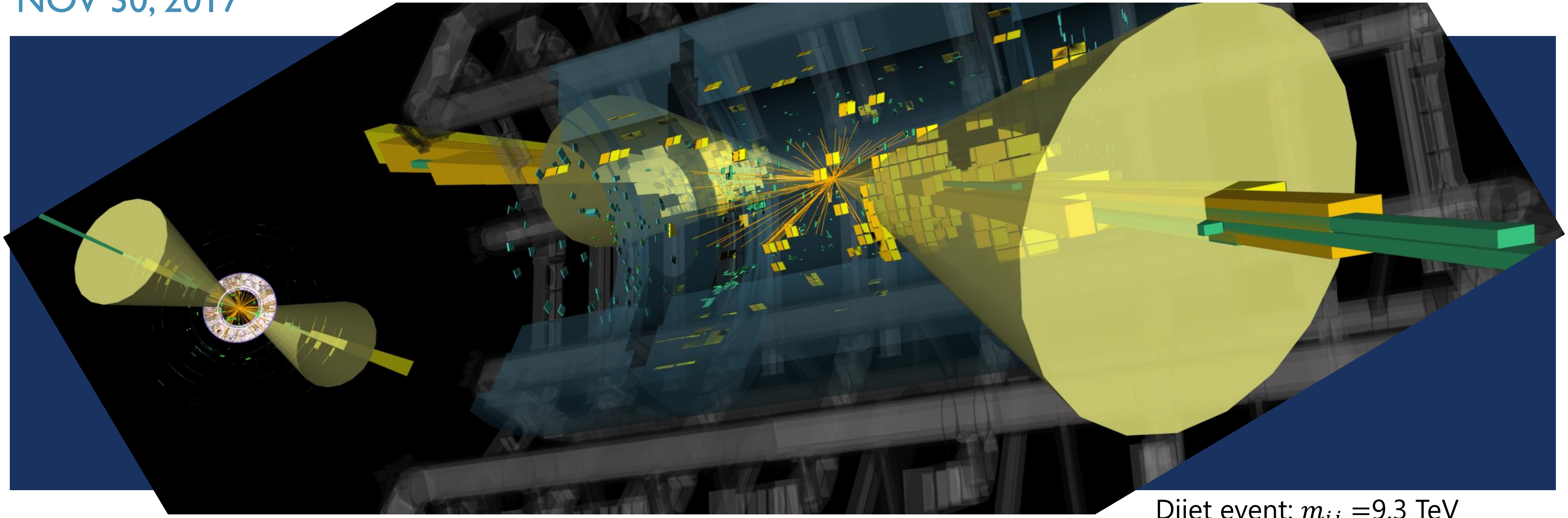
ATLAS STATUS REPORT

LHCC MEETING

NIKOLINA ILIC ON BEHALF OF THE ATLAS COLLABORATION

STANFORD UNIVERSITY

NOV 30, 2017



Dijet event: m_{jj} =9.3 TeV

OUTLINE

OPERATION

PHYSICS & PERFORMANCE

PHASE I UPGRADE

PHASE II UPGRADE

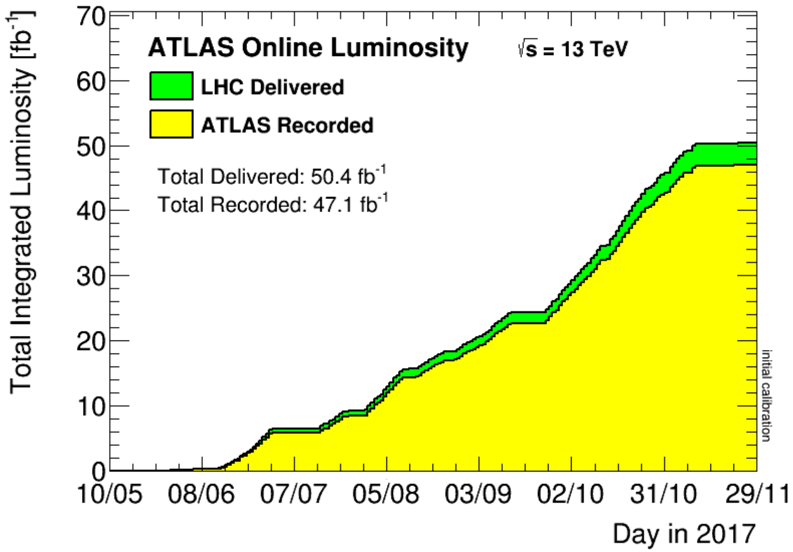
SUMMARY

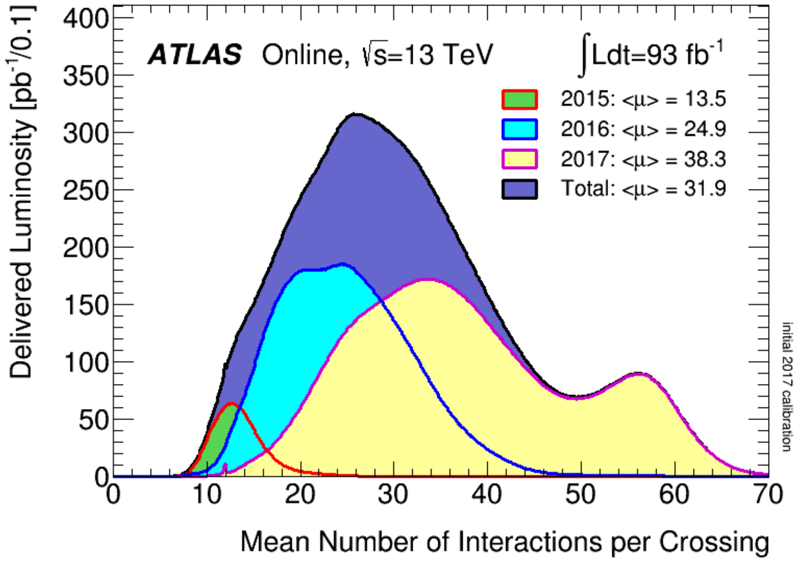
OPERATION

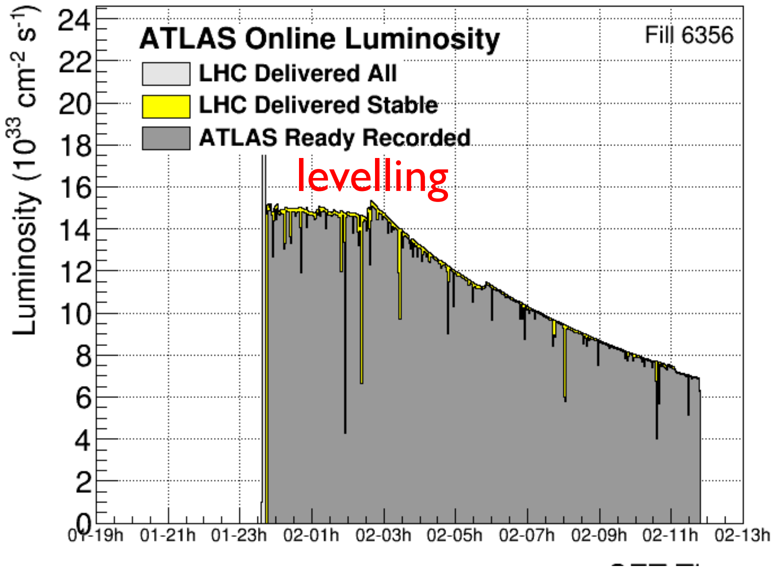
- **ATLAS Performance**
- New systems In Commissioning

ATLAS Performance

- Thanks LHC and accelerator teams for 50 fb^{-1} and the special low pileup (μ) 5 &13 TeV runs!
- Challenging conditions: Luminosity up to 2×10^{34} $cm^{-2}s^{-1}$, μ up to 80
- ATLAS requested levelling on 29th of Sept
- We can handle μ ~ 60 for trigger optimized for $1.7 \times 10^{34} \mathrm{cm}^{-2}\mathrm{s}^{-1}$ and 80 kHz Level-1 rate
  - Limitations are due to High-Level Trigger CPUs – new machines on the way to give additional capability*



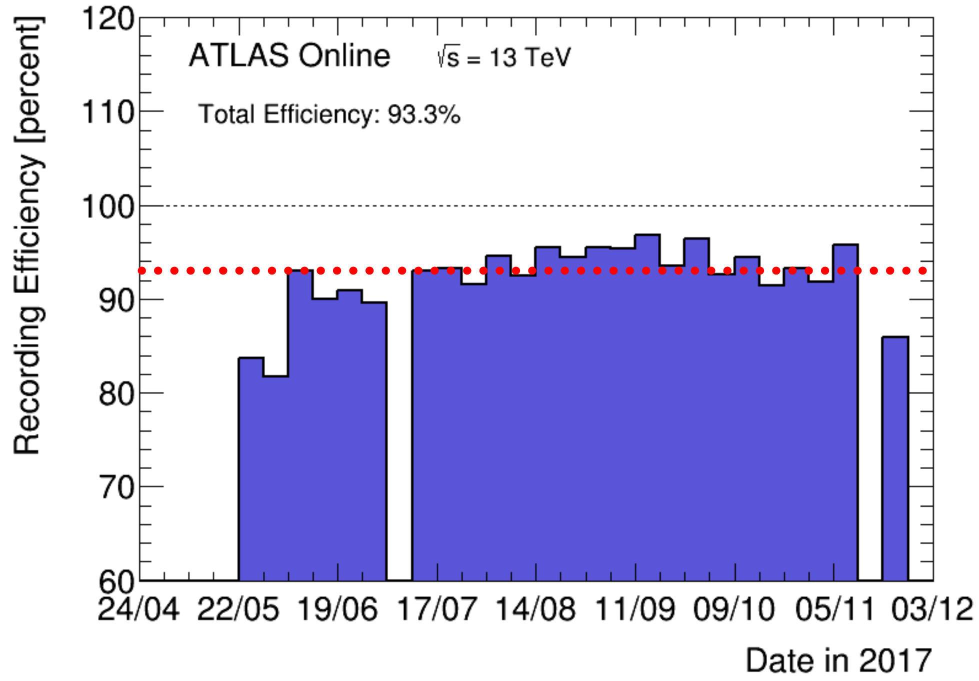




*Thanks to IT for loan of machines!

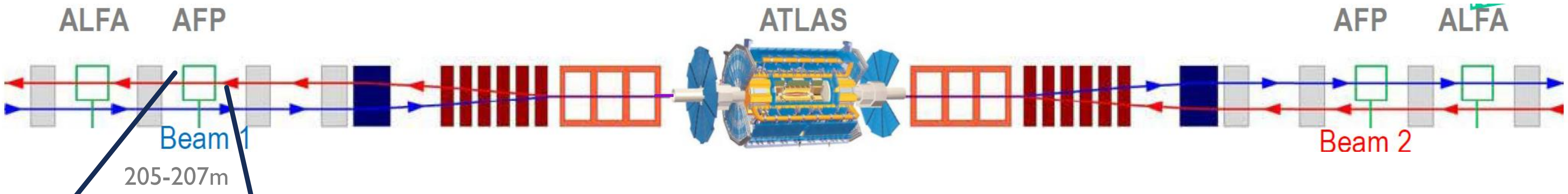
ATLAS Performance

- ATLAS achieved a high data taking efficiency (93.3%) and high data quality (>94%)
- All subdetectors ran smoothly and made improvements to deal with higher pileup
- Trigger & DAQ system performs well under stress
- Tier0 was enhanced for 2017 and is under constant load, but managing

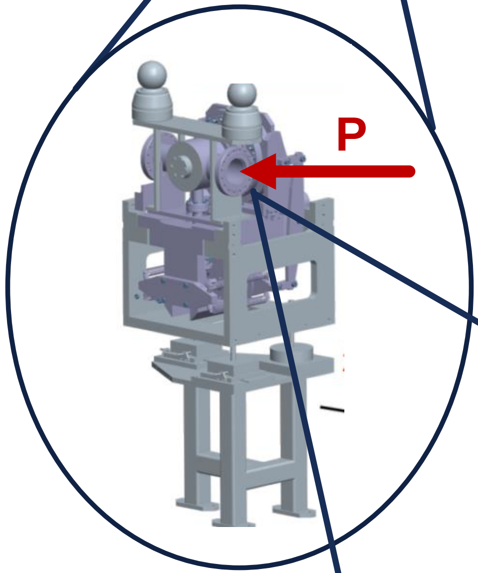


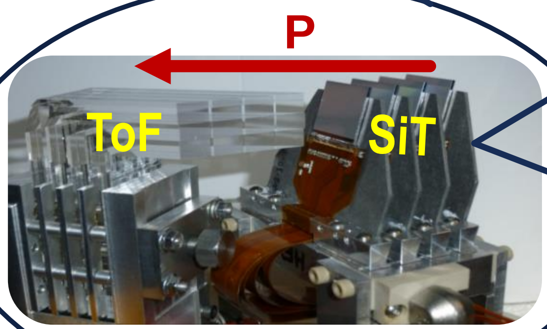
ATLAS pp 25ns run: June 5-October 8 2017										
Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
100	99.9	99.6	99.2	99.9	99.9	98.0	99.8	100	100	98.7
Good for physics: 94.1% (28.7 fb^{-1})										

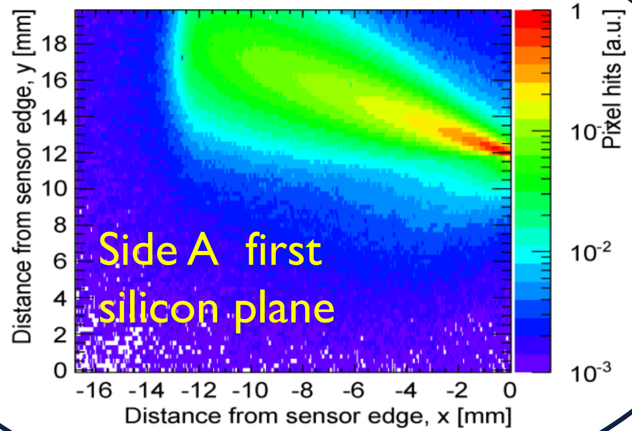
Systems in Commissioning : ATLAS Forward Proton (AFP) Detector



- AFP measures protons from diffractive processes that go down the beam pipe – provides interesting complementary physics program
- Data Analysis in progress
- Current priority performance of Silicon Tracker (SiT) and Cherenkov time-of-flight (ToF)

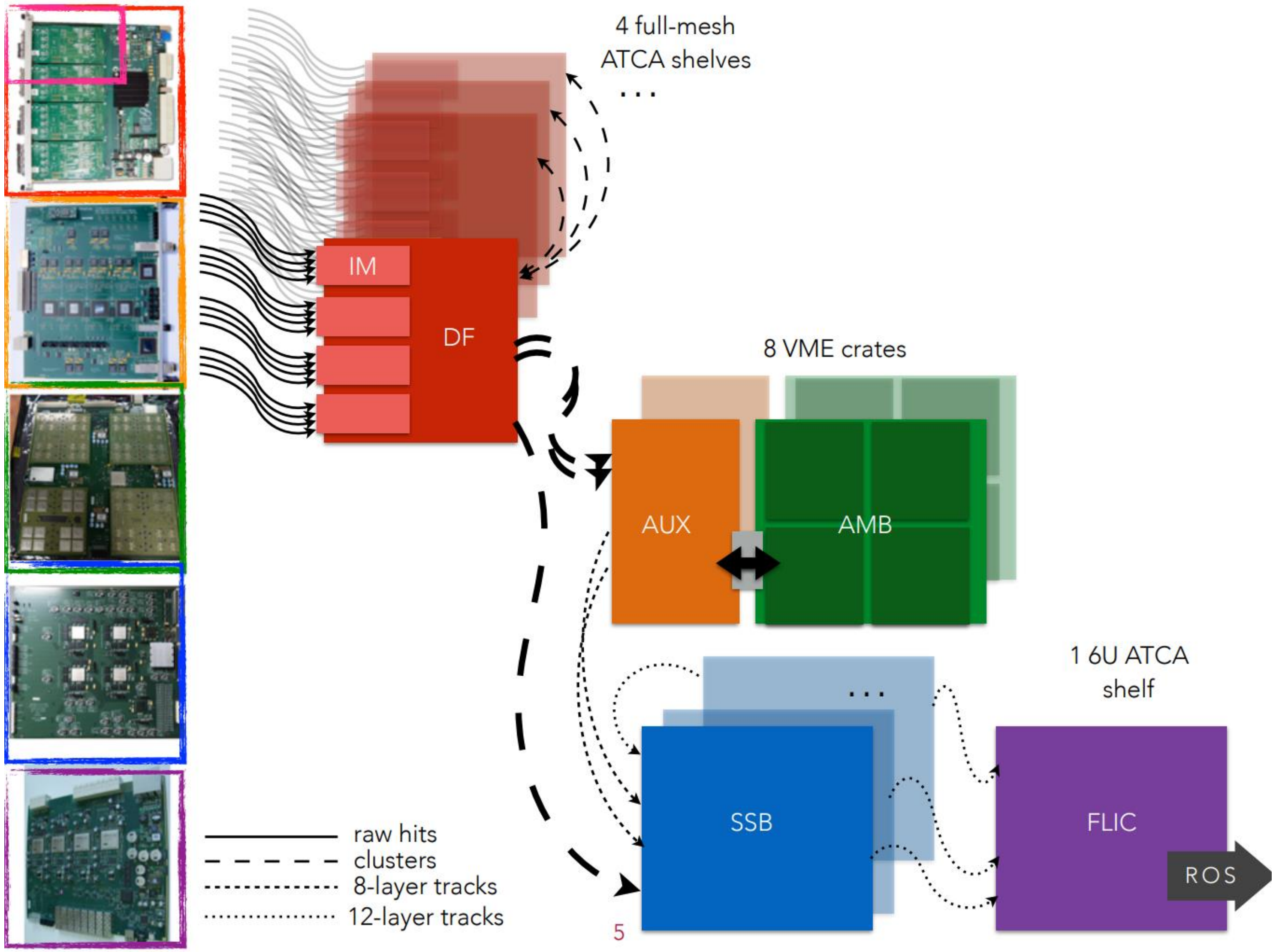






Systems in Commissioning : Fast TracKer (FTK)

FTK is designed to take Pixel & SCT data on Level 1 Triggers, reconstruct tracks with pT > 1 GeV; |η| <2.5



Hardware status:

- Associative memory boards (AMB) and chip production complete. Assembly of chip mezzanines to be completed in December.
- Second Stage board (SSB) production encountered some low rate of bit errors on high speed data transmission lines. Assessment of impact on-going.
- All other boards installed/undergoing installation

Systems in Commissioning : Fast TracKer (FTK)

Commissioning and Installation progress

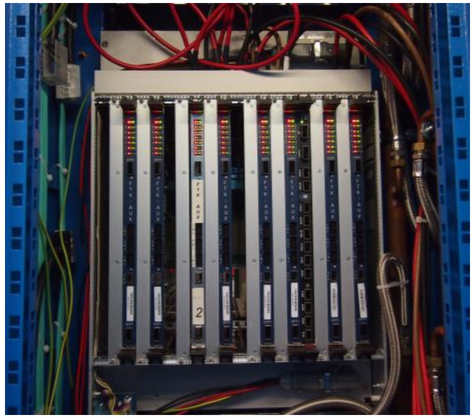
- **Still working on firmware stability.** Since Dec 2016 have put in extensive additions to firmware processing, but high pile-up conditions have been challenging for commissioning

- Can process ~1Billion events, building 8-layer tracks and writing output to the ATLAS data stream (in low pile-up conditions)
  - Slice looking at window: $2.3 < \phi < 2.9$ && $-0.1 < \eta < 1.6$
  - Data under validation

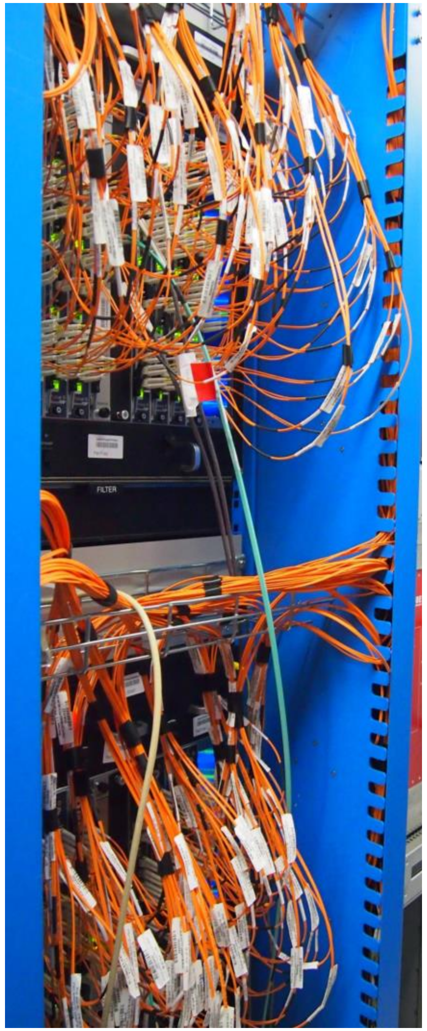
Plan:

- 2018: Commission the slice in high pileup conditions, continue firmware development and deployment of full system

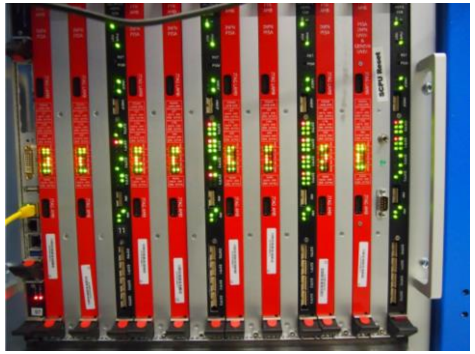
AUX boards



IM+DF boards



AMB/SSB boards



PHYSICS & PERFORMANCE

In past meetings many beyond SM searches were presented.
Now finalizing 2015/16 searches, starting 2017

Presenting today:

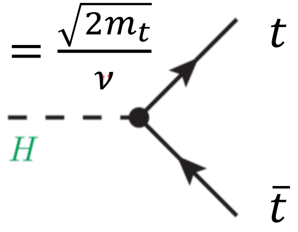
- $t\bar{t}H$ search
- Top Mass Measurement
- Triple Differential Drell-Yan Cross Section
- $ZZ \to 4\ell$ Cross Section & TGC Search
- Performance from 2017 data

For first investigation of $H \to cc$ see ATLAS-CONF-2017-078
Limit on $\sigma(pp \to ZH) \times B(H \to c\bar{c})$ is 2.7 pb

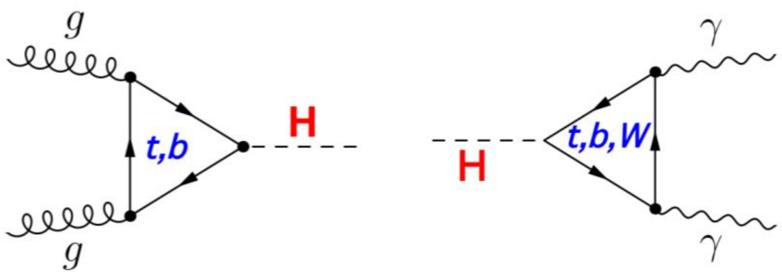
$t\bar{t}H$ Measurement

Higgs couples to fermions through Yukawa couplings (proportional to masses, hence top is largest)

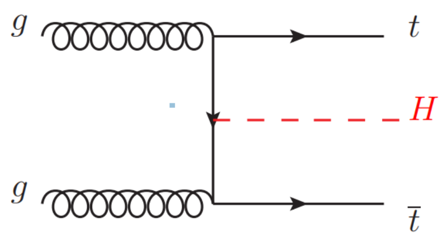
$$\lambda_t = \frac{\sqrt{2m_t}}{v}$$



λ_t measured from ggF production and $H \rightarrow \gamma\gamma$ decays (SM assumed in loops)



