Fermilab Muon g-2

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

Tracker DAQ overview

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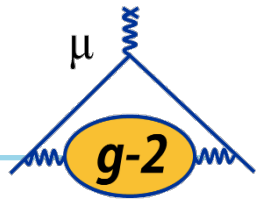
On behalf of the tracking team
7th Nov 2016

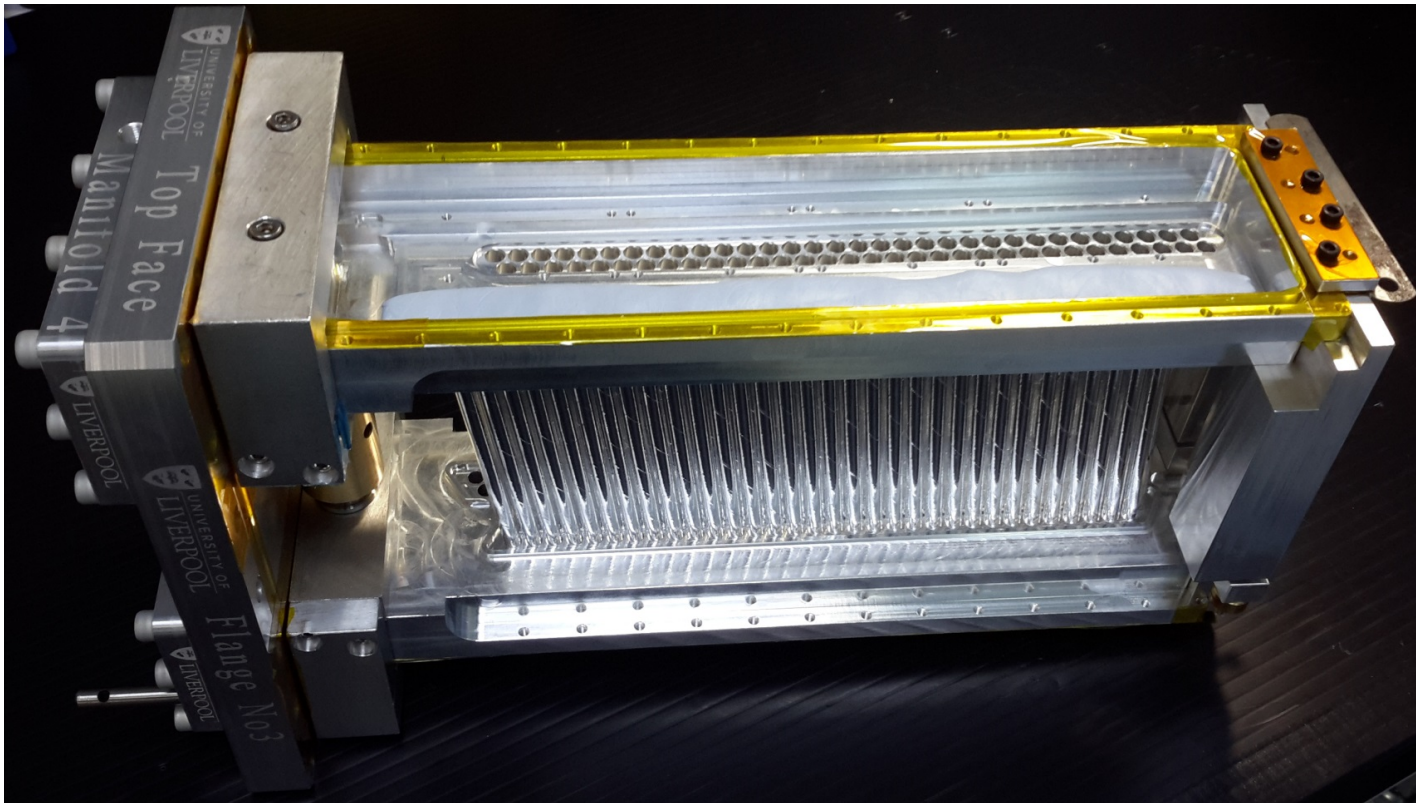
Outline



- Reminder of tracker setup
- Online to offline overview
  - Focus on path to offline, reconstruction details given earlier
- 2015 test beam results
- Lab 3 cosmic test stand
- Online data monitoring
- Plans

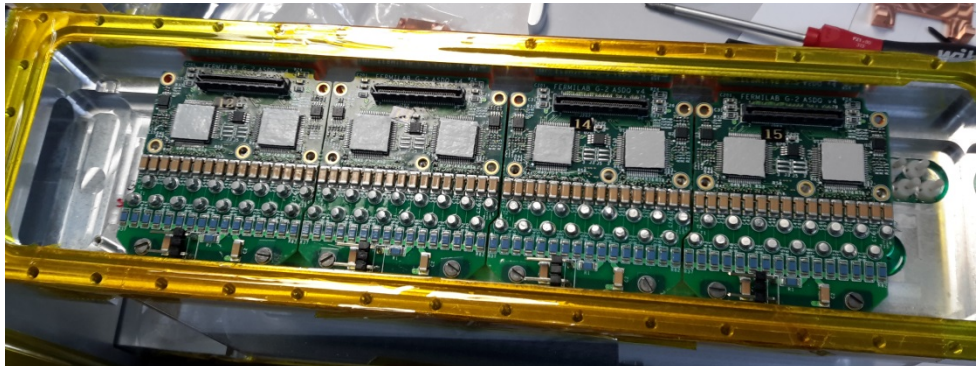
Tracker reminder

- 3 trackers in experiment
- Each tracker consists of 8 modules
- Each module has 128 mylar straws



