Основные результаты эксперимента ATLAS в 2011 году

Научная сессия ученого совета ОФВЭ ПИЯФ

27-30 декабря 2011 года

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- Status of the ATLAS detector
- Summary of main electroweak and top cross-section measurements
- New exotic physics search result summary
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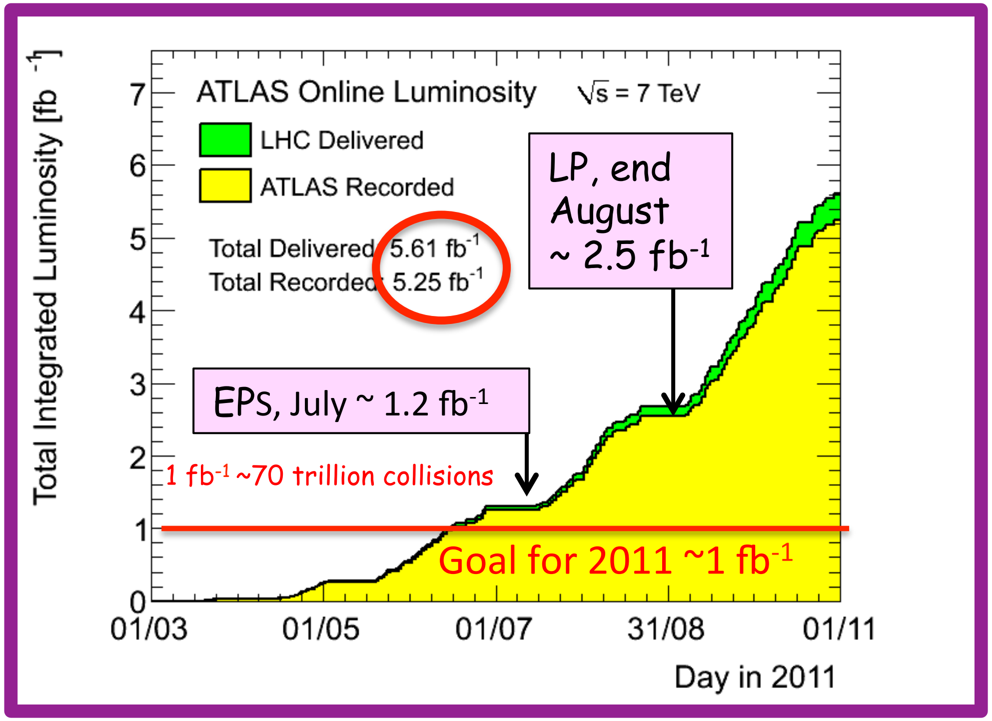
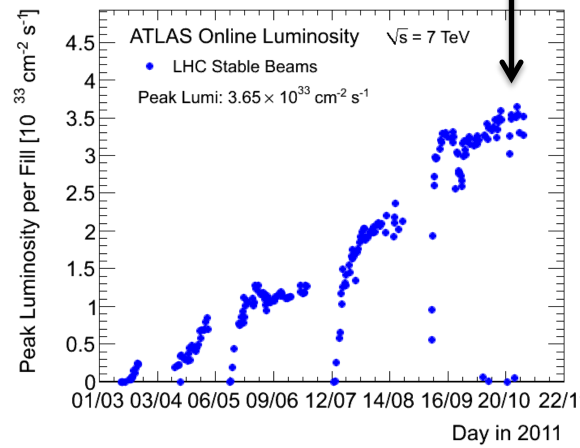
p-p integrated luminosity vs time



Peak luminosity seen by ATLAS: ~ 3.6 x10^{33} cm^{-2} s^{-1}

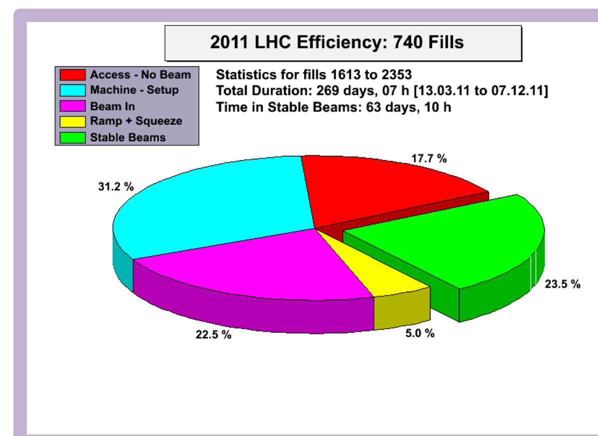


Time in stable beam 63 days out of 269 days of LHC works (23.5%)

LHC records in 2011 (in brackets design LHC values)

- Maximum luminosity delivered in one fill 122.44 pb^{-1}
- Maximum luminosity delivered in one day 135.45 pb^{-1}
- Maximum colliding bunches 1854 (2808)
- Maximum bunch population 1.9 10^{11} (1.9 10^{11})
- Bunch spacing 50(25) ns
- Maximum peak events per bunch crossing 33.96
- Longest time in stable beam 26 hours

For more LHC records see back up slides..



Detectors and triggers operation

Fraction of non-operational detector channels: (depends on the sub-detector)	few permil to 3.5%
Data-taking efficiency = (recorded lumi)/(delivered lumi):	~ 93.5%
Good-quality data fraction, used for analysis : (depends on the analysis)	90-96%

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

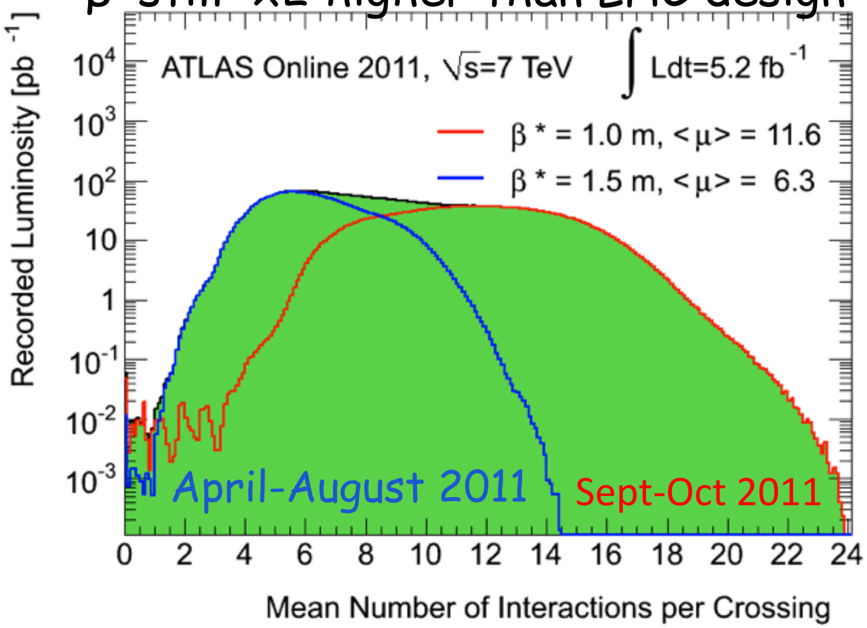
Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in pp collisions at √s=7 TeV between March 13th and October 30th (in %), after the summer 2011 reprocessing campaign

Level 1			High Level Trigger						
Muon	Calo	CTP	electron	photon	muon	tau	jet	b-jet	missing E_T
100	100	100	100	100	100	99.5	97.3	99.5	100

Luminosity weighted relative trigger quality delivery during 2011 stable beams in pp collisions at √s=7 TeV between March 13th and June 29th (in %).

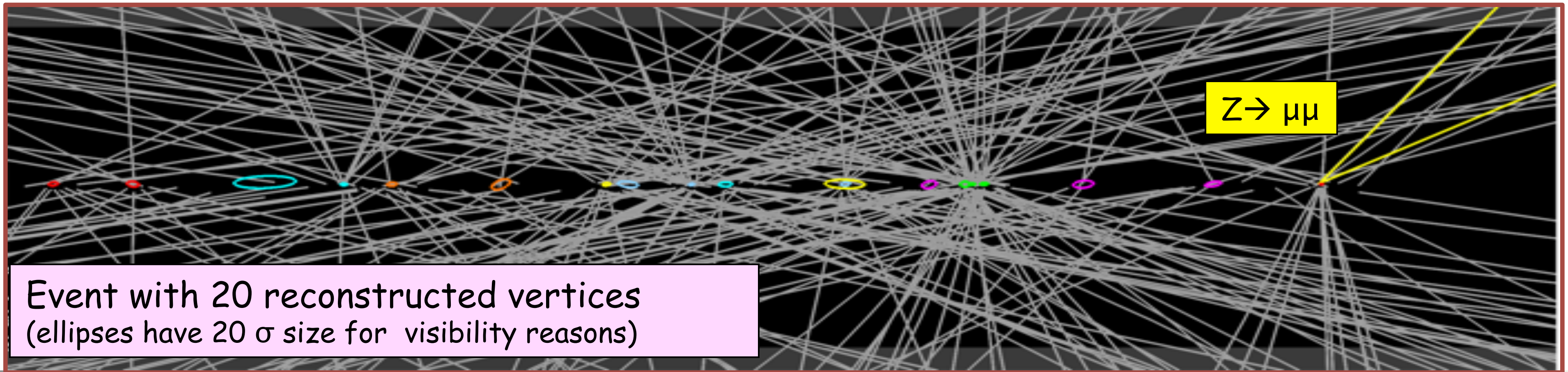
The challenge of pile-up

β*still~x2 higher than LHC design



Price to pay for the high luminosity: larger-than-expected pile-up

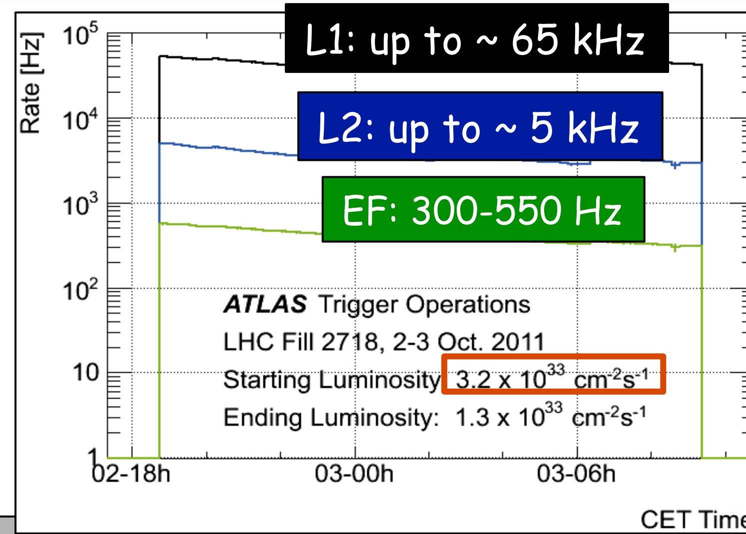
- Pile-up:
  - Number of simultaneous interactions per crossing;
  - Challenging for trigger, computing resources, reconstruction of physics objects (in particular E_T^{miss}, soft jets, ..) Precise modeling of both in-time and out-of-time pile-up in simulation is essential ;
- Result in 2011:
  - pile-up larger than expected at this early stage

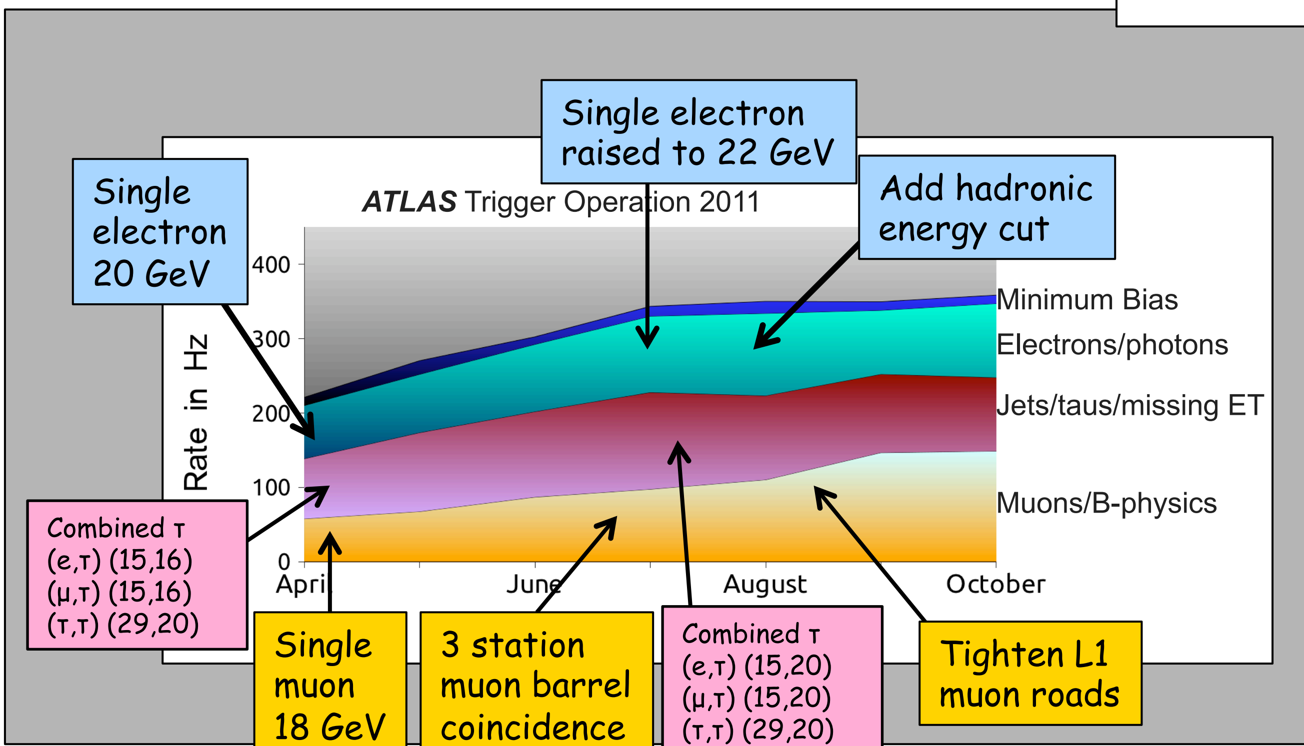


Event with 20 reconstructed vertices
(ellipses have 20 σ size for visibility reasons)

Trigger

- Coping very well with rapidly-increasing luminosity (factor ~10 over 2011) and pile-up by adapting prescales, thresholds, menu.
- Strive to maximise physics (e.g. keeping low thresholds for inclusive leptons)
- Main menu complemented by set of calibration/support triggers: e.g. special $J/\psi \rightarrow ee$ stream (few Hz) for unbiased low-p_T electron studies



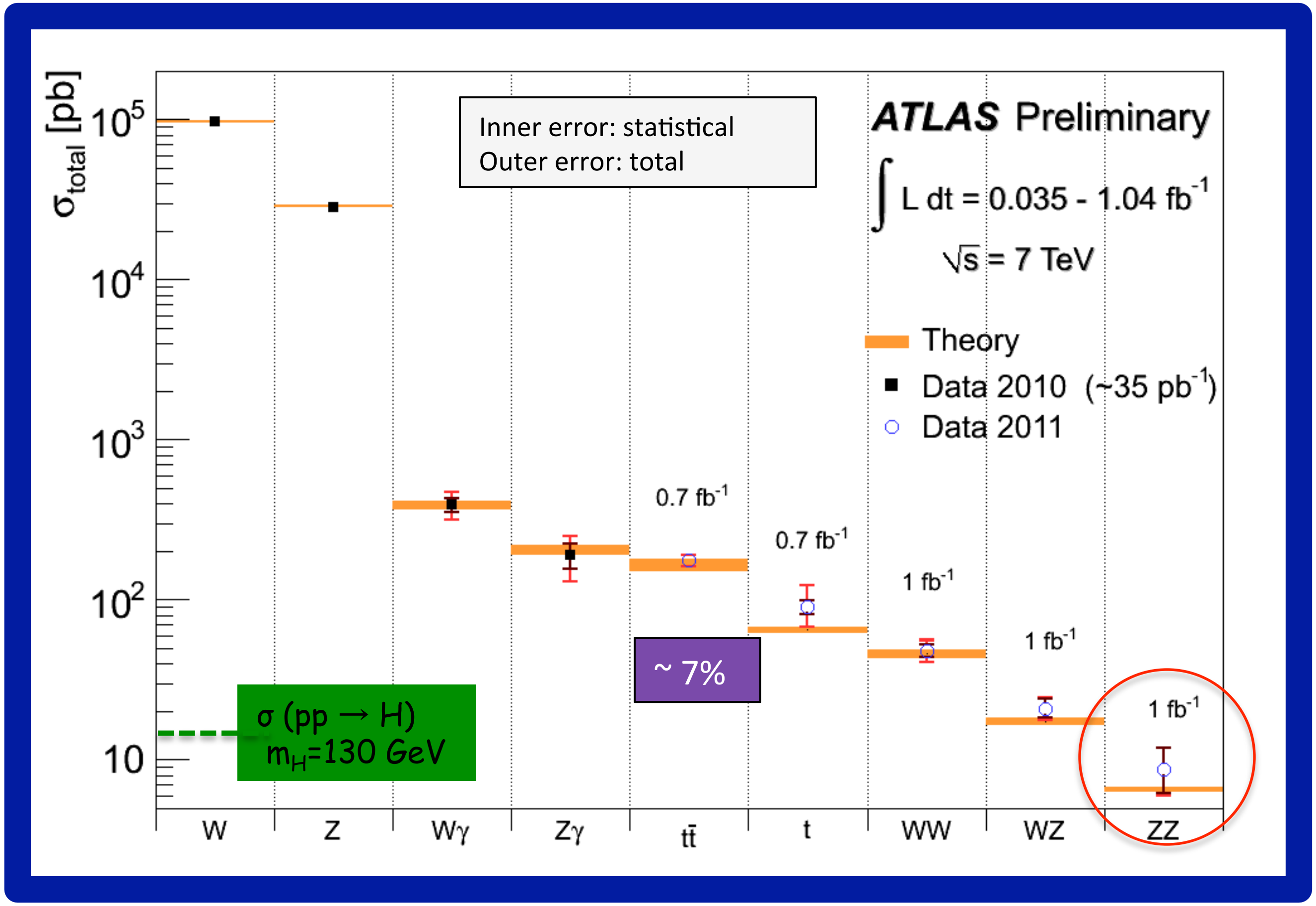


Typical recorded rates for main streams:

e/γ	~ 100 Hz
Jets/τ/E_T^{miss}	~ 100 Hz
Muons	~ 150 Hz

Managed to keep inclusive lepton thresholds ~ stable during 2011

Production cross-sections of physics processes background to searches



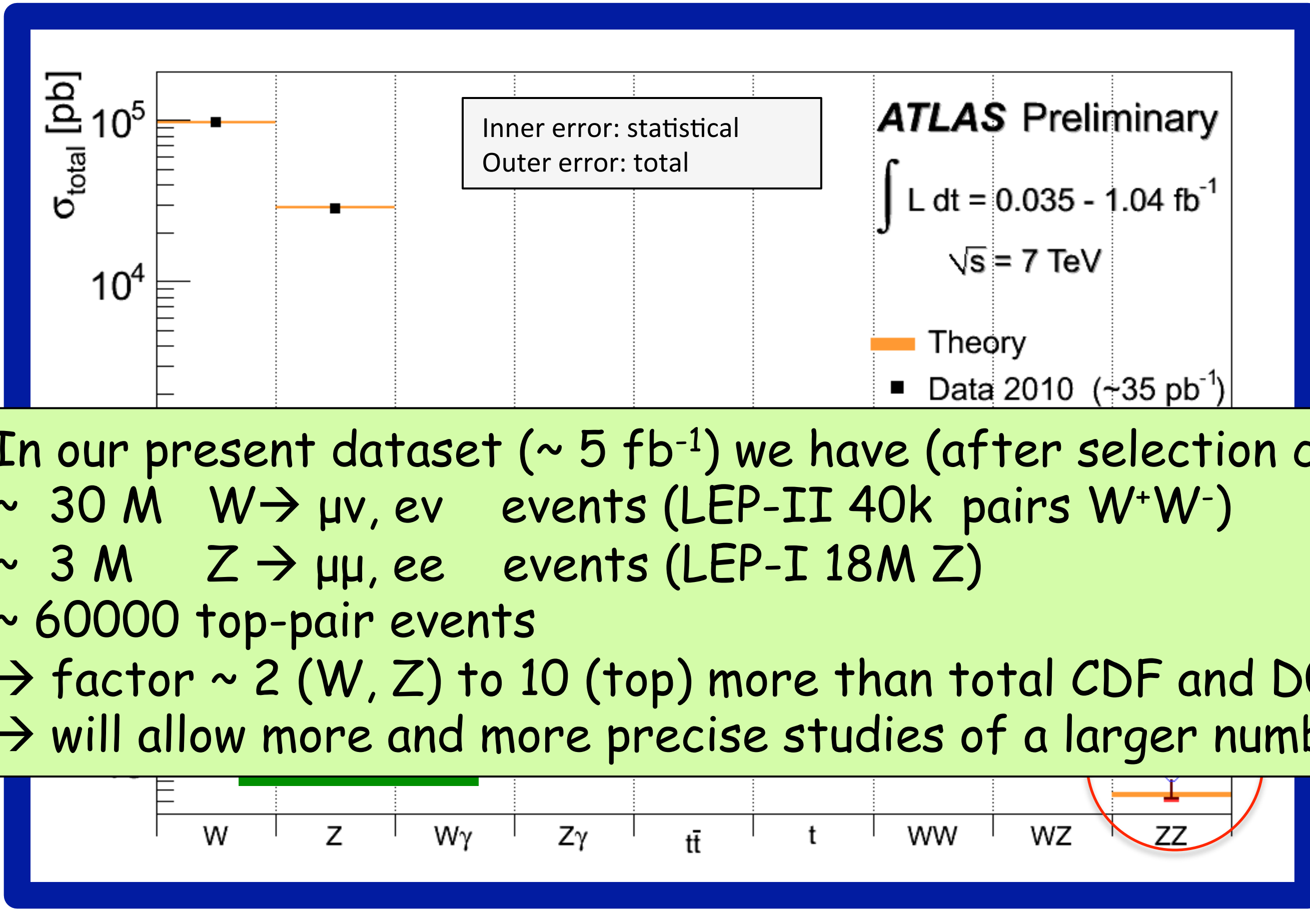
σxBR(ZZ→ 4l) ~ 40 fb
Few fb in narrow mass bin → comparable to H→ZZ$^{(*)}$→ 4l

