The ztfin2p3 pipeline for DR2.5 & beyond.

a.k.a *ztfin2p3 : what does this pipeline do.*

Marie Aubert @ ZTF SNIA Barcelona – 09/12/24

The *ztfin2p3* pipeline

How does it work ?
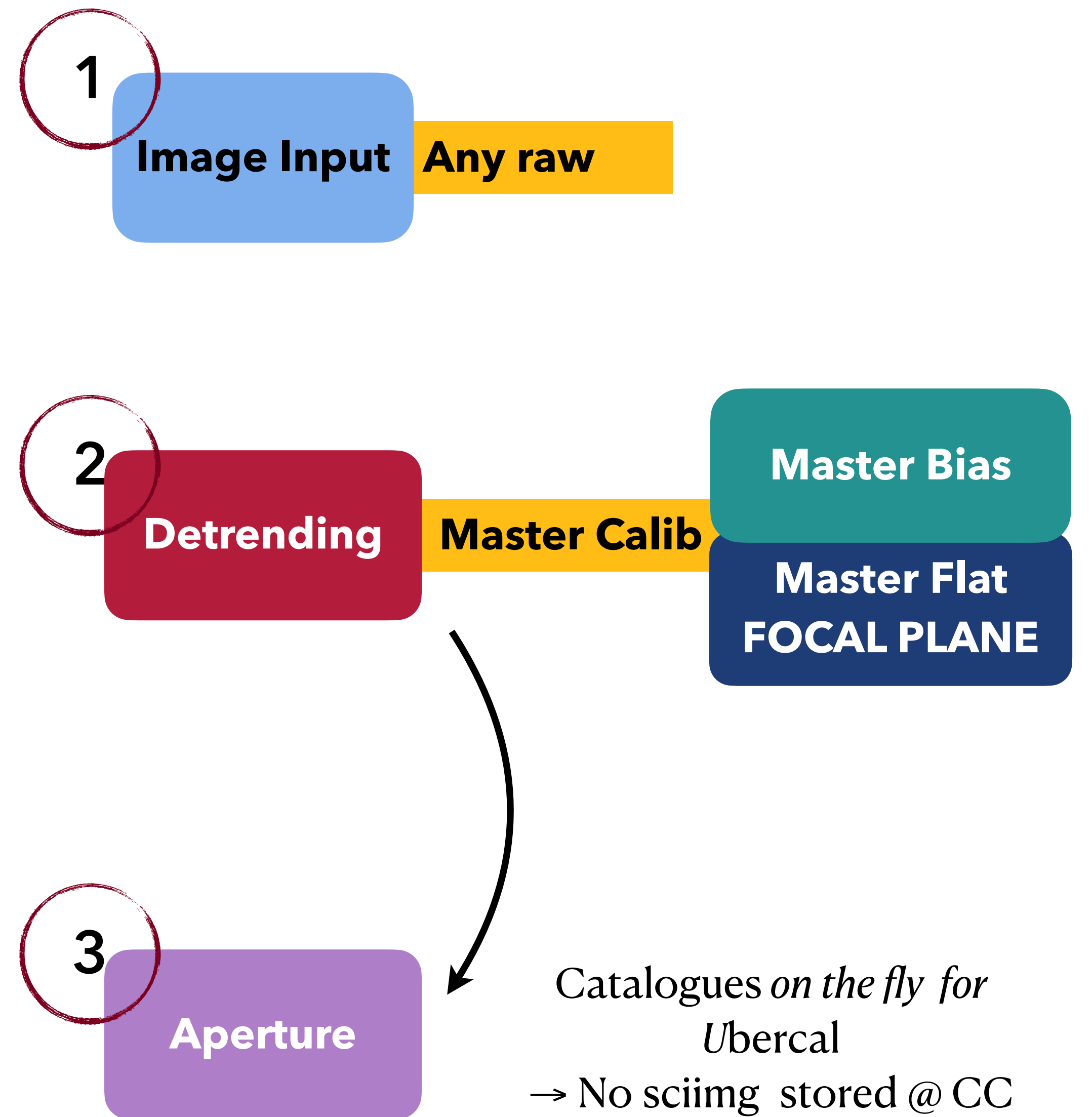**What does it do ?**

- Image I/O and handling (e.g WCS) : `ztfimg`

- Calibration and everything else : `ztfin2p3`

- 3 Main steps from *Raw* to *Aperture catalogues* :

Pipeline is developed within two dedicated python package :

→ `ztfin2p3 (Pipes)`
→ `ztfimg (I/O + pixel corrections`

`ztfin2p3 (Pipes) :` Made to work @ CC.
`ztfimg (Pipes) :` Should work on any laptop

