Fermilab Muon g-2

Managed by Fermi Research Alliance, LLC for the U.S. Department of Energy Office of Science

Muon g-2 Database

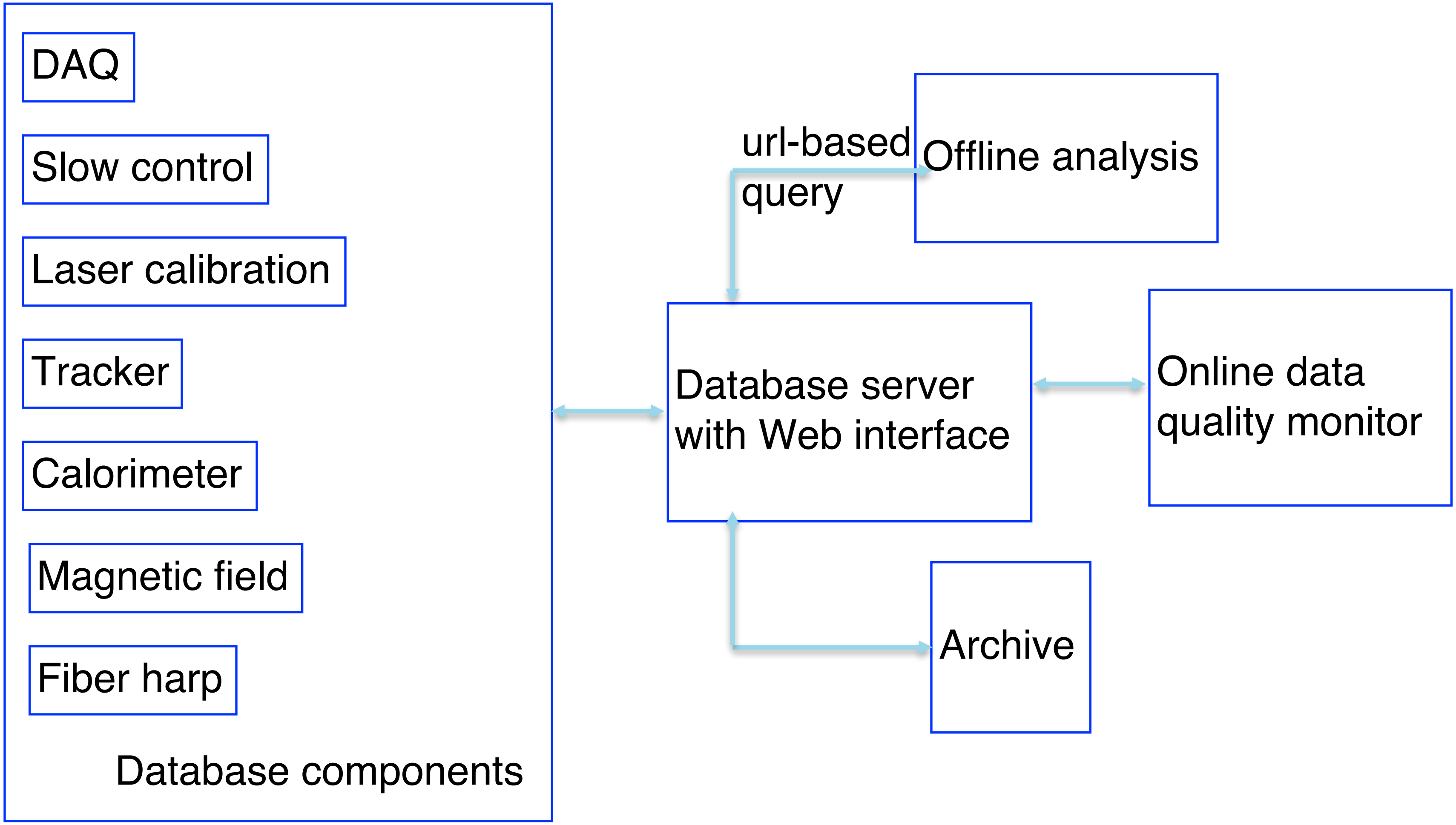
Dikai LI, Liang LI
Shanghai Jiao Tong University

