Root .h file from Wide Band μ2e DAQ

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The ADC sampling rate is 12.5 ns, The TDC rate is 6.25 ns.

- runNumber;
- subrunNumber; How the run files are divided after they are taken when the file is large.
- spillIndex; A spill: DAQ records for $\sim$ 2 minutes and 1 min gap, counts spill number.
- spillNumber; Spill number determined from DAQ, sometimes the header is corrupted and spill number is garbage, if no corruptions spill index and spill number are the same.
- boardStatus[2][22]; 22 registers that store information that are common to the entire FEB, FEB number, spill number, FEB temperature ..., see file for the rest of the settings.
- FPGABlocks[nFEBs=2][nFPGAs=8][nRegisters=38]For FPGA it stores the bias settings, trim settings, gain settings, CMB temperatures ... see file:
- spillTimestamp; Computer time of the spill.
- eventNumber; Event number within a spill.
- tdcSinceSpill[2][64]; Time since start of spill, clock ticks.
- timeSinceSpill[2][64]; tdcSinceSpill*6.25 ns
- fitStatus[2][64]; If it can reconstruct the pulse, 0 - no pulse, 1 - fit success, 2 fit failed.
- PEs[2][64];
- PEsTemperatureCorrected[2][64]; Uses many temp corrections.
- temperature[2][64]; From CMB
- pulseHeight[2][64];
- beta[2][64]; Fits pulses with Gumbel function - describe shape of pulse, beta related to the pulse width.
- time[2][64]; The time is reconstructed peak time using the Gumbel function for the fit from the event start. The event start is fixed from the trigger, but is before the trigger. Part of RMS of timing is due to Gumbel fit.
- LEtime[2][64]; The time of 50% of the fitted pulse height. There is some debate whether this should be 20and if the LE time should be preferred over the peak time.
- adc[2][64][127]; The binary data stores 128 words, where the first word contains the number of ADC samples, 127, and the channel number. The remaining 127 words store the 127 ADC samples
- recoStartBin[2][64]; Not relevant, used for debugging.
- recoEndBin[2][64];
- pedestal[2][64]; Reconstruction 2 steps, 50 to 60 samples before the waveform gives the ped and dark count. Used for the calibration and the reconstruction.

- PEsReflectedPulse[2][64]; The code doesn't have any advanced method to find reflected pulse. It simply stores the 2nd pulse that follows the main pulse (the one with the largest peak).
- PEsTemperatureCorrectedReflectedPulse[2][64];
- pulseHeightReflectedPulse[2][64];
- betaReflectedPulse[2][64];
- timeReflectedPulse[2][64];
- LEtimeReflectedPulse[2][64];
- recoStartBinReflectedPulse[2][64];
- recoEndBinReflectedPulse[2][64];

From Ralf Ehrlich

- What do you mean by latch information at the boardStatus? It has 22 registers that store information that are common to the entire FEB (responsible for 64 channels), e.g. FEB number, spill number, FEB temperature. See attached file for the content of each register.

- There is one variable missing after the boardStatus: FPGABlocks[nFEBs][nFPGAs][nRegisters]. It has 38 registers per FPGA. One FPGA is responsible for 16 channel. An FEB has 4 FPGAs. It stores information about the bias settings, trim settings, gain settings, CMB temperatures, ... See attached file for the content of each register.

- The time is the reconstructed peak time of the pulse (using the Gumbel function for the fit). The beginning of the event (time=0) is set at a fixed (user adjustable, value can be read from the 20th register in the boardStatus) time difference *before* the FEB receives the trigger. 127 ADC samples (with a sampling time of 12.5ns) are readout starting at this time=0 which will include data from before and after the FEB received the trigger. Also, the major source of the RMS of the time is the accuracy of the fit (impacted by the sampling time of 12.5ns).

- The debate w.r.t. the LEtime was, if 50% of the pulse height or 20% of the pulse height should be used (or any other percentage), and if the LE time should be preferred over the peak time.

- The binary data stores 128 words, where the first word contains the number of ADC samples (127 in our case) and the channel number. The remaining 127 words store the 127 ADC samples, where only 12 bit of each word (16 bit) are used. However, none of this is actually relevant when reading the Root file. The adc variable simply stores the 127 adc values of the event.

- The pedestal information shouldn't be there, because it's already stored in the summary tree (because it's constant for the entire subrun).

The code doesn't have any advanced method to find reflected pulse. It simply stores the 2nd pulse that follows the main pulse (the one with the largest peak). This 2nd pulse can be the reflected pulse (reflected by the SiPM or a reflector on the other fiber end), but could also be an after pulse or a noise hit. The reflected pulse may not even be visible, because it's either too small (or even not existing), or it followed too closely after the main pulse, so that both pulses got merged.

Please let me know, if you have any other questions.