Closeout Report

on the

Department of Energy
Review Committee

on the

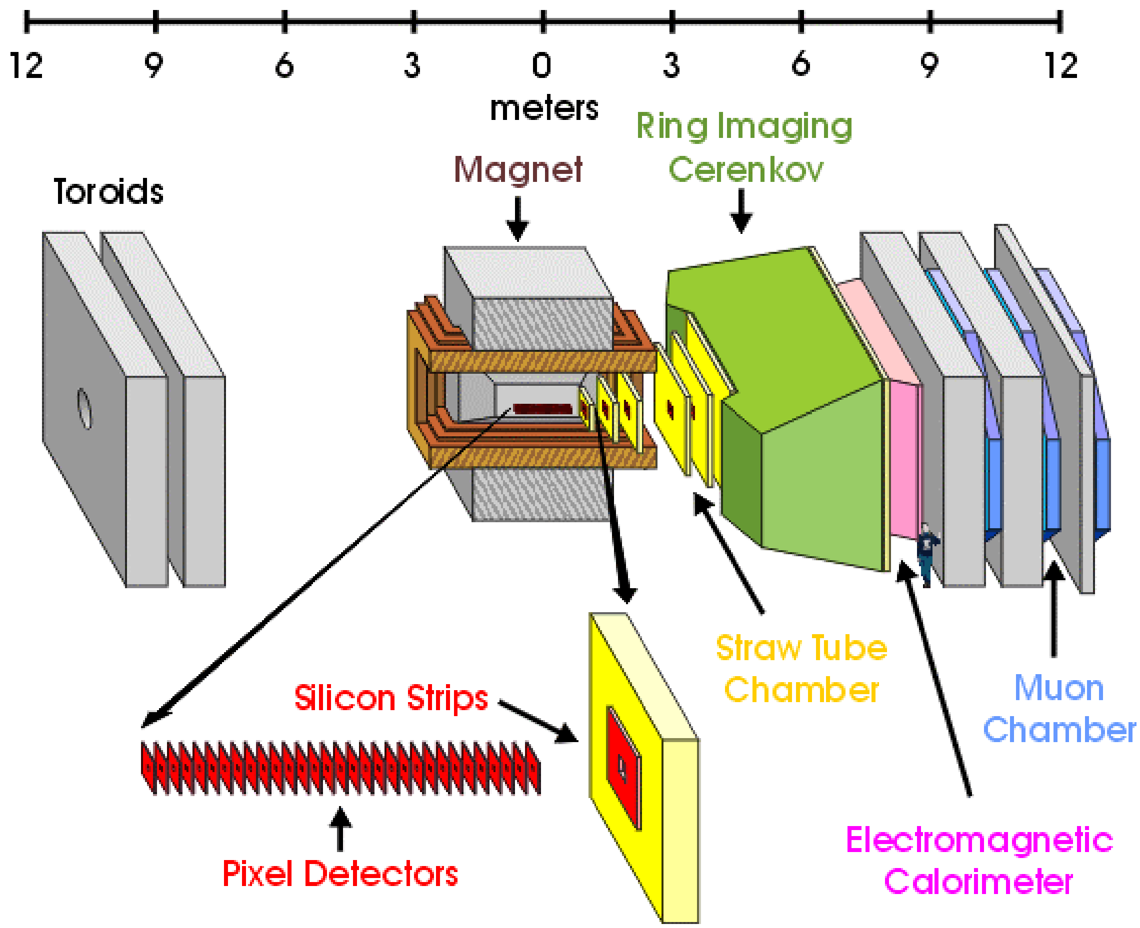
Technical, Cost, Schedule, and
Management Review

of the

B PHYSICS at the TEVATRON (BTeV) PROJECT

April 29, 2004

BTeV Detector Layout



Department of Energy Review of the B-Particle Physics at the Tevatron (BTeV) Project
April 27-29, 2004

Daniel R. Lehman, DOE, Chairperson

SC1 Interaction Region (WBS 2.0)

* Steve Gourlay, LBNL
Wolfram Fischer, BNL

SC2 C-Zero Outfitting (WBS 3.0)

* Bill Wisniewski, SLAC
David Ayres, ANL

SC3 Mechanical and Integration (WBS 1.1, 1.10)

* Dick Loveless, U. of Wisconsin
David Lissauer, BNL

SC4 Pixel and Strip Detectors (WBS 1.2, 1.7)

* Gil Gilchriese, LBNL
Claudio Campagnari, UCSB

SC5 RICH Detector (WBS 1.3)

* Nigel Lockyer, U. of Penn
Jerry Va'vra, SLAC

SC6 Electromagnetic Calorimeter (WBS 1.4)

* Peter Denes, LBNL
Ren-yuan Zhu, Caltech

SC7 Muon and Straw Detectors (WBS 1.5, 1.6)

* Vinnie Polychronakos, BNL
Seog Oh, Duke University

SC8 Trigger and DAQ (WBS 1.8, 1.9)

* Andy Lankford, UC Irvine
John Haggerty, BNL
Paul Padley, Rice University

SC9 Cost and Schedule

* Mark Reichanadter, SLAC
Steve Tkaczyk, DOE

SC10 Management

* Sam Aronson, BNL
Yousef Makdisi, BNL
Bernhard Mecking, TJNAF
Barry Miller, ORNL
Robert Paulos, U. of Wisconsin

Observers

Aesook Byon, SC-20
Mike Procario, SC-20
Ron Lutha, FAO
Jane Monhart, FAO
Joe Dehmer, NSF
Claudio Luci, INFN

LEGEND

SC Subcommittee
* Chairperson

Count: 25 (excluding observers)

DOE F 1325.8
(08-93)

United States Government **Department of Energy**

memorandum

DATE: March 9, 2004

REPLY TO
ATTN OF: SC-20

SUBJECT: Request to Conduct a CD-1 Review of the BTeV Project

TO: Mr. Daniel Lehman, Director, Construction Management Support Division, SC-81

I would like to request that you conduct a CD-1 Review for the B Physics at the Tevatron (BTeV) Project on April 27-29, 2004 at Fermi National Accelerator Laboratory. The purpose of this review is to validate the cost range and schedule, which are needed for Critical Decision 1 (Approval of Alternative Selection and Cost Range).

