

Temperature and Humidity Monitor for CMS Tracker Electronics Testing

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CMS Tracker System

CMS DETECTOR

Total weight : 14,000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

STEEL RETURN YOKE
12,500 tonnes

SILICON TRACKERS
Pixel ($100 \times 150 \mu\text{m}$) $\sim 1\text{m}^2$ $\sim 66\text{M}$ channels
Microstrips ($80 \times 180 \mu\text{m}$) $\sim 200\text{m}^2$ $\sim 9.6\text{M}$ channels

SUPERCONDUCTING SOLENOID
Niobium titanium coil carrying $\sim 18,000\text{A}$

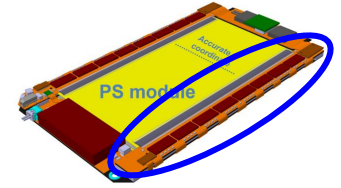
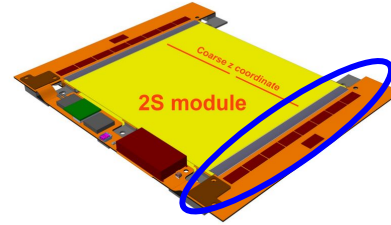
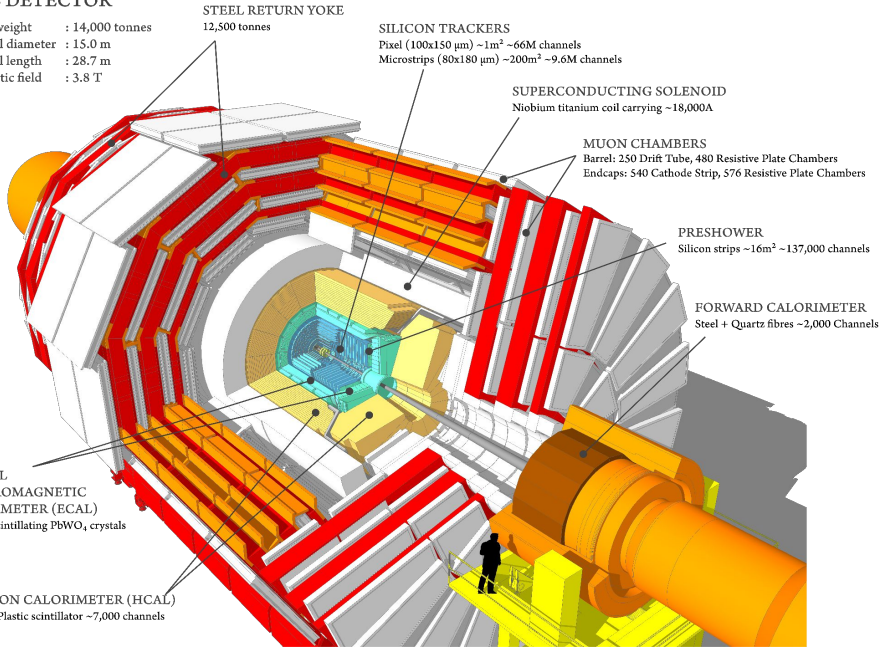
MUON CHAMBERS
Barrel: 250 Drift Tube, 480 Resistive Plate Chambers
Endcaps: 540 Cathode Strip, 576 Resistive Plate Chambers

PRESHOWER
Silicon strips $\sim 16\text{m}^2$ $\sim 137,000$ channels

FORWARD CALORIMETER
Steel + Quartz fibres $\sim 2,000$ Channels

CRYSTAL
ELECTROMAGNETIC
CALORIMETER (ECAL)
 $\sim 76,000$ scintillating PbWO_4 crystals

