

LARP

Maximum coil stress studies with subscale coils

Paolo Ferracin

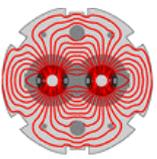
LARP Collaboration Meeting

Port Jefferson

April 6 - 8, 2005



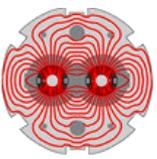
Superconducting Magnet Group



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Outline

- Task goals and proposal
- Cost and schedule

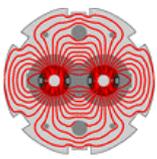


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Task goals and proposal

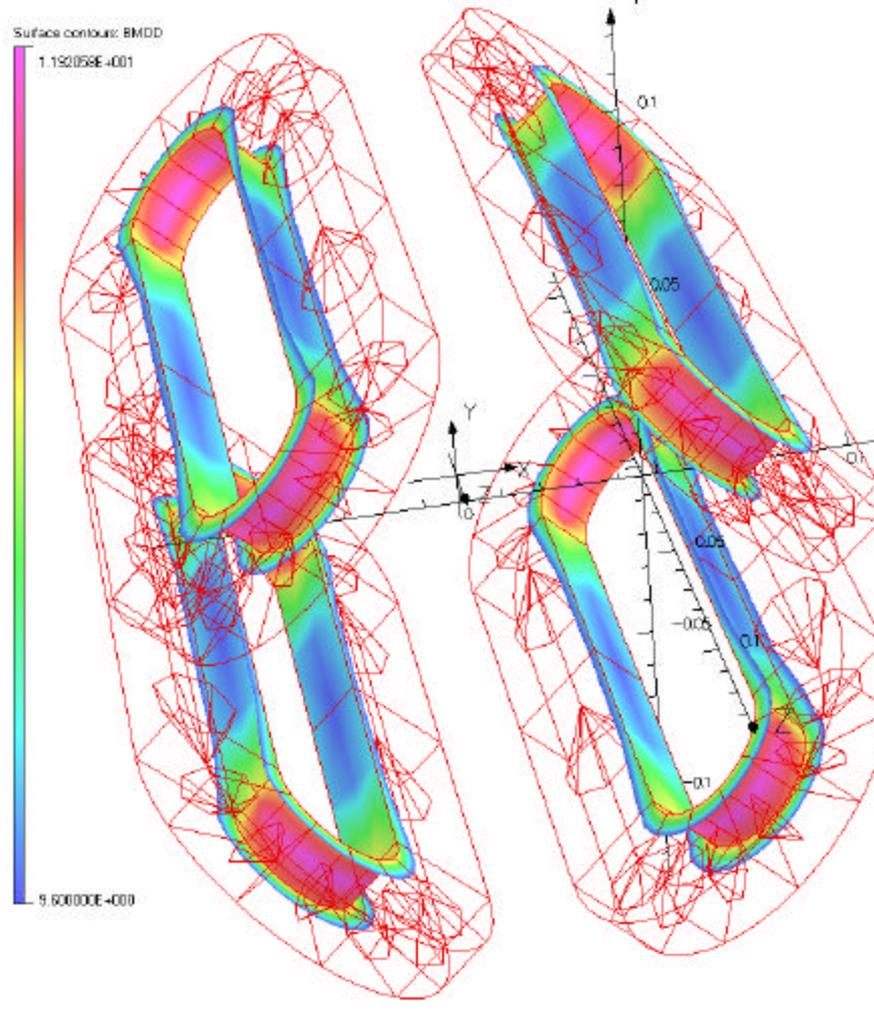
- Goals
 - Evaluate **stress limits** for Nb₃Sn coils
 - **Permanent degradation** of superconducting cable as a function of compressive stress
 - Realistic **magnet conditions**
- Proposal
 - **Two** possible subscale **options**
 - SQ02
 - Stress limit subscale dipole
 - Alternative option: HD1



