



US LHC ACCELERATOR PROJECT
brookhaven - fermilab - berkeley

Status of the LHC Accelerator

J. Strait
Fermilab

HEPAP Meeting 13-14 July 2001



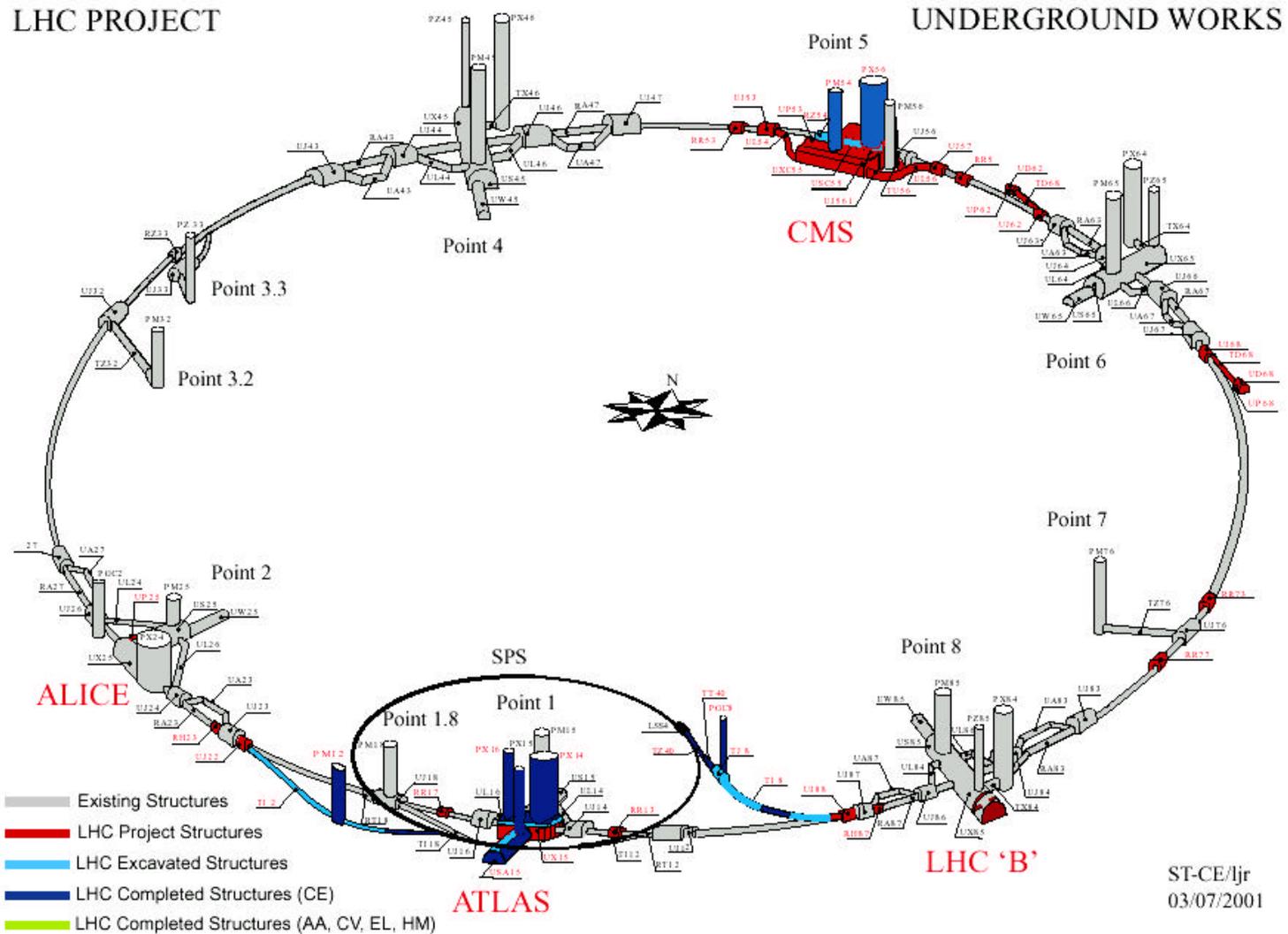
Outline

- I. Status of the overall LHC project
- II. Status of the US LHC Accelerator Project
- III. Plans for US involvement in LHC commissioning and operations.



I. Status of the Overall LHC Project

Civil Construction





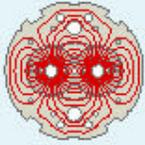
Main Magnets

Dipoles

- Currently receiving dipoles under the initial “30 per vendor” contracts.
- First two complete magnets have been tested and are good. ←
- Expect by the end of the year at least 16 collared coils and 10 complete magnets.
- Contracts for full production to be adjudicated at the Sept or Nov FC. Expect to approach full production of 8 dipoles/week by the end of 2002.