1 **Image Input** **Any raw**

2 **Detrending** **Master Calib** **Master Bias**
Master Flat FOCAL PLANE

3 **Aperture**

Catalogues *on the fly* for *U*bercal
→ No sciimg stored @ CC

The *ztfin2p3* pipeline

(1) **Reading raw images (CCDs)**

Image Input **Any raw**

- Image Input and handling (e.g WCS) : `ztfimg`

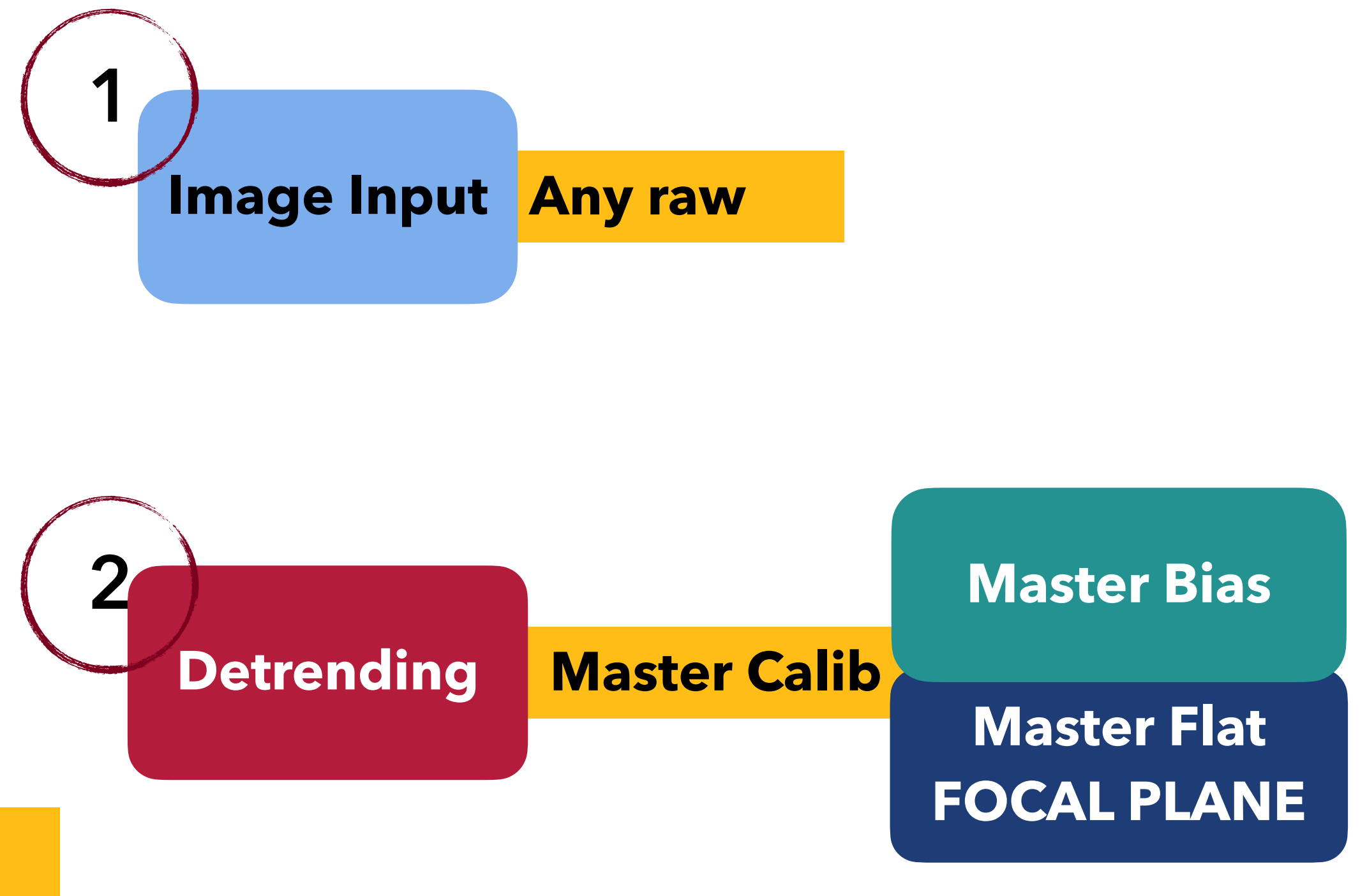- Image Input is the basis → Applies to any raw opened in the pipeline :

Image Input :   `ztfimg.RawCCD`
`ztfimg.RawQuadrant`

1. Open
2. Pocket correction (date > 20191022)
3. Corr for NL from linearity tables / rcid **(date dependent)**
3. Corr for overscan :
- Only last five columns used for model.
- Model is cubic polynomial applied to sigma-clipped overscans

The *ztfin2p3* pipeline

2 **Detrending raw images**

- Image I/O and handling (e.g WCS) : `ztfimg`

- Calibration `ztfin2p3`

1 **Image Input** **Any raw**

2 **Detrending** **Master Calib** **Master Bias**

Master Flat FOCAL PLANE

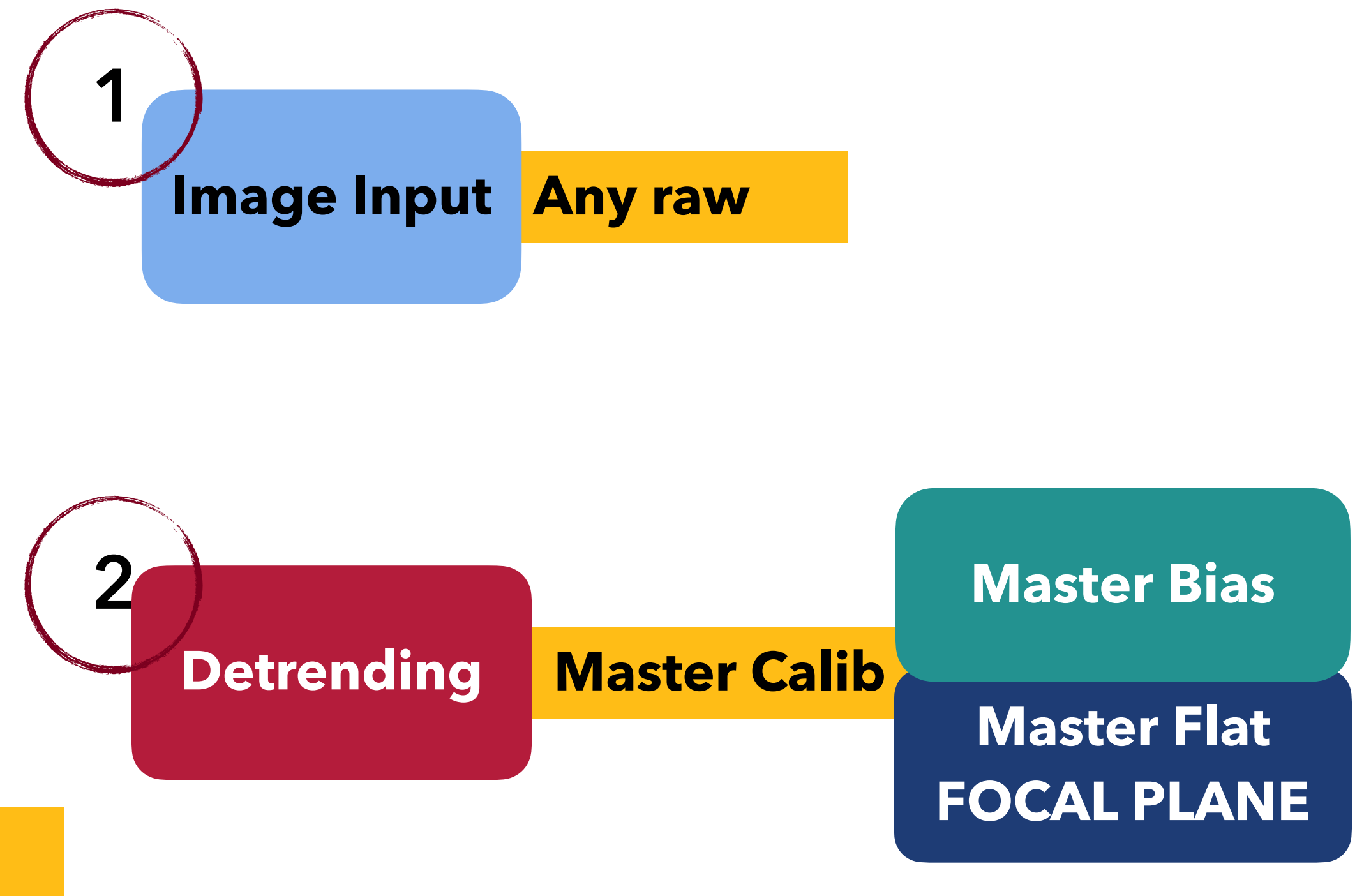**Master Calib**

Master Bias

Image I/O

1. Use last 10 bias / day
2. Pixel-level sigma-clipped (3) median
→ **Store (with Header → package versions)**
→ **Image are store in fits files / CCD.**

```
ztfin2p3.pipe.newpipe
     class BiasPipe
```

