ATLAS Status Report

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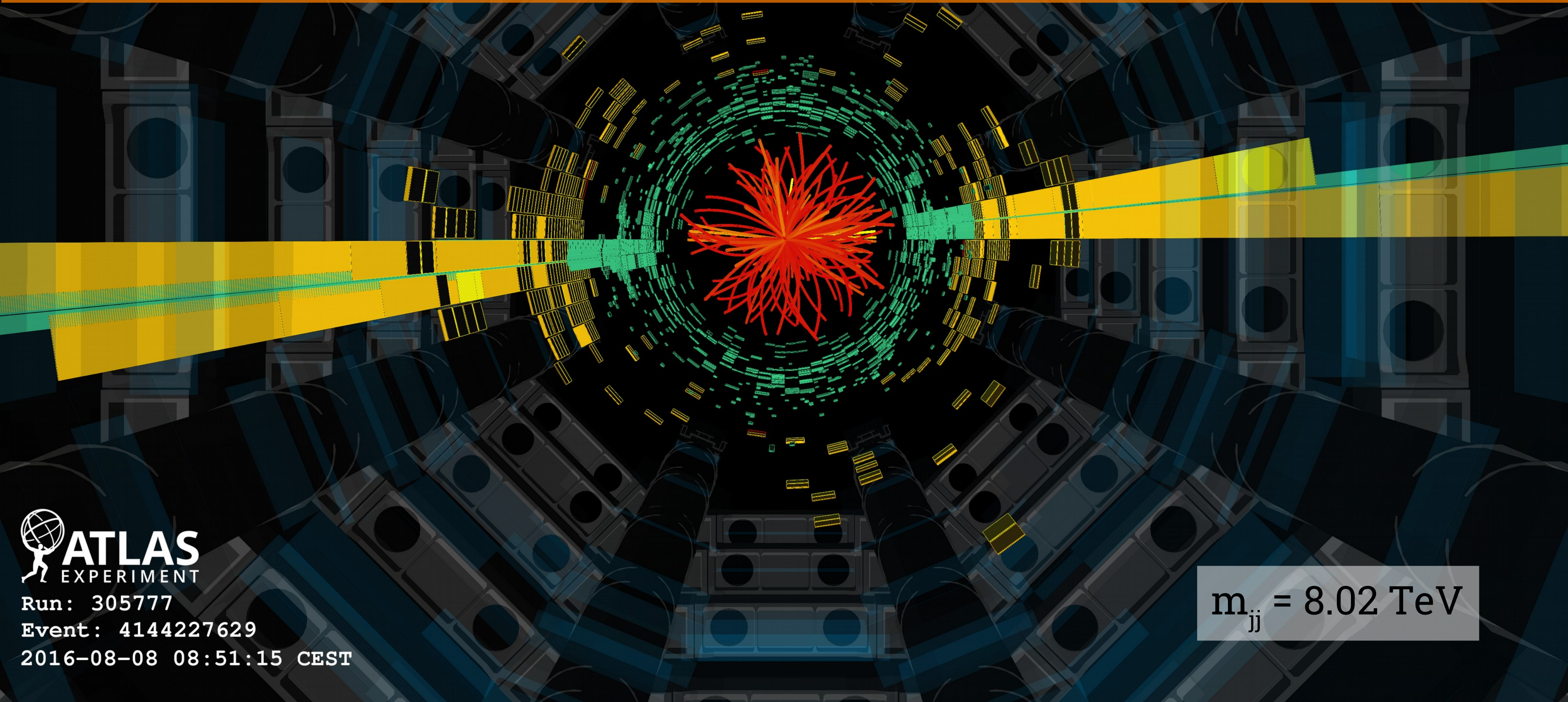
5 June 2019

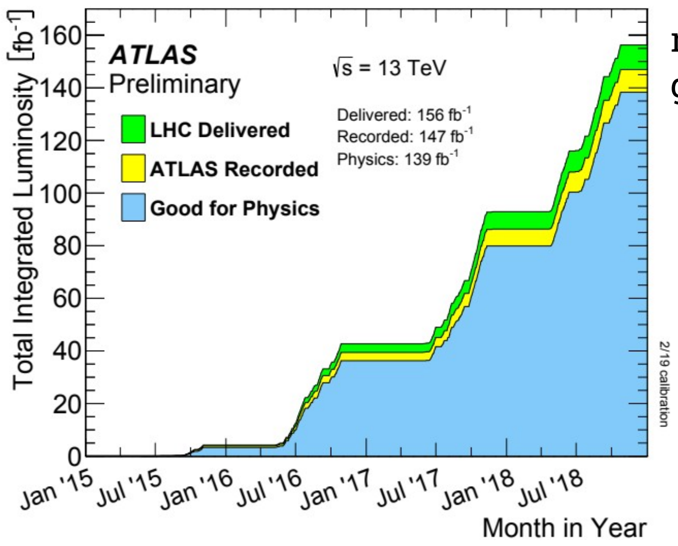
TEXAS
The University of Texas at Austin

ATLAS EXPERIMENT

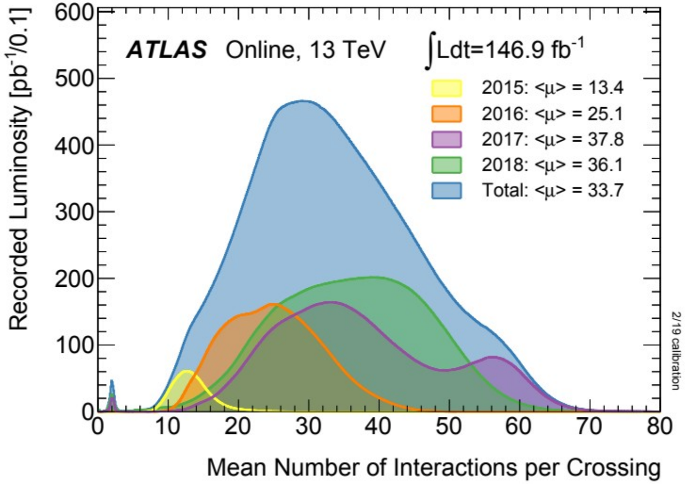
Recent Physics Results



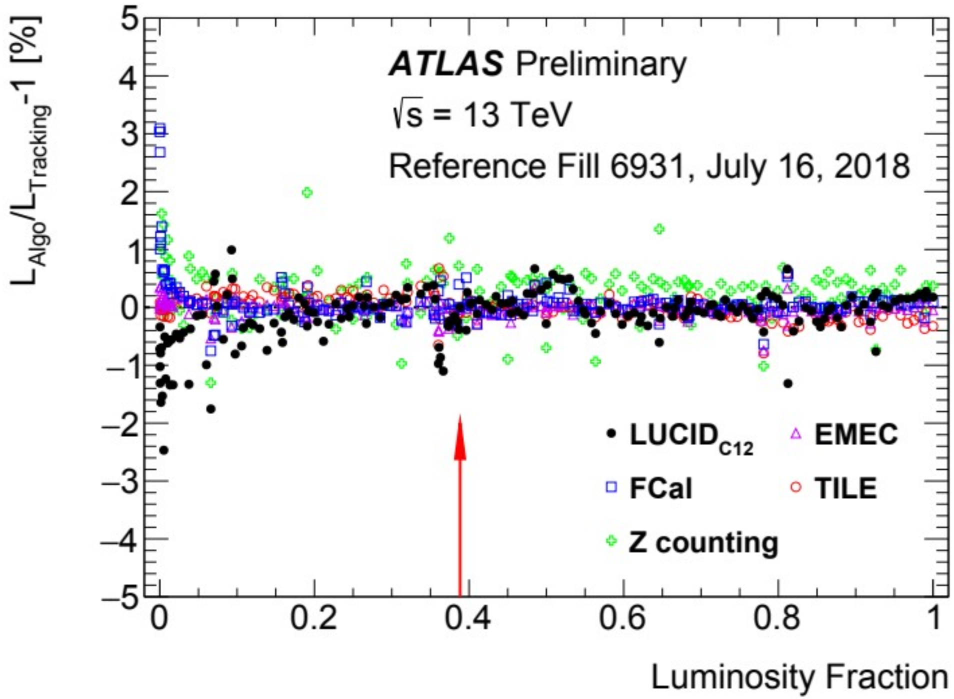
13 TeV Dataset & Luminosity



recording eff ~ 94%
good for physics ~ 95%



comparative stability of different lumi measurements in 2018



2018 prelim lumi uncertainty 2.0%
(of which stability 0.8%)

Full Run 2 prelim uncertainty 1.7%

ATLAS-CONF-2019-021

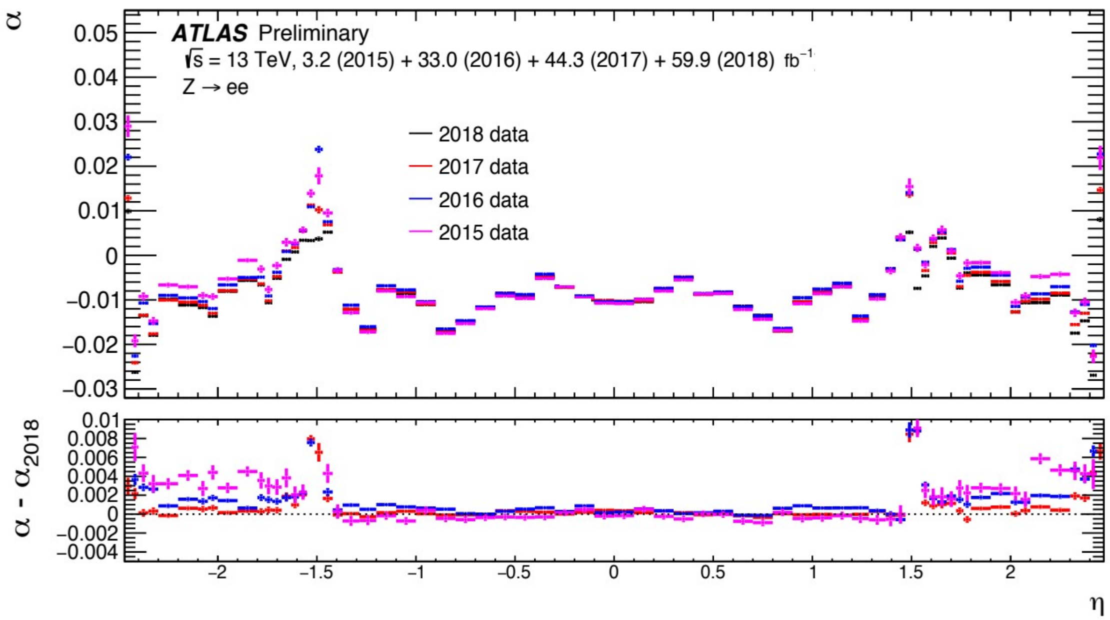
LHC Lumi Days

Performance

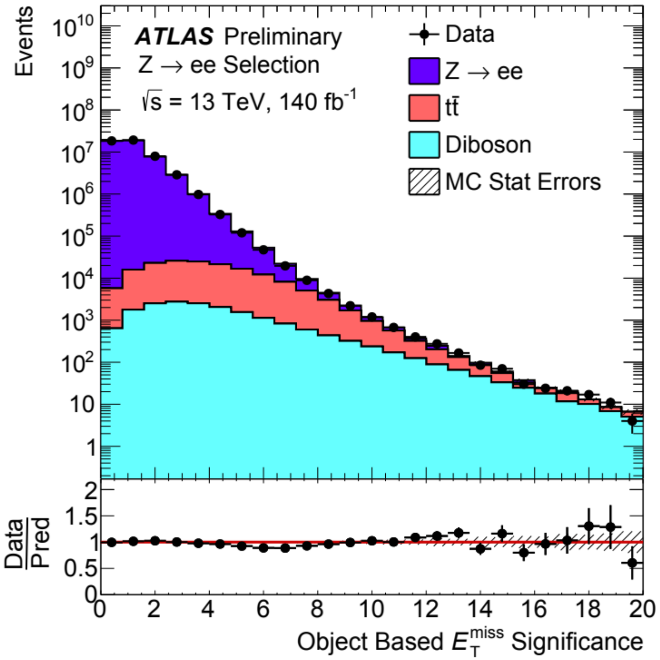
- Studies on object reconstruction, lumi performance to support initial search results using full 139 fb^{-1}
- Work ongoing to provide the best possible uncertainties for precision measurements

$E_{data} = (1+\alpha)E_{MC}$

electron energy scale correction



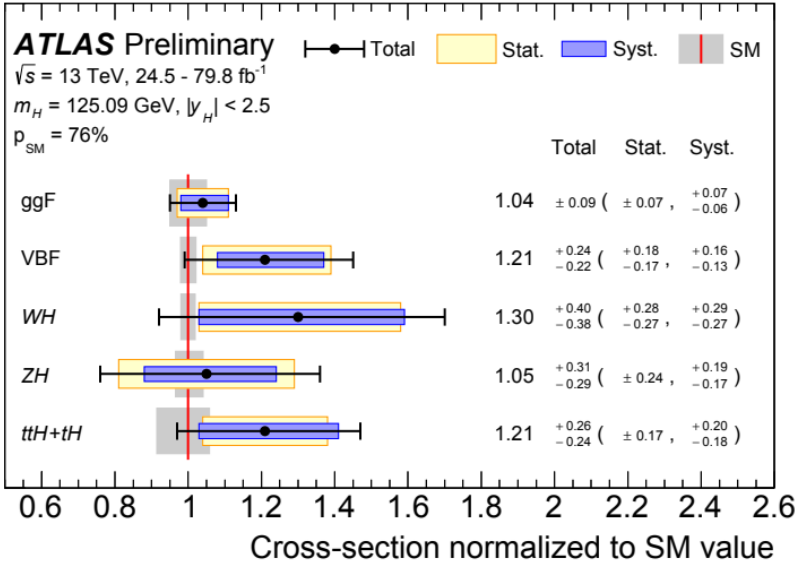
Missing transverse energy significance



Higgs Coupling Combination

- Combine Run 2 results (up to 80 fb^{-1}) for a global picture of Higgs interactions
- Move beyond simple coupling modifiers in a full combination
  - "Simplified Template Cross Sections" provide constraints on Higgs production as a function of associated objects & kinematic regime – e.g. high p_T where new physics effects might become important
  - sensitivity to more subtle BSM effects, improve model-independence

Analysis	Integrated luminosity (fb^{-1})
$H \to \gamma\gamma$ (including $t\bar{t}H$, $H \to \gamma\gamma$)	79.8
$H \to ZZ^* \to 4\ell$ (including $t\bar{t}H$, $H \to ZZ^* \to 4\ell$)	79.8
$H \to WW^* \to e\nu\mu\nu$	36.1
$H \to \tau\tau$	36.1
VH, $H \to b\bar{b}$	79.8
VBF, $H \to b\bar{b}$	24.5 – 30.6
$H \to \mu\mu$	79.8
$t\bar{t}H$, $H \to b\bar{b}$ and $t\bar{t}H$ multilepton	36.1
$H \to$ invisible	36.1
Off-shell $H \to ZZ^* \to 4\ell$ and $H \to ZZ^* \to 2\ell 2\nu$	36.1

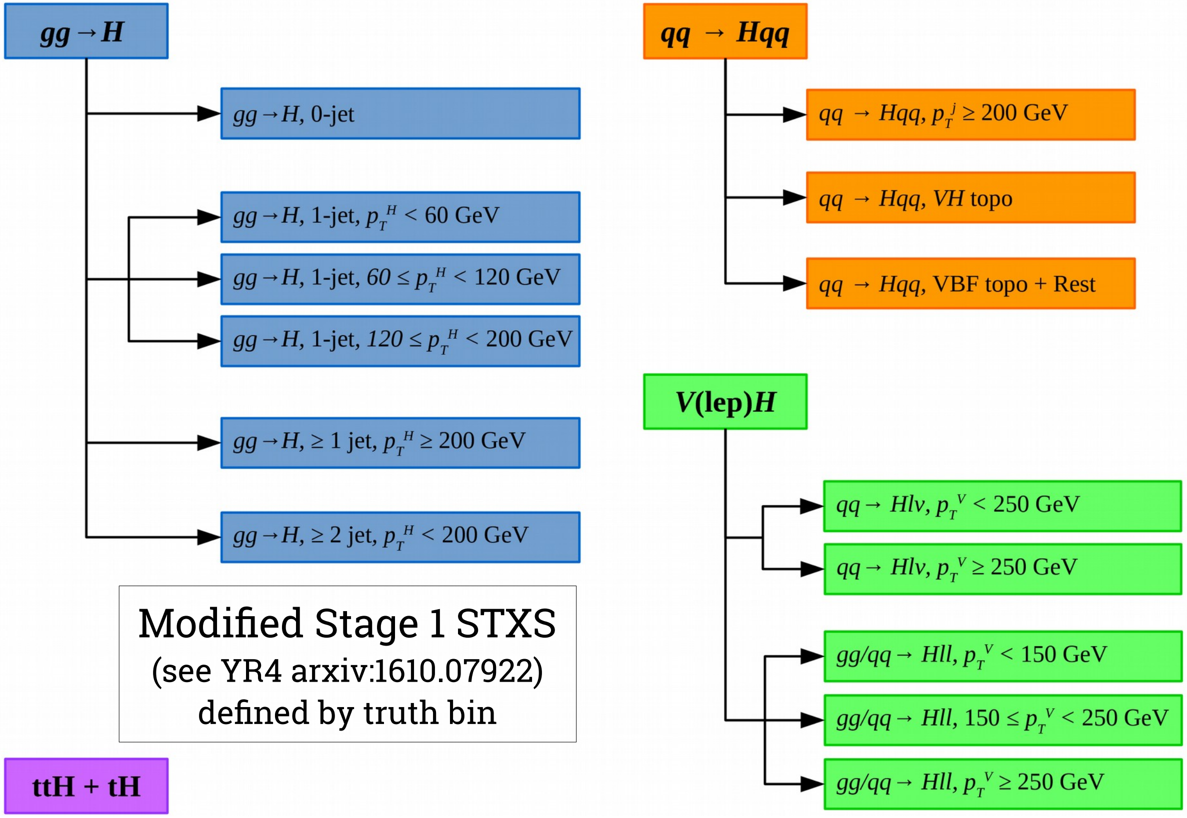


6.5σ single-experiment observation of vector boson fusion (5.3 expected)

