Software for the new prototype

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Outline

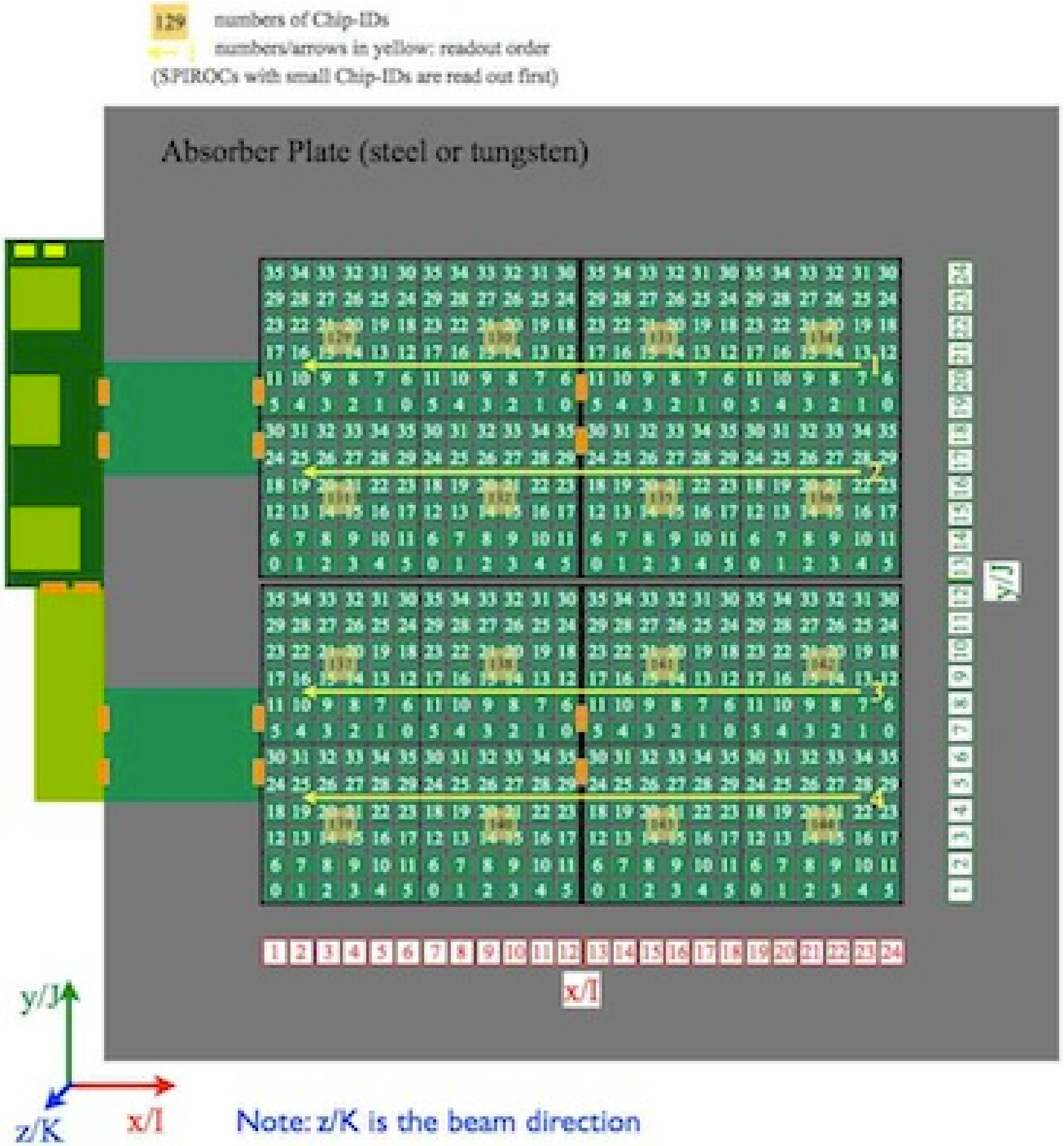
- Basic class
  - Mapping class and functions
  - Data structure class and functions
- Database tools
  - Database maintain tools for hardware expert
  - Database tools for users
- Data format converter and events sorting
  - Marlin processor
  - Slow control data
- Reconstruction

