INTT BCO Calibration module update

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Motivation Review

- INTT has two run modes: trigger (including extended) readout mode and streaming readout mode.

- The timing offset between INTT and GL1 (global timing for sPHENIX) must be used to correlate INTT hits with other subsystems or RHIC bunches.

- The method for calculating the BCO offset (the peak value of the BCO difference plot) is different.

  Trigger mode BCO Offset

  ```
  int offset = (intt_raw_hit->get_FPHX_BCO() - (intt_raw_hit->get_bco() & 0x7fU) + 128) % 128;
  ```

  Streaming mode BCO Offset(newly implemented)

  ```
  int offset =   intt_raw_hit->get_FPHX_BCO() + intt_raw_hit->get_bco() - gl1_bco;
  ```

  (Note : Hit BCO(FPHX BCO + INTT BCO) - GL1 BCO)

- Streaming BCO offset calibration run by run?

macro code

https://github.com/sPHENIX-Collaboration/macros/blob/master/calibrations/intt/macro_Calib.C

Run-mode classification

```
#include <intt/InttOdbcQuery.h> // To get data taking mode
InttOdbcQuery query;
query.Query(run_num);
// Construct file paths
inttcalib->SetHotMapCdbFile(hotmap_cdb_file);
inttcalib->SetHotMapPngFile(hotmap_png_file);
inttcalib->SetBcoMapCdbFile(bcomap_cdb_file);
inttcalib->SetBcoMapPngFile(bcomap_png_file);
inttcalib->SetBcoMaximumEvent(num_evt); // default = 50k
inttcalib->SetStreamingMode(query.IsStreaming());
inttcalib->SetRunNumber(run_num);
std::cout << "Run: " << run_num << " is \n"
          << "\t" << (query.IsStreaming() ? "streaming" : "triggered") << std::endl;
```

InttObdcQuery.h class implemented by Joseph, Thanks!

Run mode is loaded from database

Result(CDBTTree)

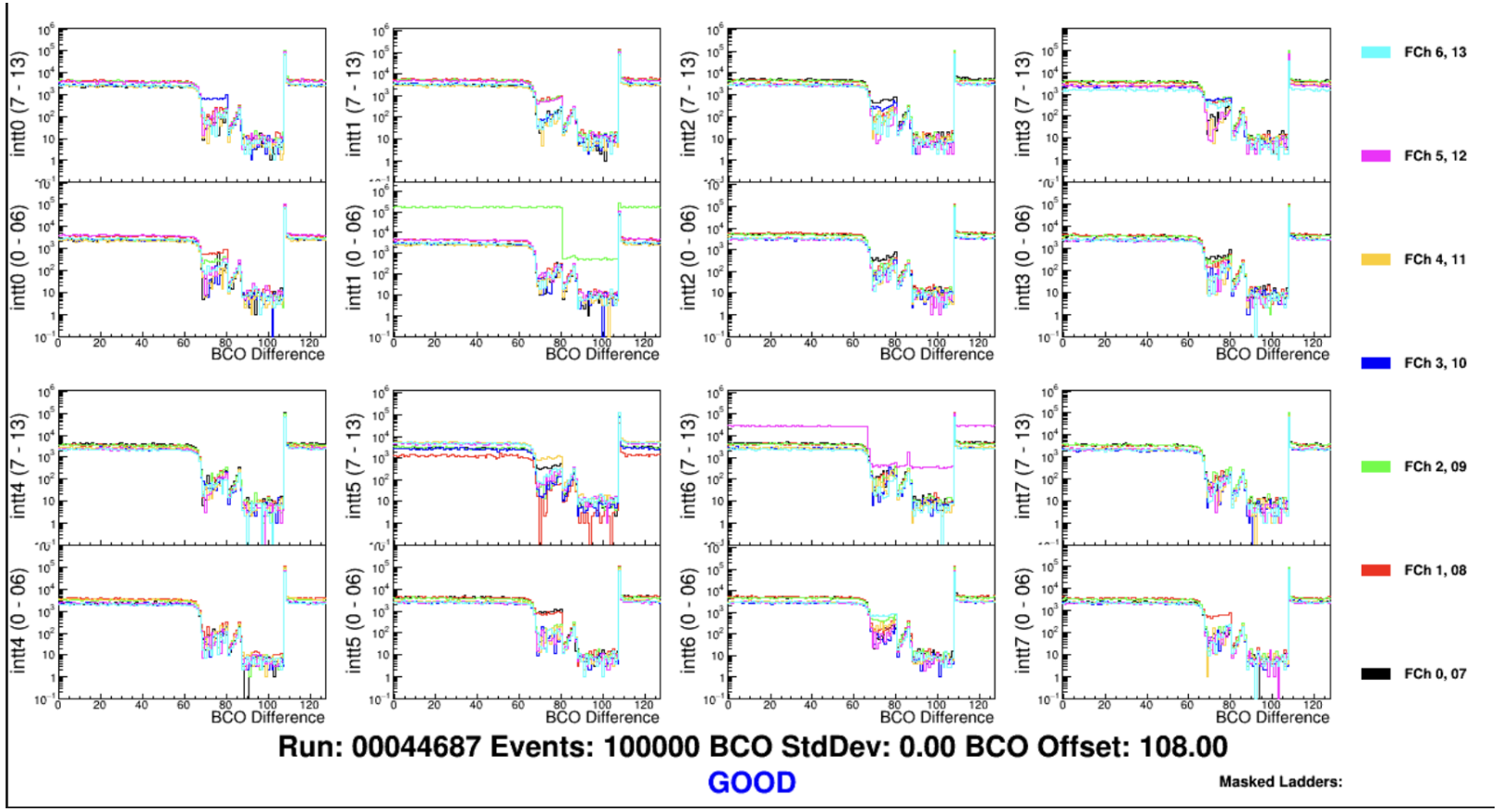
- CDBTTree : BCO offset for every FEEs 14x8 = 112 run by run
- Struture of CDBTTree is identical for trigger and streaming mode

