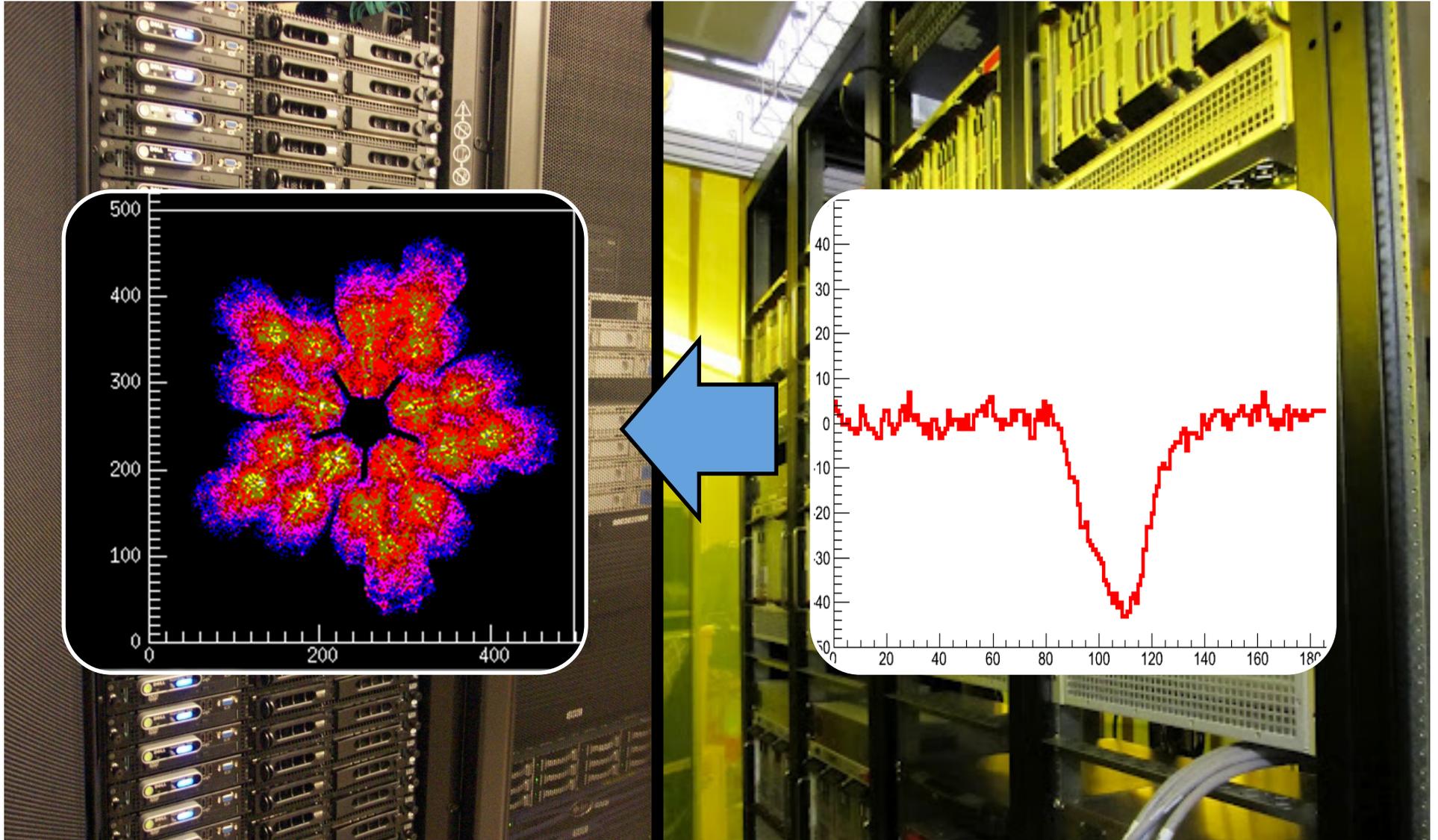
