

# The ATLAS Detector and Point-I Operations

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Slides prepared by Kerstin Lantzsch (ATLAS Run Coordinator)



October 21, 2019  
ATLAS Induction Day



# Overview



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The ATLAS Experiment at the CERN Large Hadron Collider

## I. The ATLAS Detector

## II. Point 1 Operation



# Overview



## 0. LHC Long-Term Schedule

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The ATLAS Experiment at the CERN Large Hadron Collider

## I. The ATLAS Detector

## II. Point 1 Operation



# SHUTDOWN: NO BEAM

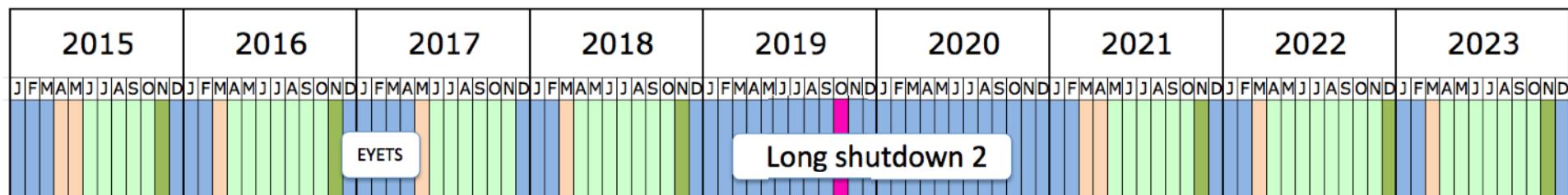
	BIS status and SMP flags	B1	B2
Comments (03-Dec-2018 04:38:24)	Link Status of Beam Permits	false	false
This was the last dump of Run2 !	Global Beam Permit	false	false
Going to access today, estimate 2 years	Setup Beam	true	true
	Beam Presence	false	false
	Moveable Devices Allowed In	false	false
	Stable Beams	false	false

# SHUTDOWN: NO BEAM

We are now in  
**Long Shutdown 2 (LS2)**

	BIS status and SMP flags	B1	B2
Comments (03-Dec-2018 04:38:24)	Link Status of Beam Permits	false	false
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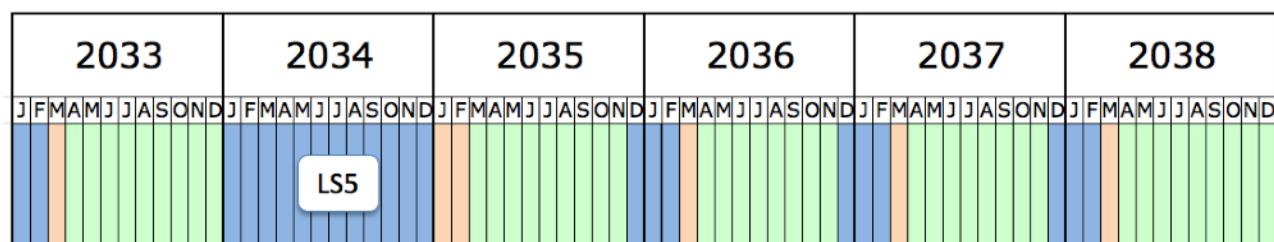
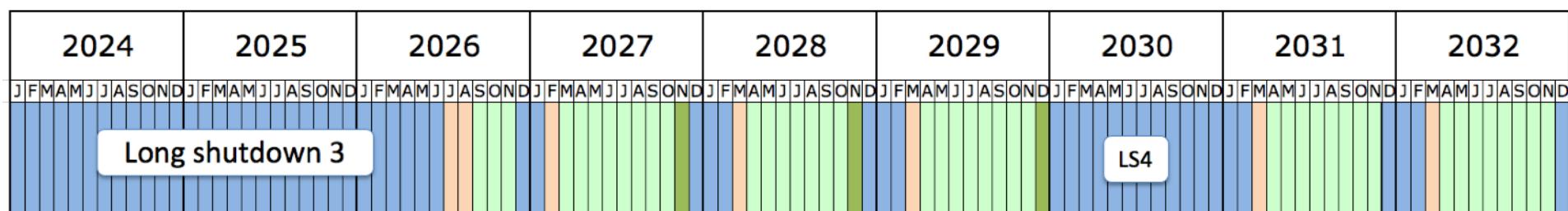
# LHC Long-Term Schedule



LHC Run-2: DONE!

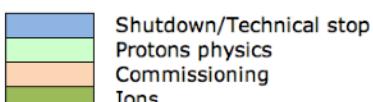
↑ You are here

LHC Run-3: TODO



2 Years of Shutdown  
**(LS2 = Long Shutdown 2)**

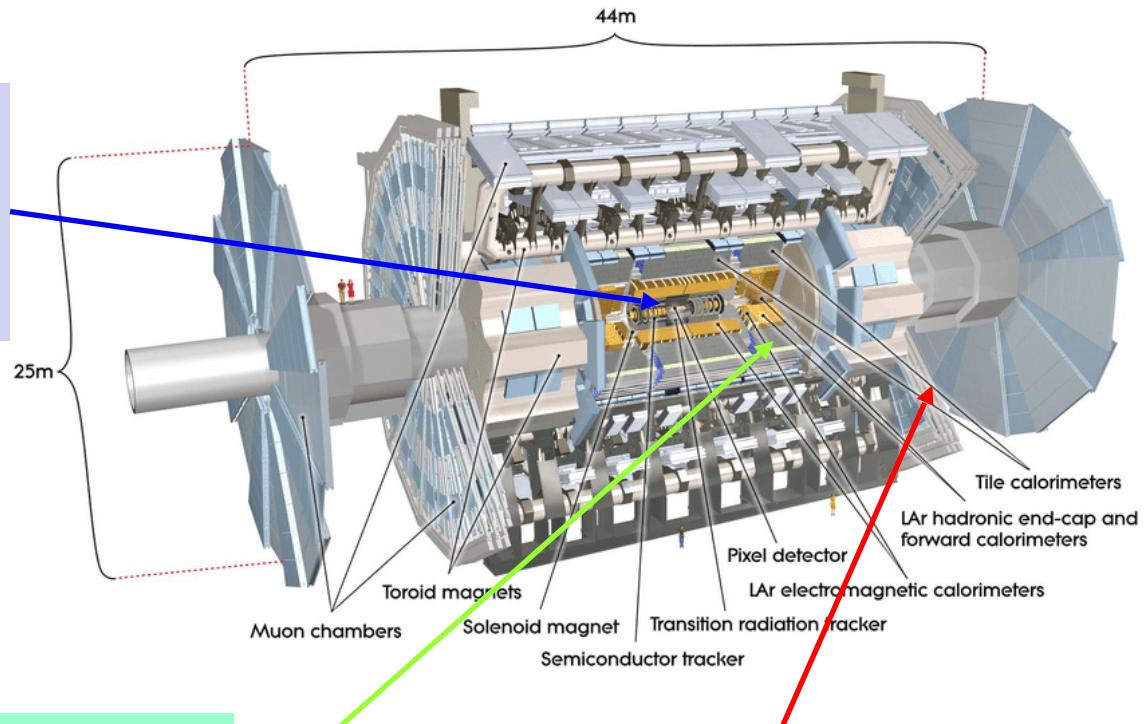
Physics Data Taking resumes in **2021**



*A multi-purpose hadron collider experiment...*

## Inner Detector

- Silicon Pixel Detector (PIX)
- Silicon Strip Detector (SCT)
- Transition Radiation Tracker (TRT)



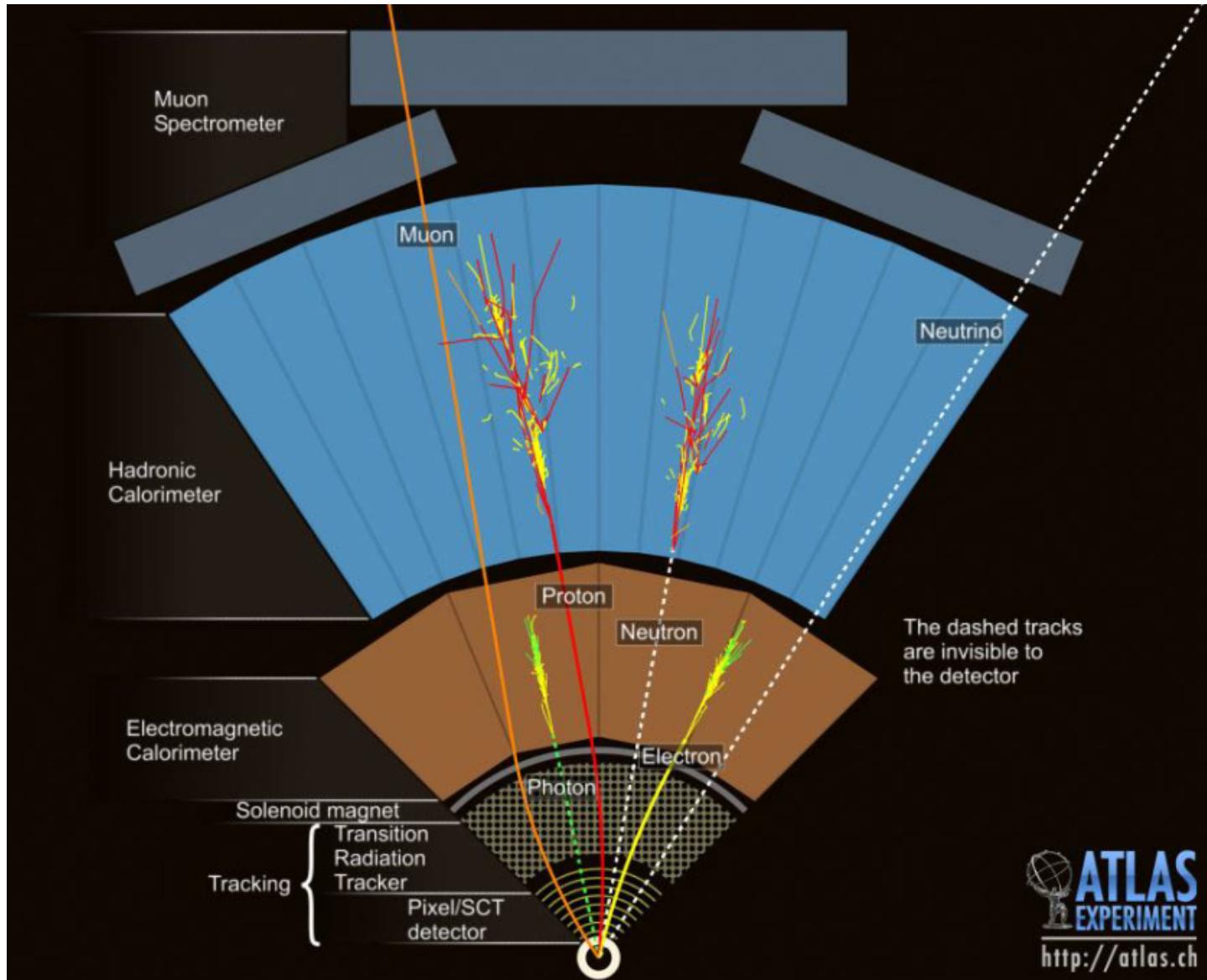
## Calorimeter

- Liquid Argon: EM + had EC calorimeter (LAr)
- Fe/Scintillator hadronic Tile calorimeter (TILE)

## Muon Spectrometer

- Monitored Drift Tubes (MDT)
- Resistive Plate Chambers (RPC)
- Thin Gap Chambers (TGC)
- Cathode Strip Chambers (CSC)

