DØ Performance and Planned Improvements

- **Operations**
  - Collection of data
  - Detector status
  - Processing: local & remote
- **Algorithms**
- **Upgrades**

Institutions:

84 Total

35 US, 49 non-US

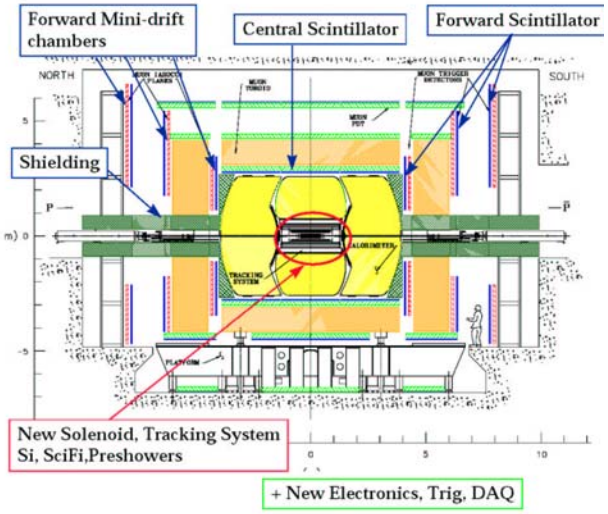
Collaborators

~ 675 Total

~ 50% from non-US institutions

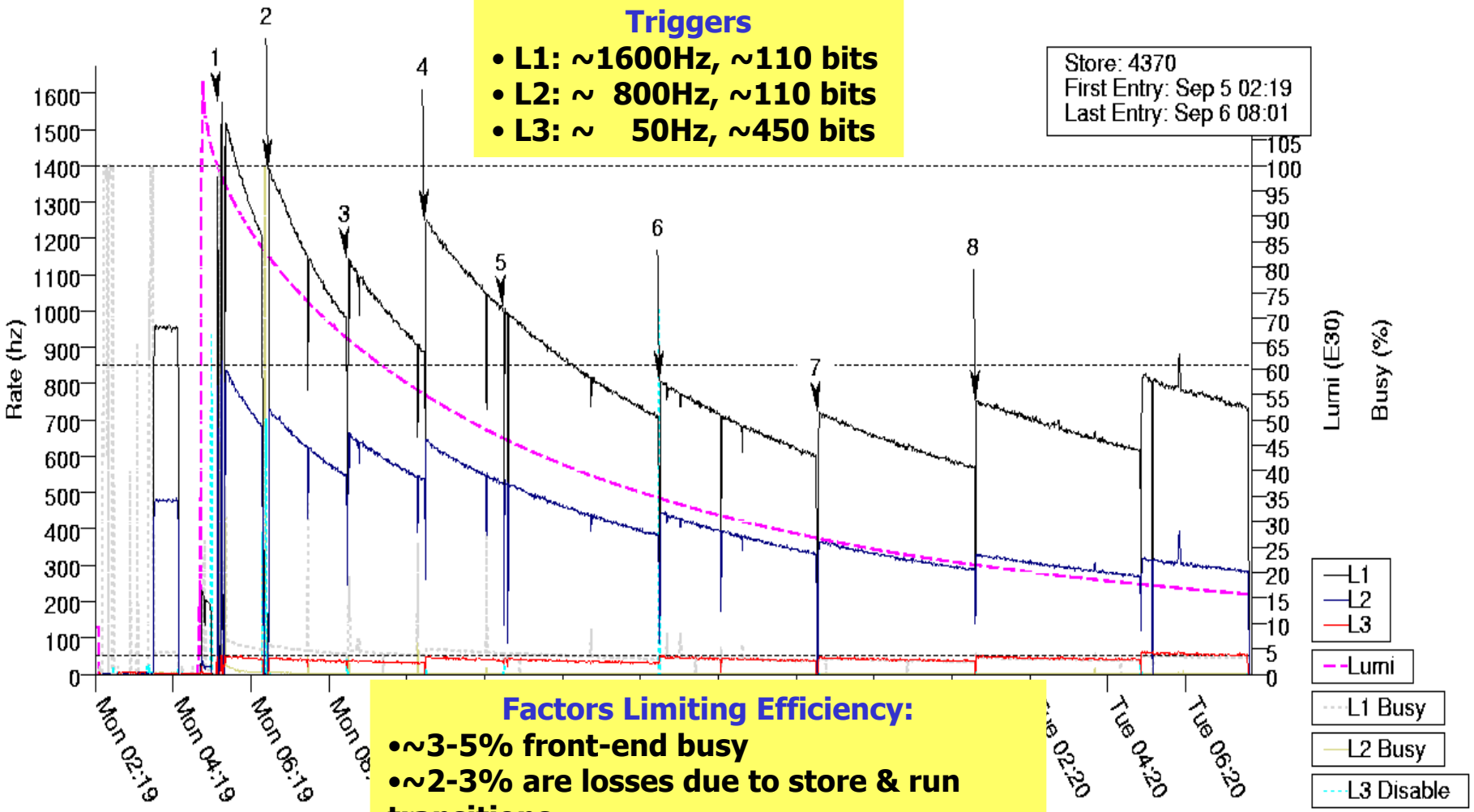
~ 100 post-docs

~ 140 graduate students



A "100E30" Store

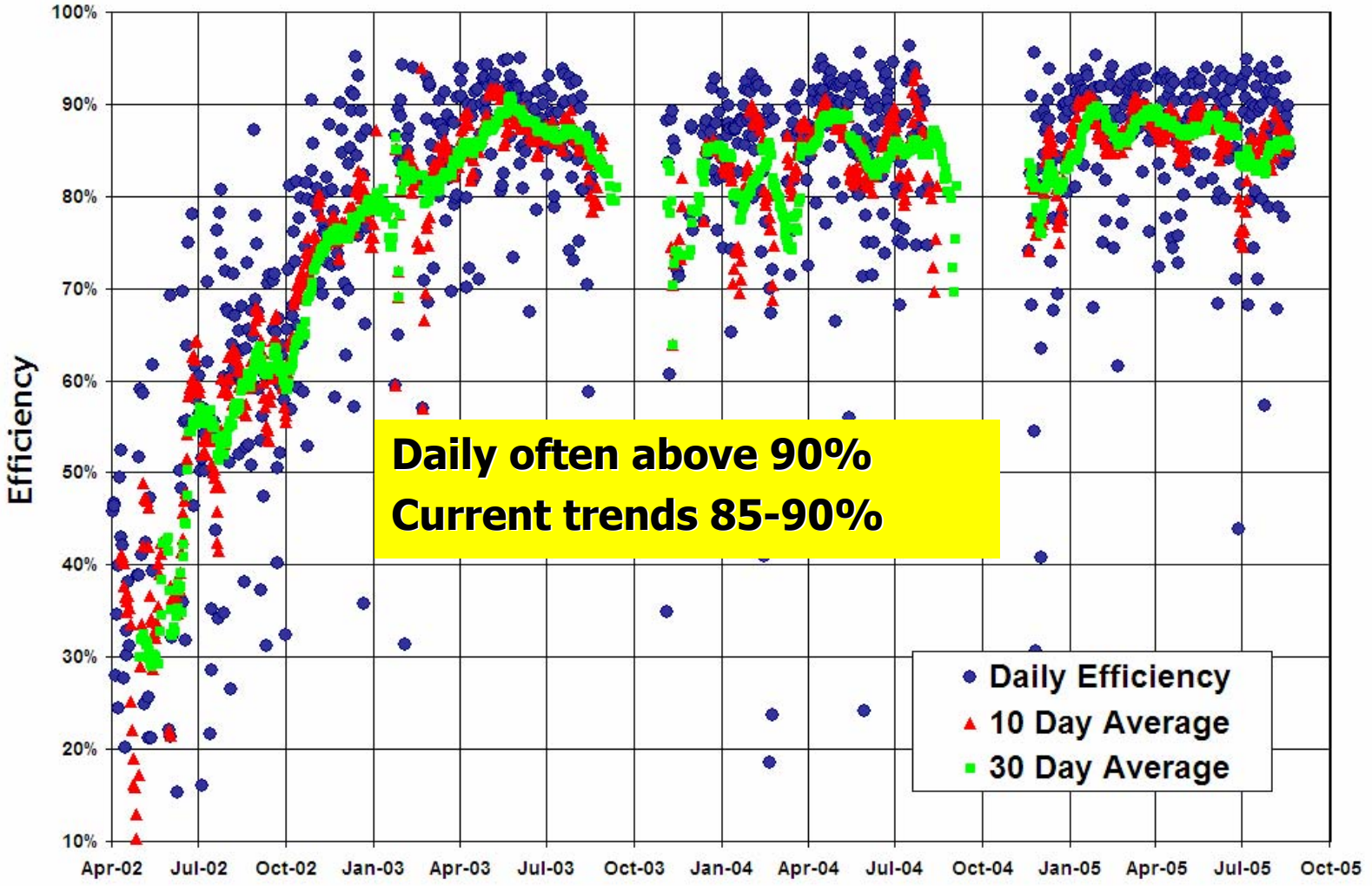
Triggers
- **L1: ~1600Hz, ~110 bits**
- **L2: ~ 800Hz, ~110 bits**
- **L3: ~ 50Hz, ~450 bits**