BTeV is an experiment proposed to be run at the Tevatron after the completion of Run II. It is a technically aggressive experiment that hopes to utilize recently developed technology to enhance its physics capability. It will have a competitor in the LHC-B experiment, so it is important that BTeV can meet its planned schedule. It will be built while Run II is operating, so the resources needed by BTeV must be compatible with those available while operating Run II. All of these points reinforce the need for a high quality technical, cost, schedule, and management review.

In performance of a general assessment of progress, current status, and the identification of potential issues, the committee should address the following specific items:

1. Technical Scope: Does the proposed design and associated implementation approach satisfy the performance requirements?
2. Cost Estimates: Is the cost estimate consistent with the plan to deliver the technical scope with the stated performance? Is the contingency adequate for the risk?
3. Schedule: Is the proposed schedule reasonable and appropriate in view of the technical tasks and proposed funding profiles? Has the critical path been identified?
4. Resources: Is the proposed resource allocation adequate to meet the project's goals without impacting the overall laboratory program?
5. Management: Is the proposed management structure adequate to deliver the proposed technical scope within specifications, budget, and schedule?
6. Risks and Mitigations Strategies: Have the risks for the cost, schedule and scope been identified? Are there adequate mitigations strategies for these risks?

Michael Procario is the program manager for the BTeV Project in this office and will serve as the Office of High Energy Physics (OHEP) contact person for the review.

We appreciate your assistance in this matter. As you know, these reviews play an important role in our program. I look forward to receiving your Committee's report.

You are asked to submit a formal report to OHEP within 60 days of the review.

/signed/

Robin Staffin
Associate Director
Office of High Energy Physics

Department of Energy Review of the
B-Particle Physics at the Tevatron (BteV) Project

REPORT OUTLINE/WRITING ASSIGNMENTS

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   - 2.12 CO Outfitting (WBS 3.0) .... Wisniewski/Subcommittee 2
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5. Management (WBS 4.0) .... Aronson/Subcommittee 10

<u>Appendices</u>

A. Charge to the Committee
B. Review Participants
C. Review Agenda
D. Cost Tables
E. Schedule Charts
F. Management Chart
G. Action Items

Section 2.1 WBS 1.1 Vertex Magnet, Toroid Magnet, and Beam Pipes

David Lissauer and Dick Loveless

- **Vertex Magnet - recovered from SM3 and reassembled with new pole piece**
- **Toroid Magnets - pair of 16' toroids at each end of BTeV**
- **Beam pipes - 1" and 2" BE Beam Pipes recovered from CDF and modified for BTeV**
- **Schedule - install during '06 and '07, looks OK**
- **Cost estimates seem reasonable**
- **No recommendations**

2.2 Pixel Detector (WBS 1.2)

- The proposed design satisfies the performance requirements.
- Technical status and work plan is excellent.
- Cost estimate is detailed with substantial backup.
  - BTeV estimated cost

    Base: $15.5 With Contingency: $21.6
  - Our estimate

    Base: $16.2 With Contingency: $23.0
- L3 management has done excellent job so far but will need strengthening as production phase begins.
- More personnel (particularly postdocs from FNAL and universities) needed to meet goals.
- Additional university groups would strengthen effort

2.2 Pixel Detector (WBS 1.2)

- Very low probability that critical milestones as proposed will be met. Too little float in proposed schedule at this stage of project.
- Technical status could allow faster ramp up to full production but
- Schedule is constrained substantially by limited funding profile.

2.2 Pixel Detector (WBS 1.2)

- Recommendations
  - Develop a more conservative schedule with significantly more float (≥ 6 months).
  - Evaluate options for relaxing the funding profile constraints to achieve a more conservative schedule.
  - Evaluate the schedule and performance impact of significant staging options eg. ½ of the pixel readout planes.

Section 2.3 WBS 1.3 RICH Findings and Comments

- Group is strong with much experience from CLEO RICH
- Detector design meets physics goals
- Details of design well thought out-good documentation
- Impressed with amount and quality of work done
- Working in visible wavelengths simplifies design and operation
  - Good understanding of photoelectrons, Cherenkov angle resolution and rates
  - Neutron backgrounds-preliminary detailed calculations done
  - Neutron backgrounds and design concept (MAPMT) similar to HeraB
  - BTeV working on bottoms up neutron shielding plan-conservative approach
- Committee agrees with details of cost and schedule presented
- Group size roughly what is needed based on CLEO experience
- Benefit from another group-not essential
- Management-all L3 positions have names identified-experienced