Good agreement with SM expectations (within present uncertainties)

Experimental precision starts to challenge theory for e.g. tt (background to most H searches)

Measuring cross-sections down to few pb (~ 40 fb including leptonic branching ratios)

Production cross-sections of physics processes background to searches



In our present dataset (~ 5 fb^{-1}) we have (after selection cuts):

~ 30 M W→ μν, eν events (LEP-II 40k pairs W^+W^-)

~ 3 M Z → μμ, ee events (LEP-I 18M Z)

~ 60000 top-pair events

→ factor ~ 2 (W, Z) to 10 (top) more than total CDF and D0 datasets

→ will allow more and more precise studies of a larger number of (exclusive) process

to H→ZZ$^{(*)}$→ 4l

Good agreement with SM expectations (within present uncertainties)

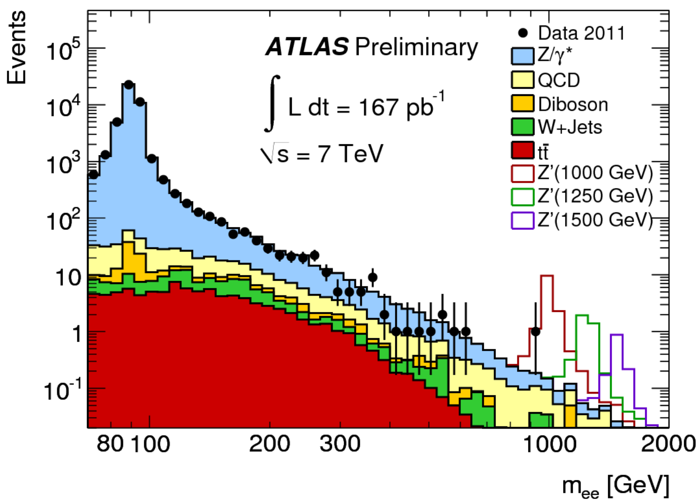
Experimental precision starts to challenge theory for e.g. tt (background to most H searches)

Measuring cross-sections down to few pb (~ 40 fb including leptonic branching ratios)

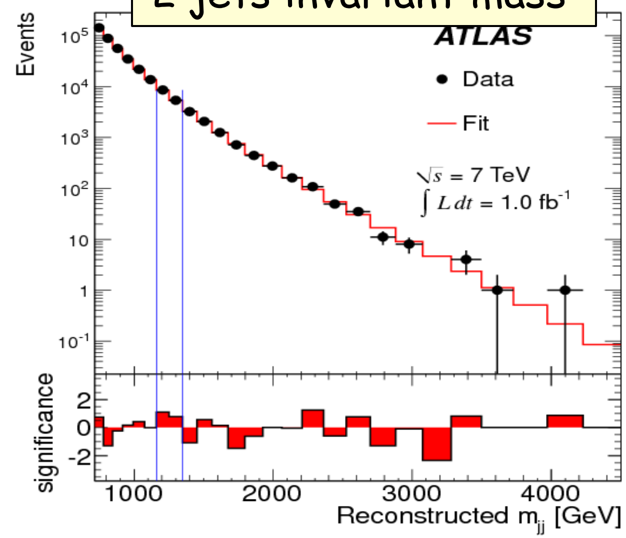
Search for heavy new particles – resonances

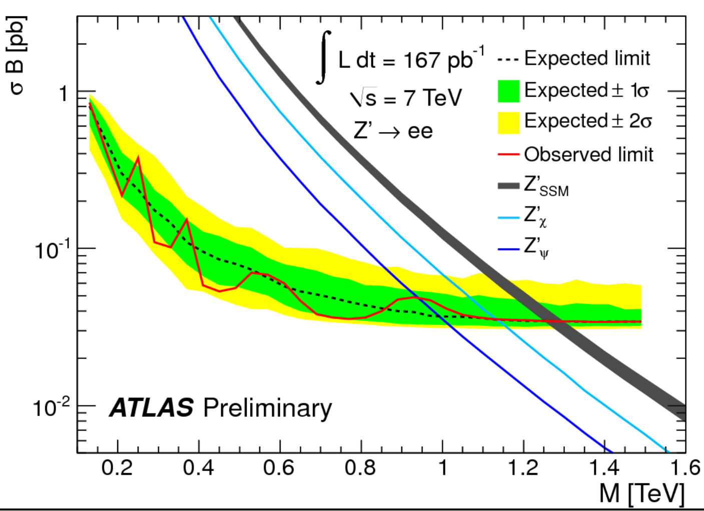
Search for peaks in different spectra - reached very high masses: ~ 4 TeV (m_{jj}) and 1 TeV (m_{ee})

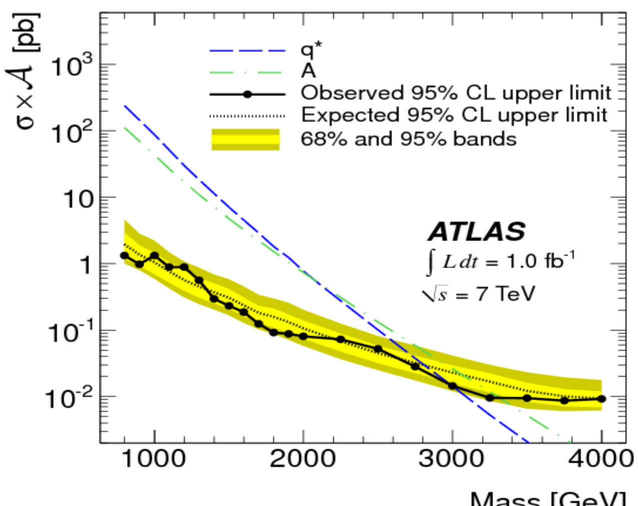
2 electrons invariant mass



2 jets invariant mass

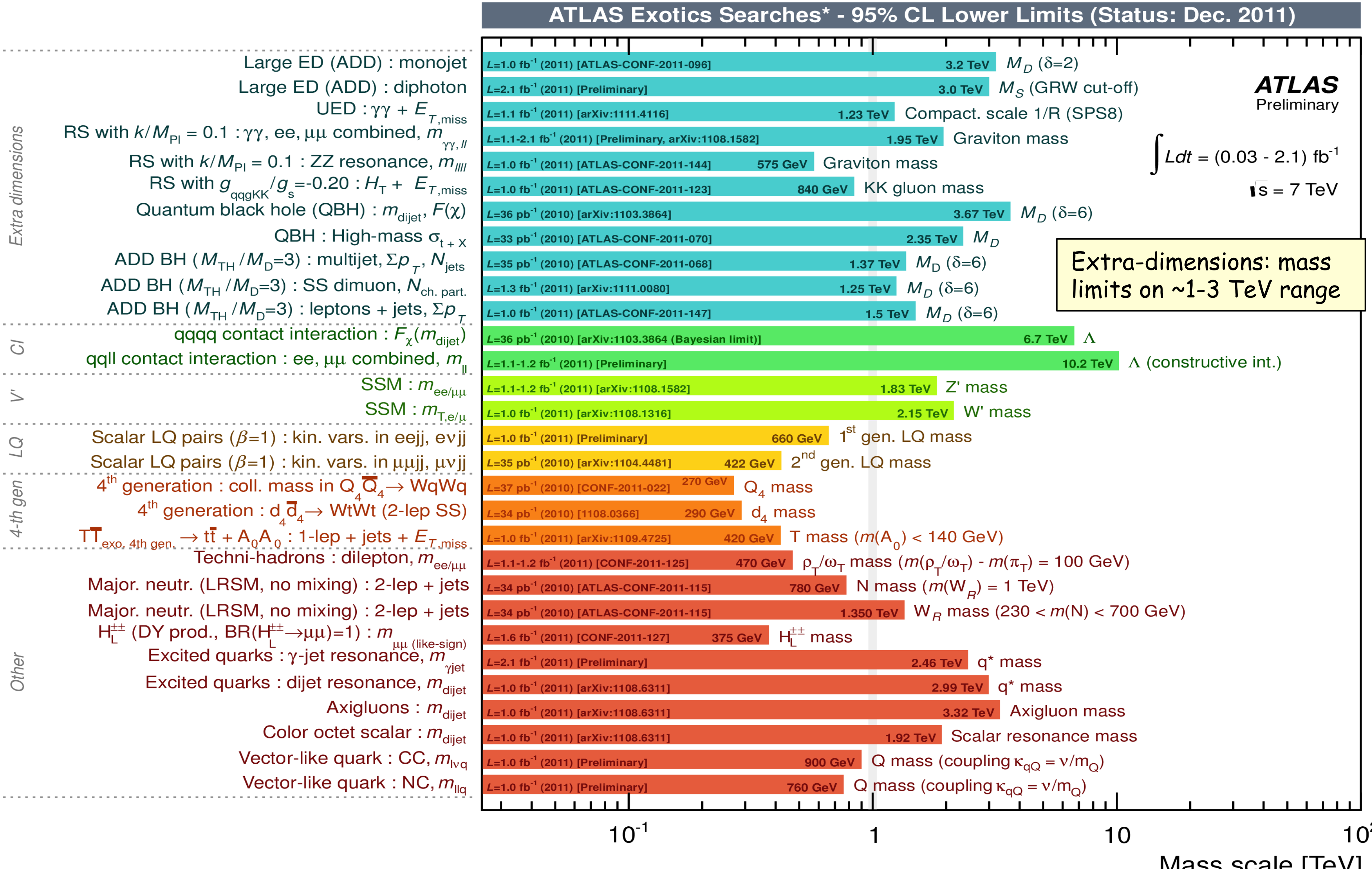






This allows to put more stringent lower mass limits to heavy new particles

New exotic physics search result summary

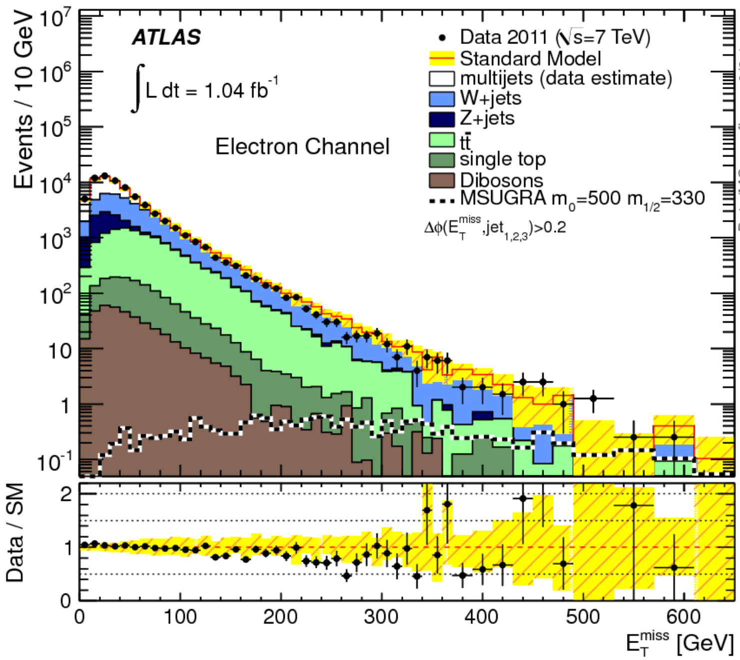


Extra-dimensions: mass limits on ~1-3 TeV range

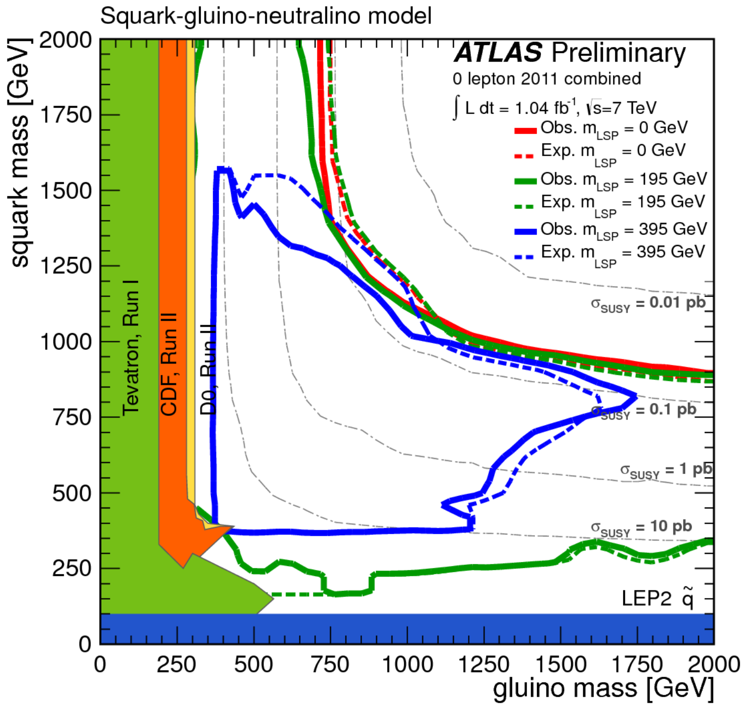
*Only a selection of the available results leading to mass limits shown

SUSY search results

- Searching for SUSY:
  - Sum all energy in the detector
  - Compute the energy balance in the plane transverse to the beam axis (ETmiss)
  - Might be due to neutrinos (known that mostly don't interact) or maybe SUSY
- ETmiss distribution well described within 5 orders of magnitude:
  - Very good understanding of the detector !

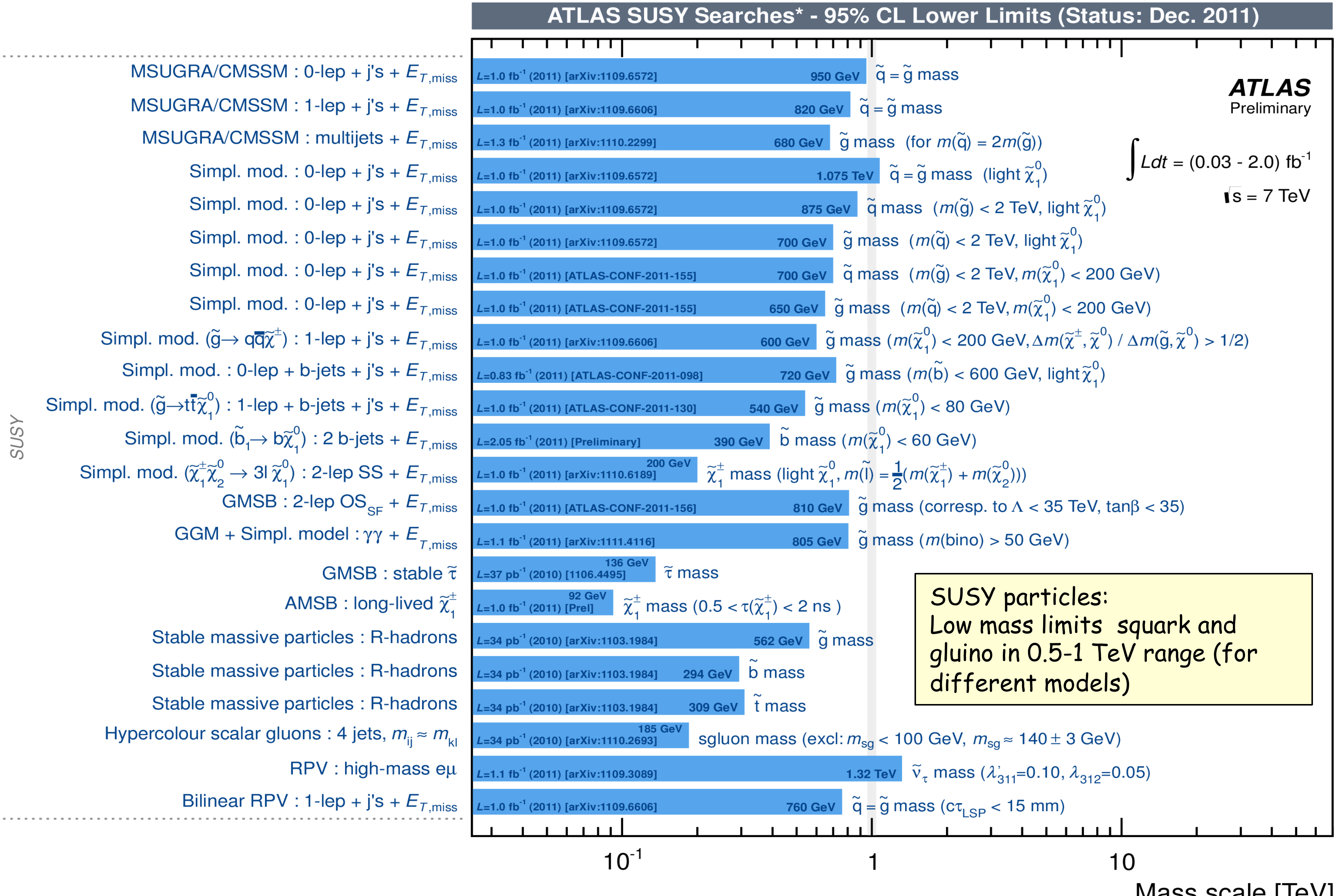


- Limits on different SUSY particle masses are extracted
- Plot of the exclusion region for squark and gluino masses



lightest supersymmetric particle (LSP)

SUSY search result summary



*Only a selection of the available results leading to mass limits shown

Standard Model Higgs searches in ATLAS

Higgs searches have guided the conception, design and technological choices of ATLAS and CMS:

- perhaps the primary LHC goal
- among the most challenging processes

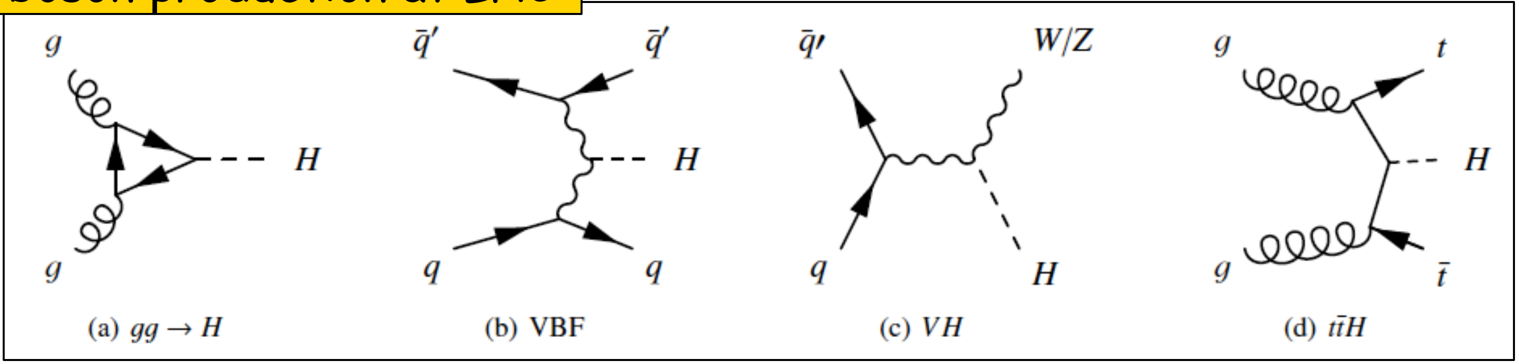
→ have set some of the most stringent performance (hence technical) requirements: lepton identification, lepton energy/momentum resolution, b-tagging, E_T^{miss} measurement, forward-jet tagging, etc.

