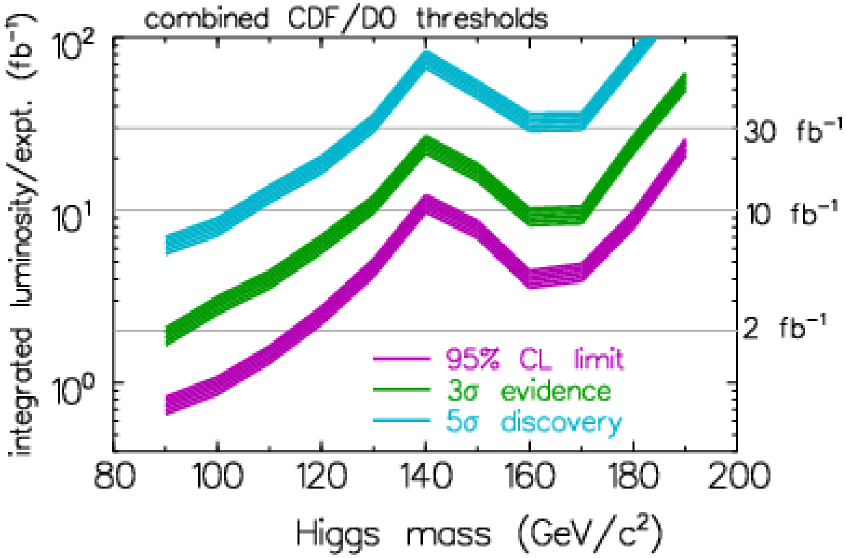
Run IIb D-Zero Detector Project

- Overview of experiment, project
- Organization
- Cost, schedule tools
- Documentation provided to Committee
- Risk analysis
- Schedule, cost overview
- Project cost & funding
- Manpower profiles
- Procurement strategy
- Conclusions

Jonathan Kotcher
D-Zero Run IIb Project Manager
DOE External Independent Review of the Run IIb Projects
November 4-8, 2002

Run IIb Motivation

- Direct probe of Higgs sector unique to Fermilab program until turn-on of LHC
- Laboratory: determine experiment's needs in order to optimize Higgs reach, exploit luminosity during next 5+ years
- 15 fb^{-1} per experiment probes M_H ~ 180 GeV/c^2 (95% CL)
  - LEP limit (M. Grunewald, ICHEP '02)
    - $M_H > 114.4$ GeV/c^2 (95% CL)
  - Latest global fit to electroweak data (M. Grunewald, ICHEP '02)
    - $M_H = (81^{+52/-33})$ GeV/c^2
    - $M_H < 193$ GeV/c^2 (95% CL)
- Prospects for Higgs search at Fermilab continue to be extremely positive
  - Opportunity unique, time scales finite
  - Requires fast, efficient definition and ramp-up of projects, application of resources – accelerated approach
  - Experiment, laboratory collaborating very closely together to realize this



Run IIb Philosophy

- Collaboration, Project Management have been designing Run IIb project with full awareness of tight constraints
  - Abbreviated time scales make for unique situation in HEP
  - Collaboration is, and will be, multi-tasking
    - Run IIb upgrade + commissioning, operations, data analysis, physics
- Have sought to limit scope, complexity wherever possible, value engineering concepts applied during all phases of design
  - Exploit existing designs, systems, experience
  - Effort to find alternatives to designs that require broad replacements of infrastructure
  - Carefully crafting sub-projects, assignments, & responsibilities
  - Target high-p_T program exclusively
  - Some examples:
    - common DZero/CDF silicon (SVX4) readout chip, stave modularity, reuse trigger readout cards/infrastructure, single-sided silicon only, exploit D-Zero/FNAL expertise in carbon fiber, etc.
- D-Zero Run IIb project scope & total cost essentially unchanged since project plan first proposed in November '01

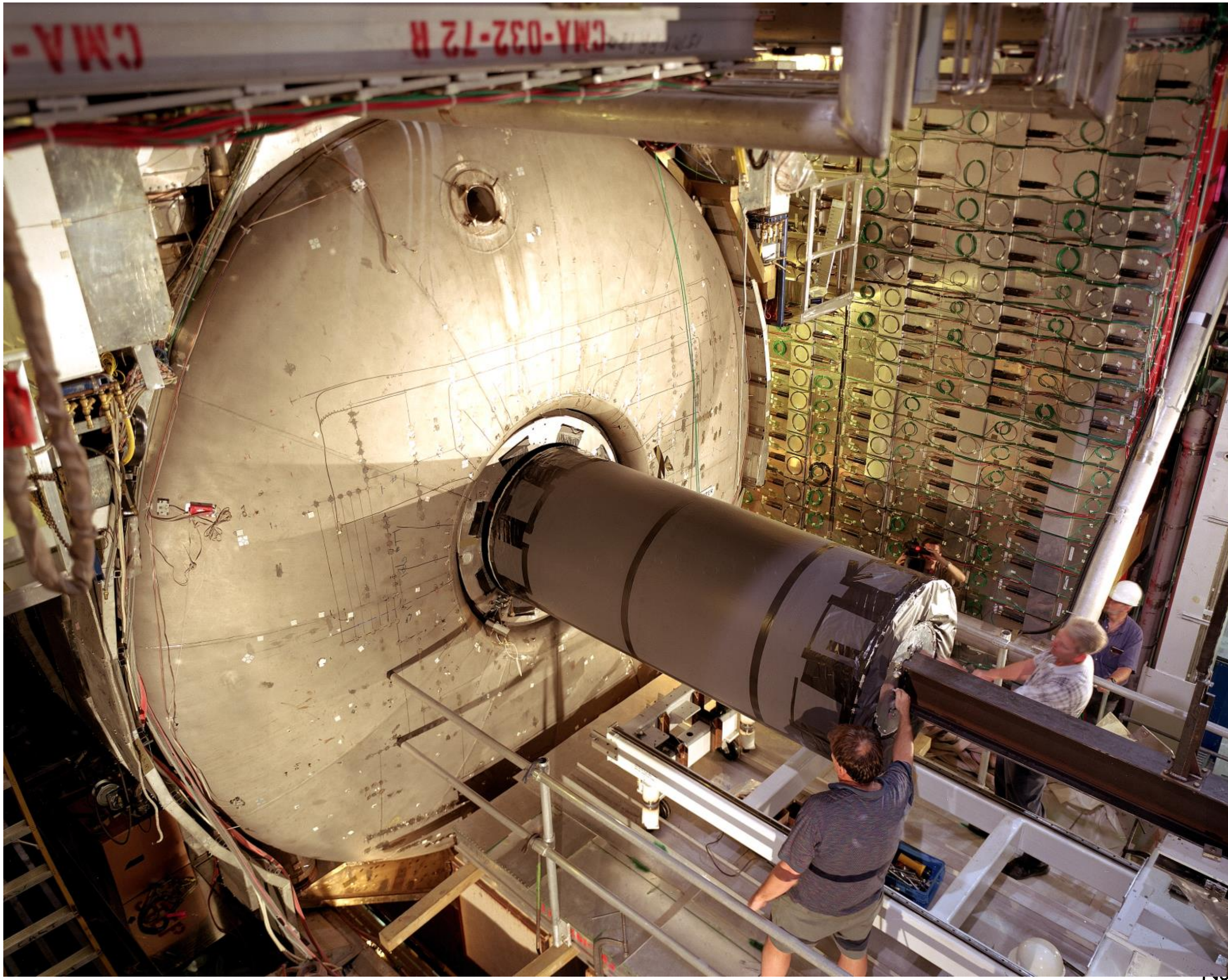
Run IIb Design Guidelines

- 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)

- Silicon:
  - Current detector designed for ~ 2 fb^{-1}, evidence that it will survive to 4-5 fb^{-1}
    - The most appropriate radiation-hard technology used at that time
  - After study of various options, have chosen to pursue full silicon replacement
    - Partial replacement not viable: unacceptable level of technical risk, more down-time for removal/installation, limited SVX2 chip availability, etc.
- Trigger:
  - Increase in luminosity results in unacceptable increase in rates - occupancies, pileup, combinatorial effects
  - Move rejection upstream in readout stream (contain dead time), maintain both downstream rejection, event selectivity
  - Address need for higher-bandwidth data logging

Fiber Tracker Insertion into Bore



The DO Collaboration

Institutions:
- 35 US, 41 non-US

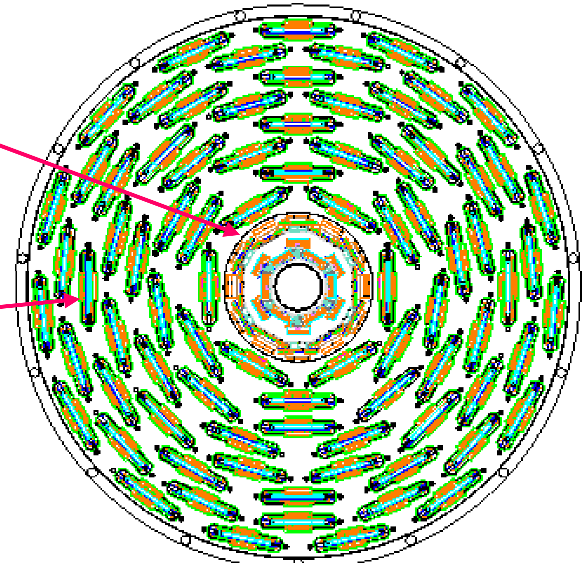
Collaborators:
- 334 from US
- 312 from non-US institutions
  - (note strong European involvement)

Subproject Overviews

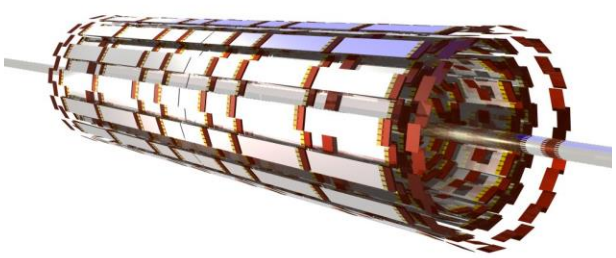
- **WBS 1.1: Silicon Detector**
  - Replace with more radiation-hard version, improved b-tagging capability
- **WBS 1.2: Trigger Systems**
  - Level 1: Shift some trigger functionality upstream to hardware level trigger
    - WBS 1.2.1, L1 Calorimeter Trigger
    - WBS 1.2.2, L1 Calorimeter/Track Match
    - WBS 1.2.3, L1 Central Track Trigger
  - Level 2: Incremental upgrades to Run IIa systems
    - WBS 1.2.4, L2 Beta System
    - WBS 1.2.5, L2 Silicon Track Trigger
- **WBS 1.3: DAQ/Online System**
  - Address need for enhanced filtering capability, higher bandwidth data logging
- **WBS 1.4: Project Administration**
  - Project personnel, travel, miscellaneous supplies
- **WBS 1.5: Installation**
  - Integration of silicon, trigger installation & pre-beam commissioning