g-2 Computing Review
8 November 2016

Outline

- Requirements
  - Build up g-2 database, for data analysis, data quality, archive
- Status
  - Collected information from sub-detectors (spreadsheet and specification document), individual databases to be centralized
- Plans
  - Centralizing and building database, start from DAQ, slow control, laser calibration
- Schedule
  - Generate database (test version) by the end of 2016, full version ready before the start of beam (April, 2017), keep update and maintain during the g-2 experiment

Muon g-2 Database Overview



DAQ

Slow control

Laser calibration

Tracker

Calorimeter

Magnetic field

Fiber harp

Database components

Database server with Web interface

url-based query

Offline analysis

Online data quality monitor

Archive

Requirements

- Description of data information collected from each sub-detector:
  - Data format, data structure, data size, write/read rate
- Store and/or access information in database
  - Database format
  - Database server, web interface, command line
- Documentation
  - Specification document
  - Wiki page

Status - Data information

- Description of data information collected
  - Data format, data structure, data size, write/read rate

Slow control

Variables	Data Type	Data Size(Bytes)	Readout Rate
Hall Temperatures (x64)	Float	4 * 64 = 256	1 Hz
Hall Humidity (x2)	Float	4 * 2 = 8	1 Hz
Hall Air Pressure (x2)	Float	4 * 2 = 8	1 Hz
Tilt Sensor (x2)	Float	4 * 2 = 8	1 Hz
Calibrations			
Temp sensors (x64)	Float	4 * 64 = 256	N/A
Hall air pressure (x2)	Float	4 * 2 = 8	N/A

Status - Database size

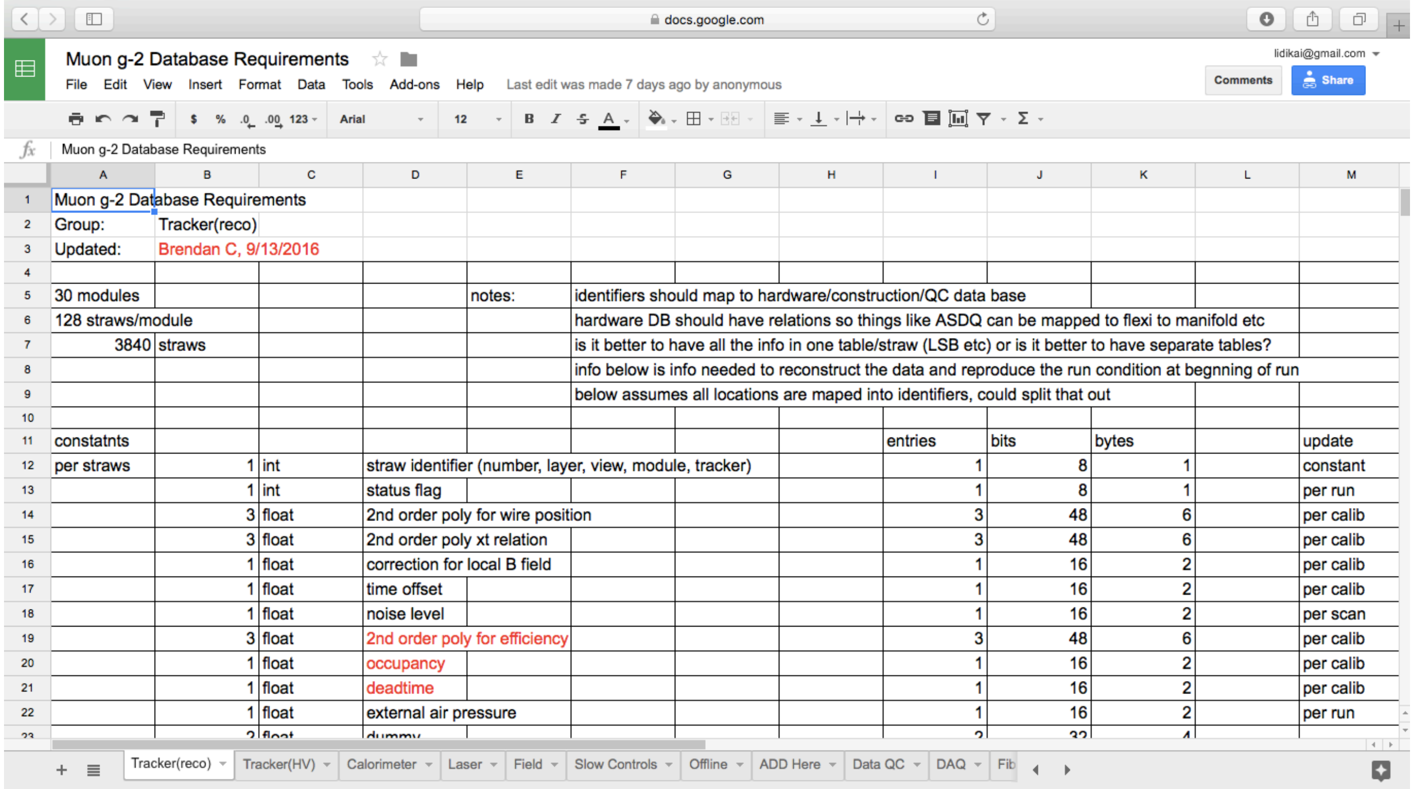
Variables	size	rate	1day	1year	3years
Data quality	82 Byte	1 Hz	6.76MB		
Slow control	280 Byte	1 Hz	23 MB		
magnetic field	41 Byte	1 Hz	3.38 MB		
Other main parts	977 kByte	per hour	22.90 MB		
Total			56.04 MB	19.98 GB	59.9 GB

