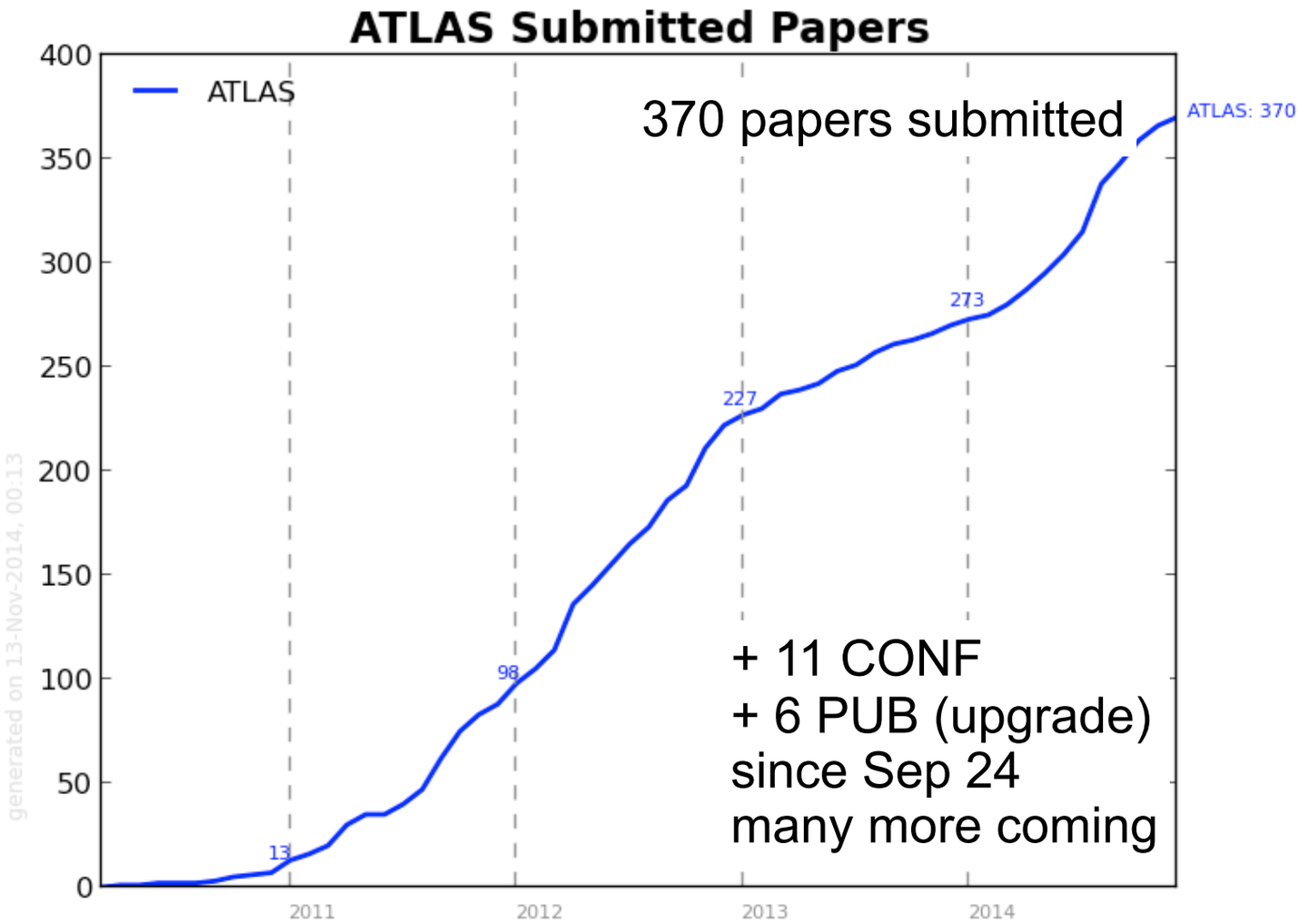
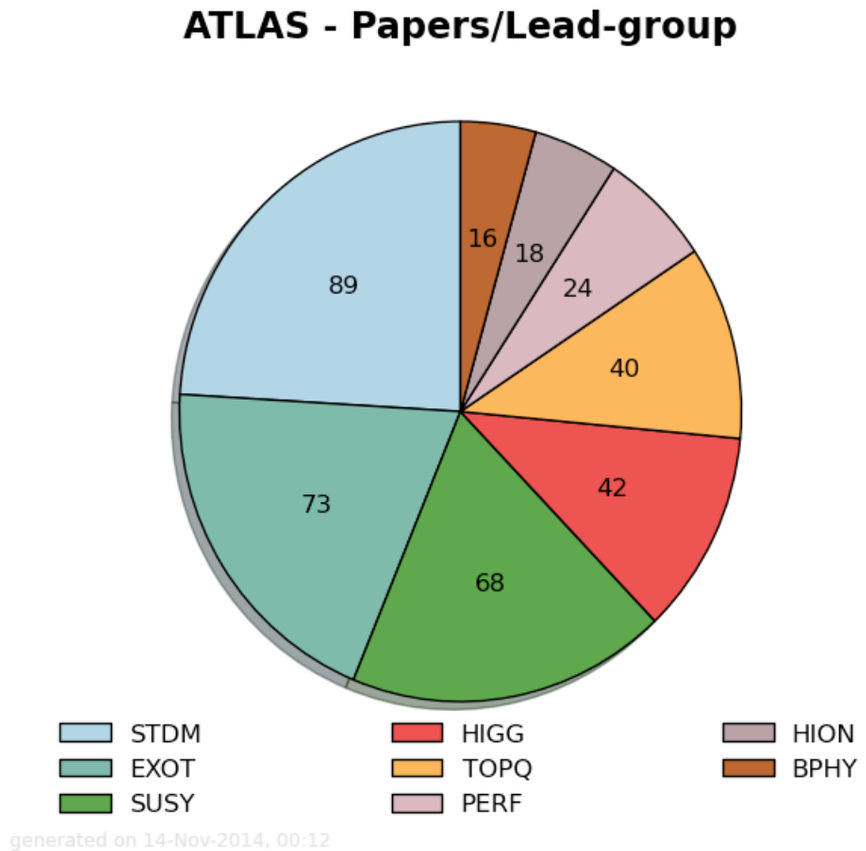
ATLAS
status report

Olya Igonkina
(NIKHEF)
for ATLAS collaboration

- Newest Run 1 results
- ATLAS data taking in M6 cosmics run
- Trigger and preparation for run 2

Publication status

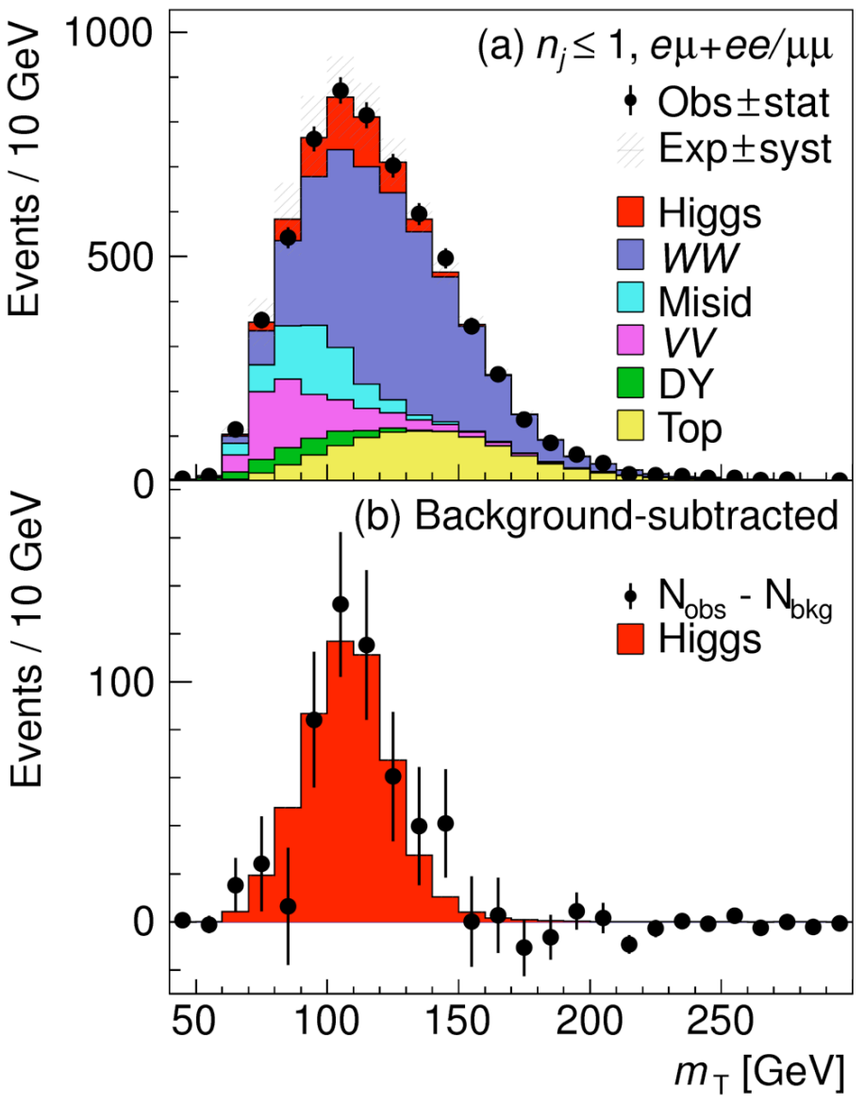




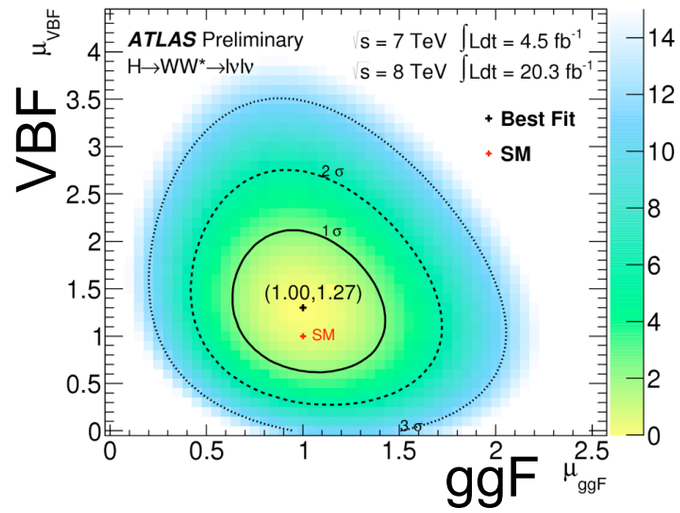
Few highlights on next slides

Observation of H→WW*

ATLAS Prelim. $H \to WW^*$
$\sqrt{s} = 8\,\text{TeV}, \int L\,dt = 20.3\,\text{fb}^{-1}$
$\sqrt{s} = 7\,\text{TeV}, \int L\,dt = 4.5\,\text{fb}^{-1}$



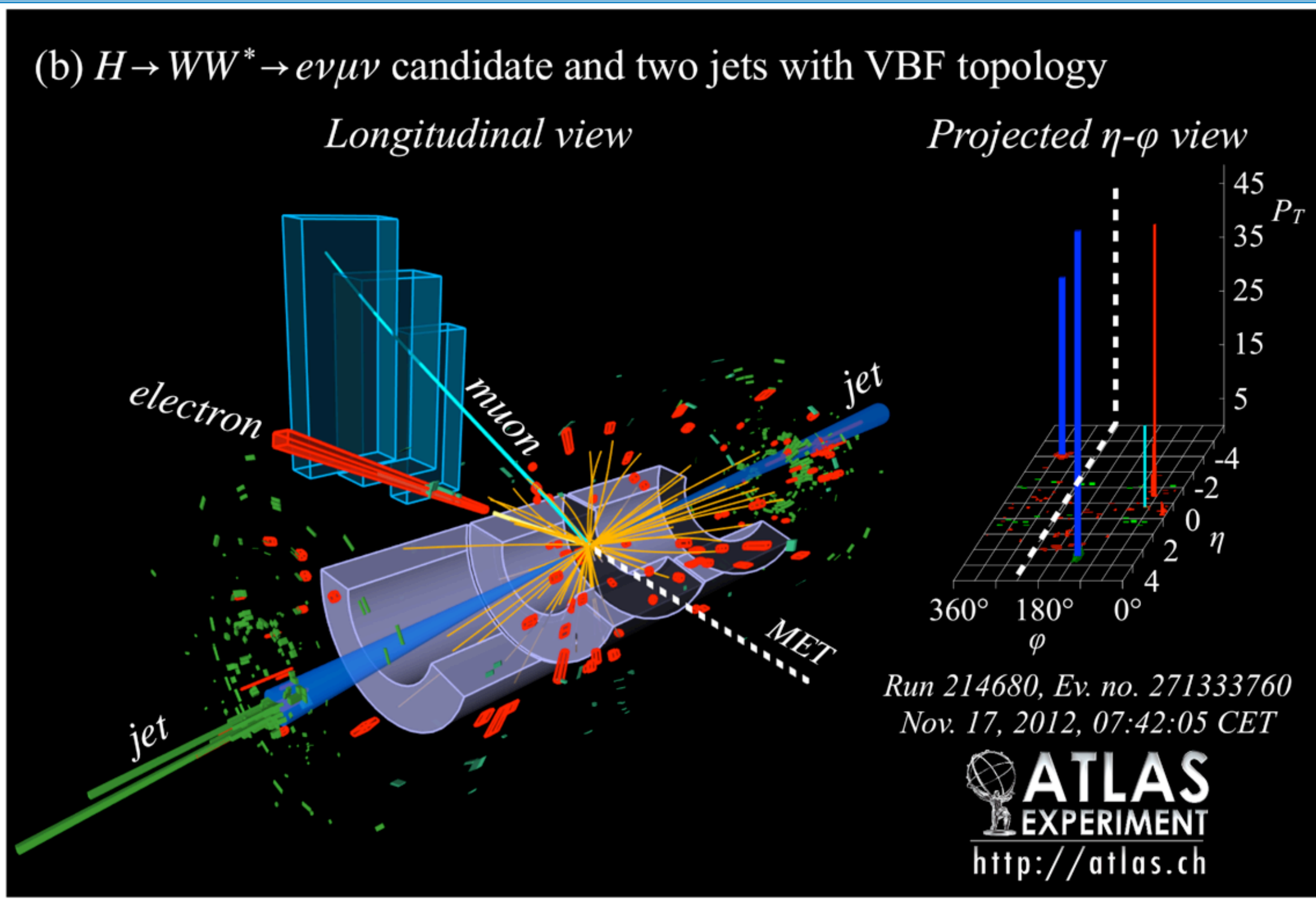
Observed μ =1.08 ± 0.22



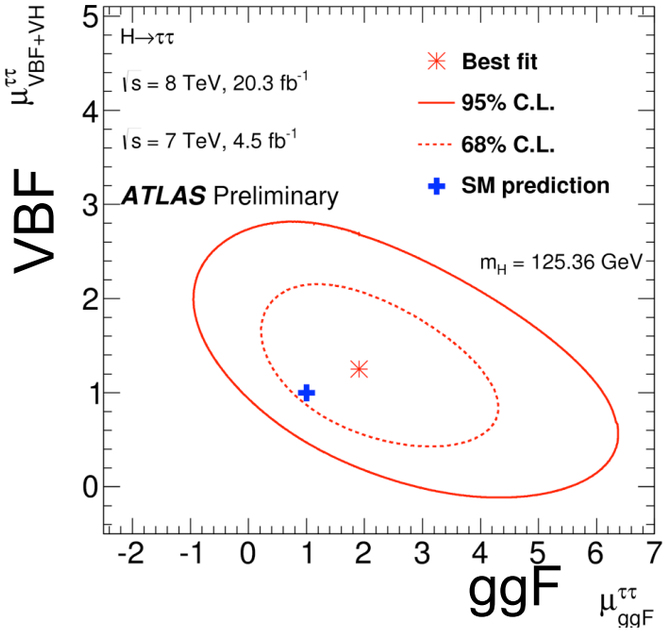
Sample	Signal significance: Exp. Z_0	Signal significance: Obs. Z_0	Signal significance: Bar graph of observed Z_0	Observed central value: μ_{obs}	Observed central value: $\mu_{obs} \pm$ stat. (thick) $\pm$ total (thin)
$n_j = 0$	3.71	4.09		1.14	
$e\mu$, $\ell_2 = \mu$	2.92	3.08		1.07	
$e\mu$, $\ell_2 = e$	2.33	3.12		1.40	
$ee/\mu\mu$ category	1.44	0.70		0.47	
$n_j = 1$	2.61	2.49		0.96	
$e\mu$ category	2.51	2.83		1.16	
$ee/\mu\mu$ category	1.04	0.21		0.20	
$n_j \geq 2$, ggF, $e\mu$	1.20	1.44		1.20	
$n_j \geq 2$, VBF-enr.	3.38	3.84		1.20	
$e\mu$ category	3.01	3.02		0.98	
$ee/\mu\mu$ category	1.58	2.96		1.98	
All n_j, all signal	5.76	6.07		1.08	
ggF as signal	4.34	4.28		1.01	
VBF as signal	2.68	3.25		1.27	

6.1σ!
ggF 4.3σ
VBF 3.2σ

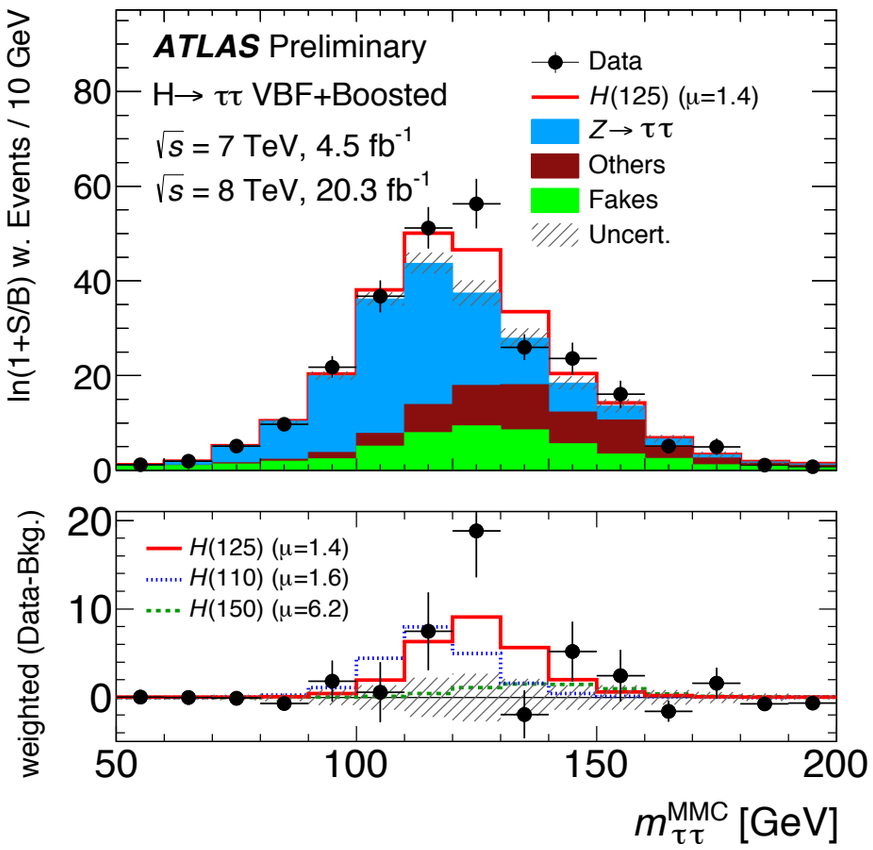
(b) $H \to WW^* \to e\nu\mu\nu$ candidate and two jets with VBF topology



