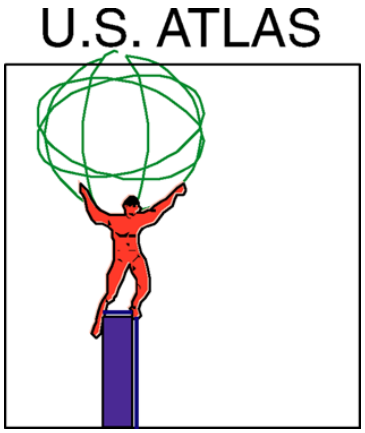
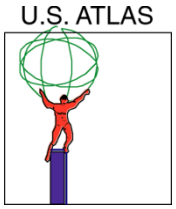


Status of ATLAS

Mike Tuts

Columbia University



Outline

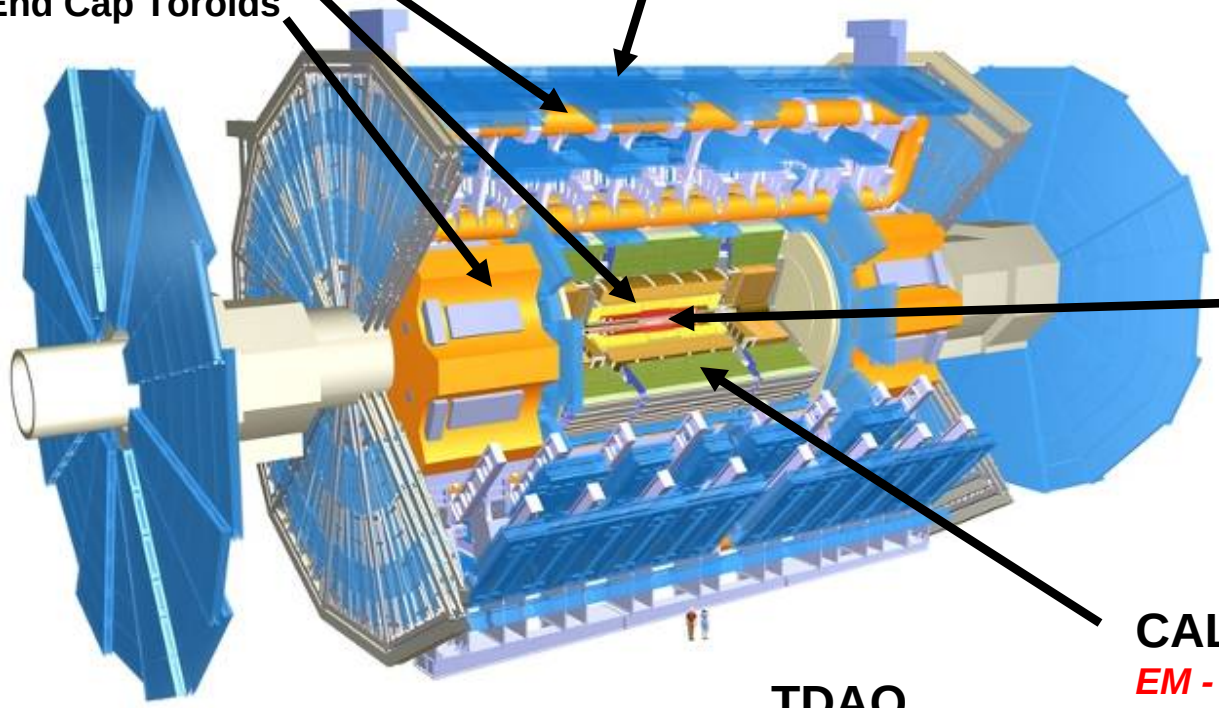
- ATLAS Detector
- Commissioning status
- Computing status
- Physics readiness
  - Cosmic ray running
  - First beam
- Near term shutdown activities
- Future planning - upgrade

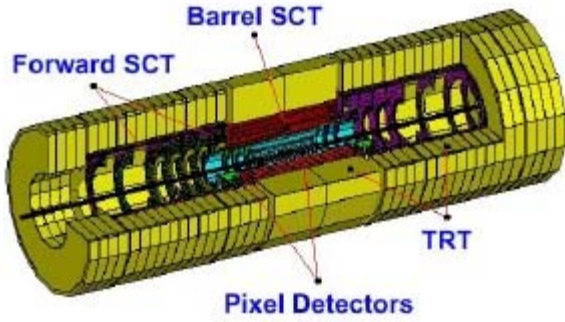
U.S. ATLAS

ATLAS

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

MAGNETS
8 Barrel Toroids
Central Solenoid
End Cap Toroids





INNER DETECTOR (ID)
Pixels
Silicon Strip (SCT)
Transition Radiation Tracker (TRT)

CALORIMETERS
EM - Liquid Argon – Lead
HAD - Scintillator Tile

TDAQ
ROI Builder
High Level Trigger

Diameter 25m
Length 46m
Weight 7,000 tons

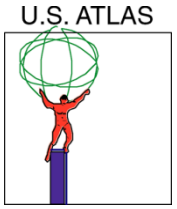
U.S. ATLAS

ATLAS Collaboration

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, *Fresno State*, Geneva, Genoa, Giessen, Glasgow, Göttingen, LPSC Grenoble, Technion Haifa, Hampton, Harvard, Heidelberg, Hiroshima, Hiroshima IT, Indiana, Innsbruck, *Iowa*, 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, *Louisiana Tech*, 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, *NIU*, 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, *South Carolina*, 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

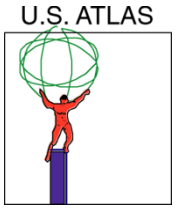
US Snapshot as of Sept 30, 2008

- **43 US institutes are about 21-22% of ATLAS**
  - 5 affiliated institutes (in *italics*)
  - 38/169 voting institutions (22%)
  - 395/1817 "current M&O authors = PhDs" (22%) – for cat A/B
  - 592/2800 M&O authors + in process of qualifying + students (21%)
  - 497.75/2347.25 Operations tasks share (students count .75) (21%)



Recent Timeline

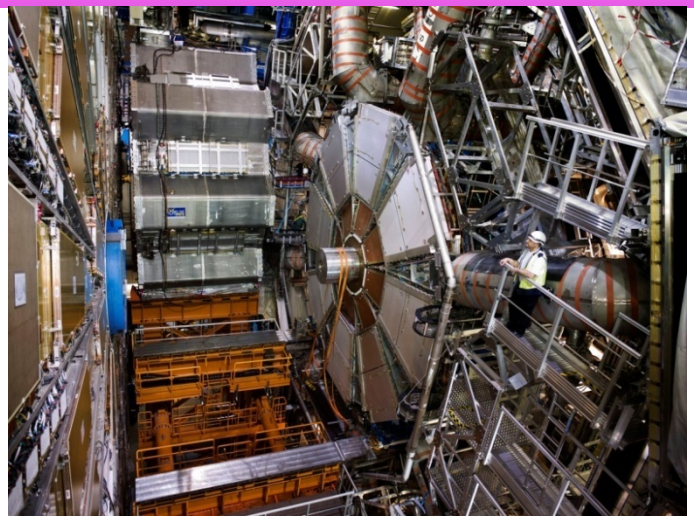
- 2/08 Test of full computing chain ("Full Dress Rehearsal" FDR 1)
- 6/08 Closure of beam pipe
- 7/08 FDR 2
- 9/10/08 First beam!
- 9/18/08 "incident" - impact on plans
- Now – shutdown work underway



Recent Detector Activity

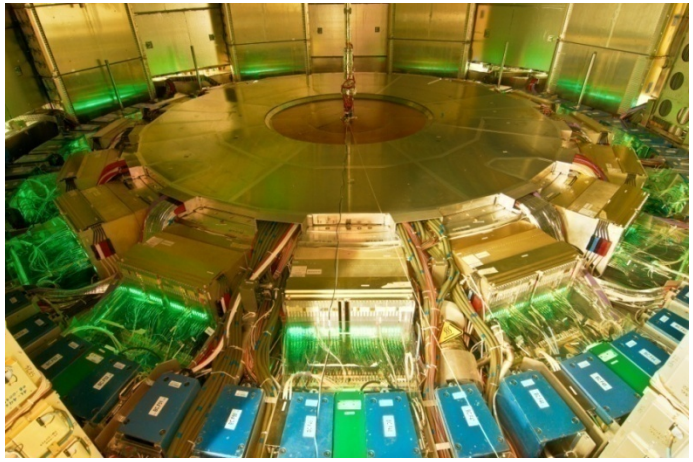
- Overall test of the magnet system (including stability tests)
- Re-installation and debugging of the Inner Detector evaporative cooling plant
- Commissioning of the inner detectors
- Fixing assorted calorimeter problems (low voltage, magnetic shielding,…)
- Completion of the forward muon system (HO wheels, gas systems, debugging, tests)
- Commissioning of the RPC system
- Final installation of luminosity detector (LUCID)
- Buttoning up the detector
- Taking cosmics & first beam – splash events
- Start of shutdown activities

