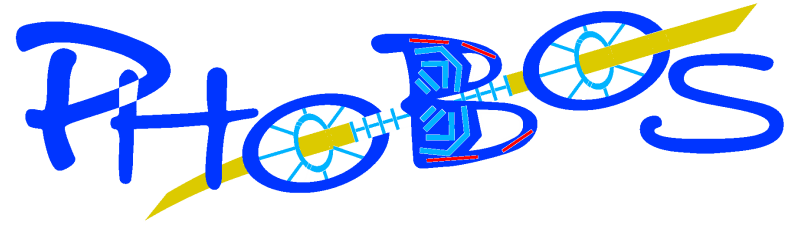




MASSACHUSETTS
INSTITUTE OF
TECHNOLOGY



PROOF in PHOBOS

A decorative graphic consisting of three overlapping squares (yellow, red, and blue) and a black crosshair.

Maarten Ballintijn / MIT

maartenb@mit.edu

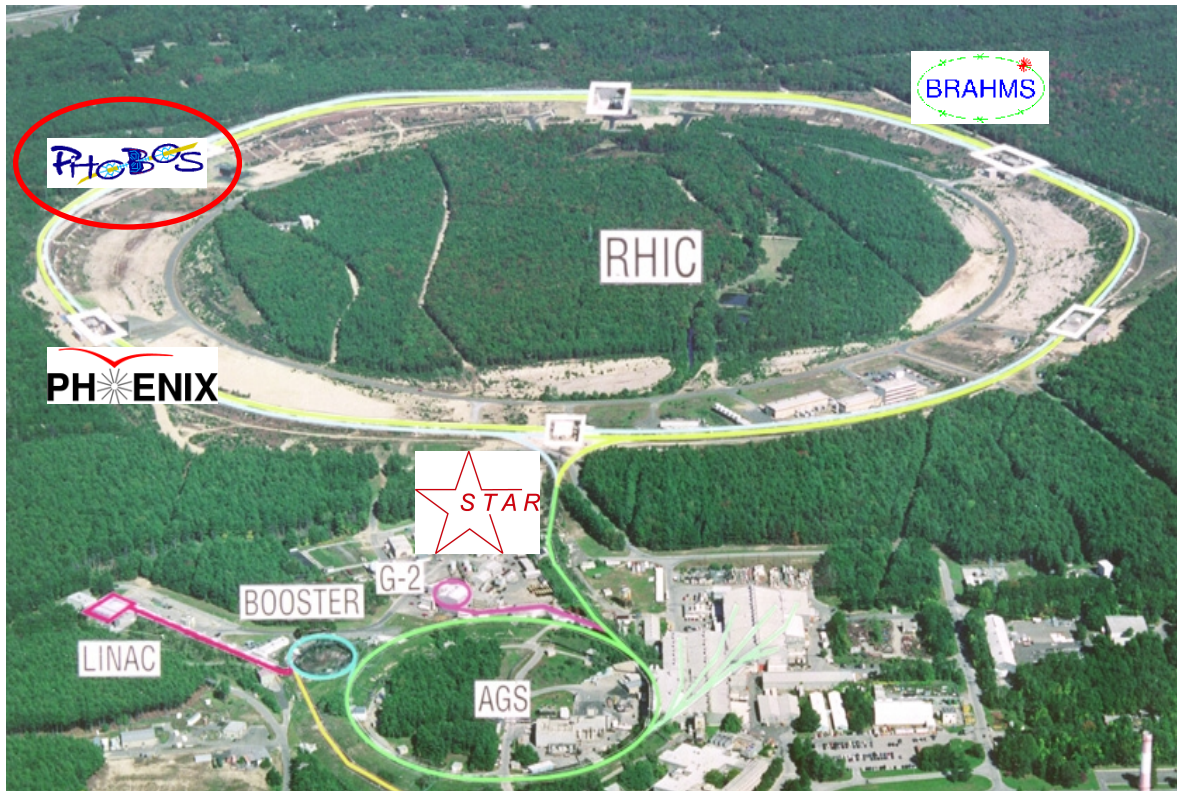
May 24, 2006 – Application Area Meeting

A decorative graphic consisting of overlapping yellow, red, and blue squares with a black crosshair.