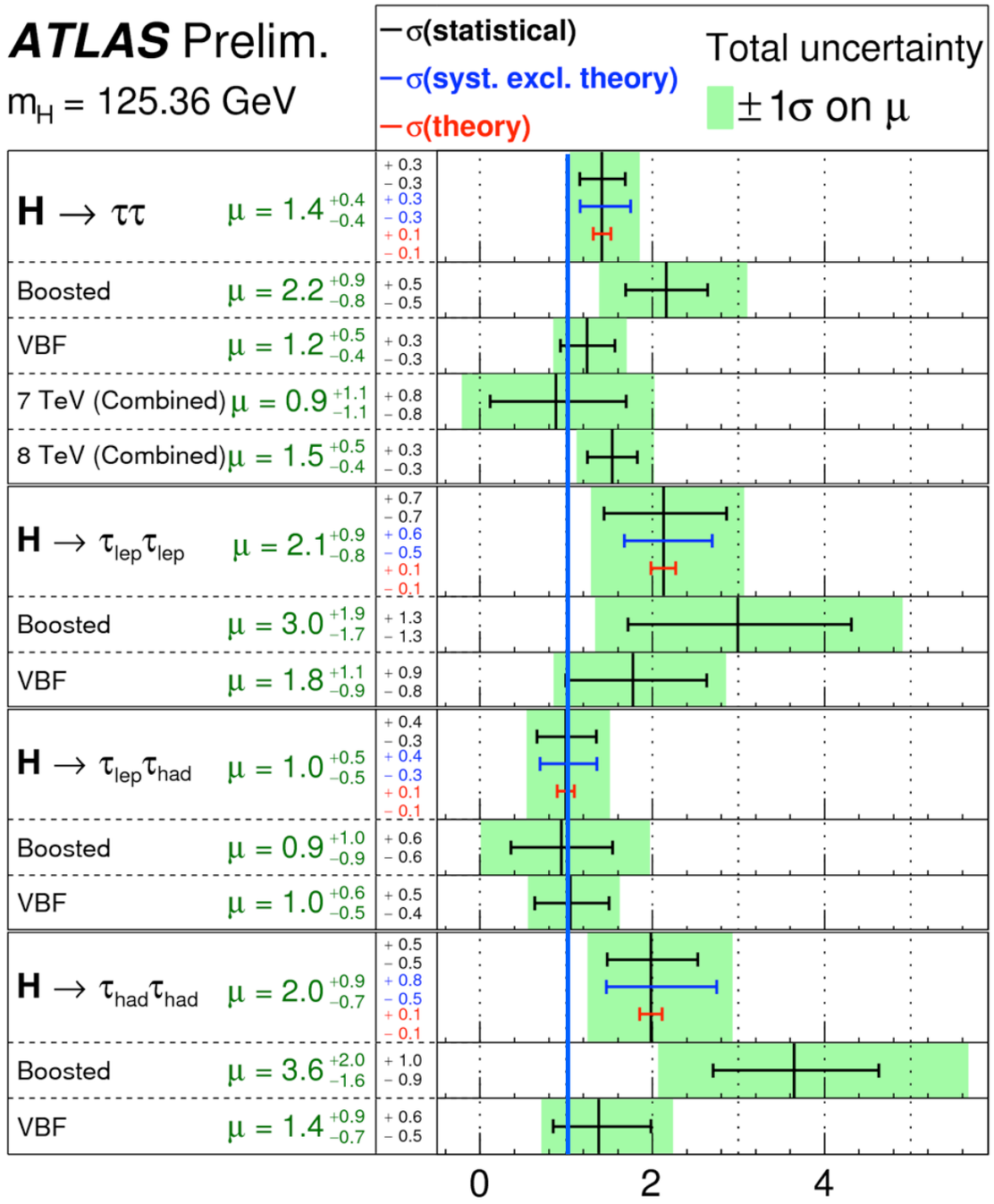
Evidence of H→ττ



Observed μ =1.4 ± 0.4



Signal:
expected 3.5σ
observed 4.5σ

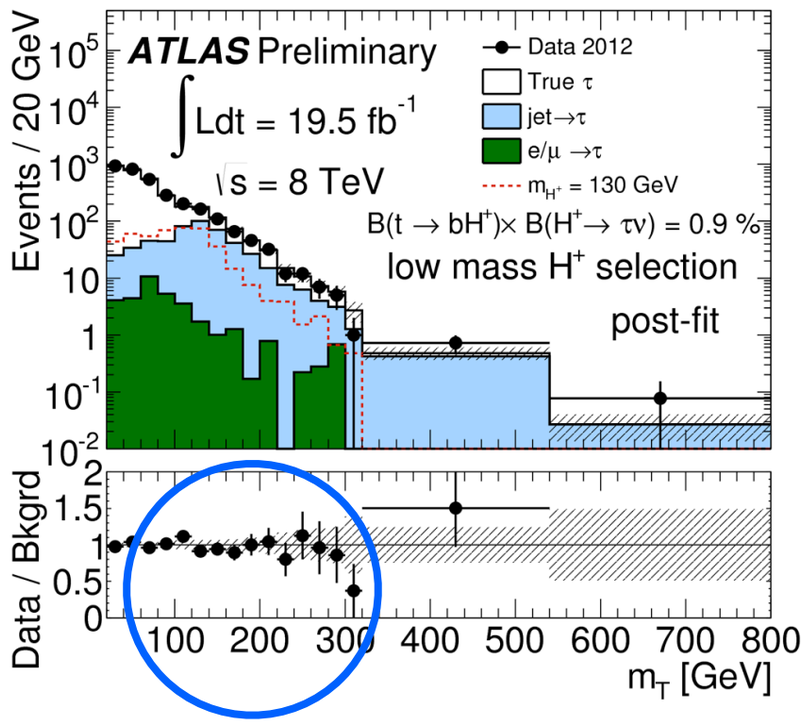


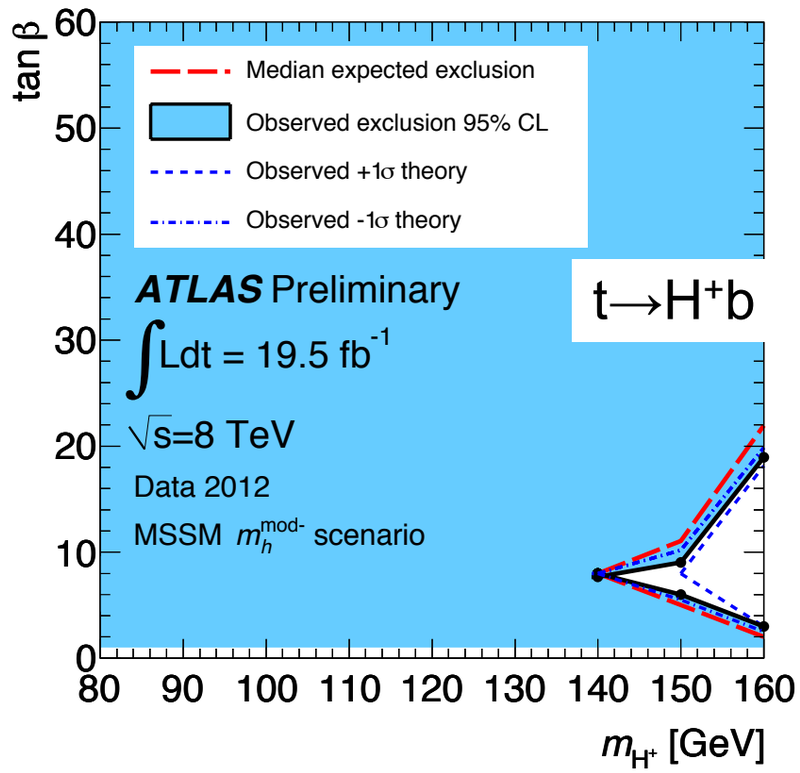
$H^+ \rightarrow \tau\nu$

Inclusive τ background obtained from μ+jets events using embedding technique

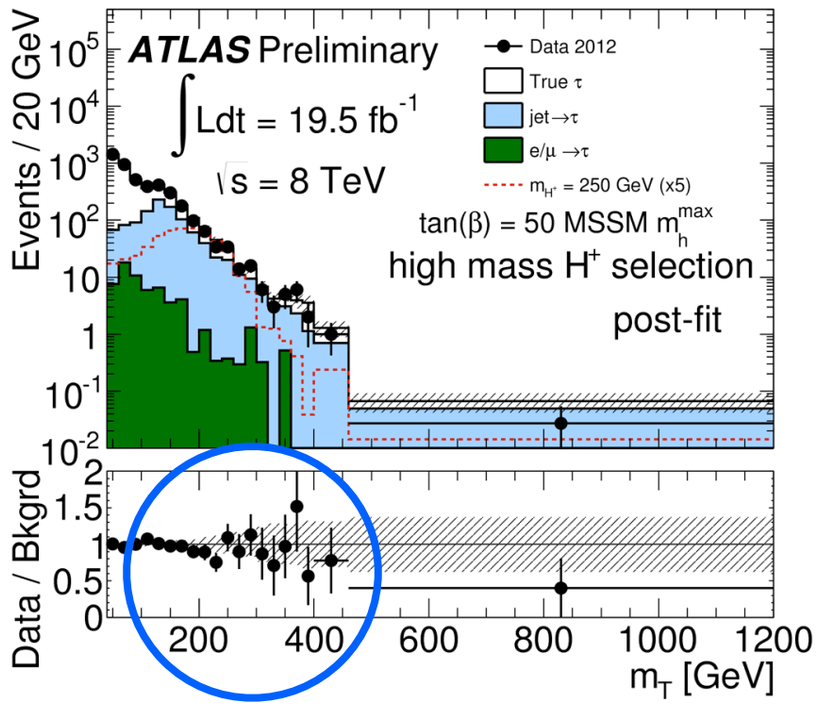
Interpretation MSSM "m_h mod-"

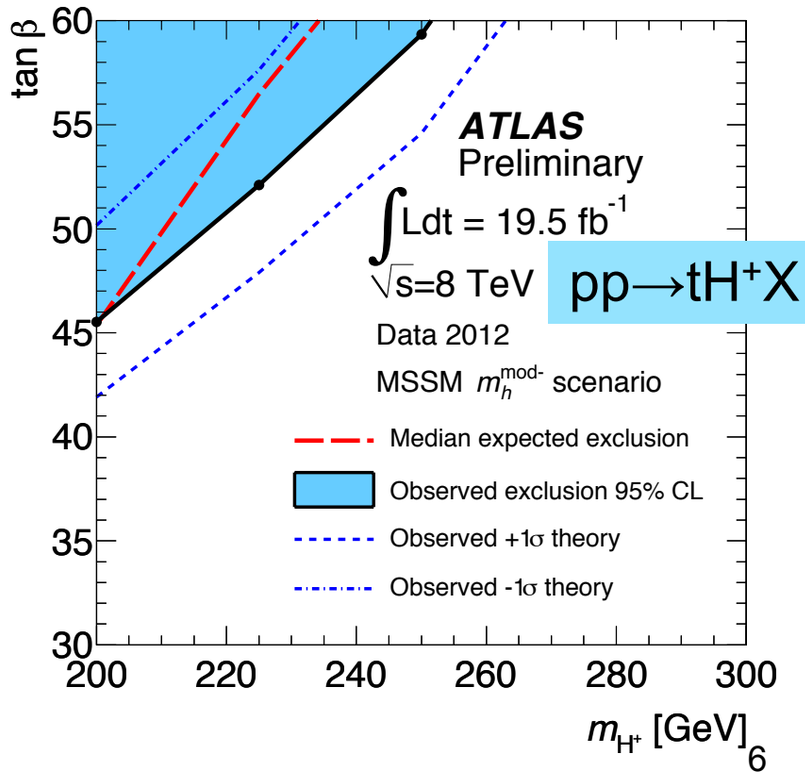
Low Mass
$t \rightarrow H^+b$





High Mass
$pp \rightarrow tH^+X$



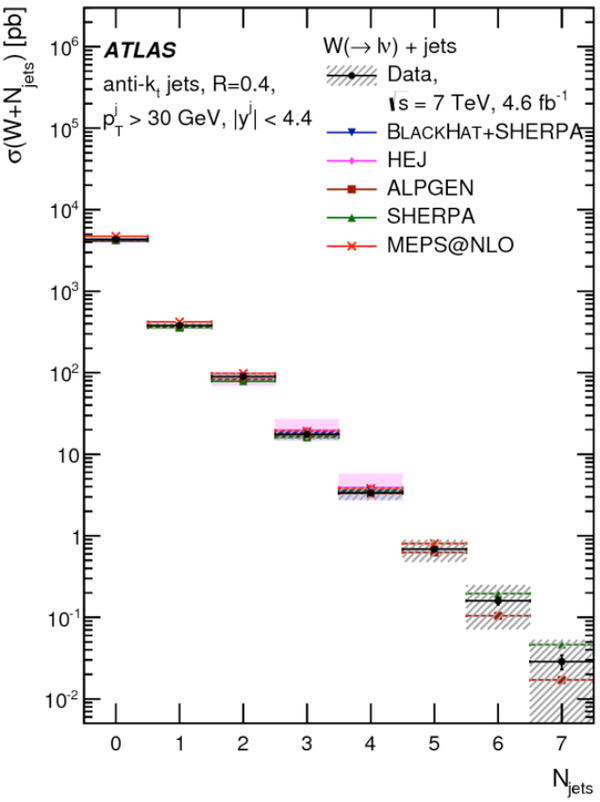


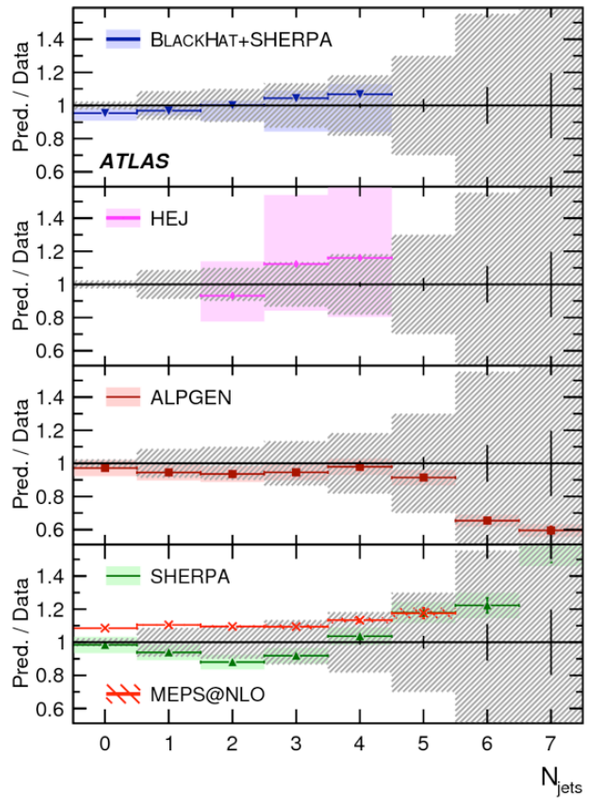
Submitted to EPCJ
arXiv:1409.8639

W($\ell\nu$)+jets (7 TeV)

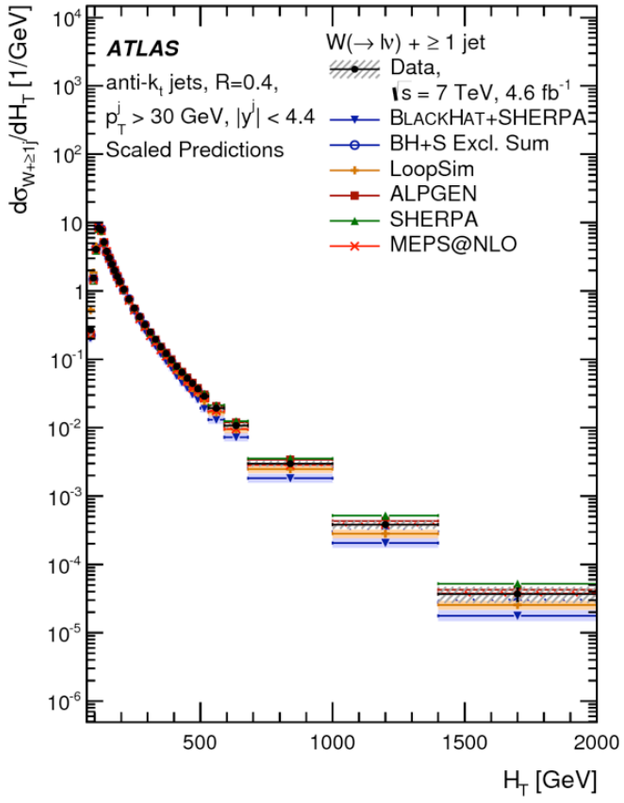
- State-of-the-art Measurement vs State-of-the-art Generators
- 34 differential cross-section distributions, unfolded to fiducial phase-space
- Reasonable agreement with theoretical calculations although none of the predictions describe all distributions

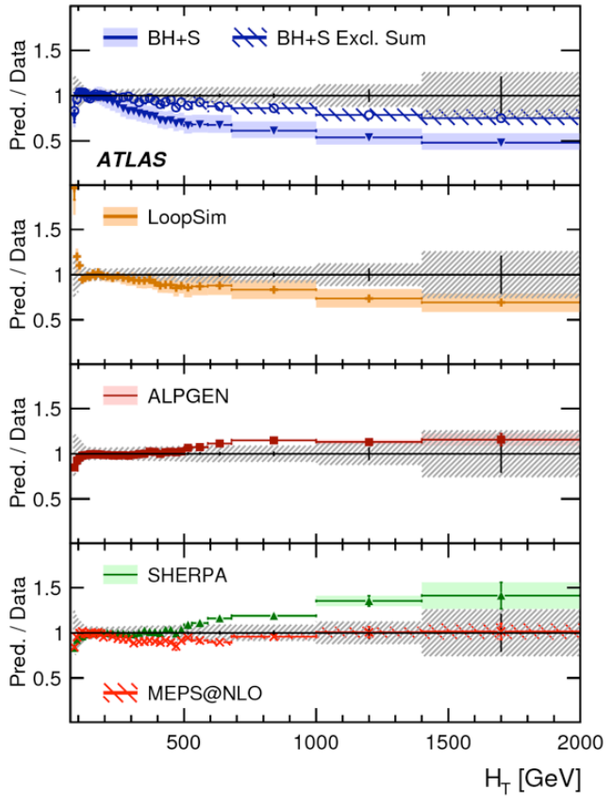
Jet multiplicity



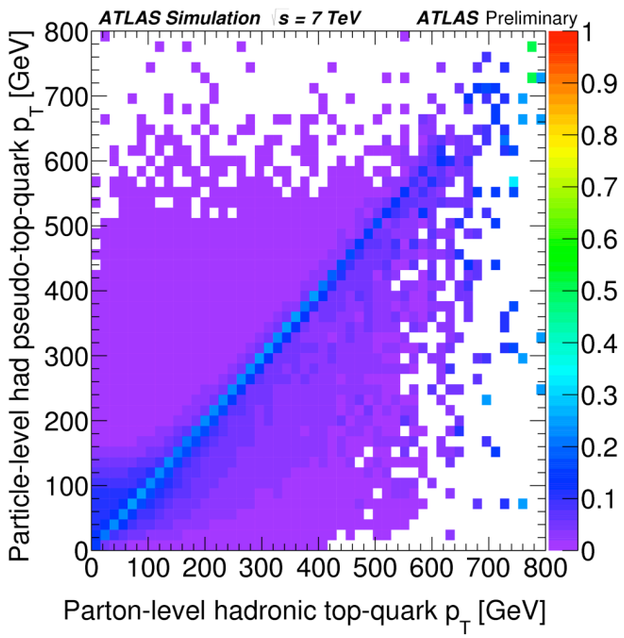


HT=$p_T(\ell)+\Sigma p_T(\text{jets})+\text{MET}$



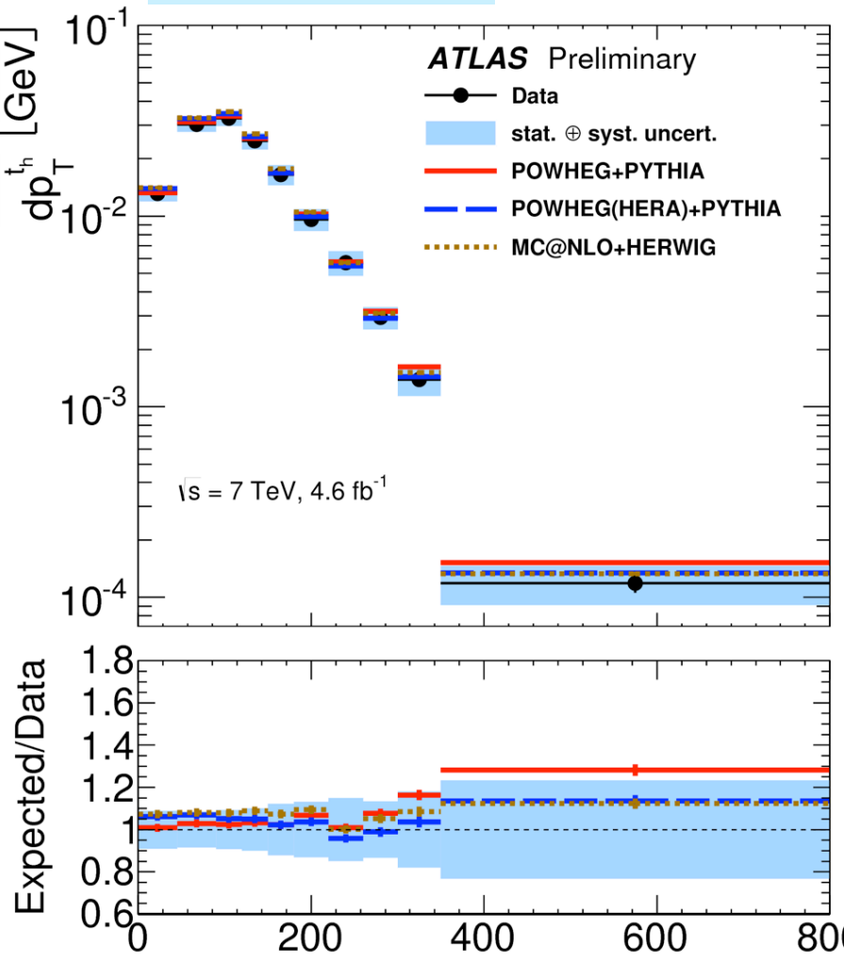


“Pseudo-top-quark” (7 TeV)

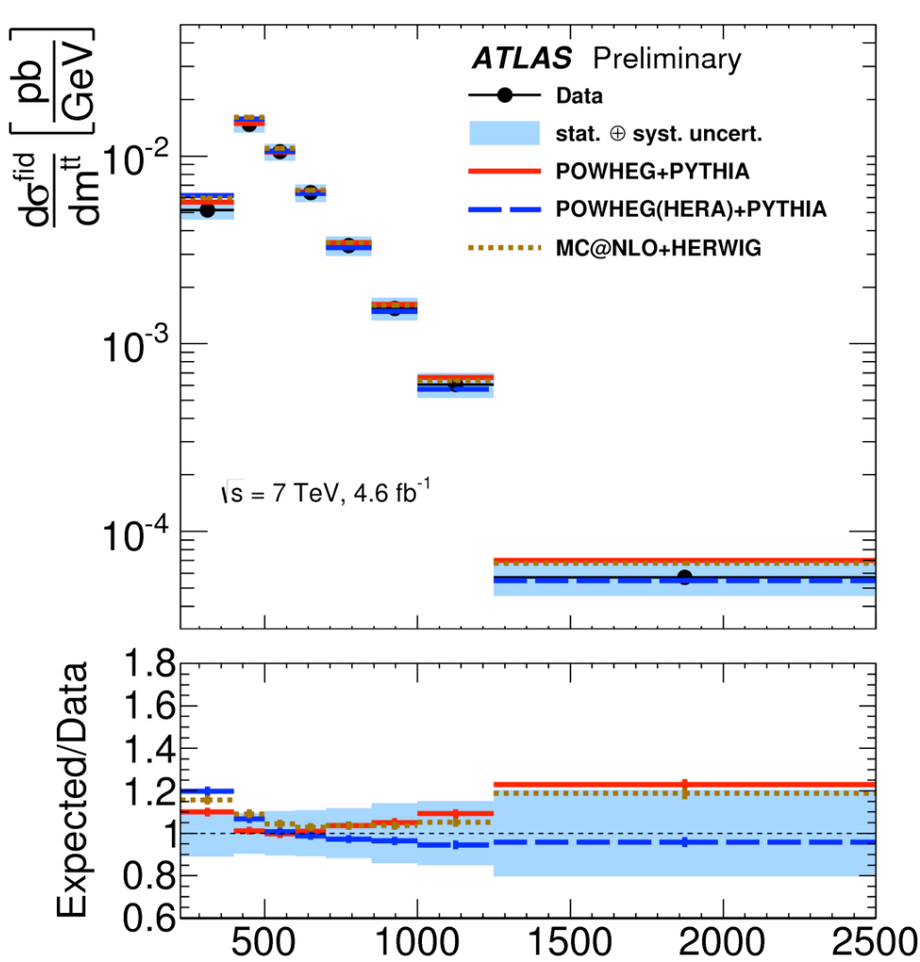


Differential ttbar cross section as function of pseudo-top observables. Pseudo-top is proxy for simplified kinematic top reconstruction at particle level. Both leptonic and hadronic pseudo-tops considered.

