



US LHC Accelerator Research Program
brookhaven - fermilab - berkeley

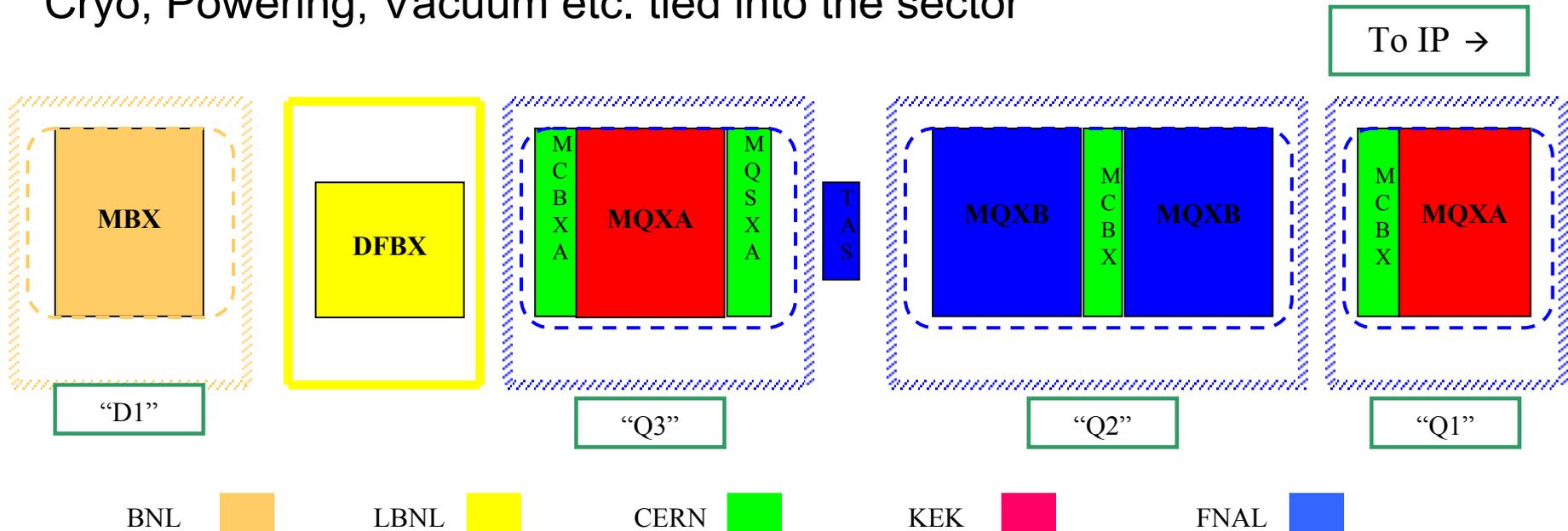
US Participation in the LHC Hardware Commissioning

Michael Lamm for the HC subgroup
26 February 2004



Major US Contributions to the LHC in the IR Inner Triplets

Cryo, Powering, Vacuum etc. tied into the sector



Other important Contributions

Hadron and neutral absorber for high luminosity region(LBNL)

Other separation dipoles (BNL)

Courtesy of Jim Kerby



Events Since Danfords Meeting I

- Visit to CERN in November (Lamm, Peggs, Pfund, Rasson)
 - Presentation at HCWG
 - The time frame for the installation and commissioning has been detailed.
 - CERN is counting on our active participation in the installation and commissioning
 - They are interested in having US scientists and engineers stationed at CERN during the commissioning process. US participants would be integrated into the HC teams, will be given real jobs and responsibilities.
 - CERN was made aware that some of the people who need to contribute can only make short duration trips.
 - There is a proposal to do an above ground “fit up” of the USLHC IR components.



Events Since Danfords Meeting II

- Chamonix Workshop
 - Installation and Commissioning Schedule Updated. The first sector to be installed is (still) sector 7-8, followed immediately by sector 8-1.
 - US magnets cannot be installed until the CERN-supplied beam screens arrive at CERN (scheduled for March 2005)
 - Installation of IR in sector 7-8 begins in May 2005
 - Expect commissioning to begin Fall 2005 (after complete installation and interconnect of sector 7-8)
 - Spring 2006 is the scheduled time of the Injector/sector test. All elements in sector 8-1 and 7-8 are at nominal temperature. Sector 7-8 is fully commissioned; sector 8-1 will be powered as needed.