RICH Findings and Comments

- Risks: MAPMT vendor cannot produce
  - Backup HPD
  - performance cost none
  - 4-5 months delay
  - $1.2 M additional cost (handled by contingency)
- Mirror vendor cannot produce
  - Several options
  - One is classical thick glass
  - Performance cost is material in front of calorimeter-conversions x4 X0
  - Additional delay a few months- however it is cheaper
- Using a novel gas-C4F8O
  - If problems-backup is C3F8-chosen for refractive index
  - Slight performance costs-no delay-no additional cost

RICH Findings and Comments

- Aggressive test beam program addressing R&D issues and testing design components
- Well funded through MRI and NSF R&D grant
- Mechanical engineer has worked through installation

- Recommendations
  – Test detector prototypes in C0 ASAP to gain experience in a hadron collider
  – Measure neutron fluxes in various locations in C0

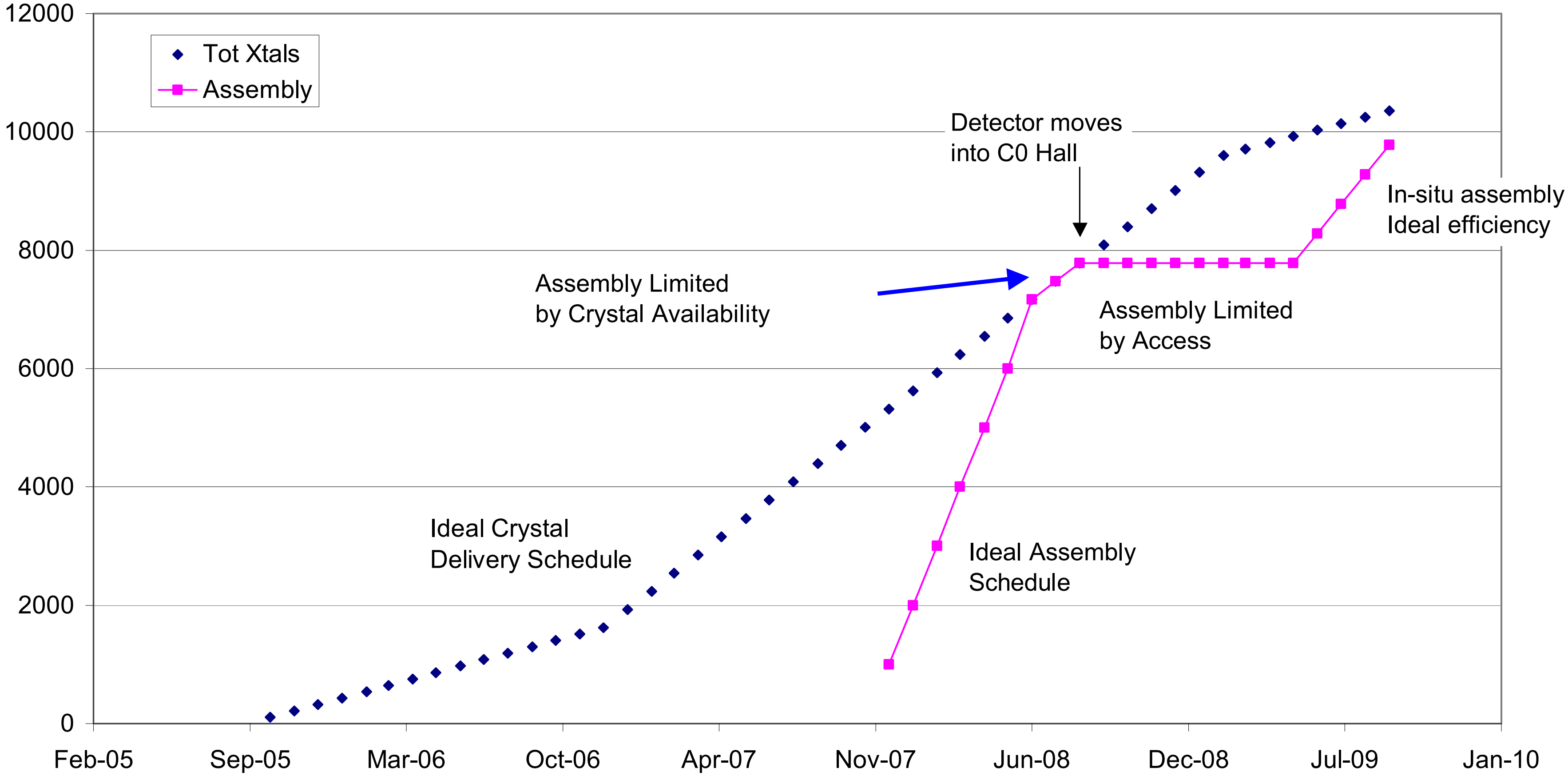
WBS 1.4 – Electromagnetic Calorimeter

- Technical Scope
  - $PbWO_4$ crystals – logical choice, leverage CMS experience
  - Safety margin: ultimate crystal performance not crucial in order to achieve BTeV's physics goals
    - Constant term less important for low-energy photons. Good stochastic term ensures high performance with respect to LHCb
    - Position resolution requirements are modest

