

Weekly meeting

Miscellaneous updates

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Introduction

What's new

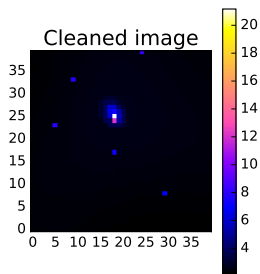
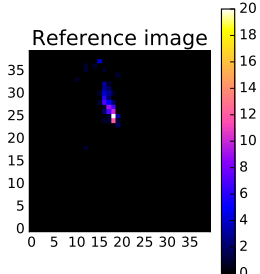
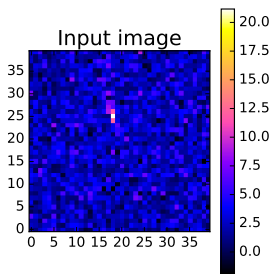
- ▶ Refactor the library (for future changes)
- ▶ Fix the issue about the non null background with WT
- ▶ Make additional plots plot: N_{pe} , scores vs N_{pe}

Reminder of the main issue: $\text{background} > 0$ with Wavelets

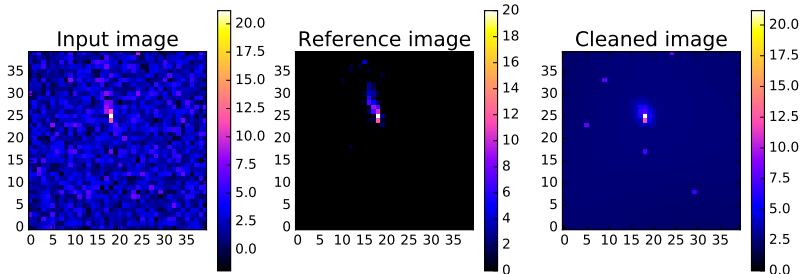
Reminder of the main issue: $\text{background} > 0$ with Wavelets

Reminder of the main issue: background > 0 with Wavelets

Look at the scale of the cleaned image...



It's more obvious with 'vmin=0' in matplotlib...



Solution

Solution

- ▶ Remove the largest plane in the wavelet space
- ▶ I took advantage of this to switch from mrtransform to mrfilter (both are part of Cosmostat's Sparce 2D suite)
- ▶ Mrfilter advantages:
 - ▶ has more options to solve the background issue, remove isolated pixels, handle negative values, ...
 - ▶ has more options for filtering and handle more complex wavelets reconstruction
 - ▶ should be faster

MrFilter

Used options:

- ▶ K Suppress the last scale (to have background pixels = 0)
- ▶ k Suppress isolated pixels in the support
- ▶ C1 Coef Detection Method: K-SigmaNoise Threshold
- ▶ s3 K-SigmaNoise Threshold = 3 sigma
- ▶ m3 Noise model (m10 works better but is much slower)...

Benchmark

Benchmark function

The error function \mathcal{E} is given by:

$$\mathcal{E}(\hat{\mathbf{s}}, \mathbf{s}^*) = (\mathcal{E}_1(\hat{\mathbf{s}}, \mathbf{s}^*), \mathcal{E}_2(\hat{\mathbf{s}}, \mathbf{s}^*))^T$$

$$\mathcal{E}_1(\hat{\mathbf{s}}, \mathbf{s}^*) = \text{mean} \left(\text{abs} \left(\frac{\hat{\mathbf{s}}}{\sum_i \hat{\mathbf{s}}_i} - \frac{\mathbf{s}^*}{\sum_i \mathbf{s}^*_i} \right) \right)$$

$$\mathcal{E}_2(\hat{\mathbf{s}}, \mathbf{s}^*) = \frac{\text{abs}(\sum_i \hat{\mathbf{s}}_i - \sum_i \mathbf{s}^*_i)}{\sum_i \mathbf{s}^*_i}$$

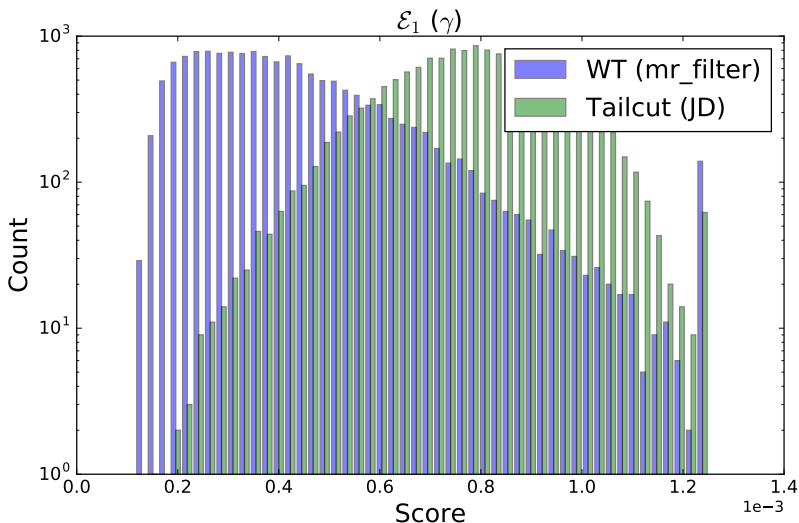
Where:

