DAQ data structure for the Muon g-2 experiment

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Abstract

This document outlines the DAQ data structure of the Muon g-2 experiment. A detailed list of the MIDAS data bank will be shown and their contents will described.

Contents

1 MIDAS DAQ output in a nutshell

The main DAQ framework for the Muon g-2 experiment is based on MIDAS [cite].
Add MIDAS event structure description here and refer to Fig. 1.

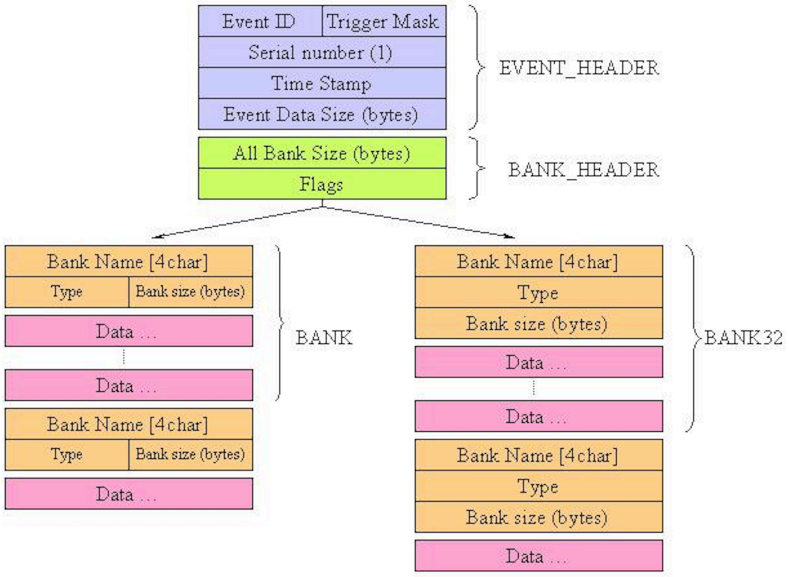

Figure 1: *MIDAS event structure.*

2 MIDAS Bank list

Hundred of banks will be stored in each MIDAS event and it is very important to classify them properly. Add more descriptions here.

2.1 Calorimeter-related banks

There are 3 fill types for the calorimeter. `Muon` fill is the typical muon events, laser fill is event dedicated for laser calibration and monitoring events and pedestal fill is trivia from its name. Data from each fill type is identified from the bank name. The muon fill is denoted by "**C**", the laser fill is denoted by "**L**" and the pedestal fill is denoted by "**P**". A summary of the banks is listed in Tab. 1.

2.2 Auxiliary detector-related banks

A separate T/Q-method is needed for auxiliary detectors. Their data banks are denoted with the initial "**K**". A list of these banks are summarized in Tab. 2.

2.3 CCC related banks

2.4 Field related banks

Overall instructions:

Table 1: *MIDAS bank list for the calorimetry data.*

Bank name			Description
muon fill	laser fill	pedestal fill	
CA	LA	PA	AMC13 Header
CB	LB	PB	WFD5 header
CC	LC	PC	GPU timing data
CF	LF	PF	GPU fitted data
CH	LH	PH	per-crystal Q-method data (N-th event, end of run)
CL	LL	PL	Clock data
CP	LP	PP	Pedestal
CQ	LQ	PQ	per-calo Q-method data (every event)
CR	LR	PR	WFD5 raw data
CT	LT	PT	T-method islands
CZ	LZ	PZ	AMC13 CDF trailers

Table 2: *MIDAS bank list for auxiliary T/Q data. This is mainly for the fiber harps, quads and kickers.*

Bank name	Description
KH	Per aux. detector channel Q-method data (N-th event, end of run)
KQ	Per aux. detector Q-method data (every event)
KT	T-method data

Table 3: *MIDAS bank list for the CCC data.*

TTCA	AMC13 Header
TTCR	CCC AMC13 Payload
TTCZ	AMC13 Trailer

All field-team banks are filled once per event. For many field-team banks, a c struct is defined in the `field_struct.hh` file, accessible for all frontends and unpackers. Programmers should able to cast the read-out bank (array of bytes) onto a pointer of the corresponding struct. A midas bank can be an entire struct (like **TLNP**, **ABPR**, etc) or a array of structs (like **GALI**). A list of these banks are summarized in Tab. 4.

Table 4: *MIDAS bank list for the magnetic field related data.*

System	Name	Description
Fixed probe	FXPR	Fixed probe, header + NMR waveforms
Trolley	TLNP	Trolley NMR Pulse, header + NMR waveforms
	TLBC	Trolley Barcode, header + Barcode waveforms
	TLMN	Trolley Monitors (temperatures, voltages and pressure), header + voltage waveforms
	GALI	Galil (trolley and garage) data, positions + velocities + control voltages + tensions
Absolute probes	ABPR	Absolute probe (spherical probe and plunging probe are using the same bank), header + NMR waveforms
Flux gate	FLUX	Flux gate, fluxgate waveforms
Surface coil	SFCL	Surface coil, current readouts

3 Bank contents

This section details contents of each MIDAS bank.