Outline

- The PHOBOS Experiment at RHIC
- Data Analysis at RCF
- PROOF at RCF
- Analysis Examples
- Future PROOF Developments at MIT

Relativistic Heavy Ion Collider (RHIC)

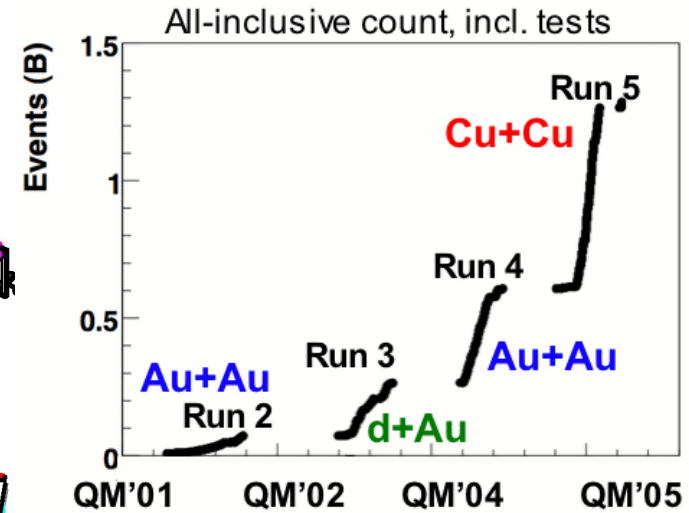
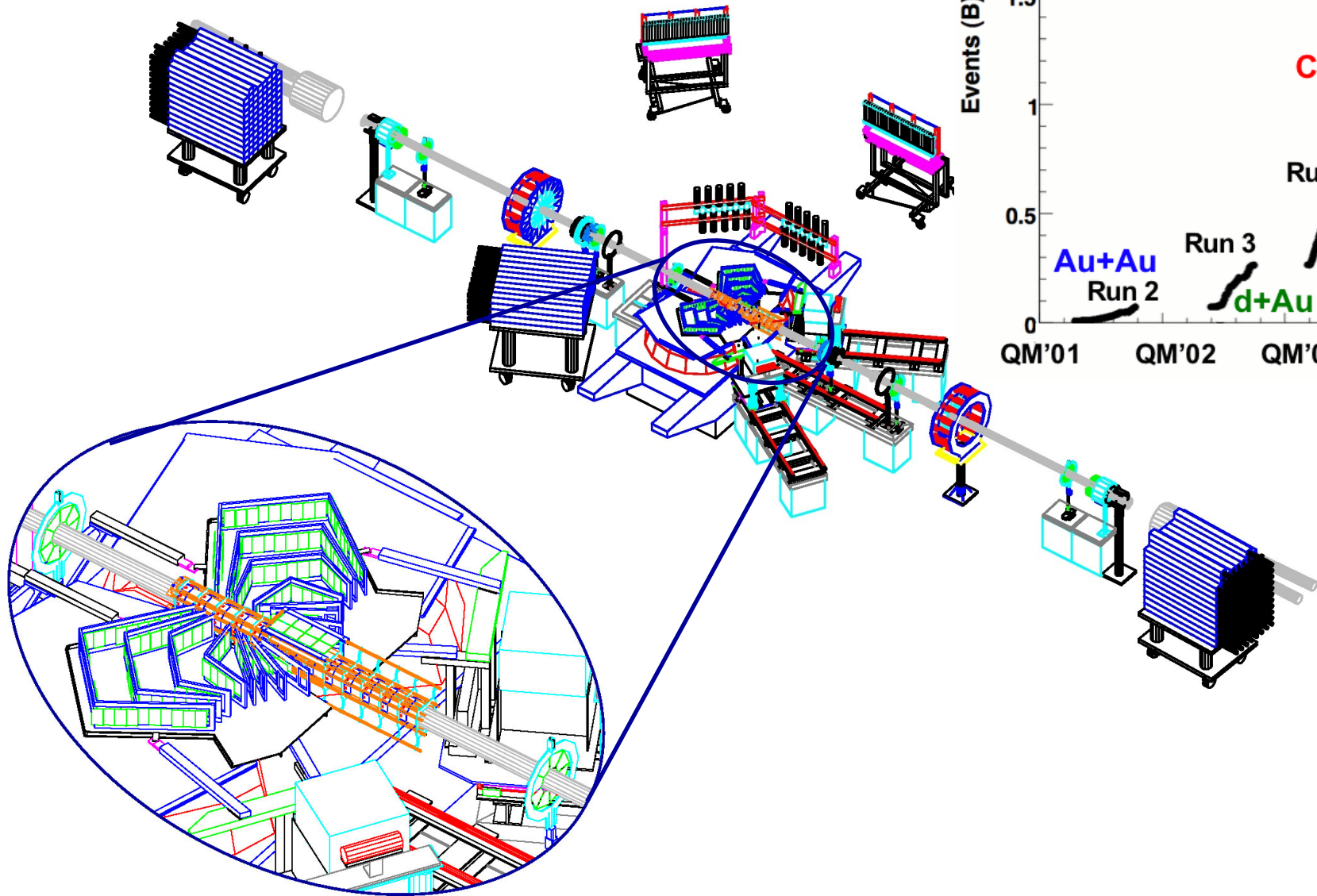


