



# **US LHC ACCELERATOR PROJECT**

*brookhaven - **fermilab** - berkeley*

## Status of the Fermilab - LHC Program

*Jim Kerby*

DOE Review of the US-LHC Accelerator Project

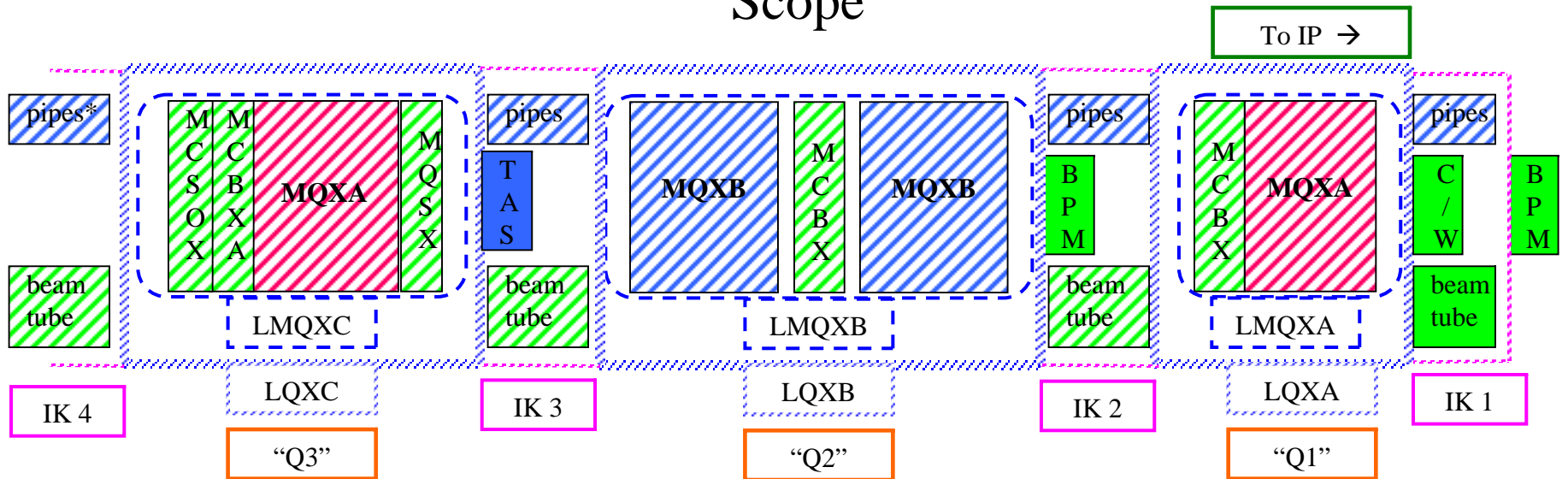
*26 July 2004*



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## Scope



Fermilab:

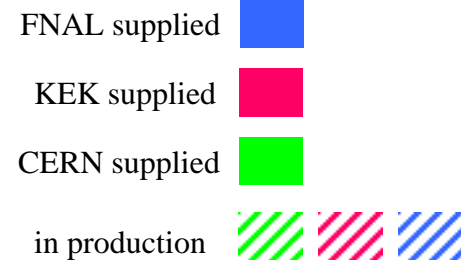
Designs, fabricates and tests the MQXB quadrupole magnet

Designs, fabricates, assembles and tests the LMQXx and LQXx Cryostats

Designs and procures portions of the Interconnect Kits, providing integration support for each

Provides Engineering and Test support for the DFBX

Is the lead lab in the Accelerator Project





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## Fermilab-LHC Status

Production is in full swing:

- 15+/18 MQXB complete; 6 / 10 LQXB Complete (Oct – 12/18, 3/9\*)
- 13/18 MQXA delivered to FNAL; 4\*/18 LQXA/C complete (was - 5/18, 0/18)
- 13/27 MCBX delivered to FNAL; 3/9 MQSX/MC SOX delivered to FNAL (was 5/27, 0/9)
- 19 production HTS lead pairs tested by May, 2 leads returned to Pirelli for rework (was 8+)
- DFBX FNAL GFM delivered (ducts were in construction)

