DØ Detector and Collaboration: Run Beyond 2011

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Talk Outline

- DØ experiment physics goals and detector design
- DØ data collection, processing and physics analysis – excellent success
- Tevatron run extension – delivered and analyzed luminosity
- DØ detector is capable of handling 20 fb^{-1} of delivered luminosity
  - Muon system
  - Calorimeter
  - Central Fiber Tracker
  - Silicon detector
  - Infrastructure
- Collaboration is interested in running beyond 2011
  - 85% of groups are signing Expression of Interest

Running beyond 2011 is an exciting option with excellent physics potential supported by the collaboration. The detector will handle 20 fb^{-1} of delivered luminosity.

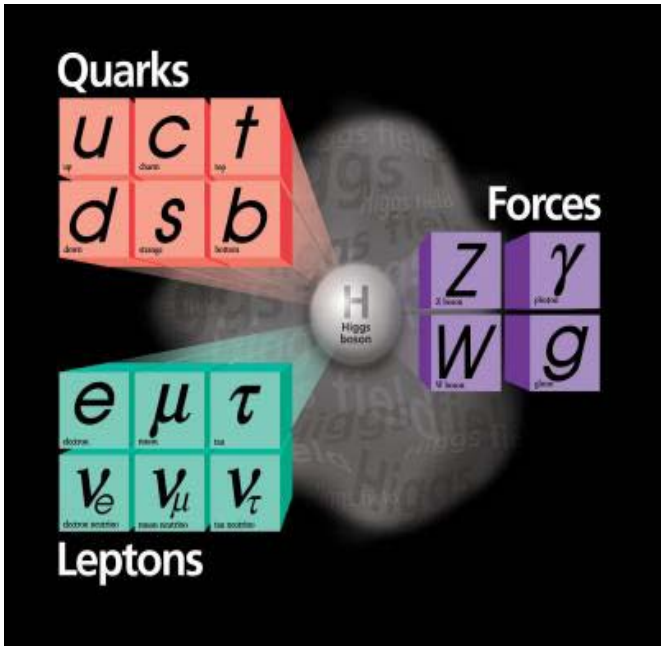
Tevatron Physics Goals

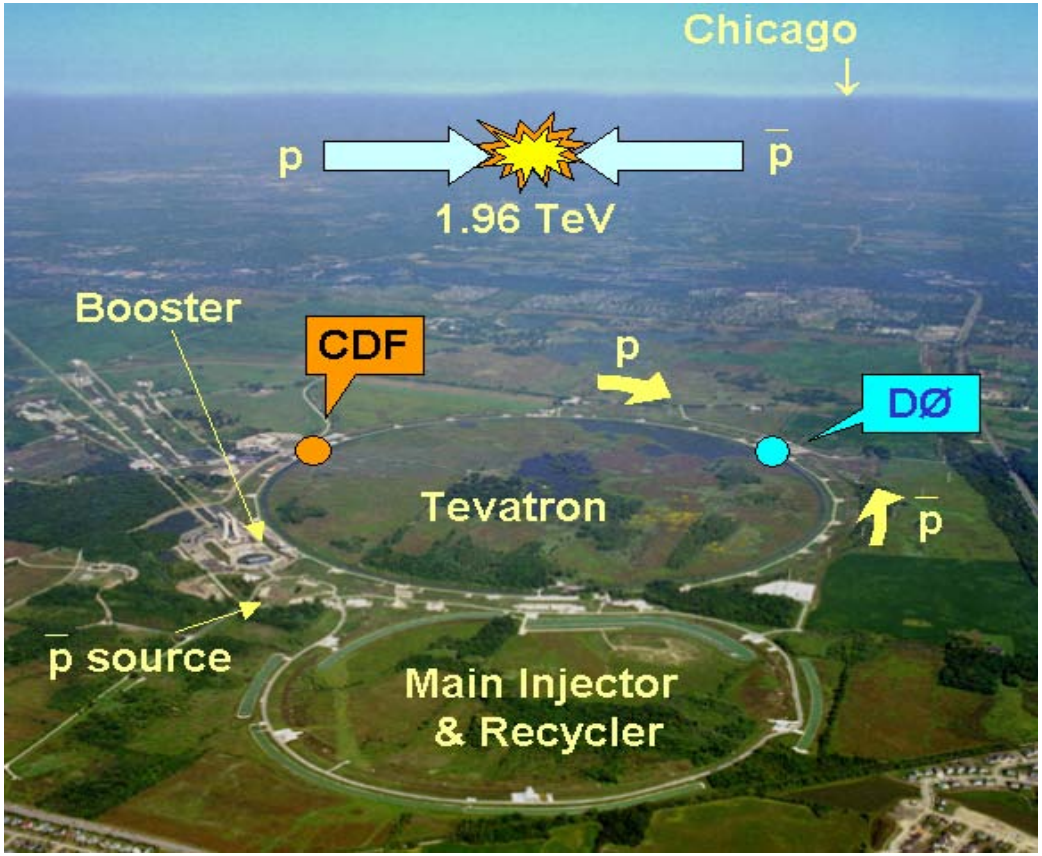
Precision tests of the Standard Model

- Weak bosons, top quark, QCD, B-physics…

Search for particles and forces beyond those known

- Higgs, supersymmetry, extra dimensions….





Fundamental Questions

Quark sub-structure?

Origin of mass?

Matter-antimatter asymmetry?

What is cosmic dark matter? SUSY?