Quadrupoles

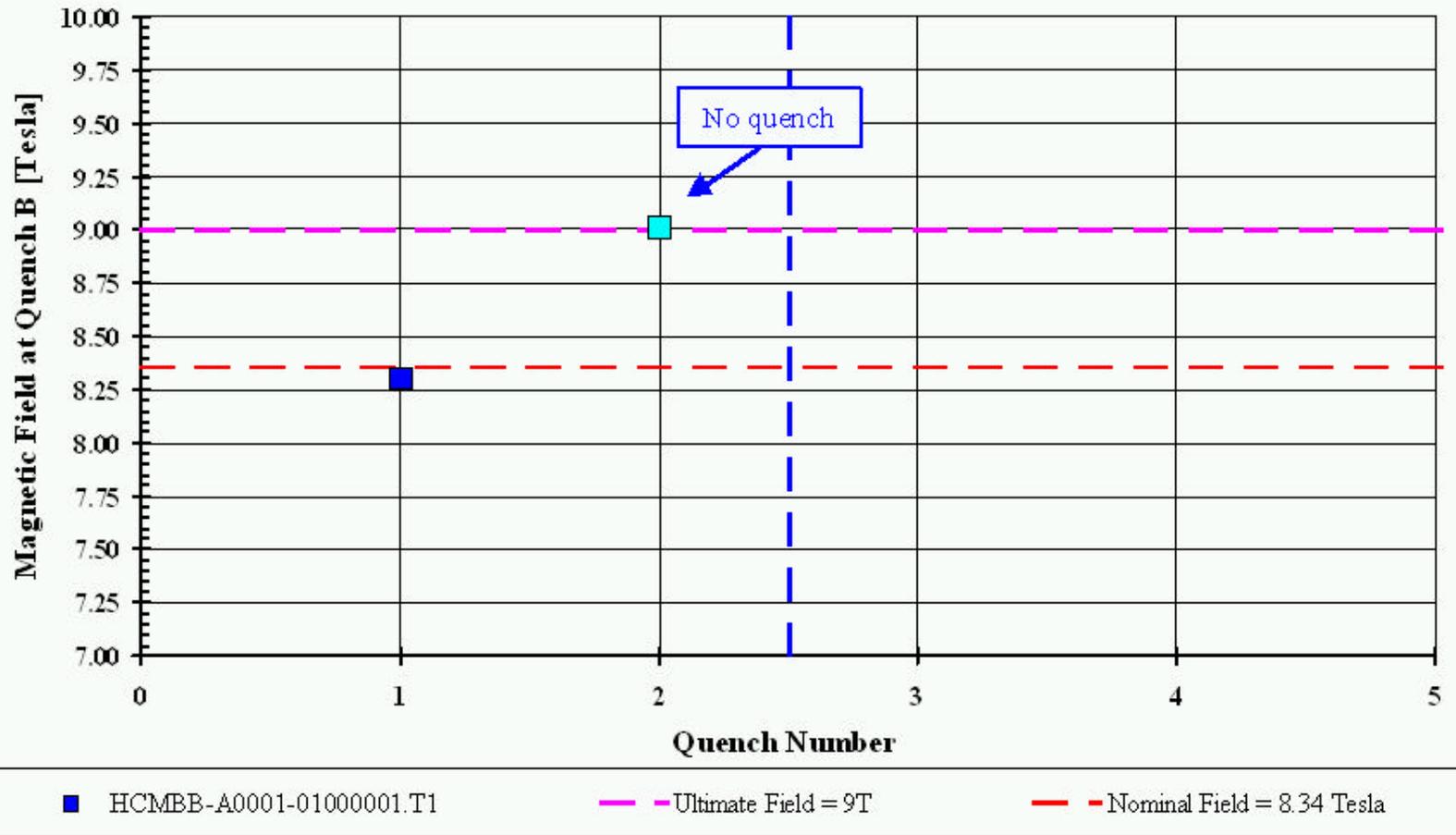
- 3 pre-production prototypes made by Saclay easily meet requirements. ←
- Now in short straight sections for string test #2.
- Contract has been placed with ACCEL for series production.