- ▶ $\hat{\mathbf{s}}$ is the output image (the "cleaned" image) $\in \mathbb{R}^d$
- ▶ \mathbf{s}^* is the reference image (the "clean" image) $\in \mathbb{R}^d$
- ▶ i is the index of a PMT (i.e. of a pixel) within an image

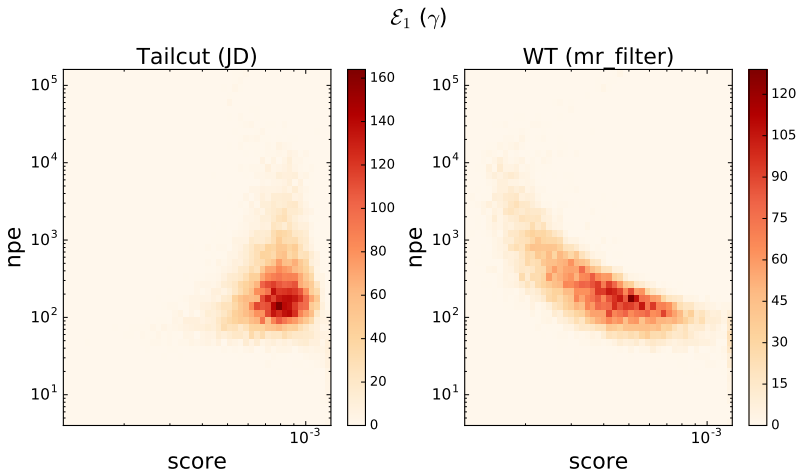
- ▶ ASTRI mini-array (calibrated data)
- ▶ Telescopes 1 to 33 only (ASTRI)
- ▶ Polychromatic event set
- ▶ Input files: `sapcta:/dsm/manip/cta/DATA/astri_mini_array/fits/gamma/`
- ▶ Source file:
`sapcta:/dsm/manip/cta/DATA/astri_mini_array/gamma/run1001.simtel.gz`
- ▶ Num samples: 14899 images

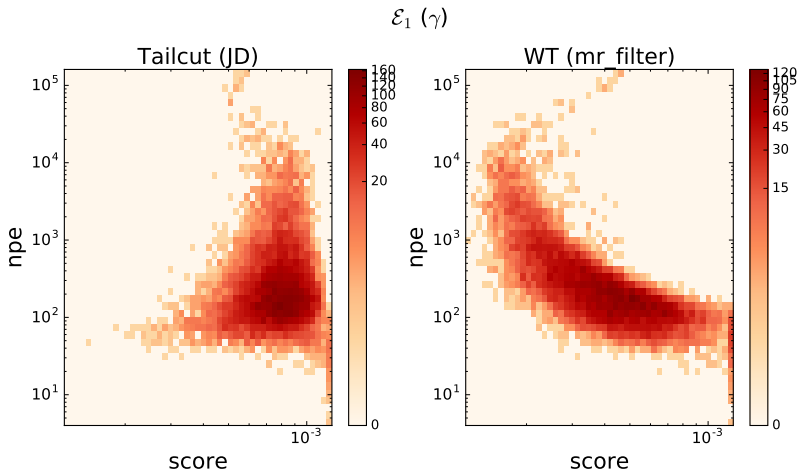
Cleaning algorithms:

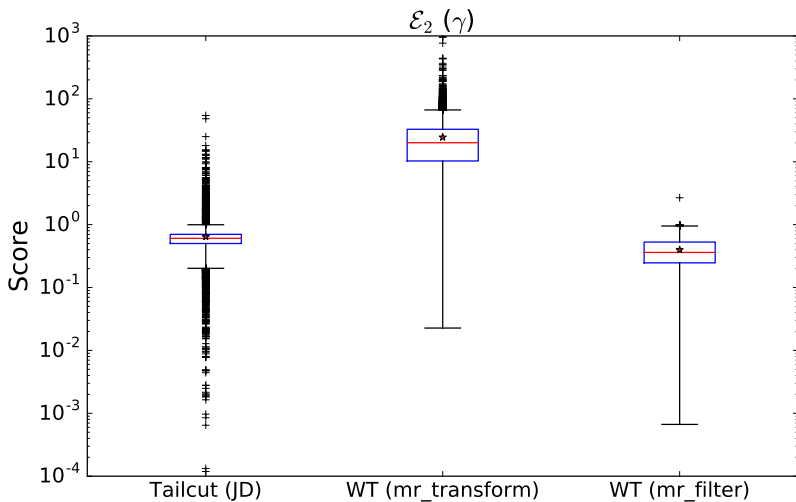
- ▶ Tailcut: JD's implementation
- ▶ FFT: Numpy implementation
- ▶ Wavelets: Cosmostat Sparce2D (mr_transform) b-Spline wavelet transform

