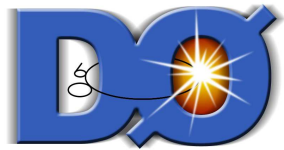
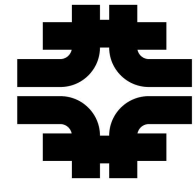


# Data Reprocessing on Worldwide Distributed Systems



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(Fermilab)



## Outline

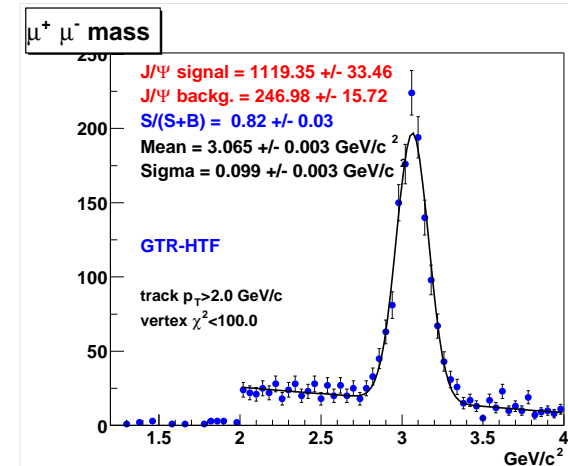
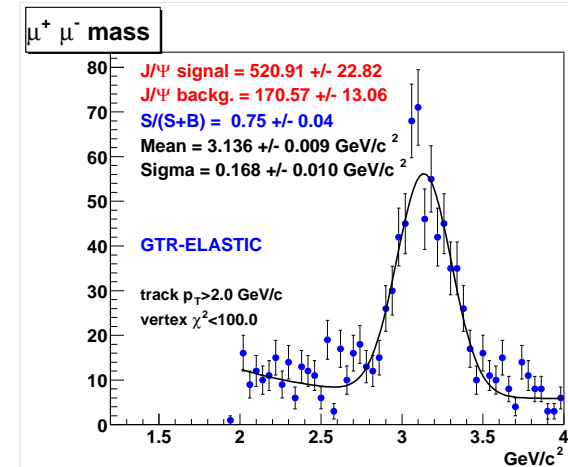
- Introduction
- Distributed data rereconstruction  
(Contributing centres, data and job distribution, ...)
- Problems
- Summary

# Introduction

## Improved understanding of the DØ-Detector

- DØ tracking improved significantly during 2003
- Basis:
  - improved understanding of the DØ-Detector
  - based on reality rather than design/plans
- $100 \text{ pb}^{-1}$  (60%) of the data were reconstructed with older software versions

