WED, 7/8/2024

MTD, CMS, CERN

SUPERVISOR

Dr. Ozgur Sahin

DONE BY

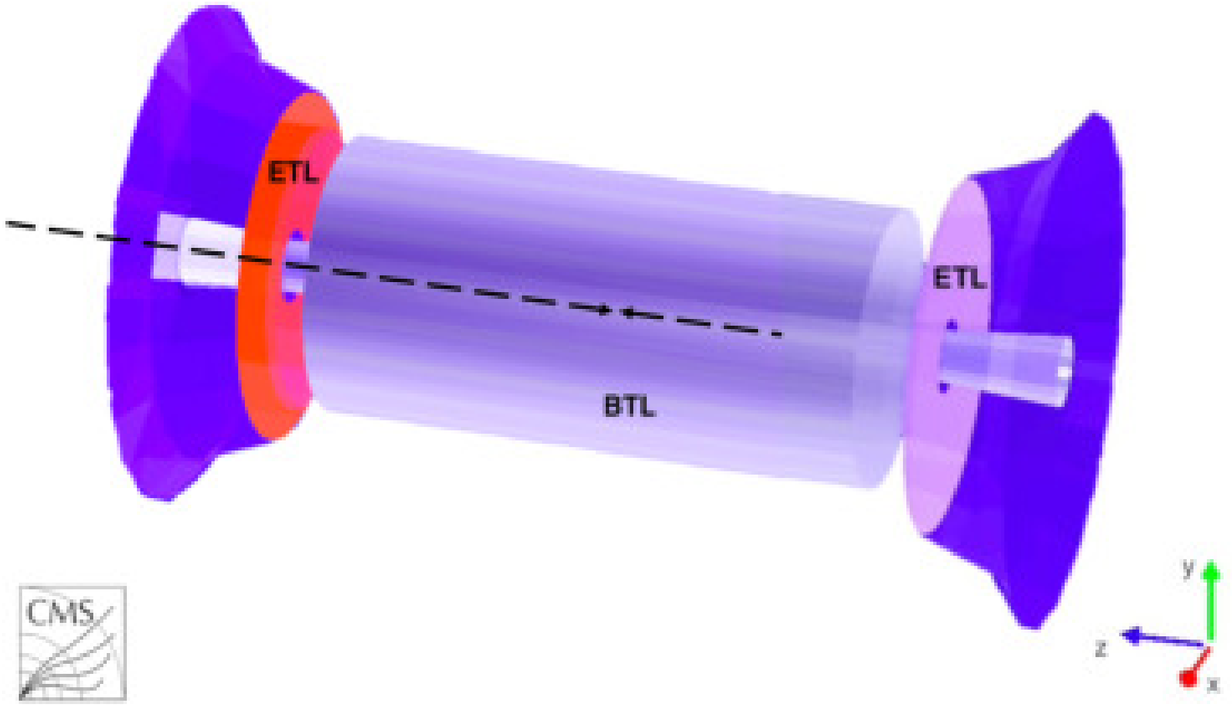
Alaa Husain

# Calibration of the Temperature Sensors for the CMS MTD DAQ System

By: Alaa Husain

- **Precise Timing:** Measures MIP production time with 30-40 picosecond resolution.
- **Pileup Mitigation:** Helps manage 200 simultaneous interactions per bunch crossing at HL-LHC.

The MIP Timing Detector (MTD) upgrade for the CMS experiment at CERN will enhance the detector's performance by providing precise timing information, reducing pileup effects, and improving track-to-vertex association.



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## Motivation

To achieve the 30-40 picosecond resolution, the significant noise necessitates that the system operate at -40°C. Which as a result necessitates precise temperature monitoring.

## Task

To calibrate the thermal sensors of the MTD's DAQ system to ensure precise and accurate readings that reflect real temperatures.

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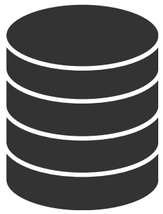
## What is it?

The Low Power Giga Bit Transceiver (LpGBT) is a radiation tolerant ASIC that can be used to implement multipurpose high speed bidirectional optical links for high-energy physics experiments.