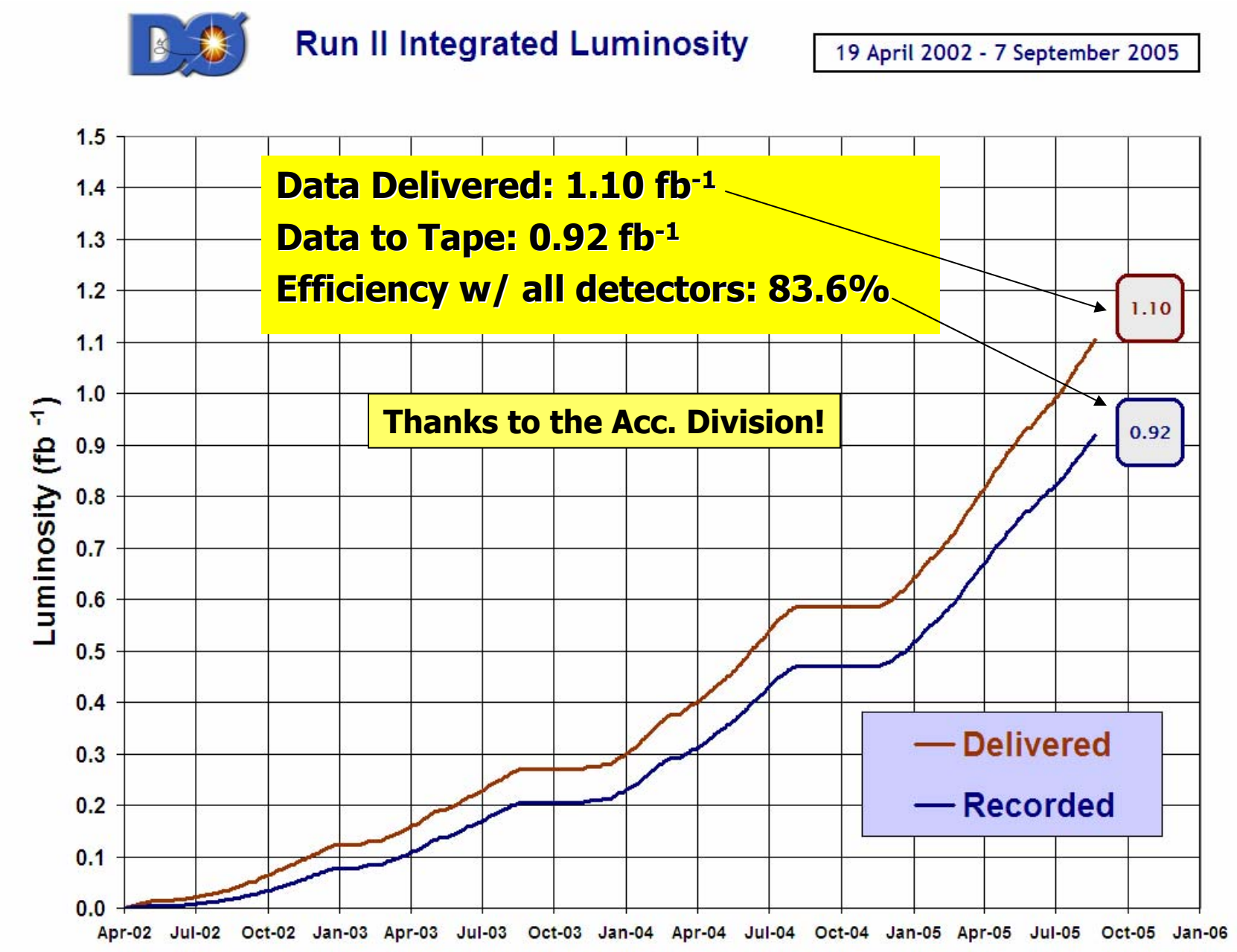


Factors Limiting Efficiency:
- **~3-5% front-end busy**
- **~2-3% are losses due to store & run transitions**
- **~5% "incidentals"**

Daily Data Taking Efficiency

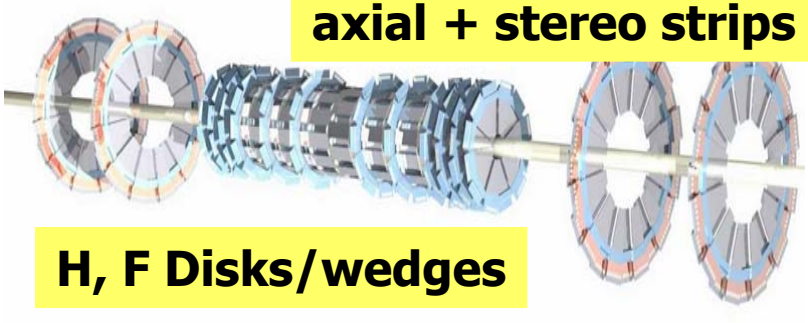
19 April 2002 - 7 September 2005




Run II Integrated Luminosity
19 April 2002 - 7 September 2005
Data Delivered: 1.10 fb-1
Data to Tape: 0.92 fb-1
Efficiency w/ all detectors: 83.6%
Thanks to the Acc. Division!
1.10
0.92
Delivered
Recorded
Luminosity (fb -1)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06

