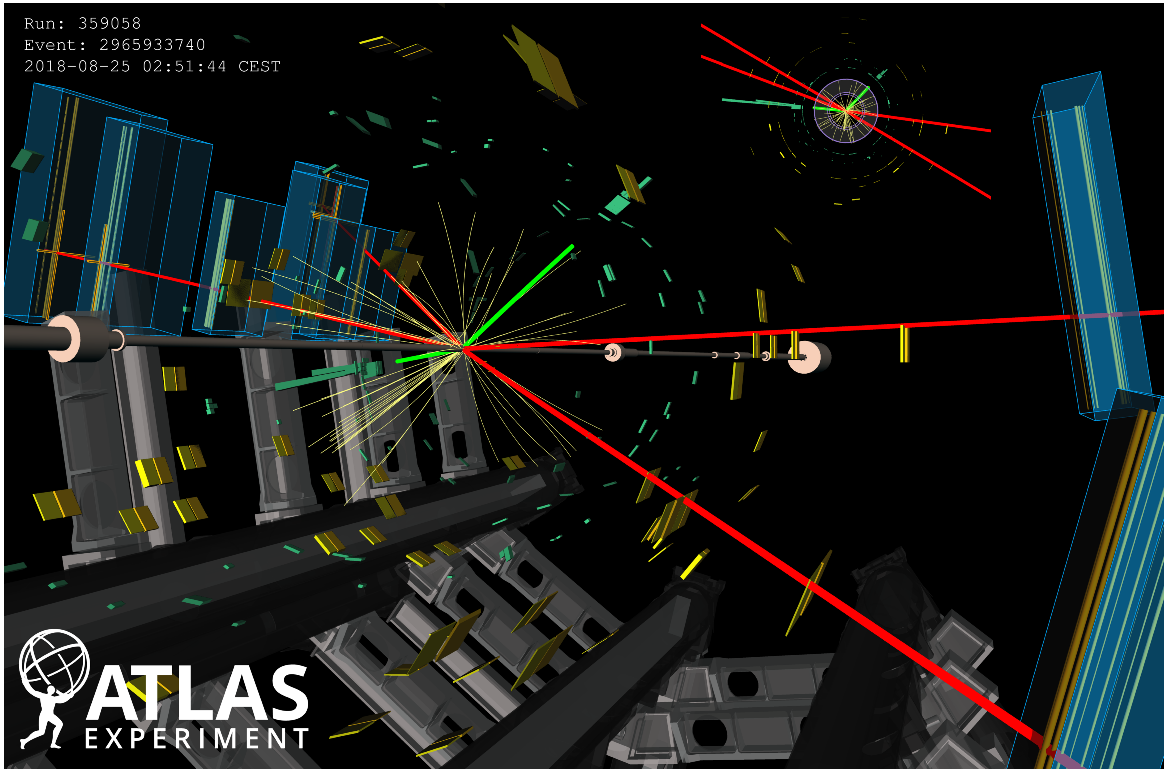
Status of the ATLAS Experiment



Karl Jakobs
University of Freiburg / Germany

49th Meeting of the ATLAS RRB, 28th October 2019

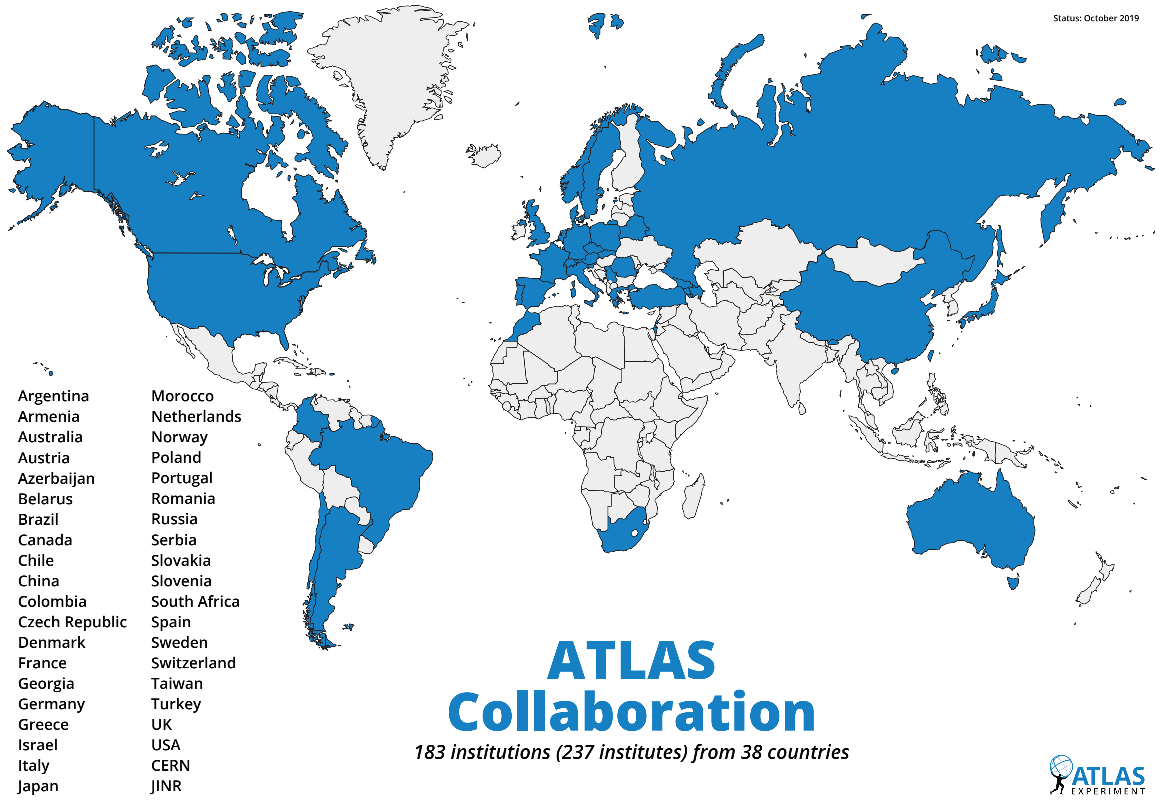
Status of the ATLAS Experiment

- Collaboration composition
- Recent physics highlights
- Decision on the ATLAS FTK project
- Status of the Phase-II MoUs and funding
- Status of the Phase-II projects

Karl Jakobs
University of Freiburg / Germany

49th Meeting of the ATLAS RRB, 28th October 2019

The ATLAS Collaboration



183 Institutions (237 Institutes) from 38 Countries

(four additional institutes joined since last RRB meeting)

- Universidade de Lisboa Instituto Superior Técnico (IST) → Portuguese cluster (→ 6 institutes)
- Universidad Andrés Bello, Chile → Chilean ATLAS cluster (→ 3 institutes)
- iThemba Labs, South Africa → South African ATLAS cluster (→ 5 institutes)
- University of South Africa (UNISA)

Technical Associate Institutes

A new status as **Technical Associate Institute** has been defined;

Approved by the ATLAS Collaboration Board in Feb 2019

- *Designed for research laboratories or universities that seek to have a close cooperation with the ATLAS Collaboration on primarily technical work over an extended (multi-year) period of time.*

  They do not intend to join the ATLAS Collaboration as a full member Institution and do not intend to contribute to the ATLAS physics programme;

  → no signature of physics publications;
  Instead: common publications with ATLAS authors on technical work (project-related publications)

- *The principal reason for a Technical Associate membership is cooperation on one or more challenging technical project(s) relevant for the ATLAS Collaboration,*
  e.g. detector development, engineering, electronics, firmware, software and computing, ...

Associated Technical Institutes (cont.)

Five Institutes have been accepted in the June Collaboration Board (CB) for an association to ATLAS as **Technical Associate Institute:**

- **École nationale Supérieure d'Informatique (ESI), Algiers / Algeria**
  (engagement in the Software & Computing Activity)

- **University of West Attica, Athens / Greece**
  (engagement on electronics, in the Muon project, on NSW and Phase-II)

- **Universidad de Castilla La Mancha / Spain**
  (engagement in TDAQ, DAQ network technologies and system optimization for Phase-II.

- **Fachhochschule Dortmund, Dortmund / Germany**
  (engagement on electronics, in the ITk Pixel project, RD53 chip)

- **Omega Ecole Polytechnique, Palaiseau / France**
  (engagement on electronics, in the LAr and HGTD upgrade projects)

Cooperation Agreements between CERN and these Institutes have been signed

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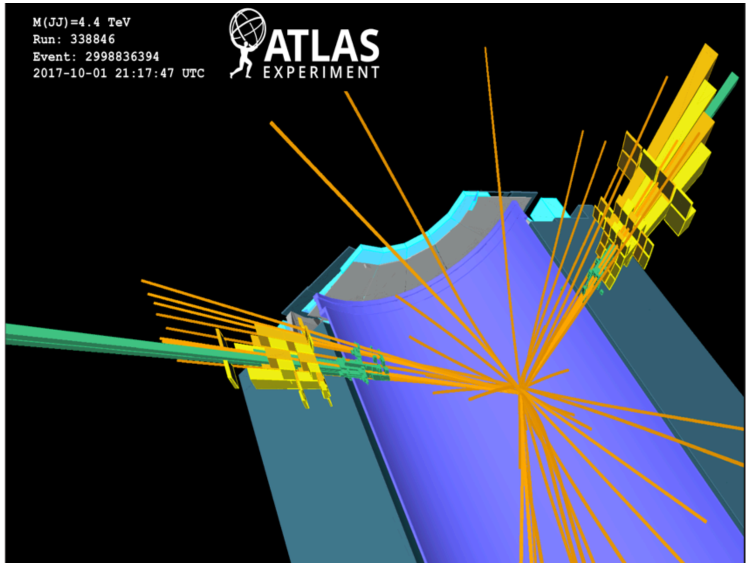
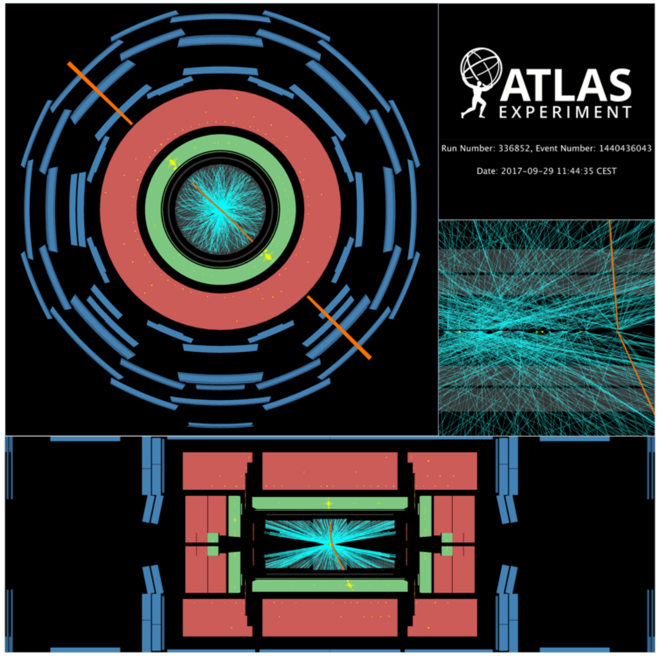
Two additional institutes have been accepted in the October CB:

- Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences / China (HGTD, sensors)
- University of West Bohemia, Pilsen/Czech Republic, Faculty of Electrical Engineering (Forward, electronics)

Recent Physics Highlights

- Already many analysis results based on full Run-2 dataset 139 fb^{-1} (2015 - 2018 data)
  https://twiki.cern.ch/twiki/bin/view/AtlasPublic/ResultswithData2018





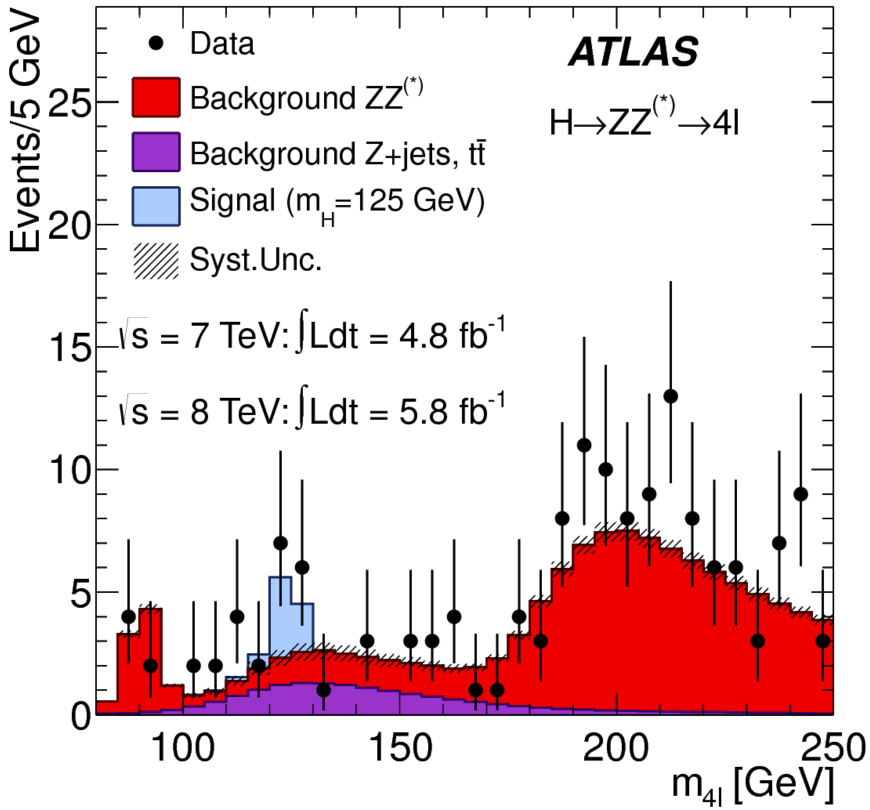
- First wave of search results (winter, spring) is followed by measurements based on full Run-2 dataset

