DØ Analysis and Computing Model

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Workshop on Data Preservation and Long Term Analysis in HEP

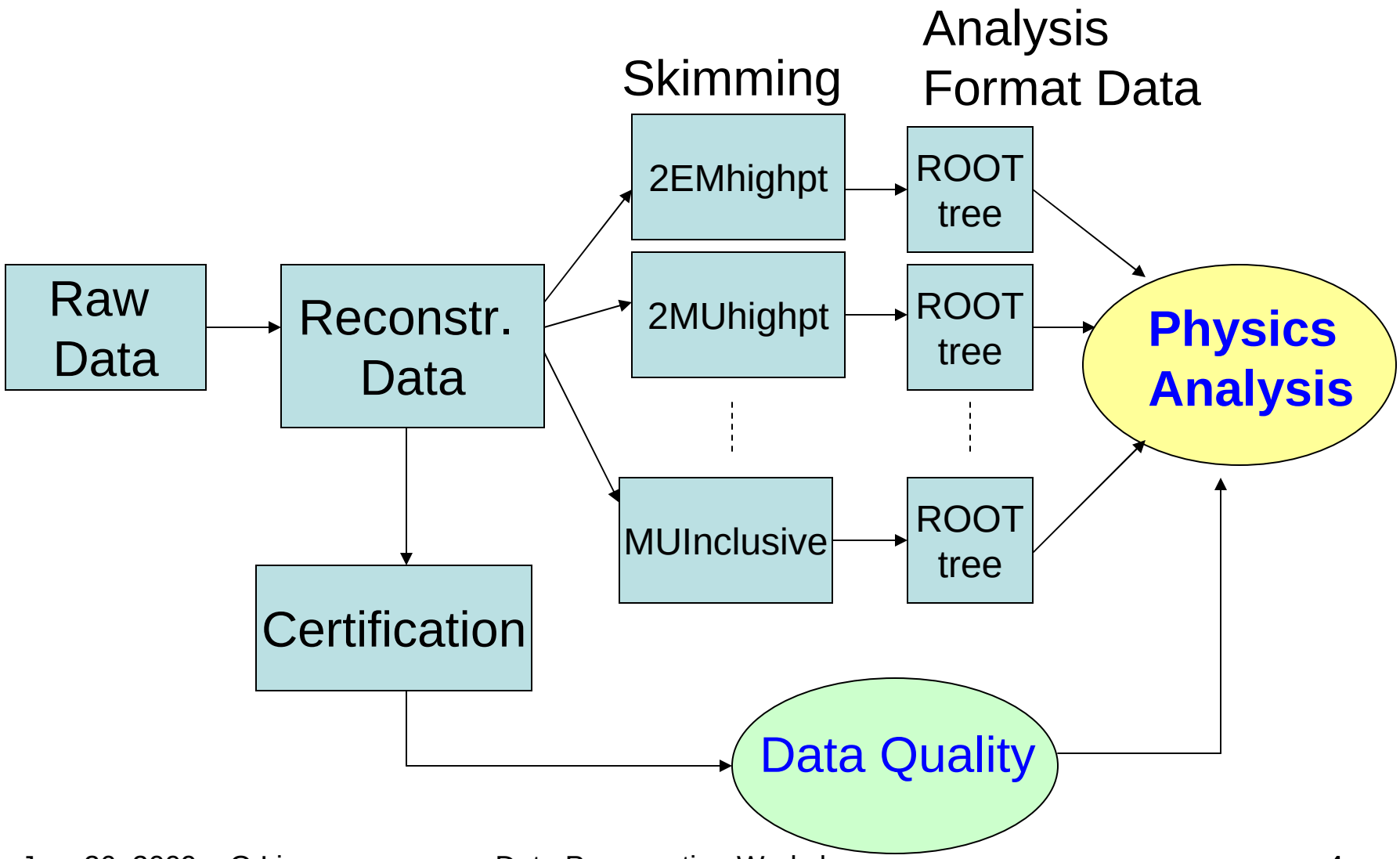
The DØ Experiment

- At Fermilab Tevatron
  - $\overline{P}P$ collider experiment
  - Run I: 1.8 TeV, ~100 pb^{-1}
  - Run II: 1.96 TeV
    $\int Ldt$ ~ 5 fb^{-1} so far
    expect ~8 fb^{-1} by 2010
- DØ collaboration:
  - ~600 physicists from 18 nations
  - 82 institutions
  - ~50% from non-US institutions