What is space-time structure? Extra dimensions?…

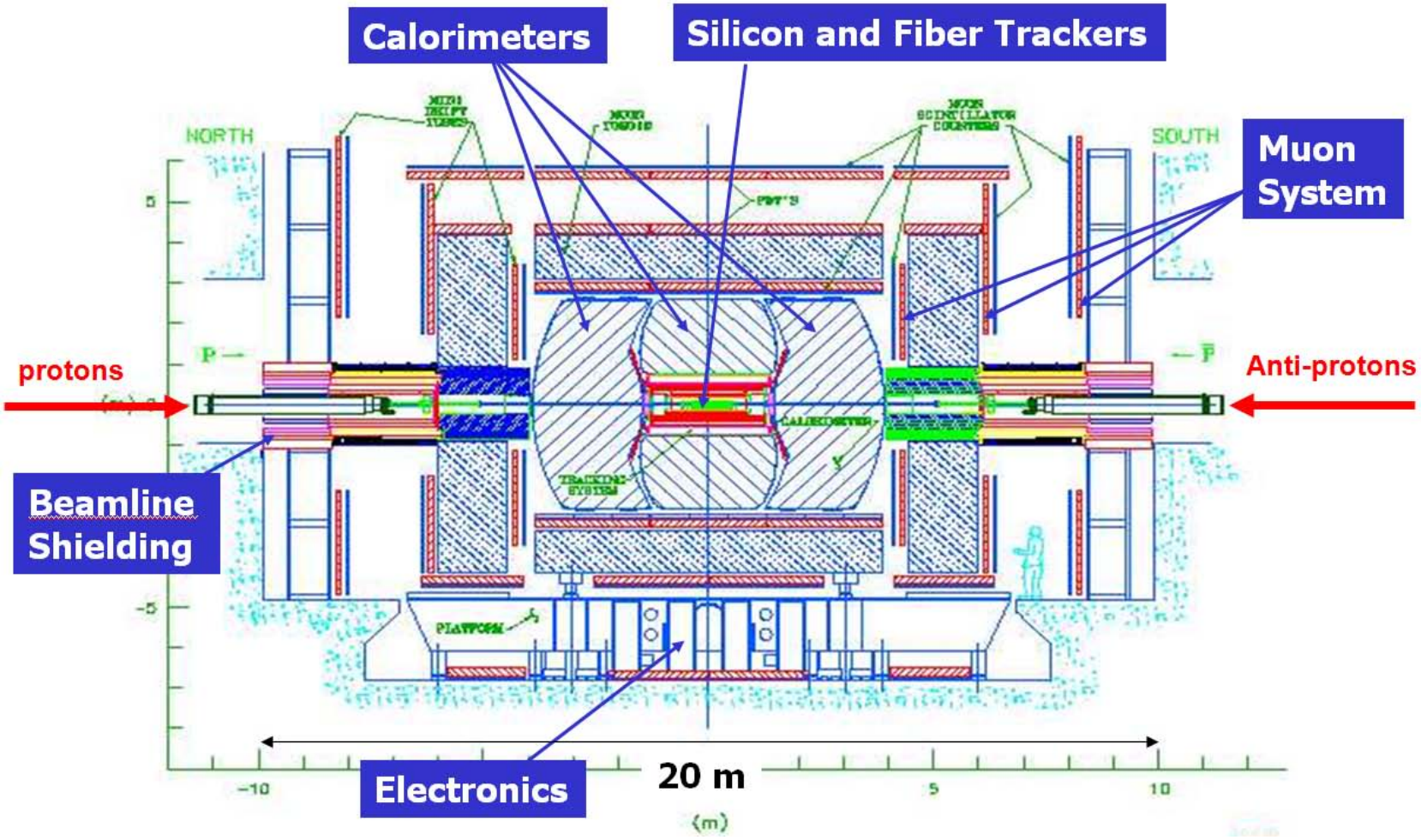
The DØ Detector

Driven by physics goals, the detectors emphasize

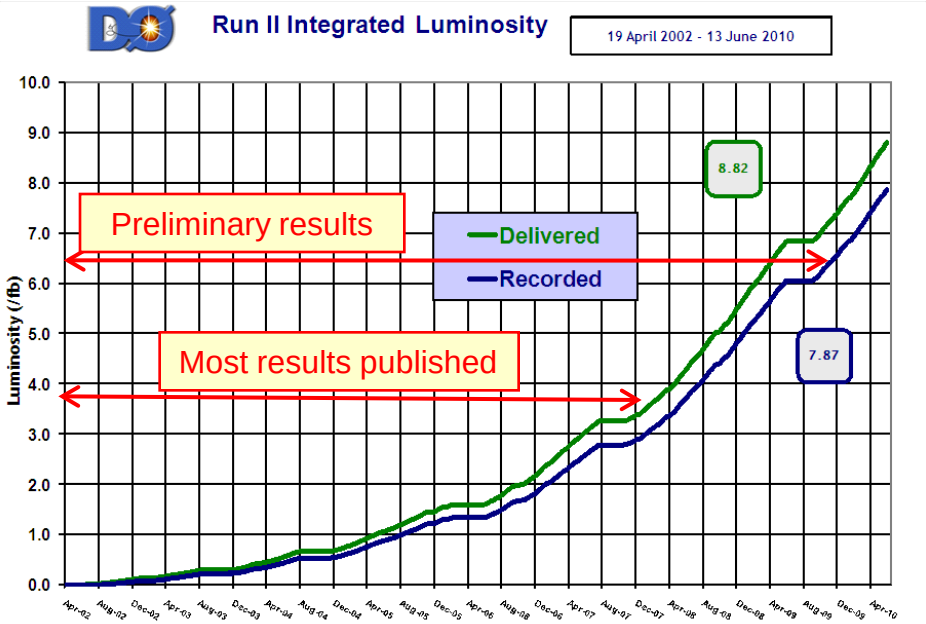
Electron, muon and tau identification

Jets and missing transverse energy

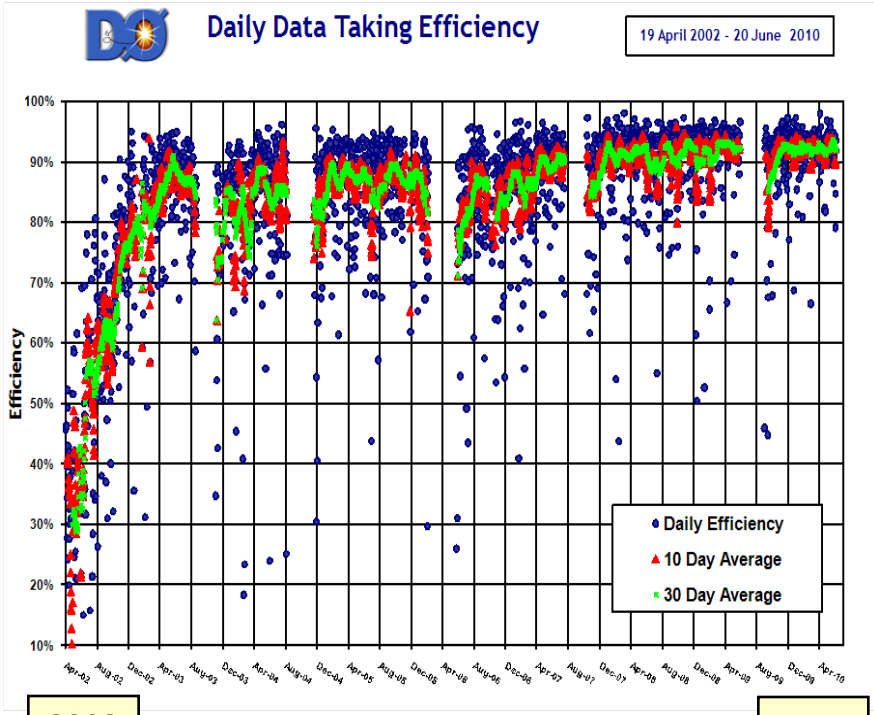
Flavor tagging through displaced vertices



Data Collection



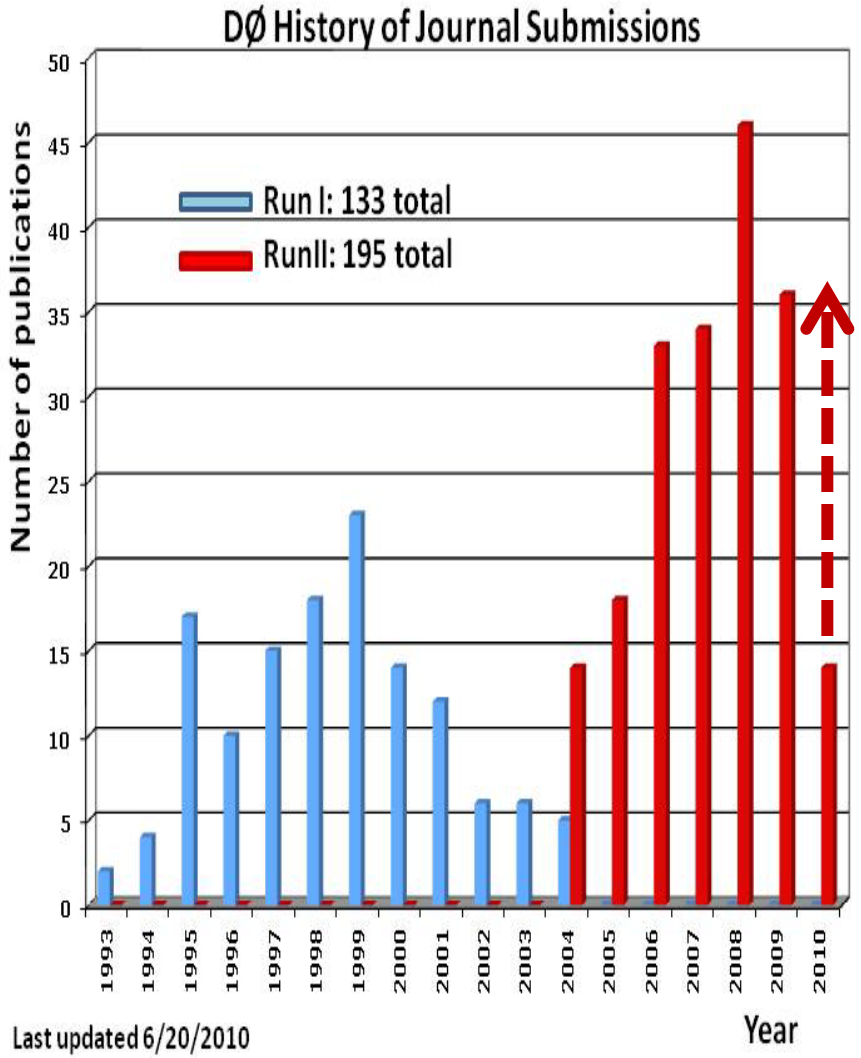
- DØ experiment is smoothly recording high quality physics data
  - Typical week over 55 pb^{-1}
- Averaging 90% data taking efficiency
  - Even with higher luminosity!
- As of today DØ has ~ 8 fb^{-1} on tapes
- All detectors are functioning well



- Raw data reconstruction is smooth
  - Data processed within a week of collection
  - Above 7 fb^{-1} results will be presented at ICHEP this summer
- Excellent rate of Monte Carlo simulation
  - ~50 million events per week

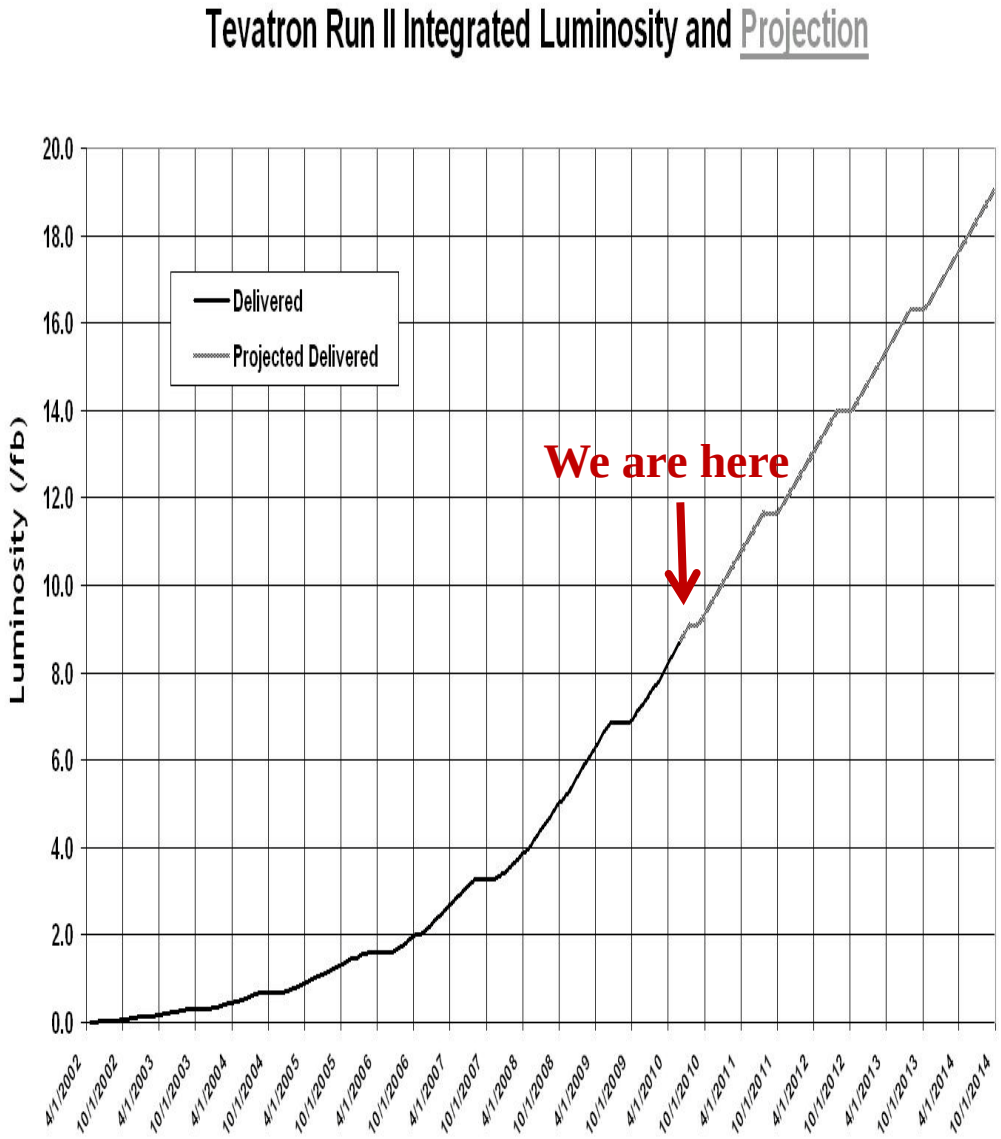
Excellent Recent Progress with Physics Analysis

