XXXVII Meeting on
Fundamental Physics
Benasque
9-February-2009

ATLAS Status Report

Cristobal Padilla (IFAE-Barcelona)
On behalf of the ATLAS Collaboration

Outline:

1. The ATLAS Detector
2. History of the Construction
3. Commissioning
4. Roadmap to Physics
5. Summary

ATLAS Collaboration

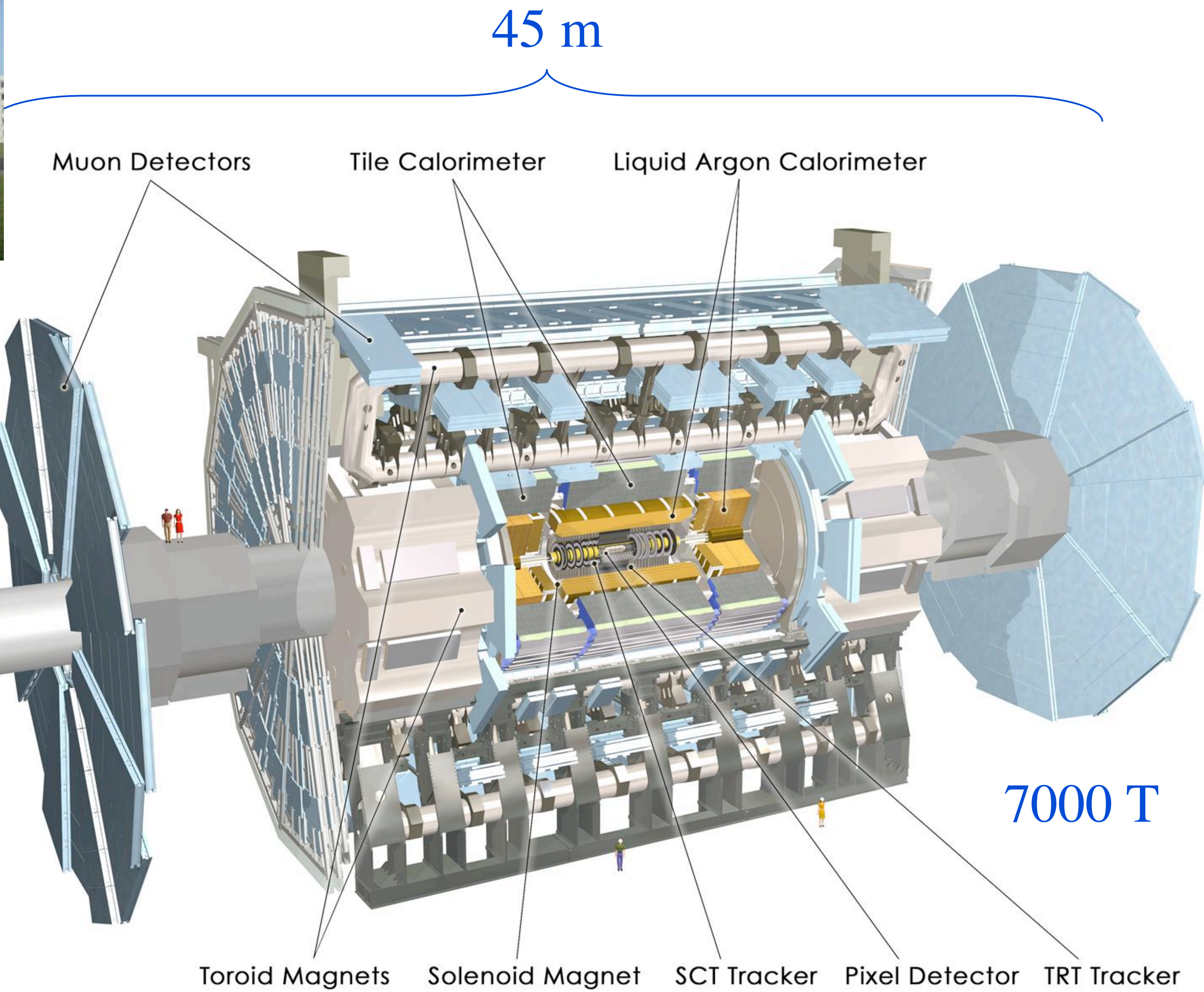
37 Countries
169 Institutions
2500 Scientific Authors total
(1800 with a PhD, for M&O share)

Albany, Alberta, NIKHEF Amsterdam, Ankara, LAPP Annecy, Argonne NL, Arizona, UT Arlington, Athens, NTU Athens, Baku, IFAE Barcelona, Belgrade, Bergen, Berkeley LBL and UC, HU Berlin, Bern, Birmingham, UAN Bogota, Bologna, Bonn, Boston, Brandeis, Bratislava/SAS Kosice, Brookhaven NL, Buenos Aires, Bucharest, Cambridge, Carleton, Casablanca/Rabat, CERN, Chinese Cluster, Chicago, Chile, Clermont-Ferrand, Columbia, NBI Copenhagen, Cosenza, AGH UST Cracow, IFJ PAN Cracow, UT Dallas, DESY, Dortmund, TU Dresden, JINR Dubna, Duke, Frascati, Freiburg, Geneva, Genoa, Giessen, Glasgow, Göttingen, LPSC Grenoble, Technion Haifa, Hampton, Harvard, Heidelberg, Hiroshima, Hiroshima IT, Indiana, Innsbruck, Iowa SU, Irvine UC, Istanbul Bogazici, KEK, Kobe, Kyoto, Kyoto UE, Lancaster, UN La Plata, Lecce, Lisbon LIP, Liverpool, Ljubljana, QMW London, RHBNC London, UC London, Lund, UA Madrid, Mainz, Manchester, CPPM Marseille, Massachusetts, MIT, Melbourne, Michigan, Michigan SU, Milano, Minsk NAS, Minsk NCPHEP, Montreal, McGill Montreal, FIAN Moscow, ITEP Moscow, MEPhI Moscow, MSU Moscow, Munich LMU, MPI Munich, Nagasaki IAS, Nagoya, Naples, New Mexico, New York, Nijmegen, BINP Novosibirsk, Ohio SU, Okayama, Oklahoma, Oklahoma SU, Olomouc, Oregon, LAL Orsay, Osaka, Oslo, Oxford, Paris VI and VII, Pavia, Pennsylvania, Pisa, Pittsburgh, CAS Prague, CU Prague, TU Prague, IHEP Protvino, Regina, Ritsumeikan, UFRJ Rio de Janeiro, Rome I, Rome II, Rome III, Rutherford Appleton Laboratory, DAPNIA Saclay, Santa Cruz UC, Sheffield, Shinshu, Siegen, Simon Fraser Burnaby, SLAC, Southern Methodist Dallas, NPI Petersburg, Stockholm, KTH Stockholm, Stony Brook, Sydney, AS Taipei, Tbilisi, Tel Aviv, Thessaloniki, Tokyo ICEPP, Tokyo MU, Toronto, TRIUMF, Tsukuba, Tufts, Udine/ICTP, Uppsala, Urbana UI, Valencia, UBC Vancouver, Victoria, Washington, Weizmann Rehovot, FH Wiener Neustadt, Wisconsin, Wuppertal, Würzburg, Yale, Yerevan


ATLAS

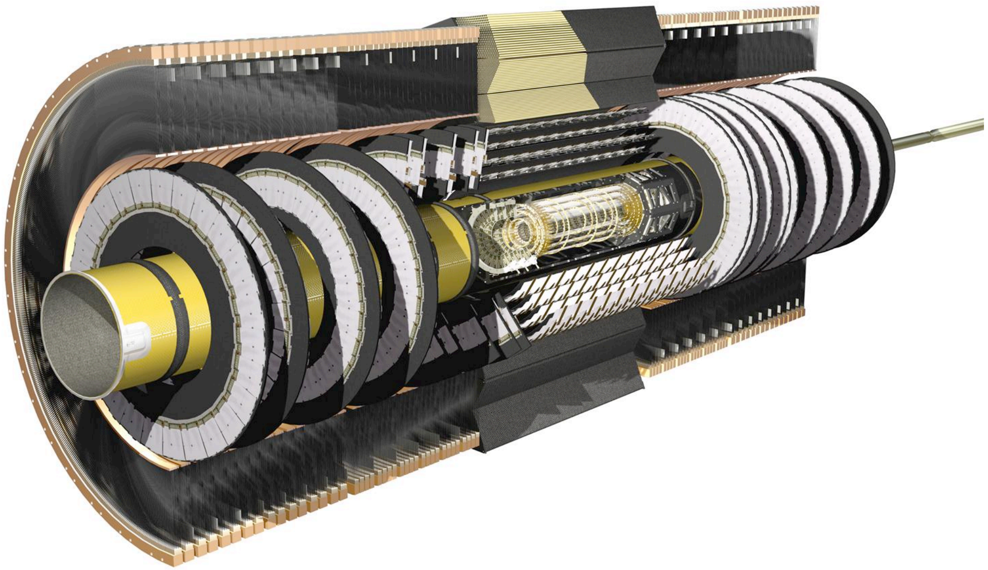
ATLAS Detector

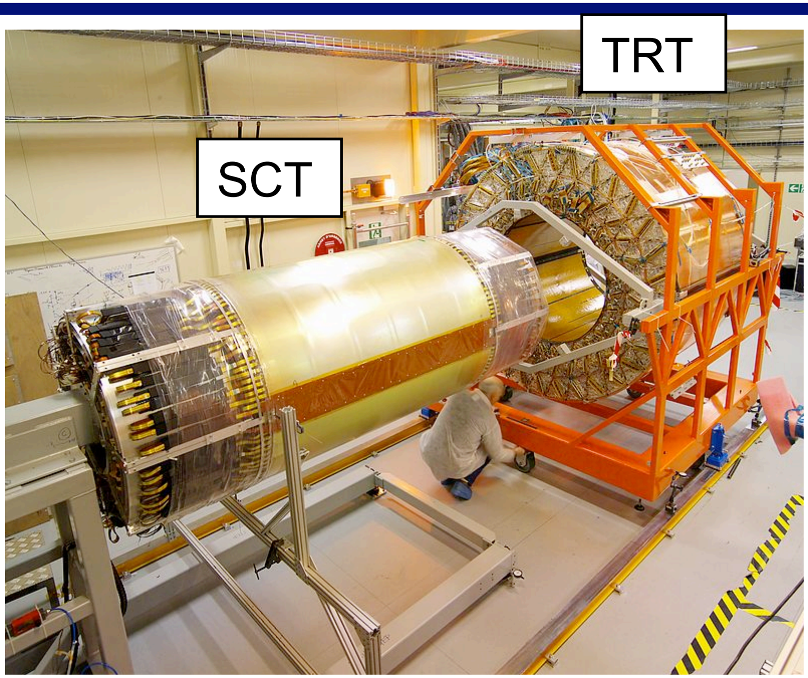
ATLAS superimposed to the 5 floors of building 40

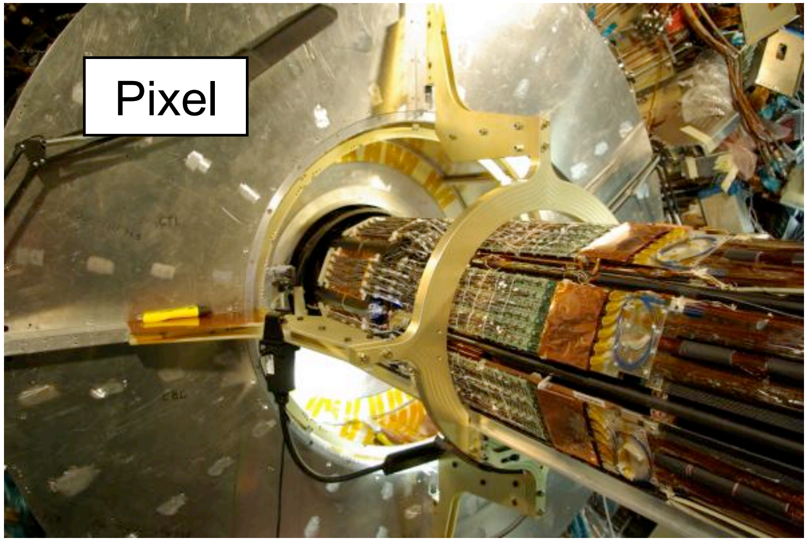


Inner Detector

Tracking **$|\eta|<2.5$** **B=2T**



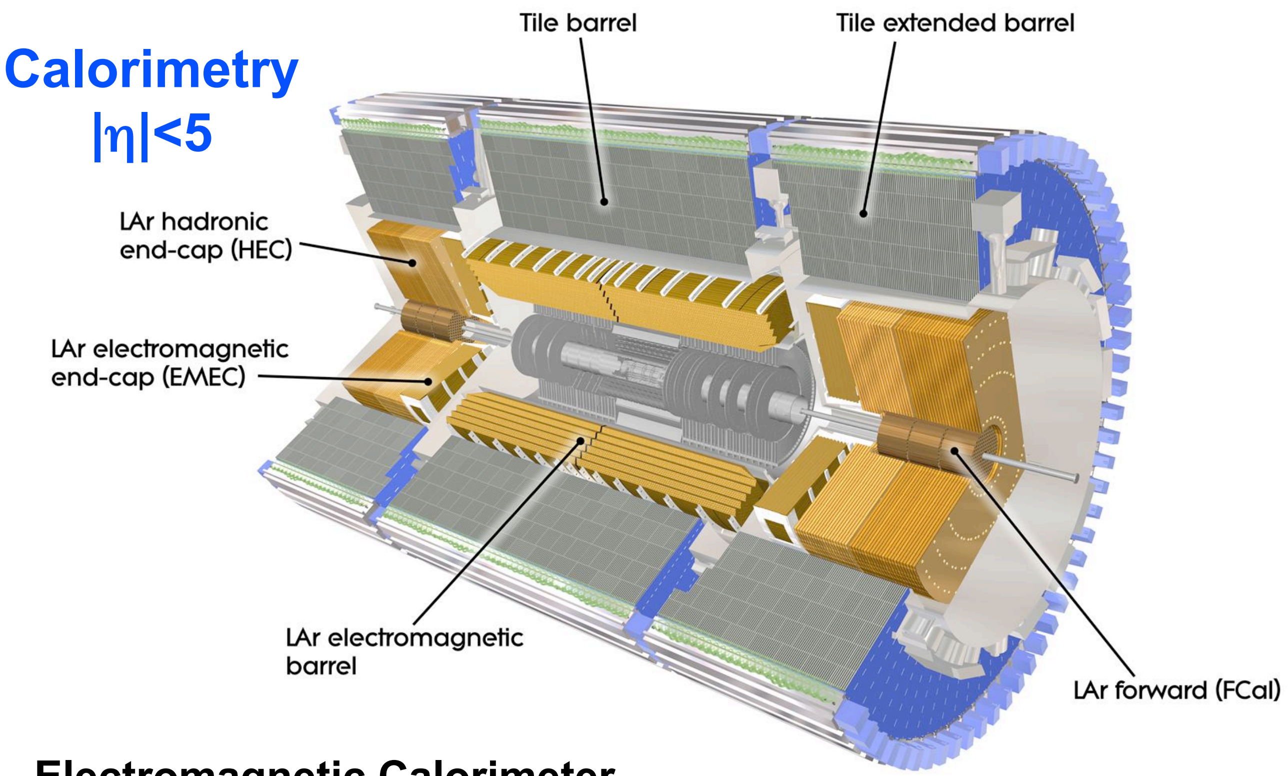


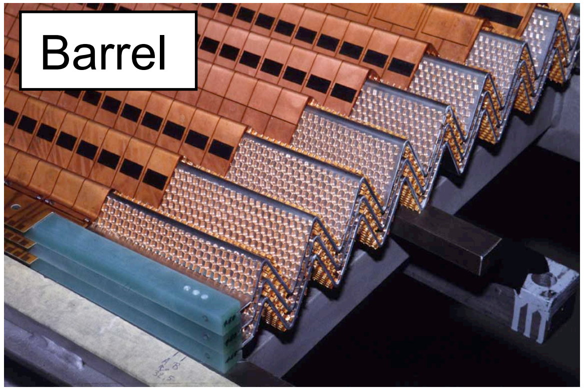


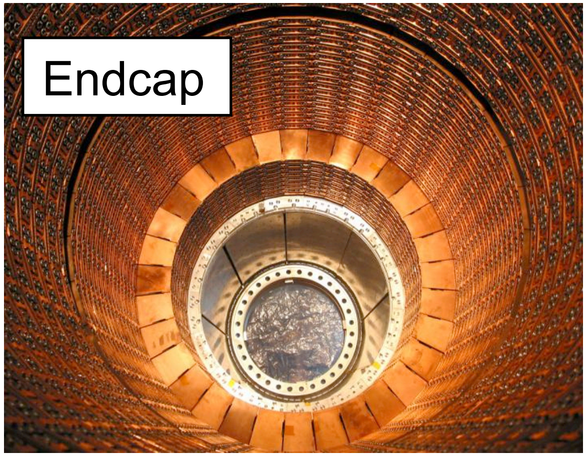
Silicon pixels **(Pixel)**: 0.8 10^8 channels
Silicon strips **(SCT)** : 6 10^6 channels
Transition Radiation Tracker **(TRT)** :
straw tubes (Xe), 4 10^5 channels
e/π separation

$$\sigma/p_T \sim 5\times10^{-4}\ p_T \oplus 0.01$$

Calorimetry







Electromagnetic Calorimeter

barrel,endcap: Pb-LAr

~10%/√E energy resolution e/γ

180000 channels: longitudinal segmentation

Hadron Calorimeter

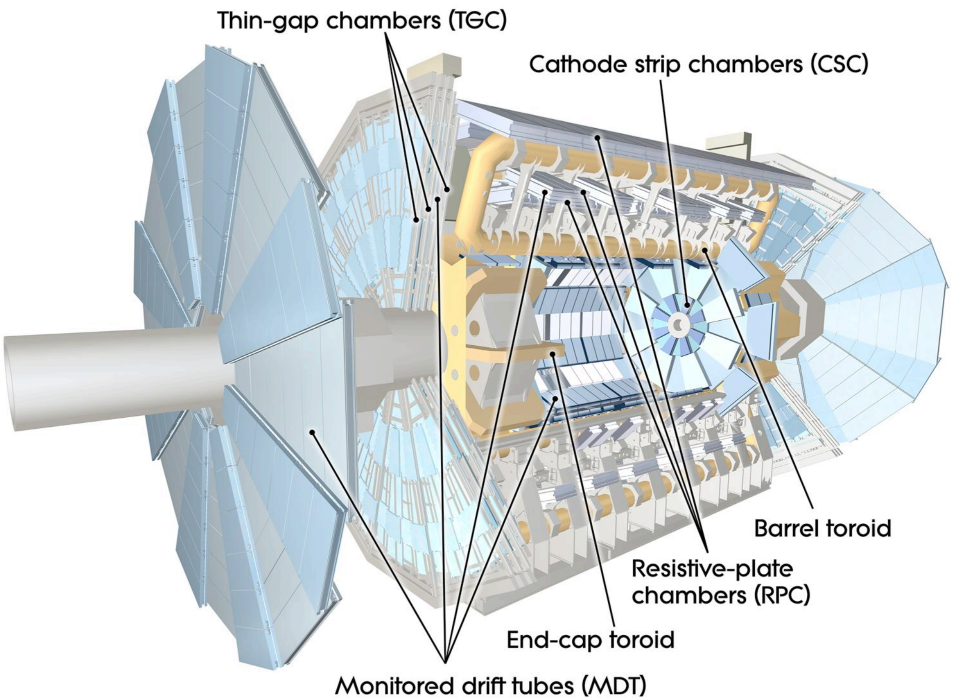
barrel Iron-Tile EC/Fwd Cu/W-LAr (~20000 channels)

$\sigma/E \sim 50\%/\sqrt{E} \oplus 0.03$ pion (10 λ)

Trigger for **e/γ , jets, Missing E_T**

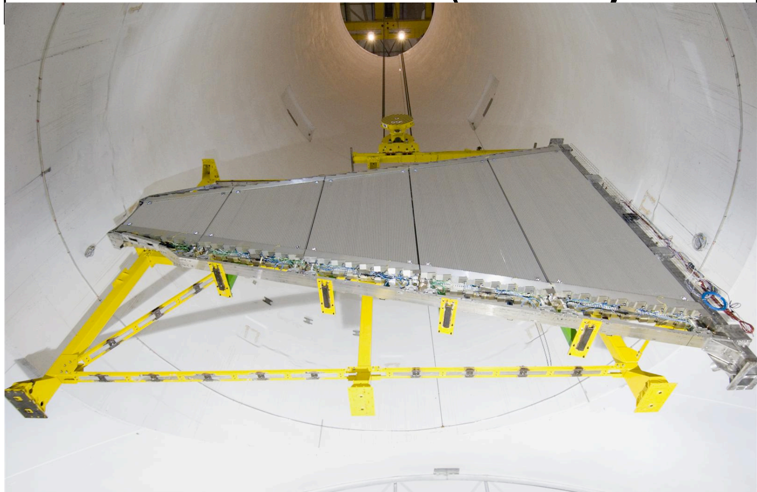
Muon System

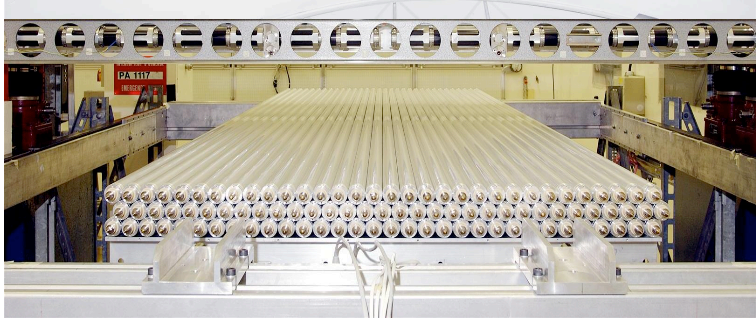
Stand-alone momentum resolution
$\Delta pt/pt < 10\%$ up to 1 TeV

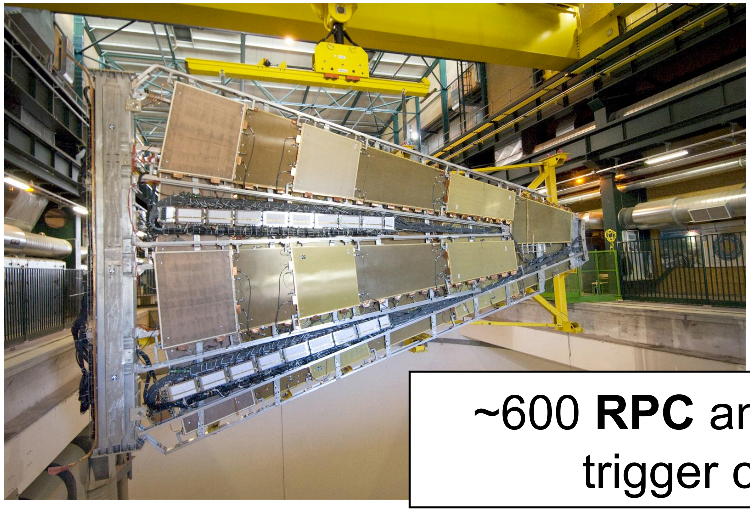


2-6 Tm $|\eta|<1.3$ 4-8 Tm $1.6<|\eta|<2.7$

~1200 **MDT** precision chambers for track reconstruction (+ **CSC**)

