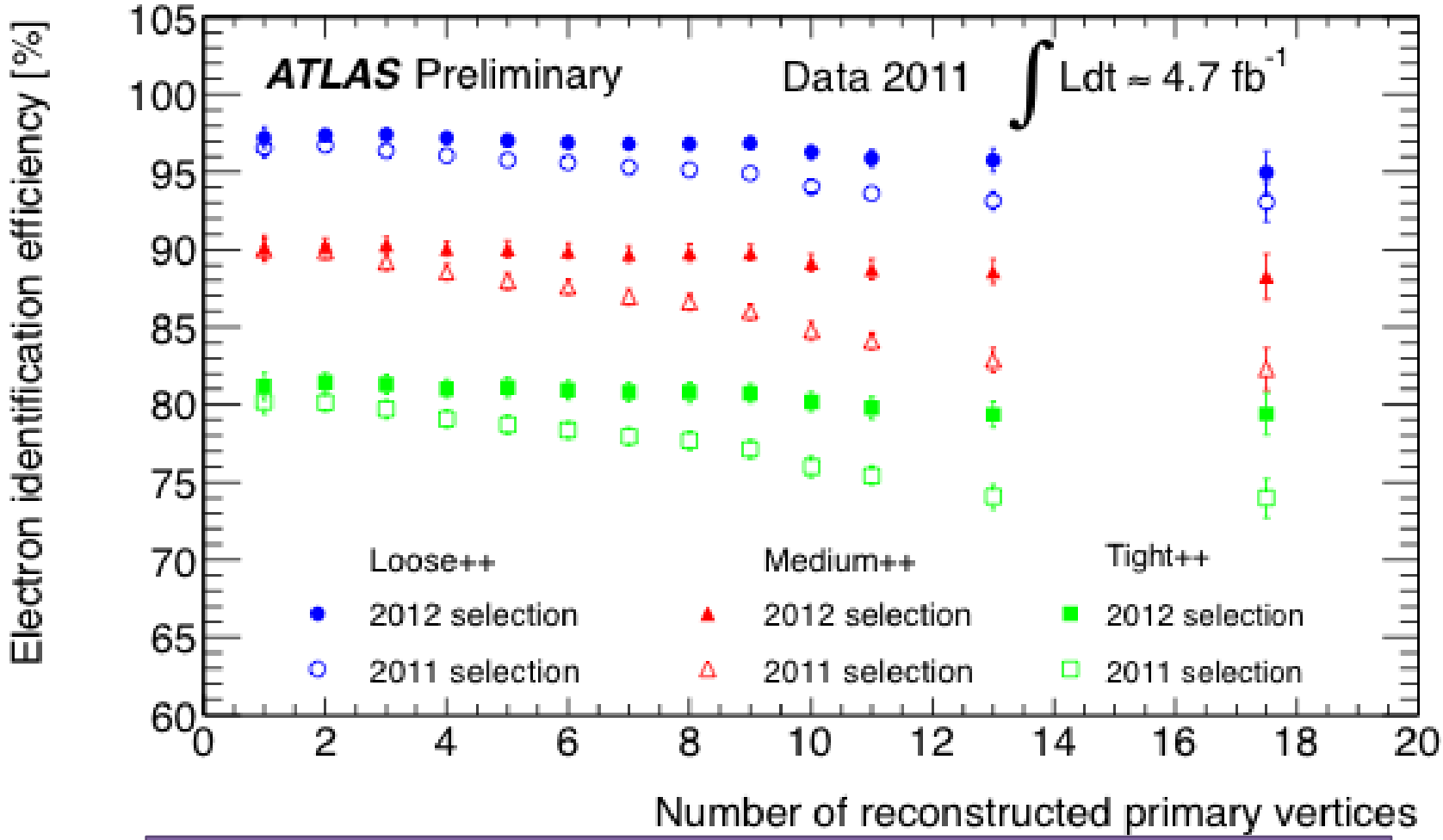
Hits on tracks are constant even at pileup of 30 (from special 2011 run)

- Number of tracks scales linearly with pileup
- *Fakes increase but can be recovered with "robust cuts'*

ATLAS Talk: S. STRANDBERG, Tracking, vertices and B-tagging performance (5D)
Several posters



Electron performance for high pileup improved!



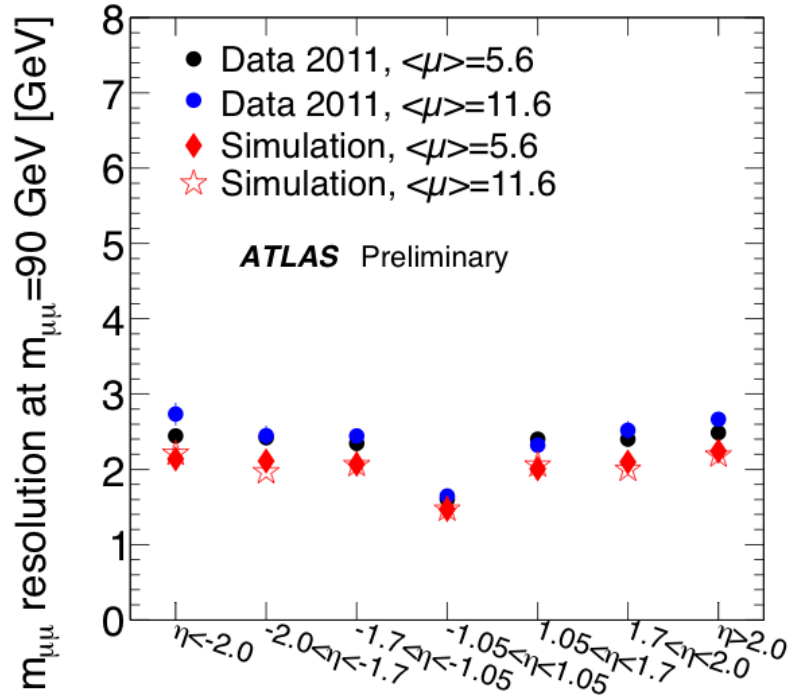
ATLAS Talk: D. TSIONOU, Electron And Photon Performance Measurements (1E)

Electron/photon trigger in 2011: ATLAS-CONF-2012-048,

Muon Performance

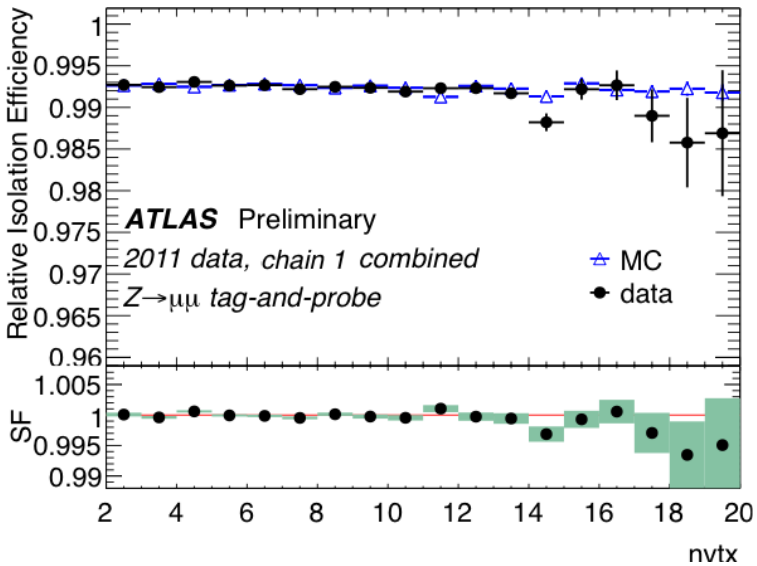
Mass resolution and isolation is well described by the Monte Carlo

ATLAS Poster: W. SPEARMAN, Study of the ATLAS muon identification efficiency in the presence of high pile-up (1D)

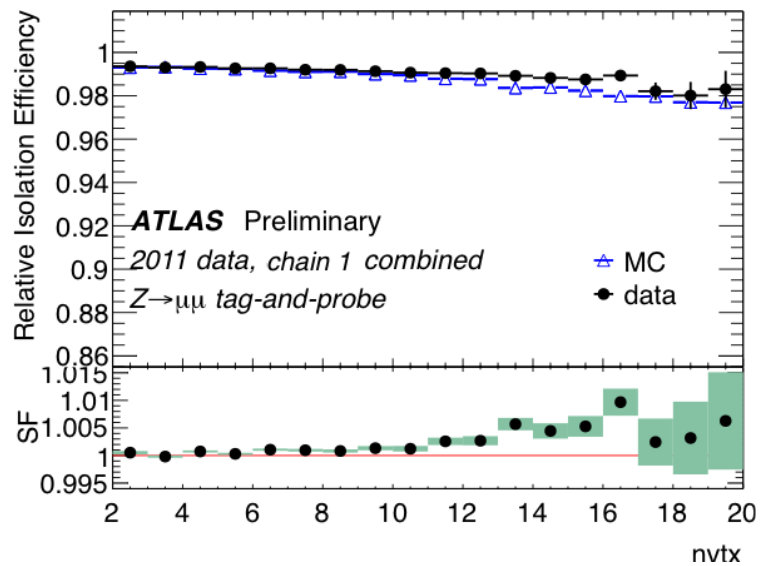


Isolation efficiency

Tracks: $\sum^{0.2} p_t^{trk}/p_t^{\mu} < 0.15$

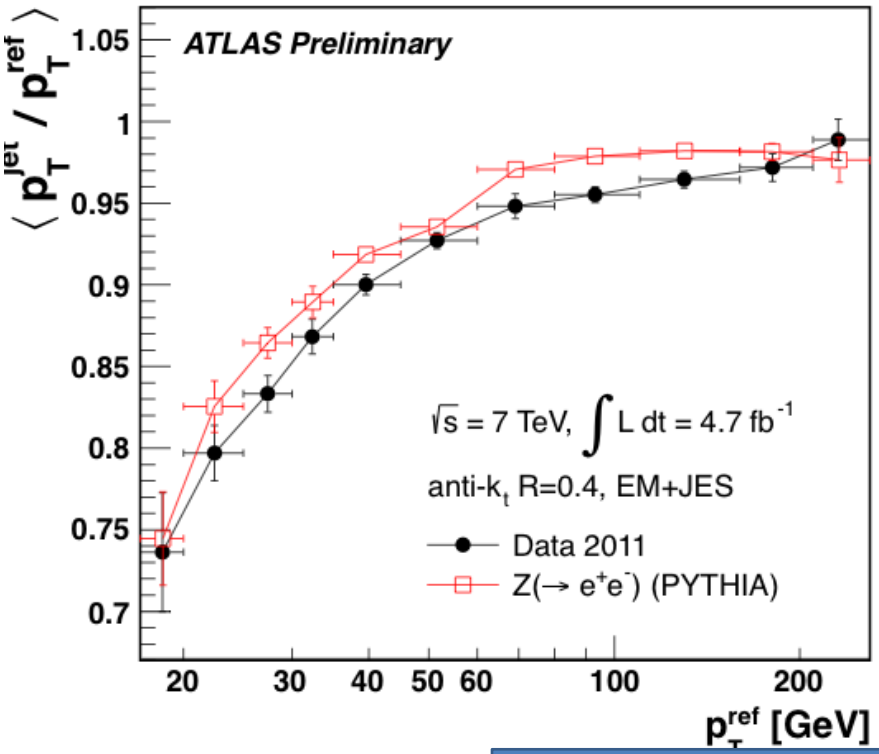


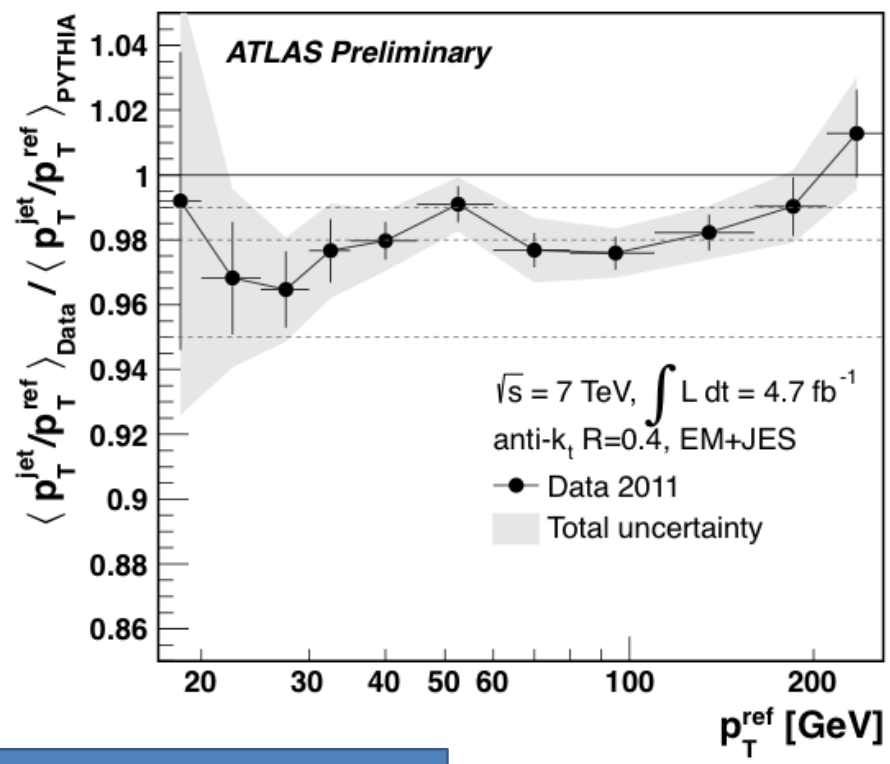
Calo: $\sum^{0.2} E_t/p_t^{\mu} < 0.3$



Jet Energy Scale Performance

Use p_t balance in events with jets recoiling against Z (e^+e^-)





Uncertainty less than 2% for p_t > 25 GeV

ATLAS-CONF-2012-053, ATLAS-CONF-2011-159: Validating the measurement of jet energies with the ATLAS detector using Z+jet events from proton-proton collisions at sqrt(s) = 7 TeV

ATLAS Performance Talks and Posters

ATLAS TALKS

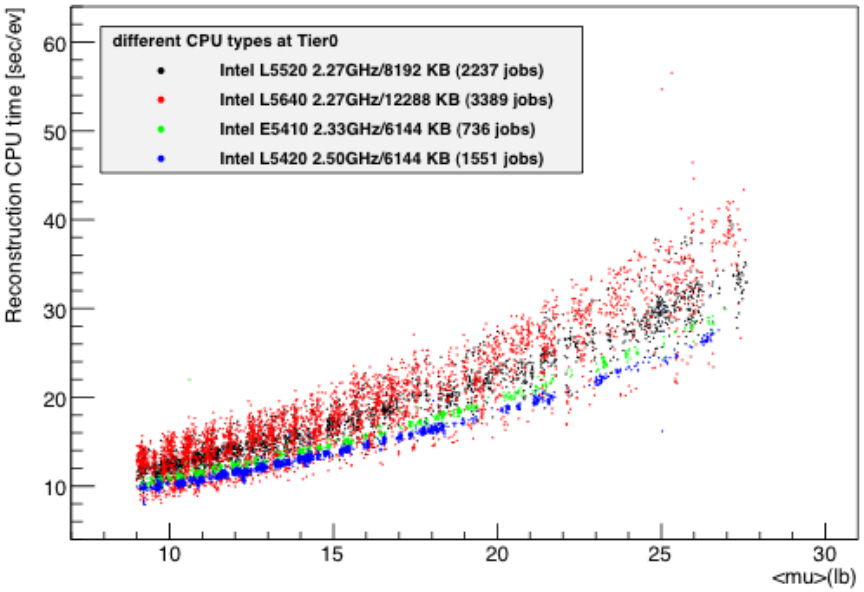
S. STRANDBERG
Tracking, vertices and B-tagging performance (5D)
D. TSIONOU
Electron And Photon Performance Measurements (1E)

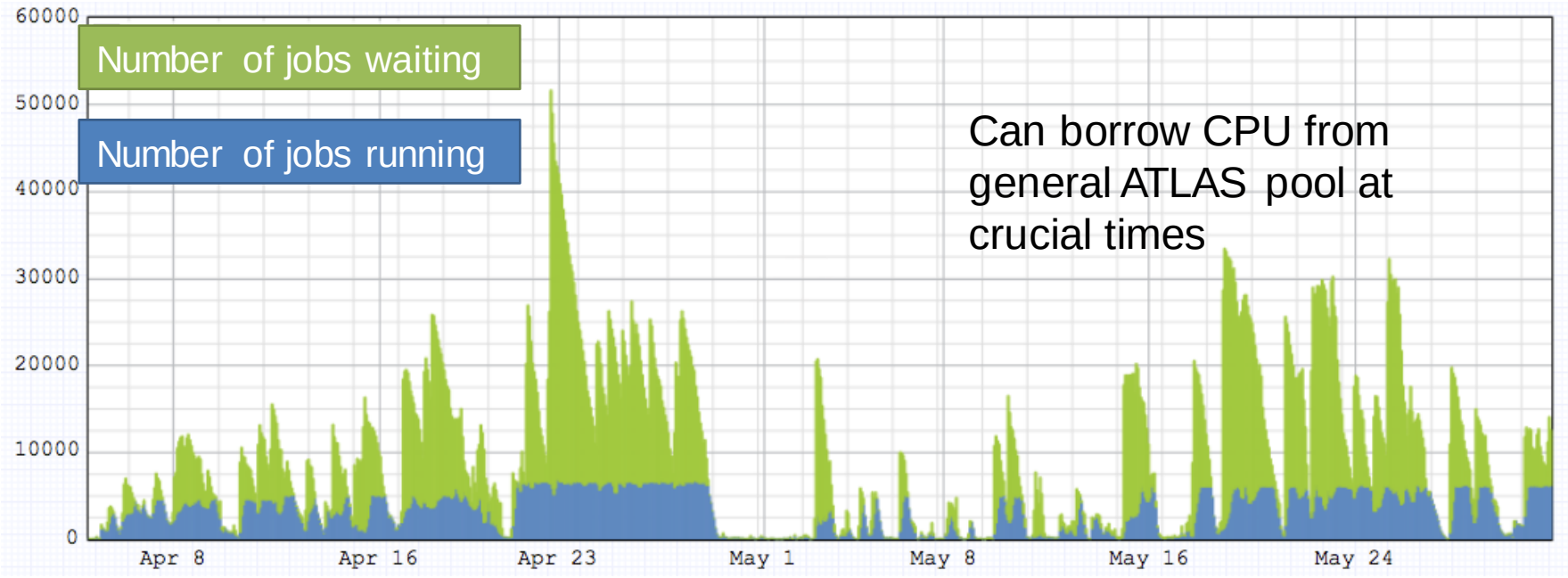
ATLAS POSTERS (1D)

S. BEDIKIAN
Reconstruction and Identification of Hadronically Decaying Tau Leptons
D. DUDA
Measuring the b-jet tagging efficiency using top anti-top events
A. PARODI
Measuring the b-jet tagging efficiency on c-jets containing D* mesons
C. JUNG
Measuring the b-jet tagging efficiency using samples of jets containing muons
W. SPEARMAN
Study of the ATLAS muon identification efficiency in the presence of high pile-up
I. VICHOU
Tile Calorimeter performance
G. WATTS
Combining b-tagging Calibrations

Offline Reconstruction in 2012

- Recent improvements in tracking time at high pileup allow us to run with a 0.4kHz rate for prompt streams at Tier0
- *Assumes 30% LHC duty cycle*

