

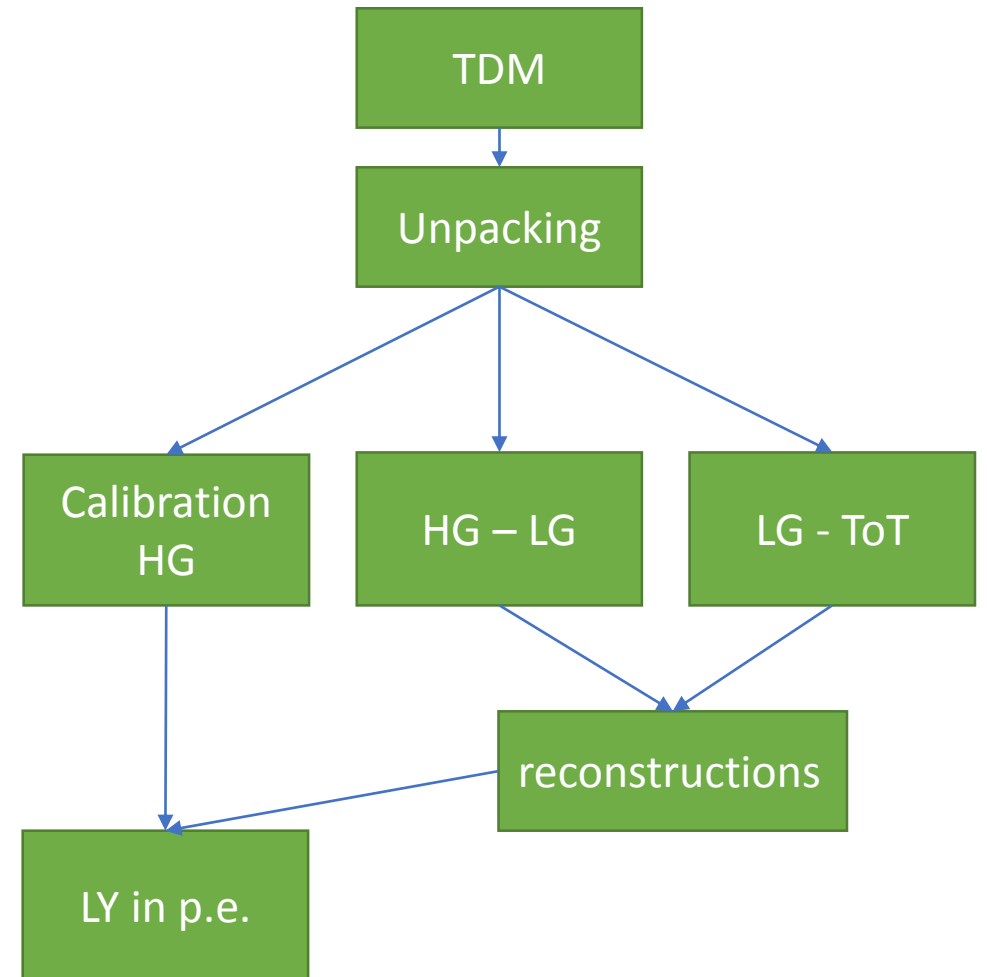
# Data unpacking software

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# Unpacking structure:

- TDM Unpacking
- DAQ Unpacking
- Calibration
- HG-LG calibration
- LG-ToT calibration
- Amplitude reconstructions



# TDM unpacking

- Input file
  - Daq file for one MCR in TDM mode;
- Output file
  - Several daq files for each FEBs;
- Implemented checks
  - TDM slot starts == TDM slot end
- Future implementations:
  - $\text{checksumL} = \text{checksumL} + \text{data};$
  - $\text{checksumH} = \text{checksumH} + \text{chksumL};$

