Run IIb Status

- D0 Run IIa Status
- Run IIa Accelerator Performance
- Run IIb Design Guidelines
- Run IIb Overview
- Run IIb Technical Status
- Run IIb Management

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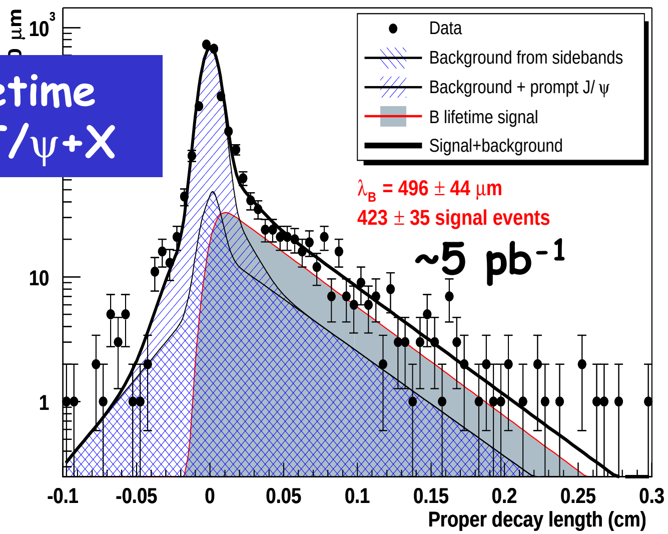
DO Run IIa Status

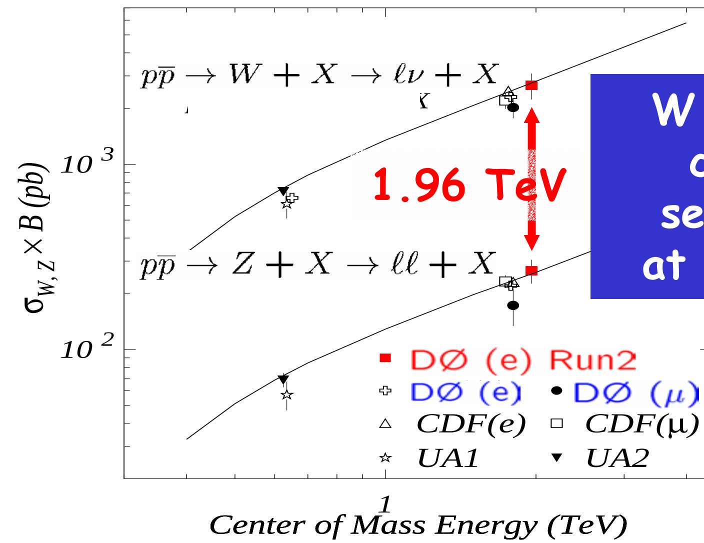
- The detector is working and is recording physics data
  - Silicon and fiber tracker hit efficiencies > 98%
- Reconstruction farm and analysis systems are working well
- First physics measurements were presented at ICHEP, based on
  5-10 pb^{-1} of data
  - See www-d0.fnal.gov/results
- Improvements still in store:
  - Trigger and DAQ system
  - Offline reconstruction (alignment, efficiencies)
- By next summer (LP2003 at Fermilab), we expect physics results with a few hundred pb^{-1}
  - significantly increased sample over Run I with improved detector and a higher center of mass energy
    - Top quark measurements with increased statistics and purity
    - Jet cross section at high E_T (constrain gluon PDF)
    - New limits on physics beyond the SM
    - …

