Status of the commissioning with beam

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Cheng-Wei Shih (remote)

Overview

We have taken data with the beam since May/25. The conditions and purpose of the measurements vary and are hard to follow for people outside BNL. A brief overview of the measurement and an introduction to data analysis are given.

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Basic Conditions

- Au + Au collisions at $\sqrt{s}$ = 200 GeV
  - The number of beam bunches varied. It was 56 × 56, basically.
  - 6 × 6 was provided at the beginning of the commissioning (run 7364 - 7350 and run 8005 - 8059).
- MBD provided triggers.
- RCDAQ did DAQ in BigPartition in local/global modes.
  - local mode: standalone
  - global mode: DAQ with other subsystems
- All FELIX servers took data.
  - intt1 and intt7 tended to be noisy. They were sometimes not used.

FPHX parameters

Parameter	Value	Parameter	Value
Vref	1	N1sel	6
DAC0	23	N2sel	4
DAC1	30	FB1sel	4
DAC2	60	Leaksel	0
DAC3	90	P3sel	0
DAC4	120	P2sel	4
DAC5	150	Gsel	2
DAC6	180	BWsel	8
DAC7	210	P1sel	5
		Injsel	0
		LVDS	63

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  - local mode: standalone
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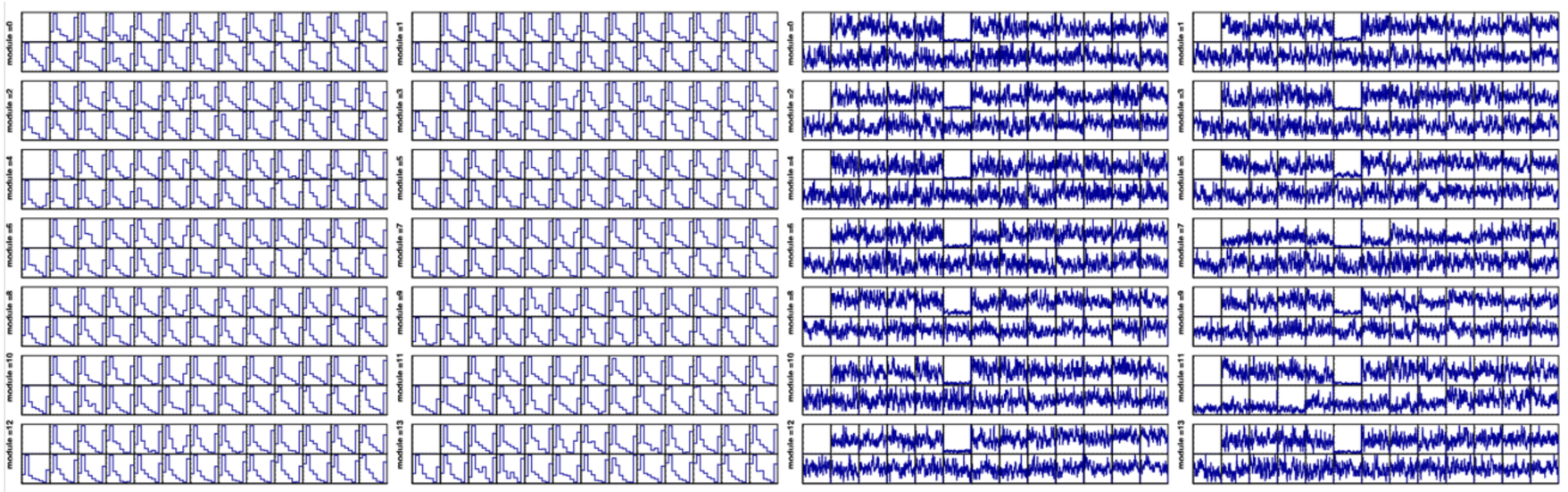
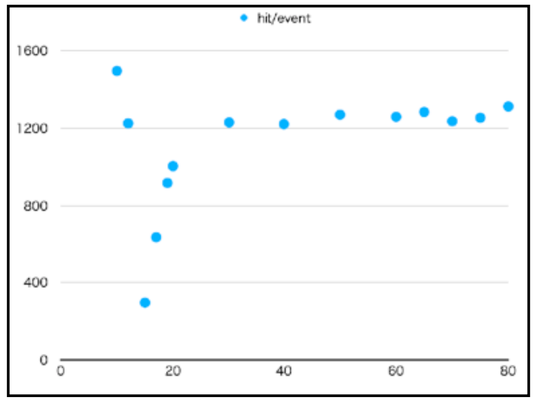
- All FELIX servers took data.
  - intt1 and intt7 tended to be noisy. They were sometimes not used.
- 4 major campaigns were conducted.
  - 1st: May/23/2023 - May/24, Optimization of FELIX parameters (*open_time*, *n_collisions*, *L1_delay*) to time-in
  - 2nd: May/30/2023: Optimization of FELIX parameter *modebit* to time-in for intt2
  - 3rd: June/02/2023: Optimization of FELIX parameters *modebit* and *n_collisions* to time-in for the other servers
  - 4th: June/04/2023: DAC scan
  - (not done yet) 5th: June/08/2023: Optimization of FELIX parameter *open_time*