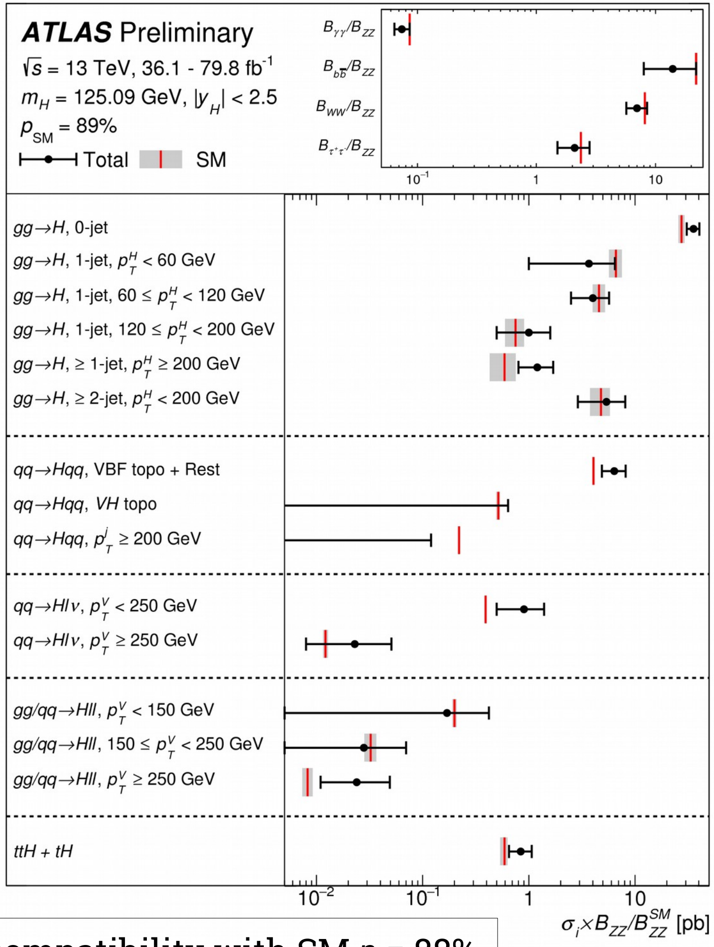
ATLAS-CONF-2019-005

Higgs Coupling Combination: STXS

ATLAS-CONF-2019-005



Modified Stage 1 STXS
(see YR4 arxiv:1610.07922)
defined by truth bin



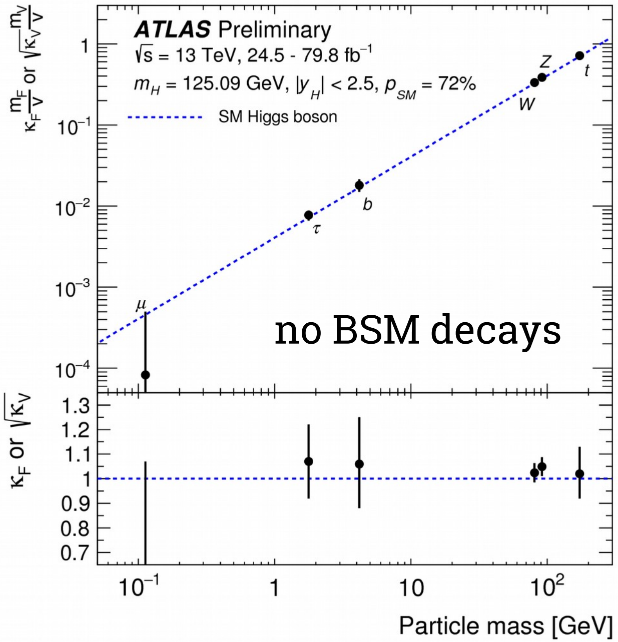
compatibility with SM p = 88%

Higgs Couplings Combination, κ-framework

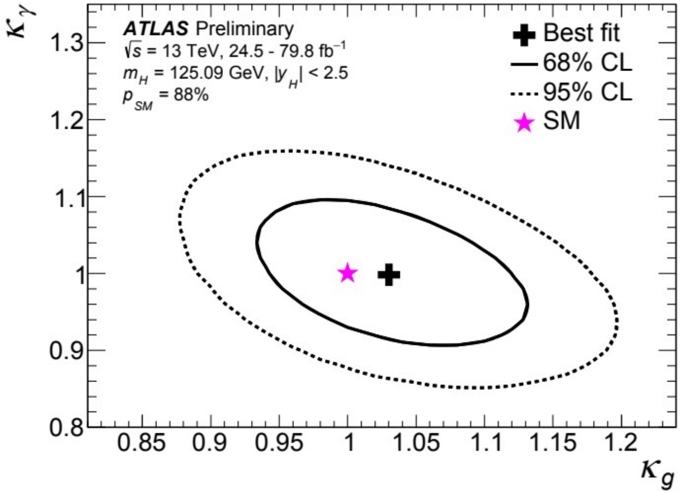
- Simple scalings κ_i of SM couplings

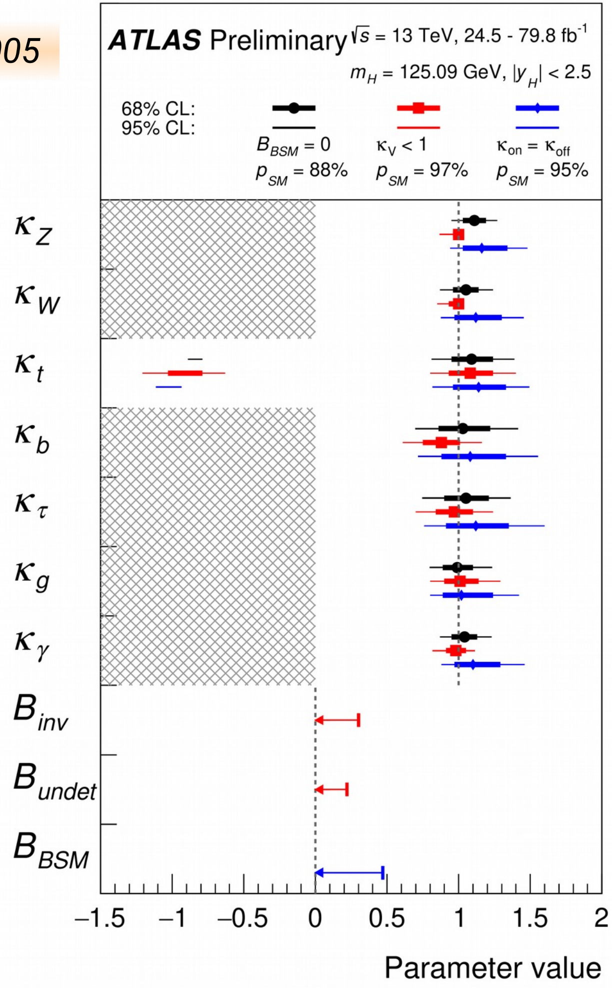
ATLAS-CONF-2019-005

  - include H → invisible branching fraction limits, width constraints from off-shell measurements to constrain unseen decays
  - SM: $\kappa_i = 1$



"effective couplings" κ_g, κ_γ encapsulate loop effects



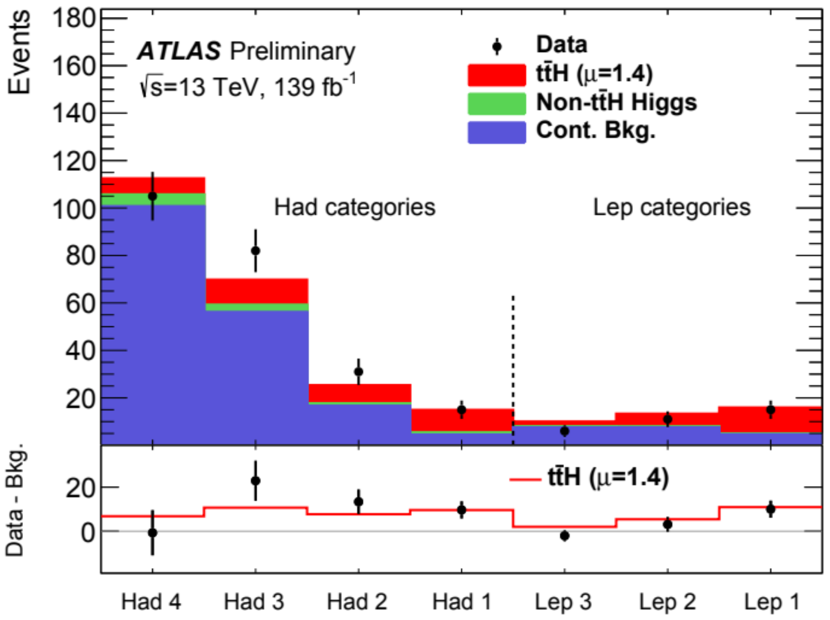


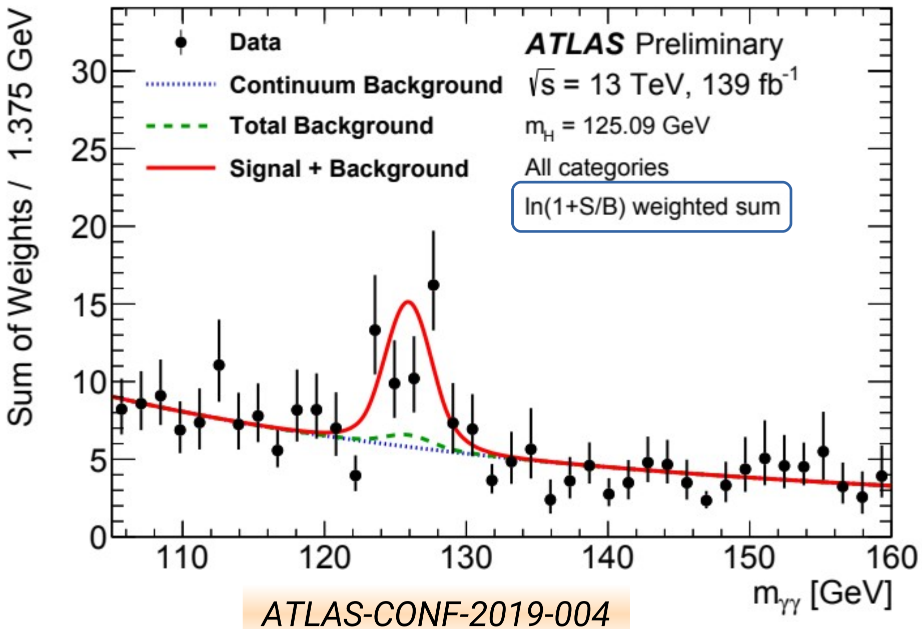
$t\bar{t}H$, $H \to \gamma\gamma$

139 fb^{-1}

- Use high-resolution $H \to \gamma\gamma$ decay to search for ttH production
  - measures top quark Yukawa coupling
  - hadronic and leptonic categories of top pair decays; BDTs used to select bins of various purity
- 4.9σ observed signal (4.2σ exp); $\mu_{t\bar{t}H} = 1.38\ ^{+0.41}_{-0.36} = 1.38\ ^{+0.33}_{-0.31}\ (\text{stat.})\ ^{+0.13}_{-0.11}\ (\text{exp.})\ ^{+0.22}_{-0.14}\ (\text{theo.})$

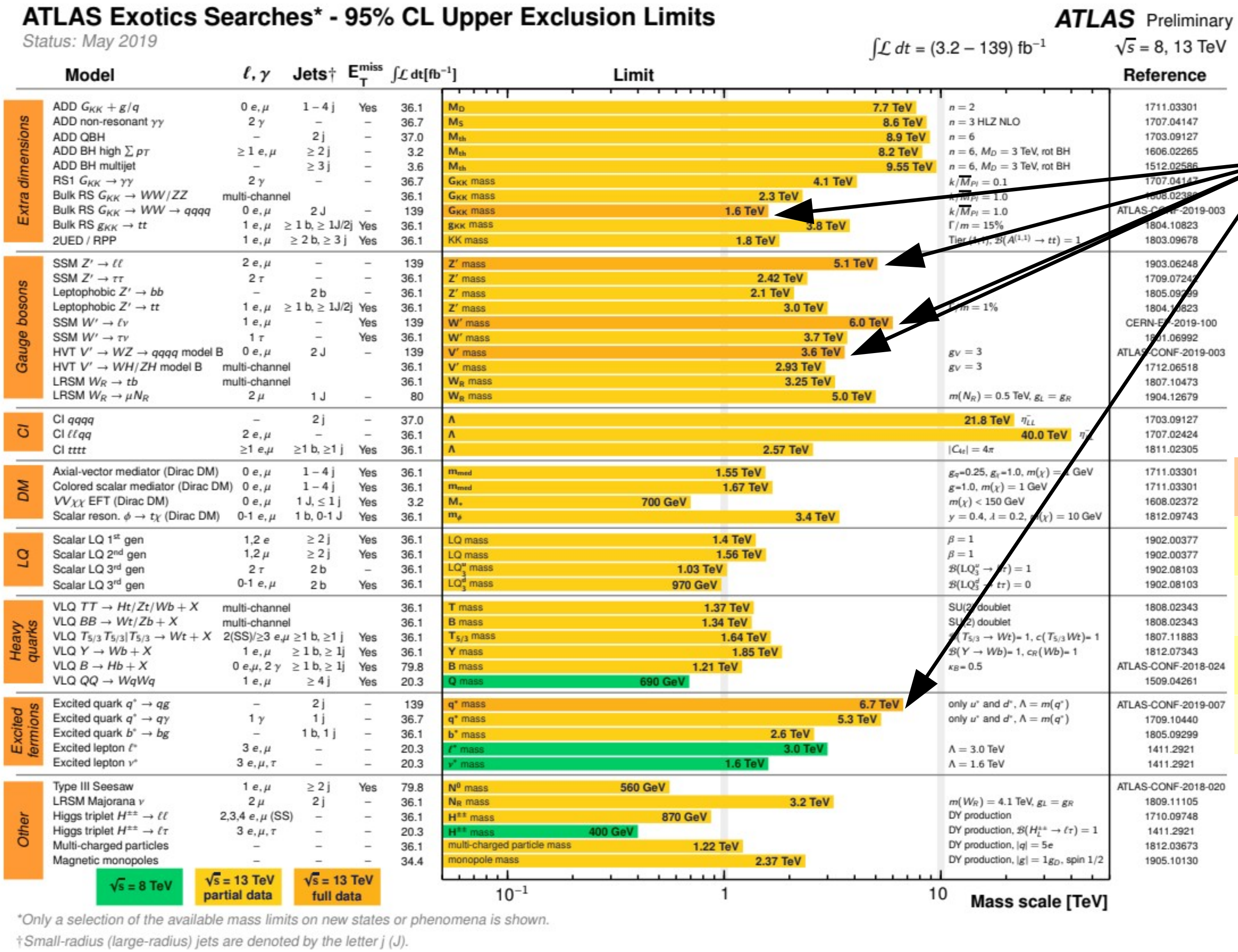
(2017 multi-channel combination: 6.5σ obs, 5.1 exp)





ATLAS-CONF-2019-004

Exotics Summary



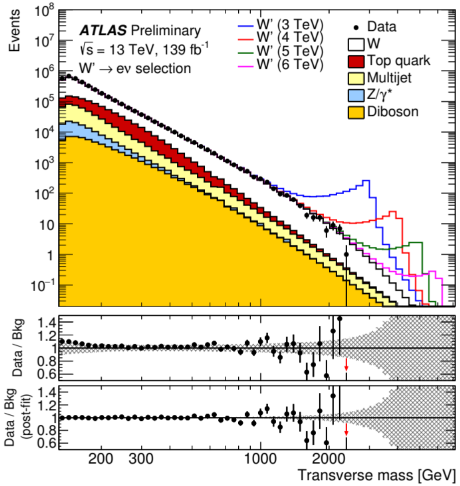
Highlighting resonance searches with the full 139 fb⁻¹

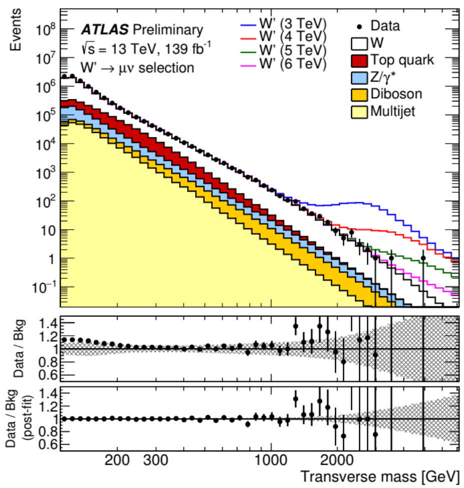
Are there new particles produced in the s-channel?

