Results from the ATLAS

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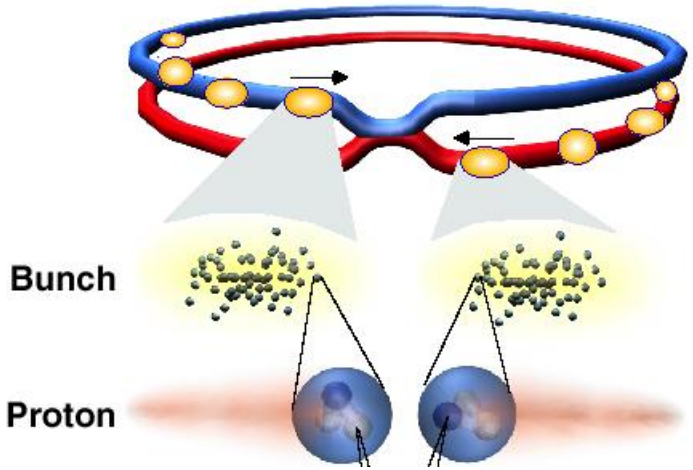
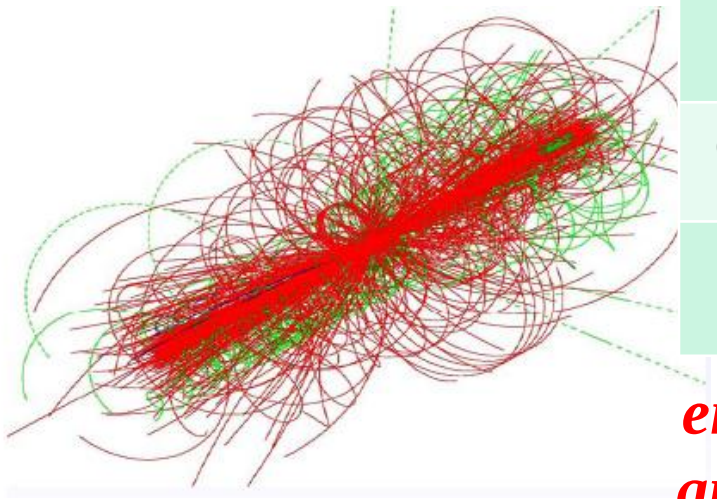
JINR and Sofia University
for the ATLAS Collaboration

Large Hadron Collider (LHC)

Proton-Proton Collisions at the LHC



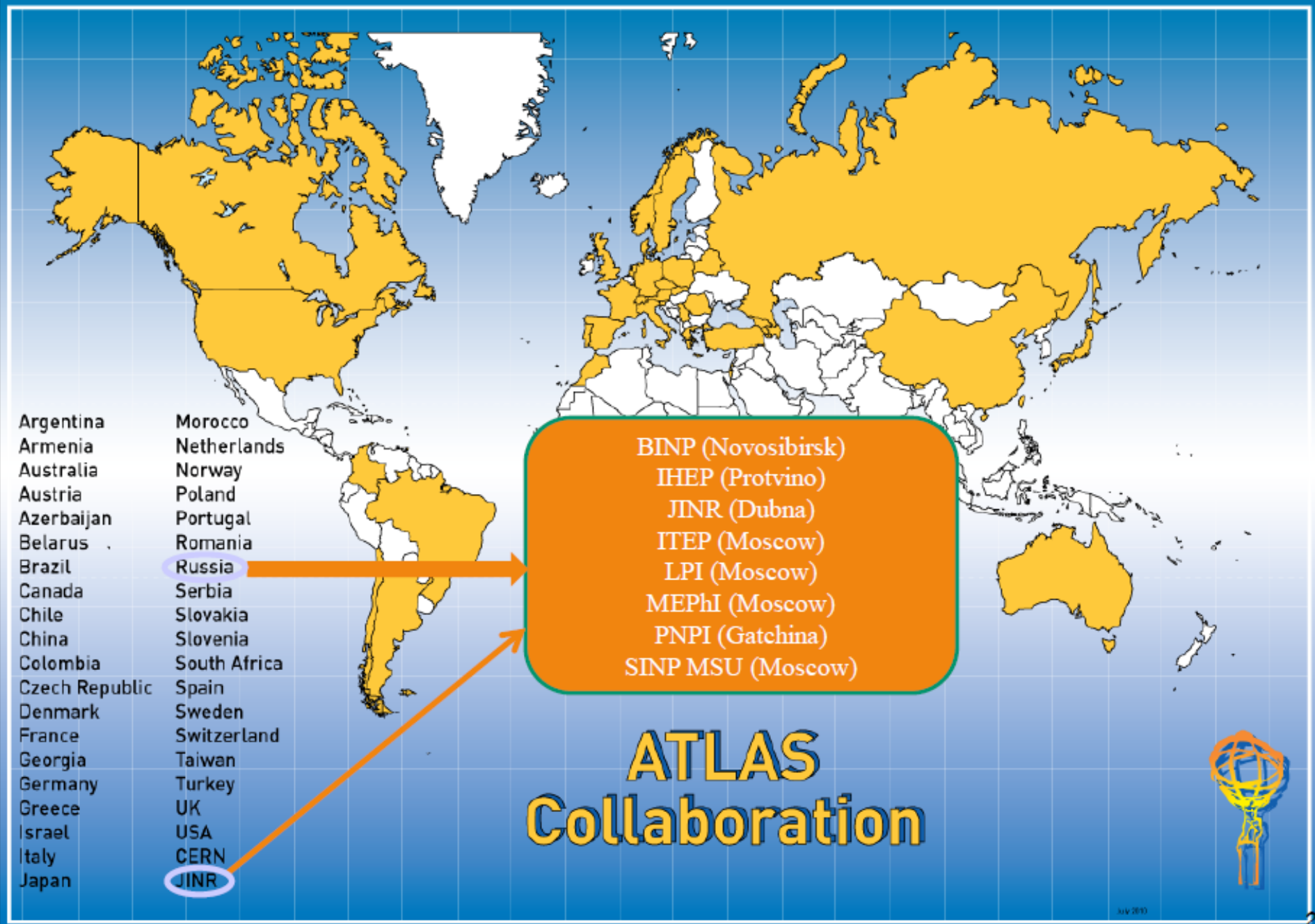
10^9 interactions per second !!!



	Present	Nominal
beam energy	4 TeV	7 TeV
N. of bunches	1380	2808
bunch spacing	50 ns (~15 m)	25 ns (~7.5 m)
β^*	0.6 m	0.55 m
proton/bunch	1.5×10^{11}	1.15×10^{11}
events/crossing	30	19
Λ [cm $^{-2}$ s $^{-1}$]	6.7×10^{33}	10^{34}

enormous challenge for the detectors and for data collection/storage/analysis

~3200 authors 174 Institutions and 38 Countries, ~1000 PhD students



The Largest and Most Complex Detector

A
T
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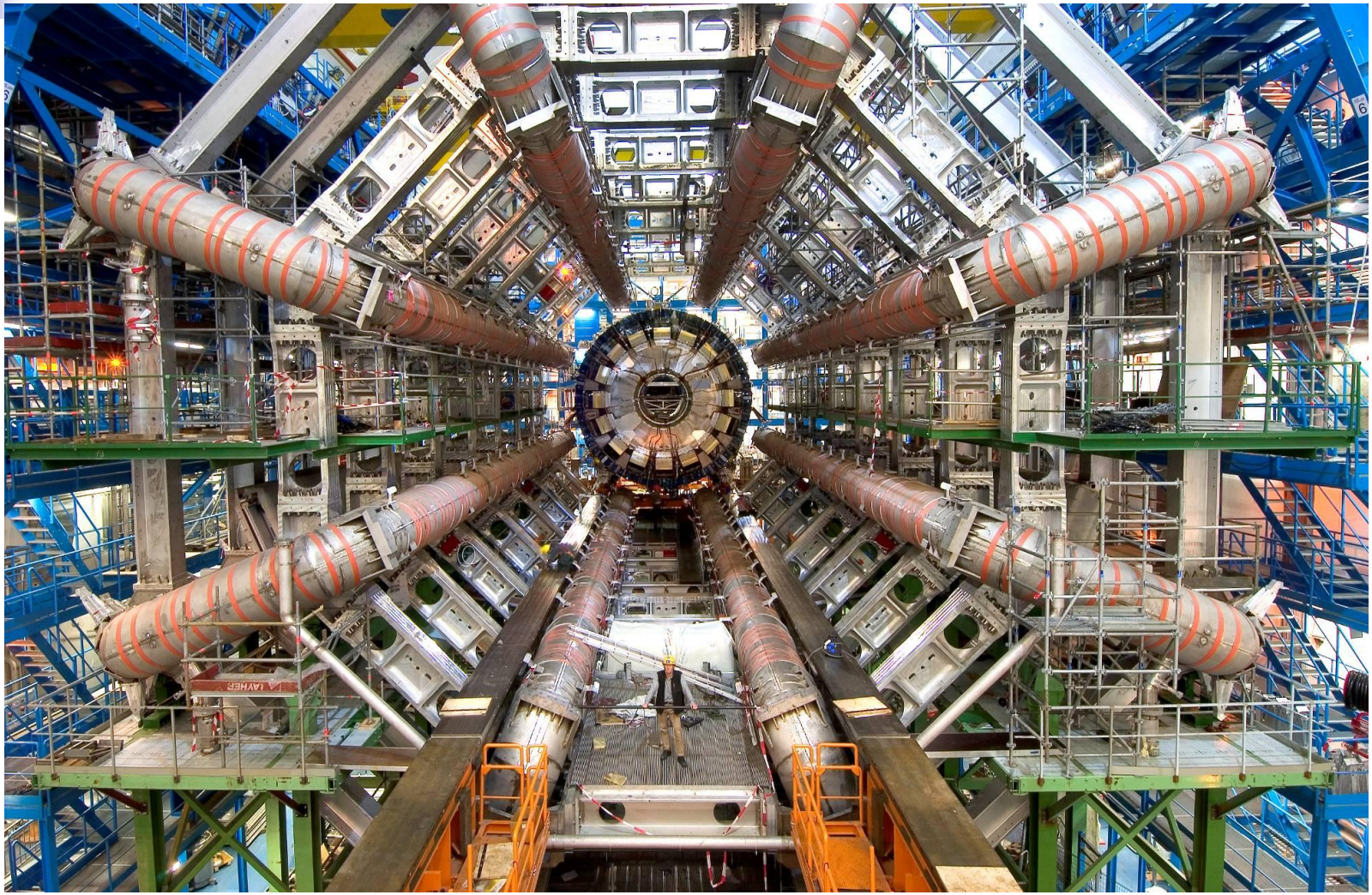
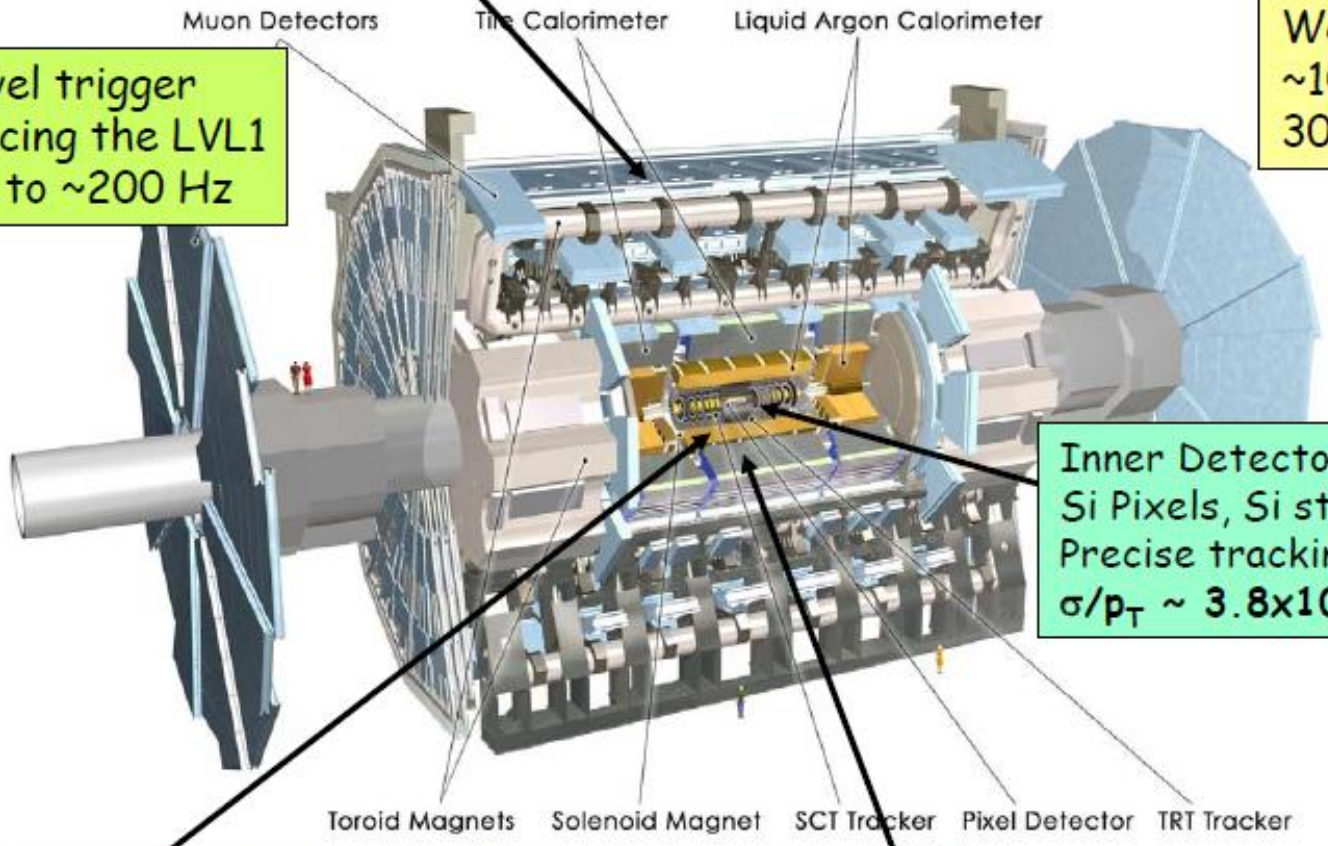


Muon Spectrometer ($|\eta|<2.7$) : air-core toroids with gas-based muon chambers
Muon trigger and measurement with momentum resolution < **10% up to E_μ ~ 1 TeV**

Length : ~ 46 m
Radius : ~ 12 m
Weight : ~ 7000 tons
~10^8 electronic channels
3000 km of cables

3-level trigger reducing the LVL1 rate to ~200 Hz

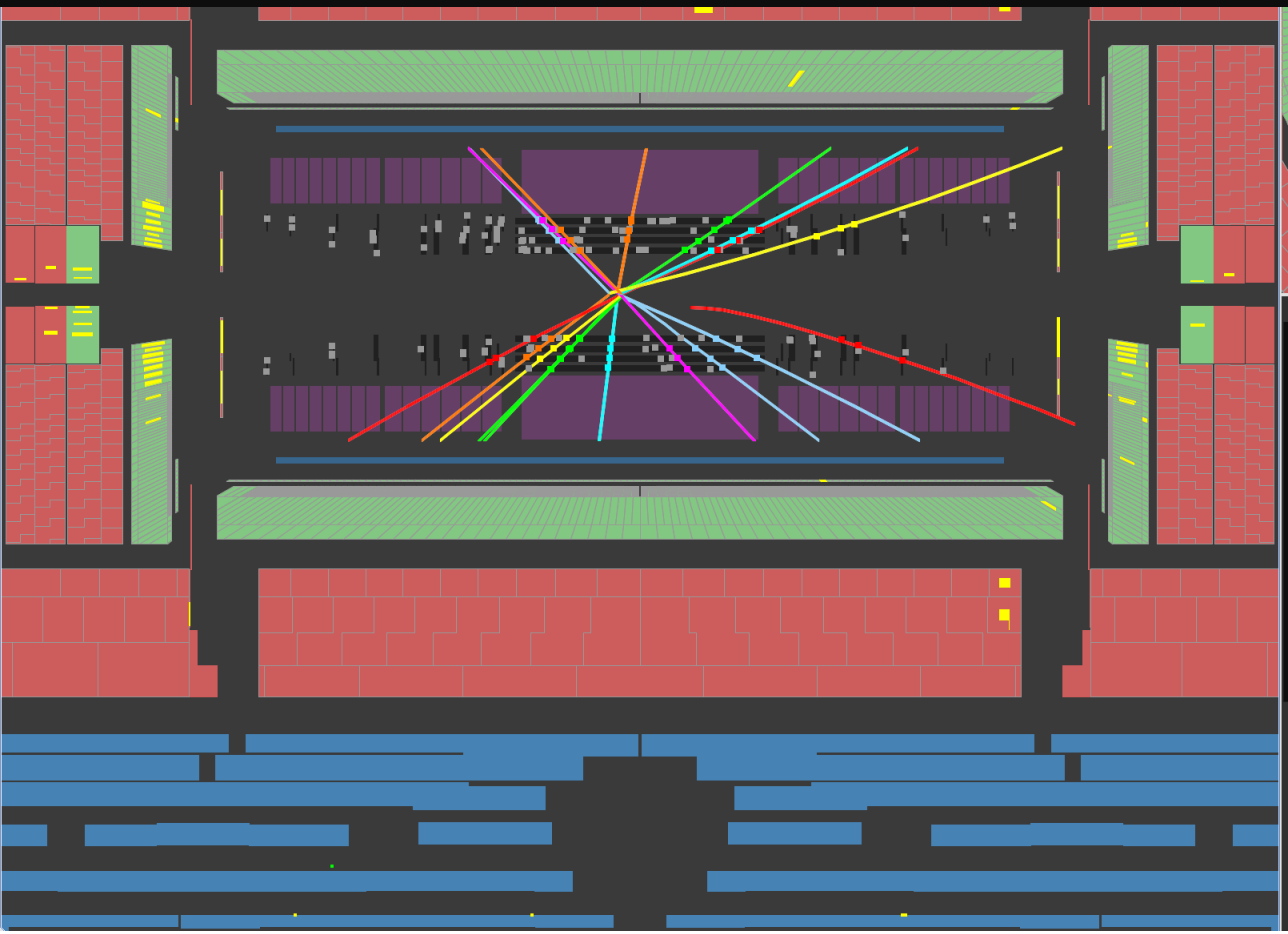


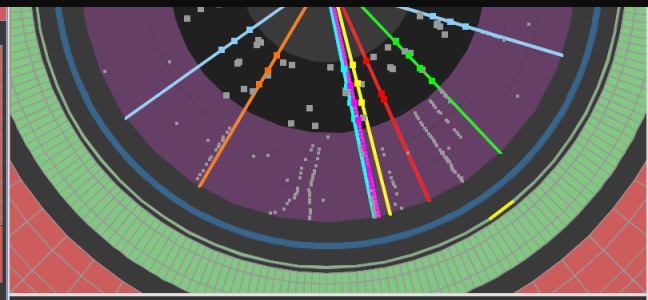
Inner Detector ($|\eta|<2.5$, B=2T):
Si Pixels, Si strips, TRT
Precise tracking and vertexing,
σ/p_T ~ 3.8×10^{-4} p_T (GeV) $\oplus$ 0.015

EM calorimeter: Pb-LAr Accordion
e/γ trigger, identification and measurement
E-resolution: **σ/E ~ 10%/$\sqrt{E}$ $\oplus$ 0.007**
granularity :.025 x .025 $\oplus$ strips

HAD calorimetry ($|\eta|<3$): segmentation **0.1 x 0.1**
Fe/scintillator Tiles (central), Cu/W-LAr (fwd)
E-resolution: **σ/E ~ 50%/$\sqrt{E}$ $\oplus$ 0.03**
FWD calorimetry:W/LAr **σ/E ~ 90%/$\sqrt{E}$ $\oplus$ 0.07**

We were lucky - shortly after colliding beams were announced on November 23 2009 at 14:22 an interesting event appeared on our screens





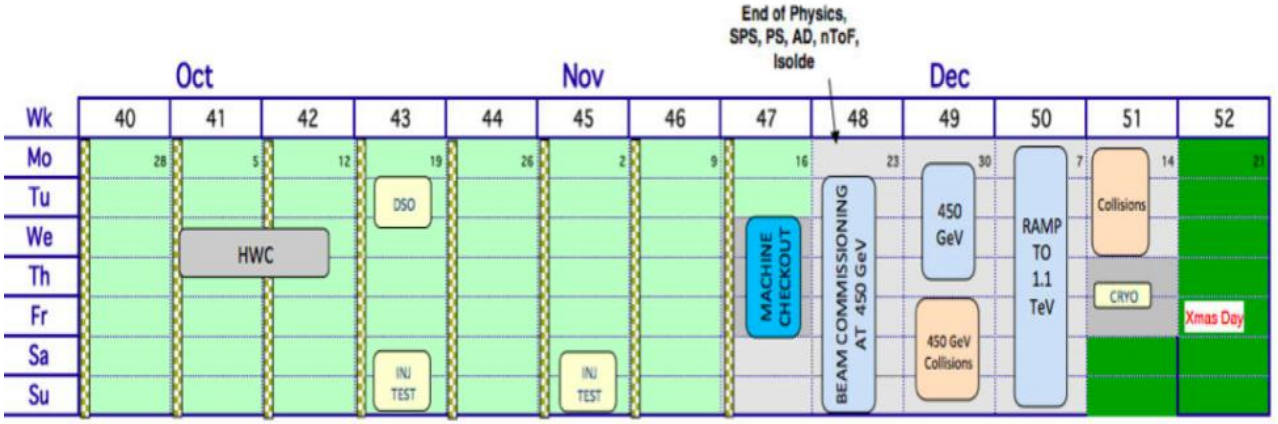
ATLAS EXPERIMENT

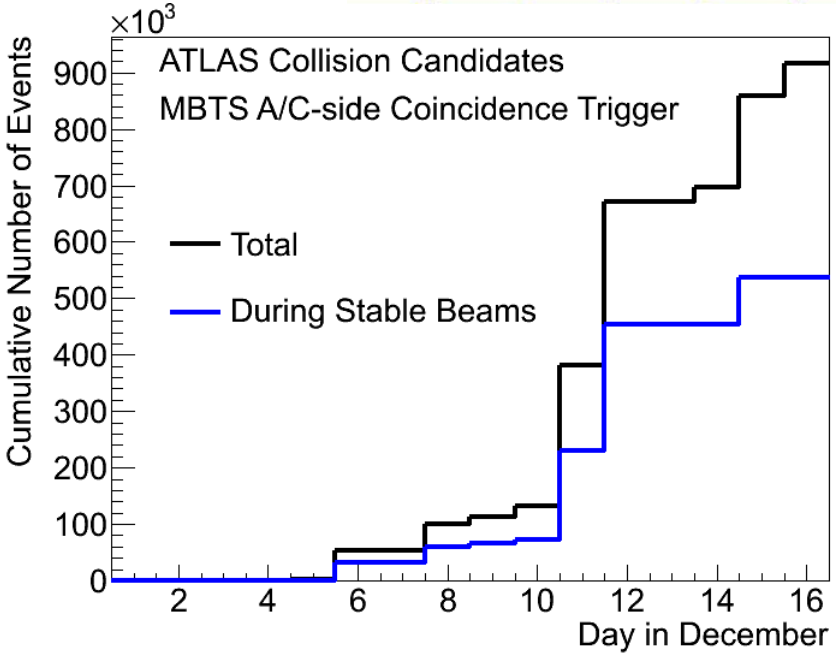
2009-11-23, 14:22 CET

Run 140541, Event 171897

Candidate Collision Event

2009 Plan and Results





90% data-taking efficiency

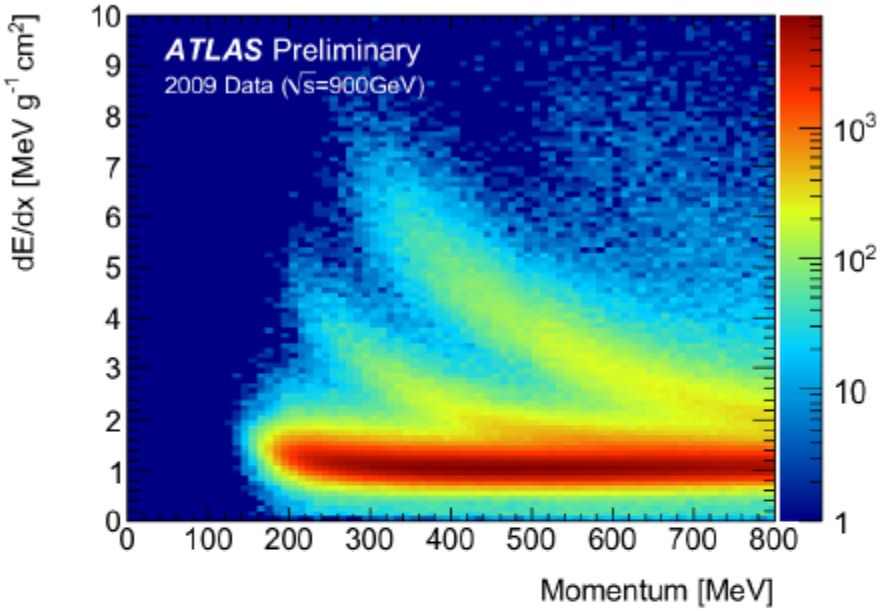
Integrated luminosity recorded by ATLAS in 2009: 20 μb^{-1}
Integrated luminosity recorded during stable beams: 12 μb^{-1}
Maximal peak luminosity seen by ATLAS: 7× 10^{26} cm^{-2} s^{-1}
Total number of collisions recorded: 917 Kevents
with stable beams: 538 Kevents
collision candidates at 2.36 TeV: 34 Kevents

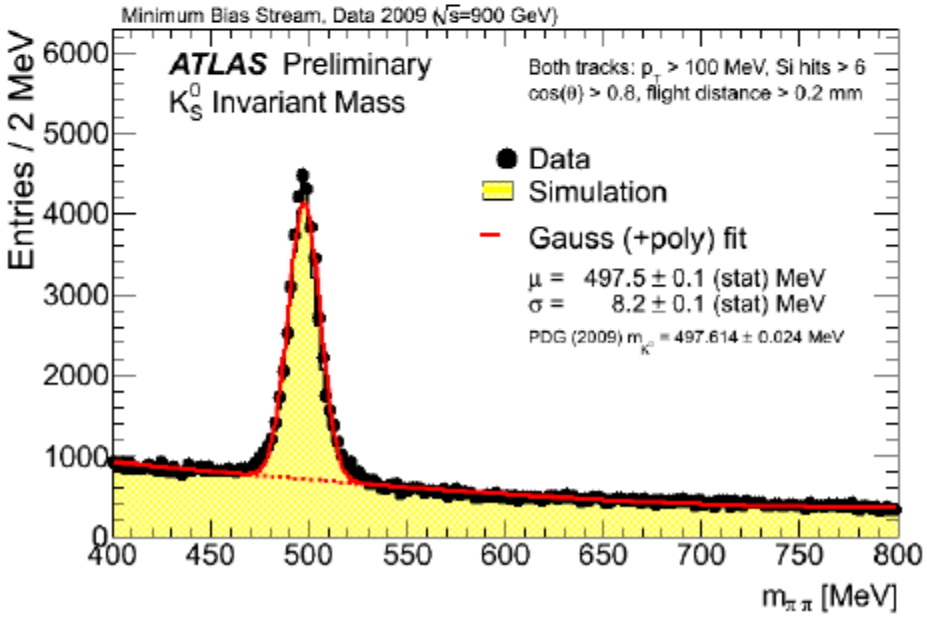
Mass Peaks in MinBias Data

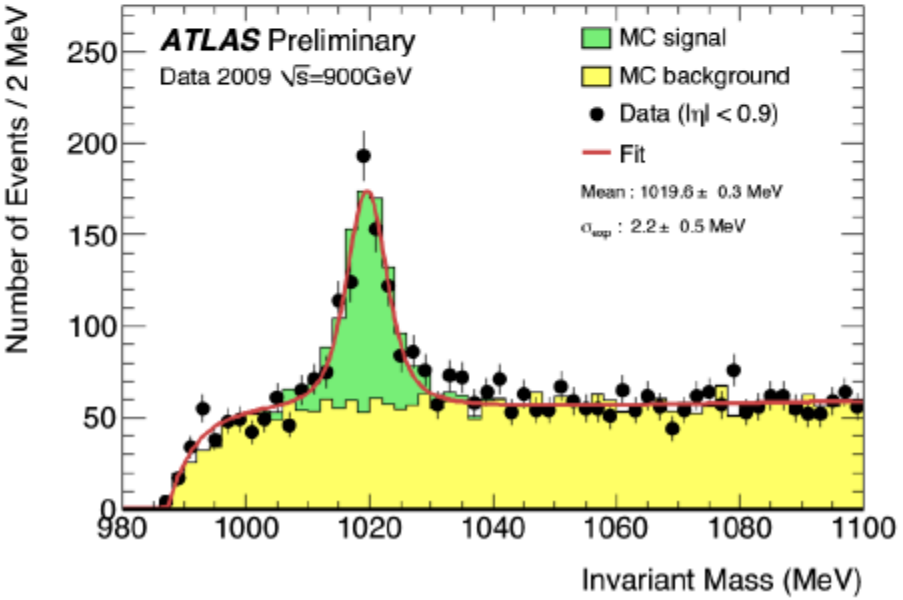
Ks decays are abundant (bottom left), and provide stringent tests of tracking, including sensitivity to material effects (see later).

Reconstruction of ϕ peak (bottom right) requires use of dE/dx information from Pixel detector (right) to identify $K^{\pm}$ up to ~ 500 MeV.

Reconstructed K_S and ϕ masses are consistent with PDG values, and widths are well reproduced by Monte Carlo.