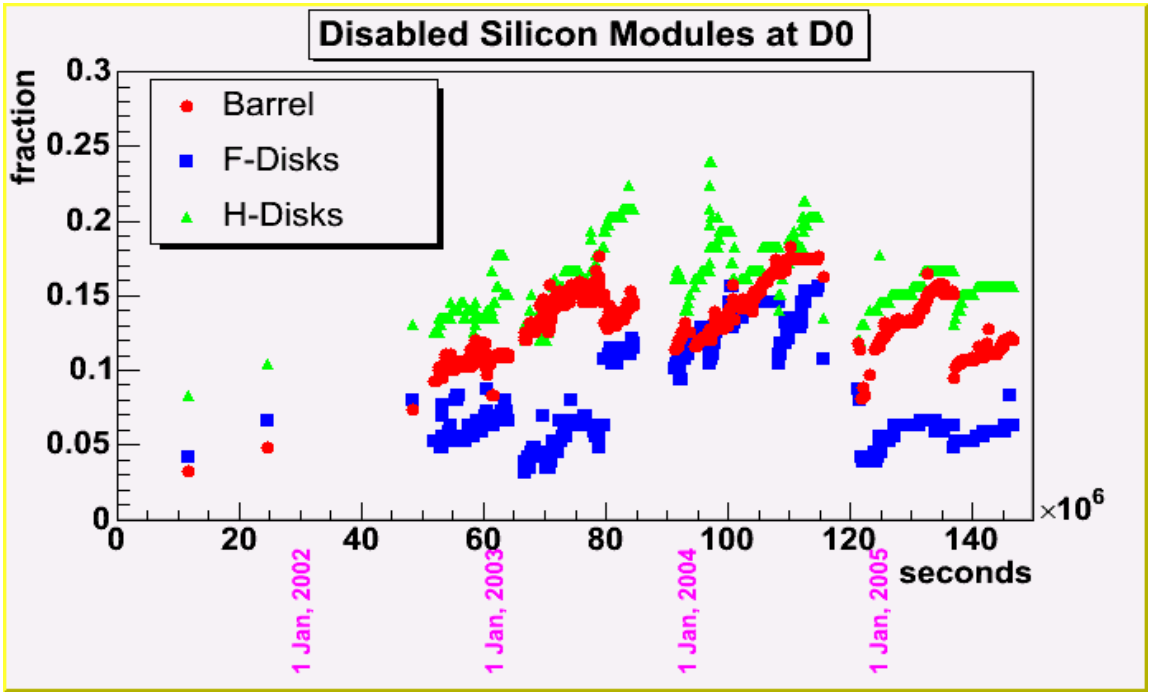
Silicon Microstrip Detector

4 barrel layers
axial + stereo strips



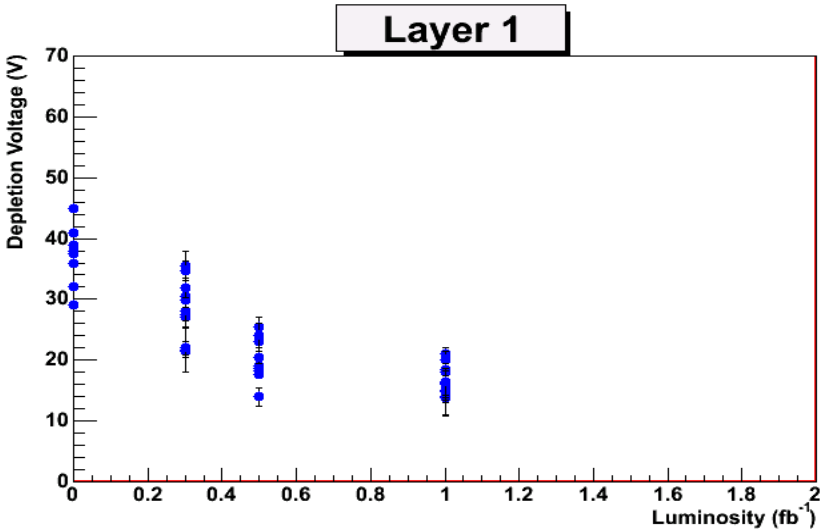
H, F Disks/wedges

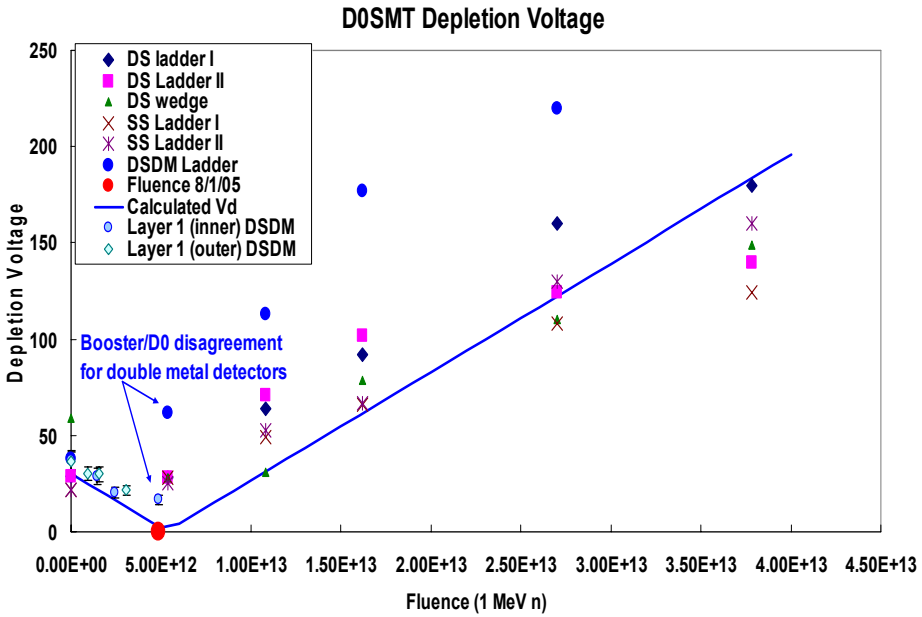
- **793k Channels**
- **S/Noise: > 10 all devices**
- **Cluster Efficiency: > 97%**
- **No fiducial loss**



Radiation Hardness

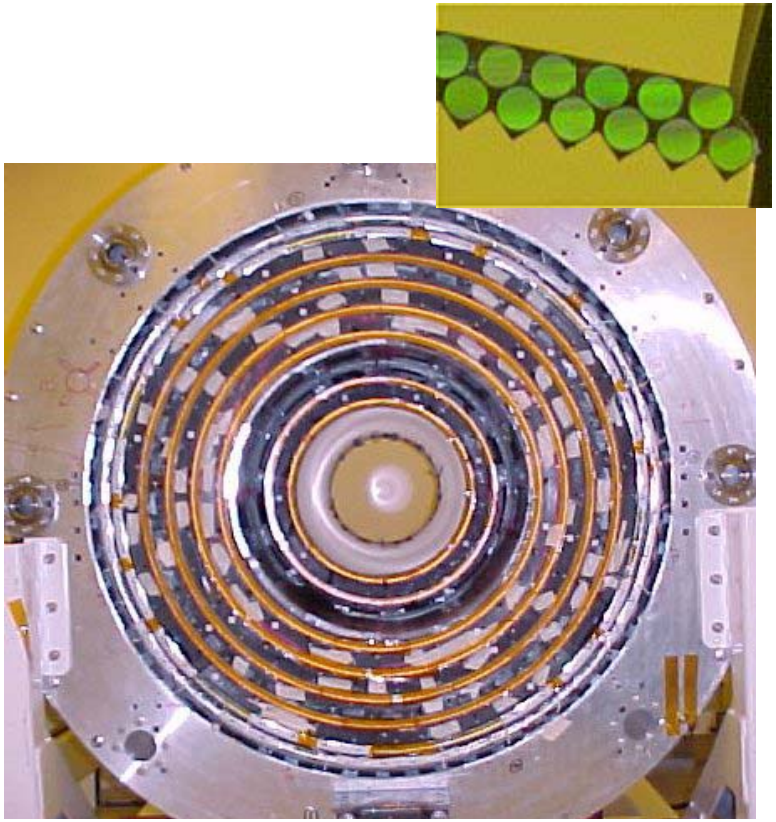
- **Studied**
  - In the booster
  - In situ with HV Scans of noise and efficiency
- **Depletion voltages**
  - Evolving as expected
  - For inner layer $V_{depletion} \sim V_{max} = 150V$ at 5—7 fb^{-1}





Central Fiber Tracker & Preshowers

- Eight axial & eight stereo layers
- VLPC readout at 8K
- Performing well
  - good light yield
  - layer $\varepsilon > 98\%$
- After November 2003 shutdown ~ 1% of VLPC channels not functional
  - was 0.1% before November
  - a one-time event
  - water contamination in cryostat?
- Last shutdown warmed up 1 (of 2) cryostats
  - pumped out 0.5l H_20
  - Upon cool down same loss rate BUT different channels
- Does not seriously degrade performance, but requires vigilance.

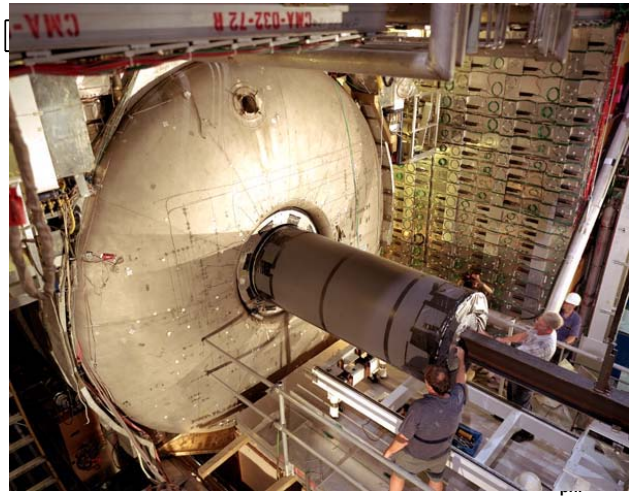


Solenoid

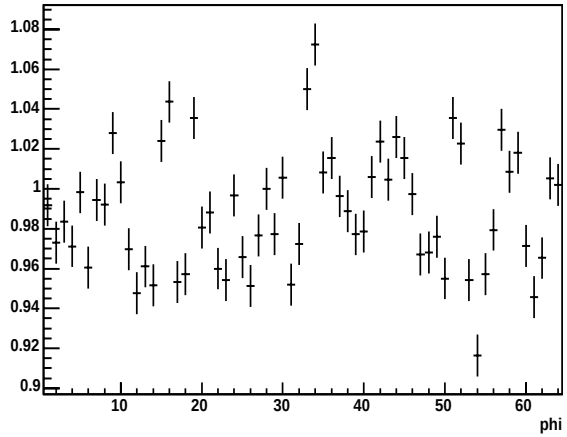
- Coming out of FY04 shutdown, while attempting to ramp to full current, the solenoid quenched.
- Clues :
  - An additional ~8W heat load was seen on the cooling system during operation
  - The south end of support cylinder shows an elevated temperature when powered
  - An excess in resistance is seen in the inner coil layer
  - Careful detailed review of history of temperature rise of south coil support when powered indicates that the degradation is strongly correlated with coil thermal cycles above 90K
- Diagnoses: Suspect degradation of inner layer conductor joint at south end of solenoid coil.
- Prescription:
  - Minimize future thermal disturbances
  - Limit power cycles
  - Upgraded cryogenics plant to provide additional operating margin
- Carefully monitored coil resistance and support temperature since beginning of FY05 run & show no further signs of degradation.
- Have run stably at 4550A (rather than 4750A)

Calorimeter

- Liquid argon calorimeter with uranium absorber
  - Operating Smoothly
  - 99.9% of 55,000 channels operational
- Aggressive program to reduce noise was productive, certain types of noise down 4 orders of magnitude.
- Completed an in situ cell-by-cell calibration of EM and Had calorimeters
- Z pole resolution improves from 3.35 GeV to 2.93 GeV



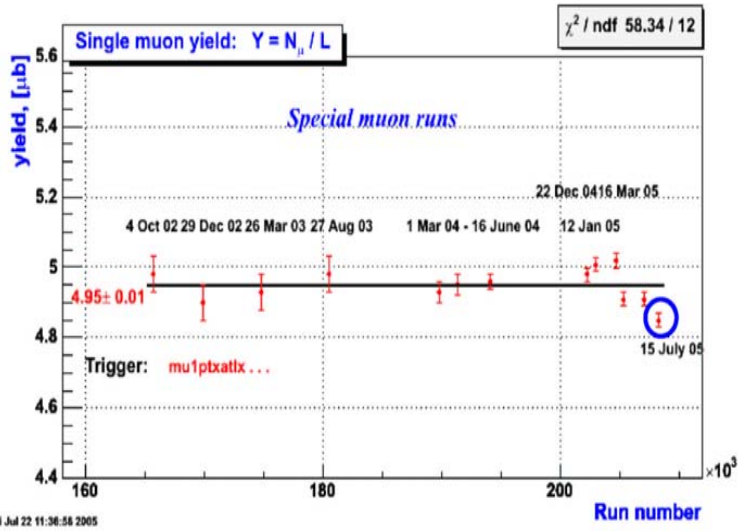
layer 3 Calibration Constants

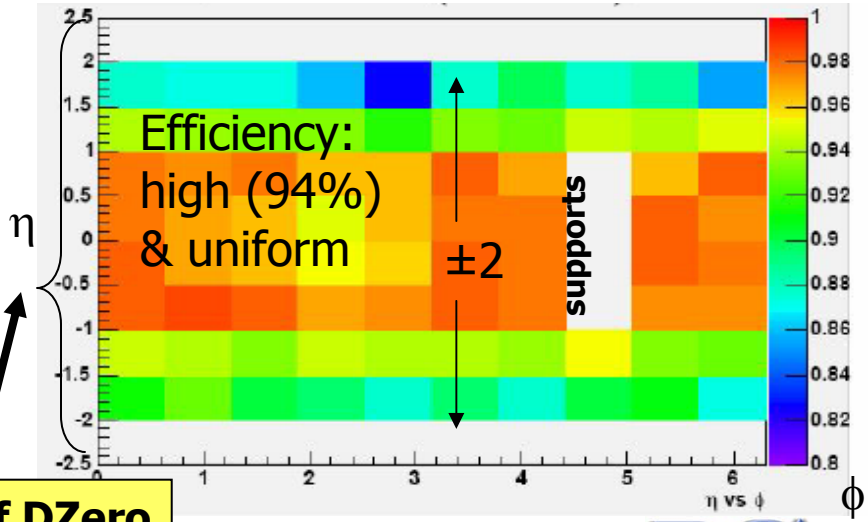


Correction factors at η=0.5

Muon Systems

- Three layers tracking & triggering
- Central
  - PDTs: 98.6% of 8k tubes active
  - Scintillator: 99.8% of 630 counters active
- Forward
  - Scintillator:
    - 99.9% of 4608 counters active
    - Expect around 10% degredation (mainly in phototube) at 15 fb^{-1}
  - MDTs:
    - 99.7% of 50k wires active
    - one plane disabled due to broken wire.
- Stable to 1%
- Highly Efficient