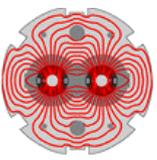


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Stress limit study: SQ02



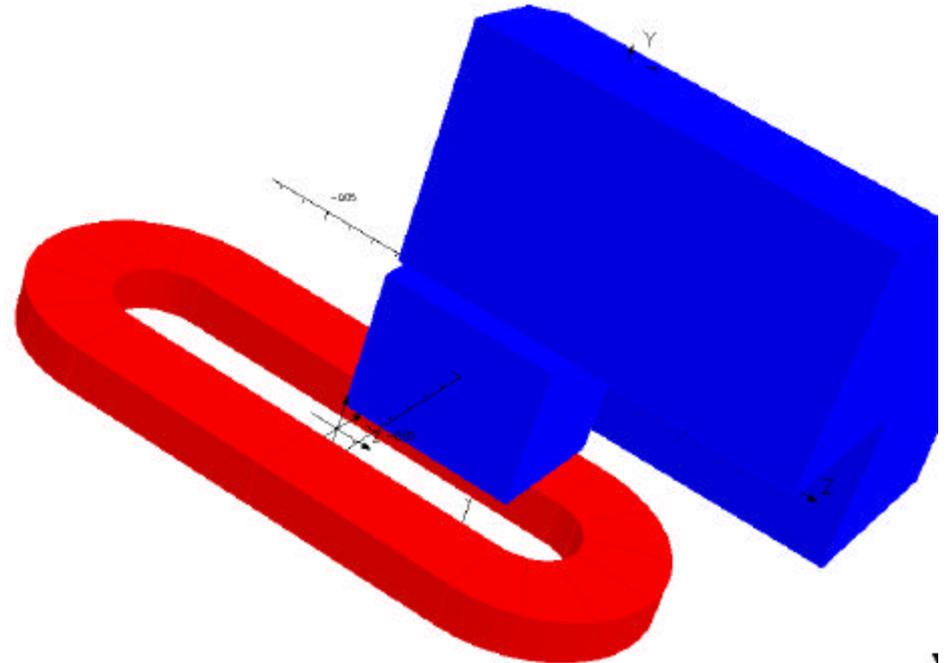
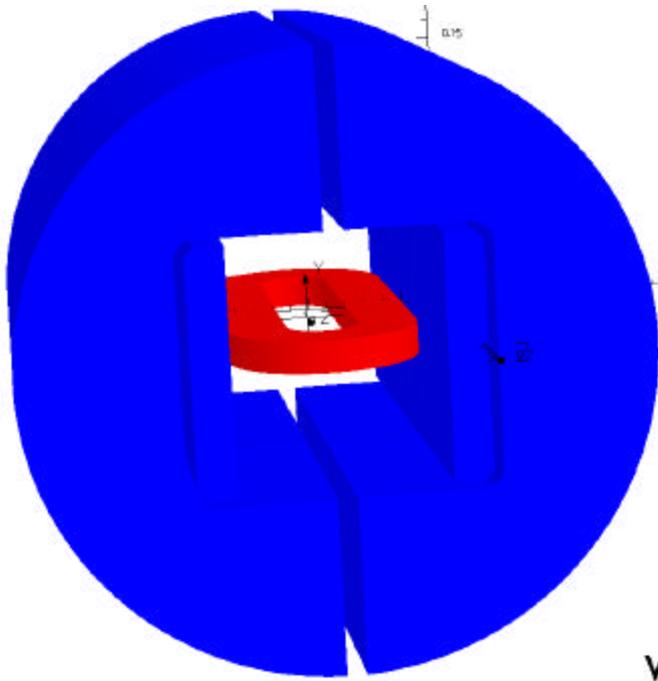
- **Maximum** stress in coil straight section
 - **With** bore
 - 100 - 150 MPa
 - **Without** bore
 - > 200 MPa
- **Peak field** in the ends
 - About 2 T **higher** than straight section
- Peak **stress** in the ends through **axial loading**?

