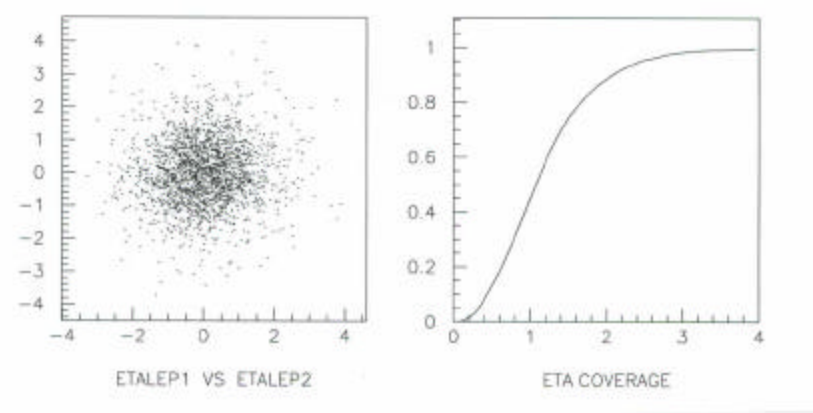
Bringing Up the Muon System

"Tom, what will be required from the 'software world' every step along the way to a well-understood detector?" - Harry Melanson 1/23/2001

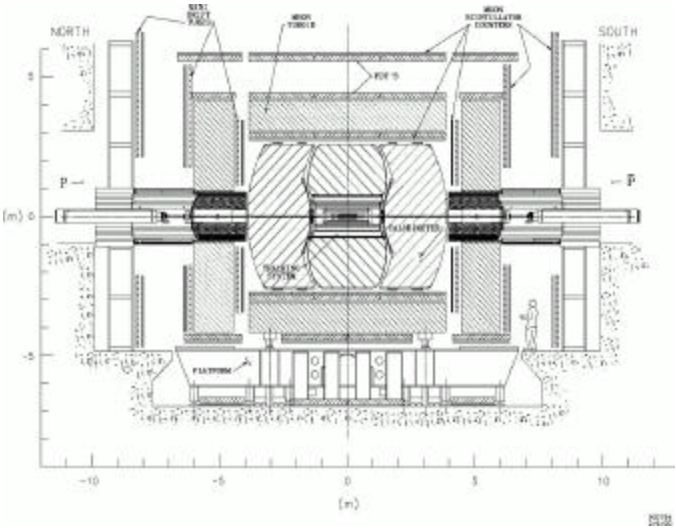
- **Detector Status (why bother?)**
- **How to Discover the Higgs**
- **The First 100,000 Events**
- **The First 100,000 Muons**
- **Editorial Remarks**



Muons from top

Tom Diehl
1/26/2001

Detector Status



It's been rolled into the collision hall!

- **Muon Detectors & Electronics**
  - All scintillation counters, MDT's, & PDT's have been installed and tested.
  - All Front-End & Readout electronics is in-hand and most is installed and tested.
  - Cosmic Ray Muon Data has been recorded with all types of muon detectors.
  - By March 1st (or within a few weeks) all of the muon detectors will be completed and fully operational.
  - One or two central trigger octants ready.

Detector Status

- **Early Run II Muon Detector Operating Configuration**
  - Much of the rest of the D0 detector will not be ready right away and some not ready for several months so ...
  - Muon detector will be in “open” configuration most of the time. We leave the detector h.v. off when we are open.
- **Why Bother?**
  - Surely we will collect data from a few stores with the detector closed. There is much to learn from the first 100,000 events.
  - Ultimately, the rest of the experiment will catch up and we’ll have the full power of the upgraded detector.