Search	Reference
W' → ℓν	EXOT-2018-30
Z' → ℓℓ	arxiv:1903.06248
Dijet resonances	ATLAS-CONF-2019-007
VV resonances	ATLAS-CONF-2019-003

W’, Z’ Searches

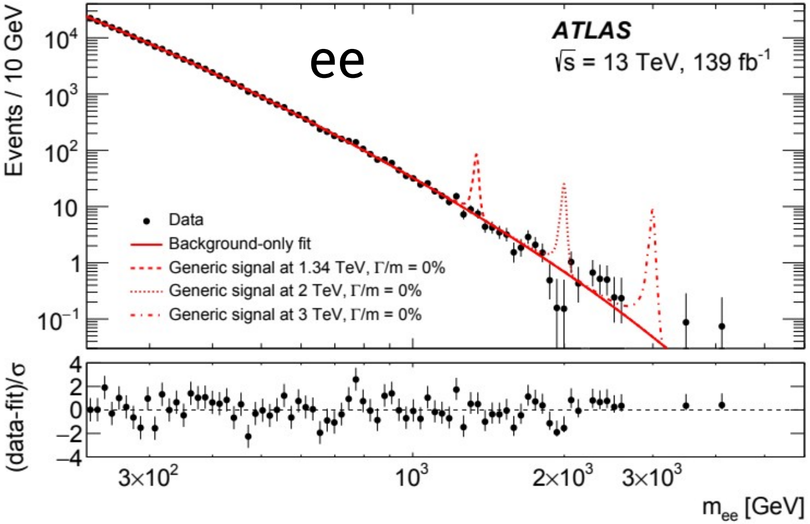
- Search for resonances decaying to ℓν or ℓℓ (ℓ = e, μ)
  - provide cross section limits as a function of resonance width (and mass limits for some benchmark models, e.g. sequential standard model)

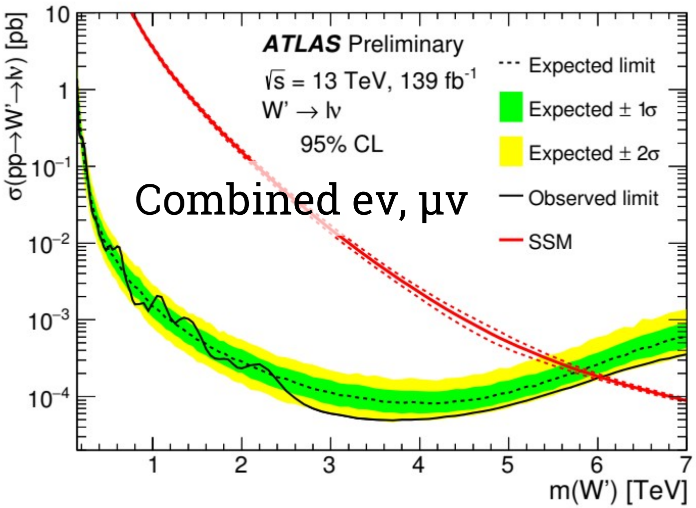




arxiv:1903.06248 (sub. to Phys Lett B)

Z’





W’

EXOT-2018-30

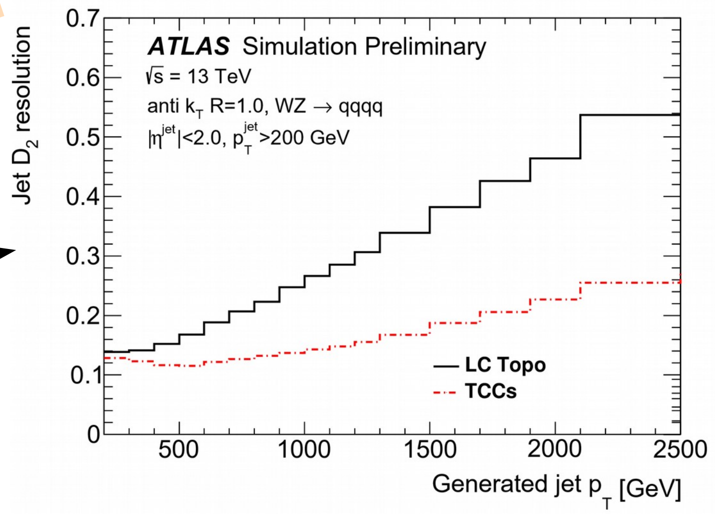
$139\ \mathrm{fb}^{-1}$

Diboson Resonance Search

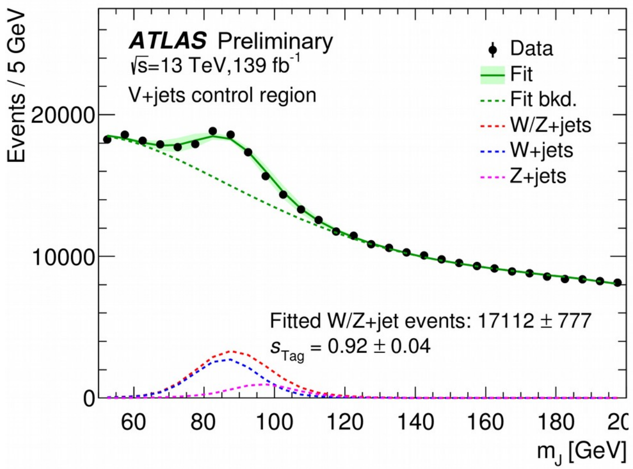
ATLAS-CONF-2019-003

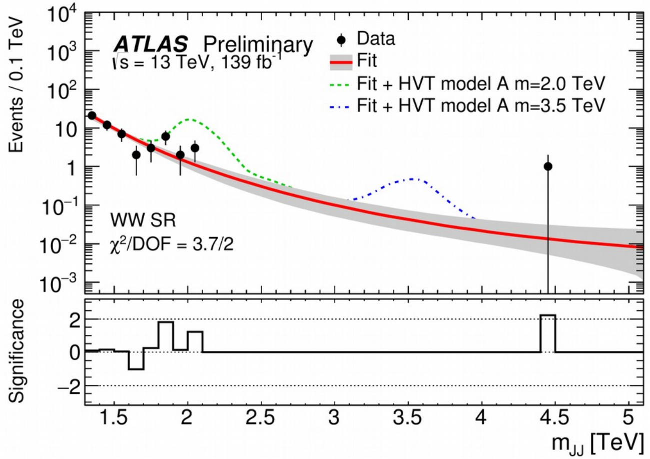
139 fb^{-1}

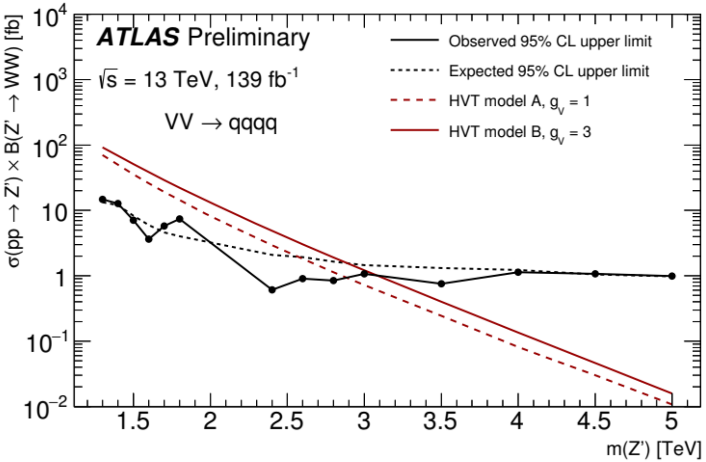
- WW/WZ/ZZ resonance search
  - benchmark models: heavy vector triplets; radions; RS gravitons
- all-hadronic channel
  - R=1.0 jets: combine calo+track information (“Track-CaloClusters”) for better substructure resolution
  - select jets using n_{trk}, D_2 substructure, m(jet)



$p_T^{j1,j2}$ > 600, 200 GeV; one tag, one anti-tag



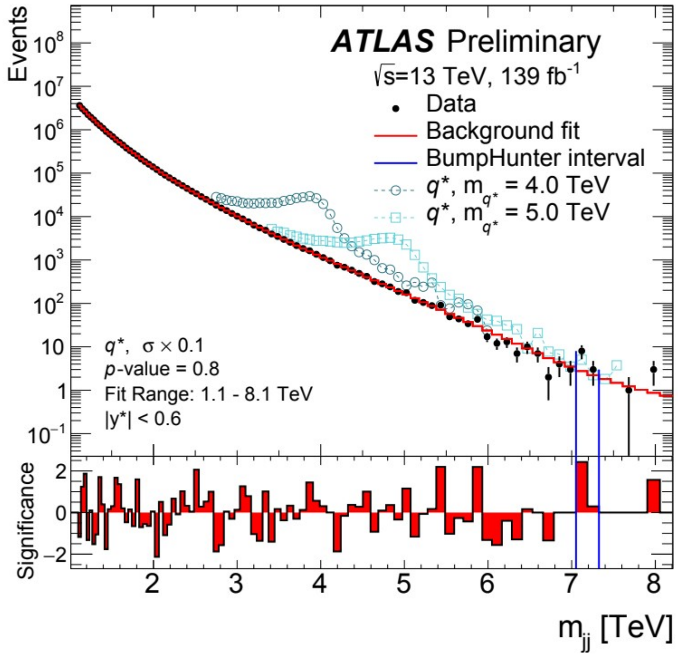


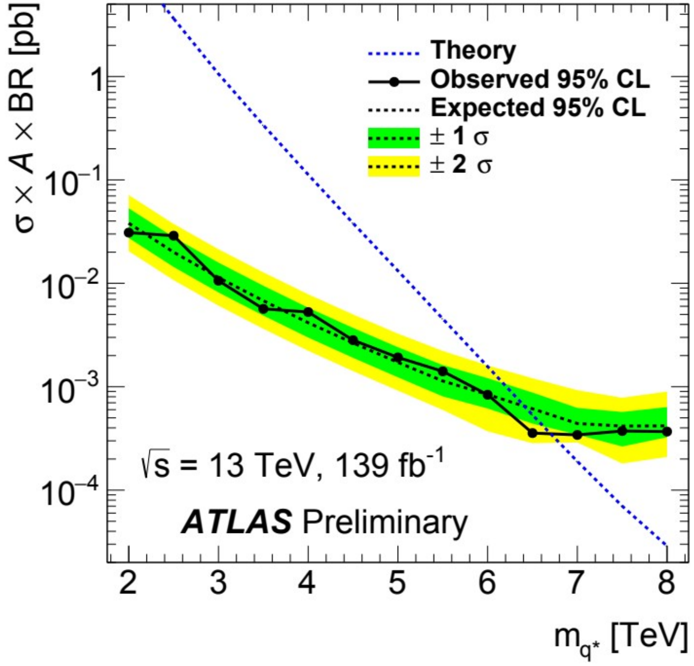


Dijet Resonance Search

- Dijet resonances could arise from e.g. excited quarks (q' → qg)
  - dijet resonance search a typical probe for compositeness
- Smooth background distribution fit to data
- Bump search algorithm used to search for excesses

ATLAS-CONF-2019-007





139 fb^{-1}

SUSY: Summary

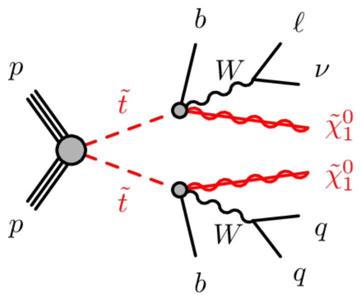
- Large number of new 139 fb^{-1} results

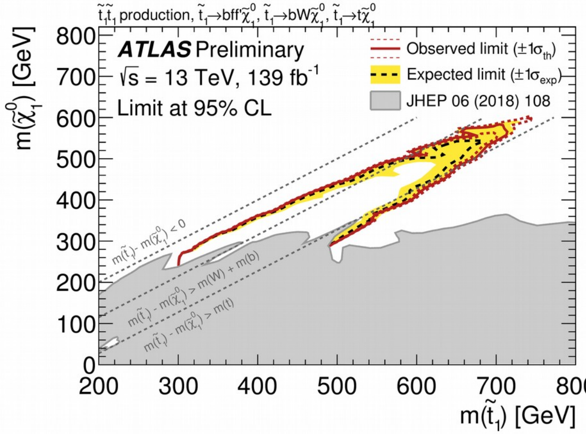
Final State	Probes	Reference
3ℓ + 0b + MET	chargino+neutralino	ATLAS-CONF-2019-020
$h \rightarrow \gamma\gamma + (\ell\nu/qq')$ + MET	chargino+neutralino	ATLAS-CONF-2019-019
2τ + MET	staus	ATLAS-CONF-2019-018
ℓ + b + jets + MET	stop 3-body	ATLAS-CONF-2019-017
$(Z \rightarrow \ell\ell) + \ell$ + jets + MET	stop with Z	ATLAS-CONF-2019-016
2 same sign $\ell/3\ell$ + jets + MET	gluinos/sbottom/stop/gluinos $\rightarrow$ RPV stop	ATLAS-CONF-2019-015
$\ell\ell$ + j + MET	compressed spectrum ewkinos, sleptons	ATLAS-CONF-2019-014
$\geq$ 3b + MET	sbottom with Higgs in decays	ATLAS-CONF-2019-011
2ℓ + MET	charginos/sleptons	ATLAS-CONF-2019-008
Displaced μ and vertex	long-lived stop RPV	ATLAS-CONF-2019-006

SUSY: Stop Production

- Direct stop production with “unusual” decays
  - three-body decay $\tilde{t}_1 \to bW\tilde{\chi}_1^0$ in the ℓ + jets + MET final state

ATLAS-CONF-2019-017

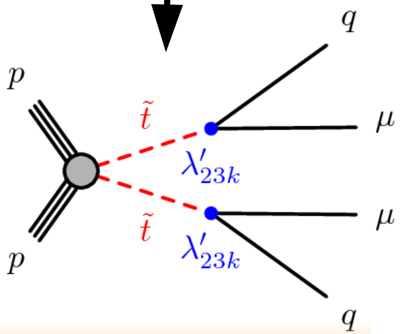




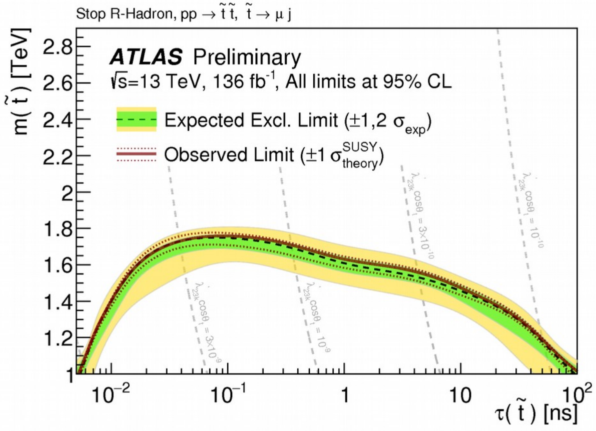
139 fb^{-1}

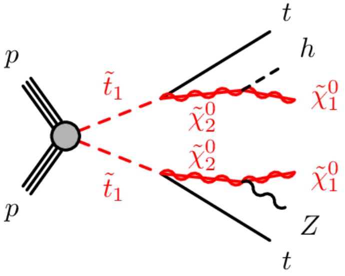
  - Z + top ($\tilde{t} \to tZ\tilde{\chi}_1^0$ or $\tilde{t}_2 \to \tilde{t}_1 Z$)

  - long lived stop RPV $\tilde{t} \to q\mu$ displaced muon + vertex

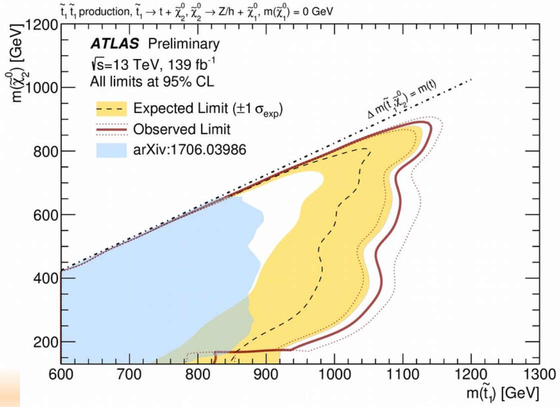


ATLAS-CONF-2019-006





ATLAS-CONF-2019-016

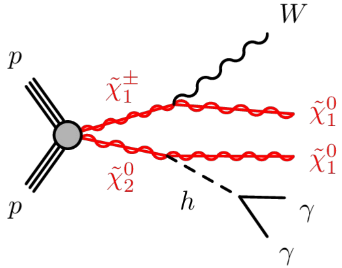


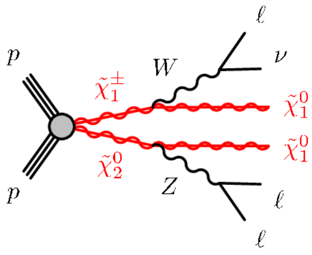
SUSY: Chargino-Neutralino Production

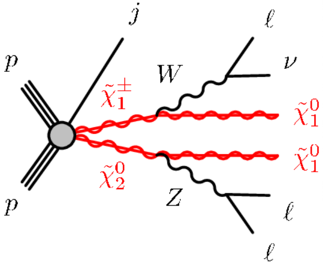
- Trilepton ATLAS-CONF-2019-020
  - (emulated) recursive jigsaw
  - SRs with and without ISR