171 publications,	36 fb^{-1}	(2015 - 2016 data)
37 public results (11 papers),	139 fb^{-1}	(2015 - 2018 data)
2 public results (1 paper),	1.7 nb^{-1}	(2018 Heavy Ion data)

Higgs boson Physics

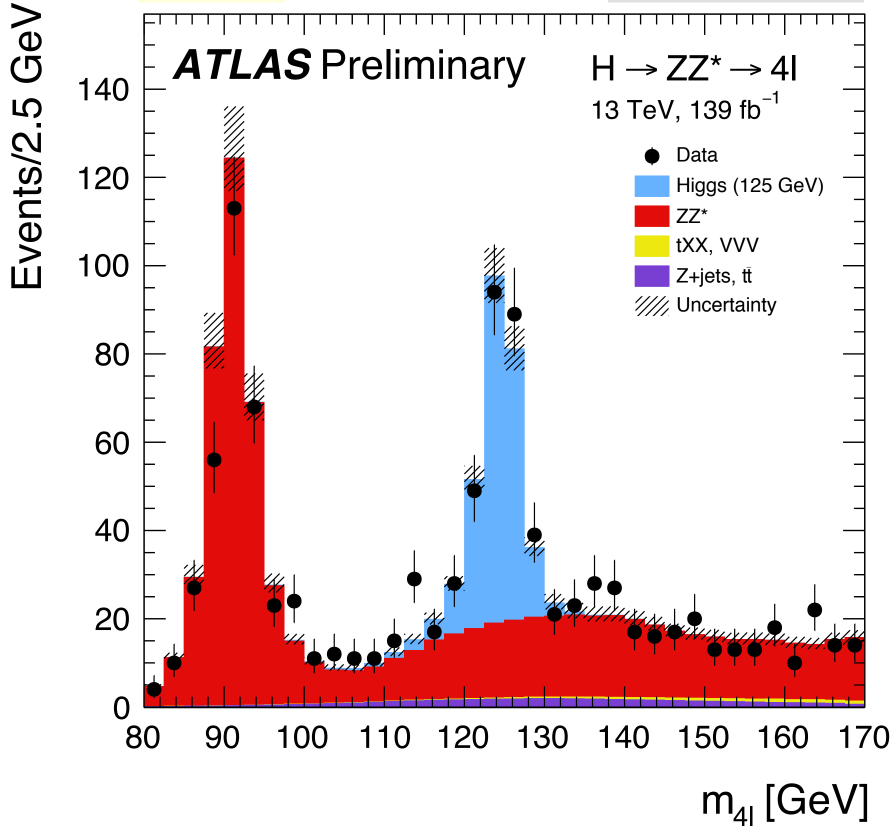
2012

Phys. Lett. B716 (2012) 1



2019

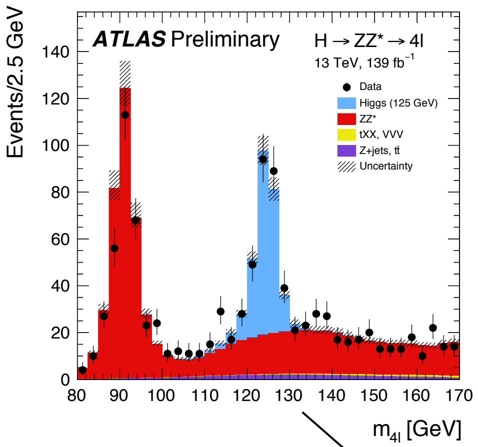
ATLAS-CONF-2019-025



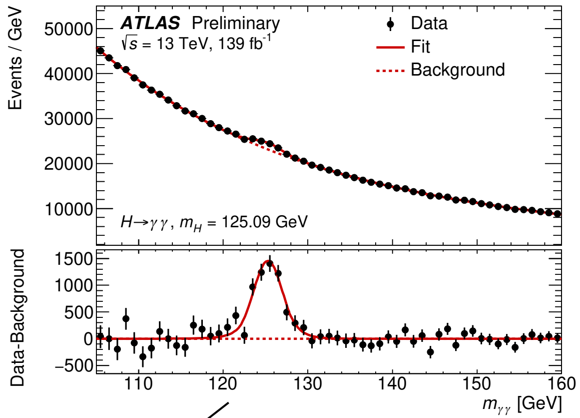
Huge progress illustrated by comparison of H → ZZ* → 4ℓ signals

Higgs boson Physics

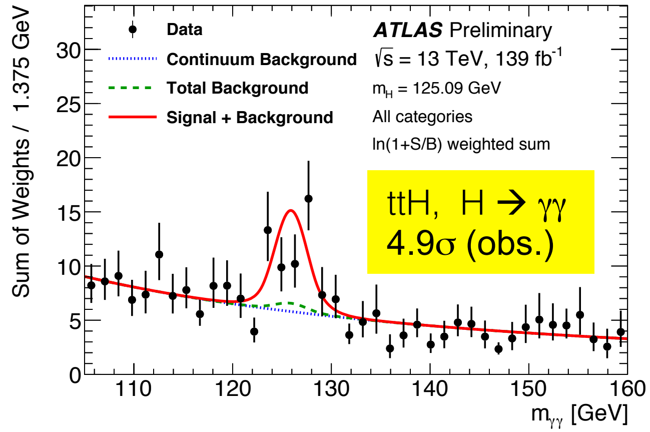
ATLAS-CONF-2019-025

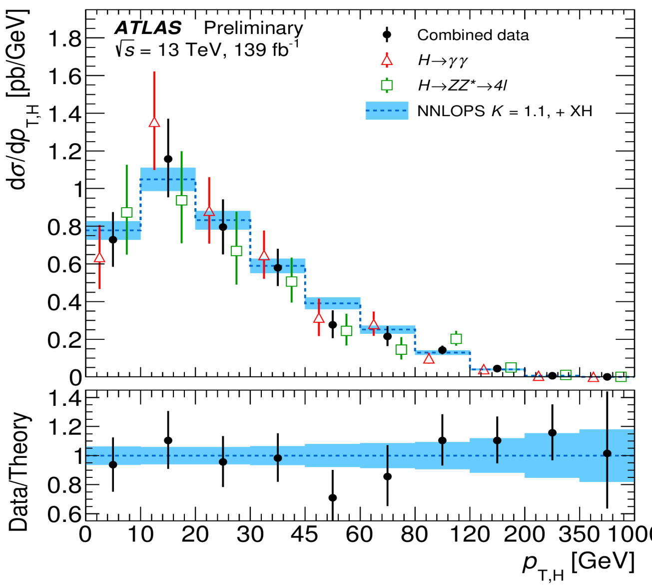


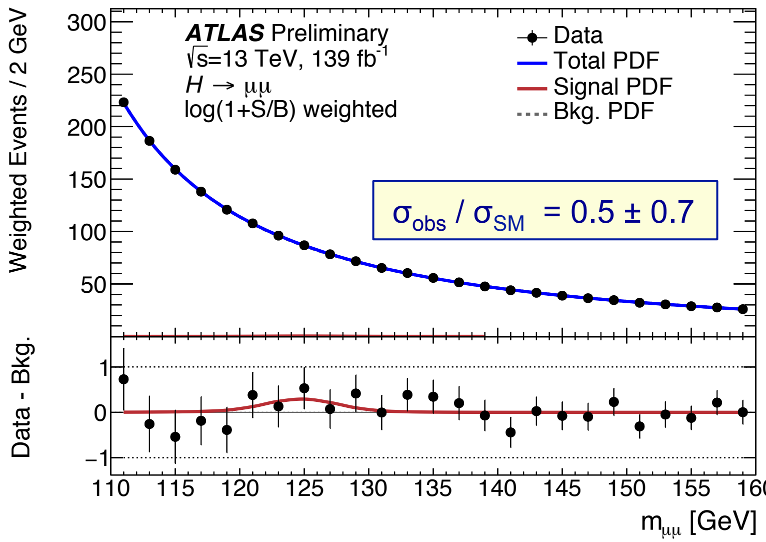
ATLAS-CONF-2019-029



ATLAS-CONF-2019-004



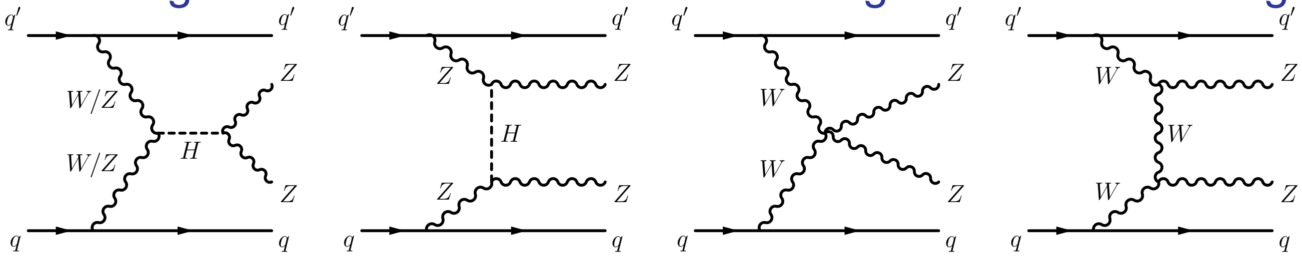




Run-3 data + combination with CMS will be important!

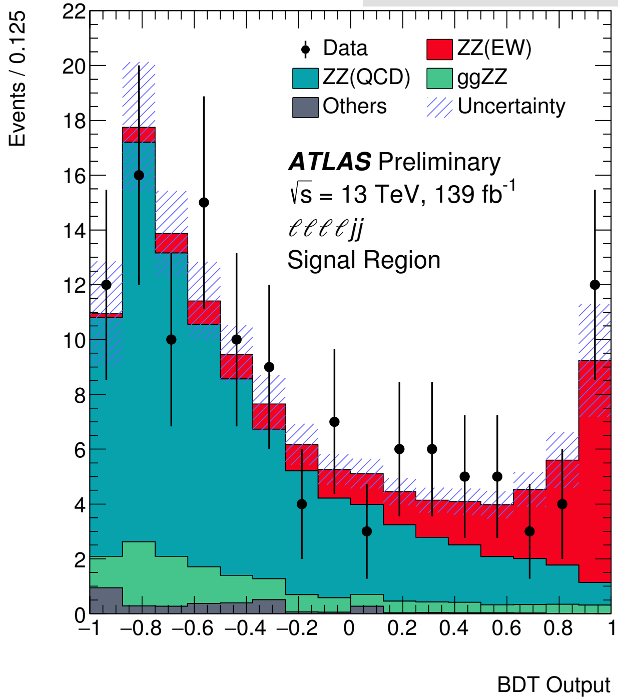
Observation of Vector Boson Scattering in ZZjj

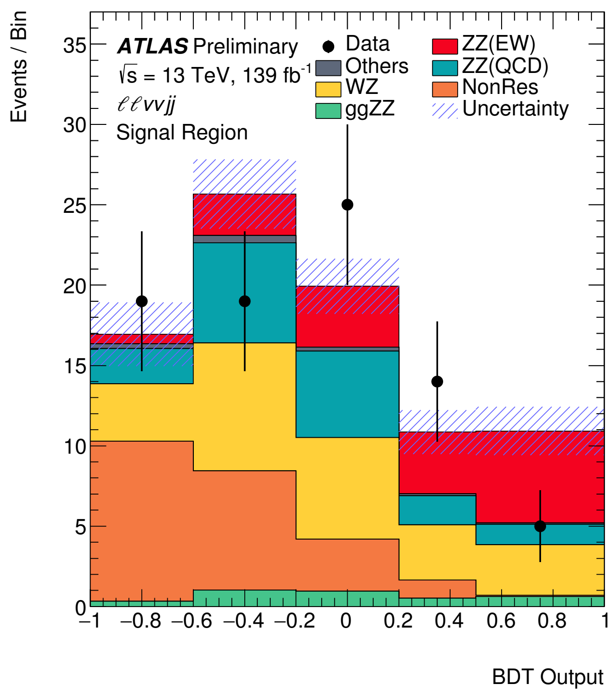
- Higgs boson regularises the weak boson scattering cross section at high energies