Status - Database format

- Database format and settings
  - Current: mixture of various formats, ODB, MySQL, Postgres
  - MySQL workbench for tracker, data analysis
  - Plan to convert to Postgres
- Type of database
  - "Static" hardware information and quality control results
  - "Dynamic" hardware connections and settings
  - Slow control data
  - Calibration data
  - Run log

Status - Documentation - Spreadsheet

- Description of data information collected from each sub-detector (spreadsheet and specification document)
    - Data format, data structure, data size, write/read rate



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Muon g-2 Database Requirements												
2	Group:	Tracker(reco)											
3	Updated:	Brendan C, 9/13/2016											
4													
5	30 modules				notes:	identifiers should map to hardware/construction/QC data base							
6	128 straws/module					hardware DB should have relations so things like ASDQ can be mapped to flexi to manifold etc							
7	3840	straws				is it better to have all the info in one table/straw (LSB etc) or is it better to have separate tables?							
8						info below is info needed to reconstruct the data and reproduce the run condition at begnning of run							
9						below assumes all locations are maped into identifiers, could split that out							
10													
11	constatnts								entries	bits	bytes		update
12	per straws	1	int	straw identifier (number, layer, view, module, tracker)					1	8	1		constant
13		1	int	status flag					1	8	1		per run
14		3	float	2nd order poly for wire position					3	48	6		per calib
15		3	float	2nd order poly xt relation					3	48	6		per calib
16		1	float	correction for local B field					1	16	2		per calib
17		1	float	time offset					1	16	2		per calib
18		1	float	noise level					1	16	2		per scan
19		3	float	2nd order poly for efficiency					3	48	6		per calib
20		1	float	occupancy					1	16	2		per calib
21		1	float	deadtime					1	16	2		per calib
22		1	float	external air pressure					1	16	2		per run
23		2	float	dummy					2	32	4		