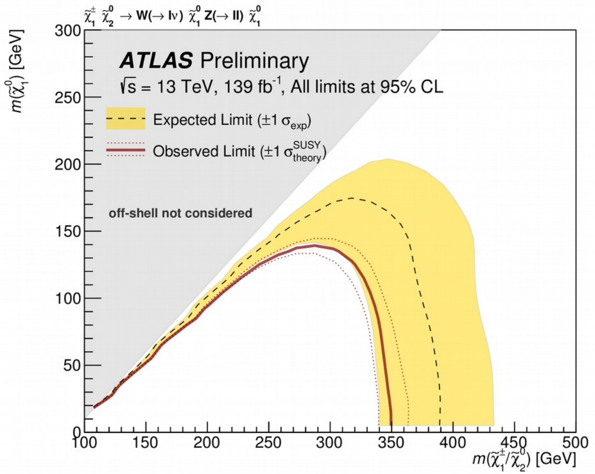
- Higgs ATLAS-CONF-2019-019
  - use h → γγ decay, W → ℓν or qq’ on the other side

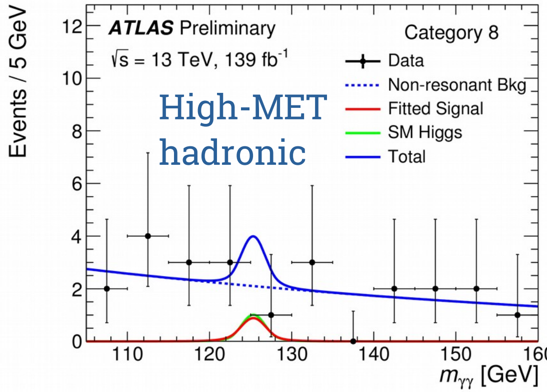
139 fb^{-1}

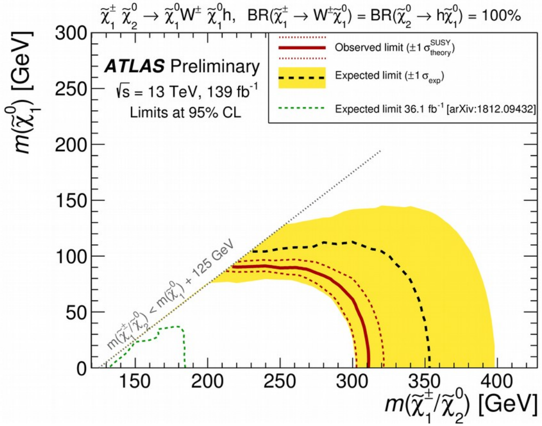










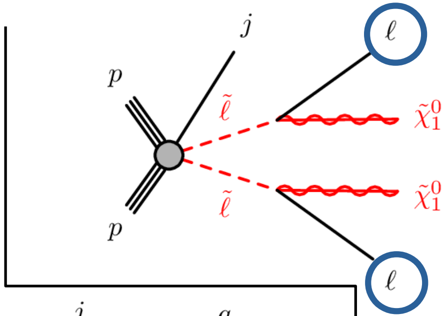


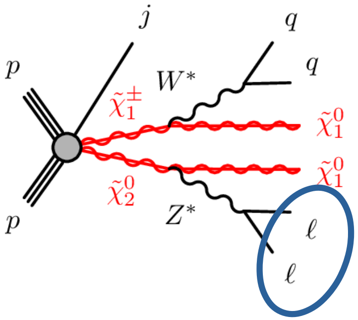
Both analyses: excesses in 36 fb^{-1} not seen in full dataset

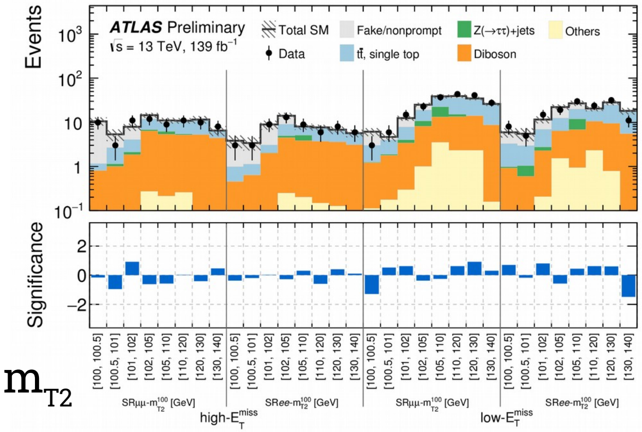
SUSY: Compressed Spectra

- Small sparticle mass splittings → low p_T SM particles: hard to trigger and reconstruct
  - use initial state jets (> 50 GeV) to provide a boost to increase MET
  - target electroweakinos and sleptons with same-flavor dilepton analysis
- Use MET trigger
- Recursive jigsaw to isolate ISR
- Sensitivity to mass splittings ~ 1 GeV

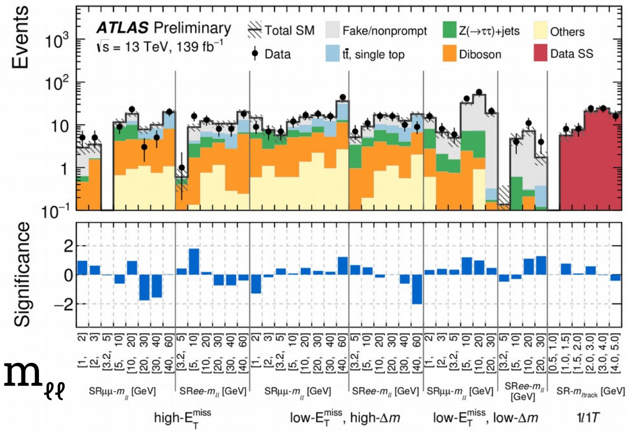
ATLAS-CONF-2019-014



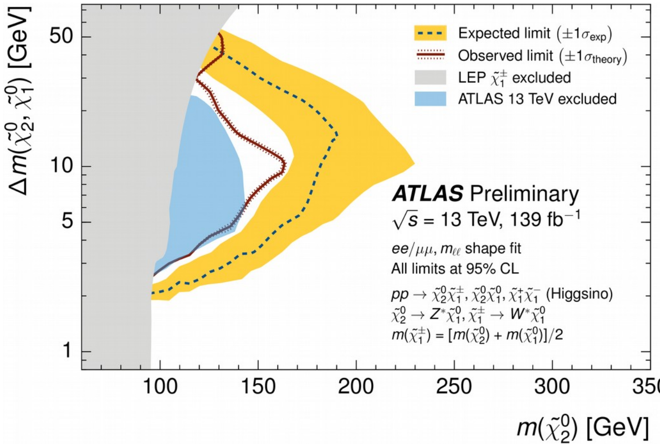


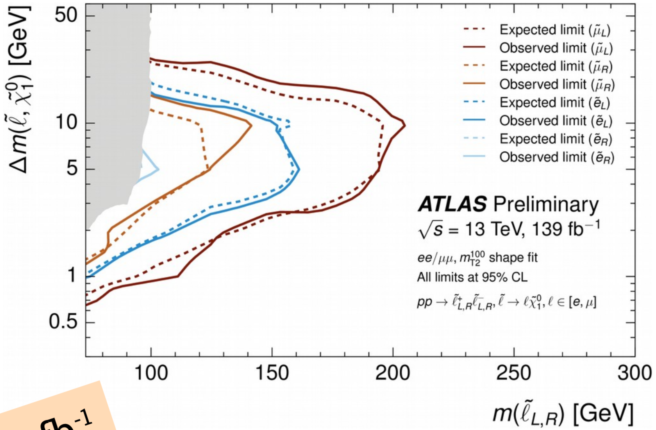


m_{T2}



$m_{\ell\ell}$

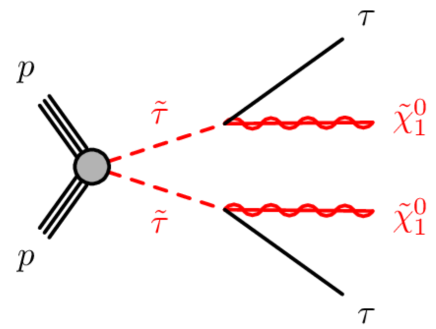




139 fb^{-1}

SUSY: Staus

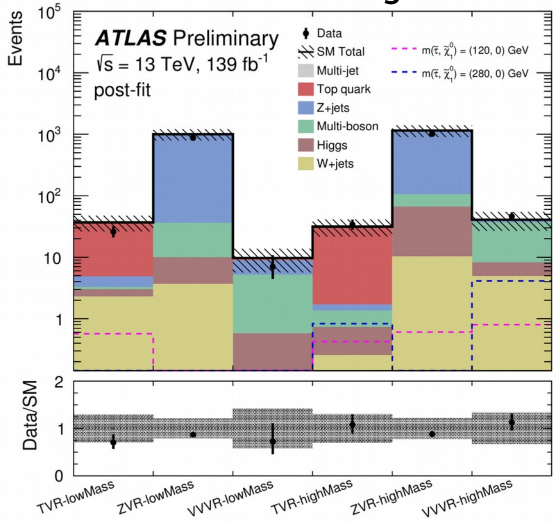
- Potential scenario: colored superpartners very heavy, sleptons accessible at LHC (and staus lightest)
- Search for stau pair production
  - two hadronic taus + MET
  - m(ττ) > 120 GeV (remove Z/H), events with b-jets (remove $t\bar{t}$), m_{T2} > 70 GeV (remove $t\bar{t}$, WW)



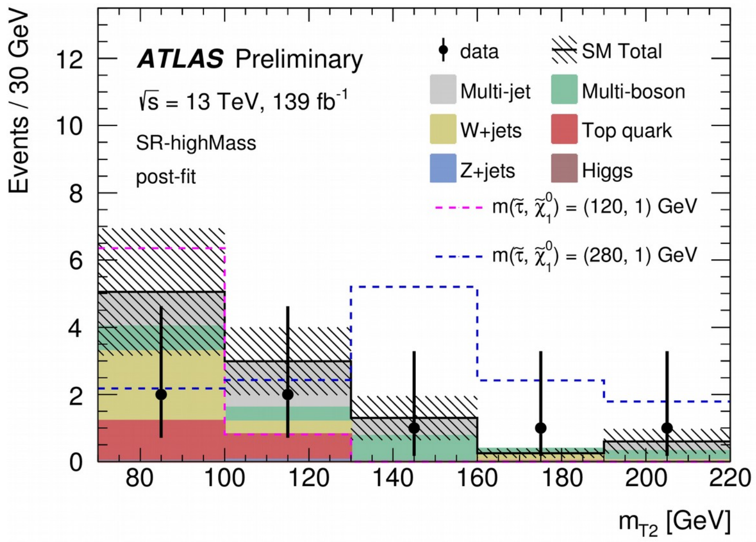
139 fb^{-1}

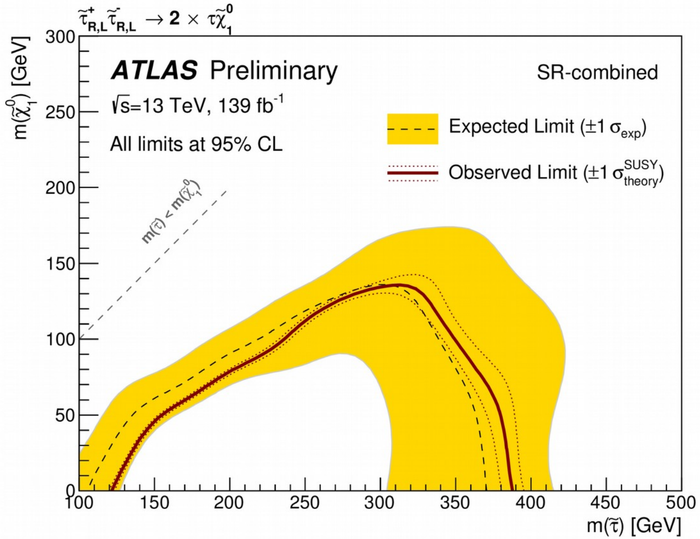
ATLAS-CONF-2019-018

validation regions



high mass SR



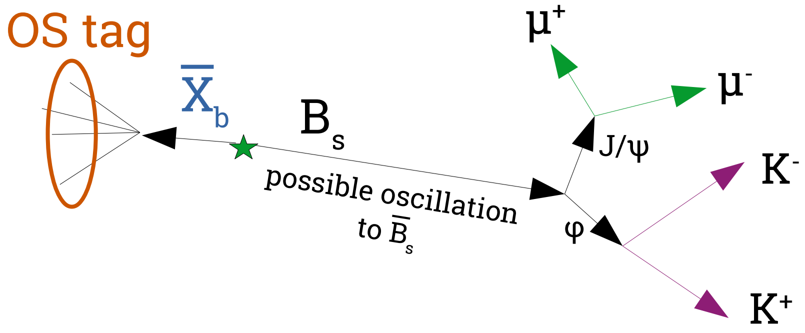


first sensitivity for $m_{\tilde{\tau}}$ > 110 GeV

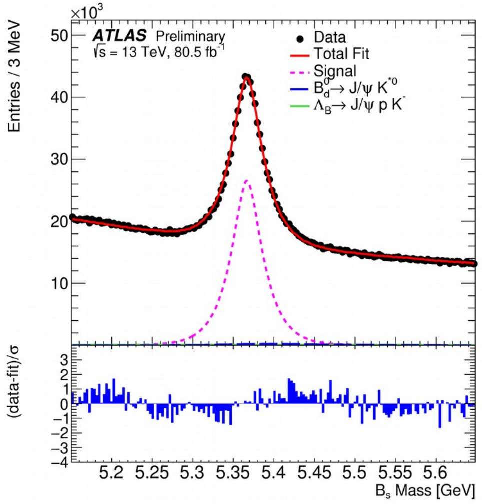
$B_s \to J/\psi\ \varphi$

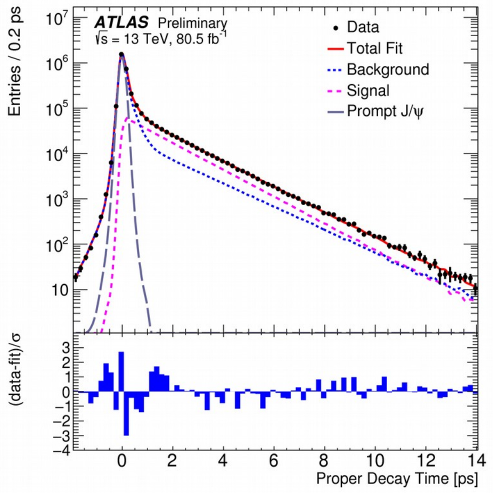
ATLAS-CONF-2019-009

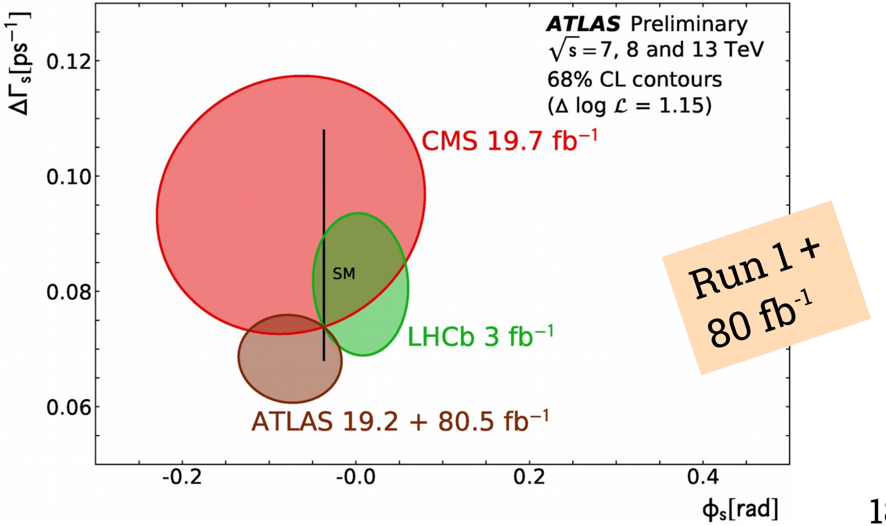
- New physics can affect mixing in the B_s system
  - CP violating phase φ_s from interference of decays with and without mixing in $B_s \to J/\psi\ \varphi$ is small in SM (~ −0.036)
- Flavor of produced B_s tagged via tagging charge of "opposite side" tracks (opposite side B hadron region identified using lepton or b-tagged jet)
- Precision measurement of proper time
- Fit includes interference with S-wave J/ψ K K