The *ztfin2p3* pipeline

2   **Detrending raw images**

- Image I/O and handling (e.g WCS) : `ztfimg`

- Calibration `ztfin2p3`

1   **Image Input**   **Any raw**

2   **Detrending**   **Master Calib**   **Master Bias**   **Master Flat FOCAL PLANE**

Master Calib

Master Flat

Image I/O

Master Bias

1. Pixel-level sigma-clipped (3) median **/ LED**
2. Normalize flat / **LED / CDD** with **CCD Median**
3. Average CCD & norm to get **Flat / Filter**
4. Re-open everything to estimate **median level at Focal Plane level**
   → **Store in Header**
   → **Image are store as CCD normalized in fits files.**

```
ztfin2p3.pipe.newpipe
class FlatPipe
```

The *ztfin2p3* pipeline

Detrending raw images

- Image I/O and handling (e.g WCS) : `ztfimg`
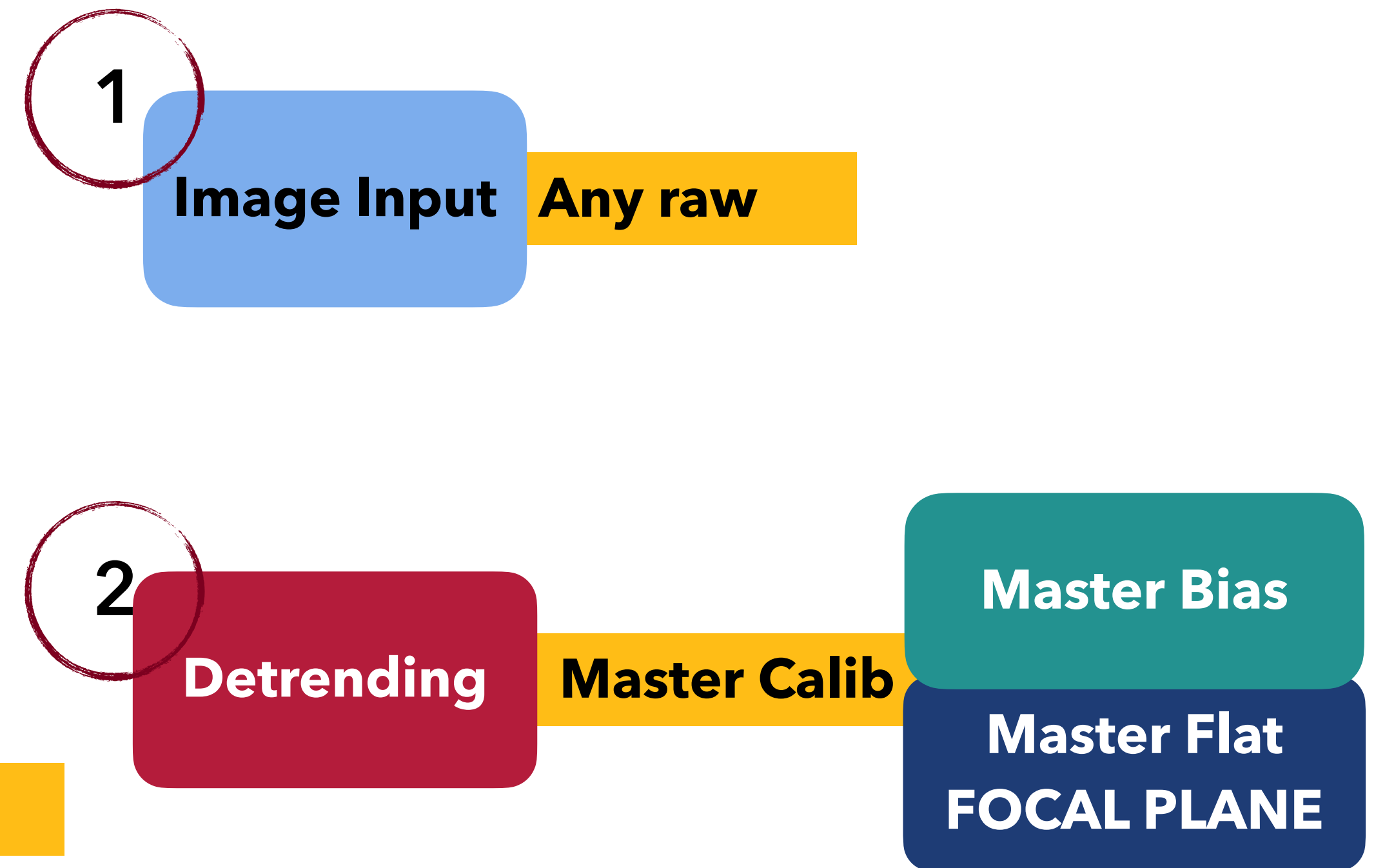
- Calibration `ztfin2p3`

