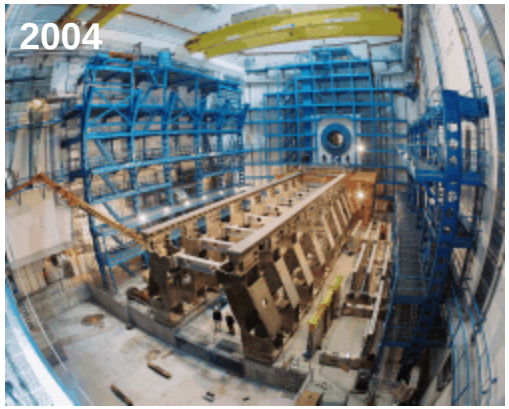
ATLAS Status & First Results

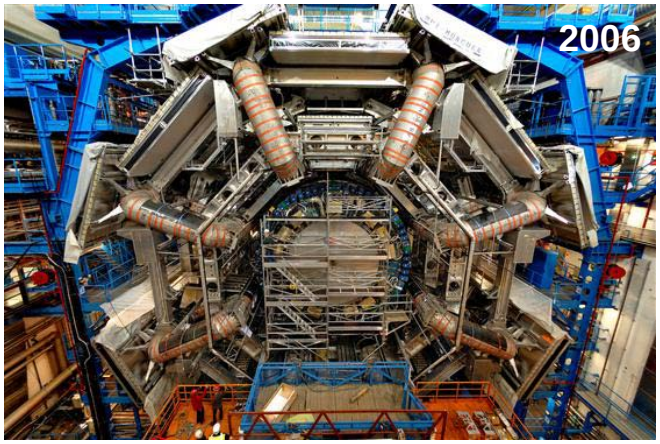
Andrew J. Lankford

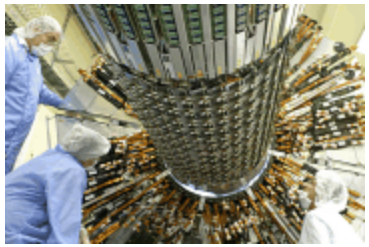
University of California, Irvine & CERN

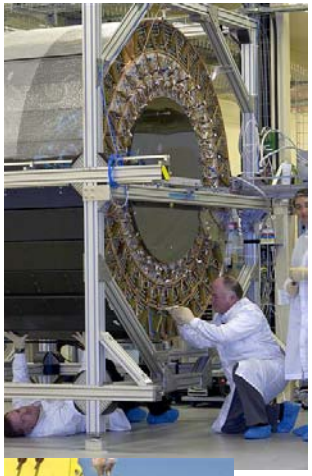
for the ATLAS Collaboration

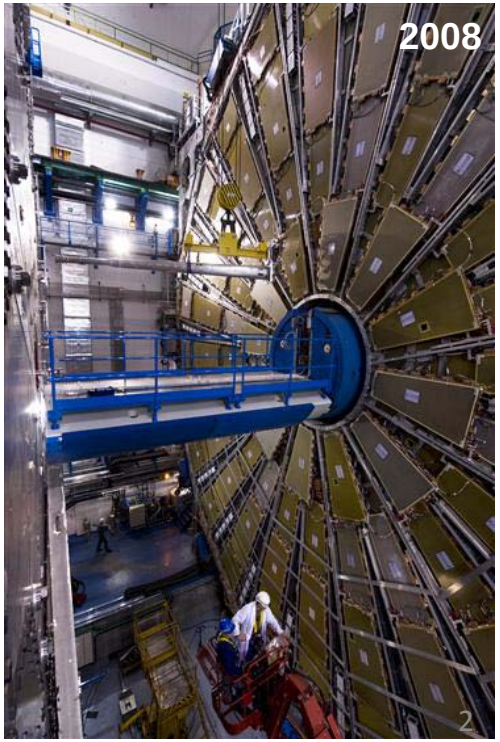
ATLAS is the product of >20 years sustained activity by a worldwide scientific community.

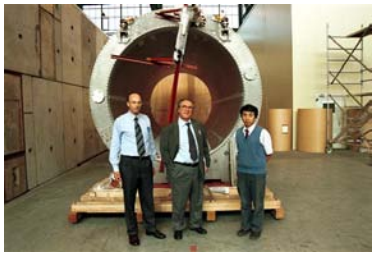


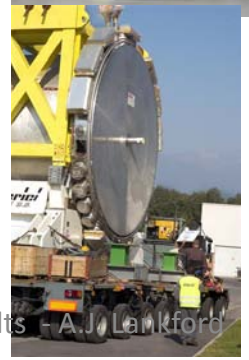












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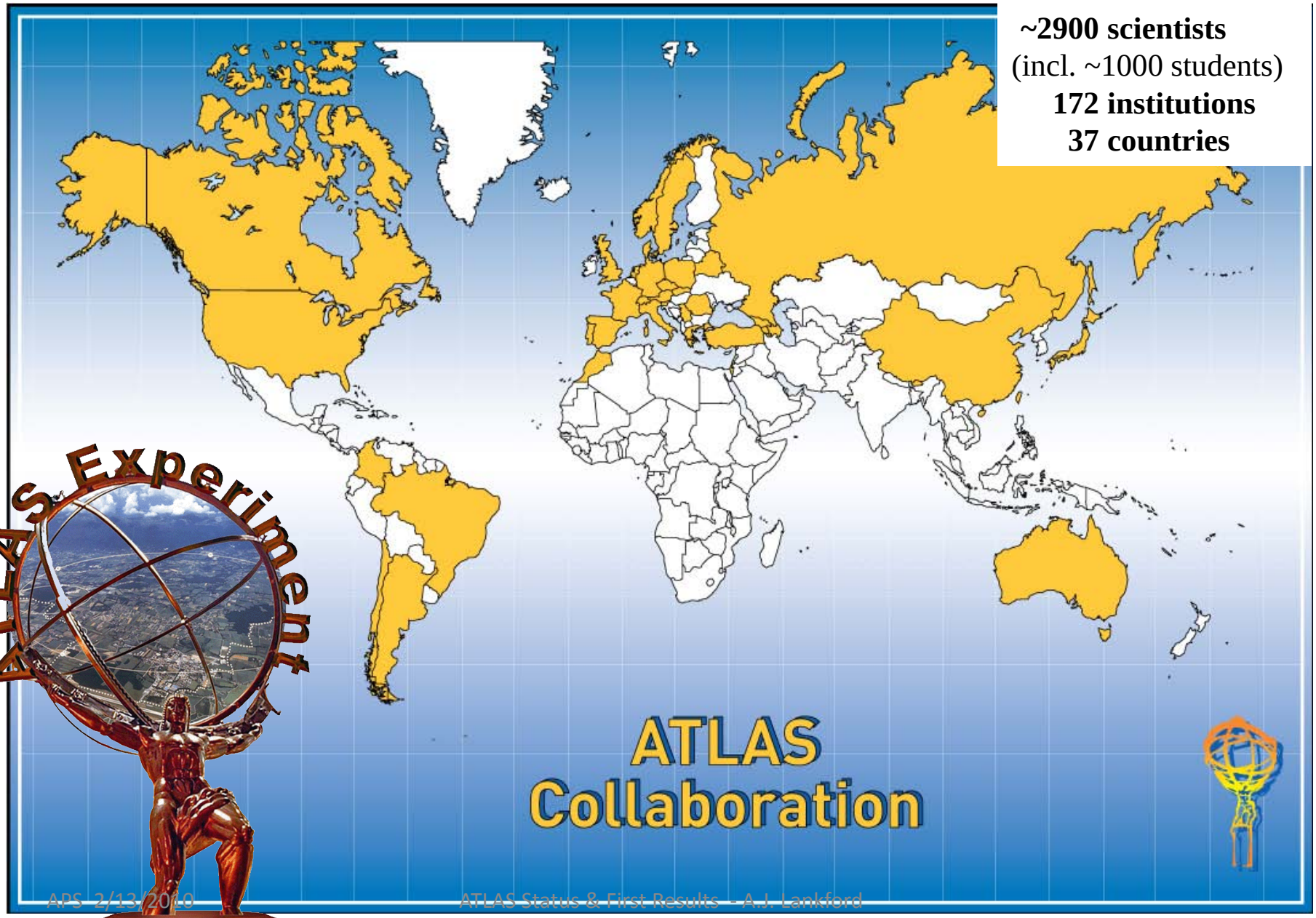

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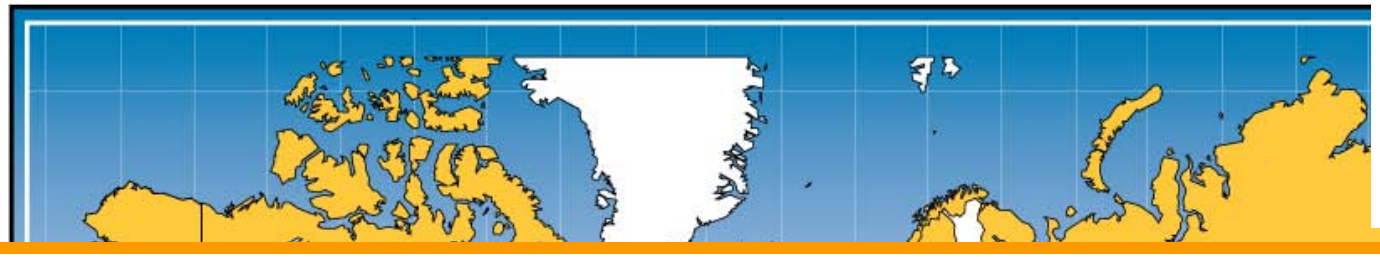


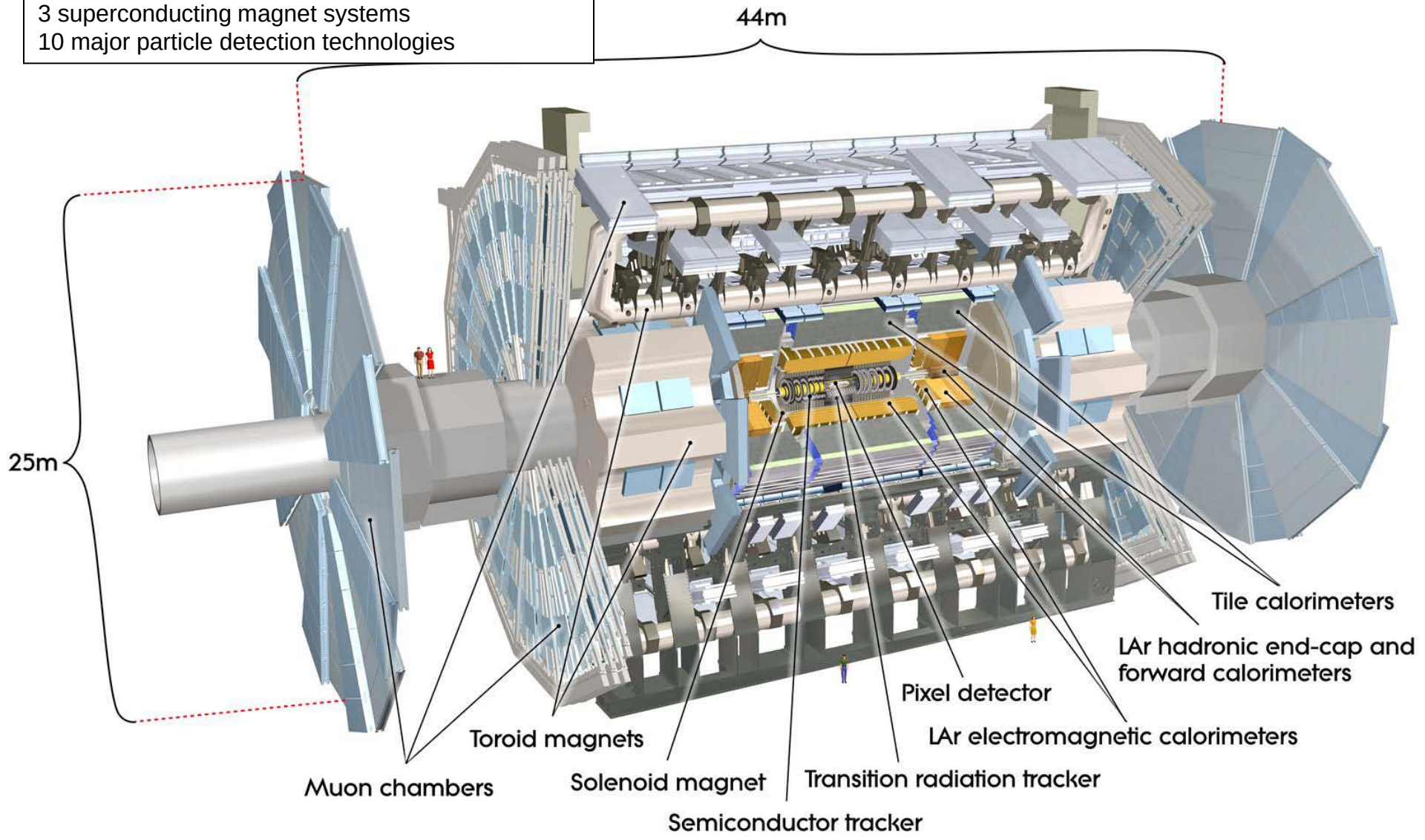
~2900 scientists
(incl. ~1000 students)
172 institutions
37 countries

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, Brasil Cluster, Bratislava/SAS Kosice, Brookhaven NL, Buenos Aires, Bucharest, Cambridge, Carleton, CERN, Chinese Cluster, Chicago, Chile, Clermont-Ferrand, Columbia, NBI Copenhagen, Cosenza, AGH UST Cracow, IFJ PAN Cracow, SMU Dallas, UT Dallas, DESY, Dortmund, TU Dresden, JINR Dubna, Duke, Edinburgh, Frascati, Freiburg, Geneva, Genoa, Giessen, Glasgow, Göttingen, LPSC Grenoble, Technion Haifa, Hampton, Harvard, Heidelberg, Hiroshima IT, Indiana, Innsbruck, Iowa SU, Iowa, UC Irvine, 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, RUPHE Morocco, 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, Rome I, Rome II, Rome III, Rutherford Appleton Laboratory, DAPNIA Saclay, Santa Cruz UC, Sheffield, Shinshu, Siegen, Simon Fraser Burnaby, SLAC, NPI Petersburg, Stockholm, KTH Stockholm, Stony Brook, Sydney, Sussex, AS Taipei, Tbilisi, Tel Aviv, Thessaloniki, Tokyo ICEPP, Tokyo MU, Tokyo Tech, Toronto, TRIUMF, Tsukuba, Tufts, Udine/ICTP, Uppsala, UI Urbana, Valencia, UBC Vancouver, Victoria, Waseda, Washington, Weizmann Rehovot, FH Wiener Neustadt, Wisconsin, Wuppertal, Würzburg, Yale, Yerevan