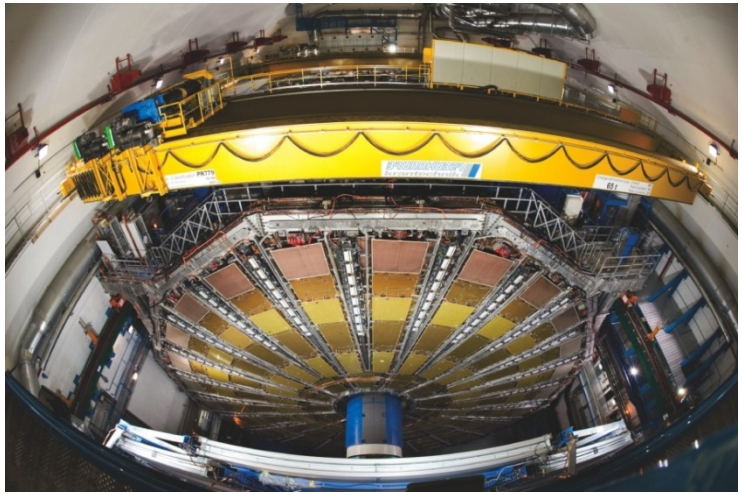
In Pictures



View in April, barrel toroids, small muon wheel, endcap toroid, big muon wheel

16th June closure of beam pipe & insertion of LUCID detector





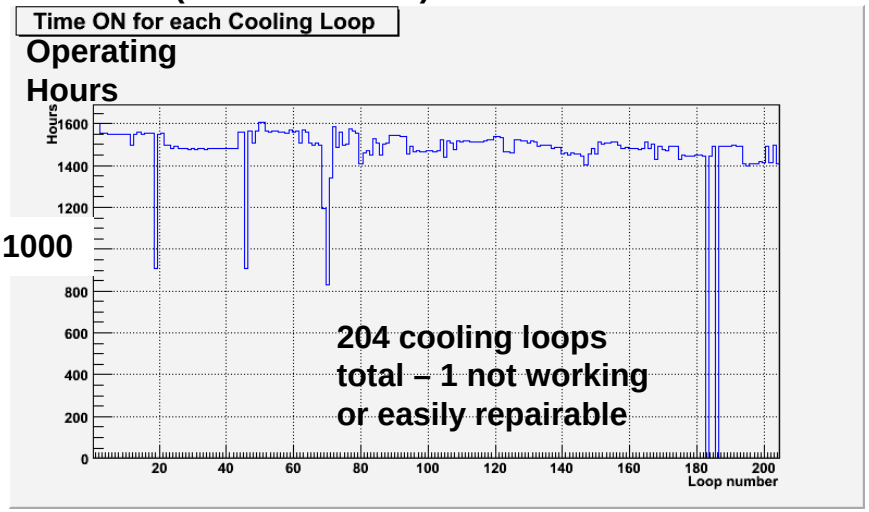
Top view during closure of ATLAS – muon big wheel and crane visible (top) – no incidents or damage!

Performance

- Toroids and end cap toroids now operating stably at 20.4kA (after in situ leak repair)
- On/off ~5 hours

Testing of toriod magnets – reached stable operation at 20.4kA (almost nominal)

- Inner detector evaporative cooling system compressors failed 7 repaired
- Caused delay of ~3 months – so pixels had little commissioning time before close up



Cooling loop operating time vs cooling loop

Operational Status Summary

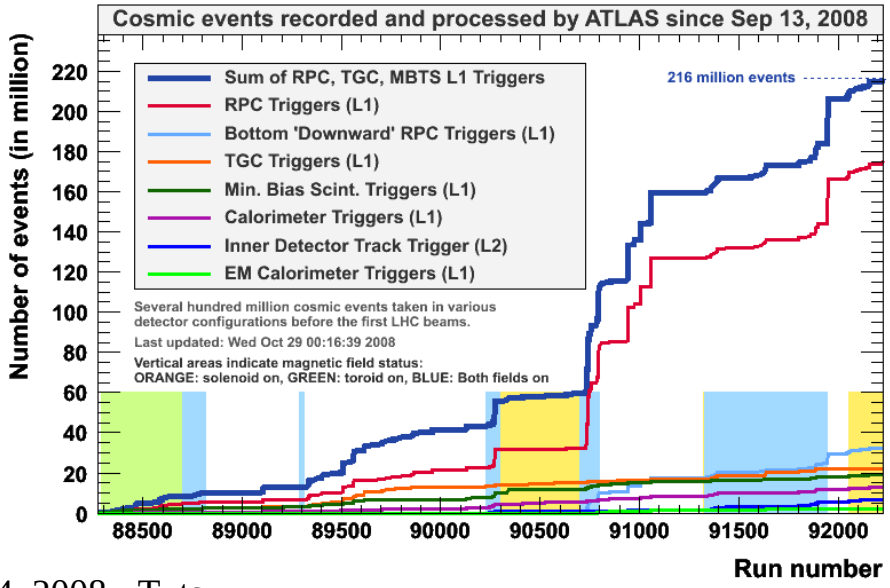
Subsystem	Current Problem /dead Channels	Comments
Si - Pixels	0.8%	Cooling loop leaks keeping 4.3% off till beam
Si - SCT	0.4% (barrel); 2.2% (end cap)	Cooling loop leak (0.3%); heater short (0.6%) could be repaired
TRT	1-2%	
Calorimeter - LAr	<0.1% (EM, HEC); 1.7% (EC)	~1% currently bad readout channels – repair during shutdown
Calorimeter - Tile	1.4%	2 LVPS + isolated channels in digitizers, HV, timing errors etc
Muon – MDT Barrel/Endcap	1.7%	HV, readout, gas – goal to reduce to ~0.2%
Muon – CSC	1.6%	ROD readout remains an issue
Muon RPC/TGC	10.4%/0.2%	RPC still commissioning; noise, HV

Trigger and DAQ

- Level 1 system fully installed
  - Much done with cosmics and splash events
  - Need colliding beams for some aspects
- L2 & High Level Trigger
  - ~35% of system installed (850 PC x 8 core)
  - 100kHz -> 200 Hz
- >200M cosmics recorded since mid-Sept
- Secure remote monitoring developed
  - Using remote partition decoupled from network in ATLAS control room

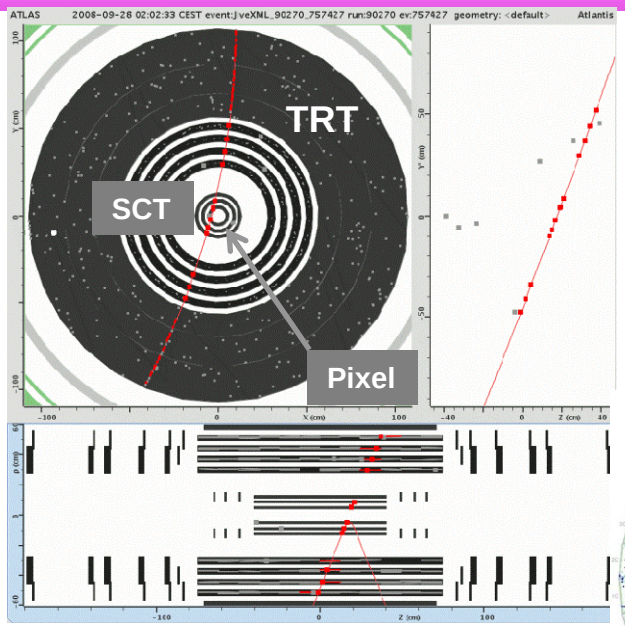
HLT & L2 PC racks (~35% of total)

L1 Racks



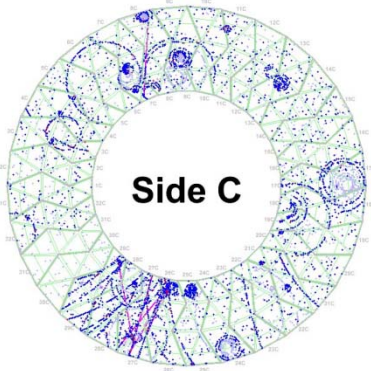
Commissioning with Cosmics Inner Detector

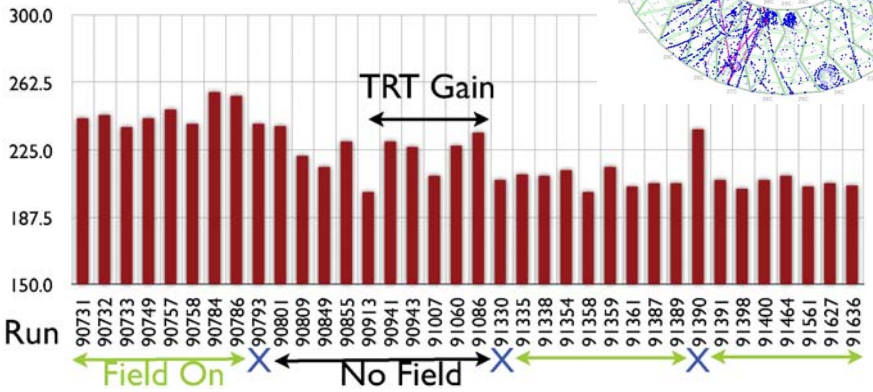
- **Inner detector (Pixels, SCT, TRT)**
  - **Integrated in readout**
  - **Noise performance is good**
  - **TRT fully operational**
    - **Now running final Xe gas**



Cosmic track through TRT, SCT & Pixels (B = 2T)

Cosmic in TRT (with $Ar/CO_2/O_2$)