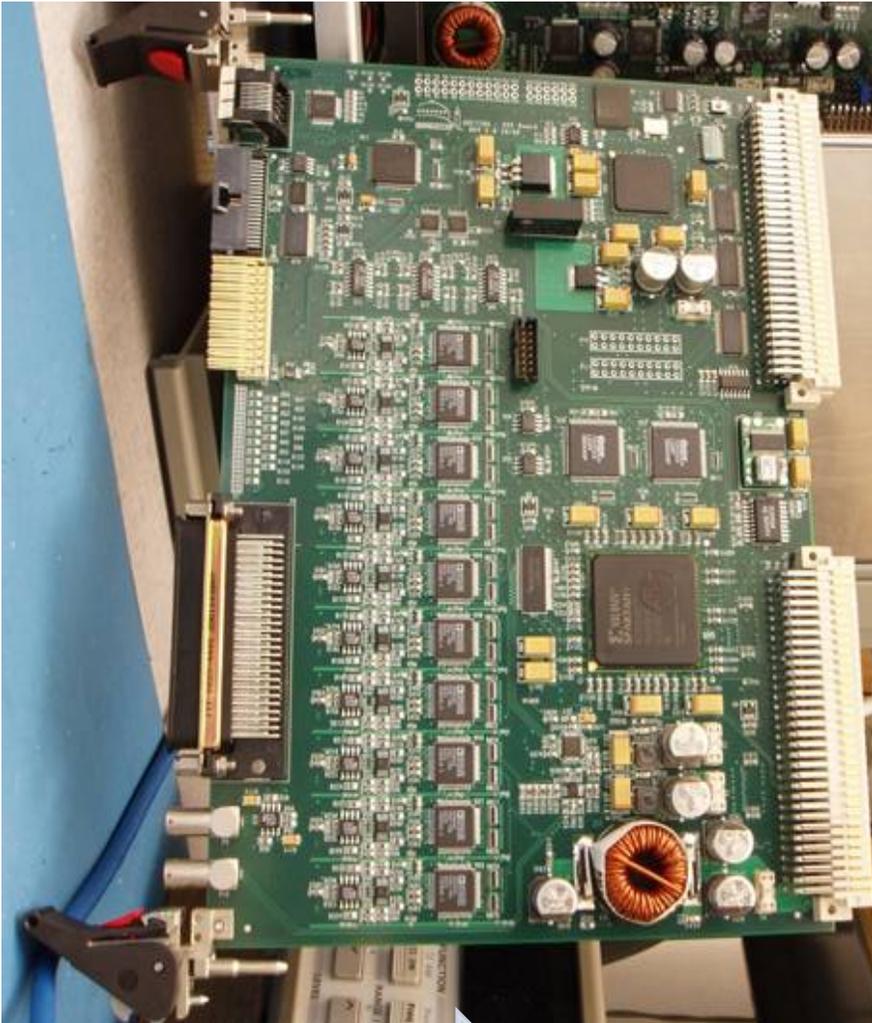