Particle level

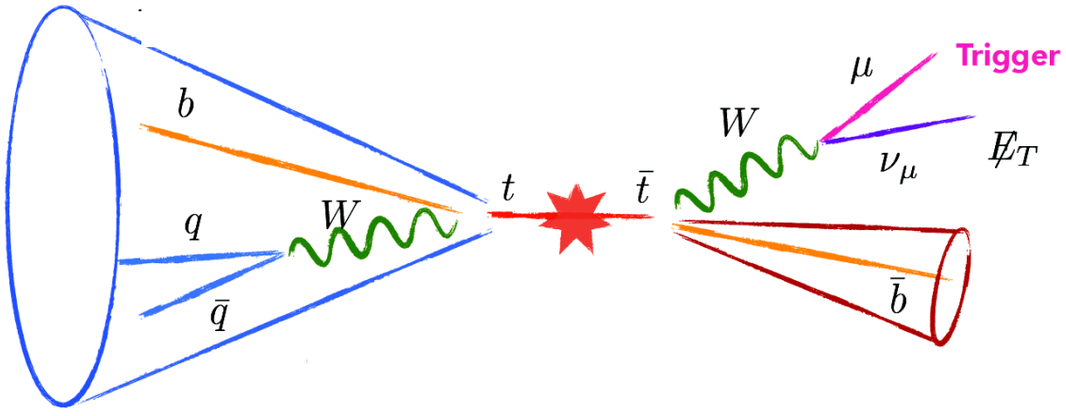


p_T of pseudo-top-quark decaying hadronically, [GeV]



Easier to use for theoretical calculations (here NLO)

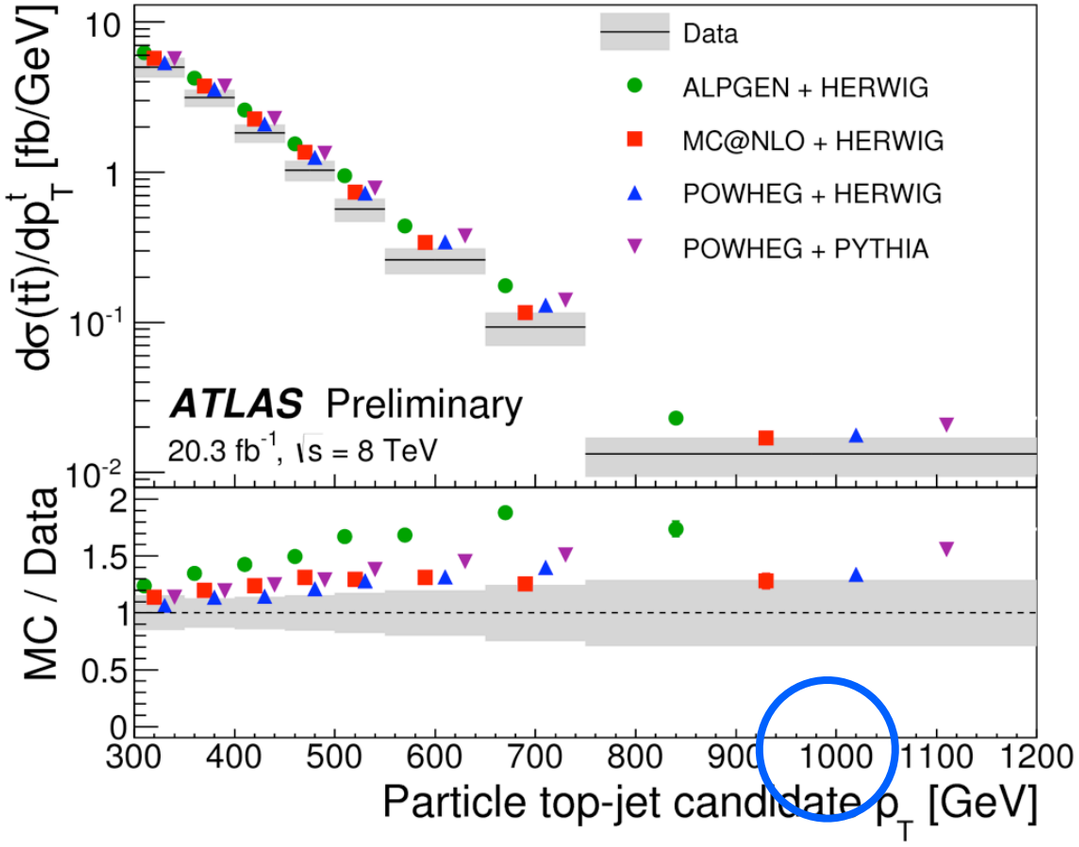
Highly Boosted Top



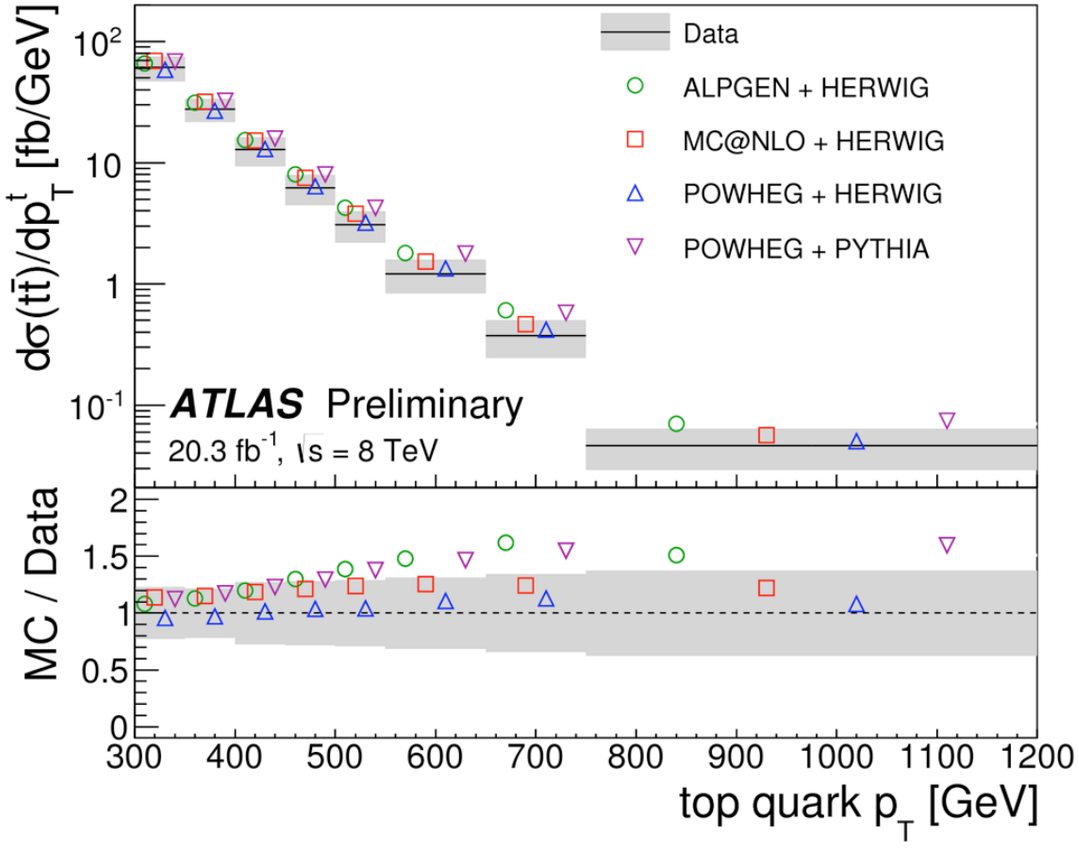
AntiKt dR=1.0, jet substructure

Access to very energetic top quark, sensitive to BSM
Softer p_T than predicted by MC
Use to improve Powheg for Run 2

Particle level



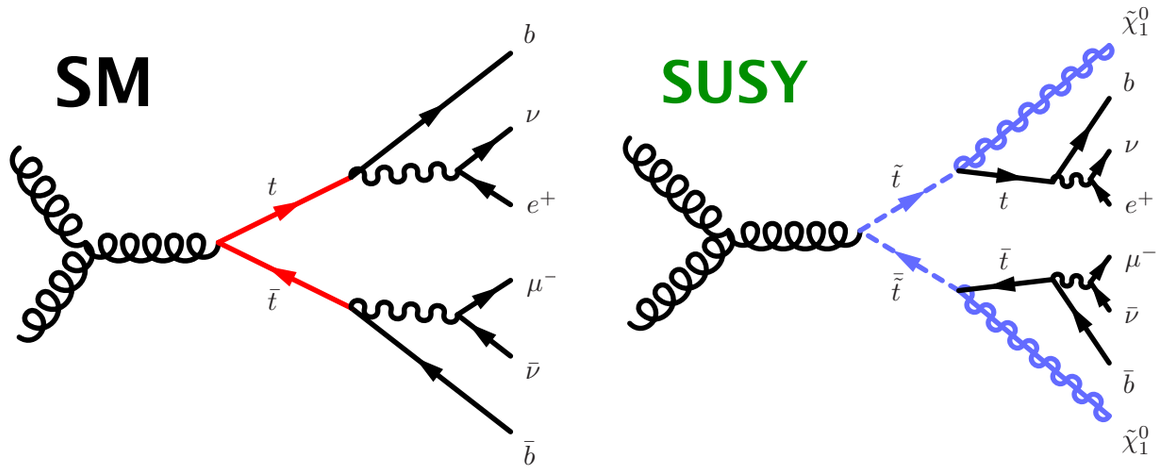
Parton level

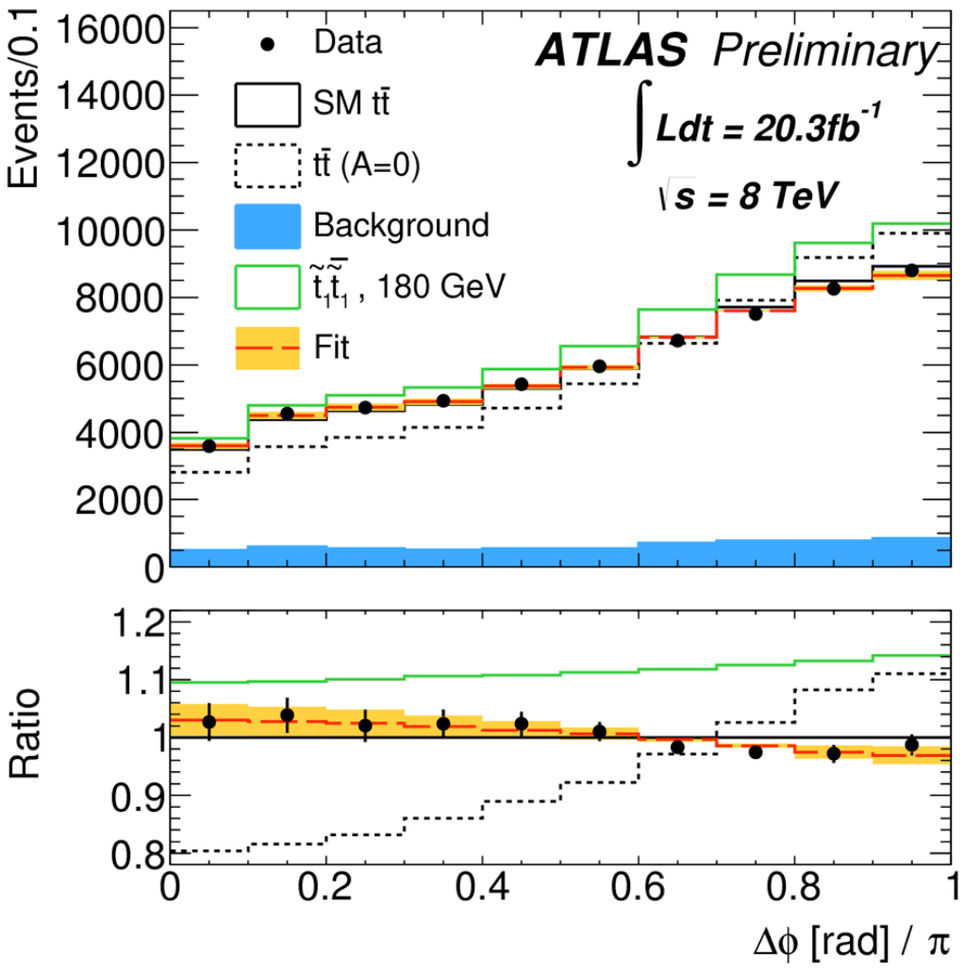


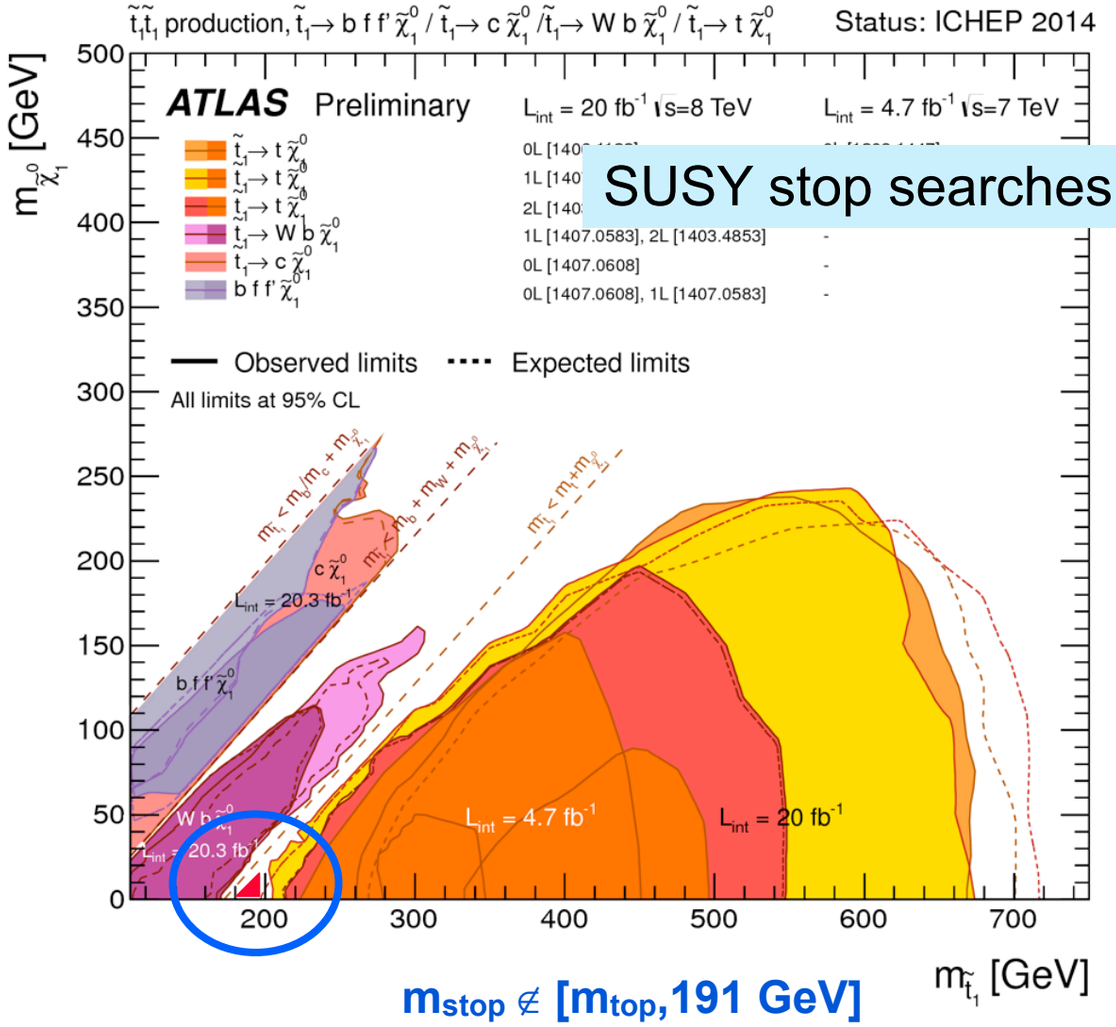
top anti-top spin correlations

$$A = \frac{N_{\uparrow\uparrow} + N_{\downarrow\downarrow} - N_{\uparrow\downarrow} - N_{\downarrow\uparrow}}{N_{\uparrow\uparrow} + N_{\downarrow\downarrow} + N_{\uparrow\downarrow} + N_{\downarrow\uparrow}}$$

SM: A = 0.318 ± 0.005
Observed: A = 0.38 ± 0.04







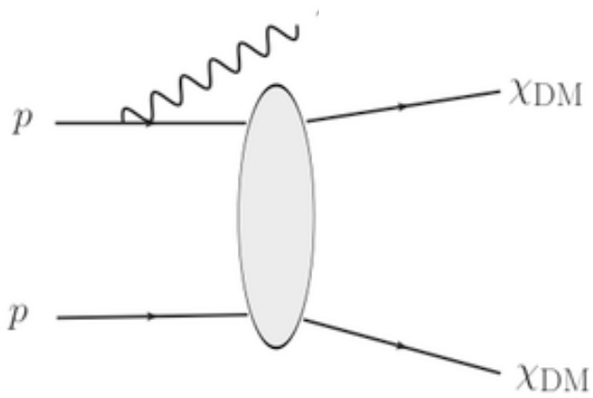
SUSY stop searches

$m_{stop} \notin [m_{top}, 191\ GeV]$

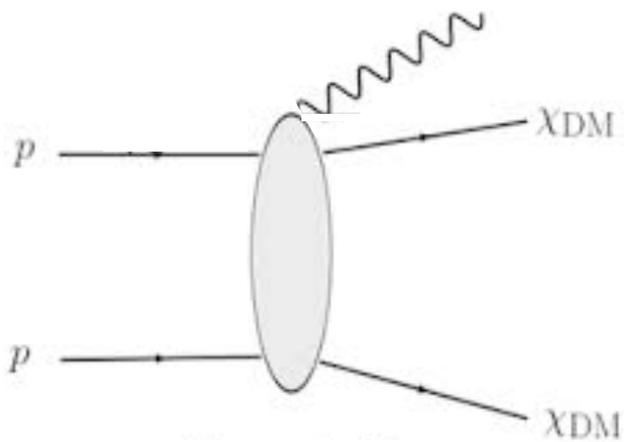
Invisible Particles Searches

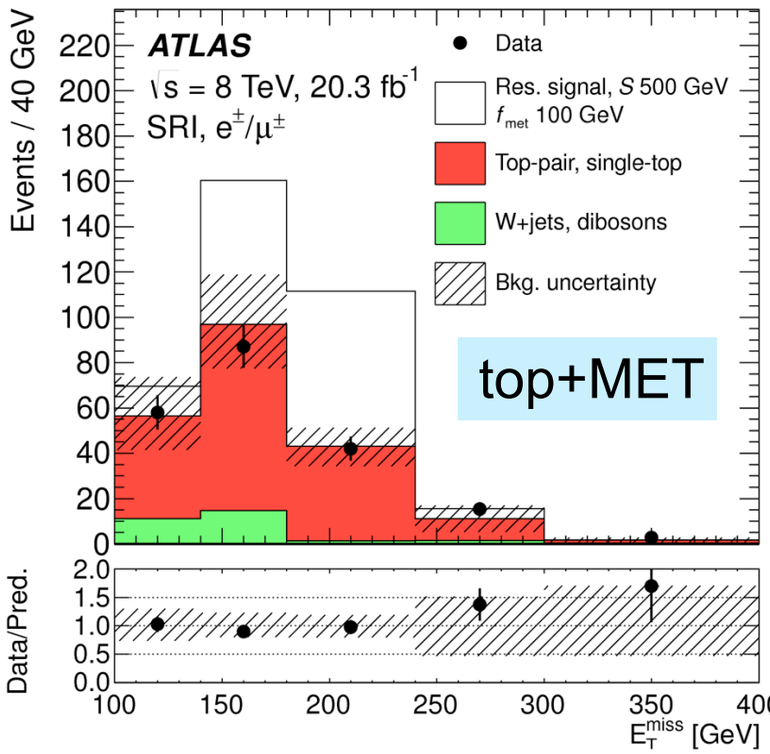
arXiv: (Submitted to)
γ+MET 1411.1559 (PRD)
b/bb+MET 1410.4031 (EPJC)
top+MET 1410.5404 (EPJC)

