Compatibility of NSCL devices with Gretina

Outline
- Fragmentation beams at the NSCL, beamline tracking, and DAQ
- Possible vault locations
- NSCL Detectors and DAQ
  - S800 spectrograph
  - Modular Neutron Array
  - Beta Counting System

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GRETINA Auxiliary Detector Workshop
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NSCL Science Thrusts
Beams of Exotic Nuclei prepared and studied at the CCF

• NSCL provides users with exotic beams made by physical means and identified event-by-event
NSCL Coupled Cyclotron Facility

0.15c → 0.40c

0.15c → 0.40c

Image 2 Tracking (DAQ)
- Dispersion 5.5 cm/% (Δp/p)
- 2 Tracking PPACs (Δx/x ~ 2.5 mm), up to 400 kHz
- 400 channels, read via XLM72 and VME
- Sample continuously (with 10 MHz) into switched capacitor array (STAR FEE, 512 samples deep, 1 ADC per channel), after trigger look back in time and read 8 samples (10 bits/sample). Zero suppressed data stored in SRAM of XLM72.
- Data size out of VME: ~100 words/event
- Reading 8 samples takes ~80 μs, but since the trigger is derived from the final trigger (in S800, e.g.) this happens “rarely”

Timing detector (DAQ)
- 2 channels, 1 MHz

A1900 fragment separator
- Rare isotope separation by physical means
- Highly selective: 1 in 10^{-15-16}
- Event-by-event particle isotopic identification, cocktail beams possible
- Δp/p < 3%, user can choose
- Can track beam momentum event-by-event in image 2
- Epics controlled
- Facility parameters available to users in data stream
Possible vault locations for Gretina

N2/N3 neutrons
MoNA or Neutron Walls, Sweeper Magnet

flight times for beams (v=0.3 c)
- A1900 FP to vault: few hundred ns
- S800 target to S800 FP: ~100 ns

S3 charged particles
S800 spectrograph

S2 neutrons and beta
(after RF separator)
Beta Counting System
Mona or Neutron Walls
Modular Neutron Array and Sweeper Magnet

**MoNA (DAQ)**
- 576 channels read via VME
- Can accept external trigger for 400 ns, can provide trigger for others within 600 ns
- Trigger logic uses 10 customized VME FPGA modules (XLM72)

**Sweeper Magnet (DAQ)**
- See S800 FP
Beta Counting System
designed to fit into 6” diameter tubing

Beta Counting System (DAQ)
• Si-strip and PIN detectors
  – 350 channels, currently read via VME, digital electronics in ~2 years
  – 200 Hz
  – Correlate events with free-running clock or trigger Gretina with Si detectors
S800 spectrograph
S800 Spectrograph

- High resolution ($p/\Delta p = 10,000$, dispersion matched, $p/\Delta p = 2,000$ focused mode)
- Large acceptance (20 msr, $\Delta p/p = 5\%$)
- Rotates $0^\circ – 60^\circ$ and weighs 250 tons
- $B_{\rho_{\text{max}}} = 4 \text{ Tm}, 4.9 \text{ Tm for analysis line}$
- Dispersion 10 cm/% ($\Delta p/p$)
- Experiments with SeGA show significant blinding of detectors for $<20^\circ$ due to pre-amp overload
S800 analysis line and focal plane detectors

- Two S800 Intermediate Image Tracking PPACs (DAQ)
  - $\Delta x/x \sim 2.5$ mm
  - 256 channels
  - Read via XLM72 and VME
  - Event rate up to 400 kHz
  - Sample continuously (with 10 MHz) into switched capacitor array (STAR FEE, 512 samples deep, 1 ADC per channel), after trigger look back in time and read 8 samples (10 bits/sample). Zero suppressed data stored in SRAM of XLM72.
  - Data size out of VME: ~200 words / event
  - Latency: Reading 8 samples, which takes ~80 $\mu$s, but since the trigger is derived from the final trigger (in S800, e.g.) this happens rarely

- S800 focal plane detector (DAQ)
  - Ion Chamber
    - 16 channels, CAMAC, 10 kHz, ~16 words/event
  - Plastic detectors
    - 4 channels, VME, 1 MHz, ~8 words / event
  - 2 CRDC tracking detectors
    - $\Delta x/x \sim 0.5$ mm
    - 448 channels
    - Read via XLM72 and VME
    - Event rate up to 10 kHz
    - Sample (with 40 MHz) into switched capacitor array (STAR FEE, 512 samples deep, 1 ADC per channel), after trigger from Anode read 12 samples (10 bits/sample). Zero suppressed data stored in SRAM of XLM72.
    - Data size out of VME: ~400 words / event
    - Latency: Reading 12 samples, which takes ~120 $\mu$s, but since the trigger is derived from the final trigger this happens rarely

- It takes 300 ns to make trigger in S800 FP and to deliver to Gretina
- $\Delta t$ in S800 FP: 160 ps
Installation of Gretina in front of S800

Center of Gretina off ~ 30 cm from nominal S800 target position

- Proposed to add fourth ring to quarterspheres to optimally place detectors for intermediate-energy beams
- Beam line is 6” diameter tubing (6.125” clearance) to accommodate dispersion and scattered beam
Data acquisition systems and composition 
(Ron Fox)

- Multiple “significant” detector systems
- Independently developed, independent subsystem responsibilities
- Large hardware/code/protocol investment in development
- May run independently.
- May “plug” together to perform a larger experiment
- May plug-unplug-plug during the lifetime of a single experiment for setup/troubleshooting/production.
Prerequisites for composition

• Standard outer level event structure.
  – Each segment of an event self-describing.
  – Each segment of an event can be easily/independently ignored.

• Event building operates by composing segments.
  – Published mechanisms to tie systems together.
  – Published synchronization/timing standards.

• Event analysis builds analysis parameters via a pipelined decomposition of the raw event.
Event Building at NSCL
>99% availability incl. user code
Summary

• **Necessary**
  – Clearance for 6” diameter beam tubing (6.125” desired since beam line has pump attached -> vibration)
  – Composable data acquisition system that can accommodate other detectors
  – External trigger for up to 300 ns after $\gamma$-flash

• **Most desirable**
  – Configuration that allows S800 operation without acceptance loss

• **Desirable**
  – External trigger for up to 500 ns after $\gamma$-flash