



Status of the 12 GeV Upgrade and the SHMS R&D and PED Projects

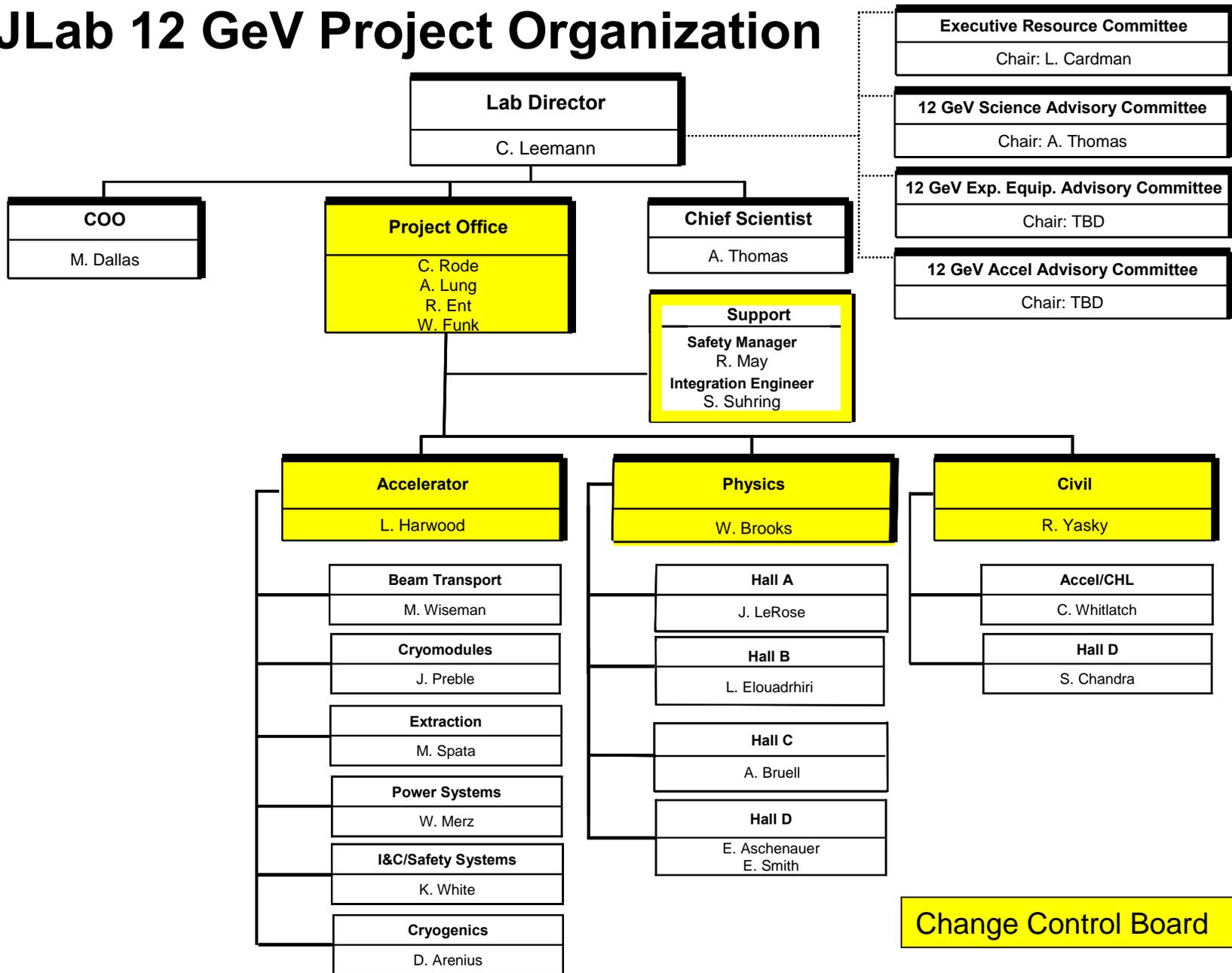
Antje Bruell
Hall C meeting, Jan 26 2007



- **Status of the 12 GeV Upgrade**
 - New management structure
 - Time lines
 - “Latest” cost profile
- **R&D and design work in**
 - Previous R&D work
 - R&D plans for this year
 - Conceptual design work
 - Future design plans for Hall C
- **Summary**