⇒ *Redo reconstruction of data*



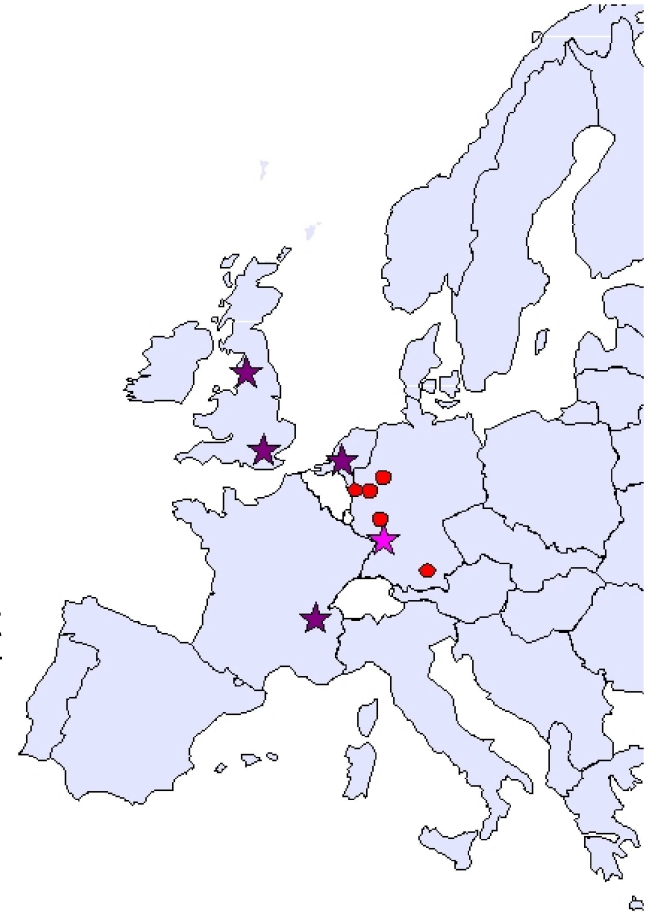
# Rereconstruction

## The tasks from Computing perspective

- $100 \text{ pb}^{-1}$  correspond to ca. 300M events.
- Rawdata 250kB/Event  $\implies$  75TB.
- DST output 150kB/Event  $\implies$  45TB.
- 50s/Event on 1GHz PIII CPUs  
 $\implies$  2000CPUs for completion within 3 Months.
- Central Farm (1000CPUs) used to capacity with data taking.
- Shutdown of 8 weeks sufficient to do 30%.

# Available Resources

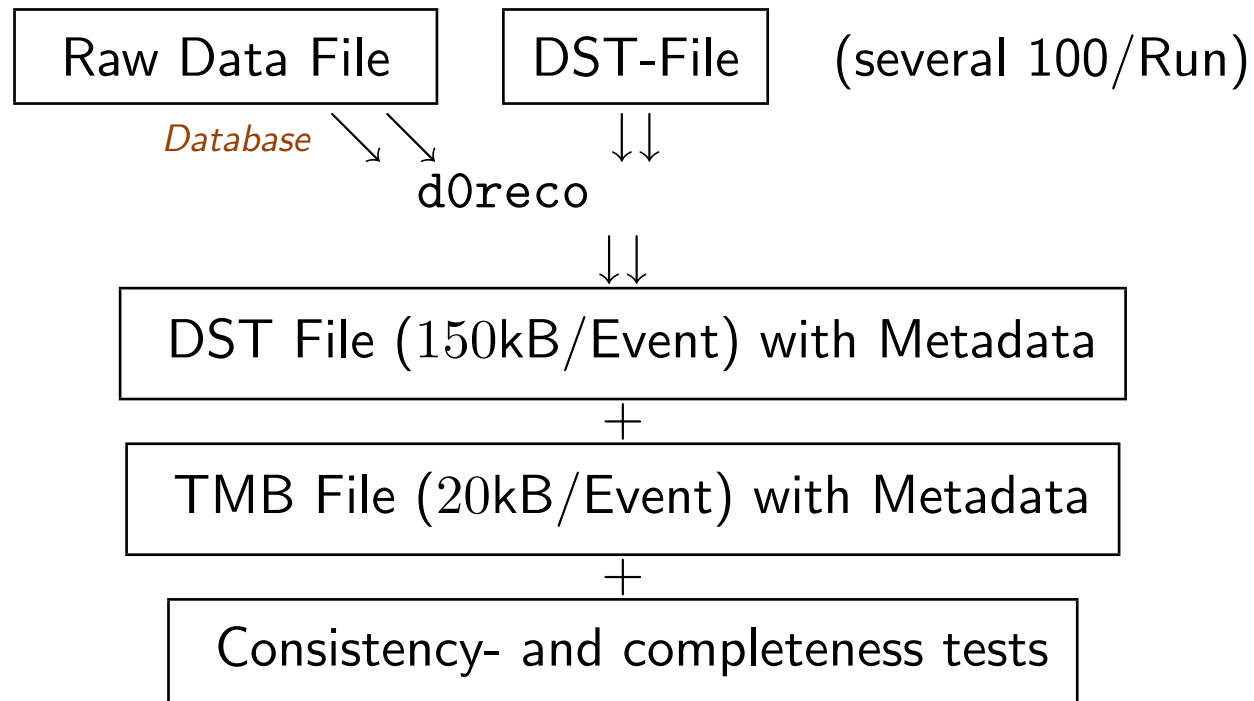
FNAL Farm,	1000CPUs	DØ installed
GridKa,	300CPUs	DØ installed
Lyon,	220CPUs	DØ installed
Nikhef,	80CPUs	in EDG
	320CPUs	in EDG
SAR,	130CPUs	DØ installed
UK,	340CPUs	DØ installed
Westgrid,	300CPUs	DØ installed, from Oct
<b>External</b>	<b>1690CPUs</b>	<b>(1GHz PIII equiv.)</b>



