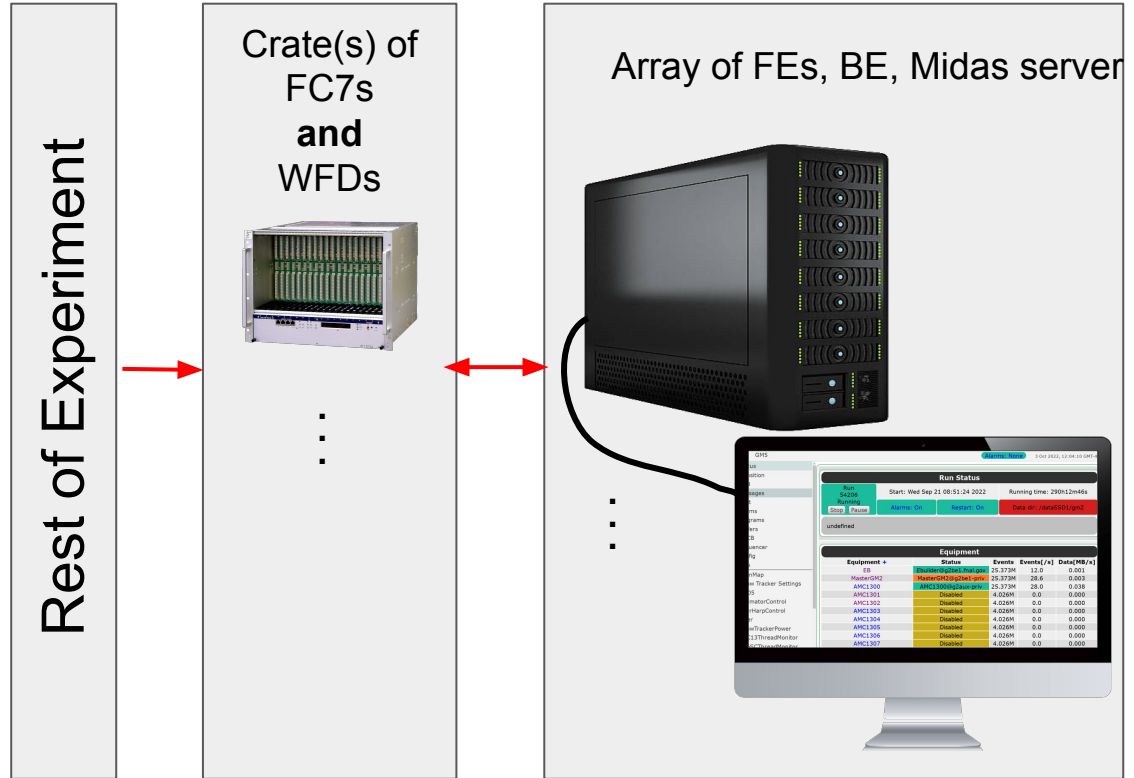


Data Acquisition (DAQ)

Jack Carlton
University of Kentucky

g-2 DAQ (Modified for One Crate Support)

- Retains g-2 hardware, but made more flexible
- Same general process:
 - Communicate with μ TCA crate, initialize hardware
 - Read TCP packets from μ TCA crate
 - Write to midas data banks



Midas Framework

- C/C++ (mostly) package of modules for
 - run control,
 - expt. configuration
 - data readout
 - event building
 - data storage
 - slow control
 - alarm systems
 - Etc.
- Can link with custom software

The screenshot displays the Midas Framework GM5 interface. On the left is a sidebar menu with options: Status, Transition, ODB, Messages, Chat, Alarms, Programs, Buffers, MSCB, Sequencer, Config, Help, ChanMap, Straw Tracker Settings, WFD5, CollimatorControl, FiberHarpControl, Laser, StrawTrackerPower, AMC13ThreadMonitor, CaloSCThreadMonitor, and TDAQThreadMonitor. The main panel is titled 'GM5' and shows 'Alarms: None' and the date/time '3 Oct 2022, 12:04:10 GMT-4'.

Run Status

Run 54206 Running
Start: Wed Sep 21 08:51:24 2022 Running time: 290h12m46s
Data dir: /dataSSD1/gm2

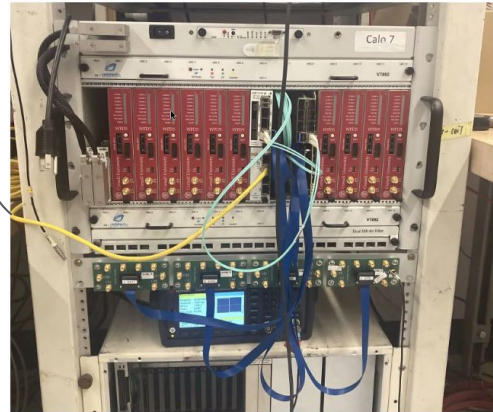
Buttons: Stop, Pause, Alarms: On, Restart: On

undefined

Equipment

Equipment +	Status	Events	Events[/s]	Data[MB/s]
EB	Ebuilder@g2be1.fnal.gov	25.373M	12.0	0.001
MasterGM2	MasterGM2@g2be1-priv	25.373M	28.6	0.003
AMC1300	AMC1300@g2aux-priv	25.373M	28.0	0.038

Hardware Requirements



- Micro Telecom Computing (μTCA) crate with Modules:
 - Waveform Digitizers (WFD5(s)/Rider(s))
 - Controller (FC7)
 - MicroTCA Carrier Hub (MCH)
 - Advanced Mezzanine Card (AMC)
- “Frontend” computer with available PCIe slots for the following...
- Meinberg PCIe Clock Card
 - Custom connector
- 10 Gigabit Ethernet Network Interface Card (10GbE NIC)
 - SFP+ connectors