Overview of DØ Computing

- Data Reconstruction
  - Local farm (FermiGrid) with mature and stable algorithms
- Monte Carlo Generation
  - Remote Farms (OSG, LCG, native SamGrid, and non-grid, etc.)
- Analysis
  - Local clusters
  - CPU-intensive analyses use grid resources

DØ Analysis Model



Data Size

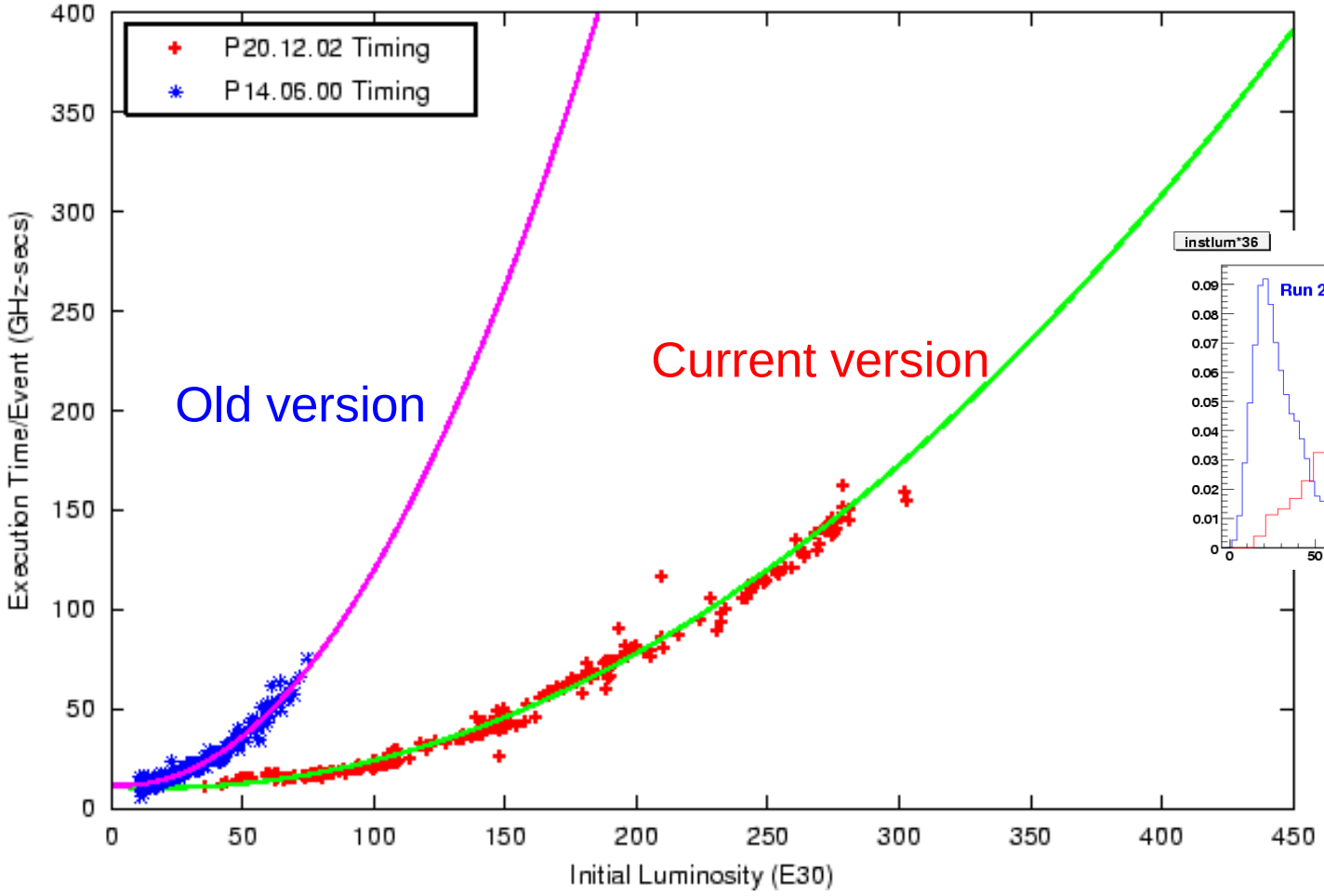
- Total storage (as today): 4872 TB.
- Raw data in Run II:
  - Total 4.8 Billion events collected so far,
  - Expect ~8 Billion events by the end of 2010.
- File size:
  - Raw data: 200 kb/event;
  - Reconstructed data: 120 kb/event;
  - Analysis format: 75 kb/event.