WBS 1.1: 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

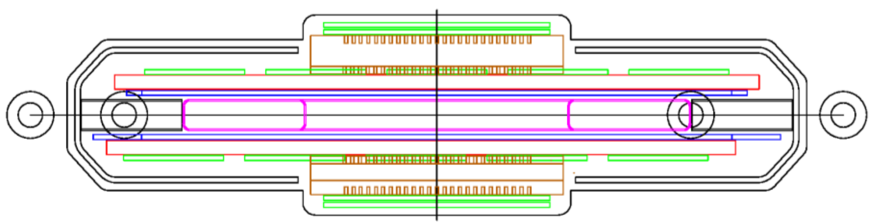


- Employ single sided silicon only, 3 sensor types
  - 2-chip wide for Layer 0
  - 3-chip wide for Layer 1
  - 5-chip wide for Layers 2-5
- No element supported from beampipe



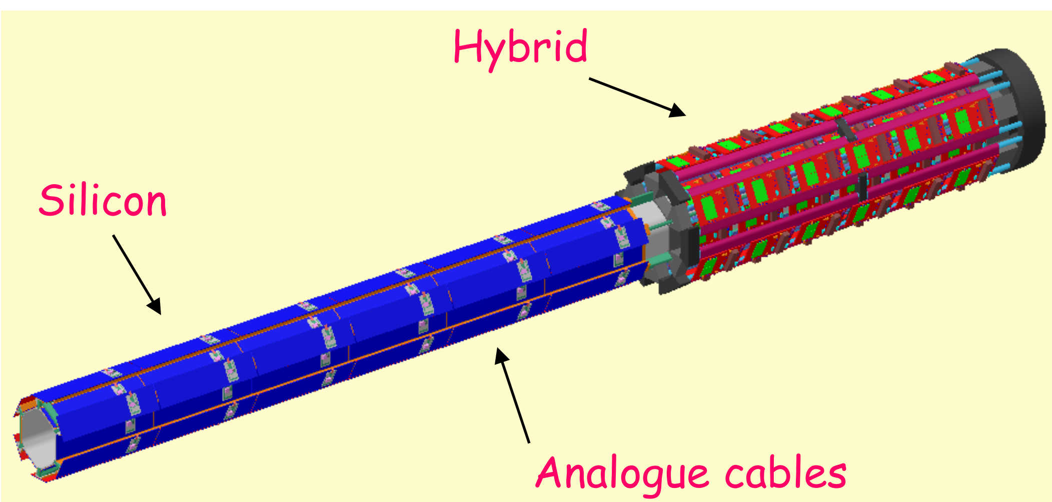
Silicon Detector Elements

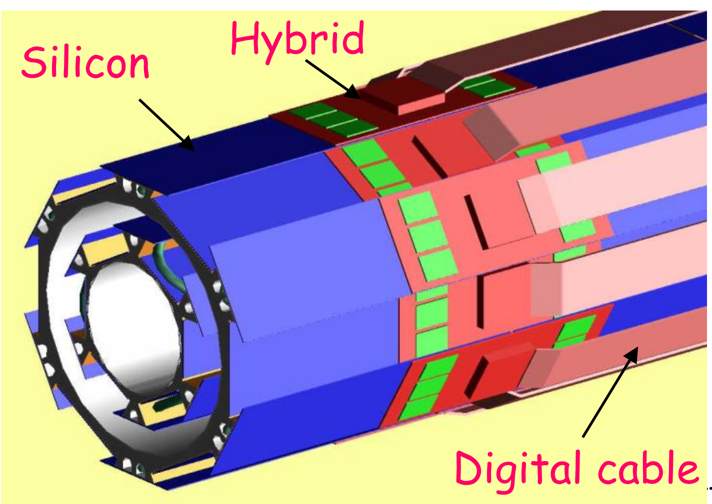
- 168 silicon staves: basic building block of outer layers
- Supported in positioning bulkheads at z=0, z=610 mm



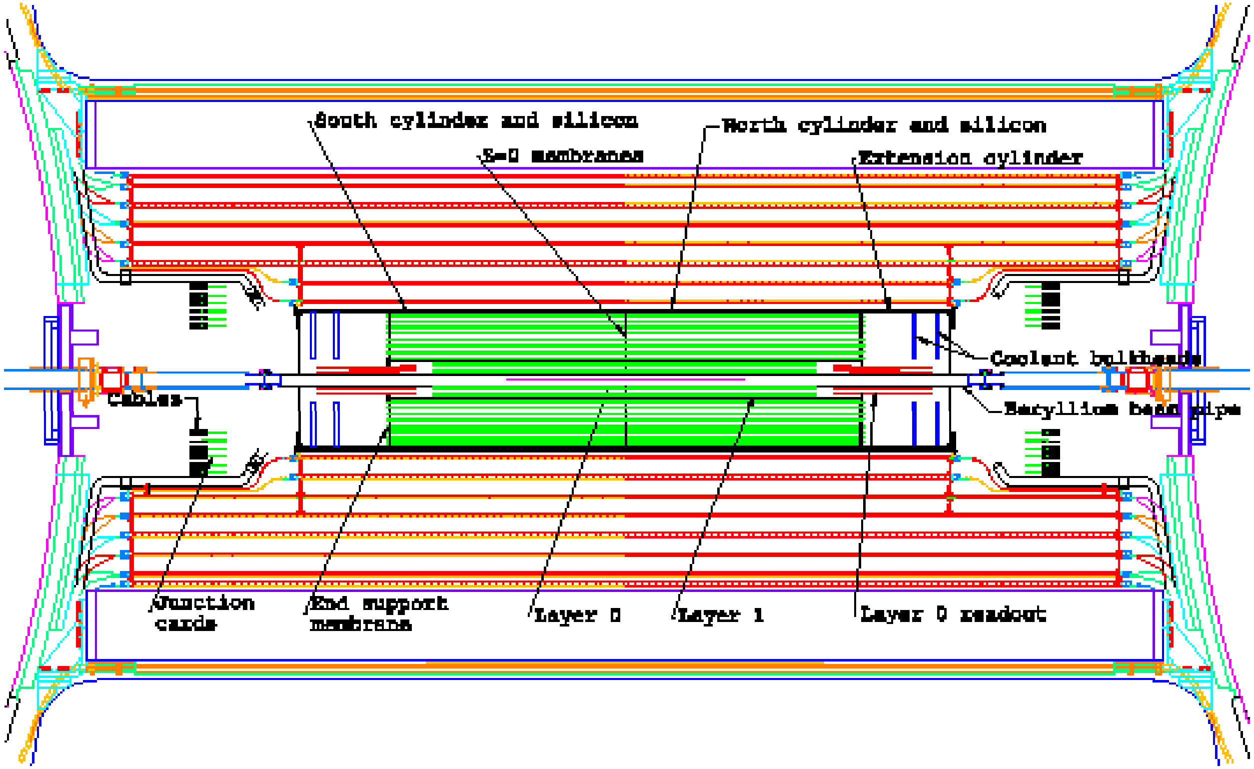
- Layer 0
  Support structure: University of Washington

- 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

WBS 1.2: Run IIb Trigger Upgrade

System	Problems	Solutions
Cal	1) Trigger on $\Delta\eta\times\Delta\phi$=0.2×0.2 TTs ⇒ slow turn-on curve 2) Slow signal rise ⇒ 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)	$W \to e\nu$ $WH \to e\nu jj$	1.3	0.7
Di-EM (1 EM TT > 7 GeV, 2 EM TT > 5 GeV)	$Z \to ee$ $ZH \to eejj$	0.5	0.1
Muon (muon p_T > 11 GeV + CFT Track)	$W \to \mu\nu$ $WH \to \mu\nu jj$	6	0.4
Di-Muons (2 muons p_T > 3 GeV + CFT Tracks)	$Z \to \mu\mu$, $J/\Psi \to \mu\mu$ $ZH \to \mu\mu jj$	0.4	< 0.1
Electron + Jets (1 EM TT > 7 GeV, 2 Had TT > 5 GeV)	$WH \to e\nu$+jets $tt \to e\nu$+jets	0.8	0.2
Muon + Jet (muon p_T > 3 GeV, 1 Had TT > 5 GeV)	$WH \to \mu\nu$+jets $tt \to \mu\nu$+jets	< 0.1	< 0.1
Jet+MET (2 TT > 5 GeV, Missing E_T> 10 GeV)	$ZH \to \nu\bar{\nu}b\bar{b}$	2.1	0.8
Muon + EM (muons p_T > 3 GeV+ CFT track + 1 EM TT > 5 GeV)	$H \to WW, ZZ$	< 0.1	< 0.1
Single Isolated Track (1 Isolated CFT track, p_T > 10 GeV)	$H \to \tau\tau$, $W \to \mu\nu$	17	1.0
Di-Track (1 isolated tracks p_T > 10 GeV, 2 tracks p_T > 5 GeV, 1 matched with EM energy)	$H \to \tau\tau$	0.6	<0.1

Level 1 systems

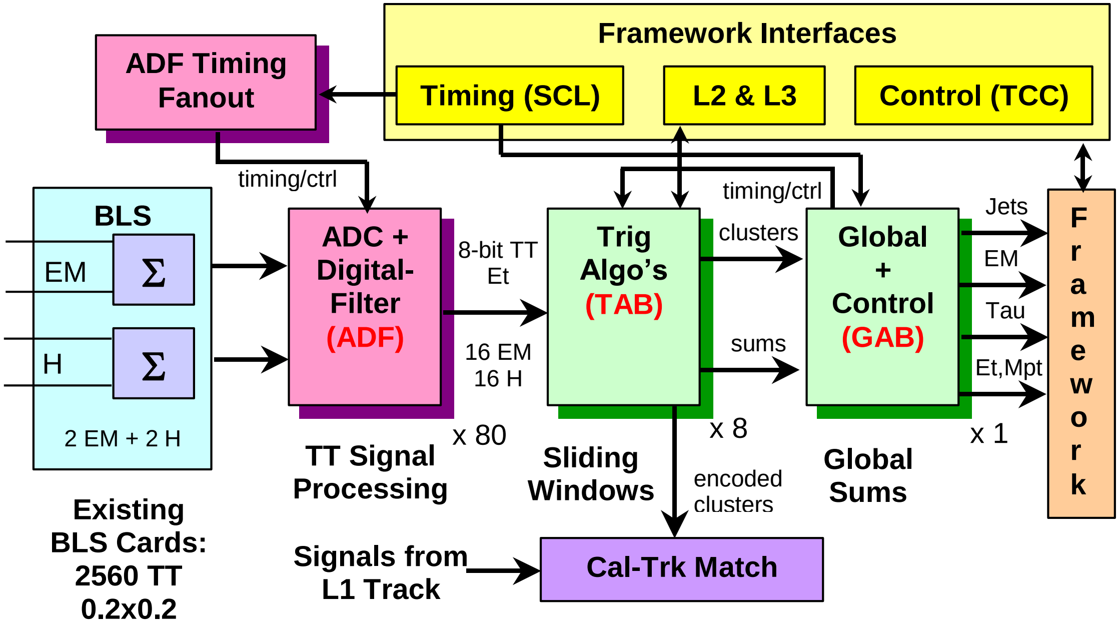
Core Run IIb trigger menu, simulated at 2E32, 396 ns