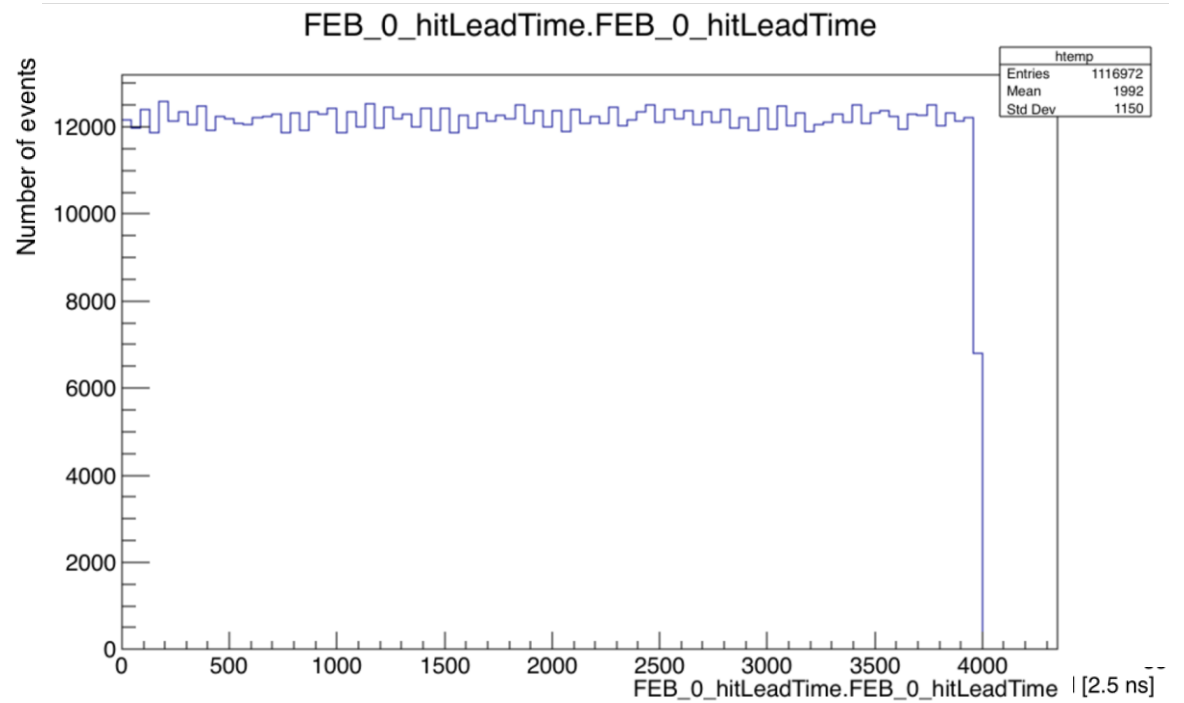
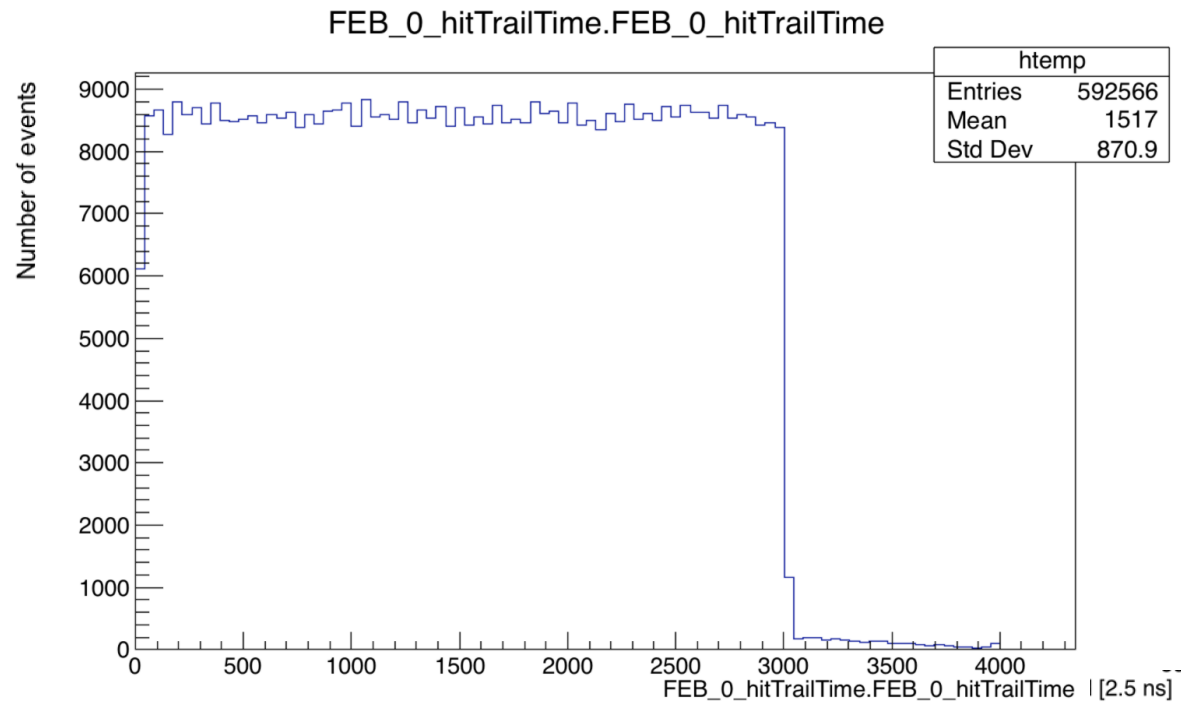
# DAQ unpacking

- Input file
  - List of daq files after TDM unpacking
- Output file
  - Root file with separate trees
- Future implementations:
  - Adding one more branch - global time in ns