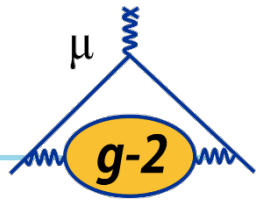
g-2 tracker reminder

- Each straw is filled with Ar:Eth and surrounds a wire kept at a high potential w.r.t the straw
- Incident charged particle ionises the gas, creating a current along the wire, detected by ASDQs housed in manifold



4 x ASDQ per manifold
16 channels per ASDQ

Online data requirements



- Multi-module readout
- Have 10ms to process data before next trigger
- Precise steerable run configuration
- Synchronisation of hit times between modules
- Online data quality monitoring (DQM)

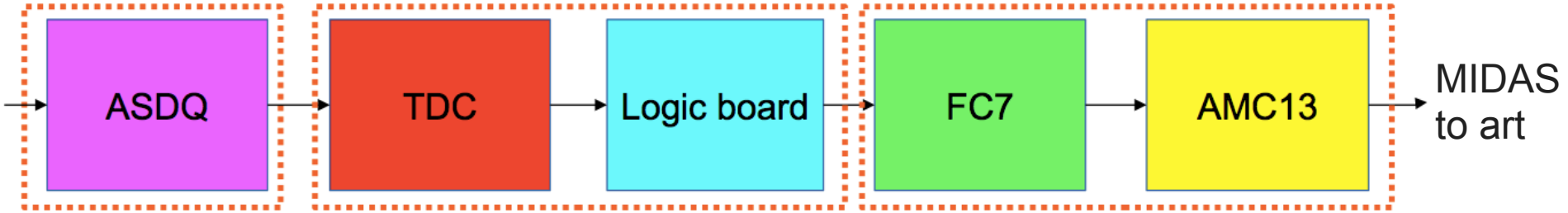
Expected rates

- Expecting ~6 hits per fill per straw, 12 Hz rate, we get:

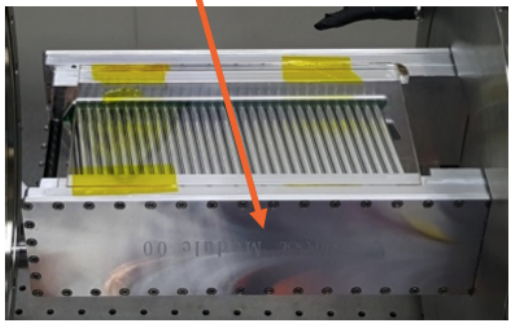
		bits Per Fill	Mb/s
Per TDC	Header+Footer	32	0.049
	Data words	96	
	Total words	128	
	Total bits	4096	
Per Logic Board	Header+Footer	14	0.202
	Data words	512	
	Total words	526	
	Total bits	16832	
Per Tracker	Header+Footer	8	3.235
	Data words	8416	
	Total words	8424	
	Total bits	269568	