1 Image Input | Any raw

2 Detrending | Master Calib | Master Bias | Master Flat FOCAL PLANE

Master Calib

Image I/O | **Detrending**

Master Bias

Master Flat FOCAL PLANE

1. Get the nearest calib files → CCD, filter, date matching.
2. Open raw file with ztfimg **1**
3. Correct for bias ($I_{\mathrm{raw}} - I_{\mathrm{master\,bias}}$)
4. Correct for flat at focal plane level $I_{\mathrm{sci}} = \dfrac{I_{\mathrm{bias\,corr}}}{I_{\mathrm{Flat}}} \times \dfrac{N_{\mathrm{fp}}}{N_{\mathrm{ccd}}}$
5. Separate I_{sci} into four quadrant → IPAC like sci format.
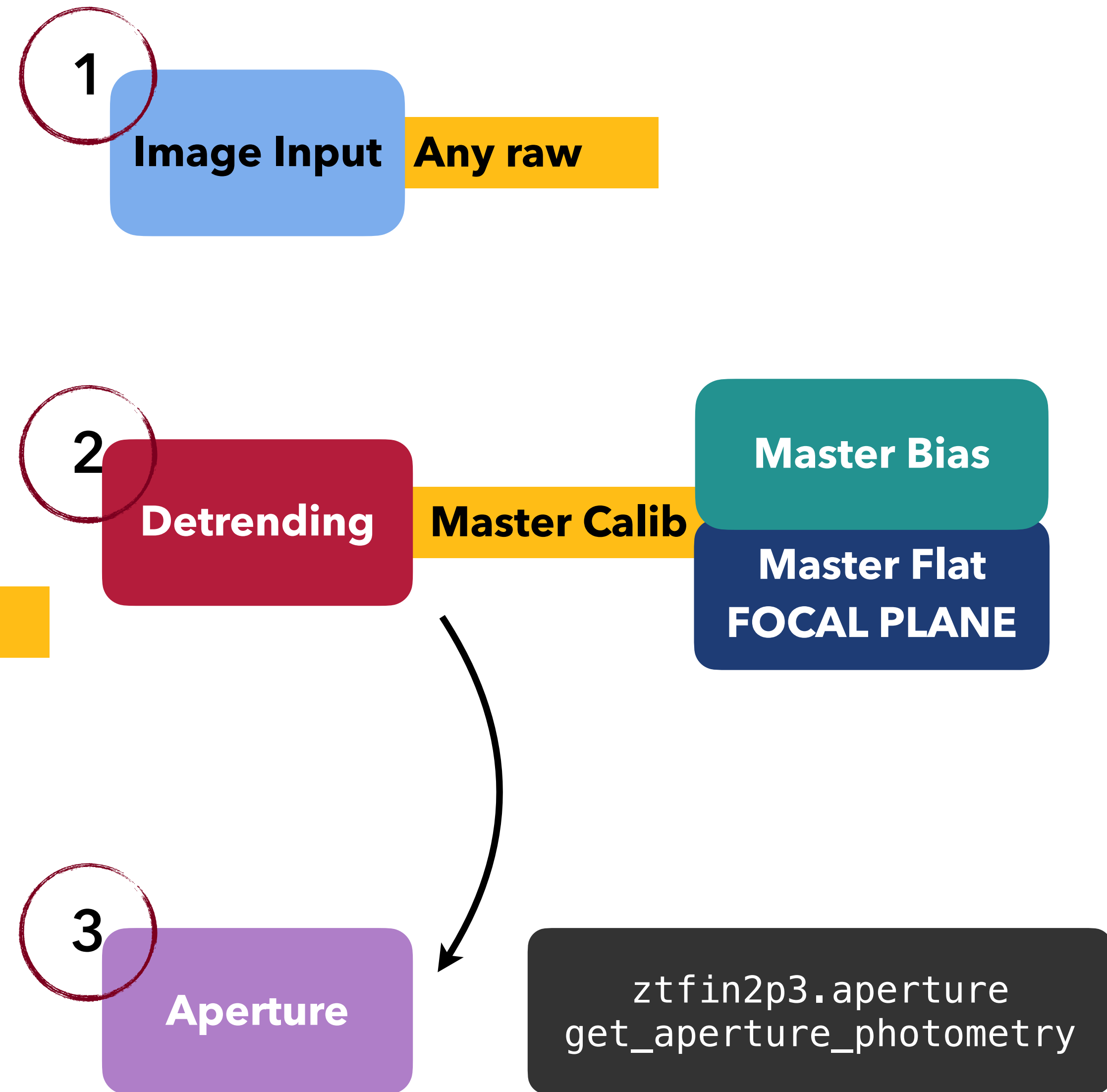6. Get associated headers & go from there

```
ztfin2p3.science
build_science_image
build_science_header
```

```
#Output :
ztfimg.ScienceQuadrant
x4
```

The *ztfin2p3* pipeline

(3) **Aperture on detrended image**

- Image I/O and handling (e.g WCS) : `ztfimg`

- Calibration `ztfin2p3`

(1) Image Input — Any raw

(2) Detrending — Master Calib — Master Bias — Master Flat FOCAL PLANE

Master Calib

Image I/O
Detrending
Aperture (Forced Photometry)

1. Match Image to source catalogue to each quad : **GAIA DR3 - Ben ver.**
2. R.A , Dec to ra,dec with pec-vel
3. → (x, y) quadrant coord.
4. `sep` package aperture
5. Format and store to parquet