Events Since Danfords III

- In the last few weeks
 - Discussions among LARP Hardware Commissioning Subgroup
 - Internal discussions about level of Participation
 - More detailed discussion with CERN about participation
 - Preliminary effort and cost spread sheet, statement of work



LARP Hardware Commissioning in FY04

-0.5 FTE spread over three laboratories

-Activities include

Planning for FY05-8

Defining participation

Deliverable activity past CERN acceptance

Participation in Surface Fit Ups

TAS

Inner triplet

These Fitups will likely take place over a 3 months period during the Summer or Fall of CY04



Effort by Task/Fiscal Year

“Above Ground” Mechanical Fitup”

- Inner Triplet (D1,DFBX,Q3-Q1) Does not include TAS fitup
- Time Frame: September-October? 2004
- Purpose of Test
 - Assemble all pieces for one complete IR
 - Mechanical fitup of interconnects
 - Pipes adjustments to install length, dry fit
 - Vacuum tests
 - Shields, interconnect kits
 - Magnets on alignment jacks
 - Electrical continuity
 - Exercise alignment (SSW?)
 - Build DFBX Cable trays as per final installation
- Level of Effort
 - FNAL 2 FTE-Months Eng. 2 weeks physicist
 - LBNL 2 FTE-Months Eng.
 - BNL 1 FTE-Month



Effort by Task/Fiscal Year

Installation

- Time Frame: First IR May-July 2004, Continuous throughout FY2006
- Purpose of Test
 - Assure that US components are installed properly
 - Check installation procedures
 - Participate in first electrical connections
 - Review electrical and alignment data
- Level of Effort FY05
 - FNAL 2 FTE-Months Eng. 2 weeks physicist
 - LBNL 1.5 FTE-Months Eng.
 - BNL 1 FTE-Month Eng/Physicist
- Level of Effort FY06 is about the same
 - Less effort/IR but more IR's



Effort by Task/Fiscal Year

Commissioning

- Time Frame: Fall 2005 through Spring 2007
- Purpose of Test
 - Once installation complete, all aspects of bringing system to full operation. Injection test in Spring 2006
- Level of Effort (mostly starts in FY06)
 - Two full time FTE's stationed at CERN through First 2 IR commissioning and Injector tests. Other effort from all labs
 - FNAL 1 FTE-Months Eng. 1 FTE physicist
 - LBNL 2 FTE-Months Eng.
 - BNL 1 FTE-Month



Effort by Task/Fiscal Year

Oversight

- Time Frame: Fall 2005 through Spring 2007
- Level of Effort
 - Less than .1 FTE/institution



Recent Changes in Effort/Cost

- Original Plan Calls for 2 FTEs in FY05, 6, 7 1 FTE in FY08
- Slide in Commissioning towards FY06 argues for delay in “resident participation”
- Real Cost of Travel and Living Expenses included



Proposed FTE and Manpower

		FNAL	BNL	LBNL	Total	Yearly Total
FY05	FTE	0.88	0.24	0.31	1.43	1.43
FY06	FTE	2.28	0.24	0.35	2.87	2.87
Institution total		3.15	0.48	0.66	4.30	

		FNAL	BNL	LBNL	Total	Yearly Total
FY05	Salary	\$142.2K	\$59.3K	\$78.5K	\$280.0K	\$406.7K
	M&S	\$79.5K	\$19.8K	\$27.4K	\$126.7K	
FY06	Salary	\$367.1K	\$60.9K	\$87.3K	\$515.3K	\$710.7K
	M&S	\$140.0K	\$19.8K	\$35.6K	\$195.4K	
Institution total		\$728.8K	\$159.7K	\$228.9K	\$1117.4K	



Conclusion

- This is our best estimate of required costs for full participation
- Moving effort from FY05 to FY06 reduces FY05 but mostly effects commissioning. Installation and Fitup cost remain about the same