1st: Scanning FELIX parameters

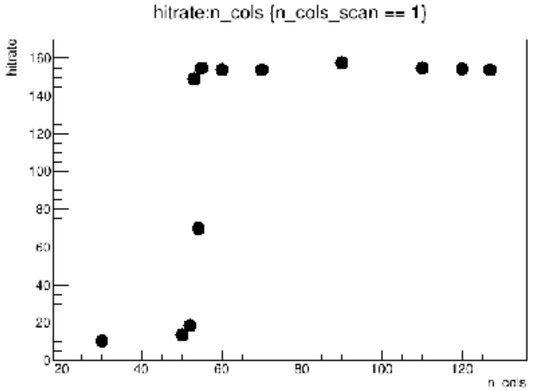
- There are 4 FELIX parameters to be optimized for time-in:
  - LV1 Delay: a delay on trigger signals, which are fed to INTT's FELIXs, in the GTM module
  - n_collisions: width of BCO time window for hits
  - open_time: waiting time to correct hits from ROCs
  - modebit:
    Detailed explanations were given by Itaru.
- All INTT DAQ servers were used.
- We could get some data, but the time-in was not so successful.
- The results were reported in [the shift change meeting].



ADC and channel distributions of all half-ladders in intt1.
Run8000: The largest time windows to get beam data anyway.



Hit rate as a function of open_time.



Hit rate as a function of n_collisions.