JLab 12 GeV Project Organization



Change Control Board

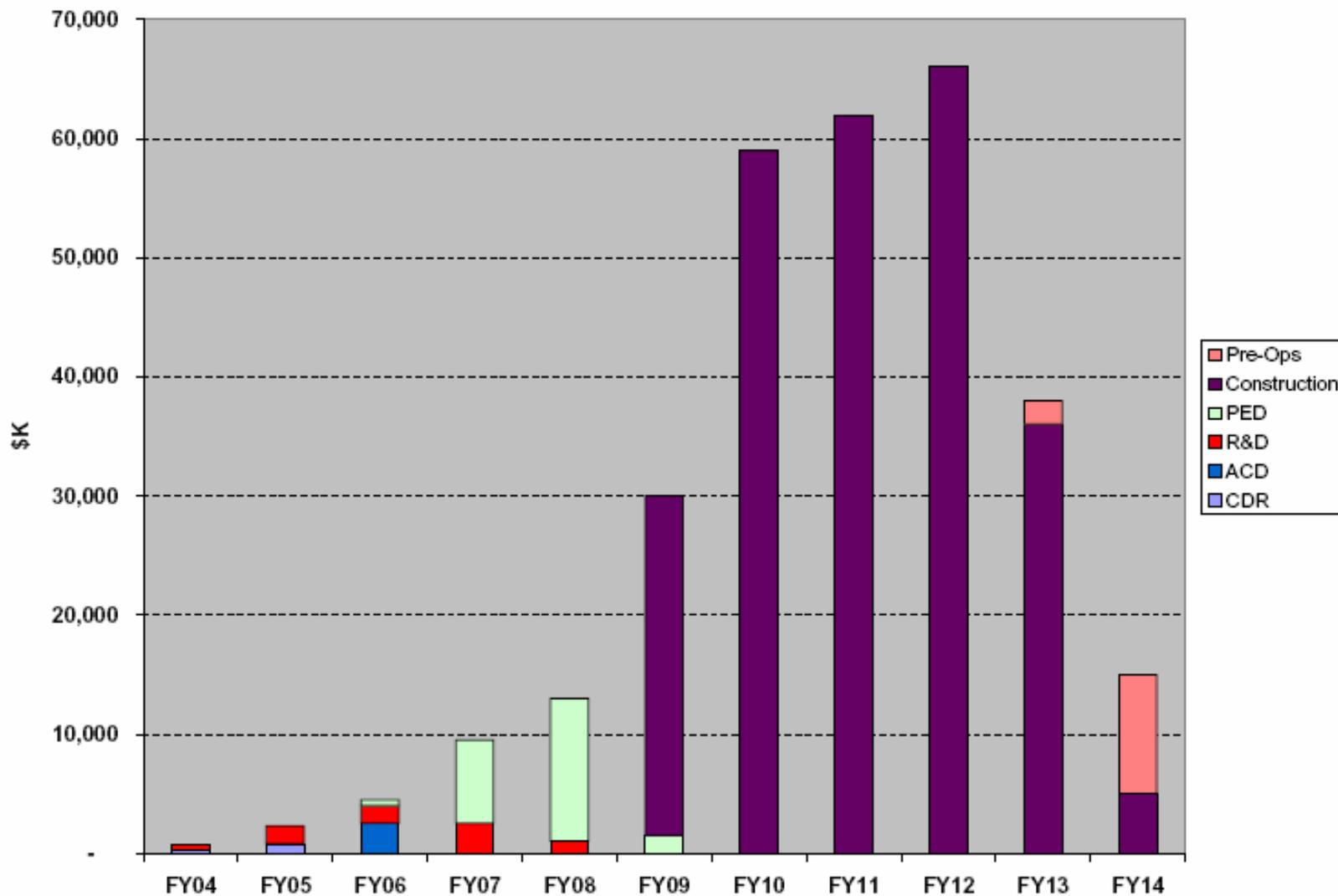
DOE Critical Decision Schedule

	Lehman-05 (July 2005)	CD-1 (Feb 2006)	Lehman-06 (April 2006)
CD-0 Mission Need	2QFY04 (A)	2QFY04 (A)	2QFY04 (A)
CD-1 Preliminary Baseline Range	4QFY05	2QFY06(A)	2QFY06(A)
CD-2A Long Lead CD-3A Construction	2QFY07	4QFY06 3QFY07	NA
CD-2B Performance Baseline	4QFY07	4QFY07	4QFY07
CD-3B Start of Construction	3QFY08	4QFY08	4QFY08
CD-4 Start of Operations	1QFY13	1QFY14	1QFY15

Long term schedule (CD-4) delayed 2 years since Lehman-05 ; 1 year since CD-1 Approval

12 GeV Funding Profile

12 GeV - \$300M Total TPC - 15-Jul-2006



12 GeV Funding 9-JAN-07

	<u>FY04-06</u>	<u>FY07 Plan</u>	<u>FY07 To Date*</u>	<u>% FY07</u>
OPC	7000	2500	945	38%
TEC	500	7000	2175**	31%
TPC	7500	9500	3120	33%

*** Continuing resolution through 15-FEB-07**

**** Additional funds expected 31-JAN-07**

FY07 Continuing Resolution Impacts

- **Currently still on track for CD-2 on 30-SEP-07**
 - **Have slowed down design procurements until 30-JAN-07 and 15-FEB-07 funding arrival**
 - **Expect full PB FY07 funding rate through 15-FEB-07**
- **If we do not get the \$7M PED funds, we will request permission to re-program 6 GeV operations funds to 12 GeV**
- **If we get $\geq 85\%$ of FY07 PED funding, we can still hold CD-2 in FY07.**
 - **If we do not, CD-2 would slip $> 1Q$ and, per DOE guidance, construction start would be delayed from FY09 to FY10**
 - **This would increase TPC by $> \$10M$ due to escalation, etc.**