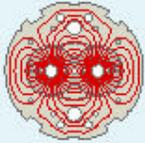


the Large Hadron Collider accelerator

Series dipole #1

Training Quenches at 1.8K

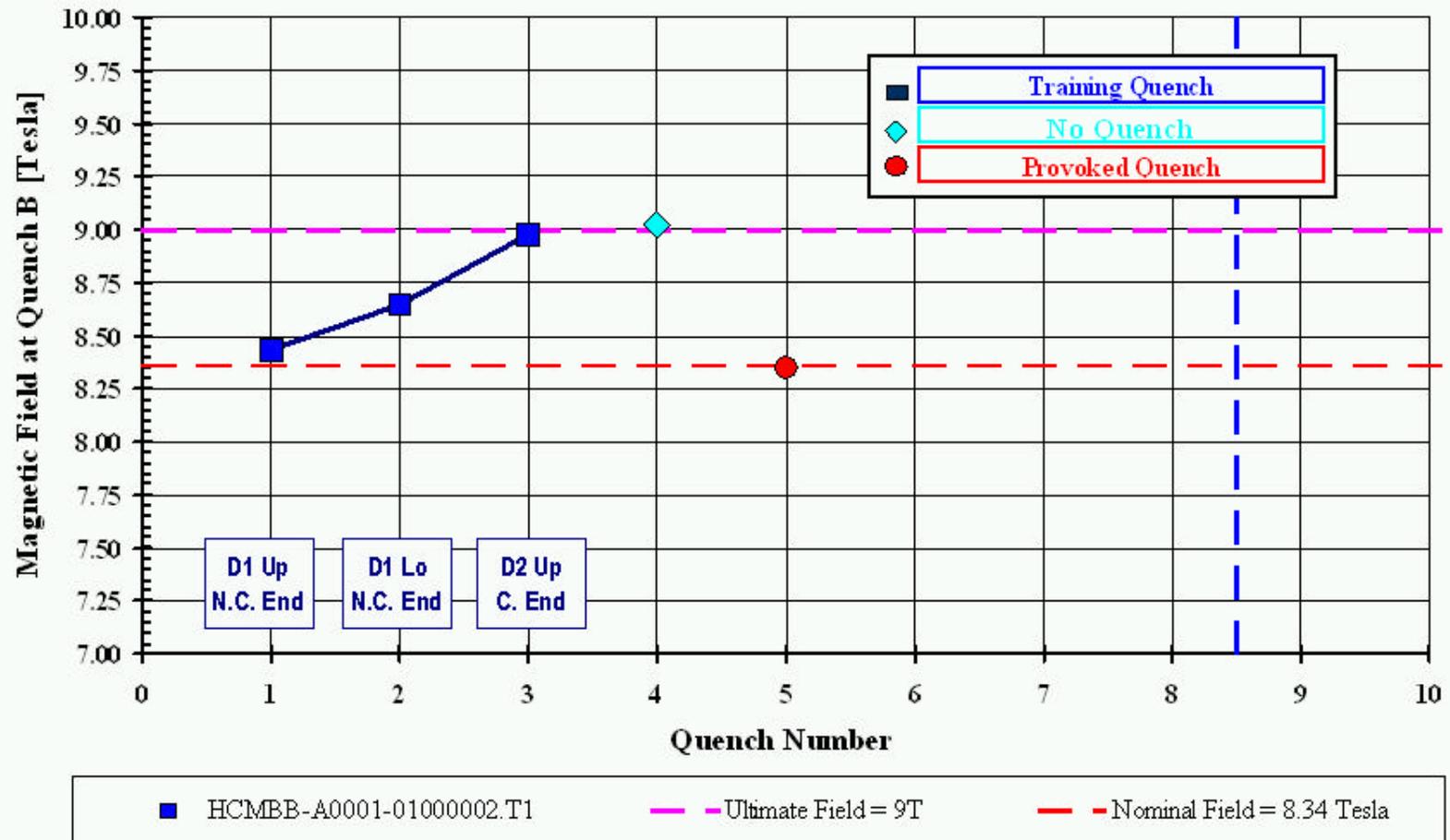




the Large Hadron Collider accelerator

Series dipole #2

Training Quenches at 1.8K

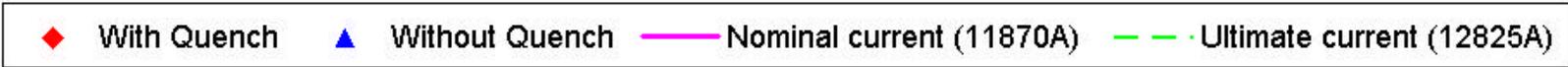
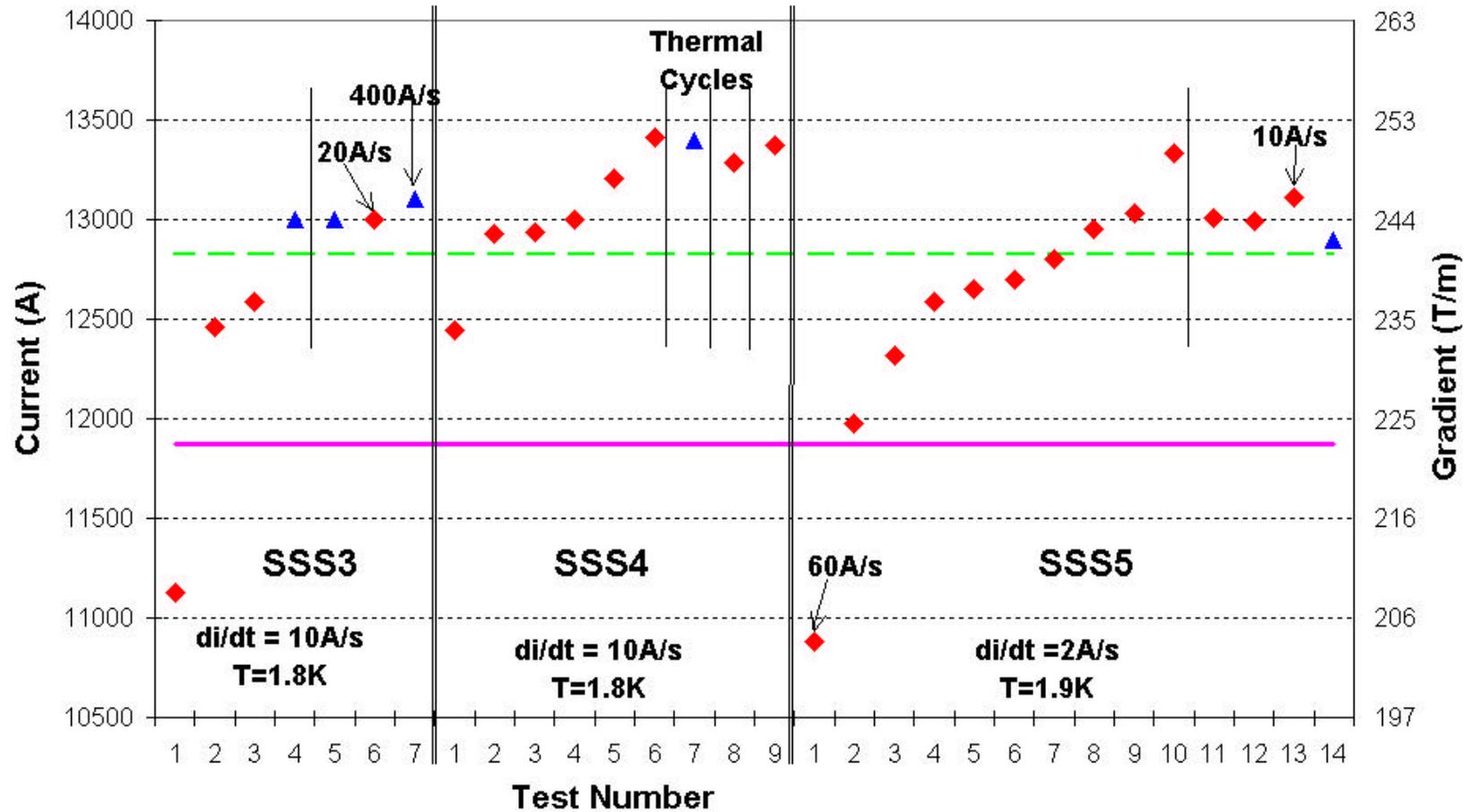


Dipole tested in June 2001 - A. Siemko/LHC-MTA



Pre-production LHC Arc Quadrupoles

Quench History





Superconducting Cable

Cable production is the critical technical item.