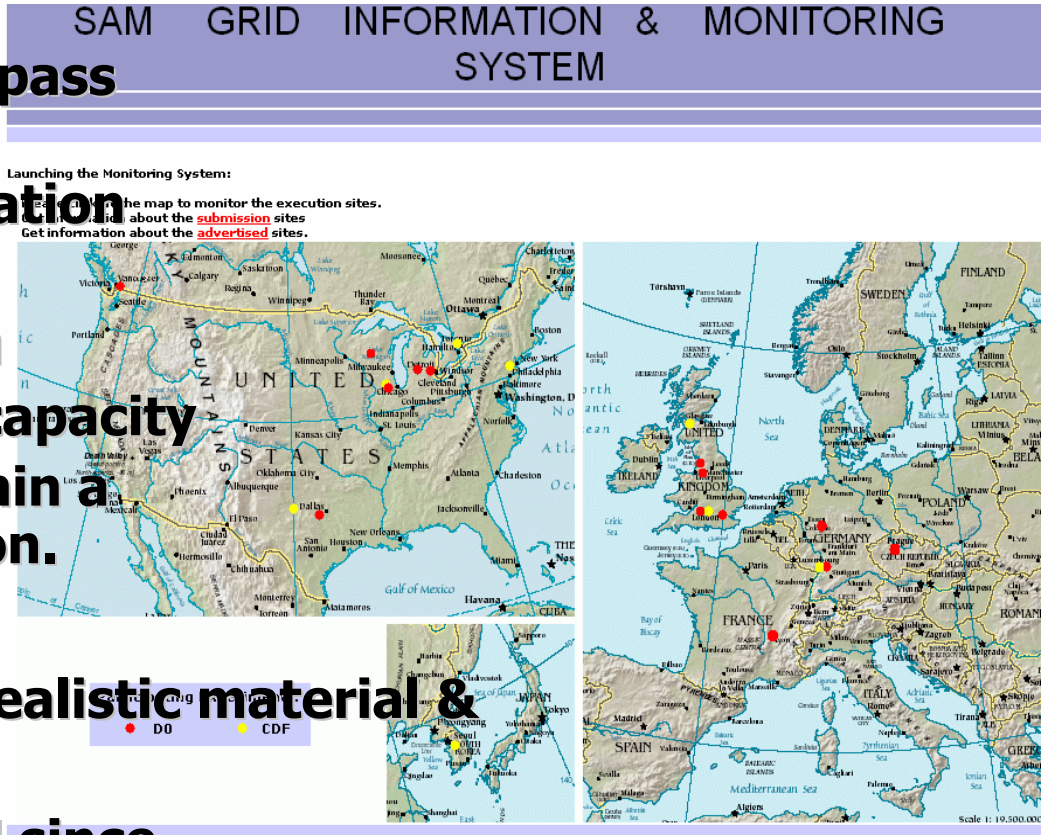
Strength of DZero

Overall Tracking Performance

- **Alignment: B=0 Field, verified w/ cosmics**
  - **CFT: fibers positioned to ~10um**
  - **SMT: single element alignment ~3um in transverse plane**
  - **SMT-CFT relative alignment: <10um**
  - **Stable: <5um motion over time**
- **High p_T Electrons:**
  - **Efficiency: ~87% for $|\eta|<2$**
  - **Fakes: 1-2%**
- **High p_T Muons**
  - **Efficiency: 98% central, 95% overall**
  - **Fakes: <1%**

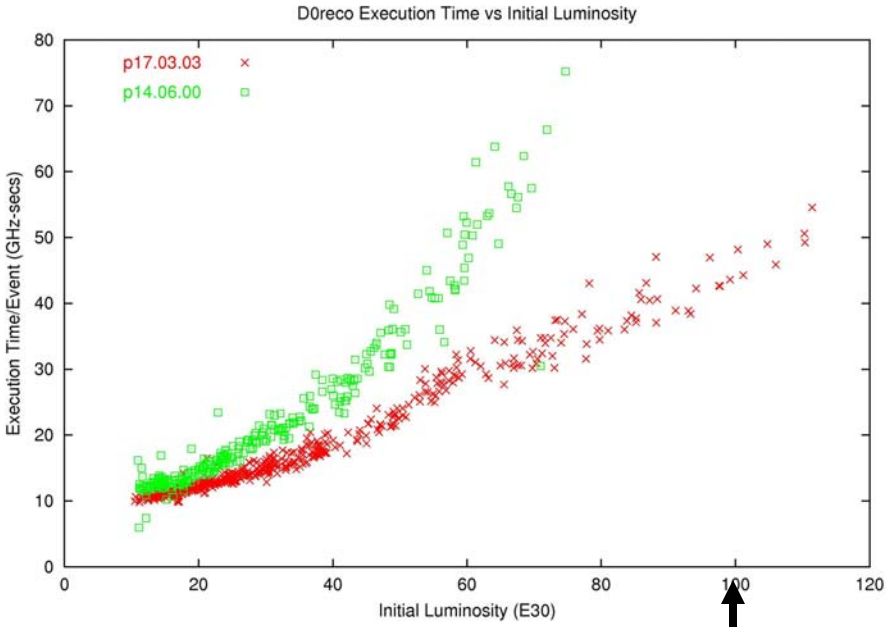
Processing: Onsite & Remote

- **Basic Strategy**
  1. **Initial reconstruction pass at Fermilab**
  2. **Reprocessing & simulation offsite.**
- **Reconstruction Farm**
  - **15-20M event/week capacity**
  - **Events processed within a day or two of collection.**
- **Simulation**
  - **Upgraded to include realistic material & Luminosity profiles.**
  - **76 M events produced since August, 2004**
  - **Capable of ~3M events per week**



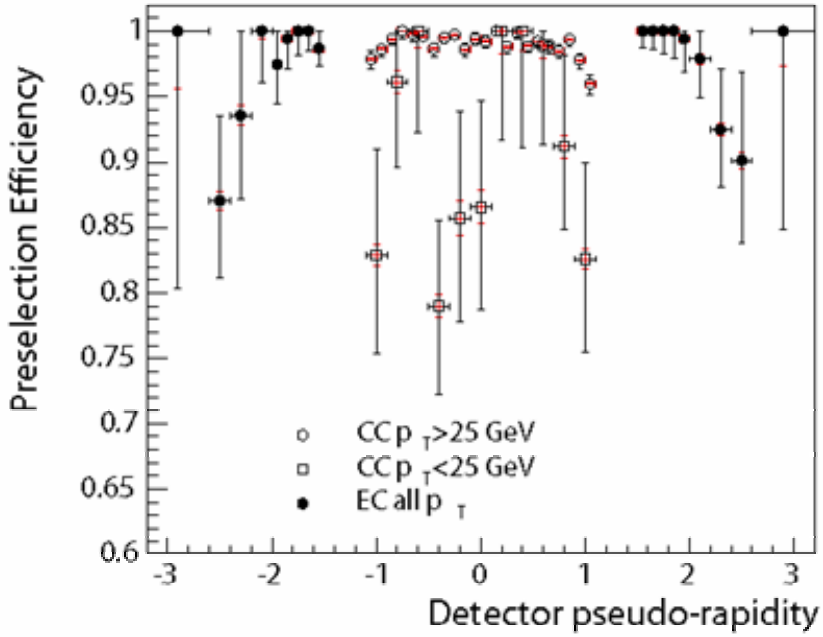
(Re)Processing

- **New reconstruction version much improved**
  - Faster
  - Grid Friendly
  - Calorimeter calibrated in situ at the cell level
- **Reprocessing first 470pb^{-1}**
  - 2004 "Pilot": reprocessed 140pb^{-1} remotely w/ GRID
  - Uses SamGrid (SAM+JIM), >10 offsite farms
  - Started Friday March 25, 2005
    - 795M of 986M complete
    - 671M remote
  - Should be complete by October, 2005