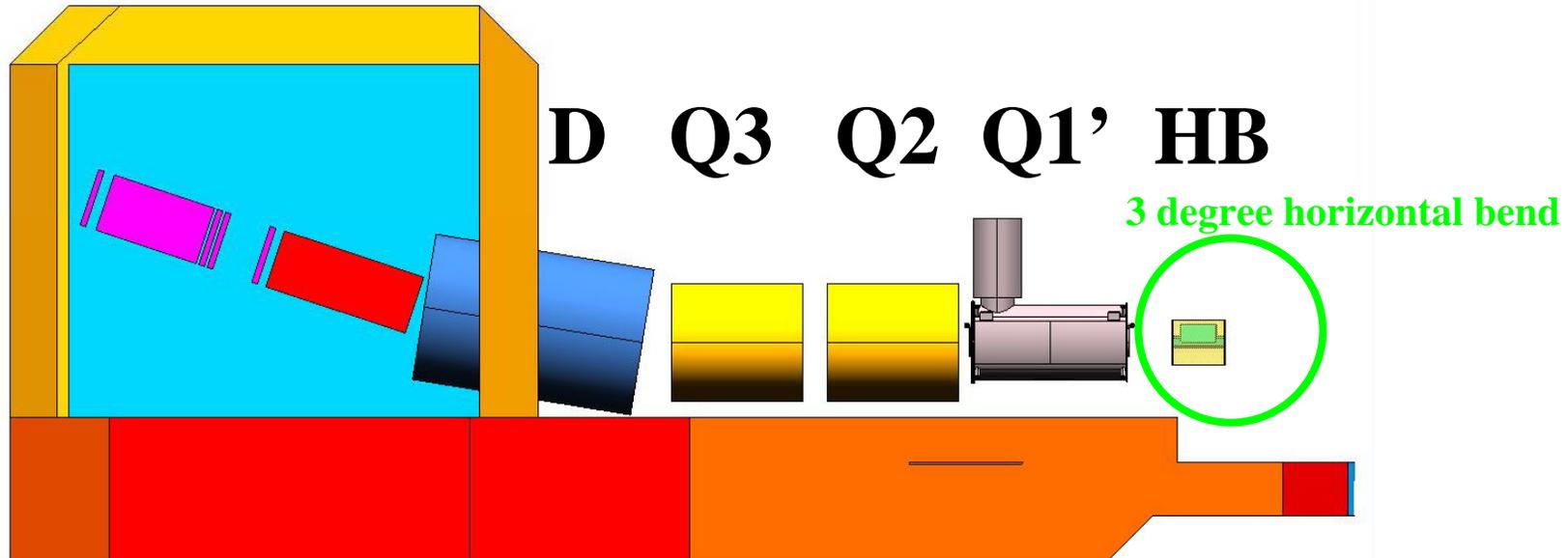
The latest (final) SHMS design



SHMS

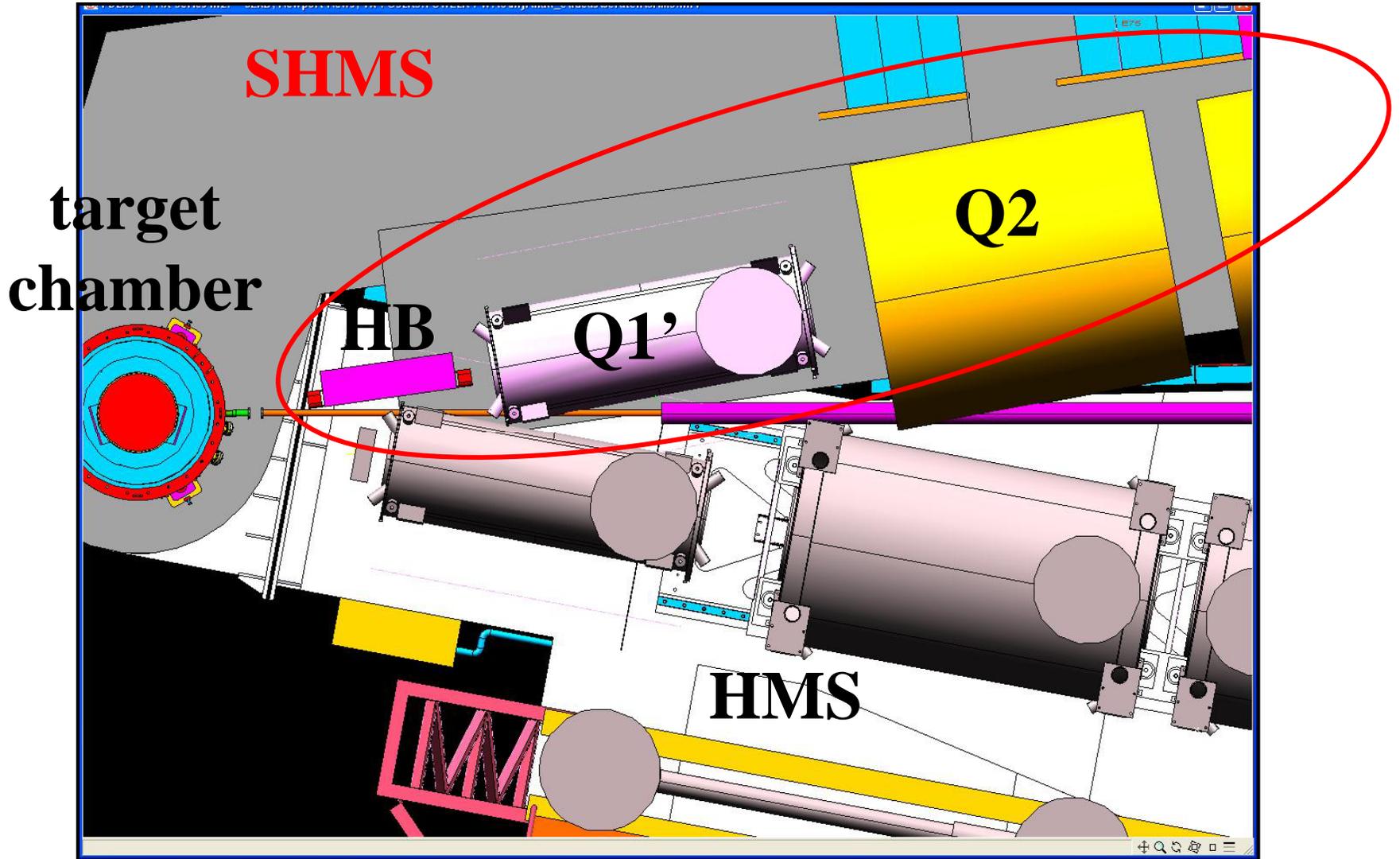
Minimum angle of 5.5 degree
Relatively large solid angle