- 53 new results presented by DØ at 2010 winter conferences
- New results in all physics areas
  - B physics, Electroweak, New Phenomena Searches, QCD, Top Quark, Higgs Searches
- 77 abstracts submitted by DØ to ICHEP 2010
  - Tevatron is presenting absolute majority of the experimental results
- ~200 papers published by DØ collaboration in Run II
  - Excellent future publication projections



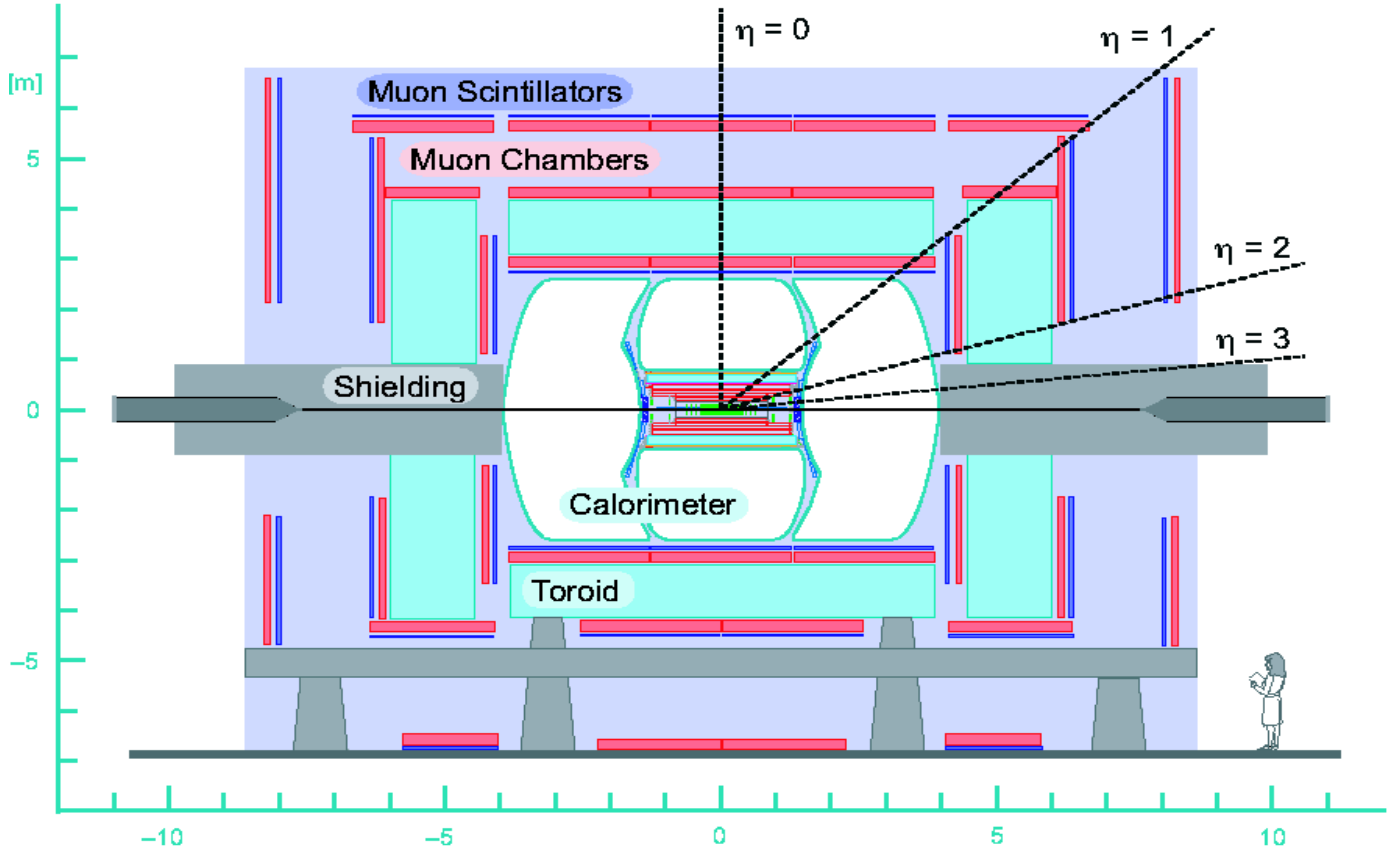
30 PhDs were defended over past year at DØ !

Tevatron Luminosity Projections



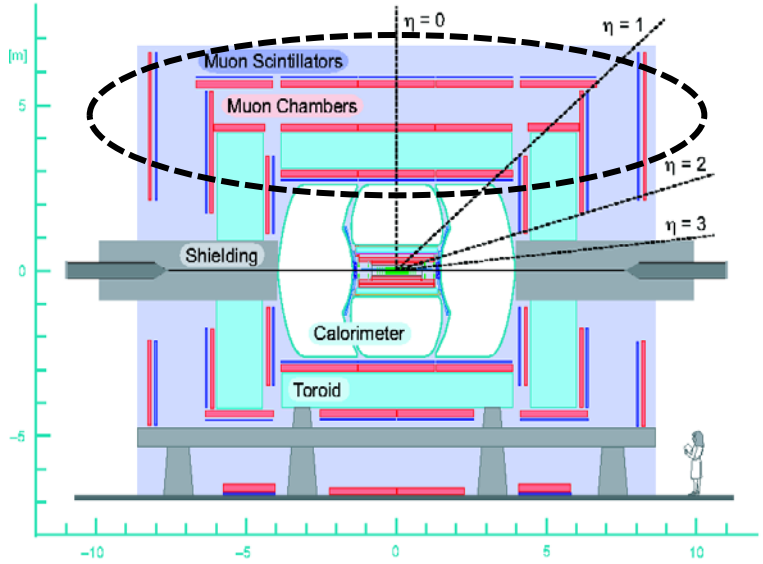
- Extrapolating beyond 2011 with the same rate of delivering luminosity brings us to ~20 fb^{-1} delivered by the end of 2014
  - Three years provides doubling data set and additional cycle for students and postdocs
- Expect record to tape ~90% of the delivered luminosity
- Data set for analyses requiring all elements of the detector
  - ~90% of recorded luminosity
  - ~16 fb^{-1} will be available for Higgs searches

The DØ Detector



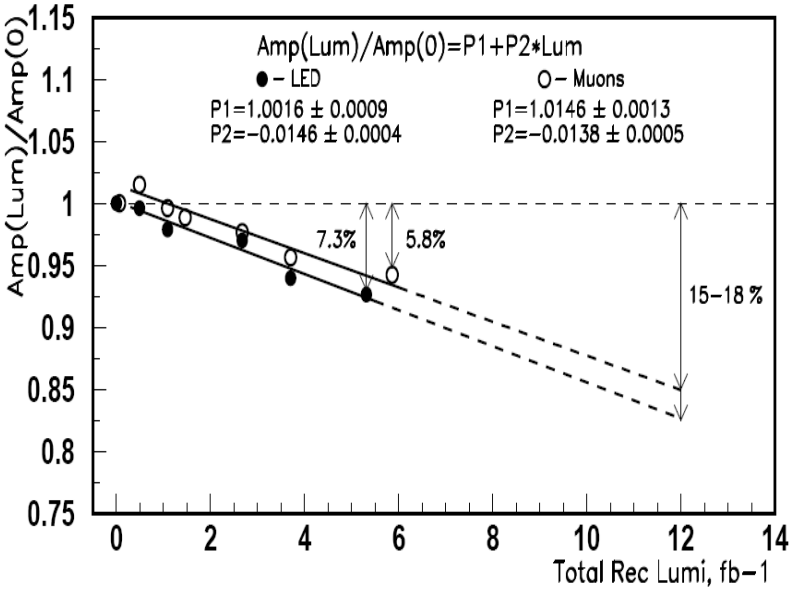
- Designed/upgraded for Run II to run to luminosity of ~2 fb^{-1}, peak luminosity ~$2 \cdot 10^{32}$ $cm^{-2}s^{-1}$ and beams crossing time of 132 ns
- We are using the detector well beyond it's design goals
  - And its serves us well!
- We will consider performance of all major elements of the detector starting from the muon system and going inside