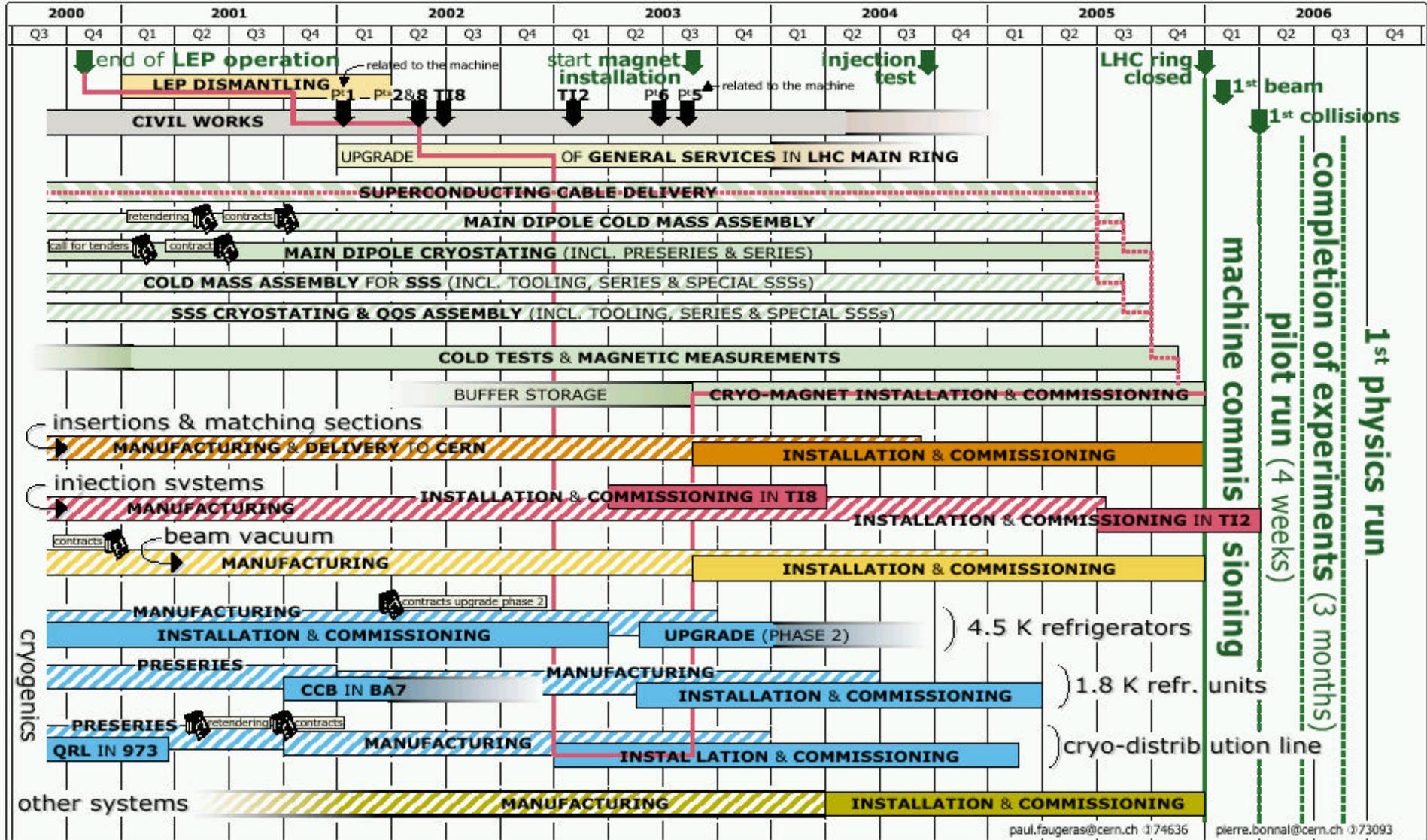
- Very demanding specification has been hard for all of the vendors to meet. ... All are ~6-12 months behind original schedule.
- Production is finally starting to ramp up.
 - Cable is on hand sufficient for all magnets to be built this year.
 - Wire now being produced at the rate of about 50 “unit lengths” per week.
 - Expect to increase to full rate of about 270 unit lengths per month by January 2002.
 - Production to be completed in early 2005.