- Expecting 3 Tracker total = 9.7 Mb/s

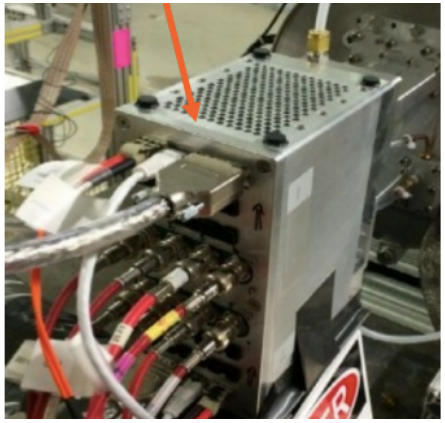
Online data requirements



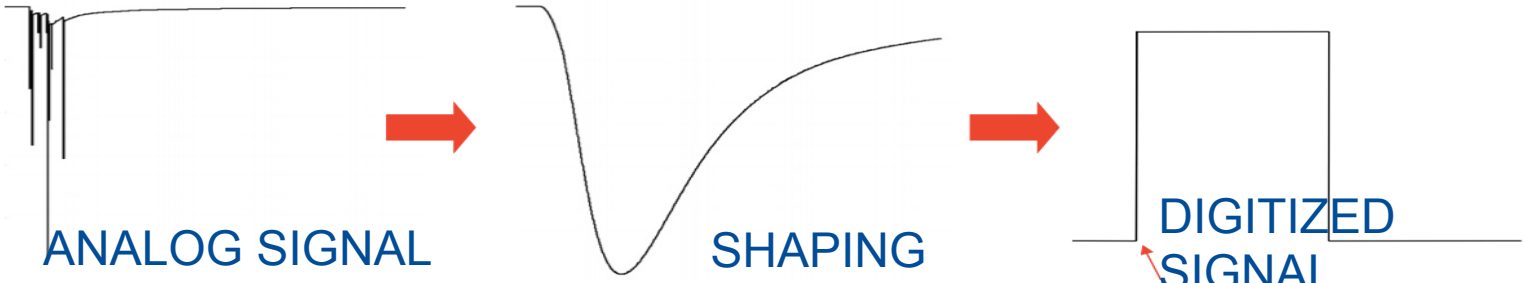
MANIFOLD



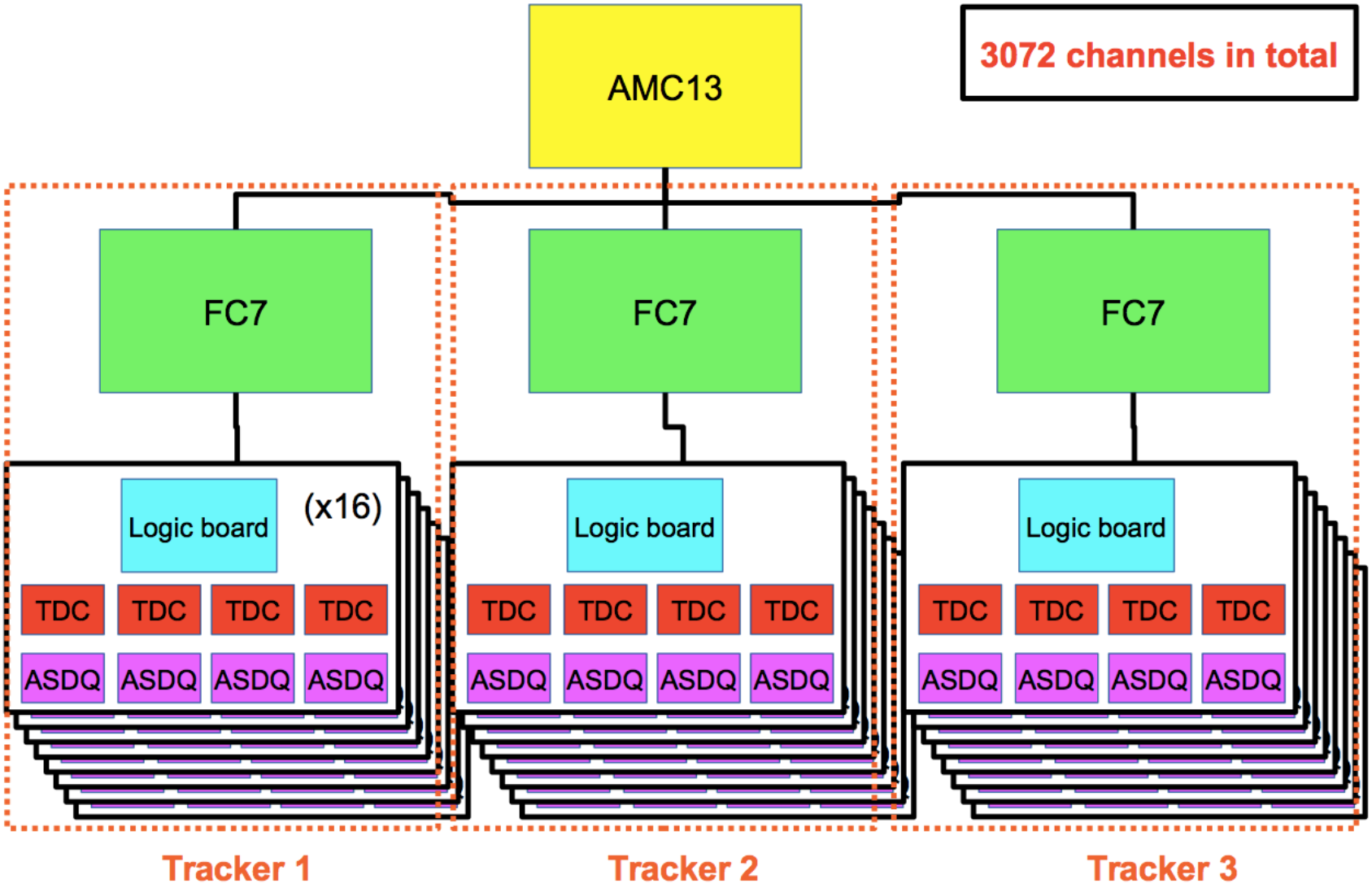
FLOBBER



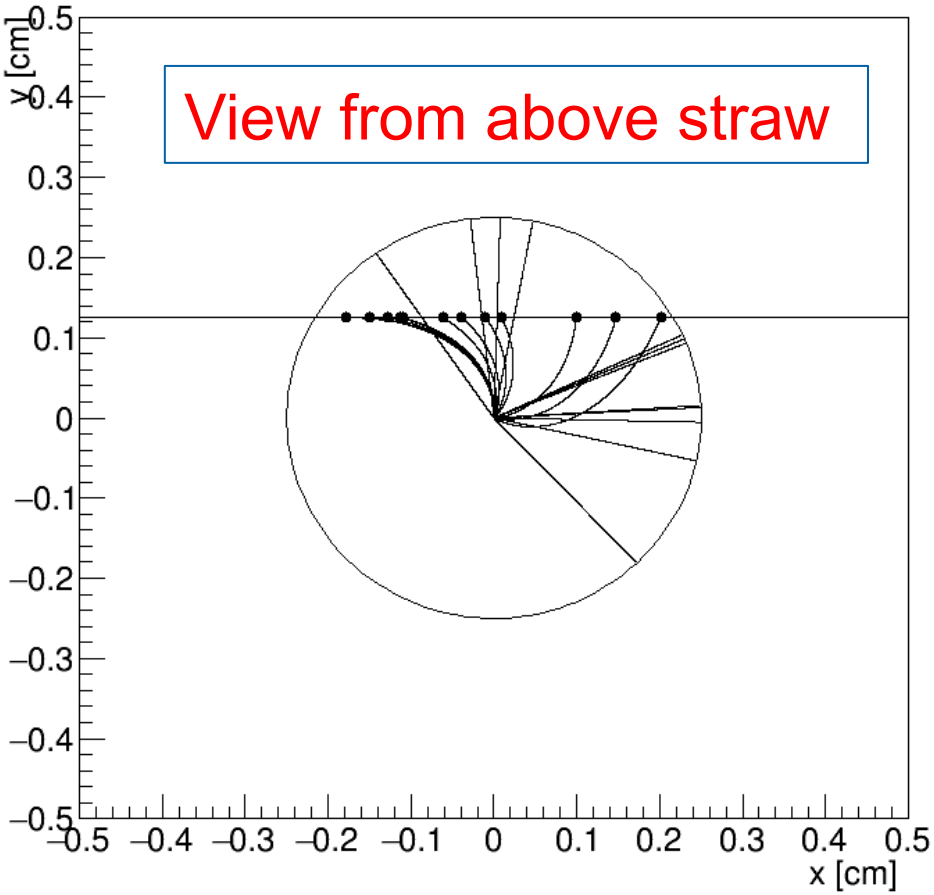
μTCA crate