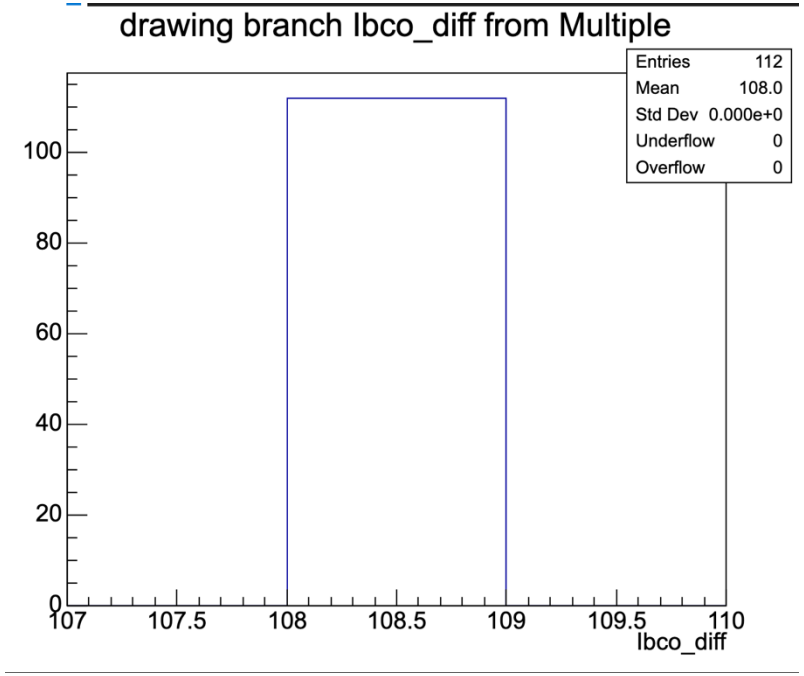
```
TFile**         bcomap_run_00044610.root
 TFile*         bcomap_run_00044610.root
  KEY: TTree    Single;1        Single
  KEY: TTree    Multiple;1      Multiple
root [2] Multiple->Print()
******************************************************************************
*Tree    :Multiple  : Multiple                                                *
*Entries :      112 : Total =            4499 bytes  File  Size =       1294 *
*        :          : Tree compression factor =   3.27                       *
******************************************************************************
*Br    0 :IID       : IID/I                                                  *
*Entries :      112 : Total  Size=        999 bytes  File Size  =        260 *
*Baskets :        1 : Basket Size=      32000 bytes  Compression=   2.01     *
*.............................................................................*
*Br    1 :Ibco_diff : Ibco_diff/I                                            *
*Entries :      112 : Total  Size=       1029 bytes  File Size  =        106 *
*Baskets :        1 : Basket Size=      32000 bytes  Compression=   4.98     *
*.............................................................................*
*Br    2 :Ifelix_channel : Ifelix_channel/I                                  *
*Entries :      112 : Total  Size=       1054 bytes  File Size  =        144 *
*Baskets :        1 : Basket Size=      32000 bytes  Compression=   3.70     *
*.............................................................................*
*Br    3 :Ifelix_server : Ifelix_server/I                                    *
*Entries :      112 : Total  Size=       1049 bytes  File Size  =        137 *
*Baskets :        1 : Basket Size=      32000 bytes  Compression=   3.88     *
*.............................................................................*
root [3]
```

```
root [3] Single->Scan()
***********************************
*    Row   * DStdDev.D * Isize.Isi *
***********************************
*        0 *         0 *       112 *
***********************************
```

