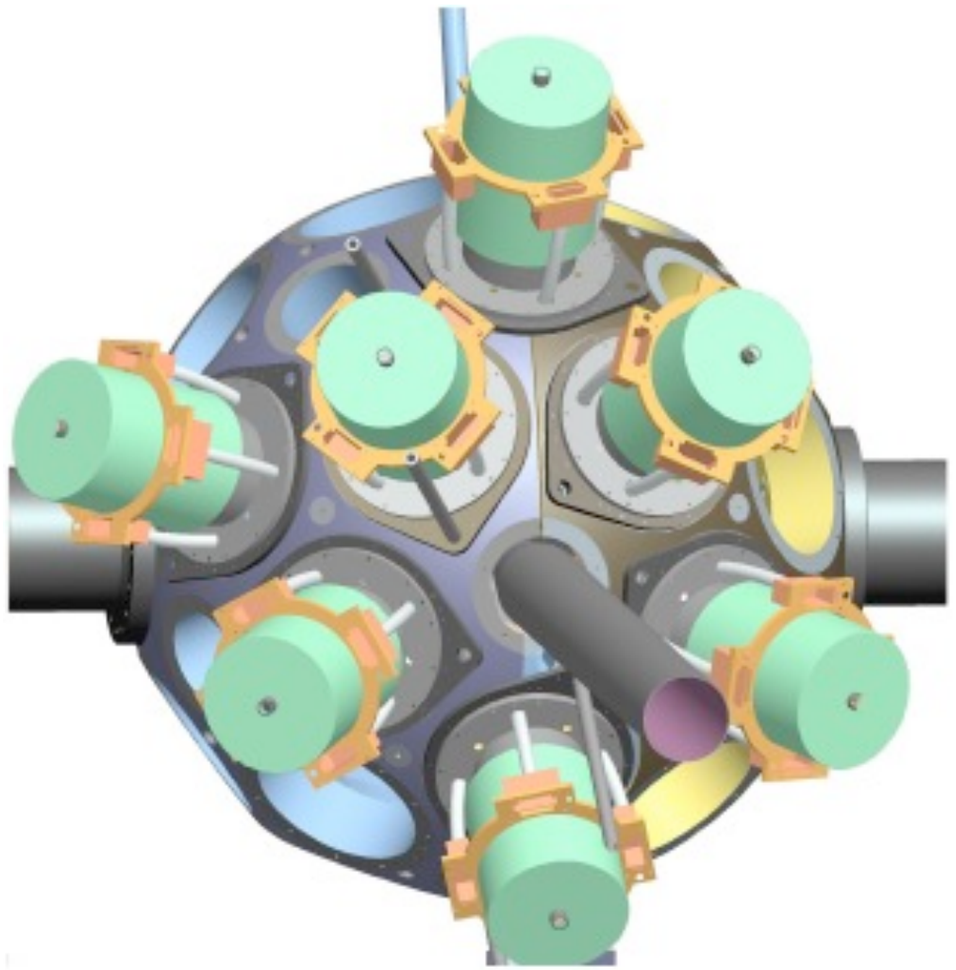
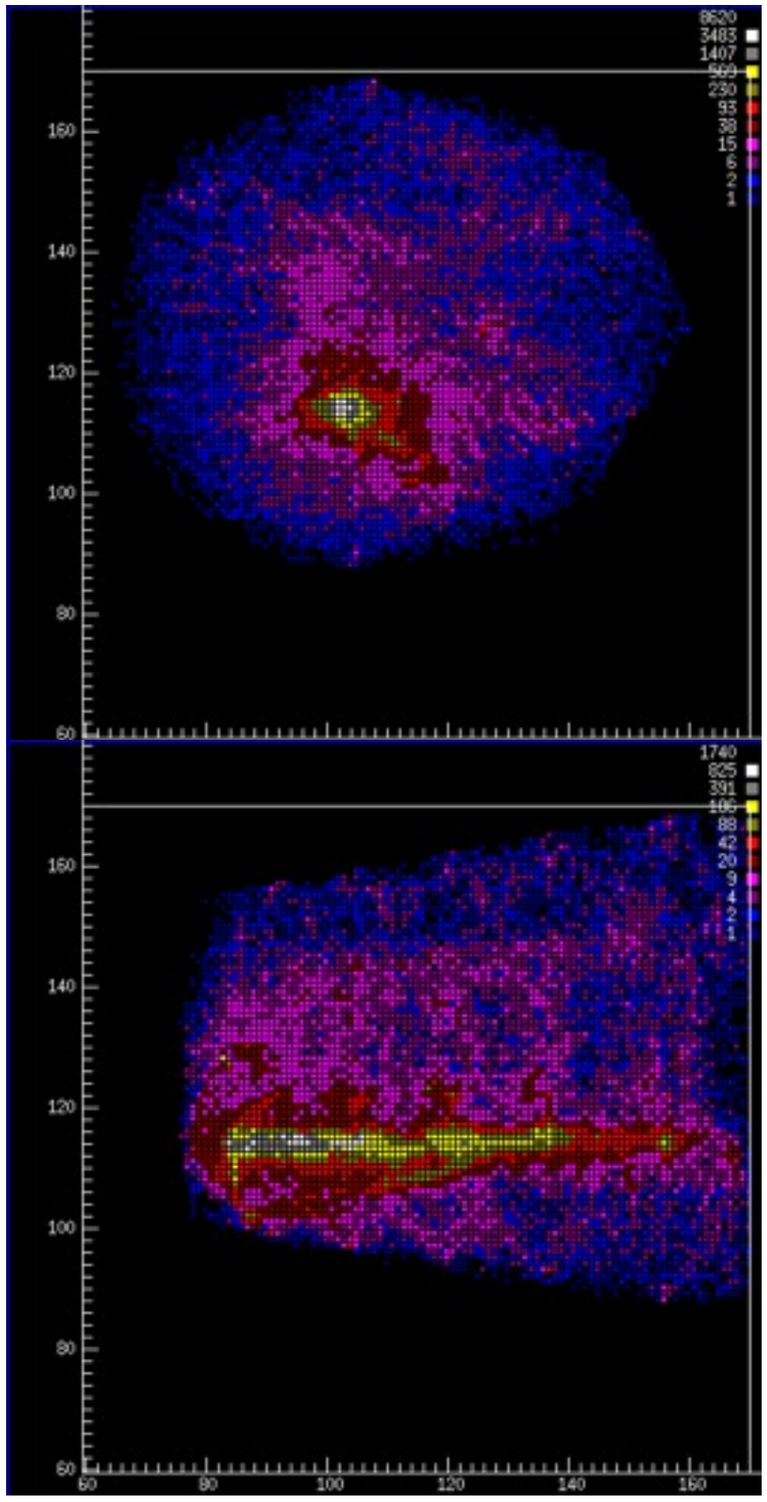
GRETINA Data Analysis