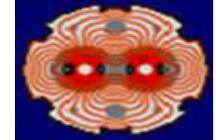
Additional Backup slides



Plans for Starting Up the LHC

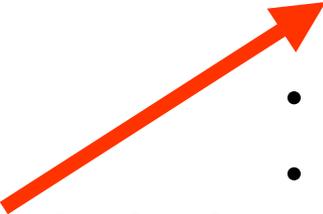


LHC Project Workshop CHAMONIX XIII 19-23 January 2004



The workshop focused on the performance and operation of the LHC as well as the construction, installation and commissioning of the project :

Topics of Discussion

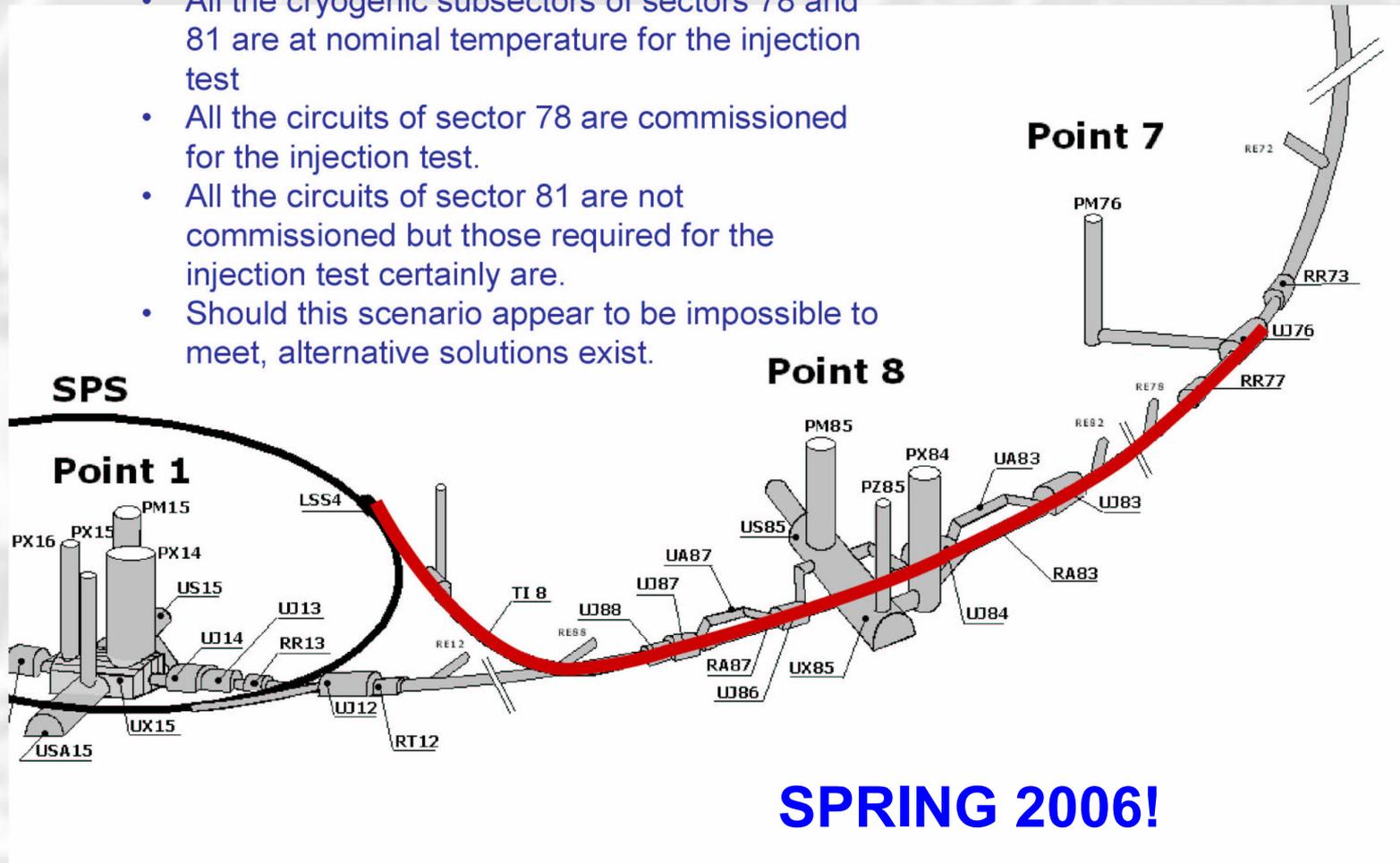
- Injector Complex
 - Beam Collimation
 - Magnets
 - **Installation and Commissioning**
 - Actual Running of the LHC
- Arc magnets installation imminent
 - Commissioning Starts in mid 2005
 - Sector Test in mid 2006
 - Finish Commissioning in 2007
 - First Beam mid 2007!
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See: <http://ab-div.web.cern.ch/ab-div/Conferences/Chamonix/2004>

