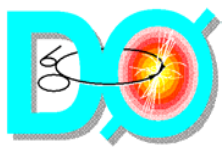


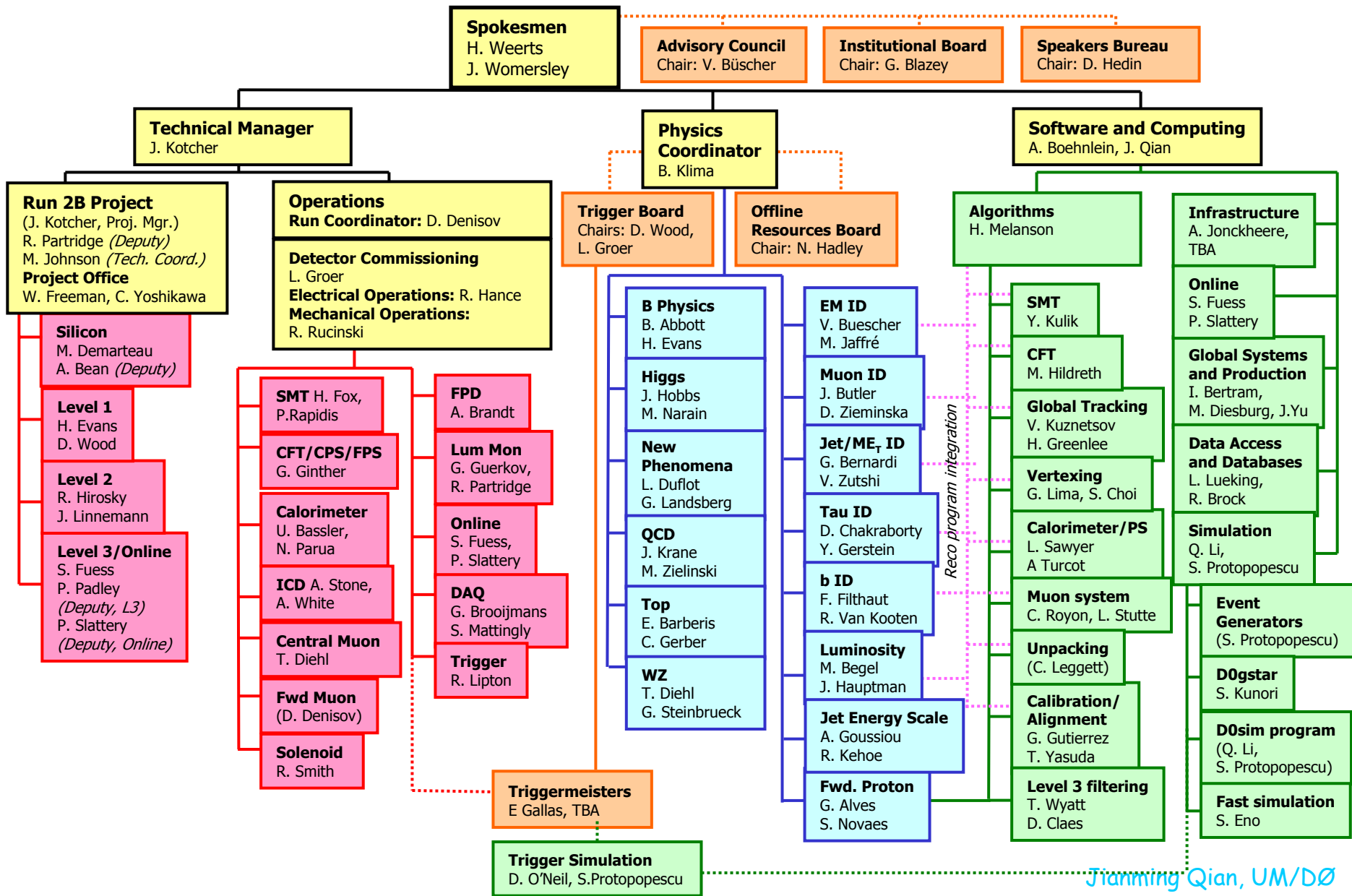
Software & Computing

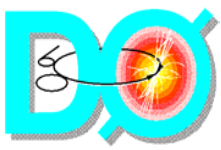
Overview

- **Where we are now**
- **Where we want to go**



Organization



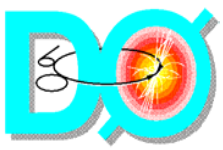


Where We Are Now

All building blocks are in place ...

