The ATLAS experiment
Status and prospects

NEW TRENDS IN HIGH-ENERGY PHYSYCS

24-30 September 2018

Montenegro/Europe
Budva, Becici

Splendid Hotel,
Conference Hall

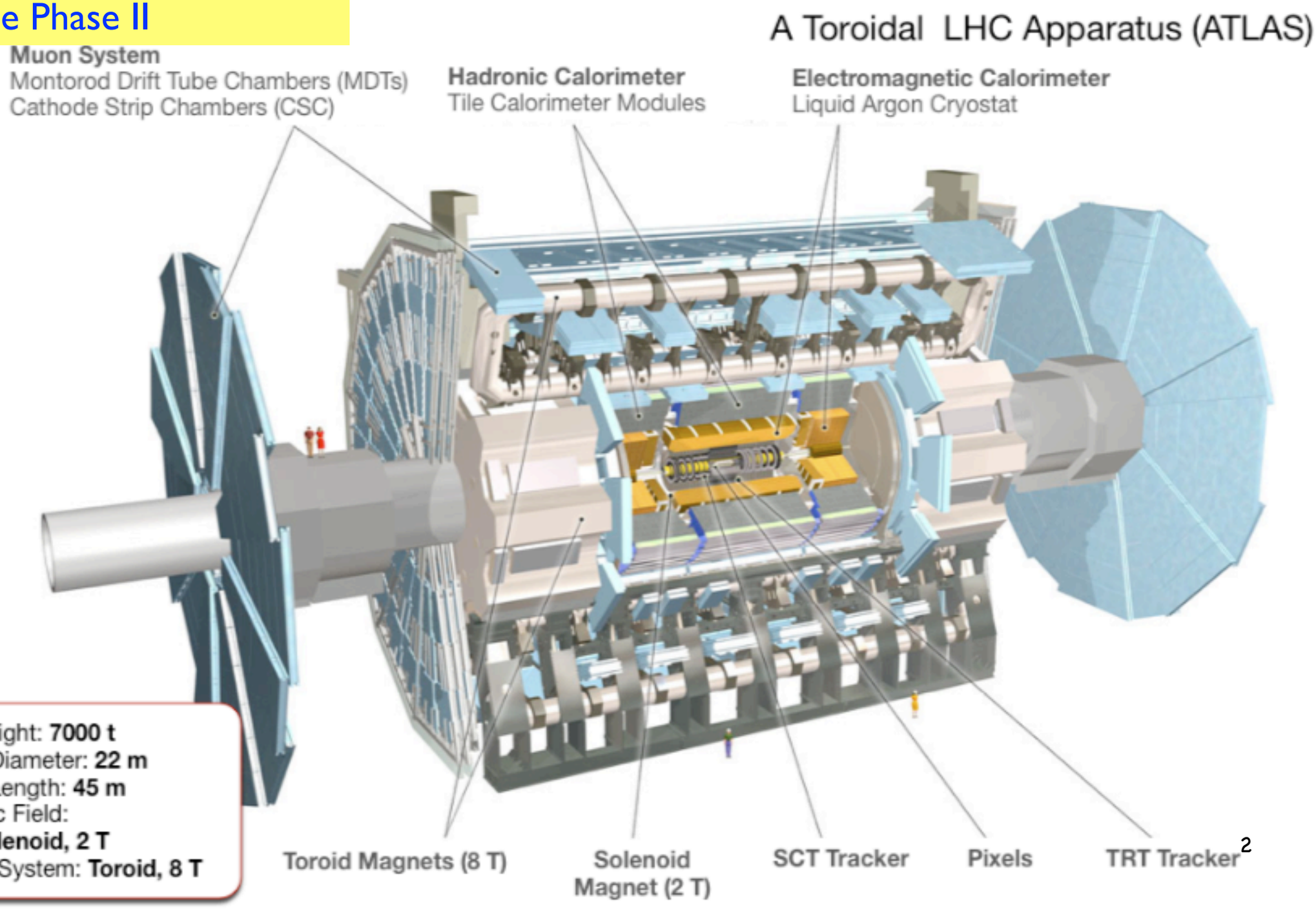
Gabriella Gaudio
INFN – Pavia

On behalf of the ATLAS collaboration

http://indico.jinr.ru/event/ntihep2018

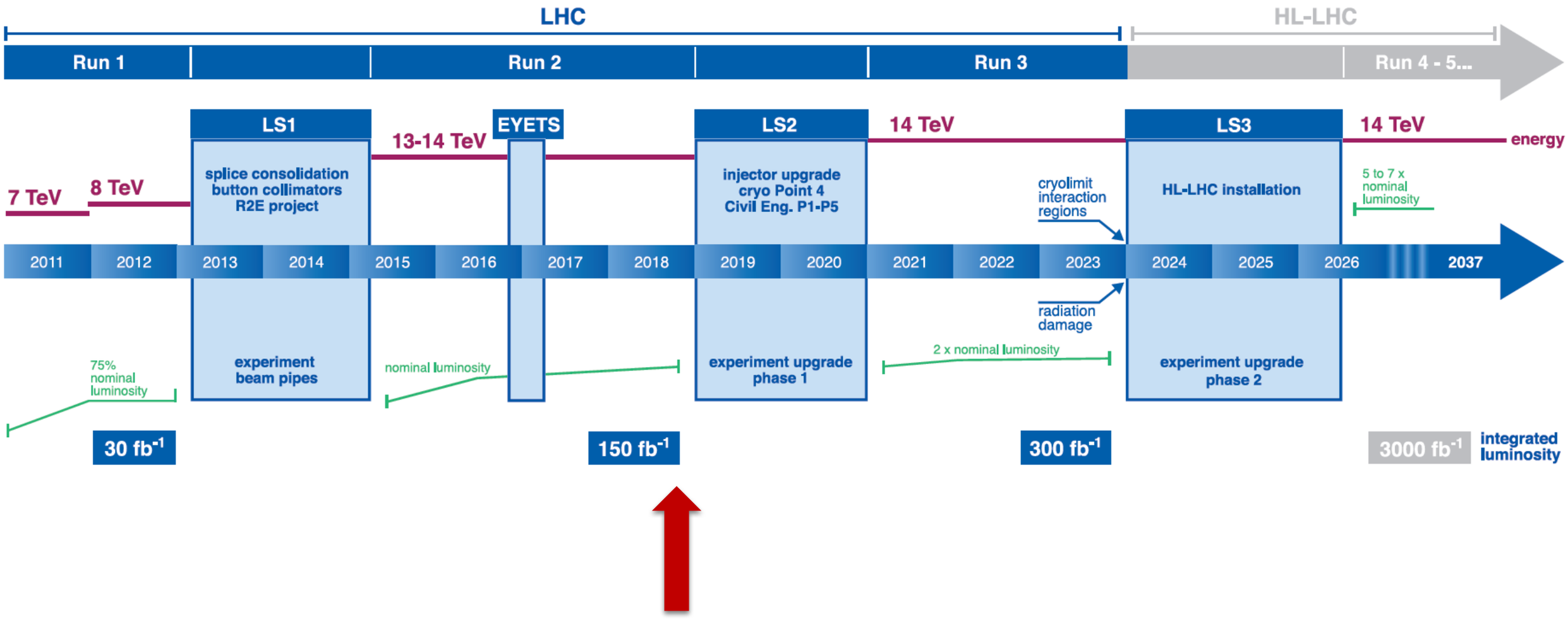
OUTLINE

- ATLAS in Run II
  - LHC and ATLAS performance
- ATLAS Upgrade Phase I
- ATLAS Upgrade Phase II