Muon System

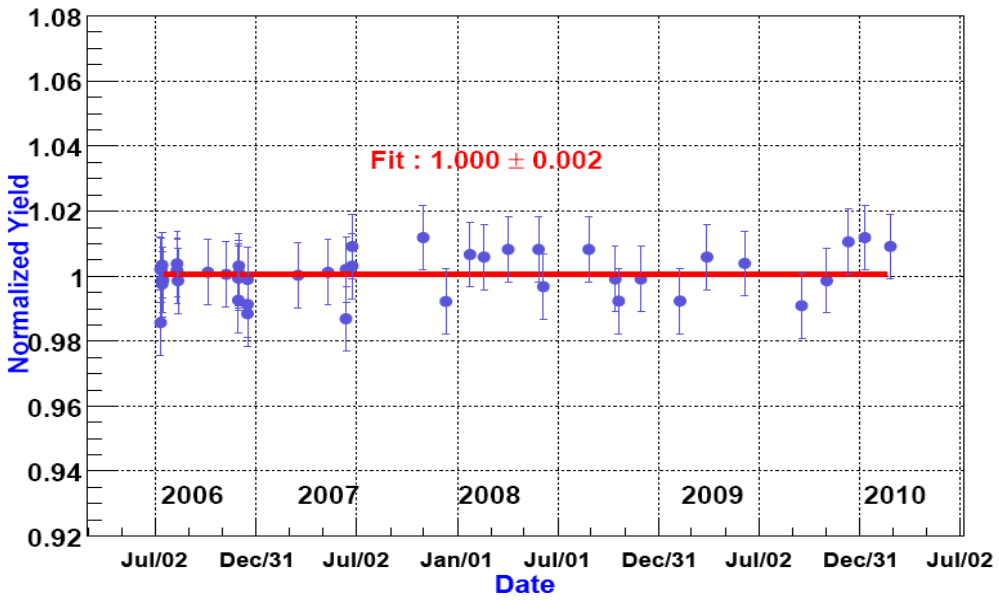


- Scintillation trigger counters and drift tubes
  - ~60 thousand channels
  - ~ 99% of channels are in operation
- Had serious aging issues in Run I
  - Learned the lesson
- Closely monitoring radiation effects in all detectors
- No un-expected aging effects observed
  - Minor adjustments to operating parameters will be needed

Scintillation counters light yield

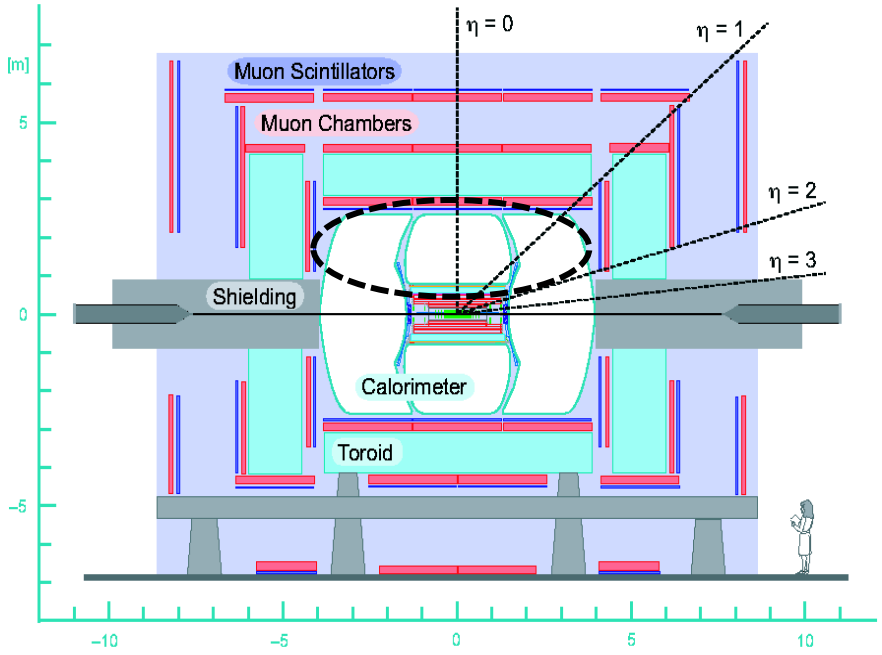


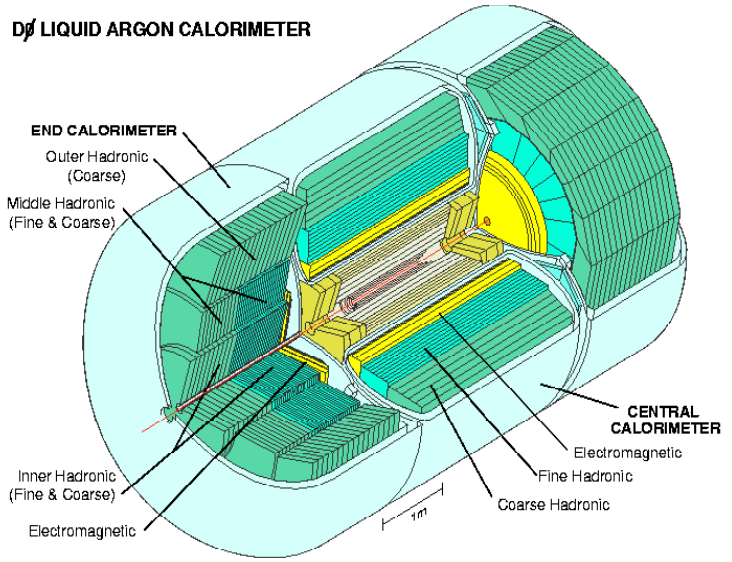
Single Muon Yields from July 2006 to March 2010.



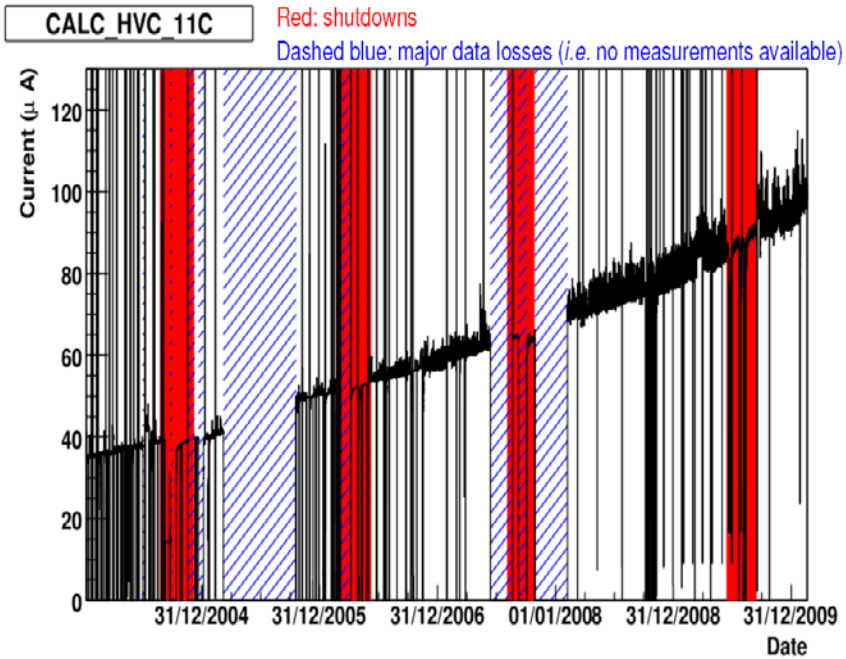
Monitoring of muon system using inclusive muon production

Calorimeter

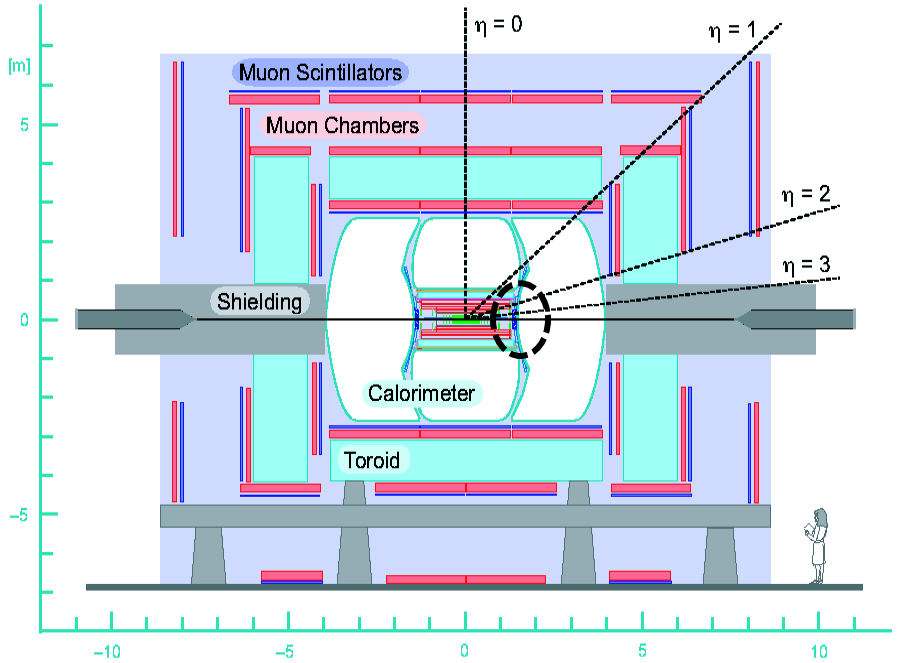


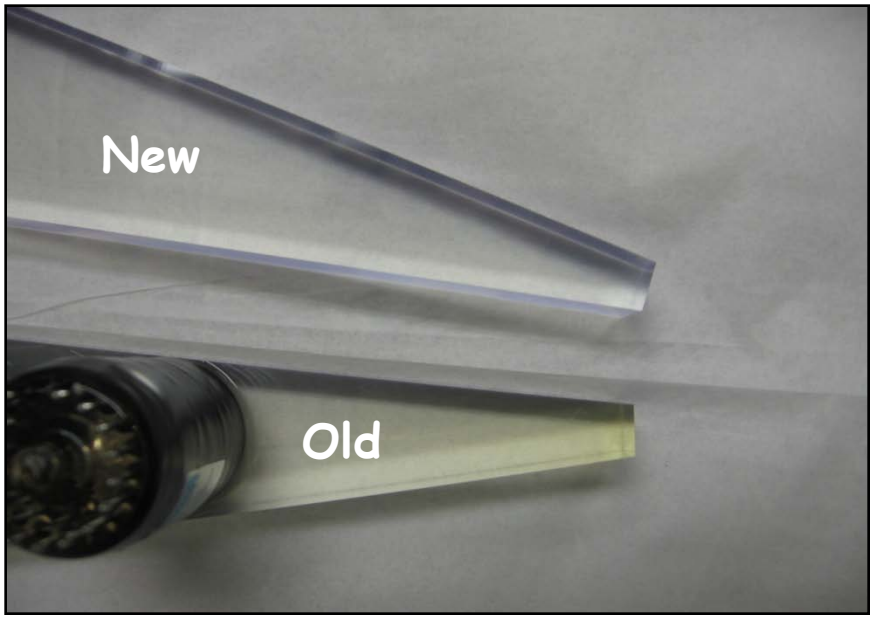


- Liquid Ar and uranium
  - "Nothing to age"
- Liquid Ar purity is stable as well the position of Z boson mass peak
- Over 99.9% of channels are operating
- Increase is observed in the calorimeter currents with time
  - Not expected to deteriorate cal performance