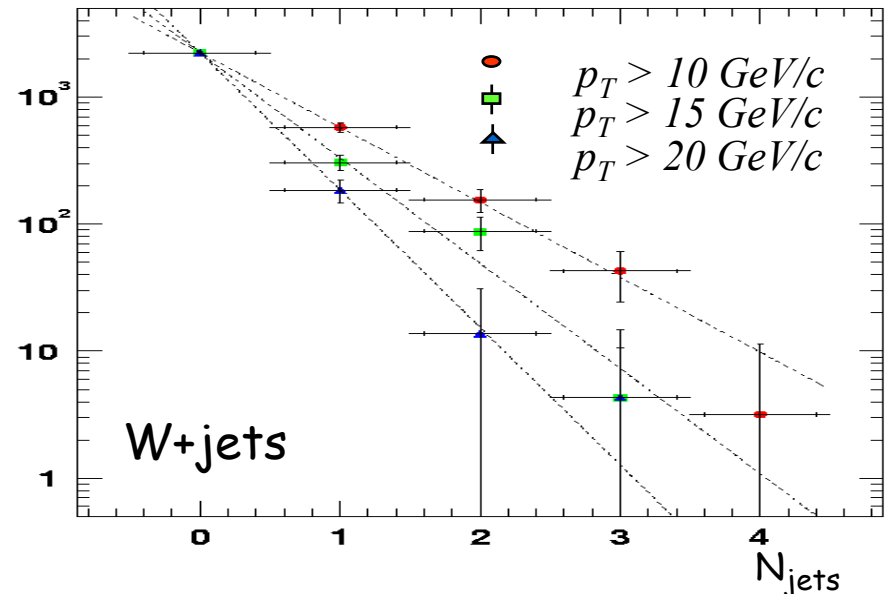
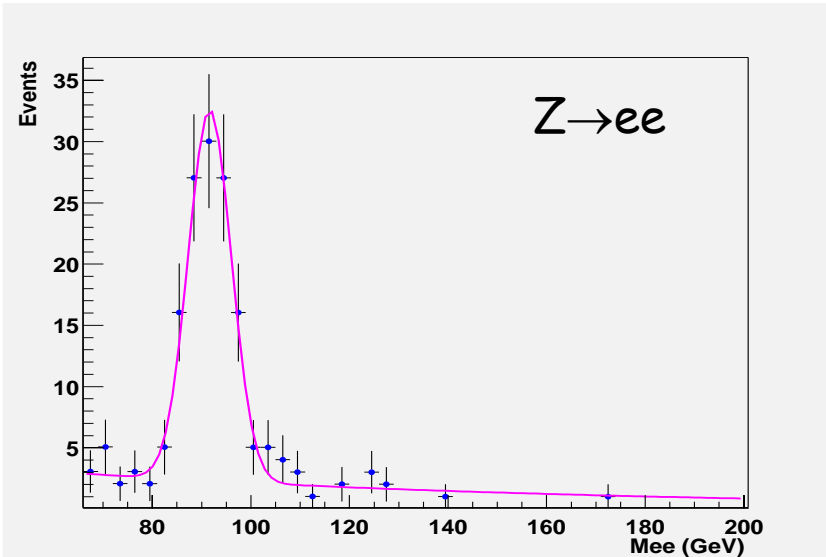
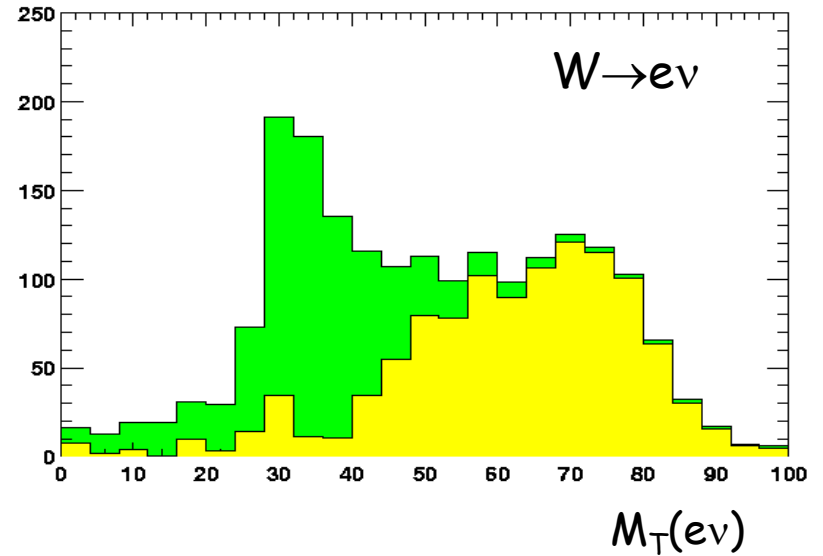
- **PC/Linux based Level-3 is taking a 500 Hz input and the DAQ is capable of writing at ~50 Hz.**
- **The offline reconstruction program (DØRECO) has all the basic reconstruction functionalities, is deployed at all farms, and writes DØRECO output in a temporary format.**
- **Data processing is done at Fermilab. The central farm is capable of processing event at ~12 Hz DC (20 sec/event on a 500 MHz processor) .**
- **Monte Carlo needs of physics analyses are met by remote farms (Czech R., France, G. Britain, Netherlands, USA)**
- **Geant-based (slow) and parameterized (fast) simulation programs exist and are being refined.**
- **Basic infrastructures and functionalities of data handling and access are in place. Data are stored in the Enstore system via SAM.**
- **Analysis CPUs are provided by an SGI O2000 system (dømino) and Linux desktops (ClueDØ, ...).**