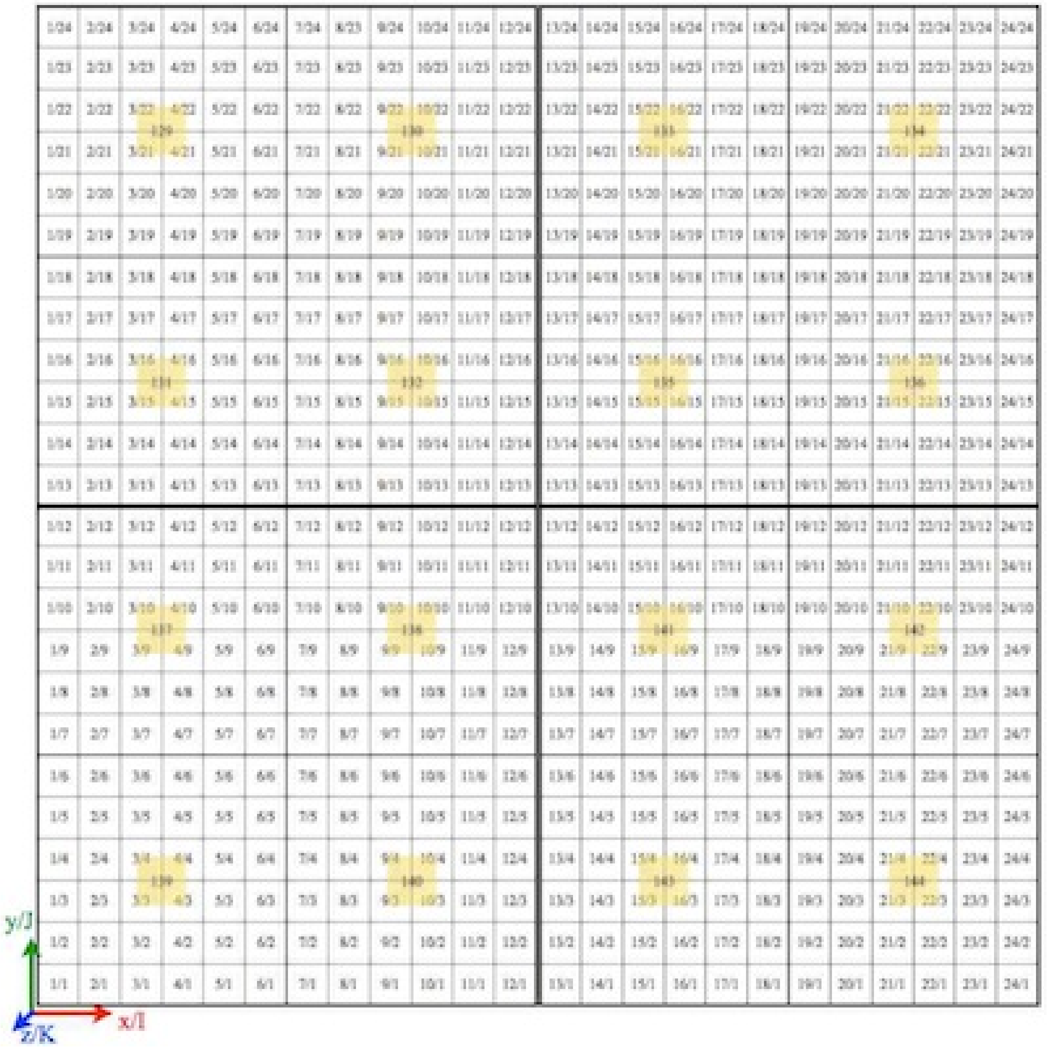
Response persons

- Coordination: Shaojun Lu
- LCIO converter: Shaojun lu
- Slow control data: Oskar Hartbrich
- Database tools: Shaojun Lu
- Reconstruction: Shaojun Lu, Sebastian Laurien
- RootTreeWriter and analysis: NN

- Basic ideas:
  - use LCIO, database and Marlin (ilcsoft framework)
  - reuse as much as possible the existing class, tools, and processors

Mapping


129
numbers of Chip-IDs
numbers/arrows in yellow: readout order
(SPIROCs with small Chip-IDs are read out first)
Absorber Plate (steel or tungsten)
129
130
133
134
131
132
135
136
137
138
141
142
139
140
143
144
1
2
3
4
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
x/I
y/J
y/J
z/K
x/I
Note: z/K is the beam direction