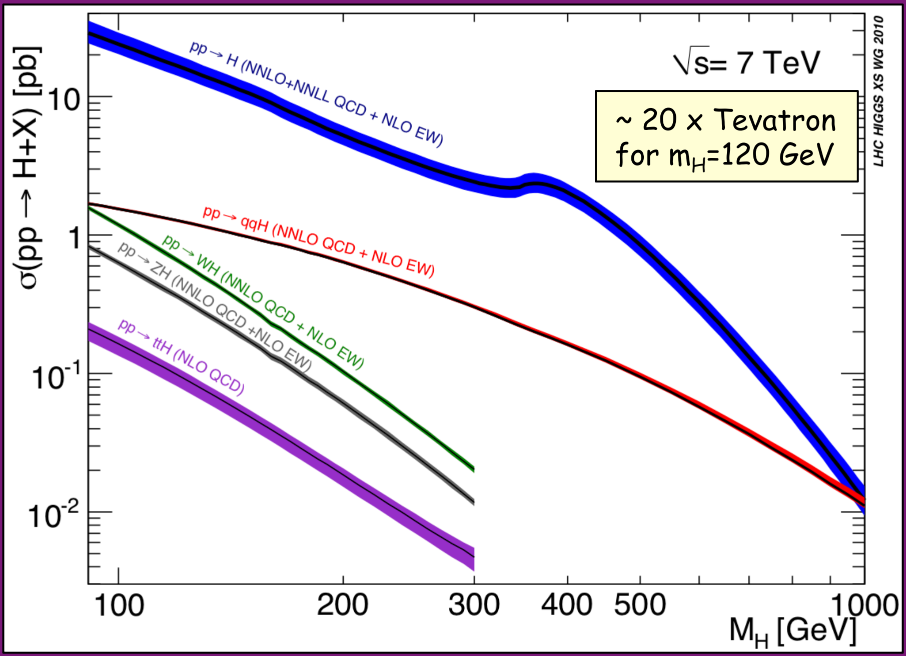
After 2 years of LHC operation, ATLAS has achieved excellent sensitivity over a large part of the allowed mass range, thanks to:

- outstanding LHC performance → > 5 fb^{-1}
- high detector operational efficiency and data quality
- excellent detector performance; mature understanding reflected in detailed modeling of several subtle effects included in the simulation
- huge numbers of physics results produced with the 2010-2011 data → the main SM processes and many backgrounds to Higgs searches studied in detail (and compared to theory)

SM Higgs production cross-section and decay modes

Higgs boson production at LHC





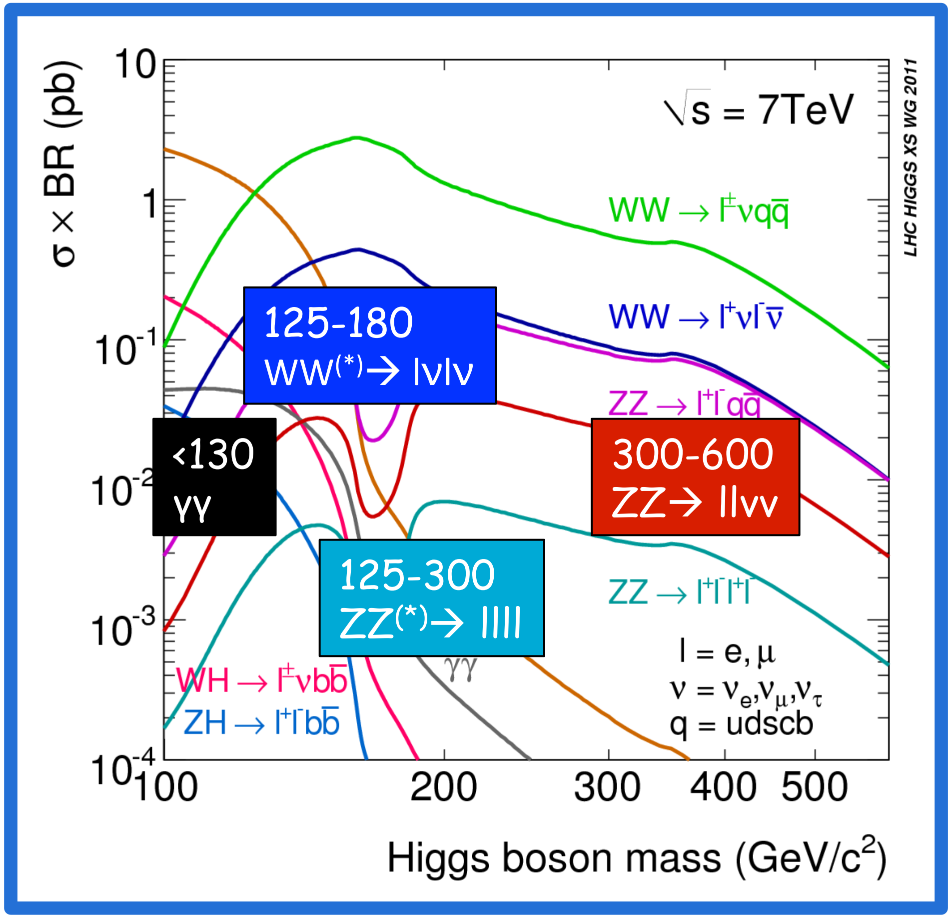
- Gluon fusion: Dominant process at LHC, but the cross-section theoretical uncertainty is at the 15% level (NNLO+NNLL)
- VBF: process known at the 5% N (NLO). Forwards jets and a rapidity gap
- Associated W,Z production: known at (N)NLO at 5%
- Associated ttbar production: known at NLO (15%)

- ❑ Cross-sections computed to NNLO in most cases → theory uncertainties reduced to < 20%
- ❑ Huge progress also in the theoretical predictions of numerous and complex backgrounds

SM Higgs decay modes

H→ZZ→llll	golden channel
H→ZZ→llνν/llbb	good @ high mass
H→WW→lνlν	most sensitive
H→WW→lνqq	highest rate
H→γγ	rare but good @ low mass
H→ττ	good s/b, rare, but good @ low mass
H→bb (ttH,WH/ZH)	useful but difficult due to large backgrounds

Experimentally most sensitive channels vs m_H



Summary of present Higgs searches in ATLAS

Channel	m_H range (GeV)	Int. lumi fb^{-1}	Main backgrounds	Number of signal events after cuts	S/B after cuts	Expected σ/σ_{SM} sensitivity
$H \to \gamma\gamma$	110-150	4.9	$\gamma\gamma$, γj, jj	~70	~0.02	1.6-2
$H \to \tau\tau \to ll+\nu$	110-140	1.1	$Z \to \tau\tau$, top	~0.8	~0.02	30-60
$H \to \tau\tau \to l\tau_{had}$	100-150	1.1	$Z \to \tau\tau$	~10	~5 10^{-3}	10-25
$W/ZH \to bbl(l)$	110-130	1.1	W/Z+jets, top	~6	~5 10^{-3}	15-25
$H \to WW^{(*)} \to l\nu l\nu$	110-300	2.1	WW, top, Z+jet	~20 (130 GeV)	~0.3	0.3-8
$H \to ZZ^{(*)} \to 4l$	110-600	4.8	ZZ*, top, Zbb	~2.5 (130 GeV)	~1.5	0.7-10
$H \to ZZ \to ll\,\nu\nu$	200-600	2.1	ZZ, top, Z+jets	~20 (400 GeV)	~0.3	0.8-4
$H \to ZZ \to ll\,qq$	200-600	2.1	Z+jets, top	2-20 (400 GeV)	0.05-0.5	2-6
$H \to WW \to l\nu qq$	240-600	1.1	W+jets,top,jets	~45 (400 GeV)	10^{-3}	5-10

- Based on (conservative) cut-based selections
- Large and sometimes not well-known backgrounds estimated mostly with data-driven techniques using signal-free control regions

$H \rightarrow WW^{(*)} \rightarrow l\nu l\nu$ (evev, μνμν, evμν)

110 < m_H < 300 GeV

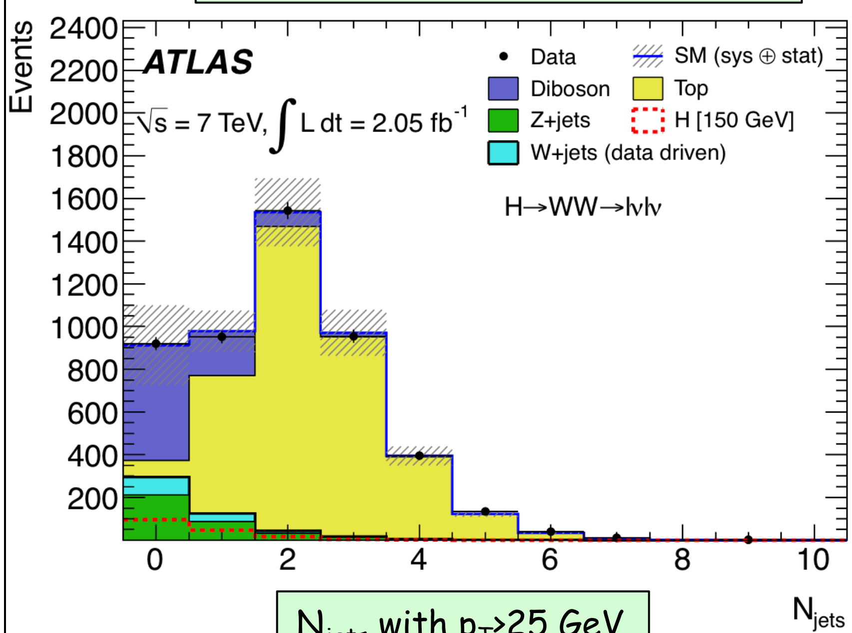
- Most sensitive channel over ~ 125-180 GeV (σ ~ 200 fb, S/B~0.3)
- However: challenging: 2ν → no mass reconstruction/peak → "counting channel"
- 2 isolated opposite-sign leptons, large E_T^{miss}
- Main backgrounds: WW, top, Z+jets, W+jets
  - → $m_{ll} \neq m_Z$, b-jet veto, …
  - → Topological cuts against "irreducible" WW background: p_{Tll}, m_{ll}, $\Delta\phi_{ll}$ (smaller for scalar Higgs), m_T (ll, E_T^{miss})

Crucial experimental aspects:
- understanding of E_T^{miss} (genuine and fake)
- excellent understanding of background in signal region → use signal-free control regions in data to constrain MC → use MC to extrapolate to the signal region

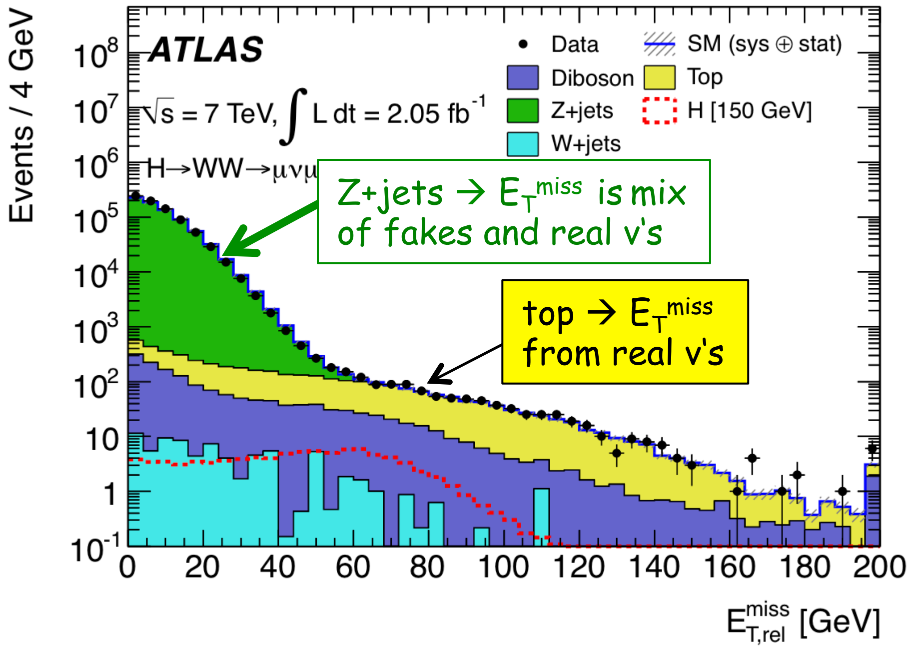
2.1 fb^{-1}

Control region	MC expectation	Observed in data
WW 0-jet	296±36	296
WW 1-jet	171±21	184
Top 1-jet	270±69	249

After leptons, m_Z and E_T^{miss} cuts



N_{jets} with p_T>25 GeV



E_T^{miss} spectrum in data for inclusive events with $\mu^+\mu^-$ pair well described (over 5 orders of magnitude) by the various background components. Dominated by real E_T^{miss} from ν's starting at E_T^{miss} ~ 50 GeV
→ little tails from detector effects

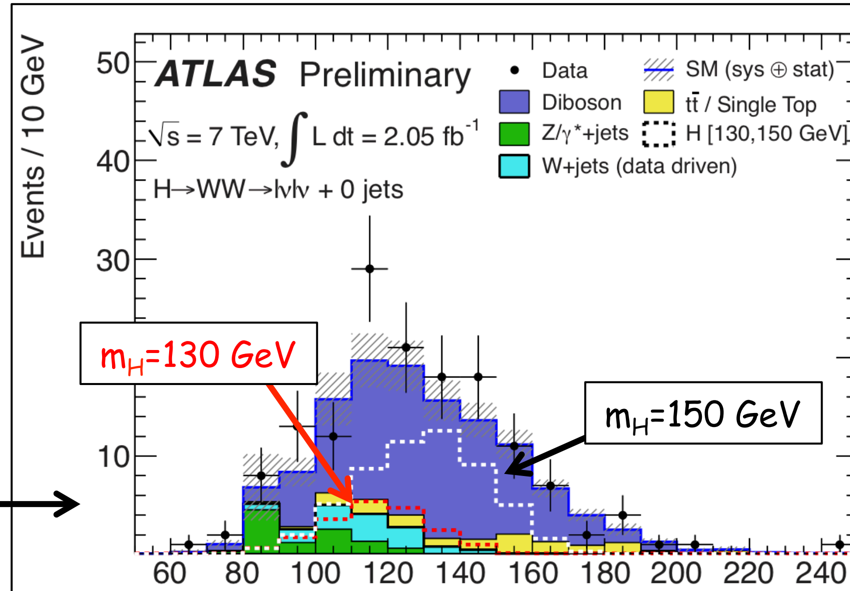
E_T^{miss} spectrum and resolution very sensitive to pile-up → we will include Period-B data when understanding at similar level as Period A

2.1 fb^{-1}

After all cuts (selection for m_H=130 GeV)

Observed in data	94 events 10 ee, 42 eμ, 42 μμ
Expected background	76 (±11)
Expected signal m_H=130 GeV	19 (±4)

Transverse mass spectrum after all cuts (except M_T) →



$$m_T = \sqrt{(E_T^{\ell\ell} + E_T^{miss})^2 - (\mathbf{P}_T^{\ell\ell} + \mathbf{P}_T^{miss})^2}$$

2.1 fb^{-1}

After all cuts (selection for m_H=130 GeV)

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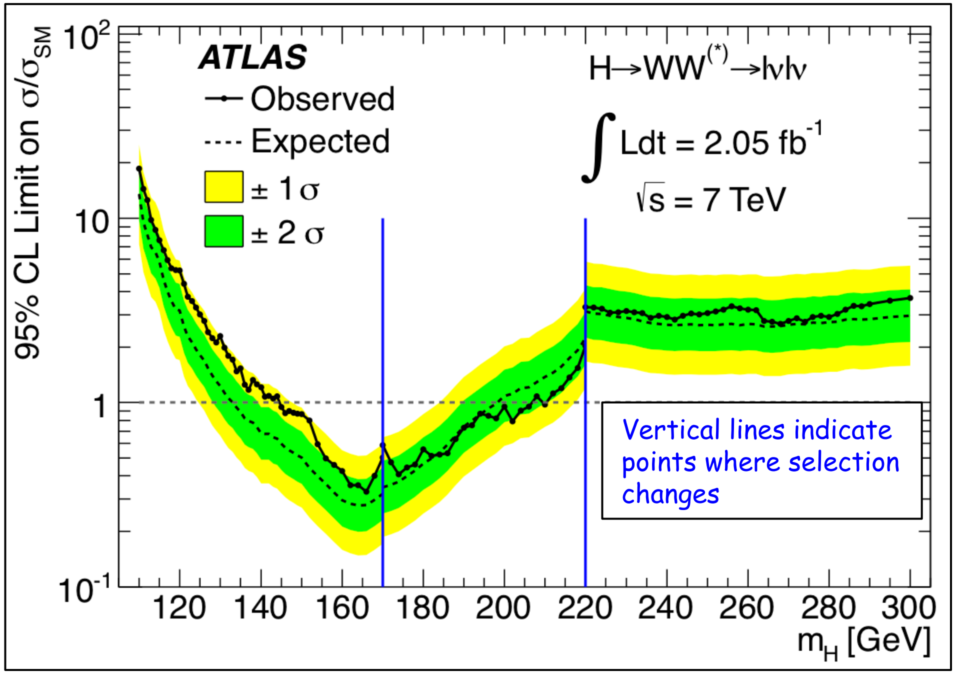
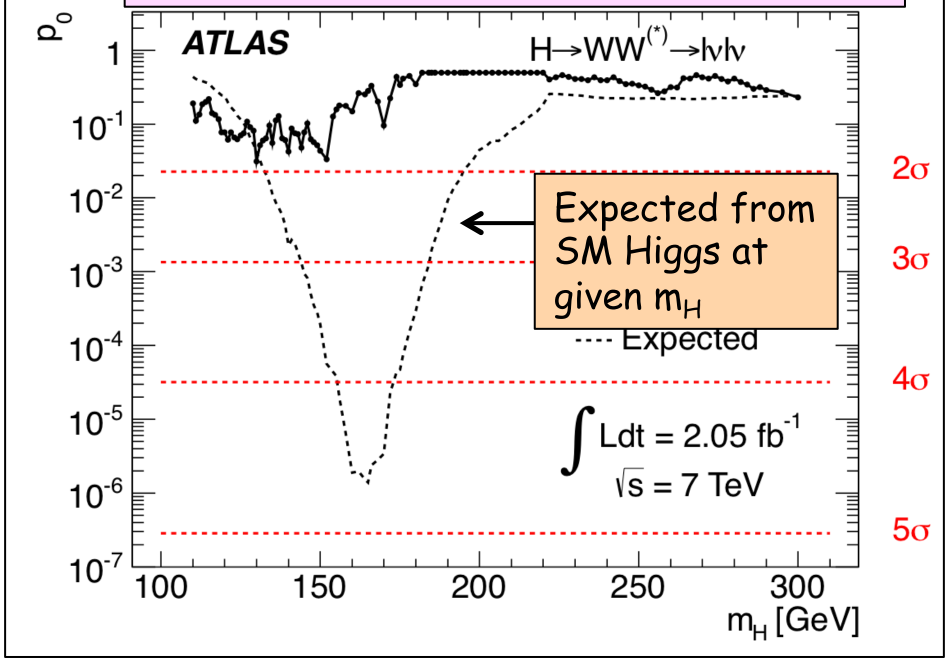