γ, t, b, bb̄, tt̄

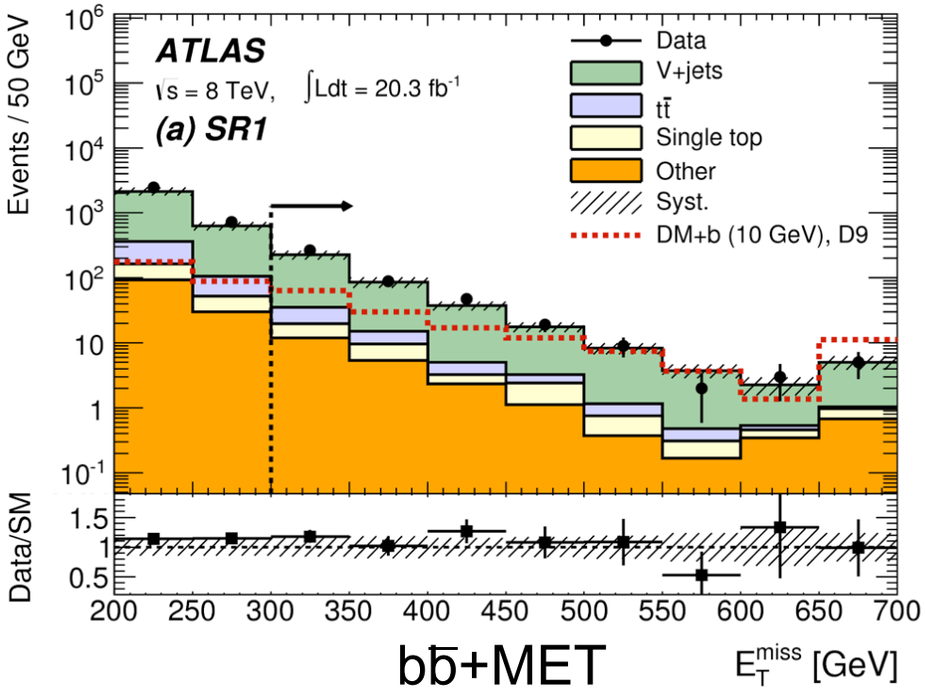


γ, t, b, bb̄, tt̄

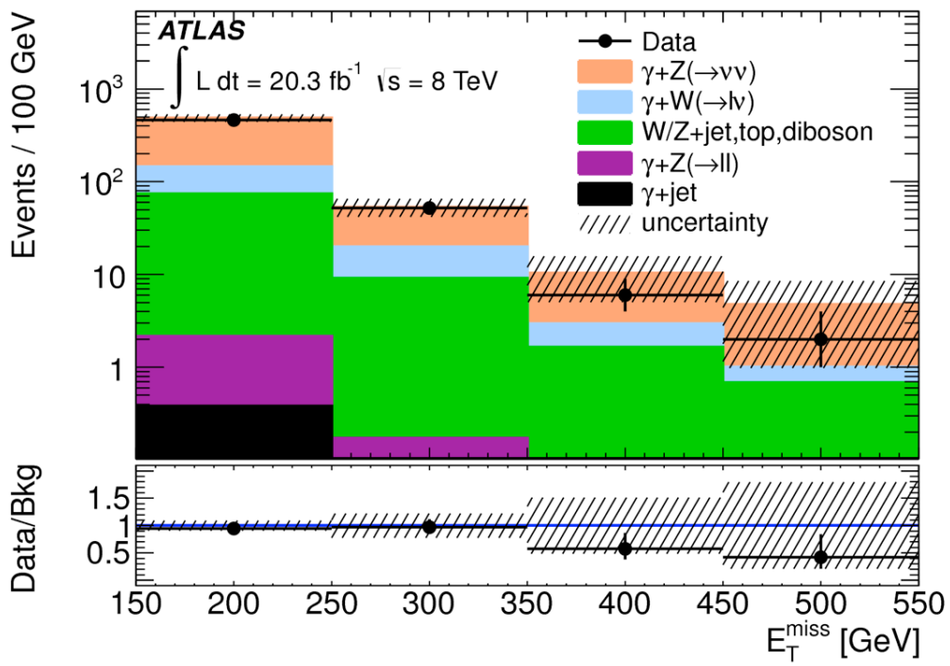




heavy quarks + MET



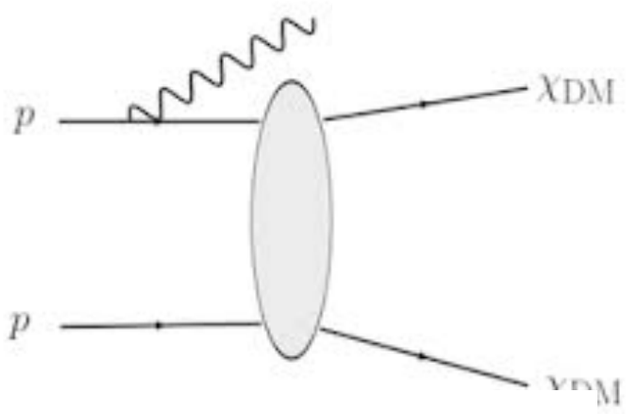
photon+MET



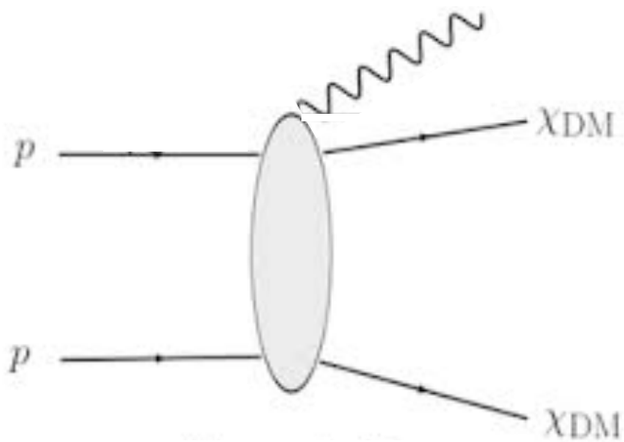
Invisible Particles Interpretations

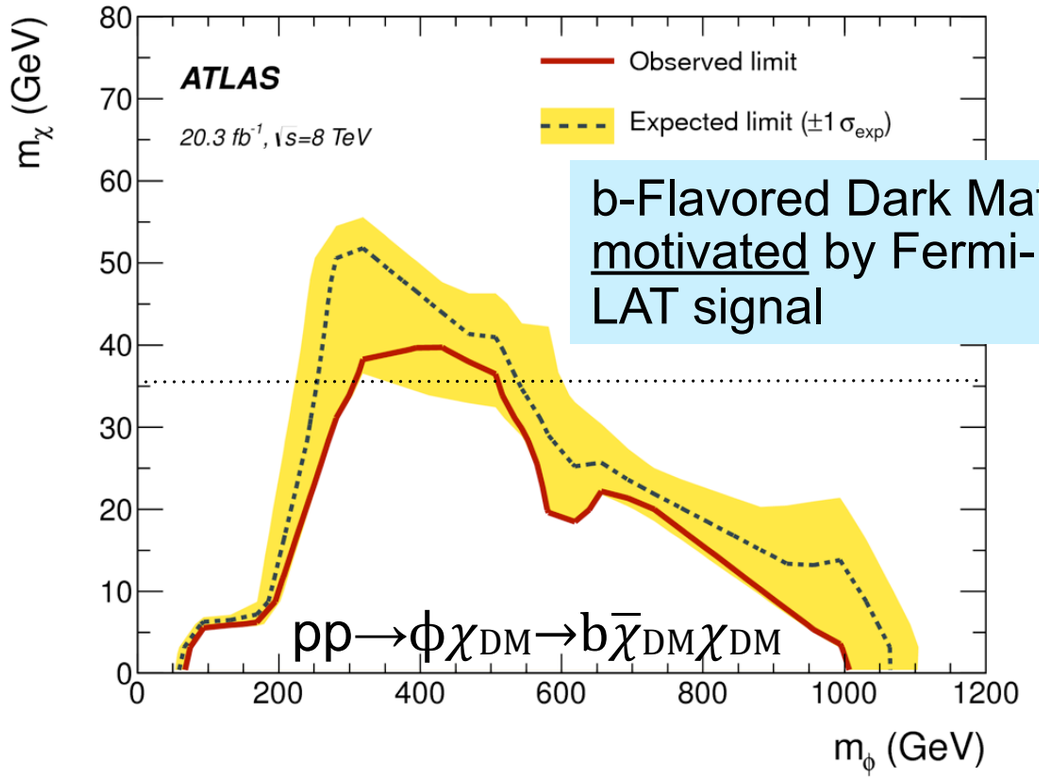
arXiv: (Submitted to)
γ+MET 1411.1559 (PRD)
b/bb+MET 1410.4031 (EPJC)
top+MET 1410.5404 (EPJC)

γ, t, b, bb̄, tt̄

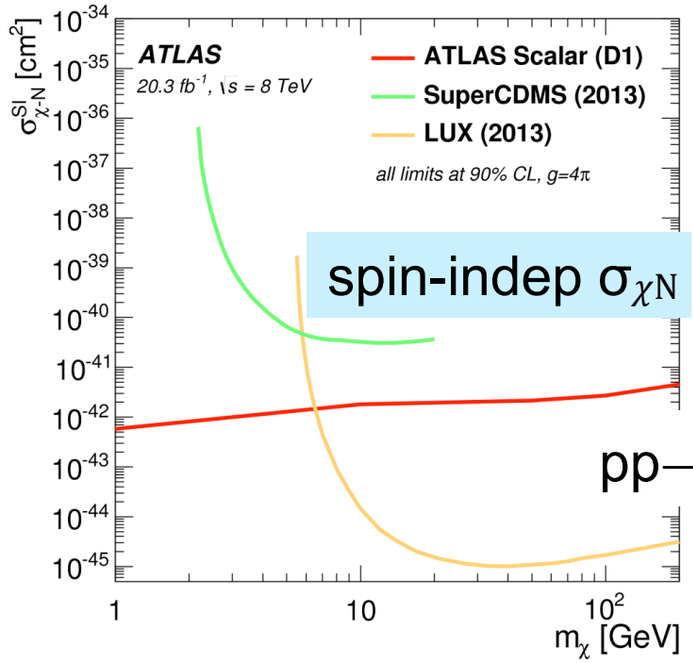


γ, t, b, bb̄, tt̄

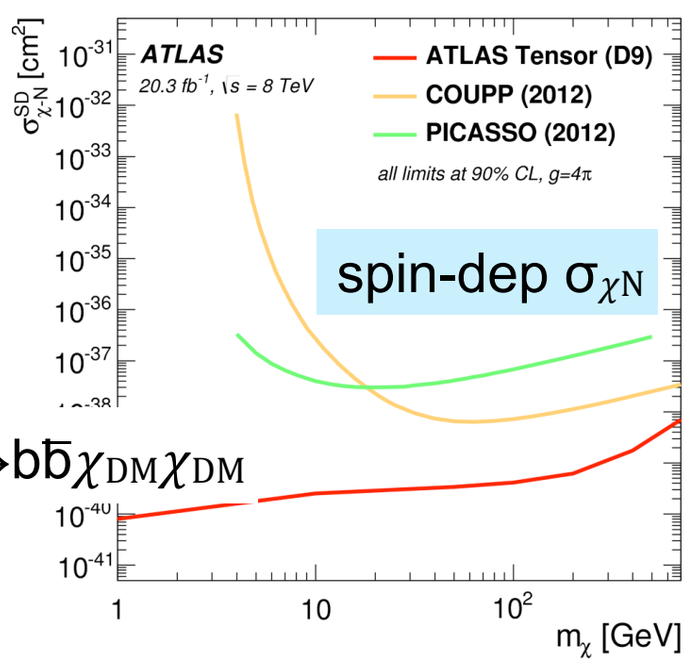




b-Flavored Dark Matter motivated by Fermi-LAT signal

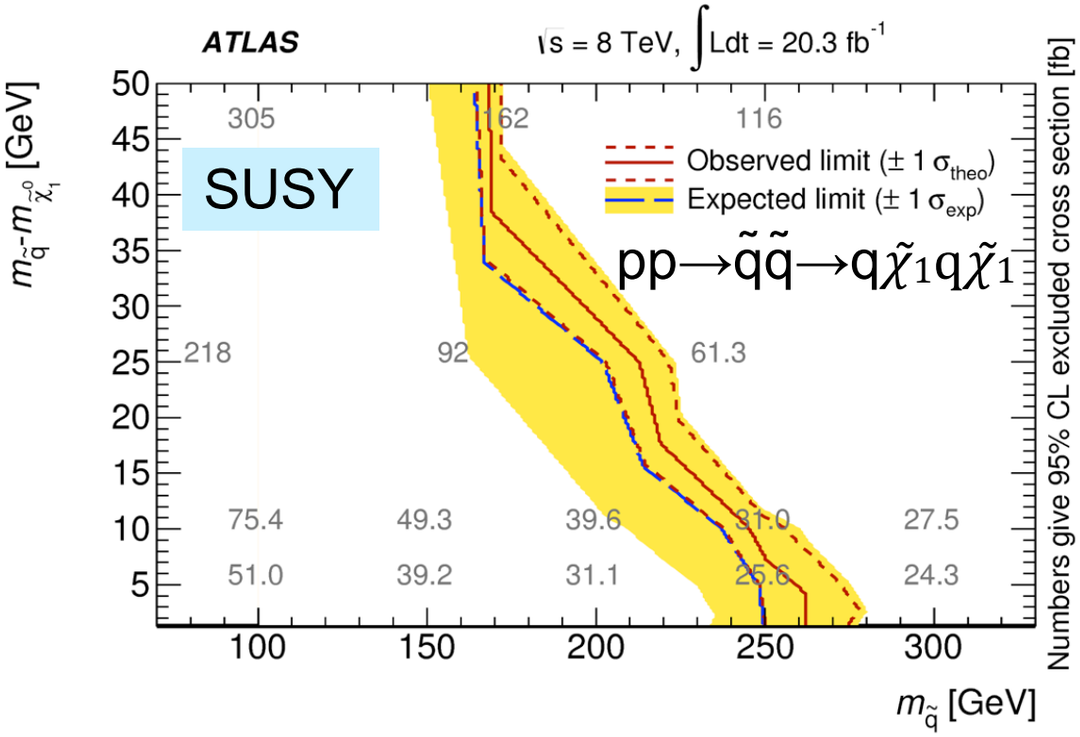


spin-indep $\sigma_{\chi N}$



spin-dep $\sigma_{\chi N}$

$pp \to b\bar{b}\chi_{DM}\chi_{DM}$

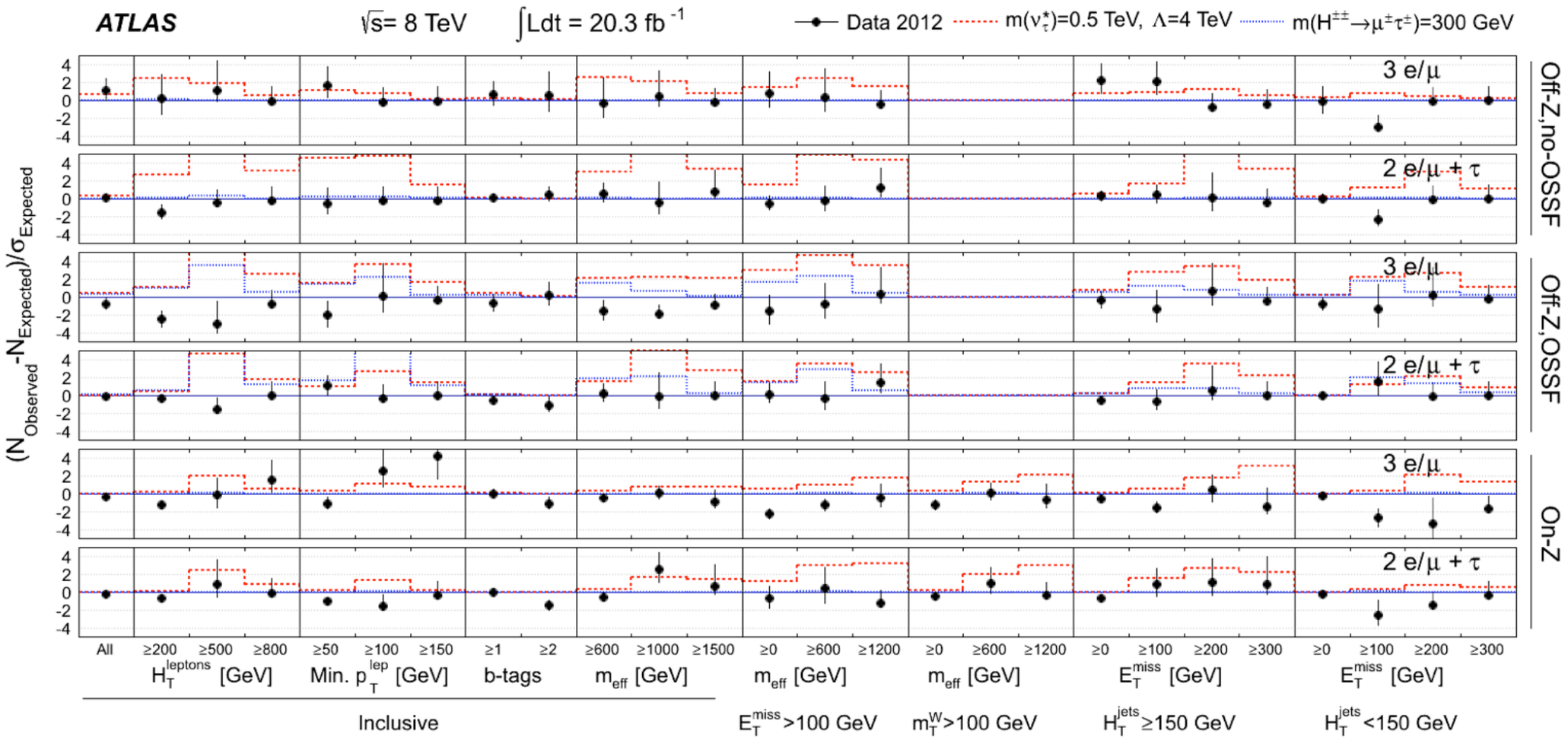


EFT approaches:
1) take only phase space where EFT is valid (as above)
2) or work with simplified models

Submitted to JHEP
arXiv: 1411.2921

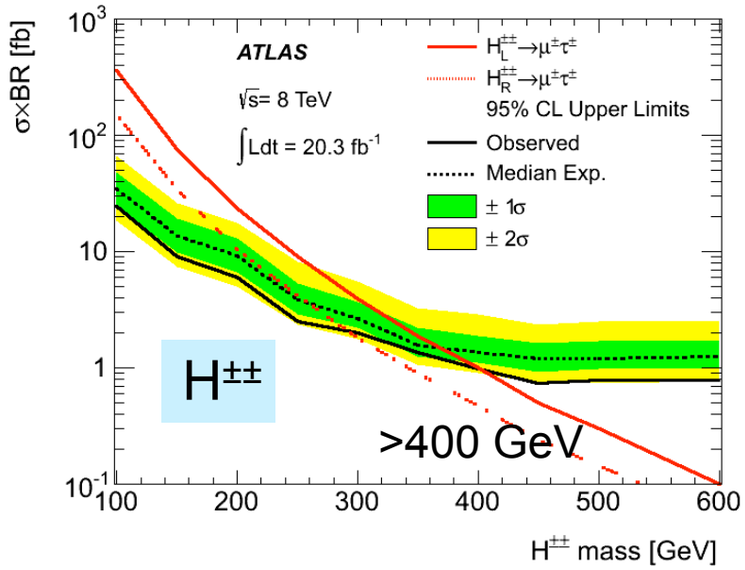
Multi-lepton searches

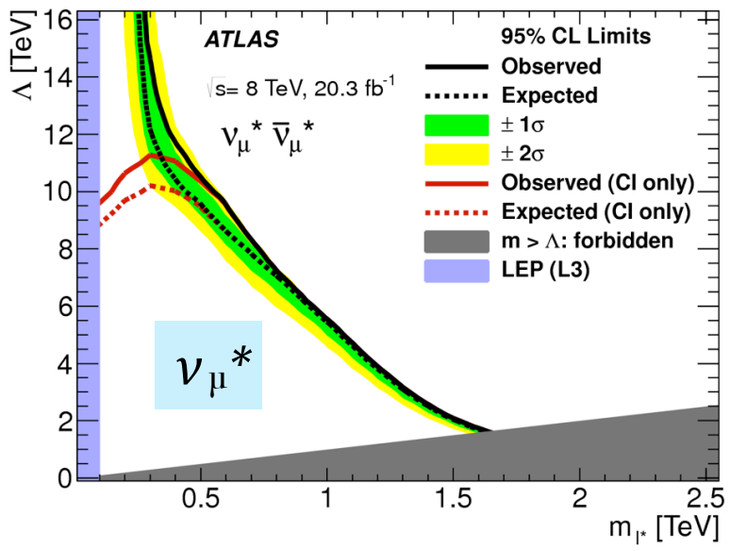
3 leptons, on/off Z different lepton pT, jets, bjets, m_{eff}, MET



No deviation observed

Interpretations
for $H^{\pm\pm}$
excited leptons (e^*, μ^*, τ^*)
excited neutrinos (ν_e^*, ν_μ^*, ν_τ^*)