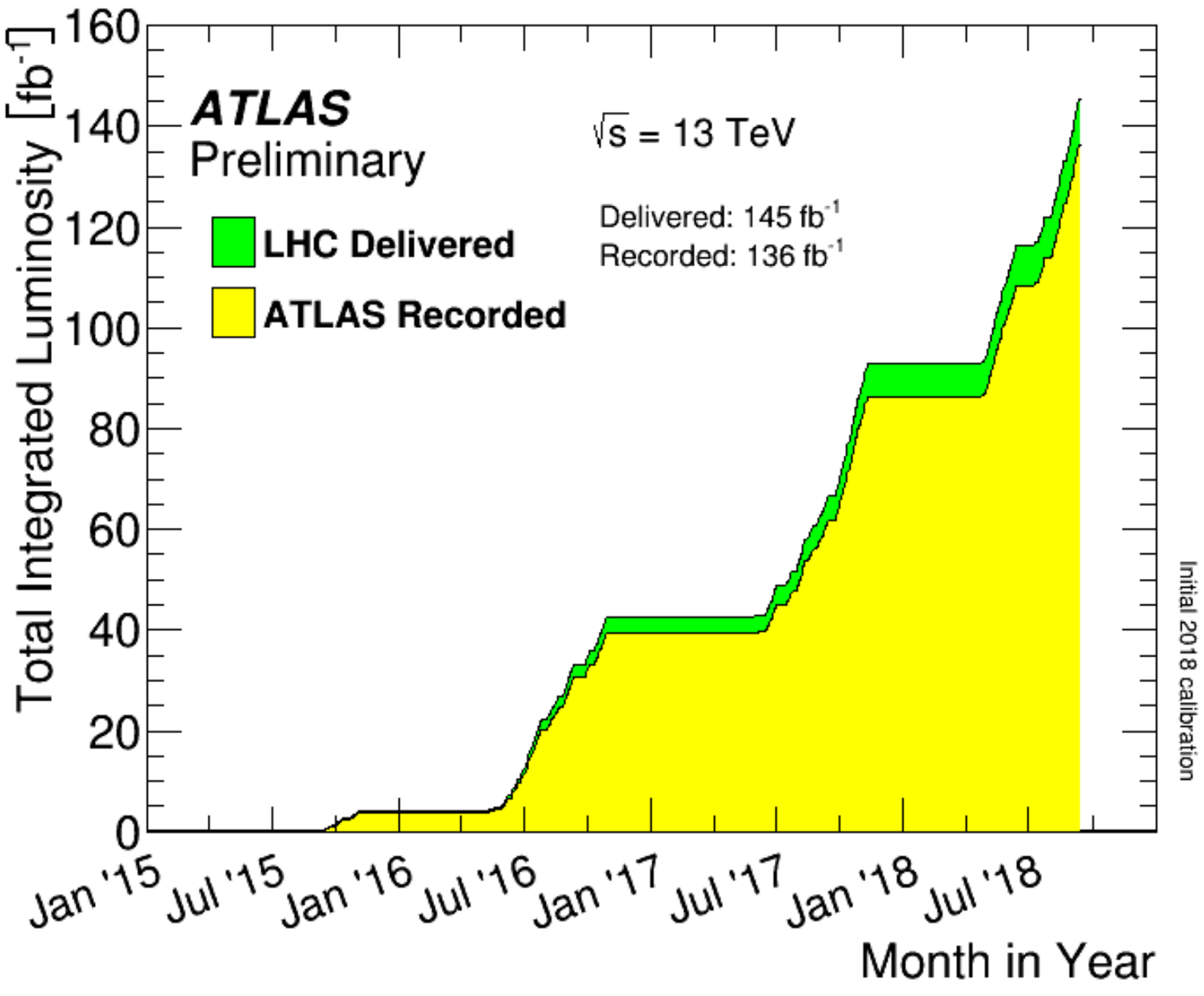


ATLAS now

LHC / HL-LHC Plan



ATLAS Run-2 data-set



Expect $\mathcal{L}$=150 fb^{-1} for the full Run II (2015-2018) data-set

Excellent LHC performance

+

Great ATLAS response

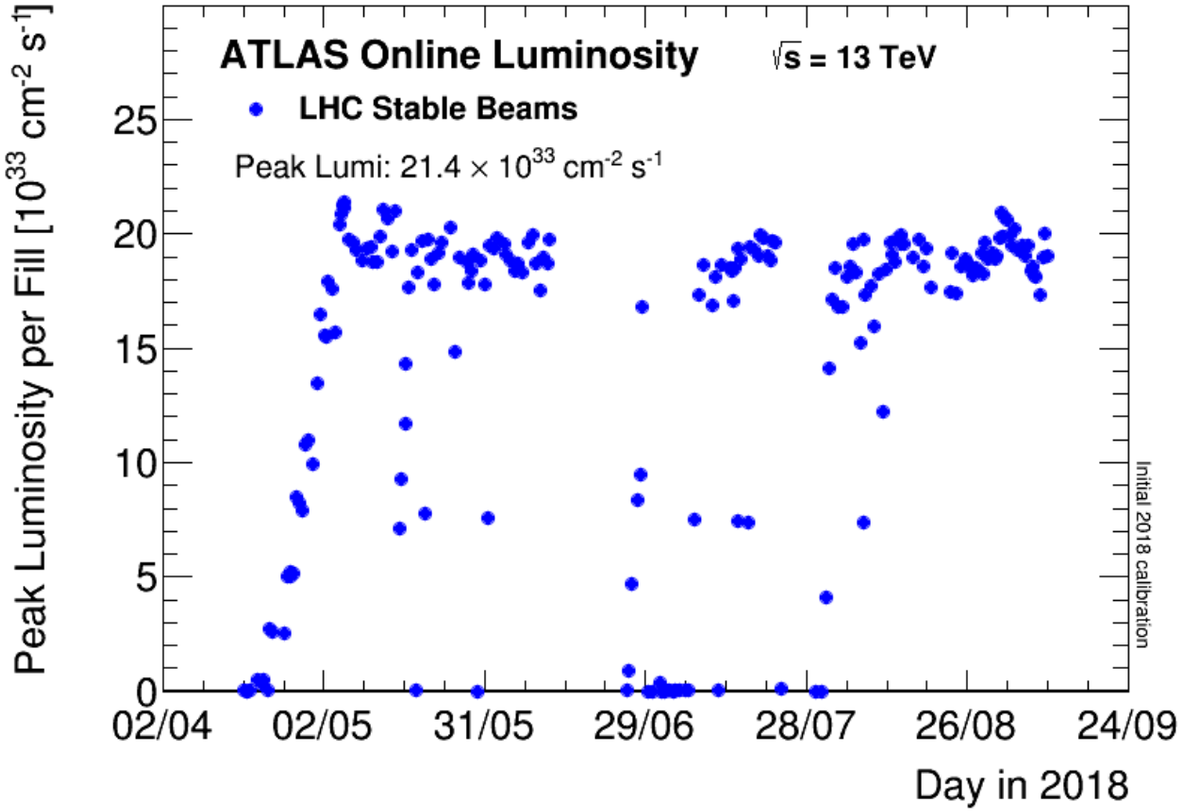
Run-II data taking

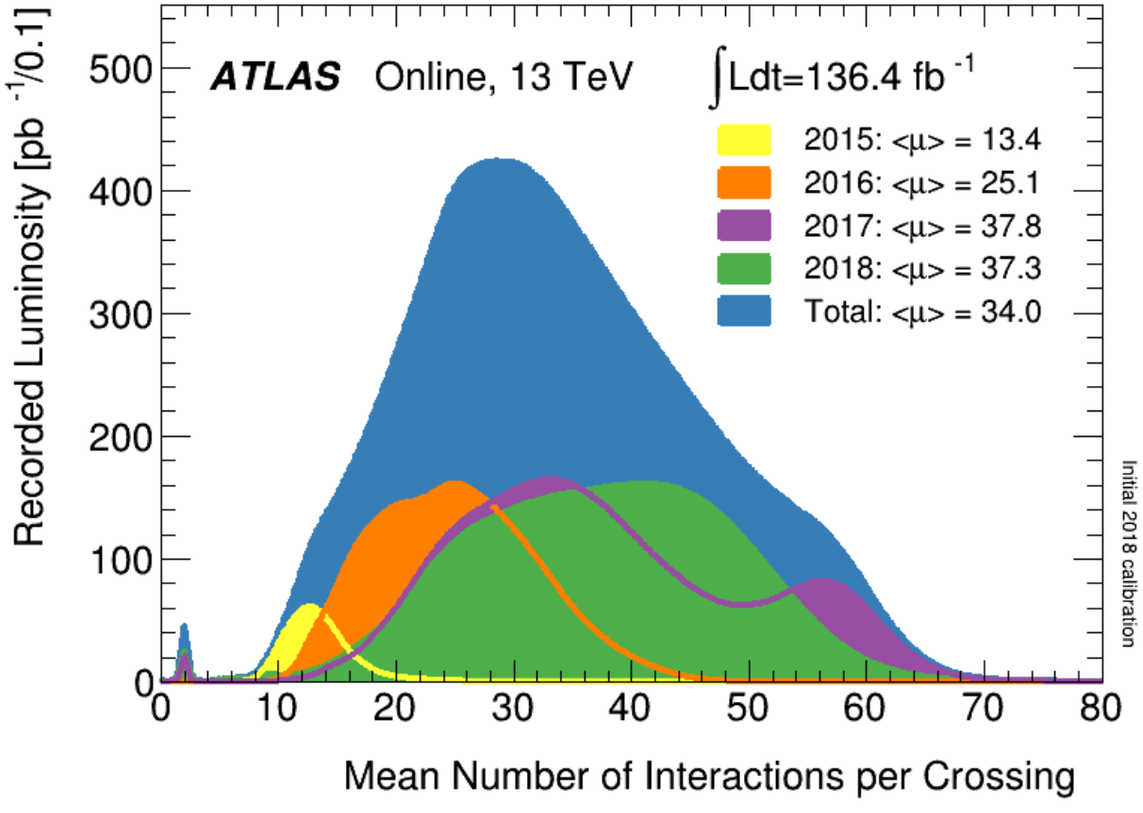
- Excellent machine performance
- Running at about double of design luminosity

Detector read-out with large occupancy, high trigger rate, data bandwidth, processing computer power

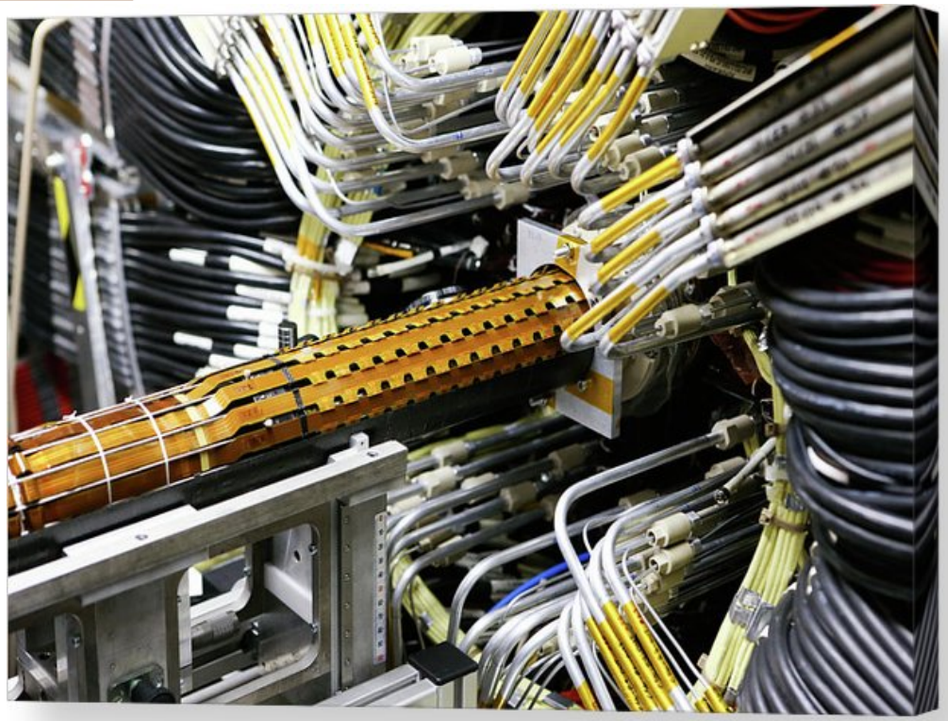
Luminosity levelling required

- Huge experimental challenge due to pile-up (multiple p-p interaction in the same bunch crossing)
  - Multiple vertices, many low p_T tracks
  - Underlying energy deposit in the calorimeter





RunII ATLAS Performance



- Innermost pixel layer IBL, 3.4 cm from interaction point
- Muons: MDT in 1.1 < |η| < 1.3, RPC in Barrel Feet Sectors
- Forward proton detectors, AFP (one/two arms in 2016/2017, 205+217m from IP)
- In addition, various consolidations provide improved running at high luminosities and rates (tracking, calorimetry, muon, luminosity measurement, etc.)