Physics with Run II data

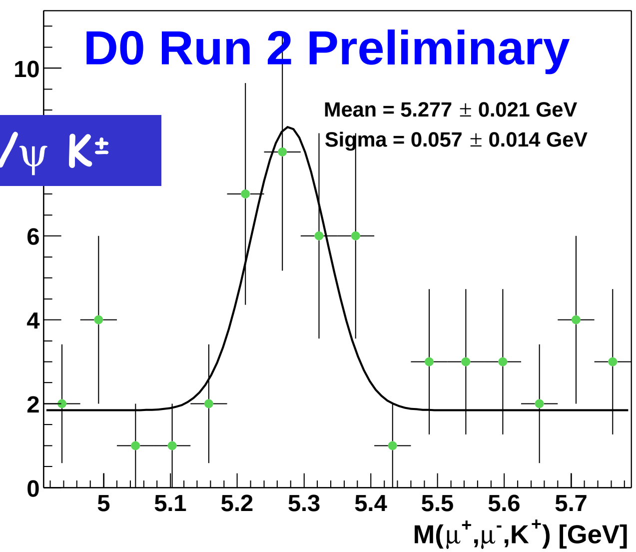
B lifetime
B → J/ψ+X



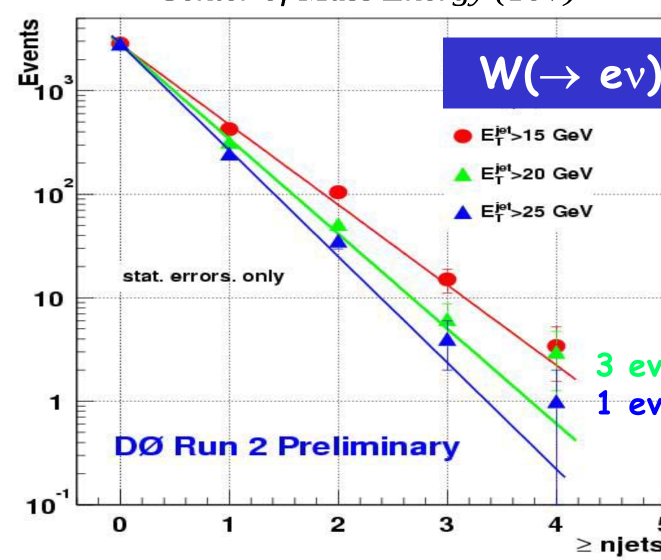
W and Z cross sections at new √s



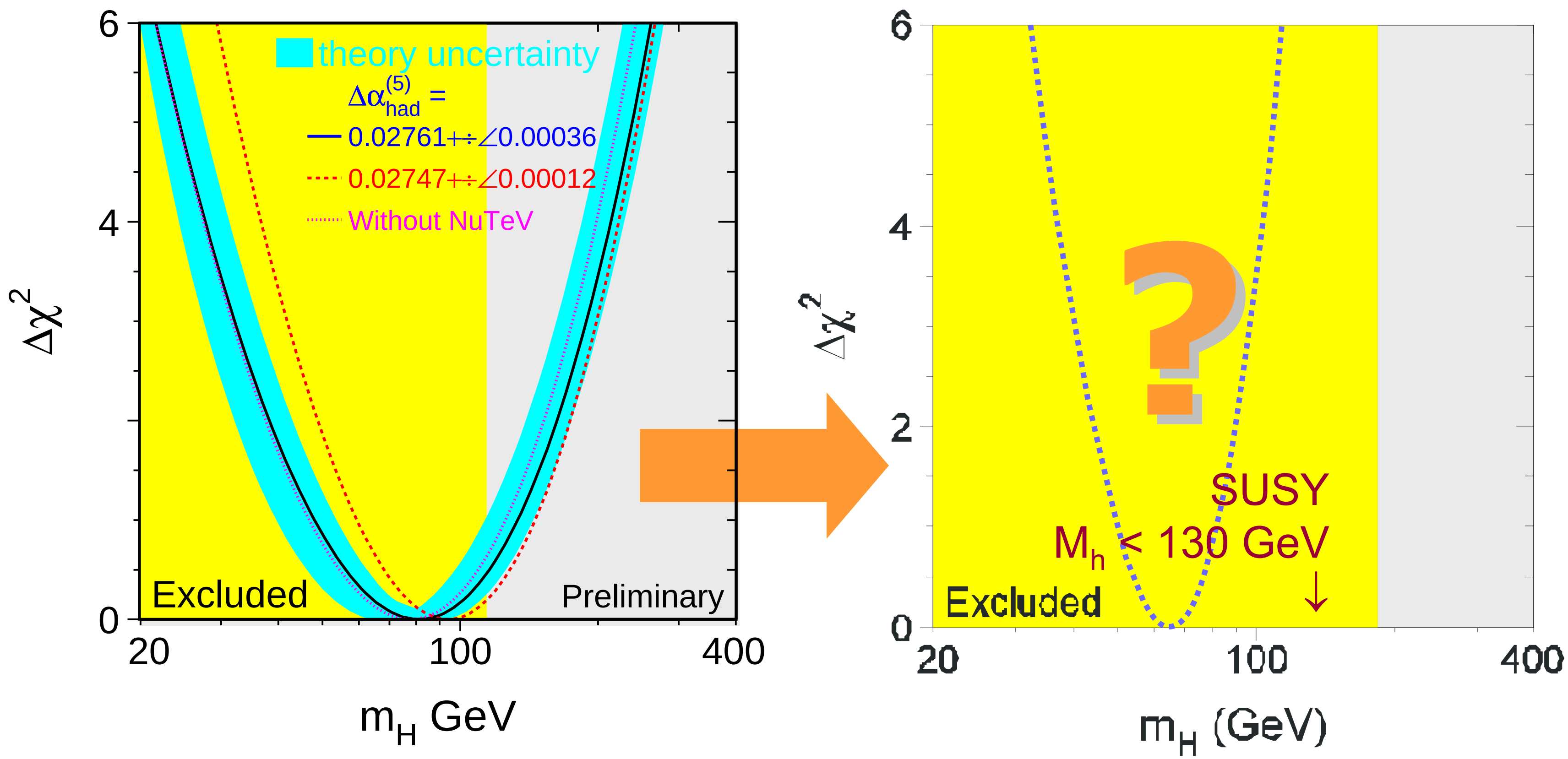
B± → J/ψ K±



W(→ eν) + jets



What Run IIb can do for us