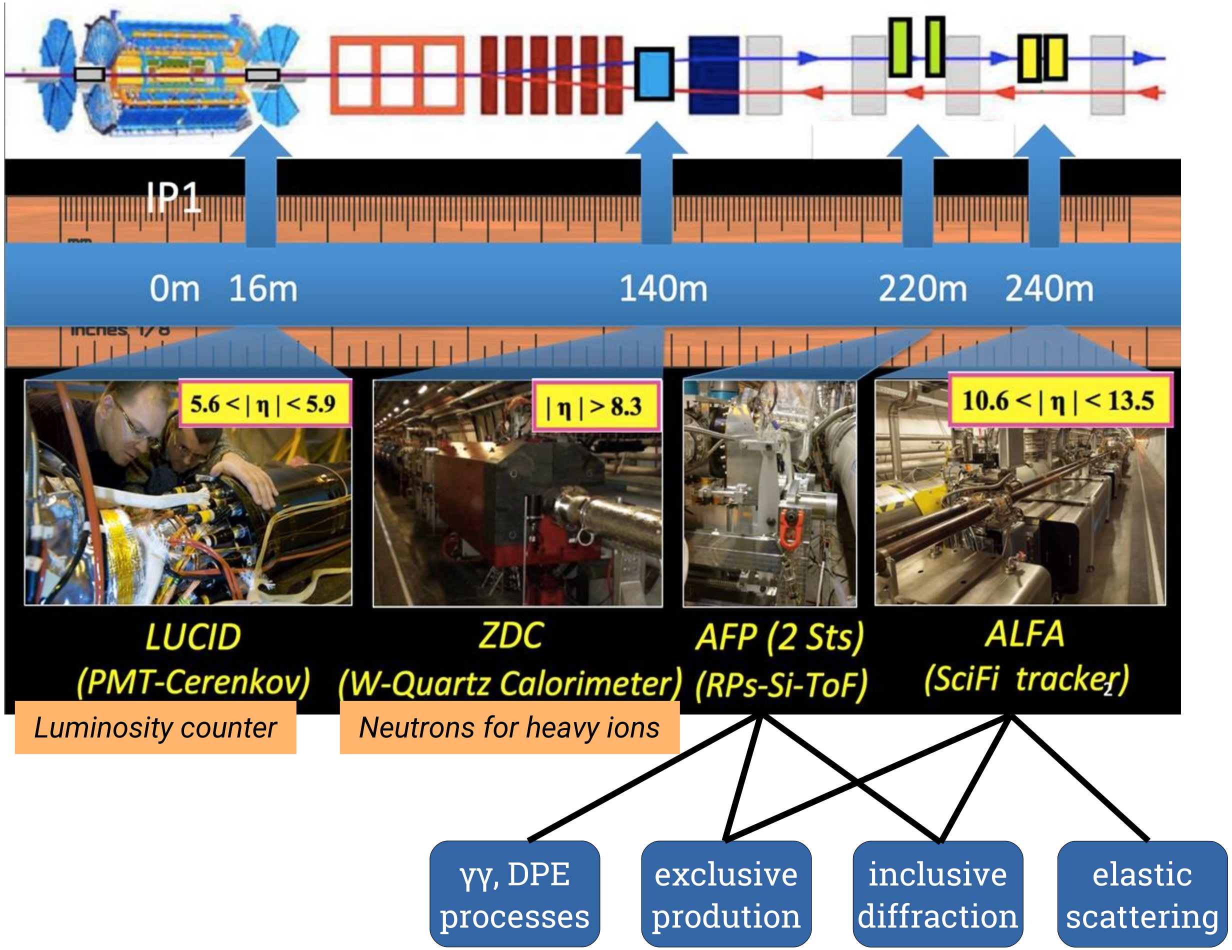
$$\phi_s = -0.076 \pm 0.034\ (\text{stat.}) \pm 0.019\ (\text{syst.})\ \text{rad}$$







Forward System



- **ALFA** – data during runs with special LHC optics
- **AFP** – data during special runs and also generic high-μ physics
- ALFA/AFP operation in Run 3 intricately connected to beam optics
- Radiation damage to ALFA fibers → manageable now, but motivates √s = 14 TeV ALFA run as early as possible in Run 3

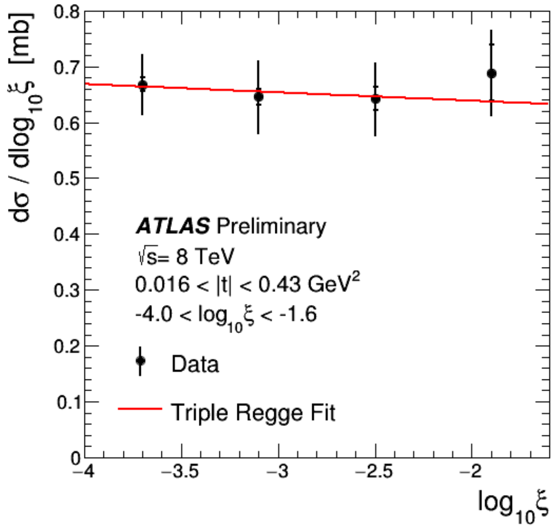
ALFA 8 TeV total xsec: $\sigma_{\text{tot}}(pp \to X) =$
$96.07 \pm 0.18\,(\text{stat.}) \pm 0.85\,(\text{exp.}) \pm 0.31\,(\text{extr.})\text{ mb}$

PLB 761, 158 (2016)

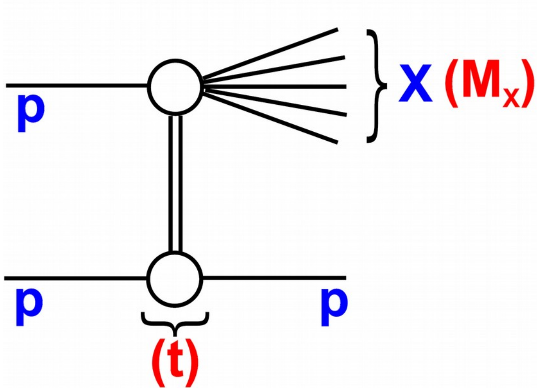
Forward Physics

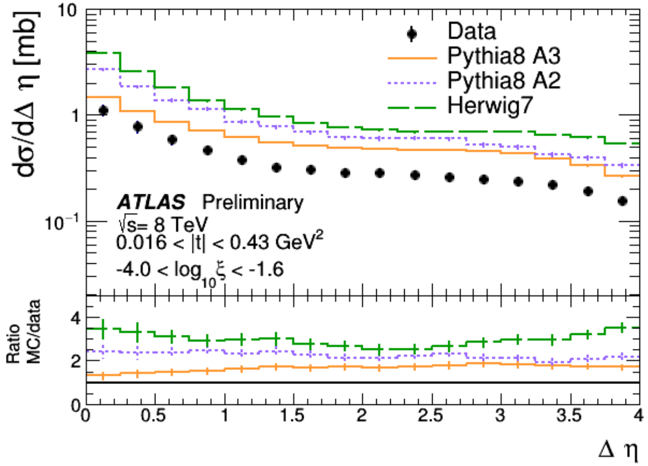
- Single diffractive events in ALFA
  - tag intact proton – suppress double diffractive/non-diffractive background
  - study exchanged color-neutral system & characteristics of rapidity gap
  - improve constraints on σ_{inel}
- Trigger on min bias trigger scintillators + ALFA coincidence
- Use central tracker to obtain rapidity gap Δη and fractional proton energy loss $\xi = M_X^2/s$

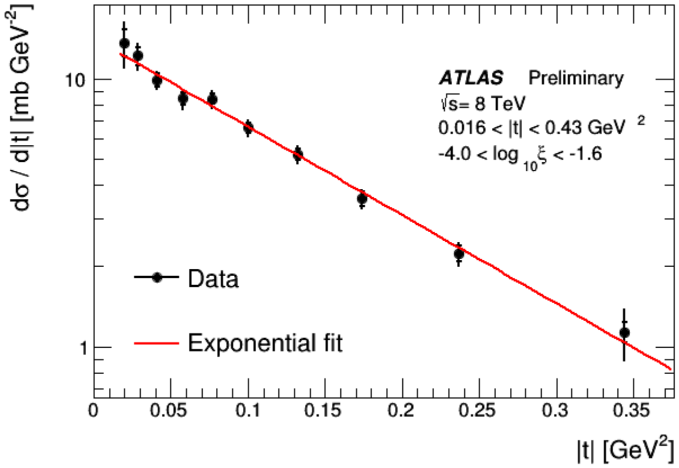
8 TeV ALFA run



ATLAS-CONF-2019-012





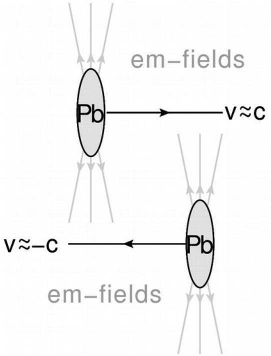


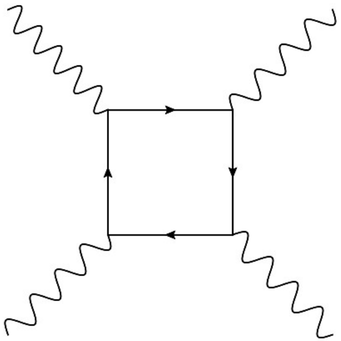
Light-by-Light Scattering

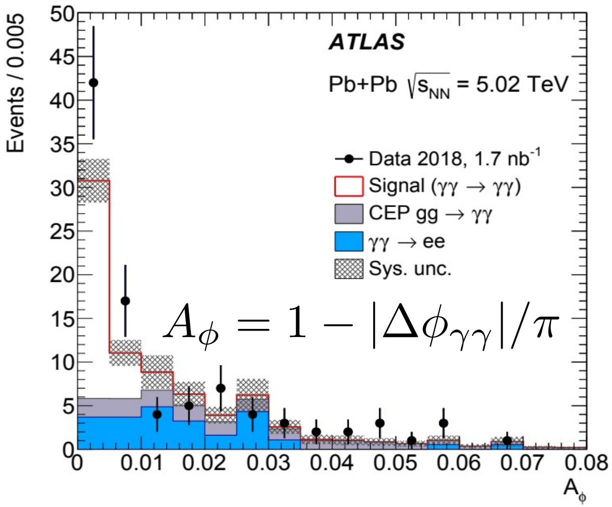
- $\gamma\gamma \rightarrow \gamma\gamma$ through a loop is a fundamental QED process
  - violates superposition principle of classical electromagnetism
  - $\sigma \propto \alpha^8$
- Ultraperipheral heavy ion collisions are an ideal system to search for $\gamma\gamma \rightarrow \gamma\gamma$
  - colliding the nuclei's E, B fields – cross section enhanced by a factor $Z^4 = 4.5 \times 10^7$ over proton collisions
  - in-time pileup negligible → look for events with two photons and nothing else
    - $E_T^{\gamma} > 3$ GeV, back-to-back in φ, low $p_T^{\gamma\gamma}$
    - Trigger allows a maximum amount of calo energy
- 8.2σ observation (6.2 exp)

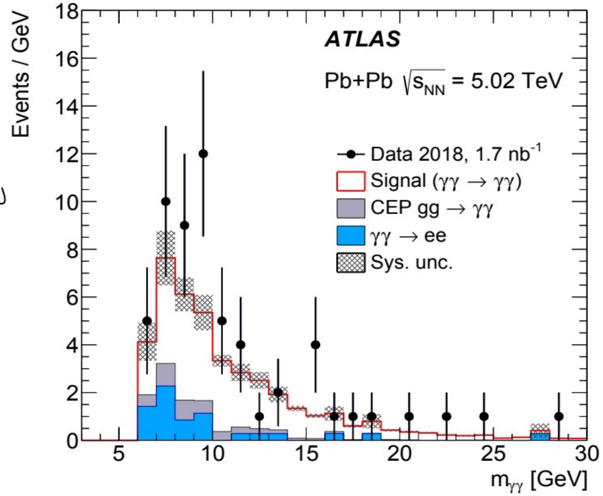
arxiv:1904.03536 (sub. to PRL)

2018 PbPb data





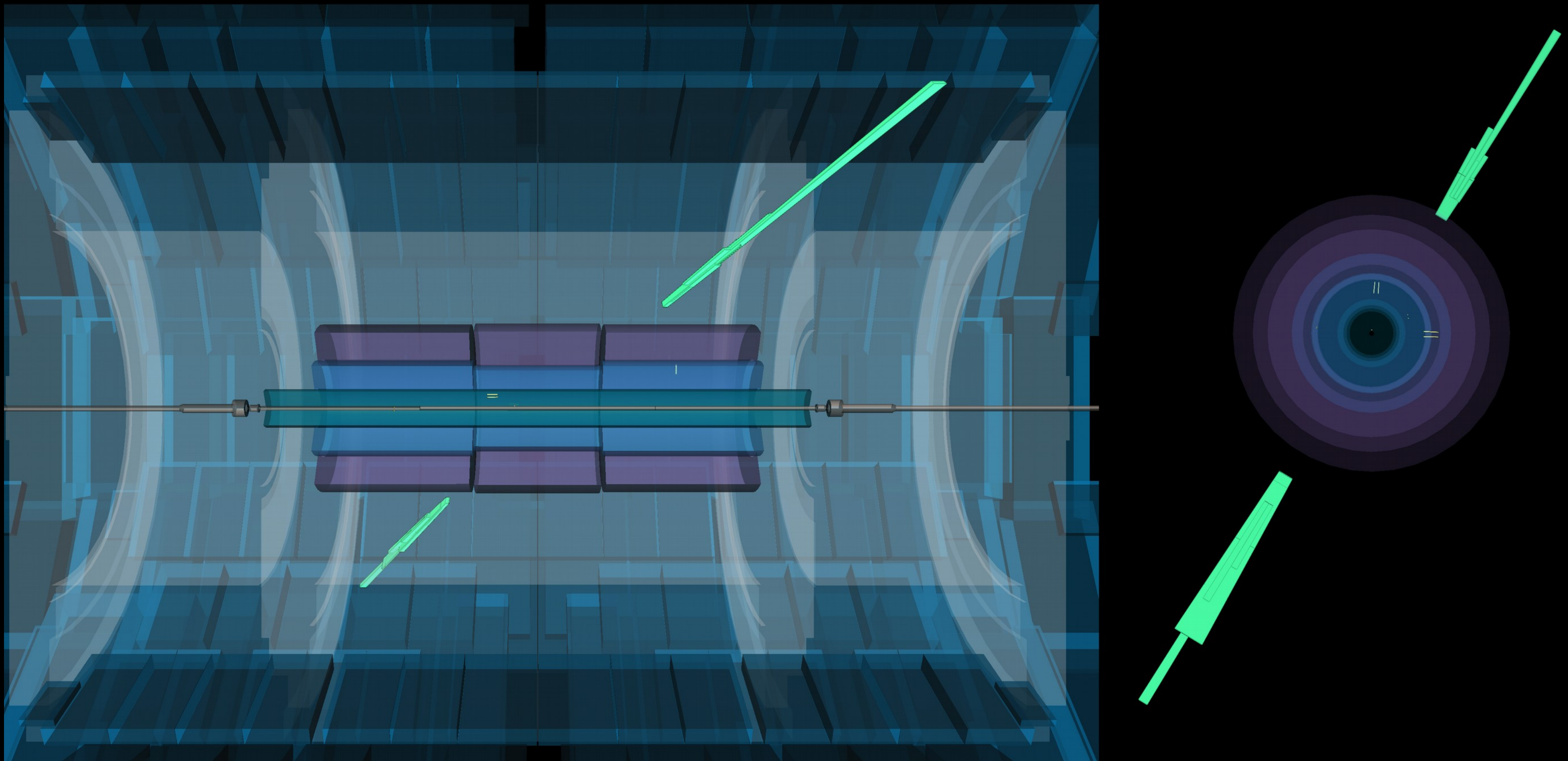




ATLAS EXPERIMENT

Run: 366994
Event: 453765663
2018-11-26 18:32:03 CEST

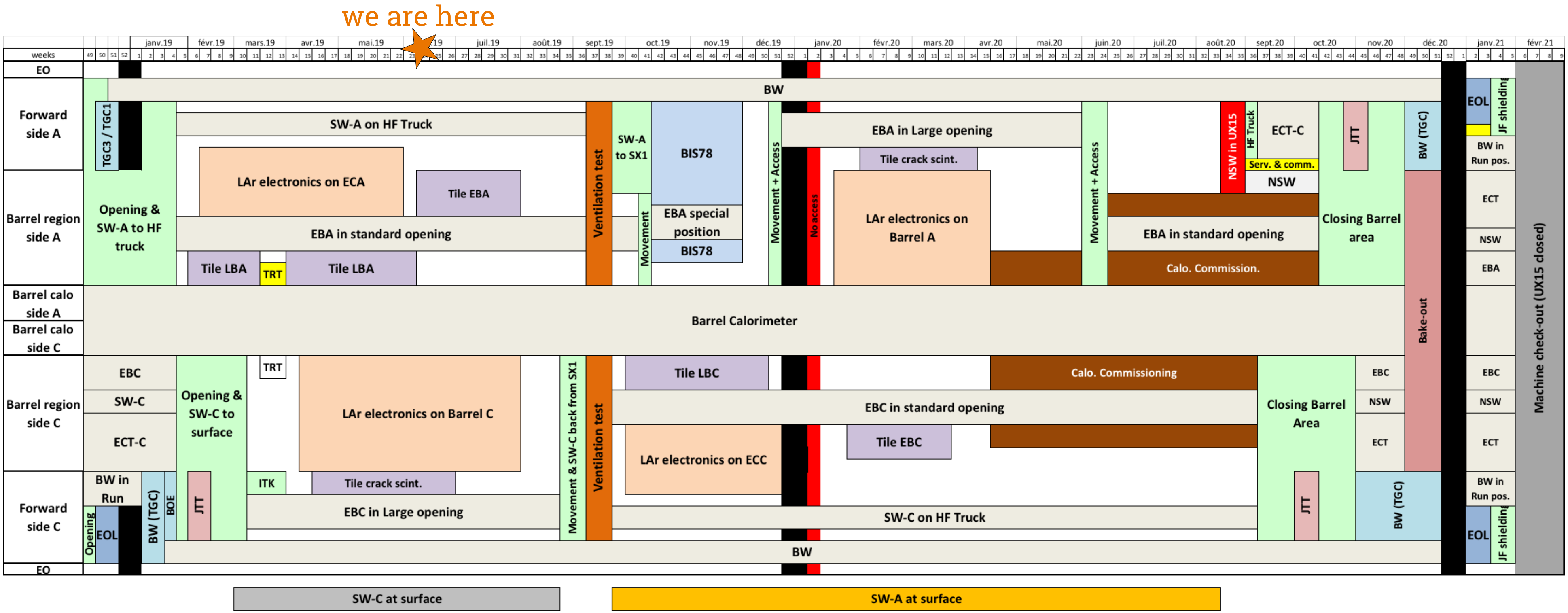
$\gamma\gamma \to \gamma\gamma$ candidate