# DAQ unpacking event creation procedure:

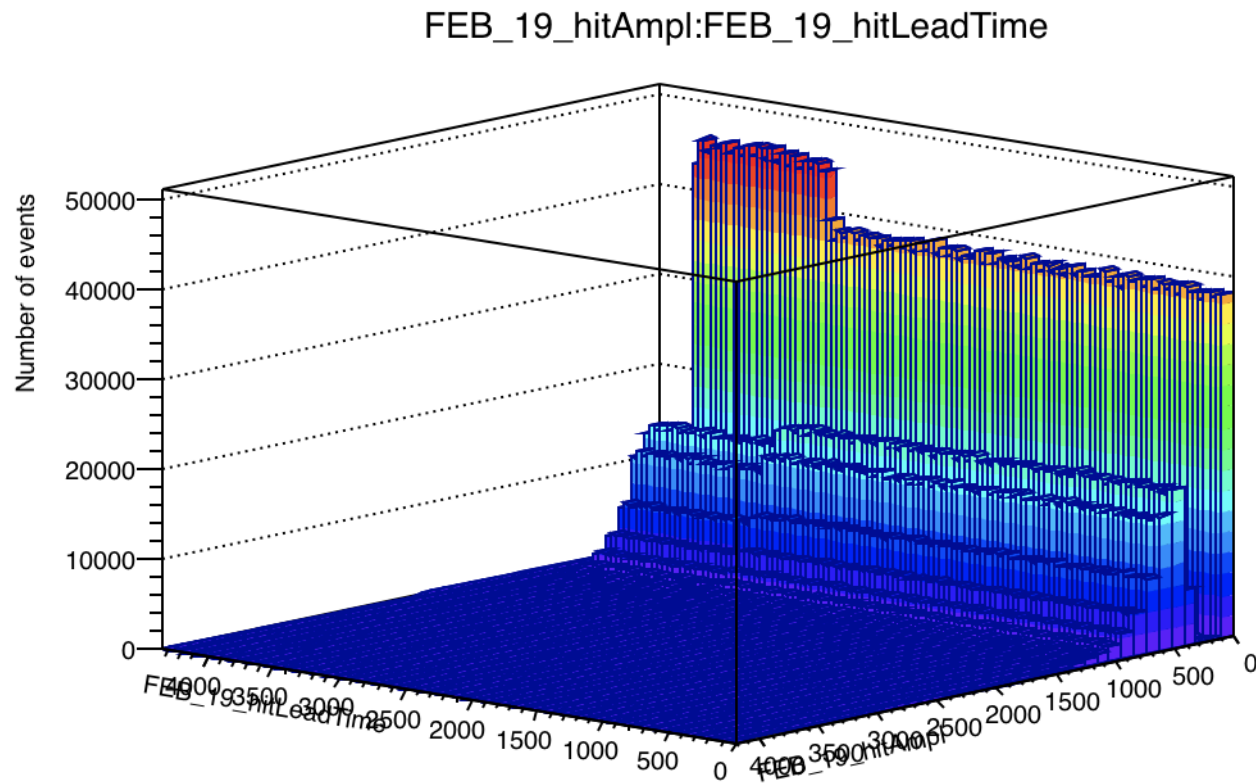
- Spill header & spill time (10um & 10ms)
- GTrig Header
- Event data
  - Event creation if was hit rising time (check TagID);
  - Push hit falling time (if it exist, else push “-1”, with HitID check);
  - Push hit Amplitude HG (if it exist, else push “0”, with HitID check);
  - Push hit Amplitude LG (if it exist, else push “0”, with HitID check);
- GTrig Trailer (Gtrig Tag Header == GTrig Tag Trailer)
- Spill Trailer (Spill Tag Header == Spill Tag Trailer) & spill time

# Difference between versions 2 vs 3



~2 times more events

# Issue with HG Amplitude = 0



Possible explanation:

- 1) Events, which are in the last GTrig of each spill.
- 2) Hit ID issue



GTRIG\_tag\_#n

GTRIG\_tag\_#n+1

GTRIG\_tag\_#n+2

GTRIG domain

GTRIG

Tag increments every 10 us



HIT time

Digital hit  
Trigger...  
Sampled at 400 MHz



Ch0: HIT counter: 12 bits

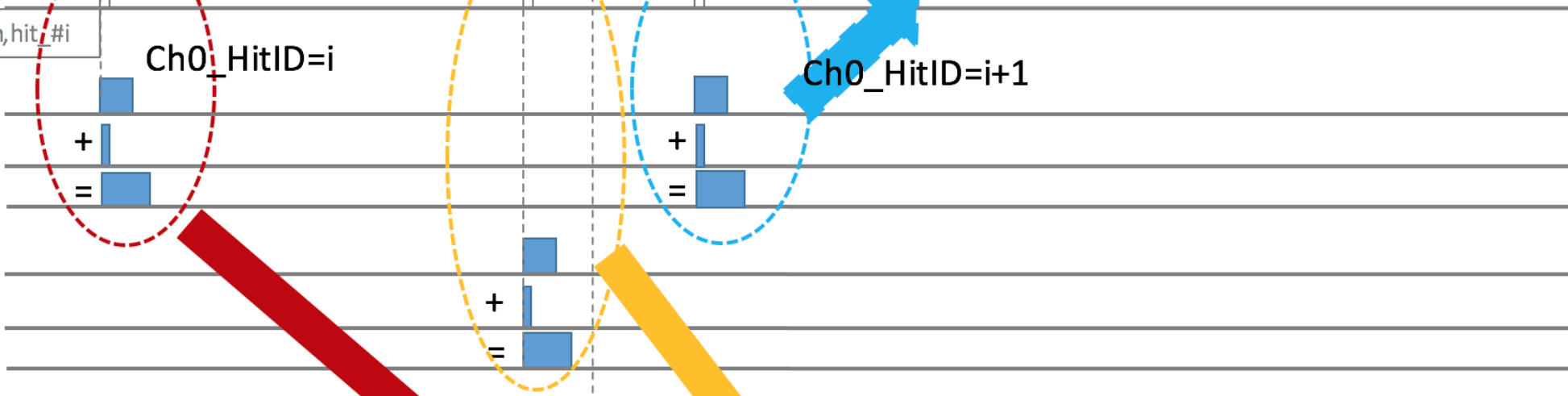
Ch0: Tag counter: 2 bits

Ch0: HIT time: 14 bits

Ch31: HIT counter: 12 bits

Ch31: Tag counter: 2 bits

Ch31: HIT time: 14 bits  
L0-FIFO stage



Hit time domain

Ch0

Ch31

L1 Hold

