



BNL Role in ATLAS Computing

DOE Annual HEP Program Review

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ATLAS Computing



❖ Facility support

- Local (U.S.) software support
- BNL Tier 1 Center
- Production (Simulation & Reconstruction)
- Develop & deploy Grid Tools & Services

❖ Software

- Core Software
- Reconstruction & Simulation

❖ Analysis

- Physics capabilities at the LHC
- Preparation for Analysis

WHO from BNL?



❖ ATLAS Computing Facility (ACF) Group:

- Responsible for the U.S. Tier 1 Facility
- B. Gibbard, R. Baker
- + 5 FTE ATLAS support staff (sharing common ground with RCF staff)

❖ Physics Application Software (PAS) Group

- Responsible for many key ATLAS core software deliverables
- T. Wenaus, D. Adams,
- W. Deng, P. van Gemmeren, P. Nevski, V. Perevotchikov, A. Undrus

❖ Omega & Theory Group

- Involved in a wide range of core software, simulation, reconstruction and physics analysis in ATLAS
- K. Assamagan, D. Damazio, S. Kandasamy, H. Ma, F. Paige,
- S. Rajagopalan, V. Shelkov, H. Takai

U.S. ATLAS Tier 1 Facility

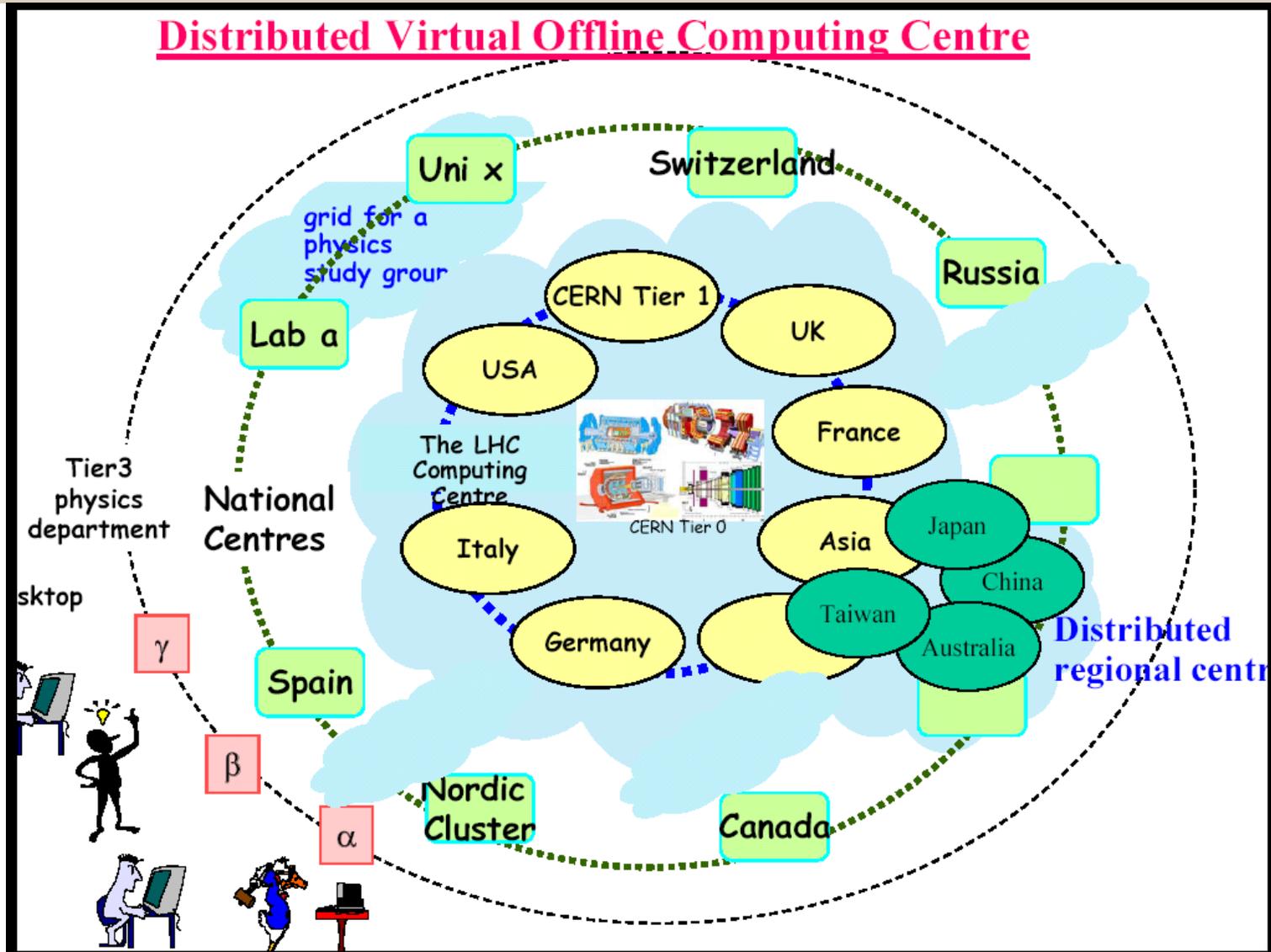


- ❖ Supply capacities to the ATLAS Distributed Virtual Offline Computing Center
 - At levels agreed to in a computing resource MoU (yet to be written)
- ❖ Guarantee the Computing Required for Effective Participation by U.S. Physicists in the ATLAS Physics Program
 - Direct access to and analysis of physics data sets
 - Simulation, re-reconstruction, and reorganization of data as required to support such analyses
- ❖ BNL serves as the U.S. Tier 1 Facility
 - Co-Located with the RHIC Computing Facility under B. Gibbard
- ❖ Tier 1 capacity expected to be ~20% of Tier0
 - ~ Five U.S. Tier 2 centers, each ~20% of Tier 1 capacity.

LHC Computing Facilities Model



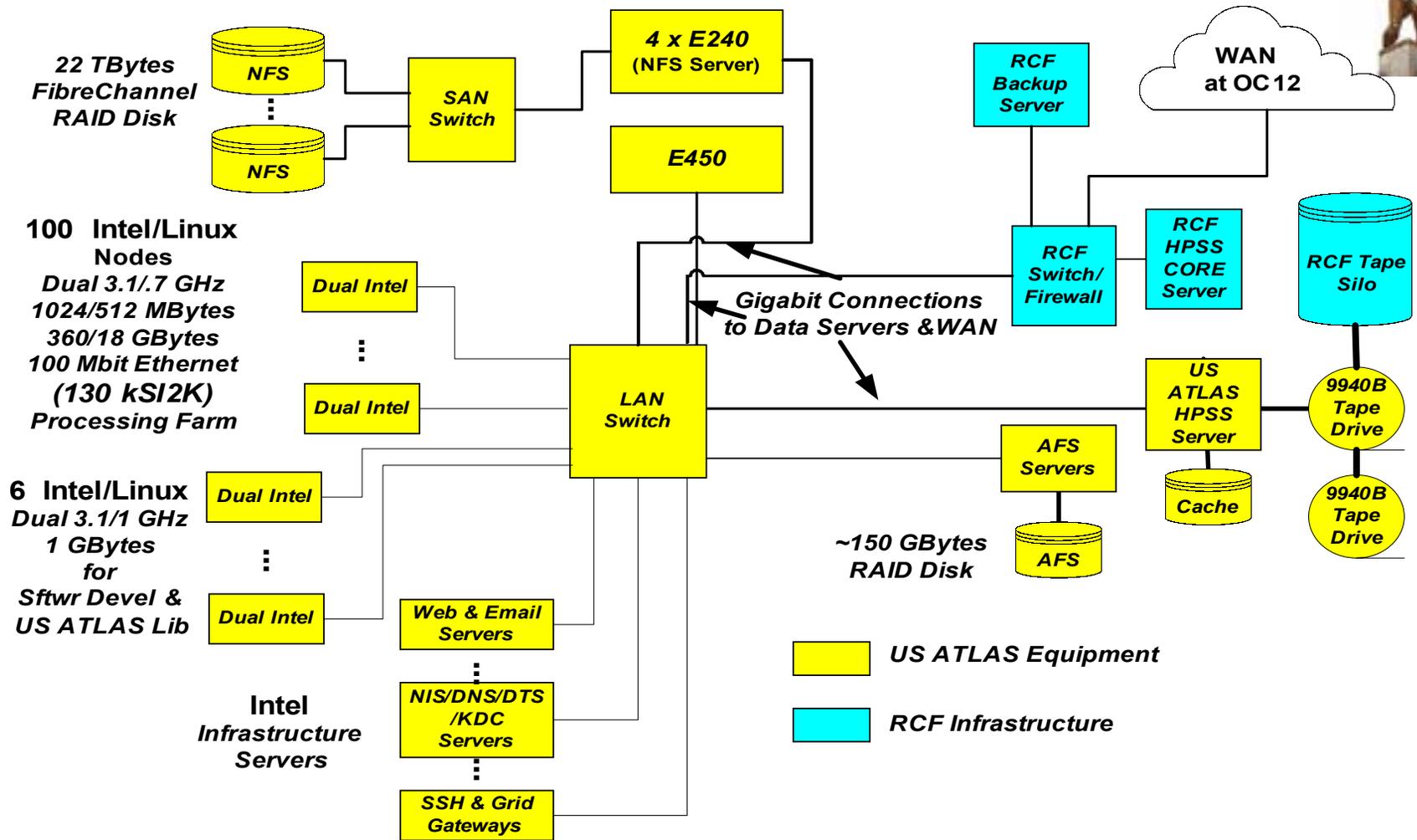
Distributed Virtual Offline Computing Centre