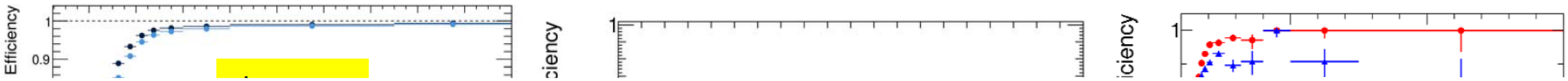
ATLAS pp data: April 25-August 20 2018

Inner Tracker			Calorimeters		Muon Spectrometer				Magnets	
Pixel	SCT	TRT	LAr	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.7	99.6	100	99.6	100	99.7	99.6	100	100	100	99.3

Good for physics: 96.5% (36.4 fb^{-1})

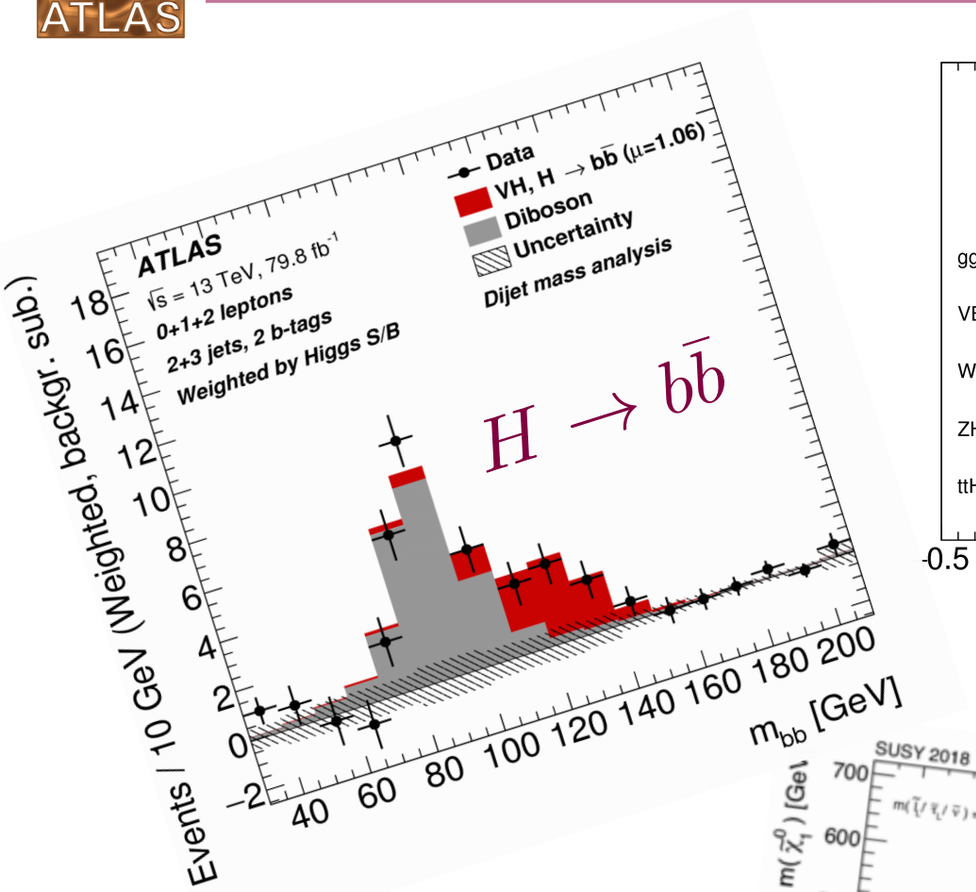
Luminosity weighted relative detector uptime and good data quality efficiencies (in %) during stable beam in pp collisions at $\sqrt{s}$=13 TeV between April 25 – August 20 2018, corresponding to a delivered integrated luminosity of 39.2 fb^{-1} and a recorded integrated luminosity of 37.7 fb^{-1}. Dedicated luminosity calibration activities during LHC fills used 0.7% of recorded data and are included in the inefficiency. The luminosity includes 193 pb^{-1} of good data taken at an average pileup of μ=2.