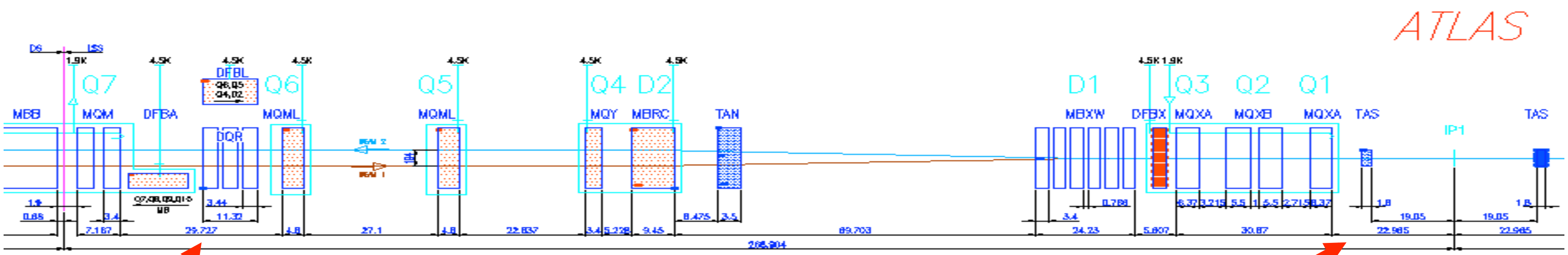






~600 **RPC** and ~3600 **TGC** trigger chambers

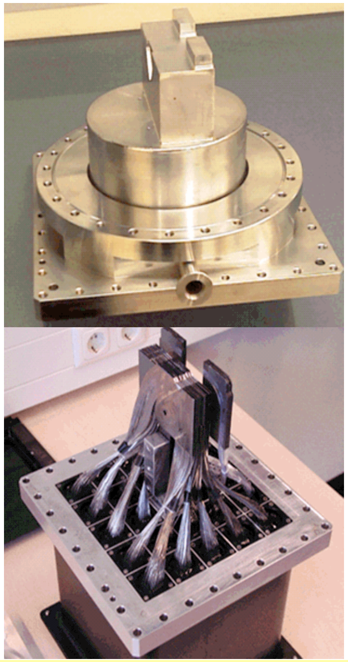
Forward Detectors



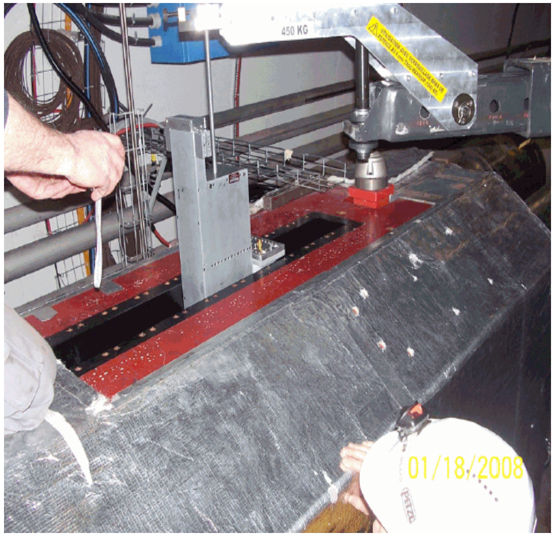
ALFA at 240 m

ZDC at 140 m

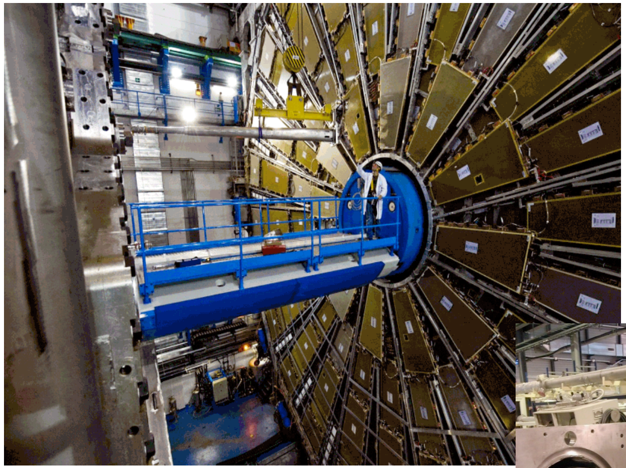
LUCID at 17 m

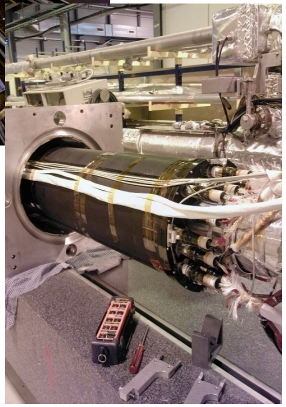


Absolute Luminosity for ATLAS



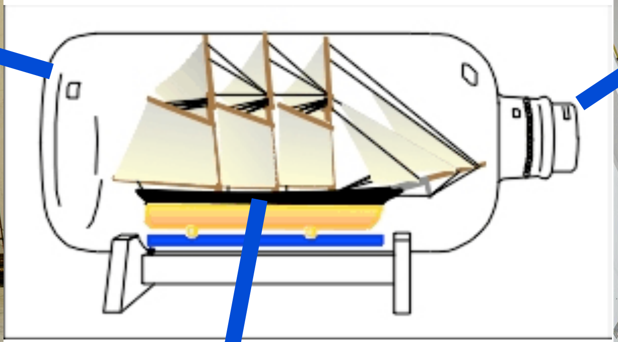
Zero Degree Calorimeter





Luminosity Cerenkov Integrating Detector

Short History of the Construction & Installation

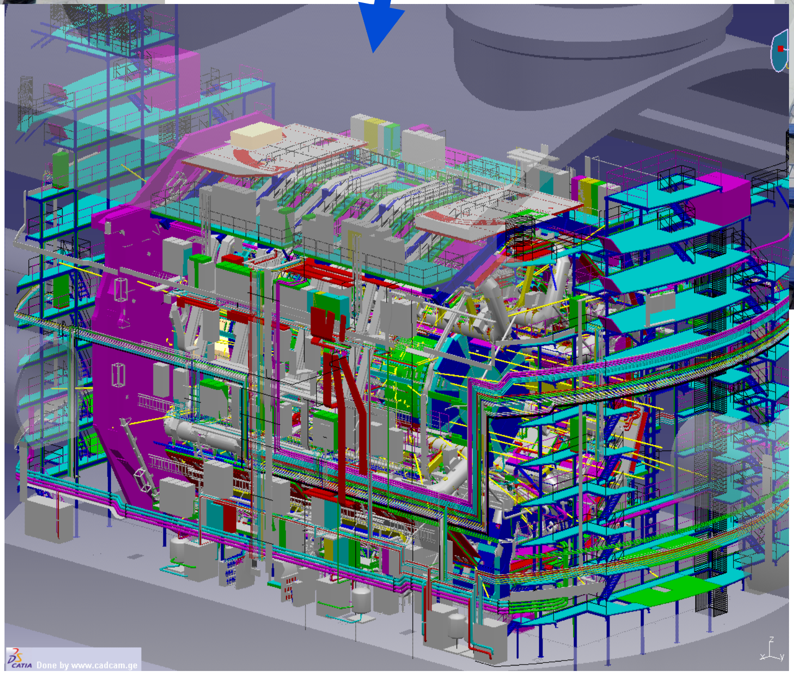


JUNE 2003

Cavern

92m underground

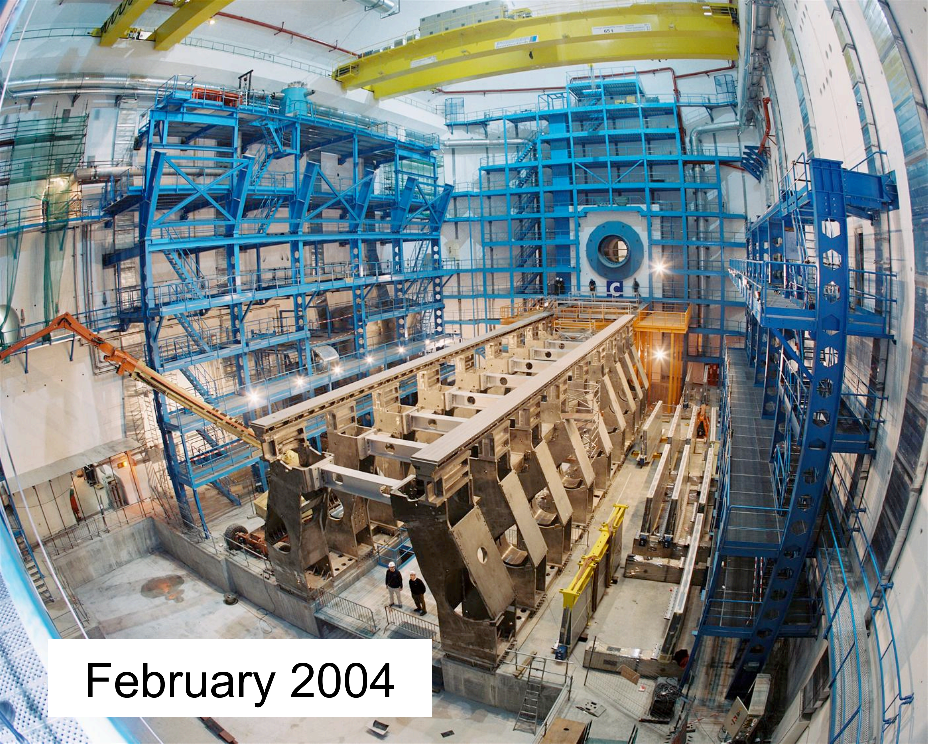
55m long
32m wide
35m high
Shafts
Height 57 m
Radius 14 m



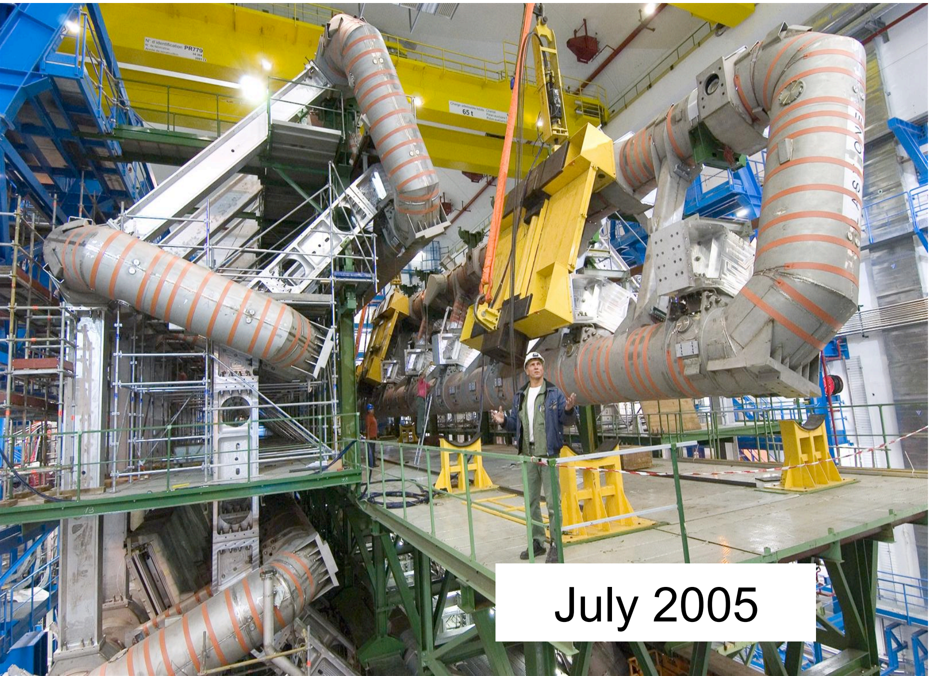
Today

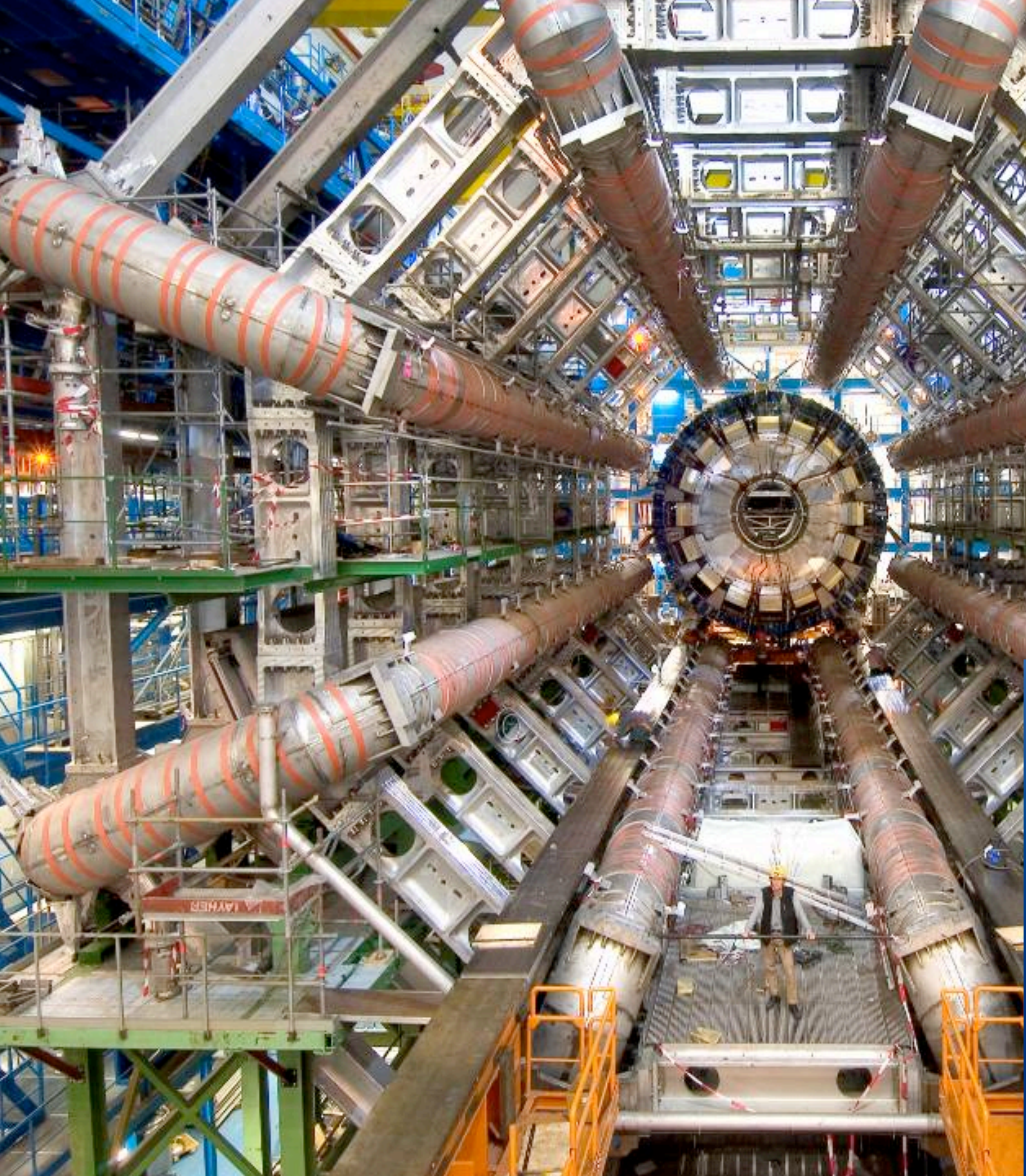
ATLAS

is built


February 2004


October 2004


July 2005



The ATLAS Jigsaw Puzzle

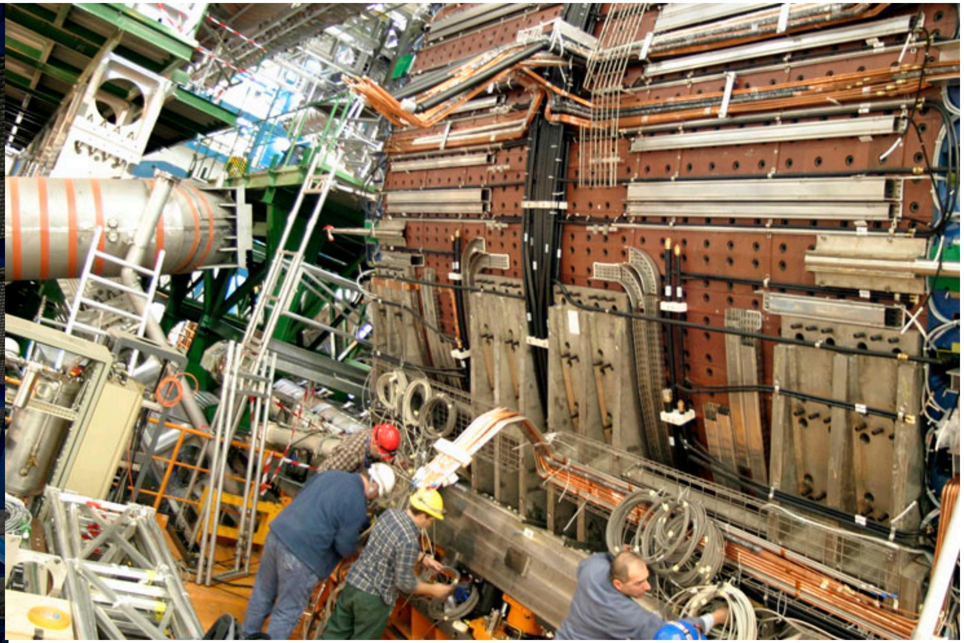
500 piece photo of the detector, made by Ravensburger.
The puzzle can be purchased at the ATLAS Secretariat.

Click here for the full image.

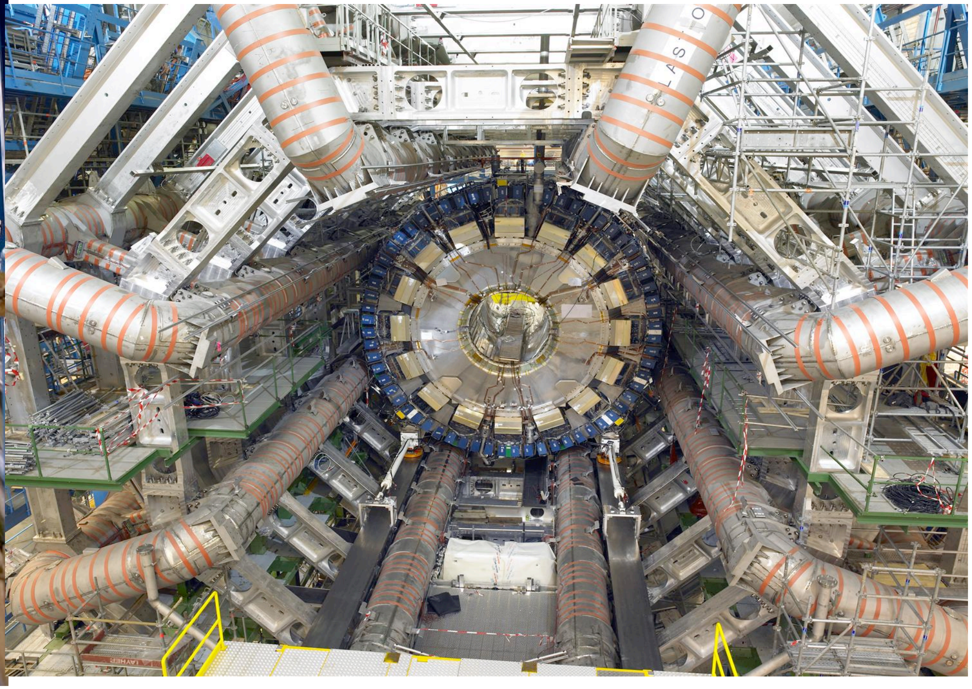
Prices:

1 box @ 15 CHF a box
2 boxes @ 14 CHF a box
3 boxes @ 13 CHF a box
4 boxes @ 12 CHF a box
5 or more boxes : 10 CHF a box
(CHF = Swiss Franc)

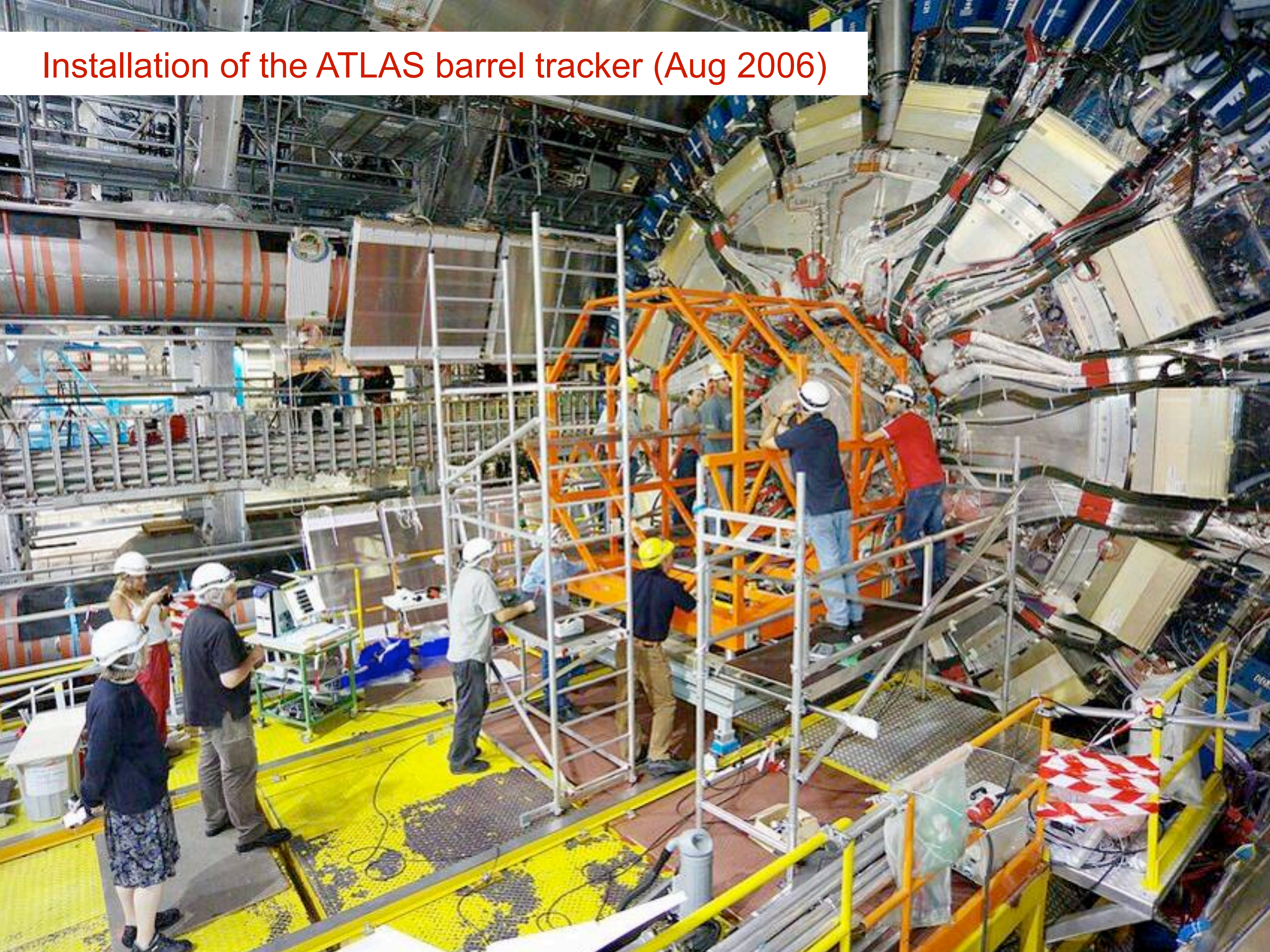
October 2004

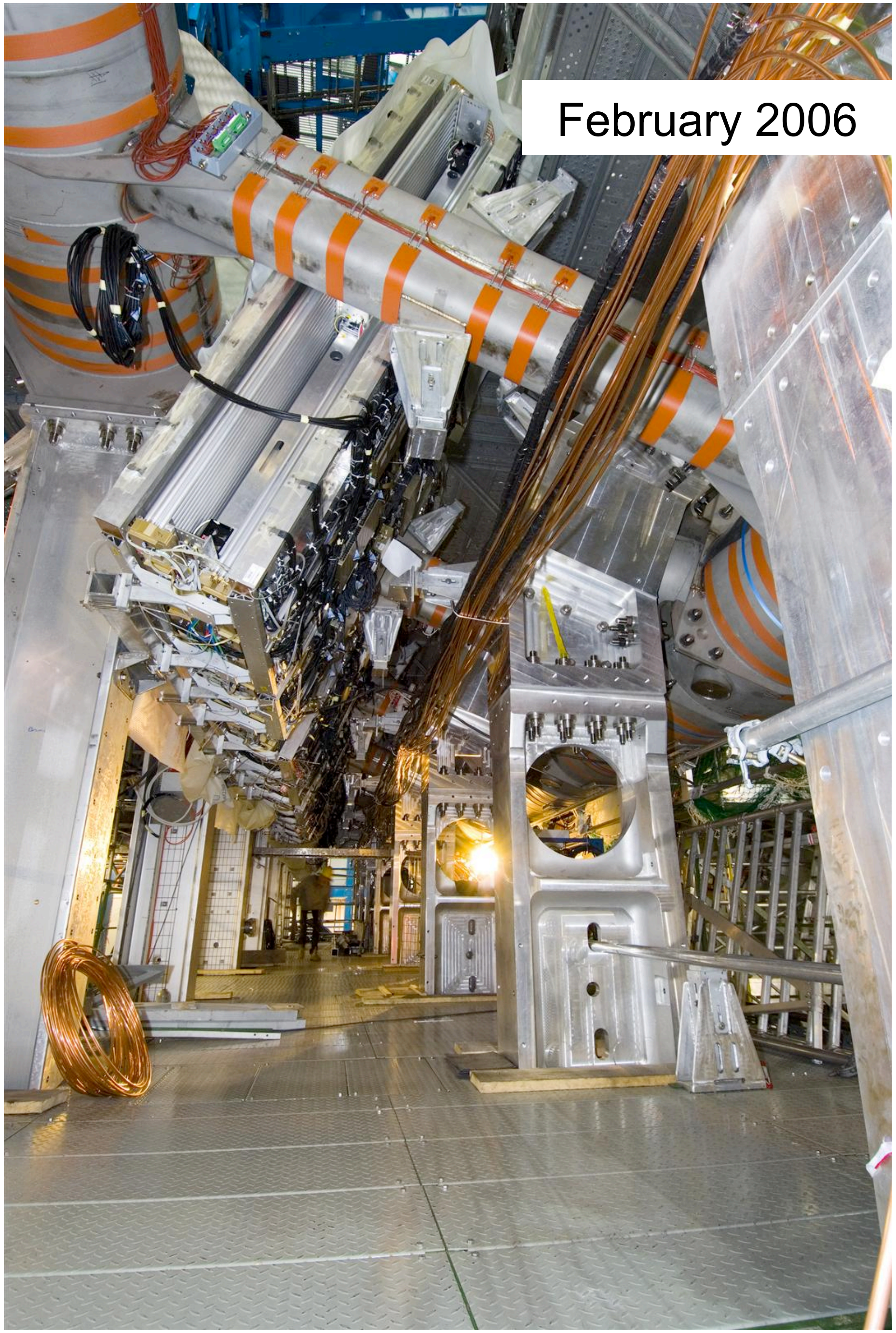


November 2005



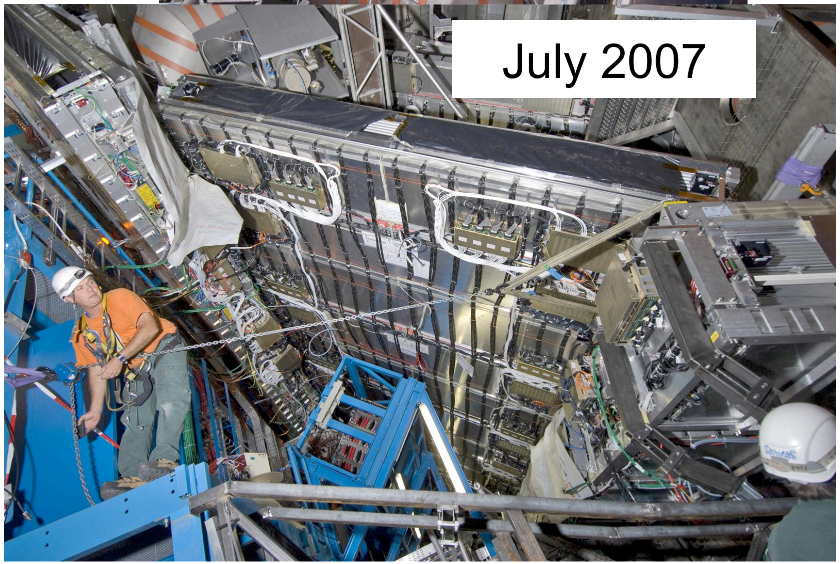
Installation of the ATLAS barrel tracker (Aug 2006)