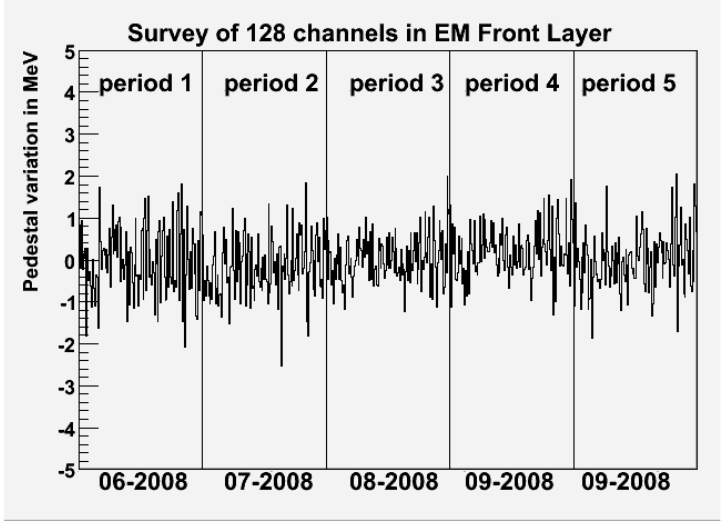


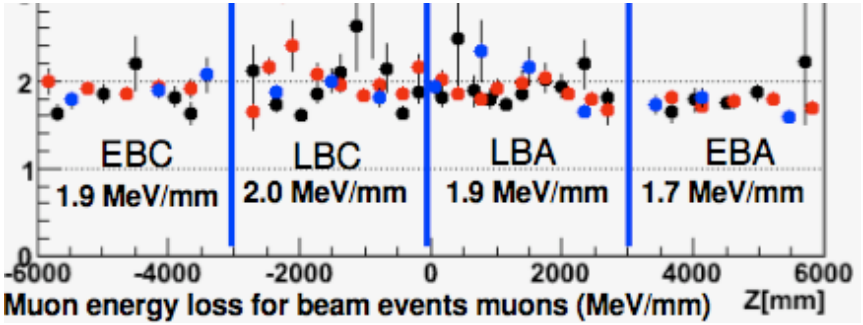


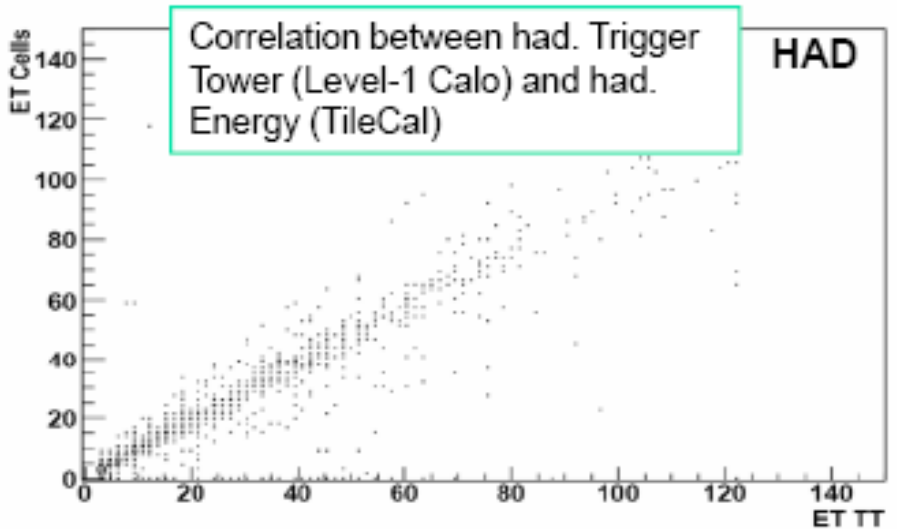
Residuals show excellent performance and monitoring capabilities (~real time)

Commissioning with Cosmics Calorimeters

- LAr calorimeters operational for 3 years
  - ~All channels operating
  - Problem of LVPS in B field solved with shielding
- Tile Calorimeter also operational for years
  - ~All channels operating
  - Refurbishments complete

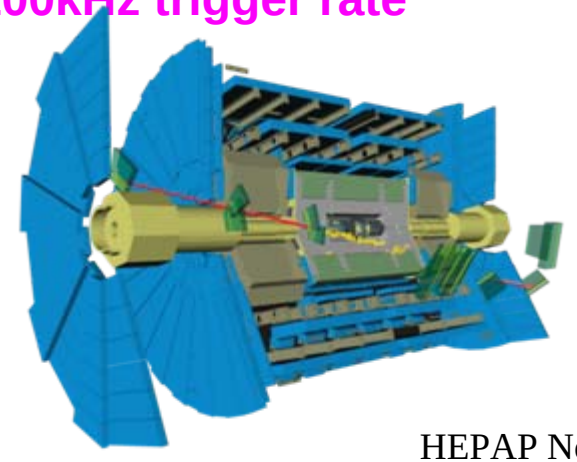




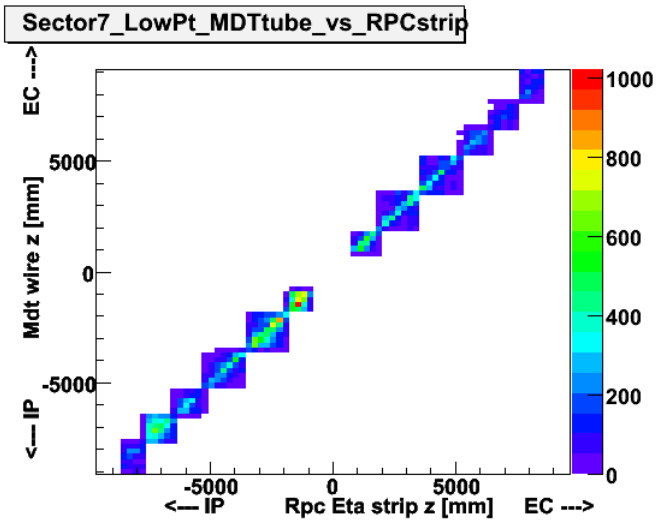


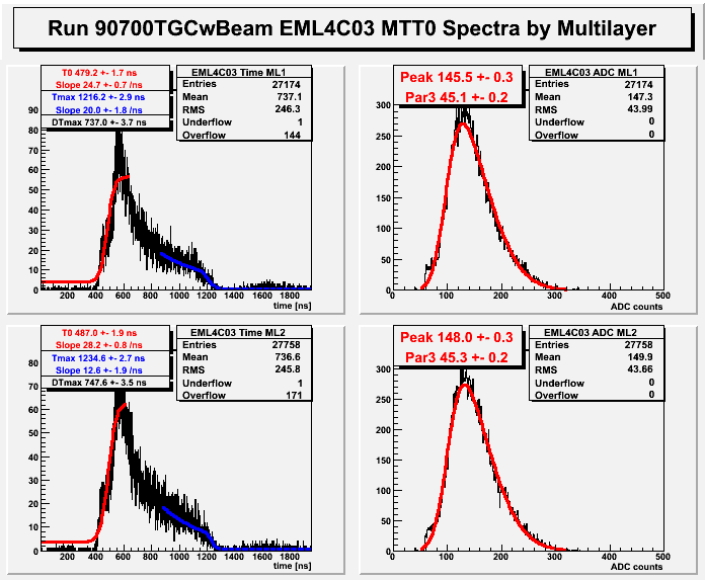
Commissioning with Cosmics Muon System

- All Muon chambers installed and used in global runs
  - Cathode Strip Chamber Read Out Drivers still being debugged
  - Noise under control
  - Excellent timing for RPC and TGC triggers achieved
  - Trigger system stable at 100kHz trigger rate