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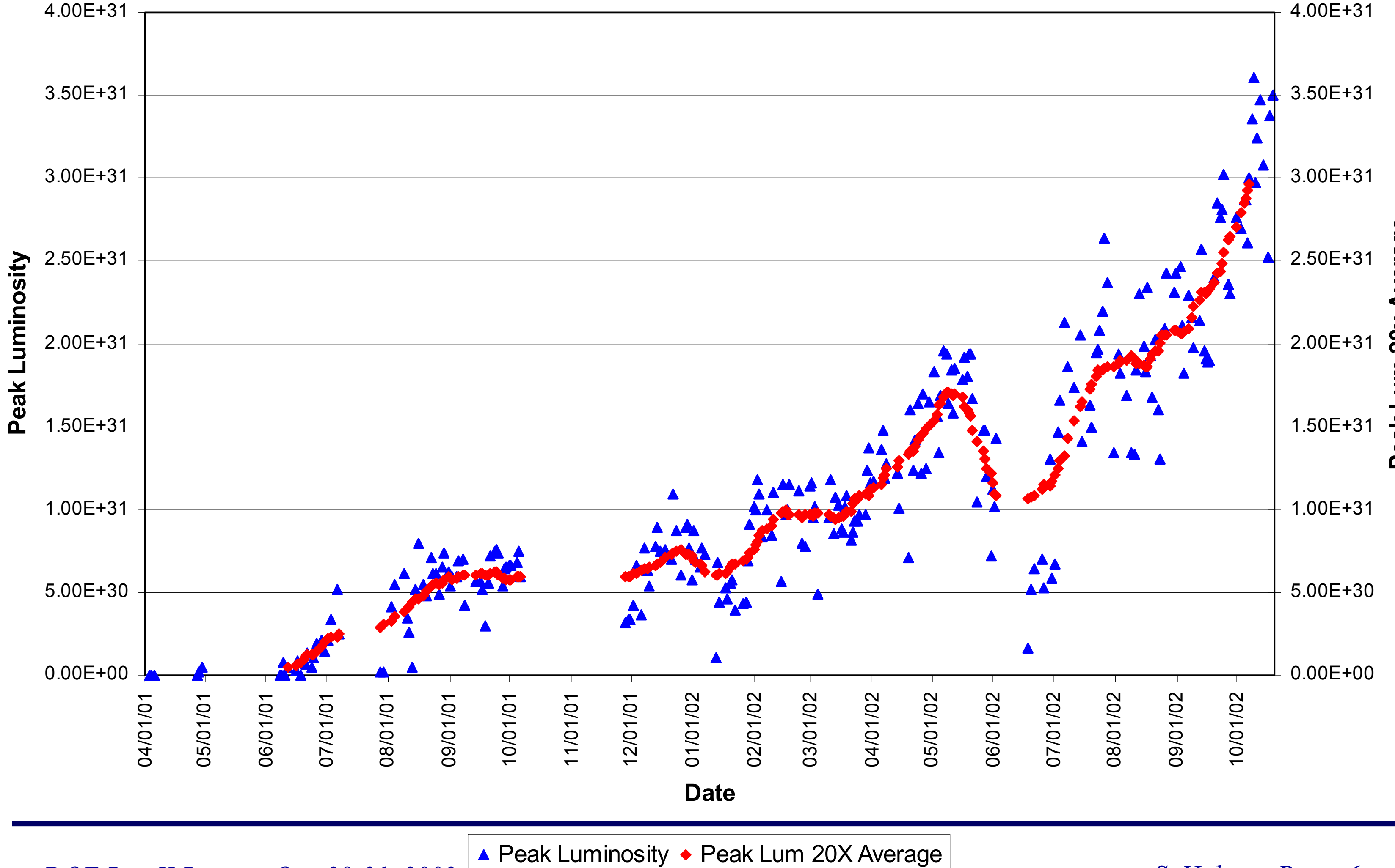
Grünewald, Heintz, Narain, Schmitt, hep-ph/0111217
Assumes current central values
$\delta\Delta\alpha^{(5)}_{had}(M_Z^2) = 10^{-4}$, δM_W = 20 MeV, δm_t = 1 GeV