# Particle Detection



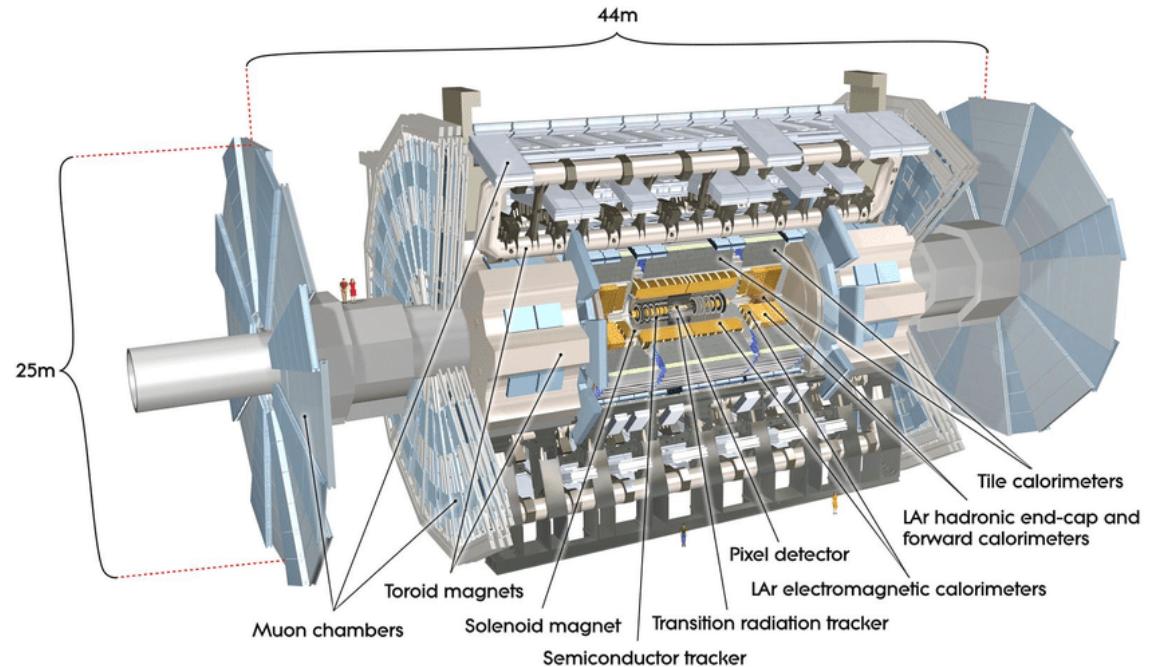
*A multi-purpose hadron collider experiment...*

## Magnets

- Solenoid (2T)
- Toroid (4T)

## Infrastructure

- Cooling
- Electricity
- Gas
- Cryogenics
- ...



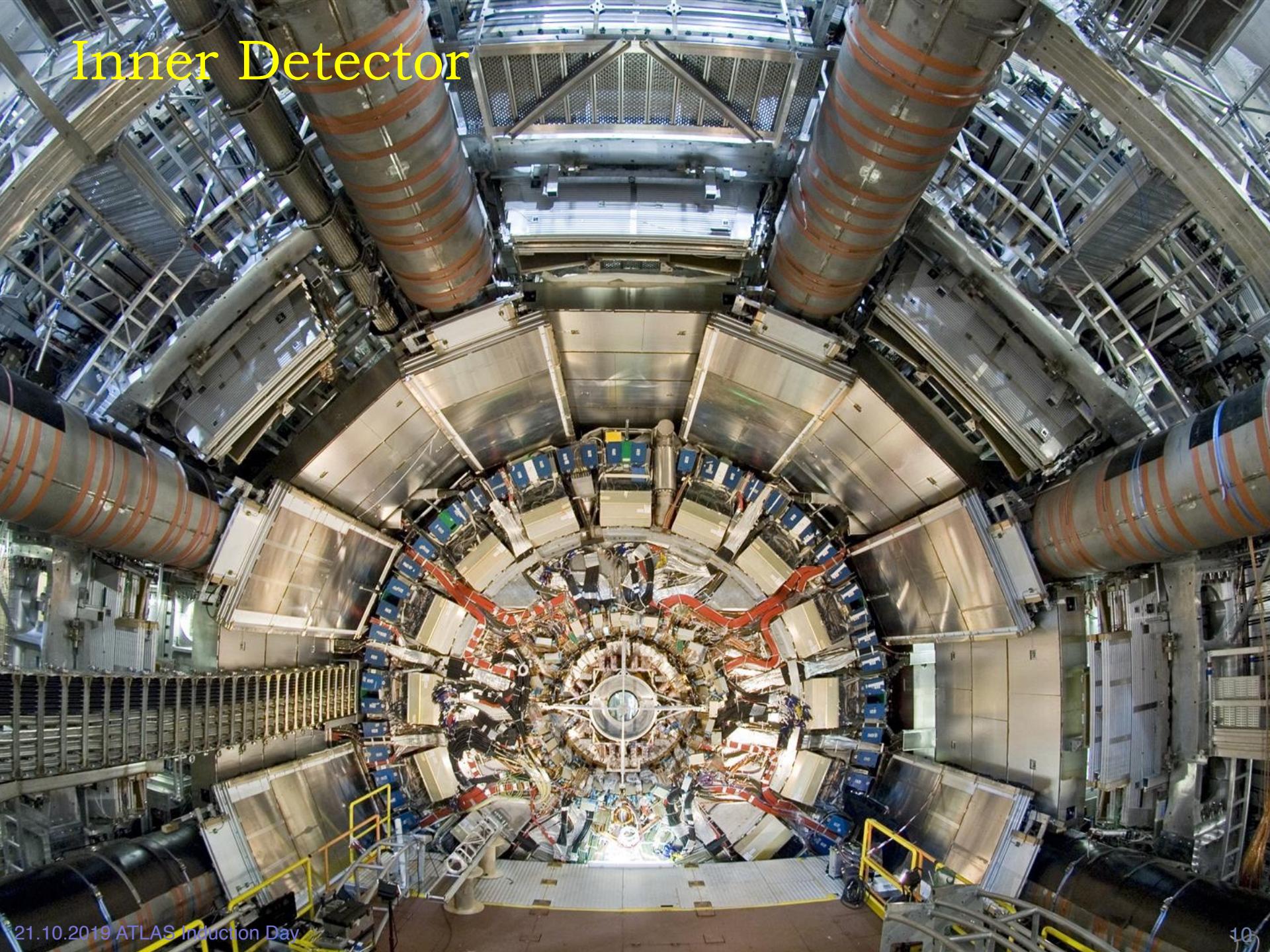
## Trigger, DAQ and DCS

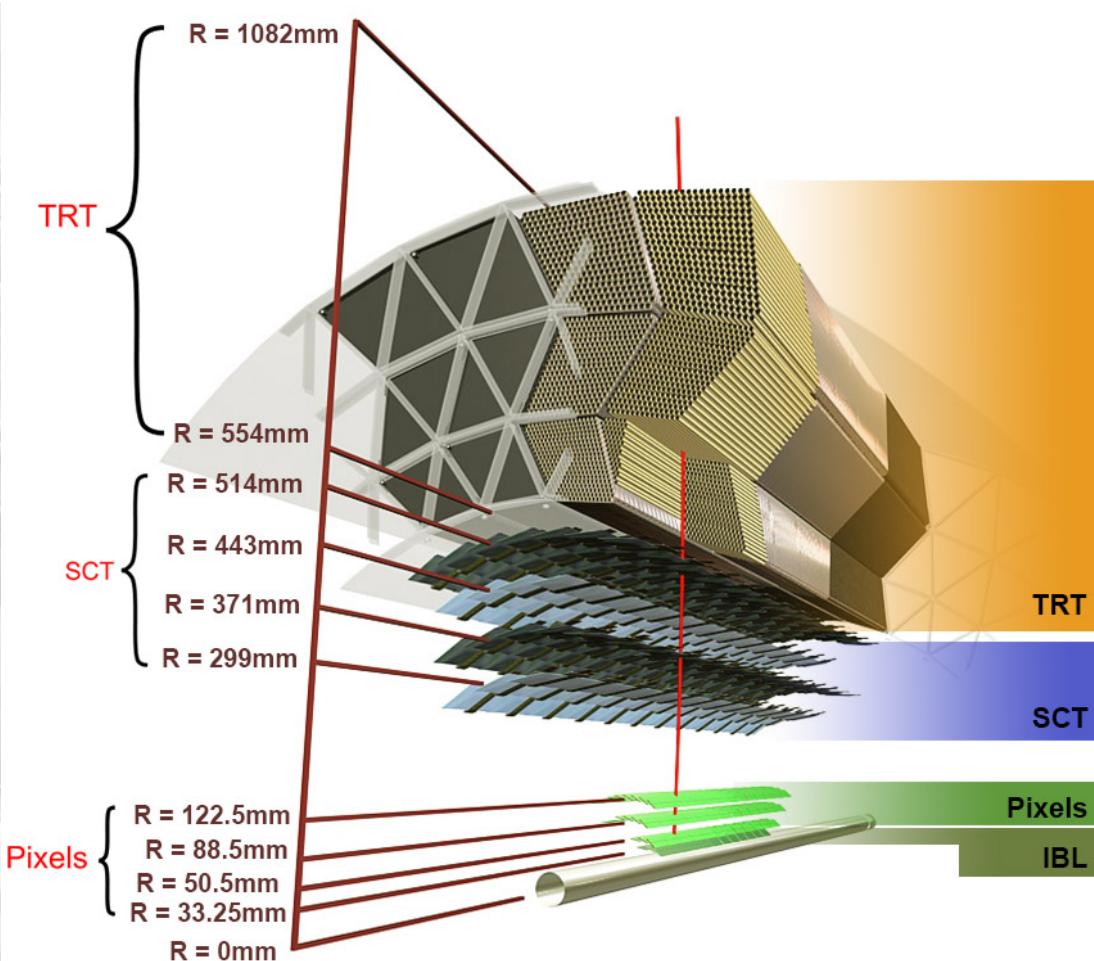
- DCS: Control System, Thousands of Channels
- DAQ: More than 100 Million Readout Channels
- Trigger: 1 event every 25 ns → ~1.5 kHz recorded

## “Small” Detectors

- Beam Conditions Monitor (BCM)
- Lucid (Luminosity)
- ALFA (Forward, Luminosity)
- AFP (Forward Physics)