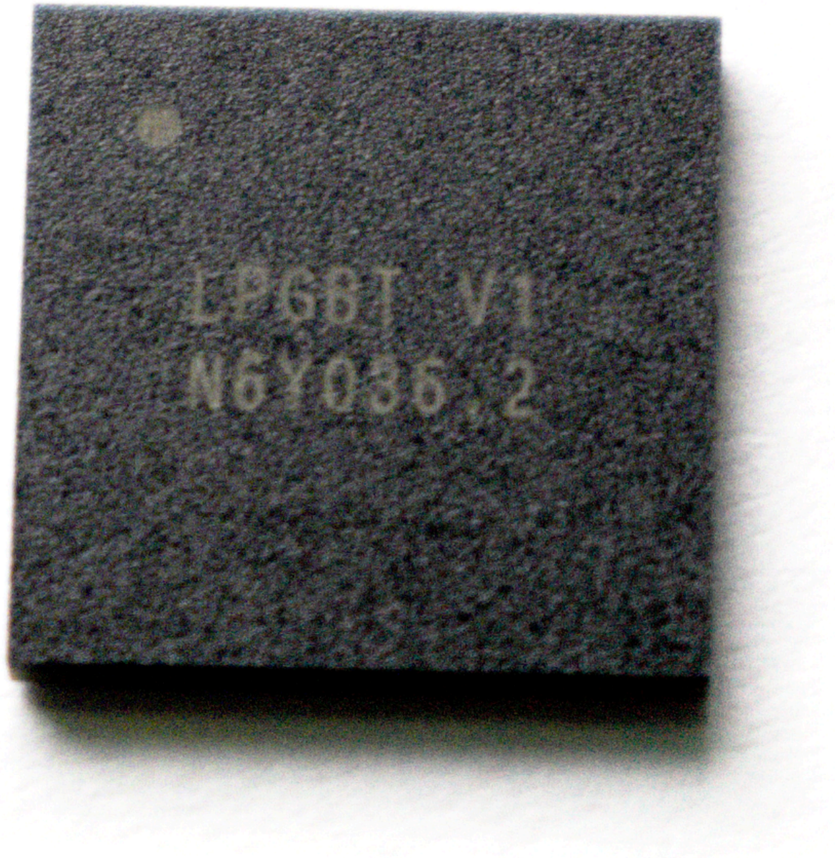
## LpGBT Data Paths:



Data Acqusition (DAQ)

Timing and Trigger Control (TCC)

Slow Control (SC)



# IV LpGBT Architecture & Functionality Overview

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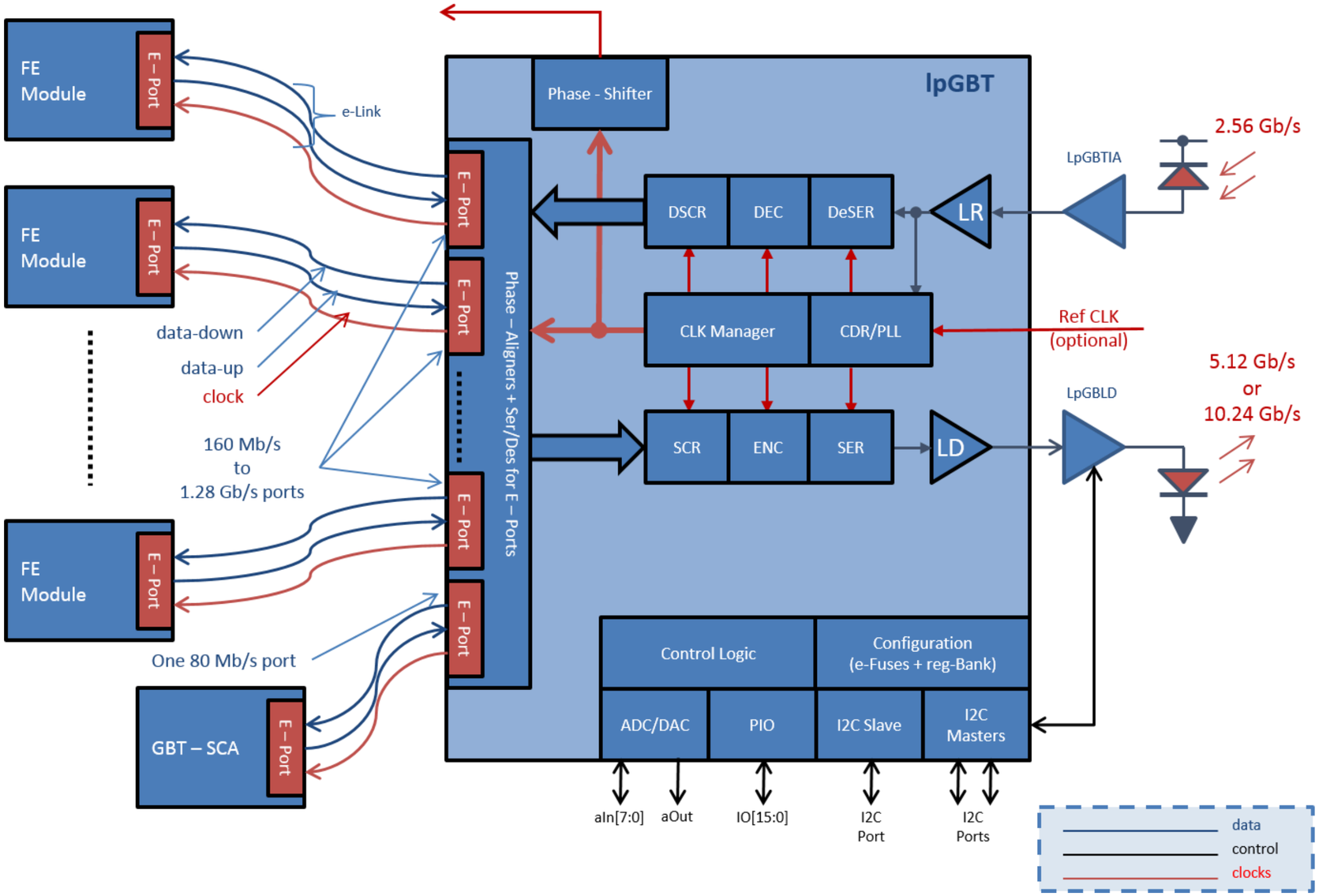


## What are RTDs?

An RTD is a temperature sensor that utilizes the variations in resistance to measure temperature. Basically when the temperature changes, the RTD's resistance increases predictably.

