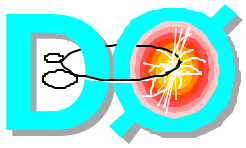


D0 Run 2b Project

- Project Organization
- Run 2b Project:
  - General Overview
  - Overview of Individual Sub-Projects
  - Comments on Silicon, Trigger Development
- Outline of M&S Budget
- Discussion of Project Manpower
- Total Project Cost
- Observations
- Conclusions

Jon Kotcher

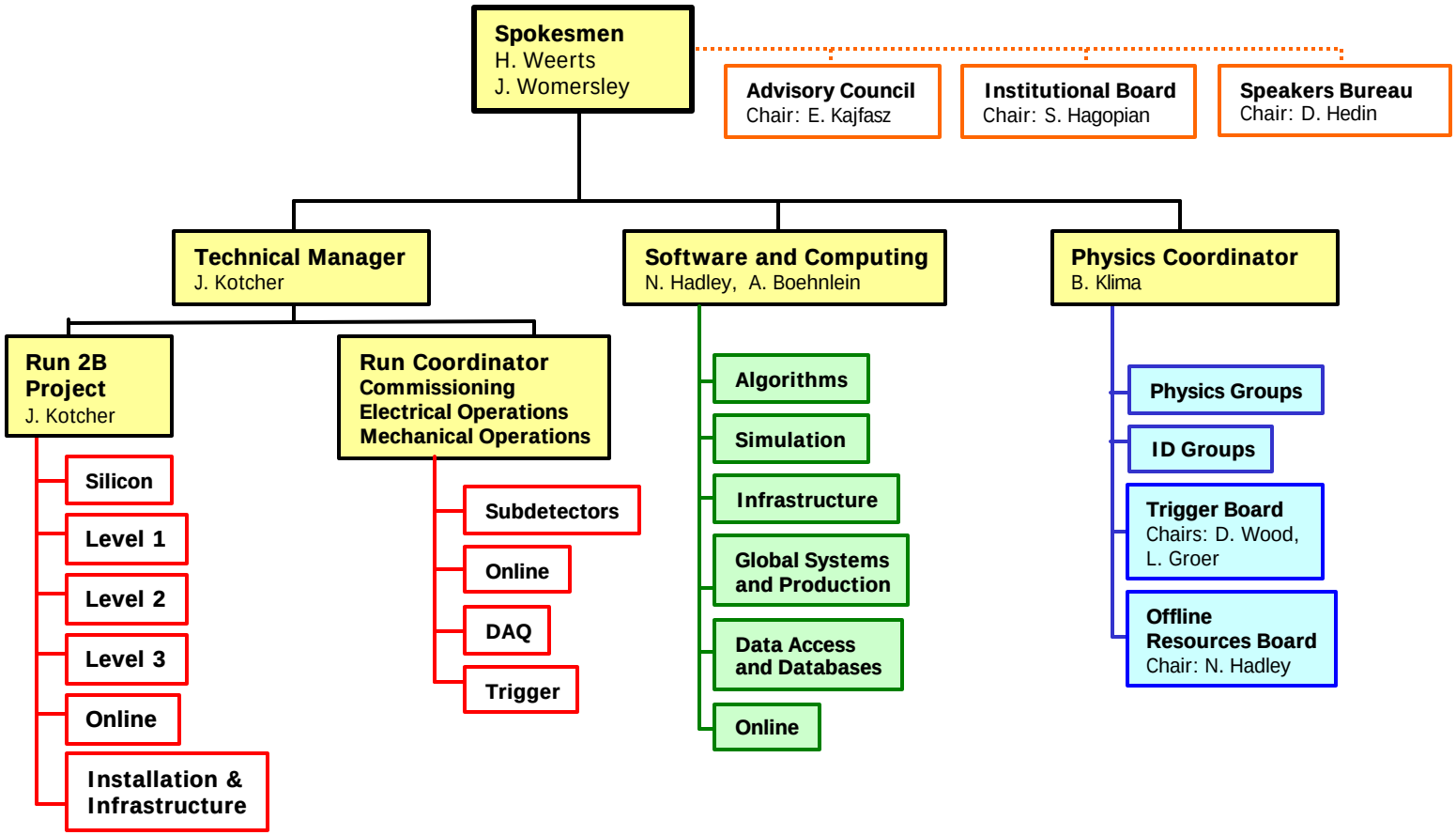
Director's Technical Review

December 3-5, 2001

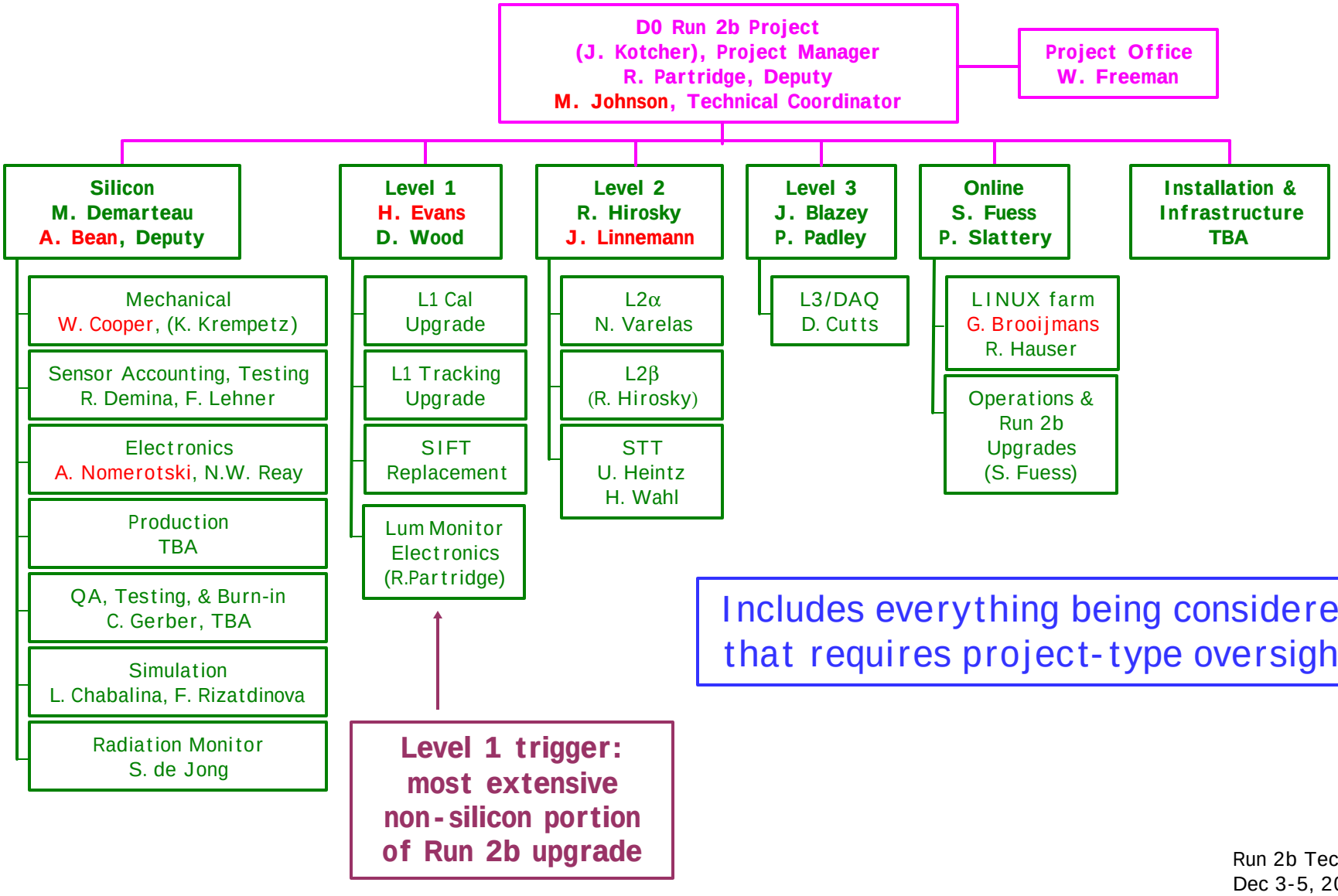
Total Project Cost

					0.10									0.31			
Sub-Project	M&S					Total	Labor								Total	TOTAL	TOTAL
	Cost(k$)	Cont(%)	Cont(k$)	Total(k$)	Ind	M&S	F	U	Cost(k$)	Cont(%)	Cont(k$)	Total(k$)	Ind		Labor	(FY02k$)	(ThenYk$)
Silicon	8,102	42	3,403	11,504	1,150	12,655	4,818	1,201	6,019	50	3,009	9,028	2,775		11,804	24,458	25,218
Level 1 Cal Trigger	726	50	363	1,089	109	1,198	56	621	676	50	338	1,014	312		1,326	2,523	2,603
Level 1 Cal Track Matching	97	50	49	146	15	160	30	62	92	50	46	139	43		181	341	352
Level 1 Track Trigger	359	50	180	539	54	592	5	125	130	50	65	195	60		255	847	871
Level 2 Silicon Track Trigger	402	48	193	595	59	654	13	129	141	50	71	212	65		277	931	958
Level 2 β Upgrade	72	37	27	99	10	109	0	19	19	50	10	29	9		37	146	150
SIFT Replacement	881	24	211	1,092	109	1,202	374	0	374	50	187	561	173		734	1,936	1,993
Level 2 β	443	35	155	598	60	657	0	152	152	50	76	228	70		298	955	982
Commercial DAQ	482	41	198	680	68	748	107	0	107	50	53	160	49		209	957	983
TOTAL PROJECT COST	11,563	41	4,777	16,340	1,634	17,974	5,402	2,309	7,711	50	3,855	11,566	3,555		15,121	33,095	34,111
FUNDING SOURCES																	
FNAL M&S Guidance						9,100	-	-	-	-	-	-	-		-	-	