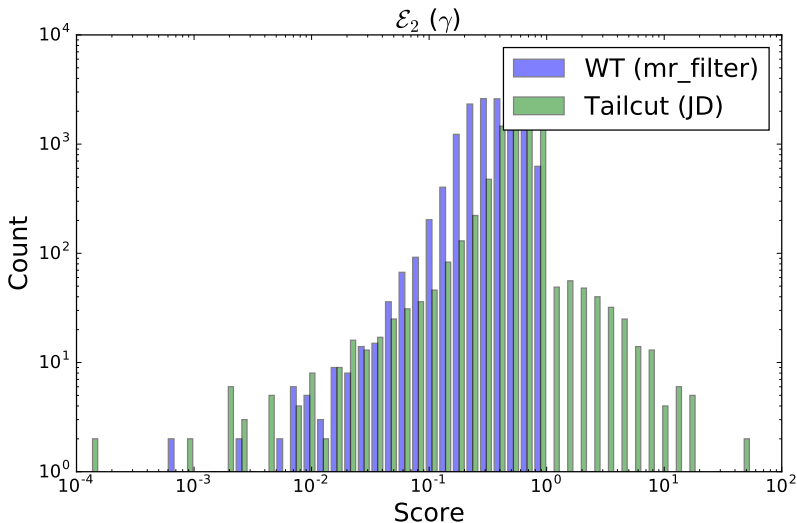


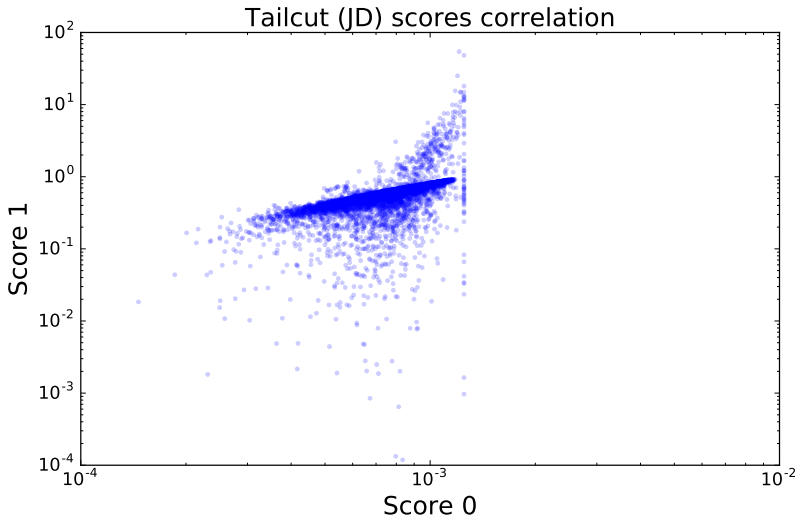
Gammas

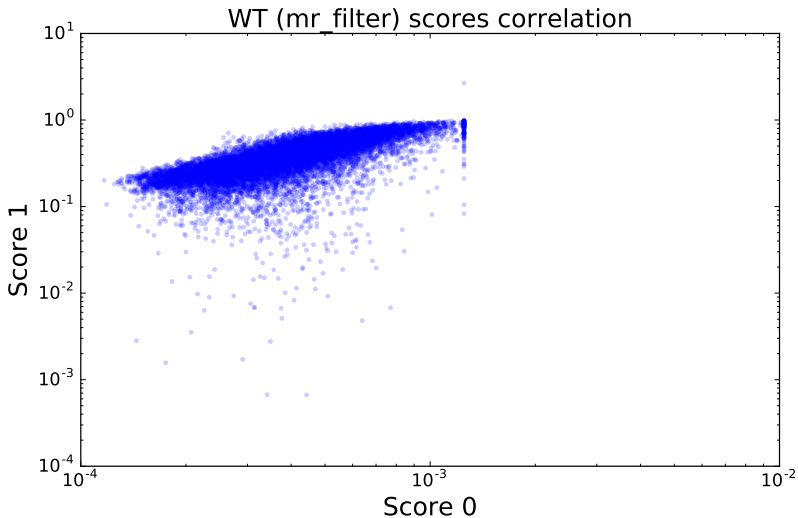


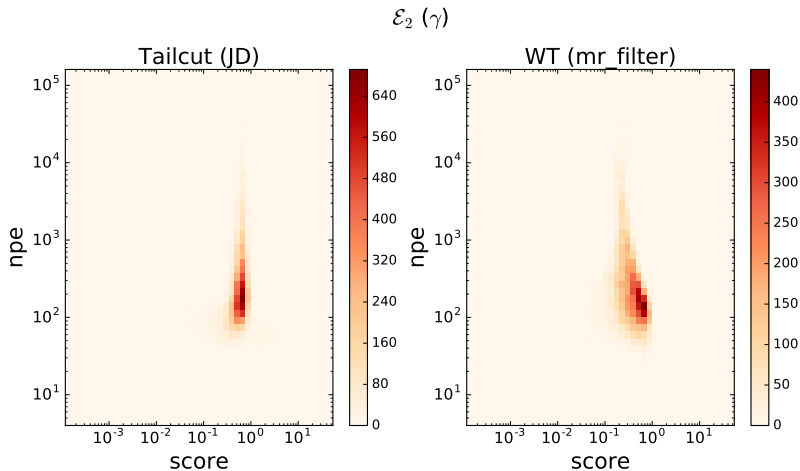


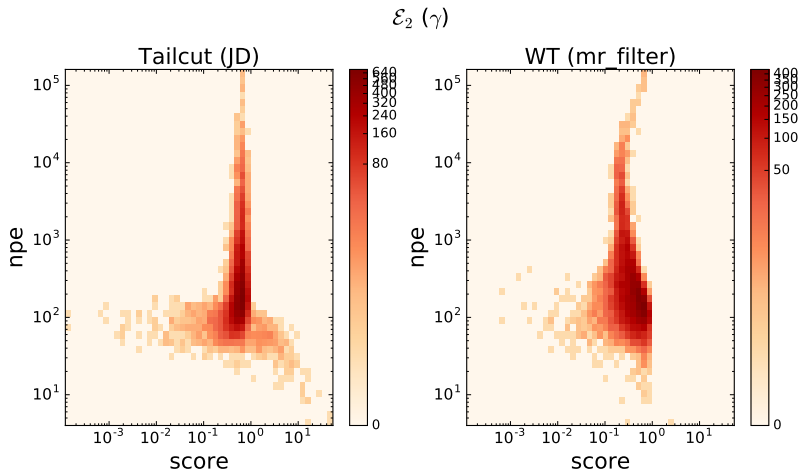












Protons

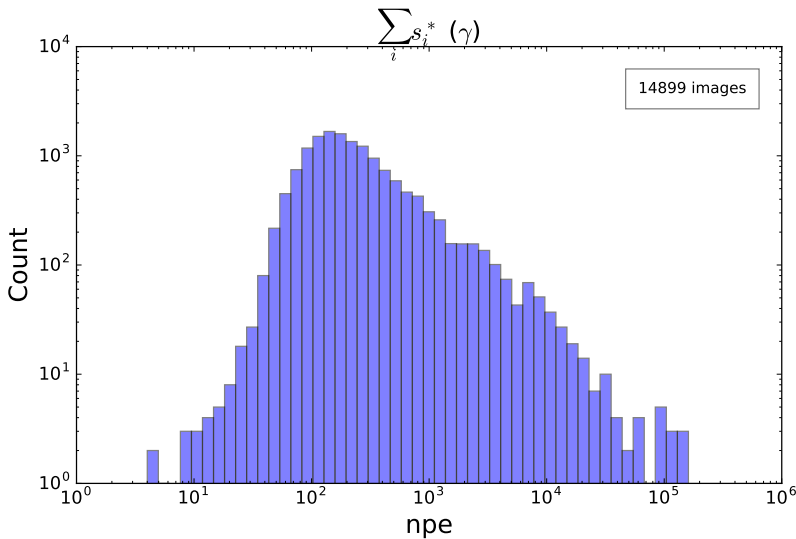
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- ▶ Telescopes 1 to 33 only (ASTRI)
- ▶ Polychromatic event set
- ▶ Input files: `sapcta:/dsm/manip/cta/DATA/astri_mini_array/fits/proton/`
- ▶ Source file:
`sapcta:/dsm/manip/cta/DATA/astri_mini_array/proton/run10001.simtel.gz`
- ▶ Num samples: 2203 images