Result(Triggered mode / GOOD RUN)

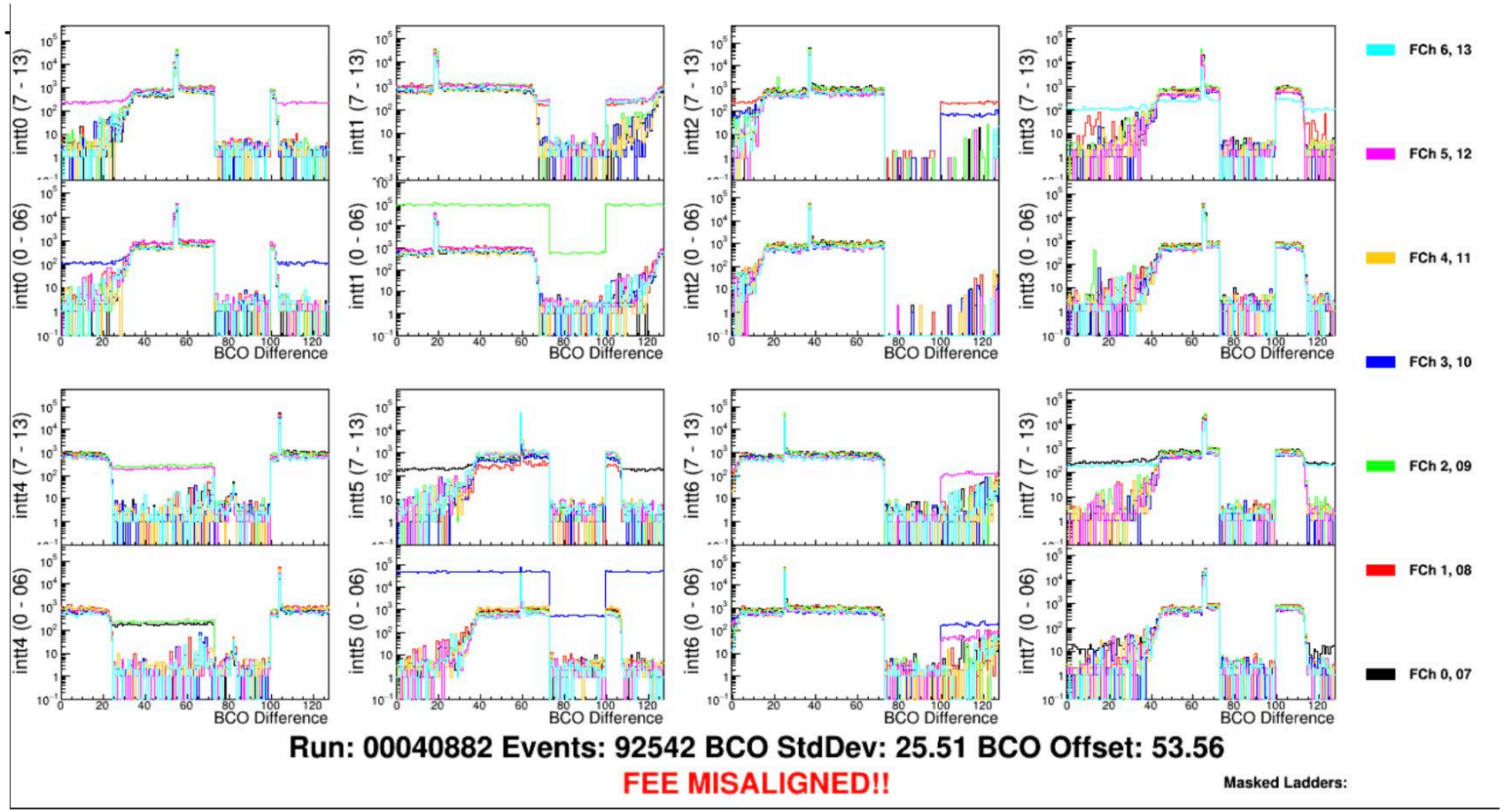
- BCO difference plot(.root or .png) : BCO offset for every FEEs 14x8 = 112 run by run
-