US ATLAS Regional Center (Tier 1) at BNL



Mar '04



U.S. ATLAS Tier 1 Facility



❖ Functions

- Primary U.S. data repository for ATLAS
- Programmatic event selection and AOD & DPD regeneration from ESD
- *Chaotic* high level analysis by individuals
 - Especially for large data set analyses
- Significant source of Monte Carlo
- Re-reconstruction as needed
- Technical support for smaller US computing resource centers

❖ Co-located and operated with the RHIC Computing Facility

- To date a very synergistic relationship
- Some recent increased divergence (Linux RH version)
- Substantial benefit from cross use of idle resources (2000 CPU's)

U.S. ATLAS Software Support



- ❖ Alex Undrus (BNL) is a full time librarian
 - Manage ATLAS and other relevant external software locally at BNL.
 - Software available over AFS for U.S. physicists for both software development and analysis.
 - Provide nightly builds of the software (automated tool now also in use by CERN-ATLAS and LCG-Application)

- ❖ Alex is also a member of the ATLAS software infrastructure team (SIT).
 - Coordinate activities with international ATLAS

Data Challenge Production

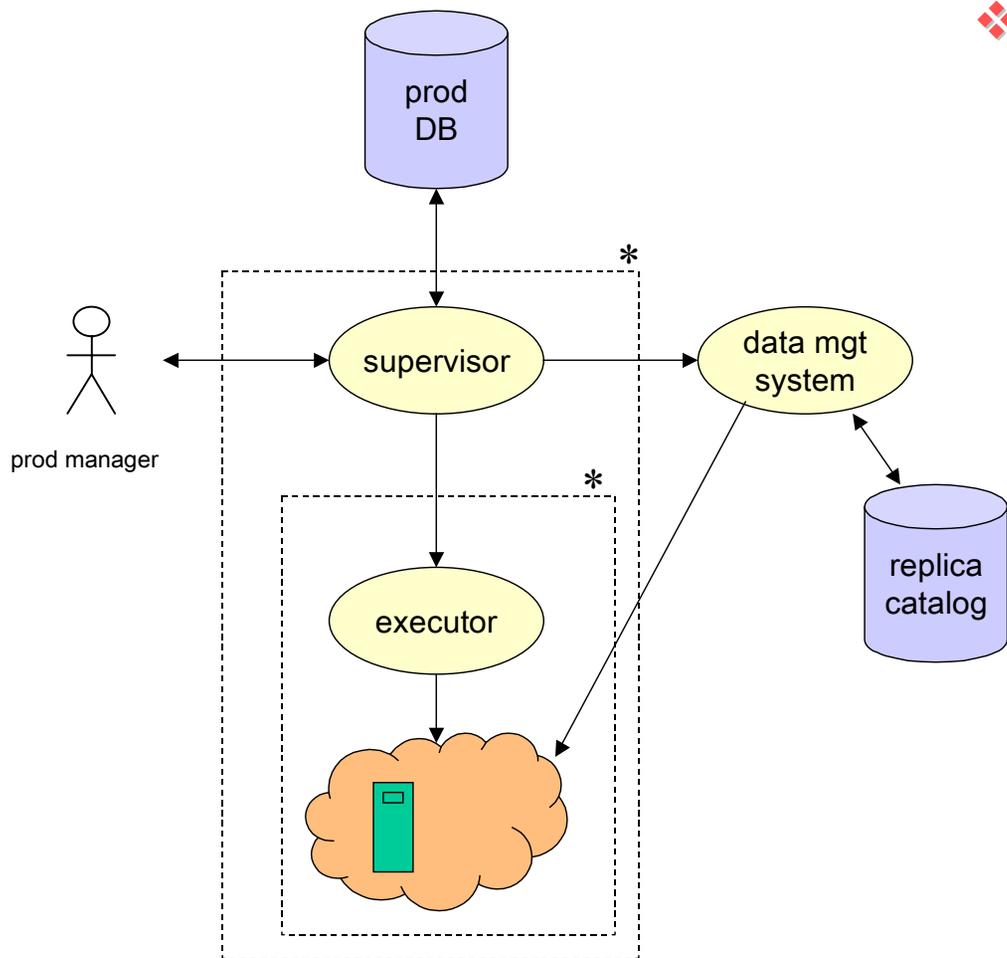


- ❖ **Data Challenge I (FY03) with a scale of 10^7 events**
 - U.S. provided 8% of CPU cycles and handled 14% of total production
 - Minimal use of Grid computing