Analysis deadtime = 9 μs

MUX output and digitisation

Ch0: 12 bits

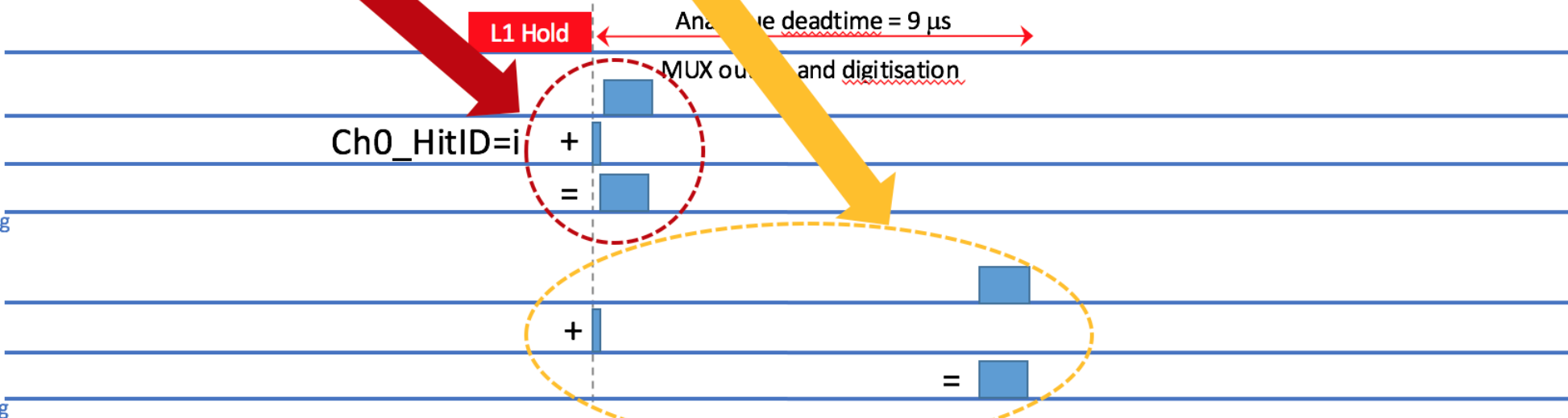
Ch0: Tag counter: 2 bits

Ch0: L1-FIFO stage:  
12/7/3/2bits ADC/ch/ID/tag

Ch31: 12 bits

Ch31: Tag counter: 2 bits

Ch31: L1-FIFO stage:  
12/7/3/2bits ADC/ch/ID/tag



Hit amplitude domain

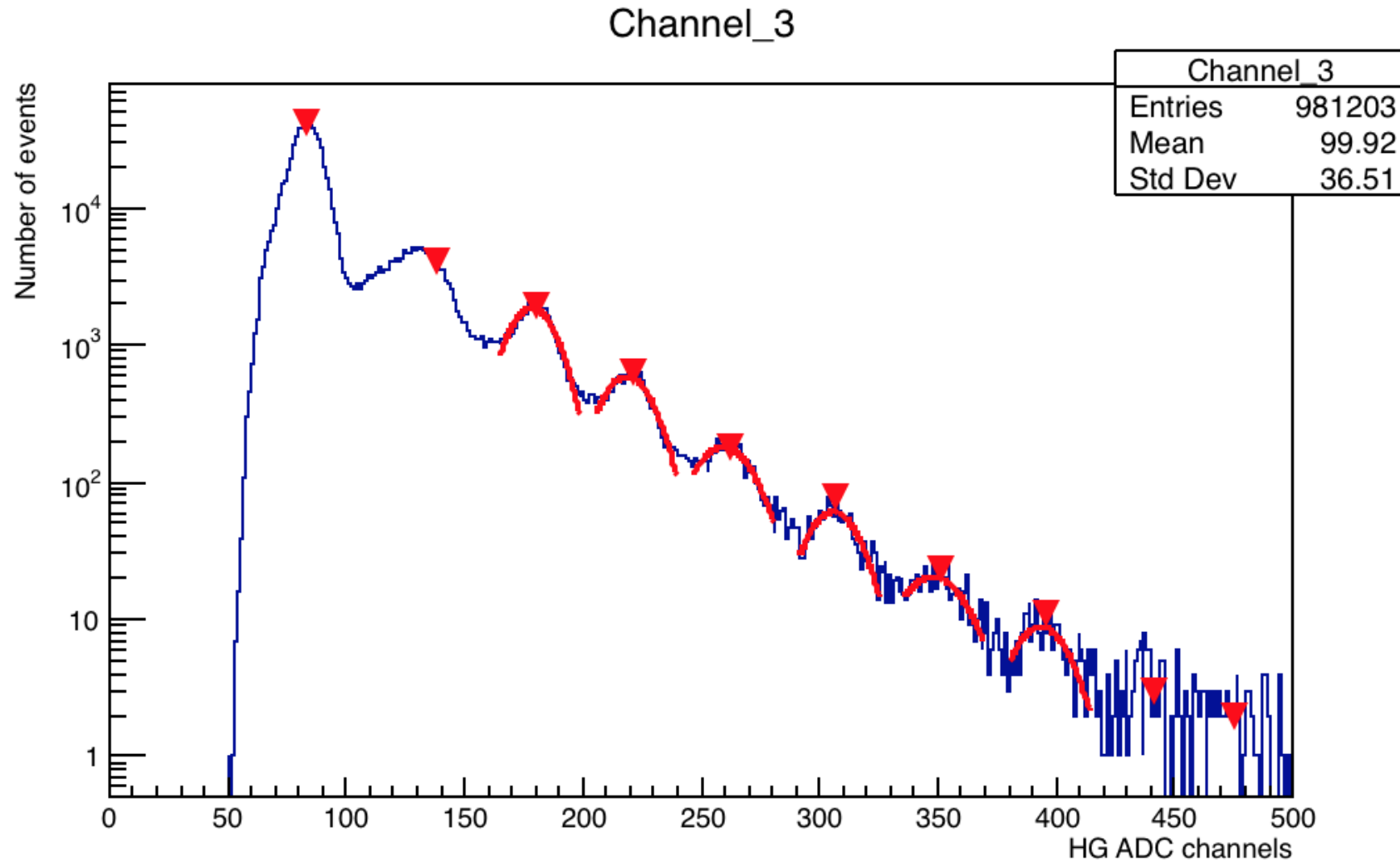
Ch0

Ch31

# Calibration

- Input file
    - Daq file for one FEBs;
  - Output files
    - Root file with plots & fitting for each channel;
    - Txt file with gain & peaks location
