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# Computational Grid Needs for High Energy Physics Experiments

Computational Grid Meeting

2 November 2005



# About myself



- **New faculty in Physics, since August 2005**
  - **Research in High Energy Physics**
    - **Basic Science**
    - **Experimental Research**
  - **Explore the constituents of matter**
  - **Unify fundamental forces**
  - **Search for the Higgs boson – origin of mass**
  - **Large scale experiments**
  
- **Collaboration**
  - **Fermi National Accelerator Laboratory – FERMILAB**
    - **Batavia, Illinois (60 miles Northwest of Hammond)**
  - **European Center for Nuclear Research – CERN**
    - **Geneva, Switzerland**



# Experiments



## ➤ Typical Design

- **Collider** – initiates collisions between sub-atomic particles
- **Detector** – detects these collisions
- **Computing farms** – record these collisions for physics analysis
- **DZERO Detector** (750 physicists)
  - FERMILAB
- **CMS Detector** – Compact Muon Solenoid (2500 physicists)
  - CERN

**Both are INTERNATIONAL Collaborations**



# Fermilab



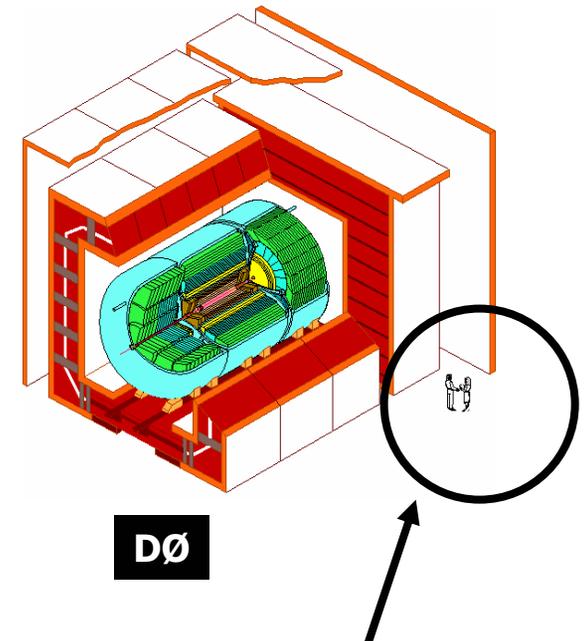
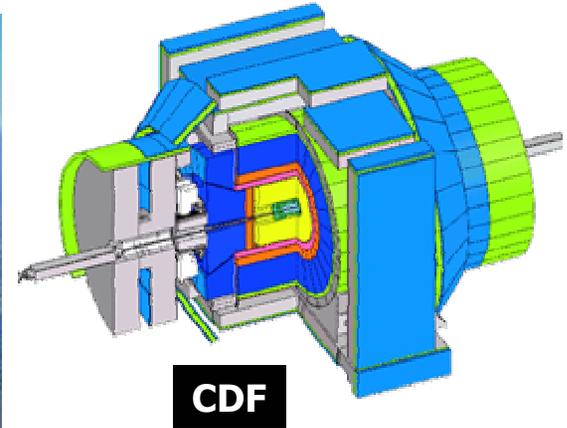
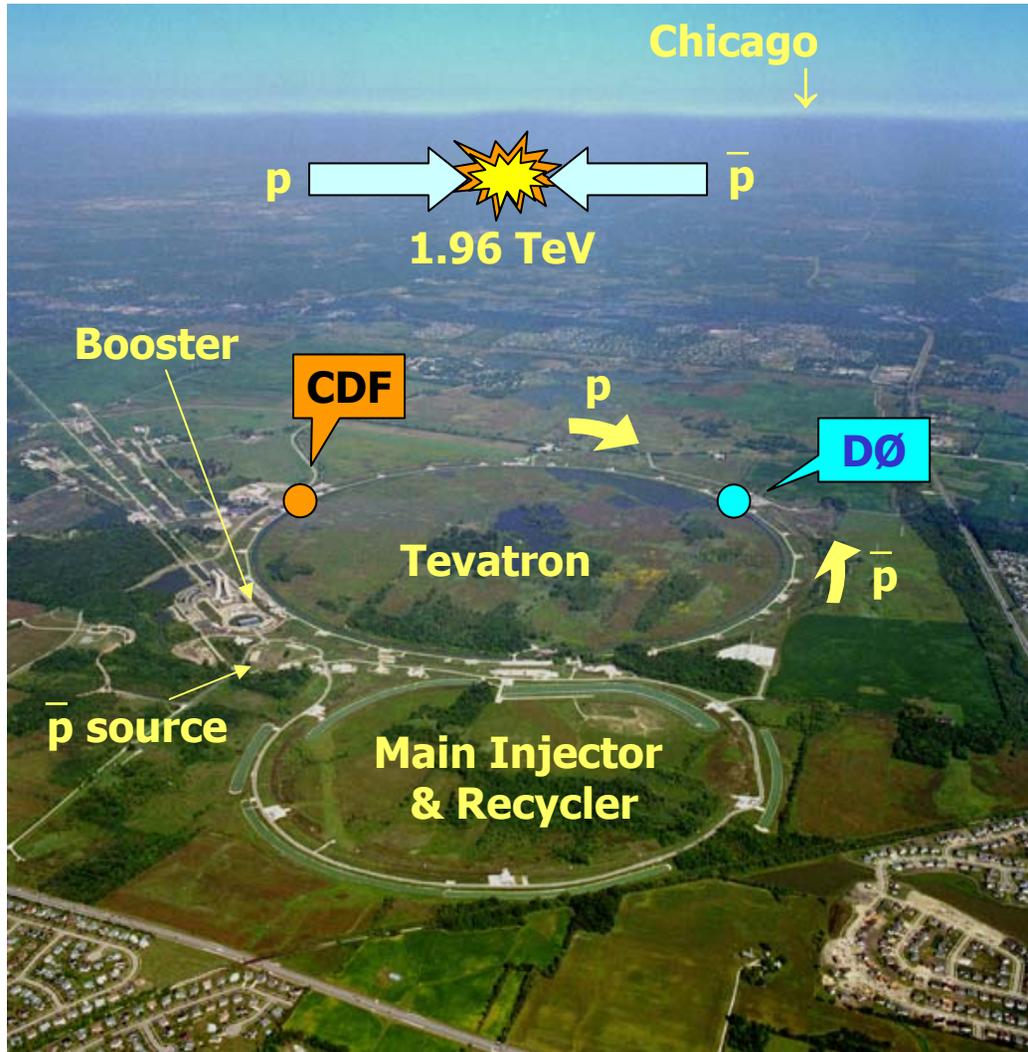
- Located 35 miles west of Chicago, Illinois
- **Largest U.S. laboratory** for research in high-energy physics
- Operated by **Universities Research Association (URA)** - a consortium of 90 research universities