- ❖ **Data Challenge II : (FY04) with a scale : $\sim 10^8$ events**
 - Simulation + Digitization phase to start in May
 - Followed by Reconstruction phase in July
 - First use of GEANT4 for simulation + new Digitization
 - Use of several new software tools including POOL persistency
 - Grid-centric production
 - Internal review to address U.S. readiness for DC2 (April 9)
 - R. Baker, W. Deng, P. Nevski (BNL personnel involved in DC2)
 - DC2 Experience forms input to the Computing Model.

- ❖ **Expect significant use of Tier 1 resources for Combined Test-Beam as well**

New Production System for DC2



❖ Goals

- Automated data production system for all ATLAS facilities
- Common database for all production - Oracle currently
- Common supervisor run by all facilities/managers - Windmill
- Common data management system - Don Quihote
- Executors developed by middleware experts (Capone, Lxor, NorduGrid, batch systems, CanadaGrid...)
- Final verification of data done by supervisor

Leading BNL Roles in ATLAS Software/Physics



D. Adams	Distributed Analysis Coordinator
K. Assamagan	Analysis Tools Coordinator
H. Ma	LAr Database Coordinator
F. Paige	SUSY Physics Group co-coordinator
S. Rajagopalan	LAr Software Coordinator
T. Wenaus	LCG Applications Area Coordinator Now appointed also as the ATLAS Database Project co-leader (May 1, 2004)

Torre and I are members of the ATLAS computing and software management groups respectively.

Core Software Activities

Event Data Model



- ❖ **Event Data Model Architecture providing : (S. Rajagopalan)**
 - Memory management for Event Data Objects
 - On-demand access to objects from persistency
 - Persistable navigation between objects (Track→Hits or Jets→Cells)
 - History (how objects are created)
 - Efficient access to data in regions of interest

- ❖ **Common EDM Infrastructure and Framework with HLT**
 - Simplifies testing HLT algorithms offline and vice-versa

- ❖ **Access to in-memory objects from ROOT (V. Perevotchikov)**
 - Allows interactive ROOT analysis during reconstruction processing

Core Software Activities

Data Management



- ❖ BNL current efforts are to integrate the ATLAS software with POOL to provide persistency support.
 - Its longer term include direct contributions to the POOL effort in the areas of Persistency Support and Event Collections
 - P. van Gemmeren, H. Ma

- ❖ BNL is also providing based persistency for non-event data
 - S. Kandasamy, H. Ma
 - Oracle support for LAr Calorimeter production data
 - Conditions data for LAr TB and Data Challenge
 - Hong Ma is the overall Liquid Argon database coordinator
 - Oversees the needs of production, installation, online, offline and testbeam efforts in the LAr community.

Core Software Activities

Distributed Analysis



- ❖ Extends physicist analysis in analyzing large data sets and extracting results to include distributed processing, data and users.
- ❖ Provides a well defined language for submitting interactive and batch requests. Interfaced to well known Analysis tools (Python, ROOT, ...)
- ❖ Work coordinated closely with the LCG ARDA project
 - D. Adams is the ATLAS Distributed Analysis Coordinator
 - and is the ATLAS representative in LCG-ARDA

The LCG Project



- ❖ To help the LHC experiments prepare, build and operate the computing environment needed to manage and analyze multi-PB scale data coming from each detector.
- ❖ Main working body of the LCG is the Project Execution Board (PEB) chaired by Les Robertson.
- ❖ PEB has four areas, each with a project manager:

✓ Applications (T. Wenaus)

Grid Technology

Fabrics

Grid Deployment

LCG Applications Area



❖ Identifies and provides solutions for common projects:

- Long term advantages in providing resources, support and maintenance

❖ Identified Common Projects are:

✓ Persistency Framework Project (POOL)

■ Physicist Interface Project (PI)

- Interfaces and tools with which physicists will use the software

■ Core Libraries and Services Project (SEAL)

- Core libraries, Object Dictionary, Scripting Services etc.

