Photometric Data Reduction

StarDICE workshop

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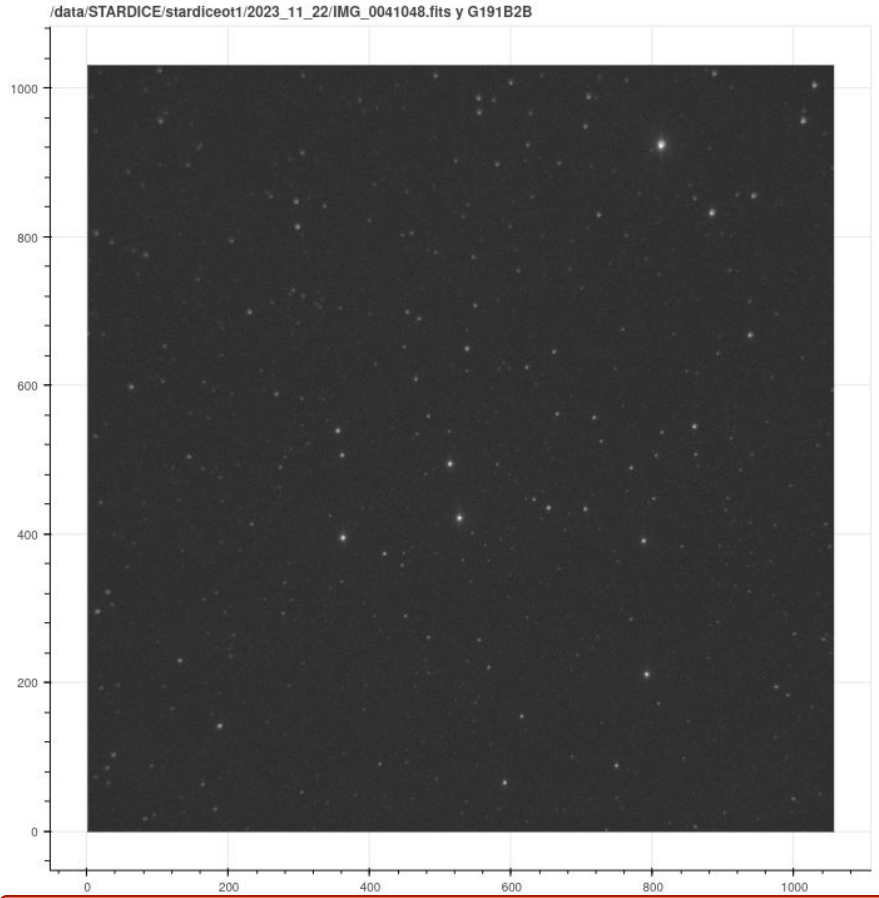
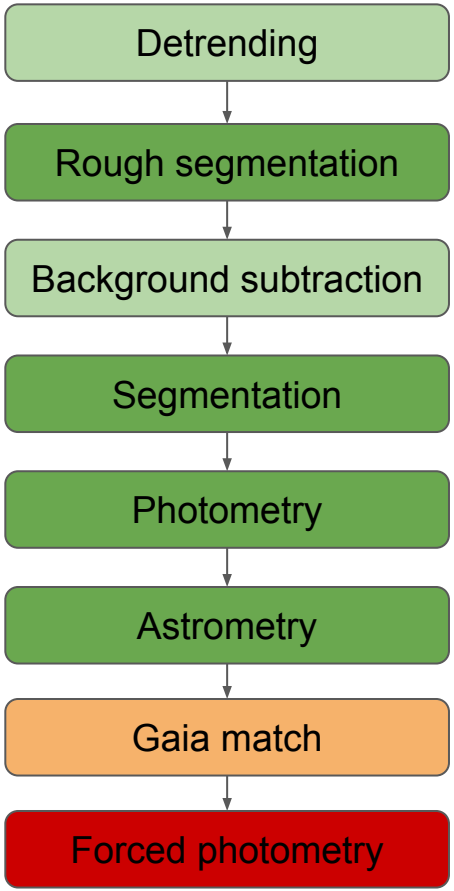
The photometric data looks like this