$t\bar{t}H$ is best direct way to measure λ_t



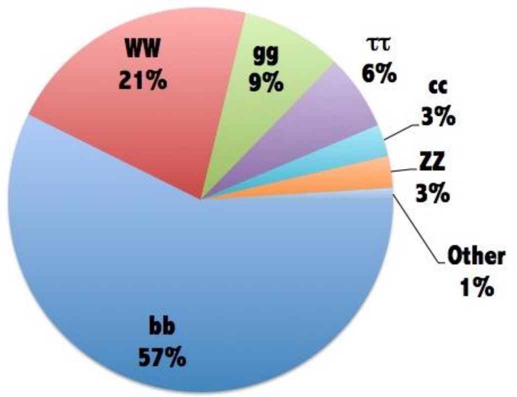
Difficult Measurement

- $t\bar{t}H$ production: O(0.5 pb)
- Large irreducible backgrounds
  - $t\bar{t}b\bar{b}$ O(15)pb, $t\bar{t}W/Z$ O(1.5)pb

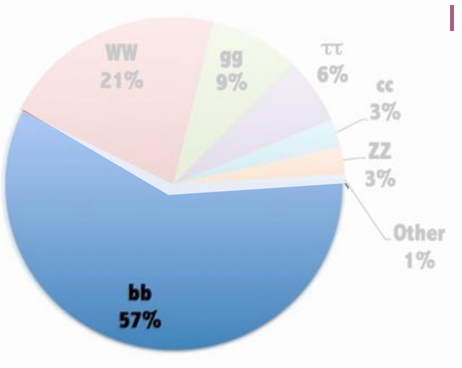
Lots of possible signatures

- $t\bar{t} \rightarrow 1$ or $2\ell, \boldsymbol{H} \rightarrow \boldsymbol{bb}$ NEW
- $t\bar{t} \rightarrow 1$ or $2\ell, \boldsymbol{H} \rightarrow \boldsymbol{WW}, \boldsymbol{\tau\tau}, \boldsymbol{ZZ}$ NEW
- Combined with $H \rightarrow \gamma\gamma$, $ZZ \rightarrow 4\ell$

Higgs boson decays



$t\bar{t}H$: $t\bar{t} \rightarrow 1$ or $2\ell, H \rightarrow bb$

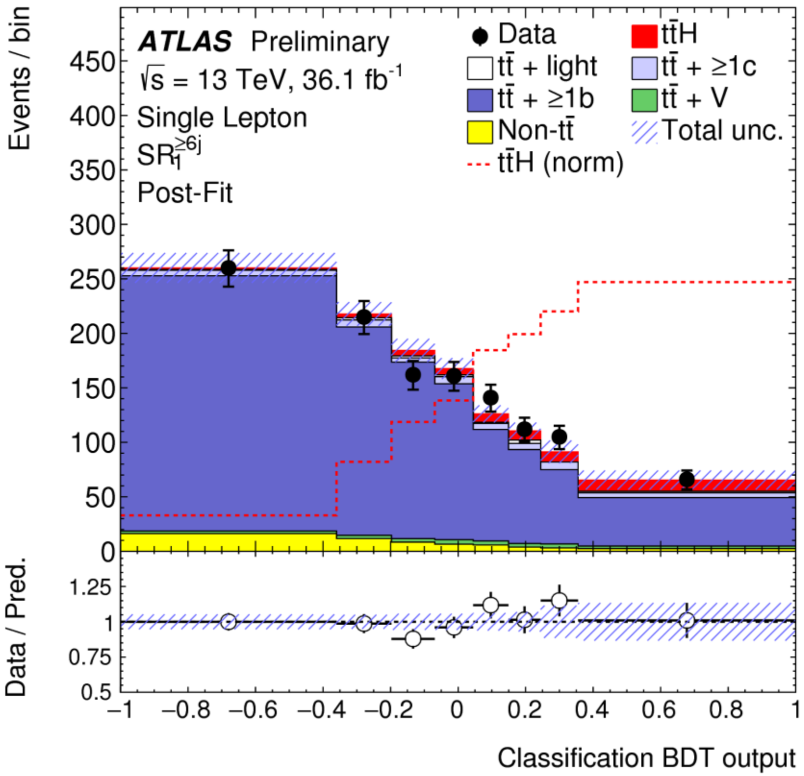


- Main challenge: $t\bar{t}$ +heavy flavour is large irreducible background
  - Difficult to model in MC, relying on data-driven techniques to reduce uncertainties on background

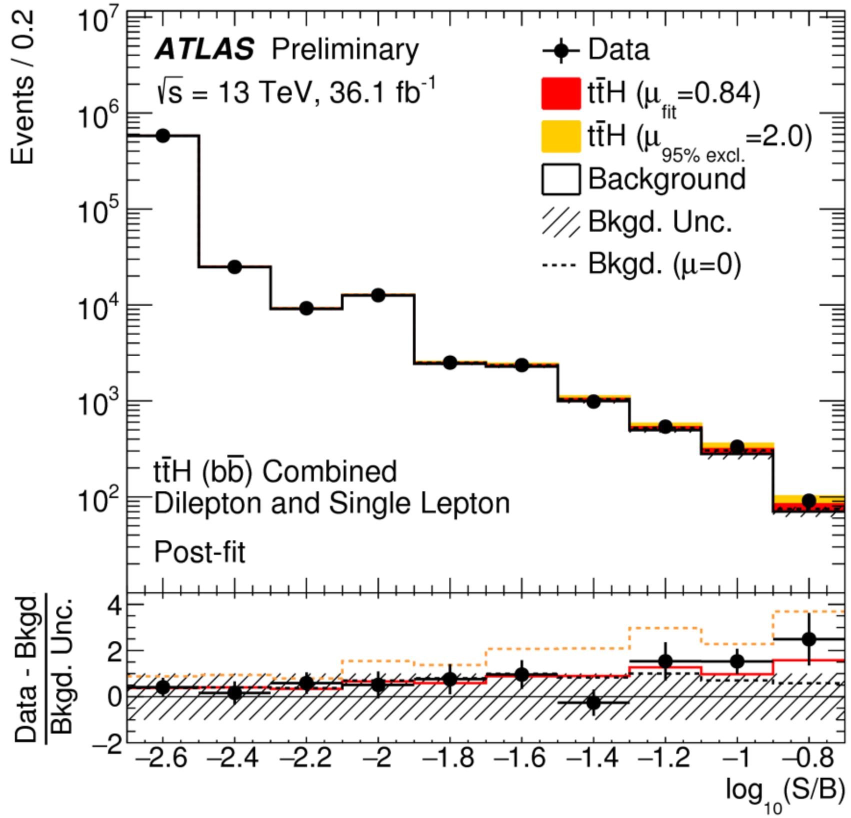
- Signal/control regions defined by number of jets, b-jets and tightness of b-tagging criteria (8 SRs)

- Signal region is binned in classification BDT that includes kinematic variables and other MVAs as input

>6 jets region

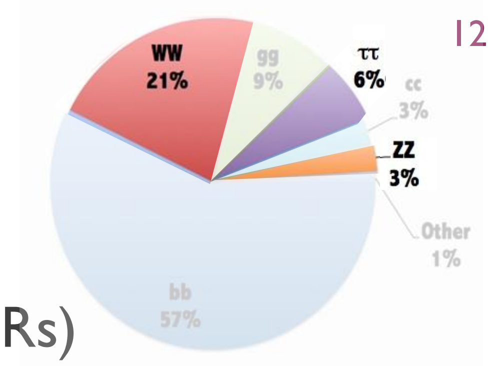


Significance: 1.4σ (exp. 1.6σ)



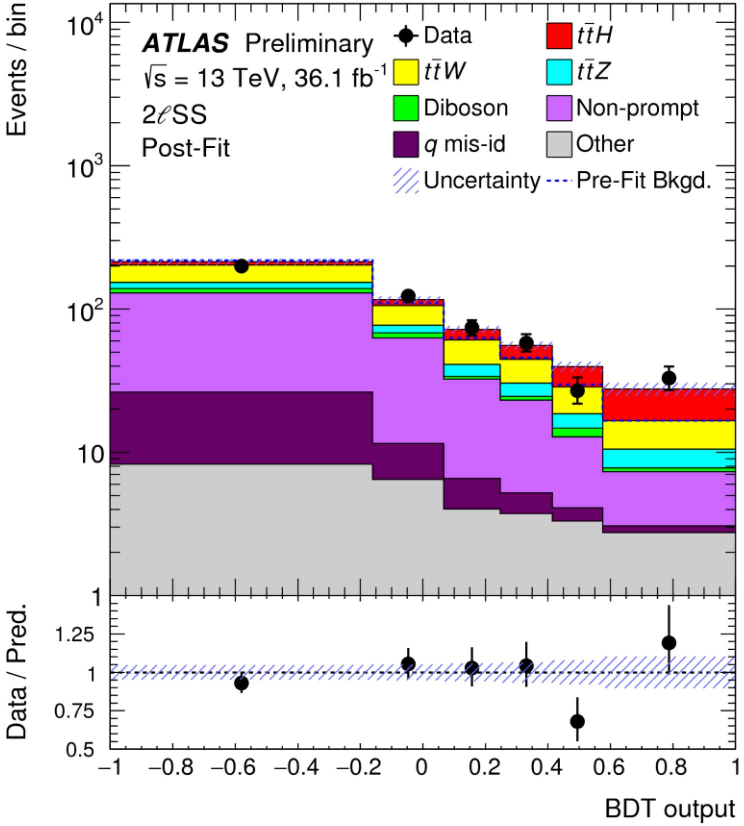
ATLAS-CONF-2017-076

$t\bar{t}H : t\bar{t} \rightarrow 1 \text{ or } 2\ell/\tau_{had},\ \ H \rightarrow WW, \tau\tau,\ ZZ$

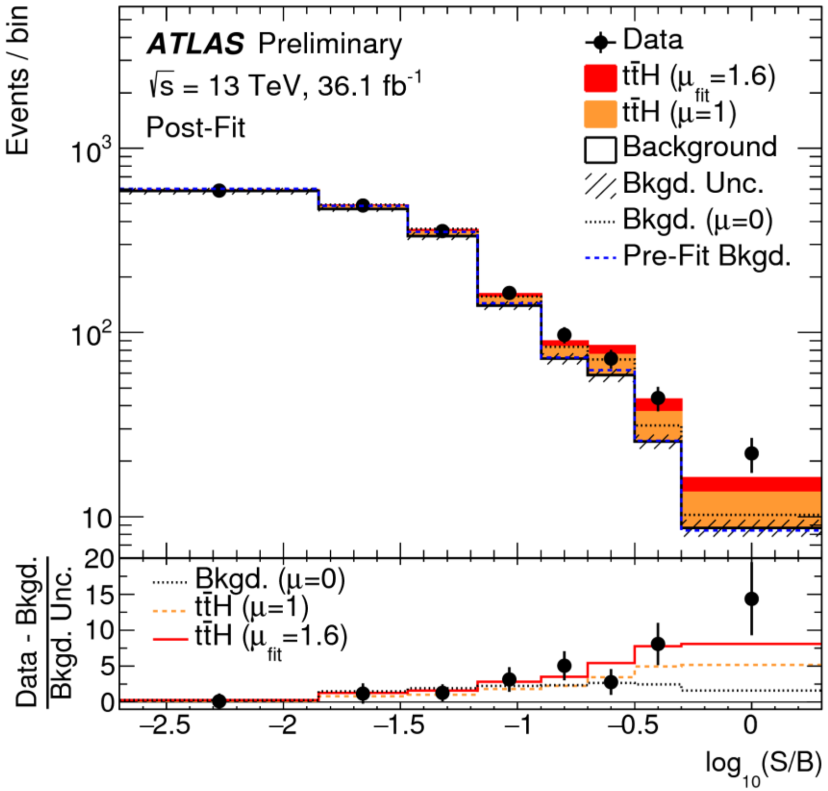


- Main challenge is predicting backgrounds that fake taus and leptons
- Signal/control regions categorised by the number and flavour of leptons (7 SRs)
- BDT shape is used as discriminant fit
- Uncertainties: Signal modelling (scale), Jet, non-prompt lepton estimation (limited CR statistics)

2 same sign lepton region



Significance: 4.1σ (exp. 2.8σ)



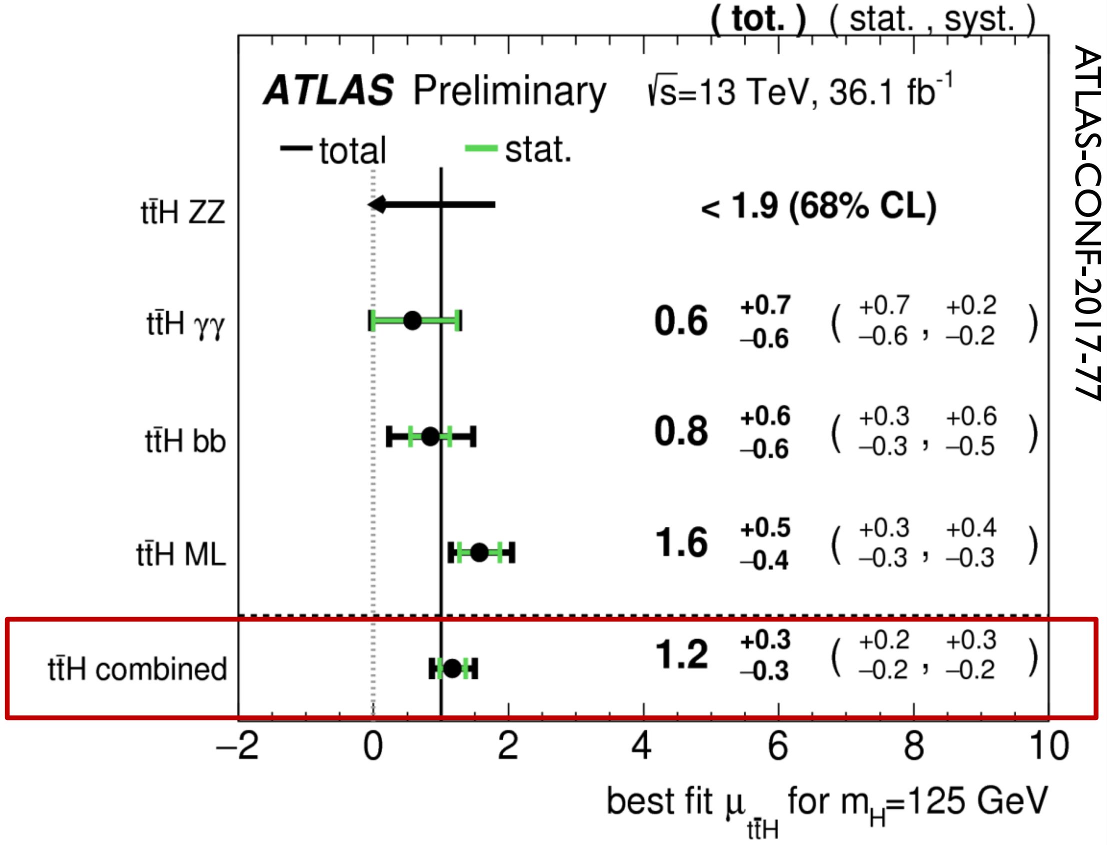
ATLAS-CONF-2017-77

$t\bar{t}H$ Combined Result

- Combined with: $H \rightarrow \gamma\gamma$ and $H \rightarrow ZZ \rightarrow 4\ell$

$\sigma(t\bar{t}H) = 590^{+160}_{-150}$ fb SM $\sigma(t\bar{t}H) = 507^{+35}_{-50}$ fb

Channel	Significance Observed	Significance Expected
Multilepton	4.1σ	2.8σ
$H \rightarrow b\bar{b}$	1.4σ	1.6σ
$H \rightarrow \gamma\gamma$	0.9σ	1.7σ
$H \rightarrow 4\ell$	—	0.6σ
Combined	4.2σ	3.8σ



EVIDENCE of $t\bar{t}H$ production!

Top Mass

- m_{top} provides information for global fits of EW parameters which are used to test the consistency of SM

- Top mass in lepton+jets ($t\bar{t} \rightarrow WWbb \rightarrow \ell\nu\ qq\ bb$): NEW

$$\boldsymbol{m_{top} = 172.08 \underset{stat}{\pm 0.39} \underset{syst}{\pm 0.82}\ \mathbf{GeV}}$$

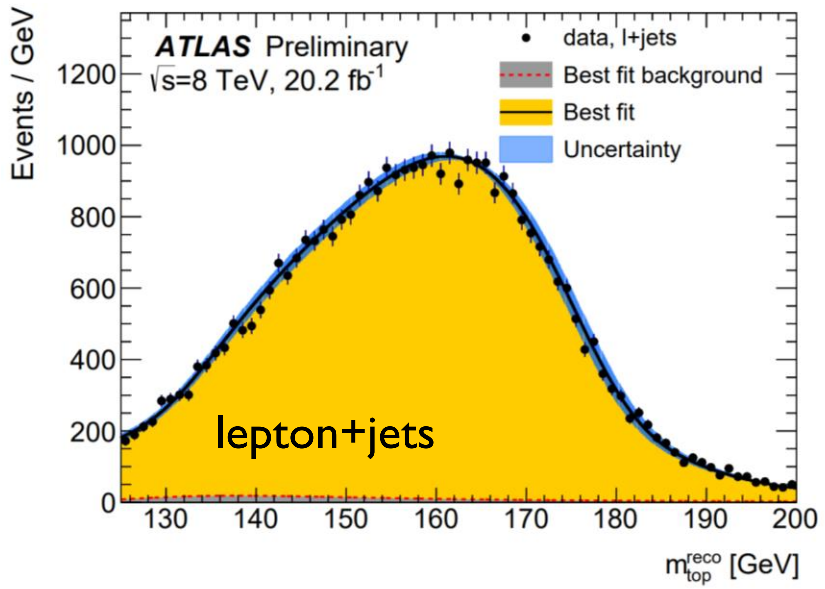
- Top mass in dilepton ($t\bar{t} \rightarrow WWbb \rightarrow \ell\ell\nu\nu bb$):

$$\boldsymbol{m_{top} = 172.99 \underset{stat}{\pm 0.41} \underset{syst}{\pm 0.74}\ \mathbf{GeV}}$$

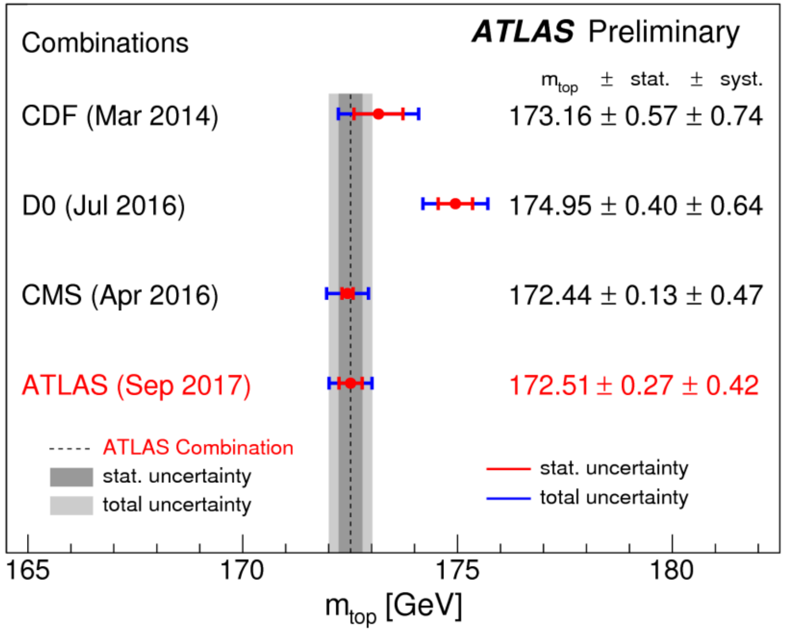
- ATLAS combined measurement (with 7/8 TeV data):

$$\boldsymbol{m_{top} = 172.51 \underset{stat}{\pm 0.27} \underset{syst}{\pm 0.42}\ \mathbf{GeV}}$$

- Systematic uncertainties reduced in combined measurement thanks to careful evaluation of correlations



ATLAS-CONF-2017-071



ATLAS-CONF-2017-071

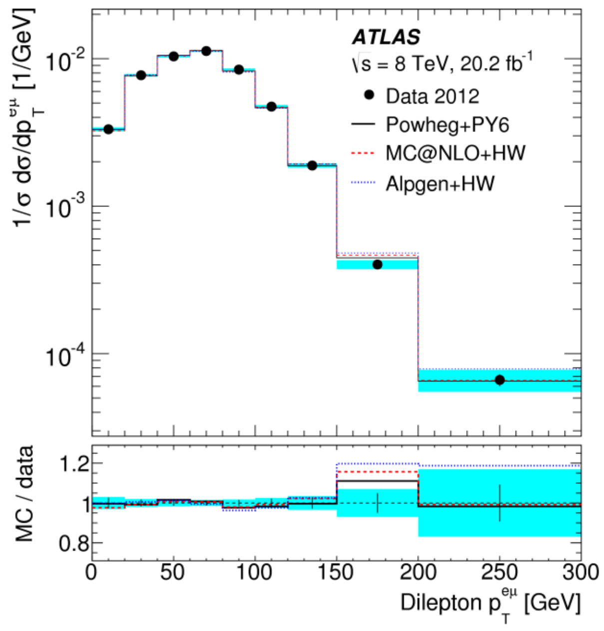
Top Mass from differential cross section

- Can precisely measure differential cross sections in $t\bar{t} \rightarrow WWbb \rightarrow e\nu\mu\nu bb$ for various observables: $p_T^{\ell}, p_T^{e\mu}, m^{e\mu}, p_T^{e} + p_T^{\mu}, E^{e} + E^{\mu}$

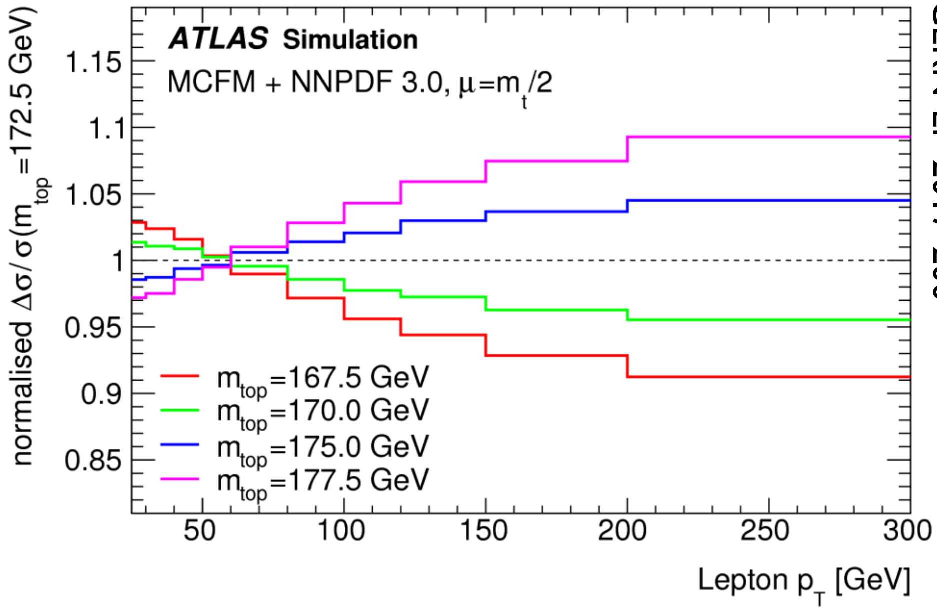
- Measuring different observables is interesting since they all have different sensitivities to higher order and non-perturbative effects