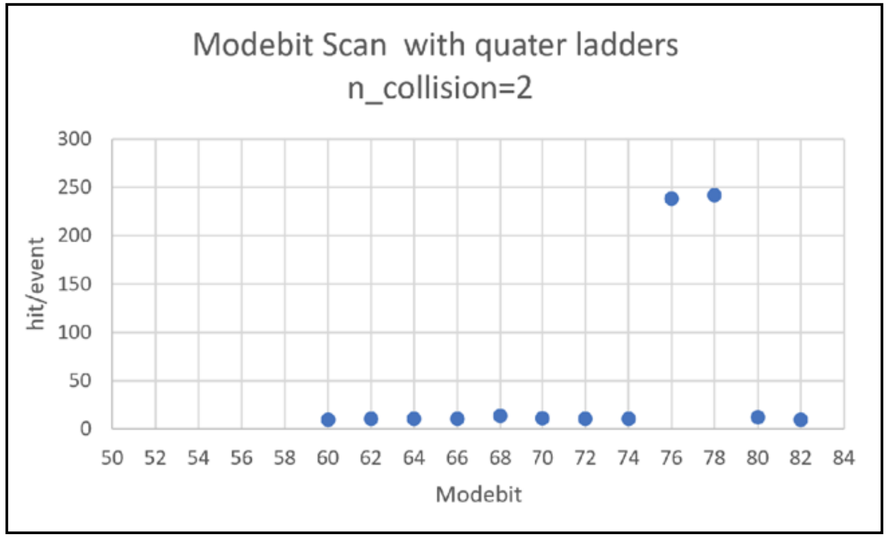
2nd: modebit scan with only intt2

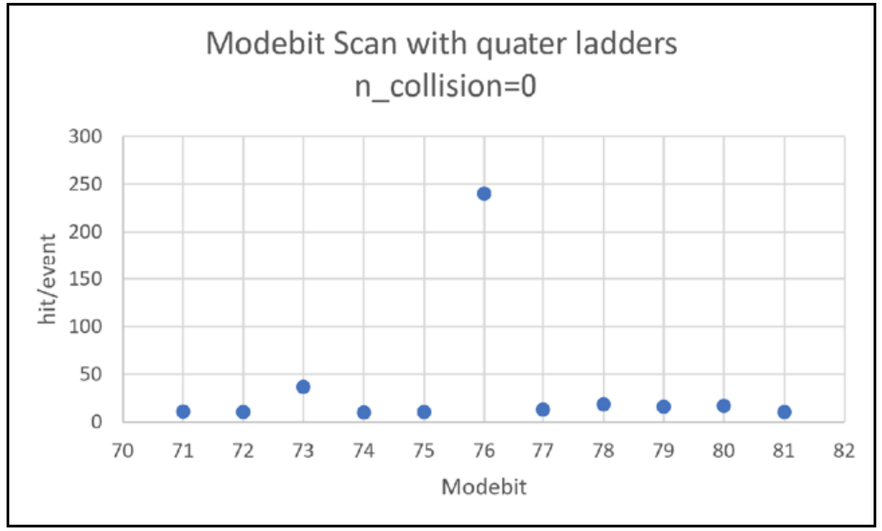
- Data taking with scanning modebit and fixed parameters
  - LV1 Delay: 25
  - n_collisions: 0 or 2
  - open_time: 35
- Only intt2 was used due to an issue on GTM.
- Golden data: commissioning_5_30/hit_files/calib_intt2-00008118-0000.root
- Joseph, Mai&Genki confirmed INTT timed-in by online analysis.
- The results were reported at the shift change meeting.

Run list for modebit scan

Run	内容
8102 - 8115	modebit scan with n_collisions=2 (wider time window)
8116 - 8125	scan with n_collisions=0