1/24	2/24	3/24	4/24	5/24	6/24	7/24	8/23	9/24	10/24	11/24	12/24	13/24	14/24	15/24	16/24	17/24	18/24	19/24	20/24	21/24	22/24	23/24	24/24
1/23	2/23	3/23	4/23	5/23	6/23	7/23	8/23	9/23	10/23	11/23	12/23	13/23	14/23	15/23	16/23	17/23	18/23	19/23	20/23	21/23	22/23	23/23	24/23
1/22	2/22	3/22	4/22	5/22	6/22	7/22	8/22	9/22	10/22	11/22	12/22	13/22	14/22	15/22	16/22	17/22	18/22	19/22	20/22	21/22	22/22	23/22	24/22
1/21	2/21	3/21	4/21	5/21	6/21	7/21	8/21	9/21	10/21	11/21	12/21	13/21	14/21	15/21	16/21	17/21	18/21	19/21	20/21	21/21	22/21	23/21	24/21
1/20	2/20	3/20	4/20	5/20	6/20	7/20	8/20	9/20	10/20	11/20	12/20	13/20	14/20	15/20	16/20	17/20	18/20	19/20	20/20	21/20	22/20	23/20	24/20
1/19	2/19	3/19	4/19	5/19	6/19	7/19	8/19	9/19	10/19	11/19	12/19	13/19	14/19	15/19	16/19	17/19	18/19	19/19	20/19	21/19	22/19	23/19	24/19
1/18	2/18	3/18	4/18	5/18	6/18	7/18	8/18	9/18	10/18	11/18	12/18	13/18	14/18	15/18	16/18	17/18	18/18	19/18	20/18	21/18	22/18	23/18	24/18
1/17	2/17	3/17	4/17	5/17	6/17	7/17	8/17	9/17	10/17	11/17	12/17	13/17	14/17	15/17	16/17	17/17	18/17	19/17	20/17	21/17	22/17	23/17	24/17
1/16	2/16	3/16	4/16	5/16	6/16	7/16	8/16	9/16	10/16	11/16	12/16	13/16	14/16	15/16	16/16	17/16	18/16	19/16	20/16	21/16	22/16	23/16	24/16
1/15	2/15	3/15	4/15	5/15	6/15	7/15	8/15	9/15	10/15	11/15	12/15	13/15	14/15	15/15	16/15	17/15	18/15	19/15	20/15	21/15	22/15	23/15	24/15
1/14	2/14	3/14	4/14	5/14	6/14	7/14	8/14	9/14	10/14	11/14	12/14	13/14	14/14	15/14	16/14	17/14	18/14	19/14	20/14	21/14	22/14	23/14	24/14
1/13	2/13	3/13	4/13	5/13	6/13	7/13	8/13	9/13	10/13	11/13	12/13	13/13	14/13	15/13	16/13	17/13	18/13	19/13	20/13	21/13	22/13	23/13	24/13
1/12	2/12	3/12	4/12	5/12	6/12	7/12	8/12	9/12	10/12	11/12	12/12	13/12	14/12	15/12	16/12	17/12	18/12	19/12	20/12	21/12	22/12	23/12	24/12
1/11	2/11	3/11	4/11	5/11	6/11	7/11	8/11	9/11	10/11	11/11	12/11	13/11	14/11	15/11	16/11	17/11	18/11	19/11	20/11	21/11	22/11	23/11	24/11
1/10	2/10	3/10	4/10	5/10	6/10	7/10	8/10	9/10	10/10	11/10	12/10	13/10	14/10	15/10	16/10	17/10	18/10	19/10	20/10	21/10	22/10	23/10	24/10
1/9	2/9	3/9	4/9	5/9	6/9	7/9	8/9	9/9	10/9	11/9	12/9	13/9	14/9	15/9	16/9	17/9	18/9	19/9	20/9	21/9	22/9	23/9	24/9
1/8	2/8	3/8	4/8	5/8	6/8	7/8	8/8	9/8	10/8	11/8	12/8	13/8	14/8	15/8	16/8	17/8	18/8	19/8	20/8	21/8	22/8	23/8	24/8
1/7	2/7	3/7	4/7	5/7	6/7	7/7	8/7	9/7	10/7	11/7	12/7	13/7	14/7	15/7	16/7	17/7	18/7	19/7	20/7	21/7	22/7	23/7	24/7
1/6	2/6	3/6	4/6	5/6	6/6	7/6	8/6	9/6	10/6	11/6	12/6	13/6	14/6	15/6	16/6	17/6	18/6	19/6	20/6	21/6	22/6	23/6	24/6
1/5	2/5	3/5	4/5	5/5	6/5	7/5	8/5	9/5	10/5	11/5	12/5	13/5	14/5	15/5	16/5	17/5	18/5	19/5	20/5	21/5	22/5	23/5	24/5
1/4	2/4	3/4	4/4	5/4	6/4	7/4	8/4	9/4	10/4	11/4	12/4	13/4	14/4	15/4	16/4	17/4	18/4	19/4	20/4	21/4	22/4	23/4	24/4
1/3	2/3	3/3	4/3	5/3	6/3	7/3	8/3	9/3	10/3	11/3	12/3	13/3	14/3	15/3	16/3	17/3	18/3	19/3	20/3	21/3	22/3	23/3	24/3
1/2	2/2	3/2	4/2	5/2	6/2	7/2	8/2	9/2	10/2	11/2	12/2	13/2	14/2	15/2	16/2	17/2	18/2	19/2	20/2	21/2	22/2	23/2	24/2
1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1	13/1	14/1	15/1	16/1	17/1	18/1	19/1	20/1	21/1	22/1	23/1	24/1

- CERN testbeam hardware setup
- model/chip/channel : I/J/K : x/y/z (right hand coordinator)
- z/K is the beam direction, y/J direction is up.

Mapping parameters

- E4DMapper.hh/.cc

Parameters

```
const std::string CellIDEncoding("M:3,S-1:3,I:9,J:9,K-1:6");
const std::string ModuleEncoding("module:6,chip:5,chan:5,SiPM:16");

//Hardware Module information
unsigned int _nChip;
unsigned int _nChannel;
unsigned int _nModule;
int _nCellID1;

//Hardware Local Module information
unsigned int _nI;
unsigned int _nJ;
unsigned int _nK;
int _nCellID0;
```

Mapping functions

CellID functions

- E4DMapper.hh/.cc

```
//getCellID0
int getCellID0FromIJK( const unsigned int I, const unsigned int J, const unsigned int K)
int getCellID0FromModuleChipChannel( const unsigned int module, const unsigned int
chip, const unsigned int channel)
int getCellID0FromCellID1( const int CellID1)

//getCellID1
int getCellID1FromModuleChipChannel( const unsigned int module, const unsigned int chip,
const unsigned int channel)
int getCellID1FromIJK( const unsigned int I, const unsigned int J, const unsigned int K)
int getCellID1FromCellID0( const int CellID0)
```

Mapping database tools

Tool for experts

```
writeHBUMapping --inFile <mapping.txt>
--dbinit <calice_database>
--folder <database_folder>
--parameterFile <default_constant.txt>
--from <2012-11-01-00-00-00-000000000>
--until <2012-12-31-00-00-00-000000000>
```

Tool for users

```
dumpCalib <database_folder> <tag>
<2012-11-02-18-15-13> <e4d>
```

Labview DAQ data structure

- Labview DAQ data structure
  - 12 integer:
  - BunchXID/I:CycleNr/I:ChipID/I:ASICNr/I:EvtNr/I:Channel/I:TDC/I:ADC/I:xPos/I:yPos/I:HitBit/I:GainBit/I
  - BunchXID + CycleNr == Event
  - # Date / Time : Fr, 2. Nov 2012 21:46:45