How to Discover the Higgs Boson

- Preliminary to publishing the discovery of $p\bar{p} \rightarrow Wh \rightarrow mnb\bar{b}$

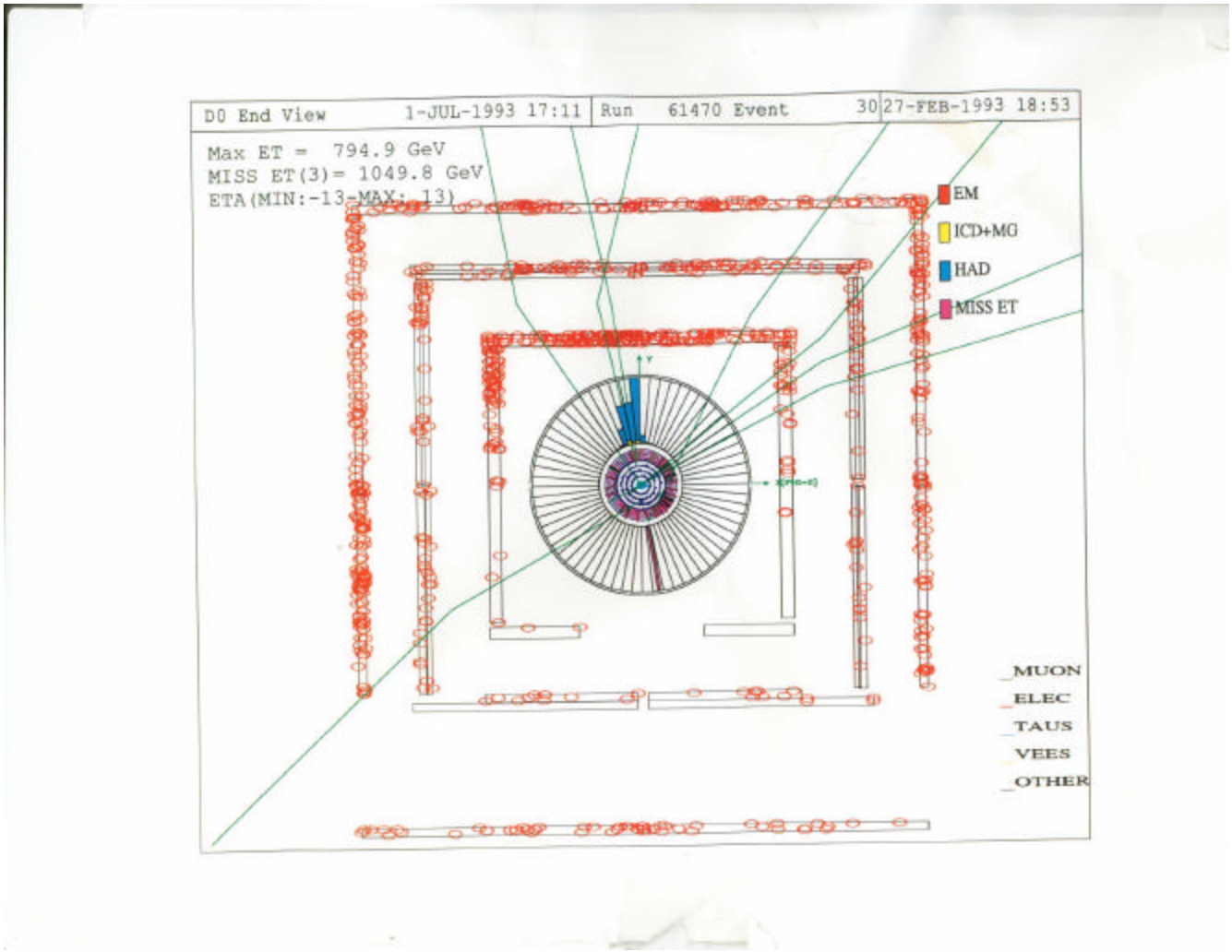
  We must demonstrate expertise in two basic items:

1. Hits and Backgrounds
B. W's and Z's (some well understood process)

- We tune the detector hardware & trigger and reconstruction software to find the best way that they work together.
- A rule: "It works on Monte Carlo (test stand)" is only a good first step for software (hardware).