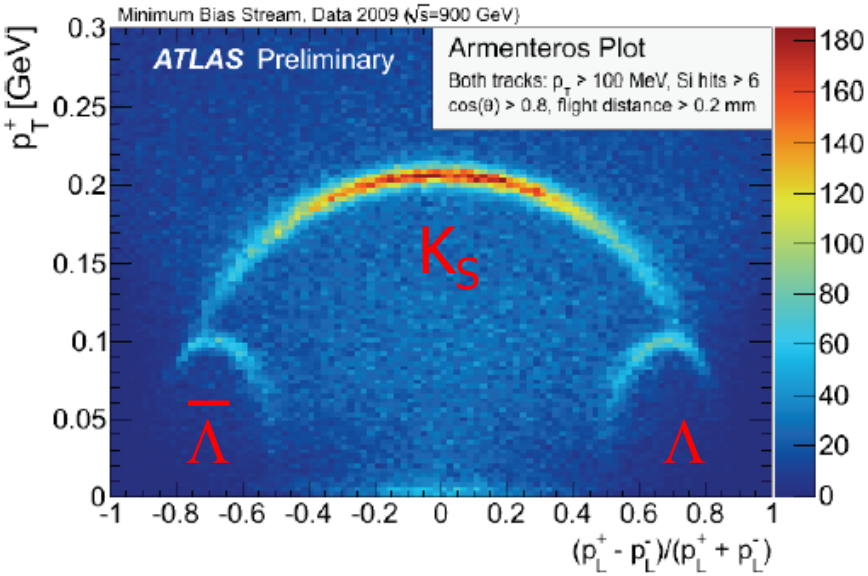


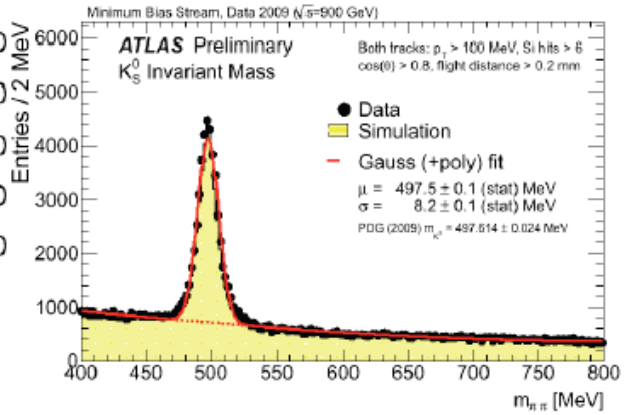


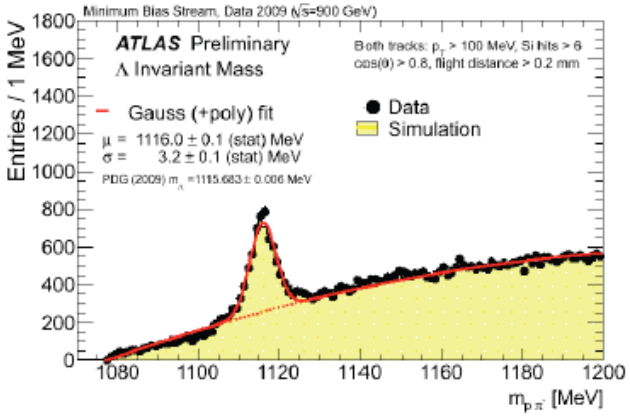


1953: Podolanski-Armenteros Plot

Tracking - strange particles







Detailed studies of tracking efficiency, momentum scale and momentum resolution ongoing using strange particle decays (K_S).

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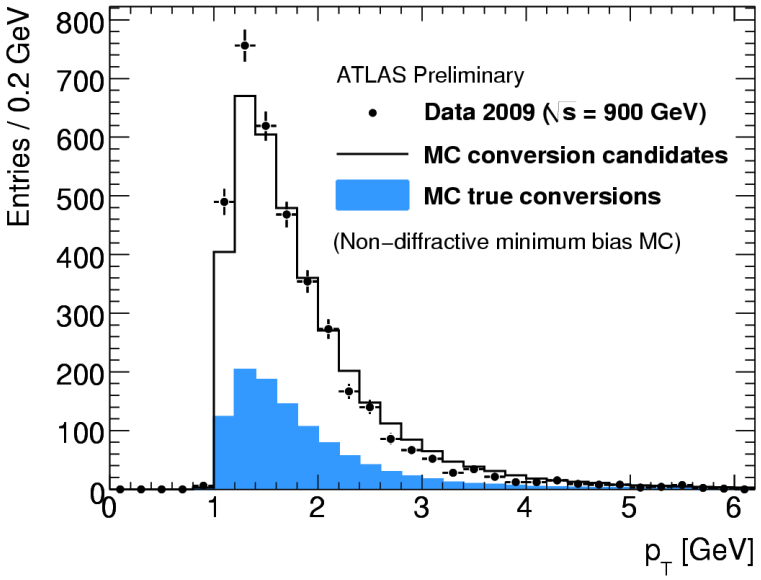
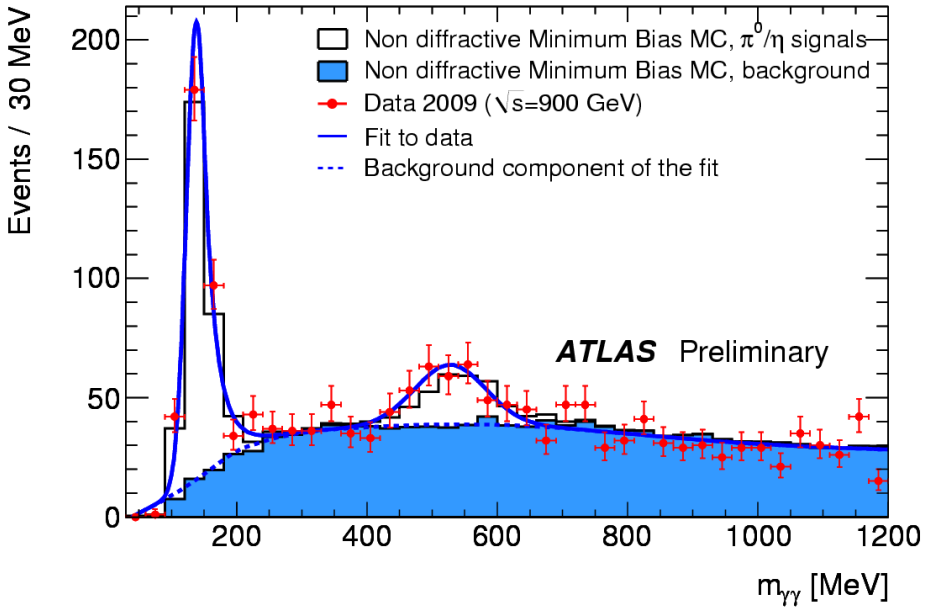
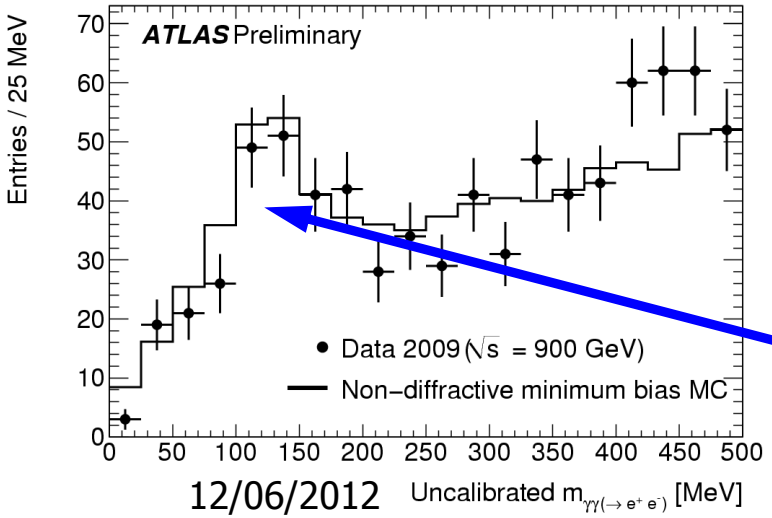
Reconstruction of γ, π^0 (1950), η (1960)



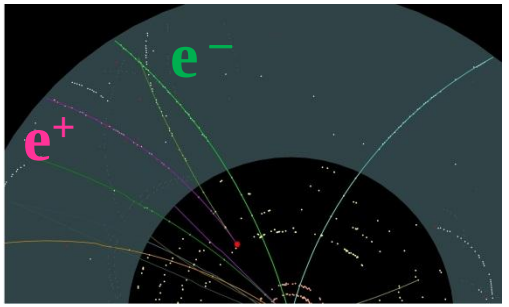




- $\pi^0 \rightarrow \gamma\gamma$: m = 134.0 ± 0.8 (stat) MeV
- $\eta \rightarrow \gamma\gamma$: m = 527 ± 11 (stat) MeV

Reconstructed from converted photons

$\gamma \rightarrow e^+ e^-$

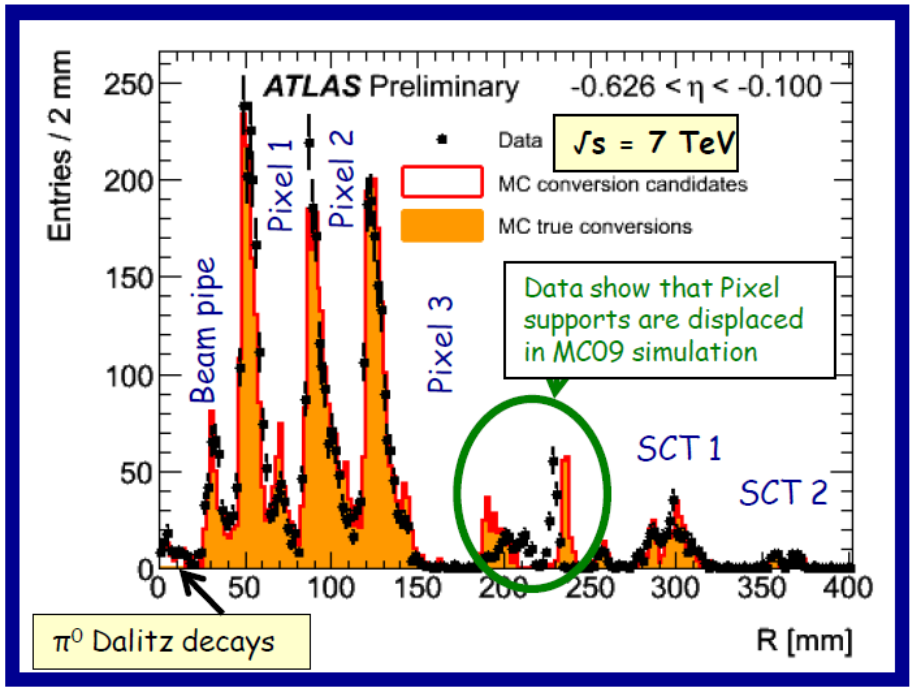


R ~ 30 cm (1st SCT layer)

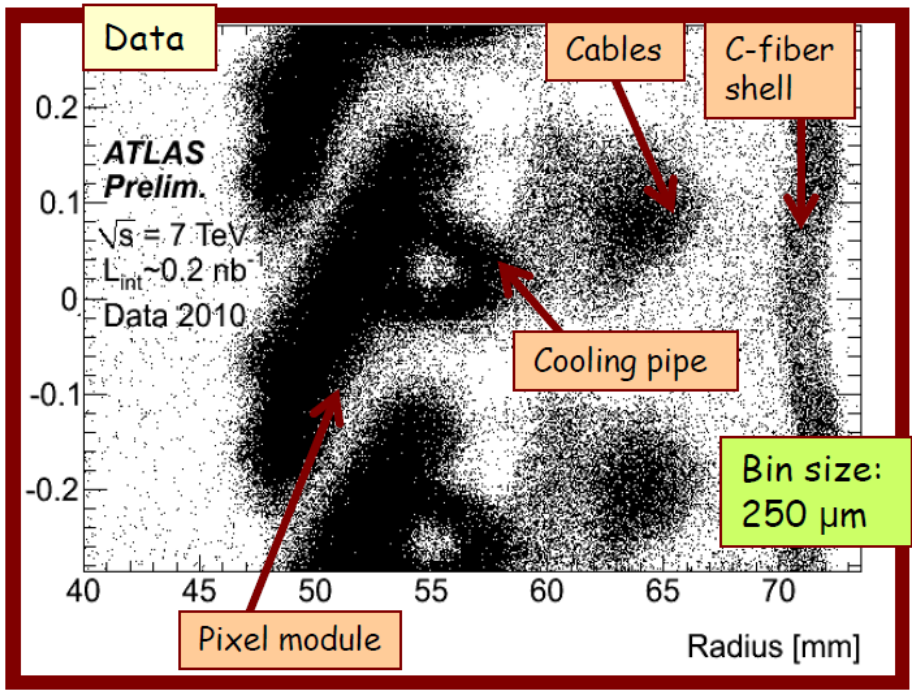
Inner Detector Material mapping: γ→ee

Goal is to know material to better than 5%
(e.g. for W-mass measurements)

Reconstructed conversion point in the radial direction of $\gamma \rightarrow e^+e^-$ from minimum bias events (sensitive to X_0)

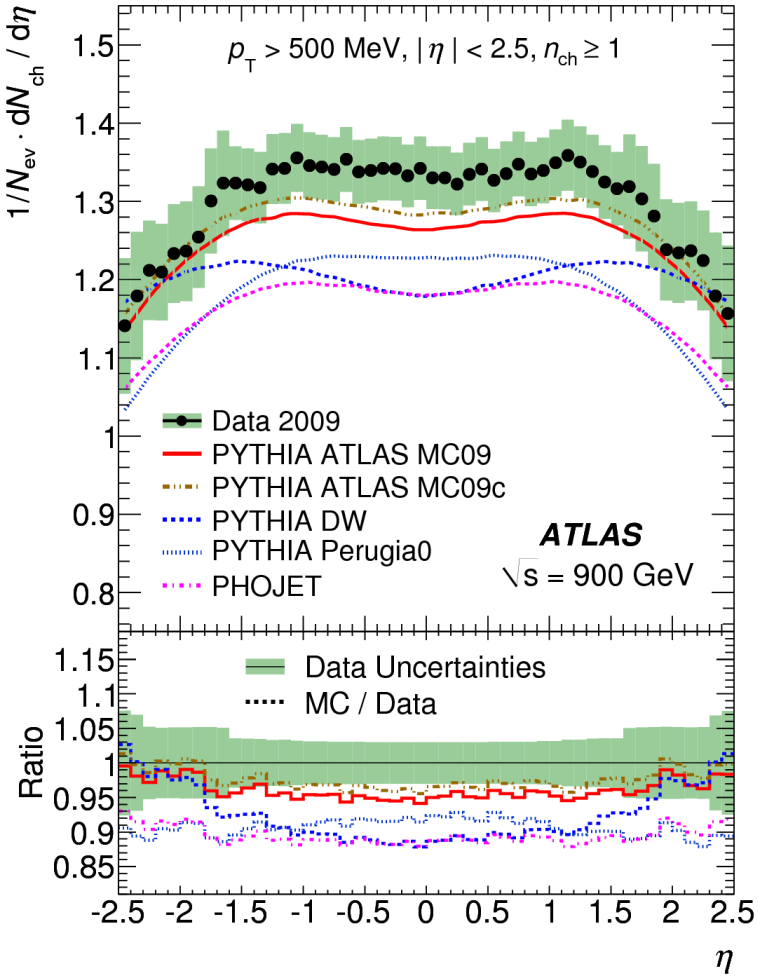


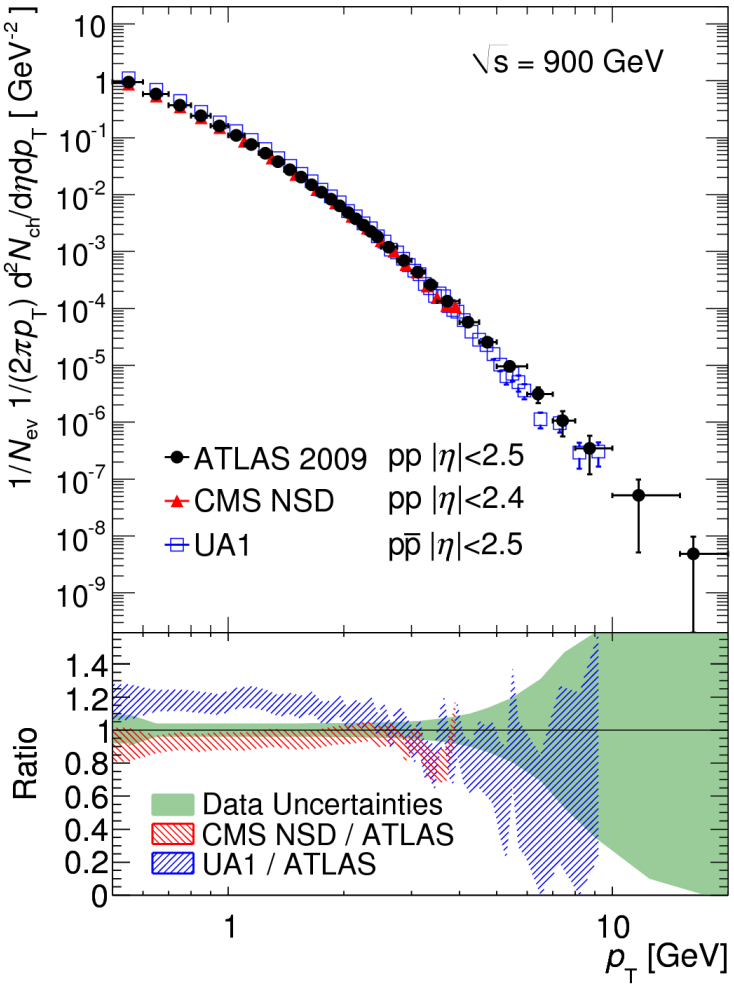
Reconstructed secondary vertices due to hadronic interactions in minimum-bias events in the first layer of the Pixel detector (sensitive to interaction length λ → complementary to γ conversion studies)



Charged-particle multiplicities

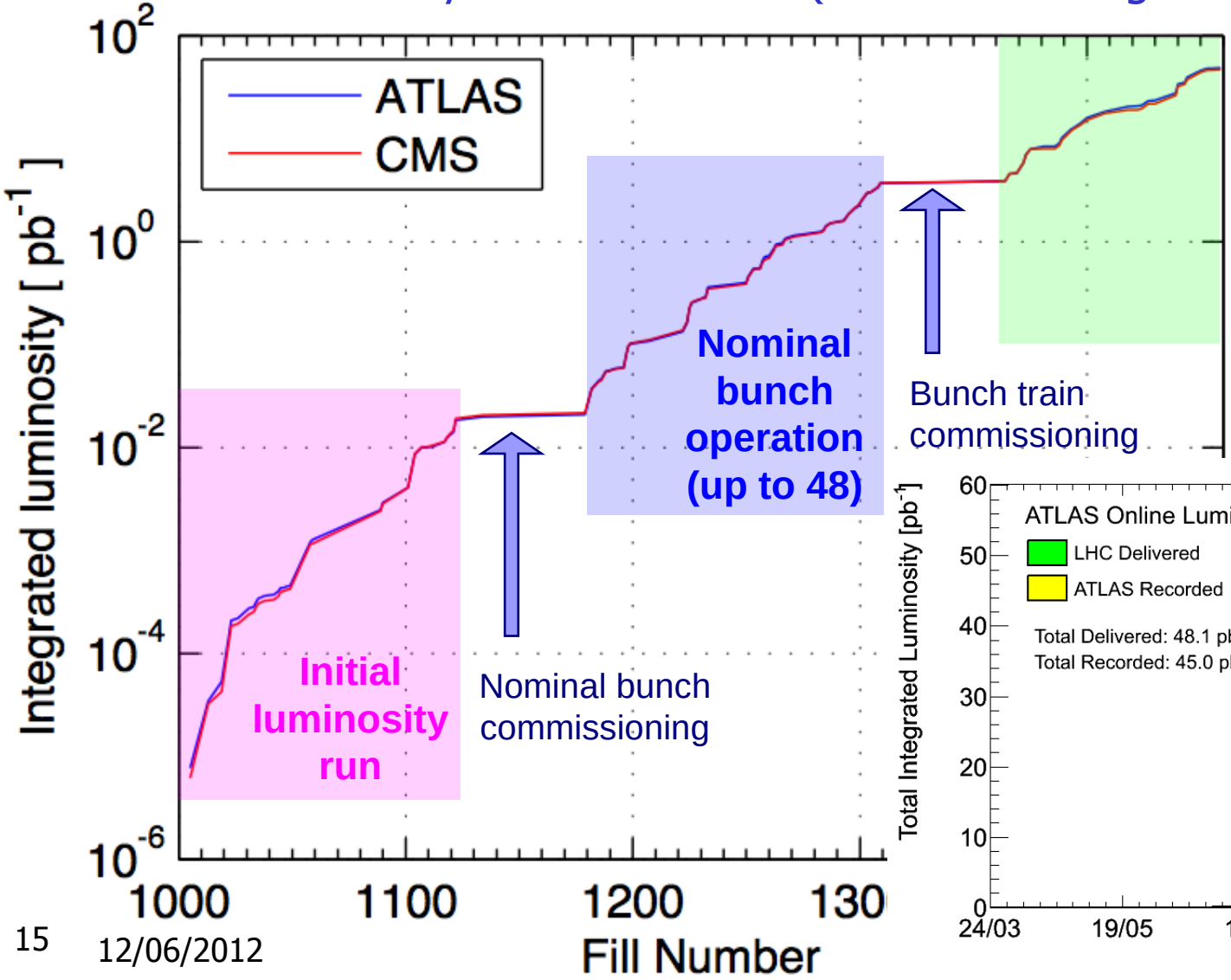
Our first physics paper Phys.Lett. B688 (2010) 21-42





2010: new energy and luminosity frontiers

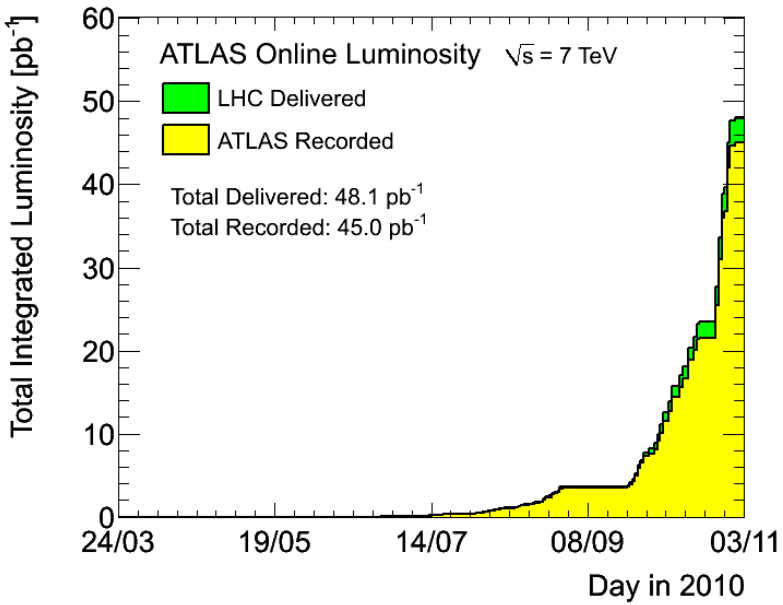
Peak luminosity $2.1 \times 10^{32}\ cm^{-2}s^{-1}$ (5 orders of magnitude in ~200 days)



2010

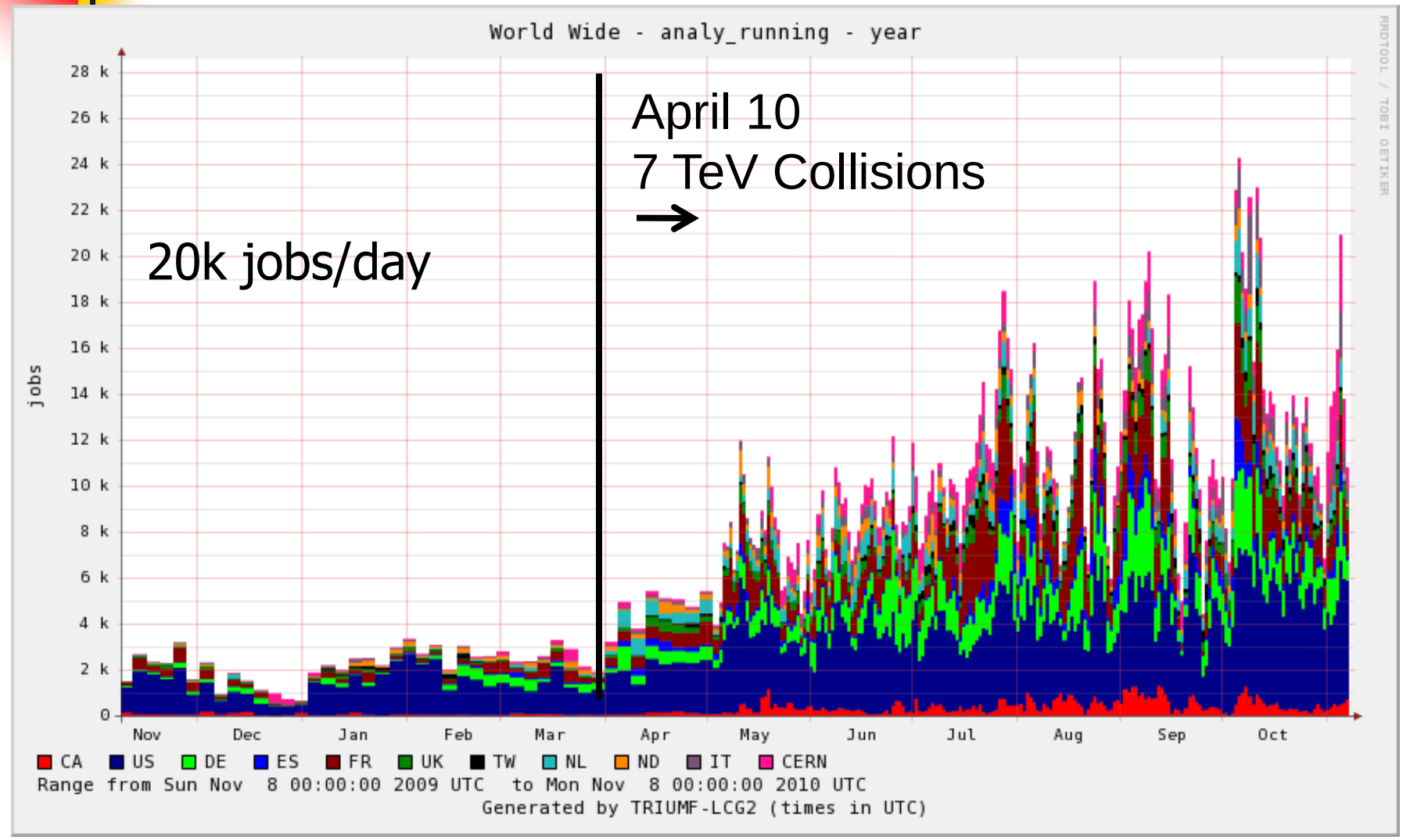
	2010	Nominal
beam energy	3.5 TeV	7 TeV
N. of bunches	368	2808
bunch spacing	150 ns (~ 45 m)	25 ns (~7.5 m)
β^*	3.5 m	0.55 r
proton/bunch	1.2×10^{11}	1.15×10^{11}
events/crossing	2	19
Λ [cm $^{-2}$ s $^{-1}$]	2.1×10^{32}	10^{34}

- *27 February : machine operation started again*
- 19 March : first (single) beams ramped up to 3.5 TeV
- 30 March: first collisions at 3.5+3.5 TeV



93.6% data-taking efficiency

User analysis jobs on GRID

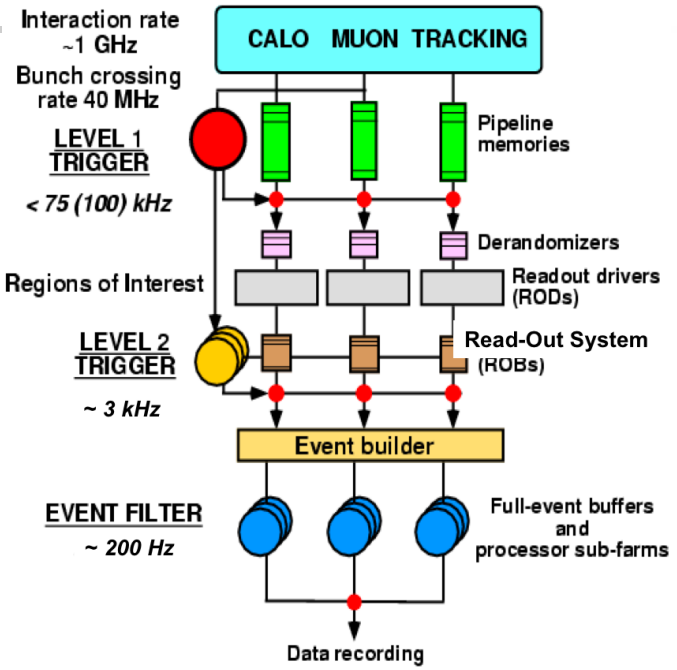


- More than 1000 users, with huge increase in number of running jobs

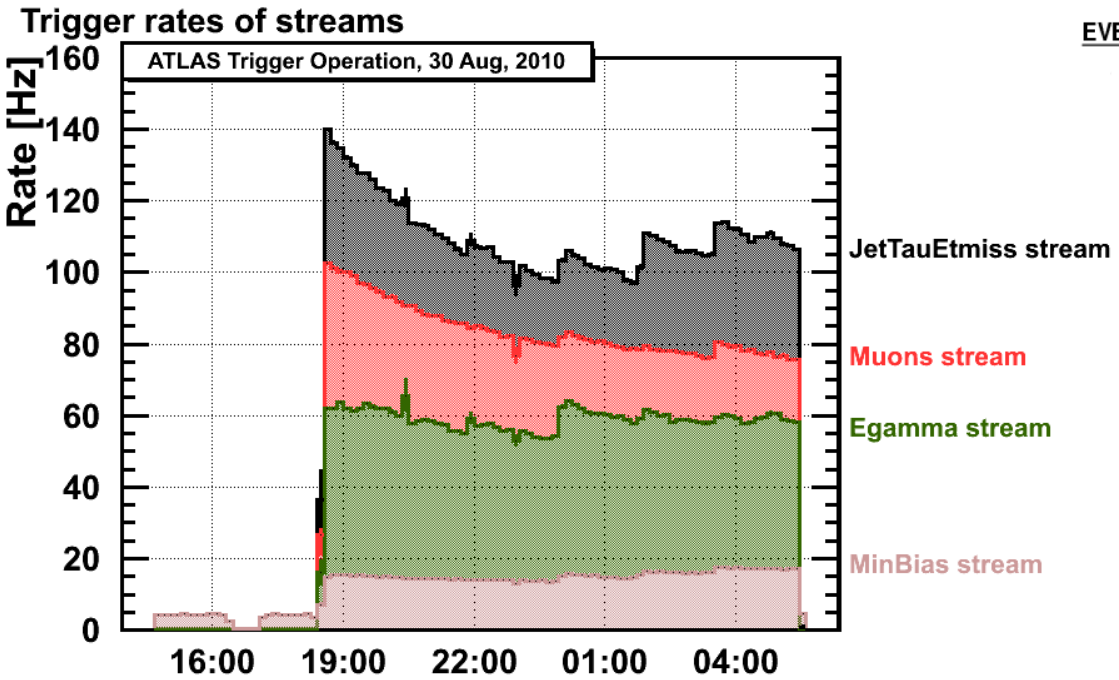
Trigger

ATLAS has a three level trigger

All three levels are now actively selecting events



Trigger rates of major streams



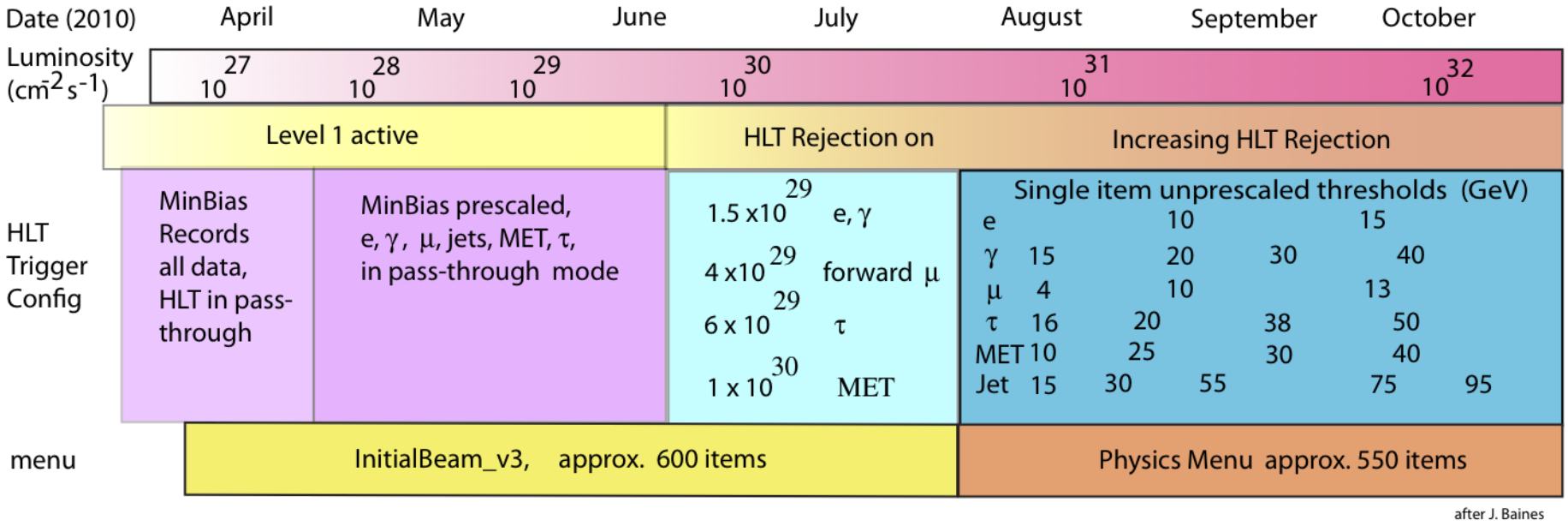
Prescales are adjusted throughout the fill to hold the output rate around 300 Hz.