Recent technical results better:

- LQXB04, LQXB05, LQXA01 tests complete (LQXB03 hadn't been tested)

Cost & schedule variances holding steady

- BCR59 complete (was just starting)

Overall schedule still a concern

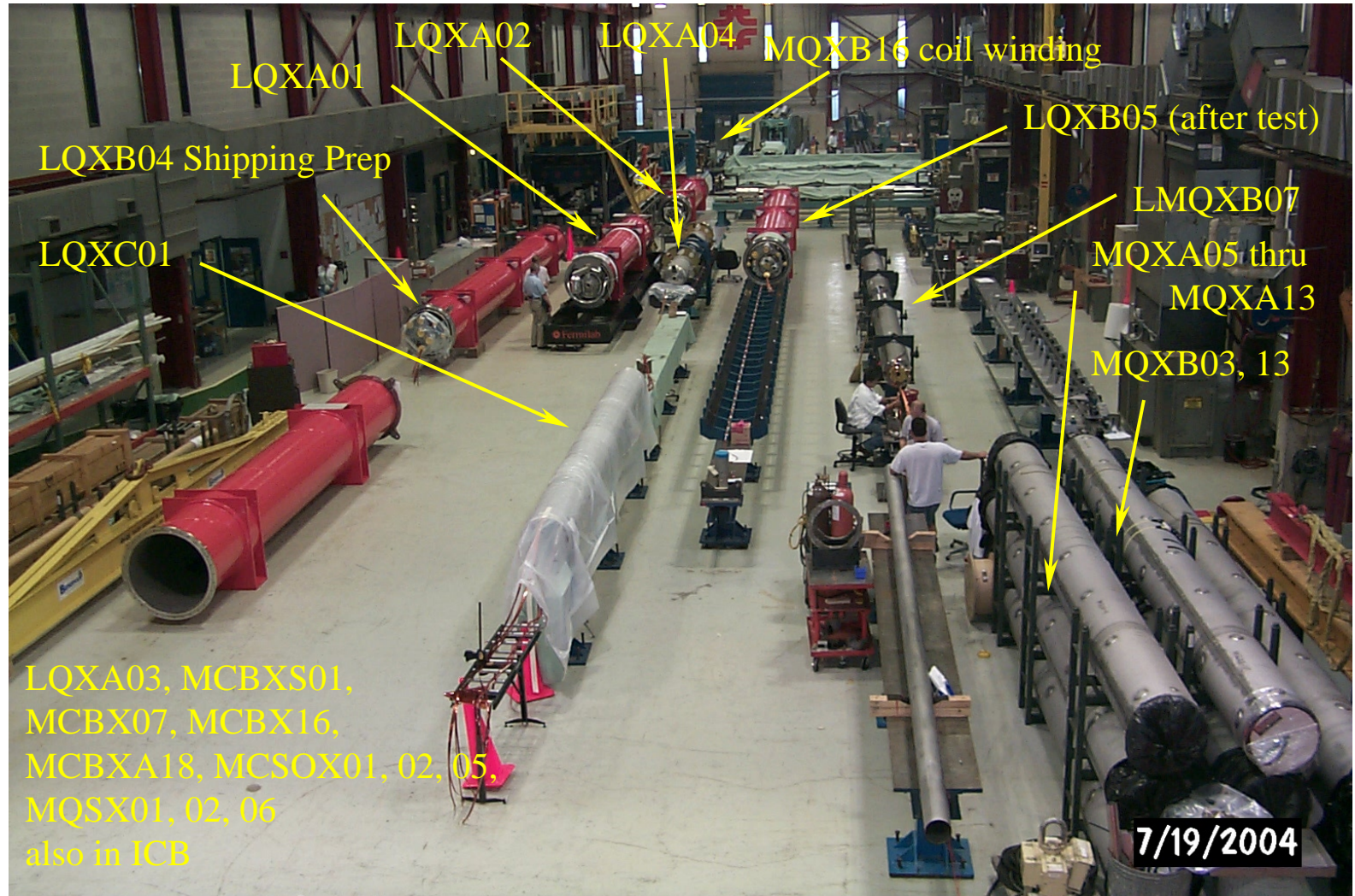
- Mitigated for the moment
- Cryostat production effort getting up to speed, ICB effort organized w/ eye on MTF Stand 4
- Inner cable problem delayed closeout of MQXB production
- End game requires constant attention