First 100,000 Events

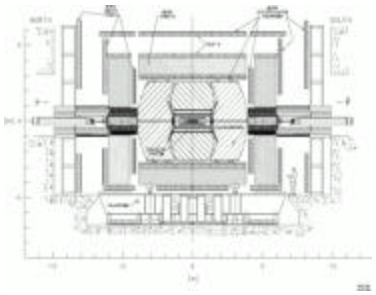
Addresses Question



What are all these hits?

- **Position, time spectrum, & scintillator-drift chamber hit correlations, hot spots (if any).**

Muon Hits & Background Hits



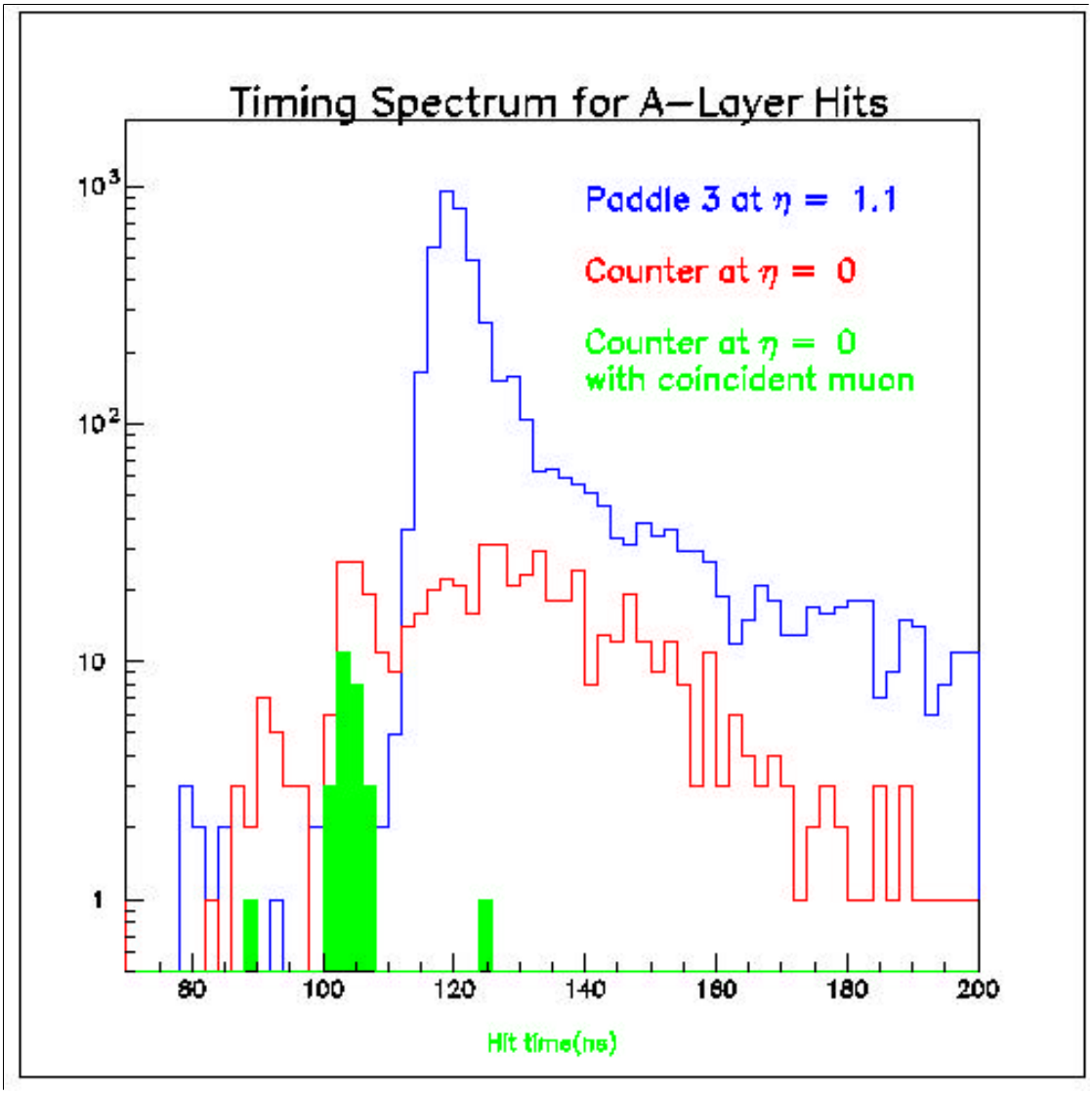
⇔ Muon Hits & Background Hits ⇔ Computing Icon