Cosmic ray in endcap muon system





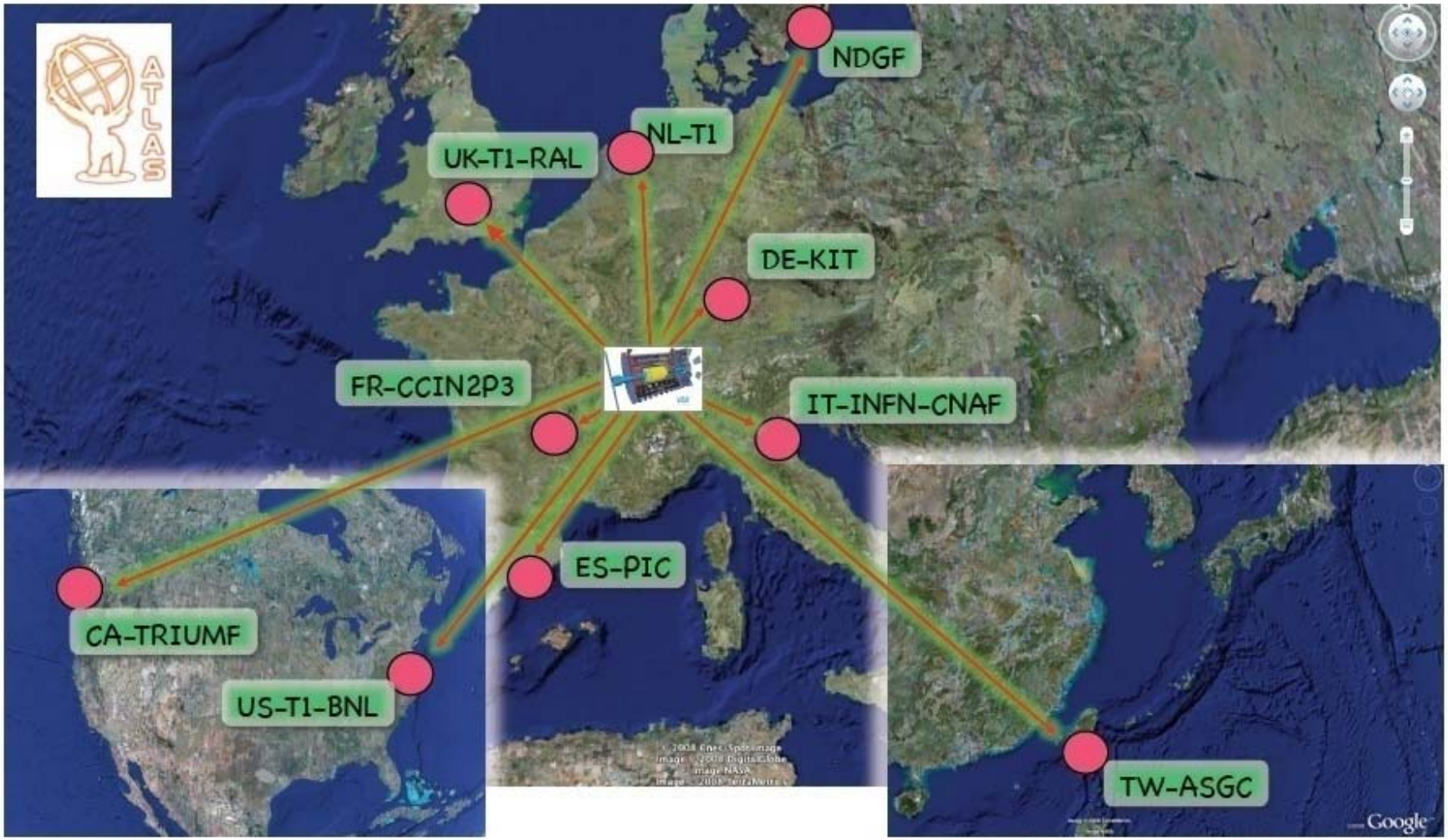
U.S. ATLAS

Recent Computing Activities

- Work focused on preparing for data taking
  - Full dress Rehearsals (FDR1, 2) test end to end performance
- Optimizing software performance
  - To meet Computing Model targets for CPU, memory, disk
  - FDR2A -> FRD2C improved CPU use efficiency by ~ x2 (ok for 2009, but need eventual further x2 improvement)
- Event store and data management
  - Successful support for many hundreds of Terabytes of cosmic + single beam data
  - Growing demand for access to detector data; scalability ok now, but may require future work
  - US developed tagged database used for event-level selection
- Production and Distributed analysis (PanDA)
  - Rolled out ATLAS wide (initially US product)
  - So far handling 500k jobs/week with headroom to spare
  - Lots of operations driven development

U.S. ATLAS

Tier 1 Centers



2009 Computing Need Planning Assumptions

- **Cosmics: full detector cosmic ray run completed, but individual subsystem runs continue**
  - **960TB until ~April 09 (current LHC schedule), kept through 2009**
  - **Increased MC simulation data in light of no collision data – two passes of 25M (full simulation) + 160M (fast simulation)**
- **Collision data: 8M seconds of LHC data taking**
  - **Increased from 6M according to Computing scrutiny group**
- **User Analysis: reduced until collisions start**
  - **N-tuple analysis reduced to 50% of previous**
  - **Reco based analysis to 20% of previous**
  - **Doubled simulation**

2009 Requests

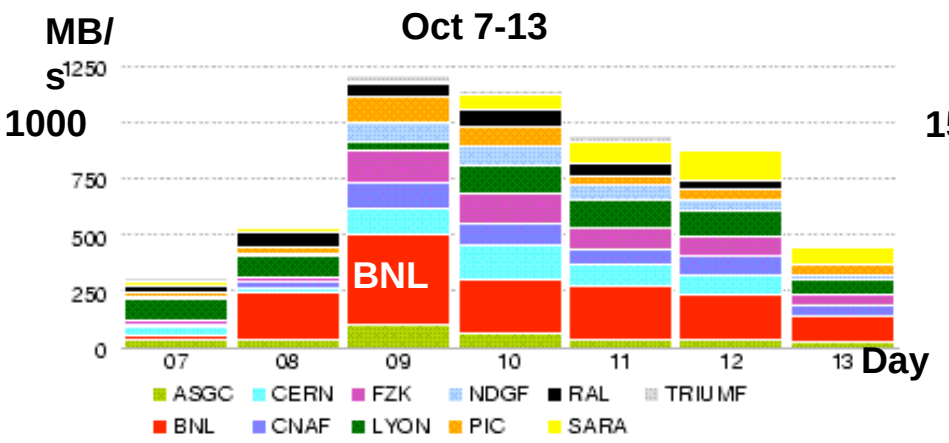
- **ATLAS 2009 computing requests for Tier 1 and Tier 2 resources is unchanged from the 2007 estimate (even with current LHC delay)**

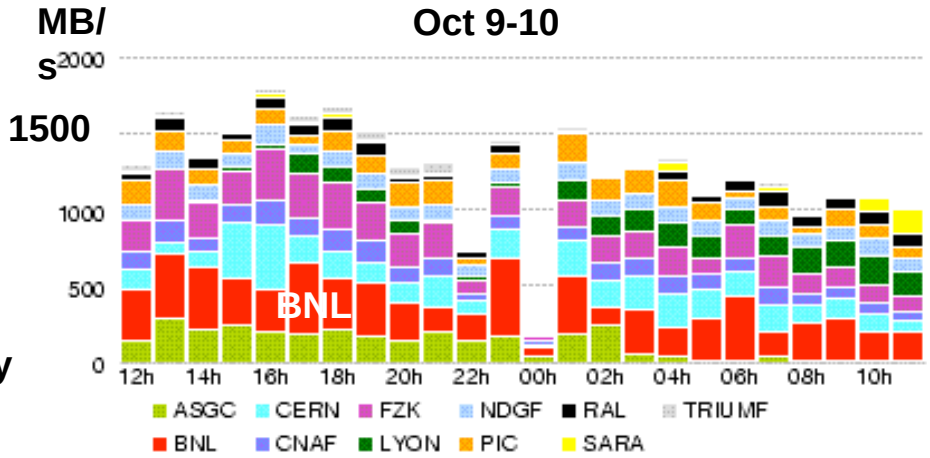
	CPU (MSI2k)	Disk (PB)	Tape (PB)
Tier 0	7.6	0.7	8.6
CAF	5.8	3.3	1.1
Total CERN	13.4	4.0	9.7
Sum of T1	28.4	20.9	15.8
Sum of T2	27.0	13.3	-

- **US ATLAS is ~23% of the total**

	CPU (MSI2k)	Disk (PB)
US Pledge	7.3	5.8
US Installed	5.0 + 2.0 (in process)	2.1 + 2.0 (in process)

