TQS
Status and Plan

Helene Felice
# TQS Tests

<table>
<thead>
<tr>
<th>Magnet</th>
<th>Conductor</th>
<th>Coils</th>
<th>Island</th>
<th>Temperature</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>TQS01a</td>
<td>MJR 54/61 (1900 A/mm²)</td>
<td>5, 6, 7, 8</td>
<td>Bronze</td>
<td>4.4 K</td>
<td>April 2006 LBNL</td>
</tr>
<tr>
<td>TQS01b</td>
<td>MJR 54/61</td>
<td>14, 15, 7, 8</td>
<td>Bronze</td>
<td>4.4 K</td>
<td>Nov, 2006 LBNL</td>
</tr>
<tr>
<td>TQS01c</td>
<td>MJR 54/61</td>
<td>5, 15, 7, 8</td>
<td>Bronze</td>
<td>4.4 K &amp; 1.9 K</td>
<td>March 2007 FNAL</td>
</tr>
<tr>
<td>TQS02a</td>
<td>RRP 54/61 (2800 A/mm²)</td>
<td>20, 21, 22, 23</td>
<td>Titanium</td>
<td>4.4 K &amp; 1.9 K</td>
<td>June 2007 FNAL</td>
</tr>
<tr>
<td>TQS02b</td>
<td>RRP 54/61</td>
<td>22, 23, 28, 29</td>
<td>Titanium</td>
<td>4.4 K &amp; 1.9 K</td>
<td>March 2008 CERN</td>
</tr>
<tr>
<td>TQS02c</td>
<td>RRP 54/61</td>
<td>22, 23, 28, 20</td>
<td>Titanium</td>
<td>4.4 K &amp; 1.9 K</td>
<td>June and Sept. 2008 CERN</td>
</tr>
<tr>
<td>TQS02d</td>
<td>RRP 54/61</td>
<td>22, 23, 28, 20</td>
<td>Titanium</td>
<td>4.4 K &amp; 1.9 K</td>
<td>Dec. 2008 CERN</td>
</tr>
<tr>
<td>TQS03a</td>
<td>RRP 108/127</td>
<td>30, 31, 32, 33</td>
<td>Titanium</td>
<td>4.4 K &amp; 1.9 K</td>
<td>Summer 2009 CERN</td>
</tr>
</tbody>
</table>
TQS02a, TQS02b and TQS02c Training

TQS02a (20, 21, 22, 23)
FNAL

$\varepsilon_\theta$ from 1370 to 1600 $\mu\varepsilon$
$\varepsilon_z$ from 1100 to 1500 $\mu\varepsilon$

TQS02b (28, 29, 22, 23)
CERN
Limitation by coil 29

Coil 29 replaced by coil 20

TQS02c (28, 20, 22, 23)
CERN

[Graph showing quench number versus gradient with different markers and labels for different cooldowns and thermal cycles, indicating data points for each training session.]
TQS02c Thermal Cycles – 4.4 K and 1.9 K Trainings

**TQS02c - 1CD coil 23 ramp quenches at 4.4 K and 1.9 K**

**TQS02c – 2CD coil 23/28 inner / outer**

**TQS02c – 3CD coil 23 inner at 4.4 K and ramp at 1.9 K**

1.9 K tests confirm the instable behavior observed in TQS02a and b

Similar quench location at 4.4 K and 1.9 K

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Helene Felice

04/09/2009
1.9 K ramp rate dependence inversion confirmed by TQS02c third cool-down
No complete disassembly
⇔ Thermal cycle with reduced end loading
Juan Carlos Perez CERN
Ray Hafalia LBNL

Steel bars preventing the end plate from axially fully preloading the coils

Increase of axial tension in the rods during cool-down
⇒ plate pushing against a low thermal contraction part

Same room temperature axial loading
Instability tests performed on TQS02c and TQS02d

Test plan prepared by B. Bordini (CERN), M. Bajko (CERN), S. Caspi and H. Felice
Based on B. Bordini’s work on instabilities: modeling and strand measurement

**Objectives:** to understand the influence of the transport current distribution on magnet performances

**Strand experiment** performed on an RRP strand 54/61 by B. Bordini:

- Current hold at 1350 A at 4.3 K and 6 T → quench at 2.14 K
- Ramping at 2.14 K: quench current = 1050 A

- Current hold at 1200 A at 3.2 K and 6 T → to 1.9 K, quench when ramping
- Ramping at 1.9 K: quench current = 1000 A

- Current hold at 1250 A at 4.3 K and 6 T → to 1.9 K, quench when ramping

The objective was to perform the same test with the magnet
**TQS02c - Cool-down with constant current**

In collaboration with Bernardo Bordini and Marta Bajko

**Principle of the experiment:**
Ramping at the quench current minus 200 A ~ 12100A

No flux jump while cooling

- 4.3 K training quench 12300 A
- Quench 13: 12100 A coil 28 inner
- Quench 14: 11300 A coil 23 ramp
- Quench 15: 12418 A coil 23 inner A9A10
- Quench 16: 12293 A coil 28 inner lost
- Quench 17: 11289 A coil 23 ramp
- Quench 18: 11532 A coil 23 ramp

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Temperature dependence of TQS02c
In collaboration with Bernardo Bordini and Marta Bajko

Quench at 2.67 K: 13037 A ⇔ 231 T/m

Area to investigate

Temperature (K)

Current (A)
TQS02c and TQS02d Temperature dependence

In collaboration with Bernardo Bordini and Marta Bajko

Quench current (A) vs. Temperature (K)

- TQS02c 23 ramp
- TQS02c 23 inner/outer
- TQS02c 28 inner
- TQS02d 23 ramp
- TQS02d 23 inner/outer
- TQS02d 28 outer

TQS02d Low end loading
Coil 28 possibly training
Coils: 20, 22, 23 with copper cladding => ~3.7 ohms per strip

Coil: 28 without copper cladding => ~8.7 ohms per strip
TQS02c Protection Heater Powering

Test of coil 28 PH
C = 4.4 mF τ = 31 ms

Test of coil 22 PH (CC)
C = 4.4 mF τ = 27 ms

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Delay time versus I magnet

\[ \tau \sim 30 \text{ ms} \]

\( \tau \) values for different power densities:
- 55 W/cm\(^2\)
- 73 W/cm\(^2\) CC
- 75 W/cm\(^2\)
- 95 W/cm\(^2\) CC
- 105 W/cm\(^2\)
- 139 W/cm\(^2\)
Delay time versus Power deposition

\[ \tau \sim 30 \text{ ms} \]

![Graph showing delay time versus power deposition with different currents and powers represented by various markers and colors.](image)
Comparison with previous tests

\[ \tau \sim 30 \text{ ms} \]
Coils fabrication and instrumentation
⇒ 30 and 31 potted, being instrumented
⇒ 32 and 33 prepared for potting
⇒ 2 types of strain gages wiring
  ⇒ 30 and 31 with full bridges powered in series
  ⇒ 32 and 33 with each full bridge powered individually

TQS02d back from CERN and ready to be disassembled

Assembly
Shipping end of May
Test at CERN summer 2009

Test plan
Training / Ramp rate => 108/127 at 4.4 K ad 1.9 K
1.9 K tests => instability?
Protection heater tests