LS2 Activities

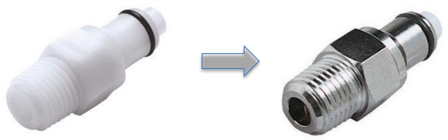
Planning

- Many activities happening in parallel in cavern
  - potential for conflict between different systems must be managed

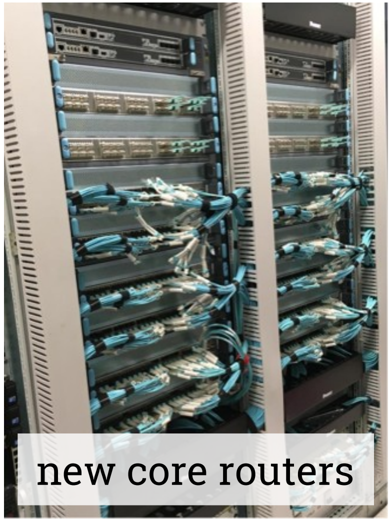


Maintenance

- Leak finding/repair
  - comprehensive refurbishment of LAr & Tile cooling circuits (connectors, hoses …)
  - RPC gas leak repairs progressing well



- Refurbishment of DAQ networks at P1
  - router & switch replacement, bandwidth increase
  - node transition to CentOS 7
  - HLT farm used for MC generation when available

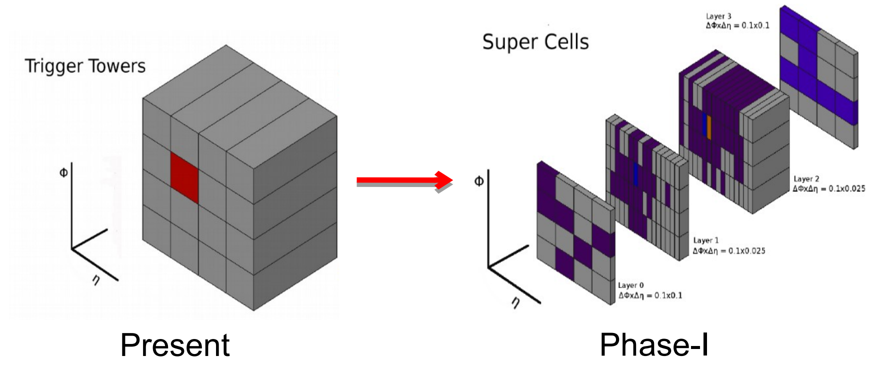


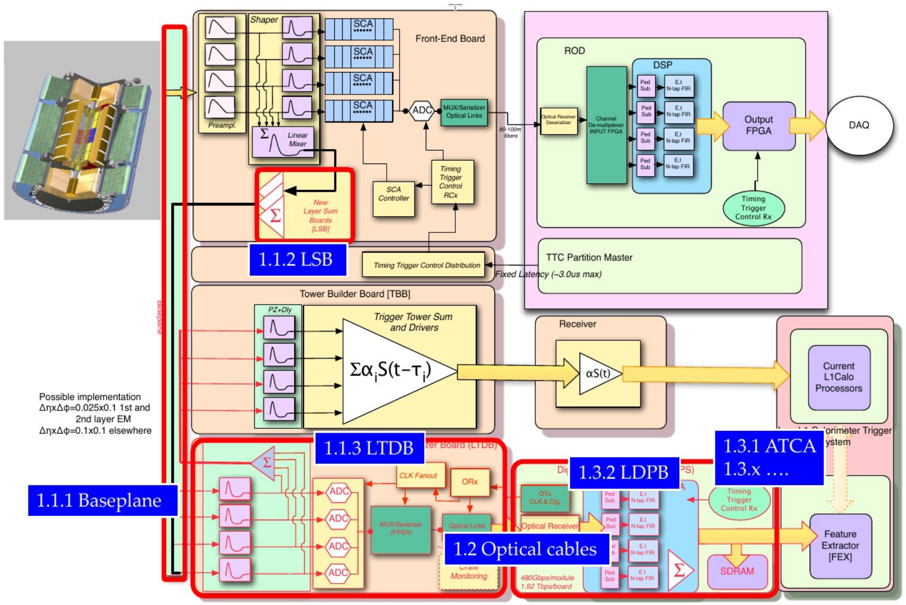
new core routers

- Replacement of crack scintillators & min bias trigger scintillators (MBTS) in progress
  - crack scintillators significantly improve energy resolution in $|\eta| \sim 1.2\text{-}1.6$; replacement will extend coverage to 1.72
- Plans to study pixel depletion depth via program of cosmic runs during LS2
  - ID was warm for only 17 days during endplate opening

LAr Trigger Upgrade

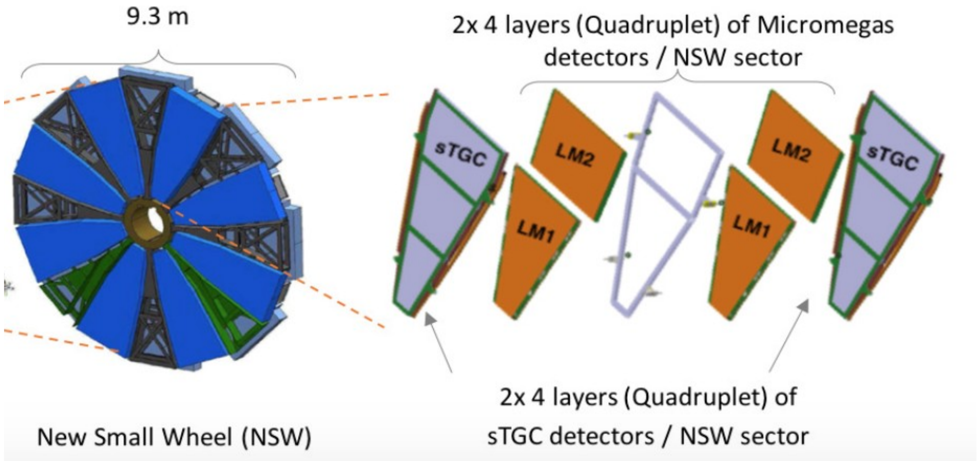
- Installation of new trigger data path for liquid argon calorimeter
  - synergistic with “regular” maintenance
- Front-end board rework, crate baseplane replacement proceeding well
  - 50 FEB/wk achieved (1524 total)
- Commissioning of new crates ongoing
  - validate old trigger path first, then new path when possible





- *New elements are highlighted in RED*

Muon New Small Wheel

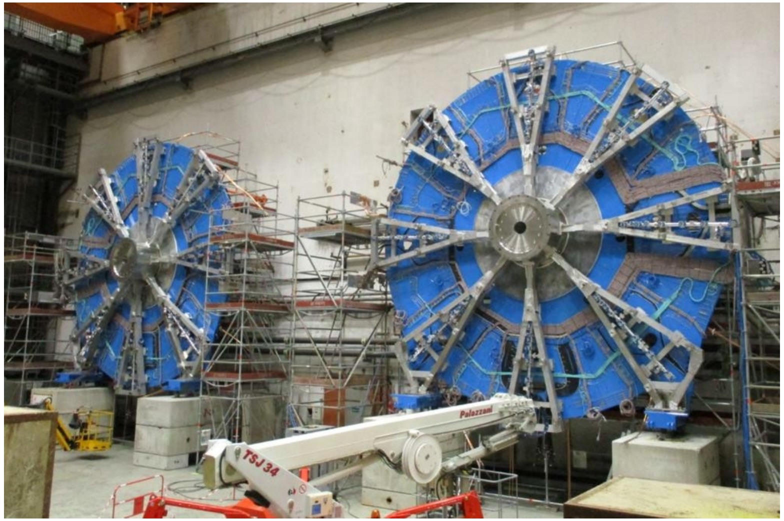


Assembled sTGC wedges, waiting for services and electronics

First complete Micromegas double wedge in cosmic ray test stand for electronics studies

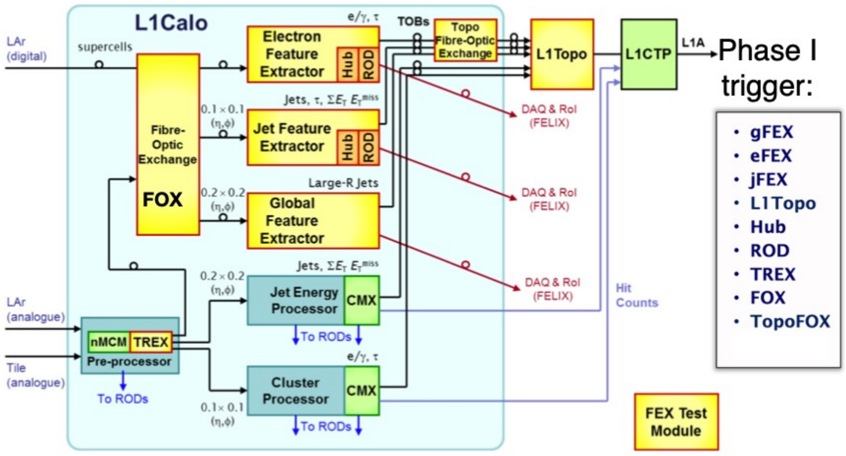
Electronics test on sTGCs

Muon New Small Wheel



- NSW structure ready to receive detector sectors: installation of 1st sector planned in summer
  - Services installation on A-side wheel is complete
- sTGC:
  - Production is progressing according to schedule, 27 chambers shipped to CERN. Wedge assembly ongoing, first 5 wedges completed
- Micromegas:
  - Production is ongoing. Some remaining HV stability issues
  - Wedge assembly PRR was passed in April
  - 1st double wedge assembled successfully, further wedge integration driven by chamber availability
- Electronics:
  - 50% of front end ASIC (VMM) series production wafers received → packaging next
  - All electronics cards are either in pre-production or production, with some delays on the Micromegas frontend board (MMFE8)
- Good progress, but installation of first wheel (A-side) in LS2 remains a challenge

TDAQ Upgrade



Surface Test Facility

L1Calo:

- Prototype boards exist for all feature extractors (FEXs).
- Being tested in Surface Test Facility (STF)@CERN aiming for full FEX-Hub-ROD-FELIX data path.
- Baseline algorithms established for all FEXs.
- Installation Q4-2019 until Q1-2020.

L1Muon:

- Barrel+Endcap Muon Sector Logic (SL) installation planned for July 2019.
- Muon-central trigger processor interface: Installation from Q4 2019 onwards.

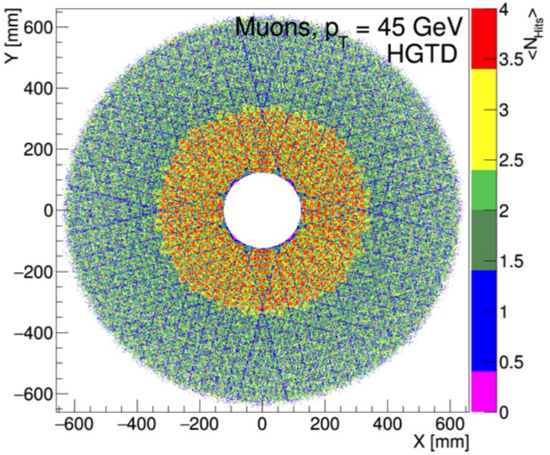
FELIX (common readout driver):

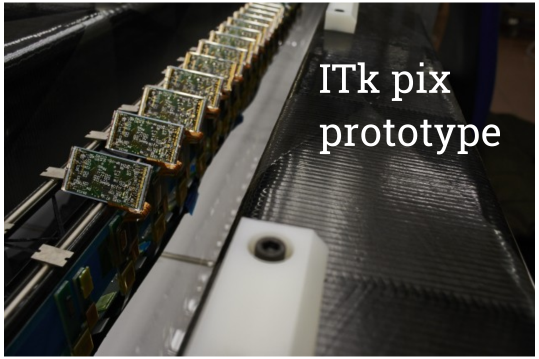
- Significant stability improvements in firmware and software; FPGA utilisation under control.
- Pre-production of 20 boards testing found issues, under evaluation, final PRR foreseen May 2019 is delayed.
- Target for installation Q3 2019.

Phase-II Upgrades

Phase-II upgrades

- Six TDR approved (ITk pixel, ITk strips, LAr, Tile, Muon, TDAQ) + one Technical Proposal (HGTD)
  - ATLAS review identified additional R&D steps for HGTD: TDR to be submitted by April 2020
- 5 MoUs released for signature
  - ITk pixel being prepared for summer
- Project baselining process complete
  - Follow-up reviews of ITk pixel and TDAQ planning scheduled by beginning of July
- ITK strips, LAr and Muons passed P2UG in-depth review in May – milestones approved
- In-depth review of ITk pixel and common items, Tile and TDAQ in November



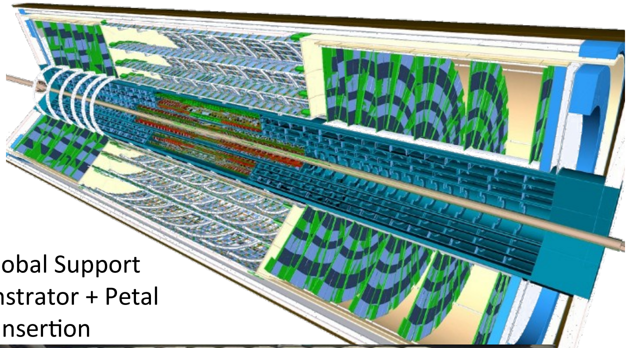


Muons & ITk Strips

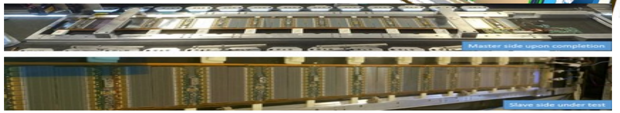
BIS78 sMDT chambers

Muon upgrade:

- Design of new electronics for MDT/TGC/RPC: new ASICs are either in pre-production or have first prototypes
- BIS7/8, a pilot project for new barrel-inner chambers, on track for installation in LS2



EC Global Support Demonstrator + Petal Insertion



ITk Strips:

- Undergoing the transition from prototyping to pre-production.
- This coming year will have most of the technical reviews allowing for pre-production (final design review)
  - First FDR to allow for sensor preproduction finished this April
  - Next FDR for global mechanics next week

Conclusion

- Excellent progress in exploiting full 139 fb^{-1} dataset for search analyses
  - 15 public results in SUSY, exotic resonances, Higgs
  - also first result from Nov 2018 heavy ion run!
- Studies in progress to obtain ultimate accuracy for precision analyses
- Long Shutdown activities: detector refurbishment + Phase-I upgrade installation making good progress.
  - Software + TDAQ overhaul for multithreading also proceeding
- Phase-II upgrade activities passing major project milestones – TDR approval, MOUs, baselining

Many thanks to the LHC & computing professionals without whom our results would not be possible!