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

Available L1 bandwidth budget: 5 kHz

WBS 1.2.1: Calorimeter Trigger Upgrade

- Digital Filtering of input signals
  - necessary for 132 ns operation
  - improves E_T estimate at all beam crossing rates
- Jet/EM/tau clustering using ATLAS sliding-window algorithm
  - jets broader than 0.2x0.2 Trigger Towers (TT)
  - cluster topology cuts possible



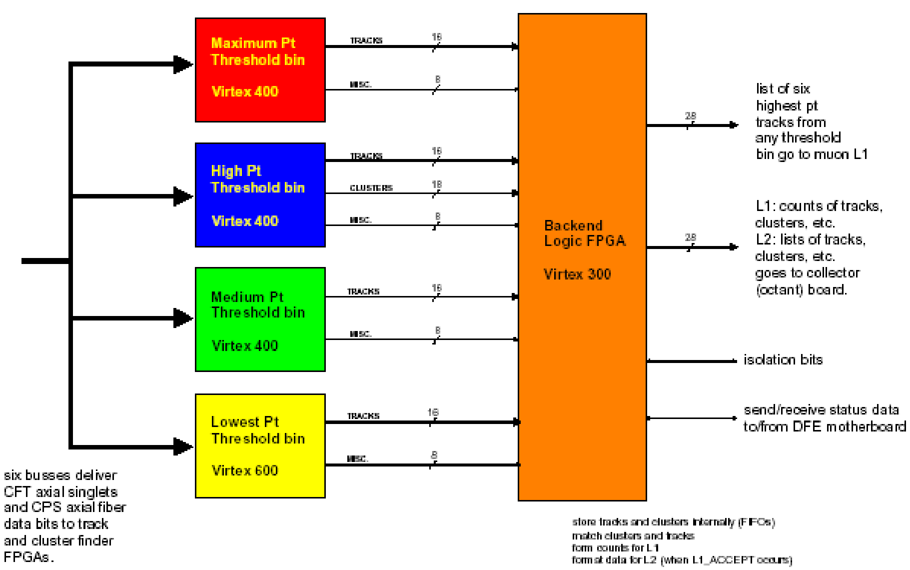
WBS 1.2.1:

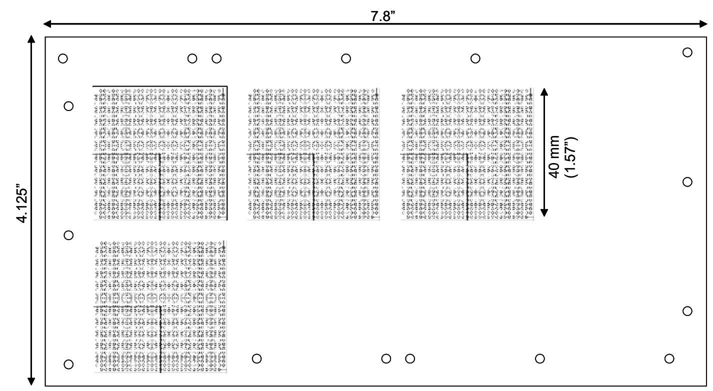
L3 managers:
M. Abolins (MSU),
H. Evans (Columbia),
P. LeDu (Saclay)

WBS 1.2.3: Level 1 CTT Implementation

- Digital Front End Axial (DFEA) daughter cards get replaced with new layout with larger FPGA's (Xilinx Virtex-II XC2V6000)
  - Only 80 daughter cards get replaced;
  - rest of Run IIa system remains intact
- Baseline algorithms compiled; occupy ~40% of the resources of the XC2V6000's.

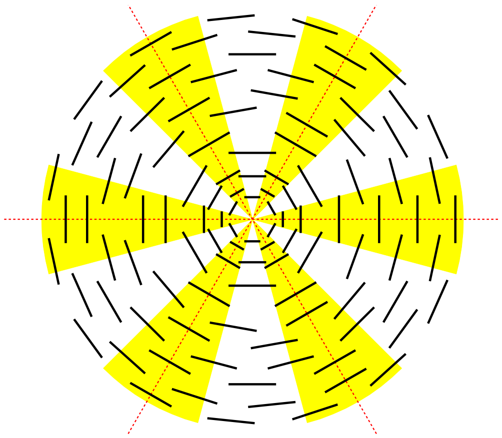
CFT/CPS AXIAL Trigger Daughter Board Dataflow





DFEA layout with new FPGA footprints

Run IIb Level 2 Trigger Upgrade



- Modest upgrades to two components:
  - Silicon Track Trigger
    - Vital for triggering on b-quarks
      - $ZH \rightarrow \nu\nu bb$
      - $Z \rightarrow bb$ (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
  - Level 2β processors
    - More processing power required to retain same Level 2 rejection
    - Add 12 additional processors

Trigger upgrades centered at collaborating universities & laboratories, US and foreign

Trigger Upgrade Project Institutions

Sub-project	Institution(s)
Calorimeter: ADF	Saclay, MSU
Calorimeter: TAB	Columbia
Track trigger	Boston U., FNAL
Cal-Track match	U. of Arizona
Simulation & algorithms	Notre Dame, Saclay, Kansas, Manchester, Brown
Online software & integration	MSU, Northeastern, FSU,Langston
Level 2β	Orsay, Virginia, MSU
STT upgrade	Boston, Columbia, Stony Brook, FSU

- Strong, active institutions
- Largely University-driven
- Combination of RunIIa experience and new ideas

- Engineering, technical and physicist manpower identified for delivering upgraded trigger
- Other institutions expressing interest

WBS 1.3: DAQ/Online

System	Items	Need
Level 3 filter nodes	96 more L3 Farm nodes	Match to rates and processing requirements
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

WBS 1.5: Installation

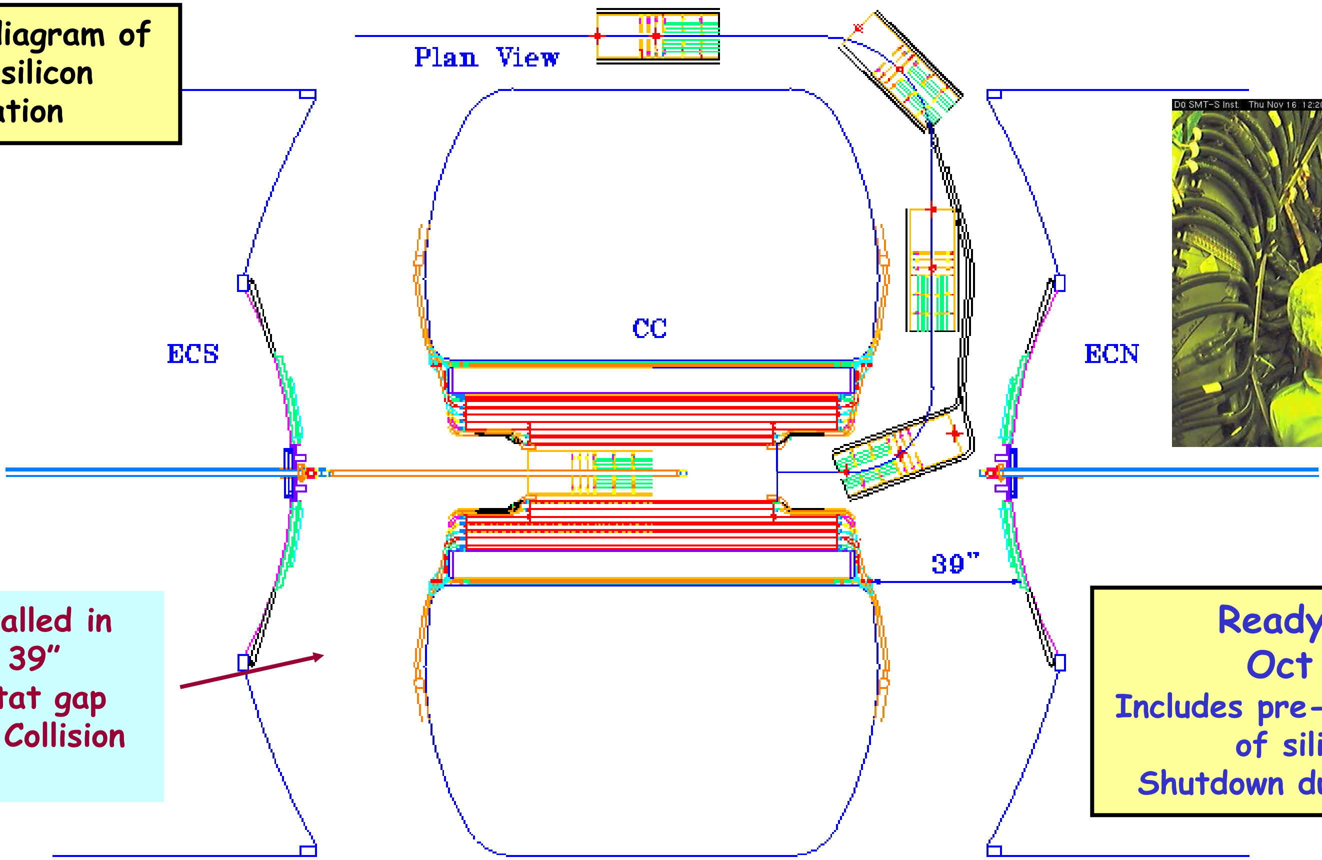
Installation sub-project contains integrated plan for silicon, trigger installation and commissioning