Consistency of the data with the background-only expectation

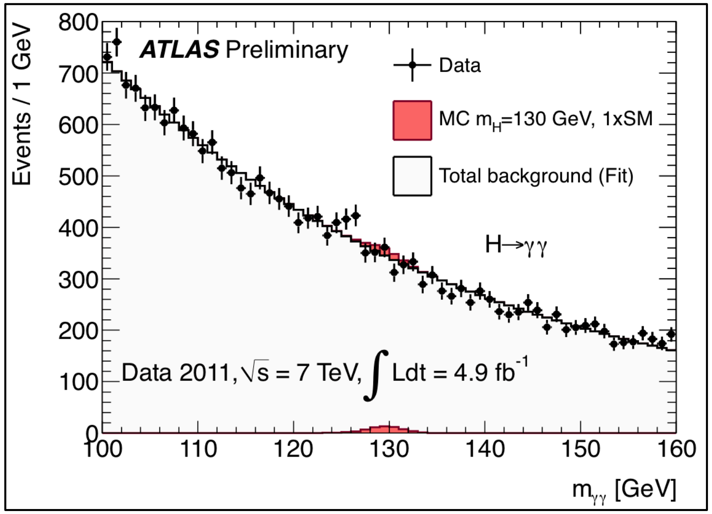


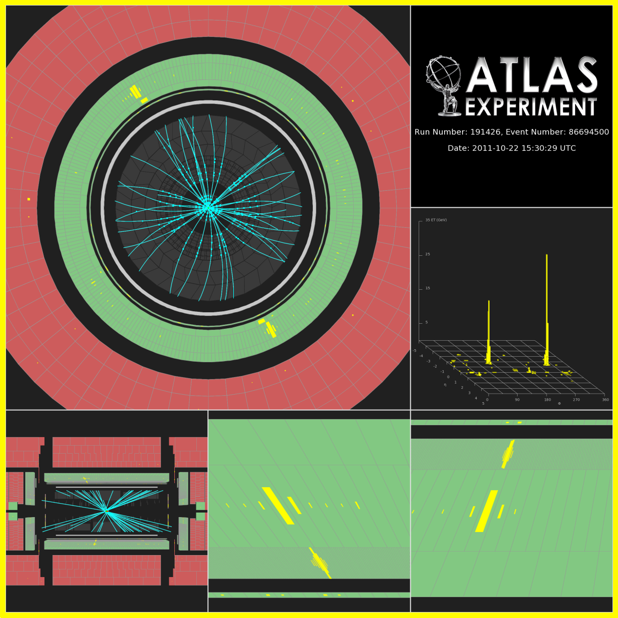
- Excluded (95% CL): 145 < m_H < 206 GeV (expected: 134-200 GeV)
- Observed limit within 2σ of expected: max deviation 1.9 σ for m_H ~ 130 GeV

$H \rightarrow \gamma\gamma$

- Small cross-section: $\sigma \sim 40$ fb
- Simple final state: two high-p_T isolated photons $E_T(\gamma_1, \gamma_2) > 40, 25$ GeV
- Main background: $\gamma\gamma$ continuum (irreducible, smooth, ..)
- Events divided into 9 categories based on η-photon (e.g. central, rest, …), converted/unconverted, $p_T^{\gamma\gamma}$ perpendicular to γγ thrust axis
- ~70 signal events expected in 4.9 fb^{-1} after all selections for m_H=125 GeV ~ 3000 background events in signal mass window → S/B ~ 0.02

$110 \leq m_H \leq 150$ GeV

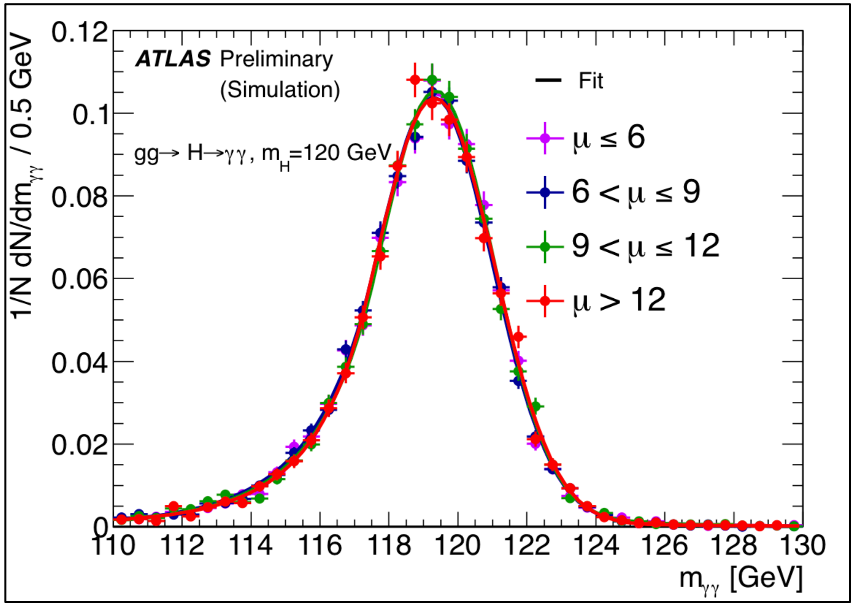


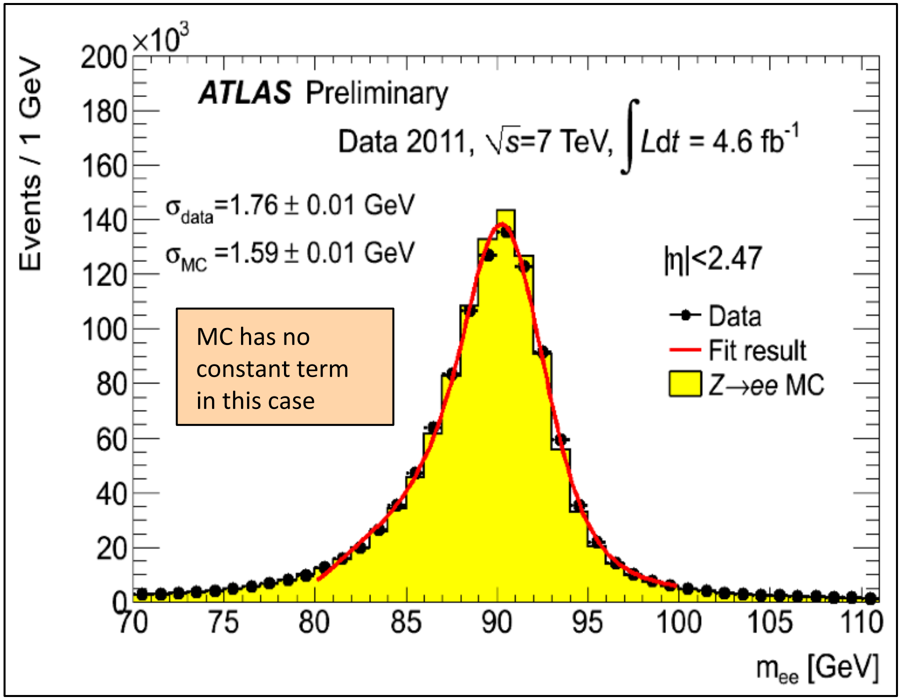


Crucial experimental aspects:
- excellent γγ mass resolution to observe narrow signal peak above irreducible background
- powerful γ/jet separation to suppress γj and jj background with jet → π^0 faking single γ

$m^2_{\gamma\gamma} = 2 E_1 E_2 (1-\cos\alpha)$

m_H=120 GeV	σ ($m_{\gamma\gamma}$) GeV	Event fraction in ± 1.4 σ ($m_{\gamma\gamma}$)
All	1.7	80 %
Best category (unconverted central)	1.4	84%
Worst category (~10%) (≥ 1 γ converted, ≥ 1 γ near barrel/end-cap transition)	2.3	70%





Present understanding of calorimeter E response (from Z, J/ψ → ee, W→ eν data and MC):

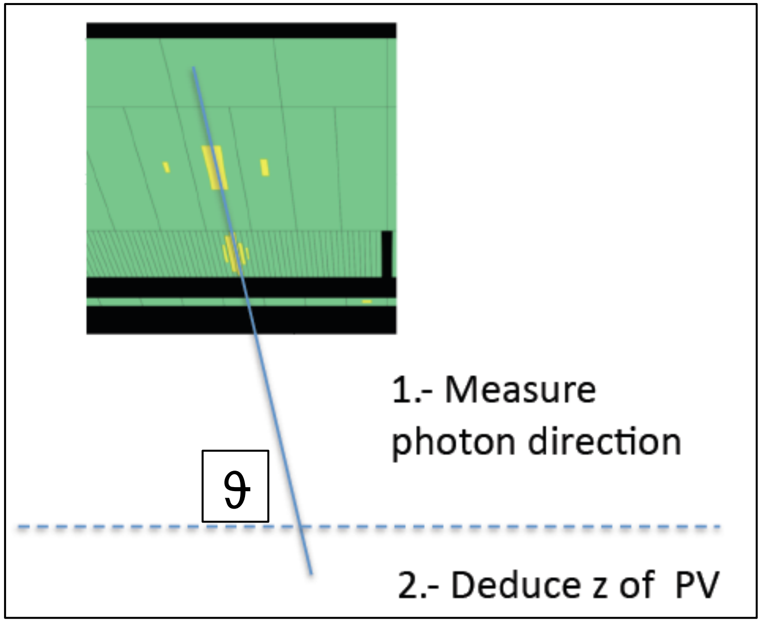
- Energy scale at m_Z known to ~ 0.5%
- Linearity better than 1% (over few GeV-few 100 GeV)
- "Uniformity" (constant term of resolution): 1% (barrel) -1.7 % (end-cap)

Electron scale and resolution transported to photons using MC (systematics few from material effects)

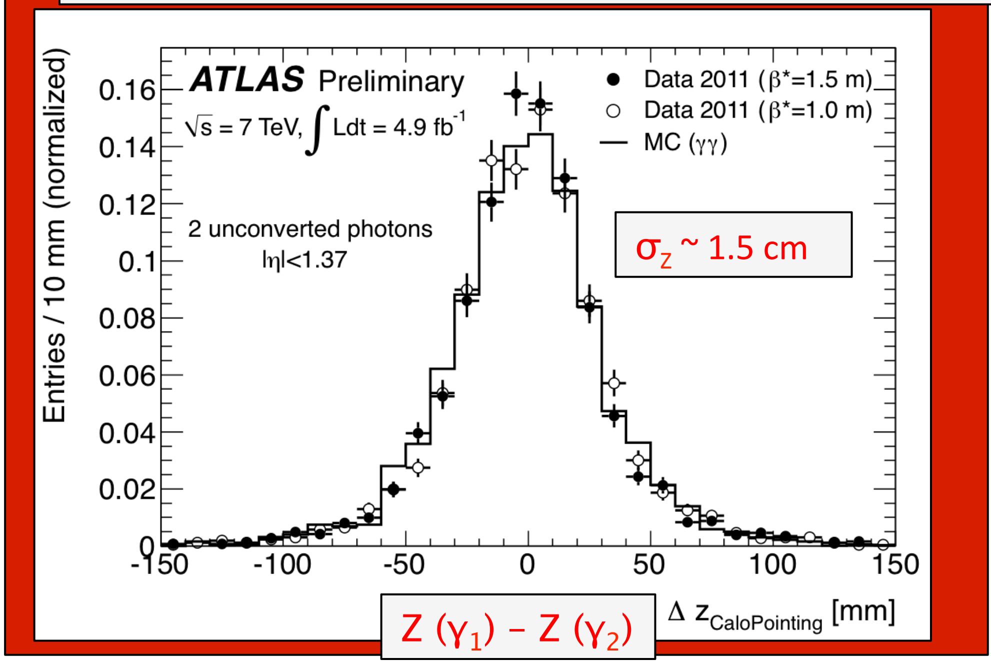
$m^2_{\gamma\gamma} = 2\, E_1\, E_2\, (1 - \cos\alpha)$

α=opening angle of the two photons

Use longitudinal (and lateral) segmentation of EM calorimeter to measure photon polar angle ϑ crucial at high pile-up: many vertices distributed over σ_Z (LHC beam spot) ~ 5.6 cm → difficult to know which one produced the γγ pair



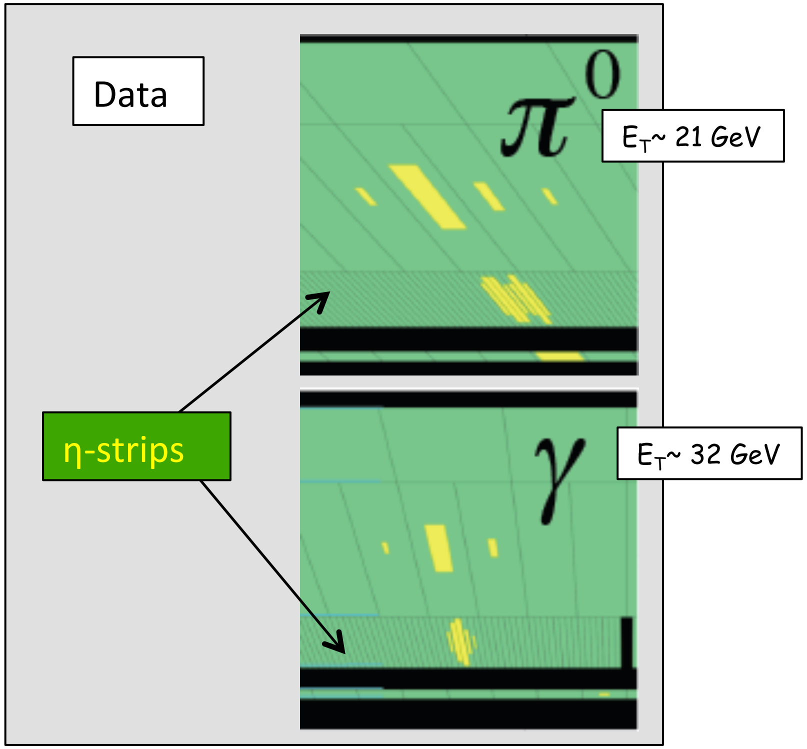
Z-vertex as measured in γγ events after selection from calorimeter "pointing"

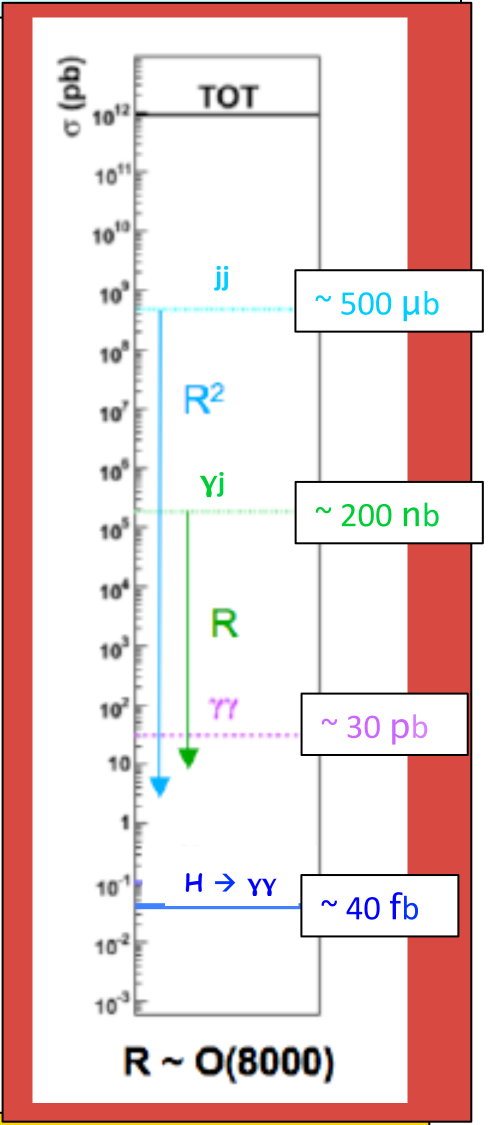


- ❑ Calorimeter pointing capability reduces vertex uncertainty from ~ 5.6 cm (LHC beam spot) to ~ 1.5 cm
- → Contribution to mass resolution from angular term is negligible with calo pointing (γ → ee vertex also used)
- ❑ Robust against pile-up

Potentially huge background from γj and jj production with jets fragmenting into a single hard π^0 and the π^0 faking single photon

Determined choice of fine lateral segmentation (4mm η-strips) of the first compartment of ATLAS EM calorimeter

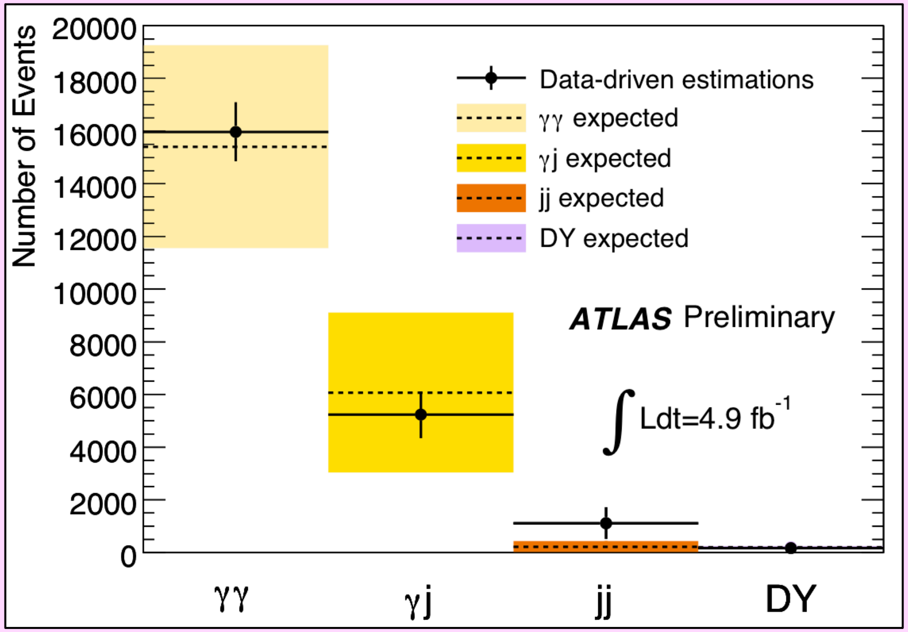




However: huge uncertainties on σ (γj, jj) !! → not obvious γj, jj could be suppressed well below irreducible γγ until we measured with data

After all cuts: 22489 events with $100 < m_{\gamma\gamma} < 160$ GeVobserved in the data

Sample composition estimated from data using control samples



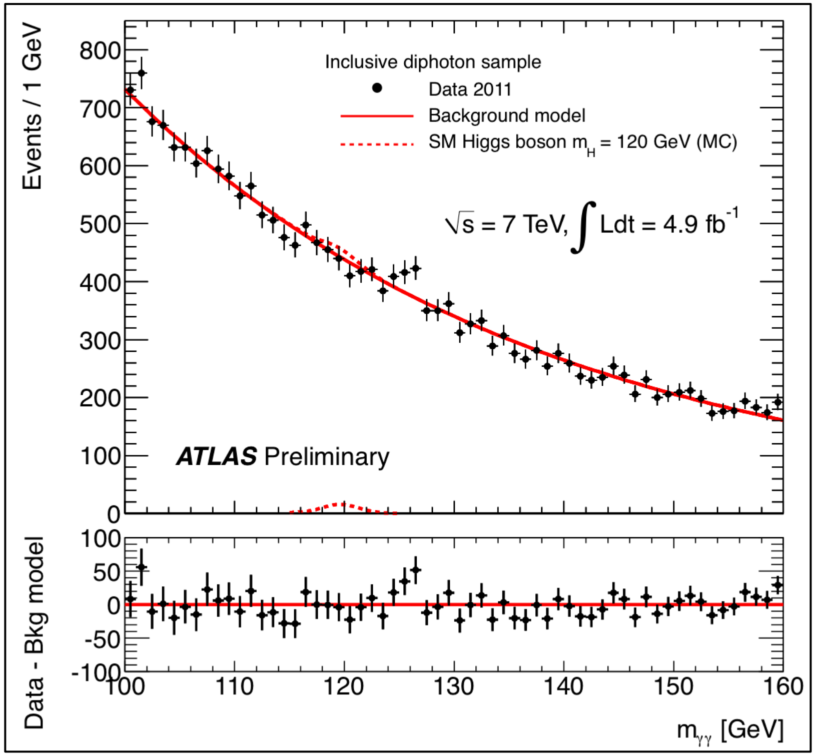
	Number of events	Fraction
γγ	16000 ± 1120	71 ±5 %
γj	5230 ± 890	23 ±4 %
jj	1130 ± 600	5 ±3 %
DY/Z	165 ± 8	0.7 ±0.1 %