Baseline

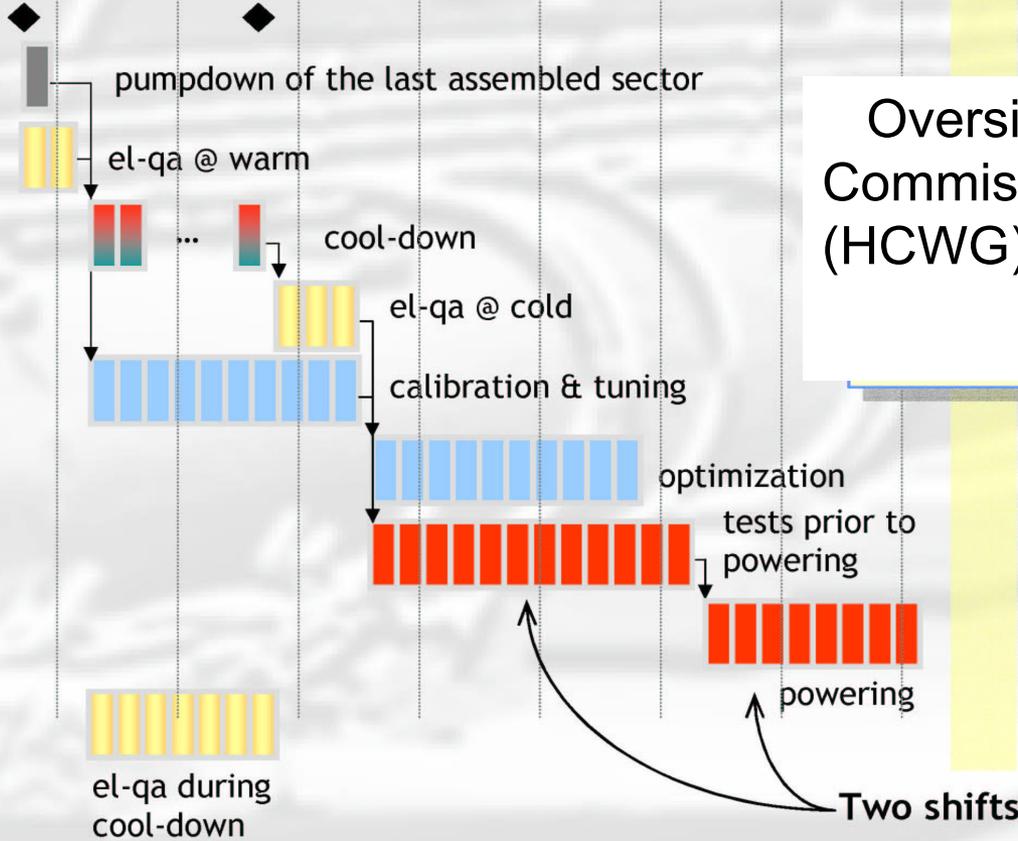
- Sectors 78 and 81 are completely installed before the injection test
- All the cryogenic subsectors of sectors 78 and 81 are at nominal temperature for the injection test
- All the circuits of sector 78 are commissioned for the injection test.
- All the circuits of sector 81 are not commissioned but those required for the injection test certainly are.
- Should this scenario appear to be impossible to meet, alternative solutions exist.