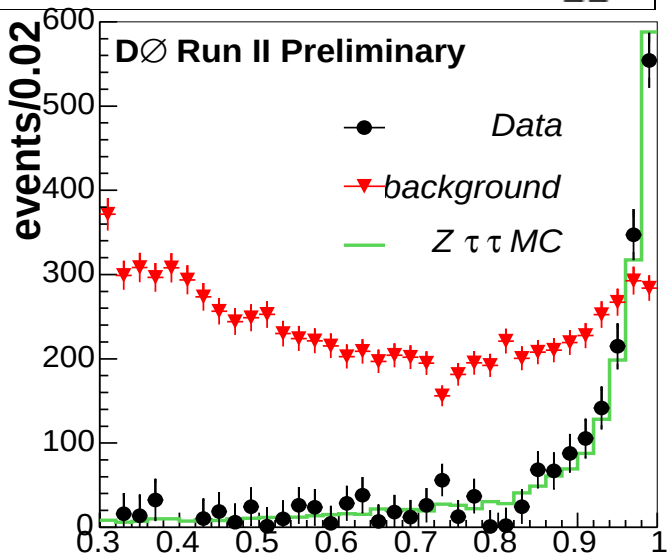
Improving Electron Acceptance

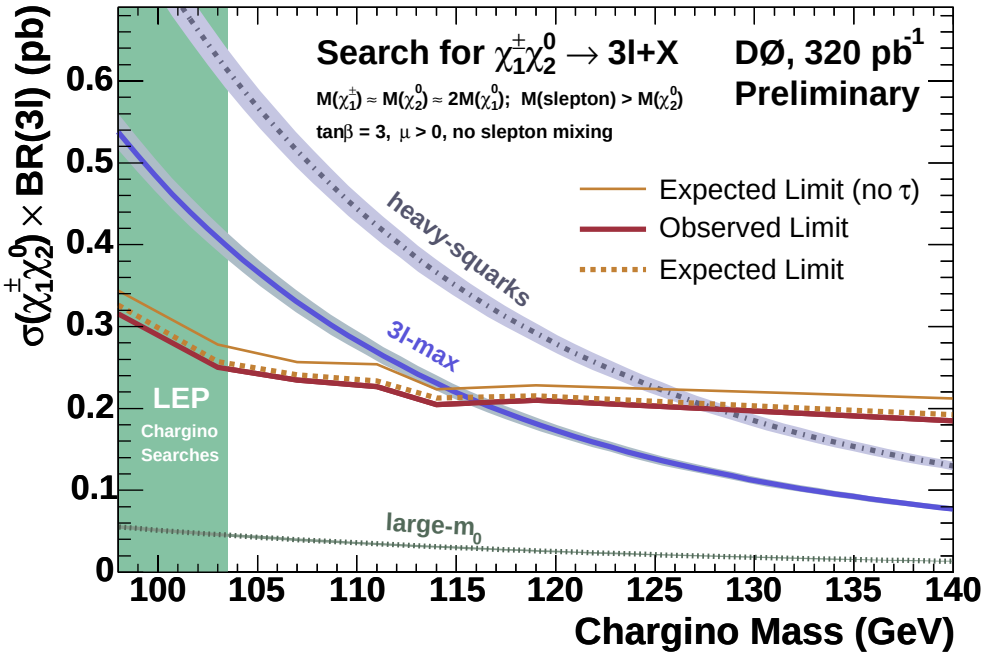
- For searches, extending electron acceptance beyond central region.
- Backgrounds ~1% in CC expected to be similar in EC.
- Working to achieve lower trigger thresholds with calorimeter trigger upgrade and understand track matching in the forward regions.

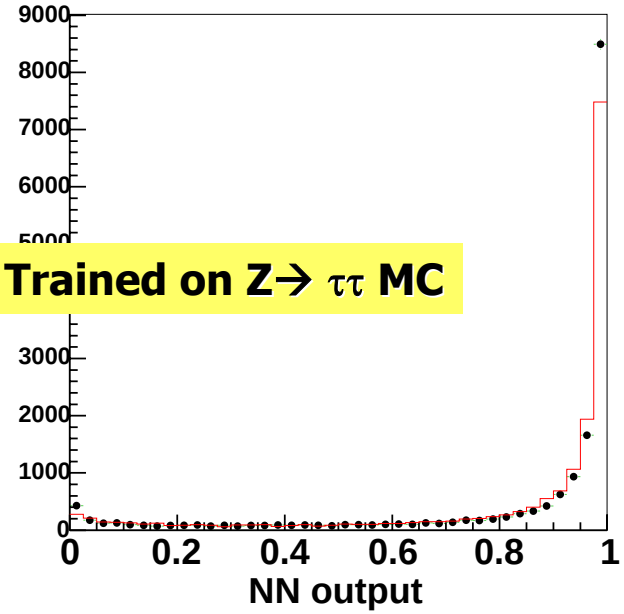


τ ID and Improvements

- NN Tau ID has reached maturity within DZero
- Used to measure published σ*B(Z→ ττ)
- Increasing sensitivity of searches
- Continuing to improve sensitivity