- By directly comparing fixed order calculations to cross-section, the top mass in the pole renormalisation scheme can be measured:

$$m_t^{pole} = 173.2 \pm \underset{stat.}{0.9} \pm \underset{syst}{0.8} \pm \underset{theory}{1.2}\ GeV$$



CERN-EP-2017-200



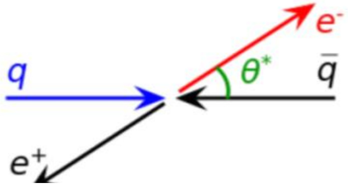
CERN-EP-2017-200

Triple Differential Drell – Yan Cross Section

- Earlier in the year we presented 7 TeV results of W mass (19 MeV precision, arXiv:1701.07240) and W/Z differential cross section (reaching 0.3% precision, arXiv:1612.03016)

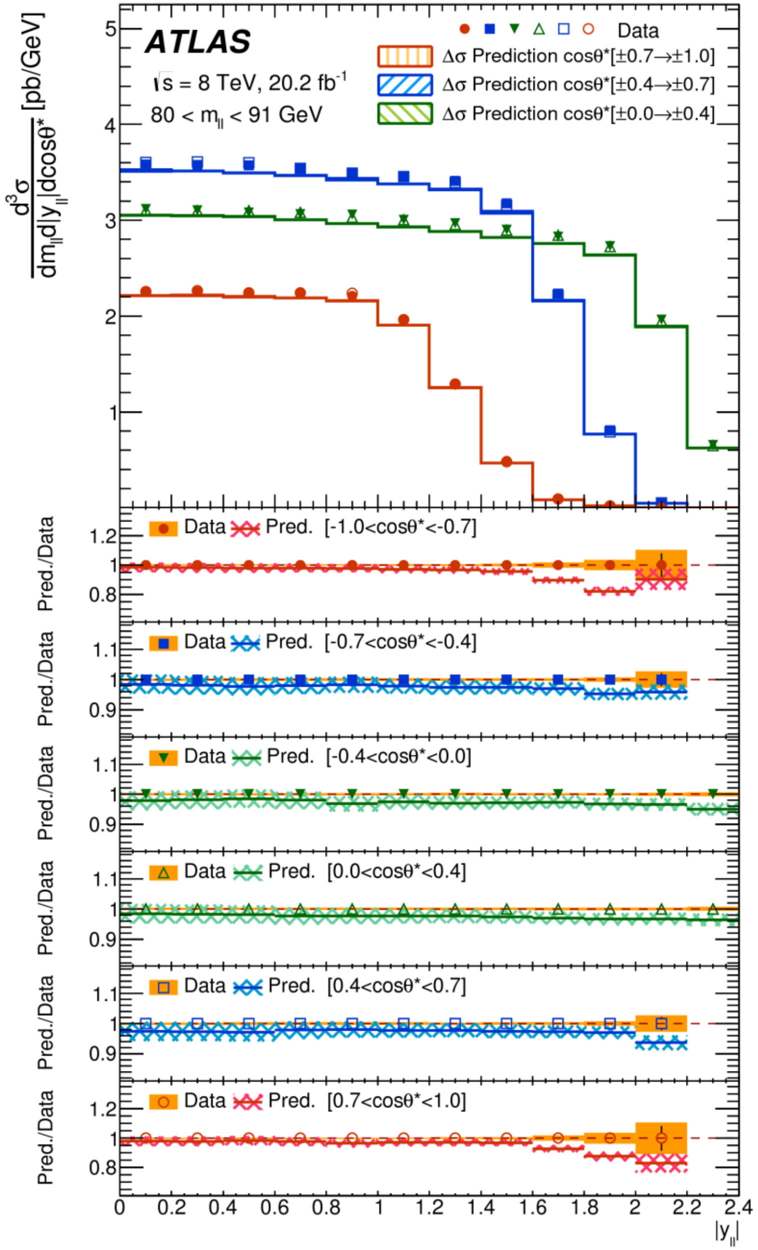
- Benefiting from excellent understanding of 7 TeV data, triple differential cross sections were measured in $Z/\gamma^* \to \ell\ell$

$$d^3\sigma = \frac{d^3\sigma}{dm_{\ell\ell}\,d|y_{\ell\ell}|\,dcos\theta^*}$$



Sensitive to Z/γ interference PDF Weak coupling constant

- Sub-percent precision is reached and the increased statistics of the 2012 data allows for much more detailed measurements



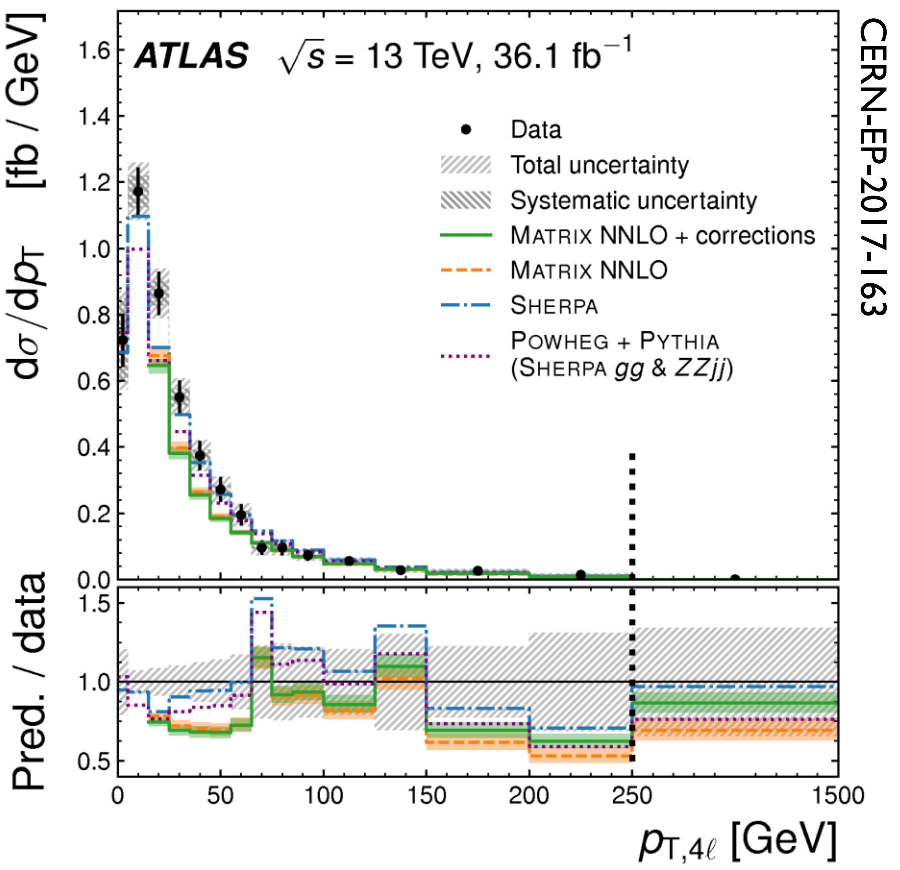
CERN-EP-2017-152

ZZ → 4ℓ Cross Section & TGC Search

- ZZ production tests electroweak sector of SM at high energies. Large Run-2 data sample allows to probe differential distributions

- Integrated and differential cross sections measured and agree with NNLO predictions

$$\sigma_{inclusive} = 17.3 \pm \underset{stat.}{0.6} \pm \underset{syst}{0.5} \pm \underset{lumi}{0.6}\ \text{pb}$$



$ZZ \to 4\ell$ Cross Section & TGC Search

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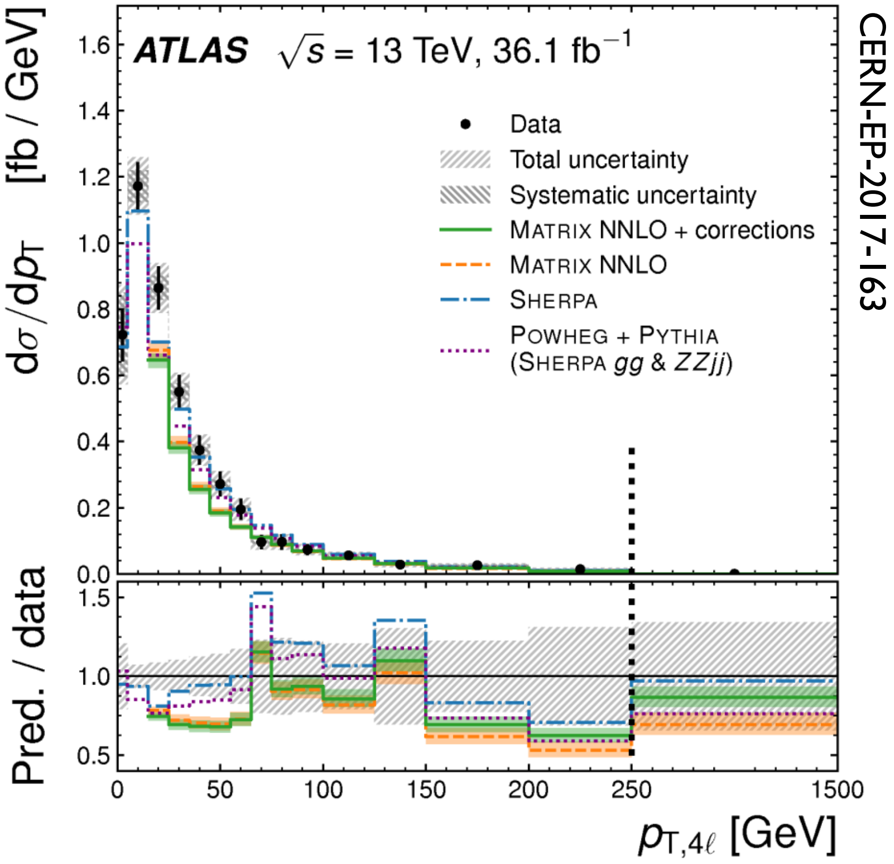
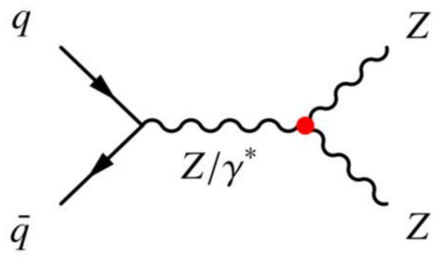


Bonus

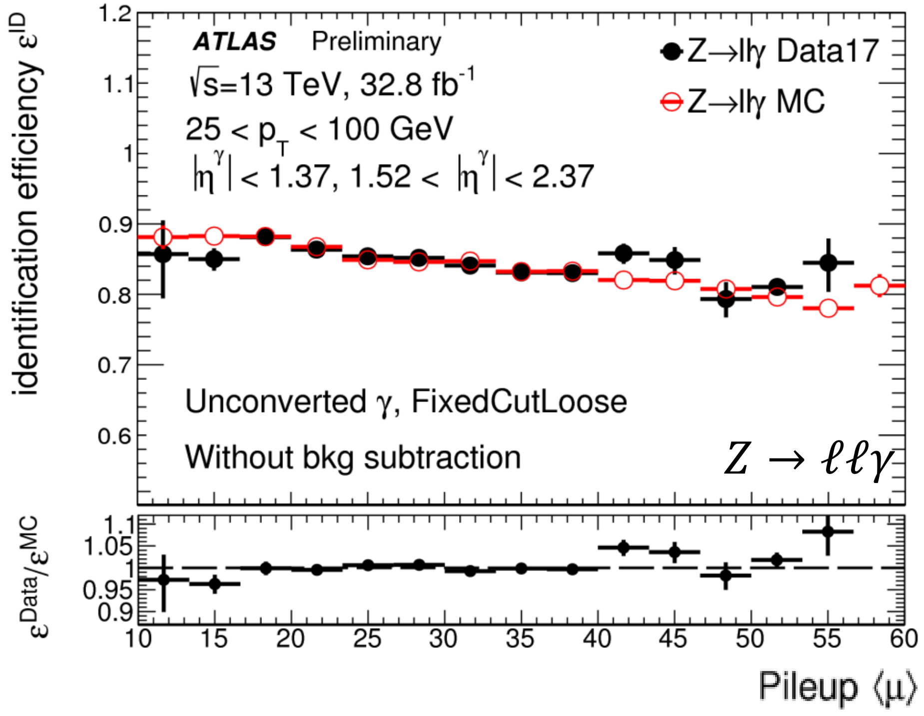
- A search for BSM neutral triple gauge couplings is performed. No evidence for couplings is found but more stringent limits compared to previous measurements have been set for neutral aTGC and EFT parameters



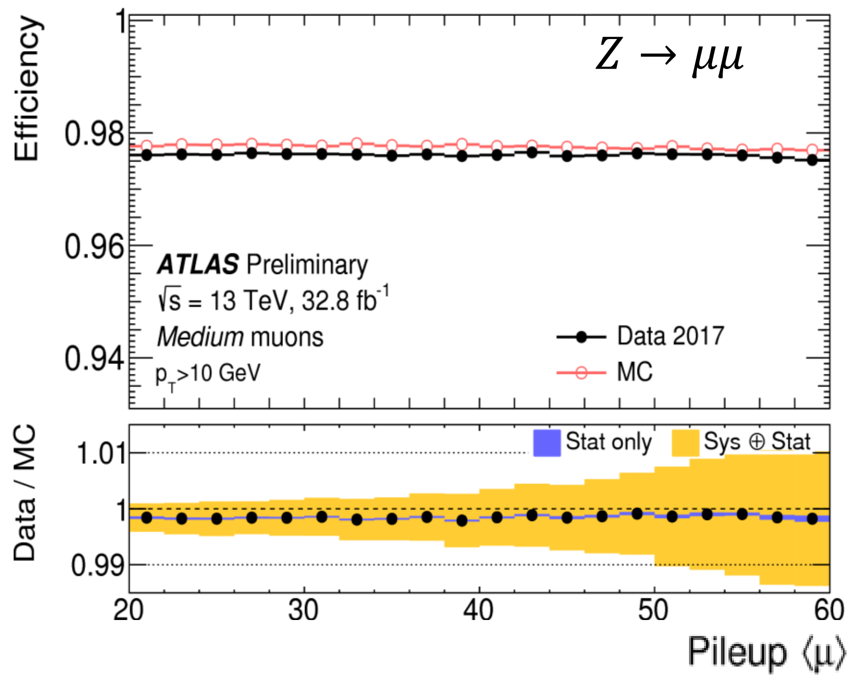
Performance from 2017 data

- The efficiency of reconstructing photons and muons remains high even at large pileup
  - Dependence on pileup is well modelled by MC

Photons



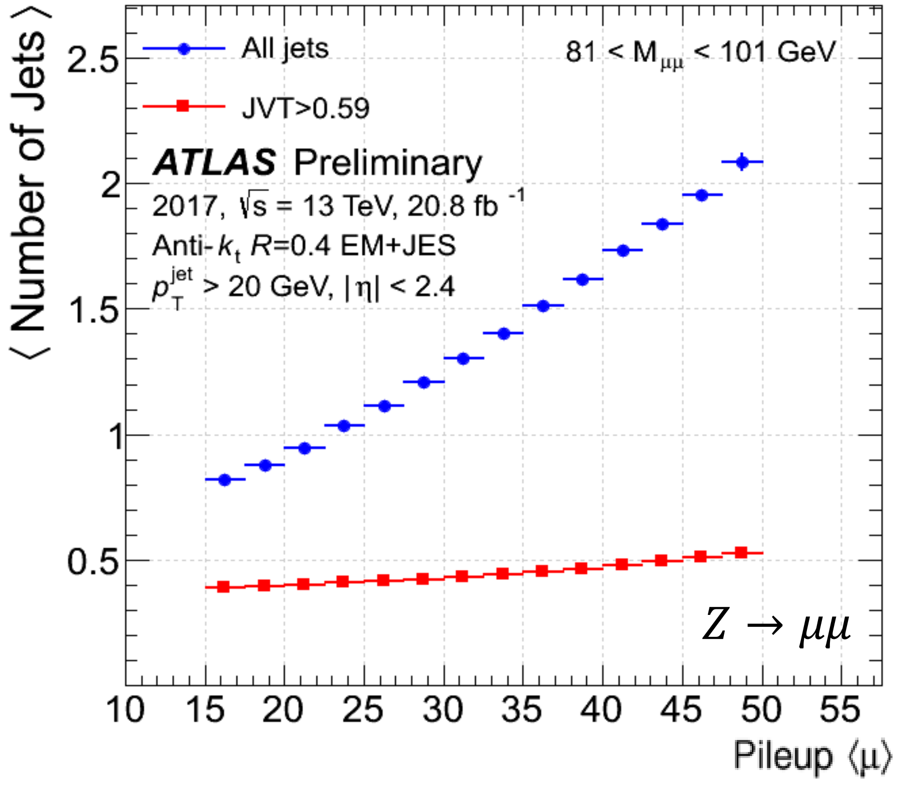
Muons



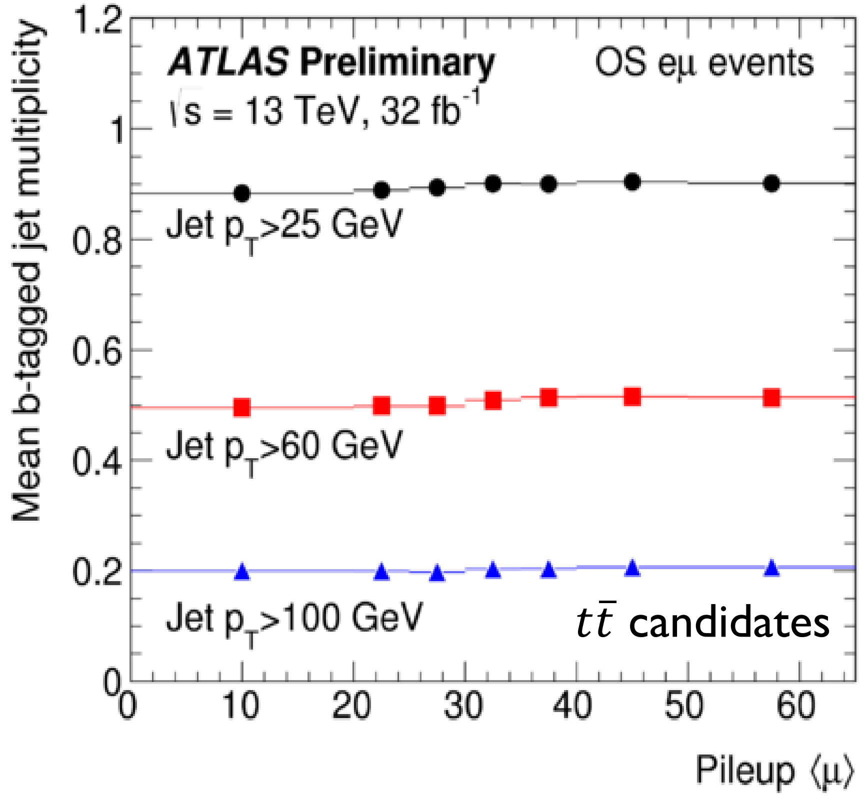
Performance from 2017 data

- Fake (pile-up) jet rates under control with the application of pileup reduction techniques (Jet Vertex Tagger (JVT) - based on tracking information)
- B-tagging is stable as pileup increases

Jets



b-tagged jets

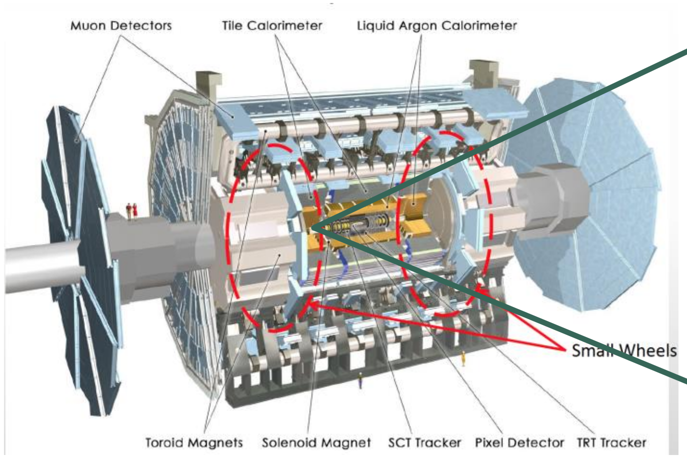


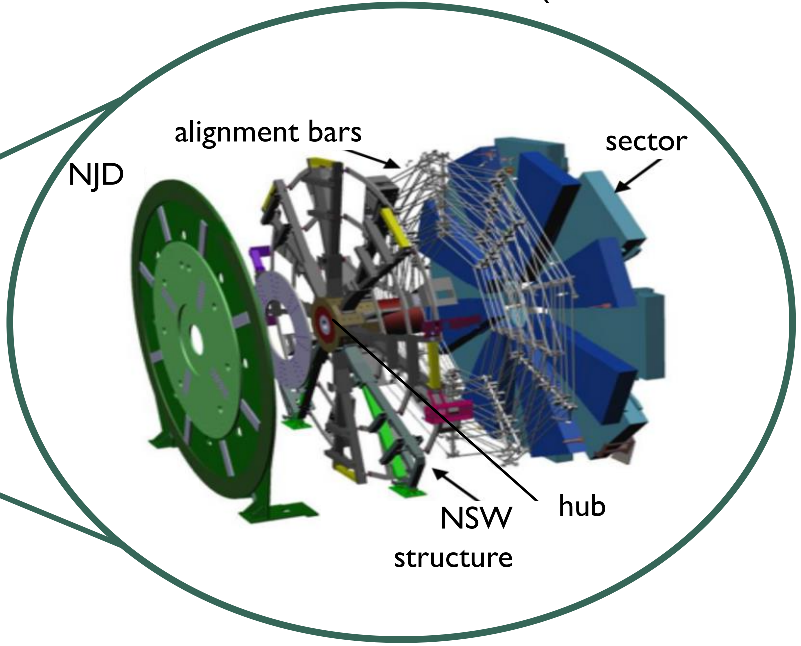
PHASE I UPGRADE

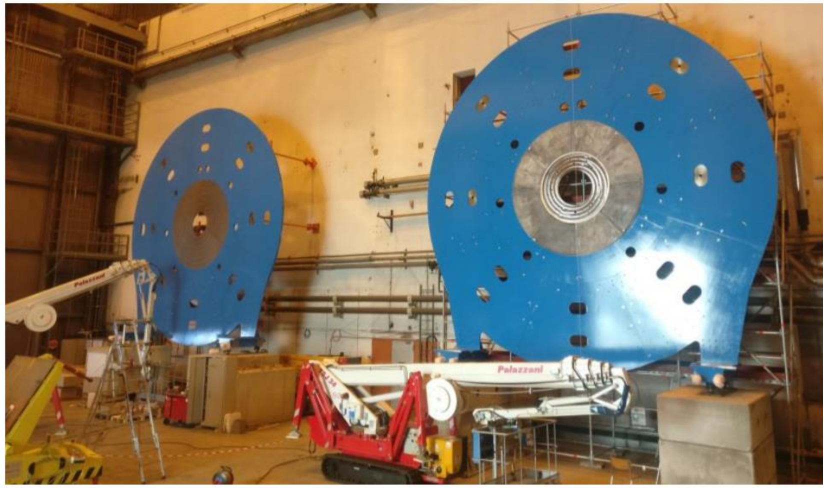
- New Small Wheel
- LAr Electronics Upgrade
- TDAQ Upgrade

New Small Wheel

Wheel = 16 sectors (8 small+8 large)