LHC Project

Working Summary Schedule

Date : 2001-05-09





LHC Project

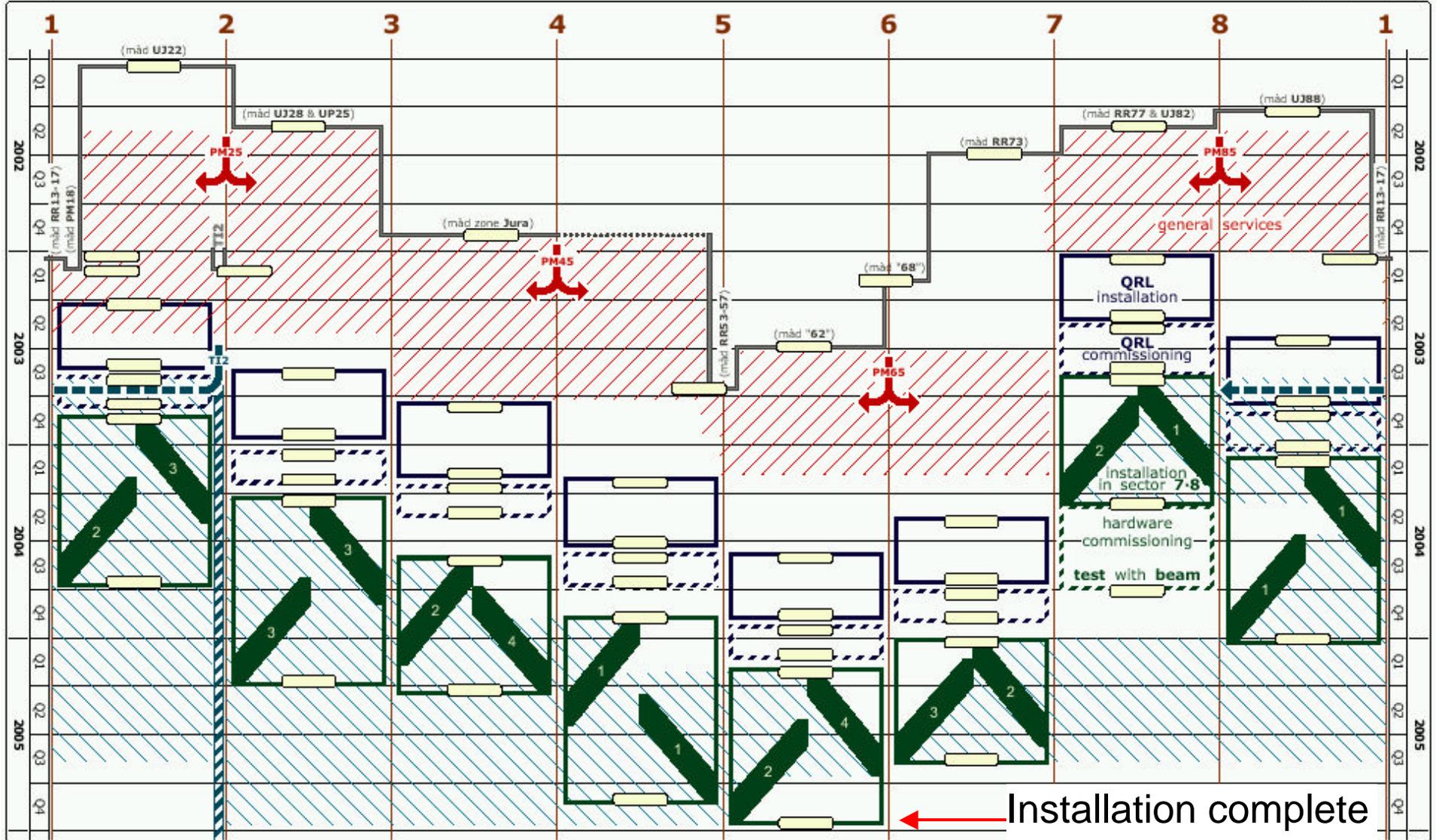
Summary Installation Schedule

LHC-PM-MS-0009 rev. 2.0

AC/TCP

311826

Date : 2001-05-23





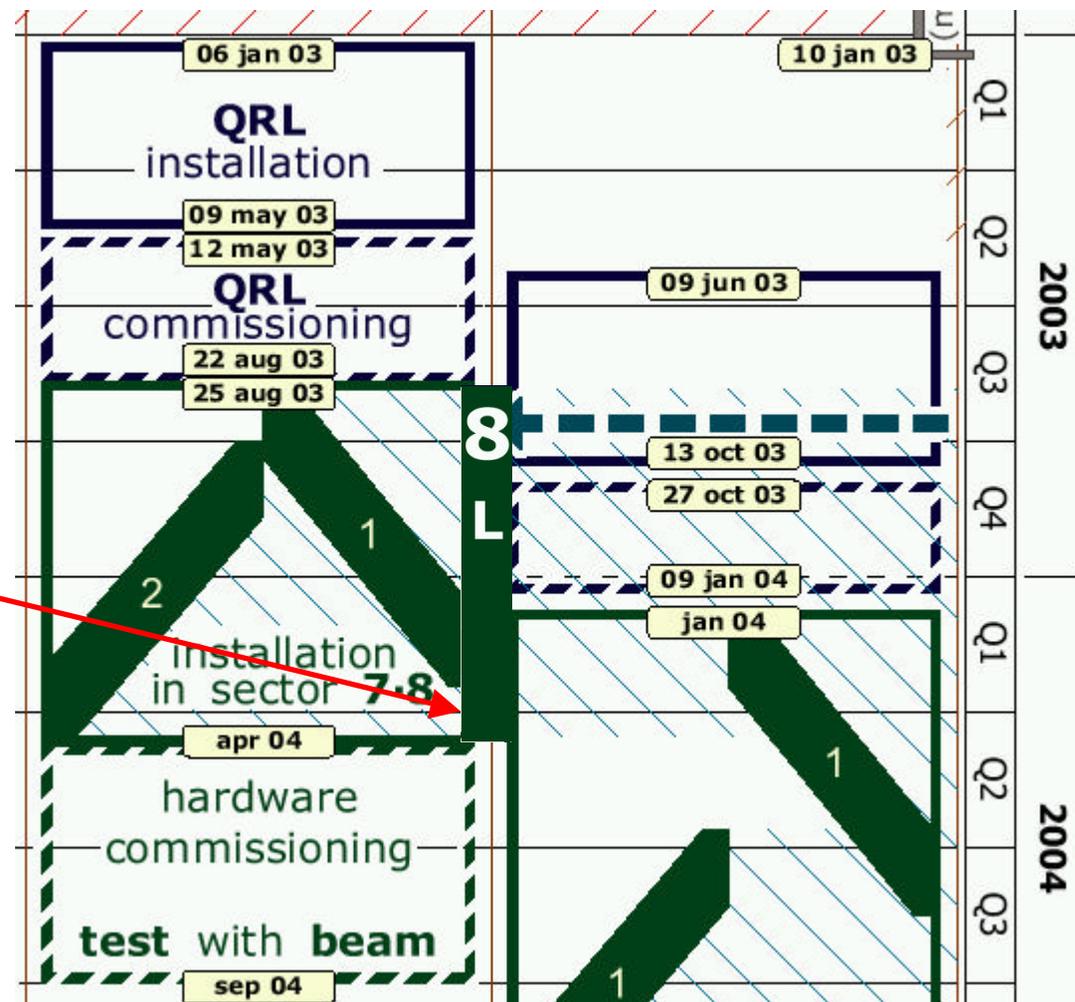
Sector Test Schedule

This will be a major milestone for the LHC Project as a whole and for the US part.