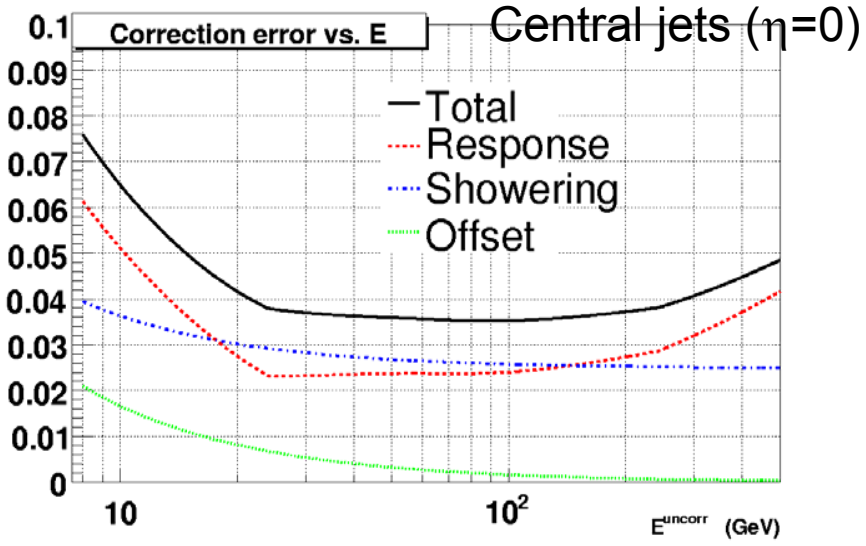


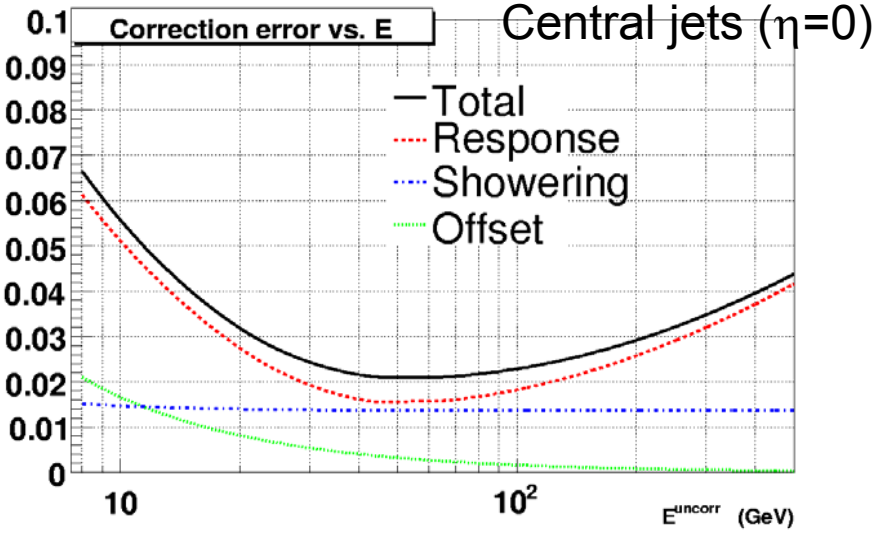


Trained on Z→ ττ MC

G.C.Blazey/ NIU

Jet Energy Calibration and Improvements

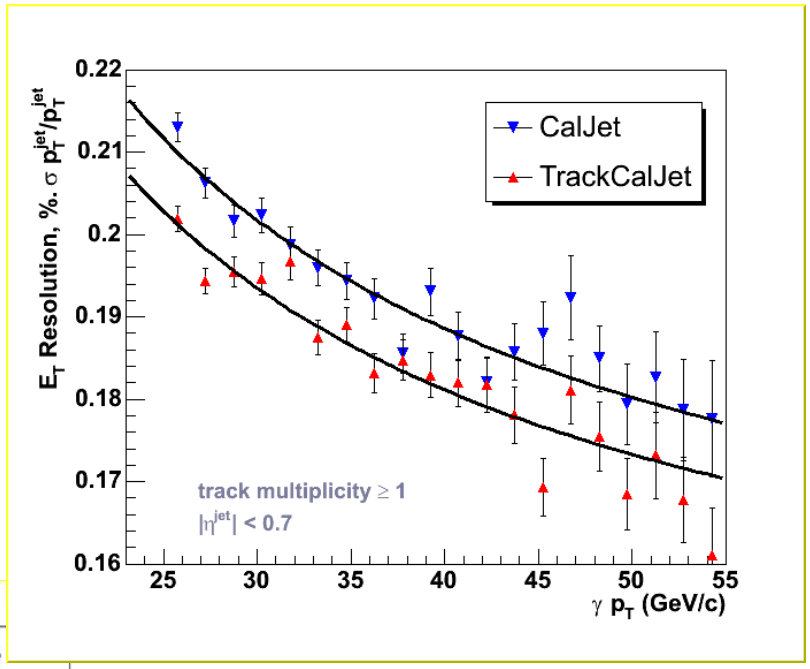


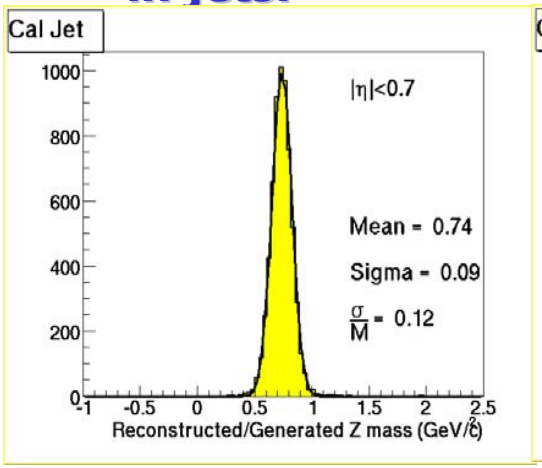


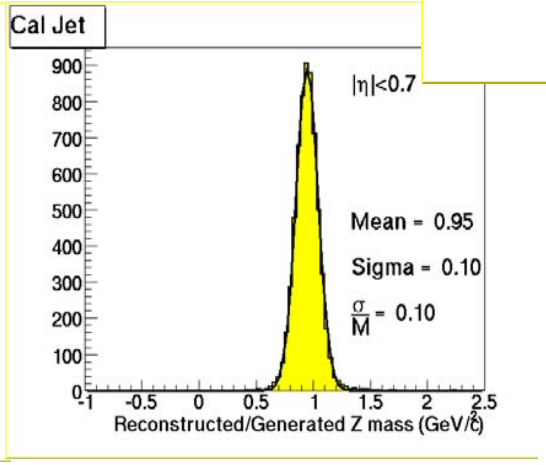
- **Negligible statistical uncertainties**
- **Factor of two improvement in systematic uncertainties in jet response related to photon purity and background estimation**
- **With completion of MC study out-of-cone energy loss uncertainty reduced from 2% to 0.5%**
- **Further improvements not shown here:**
  - **Jet response bias measurement at low E**
  - **Jet response extrapolation using Monte Carlo at high E**
- **Some Beneficiaries**
  - **Top mass in lepton+jets, cross sections**
  - **Single top**
  - **Any Search w/ jets**
  - **Inclusive jets…**

Jet Resolution & Improvements

- TrackCal Jet, an "add-on"
- Improve calorimeter jet resolution using tracks for hadron response.
- Track momentum measurements set an accurate scale for hadron response.
- Takes into account the non-linear response of individual particles in jets.



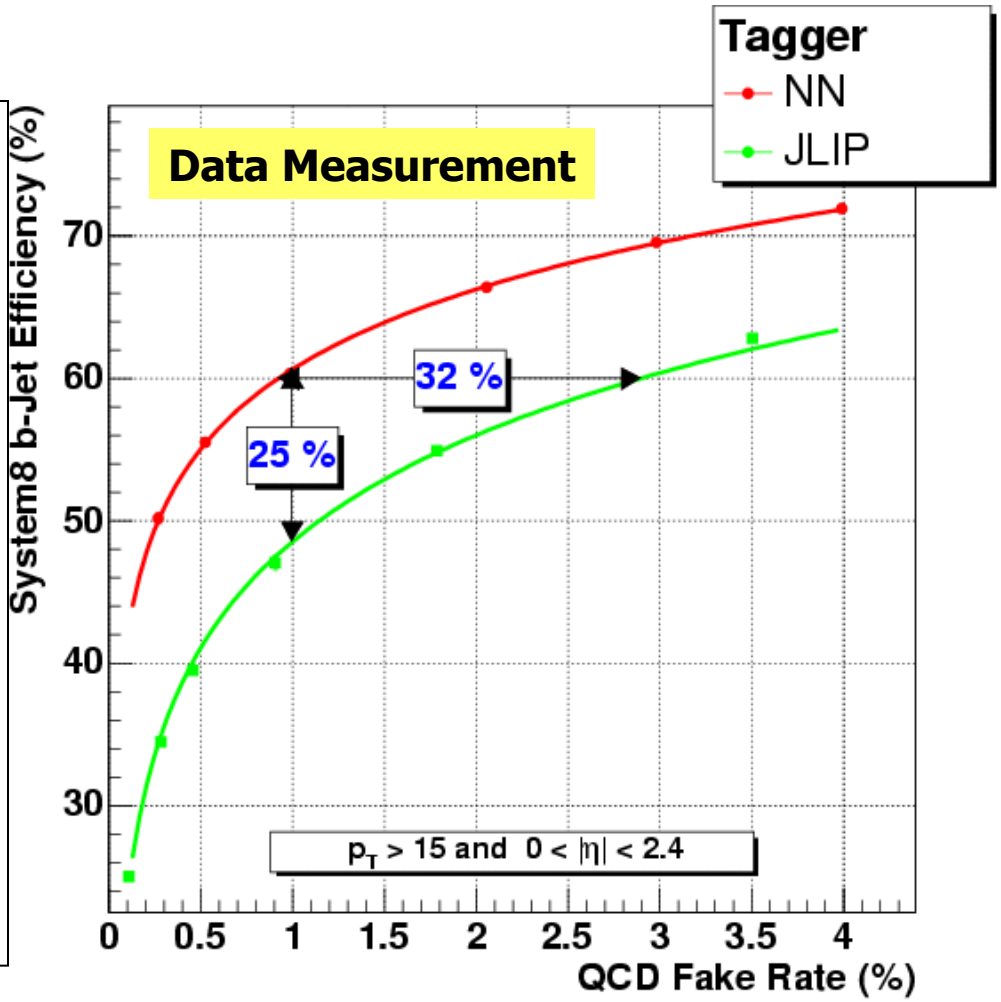




* 10% improvement in jet resolution.
* 20% improvement in MC Z resolution

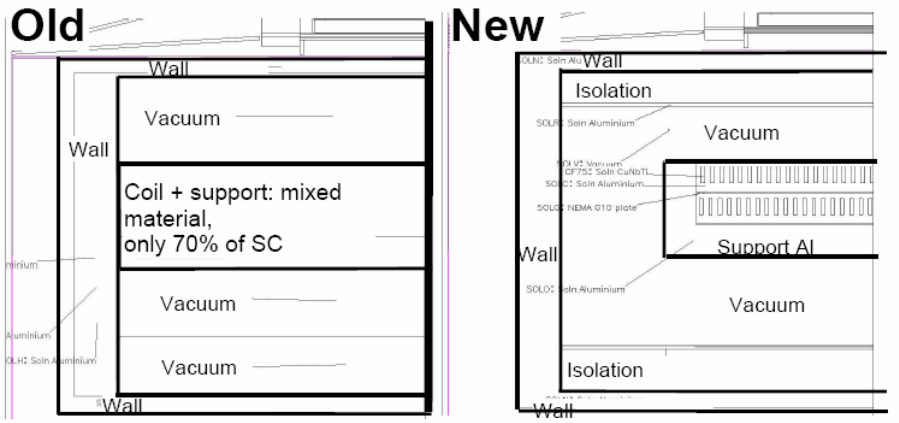
B-ID & Improvements

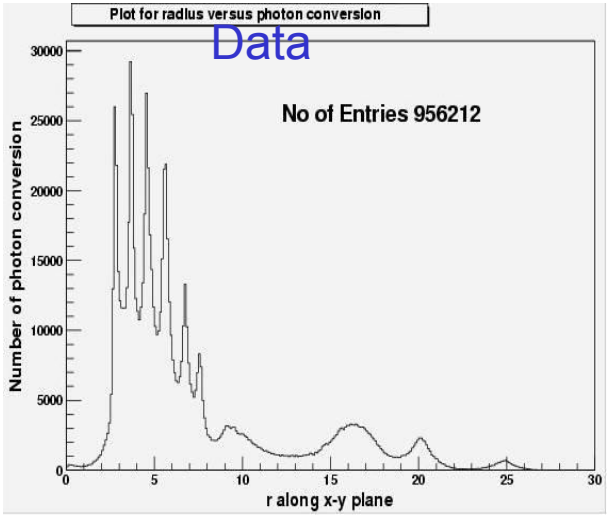
- Based on NN
- Seven inputs from
  - Secondary vertex tagger
  - Jet impact parameter tagger
- Significant improvement
  - 25% at fixed fake
  - X3 less fakes at fixed efficiency

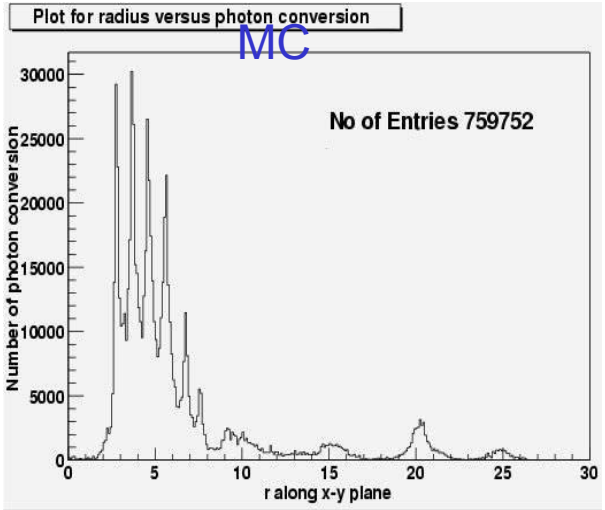


Simulation and Improvements

- **Improving description of material**
  - **Calorimeter, Cryostat, Solenoid**
  - **SMT volume, verified with photon conversions**