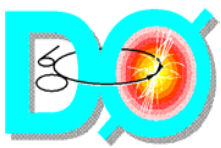
... we are producing first physics results!



Back to the Past

- We are identifying electrons, photons, muons, jets and mET
- We are reconstructing Ws and Zs
- We are pursuing basic analyses with limited statistics

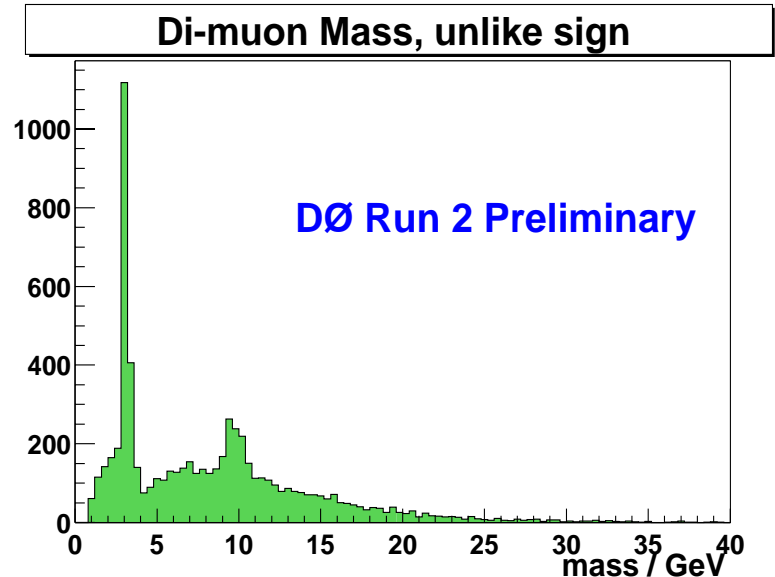
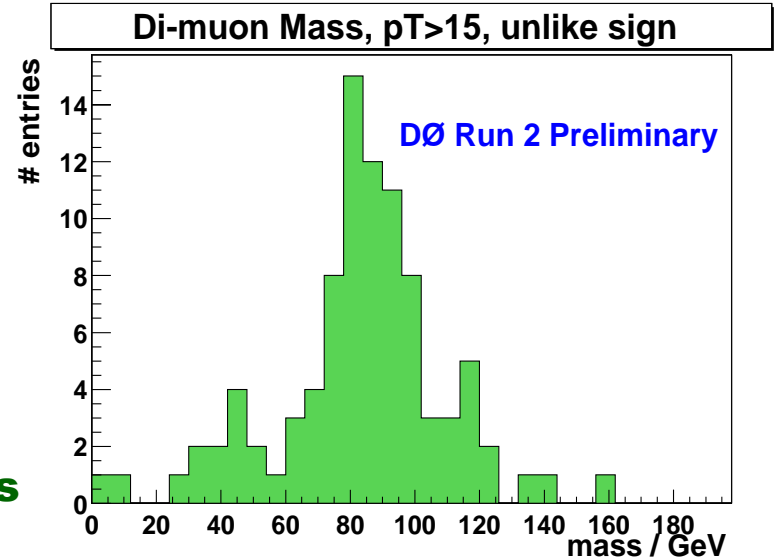
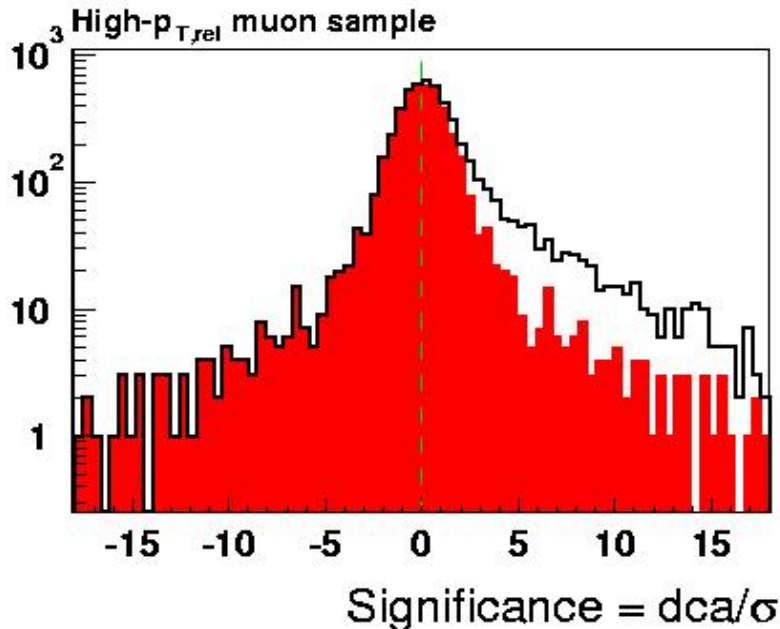