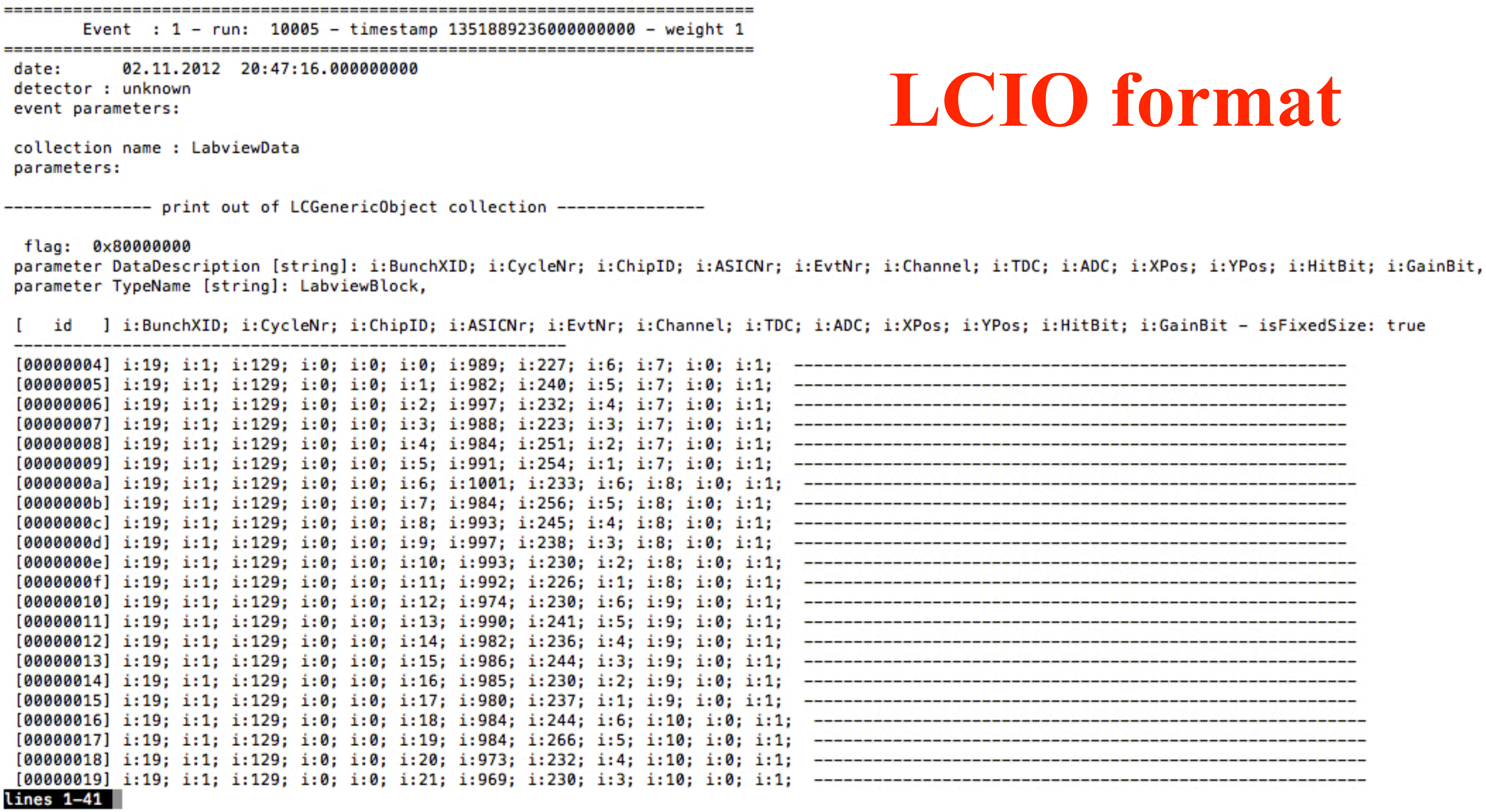
LabviewBlock

- LabviewBlock.hh/.cc

```
class LabviewBlock : public LCFixedObject<NINT,NFLOAT,NDOUBLE>
    //parameters
    12 integer
    //getFunctions
    int GetBunchXID() const {  return getIntVal(0); }
    int GetCycleNr() const {  return getIntVal(1); }
    int GetChipID() const {  return getIntVal(2); }
    int GetASICNr() const {  return getIntVal(3); }
    int GetEvtNr() const {  return getIntVal(4); }
    int GetChannel() const {  return getIntVal(5); }
    int GetTDC() const {  return getIntVal(6); }
    int GetADC() const {  return getIntVal(7); }
    int GetXPos() const {  return getIntVal(8); }
    int GetYPos() const {  return getIntVal(9); }
    int GetHitBit() const {  return getIntVal(10); }
    int GetGainBit() const {  return getIntVal(11); }
```