Peter Denes
Ren-yuan Zhu

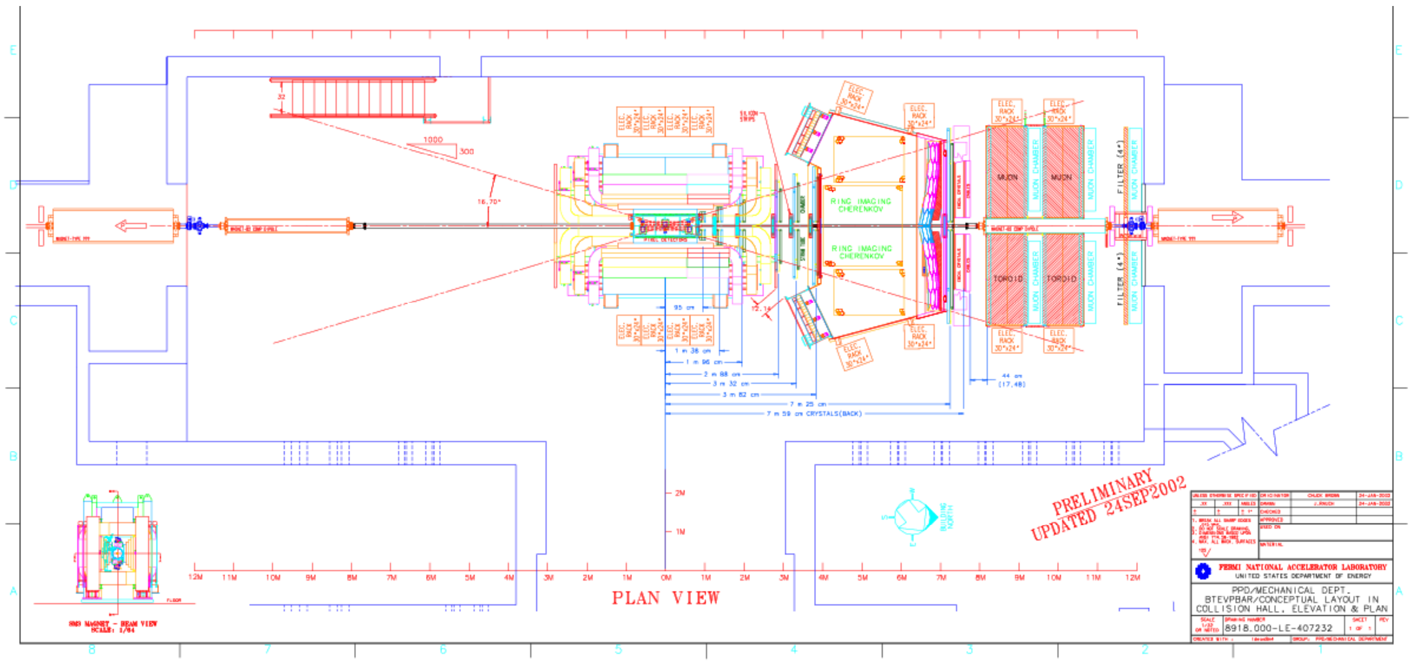
Schedule

Schedule is very tight



Options

- Forward-fund crystal procurement
- ***AND*** accelerate detector assembly
- ***OR*** modify installation sequence



Cost, Resources, Management

- Cost estimates look reasonable
- Labor was calculated as FTEs = Hours/1768 – which undercounts bodies. More people will be needed during the installation and commissioning crunch
  - Labor Cost/Total Cost ~ 1/6
  - 90% of identified labor cost is Fermilab EE for electronics
  - Rest of work done mostly by physicists and students
- Electronics=FNAL. Most other work currently done at IHEP, and UMN. Coordination between L2 manager and IHEP working well.

Risk

- Technical – OK
- Cost – possible labor underestimate and costs related to schedule
- Schedule – significant risk.
  - There are ways to mitigate the risk, must be coordinated with BTeV Management
  - Integration Engineer (who tracks and programs progress, coordinates ECAL I&I, and oversees assembly engineering) would be useful.

Recommendations

1. Explore ways to arrive at a schedule with comfortable float (≥6 months) by working with BTeV Management and Installation & Integration
2. Add an Installation Engineer to the project
3. Add US collaborators

WBS 1.5 Muon DetectorsTechnical Scope
Section 2.5, S. Oh, V. Polychronakos

Requirements:

- Spatial resolution: 2 mm
- The detector should operate with either 132 or 396 ns bunch crossing at better than 98% efficiency
- Be capable of rates of up to 200 kHz per tube
- Operational life time of 10 years.

The technical approach is appropriate, satisfies all the requirements with no technical risks that one could identify

Resources and Management

- The collaboration consists of a small but dedicated and experienced group of, currently, 15 members, mostly physicists
- Will eventually engage several graduate and undergraduate students
- Additional participation by a Pavia group possible.

- The Management is in place
- The committee believes that more technical help and the appointment of a project engineer are needed.
- The collaboration would benefit from additional groups.

Cost Estimate

- The cost of M&S: 2,929 k$ with 37% contingency.
- Labor cost 882 k$ with 27% contingency.
- There are several large procurements (greater than 100 k$), none of which requires any prior R&D and none from foreign sources

The M&S estimate is appropriate but the labor cost may increase if more technical help is added as mentioned in the previous slide. We also believe that the assigned contingency on the labor costs should be higher.

Schedule

- 1/3 of the wheels expected to be ready for installation during the 2007 shutdown.
- The rest during the 2008 shutdown or during short intervals that may be available during the following running period.
- This schedule was requested by the BTeV management in order to alleviate the expected congestion at the 2009 shutdown.

This schedule for early installation allows no float. Earlier funding that would allow pre production to start in FY2005 would mitigate the schedule risk. More flexible installation planning would add float to the schedule.