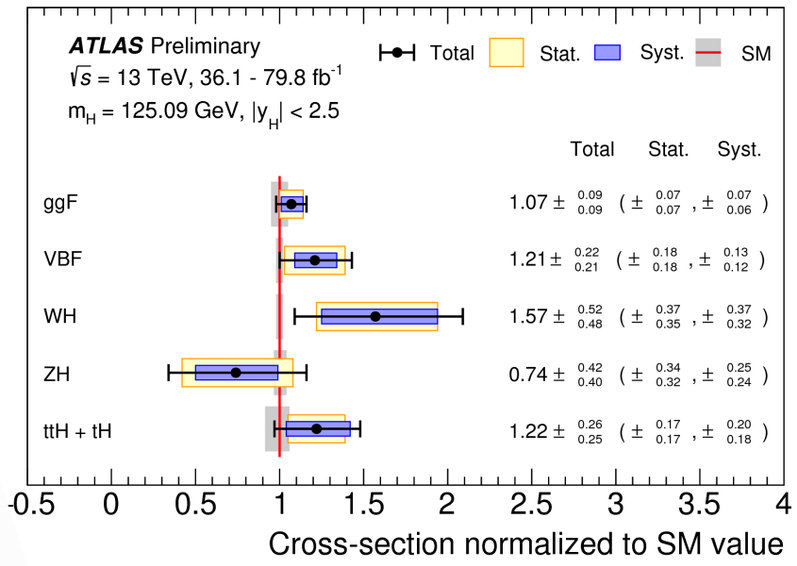
ATLAS Physics Performance

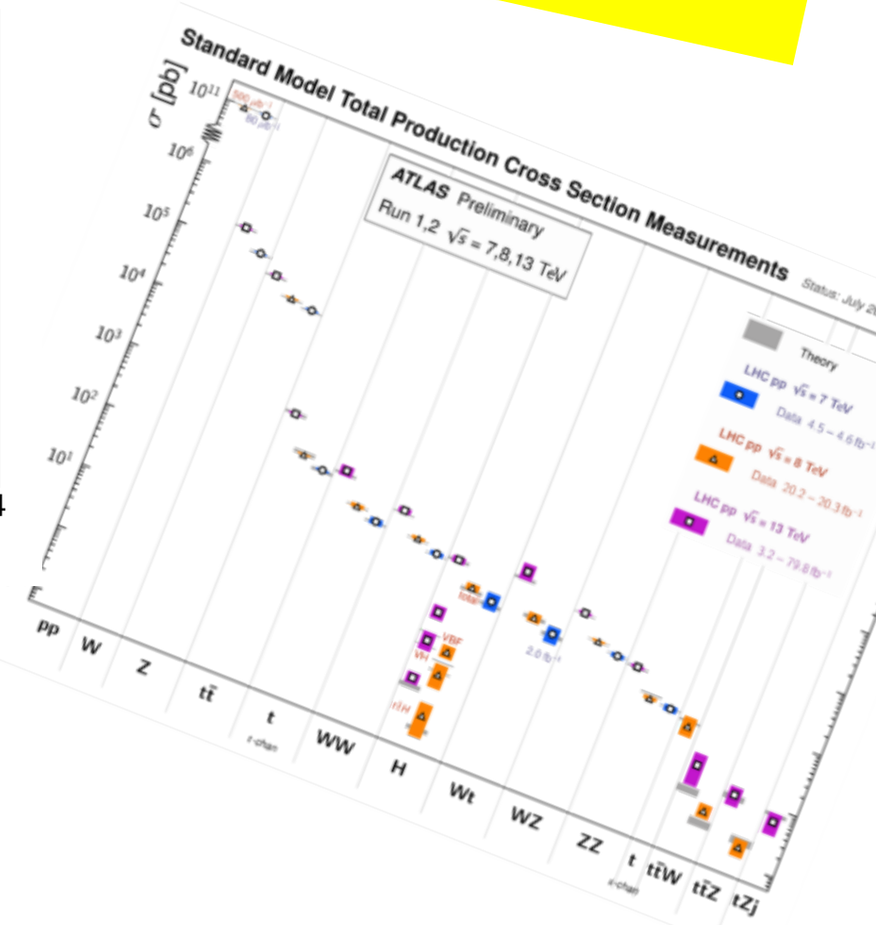


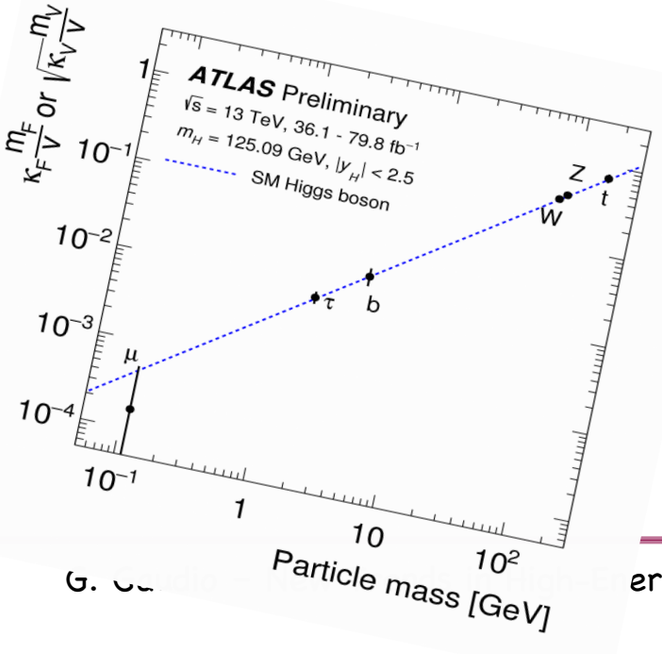
ATLAS Physics Highlights

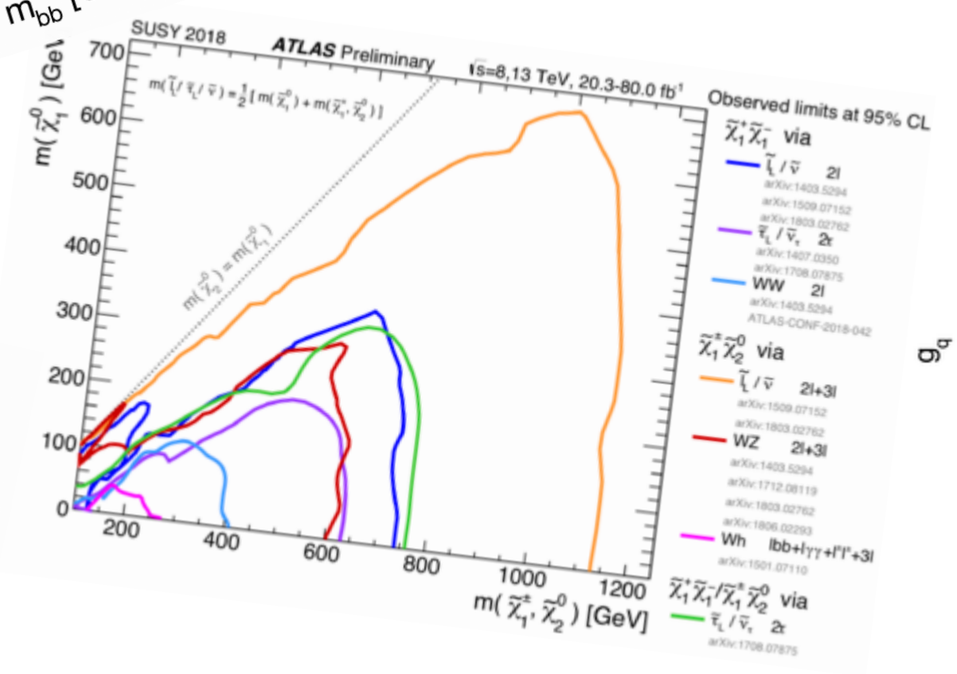
See Merve and Tomas talk for details

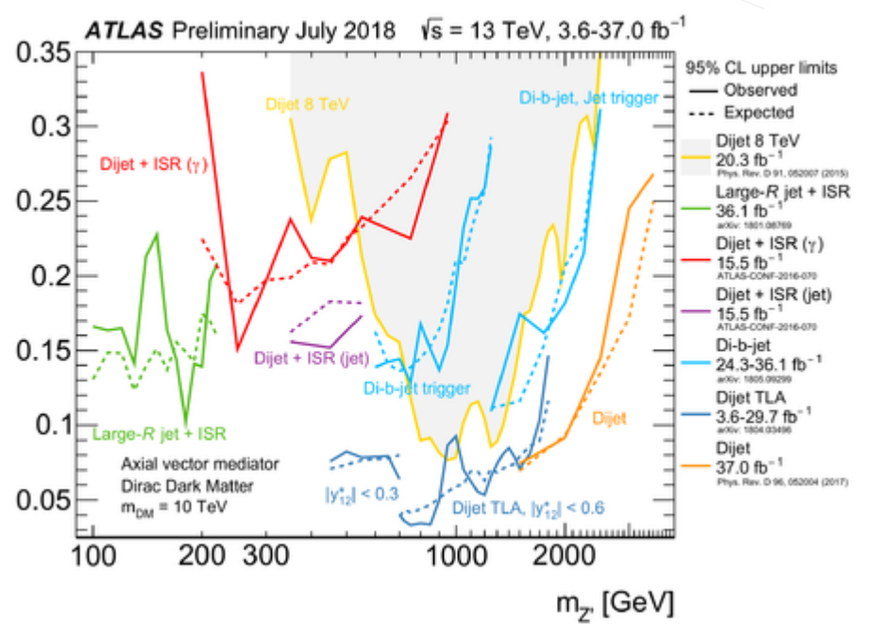






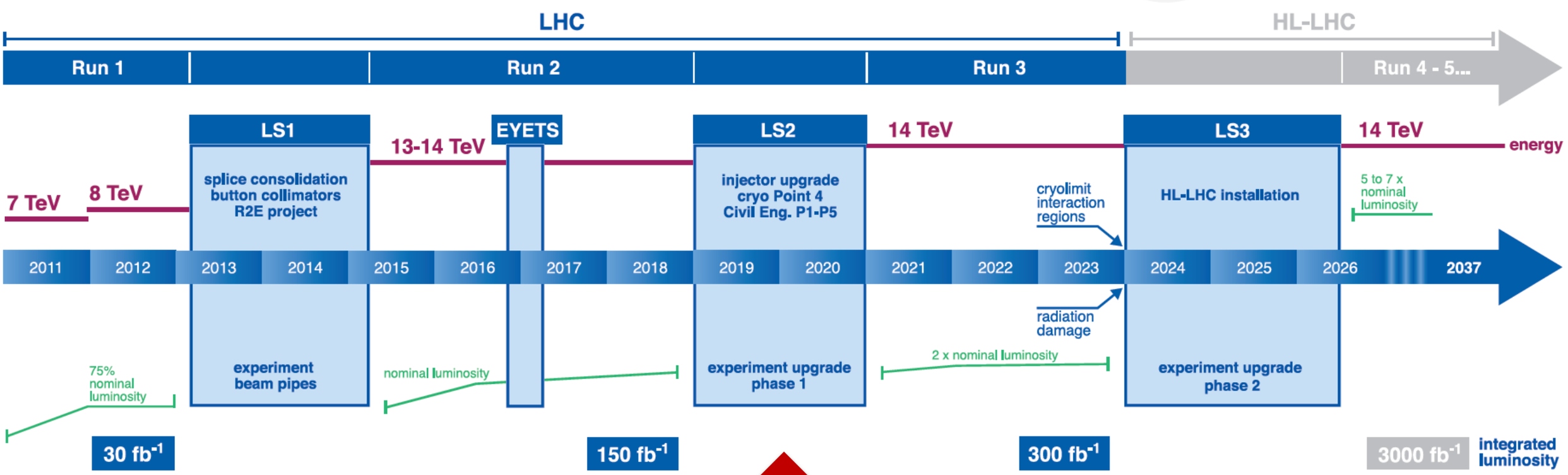






ATLAS Phase I Upgrades (2019-2020)

LHC / HL-LHC Plan



Upgrade Goals:

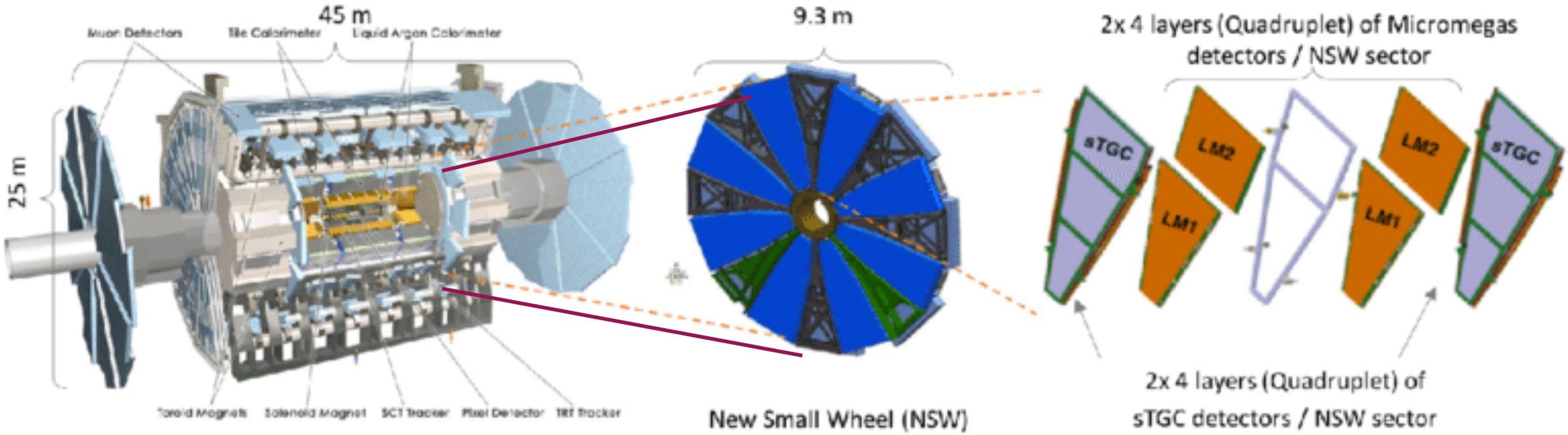
- Better trigger capabilities (efficiency and fake rejection)
- Maintain same acceptance and p_T thresholds with higher pileup

✦New Small Wheel
✦High Granularity L1 Calorimeter Trigger
✦Fast Track Trigger
✦TDAQ

ATLAS Phase I Upgrades (2019-2020) - NSW

Muon: New Small Wheel (NSW) (ATLAS-TDR-020-2013)

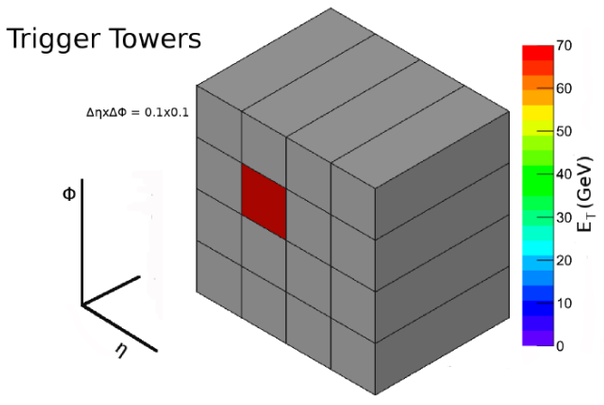
replacement of the inner stations of the endcap muon system with a new muon detector: sTGC + MicroMegas (trigger and precise tracking)

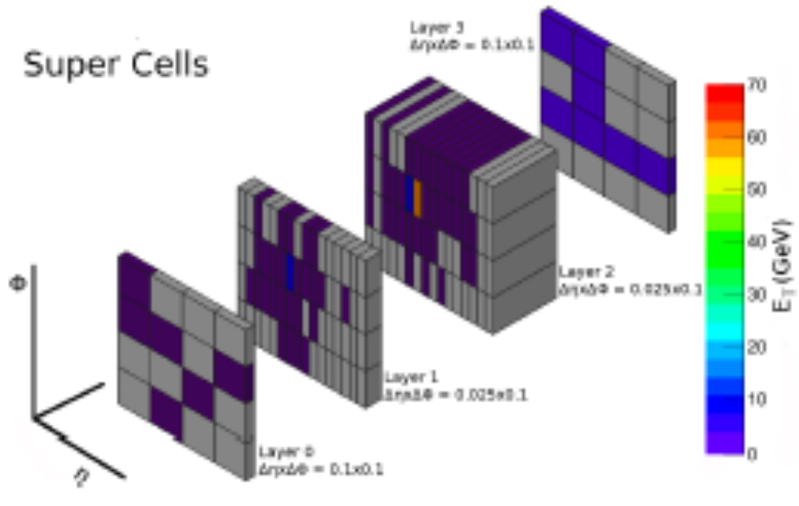


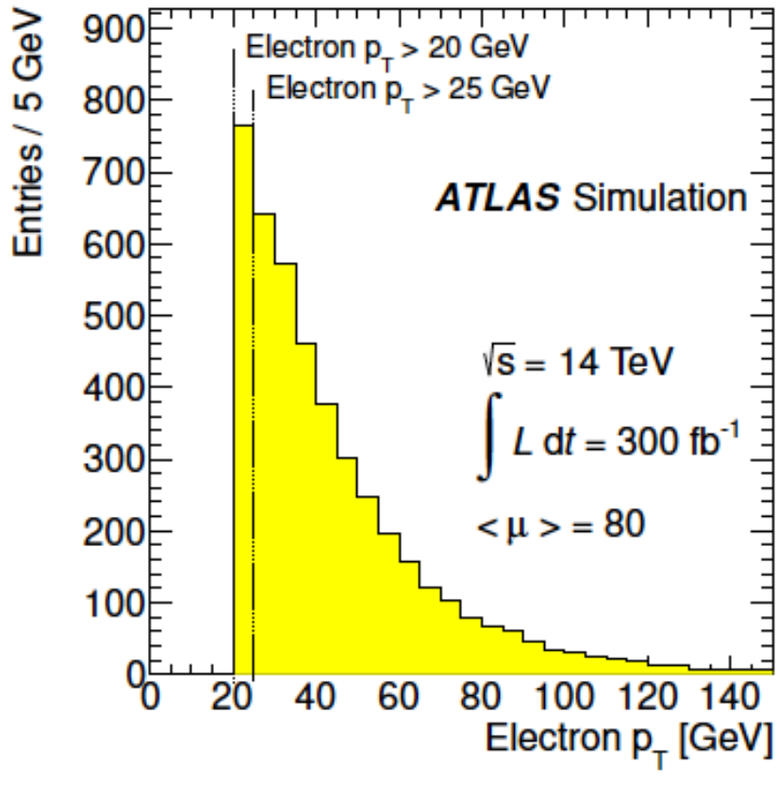
ATLAS Phase I Upgrades (2019-2020) - LAr