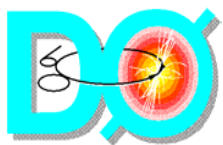


Looking to the Future

The new magnetic inner tracking system

- significantly improves our muon momentum resolution
- identify b-quark jets through large impact parameters and/or secondary vertices
- reconstruct long-lived neutral particles through their decays to charged particles





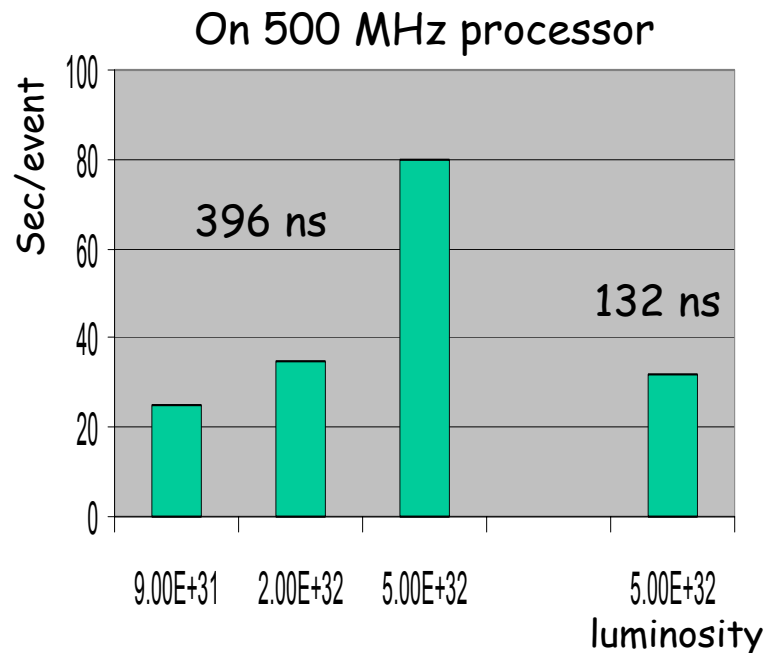
Level-3 and DØRECO

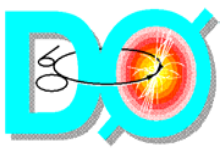
Level-3 Status:

- **Basic functionalities: event building, filtering through partial reconstruction, streaming, monitoring in a time budget of 0.1 sec.**
- **Most filters are being implemented and tested. Some of them are running online providing rejections.**
- **The farm currently has 48 GHz CPU power and is running with a factor of ~10 rejection.**
- **Streaming and monitoring tools are being developed.**