The Injection Test



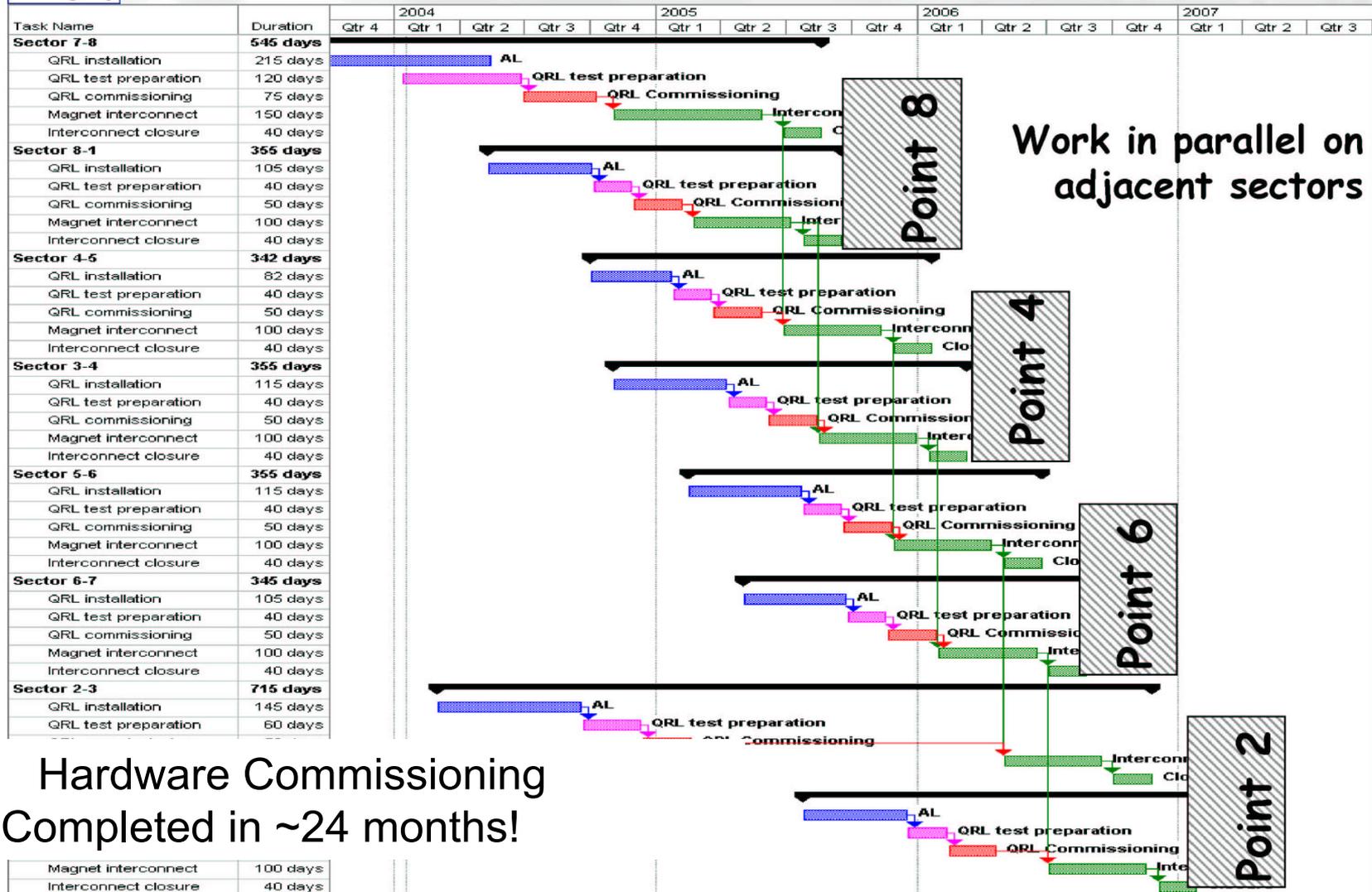
SPRING 2006!

commissioning of cold sector 7-8





Commissioning of LHC Sectors



Hardware Commissioning Completed in ~24 months!

Magnet interconnect	100 days
Interconnect closure	40 days



Participation Beyond FY04

Effort comes from two sources:

1. Physicists and engineers stationed at CERN for extended periods during the installation and commissioning process
2. Specialists stationed at CERN for short durations (1-3 months) during critical periods such as initial installation and cool down and powering
 - Types of people
 - Interconnect/mechanical specialist (Mechanical Engineer)
 - Cryogenic specialist (Cryogenic Engineer)
 - Magnet and component specialist (Magnet Scientist)



Interconnect/mechanical Specialist

Mechanical Engineer who participates in the installation and interconnection of the USLHC deliverables.