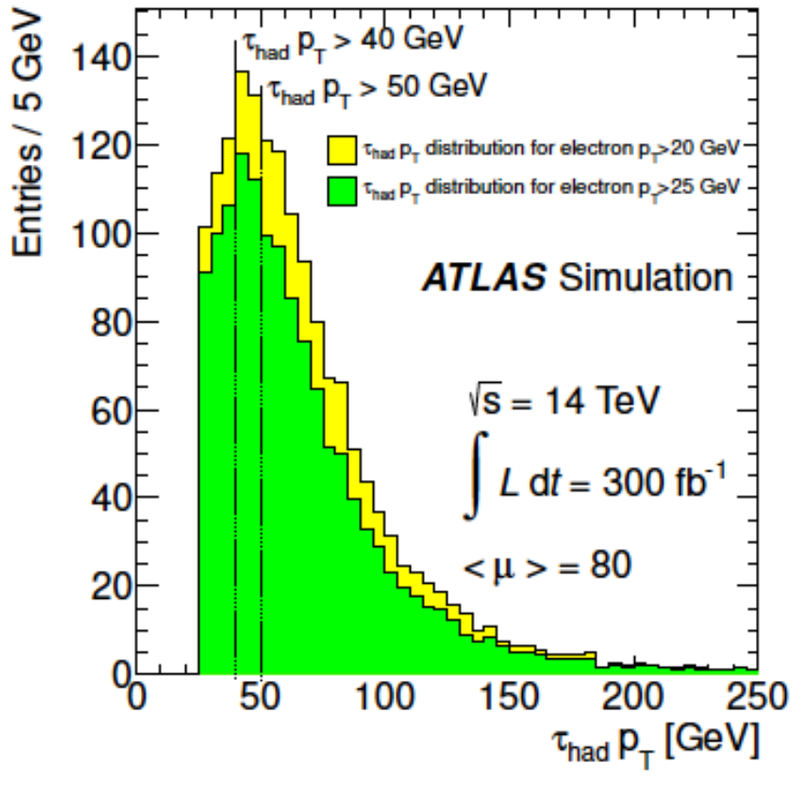
LAr: High Granularity L1 Calorimeter Trigger (ATLAS-TDR-022-2013)

- Finer granularity schema based on "Super Cells" (first and middle layer)
- Upgraded Trigger processor, called Feature Extractors (FEXs)
- FE demonstrator successfully integrated since 2015







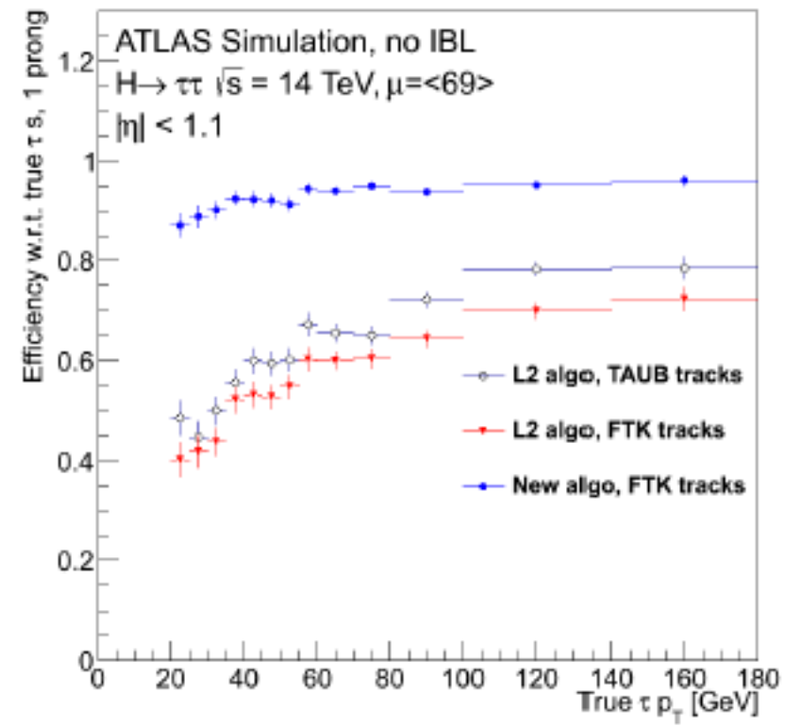


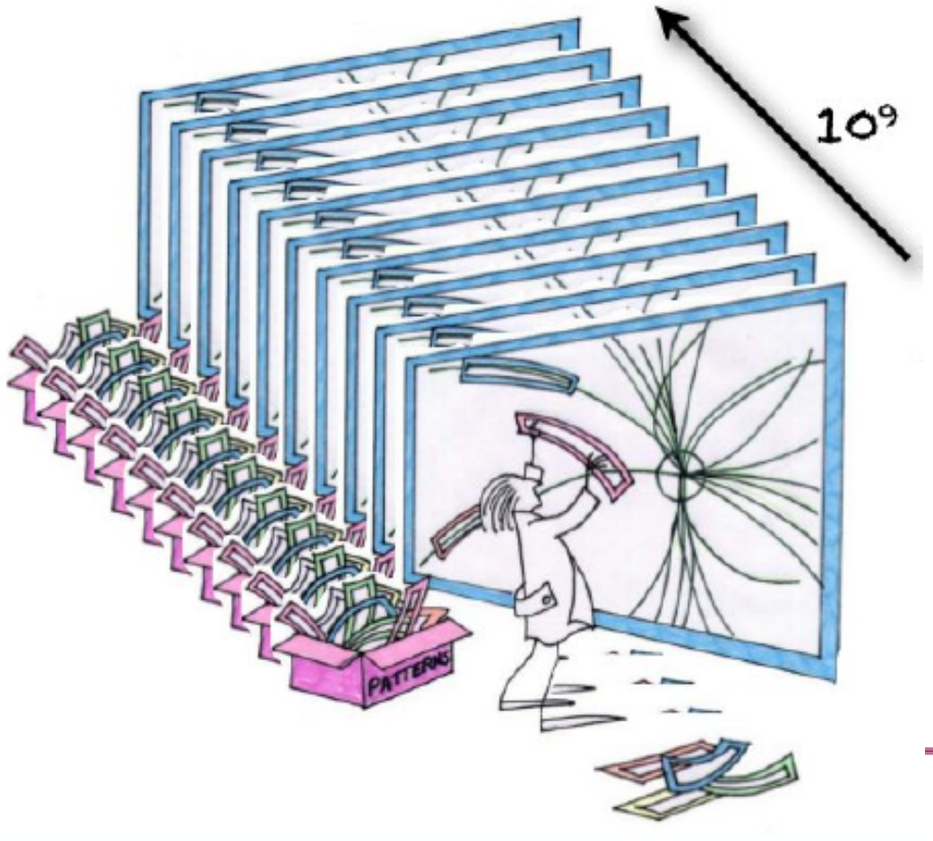
Simulated H→ττ events with one τ decaying to eν and one τ decaying hadronically

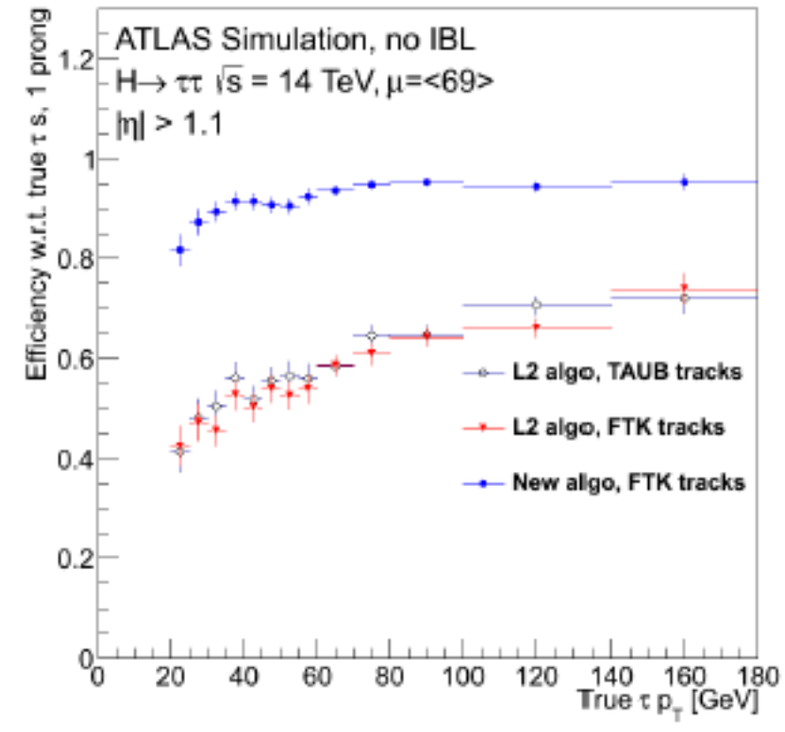
ATLAS Phase I Upgrades (2019-2020) - FTK

Fast Track Trigger (FTK) (ATLAS-TDR-021-2013)

- HW triggers based on Si-tracking layers
- Compare tracks to pre-calculated tracks through Associative Memories
- Commissioning ongoing in Run-II