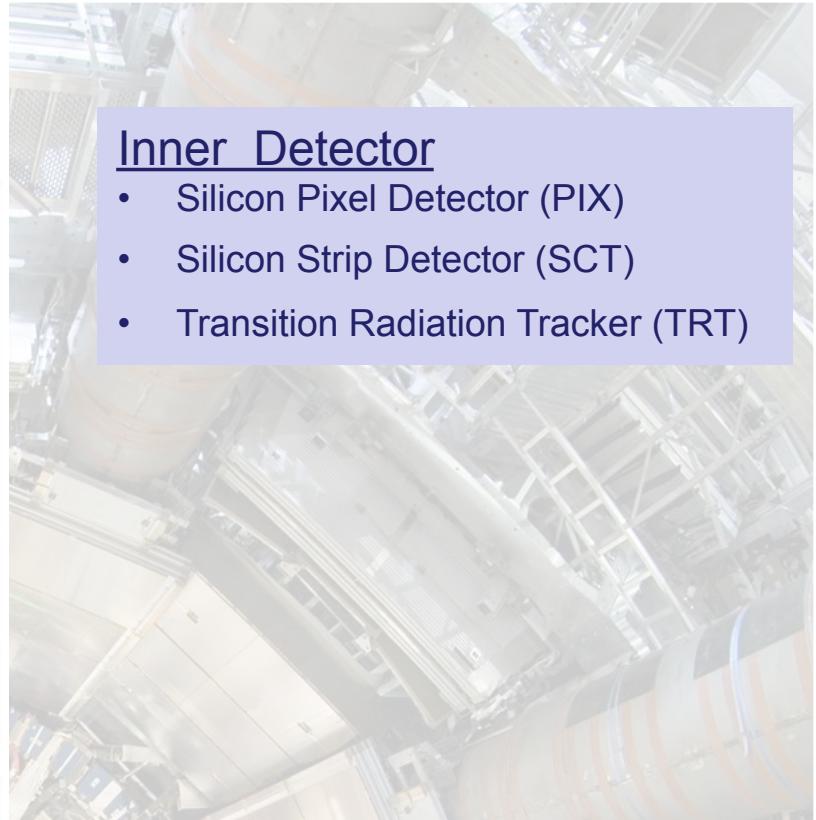
# Inner Detector



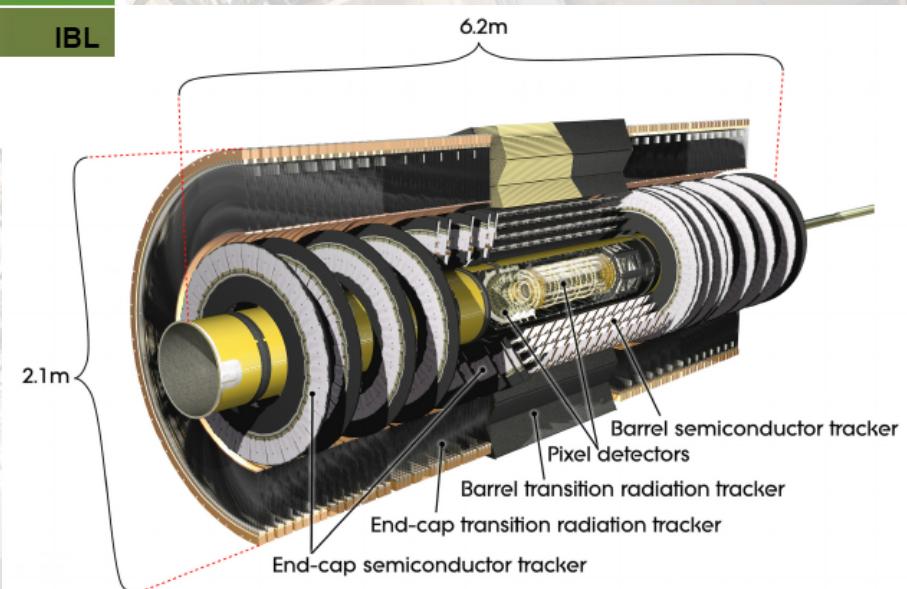


## Inner Detector

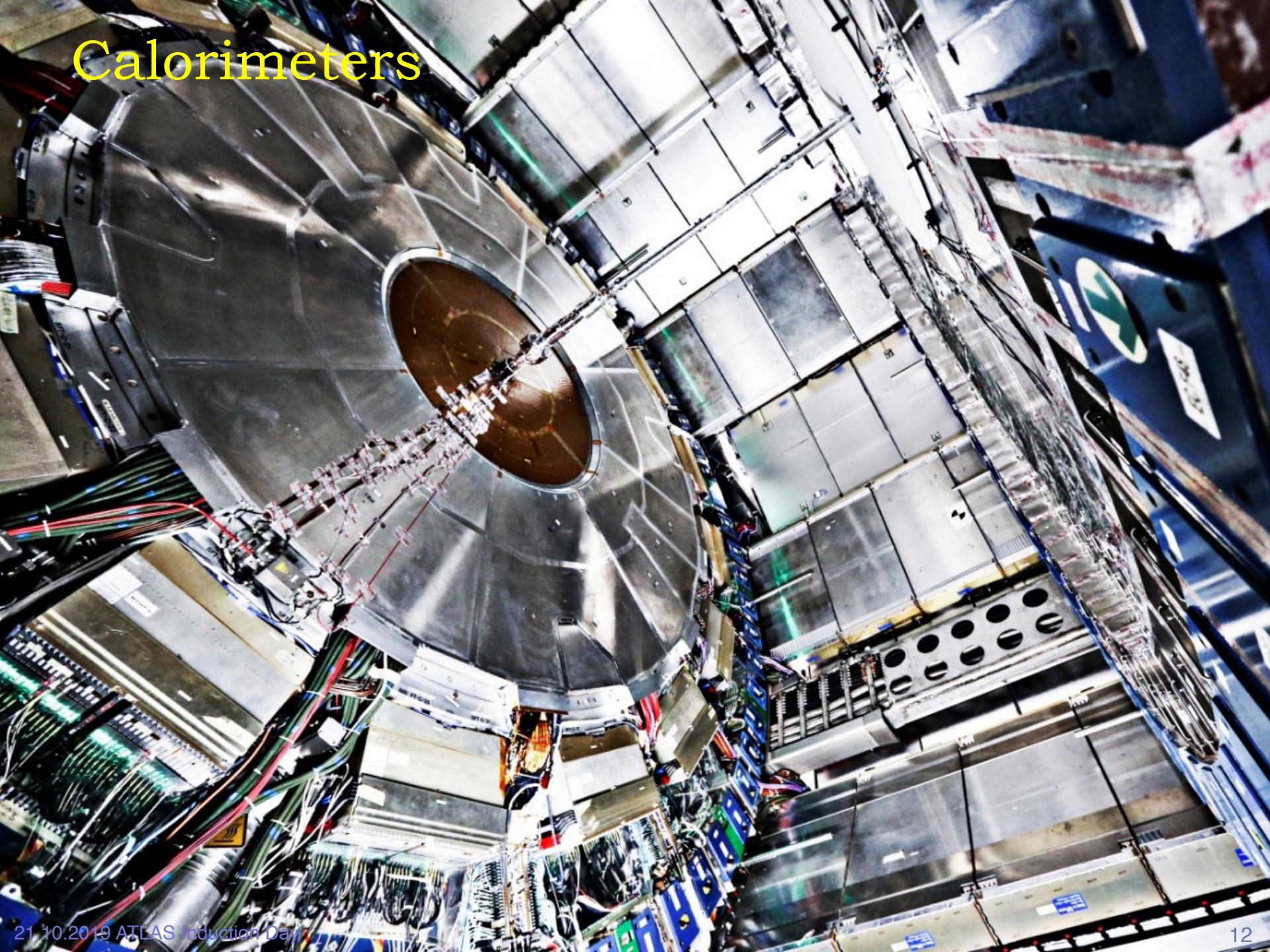
- Silicon Pixel Detector (PIX)
- Silicon Strip Detector (SCT)
- Transition Radiation Tracker (TRT)