- ZZjj analysis exploits decays to four charged leptons ($\ell\ell\ell\ell$) and ($\ell\ell\nu\nu$)
- Multivariate analysis to separate EW signal from backgrounds (e.g. QCD ZZ)

ATLAS-CONF-2019-033





Observed (expected) significance for EW production: 5.5σ (4.3σ)

σ_{fid}(EW) = 0.82 ± 0.21 fb

SM pred.= 0.61 ± 0.03 fb

ATLAS observed vector-boson scattering at:

- 6.9σ in WW channel
- 5.3σ in WZ channel

→ All VVjj channels have now been observed

Top-Quark Physics

- tt cross section: eμ final state and ≥ 1 b-tagged jet

Total $\sigma_{t\bar{t}} = 826.4 \pm 3.6 \pm 11.5 \pm 15.7 \pm 1.9\,\text{pb}$ ± 2.4%

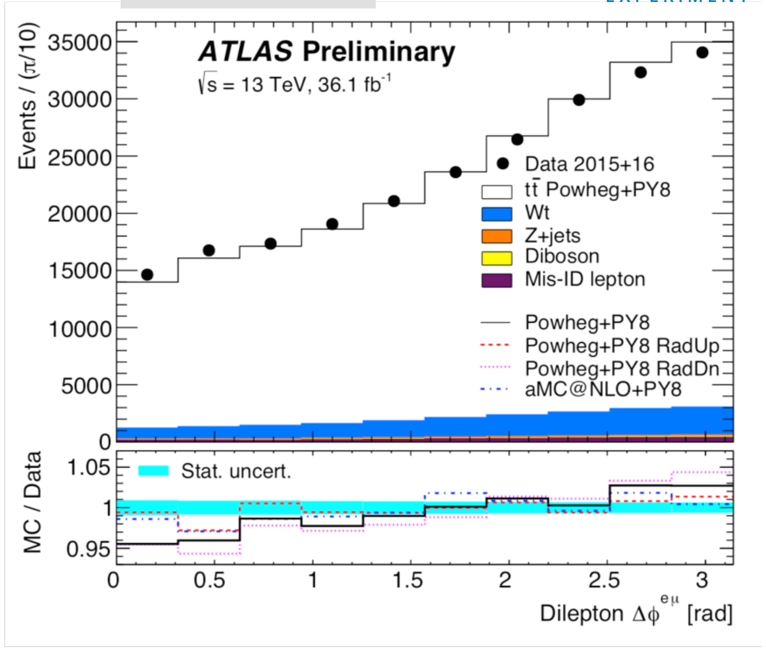
NNLO+NNLL prediction: $832 \pm 35^{+20}_{-29}\,\text{pb}$

(Fiducial and differential cross sections also provided)

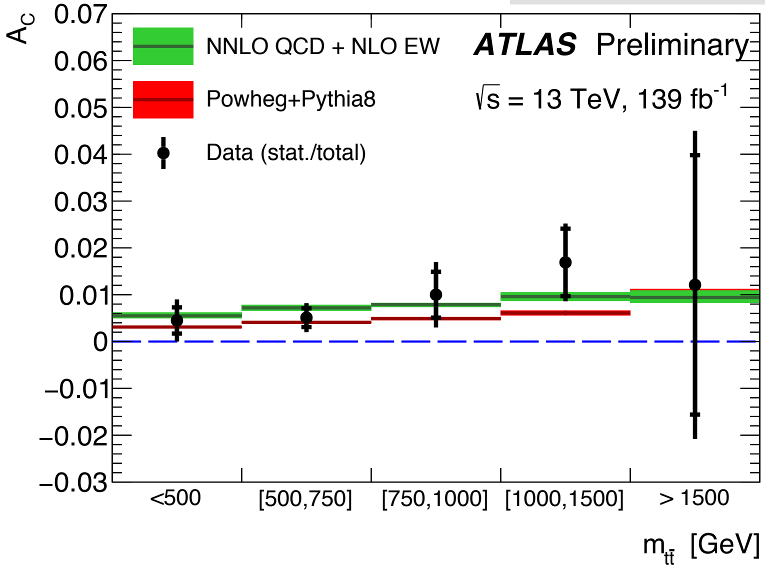
- Pole mass measurement: $m_t^{\text{pole}} = 173.1^{+2.0}_{-2.1}\,\text{GeV}$

- Charge asymmetry measurement
  → non-zero at 4σ (first evidence at the LHC)

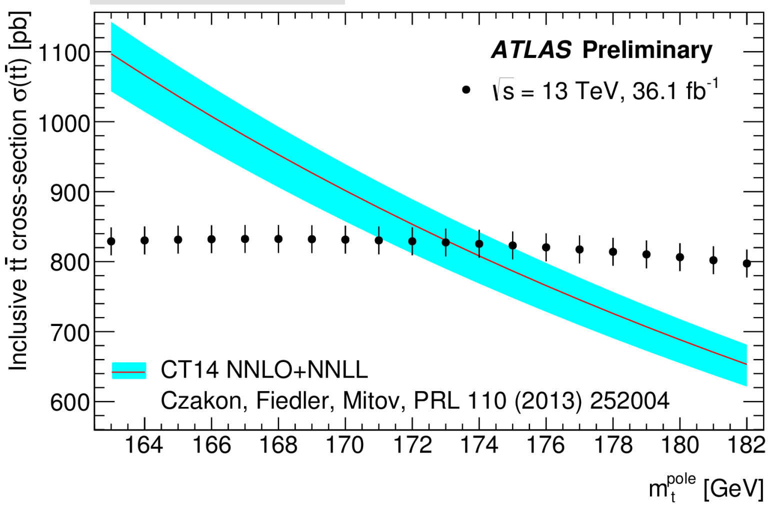
ATLAS-CONF-2019-041



ATLAS-CONF-2019-026



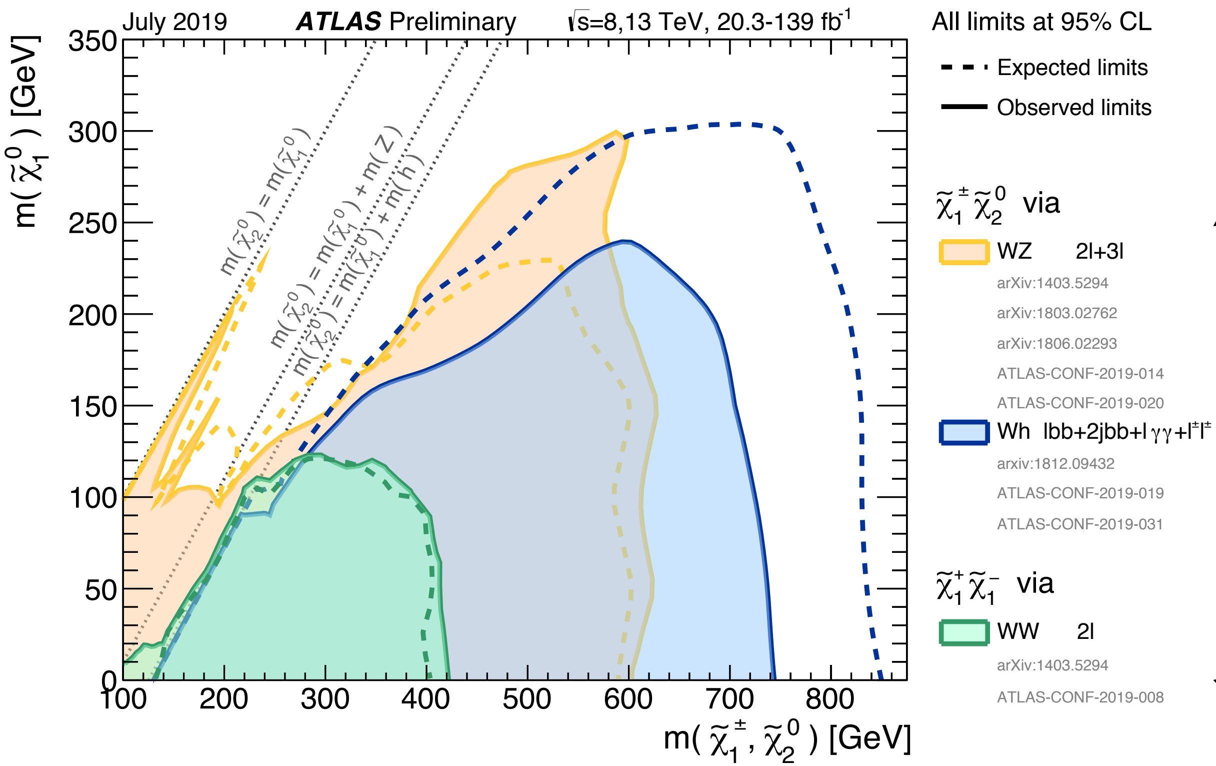
ATLAS-CONF-2019-041

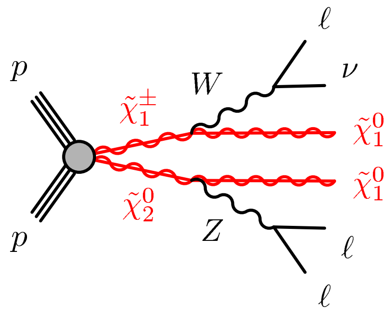


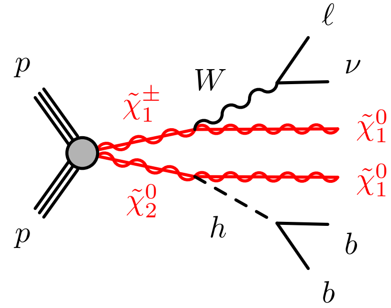
SUSY: Electroweak production

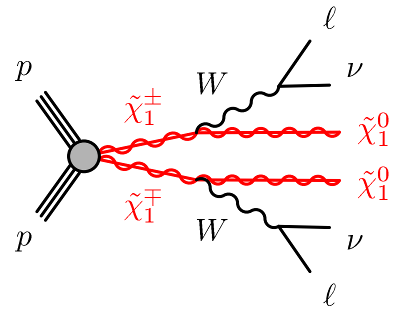
If squarks and gluinos are very heavy, then electroweak production of SUSY particles could dominate → much lower cross sections, challenging phase space to explore

Summary of some recent ATLAS SUSY EWK results with 139 fb^{-1}





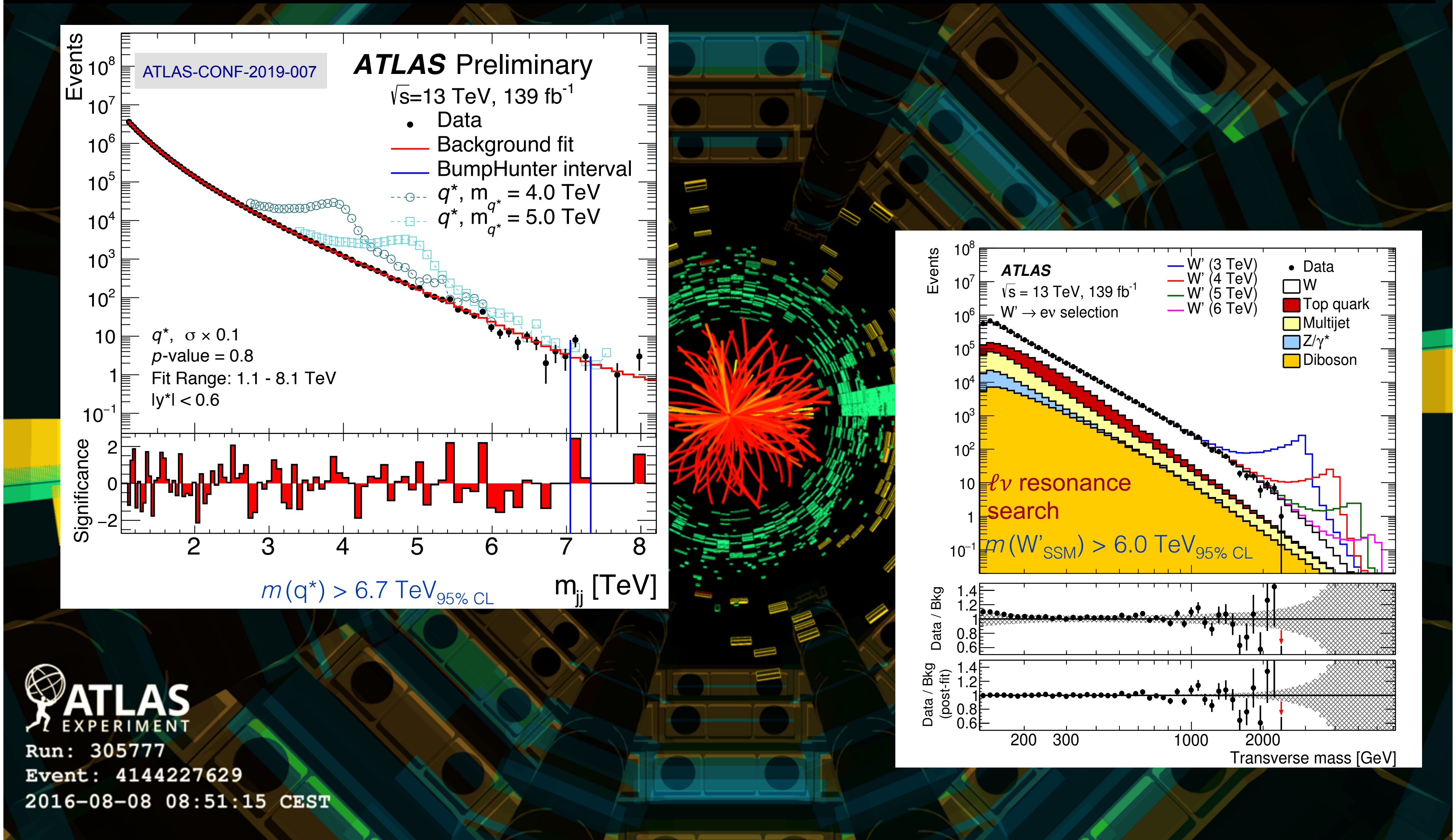




Most favourable case: electroweakino production with decays through light sleptons: exclusion reaches up to 1 TeV (not shown)