  - Implemented checks
    - Each peak sigma should be less than default
    - Each distance between peaks should be in default range
  - Future implementations:
    - Input file – list of daq files;
    - Output files – Sqlite database with gain & peaks location values
    - “Pedestal” search.
- What will be good to have:**
- Special word like “Acquisition start” with FEB’s board ID

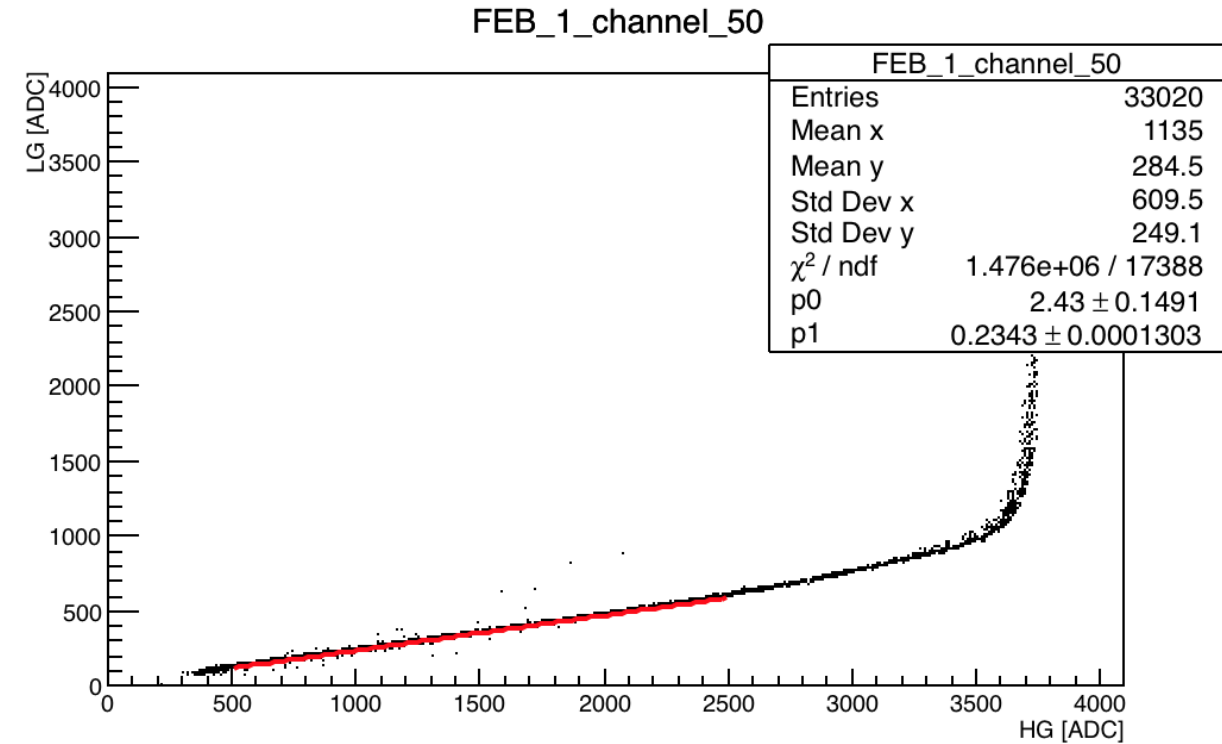
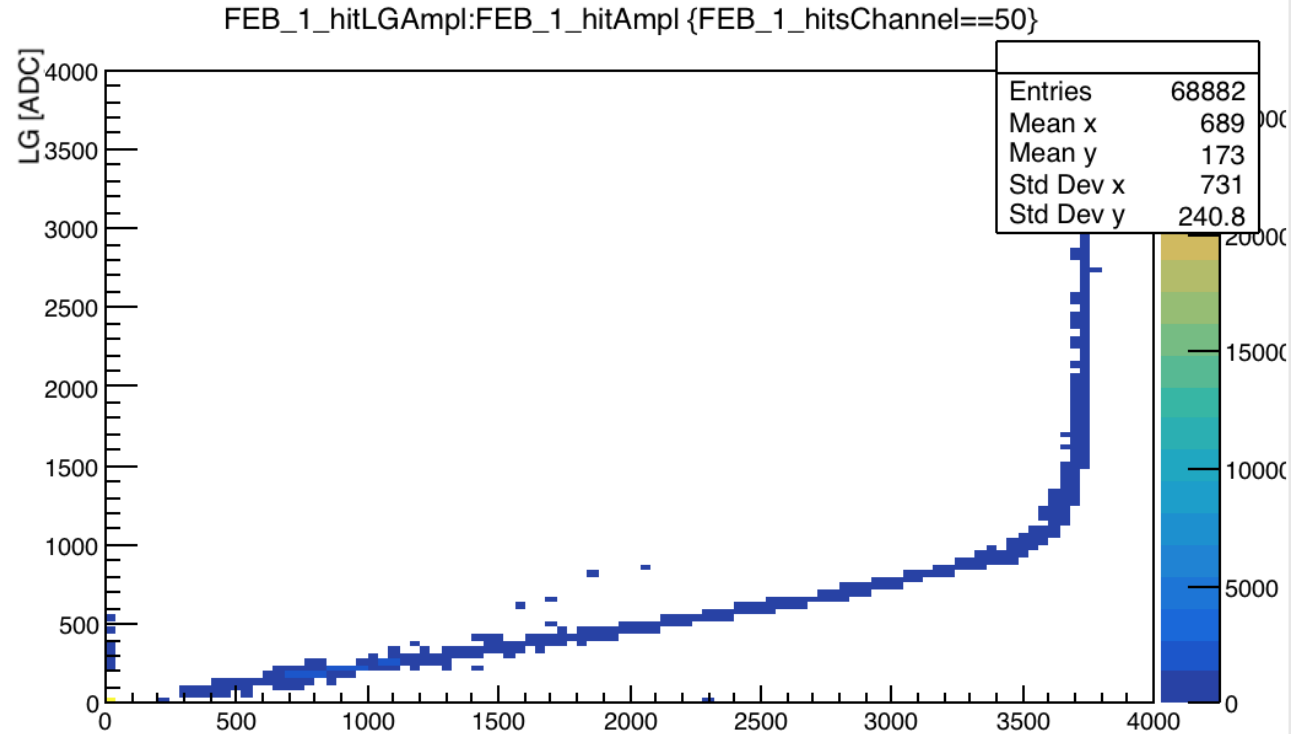
# Calibration example



