Update on the Inner Triplet Powering and Protection

*Felix Rodriguez Mateos*

for the **Magnet Circuit Forum (MCF)**

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Content

- Inner Triplet Circuit
- ECR on HL-LHC Circuits
- K-modulation Circuit
- Cold Diodes
- Quench Detection Instrumentation
- ECR on “Local Powering” of Corrector Package Circuits
- Disconnectors
- Conclusions
IT Circuit

All the information is available from the Magnet Circuit Forum

BASELINE

Option

See presentation on crow bar designs by H Thiessen this pm
Inner triplet as system

<table>
<thead>
<tr>
<th>Magnet</th>
<th>Cold Powering</th>
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<tbody>
<tr>
<td></td>
<td>$I_{\text{ult}}$ (kA)</td>
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<tr>
<td>MQXF</td>
<td>17.82</td>
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<tr>
<td>Trim Q1</td>
<td>2</td>
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<tr>
<td>Q2a/Q2b</td>
<td>Protec.</td>
</tr>
<tr>
<td>Trim Q3</td>
<td>2</td>
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ECR on HL-LHC Circuits

- Suppression of Q2a trim
- Additional Q1a k-modulation circuit
- Ratings of the superconducting elements of the inner triplet circuit
- Cold Diodes – still as option
- Circuit Disconnectors
- “Local Powering” of 120A/200A corrector circuits of the Inner Triplet
K-modulation Circuit
Impact of K-modulation Configuration (warm powering)

- K-modulation circuit has impacts to the following:
  - Current looping in sub-circuits
  - Decoupling matrix configuration
  - Power converters state management

- Disconnection and reconnection of the k-modulation circuit
  - Current looping is not a problem, but needs to be considered
  - Same configuration could be kept for the decoupling matrices (at a risk of additional instability - to be studied)
  - One software for state management could be maintained

A permanent configuration is preferable for development and complexity reduction

See talk by L Williams on k-mod feeders this pm

Felix Rodriguez Mateos
Impact of K-modulation Configuration on Protection

- k-modulation circuit seems to be beneficial in reducing the maximum voltages in case of imbalanced quench between Q1a and Q1b.

- In any case, Q3 has to undergo the quench discharges regardless of absence of k-modulation circuit.

- It is critical that during operation / quench, the 35 A trim circuit does not switch from connected to disconnected, as this would lead to very high voltages in the circuit.

Both presence or absence of the k-modulation circuits are acceptable for WP7. However, it would be preferable to keep one circuit configuration to limit complexity and help automated analysis.
Cold Diodes
Radiation levels at the cold diodes position

See plenary talk by Giorgio D’Angelo and session on Wednesday am about radiation levels and effects, test results so far, etc

Ruben Garcia Alia et al.
Position to place the cold diodes

Integration studies on going

See slides by Y Leclercq
Vto vs dose/fluence for diodes at CHARM

Open questions:

a) margins in terms of Vto, Vfwd, Vrev, C
b) effects of annealing

See slides from G D’Angelo and A Monteuuis
Instrumentation for Quench Detection
Quench Detection Baseline

- Recall on quench protection strategy
- Every pole of the magnet is instrumented
- QD system measures the voltage over each pole of a magnet using an isolated channel
- Internal magnet bus bars are covered by the pole voltages
- Bus bars between magnets and magnets to link are covered by dedicated, isolated channels
QD instrumentation

Endorsed by MP3
- Vtaps with unique names
- Vtaps in the trims are not needed
- Vtaps needed before the DFX
ECR on “local powering” of the corrector package circuits

See presentation on this topic this afternoon
Baseline/recommendations

120A/200A circuits powered with sc link

Recommendations by TCC

• To decouple the decision on the sc link from location of power converters
• Approve the changes to the link
• Study on going to keep converters in UR
Disconnectors
Integration Concept in the UR (Q1 → D1) with CDBs

- Proposed integration concept with CDBs and distributed current leads

See talk by Samer Yammine on Thursday
Conceptual Solution for the IT Main Circuit

18 kA

CDB1-1

CDBX-1

CDBA1

± 2 kA

CDB1-2

CDB2-1

CDB2-2

CDB2-3

CDB3-1

CDB3-2

CDBX-2

Q1

Q2a

Q2b

Q3

± 35 A
Conclusions

- Inner Triplet Circuit is consolidated (looking forward to include cold diodes in baseline)
- ECR on HL-LHC Circuits has been issued, documentation up to date
- K-modulation circuit is proposed to remain connected
- Cold Diodes – radiation tests ongoing, promising results
- Quench Detection Instrumentation – endorsed by MP3
- ECR on local powering, approved by TCC the changes on sc link, pending location of converters
- Disconnectors – final stage of study and approval by TCC
Thanks
Questions?