- **Run I Experience**
  - Every event had many muon detector hits. Some had hundreds. Even events without muons had muon hits. (see lessons)
  - It was very difficult to determine what was going on and the hardware and software people battled in their common ground.
  - Run II Detector Design Finer Pitch Trackers & Scintillators & Shielding

Common Ground or Battle Ground?

Hints From Run I

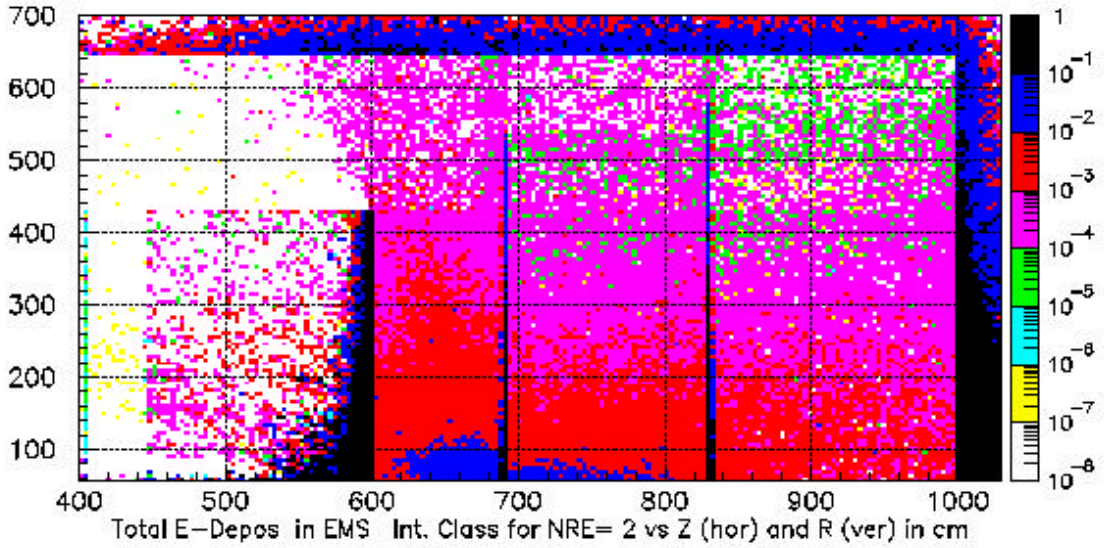
- **A-Layer Background**

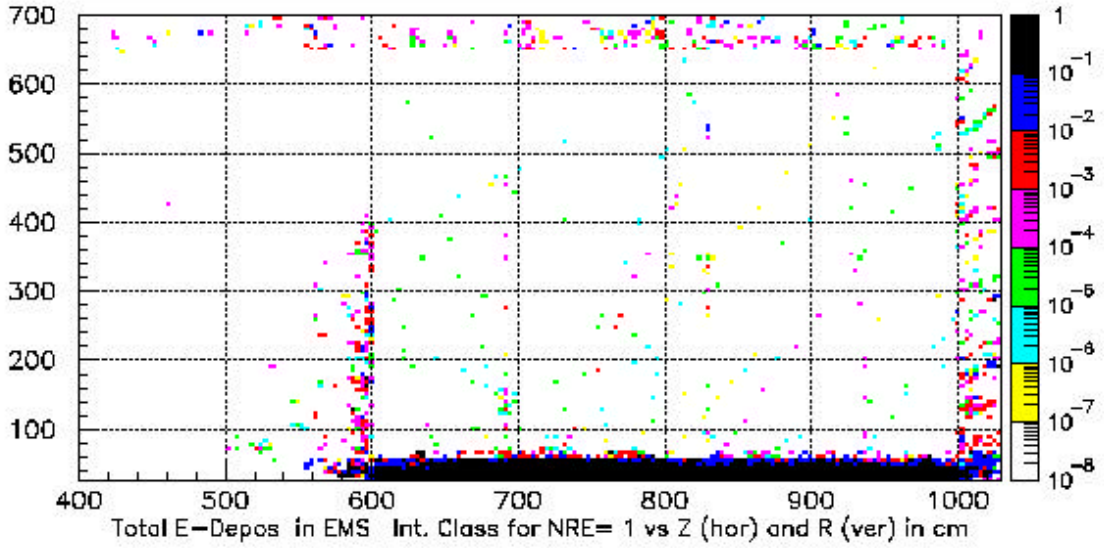


- **B-Layer Background > 30 ns late**

Hints from Run I