LabviewConverter

- Marlin Processor: LabviewConverter
  - Data format; Date /Time; and Events sorting



```
==========================================================================
        Event  : 1 - run:  10005 - timestamp 1351889236000000000 - weight 1
==========================================================================
 date:      02.11.2012  20:47:16.000000000
 detector : unknown
 event parameters:

 collection name : LabviewData
 parameters:

--------------- print out of LCGenericObject collection ---------------

  flag:  0x80000000
 parameter DataDescription [string]: i:BunchXID; i:CycleNr; i:ChipID; i:ASICNr; i:EvtNr; i:Channel; i:TDC; i:ADC; i:XPos; i:YPos; i:HitBit; i:GainBit,
 parameter TypeName [string]: LabviewBlock,

 [   id   ] i:BunchXID; i:CycleNr; i:ChipID; i:ASICNr; i:EvtNr; i:Channel; i:TDC; i:ADC; i:XPos; i:YPos; i:HitBit; i:GainBit - isFixedSize: true
 --------------------------------------------------------
 [00000004] i:19; i:1; i:129; i:0; i:0; i:0; i:989; i:227; i:6; i:7; i:0; i:1;  --------------------------------------------------------
 [00000005] i:19; i:1; i:129; i:0; i:0; i:1; i:982; i:240; i:5; i:7; i:0; i:1;  --------------------------------------------------------
 [00000006] i:19; i:1; i:129; i:0; i:0; i:2; i:997; i:232; i:4; i:7; i:0; i:1;  --------------------------------------------------------
 [00000007] i:19; i:1; i:129; i:0; i:0; i:3; i:988; i:223; i:3; i:7; i:0; i:1;  --------------------------------------------------------
 [00000008] i:19; i:1; i:129; i:0; i:0; i:4; i:984; i:251; i:2; i:7; i:0; i:1;  --------------------------------------------------------
 [00000009] i:19; i:1; i:129; i:0; i:0; i:5; i:991; i:254; i:1; i:7; i:0; i:1;  --------------------------------------------------------
 [0000000a] i:19; i:1; i:129; i:0; i:0; i:6; i:1001; i:233; i:6; i:8; i:0; i:1;  --------------------------------------------------------
 [0000000b] i:19; i:1; i:129; i:0; i:0; i:7; i:984; i:256; i:5; i:8; i:0; i:1;  --------------------------------------------------------
 [0000000c] i:19; i:1; i:129; i:0; i:0; i:8; i:993; i:245; i:4; i:8; i:0; i:1;  --------------------------------------------------------
 [0000000d] i:19; i:1; i:129; i:0; i:0; i:9; i:997; i:238; i:3; i:8; i:0; i:1;  --------------------------------------------------------
 [0000000e] i:19; i:1; i:129; i:0; i:0; i:10; i:993; i:230; i:2; i:8; i:0; i:1;  --------------------------------------------------------
 [0000000f] i:19; i:1; i:129; i:0; i:0; i:11; i:992; i:226; i:1; i:8; i:0; i:1;  --------------------------------------------------------
 [00000010] i:19; i:1; i:129; i:0; i:0; i:12; i:974; i:230; i:6; i:9; i:0; i:1;  --------------------------------------------------------
 [00000011] i:19; i:1; i:129; i:0; i:0; i:13; i:990; i:241; i:5; i:9; i:0; i:1;  --------------------------------------------------------
 [00000012] i:19; i:1; i:129; i:0; i:0; i:14; i:982; i:236; i:4; i:9; i:0; i:1;  --------------------------------------------------------
 [00000013] i:19; i:1; i:129; i:0; i:0; i:15; i:986; i:244; i:3; i:9; i:0; i:1;  --------------------------------------------------------
 [00000014] i:19; i:1; i:129; i:0; i:0; i:16; i:985; i:230; i:2; i:9; i:0; i:1;  --------------------------------------------------------
 [00000015] i:19; i:1; i:129; i:0; i:0; i:17; i:980; i:237; i:1; i:9; i:0; i:1;  --------------------------------------------------------
 [00000016] i:19; i:1; i:129; i:0; i:0; i:18; i:984; i:244; i:6; i:10; i:0; i:1;  --------------------------------------------------------
 [00000017] i:19; i:1; i:129; i:0; i:0; i:19; i:984; i:266; i:5; i:10; i:0; i:1;  --------------------------------------------------------
 [00000018] i:19; i:1; i:129; i:0; i:0; i:20; i:973; i:232; i:4; i:10; i:0; i:1;  --------------------------------------------------------
 [00000019] i:19; i:1; i:129; i:0; i:0; i:21; i:969; i:230; i:3; i:10; i:0; i:1;  --------------------------------------------------------
lines 1-41
```

LCIO format

Slow control data

- Slow Control Class and test has been done by Oskar

  //parameters
  68 parameters / chip
  //getFunctions
  getPACapacitor() getPAEnable() getPATestCapacitor()
  … …
  more coming, Oskar will fully implement them
- Will save into database (only once per run)
  - with start and stop timestamp
  - implement into lcio converter step

Reconstruction

- USE ILCsoftware framework: LCIO / Marlin Processors:
  - read Mapping and condition/calibration constants from database
    - ModuleDescription, ModuleConnection, Mapping, Pedestal, MIP … …
  - apply to the converted data (LCIO format), Converter with (Model,chip,channel,ADC,TDC …)
  - write out as CalorimeterHit (LCIO format), Reconstruction with (x,y,z,E,t …)
  - analysis the data and write into root for final plots

Current status

- ModuleDescription, ModuleConnection (following DONE)
  - Use the existing CALICE class
  - We use the same name - AHCAL, but obviously, it is new detector.
  - Need to create database tools for new prototype
- Pedestal Marlin processor (DONE)
  - Labview DAQ data structure: 36 channels/chip, timestamp
  - Not structured with 500 pedestal, ... and beam data
  - Need a good available value of pedestal for the reconstruction of first event,
  - Extract the pedestal value from dedicated pedestal runs, and write into database
- More calibration runs will be analyzed by expert, more database folders will be created for the new prototype

Summary and outlook

- The database tools for the new prototype have been created as needed
- Part of the database folders have been created for the new prototype for the data reconstruction, more are in progress.