This is set by our offline capacity.

Trigger Menu Evolution

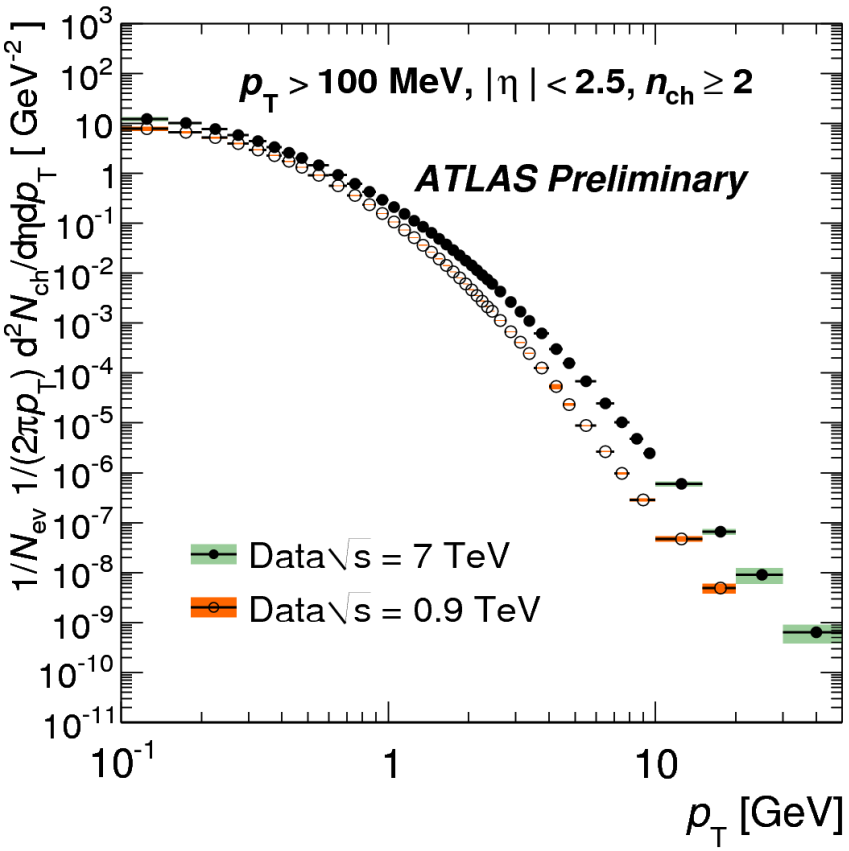
- Five orders of magnitude increase in luminosity
- Gradually commission and then apply HLT rejection

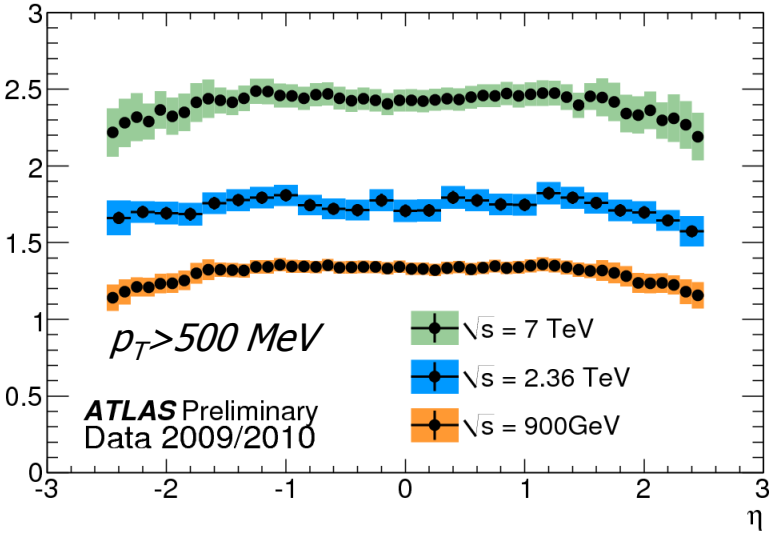
Evolution of HLT configuration during the pp run:



after J. Baines

First measurements with pp





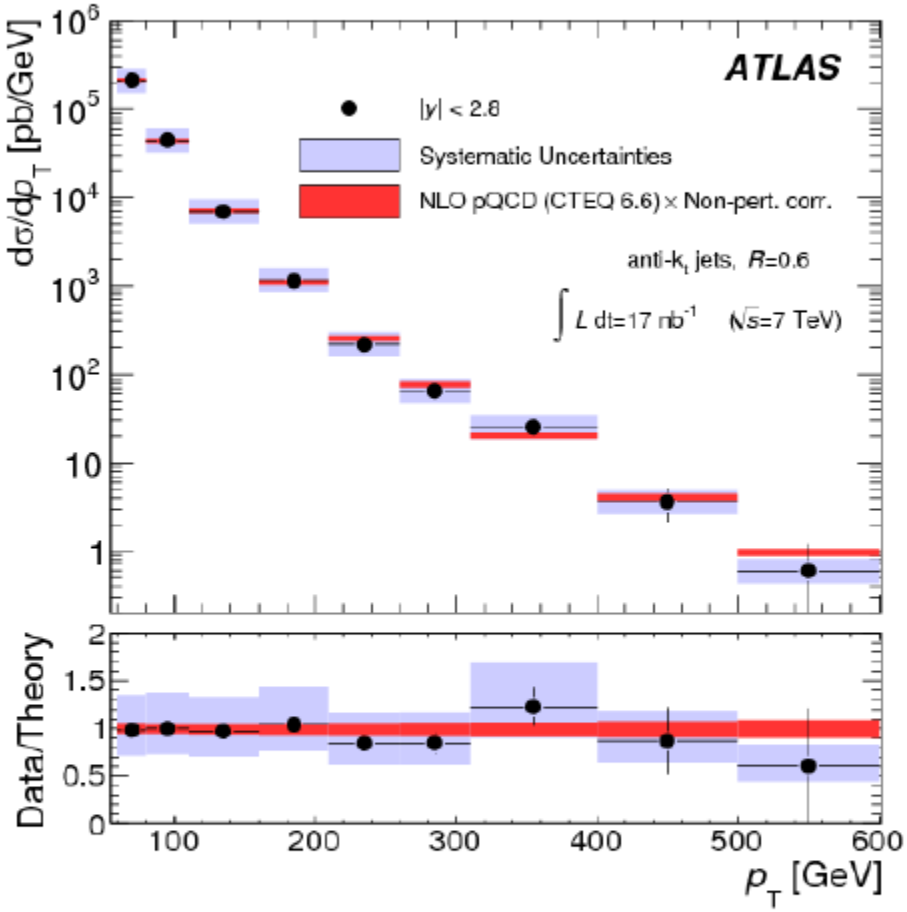
Number of charged particles as a function of p_T and η
Plus studies of underlying event, new MC tune…

- Charged-particle multiplicities in pp interactions at sqrt(s) = 900 GeV measured with the ATLAS detector at the LHC. Phys Lett B 688, 1, 21
- Additional results with 2.36 and 7 TeV data

Inclusive jet cross-section

All Jets from events with at least One Jet $p_T^j > 60$ GeV, $|y^j| < 2.8$

- Measured jets corrected to particle-truth level(incl μ and ν) using parton- shower MC (Pythia, Herwig):
- Results compared to NLO QCD prediction after corrections for hadronization and underlying event
- Theoretical uncertainty: ~20% (up to 40% at large $|y_j|$) from variation of PDF, α_s, scale (μ_R, μ_F)
- Experimental uncertainty: ~30-40% dominated by Jet E-scale (known to ~7%,)
- Luminosity uncertainty(11%) not included



Good agreement data-NLO QCD over 5 orders of magnitude

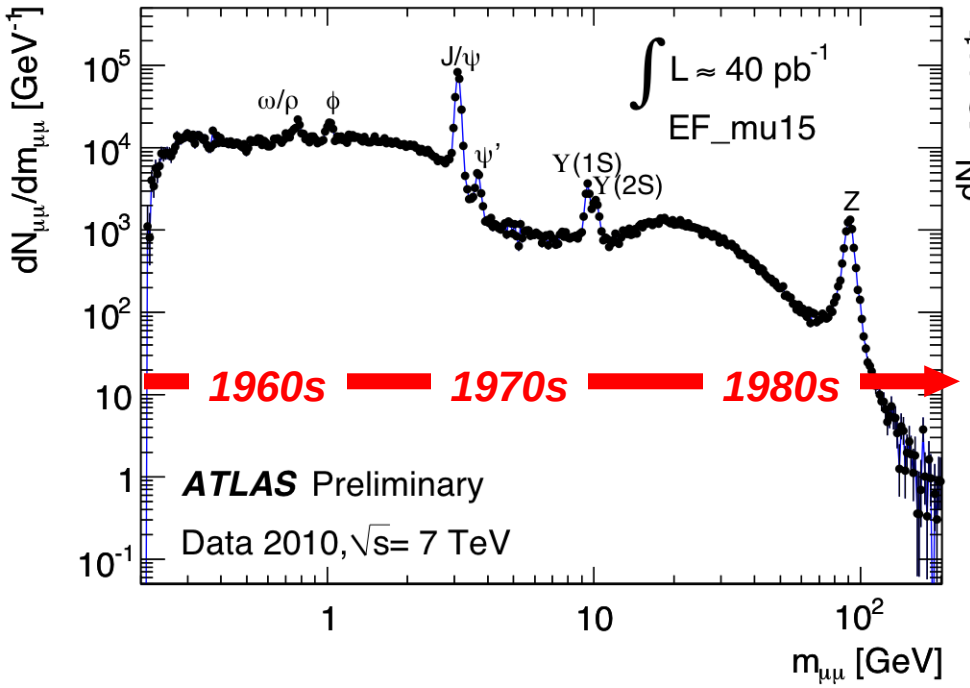
Di-Muon and Di-Electron Spectra

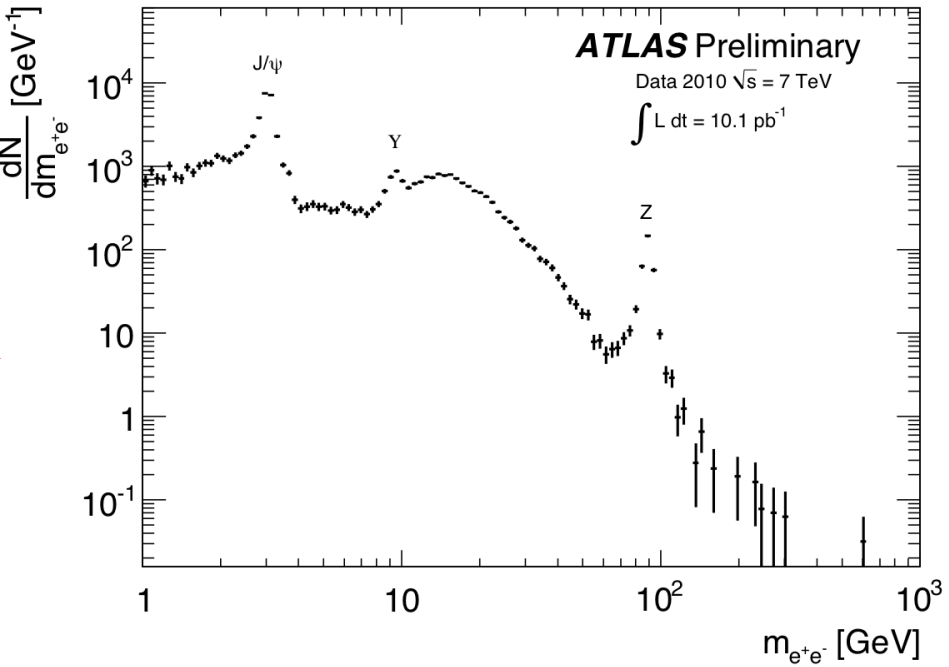
Di-Muon:

- Leading muon, p_T>15 GeV, second muon, p_T>2.5 GeV

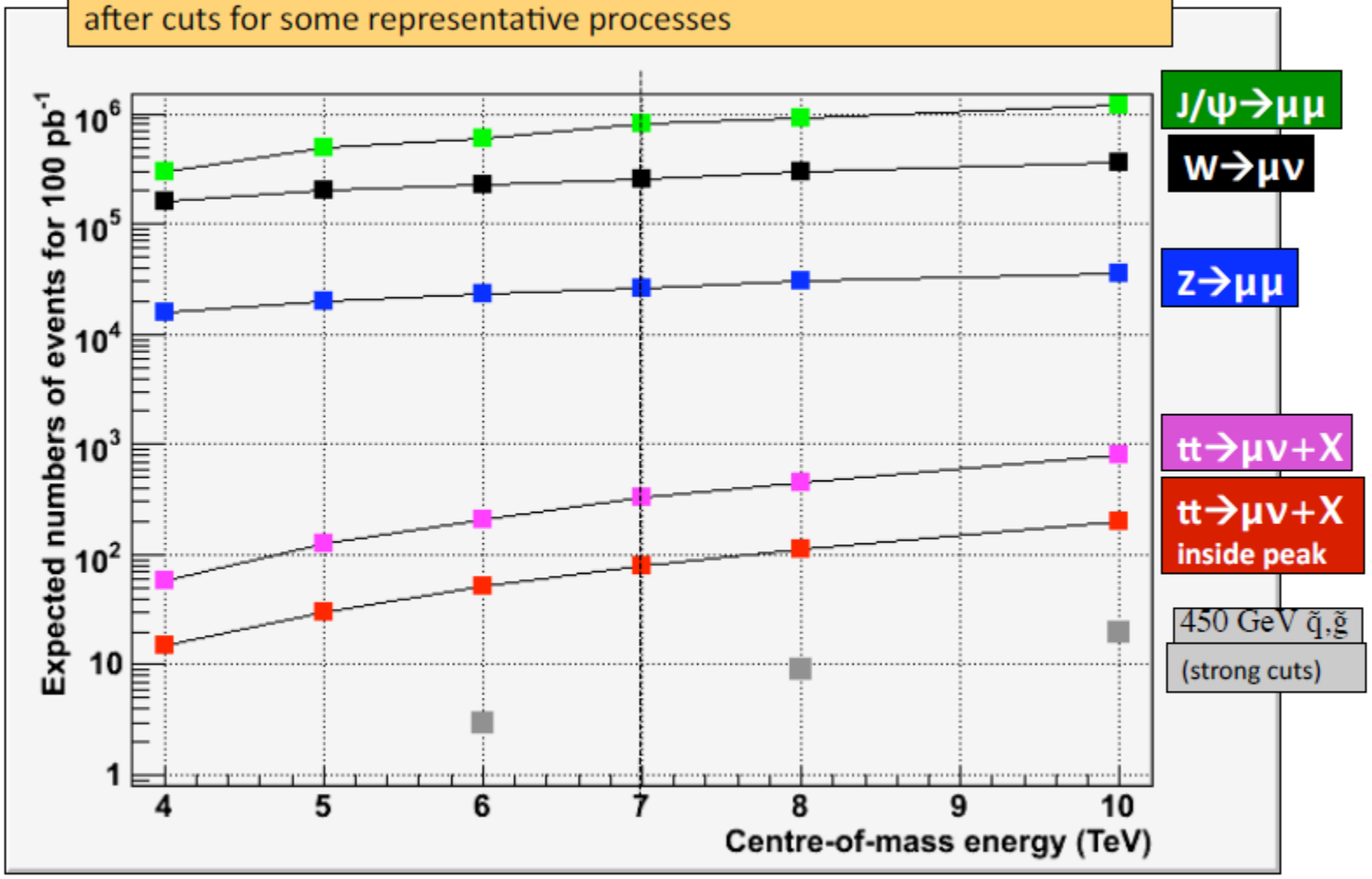
Di-electron:

- Data with 5 GeV E_T di-electron trigger (prescaled in later data)
- Trigger selection produces shoulder around 15 GeV





Expected number of events in ATLAS for 100 pb^{-1} (Fall 2010 ?)
after cuts for some representative processes



Observation of W -1-

- W and Z detection and reconstruction is an important step for physics, calibration and performance;
  - W NNLO cross-section production at √s=7 TeV: 10.45 nb (~3% theory uncertainty)

Main selections : W → eν
-- Trigger: LVL1 EM activity, E_T>2 GeV
-- E_T (e) > 20 GeV, |η|<2.47
-- tight electron identification criteria
-- E_T^{miss} > 25 GeV
-- transverse mass m_T > 40 GeV

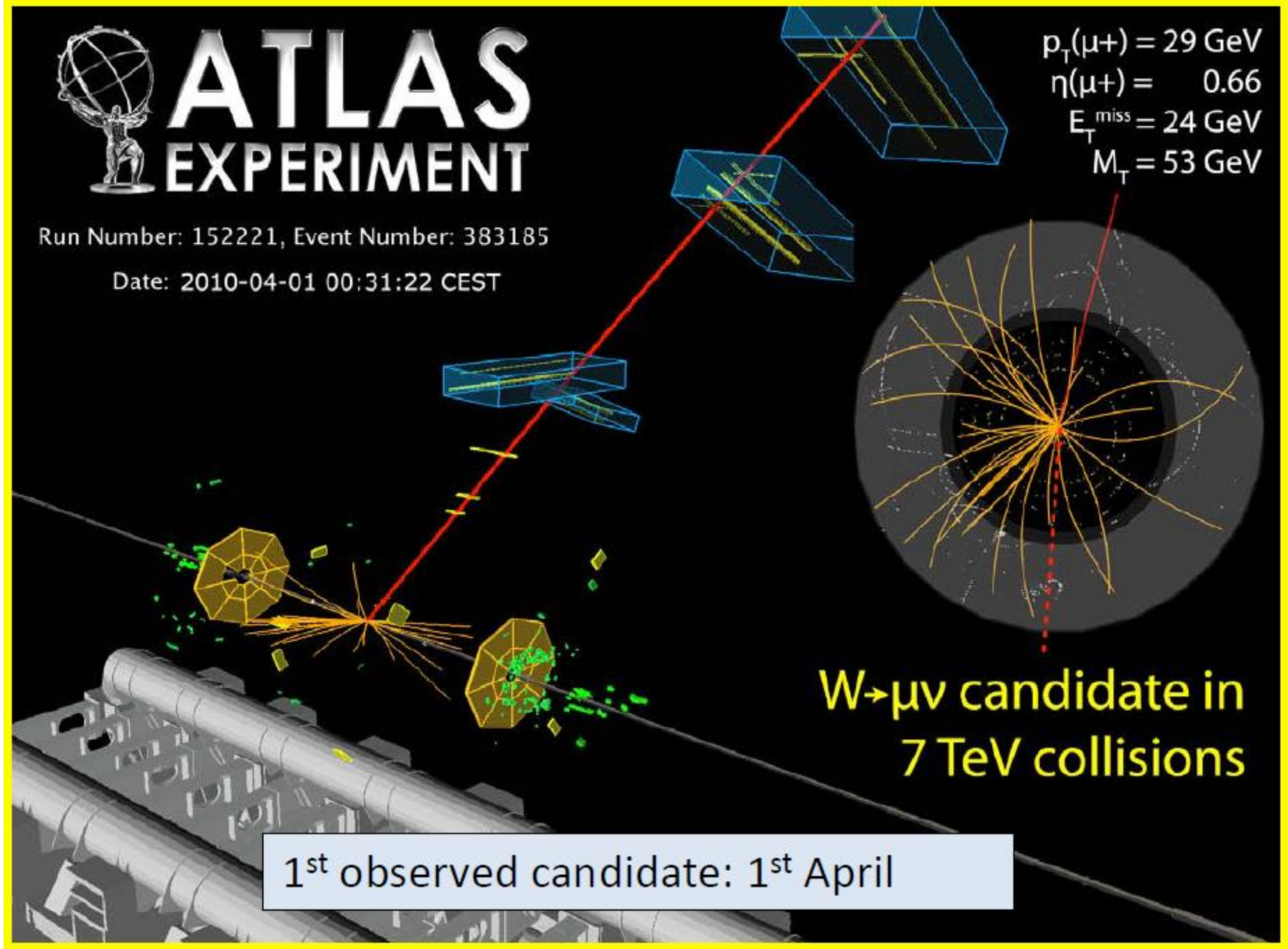
Main selections : W → μν
-- - Trigger: LVL1 few GeV p_T;
-- p_T (μ) > 20 GeV, |η|<2.4
-- $|\Delta p_T$ (ID-MS)| < 15 GeV
-- combined muon; isolated; $|Z_\mu - Z_{vtx}|$<1 cm
-- E_T^{miss} > 25 GeV
-- transverse mass m_T > 40 GeV

	W → eν	W → μν
Integrated luminosity	6.7 nb^{-1}	6.4 nb^{-1}
Observed number of events	17 (11+,6-)	40 (25+,15-)
Expected total	23.1±5.0 ±1.2(stat)±1.7(syst)±4.6 (lumi)	28.7± 6.9 ±0.5(stat)±3.9(syst)±5.7 (lumi)
Expected signal Expected background	20.7± 4.4 2.4 ± 1.4	25.9 ± 6.3 2.8 ± 1.1

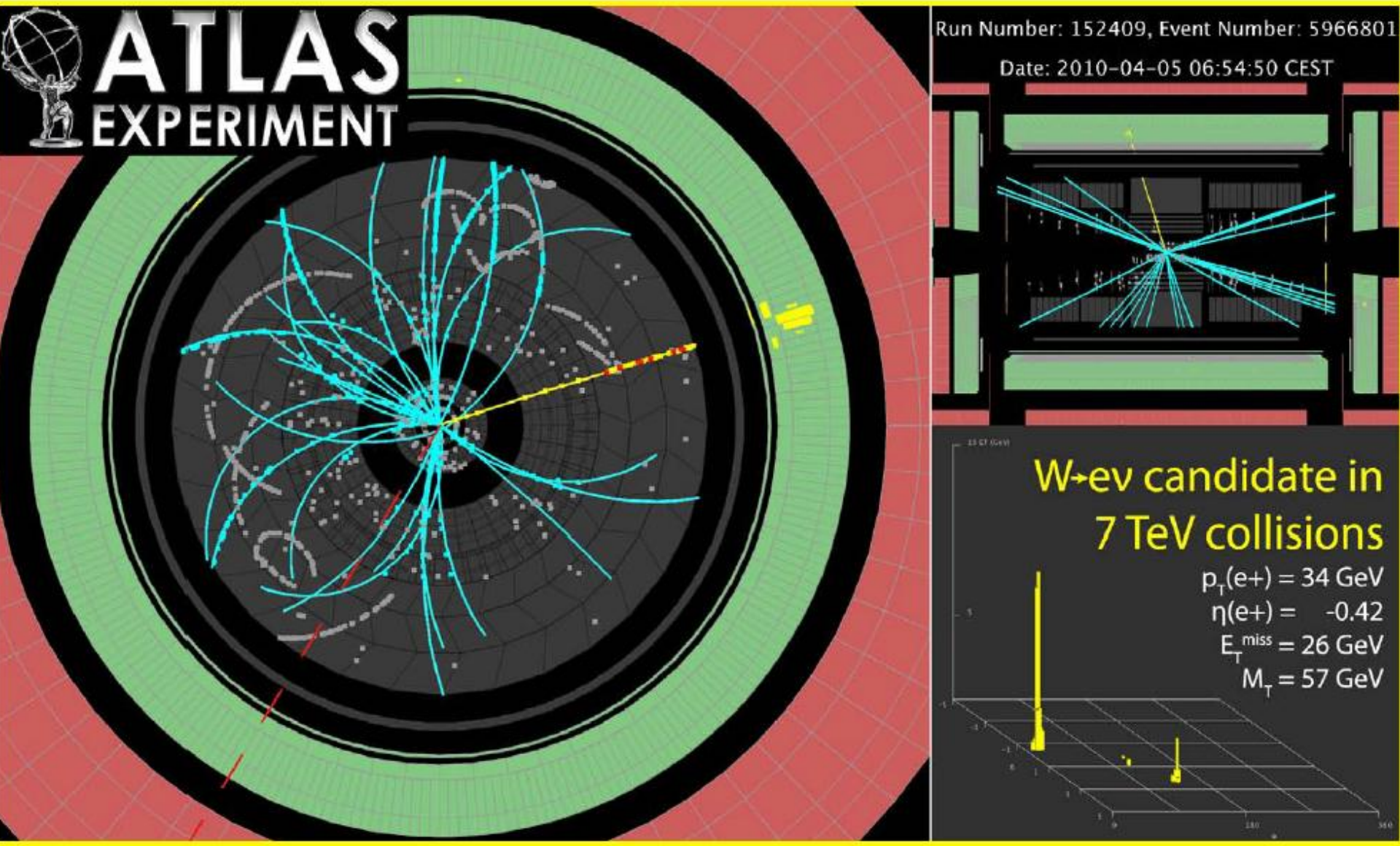
Background estimation: mainly data driven, using control samples (low MET, non-isolated leptons) with enhanced background contributions

Efficiency: ~ 30%
Background: mainly QCD jets

Efficiency: ~ 40%
Background: mainly QCD jets and Z→μμ


ATLAS
EXPERIMENT
Run Number: 152221, Event Number: 383185
Date: 2010-04-01 00:31:22 CEST
$p_T(\mu+) = 29$ GeV
$\eta(\mu+) = 0.66$
$E_T^{miss} = 24$ GeV
$M_T = 53$ GeV
W→μν candidate in
7 TeV collisions
1st observed candidate: 1st April

2nd observed candidate: 5 April



Missing Transverse Energy -1-

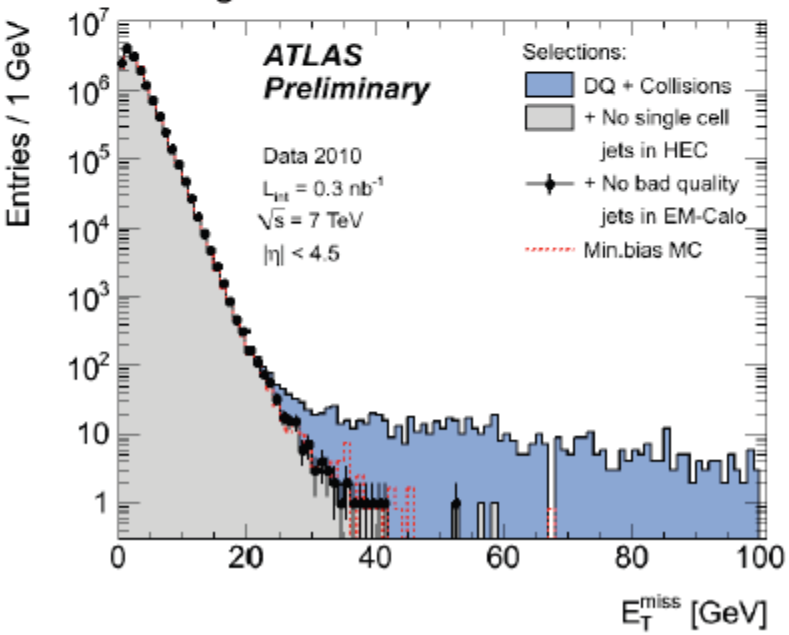
- Understanding of Missing Transverse Energy (MET) is crucial for New Physics searches;
- MET: $\mathbf{E}_T^{miss} = -\Sigma\, \mathbf{E}_{cell}$ (vector sum) $- \Sigma\, P_T$(muons)
- Event cleaning: important to remove bad events using jet reconstruction to probe the quality of the data

• Jet cleaning: events with at least a "bad jet" with $p_T > 10$ GeV at the EM scale, are removed from the analysis;

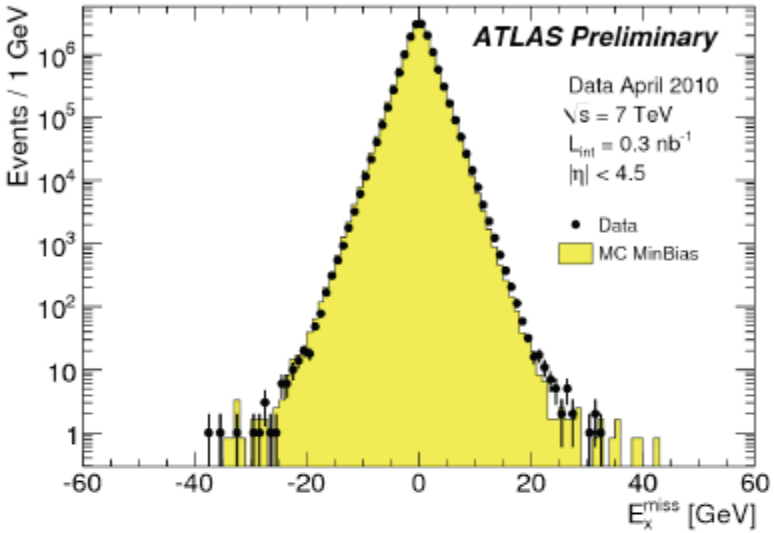
Bad jet:

- *Cells from noise burst due to discharges in the hadronic endcap calorimeter*
- *Coherent noise in the electromagnetic calorimeter*
- *Large out-of-time energy depositions, e.g. from cosmic ray muons*
- ***Rejects ~ 0.01% of jets with p_T>10 GeV***

E_T^{miss} distribution for 14.4 million collision events from 7 TeV data, after successive jet cleaning selections

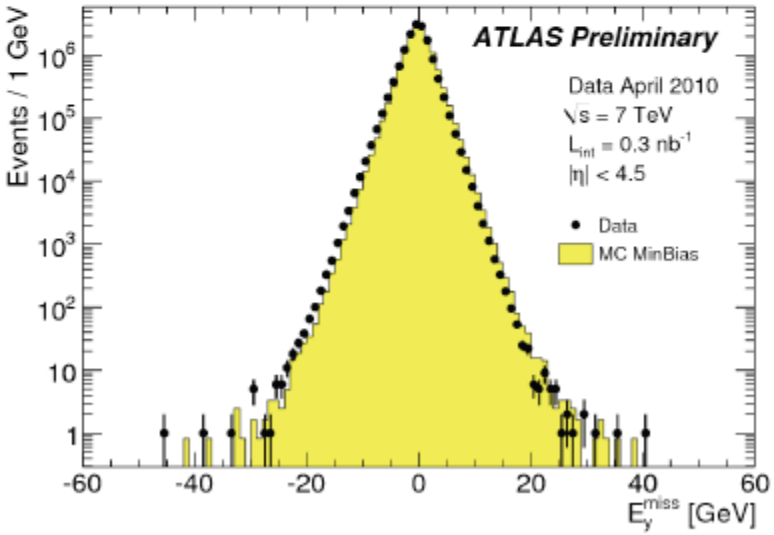


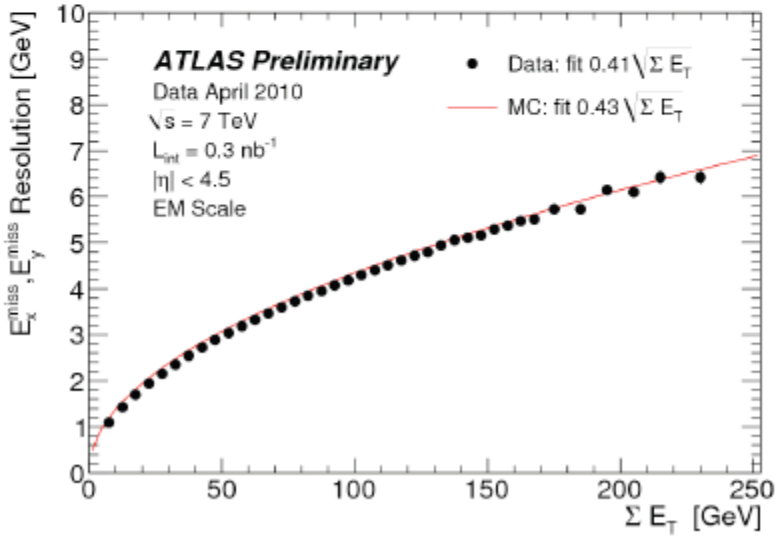
Missing Transverse Energy -2-



Distribution of E_T^{miss} (x,y) as measured in a data sample of 14.4 million selected minimum bias events (dots) at 7 TeV center-of-mass energy, recorded in April 2010

E_T^{miss} (x,y) resolution as a function of the total transverse energy (Sum E_T) for minimum bias events. The line represents a fit to the resolution obtained in the Monte Carlo simulation and the full dots represent the results from data taken √s= 7 TeV.