Current Performance
Initial Luminosity (through 10/20/02)



Current Performance
Modifications to the Complex

- Every improvement in luminosity performance has been associated with a specific modification to the accelerator complex. Major modifications since January 1, 2002:
  - Accumulator->Main Injector transfer optics
  - Adjustment of tunes and helix during low beta squeeze
  - Modified injection helix
  - Proton beam loading compensation in Main Injector
  - Accumulator (stochastic) cooling upgrade
  - Accumulator shot lattice
  - Antiproton beam loading compensation in Main Injector
  - Tevatron beam line tuner (BLT)
  - Tevatron tune/coupling drift compensation
  - Tevatron (horizontal) dampers
- **Note: $(1.15)^{10} = 4.0$**

Run IIb Design Guidelines

- Run IIb: increase in instantaneous, integrated luminosity relative to guidelines that drove Run IIa detector design

	Integrated Luminosity (fb^{-1})	Instantaneous Luminosity ($X10^{32}cm^{-2}sec^{-1}$)
Run IIa	2	1-2
Run IIb	10-15	2-5
Requirements for Run 2b	Silicon replacement, more rad-hard version	Trigger upgrades (dominated by Level 1)

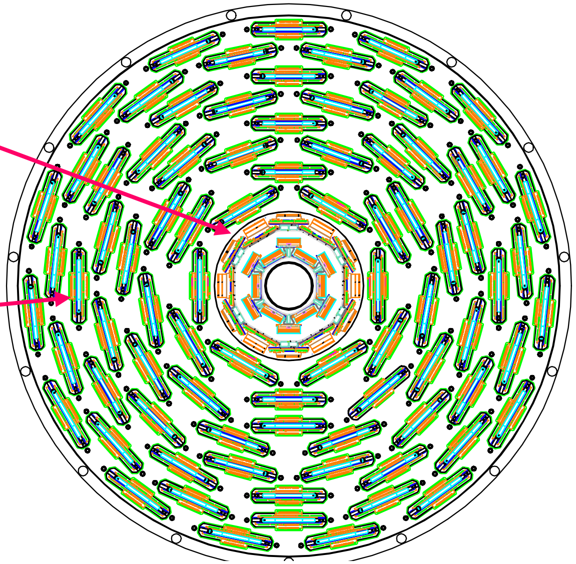
- Laboratory Guidance:
  - Be able to operate at 2E32 @ 396 ns with full functionality
  - Provide headroom up to ~4E32 @ 396 ns with reduced functionality
  - Retain capability of operating @ 132 ns
- Silicon:
  - Current detector designed for ~ 2 fb^{-1}, evidence it will survive 4-5 fb^{-1}
- Trigger:
  - Move rejection upstream in readout stream (contain dead time), maintain both downstream rejection, event selectivity

Run IIb Overview

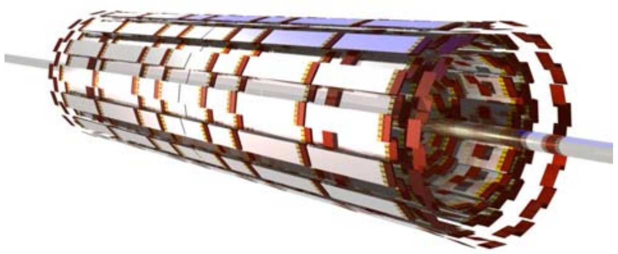
- Silicon Detector
  - Replace with more radiation-hard version
- Trigger Systems
  - Level 1: Shift some trigger functionality upstream to hardware level trigger
    - L1 Calorimeter Trigger
    - L1 Calorimeter/Track Match
    - L1 Central Track Trigger
  - Level 2: Incremental upgrades to Run IIa systems
    - L2 Beta System
    - L2 Silicon Track Trigger
- DAQ/Online System
  - Address need for enhanced filtering capability, higher bandwidth data logging
- Installation
  - Integration of silicon, trigger installation & pre-beam commissioning