# GRETINA Interfaces & Experience

Chris  
Campbell  
GRETINA/LBL

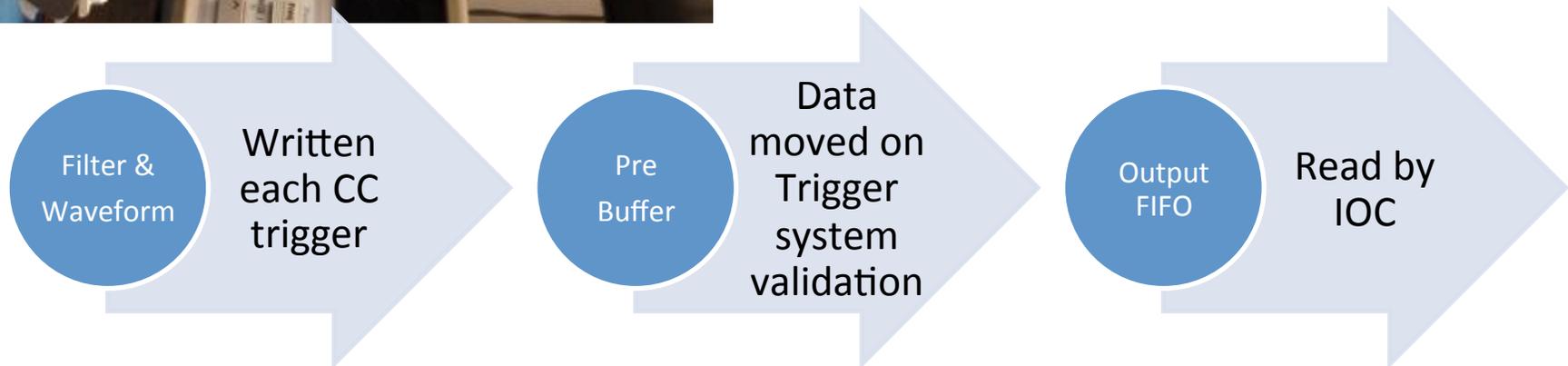


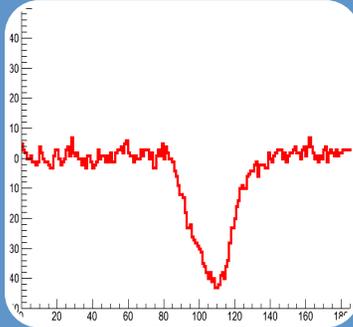
**Much of Gretina DAQ is dedicated to waveform collection and analysis**



# Gretina Digitizer (LBL)

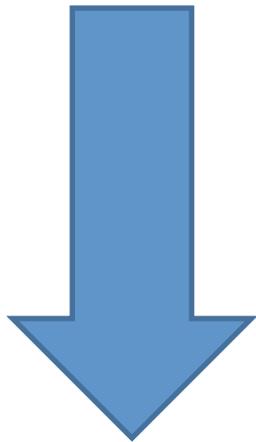
- 10 channels (9 segs + core) / board
- 4 boards / Gretina crystal
- Flash ADC (1 FADC/channel)
  - 100 MHz
  - 14 bit
  - 200 MB/sec of waveforms/channel
- On-board FPGA filters
  - Leading Edge (trigger primitive)
  - Energy (trapezoid)
  - Pole-zero correction
  - Baseline Restoration



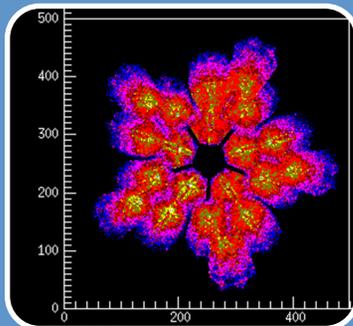


## Waveform data

- Voltage vs. time for segments and central contact
- Net charge signals measure deposited energy
- Neighboring transients => sub-segment positions



- Decomposition fits a superposition of N basis signals to measured waveforms
- Segment cross-talk at the same scale as transients being fit.



## Interaction point data

- Interaction points by crystal
- Crystal: Energy, position, time
- Interactions: Energy split and position in crystal

# Interfaces to Gretina (DAQ)

- Other DAQ
- Other detectors or signals
- Facility computing
- Software
- People
  - Device physicists, engineers, experts
  - End users, shift takers, data analyzers

# Auxiliary DAQ requirements

- Synchronized Timestamps
  - Gretina provides 50MHz clock and IMP SYNC (clock reset)
  - BGS added to TS to BGS DAQ using a scaler
  - S800 adapted clock to their existing FPGA-based trigger
  - CHICO2 and Phoswich Wall used a MyRIAD card
- Trigger
  - Externally, IN/OUT via NIM signals
  - Internally, Gretina trigger handles gamma-multiplicity, coincidence with external, etc.
  - BGS particle singles directly used as validation trigger
  - S800, CHICO2, and Phoswich Wall took GammaOR [Latency: >~250ns] from Gretina and returned Particle-AND-Gamma.Live

