TEC Status Report

Tracker General Meeting, February 7th, 2007

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On behalf of the TEC Community
Outline

• TEC+ Status and Plans
  - Selected results from cold test
  - Preparation and plans for insertion into support tube

• TEC- Status and Plans
• 4 sectors = 50% of TEC+ have been tested cold at CERN
• 2 sectors = 800 modules = 5% of the tracker tested at once
• Sectors 2 & 5: - cold test on December 13\textsuperscript{th}/14\textsuperscript{th}
  - results presented at QA meeting January 10\textsuperscript{th} by Richard Brauer
• Sectors 1 & 3: - cold test on January 13\textsuperscript{th}/14\textsuperscript{th}
  - results presented at QA meeting February 6\textsuperscript{th} by Alexander Linn
• Lyon cold room can go down to -25 °C
• In addition, active cooling with C\textsubscript{6}F\textsubscript{14} by one, later two chillers
• Aim for silicon temperature at -10 °C when powered and configured
• TEC volume and cold room flushed with dry air (T\textsubscript{dew} = -70 °C)
• Extensive temperature and humidity monitoring (> 30 external T+H probes and 16 thermistors)
• All sectors measured warm (T\textsubscript{chiller} = +15 °C) - cold - warm
TEC+ Cold Test

Sectors 2 & 5:

Sectors 1 & 3:
Hybrid Temperature

- Sector 1: old magnet test chiller, $T_{\text{fluid}} = -15^\circ\text{C}$
- Sector 3: CERN PIC chiller, $T_{\text{fluid}} = -20^\circ\text{C}$
- Cold room temperature: -21°C
- Generic DCU calibration constants used
Hybrid Temperature

Mean values computed for modules sharing the same Sector.
Silicon Temperature

- Sector 1: old magnet test chiller, \( T_{\text{fluid}} = -15^\circ\text{C} \)
- Sector 3: CERN PIC chiller, \( T_{\text{fluid}} = -20^\circ\text{C} \)
- Cold room temperature: -21°C
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Silicon Temperature

Mean values computed for modules sharing the same Sector.
Low voltages

Sectors 1 & 3; chips fully configured:

1.25V

- **Warm**: Low voltage: V1.25
  - Entries: 800
  - Mean: 1.218
  - RMS: 0.02909

- **Cold**: Low voltage: V1.25
  - Entries: 800
  - Mean: 1.219
  - RMS: 0.02598

2.50V

- **Warm**: Low voltage: V2.5
  - Entries: 800
  - Mean: 2.459
  - RMS: 0.03974

- **Cold**: Low voltage: V2.5
  - Entries: 800
  - Mean: 2.457
  - RMS: 0.03719
Optical Gains

Sectors 1 & 3

Gain from opto scan, $T_{\text{silicon}} \approx 23^\circ C$, $T_{\text{hybrid}} \approx 33^\circ C$

- Warm

Gain setting optimized for gain $= 0.8 V/V$, $T_{\text{silicon}} \approx 23^\circ C$, $T_{\text{hybrid}} \approx 33^\circ C$

- Warm

Gain from opto scan, $T_{\text{silicon}} \approx -11^\circ C$, $T_{\text{hybrid}} \approx 0^\circ C$

- Cold

Gain setting optimized for gain $= 0.8 V/V$, $T_{\text{silicon}} \approx -11^\circ C$, $T_{\text{hybrid}} \approx 0^\circ C$

- Cold
increase of gain with lower temperature leads to double peak in gain distribution
Tick Height

Sectors 1 & 3

warm

Front petals

Back petals

Sector 1

Sector 3
Mean raw and common mode subtracted noise per APV in deconv. mode: sectors 1 & 3

See later
Single Strip Noise

Sectors 1 & 3 in deconvolution mode

Normalization to tick height (assuming tick height corresponds to 8 MIPs and 1 MIP corresponds to 25000 e⁻/300 μm) and to strip length of ring 1

- Comparison between room temp. and cold
- APV parameters optimised for 0 °C
- Mean difference: 52 e⁻ ≈ 3%
- Known real defects not included
- Tails due to two lasers with slightly higher noise and two APVs with slightly lower noise in cold
Common Mode Noise

Mean common mode noise divided by mean common mode subtracted noise (both per APV) in deconv. mode: sectors 1 & 3

see later

known problem
Common Mode Noise

Comparison between room temperature and cold

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TEC Status Report
RMS of noise divided by mean noise (both per APV) in deconv. mode: sectors 1 & 3

Known problem
Noise Flatness

Comparison between room temperature and cold

![Comparison Graphs]

- **Room Temperature**
  - $\chi^2 / \text{ndf}$: 205.6 / 144
  - Constant: $56.29 \pm 1.40$
  - Mean: $0.02484 \pm 0.00004$
  - Sigma: $0.001969 \pm 0.000033$