ATLAS
Collaboration

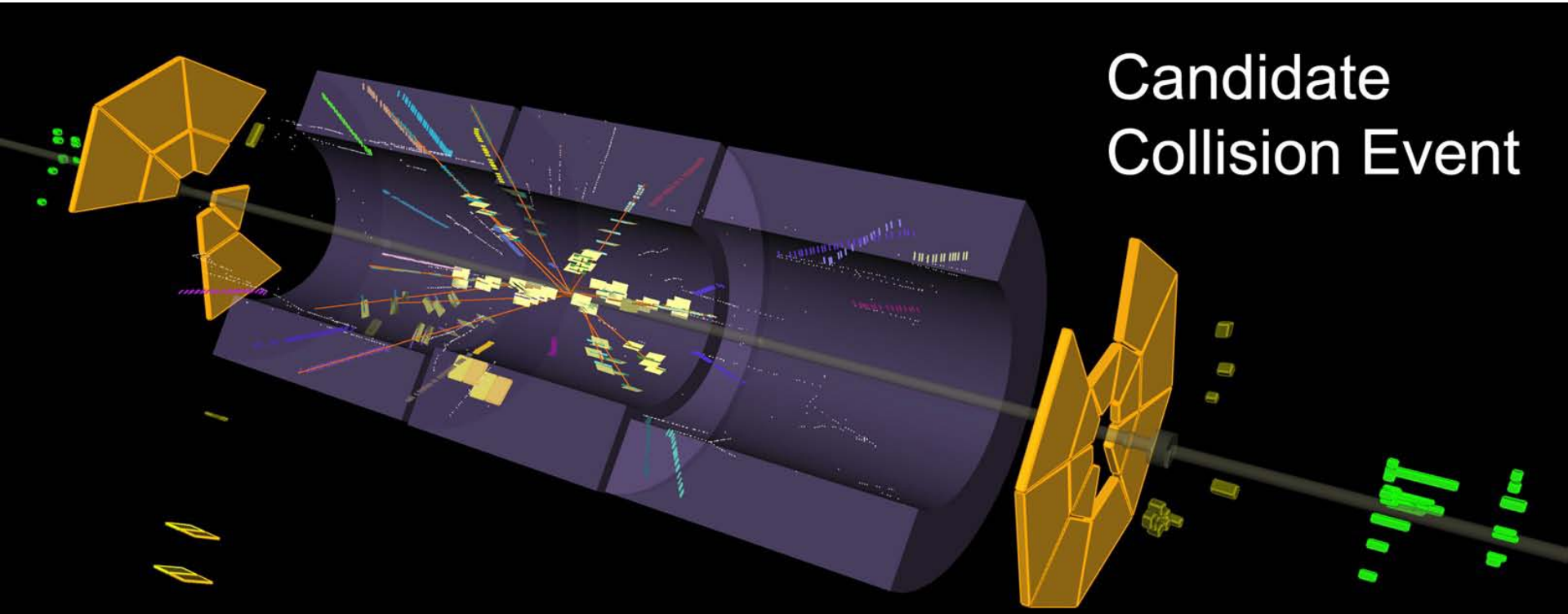
ATLAS Detector

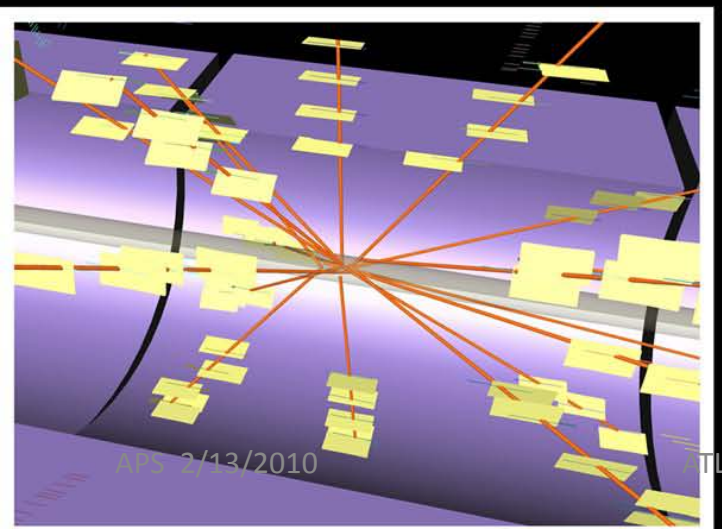
3 superconducting magnet systems
10 major particle detection technologies



application-specific (rad-hard/tolerant) electronics
advanced IT solutions for control, data acquisition & processing

First Candidate Collision Event in ATLAS: Nov. 23, 2009





Note:

Magnetic field off.
Some detectors off or at reduced voltage
when beam not “stable”

2009-11-23, 14:22 CET
Run 140541, Event 171897

http://atlas.web.cern.ch/Atlas/public/EVTDISPLAY/events.html

Commissioning Prior to Collisions

Test beam data:

- understood detector response
- developed calibration procedures
- tuned simulation

Cosmic ray data samples: 2008 + 2009

enabled tuning detector performance

- survey detector response
- preliminary calibration, alignment, timing

Beam splashes: 2008 + 2009

single beam on upstream collimator illuminates much of detector

enabled further performance tuning

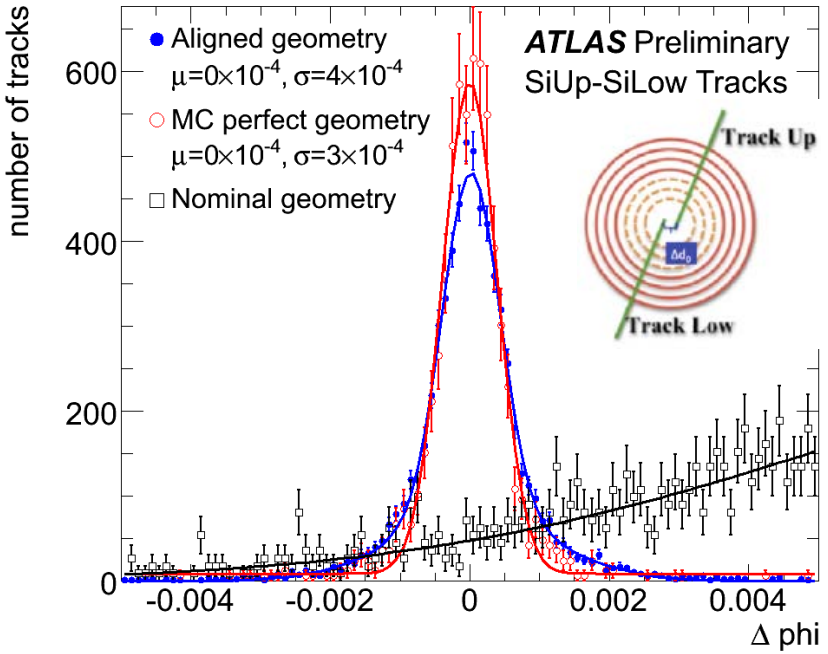
- especially detector timing

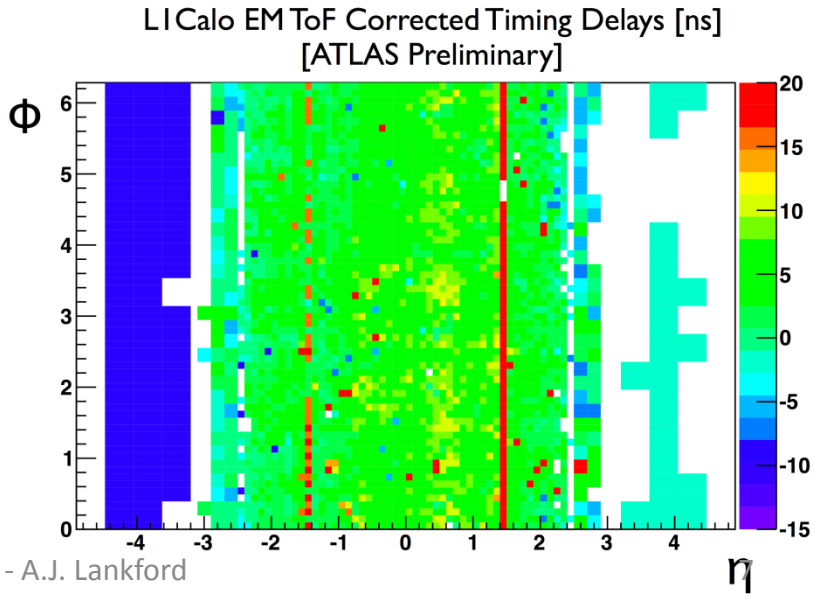
Data Challenges

- Large-scale tests of computing & grid infrastructure, incl. distributed analysis
  - w/ simulated data, test-beam data, cosmics data
  - Robotic & human "stress" tests

Achieved good detector understanding

Well prepared for first collisions





ATLAS Commissioning Run

2009 Collision Data

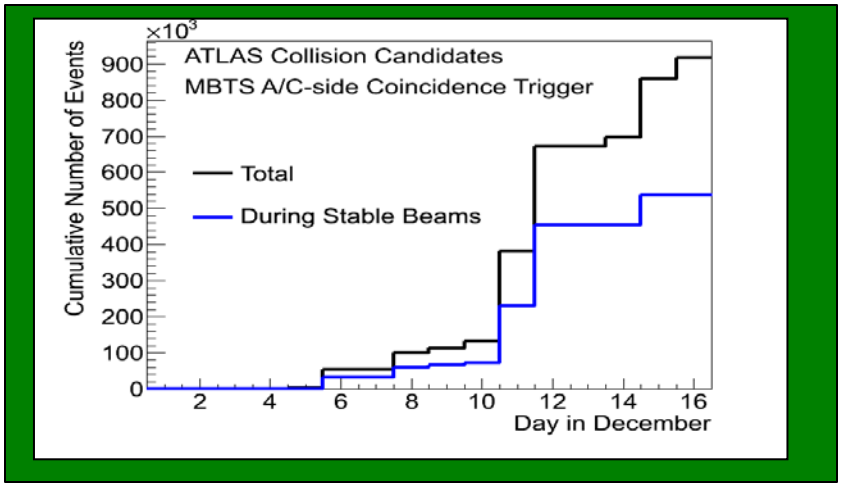
Total # collision candidates: 917k

~20 μb^{-1} (<30% uncertainty)

with stable beam: 538k

~12 μb^{-1} (<30% uncertainty)

@ 2.36 TeV: 34k



Max peak luminosity seen by ATLAS: ~7 x 10^{26} cm^{-2}s^{-1}

ATLAS data-taking efficiency ~90%

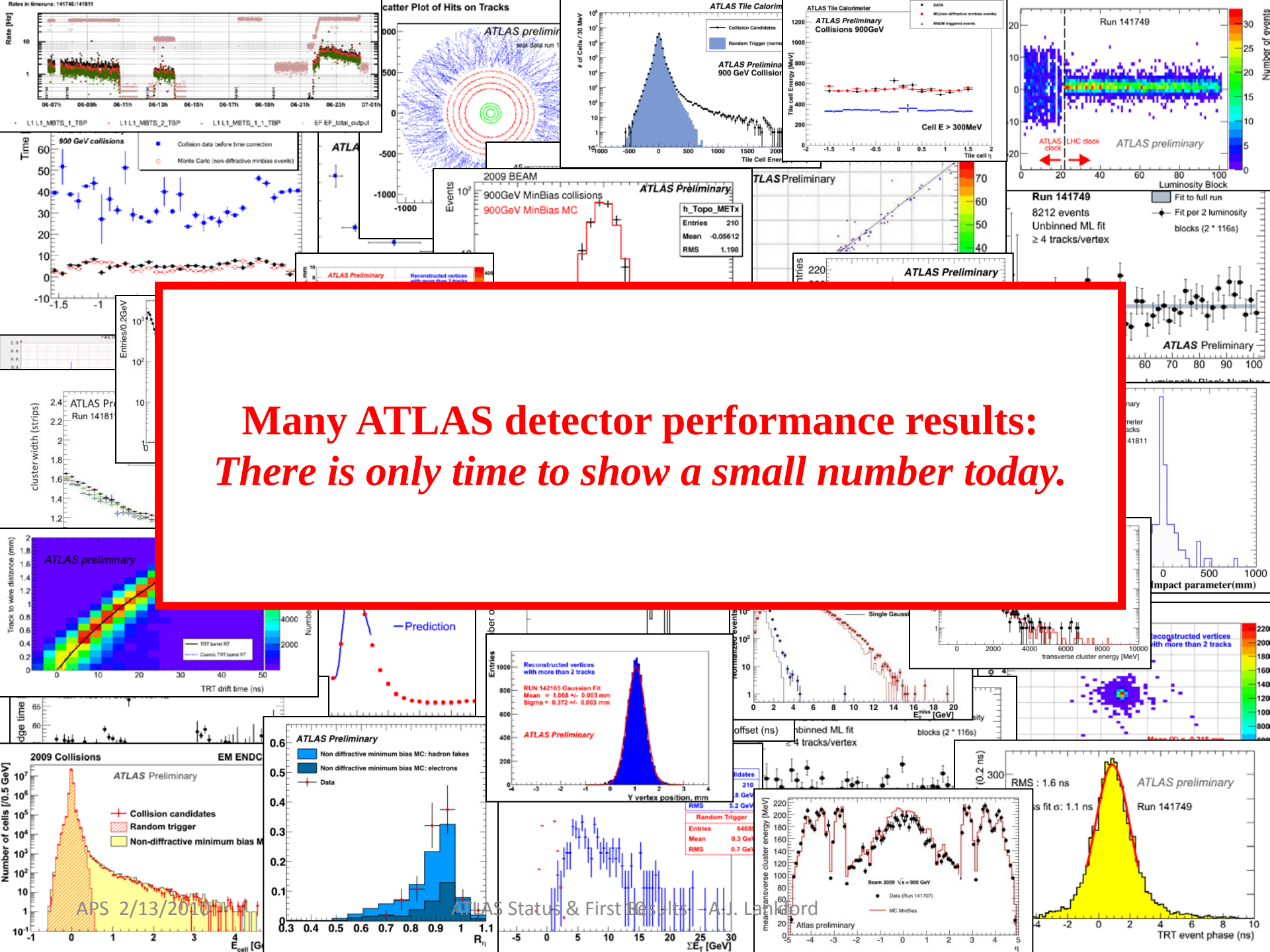
2009 run provided ATLAS with:

- **Invaluable opportunity to operate ATLAS detector & offline data processing under realistic conditions**
- **Invaluable first view of ATLAS response to collision data**
- **Valuable data for detector tuning**
- **Sizable data sample for studying inclusive p-p reactions**

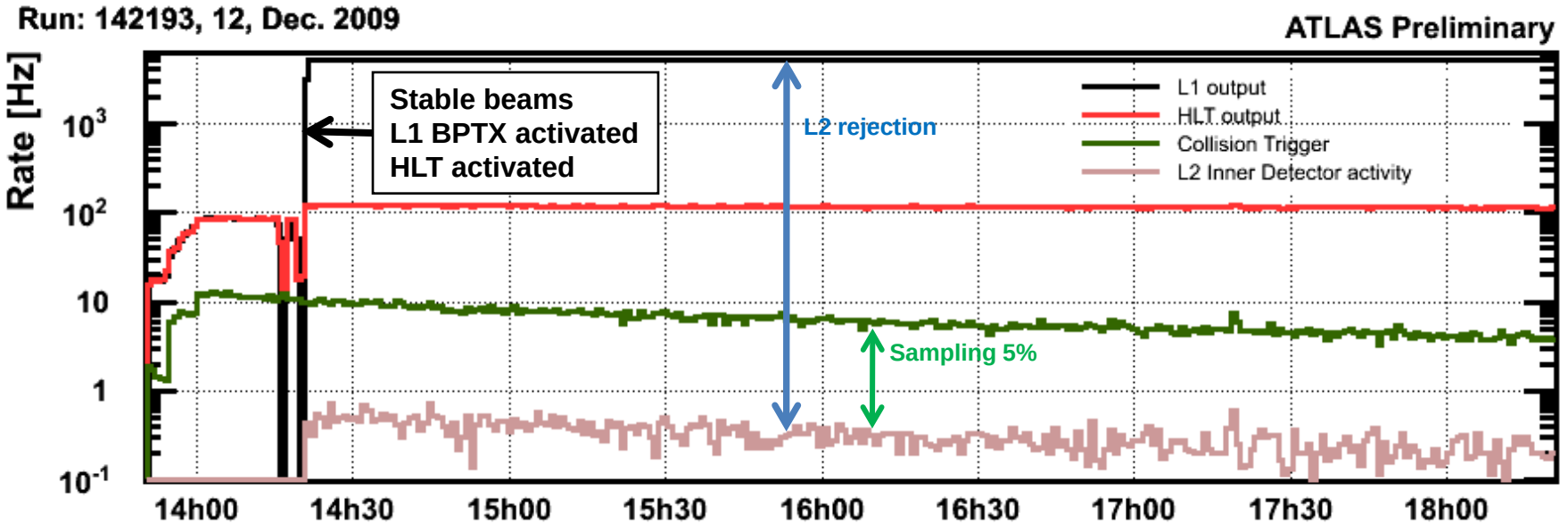
ATLAS Detector Status

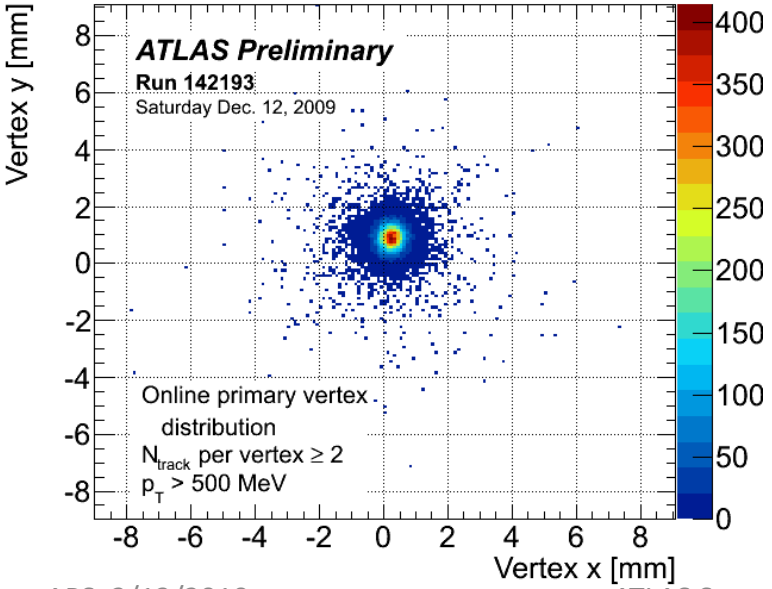
Subdetector	Number of Channels	Approximate Operational Fraction
Pixels	80 M	97.5%
SCT Silicon Strips	6.3 M	99.3%
TRT Transition Radiation Tracker	350 k	98.2%
LAr EM Calorimeter	170 k	98.6%
Tile calorimeter	9800	98.0%
Hadronic endcap LAr calorimeter	5600	99.9%
Forward LAr calorimeter	3500	100.%
MDT Muon Drift Tubes	350 k	99.7%
CSC Cathode Strip Chambers	31 k	98.5%
RPC Barrel Muon Trigger	370 k	99.5%
TGC Endcap Muon Trigger	320 k	99.4%
LVL1 Calo trigger	7160	99.5%

ATLAS was fully operational for 2009 run.
Detector systems operating with very high efficiency.


Many ATLAS detector performance results:
There is only time to show a small number today.

Level 1 & High Level Trigger for 2009 Commissioning Run

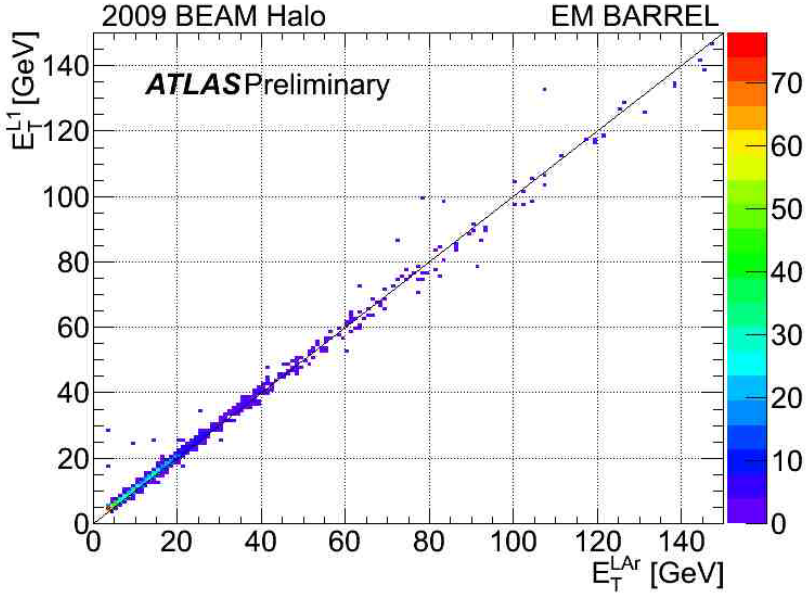




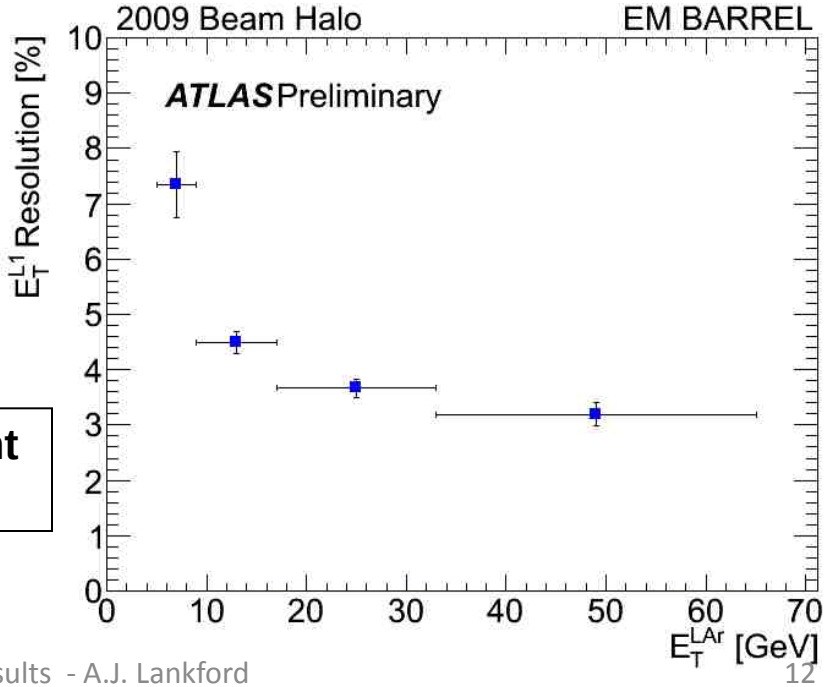
L1: Collision trigger (scintillators)
+ Beam Pickup sample (when HLT active)
HLT: Selection: silicon space points, >1 track
(to check efficiency of L1 min bias trigger)
HLT: Pass-thru + Calibration triggers
>200 chains

Primary vertex and beam spot determined online using L2 trigger
spot size ~ 250 μm

Early Performance of Level 1 Calorimeter Trigger



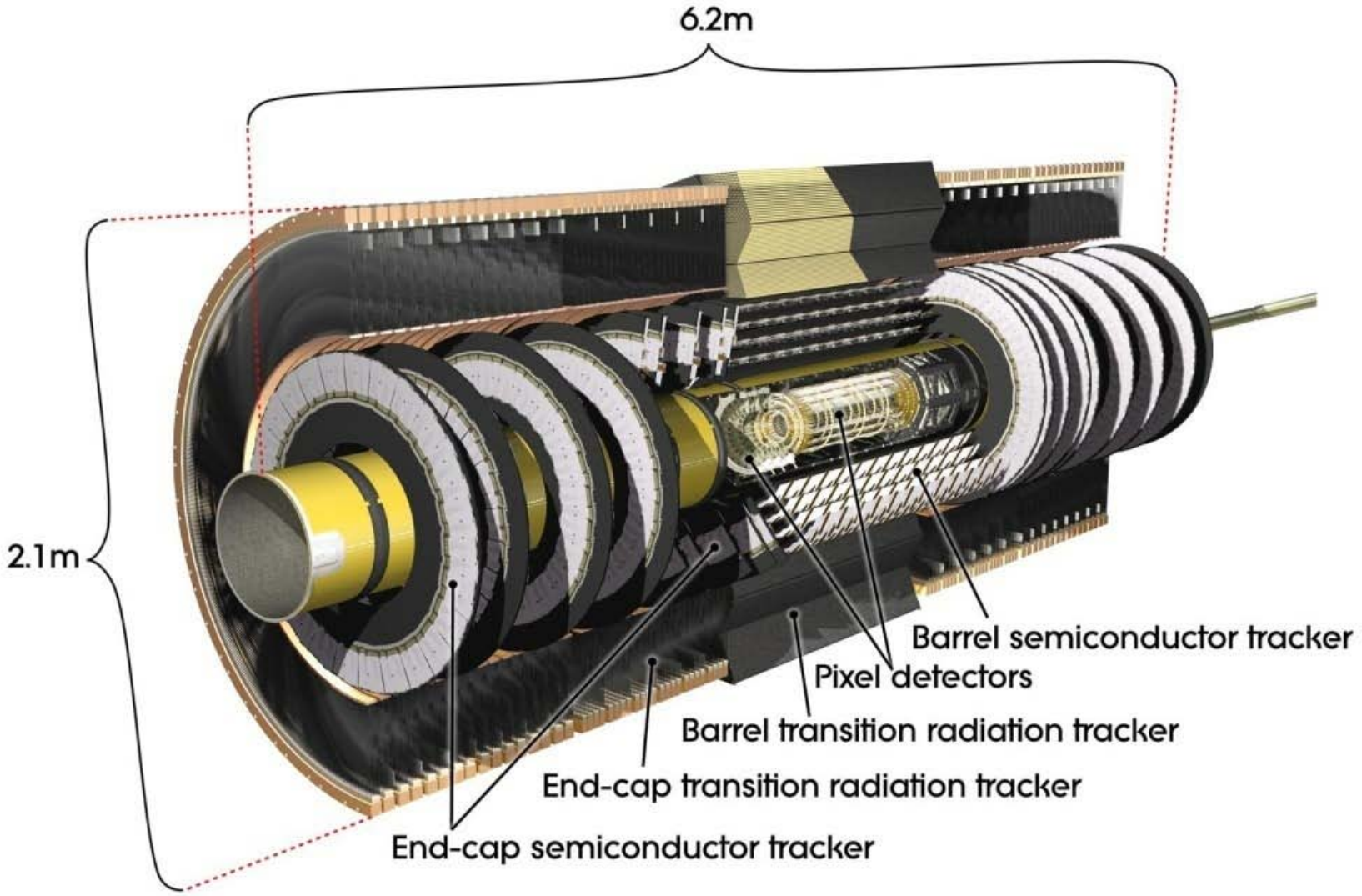
Comparison of E_T(L1 tower) and $\sum E_T$ (offline)
(separate trigger & readout processing)
using "halo" events from single beam



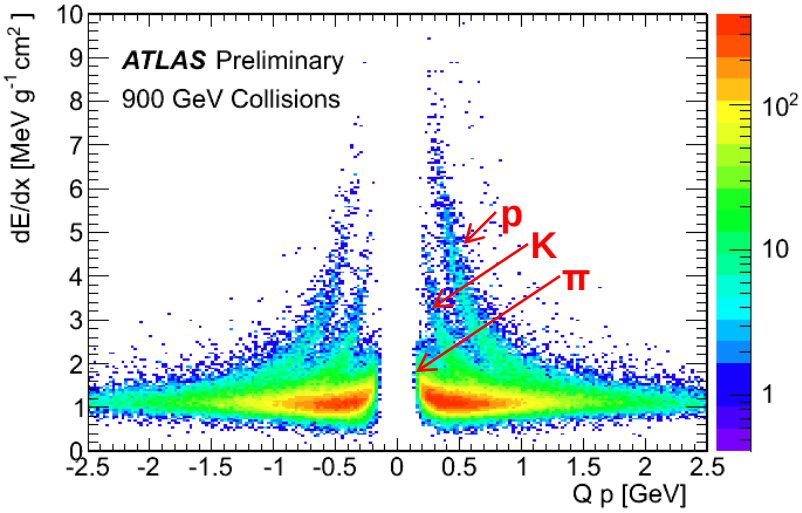
Level 1 E_T resolution meets requirement
(<5% at high energy)