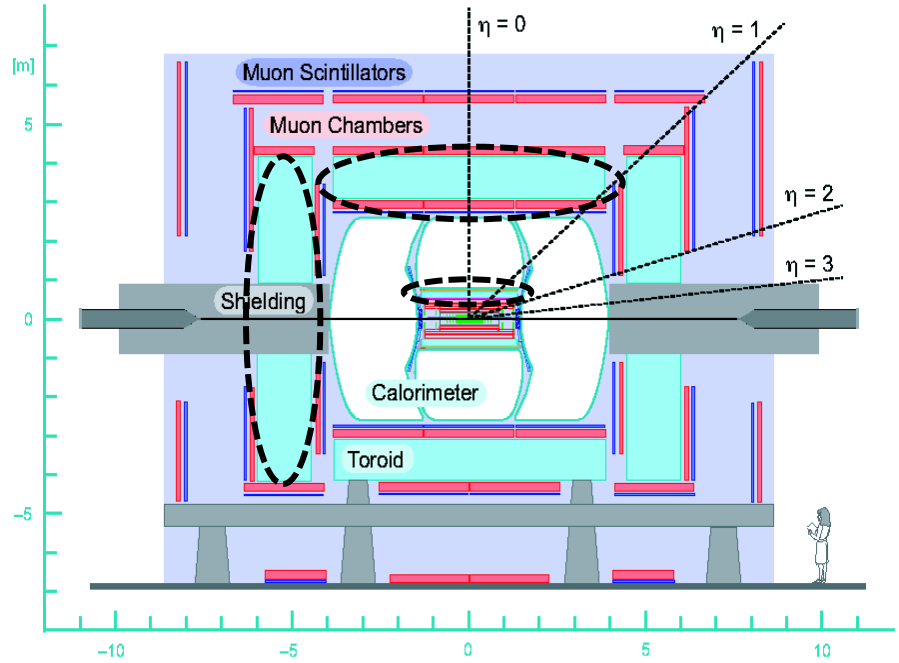
Luminosity Detector





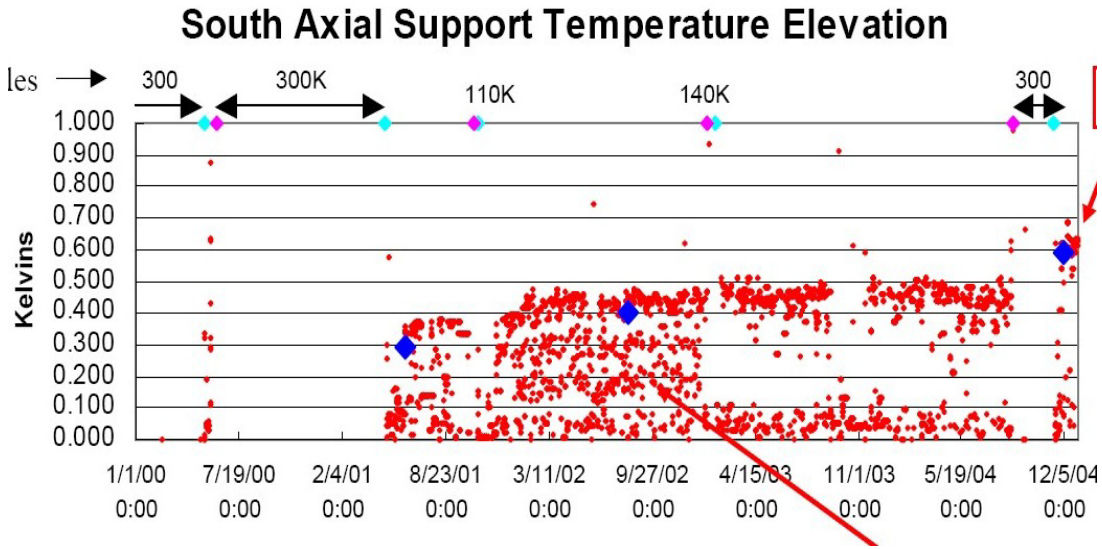
- Two arrays of 24 scintillation counters on both sides of the interaction region
- Closely monitoring effects of radiation in large flux of the forward region
  - Well studied by now
- Replaced scintillator past summer
- Replacing scintillator in summer of 2010
  - Will replace every 1-2 years beyond 2011
  - Several weeks to replace, cost is rather moderate

Magnets

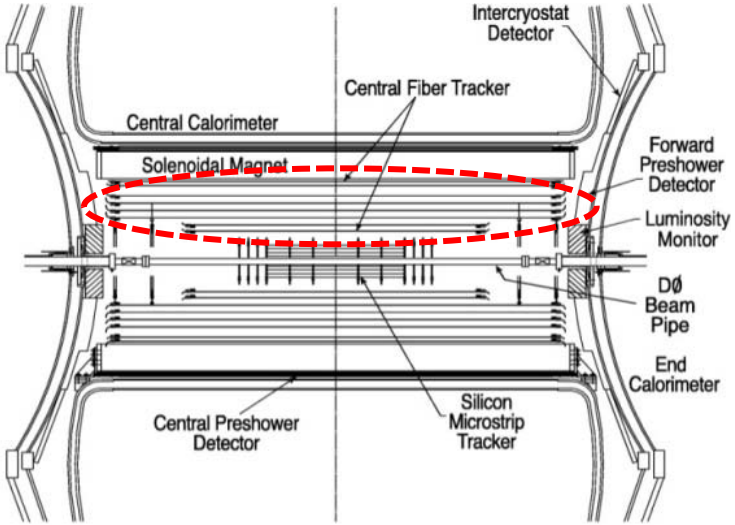


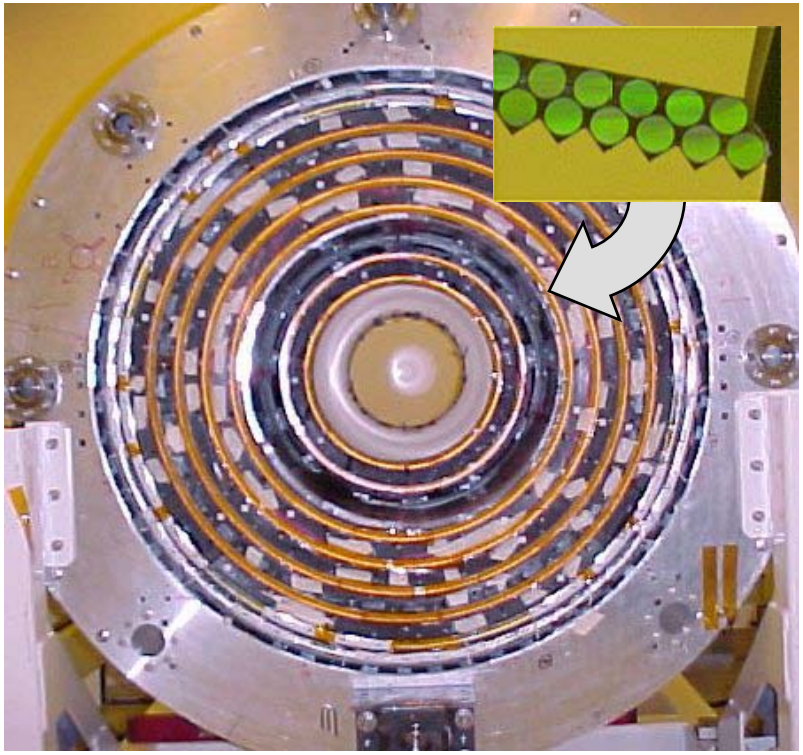
- Muon iron toroid with 1.8 T field
  - Operates smoothly since Run I
- Superconducting solenoid with 2 T field
  - Reduced current by 5% in 2004 due to deterioration of the joint after warm up
  - Runs very stably since 2004

- Have to keep solenoid coil cold
- Regularly reverse field as needed
  - To reduce detector asymmetries in analysis