Observation of W -2-

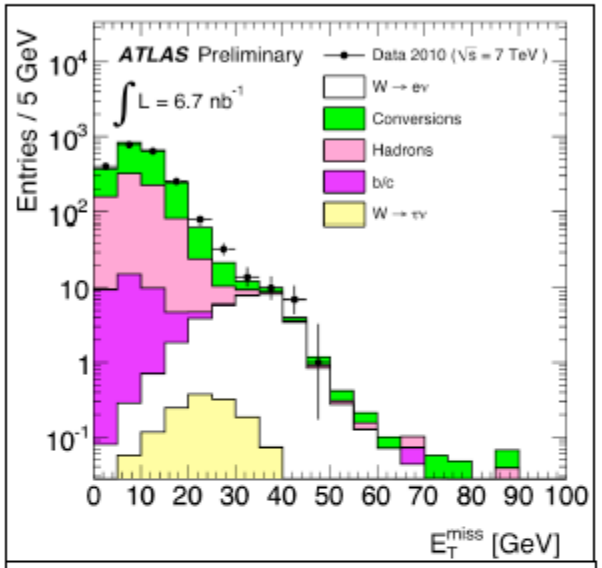
After pre-selection:

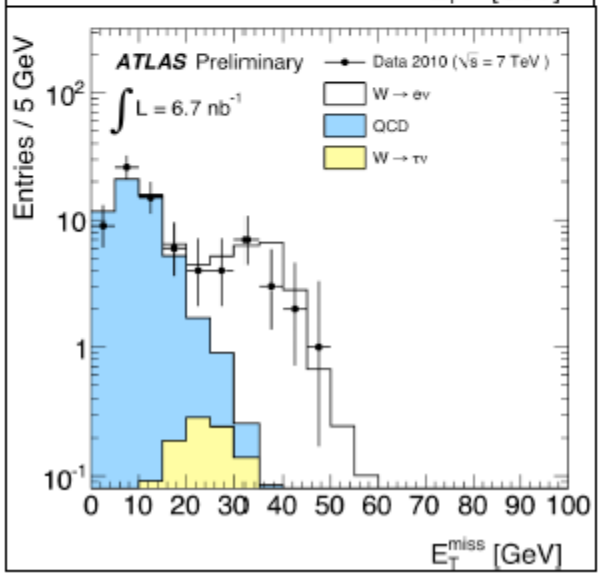
- W → eν:
  loose $e^{\pm}$, $E_T > 20$ GeV
- W → μν:
  $p_T(\mu) > 15$ GeV
  $|\Delta p_T(\text{ID-MS})| < 15$ GeV
  $|Z_\mu - Z_{vtx}| < 1$ cm

As above +:

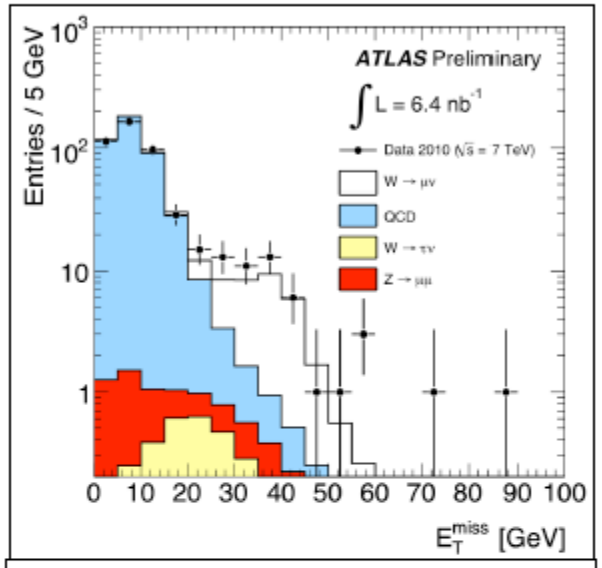
- Tight electrons
- Isolated muons (track isolation)

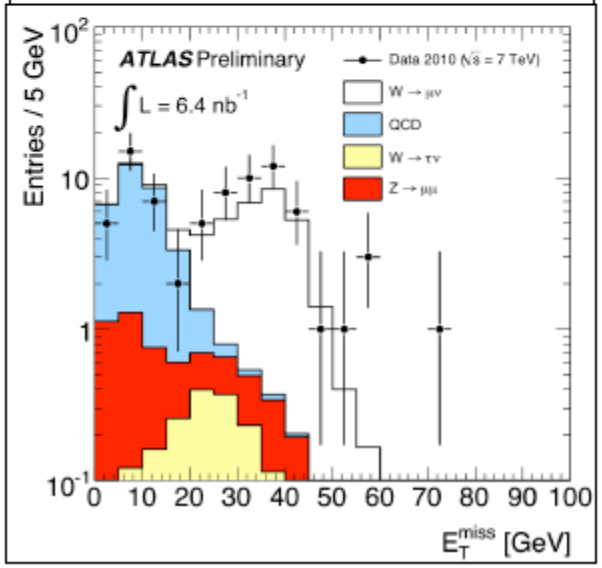
Electron channel





Muon channel

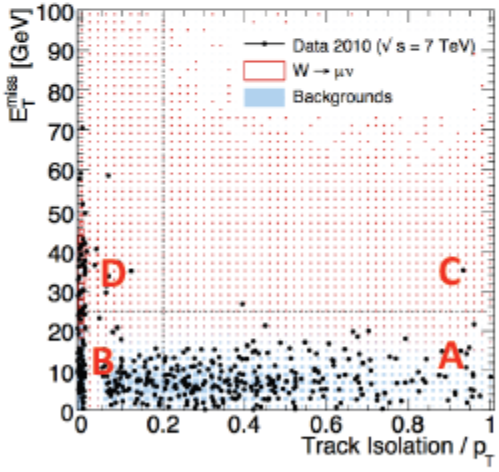




Observation of W -3-

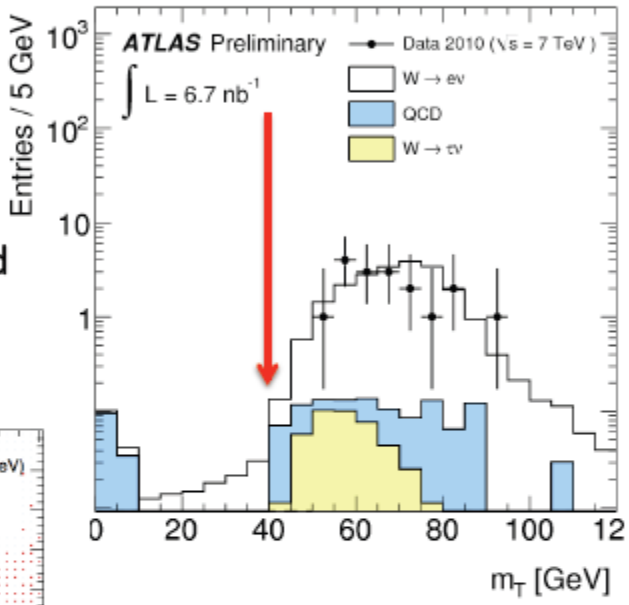
Cuts as before +:
- **MET > 25 GeV**

Data driven background estimation; example: the muon channel

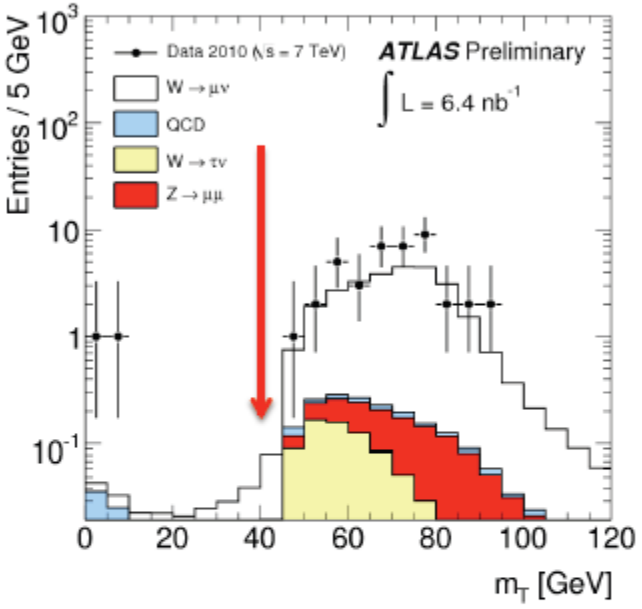


$$N_D^{QCD} = N_C \times N_B / N_A$$

Electron channel



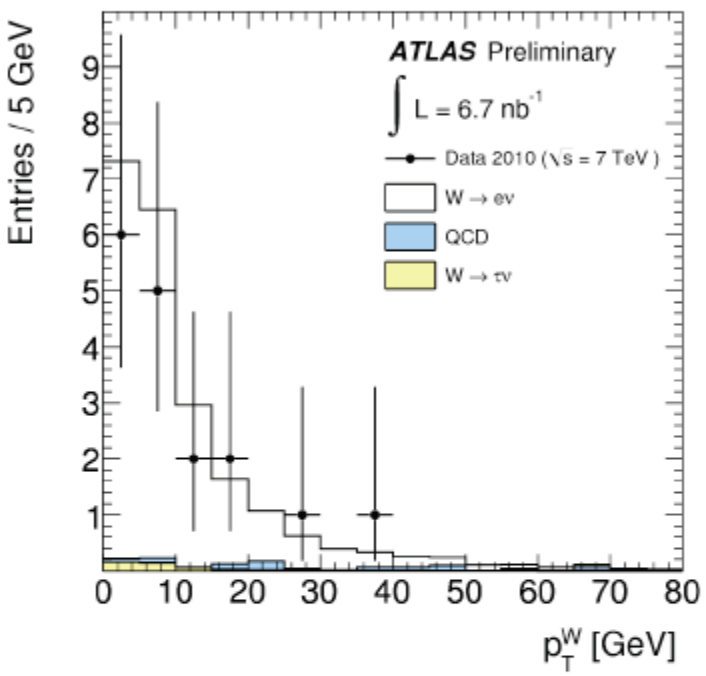
Muon channel

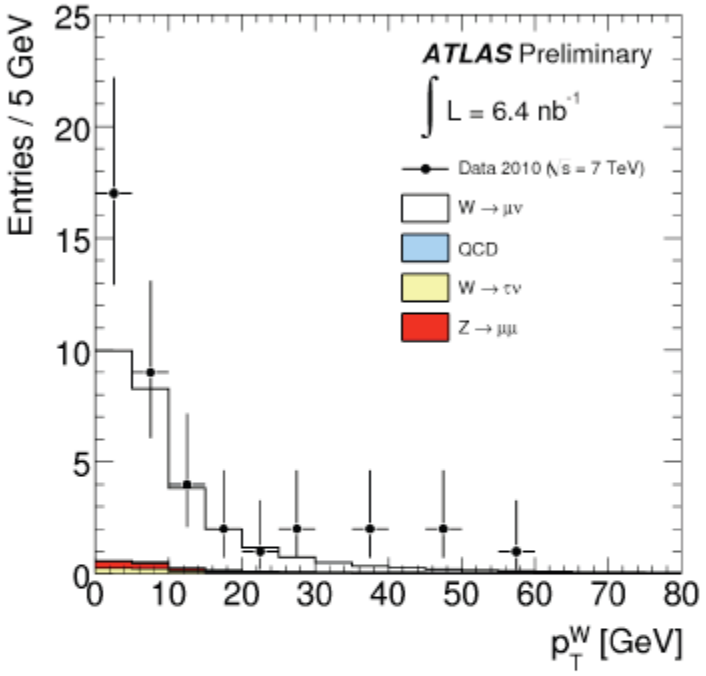


Observed	17
Expected	23.1 ±1.2(stat)±1.7(syst) ±4.6(lumi)
Signal	20.7±1.5(syst) ±4.1(lumi)
Background	2.4±1.2(stat)±0.4(systs) ±0.5(lumi)

Observed	40
Expected	28.7 ±0.5(stat)±3.9(syst) ±5.7(lumi)
Signal	25.9±3.6(syst) ±5.2(lumi)
Background	2.8±0.5(stat) ±0.8(syst) ±0.6(lumi)

W properties



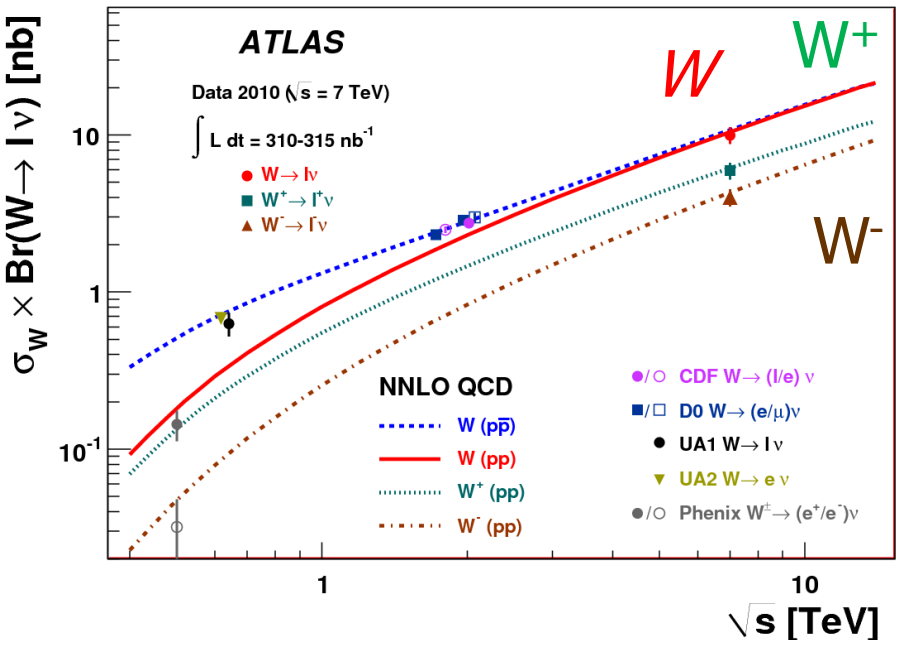


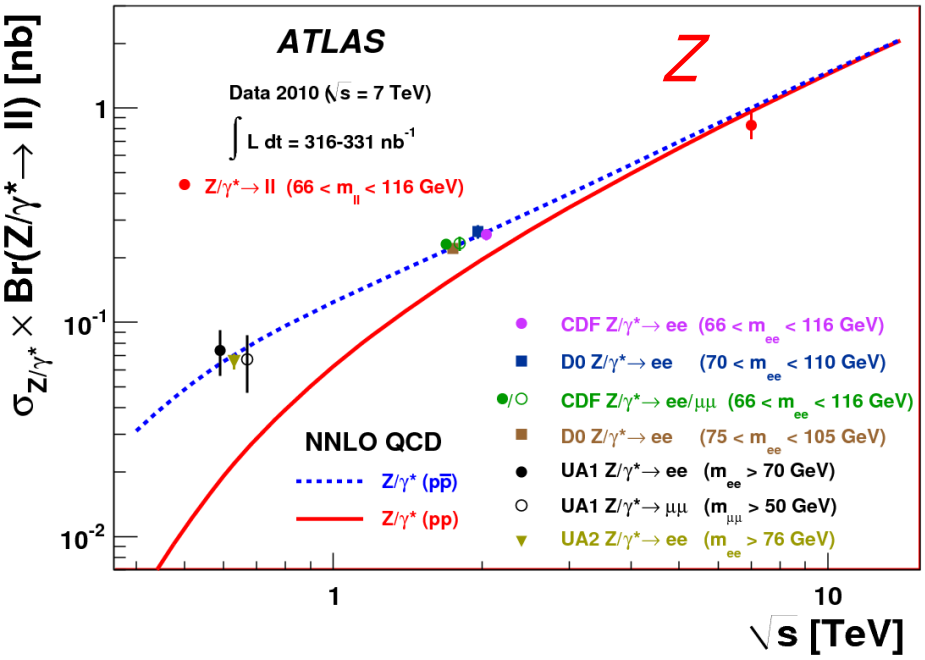
Electron channel:
17 candidates
11 W+
6 W-

Muon channel:
40 candidates
25 W+
15 W-

SM W+/W- ~ 1.4

W and Z cross section with e and μ



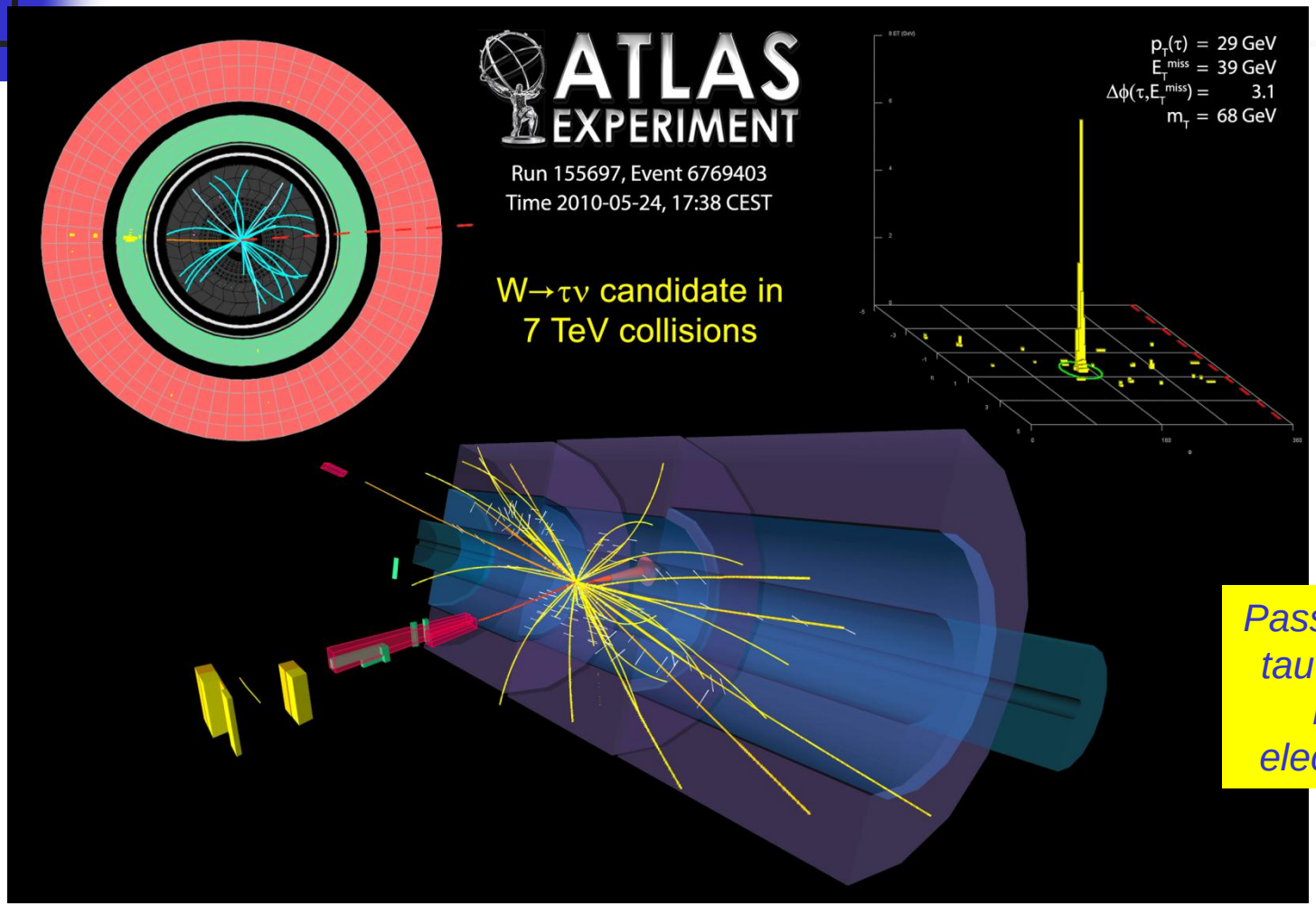


$$\sigma_W^{\text{tot}} \cdot \text{BR}(W \to \ell\nu) = 9.96 \pm 0.23(\text{stat}) \pm 0.50(\text{syst}) \pm 1.10(\text{lumi}) \text{ nb}$$

$$\sigma_{Z/\gamma^*}^{\text{tot}} \cdot \text{BR}(Z/\gamma^* \to \ell\ell) = 0.82 \pm 0.06(\text{stat}) \pm 0.05(\text{syst}) \pm 0.09(\text{lumi}) \text{ nb}$$
$$(66 < m_{\ell\ell} < 116 \text{ GeV})$$

- Dominant lumi uncertainty (11%) should be reduced by a factor 2 soon.
- Measurement of the W⟶lν and Z/γ* ⟶ll production cross sections in p-p collisions
- at sqrt(s) = 7 TeV with the ATLAS detector, Submitted to JHEP (11 Oct 2010)

And Even Some Candidate W to Tau Nu Events

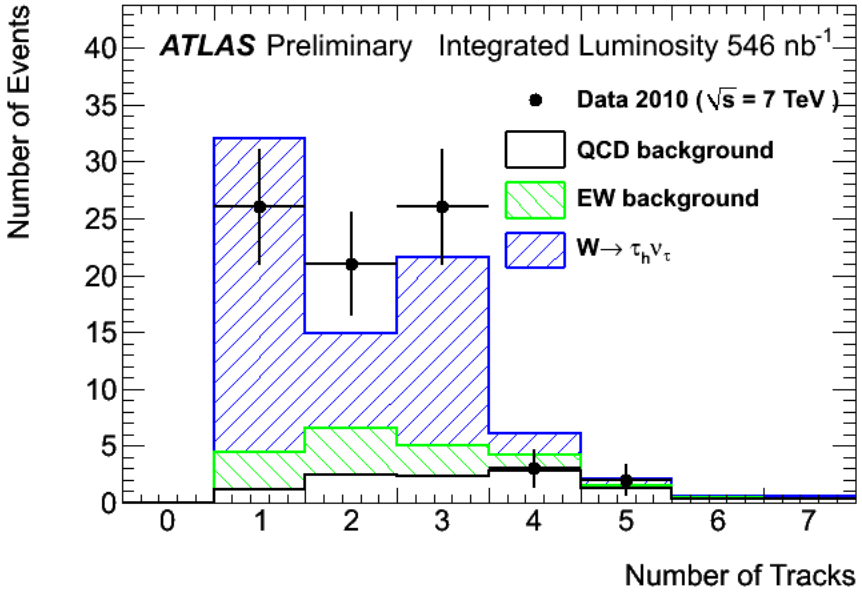


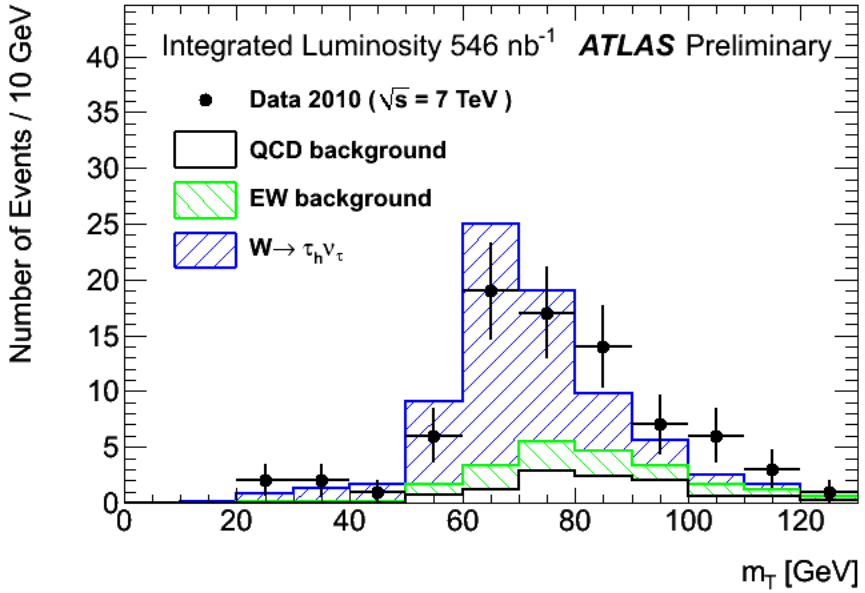
Passes tightest tau cuts; fails loosest electron cuts.

This channel has substantially more background, so it's more difficult to tell event-by-event if a given event is a real tau or background.