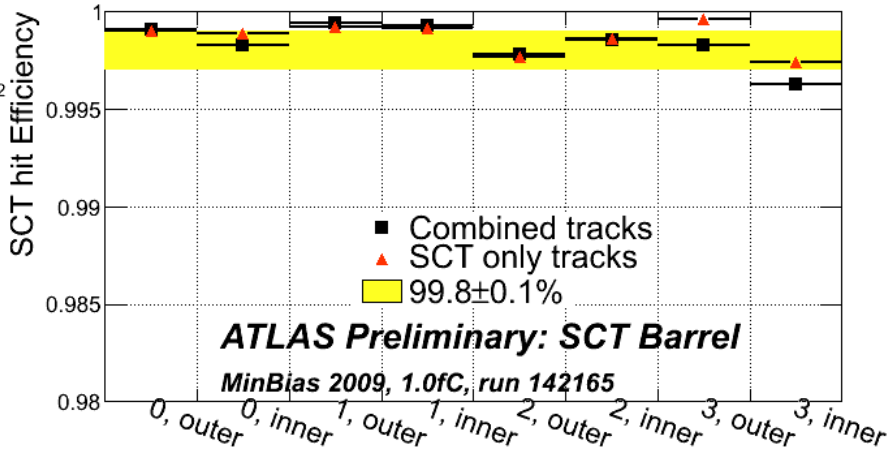
Inner Detector

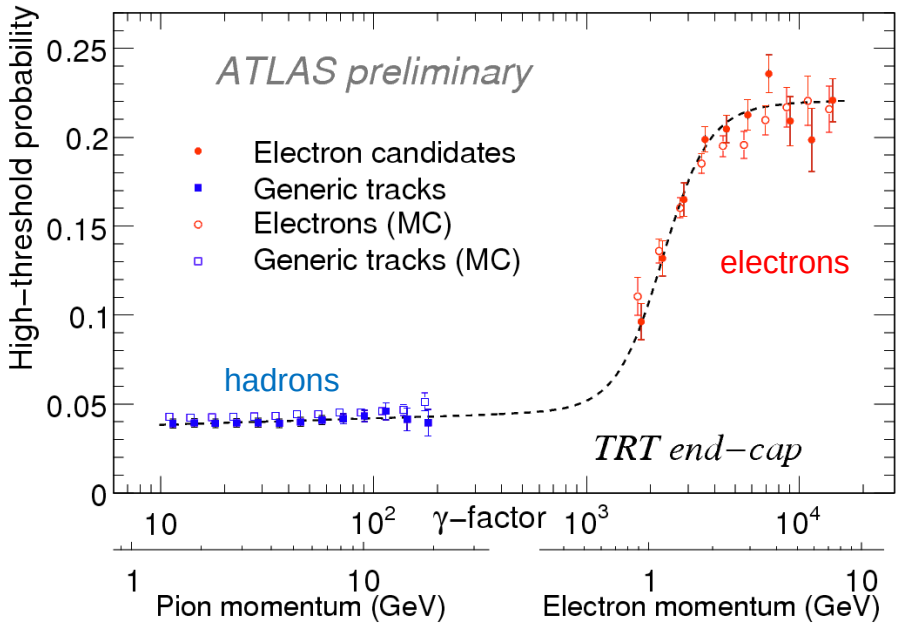
charged particle detection **momentum measurement**