3.1 Calorimeter-related banks

CA (LA, PA) and CZ (LZ, PZ) banks

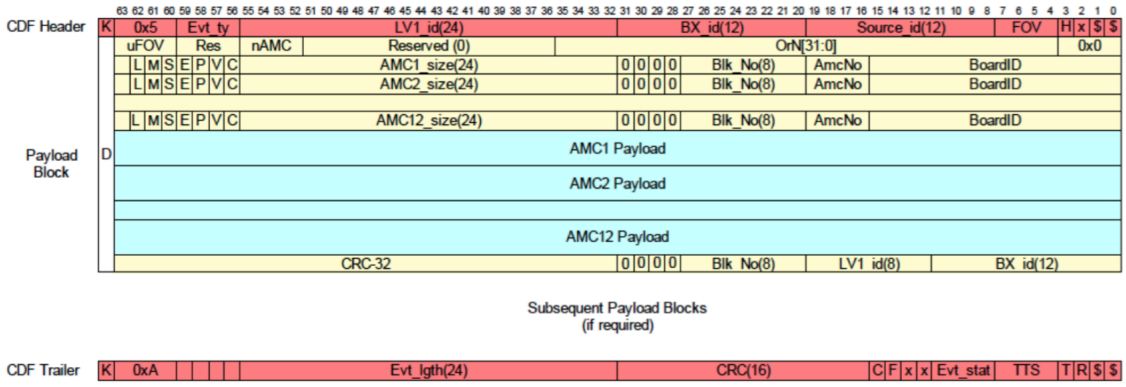

Figure 2: *Data structure for AMC13 to DAQ. The first 2 64-bit words are stored in the CA (LA, PA) bank.*

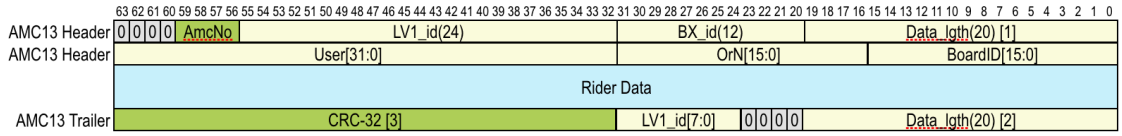

Figure 3: *Data structure for Rider to AMC13.*

CB (LB, PB) banks

CR (LR, PR) banks

This is the bank for the WFD5 payload.

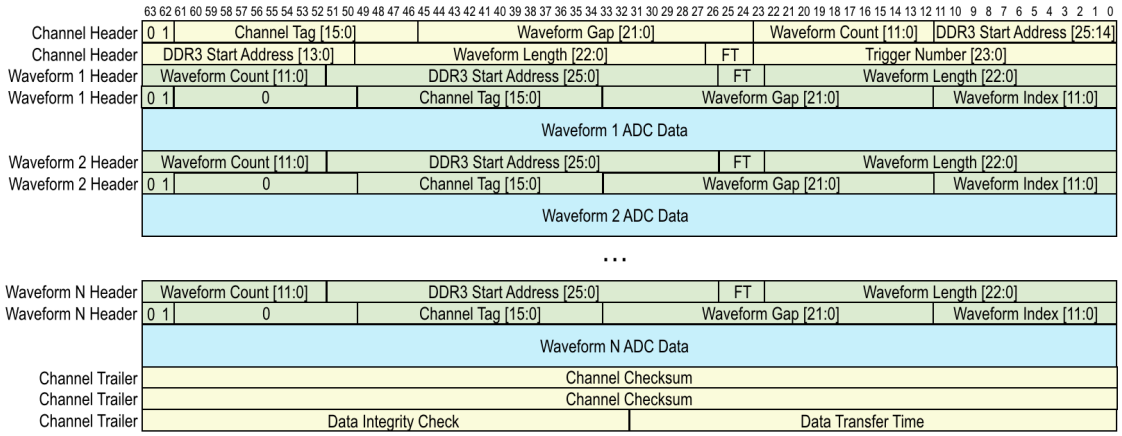

Figure 4: *Data structure for Rider.*

C? (L?, P?) banks

This is the bank for the WFD5 payload in the asynchronous mode.

CT (LT, PT) banks

This place is reserved for T-method (chopped island) bank.