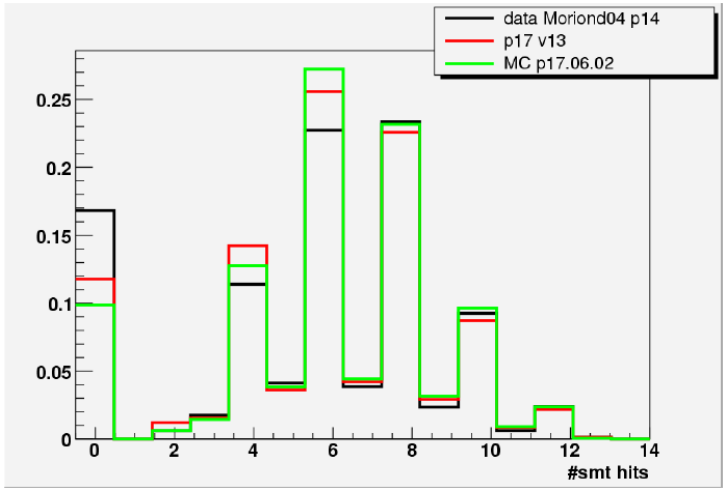


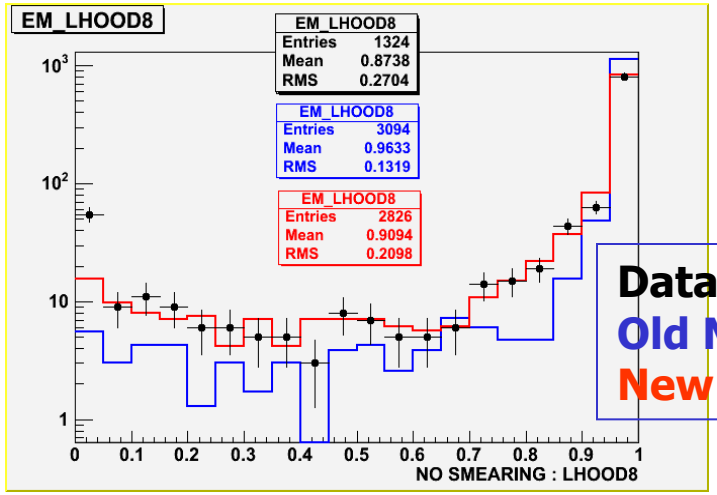




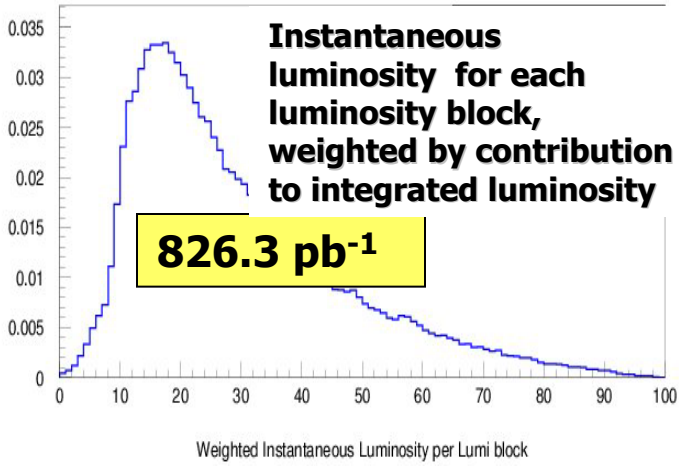
Simulation and Improvements

- **Simulation of dead channels in SMT & CFT**
- **Overlay of zerobias events on top of MC hard scatter**
  - **simulate detector occupancy, noise…**
  - **one zerobias event per MC event**
  - **Taken randomly from Run II luminosity profile:**





Data
Old MC
New MC



Publications

(http://www-d0.fnal.gov/www_buffer/pub/Run2_publications.html)

2004

1) *Search for Doubly-charged Higgs Boson Pair Production in the Decay to mu+mu+mu-mu- in pbarp Collisions at sqrt(s)=1.96 TeV*
2) *Observation and Properties of the X(3872) Decaying to J/psi pi+pi- in pbarp Collisions at sqrt(s)=1.96 TeV*

2005

1) *Search for Supersymmetry with Gauge-Mediated Breaking in Diphoton Events at DZero*
3) *Measurement of Dijet Azimuthal Decorrelations at Central Rapidities in pbarp Collisions at sqrt(s)=1.96 TeV*
4) *Measurement of the B_s^0 Lifetime in the Exclusive Decay Channel B_s^0->J/psi phi*
5) *A Search for the Flavor-Changing Neutral Current Decay B_s^0->mu+ mu- in pbarp Collisions at sqrt(s)=1.96 TeV*
6) *Measurement of the Ratio of B+ and B0 Meson Lifetimes*
7) *Measurement of the Lambda-B Lifetime in the Decay Lambda-B -> J/psi Lambda With the D0 Detector*
8) *A Search for Wbb and WH Production in pbarp Collisions at sqrt(s)=1.96 TeV*
9) *Measurement of the WW Production Cross Section in pbarp Collisions at sqrt(s)=1.96 TeV*
10) *A Measurement of the Ratio of Inclusive Cross Sections pbarp->Zb/pbarp->Zj at sqrt(s)=1.96 TeV*
11) *A search for anomalous heavy-flavor quark production in association with W bosons*
12) *First measurement of sigma(ppbar->Z)xBr(Z->tau tau) at sqrt(s)=1.96 TeV*
13) *Search for first-generation scalar leptoquarks in ppbar collisions at sqrt(s)=1.96 TeV*
14) *Study of Zgamma events and limits on anomalous ZZgamma and Zgammagamma couplings in pbarp collisions at sqrt(s)=1.96 TeV*
15) *Measurement of inclusive differential cross sections for Upsilon(1S) production in ppbar collisions at sqrt(s)=1.96 TeV*
16) *Measurement of the p-barp -> Wgamma +X Cross section and Limits on Anomalous WWgamma Couplings at sqrt(s)=1.96 TeV*
17) *Search for Randall-Sundrum Gravitons in Dilepton and Diphoton Final States*
18) *Search for right-handed W bosons in top quark decay*

Accepted or Submitted

20) *Production of WZ Events in p-barp Collisions at sqrt(s)=1.96 TeV and Limits on Anomalous WWZ Couplings*
21) *Search for neutral supersymmetric Higgs bosons in multijet events at sqrt(s)=1.96 TeV*
22) *Search for supersymmetry via associated production of charginos and neutralinos in final states with three leptons*
23) *Search for single top quark production in pbarp collisions at sqrt(s)=1.96 TeV*
24) *Measurement of the lifetime difference in the Bs system*
25) *Measurement of semileptonic branching fractions of B mesons to narrow D** states*
26) *Search for large extra spatial dimensions in dimuon production at DZero*

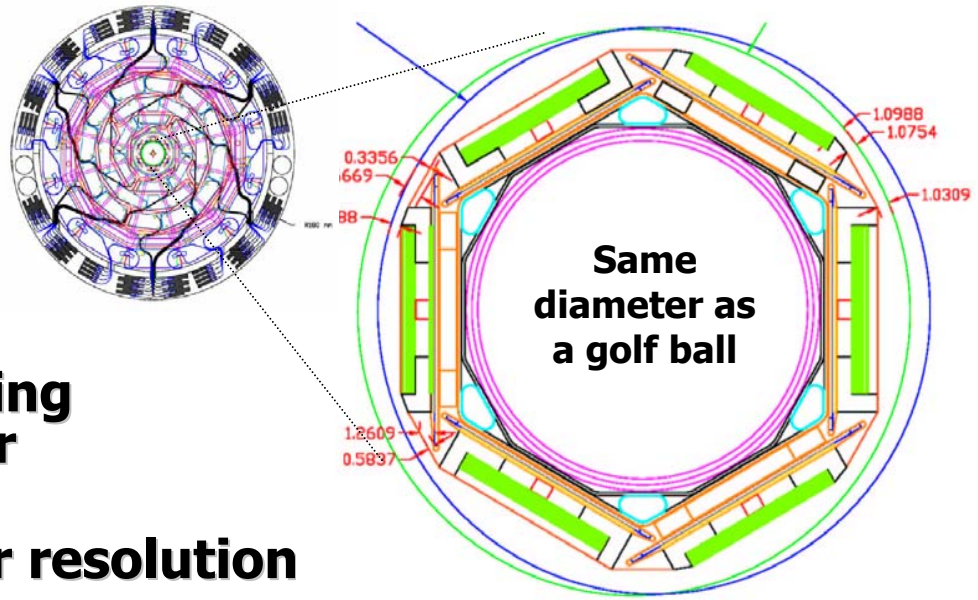
27) *Measurement of the ttbar cross section in pbarp collisions at sqrt(s)=1.96 TeV using kinematic characteristics of lepton plus jets events*
28) *Measurement of the ttbar cross section in pbarp collisions at sqrt(s)=1.96 TeV using lepton plus jets events with lifetime b-tagging*
29) *Measurement of the ttbar production cross section in pbarp collisions at sqrt(s)=1.96 TeV in dilepton final states*
30) *Search for the Higgs Boson in H->WW(*) Decays in ppbar Collisions at sqrt(S)=1.96 TeV*
31) *The Upgraded D0 Detector*

Thirty(+1) Run II Papers

Luminosity: ~0.3-0.4fb^{-1} as much as 0.6fb^{-1}
Group: B-8/EW&QCD-6/NewP-6/Higgs-5/Top-5
Twenty-six in Draft or Review
Conference Results: 61 Approved