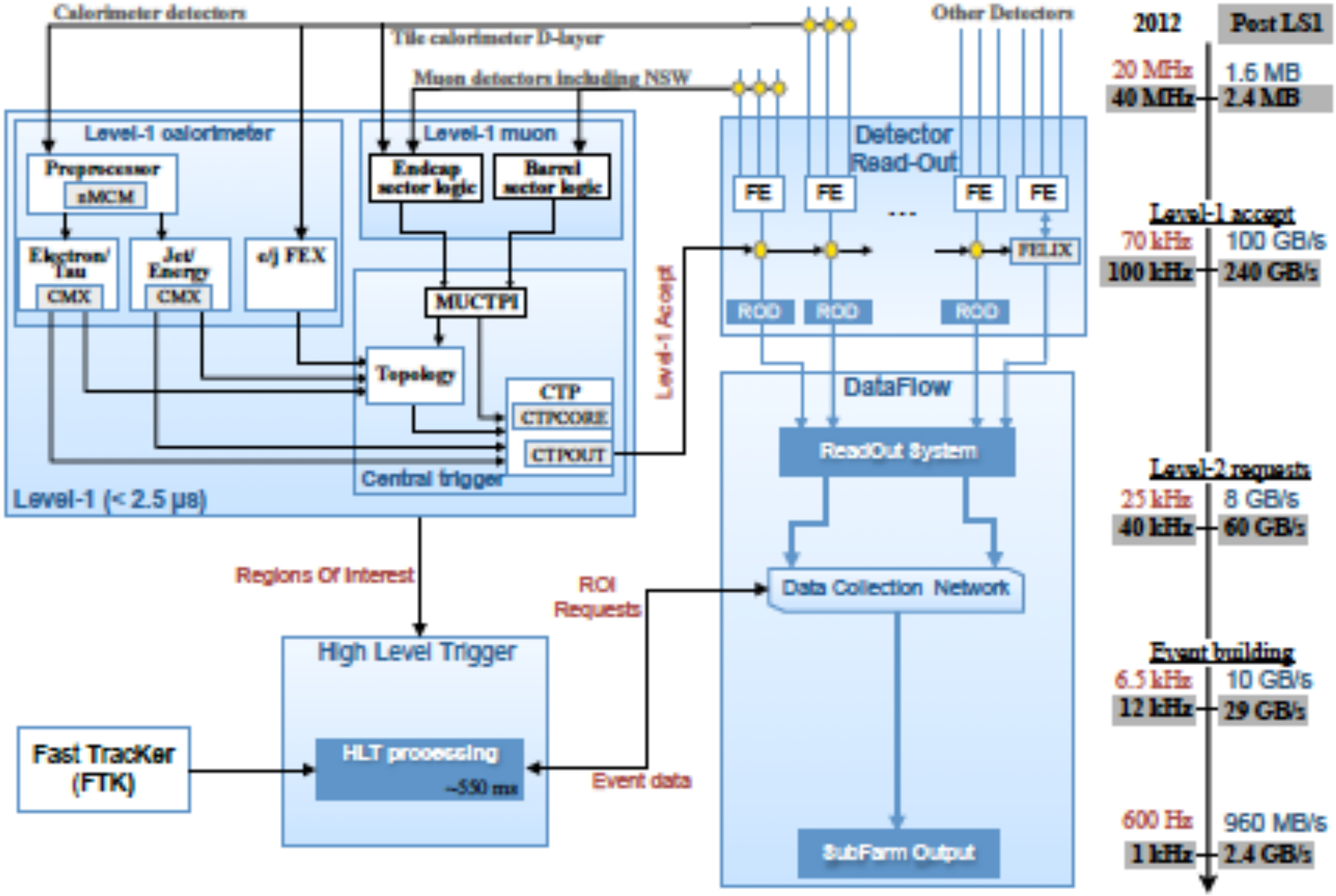


ATLAS Phase I Upgrades (2019-2020) - TDAQ

Trigger/DAQ Phase I Upgrade

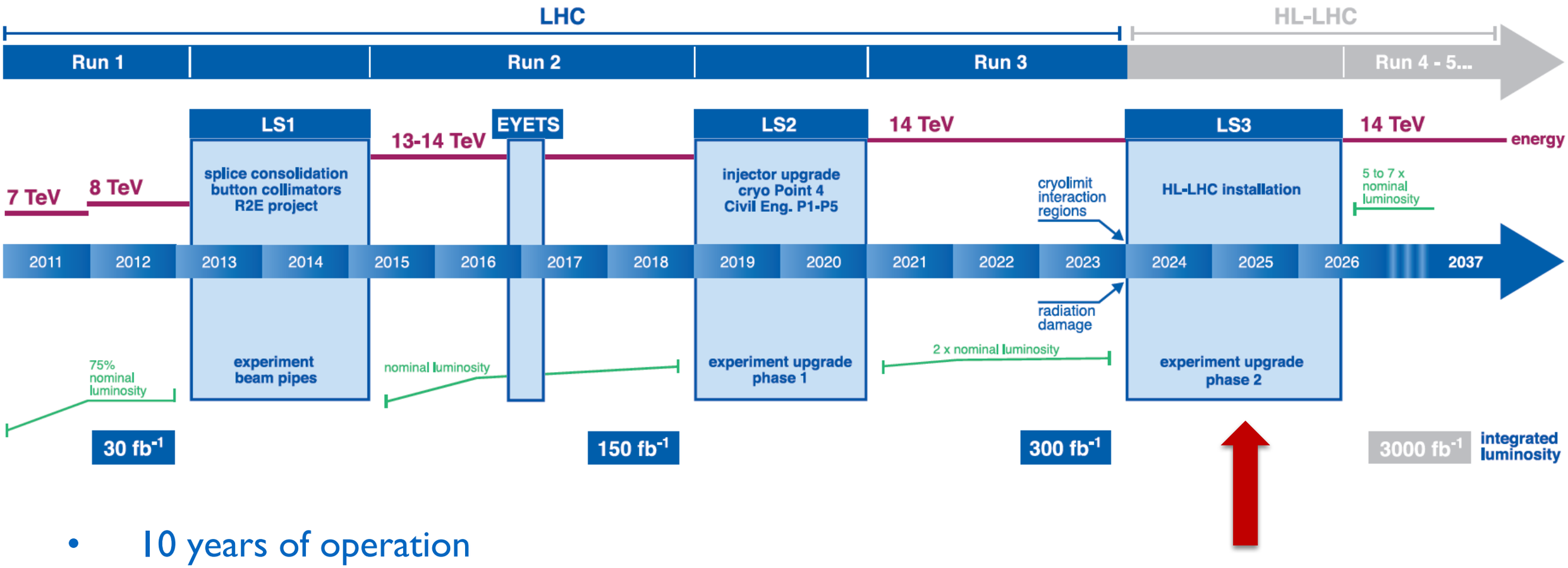
(ATLAS-TDR-023-2013)

- General TDAQ schema
- L1Calo
- L1Muon



ATLAS Phase II Upgrade (2024-2026) toward HL-LHC

LHC / HL-LHC Plan



- 10 years of operation
- instantaneous luminosities **7.5×10^{34} cm^{-2} s^{-1}** (after levelling),
- **25 ns** between bunch crossings
- integrated luminosity of **3000 fb^{-1}**
- average pile-up up to **$< \mu >= 200$**.