⇒ capacity more than doubled.

**But:** Each cluster is different; even „DØ installed“ can be very different.

## Application flow of a rereconstruction jobs



- Several TMB files shall be merged before storing.  
⇒ Creates **more complicated workflow**
- Database access from Europe *much* to slow  
⇒ **old DSTs as Input.**

# Management of Large Batches of Jobs

## Problem

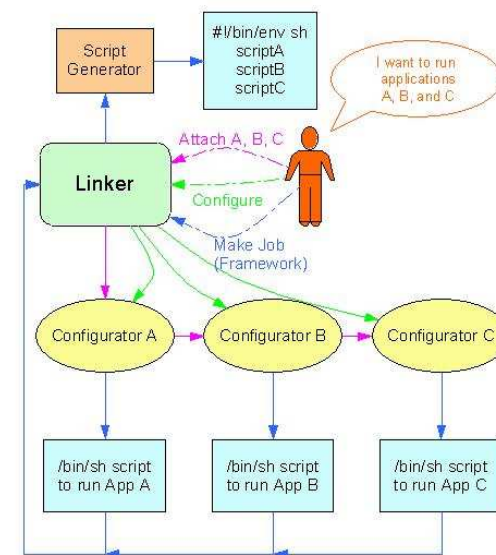
Initialisation, local paths for intermediate and final results, copy mechanisms are different on different clusters:  
**person power intensive.**

## Base of improvements

Automate linking for several programs into a single job based on a job description and local configurations.

## Workflow management: Runjob

- handles chains of executables
- passes output of one program as input to a following
- track metadata
- separates calling details from organisation
- allows for automatic parallelisation of jobs



