Cost & Scheduling of Magnet Fabrication

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Outline

- Status
- Working Schedule and Plan
  - Quadrupoles
  - Spools
  - Infrastructure
  - Decision Points / Deadlines used
- Cost
  - Guidelines / Status
  - Summary
- Next Steps

Status

- **Since the last review we have focused on developing the technical design (the CDR)**
  - **We now have a reasonably complete component list**
  - **The R&D / decision list is not complete**
- **We have started the schedule and estimating exercise**
  - **The first iteration is just completed, and will be presented**
  - **FY05$, no G&A, no contingency**
  - **It is not scrubbed**
  - **It is not in final form**
  - **It is not in OpenPlan**
  - **It is not my August 2001 WAG (☺)**
- **We follow the BTeV guidelines for rates, hours, etc**
- **We estimate everything, but**
  - **The plan isn't final**
  - **Project / Division horse trading may not be complete**
  - **Handling of spares unknown (to me)**

Working Schedule and Plan

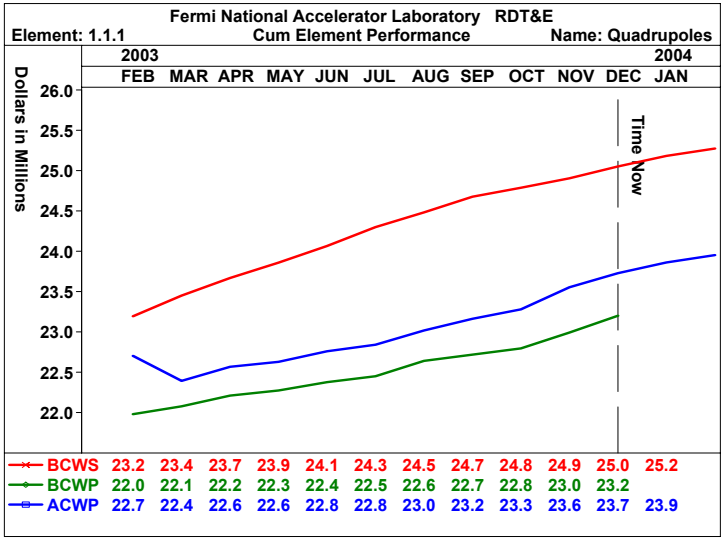
- **We are putting together a plan consistent with the Project needs**
  - **Summer 2009 installation**
  - **The correct number of components**
  - **Directed R&D program**
  - **Infrastructure upgrades**
  - **Fully tested and qualified components ready for installation**
- **There are several technical unknowns**
  - **HTS leads**
  - **Correctors**
  - **Spool Assembly**
  - **Detail Integration**
- **There are several cost / procurement uncertainties**
  - **HTS Leads**
  - **Correctors**
  - **Spool Assembly**

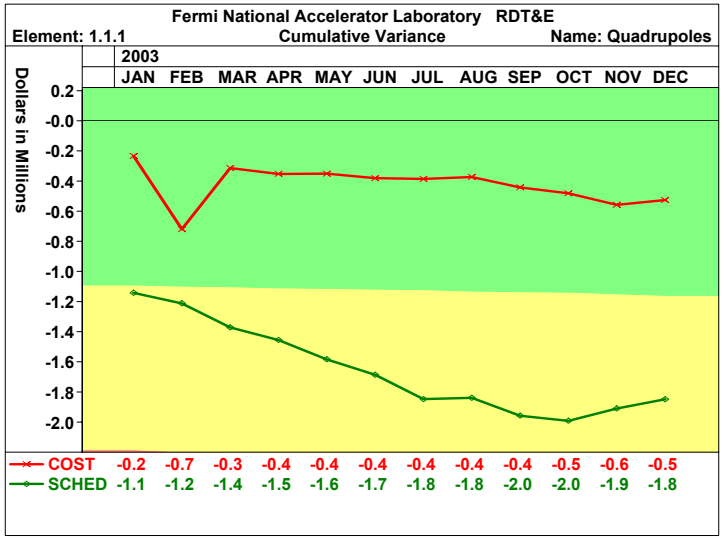
Working Schedule and Plan

- **Production plan developed working backwards and including some schedule float before installation…**
  - **Quadrupole coil winding to start in June 2006 (FNAL)**
  - **New Test Stand Procurement July 2005 (FNAL)**
  - **Spool Assembly starts in May 2007 (Industry, test FNAL)**
  - **Corrector magnet production starts in April 2006 (Industry, test FNAL?)**
  - **HTS Lead production starts in October 2005 (Industry, test FNAL)**
- **This leaves ~18 months for R&D as needed**
  - **Interfaces for the test stand are crucial—detail integration**
  - **Corrector design and vendors**
  - **Spool design and vendors**
  - **HTS lead design & vendors**
- **The following slides take a snap shot of each portion of the program, identifying the status of the estimate, the basis, and the open technical questions we have to drive through to get to a baseline**

Quadrupoles

- Technical, Schedule and Cost are well understood
- Major design issues dealt with in LHC program…the collared coil is nearly (or is) identical.
- LHC program serves as BOE, and source for lessons learned
- 2 major procurements recently investigated
  - SC Cable, 0.8-1.2M$
  - Collar steel, 0.2M$
- Remainder scaled based on LHC production experience
- Labor from LHC production experience