DØRECO Status:

- **Basic functionalities: reconstructing all physics object candidates, produce DST and Thumbnails (TMB).**
- **The current DØRECO has all reconstruction functionalities, but does not yet produce DST or TMB.**
- **Current version takes 20 CPU seconds per event on a 500 MHz benchmark processor. New version takes longer. Algorithm speed is a concern.**





Global Production System

Fermilab Farm: Data Processing

- **An SGI O2000 as the I/O server, used to buffer all output back to central storage facility.**
- **Two Gb and one 100 Mb Ethernet interfaces providing inside and outside connections.**
- **122 dual processor Intel systems as worker nodes with a total of 0.186 THz CPU power.**
- **128 dual processor 2.0 GHz nodes are on order, this will bring the CPU capacity to 0.565 THz.**

Remote Farms: Monte Carlo Production

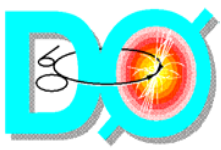
- **Remote Monte Carlo farms have been meeting our physics needs.**
- **Current sites: Boston, CCIN2P3, Lancaster, NIKHEF, Prague, UTA. All sites are running full GEANT simulation.**
- **Potential future sites: UCD Ireland, Karlsruhe, Manchester, Univ. of Michigan, Oklahoma, Tata, ...**



Data Handling & Databases

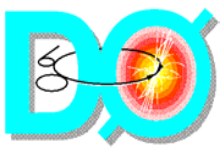
- **SAM (Sequential Access to data via Meta-data) is used to catalog data files produced by the experiment and provides distributed data storage and access to production and analysis centers.**
- **Data storage and access are provided through SAM stations deployed at production and analysis sites.**
- **The central database contains all metadata for each file registered with the system, as well as station configuration and operational information.**
- **The raw data from DAQ, data RECO outputs from the central production farm, MC RECO outputs from remote production farms as well as user files are stored at the Fermilab Enstore facility via SAM.**
- **Both ADIC robot with LTO drives and STK robot with 9940 drives are in use. The system has handled a peak volume of > 2 TB a day so far.**
- **An 8 processor SUN 4500 provides access to Oracle databases for both onsite and offsite needs. The implementation of DB servers reduces the number of licenses required.**

The current system works well and needs to be scaled, evolved and improved to meet Run IIa and IIb needs