- 31 nights with data since first light on 2022-12-07
- Out of those 31, 14 have more than 1000 images
- 12 with reasonably complete metadata and a range in airmass greater than 40°
- We mostly targeted
  - G191B2B (11nights) primary standard, dense field
  - BD+28 4211 (8 nights) bright standard, medium field
  - P177D (4 nights) solar analog
  - HD116405 (2 nights) bright isolated star
- In general the sequence is 5 images in each of the grizyGu filters

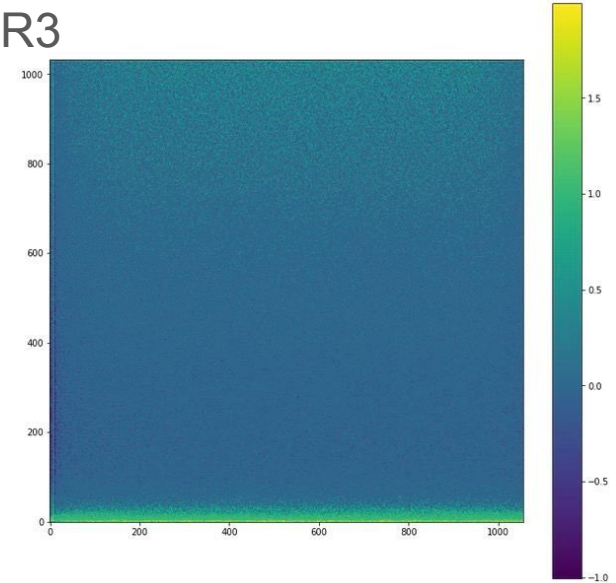
Image reduction : overview of the current online

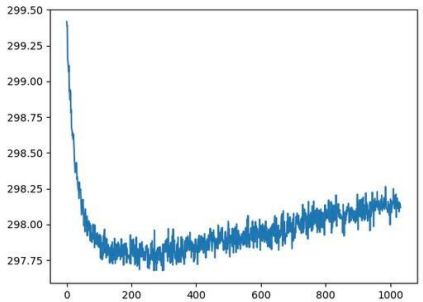


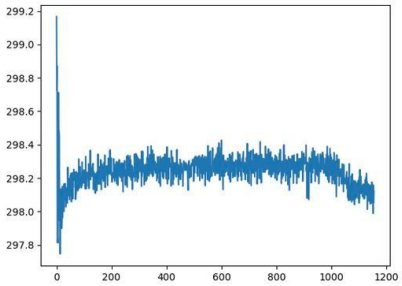
- Green: Done
- Light green: known issues, to be modified
- Orange: outside the online pipeline
- Red: to be done
- For the time being, the end result of the data reduction pipeline is an aperture photometry catalog of **detected** objects in the image
- This means that the photometry has a selection bias
- For the analysis, the match is made to an external catalog outside the reduction pipeline