$W \rightarrow \tau\nu$ observation

- Observation of $W \rightarrow \tau\nu$ based on 550nb^{-1} also available.
- 78 events with hadronic τ decay candidates. Backgrounds:
- 11.1±2.3±3.2 from QCD
- 11.8±0.4±3.7 from other W/Z decays
- Event properties consistent with expectation





Z → ee, μμ measurements

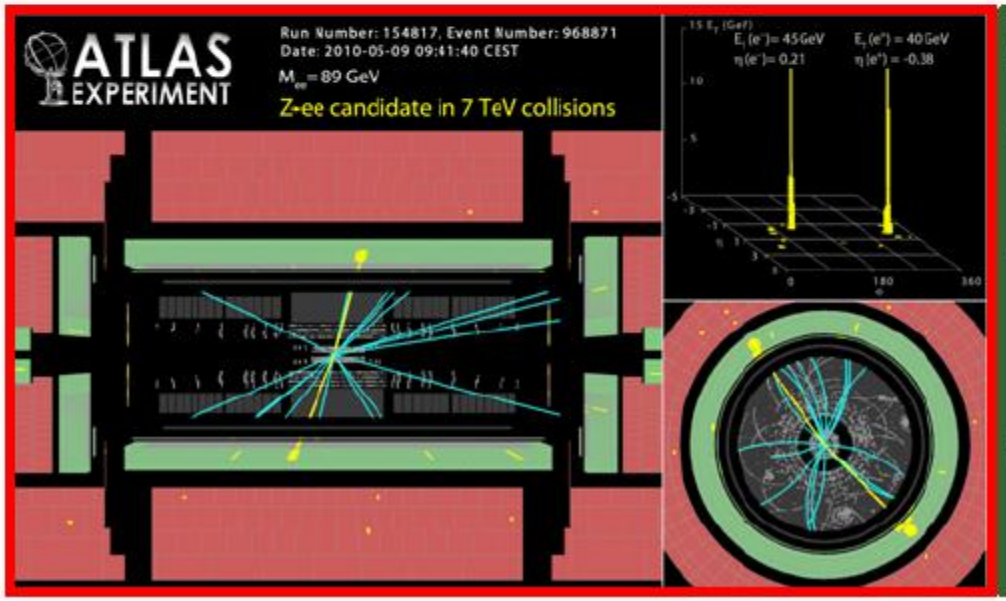
$\sigma^{NNLO}(\gamma^*/Z \rightarrow ll) \sim 0.96$ nb per family for $66 < M(ll) > 116$ GeV

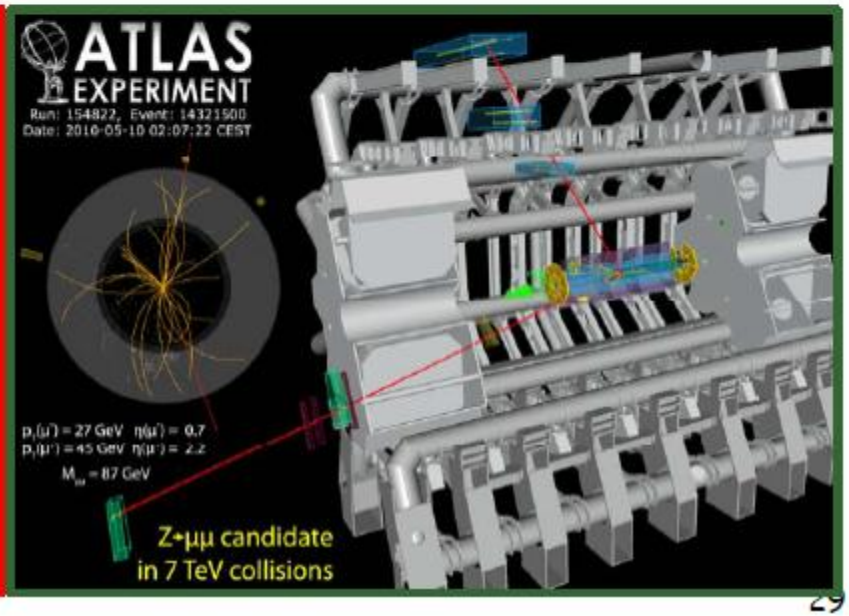
Main selections : Z → ee
- 2 opposite-sign electrons
- $E_T > 20$ GeV, $|\eta| < 2.47$
- **medium** electron identification criteria
- $66 < M(e^+e^-) < 116$ GeV

Acceptance x efficiency : ~ 30%
Expected S/B ~ 100
Main background: QCD jets

Main selections : Z → μμ
- 2 opposite-sign muons
- $p_T > 20$ GeV, $|\eta| < 2.4$
- $|\Delta p_T$ (ID-MS)$| < 15$ GeV
- **isolated**; $|Z_\mu - Z_{vtx}| < 1$ cm
- $66 < M(\mu^+\mu^-) < 116$ GeV

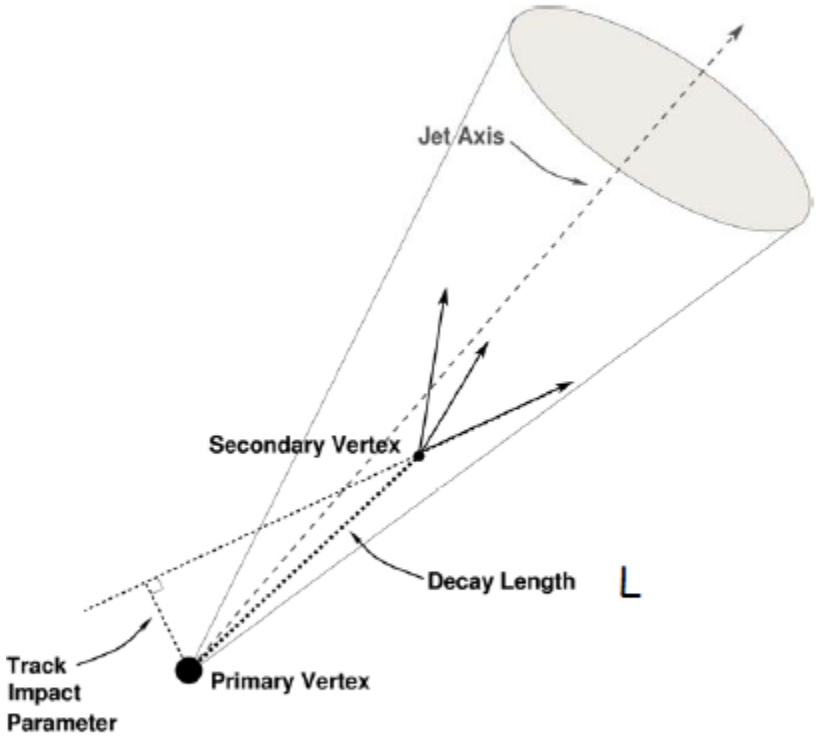
Acceptance x efficiency: ~ 35%
Expected S/B > 100
Main backgrounds : tt, Z→ ττ

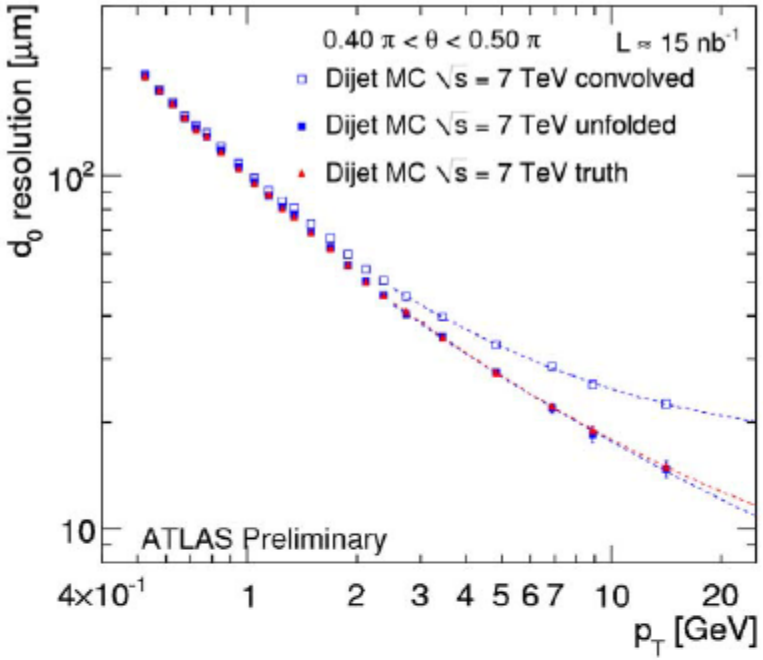


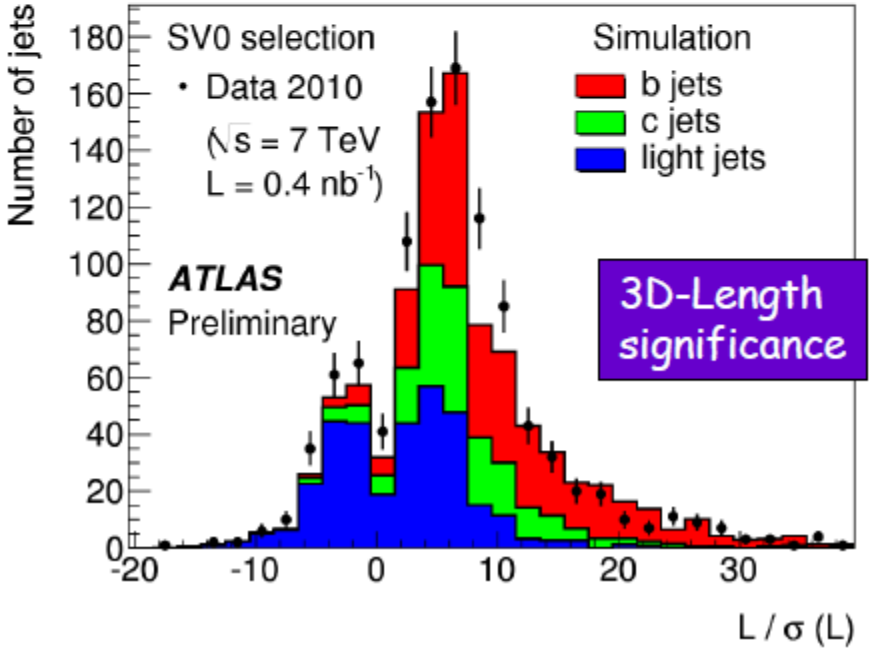


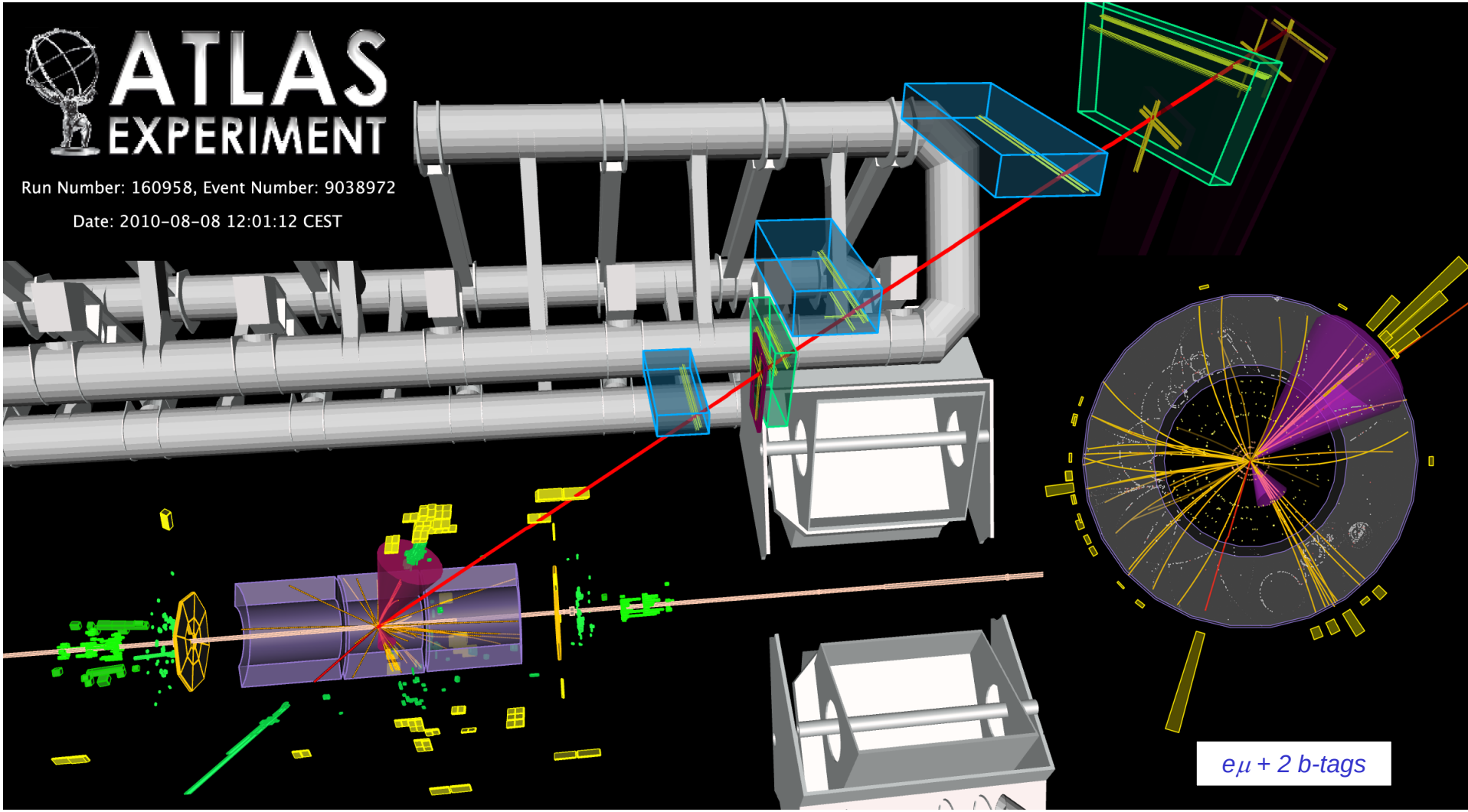
B-tagging

Example of the SV0 algorithm

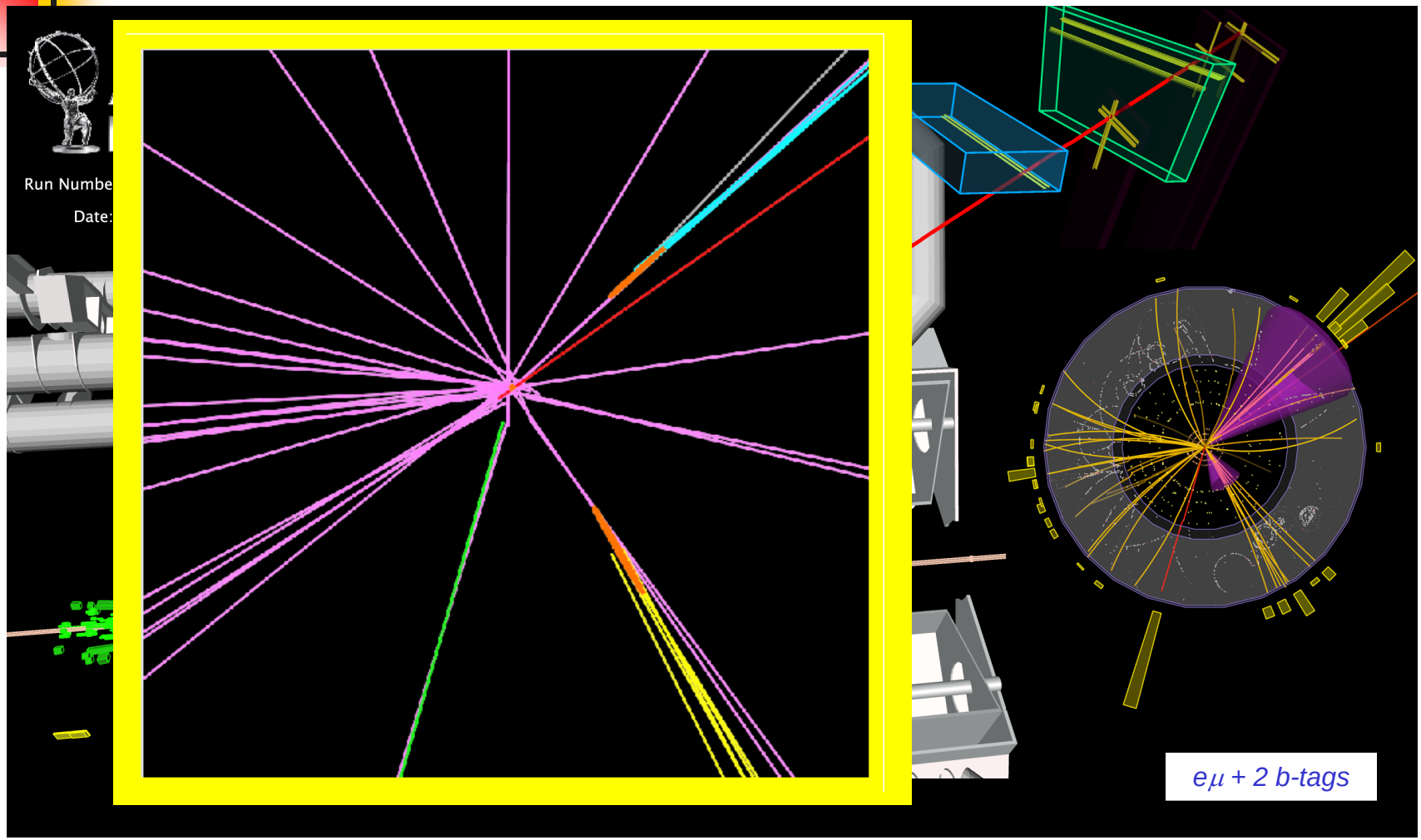






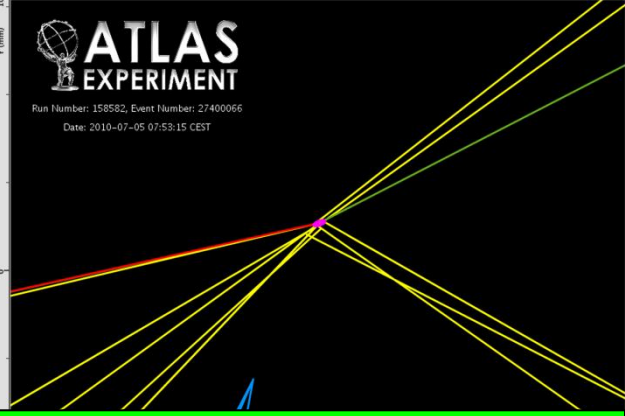


Events keep pouring in, including this "golder-than-gold" candidate.



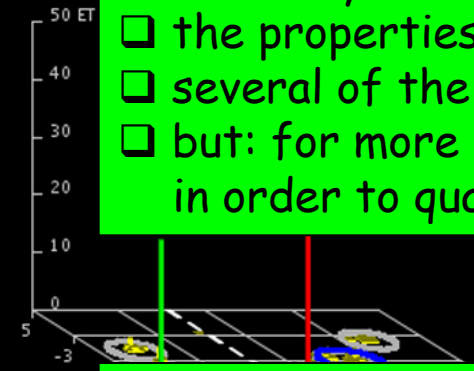
Close-up of the b-tags.

eμ candidate



In summary:

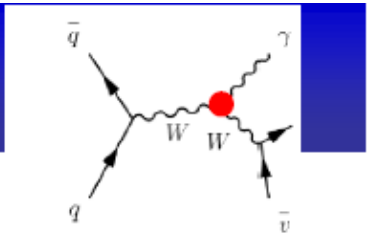
- ❑ the properties of the 9 observed candidates are consistent with tt production
- ❑ several of the candidates are in a region where the expected signal purity is high
- ❑ but: for more conclusive statements, more data ("control samples") are needed in order to quantify the backgrounds

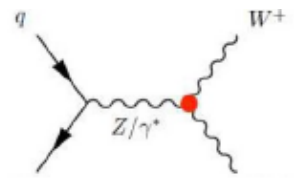


The era of top-quark studies at the LHC has started

$p_T(\mu)$= 48 GeV $p_T(e)$=23 GeV
p_T (b-tagged jet) = 57 GeV
Secondary vertex:
-- distance from primary: 3.8 mm
-- 3 tracks p_T > 1 GeV
-- mass=1.56 GeV
E_T^{miss}=77 GeV, H_T=196 GeV

Diboson Production

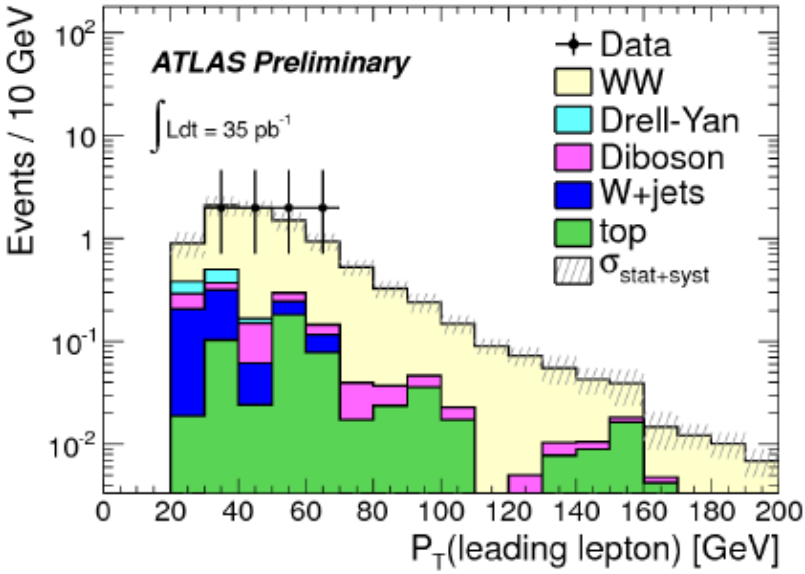


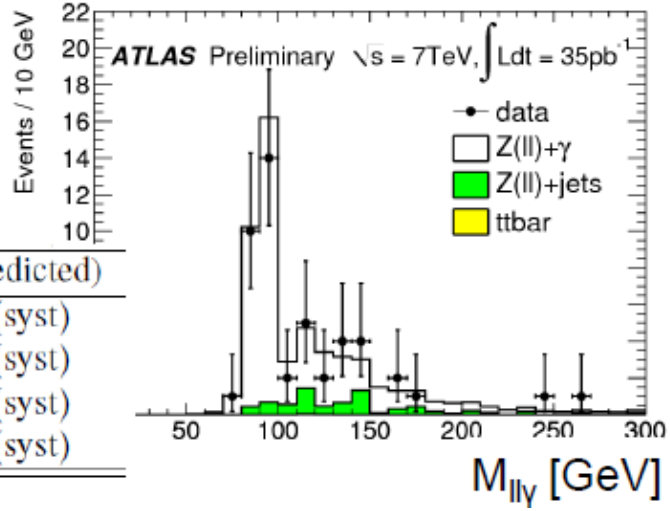


- WW Production **ATLAS-CONF-2011-015_**
  - Test non-abelian nature of EW sector
    - Sensitive to **Triple Gauge Couplings**
  - Main background to H → WW
  - NLO prediction: 46 ±3 pb
  - Results:

$$\sigma_{WW} = 40^{+20}_{-16}\,(stat) \pm 7\,(syst)\,pb$$

  - 8 events observed, 1.7 ± 0.6 bkg expected
  - Dominated by statistical uncertainty 44%
- W/Z+γ Production
  - Sensitive to Triple Gauge Couplings
  - Important test of SM



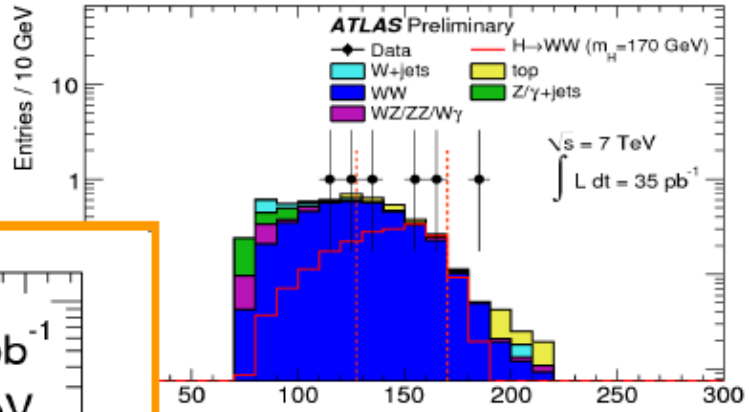


ATLAS-CONF-2011-013

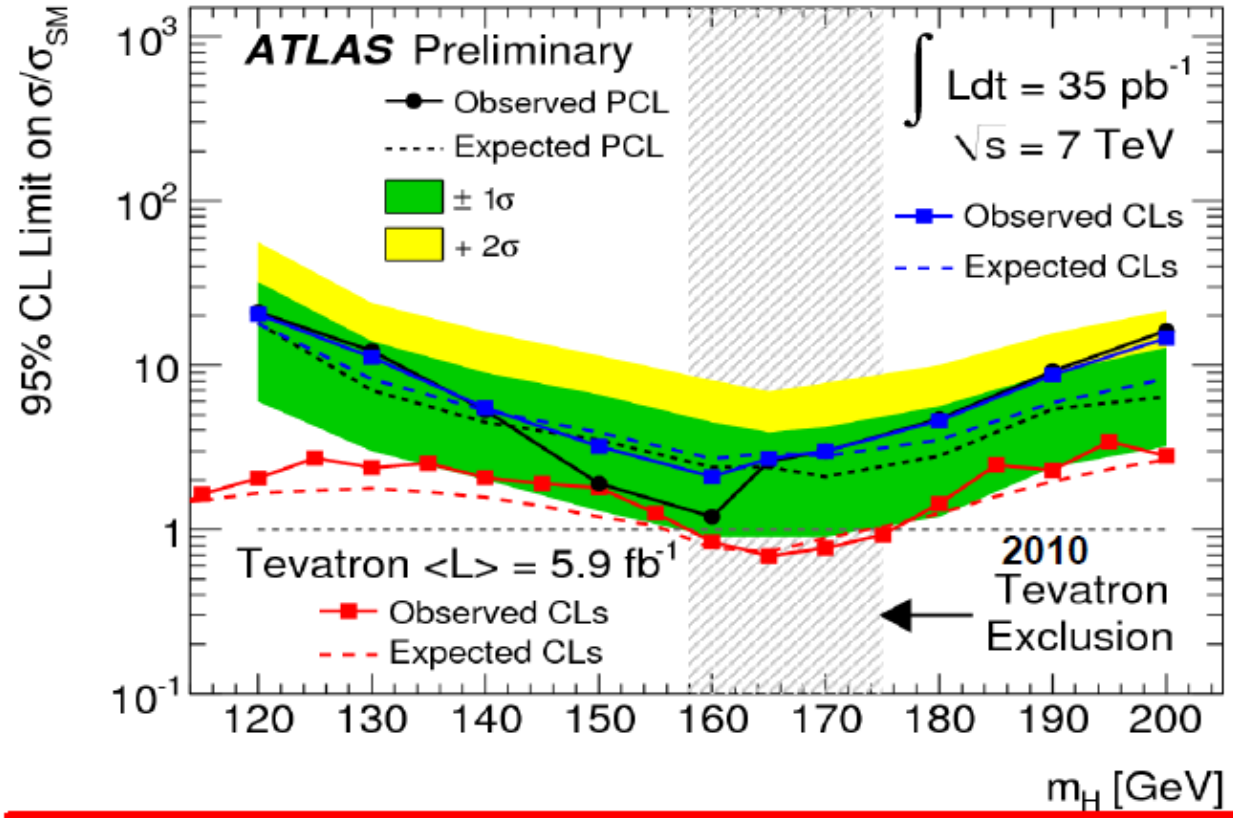
	$\sigma^{total}[pb]$(measured)	$\sigma^{total}[pb]$(predicted)
$pp \to e\nu\gamma$	$73.9 \pm 10.5(stat) \pm 14.6(syst) \pm 8.1(lumi)$	69.0 ± 4.6(syst)
$pp \to \mu\nu\gamma$	$58.6 \pm 8.2(stat) \pm 11.3(syst) \pm 6.4(lumi)$	69.0 ± 4.6(syst)
$pp \to e^+e^-\gamma$	$16.4 \pm 4.5(stat) \pm 4.3(syst) \pm 1.8(lumi)$	13.8 ± 0.9(syst)
$pp \to \mu^+\mu^-\gamma$	$10.6 \pm 2.6(stat) \pm 2.5(syst) \pm 1.2(lumi)$	13.8 ± 0.9(syst)

SM Higgs →W W*→lν lν (l = e, μ)

- Strong sensitivity in 120 < m(H_{SM}) < 200 GeV
- Cut-based analysis
- Combining H + 0 jet, H + 1 jet and H + 2 jet



Transverse mass (H+0 jets)



Data-driven estimation WW, tt, W+jets, Z+jets backgrounds

Upper limit on σxBR(H→WW*)

- m_H=120 GeV : 54 pb
- m_H=160 GeV : 11 pb
- m_H=200 GeV : 71 pb

... will be catching up with the Tevatron very soon.

16

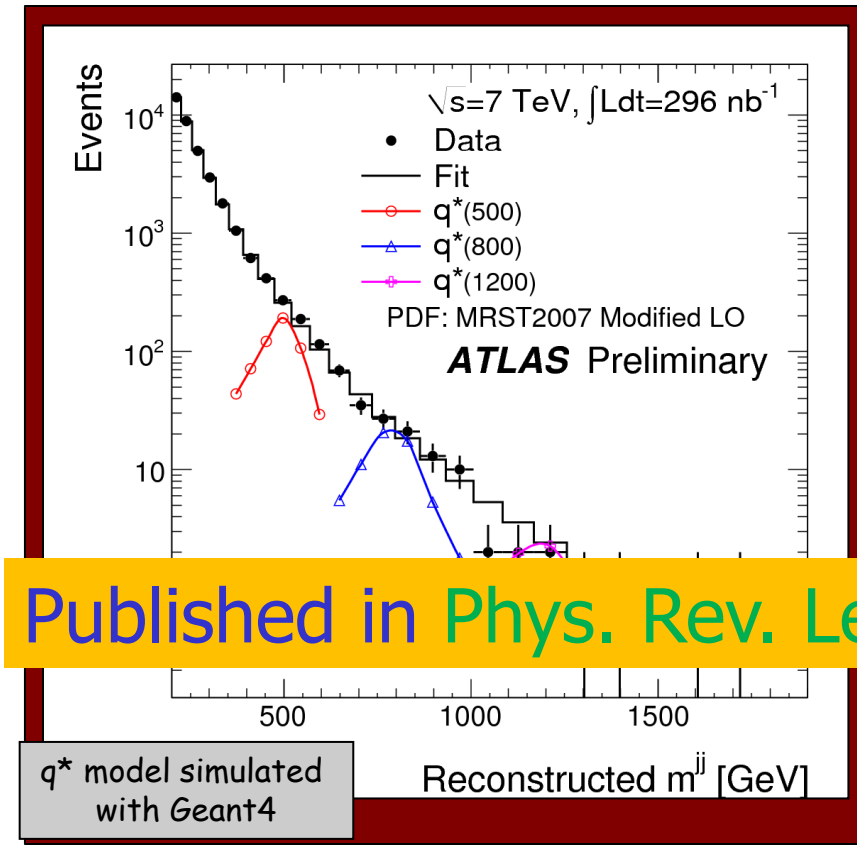
Searches for excited quarks: q* → jj

Full data sample analysed

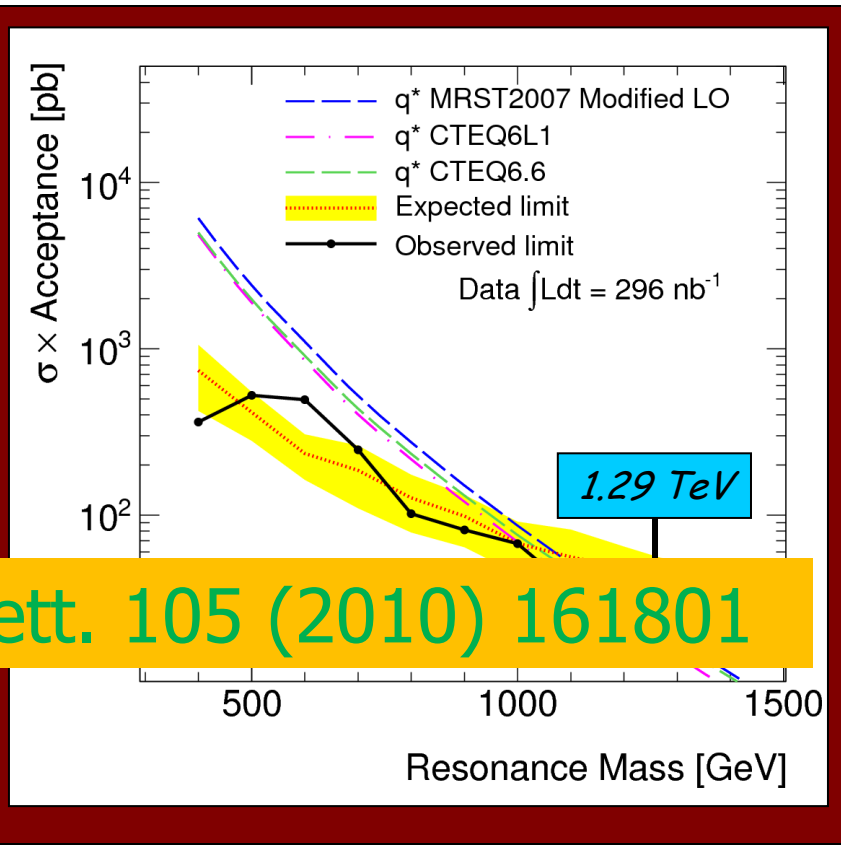
Looked for di-jet resonance in the measured M(jj) distribution
→ spectrum compatible with a smooth monotonic function → no bumps

0.4 < M (q*) < 1.29 TeV excluded at 95% C.L.