ATLAS Phase II Upgrade (2024-2026) toward HL-LHC

LHCC-I-023

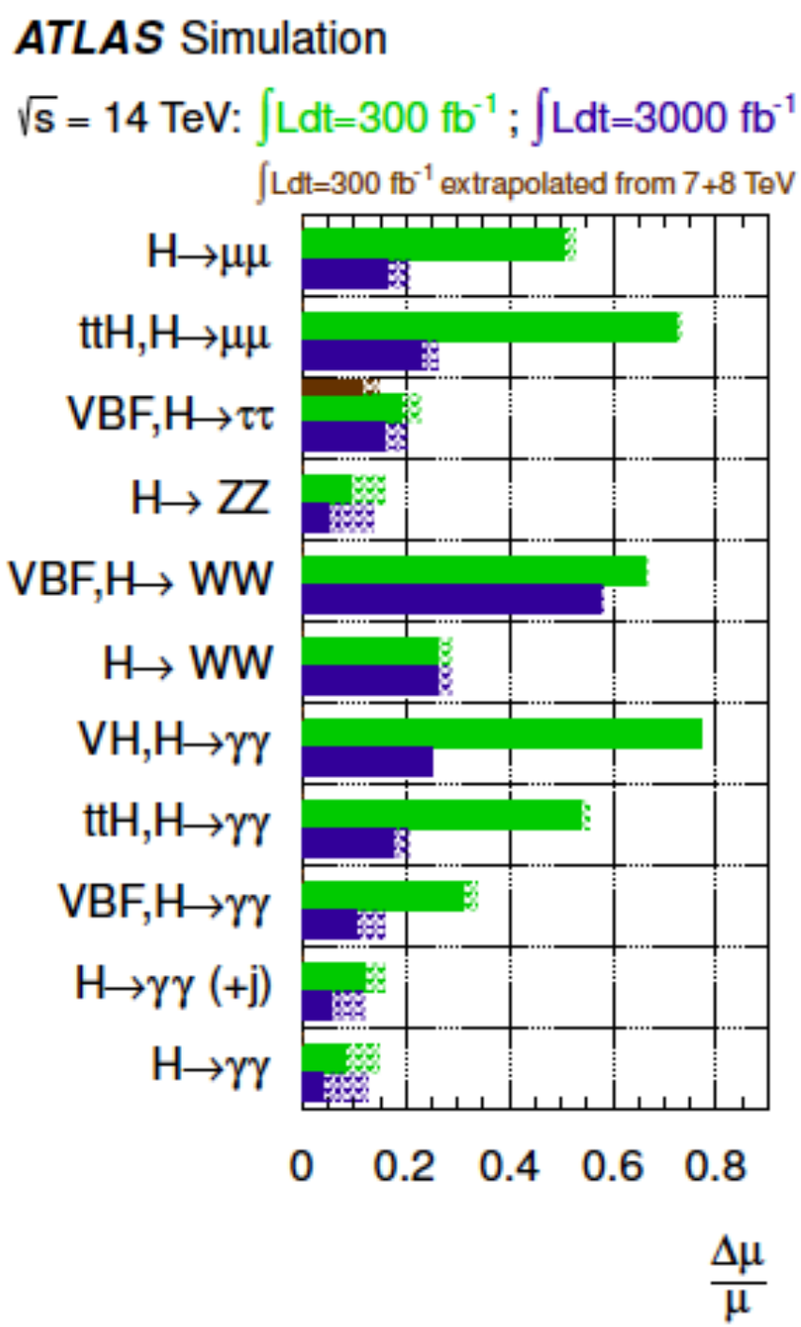
Higgs boson

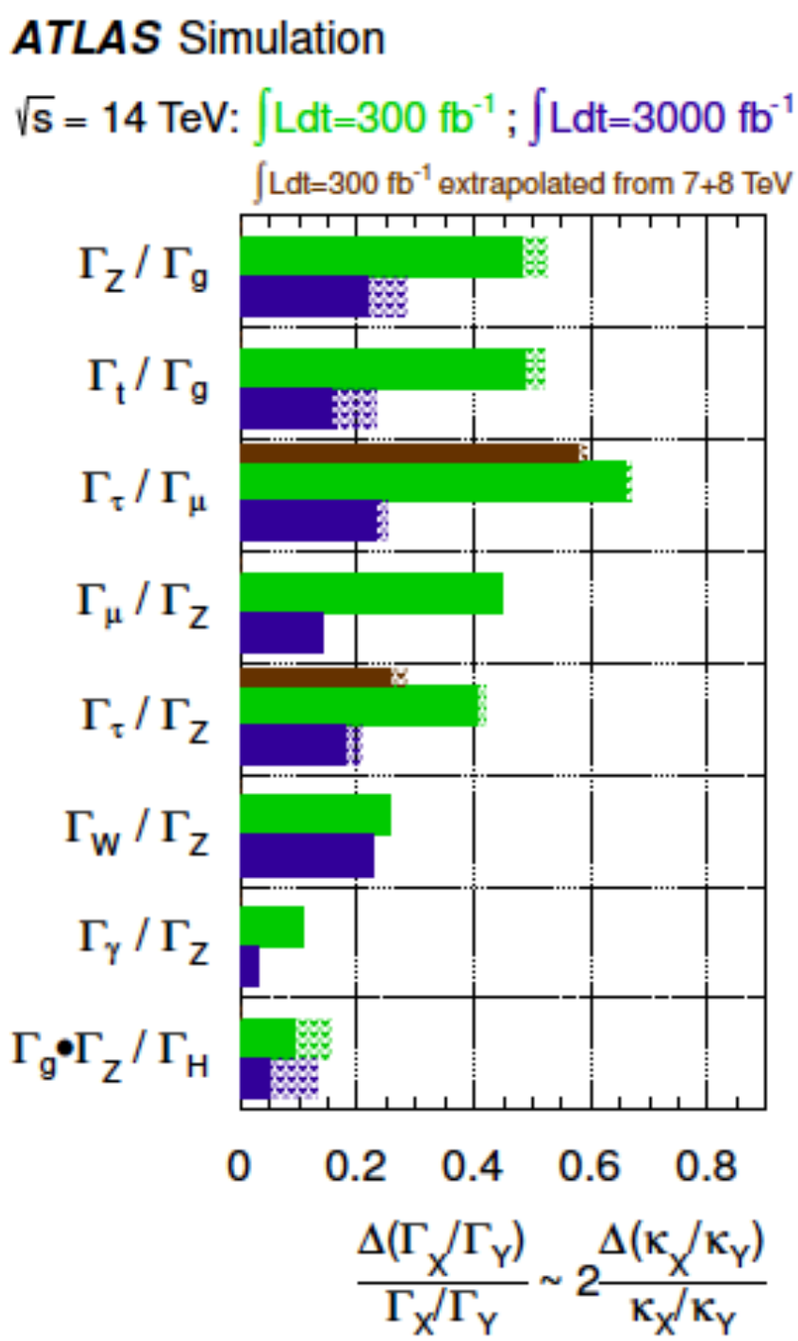
Expected measurement precision on:

- signal strength

$$\mu = \frac{\sigma \times BR}{(\sigma \times BR)_{SM}}$$

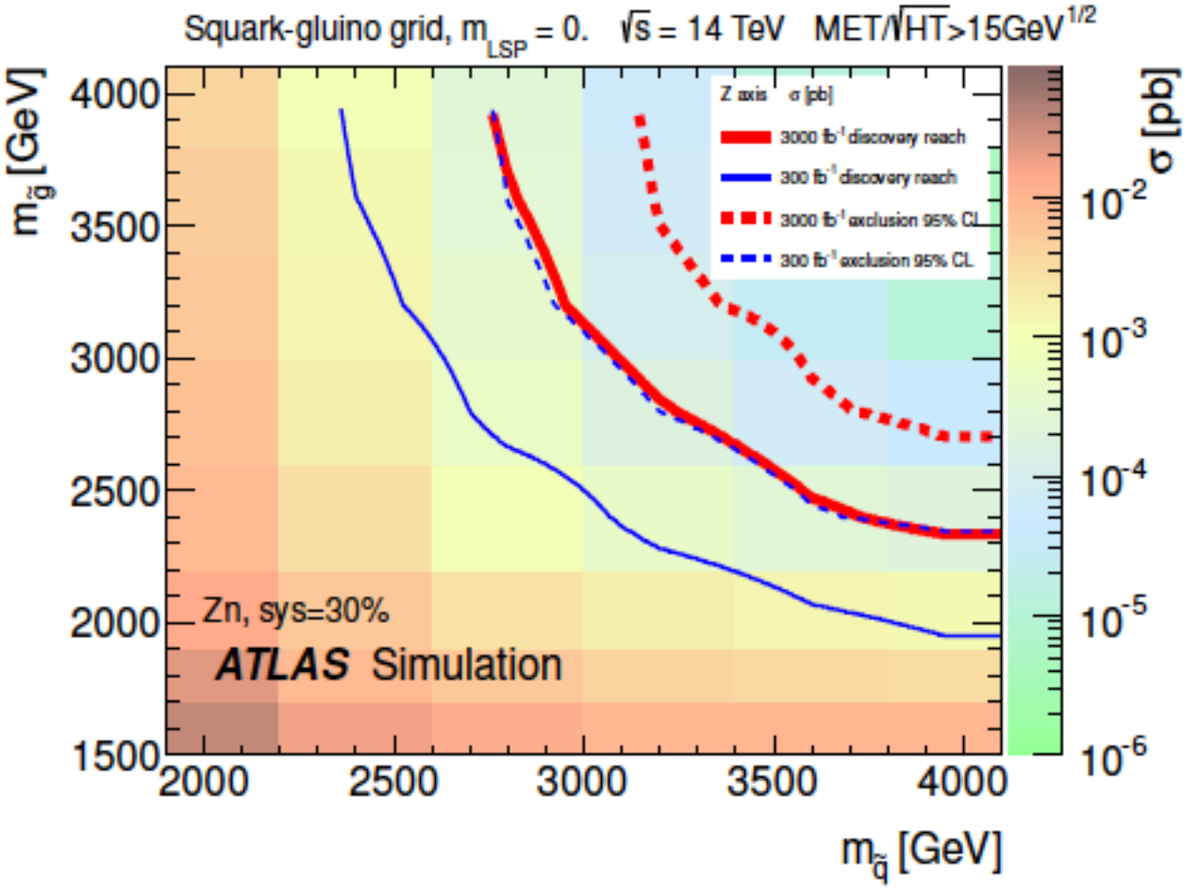
- Relative uncertainties of coupling parameters



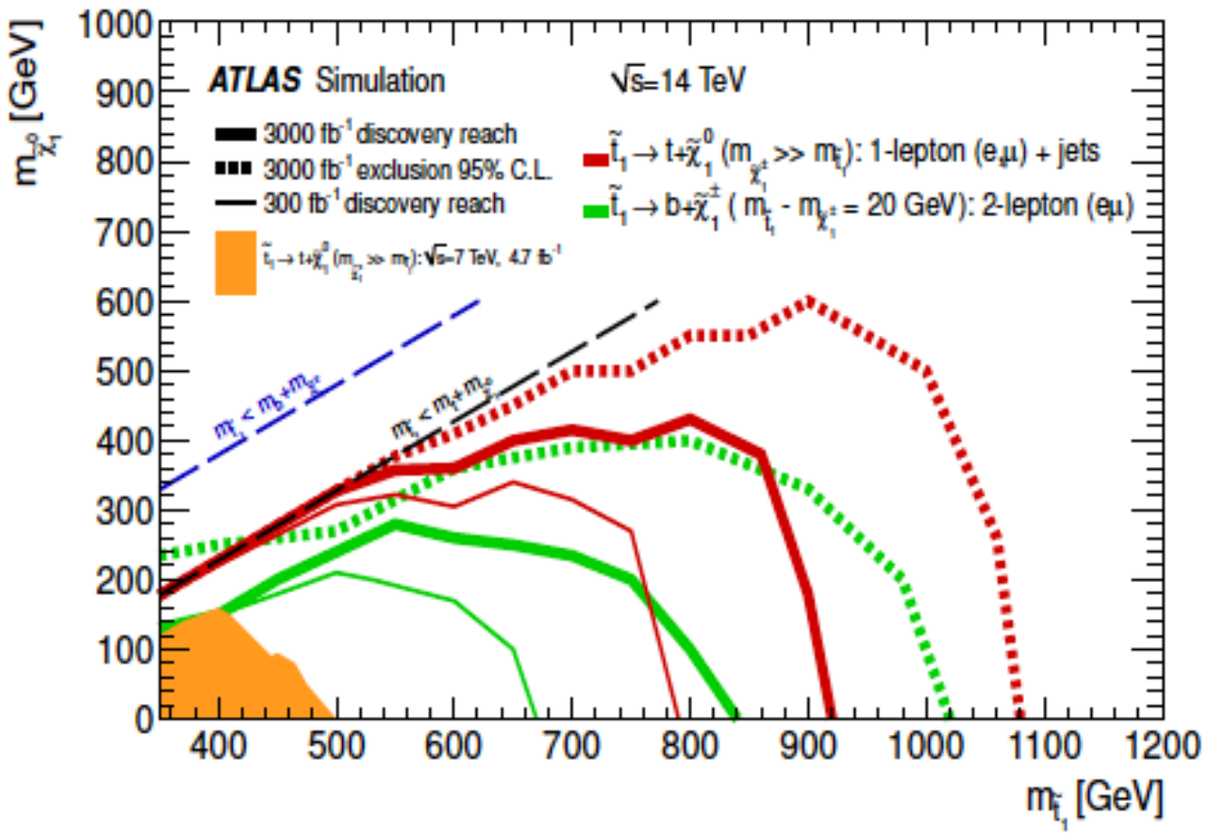


ATLAS Phase II Upgrade (2024-2026) toward HL-LHC

BSM Physics: benchmark examples



LHCC-I-023



95% CL exclusion limits (dashed lines)
5σ discovery reach (solid lines)

ATLAS Phase II Upgrades

A major update of the experiment is foreseen:

- 6 Technical Design Report (TDR) released in 2017
- 1 technical proposal submitted (High Granularity Timing Detector)

ITK (Inner TracKer): completely new all Silicon detector
Pixel: ATLAS-TDR-030 Strip: ATLAS-TDR-025

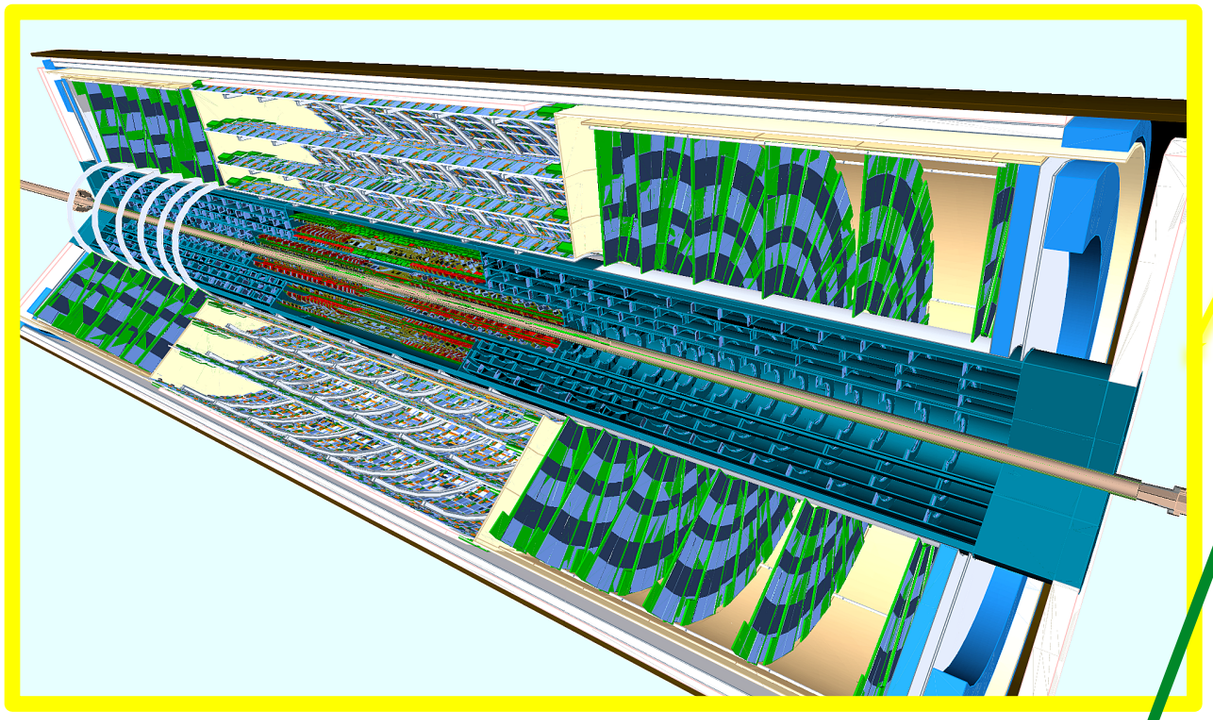
Calorimeter (ATLAS-TDR-027 and -028):
FE/BE Electronics LAr/Tilecal detectors