Direct slepton production excluded up to 700 GeV mass (ATLAS-CONF-2019-008)

Highest-mass central dijet event of 8.0 TeV selected in resonance search



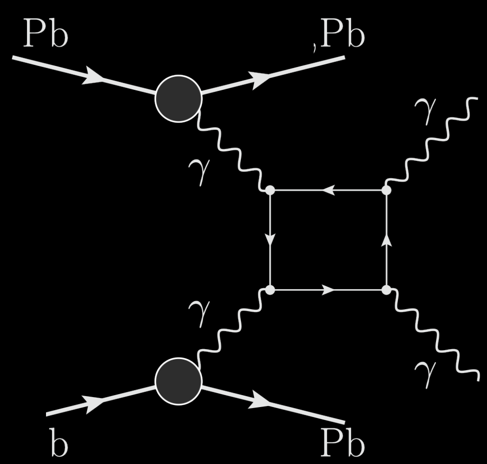
Observation of light-by-light scattering in 5.02 TeV ultraperipheral Pb+Pb collisions taken in 2018

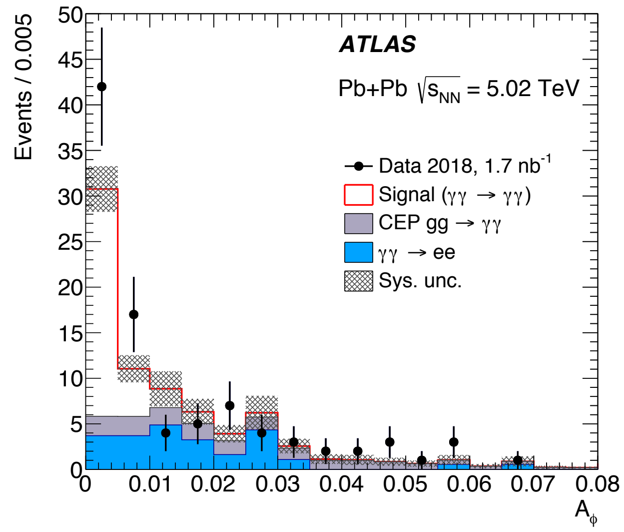
Phys. Rev. Lett. 123 (2019) 052001

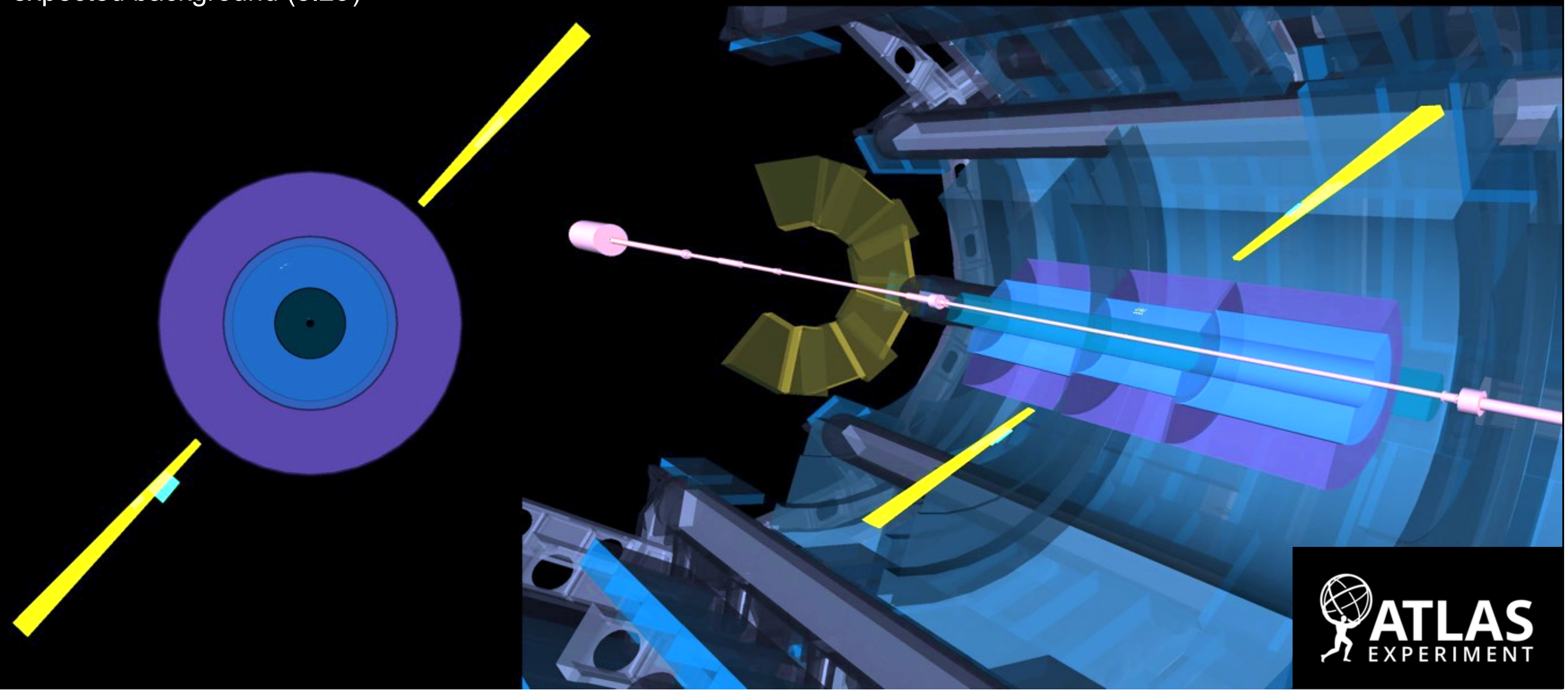
Field strength of up to 10^{25} V/m
$\gamma\gamma$ luminosity ~ Z^4 ~ 5 10^7

Look for low-energy back-to-back photon pair with no additional activity in detector

59 $\gamma\gamma \rightarrow \gamma\gamma$ candidate events observed for 12 ± 3 expected background (8.2σ)







Heavy Ion Physics

Ultraperipheral PbPb collisions are rich source of photons

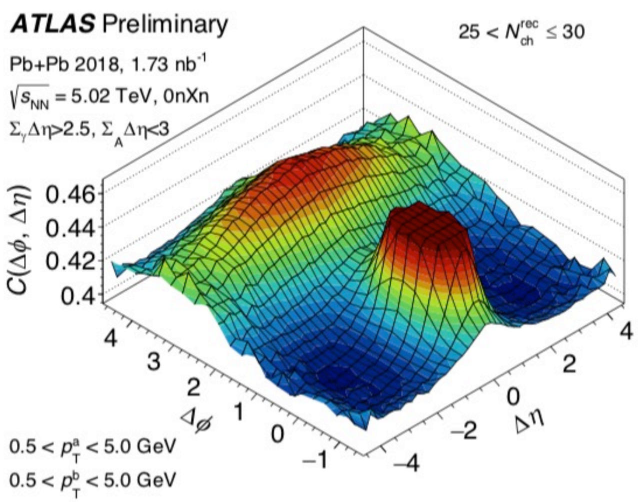
Look for two-particle correlations in γ+Pb scattering (selected by dedicated photo-nuclear trigger)

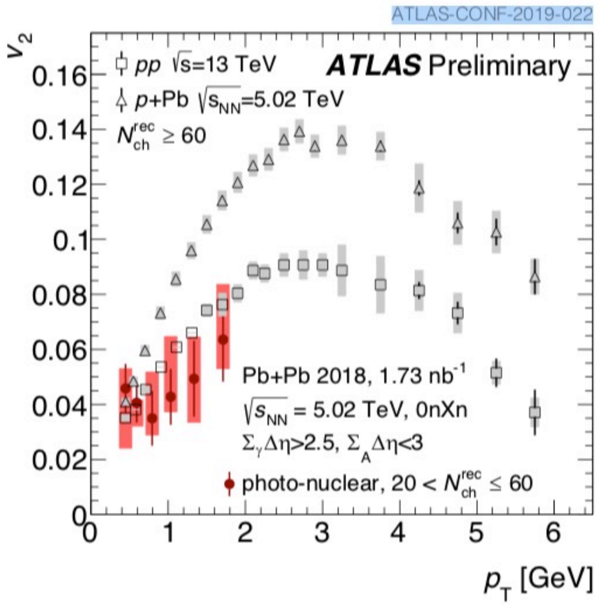
Two-particle correlations observed in non-UPC Pb+Pb, p+Pb in pp collisions:

- Long-range azimuthal correlations ("ridge") due to collective behavior in "quark-gluon plasma", quantified via Fourier decomposition of yields in ϕ (v_2 is the leading term, called elliptic flow)

Can such an effect occur in photo-nuclear collisions?

ATLAS-CONF-2019-022





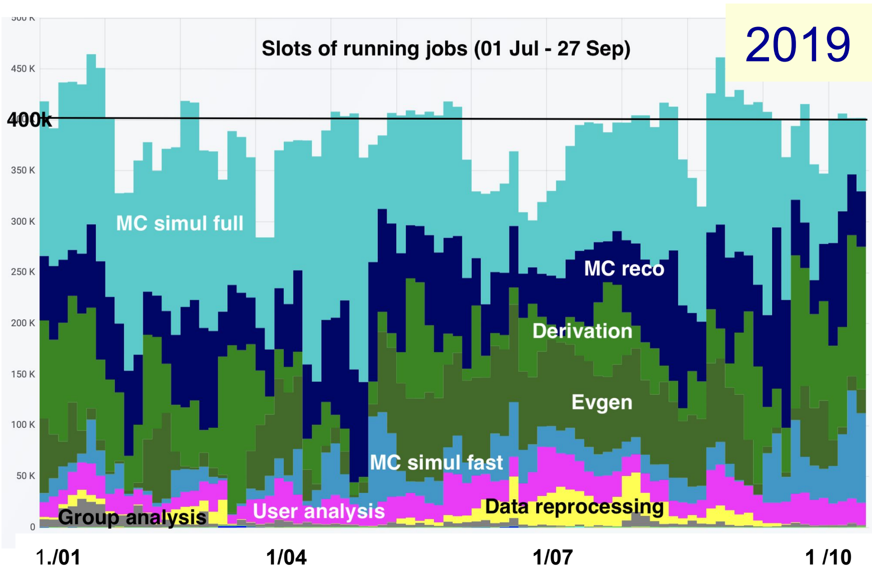
- Vector-meson dominance: photon fluctuates to vector meson γ+Pb ⇔ ρ+Pb