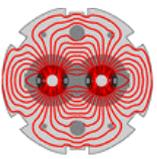


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Stress limit study: subscale dipole

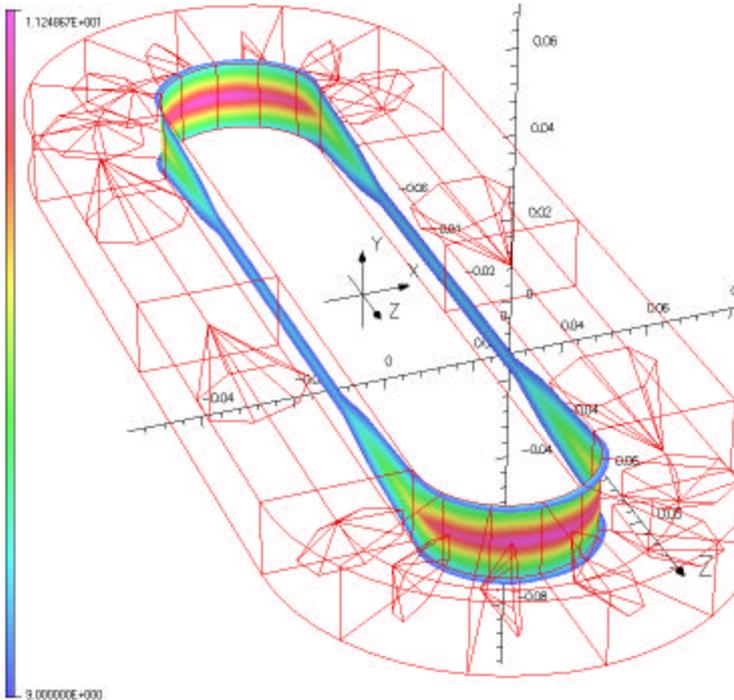
- **One** subscale coil
- Aluminum bronze **island**
- **> 11 T** at **~ 11 kA**
- s_x required ~ 100 MPa
- $F_z \sim 90$ kN
- With / without **iron filler**



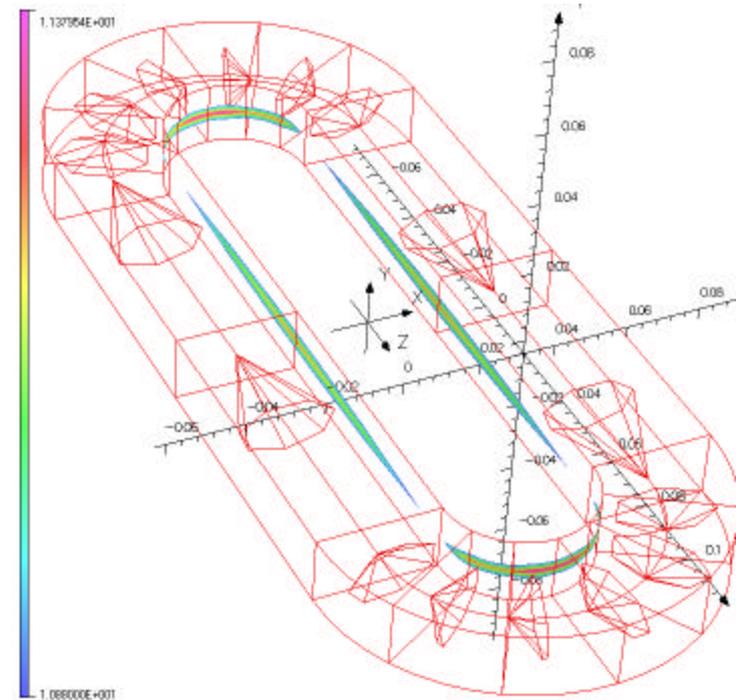


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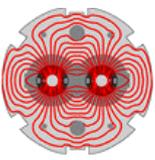
Stress limit study: subscale dipole



- Without iron filler
~ 2 T difference



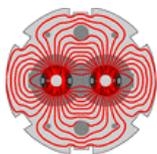
- With iron filler
~ 0 T difference



Stress limit study: subscale dipole

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- Support structure
 - **Shell** thickness 12 mm (subscale)
 - 100 MPa shell stress increase during cool-down
 - Coil $s_x \sim 150$ MPa
 - **Bladder** width $2 * 15$ mm
 - 50 MPa bladder pressure
 - Coil $s_x \sim 100$ MPa
- Total **range**
 - Coil $s_x \sim 150 ? 250$ MPa
- Outer diameter
 - Between 250 mm (SM) and 500 mm (SQ)
- **Changing pre-stress** with the magnet attached to the header may be possible
- Possible **issue**: high stress in the end region