- 4 Experiments
 - 2 big and 2 small
- Complementary capabilities

First Physics in '00 Versatile machine

- **Au+Au ('00-'02)**
 - 19.6 GeV
 - 56 GeV
 - 130 GeV
 - 200 GeV
- **p+p ('02,'03)**
 - 200 GeV
 - polarized
- **d+Au ('03)**
 - 200 GeV

PHOBOS Experiment





Data Analysis at RCF

- RHIC Computing Facility
 - Large centrally managed facility
 - Sub cluster for each experiment
- Components of the Facility
- Batch System
- Data Storage and Data Handling



Components of the Facility

- 25 Interactive Nodes
- 425 Compute nodes w/ distributed disk
 - 100 TB disk space
 - Mix of 100Mb and 1Gbit Ethernet
- HPSS tape robot / Mass Storage System
- Centralized disk space
 - NFS (0.9 TB) – home directories, software
 - Panasas (3.8 TB) – data, proof work directories



Batch Systems

- LFS batch system
 - Phased out in favor of Condor because of cost
- Condor
 - Kerberos authentication
 - Computing on Demand (COD) enabled for use with PROOF
 - Complex configuration – 4 priority levels (queues) – 4 x larger # VMs



Data Storage and Handling

- NFS servers
 - Home directories, Software, some Data
- Panasas
 - Replacing NFS for data
 - Used for PROOF directories
- Distributed Disk and rootd
 - Highly scalable
 - Cost effective
 - Needs management software: CatWeb



CatWeb Catalog and Data Manager

- PHOBOS File Catalog
 - All reconstructed and DST data (in HPSS MSS)
- Data management
 - Web based user interface
 - Database back-end and daemons for pools
- Storage pools – scatter data to avoid hot spots
- FileSets
 - Global and per user
 - Unit of data management and file access

- PhAT – Phobos Analysis Toolkit
 - ROOT based analysis environment
 - Collection of modules implementing reconstruction, calibration and analysis
 - AnT – Analysis Tree – DST supporting all PHOBOS Analysis efforts
 - PAR files available for all the modules
 - TGrid Interface to CatWeb



PROOF At RCF

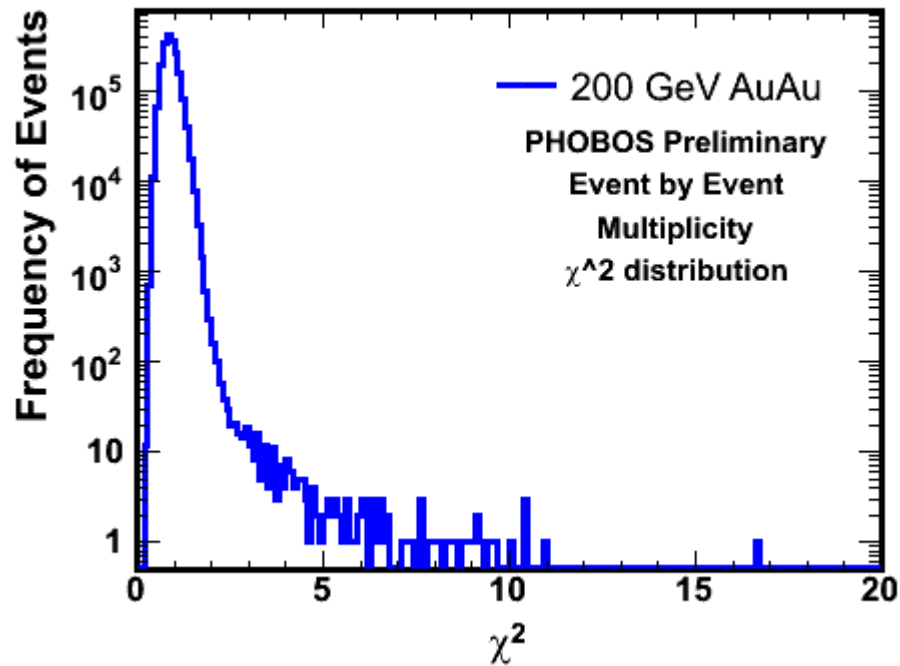
- Direct (xinetd) vs. Condor COD
- Intelligent proofserv wrapper
 - Multiple versions
 - No root access
 - Debug support (e.g. run with valgrind)
- PROOF server configuration
 - Per user config files - deprecated
 - Global predefined config files
 - Need a resource broker / scheduler