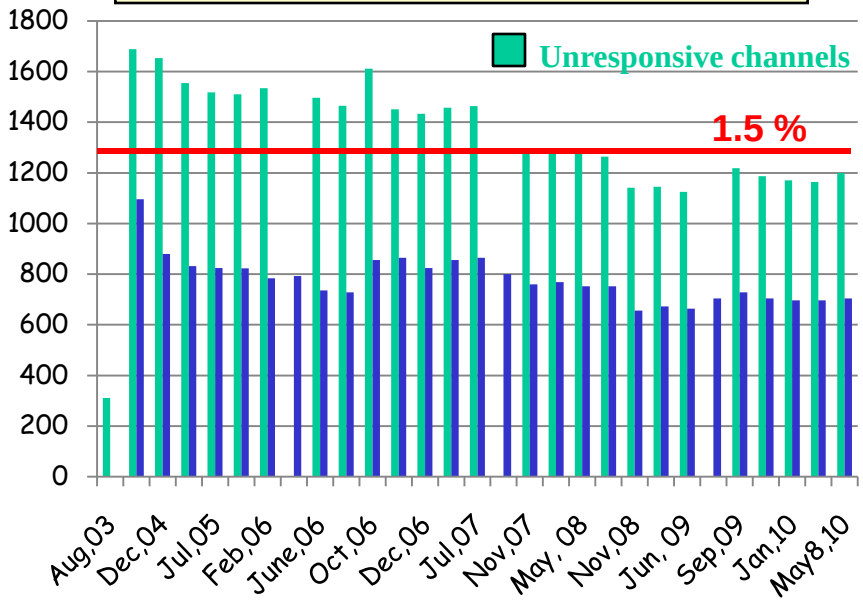


Fiber Tracker





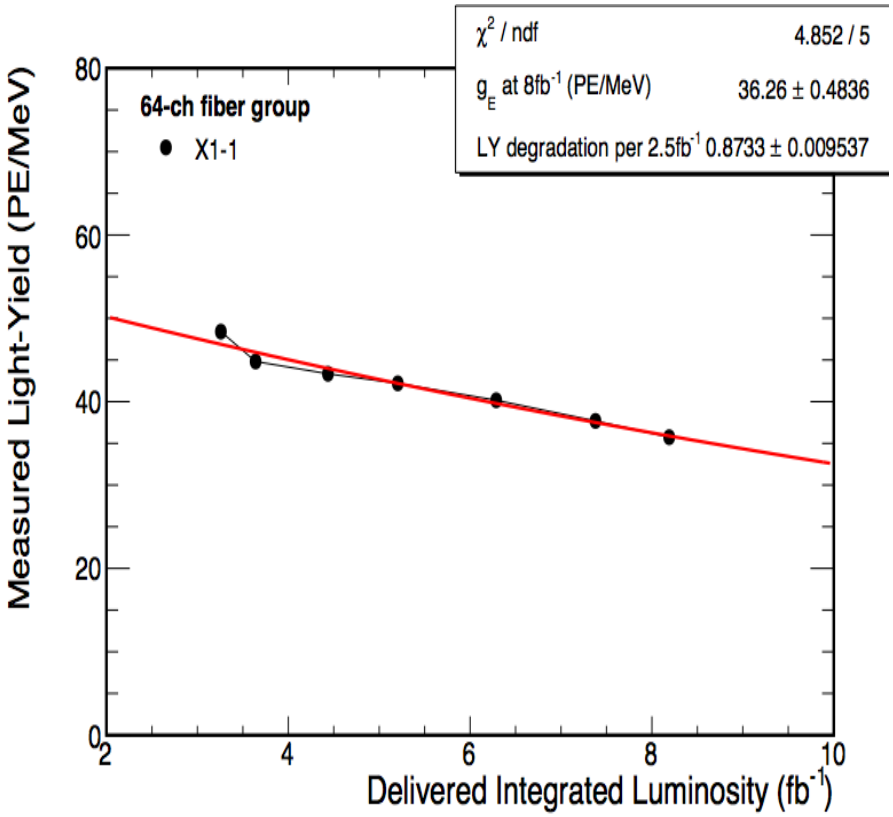
Number of unresponsive channels

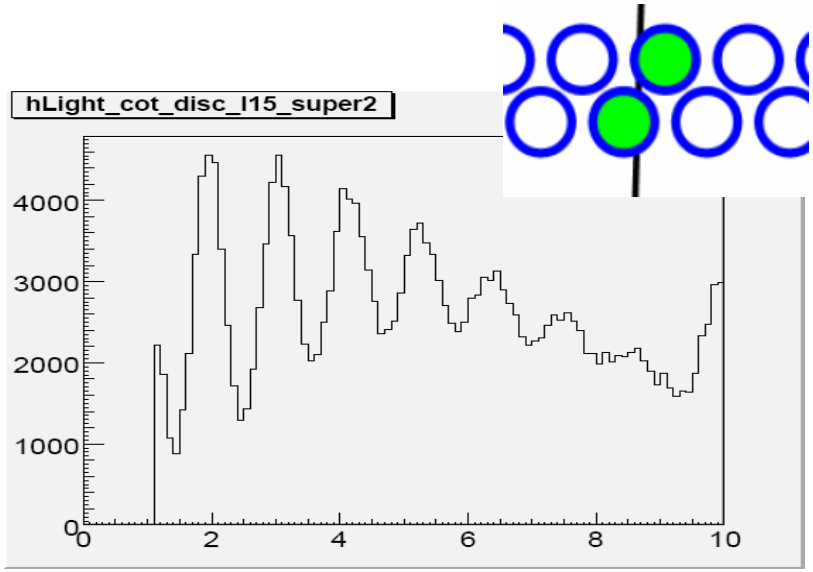


- 77,000 of ~1 mm diameter scintillating fibers arranged in 8 axial and 8 stereo layers
- Readout of light with Visible Light Photon Counters (VLPC) with ~80% quantum efficiency and high gain
- Number of operating channels is 98% and stable
- Detector critical for charged particles tracking also used for triggering

Fiber Tracker Radiation Aging

- Plastic scintillator and clear light guides are aging as expected
- Reduction in light yield by 35% between now and 2014 is expected
- Moderate dependence of radiation aging vs radius is observed
  - Degradation is not substantially higher for inner layers
- No aging issues with other elements of the fiber tracker seen or expected

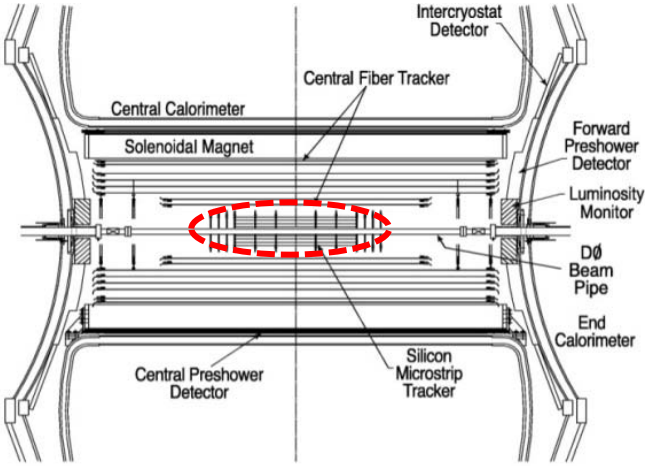


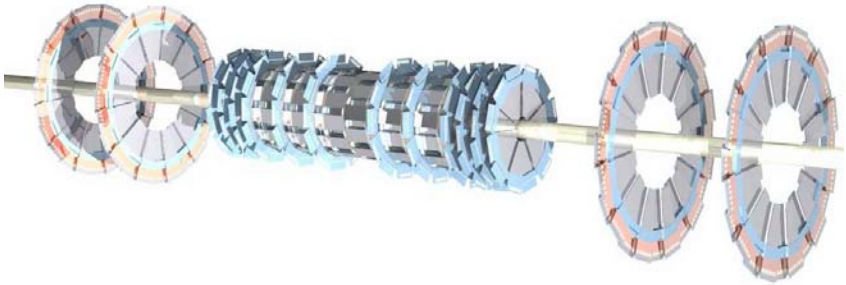


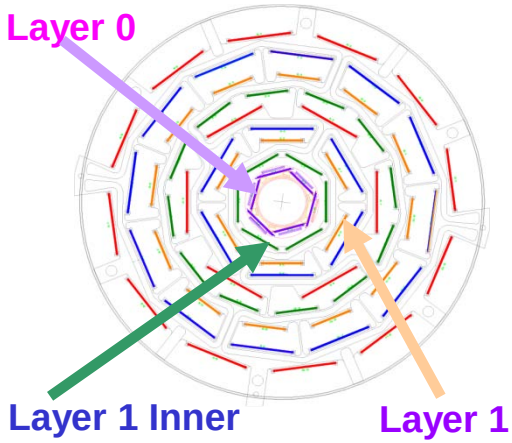
Number of photoelectrons

- With 20 fb^{-1} of integrated luminosity for central η tracks expect ~3.6 phe on average
  - Expected to provide ~95% per layer cluster efficiency
- Options of reducing on-line thresholds and optimization of VLPC operation are under investigation