Risk Analysis

- ASDQ Procurement

  Worry of process obsolescence can be easily mitigated by timely procurement

- Time required to assemble planks

  Legitimate worry, will require pre-production to better judge construction time. Advancing pre-production would greatly mitigate this risk

Recommendations

- Investigate ways to secure funding to advance start of pre production to FY2005
- Consider appointing a project engineer to coordinate and oversee production.
- Actively seek more collaborators

2.6

BTeV Review

WBS 1.6 : Straw Tracker

V. Polychronakos

S. Oh

(2.6)WBS1.6 : Findings

- Technical scope
  - The design is mature and should work.
  - There are some urgent R&D tasks to be addressed to meet the production schedule.
- Cost ($9.825M)/Contingency (29%)
  - Cost is on the high side (wrt TRT) ->adequate
  - Contingency is adequate
- Resources/management
  - The straw collaboration/management is strong to carry out the construction. The project could use a project engineer (at least ~1/2) to coordinate the procurement, schedule and production facilities.

- Schedule
  - Mechanics: schedule is tight (45 float). Should (and can) move up the production start by ~six months to increase the float
  - Electronics: schedule is also tight (70 float). Should (and can) speed up the TDC design, and board production to increase float by ~six months.
- Funding profile
  - Should accelerate funds for R&D and production.

WBS1.6: Recommendations

1. Select the straw material, straw diameter and wire diameter within this year. Clear work plan should be provided.
2. Put additional effort on the aging test.
3. Produce more prototypes (preferentially in all production sites) and test. They should be built with production components and tooling as much as possible.
4. Move up the production schedule by ~six months
5. Strengthen the management with a project engineer

2.7 Silicon Strips (WBS 1.7): Comments and Findings

Scope

- Well defined
- Understood
- Approach matched to requirements
- Proven technology
- Expert group

Cost Estimate

- Credible. Based on:
  - past experience
  - vendor quotes
- Adequate Contingency

2.7 Silicon Strips (WBS 1.7): Comments and Findings

Schedule

- Credible
- Critical-Path identified
- Ends 6 mo. early
- Backloaded
- Could start earlier
  - Insurance
  - Constrained by $ profile

Resources

- **INFN involvement crucial**
  - No commitment yet
  - Project would be jeopardized without INFN personnel.
- US Physicist participation thin
  - No FNAL physicist
  - Expected to grow with time (students, postdocs)
  - Probably OK, but should be watched

2.7 Silicon Strips (WBS 1.7): Comments and Findings

Management

- Adequate
- Would like to see more full time physicists as L3 managers

Risk

- Chip
  - what if 0.25 μm process discontinued
  - Pay attention, multiple vendors

2.7 Silicon Strips (WBS 1.7) Recommendations

1. Reevaluate the contingency assigned to currency fluctuation for procurements from foreign companies.

2. Move the engineering costs from WBS item 1.7.6 (Project Management) to their appropriate places.

John Haggerty, BNL
Andy Lankford, UC Irvine
Paul Padley, Rice

WBS 1.8 Trigger & WBS 1.9 Data Acquisition Comments & Findings - p 1

Technical Scope

- **Well-matched to demanding performance requirements**
- **Challenging aspects addressed by extensive simulation and hardware R&D**

Cost

- **Base cost and contingency generally reasonable**
- **Aggressive (15%/yr) de-escalation of FPGA** (Field Programmable Gate Array**) costs used**

Schedule

- **Driven by funding profile**
- **Provides inadequate schedule contingency**

John Haggerty, BNL
Andy Lankford, UC Irvine
Paul Padley, Rice

WBS 1.8 Trigger & WBS 1.9 Data Acquisition Comments & Findings - p 2

Resources

- **Engineering allocation adequate**
- **Resources are backloaded**
- **Substantial physicist effort for software activities needs to be identified**

Management

- **Organization appropriate to task**
- **Tight coupling between WBS 1.8 & 1.9**
- **Tight coupling of L3 software and offline software needed**
- **Tight coupling of data acquisition and detector-specific front-end electronics needed**

Risks & Mitigation Strategies

- **Risks have been identified and are being investigated during development.**
- **Appropriate mitigation strategies have been identified.**

John Haggerty, BNL
Andy Lankford, UC Irvine
Paul Padley, Rice

WBS 1.8 Trigger & WBS 1.9 Data Acquisition Recommendations

1. **Develop a schedule which (a) completes critical design and validation activities as soon as possible and is ready for production six to nine months in advance of the production start date, and (b) completes production of the trigger and data acquisition systems six to nine months in advance of first collisions.**

2. **Reevaluate the basis of estimate of the FPGA costs to allow for uncertainty in the de-escalation profile.**

3. **Quickly identify and apply new individuals and groups to provide the physicist effort called for by the WBS.**

Section 2.10 WBS 1.10 Installation & Integration

David Lissauer and Disk Loveless

Findings (Technical scope)

- A large amount of work has been done and the major items seem to be well understood. We applaud the fine job that has been done by the present I&I group.
- Interface to subsystems needs to be better defined.
- Installation windows are very tight.
- Coherent integration design with 3D model can be very useful in defining and eliminating spatial conflicts
- Task forces set up to cover cables, racks, grounding, etc. have worked very well.

Findings (Cost Estimates):

- Cost for 1.10 is 6.9M$ with contingency of 3.4M$
- Installation risk seems high due to unforeseen problems and delays; increase to 75% contingency.
- Items over 100K$ investigated and seemed reasonable.