- **Cold**
  - $\chi^2 / \text{ndf}$: 152.6 / 160
  - Constant: $46.94 \pm 1.15$
  - Mean: $-4.257e-05 \pm 4.578e-05$
  - Sigma: $0.002402 \pm 0.000038$
Problems during Cold Test

Sectors 2 & 5:
• Two modules with flaky I²C communication in the cold
  - Sector 5, FP7, module 7.1: I²C lost at 0°C
  - Sector 5, FP1, module 7.1: I²C lost at -4°C and recovered at -14°C, stayed ok
• One laser with low noise in the cold, tick looks ok, recovered after warming up (sector 2, BP2, laser 7.5/0)

Sectors 1 & 3:
• One module with flaky I²C communication at room temperature after cold test
  (sector 3, BP8, module 4.2; to be confirmed during slice test)
• One bad laser at room temperature both before and after cold test, but ok in the cold (sector 3, BP4, laser 2.1/0)
• One bad APV: high CM but ok in Aachen and before and after cold test, very low noise in the cold (sector 3, BP3, module 4.3)

⇒ I²C problems on level of 2 %
⇒ Laser problems on level of 0.5 %
This includes all problems with “flakyness” of components during cold test.
Preparation for Insertion

TEC+ moved from rotation cradle into “mini chariot”, which is needed to move later into Antti chariot
Preparation for Insertion

“Rotation disk” removed...
Preparation for Insertion

...and replaced by carbon fiber front disk

Gap between front disk and skins will be closed by CF ring and sealed with tape
Preparation for Insertion

Sliding pads for support of TECs on rails in support tube and z-stops mounted
• Manifold connections of all petals tightened after cold test
• All sectors again tested for leaks
• Pressure decay test with Nitrogen at ~ 12 bar (custom Aachen/Lyon system)
• One leak found (next slide)
• Other seven sectors have leak rate $< 1.8 \times 10^{-4}$ mbar l/sec (cut for single petal circuits: $1.3 \times 10^{-4}$ mbar l/sec)
Preparation for Insertion

- One small leak found (sector 6, BP4)
- Bubble test: leak between manifold and pipe
- Petal ok after production, but circuit bad in Aachen integration (slipped through QC)
- Mishandling? Manifolds known to be fragile
- Leak fixed by filling slit with glue
- Titanium piece glued as strain relief
- New test to be done
Roadmap to Insertion for TEC+

7.2. Grounding of front disk
    Sealing of sliding pads with silicon
    Mounting of bellow
    Weighing of TEC+
    Investigate damage on two ribbons (bulkhead side);
    can probably be fixed in support tube

8.2. Move into Antti chariot

9.2./12.2. Metrology: envelope (with skins) and structure (without skins)

10.2. Finalize grounding on bulkhead (Nitrogen pipes, skins, cables...)

16.2. Review “readyness for insertion”

21.2./22.2. Final sealing of skins and front disk
    Insertion
TEC- Status

- Sectors 4 & 8 re-tested in the TIF
- Moved to cold room
- One leaky petal exchanged (problem to be investigated)
- Two ribbons (sector 7) damaged and exchanged
- Two cold tests foreseen: sectors 2 & 7 and sectors 4 & 6
- Commissioning at room temperature for sectors 2 & 7 done
- Cold test this week
TEC- Performance from Integration

Noise normalized to tick height and strip length of ring 1

![Graph showing noise distribution and statistical data](image)

<table>
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<tr>
<th>Sector</th>
<th>Missing</th>
<th>%</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>8</td>
<td>512</td>
<td>0.21%</td>
<td>2 broken fibers</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0.00%</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>0.00%</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>0.00%</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>384</td>
<td>0.16%</td>
<td>1 bad APV, 1 broken fiber</td>
</tr>
<tr>
<td>3</td>
<td>256</td>
<td>0.11%</td>
<td>1 broken fiber</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0.00%</td>
<td>-</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0.00%</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1152</strong></td>
<td><strong>0.06%</strong></td>
<td>-</td>
</tr>
</tbody>
</table>
TEC- Plan

Week 6 (this week): cold test of sectors 2 & 7

Week 7: second test at room temperature;
cabling of sectors 4 & 6

Weeks 8/9: cold test of sectors 4 & 6

Week 10/11 (mid March): move to TIF and insertion into support tube
Summary & Outlook

**TEC+:**
- Cold test finished, 50% of TEC+ tested
- Generally good noise performance
- Flakyness with $I^2C$ and laser output on level of few per mille observed
- Preparations for insertion into support tube ongoing
- Insertion foreseen for end of February
- Participation in slice test

**TEC-:**
- Two sectors re-tested at room temperature
- 50% of TEC- to be cold tested
- Commissioning of S2 & S7 at room temperature done
- Insertion envisaged for mid of March