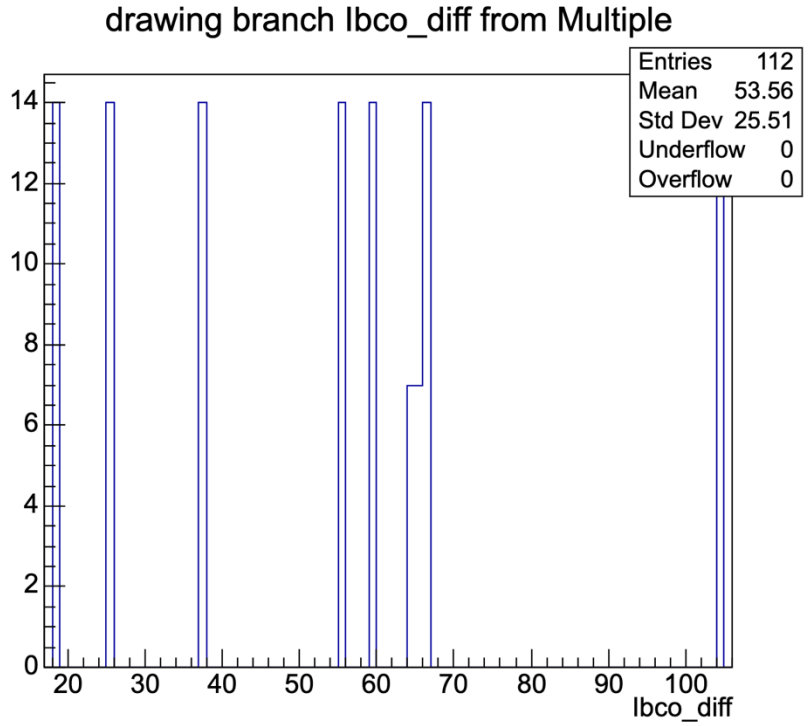




Result(Triggered mode / BAD RUN)

- BCO difference plot(.root or .png) : BCO offset for every FEEs 14x8 = 112 run by run