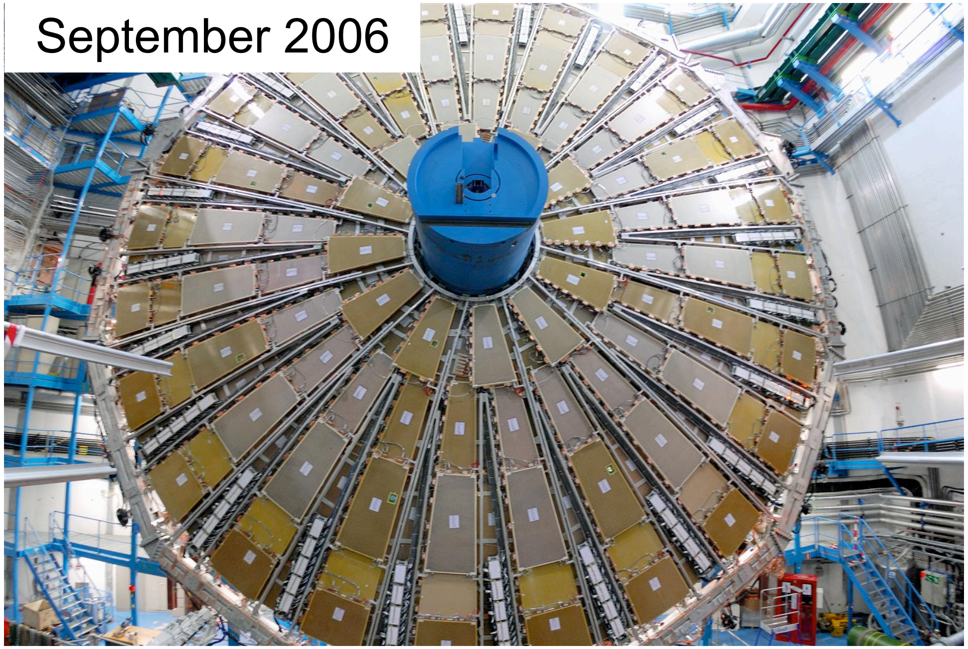


February 2006

October 2006



July 2007


September 2006


September 2007


February 2008

A Historical Day

Closure of the LHC beam pipe ring on 16^{th} June 2008 (the last piece was the one shown here in ATLAS)

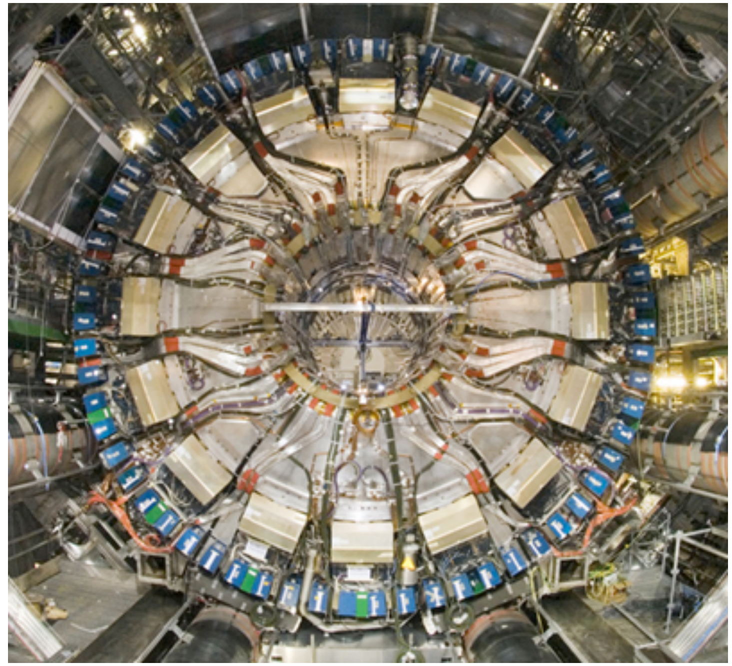
Hardware Readiness: Liquid Argon Calorimeters

Installation in the cavern

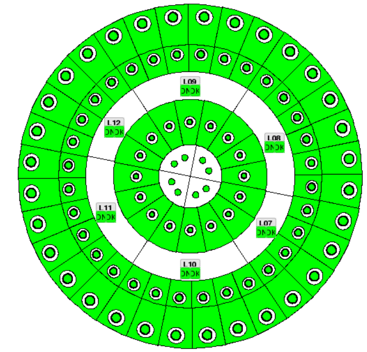
Barrel in October 2004,
End-caps by 2006

Electronics equipment completed

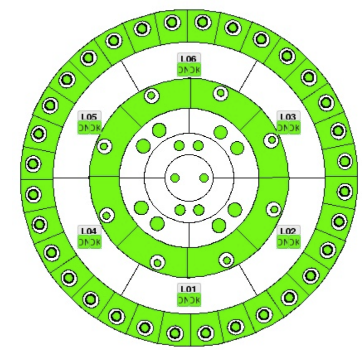
Back-End May 2007
Front-End April 2008
(some refurbishment was needed)



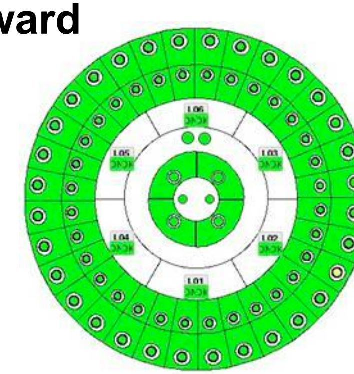
EM Barrel



EM EndCap



Had. EndCap & Forward



Since May 2008

full calorimeter up, integrated in DAQ, slow control

in steady running mode

~190.000 channels read-out

~0.02% dead (isolated) channels

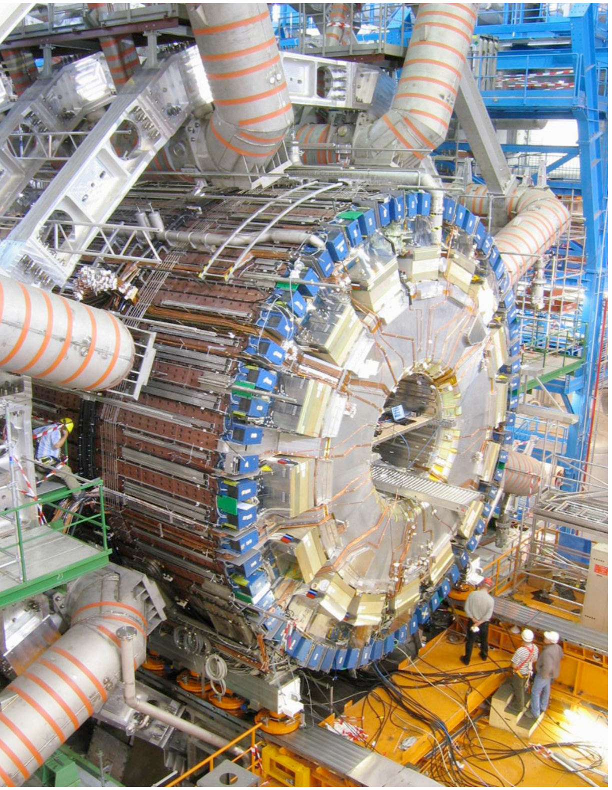
+ ~1.5% (½ barrel module - power supply control lost)

being repaired during the currently ongoing shutdown

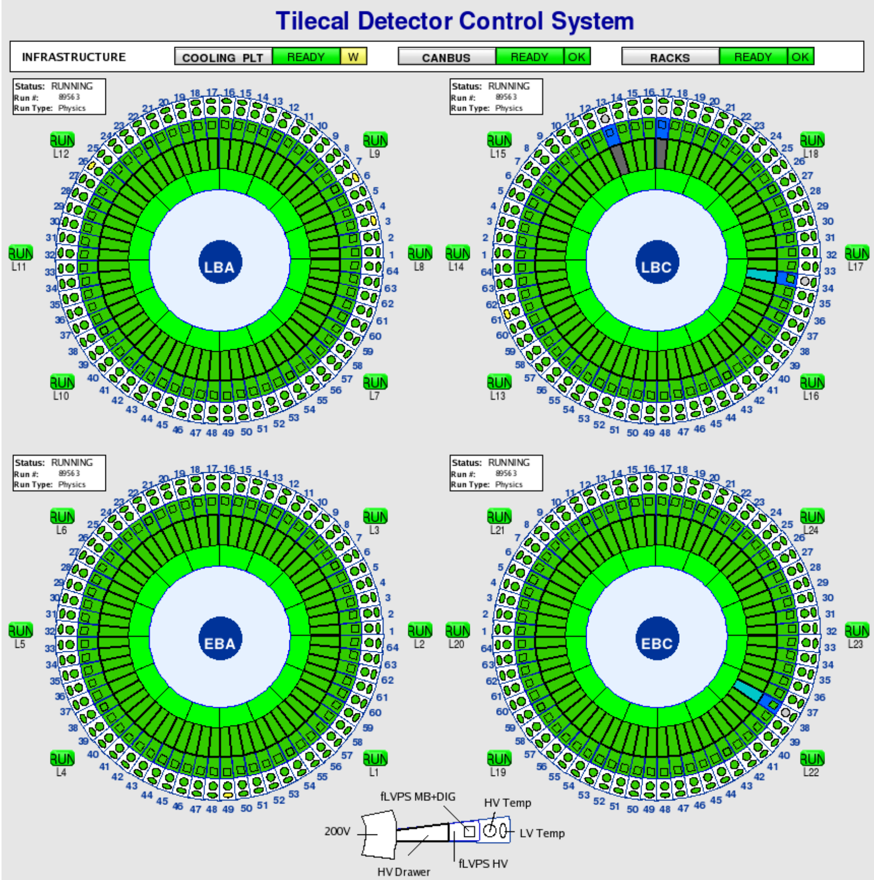
Hardware Readiness: Tile Calorimeter

Installation in the cavern

Ext. Barrel C December 2004
Barrel October 2005
Ext. Barrel A May 2006



Electronics equipment completed
May 2008 (some refurbishment was needed)

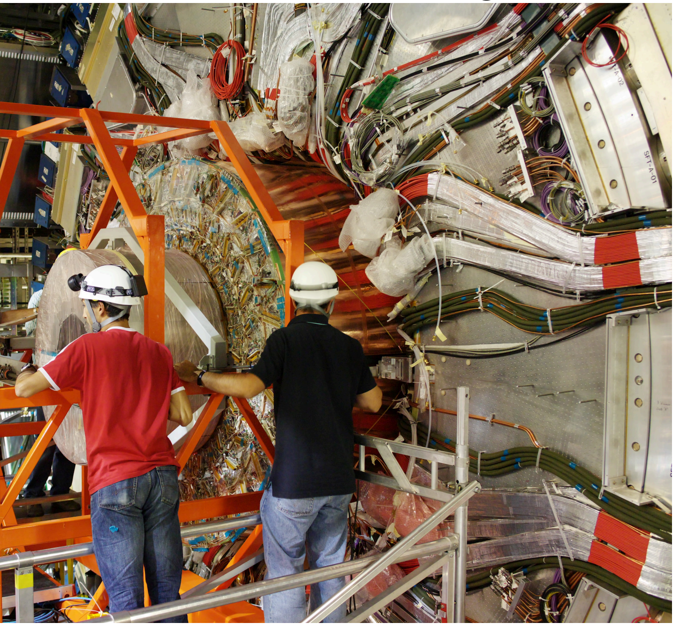


full calorimeter up and running, integrated in DAQ
~10000 PMTs → 5000 cells

~0.2% dead (isolated) cells and 2 of 256 sectors off – power supply problem
Being repaired during the shutdown

Hardware Readiness: Inner Detector

TRT/SCT installed Aug 2006



Pixel installed June 2007

Only limited running before the LHC startup because of the several cooling problems in the silicon detectors that needed some R&D to be solved

ID volume sealed
complex End-Plate with 1000 feed-throughs

Hardware Readiness: Inner Detector

- **Solenoid field:** mapping done with precision ~10^{-4}
- **Pixel** ~0.6% dead/problematic channels
  except EndCap wheel A: ~4.2% (+ 8.3% if cooling loop inoperable)
- **SCT** barrel ~0.35%, end-caps ~0.26% dead/problematic channels
  except EndCap wheel C: ~1.6% (1.3% due to cooling loop failure)
- **TRT** : dead channels 1.2-2.0%,
- The critical path issue was the evaporative cooling system repair and cleaning of the plant, after a failure on 1st May 2008, which ended late July
- Priority then given to Pixel operation
  - First to safely bake-out the beam pipe (early August)
  - Then to operate the full detector (for the first time in September/Octorer)
- All ID sub-detectors integrated in the ATLAS DAQ and took significant data
- The TX plug-ins (opto-transmitter) remain an issue; they are dying at a significant rate
  - Off-detector: they affect both SCT and Pixel
  - A new production is now planned.

Hardware Readiness: Muon System

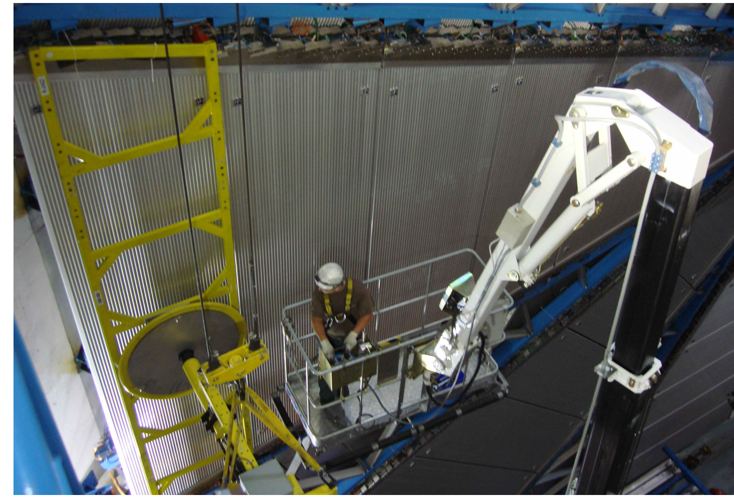
Chamber Installed
February 2005

All chambers installed
(few chambers staged to 09)

All wheels to final position
before 2008 LHC run

Most alignment rays are
operational
Good results: ~200 μm

Magnetic field measurement
< 5% of probes lost
ΔB/B=1.5%

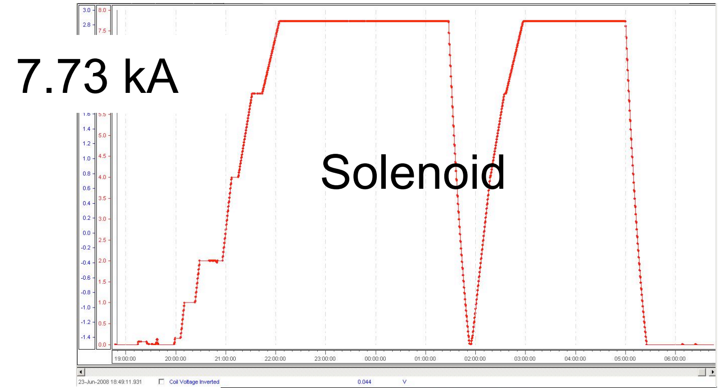


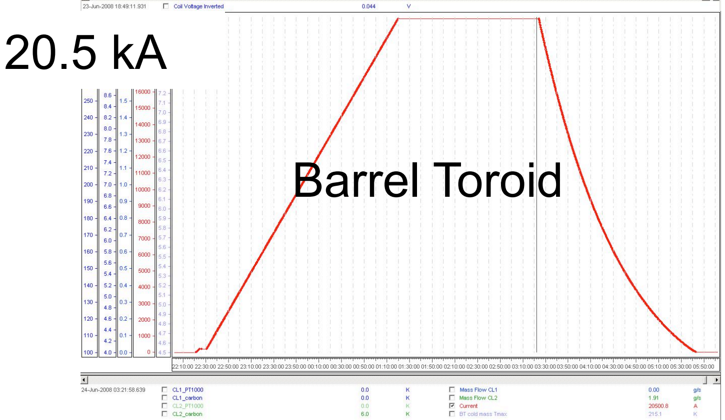
Last Muon Chamber
Installed July 1rst 08

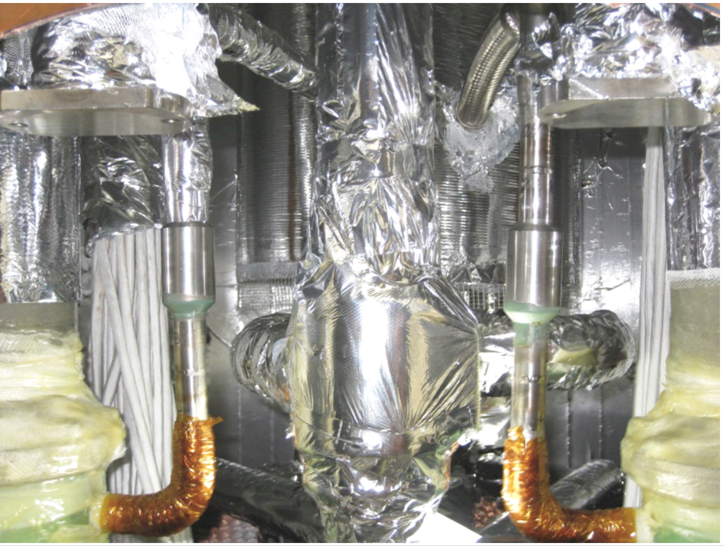
Very few bad channels
Few chambers with problem
(gas leak, overpressure accident,...)
Some loss of redundancy but
no acceptance hole

Toroids and Solenoid Magnet Systems

- Central Solenoid up to full field at 7.73 kA nominal in Aug 06
- Barrel Toroid up to full field at 20.5 kA nominal in Nov 06
- EndCap-C Toroid up to full field at 20.5 kA nominal in June 08







EndCap-A Toroid

Leak in electrical pipe isolators - 23rd May

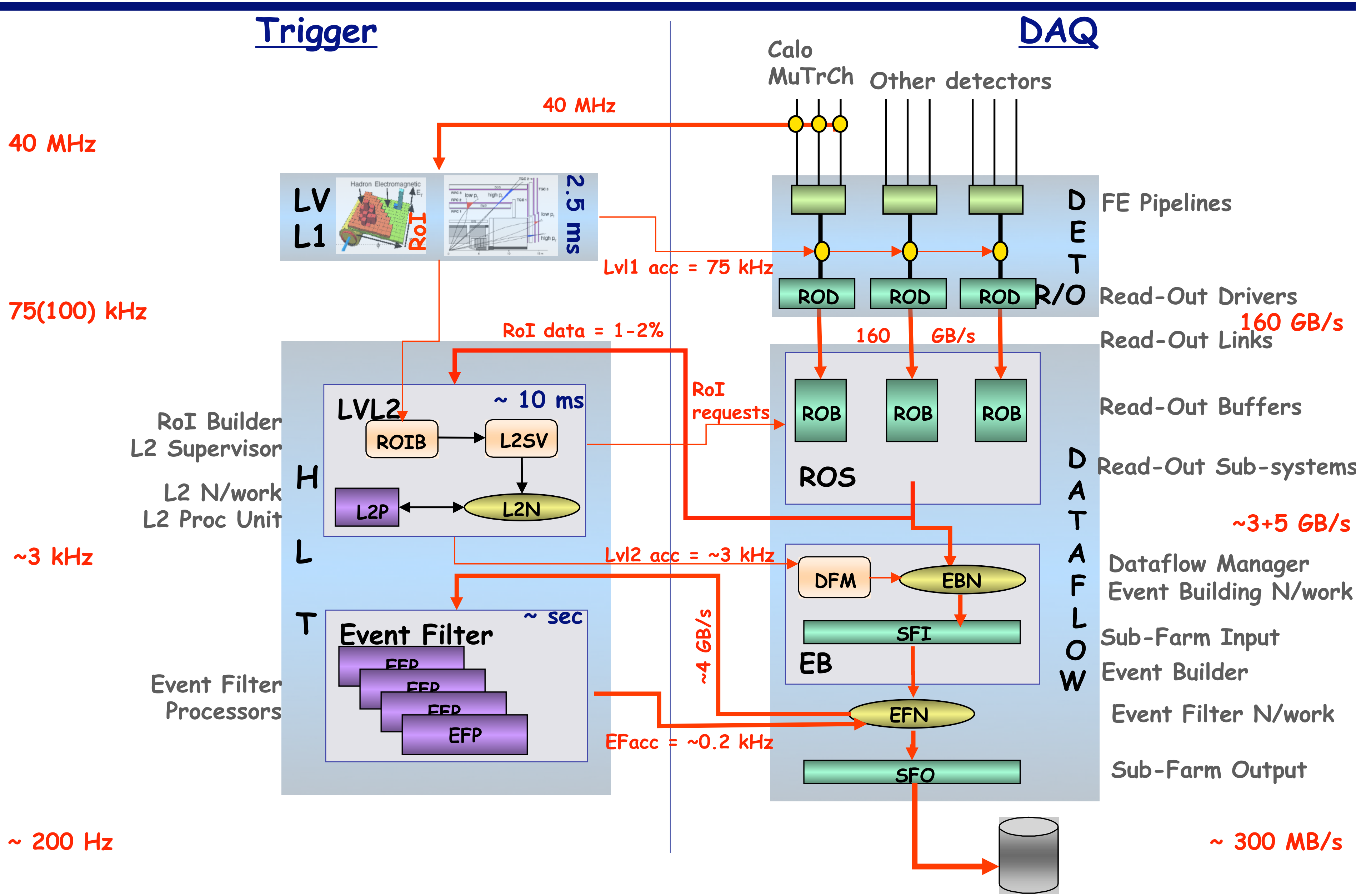
Toroid warmed-up/repaired/cooled - 20th July