Online data requirements

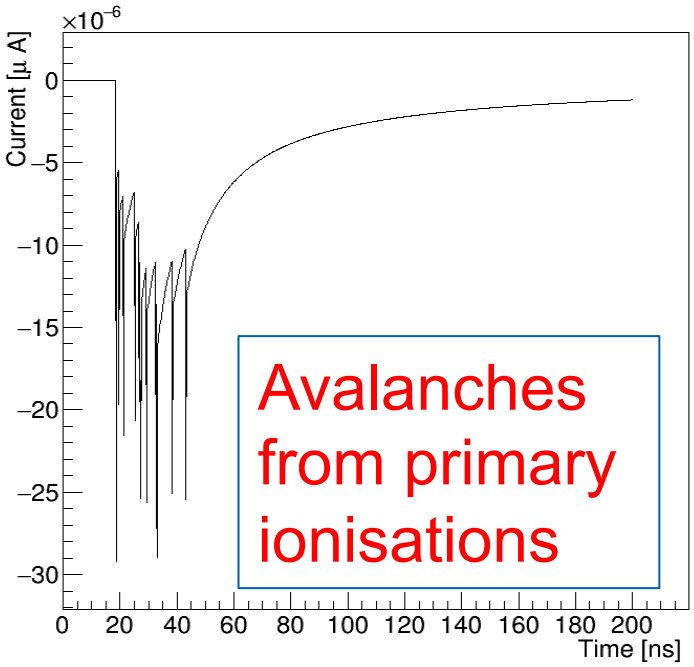


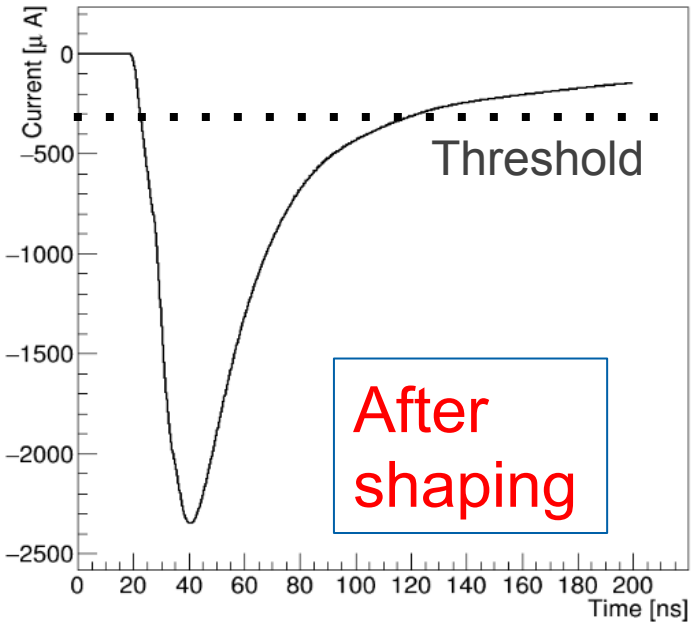
Modeling detector response



- Using GARFIELD we can simulate the drift time as a function of straw radius in a magnetic field
- Multiple ionisations per e+ crossing expected

