ATLAS Status Report

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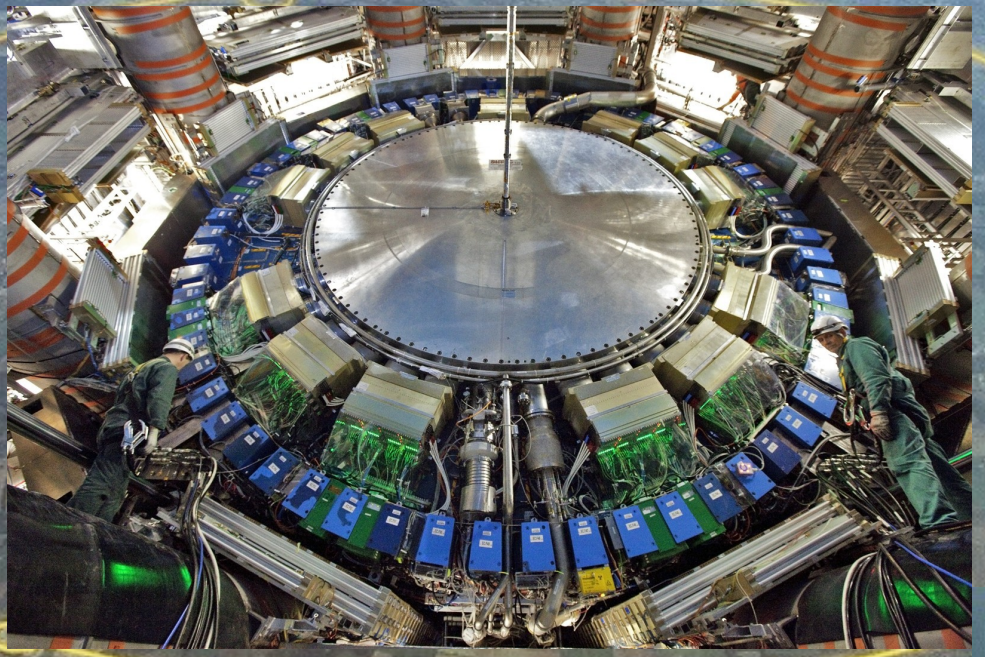
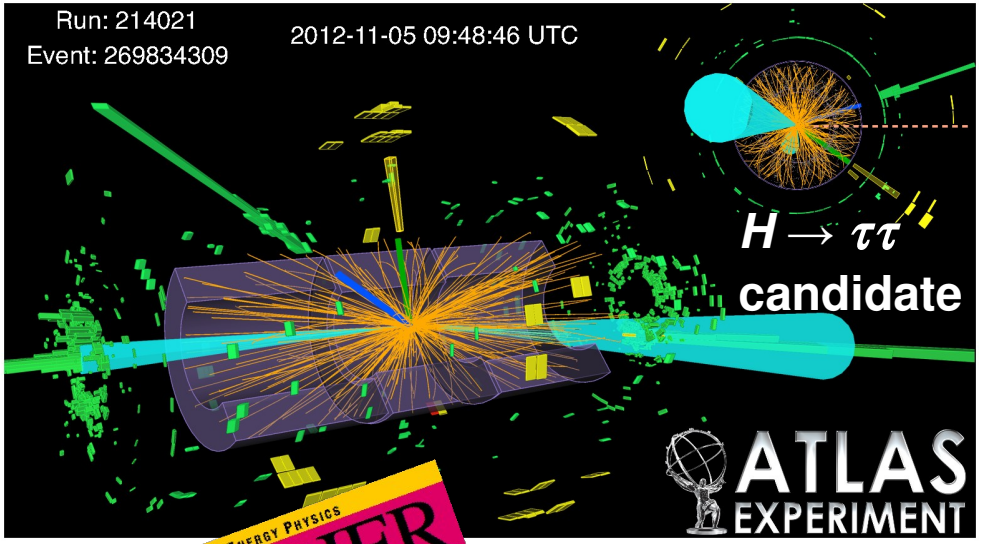
116th LHCC Open Session
4th Dec 2013



Outline

- LS1 activities:
  - Detector status and maintenance
  - Trigger/DAQ, Offline
  - Preparation for Run-2
- New Physics Results:
  - Higgs measurements
  - SUSY/Exotics searches
  - Top and Standard Model Physics
  - Heavy Ions physics
- Upgrade physics studies
- Conclusions



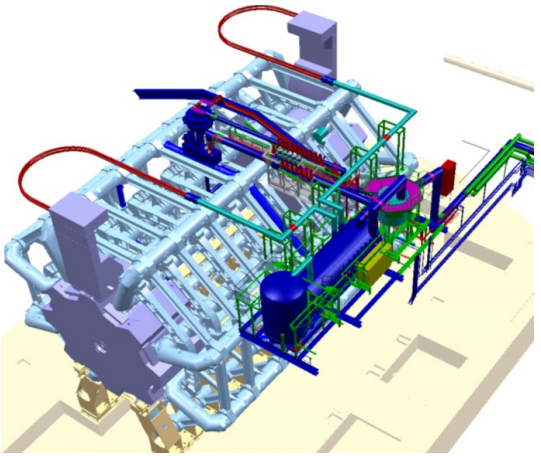
CERN Open Days

- CERN open to the general public during two days (28-29 September):
  - Underground visits: ~2500 people
  - In the various ATLAS tents at surface activities: ~5000 people
  - Team of volunteers: 190 people
  - ATLAS Cinema built from scratch.
  - Big Lego activity, Higgs corner, GOLab, Computing corner, Souvenir photo stand, and underground waiting tent with films and talks while queueing to go underground.

Point-1 Infrastructure

- **During 2013 activities focus on infrastructure, detector maintenance and consolidation and installation of new systems.**
- **During 2014 ATLAS will re-establish operations and re-commission the detector.**
- Infrastructure:
  - Al beam pipes to replace Fe ones close to the TAS absorbers: construction in very advanced status.
  - Thermosiphon evaporative cooling for Inner Detector to enhance reliability of the cooling system: commissioning started → it will be ready for connection with Detectors in Spring 2014
  - Separate magnet cryogenics to reduce the risk of detector down time: redundant main compressor, He dryers installation and new He dewar for Solenoid → very advanced, on schedule.
  - UPS installed to protect ATLAS detector in case of short power glitches.

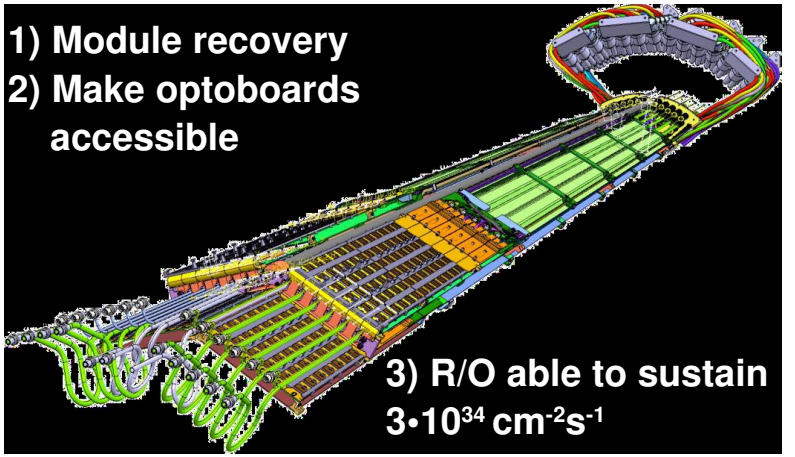
  Thanks to the CERN EN/EL and EN/CV experts for their work!

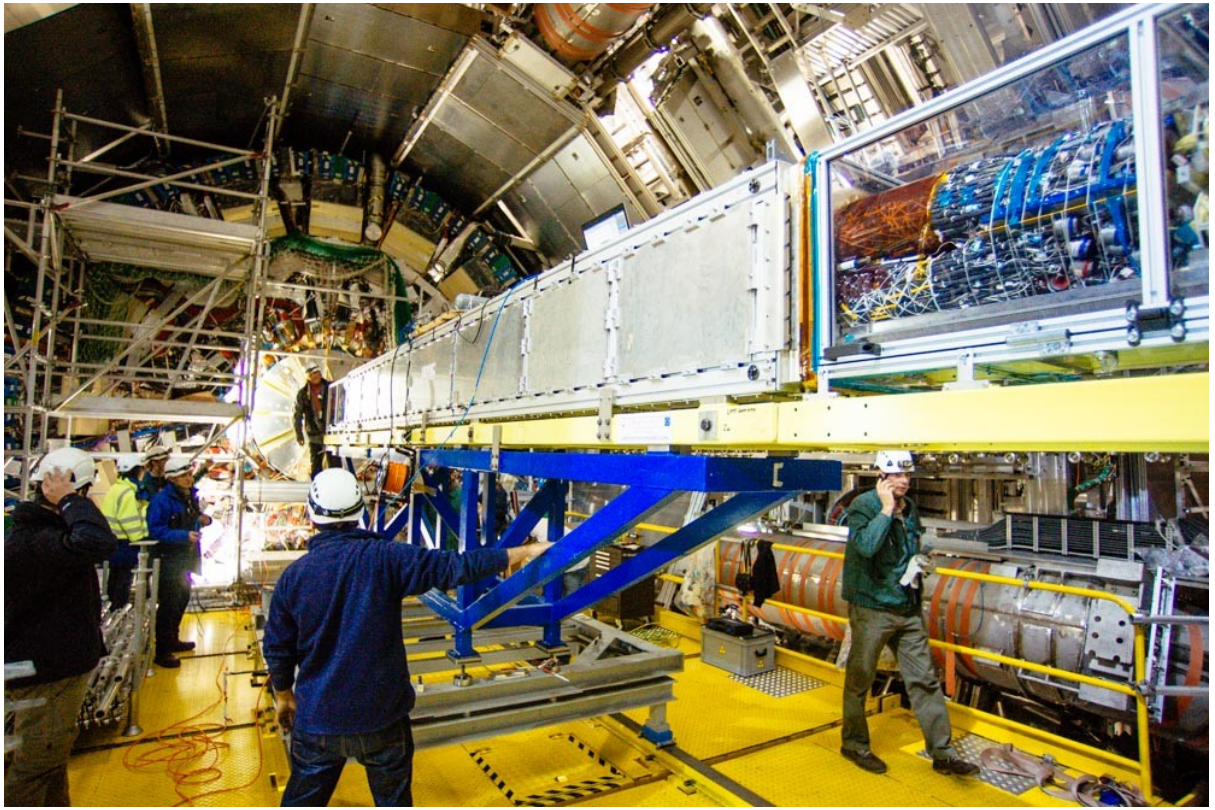


Inner Detector activities

- **Pixel:** Service refurbishment finished → all services in place since October.
- Recovery of the detector read-out back to 99% operational fraction (was 95% at the end of run-1 with loss-increasing trend). Few modules remain with non-reachable HV problems.
- Diamond Beam Monitor (DBM) installed in October
- **Pixel insertion this week**

Pixel Services

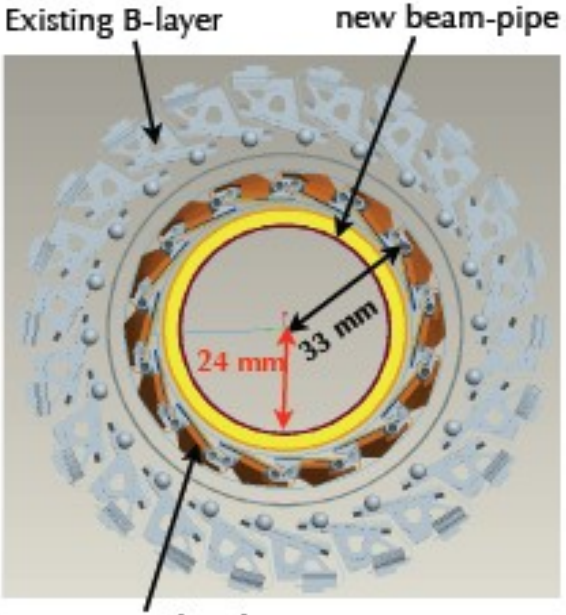


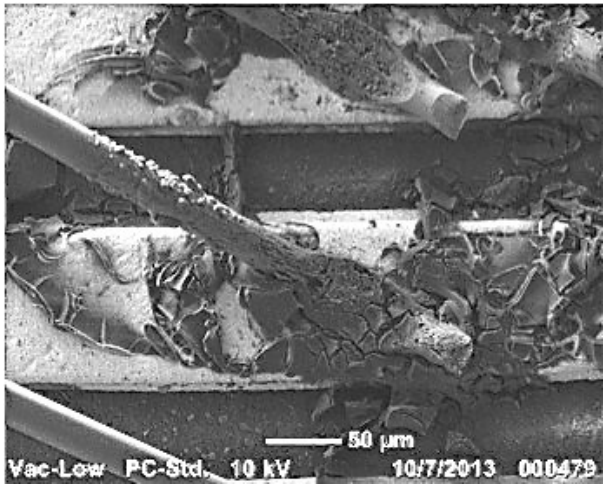


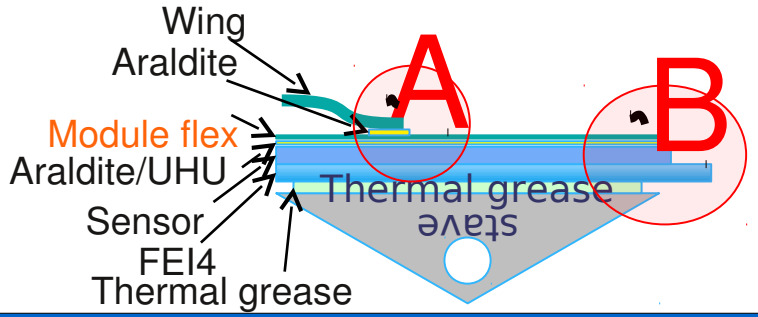
- **TRT:** leaks fix campaign completed. Few remaining leaks to be controlled by improved gas distribution.
- **SCT:** consolidation of the Back-End electronics to be able to cope with ~90 pile-up events at 14 TeV and for the optical transmitters.

Insertable B-Layer (IBL)

- IBL is the new Pixel layer, mounted on the beam-pipe.
- Inner Support Tube inserted 2mm from the existing B-layer.
- **Infrastructure is ready to receive the IBL staves:** 14 to be deployed, 20 will be built in total (12 already built).
- The cooling infrastructure is being installed and commissioned
- Clear signs of corrosion observed on Wire bonds wing area and FE-bonds (0.5%/0.3% affected).
  - Corrosion possibly triggered by combination of halogene contained on flex circuits with small amount of condensation.
  - Detailed analysis of process and origin of halogene on modules is on-going.
  - Resume stave production and keep them dry
  - Rework of damaged components
  - Procure components to allow new modules to be built
- Baseline is to install the IBL in May



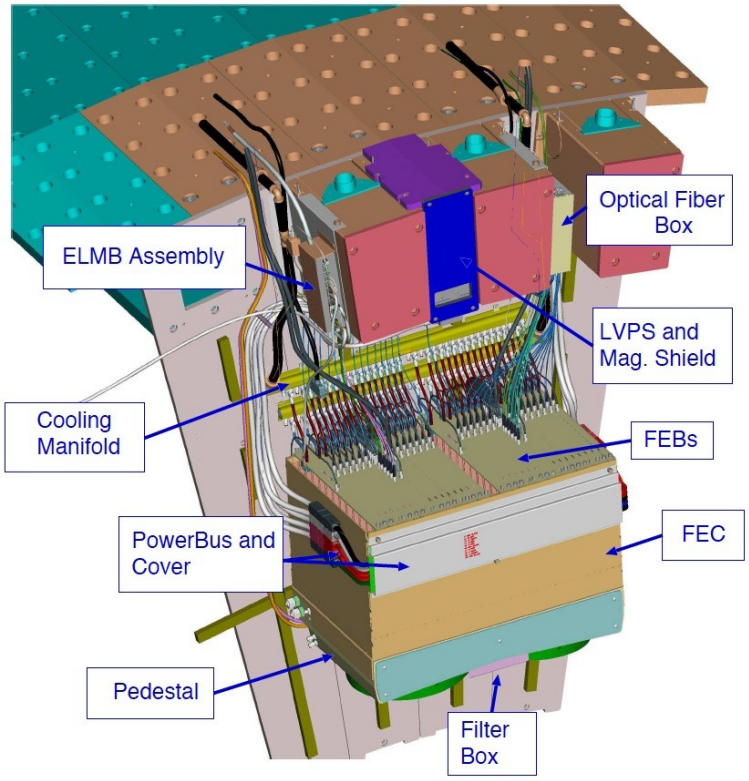


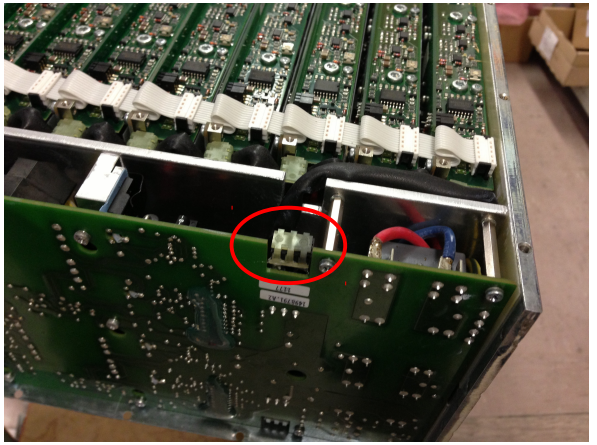


Two areas are effected: wing to modules and modules to FE.

LAr Calorimeter

- LS1 activities update:
  - Installation of new low voltage power supplies (LVPS) finished in July 2013 (58 in total, 12 already installed beg. 2012).
    - **LVPS are operating since months on-detector, after ~3 months burn-in tests.**
    - However, one LVPS had a failure beginning of November 2013 Problem traced to bad contact in the first connector of the power bus harness → investigating at the moment how to eliminate this risk for all 58 power supplies (e.g. power bus soldering to PCB).
  - Extraction and repair of 10-20 front end boards (FEBs) planned for beginning 2014 (out of a total of 1524 FEBs).
  - Read-out system is kept in operation periodically acquiring calibration data.
  - **Prepare DAQ to run in 4-samples** read-out mode with 100 kHz L1A rate and 0% busy (not counting 2-3% complex dead-time).
    - Small effect on performance being investigated.



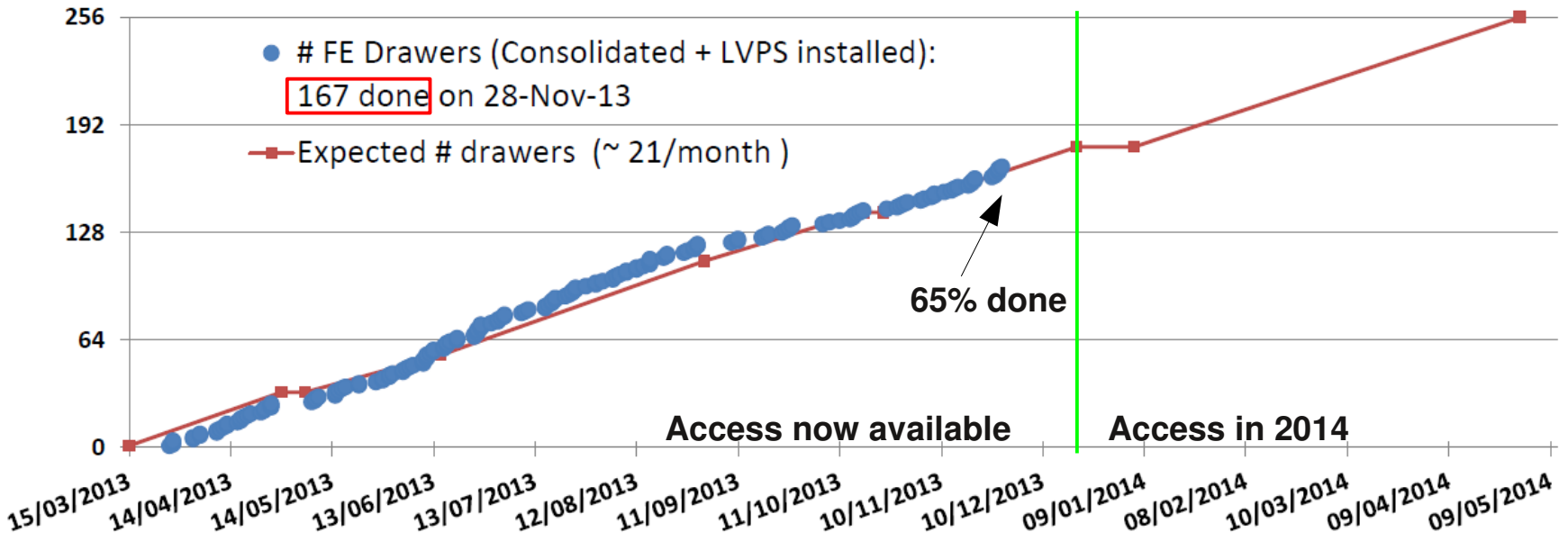


Tile Calorimeter

- Replacement of LVPS is on-going:
  → **75% done and installed.** Rest of LVPS is ready, but not accessible now.
  - Mechanical consolidation of transformers against thermal cycles required extraction of the installed ones.
  - Night shifts in parallel to Pixel installation, as planned.

- **Consolidation of electronics drawers happening in parallel (65% done).**

- All missing crack counters installed (16 were missing during Run-1 out of 128 in total for 1.4<η<1.6)



Muons

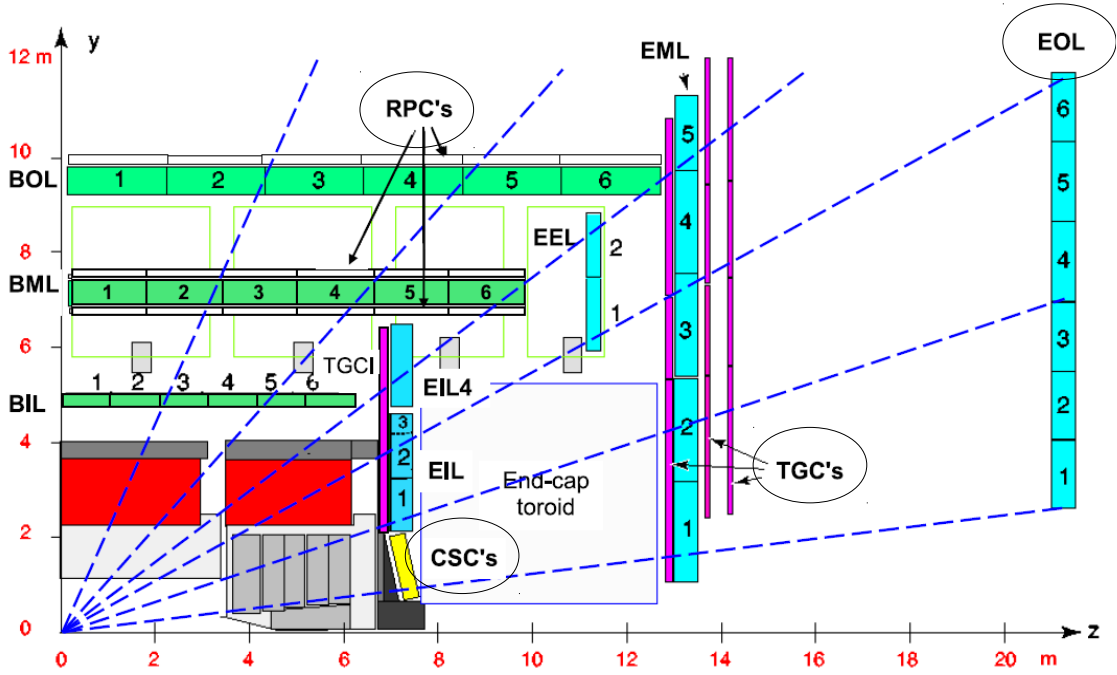
- **Detector maintenance:**

  - **RPC:** the leak fixing campaign is ongoing with both the total replacement of the gas inlet or its repair (very successful new technique).