EndCap-A tested up to 21kA – 23rd July

Combined test of 3 magnets at 15kA - 31rst July

Operated during the cosmic run in September

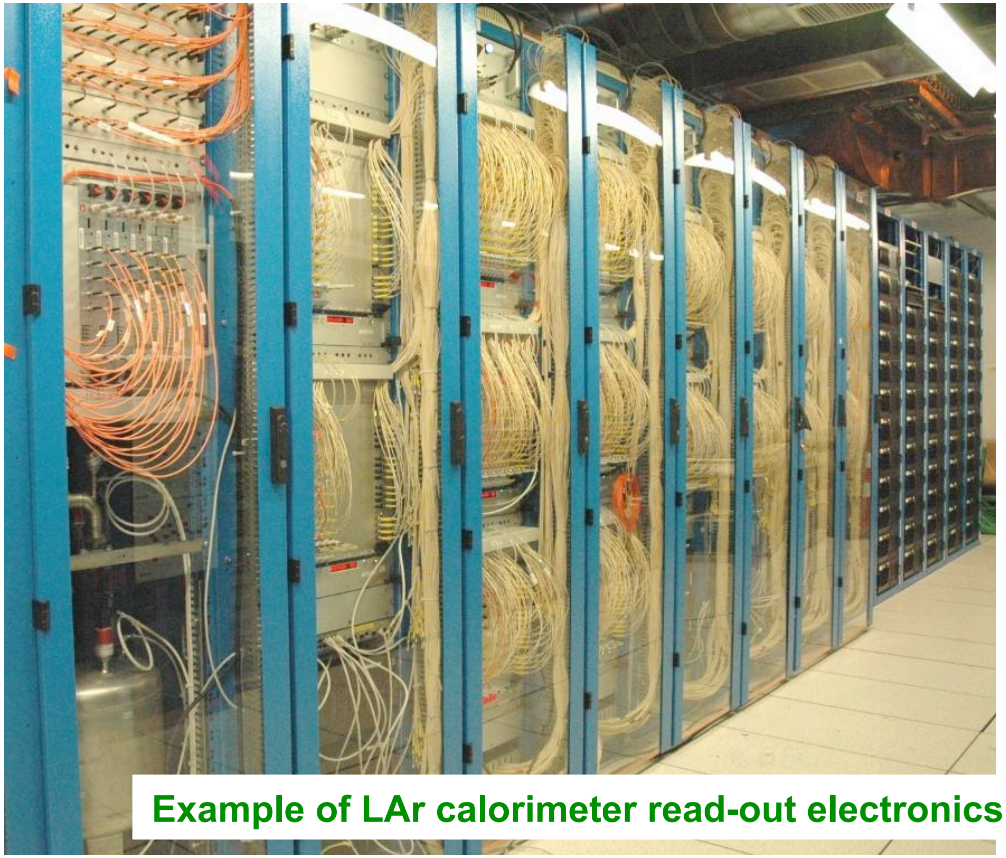
Trigger/DAQ Architecture



Trigger/DAQ Architecture

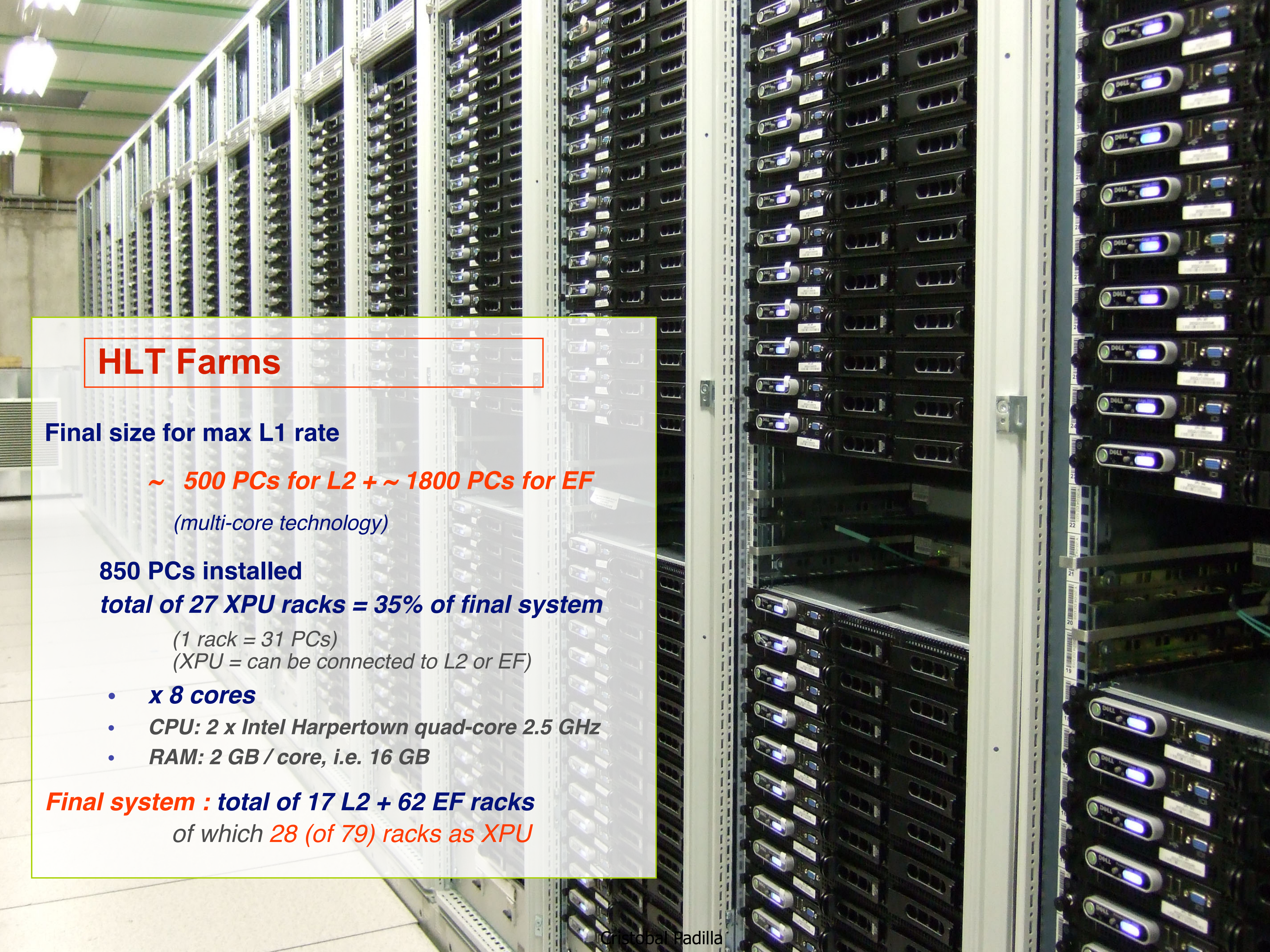
Example of Level-1 Trigger electronics

The read-out electronics, trigger, DAQ and detector control systems have been brought into operation gradually over the past years, along with the detector commissioning with cosmics



Example of LAr calorimeter read-out electronics

In total about 300 racks with electronics in the underground counting rooms



HLT Farms

Final size for max L1 rate

~ 500 PCs for L2 + ~ 1800 PCs for EF

(multi-core technology)

850 PCs installed

total of 27 XPU racks = 35% of final system

(1 rack = 31 PCs)
(XPU = can be connected to L2 or EF)

- ***x 8 cores***
- ***CPU: 2 x Intel Harpertown quad-core 2.5 GHz***
- ***RAM: 2 GB / core, i.e. 16 GB***

Final system : total of 17 L2 + 62 EF racks

of which 28 (of 79) racks as XPU

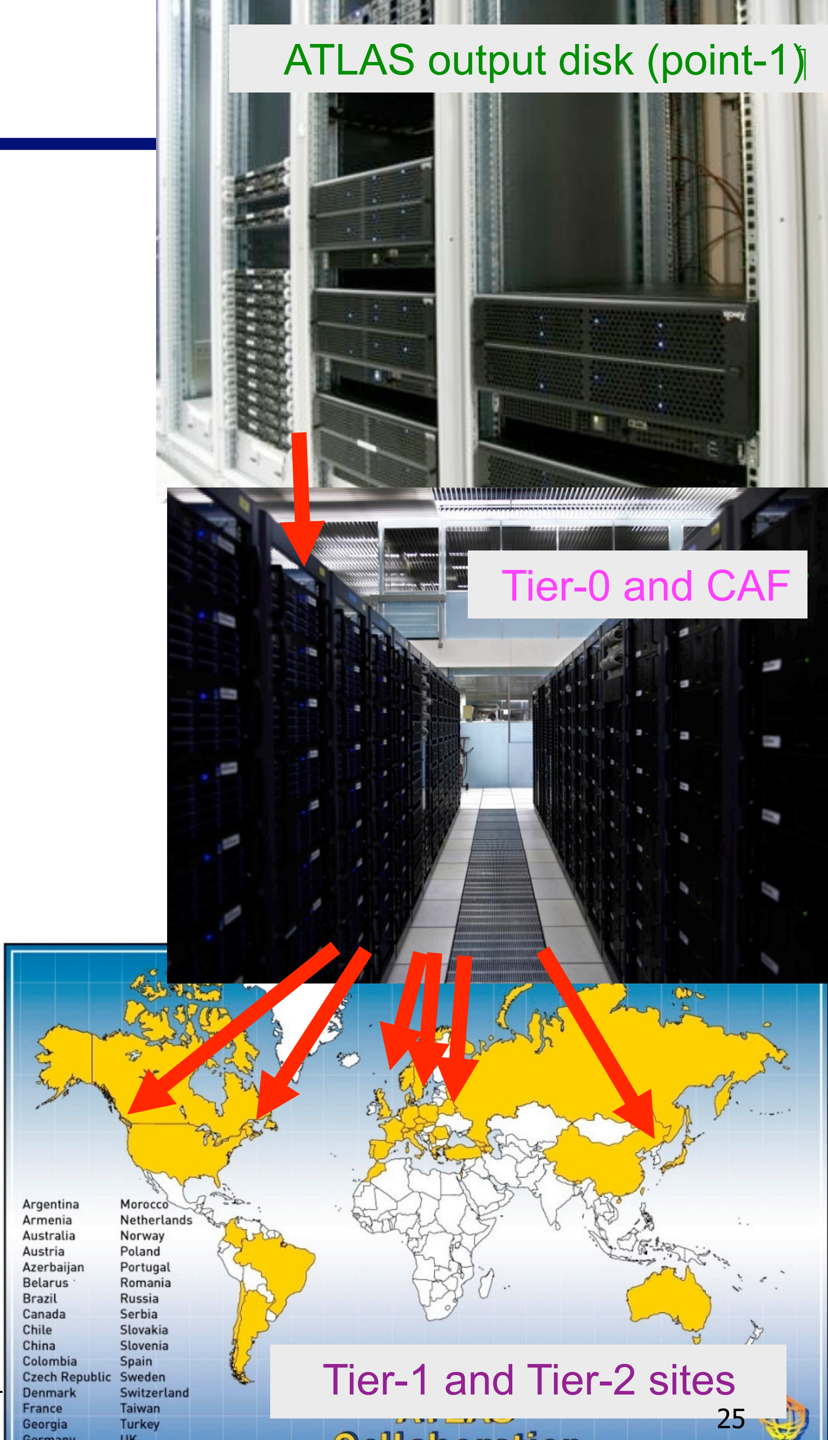
Cristobal Padilla

Final Dress Rehearsal

- Played data through the computing system just as for real data from the LHC
  - Starting at point 1
  - Processed data at CERN Tier-0
  - Shipped up to Tier-1 and Tier-2s for physics analysis

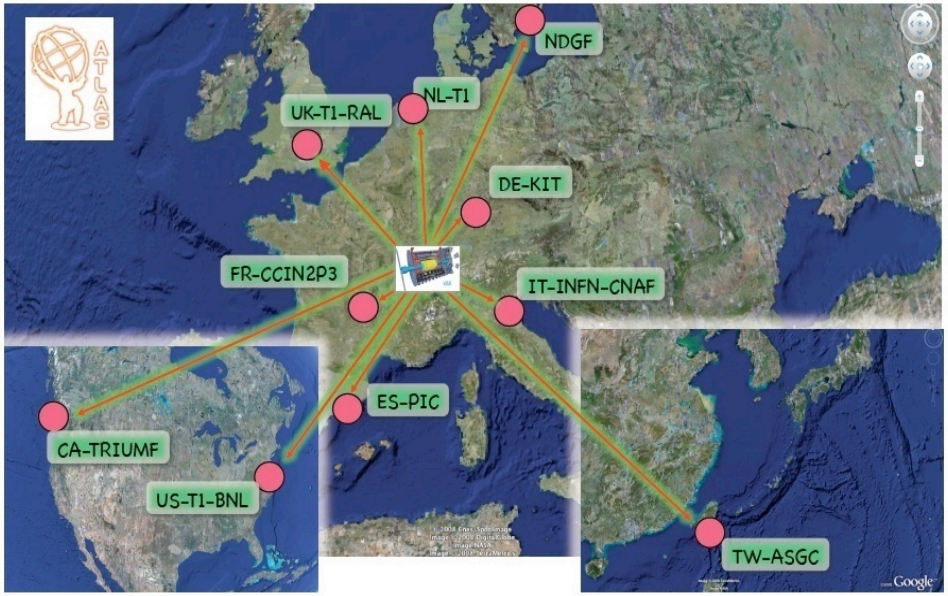
- Complementary to other commissioning activities with cosmics

- Two FDR runs (February and June-July 2008)

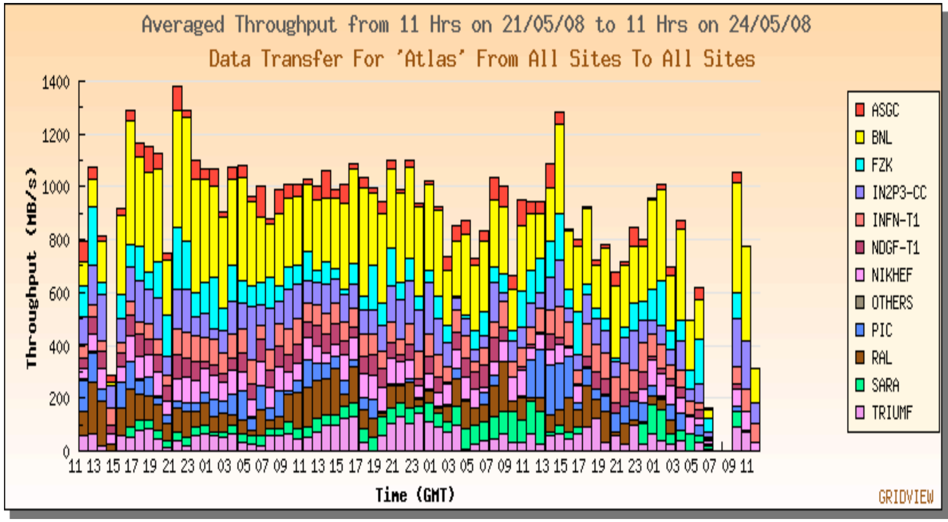


Final Dress Rehearsal

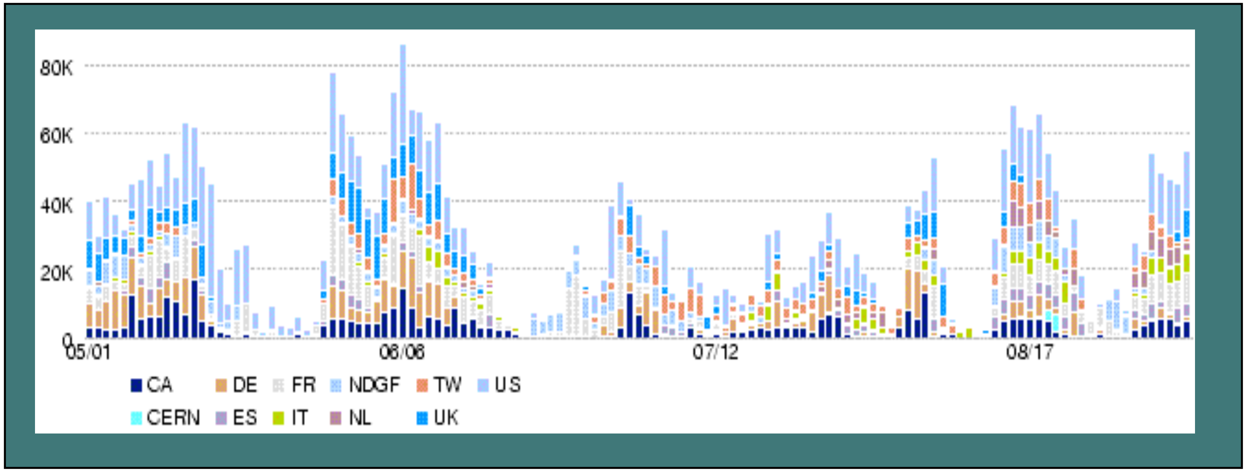
wLCG Grid: Tier-0 and the 10 ATLAS Tier-1s



Data transfer Tier0--> Tiers-1

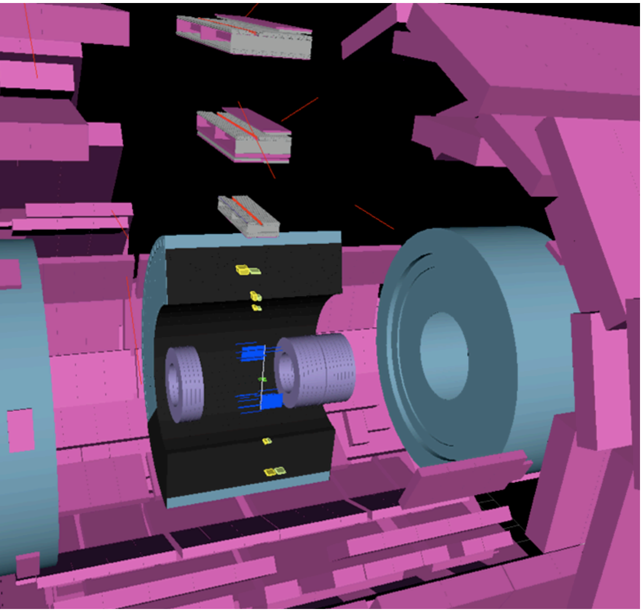


Nominal peak level (~1 GB/s) sustained over 3 days

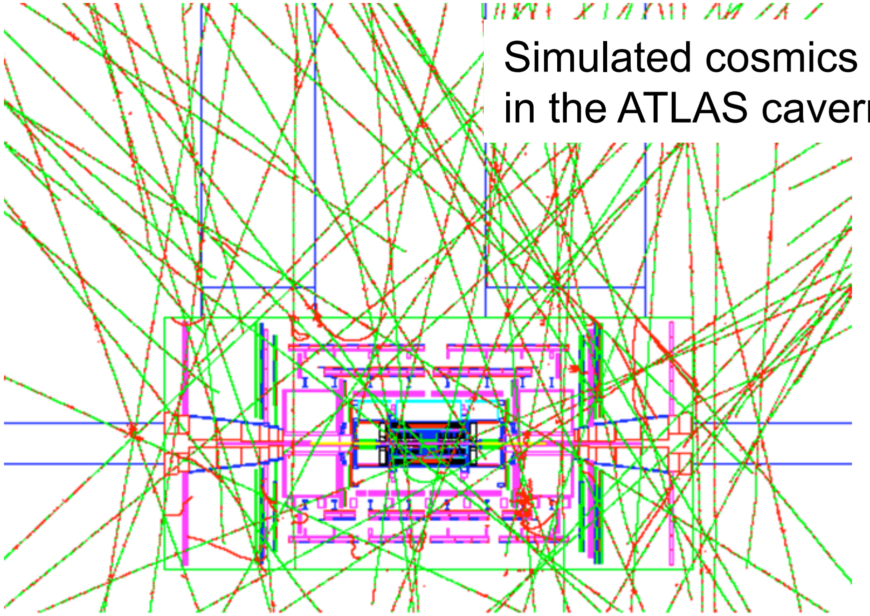


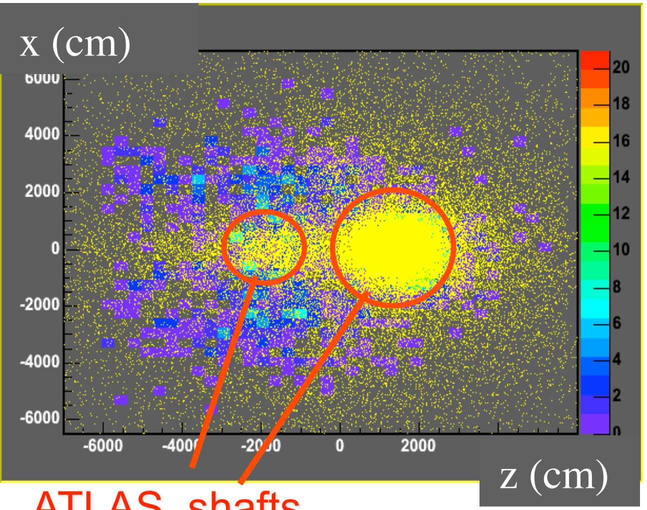
Number of world-wide ATLAS production jobs per day from 1 May to 5 September 2008

Commissioning with Cosmics



Real Cosmic Event

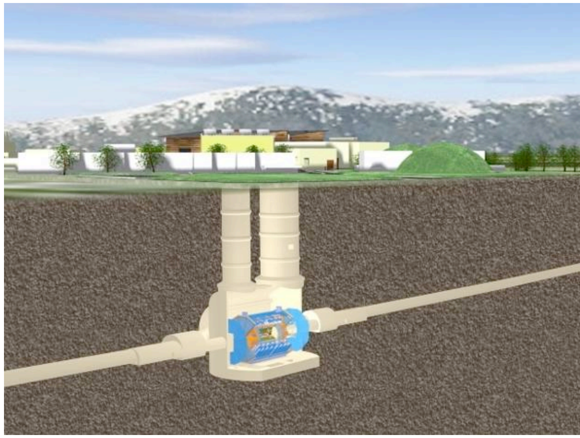




ATLAS shafts

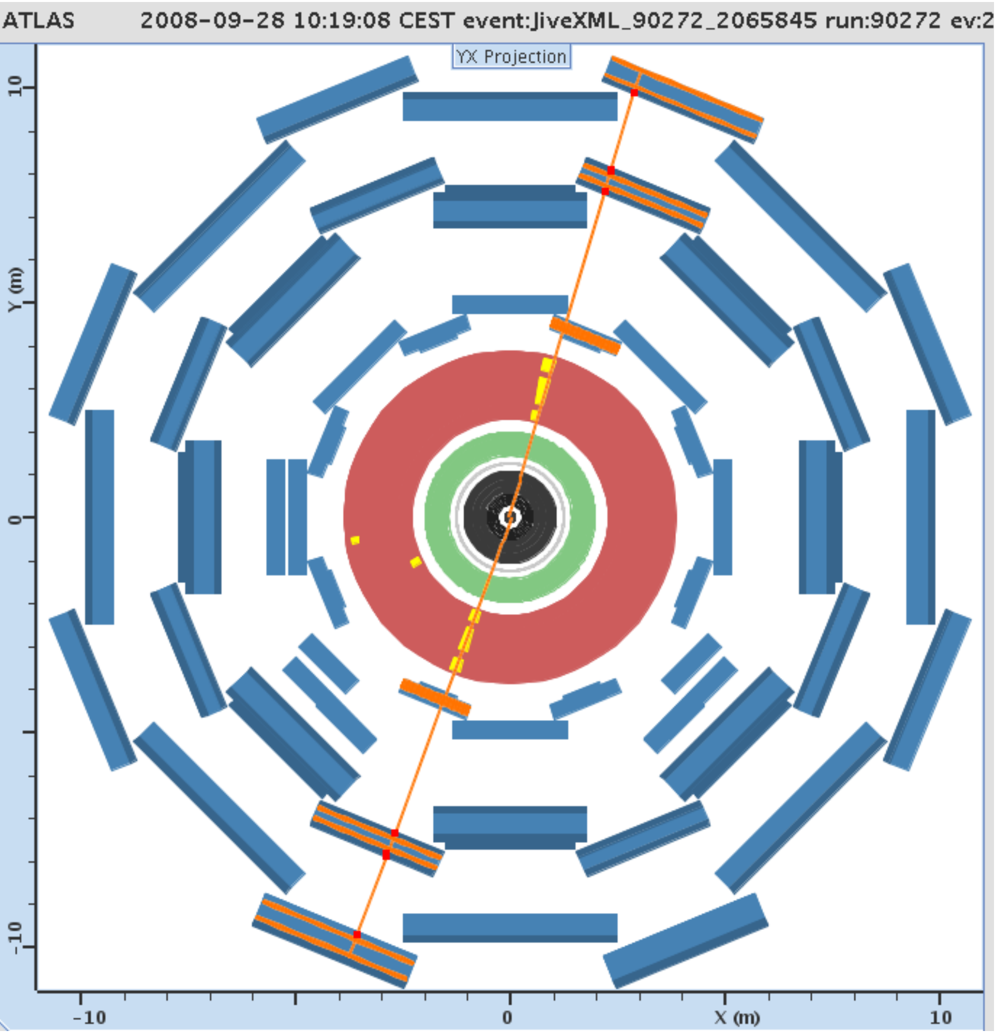
Muon impact points extrapolated to surface as measured by Muon Trigger chambers (RPC)

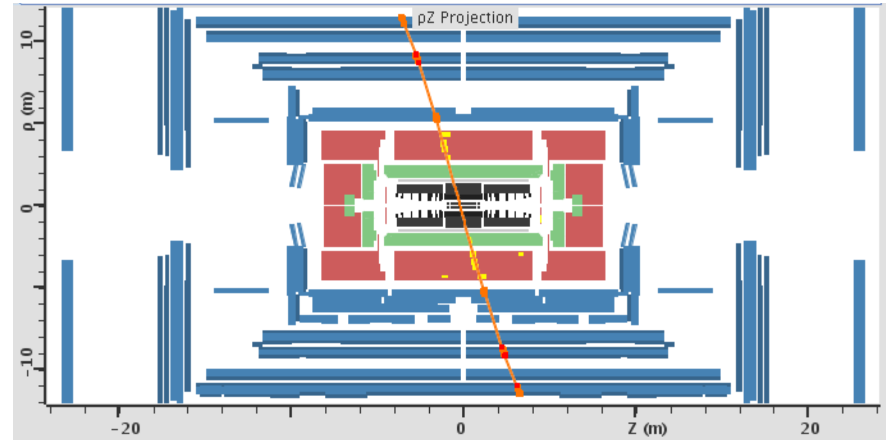
(Calorimeter trigger also available)

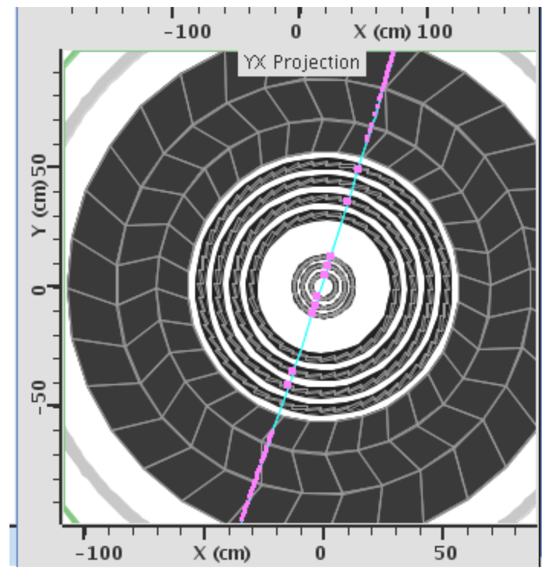


Rate ~100 m below ground:
~ O(15 Hz) crossing Inner Detector

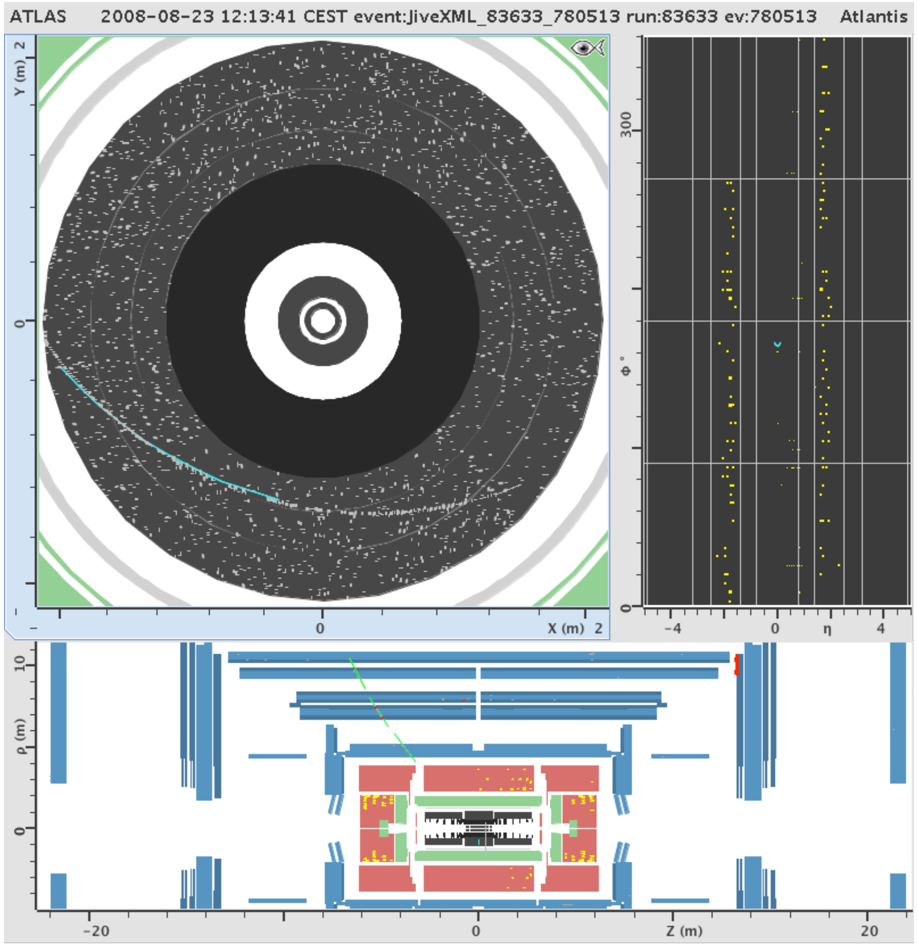
A Nice Cosmic Muon Through the whole Detector