- **Effect of Shielding on B- and C-Layers**





In units of 10^{n} GeV/cm^3 per sec, where the color indicates the power n

First 100,000 Muons

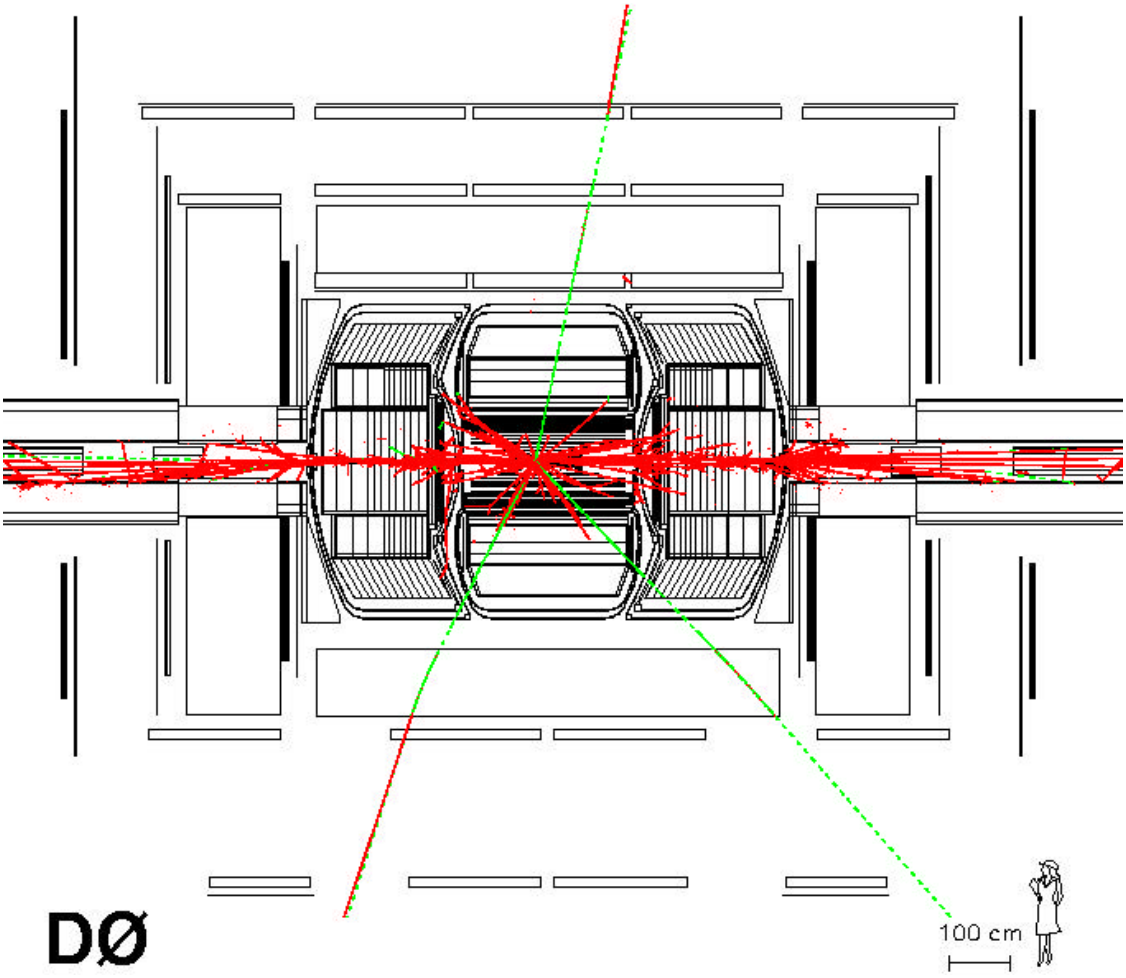
- **Streamed muon sample**
  - Reco'd muons
  - L1 & L3 Mark & Pass muons
- **Tune/Verify detectors**
  - Drift Chambers
    - #3 layer segments vs. # 2 layer segments
    - hits per track
  - Scintillator
    - tighten timing gate edge-position and gate width
- **Measure algorithm efficiencies**
  - Effective Hit Use
  - Geometrical Acceptance
  - Track probabilities
  - ID Criteria