**Tracking:**  
Momentum and Position  
Measurement of charged particles



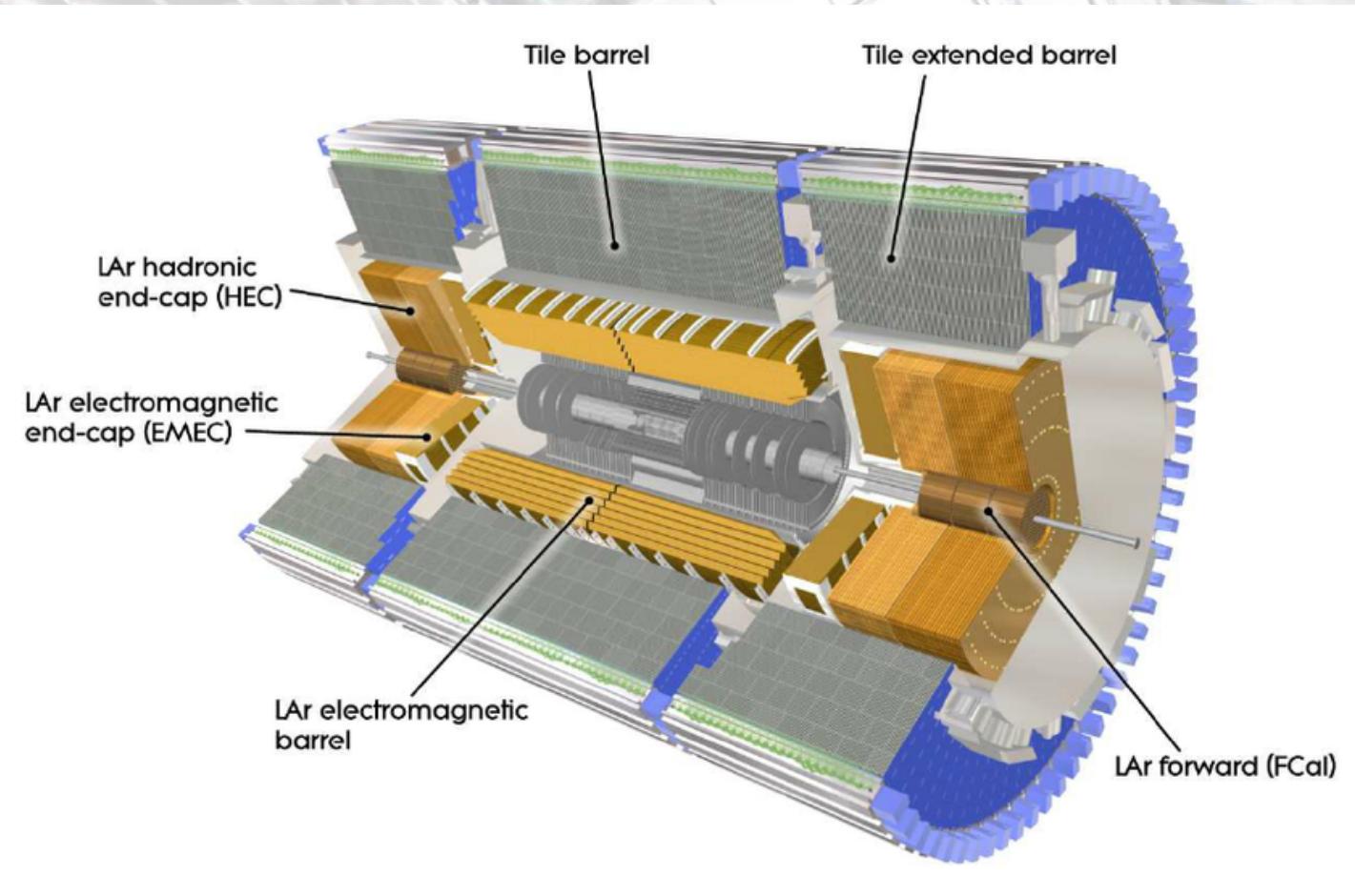
# Calorimeters



# Calorimeters

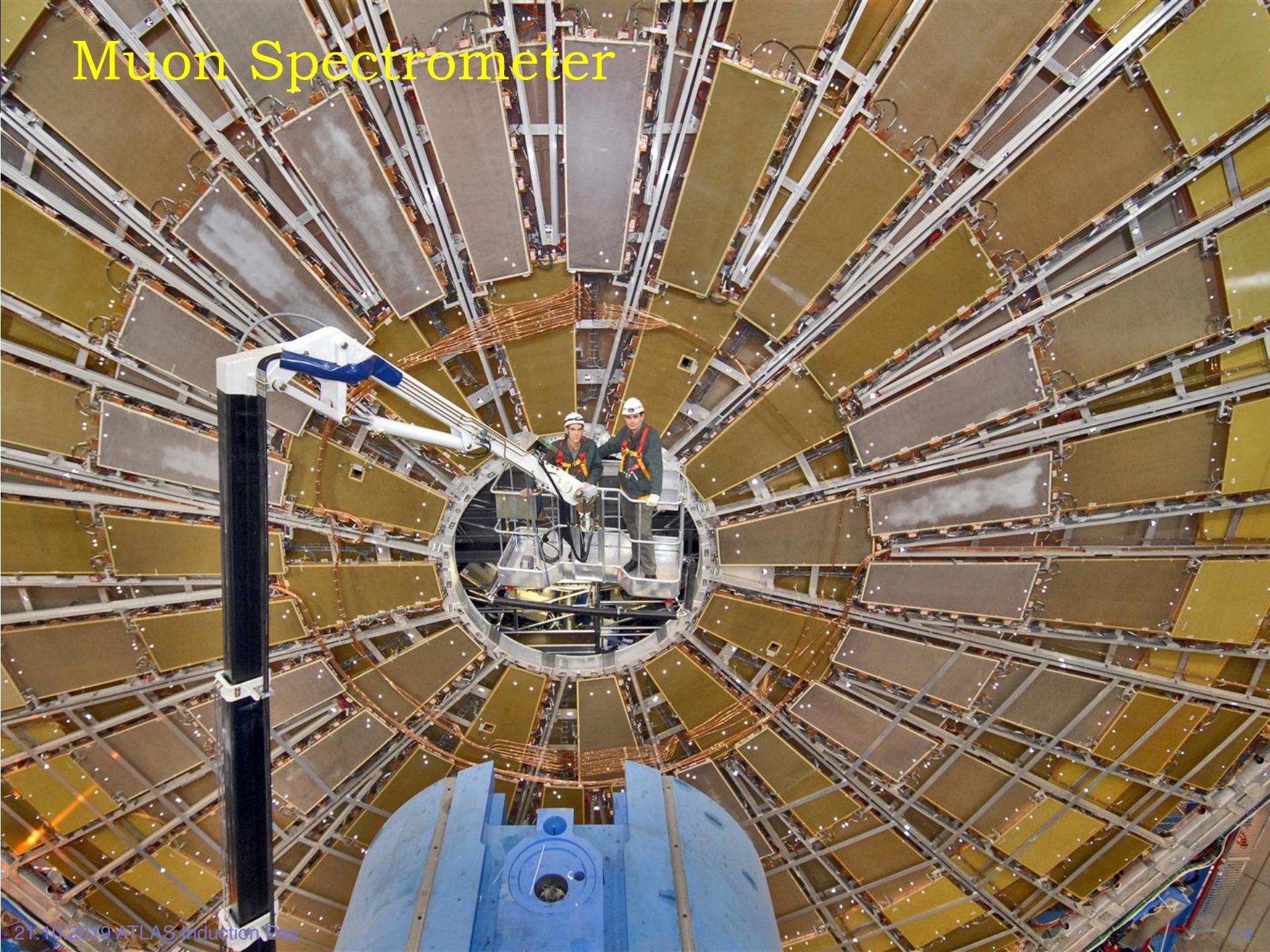
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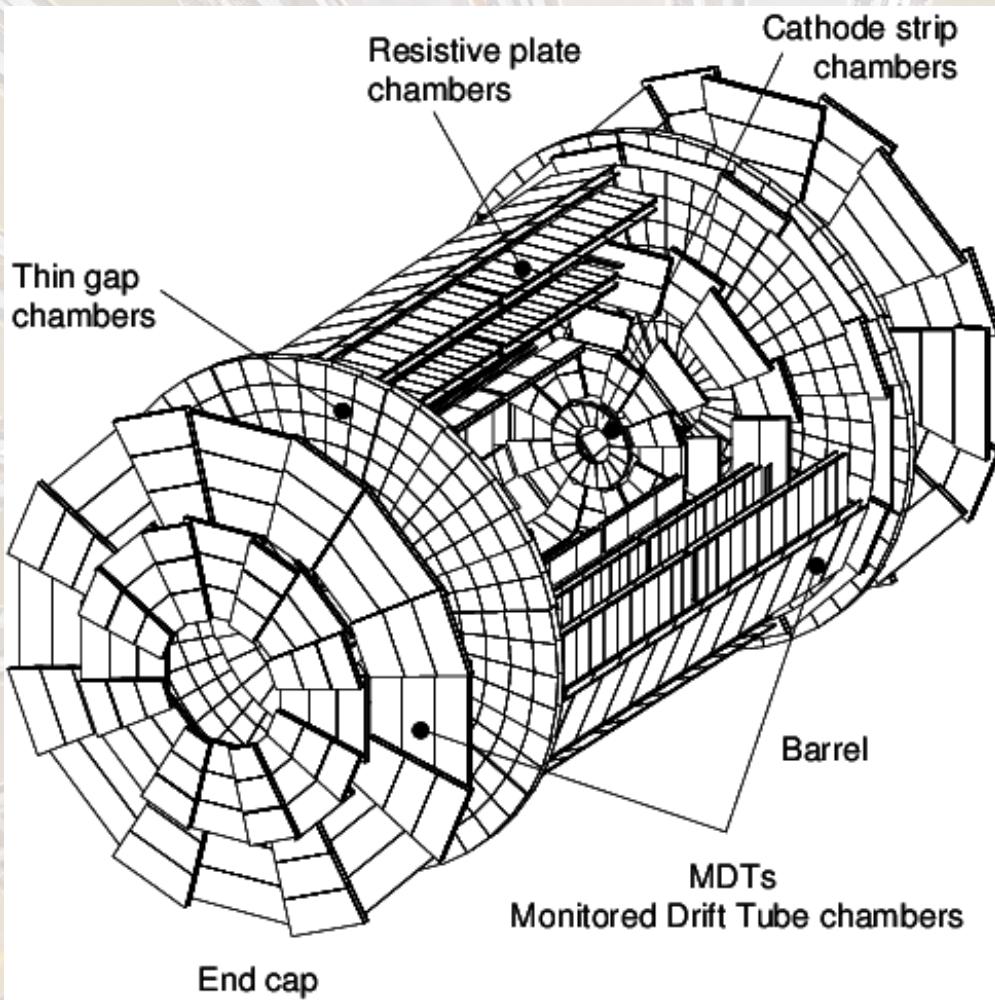


## Energy Measurement, Trigger Input

# Muon Spectrometer



# Muon Spectrometer



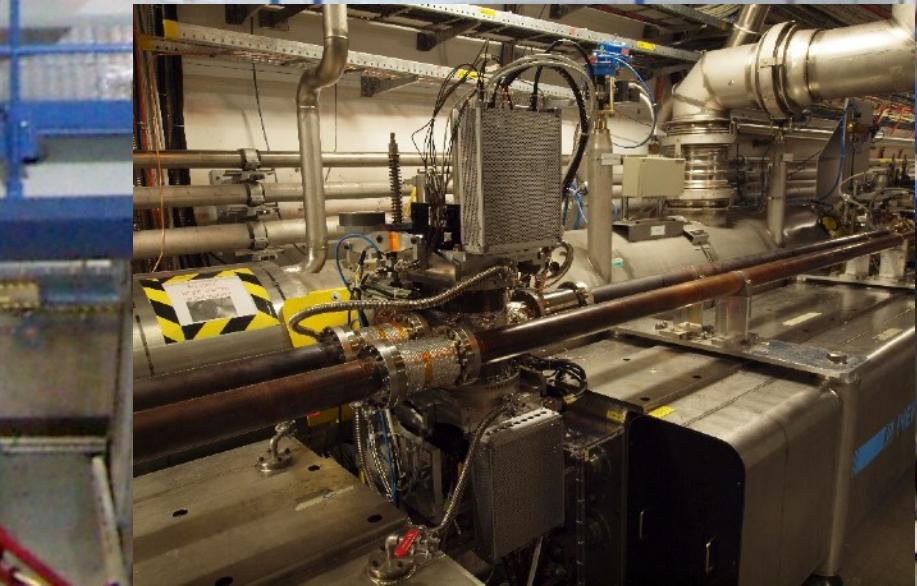
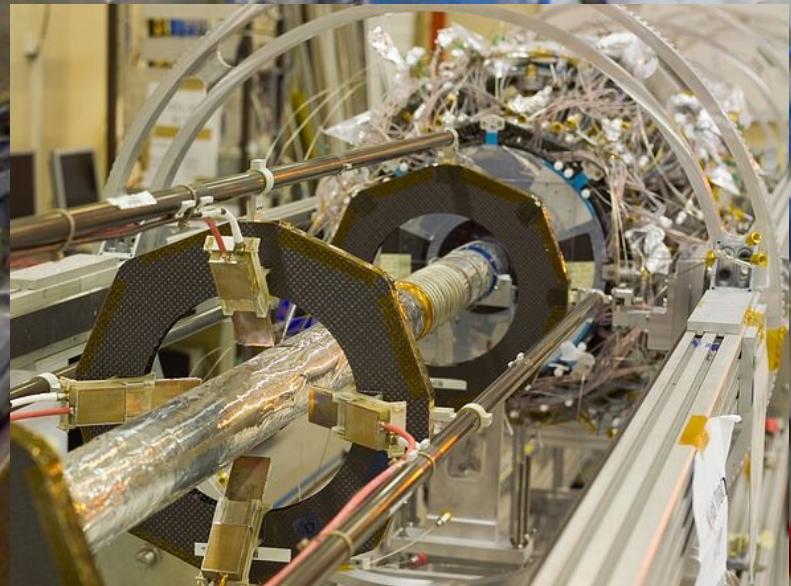
## Muon Spectrometer

- Monitored Drift Tubes (MDT)
- Resistive Plate Chambers (RPC)
- Thin Gap Chambers (TGC)
- Cathode Strip Chambers (CSC)

**Momentum and Position Measurement of Muons, Trigger**

# “Small” Detectors

BCM, Lucid, ALFA



# “Small” BCM, Lucid

## LUCID

- 2x16 Photo-Multiplier Tubes  
(quartz windows as Cerenkov medium)
- 2x4 bundles of quartz Fibers

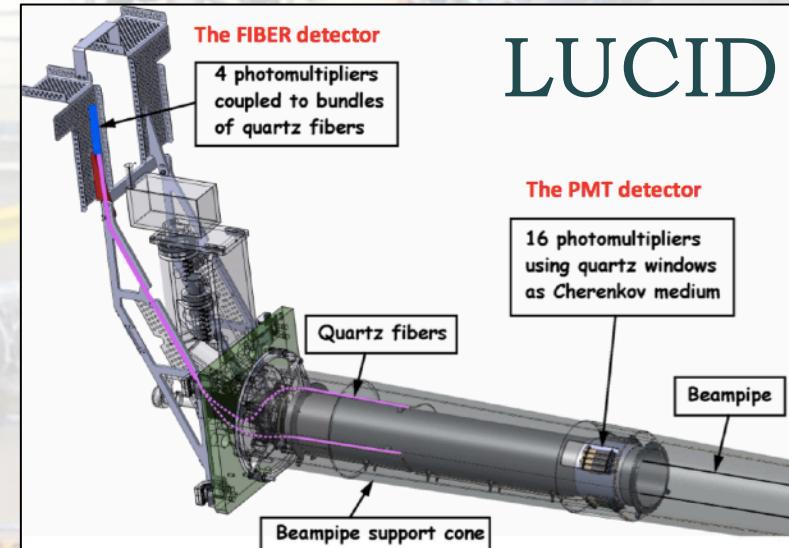
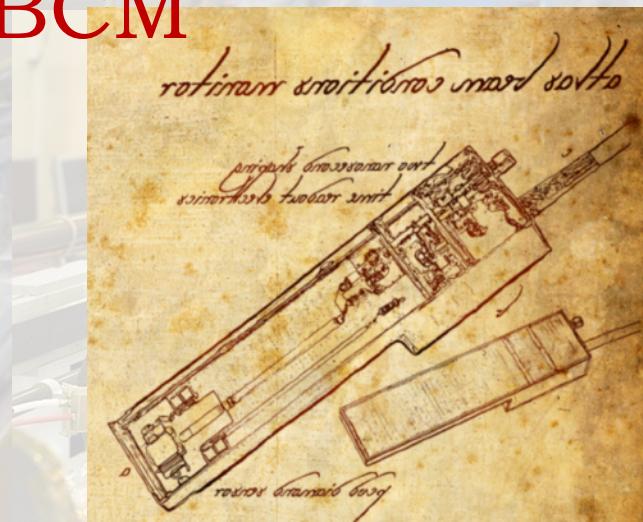
## ALFA

- Scintillating Fibers
- 8 Roman Pots, 240m from Interaction Point

## Beam Conditions Monitor (BCM)

- 8 pCVD Diamond Sensors
- Fast Readout Electronics
- Buffering > 1000 LHC orbits of data

