Calibration algorithms - development notes

Content

pnCCD overview

Large area pnCCD DAQ and Elictronics, Lothar Struder & Robert Hartmann

Development of calibration of pnCCD

2014-01-22 Meeting minutes

Hi everyone,

Here is a short summary of what I heard today for how we should start
with the pnCCD.

For pnCCD algorithms:
common-mode, pedestals, hot-pixels, quadrant rotations, hit-finders,
support in mikhail's calibManager

For pnCCD online displays: (using matplotlib for now)
shot by shot raw data
shot by shot calibrated data
projections of the above
region-of-interest
strip-charts of interesting quantities
(also display calibration values like noise-map,pedestal-map)

After this we will work on the acqiris as well (acqiris
constant-fraction algos already exist in psana).

Attached below is a 12 line python program that plots a real pnCCD
image and an x-projection (amoc0113 also has pnccd data we can look
at). You can run it on a psana node by saving it to pnccd.py and
doing "sit_setup" and then "ipython pnccd.py". This sort of code
should work online too (although we may have to change matplotlib
settings) as well as with calibrated images.

Display group (dan, mikhail, me) meets Thursday at 10:30. Analysis
group (sebastian, ankush(?), phil, mikhail, me) meets Friday at 1.

See you then...

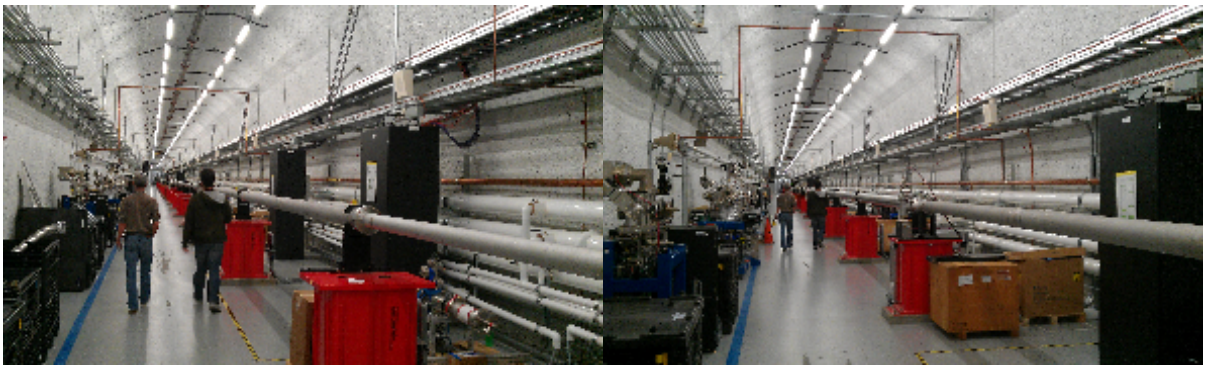
chris

Script form Chris

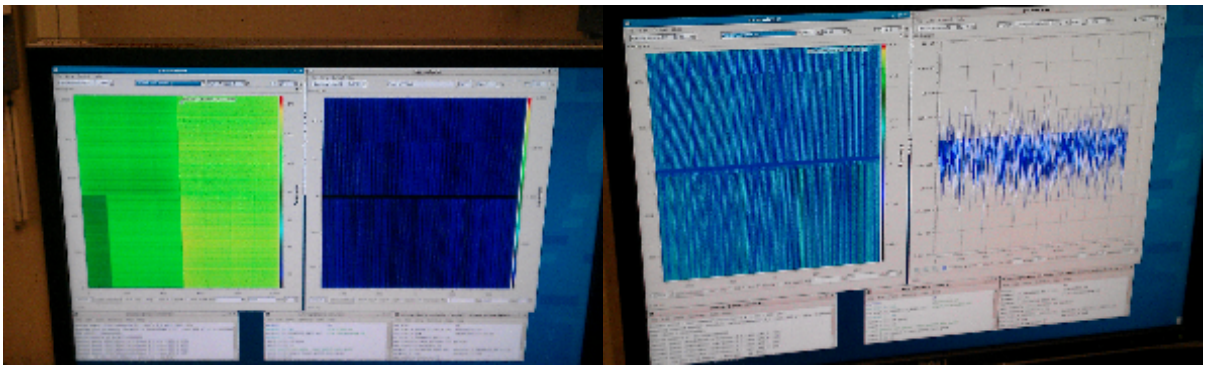
Use interactive psana framework `~cpo/ipsana/shm.py`:

```
from psana import *

events = DataSource('shmem=1_1_XCS.0').events()
src = Source('DetInfo(XcsBeamline.1:Tm6740.5)')
import matplotlib.pyplot as plt

plt.ion()
fig = plt.figure('pulnix')
ax = fig.add_axes([0.1, 0.1, 0.8, 0.8])  # x0, y0, h, w

for i in range(100):

    evt = events.next()
    frame = evt.get(Camera.FrameV1, src)

    ax.cla()
    ax.imshow(frame.data16())
    fig.canvas.draw()
```