(3) Aperture

```
ztfin2p3.aperture
get_aperture_photometry
```
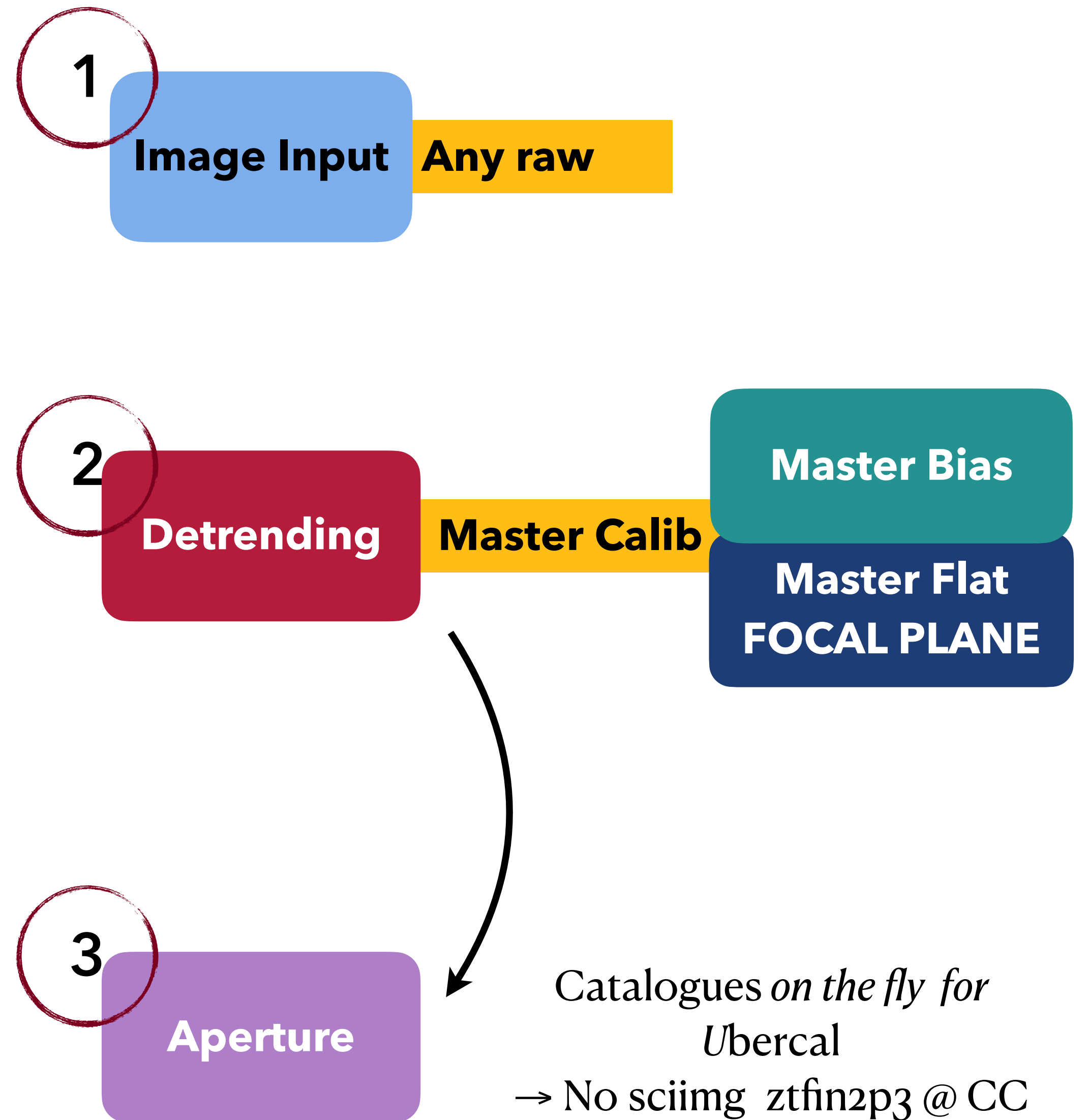
Aspects to note

→ Masks

→ Headers

→ Science images

→ Cal + Raw

NOT REPROCESSED.
(Using ZTF IPAC masks & header)

NOT STORED.
Plan is : *On the fly computations.*

STORED ON DISK :
Easy to create re-create image if needed.

1 **Image Input** **Any raw**

2 **Detrending** **Master Calib**

Master Bias

Master Flat FOCAL PLANE

3 **Aperture**

Catalogues *on the fly for Uber*cal
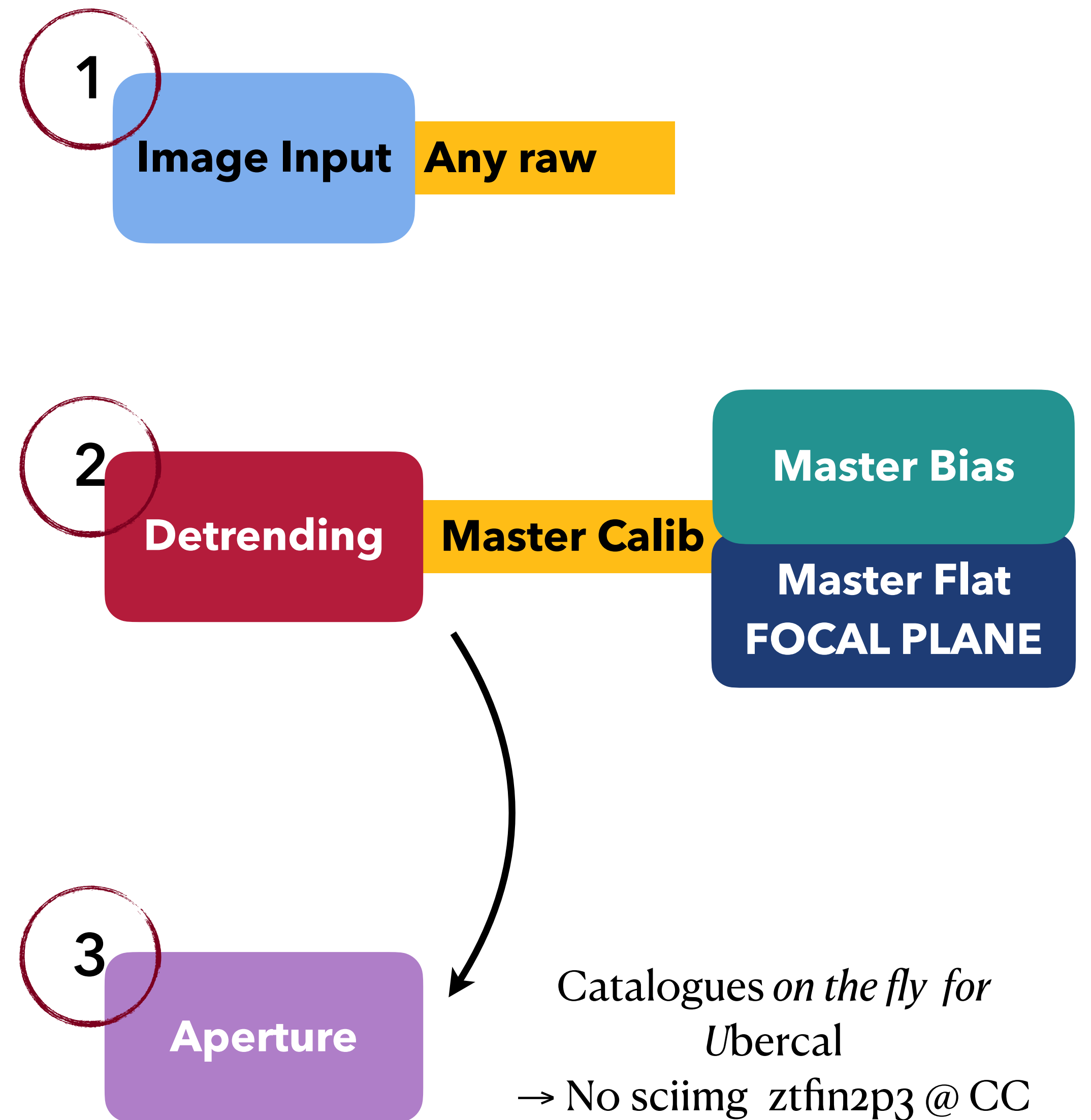→ No sciimg ztfin2p3 @ CC

Pipeline status

« Ready to run » : Implementation aspects are coded.