HADRON CALORIMETER (HCAL)
Brass + Plastic scintillator $\sim 7,000$ channels



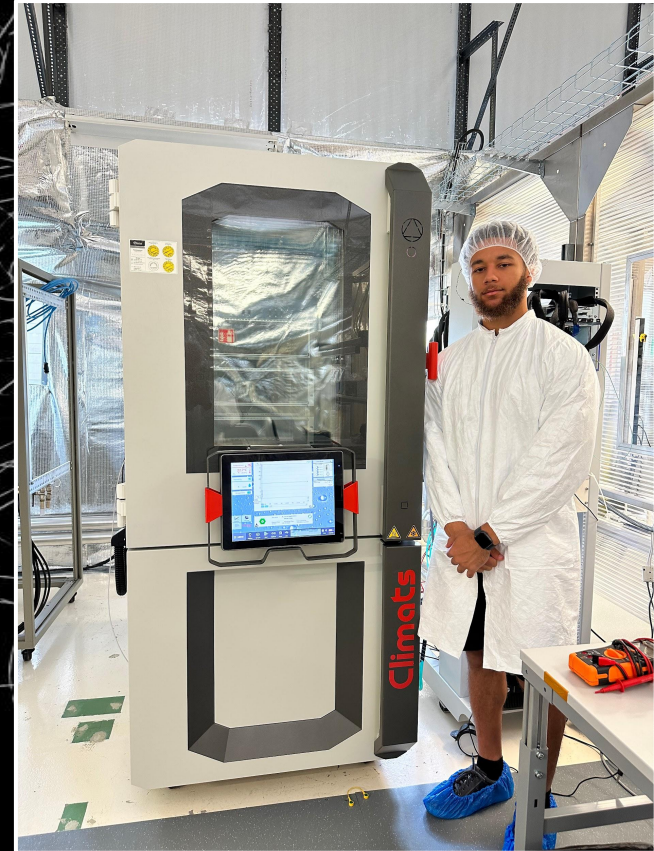
Front End Hybrid Electronics

- Used to gather and deliver binary data from silicon sensor
- Phase-2 upgrade desires less bulk electronics

Testing of the Hybrids

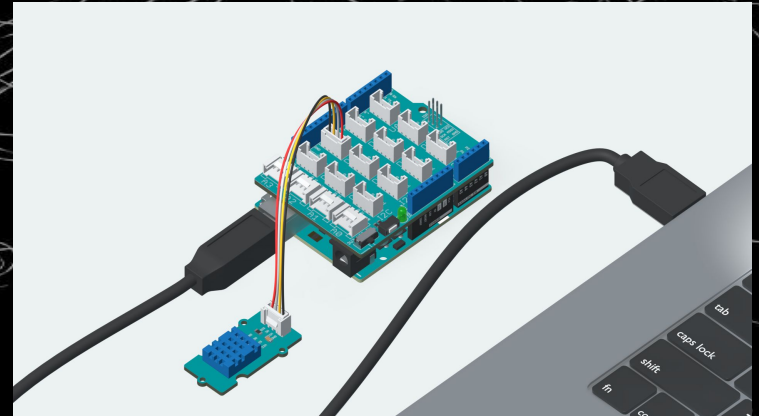
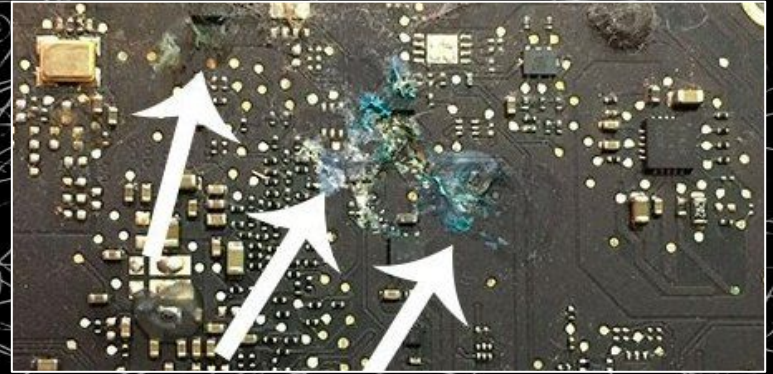
- Tests of the Hybrid Electronics must be done in Climatic Chamber
- Testing done at 25 °C and -40 °C
- Temperature, dew point, and relative humidity monitor needed to conduct testing.

$$Dp(T, RH) = \frac{\lambda \cdot \left(\ln\left(\frac{RH}{100}\right) + \frac{\beta \cdot T}{\lambda + T} \right)}{\beta - \left(\ln\left(\frac{RH}{100}\right) + \frac{\beta \cdot T}{\lambda + T} \right)}$$



Why is the monitoring needed?