# Auxiliary DAQ data flow

- Merge data streams (+ Run Control):
  - Auxiliary DAQ can output to the Global Event Builder directly [Latency: a few seconds]
  - Gretina Run Start/Stop controlled over EPICS
  - Gretina ready-to-run available over EPICS
  - S800 and CHICO2 used these method
- File merge and manual run sync:
  - DAQs write independent data files
  - Post-processing merges according to timestamps
  - BGS and Phoswich Wall used these methods

# Computing: Mode 2



70 nodes  
2 cpu / node  
4 core / cpu

Data from  
GRETINA  
Detectors

Segment events

40 channels  
per detector

Crystal Event Builder

Crystal events

Parallelism:  
4 Decomp  
instances  
per crystal

Signal Decomposition

Interaction points

1-28 crystals

Data from  
Auxiliary  
Detectors

Global Event Builder

This is where  
"events" may  
be defined!

**Goal:**  
**Processing 20,000**  
**Gamma rays /sec**

Analysis & Archiving

# GEB (Global Event Builder) packets

## GEB header

Type

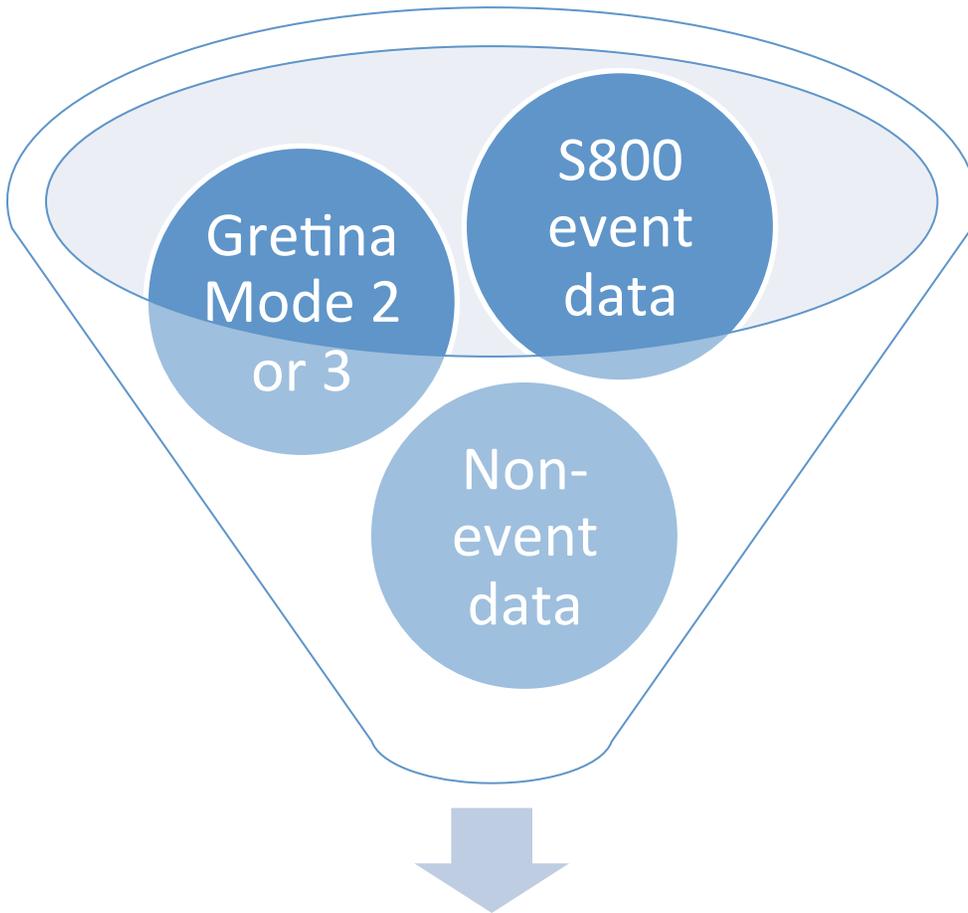
Payload size  
(bytes)

Timestamp

Gretina, S800, Non-Event,  
Etc.