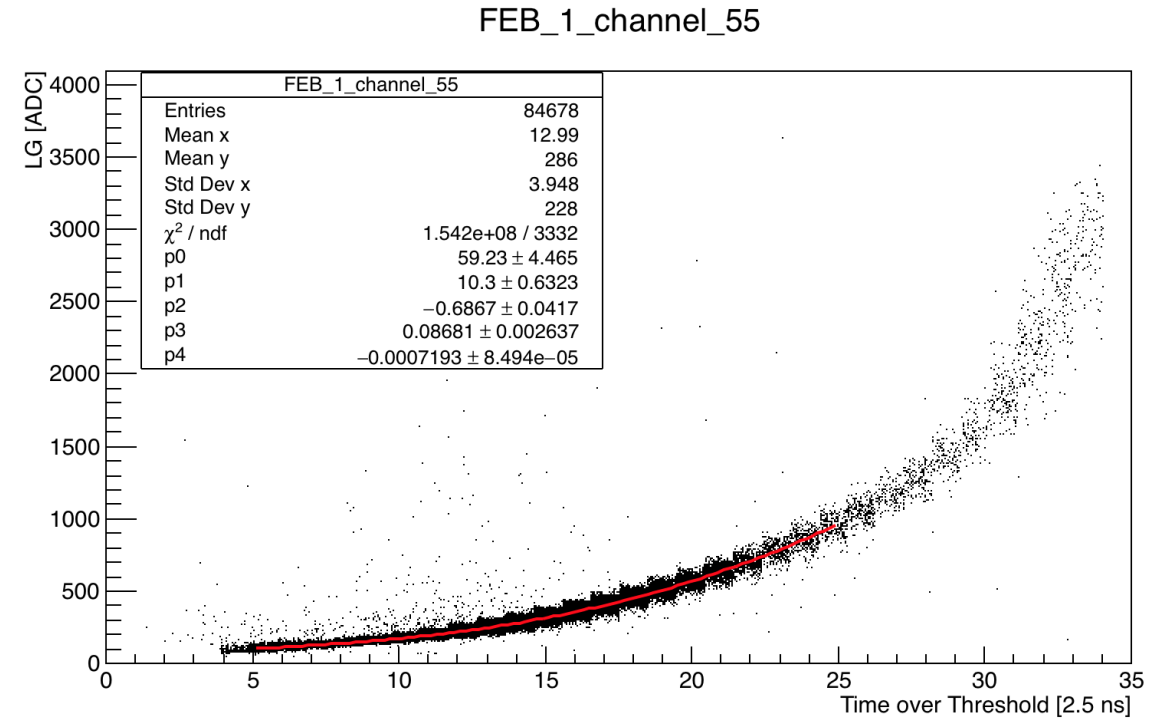
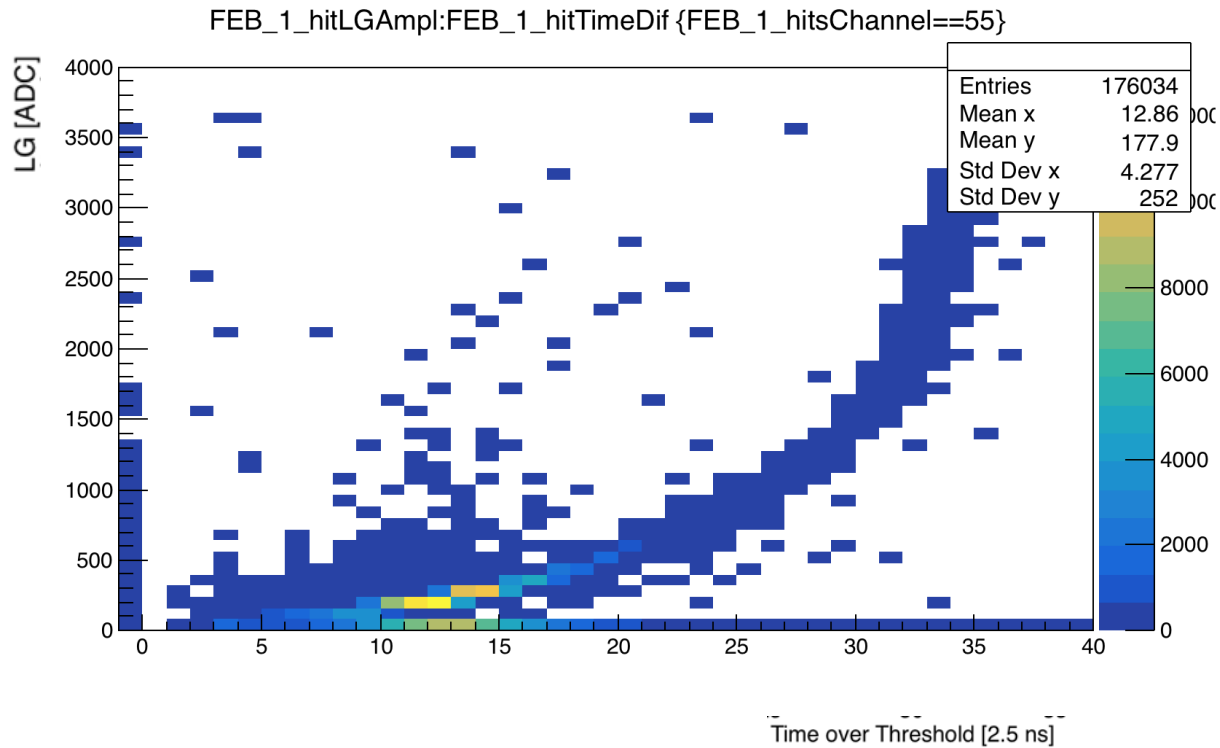
# HG-LG & LG-ToT calibrations