Preparation for "200E30+" Stores

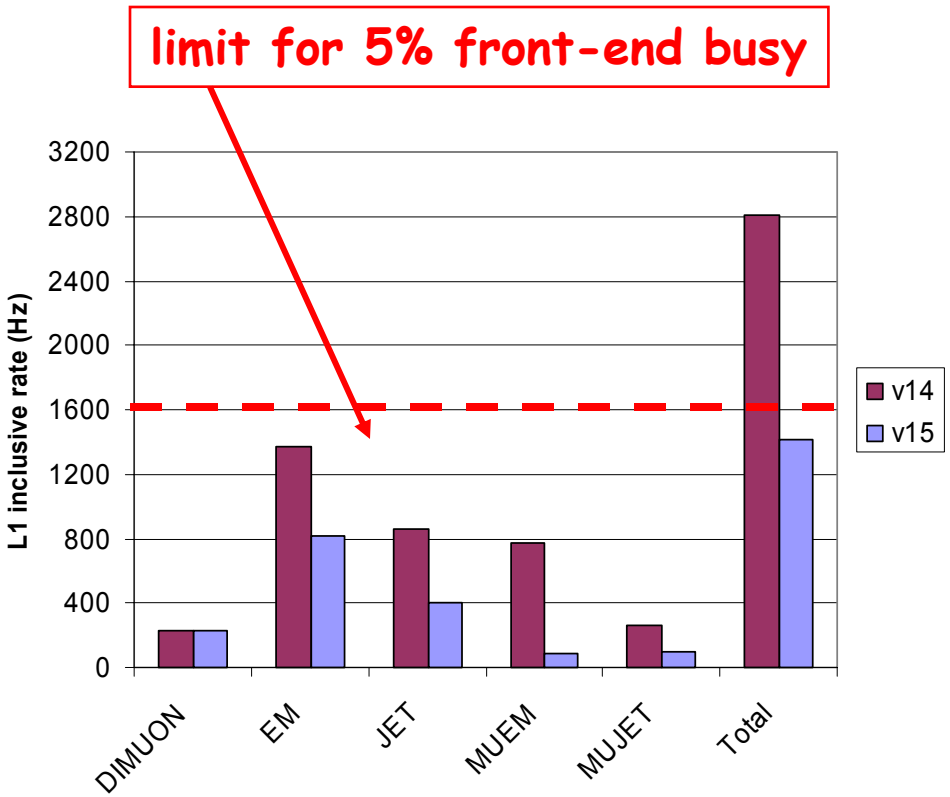
- **Layer Zero detector - an inner layer of silicon**
  - Mitigate tracking losses due to radiation damage and detector aging
  - Provide more robust tracking and pattern recognition for higher luminosities
  - Improve impact parameter resolution



- **Trigger/DAQ Upgrades**
  - Complete upgrade program to keep trigger rates down as luminosity increases
  - L1 upgrades (Calorimeter, Central Track Trigger, Cal Trk-Match)
  - L2 upgrades (Silicon Track Trigger, L2 β processors)
  - DAQ/Online (Upgrade L3 processing power, database & host servers, control systems)

"200E30" Strawman Trigger List

- Current Trigger good to ~120E30
- Upgrade Trigger Task Force
- Estimate
  - Includes only L1cal upgrades
  - Further improvements anticipated from L1CTT and L1caltrack
- Rates projected to 200e30 using data:
  - Pre-upgrade: 2800 Hz
  - Upgraded: 1400 Hz
  - Efficiency equal or better
  - Implemented @ shutdown



Run IIb Upgrade Current Status

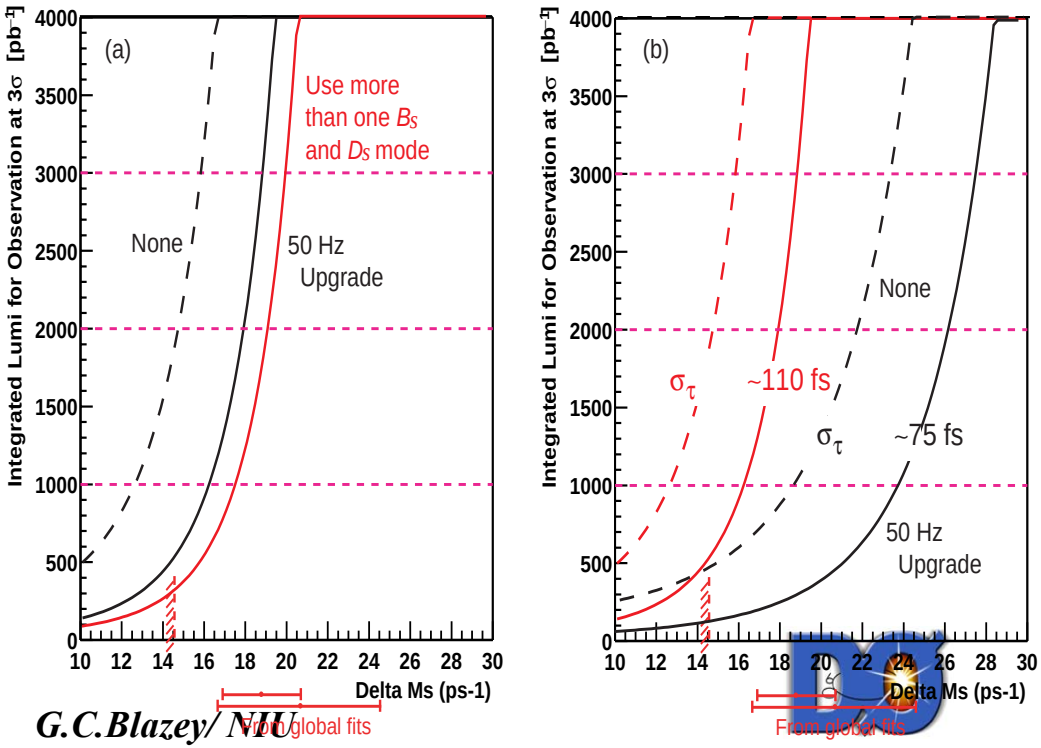
- **Layer Zero**
  - Completed. All channels read out
  - Technical Readiness Review (TRR) scheduled for Sept. 16
  - Cooling and clearance tests remain
  - Installation mockups successful, fine tuning procedures
  - Software ready.
- **Trigger/DAQ Upgrades**
  - L1 all hardware in hand and bench tested
    - L1CTT system tests have been completed and TRR held.
    - L1Cal system tests well advanced and TRR held.
    - L1 Cal-Trk Match has made a full integration vertical slice.
  - L2 upgrades hardware in hand
    - β processors tested at DZero and UVa
    - STT TRR towards end of September.
  - DAQ/online essentially complete

Comments on Upgrade

- The upgrades are ready to install
  - In two cases, the collaboration has had the chance to hold full reviews
  - The rest of the subprojects will also be reviewed – but no showstoppers
- The RunIIb project phenomenally successful! A technically challenging project finishing within a couple of months of the original forecast two years ago.
- Especially in the last few months many people have been working extremely hard to bring the projects to installation readiness.
- DZero ready to install upgrades Oct 31st:
  - Improves quality/efficiency of DZero data and collection
  - Allows experts to move on to physics commissioning and analysis

Looking forward - other initiatives

- **New electronics for central fiber tracker (AFE II)**
  - Helps tracking efficiency in high luminosity/occupancy environment.
  - Approved early '05.
  - Different timescale - completion late 2006
- **Have submitted a proposal to improve Bs mixing reach.**
  - Measurement is statistically limited.
  - L3 bandwidth
  - 50 Hz store average limited by computing budget
  - Have submitted a proposal to DOE for additional offsite reconstruction CPU
    - Located at IndianaU and UofOklahoma
    - 50% match by the institutions



Experimental and Analysis Plan

- Each December upper management proposes a set of major goals for the experiment. The CY05 goals focused on
  - Completion of the upgrades
  - Preparation of the full Run IIa data set for CY06 presentation and publication
  - Increased automation/efficiency for long term data preparation and analysis
- Highlights of late CY05 goals:
  - July:
    - Reprocessing well underway.
    - Implementation of Common Analysis Format
  - August/September:
    - Complete upgrade elements.
  - October:
    - Preliminary version new jet calibration.
  - November:
    - Processing and Reprocessing of entire 1fb^{-1} data set complete with improved calibration/tracking
    - Automated certification of all object definitions.

Key to future efficiencies

Conclusions

- The DØ detector is working well at ~90% efficiency
- World-wide processing keeping pace
- Algorithms and simulation reaching maturity and improved sensitivity.
- Publishing at a healthy rate (up to 600 pb^{-1})
- Preparing for the future.
  - Operational Efficiency
  - Upgrades
- The collaboration is enthusiastic about the nearly 1.0 fb^{-1} data to tape and the prospects more.

On the operational side both experiments are ready and preparing for the full run – we have the means – next you'll hear we have the will.

Details on Prospects for B_s Mixing

- New Layer-Zero silicon improves decay length resolution 30%
- Bandwidth increase will increase statistics threefold
- Improved triggering with STT and invariant mass at L3
- Add hadronic Bs decays
  - Trigger on flavor-tagging
  - Excellent proper time resolution since full reconstructed
- Analysis Techniques
  - Add more decay channels $D_s \rightarrow K_s^0 K$, K^*K^*, 3π
  - Improve boost estimate (semileptonic modes)
  - Improve opposite-side flavor tag (now εD^2 ~2% → 2.5%)
  - Add same-side flavor tag (εD^2 ~1.5-2%) by summer
  - Un-binned likelihood fit: event-by-event resolution and purity