detectors



No slider !!!

Front region of SHMS & HMS



Summary of FY05/06 R&D



- R&D plan focused on identified risk components
 - Moderate risk: **superconducting magnets**
 - Low risk: Hall C detector components
- **Summary of FY05/06 R&D tasks**
 - 1) Test of SSC superconductor ✓
 - 2) Prototype of burnout proof current lead ✓
 - 3) Feasibility study of combined function magnet ✓
 - 4) Examination of the engineering & technical feasibility and the cost impact of increasing the Q1 gradient ✓
 - 5) Build and test a prototype of the quartz detector
 - 6) Develop alternative calorimeter configurations



Examination of the engineering & technical feasibility and the cost impact of

a) increasing the Q1 gradient to 8.9 T/m (presently 8 T/m) and lengthening the Q1 cold mass by 15%

(FEA analysis to confirm adequate engineering margins)

b) using the existing SSC cable for the Q1' coil

(paper study on coil performance and winding feasibility)

(addresses risks in cost, schedule and performance)

Status:

- Just finished (Sep 20, 2006)
- Work done by Scientific Magnetics, spin-off of Oxford (builders of the original Q1 magnets)
- Independent stress and force analysis at Jlab
- **No problems !**



- R&D on new horizontal bend magnet
 - **Reshaping and testing of existing SSC cable**
 - SSC cable keystoneed during fabrication for SSC magnets
 - HB and Q1' magnet coils are rectangular cross section coils requiring flat cable
 - Re-rolled cable needs to be tested for degradation in performance
 - **Status:**
 - Sufficient amount of cable for both Q1' and HB magnet shipped to company in New England for reshaping (unrolling)
 - Unrolling done last week
 - full report expected within the next two weeks
 - testing of samples of unrolled cable to be done at Brookhaven as soon as possible
 - possibly try to test all cable necessary for building these magnets this year !



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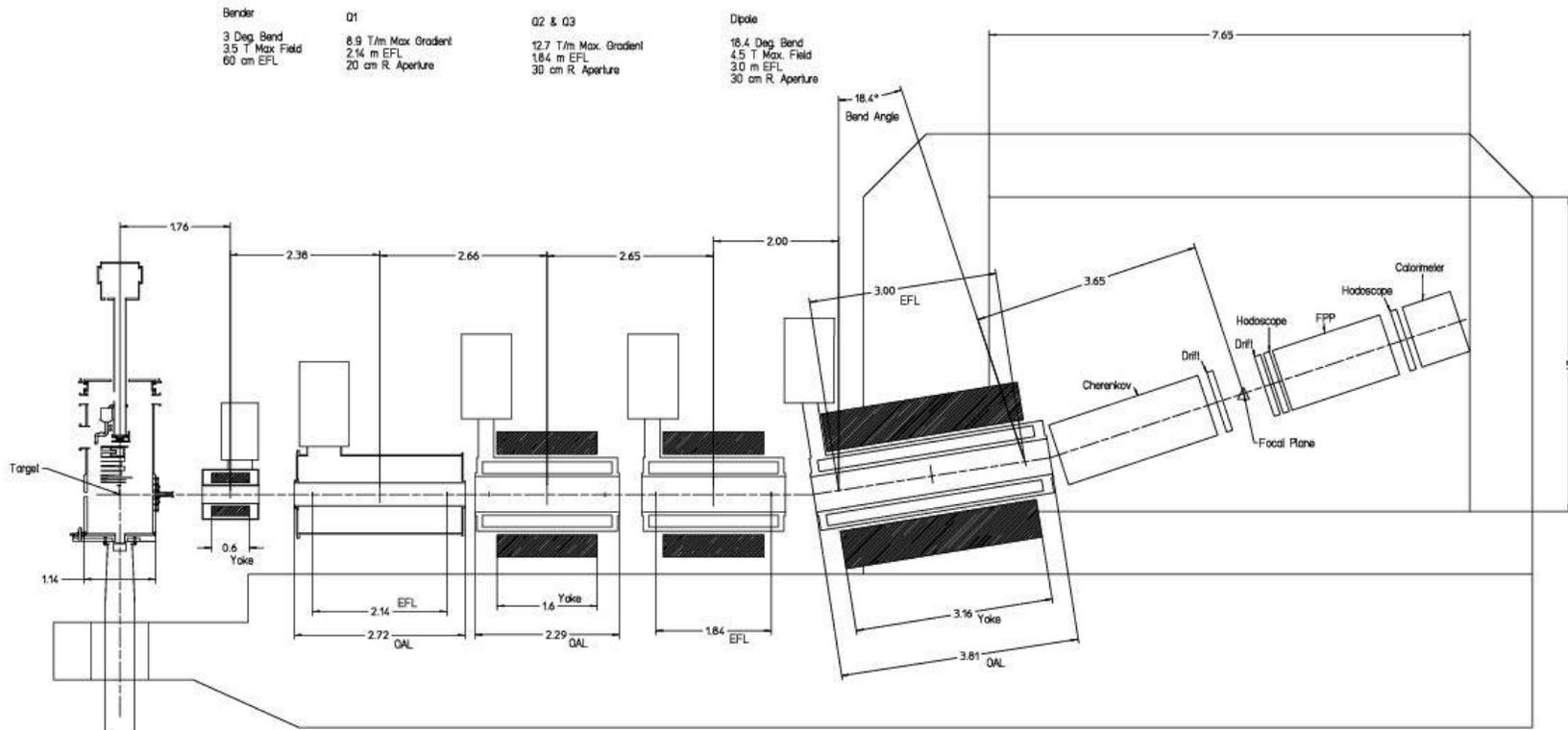