γj + jj << γγ irreducible (purity ~ 70%)

Photon identification efficiency: ~ 85±5% from MC, cross-checked with data ($Z \rightarrow ee$, $Z \rightarrow ee\gamma$, $\mu\mu\gamma$)

After all selections: kinematic cuts, γ identification and isolation

- 22489 events with $100 < m_{\gamma\gamma} < 160$ GeV observed in the data
- expected signal efficiency: ~ 35% for m_H=125 GeV



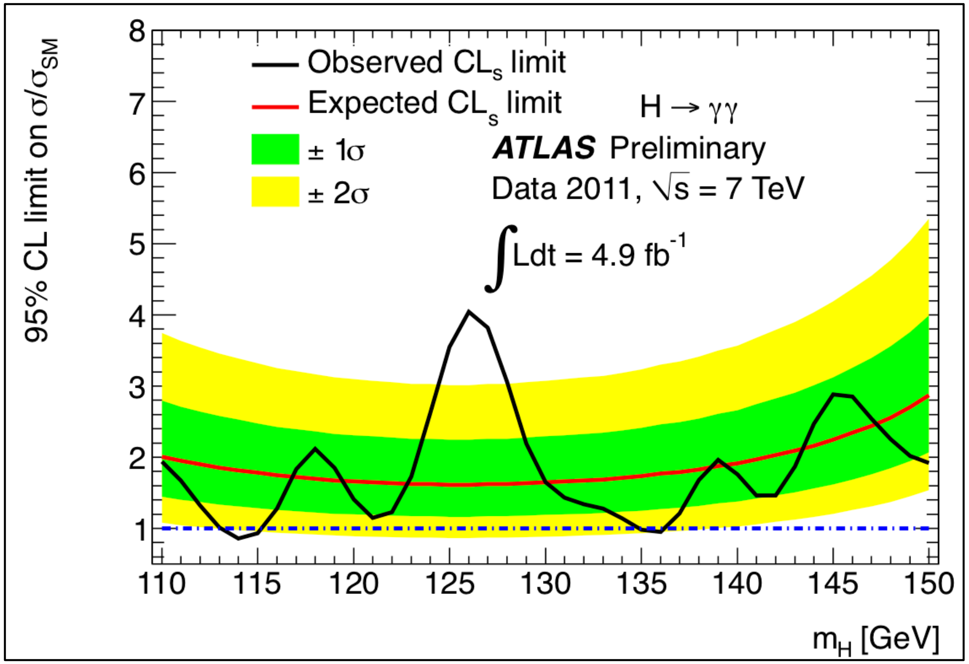
$m_{\gamma\gamma}$ spectrum fit with exponential function for background plus Crystal Ball + Gaussian for signal → background determined directly from data

Systematic uncertainties on signal expectation

Type and source	Uncertainty
Event yield	
Photon reconstruction and identification	±11%
Effect of pileup on photon identification	±4%
Isolation cut efficiency	±5%
Trigger efficiency	±1%
Higgs boson cross section	+15%/ − 11%
Higgs boson p_T modeling	±1%
Luminosity	±3.9%
Mass resolution	
Calorimeter energy resolution	±12%
Photon energy calibration	±6%
Effect of pileup on energy resolution	±3%
Photon angular resolution	±1%
Migration	
Higgs boson p_T modeling	±8%
Conversion reconstruction	±4.5%

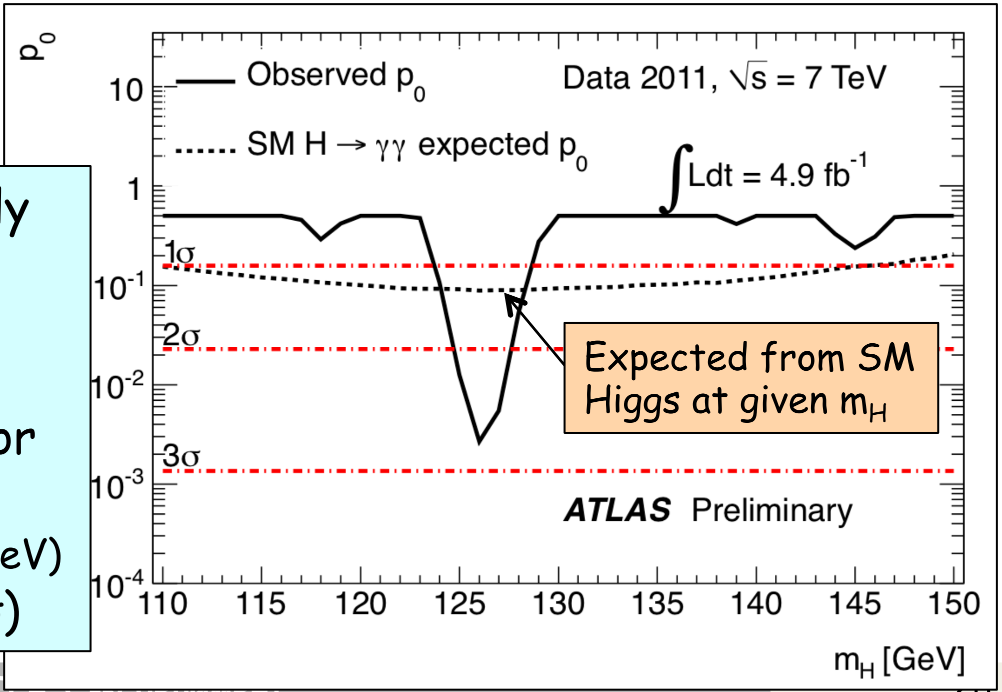
Main systematic uncertainties

Expected signal yield : ~ 20%
H→ γγ mass resolution : ~ 14%
H→ γγ p_T modeling : ~ 8%
Background modeling : ±0.1-5.6 events



Excluded (95% CL):
$114 \leq m_H \leq 115$ GeV, $135 \leq m_H \leq 136$ GeV

Consistency of the data with the background-only expectation



Expected from SM Higgs at given m_H

Maximum deviation from background-only expectation observed for m_H~126 GeV:

- local p_0-value: 0.27% or 2.8σ
- expected from SM Higgs: ~ 1.4σ local
- global p_0-value: includes probability for such an excess to appear anywhere in the investigated mass range (110-150 GeV) ("Look-Elsewhere-Effect"): ~7% (1.5σ)

$H \rightarrow ZZ^{(*)} \rightarrow 4l$ (4e, 4μ, 2e2μ)

$110 < m_H < 600$ GeV

- σ ~ 2-5 fb
- However:
  - -- mass can be fully reconstructed → events would cluster in a (narrow) peak
  - -- pure: S/B ~ 1
- 4 leptons: $p_T^{1,2,3,4} > 20,20,7,7$ GeV; $m_{12} = m_Z \pm 15$ GeV; $m_{34} > 15\text{-}60$ GeV (depending on m_H)
- Main backgrounds:
  - -- $ZZ^{(*)}$ (irreducible)
  - -- $m_H < 2m_Z$: Zbb, Z+jets, tt with two leptons from b/q-jets → l

→ Suppressed with isolation and impact parameter cuts on two softest leptons

- Signal acceptance x efficiency: ~ 15 % for m_H~ 125 GeV

Crucial experimental aspects:

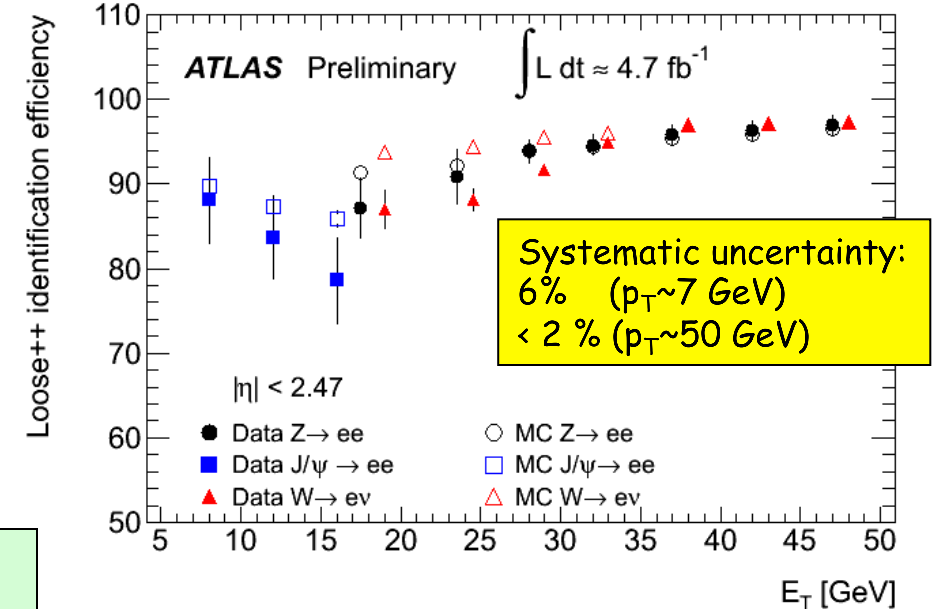
- High lepton reconstruction and identification efficiency down to lowest p_T
- Good lepton energy/momentum resolution
- Good control of reducible backgrounds (Zbb, Z+jets, tt) in low-mass region:
  - → cannot rely on MC alone (theoretical uncertainties, b/q-jet → l modeling, ..)
  - → need to compare MC to data in background-enriched control regions (but: low statistics ..)

→ Conservative/stringent p_T and m(ll) cuts used at this stage

Identification efficiency from
J/ψ → ee, W → eν, Z→ ee data samples

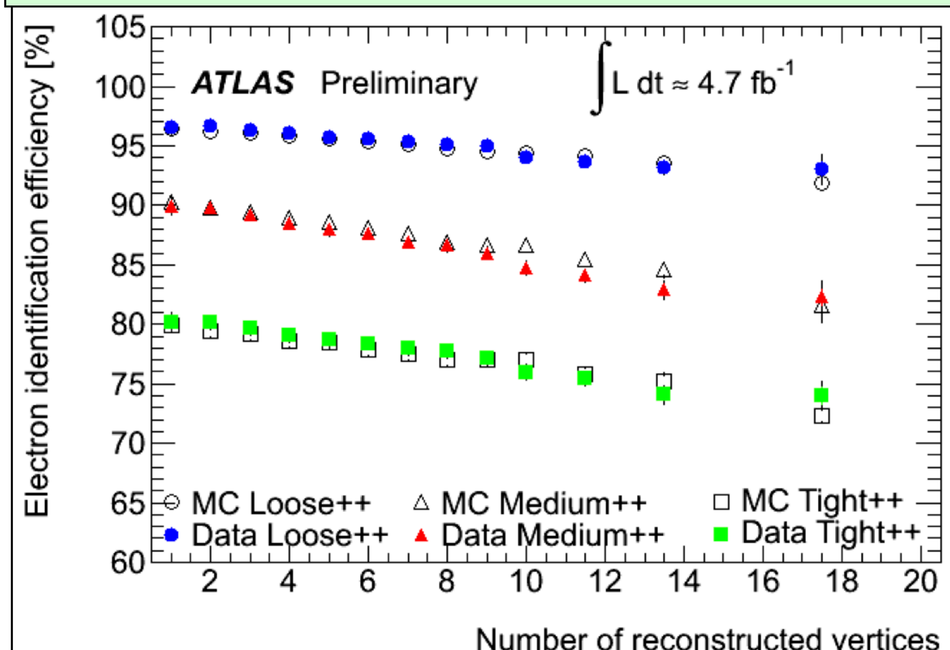
Crucial to understand low-p_T electrons (affected by material) with data

Electron performance

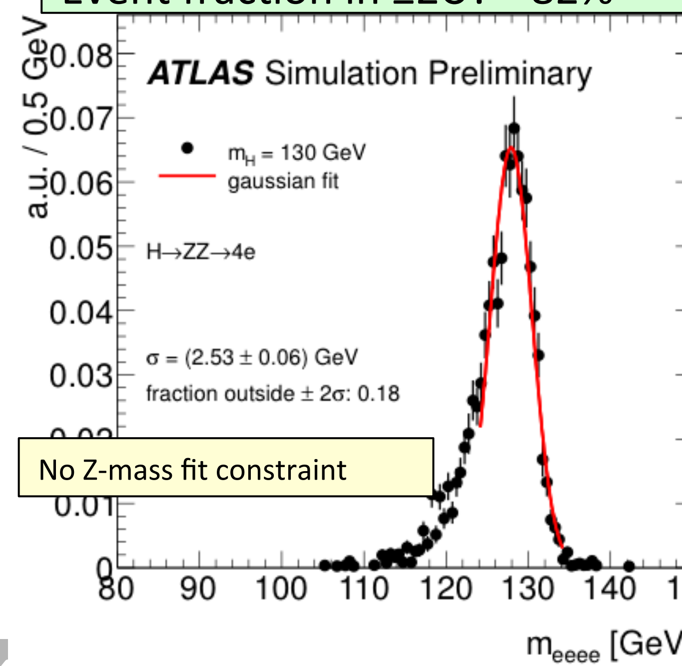


Systematic uncertainty:
6% (p_T~7 GeV)
< 2 % (p_T~50 GeV)

Variation of electron efficiency with pile-up (cuts not re-tuned yet) well modeled by simulation: from Z→ ee data and MC samples

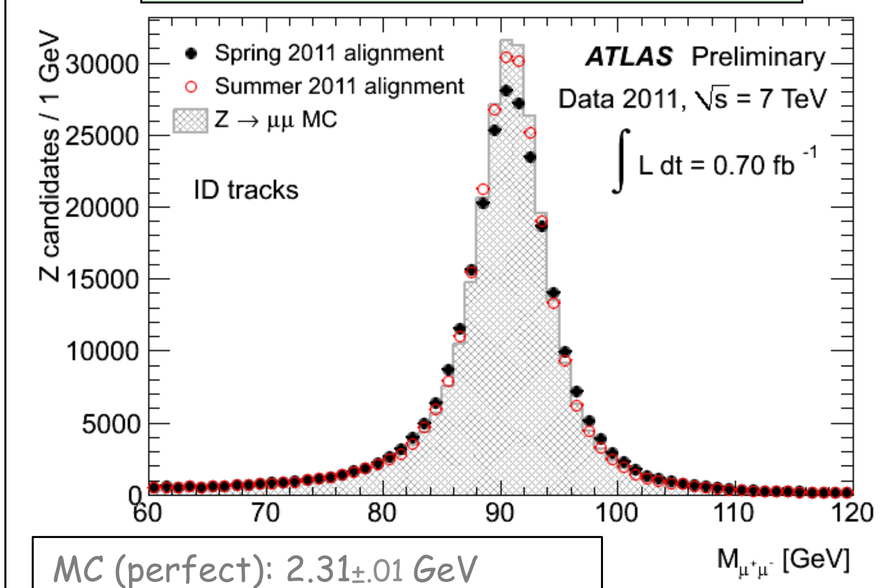


H→ 4e mass resolution: 2.5 GeV
Event fraction in ±2σ: ~ 82%



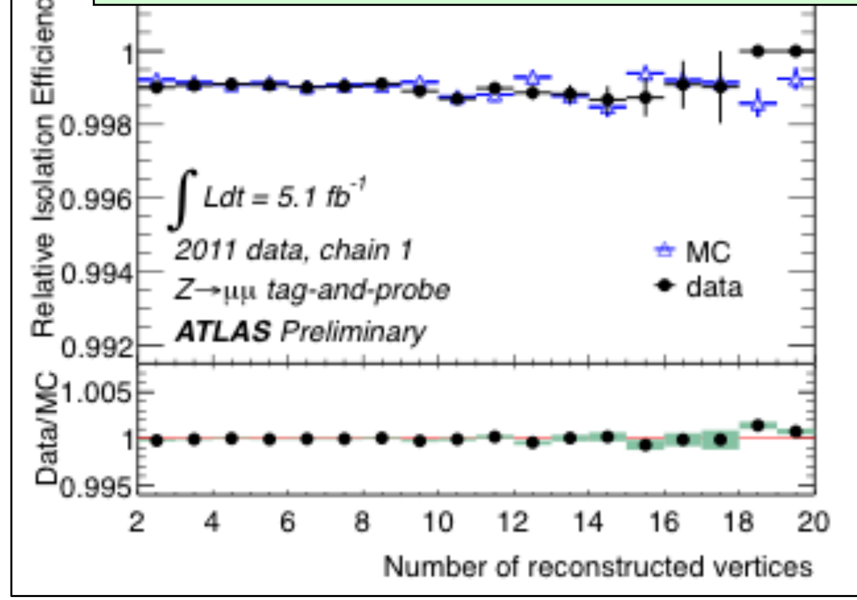
No Z-mass fit constraint

Improving Z→μμ mass resolution



MC (perfect): 2.31±.01 GeV
Data Spring 2011 : 2.89±.01 GeV
Data Summer 2011: 2.45±.01 GeV

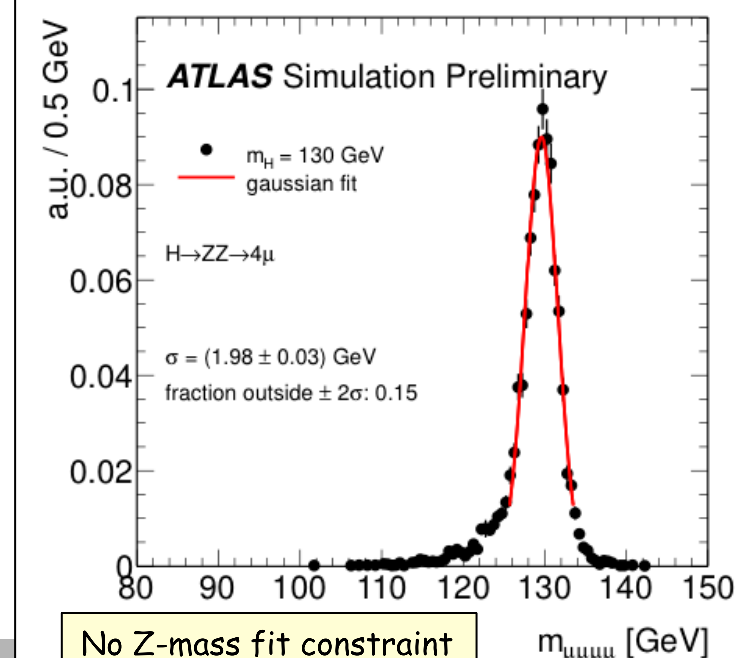
Muon (calorimetric) isolation efficiency from Z→μμ events in data and MC



