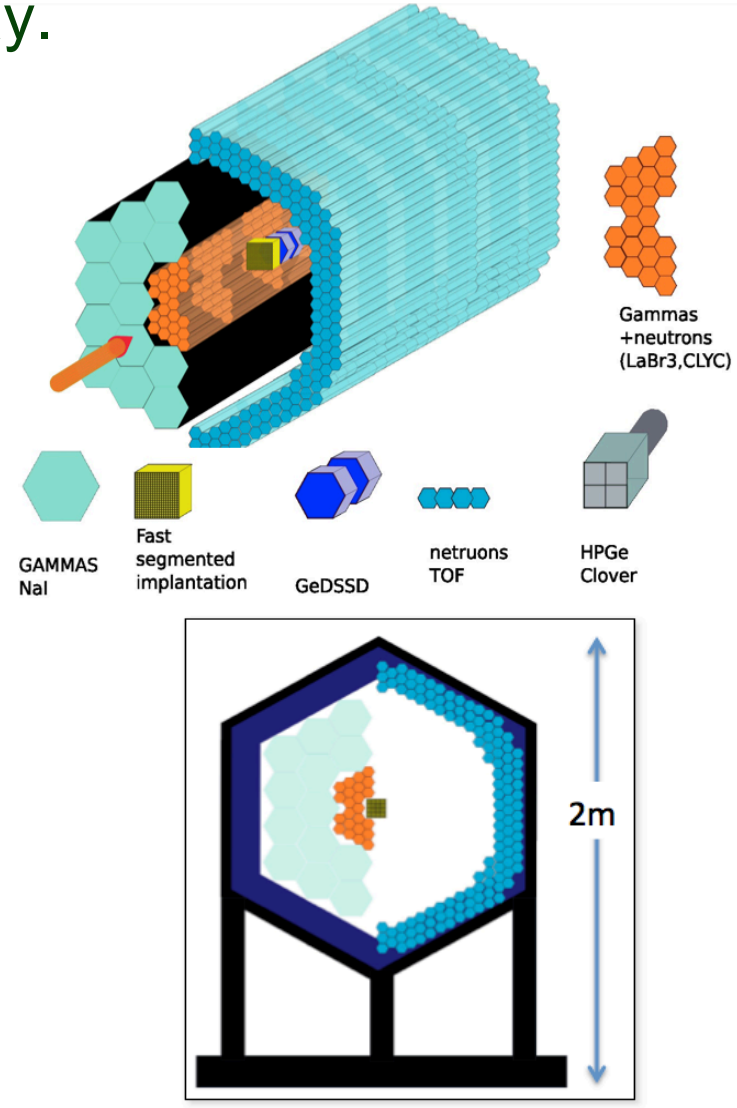
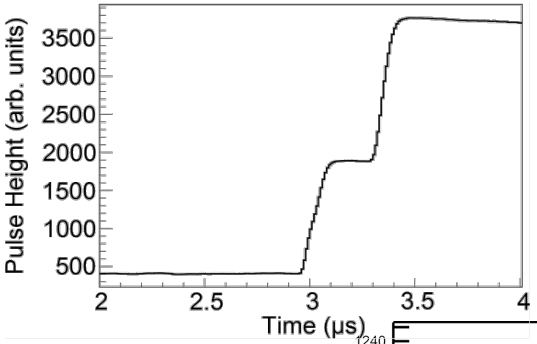
Decay Spectroscopy Station