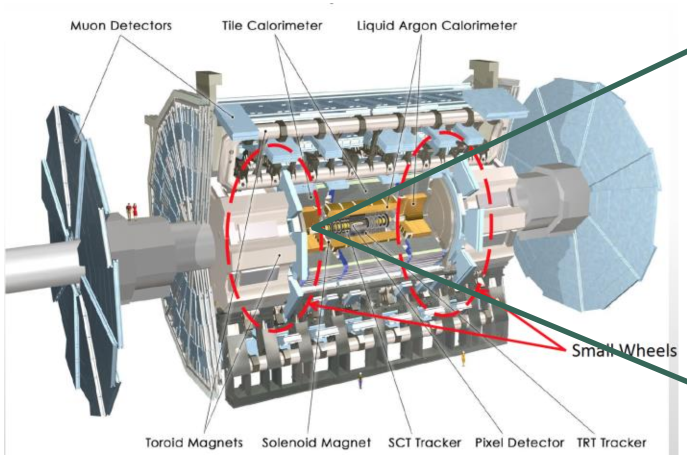
NSW Engineering:

- New JD shielding assembly completed at CERN
- All major mechanical elements now under production, including the Hubs

Electronics for Trigger and Readout:

- Preproduction version of 4 ASICs (VMM, ART, TDS, ROC) sent for fabrication
  - test of ROC will define whether a new version is needed
- On detector cards passed review (2/3 types of L1DDCs, ADDC, Router)
- Final prototypes of front-end boards are in the final design stages
  - still some trouble with noise that will be clarified

New Small Wheel



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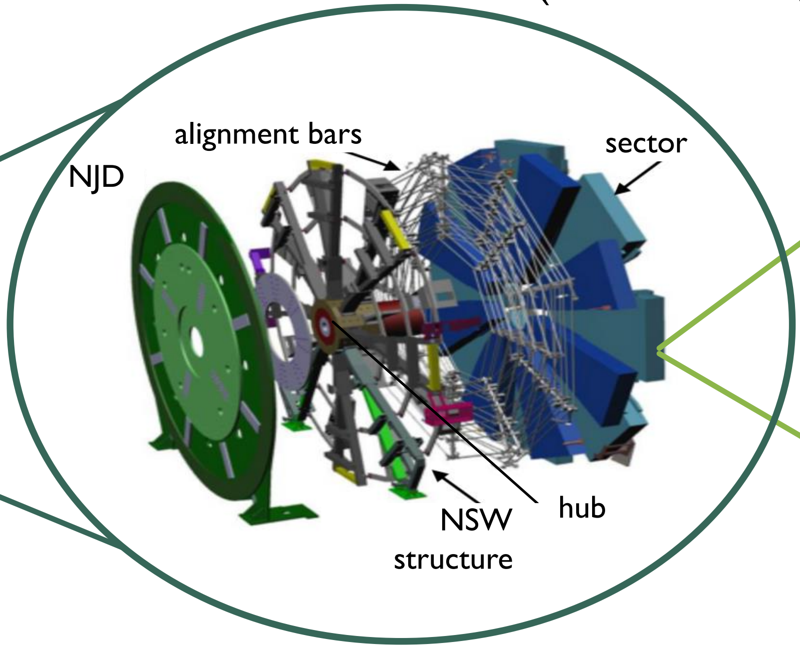
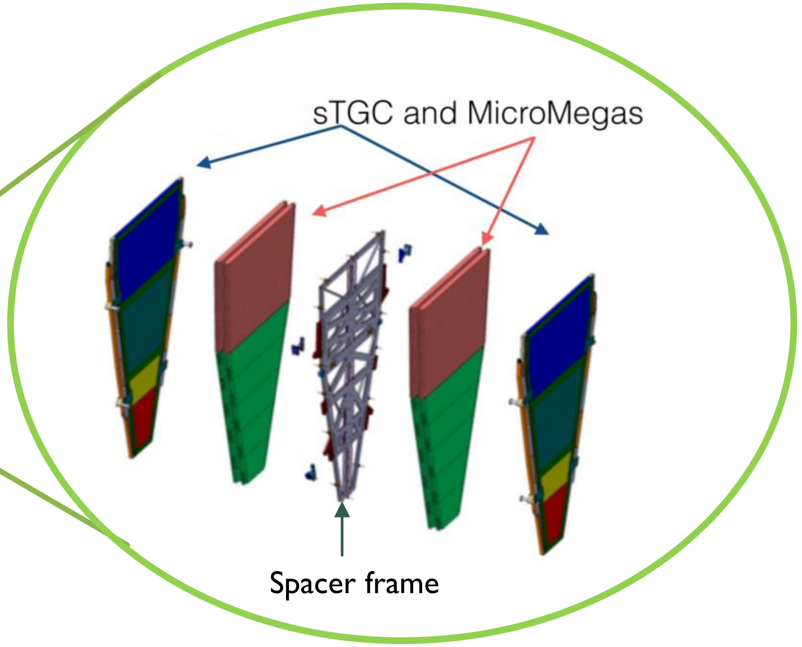


Sector: 2 sTGC and 2 MM wedges

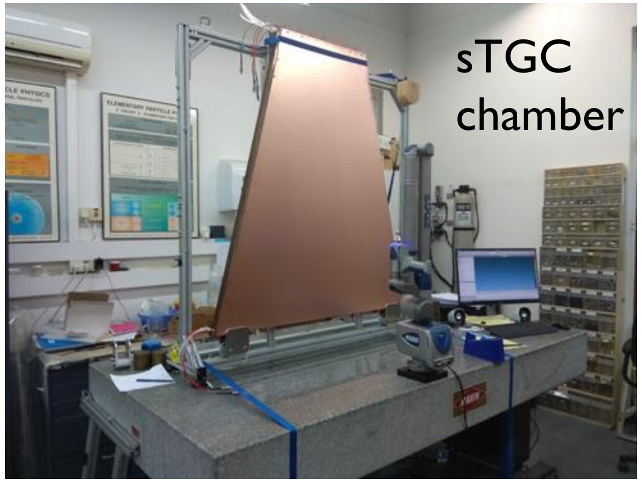


MicroMegas (MMs) - **on track to assemble first wedge in Feb 2018!**

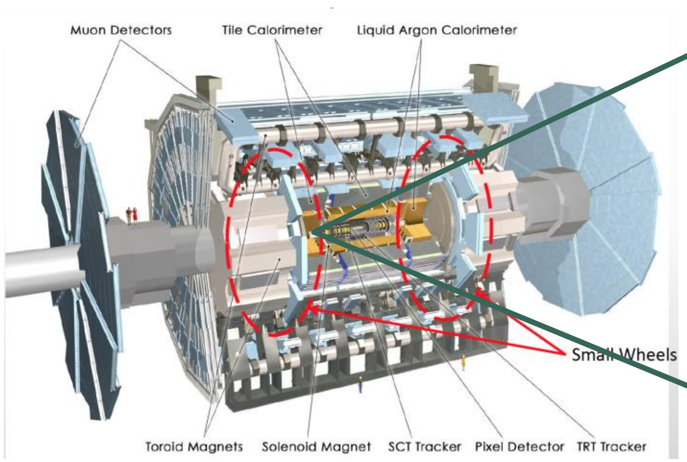
- Readout board production progressing steadily
- Chamber series production started after summer, first chambers to be shipped to CERN end of 2017
- Received pre-series for spacer frames

Small TGC (sTGC) - **on track for wedge integration at CERN in spring 2018!**

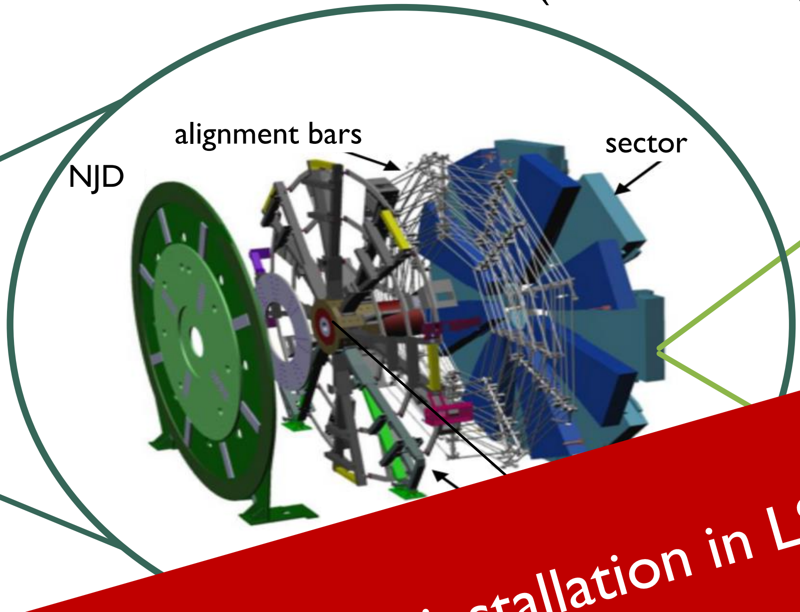
- Cathode board production ongoing with 3 vendor chains
- Chamber series construction started, first chamber assembled



New Small Wheel



Wheel = 16 sectors (8 small+8 large)



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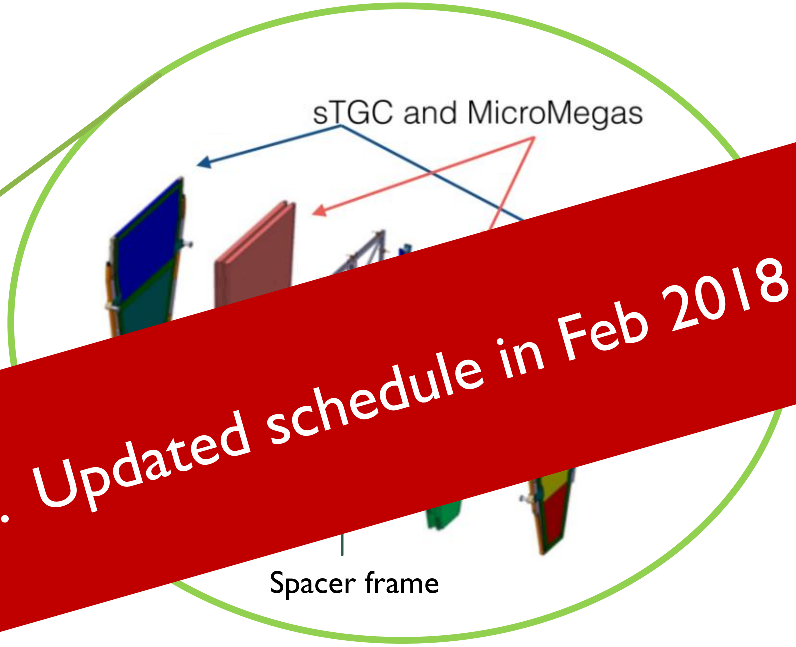


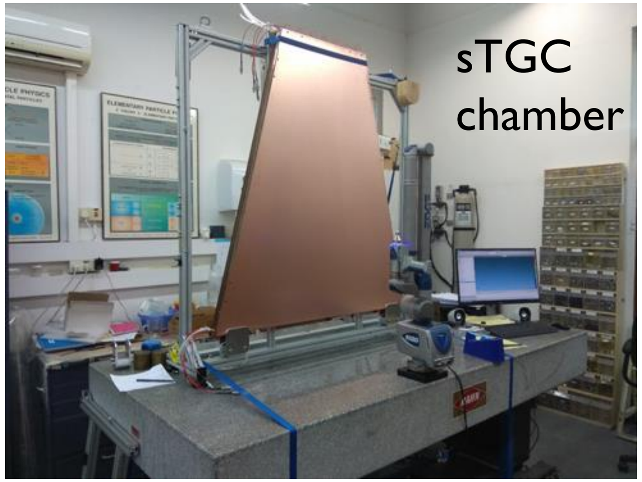
NSW Construction is on critical path for installation in LS2. Updated schedule in Feb 2018

MicroMegas (MM ... 2018!

- ... after summer, first chambers to be shipped to CERN end of 2017
- ... spacer frames

Sma... (sTGC) - **on track for wedge integration at CERN in spring 2018!**

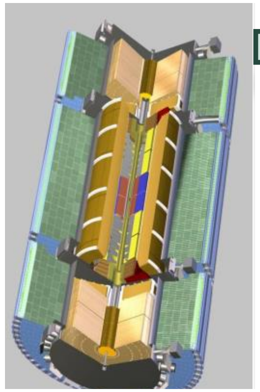
- Cathode board production ongoing with 3 vendor chains
- Chamber series construction started, first chamber assembled



LAr Electronics Upgrade

Front End (on detector) | Back End (USA 15)

Current | Phase I



Baseplane

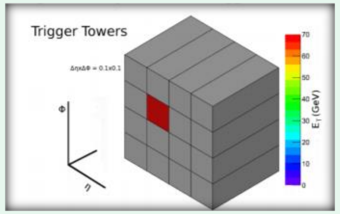
Front End Board (FEB)

Layer Sum Board (LSB)
sum signals from cells

Controller Board

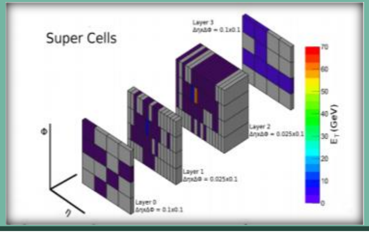
Tower Builder Board (TBB)

Granularity: $0.1 \times 0.1 (\eta \times \phi)$
Resolution: 1 GeV



LAr Trigger Digitizer Board (LTDB)

Digitize cells
Granularity: $\times\ (5 - 10)$
Resolution: 32-125 MeV



To RODs

Trigger towers to L1Calo

In Phase I Need finer granularity & energy resolution to be more robust against pileup

LAr Digital Processing System (LDPS)
Calculates E_T

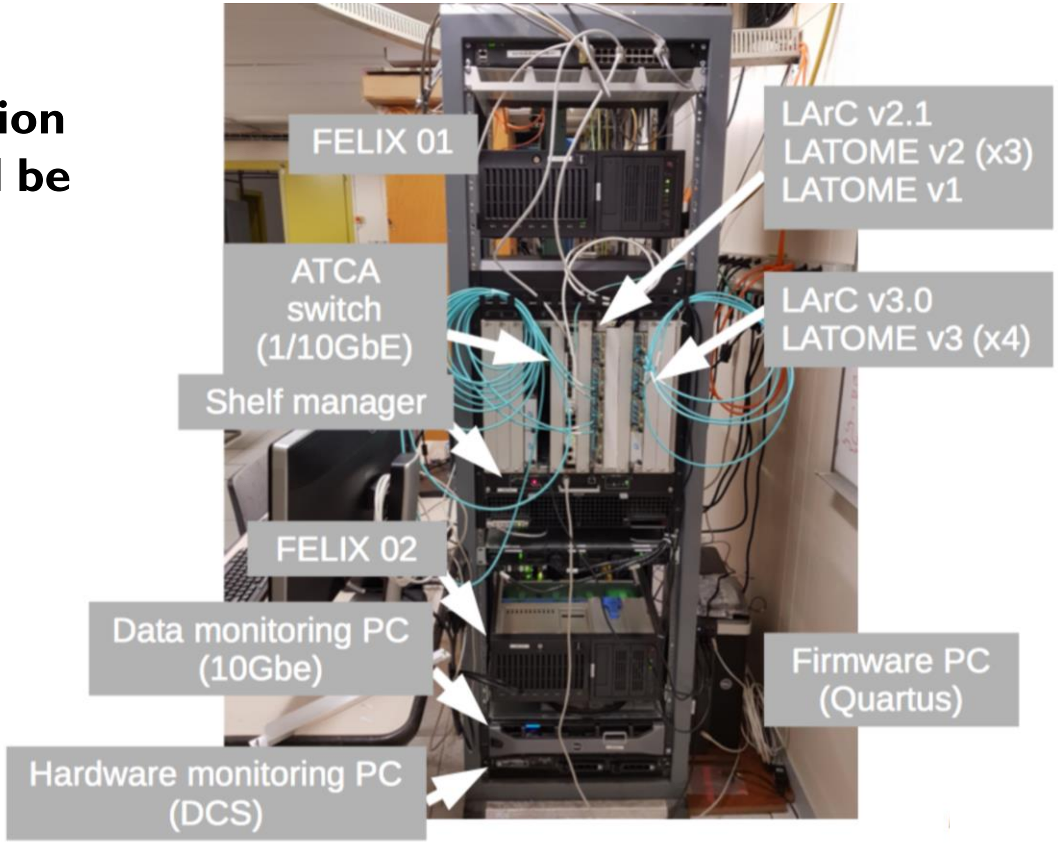
Latome

To L1 Calo FEX

To FELIX

LAr Electronics Upgrade

Test system setup for backend integration and firmware debugging. Front end will be integrated when prototypes arrive



Baseplane

Baseplane: Prototype testing/ production ongoing

Layer Sum Board (LSB)

EM production done, testing ongoing

LAr Trigger Digitizer Board (LTDB)

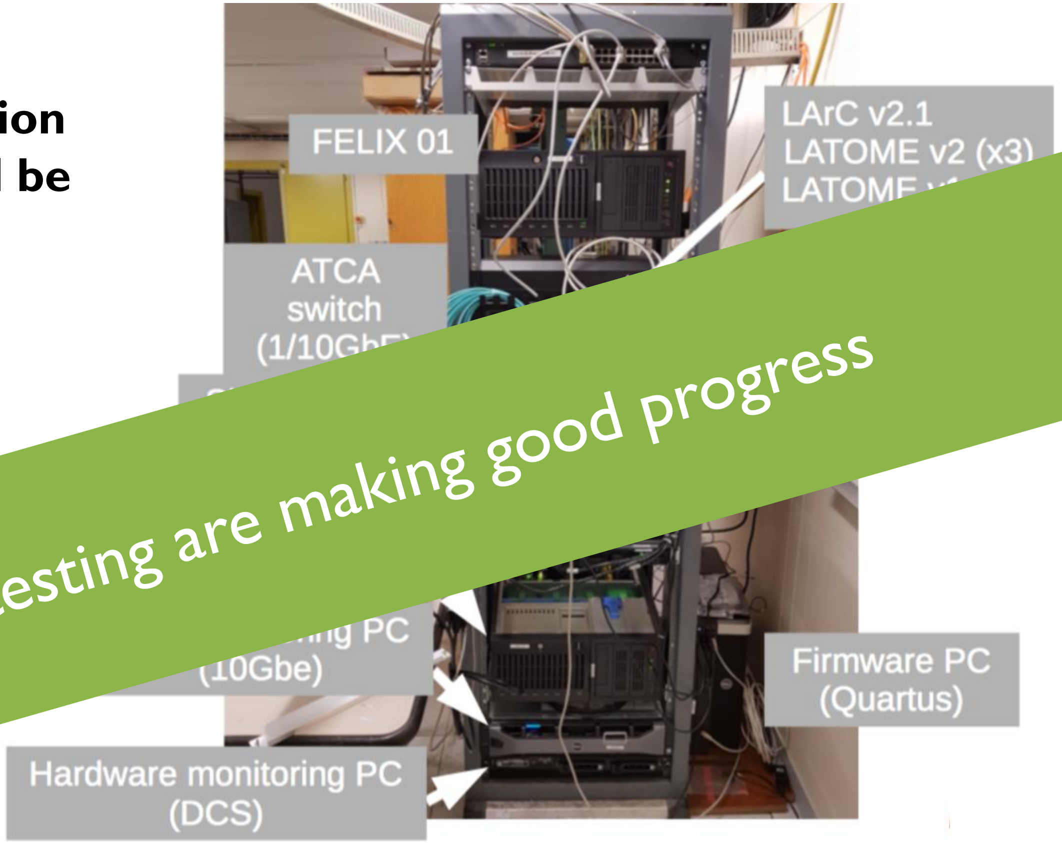
Pre-production boards being cabled.
ASICs production engineering run submitted

LAr Digital Processing System (LDPS)

PRR beginning of 2018, production to follow (35 carriers, 150 LATOME)

LAr Electronics Upgrade

Test system setup for backend integration and firmware debugging. Front end will be integrated when prototypes arrive



Layer Sum Board (LSB)

EM production done, testing ongoing

F
te
pr production
ongoing

Basepl

Trigger Digitizer Board (LTDB)

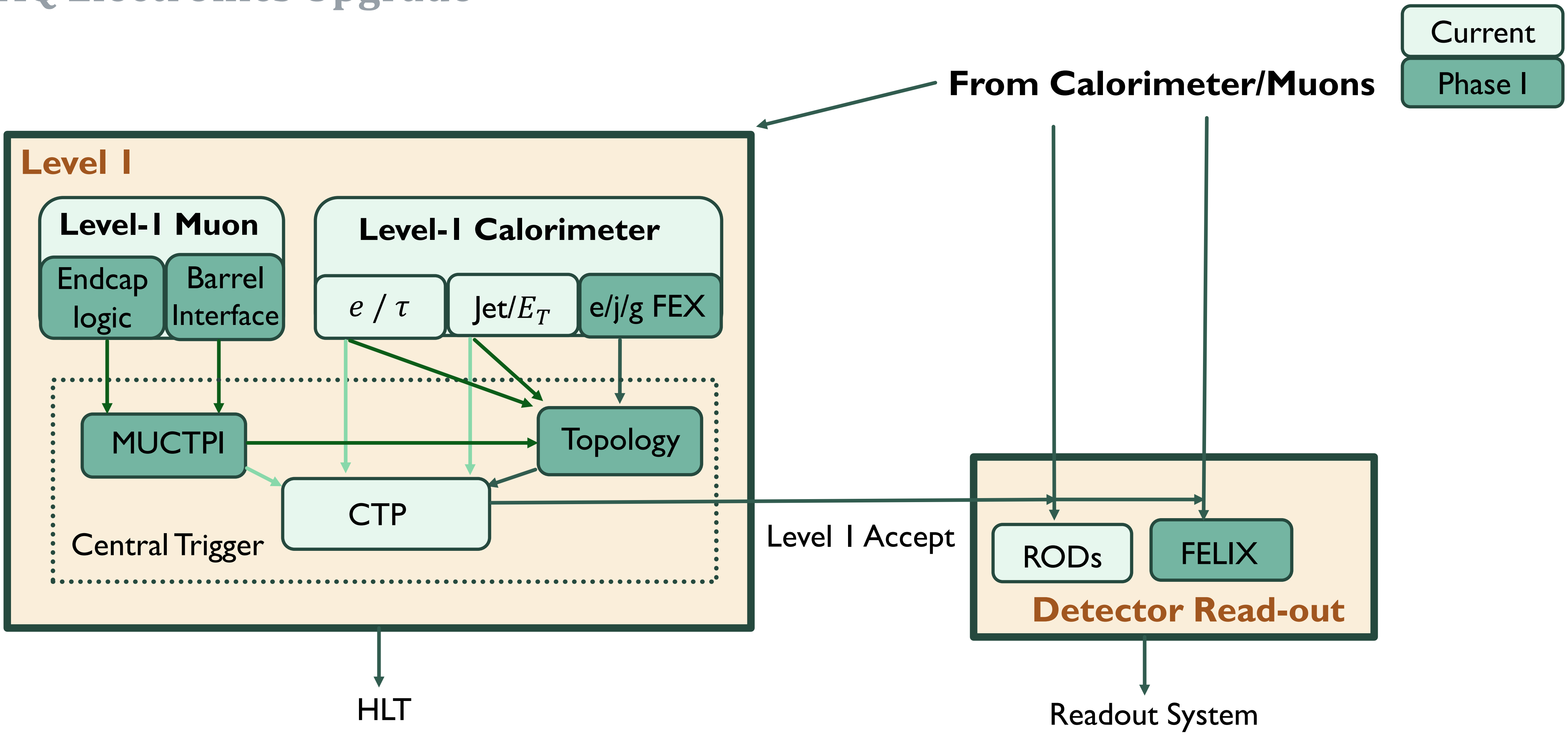
Pre-production boards being cabled.
ASICs production engineering run submitted

LAr Digital Processing System (LDPS)

PRR beginning of 2018, production to follow (35 carriers, 150 LATOME)