Activity in Collision Hall dominated by silicon installation, hookup

Split-silicon design allows installation in Collision Hall

Detector platform not rolled out - much reduces time, effort, risk

Conceptual diagram of Run IIa silicon installation



Silicon installed in nominal 39" intercryostat gap available in Collision Hall

Ready for Beam:
Oct 25, 2006

Includes pre-beam commissioning of silicon, trigger

Shutdown duration: 7 months

D0 Experiment Organization

- **Spokespersons**
  G. Blazey
  J. Womersley
  - **Advisory Council**
    Chair: V. Büscher
  - **Institutional Board**
    Chair: T. Wyatt
  - **Speakers Bureau**
    Chair: D. Hedin
  - **Run IIb Project**
    J. Kotcher
    - Silicon
    - Trigger
    - DAQ/Online
    - Administration
    - Installation
  - **Run Coordinator**
    D. Denisov
    - Subdetectors
    - Online
    - DAQ
    - Trigger
  - **Software and Computing**
    A. Boehnlein, J. Qian
    - Algorithms
    - Simulation
    - Infrastructure
    - Global Systems and Production
    - Data Access and Databases
    - Online
  - **Physics Coordinator**
    B. Klima
    - Physics Groups
    - ID Groups
    - Trigger Board
    - Offline Resources Board

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

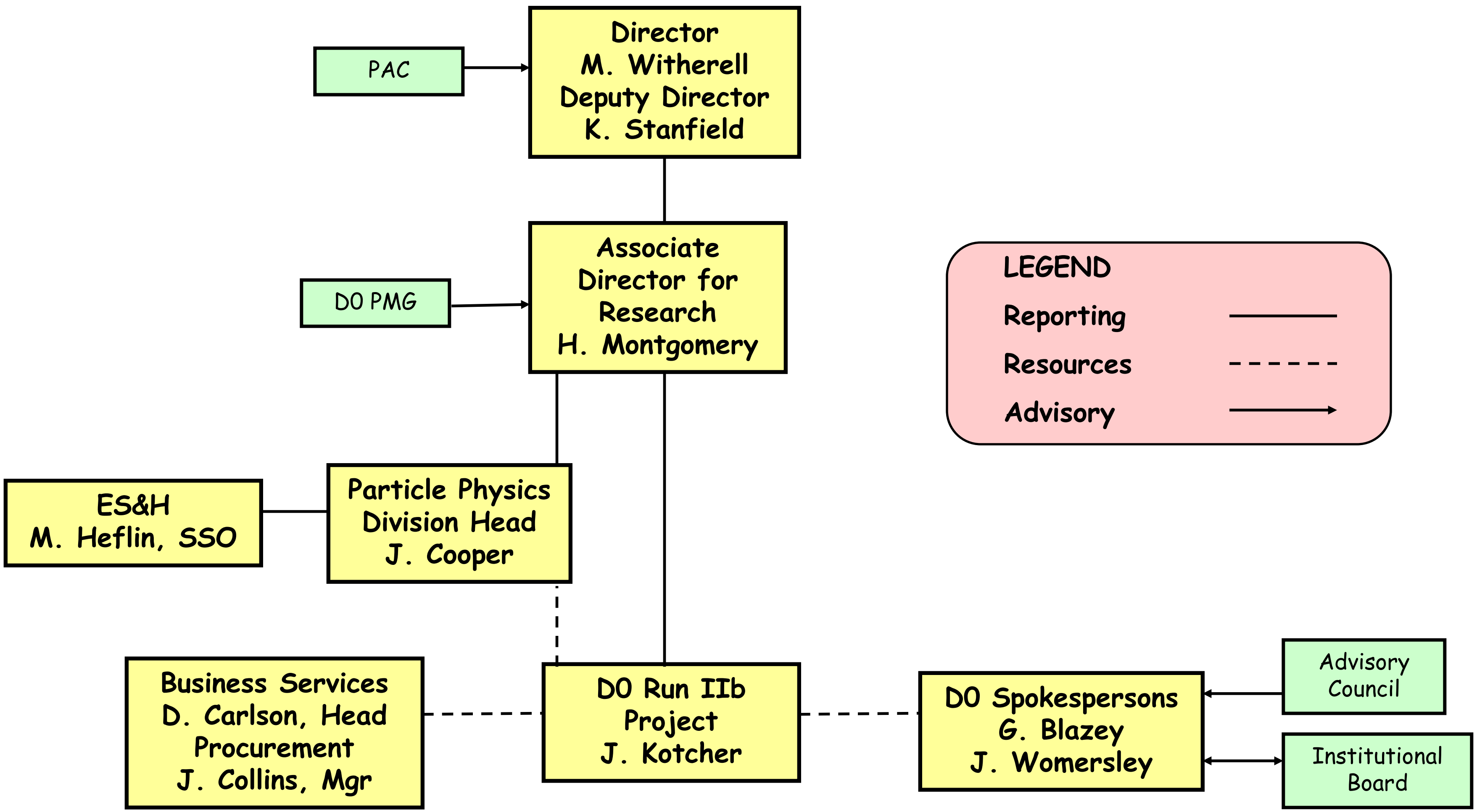
WBS 1.5 Installation
R. Smith

- 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.

Project Reporting Structure



Past Run IIb Milestones, Reviews

- April/Nov 00: Initial presentations of Run IIb plans to PAC
- June 01: D-Zero Trigger Task Force put in place to clarify Run IIb trigger needs
  - Co-chairs: M. Hildreth, R. Partridge
- Nov 01: Silicon TDR and Trigger/Online CDR presented to PAC
- Dec 01: Director's Technical Review of CDF and D-Zero Run IIb Upgrades
  - Chair: J. Pilcher
- April 02: Director's Review of Run IIb Upgrade Projects
  - Chair: E. Temple
- June 02: Aspen PAC recommends Stage I approval
- Aug 12-15 '02: Director's Review of Run IIb Upgrade Projects
  - Co-chairs: E. Temple, J. Pilcher
  - Silicon sub-project "well developed", design "clearly mature"
  - All five trigger sub-projects deemed "ready for baselining"
  - Project preparedness, quality & depth of staffing noted
- Sep 24-26 '02: DOE (Lehman) Review
  - "DOE should move forward expeditiously with CD-1, CD-2, CD-3a"

Run IIb Trigger Task Force

- Run IIb Trigger Task Force in place 6/25/01:
  - Co-Chairs: M. Hildreth (Notre Dame), R. Partridge (Brown U)
- Charge: investigate triggering in high-rate environment
  - Provided starting point, basis for all proposed Run IIb trigger designs – Conceptual, Technical Design Reports

- Calorimeter
  - M. Abolins (MSU)
  - D. Baden (UMaryland)
  - B. Kehoe (MSU)
  - P. Le Du (Saclay)
  - E. Perez (Saclay)
  - M. Tuts* (Columbia)
  - V. Zutshi (BNL)
- Technical/Hardware
  - D. Edmunds (MSU)
  - M. Johnson* (Fermilab)
  - J. Linnemann (MSU)
  - D. Schamberger (Stony Brook)
- Tracking
  - B. Abbott (UOklahoma)
  - D. Alton (UMichigan)
  - V. Bhatnagar (Orsay)
  - F. Borcherding (Fermilab)
  - S. Chopra (BNL)
  - F. Filthaut (UNijmegen)
  - Y. Gerstein (Brown U)
  - G. Ginther* (URochester)
  - P. Petroff (Orsay)
- Muon
  - J. Butler (Boston U)
  - K. Johns* (UArizona)

* = Sub-Group Chair

Cost, Schedule Tools

- Work from resource-loaded schedule in MS Project 2000. To set scale:
  - Silicon (1.1) – 1000 lines
  - Trigger (1.2) – 340 lines
  - Online (1.3) – 150 lines
  - Project Administration (1.4) – 20 lines
  - Installation (1.5) – 180 lines

Total: 1690 lines

- MS Project schedule is primary project tool used for cost, schedule development
  - All M&S, labor, contingency estimates, & risk factors loaded directly into schedule
- Project costs reflect technical manpower only
  - Physicists are not costed, but are fully loaded & used for project planning
- Burdening, escalation introduced external to schedule for this review
  - COBRA, primary project cost tracking tool, in final stages of preparation
    - Introduces these factors - calculates earned value
  - Full D-Zero Run IIb schedule has been uploaded into COBRA

COBRA Output from Run IIb Schedule

Program: D0MASTER	Description: D0 MASTER PROGRAM	Approval:
Run Date: 11/3/2002	Status Date: 9/30/2001	Program Manager Functional Manager Cost Account Manager

WBS[2]	Funding-CA			FY 01	FY 02	FY03	FY 04	FY 05	FY 06	Cumulative
1.1 Run IIb Silicon										
	EQU									
		MSPDIRECT	BCWS	0	0	1,335,769	4,299,688	1,961,547	147,761	7,744,765
		MSPBURDEN	BCWS	0	0	288,619	1,035,126	581,824	53,685	1,959,254
	Funding-CA Totals:		BCWS	0	0	1,624,389	5,334,814	2,543,371	201,446	9,704,019
	INK-MRI1									
		MSPDIRECT	BCWS	15,021	845,785	791,852	715,822	57,530	894	2,426,903
	Funding-CA Totals:		BCWS	15,021	845,785	791,852	715,822	57,530	894	2,426,903
	INK-OTHER									
		MSPDIRECT	BCWS	0	0	0	14,000	0	0	14,000
	Funding-CA Totals:		BCWS	0	0	0	14,000	0	0	14,000
WBS[2] Totals:			BCWS	15,021	845,785	2,416,241	6,064,635	2,600,900	202,340	12,144,922
1.2 Run IIb Trigger Upgrade										
	EQU									
		MSPDIRECT	BCWS	0	0	309,819	487,801	455,560	52,743	1,305,924
		MSPBURDEN	BCWS	0	0	54,189	103,144	109,414	16,663	283,410
	Funding-CA Totals:		BCWS	0	0	364,008	590,945	564,975	69,406	1,589,333
	INK-FOREIGN									
		MSPDIRECT	BCWS	0	217,730	220,139	105,442	56,294	0	599,605
	Funding-CA Totals:		BCWS	0	217,730	220,139	105,442	56,294	0	599,605
	INK-MRI2									
		MSPDIRECT	BCWS	0	0	90,776	73,256	392,815	5,139	561,986
	Funding-CA Totals:		BCWS	0	0	90,776	73,256	392,815	5,139	561,986
	INK-OTHER									
		MSPDIRECT	BCWS	0	147,947	159,547	50,205	11,931	31,423	401,053
		MSPBURDEN	BCWS	0	0	0	0	1,939	8,283	10,222
	Funding-CA Totals:		BCWS	0	147,947	159,547	50,205	13,870	39,706	411,276
WBS[2] Totals:			BCWS	0	365,677	834,470	819,848	1,027,954	114,251	3,162,200
1.3 Online Systems										
	EQU									
		MSPDIRECT	BCWS	0	0	50,178	228,731	300,997	235,665	815,571
		MSPBURDEN	BCWS	0	0	9,912	52,395	83,281	65,312	210,900
	Funding-CA Totals:		BCWS	0	0	60,090	281,126	384,278	300,977	1,026,471
WBS[2] Totals:			BCWS	0	0	60,090	281,126	384,278	300,977	1,026,471
1.4 Run IIb Project Administration										
	EQU									
		MSPDIRECT	BCWS	0	0	209,200	295,126	297,755	265,330	1,067,411
		MSPBURDEN	BCWS	0	0	56,271	90,792	101,714	99,321	348,098
	Funding-CA Totals:		BCWS	0	0	265,471	385,917	399,469	364,651	1,415,509
WBS[2] Totals:			BCWS	0	0	265,471	385,917	399,469	364,651	1,415,509
Grand Totals:										
			BCWS	15,021	1,211,462	3,576,272	7,551,526	4,412,602	982,219	17,749,101