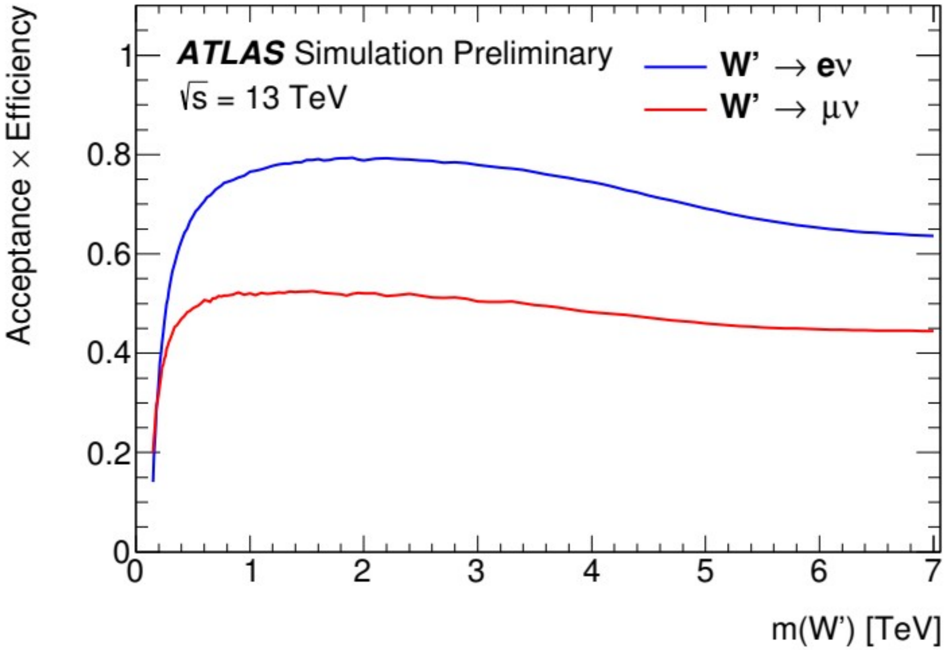
Extra

Higgs Combination Categories

	$H\to\gamma\gamma$	$H\to ZZ^*$	$H\to WW^*$	$H\to\tau\tau$	$H\to b\bar{b}$
$t\bar{t}H$	$t\bar{t}H$ leptonic (3 categories) $t\bar{t}H$ hadronic (4 categories)	$t\bar{t}H$ multilepton 1 ℓ + 2 τ_{had} $t\bar{t}H$ multilepton 2 opposite-sign ℓ + 1 τ_{had} $t\bar{t}H$ multilepton 2 same-sign ℓ (categories for 0 or 1 τ_{had}) $t\bar{t}H$ multilepton 3 ℓ (categories for 0 or 1 τ_{had}) $t\bar{t}H$ multilepton 4 ℓ (except $H\to ZZ^*\to 4\ell$) $t\bar{t}H$ leptonic, $H\to ZZ^*\to 4\ell$ $t\bar{t}H$ hadronic, $H\to ZZ^*\to 4\ell$			$t\bar{t}H$ 1 ℓ, boosted $t\bar{t}H$ 1 ℓ, resolved (11 categories) $t\bar{t}H$ 2 ℓ (7 categories)
VH	VH 2 ℓ VH 1 ℓ, $p_{\mathrm{T}}^{\ell+E_{\mathrm{T}}^{\mathrm{miss}}} \geq 150$ GeV VH 1 ℓ, $p_{\mathrm{T}}^{\ell+E_{\mathrm{T}}^{\mathrm{miss}}}$ <150 GeV VH $E_{\mathrm{T}}^{\mathrm{miss}}$, $E_{\mathrm{T}}^{\mathrm{miss}} \geq 150$ GeV VH $E_{\mathrm{T}}^{\mathrm{miss}}$, $E_{\mathrm{T}}^{\mathrm{miss}}$ <150 GeV VH+VBF $p_{\mathrm{T}}^{j1} \geq 200$ GeV VH hadronic (2 categories)	VH leptonic 0-jet, $p_{\mathrm{T}}^{4\ell} \geq 100$ GeV 2-jet, $m_{jj} < 120$ GeV			2 ℓ, $75 \leq p_{\mathrm{T}}^{V} < 150$ GeV, $N_{\mathrm{jets}} = 2$ 2 ℓ, $75 \leq p_{\mathrm{T}}^{V} < 150$ GeV, $N_{\mathrm{jets}} \geq 3$ 2 ℓ, $p_{\mathrm{T}}^{V} \geq 150$ GeV, $N_{\mathrm{jets}} = 2$ 2 ℓ, $p_{\mathrm{T}}^{V} \geq 150$ GeV, $N_{\mathrm{jets}} \geq 3$ 1 ℓ $p_{\mathrm{T}}^{V} \geq 150$ GeV, $N_{\mathrm{jets}} = 2$ 1 ℓ $p_{\mathrm{T}}^{V} \geq 150$ GeV, $N_{\mathrm{jets}} = 3$ 0 ℓ, $p_{\mathrm{T}}^{V} \geq 150$ GeV, $N_{\mathrm{jets}} = 2$ 0 ℓ, $p_{\mathrm{T}}^{V} \geq 150$ GeV, $N_{\mathrm{jets}} = 3$
VBF	VBF, $p_{\mathrm{T}}^{\gamma\gamma jj} \geq 25$ GeV (2 categories) VBF, $p_{\mathrm{T}}^{\gamma\gamma jj}$<25 GeV (2 categories)	2-jet VBF, $p_{\mathrm{T}}^{j1} \geq 200$ GeV 2-jet VBF, p_{T}^{j1}<200 GeV	2-jet VBF	VBF $p_{\mathrm{T}}^{\tau\tau} > 140$ GeV ($\tau_{\mathrm{had}}\tau_{\mathrm{had}}$ only) VBF high-m_{jj} VBF low-m_{jj}	VBF, two central jets VBF, four central jets VBF $+\gamma$
ggF	2-jet, $p_{\mathrm{T}}^{\gamma\gamma} \geq 200$ GeV 2-jet, 120 GeV $\leq p_{\mathrm{T}}^{\gamma\gamma}$¡200 GeV 2-jet, 60 GeV $\leq p_{\mathrm{T}}^{\gamma\gamma}$¡120 GeV 2-jet, $p_{\mathrm{T}}^{\gamma\gamma} < 60$ GeV 1-jet, $p_{\mathrm{T}}^{\gamma\gamma} \geq 200$ GeV 1-jet, 120 GeV $\leq p_{\mathrm{T}}^{\gamma\gamma}$¡200 GeV 1-jet, 60 GeV $\leq p_{\mathrm{T}}^{\gamma\gamma}$¡120 GeV 1-jet, $p_{\mathrm{T}}^{\gamma\gamma} < 60$ GeV 0-jet (2 categories)	1-jet, $p_{\mathrm{T}}^{4\ell} \geq 120$ GeV 1-jet, 60 GeV$\leq p_{\mathrm{T}}^{4\ell}$¡120 GeV 1-jet, $p_{\mathrm{T}}^{4\ell} < 60$ GeV 0-jet, $p_{\mathrm{T}}^{4\ell} < 100$ GeV	1-jet, $m_{\ell\ell} < 30$ GeV, $p_{\mathrm{T}}^{\ell_2} < 20$ GeV 1-jet, $m_{\ell\ell} < 30$ GeV, $p_{\mathrm{T}}^{\ell_2} \geq 20$ GeV 1-jet, $m_{\ell\ell} \geq 30$ GeV, $p_{\mathrm{T}}^{\ell_2} < 20$ GeV 1-jet, $m_{\ell\ell} \geq 30$ GeV, $p_{\mathrm{T}}^{\ell_2} \geq 20$ GeV 0-jet, $m_{\ell\ell} < 30$ GeV, $p_{\mathrm{T}}^{\ell_2} < 20$ GeV 0-jet, $m_{\ell\ell} < 30$ GeV, $p_{\mathrm{T}}^{\ell_2} \geq 20$ GeV 0-jet, $m_{\ell\ell} \geq 30$ GeV, $p_{\mathrm{T}}^{\ell_2} < 20$ GeV 0-jet, $m_{\ell\ell} \geq 30$ GeV, $p_{\mathrm{T}}^{\ell_2} \geq 20$ GeV	Boosted, $p_{\mathrm{T}}^{\tau\tau} > 140$ GeV Boosted, $p_{\mathrm{T}}^{\tau\tau} \leq 140$ GeV	

W’ Efficiency

- Decrease at high mass due to low mass off-shell component becoming dominant.



$B_s \to J/\psi\ \varphi$

Parameter	Value	Statistical uncertainty	Systematic uncertainty
ϕ_s[rad]	–0.076	0.034	0.019
$\Delta\Gamma_s[\mathrm{ps}^{-1}]$	0.068	0.004	0.003
$\Gamma_s[\mathrm{ps}^{-1}]$	0.669	0.001	0.001
$\lvert A_{\parallel}(0)\rvert^2$	0.220	0.002	0.002
$\lvert A_0(0)\rvert^2$	0.517	0.001	0.004
$\lvert A_S\rvert^2$	0.043	0.004	0.004
$\delta_\perp$ [rad]	3.075	0.096	0.091
$\delta_\parallel$ [rad]	3.295	0.079	0.202
$\delta_\perp - \delta_S$ [rad]	–0.216	0.037	0.010

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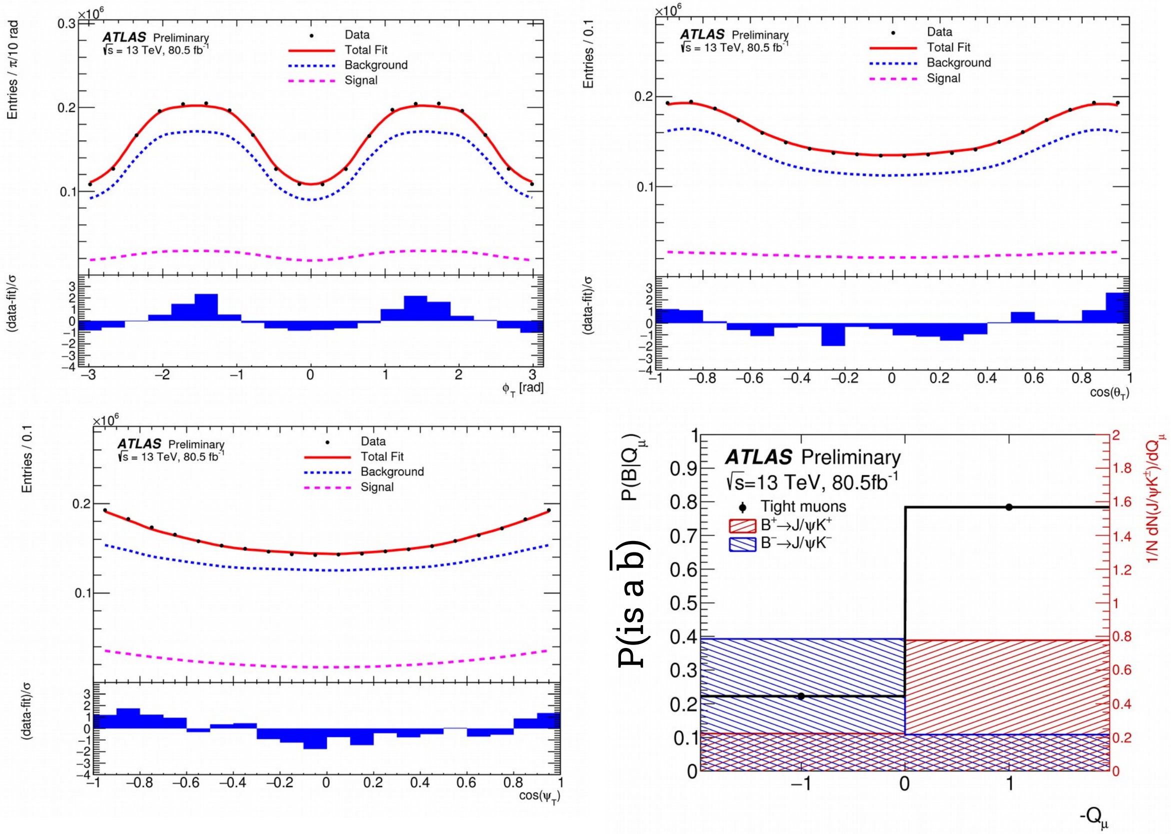
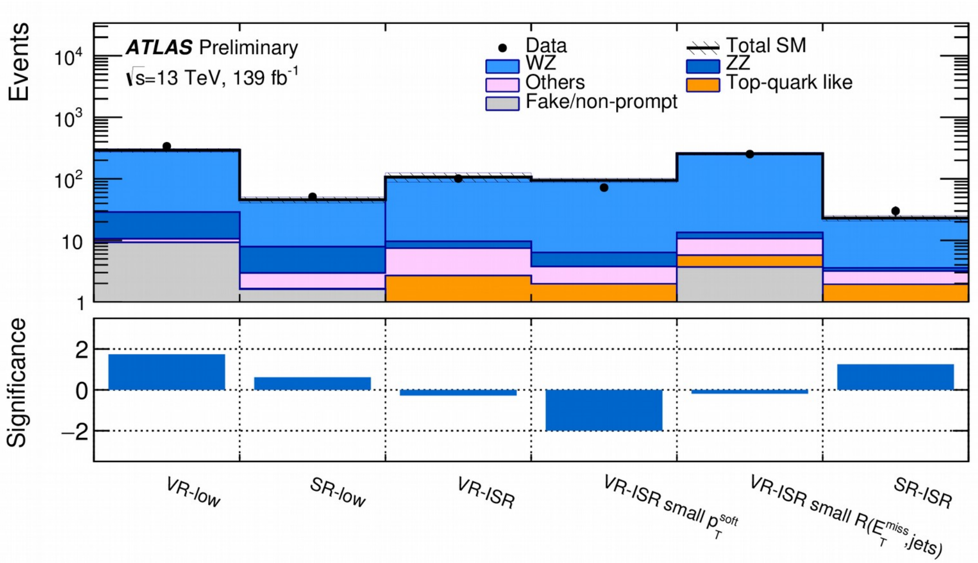
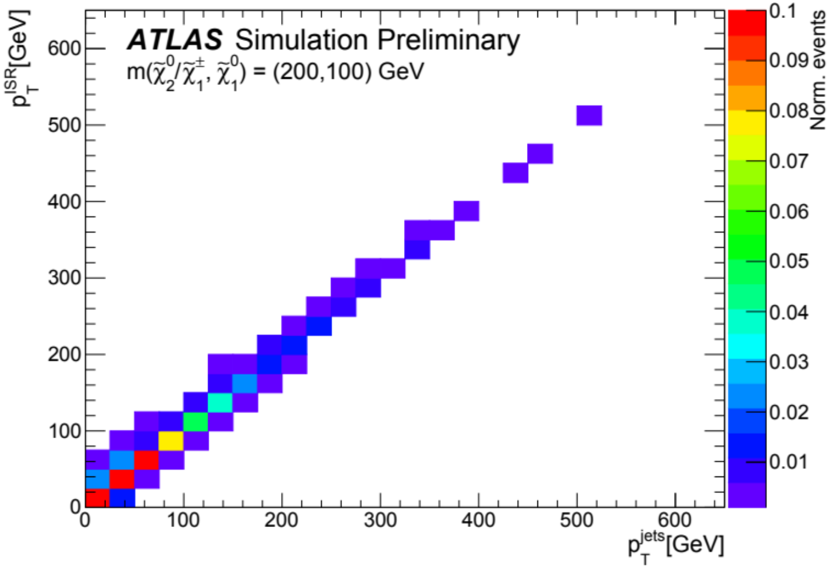
Tag method	Efficiency [%]	Effective Dilution [%]	Tagging Power [%]
Tight muon	4.50 ± 0.01	43.8 ± 0.2	0.862 ± 0.009
Electron	1.57 ± 0.01	41.8 ± 0.2	0.274 ± 0.004
Low-p_T muon	3.12 ± 0.01	29.9 ± 0.2	0.278 ± 0.006
Jet	5.54 ± 0.01	20.4 ± 0.1	0.231 ± 0.005
Total	14.74 ± 0.02	33.4 ± 0.1	1.65 ± 0.01



SUSY Trilepton Distributions

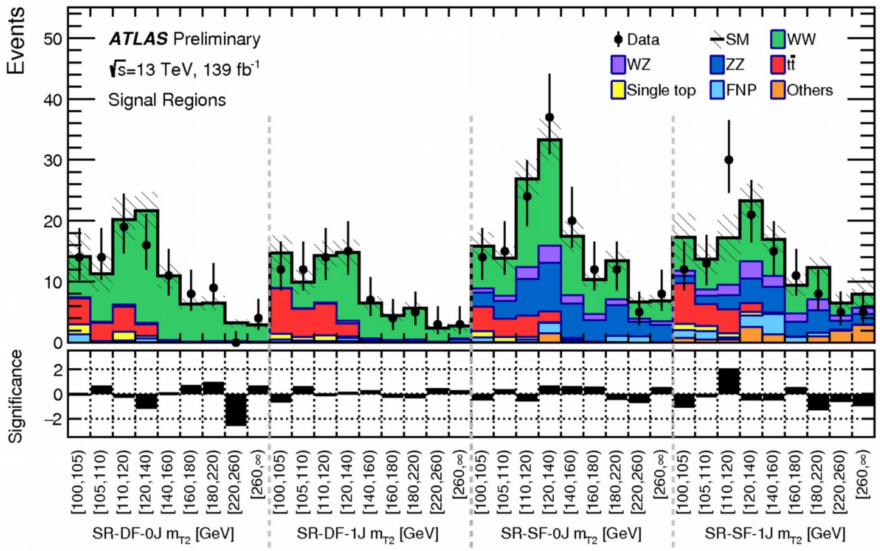


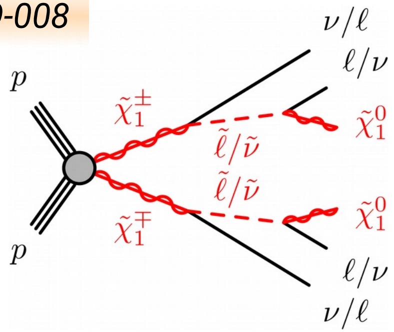


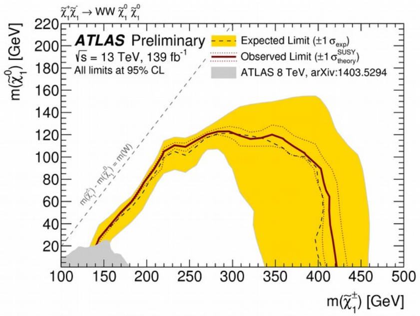
SUSY: Chargino/Slepton Production

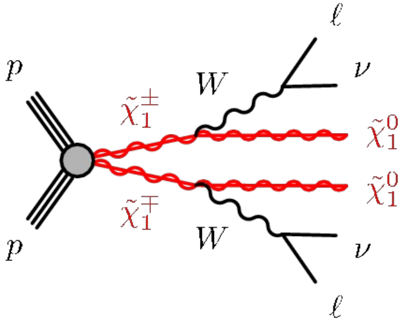
ATLAS-CONF-2019-008

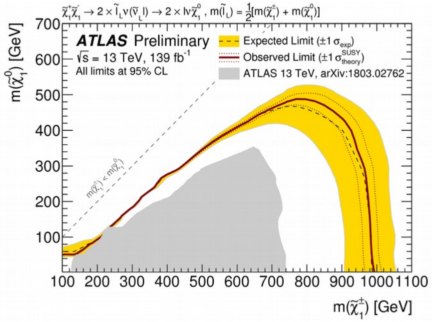
- Chargino/slepton production
  - final state 2ℓ (e/μ) + MET
  - m(ℓℓ) > 100 GeV (eμ) / 121.2 GeV (ee/μμ), b-jet veto, MET > 110 GeV, no more than one jet
  - SRs binned in m_{T2}, # jets, flavor