Findings (Schedule):

- Milestones mostly late in the project, define earlier milestones
- Present schedule unrealistic by ~6 months, incorporate bottom-up info from subsystems
- Alignment takes 1000 hours of real time, develop a more optimal adjustment design.

Findings (Resources):

- About 25 FTE in ‘08 and ‘09, seems reasonable.

Findings (Management):

- Boxology seems well-defined and complete
- Need to appoint a L2 physicist for I&I

Findings (Risks):

- Delays in subsystem installation
- Design changes within subsystems

Recommendations:

1) Develop schedule with adequate contingency using bottom-up info
2) Use engineering design to decrease the installation duration
3) Appoint level 2 physicist for installation and integration
4) Increase installation contingency to 75%

Section 2.11

C0 IR
WBS 2.0

S. Gourlay, LBNL
W. Fischer, BNL

Findings and Comments

- New IR with β^* of 35 cm and luminosity of 1E32
  - 10 new quads and spools
  - Constraints
    - Maintain option to run CDF and D0
    - Magnetic components outside hall
    - Reuse Tevatron infrastructure as much as possible
    - Install during 2009 shutdown

Base Cost
$26M

C0 IR
WBS 2.0

- IR design
  - Well-established, solid design but much more to do
  - Work on reducing experimental background has begun
  - Pixels are 6mm from beam

- Magnets
  - Quads
    - Based on LHC design
    - Insignificant mods to coldmass design
    - New support system and cryostat design
    - Production dovetails well with LHC construction project

C0 IR
WBS 2.0

- Magnets
  - Spools
    - New, complex components
      - Based on existing LHC experience
      - TD is well-qualified for the task
    - One spool vendor has been identified so far
    - HTS leads are required – configuration not yet established
    - Several options exist for correction elements **(critical path)**
  - Other tasks
    - Straight-forward application of existing expertise and resources

C0 IR
WBS 2.0

- General
  - Only a few loose-ends prior to CD-2
  - Experienced management
    - All areas covered
  - TD resources existing or requisitions signed for required manpower
  - Schedule is aggressive but plausible
    - However, vulnerable to delays in long-lead procurements
      - E.g. conductor RFP is ready and scheduled for release in October

C0 IR
WBS 2.0

- Recommendations
  - Increase AP manpower to work on beam dynamics during preliminary design phase
  - Study failure modes that could damage pixels
  - Determine effect of BTeV pixels on beam dynamics
  - Assess viability of hanging support system well before release of vacuum vessel RFP in Feb. 05
  - Resolve HTS lead issue before CD-2
  - Aggressively pursue choice of vendor for correction coils with emphasis on schedule
  - Review preliminary spool design prior to CD-2 if possible

2.12 C-0 Outfitting (WBS 3.0) D.Ayres, W.Wisniewski

Findings

The scope of C-0 Outfitting involves the architectural, structural, mechanical and electrical finish-out work for the BTeV detector in the existing C-0 Building. The scope also includes modification to the Main Ring C-0 Service Building and primary power for the Interaction Region.

For the C-0 building, the architectural and structural work includes two mezzanine floors, stairs, elevator, partitions, raised computer floors and toilets. HVAC systems for the collision and assembly halls, the chilled water system, high-density computer room cooling and fire protection systems are included in the mechanical finish-out task. Electrical work includes providing primary power and three distribution subsystems for power supplies, quiet electronics and house power, along with a 250 KVA generator. Support for the IR Hall includes primary power and three transformers, 480 V secondary power including panel boards, as well as several other minor tasks. In addition, a 13.8KV feeder will be run from the Kautz Road Substation to the C-0 Building.

This work is divided into four tasks: C-0 Outfitting Phase 1, Phase 2, C Sector HV and Pre-procurement Items. Phase 1 (WBS 3.1) covers work to allow beneficial occupancy of the Assembly Hall for magnet construction, and install the mezzanine and partitions, stairs, elevator, toilets, fire protection and power. It is intended to start immediately on project approval. Beneficial occupancy is expected in January 2006. The cost of this task, including 20% contingency, is $2.69M. Phase 2 covers HVAC, chilled water, raised computer floors, high-density computer cooling, and the balance of power. Design for this phase starts in mid FY 06; construction is completed in late FY07. The cost of Phase 2 is $2.80M, including 22% contingency. The C Sector HV Task covers installation of the IR feeder as well as the new feeder from the substation. Work commences in early FY06 and finishes in early FY07. The cost for this task with 20% contingency is $.93M. Pre-procurement items cost $.80M with 20% contingency included. The total cost is estimated to be $7.21M.

Comments

The C-0 Outfitting Team is to be commended for their good progress since they began work in October 2003.

The requirements for C-0 Outfitting were determined by the needs of the detector subsystems and the Interaction Region (WBS 2.0) task. These requirements and their updates are passed to C-0 Outfitting (WBS 3.0) via the Integration Group (WBS 1.10). The proposed outfitting design satisfies these requirements. These requirements, often generated by task forces (e.g., heat load), are reviewed by the BTeV Technical Board and are documented on the BTeV web page. The Outfitting management follows the progress of the experiment design via regular attendance at bi-weekly collaboration meetings. The outfitting team is to be commended for its intense involvement in the activities of the experiment, which will smooth the way to success. However, the Committee feels that the boundaries between Outfitting and the other systems, Integration and Interaction Region, should be more crisply defined. The implementation of C-0 Outfitting tasks involves standard industrial construction techniques.