  - **MDT:** leaks on Endcap Outer (EO) chambers EOS fully repaired, leaks on EOL chambers waiting for the closing of the detector to access the EO wheels in late 2014.

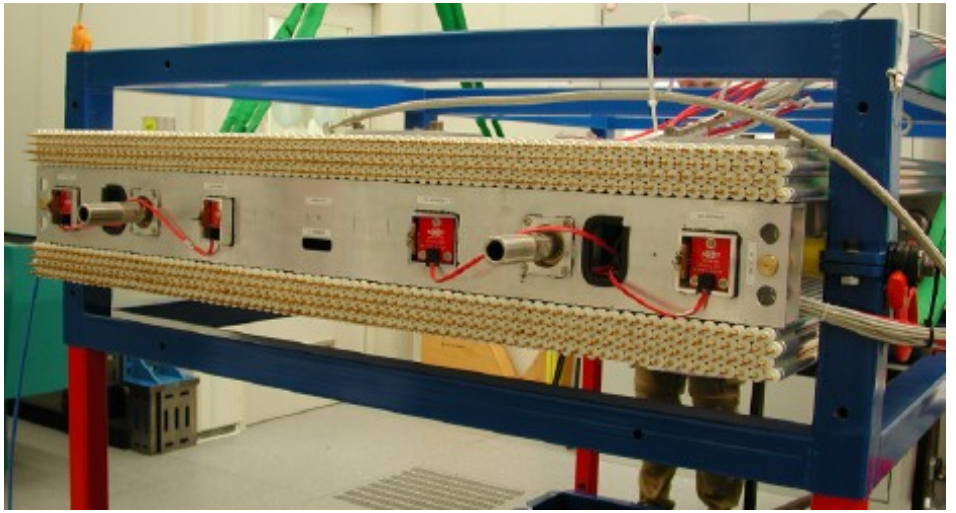
  - **CSC:** two chambers of the Small Wheel on surface, repaired and re-installed.

  - **TGC** chamber exchange: 5 chambers being installed (out of 29 on a total of 1578). The rest starting when the other surfaces of the big wheels accessible.

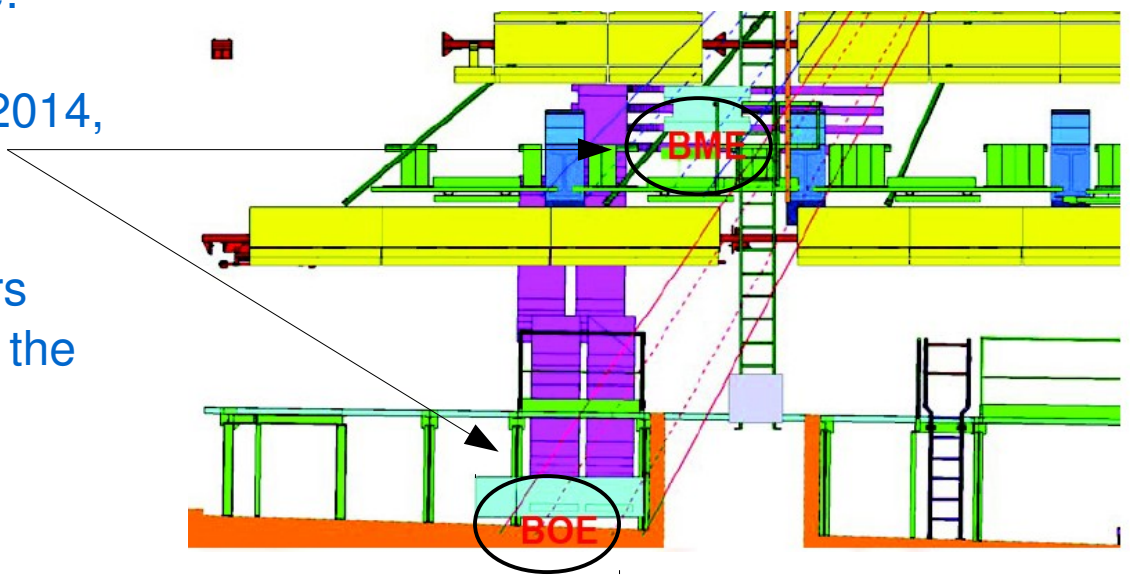


Muons (2)

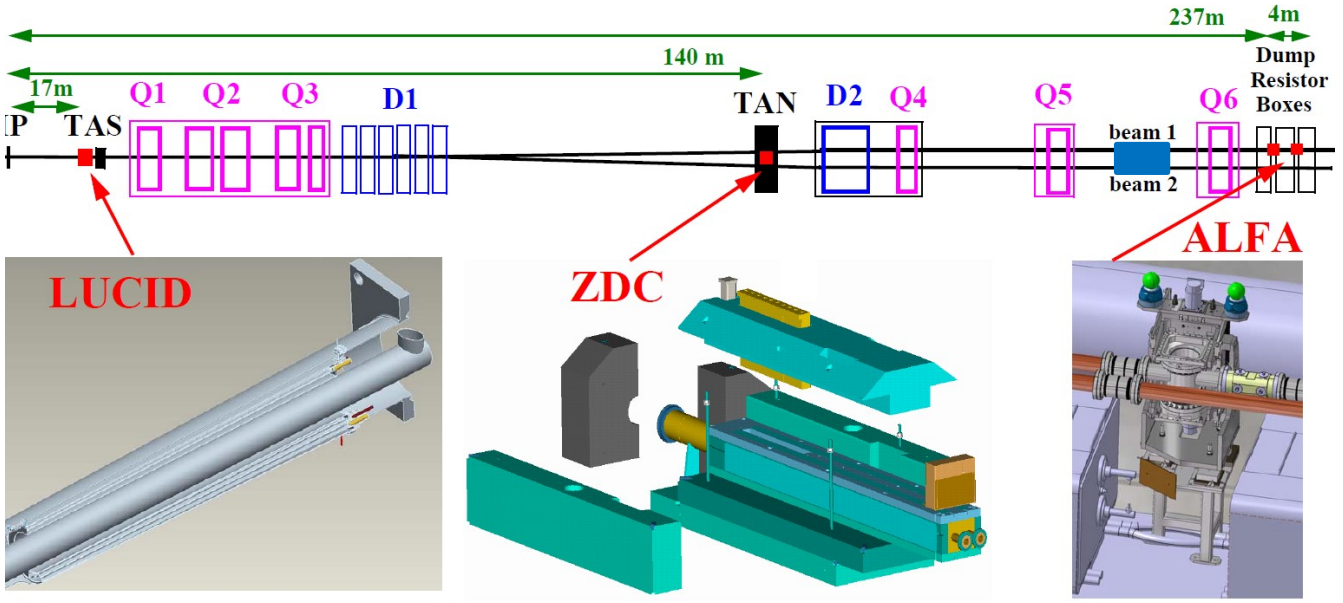
- Readout and trigger improvements:
  - TGC readout being improved to reduce risk of stopping data-taking by getting stuck in "busy" state.



- New installations:
  - Barrel Middle/Outer Elevator chambers (BOE/BME) to increase acceptance: BOE MDT and RPC installed, BME scheduled to be installed in March 2014, first BME-MDT produced
  - Alignment: installation of the sensors linking BEE chambers to the rest of the endcaps is ongoing



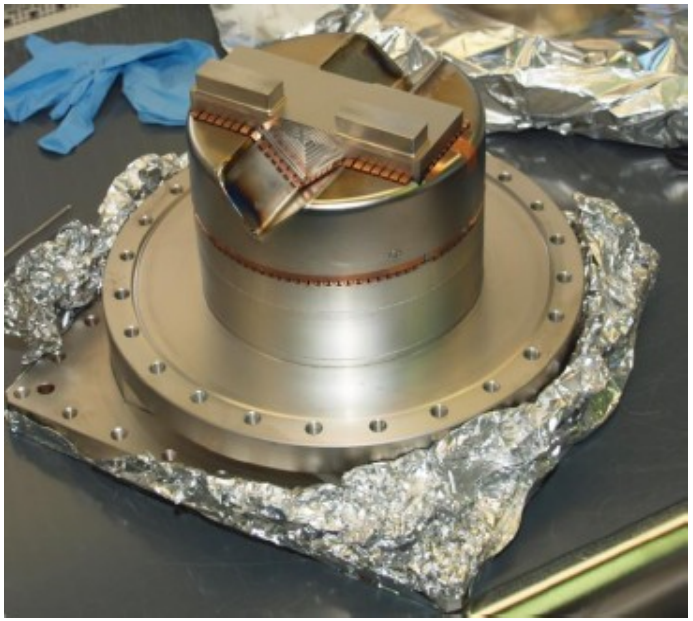
Forward Detector



• New **LUCID** photomultipliers needed after replacement of the beam-pipe to reduce acceptance → construction in progress.

• **ALFA**: during Run-1 temperatures close to critical → aim for LS1 is to reduce the cavity and consequently the impact of Radio Frequency heating.

- **First prototype has been finalized**
- **Production started, delivery early Jan 2014 followed by assembly, testing and vacuum validation.**



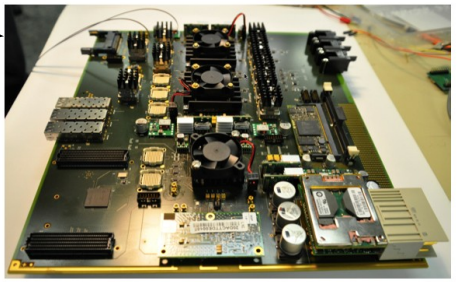
Trigger/DAQ

- **HLT Trigger:** significant speed increases (>3x) achieved in several areas
  - thanks to detailed code inspection, profiling and hand-optimisation
  - helps compensate for pile up increase, allow more use of offline algorithms
  - on track, but more work to be done for Run-2

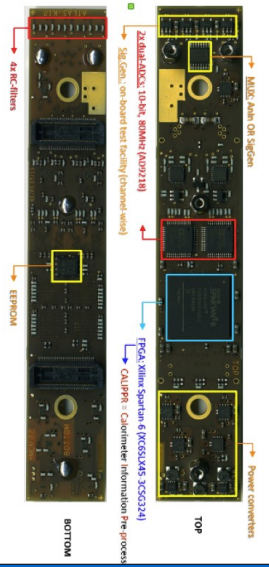
- **Level-1 Trigger** upgrade during LS1 (CERN-LHCC-2013-018):
  - L1-Topo provides extra rejection at L1
    - for B-physics, $H \rightarrow \tau\tau$, $ZH \rightarrow \nu\nu bb$
  - L1Calo upgrades deal with high rates from bunch train effects:
    - Signal Filtering and dynamic pedestals in nMCMs (part of the L1Calo preprocessor modules)

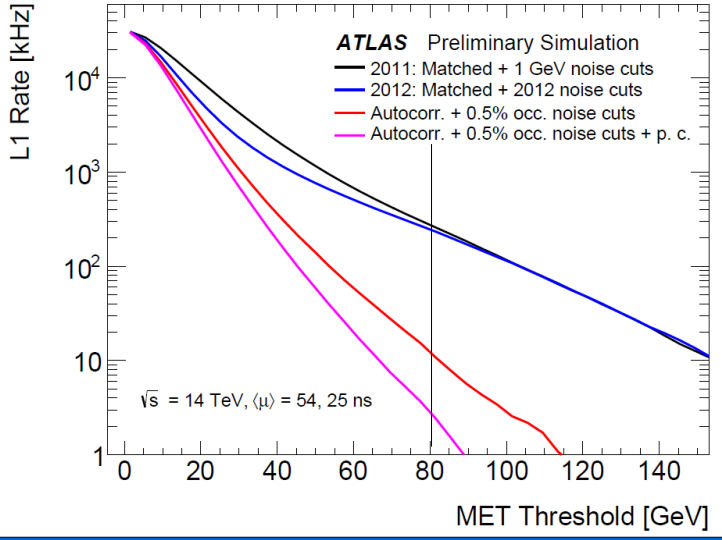
Topo-processor will allow cut on event topology, e.g. angle of E_T^{Miss} with jets.

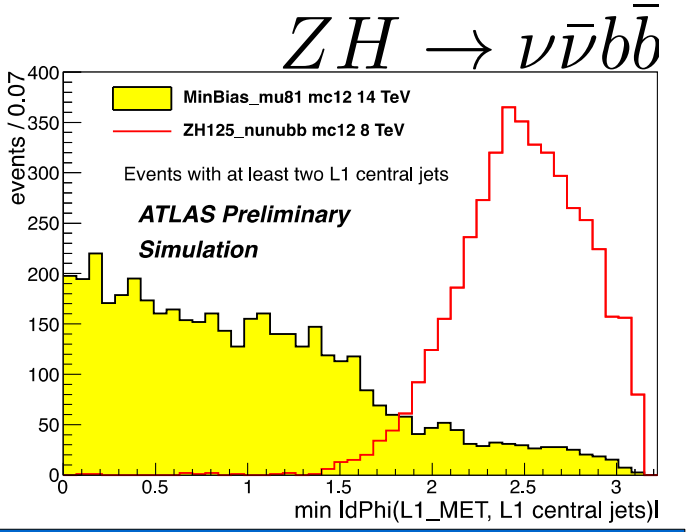
prototype under test



nMCM reduces bunch train effects on the trigger using an autocorrelation filter. **First boards tested,** ~3000 needed being produced





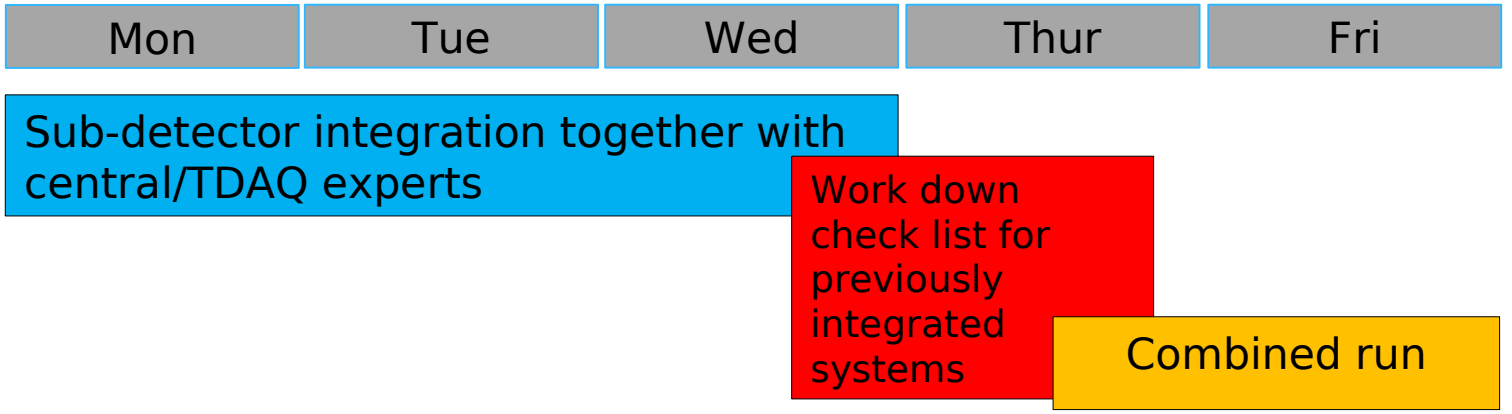


Prep. for Run-2: Milestone Weeks

- **"Milestone weeks" will start in Spring 2014 to re-establish detector integration and operations** (every 6 weeks).
- Test sub-detector migration to new software and TDAQ release.
- Validate functionalities in combined data-taking: configuration, state transitions, data-taking recovery, high-rate dry run,...
- Random triggers will be used in the first M-weeks, then cosmic triggers.
- Walk-through check-list for each of the systems:
  - Data Acquisition, online DQ, DCS,
  - Expert system, Shifter Assistant rules

M-weeks will also allow to re-establish offline activities in 2014:

- Tier0 operations, calibration loop, offline DQ alignment and detector conditions.
- Test new detector components (e.g. IBL)



Computing

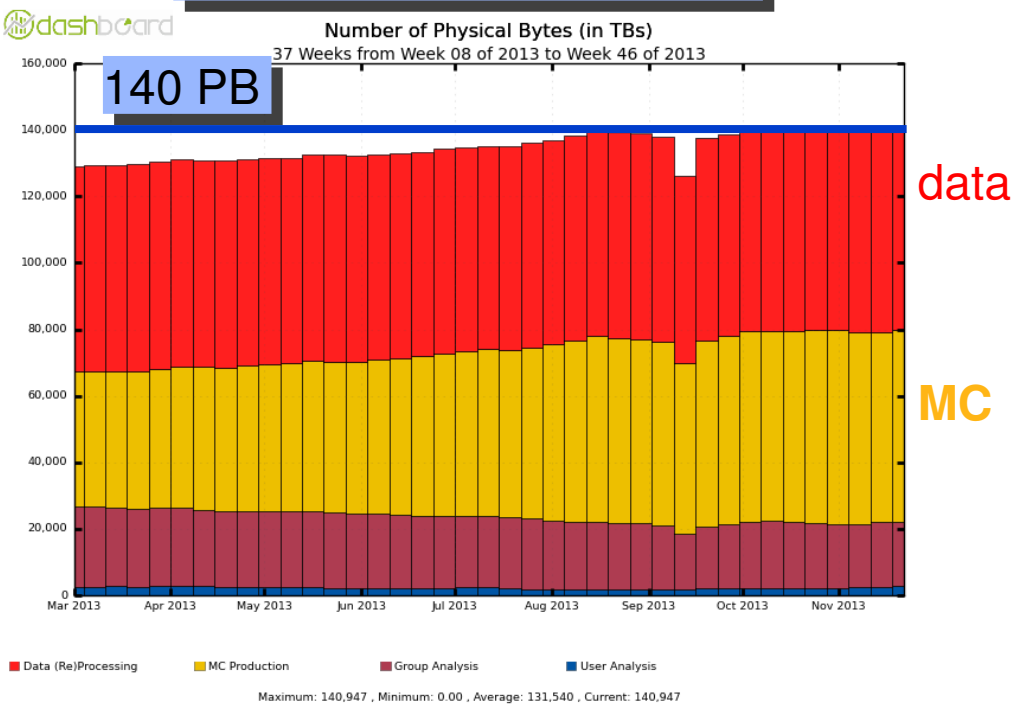
ATLAS Software and Computing is continuing the daily operations to guarantee the timely throughput of physics analyses of Run-1 data and at the same time working on the upgrade program needed for Run-2:

- Rucio for data management is being deployed.
- Deft/JEDI for the ProdSys II system.

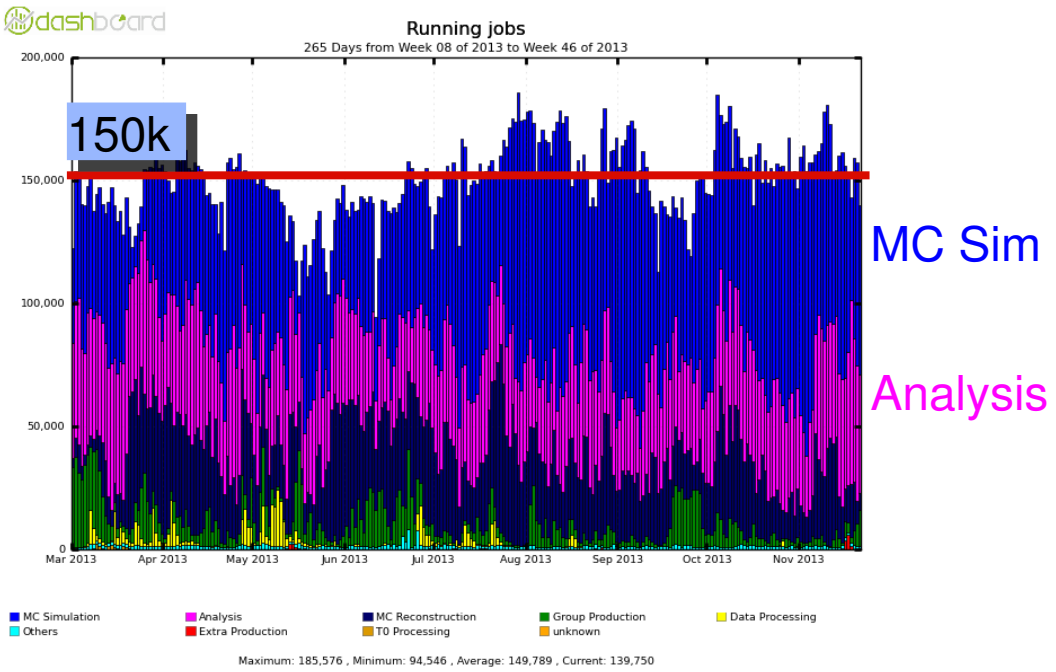
For ATLAS WLCG/Grid resources production is on-going as always, resources are fully used.

Excellent Distributed Computing and site performance

Disk and Tape usage/PB



Parallel running jobs

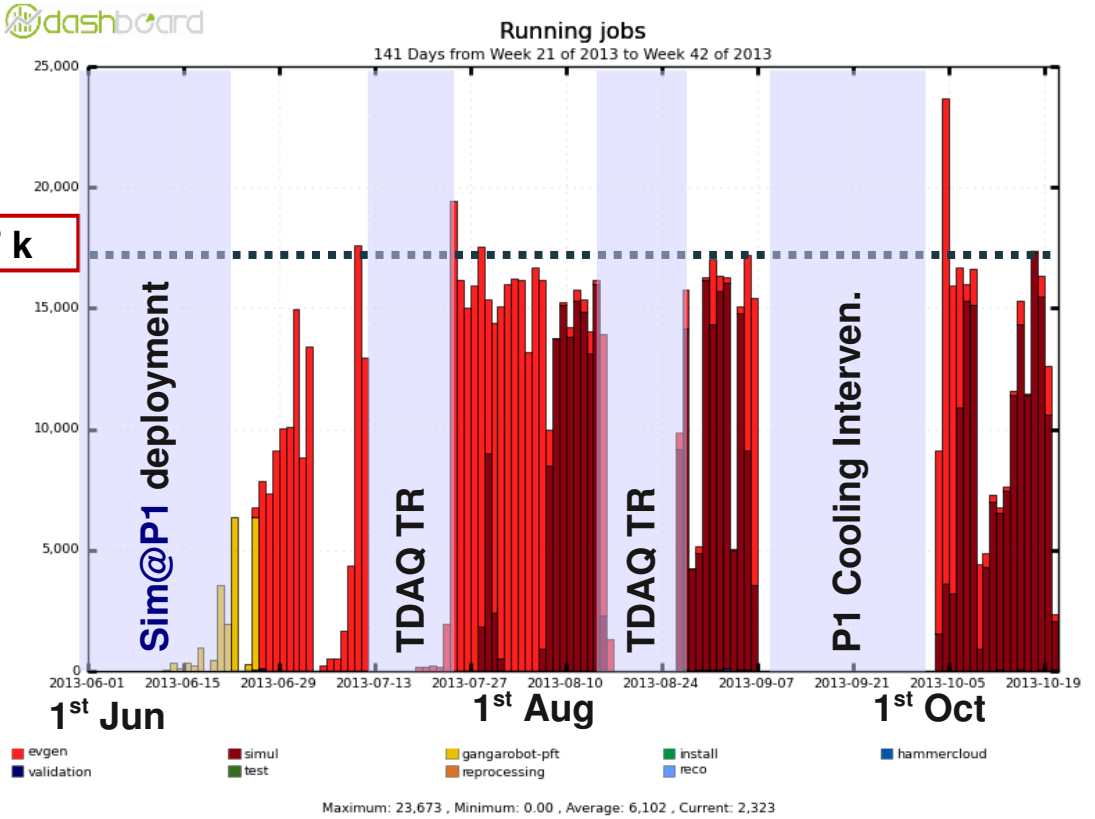


Computing (2)

Sim@P1:

- Usage of the HLT farm for MC simulation when not taking data.
- Significant computation power (comparable to a large Tier1) and based on cloud technology (OpenStack)
- **Farm available 55% since June 1st 2013**
  - 45 min to fully setup Sim@P1
  - Shutdown time: 10 min

    → Valuable resource during shutdown



- **High performance Computing (HPC):**

ATLAS started **evaluating opportunistic usage of free HPC resources** (both x86 and non-x86 architecture) for standalone jobs (primarily event generation).
Early results suggest real potential.