NSF Silicon MRI						2,033	-	367	367	-	-	-	-		367	2,400	
FNAL Manpower						-	3,323	-	3,323	-	-	-	1,021		4,344	4,344	
Foreign Contributions (est.)						1,000	1,332	-	1,332	-	-	-	-		1,332	2,332	
DZero Computing Funds (est.)						1,000	-	-	-	-	-	-	-		-	1,000	
NSF Trigger MRI (proposed)						2,000	-	600	600	-	-	-	-		600	2,600	
TOTAL FUNDING						15,133	4,655	967	5,622	-	-		1,021		6,643	21,776	
UNIDENTIFIED FUNDING						(2,841)	(747)	(1,342)	(2,089)	-	-		(2,534)		(8,478)	(11,318)	

D0 Experiment Organization



Run 2b Project Organization



Run 2b Project Overview

- Upper tier of project management in place Jun '01
- All WBS Level 2 sub-project managers chosen (Sep '01)
  - Mix of past D0 project experience, fresh blood
  - Most silicon sub-task managers identified
    - Strong group, actively collaborating on new design
  - Most trigger sub-task management in place, Level 1 sub-tasks remain
    - Major outstanding portion of Run 2b that remains to be assigned
      - Much interest within collaboration to participate, US & foreign
      - Expressions of interest submitted
      - NSF MRI proposal in preparation
- Thoughts on how to approach 5E32, 15 fb^{-1} have greatly matured during past 6 months
  - Two components required to maintain physics capability through Run 2b:
    - Replacement of present silicon detector with more radiation-hard version
    - Trigger upgrades to control dead time, maintain event selectivity in high-rate environment
      - Level 1 trigger upgrade primary component
  - Described in two Design Reports provided
  - Fully outlines scope of upgrades for Run 2b

Sub-Project Overviews