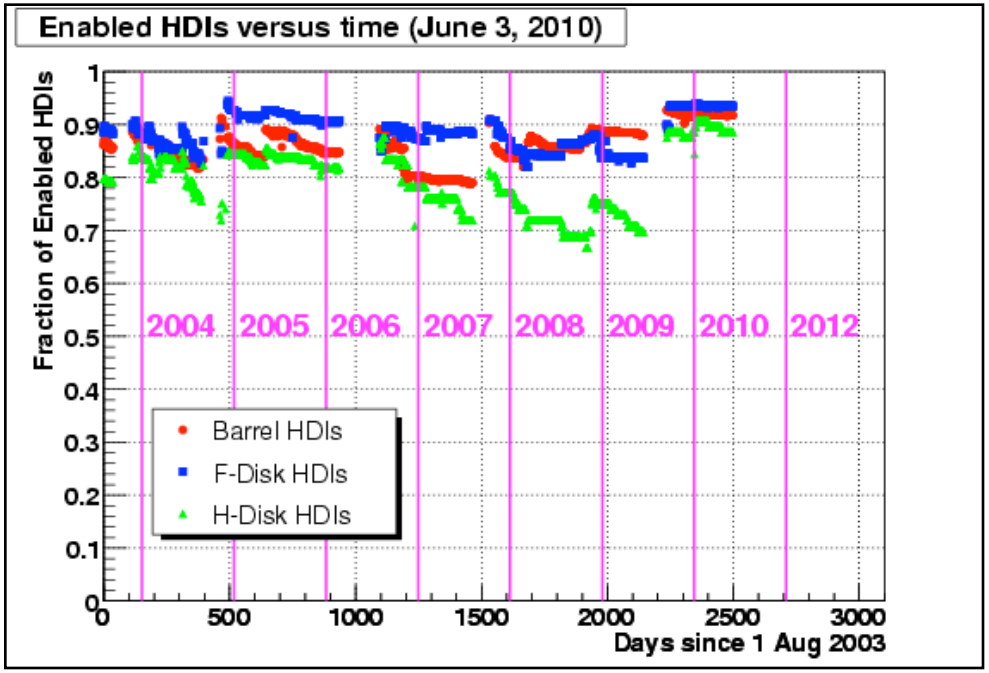
Silicon Detector





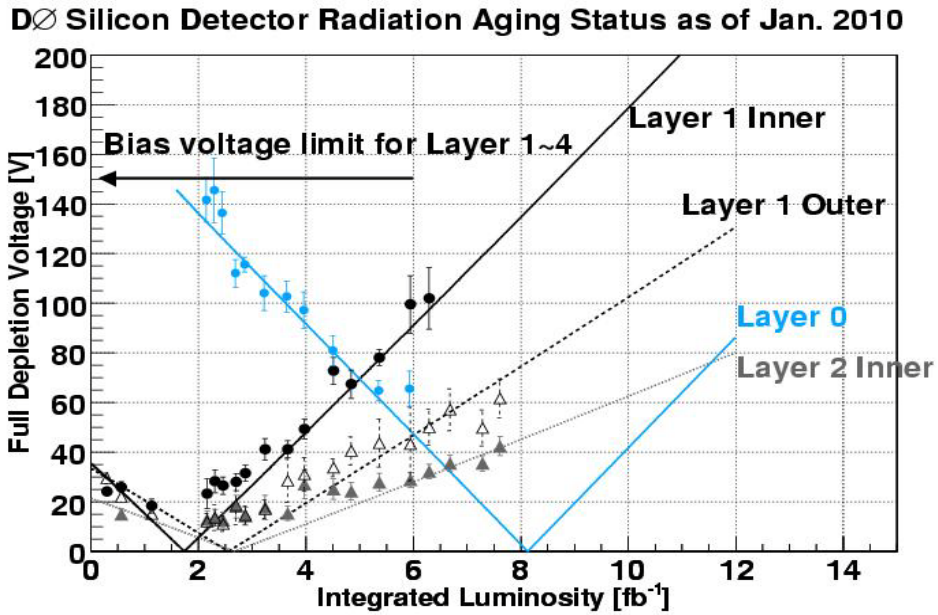


- ~800k channels, barrels and disks
- "Layer 0" was installed in 2006 to mitigate effect of radiation aging of inner layers

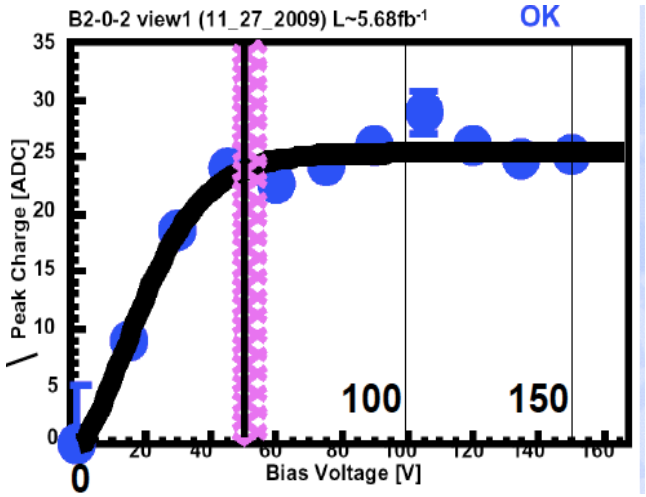


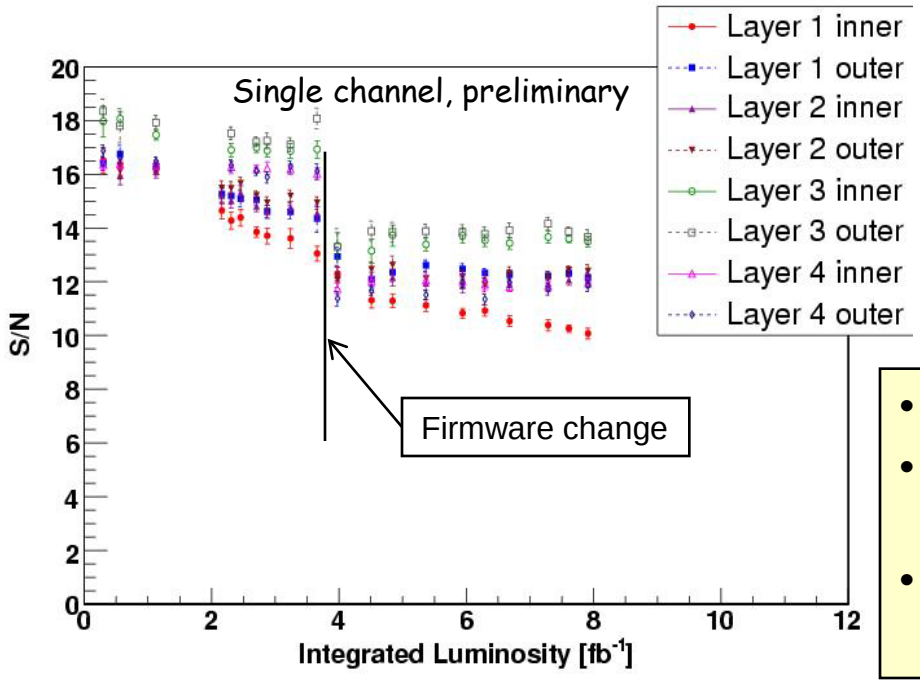
- ~90% of channels are currently operating
  - Largest fraction in Run II
  - Due to inventions and improvements in operation

Silicon Detector Radiation Aging



- Radiation aging is progressing as expected and closely monitored
- Expect Layer 1 inner and outer to reach limit of depletion voltage by ~10 fb^{-1}
  - Will operate underdepleted still providing useful information
- Layer 0 and Layers 2,3 and 4 will be fully operational up to 20 fb^{-1}

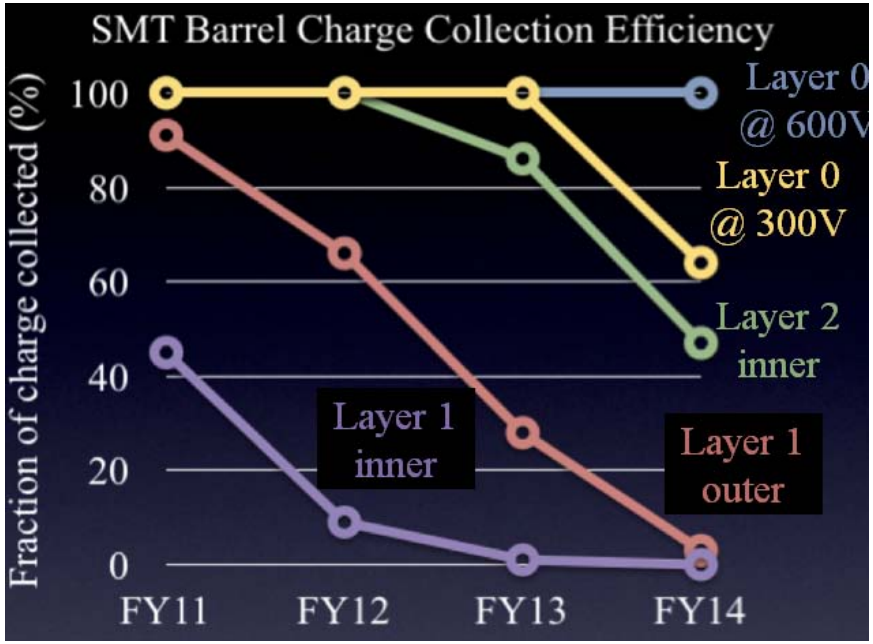


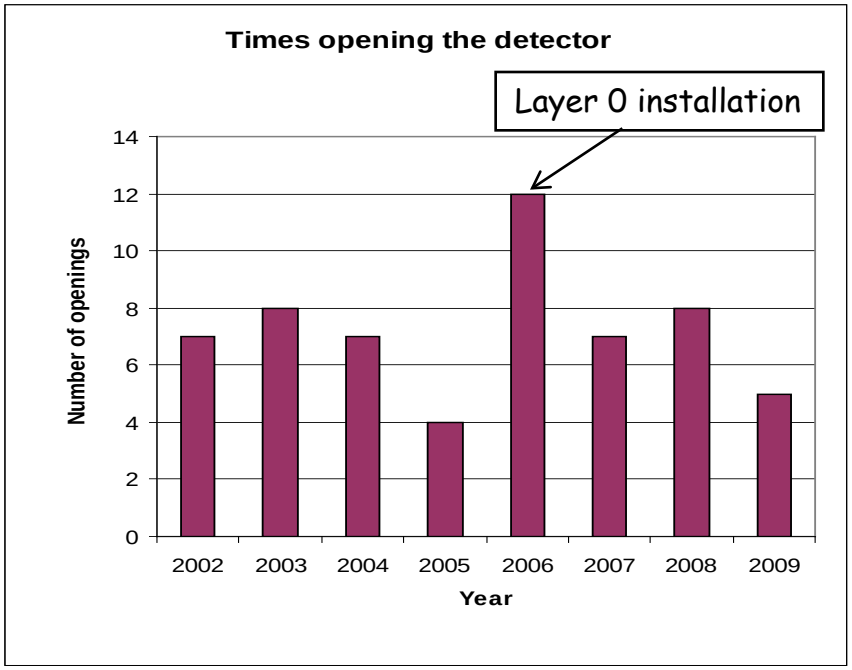


- S/N ratio is pretty stable after 4 fb^{-1}
- Drop in S/N at 4 fb^{-1} is due to firmware change and we expect to recover this drop
- No major deterioration of the silicon detector is expected with 20 fb^{-1}, except Layer 1