- R&D on new horizontal bend magnet (cont)
 - **Simulate and measure the radiation heat expected at the position of the horizontal bend magnet**
 - Simulate expected radiation heat (see Tanja's talk)
 - Build test device and measure for various angles and targets at 6 GeV (originally planned for April/May 2007, schedule now very uncertain !)
 - Compare to simulation and extrapolate to 11 GeV
 - **Design, build and test a scale cross section model of the horizontal bend SC coil**
 - Test heat removal and insulation properties
 - Measure life expectancy of heat removal & insulation systems and force constraint systems under cryogenic conditions
 - Possibly serve as a radiation degradation test bed

Hall C R&D Plan - FY07



- R&D on new horizontal bend magnet
 - Simulate the radiation heat expected at the position of the horizontal bend magnet
 - Input: exact geometry of SHMS (in progress)





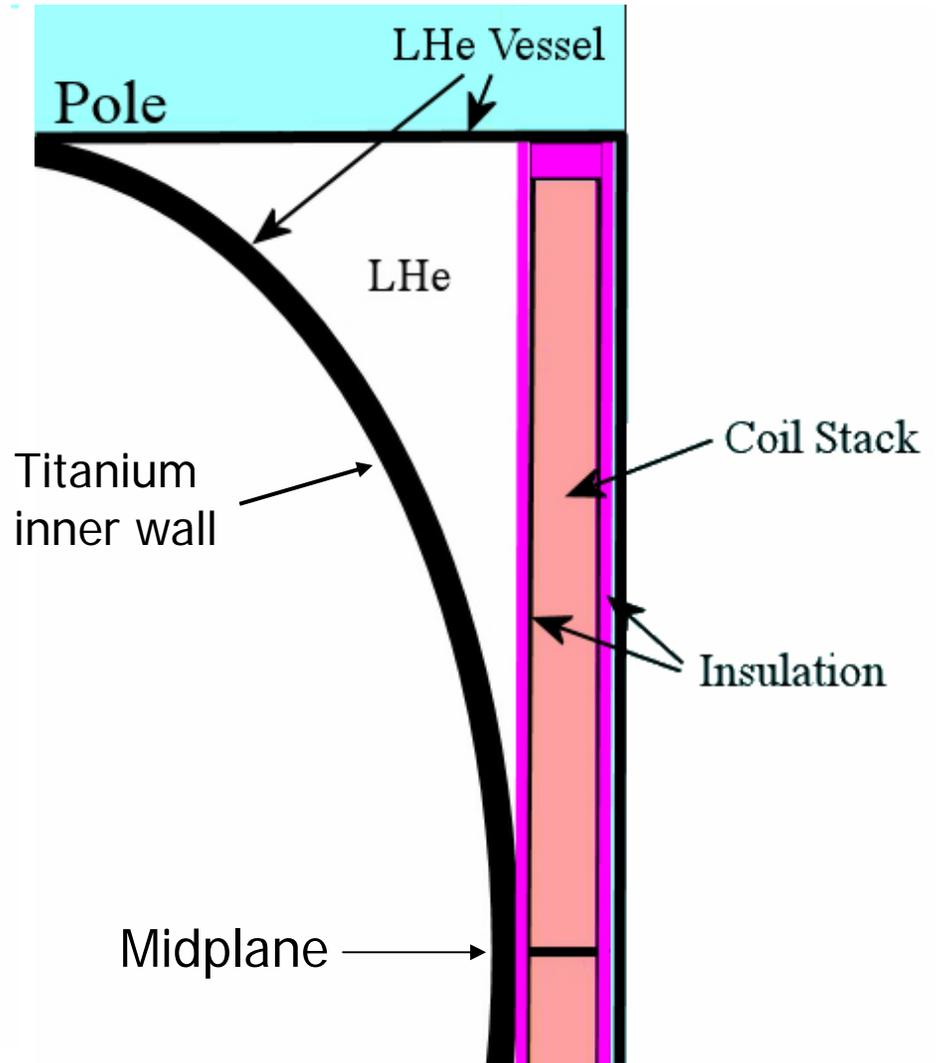
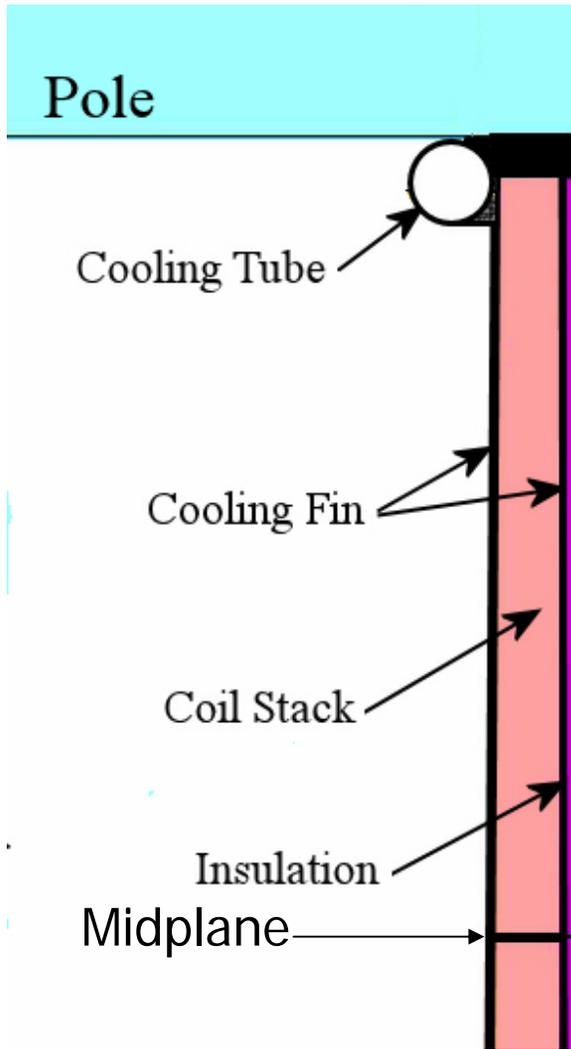
Next steps:

- measure the radiation heat at the position of the horizontal bend magnet**
 - **Build test device and measure for various angles and targets at 6 GeV**
 - **Compare to simulation, improve simulation for $A>1$ targets and extrapolate to 11 GeV**