**High Rise**



# The Fermilab Tevatron Collider

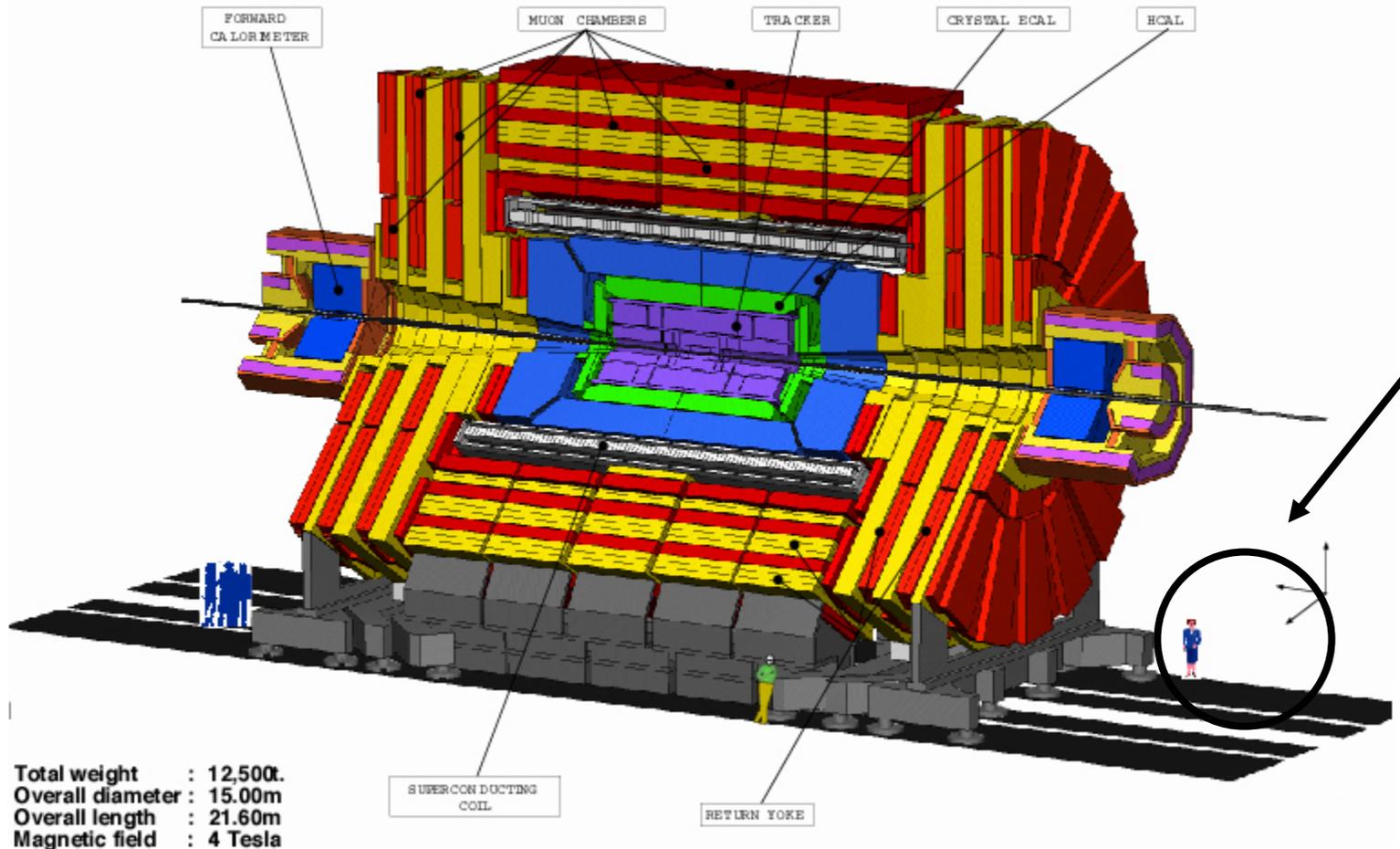




# CMS at CERN



## CMS A Compact Solenoidal Detector for LHC





# Data Recording



- **Both experiments will record petabytes of data**
  - 1 petabyte = 2 to the 50<sup>th</sup> power byte  
= 1024 terabytes
  - 1 terabyte = 2 to the 40<sup>th</sup> power byte  
= 1 trillion bytes
- **Computing needs exceed the capabilities**
  - Scattered geographical location of collaborators
  - Bottleneck to access the same computing resources
- **Computing Grid is recognized as a solution**



# Crucial Factors



- **Success of Grid Computing depends upon**
  - **High-speed internet connections from the central laboratory (Fermilab or CERN) to remote institutions**
  - **Ability to use general-purpose computing facilities**
  - **Existence of robust software tools**
- **Each member institution constructs a**
  - **Institutional Analysis Center (IAC) – acts as a gateway to the grid for users within that institution**
    - **These IACs combine dedicated rack-mounted servers and personal desktop computers into a local physics analysis cluster.**



# Next



- **If successful in achieving the IAC status**
  - **Upgrade to becoming a Regional Analysis Center (RAC)**
    - **Manages and Controls a group of IAC's- typically located in proximity**
    - **Allows smooth data usage and storage to a larger number of collaborators**
    - **Reduces the online and offline usage traffic at the main lab**



# Existing Grid Technologies





# Summary



- Lots of **student projects** in hardware and software for students at the University and Fermilab
- Promotes **inter-disciplinary** collaboration for research
- Tremendous potential for **outreach activities** and **summer student programs** at Fermilab
- A very **exciting physics** to work on
- Most importantly, it will establish PUC to be **nationally and internationally competent** for this challenging technology