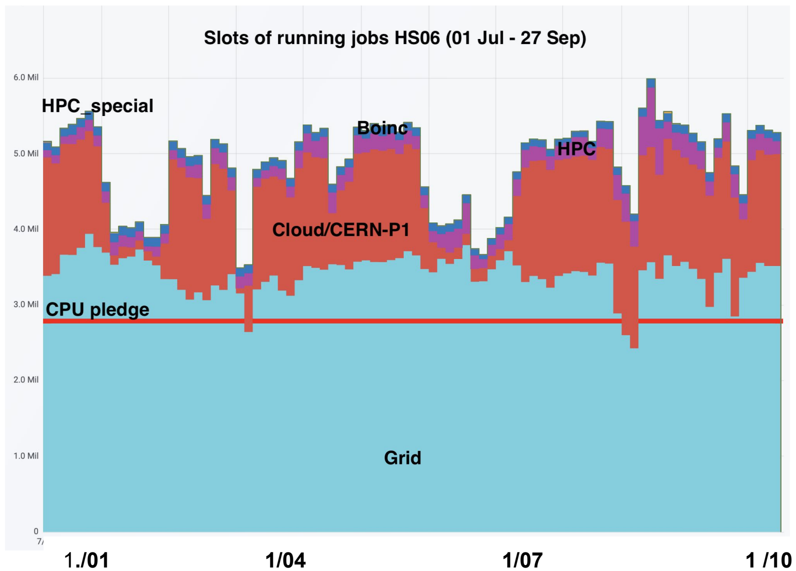
Software & Computing

- Preparation and validation of the Run-3 software release (R22), incl. multithreaded Athena, ongoing; good progress, some delays, but not critical
  - Performance optimization during 2020
  - Feature freeze planned for mid 2020 to prepare for Run-2 data and MC reprocessing to achieve a a consistent dataset with Run 3

- Analysis Model Study Group for Run 3 has worked out improvements to our overall ATLAS analysis model (ATL-COM-SOFT-2019-027)
  A prototype for DAOD_PHYS is available with a size of 40 kB / event

- Enabling new improved **Fast Simulation** for production remains a high priority





Preparations for HL-LHC software

ATLAS is following **two main development routes** for HL-LHC:

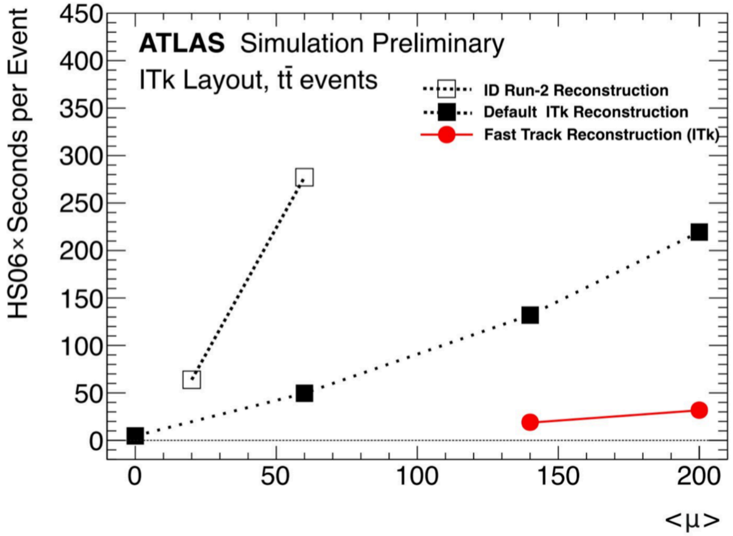
(i) Re-thinking existing workflows and algorithms to achieve sustainable performance with Run-4 data and Monte Carlo

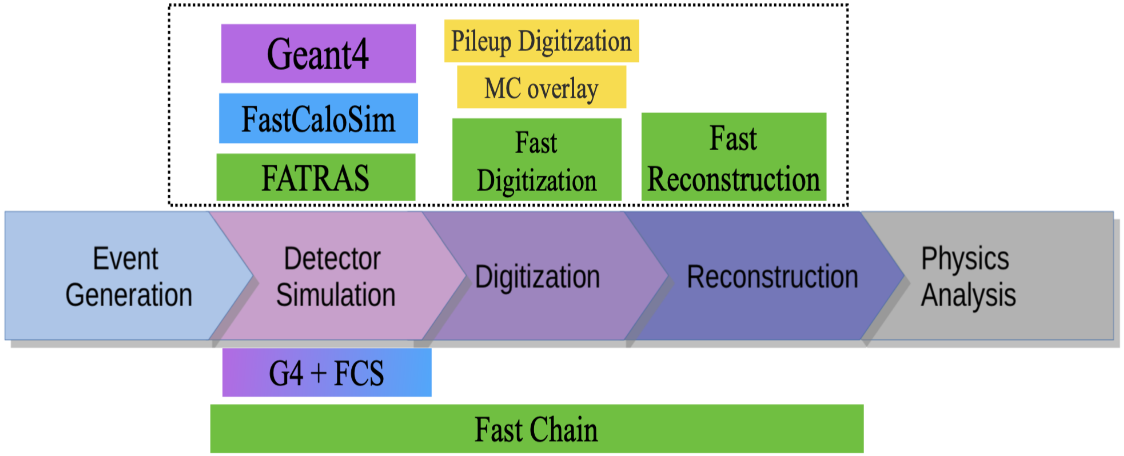
(ii) Equipping the ATLAS software to run in heterogeneous computing environments

Preparations for HL-LHC software

(i) Re-thinking existing workflows and algorithms to achieve sustainable performance with Run-4 data and MC

→ Focus on the biggest CPU consumers: track reconstruction and simulation



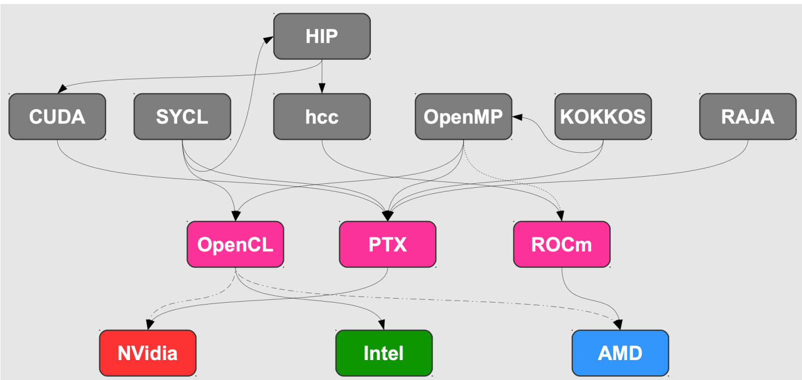


- ID track reconstruction workflow is being re-thought for extremely high pile-up environments taking advantage of ITk
- Geant4 settings are being revisited to identify where savings can be made
- Fast Chain Simulation is being prepared to combine “full” simulation (Geant4) with fast simulation (calo, tracking) with fast digitisation and reconstruction

Preparations for HL-LHC software

(ii) Equipping the ATLAS software to run in heterogeneous computing environments

- Equipping Athena to offload work onto computational accelerators (of whatever type)
- Investigating portability libraries such as SYCL and OneAPI: working to converge on a common solution with CMS
- Limited work on re-coding algorithms in CUDA: not a priority until portability questions are settled, but useful for feasibility studies
- Profiling the existing software to figure out where offloading to accelerators will have the biggest impact
- Interest in using machine learning (ML) techniques for parts of the chain (e.g. fast simulation, tracking) but not yet proven that the techniques can be made to work with sufficient performance



Note that substantial gains might be achieved should the event generators and Geant4 be equipped for heterogeneous computing environments. This should be a priority for the relevant developers

Preparations for HL-LHC Distributed Computing

- ATLAS is already well advanced in **developing and deploying technology for connecting to a variety of computing resources** including exascale HPCs.
  Many of these (Harvester, event service) are in use already.

- R&D to **extend existing technology to better handle accelerators**, provisioning, containers, networking, remote storage and mixed workload execution

- **Data management** is a topic on which much R&D is being committed, covering smart data placement, third-party-copying, streaming and caching

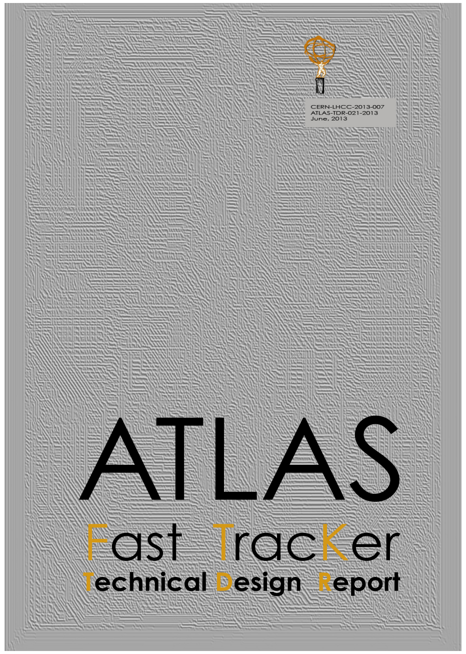
- **New analysis model** includes a prototype analysis format for Run 4 (DAOD_PHYSLITE with 10 kB/event target) which will be introduced from the start of Run 3, along with the data carousel for increasing fluidity between disk and tape

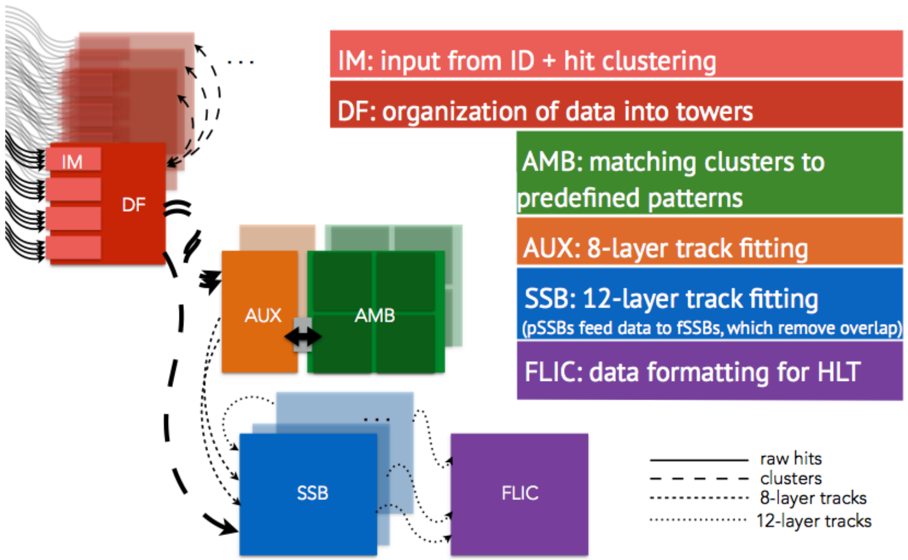
- IRIS-HEP framework essential for delivery of many of these components

LHCC review of Run-4 computing and software will take place in Spring 2020. ATLAS will prepare a ***Conceptual Design Report*** *into all aspects of its computing and software as input for this review.*

Editorial team in place: Paolo Calafioura and Davide Costanzo

Decision on Fast TracKer (FTK) Project

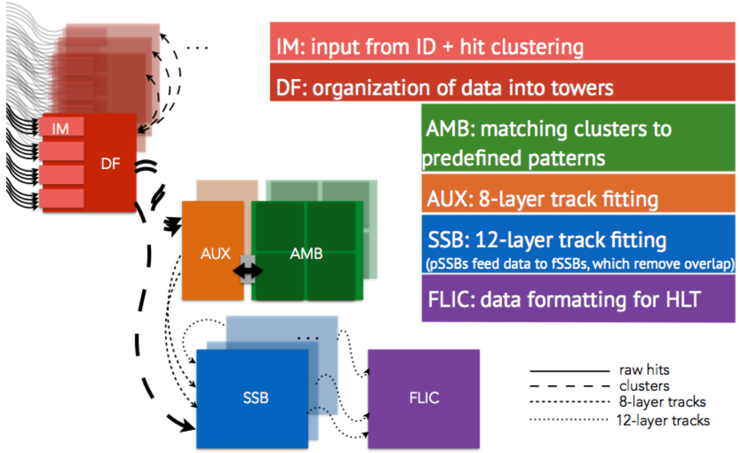




*The **ATLAS Collaboration** has decided to close the Phase-I project on the development of the Fast TracKer (FTK).*

This decision was taken by a vote of the ATLAS Collaboration Board in its meeting on 11th October. A large majority (~94%) of ATLAS institutions voted in favour of closing the project.

FTK Development



- TDR milestones were not achieved on time

  TDR milestones:
  * Installation of system, full barrel region, μ ~ 46, by July 2015
  * Installation of system, entire detector, μ ~ 46, by end 2015
  * Completion of system, entire detector, μ ~ 69, by end 2018

- No running system during Run 2 (2015 – 2018); Limited to a slice (no data sharing / DF functionality, hardware problems on SSB), however, the principle of associative-memory based track finding (AMB, Italy) in high-pileup environment at the LHC has been demonstrated

  → ATLAS management initiated a review in June 2018
  "What is required to achieve successful commissioning during LS2?"
  Goal: FTK must be fully functional during Run-3 production years (2022 – 2023)
  (note that there will be no FTK at HL-LHC, Run 4 and beyond)

- Conclusion of the review panel (Feb. 2019): significant increase in resources required, in particular on the technical side
  (6 FTEs, firmware engineers, incl. an overall system engineer)

FTK Development(cont.)