- Input file
  - List of daq files after TDM unpacking
- Output files
  - Root file with plots & fitting for each channel
  - Txt files with fit parameters for all FEBs & channels
- Cuts for fitting:
  - HG & LG & ToT > 0
- Future implementations:
  - Output files – Sqlite database with fit parameters
  - Combine with HG – p.e. calibration

# HG-LG example:



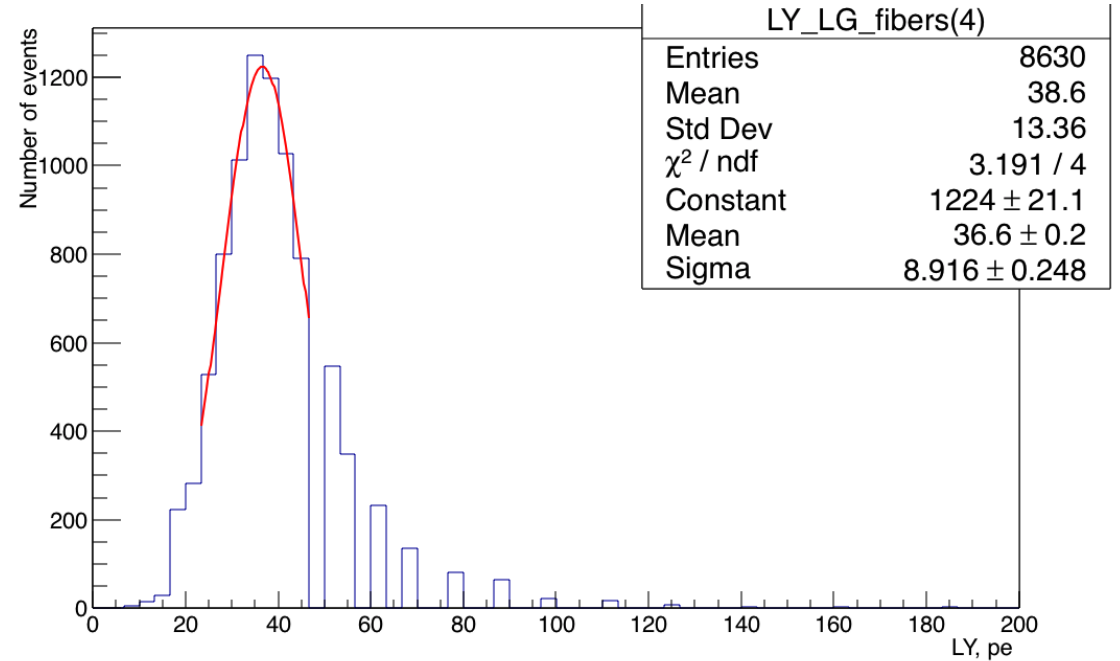
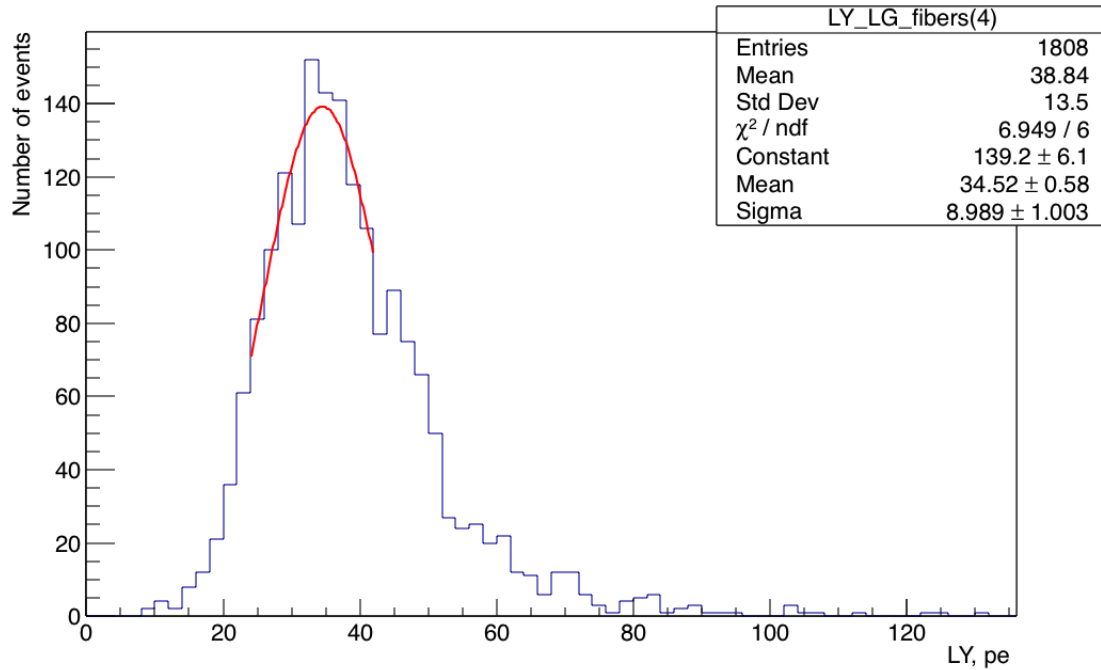
# LG-ToT example:



# Amplitude reconstructions

- Input file
  - \*\_all.root
- Output file
  - \*all\_reconstructed.root
- New branches
  - hitAmplRecon
  - hitLGAmplRecon
- Future implementations:
  - Combine with HG – p.e. calibration
  - Add LY branch in p.e.

# LY reconstruction with LG vs ToT data:



Time Slot Start																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
TDM ID				ID=0		Slot ID						TDM TAG																						
Spill header																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
Spill header ID				Board ID								0	SId		Spill tag (from reset request)																			
Spill time ID				Spill time on spill start (10ms resolution, max=745.6 h=31 days)																														
GTRIG header #1																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
GTRIG header ID				Global Trigger tag (from reset request)																														
Event Data : Hit #1																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
Hit time ID				Channel ID								Hit ID		Tag ID		EDGE	Hit time (2.5ns res.)																	
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
Hit Amplitude ID				Channel ID								Hit ID		Tag ID		Amplitude ID			Amplitude measurement															
...																																		
Event Data : Hit #n																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
Hit time ID				Channel ID								Hit ID		Tag ID		EDGE	Hit time (2.5ns res.)																	
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
Hit amplitude ID				Channel ID								Hit ID		Tag ID		Amplitude ID			Amplitude measurement															
GTRIG trailer #1																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
GTRIG trailer 1 ID				Global Trigger tag (from reset request)																														
GTRIG trailer 2 ID				Hit counts within gtrig*						Global Trigger time (10us res. % current spill start, max=10.5s)																								
Spill trailer																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
Spill trailer ID				Board ID								0	SId		Spill tag (from reset request)																			
Spill trailer ID				Board ID								1	SId		Temperature															Humidity				
Spill time ID				Spill time on spill end (10ms resolution, max=745.6 h=31 days)																														
Time Slot End																																		
31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0			
TDM ID				ID=1	Slot ID						21-bits CHECKSUM																							

Table 4 : TDM, GTRIG, SPILL & DATA structure for the FEB readout communication