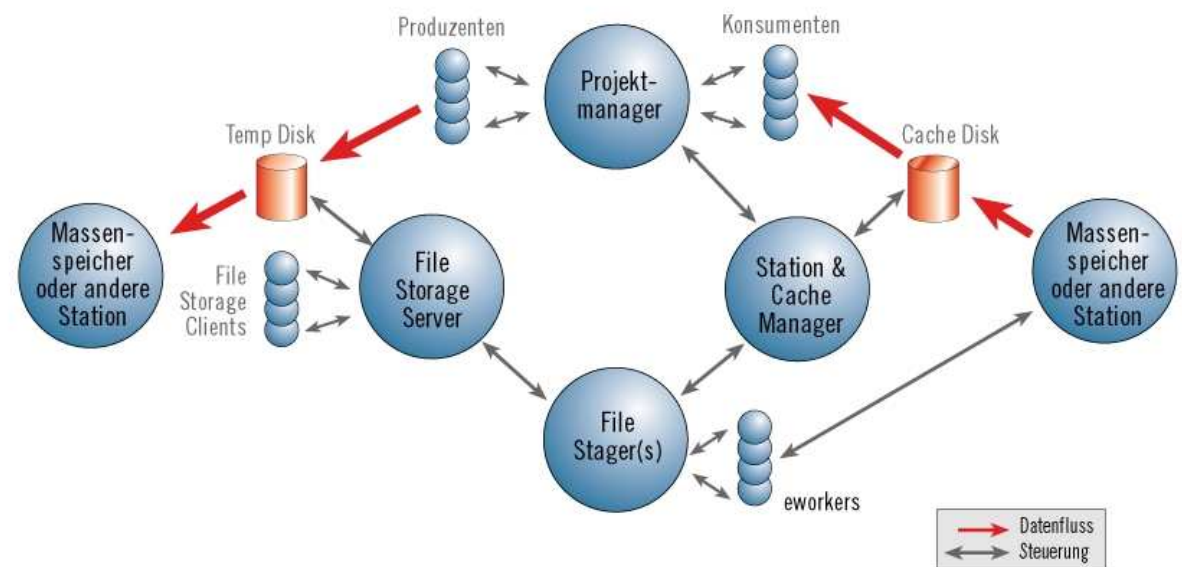
# Distribution of Input Data

## Sequential Access through Metadata: SAM

The order of events in the dataset has no meaning.

## Optimisation

- Don't loop through file lists.
- Request **datasets**.
- The order in which files corresponding to a dataset are processed may change.
- The system optimises the order to minimise tape access and tape mounts.



## WAN Transport

**sam\_cp** as generic interface to GridFTP, bbftp, tape access . . .

# Backflow of Results

## TMBs

- Merging of TMBs only possible at FNAL.
- Individual TMBs shouldn't be stored in SAM .
- Backflow “manually” using `sam_cp`.
  - TMBs and Metadata.
  - Logfiles and results of crosschecks.

## DSTs

- Storage initially not foreseen.
- Later: Remote storing into SAM onto decentral locations.
- Transport to user on access.

# Distribution of Jobs

## Manually

- Problematic datasets were reconstructed from RAW at FNAL.
- Datasets provided in sizes requested by each site.
- Reconstruction of these datasets started remotely
  - ⇒ Individual solutions for administrating jobs.
  - ⇒ Individual solutions for error recovery.