- Despite strong efforts made (e.g. new hirings), the necessary resources were not found; Review of the commissioning plan by ATLAS Project Management Office (PMO)

  PMO considered the proposed plan as inadequate

  → FTK team proposed a down-scoped version of FTK, running at an input rate of 35 kHz (instead of 100 kHz) → simplified firmware

- Re-assessment of the 35 kHz proposal by PMO:

  "Present plan is more solid, however, high risks remain that the project will not be completed on time; the HLT can offer an alternate strategy for accommodating the goals of the FTK with minimal risks."

Considerations by ATLAS management

- ATLAS successfully took data in Run 2, at 2 10^{34} cm^{-2} s^{-1} at pileup values of $\mu \sim 55$;
  Run-3 conditions will be similar to those in Run 2

- HLT has high performance, CPU power increased significantly over the past years, plus HLT algorithm development
  → an "extended" trigger menu can be covered by the HLT in the Run-3 production years 2022 and 2023

- The "physics case" of FTK running at 35 kHz is further diminished

→ Justification for FTK is reduced, in particular for a down-scoped version;
(At time of the proposal: large uncertainties on detector and trigger (HLT) performance under high pile-up (assumed was up to 69), expected to reach luminosities of 3 10^{34} cm^{-2} s^{-1} , ...)

- PMO: High risk remains that the project will not be completed on time

- ATLAS has higher priority projects than FTK35, e.g. New Small Wheel and Phase-II projects, that require the full attention of the Collaboration;

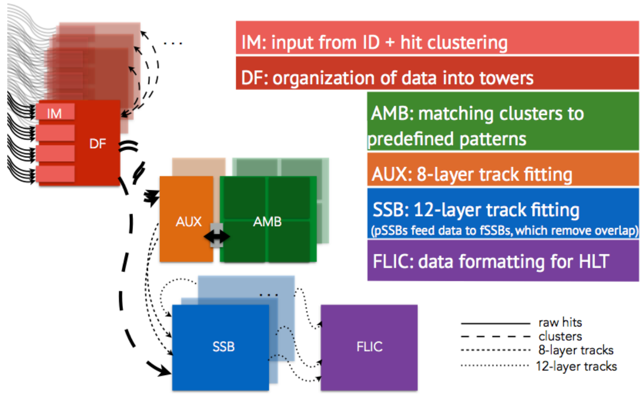
  In addition, the higher priority projects require similar types of expertise as FTK;
  Resources should not be re-directed from them to FTK

Decision on Fast TracKer (FTK) Project

- Discussion in ATLAS Collaboration Board in June

  → Proceed with strict milestone follow-up, **ATLAS TDAQ Project Leader** to define key milestones, project would be stopped in case milestones not passed

  Necessary condition: resources in place for 2020, 2021 (commissioning with data) and for operation (2022, 2023)



- However, in September it became clear that not enough resources can be secured

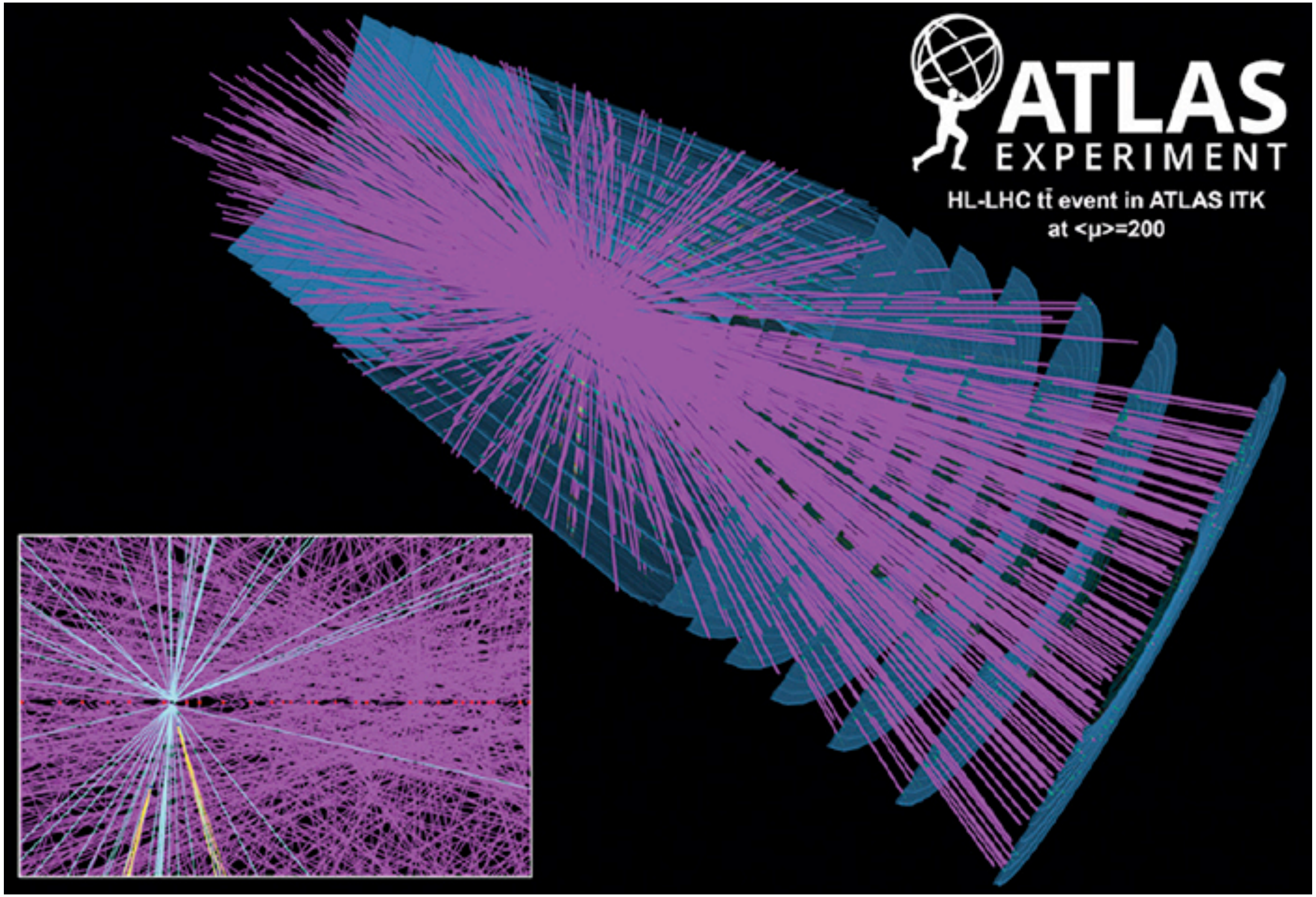
  → TDAQ managm. recommended to close the project due to lack of resources (supported with strong majority by TDAQ Institute Board)

  - This was unanimously **endorsed by the ATLAS Executive Board** on 28th September

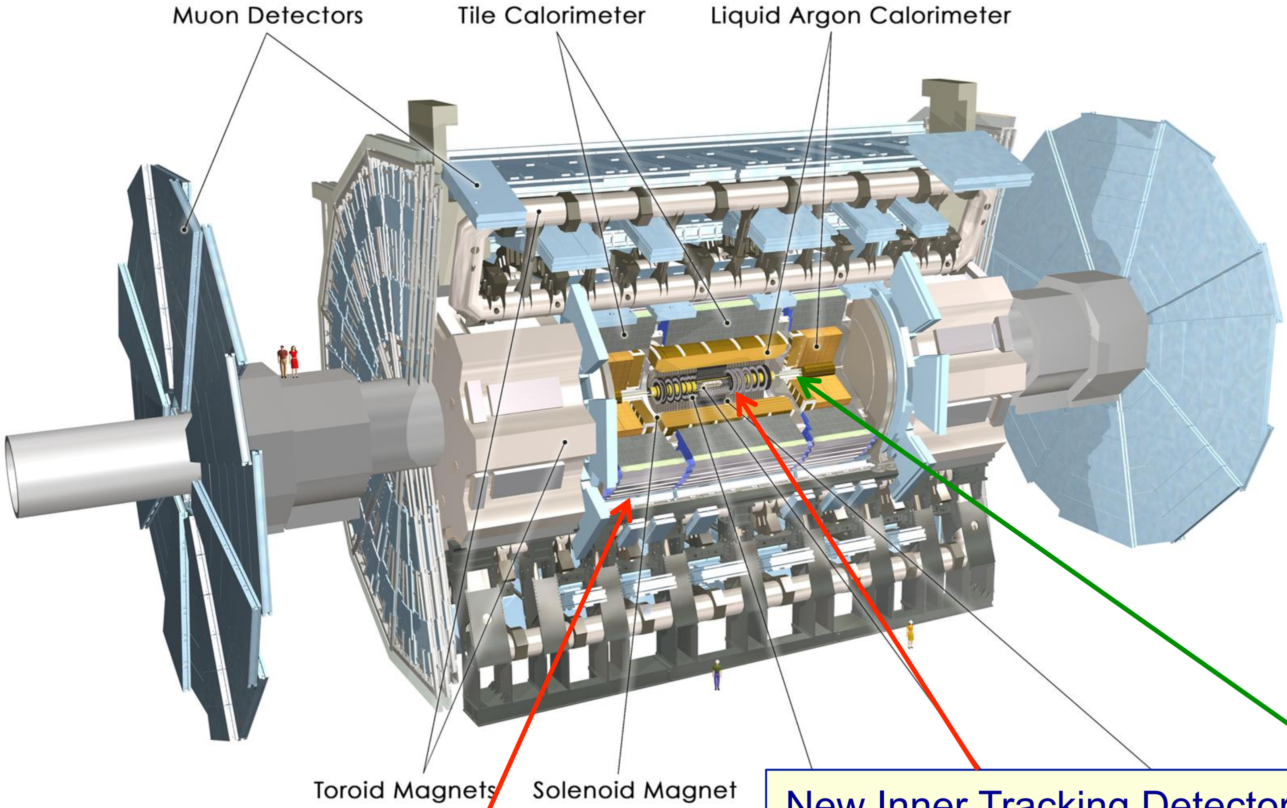
  - **Final decision** taken by the **ATLAS Collaboration Board** on 11th October;
    The proposal to close the project was supported by a large majority (~94%) of ATLAS institutions.

- FTK groups aim to publish scientific results based on 2017 / 2018 slice data, and then to integrate into other, high-priority Phase-I or Phase-II projects of the Collaboration

Status of Phase-II Upgrade Activities



ATLAS Phase-II Upgrade



Upgraded Trigger and Data Acquisition System:

- L0: at 1 MHz
  (capable of evolving to a dual-level architecture with L0 at 4 MHz)
- Improved Event Filter
  (output rate of 10 kHz, hardware tracking as co-processor)

Electronics Upgrade :

- LAr Calorimeter
- Tile Calorimeter
- Muon system

New Inner Tracking Detector
(all silicon tracker, up to $|\eta|$ =4)

New muon chambers
in the inner barrel region

High granularity timing detector
(forward region)

Phase-II Memoranda of Understanding

The Memoranda of Understanding (MoUs) for five of the six projects with TDR have been completed and have been sent out for signatures to the Funding Agencies

ATLAS Trigger/DAQ [CERN-MoU-2019-017]

ATLAS Inner Tracker (ITk) Strip Sub-Detector and Common Items [CERN-MoU-2019-018]

ATLAS Liquid Argon Calorimeter [CERN-MoU-2019-019]

ATLAS Tile Calorimeter [CERN-MoU-2019-020]

ATLAS Muon Spectrometer [CERN-MoU-2019-021]

ATLAS ITk Pixel MoU was finalised last week [CERN-MoU-2019-227], ready for signatures

To be followed by:
High Granularity Timing detector (Q4-2010 / Q1-2021)

ATLAS COLLABORATION CERN-MoU-2019-018

Addendum No. 20 to the

Memorandum of Understanding for Collaboration in the Construction of the ATLAS Detector