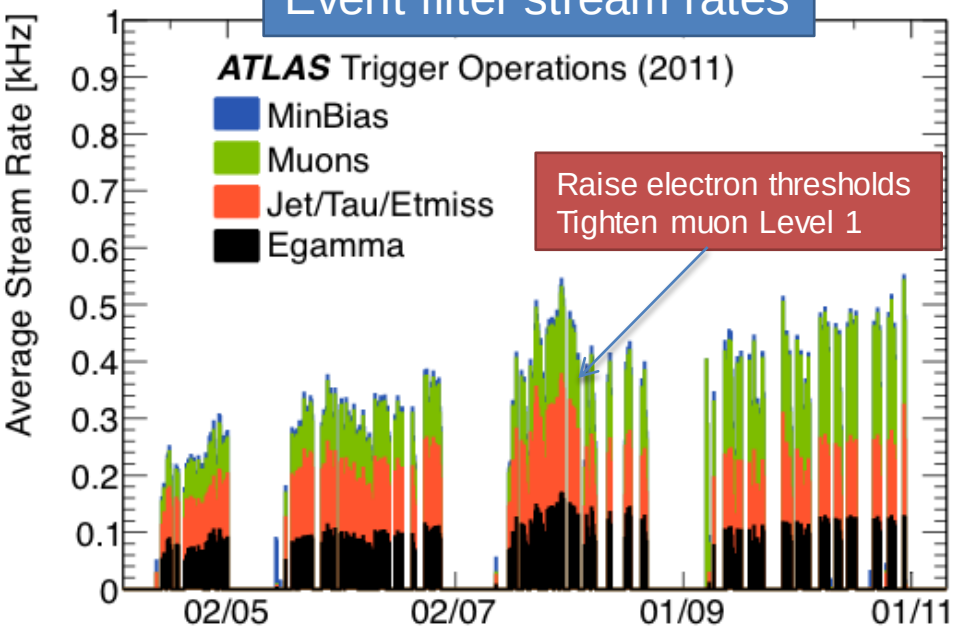


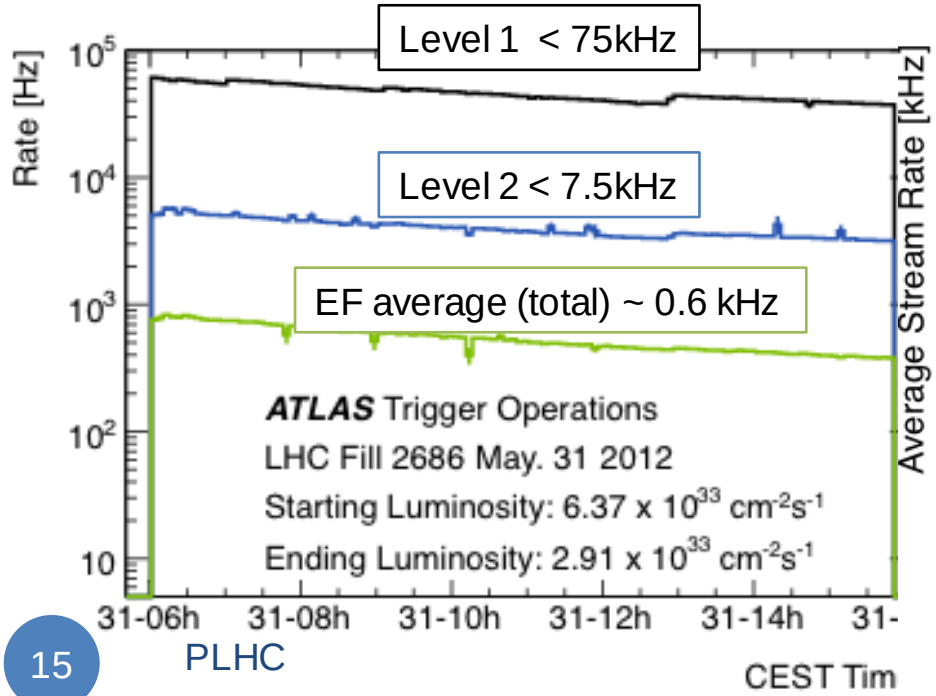


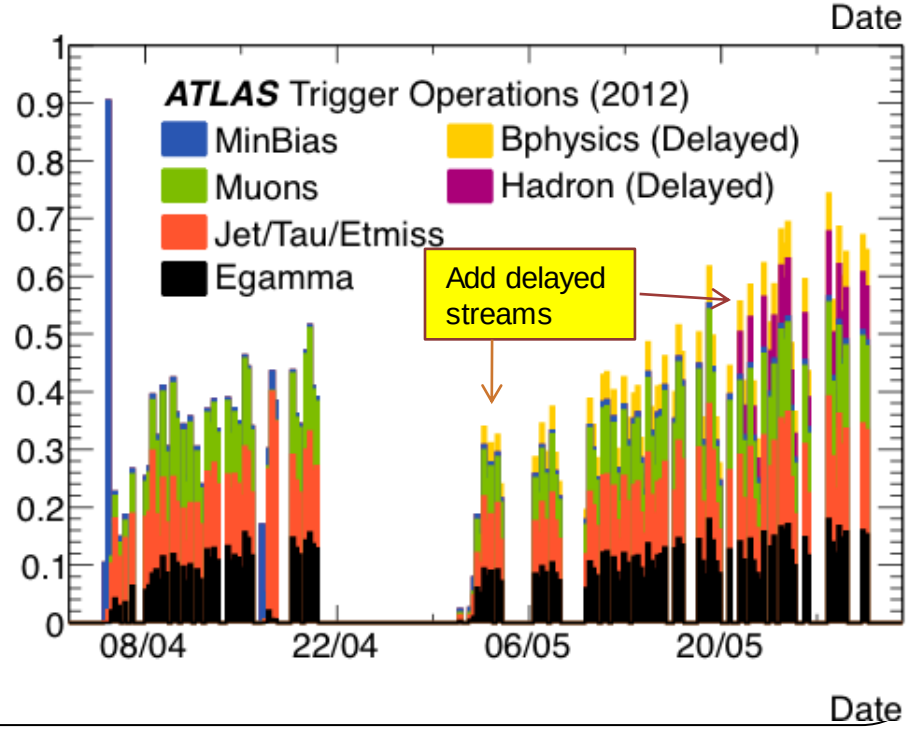
Trigger

- 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

Event filter stream rates







PLHC

Improvements to Trigger in 2012

- Pileup robust electron selection, based on 2012 offline selection

D. TSIONOU, Electron and Photon Performance Measurements (1E)

- Pileup robust tau selection (see slides)

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

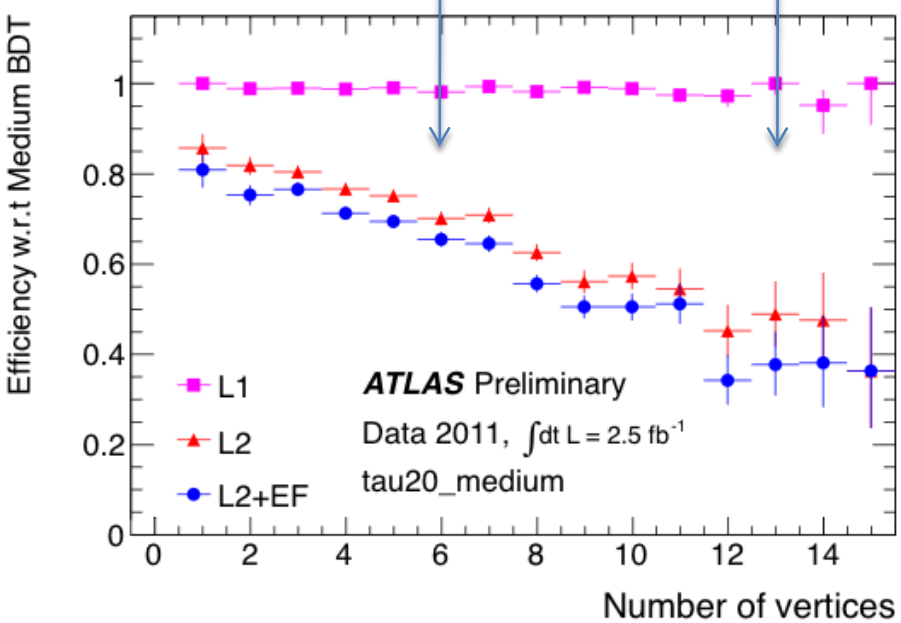
- Missing E_t (MET) improvements (threshold now lower than in 2011) :
  - Optimize L1 noise cuts to match 2012 pileup
  - Fast Front End Board sums at Level 2
  - Use offline clustering for EF

- New L1.5 jet finding based on trigger tower information

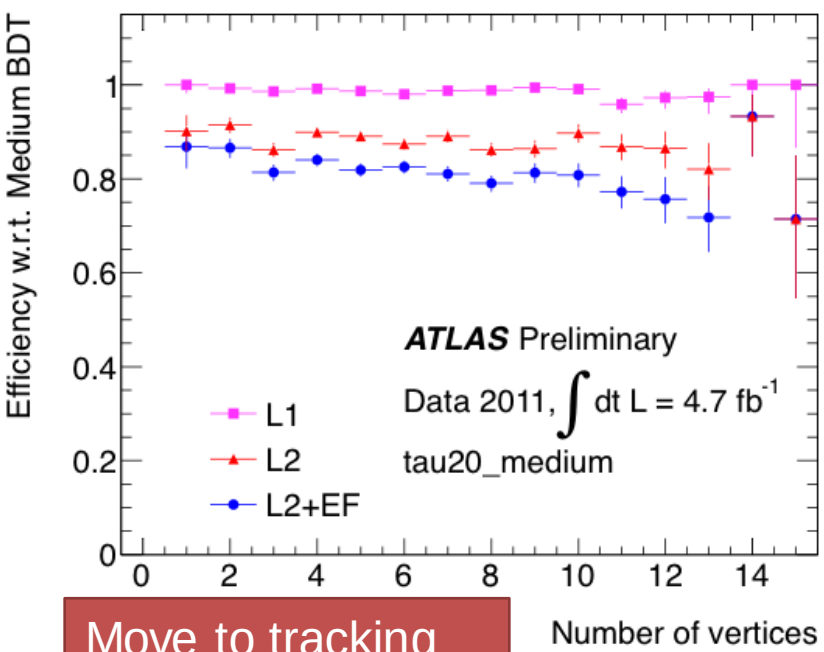
Tau Trigger and Pileup

Mean 2011 pileup

Expected mean 2012 pileup



2012 trigger emulated on 2011 Z tag and probe sample



Move to tracking based variables with Δz cuts

2012 Trigger tuned to have efficiency *independent* of pileup (e.g. using Δz)

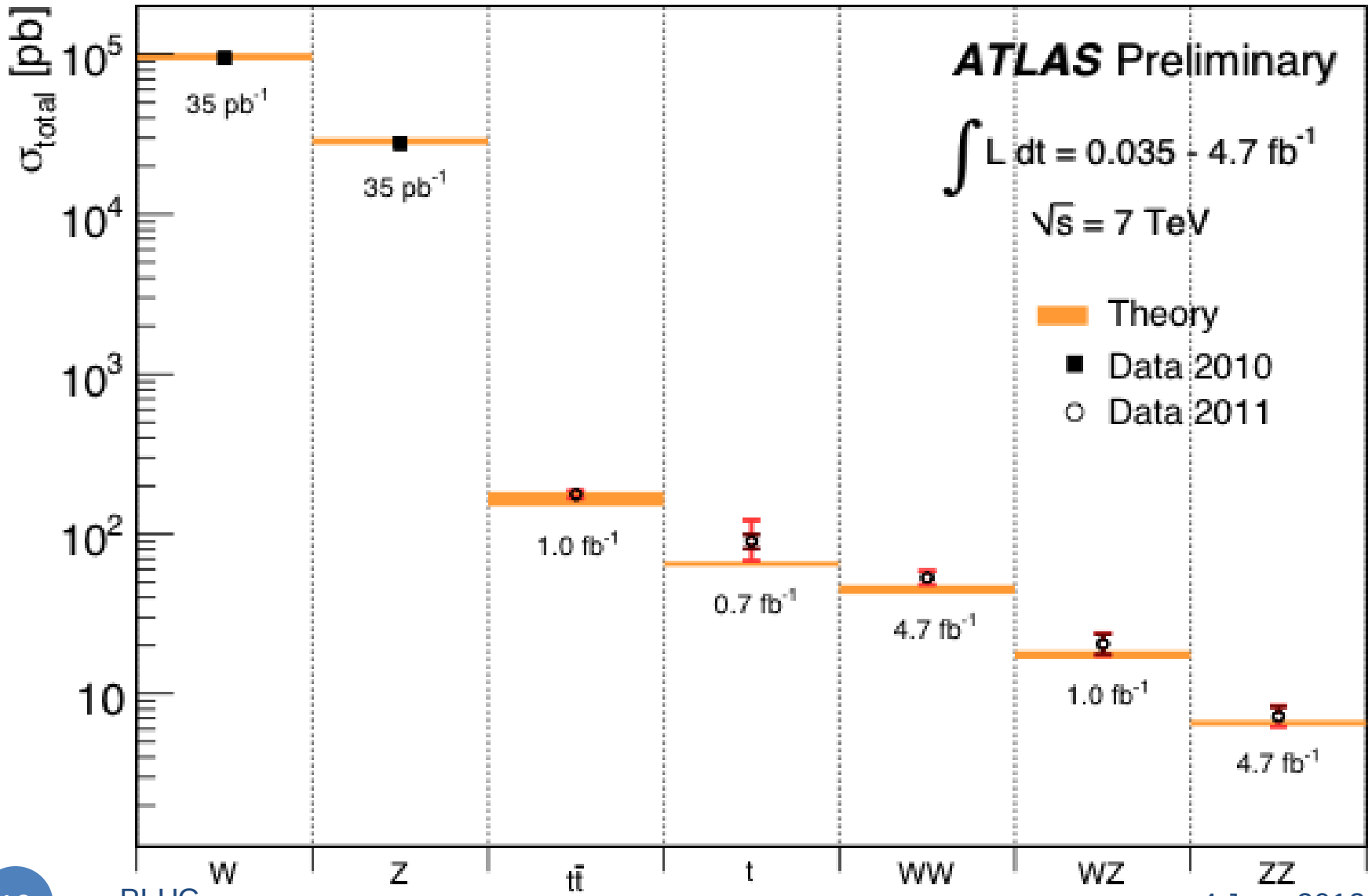
Posters: D. ZANZI, Physics with Tau Lepton Final States in ATLAS (1D),
S. Bedikian: Reconstruction and Identification of Hadronically Decaying Tau Leptons (1D)

2012 Physics Proton Trigger Menu (expectation for L_{peak} = 7 10^{33} $cm^{-2}s^{-1}$)

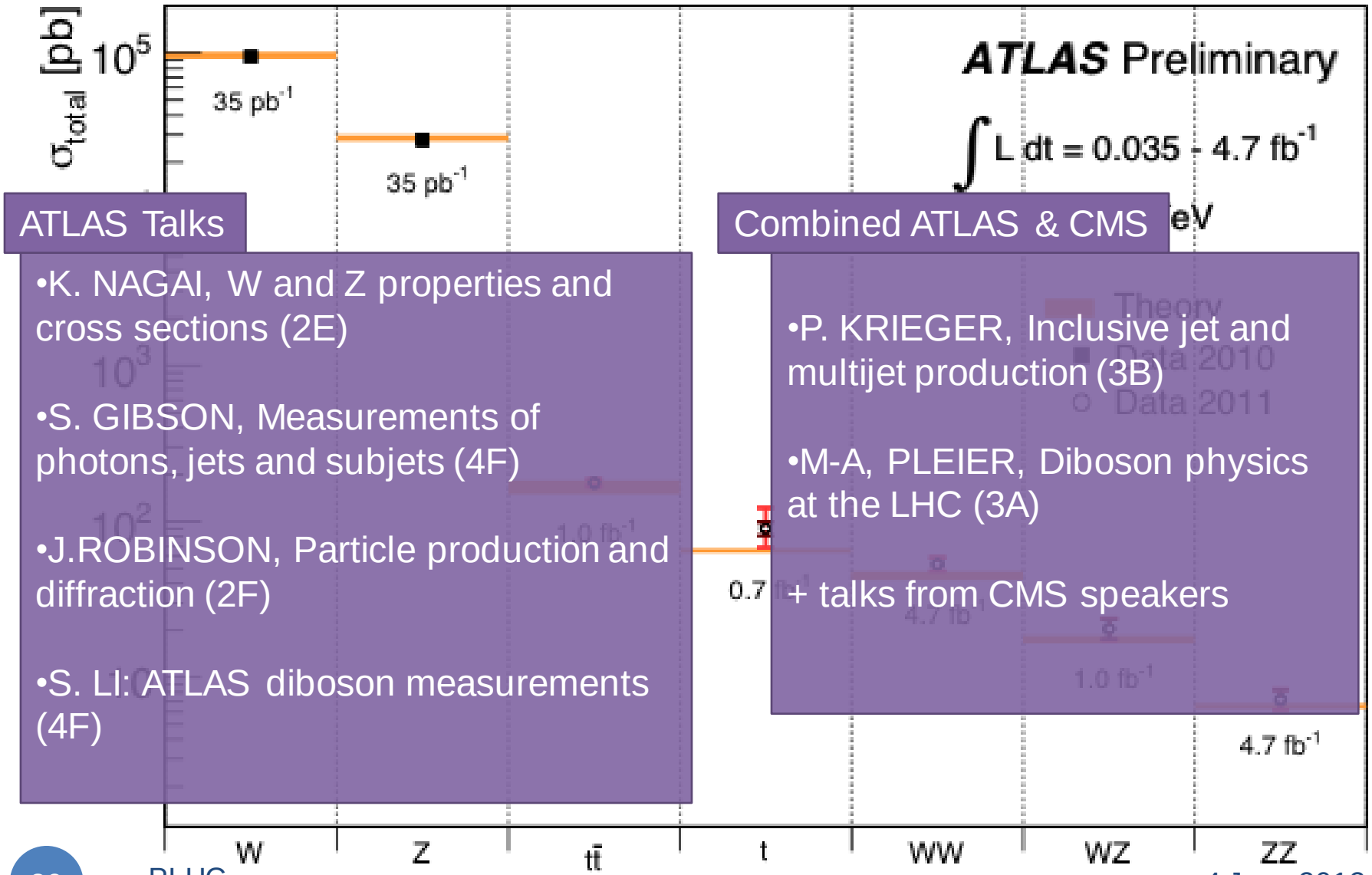
	Offline Selection	Trigger Selection		L1 Peak (kHz) L_{peak}= 7e33	EF Ave (Hz) L_{ave}= 5e33
		L1	EF		
Single leptons	Single muon > 25GeV	15 GeV	24 GeV	8	45
	Single electron > 25GeV	18 GeV	24 GeV	17	60
Two leptons	2 muons >15 2 muons > 20,10 GeV	2x10 GeV 15GeV	2 x 13 GeV 18,8 GeV	1 8	5 8
	2 electrons, each > 15GeV	2x10 GeV	2x12 GeV	6	8
	2 taus > 45, 30GeV	15,11 GeV	29,20 GeV	12	12
Two photons	2 photons, each > 25GeV 2 loose photons, > 40,30	2 x10 GeV 12,16 GeV	2 x 20 GeV 35, 25 GeV	6 6	10 7
Single jet	Jet pT > 360 GeV	75 GeV	360 GeV	2	5
MET	MET > 120 GeV	**40 GeV**	80GeV	2	17
Multi-jets	5 jets, each pT > 55 GeV	4x15GeV	5x55GeV	1	8
b-jets	b + 3 other jets pT>45 GeV	4x15GeV	4x45GeV+btag	1	4
TOTAL				**<75**	**~400 (mean)**