Link to spreadsheet

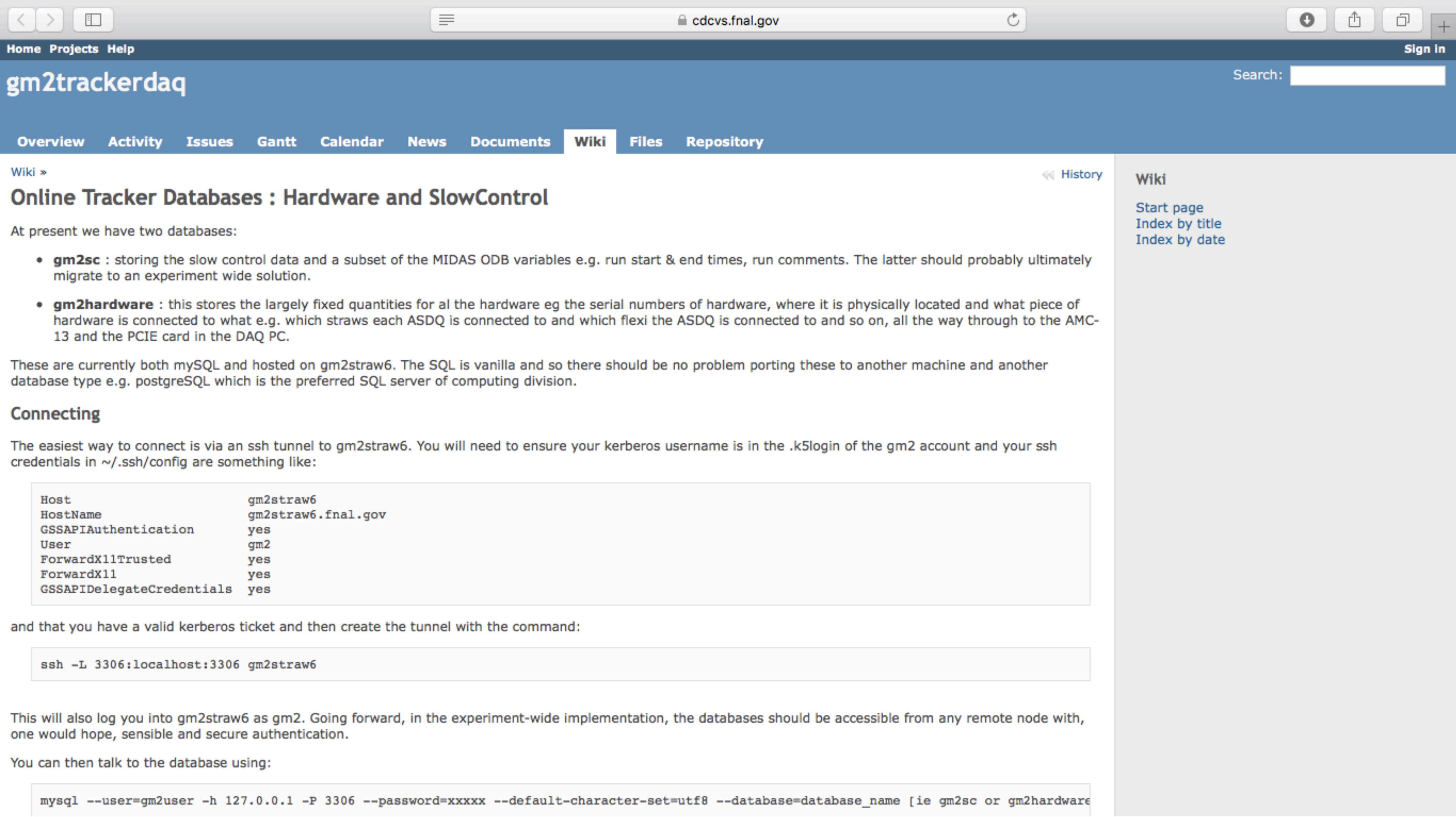
Status - Specification document

- Laser calibration system
- The calorimeter gain is calibrated and continuously monitored by a state-of-the-art high performance laser-based distributed system. There are 6 laser heads (+ 1 spare) with one filter wheel (12 positions, 11 filters), one source monitor and 4 optical fibers (in order to feed 24 calorimeter station) per laser head. There is a diffuser, a panel with 54 prisms and 2 local monitor PMT with 3 optical fibers (1 quartz, 2 PMMA) for each calo station.