Analysis Examples

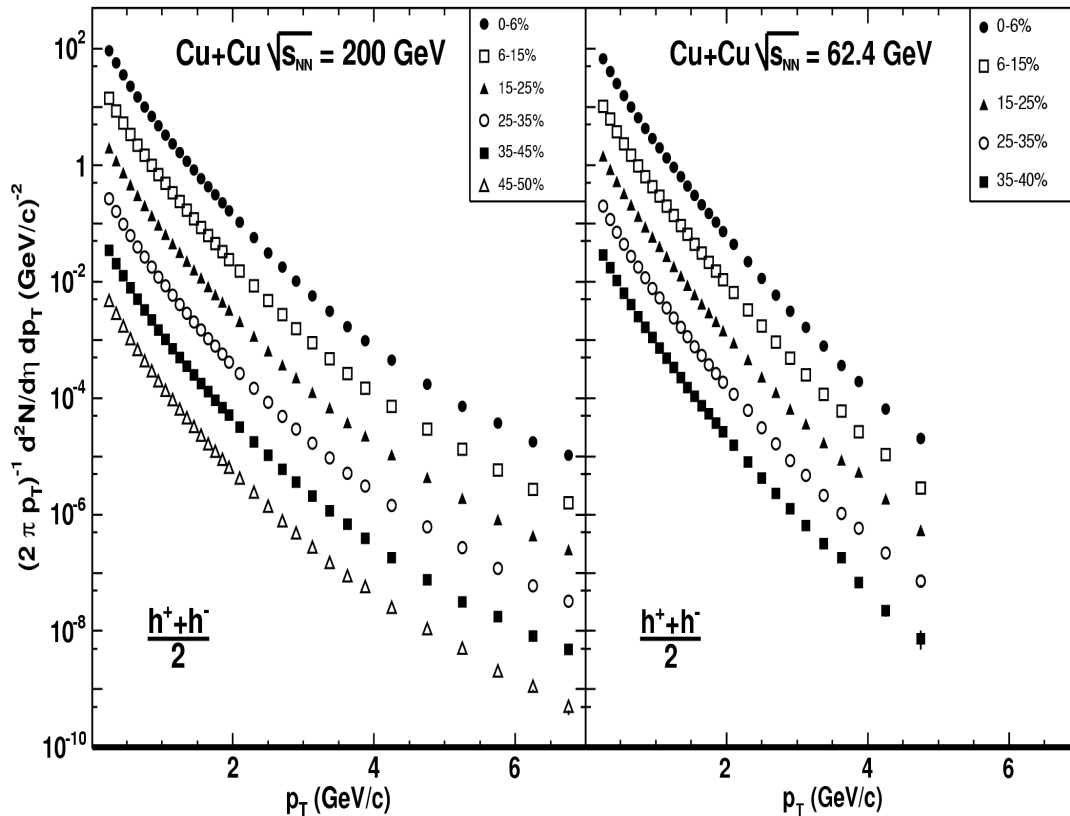
- These analysis examples were prepared using PROOF
- Presented at the Quark Matter 2005 conference in Budapest, Hungary
- For detailed information see:
 - Structure and Fine Structure of Hadron Production at RHIC, Gunther Roland, QM05 proceedings