Data are not modified or read by  
the Global event builder

# Global event builder



Global event builder

- Data are sorted according to GEB header timestamp
- Sorted data is held until it is older than the newest data by a number of seconds.
- This correlation time is set by the user.
- GEB is a data bottleneck.

# Checks that coupled DAQ is working

- First check: timestamp difference spectrum
  - Like a particle-gamma TAC
  - Often monitor this online as a function of time!
- Digitize Auxiliary detector triggers and timing signal(s) on “Bank 29”
  - Readout on every Live trigger
  - One-to-one check of triggers
  - Puts timing signal firmly in Gretina timebase
- Accounting level checks
  - Every coincidence event has at least one Gretina and one Aux Particle GEB packet
  - Scalers match counts in a file
- Deadtime? Currently fits into Aux DAQ deadtime.

# ONLINE DAQ MONITORING - GRETINA

**GRETINA User Alarm Display**

ImpSync received from Run Control? Missing ImpSync

Gretina Timestamps internally synced? Synced

Digitizer Board output FIFO status: **FIFO Overflows**

Crystals Enabled: 28

[GEB] Cluster State ■ Setup

Vocal Alarm ■

Mute Alarm ●

**Crystal rates (in Hz)**

	Average	Min	Max	Min	Max
CC2 LED triggers	0	0	0	0	5000
CC2 Data Packets	0.0	0.0	0.0	0	5000
Decompositions	-1	0	0	0	1000
Total		Time (sec)			
FIFO Overflows:	16101	Total Run: 285172.2			
Dead Time:	0 %	Inhibited	880.0		

**Timestamps**

	Master Boards			Max Difference Within a Bank
	Min	Max	Difference	
Live (sec)	285318	285319	0.9	0.0
Latched	112229619938	112229619938	0	0

Key information has been distilled into one meaningful alarm page.

Digitizer timestamp synchronization tested every 10 seconds.

Scripts/Buttons allow users to recover from problems

END

# Mode 2 Data Flow for 1kHz/crystal

IOC

- 16 MB / sec / bank from VME, to 4 Decomps
- System: 450 MB / sec to Cluster, ok 10Gb link~1.2GB/sec

Decomp

- 8 MB / sec into each node (2 Decomps) from IOC's
- Each 16kB crystal event => ~450B Mode2
- 250 kB / sec / node sent to GEB

GEB

- 15 MB / sec Total received from 56 nodes
- Disk Limitation of 60 MB / sec not a problem
- When is time-sorting a limiting factor?