All activities on track: production and testing are making good progress

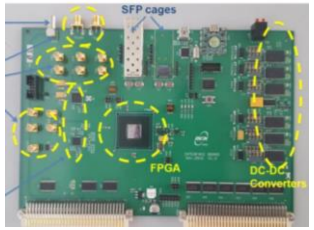
TDAQ Electronics Upgrade



TDAQ Electronics Upgrade

Endcap trigger: preproduction prototype under test

Barrel Interface – Integration tests with MUCTPI done



Endcap trigger

Barrel Interface

MUCTPI

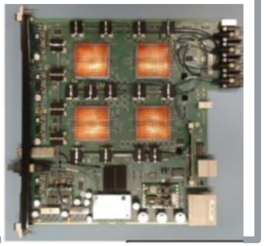
e/j/g FEX

Topology

CTP

FELIX

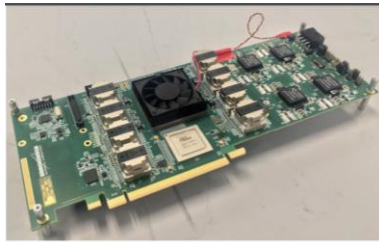
3 Feature EXtractors: Full function prototypes tested (electron/global)/ under test (jets)



Topology: specifications complete

MUCTPI – preproduction prototype almost fully tested

FELIX – preproduction prototype under test



TDAQ Electronics Upgrade

Endcap trigger: preproduction prototype under test

Barrel Interface – Integration tests with MUCTPI done

Endcap trigger

Barrel Interface

MUCTPI

e/j/g FEX

3 Fea

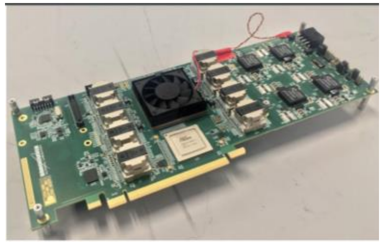
ology: specifications complete

FELIX

All activities on track: production and testing are making good progress

preproduction
otype almost fully tested

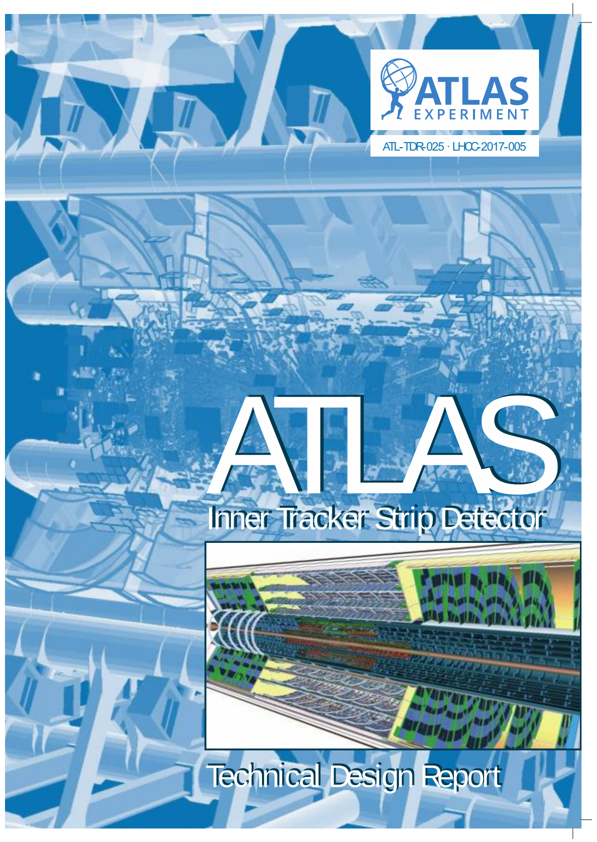
FELIX – preproduction prototype under test



PHASE II UPGRADE

- **Status of Phase – II Technical Design Reports (TDR)**

Status of Phase – II Technical Design Reports (TDR)



- **ITk Strip Tracker TDR:** approved (May)
  - MoU being developed
- **Muon TDR:** Final version with LHCC
  - Muon UCG Review was on Tues
- **LAr and Tile TDRs**: proceeded through LHCC reviews (Mon)
  - UCG Packages submitted mid-Nov
- **TDAQ and Pixel TDRs:** expected submission on Dec 15
  - UCG Packages very advanced, on track for Jan 2018 submission
- **High Granularity Timing Detector:** expression of Interest submitted to LHCC on Nov 20
- Everything on schedule for timely completion of TDR reviews in Apr 2018!

SUMMARY

- ATLAS maintained high data taking efficiency and data quality despite challenging conditions
- All detectors optimized their systems for high pileup data taking, and performed exceptionally well
- High pile-up conditions affect object reconstruction, but performance is as expected and well modelled by MC
- We are exploiting the exciting physics opportunities of the large Run-2 dataset, while continuing to capitalise on the extremely well understood Run-1 data for high-precision measurements
- Phase I upgrade plans progressing well. New Small Wheel undergoing intense activities and schedule remains tight
- Phase II TDRs are progressing well, most TDRs submitted, remaining will be by the end of the year
- ATLAS is well prepared for consolidation over YETS and we are looking forward to looking at new 2017 data sample!

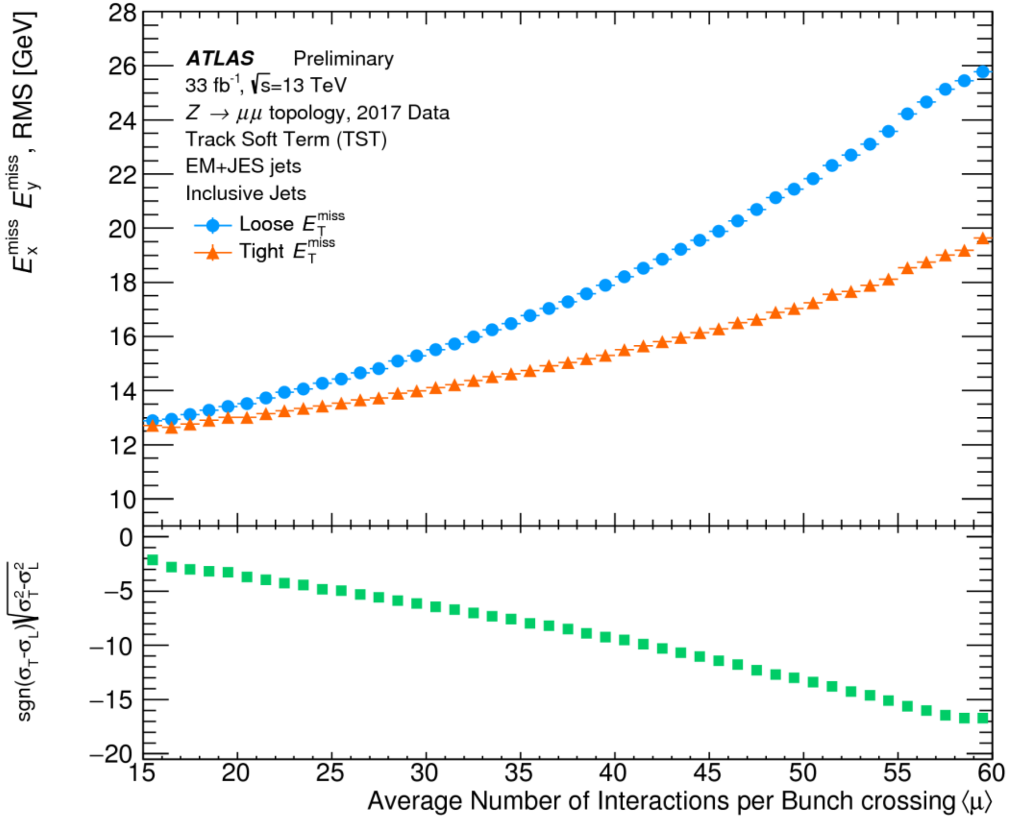
BACKUP

Performance: MET

The missing transverse energy is calculated using reconstructed objects (muons, electrons, photons, jets) and, to mitigate pileup contributions, with tracks associated with the primary vertex

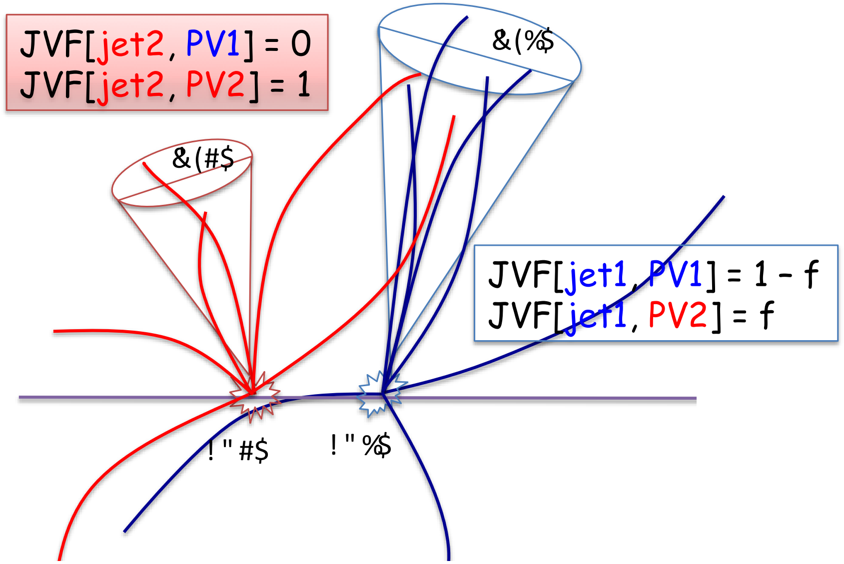
To further mitigate effects of pileup:

- Require jets to have large fraction of their p_T from primary vertex tracks
- Contributions from pileup jets outside of tracking volume reduced by increasing jet p_T threshold:
  - "Loose" jet E_T > 20 GeV
  - "Tight" jet E_T > 30 GeV



Jet Vertex Fraction (JVF)

$$JVF(jet_j, vtx_k) = \frac{\sum_i pt(trk_i^{jet_j}, vtx_k)}{\sum_n \sum_i pt(trk_i^{jet_j}, vtx_n)}$$

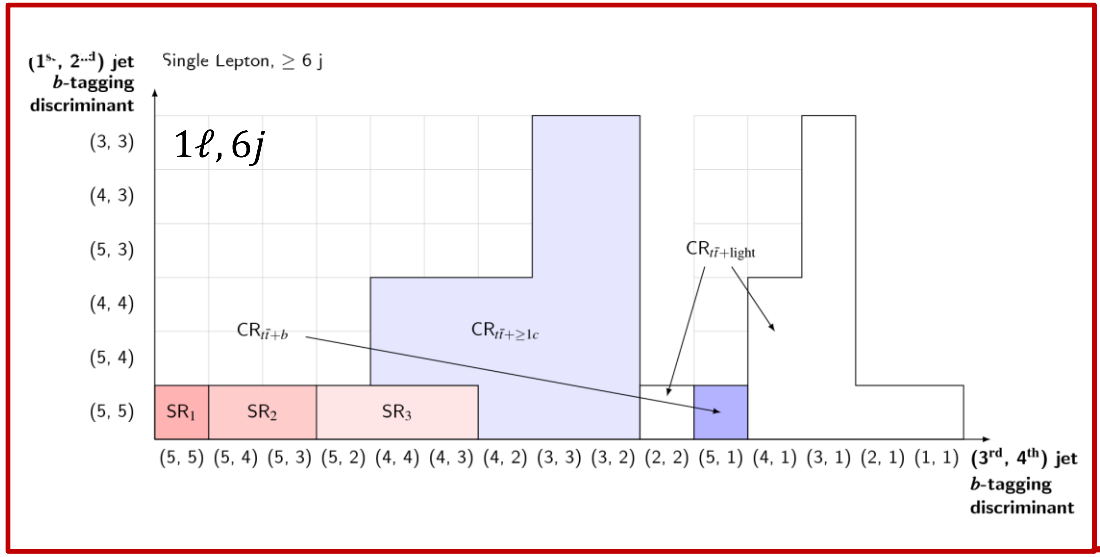


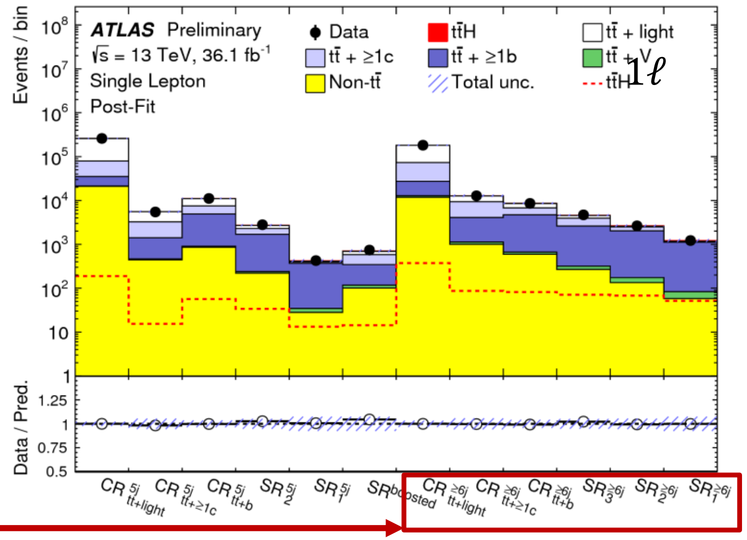
- JVF = 1 -> all the trks that match* to jet 2 have originated from vtx 2
- JVF = 0 -> none of the trks that match to jet 2 come from vtx 1
- JVF = f -> a fraction f of the trks matched to jet 1 come from vtx 2

* jet are matched to trks via a simple ΔR matching in the $\eta-\phi$ plane.

$t\bar{t}H$: $t\bar{t} \to 1 - 2\ell, \boldsymbol{H} \to \boldsymbol{bb}$

- Signal/Control regions defined by number of jets, b-jets and tightness of b-tagging criteria (4 working points)– boosted and resolved – 3 SRs ($2\ \ell + \geq 4j\ (3b)$) and 5 SRs SRs ($1\ell + \geq 5/6j\ (4b)$)
- Separate CRs to target $\bar{t}t + \geq c\ /\ b\ /\ light$ backgrounds by employ looser b-tag requirements
- SRs binned in 'classification BDT



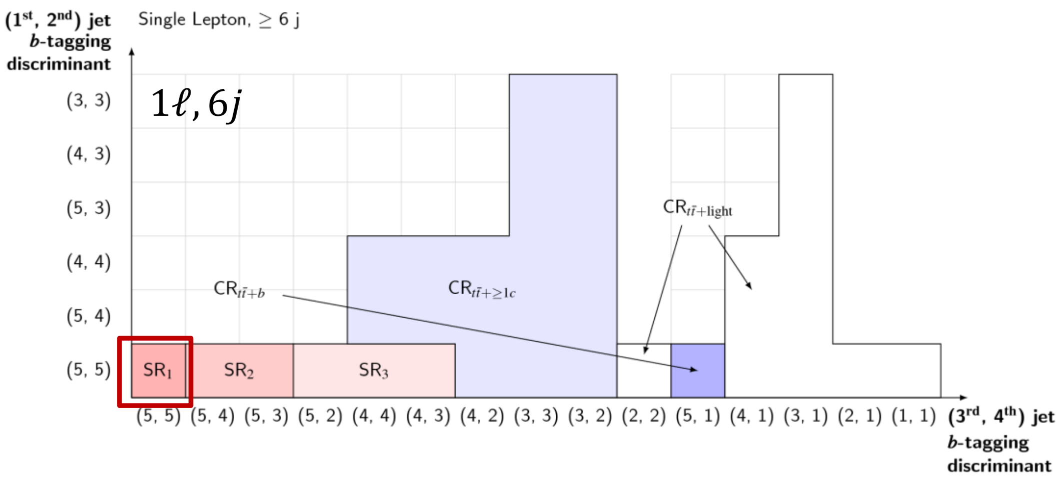


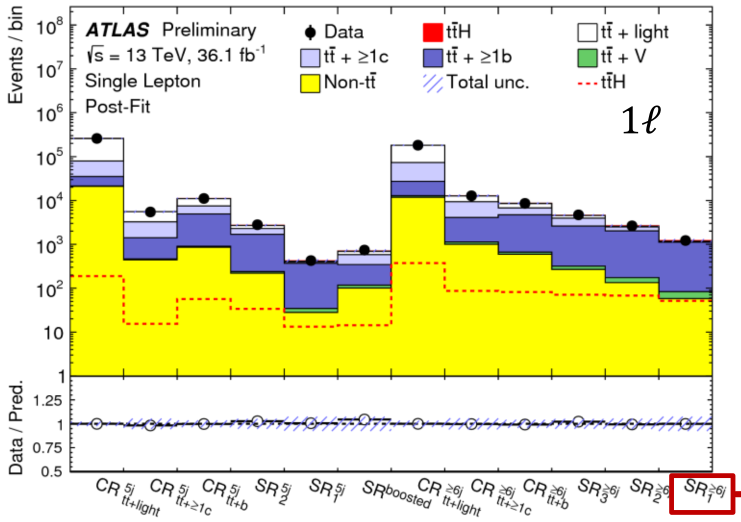
$t\bar{t}H$: $t\bar{t} \rightarrow 1-2\ell, H \rightarrow bb$

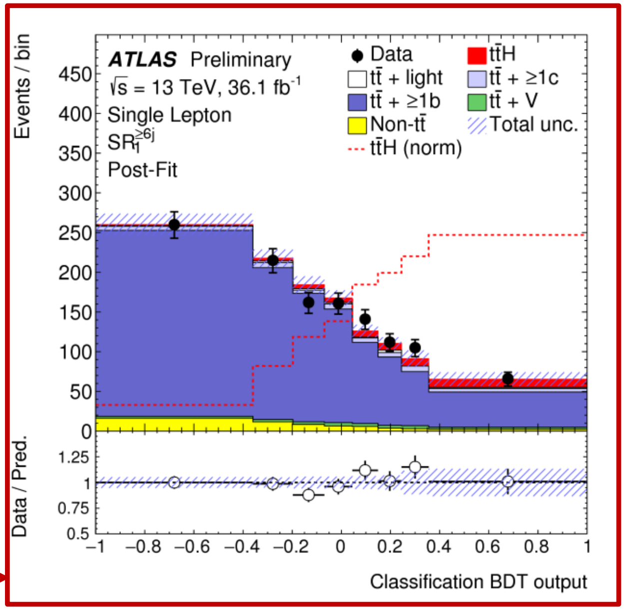
- classification BDT" is final discriminant and includes general kinematic variables such as such as invariant masses and angular separations of jets/leptons, as well as outputs of intermediate MVA in different SRs

  - 'reconstruction BDT': selects best combination of jet–parton for H/t candidates : all resolved
  - Likelihood Discriminant (LHD): signal/background probability using discriminating variables: resolved 1ℓ SR
  - Matrix Element Method (MEM): signal/background probability using matrix element calculation at parton level : 1ℓ, 6j SR 1

- Dominant uncertainties: difference between generators and uncertainties on $t\bar{t}+\geq 1b$ modelling, limited background modelling stats, b-tagging, jet

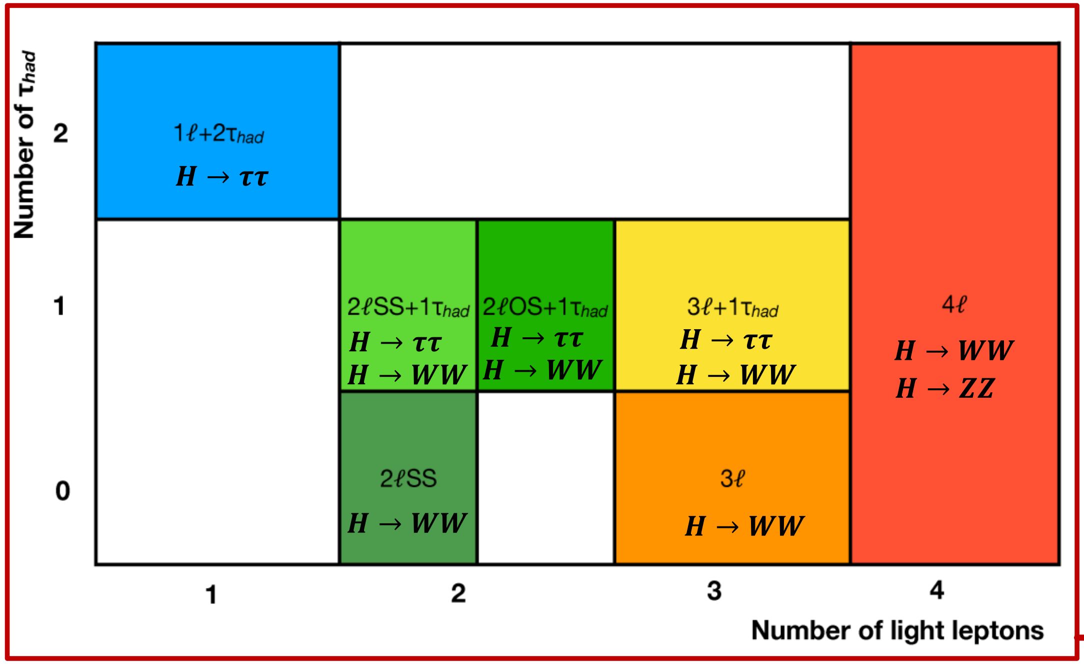


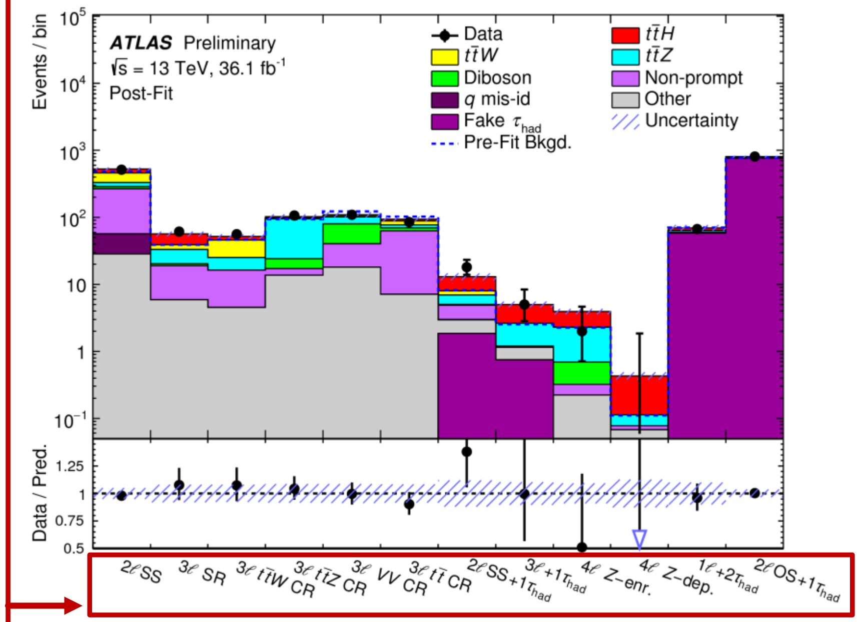




$t\bar{t}H : t\bar{t} \rightarrow 1-2\ell/\tau_{had},\ \ \boldsymbol{H \rightarrow WW, \tau\tau,\ ZZ}$

- Seven final states, categorised by the number and flavour of lepton (CRs and SRs)
- Backgrounds: fake/non-prompt leptons (mostly from b decay in $t\bar{t}$, photon conversions), q_e misidentified, jet (mostly light) misidentified as τ, Diboson, $t\bar{t}W$, $t\bar{t}Z$