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ICB  
19  
July





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## LQXB Status

LQXB01 at CERN

LQXB02 Apart

- MQXB03 in storage

LQXB03 in transit to CERN

LQXB04 being prepped for shipment

LQXB05 test just completed, being prepped for shipment

LQXB06 being hooked up on test stand (picture at right)

LQXB07 helium vessel assembly underway

LQXB08 (MQXB16) coil winding in process





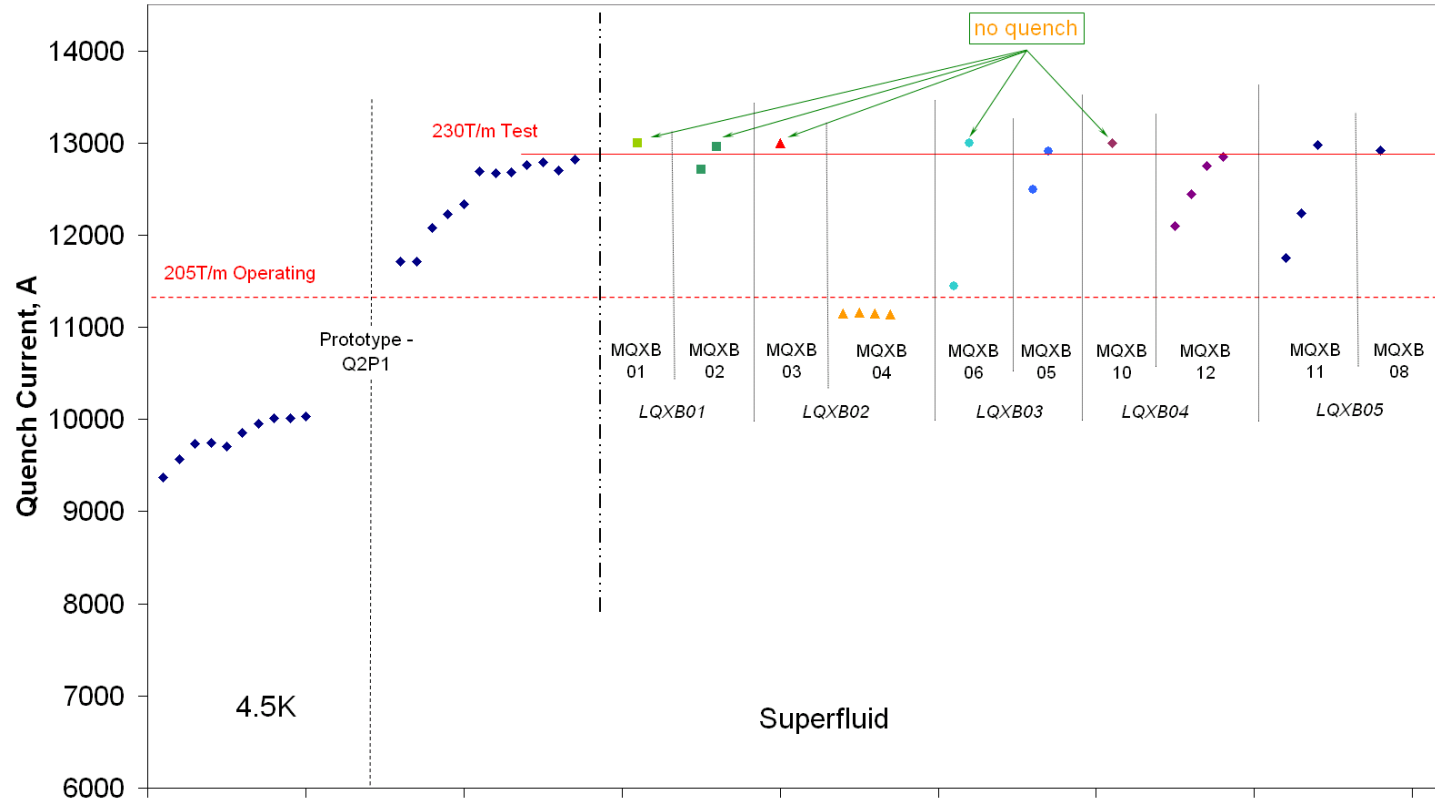
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## LQXB01/02/03 Quench Performance