Muon performance

Muon reconstruction efficiency > 95% over 4 < p < 100 GeV

H→ 4μ mass resolution: ~2 GeV
Event fraction in ±2σ: ~ 85%

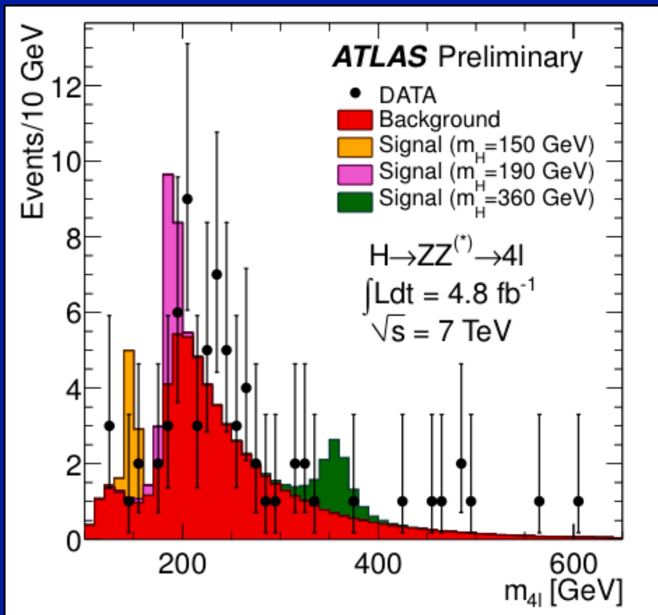


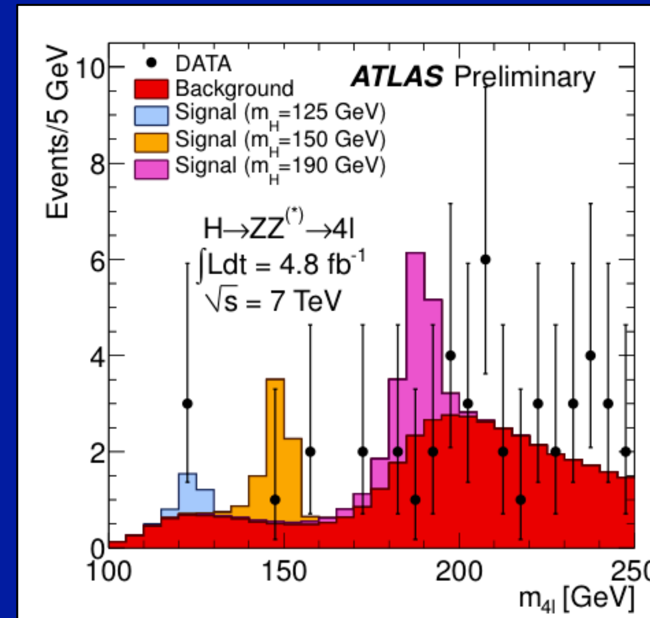
No Z-mass fit constraint

After all selections: kinematic cuts, isolation, impact parameter

Full mass range
Observed: 71 events: 24 4μ + 30 2e2μ + 17 4e
Expected from background: 62±9

m(4l) < 180 GeV
Observed: 8 events: 3 4μ + 3 2e2μ + 2 4e
Expected from background: 9.3±1.5





In the region m_H < 141 GeV (not already excluded at 95% C.L.) 3 events are observed: two 2e2μ events (m=123.6 GeV, m=124.3 GeV) and one 4μ event (m=124.6 GeV)

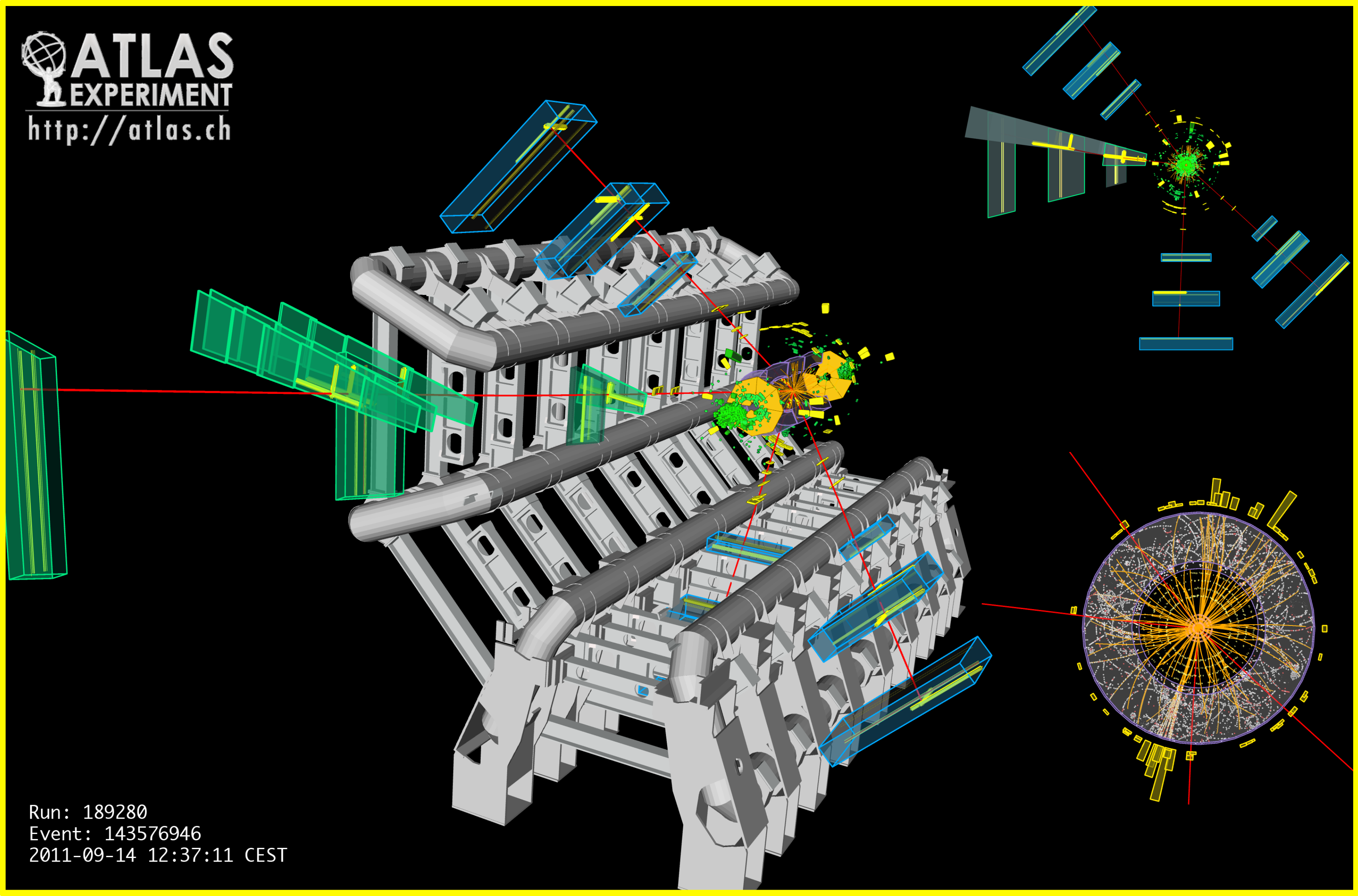
In the region 117< m_{4l} <128 GeV (containing ~90% of a m_H=125 GeV signal):
- similar contributions expected from signal and background: ~ 1.5 events each
- S/B ~ 2 (4μ), ~ 1 (2e2μ), ~ 0.3 (4e)
- Background dominated by ZZ* (4μ and 2e2μ), and Z+jets (4e)

Main systematic uncertainties

Higgs cross-section	: ~ 15%
Electron efficiency	: ~ 2-8%
ZZ* background	: ~ 15%
Zbb, +jets backgrounds	: ~ 40%

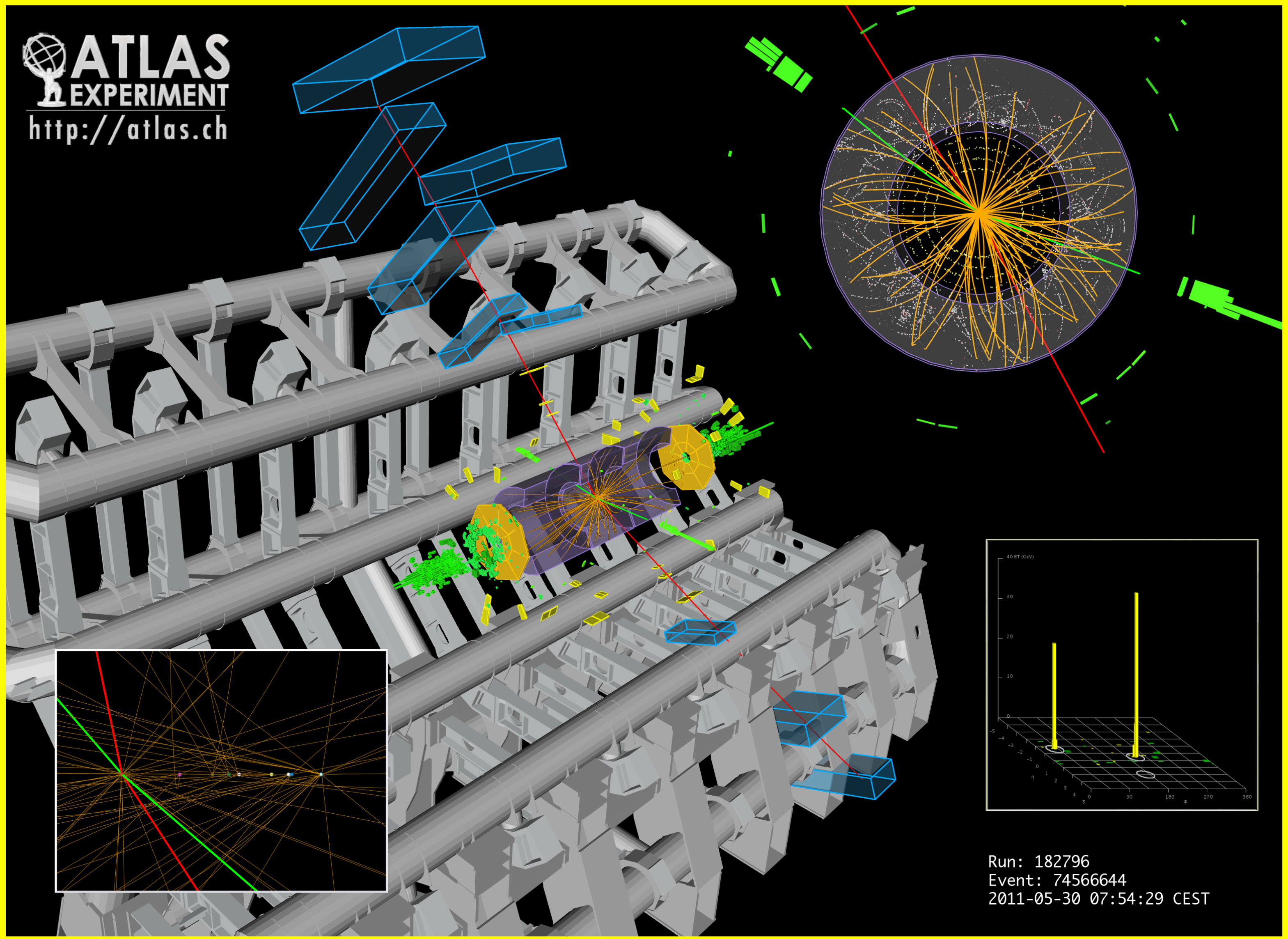
4μ candidate with $m_{4\mu}$= 124.6 GeV

p_T (μ^-, μ^+, μ^+, μ^-)= 61.2, 33.1, 17.8, 11.6 GeV
m_{12}= 89.7 GeV, m_{34}= 24.6 GeV

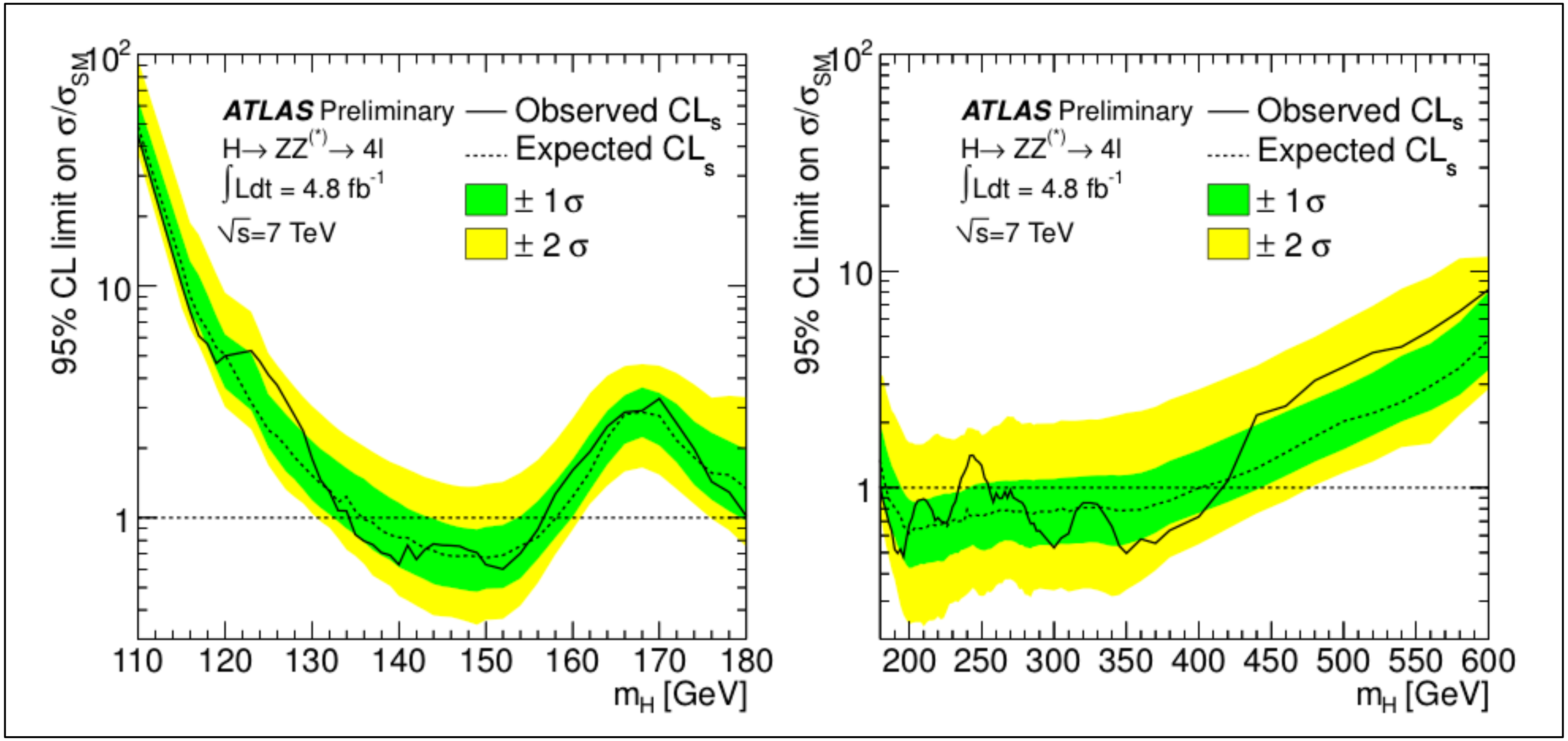


2e2μ candidate with $m_{2e2\mu}$= 124.3 GeV

p_T (e^+, e^-, μ^-, μ^+)= 41.5, 26.5, 24.7, 18.3 GeV
m (e^+e^-)= 76.8 GeV, m($\mu^+\mu^-$) = 45.7 GeV

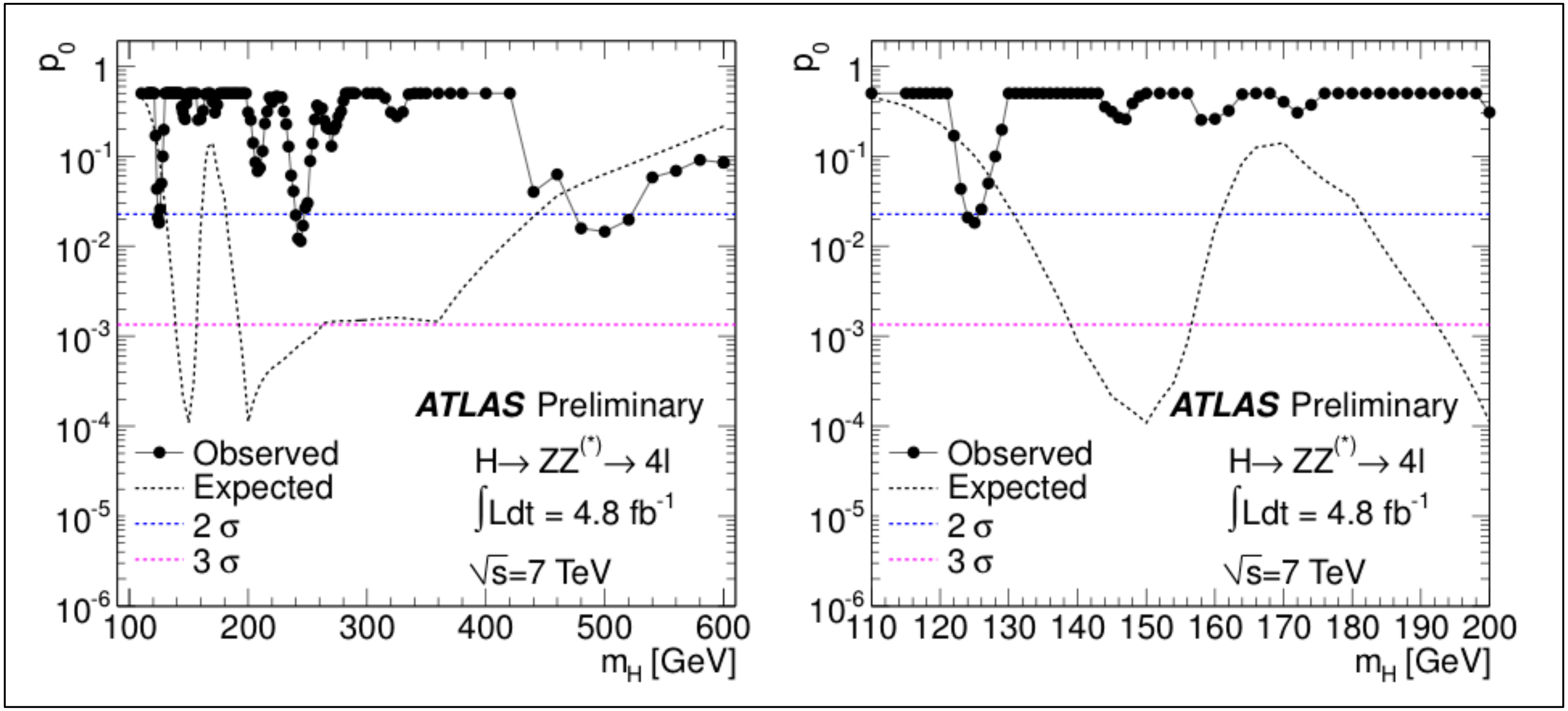


From fit of signal and background expectations to 4l mass spectrum



Excluded (95% CL): 135 < m_H < 156 GeV and 181 < m_H < 415 GeV (except 234-255 GeV)
Expected (95% CL): 137 < m_H < 158 GeV and 185 < m_H < 400 GeV

Consistency of the data with the background-only expectation



Maximum deviations from background-only expectations

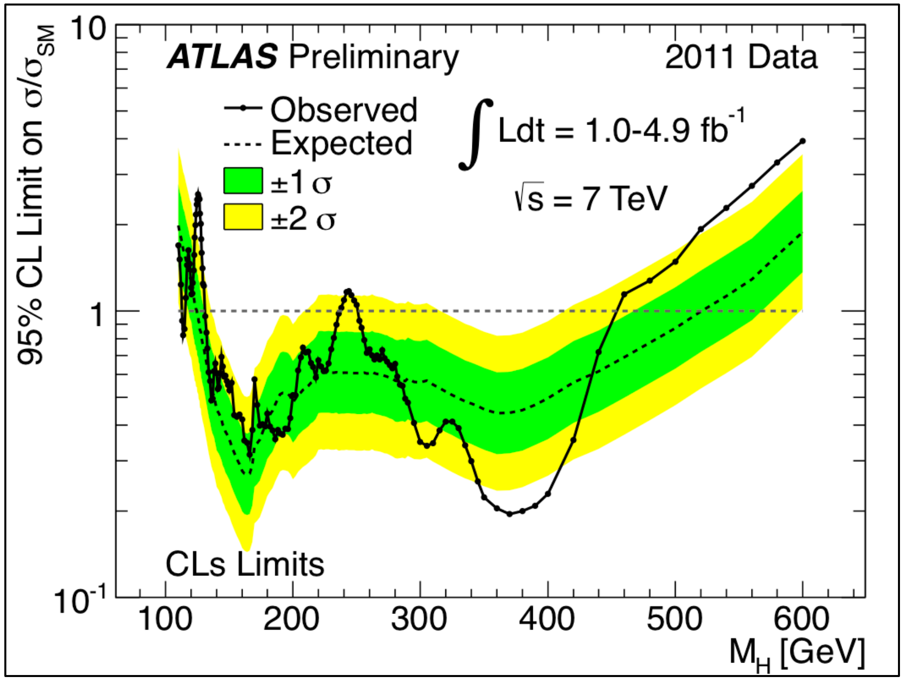
Excluded at 95% C.L. by ATLAS+CMS combination → 244