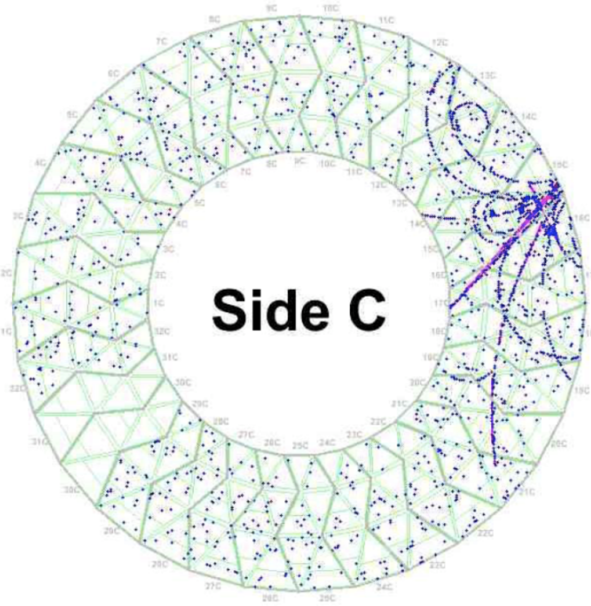


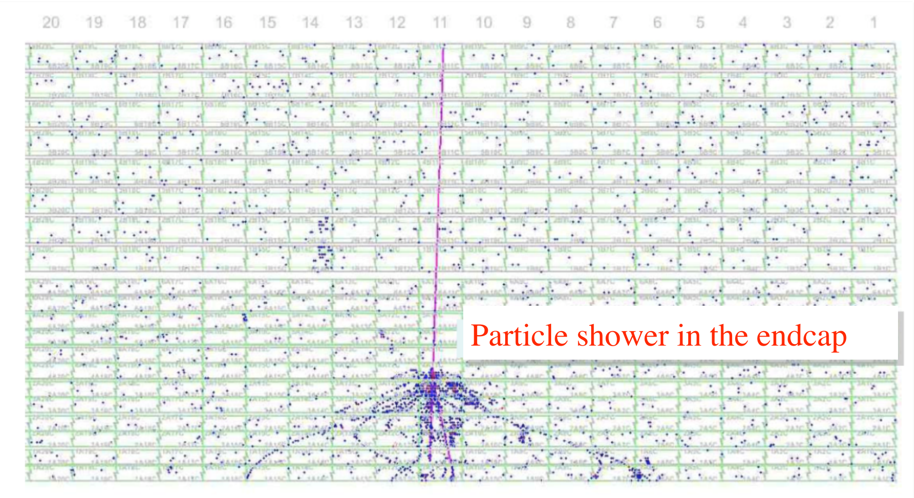




Example of Cosmic events with Magnet on





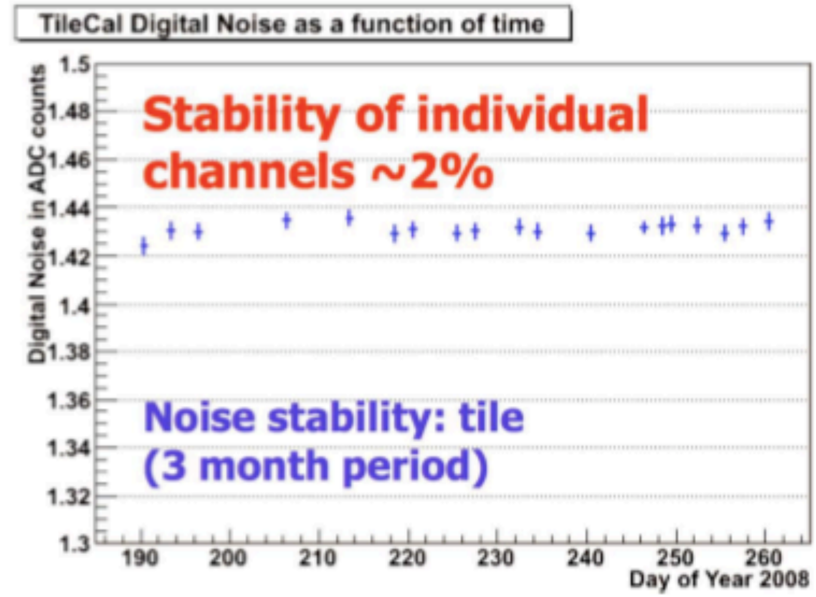


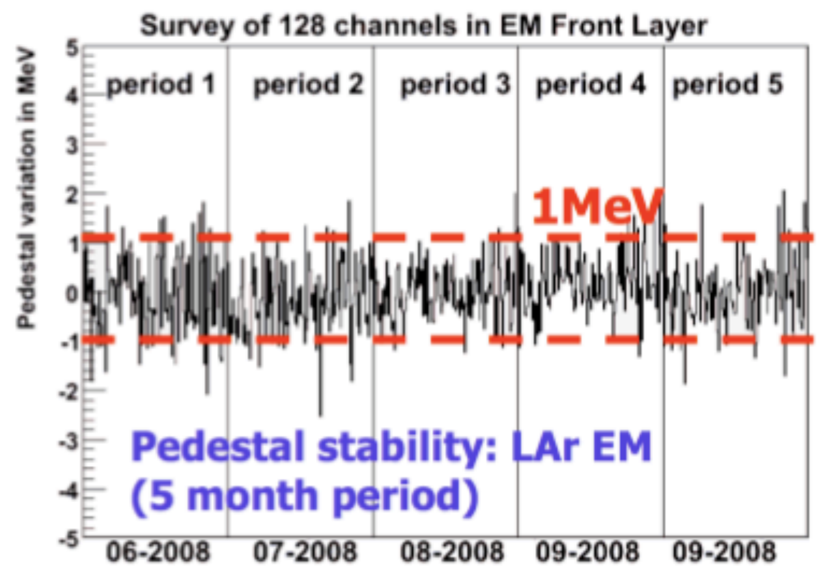
Calorimeter Calibration

- Liquid Argon (LAr) and Tile calorimeters had a long commissioning period (started cosmic data taking since 2006)

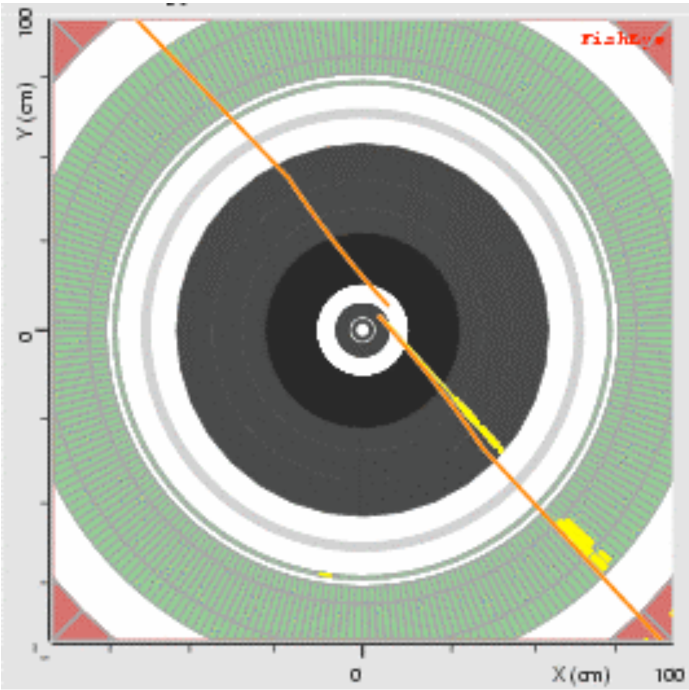
- Calibration ready
  - Pulses (LAr and Tile)
  - Radiation sources (Tile)
  - Laser (Tile)
  - MC and test beam data

- The LVL1 Calorimeter trigger is also commissioned

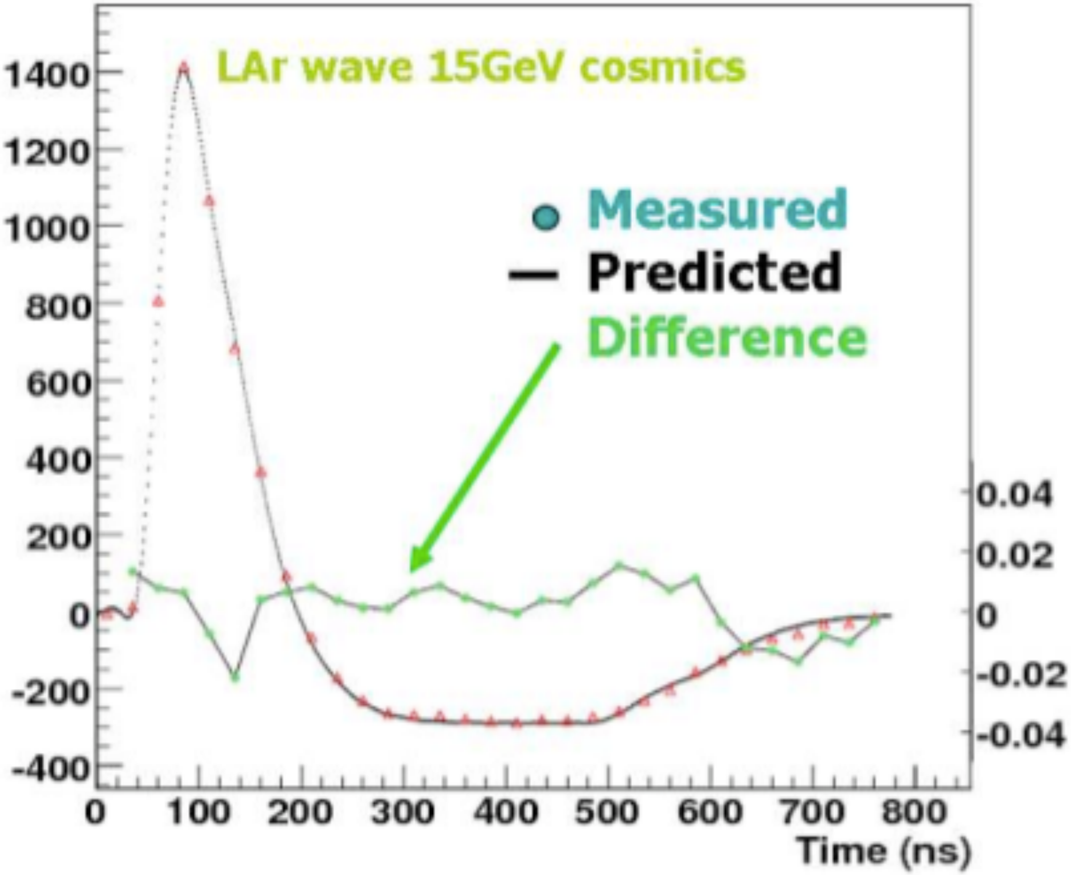




Commissioning with Cosmics



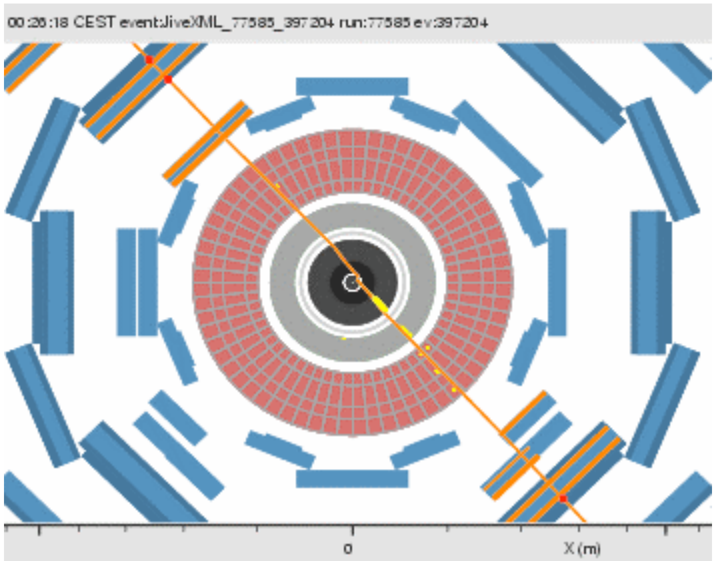
LAr Calorimeter

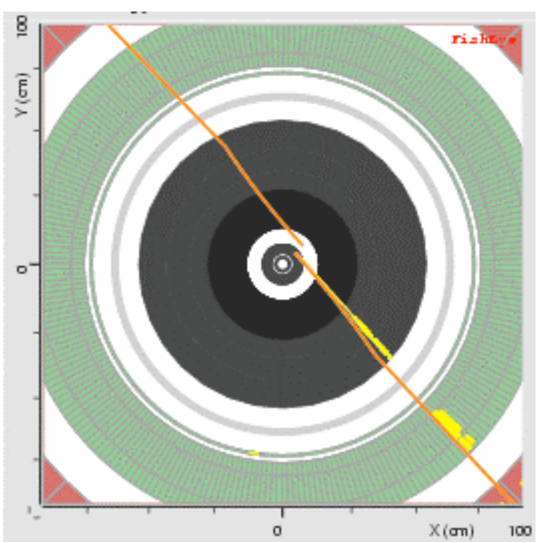


The precise knowlege of the pulse shape is important for good uniformity of calorimeter response

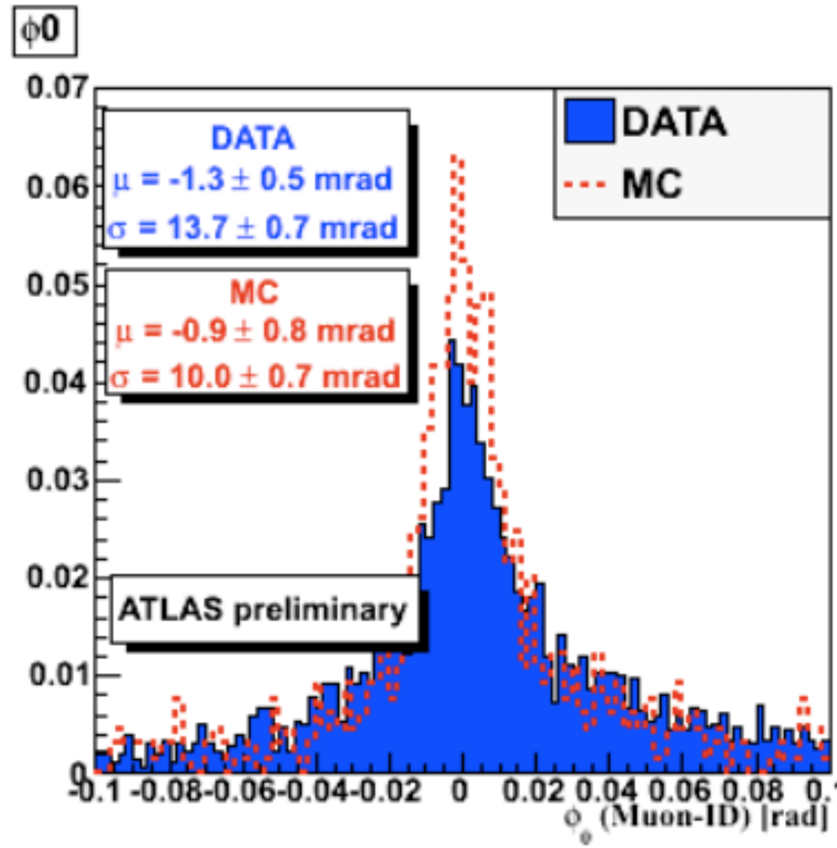
First measurements with Cosmics

Commissioning with Cosmics: Muon and ID Systems



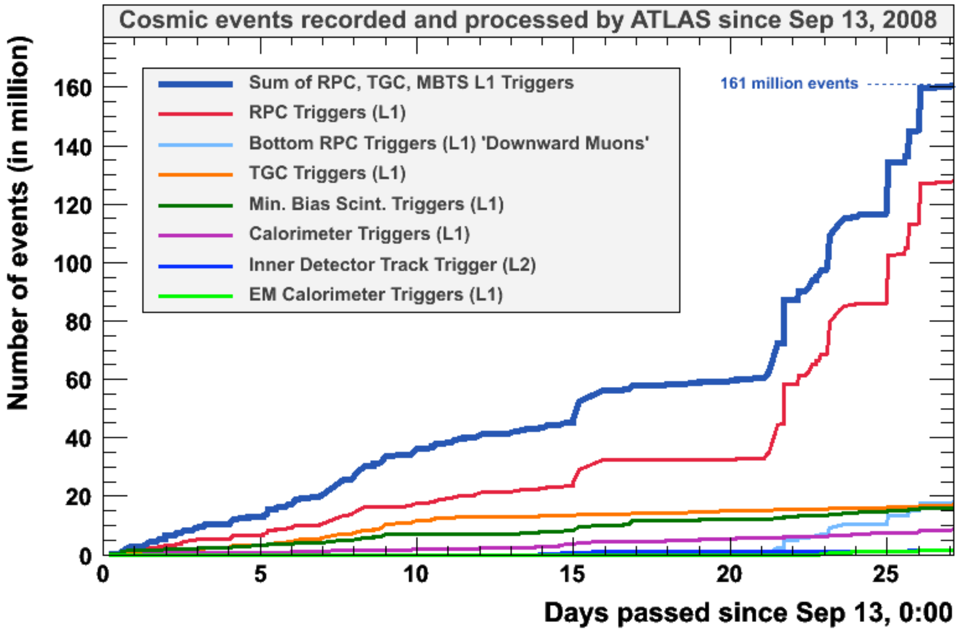


difference in the azimutal angle
between the muon and the ID



First constraints on alignment from cosmics

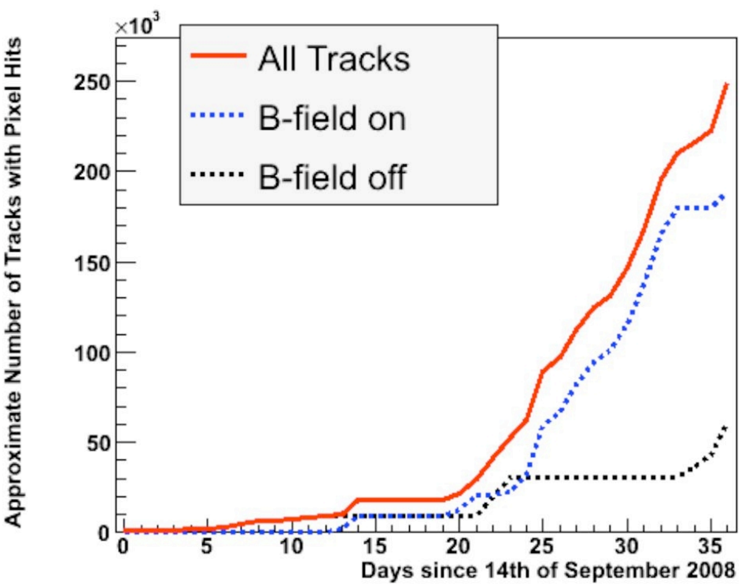
Commissioning with Cosmics



A huge amount of cosmic ray triggers are recorded, in total (left) as well as giving tracks also in the smallest-volume detector, the Pixels (below)

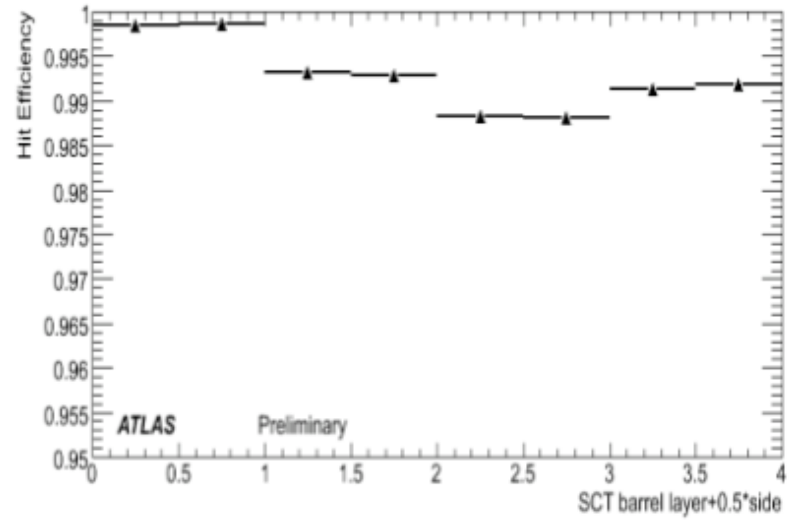
Active use of the High Level Trigger system to select tracks that cross the Pixel detector and classify the events in a special stream.

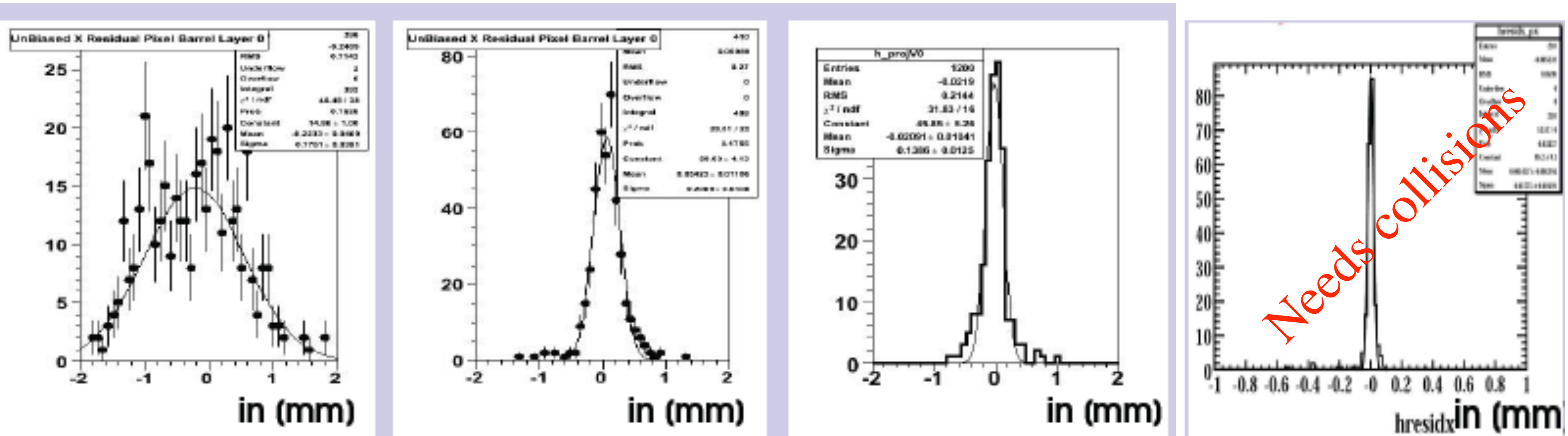
Good test of the infrastructure for trigger and analysis



ID Efficiency and Alignment

- ID Alignment to be performed in subsequent steps varying the number of DoF
  - L1: Compensate the sub-detector global misalignments
  - L2(2.5): Align sub-detector components
  - L3: aligns individual mechanical units (needs collisions)