Beam to be injected through US-provided inner triplet system at IR 8L.

Installation starts in August 2003.

Beam test in mid-2004.





Schedule Prospects

Underground civil construction:

- Now proceeding well.
- 6-9 month delays in caverns taken into account in current schedule.
- Risks of delays always exists with underground construction.

Superconducting cable:

- Has been a problem, but currently not the limiting factor.
- Will be a problem if full rate is not achieved by early next year.

Main magnets:

- Constant attention and hard work required to finish by 2005.
- Vendors may eventually exceed 8/week baseline rate.

Other technical systems:

- None believed to be on critical path, but there are many details that must be gotten right.

=> Start up in early 2006 can be achieved, but it will be tough.



II. US LHC Accelerator Project Status

IR Final Focus Systems: Points 1, 2, 5, 8

- US-built quadrupoles (FNAL)
- Japanese-built quadrupoles (KEK)
- CERN-provided correctors
- Cryostats for all quadrupole assemblies (FNAL)
- US-built beam separation dipoles (BNL)
- US-built IR feed boxes (LBNL)
- US-built specialized absorbers (LBNL)

RF Region: Point 4

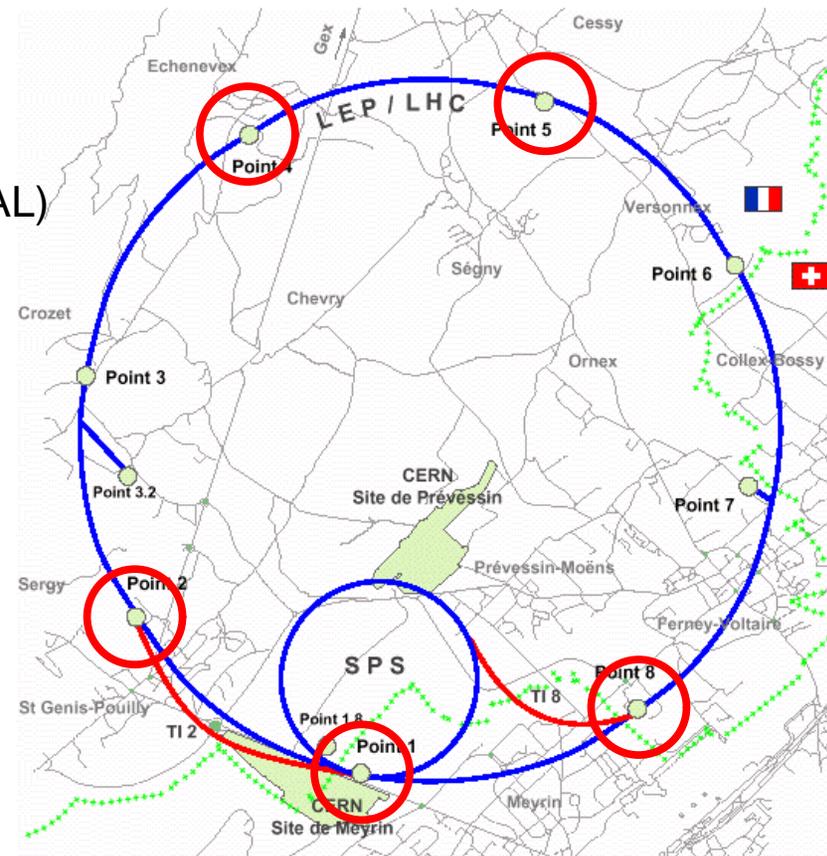
- Beam separation dipoles (BNL)

Wire and Cable for Main Magnets:

- Measurement of SC wire & cable (BNL)
- Cable production support (LBNL)

Accelerator physics (all 3 labs)

Project management and oversight (FNAL)





IR Quadrupoles (FNAL)

Full scale prototype successfully tested.