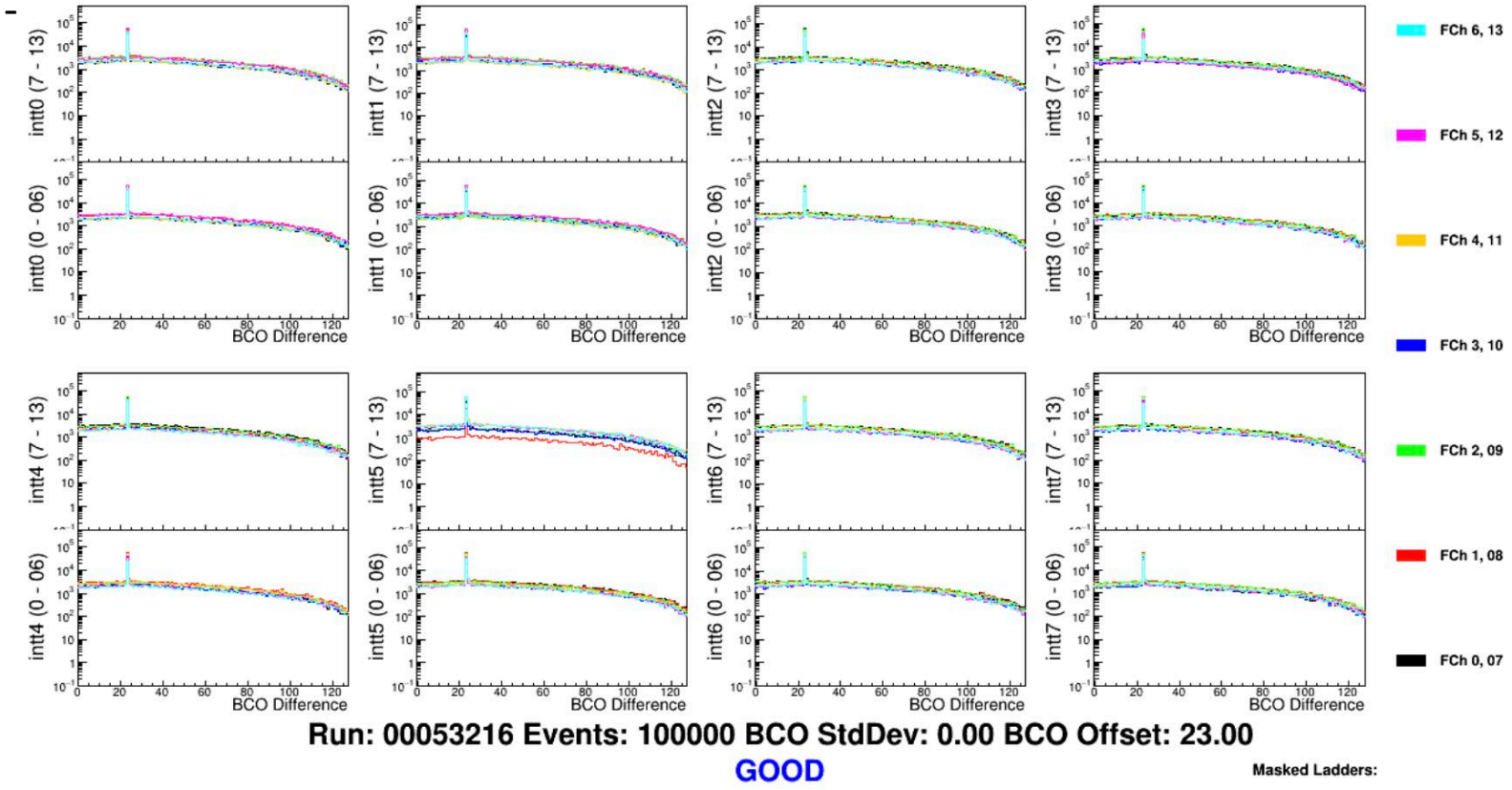


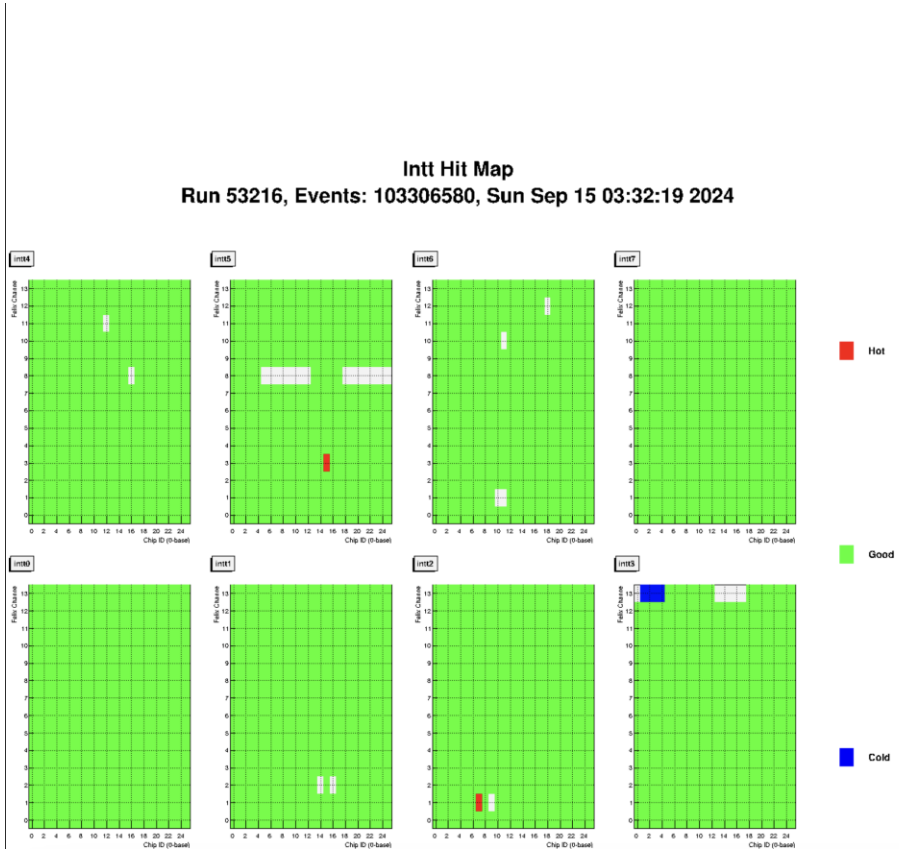


Result(Streaming mode / GOOD RUN)

- BCO difference plot(.root or .png) : BCO offset for every FEEs 14x8 = 112 run by run