Construction of the

Phase-II Upgrade

ATLAS Inner Tracker (ITk) Strip Sub-Detector and Common Items

2019-03-15 Page 1 of 80

Status of MoU signing

Funding Agency	TDAQ	ITK Strip & Common Items	LAr	Tile	Muon	Common Fund
Argentina	Signed					Signed
Armenia						Signed
Australia	Signed	Signed				Signed
Austria	Unsigned					Signed
Azerbaijan						Signed
Belarus				Unsigned		Unsigned
Brazil						Unsigned
Canada		Signed	Signed			Signed
Chile					Unsigned	Signed
China NSFC+MSTC		Unsigned			Unsigned	Unsigned
Colombia	Unsigned					Signed
Czech Republic	Signed	Signed		Signed		Signed
Denmark	Unsigned	Unsigned				Signed
France IN2P3	Unsigned	Unsigned	Unsigned	Unsigned		Signed
France CEA		Signed	Signed		Signed	Signed
Georgia				Signed		Signed
Germany BMBF	Signed	Signed	Signed	Signed	Signed	Signed
Germany DESY		Signed				Signed
Germany MPI	Signed	Signed	Signed		Signed	Signed
Greece	Unsigned				Unsigned	Unsigned
Hong Kong		Signed			Signed	Signed
Israel	Unsigned				Unsigned	Unsigned
Italy	Unsigned	Unsigned	Unsigned	Unsigned	Unsigned	Unsigned
Japan	Unsigned	Unsigned			Unsigned	Signed
Morocco						Unsigned
Netherlands	Unsigned	Unsigned			Unsigned	Signed
Norway		Unsigned				Unsigned
Poland	Unsigned	Unsigned				Unsigned
Portugal	Signed			Signed		Signed
Romania	Signed			Signed		Signed
Russia		Unsigned	Unsigned	Unsigned	Unsigned	Unsigned
JINR	Signed		Signed	Signed	Signed	Signed
Serbia						Signed
Slovak Republic	Unsigned		Unsigned	Unsigned		Signed
Slovenia		Unsigned				Signed
South Africa		Signed		Signed		Signed
Spain		Unsigned		Unsigned		Signed
Sweden	Signed	Signed		Signed		Signed
Switzerland	Signed	Signed				Signed
Taipei					Unsigned	Signed
Turkey	Unsigned				Unsigned	Unsigned
United Kingdom	Signed	Unsigned				Signed
USA DOE	Unsigned	Unsigned	Unsigned			Unsigned
USA NSF	Unsigned		Unsigned	Unsigned	Unsigned	Unsigned
CERN	Signed	Signed	Signed	Signed	Signed	Signed

- Last updated: 23-Oct-2019
  - When informed by the office of the DRC

Signed
Unsigned

- Summary

Funding Agency	TDAQ	ITK Strip & Common Items	LAr	Tile	Muon	Common Fund
Signed	12	12	6	9	6	32
% signed	46%	48%	50%	56%	35%	71%
CORE value signed (kCHF)	21'898	29'277	10'036	6'447	8'639	14'662
% CORE value	49%	39%	35%	56%	30%	60%

- CORE value "signed" (kCHF, %) and initial uncertainty

Uncertainty Index	TDAQ	ITK Strip & Common Items	LAr	Tile	Muon	Common Fund
Low	19'527 (89%)	28'877 (99%)	10'036 (100%)	4'442 (69%)	8'639 (100%)	14'662 (100%)
Medium	1'735 (8%)	400 (1%)	(0%)	1'927 (30%)	(0%)	(0%)
High	636 (3%)	(0%)	(0%)	78 (1%)	(0%)	(0%)

Fraction of **green** in "*Money Matrix*" increased from 83.5% to 90.5% **(Japan)**

An important milestone for ITk strips

CERN, 23rd August 2019: Signature of contract between CERN and Hamamatsu Photonics on production of silicon sensors for ATLAS and CMS Phase-II projects (ATLAS ITk strips, CMS strip tracker, CMS calorimeter)

Summary and Status of Phase-II Projects

- All projects (except HGTD) are now following the Phase-II technical and schedule review process of ATLAS: Specifications, PDR, FDR, and PRR (Prod. Readiness Review), (FDR is required before projects is authorized to spend CORE funds)

- All projects underwent a re-assessment / base-lining effort, by the ATLAS Project Management Office;

- Good progress on all projects:
  P2UG review in May 2019: ITk strips, Liquid Argon and Muon
  P2UG review in Nov. 2019: ITk pixel, ITk common items, Tile and TDAQ

- ITk-strip project: very good progress, already moving from prototyping into the pre-production phase; sensor pre-production order has been placed

- Areas of concern:
  * Some technical options still open in Pixel layout
  * Impact in material in the forward region of ITk on calorimeter and HGTD performance has to be understood
  * Timeline of ITk (delays, e.g. due to sensor delivery schedule, common electronics (lpGBT))

- Task force to develop strategy for precise luminosity measurement in Run 4 has been set up (→ proposal for instrumentation)

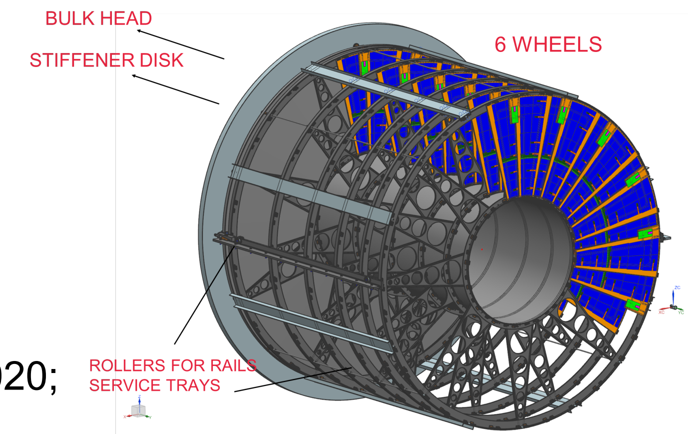
Details on Status of Phase-II Upgrade Projects

Inner Tracker (ITk Strips)

- Excellent progress in many areas, all of the required PDRs passed by end of 2018;
  Focus on final prototypes (sensors, hybrids, ASICs)

- FDR on global mechanics (supporting local support structure, of staves and petals) passed in June 2019

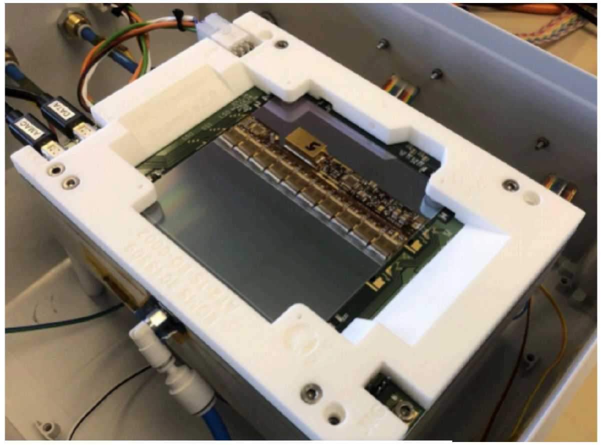
- **Sensors**: FDR passed in April 2019 → pre-production order of 5% placed in Sept. 2019 → first deliveries expected in Jan. 2020;
  HPK delivery capacity necessitated a baseline change
  → readiness of Strip Project for insertion of pixel has moved by four months to March 2025



Endcap global support

- **ASICs:** FDR (part I) in June 2019, yield > 90%, however, SEE due to insufficient triplication in the design in some areas → additional design and verification effort with submission of pre-production ASICs planned for Nov. 2019 (ABC*) and Feb 2020 (HCC*)

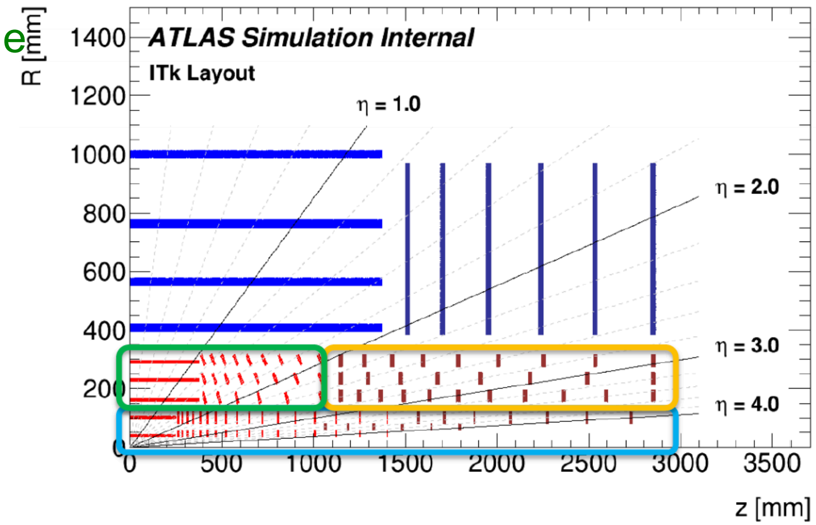
- **Modules:**
  - Prototypes based on final designs of modules and bus tapes made and meet specifications;
  - FDRs of: stave and petal bus tapes, modules and their components (hybrids, power boards) successfully completed in Sept. 2019


Barrel module with hybrid / ASICs

In transition from prototyping to pre-production

Inner Tracker (ITk Pixel)

- Good progress in many areas of this technologically ambitious project, advancing through prototyping stage



- Very substantial progress on **front-end (FE) ASIC** (**RD53A chip**, common ATLAS/CMS R&D)
  - ATLAS full-scale prototype will be delivered early in 2020
  - Differential design chosen for analogue FE

- **Sensors**: Prototypes (thin and very thin planar, 3D) under evaluation, incl. bump-bonding to RD53A ASICs; As part of market survey, prototype modules are being manufactured; irradiation tests important

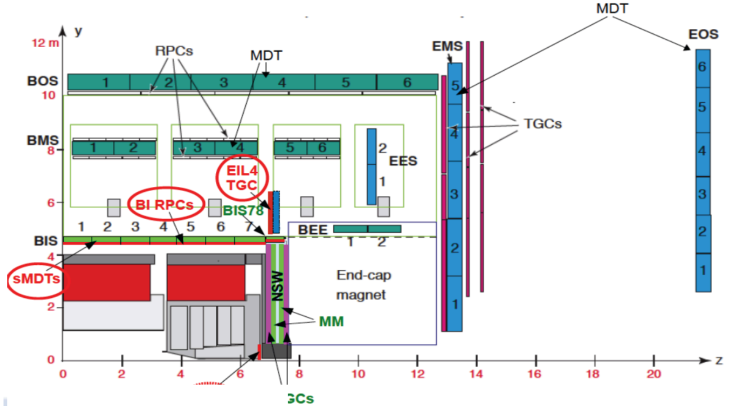
- **Modules:** - Market survey of module hybridization in final stage;
  - 200 modules are being constructed with RD53A chip (→ system tests, test of serial powering, developing module assembly and module loading)

- **On-Detector Services:**
  - Adoption of direct transmission of data via electrical cables to opto-boxes outside detector vol. (made on technical arguments, despite additional complexity on mechanical integration)
  - Demonstrator system is currently being built
  - Detailed simulation studies on impact on performance (tracking, energy (calorimeter) and timing (HGTD) measurements) are being made → results will be presented in Nov. LHCC meeting

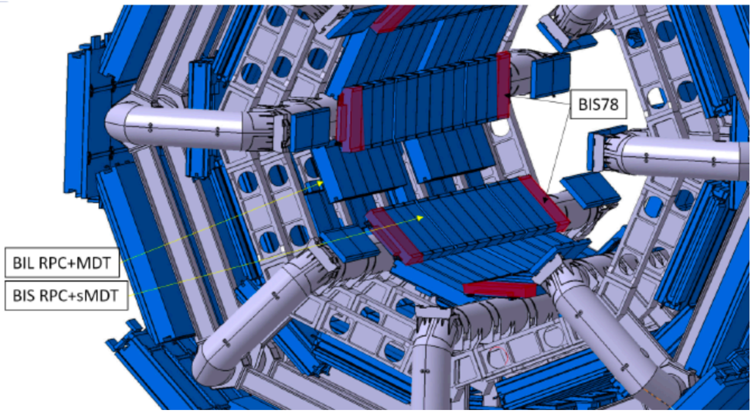
Muon Spectrometer

- **Inner Barrel sMDT:** chamber design (BIS 1-6) almost finished; FDR in Nov. 2019

- **Inner Barrel RPC:**
  - Specification review (detector, mechanics, electronics) passed in July 2019
    (changes in design: readout of η strips from two sides)
  - Single channel prototype of front-end ASIC produced, PDR in Nov 2019



- **MDT/sMDT electronics**:
  - **Amplifier-Shaper-Discriminator ASIC (ASD)** in pre-production stage
  - New **TDC ASIC** (for MDT drift time) passed PDR and v1 prototype has been successfully tested; Design of v2 with minor modifications is almost complete



- **TGC electronics:**
  - Patch Panel ASIC entering production (~11'000 ASICs by June 2020)