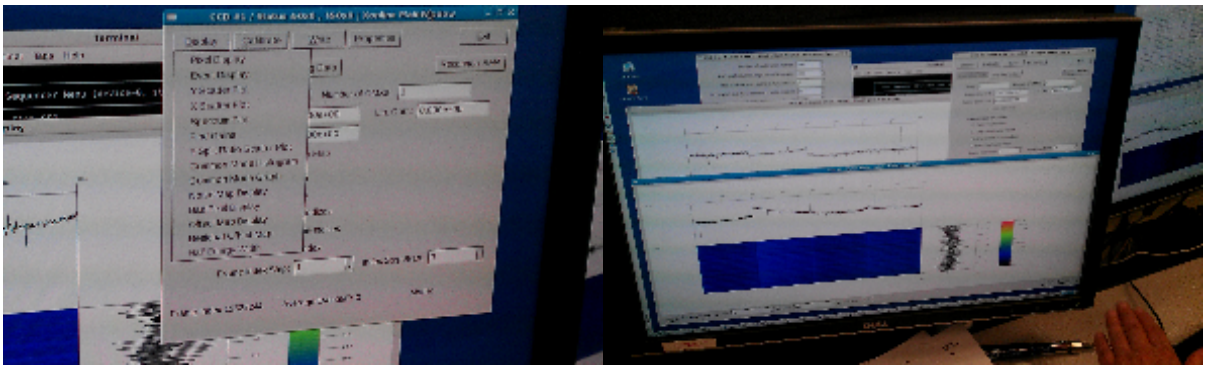
Walking and talking about unlimited pipeline (processing)



CASS Heritage



Online monitor



Data for tests

On 2014-01-27 Sebastian Carron kindly provide us with data files for pnCCD experiment amoa1214:

- Dark Run: 169, rear sensors gain 1/64, front 1/1, Imaging mode exp=amoa1214:run=169
- Run With Hits: 170 Low hit rate though, so you will have to use a hit finder of sorts exp=amoa1214:run=170

New modules for "old-style" calibration:

- pdscalibdata/include/PnccdBaseV1.h - baseclass for pnCCD parameters, defines Segs, Rows, Cols, Size
- pdscalibdata/include/PnccdPedestalsV1.h - loads pedestals from file, returns ndarray of pedestals
- pdscalibdata/include/PnccdCommonModeV1.h - the same for common mode
- pdscalibdata/include/PnccdPixelGainV1.h - the same for pixel gain
- pdscalibdata/include/PnccdPixelRmsV1.h - the same for pixel rms
- pdscalibdata/include/PnccdPixelStatusV1.h - the same for pixel status
- PSCalib::PnccdCalibPars - wrapper for all pnCCD types

Detector-dependent interface

Example can be found in `PSCalib/test/ex_calib_file_finder.cpp`:

```
// Assume that file is located in /reg/d/psdm/AMO/amotut13/calib/PNCCD::CalibV1/Camp.0:pnCCD.1/pedestals/1-end.
data

  #include "PSCalib/PnccdCalibPars.h"

  const std::string calib_dir   = "/reg/d/psdm/AMO/amotut13/calib";
  const std::string group = "PNCCD::CalibV1"; // or std::string()
  const std::string source = "Camp.0:pnCCD.1";
  unsigned long     runnum = 10;
  unsigned          print_bits = 255;

  PSCalib::PnccdCalibPars *calibpars = new PSCalib::PnccdCalibPars(calib_dir, group, source, runnum,
print_bits);

  calibpars->printCalibPars();
  ndarray<CalibPars::pedestals_t, 3>    peds = calibpars -> pedestals_ndarr();
  ndarray<CalibPars::common_mode_t, 1>  cmod = calibpars -> common_mode_ndarr();
  ndarray<CalibPars::pixel_status_t, 3> stat = calibpars -> pixel_status_ndarr();
  ndarray<CalibPars::pixel_gain_t, 3>   gain = calibpars -> pixel_gain_ndarr();
  ndarray<CalibPars::pixel_rms_t, 3>    gain = calibpars -> pixel_gain_ndarr();

  // OR:
  CalibPars::pedestals_t*    p_peds = calibpars -> pedestals();
  CalibPars::common_mode_t*  p_cmod = calibpars -> common_mode();
  CalibPars::pixel_status_t* p_stat = calibpars -> pixel_status();
  CalibPars::pixel_gain_t*   p_gain = calibpars -> pixel_gain();
  CalibPars::pixel_rms_t*    p_rms  = calibpars -> pixel_rms();

  const size_t ndim = ndim();
  const size_t size = size();
  const unsigned* shape = shape();
etc...
```

Pros

- Simple format for calibration files - just a text file with pre-defined number of values for each type:

```
973.941639 881.189675 1050.211 773.263749 899.241302 981.805836 1150.72615 993.084175 1121.15488 1029.76319
1220.14927 903.278339 1097.49944 1066.94949 1263.71044 1053.53872 1194.35915 935.320988 1317 ...
```