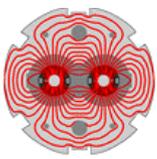


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Stress limit study: subscale dipole

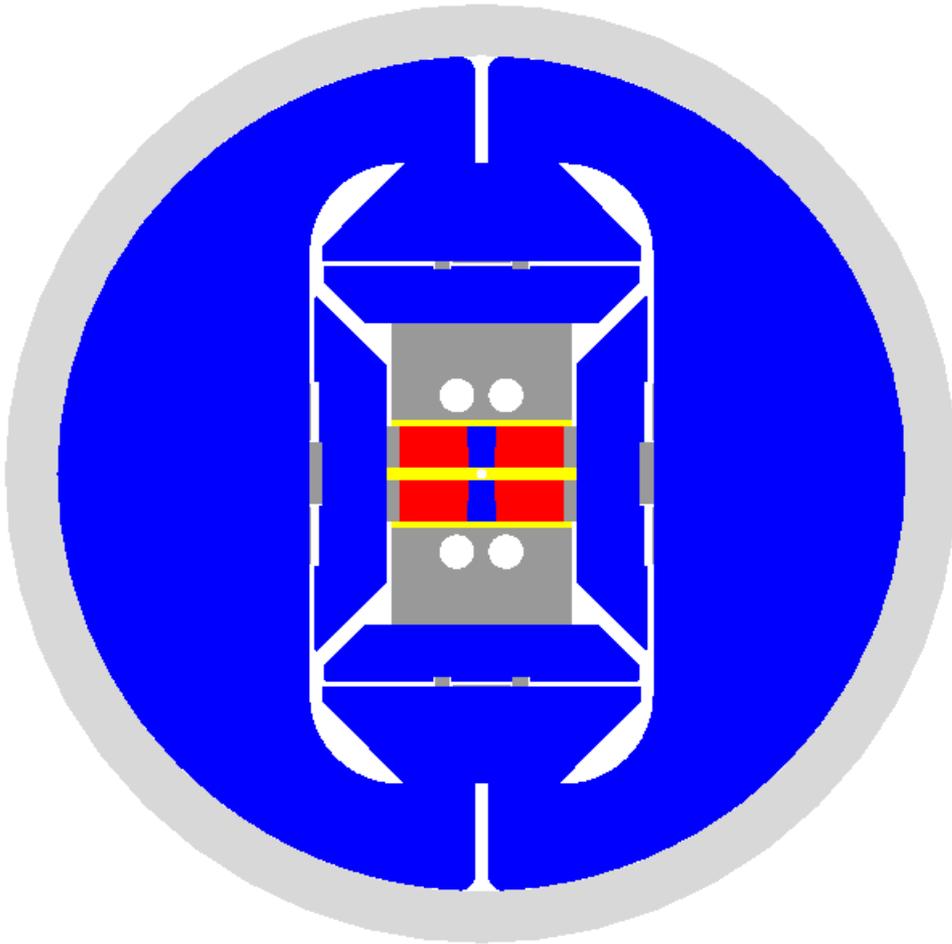
Cost and schedule

- Conceptual, magnetic, mechanical, and engineering **design**
 - Time: Q1/Q2 Cost: 0.3 FTE, 54 k\$
- Coil **fabrication** and part **procurement**
 - Time: Q2/Q3 Cost: 45 k\$
- **Assembly**
 - Time: Q3 Cost: 5 day, 3 Tech: 9 k\$
- **Test**
 - Time: Q4 Cost: 35 k\$ per test
- Total: 143 k\$



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Alternative option: HD1



- Coils and structure available
- Peak field in the **straight section**
- Maximum coil stress **reached** in HD1b: 180 MPa
- Maximum coil stress **reachable**: 200 MPa
- Possibility of assembling **only one coil** (doubling the stress)