- **Silicon (talks by W. Cooper, A. Nomerotski, A. Bean)**
  - Replace with more radiation-hard version, improve impact-parameter resolution (b-tagging)
- **Level 1 Trigger (talks by H. Evans, M. Johnson)**
  - Move rejection upstream in readout chain, contain dead time
  - Calorimeter clustering & digital filtering, cluster/track matching, enhance track trigger to respond to increased occupancies
  - Fiber tracker trigger (SIFT) chip replacement:
    - Required to address inefficiencies resulting from reduced charge collection time at 132 nsec
    - Project synched in time to 132 nsec changeover
- **Level 2 Trigger (talk by J. Linnemann)**
  - b-processors: enhance processing power relative to Level 2a system, guard against obsolescence in a system
  - Silicon Track Trigger (STT) upgrade to address increased occupancies at 5E32, map to extended silicon detector
  - Incremental addition requested for b-processor upgrade for 5E32 running

Sub-Project Overviews

- **Commercial DAQ (talk by G. Brooijmans)**
  - Baseline “custom” solution progressing, but beset by serious schedule, technical difficulties
  - Have been pursuing commercial alternative as backup, progressing well
  - Significant cost impact to implement commercial solution ($680k)
  - Decision made on how to proceed by end CY01
  - Request special attention by Committee to evaluate commercial alternative in advance of spending additional money, should we go commercial route
- **Online**
  - Address aging, obsolescence of computing hardware, need for higher bandwidth data logging, filtering capability
  - Assumed will come from operating, not included in M&S costs