Detrending

DR3





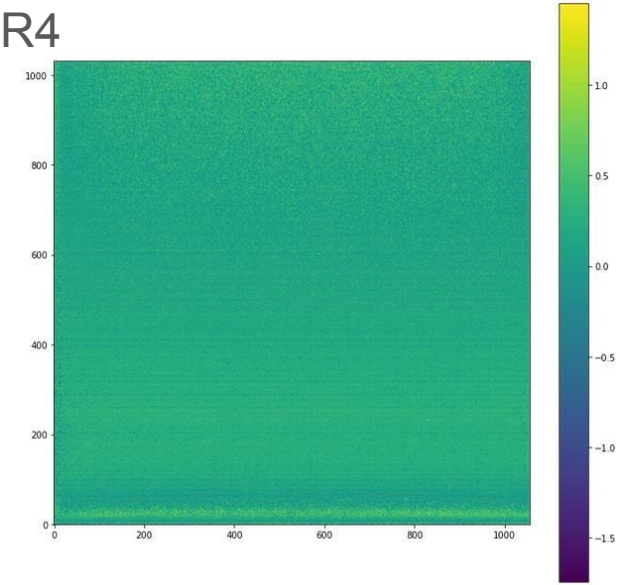


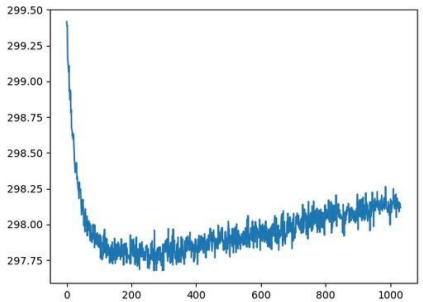
- For now simple subtraction of the overscan mean
- No dark subtraction
- No master bias
- No flat

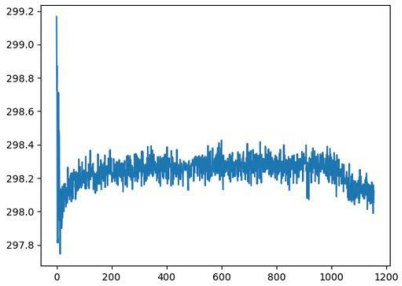
- We know from the CBP study that the overscan has a shape
- And that subtracting this shape makes visibly flatter stacks
- The new overscan subtraction is implemented in the DR4 of the CBP study
- Easy port to the only
- We may want to dedicate a few hours to acquire master bias, but this is low priority as the issue is so small

Detrending

DR4







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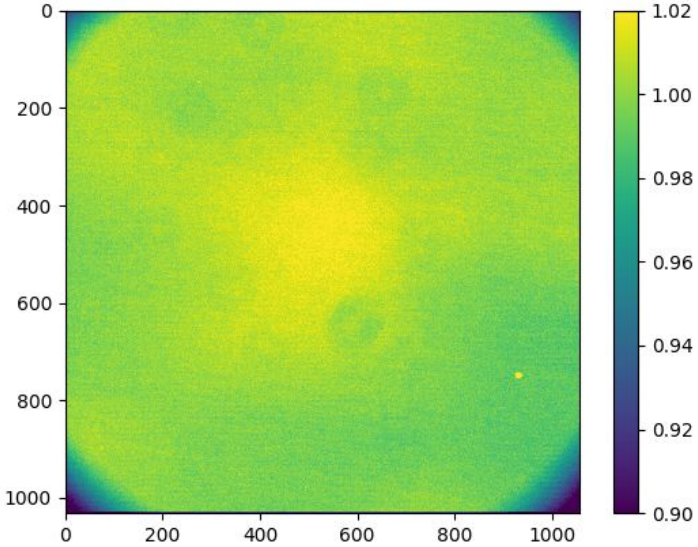
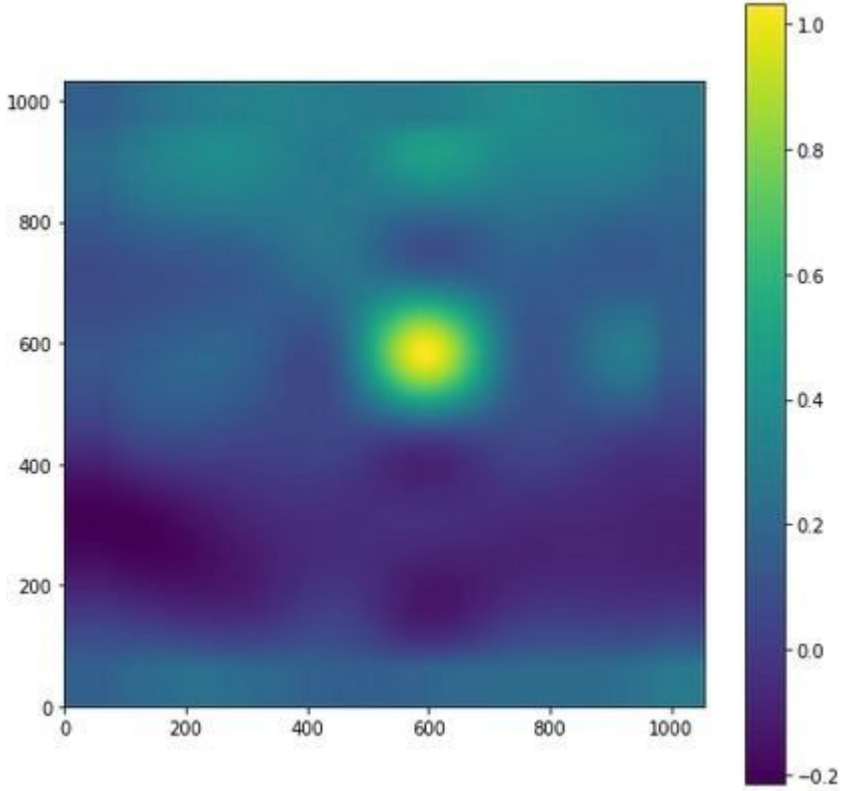
Do we want to flat-field the images ?