Right now the main work is **the data :**

→ *Downloading from IPAC which is in progress.*

Data	Status	
Headers (2018 - 2023)	✅	All good
Masks (2018 - 2023)	🔄	Dowloading
Raws sci (2018 - 2023)	🔄	Dowloading
Raws flats & bias (2018 - 2023)	✅ 🔄	Some flats & biases are hiding on disk @ IRSA

1. **Image Input** | **Any raw**

2. **Detrending** | **Master Calib** → **Master Bias** / **Master Flat FOCAL PLANE**

3. **Aperture**

Catalogues *on the fly* for *U*bercal
→ No sciimg ztfin2p3 @ CC

So we have a pipeline : What's next

✨Validation✨

- Pipeline will be tested both ways (in conjunction with Mathieu's work - just after) :

  - Starflats fits to aperture catalogues.

  - Ubercal from Ben.

- A **toy sample** has been devised by Ben on a small region of the sky between 2018 & 2023. → Dec : $[-5,35]$ deg R.A : $[345,65]$ deg in all ZTF bands.
  (~1 million quadrants to process / band)

- Starflats : 3 starflats sequence were processed as of now (2018, 2019, 2021)

Example starflats 2019-03-31

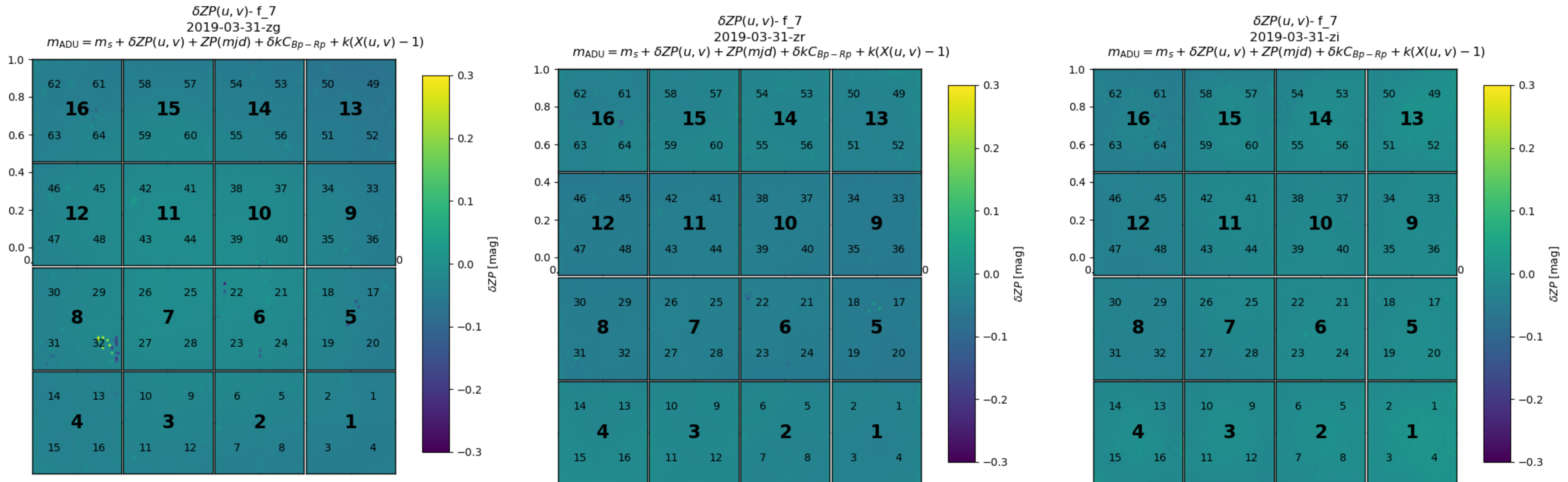*Focal plane residuals with Quadrants normalization*
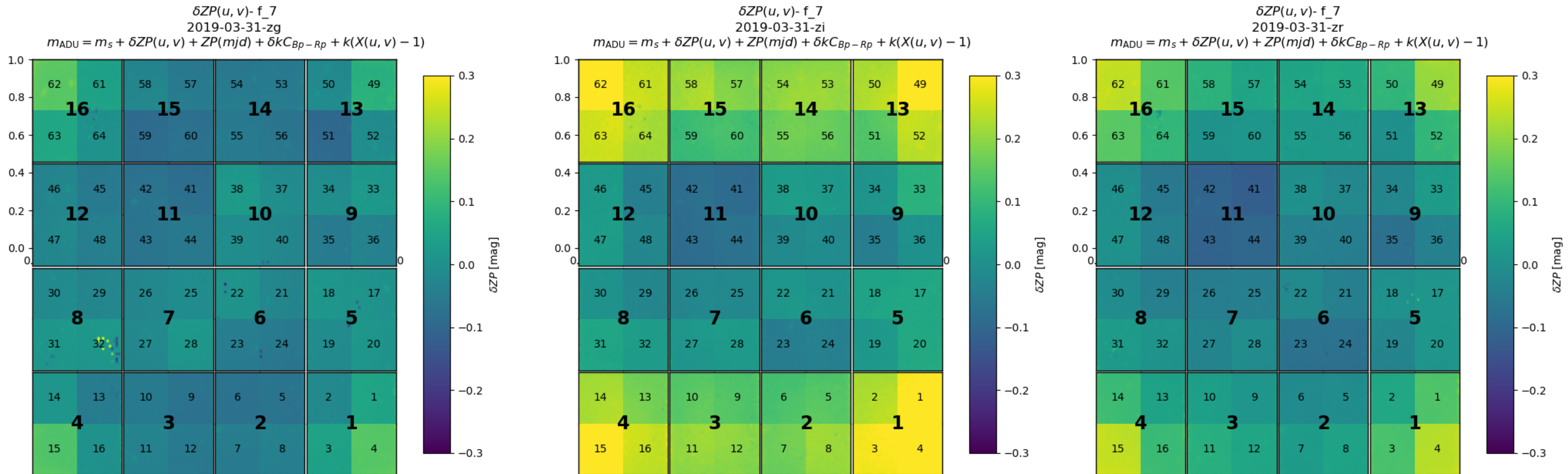
zg