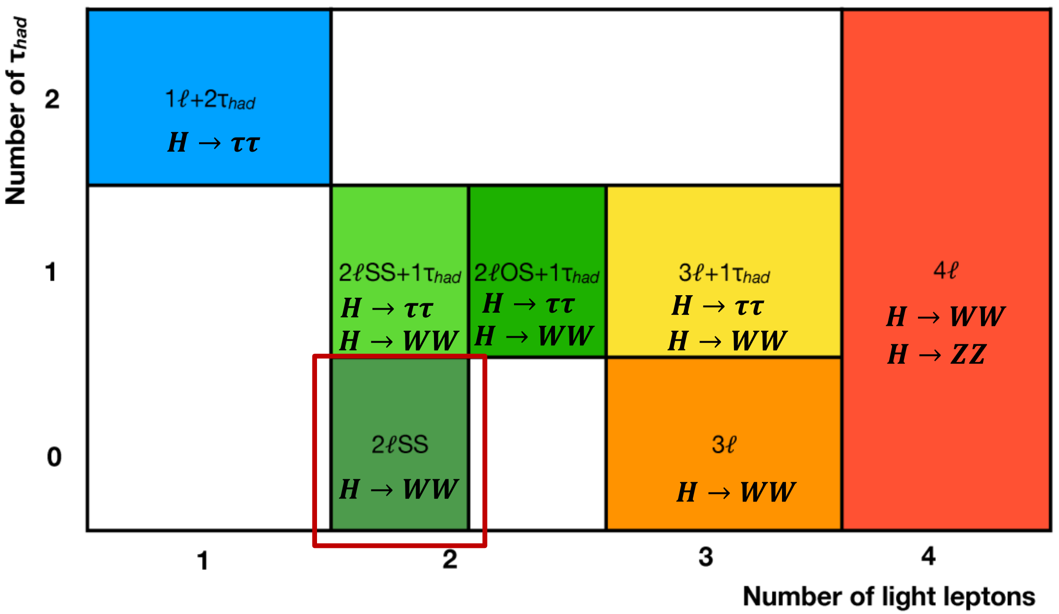


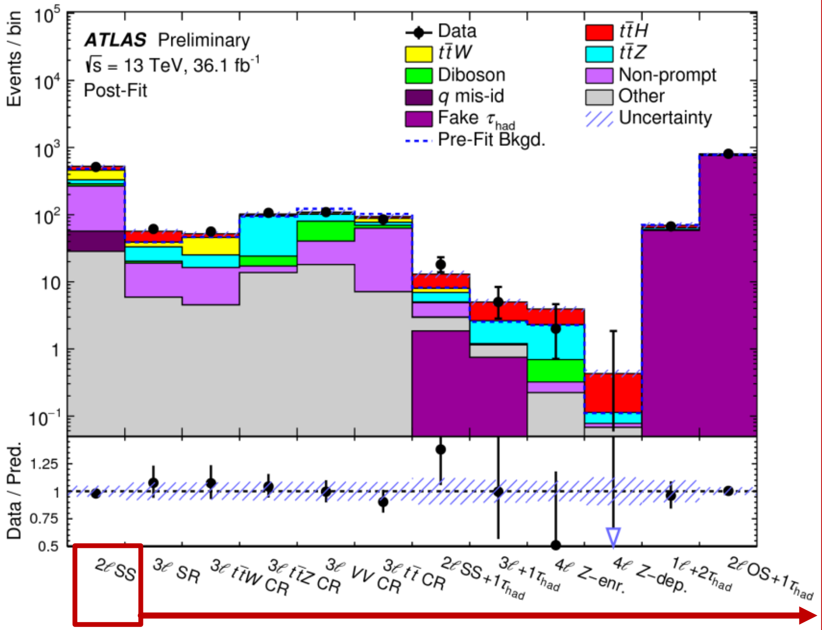


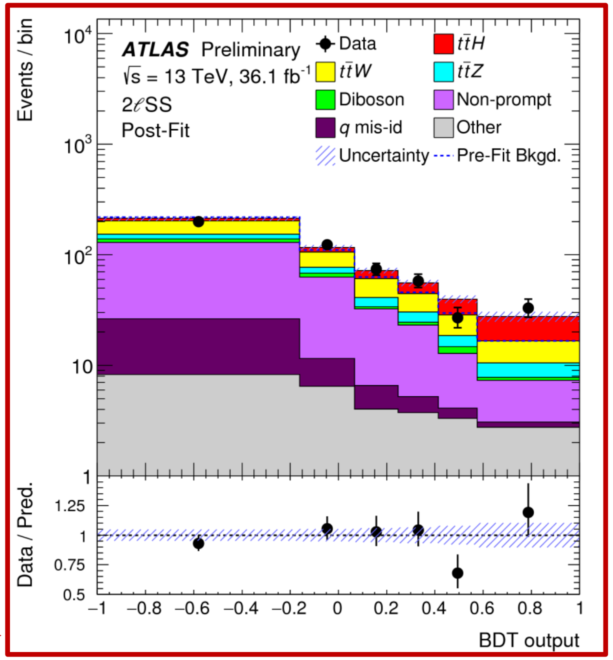
$t\bar{t}H: t\bar{t} \rightarrow 1-2\ell/\tau_{had},\ \ H \rightarrow WW, \tau\tau,\ ZZ$

- BDT shape is discriminant in 5 SRs, single bin event count in 2 SRs with lower stats

- Main uncertainties: Signal modelling (dominated by scale uncertainties), Jet energy scale and resolution, Non-prompt lepton estimation (large contribution from limited CR statistics)

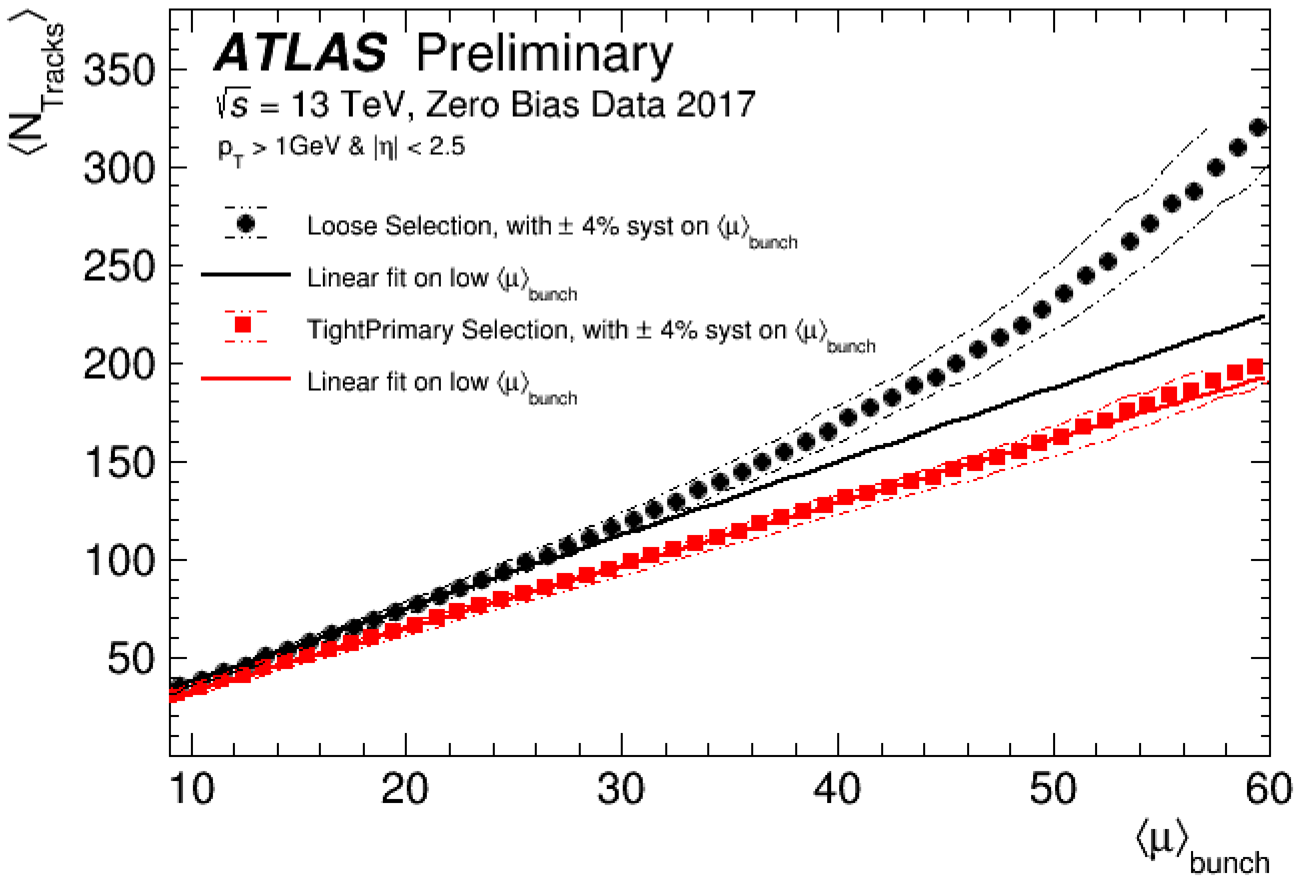




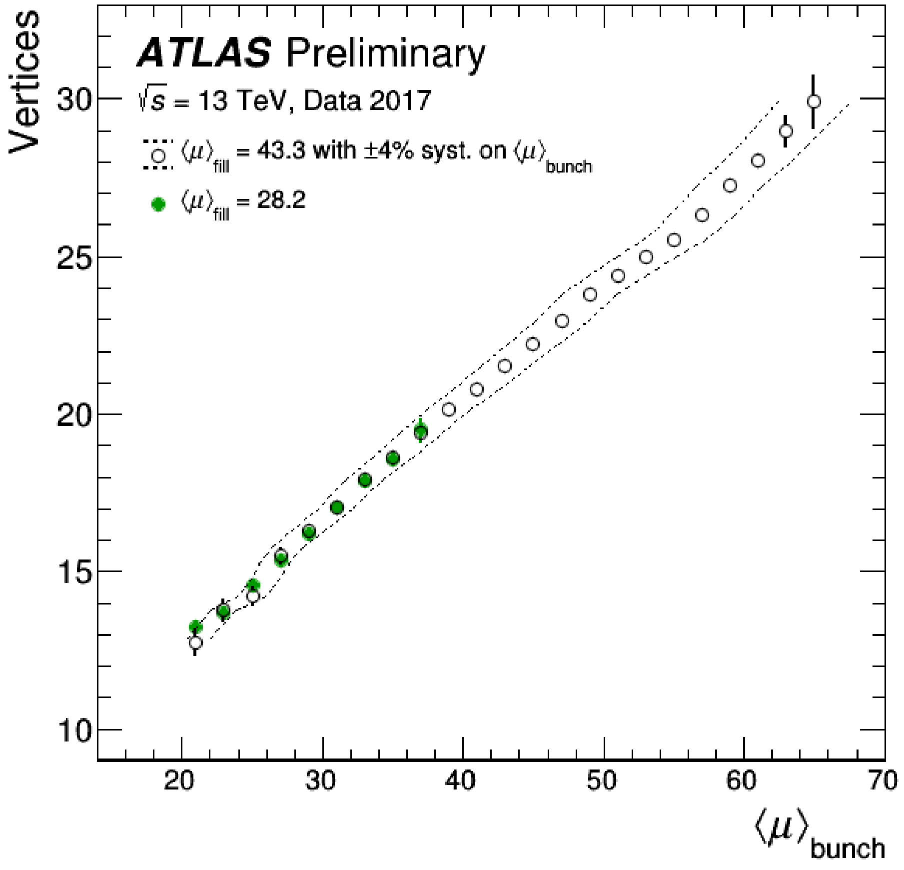


Performance

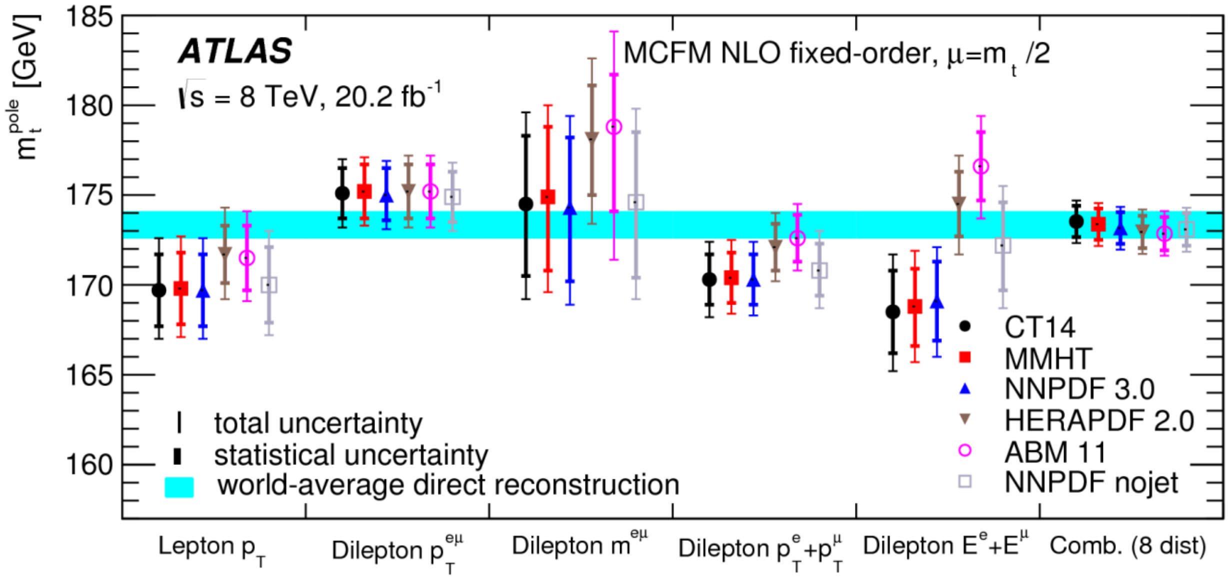
Tracks

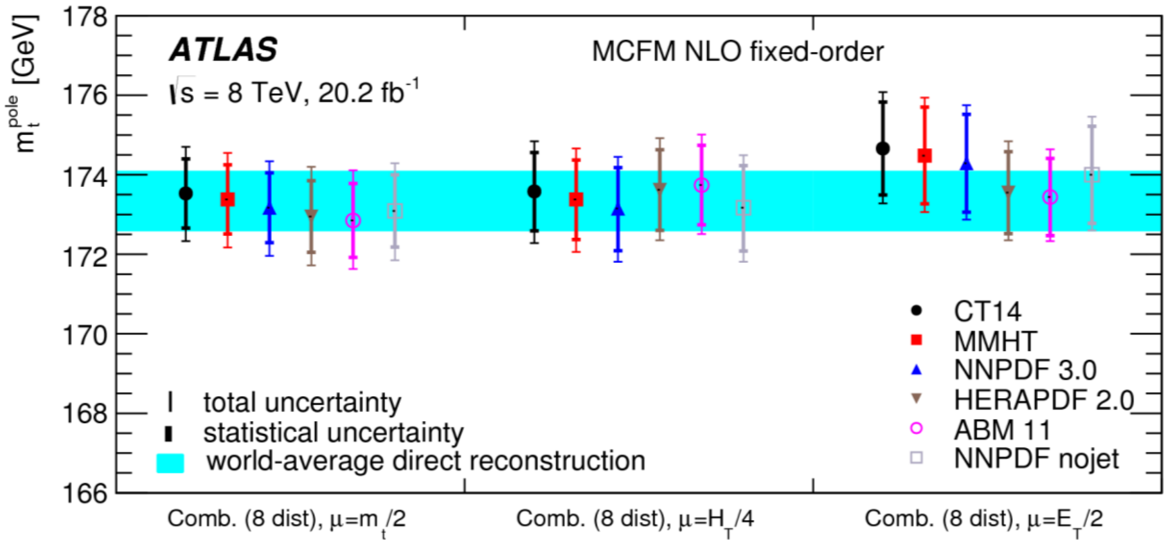


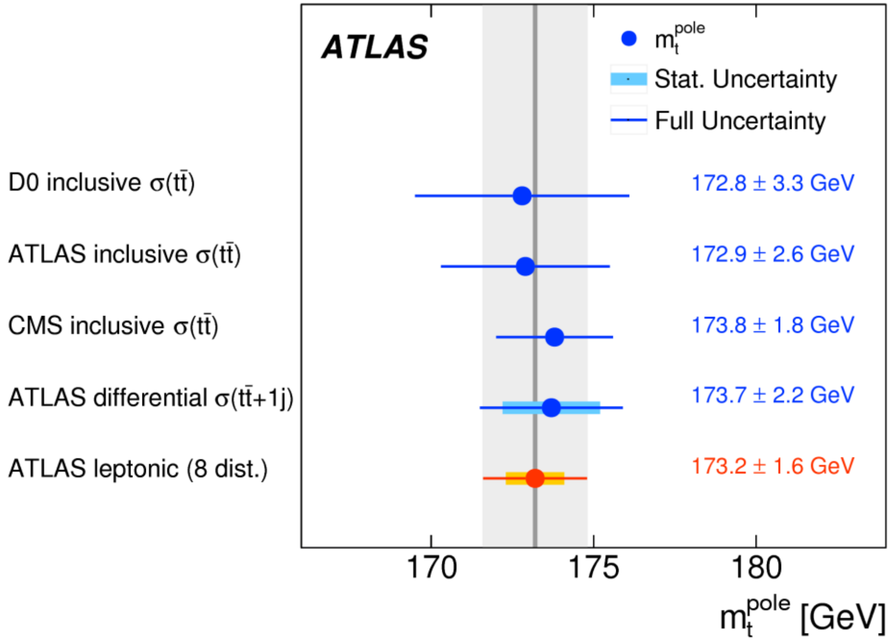
Vertices



Top Mass from differential cross section

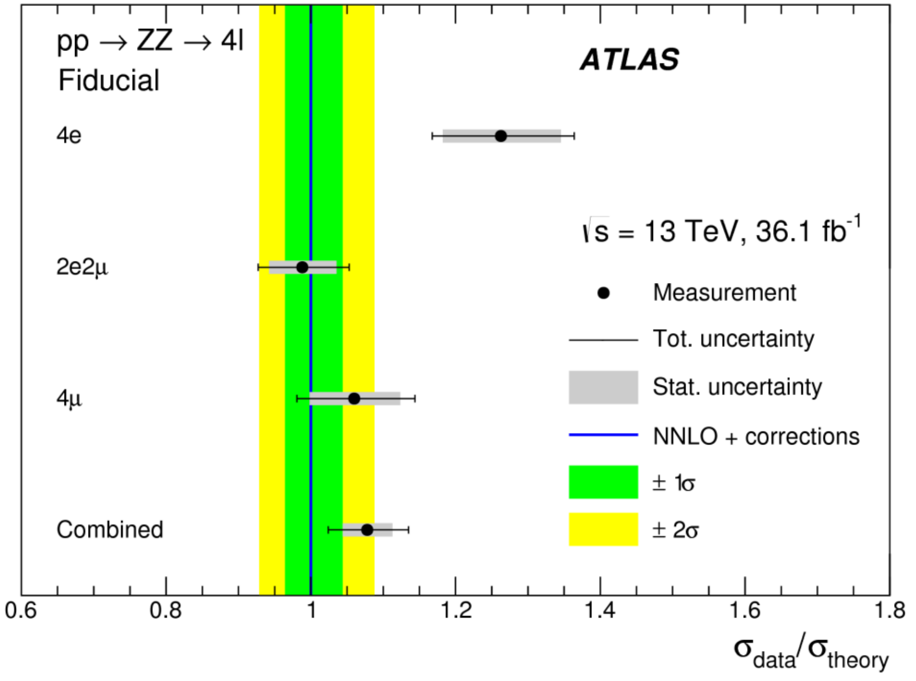


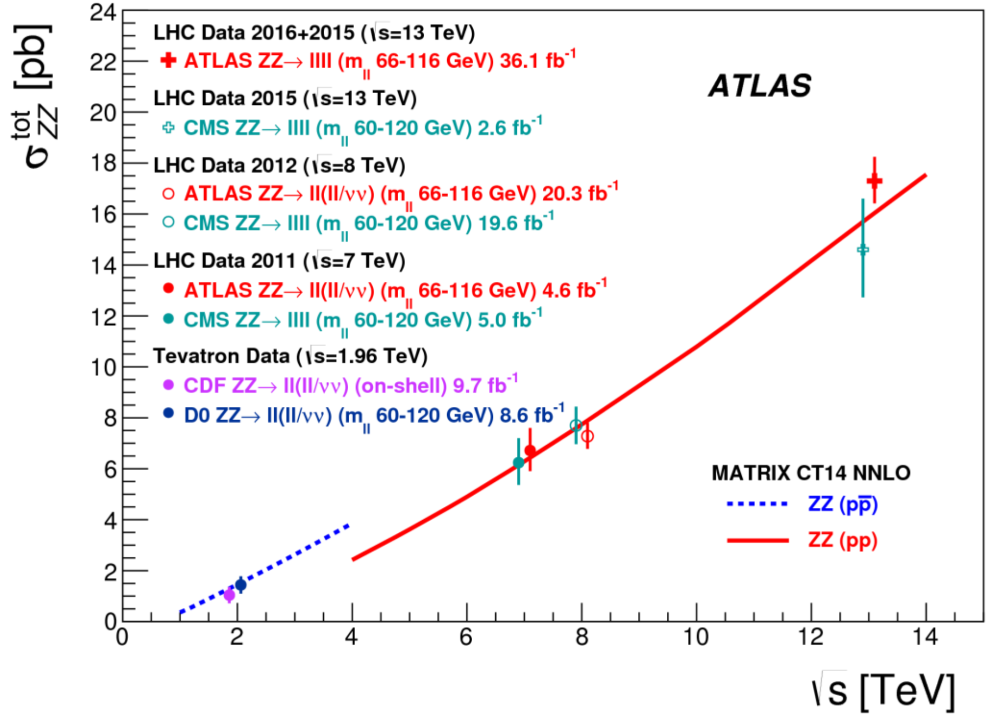




$ZZ \to 4\ell$ Cross Section & TGC Search

Inclusive cross section





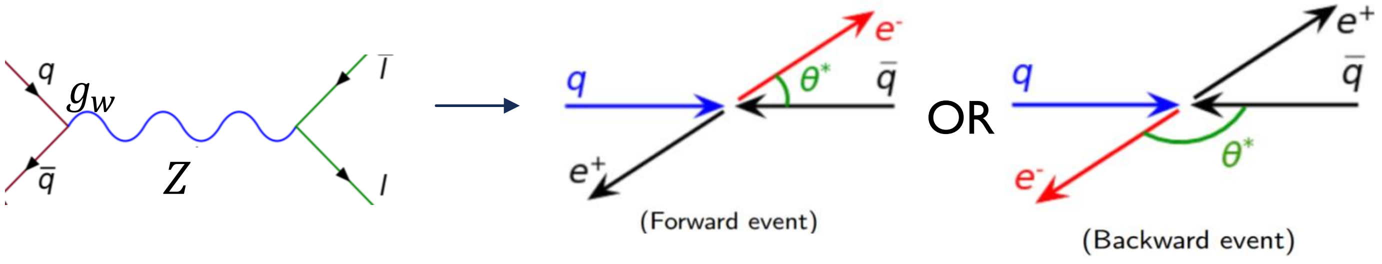
Triple Differential Drell – Yan Cross Section