Basic Silicon Design Choices

- Six layer silicon tracker, divided into two radial regions
  - Inner layers: Layers 0 and 1
    - Axial readout only
    - Mounted on integrated support
    - Assembled into one unit
    - Designed for V_{bias} up to 700 V
  - Outer layers: Layers 2-5
    - Axial and stereo readout
    - Stave support structure
    - Designed for V_{bias} up to 300 V

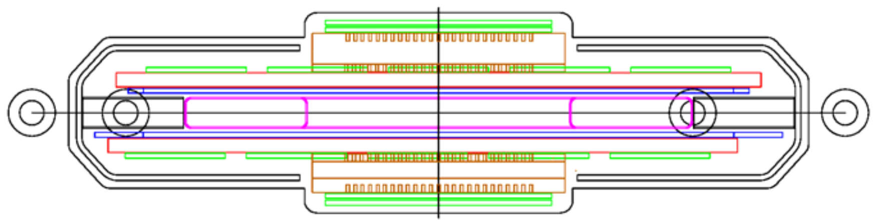


- Employ single sided silicon only, 3 sensor types
  - 2-chip wide for Layer 0
  - 3-chip wide for Layer 1
  - 5-chip wide for Layers 2-5
- No element supported from beampipe

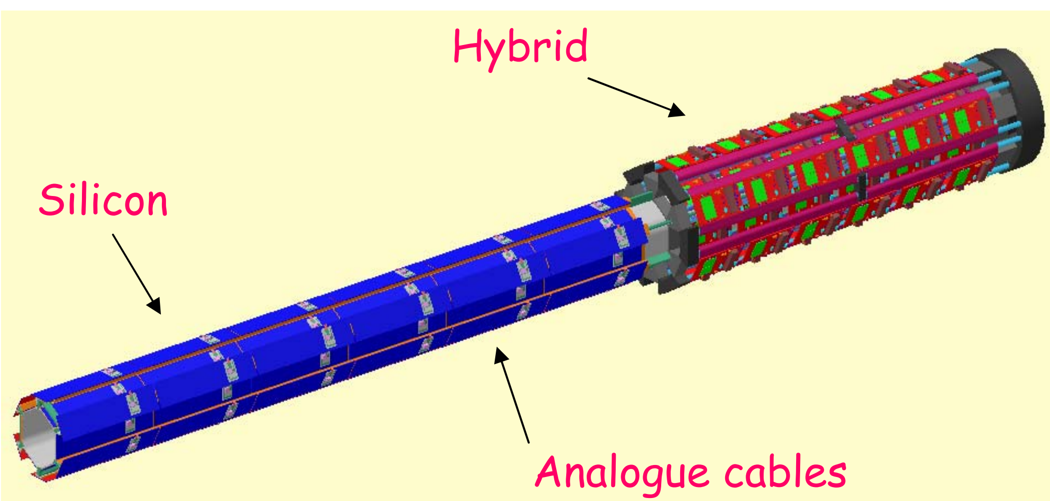


Silicon Detector Elements

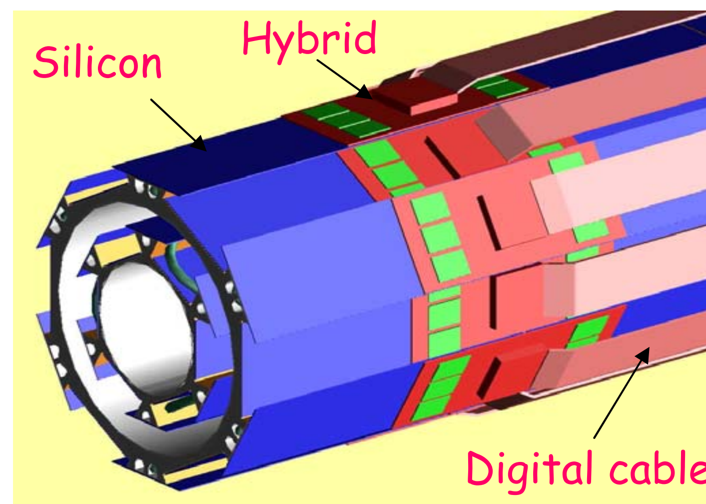
- 168 silicon staves: basic building block of outer layers
- Supported in positioning bulkheads at z=0, z=610 mm