Cost estimates are based on conceptual engineering designs that satisfy WBS 3.0 technical requirements. Cost estimates appear to be quite conservative and are backed up by detailed Basis of Estimate documentation. These BOEs are based on vendor quotes, recent experience, engineering estimates and estimating practices and schedules that are also used by contractors. There are three large (~$1M or greater) contracts and two large (>$100K) equipment purchases. Outfitting management should clean up unused WBS elements before baseline review. The contingency methodology follows DOE guidelines and is based on past experience.

The major risk factor for C-0 Outfitting is the possibility of an economic revival of the local construction industry, which could lead to higher contract bid prices. A second risk factor is the possibility of changes in technical requirements of other BTeV tasks as their engineering designs near completion. Both of these risks are adequately covered by contingency allowances. However, the committee feels that the contingency for WBS 3.2 should be increased to 26% to cover risk associated with High Density Computer Cooling.

The proposed schedule is conservative and satisfies the requirements of the BTeV experiment. The outfitting schedule is integrated with the Tevatron operation and shutdown schedule. The most demanding schedule constraint is the requirement to complete Phase 1 construction (WBS 3.1) by January 2006, when Vertex Magnet construction work begins in the Assembly Hall. This should be easily achievable with the planned funding profile if funding is made available at the beginning of FY 2005. The critical path for BTeV construction includes WBS 3.1. Completion of this task may be sped up by judiciously running some activities in parallel, at the expense of some cost increase. Potential delays associated with letting contracts near project start are a concern: the team must exercise care in prepping this procurement. The other WBS 3.0 task schedules appear to have generous float when referenced to the time that they are required.

Fermilab resources required by WBS 3.0 tasks are minimal: all construction tasks are performed by outside contractors. This task makes limited use of FESS engineering manpower (maximum of 3.5 FTE-year in FY 2007). This does not appear to be in conflict with other laboratory activities.

The management structure of WBS 3.0 is spare but this is completely appropriate given the conventional nature of the construction tasks covered.

Recommendations

1. Define and document boundaries and interfaces with both Integration (1.10) and Interaction Region (2.0) in time for the CD-2 review.

2. Involve key procurement personnel and approving officials in advance to allow for rapid placement of the large Phase I procurement at project approval (CD-2).

3.0 COST ESTIMATE

Findings:

The cost estimate for the BTeV Project was developed using a comprehensive task oriented Work Breakdown Structure (WBS) which is summarized below:

WBS 1.0 – BTeV Detector, Trigger, Data Acquisition
WBS 2.0 – Interaction Region (IR)
WBS 3.0 – C0 Outfitting
WBS 4.0 – Project Office/Project Management

In WBS 1.0, the detector has been designed by a large group, starting with a simulation effort in 1996 and then a substantial R&D effort beginning in 1998. It has a nearly complete technical baseline. The lab has recently decided to implement a "custom IR", in WBS 2.0, which is based on new magnets, rather than reused components from existing installations. This part of the project requires design of a new low-β insertion and the construction and installation of the components. It has progressed rapidly and is past the conceptual design level. The C0 Collision Hall and Assembly Area was built in 1999-2000, but was not outfitted to support a large experiment. The work in WBS 3.0 will complete the counting rooms, provide power and cooling required for BTeV and the IR, etc. It is past the conceptual design level and is ready for detailed engineering. A more detailed WBS can be found in Appendix ___.

A Summary of the BTev Project costs presented at the review is as follows
Note: Costs are in thousands of FY05 dollars unless noted as Actual Year (ay) :

WBS Item	To Go Cost	Contingency		Total
		$	%	
1.0 BTeV Detector	$93,462	$34,294	37%	$127,756
2.0 C0 Interaction Region	$25,940	$10,119	39%	$36,059
3.0 C0 Outfitting	$5,981	$1,232	21%	$7,213
4.0 BTeV Project Office	5,255	1,221	23%	6,476
Total Estimated Cost (FY05)	$130,638	$46,874	36%	$177,504
Total Estimated Cost (AY)	*$139,517*	*$50,202*	*36%*	*$189,719*
Other Project Costs(FY05)	$6,385	$2,436	38%	$8,821
Total Project Cost (FY05)	$137,023	$49,310	36%	$186,333
Total Project Cost (AY)	*$146,223*	*$52,737*	*36%*	*$198,960*

The above Other Project Costs excludes spares which could add approximately $10 Million to the Total Project Costs.

The draft Project Execution Plan indicates a Total Estimated Cost range of $190 to $230 Million and a Total Project Cost range of $210 to $243 Million for the BTeV project. This project is currently seeking DOE approval for Critical Decision 1 – Approve Preliminary Baseline Range.

The cost estimate begins in FY05 when BTeV becomes a construction project, therefore the base costs are in FY 05 dollars. Quotations and other pricing which was derived in earlier years was adjusted to the FY05 base year. The estimate includes appropriate labor rates, fringes, etc. for all institutions including Fermilab with the respective overhead rates. Material costs include various burdening rates depending on the nature and size of the procurements. Open Plan is the software tool used to develop the project cost estimate.

The project developed a bottoms-up contingency based on maturity of design using a consistent methodology for Materials & Services (M&S) and labor. It resulted in a contingency of about 36%. The BTeV detector and C0 IR are new but many pieces have been or are being built elsewhere, allowing some parts to require relatively low contingency. In many cases, the project is dealing with known vendors and has obtained solid quotes. Some of the scope has been stable for several years. There are some parts that use new or unproven technologies and those do have much higher contingencies. A detailed breakdown of contingency by WBS can be found in Appendix ___.