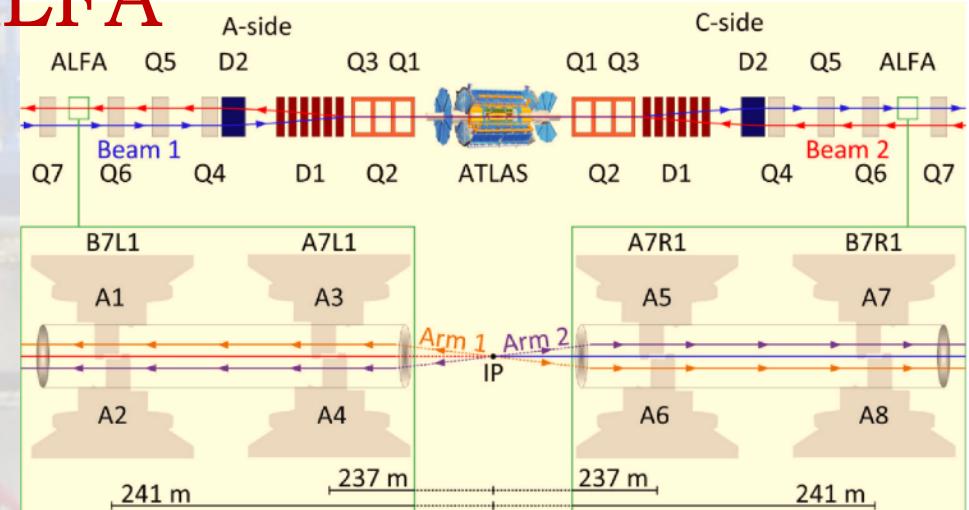
## BCM



## LUCID

## Luminosity

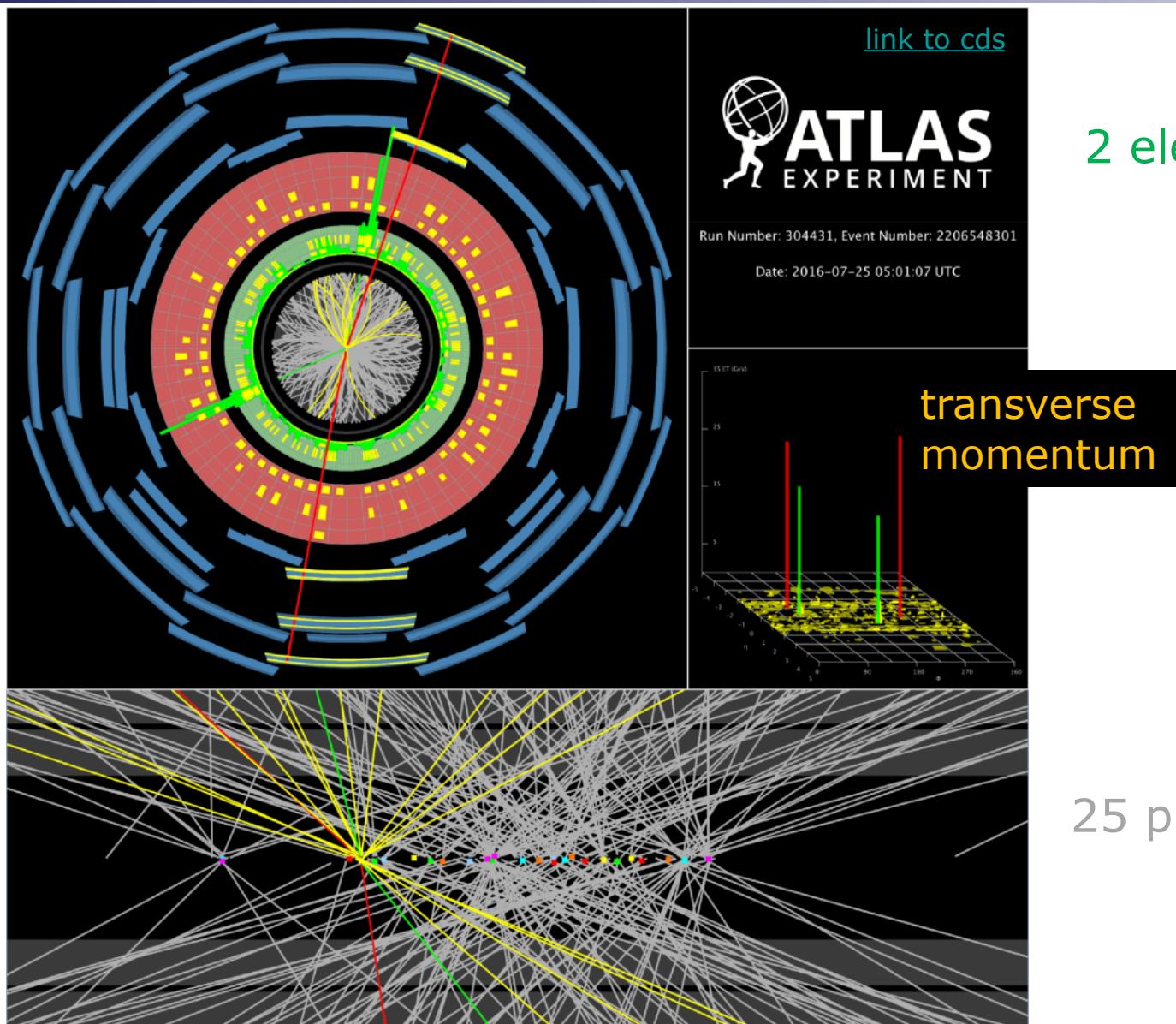
## ALFA



## Beam Protection

## Forward Physics

# ATLAS Event Display



2 electrons + 2 muons

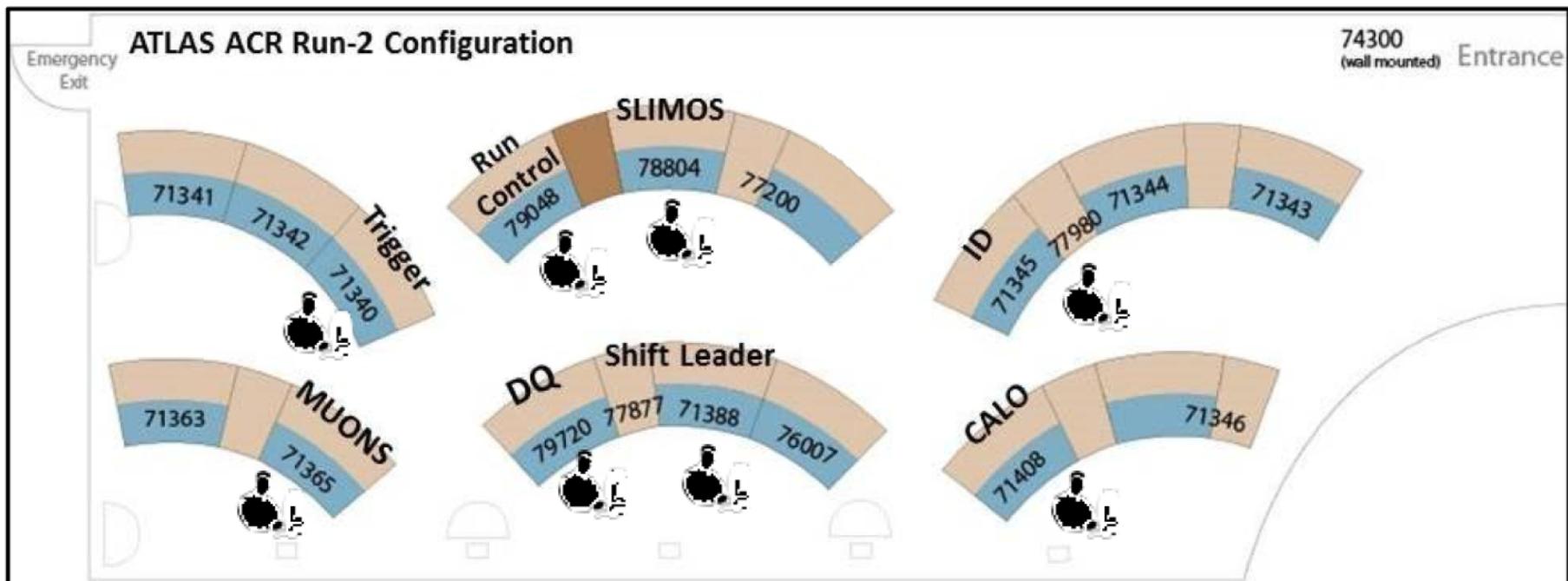
25 pile-up events

## II. Control Room Operations



# Operations at Point 1

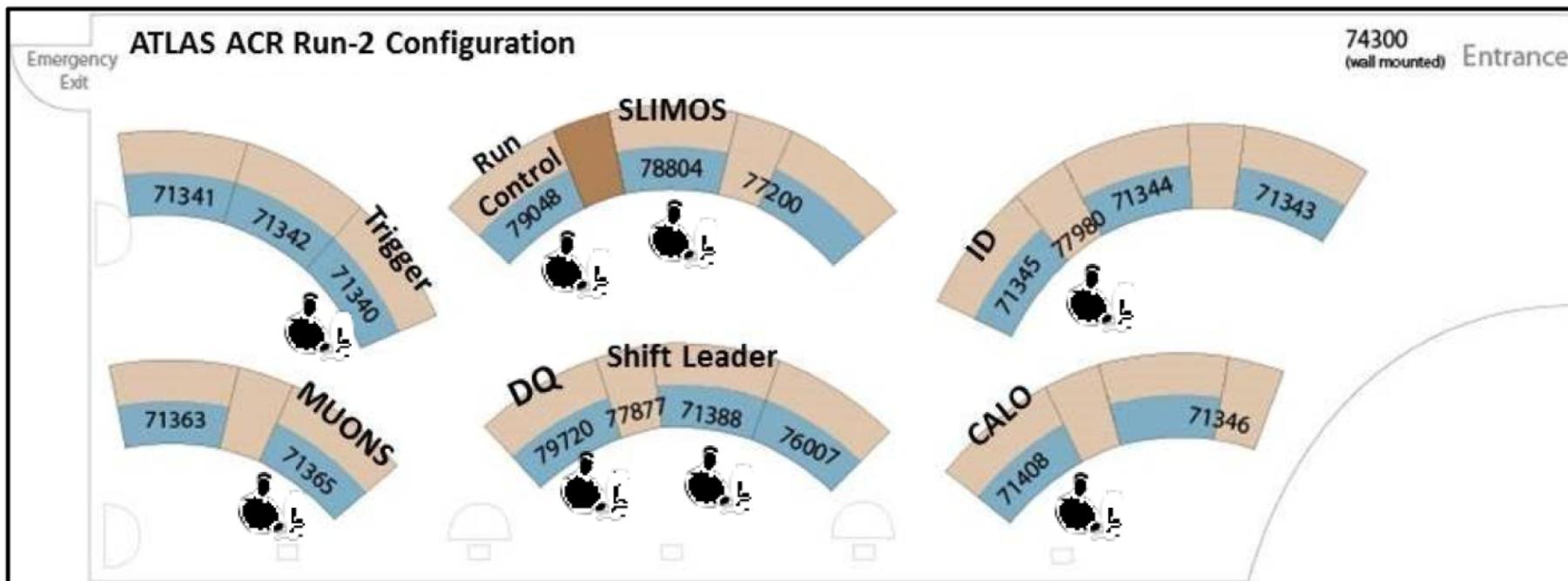
- How to operate a detector with many millions of readout channels and thousands of control channels?



# Operations at Point 1

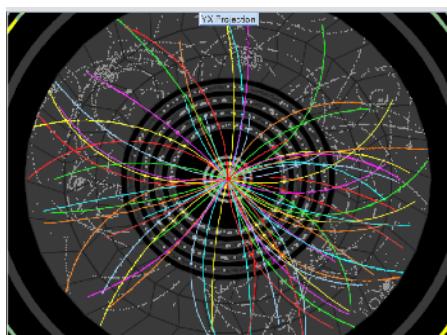
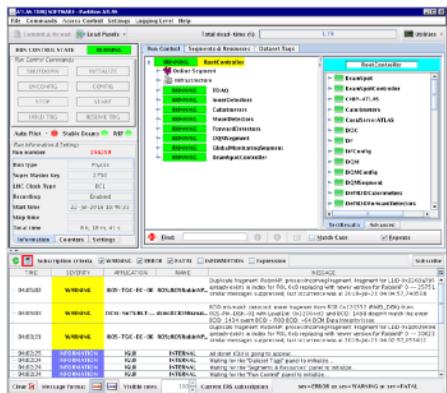
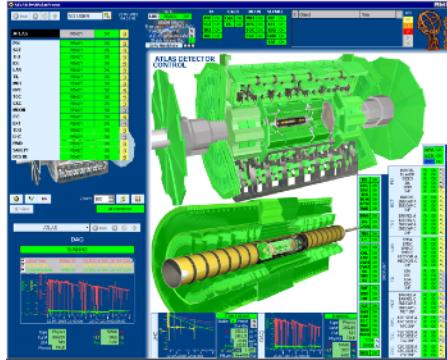
## ➤ ACR (“*ATLAS Control Room*”) Shifts

- Shifters monitor the correct working of the system (DAQ, DCS, DQ)
- (Mostly) from the subsystem communities
- Training: 5 times per year (last one in August 2018)
- A very good way to contribute to ATLAS data taking!