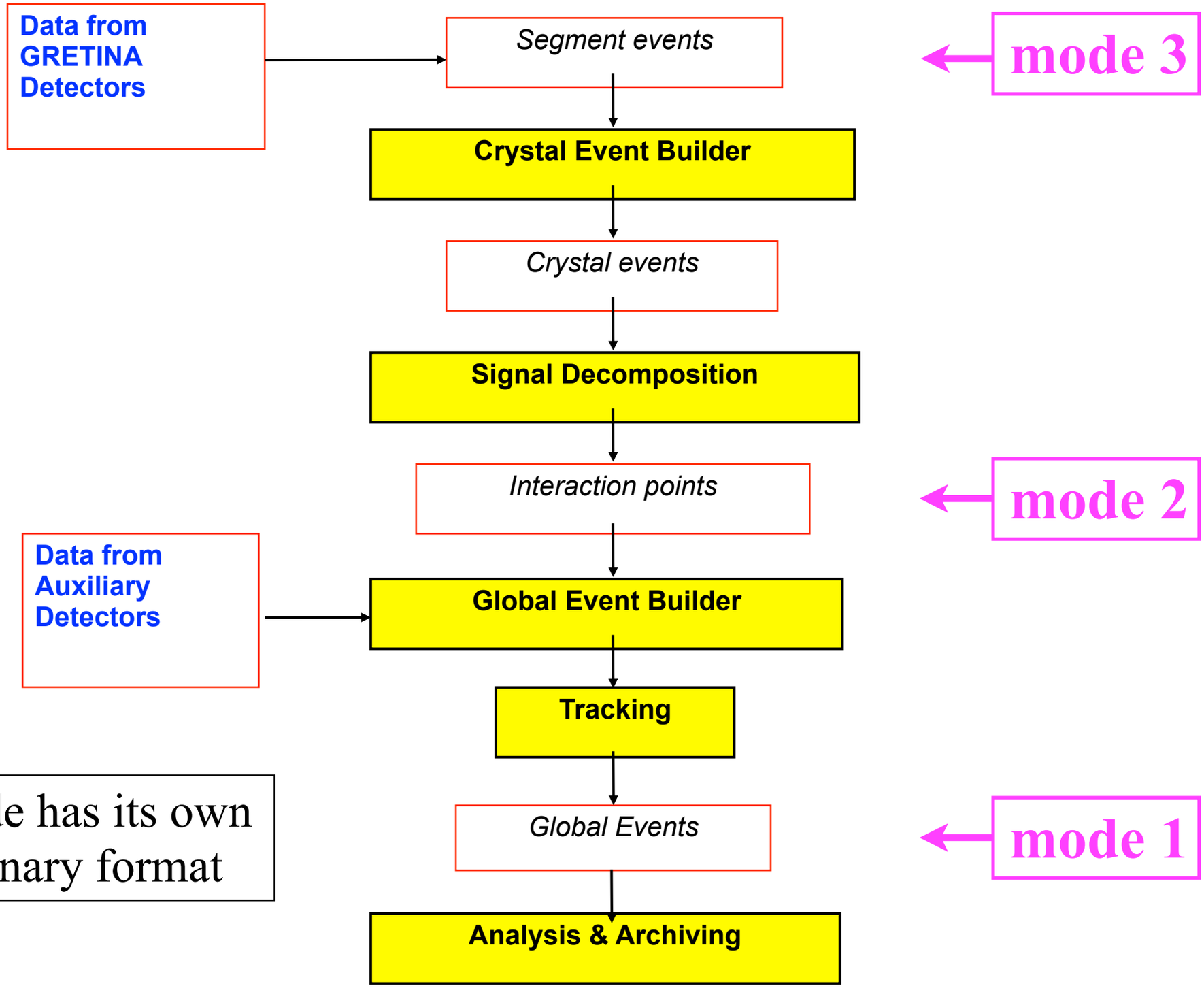
Mario Cromaz (LBNL)