- Tracking based isolation applied to single leptons at EF to limit rate
- Above triggers are used by most analyses, currently 564 items in the menu
- Many Specialized triggers, e.g. J/ψ -> e^+e^- for efficiency studies.
- Hadronic trigger in delayed stream have lower thresholds

Standard Model



Standard Model



ATLAS Talks

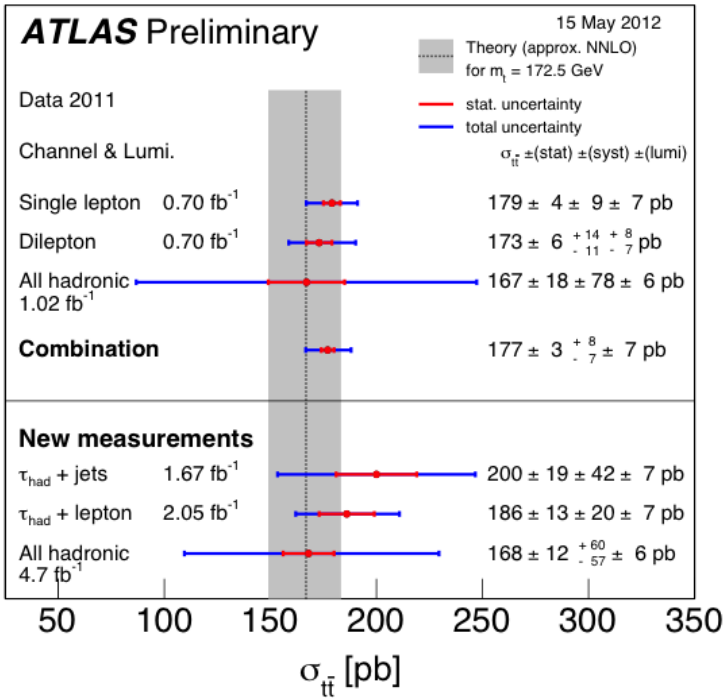
- K. NAGAI, W and Z properties and cross sections (2E)
- S. GIBSON, Measurements of photons, jets and subjets (4F)
- J.ROBINSON, Particle production and diffraction (2F)
- S. LI: ATLAS diboson measurements (4F)

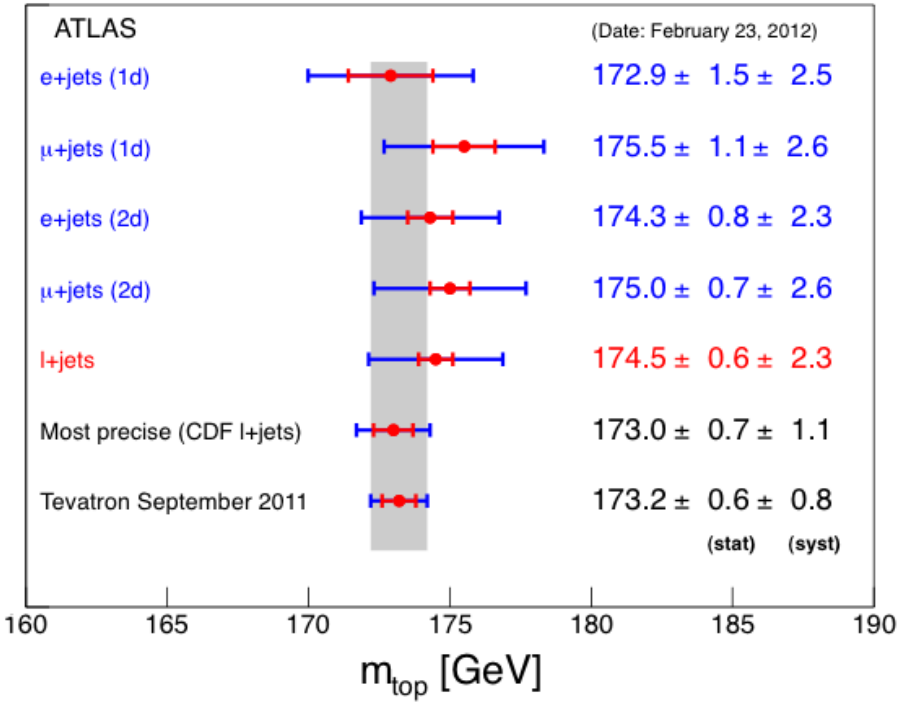
Combined ATLAS & CMS

- P. KRIEGER, Inclusive jet and multijet production (3B)
- M-A, PLEIER, Diboson physics at the LHC (3A)

+ talks from CMS speakers

Top





ATLAS Presentations

A. KNUE, Top quark properties (4E)

Y. TAKAHASHI, Top quark

ATLAS and CMS presentations

W. VERKERKE: Top properties (4B) +CMS speaker

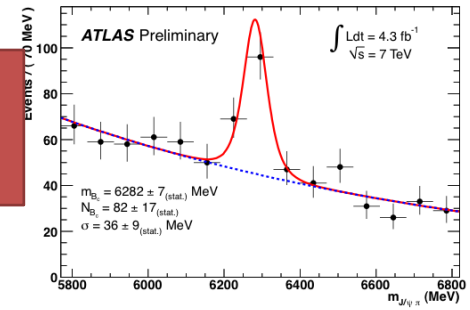
ATLAS Posters (1D)

A.BECKER: Search Measurement of t-channel single top-quark production

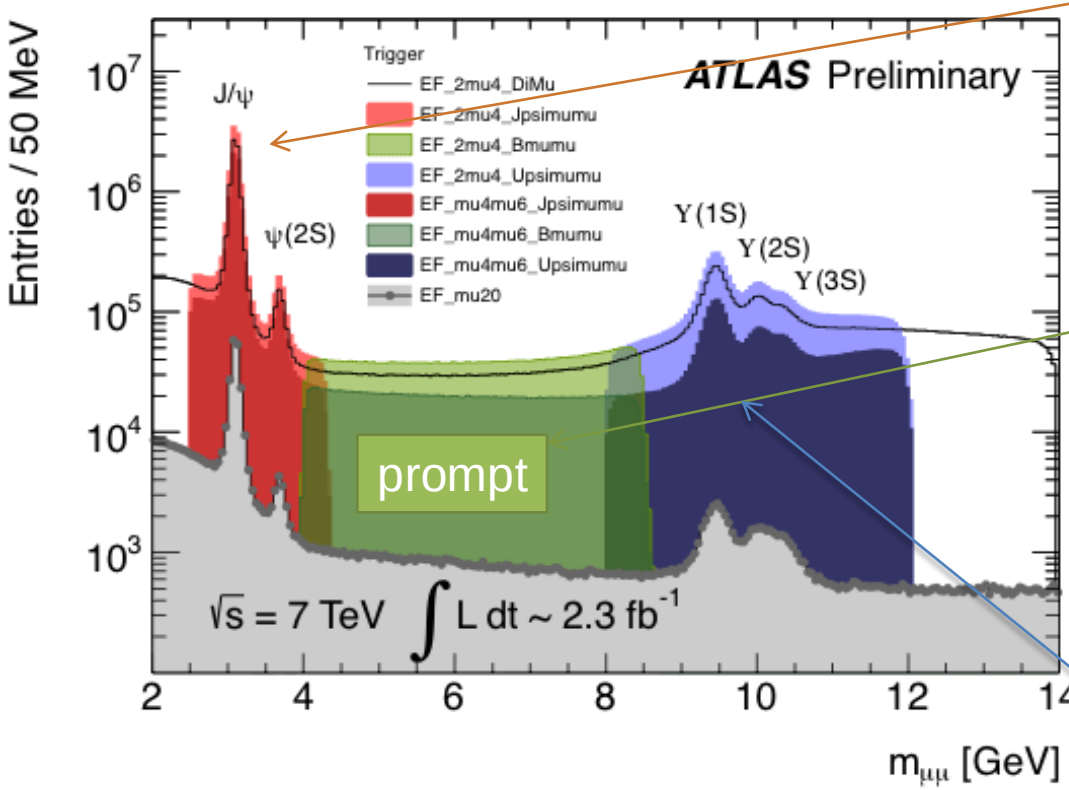
J. GODFREY: Top quark pair production cross section with hadronically decaying tau lepton

B physics

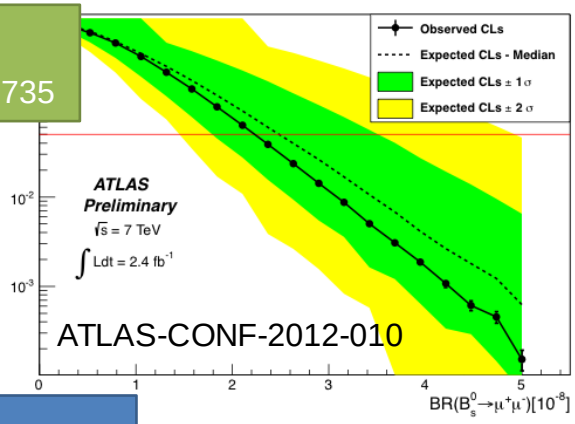
B_c observation
ATLAS-CONF-2012-028
Also λ_b lifetime



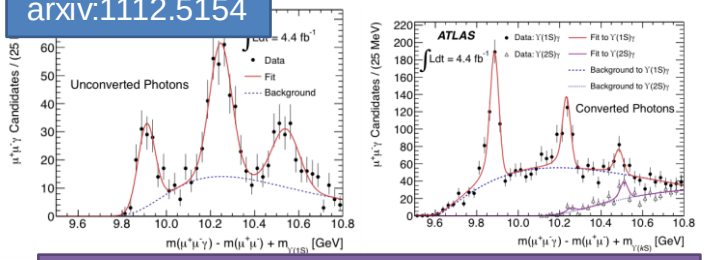
D. SCHEIRICH: Heavy flavor production (4C)



B->μμ
arxiv:1204.0735



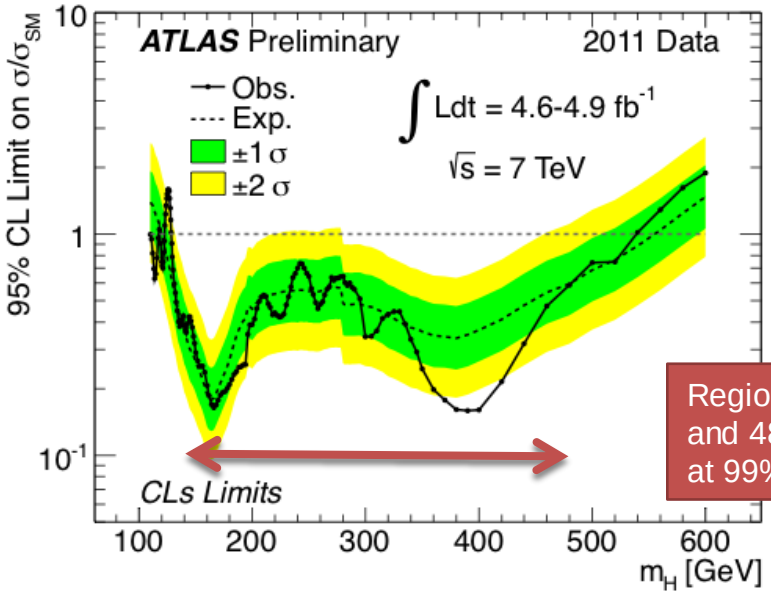
X_b
arxiv:1112.5154



T. MATSUSHITA: Onia production at ATLAS (2F)

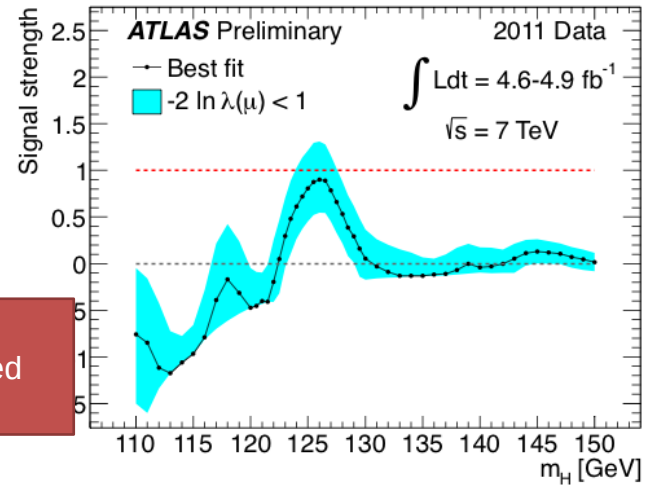
- Opportunistically save B physics triggers whenever possible
- In 2012 some B triggers are not promptly reconstructed

Higgs



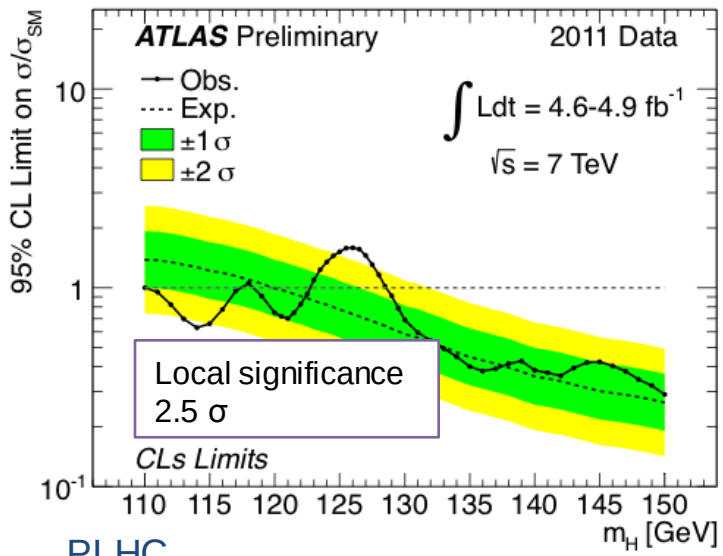
Region between 130 and 486 Gev excluded at 99%C.L

Excess seen in the low mass region:



Excess consistent with SM cross section

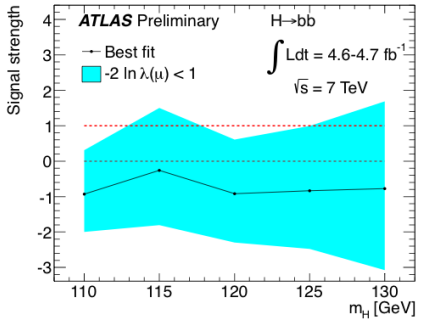
Global probability for such an excess on this plot is ~10%

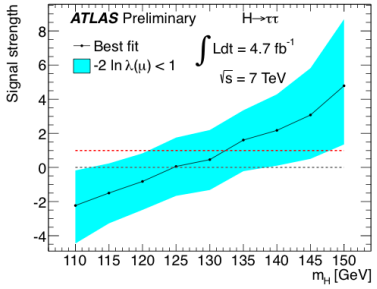


Local significance 2.5 σ

Many interesting Higgs questions:

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

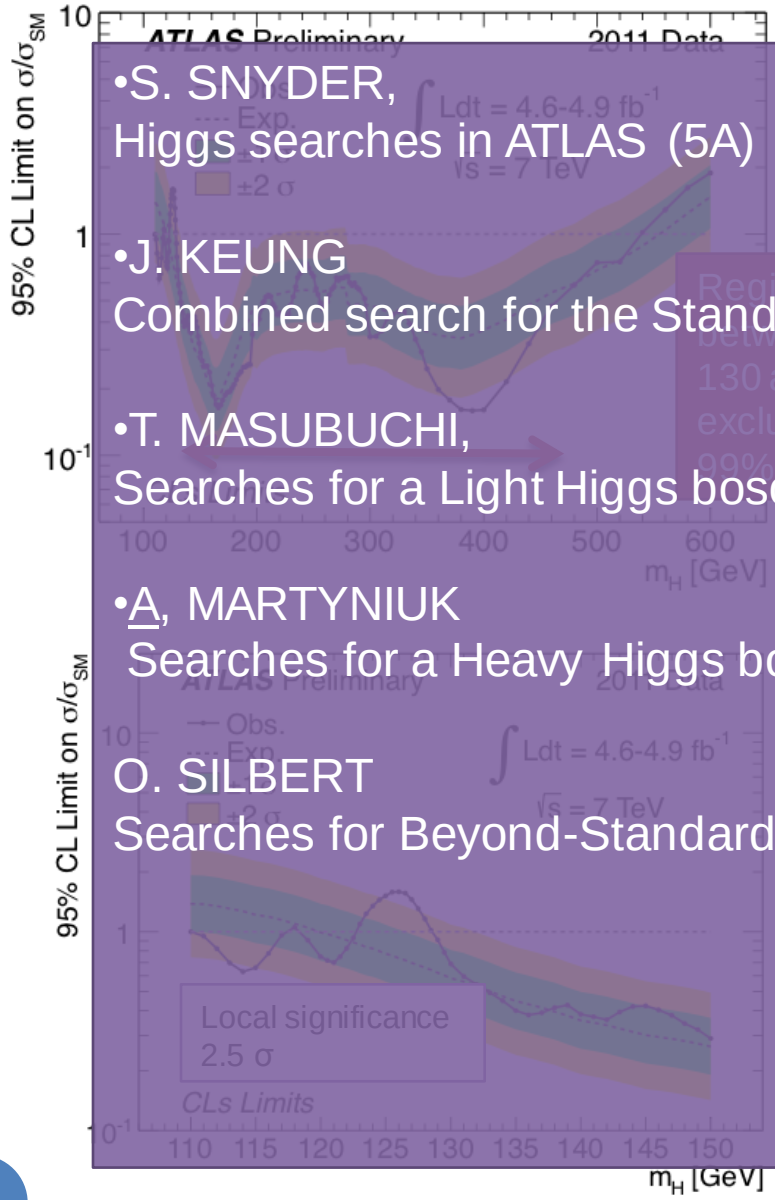




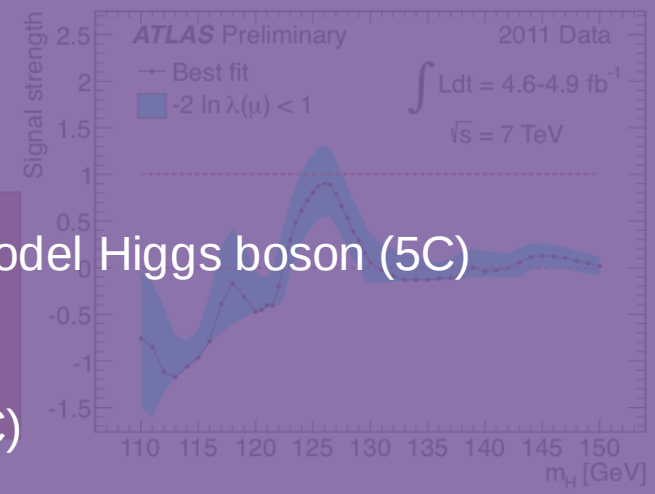
All plots from ATLAS-CONF-2012-019

Higgs

Excess seen in the low mass region:



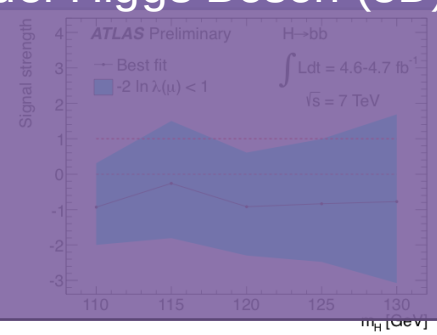
Region between 130 and 486 excluded at 99% C.L.