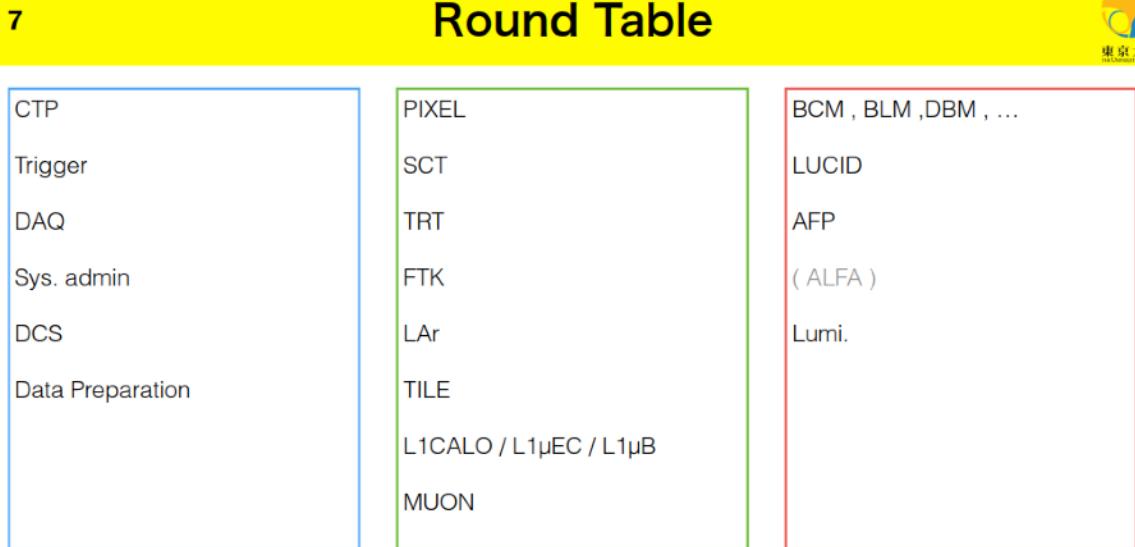
# Operations at Point 1

- ACR shifts: contribute to ATLAS data taking
  - Qualified shifters: first line of defense against loss of data
  - Monitor the system (DAQ, DCS, DQ)
  - Communicate your observations with the shift crew and your subsystem experts
  - Document and log what happens on your shift for future reference
  - See where your data are coming from
  - Become familiar with one of the subsystems
  - Become familiar with the ATLAS community - outside your analysis
  - Operations: very collaborative and constructive atmosphere: ATLAS can only take data when all systems are working



# Operations at Point 1

- On Call Experts to support operations
  - 24h per day
  - Called in case of problems
- Hardware and Software experts
  - Maintenance and Development
- Run Coordinators
  - Overall planning and coordination with respect to ATLAS data taking
- Daily meetings at Point 1
  - to review the last day's operations
  - define the plan of the day



## Plan of the Day (last update on 31 May 2018)

- Prepare for/Expect 13 TeV physics fill aiming at SB for ~12 hours
- AFTER beams are dumped, STOP run, calibration break for 1h (or less)
- Prepare for the next fill
- **May 31 (Thursday)**
  - Calibrations at the interfill **Done!**
  - Brief testing with [TileCal](#) prior to next combined run **Done!**
  - L1Topo test with TGC (if the next physics fill is not foreseen within 1h) **Done!**
  - Prepare for the next fill and start run for physics with **2556b On-going...**
  - Call Kate from Trigger if injection is delayed and there is an opportunity to test new GUI (2h) **Postponed...**
- **June 1 (Friday)**
  - Expect 90m preparations (3rd cycle---to collisions) on the LHC side
  - Assume MBTS ON to find collisions; CTP and Tile must be called
  - Run with all sub-systems [ but LAr and L1Calo OUT (to be confirmed) ] in (STANDBY), as a minimum Lumi detectors and [TileCal](#)

# LHC Calendar



	Jan				Feb				Mar				LHC to OP		Experiments valves open	
Wk	1	2	3	4	5	6	7	8	9	10	11	12	13	LHC, TI2, TI8 closed	TI2 & TI8 Beam tests	Start Beam Commissioning
Mo	1	8	15	22	29	5	12	19	26	5	12	19	26			
Tu																
We																
Th																
Fr																
Sa																
Su																
<b>“YETS” Year End Shutdown</b>				<ul style="list-style-type: none"> <li>• Maintenance</li> <li>• Consolidation</li> <li>• Updates/Upgrades</li> <li>• Milestone Weeks for Detector Operation</li> </ul>												First Beam

Apr		First Stable beams		Collisions with 1200 bunches		May		Technical Stop → No Beam									
Wk		14	15	16	17	18	19	20	21	22	23	24	25	26			
Mo	Easter	2	9	16	Scrubbing	23	30	7	14	Whitsun	21	28	4	11	18	25	
Tu																	
We																	
Th																	
Fr	<b>First Collisions</b>			Interleaved commissioning & intensity ramp up			[9]			<b>PHYSICS</b>			[24]				
Sa	<b>Splashes</b>						RAMP-UP			[20]			MD 1				
Su							Ascension						VdM program			$\beta^* = 90 \text{ m run}$	

300b 1200b 2500b

## [Special Runs]

# LHC Calendar, II



[Special Runs]

Machine Development

July		Aug								Sep				
Wk		27	28	29	30	31	32	33	34	35	36	37	38	39
Mo		β* = 90 m run												24
Tu														
We					MD 2								TS2	
Th											Jeune G.			
Fr												MD 3		
Sa														
Su														

PROTON PHYSICS

Start of LS2													
Wk	40	41	42	43	44	45	46	47	48	49	50	51	52
Mo	1	8		15	22	MD 4	29	Ion setting up	5	12	19	26	Xmas 24
Tu													
We		Special physics run											
Th						TS3				MD 5			
Fr						*							
Sa													
Su				MD 4									

Heavy Ions

300b 1200b 2500b

# Special Runs

## SpecialRunsIn2018

<https://twiki.cern.ch/twiki/bin/viewauth/AtlasProtected/SpecialRunsIn2018>

- ↓ Introduction
  - ↓ Requesting a special run 
- ↓ Special runs taken in 2018
  - ↓ Requested special runs
    - ↓ Requests affecting the LHC conditions
      - ↓  2. Luminosity VdM Scan number 1 and Length Scale (Approved)
      - ↓  3. Calibration-transfer run with isolated bunches - Approved
      - ↓  4. Luminosity mu-scan with bunch trains - Approved
      - ↓  6. Luminosity VdM Scan number 2 and Length Scale Calibration - Not approved
      - ↓  7. Pb-Pb Luminosity VdM Scan and Length Scale Calibration - Not approved
      - ↓  8. Beam-separation scans for emittance measurement - Approved - To be done twice a fill initially, and in ramp-ups/when filling steady-state, high-mu data-taking on 18 May. **Ongoing**
      - ↓  9. ALFA Run at 1.8 TeV (preferred) or 900 GeV (if backgrounds can be controlled) - Approved by LHC. Test/MD earlier in year
      - ↓  10. VdM for ALFA run - Not approved
      - ↓  11. Beam-based alignment of AFP with ALFA - Approved - 347955, 348002
      - ↓  12. Soft diffractive runs for AFP - Approved for the low-mu parts of 600b and 1200b fills after MD1/TS1. **2h10 at 600b in 3541**
      - ↓  26. beta\*-90m, 13TeV, glue-ball search - Approved - Scheduled for week 27, to follow VdM programme. Runs 354862-35494
      - ↓  27. 13 TeV low-mu running for W, Z physics - Approved to follow 26 - longer fills 20h requested for 4 days.
      - ↓  27b. Insertion of AFP during 13 TeV low-mu running for W, Z physics - (not approved)
      - ↓  28. High mu run with high intensity bunches - (not approved)
      - ↓  29. AFP insertion during PbPb running - (not approved)
    - ↓ Requests that are independent of the LHC
      - ↓  5. Use Ramp-up to disentangle mu-dependence from total-luminosity dependence Taken in fills from 72b until 2556b run 349582.
      - ↓  13. Pixel Timing Scan - Approved for 3b fill. - Run 348197
      - ↓  14. Pixel HV scan 1 - Approved for 3b run. - Run 348251
      - ↓  15. Pixel HV scan 2 - Not approved
      - ↓  16. Pixel HV scan 3 - Not approved
      - ↓  17. BCM yearly module calibration - Approved 348197
      - ↓  18. SCT timing scan - Approved for 3b run. Run 348251
      - ↓  19. SCT HV/depletion voltage scan - Approved for 3b/12b run. Run 348251
      - ↓  20. L1Calo Filter Optimisation - Approved to be taken at new peak lumi with BCMS (~1.15e11 p/b, 2500b) **Details below updated from 2017**. To be taken in a suitable 900/1200b fill following a 16L2 dump - Run 351628
      - ↓  21. L1Calo 80 MHz data sampling - Approved for the ramp-up to 300b, for 600b, 900b with no additional streamers in Main, up to 1200b when L1 rate dropped below 65 kHz s.t. deadline <2%. Approved for 600b after MD1/TS1 as long as compatible with running configuration. Runs pre-SB, 348197-349169. **Details below updated from 2017**
      - ↓  22. FCAL HV change for space charge studies - Approved for when new peak BCMS luminosity reached (~1.2e11 p/b). Done for runs 349693-350220 and 350803-
      - ↓  23. LAr Pulse Shape with single bunch data - Approved for 3b, 12b, (and 75b if single bunch) runs - Run pre-SB and 348197-348354
      - ↓  24. LAr study of lower MG/HG (medium gain to high gain) transition - Approved for 100pb-1 during toroid-off running so long as sufficient statistics for 25 are not jeopardised - Run 352123
      - ↓  25. Toroid Off Run for Muon Endcap Alignment - Approved to be taken after TS2, or opportunistically if the toroid ramps-down during data-taking - Run 352131, 352137

## Special Run:

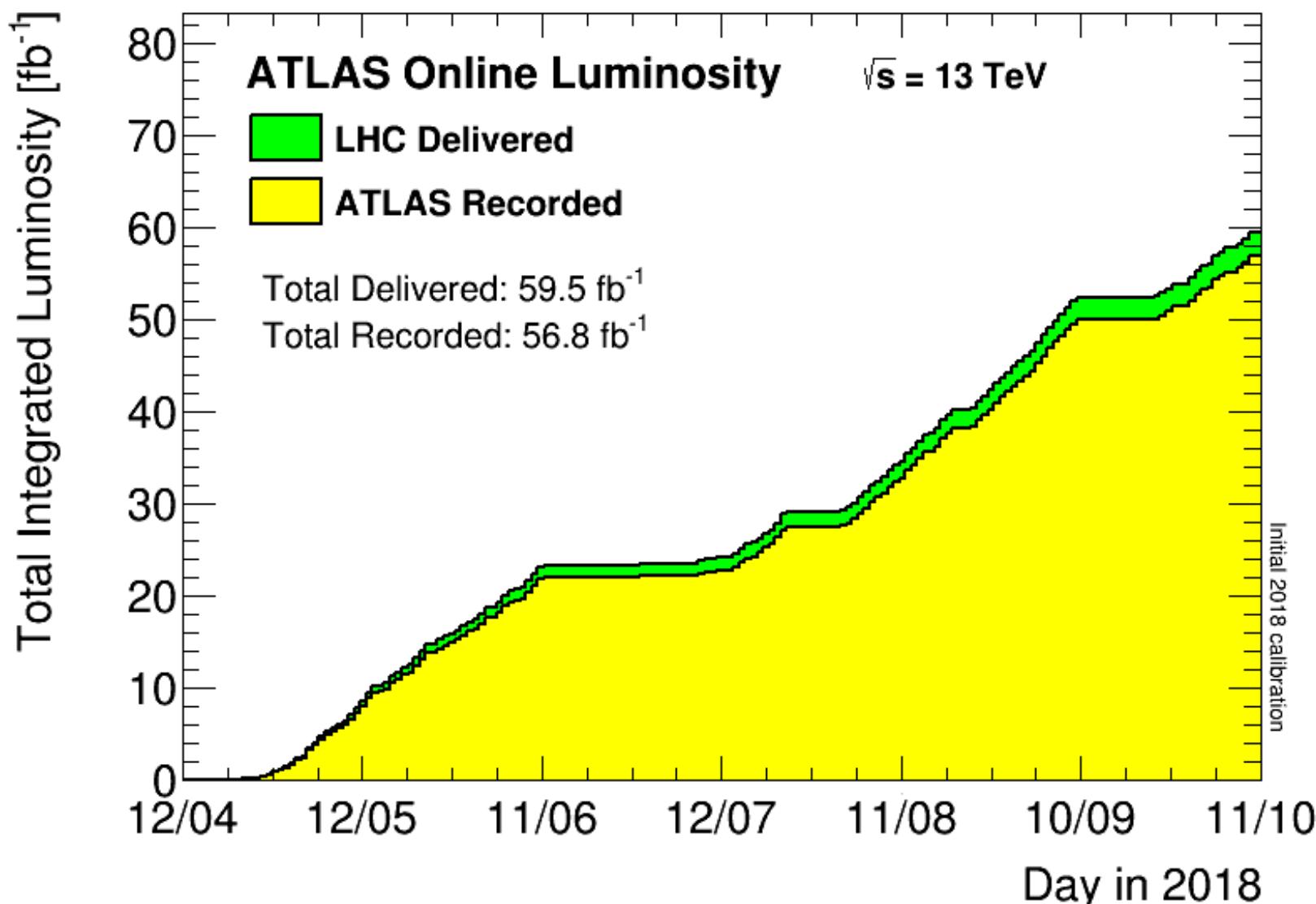
Sacrificing time out of “routine” physics running,  
for a gain in detector performance/understanding  
or “other” physics