■ Software Process & Infrastructure Project (SPI)

- Provides basic environment and tools for software development

■ Simulation Project

- Support for Geant3, Geant4, Detector Description

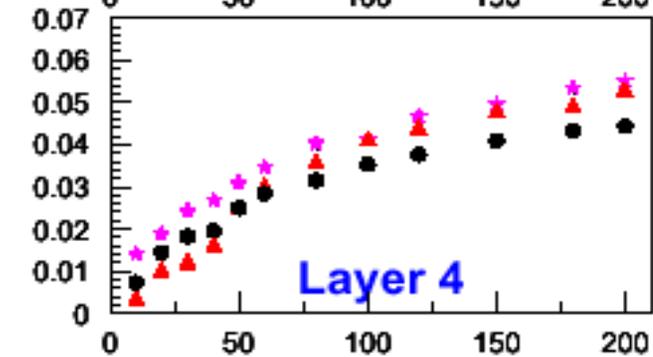
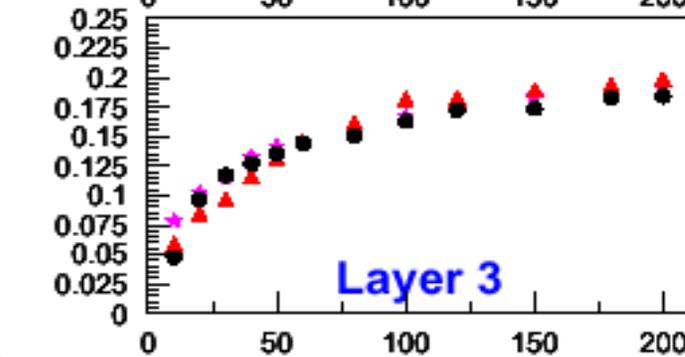
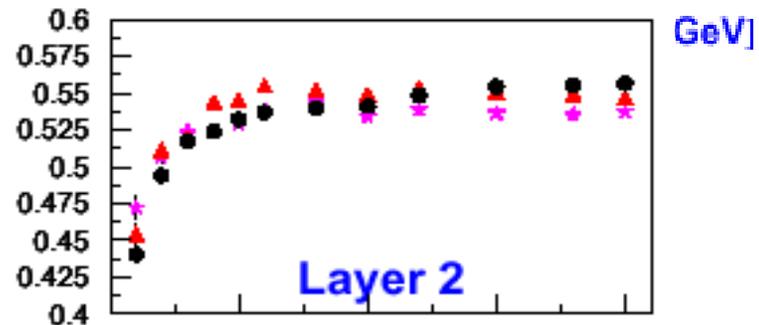
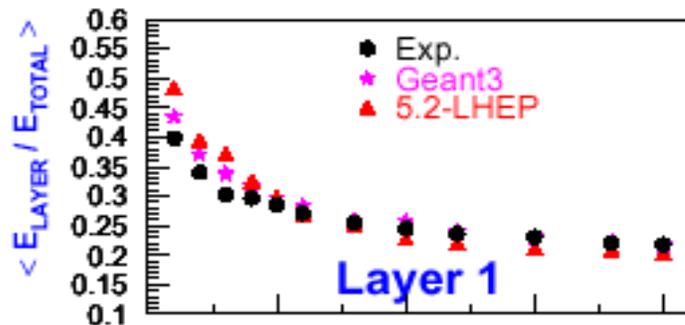
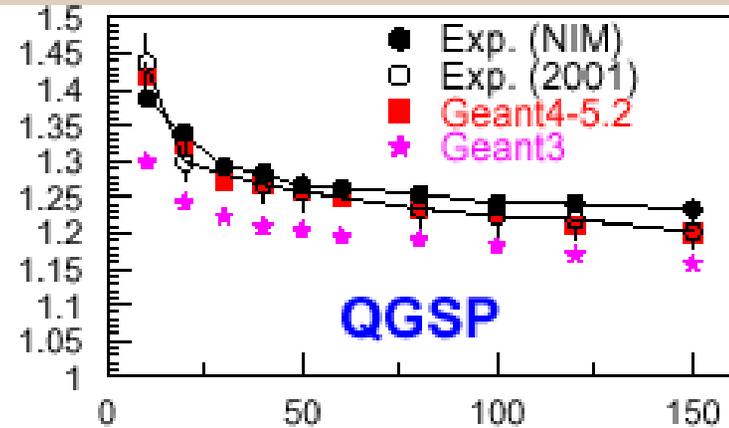
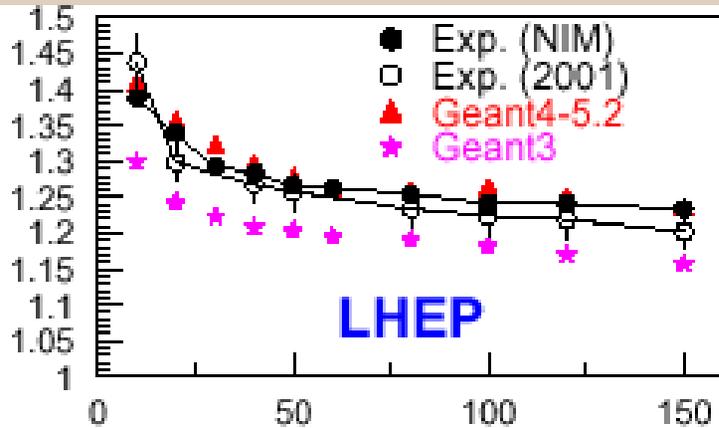
Liquid Argon Software