- design, build and test a scale cross section model of the horizontal bend SC coil**
 - **Test heat removal and insulation properties**
 - **Measure life expectancy of heat removal & insulation systems and force constraint systems under cryogenic conditions**
 - **Possibly serve as a radiation degradation test bed**

Coil Cooling Options

Conduction Cooled

Helium Bathed



Temperature due to 10W flux

I-DEAS 12 NX Series m1: JLAB, Newport News, VA : USERS.LASSITER : W:\Lassiter\Ideas_Work\Model-Files\Conduction-Bender-Coil.mf1

W:\Lassiter\Ideas_Work\Model-Files\Conduction-Bender-Coil.mf1

RESULTS: 19- B.C. 7, TEMPERATURE_19, HEAT FLUX 10 W LA
TEMPERATURE - MAG MIN: 4.50E+00 MAX: 6.60E+00

Temperature K

Maximum temperature: 6.6 K

Critical temperature: 7.75 K

Surface area
 $1.23 \times 10^{-3} \text{ m}^2$

Heat flux applied
to a larger area

6.60D+00

6.39D+00

6.18D+00

5.97D+00

5.76D+00

5.55D+00

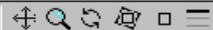
5.34D+00

5.13D+00

4.92D+00

4.71D+00

4.50D+00





Study of quartz detector

- First very preliminary tests done last summer
- Use experience from Qweak and build prototype for in beam test this spring

Study of alternative shower counter configurations

- See talk by Arthur
- Wait for decision on HERMES calorimeter !