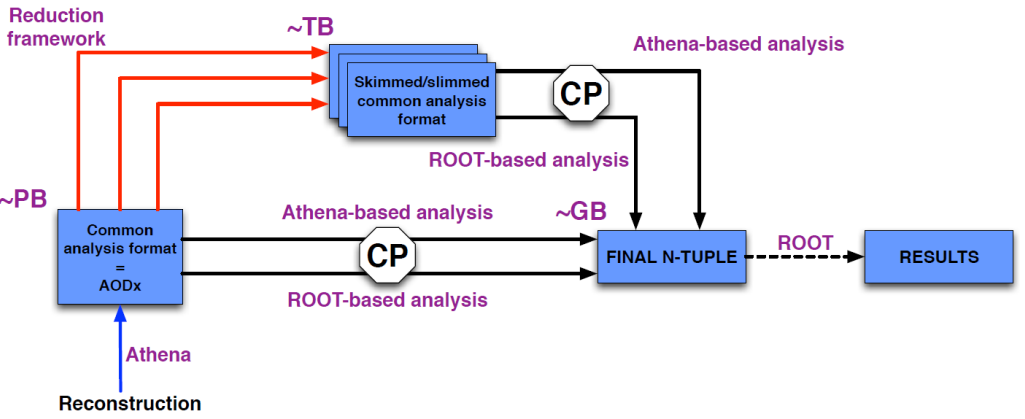
Running Jobs | Queued Jobs | Reservations

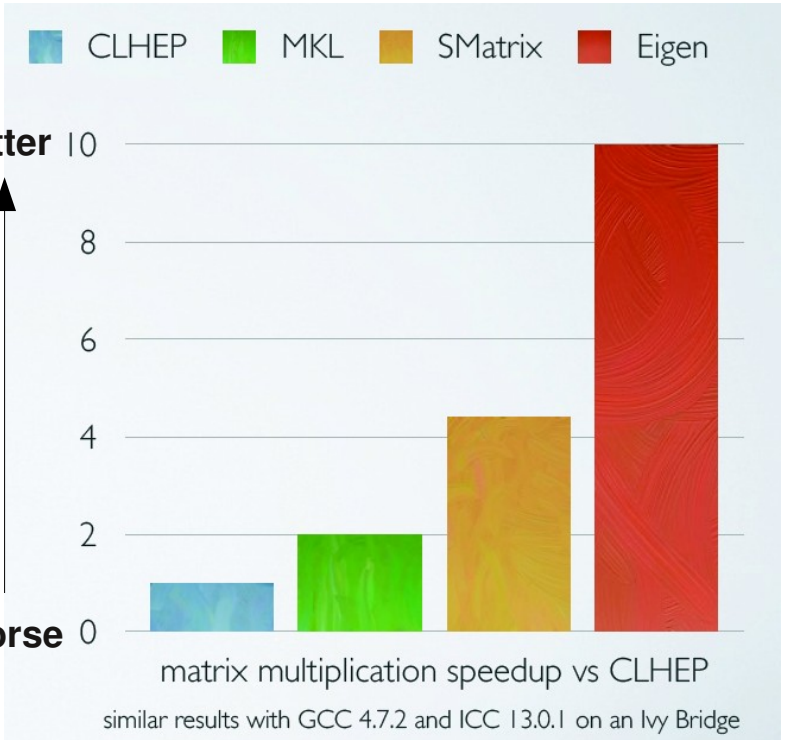
Total Running Jobs: 10

Job Id	Project	Run Time	Walltime	Location	Queue	Nodes	Mode
653066	CACS_In	15:25:12	1d 00:00:00	ANL-R10-R47-32768	R.cacs	32768	script
653009	DirectNoise	08:58:09	12:00:00	ANL-R04-R07-4096	prod-long	4096	script
653208	Peta_CESAR_2013	06:55:37	12:00:00	ANL-R02-M1-512	prod-long	512	vn
653232	ATLASP	03:28:57	06:00:00	ANL-R00-M1-512	prod-short	512	smp
653233	ATLASP	03:07:30	06:00:00	ANL-R01-M1-512	prod-short	512	smp
653234	ATLASP	03:07:04	06:00:00	ANL-R01-M0-512	prod-short	512	smp
653235	ATLASP	00:45:49	06:00:00	ANL-R02-M0-512	prod-short	512	smp
653236	ATLASP	00:25:30	06:00:00	ANL-R00-M0-512	prod-short	512	smp
653237	ATLASP	00:19:09	06:00:00	ANL-R03-M1-512	prod-short	512	smp
653238	ATLASP	00:18:42	06:00:00	ANL-R03-M0-512	prod-short	512	smp

Offline Improvements for Run-2

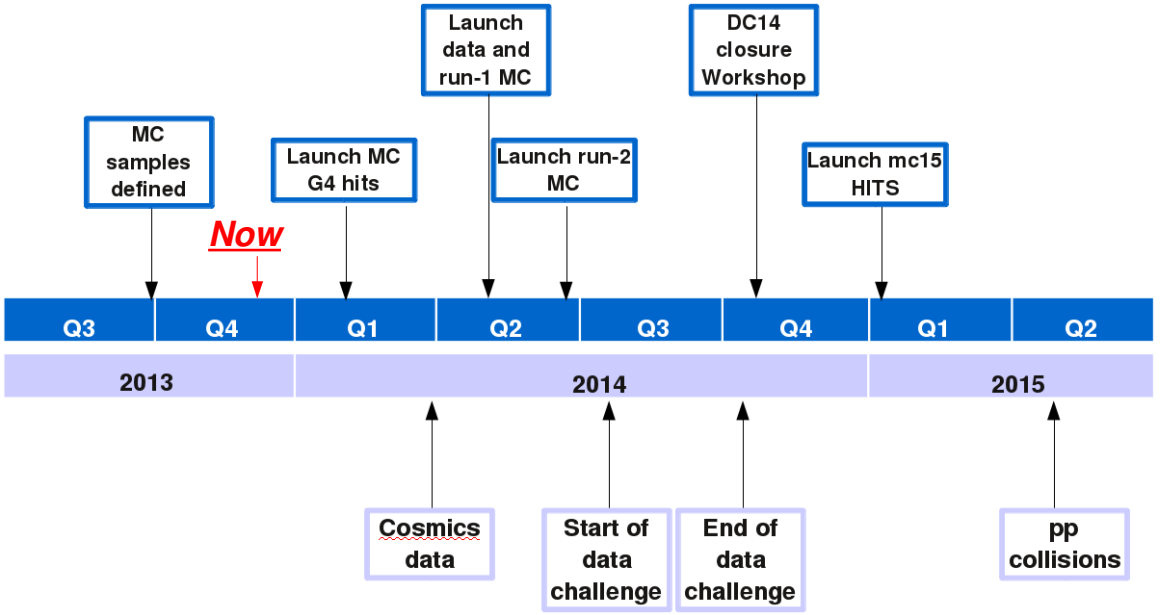
- Extensive list of on-going offline improvements for Run-2:
  - New analysis model with faster data-access, turn-around and easier access to ATLAS data:
    - New Event Data Model (xAOD)
    - New Derivation framework
    - New Analysis framework
  - New simulation framework:
    - Integrated Simulation Framework (ISF)
    - New Geant4 version and new Physics list (FTFP_BERT)
    - Improved fast simulation
  - New Reconstruction software:
    - CLHEP to Eigen migration and simplified EDM
    - (Auto-)vectorization
    - Framework support for parallel processing
    - Test new/improved objects reconstruction
    - Track reconstruction optimised for IBL





Prep. for Run-2: DC14

- Technical and Physics improvements in offline areas will be tested and validated during a data-challenge in 2014 (DC14).
- **The goal is to get ready for Run-2 analyses** and engage a large fraction of the collaboration:



- Production of MC with run-1 conditions and reprocessing of a part of run-1 data

- Production of MC with run-2 conditions

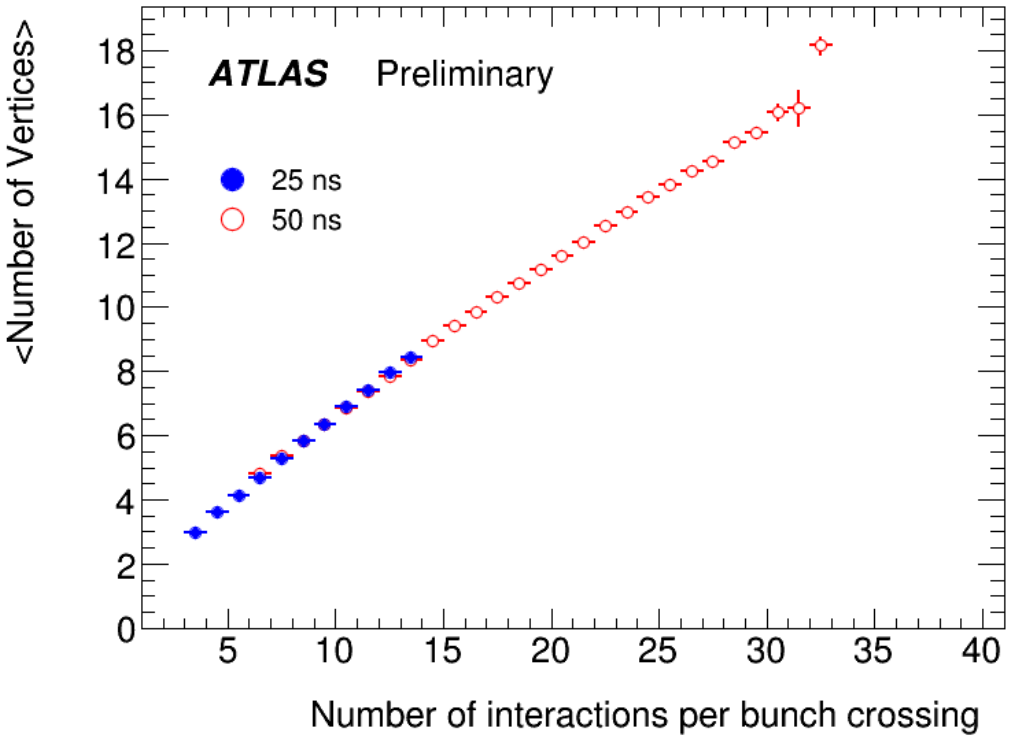
- Exercise CP groups calibrations and representative analyses from the physics groups.

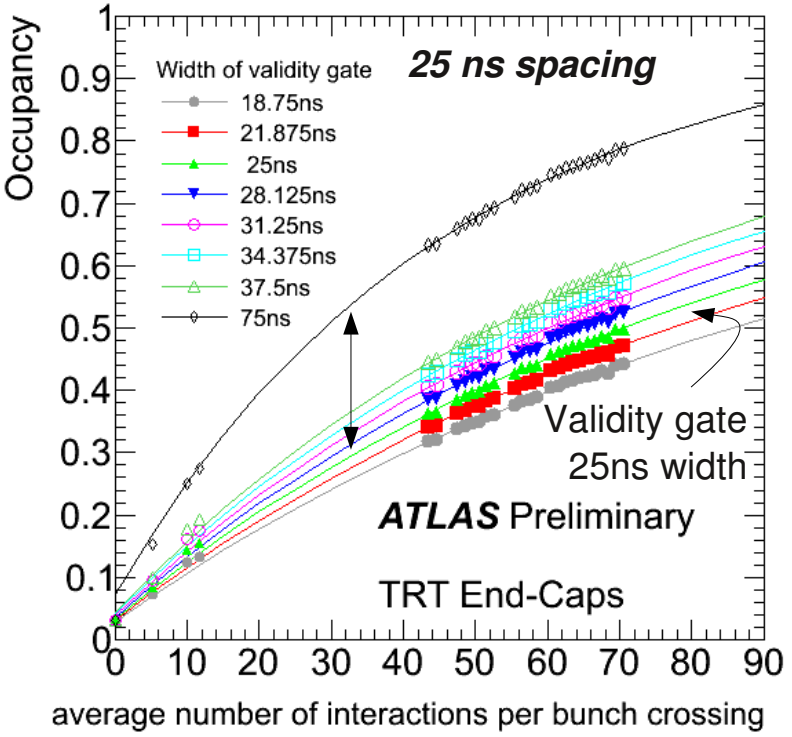
- Test both Full-sim (G4) and Fast-sim and start exploring ISF potential.

- Test the Run-2 analysis model.

Prep. for Run-2: 25ns Data Analysis

- 25ns data collected in Dec. 2012. ~10 pb^{-1} in total.
- ATLAS is analyzing the data collected to verify the detector and physics performance with 25 ns data and prepare calibration and offline performance for run-2.
- So far, no unexpected issues encountered.
- Example of 25 ns data preparation: TRT «validity» gate on the time information from the TRT hits to mitigate occupancy of the out of time pileup in TRT.



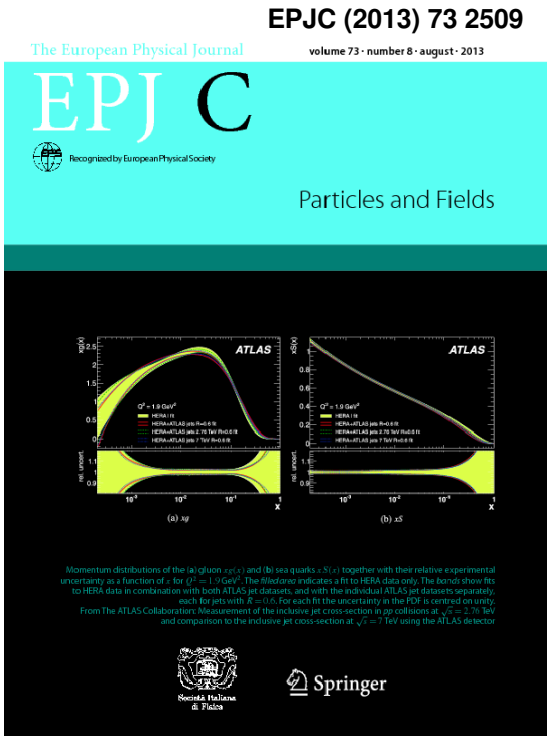


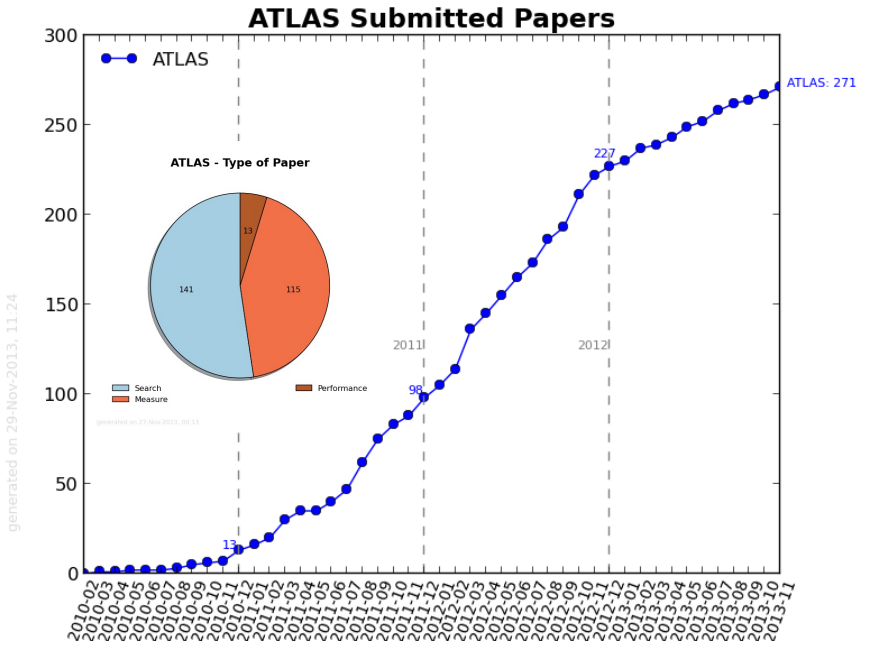
Physics Results

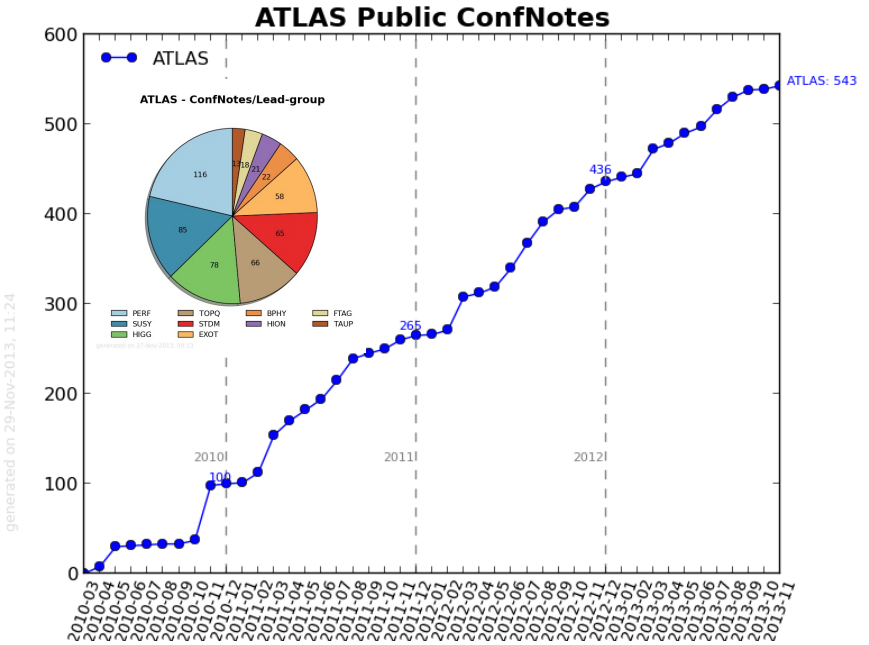
With collision data:

- ATLAS Papers submitted/accepted: **271**
- CONF Notes: **543**

- Current emphasis is on the preparation of papers collecting final results with Run-1 statistics.



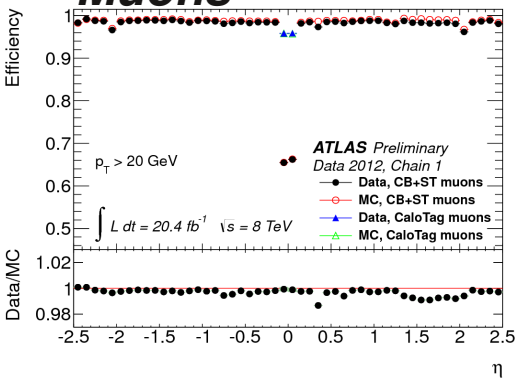


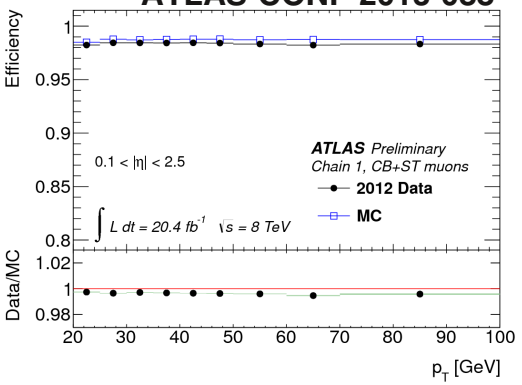


Combined Performance Activities

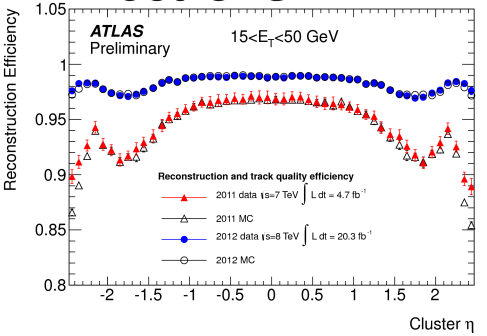
- Final results and documentation of the Run-1 detector performance and object reconstruction and identification is advancing well.
- Recent Progress by all the Combined Performance Groups:

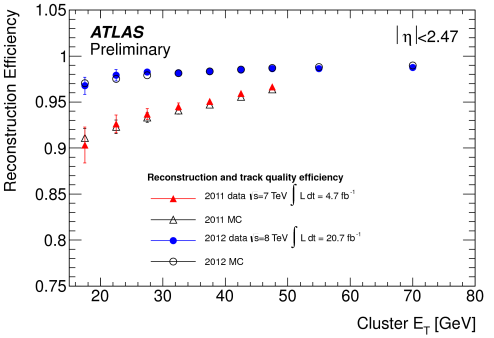
Muons



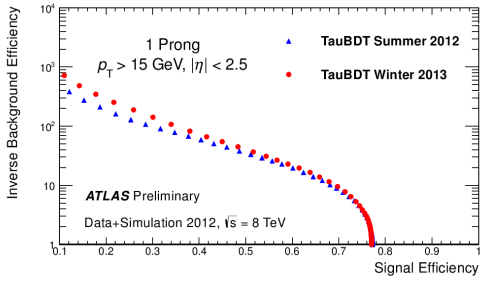


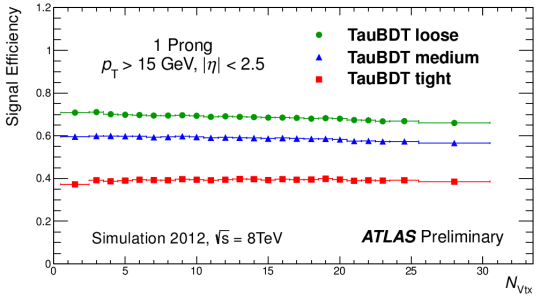
Electrons



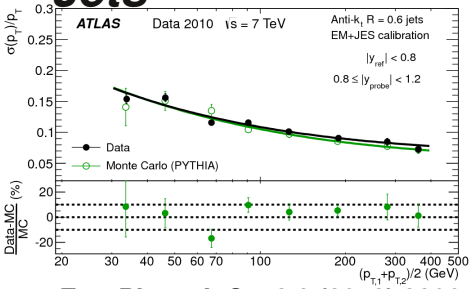


Taus





Jets



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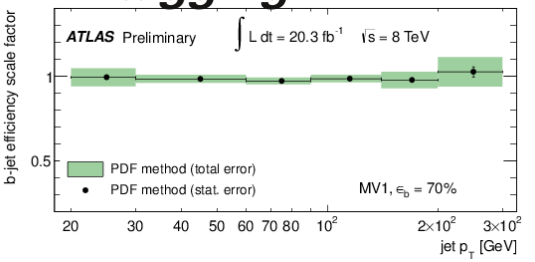
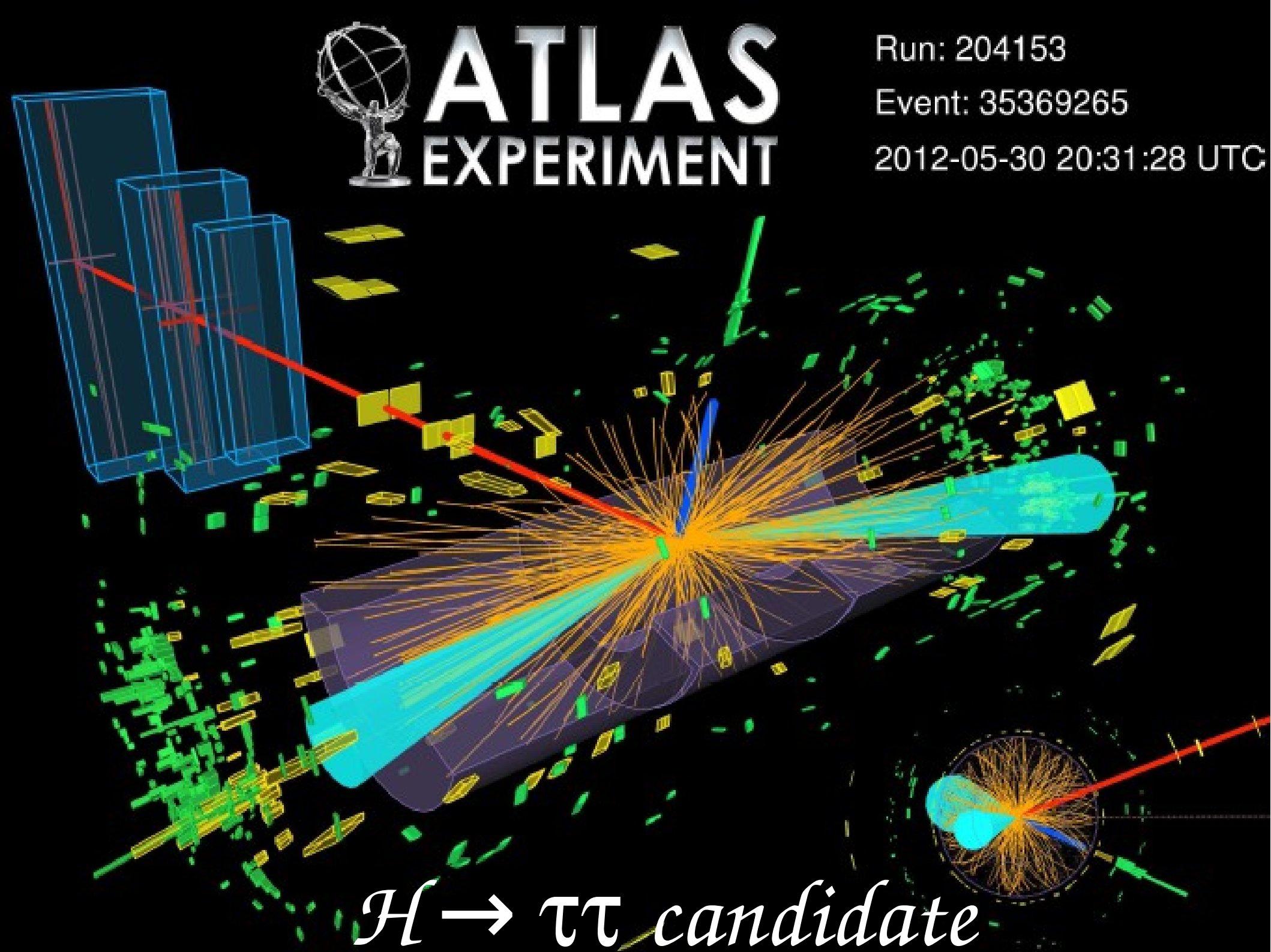
B-tagging