- ❖ S. Rajagopalan : LAr Software Coordinator
- ❖ H. Ma : LAr Database Coordinator
- ❖ In the past year, effort directed toward the upcoming Data Challenge 2 exercise and the Combined Test Beam
 - First test-beam to use the new software with the baselines ATLAS architectural tools (Athena Framework, POOL persistency, ...)
 - We have just delivered the software that allows:
 - Reading and reconstructing Testbeam data
 - Analyzing calibration runs and saving output in Database
 - Calibration algorithms and constants are being optimized
 - Testbeam (and ATLAS) simulation in place
 - Capability for online monitoring in progress
 - Validation of new software and Geant4 simulation in progress
 - ... a lot remains to be done

Geant-4 Validation

Comparison of Hadronic Endcap Simulation with TB/G3



Geant4 — LHEP

Analysis Tools



- ❖ How does a physicist do his analysis?
 - Ntuples and PAW/ROOT?
- ❖ What software tools will be made available?
 - For selection and further analysis of desired samples
- ❖ What output can the physicist expect from reconstruction?
 - In what format?
 - Will they be able to navigate back to raw information to reconstruct?
- ❖ Most of the ATLAS work has so far focused on the data flow through combined reconstruction.
- ❖ Now the effort has begun to better define the analysis stage, including particle identification.
 - 3- day analysis tools workshop in London (April 6-8)
 - K. Assamagan (BNL) leads the analysis tools group