zr

zi

Pipeline validation — as it is
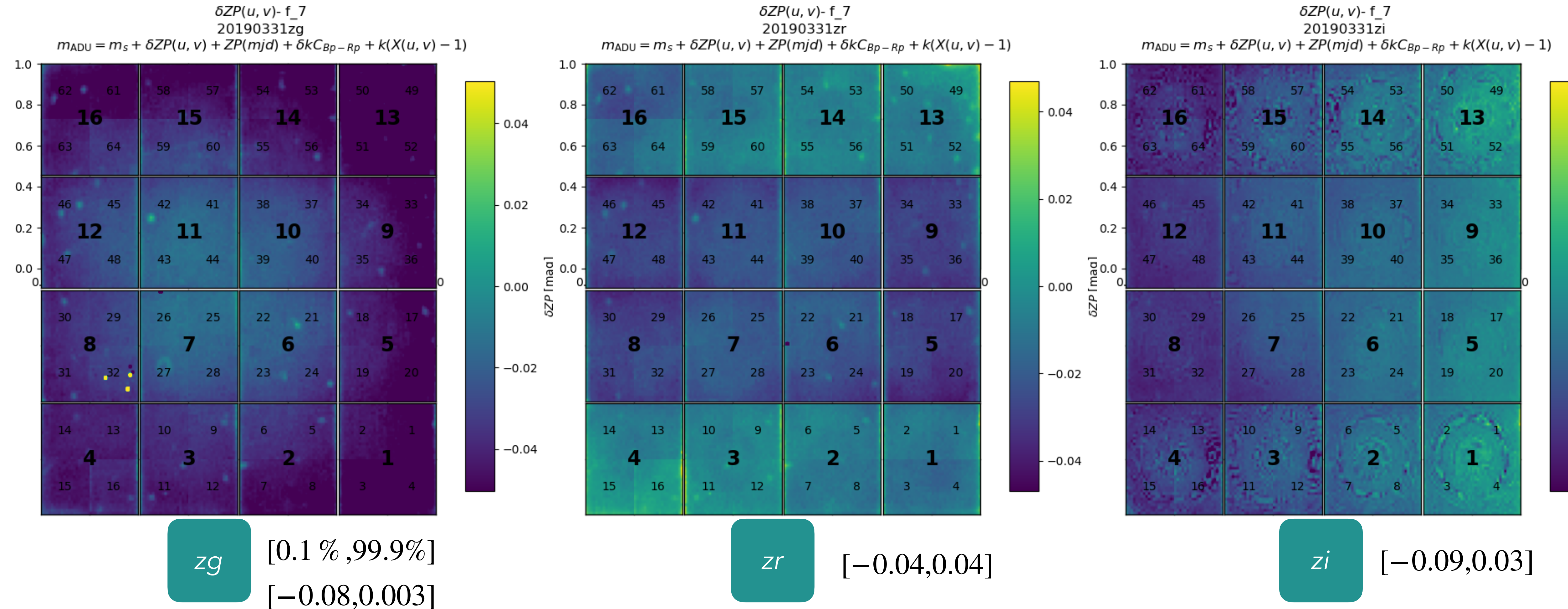
Focal plane residuals with Focal Plane normalization
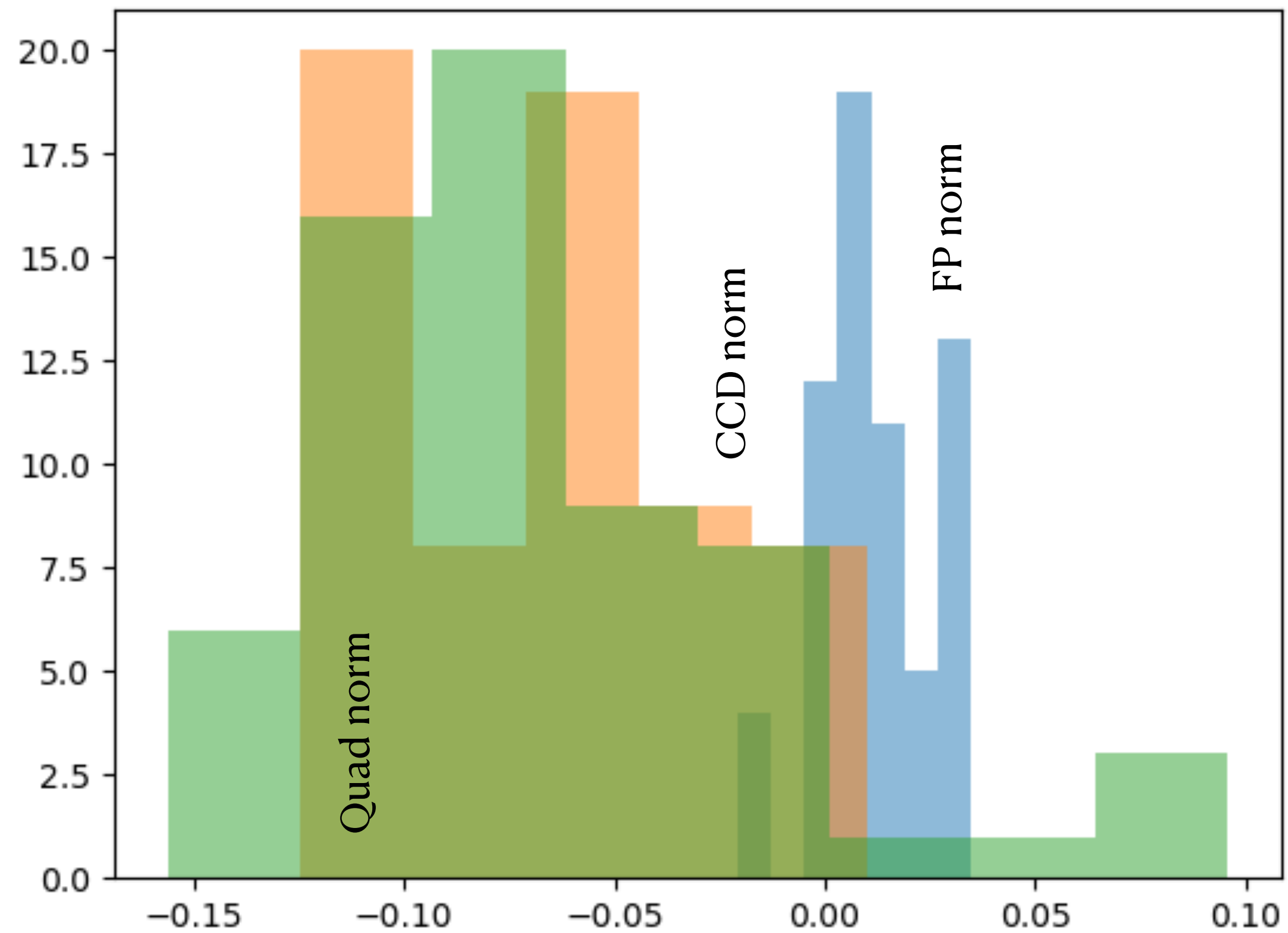
Pipeline validation — as it is