All sub-projects are progressing well, without serious issues

LAr Calorimeter

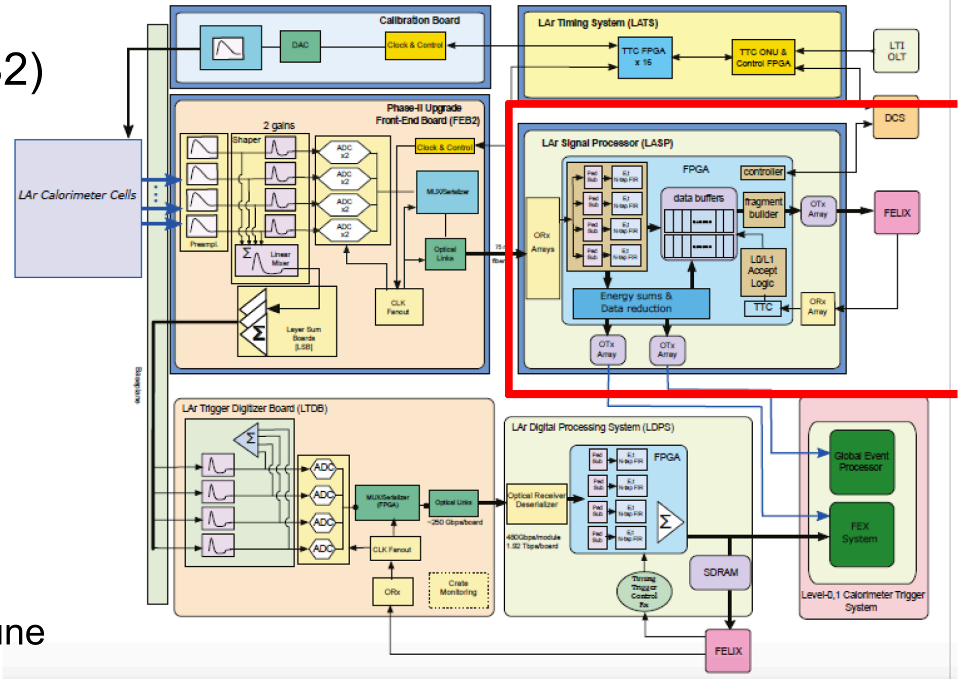
- Entirely an **electronics upgrade**

- **On-det. electronics:** Front-end board (FEB2)
  (preamplifier / shaper (PAS-ASIC), 14 bit
  40 MHz ADC, and calibration ASIC)

  - Pre-prototype for both ASICs submitted in 2018, extensively tested → specifications met, however, reduced # channels and missing functionality

  - Final test chips (full functionality, two architectures for preamp and two designs for the first ADC stage) submitted for ADC and PAS in Aug/Sept. 2019

  - Second test chip of calibration ASIC submitted in June

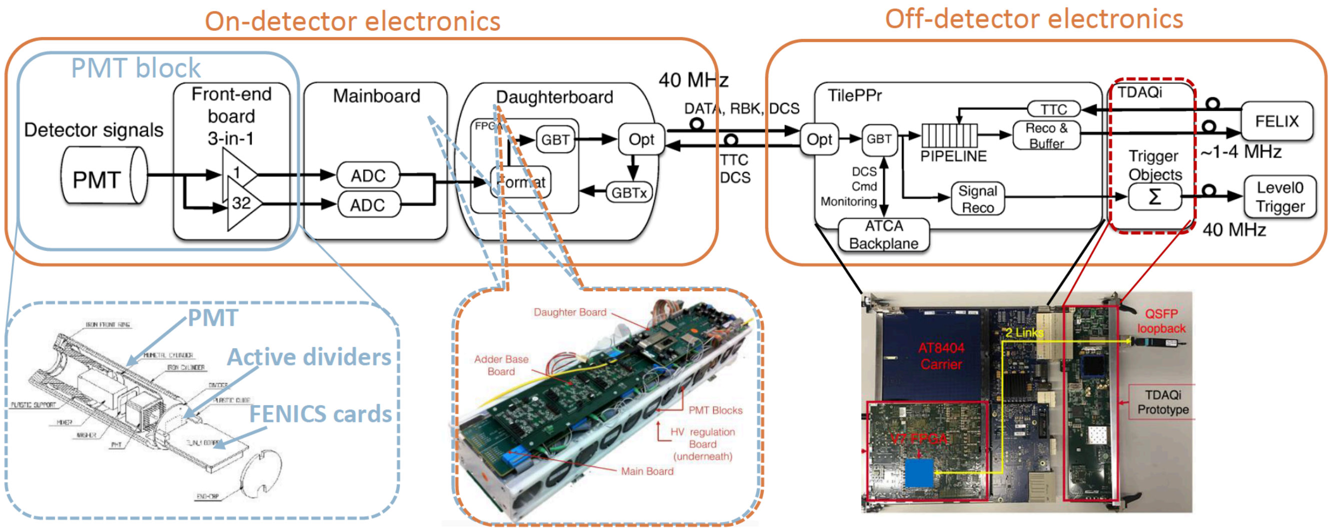


- **Off-detector electronics:** high-performance ATCA FPGA **Signal Processing board (LASP);** Very challenging design managing high power (400 W per blade) and large number of high-speed optical links (25 Gb/s), however, largely building on Phase-I experience

  A set of test boards is in final stages of design; mini series expected in spring 2020
  → evaluate design options and to benchmark initial firmware concepts

All sub-projects are progressing well, without serious issues

Tile Calorimeter



- **Mechanics**:
  - FDR of mini-drawers in April 2019 (very modest follow-ups), pre-production has started

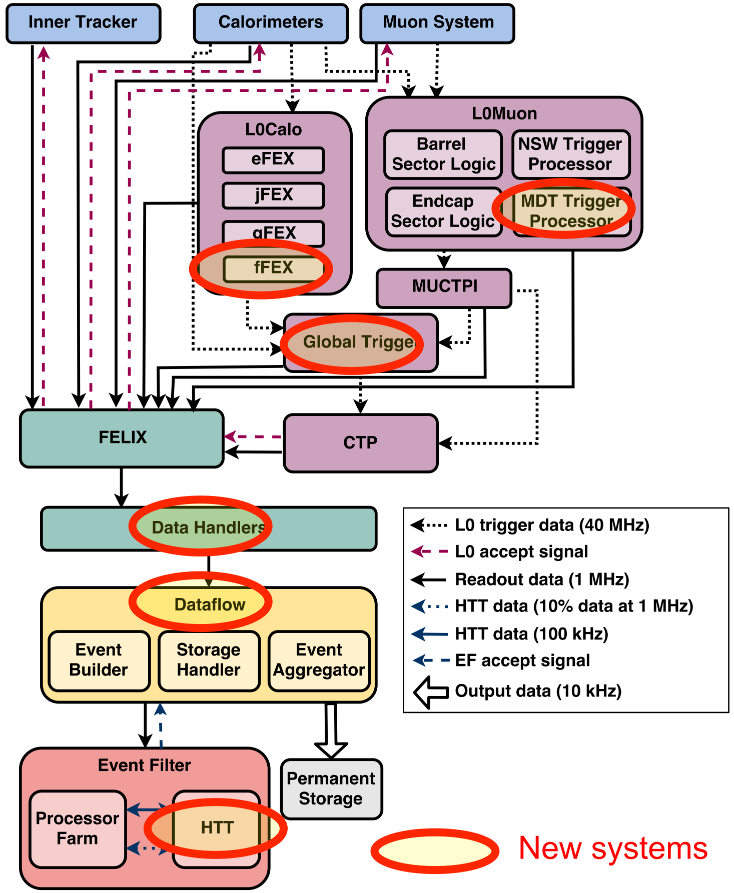
- **Electronics:**
  - A series of PDRs has been successfully completed for all **front-end electronic elements** in the readout chain (except daughter board for which additional SEU studies are required)
    in general: on-detector electronics is on track

  - Off-detector electronics: first full-scale prototype of the **Tile Preprocessor (TilePPr)** (ATCA carrier board, supporting four compact processing modules (CPM)) expected until end 2019; PDR has been successfully completed in Sept. 2019
  - TDAQi module has been produced, evaluation ongoing until spring 2020

All sub-projects are progressing well, without serious issues

Phase-II TDAQ

- Design of several critical trigger components (Global Trigger, L0-MDT) advancing well
- System Specification Review of Hardware Track Trigger (HTT) was passed in July 2019
- Evaluation of prototype associate memory ASIC (AM07) for HTT successfully completed;
  Preparation for next submission (AM08) in April 2020, PDR in Dec. 2019
  (delay due to unexpected license issues)
- Work proceeding with first examples of critical new technologies (high-speed (25 Gb/s) opto-links, PCIe Gen 4, 100 Gb/s Ethernet samples, high-capacity storage database)
- Phase-II FELIX demonstrator with 25 Gb/s links and PCI Gen 4 compatibility is under development



- As requested by UCG, a **fallback strategy** in case of delays of HTT, to be deployed in the early phase of Run 4, has been identified (Alternative EF Track WG):
  → *Procurement of the complete EF farm, foreseen to be used at μ ~ 200, already early in Run 4 would enable EF running without HTT at a nominal pileup of μ ~ 140*
  (However, 4 MHz L0/L1 scenario cannot be covered)

High Granularity Timing Detector

- The ATLAS HGTD project is very challenging
  (new technology, major R&D, late start, challenging environment, ...)

- **Technical Proposal approved in June 2018;**

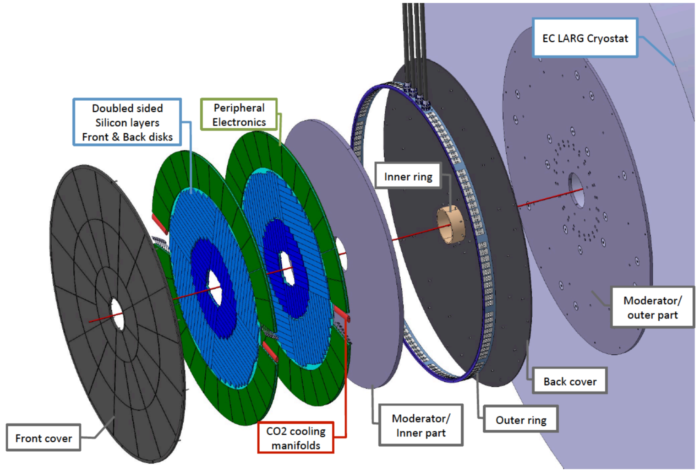
- Very significant and commendable progress has been achieved towards **submission of TDR in April 2020**

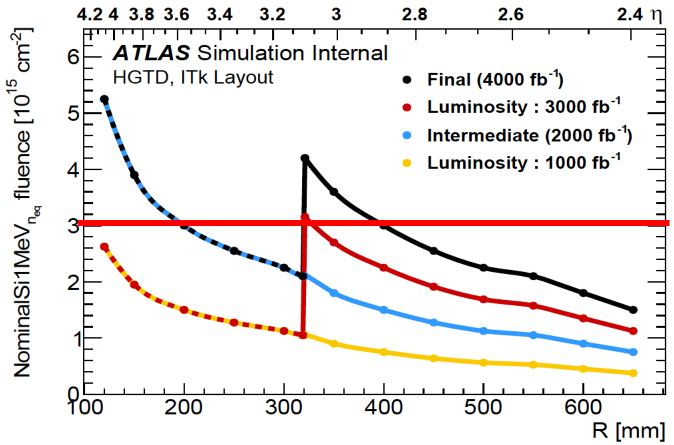
- **Sensors:** LGAD sensors from different manufacturers irradiated with neutrons, protons and X-rays; analysis ongoing → results expected end 2019

- **Front-end ASIC**: second generation prototype (ALTIROC1-V2) received in July, characterization ongoing;

  Irradiation tests (TID) on first generation prototype (V1) completed for doses up to 340 MRad; results encouraging

- First modules (5x5 arrays, HPK samples, ALTIROC1-V2) have been assembled for test-beam setup





Summary

The ATLAS experiment has entered LS2 and the major activities are at present:

(i) Physics Analysis
- Many results on full Run-2 dataset already presented
- Collaboration is now focussed to extract the final Run-2 results of the full physics programme

(ii) LS2 detector consolidation and refurbishment as well as the start of the Phase-I installation and commissioning → Talk by Ludovico Pontecorvo

(iii) The ATLAS Collaboration has decided to close the Phase-I FTK project prematurely
(system not needed anymore to achieve Run-3 physics goals, its delay has caused it to run head on into higher priority deliverables including the installation and commissioning of Phase-I upgrades and the significant ramp up of the Phase-II upgrades)

(iv) Phase-II Upgrade program
- MoUs have been finalised for all Phase-II upgrade projects, except HGTD
- Good progress on all Phase-II projects;
  * ITk-strip project moving into the pre-production phase.
  * ITk-pixel project has still open technical issues that need to be sorted out soon

The strong support of the ATLAS Funding Agencies over the last decades has been, and continues to be, fundamental to the success of the experiment

Thank you!