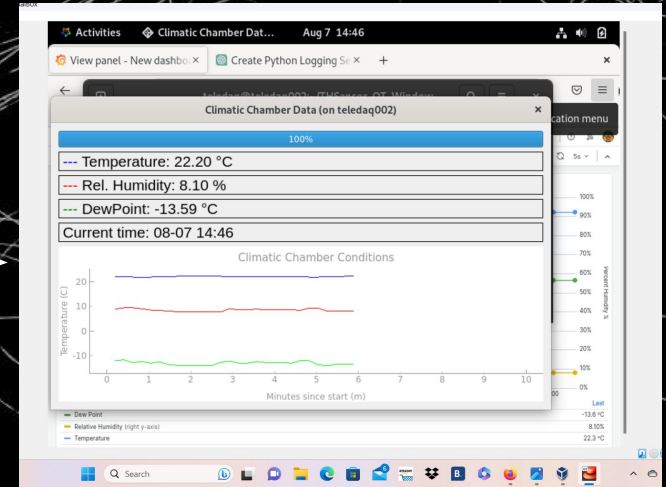
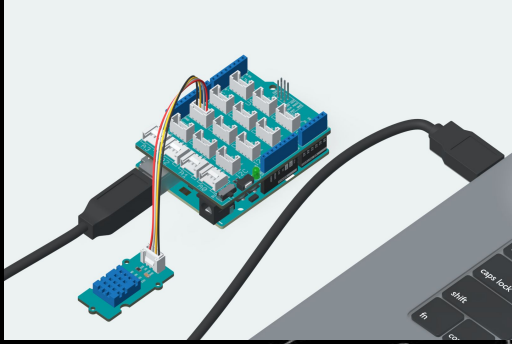
- Condensation ruins electronics → can cause a short circuit
- Climatic Chamber relative humidity sensor broken → We supply another
- Two Monitoring Systems used:
 - Built in chamber sensors
 - Strip sensors placed inside chamber