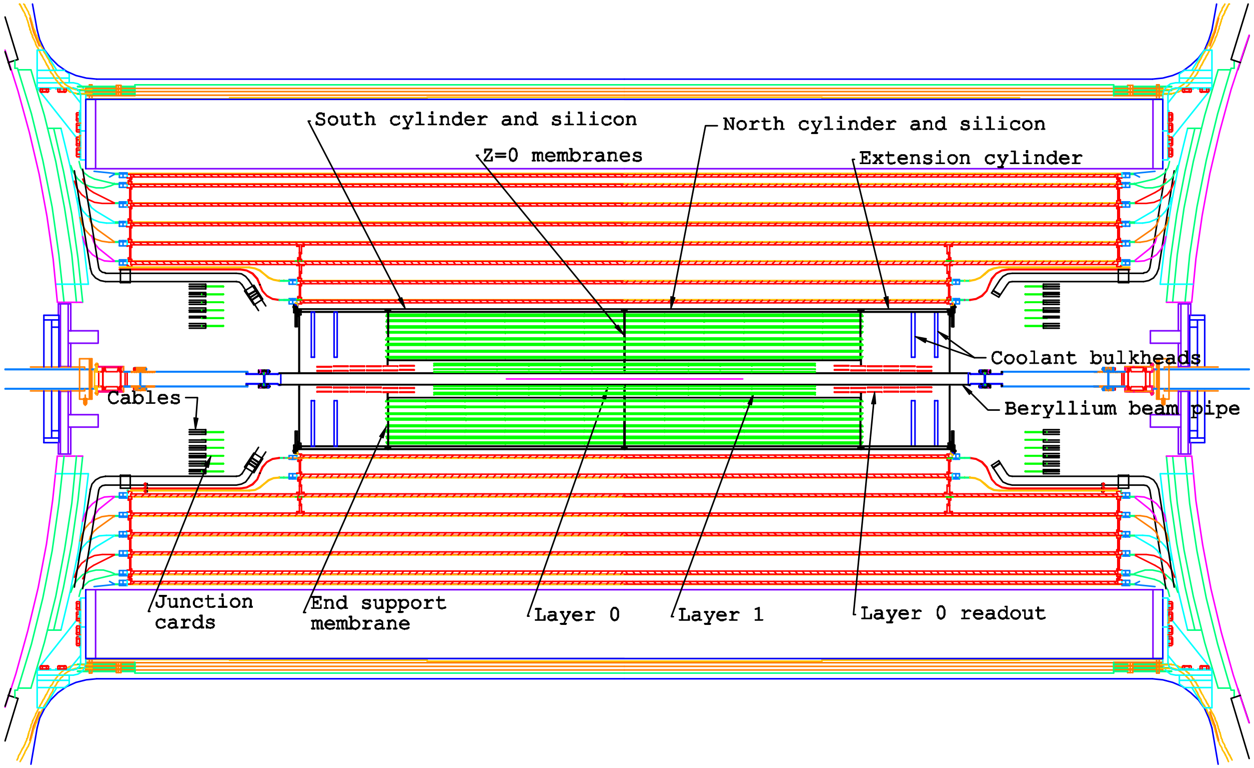
- Layer 0
  Support structure: University of Washington



- Layer 0/Layer 1 mated



Plan View of Run IIb Barrel Region



- 18.542 mm IR beam tube
- L0 and L1: 12 sensors long, each 79 mm in length
- L2 – L5: 12 sensors long, each 100 mm in length
- 1220 mm long barrel region
- Support from "bulkheads" at z = 0 and z = ±610 mm

Run IIb Level 1 Trigger Upgrade

System	Problems	Solutions
Cal	1) Trigger on $\Delta\eta\times\Delta\phi=0.2\times0.2$ TTs $\Rightarrow$ slow turn-on curve 2) Slow signal rise $\Rightarrow$ trigger on wrong crossing	• Clustering • Digital Filter
Track	1) Rates sensitive to occupancy 2) Limited match to calorimeter	• Narrower Track Roads • Improve Cal-Track Match
Muon	No Additional Changes Needed!	• Requires Track Trigger