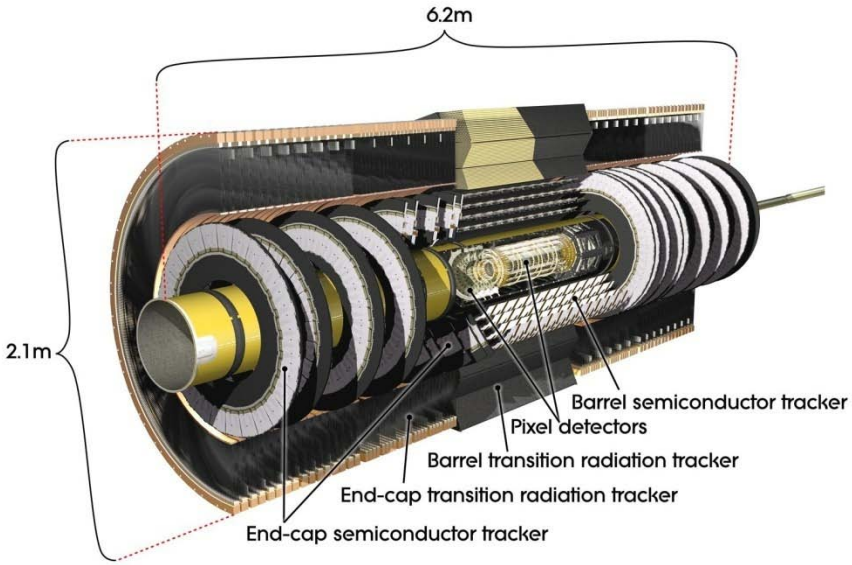


Early Performance of Inner Detector Systems

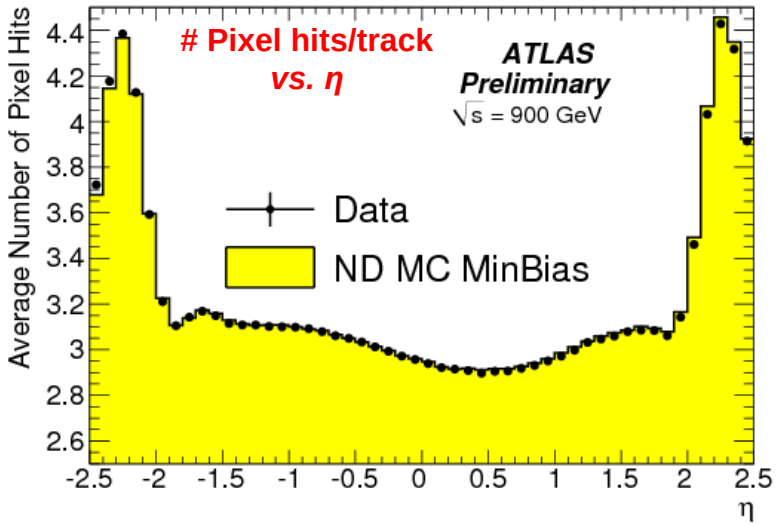


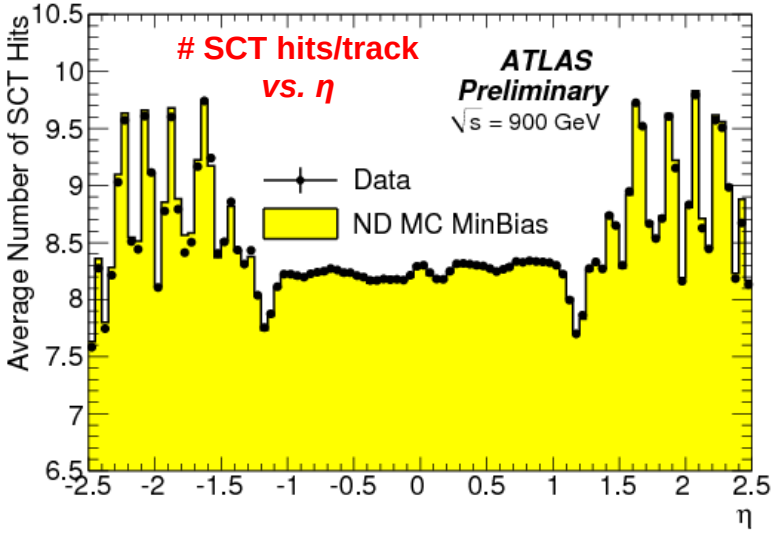


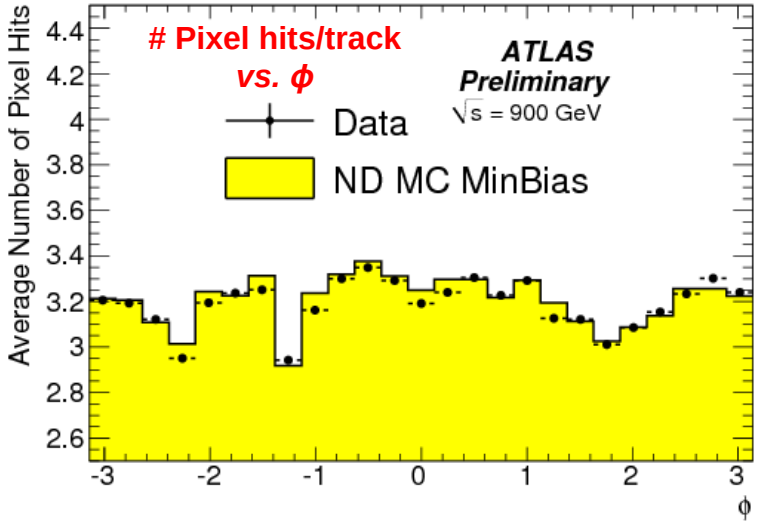


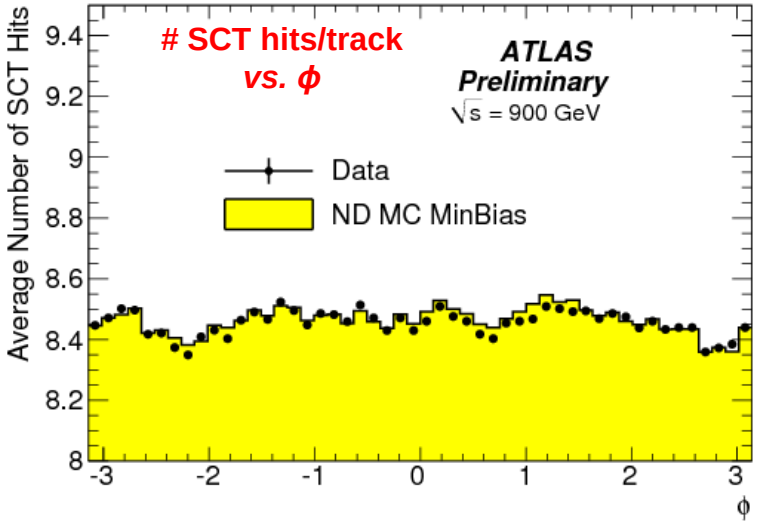


Early Performance of Inner Detector Simulation



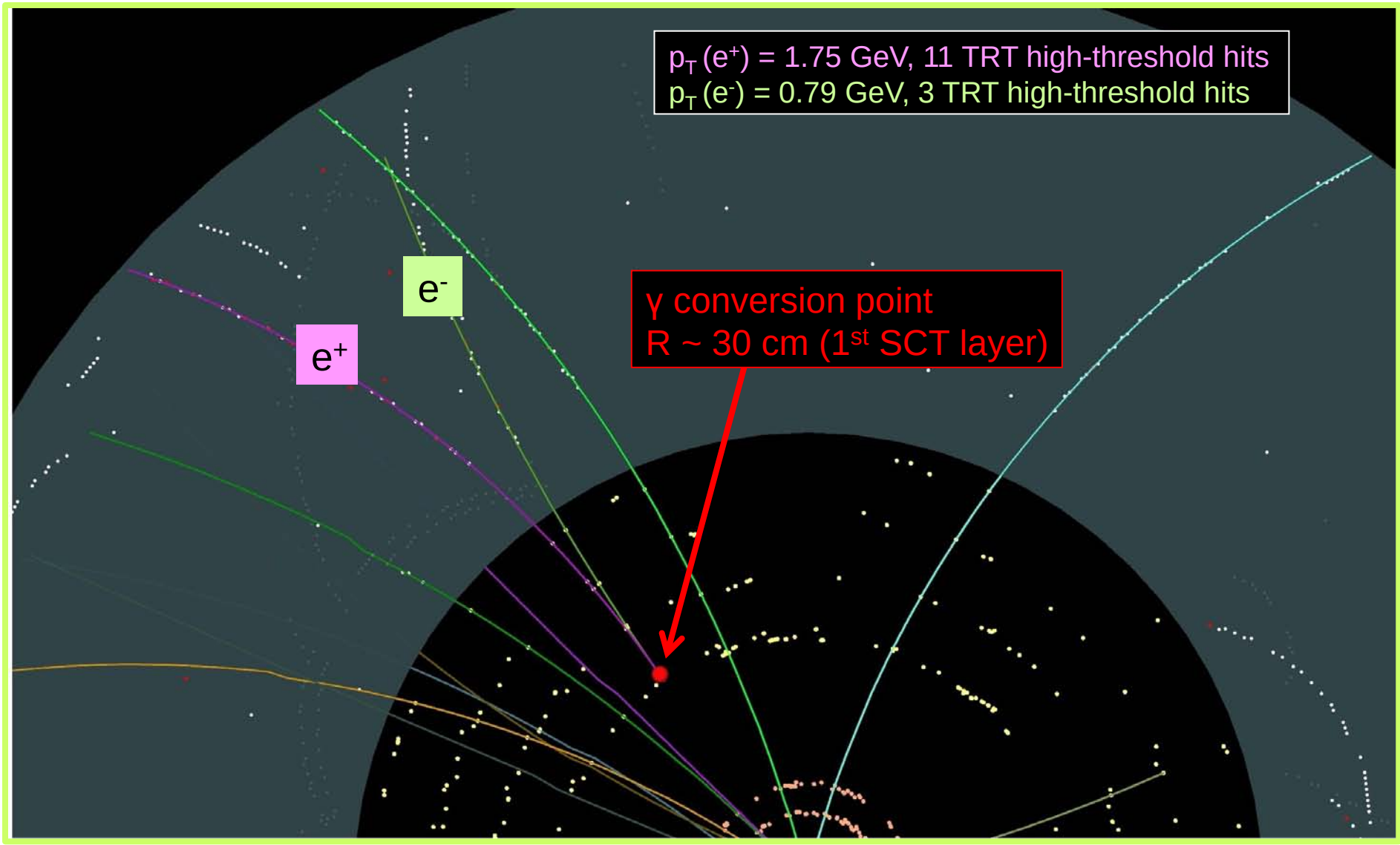




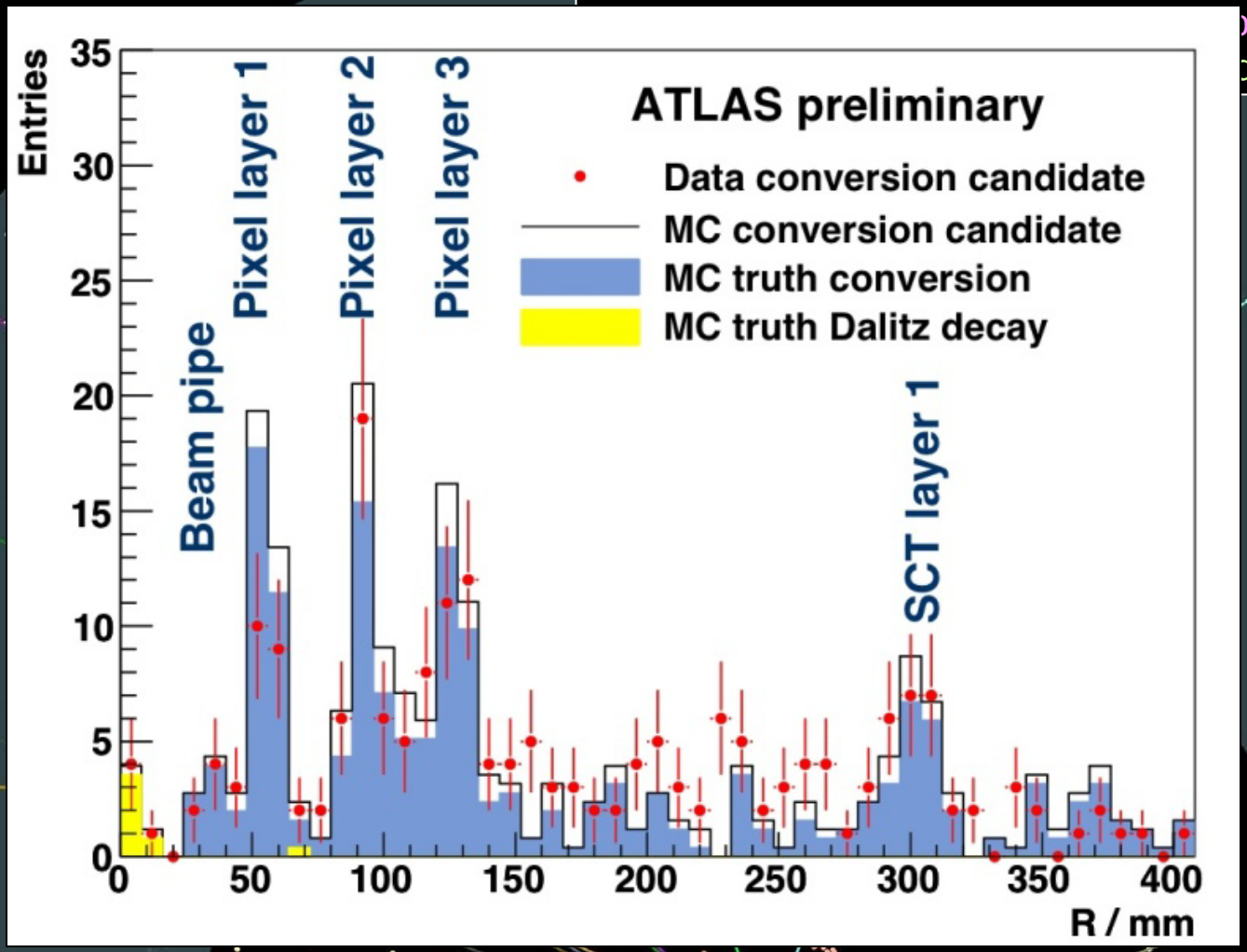


Simulation reproduces well detector geometry and material.

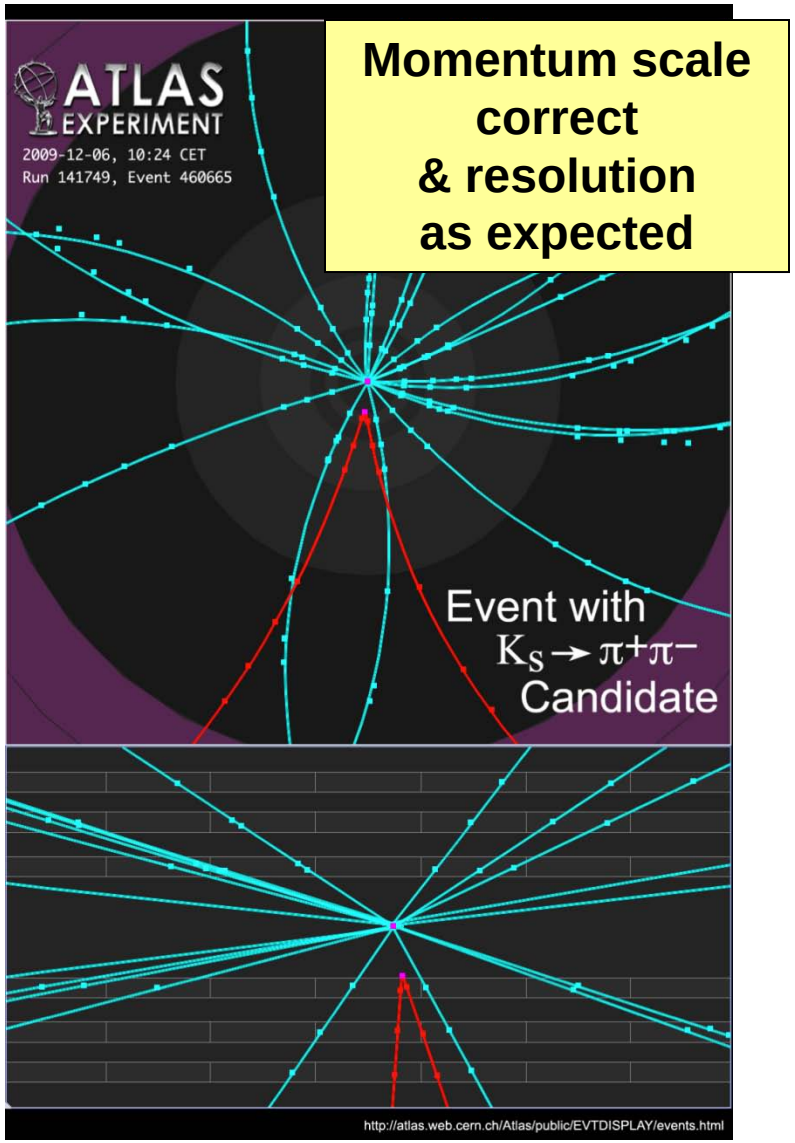
Early Performance of Inner Detector Simulation

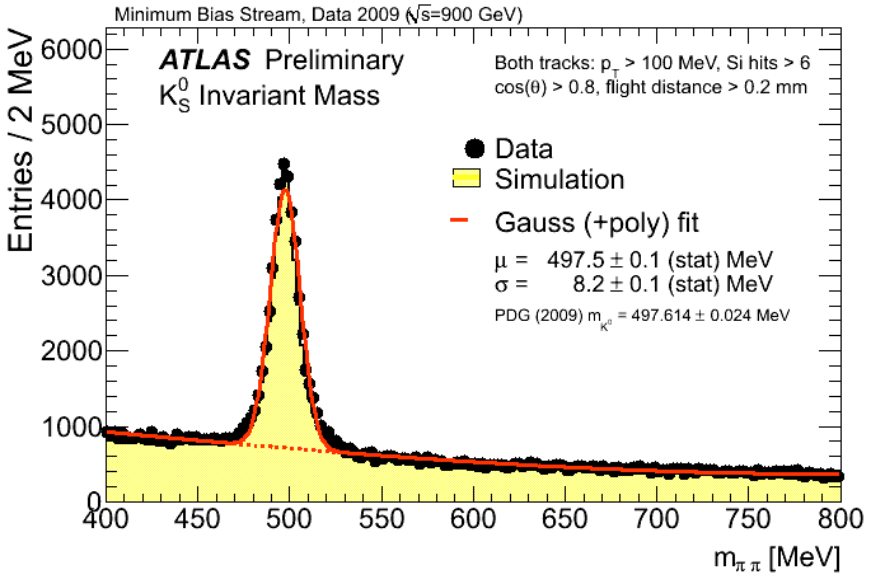


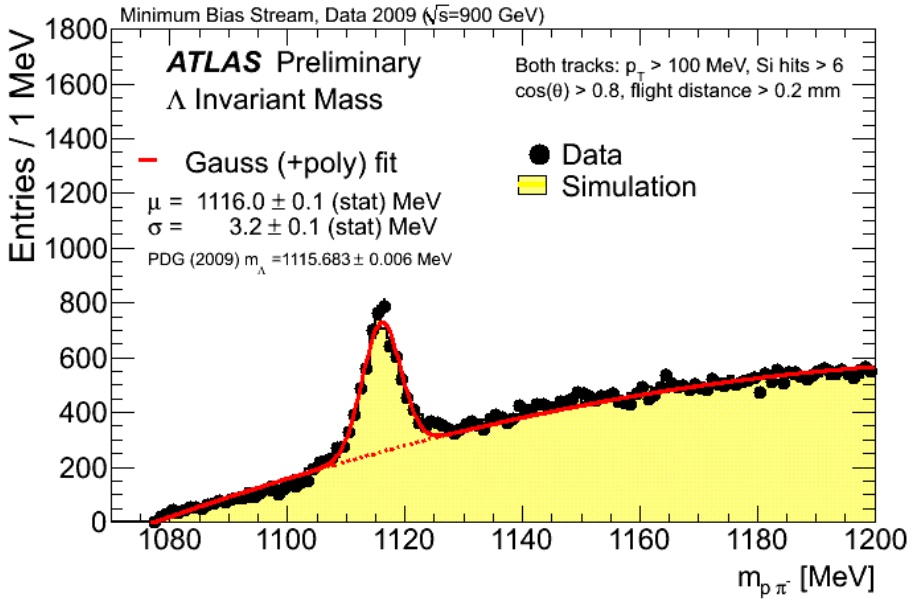
Early Performance of Inner Detector Simulation



