TEC+ Reception & Cold Test - Status and First Results

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Katja Klein
1. Physikalisches Institut B, RWTH Aachen

Thomas Bergauer, Richard Brauer, Marko Dragicevic, Dirk Heydhausen, Alexander Linn
Outline

• Motivation
• Setup
• Status
• First results
• Summary & plans

More details & results by Thomas Bergauer in TEC TIF meeting (Thursday at 9:00)
After integration in Aachen, TEC+ was transported to CERN on October 31st.

Reception test necessary to check for damage due to transport.

Cold test desirable to test the TECs in tracker operating conditions.

Two sectors (¼ of a TEC) are tested at once.

Two bad petals (located in same sector) have been exchanged at CERN.

Three sectors have not been tested in Aachen after repair of power cables.

\[ \Rightarrow \text{Minimal number of sectors to test: } 4/8 \]
\[ \Rightarrow \text{Minimal number of test cycles: } 2 \]

Decision on number of sectors to be tested will be based on outcome of the first tests!
The Setup

- 2 sectors = 25% of a TEC = 800 modules = 1888 fibers = 483 328 channels = 5% of the whole tracker!

- TEC two-sector setup is a useful testbed for debugging & commissioning of many sub systems:
  - PVSS
  - DAQ
  - CMSSW commissioning software
  - DQM
  - Interlocks

- Fruitful collaboration with software experts partly already established (DAQ, PVSS), partly to come (commissioning & DQM tools)

- Not all requests for run time can be fulfilled
The Setup – Coldroom, Chiller, Dry Air

- Lyon cold room
  - 12 kW power
  - can cool down to -20°C
  - no active heating

- Three electrical heaters in cold room to speed up the warm-up phase

- TEC itself cooled with C\textsubscript{6}F\textsubscript{14}, using dedicated chiller

- Dry air supply flushing TEC volume and cold room itself
  - flow ≈ 30m\textsuperscript{3}/h, dew point -70°C
  - connected to UPS
  - second dry air unit can be connected in case of problems
The Setup – Interlock and Monitoring

- First time a complete subdetector goes cold
- Considerable risk → interlock conditions worked out in detail
  (thanks to Jeff Spalding & Nicola Bacchetta)
- PLC interlock system
- Input: 16 thermistors, 16 PT100s, 12 external Honeywell humidity sensors
- Interlock on power supplies implemented
- Interlock on chiller and cold room to come
- PVSS running fine after some debugging and memory upgrade
- Custom interlock on dry air supply; input: humidity and flow
- In total, 3 completely independent systems for temperature and humidity monitoring
The Setup – DAQ Hardware and Software

- 24 FEDs; VME readout only
- 4 FECs for 18 control rings
- Trigger based on TTCci, TTCex, TTCoc
- Development DAQ version used ("tifdev")
- Data taking via run control
- Online Oracle data base used
- CMSSW commissioning software tested for one day
- Transition phase: some sources of information (xml files...) of old DAQ version not available anymore, but new commissioning software not yet commissioned and not routinely used...
Measurement Program

- Full commissioning at room temperature to
  - disentangle effects from transport and temperature
  - avoid having to heat up for debugging

- Cold test running condition: -20°C both for cold room and chiller

- Measurements during cold test:
  - Test of control rings and redundancy
  - I2C test
  - HV ramp-up test
  - Connection scan
  - Commissioning: timing – gain scan – timing – VPSP
  - Pedestals at peak and deconvolution mode with and without HV
  - Readout of DCUs
• Currently the first two sectors are being tested:
  sectors 2 (where two petals have been exchanged) & 5
• Very rocky start-up, many hard and software problems
• Cold room with services ready
• Sensor readout ready
• Interlock ready (but to be upgraded)
• DAQ running (but stability to be improved)
• Commissioning at room temperature done (see later)
• Detailed shift instructions
• First cooling cycle down to -25°C cold room temp. done
  - cool down about 6 hours
  - temperature difference between TEC cooling pipes and dew point above 10K
  - warm up about 8 hours with electrical heaters
• Chiller can currently not go below -10°C, to be investigated
First Results at Room Temperature

- Full commissioning at room temperature done
- Chiller at 15°C
- Relative humidity typically 10%
- Plots produced with Aachen tools
- More refined analysis to come
Chips configured with parameters as determined by commissioning

\[ T_{\text{inlet}} = +15^\circ\text{C} \]
Chips configured with parameters as determined by commissioning
Optical Gain Quality

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

Gain setting

Measured gain after optimization

Gain setting optimized for gain = 0.8 V/V, $T_{\text{silicon}} = 23^\circ \text{C}$, $T_{\text{hybrid}} = 33^\circ \text{C}$
Tick Height from Timing Run

Sector 2

Sector 5

front petals

back petals

known problem
Noise Distributions

FP1 of sector 2

Raw noise
Cms noise

ring number

module within ring

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TEC+ Reception & Cold Test
Mean Noise per APV – Deconvolution Mode

sector 2

sector 5
Mean Noise per APV – Deconvolution Mode

sector 2

TEC+ integration in Aachen:

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TEC+ Reception & Cold Test
Ratio of mean CM noise to mean intrinsic noise, per APV:

sector 2

sector 5
Common Mode Noise – Deconvolution Mode

sector 2

TEC+ integration in Aachen:

run 1068 - Sector 25 - test run 1068 - deconv mode warm with HV

run 21493 - Sector 2 - reference run 21493 - deconv mode warm with HV
Ratio of RMS of noise to mean noise, per APV:

**sector 2**

**sector 5**
Noise Flatness – Deconvolution Mode

**TEC+ integration in Aachen:**

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**run 21493 - Sector 2 - reference run 21493 - deconv mode warm with HV**

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**run 1068 - Sector 25 - test run 1068 - deconv mode warm with HV**

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sector 2
Problems at Room Temperature

• O(10) darkish optical fibers, recovered by cleaning at the MFS connectors (several times!)

• Two modules lost by HV trip (at around 370V)
  ⇒ Two modules on one HV line cannot be powered anymore
  ⇒ HV wire has been disconnected
Similar incident already in Aachen, reason unclear!
Further investigation of “Aachen module” needed.

• Already observed in Aachen: 1 module with 1 dead APV (255 in registers) and unstable I2C communication to MUX

Sector 2: 0.8 % bad channels (Aachen: 9.0 %)
Sector 5: 5.7 % bad channels (Aachen: 3.1 %)
Thank You

• Cold room services: Didier Contardo, Nick Lumb, Bernard de Callatay

• Interlocks: Machi Tsirou et al., Bernard de Callatay, Otilia Militaru

• PVSS: Frank Hartmann & Lorenzo Moretti

• DAQ: Laurent Mirabito, Frederic Drouhin et al.

• Power supplies: Guido Dirkes & Horst Breuker

• Cabling: Alexander Kaminsky et al., Karl Gill et al.

• Technical support: Maryline Gateau
Summary & Plans

- Preparations for cold test done
- Commissioning at room temperature finished
- TEC+ noise performance very similar to measurements in Aachen
  ⇒ TEC performance is robust
- The first cold cycle performed yesterday, problem with chiller observed

- Cold test to be repeated as soon as possible
- Followed by cold test of sectors 1 & 3
- About two weeks of mechanical work needed before TEC+ can go into tracker support tube