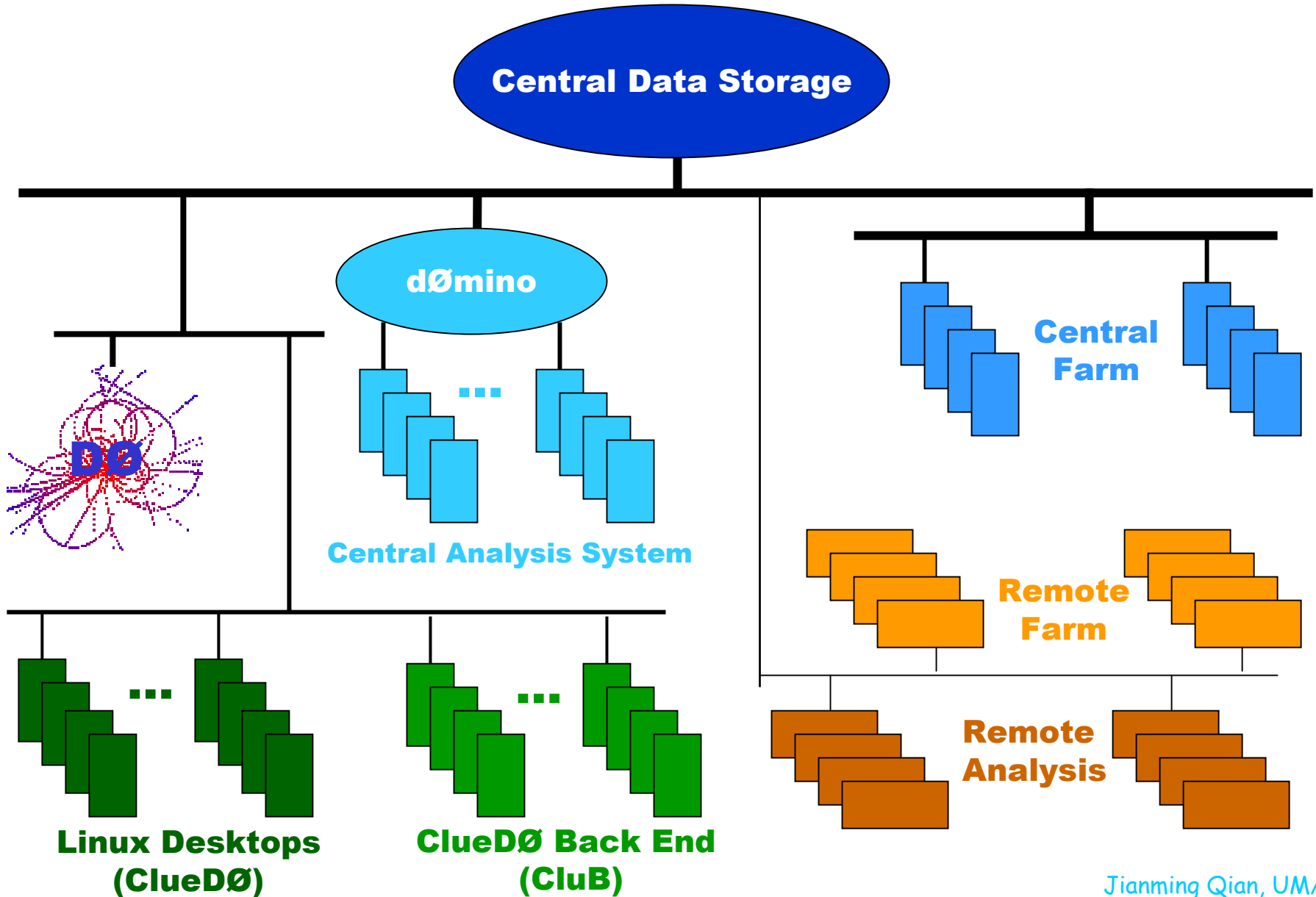


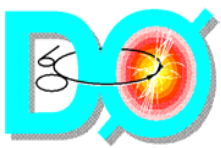
Where We Want to Go

- **An Level-3 capable of taking 1 kHz input and a DAQ capable of writing at ~50/100 Hz for Run IIa/IIb.**
- **A DØRECO running at a reasonable speed, writing out reconstructed information in both DST and TMB formats.**
- **A central Fermilab farm capable of keeping up with the online and providing some reprocessing CPU power.**
- **A global Monte Carlo production system capable of running at $\frac{1}{2}$ of the data rate and providing secondary data processing.**
- **Simulation programs provide reasonable descriptions of real data.**
- **An analysis model of central and regional centers with sufficient CPU and disk resources to meet analysis needs.**
- **A reliable and fast data handling and access system capable of providing full TMB and partial DST datasets to all analysis centers.**
- **An automatic and tiered software release system serving all production and analysis centers as well as individual institutions.**
- **...**