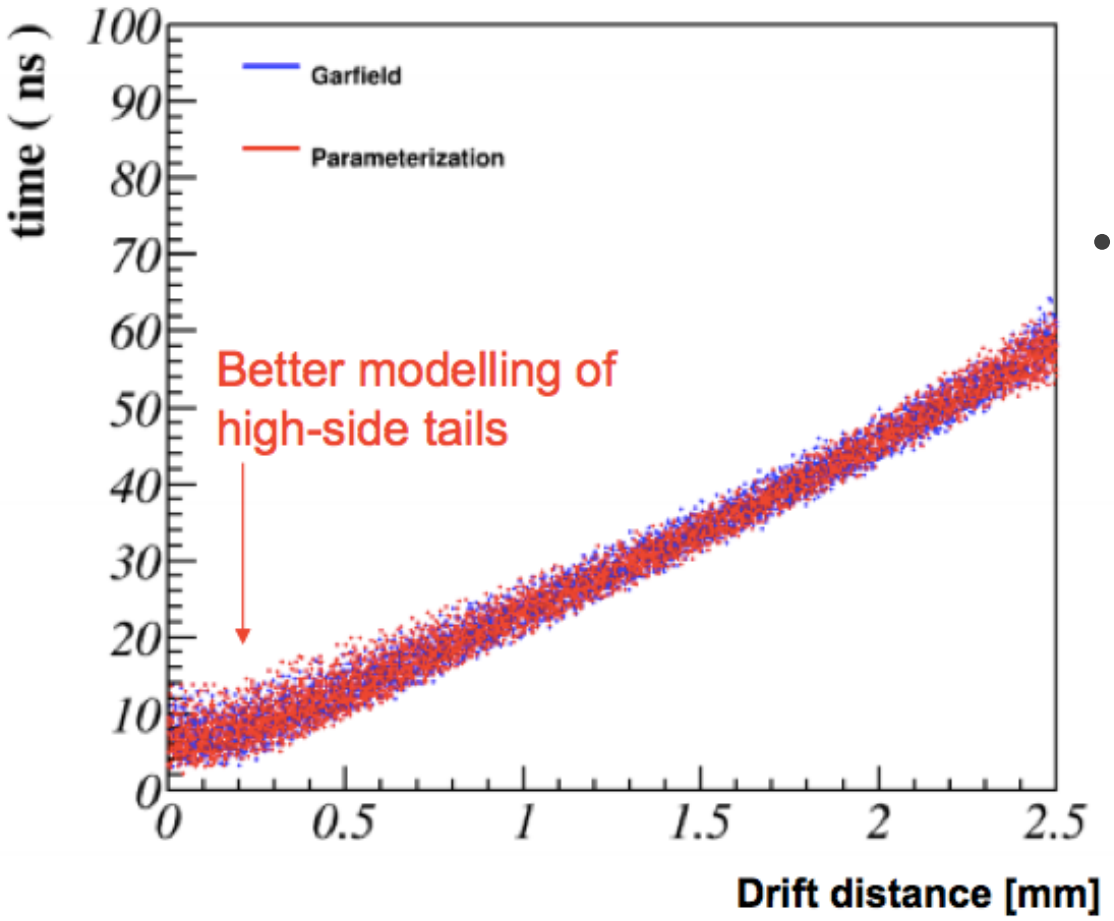
Modeling detector response





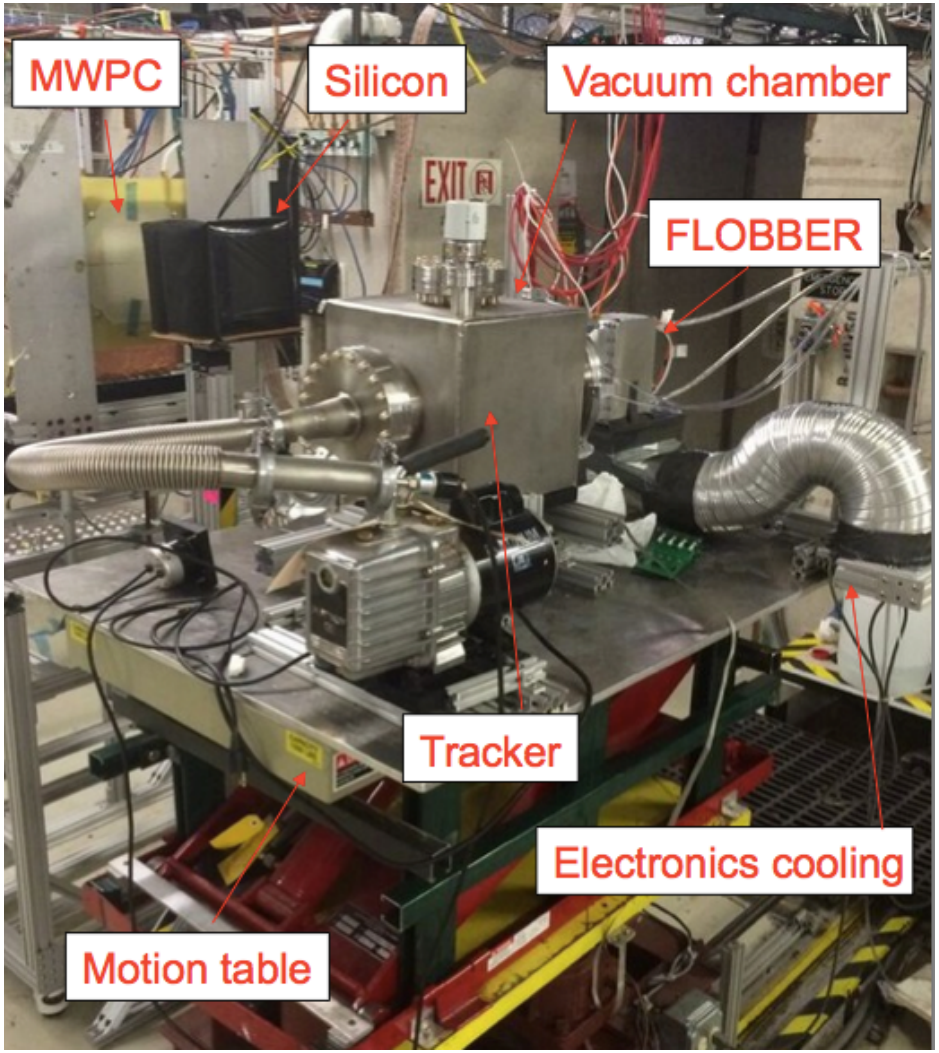
- After shaping we record time of threshold crossing
- Behaviour depends upon path length through straw, and therefore straw radius