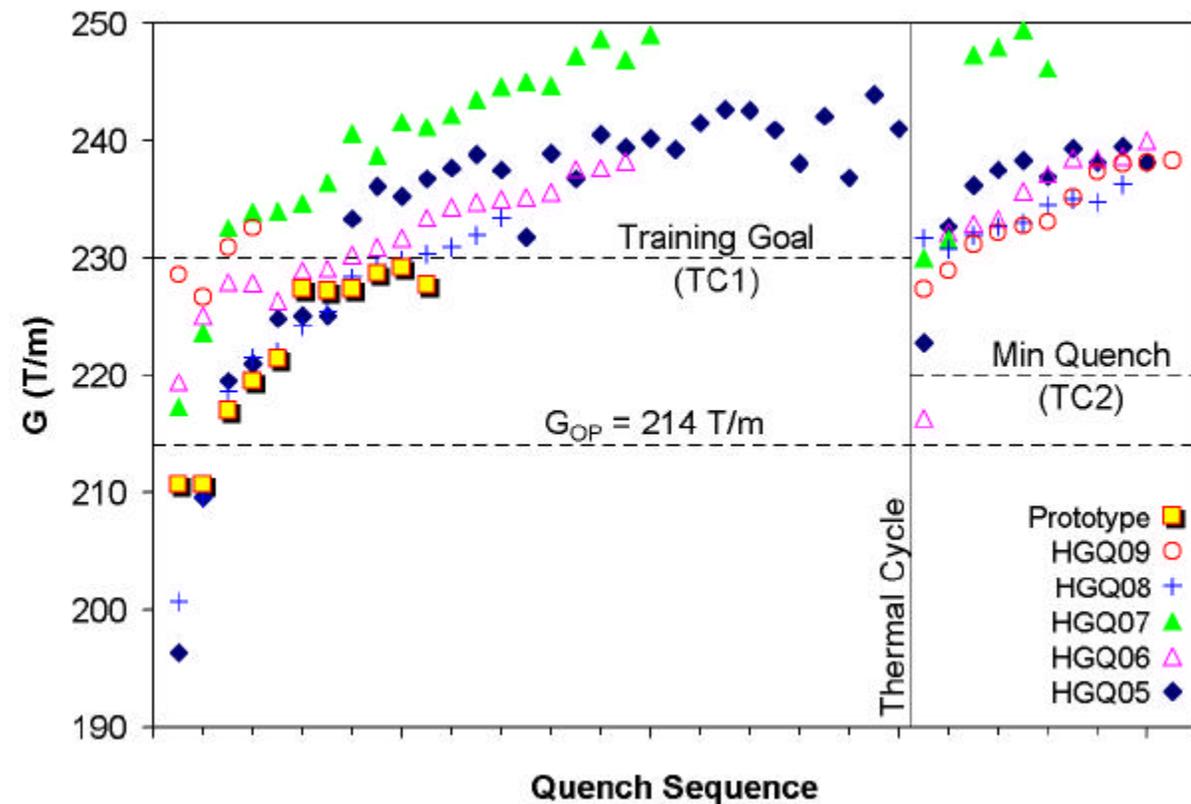
First production magnets started at both FNAL and KEK.

First complete Q2 (2 FNAL quads + CERN correction coil) this winter.

First KEK quad arrives at FNAL March 2002.



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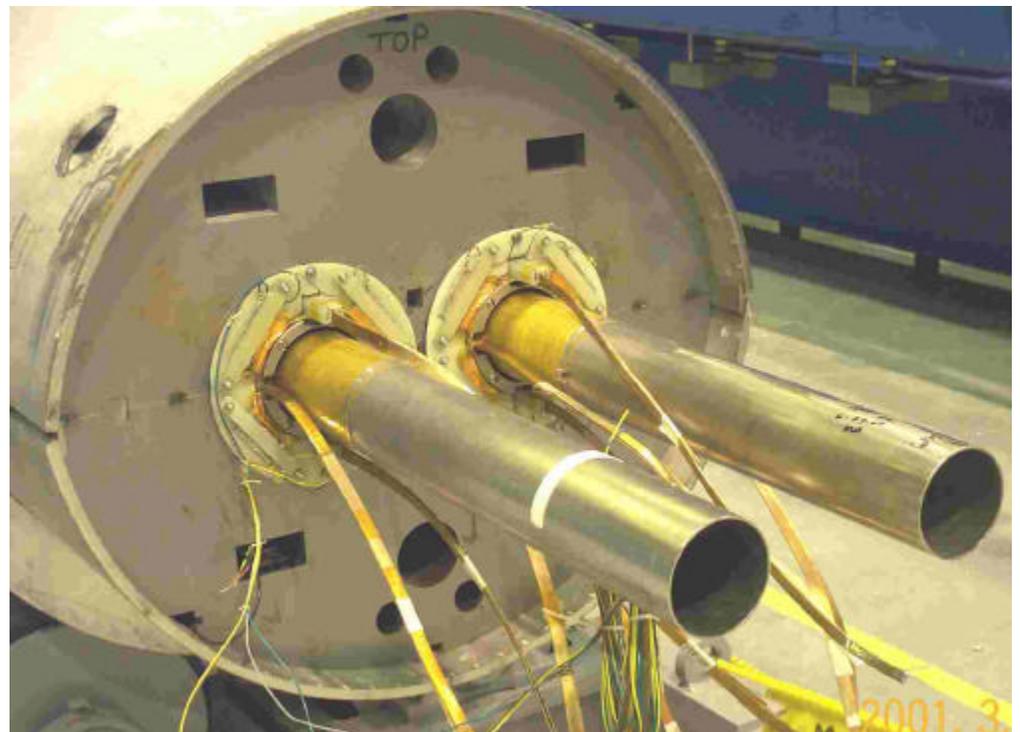


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Beam Separation Dipoles (BNL)

- All 5 D1 (single aperture RHIC-type for IRs) cold masses complete.
 - 1st complete cryotatted magnet to be tested in August.
- First D2 (twin aperture for IRs) cold mass complete...1st cryostat to arrive in August.
 - D2 #2 and #3 in production.
 - 1st complete magnet to be tested in October.
- Redesign of RF straight section halves number of D3 and D4 dipoles, and makes D4 identical to D2 except for aperture spacing.
- D3 (2 RHIC-type magnets in 1 cryostat) design to be completed this fall.





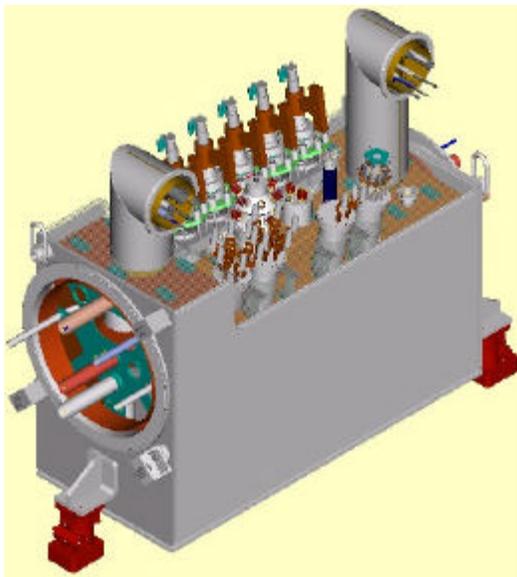
IR Feedboxes and Absorbers (LBNL)

Feedbox design nearing completion.