🎉🎉 **WE CONCLUDED THAT INTT WAS SUCCESSFULLY TIMED IN!** 🎉🎉

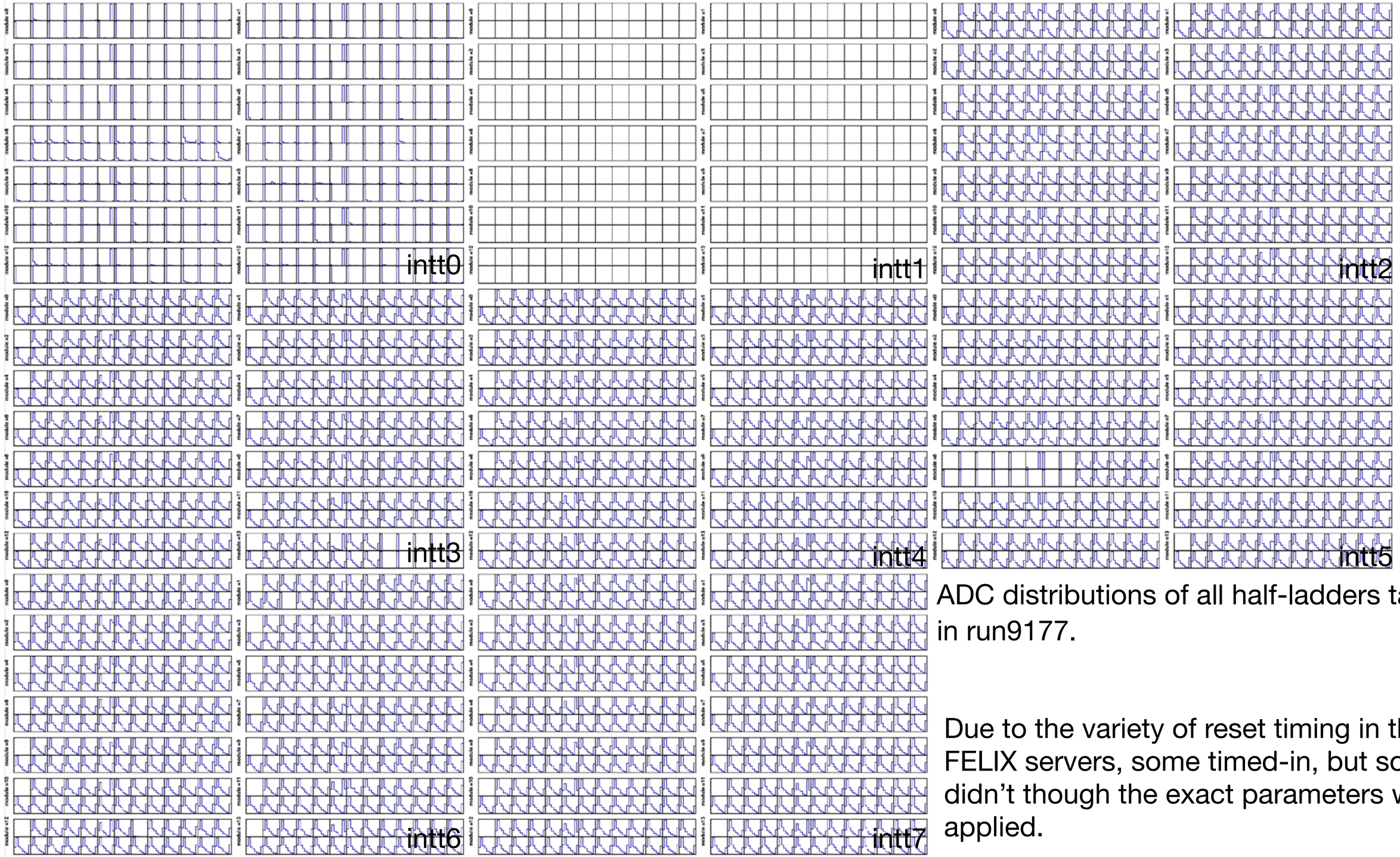




Hit rates of chips 1-13 of all half-ladders in intt2.

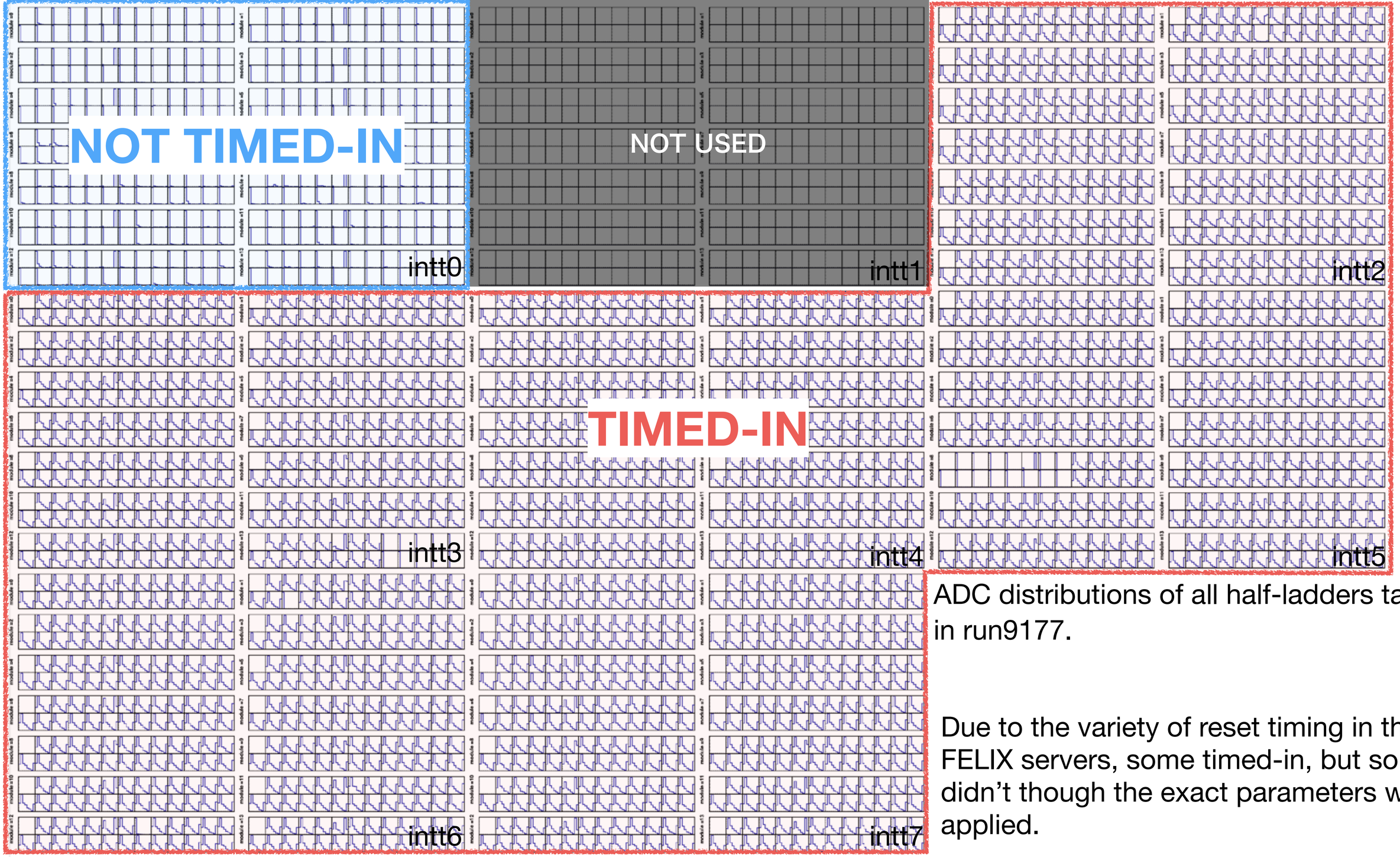
3rd: modebit scan with all servers

- Data taking with scanning modebit and fixed parameters
  - LV1 Delay: 25
  - n_collisions: 0, 2 or 4
  - open_time: 35
- All INTT DAQ servers were used.
- We found the difference in reset timing among the FELIX servers
  → Fixing this issue takes time. We decided to set n_collisions to be 4 to accept the timing difference.