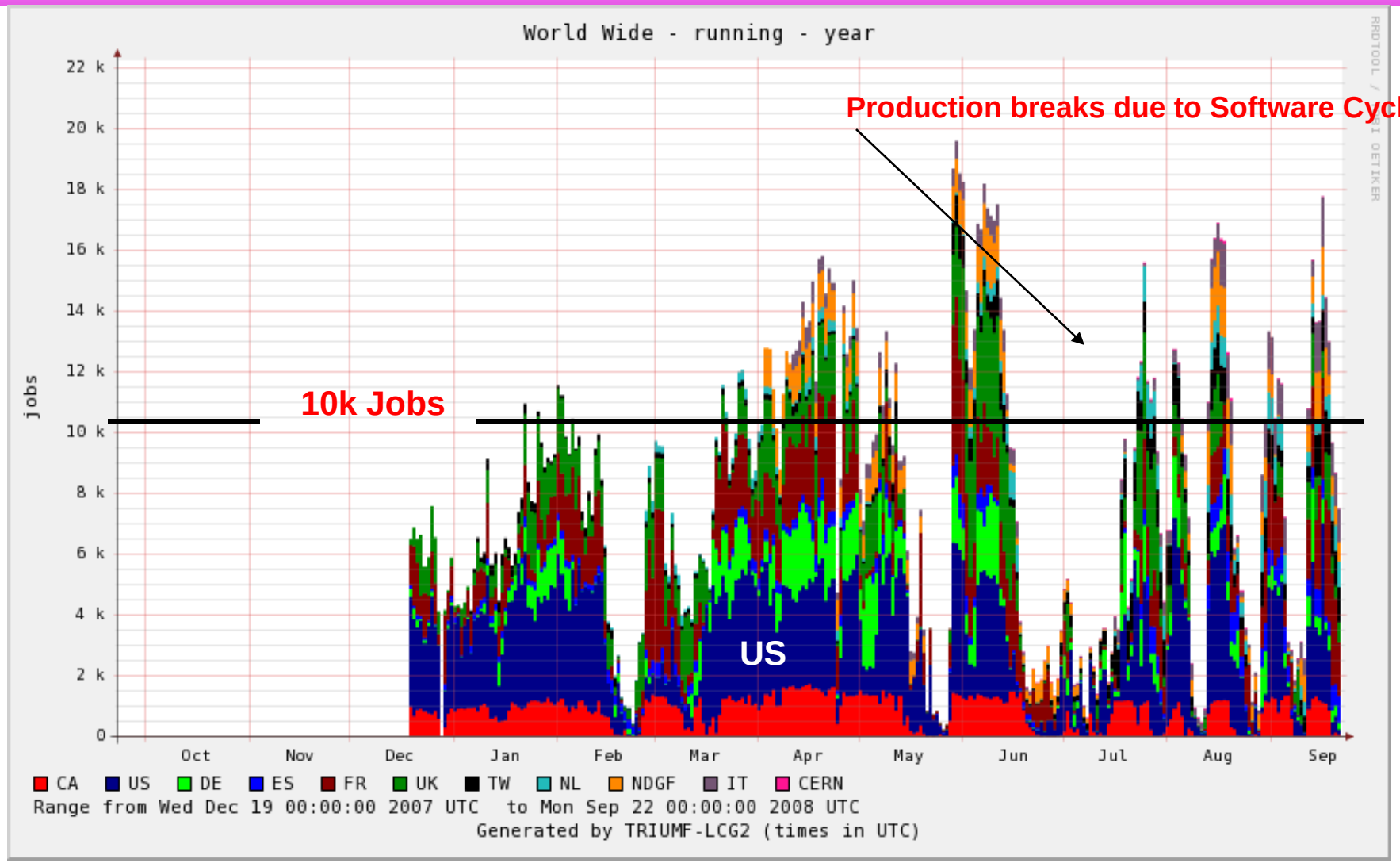
ATLAS Data Export





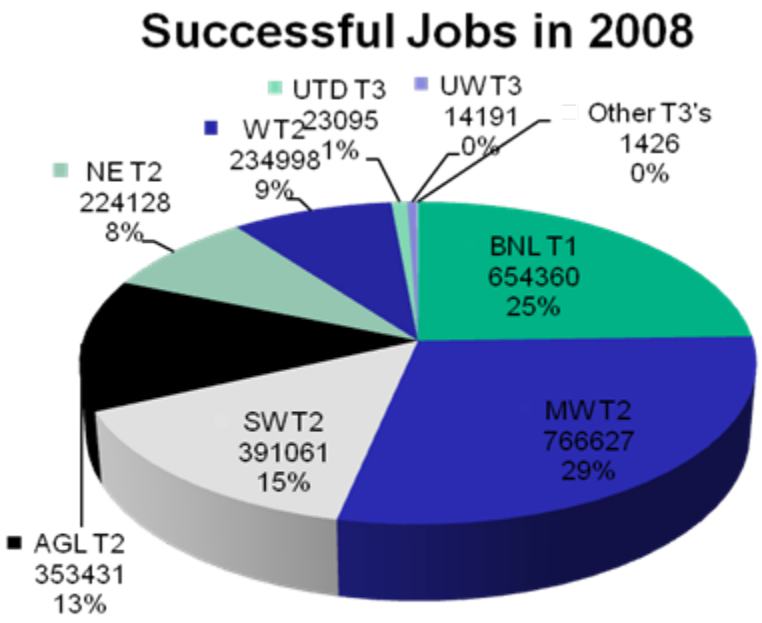
- **ATLAS exports all RAW and processed data from Tier-0 to Tier-1 and Tier-2 centers according to the Computing Model. The system can sustain the required rate of 1.2 GB/s .**
- **Data distribution patterns are periodically revised as data types (triggers) and processing needs change**
  - **US ATLAS T1 (BNL) has demonstrated sustained data rates >500MB/s**