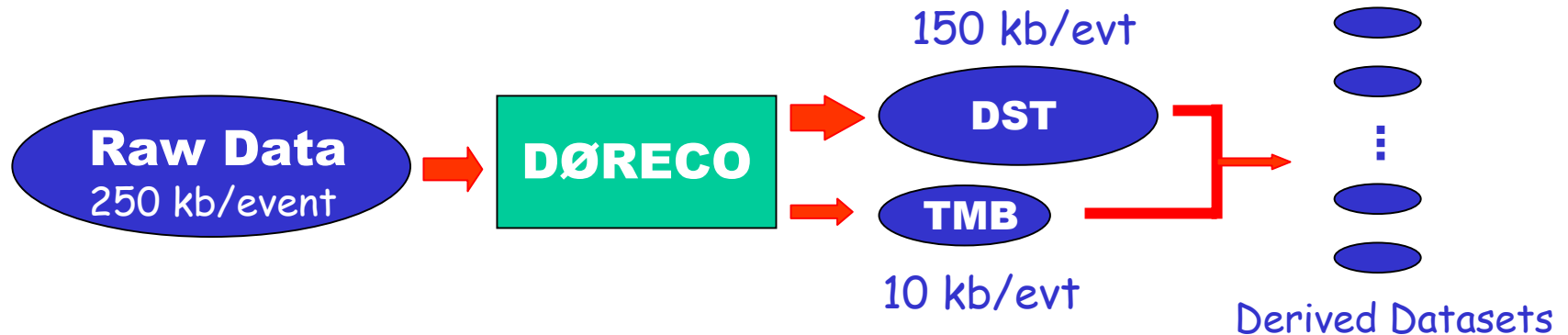


Computing Architecture

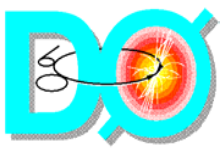




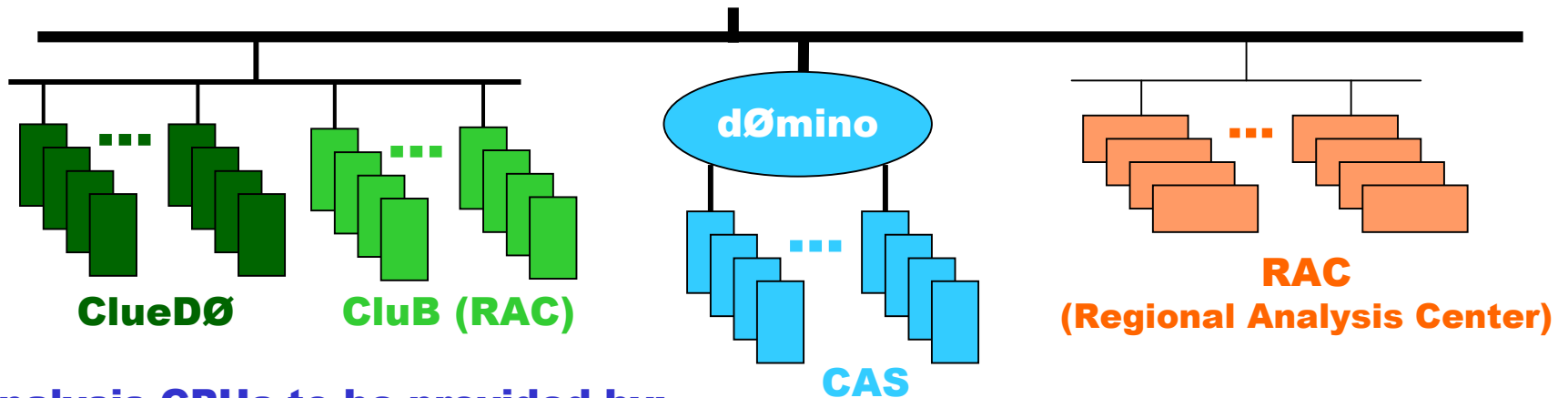
Data Tier



- **DST (Data Summary Tape):**
all high level physics objects, some detector-level information to allow calibration and limited re-reconstruction.
100% on tape, partial set on disk.
- **TMB (Thumbnail):**
all high level physics objects, good for most physics analyses,
100% on tape, 100% on disk at central and regional centers.
- **Derived Datasets:**
Physics/ID groups or their subgroups may create their derived datasets from either DST or TMB in their chosen format and are responsible for maintaining these datasets.



Analysis Model

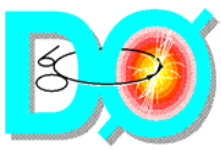


Analysis CPUs to be provided by:

- **Central Analysis System (CAS) at FCC:**
A PC/Linux dØmino back-end supplied and administrated by the computing division
- **ClueDØ/CluB at DØ:**
Linux PCs contributed mostly by institutions for interactive and batch jobs.
- **Regional Analysis Centers (RAC):**
Institutions with CPU, disk and personnel resources to serve collaborators.

Layered Analysis Approach:

- **DST stripping:**
Resource intensive, limited to physics, ID, and detector groups, done at CAS
- **TMB based:**
Medium resource required, expect to be done mostly by subgroups at RACs
- **Derived datasets:**
Individuals done daily on their desk/lap tops



Summary

- **All building blocks are in place. Have met most analysis needs so far.**
- **A road map to high luminosity and large dataset. Many systems scale.**

Many challenges remain:

- **Full Level-3 functionality**
- **Online and offline streaming**
- **DØRECO output DST and TMB content and format**
- **DØRECO quality and efficiency**
- **DØRECO speed at high luminosity**
- **Realistic detector/physics simulation**
- **Expanding Monte Carlo production capacity**
- **Central and regional analysis centers, analysis CPU needs**
- **Data handling and access for large dataset**
- **A better event display graphics**
- **...**

We are on our way...