- Inclusive and triple differential cross sections measured in $Z/\gamma^* \rightarrow \ell\ell$ and agree well with predictions

$$d^3\sigma = \frac{d^3\sigma}{dm_{\ell\ell}d|y_{\ell\ell}|dcos\theta^*}$$

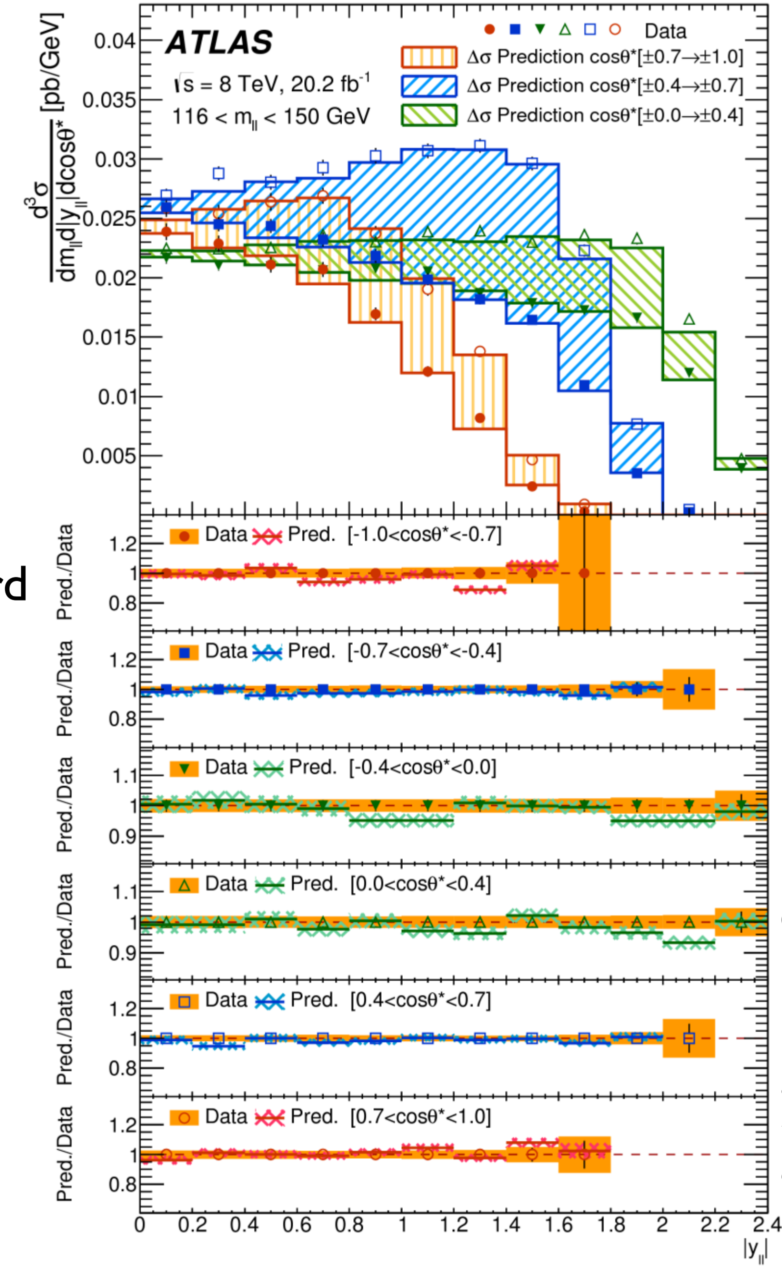
Sensitive to Z/γ interference PDF A_{FB}

- Parity violation in weak coupling (g_w) leads to different numbers of forward and backward events. This asymmetry (A_{FB}) can be used to get $\sin^2\theta_W^{eff}$



- $d^3\sigma$ allow for simultaneous measurement of A_{FB}($\sin^2\theta_W^{eff}$) and PDF ! Can reduce the large PDF uncertainty on the last extracted value of $\sin^2\theta_W^{eff}$

$\sin^2\theta_W^{eff}$ ≡ effective weak mixing angle in leptonic Z boson



CERN-EP-2017-152

Triple Differential Drell – Yan Cross Section

The triple-differential cross section is calculated as

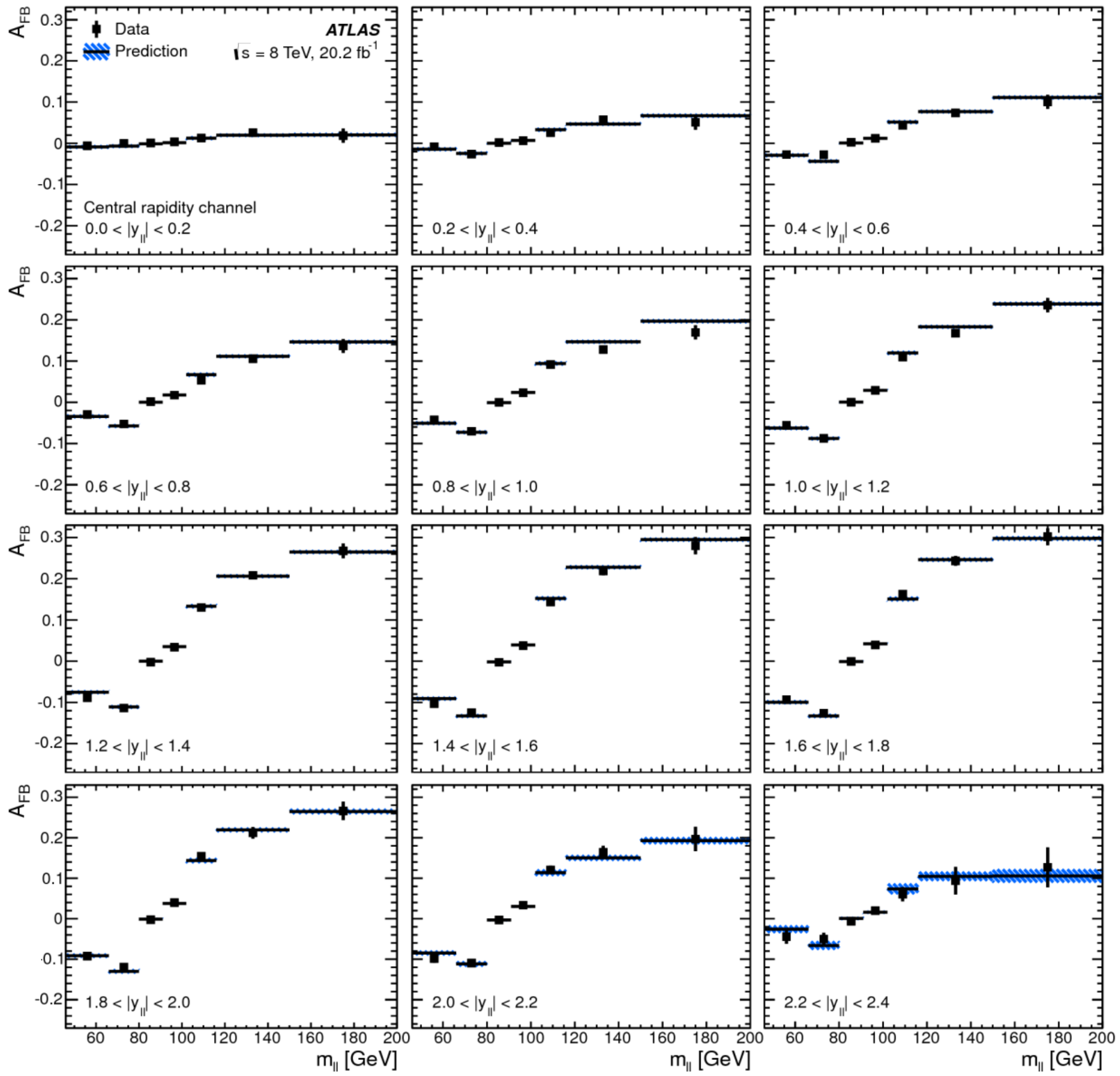
$$\left.\frac{\mathrm{d}^3\sigma}{\mathrm{d}m_{\ell\ell}\,\mathrm{d}|y_{\ell\ell}|\,\mathrm{d}\cos\theta^*}\right|_{l,m,n} = \mathcal{M}_{ijk}^{lmn} \cdot \frac{N_{ijk}^{\mathrm{data}} - N_{ijk}^{\mathrm{bkg}}}{\mathcal{L}_{\mathrm{int}}} \frac{1}{\Delta_{m_{\ell\ell}} \cdot 2\Delta_{|y_{\ell\ell}|} \cdot \Delta_{\cos\theta^*}}\,, \tag{4}$$

where i, j, k are the bin indices for reconstructed final-state kinematics; l, m, n are the bin indices for the generator-level kinematics; and $\mathcal{L}_{\mathrm{int}}$ is the integrated luminosity of the data set. Quantity N^{data} is the number of candidate signal events observed in a given bin of width $\Delta_{m_{\ell\ell}}$, $\Delta_{|y_{\ell\ell}|}$, and $\Delta_{\cos\theta^*}$, while N^{bkg} is the number of background events in the same bin. The factor of two in the denominator accounts for the modulus in the rapidity bin width. Integrated single- and double-differential cross sections are measured by summing over the corresponding indices of equation (4).

$$\cos\theta^* = \frac{p_{\mathrm{z},\ell\ell}}{m_{\ell\ell}|p_{\mathrm{z},\ell\ell}|} \frac{p_1^+ p_2^- - p_1^- p_2^+}{\sqrt{m_{\ell\ell}^2 + p_{\mathrm{T},\ell\ell}^2}}\,,$$

Triple Differential Drell – Yan Cross Section

$$A_{FB} = \frac{d^3\sigma(\cos\theta^* > 0) - d^3\sigma(\cos\theta^* < 0)}{d^3\sigma(\cos\theta^* > 0) + d^3\sigma(\cos\theta^* < 0)}.$$



From 7 TeV

$$\sin^2\theta^{eff}_{lept} = 0.2308 \pm 0.0005(\mathrm{stat}) \pm 0.0006(\mathrm{syst}) \pm 0.0009(\mathrm{PDF})$$

Combined Top Mass Uncertainties

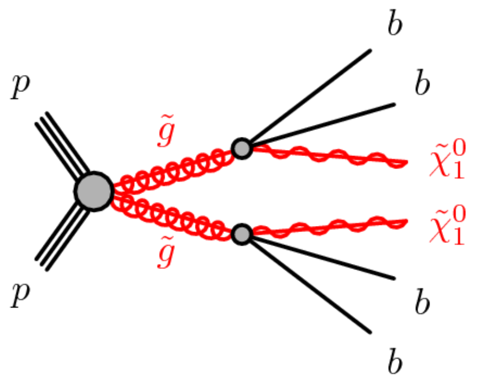
	Consistency evaluation				Measurement
	m_{top}^{7TeV} [GeV]	m_{top}^{8TeV} [GeV]	m_{top}^{l+jets} [GeV]	m_{top}^{dil} [GeV]	m_{top} [GeV]
Results	172.99	172.56	172.11	173.02	172.51
Statistics	0.48	0.28	0.36	0.39	0.27
Method	0.07	0.07	0.09	0.05	0.06
Signal Monte Carlo generator	0.24	0.12	0.17	0.10	0.14
Hadronisation	0.34	0.05	0.06	0.22	0.07
Initial- and final-state QCD radiation	0.04	0.16	0.07	0.26	0.07
Underlying event	0.06	0.09	0.01	0.11	0.05
Colour reconnection	0.01	0.07	0.17	0.03	0.08
Parton distribution function	0.17	0.04	0.13	0.05	0.07
Background normalisation	0.07	0.04	0.04	0.03	0.03
W/Z+jets shape	0.16	0.05	0.12	0.01	0.07
Fake leptons shape	0.03	0.04	0.02	0.07	0.03
Jet energy scale	0.41	0.26	0.33	0.52	0.21
Relative b-to-light-jet energy scale	0.34	0.17	0.01	0.32	0.15
Jet energy resolution	0.03	0.11	0.16	0.09	0.10
Jet reconstruction efficiency	0.10	0.02	0.05	0.01	0.03
Jet vertex fraction	0.00	0.06	0.07	0.02	0.05
b-tagging	0.25	0.18	0.31	0.04	0.17
Leptons	0.05	0.11	0.11	0.14	0.09
E_T^{miss}	0.08	0.03	0.07	0.01	0.04
Pile-up	0.01	0.08	0.10	0.05	0.06
Total systematic uncertainty	0.77	0.48	0.61	0.74	0.42
Total	0.91	0.56	0.71	0.84	0.50

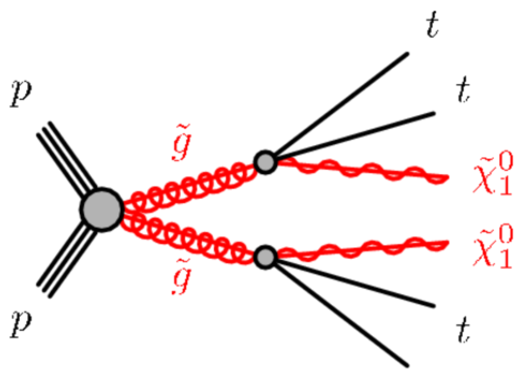
ZZ → 4ℓ Uncertainties

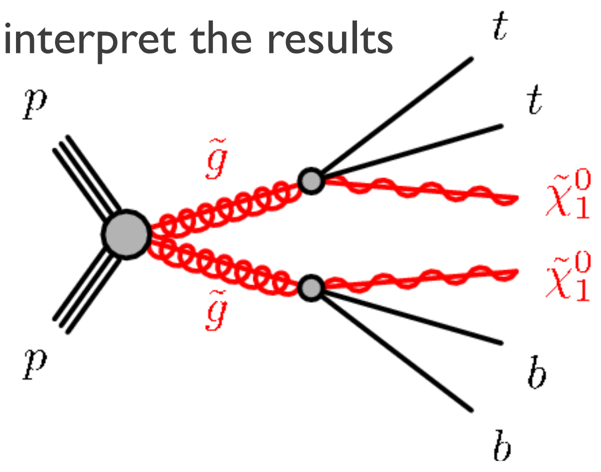
Source	Effect on total predicted yield [%]
MC statistical uncertainty	0.4
Electron efficiency	0.9
Electron energy scale & resolution	< 0.1
Muon efficiency	1.7
Muon momentum scale & resolution	< 0.1
Pileup modeling	1.2
Luminosity	3.2
QCD scales	$^{+5.2}_{-4.7}$
PDFs	$^{+2.7}_{-1.7}$
Background prediction	0.9
Total	$^{+7.4}_{-6.6}$

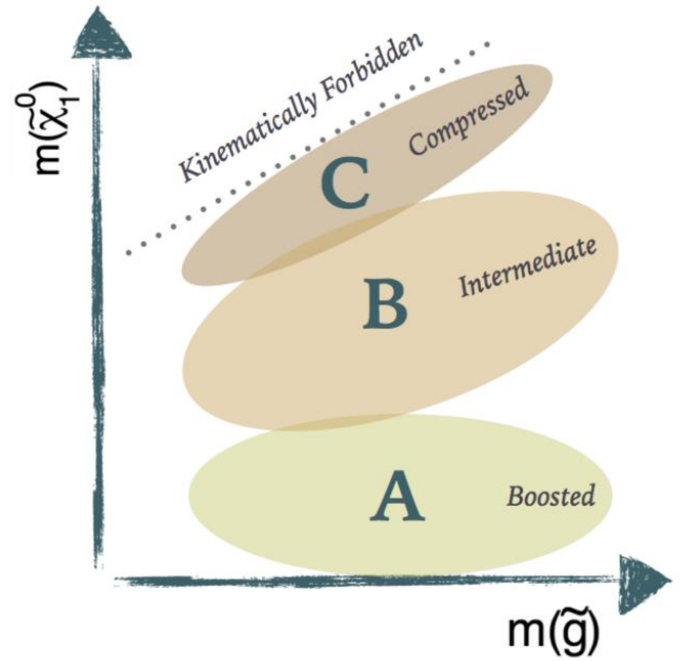
SUSY search with MET and b – *jets*

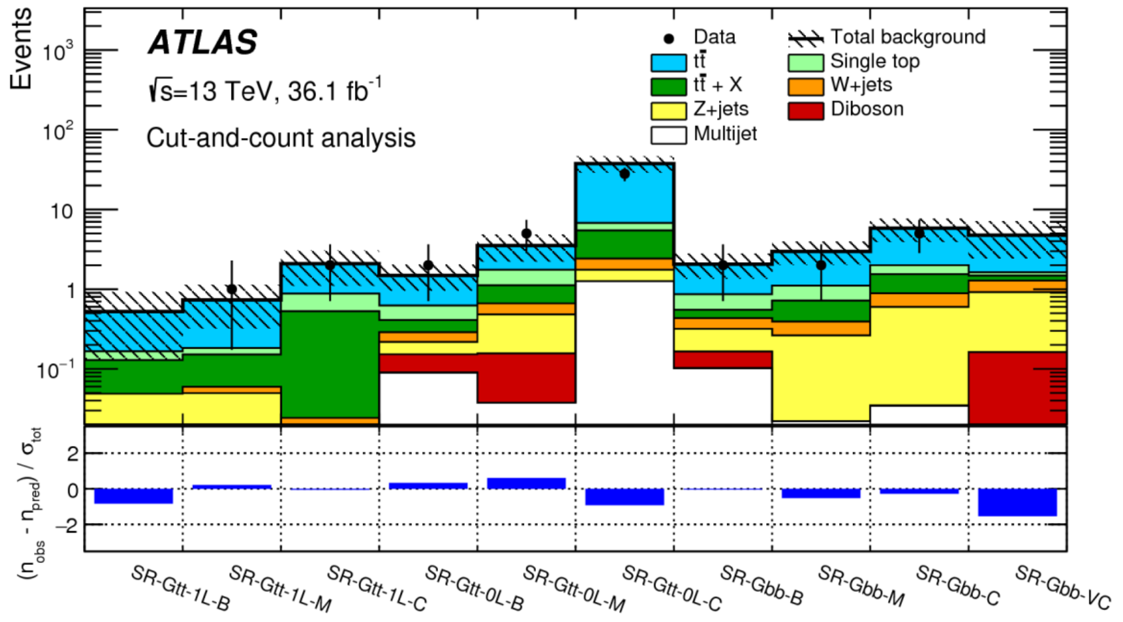
- Two simplified models are used to optimise the event selection and to interpret the results





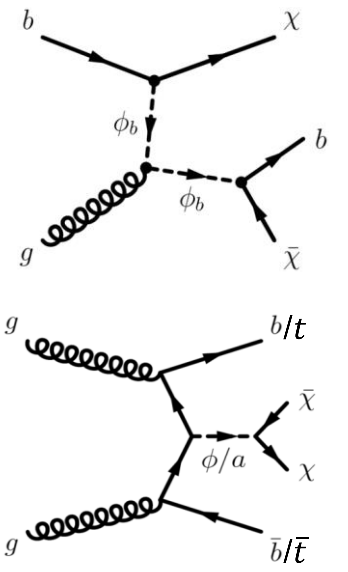


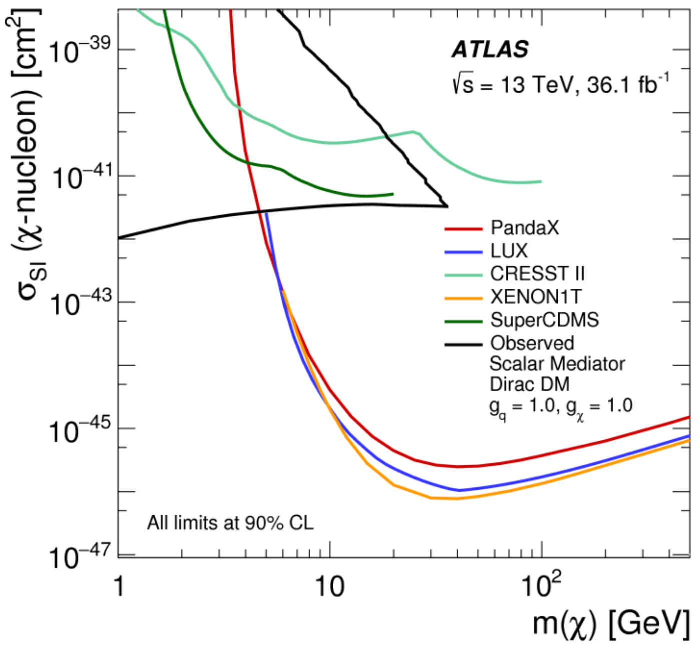


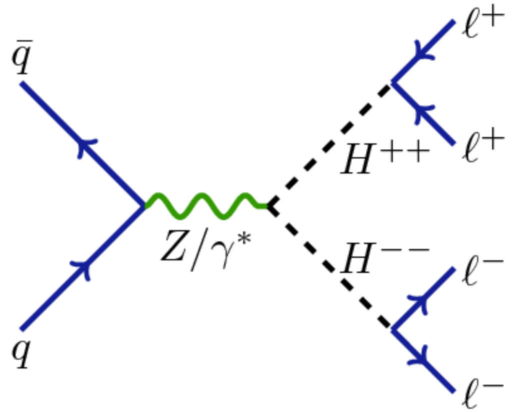


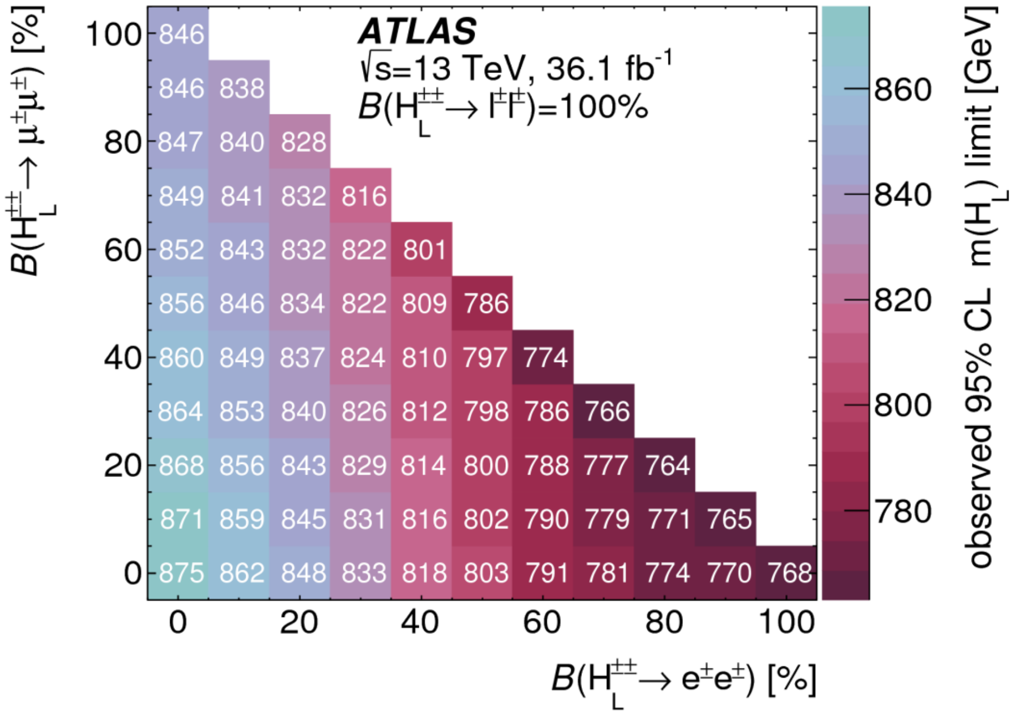
Dark Matter and Doubly Charged Higgs

Search for fermonic DM through production of: colour-neutral scalar/pseudoscaler mediator AND colourcharged scalar mediator (bottom flavour DM proposed to explain excess of gamma rays from galactic centers)