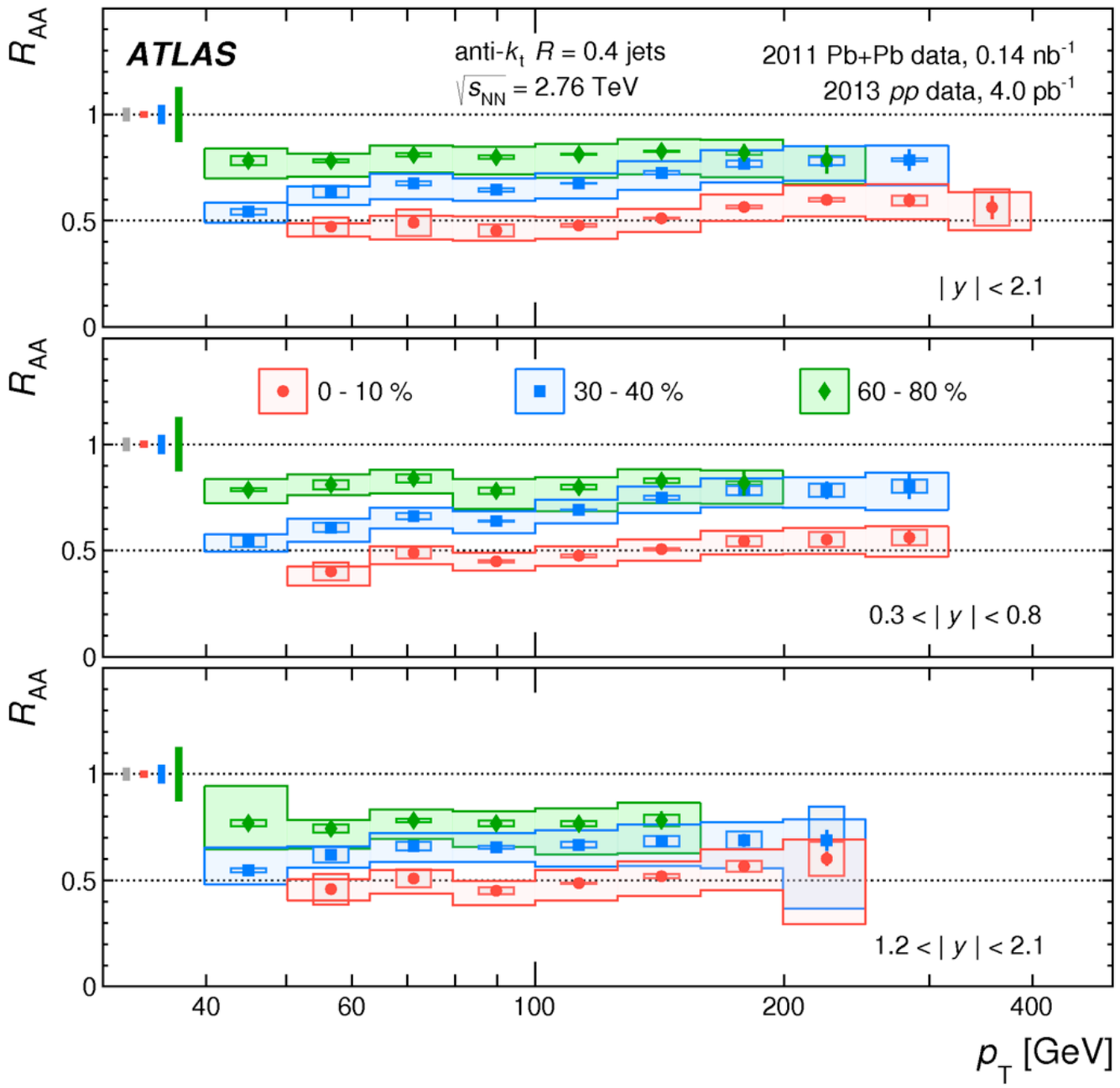
Submitted to PRL
arXiv: 1411.2357

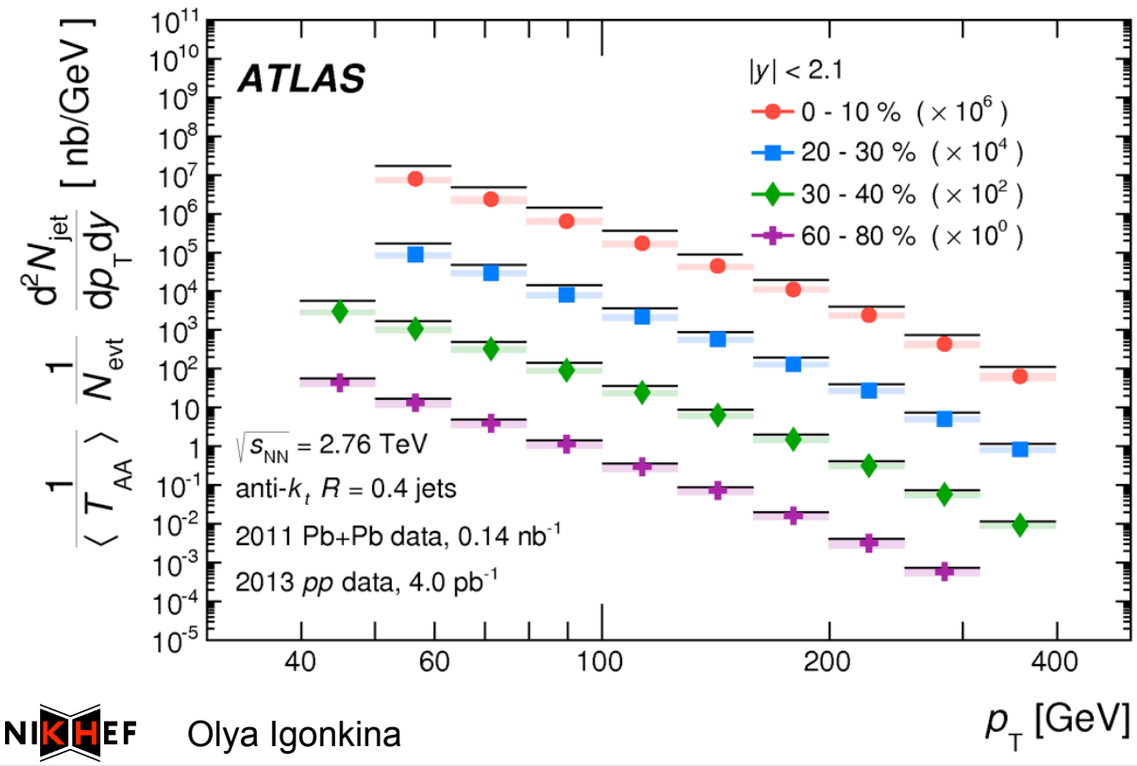
Jet suppression in Pb+Pb

$$R_{AA} = \frac{\frac{1}{N_{\rm evt}^{\rm tot} < T_{AA} >} \frac{d^2 N_{\rm jet}}{dp_T dy}\Big|_{cent}}{\frac{d^2 \sigma_{\rm jet}}{dp_T dy}\Big|_{pp}}$$

Precision measurement of jet quenching
x 2 suppression for central collisions
slight p_T dependence for central collisions

Normalized on 2013 *pp* **data** @ 2.76 TeV !





Preparation for Run 2

Completing LS1 consolidation

Lots of work at P1 : installation is practically completed, focus on re-commissioning

- Beampipe bakeout is executed and worked as expected
- IBL and pixel installation completed; connected and operational
- SCT readout operational. New ROD/BOC cards installed
- Pixel/SCT operational with run 1 cooling; new cooling is in commissioning
- TRT preparations and planning for mixed Xe/Ar system is developed
- Solenoid has been ramped up to full current. Plan to have all 4 magnets ON first week of December
- LAr fully closed, chasing an isolation issue which may require further access in December/January
- LAr LVPS running stably, demonstrator readout crate installed with two Phase-1 LTDBs
- Tile: Stable operation since the end of FE refurbishment in August. Improved Cs system back in operations.
- CSC : new RODs used since M5; firmware development is ongoing;
- RPC campaign to fix broken/cracked gas inlets is almost completed
- Big wheel was opened: 26 TGC chambers are fixed
- ALFA & LUCID are installed
- TDAQ - on next slides

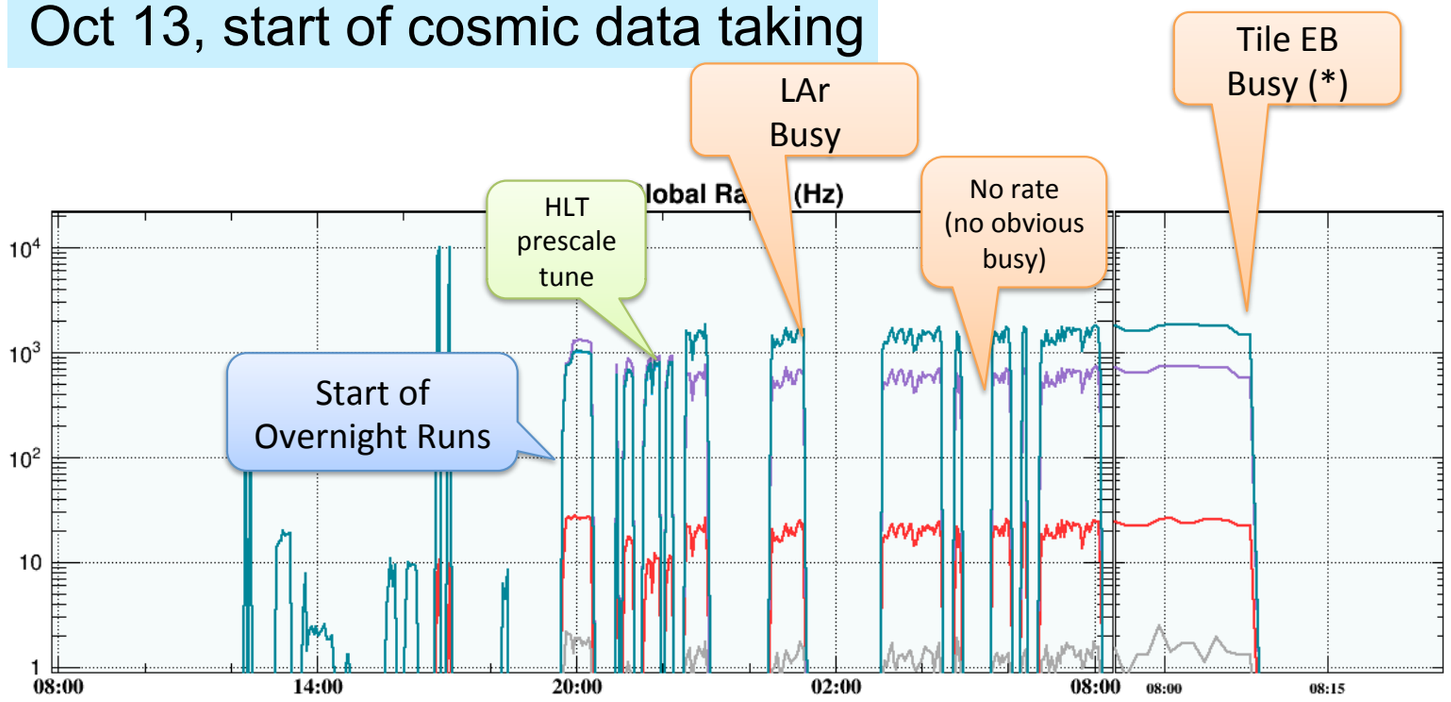
Cosmic data taking (M-weeks)

	M1 ✓	M2 ✓	M3 ✓	M4 ✓	M5 ✓	M6 ✓	**M7 - Cosmic Run Nov 24th - Dec 8th**
	Feb 17– Feb 23	Mar 31- Apr 4	May19- May 23	Jul 7- Jul 11	Sep 8- Sep 12	Oct 13- Oct 17	Full Shiftcrew; all detectors included; B field ON from Dec 1st.
PIX				X[1], X[2]	X[2]		[1] TDAQ integration, ~~using events simulated at ROD~~ [2] test with frontend, ID endplate in, detector cold nominal
IBL				X[1]	X[2]		As above, all staves in M6
SCT				X	X[2]		As above, Barrel + Endcap in M6
TRT		X					**All information in P1 Twiki:**
LAR				X			**https://atlasop.cern.ch/twiki/bin/view/Main/Run2Preparation**
TIL				X			**M5: TDAQ update, DB upgrade, all of ID joining, etc.**
MBTS				X			Both sides in M5
L1Calo	X[1]			X[2]	X[3]	X[4]	[1] Readout only. [2] Full legacy triggering with TIL + LAR [3] CMX triggering both CP/JEP systems, L1Topo Readout Commissioned. [4] L1Topo commissioned fully in trigger system →M7
CSC	X[1]				X[2]	X[2]	[1] Old RODs, side A only [2] New ROD Commissioning
MDT	X						
RPC		X[1]	X[1]				[1] TDAQ integration. HV for ~ 1 sector
TGC	X[1]					X[2]	[1] no HV/gas until Jan 2015,[2] chamber replacements
BCM		X					**M6:**
ALFA						X	• **Possibly full ID (SCT B+EC, PIX, IBL all 14 staves)**
LUCID							• **ALFA in (Lucid in M7: installation+bake-out)**
Lumi					X		• **CTP|L1|HLT|DQ, nCSC, more RPC sectors.**

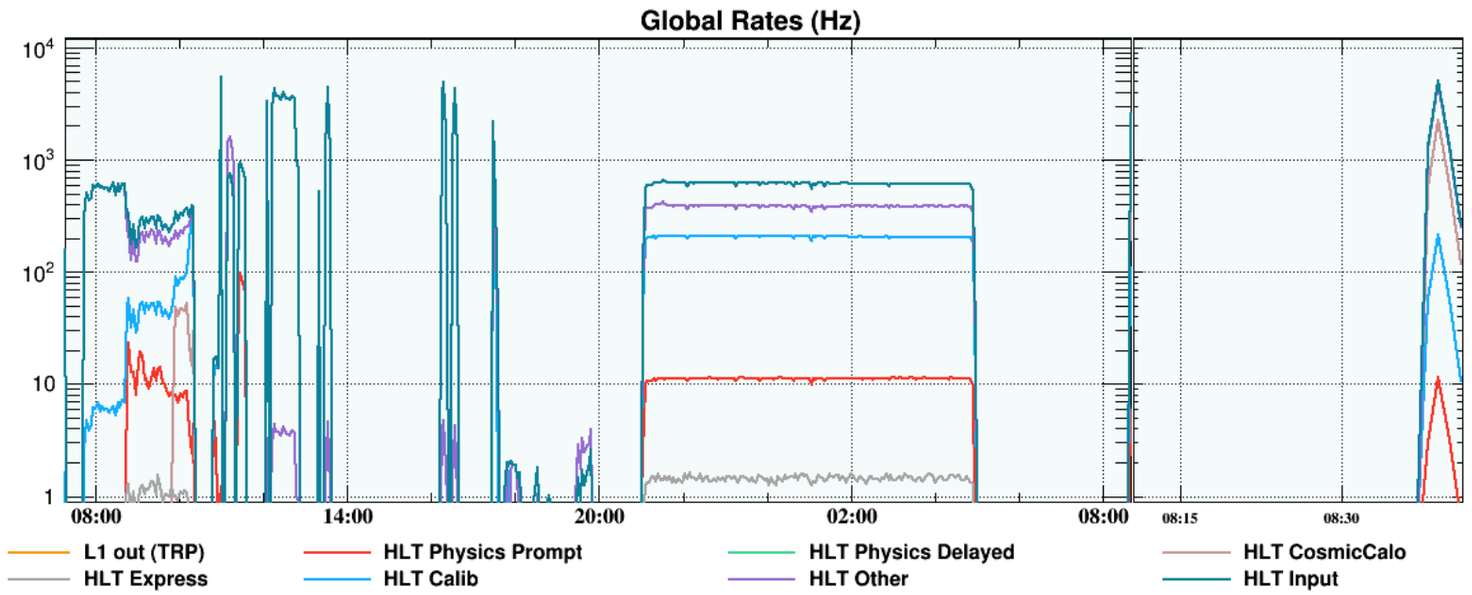
October: M6 cosmic data taking

- New Readout System (ROS PCs)
- Almost whole ATLAS with IBL, and ALFA (no TGC and no LUCID)
- Almost full coverage
- High rate tests : SCT and LAr are good, TRT is to be tested at high occupancy; CSC – ongoing
- Global Monitoring, DQ
- Prompt Reconstruction is operational; being recommissioned

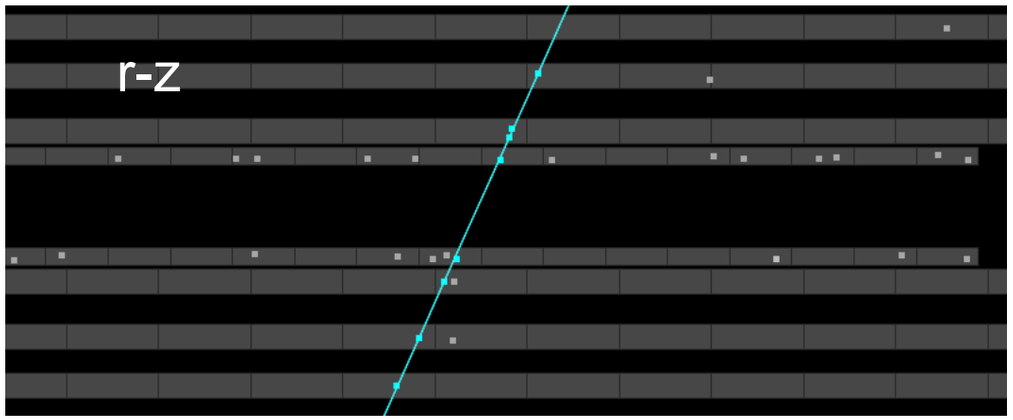
Oct 13, start of cosmic data taking



Oct 16, end of cosmic data taking.
Power outage at CERN - ATLAS takes data

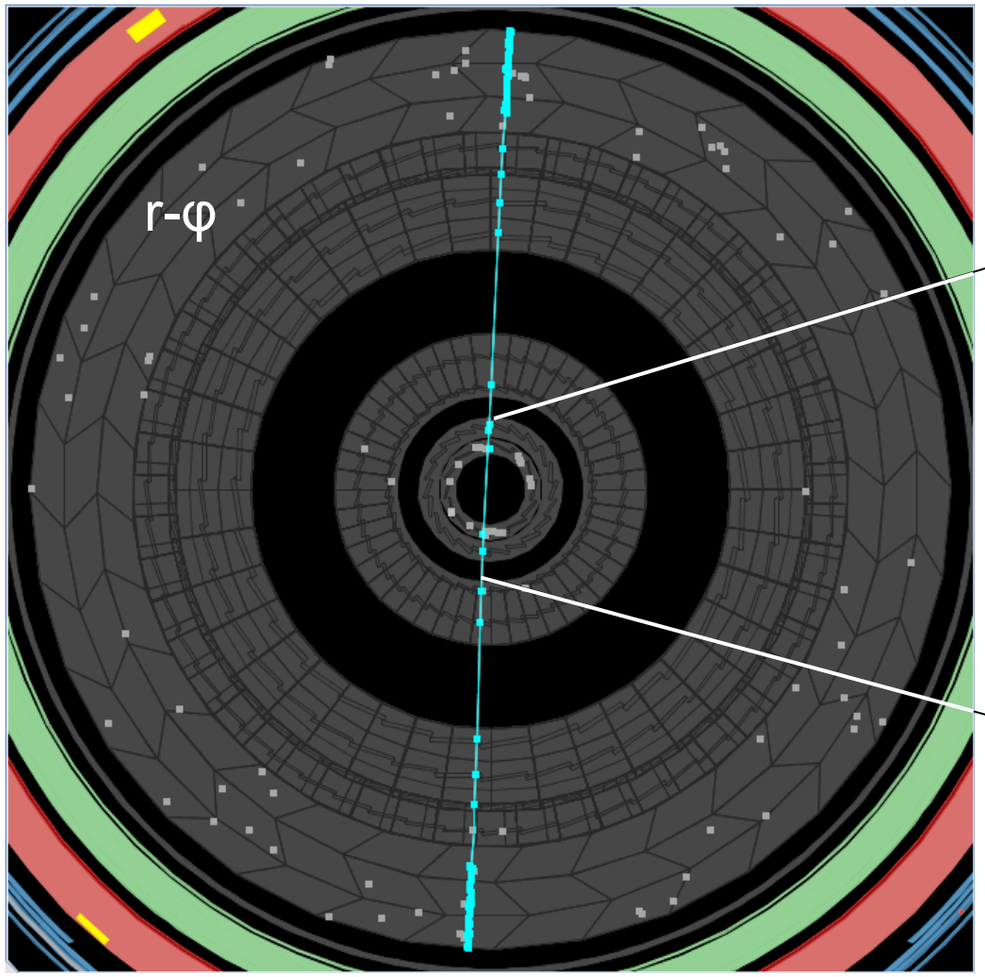


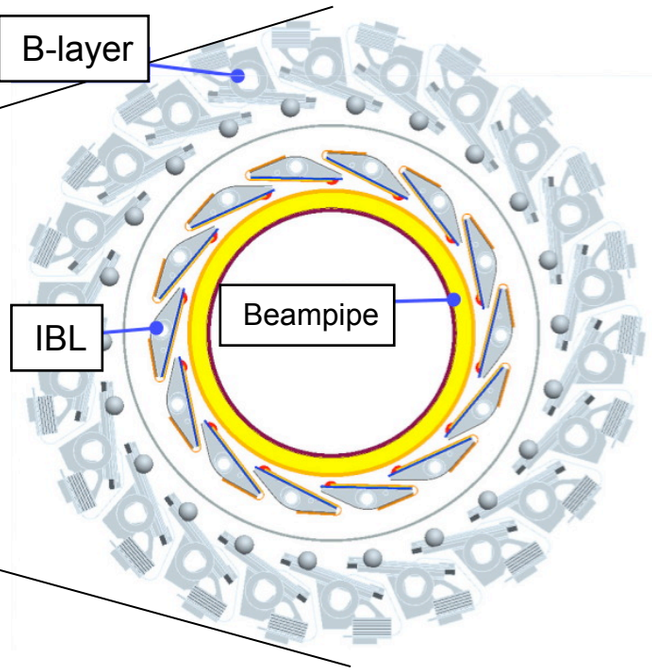
IBL integration in Cosmic run

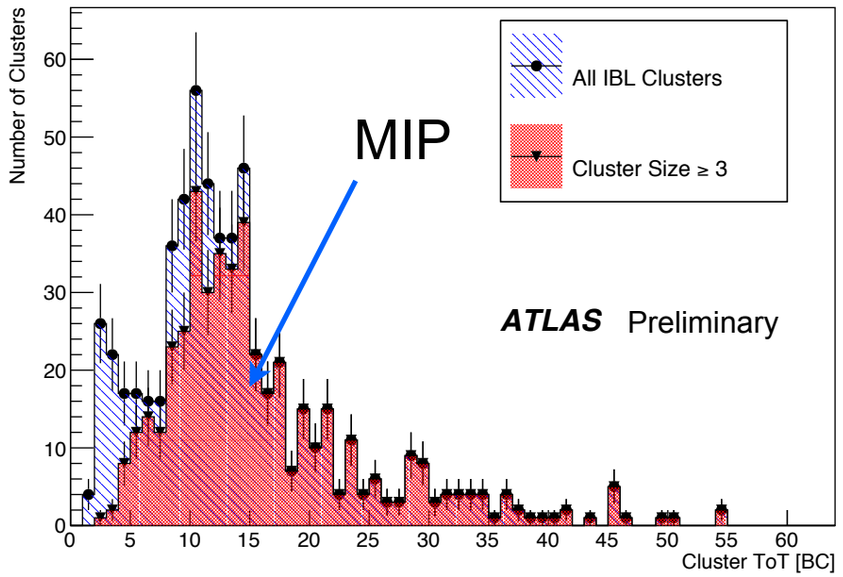


IBL and Pixel data taking with ATLAS :
Successful track reconstruction in all ID parts