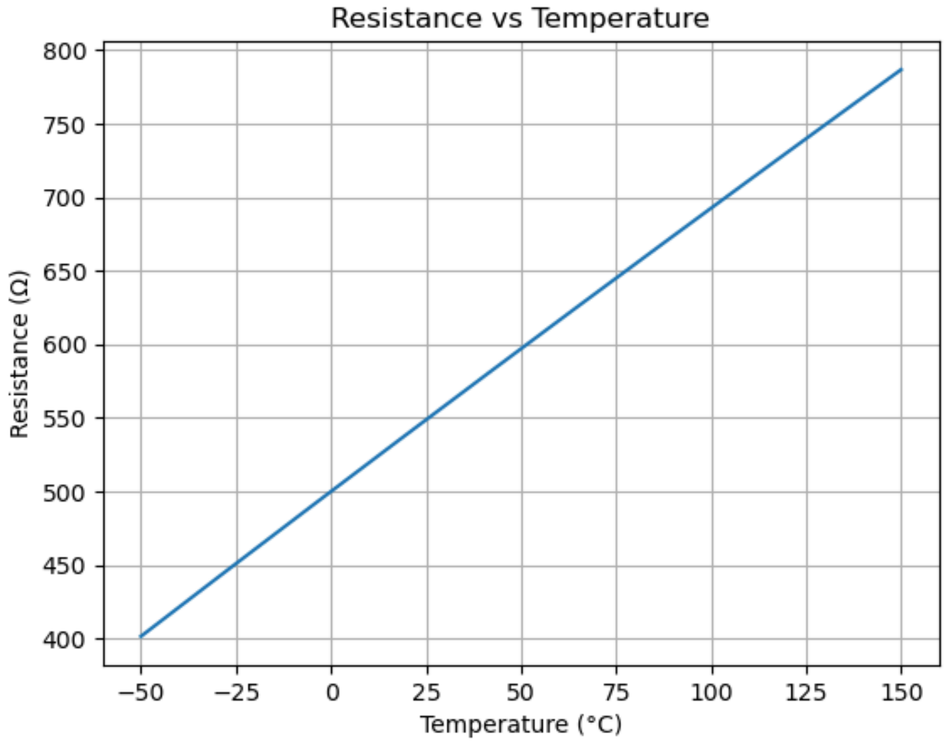
$$R_{\mathrm{RTD}} = \frac{V_{\mathrm{ADC}}}{I_{\mathrm{DAC}}}$$

## Resistance vs Temperature

according to IEC 60751:

$$-50^{\circ}\mathrm{C} \text{ to } 0^{\circ}\mathrm{C} \quad \mathrm{R(T)} = \mathrm{R_0} \times \left(1 + \mathrm{AT} + B\mathrm{T}^2 + \mathrm{C}[\mathrm{T} - 100]\mathrm{T}^3\right)$$

$$0 \text{ to } +150^{\circ}\mathrm{C} \quad R(T) = R_0 \times \left(1 + AT + BT^2\right)$$




### Where

A = 3.9083e-3 (ºC^-1)

B= -5.775e-7 (ºC^-2)

C = -4.183e-12 (ºC^-4)

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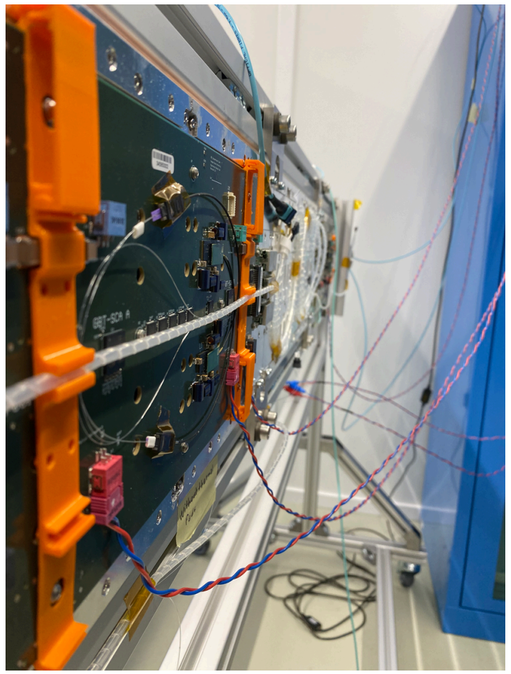
## Resolution Challenge

To achieve high detector resolutions, a stable low temperature environment of -40°C must be monitored and maintained.



## Calibration Process

Calibration is to be done by comparative analysis between the DAQ's thermal sensors and the actual temperature readings.

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# Thank you for listening!