Raw Data Processing Strategy

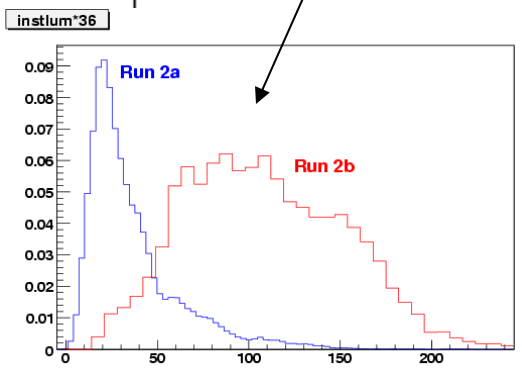
- Process raw data as soon as we can.
- Wait at least 2 days after data taking to allow for calibration constants to be determined and propagated to offline database.
- Keep as small a backlog as possible.
- Be responsive to special needs:
  - Detector configuration changes
  - Special runs
  - Whenever offline feedback is needed quickly
- Every 1-2 years, redo offline calibration for calorimeter, alignment for tracker, …

Reconstruction Timing

DØ Reconstruction CPU Timing vs Luminosity



Luminosity profile

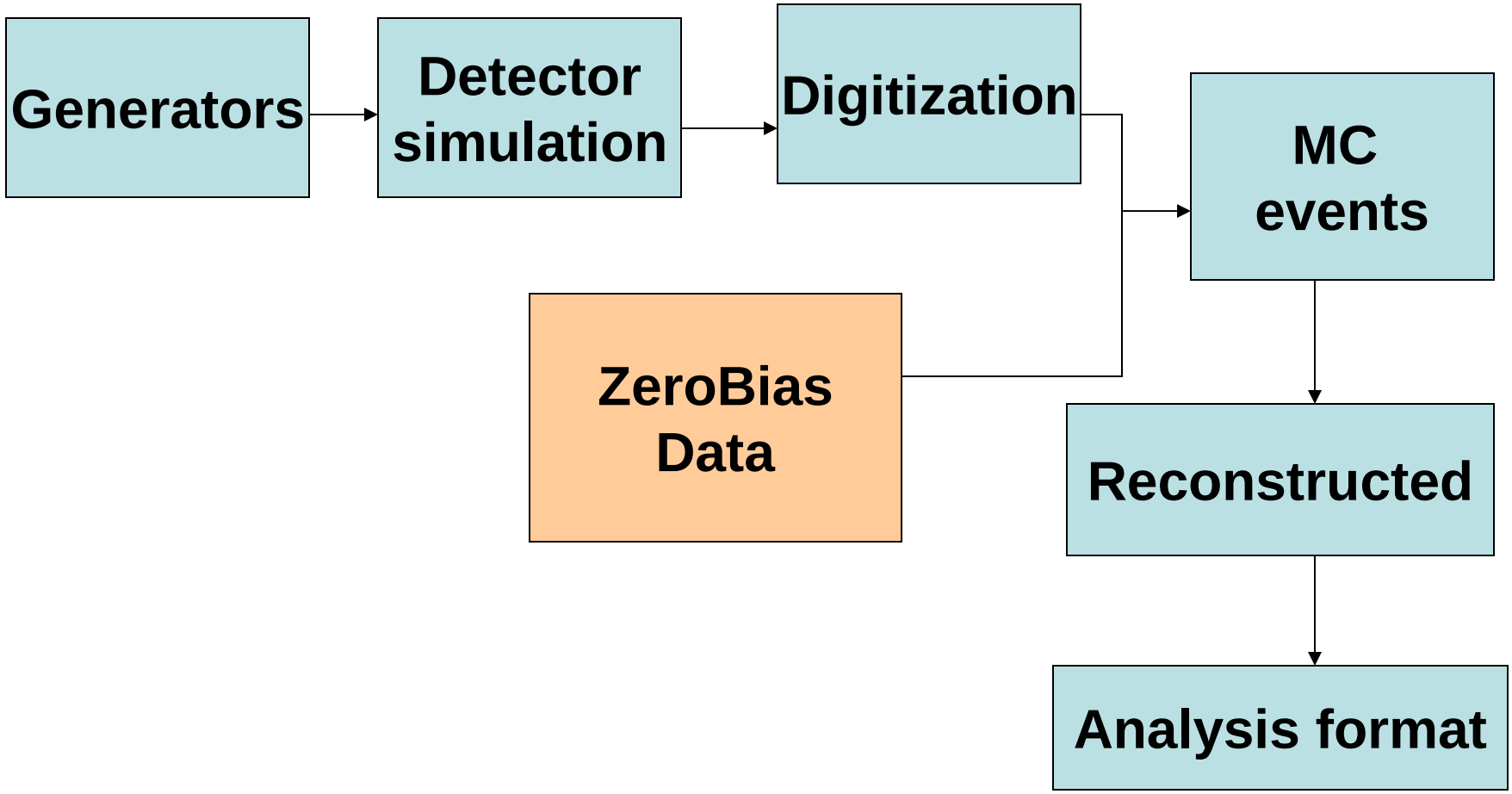


L ($10^{30}cm^{-2}s^{-1}$)

Software Releases

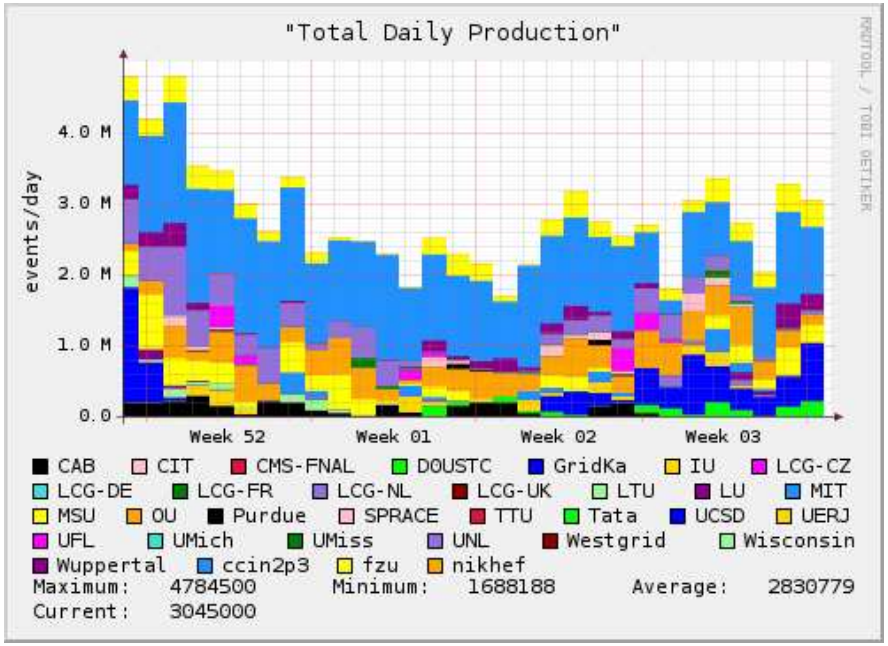
- The code is stored in CVS.
- Two kinds of releases:
  - Test release: for code development, tests
  - Production releases:
    - Two major production releases (Run IIa and Run IIb)
    - Within a major production release, some updates when detector changes … (a few times a year).