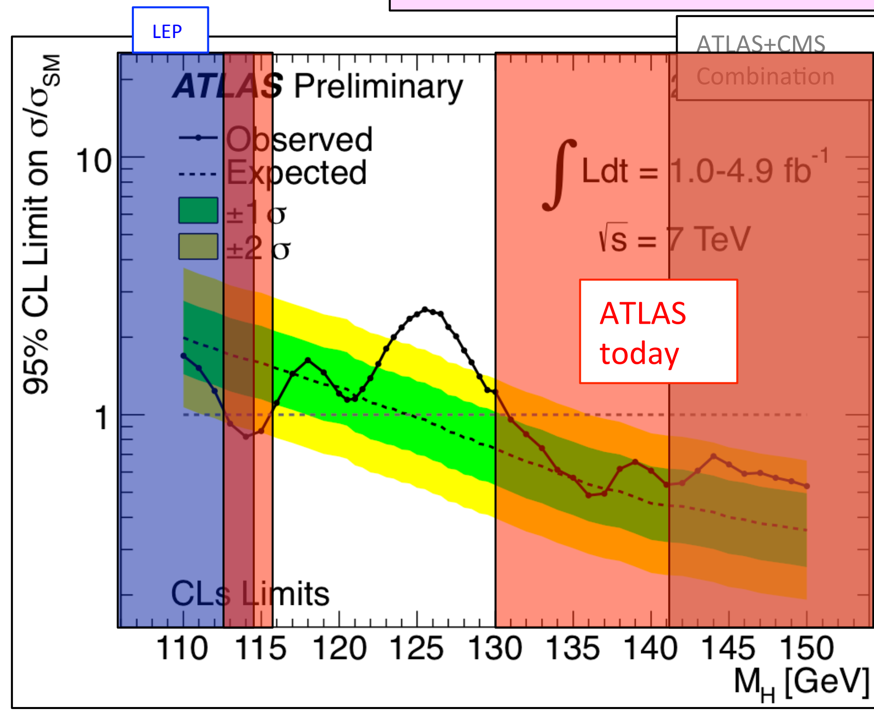
m_H (GeV)	Local (global) p_0	Local significance	Expected from SM Higgs
125	1.8% (~50%)	2.1 σ	1.4σ
244	1.1% (~50%)	2.3 σ	3.2σ
500	1.4% (~50%)	2.2 σ	1.5σ

LEE estimated over mass range: 110-600 GeV

Putting all channels together → combined constraints

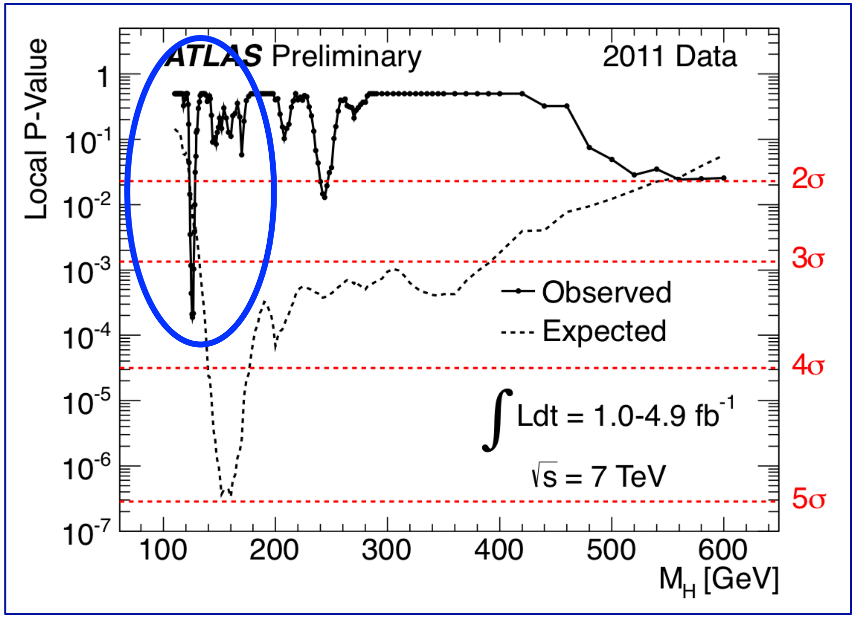
H→γγ, H→ ττ
H→ WW(*)→ lνlν
H→ ZZ(*) → 4l, H→ ZZ → llνν
H→ ZZ → llqq, H→ WW→lνqq
W/ZH→ lbb+X not included

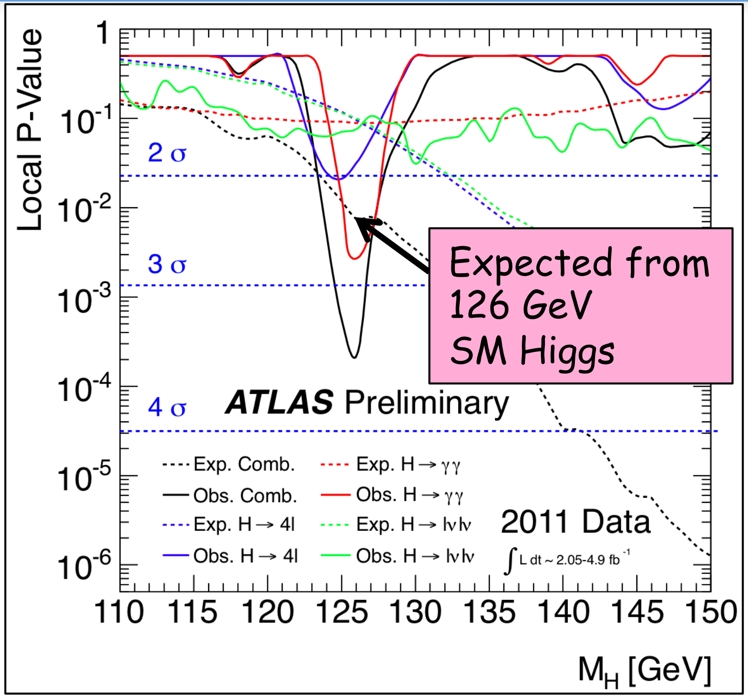




Excluded at 95% CL	$112.7 < m_H < 115.5$ GeV $131 < m_H < 453$ GeV, except 237-251 GeV
Expected if no signal	124.6-520 GeV
Excluded at 99% CL	$133 < m_H < 230$ GeV, $260 < m_H < 437$ GeV

Consistency of the data with the background-only expectation





Maximum deviation from background-only expectation observed for m_H~126 GeV

Local p_0-value: 1.9 10^{-4}
→ local significance of the excess: 3.6σ
~ 2.8σ H→ γγ, 2.1σ H→ 4l, 1.4σ H→ lvlv

Expected from SM Higgs: ~2.4σ local (~1.4σ per channel)

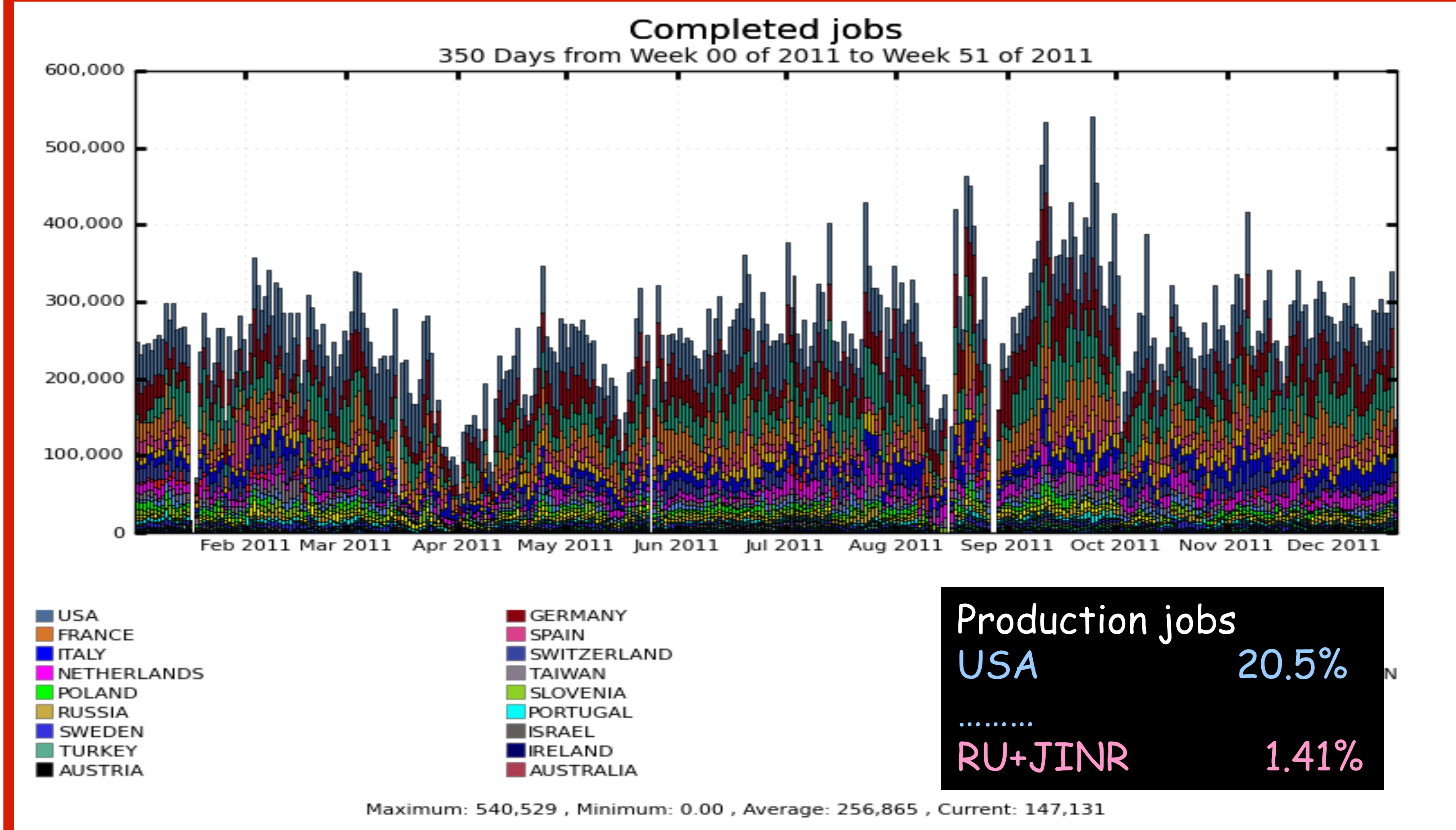
Global p_0-value : 0.6% →2.5σ LEE over 110-146 GeV
Global p_0-value : 1.4% →2.2σ LEE over 110-600 GeV

LHC plans for 2012

- 20 weeks of high intensity proton operation (May–Oct) 148 days of physics
- Possibly move to higher beam energy: 3.5 TeV→4 TeV LHC
  - Will be decided beginning of next year
- Possible peak performance with 50 ns beams:
  - 3.5 TeV: higher bunch intensity, smaller β* (0.8-0.9 m)
  - Peak luminosity increase: 20 to 30 %
  - 4 TeV: higher bunch intensity, smaller β* (0.7 - 0.8 m)
  - Peak luminosity increase: 60 to 75 %
- An integrated luminosity between 10 – 15 fb^{-1} is in reach
- In case of 25 ns bunch spacing performance at least ~ 10 - 20 % lower than with 50 ns
  - More unknowns due to several effects with smaller bunch spacing.

Bunch Spacing	Peak Luminosity	Integrated Luminosity (fb-1)	Pile Up	N max
50ns	5.80E+33	~16	~27	1.55E+11
25ns	3.80E+33	~10	~9	1.15E+11

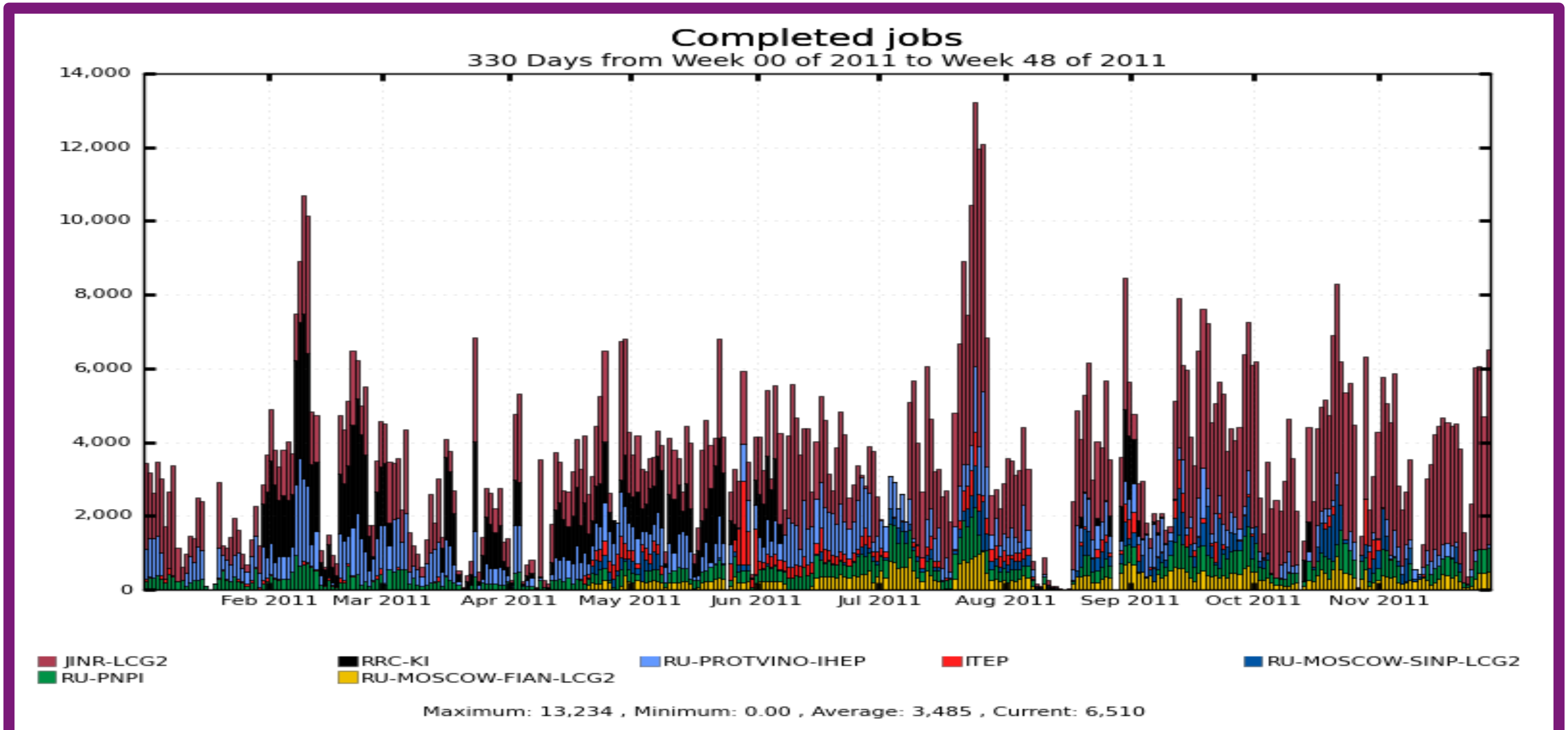
Production jobs running on ATLAS Grid every day



Includes data reprocessing and simulation at 10 Tier1-s + CERN + ~ 70 Tier2 federations> 80 sites

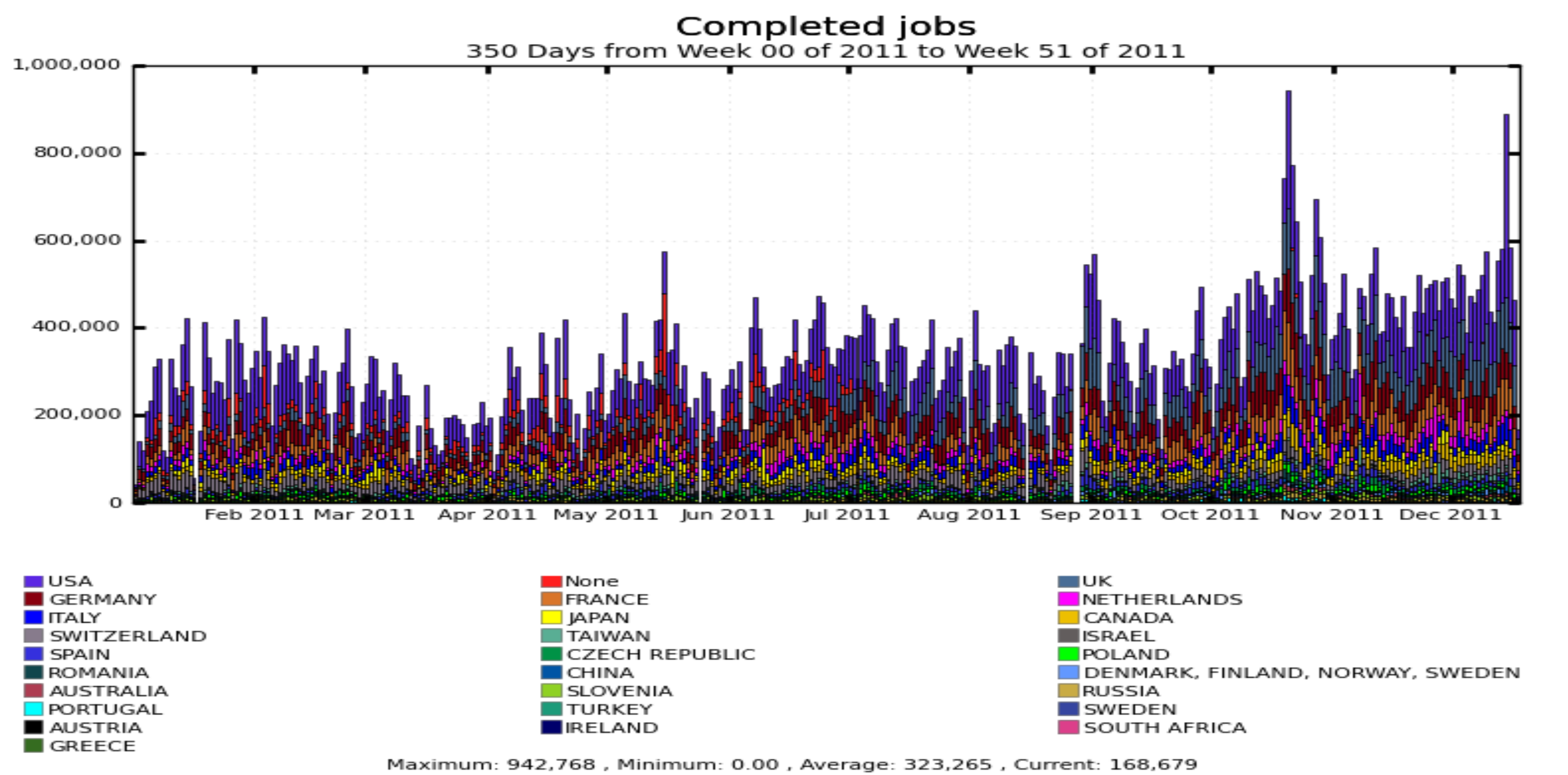
10 GB/s peak rate (Design 2GB/s)
~66 PetaBytes since LHC start