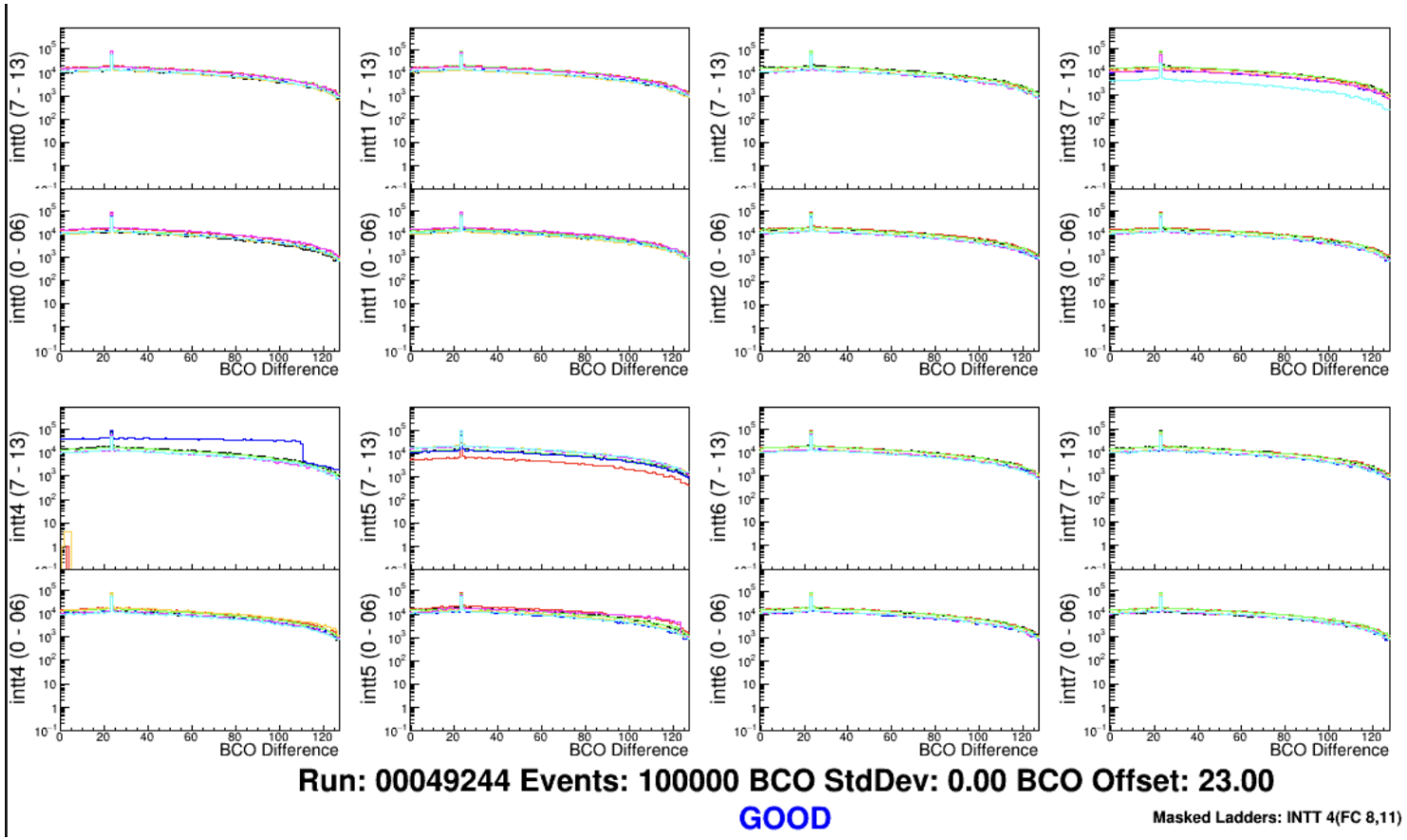
-

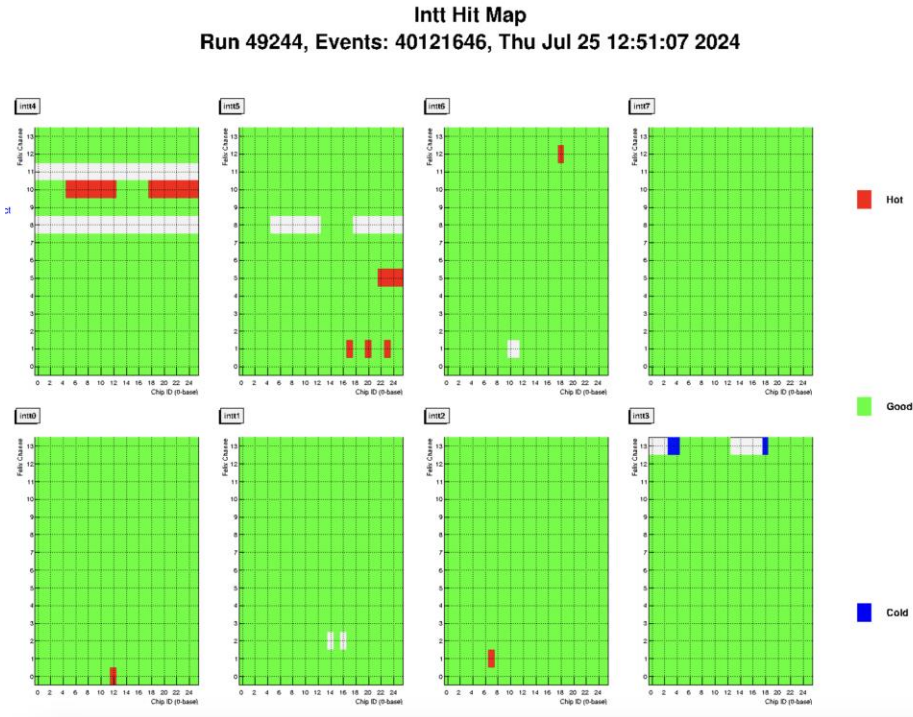




Result(Streaming mode / GOOD RUN but maksed)

