

LARP

Technology development with subscale quadrupoles

Paolo Ferracin

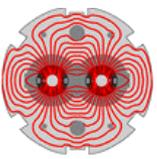
LARP Collaboration Meeting

Port Jefferson

April 6 - 8, 2005



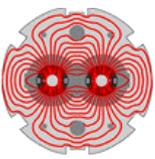
Superconducting Magnet Group



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Outline

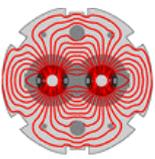
- Effect of axial loading on training
- Quench studies
- Alignment of bladder / key structures
- Additional studies



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Effect of axial loading on training

- SQ02 magnet features and analysis tools
 - Axial force ~ **100 kN** per coil
 - Axial rods ~ **150 kN** per coil
 - 3D finite element **model** of the magnet ? coil stress and conductor motion (gaps)
 - Strain **gauges** placed on rods and coils
 - Voltage **taps** in end regions
 - Peak field in the **ends**
 - Possibility of **changing load** with the magnet attached to the header (to be checked)



Effect of axial loading on training

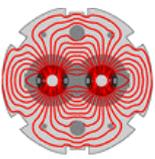
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- Goals

- Study the **relation** between **magnet performance** and **end support**
- Investigate
 - “minimum” required **axial loading**
 - “maximum” acceptable **computed gap** in the ends
 - “maximum” acceptable **conductor motion**
- **Validate** mechanical model

- Proposal

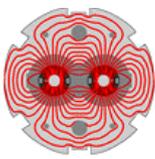
- Perform tests with **different axial loading**
 - Investigate **effect** on training
- Monitor coil stress with **strain gauges**
- Interpret test results with **mechanical model**



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Effect of axial loading on training Cost and schedule

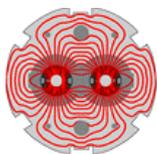
- SQ02: **nominal conditions** (high axial pre-load)
 - Time: FY05
- SQ02b: **50 %** of nominal conditions
 - Time: Q1/Q4, two weeks
 - Cost: 45 k\$
- SQ02c: **no axial loading**
 - Time: Q1/Q4, two weeks
 - Cost: 45 k\$
- Data **analysis**
 - Time: Q1/Q4
 - Cost: 0.2 FTE, 36 k\$
- Total: 126 k\$



Quench studies

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- SQ02 magnet features and analysis tools
 - High **stored energy**
 - Spot **heater**, voltage **taps**, and strain **gauges**
 - 3D finite element **model** of the entire geometry
- Goals
 - Measure **quench propagation** velocity as a function of current
 - Along the turn / turn to turn / layer to layer
 - Study **quench aftermath**
 - Model
 - **Finite element** models / **analytical** models
 - **Validity limits** of different computational approaches
- Proposal
 - Perform **heater induced** quenches during SQ02 tests
 - Analyze results and compare with models



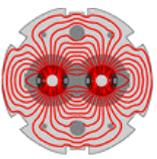
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Quench studies

Cost and schedule

- **Test** of SQ02 / SQ02b / SQ02c
 - Time: FY05-FY06
- Data **analysis** and **modeling**
 - Time: FY06 Q1/Q4 Cost: 0.2 FTE, 36 k\$ + **student**
- Total: 36 k\$ + student

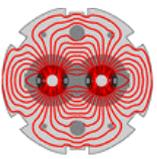




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Alignment of bladder / key structures

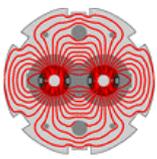
- SQ02 magnet features and analysis tools
 - 12 alignment **keys**
 - Four **identical** coils
 - Field quality **measurements**
 - Magnetic **model**
- Goals
 - Study **alignment** of magnet components and coils
 - Analyze magnetic **measurements** (non-allowed harmonics) and compare them with **computations**
 - Investigate **corrective** strategies (key clearance)



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Alignment of bladder / key structures

- **Test** of SQ02 / SQ02b / SQ02c
 - Time: FY05-FY06
- Data **analysis** and **modeling**
 - Time: FY06 Q1/Q4
 - Cost: 0.1 FTE, 18 k\$
- Total: 18 k\$



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Additional studies

- Effect of azimuthal loading on training
 - Relation between magnet performance and shell stress / coil pre-stress
- Bore function in racetrack quadrupole magnets
 - Assembly component
 - No radial support
- Test of coil with innovative rad-hard insulation