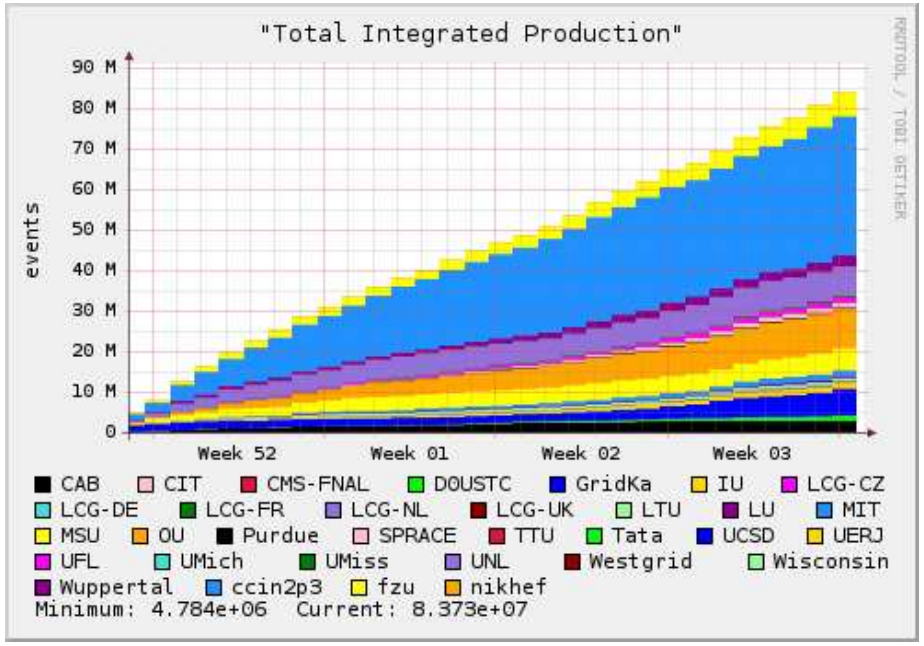
Monte Carlo Generation



Monte Carlo Generation

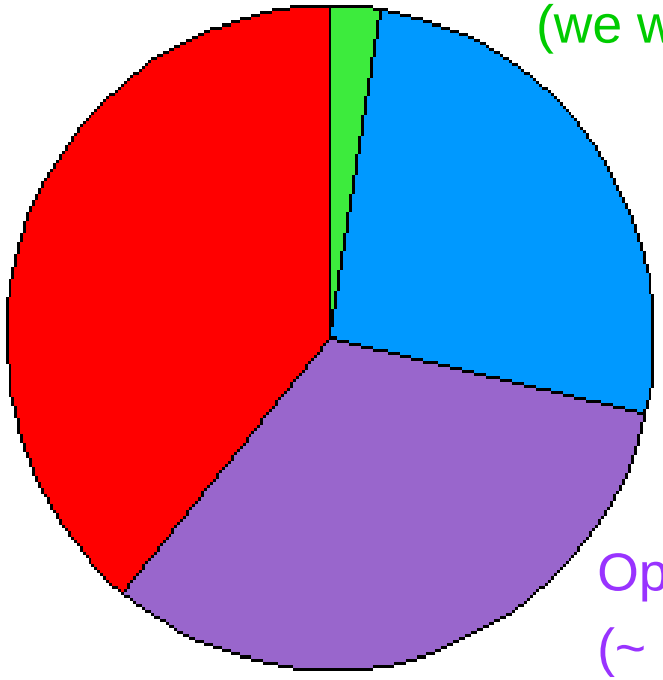
- Monte Carlo events are mainly generated at remote sites, most of them on the grid.