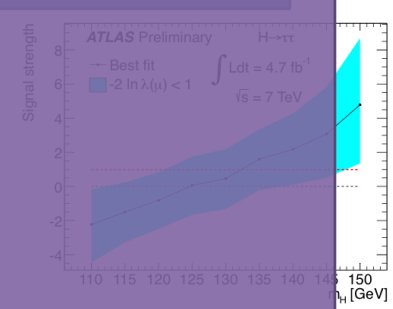


Excess consistent with SM cross section

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

Many interesting Higgs questions:
- Is there more than one Higgs?
- Are the couplings what one expects?





- S. SNYDER,
  Higgs searches in ATLAS (5A)
- J. KEUNG
  Combined search for the Standard Model Higgs boson (5C)
- T. MASUBUCHI,
  Searches for a Light Higgs boson (5C)
- A, MARTYNIUK
  Searches for a Heavy Higgs boson (5D)

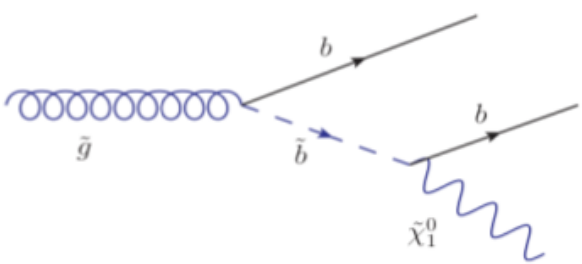
O. SILBERT
Searches for Beyond-Standard Model Higgs Boson (5D)

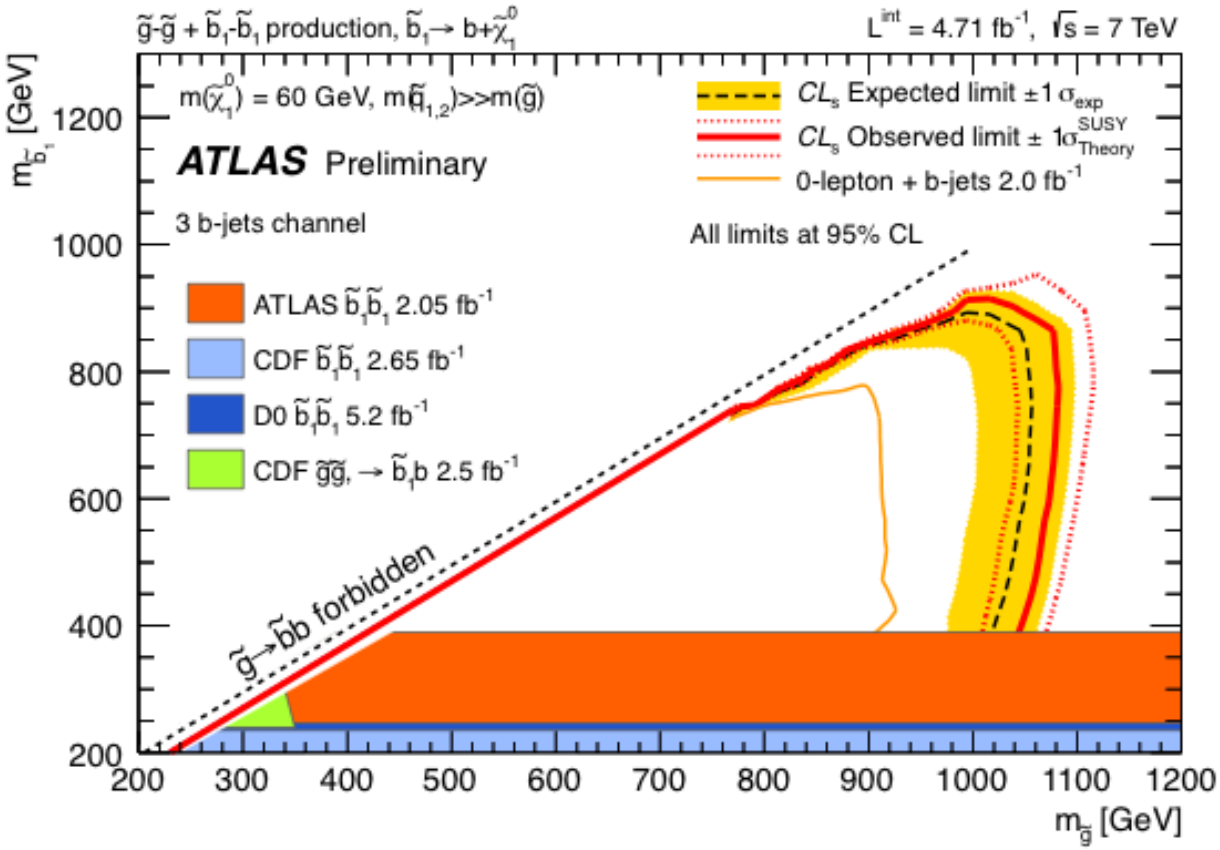
All plots from ATLAS-CONF-2012-019

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

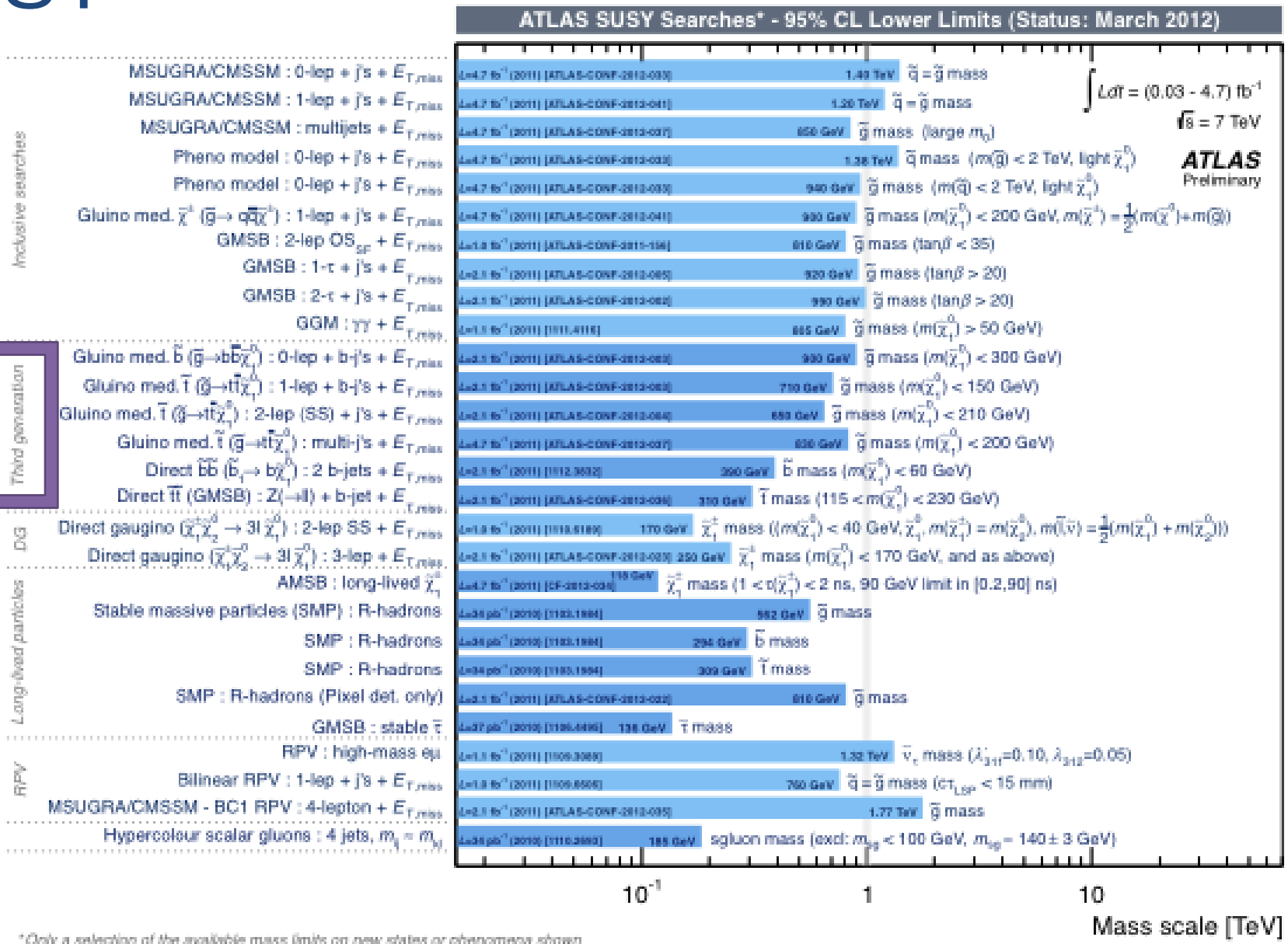
Example: 4b final state





•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



PLHC

4 June 2012

SUSY

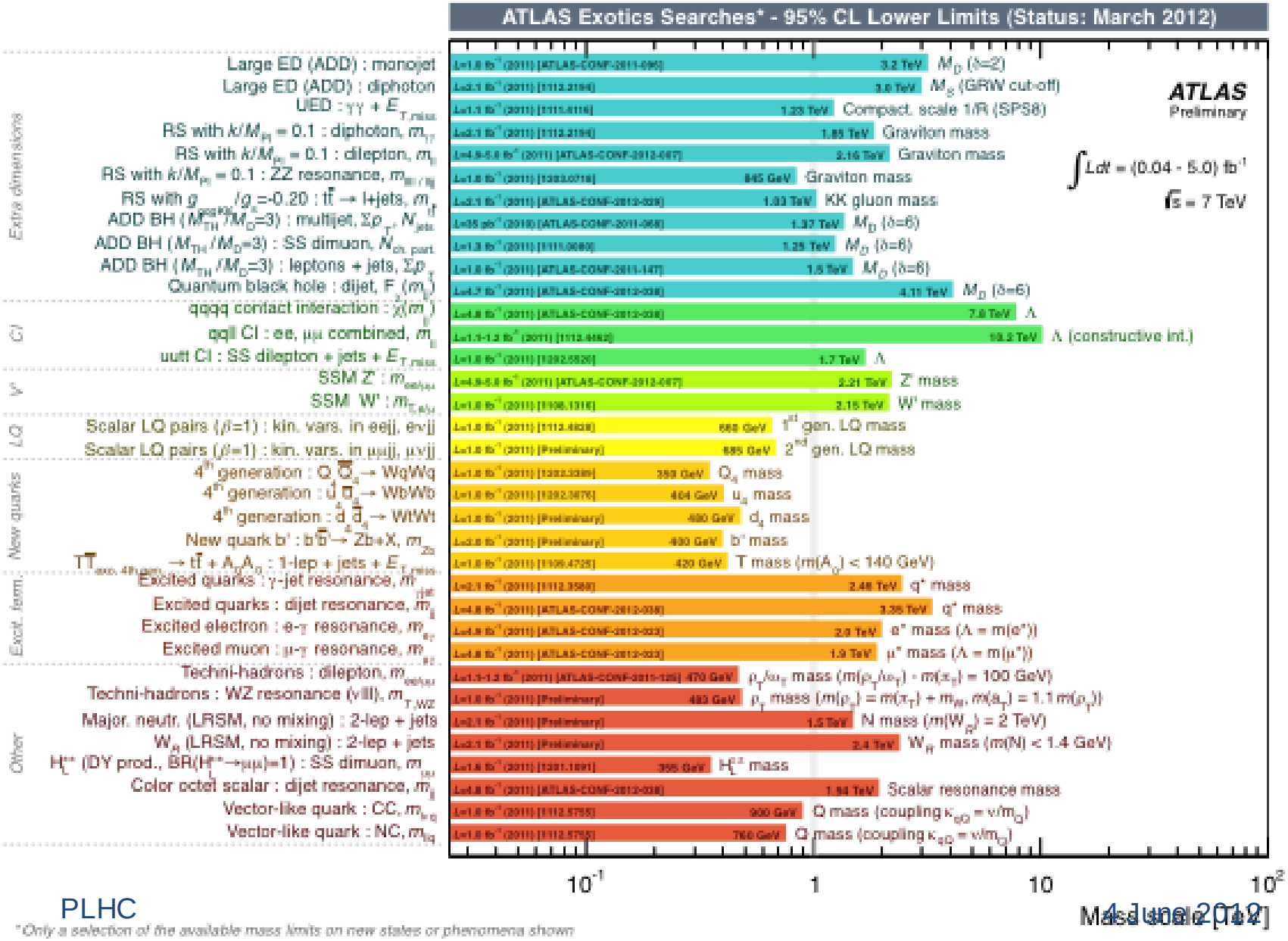
ATLAS TALKS

- J. MCFAYDEN
  Search for supersymmetric gauginos and third generation squarks with the ATLAS detector (5E)
- T. EIFERT
  SUSY and BSM searches in ATLAS (5B)
- E. KAJOMOVITZ
  Inclusive searches for supersymmetric signatures with the ATLAS detector (5E)

ATLAS POSTERS (1E)

- S. KING
  Searches for supersymmetry and UED in events with three-leptons and missing transverse momentum
- C. MARINO
  Search for massive long-lived exotic particles with the ATLAS detector
- E. CORDINA:
  Search for supersymmetry in events with four or more leptons
- Y. SASAKI
  Search for supersymmetry in final states with jets, missing transverse momentum and one isolated lepton

Exotics



*Only a selection of the available mass limits on new states or phenomena shown

Exotics

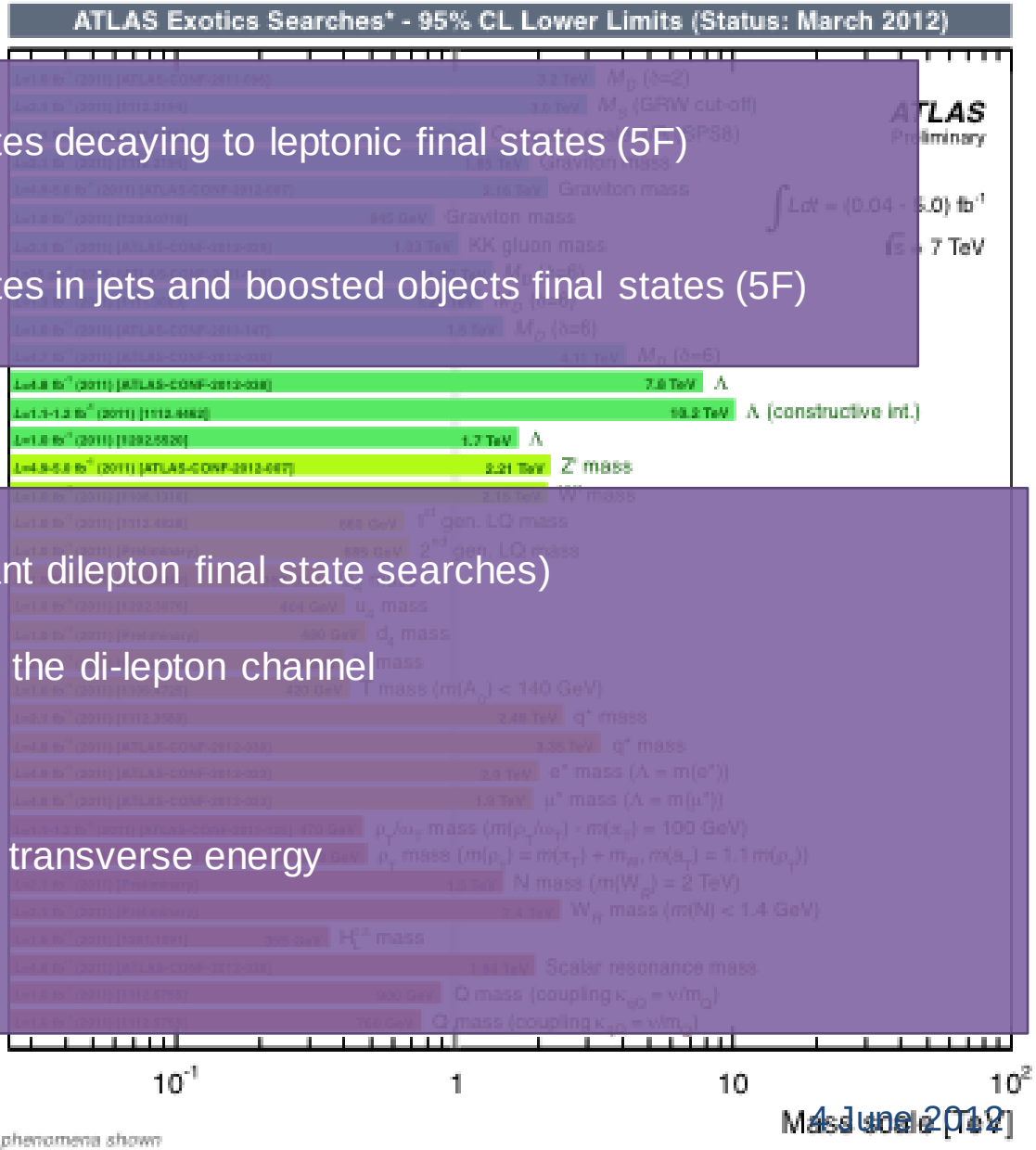
ATLAS TALKS

- R. MOORE
Searches for Exotics physics states decaying to leptonic final states (5F)

- L. APERIO BELLA,
Searches for Exotics physics states in jets and boosted objects final states (5F)

ATLAS Posters (1D)

V. BANSAL
Contact Interactions (Non resonant dilepton final state searches)
M. PETTENI
A Search for ttbar Resonances in the di-lepton channel
A. RELICH
Search for Heavy Neutrinos
R. REZVANI
Search for mono-jet plus missing transverse energy
D. WENDLAND
4th generation searches



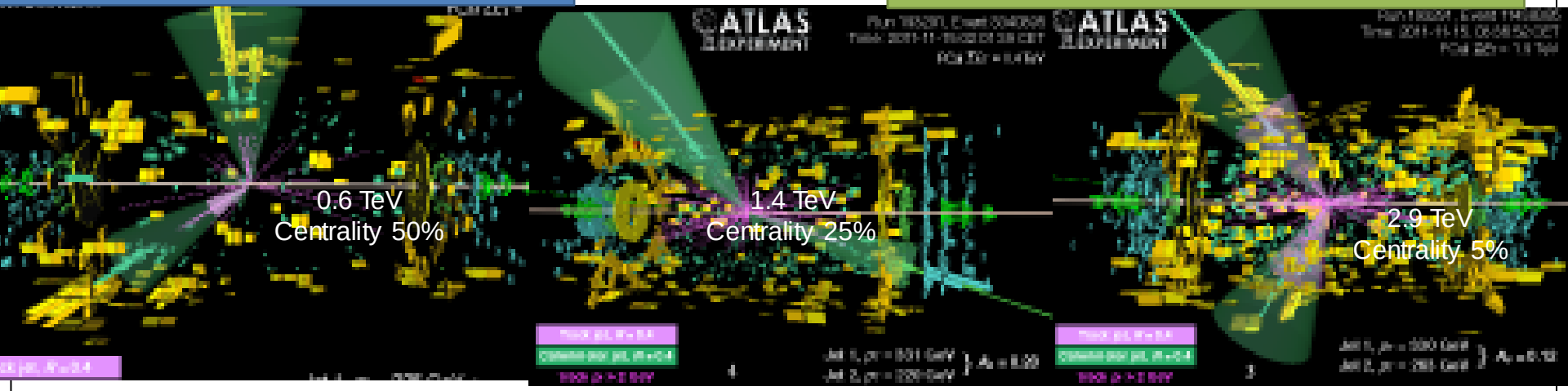
*Only a selection of the available mass limits on new states or phenomena shown