Set up in chamber

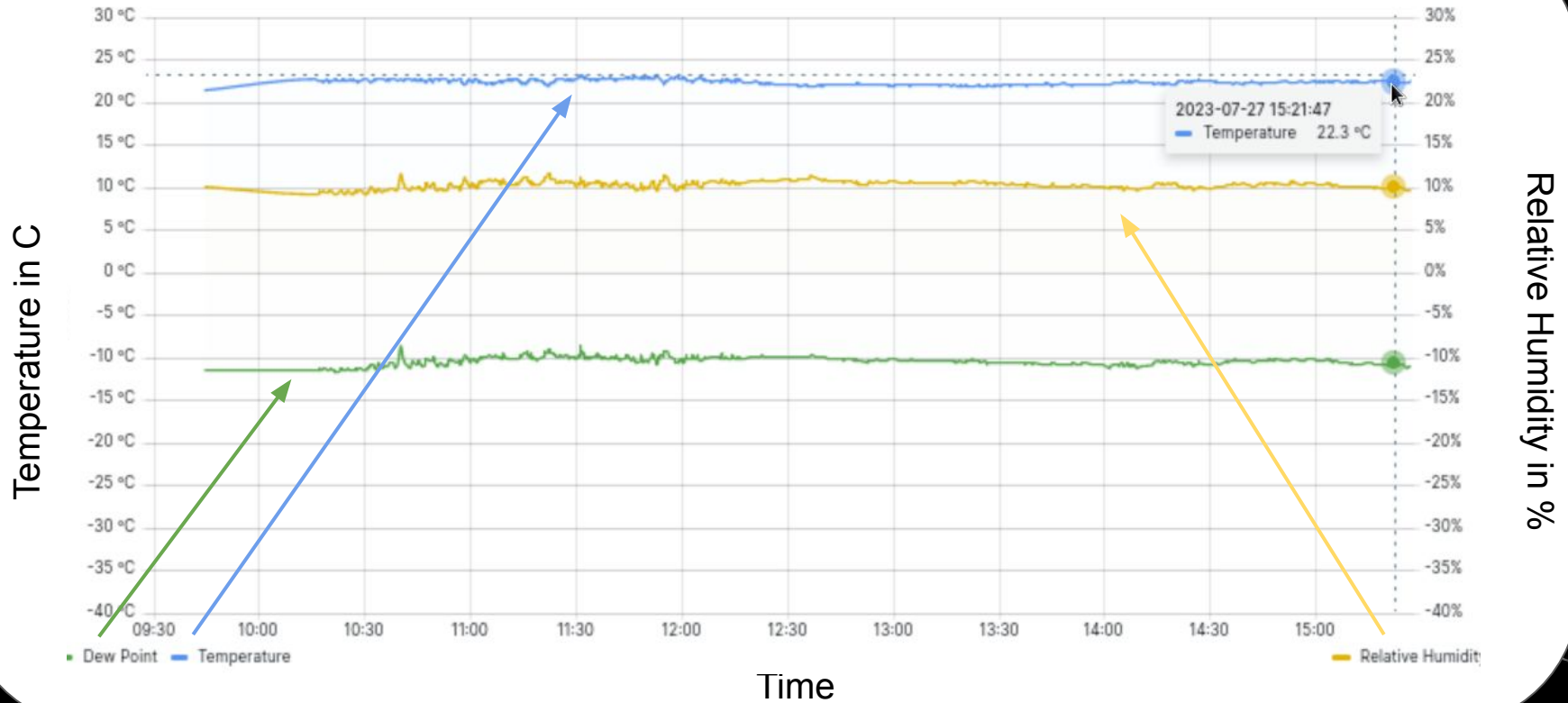


Getting Buckets

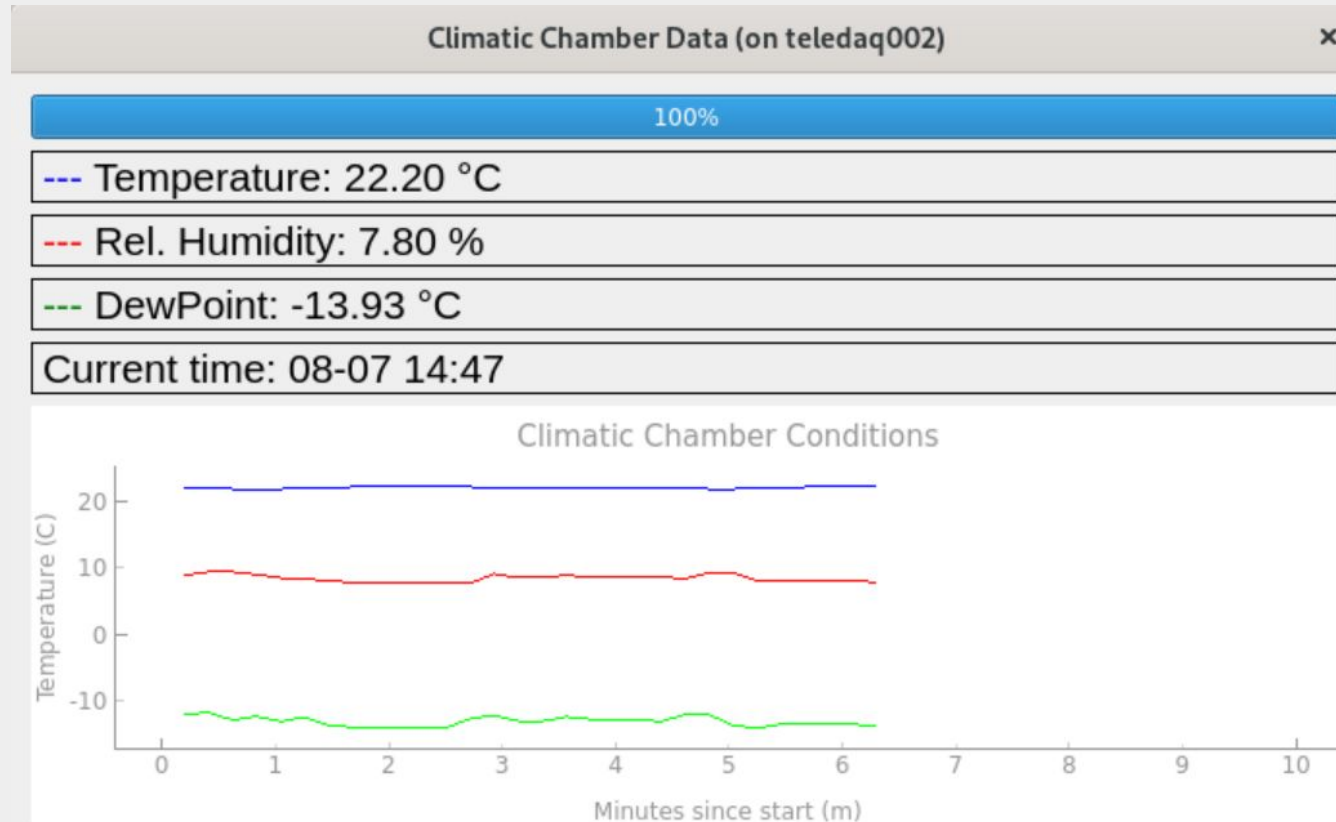


Creating Temperature Monitor pt. 1

Climatic Chamber Conditions



Creating Temperature Monitor pt. 2



Accomplished



What's Next

- Run through cold cycle with monitoring system
- Debug minor issues with sensors
- Create some sort of warning system upon threshold crossing
- Add barometric sensors
- Actual Hybrid test starts beginning of 2024!



Sources



A High Throughput Production Scale Front-End Hybrid Test System for the CMS Phase-2 Tracker Upgrade.

Mark Istvan Kovacs, Georges Blanchot, et. al.

https://www.researchgate.net/publication/340832281_A_High_Throughput_Production_Scale_Front-End_Hybrid_Test_System_for_the_CMS_Phase-2_Tracker_Upgrade

Application Note: Dewpoint Calculation

Sensirion: The Sensor Company.

http://irtfweb.ifa.hawaii.edu/~tes3/tcs3/Misc/Dewpoint_Calculation_Humidity_Sensor_E.pdf