All sub-projects

Escalated, burdened project cost (no contingency)

Final cross checks in process

Funding sources

Budgeted Cost of Work Scheduled

Documentation Provided to Committee

- Technical Design Report
  - Detailed technical descriptions of all systems: Silicon (WBS 1.1), Trigger (WBS 1.2), DAQ/Online (WBS 1.3), Installation (WBS 1.5)
- Black book:
  - Updated plenary presentations from Sep '02 DOE Baselining Review
  - GANTT charts of project schedule, milestones, critical path
  - Cost & schedule methodology, COBRA implementation & procedures
  - Risk analysis summary
  - D-Zero/CDF Silicon Comparison Document
  - Silicon Run IIb Manpower Requirements, Run IIa Comparison (PPD)
  - Committee Report from August '02 Director's Review
- Red book:
  - Project plan, acquisition documents:
    - Acquisition Execution Plan
    - Project Execution Plan
    - Project Management Plan
  - Multi-Year Run IIb Memorandum of Understanding, Statement of Work
  - Run II General Collaboration MoU

Documentation Provided to Committee

- Purple book:
  - WBS Dictionary, Basis of Estimate for all subsystems
- Five green cost books:
  - Book 1: Silicon Sensors (1.1.1), Readout (1.1.2)
  - Book 2: Mechanical Design (1.1.3), Production & Testing (1.1.4)
  - Book 3: Barrel Assembly (1.1.5), Monitoring (1.1.6), Software & Simulation (1.1.7), Administration (1.1.8)
  - Book 4: Trigger (1.2)
  - Book 5: DAQ/Online (1.3)
  - Contain supporting BoE documentation: past POs/reqs, vendor quotes, labor estimates, etc.

Silicon

- Gray Book:
  - Plenary presentations from Sep '02 DOE Baselining Review
- Blue book:
  - Selected 15' technical presentations prepared for breakouts at Sep '02 DOE Review by Level 3 Subproject Managers
- Links to previous review web pages
  - June '02 PAC, Director's Reviews, responses to past reports, etc.

Project Risk Assessment

Evaluating Impact of a Risk on Major Project Objectives

Project Objective	Very Low Impact .05	Low Impact .1	Moderate Impact .2	High Impact .4	Very High Impact .8	Comments
Cost	Insignificant cost increase	<5% cost increase	5-10% cost increase	10-20% cost increase	>20% cost increase	
Schedule	Insignificant schedule slippage	Schedule slippage <5%	Overall project slippage 5-10%	Overall project slippage 10-20%	Overall project schedule slips>20%	20% slippage ~ 8 months
Scope	Scope decrease barely noticeable	Minor areas of scope affected	Major areas of scope affected	Project scope reduction unacceptable for physics objectives	Scope of project effectively useless for physics objectives	
Technical	Technical degradation of project barely noticeable	Technical performance of final product minimally affected	Technical performance of final product moderately affected	Degradation of technical performance of final product unacceptable for physics objectives	Technical performance of project end item effectively useless for physics objectives	

Risk evaluated at WBS Level 4, project wide

Project Risk Assessment

Risk Matrix:
Product of risk impact and probability
green, yellow, red = low, moderate, high risk

Probability	Risk Score = Probability x Impact				
0.9	0.05	0.09	0.18	0.36	0.72
0.7	0.04	0.07	0.14	0.28	0.56
0.5	0.03	0.05	0.10	0.20	0.40
0.3	0.02	0.03	0.06	0.12	0.24
0.1	0.01	0.01	0.02	0.04	0.08
	0.05	0.10	0.20	0.40	0.80
	Impact on Objectives				

- Select high risk score elements, discuss means of mitigation
  - Mitigation procedure in notes field in Basis of Estimate
- Risk score used to aid assigning cost, labor, and schedule contingency

Example Risk Summary

Silicon Sensors (1.1.1) & Readout (1.1.2)

ID	WBS	Name	Cost Risk Score	Schedule Risk Score	Scope Risk Score	Technical Risk Score
1	1.1	Run IIb Silicon				
2	1.1.1	Sensors				
3	1.1.1.1	Probing Equipment Setup	🟢	🟢	🟢	🟢
16	1.1.1.2	L0 Sensors	🟢	🟢	🟡	🟡
43	1.1.1.3	L1 Sensors	🟢	🟢	🟡	🟡
73	1.1.1.4	L2-L5 Sensors	🟡	🟡	🟢	🟢
105	1.1.2	Readout System				
106	1.1.2.1	SVX4 Chips	🔴	🔴	🟡	🟡
139	1.1.2.2	L0 Hybrids	🟢	🟢	🟡	🟡
164	1.1.2.3	L1 Hybrids	🟢	🟢	🟡	🟡
196	1.1.2.4	L2-L5 Hybrids	🟡	🟡	🟡	🟡
227	1.1.2.5	L0 Analog Flex Cables	🟡	🟢	🔴	🔴
239	1.1.2.6	L0-L1 Digital Jumper Cables (KSU)	🟢	🟢	🟢	🟢
252	1.1.2.7	L2-L5 Digital Jumper Cables (KSU)	🟢	🟢	🟢	🟢
265	1.1.2.9	Testing of cables (LA Tech)	🟢	🟢	🟢	🟢
273	1.1.2.10	L0-L1 Junction Cards	🟢	🟢	🟢	🟢
283	1.1.2.11	L2-5 Junction Cards	🟢	🟢	🟢	🟢
293	1.1.2.12	Twisted-Pair Cables	🟡	🟢	🟡	🟡
311	1.1.2.13	Adapter Cards	🟡	🟢	🟡	🟡
326	1.1.2.14	SASEQ Test Stands	🟢	🟢	🟢	🟢
357	1.1.2.16	Interface Boards and backplanes	🟢	🟢	🟢	🟢
371	1.1.2.17	Low Voltage System	🟢	🟢	🟢	🟢
390	1.1.2.18	High-mass Cables	🟢	🟢	🟢	🟢
394	1.1.2.19	High Voltage System	🟢	🟢	🟢	🟢
410	1.1.2.21	Support of Downstream electronics at Fermilab	🟢	🟢	🟢	🟢

Risk assessed at WBS Level 4

(Green, Yellow, Red) = (Low, Medium, High) Risk Score

Performed for all subprojects

Schedule Baseline

- April '02 Director's Review of Run IIb Projects:
  - "…these projects, unlike many 'scientific' projects, do not have an open-ended completion date."
  - "…to provide for possible delays we suggest a significant float be added to project completion, perhaps as much as a year beyond the Silicon ready to install date, or May 2006."
  - Approach endorsed by August Director's Review Committee, DOE Baselining Committee, Laboratory Directorate
- Final project baseline developed by Project Manager by considering in detail:
  - Schedule developed by Level 2/3 Subproject Managers
  - Recommendations from aforementioned Committees, PAC, Laboratory guidance
  - PM's own experience, assessment of project plan, needs, etc.
- Three sets of milestones used for project oversight, tracking, change control:
  - 182 Project Manager's Milestones
  - 23 FNAL Director's/DOE Level 2 Project Manager's Milestones
  - 6 DOE Level 1 Milestones
  - Details provided in Project Execution/Management Plans

Subset of Project Manager's Milestones for Silicon Subproject

ID	Milestone	Date
985	Release Of Silicon Reconstruction Code	9/12
446	Successful Readout of Hybrid With SASEQ Test Stand	8/1
15	Sensor Probing Equipment Setup And Certification Complete	11/14
437	Successful Readout Of More Than 1 Silicon Hybrid	12/5
563	Silicon Prototype Mechanical Stave Built	1/6
33	Choose L0 Silicon Sensor Technology	2/20
69	Choose L1 Silicon Sensor Technology	2/20
91	L2-L5 Silicon Sensors Released For Production	3/24
262	Silicon L2-L5 Digital Jumper Cables Released For Production	4/29
38	L0 Silicon Sensors Released For Production	5/13
70	L1 Silicon Sensors Released For Production	5/13
399	Silicon High-mass Cables Ready	5/29
994	Release Silicon Unpacking And Translation Packages	6/2
999	Release Silicon Examine Package	7/11
844	Silicon Cylinders Released for Production	7/21
451	Successful Readout Of Silicon Single-unit Full-chain	7/25
1004	Release Silicon Event Display Package	9/11
237	Silicon L0 Flex Cables Released For Production	9/12
677	Begin 20cm Gang Production	9/17
798	Successful Fabrication of an Electrical-grade Pre-production Silicon Stave	10/10
138	SVX4 Released For Production	10/20
41	1st L0 Silicon Sensor Delivered	10/24
71	1st L1 Silicon Sensor Delivered	10/24
97	25% L2-L5 Silicon Sensors Delivered And Tested	11/18
194	Silicon L1 Hybrids Released For Production	11/20
358	Silicon SASEQ Test Stands Ready	11/20
225	Silicon L2-L5 Hybrids Released For Production	12/10

