

Forward Tagger Calorimeter Calibration Constants

V1.0 - 24 April 2015

Abstract

This document provides a description of the calibration constants associated to the Forward Tagger Calorimeter.

Introduction

The CLAS12 Forward Tagger (FT) is designed to detect electrons scattered at very small angles, namely from 2.5 to 4.5 degrees. It consists of three subsystems: an electromagnetic calorimeter to measure the electron energy by detecting its electromagnetic shower, a scintillation hodoscope to distinguish electron from photons and a tracker to measure precisely the electron impact point. The calorimeter is made of lead-tungstate (PbWO_4) scintillating crystals (332) with large-area avalanche photodiode (LAAPD) readout.

This document provides the list of calibration constants used by the Forward Tagger Calorimeter reconstruction algorithm to determine the final information from the measured hits. These calibration constants will be derived from real and simulated data using dedicated calibration procedures and saved to the CLAS12 calibration database, which is accessed by the reconstruction code. To facilitate the handling of the calibration constants as well as their interpretation in terms of physical quantities, these constants will be organized in tables described in the following.

FT-Cal CCDB tables

The FT-Cal calibration constants will be organized in 6 different tables described below.

ID: the table will contain an array ID[332] with values corresponding to the crystal identifier in the 22x22 grid used in the geometry description.

Energy: the table will contain the parameters used by the reconstruction algorithms to convert the measured charge in a crystal to energy.

Time: the table will contain the parameters used by the reconstruction algorithms to convert the measured signal time in a crystal to the actual time with respect to an appropriate reference time.

FADC: the table will contain the parameters that define the configuration of the FADC boards used for the calorimeter readout.

Status: the table will contain a status flag for each of the 332 crystals, indicating the functionality of the element.

Recon: the table will contain constants used in the reconstruction algorithm to correct the measured cluster energies for leakages due to the finite size of the detector and measurement thresholds.

FT-Cal Energy Table

The **Energy** table will contain the following constants:

- EMIPS[1]: energy released by a Minimum Ionizing Particle (MIP) crossing the calorimeter crystals perpendicularly to the axis. This energy (the peak of the Landau distribution) was estimated from simulations to be of 15.3 MeV;
- CHMIPS[332]: charge associated to a MIP signal as measured by the fADCs. The charge to energy conversion factor is then obtained as:
$$\text{Energy} = \text{EMIPS} * \text{Charge} / \text{CHMIPS};$$
- PEDESTAL[332]: signal pedestal to be subtracted from the measured charge before the conversion to energy;
- RMS[332]: pedestal rms;
- PAGAIN[332]: preamplifier gain;
- APDGAIN[332]: photo-sensor gain.

FT-Cal Time Table

The **Time** table will contain the following constants:

- T0, T1, T2[332]: tdc to time conversion factors;
- TCRYSTAL[332]: time offset of the crystal with respect to the reference time TCAL;
- TCAL[1]: reference time offset of the entire calorimeter with respect to the reference time used by the reconstruction;
- SIGMA[332]: crystal timing resolution as determined by the calibration procedure.

FT-CAL FADC table

The **FADC** table will contain the following constants:

- MODE[1]: fADC configuration, can be one 1 for raw mode and 7 for pulsed;
- GAIN[332]: fADC channel gain defining the conversion from voltage to fADC channel;
- OFFSET[332]: channel analog offset;
- NSAMPLE[332]: number of samples used for the signal digitization;
- NSB[332]: number of samples before the readout trigger;
- NSA[332]: number of samples after the readout trigger;

- DELAY[332]: delay applied to the signal with respect to the gate or readout window;
- THRESHOLD[332]: threshold used to define the presence of a pulse in fADC channels.

FT-Cal Status Table

The **Status** table will contain a single constant, STATUS, for each of the 332 crystals. This constant describes the status of the element: it will be set to 0 if the element is fully operational and will be set to a positive integer value, if a problem affecting the element operation is identified.

FT-Cal Recon Table

The **Recon** table will contain all the constants used by the FT-Cal reconstruction code and, in particular by the clustering algorithm.

- CRYSTAL_MIN_ENERGY[332]: energy threshold used in the clustering algorithm for each of the 332 crystals;
- CENTER_MIN_ENERGY[1]: minimum energy of the central crystals of the cluster;
- CLUSTER_MIN_ENERGY[1]: minimum reconstructed energy accepted for saving the cluster;
- CLUSTER_MIN_SIZE[1]: minimum number of crystals in cluster;
- CLUSTER_TIME_WINDOW[1]: time window used to select hits forming a cluster;
- CLUSTER_W0[1]: threshold parameter used in the log-weighting formula used to estimate the cluster centroid;
- CLUSTER_DEPTH_Z[1]: depth correction parameter;
- CLUSTER_ENERGY_CORR[3]: parameters defining the cluster energy correction function;
- CLUSTER_THETA_CORR[4]: parameters defining the correction used to determine the vertex theta angle for electron clusters;
- CLUSTER_PHI_CORR[6]: parameters defining the correction used to determine the vertex phi angle for electron clusters.

Calibration Constant Values

Initial values of the calibration constants are reported in the table below. The total number of constants is of 6662.

Table	Item	Dimension	Type	Value
ID	ID	332	Integer	
	EMIPS	1	Float	15.3
	CHMIPS	332	Float	580.608

Energy	PEDESTAL	332	Float	0
	RMS	332	Float	0
	PAGAIN	332	Float	2500
	APDGAIN	332	Float	250
Time	T0	332	Float	0
	T1	332	Float	0.05
	T2	332	Float	0
	TCRYSTAL	332	Float	0
	TCAL	1	Float	0
	SIGMA	332	Float	0
FADC	MODE	1	Integer	7
	GAIN	332	Integer	1
	OFFSET	332	Integer	0
	NSAMPLE	332	Integer	60
	NSB	332	Integer	10
	NSA	332	Integer	40
	THRESHOLD	332	Integer	5
	DELAY	332	Integer	25
Status	STATUS	332	Integer	0
Recon	CRYSTAL_MIN_ENERGY	332	Float	10
	CENTER_MIN_ENERGY	1	Float	50
	CLUSTER_MIN_ENERGY	1	Float	200
	CLUSTER_MIN_SIZE	1	Float	3
	CLUSTER_TIME_WINDOW	1	Float	10
	CLUSTER_W0	1	Float	3.45
	CLUSTER_DEPTH_Z	1	Float	65
	CLUSTER_ENERGY_CORR	3	Float	0.05199, 0.07747, -0.005168
	CLUSTER_THETA_CORR	4	Float	1.797, -4.485, -0.8671, -1.078
	CLUSTER_PHI_CORR	6	Float	4.918, -3.828, 3.841, -1.256, 2.874, -0.2195