Heavy Ion Collisions

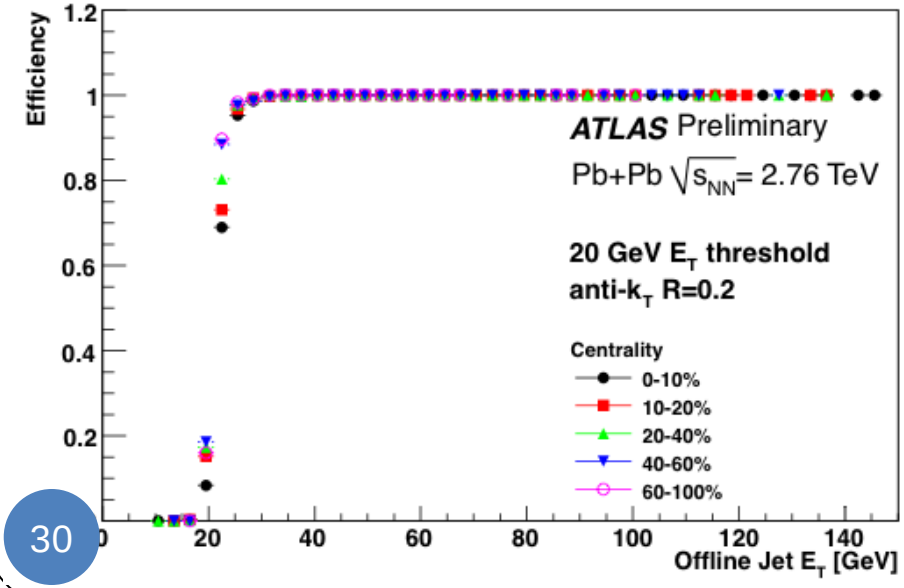
2010 ATLAS Jet Quenching: arXiv:1011.6182, PRL:105 (2010) 252303

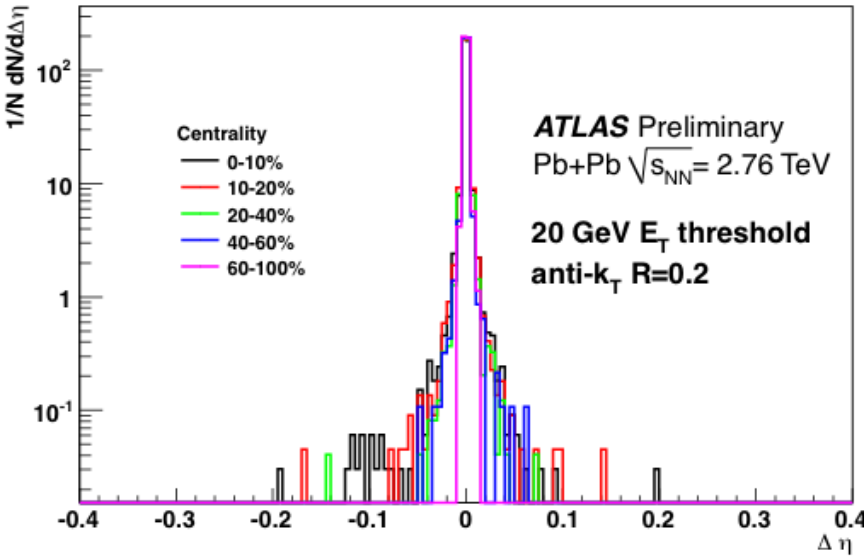
Recent results:
HP2012: http://www.ca.infn.it/hp12

Jet finding in Events (2011 run)

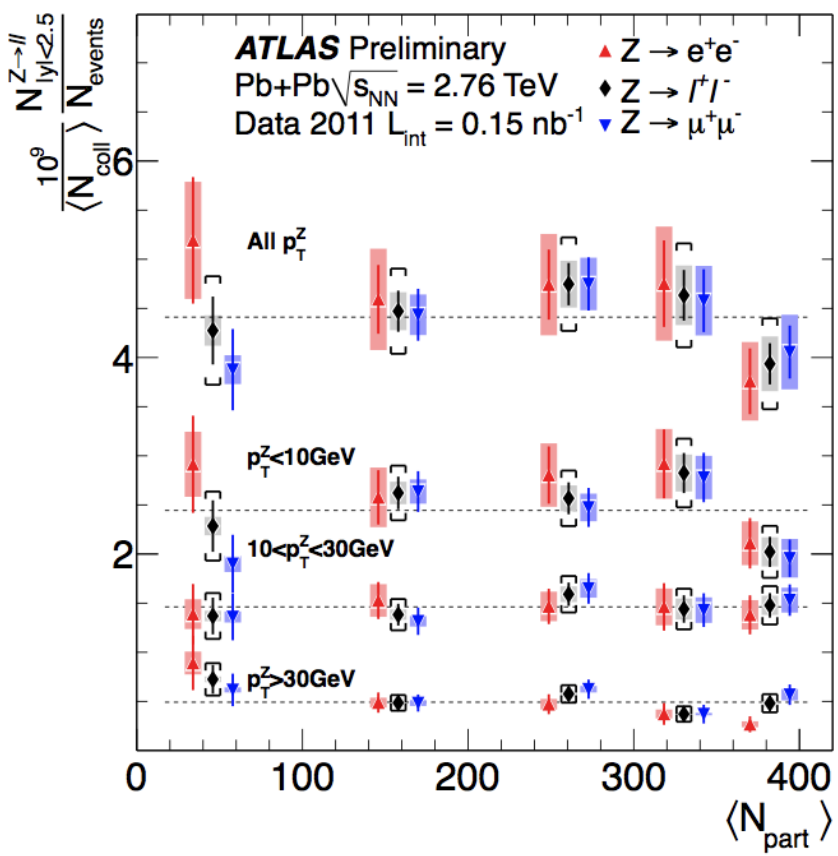


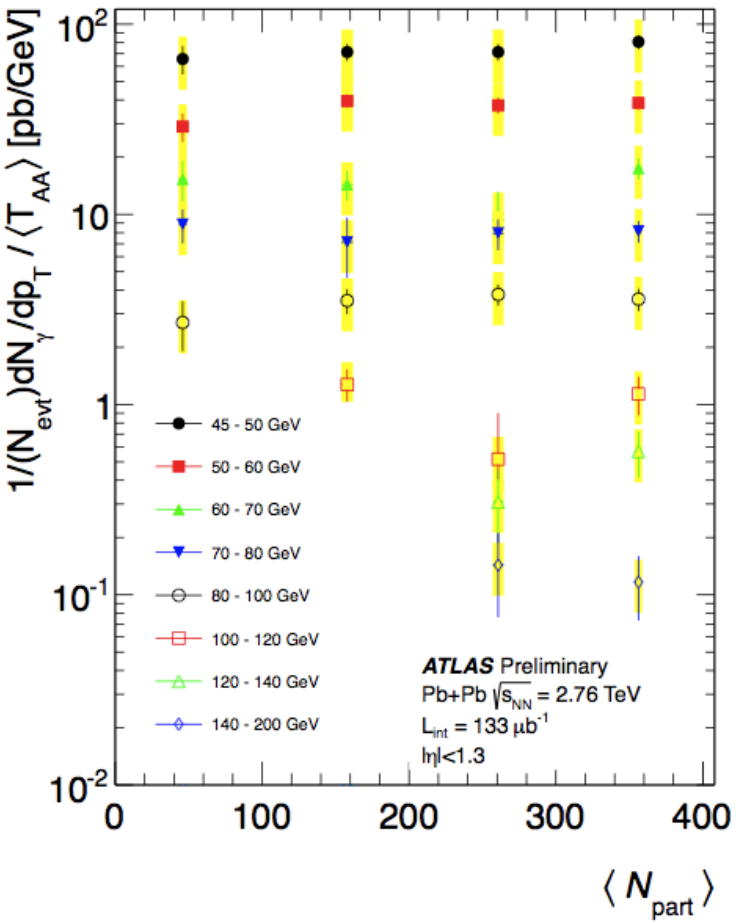
Trigger algorithm finds jets independently of centrality, hope for pileup 200?





Photons and Z Bosons in HI Events (2011 data)





ATLAS-CONF-2012-052

ATLAS-CONF-2012-051

No suppression seen for photons and Z bosons, scales as expected

LHC plans (LS1, LS2, LS3)

2009 — LHC start up, $\sqrt{s}$ = 900 GeV

2010, 2011, 2012 — $\sqrt{s}$ = 7-8 TeV , L = 6 to 8•10^{33} $cm^{-2}s^{-1}$, bunch spacing **50 ns**

~25 fb^{-1}

2013 LS1 — Go to design energy, nominal luminosity

2014, 2015, 2016, 2017 — $\sqrt{s}$ = 13-14 TeV, L = 1•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, 2020, 2021 — $\sqrt{s}$ = 14 TeV, L = 2•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•10^{34} $cm^{-2}s^{-1}$, bunch spacing **25 ns**

Plan for 50% more

~3000 fb^{-1}

LS = Long Shutdown

Phase-0 (installation 2013-14)

Main Improvements to Physics Capabilities

1. New small Be pipe

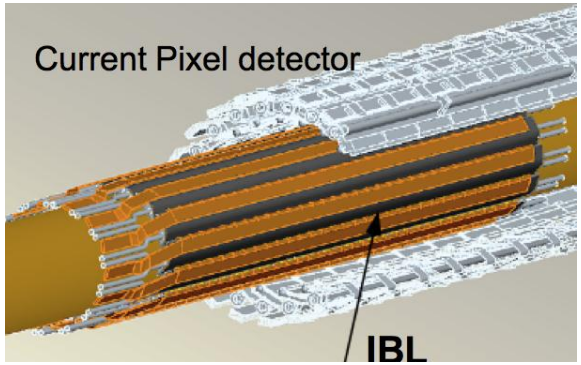
2. New insertable pixel b-layer (IBL) (drives shutdown schedule)

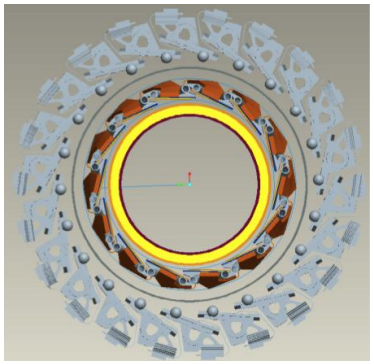
1. Finish the installation of the EE muon chambers staged in 2003 +additional chambers in the feet (new electronics) and elevators region

2. Add topological processing in level 1 of trigger

3. Improve L1 trigger readout rate to 100kHz

IBL preserves current physics performance at high pileup



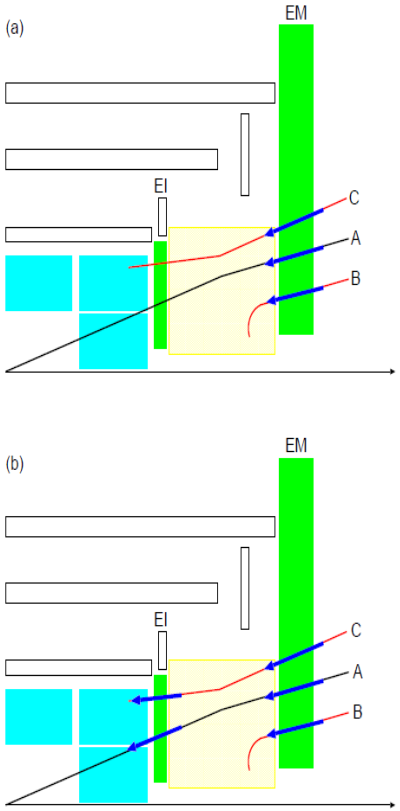


Major Projects

Phase-I (installation in or before 2018)

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

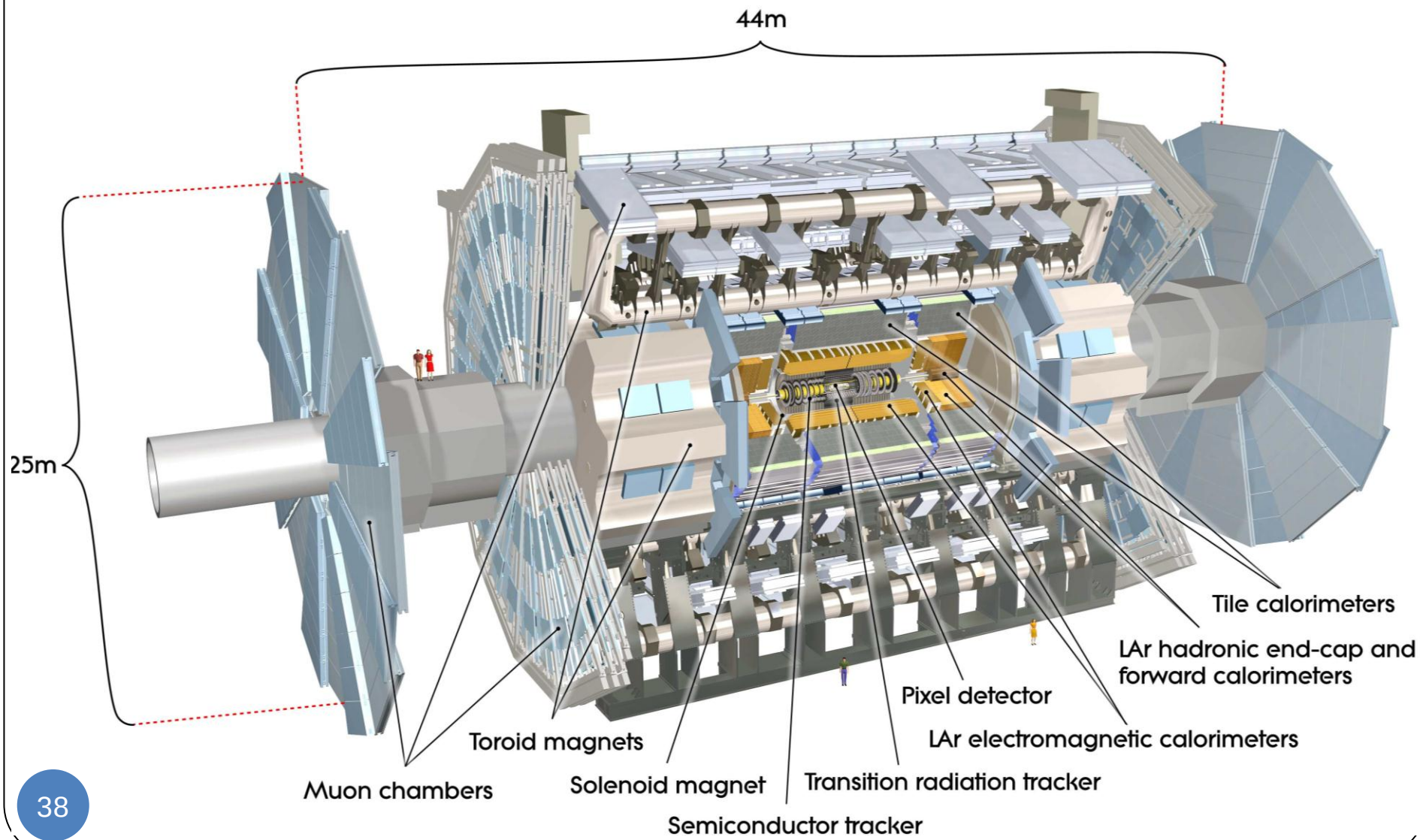
Conclusion

- 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
- Many excellent physics results based on the 2011 run will be described in detail at this conference
- 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

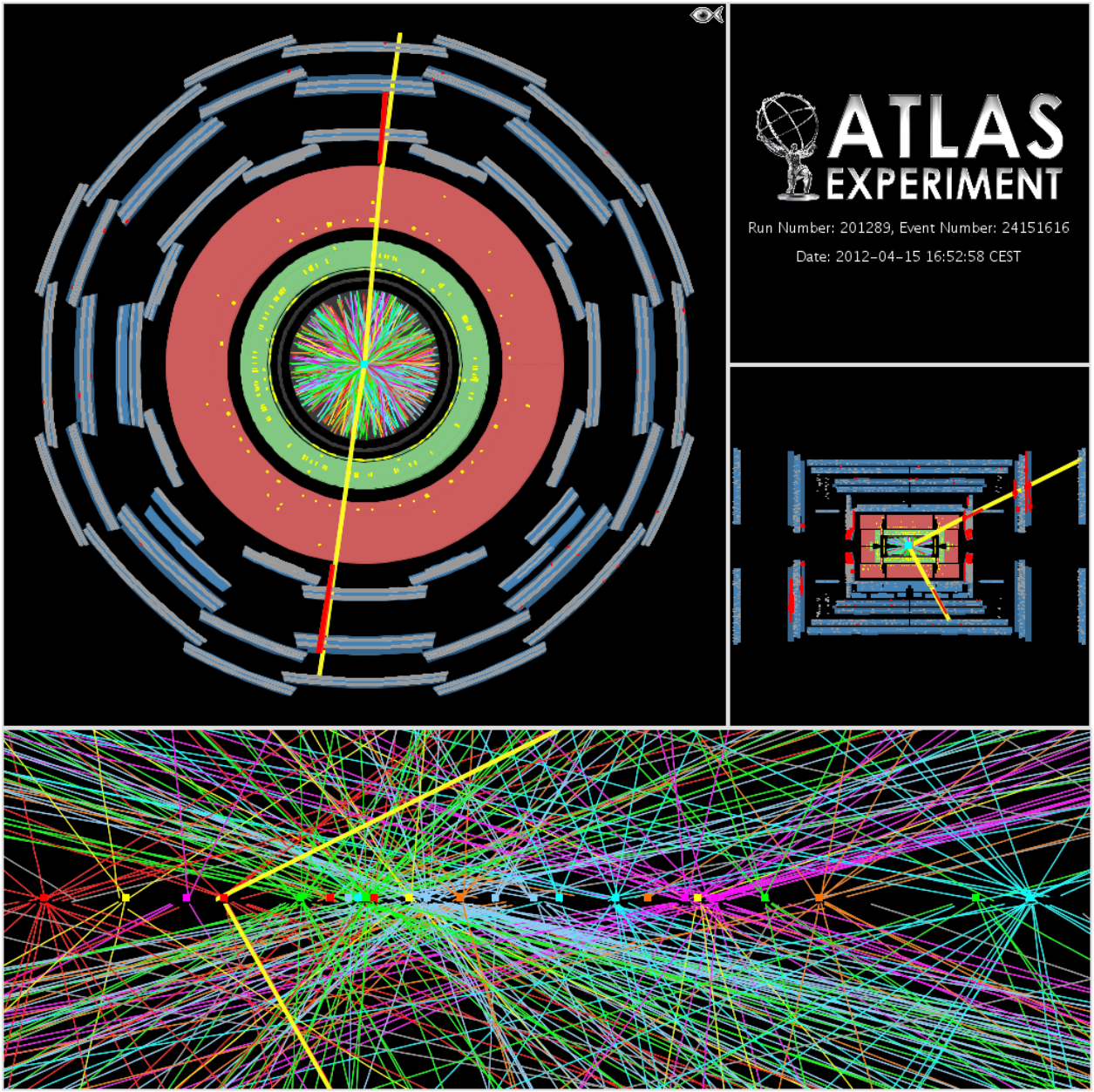
Backup

ATLAS Detector

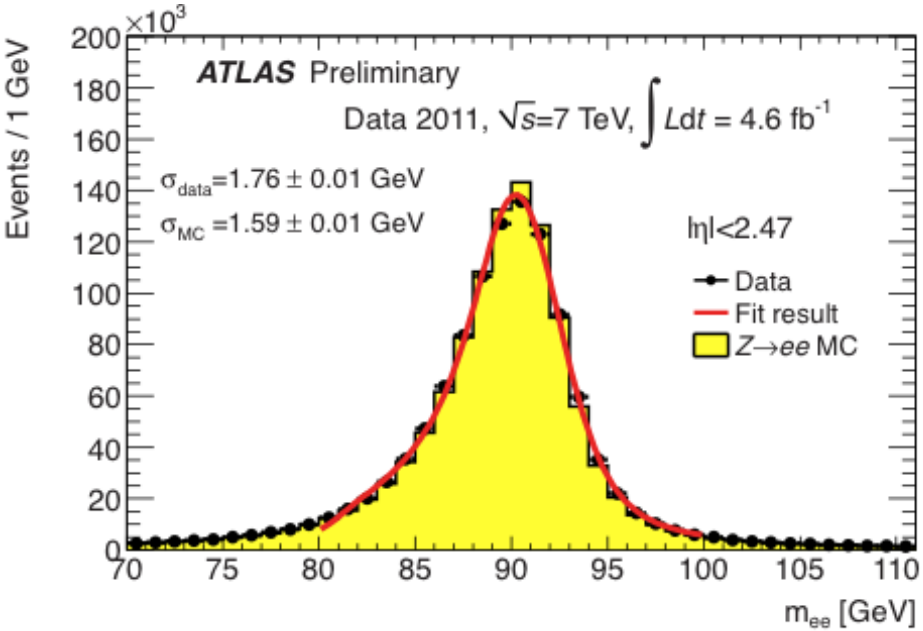
Height: ~25 m
Length: ~44 m
Weight: ~7000 tonnes