	Variable	Data Format	Data Size(Bytes)	Rate
results of filter wheel scans	calibration constants	float	2592	per 8 runs
	electrical noise	float	2592	
results of bias scans	breakdown voltage	float	2592	
	gain gradient	float	2592	
Position measurements (laser tracker)	x	float	48	per run
	y	float	48	
	z	float	48	
	pitch	float	48	
	yaw	float	48	
	roll	float	48	

Link to specification document

Status - Documentation - Wiki page



Online Tracker Databases : Hardware and SlowControl

At present we have two databases:

- **gm2sc** : storing the slow control data and a subset of the MIDAS ODB variables e.g. run start & end times, run comments. The latter should probably ultimately migrate to an experiment wide solution.
- **gm2hardware** : this stores the largely fixed quantities for al the hardware eg the serial numbers of hardware, where it is physically located and what piece of hardware is connected to what e.g. which straws each ASDQ is connected to and which flexi the ASDQ is connected to and so on, all the way through to the AMC-13 and the PCIE card in the DAQ PC.

These are currently both mySQL and hosted on gm2straw6. The SQL is vanilla and so there should be no problem porting these to another machine and another database type e.g. postgreSQL which is the preferred SQL server of computing division.

Connecting

The easiest way to connect is via an ssh tunnel to gm2straw6. You will need to ensure your kerberos username is in the .k5login of the gm2 account and your ssh credentials in ~/.ssh/config are something like:

```
Host                         gm2straw6
HostName                     gm2straw6.fnal.gov
GSSAPIAuthentication         yes
User                         gm2
ForwardX11Trusted            yes
ForwardX11                   yes
GSSAPIDelegateCredentials    yes
```

and that you have a valid kerberos ticket and then create the tunnel with the command:

```
ssh -L 3306:localhost:3306 gm2straw6
```

This will also log you into gm2straw6 as gm2. Going forward, in the experiment-wide implementation, the databases should be accessible from any remote node with, one would hope, sensible and secure authentication.

You can then talk to the database using:

```
mysql --user=gm2user -h 127.0.0.1 -P 3306 --password=xxxxx --default-character-set=utf8 --database=database_name [ie gm2sc or gm2hardware
```

[Link to wiki page - tracker database]

Plan

- Database format and settings
  - Plan to move/convert to Postgres
    - Make changes in the QueryEngine to support Postgres .json data type for data queries
    - Choose either Minerva Conditions database or NOvA style conditions, database, or both
  - Setup: Host name, port, database name, read/write account name
- Database implementation and tools
  - Tools to move from sql to Postgres
  - Web interface and command line
- Start building the database
  - Make test version from DAQ, slow control and laser calibration
- Wiki page
- Sign owner to various tasks

Schedule

- 1. Nov. - Dec.:
  - First view of database (of DAQ, slow control, laser calibration) – collaborate with Fermilab computing experts, Steve, Igor, et. al.
  - Wiki page
- 2. Jan. - Mar.:
  - Complete and test the full version database