Milestones tightly span the time frame; allow for close managerial oversight

GANTT Chart of Director/DOE Level 2 PM's Milestones for All Subprojects

ID	Task Name	
1	**Silicon**	
2	Silicon Prototype Mechanical Stave Built	1/6
3	L2-L5 Silicon Sensors Released For Production	3/24
4	SVX4 Released For Production	10/20
5	Successful Readout Of Full Silicon Stave	1/29
6	Silicon Module Production Begun	5/17
7	All Silicon Sensors Delivered And Tested	12/9
8	All SVX4 Chips Produced And Tested	12/21
9	All Silicon Hybrids Produced And Tested	3/3
10	Silicon Stave Production Begun	3/8
11	Silicon Module Production And Testing Complete	7/22
12	Downstream Silicon Readout Ready for Installation On Platform	10/25
13	Silicon Stave Production Complete	12/22
14	South Silicon Complete	2/10
15	North Silicon Complete	5/4
16	Silicon Ready To Move To DAB	5/25
17	**Trigger**	
18	L1 Trigger Cal-Trk Match Production and Testing Completed	9/23
19	L2 Silicon Track Trigger Production and Testing Complete	10/17
20	L1 Calorimeter Trigger Production And Testing Complete	1/5
21	L2 Beta Trigger Production And Testing Complete	1/5
22	L2 Trigger Upgrade Production and Testing Complete	1/5
23	L1 Central Track Trigger Production And Testing Complete	1/10
24	L1 Trigger Upgrade Production and Testing Complete	1/10
25	**Online**	
26	Online System Production and Testing Complete	10/7

DOE Level 1 Milestones, CD-4

Milestone	DOE Level 1 Milestone Date
All silicon sensors delivered and tested	12/09/04
Online System Production and Testing Complete	10/07/05
Silicon stave production complete	12/22/05
Level 2 Trigger Production and Testing Complete	01/05/06
Level 1 Trigger Production and Testing Complete	01/10/06
Silicon ready to move to D0 Assembly Building	05/25/06

CD-4, Approve Project Closeout: November, 2006

M&S, Labor Contingency/Cost Evaluation

- M&S contingency obtained from "top-down" estimate by Project Manager based on:
  - Recommendations from L2/3 subproject managers
    - Perform their own estimate at the lowest available WBS level
    - Based on detailed designs where available, extensive input from engineering & technical staff directly involved in project
    - Risk analysis in all categories – cost, schedule, technical/scope – taken into consideration
    - Guidelines provided by PM
  - DOE & Laboratory guidelines, guidance
  - Recommendations from previous Director's Review Committees
  - Fiscal history of similar completed projects
  - Complementary input from technical experts
  - Past experience
- Labor contingency estimates obtained in analogous manner
- Base M&S and labor needs estimated by Level 2/3 Subproject Managers, reviewed and approved by Project Manager

US National Science Foundation MRIs for Run IIb

- Silicon MRI submitted Feb '01, awarded July '01
  - Brown, California State (Fresno), U Illinois (Chicago), Kansas, Kansas State, Michigan State, Stony Brook, Washington, (Moscow State, CINVESTAV)
    - Principal Investigator: A. Bean
    - Co-PIs: R. Demina, C. Gerber, R. Partridge, G. Watts
  - $1.7M + $0.7M matching = $2.4M total
- Level 1 Trigger MRI submitted Jan '02, partial award granted July '02
  - Arizona, Boston, Columbia, Florida State, Langston, Michigan State, Northeastern, Notre Dame, (Saclay)
    - Principal Investigator: M. Narain
    - Co-PIs: H. Evans, U. Heintz, M. Hildreth, D. Wood
  - $456k + $113k matching = $569k total
  - Funds will go toward Central Track Trigger upgrade
  - Level 1 Calorimeter, Track Match proposal will be re-submitted at end of year
- D0 universities playing major role throughout Run IIb Project

Total Project Cost in AY k$

Includes G&A, contingency, & escalation

AY k$	Base	Cont %	Cont	Total
Silicon	15986	31	4904	20890
Trigger	3276	37	1216	4492
Online	1062	31	332	1393
Administrative	1463	25	366	1829
TOTAL PROJECT COST	21787	31	6818	28604

Cost by subsystem

AY k$	M&S + R&D Cost	G&A	Cont %	Cont	Cost+ Cont Total	Total M&S + R&D	Labor FNAL	G&A	Cont %	Cont	Cost+ Cont Total	Total Labor	Total
Silicon	8589	1082	32	3084	11673	12755	4910	1405	29	1820	6730	8135	20890
Trigger	2877	223	37	1151	4028	4251	137	39	37	65	202	241	4492
Online	652	116	29	223	874	990	229	66	37	109	338	404	1393
Administrative	126	22.3	25	37	163	185	1022	293	25	329	1351	1644	1829
TOTAL PROJECT COST	12243	1442	33	4495	16738	18180	6298	1803	29	2323	8621	10424	28604

Cost broken out into M&S + R&D, FNAL labor

Fermilab escalation, G&A rates applied

FNAL ESCALATION RATES		FY01	FY02	FY03	FY04	FY05	FY06
EQUIPMENT	BY YEAR	-2.9%	N/A	2.3%	2.8%	2.7%	2.6%
	CUMULATIVE	0.971	1	1.023	1.052	1.080	1.108
LABOR	BY YEAR	-4.0%	N/A	4.0%	4.0%	4.0%	4.0%
	CUMULATIVE	0.960	1	1.040	1.082	1.125	1.170

	EQUIPMENT	LABOR
G&A	17.72%	28.62%

Total Project Cost = $28,604k
Includes total contingency of 31% ($6,818k)

Obligation Profiles in AY k$

Obligation Profile in AY k$ (by subsystem)	FY01	FY02	FY03	FY04	FY05	FY06	TOTAL
Silicon (incl. G&A and FNAL labor)	17	1326	3407	5079	2463	168	12459
Trigger (incl. G&A and FNAL labor)	0	468	947	660	1135	40	3251
Online (incl. G&A and FNAL labor)	0	0	64	311	377	311	1062
Administration (incl. G&A and FNAL labor)	0	0	274	399	413	377	1463
Sub Total	17	1794	4693	6449	4387	895	18235
R&D (incl. G&A and FNAL labor)	0	1360	2191	0	0	0	3552
Contingency	0	0	2285	2567	1701	265	6818
Total Project Cost	17	3154	9169	9016	6088	1160	28604
Percentage by FY	0	11	32	32	21	4	

Obligations by subsystem w/R&D and contingency broken out

Obligation Profile in AY k$ (by funding type)	FY01	FY02	FY03	FY04	FY05	FY06	TOTAL
M&S (incl. cont and In-Kind contr.)	17	1794	4973	4979	3033	367	15163
R&D (incl.cont. on R&D)	0	649	926	0	0	0	1575
FNAL Labor (M&S and R&D, incl. Cont)	0	464	2217	2999	2325	617	8621
G&A (on M&S and R&D)	0	248	1053	1038	730	176	3245
TOTAL	17	3154	9169	9016	6088	1160	28604

Obligations broken out by funding type

Tables include G&A, contingency, & escalation

Funding Need in AY k$

Includes G&A, contingency, & escalation

Funding need broken out by source

TPC, Obligation Profile In AY k$	FY01	FY02	FY03	FY04	FY05	FY06	TOTAL
Silicon (incl. Cont + G&A)	17	1326	4860	7165	3443	230	17040
Trigger (incl. Cont + G&A)	0	468	1363	946	1630	56	4462
Online (incl. Cont + G&A)	0	0	84	407	499	404	1393
Administration (incl. Cont + G&A)	0	0	343	499	516	471	1829
Total (excl. R&D)	17	1794	6650	9016	6088	1160	24724
R&D (incl. Cont + G&A)	0	1360	2519	0	0	0	3880
Total Project Cost	17	3154	9169	9016	6088	1160	28604
DOE M&S	0	0	4025	4160	2507	367	11060
DOE SWF	0	0	1045	2999	2325	617	6986
DOE G&A	0	0	631	1038	730	176	2575
TOTAL DOE EQ	0	0	5701	8197	5563	1160	20621
DOE M&S R&D	0	649	926	0	0	0	1575
DOE SWF R&D	0	464	1171	0	0	0	1635
DOE G&A R&D	0	248	422	0	0	0	670
TOTAL DOE R&D	0	1360	2519	0	0	0	3880
In Kind - Foreign	0	258	201	90	49	0	599
In Kind - MRI silicon	17	1326	495	631	0	0	2469
In Kind - MRI trigger	0	0	112	57	430	0	599
In Kind - US base	0	210	141	39	47	0	437
Total In-Kind contributions	17	1794	948	819	526	0	4104
Forward Funding			0			0	
Total Project Cost	17	3154	9169	9016	6088	1160	28604