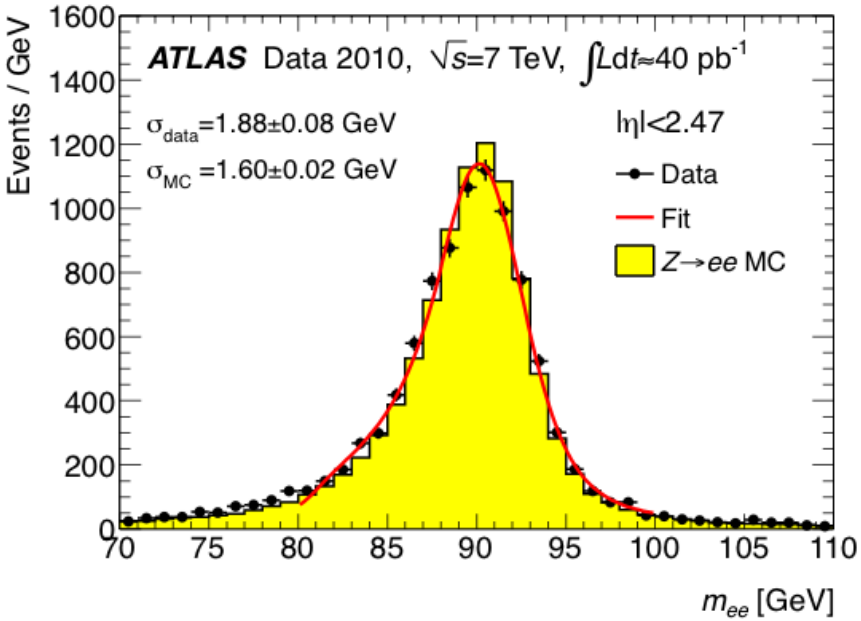


Event Display



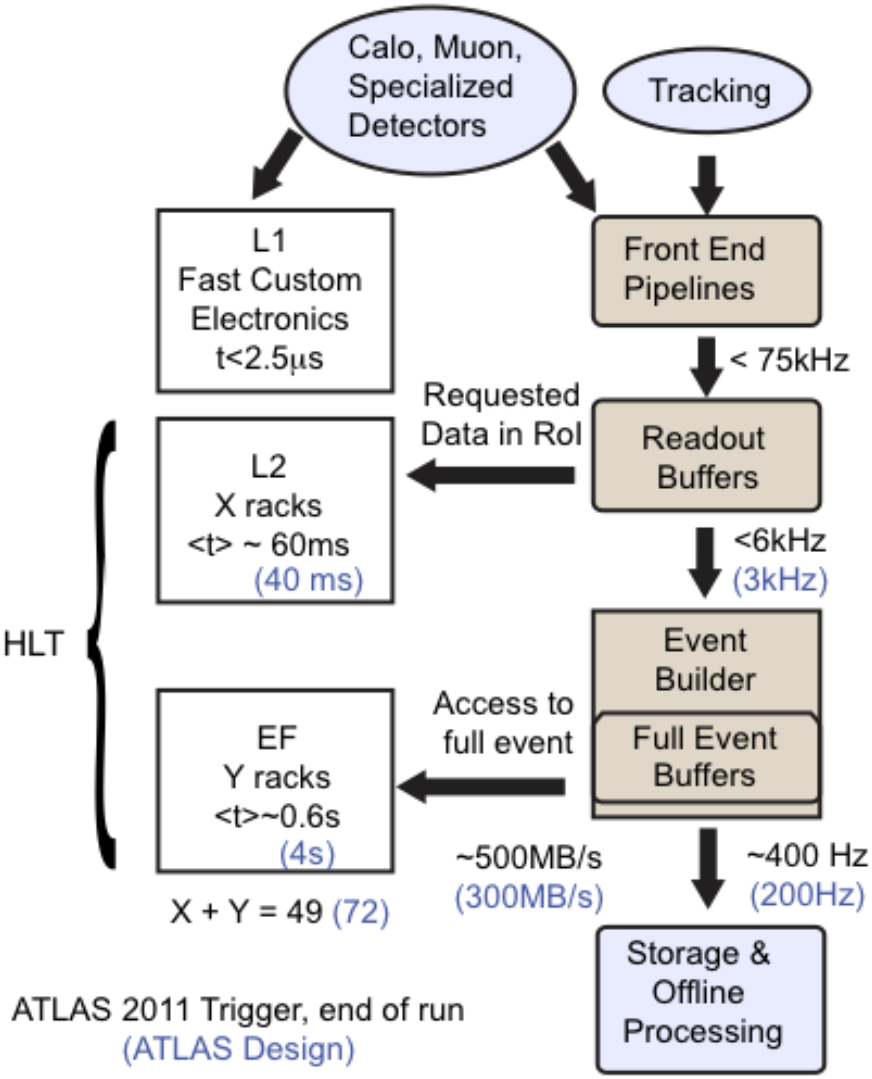
No evidence of degradation of electron mass resolution with high μ in 2011





η coverage	2011 resolution (GeV)	2010 resolution (GeV)
$\lvert\eta\rvert < 2.47$	1.76 ± 0.01	1.88 ± 0.08
$\lvert\eta\rvert < 1.37$	1.60 ± 0.01	1.62 ± 0.09
$2.47 < \lvert\eta\rvert < 1.37$	1.99 ± 0.02	1.99 ±0.22

Trigger Overview



ATLAS 2011 Trigger, end of run
(ATLAS Design)

Limits

- DAQ readout rate significantly beyond design (lower thresholds)
- Sophisticated tools in place to predict resource usage throughout system
- Can complete CPU system during the 2012 run if necessary

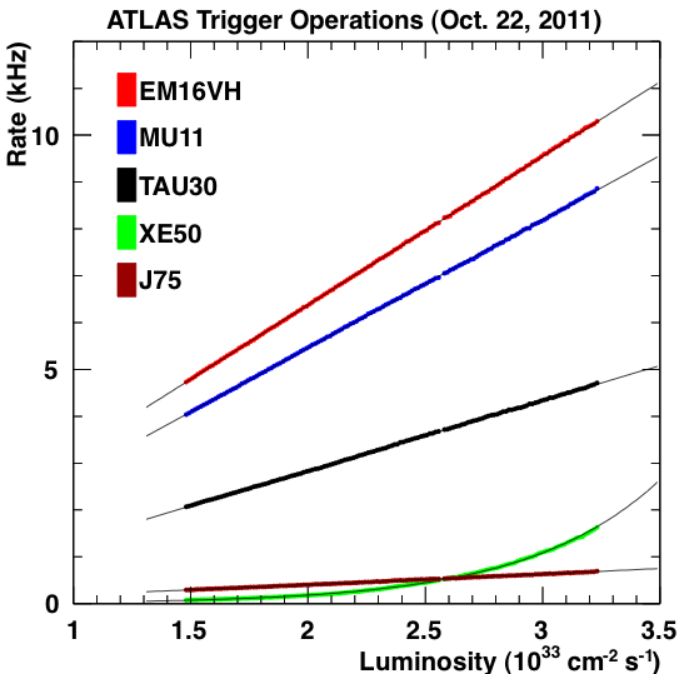
Menus and Algos

- ~200 Level 1 items
- ~500 Level 2 chains
- ~500 EF chains

arXiv:1110.1530

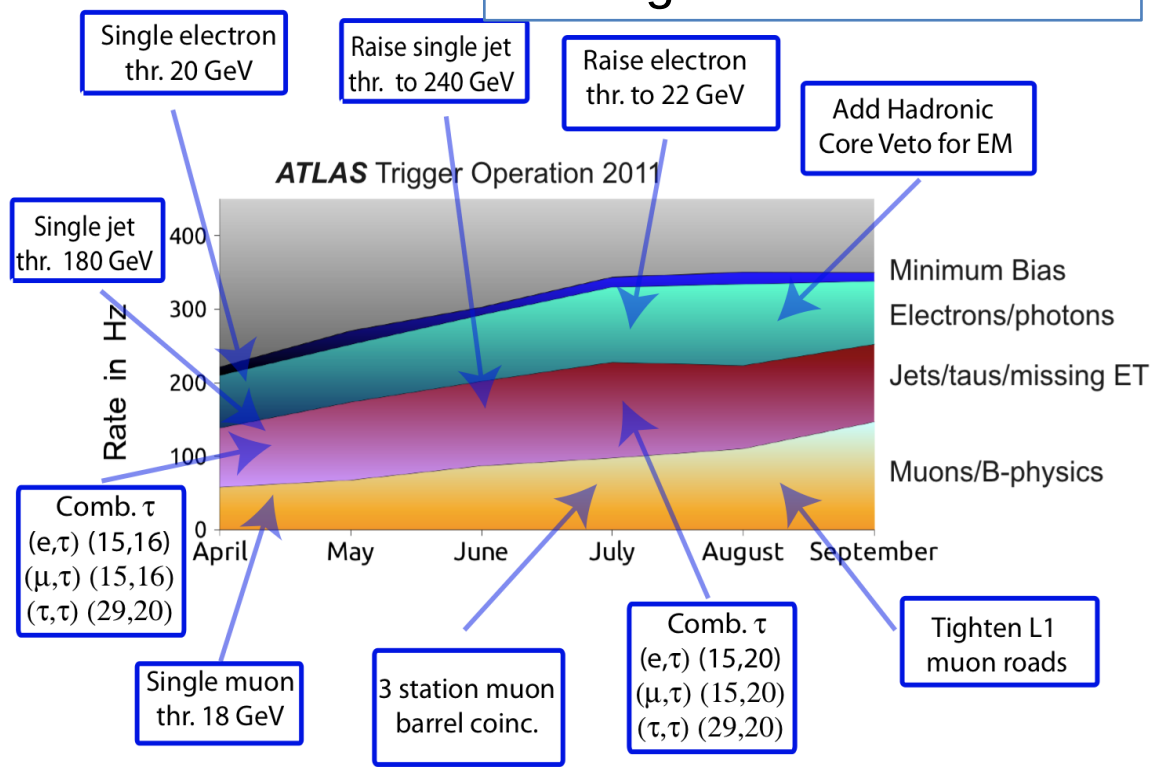
Menu complexity mainly for supporting items

Trigger Evolution and Data Quality in 2011



Level 1 Rate
(EM scale for jets)

Average Event Filter Rate

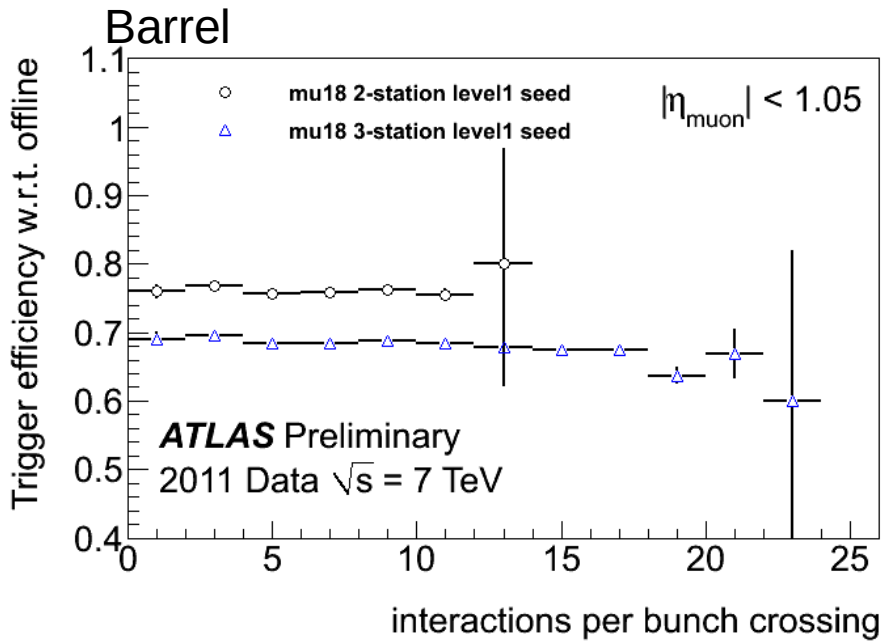


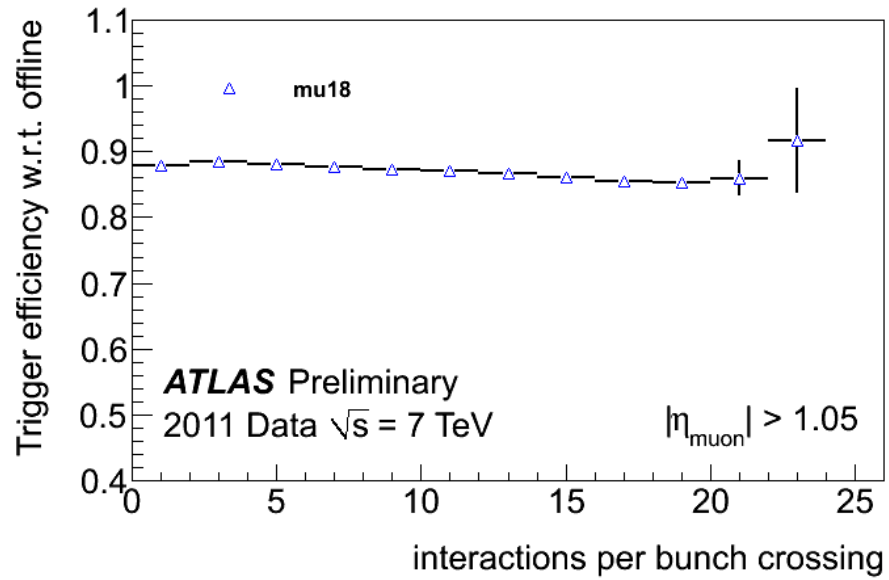
L1			HLT						
Muon	Calo	CTP	electron	photon	muon	tau	jet	b-jet	missing E_T
99.0	100	99.8	99.3	99.3	100	99.9	98.6	99.9	99.3

Luminosity weighted relative trigger quality delivery during 2011 stable beams in pp collisions at √s=7 TeV between 13 March and 31 October (in %).