## Per GRID

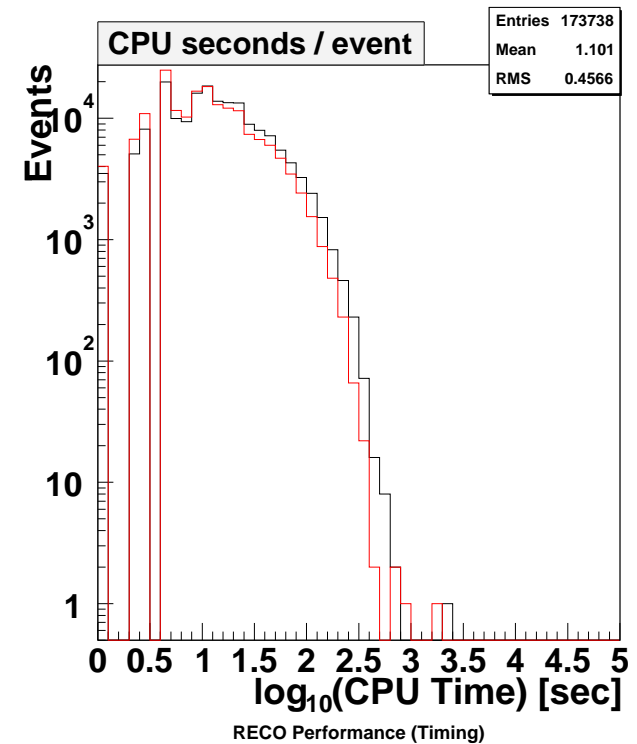
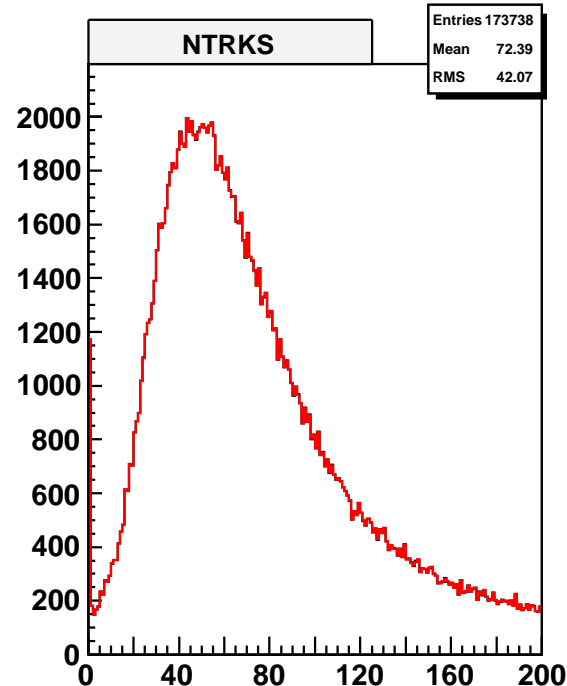
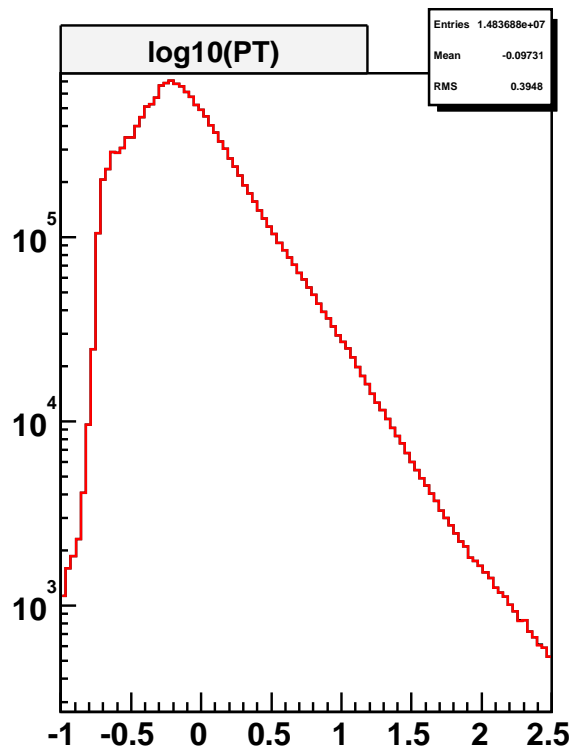
- Within the 3 British sites distribution of jobs done via SAMGrid/JIM.
- Nikhef tried to use EDG (basis of LCG) to distribute jobs to further sites.

**JIM**



# Certification of Sites

- Each centre was required to certify, i.e. process a defined dataset of 66 files.
- Results were compared to a reference (which itself was certified by comparing to processing from RAW):



# Rereconstruction, Problems

## Organisation

- Late release of d0reco
  - ⇒ Implicit dependencies on the (FNAL) environment noticed late.
  - ⇒ Incorrect planning, wrong priorities, unnecessary developments.
  - ⇒ Significant additional delay.
- The flexibility makes planning very difficult.

## Data distribution

- Delays occurred due to other applications with high number of tape access
- Bottleneck in central file router of SAM.
- Network bottlenecks on the way to some centres.

## Job Running

- A large number of jobs crashed (up to 20%).
- Lots of manual intervention.
- Bookkeeping is important.

## Data backflow

- Significant number  $\mathcal{O}(1/1000)$  of corrupted TMBs after copying back
- GridFTP doesn't check this sufficiently well.

# Summary and Outlook

- First **Data** rereconstruction on globally distributed clusters
  - 300M Events or 45TB of data were processed at 7 centres.
  - 30% or 15TB of these at systems remote of Fermilab.
  - Grid-concepts for data and job distribution were used.
- *The concepts foreseen for LHC proven in general.*
- Next distributed Data rereconstruction at DØ planned for this year
  - including external Merging, i.e. **complete external production**.
  - from raw data, i.e. with **Database access**.
  - using **SamGrid/JIM** und **LCG**.