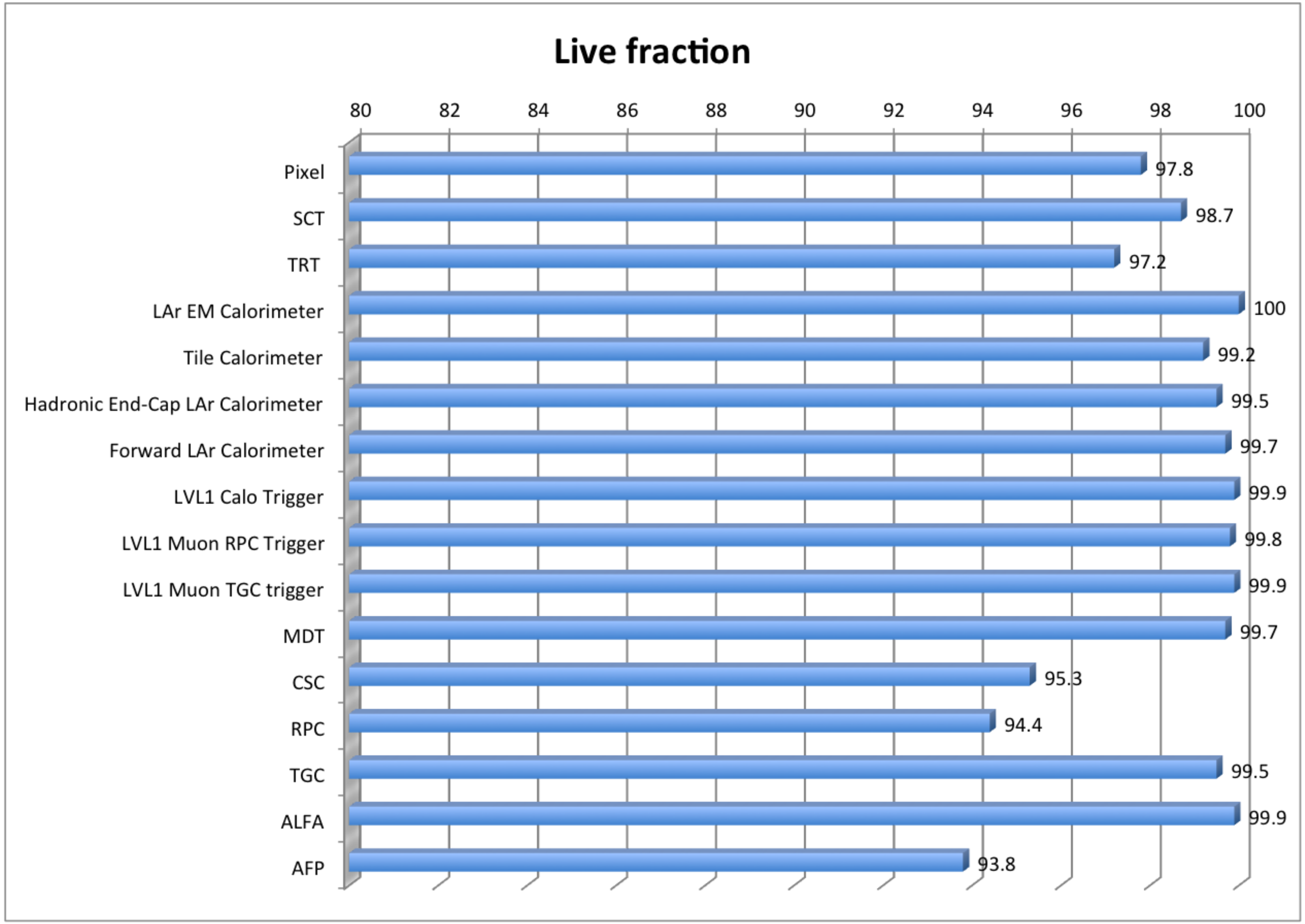






Subdetector Summary

- All subdetectors have high live fraction
- Stable magnet operation (3 toroid and 2 solenoid cycles compared to 9 in 2016)
- Very few infrastructure problems and addressed quickly



Subdetector Summary

Pixel

- Many firmware & software updates to deal whith higher μ
- Deadtime reduced (1.2% → 0.1-0.2%), DQ efficiency increased (98.9% →100%)

SCT

- Very smooth operations with negligible dead time. Limit is μ=70@100kHz, imposed by the Slink bandwidth limit. Dynamic FE chip masking ensures optimum hit efficiency beyond μ =70

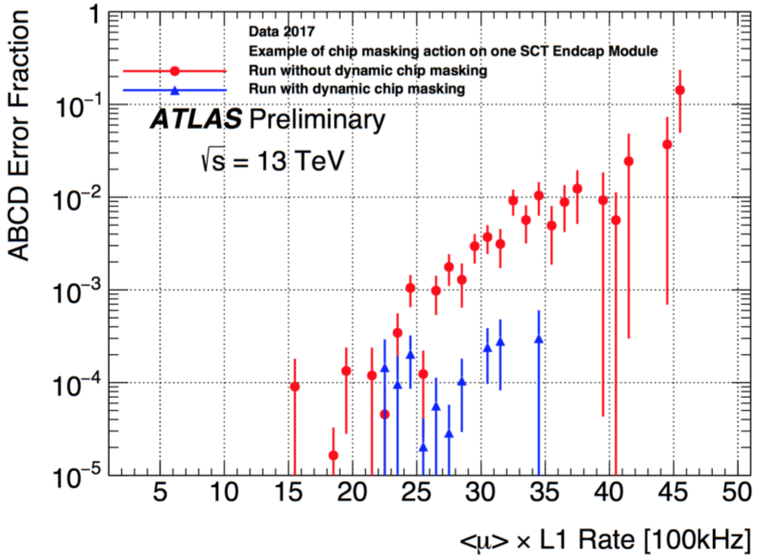
TRT

- Able to sustain rates up to μ = 77 thanks to replacement of HOLAs which increased Slink readout speed. Dead time < 0.1%
- Gas leakes slowly increasing, as expected but stable configuration in Run 2
- More aggressive readout compression is on the way to run at μ =80

DQ Efficiency June - Oct

Inner Tracker		
Pixel	SCT	TRT
100	99.9	99.6

(only 0.1% chips masked at μ=60)



Subdetector Summary

LAr

- 8b4e scheme is not optimal due to degraded out-of-time vs in-time pile-up cancellation - baseline correction in place, performs very well
- Many special runs taken allowing LAr to study the space-charge effects and signal degradation expected at high luminosities

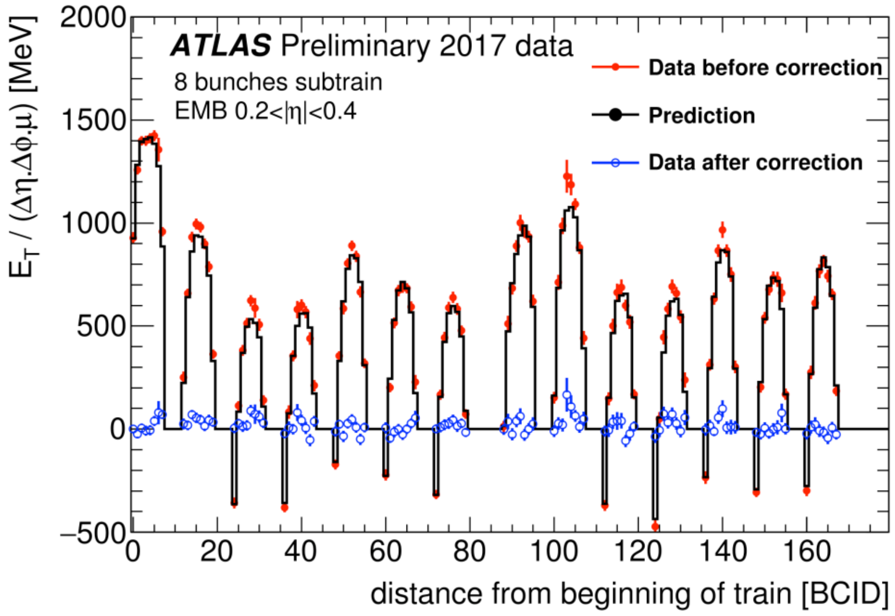
Tile

- Only 3 problematic modules
- No busy at high pile-up/rate thanks to doubling of ROD processing units and HOLAs
- Tile-Muon trigger being commissioned (for reduction of fake muon triggers in transition region)

Muons

- RPC had 48V PS failure – 25% of RPC off (Oct 29, Nov3)
- RPC leak increasing slowly as expected- mitigation measures taken on the gas system. Leak repair campaign during YETS

LAr Barrel: correction for baseline flucutation



DQ Efficiency June - Oct

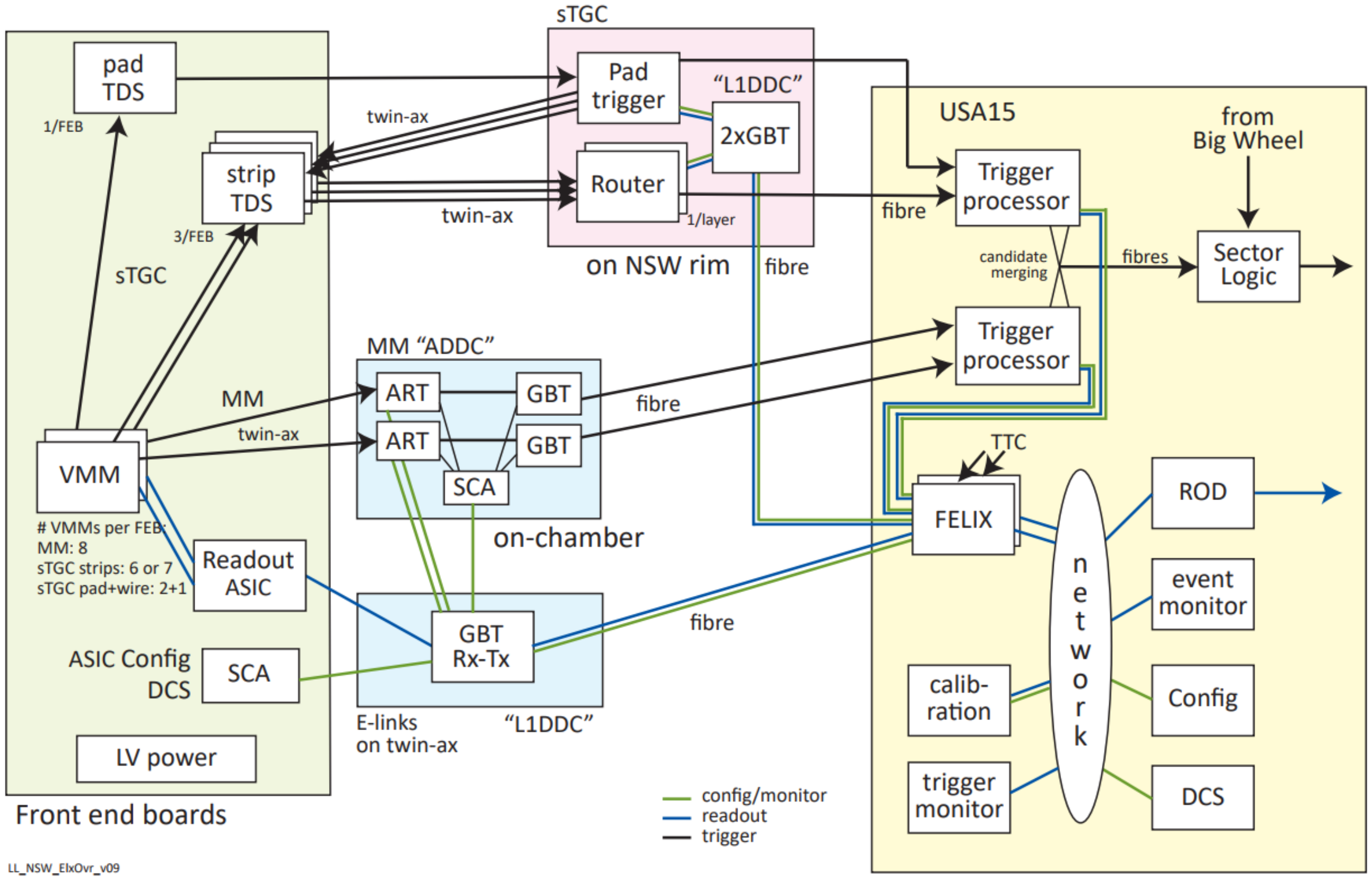
Calorimeters		Muon Spectrometer			
LAr	Tile	MDT	RPC	CSC	TGC
99.2	99.9	99.9	98.0	99.8	100

YETS Activities

- Access granted to all systems:
  - Maintenance of all infrastructure (CV, Electricity, Detector Cooling) + standard maintenance of all systems
  - No major installation this year
    - Refurbishment of the Lar Hadronic End-Cap power supplies
    - Tile repairs on the few non working modules
    - RPC leak repairs

New Small Wheel Electronics

NSW Electronics Trigger & DAQ dataflow



Legend of acronyms

VMM: NSW front end ASIC

ART: MM trigger data serializer

TDS: sTGC trigger data serializer

ROC: NSW readout controller

L1DDC: Front end to GBT readout fiber aggregator

ADDC: MM trigger data from Front end to fiber driver

Router: sTGC trigger data from Front end to fiber router

TDAQ Phase 1

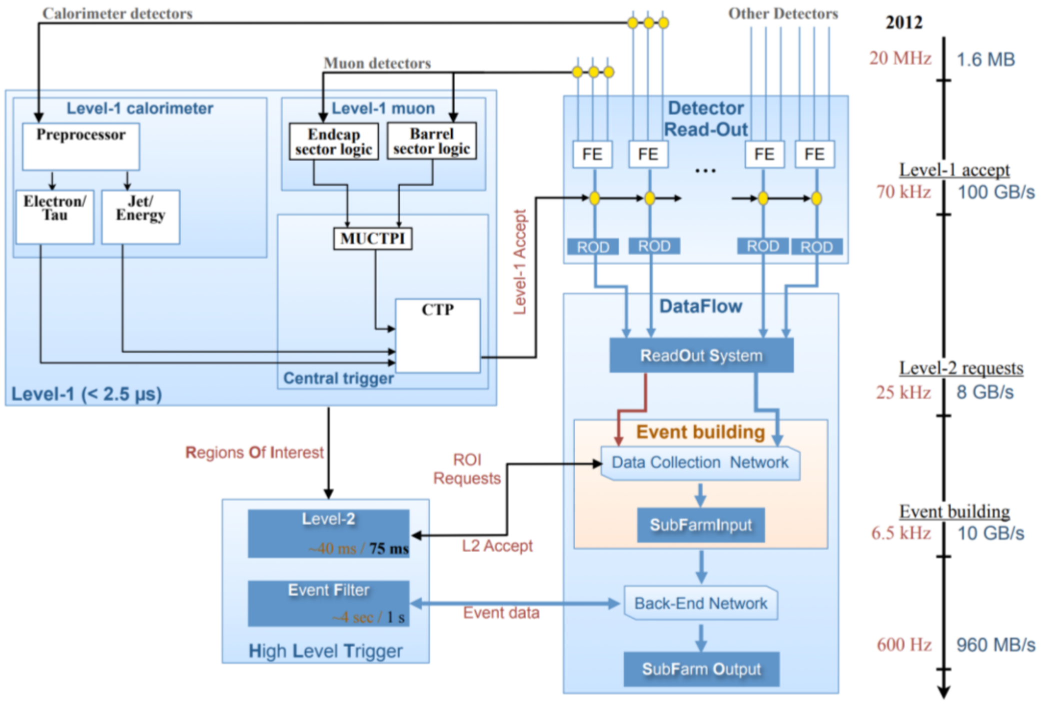


Figure 1: Schematic overview of the Trigger and DAQ system in 2012 (Run 1)

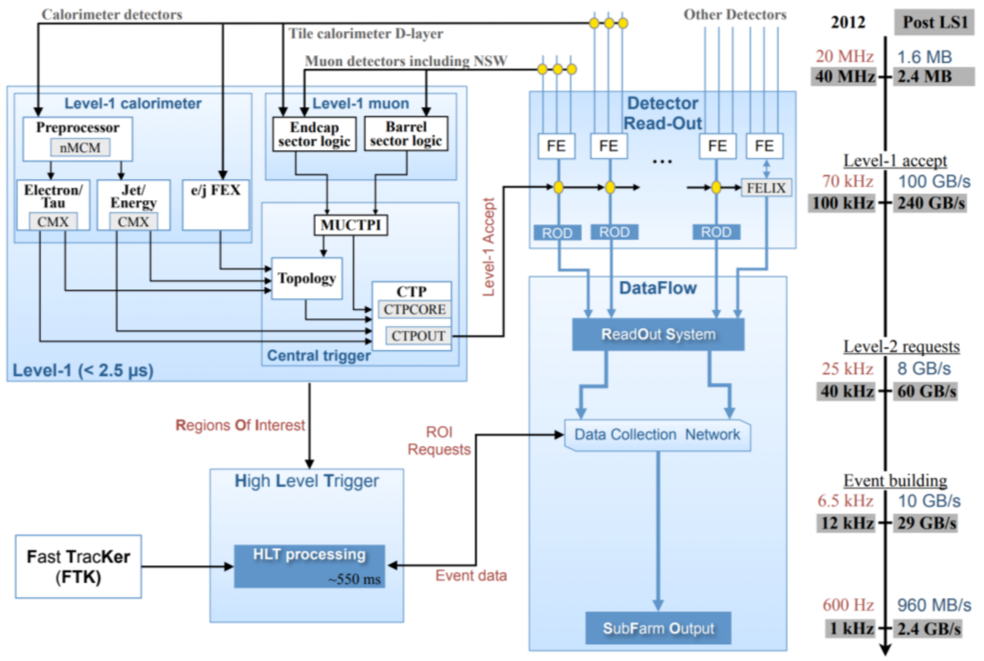


Figure 2: Schematic overview of the Trigger and DAQ system after the Phase-I upgrade

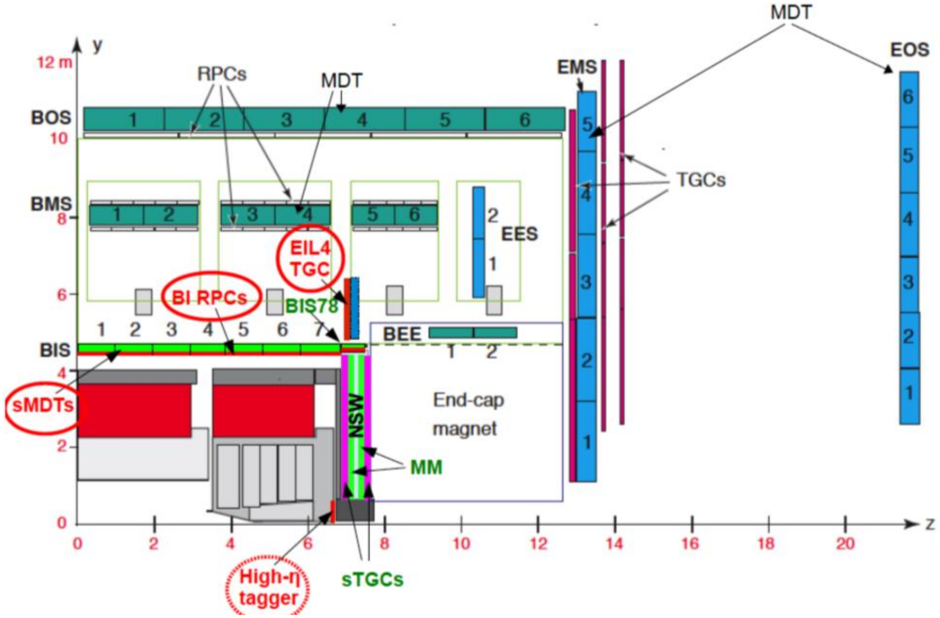
Inner TracKer (ITK) & Muon Upgrade

ITK - Strip TDR approved, Pixel submission Dec 15

- Motivation: need to maintain performance in difficult tracking environment
- Install new pixel and strip inner tracker that covers $\eta < 4$
- Strip: Market Survey still in progress. Approaching final design of FE ASICs
- Pixel: RD53A FE chip submitted, no results before Dec 15
- Progress in understanding: surface integration, commissioning, testing and installation in the pit

Muon – under review by LHCC and UCG

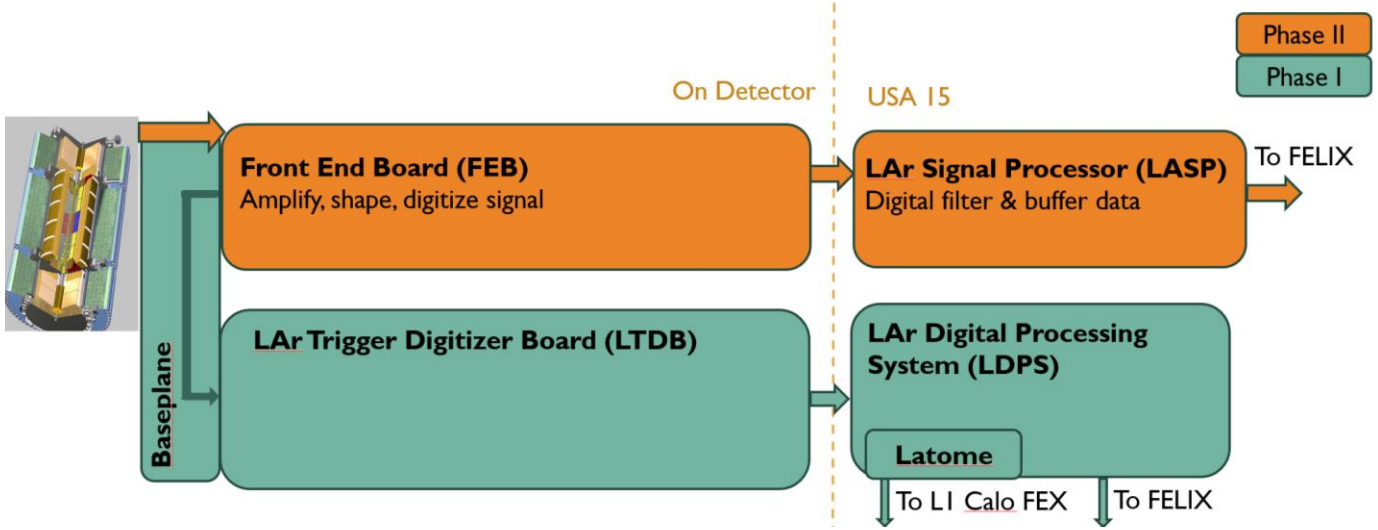
- Motivation: reduce trigger fake rate in barrel & endcap regions, increase trigger performance/geometrical coverage
- On-detector readout electronics upgrade (MDT, RPC, TGC)
- New Layer of trigger chambers in barrel (BI RPC +sMDT), upgrade chambers in transition region, include precision chambers in L0 trigger



LAr & TileCal Electronics

Motivation: need for better radiation tolerance, precision, finer trigger granularity and new L0 rate and latency requirements

Front & backend electronics will be replaced

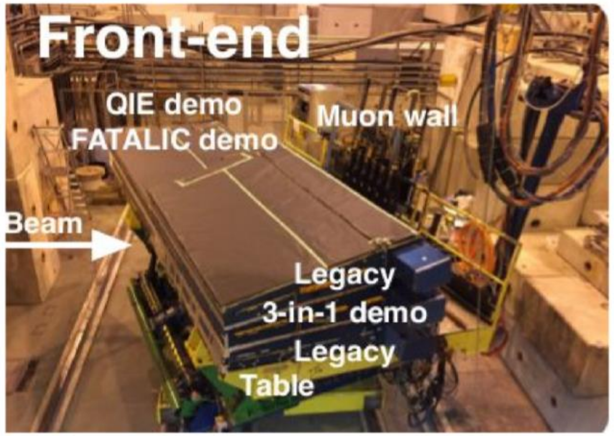


LAr electronics – TDR submitted end of Sept

- Progressing well in all areas: FEB pre-amplifier, shaper and ADC development ongoing. ASIC development, LASP prototype being developed

TileCal – TDR submitted Oct 1

- Upgrade activities are progressing very well in testing reliability/stability of prototypes
- Demonstrator project aims to validate the new T/DAQ architecture with testbeam before ATLAS installation



Drawer modules

Back-end electronics

LHCC review this week Monday

TDAQ – submit TDR to LHCC Dec 15

- Motivation: keep rates and thresholds low despite high pileup
- Many advances in design details of the Trigger, DAQ and EF systems
- Already testing promising technologies for online software