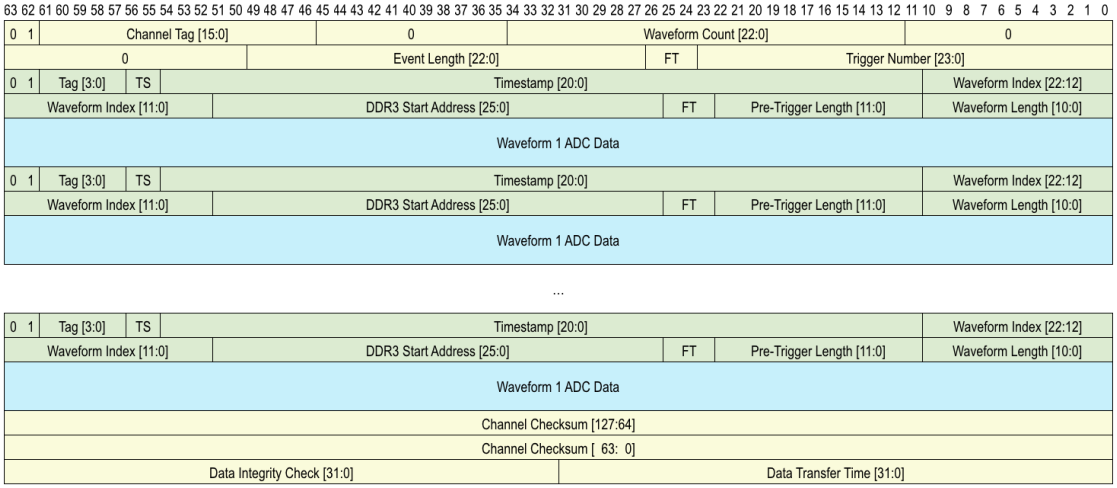

Figure 5: *Data structure for asynchronous mode for Rider.*

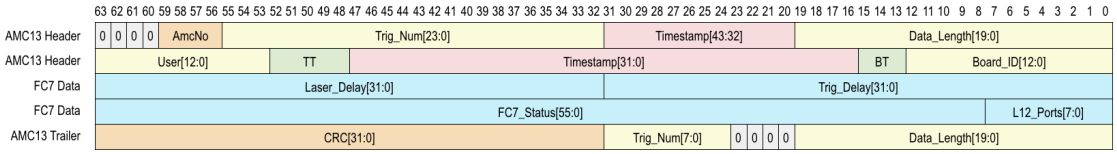

Figure 6: *Data structure for encoder FC7.*

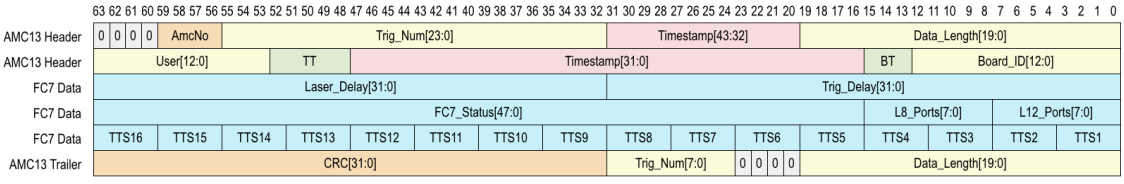

Figure 7: *Data structure for fanout FC7.*

Table 5: *MIDAS bank list for the magnetic field related data.*

start word index	type	array length	field name	content	struct name
0	Double_t	num_ch	sys_clock	system clock	fixed_t
4*num_ch	Double_t	num_ch	gps_clock	gps clock	
8*num_ch	Double_t	num_ch	dev_clock	device clock	
12*num_ch	Double_t	num_ch	snr	signal to noise ratio	
16*num_ch	Double_t	num_ch	len	length of each wave form	
20*num_ch	Double_t	num_ch	freq	frequency extracted	
24*num_ch	Double_t	num_ch	ferr	frequency error	
28*num_ch	Double_t	num_ch	freq_zc	frequency extracted, zero crossing	
32*num_ch	Double_t	num_ch	ferr_zc	frequency error, zero crossing	
36*num_ch	UShort_t	num_ch	health	health indicator of probes	
37*num_ch	UShort_t	num_ch	method	frequency extraction method	
38*num_ch	UShort_t	num_ch * rec_len	trace	NMR waveforms: Waveform_Ch1 + Waveform_Ch2 + ... + Waveform_Ch6	

Table 6: *Hard-coded macros in the FXPR bank.*

Name in the code	Name in this doc	Value
NMR_NUM_FIXED_PROBES	num_ch	378
NMR_FID_LENGTH_RECORD	rec_len	10000

3.2 Auxiliary detector-related banks

KH and KQ banks

KT bank

3.3 CCC related banks

TTCA, TTCR, TTCZ banks

3.4 Field related banks

FXPR bank

4 Parsers for MIDAS bank data

Muon g-2 offline analysis framework relies on parsers in the gm2parser namespace hosted under repository gm2unpackers to decode the data. To checkout the codes,

```
git clone ssh://p-gm2dqm@cdcvs.fnal.gov/cvs/projects/gm2unpackers
```

Alternatively, you can also use

```
mrb g gm2dqm
```

in our g-2 environment.