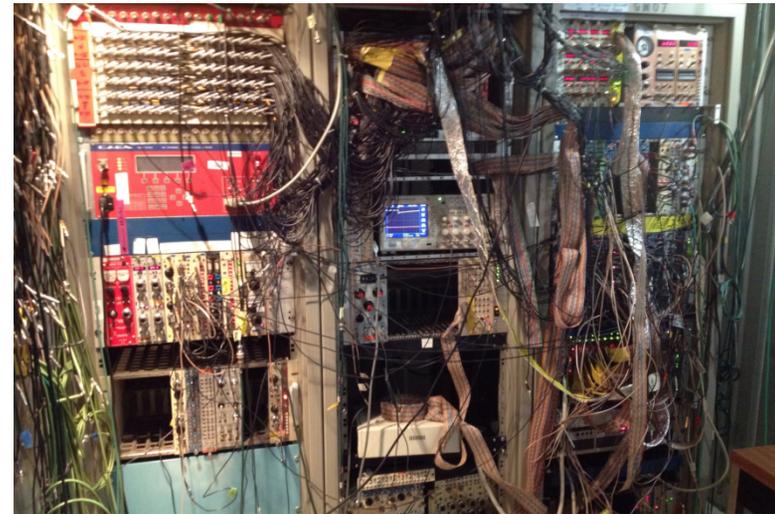
## GRETINA DAQ



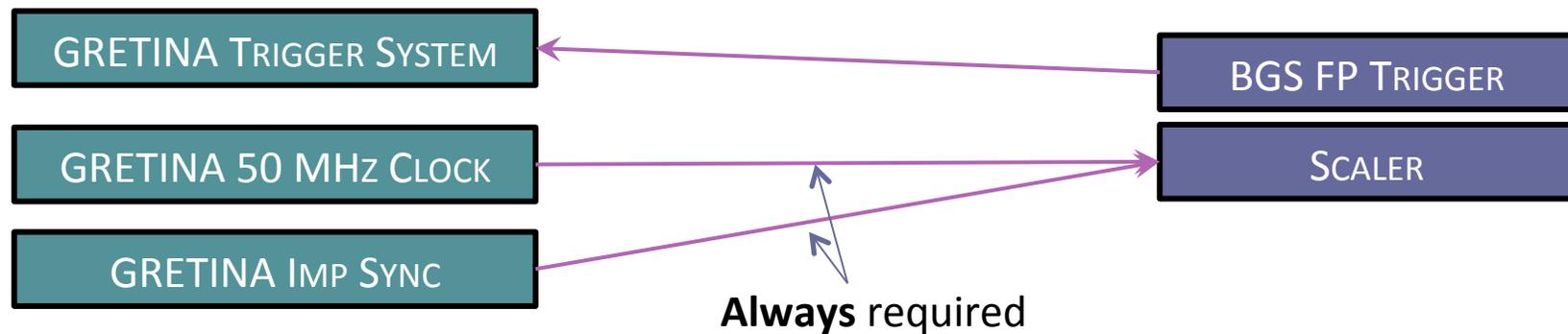
- Data acquisition including 29 IOCs, run via EPICS interface, on a cluster of computing
- 100% digital electronics, system based on time-stamping scheme
- Global event builder time orders data coming from each IOC, to create a unified data stream

## BGS DAQ

- Analog data acquisition run using RIO2, circa ~1999
- Network broadcasting of data was not achieved easily
- System based on triggered full-event readout