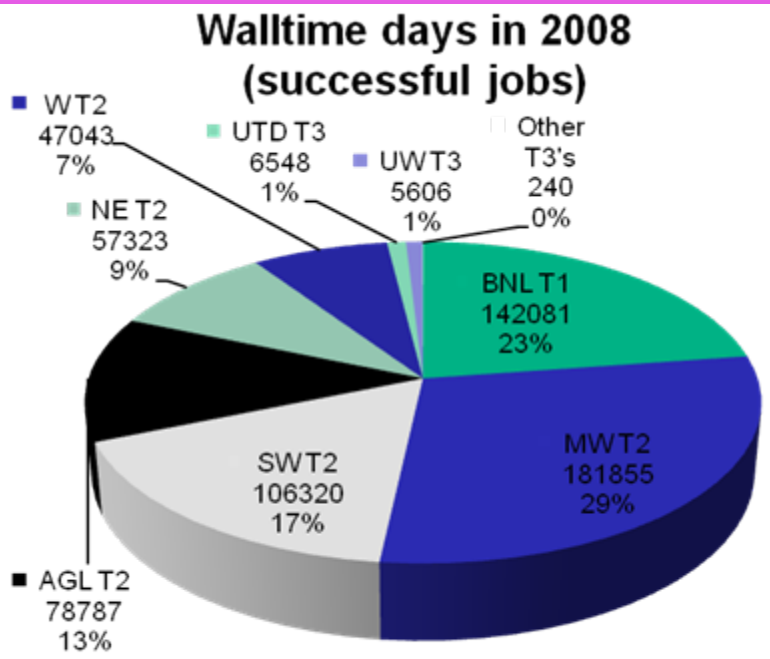
Production - 2008

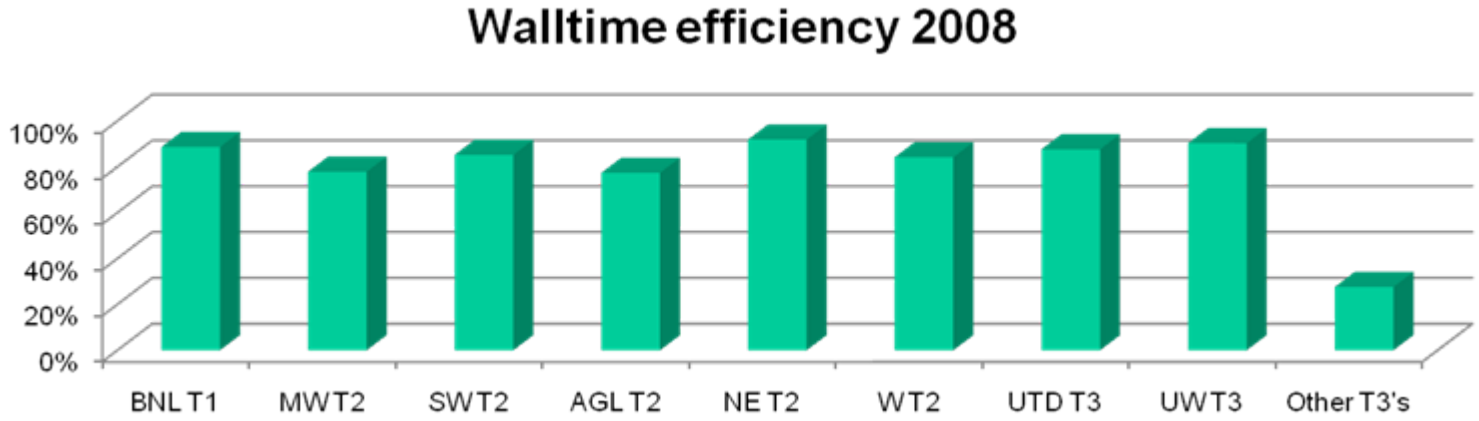


U.S. ATLAS

US Production - 2008

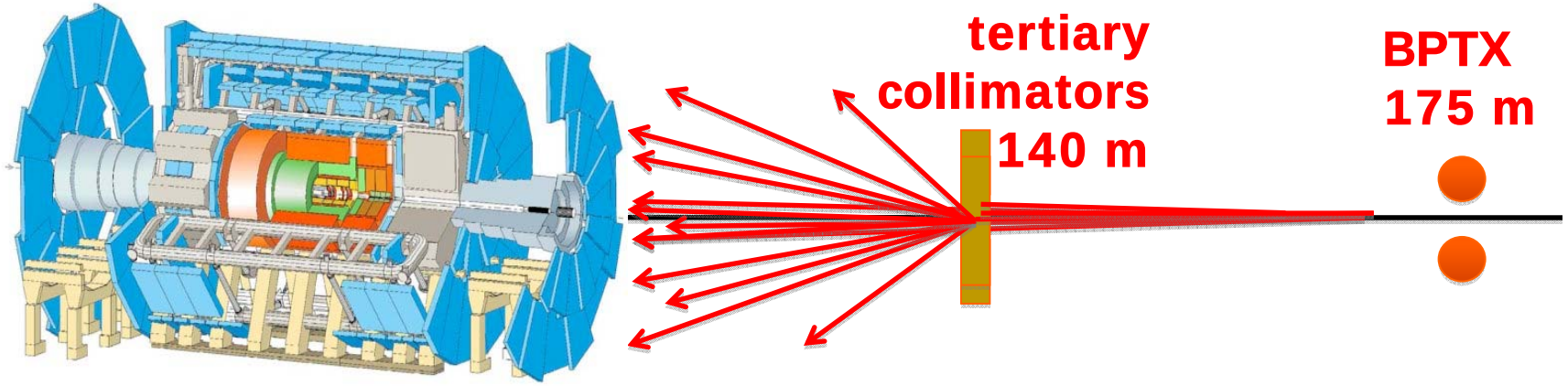






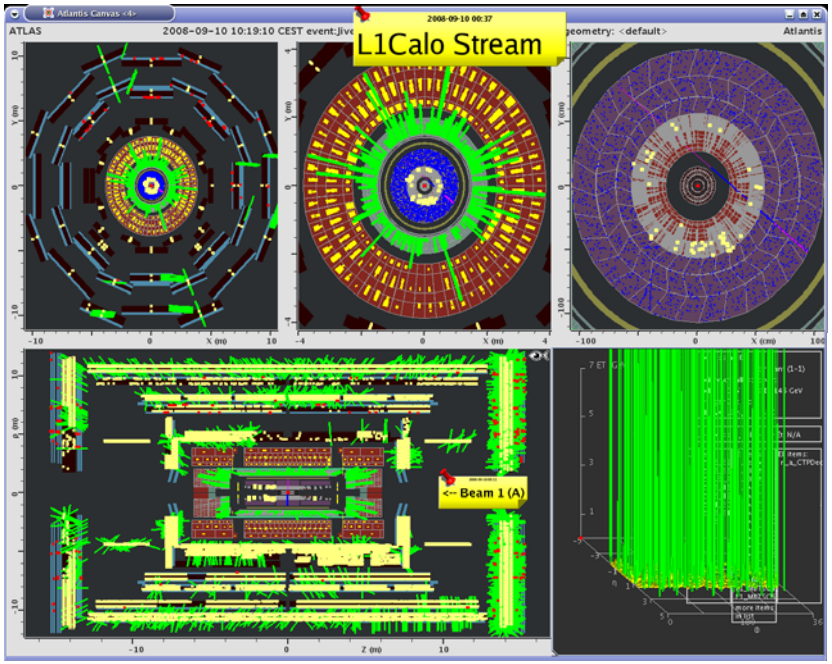
Commissioning with First Beam

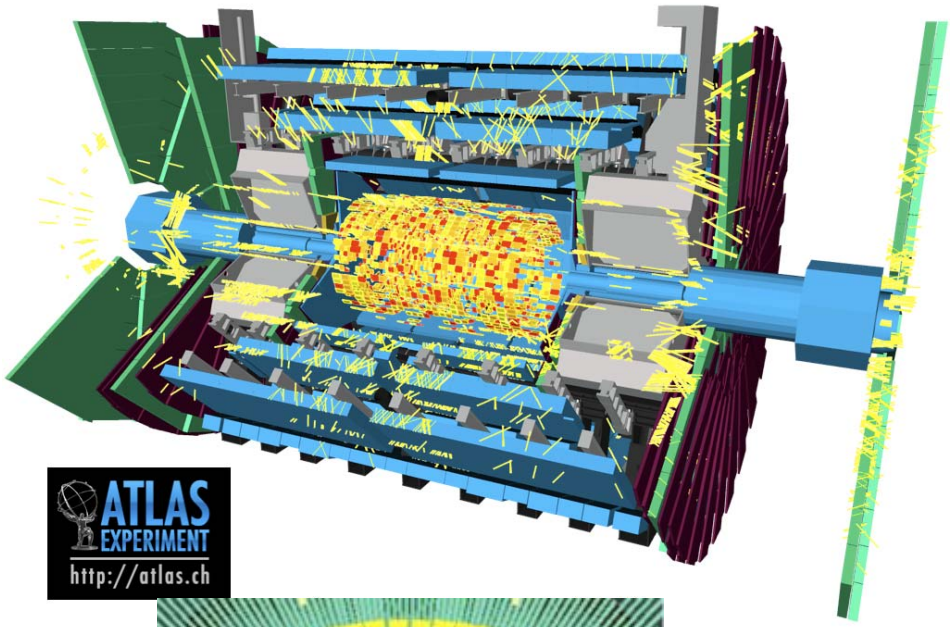
- 10:19am September 10, 2008 first beams observed in ATLAS
- Synchronization worked on first try!
- Muon system (MDT,RPC,TGC) on reduced HV; Lar (-FCAL HV) on; TRT on; SCT reduced HV; Pixel off; BCM/LUCID/MinBias Scint/Beam pickup; L1; DAQ; HLT used for streaming
- "Splash" events recorded

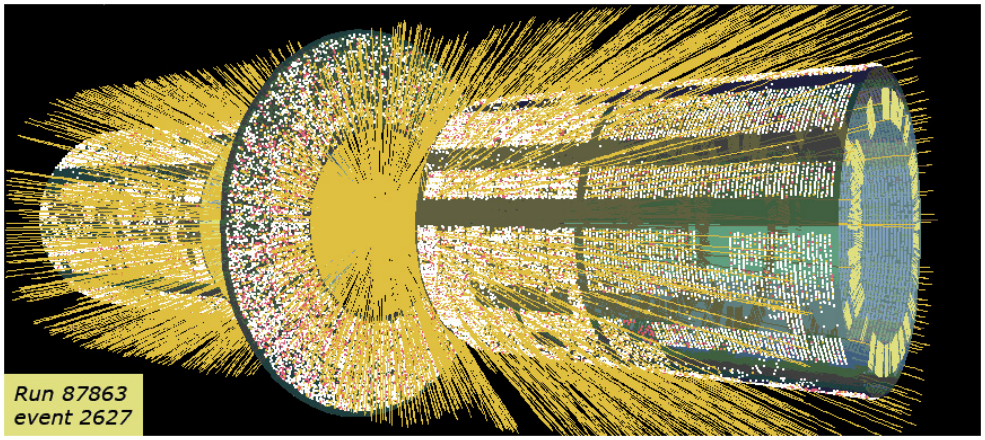


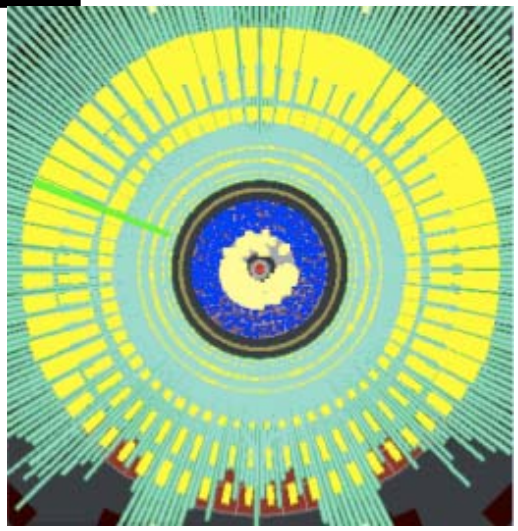
U.S. ATLAS

First Beam "Splash" Event



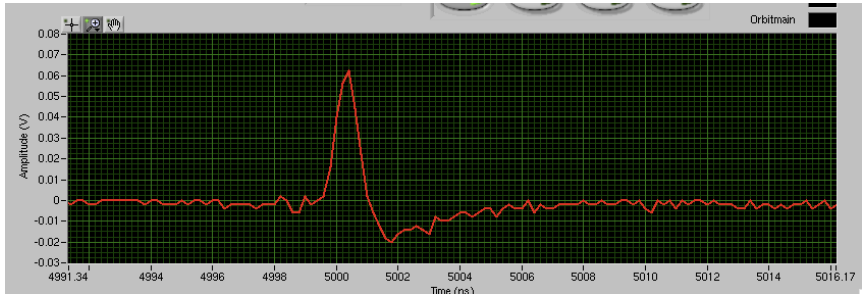




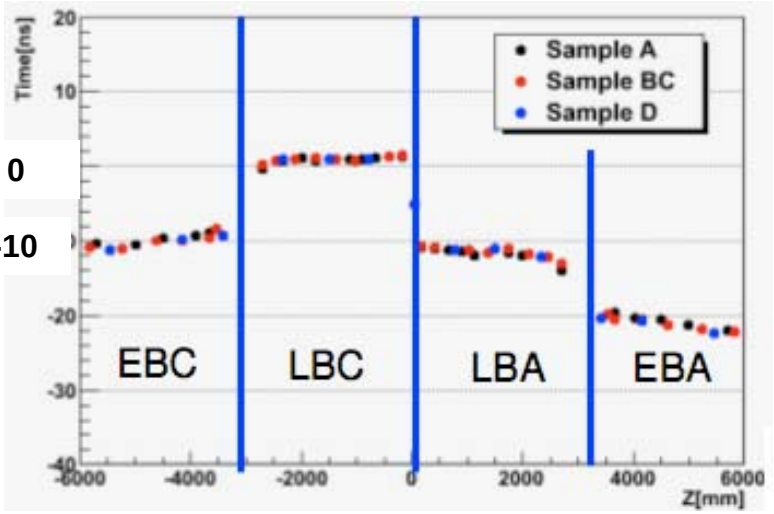


First Beam Commissioning

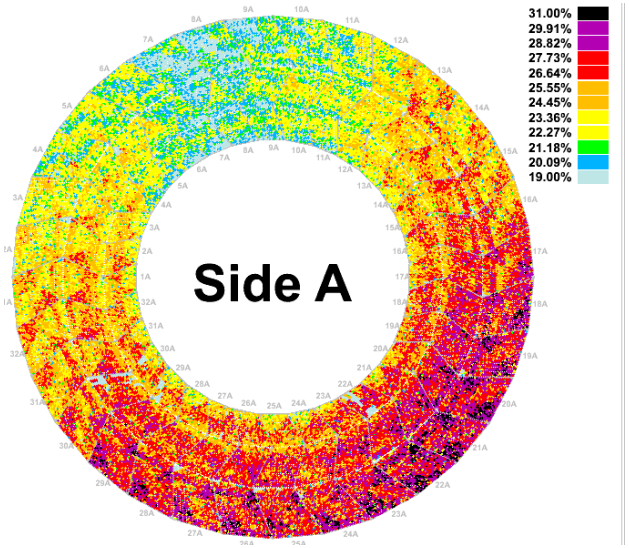
- **The beam events were used for determining timing**



Beam pickup monitor provides reference timing for other detectors



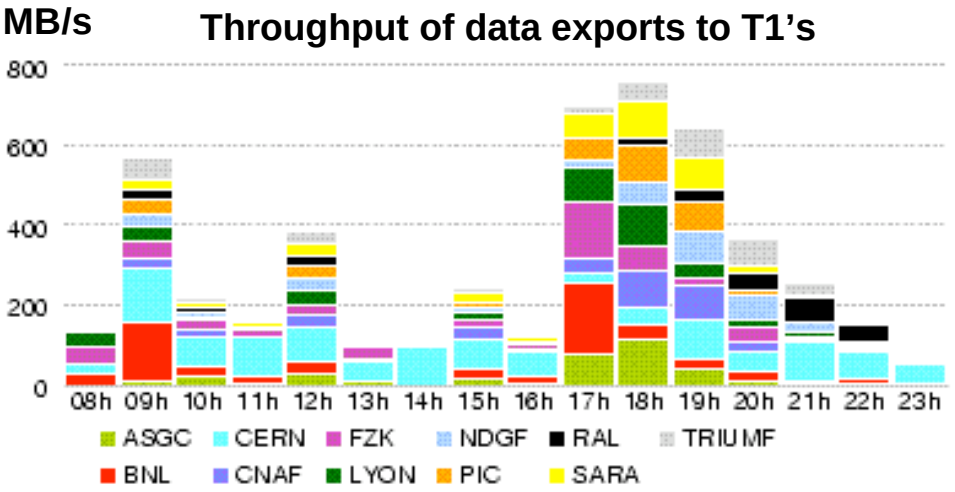
Tile Calorimeter: relative response within the different barrels, after time of flight corrections and using beam splash events. The precision is at the ns level with a single barrel.