Cons

- Too simple calibration file format, does not allow any metadata or comments.
- Detector-dependent objects and parameters "knows" about parameters' array type and shape:
  - PSCalib::PnccdCalibPars which depends on PnccdPedestalsV1, PnccdCommonModeV1, ..., PnccdBaseV1
  - `pdscalibdata::PnccdPedestalsV1::pars_t = float`

    `pdscalibdata::PnccdCommonModeV1::pars_t = uint16_t`

    `pdscalibdata::PnccdPixelStatusV1::pars_t = uint16_t`

    `pdscalibdata::PnccdPixelGainV1::pars_t = float`

  - const std::string groupName = "PNCCD::CalibV1"; - **do we really need it ?**

Detector-independent interface

- Interface is declared in the abstract base class PSCalib::CalibPars
- Access to all detector-dependent classes is hidden in the static factory class PSCalib::CalibParsStore

Factory is implemented for pnCCD only. CSPAD and CSPAD2x2 will be added soon.

```
#include "PSCalib/CalibPars.h"
#include "PSCalib/CalibParsStore.h"

// Instatiation
//Here we assume that code is working inside psana module where evt and env variables are defined through input
parameters of call-back methods.
//Code below instateates calibpars object using factory static method PSCalib::CalibParsStore::Create:

std::string calib_dir = env.calibDir(); // or "/reg/d/psdm/<INS>/<experiment>/calib"
std::string  group = std::string(); // or something like "PNCCD::CalibV1";
const std::string source = "Camp.0:pnCCD.1";
const std::string key = ""; // key for raw data
Pds::Src src; env.get(source, key, &src);
PSCalib::CalibPars* calibpars = PSCalib::CalibParsStore::Create(calib_dir, group, src, PSCalib::getRunNumber
(evt));

// Access methods
calibpars->printCalibPars();
const PSCalib::CalibPars::pedestals_t*    peds_data = calibpars->pedestals();
const PSCalib::CalibPars::pixel_gain_t*   gain_data = calibpars->pixel_gain();
const PSCalib::CalibPars::pixel_rms_t*    rms_data  = calibpars->pixel_rms();
const PSCalib::CalibPars::pixel_status_t* stat_data = calibpars->pixel_status();
const PSCalib::CalibPars::common_mode_t*  cmod_data = calibpars->common_mode();
```

Implementation of CalibParsStore

Doxy doc for CalibParsStore

Module pdscalibdata::NDArrIOV1

New approach to calibration files with header

In order to get rid of detector dependent types of calibration parameters we need to add metadata in the calibration file. All metadata can be listed in the header of the calibration files, for example, using keyward mapping (dictionary):

pdscalibdata/test/test.data

```
# RULES:
# Lines starting with # in the beginning of the file are considered as comments or pseudo-comments for metadata
# Lines without # with space-separated values are used for input of parameters
# Empty lines are ignored
# REF: https://confluence.slac.stanford.edu/display/PCDS/pnCCD+processing+pipeline#pnCCDprocessingpipeline-
CalibrationofpnCCD

# Optional fields:
# TITLE      This is a file with pedestals
# DATE_TIME  2014-01-30 10:21:23
# AUTHOR     someone
# EXPERIMENT amotut13
# DETECTOR   Camp.0:pnCCD.1
# CALIB_TYPE center_um

# Mandatory fields to define the ndarray<TYPE,NDIM> and its shape as unsigned shape[NDIM] = {DIM:1,DIM:2,DIM:3}
# TYPE        float
# NDIM        3
# DIM:0       3
# DIM:1       4
# DIM:2       8

21757   21769   33464   10769   68489   68561   77637   54810
21758   21773   33430   10628   68349   68345   77454   54729
21678   21820   33054   10637   68310   68254   77976   54617
21730   21755   33193   10904   68570   68456   77425   54648

33110   10457   68275   68299   56732   79628   21754   21558
33329   10446   68158   68183   56949   79783   21811   21779
33141   10369   68476   68506   57121   79700   21858   21839
33098   10477   68452   68416   56923   79666   21681   21761

   51      18     -28      18      71     -20     -15     -54
  178      61     257     247     161     231     111     106
    1     -40     104     -24       9     -82      23       6
  102      40     272     270     194     246      60     118
```

This C++ module is intended to read/write calibration files with header.

Interface description can be found in Doxygen doc for NDArrIOV1

pnCCD analysis for users

All other staff looks useful for all users and is migrated to the PSDM page: pnCCD processing pipeline

References

- psana - Module Examples
- Psana Module Catalog - Old
- Calibration Management Tool
- Mask Editor
- pnCCD processing pipeline - part of this page, which is useful for users
- CSPAD Calibration
- Large area pnCCD DAQ and Elictronics, Lothar Struder & Robert Hartmann
- doxy-doc for psana modules
- Doxygen doc for NDArrIOV1
- Doxy doc for CalibParsStore