Other Reconstruction Activities

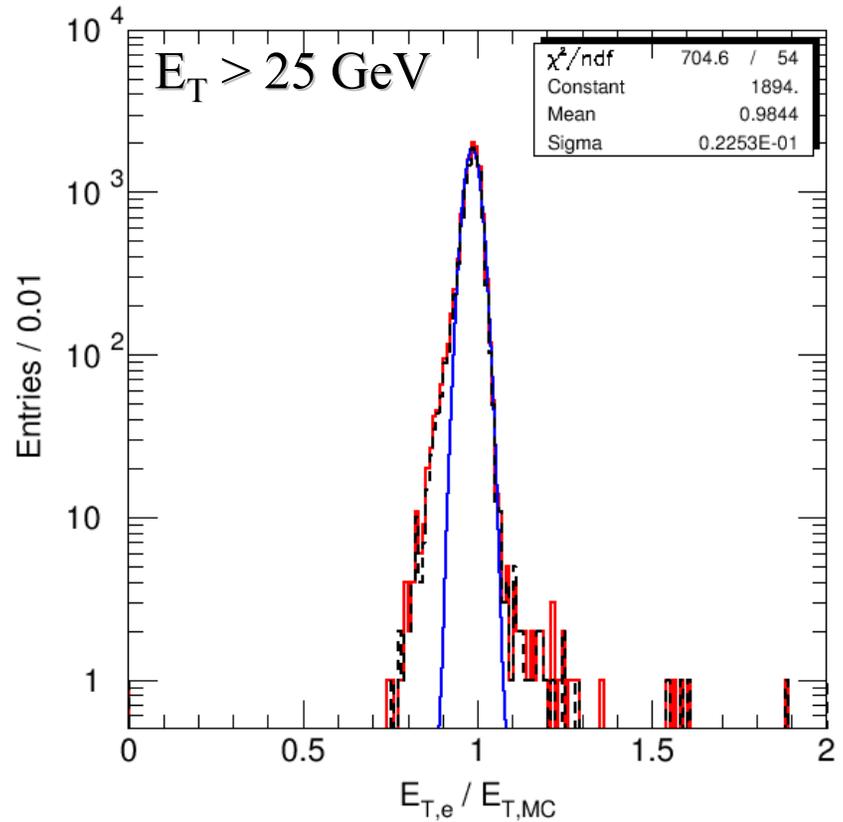
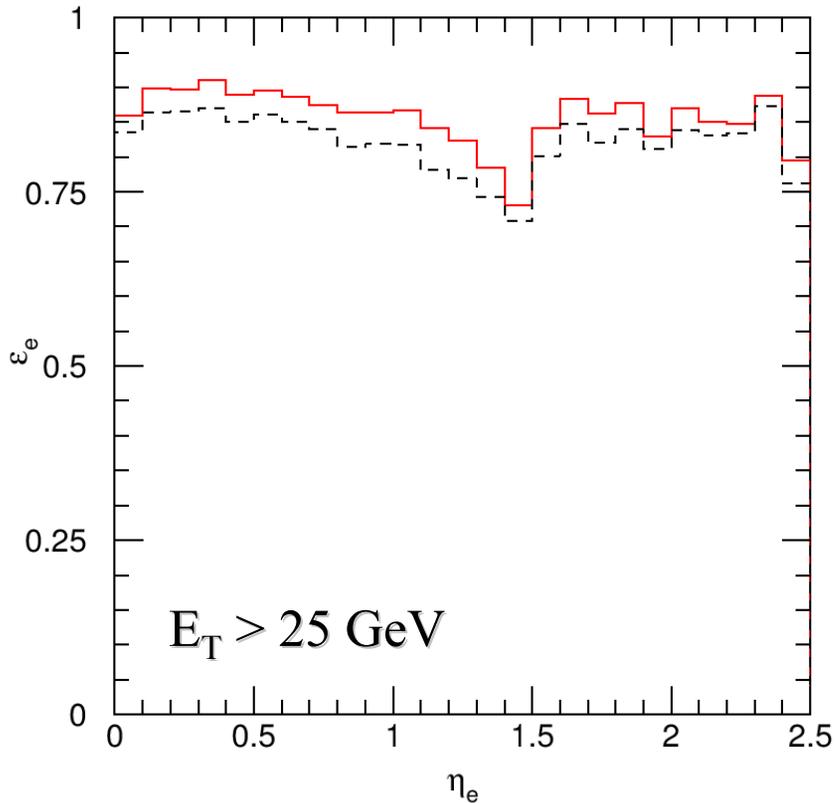


- ❖ **Muon Reconstruction (K. Assamagan)**
 - EDM and Data Converters for Muon Reconstruction

- ❖ **Combined Reconstruction Activities: (H. Ma, F. Paige, S. Rajagopalan)**
 - e-gamma Reconstruction
 - Develop algorithms to identify egamma candidates
 - Tau reconstruction
 - Jet Reconstruction and Hadronic Calibration
 - Missing E_T Reconstruction

- ❖ **Physics capabilities in the SUSY sector (F. Paige)**
 - F. Paige serves as the co-coordinator of the ATLAS SUSY Group
 - GMSB & mSUGRA models have been explored
 - Easy to discover if it exists, challenge is to understand underlying model
 - Analysis being re-studies with full simulation, pile-up + new software