## Typical Examples:

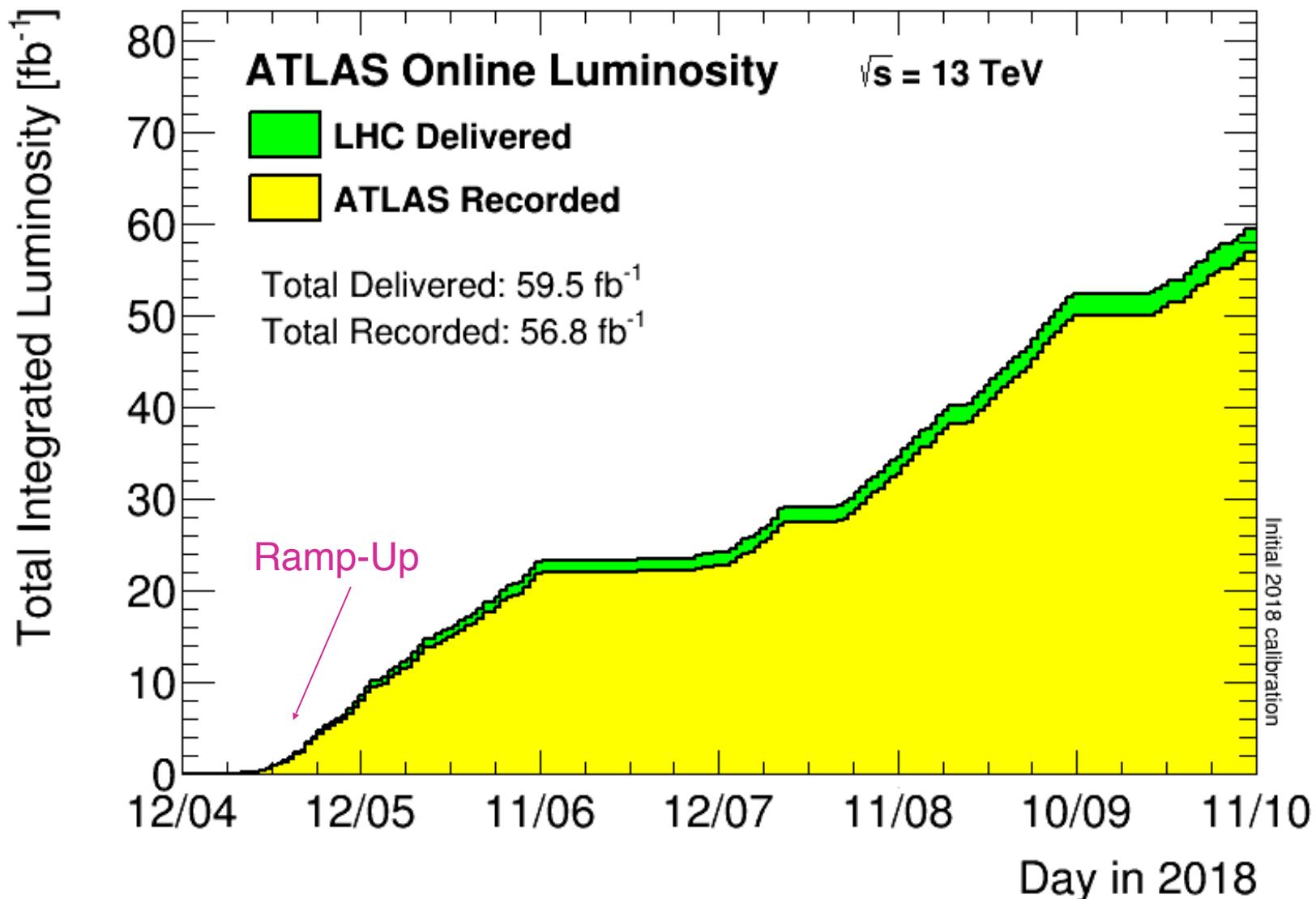
- Alignment
- Van der Meer Scan
- Forward Physics
- Low Pile-Up
- Many more...