Early Performance of Charged Particle Tracking

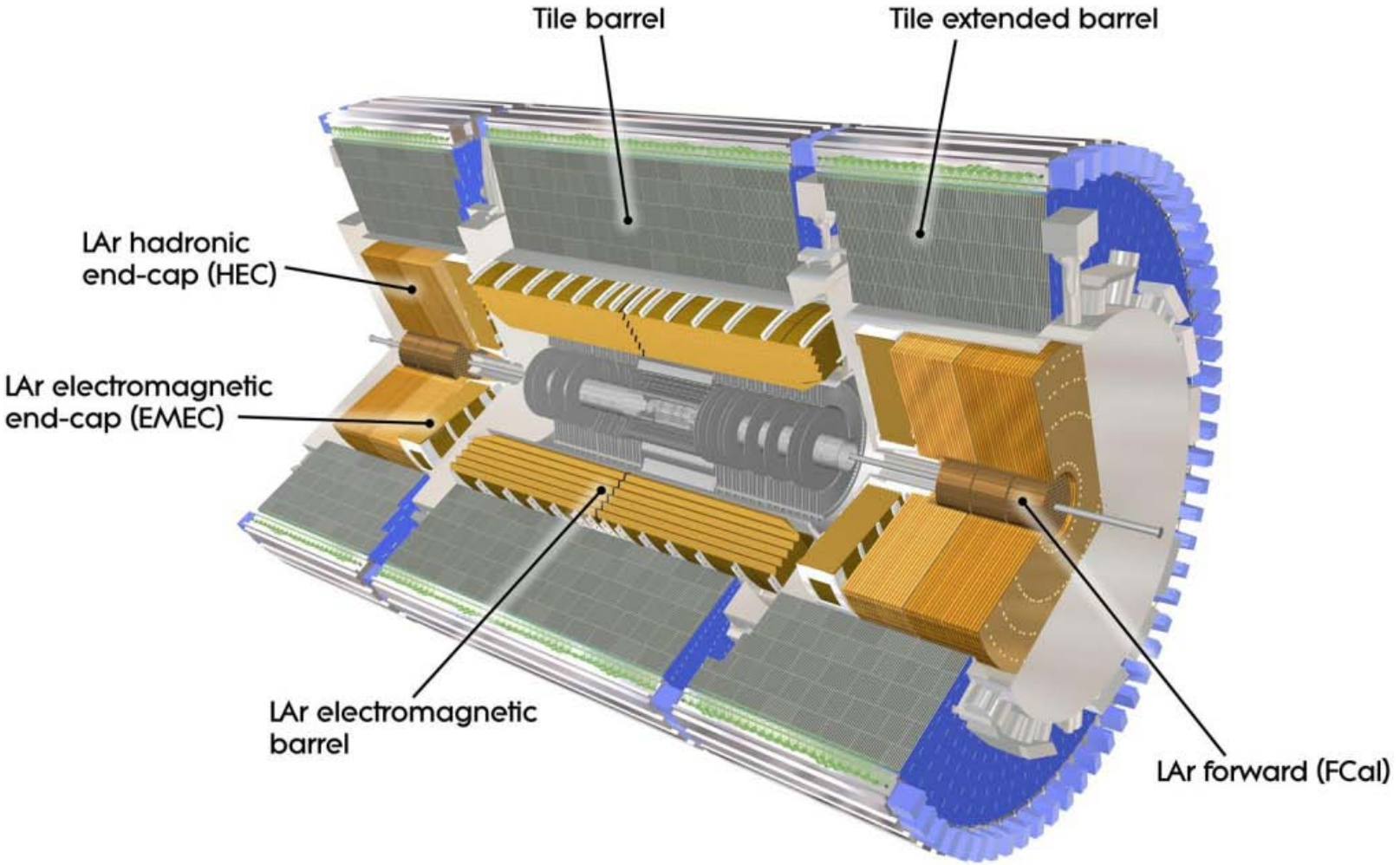




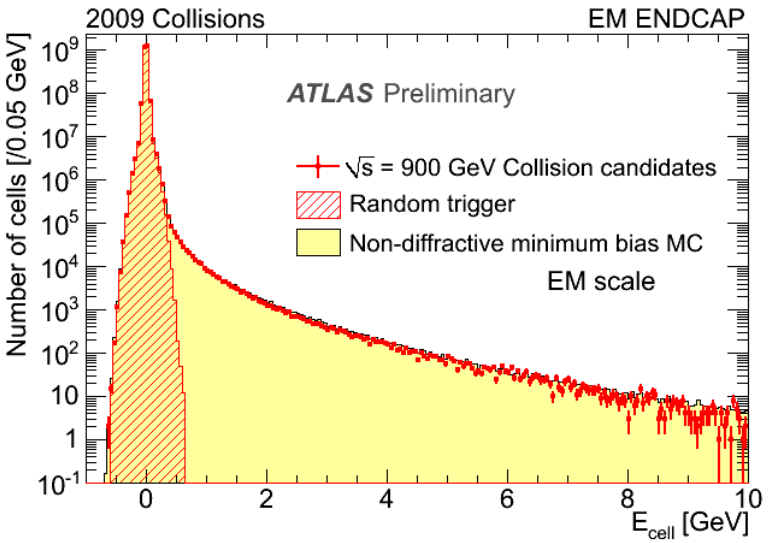


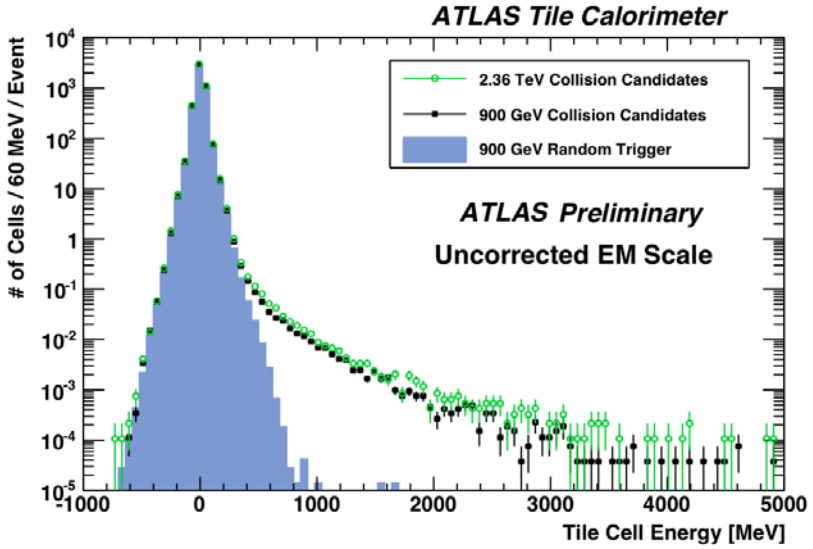
Calorimeter Systems

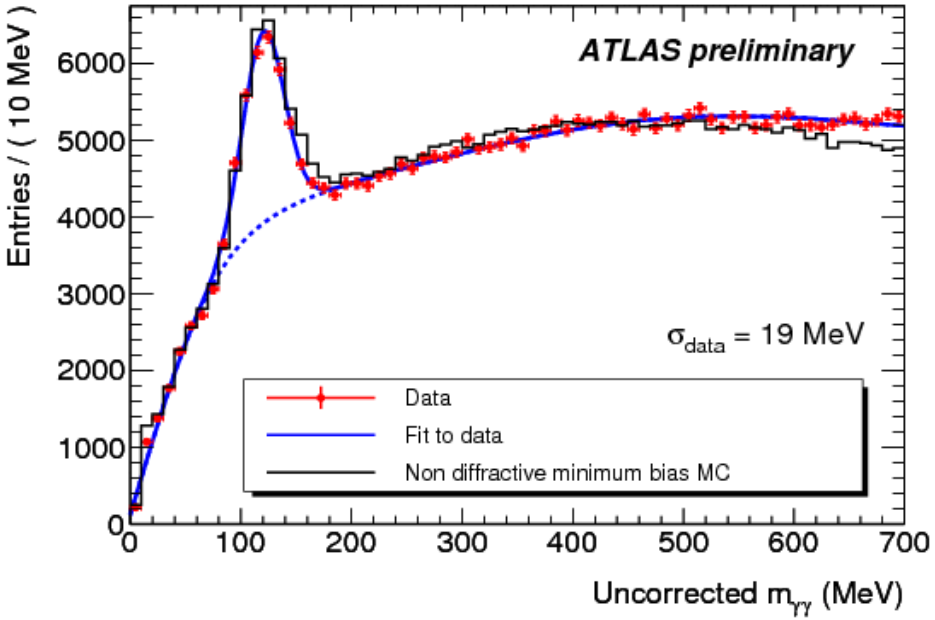
energy measurement neutral particle detection

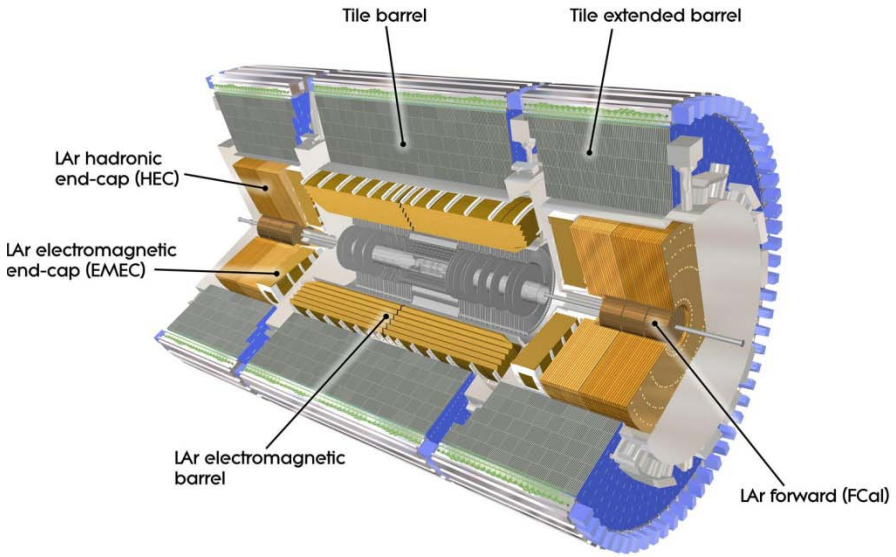


Early Performance of Calorimeters

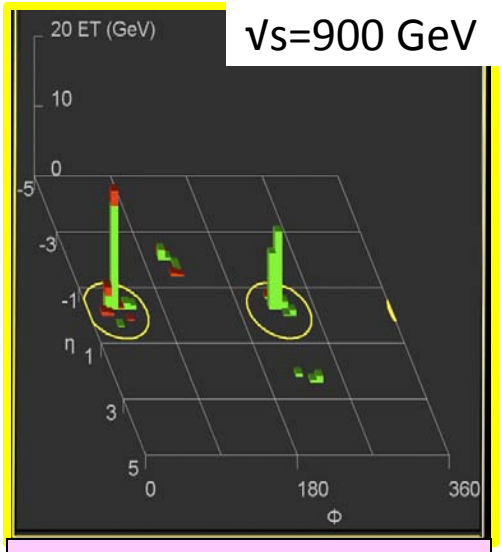






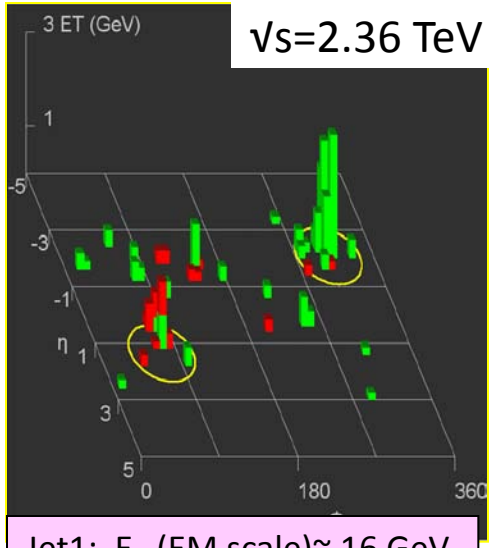


Early Performance with Jets



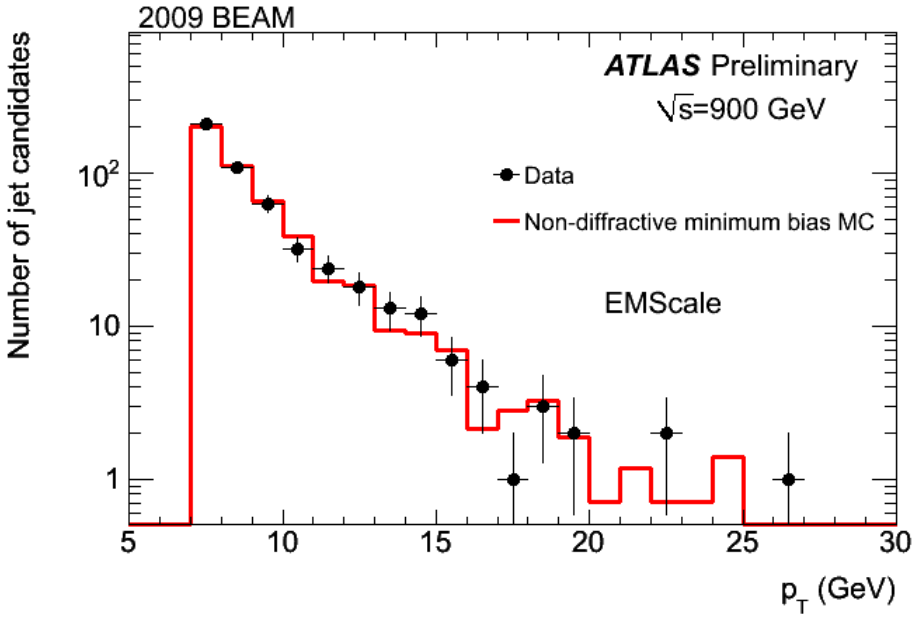
√s=900 GeV

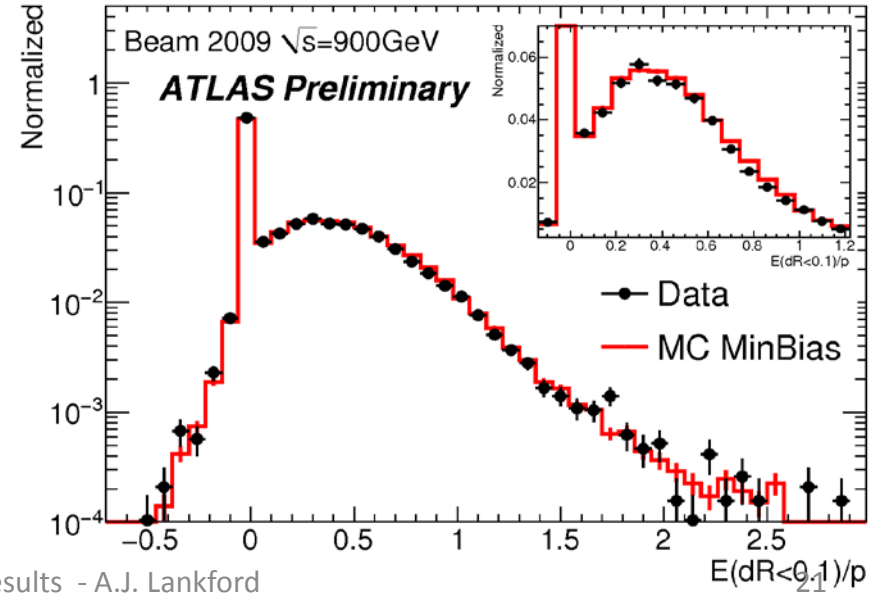
Jet1: E_T (EM scale)~ 37 GeV
Jet2: E_T (EM scale) ~ 37 GeV



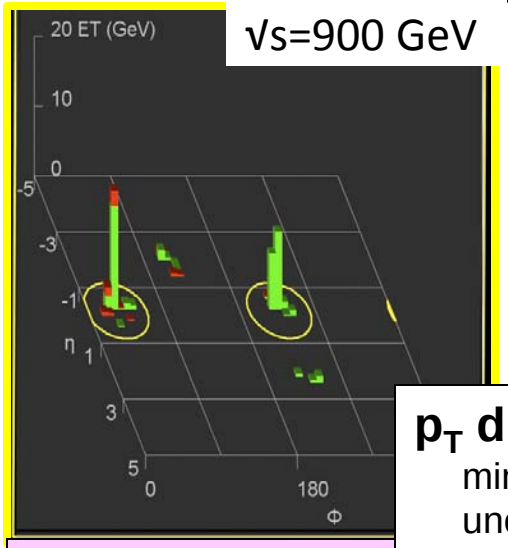
√s=2.36 TeV

Jet1: E_T (EM scale)~ 16 GeV
Jet2: E_T (EM scale) ~ 6 GeV



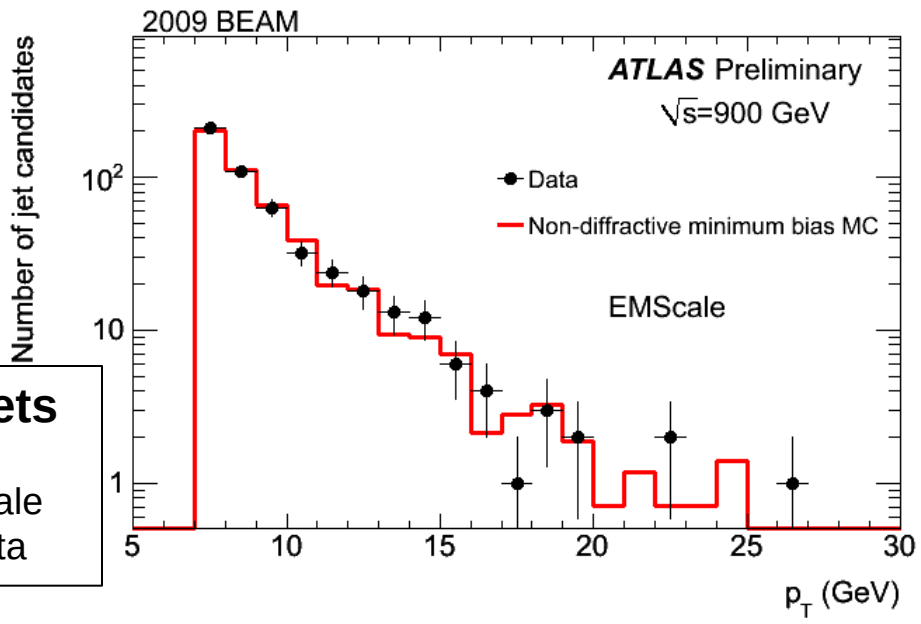


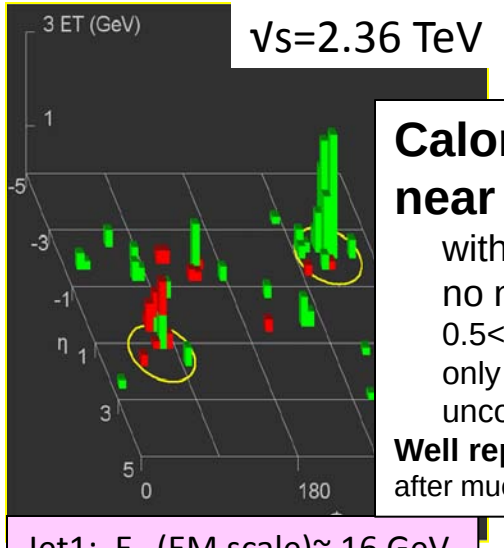
Early Performance with Jets



Jet1: E_T (EM scale)~ 37 G
Jet2: E_T (EM scale) ~ 37 GeV

p_T distribution of jets
- minimum bias trigger
- uncorrected energy scale
- sample of 900 GeV data