High-Granularity Timing Detector (HGTD)
silicon low-gain avalanche detector, 30 ps resolution

Muons (ATLAS-TDR-026):
Inner Barrel Layer (thin gap RPC and μMDT)

Trigger & DAQ (ATLAS-TDR-029)

ATLAS Phase II Upgrades



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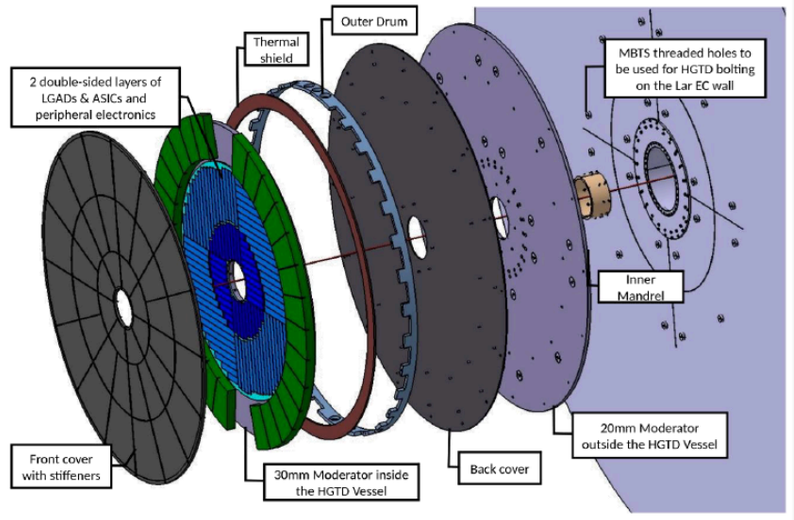
Replace Lar/Tilecal readout electronics and LV powering system:

- Limited radiation tolerance
- Incompatibility with the proposed trigger system

HGTD:
Pile-up mitigation exploiting time spread of the collisions in each bunch crossing



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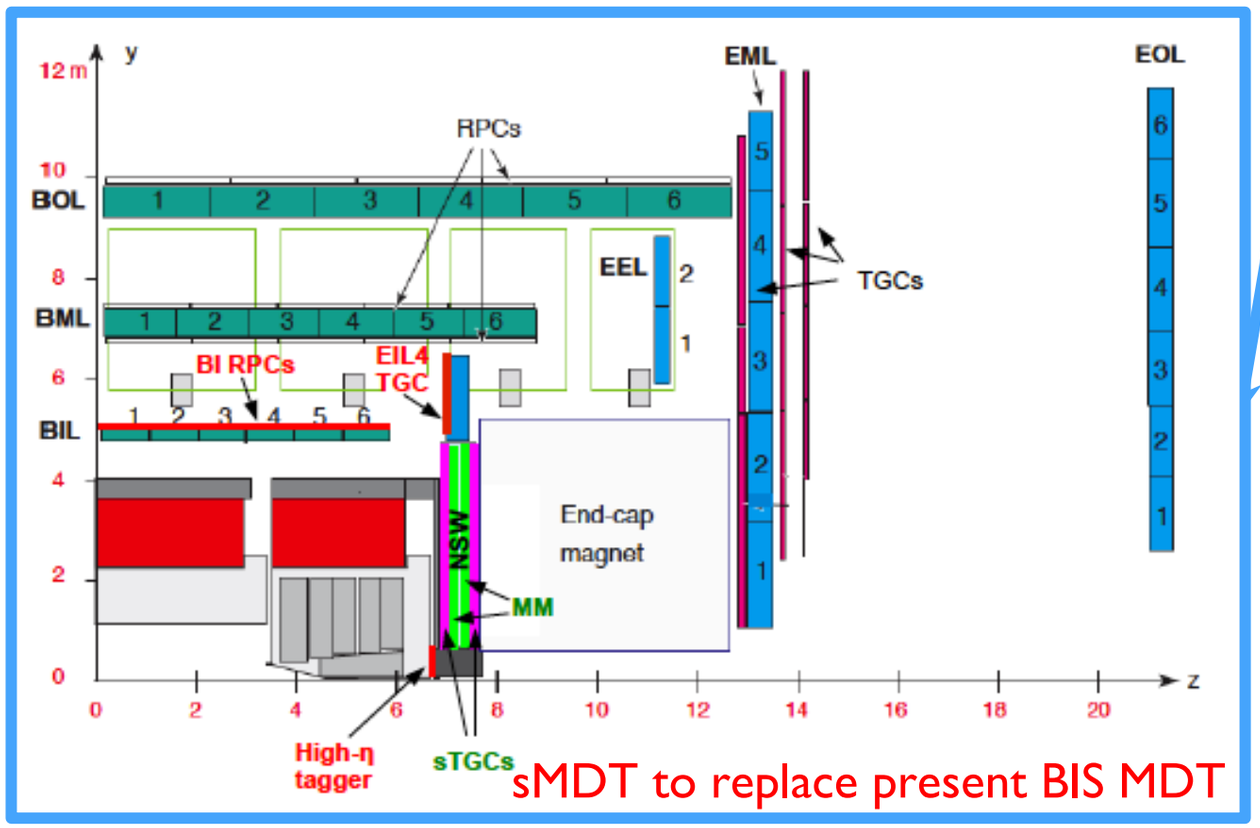
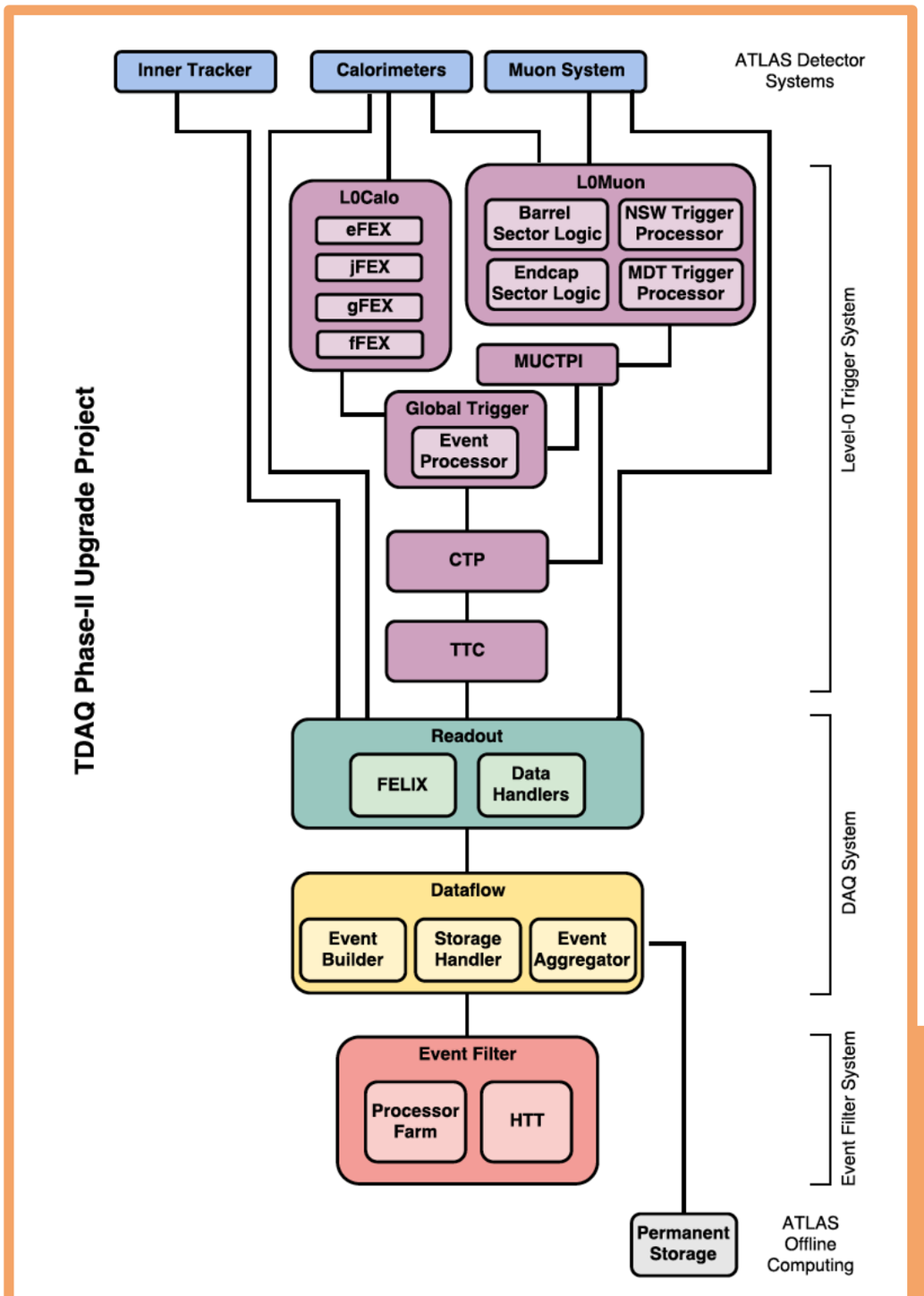


sMDT to replace present BIS MDT

ATLAS Phase II Upgrades



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Trigger & DAQ (ATLAS-TDR-029)

Trigger & DAQ: upgrade of
- L0 Trigger System
- Data Acquisition (Readout and Dataflow)
- Event Filter (CPU-based processing farm and HTT)

Conclusions

- The LHC is performing beyond its design
- ATLAS detector and trigger system working very well allowing for efficient data acquisition
  - A data set larger then 140 fb^{-1} is expected
  - Excellent results from SM and Higgs measurements … But still no new physics
- Intense upgrade program for both phase I and phase II upgrade
  - Phase I ugrade under construction
  - Phase II upgrade: TDR already approved