Tasks include:

1. Participate to the review of the handling procedures for the final positioning of the USLHC deliverables
2. Participate to the review of the interconnect procedures.
3. Participate in any surface fit up of magnets/tas/tan/dfbx and take the responsibility (design, modifications, manufacturing, follow-up) for the changes to the interconnect kit if needed.
4. Help training the contractor in charge of the interconnects and participate to the first interconnects. Follow-up the others.
5. Organize and supervise, with CERN staff, the mechanical and water connections of the cables to the power leads
6. Advise the survey team in the alignment procedures
7. Participate in vacuum commissioning including leak tests.

Critical period is October 2004 through Aug 2005, with presence throughout installation and start of commissioning



Cryogenic Specialist

Cryogenic installation and cool down of inner triplet subsector , first powering and first beam.

Task include:

1. Review with CERN engineers the procedures for the cool down of the inner triplet subsector
2. Participate to the surface fit ups and cryogenic connections in the tunnel
3. During the cool down of the inner triplet subsector, take part in the operation, monitor the cryo instrumentation, participate to the tuning of the control loops.
4. Perform specific tests such as "beam load compensating" cryo heaters, the beam screens, the quench pressure profiles and the heat loads
5. Provide feedback to alignment group on warm/cold alignment changes.
6. Participate to the cryogenic commissioning of the DFBX with HTS power leads Participate to the definition of operation procedures and maintenance plans as well as the management of technical documentation
7. During operation with beam, study the effects of beam load on cryogenic performance

Critical period is August 2005 through February 2006, with presence throughout installation and start of commissioning



Magnet Scientist

Magnet expert for the protection of the components (magnets, DFBX) and powering of the electrical circuits of the inner triplet subsector.

Tasks include:

1. Participate to the review of the interconnect procedures, with emphasis on electrical aspects
2. Participate to the review of the cool down procedure
3. Collaborate with technicians involved in electrical quality assurance during assembly and cool down to validate instrumentation and insulation integrities.
4. Participate to the review of the procedures for commissioning the electrical circuits
5. Participate in the powering tests
6. Interpret magnet performance and protection data during quench, ramps, etc
7. Act as a conduit for relaying data between US and CERN including quench and magnetic measurements (should largely occur prior to acceptance)

Critical period is October 2005 through March 2006, with presence throughout installation and start of commissioning



How LARP Personnel Would Fit Into LHC

- Details of assignment are still be worked out. However, person would most be likely assigned to CERN group related to specialty. (e.g. Cryo person assigned to AT-ACR)
- Additionally, person would be part of installation or commissioning team made of persons from various groups
 - Installation organized by Ranko Ostojic (CERN owner of Hardware)
 - Commissioning organized by Roberto Saban
- People staying for extended periods of time would be expected to take real responsibilities for Installation and Commissioning: (“no tourists!”-Saban)
- Scope of LARP is focused on US deliverables. However it is logical to expand scope to include other hardware which directly affects USLHC deliverables. e.g. Global cryogenic system or commissioning IR beyond Inner Triplet



Summarize US Participation

-Summer/Fall of 2004

Participate in Above Ground Fit UP (1-3 month)

-Fall of 2004

Preparations for transport and installation, review interc. Procedures

-May 2005

Transport magnets, install magnets

-June-July 2005

Complete interconnections

-Summer of CY05 (or Fall CY05??)

Small contingency of resident people to work on Commissioning
Cryo and Powering through the Sector test in Spring 2006

-Beyond Sector Test 2006-2007

Complete installation and commissioning of each IR, beam startup



Conclusion

- Hardware Commissioning is a small but important part of LARP
- CERN is counting on US to play an active role in the Hardware Commissioning!
- We owe it to ourselves to follow up on the excellent work that we have done in designing, building and testing these accelerator components!
- This is an excellent opportunity to gain experience with Hardware Commissioning. Could pay dividends with the BTeV commissioning and expanding the local knowledge base.