MQXB01, 02, 03, 05, 06, 08, 10, 11, 12 excellent performers

MQXB07, 09 to be tested next in LQXB06





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## KEK Status

First 13 MQXA deliveries in house

Remaining MQXA in fall 04, coordinated and consistent with our requirements

KEK / Toshiba production finished!





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## CERN Status

- 12 MCBX, 2 MCBXA, 3 MQSX and 3 MCSOX delivered
  - 10/1/1/1 used in assemblies to date
  - Small stock exists.
  - CERN testing OK keeping pace, constant communication
- Interconnect issues kept apace by frequent trips, meetings, phone calls, and emails
  - Maybe (!) we're done
- CERN desires inner triplet mockup end of summer this year
  - It will be autumn





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## Cost / Schedule Performance

Cost variance steady for ~2 years, negative in last 6 months

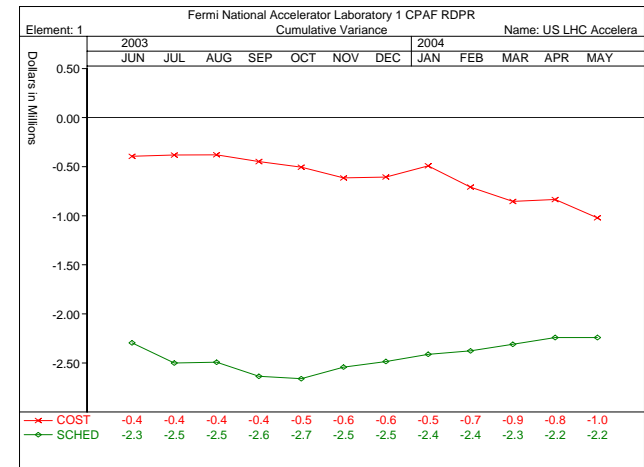
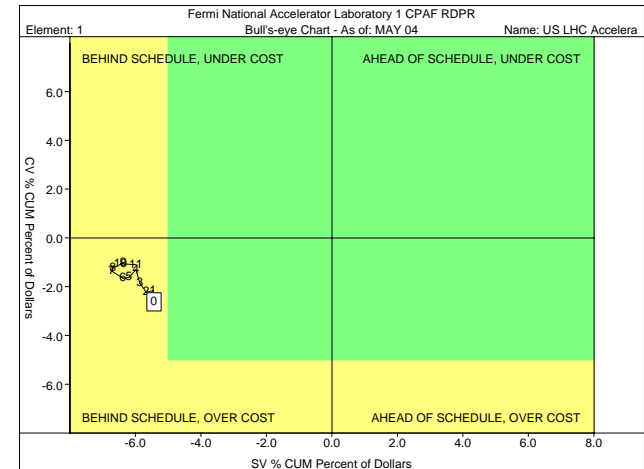
- LQXB02 work
- Shipping contracts
- Interconnect parts
- DFBX effort over-running; general EDIA & PO under-run balances out