Comments on Silicon Project

- **Silicon design quite mature, major features fully fleshed out**
  - Improved impact parameter resolution compared to Run 2a detector
  - Maintain good pattern recognition, stand-alone tracking
  - Simplicity, conservative approach:
    - Live within existing cable plant, reuse interface boards
    - Limit number of modules – 2 (axial+stereo) X 3 types (L2-5)
    - On-board electronics wherever possible (analog cables)
    - >15 fb^{-1} L0&1, >25 fb^{-1} outer layers
    - L0&1 mechanically distinct – staging if needed, future replacement?
- **Ready to begin spending on long lead-time & critical path items**
  - Cost, schedule gone through significant number of internal iterations
  - Resource loading carefully prepared
  - Assumptions quite conservative
  - Use Run 2a experience as basis wherever possible

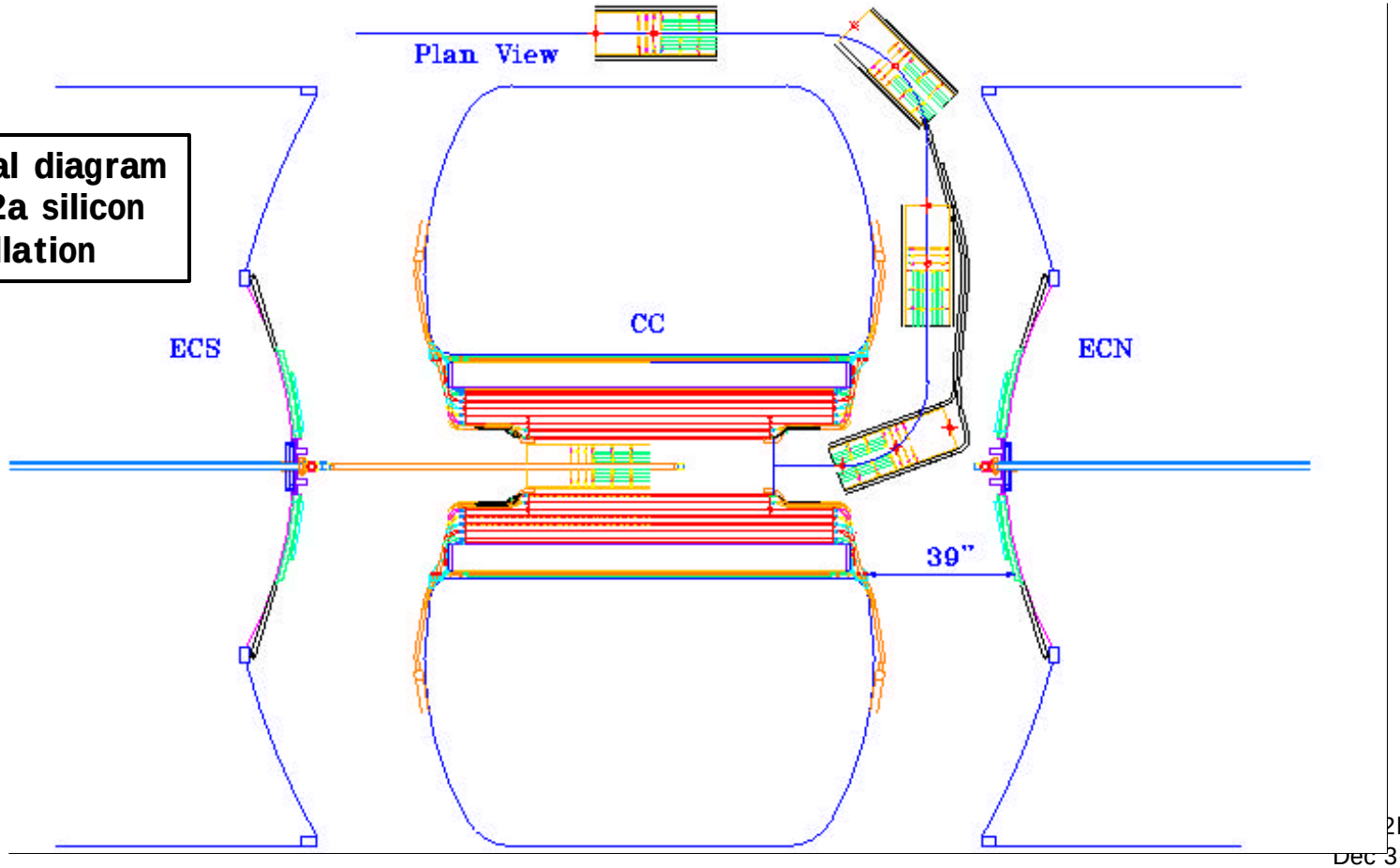
Run 2b Shutdown Constraints

Split-silicon design allows installation in Collision Hall

Platform not rolled out - much reduces time, effort, risk

Allows shutdown time to be dedicated to installation, hookup, commissioning

Conceptual diagram of Run 2a silicon installation



Run 2b Shutdown Constraints

(cont'd)