Focal plane residuals with Focal Plane normalization

$\delta ZP(u, v)$- f_7
20190331zg
$m_{\mathrm{ADU}} = m_s + \delta ZP(u, v) + ZP(mjd) + \delta k C_{Bp-Rp} + k(X(u, v) - 1)$

$\delta ZP(u, v)$- f_7
20190331zr
$m_{\mathrm{ADU}} = m_s + \delta ZP(u, v) + ZP(mjd) + \delta k C_{Bp-Rp} + k(X(u, v) - 1)$

$\delta ZP(u, v)$- f_7
20190331zi
$m_{\mathrm{ADU}} = m_s + \delta ZP(u, v) + ZP(mjd) + \delta k C_{Bp-Rp} + k(X(u, v) - 1)$

zg [0.1 % ,99.9%] [−0.08,0.003]

zr [−0.04,0.04]

zi [−0.09,0.03]

Pipeline validation — as it is

Focal plane residuals with Focal Plane normalization
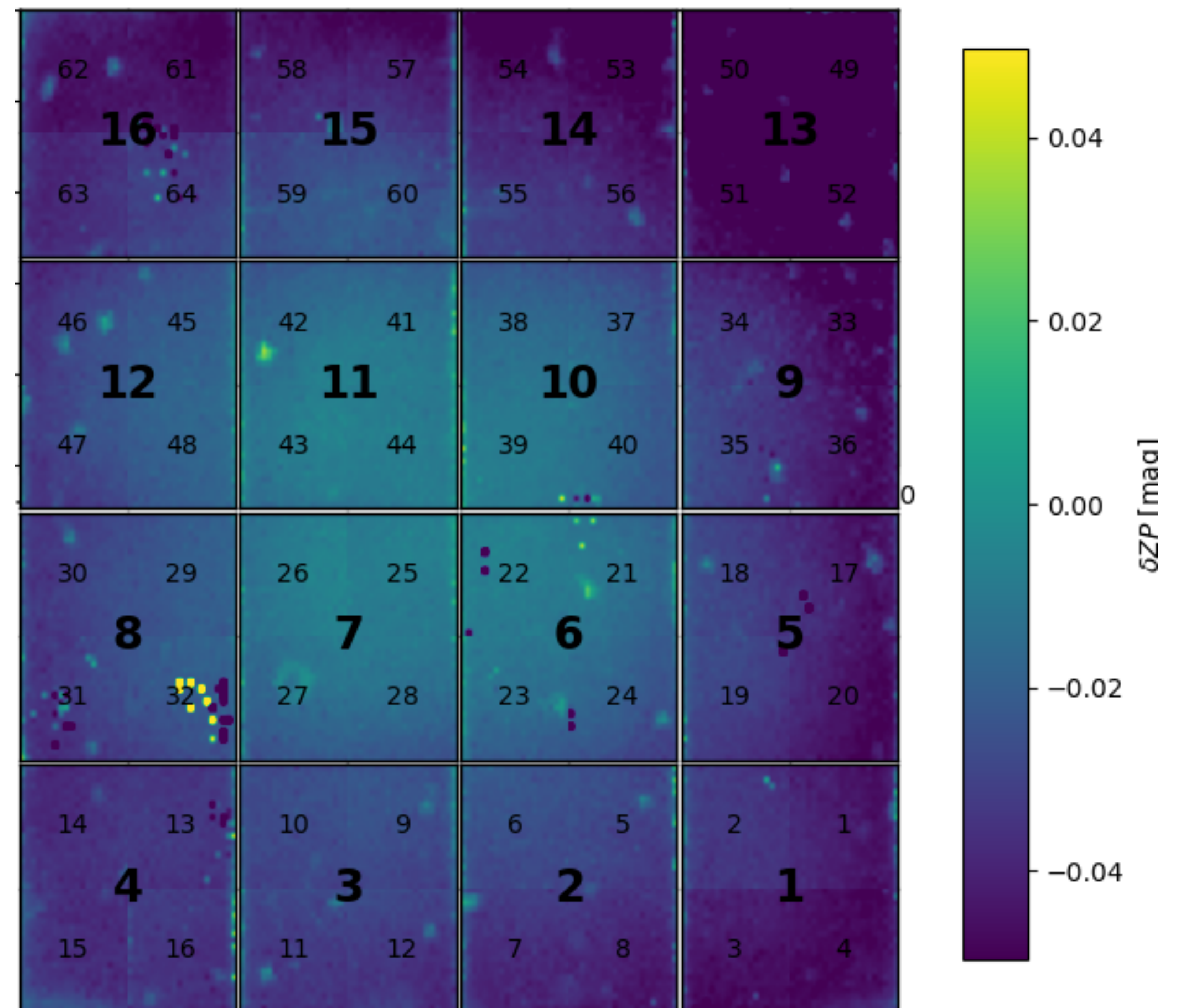
ztfin2p3 - Near future additions

ztfin2p3 : what will this pipeline do

↻ Images from 2020 & on were corrected for fringe effects in the i band.

   Plan is to include this correction in the pipeline & correct the images prior with that.

↻ Pocket effect correction (appeared in images > 2019-10-22)

   → 1st correction is implemented but needs further validations for some special cases.

ztfin2p3 - Pipeline

ztfin2p3 : what does this pipeline do.

✓ The ztfin2p3 pipeline is ready to run → Modified calibration

     ↻ → Some minor additions to be done.

✓ First results on the starflats sequence are promising :

    → Uniform focal plane
    → Quadrants variations are mitigated

↻ Pipeline validation on a larger scale (toy sample)

    → Dec : $[-5,35]$ deg R.A : $[345,65]$ deg
    → 2018 - 2023 to cover g, r and i bands.

To be plugged with the Scene Modelling pipeline

→ PSF & Aperture photometry (not forced photometry)

Mathieu's talk : Progress on the processing