Nominal
~ 1 mm

L2
10K trk - 250 μm

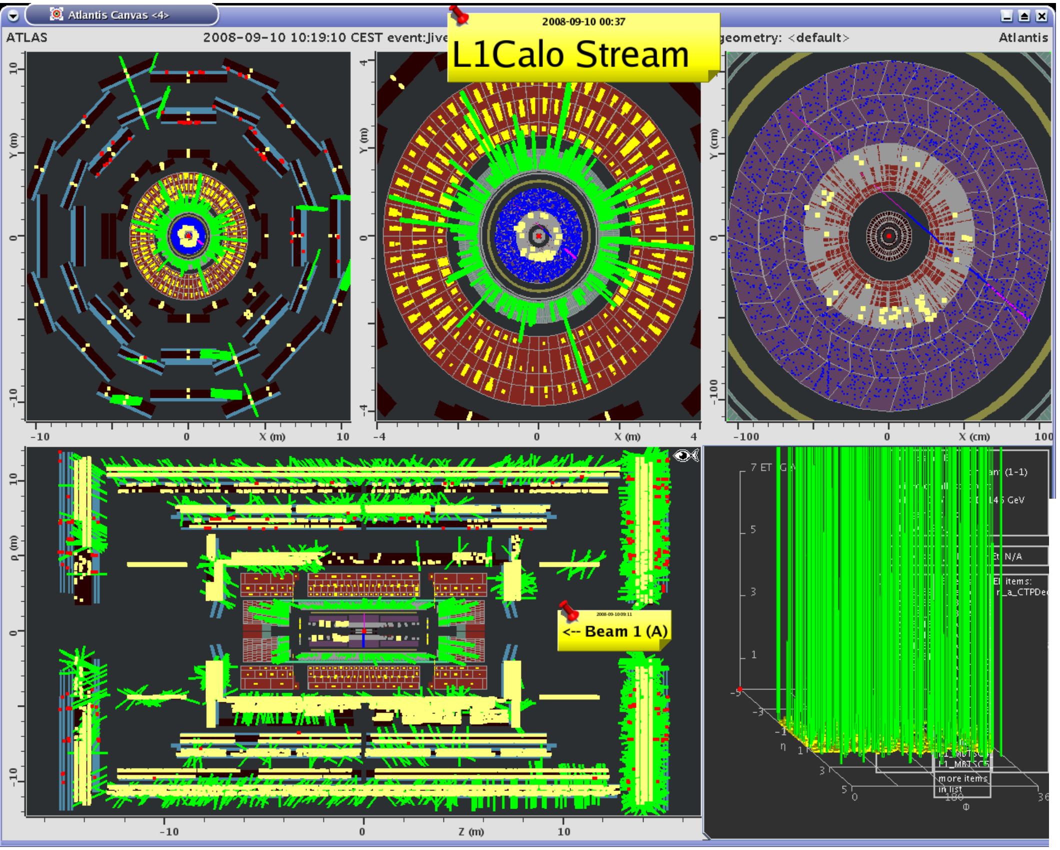
L2.5
50 K trk – 150 μm

L3 – 35 k DoF
1 M trk -15 μm

Excitement in the ATLAS Detector Control Room: The first LHC event on 10th September 2008

… as well as in the ATLAS Tier-0 and Data Quality Control Rooms: Reconstruction follow-up and analysis of the first LHC events

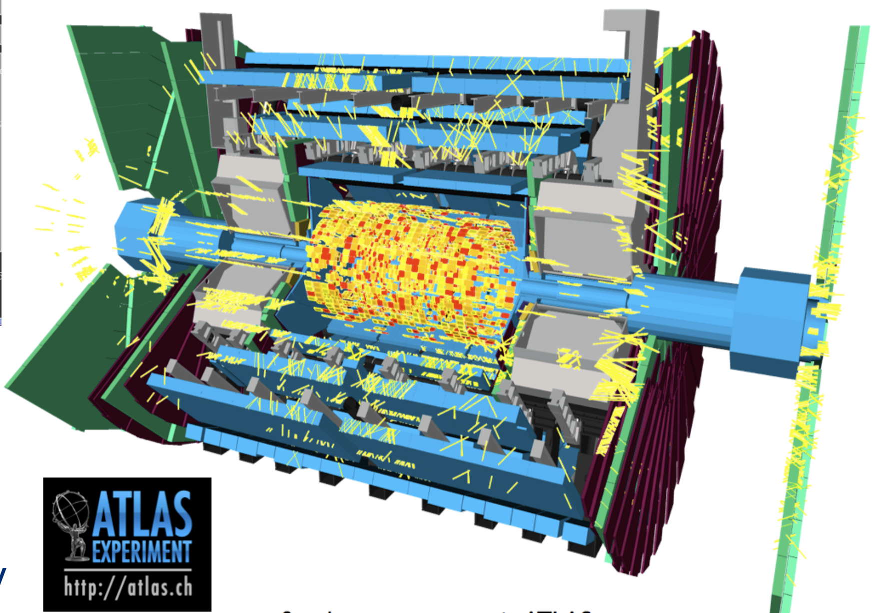
First Event in ATLAS



Online display

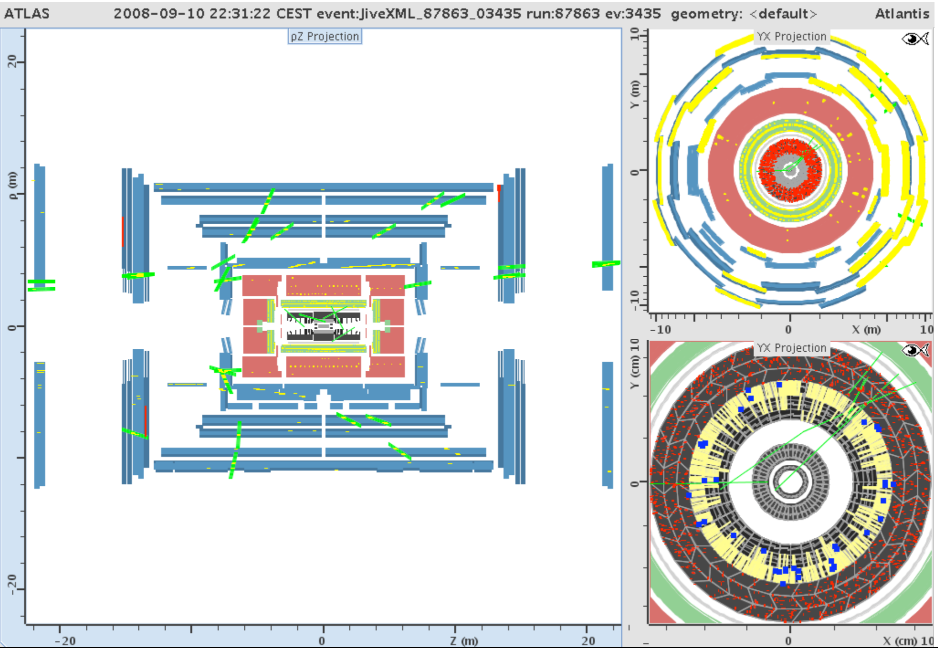
The very first beam-splash event from the LHC in ATLAS on 10:19, 10th September 2008

Offline display

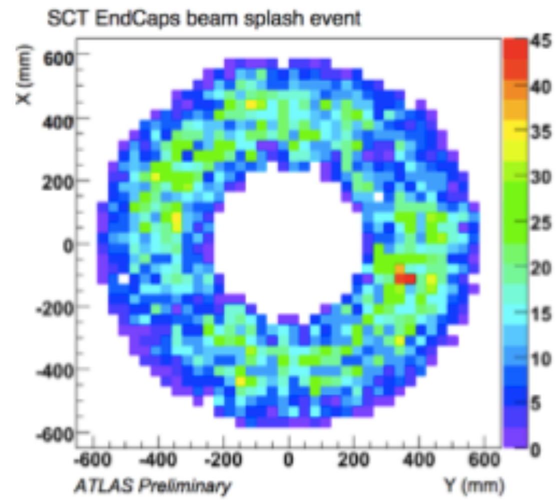


first beam event seen in ATLAS

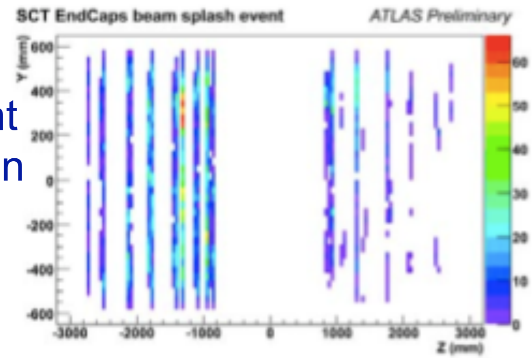
Other events in ATLAS

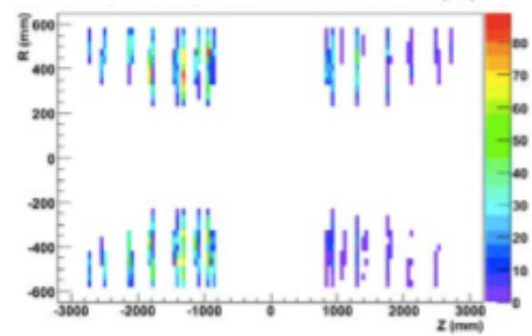


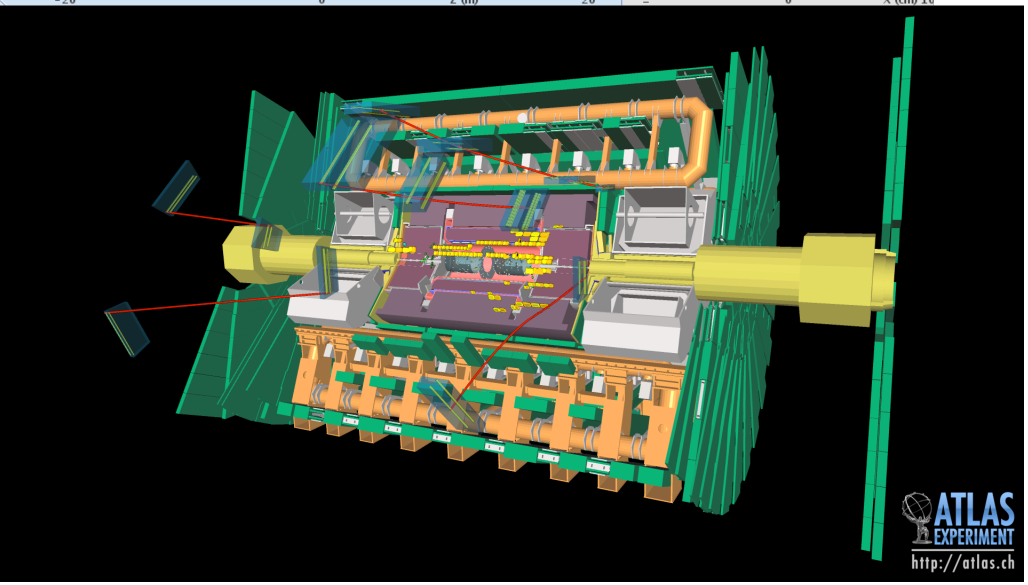
A busy beam-halo event with tracks bent in the Toroids from the start-up day



Beam event in the Silicon Tracker



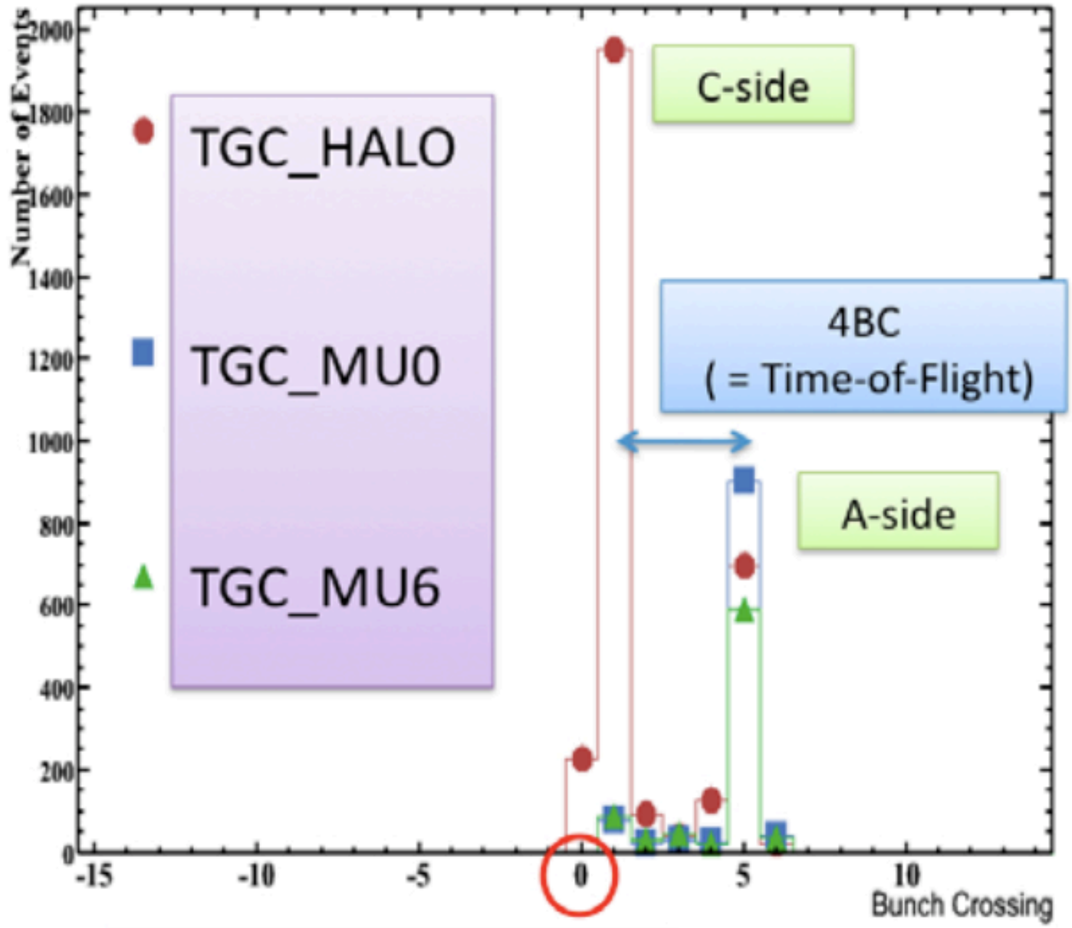




Another beam-halo event

Triggering Splash Events

- LHC changed the operations plan one day before the inauguration
  - Beam was going to stop at the collimators
- We changed the strategy very fast and used the same trigger timing setting as for cosmics to ensure that events were recorded

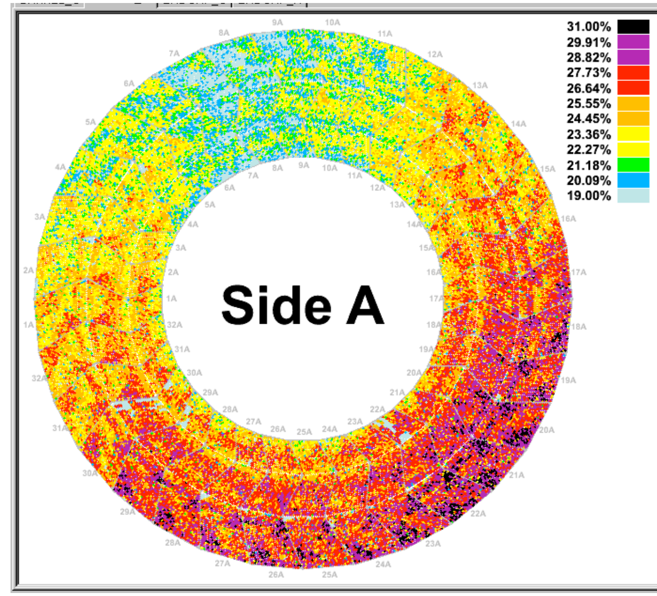


TGC trigger timing in a splash event coming from C side. The 100 ns (4 Bunch Crossings) time of flight is clearly visible

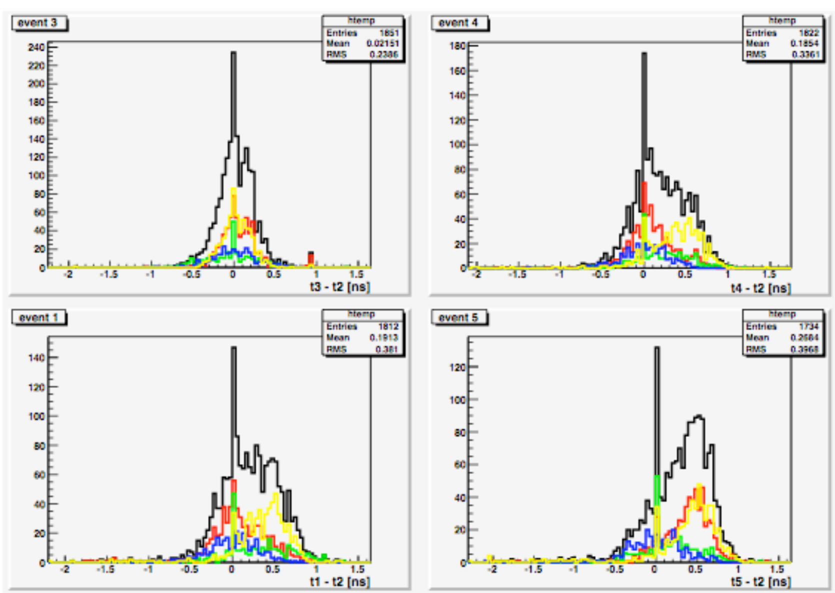
Detector Timing with Splash Events

One interesting feature of splash events is that many tracks hit the detector at the same time. All TRT tubes were fired in several splash events, so that, thanks to the intrinsic resolution, it was possible to align the time response of the entire detector using a single event.

Other splashes were used to verify the correctness of the time alignment.

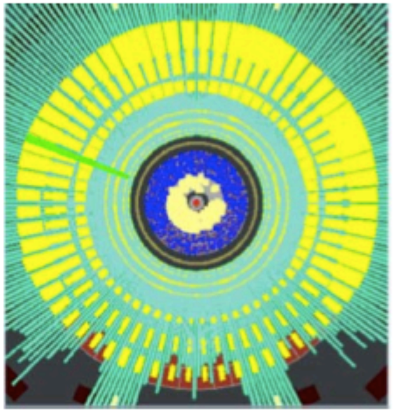


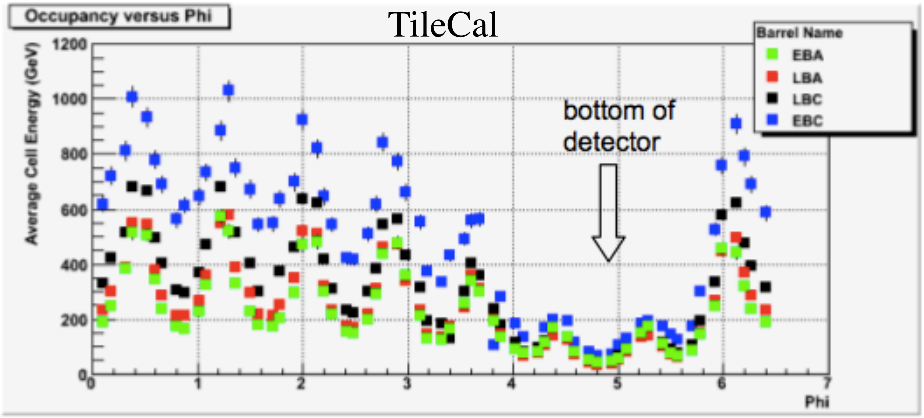
Time distribution of a single splash using the time constants measured with cosmics. The up-down Time of flight effect is visible.

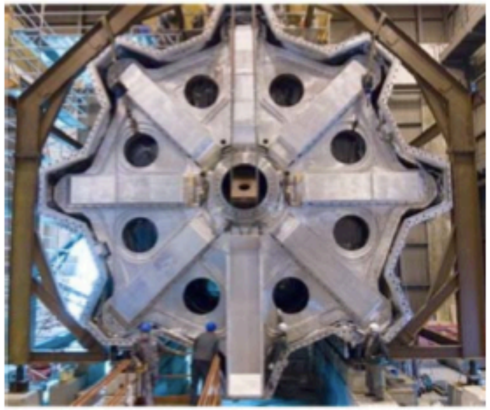


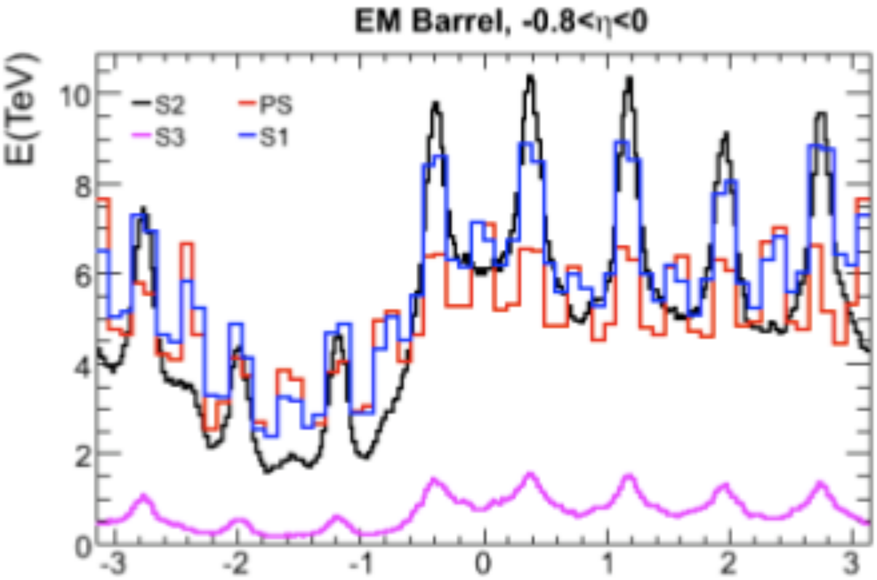
Time distributions of different splash events (in different colors) with time constants computed using a single splash event. The average width is 0.3 ns.

Energy deposits in the Calorimeter





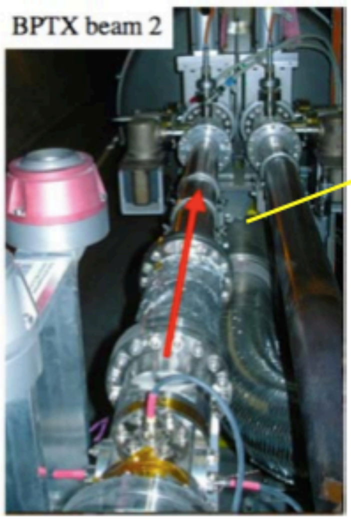




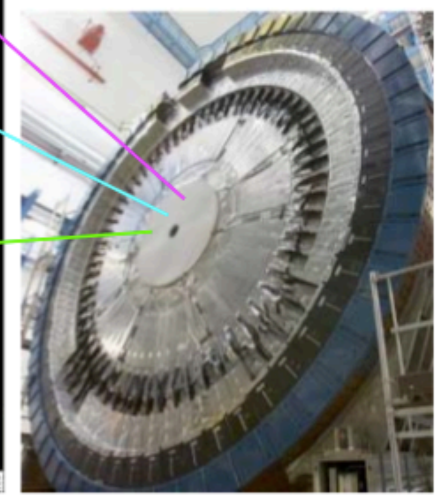
- Energy deposit from beam splash (collimator) event
- Eight-fold structure in Φ due to the material on the end-cap toroid
- Extra material in the bottom of the detector from the support structure

First Circulating Beams in ATLAS

ATLAS trigger during the circulating beams used the "Minimum Bias Trigger Scintillator" (MBTS) and the Beam Pick-up (BPTX)



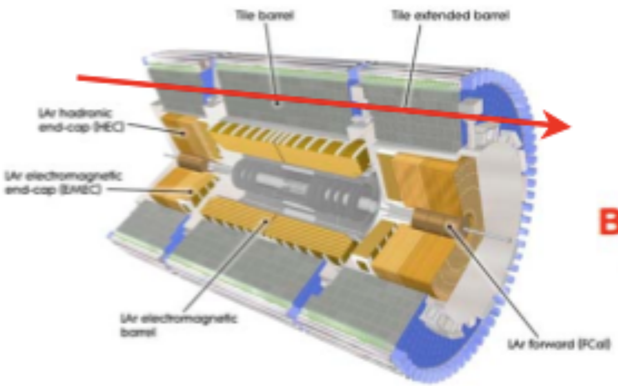
MBTS minimum-bias trigger scintillator on IP-side face of endcap calorimeter

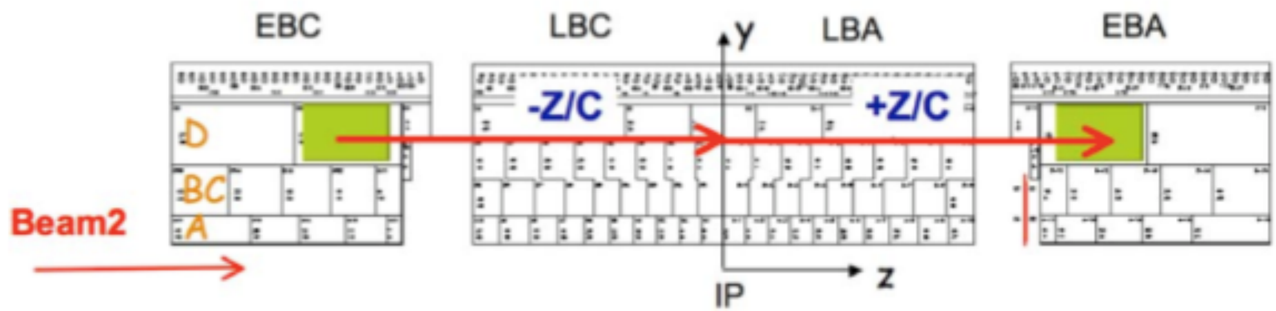


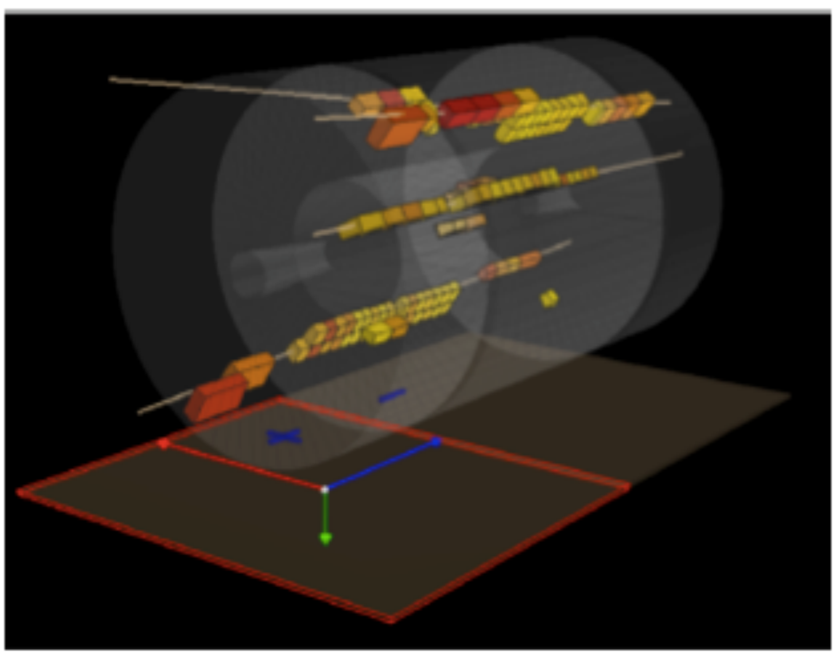
Beam becoming unstable: MBTS, initially quiet, becomes more active after several runs.
At the end the beam pick-up does not see the beam anymore while the MBTS still fires