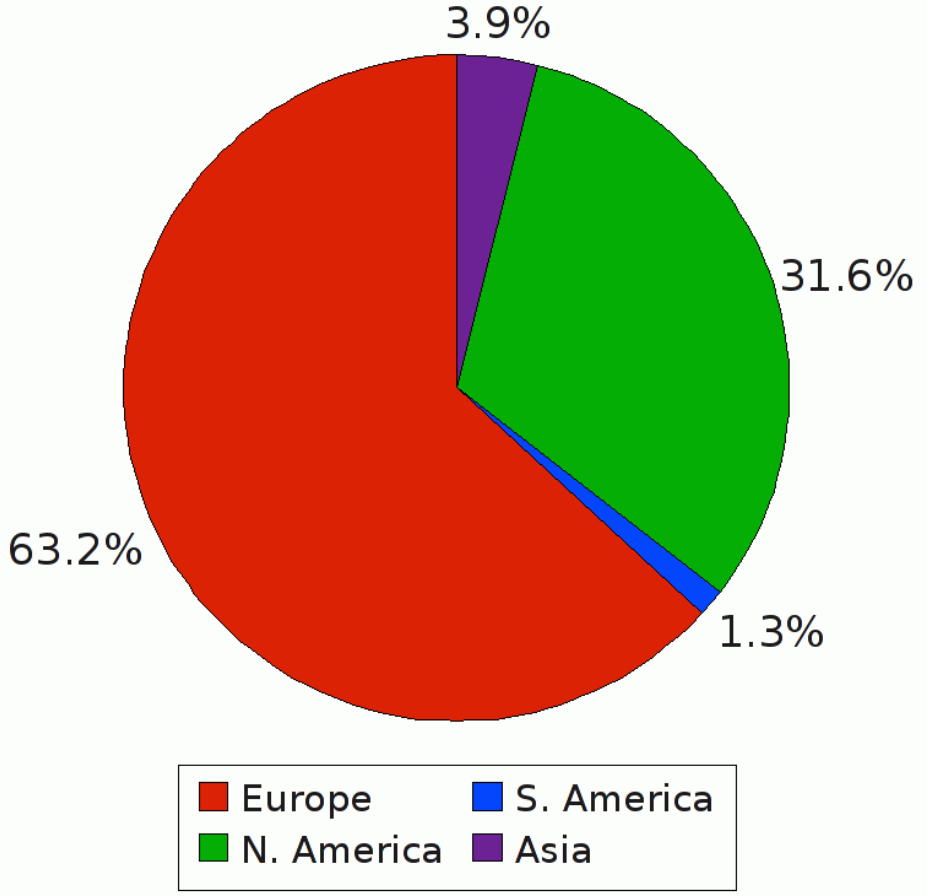
MC Generation

D0 runs MC generation on a variety of dedicated and opportunistic grid resources (~ 817 M MC events last year)



MC Generation Geographic Distribution

MC events last year:	
Europe	516 M
N. America	258 M
Asia	32 M
S. America	12 M



DØ uses computing resources worldwide

Physics Analysis

- Analyses are done in physics groups
  - Using the common analysis format data (Root-trees)
  - Using common analysis tools (particle IDs, b-tagging, efficiency, MC-data corrections, MC smearing,…)
- There are six physics groups:
  - Higgs, Top, Electroweak, New Phenomena, QCD and B physics.
- In addition, a W/Z + jets group provides vector boson plus jets selections, needed across physics groups.
- At this moment, ~70 active analyses.

Analysis Data Format

- Analysis data format is a root-tree.
  - Does not require complicated infrastructure to read (root browser is enough).
- Every physics analysis requires final corrections and systematic error estimation after root trees are made.
  - Mostly common across physics analyses and groups.
    - Common code and constants stored in cvs.
  - Database access is never required at analysis level.