- The Labview data structure class and the converter have been done. (Keep it as original if it is possible, and only sorting)
  - And more Marlin processors have/will be created
    - to monitor the known issue, (EventChecker)
    - to correct the Labview output data (may break the rule to keep it as original if it is possible)
    - to clean up the data. (may apply at reconstruction phase)

Summary and outlook

- For the reconstruction: the database tools, database folders, basic class for the new prototype data structure
  - The development is ongoing
  - All the database, class, processor and known issue will be checked.
  - Working through all the calibration constants and the database folders step by step.
- Try to reuse as much as possible existing class, database tools and Marlin processors
  - Analyze calibration runs
  - Create database folder for the new prototype
  - Create database tools if needed
  - Create Marlin processor if needed

backup

Detail Mapping

Mapping functions

- E4DMapper.hh/.cc

Model functions

```
//getChip
unsigned int getChipFromCellID0(const int cellID0)
unsigned int getChipFromCellID1(const int cellID1)
//unsigned int getChipFromIJ(const unsigned int I, const unsigned int J) //TODO
unsigned int getChipFromIJK(const unsigned int I, const unsigned int J, const unsigned int K)
//getChannel
unsigned int getChannelFromCellID0(const int cellID0)
unsigned int getChannelFromCellID1(const int cellID1)
//unsigned int getChannelFromIJ(const unsigned int I, const unsigned int J) //TODO
unsigned int getChannelFromIJK(const unsigned int I, const unsigned int J, const unsigned int K)
//getModule
unsigned int getModuleFromCellID0(const int cellID0)
unsigned int getModuleFromCellID1(const int cellID1)
unsigned int getModuleFromK(const unsigned int K)
```

Mapping functions

- E4DMapper.hh/.cc

IJK functions

```
//getI
unsigned int getIFromCellID0(const int cellID0)
unsigned int getIFromCellID1(const int cellID1)
//unsigned int getIFromChipChannel(const unsigned int chip, const unsigned int channel)     //TODO
unsigned int getIFromModuleChipChannel(const unsigned int module, const unsigned int
chip, const unsigned int channel)
//getJ
unsigned int getJFromCellID0(const int cellID0)
unsigned int getJFromCellID1(const int cellID1)
//unsigned int getJFromChipChannel(const unsigned int chip, const unsigned int channel)     //TODO
unsigned int getJFromModuleChipChannel(const unsigned int module, const unsigned int
chip, const unsigned int channel)
//getK
unsigned int getKFromCellID0(const int cellID0)
unsigned int getKFromCellID1(const int cellID1)
unsigned int getKFromModule(const unsigned int module)
```

Mapping functions

more functions

- E4DMapper.hh/.cc

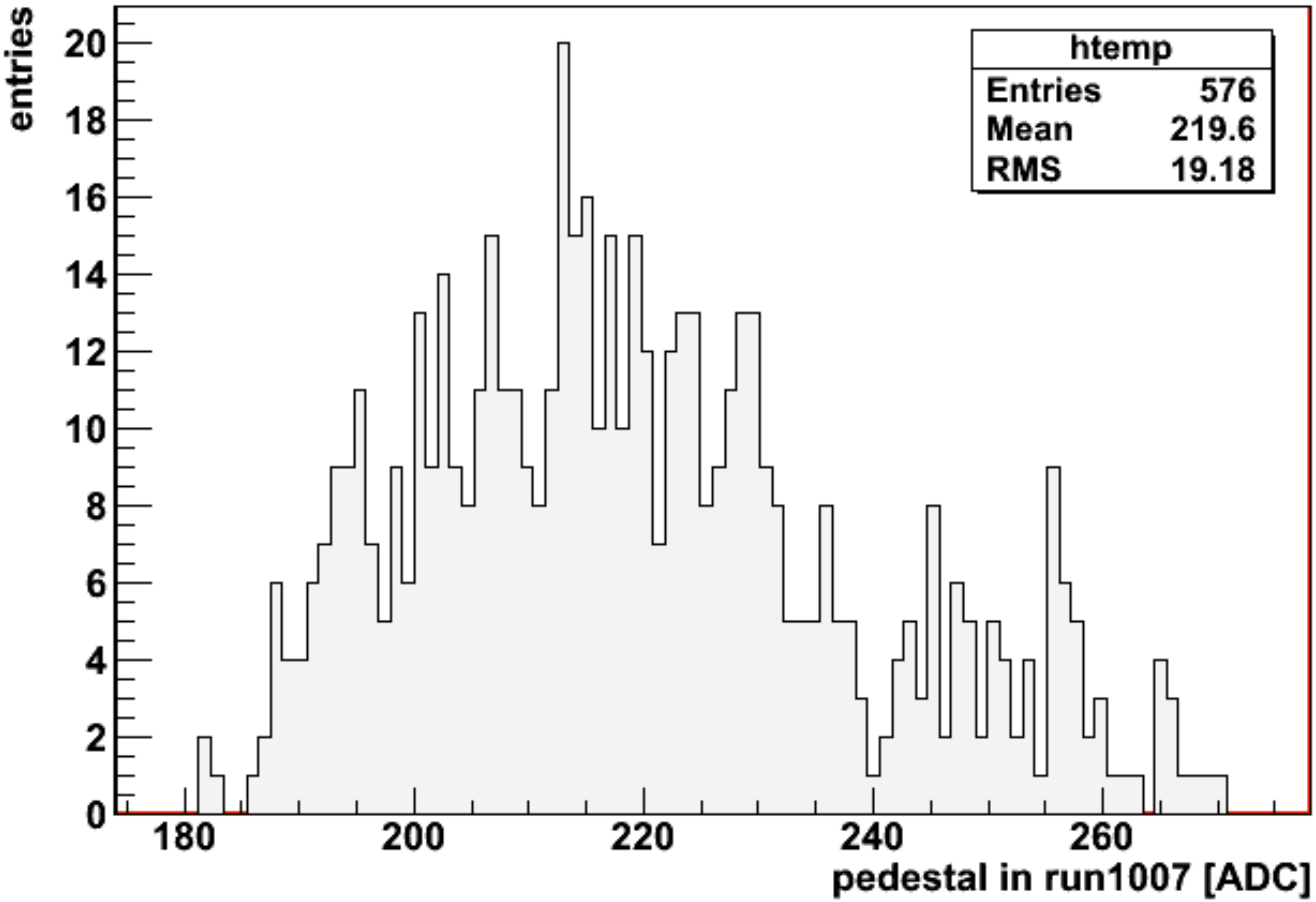
void createMapbyCellID(const int cellID1, const int cellID0)
void createMapbyMCCIJK(const unsigned int module, const unsigned int chip, const unsigned int channel, const unsigned int I, const unsigned int J, const unsigned int K)
void clear(void)
void printMap(void)
DecoderSet getDecoder()

