Testing and Improving the DESC DIA Pipeline

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Objectives & Research Question:

- What is the performance of the DESC DIA Pipeline?
- How can we improve it?

Background:

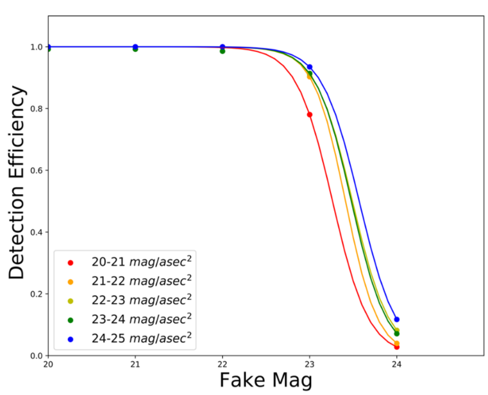
DIA is a technique for detecting transient sources and performing photometric measurements. To get the detection image (D), the Alard-Lupton algorithm estimates a PSF matching kernel which convolves a template image (R) to the seeing condition of a science image (N). The difference between the science image and the kernel convolved template image is D,

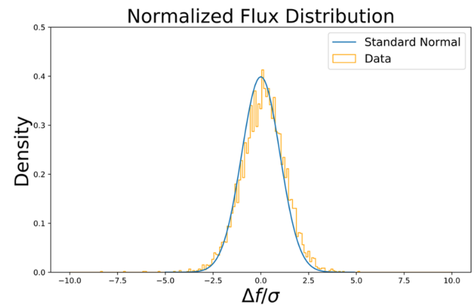
$$D = N - \kappa \otimes R.$$

Methodology:

- We add simulated sources onto DC2 calexp images. We can measure the fraction of detected sources (detection efficiency) and photometric accuracy.

Preliminary Results:





Discussion:

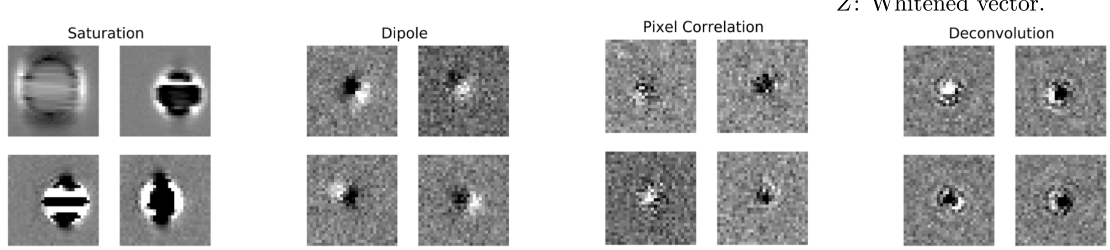
Most of detected artifacts are subtraction residuals of bright background sources. Artifacts caused by pixel saturation can be removed by applying flag selection. The majority of remaining artifacts are dipoles. We also have artifacts from pixel correlation. Ring artifacts can be found when the science PSF is much sharper than the template PSF.

Conclusions and Future Work:

- We can remove dipoles by implementing more flexible kernel bases with higher spatial degree of freedom.
- In the deconvolution scenario, we can pre-convolve the science image before kernel matching. We need to include non-diagonal covariance matrix when applying kernel estimation.
- To remove pixel correlation, the ZOGY algorithm proposes to normalize frequency modes in the Fourier space. In bright regions, we can apply the "inverse square root" of covariance matrix to each detected stamp. How to properly estimate the covariance matrix requires further work.

$$Z = \Sigma_X^{-\frac{1}{2}} X.$$

X: Random vector.
Σ_X: Covariance matrix of X.
Z: Whitened vector.



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