$H \rightarrow \tau\tau$ candidate

$H \rightarrow \tau\tau$ Analysis

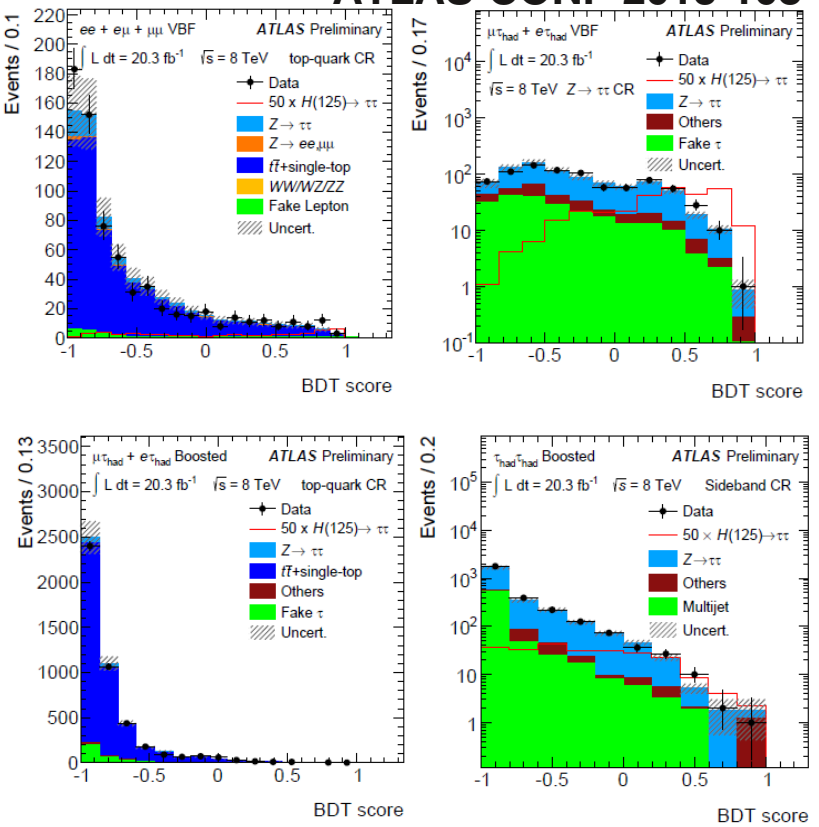
- SM $H \rightarrow \tau\tau$ analysis with full 2012 dataset, following recent results on Higgs coupling to bosons and $H \rightarrow bb$
- **Features:**
  - ATLAS exploits the $\tau_{lep}\,\tau_{lep}$, $\tau_{lep}\,\tau_{had}$, $\tau_{had}\,\tau_{had}$ final states
  - Events are separated in 2-jets (VBF) and $p_T^{\tau\tau}$ boosted categories.
  - MVA Analysis: signal is extracted from a binned fit of the BDT score.

Source of Uncertainty	Uncertainty on μ
Signal region statistics (data)	0.30
$Z \rightarrow \ell\ell$ normalization ($\tau_{lep}\tau_{had}$ boosted)	0.13
ggF $d\sigma/dp_T^H$	0.12
JES η calibration	0.12
Top normalization ($\tau_{lep}\tau_{had}$ VBF)	0.12
Top normalization ($\tau_{lep}\tau_{had}$ boosted)	0.12
$Z \rightarrow \ell\ell$ normalization ($\tau_{lep}\tau_{had}$ VBF)	0.12
QCD scale	0.07
di-τ_{had} trigger efficiency	0.07
Fake backgrounds ($\tau_{lep}\tau_{lep}$)	0.07
τ_{had} identification efficiency	0.06
$Z \rightarrow \tau^+\tau^-$ normalization ($\tau_{lep}\tau_{had}$)	0.06
τ_{had} energy scale	0.06

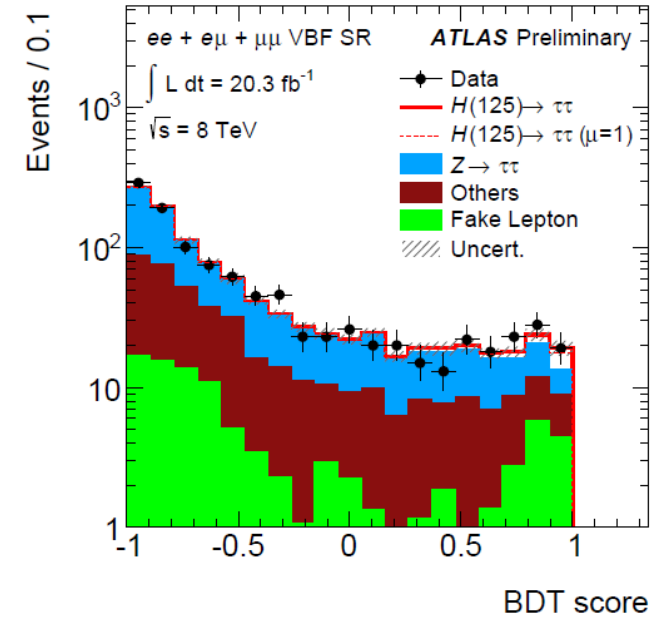
Control Region Checks:

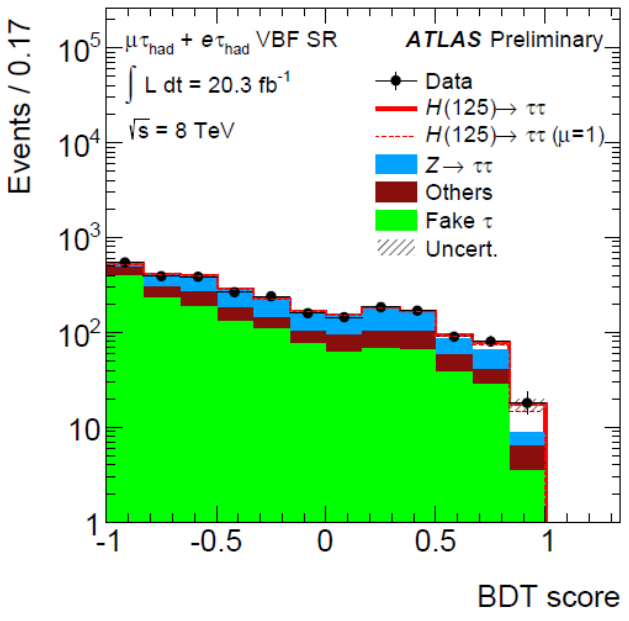
Agreement between data and MC is checked in Control Regions. Examples of BDT distributions in data CR's for major backgrounds.

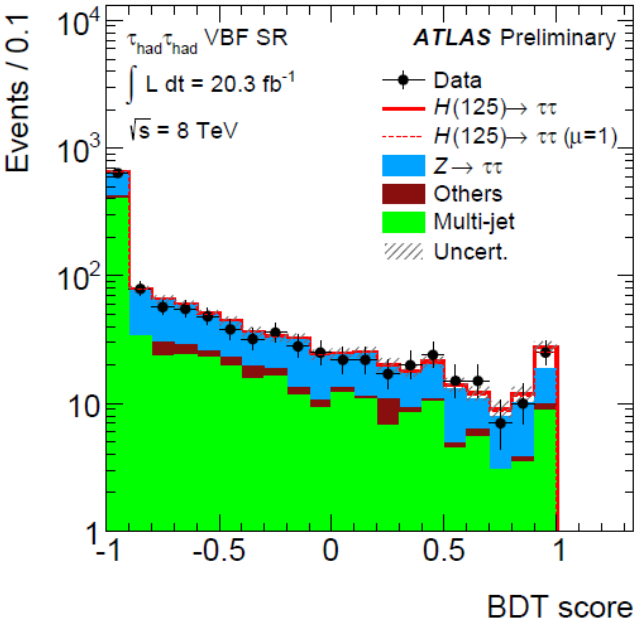
ATLAS-CONF-2013-108

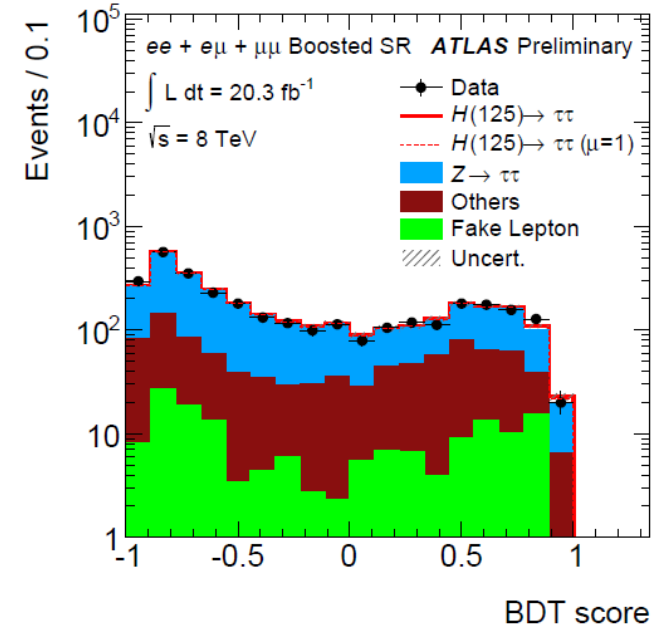


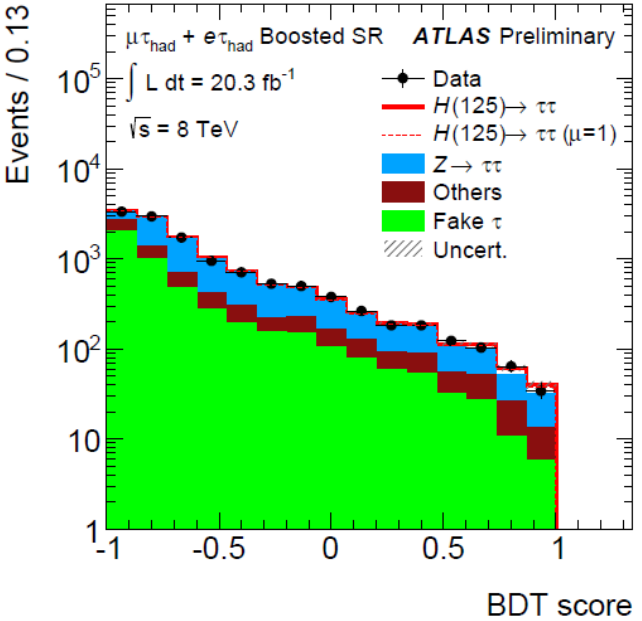
$H \to \tau\tau$ Analysis (2)

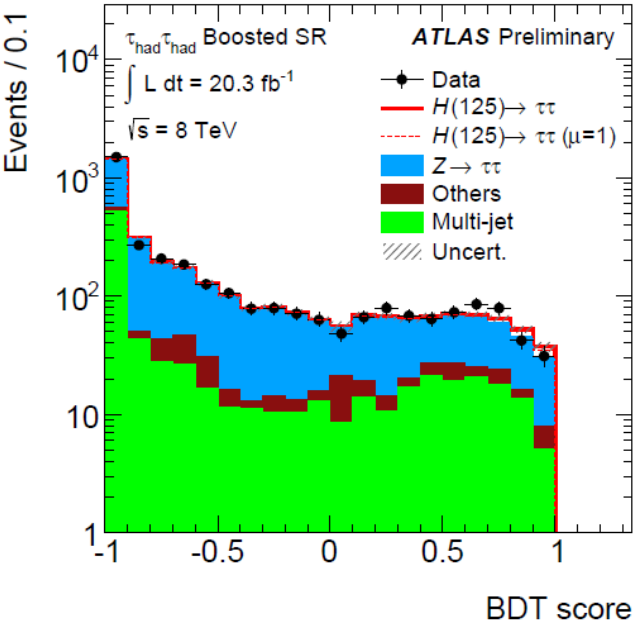








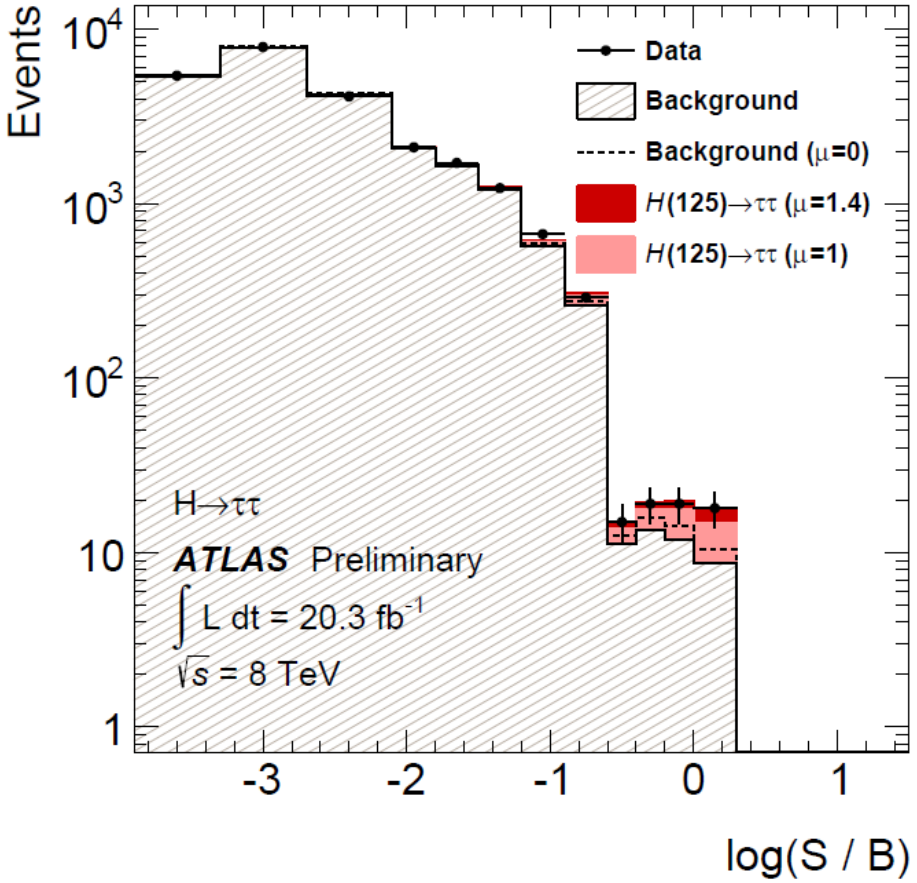


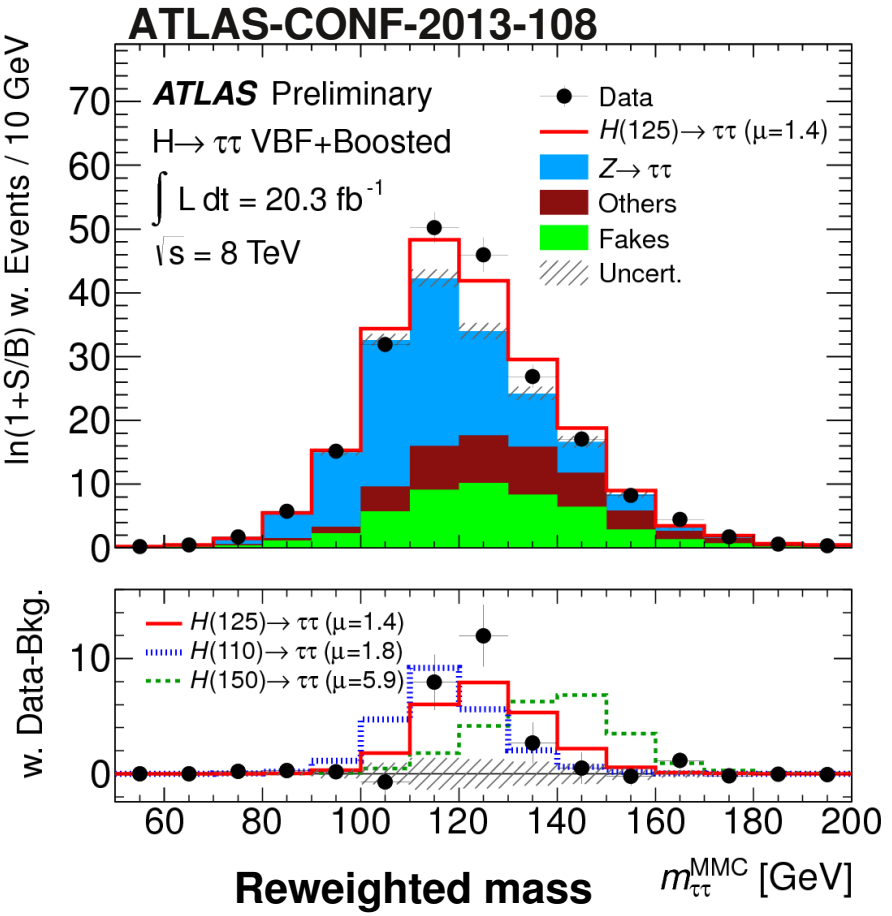


- Data is divided in 6 signal regions and 9 control region to simultaneously fit signal and backgs.

$H \rightarrow \tau\tau$ Analysis (3)

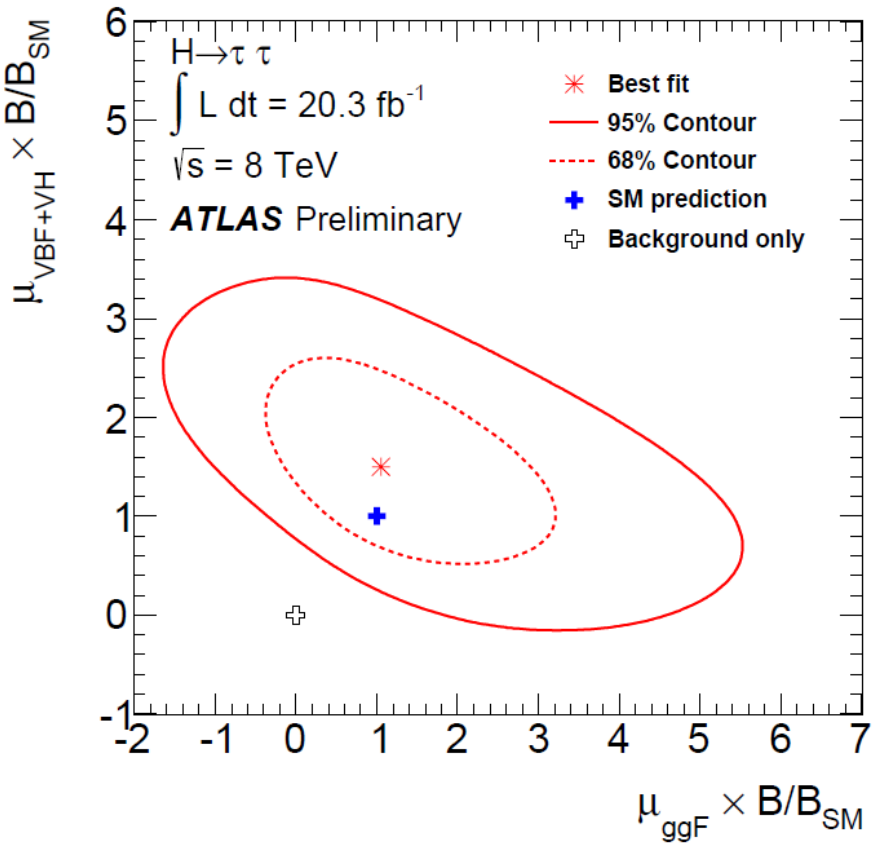
- ATLAS observes significant excess of data events in high S/B region:
  - Excess is observed in all three channels
  - *Strong evidence of $H \rightarrow \tau\tau$ decay*: **4.1 σ observed @125 GeV (3.2 σ expected).**
  - Excess of data events is compatible with presence of Higgs at 125 GeV (events are weighted by ln[1+S/B] value of the corresponding BDT-score bin)