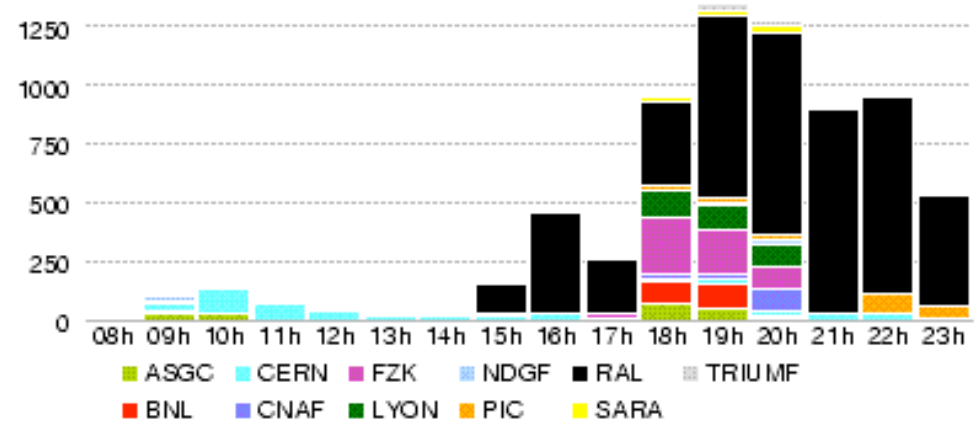


TRT: Colors represent differences in time of flight for "splash" events (8ns). The precision is ~1ns.

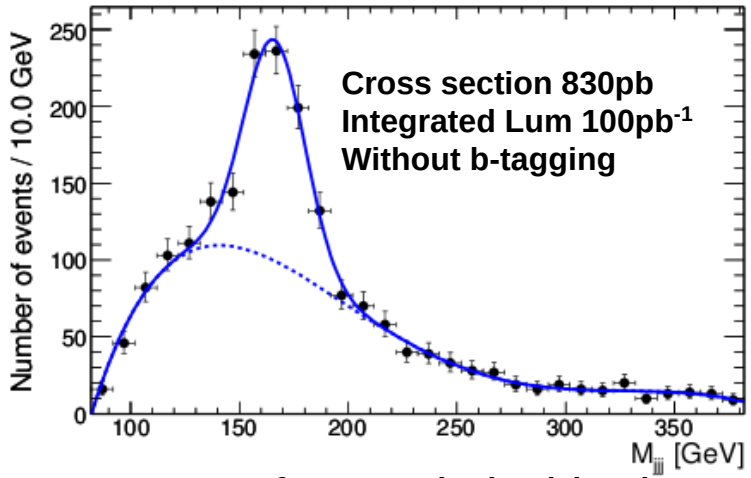
First Beam Computing

- **Effect of concurrent data access from centralized transfers and user activity**
  - **Overload of disk server**

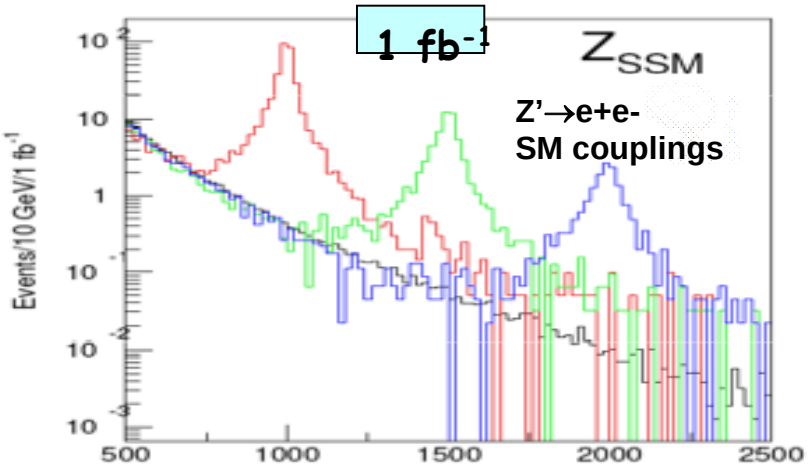




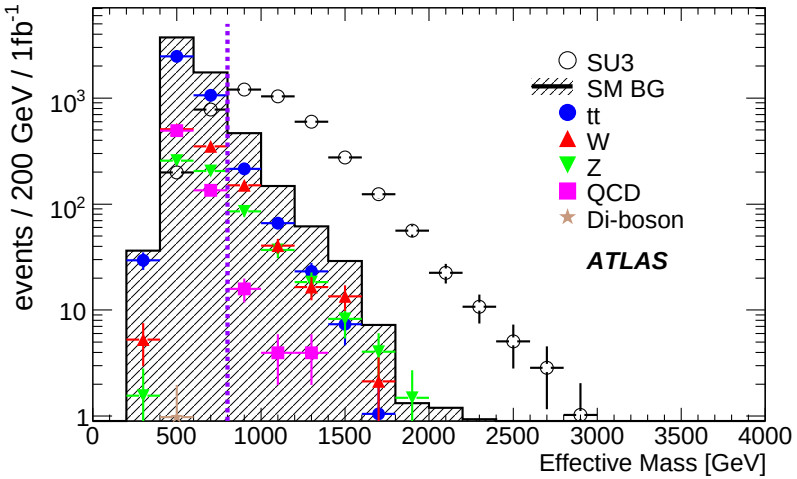
Soon to be real data…



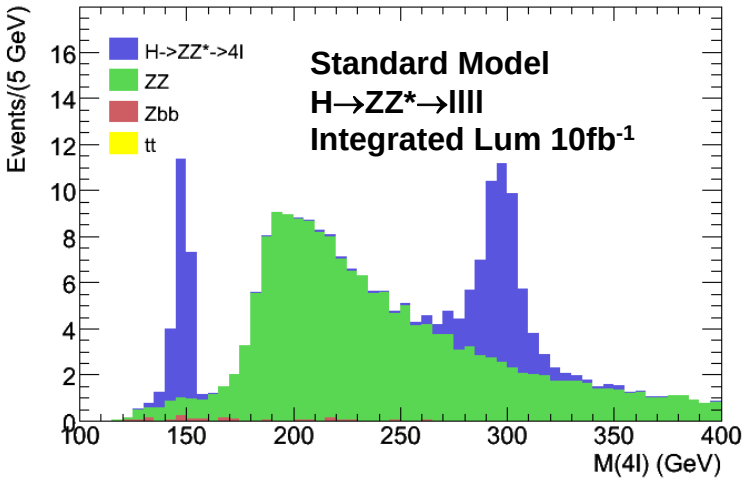
Top events from tt→WbWb→ lνb qqb



m(ll) GeV

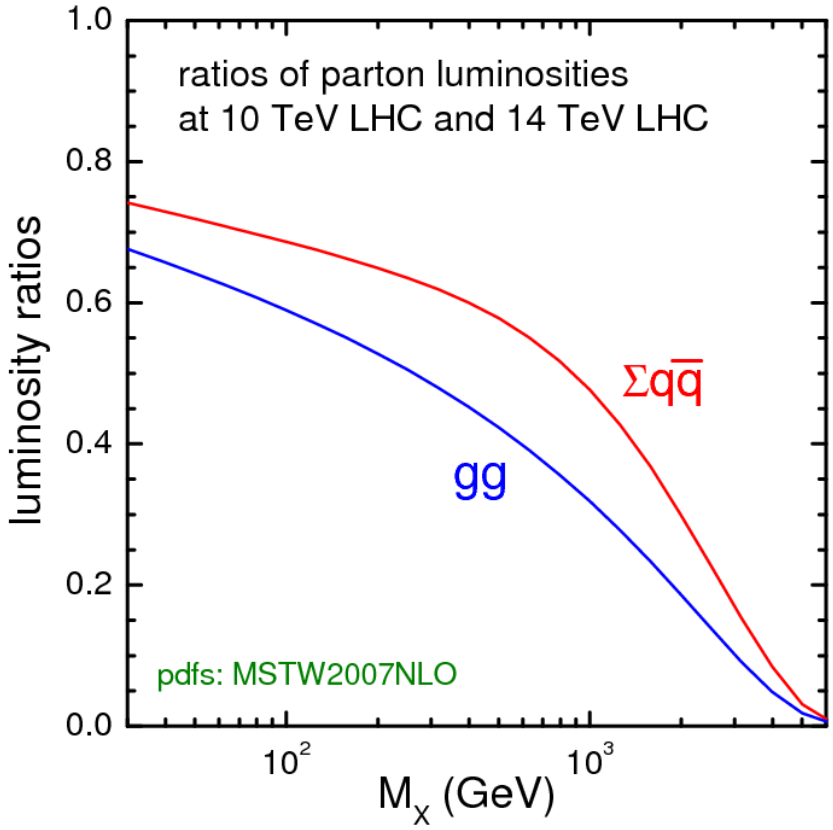


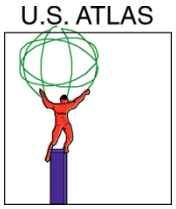
SUSY observed as SM excess – could be early