Backup

Summary

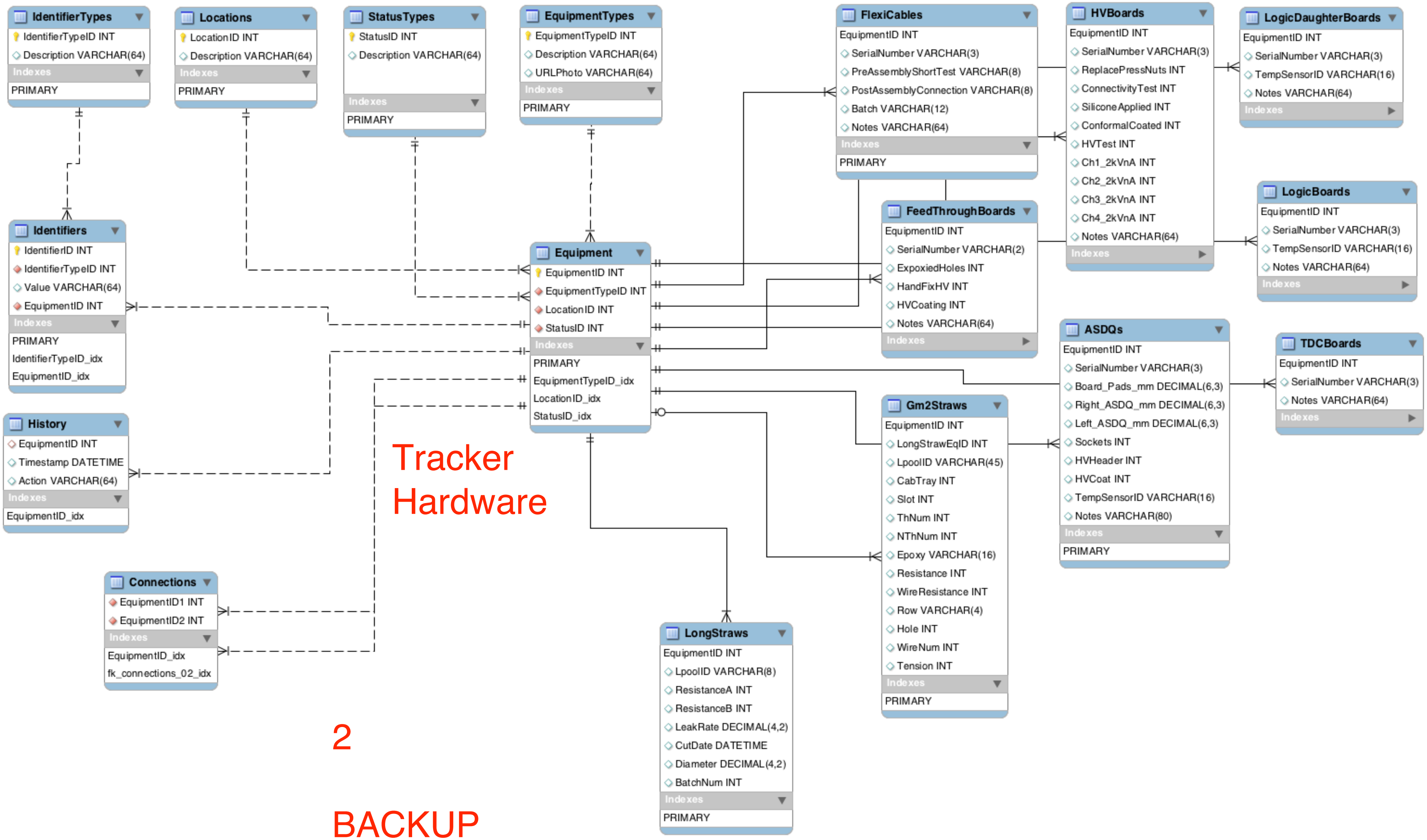
- 1. Information has been gathered
- 2. To choose database format
- 3. Starting to build database in November, and hopefully get a first demo before the end of 2016
- 4. Wiki page and owner of various tasks

Status - Sources

- https://cdcvs.fnal.gov/redmine/projects/gm2trackerdaq/wiki/Databases_ (description for tracker database)

- ssh -L 8080:g2be1-priv:80 G2Muon@g2gateway01.fnal.gov (connect to DAQ database)

Status - Data information - Structure



IdentifierTypes
IdentifierTypeID INT
Description VARCHAR(64)
Indexes
PRIMARY

Locations
LocationID INT
Description VARCHAR(64)
Indexes
PRIMARY

StatusTypes
StatusID INT
Description VARCHAR(64)
Indexes
PRIMARY

EquipmentTypes
EquipmentTypeID INT
Description VARCHAR(64)
URLPhoto VARCHAR(64)
Indexes
PRIMARY