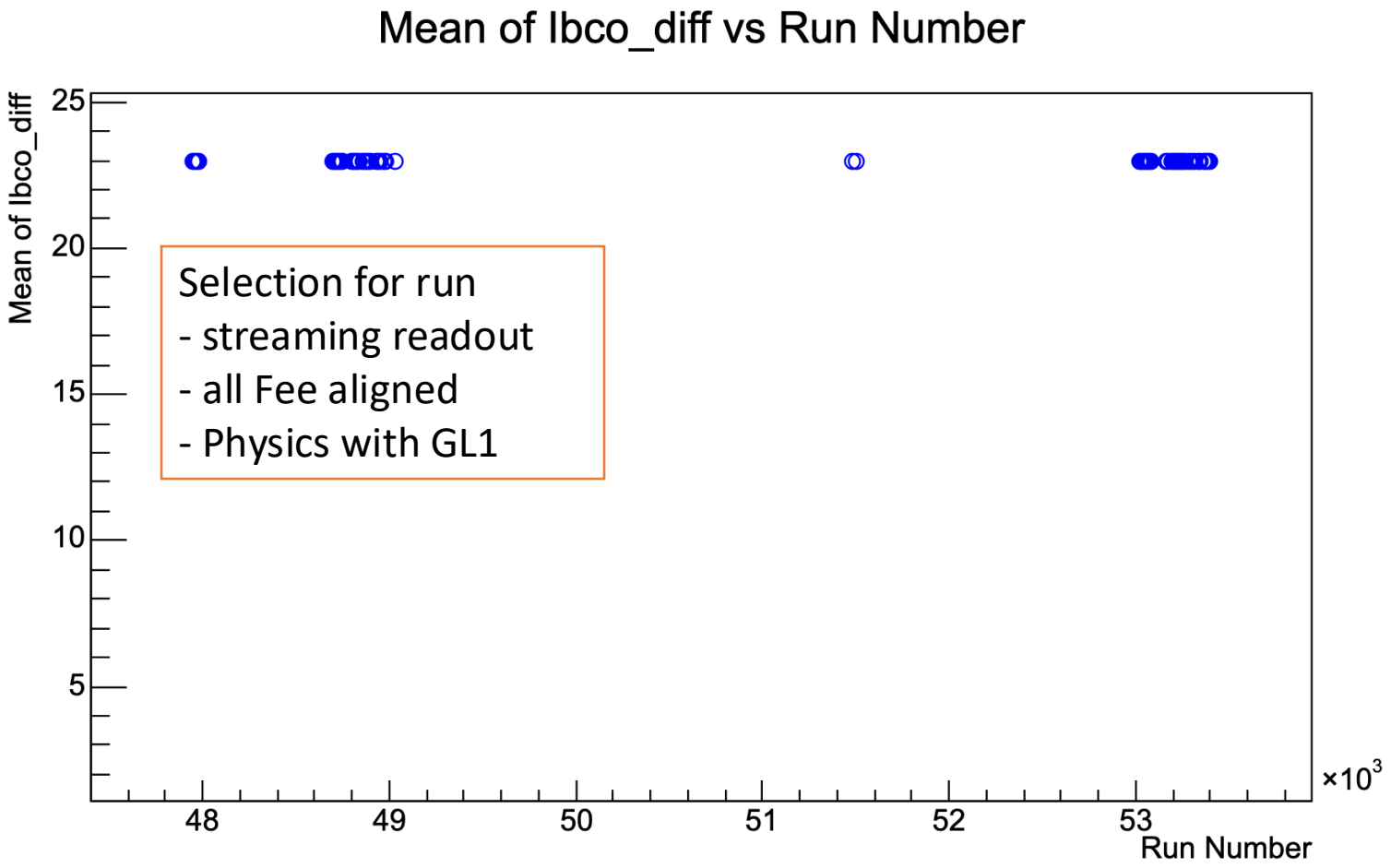
- BCO difference plot(.root or .png) : BCO offset for every FEEs 14x8 = 112 run by run





Fee 8/11 were masked during the data taking due to hot ladder issue

Streaming BCO Offset value for streaming data set



Every streaming readout run with GL1 & TPC are aligned with same BCO offset(as designed)
We don't need BCO offset calibration run by run,
but let's use new version of calibration module for future detailed debugging

Summary

- New version of calibration module ready to use

- Run mode automatically loaded from database by Joseph’s class

- We don’t need to do run by run BCO calibration in streaming readout but want to keep new version in case that we need to debug in future