Latest published limit:
CDF: 260 < M (q*) < 870 GeV

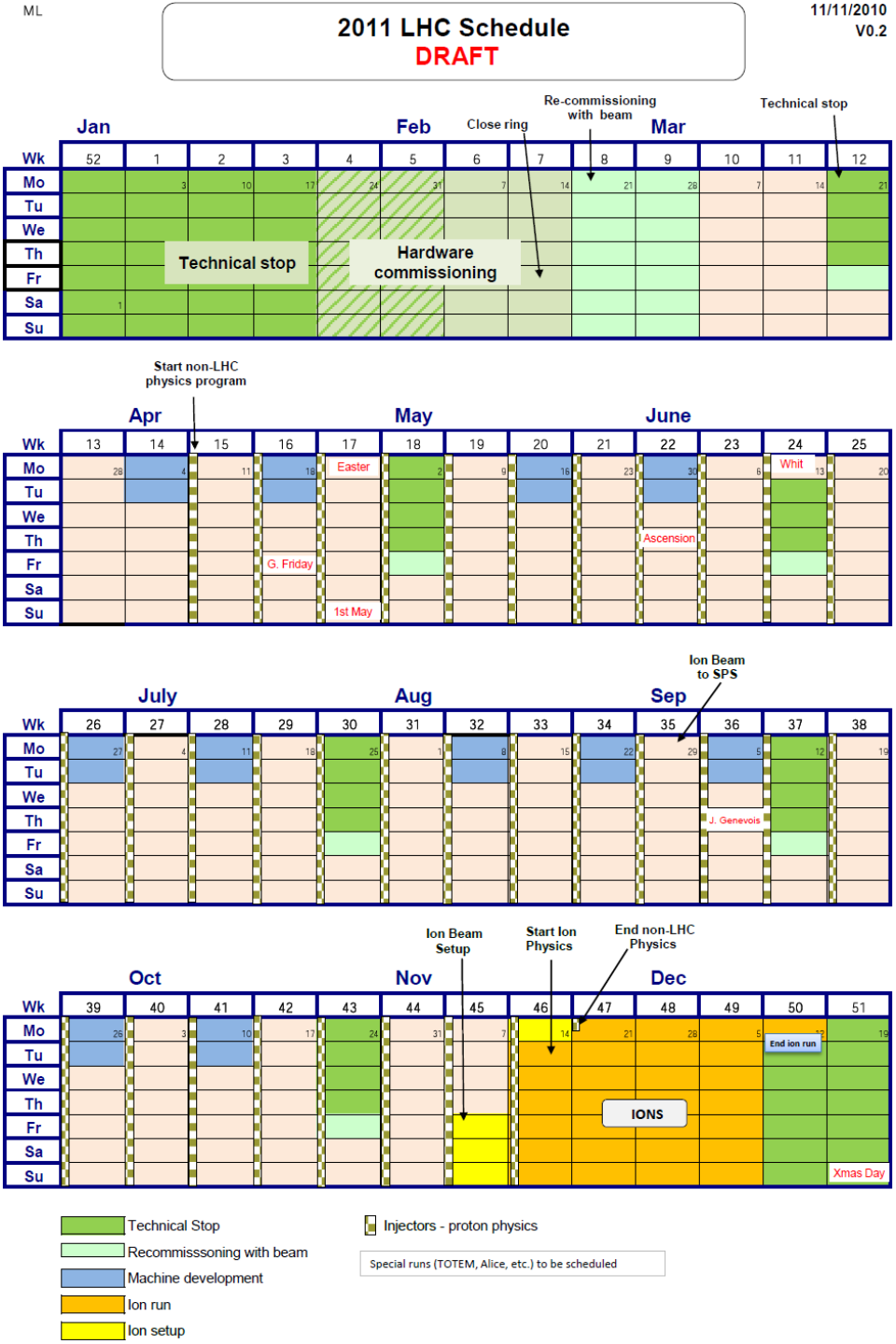


q* model simulated with Geant4



Published in Phys. Rev. Lett. 105 (2010) 161801

- Experimental systematic uncertainties included: luminosity, JES (dominant), background fit, ..
- Impact of different PDF sets studied → with CTEQ6L1: 0.4 < M (q*) < 1.18 TeV



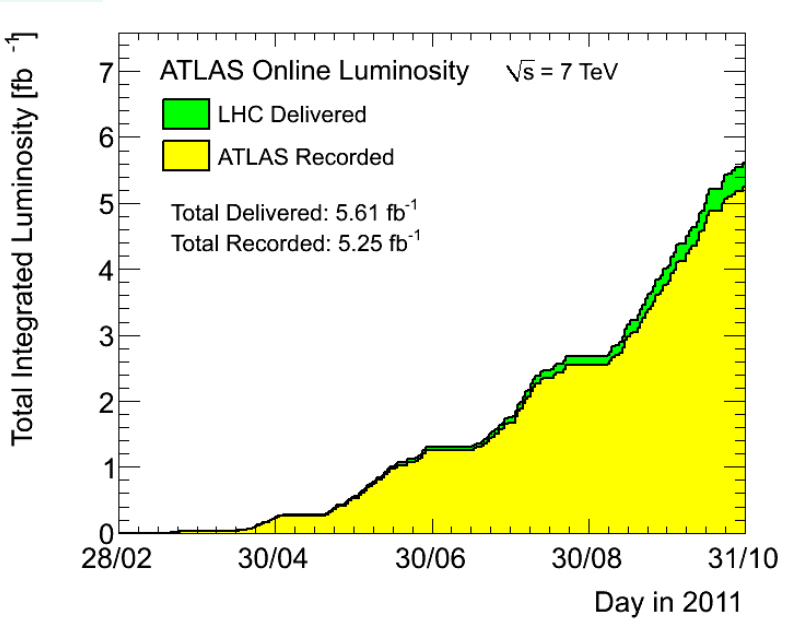
2011

- Beam back around 21st February
- 2 weeks re-commissioning with beam (at least)
- 4 day technical stop every 6 weeks
- Count 1 day to recover from TS (optimistic)
- 2 days machine development every 2 weeks or so
- 4 days ions set-up
- 4 weeks ion run
- End of run – 12th December

~200 days proton physics

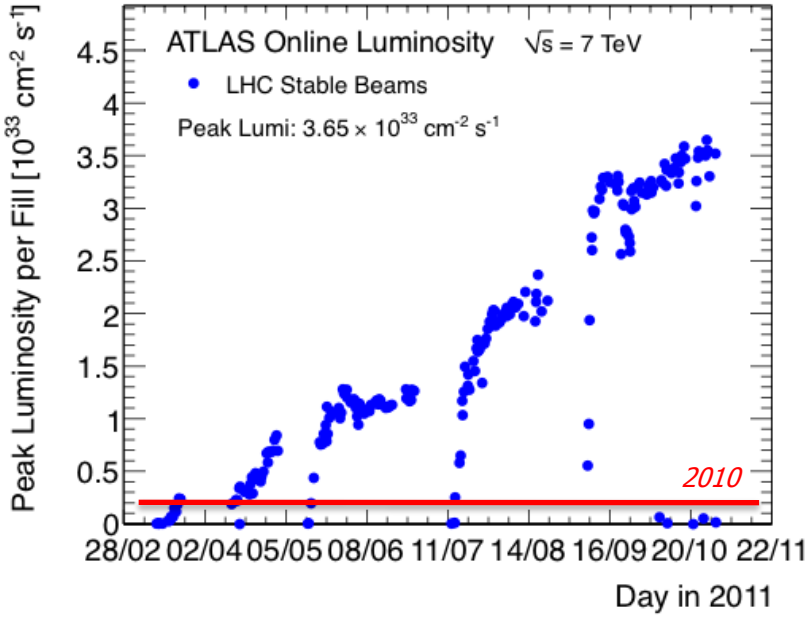
2011

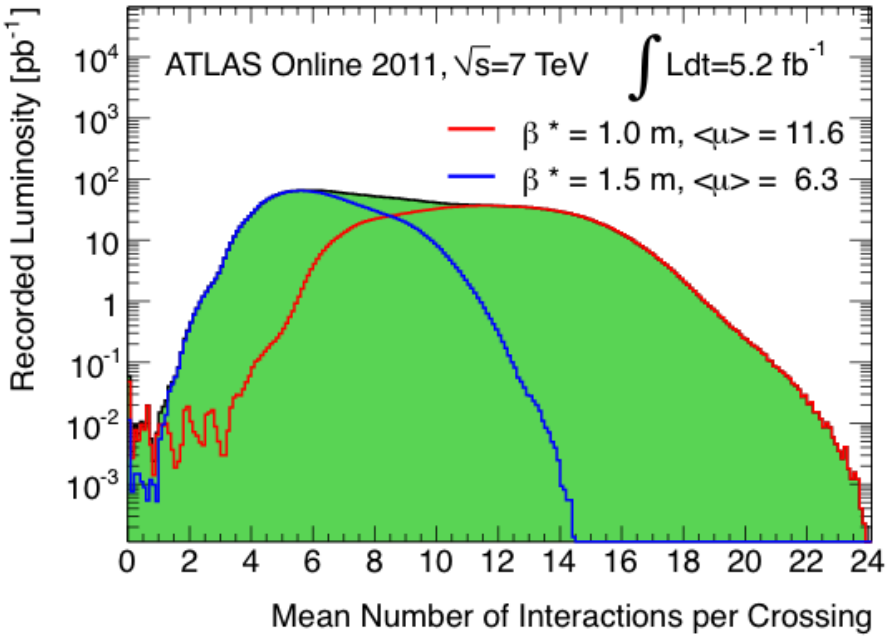
	2011	Nominal
beam energy	3.5 TeV	7 TeV
N. of bunches	1331	2808
bunch spacing	50 ns (~15 m)	25 ns (~7.5 m)
β^*	1.5 – 1.0 m	0.55 m
proton/bunch	1.45×10^{11}	1.15×10^{11}
events/crossing	6 – 12	19
Λ [cm $^{-2}$ s $^{-1}$]	3.65×10^{33}	10^{34}

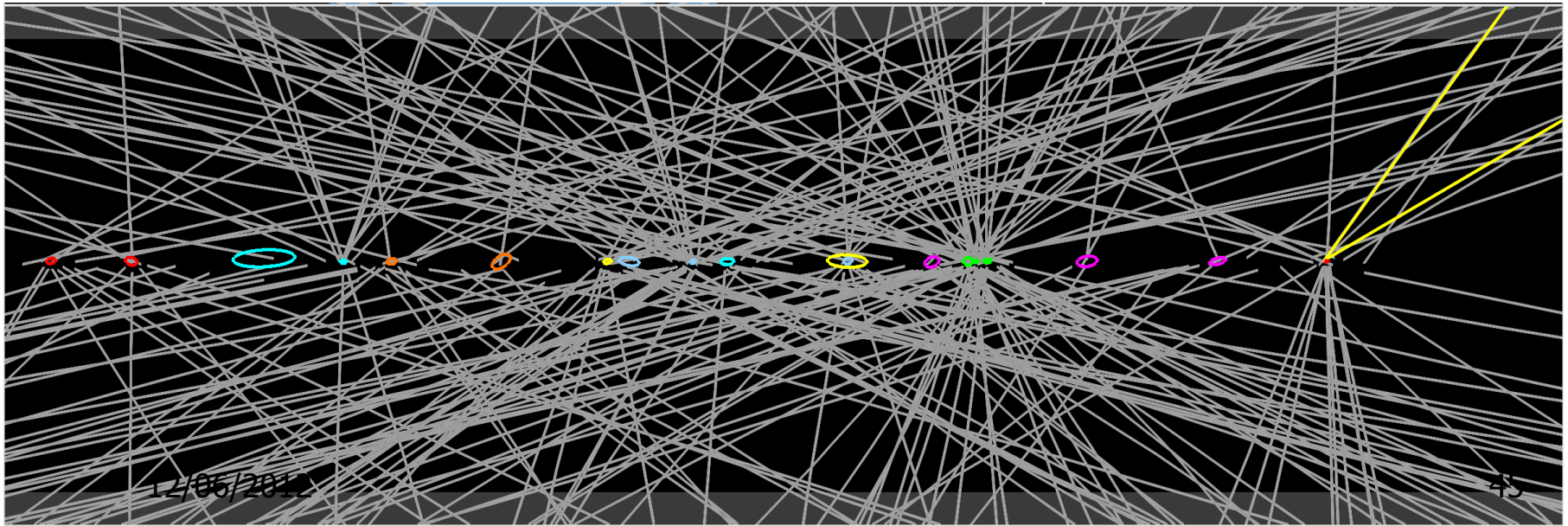


93.5% data-taking efficiency

2011 Data Taking Conditions Proton Run 5.2 fb^{-1}





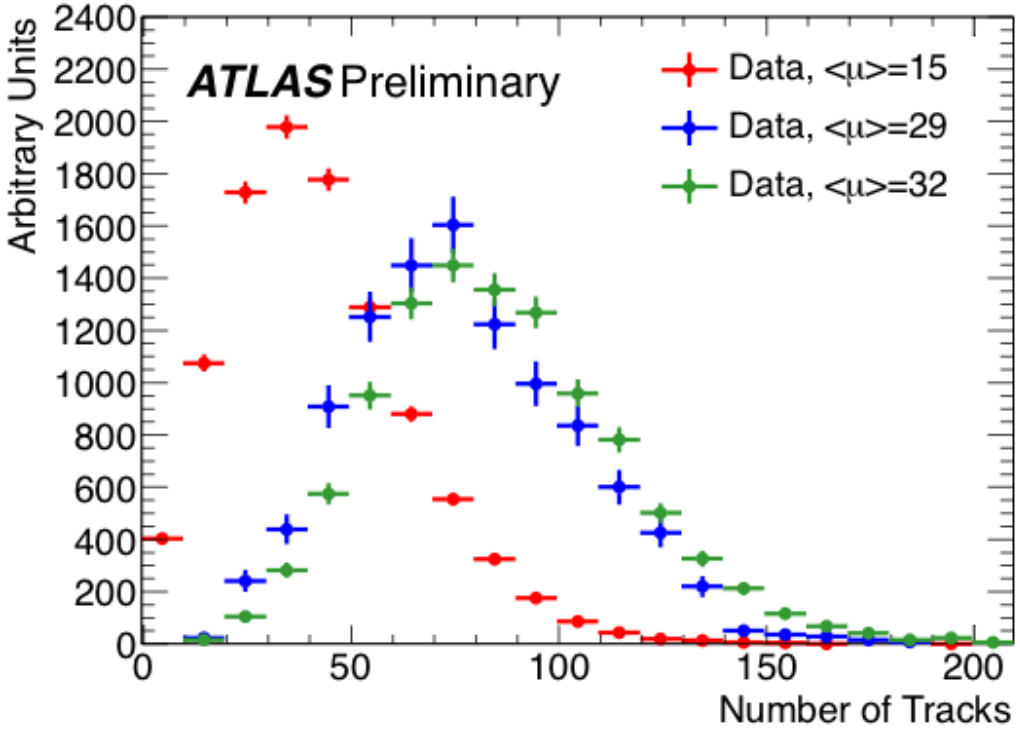


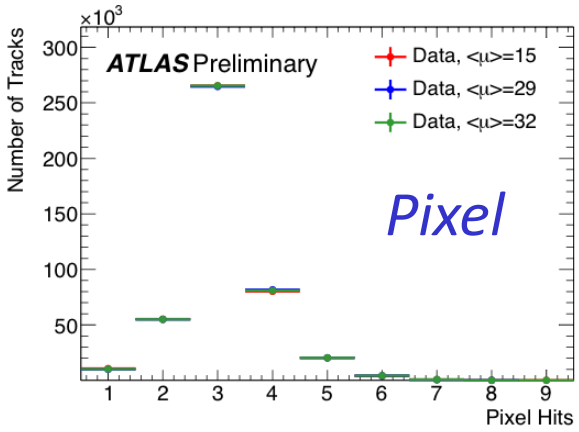
Tracking at high pile up (μ~30)

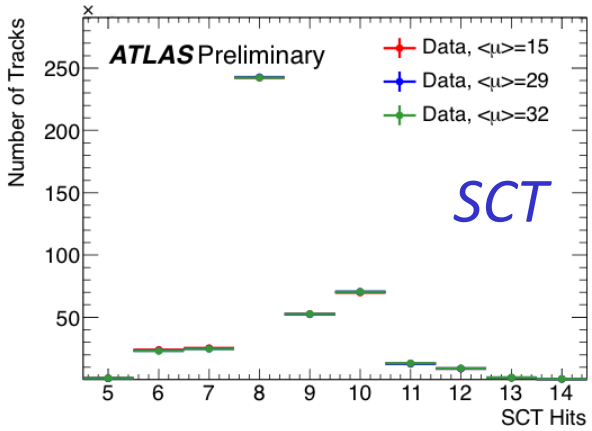
Comparison of tracks in random events between normal running and high mu run

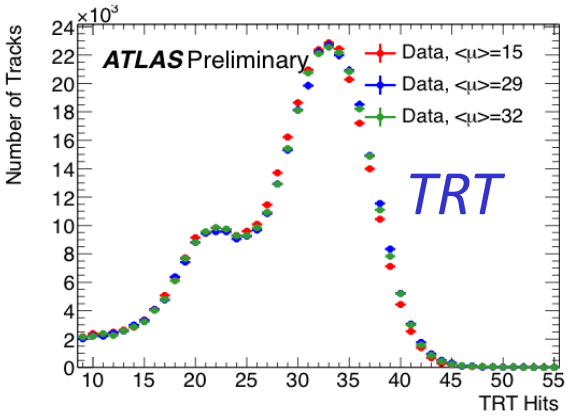
Hits on tracks are constant even at pileup of 30

Fakes will increase

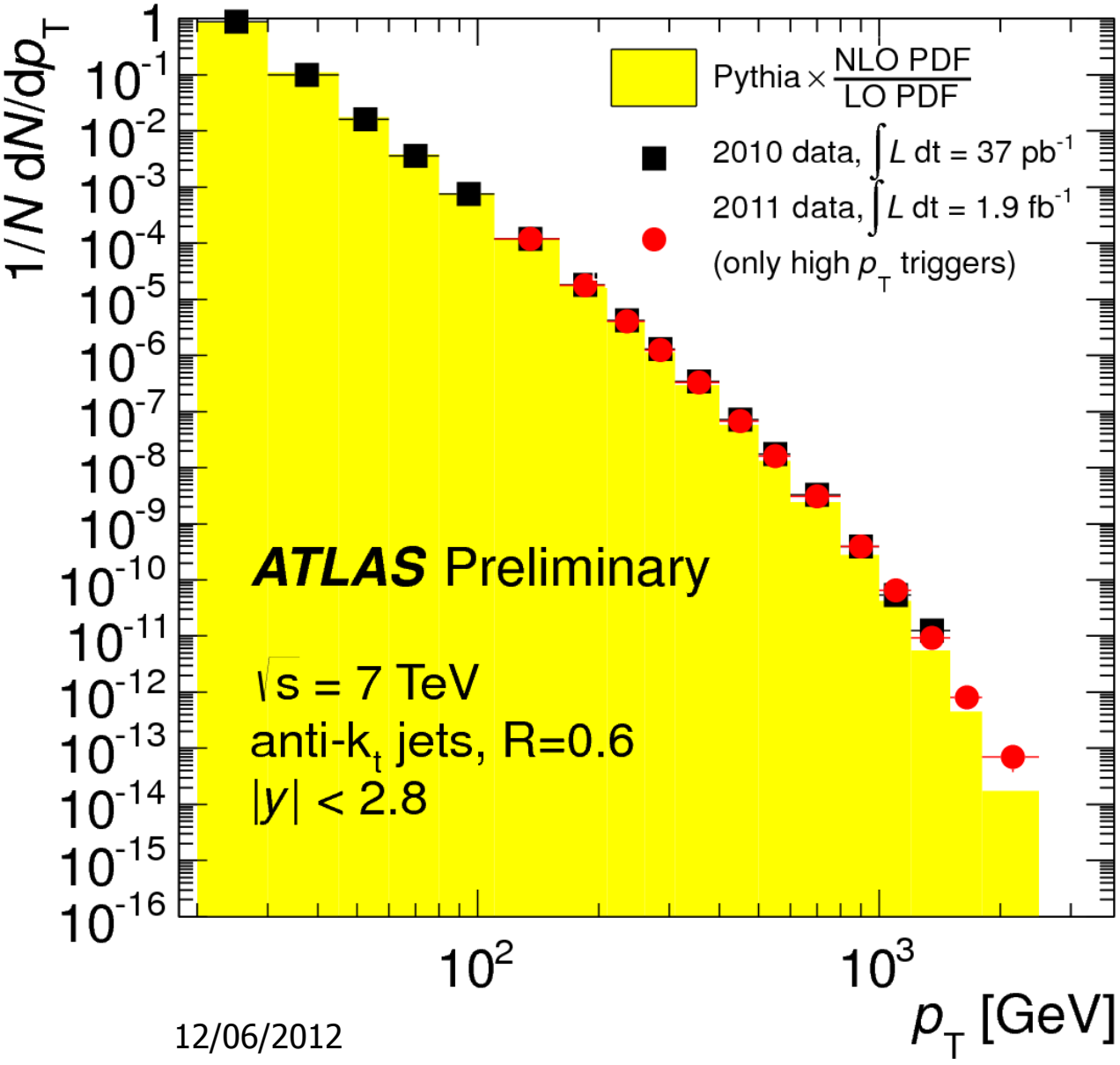




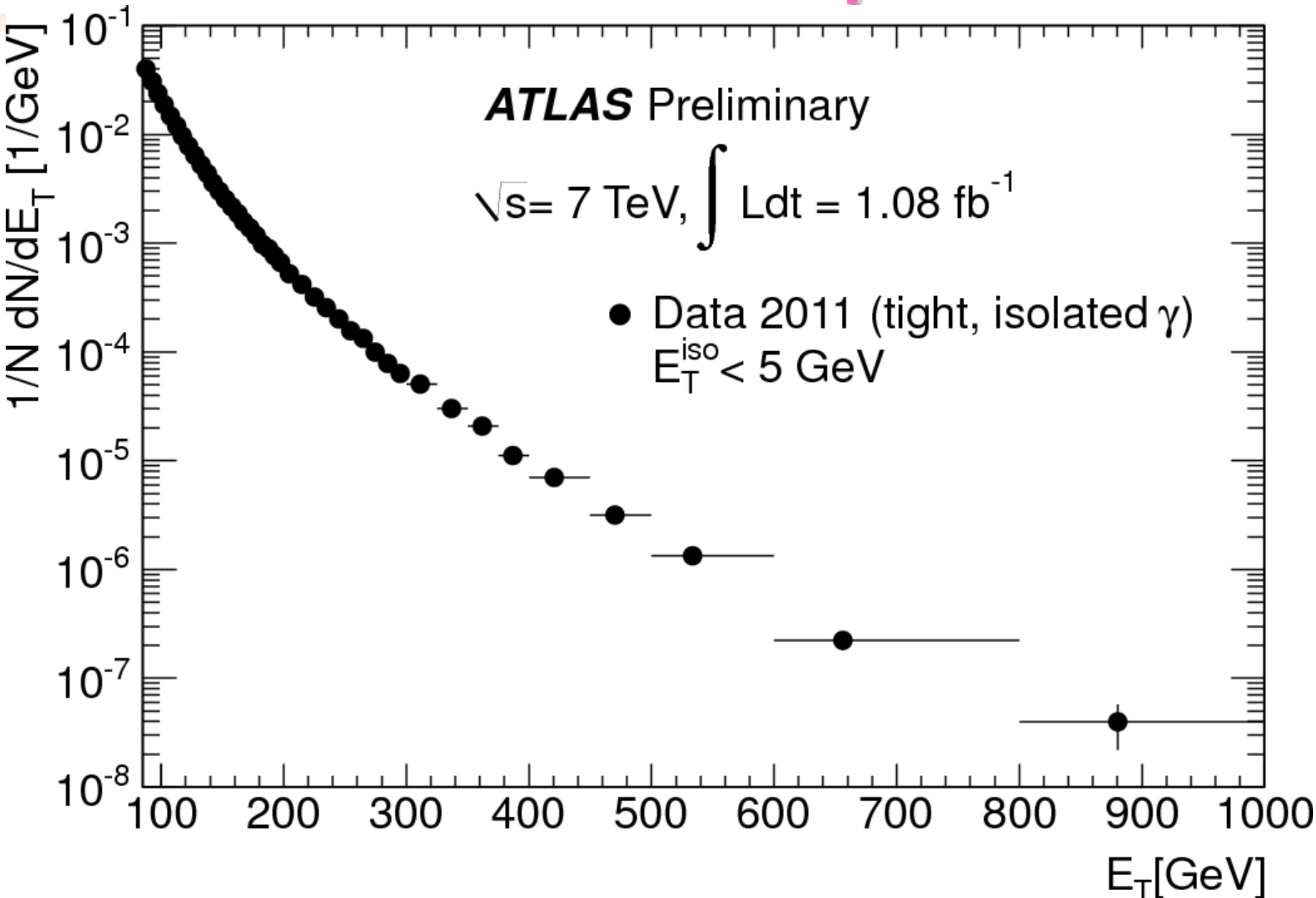




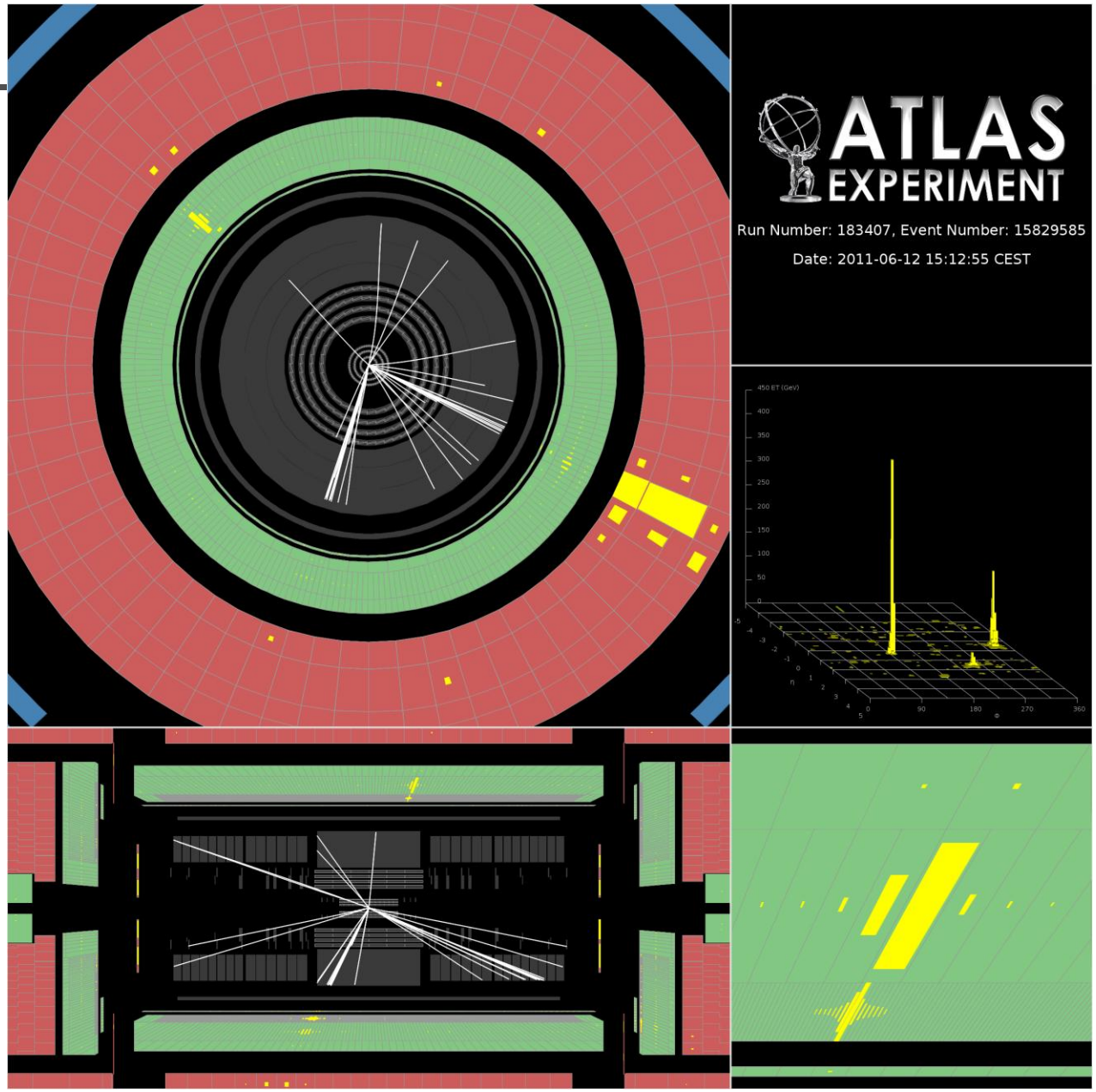
Now have covered a lot of phase space for many signatures



Photon measurements: reach also TeV scale by now!



Highest E_T (960 GeV) unconverted photon observed to-date



Top-quark physics: precision measurements on their way!