Detector response



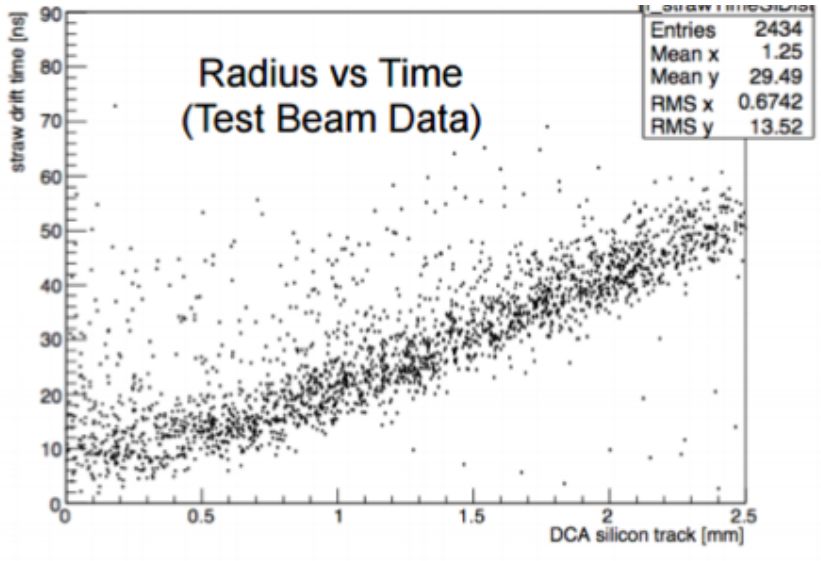
- Double asymmetric Gaussian parameterises GARFIELD response
- Check with test beam data if shape is correct…

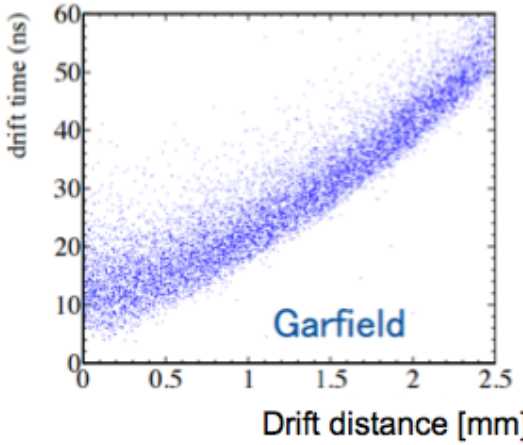
Single module test beam

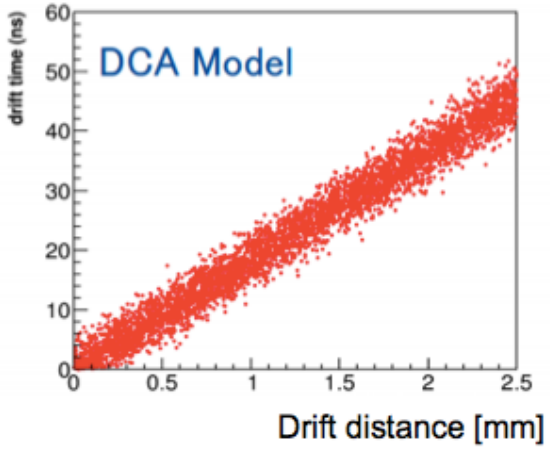


- Used test beam facilty at FNAL
- Proton beam
- Single module placed in vac tank
- 2 layers of pixilated silicon before, 2 layers after module for high resolution tracking
- Birthplace of MIDAS to art framework

Detector response - data

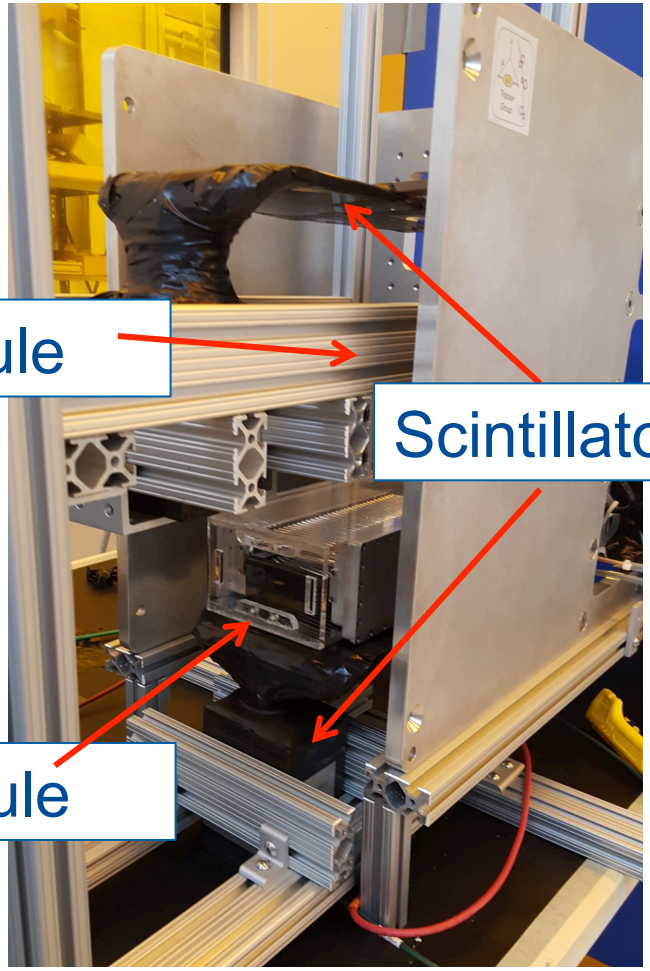






- Use silicon data for DCA of track
- Simple DCA model insufficient
- Garfield describes shape well
- For multi-module tests we need a different setup…