Trigger	Example Physics Channels	L1 Rate (kHz) (no upgrade)	L1 Rate (kHz) (with upgrade)
EM (1 EM TT > 10 GeV)	$W\rightarrow e\nu$ $WH\rightarrow e\nu jj$	1.3	0.7
Di-EM (1 EM TT > 7 GeV, 2 EM TT > 5 GeV)	$Z\rightarrow ee$ $ZH\rightarrow eejj$	0.5	0.1
Muon (muon p_T > 11 GeV + CFT Track)	$W\rightarrow \mu\nu$ $WH\rightarrow \mu\nu jj$	6	0.4
Di-Muons (2 muons p_T > 3 GeV + CFT Tracks)	$Z\rightarrow \mu\mu$, $J/\Psi\rightarrow \mu\mu$ $ZH\rightarrow \mu\mu jj$	0.4	< 0.1
Electron + Jets (1 EM TT > 7 GeV, 2 Had TT > 5 GeV)	$WH\rightarrow e\nu$+jets $tt\rightarrow e\nu$+jets	0.8	0.2
Muon + Jet (muon p_T > 3 GeV, 1 Had TT > 5 GeV)	$WH\rightarrow \mu\nu$+jets $tt\rightarrow \mu\nu$+jets	< 0.1	< 0.1
Jet+MET (2 TT > 5 GeV, Missing E_T> 10 GeV)	$ZH\rightarrow \nu\bar{\nu}b\bar{b}$	2.1	0.8
Muon + EM (muons p_T > 3 GeV+ CFT track + 1 EM TT > 5 GeV)	$H\rightarrow WW, ZZ$	< 0.1	< 0.1
Single Isolated Track (1 Isolated CFT track, p_T > 10 GeV)	$H\rightarrow \tau\tau$, $W\rightarrow \mu\nu$	17	1.0
Di-Track (1 isolated tracks p_T > 10 GeV, 2 tracks p_T > 5 GeV, 1 matched with EM energy)	$H\rightarrow \tau\tau$	0.6	<0.1

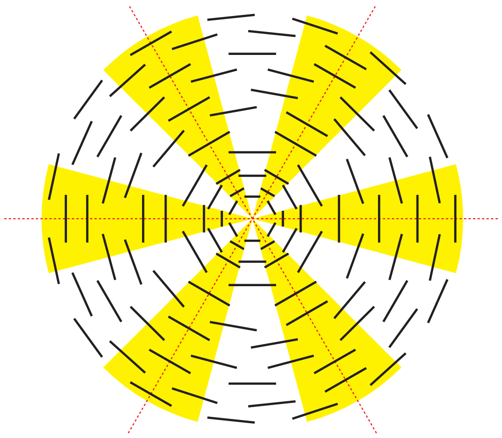
Level 1 systems

Core Run IIb trigger menu, simulated at 2E32, 396 ns

Total output rate with (without) L1 trigger upgrade = 3.2 (~30) kHz

Available L1 bandwidth budget: 5 kHz

Run IIb Level 2 Trigger Upgrade



- Modest upgrades to two components:
  - Silicon Track Trigger
    - Vital for triggering on b-quarks
      - $ZH \to \nu\nu bb$
      - $Z \to bb$ (top mass jet energy scale)
    - Improves track trigger
      - Sharper p_T turn-on
      - Reduced fake rate
    - Upgrade needed to accommodate design of new silicon detector
      - Instrumenting 5 of 6 Run IIb silicon layers
        - See report submitted to June PAC
    - May require new algorithms for L > 2E32 @ 396 ns
  - Level 2β processors
    - More processing power required to retain same Level 2 rejection
    - Add 12 additional processors

DAQ/Online

System	Items	Need
Level 3 filter nodes	96 more L3 Farm nodes	Match to rates and processing requirements (x10 current CPU)
DAQ HOST system	Linux data logging nodes and buffer disk arrays	Replace existing systems with higher performance nodes
ORACLE systems	Database nodes, disk arrays, and backup systems	Adopt lab standard ORACLE platform
File Server systems	Linux server nodes, disk arrays, and backup systems	Provide increased storage capacity
Slow Control system	VME processors for control and monitoring of detector	Improve monitoring performance for extended run

Upgrades to DAQ/Online systems required for long-term, high rate running during Run IIb

Technical Status - Silicon

- Design is mature, performs well in simulation studies, extensively documented in TDR
- Prototypes built for complete readout chain
- SVX4 drives Run IIb Project critical path
  - First submission has been extensively tested, largely works as designed
  - Several minor bugs being fixed for 2nd submission
  - Biggest concern is pedestal variation across chip
    - Single threshold → inefficiency or noise
    - Best guess is problem is in ADC comparator circuit
      - Scale-down of SVX3 circuit led to marginal design
  - Next submission expected in Jan (2 month delay)