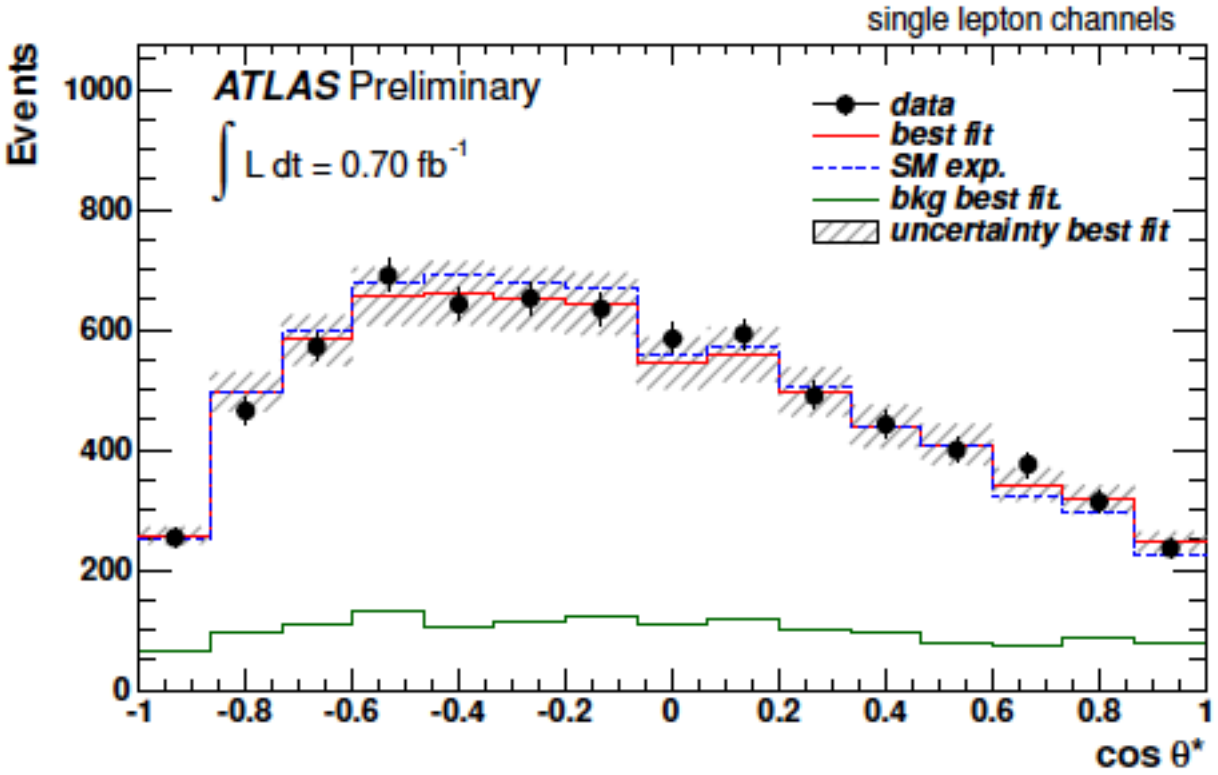
Measurement of the W-boson polarisation in top quark decays:

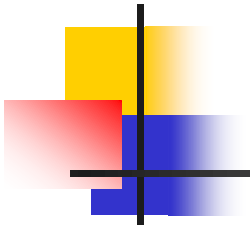
use ~ 7000 semi-leptonic and ~ 900 dilepton events (0.7 fb^{-1} dataset)

measure helicity fractions depending on W polarisation, extracted from $\cos\theta^*$ distribution between lepton and reversed b-quark in W-boson rest frame

NNLO QCD predictions are quite precise, e.g. $F_0 = 0.687 \pm 0.005$ (longitudinal)

Measurement: $F_0 = 0.75 \pm 0.08$ (stat+syst)



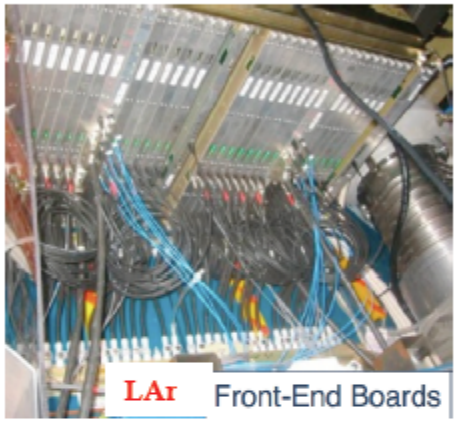


2012

Detector readiness: shutdown activities I

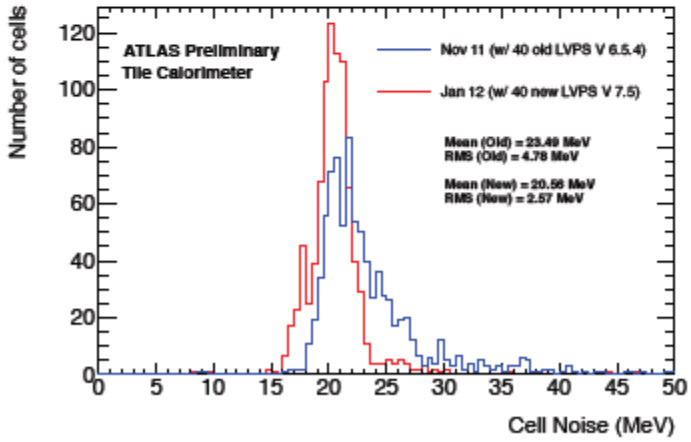
Liquid-Argon calorimeters:

- 10 Front End boards repaired and 12 New LVPS installed:
- Bad channels: 385/182468 → 106/182468 (0.06%)



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% → 0.5% today



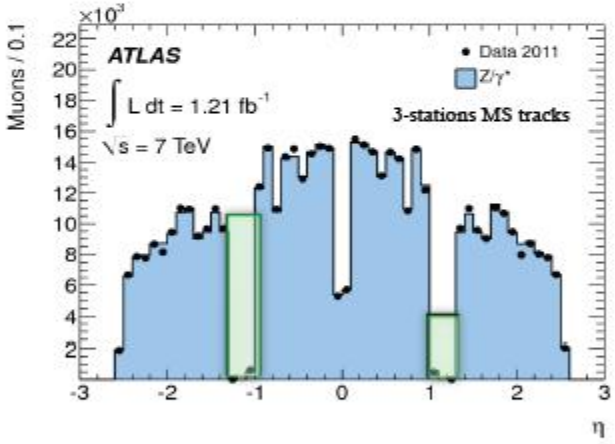
Infrastructures

- Cryogenics: NEW main compressor
- Maintenance: cryogenics, gas, cooling, access systems + Consolidation of the electrical system → Ensure smooth running in 2012

Detector readiness: shutdown activities II

Muon Spectrometer

- Installation MDT EE (precision MS tracking at $|\eta| \sim 1.2$):
  - Side C: completed
  - Side A: 4 EELs (completion 2013)



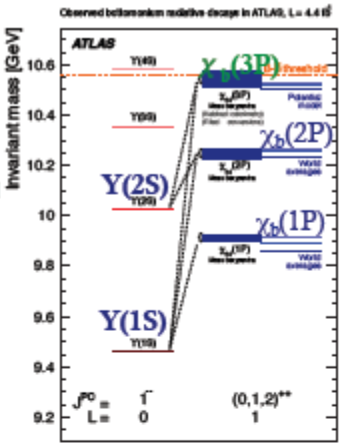
- New shielding at Z~ 7 m: To reduce large plume of Photons in MS

Detector Readiness: Summary

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	95.9%
SCT Silicon Strips	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	97.5%
LAr EM Calorimeter	170 k	99.9%
Tile calorimeter	9800	99.5%
Hadronic endcap LAr calorimeter	5600	99.6%
Forward LAr calorimeter	3500	99.8%
LVL1 Calo trigger	7160	100%
LVL1 Muon RPC trigger	370 k	98.4%
LVL1 Muon TGC trigger	320 k	100%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	97.7%
RPC Barrel Muon Chambers	370 k	93.8%
TGC Endcap Muon Chambers	320 k	99.7%

ATLAS detector "ready" for 2012 data taking

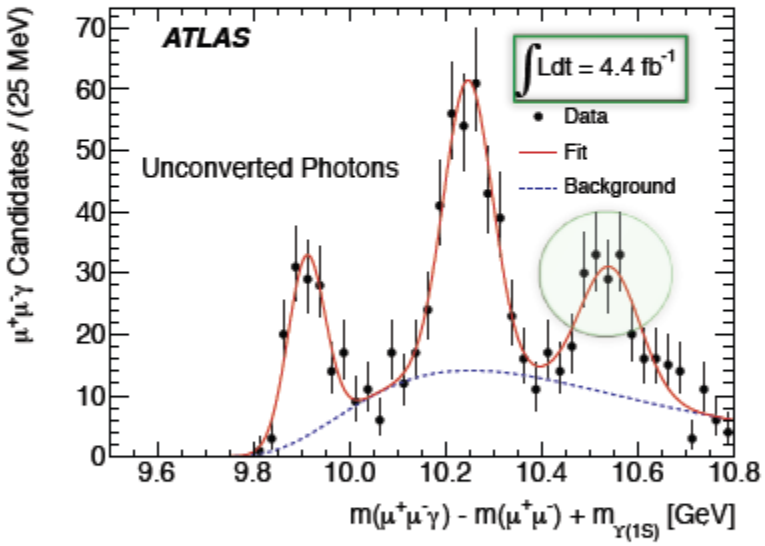
Observation of a new bb state: $\chi_b(3P)$

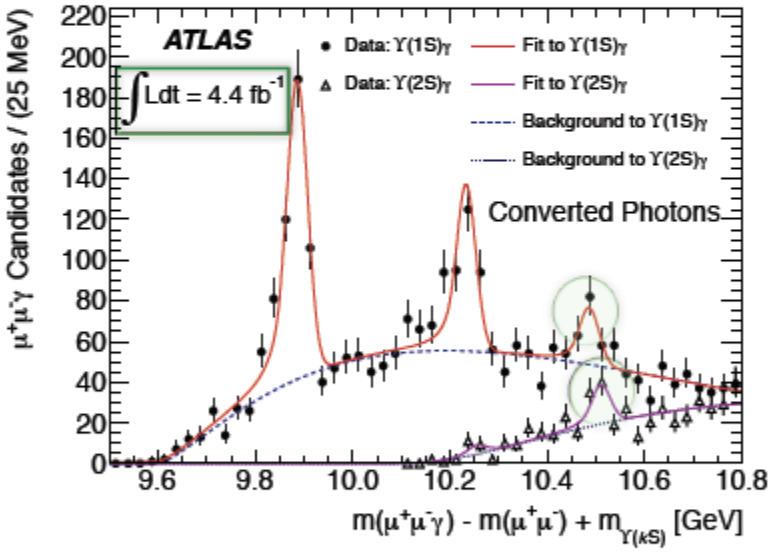


- NEW bb bound state **discovered**: spectroscopy with **~1 GeV γ**
- Reconstruction through radiative decays $\chi_b(nP)$->Y(1S)γ and $\chi_b(nP)$->Y(2S)γ

arXiv:1112:5454

$$\overline{m}_3 = 10.530 \pm 0.005\ (\text{stat.}) \pm 0.009\ (\text{syst.})\ \text{GeV}$$

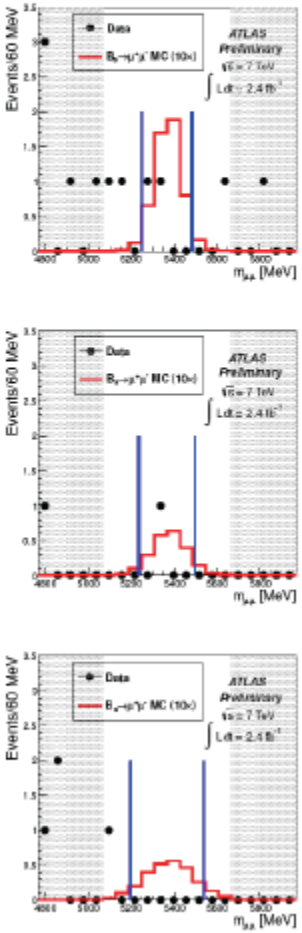




- $\chi_b(nP)$ Masses from **calorimetric (left)** and **tracking (right)** measurements: Statistical significance for $\chi_b(3P)$ > 6σ in both cases
- For Converted-γ **2 radiative transitions Y(1S)γ** and **Y(2S)γ** observed

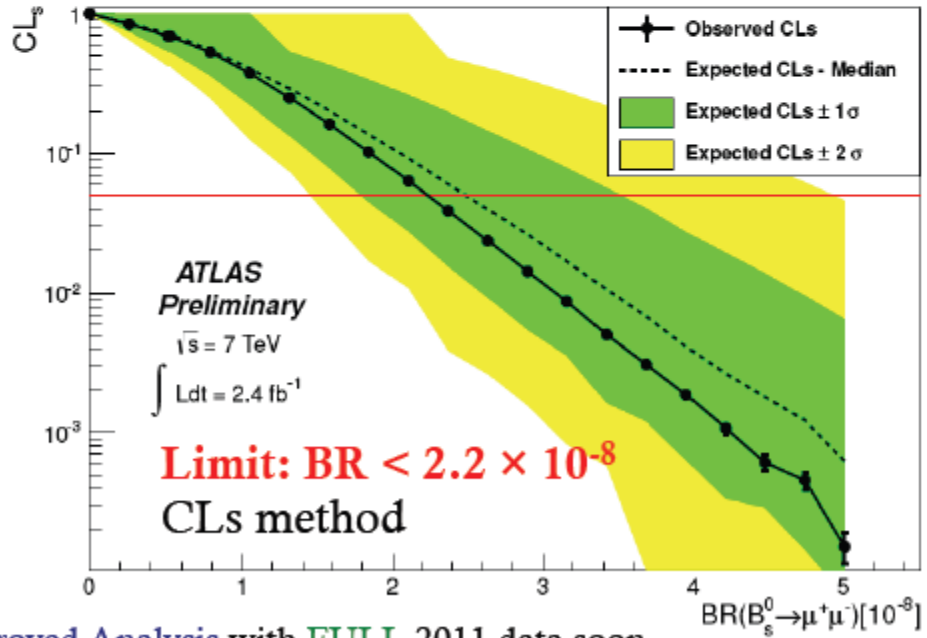
Search for $B_s \rightarrow \mu^+\mu^-$

- $B_s \rightarrow \mu^+\mu^-$ analysis with 2.4 fb^{-1} ATLAS-CONF 2011-145



Three categories of different mass resolution

$\lvert\eta_{max}\rvert$ Range	0-1.0	1.0-1.5	1.5-2.5
SES= $(\epsilon\epsilon_i)^{-1}$ $[10^{-8}]$	0.71	1.6	1.4
$\epsilon = (f_s/f_u)/\mathrm{BR}(B^\pm \rightarrow J/\psi K^\pm \rightarrow \mu^+\mu^- K^\pm)$ $[10^3]$		4.45 ± 0.38	
$\epsilon_i = N_i^{B^\pm \rightarrow J/\psi K^\pm}/\mathrm{R}^i_{A\epsilon}$ $[10^4]$	3.14 ± 0.17	1.40 ± 0.15	1.58 ± 0.26
bkg. scaling factor R_i^{bkg}	1.29	1.14	0.88
side-band count $N^{bkg}_{obs,i}$ (even numbered events)	5	0	2
expected resonant bkg. $N_i^{B\rightarrow hh}$	0.10	0.06	0.08
search region count N_i^{obs}	2	1	0

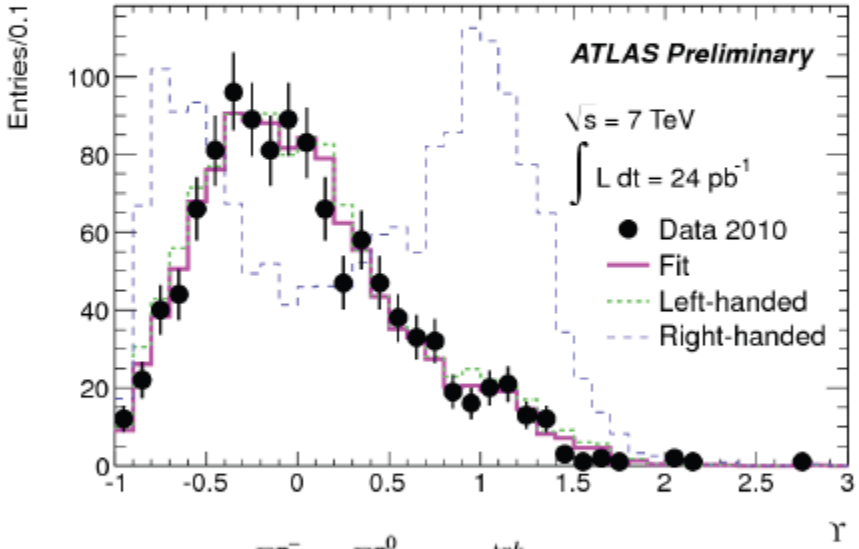


Expected Improved Analysis with FULL 2011 data soon

τ polarization from W decay

- NEW: first measurement polarization of τ polarization in W decay at hadron colliders
- This method can be applied to searches like SM Higgs (P_τ=0) or SUSY H^+ (P_τ=+1)

ATLAS-CONF 2012-009



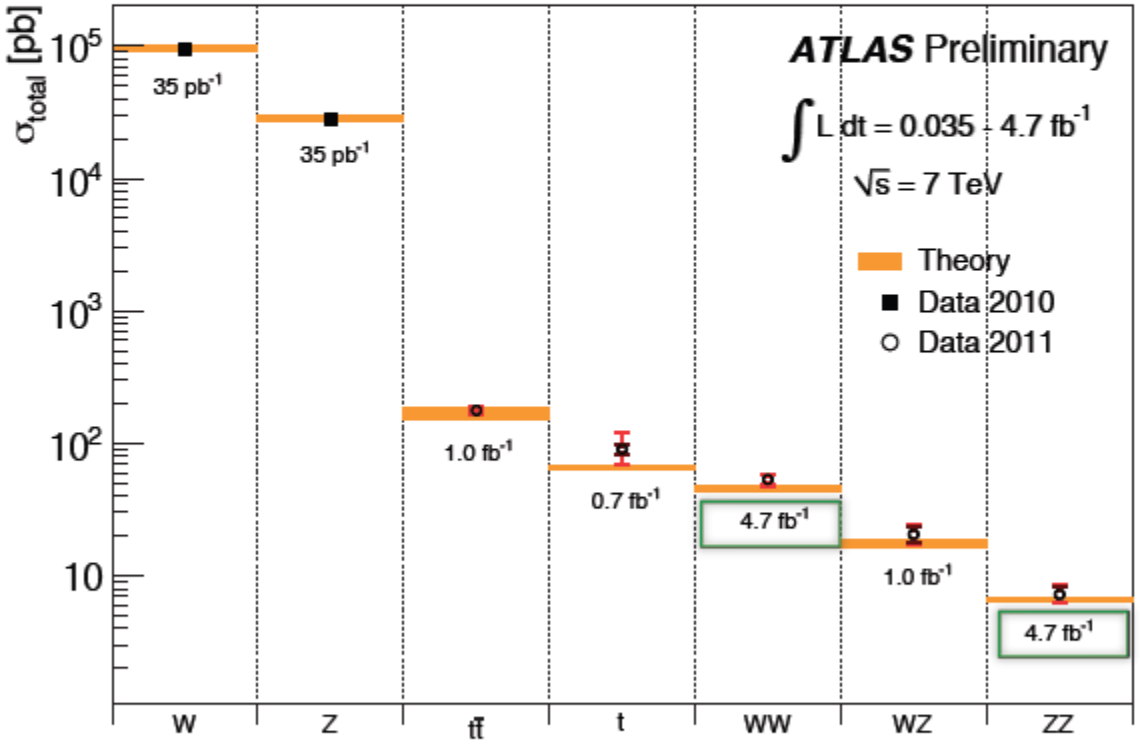
$$P_\tau = -1.06 \pm 0.04\,(stat)\,^{+0.05}_{-0.07}\,(syst)$$

- $\dfrac{E_T^{\pi^-} - E_T^{\pi^0}}{p_T} \approx 2\dfrac{p_T^{trk}}{p_T} - 1 = \Upsilon$ τ polarization from ρ decay cos(Ψ)
- Measured value compatible with V-A SM coupling

SM physics

NEW results recently published or submitted to conferences

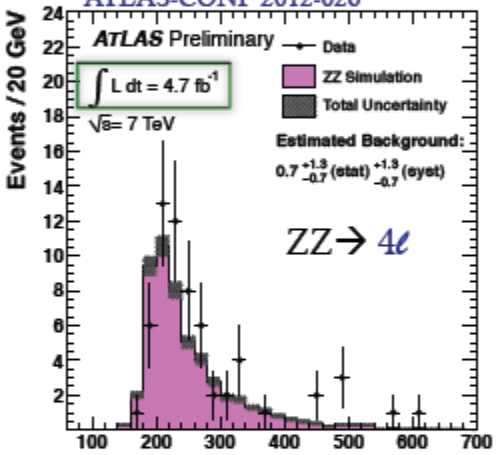
- EW results
  - WW cross section ~5fb^{-1}
  - ZZ cross section ~5fb^{-1}
  - Wγ, Zγ cross sections
  - Triple gauge coupling limits
  - Tau polarization
  - W polarization
- QCD measurements
  - Jets cross section
  - Di-jet cross section ~5fb^{-1}
  - Z+jets
  - Subjet structure
  - D* in jets
  - Rapidity gaps
  - Charged particle production (correlations, azimuthal ordering)



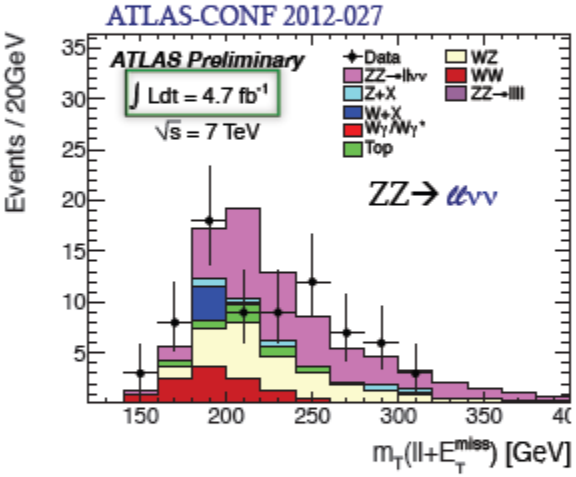
ZZ, WW cross-section measurements

- ZZ, WW cross-sections very important test of the SM and irreducible background for SM Higgs searches
- ZZ→ 4ℓ and WW→ ℓνℓν updated + ZZ→ ℓℓνν NEW with FULL 2011 data

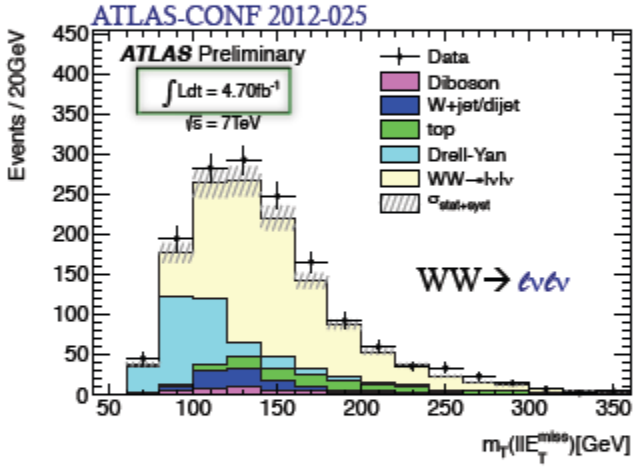
ATLAS-CONF 2012-026



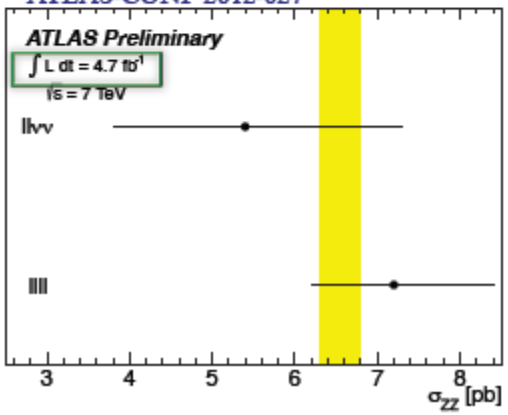
ATLAS-CONF 2012-027



ATLAS-CONF 2012-025



ATLAS-CONF 2012-027



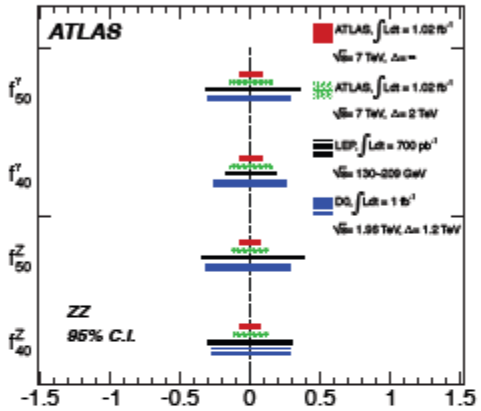
Results Compatible with each other and with SM expectations

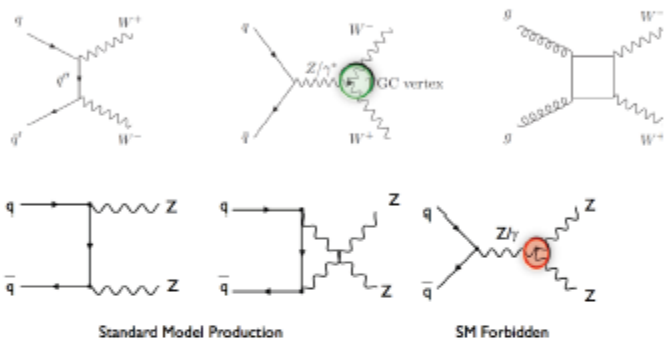
$\sigma^{TOT}(W^+W^-)=53.4\pm2.1_{stat}\ \pm4.5_{sys}\ \pm2.1_{lumi}$ pb

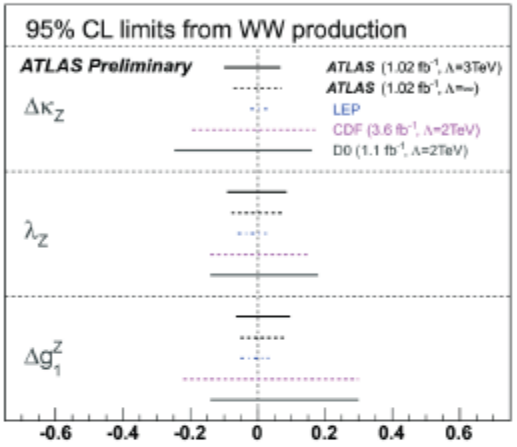
$\sigma^{SM}(W^+W^-)NLO=45.1\pm2.8$

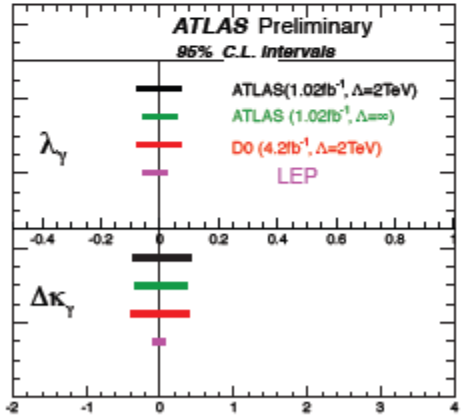
TGC limits

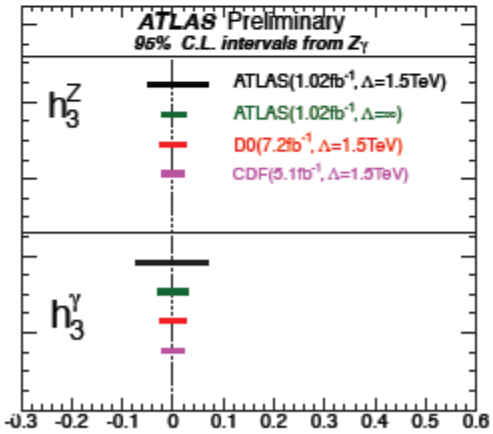
- **ZZ, WW, Zγ** and **Wγ** limits on deviation from SM on **Triple Gauge Coupling**

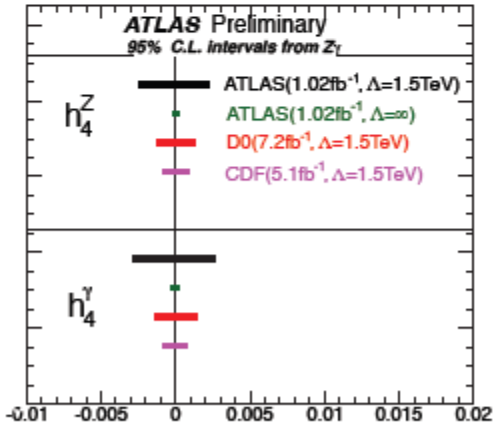












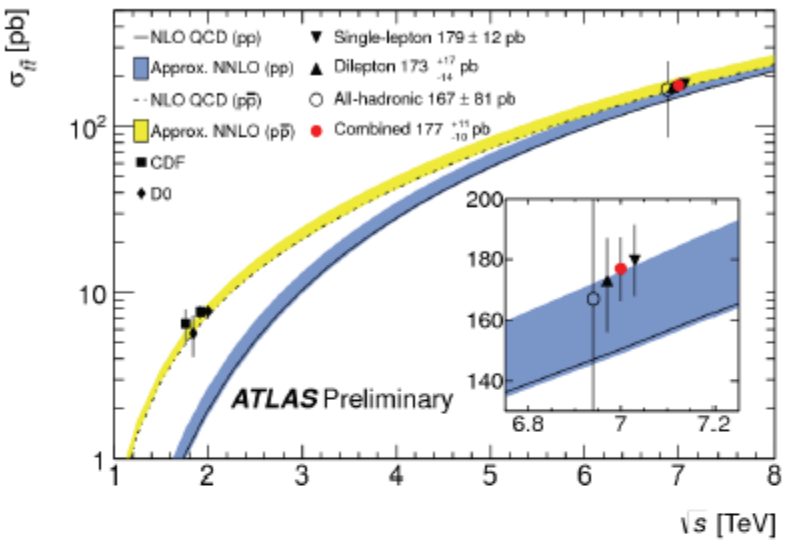
From exclusive high-$E_T(\gamma)$ fiducial measurements ($W\gamma$: $E_T(\gamma) > 100$ GeV; $Z\gamma$: $E_T(\gamma) > 60$ GeV)

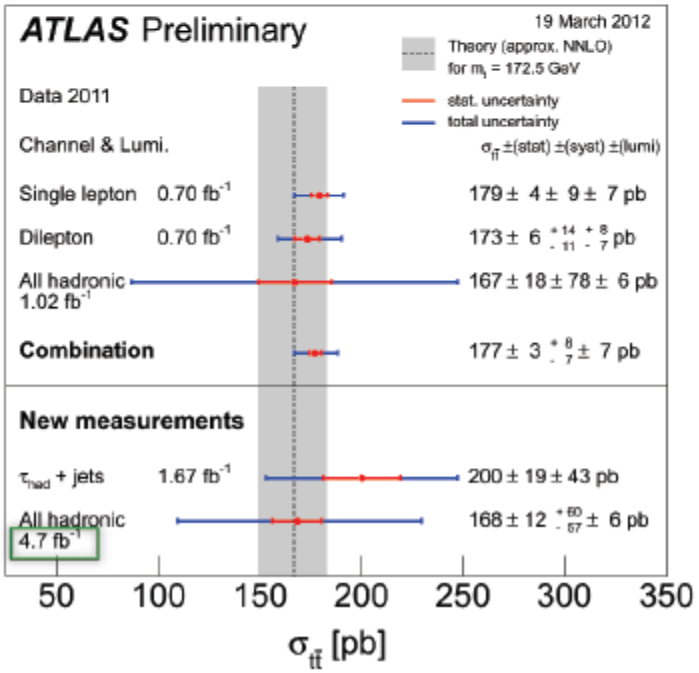
Top Cross section

- Cross section measurements: important test of perturbative QCD and important background for many searches
- A NEW combination performed with:
  - dilepton (NEW: arXiv:1202.4892), Single-lepton and All-hadronic channels
- Experimental precision **6%** → smaller than uncertainty of approx. NNLO theoretical predictions
- Measurements "systematic-limited": improvements require better understanding of detector performance, signal modeling, backgrounds
- NEW σ measurements in All-hadronic and τ

*Many more NEW Top results in backup: **Observation of spin correlations in ttbar events**, ISR/FSR measurement, top charge asymmetry, search for FCNC in single-top production, top mass update,..