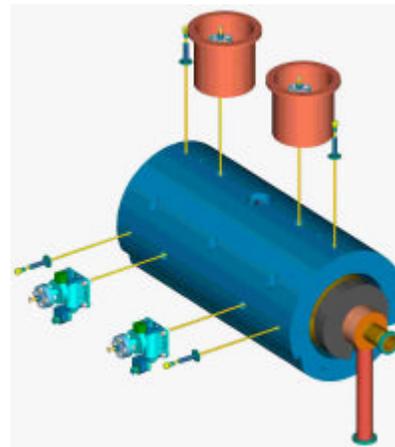
- HTS leads ordered, first pair to be tested this fall.
- Other major procurements to begin this fall.

Absorber design done; major components procured.

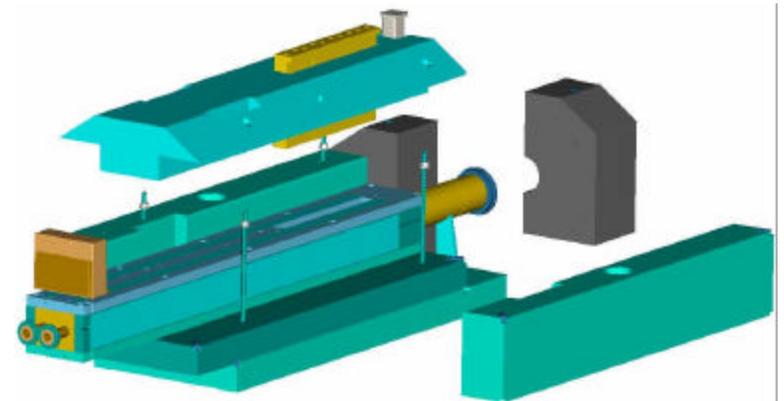
- Beam tube interface with front quad absorber not fully resolved.
- Production assembly to begin this fall.



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Schedule and Cost Status

- There are no major schedule issues.
- Cost has been our major issue in the recent past.
 - New cost baseline has been developed for the whole project, and is in the process of being codified.
 - We have succeeded in identifying and implementing cost savings that do not compromise our core deliverables.

	As of 31 May 01			Contingency Rqd		8Jul01
	BCWP	ACWP	BAC	K\$	%	EAC
BNL	27,263	26,834	45,132	2,030	13%	42,947
FNAL	24,640	28,187	37,351	2,252	19%	39,917
LBNL	10,180	9,912	17,501	2,349	23%	20,080
Total	62,083	64,932	99,983	6,631	17%	102,943

TPC 110,000
 %compl 62%
 Contingency (TPC-EAC) 7,057
 Cost to go (EAC - ACWP) 38,011
 Congingency as a fraction of cost to go 19%



III. LHC Commissioning and Operations

It is important for the US to stay involved with the LHC accelerator beyond the construction project and to continue to collaborate with CERN on the commissioning, operations, and improvements to the LHC:

- To help ensure the *optimal performance* of the LHC as a tool for fundamental physics research.
- To maintain and develop *the US labs' capabilities*, so that *the US can be the leader* in the next generation of hadron colliders.
- To continue to advance *international cooperation* in large science facilities.

CERN management (L. Evans, K. Hübner, C. Wyss, T. Taylor, S. Myers) are eager for our continued collaboration.

We are planning work in this phase that is important both to the *LHC program* and to the *domestic HEP program*.



US Program for LHC Commissioning and Ops

The main elements of the program we are planning include:

- Hardware commissioning of US-provided systems.
- Participation in the beam test of the 1st LHC sector, which includes the US-provided interaction region equipment at the left side of IR8.
- Accelerator physics calculations in preparation for the operation of LHC.
- Participation in the commissioning of the LHC as a whole.
- Initiation of and participation in accelerator physics experiments with the LHC once it is operational.
- Development and construction of 2nd generation beam instrumentation.
- Development and possible construction of 2nd generation IR quads for increasing the LHC luminosity.
- Development of remote data acquisition capability, possibly leading to establishment of a complete remote control room.



US Program for LHC Commissioning and Ops

We are developing a **proposal driven** system for planning the long-term commissioning and operations projects, which includes peer review of the proposed work.

A “**Machine Advisory Committee**” will be formed to review proposals, as well as the on-going work. Membership (~4-6) will be drawn from:

- **US accelerator experts** not directly involved with the LHC.
- **High energy physicists** with a broad perspective of the field.
- **Representatives of CERN** management (but not directly involved with the US collaboration).

This committee will advise the Operations Manager for the US LHC Accelerator Commissioning and Operations Program.



US Program for LHC Commissioning and Ops

Early funding is needed to allow a timely start on long-lead time projects and to provide continuity of collaboration with CERN.

- CERN has already begun planning for commissioning and has invited our participation.
- Installation of US-provided equipment begins in FY2003.
- The sector test takes place in FY2004.
- R&D on 2nd generation IR quads must begin soon to ensure that they can be installed when required in 2012 or 2013.
CERN and KEK are interested in developing these quads, and we must start soon if we want to be important players.
- CERN is eager for early implementation by LBNL of 2nd generation beam diagnostics.

We have requested funding of \$0.2M, \$1.0M and \$1.5M in FY 2002, 2003 and 2004 respectively, and expect this program to rise to the level of approximately \$10M/year by FY2006 or FY2007



Conclusions

- LHC startup in early 2006, as currently planned, can be achieved, but it will take a lot of hard work.
- The US part of the LHC project is on track.
- It is important for the US labs to participate in the commissioning, operations, and machine improvements of the LHC, with an early start.