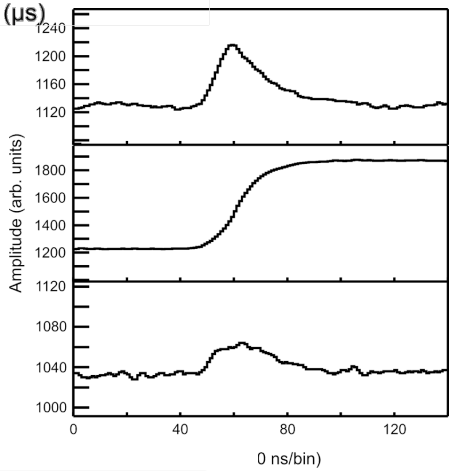
- Next generation decay spectroscopy array. Modular combination of detector types tailored to experimental requirements
  - Implantation detectors of Si, Ge, or fast scintillators
  - Photon detection for high resolution or high efficiency (HPGe, LaBr3, …)
  - Neutron detection, 3He, scintillators
- Build on experience with existing prototypes
- Flexible decay station
  - Stand-alone decay spectroscopy
  - High-efficiency recoil decay tagging behind separators
  - Commensal operation

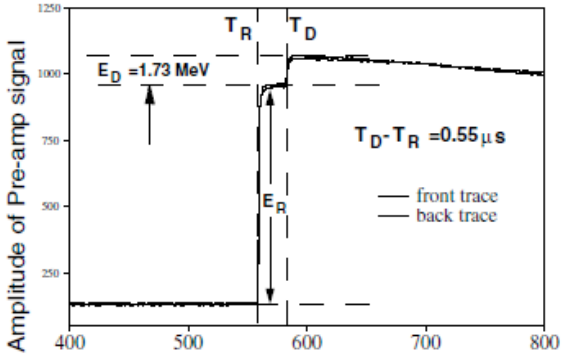


Digital Data Acquisition System

- Decay spectroscopy studies
  - Built around heterogeneous mix of digitizers
    - 100 MSPS, 12-bit adc
    - 250 MSPS, 14-bit adc
    - 500 MSPS, 12-bit adc
- Many signal types digitized
  - Si, Ge, Scintillators (plastic, CsI, $LaBr_3$),
  - Logic levels, TAC
  - Full pulse shape recording for further offline analysis
- Full system spans multiple crates.
  - Digital modules share common clock
  - Digital and analog systems intermingled
- Flexible system







Triggering and Timing

Flexible triggering schemes

- Independent channel triggering.
- External Signal
  - Channel trigger in coincidence with external signal.
  - Force trigger in presence of external signal.
  - Veto signals in presence of external signal.
- Coincidence triggering between channels within/ across modules.

Timing

- Based on digitizer internal clocks.
- System synchronization
  - Good to much better than 1 clock tick.

FRIB provides mechanism to save configuration files with data.

Coupling Other Systems

Clock distribution

- Digital master
  - Digitizers handle internal clock.
  - Coupling to analog: Export digitizer clock for counting in analog scaler.
- Digital slave
  - Accepts external clock signal for time stamping.

Synchronization distribution

- Digital master
  - Digitizers handle internal clock
  - Coupled to analog: Run start signal sent to analog system.
- Digital slave
  - Accepts external signal to reset time counters.

An external clock and sync must be accepted by system to enable data merge

FRIB provides common master clock, synchronization, and time offsets for synchronization signals

Readout and Data Rates

- Readout integrated within NSCLDAQ.
  - Modules polled at set frequency
  - When one reaches threshold, all data is removed from system
  - Data is stored in readout program for seconds to ensure all modules have some data.
- Requires an event builder
  - User defined event building window
  - Easy un-build/rebuild capability
- Wide variety of data rates
- Minimum
  - 4 32-bit words per channel
  - Example:
    - ~13 k over complete system
    - ~100 Gb for two days
- Maximum
  - More when trace capture is used. Example:
    - 500 MSPS, 6 us trace, 100 Hz across 20 channels
    - ~10 Mb/s, ~ 6 Tb for one week

Data acquisition system should reach a target of 50 Mb/s.

FRIB provides readout, event builder, and storage framework

Analysis

- Online analysis
  - Verify correct operation of system
  - Mainly inspect processed energies, times, and coincidences.
- Near-online analysis
  - Trace analysis.
  - Example: For large data set with 6 us traces need to analyze ~40 Gb per hour.

Need better handling of traces within online analysis

FRIB provides online analysis framework and computer cluster for near-online analysis