Silicon End Game

Dates obtained from silicon schedule

Activity	Date	Duration wrt previous task
Shutdown begins	May 19, 2004	-
Silicon ready to move to DAB	Aug 06	12 weeks
Silicon installed in Fiber Tracker	Aug 24	3 weeks
Silicon cabling, commissioning begins	Oct 11	7 weeks
Commissioning complete, ready to close	Dec 22	10 weeks
TOTAL SHUTDOWN DURATION		7 MONTHS

- Timing, duration of shutdown driven by silicon
- Ample time for installation of upgraded Level 1 trigger (2-3 months), but projects must be properly synched

Comments on Trigger Projects

- **Major steps taken to define Run 2b triggering needs:**
  - Run 2b Trigger Task Force
    - 29 members, first convened June 25, 2001
    - Charge: investigate triggering in higher-rate environment (5E32)
    - Provided basis for Run 2b Trigger Conceptual Design Report (CDR)
  - CDR covers all aspects of trigger needs, from present through Run 2b
  - Review of SIFT replacement project on Sep 25, '01
- **Comprehensive view of trigger has emerged**
  - Designs guided by simulations
    - Await in-situ guidance as accelerator approaches Run 2a design luminosities
  - Initial cost, resource loaded schedule in place
- **Like silicon, trigger upgrades being approached as conservatively as possible:**
  - Exploit existing designs, systems, experience
  - Effort to find alternatives to designs that require broad replacements of infrastructure
  - Carefully crafting sub-projects, assignments, & responsibilities
  - Modify course based on Run 2a results if necessary
- **Maintain high p_T program through 2007+ in most economic manner, define path that maximizes likelihood of successful completion**

Run 2b Trigger Task Force

- **Run 2b Trigger Task Force in place Mon, 6/25/01:**
  - **Co-Chairs: M. Hildreth (Notre Dame), R. Partridge (Brown U)**
- **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**

Trigger Task Force
(cont'd)

- **Task Force Charge:**
  - Develop plan for Run 2b trigger system that allows D0 to run at 132 nsec & lum 5E32 with output rates:
    - Level 1: 5 kHz
    - Level 2: 1 kHz
    - Level 3: 50 Hz
  - Installed in summer 2004
  - Reasonable cost, technical resources, development & production time, low impact on existing detector, infrastructure:
    - No tracker replacement, limited cable plant replacement, limit number additional crates in MCH, …
- **Conceptual Design Proposal submitted to Run 2b Project Mgr by Sep 17, 2001**
  - Given tight time constraints (3 months):
    - Focus on high-pT physics program, Higgs search
    - Estimate rates, rejection for various options (simulation)
      - Level 1 calorimeter, track match, singlets/doublets, CFT stereo,…
    - Focus on Level 1
      - Feasibility arguments for Levels 2,3 may be sufficient

Review of SIFT Replacement

- Fiber Tracker Trigger Chip (SIFT) must be replaced for 132 nsec running
  - Required 50-70 nsec charge collection times result in inefficiencies with current chip at 132 nsec
  - Costly project, some technical challenges
- Review of design, implementation: September 25, 2001
- Committee consisted of 2 D0 physicists, 3 non-D0 engineers:
  - M. Bowden, V. Buescher, M. Larwill, R. Lipton (chair), V. Pavlicek
- Findings:
  - Endorse overall design
    - With caveat that many details remain
  - Performance should equal that of present chip at 396 nsec
  - Recommend option that includes AFE board replacement
  - Schedule reasonable if accelerator changeover to 132 nsec occurs during Run 2b shutdown
    - Schedule includes dual chip submission
  - Tight if changeover occurs earlier than mid-CY04

Run 2b M&S Project Cost

Prior to 5E32 running

Sub-Project	M&S ($k)	Contingency (%)	Total ($k)	Fiscal Year Needed	Comments
*SIFT replacement	881	24	1,095	FY02-04	Needed for 132 nsec; includes two full ASIC submissions
Level 2b	443	35	596	FY02	$323k (of $596) is estimate of remaining project cost ($273k identified)
Commercial DAQ system	482	41	680	FY02	If needed; decision by end CY01
TOTAL M&S	$1,806k	31	$2,371k (incl DAQ option)		

Manpower included in Level 2b only (engineering only)
Assumes 132 nsec changeover in mid-CY04, drives SIFT replacement
*Denotes significant change since CDR