Flexible front-end hybrids for the CMS outer tracker upgrade.

M. Kovacs¹, G. Blanchot¹, A. Honma¹, A. Kokabi² and M. Raymond³

<https://iopscience.iop.org/article/10.1088/1748-0221/10/01/C01046>

InfluxDB Documentation.

<https://docs.influxdata.com>

Power, Readout and Service Hybrids for the CMS Phase-2 Upgrade

Angelos Zografos, Georges Blanchot, Irene M. Dominguez, Adam E. Hollos, Mark I. Kovacs and Nikola Rasevic. October 2021.

https://cds.cern.ch/record/2797682/files/CR2021_218.pdf

The Phase-2 Upgrade of the CMS Tracker Technical Design Report. CMS Collaboration.

D. Abbaneo, J. Alexander, P. Azzi, E. Brondolin, A. Cánepa, J. Christiansen, S. Costa, A. Dabrowski, C. Delaere, A. Dierlamm, M. Dragicevic, R. Frühwirth, K. Hahn, A. Honma, K. Klein, S. Mersi, A. Mussgiller, M. Narain, A. Onnela, G. Sguazzoni, G. Steinbrueck, J. Thom, A. Tricomi, F. Vasey, P. Wittich. 1 July 2017. CERN-LHCC-2017-009

Thank you / Merci