Rare high multiplicity event search



- Burak Alver
- Dataset: 11k files, 4.5 TB
- 150 slaves, ~ 1 hour

Cu and Au Transverse Momentum Spectra

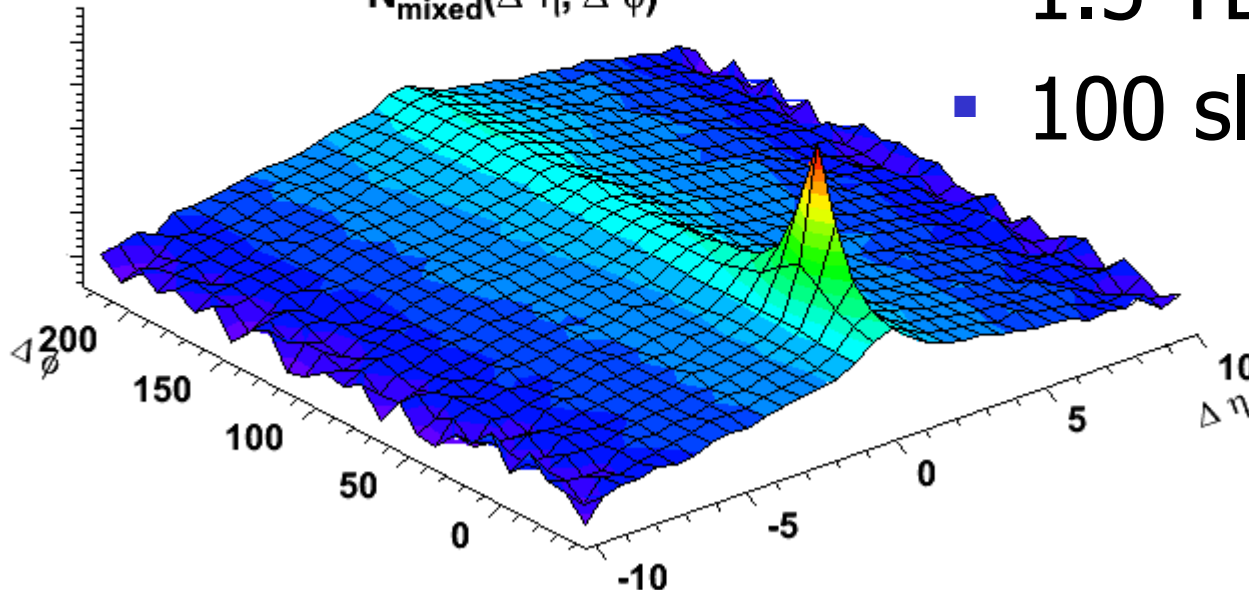


- Edward Wenger
- Dataset: 40k files, 13.5 TB
- 100 slaves, 45 min

Two Particle Correlations @ 200GeV

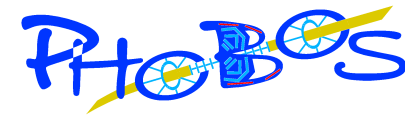
Two particle correlation function of minbias dAu 200GeV

$$C(\Delta \eta, \Delta \phi) = \frac{N_{\text{real}}(\Delta \eta, \Delta \phi)}{N_{\text{mixed}}(\Delta \eta, \Delta \phi)}$$