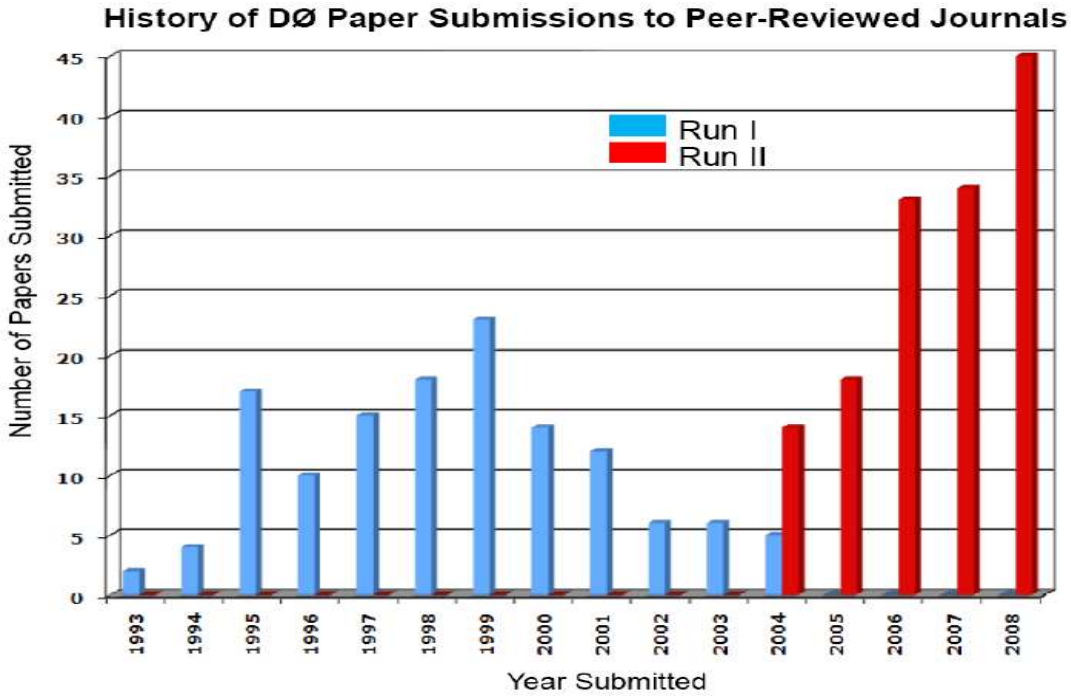
Analysis Computing

- Two local analysis computing clusters at FNAL/D0:
  - CAB (Central Analysis Backend):
    - Total ~5000 CPUs
    - CAB is managed by Fermilab Computing Division.
  - Clued0:
    - Total: ~1000 CPUs
    - Managed by the DØ collaborating institutions.
  - Both CAB and Clued0 provide reliable and efficient performance.
- CPU intensive jobs (like Matrix Element Analysis) are using grid (OSG or LCG) at remote sites.

Future Plans

- General plan is to support DØ computing through the end of Run II (end of 2010) and beyond.
  - Maintaining current infrastructure
- After Run II ends:
  - DØ users will be able to continue analyze the data to approximately 2015.
  - Fermilab/CD is planning to
    - Keep raw data for 10 year after Tevatron shutdown.
    - Keep migrating to new technology (tape storage)
    - Preserving our current computing infrastructure will require substantial resources and will depend upon analysis activity.

DØ Trends



- Run I publications continued for 8 years after Run I ended.
- Expect similar trend after Run II ends.

Data Preservation

- At what level should data be preserved?
  - the only sensible solution would be a high level format, in which most calibrations and corrections have already been applied to the data
  - For Run I, DØ created Quaero (4-vectors for objects, all SM background models). There were 10 attempts to access this data over 5 years (only 1 appeared to be a serious attempt, the rest are just tests). Not very useful.
- Where will the data and software be physically stored?
  - Fermilab seems the natural storage location, but we don't know if there will be funds for this.

Summary

- DØ analysis and computing model provides efficient way to do physics analysis.
- DØ raw data processing following data taking as soon as possible.
- Algorithms stable and handle high luminosity well.
- DØ Monte Carlo generation uses remote resources
- DØ physics analysis uses common format data (root-tree) with common analysis tools.
- After Run II ends, plan to preserve data for 10 years and continue analyze data for many years.

Happy Chinese New Year!