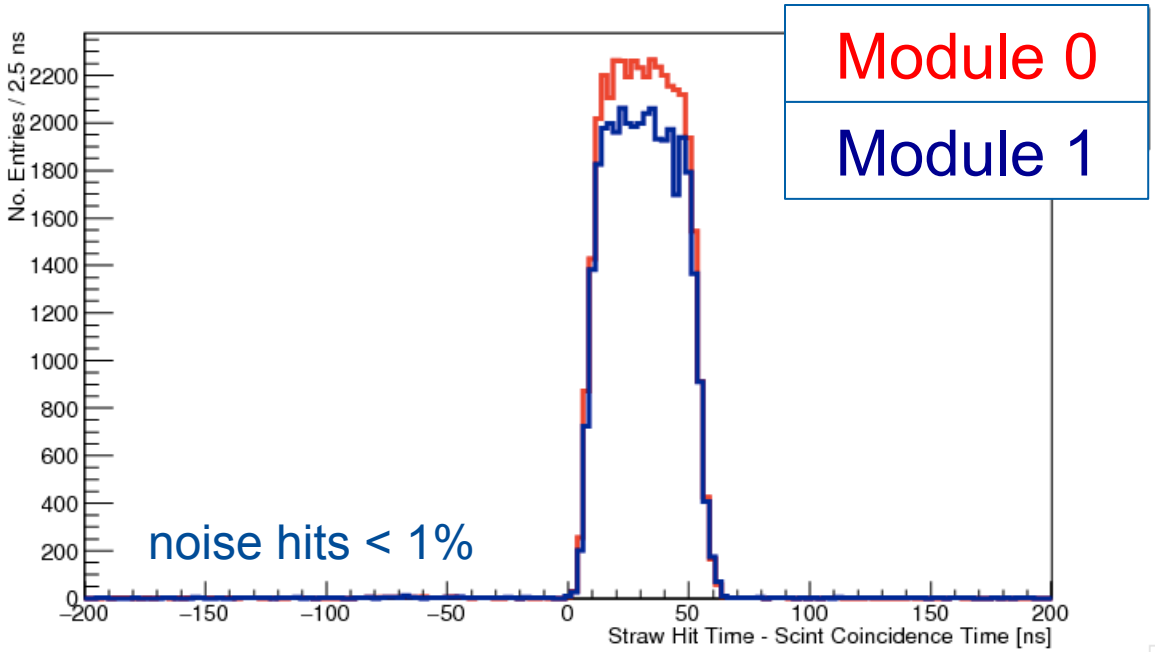
Current setup - Lab 3



- Orientate modules for vertical tracks
- Use scintillators for accurate track time
- Multiple modules (2 so far, 3 max) readout simultaneously
- Full test of DAQ and offline reconstruction

Lab 3 results

- Data accumulated for 10ms per trigger and readout at 50Hz
- Successful readout from 2 modules + scintillators simultaneously



- Pass data through full chain
- Use coincident scintillator hits as trigger
- Keep all straw hits within 200 ns of scint time
- Expected behaviour observed

- 3rd module arriving this month for integration
- Full cosmic test stand simulation in art for comparisons

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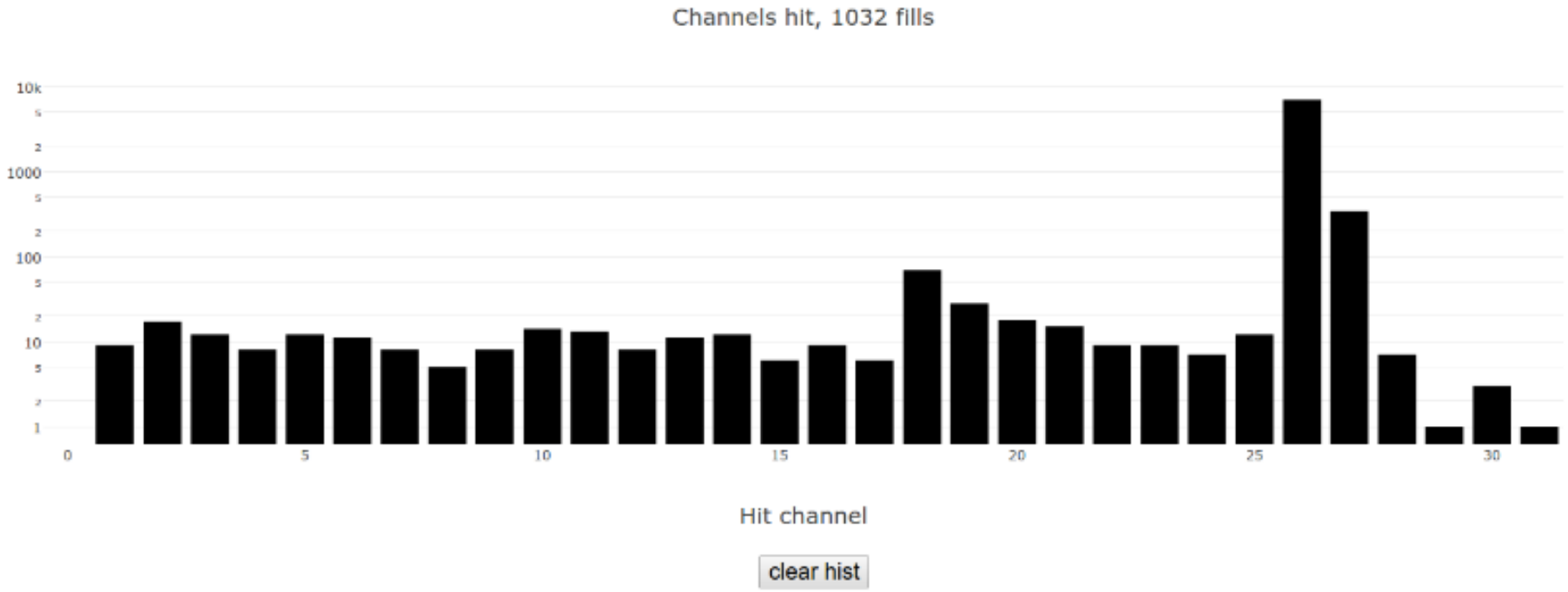
Online data monitoring