ADC distributions of all half-ladders taken in run9177.

Due to the variety of reset timing in the FELIX servers, some timed-in, but some didn't though the exact parameters were applied.



ADC distributions of all half-ladders taken in run9177.

Due to the variety of reset timing in the FELIX servers, some timed-in, but some didn't though the exact parameters were applied.

4th: DAC scan

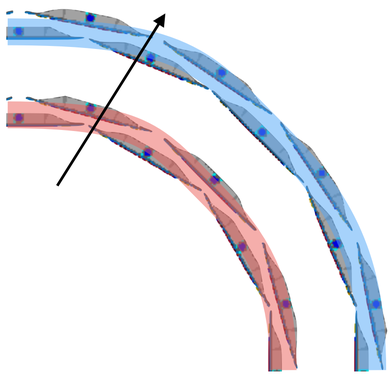
- Data taking with scanning DAC configuration and fixed parameters
  - LV1 Delay: 25
  - n_collisions: 4
  - open_time: 35
  - modebit: 78
- Precise ADC distributions over the whole range will be obtained from analysis.
- Cheng-Wei and Yuka are working on it.

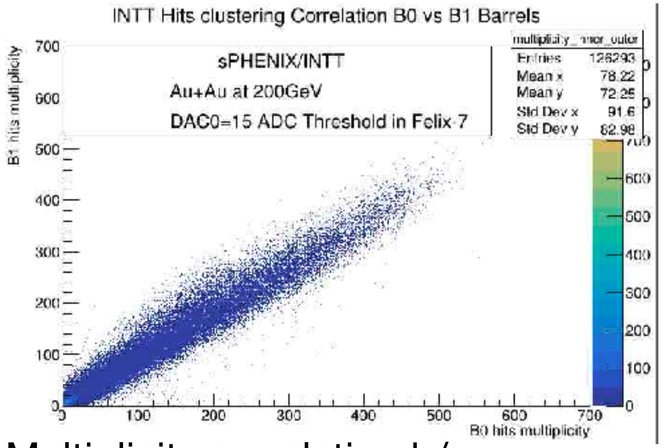
DAC configurations

Run	Scan	DAC0	DAC1	DAC2	DAC3	DAC4	DAC5	DAC6	DAC7
9303	1	8	12	16	20	24	28	32	36
9314	2	28	32	36	40	44	48	52	56
9318	3	48	52	56	60	64	68	72	76
9319	4	68	72	76	80	84	88	92	96
9320	5	88	92	96	100	104	108	112	116
9322	6	108	112	116	120	124	128	132	136
9329	7	128	132	136	140	144	148	152	156
9333	8	148	152	156	160	164	168	172	176
9334	9	168	172	176	180	184	188	192	196
9335	10	188	192	196	200	204	208	212	216

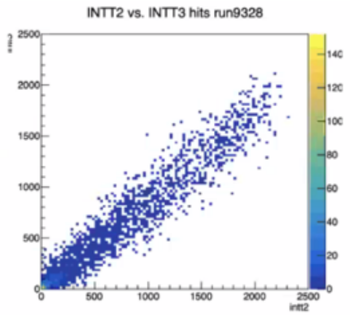
Some achievements, reports, etc.

- Self-correlations inside the same FELIX server: multiplicity of inner vs outer barrels (Mai&Genki)
  Reported in [the shift change meeting] and elsewhere (I don't know…).
  It can be one of the plots to be released from sPHENIX.
- Self-correlations over FELIX servers (Maya)
- ADC distributions after clustering (Takashi&Maya)
- Multiplicity distribution (Cheng-Wei)
- etc.