- The flat-field contains a mix of effects, some of them not relevant to point-source photometry (distortions mainly)
- A flat-field obtained from 69 twilight images
- The corner looks vignetted which is a bit surprising because the secondary was designed so that the sensor is fully illuminated
- We have a physical model that can be used to predict the vignetting, and also platescale distortion let us see if we can make sense of this picture
- We can also measure the response to point-source illumination (dithered fields or artificial star when available)

- According to the picture this is potentially an issue at the level of a few percents so worth investigating for the pre-survey

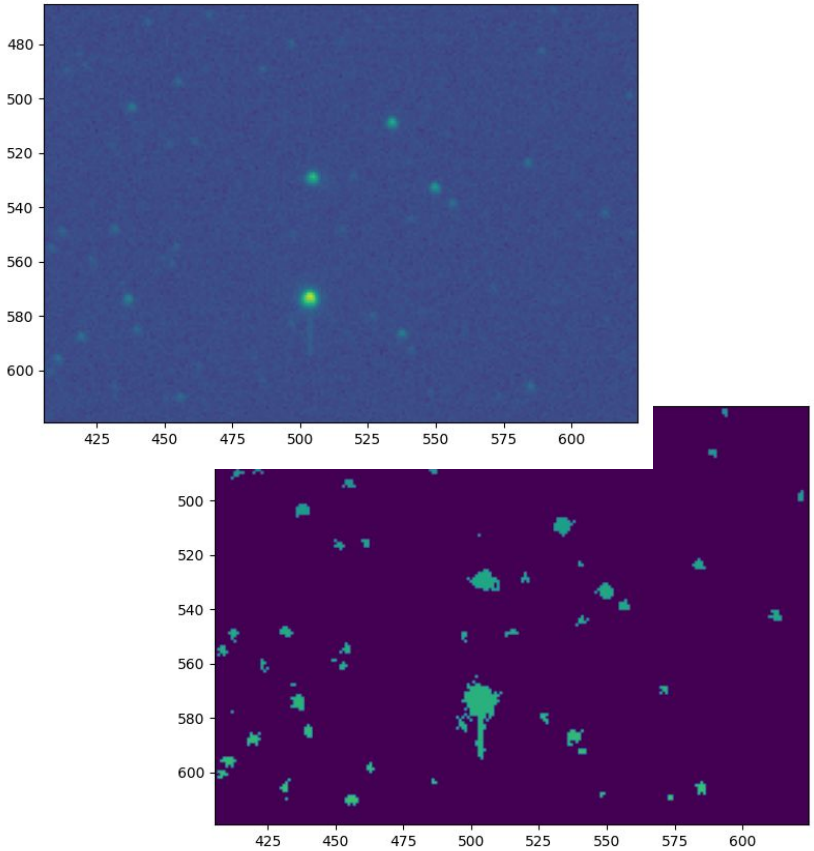
Background subtraction



- Objects above a 5-sigma threshold are detected and masked up to the 3-sigma isophotal
- The masked image is split in superpixels of 129x132 pixels (because the images are 1032x1056)
- A iterative mean with 3-sigma clipping is computed on each superpixels to form the miniback map
- The miniback map is interpolated to full resolution using a bicubic bspline
- We also build a variance map
- The interpolated map is subtracted from the original image

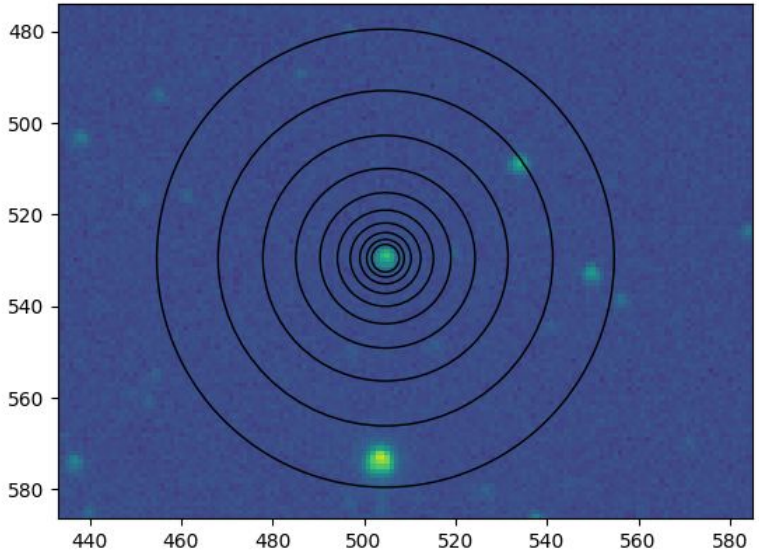
- We know from the analysis of CBP data that this procedure is eating a small fraction of the flux.
- Due to the differences in PSF, the flux fraction is chromatic

Object detection and centroiding



- Objects in the background subtracted images are detected at the 4-sigma level,
- Barycentre and 2nd moments of the 2-sigma isophotal area are computed (keys x, y, mxx, myy, mxy, area, fluxmax in the catalogs