Introduction

- GRETINA consists of 28 segmented HPGe crystals readout by ~1000 digitizers sampling each contact at 100 MHz
- due to high data rates associated with recording waveforms and the computational complexity of signal decomposition the system is highly distributed
- significant effort was made to shield the user from this complexity and simply data analysis



Modes / Formats



each mode has its own unique binary format

GEB Headers

- each event preceded by a global event builder (GEB) header
- consists of:
  - event type
  - "payload" length
  - global timestamp (48 bit, 10 ns)
- facilitates:
  - event building, routing
  - sort codes only need to know details of event type(s) they re specific two
  - new data types can be introduced without breaking existing sort codes, daq software

```
struct GEBHeader {
        int32_t type;
        int32_t length;
        int64_t timestamp;
}
```

GEB Header Types for BGS/S800

type 1: decomposed GRETINA data
type 2: raw GRETINA data
type 3: tracked GRETINA data
type 4: BGS raw data
type 5: S800 raw data
type 6: NSCL non-event data
type 7: GRETINA scalar data
type 8: bank 29 raw GRETINA data
type 9: S800 processed (physics) data
type 10: timestamped NSCL non-event data

Mode 3 Data

- data format as defined in the digitizer
- mode 3 data is done on a segment-by-segment basis
- includes :
  - energies based on trapezoidal filters done on the FPGA
  - waveforms from segments (window size, position adj.)
  - timestamp, id, flags

16 k / crystal event (40 channels) - ... Tb ...!!!