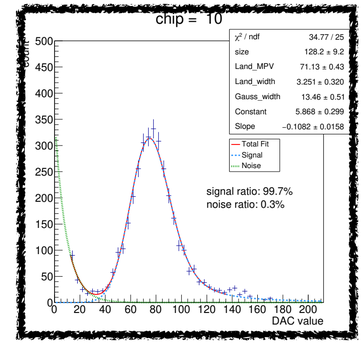


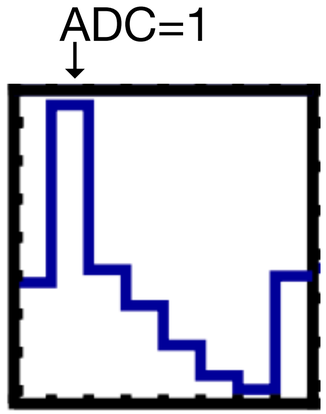


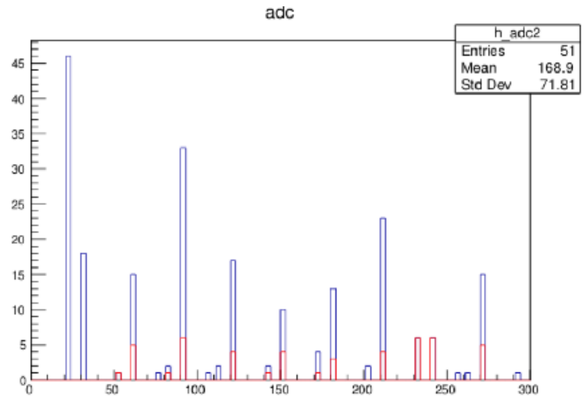
Multiplicity correlation b/w
the inner and the outer half-ladders in intt2.



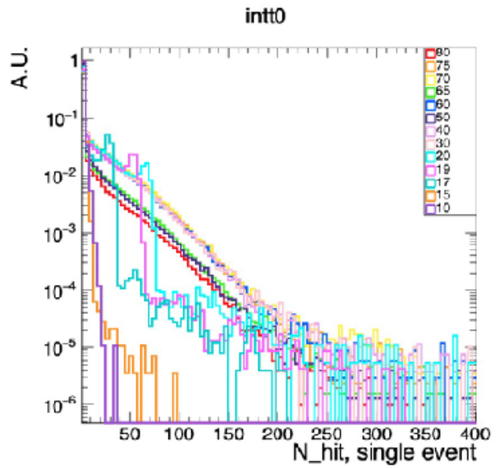
Multiplicity correlation
b/w intt2 and intt3.







ADC distribution without clustering (left) and
with clustering (right).



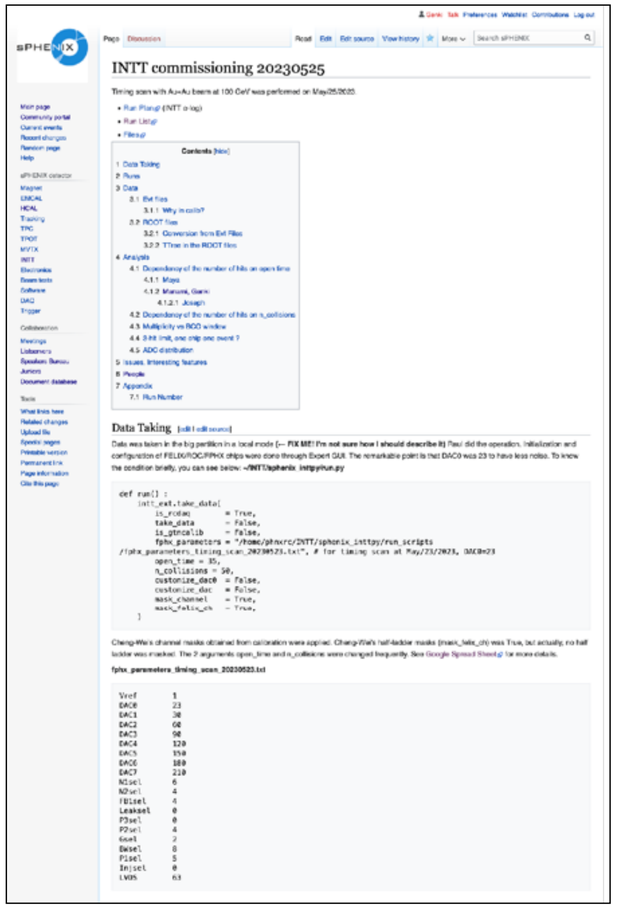
Multiplicity distribution of
the half-ladders in intt0.

Runs and data

```
Host intt0
     HostName 10.20.32.100
     User     phnxrc
     IdentityFile ~/.ssh/id_rsa
     ForwardX11 yes
     ProxyJump    OPC0
```

About Runs

- RCDAQ mode: calib or beam (Output directory depends on it)
- The configuration of FPHX chips is basically the same.
  - DAC0 was 23 in the beginning to reduce noise.
- Raul initialized/configured FELIXs/ROCs/FPHX chips, started DAQ, and ended DAQ in the beginning. Now, shifters do it.
- Cheng-Wei's mask list was applied all the time.
  - It may need to be updated, especially for intt1.
  - The mask process takes time. It can be optimized.