Muon trigger efficiency versus pileup

Z tag and probe, p_t>18 GeV



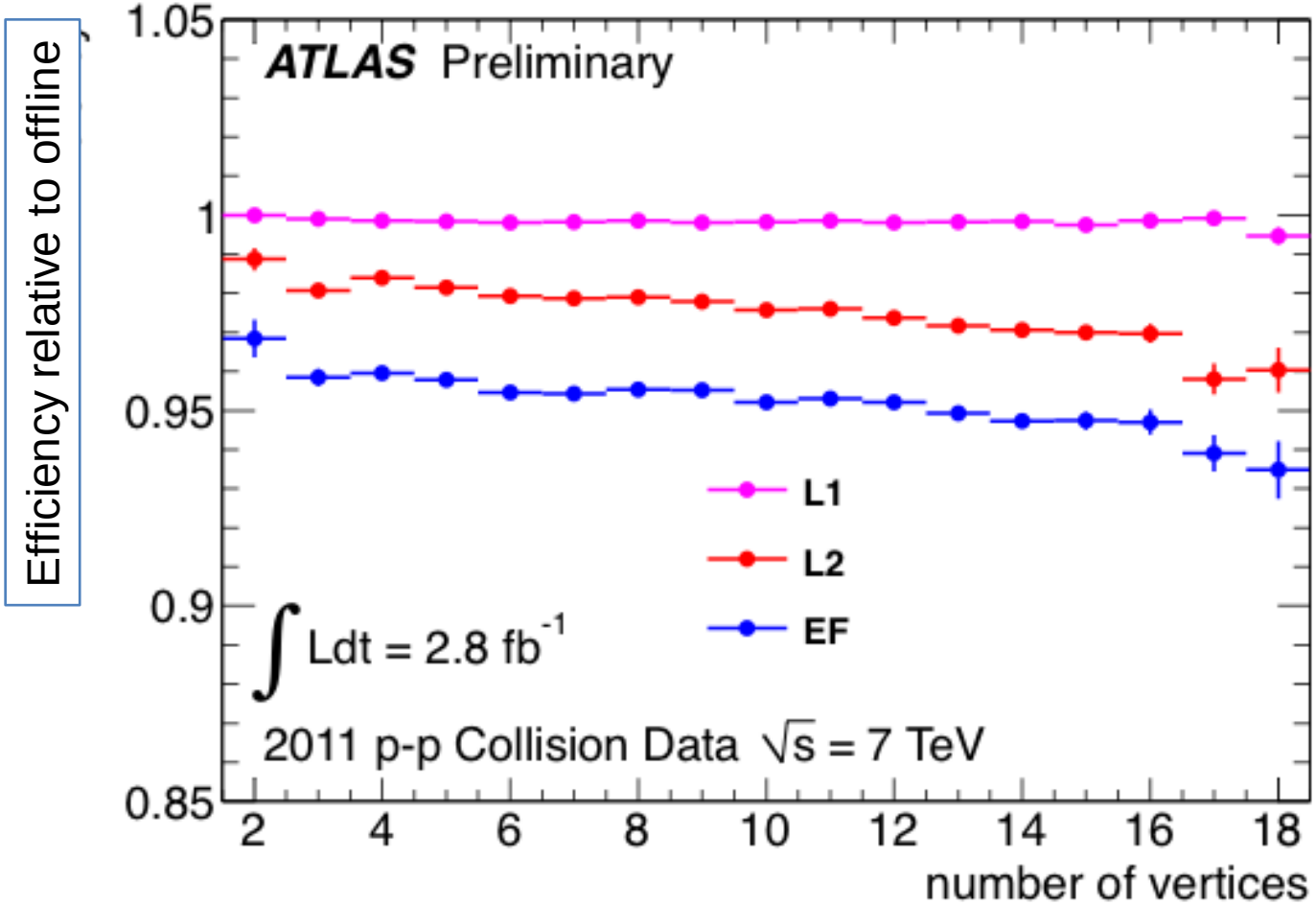


Little dependence of muon trigger with respect to muon efficiency on mean number of interactions per event

- 2 station level 1 seed used in barrel for β^*=1.5 m
- 3 station level 1 seed used in barrel for β^*=1.0 m

Electron efficiency versus number of interactions

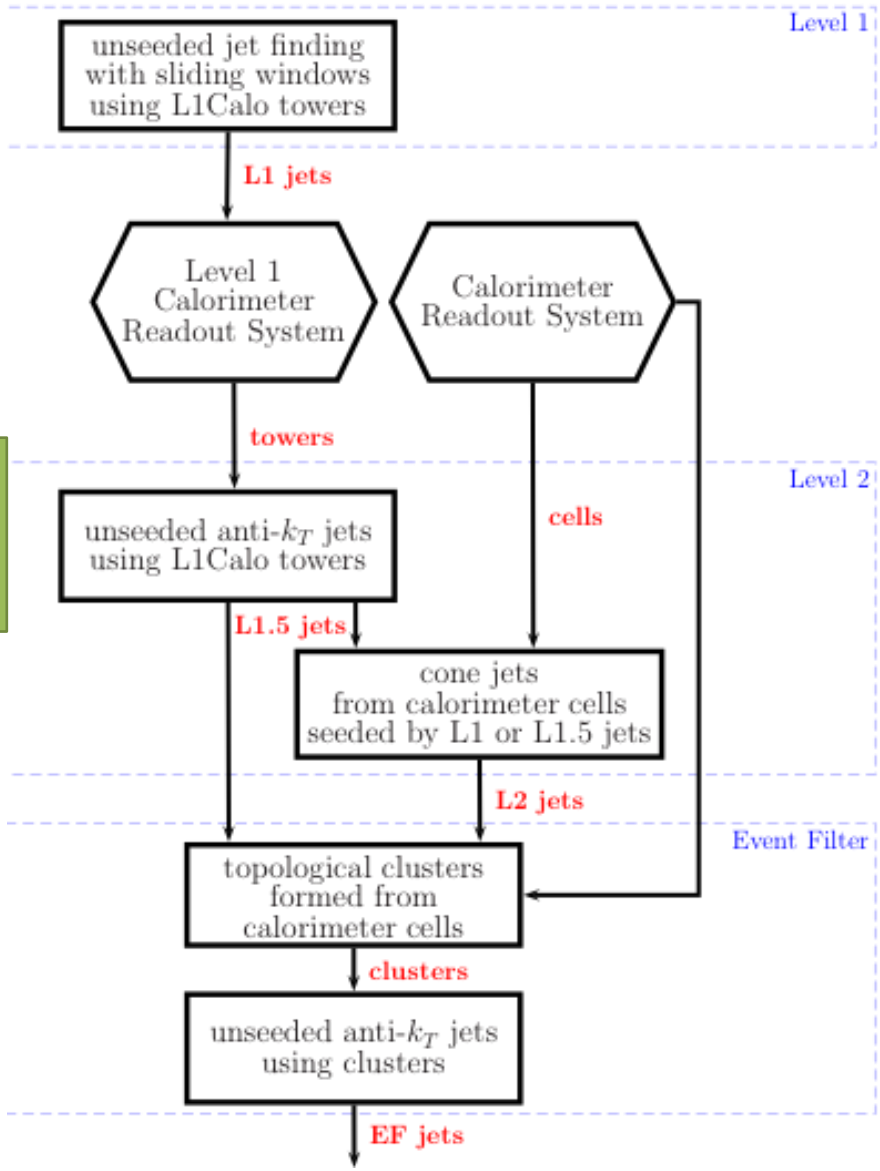
Z tag and probe
$E_t > 25$ GeV



Small dependence of trigger efficiency with respect to offline selection
Data is has β* = 1.0m

Schematic diagram of Jet triggers in ATLAS

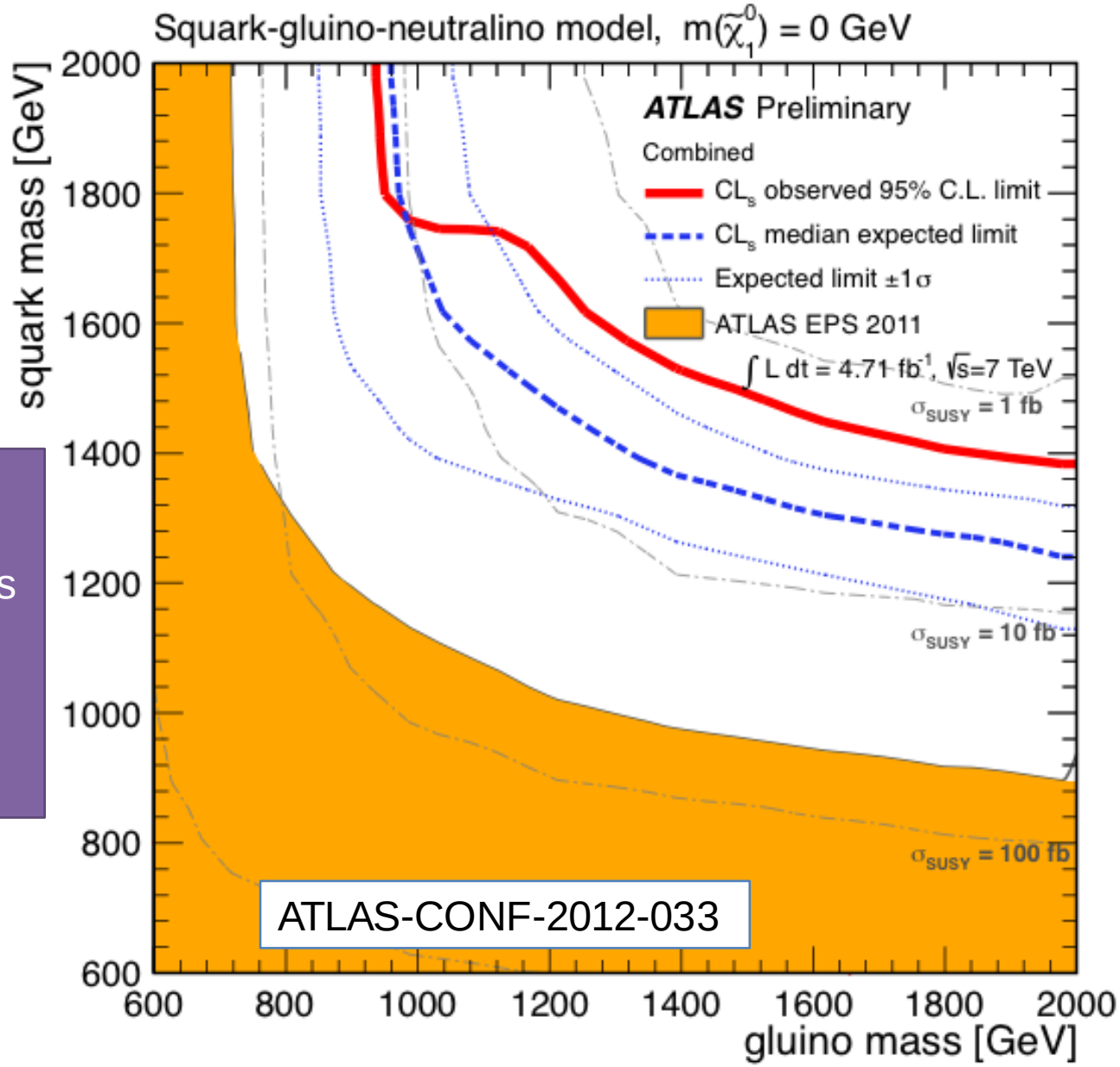
Level 1.5 allows the an anti-k_t Algorithm to be run on the jets



SUSY – squark gluino

0-lepton jet+MET analysis (depends on MET trigger)

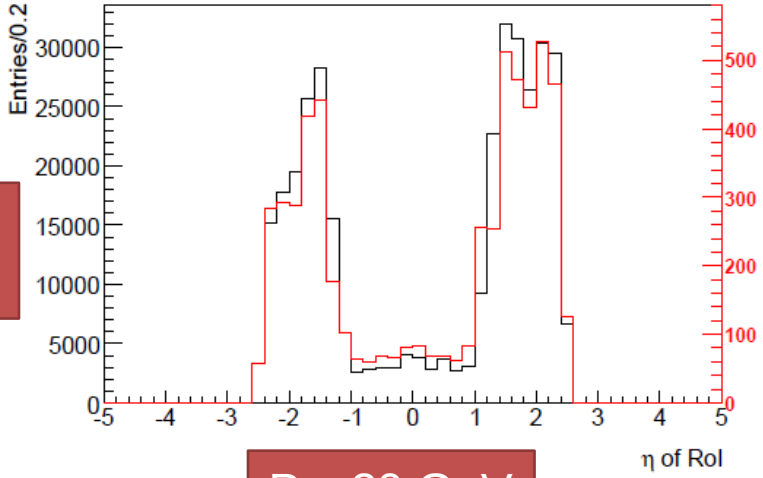
•J. MCFAYDEN Search for supersymmetric gauginos and third generation squarks with the ATLAS detector (5E)



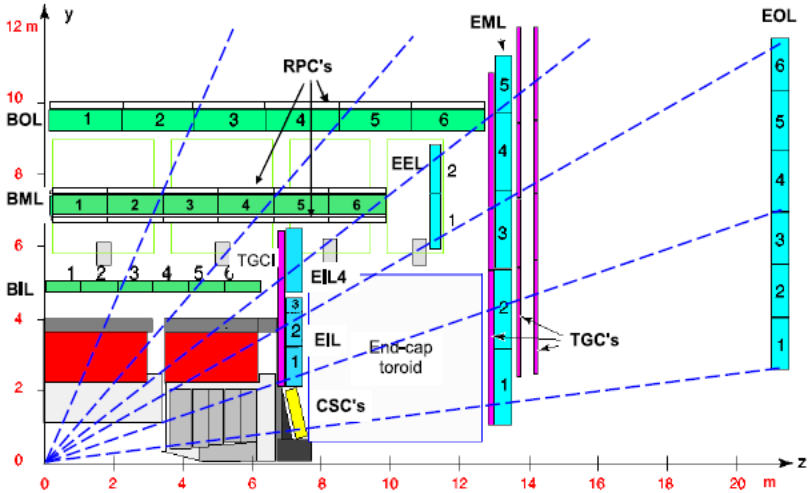
ATLAS-CONF-2012-033

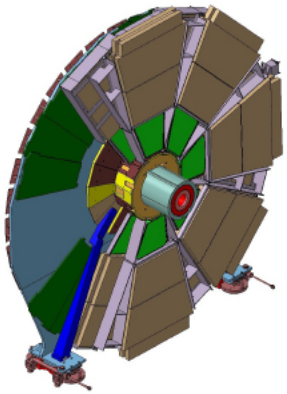
Muon upgrade

Background for 20 GeV muons all in endcap



P_t> 20 GeV





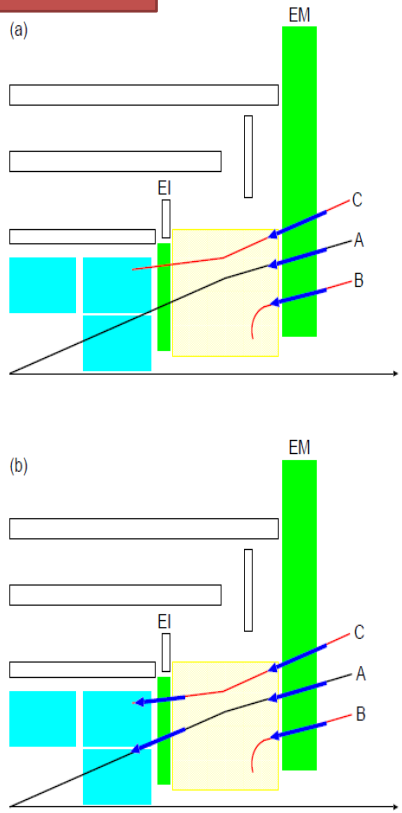
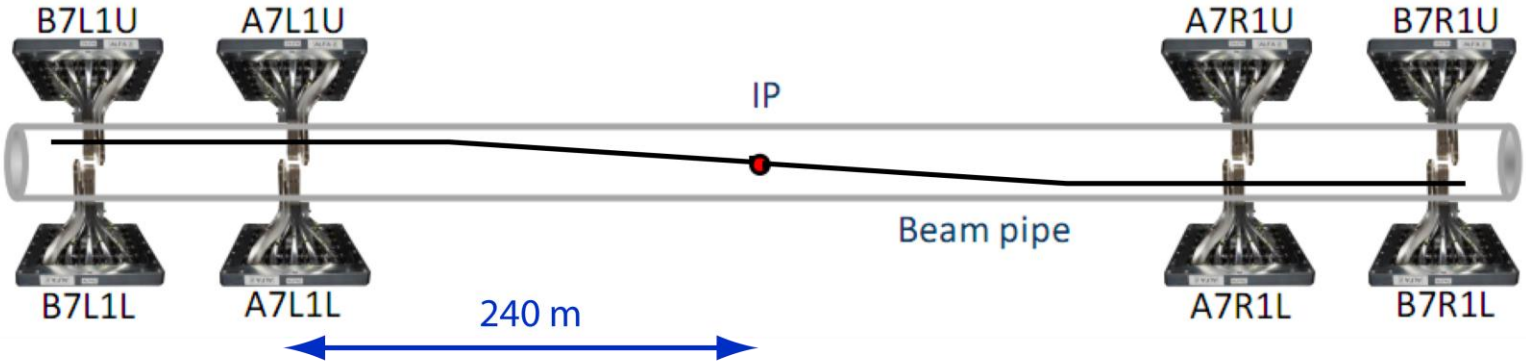


Figure 2.1. Left: A z-y view of 1/4 of the ATLAS detector. The blue boxes indicate the end-cap MDT chambers and the yellow box CSC. Right: A view of a small wheel mounted on the JD disk shielding.

ALFA: goal to measure precisely luminosity and total cross section

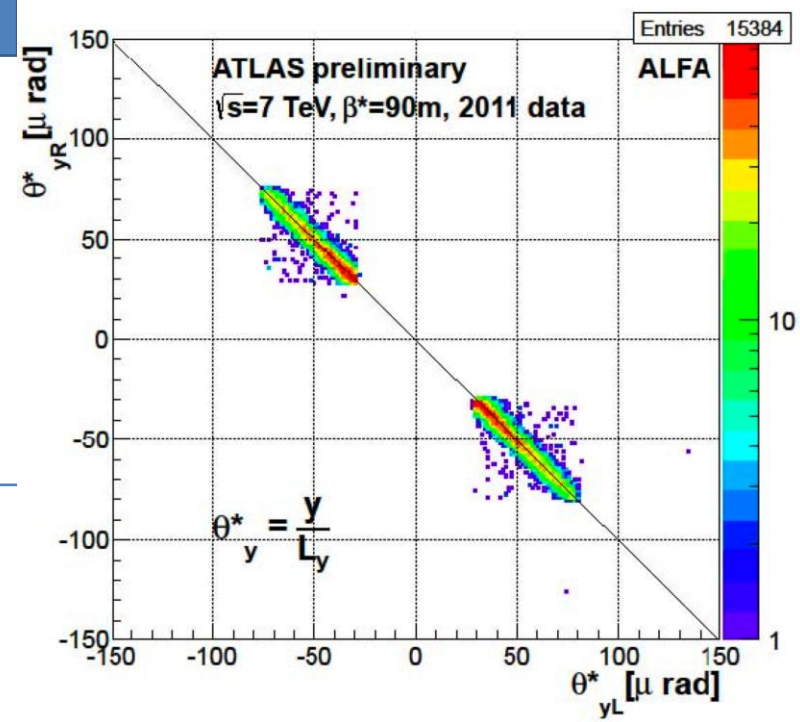


2011 run $\beta^* = 90$m, detectors at 6.5σ (~5mm):

- probe |t| in range 0.01 to 0.2-0.4GeV^2
- measure σ_{tot} via optical theorem (using vdM lumi)
- 100M events in total, 1.5M elastic and 2M diffractive events

2012 program

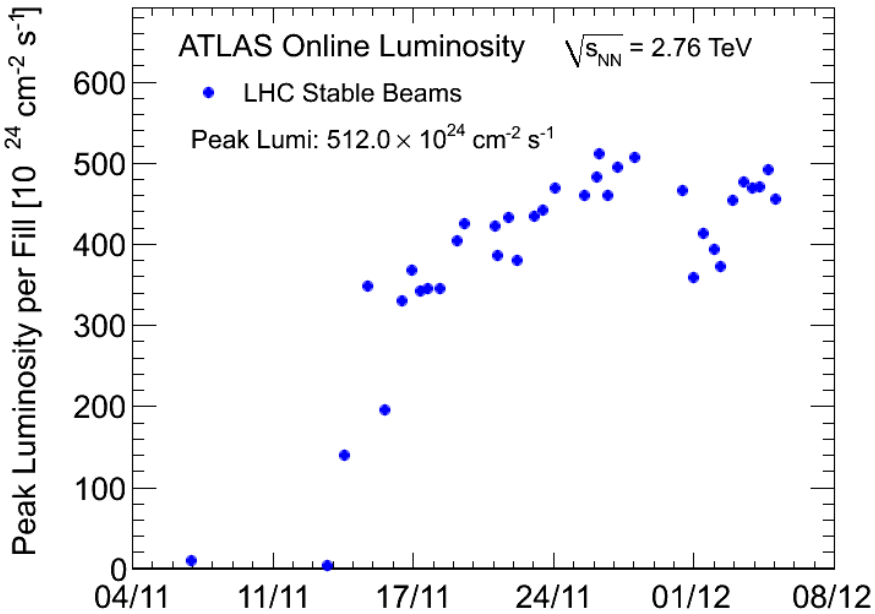
- Potential to reach Coulomb-Nuclear Interference (CNI) region
- Push β^* to 500 - 1000m
- Move detector close to the beam to touch CNI region
- Measure σ_{tot} *and luminosity simultaneously*

