

# Analysis with new peakfinder

## Content

- [Content](#)
- [Analysis of cxif5315](#)
- [New peakfinder](#)
- [Background subtraction algorithm](#)
- [Scripts](#)
- [Results](#)
  - [Arc region](#)
  - [Equ region](#)
    - [Peak selection in equatorial region](#)
    - [Event selection](#)
    - [Plots for raw peak data](#)
    - [Delta phi](#)
    - [Example of selected event](#)
    - [Angles phi and beta](#)
    - [Phi angle corrected image](#)
    - [Averaged image in q-space](#)
- [How to run examples](#)
  - [First time session](#)
  - [Regular session](#)
- [Indexing look-up table](#)
- [References](#)

## Analysis of cxif5315

### New peakfinder

New peakfinder `peak_finder_v2` from [class `ImgAlgos.PyAlgos`](#) is used in this analysis with functionality as follows

- raw detector data is corrected for pedestals, background, and common mode,
- algorithm works in windows for good pixels defined in mask,
- each group of connected pixels above threshold `thr` are considered as a peak candidate, which parameters are evaluated and saved in the text file along with experiment, run, event time stamp information

#	Exp	Run	Date	Time	time(sec)	time(nsec)	fiduc	Evnum	Reg	Seg	Row	Col	Npix
	Amaz	Atot	rcent	ccent	rsigma	csigma	rmin	rmax	cmin	cmax	bkgd	rms	son
	imcol	x[um]	y[um]	r[um]	phi[deg]								imrow

Example of peakfinder in the data processing script:

```
# initialization
winds_arc = [ (s, 0, 185, 0, 388) for s in (0,1,7,8,9,15,16,17,23,24,25,31)]

alg_arc = PyAlgos(windows=winds_arc, mask=mask_arc, pbits=0)
alg_arc.set_peak_selection_pars(npix_min=5, npix_max=500, amax_thr=0, atot_thr=1000, son_min=6)
...

# in the event loop:
peaks_arc = alg_arc.peak_finder_v2(nda, thr=20, r0=5, dr=0.05)

#similar for EQUatorial region:
peaks_equ = alg_equ.peak_finder_v2(nda, thr=20, r0=5, dr=0.05)
```

## Background subtraction algorithm

Averaged n-d array for (data) cxif5315-r0169 is used as a background. Normalization between data and background is done in four rectangular windows, highlighted in the plot:

```

from pyimgalgorithms.GlobalUtils import subtract_bkgd

# use part of segments 4 and 20 to subtr bkgd
winds_bkgd = [ (s, 10, 100, 270, 370) for s in (4,12,20,28)]

    #calibration of raw data
    nda = np.array(nda_raw, dtype=np.float32, copy=True)
    nda -= nda_peds
    nda = subtract_bkgd(nda, nda_bkgd, mask=nda_smask, winds=winds_bkgd, pbits=0)
    nda *= nda_smask
    det.common_mode_apply(evt, nda)

```

## Scripts

Data processing script uses direct access to data. Example is available since release ana-0.16.1 in

[ImgAlgos/examples/ex\\_peakfinder\\_cspad.py](#)

## Results

### Arc region

Peak data processing script is under development. Results for ARC region:

Plots for all peaks found by peakfinder in ARC region before selection:

Good peaks are selected as

```

def peakIsSelectedArc() :
    """Apply peak selection criteria to each peak from file
    """
    if sp.sonc<9      : return False
    if sp.atot<1800  : return False
    if sp.r<434      : return False
    if sp.r>442      : return False
    return True

```

where all threshold parameters were optimized to select maximum signal events at minimal background in two-peak distance distribution.

Plots for selected peaks

Single-peak events:

Two-peak events:

New peakfinder more than doubles the number of signal events in the distance distribution.

### Equ region

#### Peak selection in equatorial region

```
def peakIsSelectedEqu() :
    """Apply peak selection criteria to each peak from file
    """
    if sp.sonc<9      : return False
    if sp.atot<1800   : return False
    if sp.r<100       : return False
    if sp.r>450       : return False
    return True
```

## Event selection

```
def eventIsSelected() :
    """Apply selection criteria to entire event, based on list of peaks
    """
    sp.event_is_selected = False
    if sp.count_arc_pks_sel > 2 : return False
    if sp.count_equ_pks_sel > 5 : return False
    #if sp.count_equ_pks_sel < 0 : return False
    # Require all peaks in the narrow range of dphi[deg]
    for pk in sp.lst_equ_evt_peaks :
        if math.fabs(pk.dphicmb) > 6 : return False
    sp.event_is_selected = True
    return True
```

## Plots for raw peak data

### Delta phi

delta phi for peaks around 0°, 180°, and combined distribution

combined distribution is obtained for each peak, depending on its location in the left or right hand side, small offset from 0 and 180° is subtracted:

```
pk.dphicmb = pk.dphi000-1.5 if -90<pk.phi and pk.phi<90 else pk.dphi180-4.8
```

## Example of selected event

### Angles phi and beta

**Evaluated** for 2-peak events using equations similar to Kurtik's

**Fitted** for 2-peak events - these histograms are almost identical to evaluated

**Fitted** for >2-peak events

**Fitted** for 2-peak events

These fitted angles will be used for Fraser transformation for central part of distributions. Events selected for fitted angles phi and beta are within [-3\*sigma, +3\*sigma] of their central values, ||8° and ||26°, respectively:

## Phi angle corrected image

Image rotation is done in the `GeometryAccess.py` object through the `Detector` package. `Detector` package needs in update. In order to apply rotation pixel geometry need to be re-evaluated that slow down processing.

## Averaged image in q-space

q-space image is averaged over 1825 selected events of the `cxif5315-r0169` dataset:

# How to run examples

## First time session

Analysis example scripts from package `cxif5315` can be run from release directory, which in this example is named as "`rel-cxif5315`". To initialize release directory one has to use commands listed below.

```
ssh psana
kinit

cd <any-directory>
newrel ana-current rel-cxif5315
cd rel-cxif5315
sit_setup

addpkg Detector HEAD
addpkg PSCalib HEAD
addpkg pyimgalgos HEAD
addpkg -u cxif5315 HEAD
scons

python ./cxif5315/proc-cxif5315-r0169-data.py
python ./cxif5315/proc-cxif5315-r0169-peaks-from-file.py
```

Package `cxif5315` always needs to be added. Packages `Detector`, `PSCalib`, and `pyimgalgos` need to be added for current release `ana-current=ana-0.16.4` only.

## Regular session

```
ssh psana

cd <path>.rel-cxif5315
sit_setup

python ./cxif5315/proc-cxif5315-r0169-data.py
python ./cxif5315/proc-cxif5315-r0169-peaks-from-file.py
```

# Indexing look-up table

# References

- [class `ImgAlgos.PyAlgos`](#) - collection of n-d array processing algorithms

- [class Detector.PyDetector](#) - direct access to detector data and calibration n-d arrays