Event files

- stored in the buffer box.
- Path: /bbox/commissioning/INTT/calib/calib_intt[0-7]-0000????_0000.evt
- They can be accessed from the INTT DAQ servers (EBDB?) intt[0-7].

ROOT files

- Path: /home/phnxrc/INTT/commissioning_*_*/hit_files/
- They can be accessed from OPC0.
- inttdaq can see them too (/1008_home/phnxrc/…)

Information

- Run log: Google Spreadsheet (maintained by hand)
- sPHENIX E-Log
- sPHENIX wiki (1st, 2nd) (3rd or later are not made yet…)
- (sometimes) Mattermost

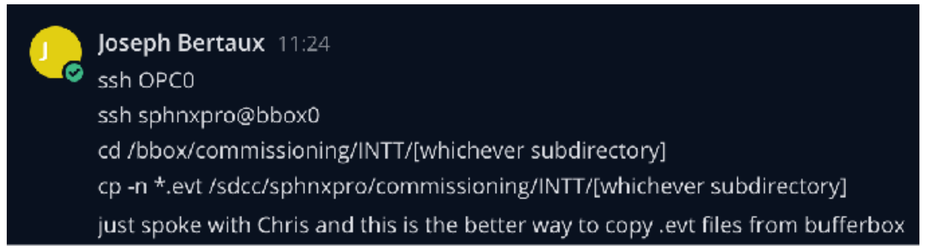
Data process and storage

Current status

- Decoding was done in each INTT DAQ servers
- ROOT files were analyzed in inttdaq to generate ADC and channel distributions.
- The decoding program consumes huge amount of memory. It can be more than 128 GB, which is the total in the DAQ servers.
- The processes are distributed to the 8 INTT DAQ servers, but it may affect to DAQ.

(Near) Future

- Sending event files to the storage in SDCC.
  - somewhere can be seen from rcas.
  - instructed how to by Chris:
  - plan: /sphenix/lustre01/sphnxpro/commissioning/INTT
  - You need to have an account for sPHENIX, but NOT PHENIX.
- Decoding in rcas
  - ROOT files will be: /sphenix/tg/tg01/commissioning/INTT/root_files (?)
- Not started at all



Data

Hit-wise TTree (same as testbench's)

- Branches are for integer.
- The structure inherits testbench's, and some branches were added.
  - pid: packet ID
  - adc
  - ampl
  - chip_id
  - module: FELIX readout ch
  - chan_id
  - bco
  - bco_full: Long64_t
  - event
  - roc: new
  - barrel: new
  - layer: new
  - ladder: new
  - arm: 0 (south), 1 (north)
  - full_fphx: new
  - full_roc: new

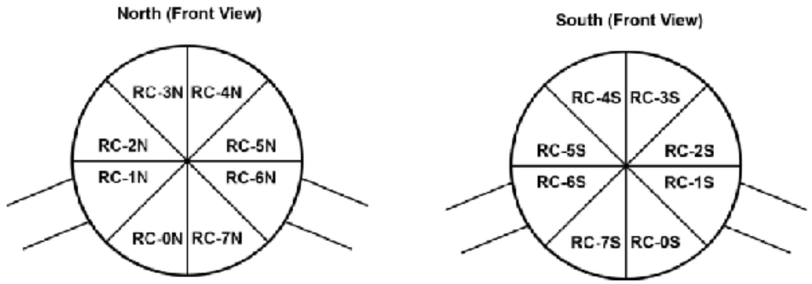
About roc, barrel, layer, ladder, arm

These variables can be used for the ROC notation (eg. RC-2N) and the ladder notation (eg B1 L0 14S).

Example:

RC${roc}${arm}

B${barrel}L${layer}${ladder}${arm}



Event-wise TTree

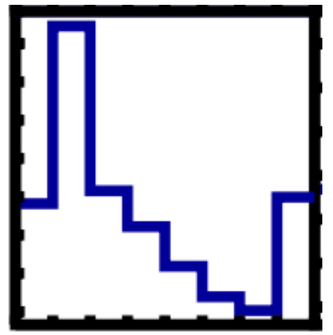
- Although I'm not sure who take responsibility on it, I took Takashi's codes for quick analysis.
- InttEvent class: INTT/hachiya/convertInttRaw/test1/InttEvent .h/cc
- Decoder: INTT/hachiya/convertInttRaw/test1/runConvertInttData.C
- File name: beam_intt?-${run}-${chunk}_event_base.root
- Generated ROOT files are in the same directory as hit-wise TTree's.