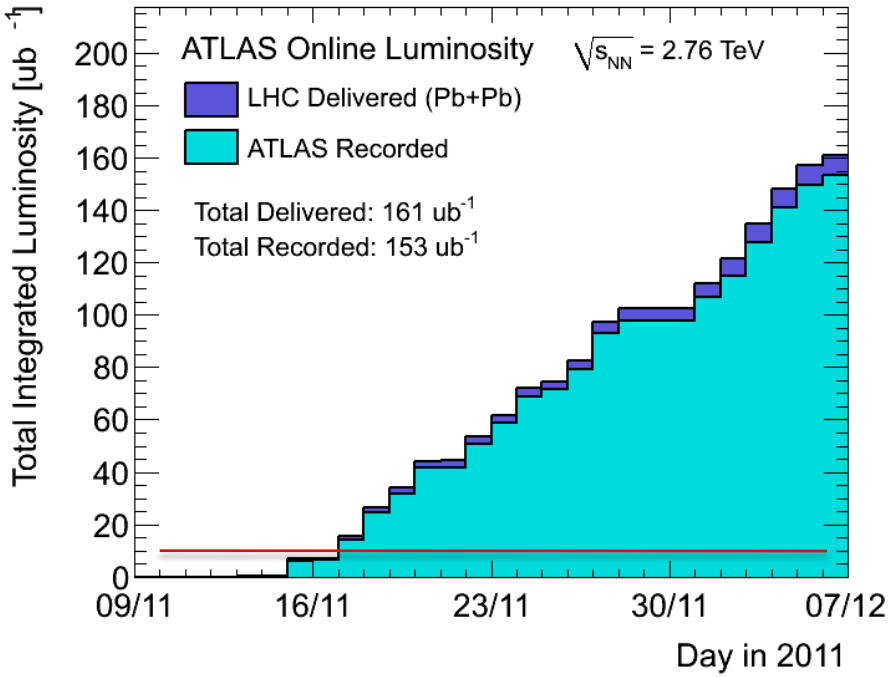


Angular correlation of protons on left & right indicating elastic scattering

HI OPERATIONS in 2011

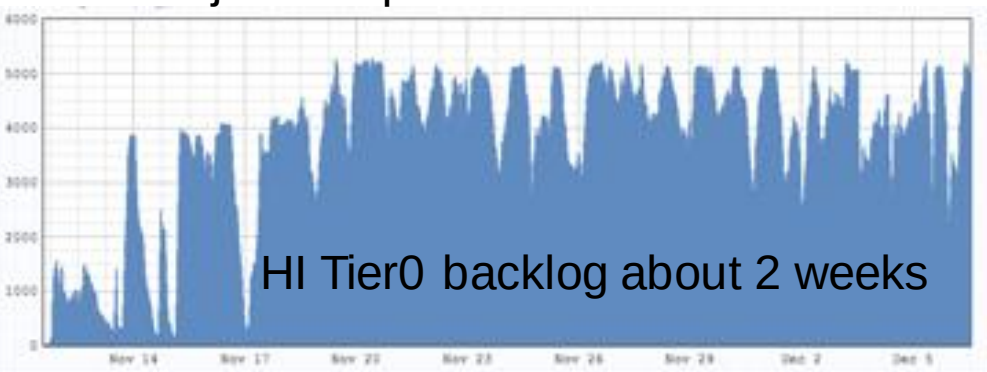
15 times more data than last year





Stream	Events Taken	Reco CPU/evt [s]
Min Bias	60M	70
Hard Probes	54M	140
UPC	6.6M	30

Tier0 jobs – up to 5000 CPUs used

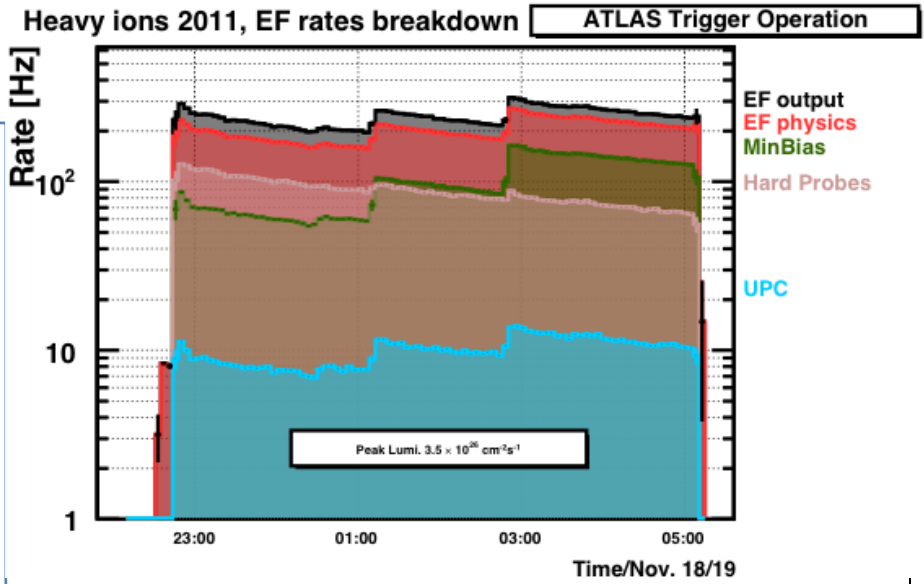


CPU carefully optimized for the HI run

Triggers for heavy ions

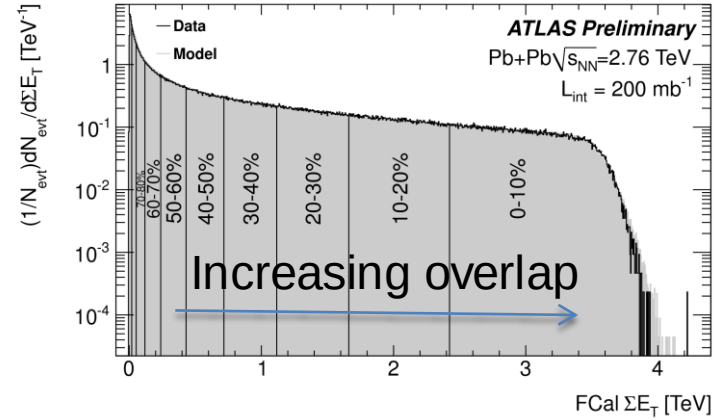
Peak luminosity $5.1 \times 10^{26} cm^{-2} s^{-1}$, gives 6 kHz of min-bias rate at L1:

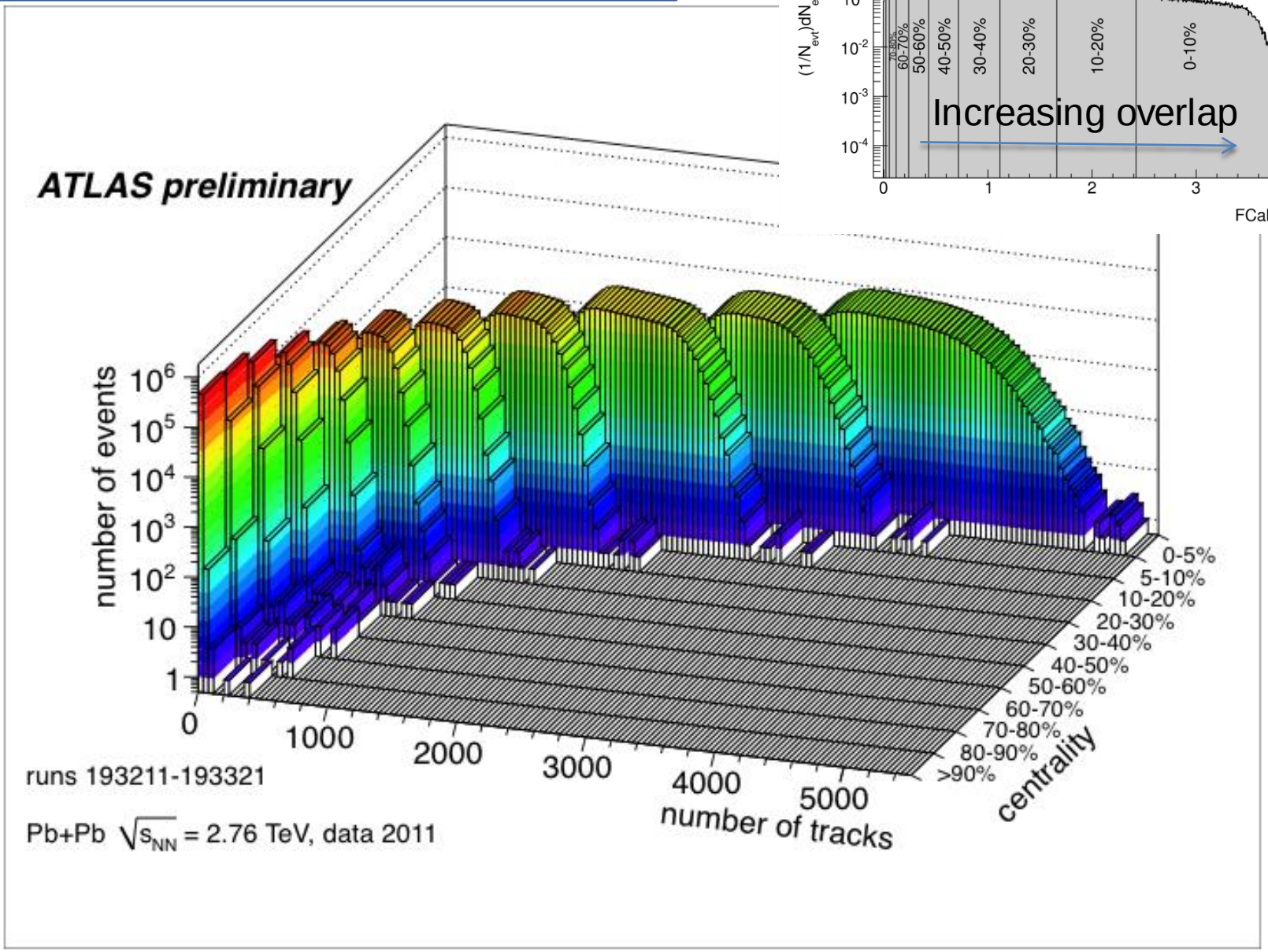
- In 2011 High Level Trigger (HLT) essential to bring output rate down to 500MB/s (200Hz for HI events)
- Two approaches used:
  - Full scan reconstruction at EF on all min-bias events triggered by L1 (jets, muons),
  - Region-Of-Interest (RoI)-based reconstruction seeded off the lowest-p_T threshold at L1 (muons, photons, electrons),

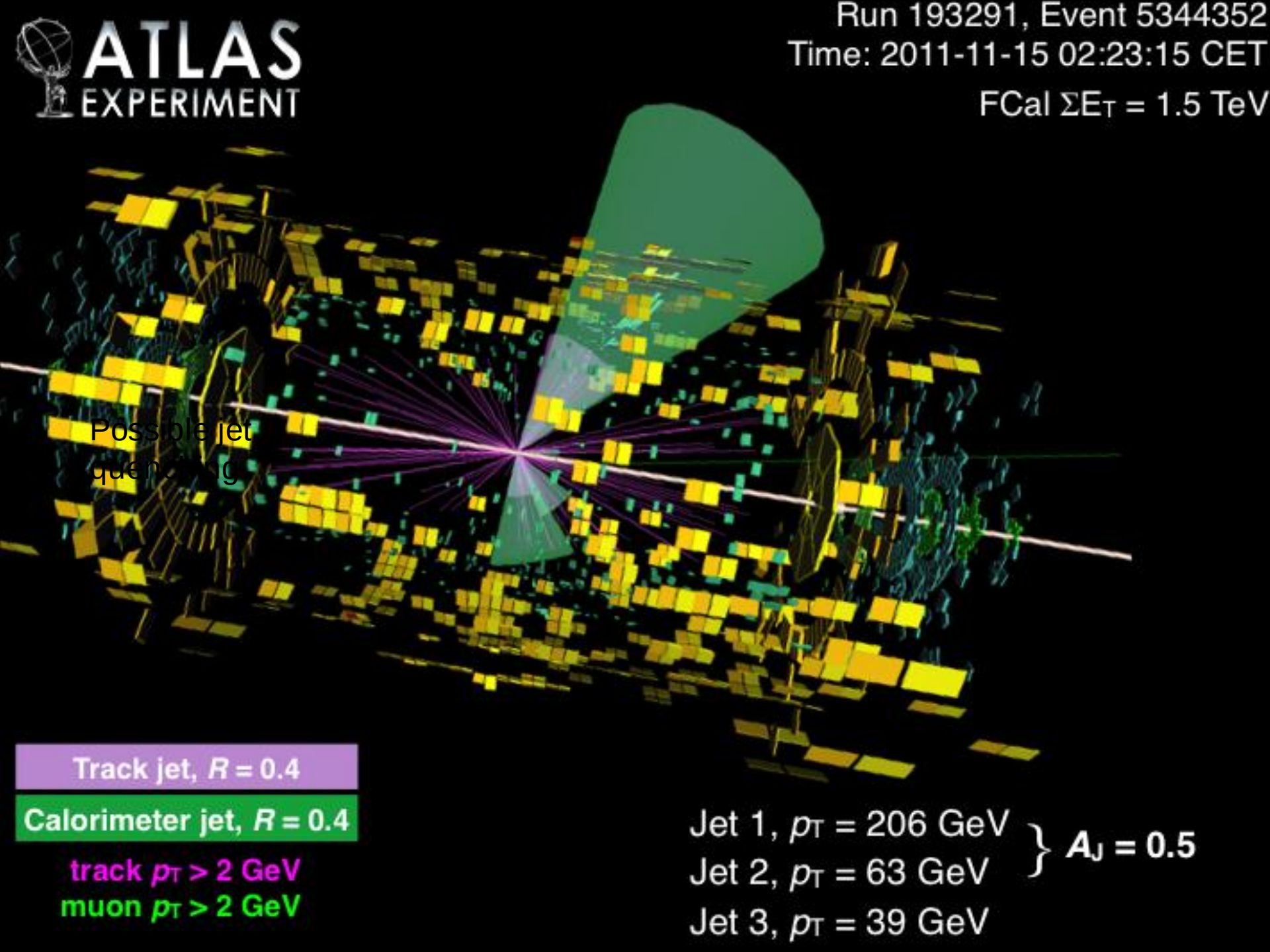


Signature	Trigger
Jets	single jet p_T> 20GeV
Muons	single muon p_T>4GeV di-muon p_T>2GeV
<u>Electron/photon</u>	single egamma p_T>14GeV di-egamma p_T>5GeV
UPC	low track multiplicity cut

Number of tracks as a function of centrality

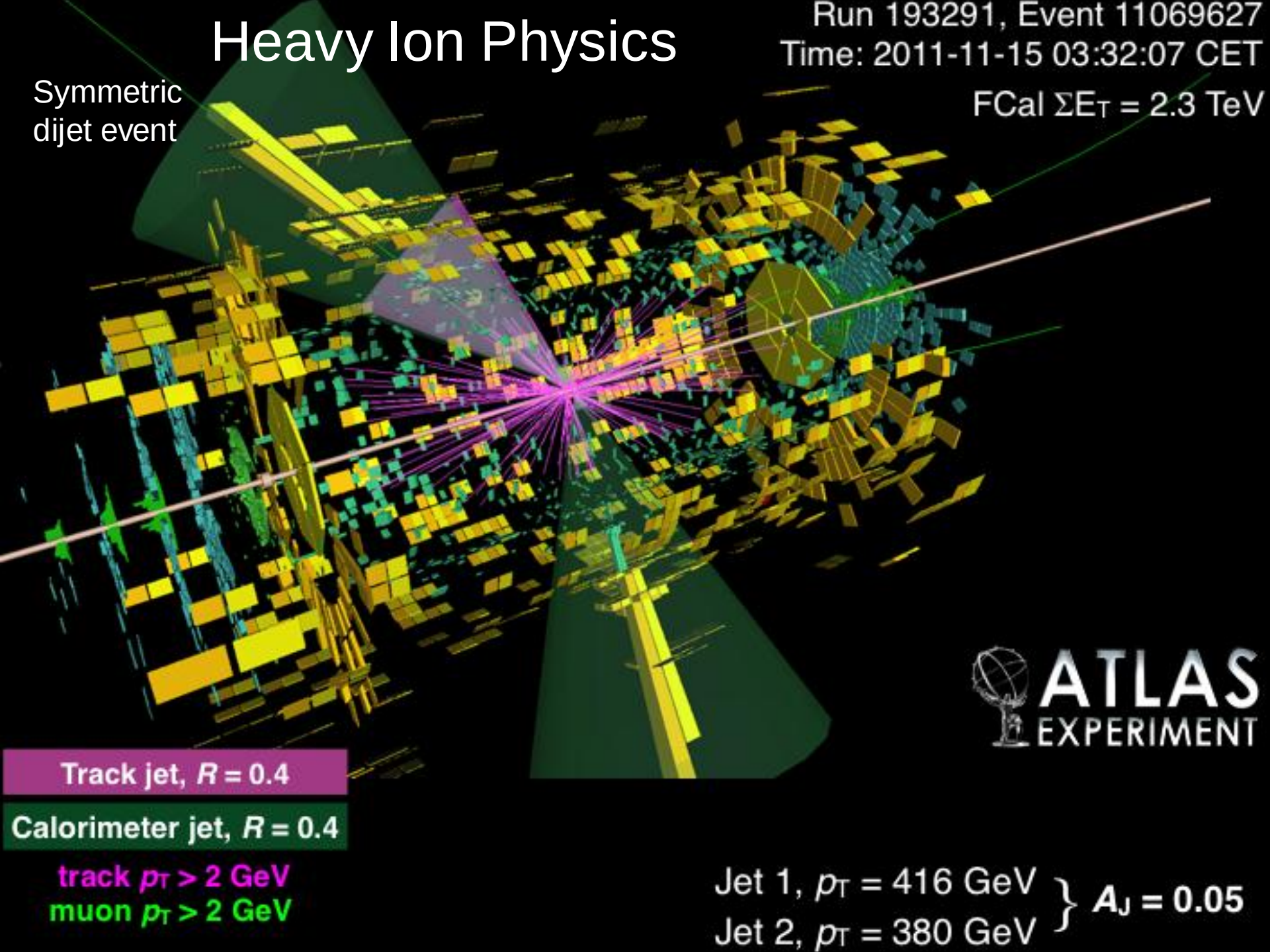





ATLAS
EXPERIMENT
Run 193291, Event 5344352
Time: 2011-11-15 02:23:15 CET
FCal ΣE_T = 1.5 TeV
Possible jet
Track jet, R = 0.4
Calorimeter jet, R = 0.4
track p_T > 2 GeV
muon p_T > 2 GeV
Jet 1, p_T = 206 GeV
Jet 2, p_T = 63 GeV
A_J = 0.5
Jet 3, p_T = 39 GeV

Heavy Ion Physics

Symmetric dijet event



LS1 and LS2 Details

LS1: Consolidation and maintenance to preserve present performance

- New Aluminum beam pipes to prevent activation problem and reduce BG
- New pixel services (nSQP) (→ pending decision this month)
- New evaporative cooling plant for Pixel and SCT + IBL CO_2 cooling plant
- Replace all calorimeter Low Voltage Power Supplies
- Consolidate part of the LUCID system
- Upgrade the magnets cryogenics with a new spare main compressor and decouple toroid and solenoid cryogenics
- Add specific neutron shielding (behind endcap toroid, USA15)
- Preparations for Phase I upgrade (moveable beam pipe, AFP prototypes,…
- Many others

LS2: Supporting Projects

1. Finish adapting central LVL1 trigger electronics to new needs
2. New tile crack-gap scintillators and some new trigger electronics
3. Adapt if proven necessary HLT (in particular network) to the new needs/conditions