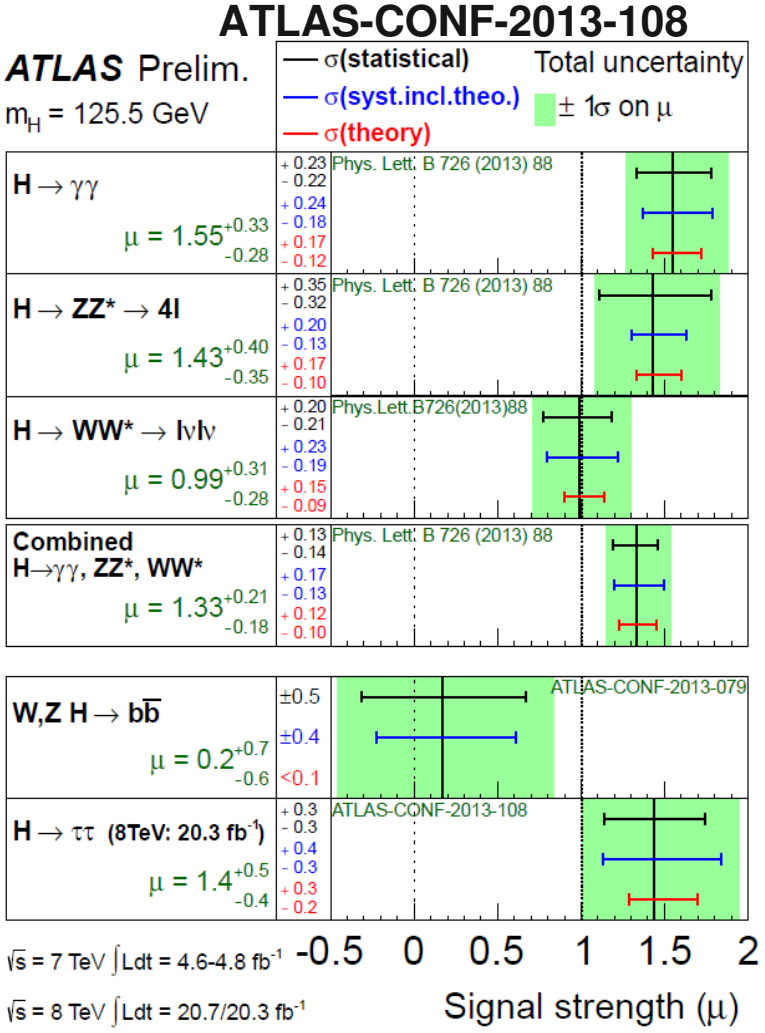




$H \rightarrow \tau\tau$ Results

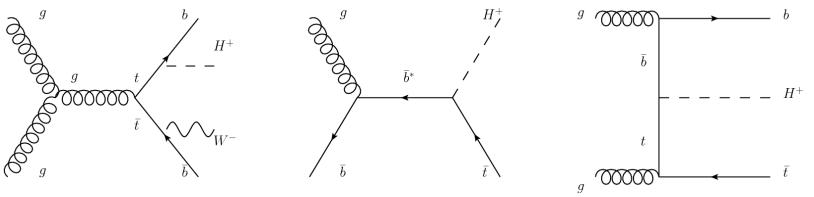
- Good sensitivity to VBF production mode
- Together with ATLAS $H \rightarrow \mu\mu$ results, it proves that the Higgs couplings is not the same for all lepton flavours, in agreement with SM.
- **Best fit $\sigma/\sigma_{SM} = 1.4^{+0.5}_{-0.4}$**

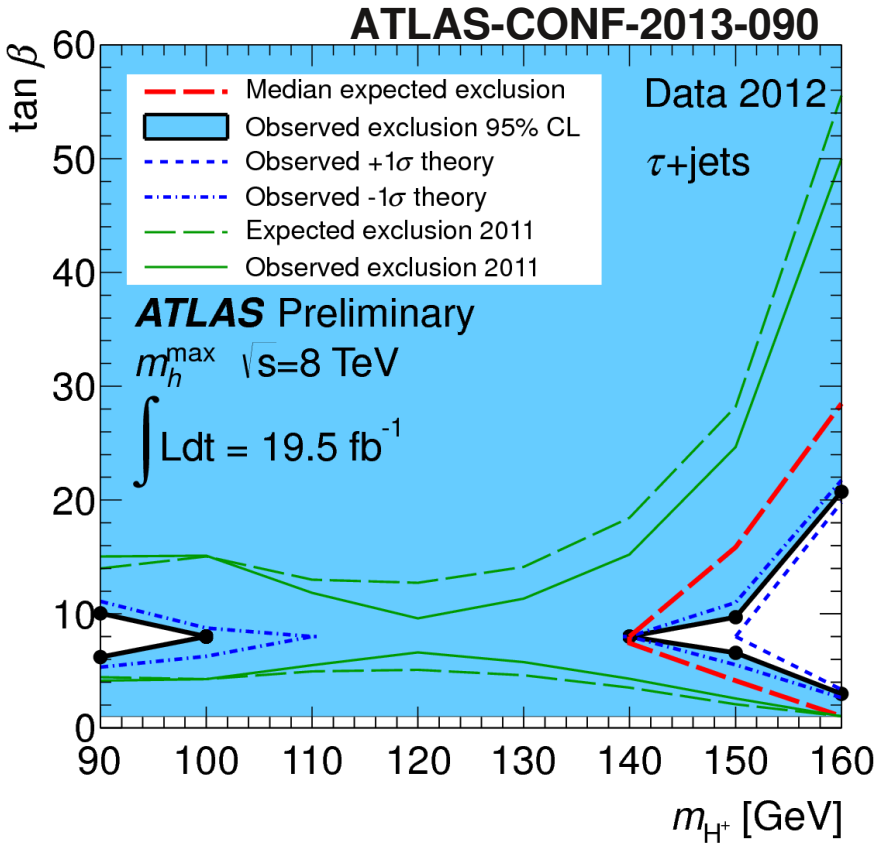


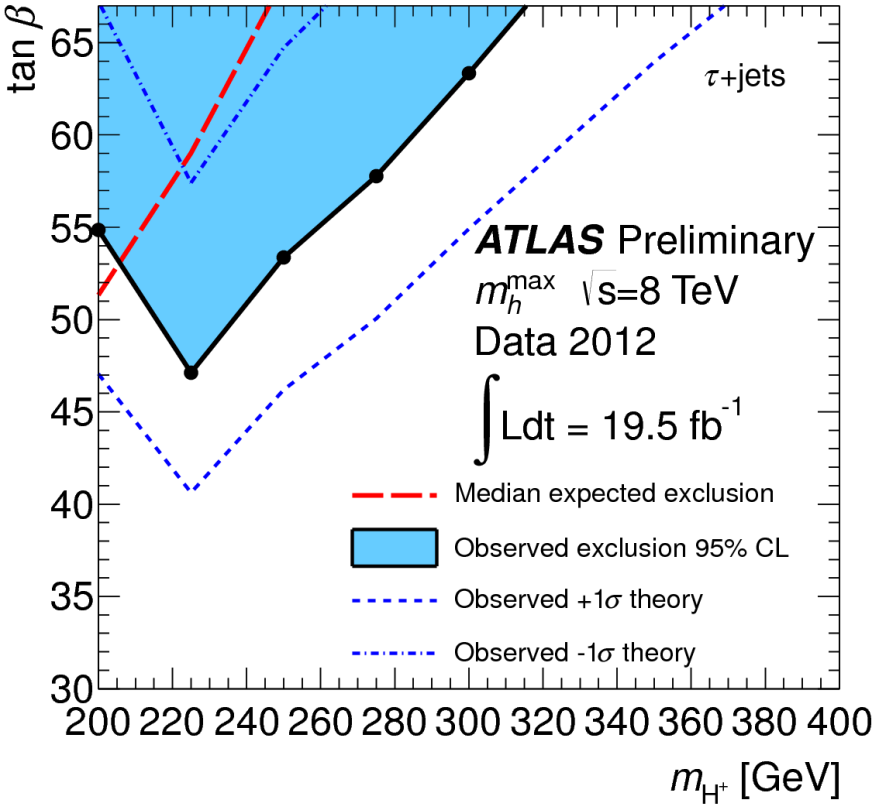


More Higgs highlights

- Recent update on charged $H^+ \to \tau^+\nu$ searches:
  - Final states with hadronically decaying taus
  - Exploit m_T distribution to extract the signal
  - Results for both below and above top-quark threshold: ($t \to Hb$ and $pp \to tH$)







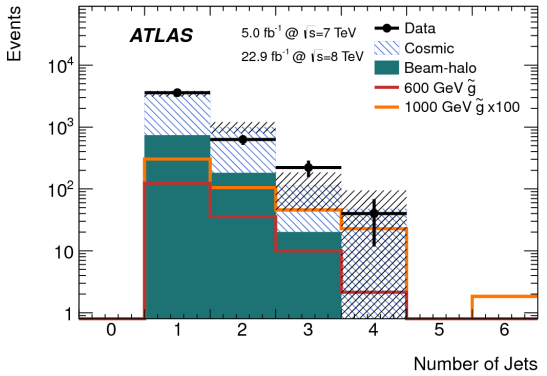
SUSY Highlights

Recent Publications:

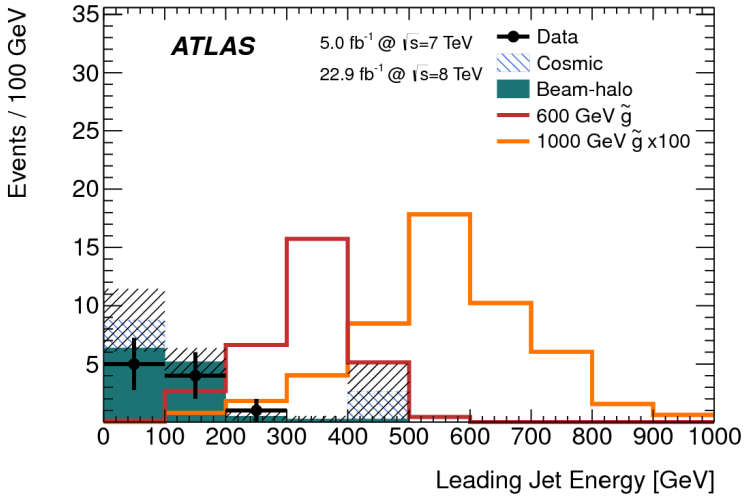
Short Title of Paper	Date	√s (TeV)	L (fb^{-1})	Document	Plots+Aux. Material	Journal
Long-lived stopped gluino or squark R-hadrons [Split-SUSY] NEW	10/2013	7+8	27.9	1310.6584	Link	Accepted by PRD
Disappearing track + jets + Etmiss [Direct long-lived charginos - AMSB] NEW	10/2013	8	20.3	1310.3675	Link	Accepted by PRD
0 leptons + 2 b-jets + Etmiss [Sbottom/stop] NEW	08/2013	8	20.1	1308.2631	Link	JHEP 10 (2013) 189
0 leptons + >=7-10 jets + Etmiss [Incl. squarks & gluinos] NEW	08/2013	8	20.3	1308.1841	Link	JHEP 10 (2013) 130

Long-lived R-hadrons search:

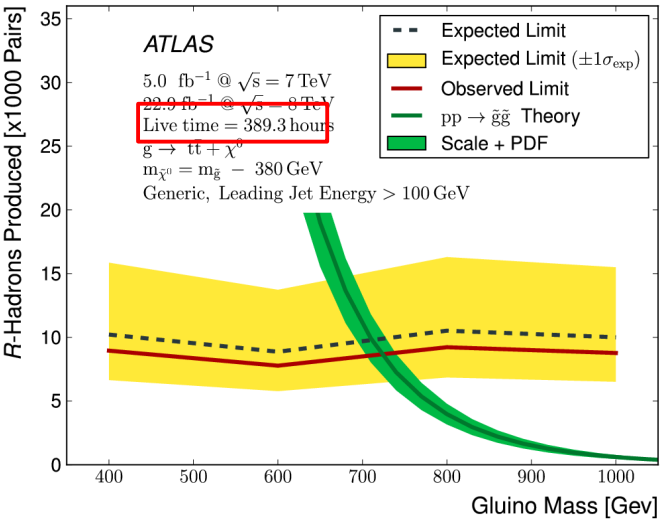
- Search in the empty bunches. Main backgrounds are cosmic rays and remaining beam-halo background. 515 hours of live data analyzed
- Event Selection requires one jet of E>100/300 GeV and veto muon segments.
- Control region with looser requirements are used to model the backgrounds.
- Allow to set limits on "split-SUSY", where gluino lifetime is expected to be long.



Control Region with relaxed muon and jet requirements



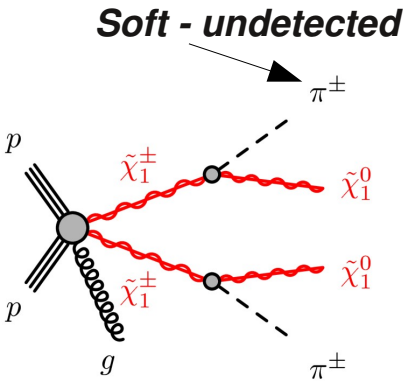
arXiv:1310.6584

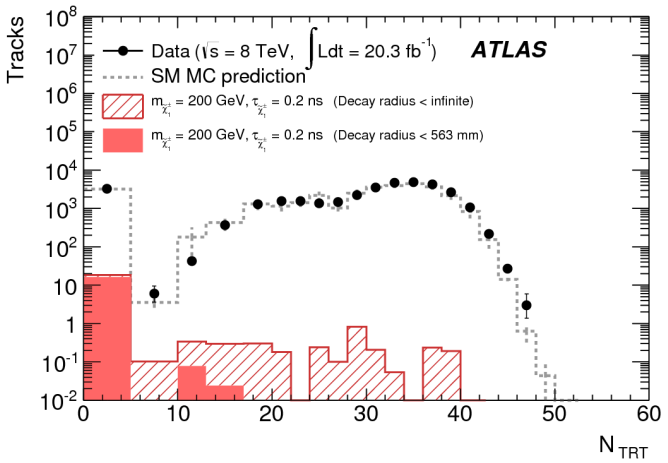


SUSY Highlights (2)

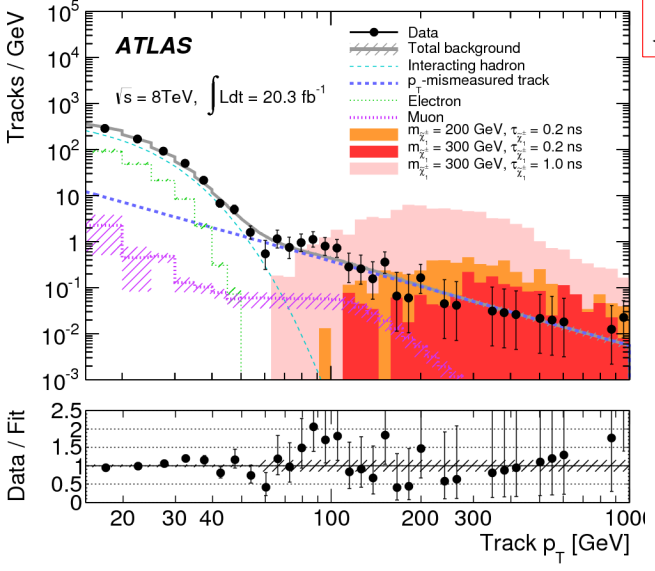
Search for nearly mass-degenerate chargino:

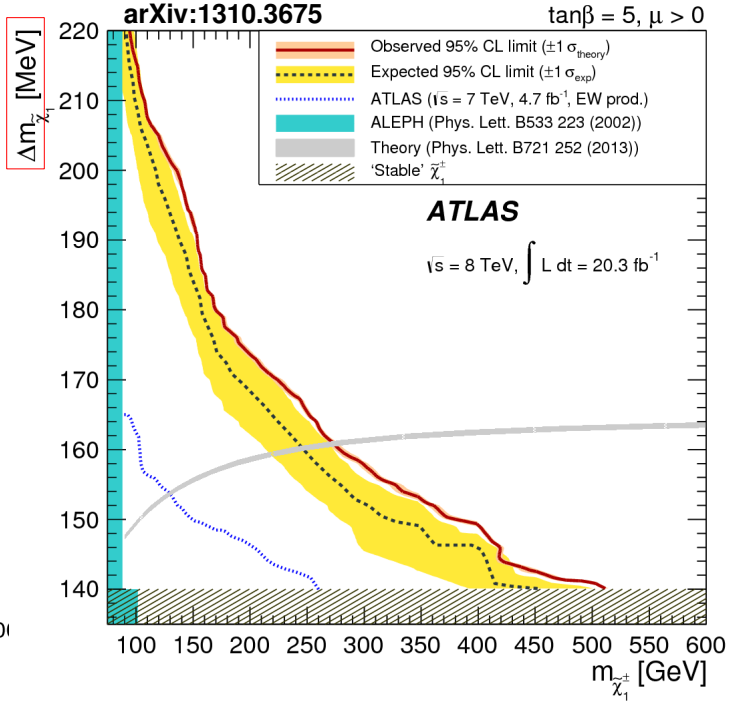
- In Anomaly-mediated supersymmetry breaking (AMSB), chargino can have a lifetime long enough to be observed in the detector before decay.
- Sensitive to lifetime in the range 0.1-10 ns.
- Analysis exploits the TRT detector to identify efficiently *"disappearing tracks candidates"*.
- A jet of p_T> 90 GeV and E_T^{miss}> 90 GeV are also required to trigger the event.
- Result greatly extend previous LEP limits for low Δm_χ





Expected number of TRT hits

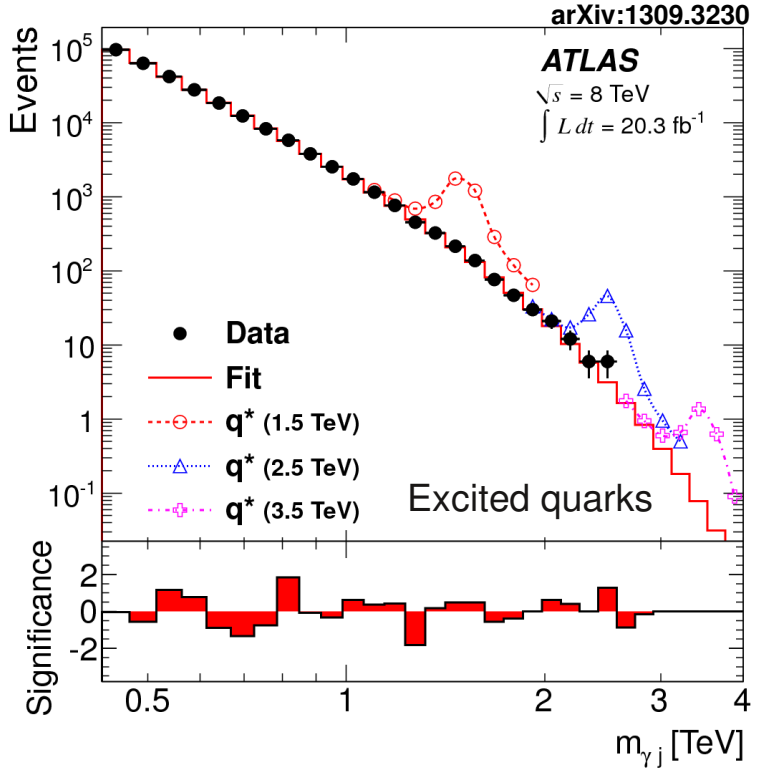


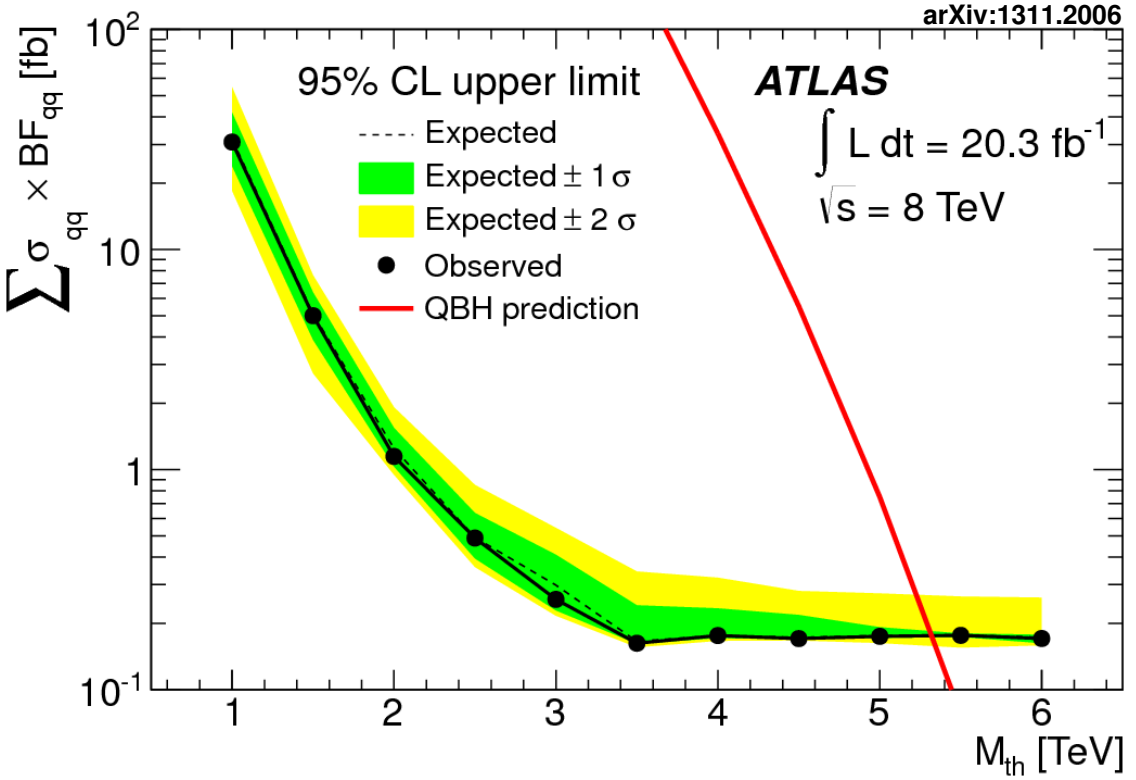


Exotics Highlights

Recent Publications:

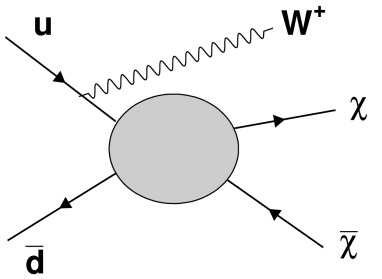
Title	Journal	Papers and Plots	Int. luminosity	Date
Search for quantum black-hole production in high-invariant-mass lepton+jet final states using proton-proton collisions at √s = 8 TeV and the ATLAS detector NEW!	Submitted to PRL	Plots and more Info; arXiv:1311.2006	20.3/fb	November 2013
Search for dark matter in events with a hadronically decaying W or Z boson and missing transverse momentum in pp collisions at √s =8 TeV with the ATLAS detector NEW!	Submitted to PRL	Plots and more Info; arXiv:1309.4017	20.3/fb	September 2013
Search for new phenomena in photon+jet events collected in proton--proton collisions at √s = 8 TeV with the ATLAS detector NEW!	Submitted to PLB	Plots and more Info; arXiv:1309.3230	20.3/fb	September 2013