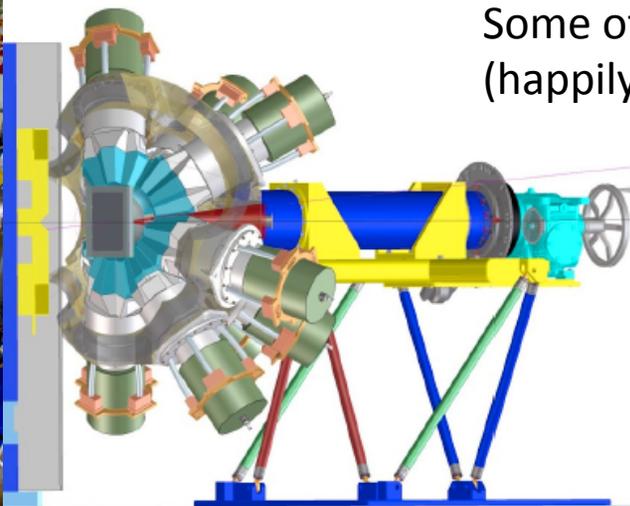
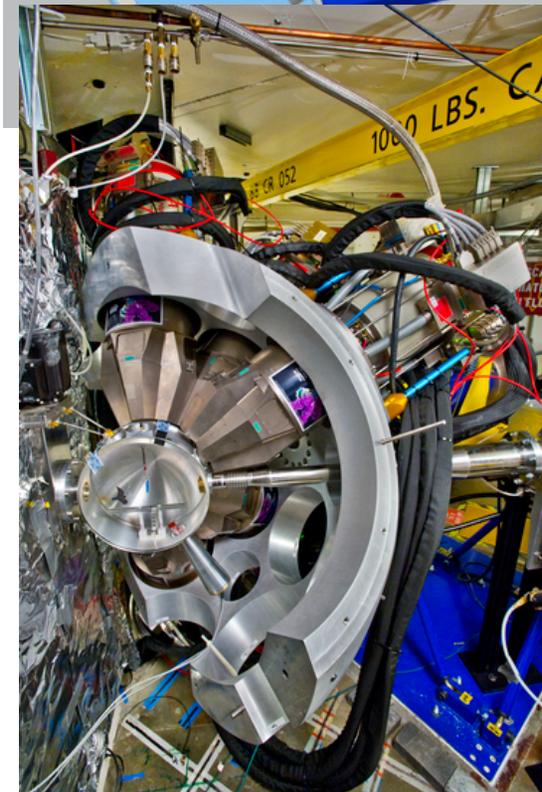
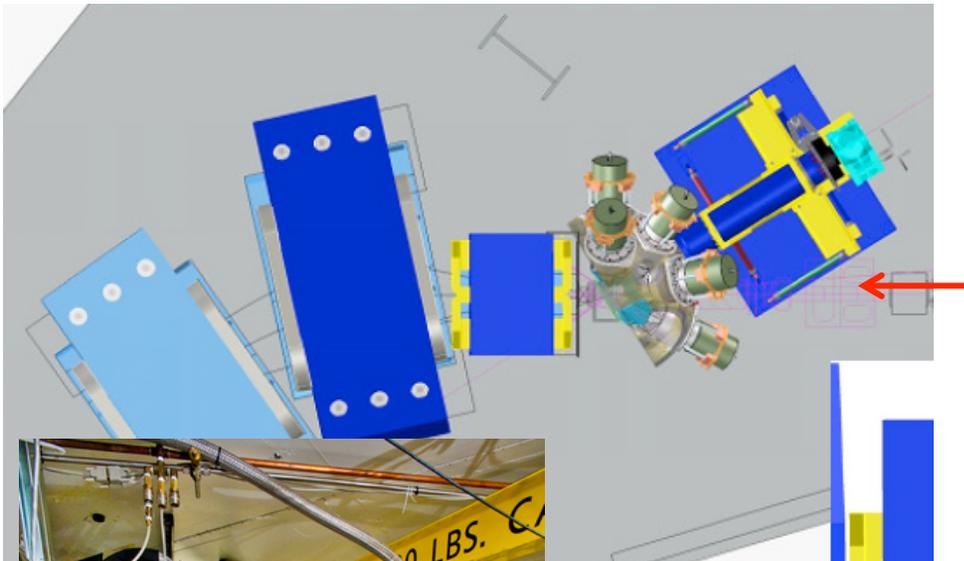
- General scheme for merging data within a GRETINA + X experiment depends on time-stamping
- System is built to include outside data into the global event builder, which is incorporated with a different global header ID type, based on the value of a **synchronized** timestamp



- Data at the BGS was taken with synchronized timestamps, but transmission of data to the GRETINA global event builder was **not** achieved
- Solution: simple software to merge two independent files from the separate acquisitions
  - C++ code was written, which rebuilt BGS events, decoded the timestamp, and created a global event-style header for each BGS event, and merged with GRETINA data, based on timestamp values
  - Code is 100% blind to the type of GRETINA data, using only the global headers to sort
  - Extension has been written to merge any two arbitrary files, provided they contain data with global event headers



# COMMISSIONING RUNS @ BGS



A large amount of analysis code development went hand-in-hand with the engineering runs, and then the commissioning runs at LBNL.

Data integrity checks and corrections were developed, calibration schemes were refined, and analysis options diversified.

Some of what was done is now (happily) obsolete, as the system performance has improved, some software solutions have been integrated into the system, and some work is still ongoing.