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Board ID[1]																Packet length (header included)											GA				
LED / external timestamp bits 0 - 15*																LED / external timestamp bits 16 – 31*															
LED / external timestamp bits 32 - 48*																Energy bits 0 – 15															
Energy bit 16 – 24								x	x	T	S	E	C	P		CFD Timestamp bits 0 – 15															
CFD Timestamp bits 16 - 31																CFD Timestamp bits 32 – 47															
CFD point 1 bits 0 - 15																CFD point 1 bits 16 – 31															
CFD point 2 bits 0 - 15																CFD point 2 bits 16 – 31															
Raw data point 0 (Sign extended)																Raw data point 1 (Sign extended)															
Raw data point 2 (Sign extended)																Raw data point 3 (Sign extended)															
.																.															

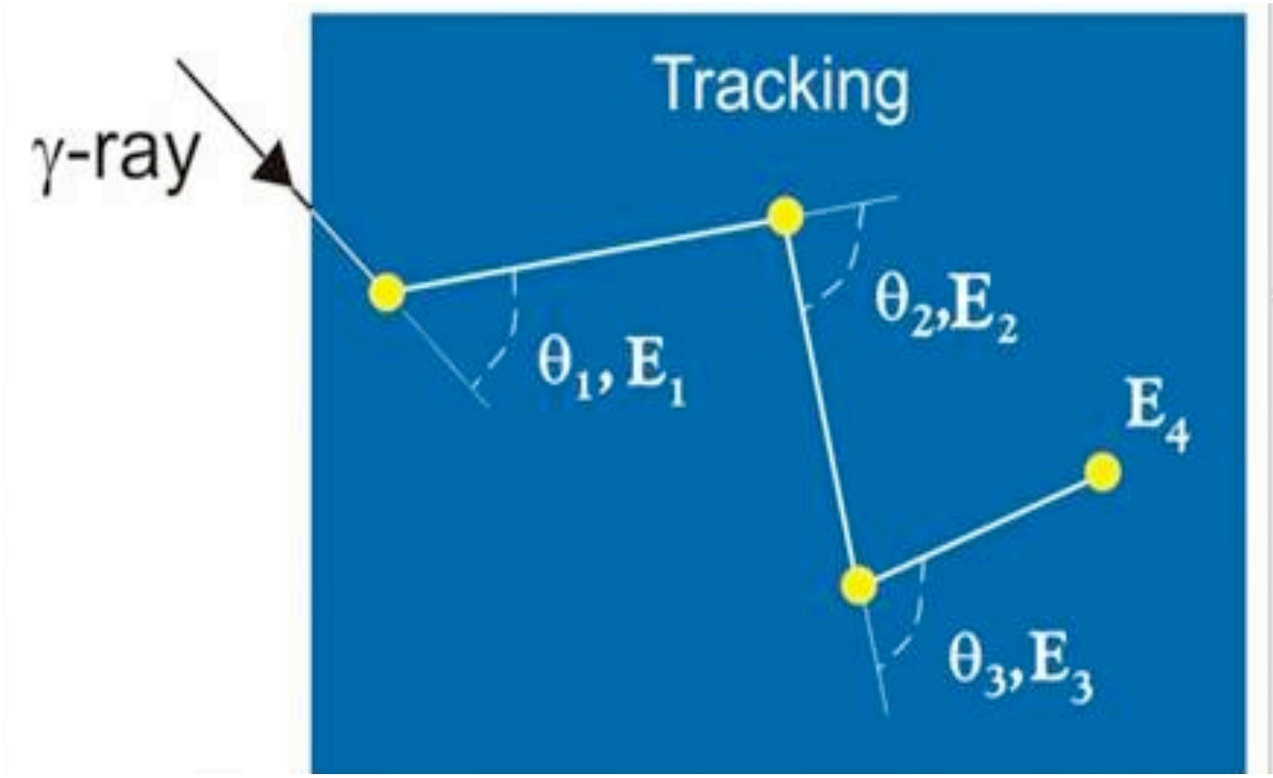
Mode 2 Data

- standard acquisition format at this point
- data following signal decomposition
  - 40 time-correlated mode-3 events reduced to a single mode-2 event
- traces from each segment fit to signal basis to determine the number, position and relative energies of interaction points
- much more compact than mode 3 data

```
struct crys_intpts {
  int type;
  int crystal_id;
  int num;
  float tot_e;       /* dnl corrected */
  int core_e[4];   /* 4 raw core energies */
  long long int timestamp;
  long long trig_time;    /* not yet impl */
  float t0;
  float cfd;
  float chisq;
  float norm_chisq;
  float baseline;
  float prestep;    /* avg tr before step */
  float poststep;   /* avg tr value following step */
  int pad;          /* non-0 on decomp error */
  struct {
    float x, y, z, e;     /*  e fraction */
    int seg;              /* segment hit */
    float seg_ener;    /* energy of hit segment */
  } intpts[MAX_INTPTS];
};
```