Quadrupoles

Cold Mass

- Direct derivative from LHC
- Parts estimated using outline of LHC…complete parts list
  - End domes, beam tubes moved from cryostat to cold mass for BTeV
  - Strand and collar steel from recent vendor communication
  - LHC specs used throughout
- Tooling modifications for length and OD of cold mass; no major procurements
  - Winding / Curing tooling mandrels
  - Winding tooling reprogramming
  - Coil lifting fixtures
  - Yoke / Skin press contact tooling
- Design EDIA – 630k$
- Parts – 2,506k$ (SC cable and collar steel in Oct 2005)

Quadrupoles

Cryostat

- Based on, but not direct derivative of LHC
- Parts estimated using updated outline of LHC
  - End domes, beam tubes moved from cryostat to cold mass
  - External heat exchanger, TAS, interconnect pipe extensions excluded
  - No scaling for diameter
- Minor tooling needs
- Multiple design interfaces to be finalized
- Design EDIA – 874k$
- Parts – 907k$ (2/3 in FY05; 1/3 in FY06)

Quadrupoles

MTF Test Stand

- Dedicated Tevatron / BTeV Stand
  - Adapters allow testing of different quads and spools
  - 10kA leads
  - 4.5K operation
- Parts estimated using LHC experience
  - Stand design updated for BTeV requirements
  - Design and commissioning time included
  - Conventional Power leads
  - Modest instrumentation
- Needed for 1st quad test—can drive schedule
- Design / Commissioning Labor – 503k$
- Parts – 310k$ (2nd half FY05)

Quadrupoles

Q1 – Q5 Production

- Direct derivative from LHC
- Touch hours, oversight based on LHC experience
  - LHC Touch hours tracking well
  - Assume for BTeV we will re-do the learning curve
- Touch Labor – 1,286k$
- Production Oversight – 1,045k$

Production Hours per Q1 - Q5 Unit		
	LHC Baseline	C0 IR Estimate
Coils	1186	1000
Coil Ass'y	384	384
Final Ass'y / Cryostat	936	812

Quadrupoles

Q1 – Q5 Test

- **Derivative from LHC**
  - **Smaller cold mass**
  - **4.5K operating temperature**
  - **Test stand occupancy estimated to be 1 month—1/2 that of LHC**
  - **Approx 10 cold days (total)**
    - Duration checked to SSC experience
  - **Effort levels updated for current LHC experience**
- **Test Labor – 671k$**
- **Cryogens – 75k$**

Spools

The Plan

- HTS Leads, Corrector Magnets, and Spool Assemblies will be procured in industry
- Design, as needed, will be done at Fermilab
- Testing of HTS leads and Correctors will be done prior to delivery of said items to the final assembly vendor (and prior to the HTS and corrector vendors getting paid)
- Cold Testing of HTS leads and Spool Assemblies will be done at Fermilab

Spools

HTS Leads

- 6kA Tevatron ready (LN2 intercept) HTS leads exist
  - Development program w/ US vendors some years back
  - Several 'H' spools retrofitted w/ HTS leads
  - 1 currently installed in tunnel
  - Actual operating limit is not known; will be determined shortly by test
- Limited number of vendors; interest level uncertain
- Assume current design, operating a present rating, 38 pr incl spares and Tevatron bus needs
- Procurement—2,090k$ (mid 2005)
- Design—30k$
- Test Labor – 187k$
- Cryogens – 169k$

Spools

Correction Elements

- Cos n(theta) design as baseline in CDR
- Uses ribbon cable similar to LHC correctors
- Limited R&D time; decision on style of corrector needed by Apr 2005
- Vendor interest and qualifications uncertain
- Plan assumes a joint prototype (FNAL/Vendor) partnership before production
- Test location TBD
- Magnets for installed spools, spare spools, and 1 shelf spare of each magnet included
- Procurement—784k$ (late 2005)
- Design / Prototype EDIA—195k$
- Production Oversight – 59k$

Spools

Spool Design / Final Assembly

- FNAL Design
- GFM includes HTS leads and Correctors
- Final Test at Fermilab
- (Very) initial comments received; limited number of available vendors with one alternative recently in financial trouble
- Estimate based on DFBX experience; vendor caution on current fluctuation in stainless steel prices
- Design / Prototype EDIA—925k$
- Procurement—4,704k$ (mid 2006)
- Production Oversight – 167k$
- Test Labor—205k$
- Cryogens—45k$

Project Management

- Oversight of the design and procurement of these items
- 685k$

Decision Points / Short Term R&D

- **HTS Leads**
  - H spool being mounted on stand now
  - Results could change Qty required by factor of 2
  - Interest of other vendors could change cost by factor of 2
- **Corrector Design**
  - We may default to the conservative design without available effort
  - Need to gauge vendor interest; if low, potentially internal?
  - Resolve test plan w/ vendors; despite low current, LHC experience not positive on tests at vendors
- **Spool Assembly**
  - At least 1 vendor capable and showing interest
  - Need to qualify the competition
- **Detail Interfaces**
  - Magnet / Spool / Test stand
  - Bus work and expansion loops
  - Instrumentation
- **Correct Decisions at the earliest possible date needed.**

Summary

- **19,054k$--this is Preliminary**
  - **Always said, never heard (review slide 3 as needed)**
  - **But we must get to a baseline, in the not so distant future**
- **Includes appraisal of current technical status of major components**
- **For this round, done blind**
  - **We get what we got**
- **We must continue technical progress, detail design development, and start interactions with vendors**
- **We must correct errors, and update the plan**
- **We must load it into OpenPlan**
- **Horse trading needs to start and finish**
  - **Confirmation on coverage of physicist and procurement salaries in the TD base budget, costing of spares, cryogens, …**