Run 2b Project Cost

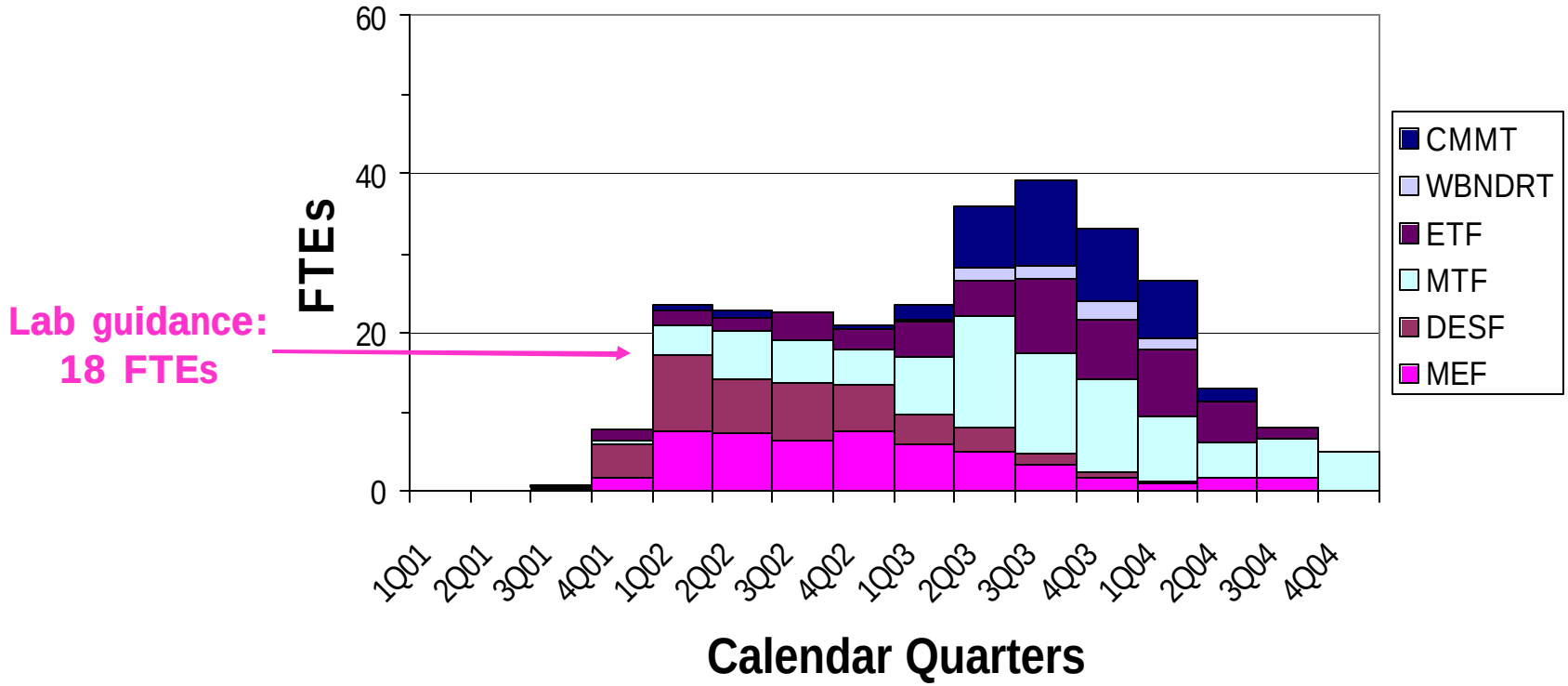
Preparation for 5E32 running

Sub-Project	M&S ($k)	Contingency (%)	Total ($k)	Fiscal Year Needed	Comments
Silicon	8,101	42	11,499	FY02-04 ($4,328k in FY02)	FY02: sensors, electronics, mechanical D0 NSF MRI: $(1.7+0.7)M
*Level 1 Calorimeter Trigger	726	50	1,089	FY03-04	Excludes $100k R&D in FY02
*Level 1 Cal/Track Matching	97	50	146	FY02-03	Utilize existing Run 2a Muon Trigger Cards
Level 1 Track Trigger	359	50	539	FY03-04	Fiber singlets; use DFE layout
Level 2 Silicon Track Trigger	402	48	593	FY02-04	Manpower included; exploit FY02 Run 2a STT production
Level 2b Upgrade	72	37	98	FY03-04	New processors
Online	950	17	1,116	FY02-06	Assumed from operating; not included in TOTALS below
TOTAL M&S	$9,757k	43	$13,964k		Preparation for 5E32 running
GRAND TOTAL M&S	$11,563k	39	$16,335k		All upgrades
FY02 request (est. - excludes most manpower, G&A)	$4,328k - silicon, includes R&D, $1,100k FY02 MRI funds not included $1,725k – trigger, includes online **Lab guidance: $2,500k equipment**				