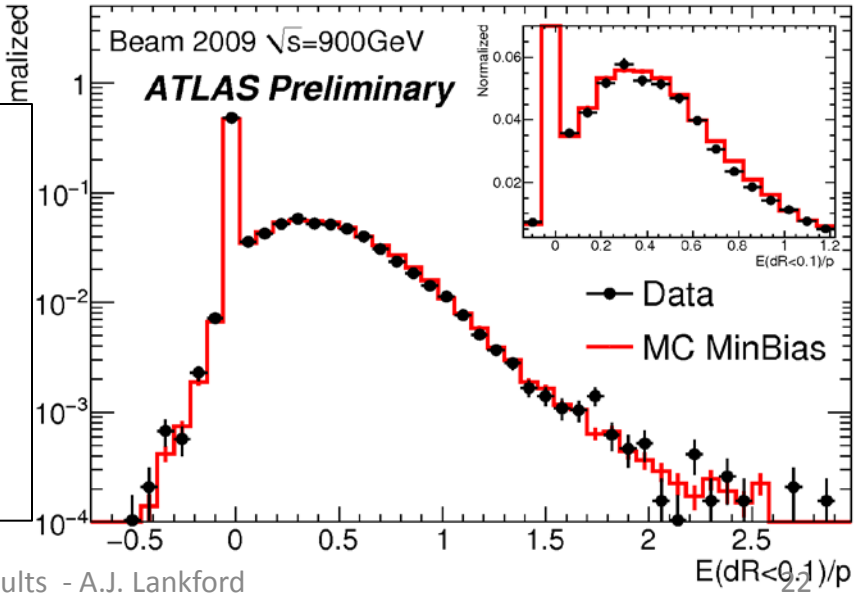




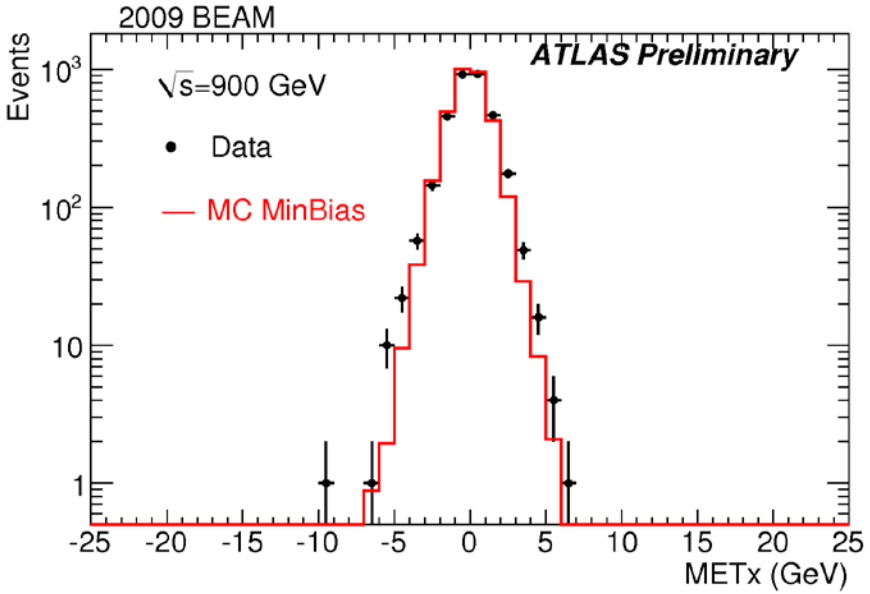
Jet1: E_T (EM scale)~ 16 GeV
Jet2: E_T (EM scale) ~ 6 GeV

Calorimeter response near isolated track
- within R<0.1
- no nearby track (R<0.4)
- $0.5<p_T<10$ GeV
- only cells in clusters
- uncorrected energy scale

Well reproduced by simulation
after much tuning with testbeam data

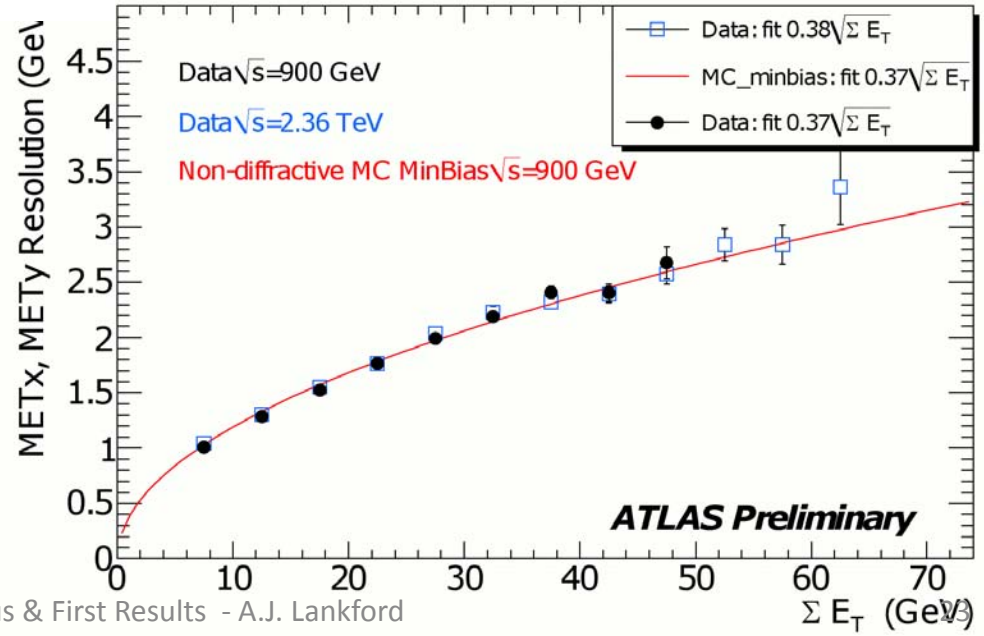


Early Missing Et Performance

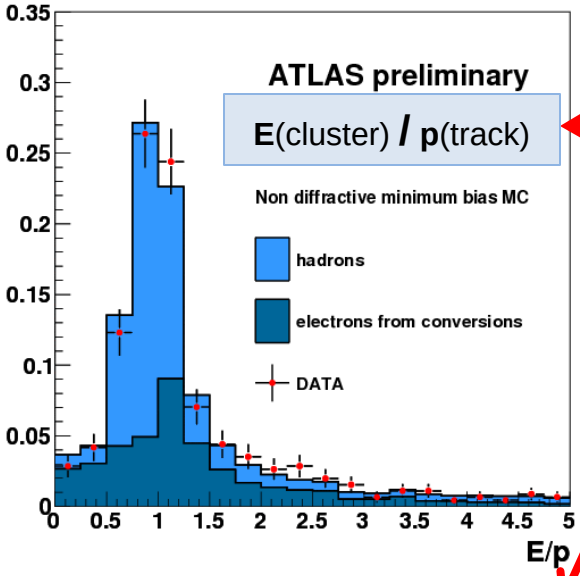


Missing transverse energy vector E_T calculated from observed E in clusters
(uncorrected energy scale)

Missing E_T resolution
Distribution without significant tails
Early performance meets expectations.

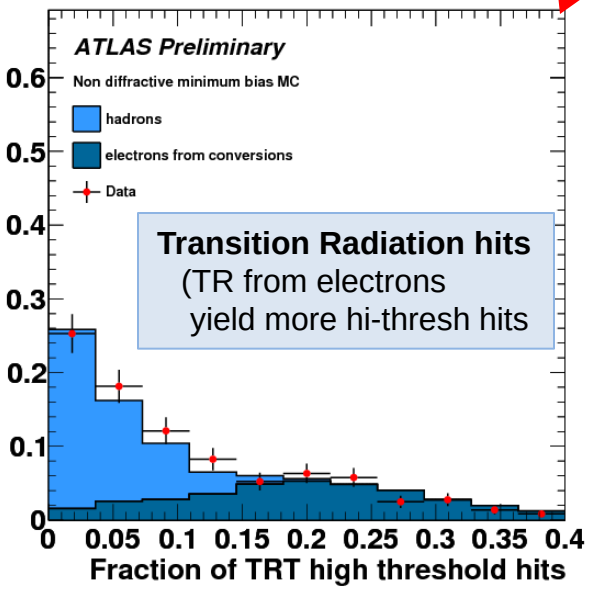


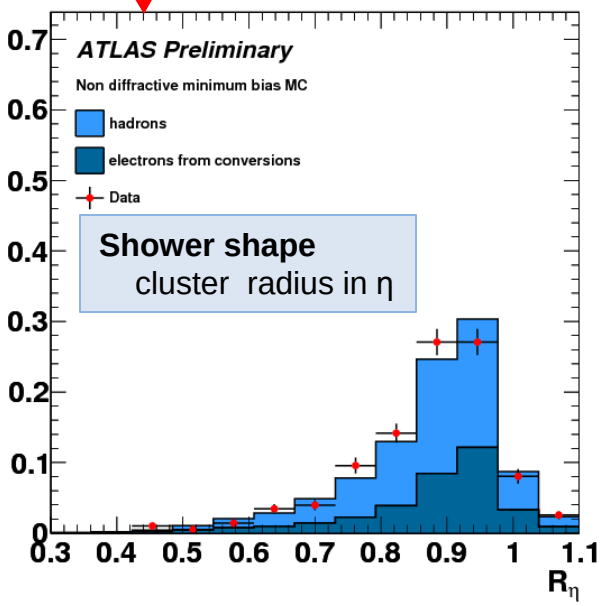
Early Performance of Electron ID



Check of electron ID variables
- **EM cluster matched to track, E/p**
- **transition radiation in tracker**
- **calorimeter shower shape variables**

Sample: EM clusters E_T>2.5 GeV + track
- 783 candidates in 330k events
- Dominated by:
  - hadron "fakes"
  - electrons from γ-conversions