DAQ, calibration, DCS, online/offline are integrated and are under the test
DCS integrated; Cooling/PS operating stably





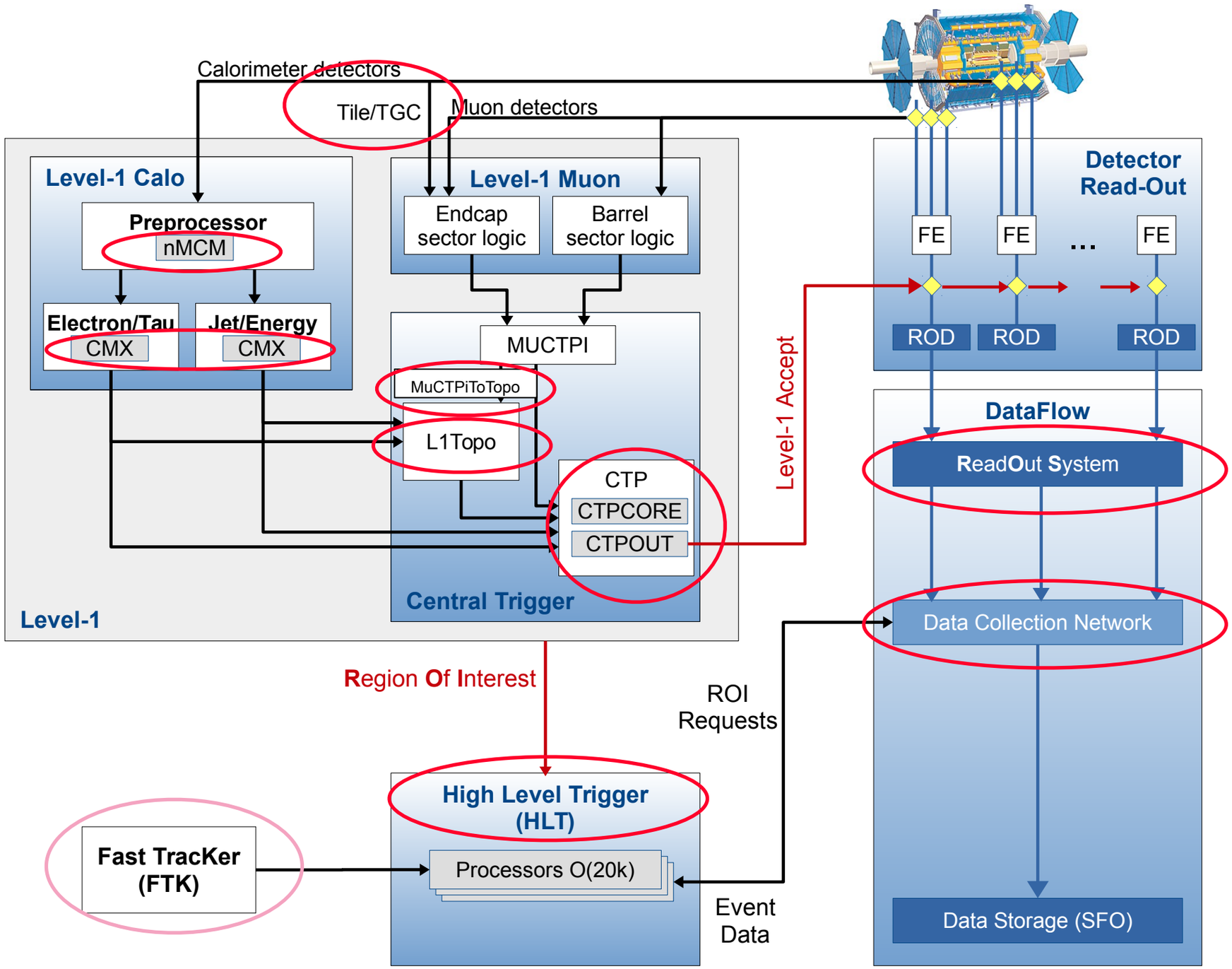


Time over Threshold

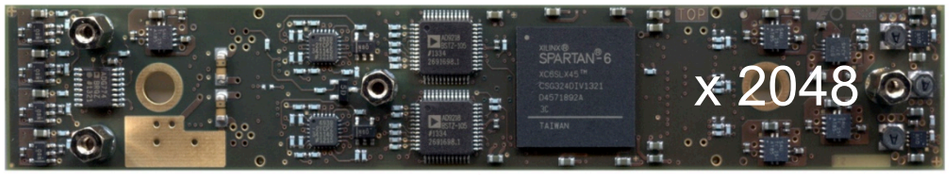
Run 2 Trigger upgrades

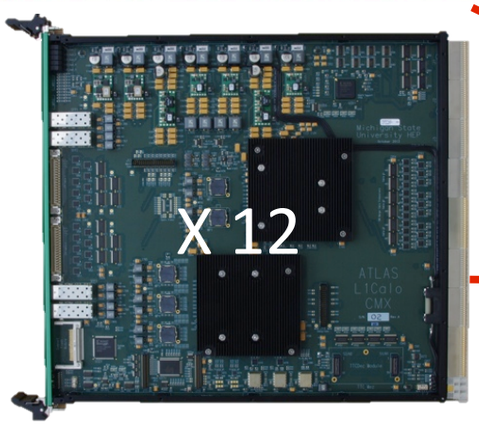
Long list of improvements in Trigger/DAQ

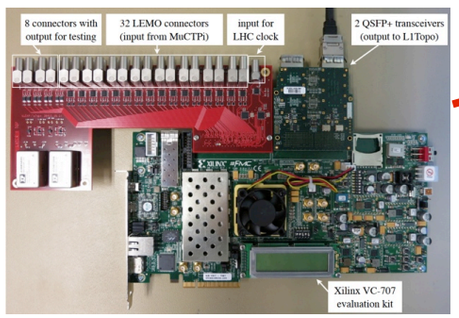
both software and hardware

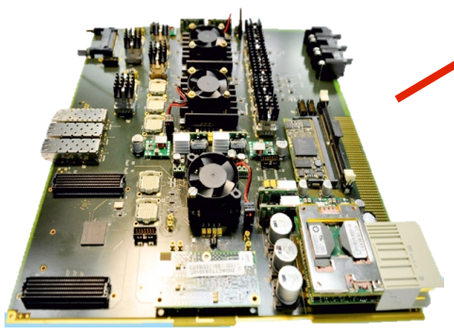


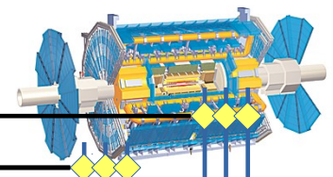
Run 2 Trigger Electronics











Calorimeter detectors

Tile/TGC

Muon detectors

Level-1 Calo

Preprocessor
nMCM

Electron/Tau
CMX

Jet/Energy
CMX

Level-1 Muon

Endcap sector logic

Barrel sector logic

MUCTPI

MuCTPiToTopo

L1Topo

CTP
CTPCORE
CTPOUT

Central Trigger

Level-1

Level-1 Accept

Detector Read-Out

FE FE ... FE

ROD ROD ROD

DataFlow

ReadOut System

Data Collection Network

Region Of Interest

ROI Reque

High Level Trigger (HLT)

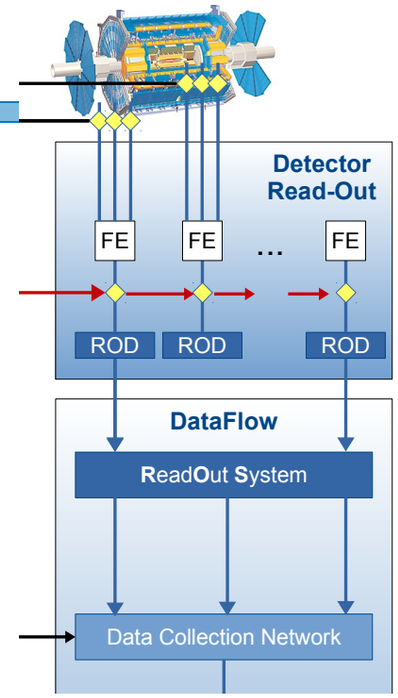
Processors O(20k)

Fast TracKer (FTK)

Ev Da

Either already in place or being installed

Readout System Replacement

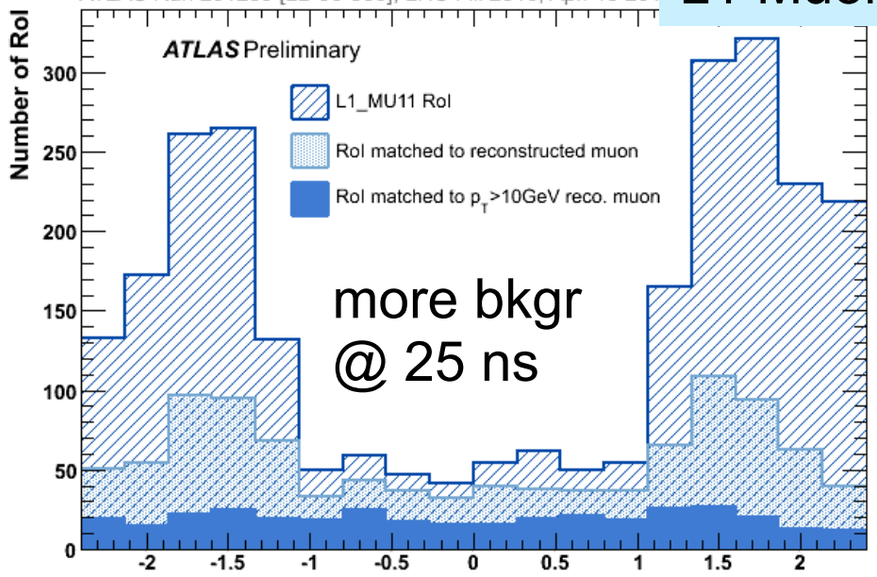


- Enthusiastic trigger developers utilize ROS far beyond design
- Upgraded system enables:
  - Operation at 100 kHz Level-1 rate (old: 75 kHz)
  - Up to 50% read-out fraction (old: 15%)
  - Migration from obsolete technology (PCI) to current (PCIe)
- 103 Generation-III ROS installed and tested
  - Complete overhaul of all ROS racks
  - Simultaneous network upgrade
  - Minimal disruption to sub-detectors (~2 weeks, 1000 man-hours)
- 221 new S-Link fibres deployed (~15% more than Run1)
  - Installation follow-up in progress now
- No major issues found; initial performance tests are good

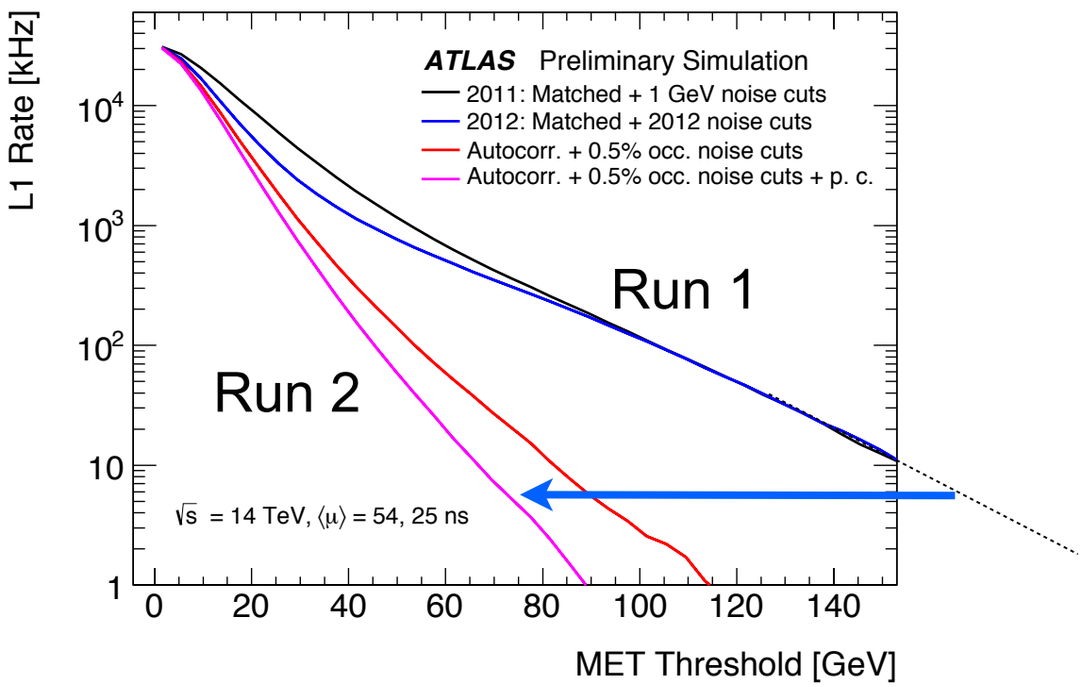
L1 Calo and L1 Muon

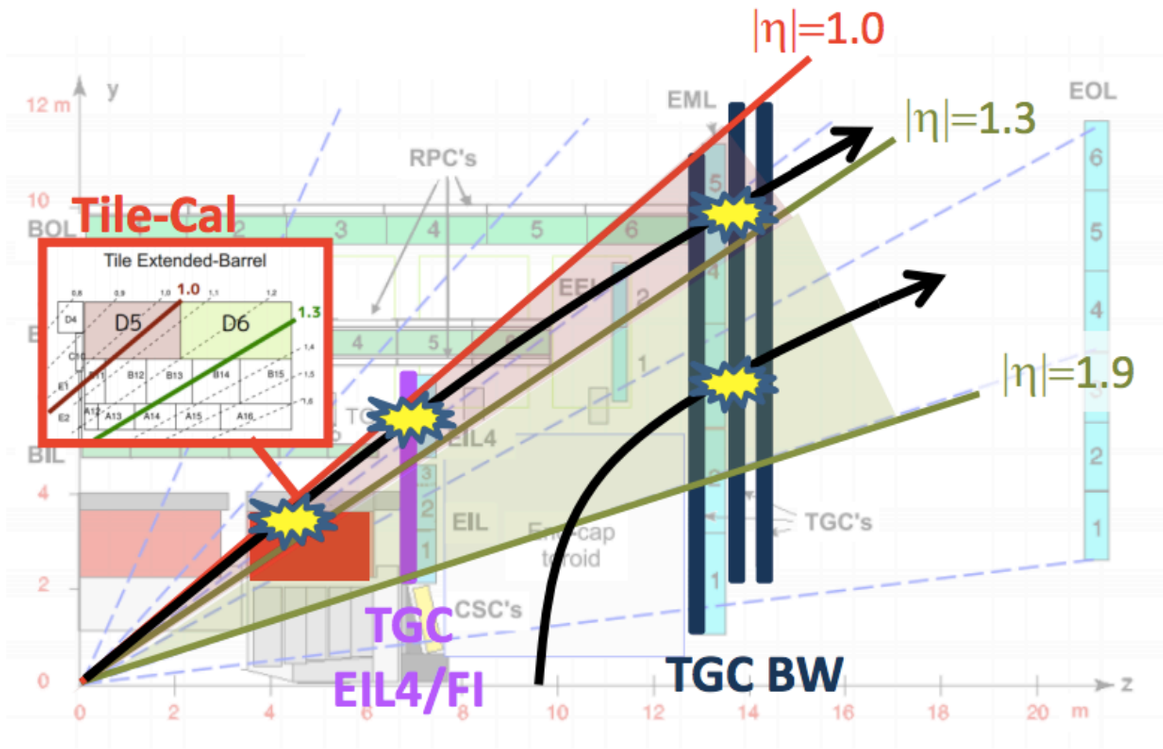
- Improved pileup suppression in L1 calo triggers, especially MET
- Fractional isolation for Calo triggers, more thresholds
- Added coincidences in muon trigger to reduce rate: e.g. Tile-endcap muon; TGC+small wheel

L1 Muon

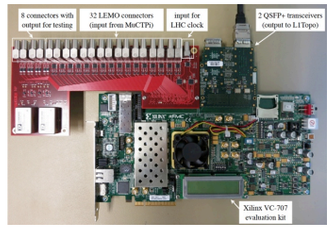


L1 MET

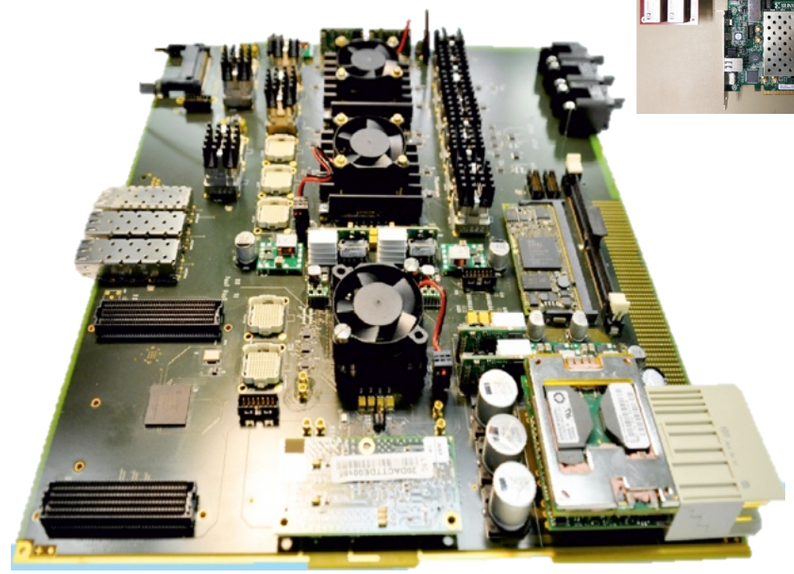


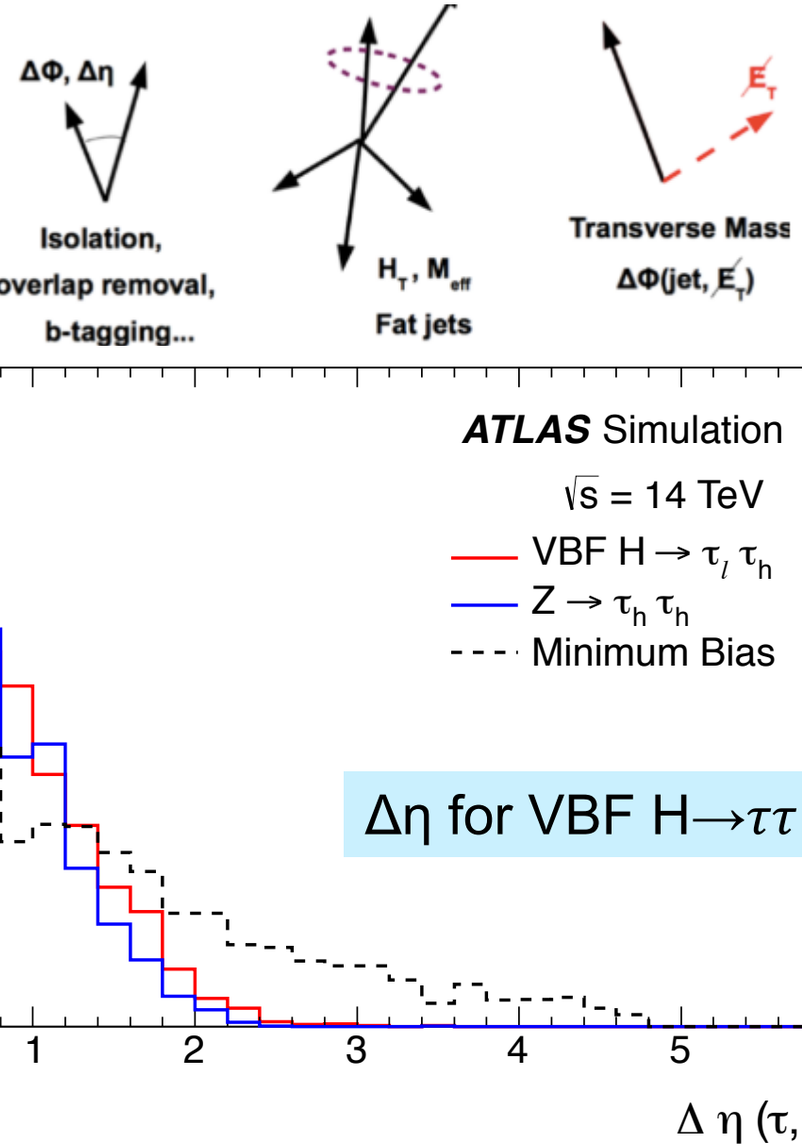


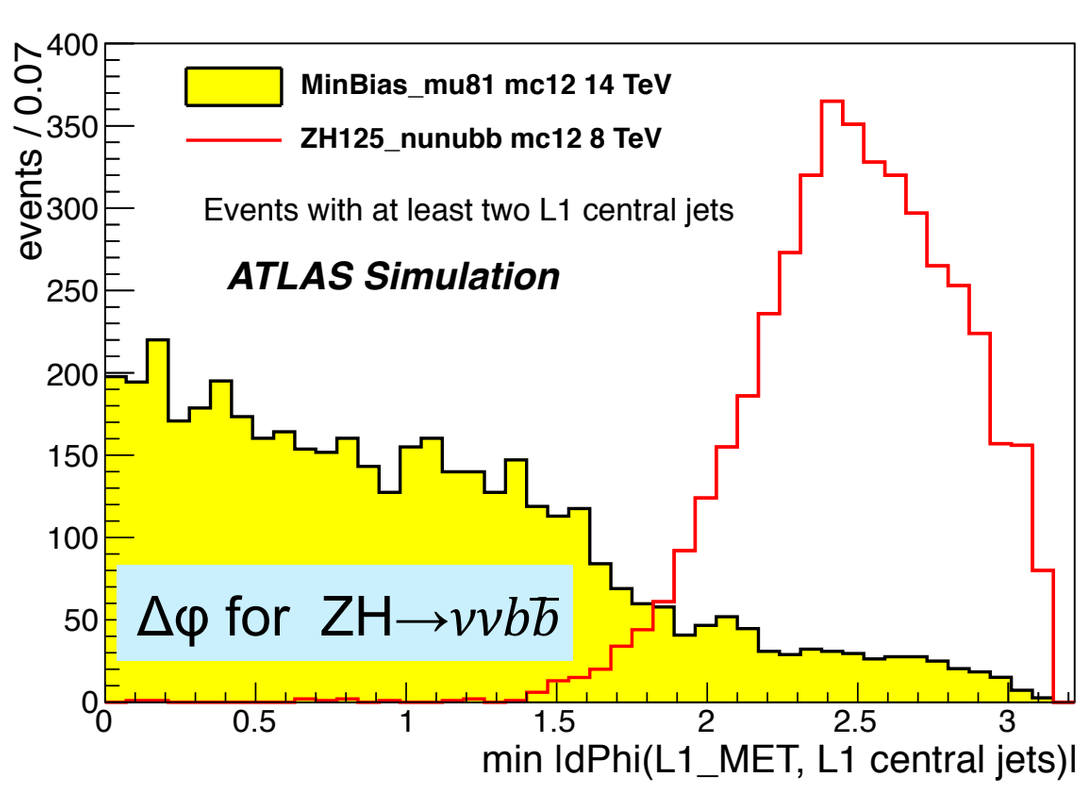
New L1 Topological module



- Topological triggers to be used already in Run 2
- both Calo and Muon
- 128 algorithms possible, >100 planned (>15 unique)
- Applications in Higgs, B-physics, Exotics, SUSY, SM