Selected FNAL Technical Manpower for Silicon Project

Comparison of silicon technical FNAL manpower needs for those manpower categories for which Laboratory guidance has been received

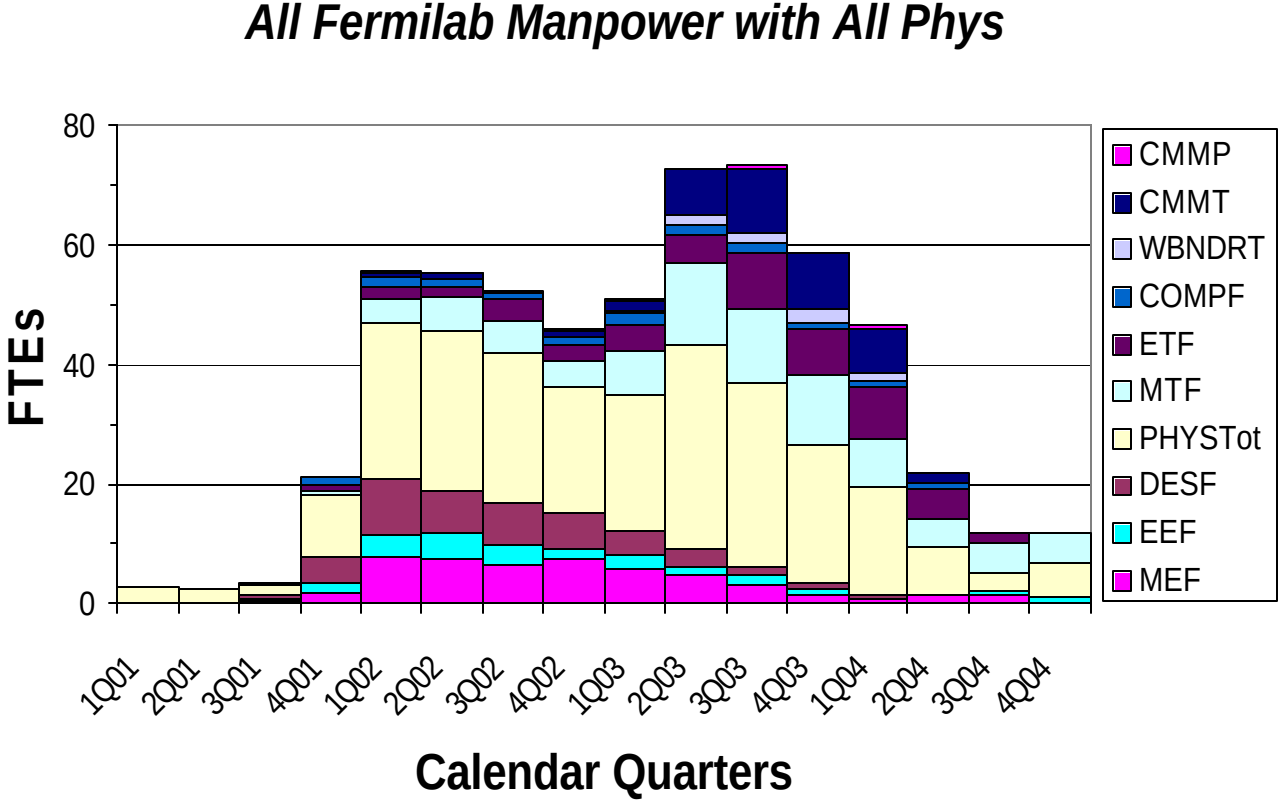
Selected Fermilab Technical Manpower



Total FNAL Technical Manpower for Silicon Project

All Fermilab technical manpower, plus all physicists (FNAL + Universities)

FNAL Resources	Person-yrs
CMM Prog	0.6
CMM Tech	10.2
Computing Prof.	3.9
Designer/Drafter	11.0
Electrical Engineer	5.7
Electrical Tech	13.1
Mechanical Engineer	12.6
Mechanical Tech	22.0
Wire Bonder	1.8
Total	80.9
Physicist (FNAL)	28.2
Physicist (Other)	37.6