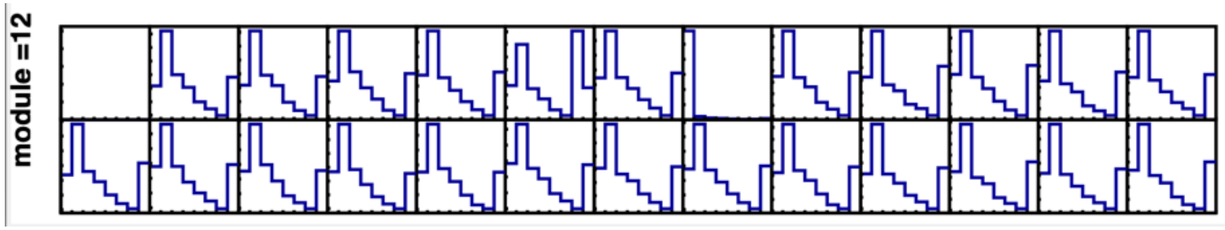
How to analyze event-wise TTree

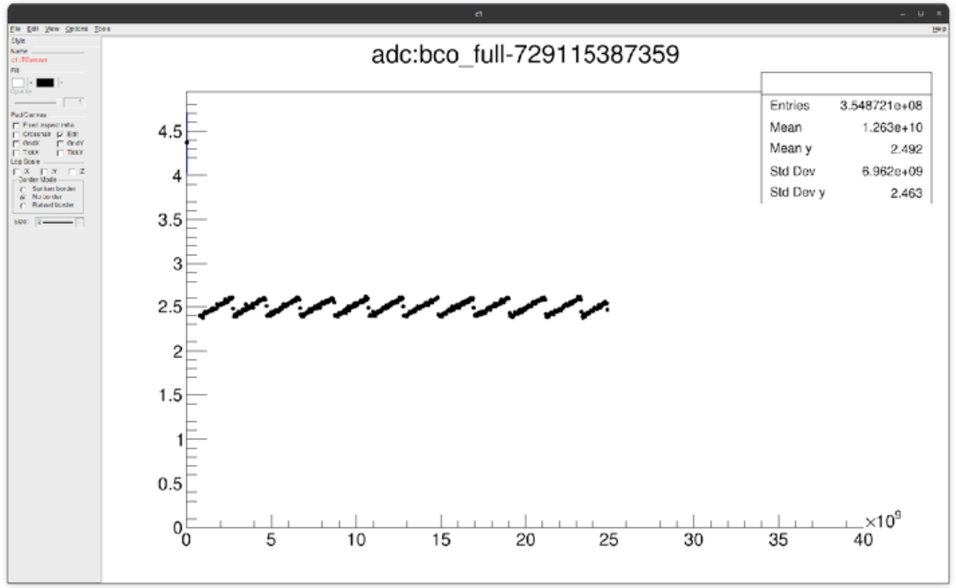
```
#include "InttEvent.cc"
#include "InttCluster.cc"

int macro()
{

  TFile* tf = new TFile( file_path.c_str(), "READ" ); // Open a ROOT file
  if( tf == nullptr )                                 // If it cannot be opend
    {
      cerr << file_path << " is not found." << endl;
      return -1;
    }
  TTree* tr = (TTree*)tf->Get( "tree" ) ;             // Get the TTree

  InttEvent* ev = new InttEvent();                    // Make an instance of InttEvent class
  tr->SetBranchAddress( "event", &ev );               // Set the branch address to the instance

  for( int i=0; i<tr->GetEntries(); i++ )             // Loop over all events in the tree
    {
      tr->GetEvent( i ) ;                             // Get i-th event
      /* write whatever you want to do */             // Contents of the event are assigned to ev
    }
```

Known issues and questions

- The shape of ADC distributions: different from those in the test beam experiment
- intt1 tends to be noisy
- No good data from chip21 and 26.
- The strange trend of ADC
- Clone hits?
- etc.







Next

- Scanning *open_time*
- Scanning DAC0
- Calibration measurements in Big Partition
- Measurements with various bias voltages
- etc.

We were asked to give a short report in the sPHENIX general meeting tomorrow. I'll reuse some slides.

Summary

- **INTT was successfully timed in!** 🎊
- Many parameters need to be optimized.
- Measurements are performed every day. Onsite crews are quite busy for those.
- Some good results had already been obtained. More analysis is necessary!