during

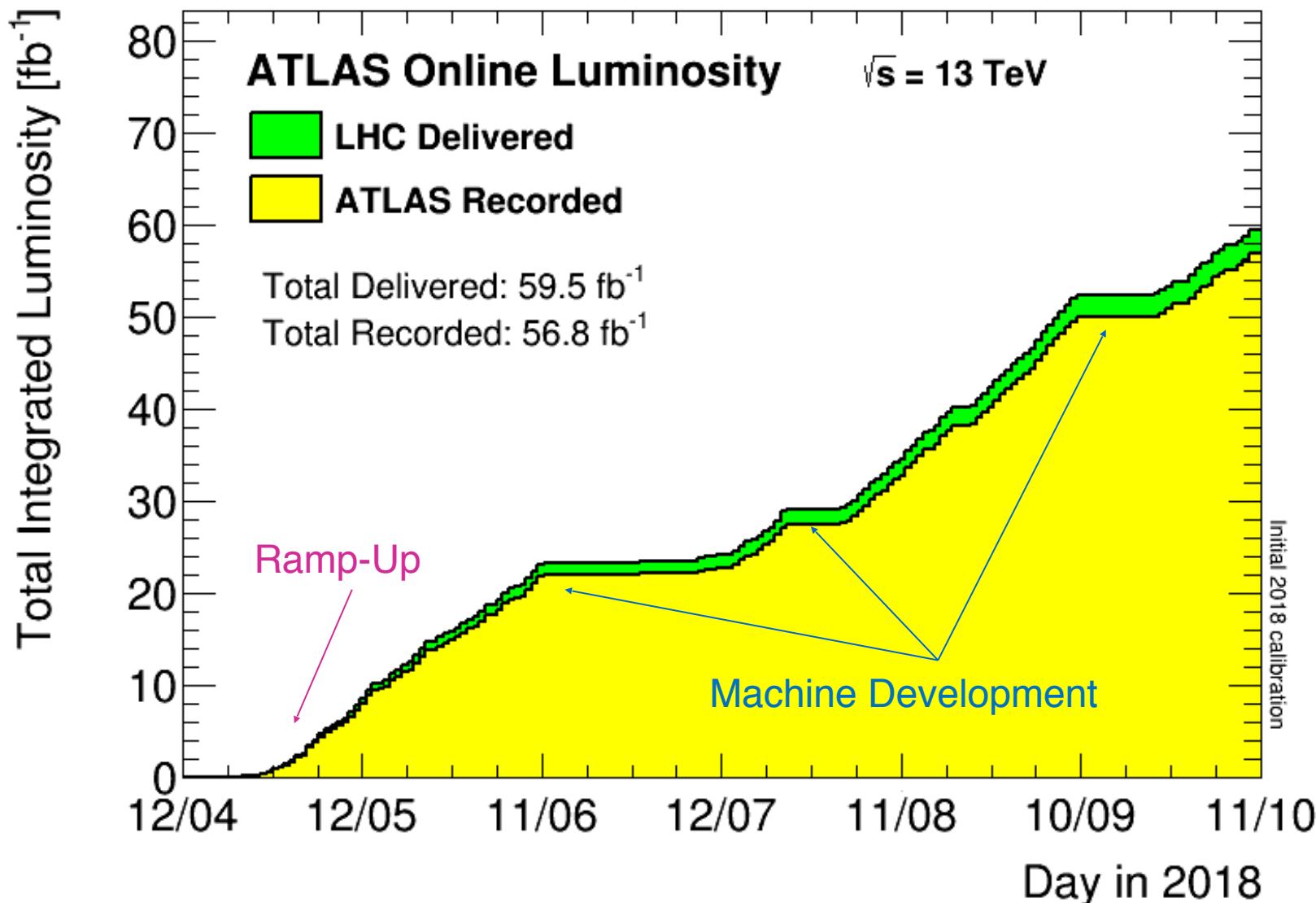
# Data Taking



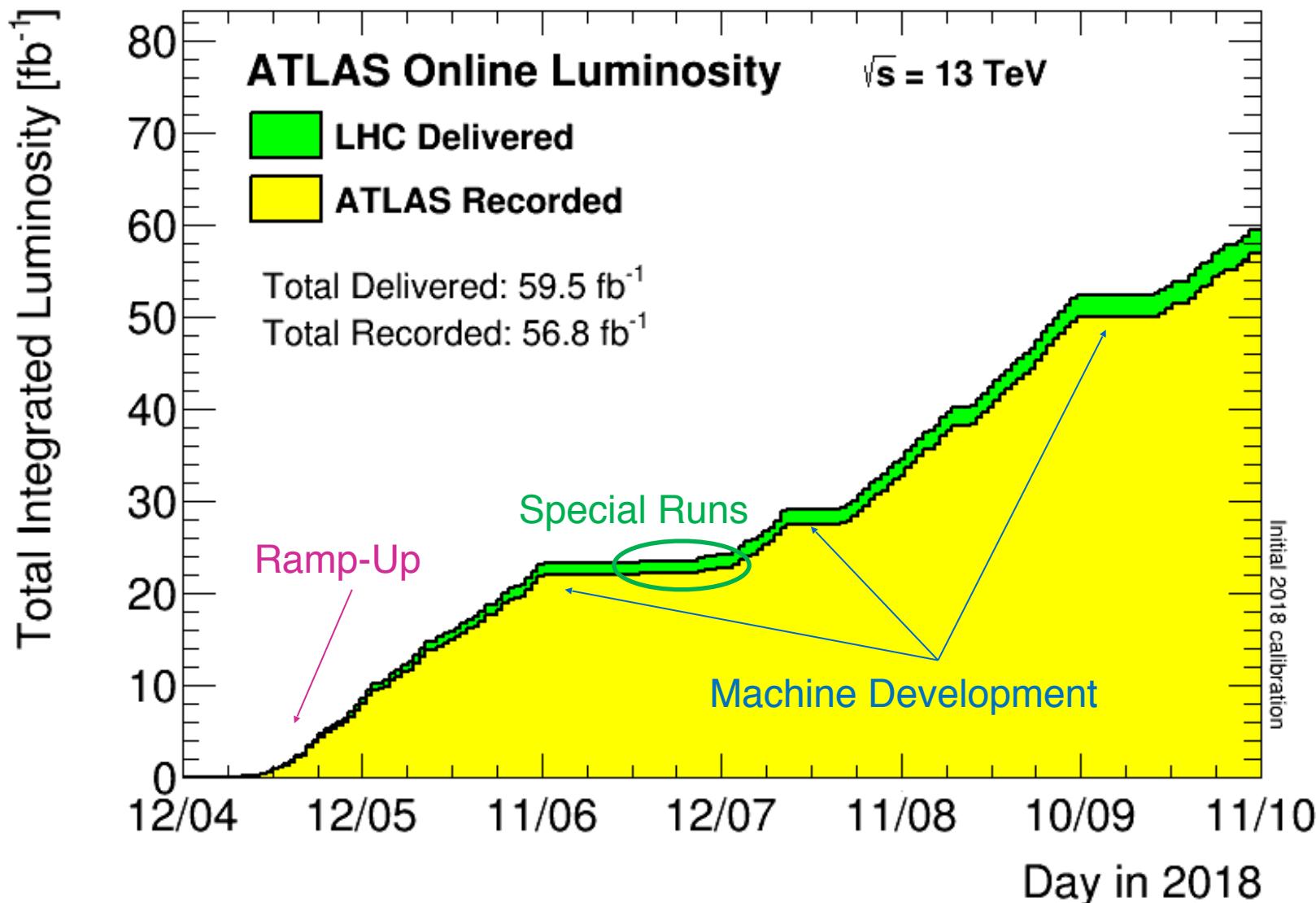
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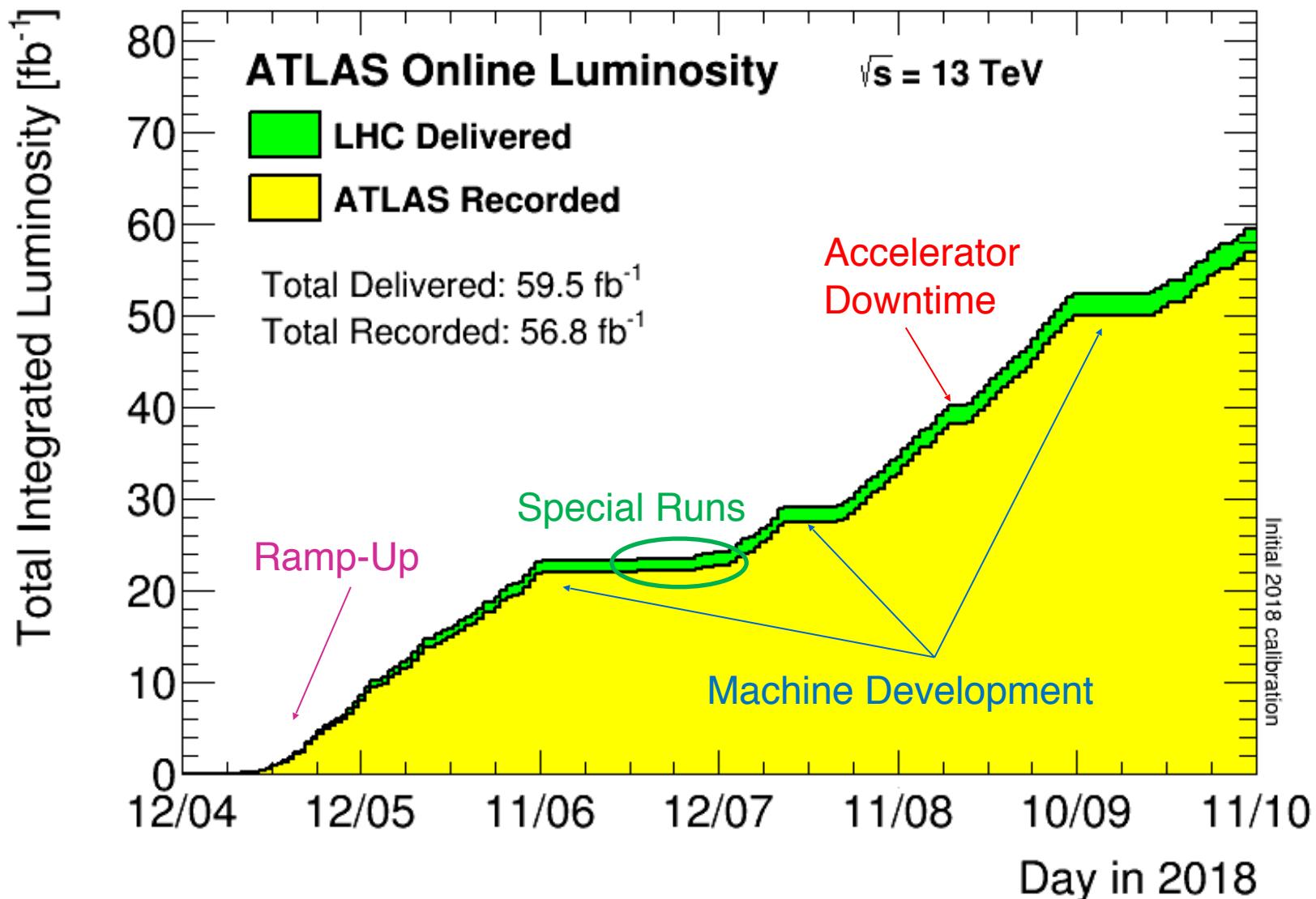
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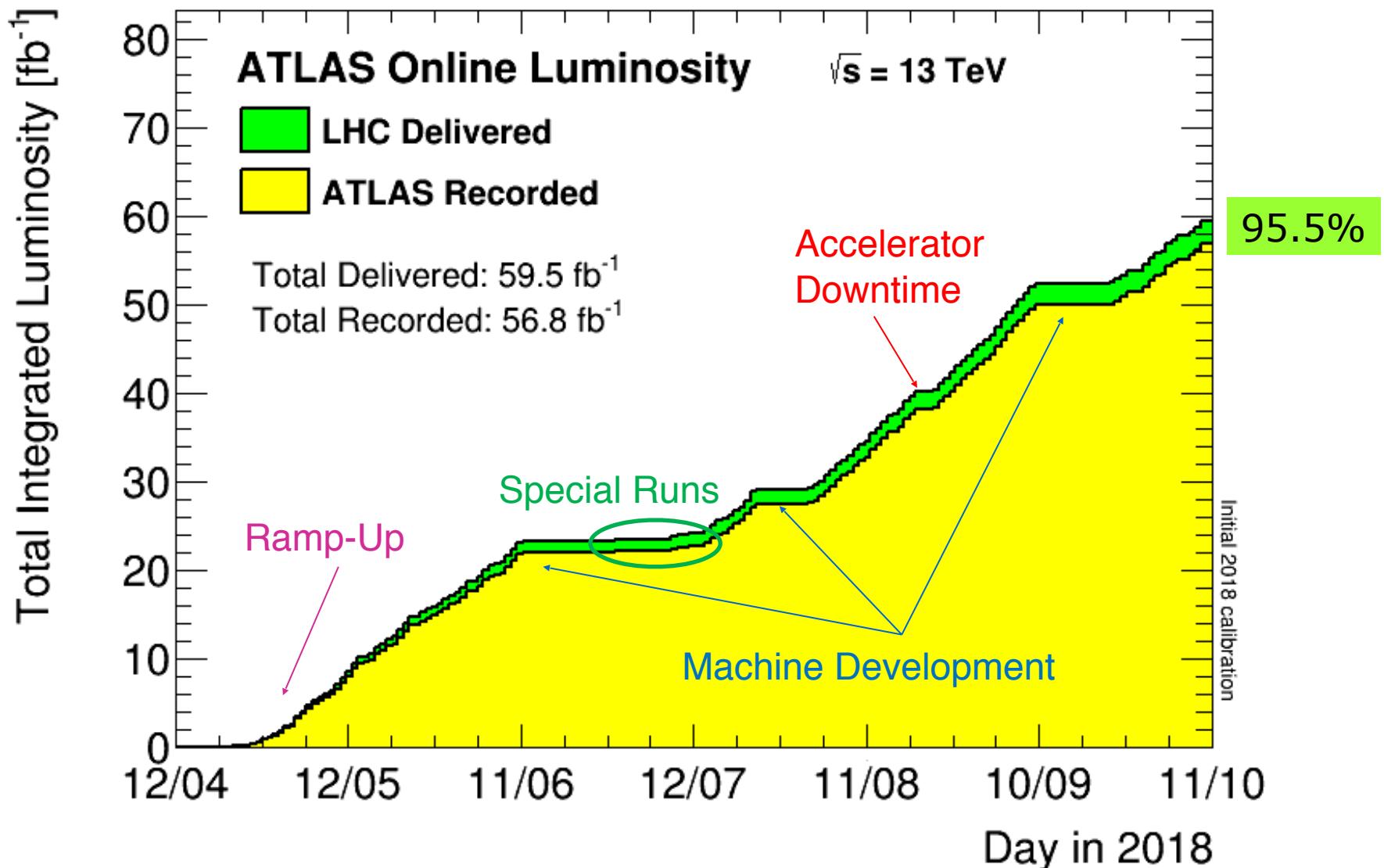
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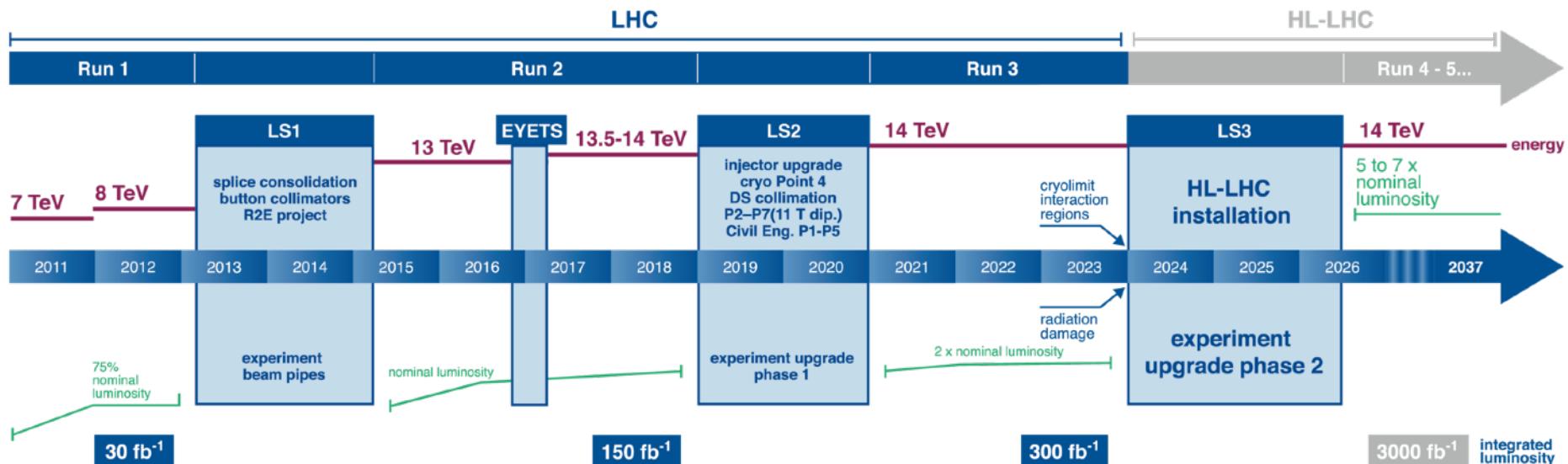
# Data Taking



# Data Taking



# Road Map



- We are at the early part of a two year Long Shutdown before the restart of ATLAS in 2021
  - No Data Taking!
- Period of maintenance, large scale upgrades, new developments, ...
  - Installation, testing and commissioning
  - Run Coordination → Technical Coordination/OPM

*Still many things to do at P1!*



# Working in P1 during LS2

## a few examples...



## ► Software

Challenge (very hard): Implement a function that takes a list of integers and returns all the straight, vertical and diagonal zig-zags. Change your function from the previous challenge to return these paths instead.

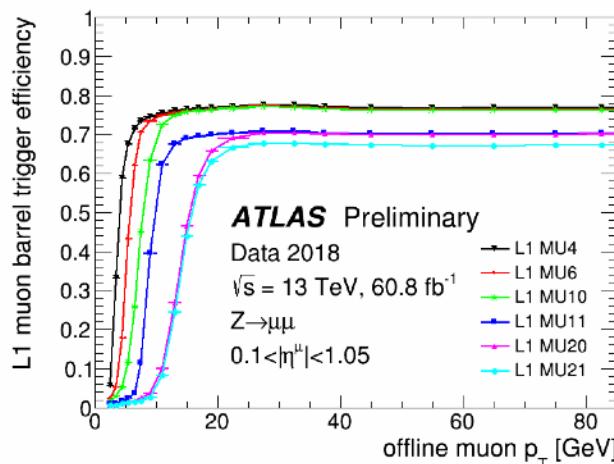
**Detector Performance**

L1 muon barrel trigger efficiency

ATLAS Preliminary  
Data 2018  
 $\sqrt{s} = 13 \text{ TeV}, 60.8 \text{ fb}^{-1}$   
 $Z \rightarrow \mu\mu$   
 $0.1 < |\eta^\mu| < 1.05$

Trigger Condition	Efficiency ( $\eta < 0.5$ )	Efficiency ( $\eta < 1.05$ )
L1 MU4	~0.35	~0.75
L1 MU6	~0.25	~0.65
L1 MU10	~0.20	~0.70
L1 MU11	~0.18	~0.68
L1 MU20	~0.15	~0.65
L1 MU21	~0.12	~0.62
L1 MU24	~0.10	~0.60

## Detector Performance



## ➤ Hardware



## 20/21: Milestone Weeks and Re-Commissioning

# Message

- Three phases, all needed for Physics Results!
  - Construction and Commissioning
  - *Operations and Data Taking*
  - Data Reconstruction and Analysis
- High quality data and efficient data taking does not come for free:
  - After 6 years of data taking still room for improvement
  - Striving to eliminate or mitigate sources of inefficiencies, make the system more robust
- Taking Part in ATLAS Operations is a unique opportunity and working environment → **Hope to see some of you at Point 1 for Run-3!**