Production jobs running on RU-ATLAS Grid every day



JINR	47.98%
IHEP	16.98%
RRC-KI	12.26%
PNPI	9.2%
FIAN	5.92%
ITEP	3.67%

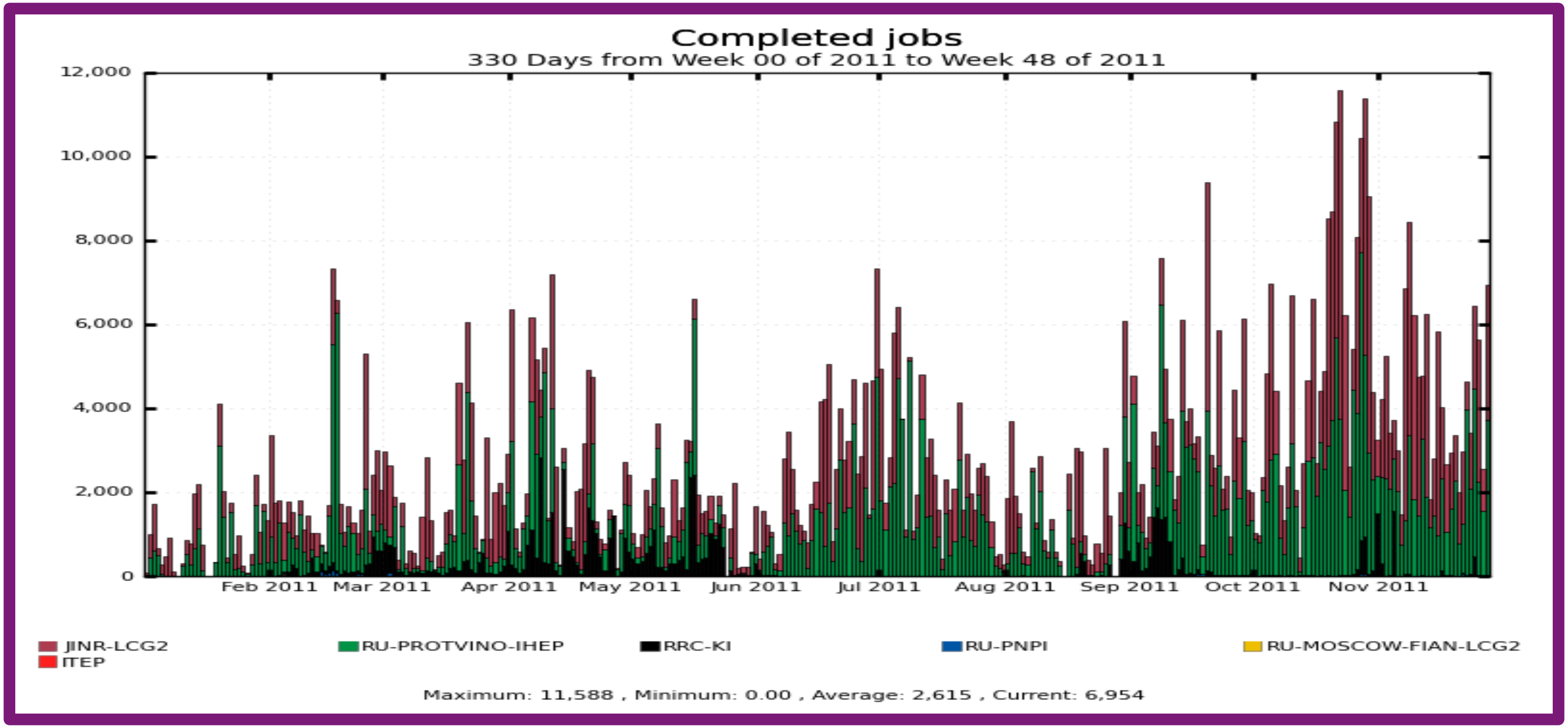
Analysis jobs running on ATLAS Grid every day



User analysis jobs	
USA	27.78%
………	
RU+JINR	0.88%

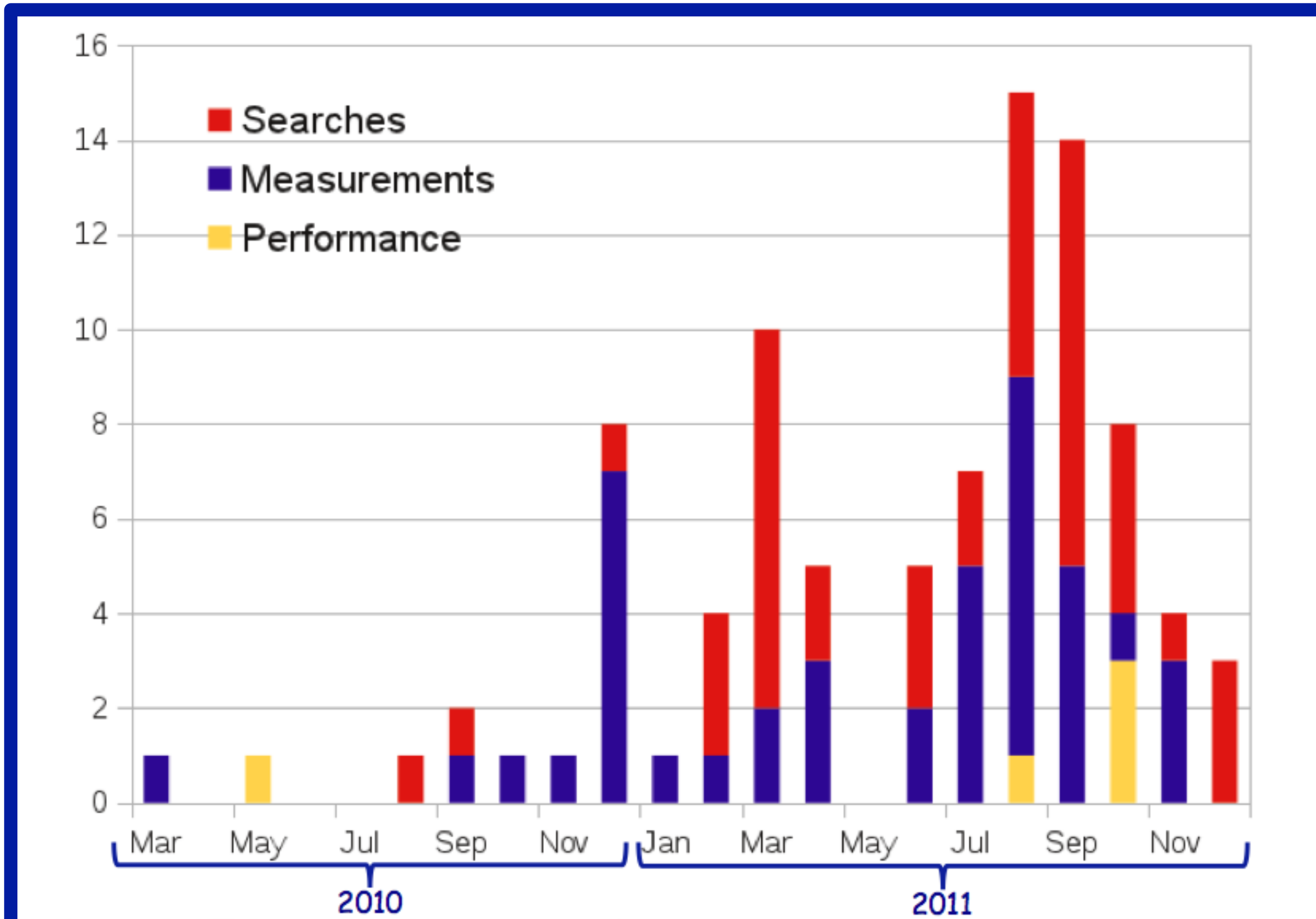
The excellent Grid performance has been crucial for fast release of physics results and for the worldwide ATLAS community to participate in an effective way to data analysis. Grid-based analysis in 2011 : > 1500 different users, ~ 83 M analysis jobs

Analysis jobs running on RU-ATLAS Grid every day



JINR	44.62%
IHEP	47.00%
RRC-KI	8.14%
PNPI	0.22%
FIAN	0.02%
ITEP	0.01%

ATLAS publications



ATLAS papers submitted for publication:

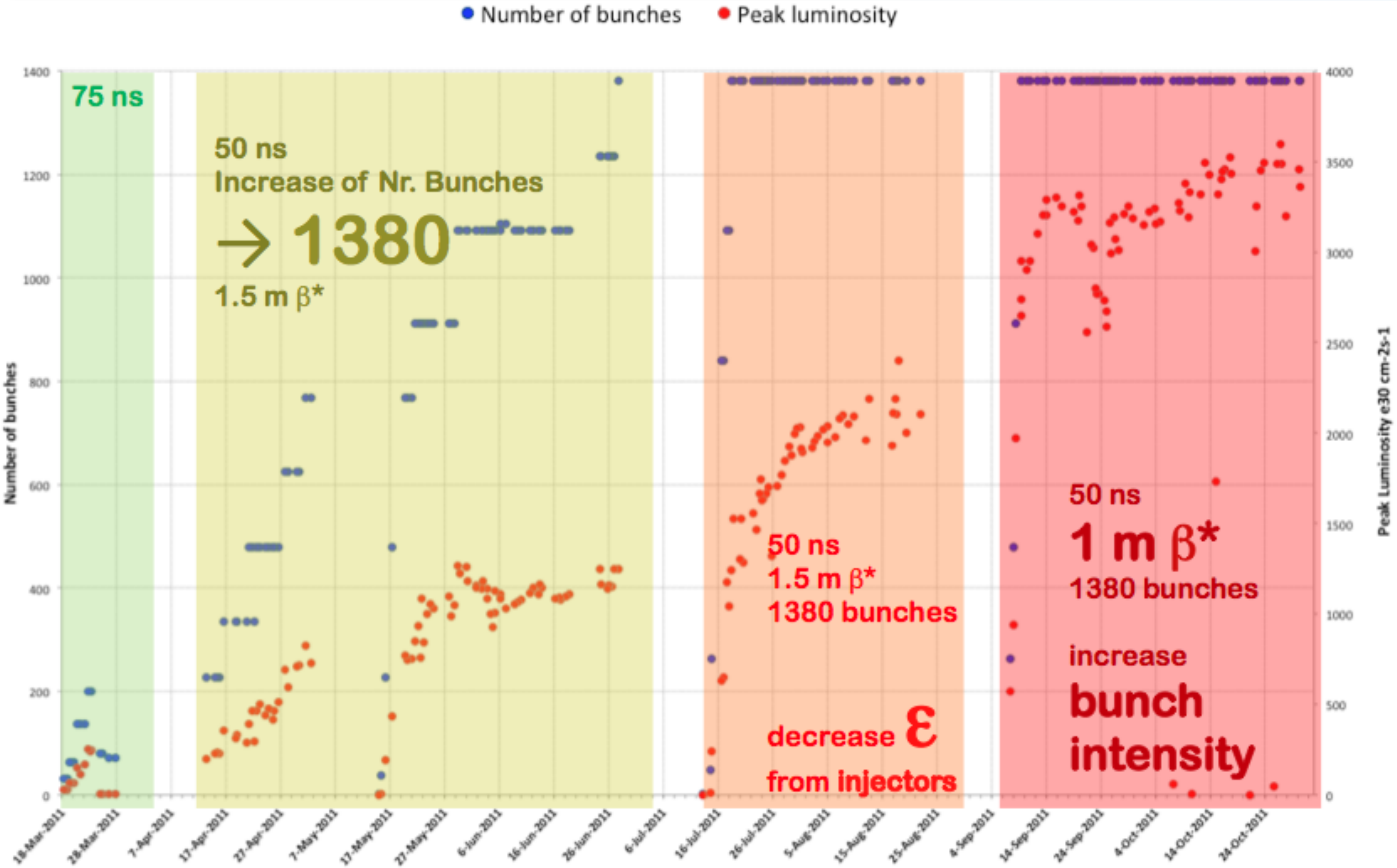
- In 2010: 16 papers
- In 2011: 75 papers until today

Conference notes:

- 265 since the start of data taking (~50 to summer conferences)

SPARES

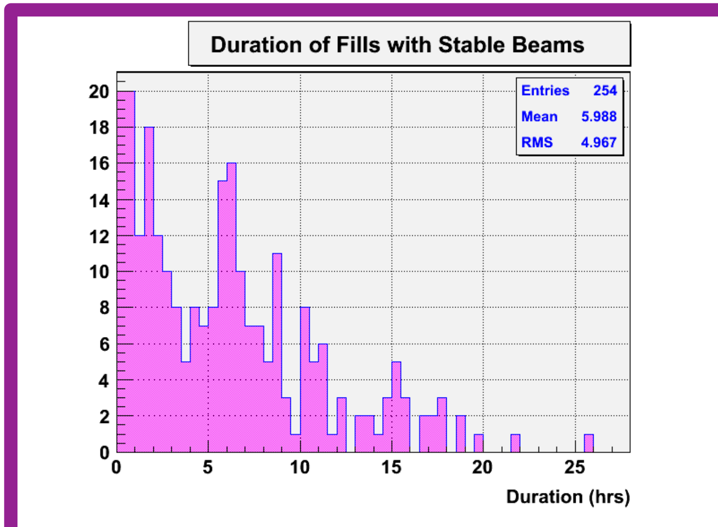
LHC parameters in 2011



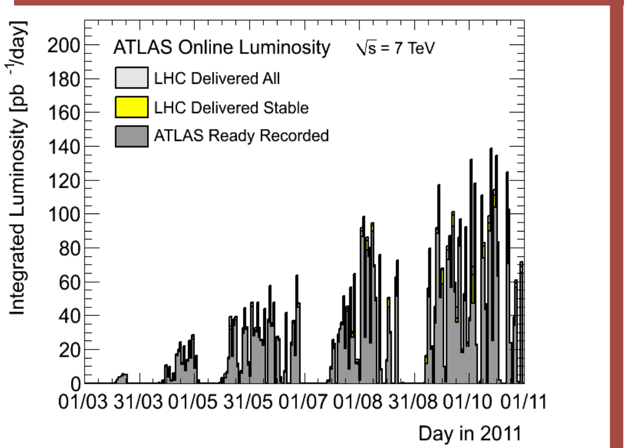
LHC records 2011 in p-p run

Items in red are records set in the past week of November 2011

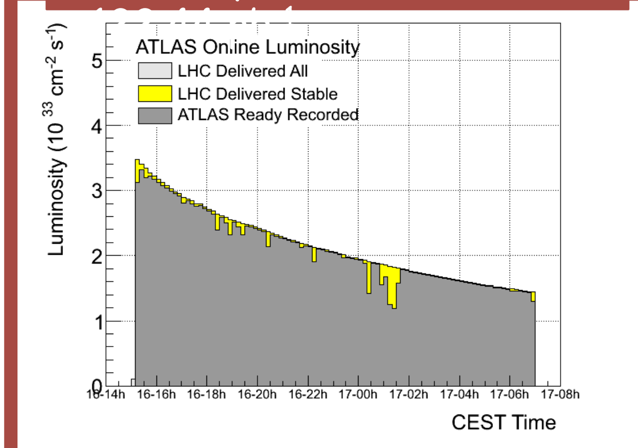
Peak Stable Luminosity Delivered	$3.65 \times 10^{33}\ cm^{-2}s^{-1}$
Maximum Luminosity Delivered in one fill	$122.44\ pb^{-1}$
Maximum Luminosity Delivered in one day	$135.45\ pb^{-1}$
Maximum Luminosity Delivered in 7 days	$583.5\ pb^{-1}$
Maximum Colliding Bunches	1854
Maximum Peak Events per Bunch Crossing	33.96
Maximum Average Events per Bunch Crossing	32.21
Longest Time in Stable Beams for one fill	26.0 hours
Longest Time in Stable Beams for one day	21.9 hours (91.2%)
Longest Time in Stable Beams for 7 days	107.1 hours (63.7%)
Fastest Turnaround to Stable Beams	2.11 hours



Integrated luminosity per day



Luminosity vs time in the fill for which maximum luminosity was delivered



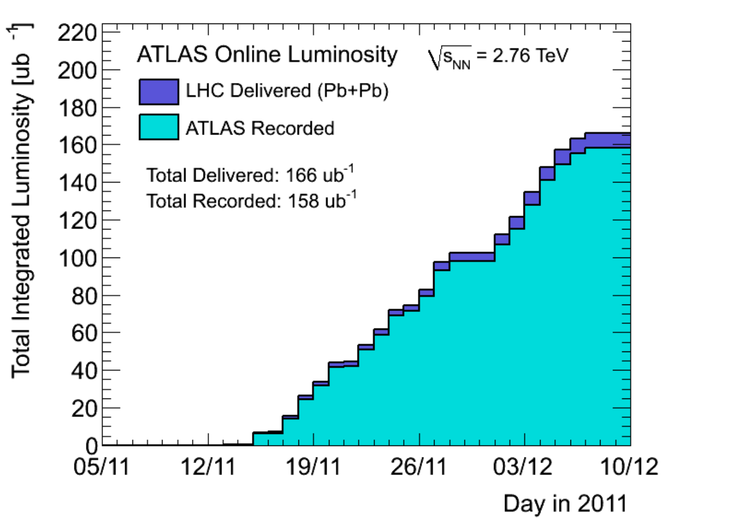
LHC design parameters

peak luminosity	$10^{34}\ cm^{-2}\ s^{-1}$
bunch spacing	25 ns
β*	0.5 m
full crossing angle θ_c	300 μrad
bunch population	1.1×10^{11}
number of bunches	2808

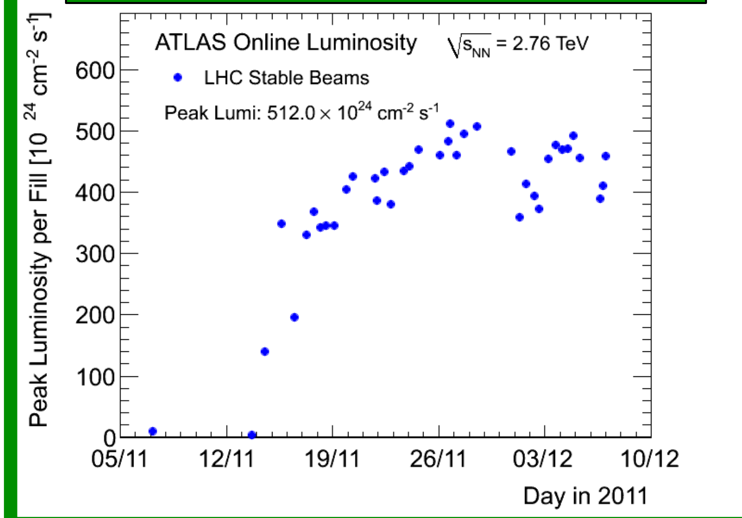
Pb-Pb integrated luminosity

17 times more Pb-Pb collisions:
- 9 μb-1 in 2010
- 158 μb-1 in 2011

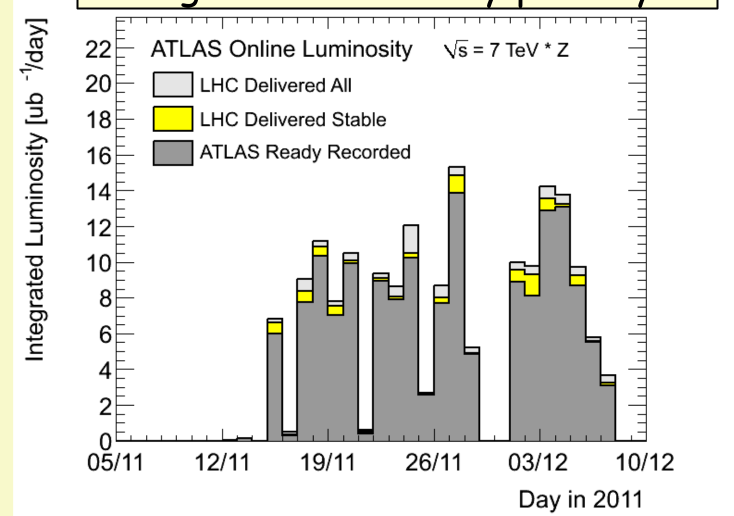
Excellent recording efficiency: 95%



Peak luminosity seen by ATLAS: ~ 5.12 x10^{26} cm^{-2} s^{-1}



Integrated luminosity per day



The LHC records in 2011. Ion run

Peak Stable Luminosity Delivered	3.65x10^{33} cm^{-2}s^{-1}
Maximum Luminosity Delivered in one fill	122.44 pb^{-1}
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Longest Time in Stable Beams for 7 days	107.1 hours (63.7%)
Fastest Turnaround to Stable Beams	2.11 hours

ATLAS detectors status

Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	96.4%
SCT Silicon Strips	6.3 M	99.2%
TRT Transition Radiation Tracker	350 k	97.5%
LAr EM Calorimeter	170 k	99.8%
Tile calorimeter	9800	96.2%
Hadronic endcap LAr calorimeter	5600	99.6%
Forward LAr calorimeter	3500	99.8%
LVL1 Calo trigger	7160	99.9%
LVL1 Muon RPC trigger	370 k100	99.0%
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	97.0%
TGC Endcap Muon Chambers	320 k	97.9%