Installation, in a perfect world:

Software Requirements

- “Frontend” computer needs to be running Redhat-Enterprise Linux 7 (RHEL7)
 - Examples: Scientific Linux 7 (SL7), CentOS 7
- Midas
- Various other open source software libraries (root, boost, cactus, etc.)
- Some custom software libraries (DAQ frontend code, unpacking libraries, etc.)
- Software installation completely handled by [installer](#) on RHEL7 systems

```
[1] git clone  
git@github.com:PIONEER-Experiment/g  
m2daq-installer  
[2] ./install.sh
```

patience...

```
[3] source ./setup_environment.sh  
[4] ./start_midas_webpage.sh
```

Open browser,
localhost:8080

Equipment	Status	Events	Events/s	Data/MB/s
MasterGM2	Running	25.373M	12.0	0.001
AMIC1301	Disabled	4.026M	0.0	0.000
AMIC1302	Disabled	4.026M	0.0	0.000
AMIC1303	Disabled	4.026M	0.0	0.000
AMIC1304	Disabled	4.026M	0.0	0.000
AMIC1305	Disabled	4.026M	0.0	0.000
AMIC1306	Disabled	4.026M	0.0	0.000
AMIC1307	Disabled	4.026M	0.0	0.000
AMIC1308	Disabled	4.026M	0.0	0.000

Data Output

- Data is output “raw” in midas “CR” data banks
 - Written to run{#}.mid.lz4 files by mlogger
- Unpacked C++ data structure using [unpacking library](#)
 - Custom analyzers can import unpacking library
 - Unpacking library include in installer

	63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 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																																																															
AMC13 Header	0 0 0 0				AMC #		Trigger # [23:0]																									Timestamp [43:32]															Data Length [19:0]																	
AMC13 Header	CE [4:0]				L	XADC				E	TT [4:0]				Timestamp [31:0]																														BT		A	Board ID [11:0]																
WFD5 Header	0 0 0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				Major Revision [7:0]				Minor Revision [7:0]				Patch Revision [7:0]																							
Channel Header	0	1	XADC			Channel Tag [11:0]										Waveform Gap [21:0]																									Waveform Count [11:0]										DDR3 Start Address [25:14]													
Channel Header	DDR3 Start Address [13:0]										Waveform Length [22:0]																				TT				Trigger Number [23:0]																													
Waveform Header	Waveform Count [11:0]										DDR3 Start Address [25:0]																				TT				Waveform Length [22:0]																													
Waveform Header	0	1	0 0 0 0				0 0 0 0 0 0				0 0 0 0 0 0				Channel Tag [11:0]										Waveform Gap [21:0]																									Waveform Index [11:0]														
WFD5 Data	Waveform 1 ADC Data																																																															

Online Database (ODB)

- GUI on midas webpage
 - Also available command line
- Allows for “on the fly” adjustments between runs
- Built in configurations:
 - Midas webpage
 - Logger write location
 - Webpage update rate
 - Etc.
- Custom configurations
 - Configure hardware
 - etc.

Online Database Browser		
Find	Create	Link Delete Create Elog from this page
/ Equipment / AMC1300 / Settings / Globals /		
Key	Value	
Sync	n	
Use AMC13 Simulator	n	
GPU Device ID	0 (0x0)	
GPU Device Name Prefix	tesla	
Send to Event Builder	y	
FE Lossless Compression	y	
FEBankByBankLosslessCompression	n	
Raw Data Store	y	
Raw Data Prescale	1000 (0x3E8)	
Raw Data Prescale Offset	1 (0x1)	
MCH IP Address	192.168.0.15	
CCC: FC7 Slot Number (1-12)	10 (0xA)	
CCC: FMC Location (top, bottom)	top	
CCC: FMC SFP Number (1-8)	1 (0x1)	

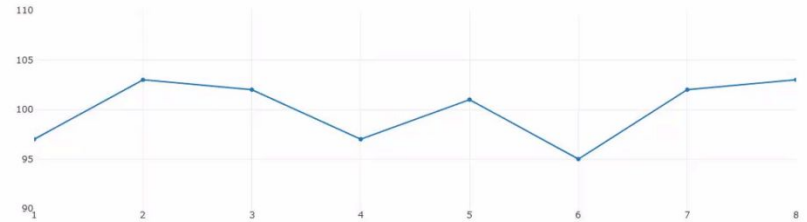
Custom Software

- Can write “clients” that connect to midas experiment
 - Python
 - C++
- Allows for user to write software to fit their needs, for example:
 - Data Quality Monitor
 - Offline Analysis
 - Automatic ODB management

Oscilloscope Plot

Data

- Data 1: 97
- Data 2: 103
- Data 3: 102
- Data 4: 97
- Data 5: 101
- Data 6: 95
- Data 7: 102
- Data 8: 103



Crude “proof of concept” DQM

Future Projects (Things We're Working On)

- Ensuring UW machine has running DAQ before PSI beamtime
- Improve DQM framework to be more adaptable using midas, unpacking, and ZeroMQ libraries
- Direct communication between WFDs/FPGAs and CPU/GPU using PCIe communication
 - Avoids the need for μ TCA crates
 - Speeds up data transfer rate ($\text{PCIe3x8} = 8\text{GB/s} = 64\text{ Gb/s} > 10\text{ Gb/s}$)
 - Possibility for direct communication to GPU (faster data processing)