Mode 1 Data

- data with interaction points that have been clustering, tracked
- no information loss at this point - grouping and sequencing of interaction points
- Torben will discuss this in detail in the subsequent talk



Sort Packages

- many sort codes have been written during the development of GRETINA, the commissioning runs at BGS and the S800 campaign at NSCL
- three primary codes in use, all root based:
  - gtsort: T. Lauritsen
  - GRETINA/BGS/S800 sort: H. Crawford
  - GRETINA/S800 sort: K. Wimmer
- additionally specialized sort codes exist for development of signal basis, testing
- sort codes are roughly of same complexity as those for Gammasphere (with the additional complication of event building)

GRETINA Analysis at Argonne

- data analysis challenge at ANL will be supporting the large number of available auxiliary devices:
  - FMA
  - Chico II
  - Phoswich Wall
  - ORRUBA
- two experimental campaigns to this point have only had one primary auxiliary detector
  - LBNL , BGS (offline merge)
  - NSCL, S800 (full online merge)
- presents a challenge in interfacing, constructing online/ offline data analysis codes

Interfacing Auxiliary Detectors

- three components to auxiliary detector interface:
  - global timestamp for event building
  - network-based readout to GRETINA global event builder (*)
  - online analysis, diagnostics
- two readout strategies:
  - online merge using global event builder (S800)
  - offline merge; each readout writes to its own file and data merged afterwards (bgs, digital gammasphere)
- recommend online merge when practical
  - diagnostics more easily automated (time synchronization)
  - less chance of mishap (my opinion ...)

Tasks Related to Analysis

- most components required for data analysis for GRETINA at ANL have been demonstrated
- assembly/testing of a general purpose, online analysis code
- immediate discussion with auxiliary detector groups to determine **detailed** interface with GRETINA
  - readout method
  - develop unpackers
  - discuss data rates, readout latencies, ...
  - develop online test procedures to verify correct operation with GRETINA
- most components required for data analysis for GRETINA at ANL have been demonstrated ... but ...
- getting an early start is essential

GRETINA Software Working Group

- one of the four technical GRETINA working groups
- scope includes signal decomposition, tracking, simulation and analysis
- excellent way to become directly involved in the GRETINA software effort
- constructing wiki - sw information, formats and other resources **(gswg.lbl.gov)**
- encourage all who are interested to join

2/28/13 GSWG Wiki | GRETINA Software Working Group

Gretina Software Working Group

Home Meetings Projects Software Community Forums Help

GRETINA Software Working Group

The GRETINA Software Working Group (GSWG) is tasked to plan and coordinate the implementation of software for the GRET gamma-ray spectrometer. Unlike previous large-scale gamma-ray spectrometers, the performance of GRETINA is contingent time, software-based signal analysis system which determines the interaction points and tracks the scattering path of gamma the HPGe detector volume. The goal of the working group is the continued enhancement and improvement of the the softwa the overall performance of these systems. The three main areas of effort are:

1. Data sorting and analysis
2. Signal decomposition and tracking
3. Detector simulation

We are currently reorganizing the working group and intend to develop this site as a hub for our activities. If you are interested in joining the group, and contributing to the GRETINA software effort, please contact Mario Cromaz at MCromaz@lbl.gov

Not exactly software related, but watch the video below to see GRETINA, and hear I-Yang Lee discuss the device.

Summary

- GRETINA is a complex instrument but most of the components for data analysis are in place
- Auxiliary detector integration will be the primary task in terms of data analysis development at ANL
- A robust online data analysis package will need to be assembled and tested to provide online diagnostics