Electron Efficiency and Resolution DC1 SUSY sample



Jet and EtMiss Resolution

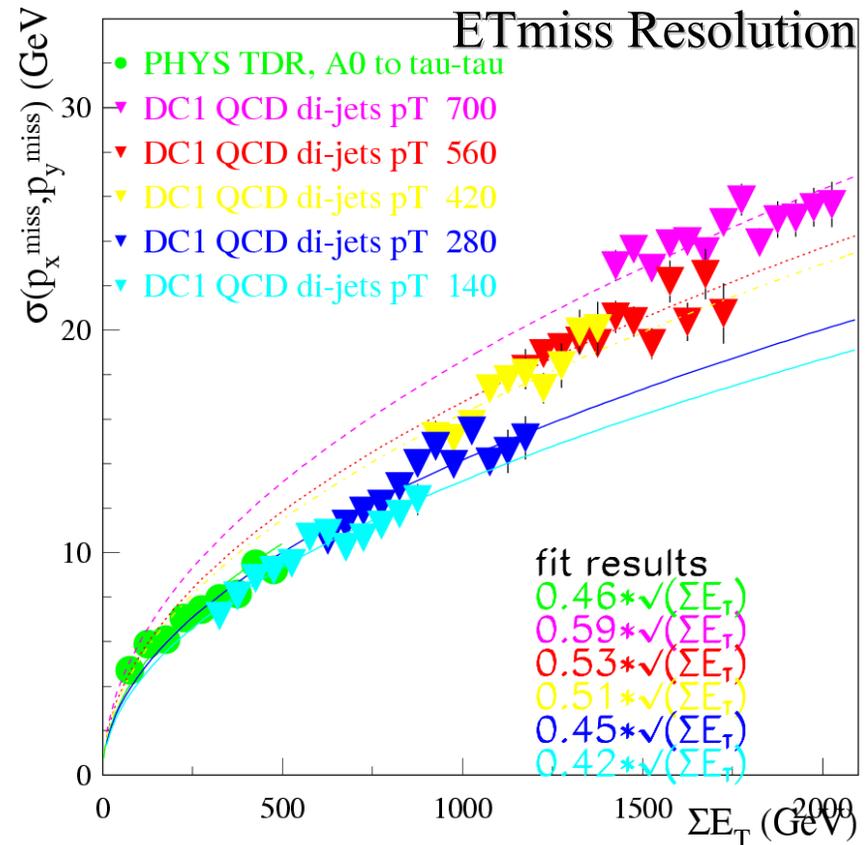
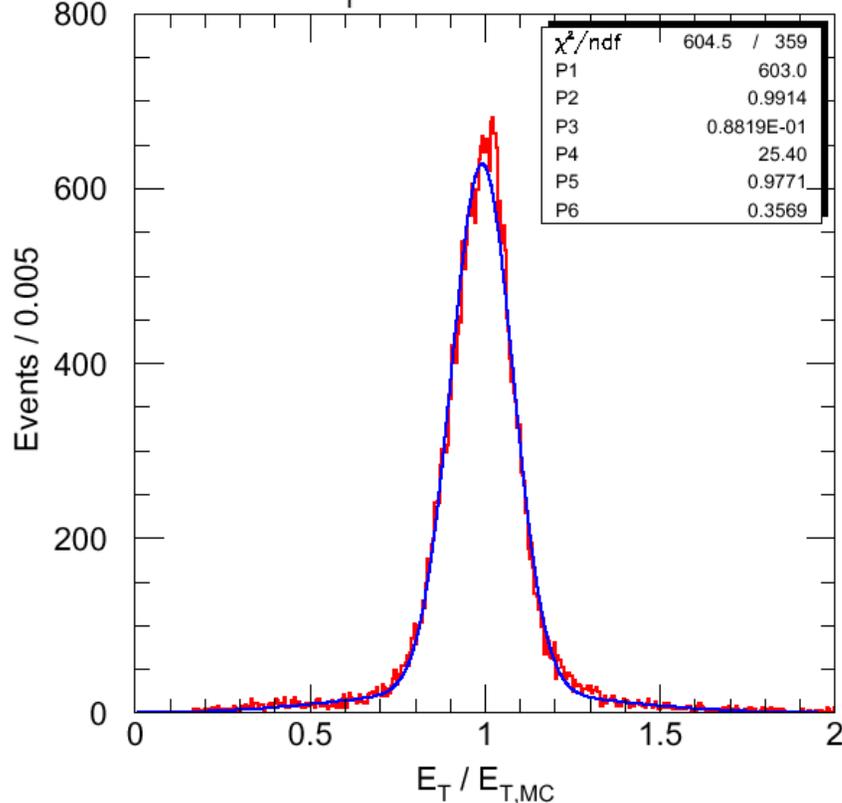
First look with new H1-based calibration



ATLAS calorimeters non-compensating ($e/\pi \sim 1.3$)

- Hadronic showers less dense than EM : so weight cells more
- H1 calibration (at cell level) produces improved linearity, jet and MissingET resolution compared to standard sampling calibration

Jet Resolution $E_T = 80-120$ GeV



Conclusion



- ❖ BNL is making significant contributions in several areas of ATLAS computing:
 - Major responsibilities both in ATLAS and U.S. ATLAS Computing
 - As a Tier 1 Center, BNL is the main node in U.S. Grid testbed

- ❖ BNL is developing significant expertise in many areas of software:
 - In turn, this expertise allows us to rapidly start looking at physics
 - Allows us to coordinate software development and analysis activities in U.S. ATLAS

- ❖ Our main problem: We continue to remain understaffed.
 - Significant cuts in project funding as well
 - Addition of V. Shelkov in the past year is helping us
 - LHC continues to be not so attractive ground for post-docs



<https://www.bnl.gov/usatlas/workshop/>