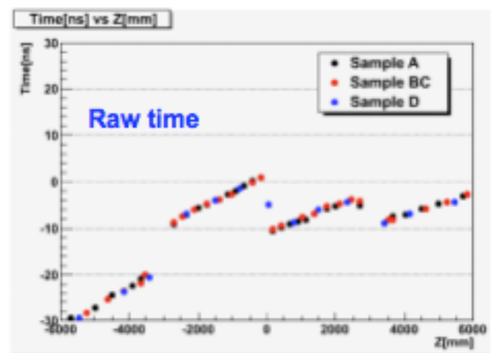
Timing Studies in the Tile Calorimeter

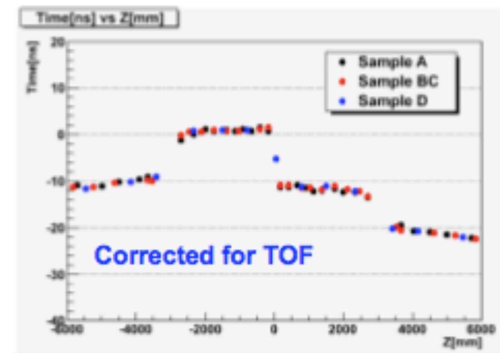
Beam splash and beam halo event both yield almost horizontal muons that can be exploited for check timing checks









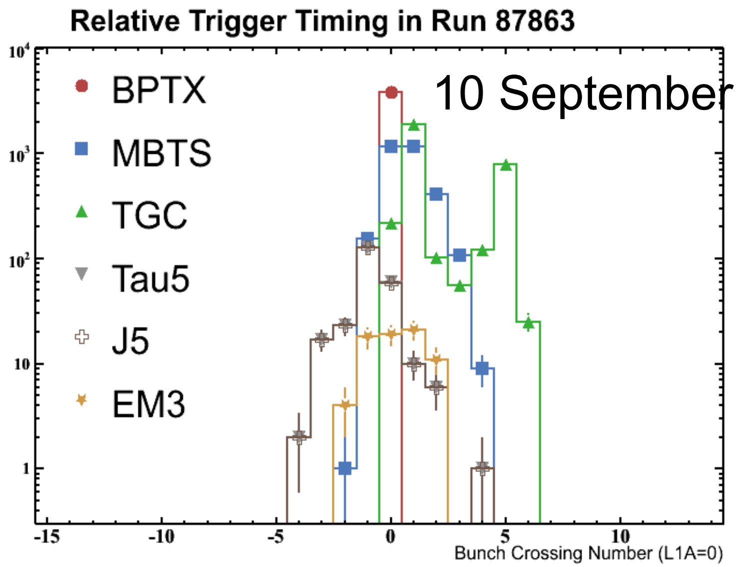


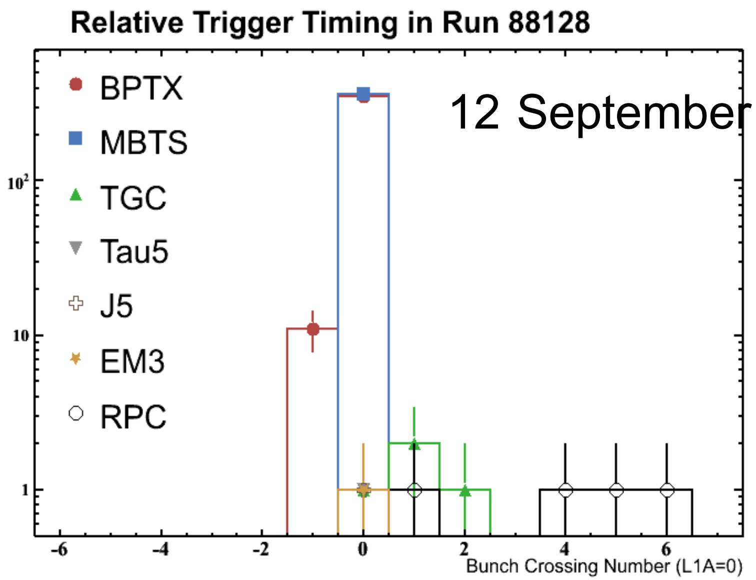
Time dispersion is ~2 ns in each partition

Offsets between partitions well whitin 1 BC

Timing-in the Trigger with Single Beams

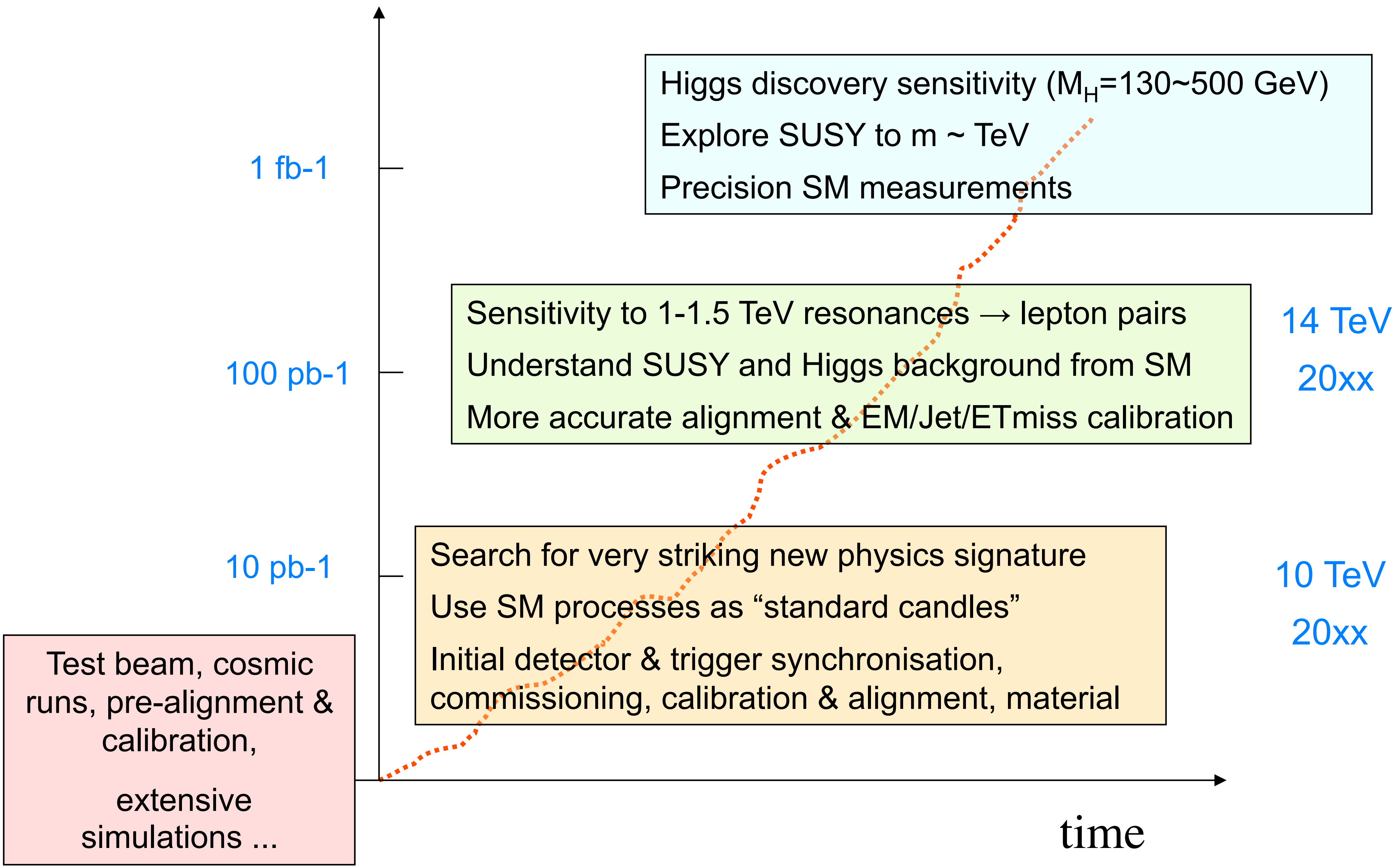
- Experiment timing based on beam-pickup ("BPTX") reference
  - First task of LVL1 central trigger team on 10th September was to commission the beam pickups
- Times of arrival of other triggers were adjusted to match
  - Plots show evolution from September 10th to September 12th
- Each LVL1 sub-system also needs to be timed internally
  - L1-Calo, L1-RPC, L1-TGC, MBTS, etc.





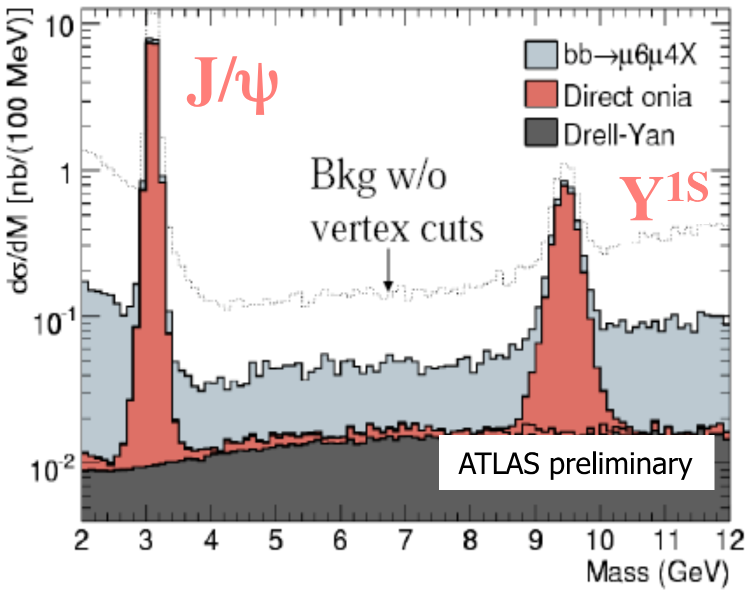
Note change of scale!

Collisions: a Physics Roadmap



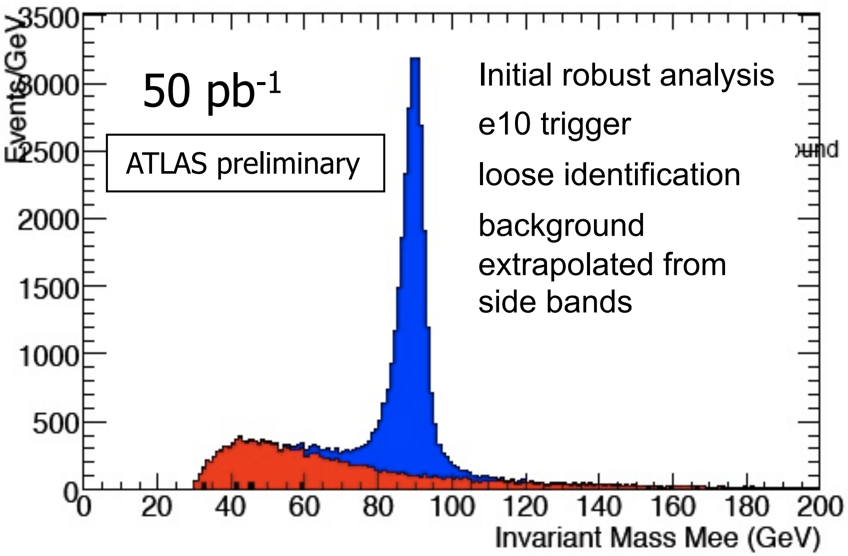
Example of first signals

1 pb^{-1}≡3 days at 10^{31}at 30% efficiency



After all cuts:
~ 5000 (800) J/ψ (Υ) →μμ / day @ L = 10^{31} cm^{-2} s^{-1}
(for 30% machine x detector data taking efficiency)

→Allow to do tests of tracker momentum scale, trigger performance, detector efficiency, sanity checks, …



After all cuts:
~ 160 Z → ee / day at L = 10^{31} cm^{-2} s^{-1}

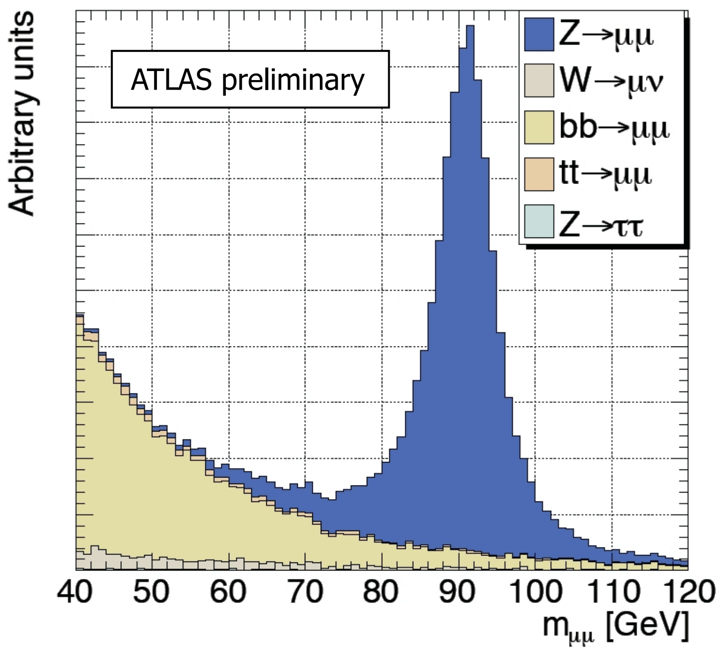
energy/momentum scale of full detector
Muon Spectrometer alignment,
lepton trigger and reconstruction efficiency, …

~25 k events (at 10 TeV reduced by 30%)
quickly dominated by systematic

W/Z Production

$Z \to \mu\mu$

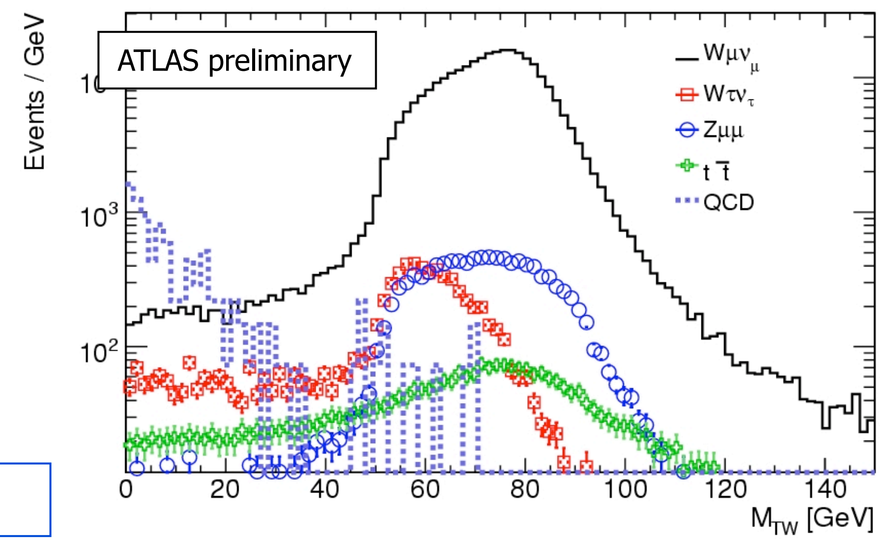
- Trigger and offline eff. from tag-and-probe
- Tracks in Muon Spectrometer



14 TeV

$W \to \mu\nu$

- Trigger and offline efficiencies from tag-and-probe ($Z \to \mu\mu$)
- Muon isolation in calo
- Missing E_T > 25GeV



$\int Ldt=50pb^{-1}$: 25.7k Z, 0.1k bckgd evt

σ=2016±16(stat)±64(syst)±202(lumi) pb

(+ isolation in Inner Detector)

$\int Ldt=50pb^{-1}$: 300k W, 20k bckgd events

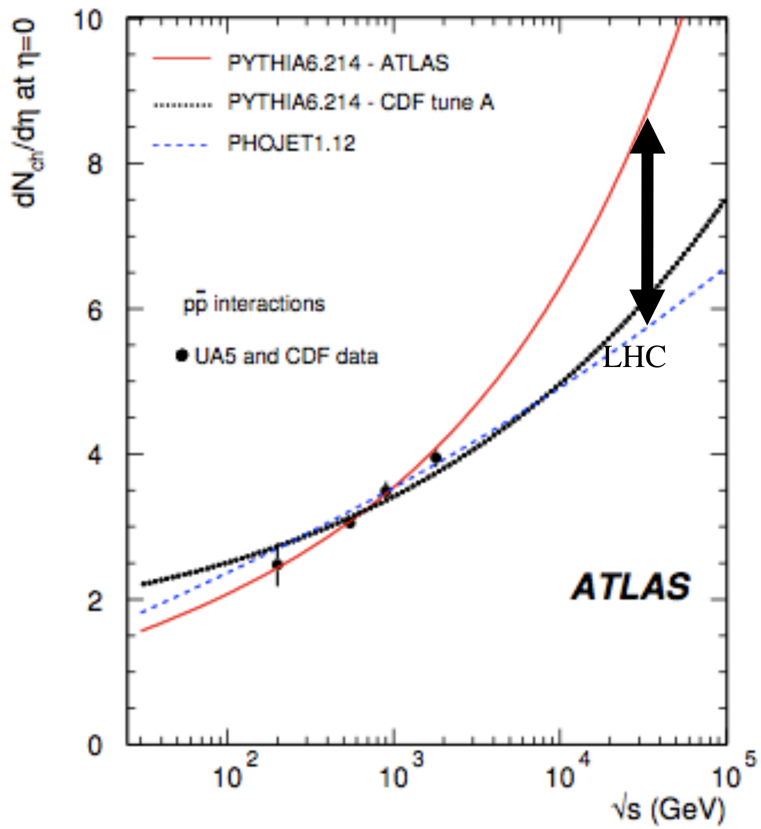
σ=20530±40(stat)±630(syst)±2050 (lumi) pb

Luminosity uncertainty vanishes in σ_W/σ_Z →stringent test of QCD

Minimum bias

Large uncertainty in extrapolation to LHC

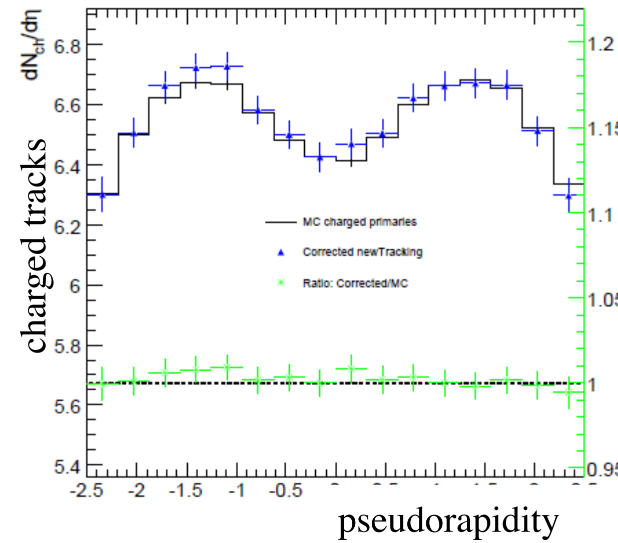
Ex: central charged particle density for non-single diffractive events

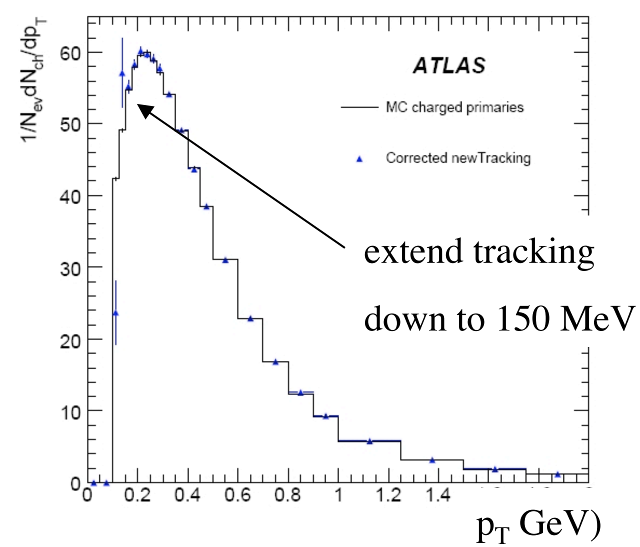


- Minimum-bias (→ pile-up)
- Underlying event in hard interaction

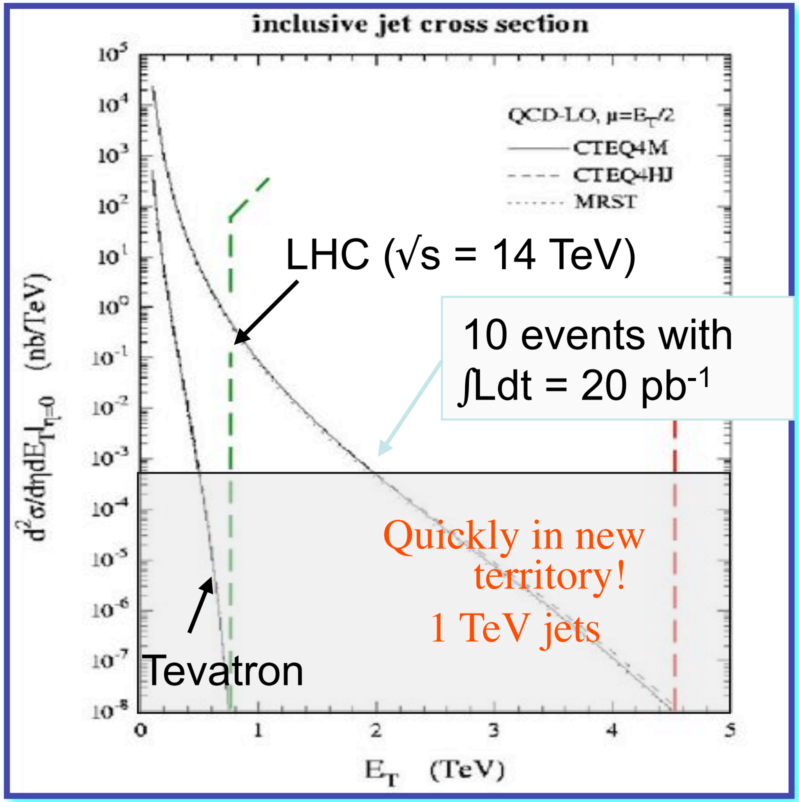
need to be well understood for precision physics

1 minute L=10^{31}cm^{-2}s^{-1} 14 TeV





Inclusive jets and W/Z+jets



Jet energy scale

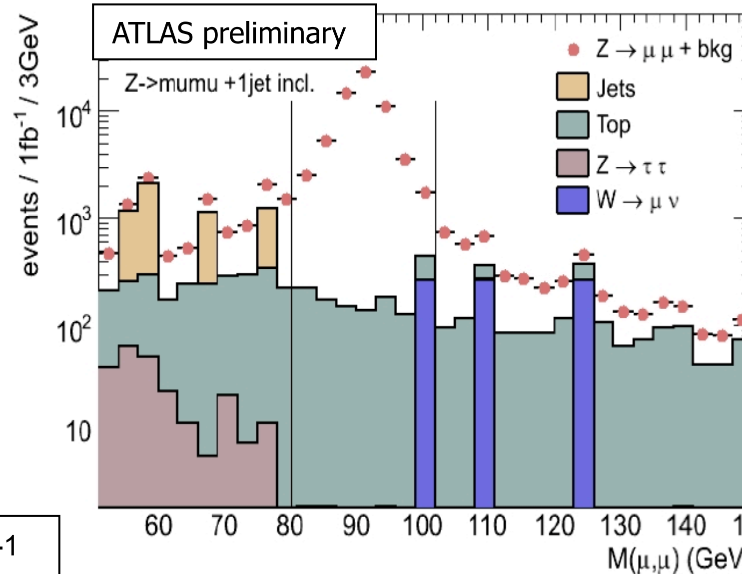
- largest source of systematic error
- initial uncertainty ~ 5-10%

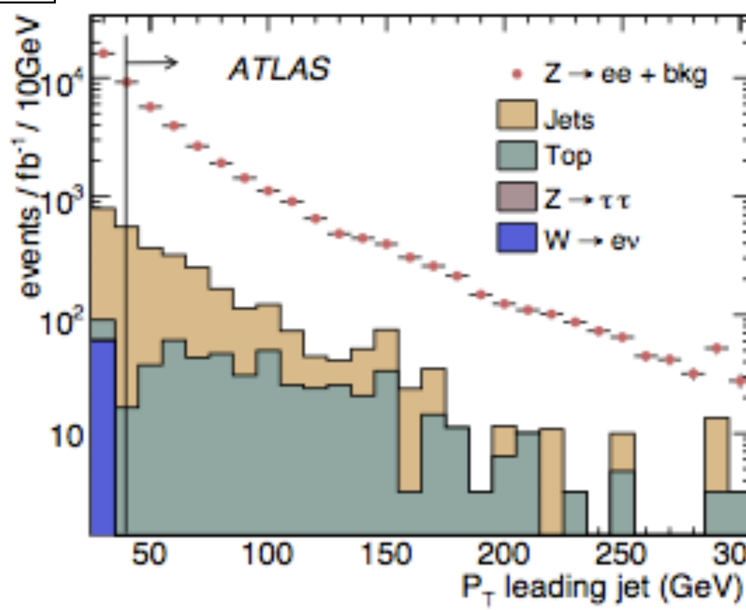
Need to reduce error for QCD test

measure W/Z + jet(s) cross-section

- important background to new physics
- γ/Z+jets calibration signal

$\int Ldt = 1 fb^{-1}$





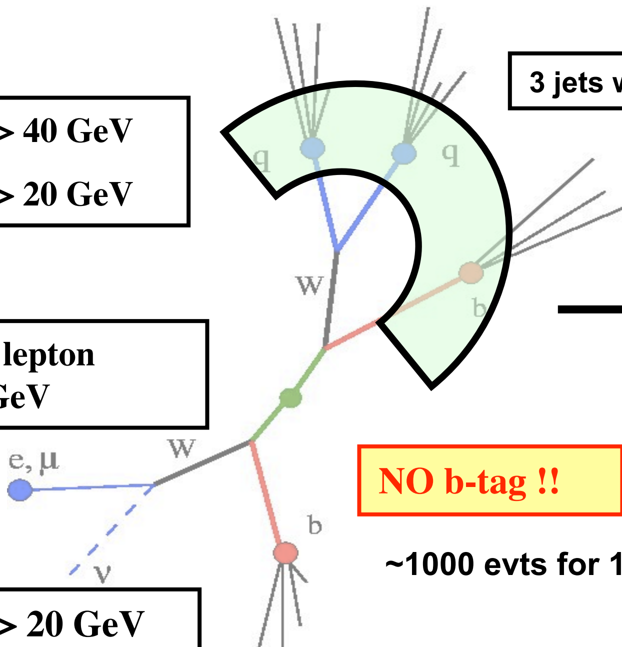
The first top quarks in Europe …

$\sigma_{tt} \approx 250$ pb for tt → bW bW → blν bjj
Note: σ_{tt}(LHC)/σ_{tt}(Tevatron)~100

3 jets p_T> 40 GeV
1 jets p_T> 20 GeV

Isolated lepton
p_T> 20 GeV

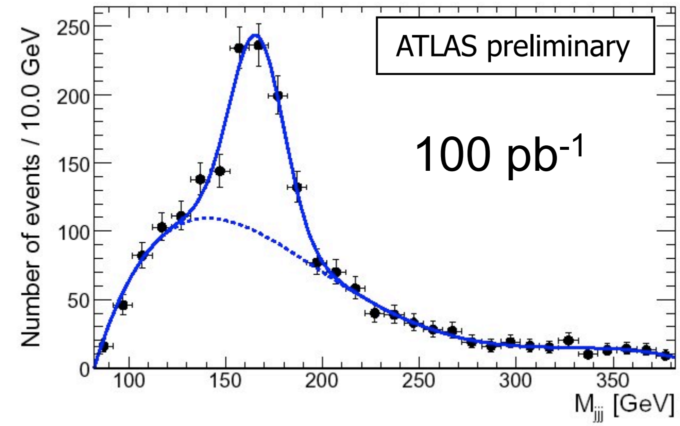
E_T^{miss} > 20 GeV

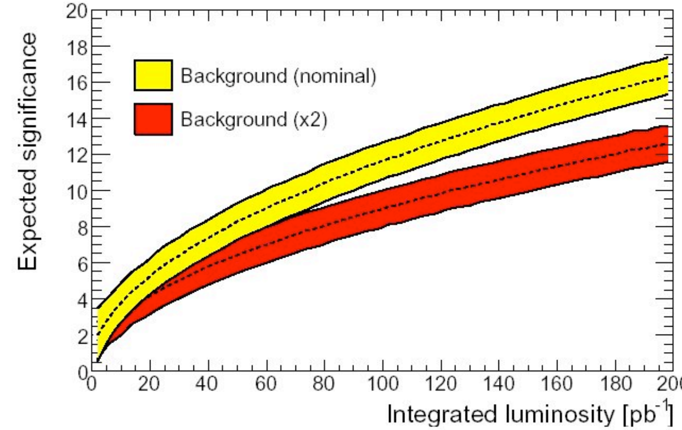


3 jets with largest $\sum p_T$

NO b-tag !!