Technical Status - Trigger

- L1 Cal – Topic of this workshop
  - Workshop provides an opportunity for extensive discussion of L1 Cal design and implementation
  - Important for multi-institutional design effort
  - Starting planning next workshop!!
- L1 Trk – Redesign DFEA daughter cards
  - Larger FPGAs to accommodate fiber singlet algorithm
  - MC simulations show significant gain in rejection
  - Key portions implemented in target FPGA
- L1 Cal-Trk Match – Similar to muon-track match
- L2Beta – Processor upgrade, no major tech issues
- L2STT – Expand to match new silicon tracker
  - Will utilize 5 of 6 tracker layers
  - May need new algorithms for highest Run IIb luminosities

Management Status

- Strong Project Management team in place
- DOE has vastly increased requirements for documentation, oversight of new projects
  - Little discrimination between $20M and $1B
- Goal of the Project Office is to insulate you from this burden to the extent possible
  - Can't be done without some input!
    - Need to track status of project in cost/schedule space
    - Regular reporting to DOE
    - MOU's to define responsibilities

Run IIb Project Organization

D0 Run IIb Project
J. Kotcher, Project Manager
R. Partridge, Deputy; V. O'Dell, Associate; W. Freeman, Assistant
M. Johnson, Technical Coordinator
C. Yoshikawa, Budget Officer; T. Erickson, Administration

WBS 1.1 Silicon
M. Demarteau
A. Bean, Deputy

- 1.1.1 Sensors — R. Demina, F. Lehner
- 1.1.2 Readout System — A. Nomerotski
- 1.1.3, 1.1.5 Mechanics & Assembly — W. Cooper, K. Krempetz
- 1.1.4 Production — J. Fast, H. Haggerty
- 1.1.4 QA, Testing, & Burn-in — C. Gerber
- 1.1.6 Monitoring — M. Corcoran, S. de Jong
- 1.1.7 Software & Simulation — F. Rizatdinova, L Shabalina
- 1.1.8 Administration — (M. Demarteau)

WBS 1.2 Trigger
H. Evans
D. Wood

- 1.2.1 L1 Cal Upgrade — M. Abolins, (H. Evans), P. LeDu
- 1.2.2 L1 Cal/Track Match — K. Johns
- 1.2.3 L1 Track Trigger — M. Narain
- 1.2.4 L2β Upgrade — R. Hirosky
- 1.2.5 Silicon Track Trigger — U. Heintz
- 1.2.6 Simulation — M. Hildreth, E. Perez
- 1.2.7 Administration — (D. Wood)

WBS 1.3 DAQ/Online
S. Fuess
P. Slattery

- 1.3.1 Level 3 Systems — D. Chapin, G. Watts
- 1.3.2 Network & Host Systems — J. Fitzmaurice, S. Krzywdzinski
- 1.3.3 Control Systems — F. Bartlett, G. Savage, V. Sirotenko
- 1.3.4 DAQ/Online Management — (P. Slattery)

WBS 1.4 Project Administration

WBS 1.5 Installation
R. Smith

- 1.5.1 Silicon Installation — Mechanical: H. Lubatti; Electronics: L. Bagby, R. Sidwell
- 1.5.2 Trigger Installation — D. Edmunds

Installation is integral part of project plan, but removed from formal Run IIb baselining

Experienced group, key positions in place for more than 1 year. All managers in place through WBS Level 3.

A Guide to DOE Acronyms

- TDR: Technical Design Report (done)
- AEP: Acquisition Execution Plan (done)
- PEP: Project Execution Plan (done)
- PMP: Project Management Plan (done)
- IPR: Independent Project Review (Lehman, done)
- EIR: External Independent Review (this week)
- PMCS: Project Management and Control System Review (next week)
- ESAAB: Energy Secretariat Acquisition Advisory Board (December or January)
- CD-n: DOE Critical Decisions (have CD-0, "Approval of Mission Need"; hoping to get CD-1, CD-2, and partial CD-3 at ESAAB)

Conclusions

- Run IIb effort has matured into a solid, well-defined project
- Full project plan in place, based on detailed technical designs and fully resource loaded schedule
  - Managing to a schedule that has Run IIb installation shutdown commencing in late spring 2005
- Lengthy DOE approval process is nearly complete
- Significant progress being made in realizing these plans
- This workshop is an important part of the process