- The positions and shapes are refined through gaussian weighting
- gwx, gwy, gwmxx …

Aperture photometry



- Photometry is performed in a series of aperture centered around the measured gaussian weighted centroid
- 10 radii, log-spaced between 3-50 pixels: 3. , 4.1, 5.6, 7.7, 10.5, 14.3, 19.6, 26.8, 36.6, 50
- apfl: sum of the pixels in the aperture
- apvar: sum of the variance map in the aperture. Does not contain the object poisson fluctuation, but contains the measured background variance (including the readout noise)
- apother: sum of the pixel segmented as another object in the aperture

Forced photometry of Gaia objects

- Errors on the position translates into biases in the photometry
- The position is chromatic (mostly because of atmospheric refraction)
- Needs a precise prediction of the object position in the image
  - Accounting for proper motion
  - Optical distortions
  - Refraction and differential refraction
- We don’t know the precision required on the position at this stage
- We are however ready to start the study

Conclusion

- The next two most obvious moves are:
  - Improve the bias subtraction (minor)
  - Implement forced photometry of the gaia stars in each images
- There are open questions
  - Flatfielding/photometry uniformity
  - Background subtraction
  - Linearity
  - Growth curves
- In those cases we need numbers that might require dedicated data sets
- The artificial star would likely help to investigate these issues (perfect background subtraction possible)
- All topics are relatively well contained (a few weeks of works, max a month)
- A bit more work on the automation/deployment of online processing itself