5+5 TeV vs 7+7TeV

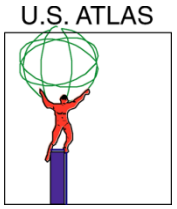
- It is likely that the initial collision data will be at 10 TeV rather than the full luminosity of 14 TeV
- Impact
  - Factors of 2 lower cross sections at few hundred GeV scales
  - More dramatic loss at TeV scales





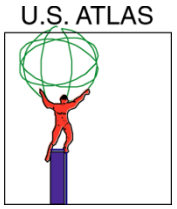
US ATLAS Operations Program Budget

USATLAS Operations Program Budgets (AY k$s)							
			FY09		FY10	FY11	FY12
	WBS	Task	Amount	Amount			
	2.0	Computing	18,319	18,319	20,368	21,482	22,189
Allocations	3.0	M&O	14,726	14,726	10,610	10,997	11,325
	4.0	R&D	3,597	3,597	3,228	3,155	3,155
		Total USATLAS	36,641	36,641	34,206	35,635	36,669
			Full Guidance	CR			
		DOE	25,200	24,354	27,206	28,159	29,144
Guidance		NSF	9,000	9,000	9,000	9,000	9,000
		Un-obligated + Carryover	4,134	4,134	-	-	-
		Total	38,334	37,488	36,206	37,159	38,144
Manage			1,693	847	2,000	1,524	1,475



08/09 Shutdown Plans

- **Last few weeks finalizing plans on**
  - **Commissioning completion activities**
  - **Start yearly maintenance**
  - **Readiness for beam resumption**
- **Specific activities**
  - **Fix electronics\LV problems in calorimeters**
  - **ID cooling & gas: fix cooling loops, distribution racks, optical readout problems**
  - **Muon small wheel chambers: especially replace damaged TGC's**
  - **Fix gas leaks in MDT & RPC systems**
  - **Replace muon MDT wheels readout fibers with rad hard**
  - **Assorted maintenance on all systems**
  - **Preserve access controls during this period**

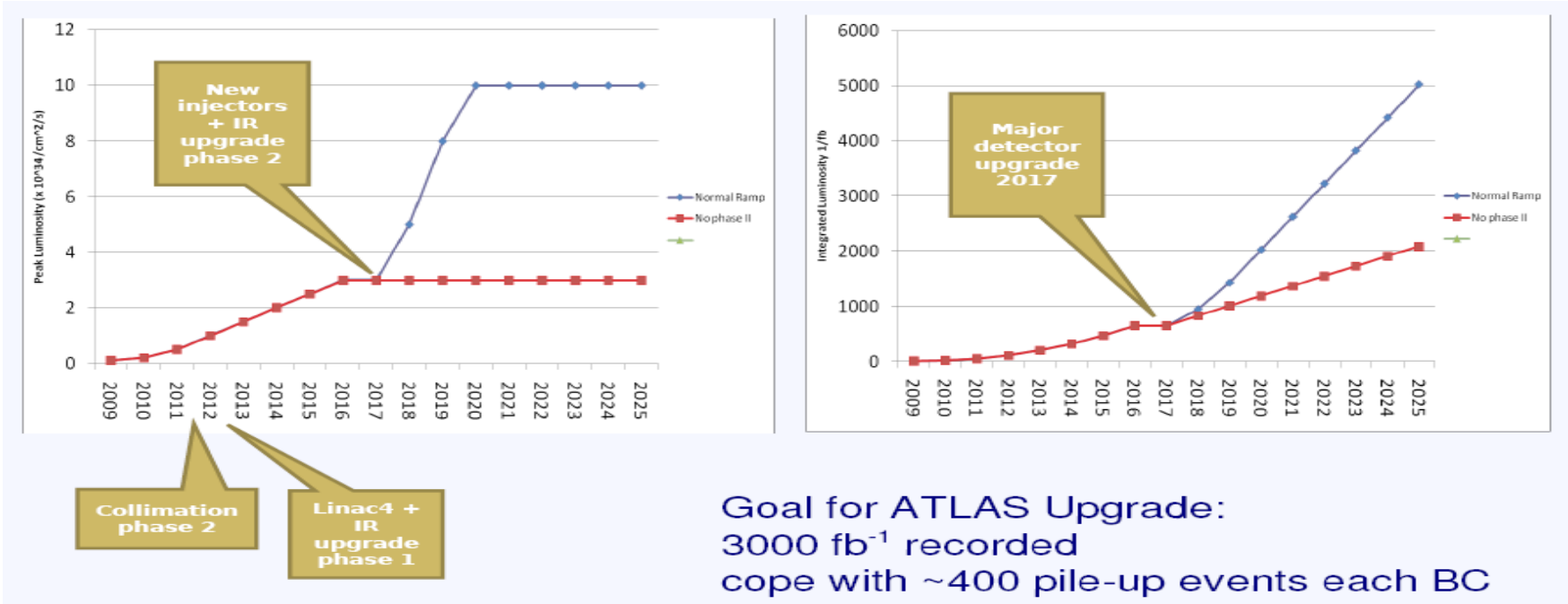


Planning for the ATLAS Upgrade

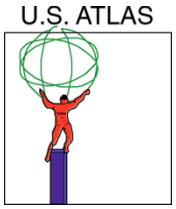
- Planning for the ATLAS Upgrade for higher luminosity running
- Supporting R&D activities for the upgrade
- Two coordinating bodies: Upgrade Steering Group and Upgrade Project Office
  - Synergy with CMS where appropriate on R&D
  - Develop coherent and realistic upgrade plan
  - Design with detector constraints in mind (power, cooling, access,…)
  - Retain technical experts in ATLAS

U.S. ATLAS

SLHC Luminosities

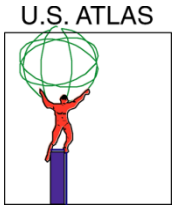


- **Above is common (ATLAS/CMS/LHC) luminosity scenario agreed to in LHCC July 2008**
- **This sets the conditions and timescales**
  - **Phase 1: 6-8 month shutdown at the end of 2012 (3 x 10^{34} $cm^{-2}s^{-1}$ by end)**
  - **Phase 2: 18 month shutdown at the end of 2016 (10^{35} $cm^{-2}s^{-1}$ by end)**
- **Still need to understand impact (if any) of LHC delay**



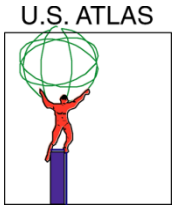
Upgrade Overview

- **For Phase 1**
  - New insertable inner layer (b-layer) pixel layer
  - TDAQ
  - investigating TRT optimization
  - Studying the implication for all systems
- **For Phase 2 (high occupancy, high integrated and instantaneous luminosity)**
  - All silicon tracker
  - Calorimeter electronics and readout; and forward calorimeter detector
  - TDAQ enhancements
  - Forward muon chambers; Be beam pipe; shielding
  - Magnets and most detectors remain in place



Upgrade Milestones

- 2009 – Letter of Intent for ATLAS changes; TDR for new B-layer pixel system
- 2010 – Technical Proposal (may include options) for ATLAS changes for sLHC
- 2011 – Technical Design Reports
- 2012 (end) – Phase 1 changes get installed
- 2016 (end) – Phase 2 changes get installed in long shutdown
- Remain adaptable, guided by:
  - Detector performance
  - Physics results
  - Machine schedule
- For the US… the next slide shows a summary from the last JOG meeting



Brief Summary of US Upgrade R&D and Construction Activities

- US supported R&D activities (coordinated with ATLAS)
  - Pixel readout chip development; 3D pixel detector development; silicon strip detector development; electronics for silicon strip and Lar; stave design; tracker simulation
  - FY09 R&D will help form the basis of tracker design report
- On Sept. 11, 2008 we presented our preferred plan for "Phase 1" of the upgrade motivated by the approved Phase 1 increase in luminosity of the LHC.
  - This included a full replacement of the tracker, FCAL and Trigger/DAQ upgrades and started in 2010, ended in 2018 and cost ~$130M
- We were told there would be no money until 2011 (DOE) and the time scale was too long. 2010 funding may be possible for NSF.
  - We are considering a reduced scope proposal with the Pixel Insertion, and the Trigger/DAQ – but still worry that the full tracker replacement needs to start in ~2012 and so there could be two "projects" starting VERY CLOSE to each other
- We have been told that there will be further guidance from the DOE and NSF soon

U.S. ATLAS

Conclusions

- **Successful single beam and cosmic data runs**
  - **Demonstrated that all the advance preparations were critical to the success in capturing these data**
- **ATLAS is ready for collisions!**
  - **Detector is working at the ~98-99% level, although maintenance is taking place**
  - **No showstoppers on the horizon**
  - **Computing is capable of handling first data and distributing it worldwide**
- **Planning for future upgrades is underway**
  - **Given US funding timescales, must start soon**
- **By this time next year we plan to be able to show you data from actual collisions!**