FlexiCables
EquipmentID INT
SerialNumber VARCHAR(3)
PreAssemblyShortTest VARCHAR(8)
PostAssemblyConnection VARCHAR(8)
Batch VARCHAR(12)
Notes VARCHAR(64)
Indexes
PRIMARY

HVBoards
EquipmentID INT
SerialNumber VARCHAR(3)
ReplacePressNuts INT
ConnectivityTest INT
SiliconeApplied INT
ConformalCoated INT
HVTest INT
Ch1_2kVnA INT
Ch2_2kVnA INT
Ch3_2kVnA INT
Ch4_2kVnA INT
Notes VARCHAR(64)
Indexes

LogicDaughterBoards
EquipmentID INT
SerialNumber VARCHAR(3)
TempSensorID VARCHAR(16)
Notes VARCHAR(64)
Indexes

Identifiers
IdentifierID INT
IdentifierTypeID INT
Value VARCHAR(64)
EquipmentID INT
Indexes
PRIMARY
IdentifierTypeID_idx
EquipmentID_idx

Equipment
EquipmentID INT
EquipmentTypeID INT
LocationID INT
StatusID INT
Indexes
PRIMARY
EquipmentTypeID_idx
LocationID_idx
StatusID_idx

FeedThroughBoards
EquipmentID INT
SerialNumber VARCHAR(2)
ExpoxiedHoles INT
HandFixHV INT
HVCoating INT
Notes VARCHAR(64)
Indexes

LogicBoards
EquipmentID INT
SerialNumber VARCHAR(3)
TempSensorID VARCHAR(16)
Notes VARCHAR(64)
Indexes

ASDQs
EquipmentID INT
SerialNumber VARCHAR(3)
Board_Pads_mm DECIMAL(6,3)
Right_ASDQ_mm DECIMAL(6,3)
Left_ASDQ_mm DECIMAL(6,3)
Sockets INT
HVHeader INT
HVCoat INT
TempSensorID VARCHAR(16)
Notes VARCHAR(80)
Indexes
PRIMARY

TDCBoards
EquipmentID INT
SerialNumber VARCHAR(3)
Notes VARCHAR(64)
Indexes

History
EquipmentID INT
Timestamp DATETIME
Action VARCHAR(64)
Indexes
EquipmentID_idx

Gm2Straws
EquipmentID INT
LongStrawEqID INT
LpoolID VARCHAR(45)
CabTray INT
Slot INT
ThNum INT
NThNum INT
Epoxy VARCHAR(16)
Resistance INT
WireResistance INT
Row VARCHAR(4)
Hole INT
WireNum INT
Tension INT
Indexes
PRIMARY

Connections
EquipmentID1 INT
EquipmentID2 INT
Indexes
EquipmentID_idx
fk_connections_02_idx

LongStraws
EquipmentID INT
LpoolID VARCHAR(8)
ResistanceA INT
ResistanceB INT
LeakRate DECIMAL(4,2)
CutDate DATETIME
Diameter DECIMAL(4,2)
BatchNum INT
Indexes
PRIMARY

Tracker Hardware

2

BACKUP

Status - Data information

- Description of data information collected
  - Data format, data structure, data size, write/read rate

Data quality

Run Log Fast DAQ (Every Fill)	Data Type	Data Size	Readout Rate	Comment
beam cycle	int	4	1 Hz	counter from beginning of run of cycles
fill #	int	2	1 Hz	1 - 12 within a cycle
p intensity	int	8	1 Hz	proton intensity from beam line information
T0 intensity	float	8	1 Hz	integral of T0 counter / proxy to intensity
T0 QF	int	4	1 Hz	Quality factor code of T0 shape
IBMS1	vector, float	16	1 Hz	MeanX, MeanY, RMSX, RMSY
IBMS2	vector, float	16	1 Hz	MeanX, MeanY, RMSX, RMSY
IBMS3	vector, float	8	1 Hz	MeanX, RMSX,
CTAG[i]	vector, int	16	1 Hz	Online calo hit counters; 4 representative numbers