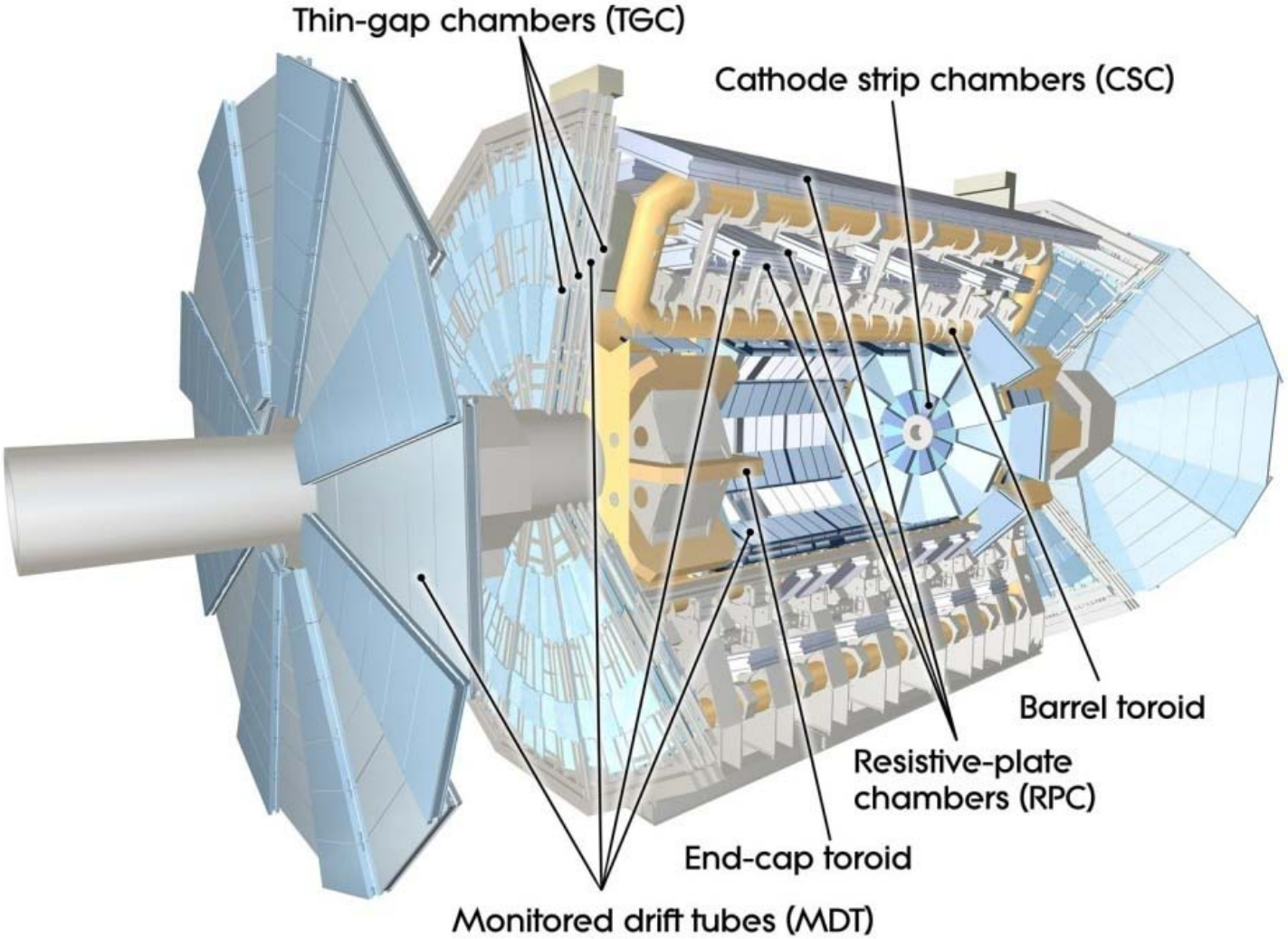


Faithful to expectations for key electron id variables

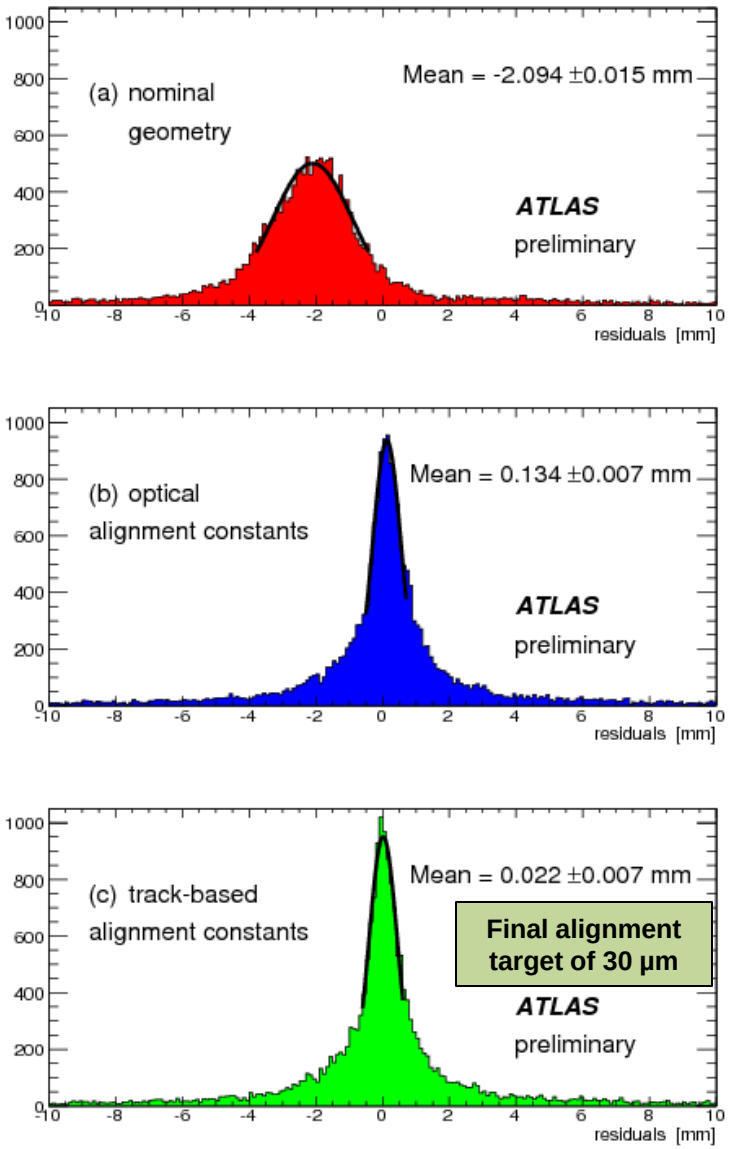
Good data-MC agreement
for (soft) electrons & hadrons (challenging regime for detector performance & detector modeling)

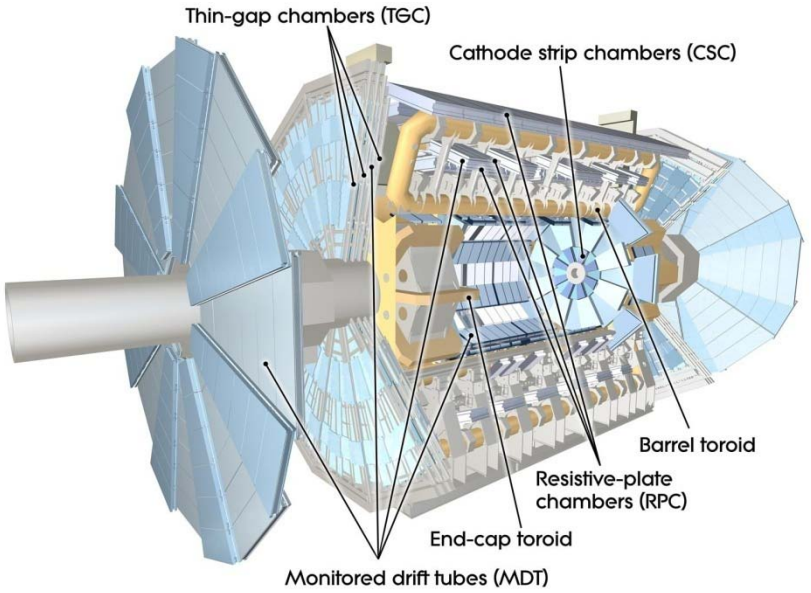
Muon Spectrometer

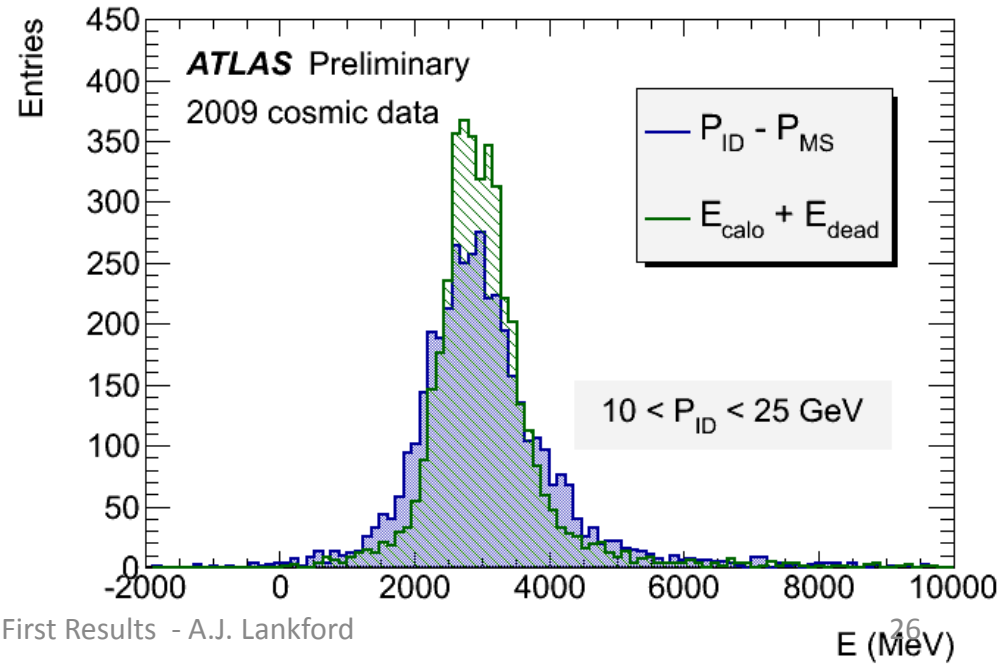
muon detection **momentum measurement**



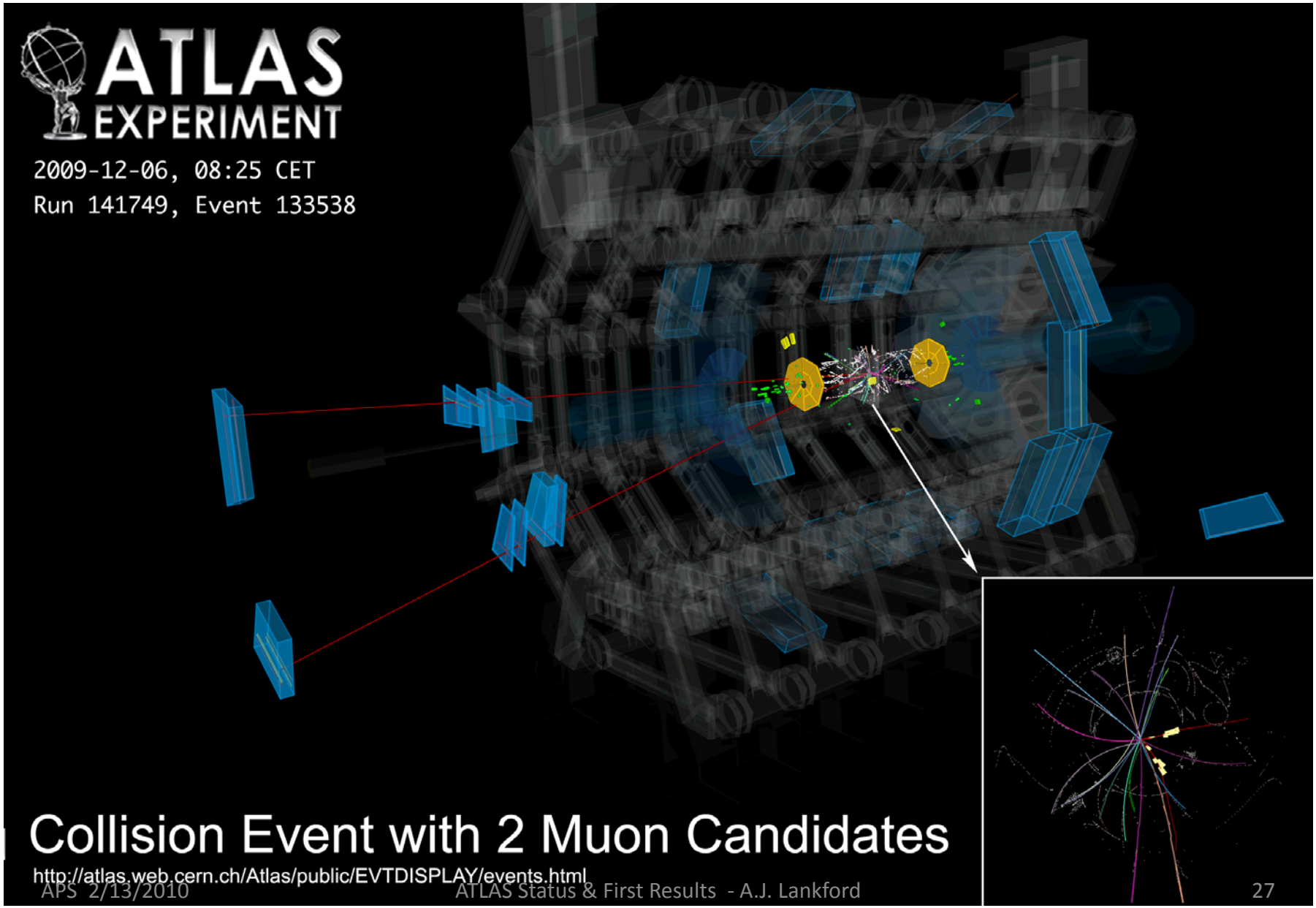
Early Performance of Muon Spectrometer







Early Performance of Muon Spectrometer

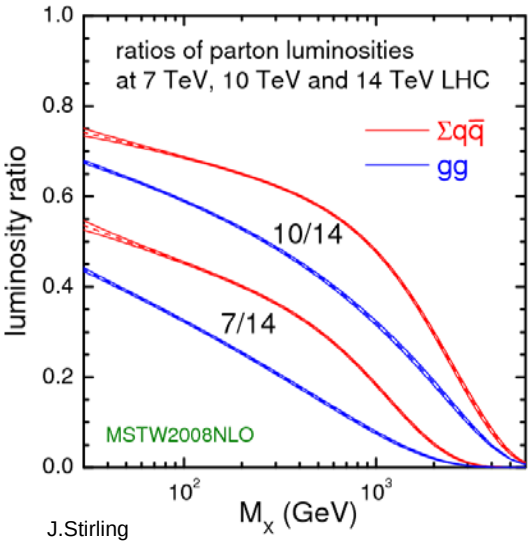


Physics Prospects for 2010 - 2011

ATLAS now looks forward to a long data-taking run at E_{cm} = 7 TeV in 2010 – 2011: ~ 1 fb^{-1}

- **Although the physics reach is less than at E_{cm}=14 TeV,**
  ~0.2*x* rate for ttbar; ~0.1*x* rate for W-prime (1.5 TeV)
  reach is beyond E_{cm}=2 TeV for high mass objects.
  ~20*x* rate for ttbar; ~200*x* rate for W-prime (1.5 TeV)

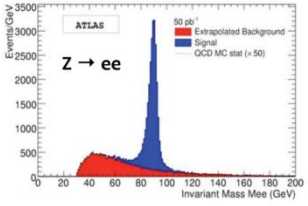
See Quigg in Session D9.

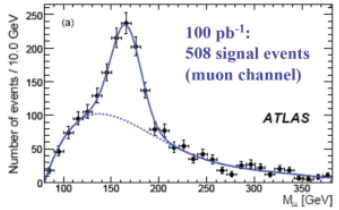


J.Stirling
http://projects.hepforge.org/mstwpdf/plots/plots.html

Beyond-Standard-Model discovery requires detailed understanding of:

- **Detector response**
  - **efficiencies, fake rates, E/p scales, resolution functions …**
- **Standard Model at 7 TeV**
  - **cross-sections, kinematic distributions, underlying event …**



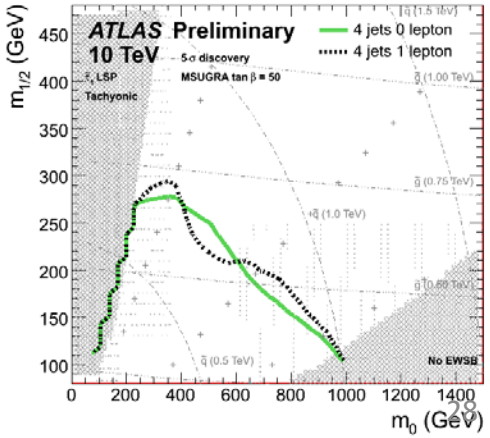


Three steps in physics program (will partially overlap)**:**

- **Understand detector & reconstruction:**
  - **using physics samples: *Z→ee*, *μμ*, ttbar, …**
- **"Re-discover" Standard Model**
  - **measure at LHC energies**
  - **understand as background to BSM searches**
- **Search for new physics**

2010/11 run will advance ATLAS well along this path,

- **with scope for discoveries, *e.g.*:**
  - **Compositeness**
  - **Supersymmetry**
  - **New gauge bosons or other high-mass resonances**
- **with sensitivity to rival or exceed the TeVatron**



Summary and Conclusions

After years of preparation (design, construction, installation, commissioning), the 900 GeV commissioning run in late 2009 provided ATLAS with:

- **A first view of the full detector (and trigger) response to collision data**
- **An opportunity to demonstrate operation of the ATLAS detector and its offline processing under realistic conditions**
- **Valuable data for further detector tuning**
- **A sizable data sample for studying inclusive p-p interactions**
- **An exciting preview of the era ahead**

Demonstrated:

- **ATLAS detector performs well and is ready for long 2010-2011 run.**
- **ATLAS simulation accurately reproduces detector geometry & material.**

Embarking in next days on data-taking run at E_{CM} = 7 TeV (target 1 fb^{-1})**,**

- **paving the way for long-range program of discovery,**
- **with potential for early discovery.**
- **See presentation of Prof. Arce, *Prospects for New Physics at the LHC,* in Session B1.**

ATLAS Collaboration congratulates and thanks the CERN accelerator and technical teams for excellent machine performance & impressive progress over the first few days of LHC commissioning. We are excited about the collaborative adventure of discovery ahead.