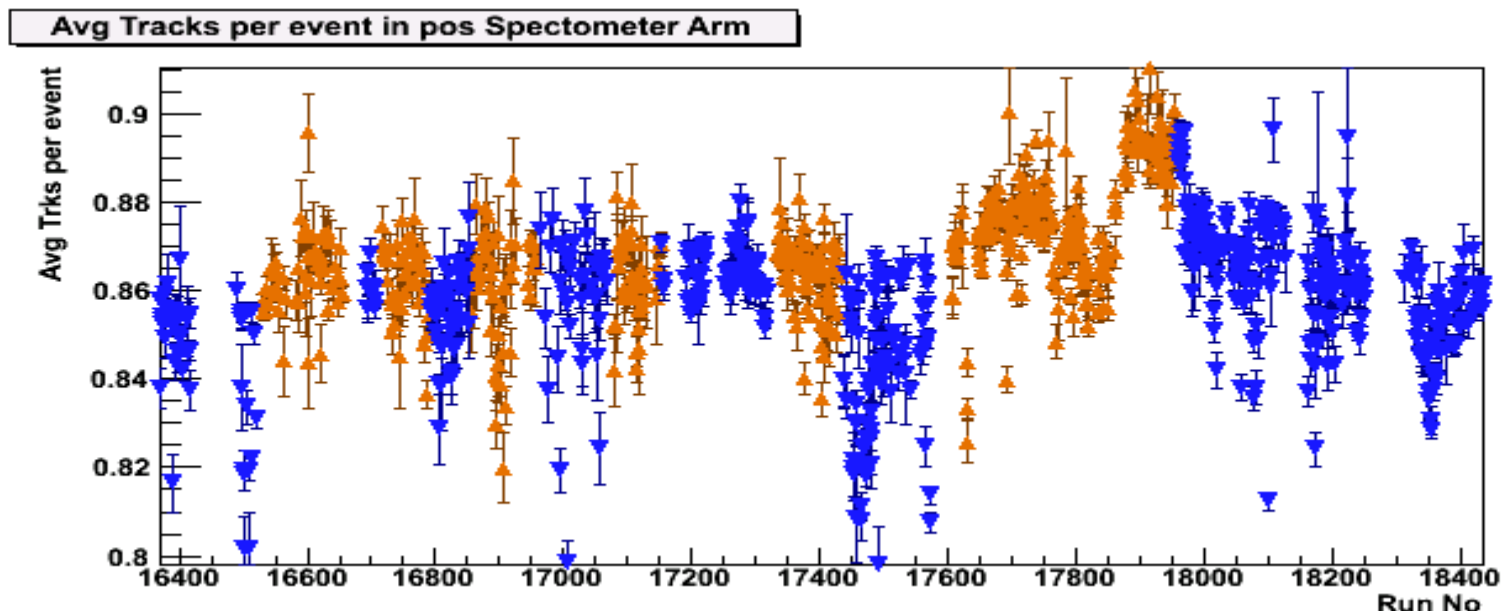


- Wei Li, Constantin Loizides
- Dataset: 4.5k files, 1.5 TB
- 100 slaves, 75 min

Identified Particle ratios using the Spectrometer



- Vasundhara Chetluru
- Dataset 40k files, 13.5 TB
- 100 slaves, 90 min



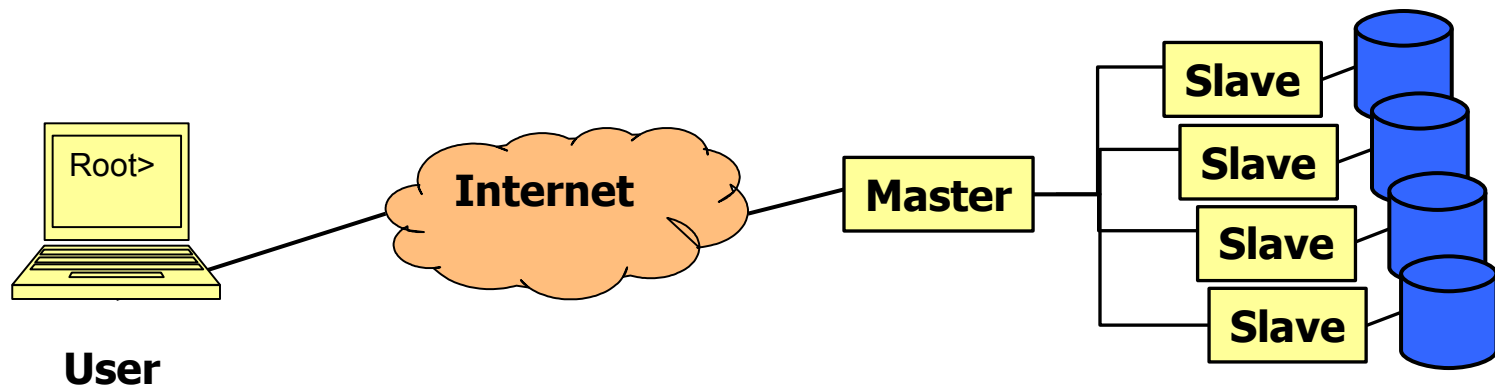


Future Work

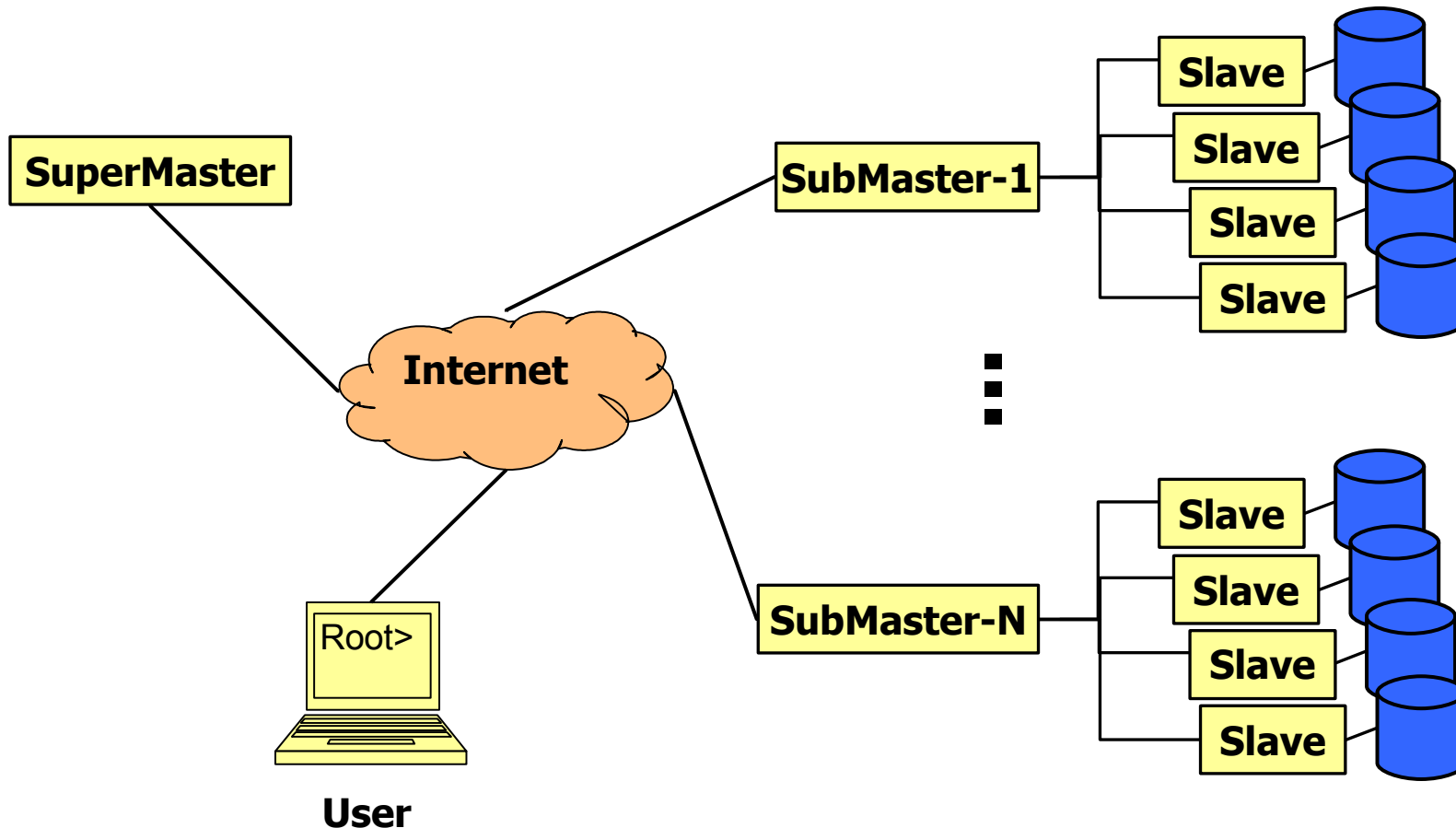
- Deploy PROOF into CMS Tier-2 Facilities
 - Starting with the Tier-2 at MIT
- Improve integration with schedulers and batch systems at RCF and on the Grid
- Extend multi-level master functionality
 - Started by Kris Gulbrandsen
 - Focus on packetizer
- Improved error handling

Multi Level Master configurations

- Default 3-tier configuration
 - client – master: Low bandwidth / high latency
 - master – slaves: High bandwidth / low latency



Multi Level Master configurations





Multi Level Master Configurations

- Geographically distributed setup (Grid)
 - Distributed data
 - Distributed computing power (replicated data)
- Scalability in large cluster
 - Parallel merging
 - Local network topology
- Static super packetizer based on mass storage domain tag

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Questions?