Infrastructure, Algorithms and Triggering

- DØ detector infrastructure does not show signs of aging
  - Routine maintenance is required
  - No issues with spares
- The experiment is operating reliably with no indication of increase in failure rates





- Exploring in details performance of the algorithms and triggering with projected detector radiation aging
  - Was not part of the original detector simulation
  - Using available data and projected detector performance
- Many options how performance could be improved

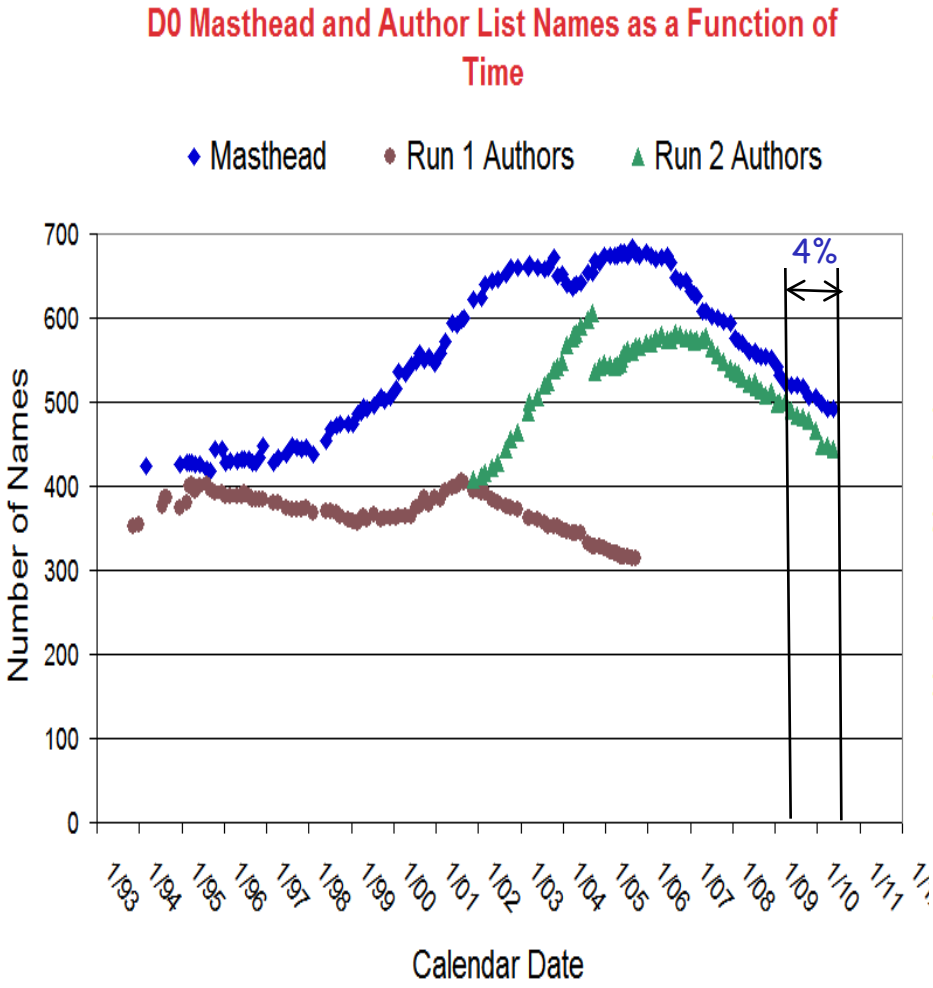
The DØ Collaboration

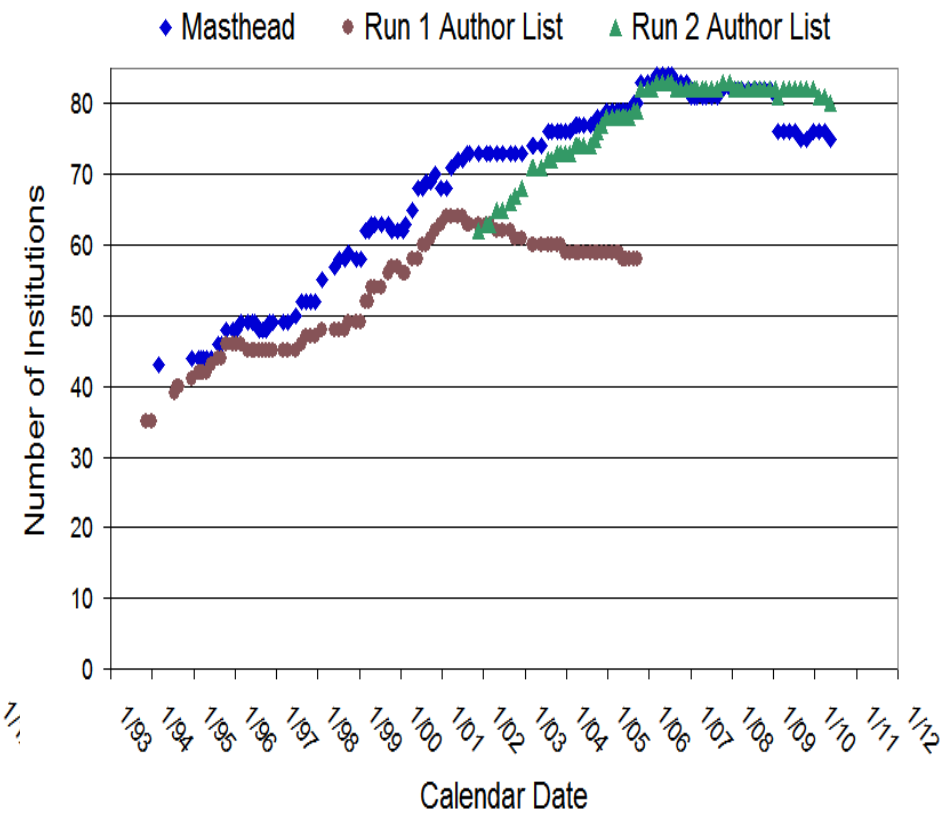
DØ is an international collaboration of
500 physicists from 19 nations who have designed, built and operate the DØ detector at the Tevatron and perform data analysis

Institutions: 86 total, 37 US, 49 non-US

- ~50% of the collaboration comprised of US groups
- ~200 students and postdocs

Collaboration Membership





- Over last year reduction in the collaboration membership is ~4%
- No reduction in number of groups participating in DØ
  - New group joined the experiment late 2009

Personpower

- DØ will need ~80-100 FTE to keep the experiment operating, to process data and to support algorithms in 2011 and beyond
  - Based on careful bottom-up analysis of the experiment needs
  - Supported by the recent reports numbers

Recent numbers: both columns are for calendar year 2009

Category	Resource Needs "FTE"	Effort Reports "FTE"
Operations	63	52
Computing	25	13
Algorithms	20	27
Management	10	15
Total service contributions	**117**	**107**
Physics analysis		152

- Operations needs are stable even with increase in the luminosity
- Computing is well developed and stable
- Algorithms require efforts and provide substantial improvements in physics reach
- Healthy fraction of the collaboration devoted to physics analysis

Personpower - Projections

- Collaboration survey was performed early in 2009 to estimate number of FTEs available for data taking in 2011 and analysis beyond
  - Strong feedback received was one of the important reasons for 2011 run extension
  - Currently we estimate even more collaborators will be actively involved in 2010 and 2011 than expected in early 2009

- We are in a process to evaluate interest of the collaboration in continuing data taking beyond 2011 for three additional years
- In May 2010 we asked all DØ groups the following question
  - "Would your institution sign a Letter of Intent to Fermilab and DOE stating that we find the physics case for additional Tevatron running compelling and that your institution wishes to participate in DØ through the extended run?"
- 100% of the groups provided feedback with 85% of the groups interested to continue at some level
- In the coming months we will be working with the collaboration to establish details of this projected participation over three years period
  - We will need support from the funding agencies and the Laboratory
  - Key experts in detector, computing and algorithms areas are critical
    - We see very strong commitments from the appropriate personnel and groups!

Summary: Tevatron Run Extension Beyond 2011

- Tevatron program is extremely successful
  - 100's of exciting physics results and discoveries
  - 100's of young scientists trained
- Extending Tevatron run provides exciting physics opportunities
- Detector radiation aging is progressing as expected, closely monitored and all detector elements are capable of handling 20 fb^{-1} of the integrated luminosity
- No issues with infrastructure or spares are expected during three additional years of running
- Understanding of triggering and algorithms performance during extended running is important
  - Special task force is formed at DØ and working actively
- Collaboration expressed strong interest in continuing Tevatron running
  - 85% of groups are interested to continue
  - In depth survey of personpower to assure all critical tasks are covered is in progress
- PAC encouragement to the collaborations and the laboratory to develop detailed plan for continuing Tevatron running will help us greatly

We see an exciting physics program with 16 fb^{-1} data set and our plan is to devote collaboration resources to continue making strong case for the extension