ATLAS-CONF-2012-024



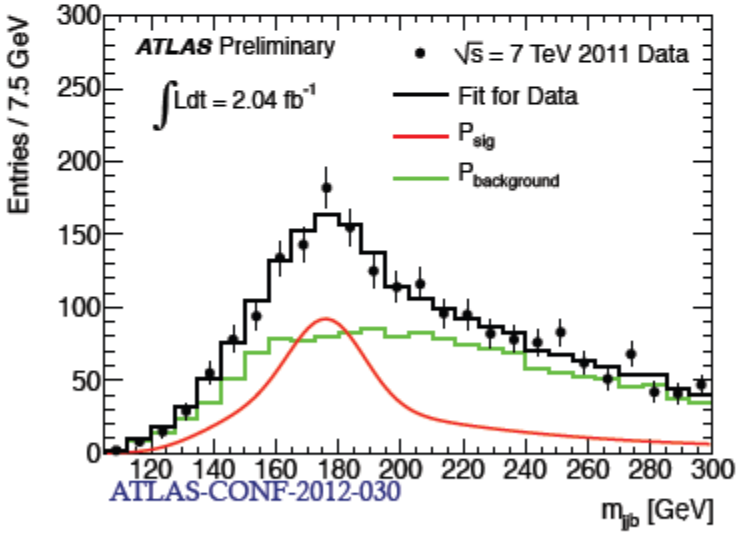


Top Mass

Top mass from template methods in top-pair lepton+jets and all-hadronic channel
Measurements already limited by systematic error

Fully hadronic channel:

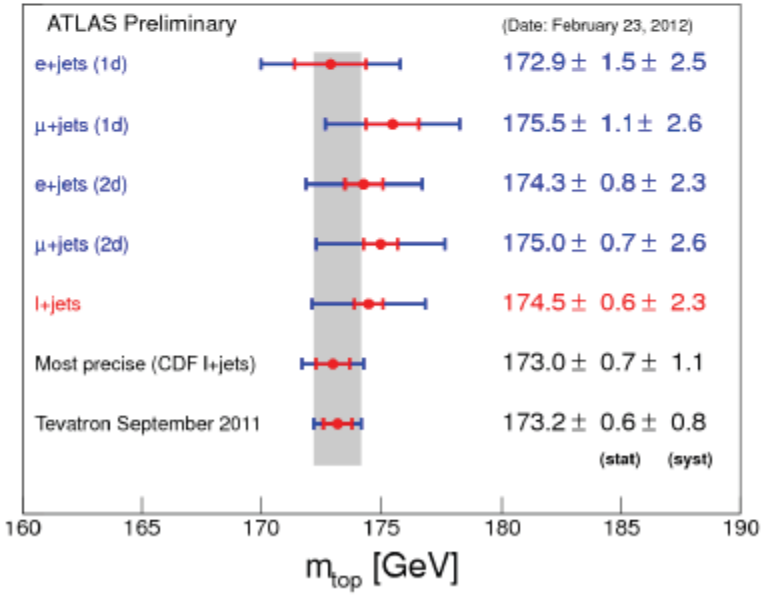
- 1D fit to m_{top}
- Use data-driven event-mixing technique to estimate multi-jet background



$m_t = 174.9 \pm 2.1\ (\text{stat.}) \pm 3.8\ (\text{syst.})\ \text{GeV}$

Lepton+jets channel:

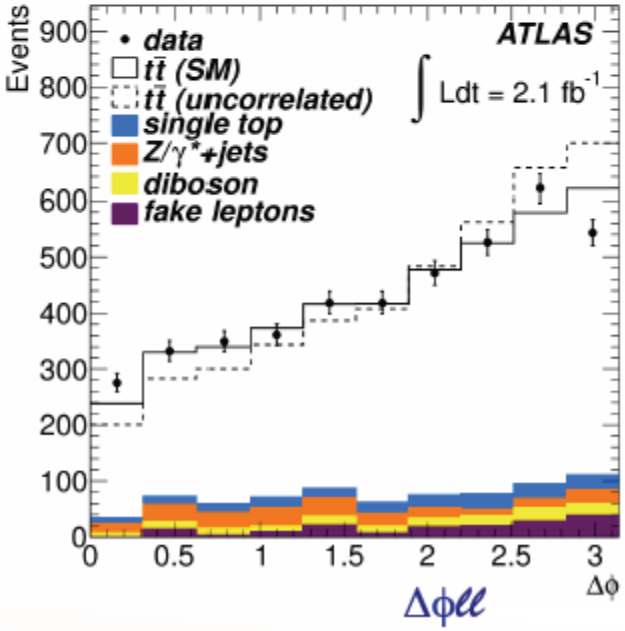
- 2D simultaneous fit to m_{top} and Jet-Energy-Scale
- Dominant systematics: bJet-Energy Scale, ISR/FSR



OBSERVATION OF SPIN CORRELATIONS IN TOP-PAIR PRODUCTION

- Spin information preserved due to quick top quark decay
- Di-lepton channel, measurement of $\Delta\phi$ between 2 leptons in lab frame
- Measured fraction of SM-like events f^{SM}
- Binned likelihood fit to two templates.

$$A = \frac{N(\uparrow\uparrow) + N(\downarrow\downarrow) - N(\uparrow\downarrow) - N(\downarrow\uparrow)}{N(\uparrow\uparrow) + N(\downarrow\downarrow) + N(\uparrow\downarrow) + N(\downarrow\uparrow)} \qquad A_{\text{basis}}^{\text{measured}} = A_{\text{basis}}^{\text{SM}} \cdot f^{\text{SM}}$$



$$f^{SM} = 1.30 \pm 0.14(stat)^{+0.27}_{-0.22}(syst) \quad \text{(SM: 1)}$$

$$A_{helicity} = 0.40 \pm 0.04(stat)^{+0.08}_{-0.07}(syst) \quad \text{(SM: 0.31)}$$

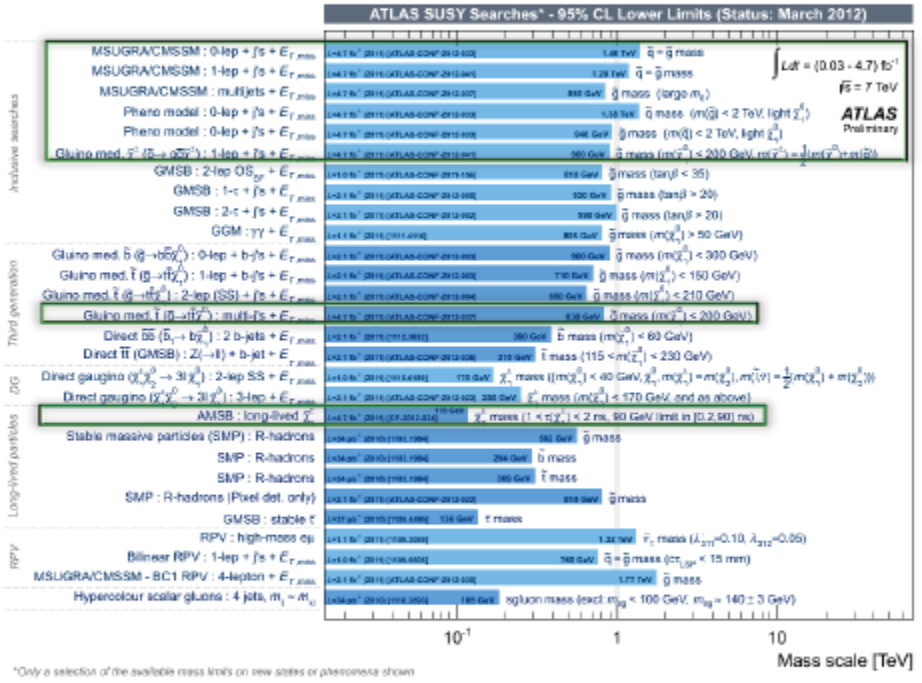
$$A_{\max} = 0.57 \pm 0.06(stat)^{+0.12}_{-0.10}(syst) \quad \text{(SM: 0.44)}$$

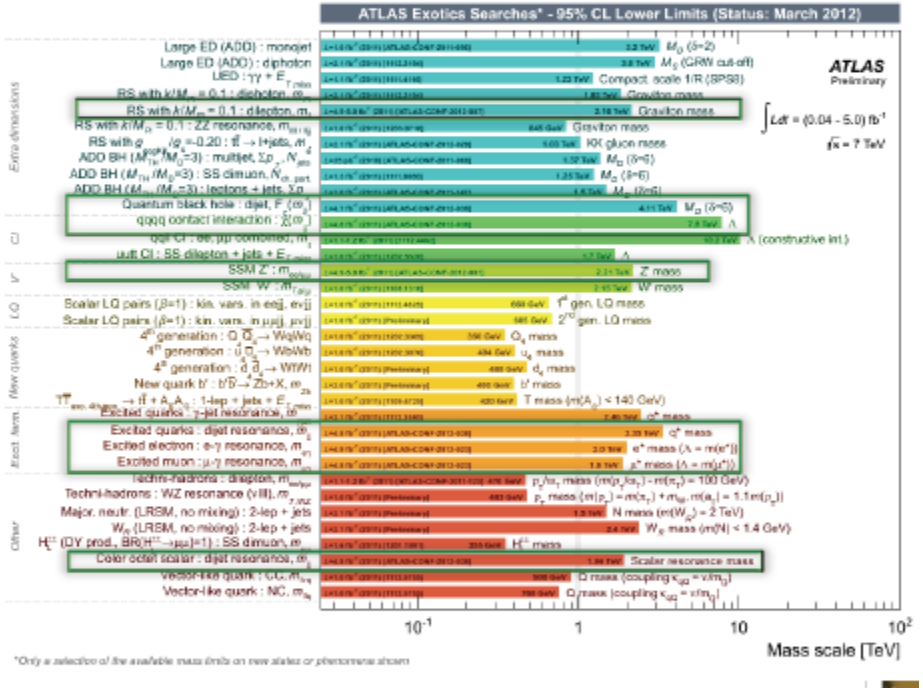
Data is inconsistent with the hypothesis of zero spin correlation with a significance of **5.1σ**

submitted to Phys. Rev. Lett. arXiv:1203.4081

SUSY + Exotics Searches Summary

Good Fraction of analyses updated with FULL 2011 Luminosity





Optimal use of delivered data: Enlarge range of "experimental topologies"

look at as many "experimental topologies" as possible

Then make happy our friend theorists:

translate results in constraints to large variety of models

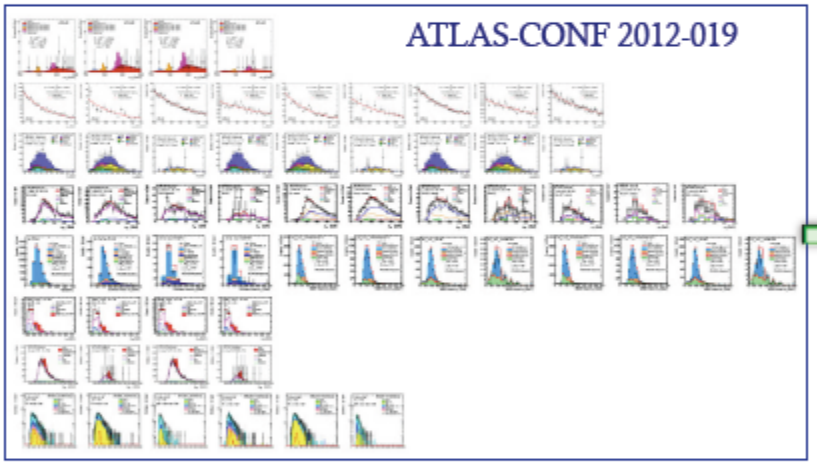
Search for the SM Higgs boson

- 12 search channels:
  - $\gamma\gamma$ and $ZZ \rightarrow 4\ell$ ~unchanged since December 2011 (published)
  - All others **updated** with **FULL 2011 available Luminosity**
- In the following show **NEW $H \rightarrow WW \rightarrow \ell\nu\ell\nu$** results and **updated COMBINATION**

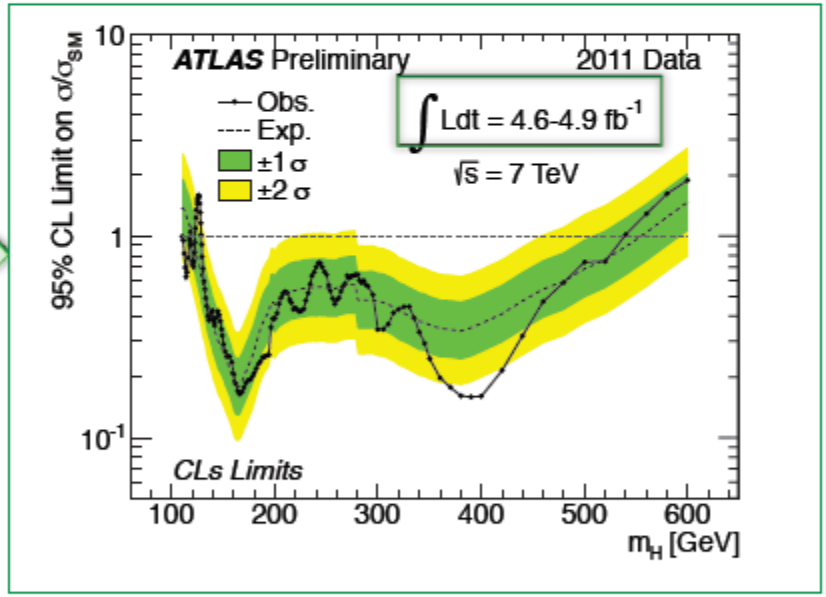
Channel	Mass range m_H (GeV)	Luminosity (fb^{-1})	Reference	
$H \rightarrow \gamma\gamma$	110-150	4.9	arXiv:1202.1414	Low Mass
$H \rightarrow ZZ^{(*)} \rightarrow 4l$	110-600	4.8	arXiv:1202.1415	Low Mass
$H \rightarrow WW^{(*)} \rightarrow l\nu l\nu$	110-600	4.7	CONF-2012-012	Low Mass
$H \rightarrow \tau\tau \rightarrow ll4\nu$ $H \rightarrow \tau\tau \rightarrow l\tau_{had}3\nu$ $H \rightarrow \tau\tau \rightarrow \tau_{had}\tau_{had}2\nu$	100-150	4.7	CONF-2012-014	Low Mass
$WH \rightarrow l\nu bb$ $ZH \rightarrow llbb$ $ZH \rightarrow \nu\nu bb$	110-130	4.7	CONF-2012-015	Low Mass
$H \rightarrow ZZ \rightarrow ll\nu\nu$	200-600	4.7	CONF-2012-016	High Mass
$H \rightarrow ZZ \rightarrow lljj$	200-600	4.7	CONF-2012-017	High Mass
$H \rightarrow WW \rightarrow l\nu jj$	300-600	4.7	CONF-2012-018	High Mass

New SM Higgs combination

- All 12 channels updated with FULL 2011 luminosity in NEW combination
- Used Profile Likelihood test statistics with CLs method and asymptotic approximation (cross checked with "ensemble test" and "Bayes")



95% CL σ Exclusion (normalized to SM σ)

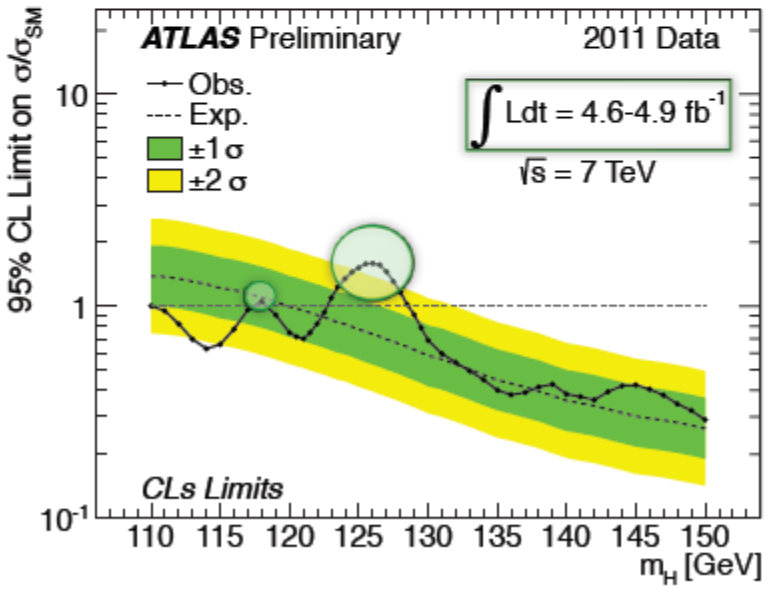


- Expected exclusion @ 95%CL **[120-555] GeV**
- Observed exclusion @ 95%CL [110-117.5] – [118.5-122.5] – [129-539] GeV
- **NOT-Excluded** @ 95%CL [117.5-118.5] - [122.5-129] - [539 GeV-..]

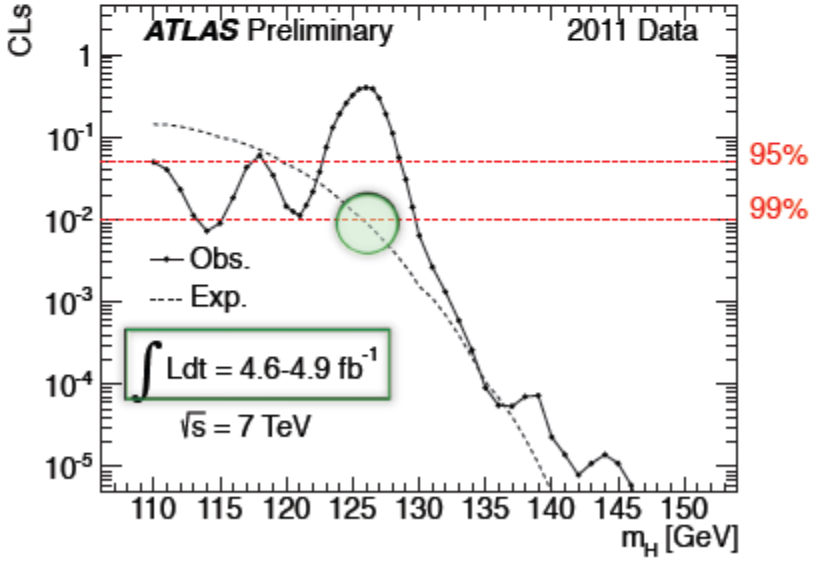
Zoom in "LOW" mass region

- Zoom in Low Mass region:
  - Tiny NOT-excluded region [117.5-118.5] GeV - Small fluctuation ("deficit") below 117 GeV (mainly $\gamma\gamma$ but also $\tau\tau$ contributes)
  - "excess" around 126 GeV does not allow exclusion in **[122.5-129] GeV**
  - **99% CL Exclusions**: Observed [130-486] GeV – Expected [**126**-503]

95% CL Exclusion (normalized to SM σ)



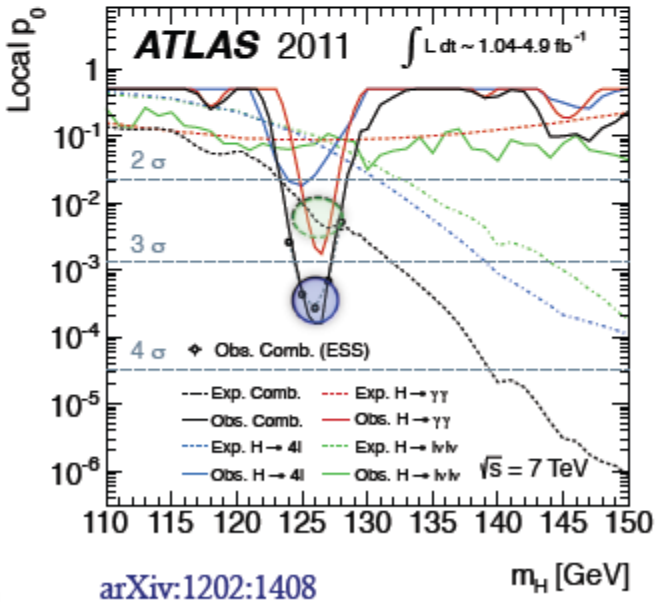
Compatibility with signal+background hypothesis



Closer look to the "excess"

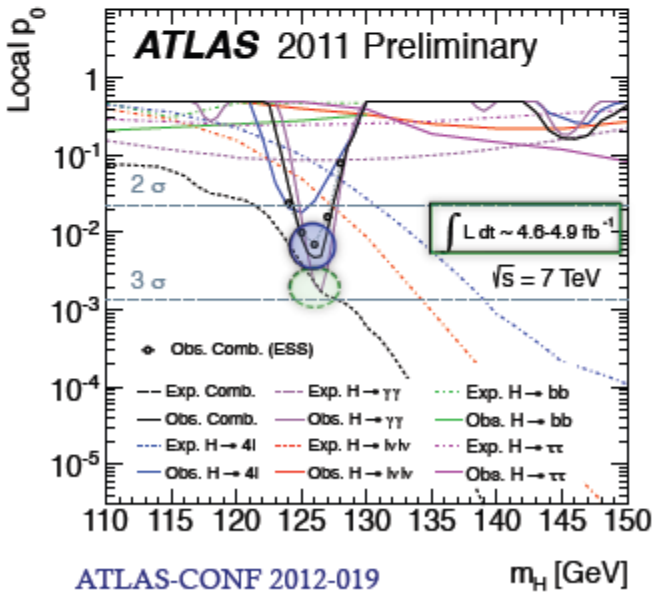
- *Published* results Local P_0 @126 GeV
  - $\gamma\gamma$ 2.8 (1.4) σ
  - $ZZ^* \rightarrow 4\ell$ 2.1 (1.4) σ
  - **$WW^* \rightarrow 2\ell 2\nu$ 1.4 (1.4) σ (2.1 fb^{-1})**
  - Comb **Observed (Expected) 3.5 (2.4)σ**

- NEW results Local P_0 @ 126 GeV
  - $\gamma\gamma$ 2.8 (1.4) σ
  - $ZZ^* \rightarrow 4\ell$ 2.1 (1.4) σ
  - **$WW^* \rightarrow 2\ell 2\nu$ 0.2 (1.6) σ (4.7 fb^{-1})**
  - … + $\tau\tau$ and bb final states
  - Comb **Observed (Expected) 2.5 (2.9)σ**



arXiv:1202:1408

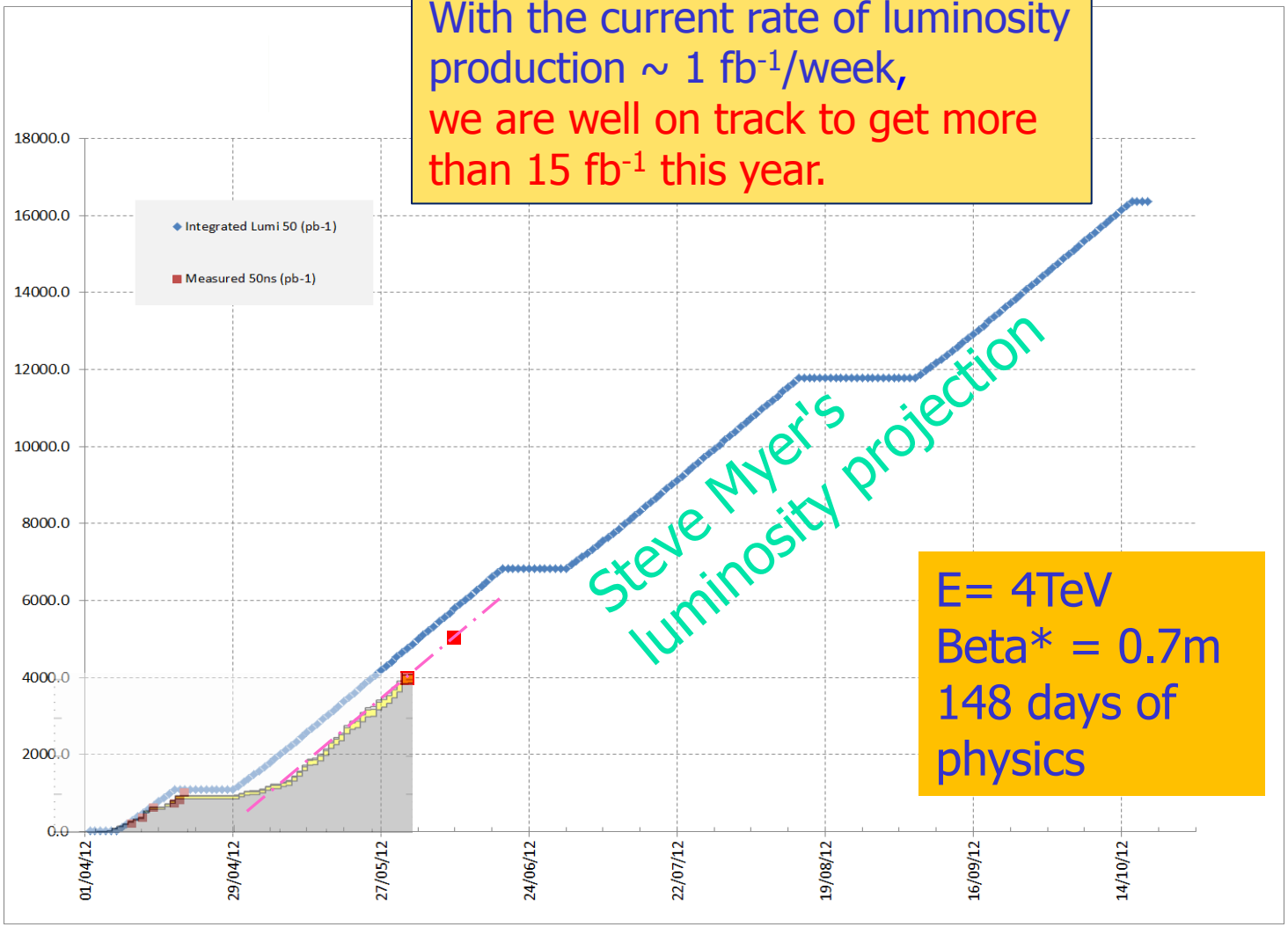
P_0 compatibility with bkg-Only hypothesis



ATLAS-CONF 2012-019

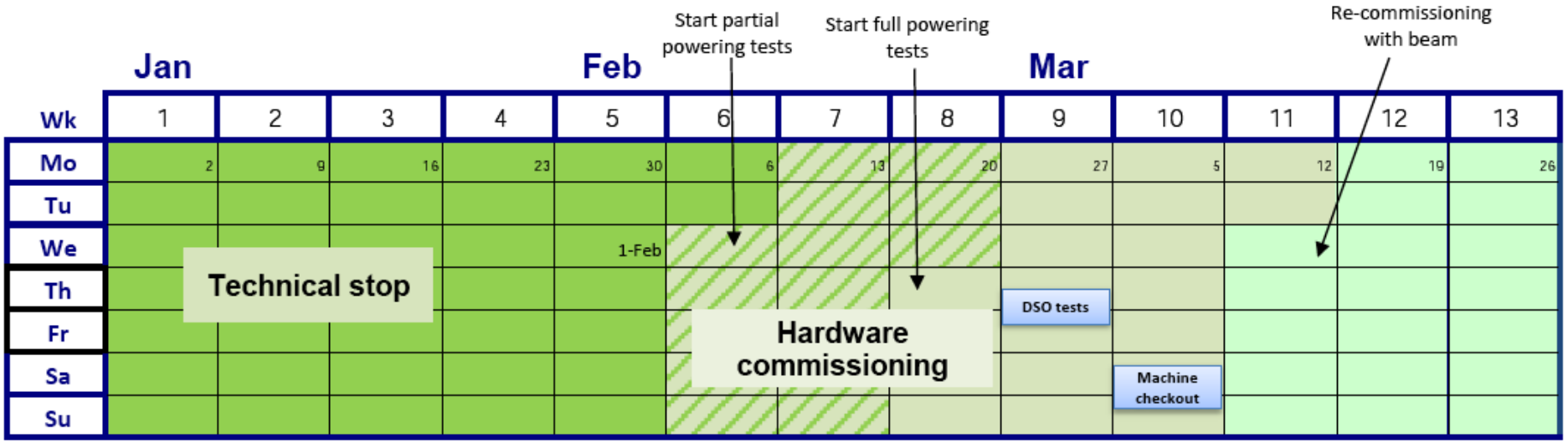
2012 Measured vs Predicted Integrated Luminosity

With the current rate of luminosity production ~ 1 fb^{-1}/week,
we are well on track to get more than 15 fb^{-1} this year.



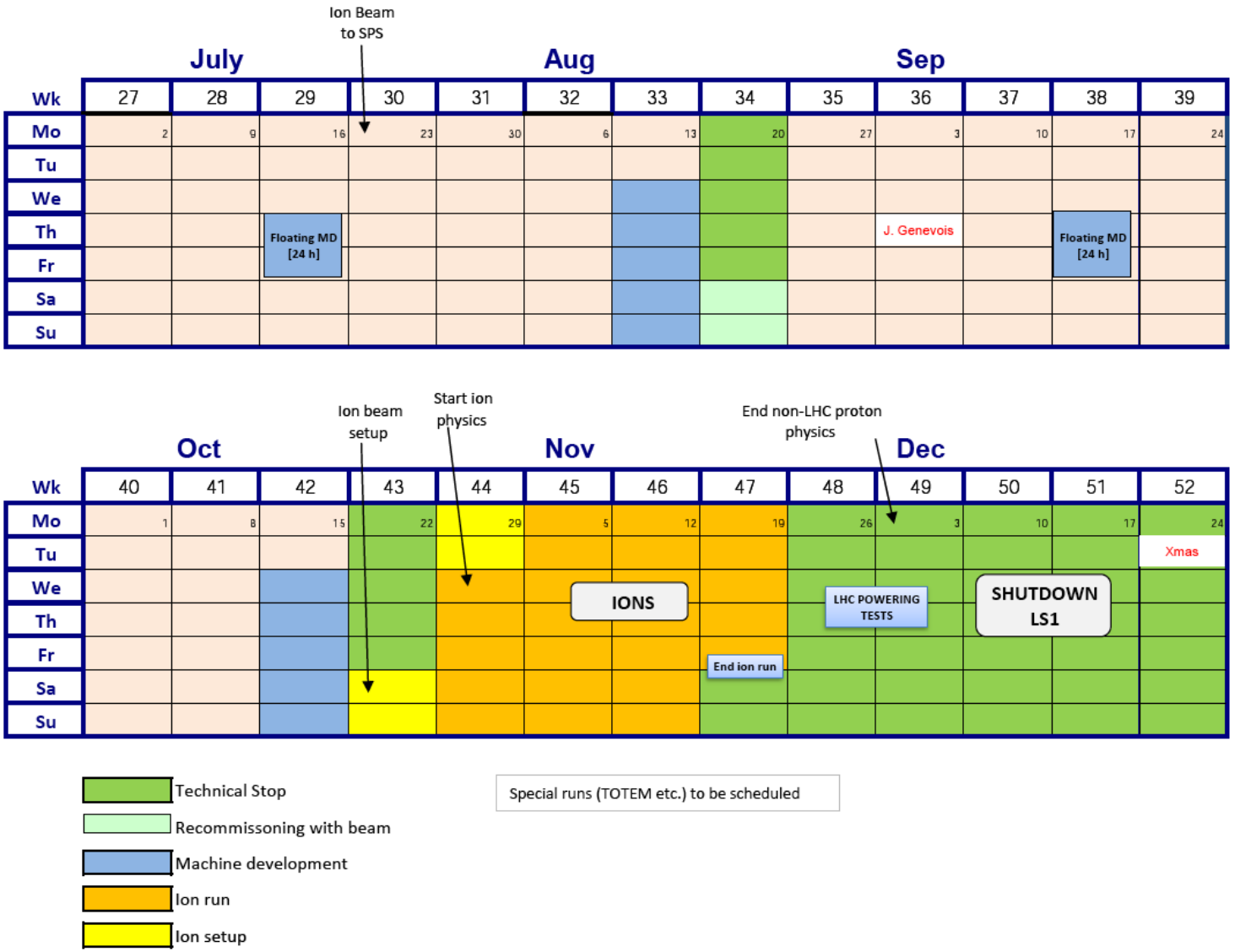
E= 4TeV
Beta* = 0.7m
148 days of physics

2012


Start partial powering tests
Start full powering tests
Re-commissioning with beam
Jan
Feb
Mar
Wk
1
2
3
4
5
6
7
8
9
10
11
12
13
Mo
Tu
We
Th
Fr
Sa
Su
2
9
16
23
30
6
13
20
27
5
12
19
26
1-Feb
Technical stop
Hardware commissioning
DSO tests
Machine checkout


Scrubbing run (date tbc)
Apr
May
June
Wk
14
15
16
17
18
19
20
21
22
23
24
25
26
Mo
Tu
We
Th
Fr
Sa
Su
2
Easter
9
16
23
30
7
14
21
Whit
28
4
11
18
25
1st May
Ascension
G. Friday
MD

2012 LHC schedule Q3/Q4



LHC Schedule Assumptions