Probably Iterative

W's and Z's

- **High pT muons provides cleanest sample for measuring efficiencies of detector hardware and software algorithms.**
- **High Rate**
  - Cross section x Branching Fraction for W(μν) @ sqrt(s) = 1.8 TeV is 2 nb. It's ~ 25% higher for 2 TeV.
  - σ.br for Z(mm) ~ 0.1 * σ.br W(μν)
  - 1 hz @ L=1e32/cm^2/s.
- **Cross Section is predictable at 2 TeV**
  - The uncertainty of the measurement at 1.8 TeV is ~ 5%, dominated by uncertainty in the luminosity.
  - Theory prediction can account for the difference in center-of-mass energy.

First 100,000 Muons



Where are all the W's and Z's?

Editorial Remarks
(disguised as sage advice)

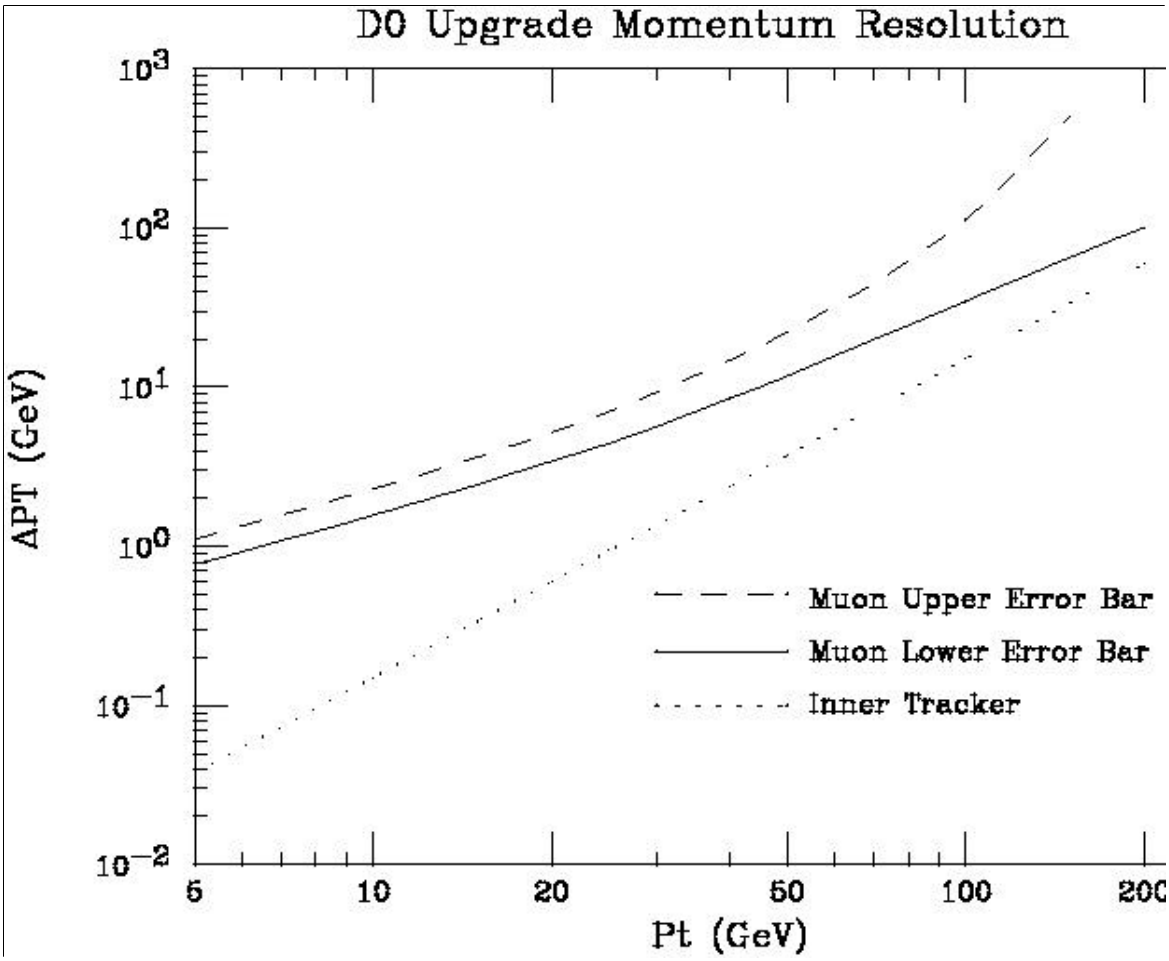
- **Now is a good time to develop experience with the on-line system**
  - Waiting until 3/1 puts us in the position of having to solve multiple problems concurrently. Namely:
    - **Technical difficulties - solvable in advance - using script runner, debugging on NT, data unpacking, time constraints, weird stuff,**
    - **Understanding what's happening in the muon system - not solvable in advance**
  - Use the time between now and 3/1 to implement as much functionality as is possible. Develop and smooth out the software machinery in advance.
- **Two examples**
  - PDT data-formatting software in Run II - a caution
  - MTC in Run I - an unexpected discovery of the detector capability