~1000 evts for 100 pb^{-1}





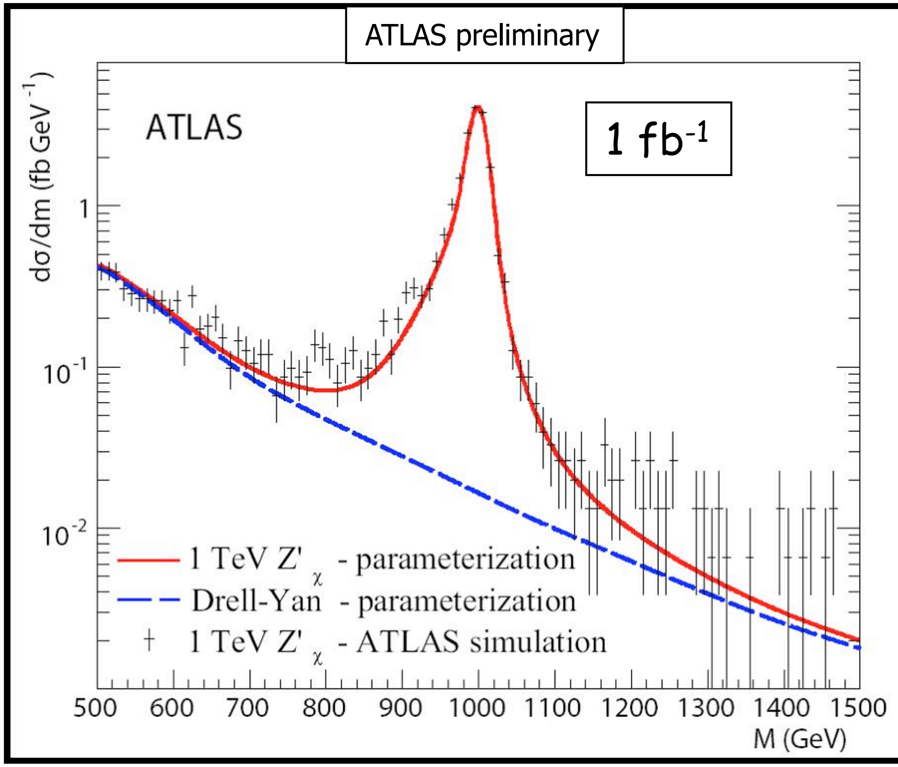
Top signal observable in early days
no b-tagging and simple analysis
~1000 evts for 100 pb^{-1}

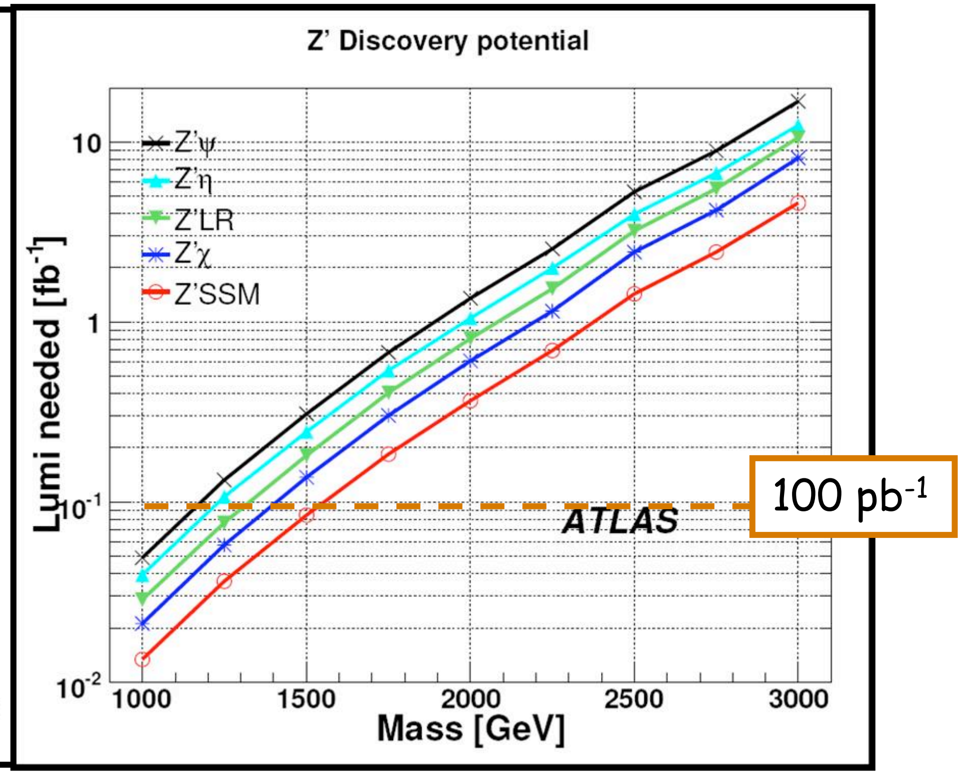
$\Delta\sigma/\sigma$ = 7% (stat) ± 15% (syst) ± 3% (pdf) ± 5%(lumi)

In addition, excellent sample to:
- commission b-tagging, set jet E-scale using W → jj peak, …
- understand / constrain theory and MC ... move-on to precision top physics

Early discovery: a narrow resonance decaying into e^+e^-?

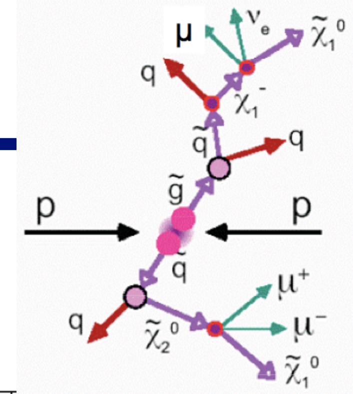
Various models predict heavy resonances decaying to leptons



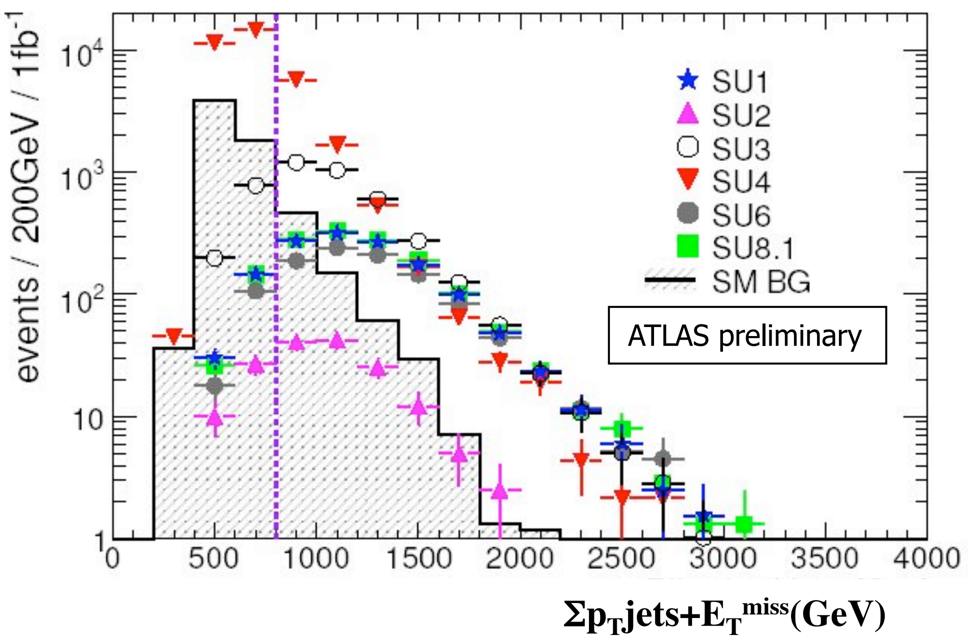


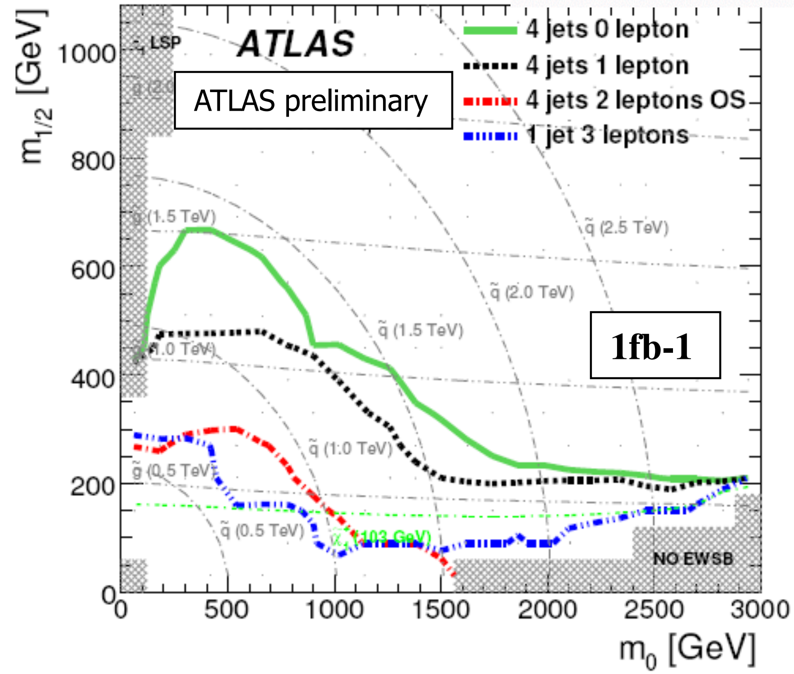
- signal is (narrow) mass peak on top of small Drell-Yan background
- with 100 pb^{-1} large enough signal for discovery up to m ~ 1.5 TeV
  σ(10 TeV) ~ ½ σ(14 TeV)
- ultimate calorimeter performance not needed

SUperSYmmetry: inclusive search



- large (strong) cross-section for $\tilde{q}\tilde{q}, \tilde{g}\tilde{q}, \tilde{g}\tilde{g}$ production
- spectacular signatures (many jets, leptons, missing E_T)





Sensitivity to SUSY beyond the Tevatron with ~100 pb^{-1}

BUT need confidence in detector performance, trigger, reconstruction, object identification

+

understanding of the backgrounds → **needs ∫ luminosity**

SM background from QCD, W/Z, top:

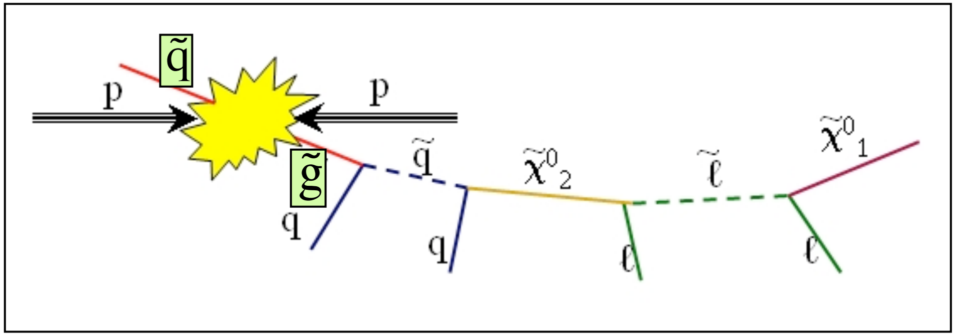
Data driven method, MC tuned to physics & detector performance, replace some reconstructed objects with Monte Carlo generated objects ...

Methods should agree

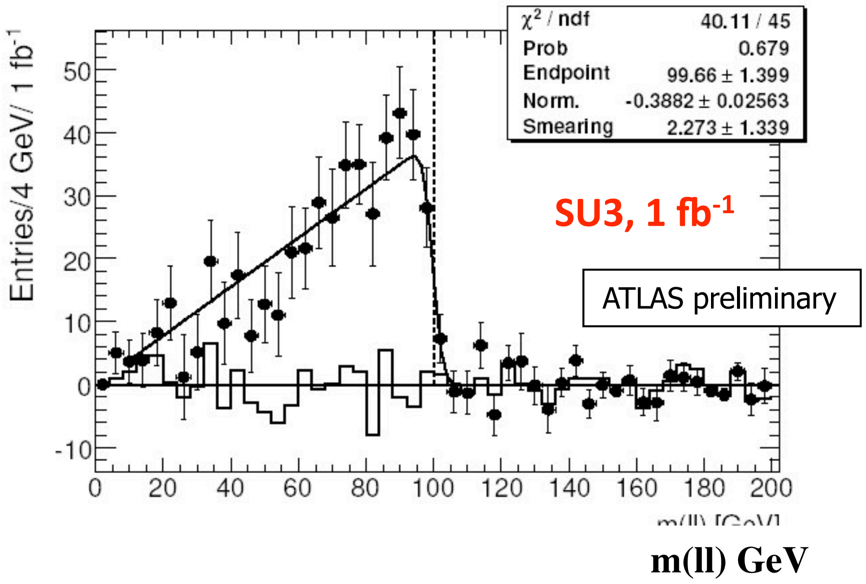
SUperSYmmetry: exclusive search

Exclusive signatures?
Try to select a suitable decay chain:

$$\tilde{q}_L \to \tilde{\chi}_2^0 q (\to \tilde{\ell}^\pm \ell^\mp q) \to \tilde{\chi}_1^0 \ell^+ \ell^- q$$



Measure invariant mass of leptons, leptons+jet, lepton+jet(low), lepton+jet(high)
→ Edges are function of SUSY masses

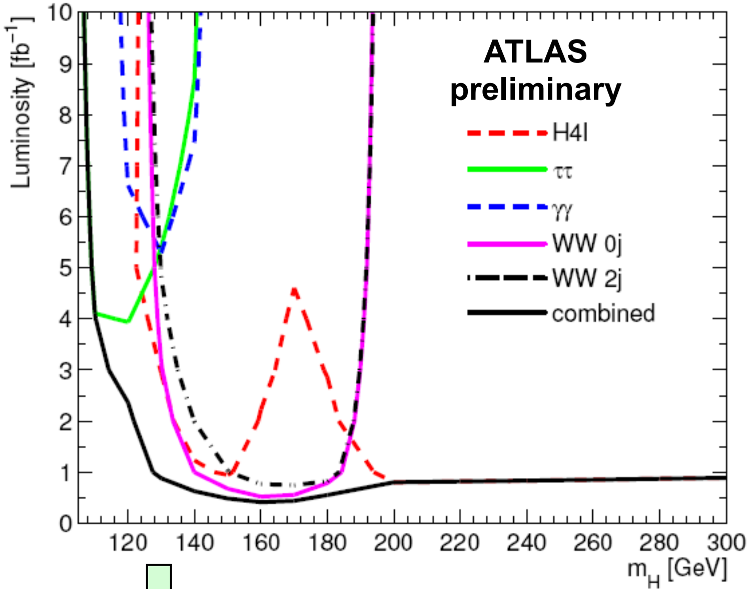


Background estimated with the flavour subtraction method:

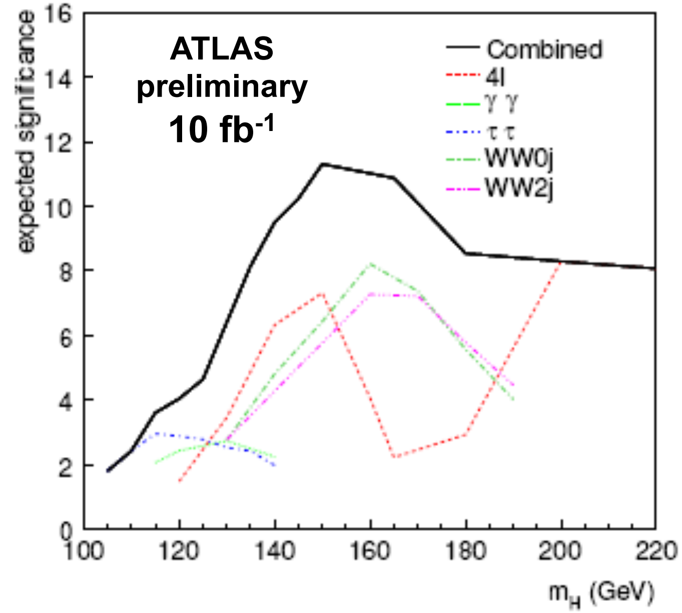
- Signal contains two opposite-sign same-flavour leptons
- Background (both SM and SUSY combinatorial) come from different decay chains and can be of same or different flavour

SM Higgs: a more difficult case

Required luminosity for 95% C.L. exclusion

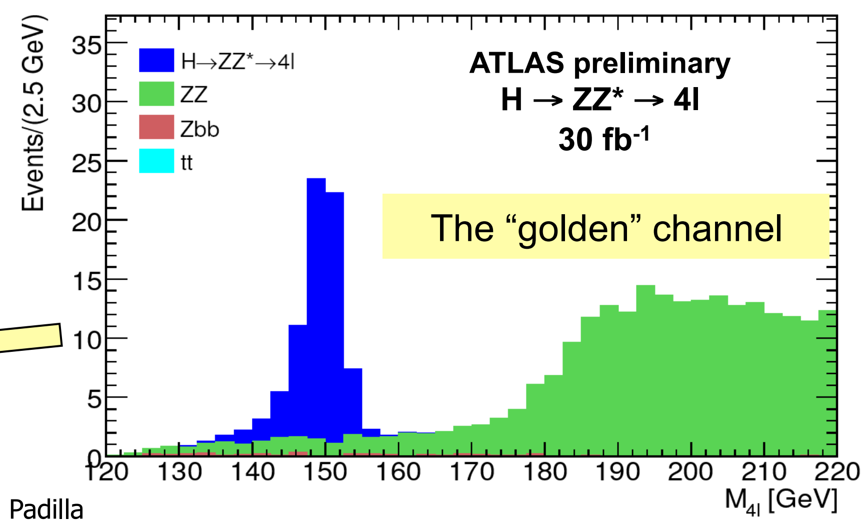


Median discovery significance

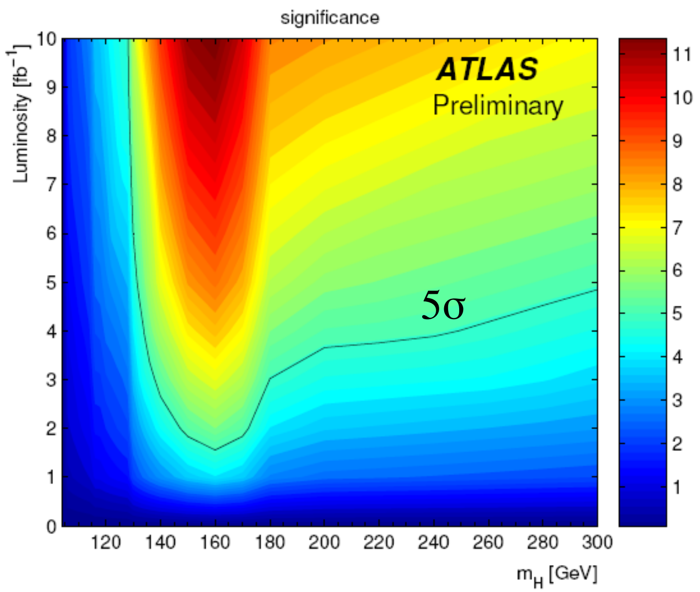


Most difficult region: low mass of ~120 GeV
Need to combine many channels
with small S/B or low statistics
(e.g. H → γγ, H→ττ, H → ZZ* → 4l, → WW →lυlυ)

- Discovery channel for mass> 200 GeV with 10fb^{-1}
- 4l is the most promising in the range 130-160 GeV
- 160-180 GeV H → WW →lυlυ more powerful
  but experimentally more difficult

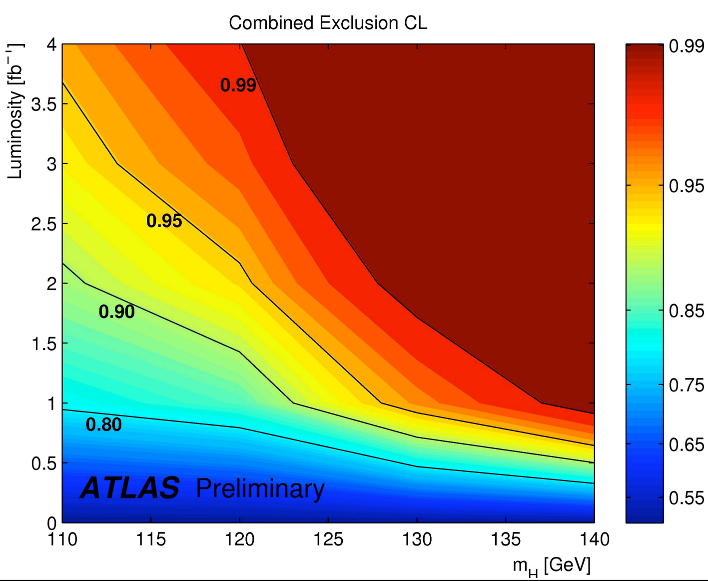


SM Higgs: a more difficult case



For 5σ discovery, one needs

- ~20 fb^{-1} to probe down to m_H=115 GeV
- 10 fb^{-1} for m_H range 127 – 440 GeV
- 3.3 fb^{-1} for m_H range 136 – 190 GeV
- Just under 2 fb^{-1} for $m_H \approx 2m_W$



For 95% CL exclusion, one needs

- 2.8 fb^{-1} for m_H = 115 GeV/c^2
- 2 fb^{-1} for m_H range 121– 460 GeV
- Less than 2 fb^{-1} to exclude $m_H \approx 2m_W$

Summary

- ATLAS is in good shape, and was ready for collisions in September
  - All the sub-detectors were ready to take data, as well as trigger, DAQ, Detector Control and Data Quality systems
  - Several improvements currently being worked out

- Commissioning with cosmics and first beams were and will be useful
  - It was a good exercise to evaluate the level of readiness of the different components and to tune the data taking procedures

- However, collisions are absolutely needed to complete the detector commissioning program
  - The same is true for trigger and off-line algorithms
  - An intense work will be needed next summer, when LHC will restart
  - ATLAS hopes to start soon to study SM processes

and be ready to search for new physics