HLT status

- Reduce rate limitations :

  L1: 75kHz → 100kHz peak

  HLT: 400Hz (plus 200Hz delayed) → 1kHz average

  (allows to keep leptonic decays of W, Z)

- Merged HLT architecture → more efficient resource utilization

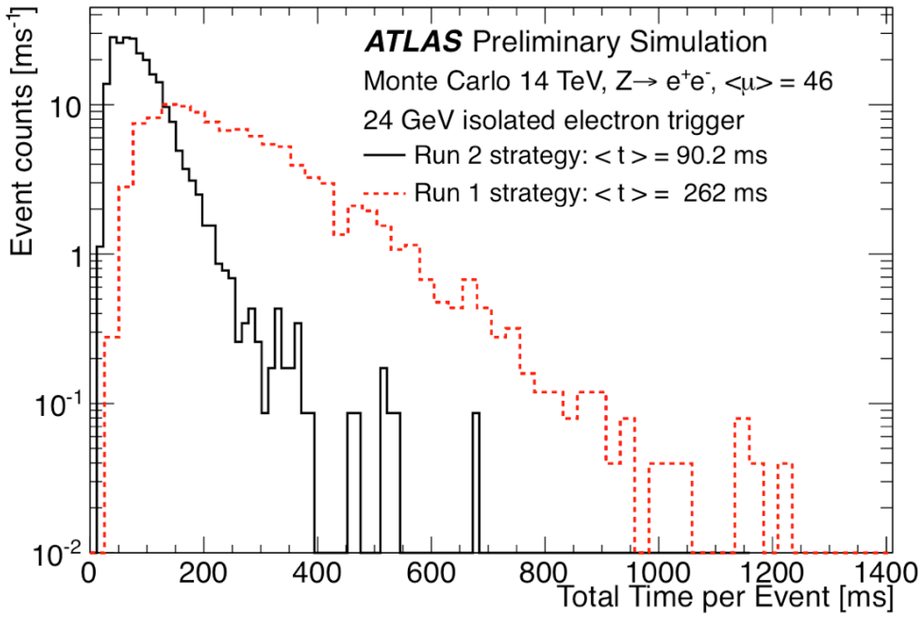
- Better / faster / smarter algorithms

- More coherence between offline reconstruction and trigger

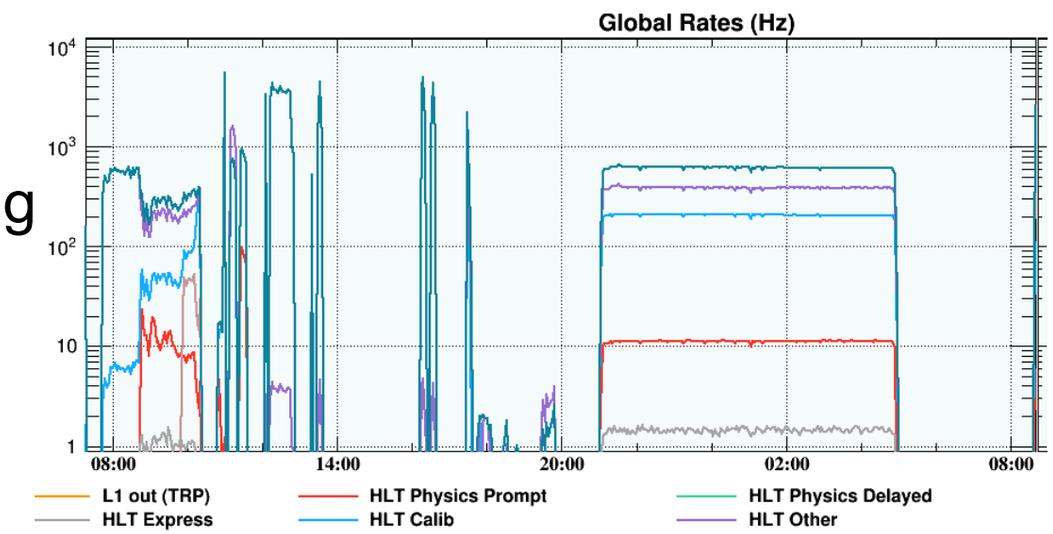
- New features such as data scouting for physics and calibrations.

- Intensive ongoing effort in implementing and validating all the new features, commissioning them already in the M-weeks.

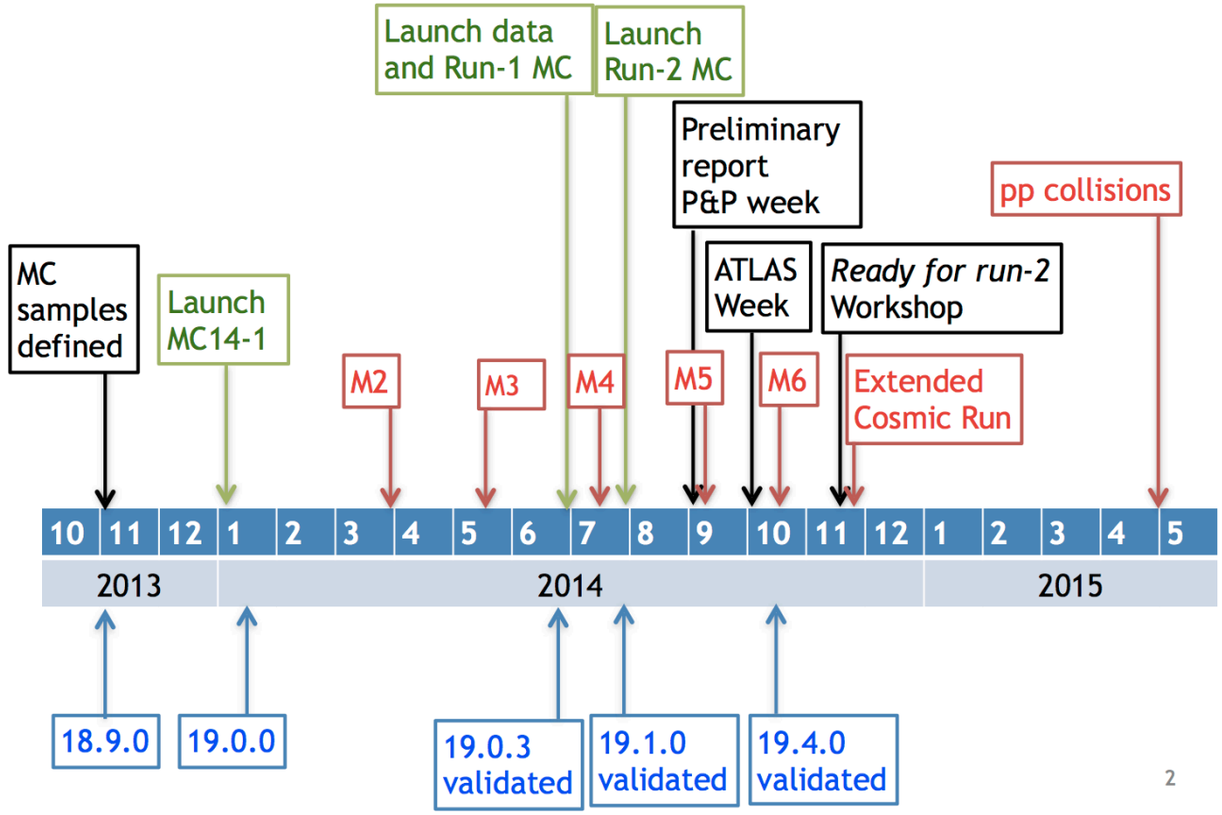
Improvement in tracking timing due to new strategy

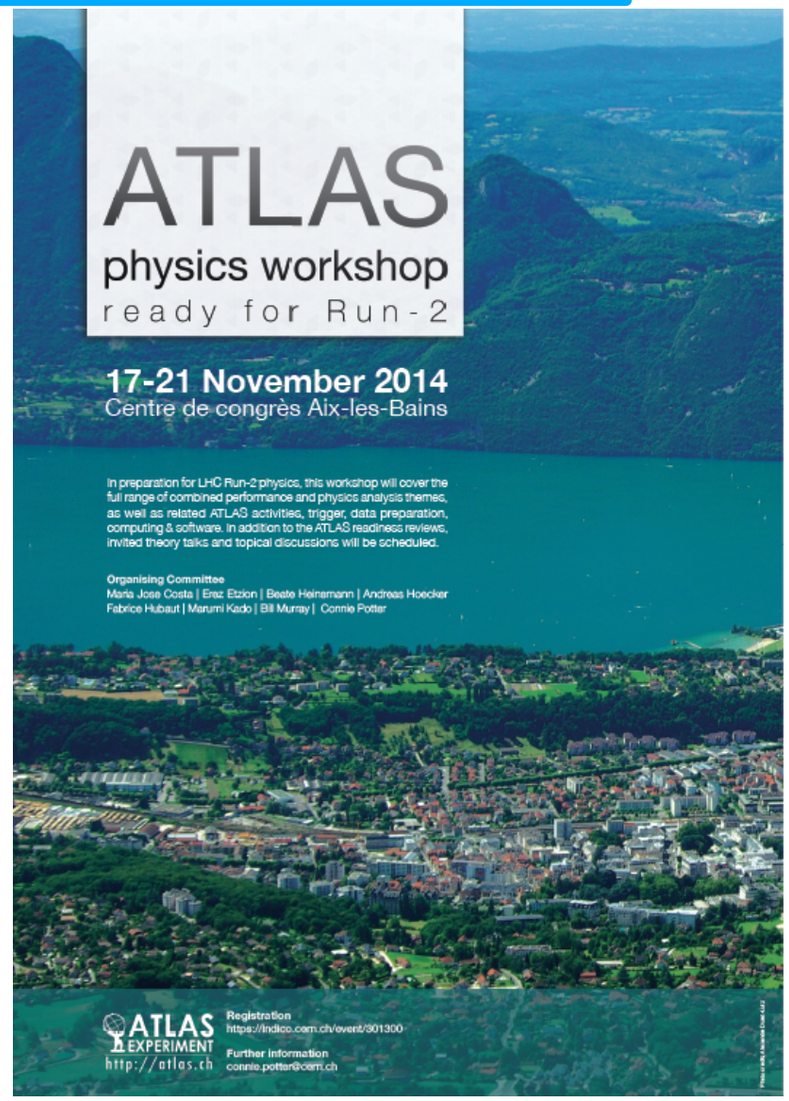


Online HLT rates (different streams)



Physics Analysis Run 2 Preparation



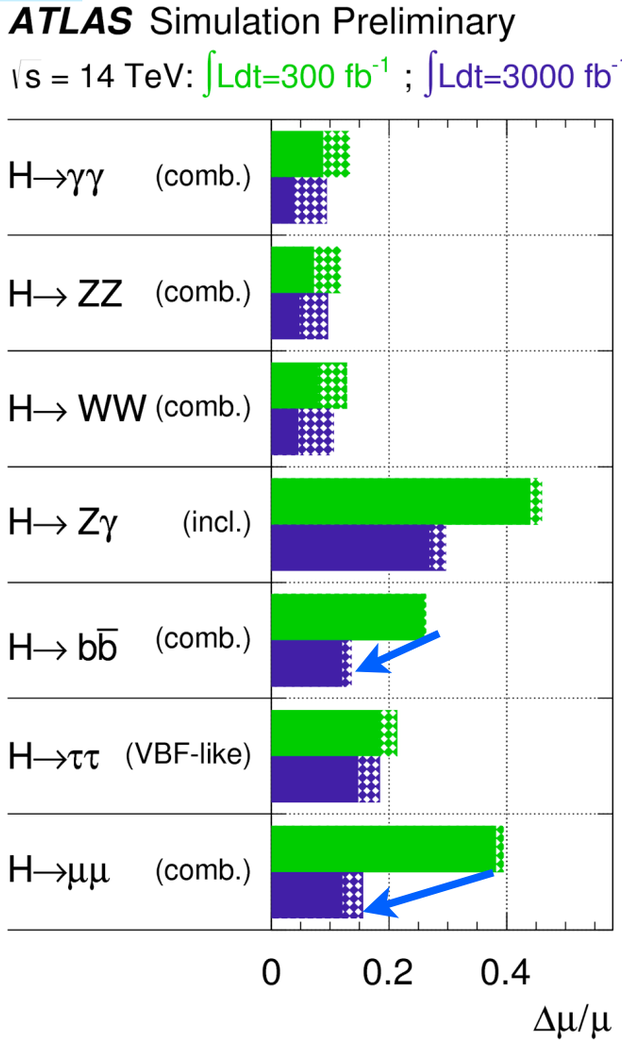


- Large samples made for “Data Challenge 14” (DC14):
  - Run-2: ~800M MC events
  - Run-1: 5 fb^{-1} of data and 500M MC events
- Used to
  - commission LS1 offline improvements and new analysis model
  - prepare for run-2 combined performance and physics analyses
- Analysis ongoing, feedback into final software releases received
  - Workshop in Aix-les-Bains this week to discuss run-2 physics preparation

If we'd have 3000 fb^{-1}

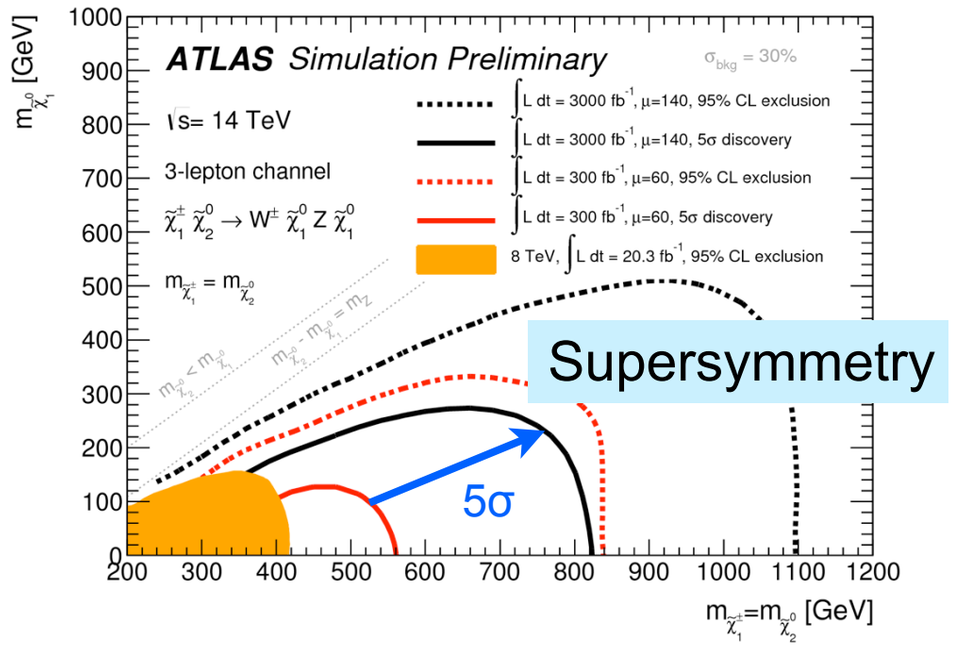
Few examples prepared for ECFA workshop

Higgs

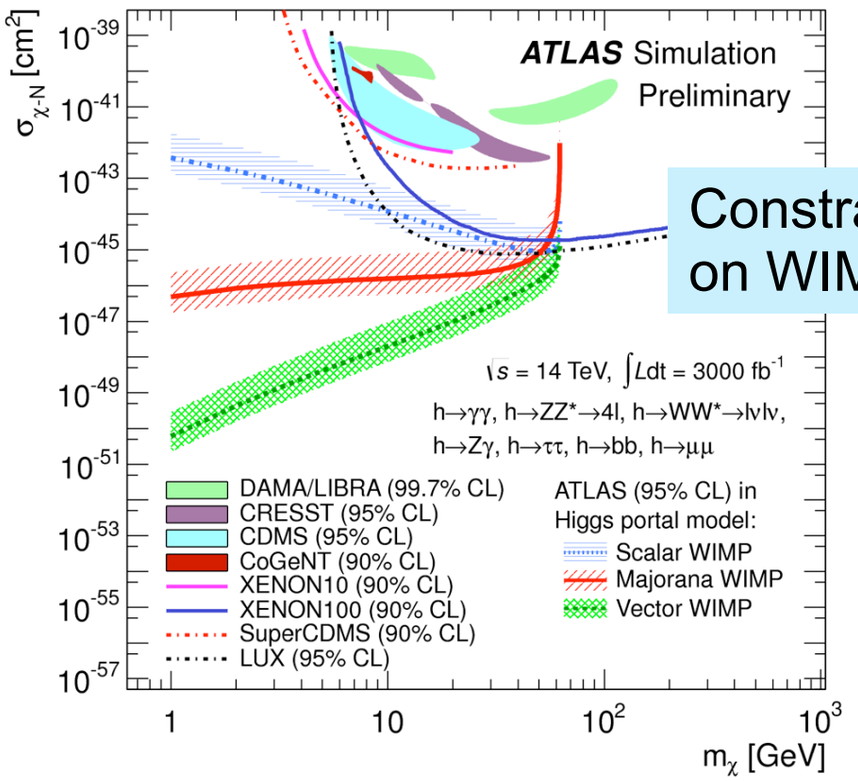


Work in progress !

Supersymmetry



Constraints on WIMP

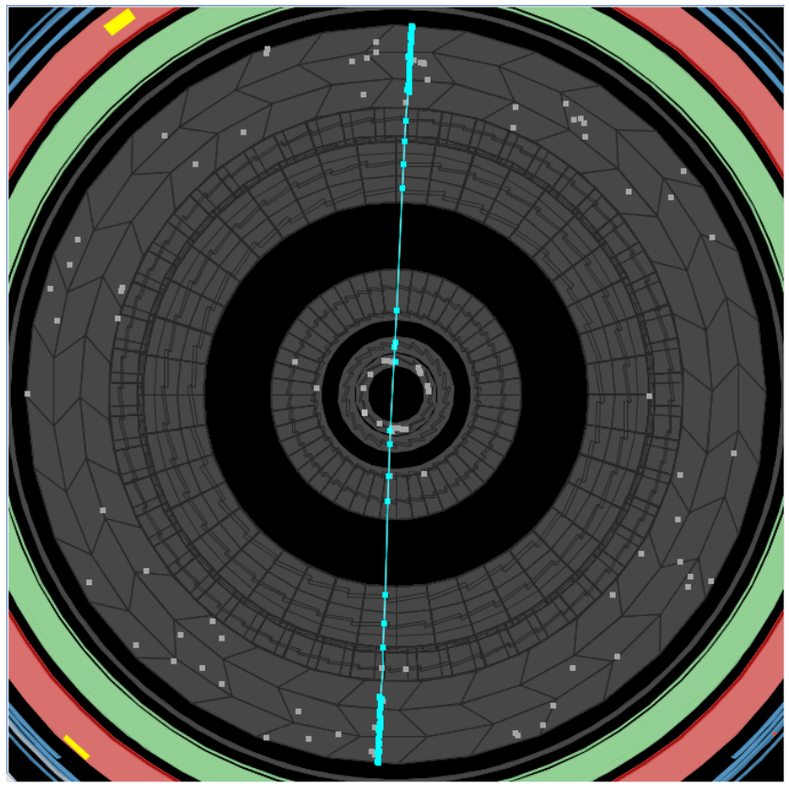


..and forward tracking: VBH H→$\tau\tau$

forward pile-up jet rejection	50%	75%	90%
forward tracker coverage		$\Delta\mu$	
Run-I tracking volume		0.24	
$\lvert\eta\rvert < 3.0$	0.18	0.15	0.14
$\lvert\eta\rvert < 3.5$	0.18	0.13	0.11
$\lvert\eta\rvert < 4.0$	0.16	0.12	0.08

Conclusions

- The flow of Run-1 papers continues, more coming soon
- ATLAS is almost fully closed again
- Many improvements in software and computing are in use, or being finalized
- Several changes to DAQ systems for 100 kHz L1 rate, including new ROS systems
- Many more improvements to L1, HLT & DAQ to help maintain trigger performance for Run-2
- Regular "milestone" weeks continue, recommissioning detectors, trigger, dataflow and prompt reconstruction
  - Cosmic tracks with IBL hits
- Next two weeks: cosmic running with all systems, magnets and full shift crew
- Physics preparations being intensively discussed in "Ready for Run-2" workshop this week in Aix-les-Bains



ATLAS is looking forward to beam in early March

Backup

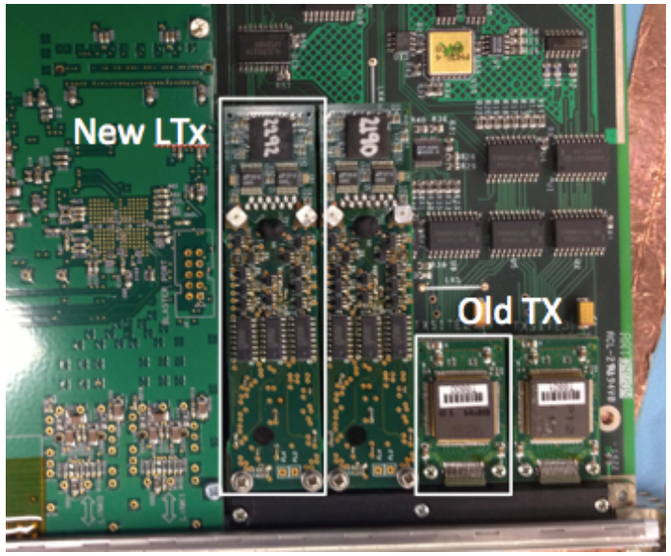
SCT

SCT is repowered and cooled – noise and gain same as end of Run1, still >99% good working channels!