Summary

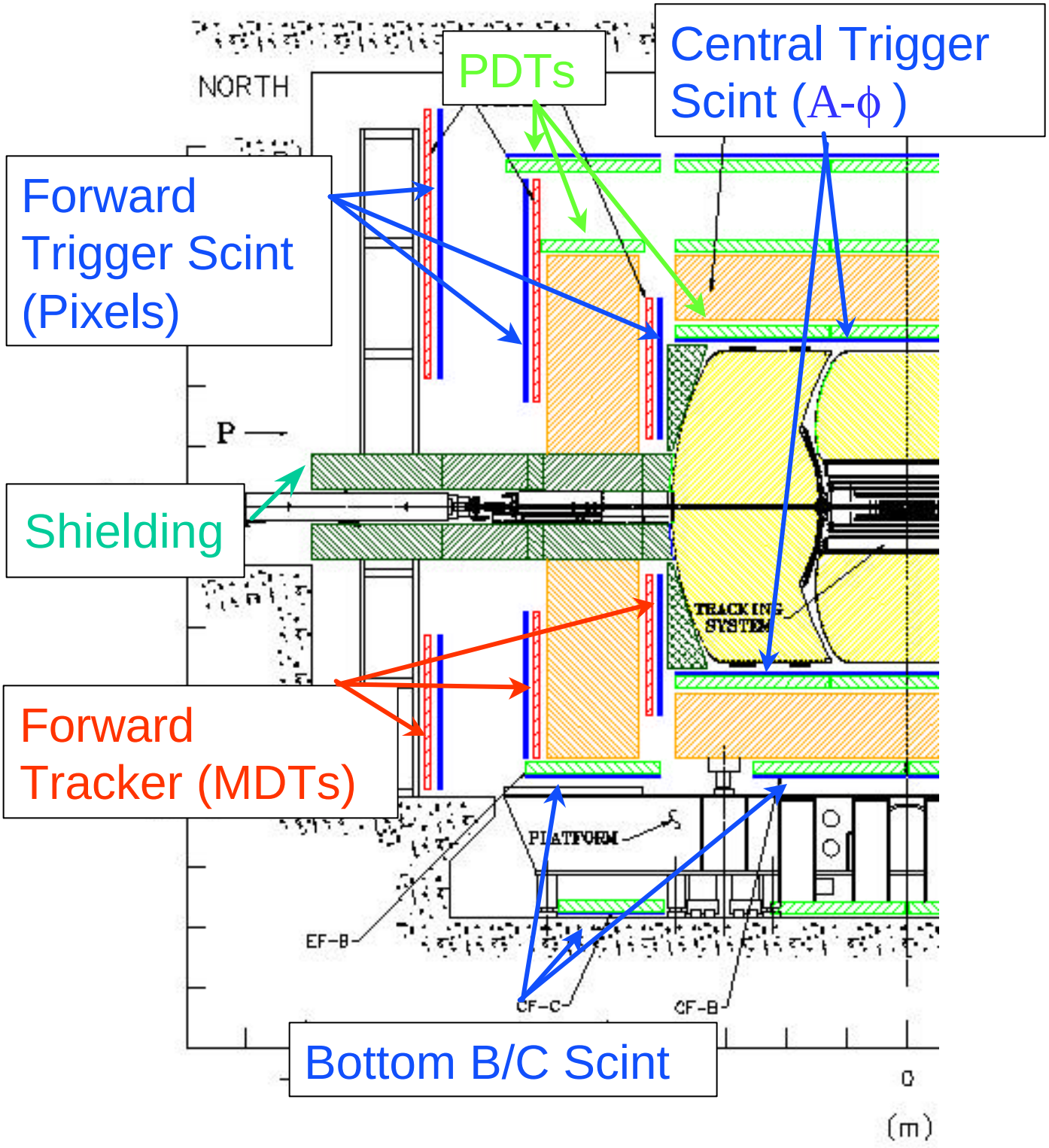
- The Run II muon detector is a fantastic improvement over Run I.
  - It's going to work, early on, with much of the full functionality.
- First 100,000 events answers
  - What are all these hits?
- First 100,000 muons answers
  - Efficiencies, effective hit use, id criteria
  - W & Z cross section is the best proof that the "MUON SYSTEM" is working.
  - Usefulness of iterations as detector capability is added.
- Sage Advice
  - Get a head start by smoothing the technical difficulties out of the machinery used look at 100,000 events and 100,000 muons
- Also, This is supposed to be fun

Momentum Resolution

- **WAMUS Momentum Resolution**
  - **inner tracker: ~?~ $dp_T=0.0015p_T^2$**
  - **WAMUS: $s(1/p)=0.18(p-2)/p^2 + 0.005$ w/ p in GeV/c**



Muon Detector Upgrade



Muon Upgrade - Tracking

- Silicon Tracker
  - Four layer barrels (double/single sided)
  - Interspersed double sided disks
  - 840,000 channels
- Fiber Tracker
  - Eight layers sci-fi ribbon doublets (z-u-v, or z)
  - 74,000 830um fibers w/ VLPC readout
- Central Preshower
  - Scintillator strips, WLS fiber readout
  - 6,000 channels
- Solenoid
  - 2T superconducting
- Forward Preshower
  - Scintillator strips, stereo, WLS readout
  - 16,000 channels