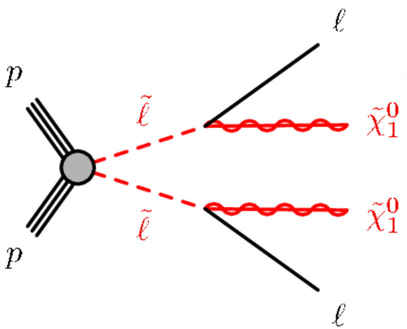


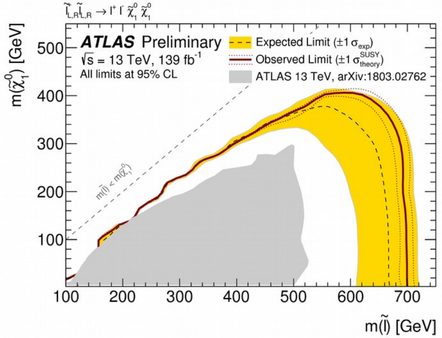




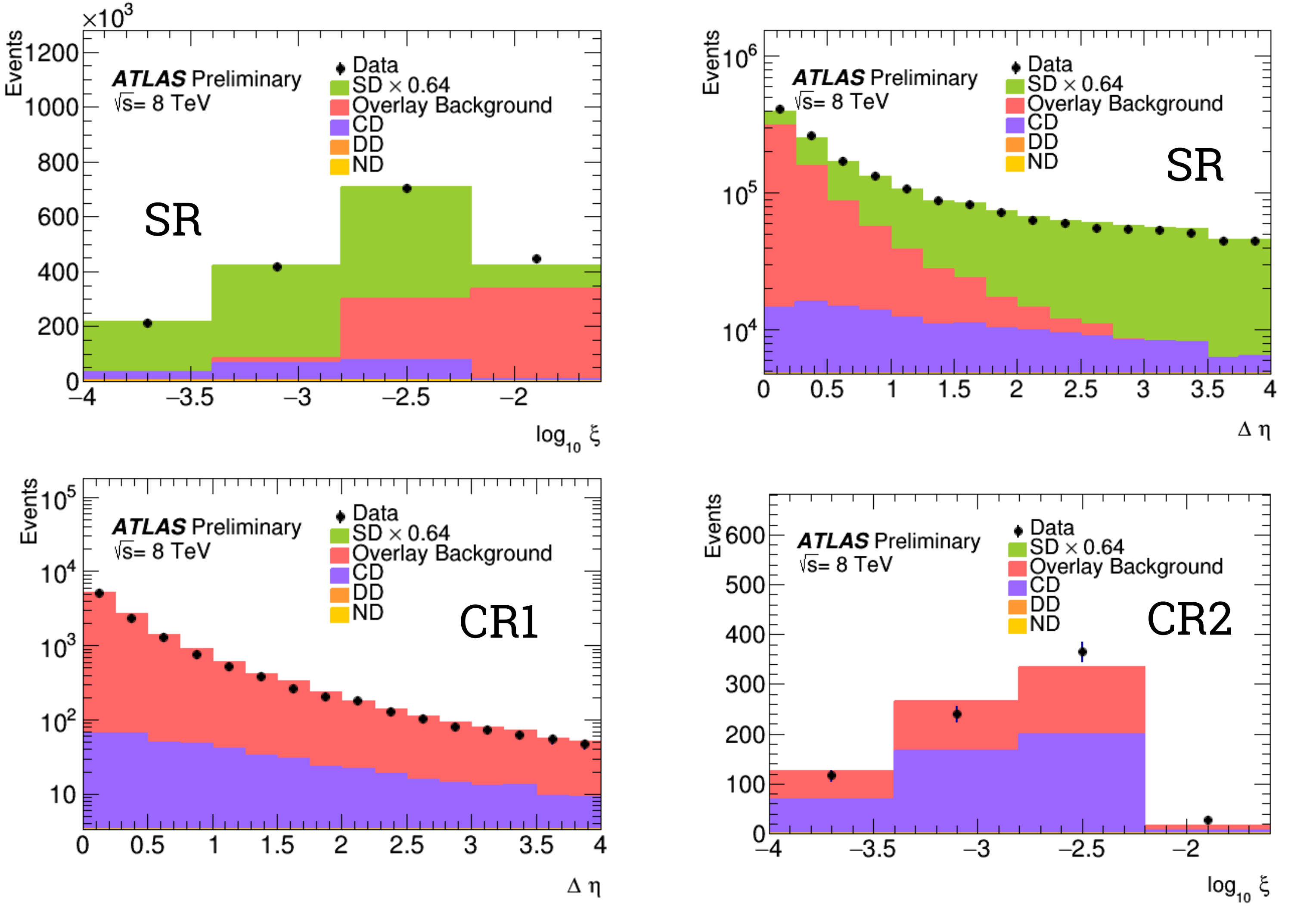




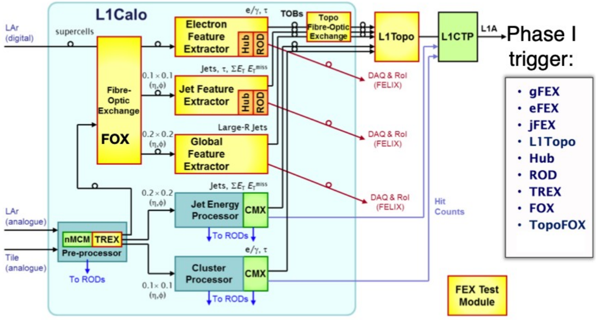




ALFA SD: background modeling



TDAQ Phase-I Upgrade



L1Calo Module	Review	Planned/ HELD
gFEX	PRR	Dec-17
eFEX	PRR	Aug-19
jFEX	PRR	Jun-19
Topo	PRR	Jul-19
Hub	PRR	Dec-18
ROD	PRR	Jul-19
TREX	PRR	Oct-19
FOX	PRR	May-18
TopoFOX	FDR	Apr-19

L1Calo:

- Prototype boards exist for all FEXs.
- Being tested in Surface Test Facility (STF)@CERN aiming for full FEX-Hub-ROD-FELIX data path.
- Baseline algorithms established for all FEXs.
- Results from latency tests are within envelopes.
- System Testing integration of modules in STF at CERN until October 2019.
- some Production Readiness Reviews, depending on inter-module tests and FW readiness have delays.
- No technical problems found so far.
- Installation Q4-2019 until Q1-2020.

FELIX:

- Significant stability improvements in firmware and software
- FPGA utilisation under control.
- Pre-production of 20 boards testing found issues, under evaluation, final PRR foreseen May-19 is delayed.
- Target for installation Q3 2019

L1Muon

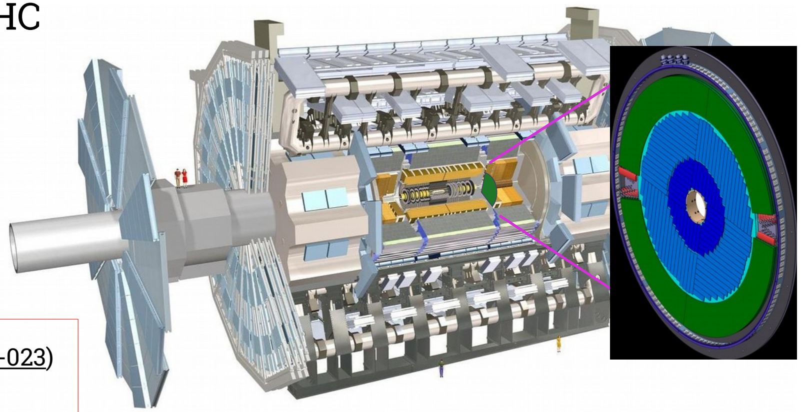
- Barrel+Endcap Muon Sector Logic (SL) installation planned for July 2019. Then cabling to MuCTPi.
- MuCTPi: final tests to make choice between two Prototypes ongoing (different SoC).
- Tests of connection between BW Trigger Processor (TP) and SL successful.
- Installation from Q4 2019 onwards.

High Granularity Timing Detector (HGTD) for HL-LHC

- σ_t /track ~ 30-50 ps up to end HL-LHC
- 2.4 < |η| < 4.0 ; Z ~+-3.5 m from IP
- < 10% occupancy
- 1.3 × 1.3 mm2 LGAD pixels (6.4 m2)
- 3.6×10^6 channels
- Luminosity (hit counting) detector
- < (3-5) $\times 10^{15} n_{eq}/cm^2$

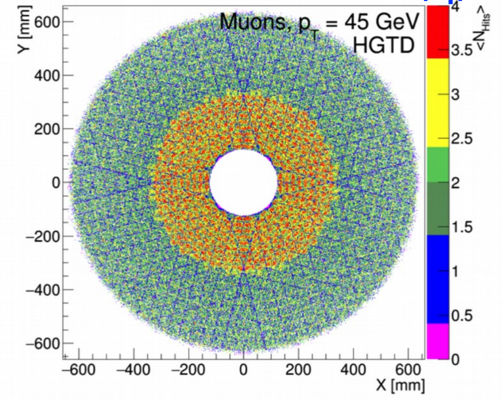
TP approved in June 2018: (CERN-LHCC-2018-023)

Deliver TDR to LHCC by April 2020

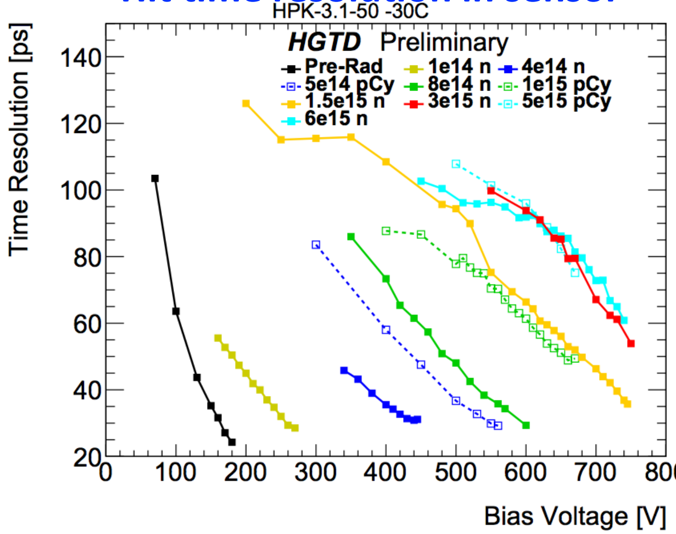


~2 hits/track 2.4 < |η| < 3.1

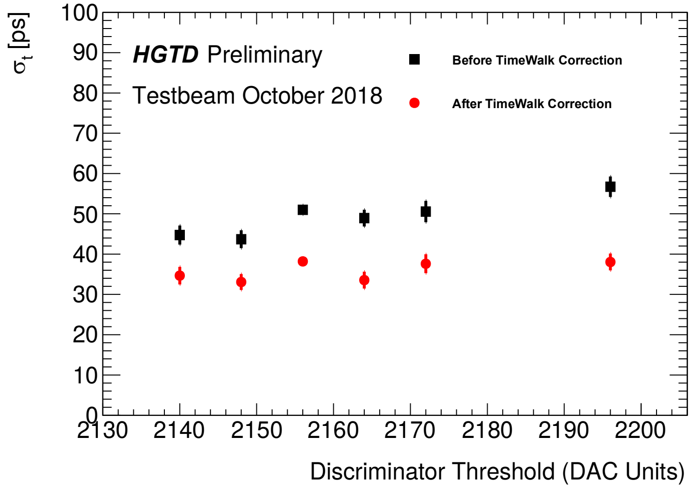
~ 3 hits/track 3.1 < |η| < 4.0

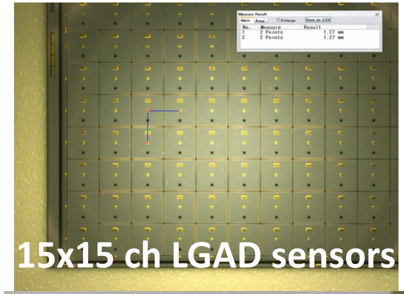


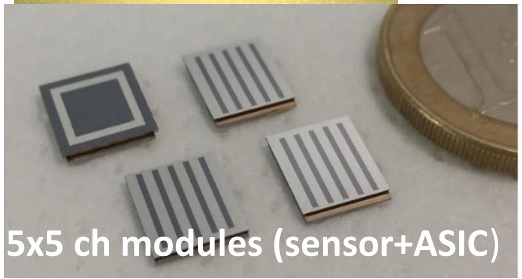
Hit time resolution in sensor



ASIC(Altiroc0 2x2 ch)+sensors in testbeam

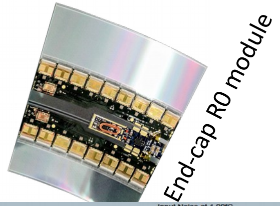


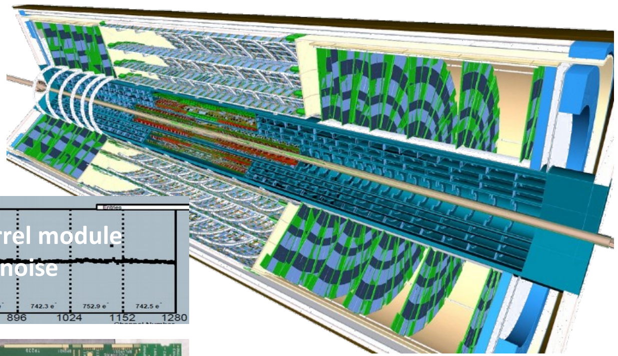


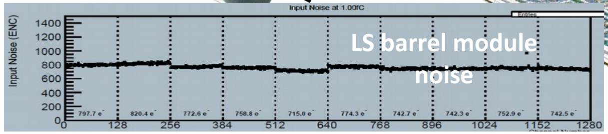


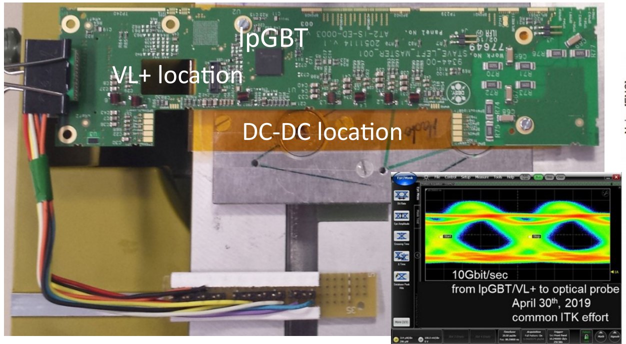
Recent Developments in the ITk Strip Sub-system (WBS 2.2)

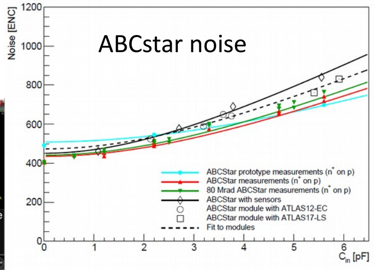
- ITk Strip System consists of 4 barrel cylinders and 2 end-cap with 6 disks each
  - 165 m^2 of silicon (61 m^2: ID), ~18 k modules (~4k modules ID)
- Adopted multi-modular approach (staves/petals)
  - Designed manufacturability and mass production into components from the start
- The ITk Strip project is undergoing the transition from prototyping to pre-production
- Some highlights:
  - Last prototype readout ASIC (ABCstar) and Hybrid Control Chip (HCCstar) have >90% grade A yield
  - Excellent module performance matches expectations
  - First End of Substructure (EoS) cards with lpGBT and VTRX+ working well
  - First double sided (ABC130-based) stave completed anc tested
- This coming year will have most of our technica reviews allowing for pre-production (FDR)
  - First FDR to allow for sensor preproduction finished this April

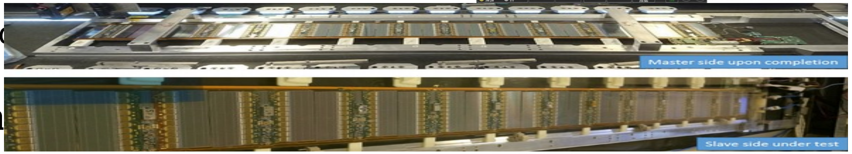




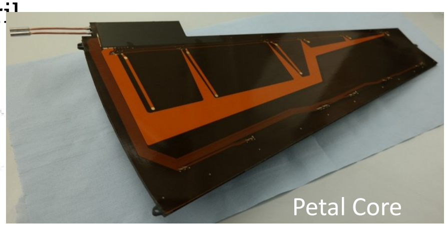




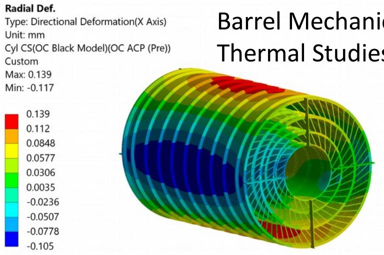




End-cap sensor layouts

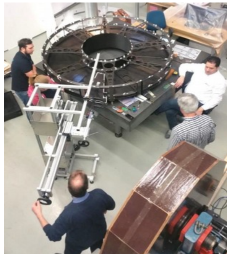

Petal Core

Barrel Mechanics Thermal Studies



EC Global Support Demonstrator + Petal Insertion

Wheel mockup @Nikhef



The Muon Phase-II Upgrade

- The design of new electronics for MDT / TGC / RPC is progressing: New ASICs are either in pre-production phase (MDT ASD, TGC PP ASIC) or we have first prototypes (MDT TDC, RPC FE).

- BIS78, a pilot project for Barrel-Inner (BI) chambers (<10% of total), is on track for installation in LS2: first RPC production module has very good quality. Half of sMDT chambers.

- The design of the new BI chambers is progressing well. New baseline for RPCs includes two-sided h-h strip readout (instead of h-j) and staggered chambers in the large sectors, to improve acceptance and simplify layout and services.