Pedestal studies

Basic information

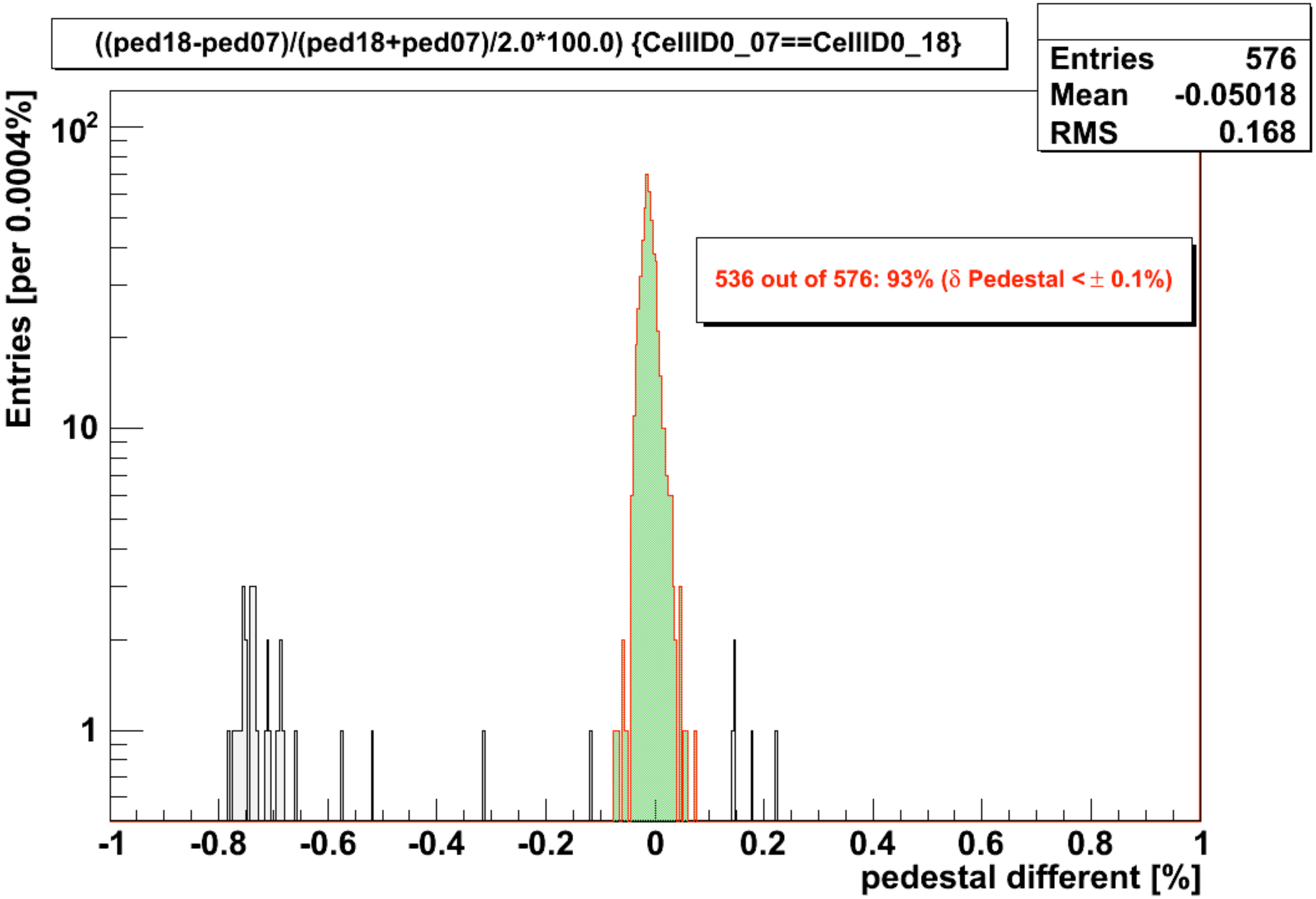
- Two pedestal runs 10007 and 10018
  - run10007 has 4500 Cycles (!4501 Cycles)
  - run10018 has 1000 Cycles
  - external trigger pedestal runs
  - no beam
- No double count chips found by EventChecker
  - Done by LabviewConverter and EventChecker (two Marlin processors)
- run10007 has 69366 events in 4501Cycles
- run10018 has 15366 events in 1000 cycles
- !16*4501 = 72016, 16*1000 = 16000