Contingency on DOE Equipment Portion = 46%

Project Funding in AY k$

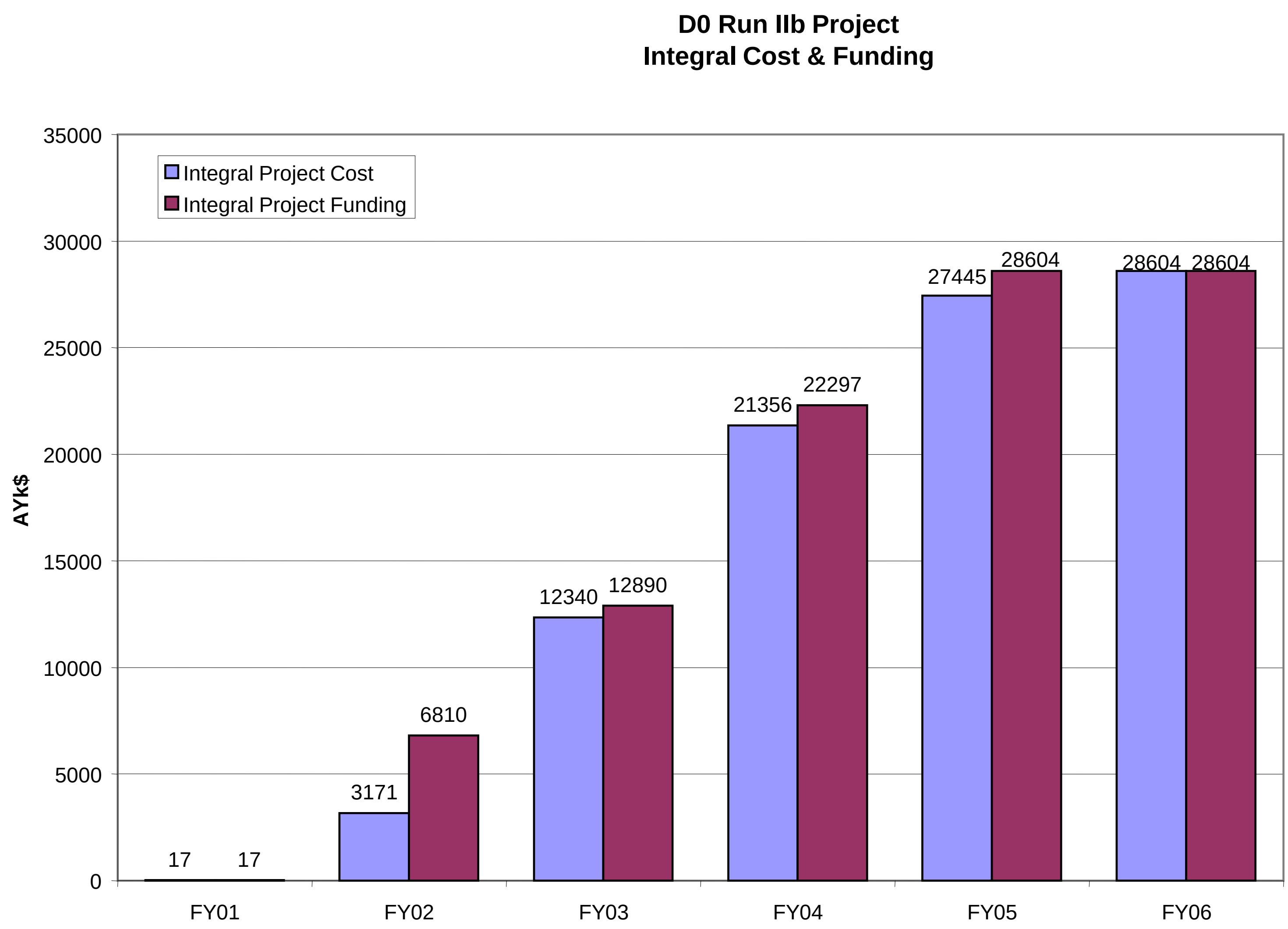
Includes G&A, contingency, & escalation

Total Project Cost In AY k$	FY01	FY02	FY03	FY04	FY05	FY06	TOTAL
Silicon (incl. Cont + G&A)	17	1326	4860	7165	3443	230	17040
Trigger (incl. Cont + G&A)	0	468	1363	946	1630	56	4462
Online (incl. Cont + G&A)	0	0	84	407	499	404	1393
Administration (incl. Cont + G&A)	0	0	343	499	516	471	1829
Total Project	17	1794	6650	9016	6088	1160	24724
R&D (incl. Cont + G&A)	0	1360	2519	0	0	0	3880
Total Project Cost	17	3154	9169	9016	6088	1160	28604
Project Funding in AY k$	FY01	FY02	FY03	FY04	FY05	FY06	TOTAL
DOE EQ	0	3500	2752	8588	5781	0	20621
DOE R&D	0	1499	2380	0	0	0	3880
In Kind - Foreign	0	258	201	90	49	0	599
In Kind - MRI silicon	17	1326	495	631	0	0	2469
In Kind - MRI trigger	0	0	112	57	430	0	599
In Kind - US base	0	210	141	39	47	0	437
Total In-Kind contributions	17	1794	948	819	526	0	4104
Forward Funding	0	0	0	0	0	0	0
Total Funding	17	6793	6080	9407	6307	0	28604

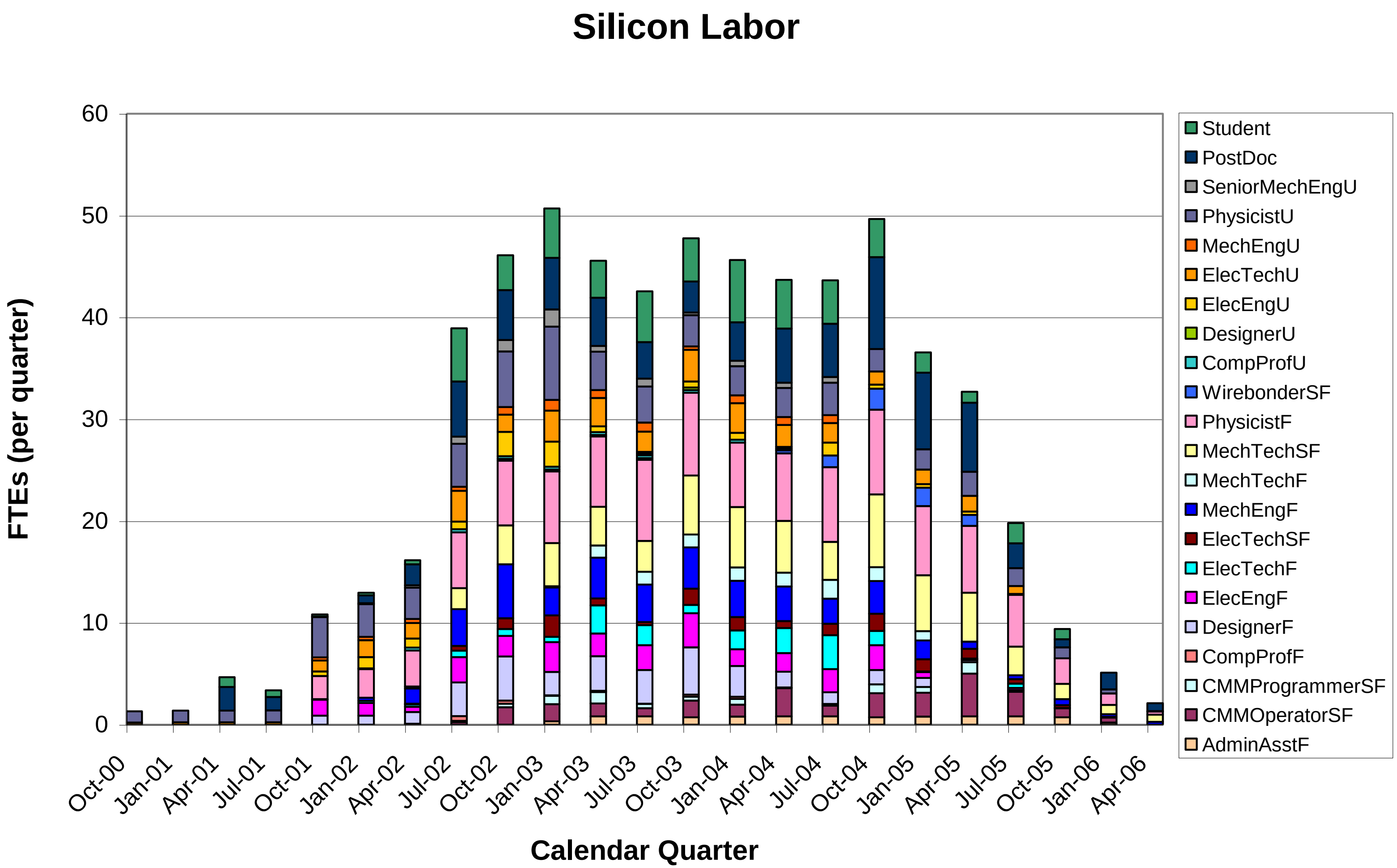
Funding guidance provided by Laboratory

Excess in given year will be carried over to subsequent years

Integral Project Cost & Funding



Total Silicon Labor



Includes all personnel, all categories – physicists, technical, and administrative – required to deliver silicon detector

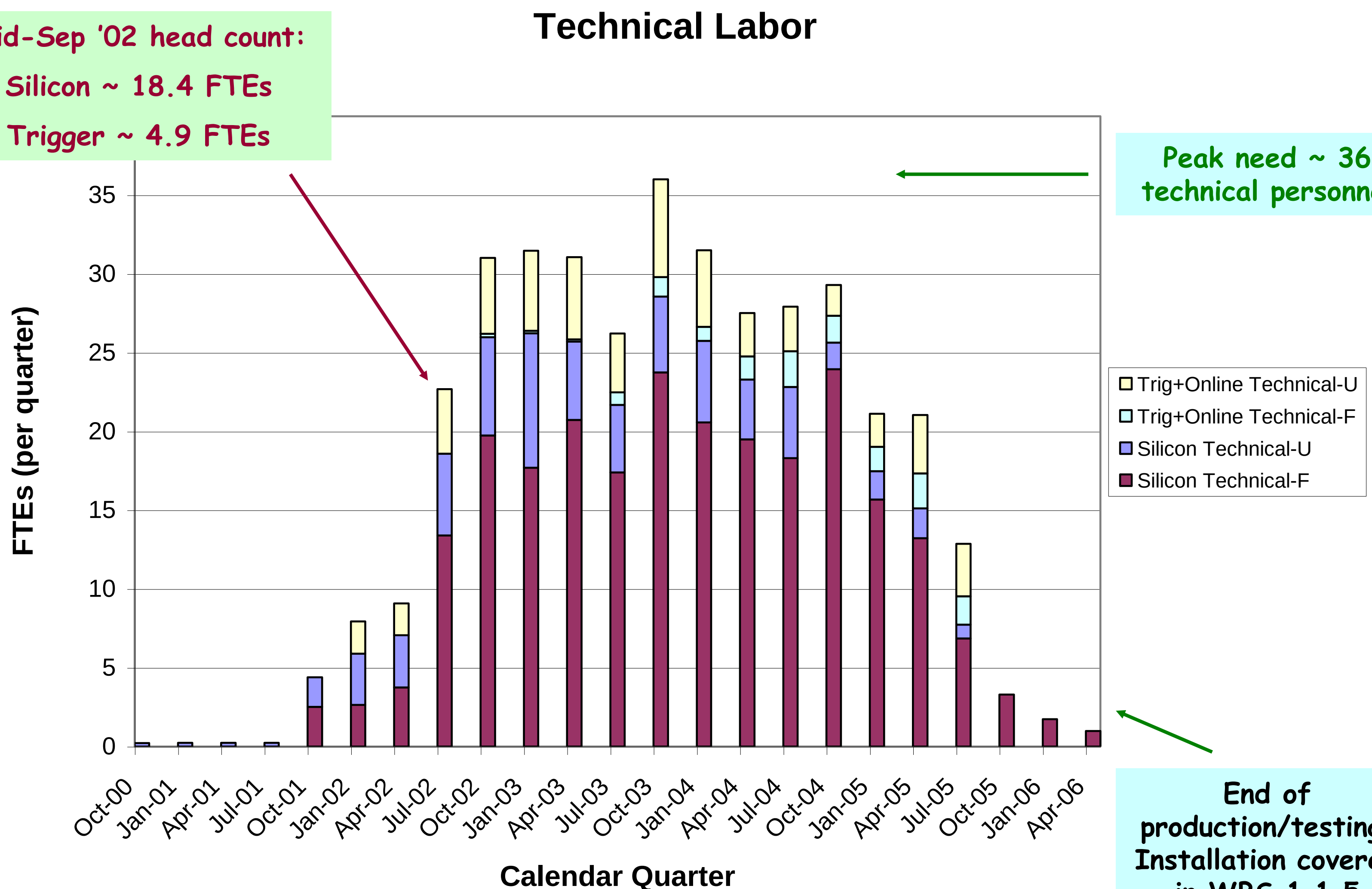
Base need only – contingency not included