Schedule variance improving

- Production ramping up, crew increased
- Magnet shipments, LQXA/C Cryostat work
- MTF effort to hit baseline testing targets helps on last magnets

BCR59 covers LQXB02 and shipping contract variances, sets new BAC

- FNAL management working to the new BAC, multiple challenges remain





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## Schedule Issues and Risks

Expect all magnets to be ready to ship by June '05

Fundamentally OK (for now -- constant vigilance)

Cold Testing and ICB Production are critical paths

- Linked by need to maximize Stand 4 Occupancy
- Need for more cable drives link upstream to cold mass production

Focus on production efficiency

Focus on test efficiency

Focus on shipping efficiency



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## Technical Issues and Risks 1

### Rebuild of LQXB02

- MQXB04 smoking gun not found
- Decide on rebuild options...baseline in BCR59 using prototype
  - Fails hipot at 4kV, probably voltage tap to beam tube
  - Some minor checks to finish out, probably not viable solution
- Decision depends on technical findings and cost

### Cable Inventory

- Inner cable reels 830; 831 (Oxford/LBNL) unstable and not usable; short of inner cable to complete project
- LBNL cabled SSC inventory (wrong twist)
  - Cables well - First coils look ok so far.

### LQXC01

- The last '1<sup>st</sup> item' we have to complete



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## Technical Issues and Risks 2

### Shipping

- 1<sup>st</sup> magnet through, 26 to go
- Recent ESA satellites of rogue waves are comforting
- Always real concerns

### Acceptance at CERN

- 1<sup>st</sup> 2 magnets through the pipeline, getting better but always work
- Tolerances, tolerances, tolerances

### Magnet Test Results

- Recent tests OK, but chance of future failure non-zero
- Collection and reduction of all data is tough
- Testing of LQXC01 in debate



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## Cost Issues and Risks 1

Money money money

BCR59 covers most ACWP through October 2003; and discrete scope changes associated with

- LQXB02 rebuild
- DFBX lead testing and oversight
- Q1-Q2 interconnect redesign
- EDIA on magnet testing
- FNAL management challenges
- Shipping contract
- Corrector delivery delays and schedule impact

It is not a blank check, and many challenges remain



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## Cost Issues and Risks 2

Loss of a magnet assembly (i.e. failed test)

- Previously estimated (May 2001 DOE review) as 360k\$ (direct).
- Current loss does not exclude another one in future
- Re-estimate MQXB04/LQXB02 rework costs range 265k\$ - 357k\$ (direct)
  - Recent technical information suggests the cheapest option is out

Schedule extension due to delay in deliveries

- Program extensions cost on the order of 40k\$ per month; USLHC, CERN, Fermilab working to minimize impacts whenever possible
- BCR 59 includes an extension of 11 months...
- Corrector magnets are the remaining deliverable to be tracked

Schedule extension due to changes in design

- “I do not see any on the horizon.” ← from October
- My prognostication was bad. The KEK magnets in the Q3 were rotated 180 degrees, due to a weld warpage in their production process. Production schedule juggled to accommodate.



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## Cost Issues and Risks 3

### Risk of Shipping Problems

- Either catastrophic or nagging, in schedule or costs

### Parts costs

- Cost of steel fluctuations have been noticeable

### Potential need for minor reworks

- Pipe tolerances, electrical connections, retaking of survey data, re-analysis of data, cross checks

### Testing of 2<sup>nd</sup> KEK magnet

- Deferred to end of line, judgement made on project status at that time.

We have 5/3/9 LQXA/B/C assemblies to make, 4 LQXB to test, and 9/7/9 LQXA/B/C to ship. The cumulative effect of multiple 'small' issues can be very real.

Constant vigilance.



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## Summary

Technical progress is good.

Schedule appears reasonable.

Cost pressures are real.

The remaining scope of the Fermilab-LHC project is non-negligible. Effects of issues, large and small, will be noticeable.

It is far too early to relax.