Pedestal mean distribution



- The pedestal distribution shows that individual pedestal value needed for the offline calibration

Pedestal mean difference distribution



- The green shows 93%
- 40 channels out of +/- 0.1%

All channels are smaller than 0.8%

Pedestal

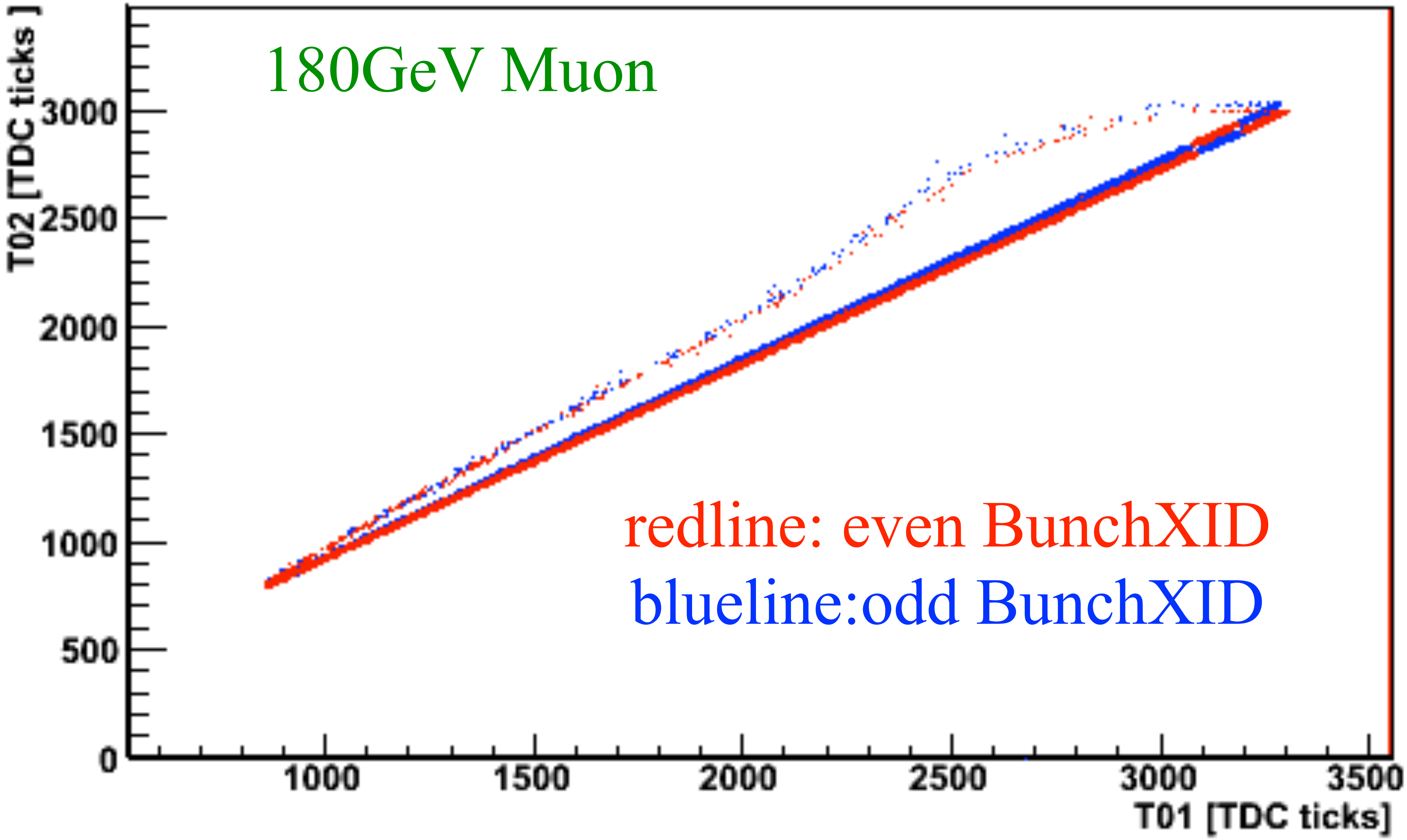
- Pedestal:
  - The difference of pedestal mean from CERN testbeam pedestal runs (between two runs 10007 and 10018) shows maximum 0.8% here.
  - Write these value into database for calibration in the next step data processing
  - Format: SimpleValue class (reused exist class)
- These value carry out with the Marlin processor for the new prototype detector, works with the new data structure
  - LabviewPedestalProcessor
- Benjamin Hermberg will analyze the pedestal, and provide more detail studies on the CERN test beam.

Timing T0

(Offline swap bunchXID during Converter has been implemented)

Timing T0

- After swap BunchXID, get much better.
- HitBit == 1, ADC > 600,


180GeV Muon
redline: even BunchXID
blueline:odd BunchXID
T02 [TDC ticks]
T01 [TDC ticks]