FNAL Technical Manpower for Silicon, Lab Guidance

Silicon technical FNAL manpower needs vs. Lab guidance, by manpower type

Manpower Type	Total person-yrs needed (from schedule)	Total person-yrs available (Lab guidance)	Difference (person-yrs)
Mechanical Engineers	12.6	9	-3.6
Designers/Drafters	11.0	6	-5.0
Mech & Elec Technicians	35.1	27	-8.1
CMM Technicians	10.2	9	-1.2
Wirebonder Technicians	1.8	3	+1.2
TOTALS	71	54	-16.7

- Laboratory guidance for categories other than those above not yet available (i.e., electrical engineers, etc.)
- Assumes 3 year project duration
- Contingency not included

Trigger Manpower Estimate

Estimated technical manpower needs from FNAL & universities for trigger projects, extracted from resource-loaded schedule

Project	EE needed (person-yrs)	Mech & El Techs needed (person-yrs)	Totals (person-yrs)
Level 1 Calorimeter	5.6	4.2	9.8
Level 1 Track Matching	0.8	0.6	1.4
Level 1 Track Trigger	1.3	0.5	1.8
Silicon Track Trigger	1.3	0.6	1.9
Level 2b	1.8	-	1.8
SIFT replacement	3.0	2.4	5.4
Commercial DAQ	0.9	-	0.9
TOTAL TRIGGER	14.7	8.3	23.0

- All Level 1 trigger manpower expected to come from foreign sources, NSF MRI
- Remaining trigger manpower expected to come from combination of FNAL and universities (some paid for through Run 2b project)
- Contingency not included
- Lab guidance for these projects not yet received

Observations

- Run 2b project unique with respect to past efforts
  - Fixed, externally-imposed end date
  - Schedule is primary (only?) variable of interest
  - Differs significantly from way we've done business in past
- D0 Run 2a silicon has been enormously successful
  - Strong group:
    - Significant expertise, silicon experience
    - Able sub-project leadership
    - Collaborating well, developing technically sound, practical device
  - Run 2a silicon a proven success through all phases to date:
    - Fabrication, installation, in-situ hookup & operations, beam data, reconstruction
  - Collaboration stepped up in Run 2a, will do so again
- Laboratory well-equipped for such an undertaking
  - Much silicon expertise
  - Deep technical staff, mechanical & electrical
  - Past experience indicates that helpful, active Laboratory support will be there once commitment is made

Observations

- Silicon schedule is aggressive, has little contingency
  - Probably have more time than we've planned for, but should not count on it
- Financial, other commitments must be made available now in order remain on track
  - Long ramp up would be costly, resulting delay difficult to recover from
  - Waiting for full baselining (1st quarter CY02) before spending is not tenable
  - Limited ability to use schedule as contingency in this project
- Despite all of our efforts, tremendous difficulty getting project to next stage
  - Financial bottom line must be solved (integral & profile) before approval to spend money will be granted
- **If it takes 6+ months to obtain approval to spend money, and/or the amounts are insufficient to keep Run 2b on track, opportunity unique to US program to significantly extend Higgs reach prior to LHC may disappear**

Observations

- **Bottom Line for FY02:**
  - **$4,328k - $1,100k D0 MRI = $3,228k to keep SMT on track in FY02**
    - **Full D0 MRI contribution (FY02-04): $1.7M + $0.7M matching**
    - **FY02 silicon funding request contains some allowance for time contingency**
  - **$1,725k to maintain momentum of Run 2b trigger upgrades**
  - **TOTAL FY02 REQUEST = $4,953k M&S (includes trigger contingency)**
  - **Lab guidance: $2,500k M&S**
- **Cannot keep pace on all fronts in FY02 within these constraints**
  - **At moment, silicon alone cannot be properly supported**
  - **Choices among non-silicon projects will also have to be made**
  - **Overall cost integral also a concern**
- **D0 commitment is there to make this work, but must get what we need**
  - **Only relevant if made available on time scales consistent with Run 2b goals**

Conclusions

- Run 2b upgrades will allow us to exploit unique discovery potential of Tevatron while opportunity is available
- Time window is tight, finite - but probably longer than we anticipate at this point
- Much headway made in defining, fleshing out D0 Run 2b projects during past 6 months.
  - All attempts made to limit scope; aimed for conservative, simple technical approaches
- Spending, commitment must begin now if this is to allow us to continue running unabated beyond ~ 2005
  - Ramp up must be timely
  - Resources must be made available
  - Projects need to be established on short time scales
- This is our first extensive technical review. We eagerly anticipate any advice Committee can provide on our project plan:
  - Scope, technical approach, cost, schedule, etc.