Comments:

The Cost Estimate is unusually complete for this stage in the project. The cost and schedule subcommittee looked at the methodologies used to develop and document the cost estimate and was very impressed with the depth and completeness of the information. A few examples were chosen and reviewed down to the lowest levels. The details were well documented and wage rates, indirect factors, escalation, etc. were all appropriately applied.

The technical subcommittees reviewed their respective sections of the cost estimates and found areas where additional costs could be added to the project, in the range of $4-5 Million, as discussed earlier in this report and in Appendix ___.

The committee concluded that at this time the BTeV cost estimate is within the range of costs provided in the draft Project Execution Plan and that this range could be used as a basis for requesting Critical Decision 1, if supported by an appropriate funding profile.

Recommendations:

1. Consider the suggested cost estimate adjustments discussed in this report.
2.Use a Total Project Cost range on the order of $210-243 for requesting CD-1 approval.

4.0 SCHEDULE & FUNDING

Findings

The integrated resource-loaded cost/schedule estimate for BTeV Project consists of ~18,000 schedule activities, with an estimated Total Project Cost (TPC) of $199.0M Actual-Year dollars and is consistent with Milestone L 1-8 "Detector complete and Ready For Commissioning With Beam" in October 2009. The proposed DOE CD-4 milestone, 'Approve Start of Operations' is scheduled for 3rd Quarter of 2010.

The BTeV management team presented high-level critical path analyses for most of the BTeV Systems and prepared estimates on available float to the commissioning date of October 2009. The BTeV critical path to the October 2009 date currently has 30 days of float.

Only the final implementation of the BTeV detector during the FY09 shutdown will extend beyond the normal annual Tevatron maintenance shutdowns. However, adequate access to the Tevatron during scheduled shutdowns is crucial to the BTeV detector integration.

Sources of forward-funding outside the DOE's Office of Science are being sought, namely $7.5M from Syracuse University, however, to date no source can be considered firm. The BTeV management team is actively seeking other additional funding sources outside of the DOE.

Comments

Schedule performance against a baseline plan will be key to the success of the BTeV Project. However, thirty days of explicit float to the "Detector complete and Ready For Commissioning With Beam" milestone is not adequate for a project at this early phase. The committee finds the BTeV proposed work plan not achievable with the proposed funding and resources profile.

The BTeV schedule is funding profile-limited. Cumulative planned work in FY05 will nearly saturate available funding, and assuming this work is fully committed, will leave no available funding contingency for solving problems or maintaining schedule. Most procurements in FY05 are identified as long-lead procurements necessary to stay to the current schedule, which are; superconducting wire, high-temperature power leads, QIE chip and ASDQ chip (Maxim Process).

In addition, the late arrival of funds in the project profile is likely to drive BTeV to have even greater schedule risk, which is seen as particularly acute in the areas of pixels, muons and crystals.

Other areas of concern not fully addressed in the BTeV schedule are the time and effort necessary to commission the Interaction Region and offline computing.

Management may wish to consider the following;

a. 'work-around' strategies to address the system schedule risks and add flexibility to the overall BTeV schedule.
b. Additional in-kind contributions or new funding sources
c. Assign integration staff to expedite
d. Look at descope and staging scenarios
e. Evaluate and optimize each of the critical BTeV subsystems to 'value engineer' scope to recover schedule.

Table 4-1. BTeV DOE Proposed Funding Estimate (Escalated M$)

	FY05	FY06	FY07	FY08	FY09	Total
DOE Funding	13.10	41.20	51.20	51.70	44.90	202.10
Univ Forward Funding	7.50	0.00	0.00	0.00	-7.50	0.00
Total Available Funding	20.60	41.20	51.20	51.70	37.40	202.10

Recommendations

1. Reevaluate each of the BTeV system schedules and master schedule to provide realistic float and review with the DOE sponsors as soon as possible.

WBS 4.0 Management

Findings and Comments

- Project Management is to be commended for rapidly "Projectizing" the BTeV effort.
  - Many experienced and highly capable individuals have been brought together at all management levels; modern management tools have been acquired (or created) and put to use throughout the project. Buy-in by all management levels is evident.
- We found the scope of Project Management (including the management at the Subsystem level) to be appropriate to the needs of the BTeV Project.
- Some important vacancies remain in the Project Office and at the Subsystem level. In the Project office we identify the following needs:
  a. Budget Officer (also identified by Project Management; to be hired)
  b. Integration physicist (also identified by Project management; TBD)
  c. System engineer
  d. Quality management officer
  e. Procurement liaison/expediter

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WBS 4.0 Management

- The key challenge for BTeV Project Management is to define a project scope, cost and schedule that satisfy the funding constraints and the schedule guidance
- They have scoped the project in a way which can be expected to deliver the desired scientific product within the specified cost range of $210 – 243M.
  - The quality of the cost and contingency estimates was found to exceed our expectations in many areas for a project at this stage of maturity
- However, the Committee feels that Project Management has not yet been able to develop a plan consistent with profile and schedule guidance
  - Based on the plan presented, it appears that adding 6-12 months to the "Detector Complete and Ready for Commissioning with Beam" milestone (October 2009) would result in an aggressive but achievable schedule

Summary

- The Committee supports the proposed technical scope and the cost range presented

<u>Recommendation</u>

- Develop a schedule and funding profile for BTeV, such that the desired scientific capabilities are obtained while ensuring that the scientific output is competitive and timely. Provide revised plans to DOE as soon as possible, to support the CD-1 decision process