Total Technical Label

Mid-Sep '02 head count:

Silicon ~ 18.4 FTEs

Trigger ~ 4.9 FTEs



Peak need ~ 36 technical personnel

End of production/testing. Installation covered in WBS 1.1.5

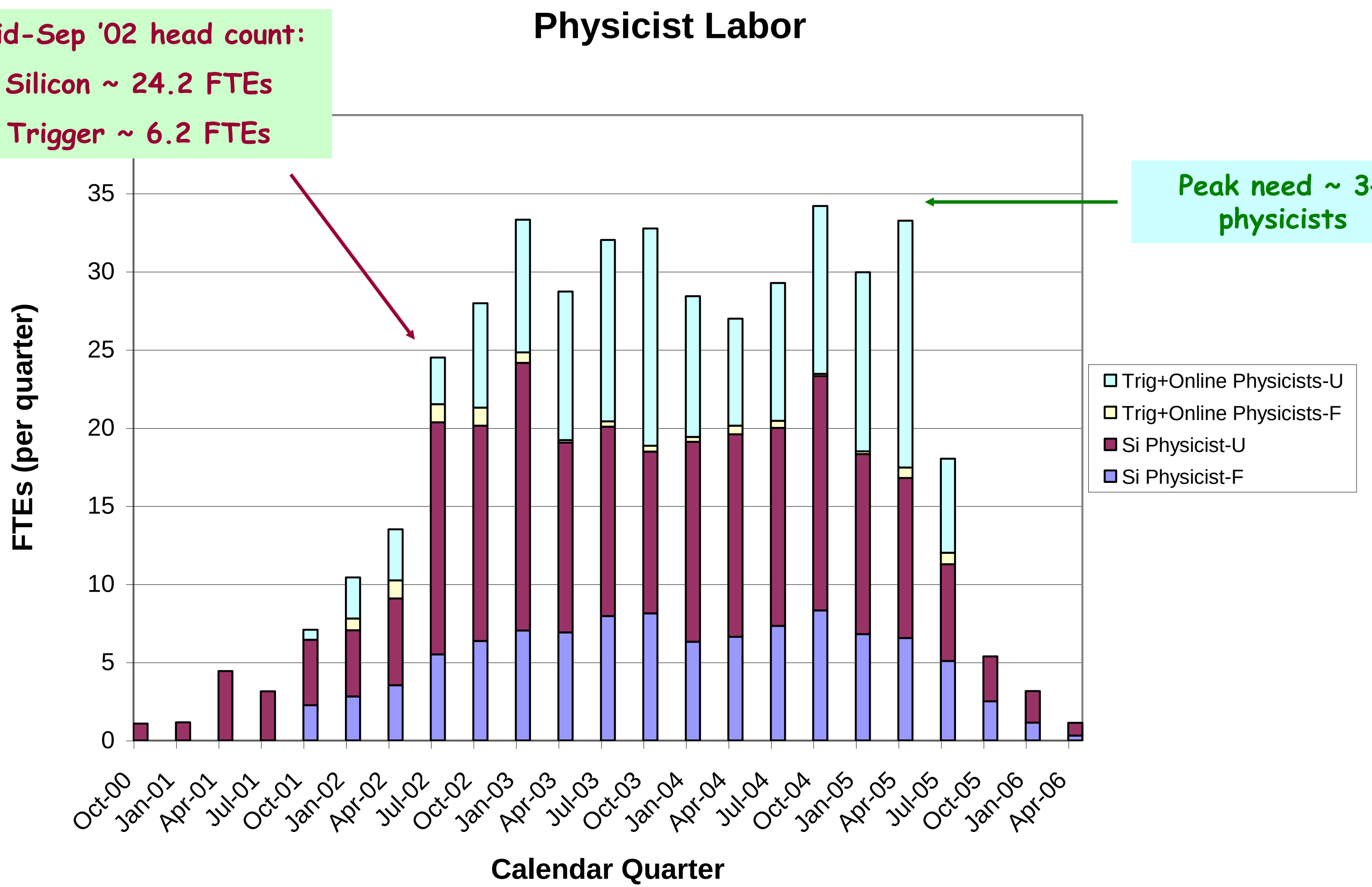
Technical labor required to deliver silicon and trigger+online projects, divided into Fermilab and university components

Total Physicist Labor

Mid-Sep '02 head count:

Silicon ~ 24.2 FTEs

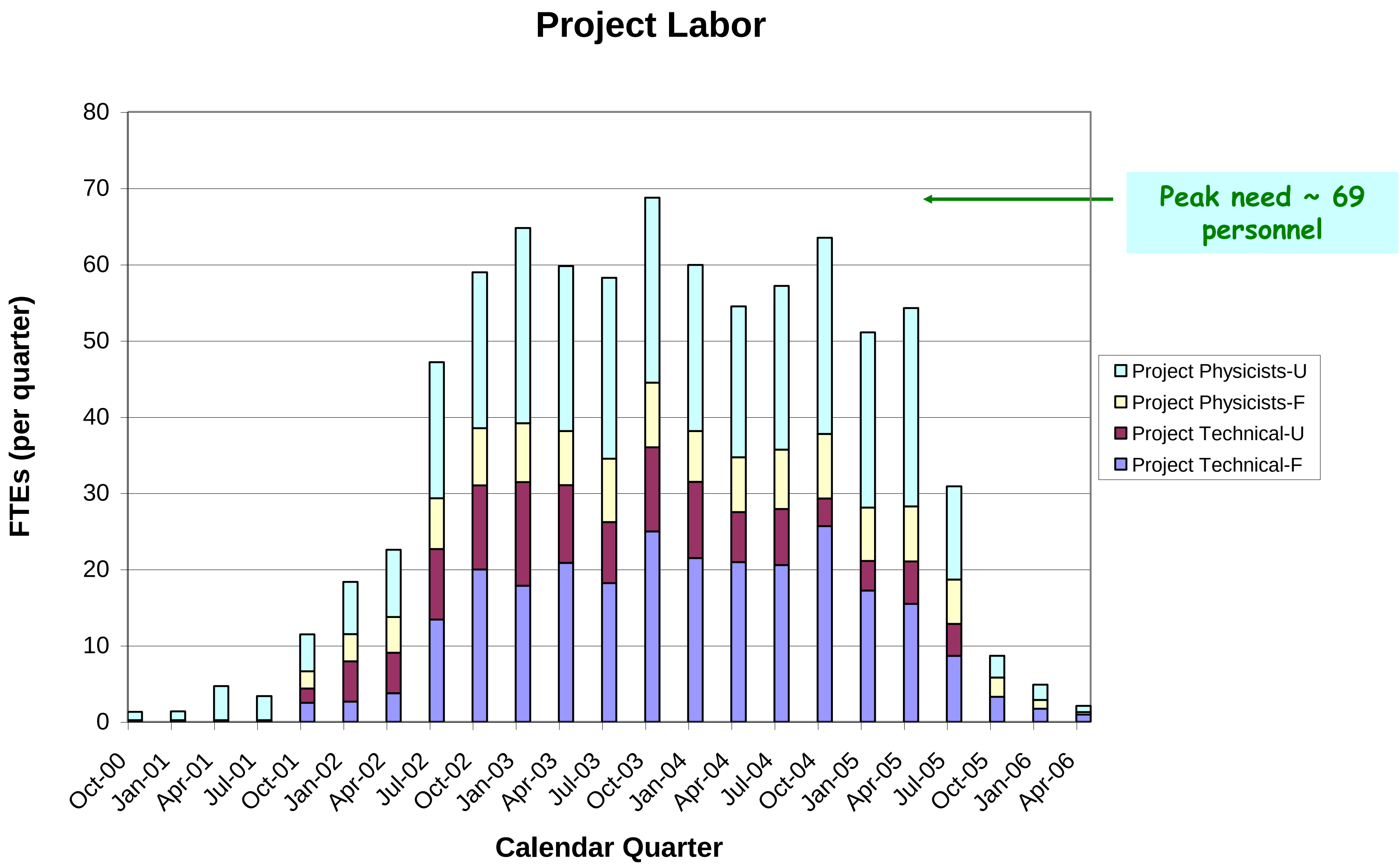
Trigger ~ 6.2 FTEs



Peak need ~ 34 physicists

Physicists required to deliver silicon and trigger+online projects, divided into Fermilab and university components

Total Project Labor



Total required to deliver silicon and trigger+online projects, divided into Fermilab and university components

Near Term Procurements, Strategy

Silicon Procurements Over $100k

Item	Cost (FY02 k$)	Production Start Date
SVX4 2nd Prototype Chip	158	02/27/03
L2-L5 Sensors	1,453	03/25/03
L2-L5 Digital Jumper Cables	263	04/30/03
L0 Sensors	161	5/14/03
L1 Sensors	155	5/14/03
Analog Cables	167	9/15/03
SVX4 Production Chips	475	10/21/03
L2-L5 Production Hybrids	382	12/11/03
Twisted Pair Cables	256	12/7/04

Total silicon procurements in FY03: $3.1M

- Project & FNAL Procurement have been developing collaborative approach to facilitate procurements
  - Series of meetings between Project and FNAL Procurement, Business Services, & Project Management Offices
  - Quantify cycle times, procurement steps
  - Post-mortems of early prototype orders, identify and ameliorate potential bottlenecks
  - Expedite convergence of specifications, etc. with vendors
  - Specific needs of Run IIb projects discussed
- Example: L2-5 sensor order
  - Pre-production order out 8/02
  - Experience being applied to expedite 3/03 production order
- Project, Laboratory, & FNAL DOE Office working together to develop efficient acquisition strategy

Conclusions

- Run IIb has matured into a solid, well-defined project
- Full project plan in place, based on detailed technical designs and fully resource loaded schedule
- Management & acquisition plans in signature, financial & schedule control systems in place
- Design & prototyping well advanced; experienced, dedicated project team in place, poised to move on to project construction
- We have developed a technically robust, well-justified project plan that will enable us to properly address the physics of interest on the time scales required