Online calibration of the TRB3 FPGA TDC with DABC software
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TRB3 hardware
- 5 Lattice ECP3-150EA FPGAs
- 4 peripheral FPGAs as TDCs
- 1 central FPGA for trigger system and GbE
- TrbNet (control) and UDP/IP/GbE (data)
- various add-on boards (ADC, PADIWA,..)

FPGA TDC

\[ t_{\text{stamp}} = (\text{epoch} \times 2048 + t_{\text{coarse}}) \times 5\text{ns} - \text{Calibr}(t_{\text{fine}}) \]
Online calibration of TRB3 FPGA TDC with DABC software

- **required per each TDC channel** (~ 48) for each FPGA design
- **may frequently measure calibration tables** from uniform-distributed fine times
- **may use known temperature dependency function**
- **can be done during data taking with DABC event builder software**
- **precision ~ 10 ps** (without calibration: 200 ps)
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Abstract

The TRB3 trigger readout board features a FPGA based TDC which is used for digitizing time intervals up to 256 ns and a time precision of 6 ps per channel. The online calibration of the TDC is performed using a dedicated DABC software. The software calibration can be applied to each channel individually, allowing the correction of the TDC delays and gain. The online calibration is performed using a set of predefined calibration parameters, which are stored in the FPGA memory. The calibration process can be performed continuously, allowing the correction of the TDC delays and gain as needed. The online calibration is performed using a set of predefined calibration parameters, which are stored in the FPGA memory. The calibration process can be performed continuously, allowing the correction of the TDC delays and gain as needed.

TRB3 hardware

The TRB3 board consists of a FPGA, a power supply, a data acquisition card, and a user interface. The FPGA is used for digitizing time intervals and calculating the TDC values. The power supply provides the necessary power for the board, and the data acquisition card is used for collecting and processing the data. The user interface is used for controlling the board and displaying the results.

Online software

Data acquisition for TRB3 has been implemented with DABC framework [1]. The data from the TRB3 boards are sent through the DABC server and then processed and analyzed in the DABC software running on a laptop. The software allows for real-time monitoring of the calibration progress and provides powerful tools for configuring and controlling the board. The software also allows for the generation of comprehensive reports and analysis of the calibration results.

FPGA TDC

The primary function of the FPGA TDC is to digitize time intervals up to 256 ns with a time precision of 6 ps per channel. The TDC values are stored in the FPGA memory and can be accessed continuously. The TDC values can be corrected in real-time using the DABC software, allowing for the online calibration of the TDC delays and gain.

DABC web interface

The DABC software has a web interface, which allows the user to control the board and access the calibration results through a web browser. The interface is intuitive and easy to use, and it provides powerful tools for monitoring and controlling the board. The interface also allows for the generation of comprehensive reports and analysis of the calibration results.

Timestamp counters

The timestamp counters are used to obtain precise time information. The counters are configured to provide time stamps with a precision of 1 ns. The time stamps are used for triggering the TDC and for measuring the time intervals.

Statistical calibration approach

The statistical approach for the calibration is based on the analysis of the TDC values. The analysis is performed using a set of predefined calibration parameters, which are stored in the FPGA memory. The analysis is performed continuously, allowing the correction of the TDC delays and gain as needed.

Temperature dependency

The temperature dependency of the TDC is an important factor to consider when calibrating the TDC. The TDC values are affected by temperature, and the calibration parameters must be adjusted to account for this effect.

ToT temperature corrections

The ToT temperature corrections are performed using a dedicated software. The software is used for calculating the temperature corrections and for applying them to the TDC values. The corrections are applied continuously, allowing the correction of the TDC delays and gain as needed.

The complete DABC process, including data taking, TDC calibration and data analysis, is performed continuously and can be controlled using the DABC software. The software allows for the generation of comprehensive reports and analysis of the calibration results.