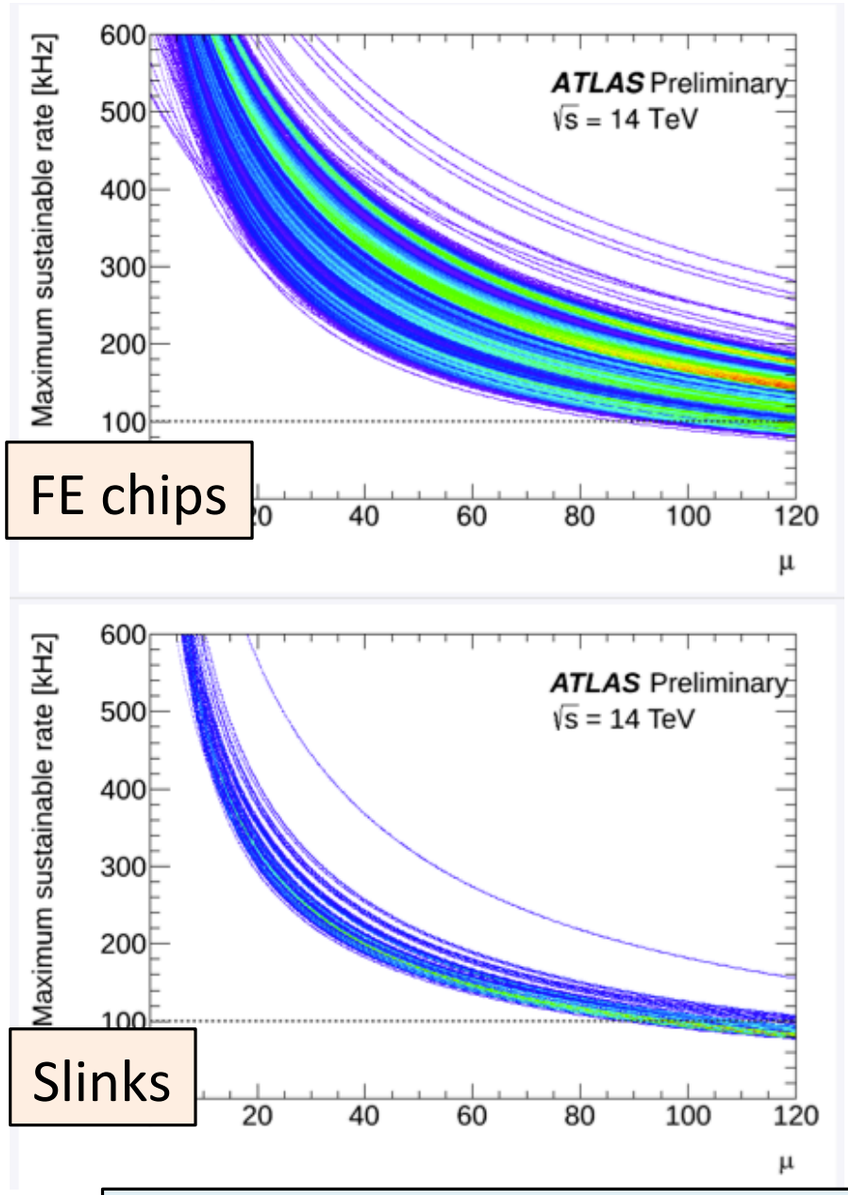
Main LS1 developments:

1. Expansion of DAQ to accommodate higher pileup

2. New commercial off-detector optical transmitters



DAQ expansion: 90→128 RODS



Limit μ~87 at 100kHz L1 rate

TRT status

1.TRT HV overshoot after beam dump (in 2012 run up to 120 V of overshoot) .

Task force is formed. We consider different approaches to solve this problem. Time scale August 2015).

2. Reach a stage of smooth running at high occupancy and at L1 trigger rate of 100 kHz.

The main issue is a huge processing load on RODs during data compression. Many FM developments have been done and still continue. Currently can operate at 104 kHz trigger rate with occupancy of 2%, expected occupancy in RUN2 is ~50%. There were still problems running at high rate with this occupancy. Some important improvements done: word length form the straws reduced, operation clock in some parts of the RODs increased and asynchronous mode of operation of some chips added, direct look-up table for most common patterns implemented. Significant breakthrough is expected by M7.

3.Base line scenario of operation in mixed Ar/Xe mode developed.

In this scenario 1 internal layer of the barrel modules (out of 3) and two EC wheels (1 side A and 1 side C) will run with Ar mixture. Estimates show that at this configuration TRT can run at least till the end of 2015. Simulations show that in the base line scenario an impact on the electron identification performance is small. Effect on E-Gamma physics including worse scenario (when 2 layers out of 3 of the barrel will run with Ar mixture) are under study now but previous studies this effect can be minimized even Xe.

LAr status

Hardware work during LS1:

LAr On-Detector Low Voltage Supplies (LVPS):

New LVPS have been installed on the detector in 2013

After failures end 2013 and beg. 2014 two repair/refurbishment campaigns were successfully completed. All 58 LVPS are now working on the detector as expected since June 2014.

Smaller Repair Works Finished:

23 Front-End Boards (out of 1524 in total) have been repaired or replaced

Replacement of damaged read-out fibre: 2 replacement fibre cables inside a flexible pipe have been added. 1 cable has been connected in July to replace the damaged one.

LAr Preparations for Run 2:

End-cap C and Barrel cryostats both lost their isolation to other parts of ATLAS (single-point grounding violated), we register small leakage currents on grounding monitors.

End-cap C isolation depends on the exact position of the end-cap C cryostat (isolation lost in closed position).

Trying to identify source(s), many tests/checks ongoing.

Also trying to assess impact on physics data taking (no impact found yet, but impossible to predict what happens with beam).

Discussions have started whether re-opening of ATLAS is necessary to further investigate and cure the problem.

LAr online software migrated to TDAQ 5 in summer 2014. Since then work ongoing to speed-up calibration data taking,

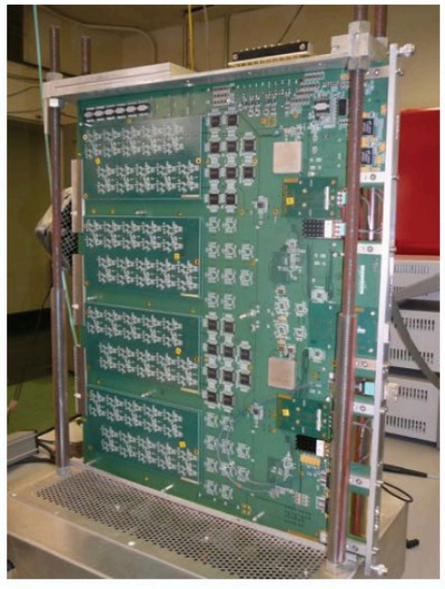
High rate capabilities: Ready to run in 4-sample read-out mode with >100kHz L1-accept rate and 0% busy (demonstrated in ATLAS high-rate tests in September 2014).

Documentation, Shifter training: Run-1 material revisited and being improved in preparation for M7

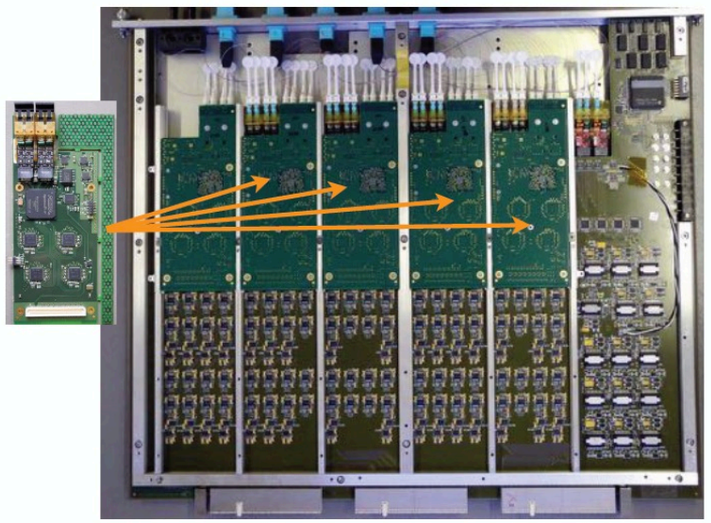
LAr Phase 1 Upgrade demonstrator

- Goal of Upgrade Demonstrator:
  - Explore in-situ (before LS2) energy reconstruction & BCID algorithms
  - Trigger efficiency & background rejection capabilities
  - Installation & operation conditions
- Demonstrator installation on the detector in June/July 2014 after ATLAS internal review and thorough testing on surface:
  - 2 new baseplanes, 2 LAr Trigger Digitizer Boards (LTDBs), Front-End Boards equipped with new Layer Summing boards
  - Also 2 pre-prototype boards installed at the receiving end in USA15.
- Total noise, coherent noise and correlation coefficients measured in-situ → comparable to all other crates

2 different demonstrator LTDBs installed in-situ



Digital motherboard, analog mezzanines



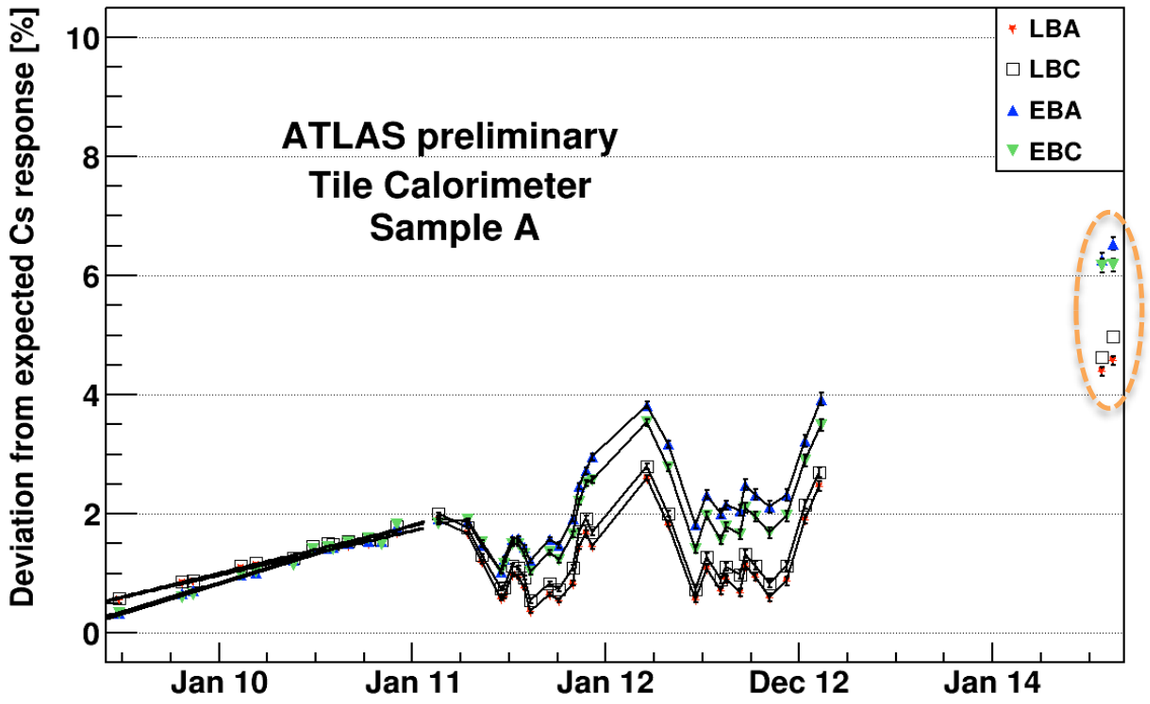
Analog motherboard, digital mezzanines

Tile

Detector

During LS1 all the on detector Low Voltage Power Supplies (LVPS) were replaced and the FE electronics were consolidated for better power distribution and data transmission.

- No LVPS trips, better noise performance and lower data-corruption occurrence.

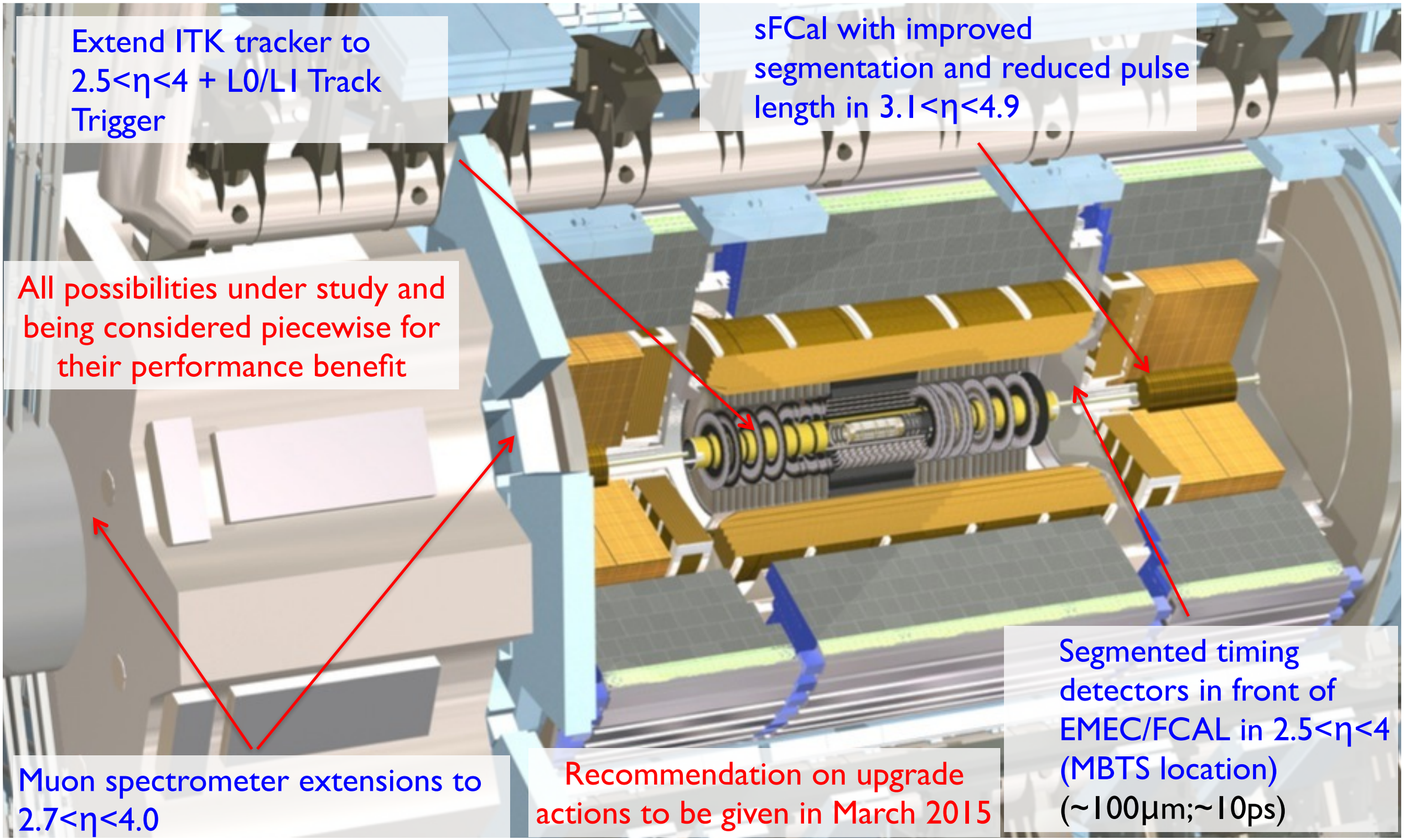


Response of the 1st layer cells to Cs, response change is due to PMT gain drift

Calibration systems

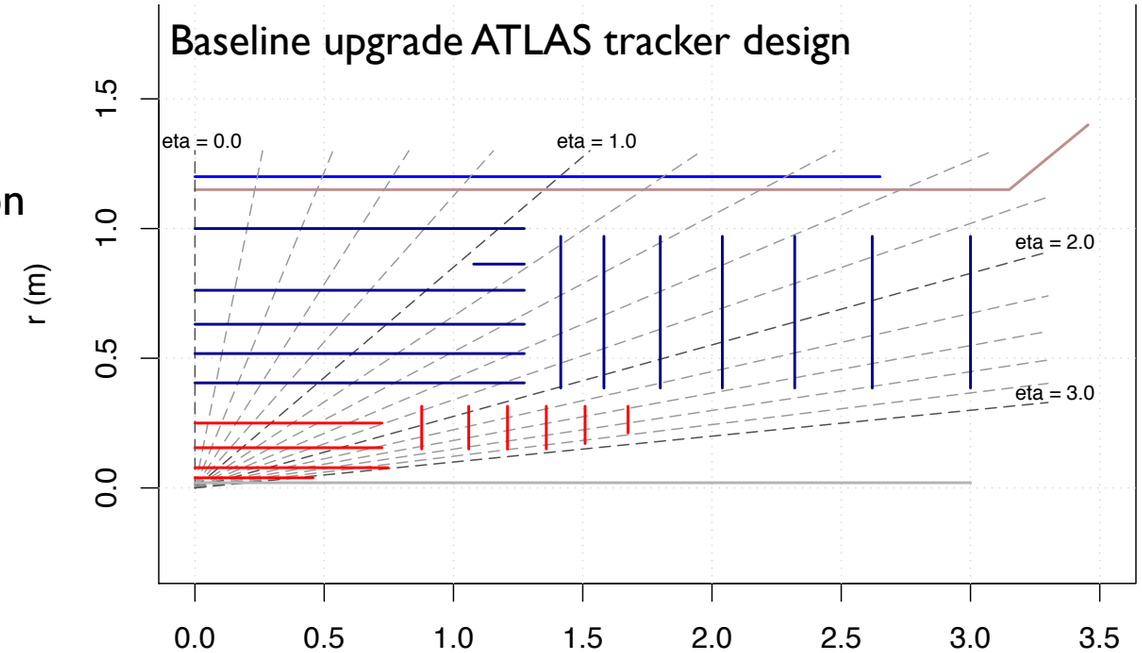
- A new laser system was installed in the electronics room in the end of October and is being commissioned.
  - Exhibits better stability control
- The Cs radioactive source system has been reinforced against possible small leaks and 3 sets of scans have been performed since July 14.
  - Allowed to re-establish the cell energy scale compared to the end of Run 1.

ATLAS Phase 2 Options

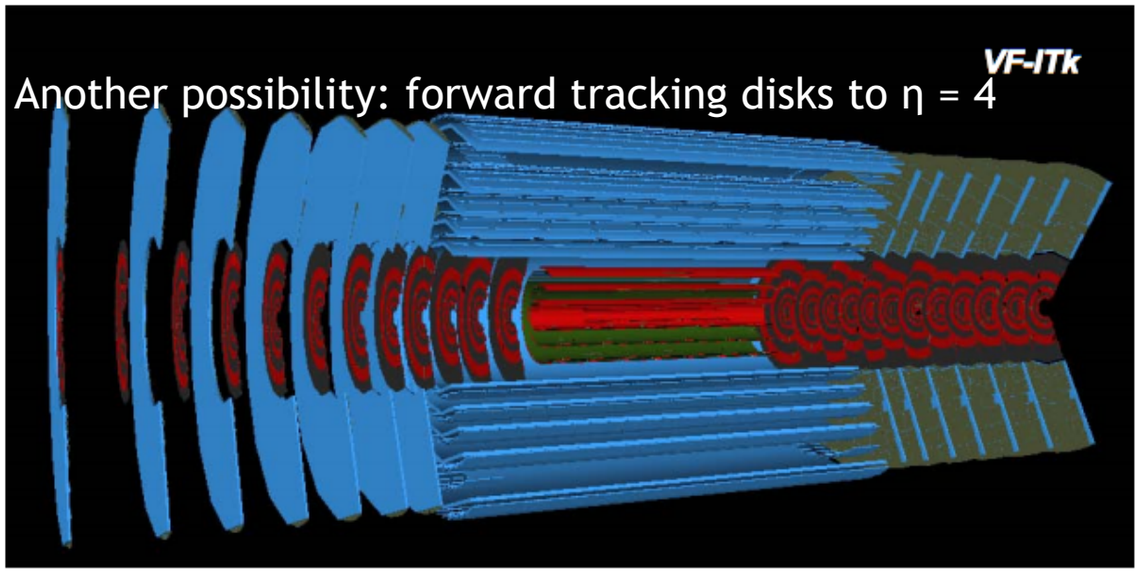


ATLAS Phase 2 Itk Options

- Improve tracking acceptance to:
  - Reconstruct low p_T tracks and improve Missing E_T resolution
  - Improve pileup jet rejection up to large pseudorapidity
    - Important for VBF tagging and drives Higgs measurements at large rapidity
- Consider each proposal and separate improvement piecewise to evaluate individual physics impact
  - A number of tracking geometries are being investigated
  - Likewise, the spatial granularity of the tracker is being studied



Another possibility: forward tracking disks to η = 4



Possible design: staggered tracking ring to η = 4