Status of conceptual design



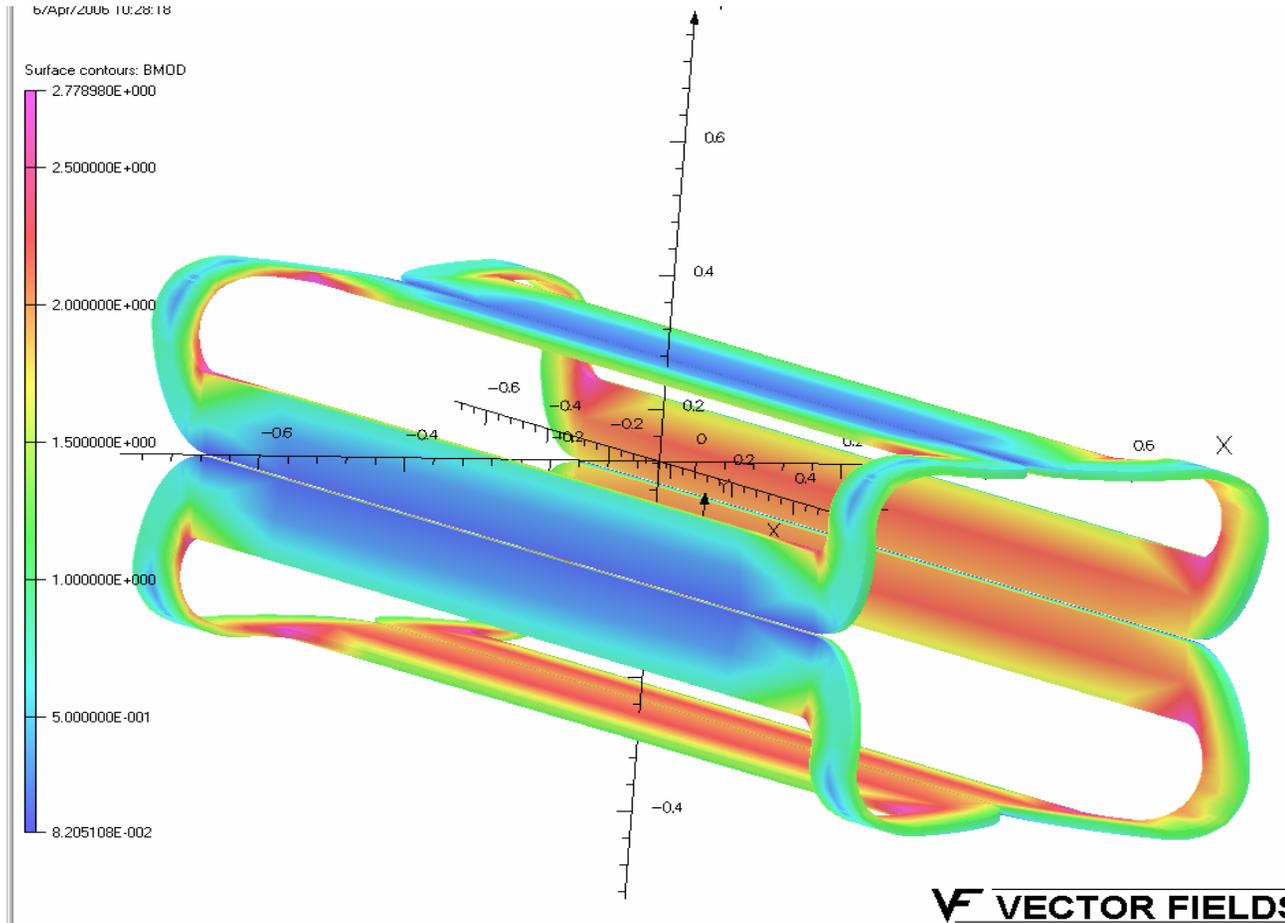
- 1) **spectrometer design optimized** ✓
(simpler magnets, larger acceptance, larger scattering angle)
- 2) **conceptual design for magnets in new SHMS design existing** ✓
- 3) **stress and force analysis for Q1' cold iron magnet completed** ✓
- 4) **tolerance analysis for new SHMS design completed** ✓
(recommendation #26 of 2005 Lehman review)

Presently ongoing (contracts awarded at very end of FY06):

- 1) **conceptual design of cold mass and force collar for new dipole**
- 2) **conceptual design of cold mass and force collar for Q2/Q3**
- 3) **conceptual design of cold mass and force restraint for horizontal bend magnet**
- 4) **quench analysis of Q2/Q3 quadrupoles and dipole (new software tools)**
- 5) **trial winding of the Q1' coil using SSC cable**

stress and force analysis for Q1' cold iron magnet

- Status: **completed**



➤ **All forces within margins**

➤ **Exception:**
total tie bolt force
($\sim 3 \times 10^5$ N)

➤ **Stress in Tie bolt**
about 60% above
HMS design

possible solutions:

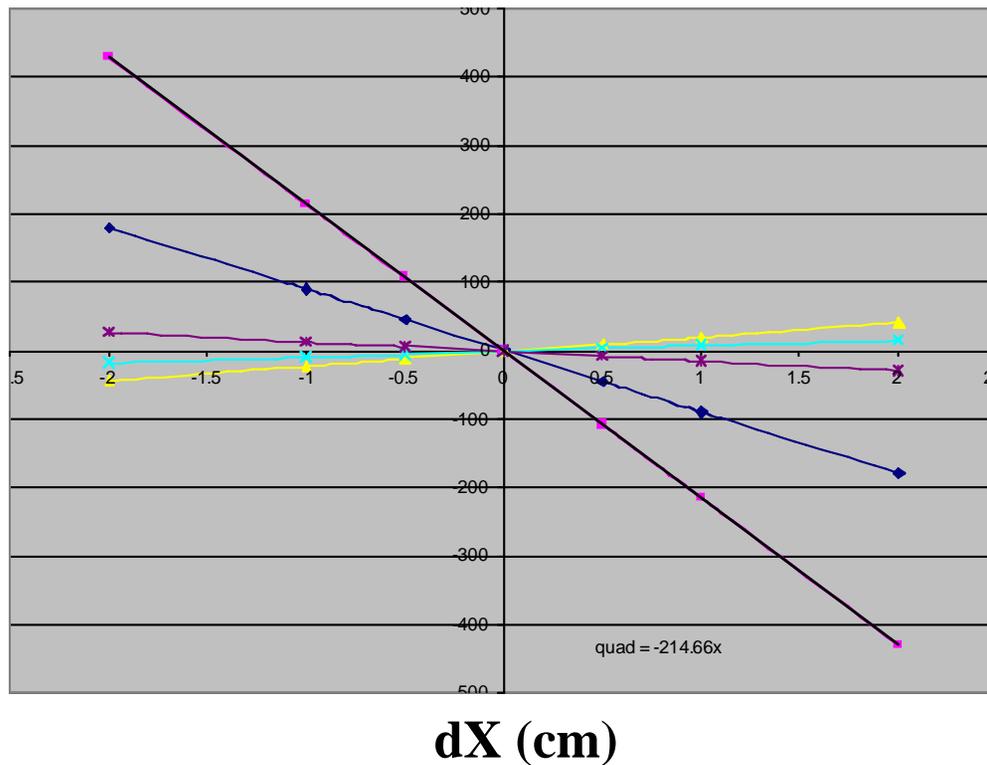
a) larger tie bolts

b) > 1 tie bolt
per sector

Resolution Studies



- New design maintains excellent resolution
- Resolution still dominated by multiple scattering
- **Large tolerances in field inhomogeneities acceptable !**



**Example of
higher
harmonics
caused by
construction
errors (dipole
at 45000 Gauss)**



1) Prepare reference design for Q1', Q2/Q3 and dipole magnet

- Use combination of inhouse engineering and designing labor plus contracts to outside companies
- Resource loaded schedule available
- FY07 PED plan focused on preparation for CD-2 review
- All PED tasks expected to be completed by early summer 2008
- To do:
 - magnetic analysis (lot's of progress (Paul, Steve), additional help by Fermilab engineer ?)
 - design of superconductor (in progress)
 - design of helium vessel and nitrogen shield (preliminary drawings done by Paulo)
 - design of energy dump and quench protection system (under study)
 - (design of control system, copy of new HMS system, almost trivial)
 - design of vacuum vessel
 - design of magnet support and stand
 - preliminary design of cryostat (just started)



2) Prepare reference design for horizontal bend magnet

- Expected to be done in collaboration with Michigan State University
- FY07 PED plan focused towards CD-2 requirements
- All PED tasks expected to be finished by summer 2008
- first contract in place
- MoU to be completed and signed as soon as possible !



3) Prepare reference design for carriage and shield house

- **Contract to update preliminary drawings for new SHMS design just awarded to Alion Science and Technology (new company of Roy Vaughn, contractor of both the HMS carriage/shield house design and the original SHMS carriage/shield house design)**
- **results and new cost estimate expected by April/May 2007**
- **CAD drawings provided by Mike Fowler**
- **more than sufficient for CD-2 requirements !**

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3) Prepare design for detector package

- Almost all detectors are copies of existing detectors
- Present goal (simple): collect existing drawings
- Successful for
 - Wire Chambers (Hampton)
 - Scintillator Hodoscopes (Dave Mack)
 - Aerogel Cerenkov (UVa, Donal Day)
- new design for quartz detector (R&D project, Qweak)
- MRI for wire chambers, hodoscopes and detector frame just submitted to NSF
- missing: noble gas Cerenkov (Argonne, UVa ?)
- shower counter: awaiting decision on HERMES calorimeter blocks (plus PMTs and high voltage) from NIKHEF (end of February)
- results and new cost estimate expected by April/May 2007
- more than sufficient for CD-2 requirements !



4) Prepare design for additional infrastructure

- Includes:
 - New beam line (more or less complete, cost update needed)
 - New scattering chamber (almost done - new chamber for SANE)
 - Cabling (to be updated by Bill Vulcan)
 - Cryogenic system/connections to existing system
 - DAQ and Slow control (to be updated with Steve Wood)
 - Vacuum system
 - Moeller and Compton polarimeter (Dave Gaskell)
- new cost estimate **needed by April/May 2007**

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SUMMARY



- **New project management structure for 12 GeV in place and effective (my personal view) !**
- **The R&D and PED part of the 12 GEV project is in principal on track to achieve CD-2 by the end of this fiscal year (however contingent on further budget decisions/desasters...)**
- **The R&D necessary for Hall C is concentrated on the new HB magnet and the design of the calorimeter and the new quartz detector (needs 5 GeV beam for in beam testing at some time !)**
- **PED work for Hall C is concentrated on the various magnets and the carriage/shield house and is progressing reasonably well (BUT needs to hire 2 additional designers!)**
- **A lot of work remains to be done to achieve CD-2 AND CD-3 !**