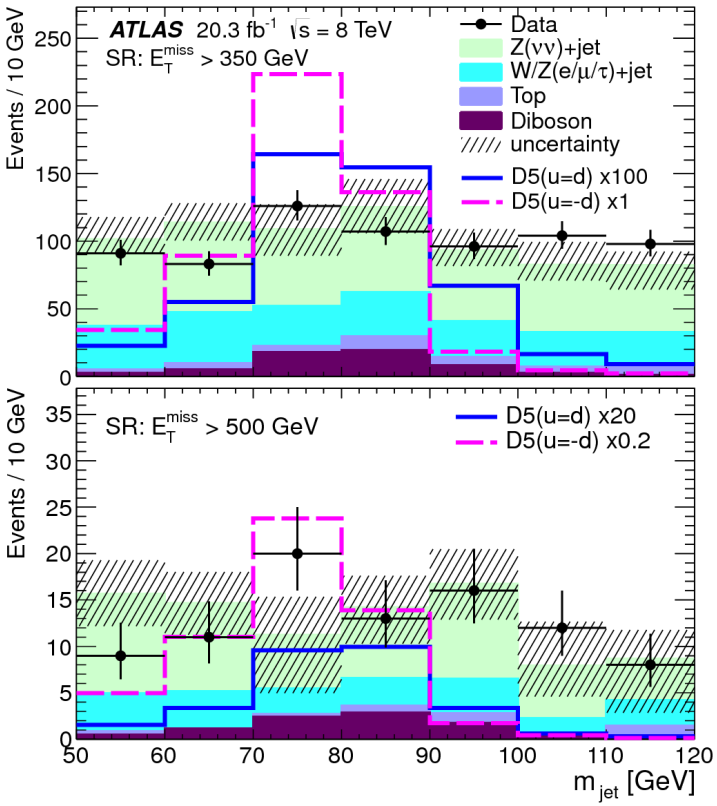


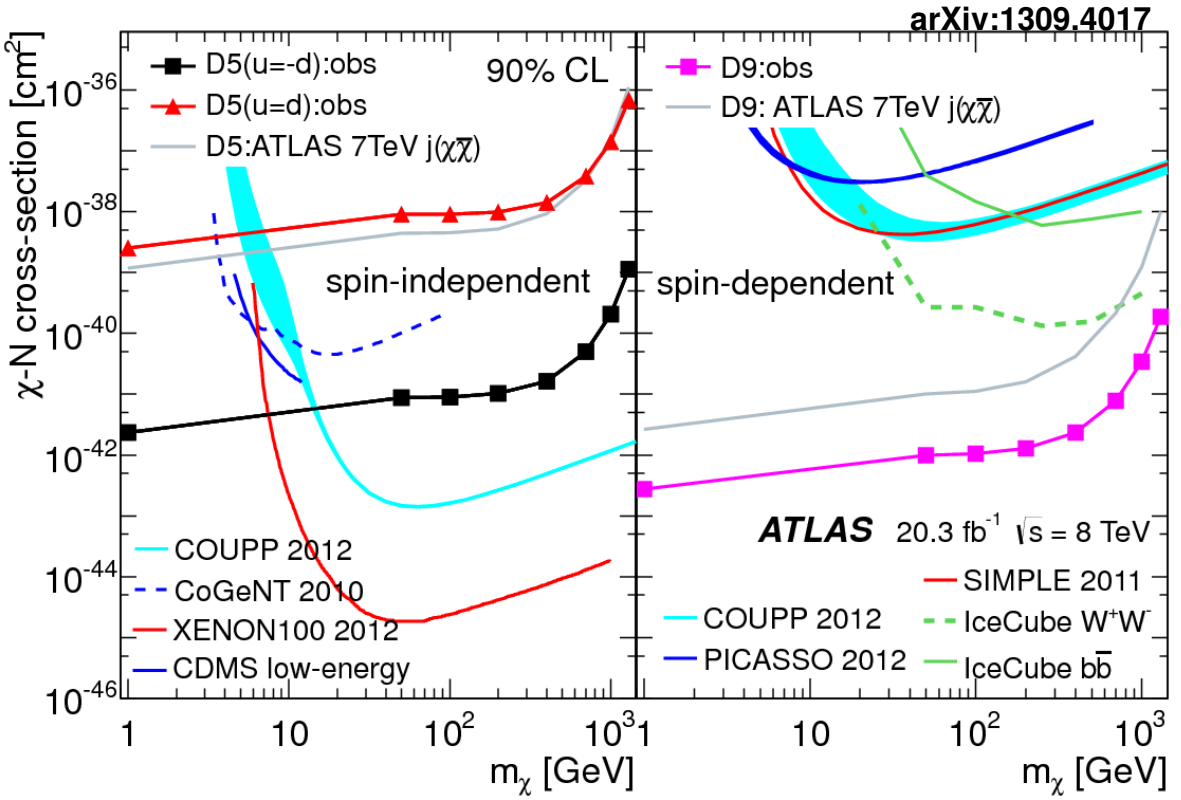


Exotics Highlights (2)

- Dark matter search in W/Z (→ quarks) + E_T^{miss} final state:
  - Final state is defined by a boosted vector boson, identified as a single jet of $\Delta R=1.2$ and $p_T>250$ GeV, and $E_T^{miss}>350$ (500) GeV
  - Selection is validated in top-enriched Control Region
  - Results are interpreted in terms of χ and H → inv exclusion limits







Top and SM Publications

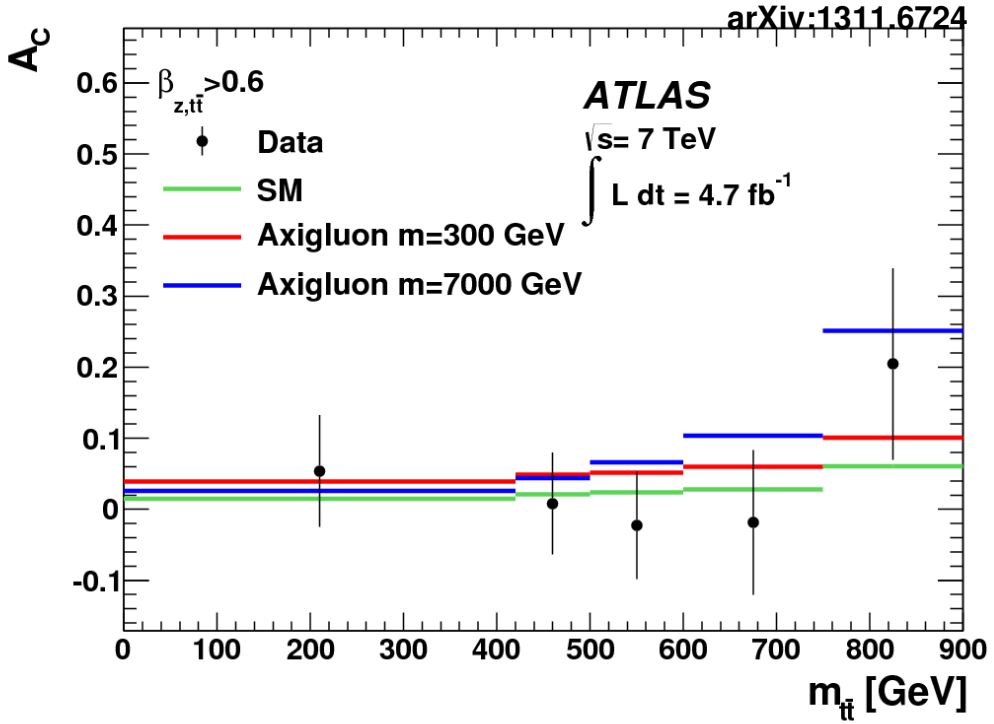
Measurement of the ttbar charge asymmetry in lepton+jets events.
Motivated by A_{FB} anomaly at TeVatron

Inclusive and differential measurements are performed:

$$A_C = \frac{N(\Delta|y| > 0) - N(\Delta|y| < 0)}{N(\Delta|y| > 0) + N(\Delta|y| < 0)}$$

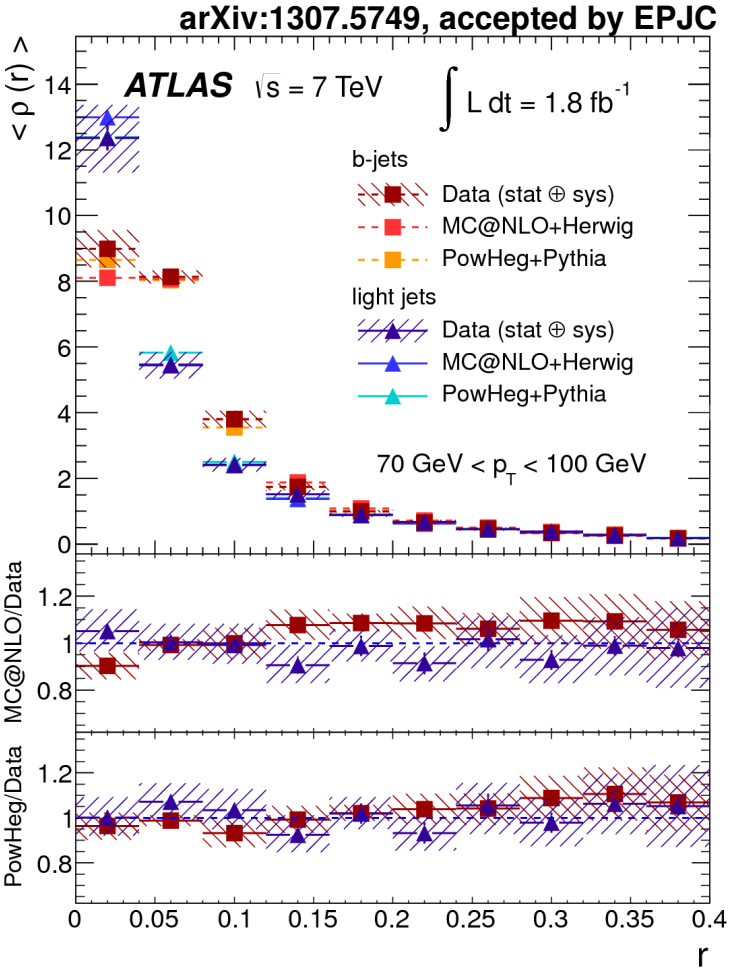
A_c =0.006±0.010

consistent with A_C^{SM}= 0.0123±0.0005



Differential jet shape for b- and light jets in ttbar events:

$$\rho(r) = \frac{1}{\Delta r} \frac{p_T(r - \Delta r/2, r + \Delta r/2)}{p_T(0, R)}$$



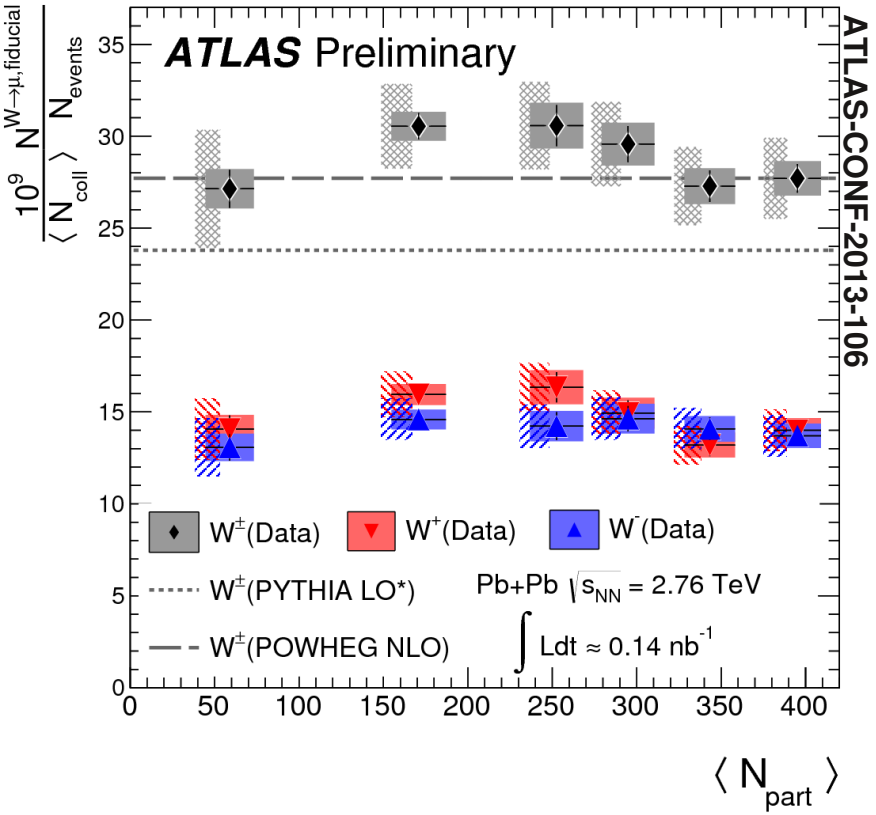
Other recent publication: **Measurement of the inclusive isolated prompt photon cross section using 4.6 fb^{-1} (arXiv:1311.1440)**

Heavy Ions Results

- New results for both Pb+Pb and p+Pb collisions

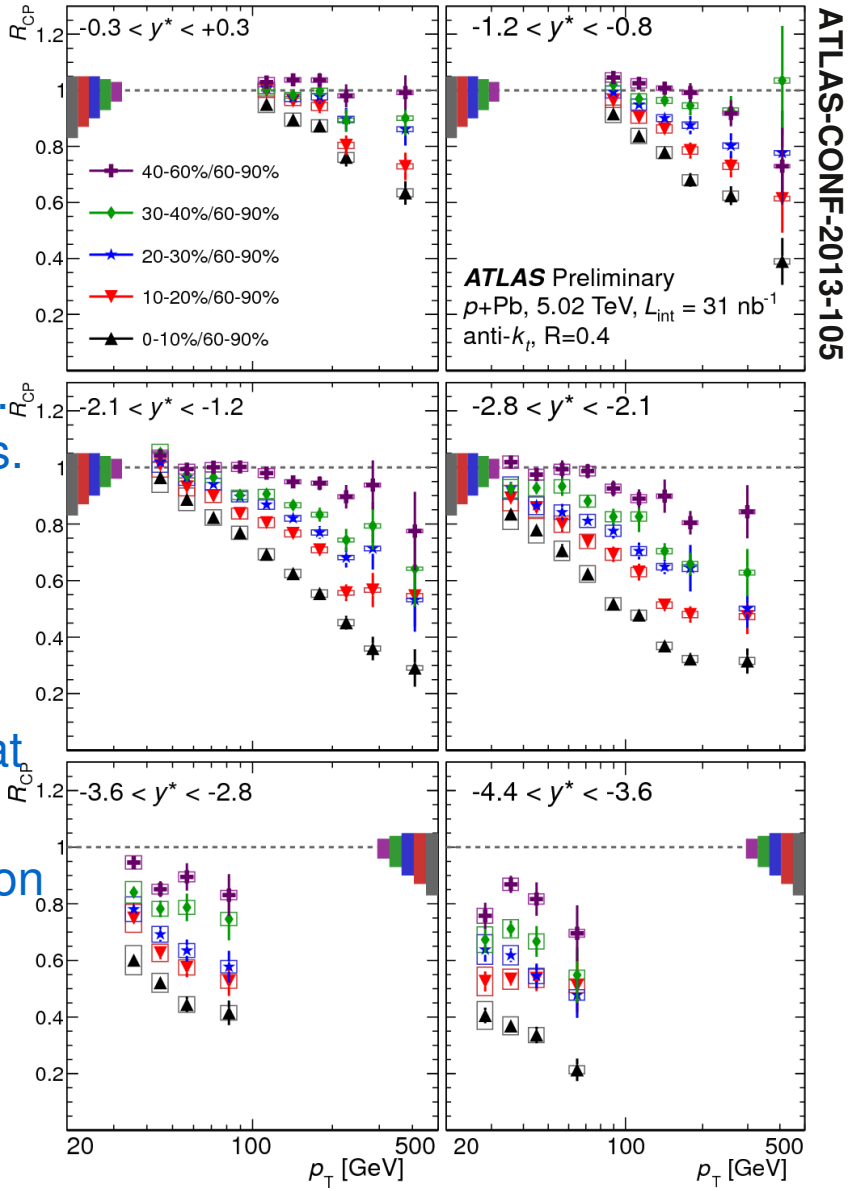
Ncoll in different centrality classes is obtained with the Glauber Monte Carlo analysis for both Pb+Pb and p+Pb collisions.

W charge asymmetry in Pb+Pb collisions. *W* production yields well modelled by NLO Generator.



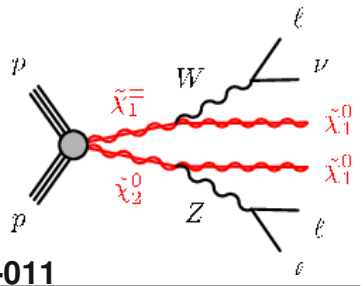
Centrality dependence of inclusive jet prod. in p+Pb collisions.

→ Found strong reduction of jet yields in central collisions wrt peripheral ones at high p_T and at forward eta (proton direction).



Detector Upgrade and Physics Projections

- ECFA High Luminosity LHC Experiments Workshop (1st – 3rd Oct):
  - to develop a common approach to the HL-LHC programme and to identify synergies and possible effort to collaborate in areas of common interest
  - ATLAS presented new detailed studies on the expected sensitivity for Phase-1 and Phase-2 LHC upgrades.
- Several topics were covered, which included:
  - Physics goals, theoretical developments and performance reach
  - Long Shutdown constraints and radiation and activation effects
  - Detector, electronics and read-out systems
  - Trigger/DAQ/Offline/Computing

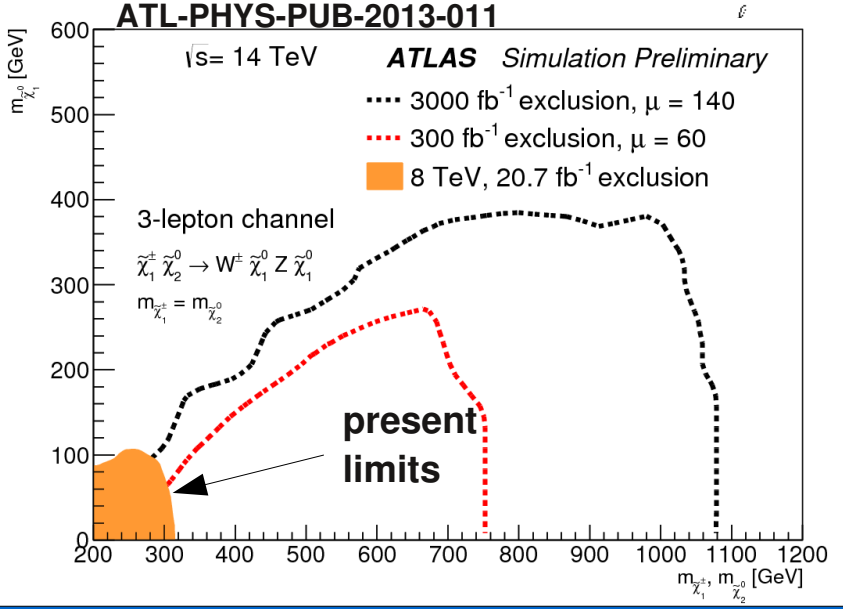


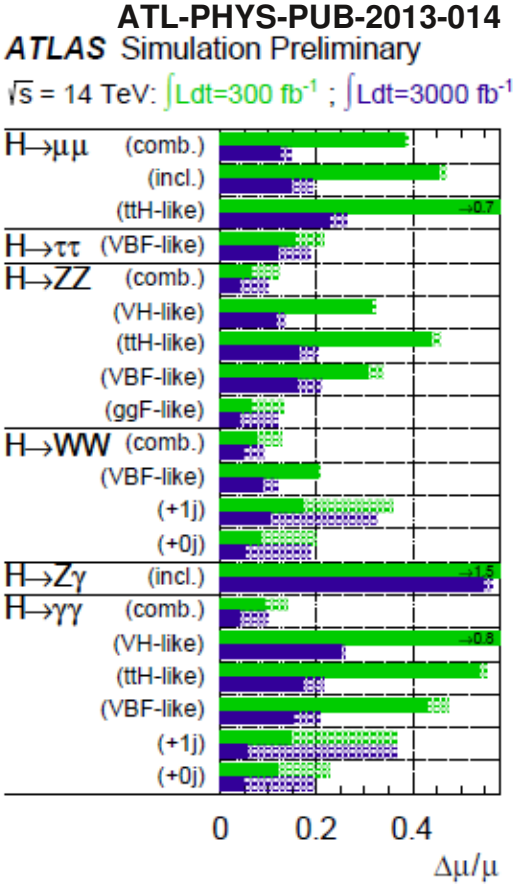
Main conclusions:

•3000 fb^{-1}: typical precision 3-10% for main Higgs production modes and rare modes becomes accessible.

• Reduce theory uncert. important for precise measurem.

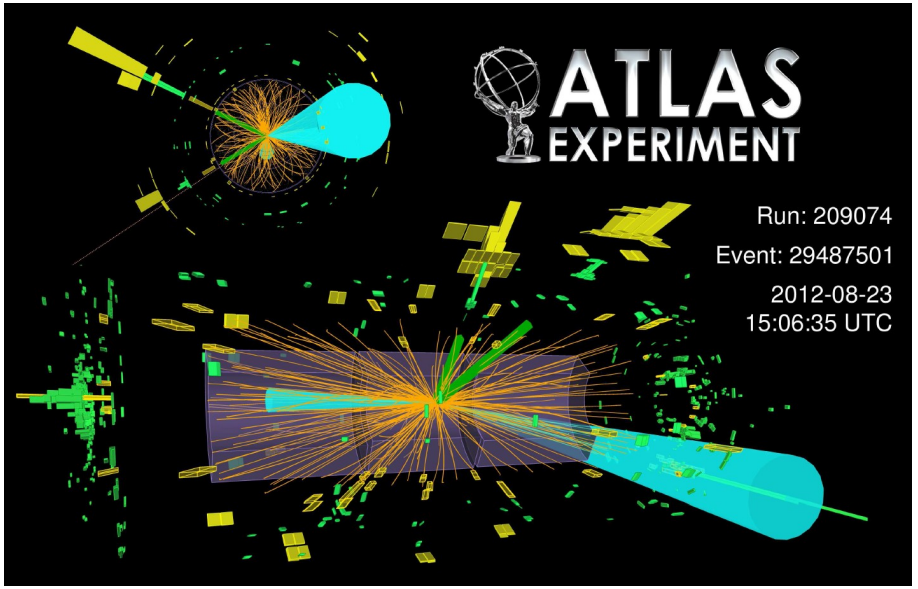
• SUSY: 3000 fb^{-1} typically extend mass reaches by 30-50% (compared to 300 fb^{-1})



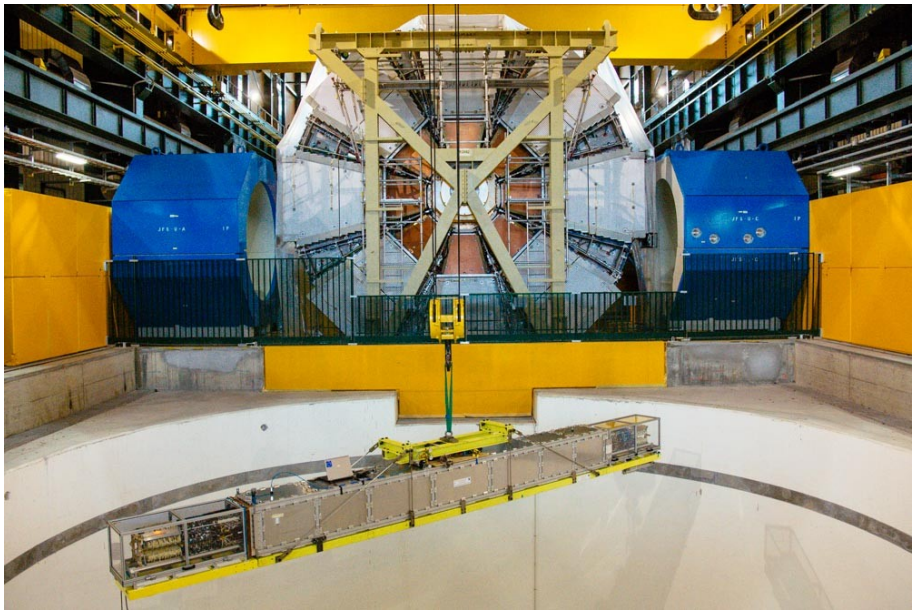


Summary

- **Extensive preparation for Run-2 is on-going:**
  - Detector maintenance and consolidation is on track, though IBL is on critical path.
  - Software and Computing preparation for Run-2 progressing well.
  - Data Challenge and Detector integration weeks have been prepared to get ready for Run-2 data-taking and analysis

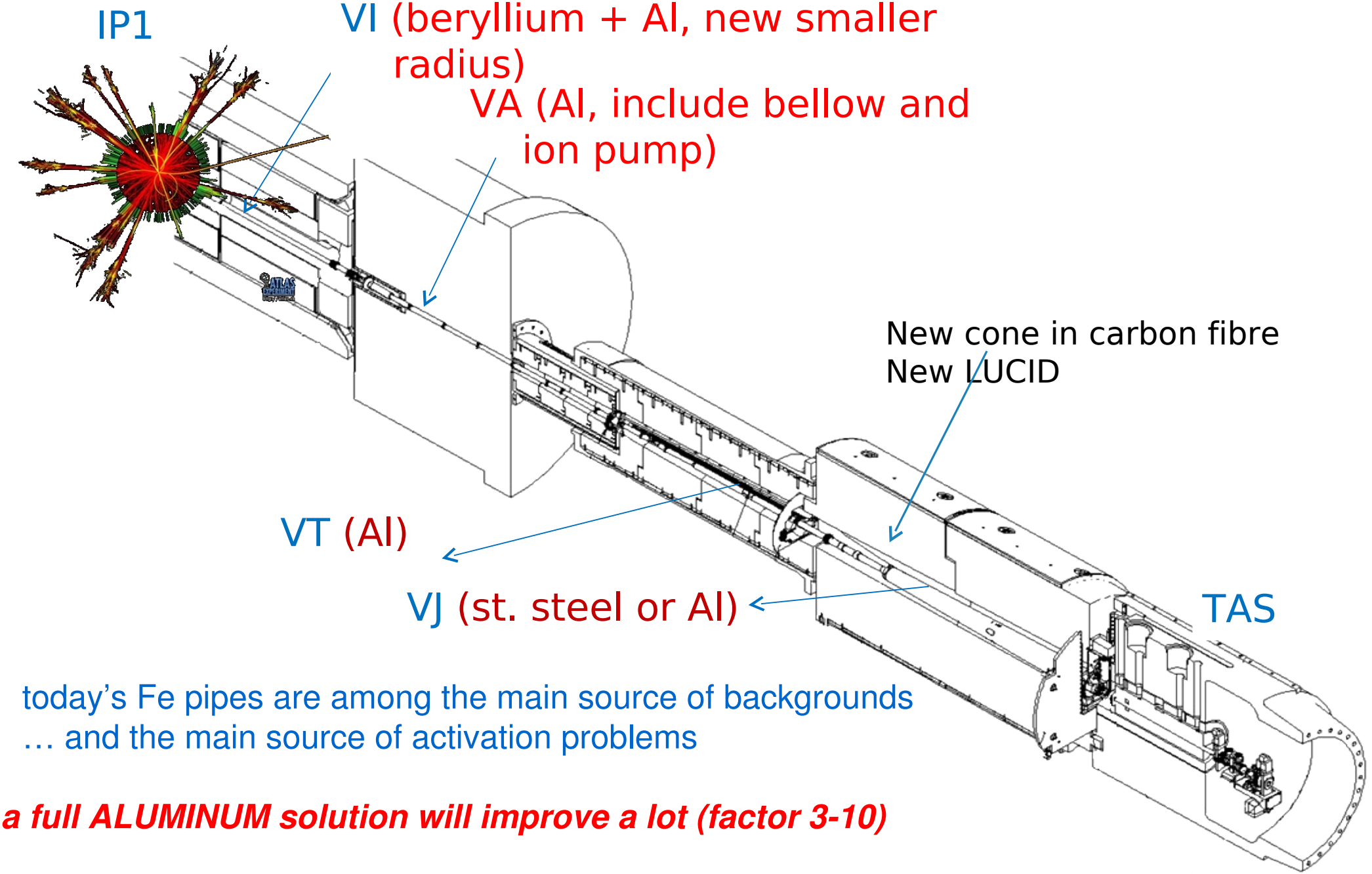


- **Wrapping-up Run-1 physics results:**
  - Clear evidence of $H \rightarrow \tau\tau$ decay (4.1 σ): signal strength compatible with SM predictions.
  - Searches for new phenomena are continuing.
  - Focus on final publications.