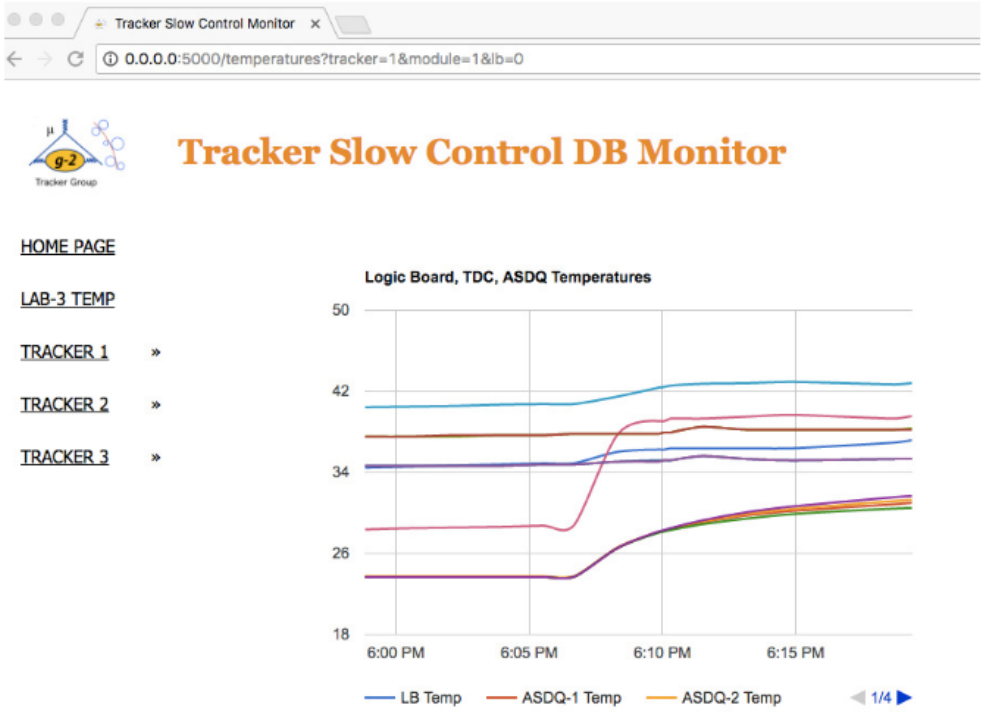
- Use MIDAS and art for our online monitoring
- Currently a series of sanity check (run number, MIDAS status) and hit map histograms



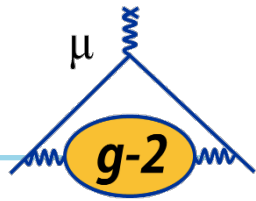
Online data monitoring - slow control

- Using system very similar to calorimeter
- Currents, voltages, temperatures and DAQ errors recorded every 30 seconds in mySQL db, interfaced with MIDAS

- Python code queries db and creates flask web server instance to display DB quantities

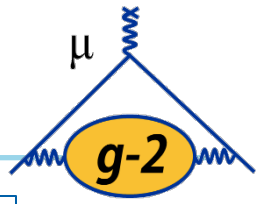


Conclusions



- Have demonstrated full readout chain for multi-module setup
- MIDAS to art interface also used by calo team
- Same online monitoring system with MIDAS interface
- Detector response parameterisation informed using GARFIELD simulation - verified with test beam data

Online data requirements - revisited



- Multi-module readout ✔

Demonstrated for 2 modules using lab 3 setup

- Precise steerable run configuration ✔
- Have 10ms to readout each fill ✔

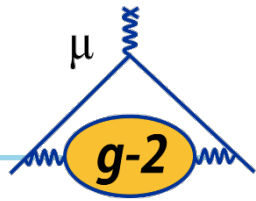
Successfully running at ~4 times worse case scenario rate

- For tightly spaced fills, even in the worse case scenario where we have 10ms, the DAQ can handle completely full buffers in 8ms. With expected number of hits we can do it in 0.4ms

- Synchronisation of hit times between modules ✔

- Online data quality monitoring (DQM) ✔

Plans



- Install 3rd module into cosmic stand
- Run full reconstruction on cosmic data
- Use scintillator t0 to refine reconstruction algorithms
- Import GARFIELD parameterisation to art framework

- backups…

Expected rates

- Expecting ~6 hits per fill per straw, 12 Hz rate, we get:

		bits Per Fill	bits Per second	Mb/s
Per TDC	Header+Footer	32	384	0.049
	Words	96	1152	
	Total words	128	1536	
	Total bits	4096	49152	
Per Logic Board	Header+Footer	14	168	0.202
	Words	512	6144	
	Total words	526	6312	
	Total bits	16832	201984	
Per Tracker	Header+Footer	8	96	3.235
	Words	8416	100992	
	Total words	8424	101088	
	Total bits	269568	3234816	

- 3 Tracker total Mb/s = 9.7