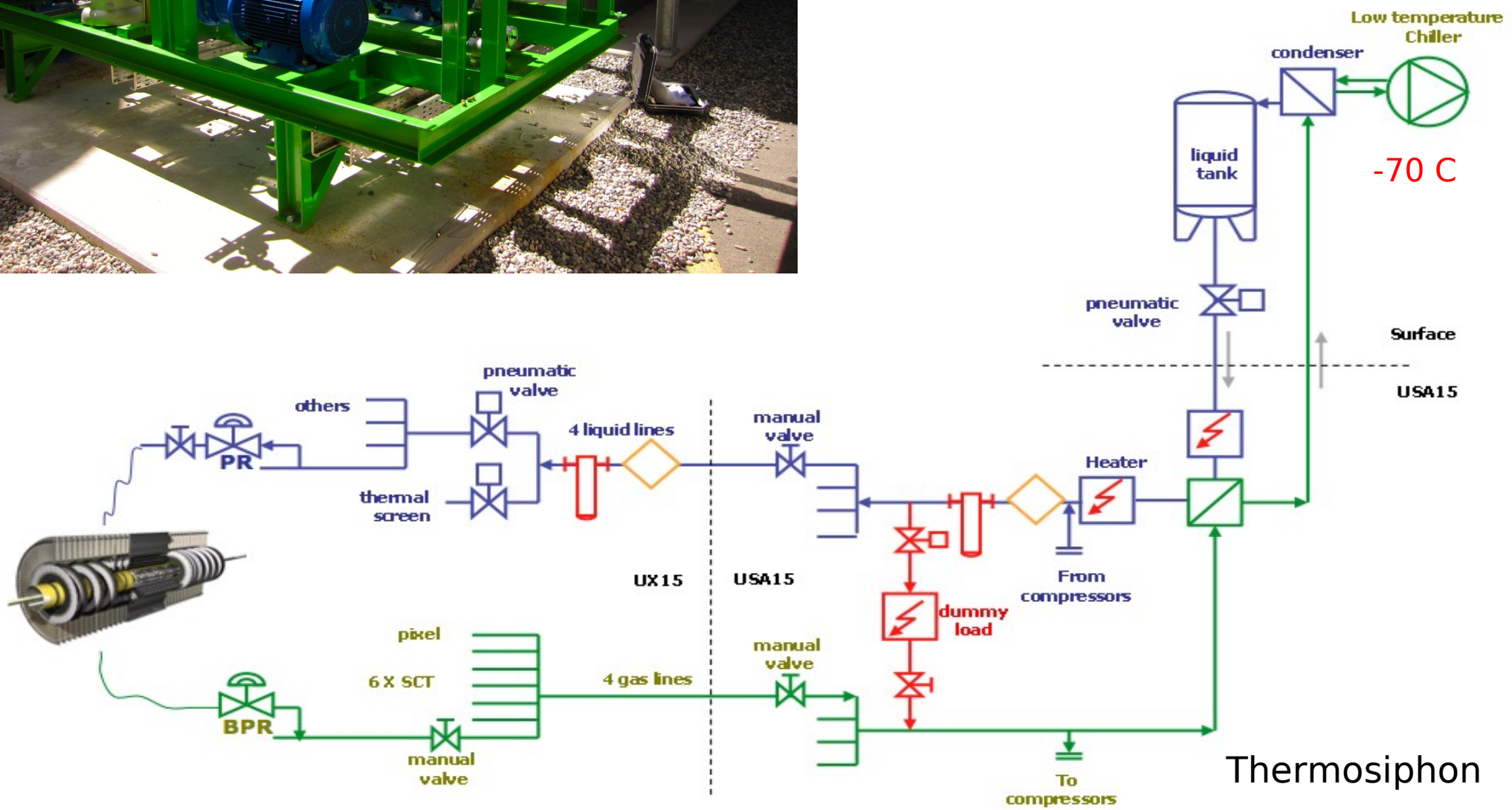
- Updated Projections of the ATLAS sensitivity for Phase-1 and Phase-2 in several physics areas have been produced.

Bonus Slides



today's Fe pipes are among the main source of backgrounds
… and the main source of activation problems

a full ALUMINUM solution will improve a lot (factor 3-10)



Thermosiphon

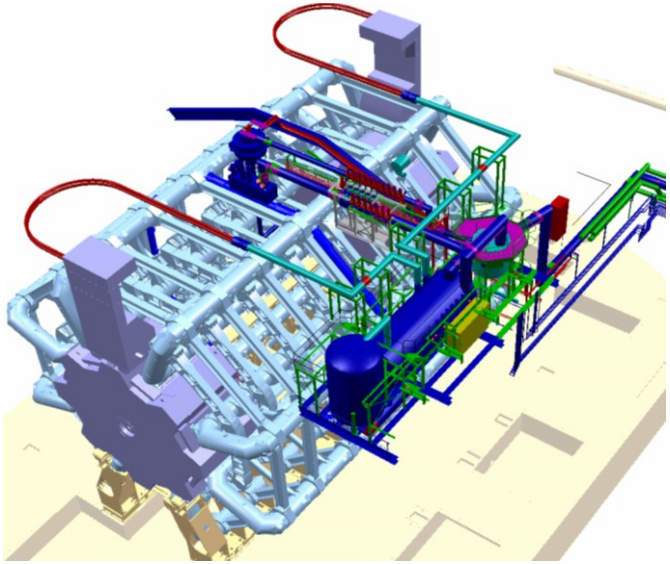
Consolidation Cryogenics

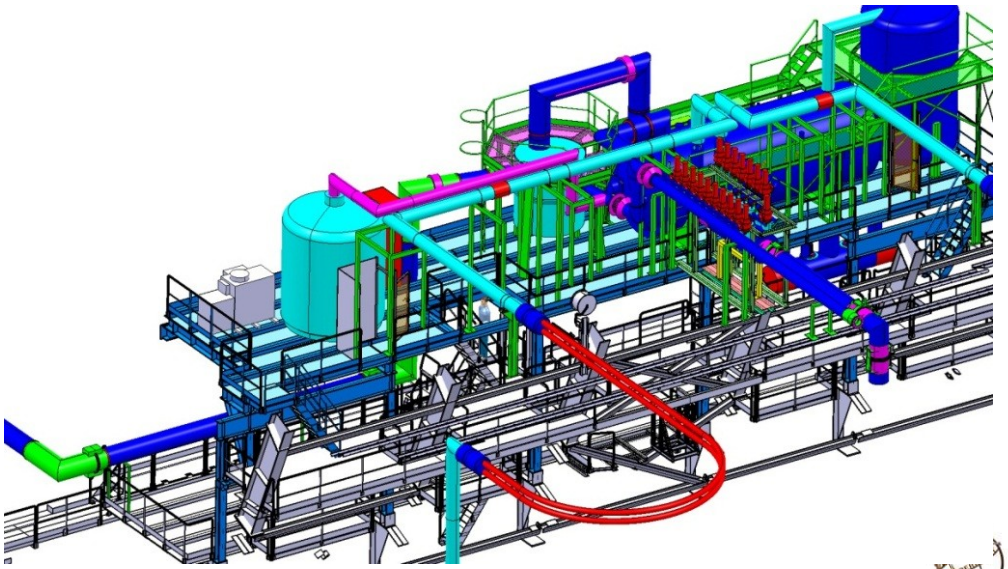
Why? To reduce risk of detector down time since cryogenics causes a large fraction of the down time

Redundant main compressor and boosters: to avoid risk of 1 year down, no data taking, on compressor break down

Helium dryers installation: to reduce risk of clogging filters

New 10 kL helium dewar for Solenoid: to enable solenoid operation when toroid is in fast dump recovery lasting 4 days



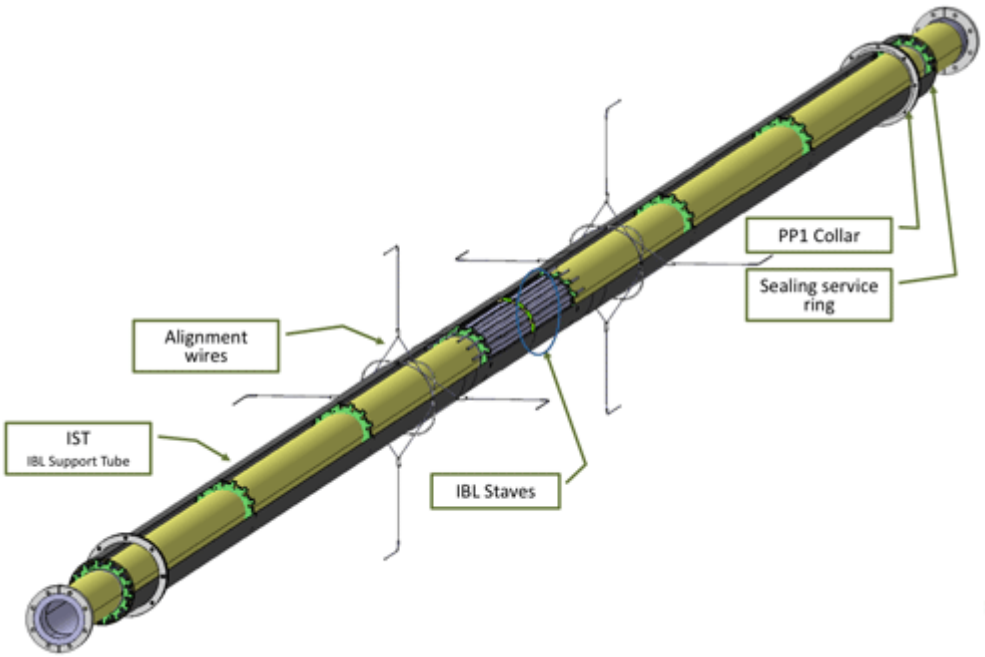


Insertable B-Layer

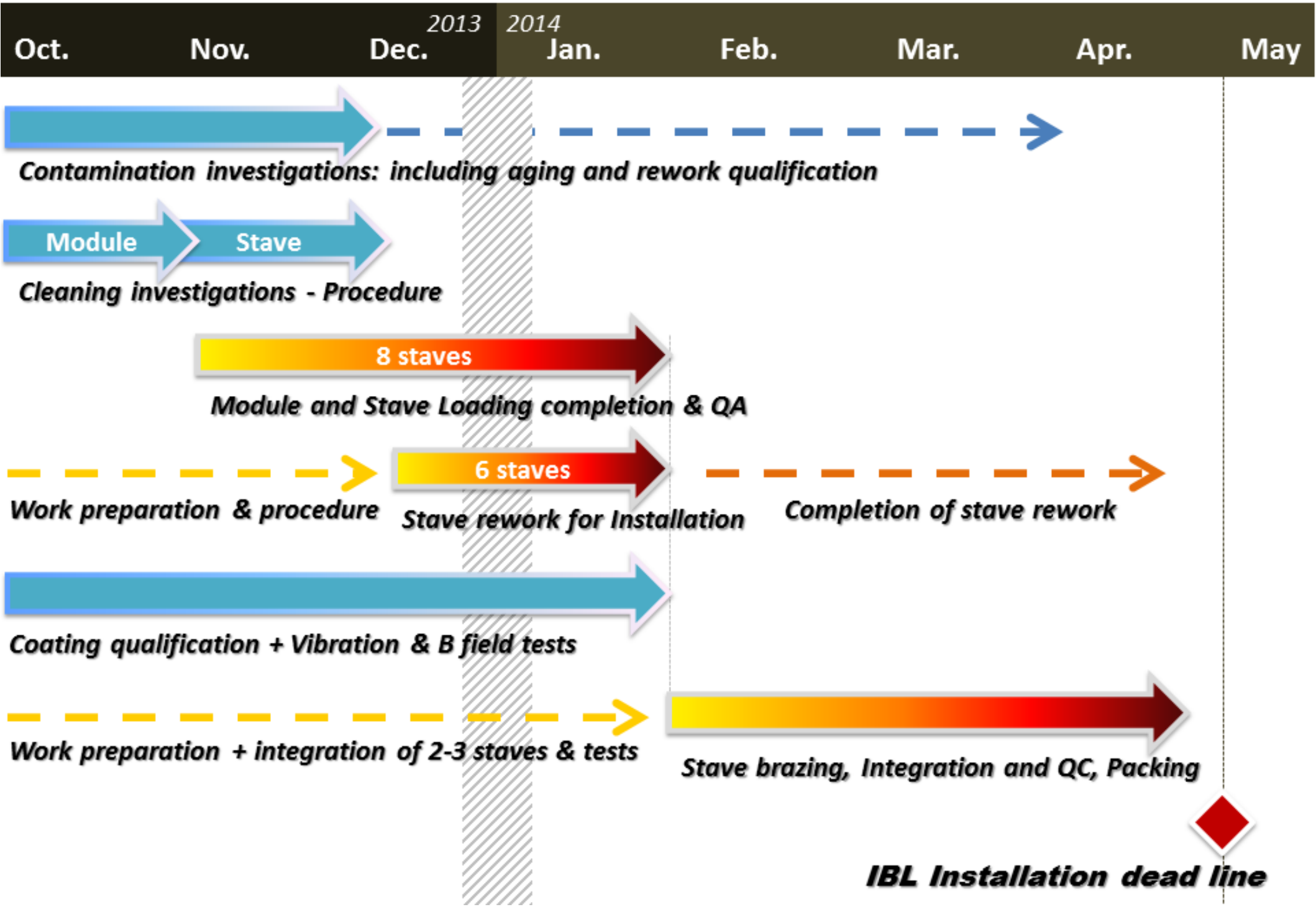
Recovery plan in place:

- Newly built staves without thermal cycling have no sign of corrosion → avoid thermal cycle and keep dry.
- Repair affected staves:
  - cleaning of the modules is the current highest priority
- Assembly of remaining 8 staves
  - Proceed after cleaning is established
  - Proceed with qualified stave assembly procedures
- Evaluating coating of the components
- Build additional staves with corrosion-hard components

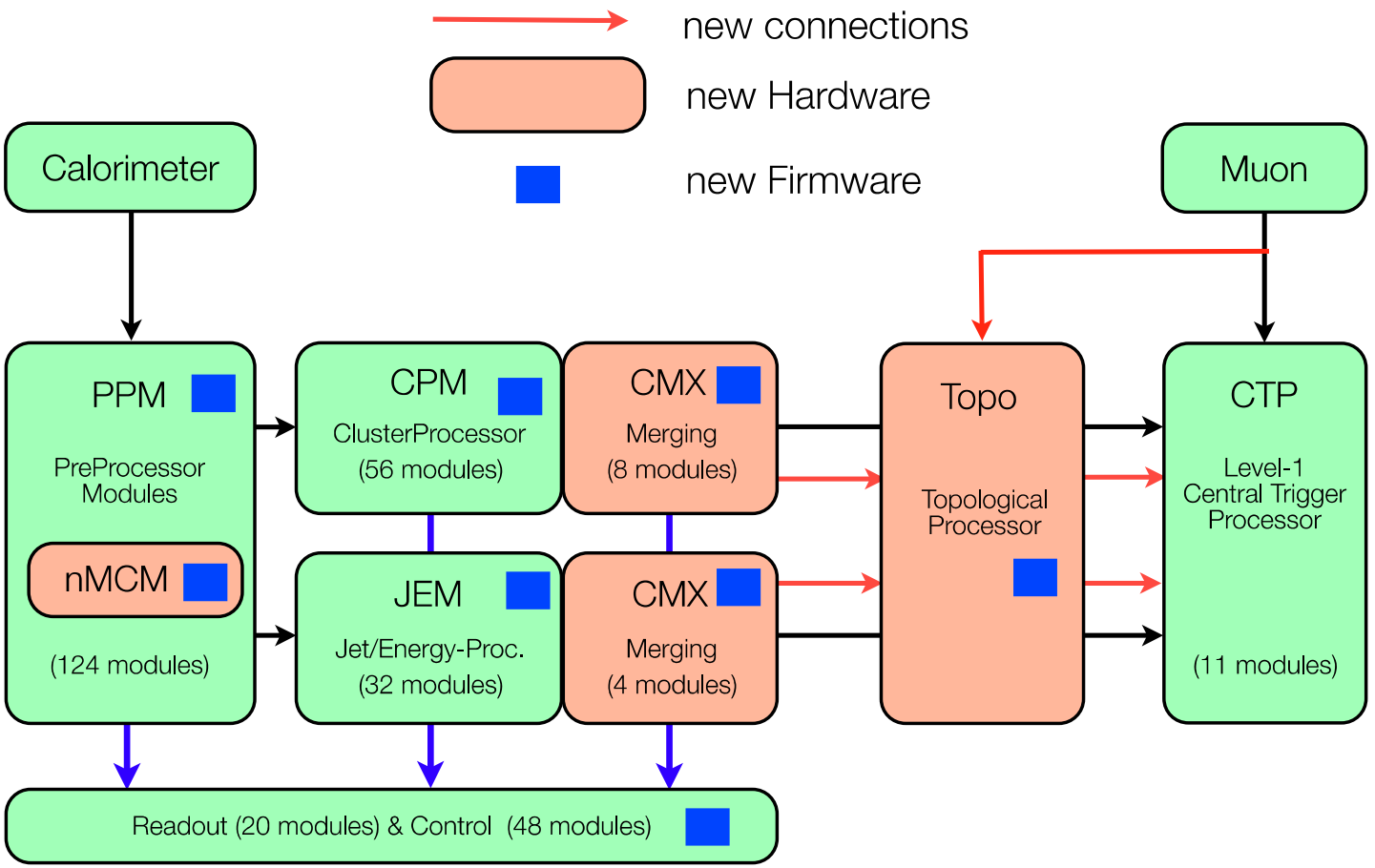
- Keep the schedule:
  - Stave loading restarted in November
  - Demonstrate success of repairs and start repairs in December
  - Start stave to Inner Positioning Tool (IPT) integration latest end Jan/beg Feb (better earlier but contingent on above)



IBL Work program towards completion



Trigger/DAQ


new connections
new Hardware
new Firmware
Calorimeter
Muon
PPM
PreProcessor Modules
nMCM
(124 modules)
CPM
ClusterProcessor
(56 modules)
JEM
Jet/Energy-Proc.
(32 modules)
CMX
Merging
(8 modules)
CMX
Merging
(4 modules)
Topo
Topological Processor
CTP
Level-1 Central Trigger Processor
(11 modules)
Readout (20 modules) & Control (48 modules)

LAr Phase I Upgrade

For the **LAr phase I upgrade** we assume a LHC Run-3 luminosity of $L = 3 \times 1034 cm^{-2}s^{-1}$ and $\langle \mu \rangle = 80$ interactions per bunch crossing
The overall **Level-1 rate** will be **limited to 100kHz.**
Current trigger menu (Run-1) would result in **270kHz Level-1 EM rate** alone
dominated by jet background
need to improve jet-rejection capabilities
supply **more information** about shower development at **Level-1**:

Higher granularity in η

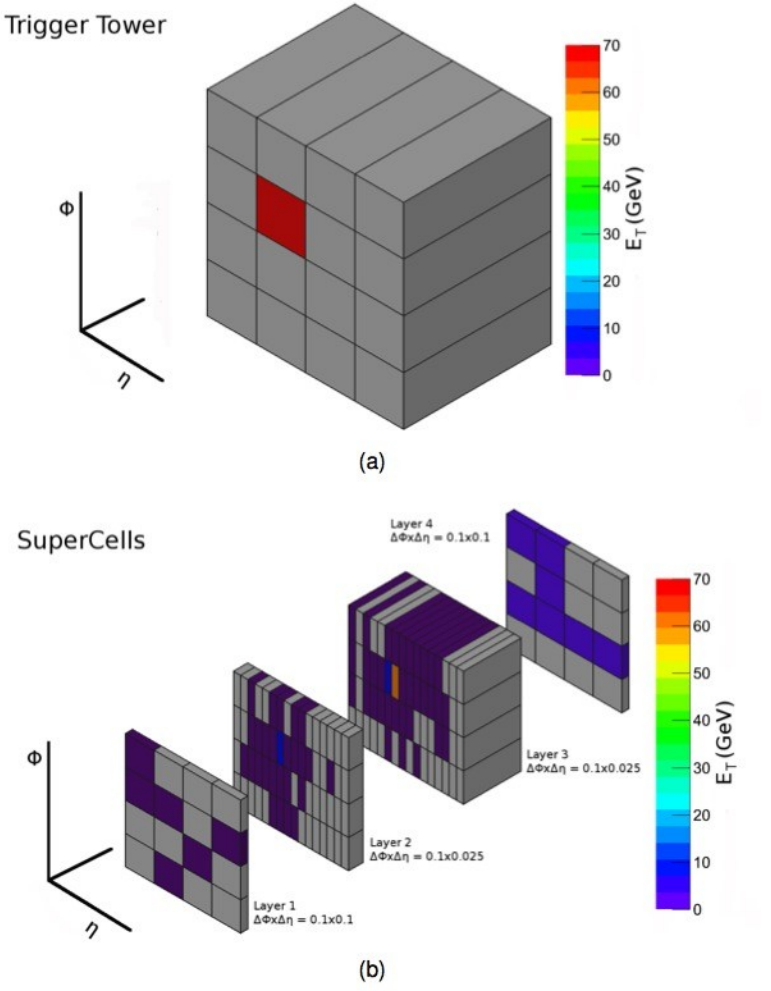
Layer information

Finer quantization scale:

- least significant bit: 1 GeV , 32 MeV (strips) and 125 MeV (middle)

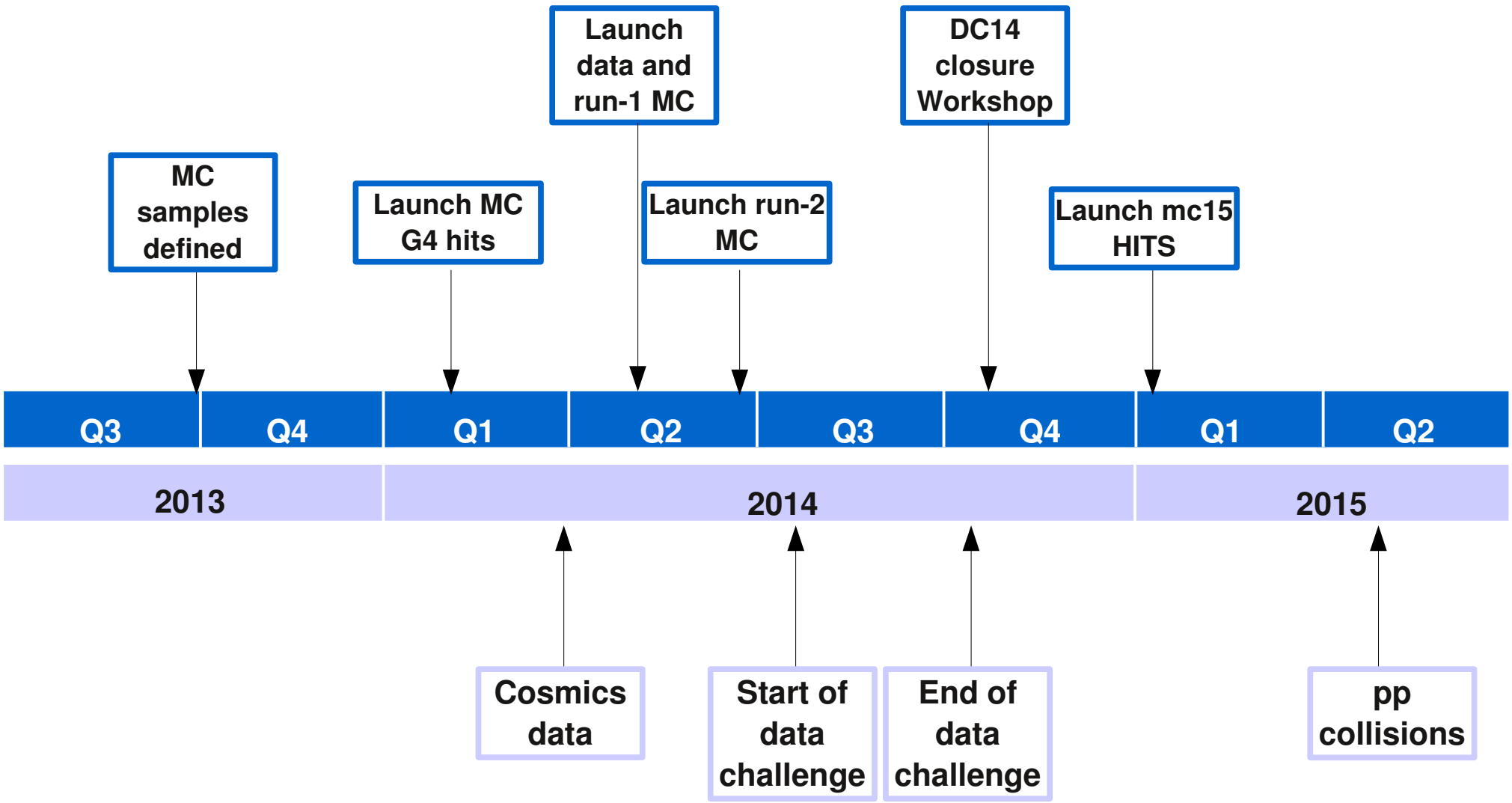
Possibility to use **global event quantities** to e.g. correct for pile-up (global feature extractor – L1Calo)

TDR approved by ATLAS CB and presented to LHCC in September



Simulation of a 70GeV electron
seen by existing Level-1 calorimeter trigger (above, (a))
and by the proposed upgrade trigger electronics (below, (b))

DC14 timeline



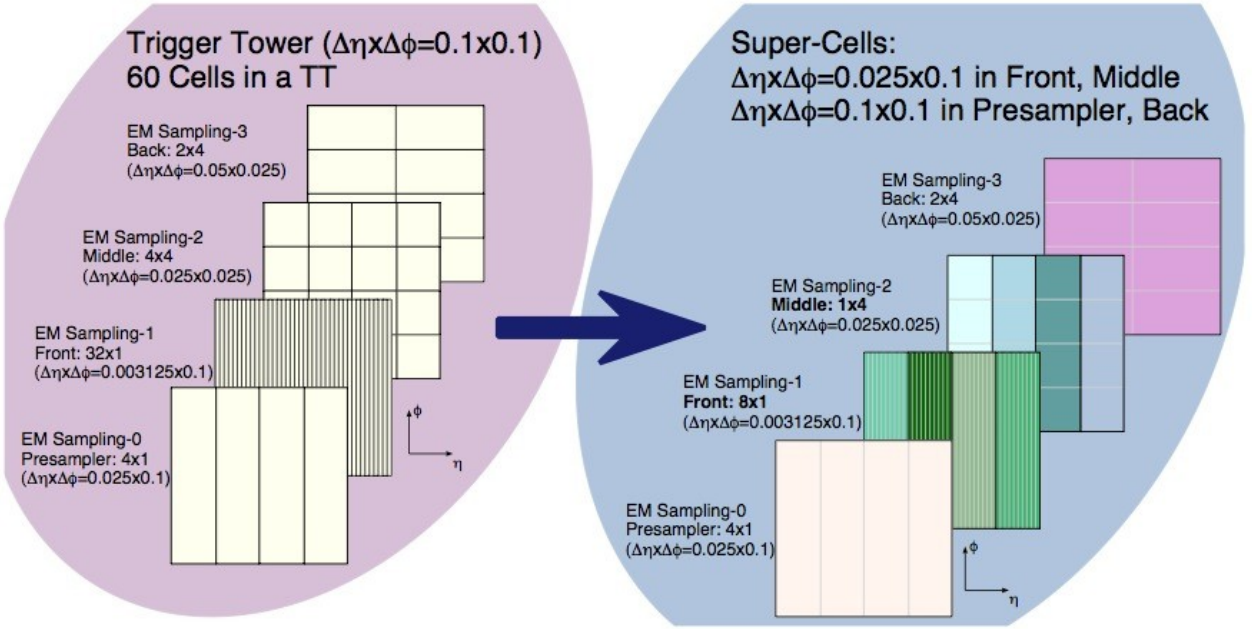
From Trigger Towers to Super Cells

Example (EM Barrel) of granularity increase

one Trigger Tower (TT)

10 Super-Cells (SCs)
(1 PS, 4 FRONT,
4 MID, 1 BACK)

	Layer	Elementary Cell	Trigger Tower		Super Cell	
		$\Delta\eta \times \Delta\phi$	$n_\eta \times n_\phi$	$\Delta\eta \times \Delta\phi$	$n_\eta \times n_\phi$	$\Delta\eta \times \Delta\phi$
0	Presampler	0.025×0.1	4×1	0.1×0.1	4×1	0.1×0.1
1	Front	0.003125×0.1	32×1		8×1	0.025×0.1
2	Middle	0.025×0.025	4×4		1×4	0.025×0.1
3	Back	0.05×0.025	2×4		2×4	0.1×0.1

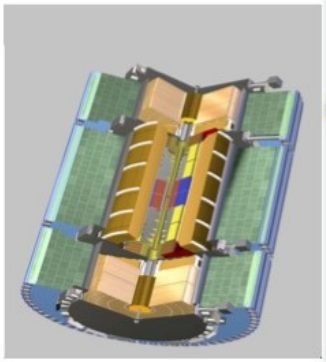


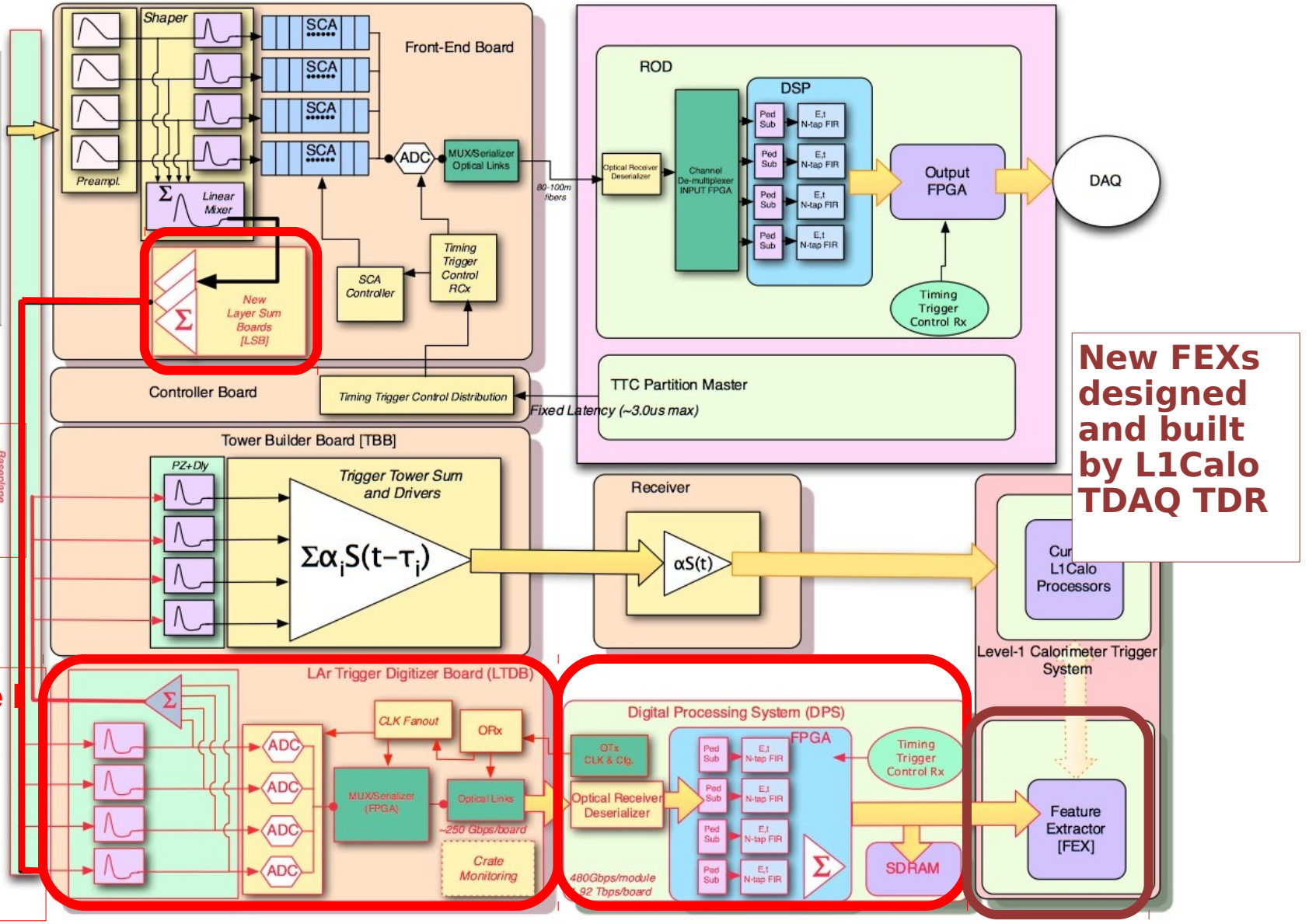
In addition to higher lateral and longitudinal granularity:

- Finer quantization scale: TT: 1GeV SCs: 32/125MeV in

  (strips/middle)
- New global feature extractor (L1Calo)

The Proposed Phase I Upgrade





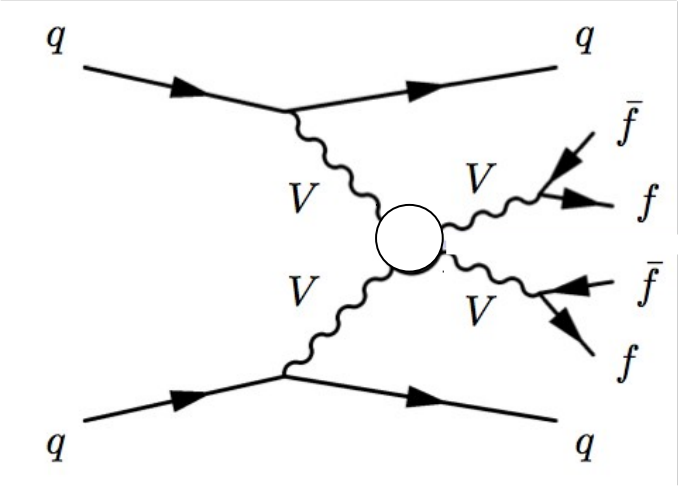
New or modified components in red. LAr TDR

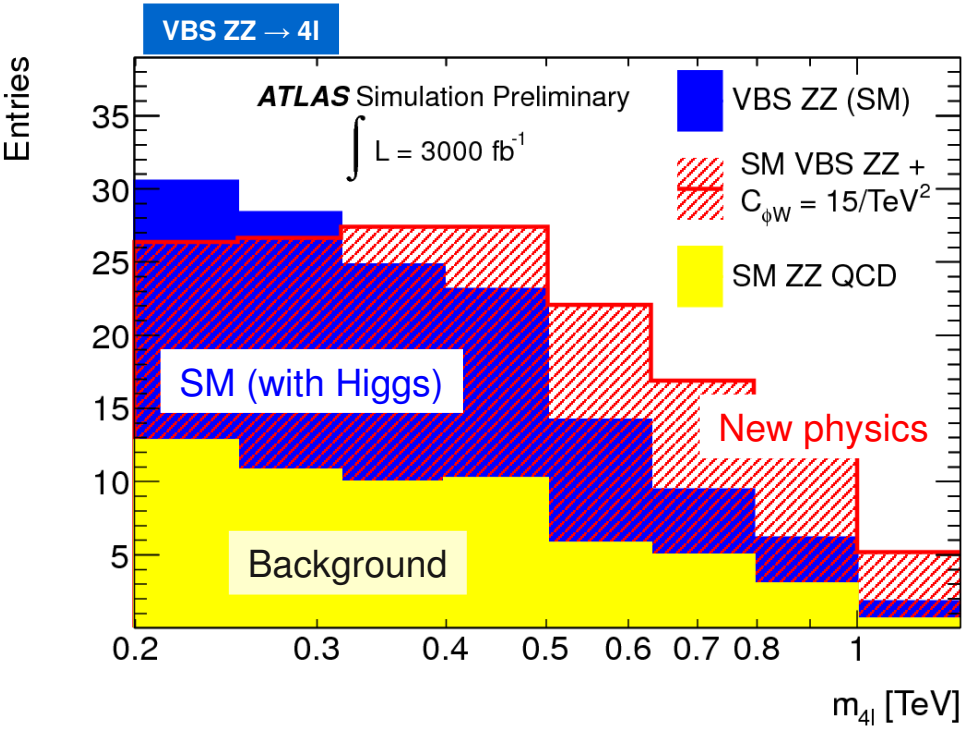
Possible implementation
ΔηxΔφ=0.025x0.1 1st and 2nd layer EM
ΔηxΔφ=0.1x0.1 elsewhere

Proposed phase I upgrade fully compatible with plans for phase II upgrade

New FEXs designed and built by L1Calo TDAQ TDR

VBS



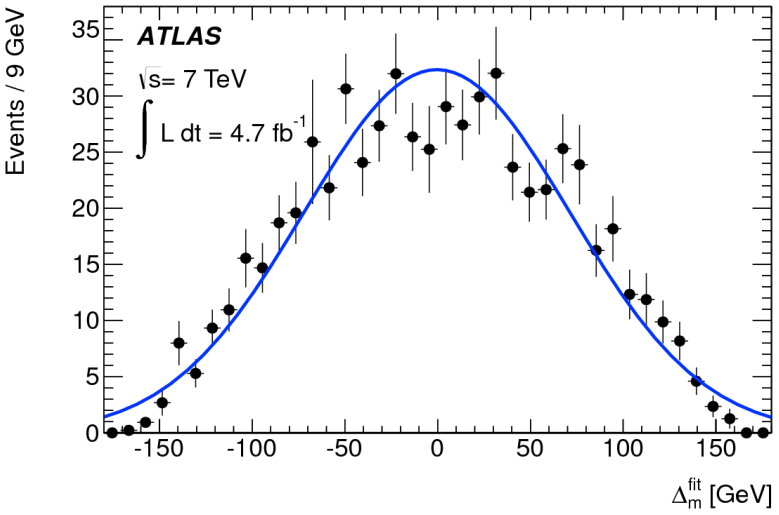


If behaviour as expected by SM cross section (no divergence thanks to Higgs contribution) process can be measured to 30% (10%) with 300 (3000) fb^{-1}

If new physics exists: sensitivity increases by factor of ~ 2 in terms of scale and coupling reach between 300 and 3000 fb^{-1}

HL-LHC is crucial for a sensitive study of EWSB dynamics.

Top/SM



Main systematics are from b/b-bar fragmentation model and b-tagging effect

Systematic Uncertainty	$\Delta(\Delta m)$ [GeV]
b/b decay uncertainties	0.35
Kaons inside b-jets	0.08
Residual b vs $\bar{b}$ differences	0.08
b-tagging	0.08
Mis-tagging as a b-quark jet	0.05
Jet energy scale	0.04
b-jet energy scale	0.05
Jet energy resolution	0.03
Parton shower	0.08
MC generator	0.08
ISR/FSR	0.07
Calibration method	0.05
Non-$t\bar{t}$ normalization	0.04
Non-$t\bar{t}$ shape	0.04
Parton distribution function	0.02
Lepton energy scale asymmetry	< 0.01
Electron reconstruction & identification	0.02
Muon reconstruction & identification	0.04
Top mass input	0.04
Total	0.41

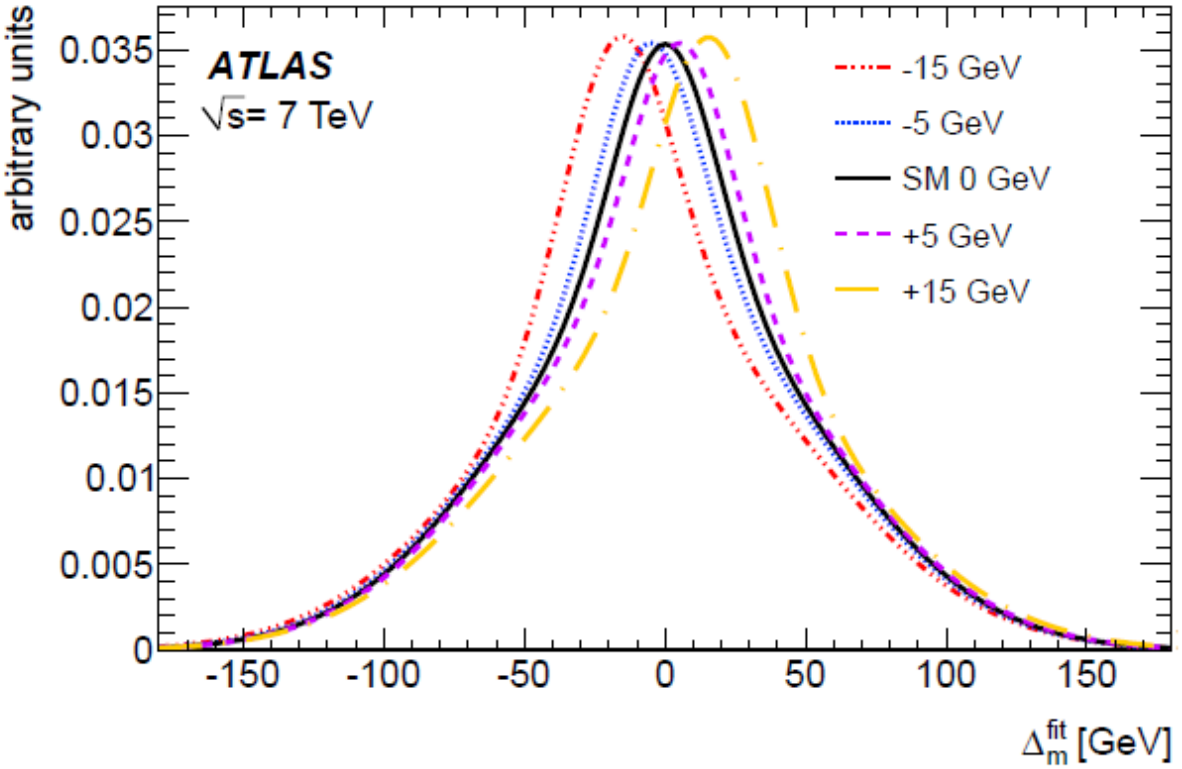


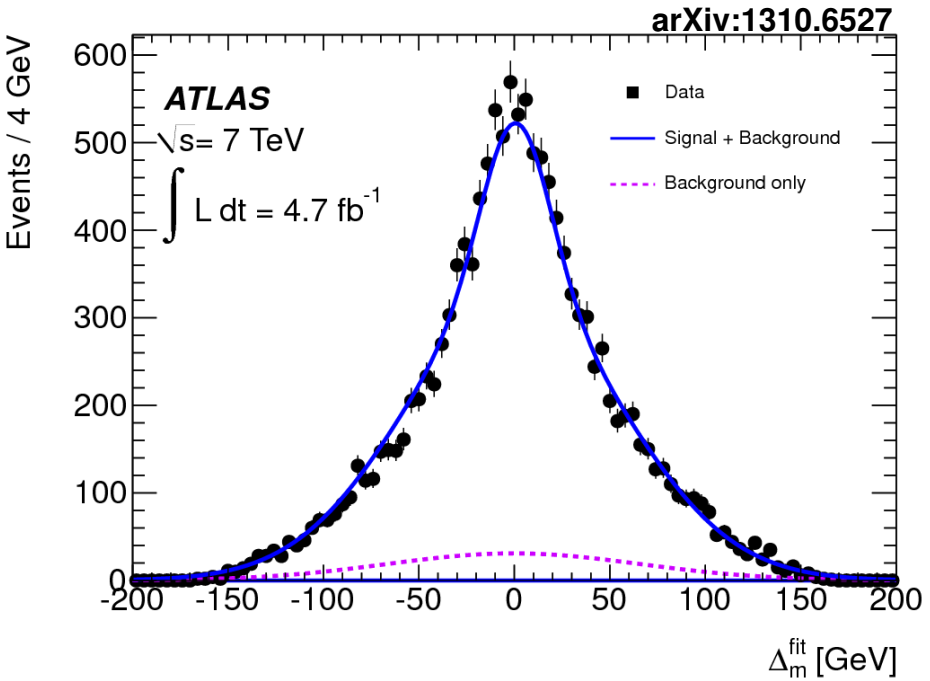
Fig. 1: Parameterization of Δ_m^{fit} for simulated $t\bar{t}$ samples with different values of Δm.

Top/SM

Measurement of the top-anti-top mass difference
In lepton+jets events.
Kinematic fit used to reconstruct top mass.
Unbinned maximum likelihood used to measure Δm.

$$\Delta m \equiv m_t - m_{\bar{t}} =$$

0.67±0.61(stat)±0.41(syst) GeV
consistent with CPT invariance.



Heavy Ions

NLO Generator better describes the data

Eta-dependence of the muon charge asymmetry is sensitive to isospin effects.
No sensitivity to differentiate NLO to LO PDFs.