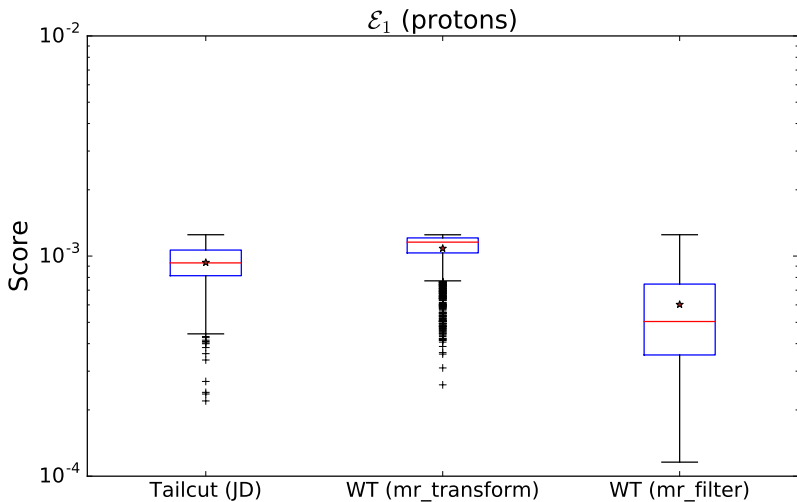
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- ▶ Tailcut: JD's implementation
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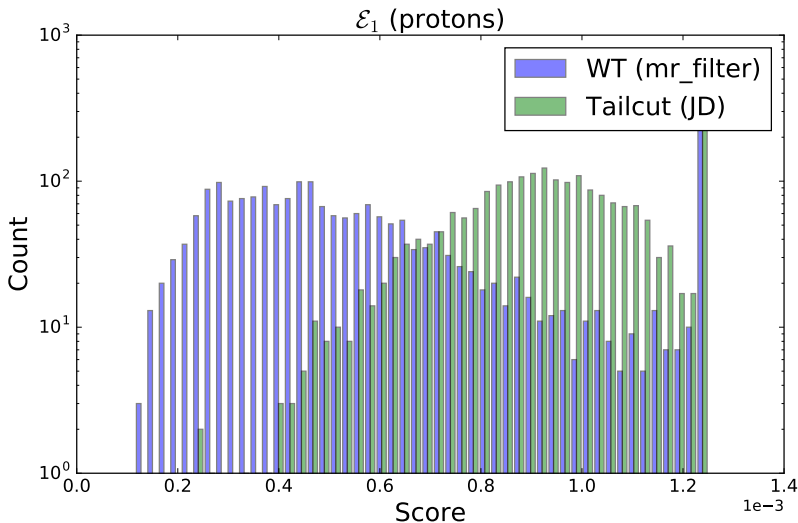
Protons

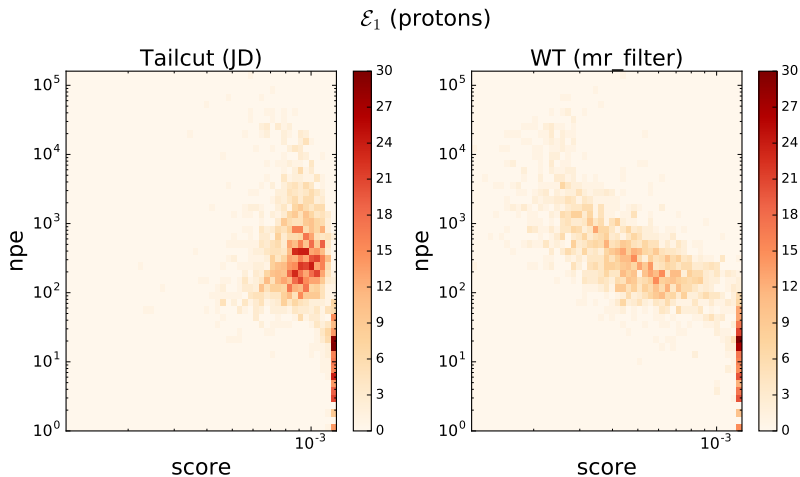


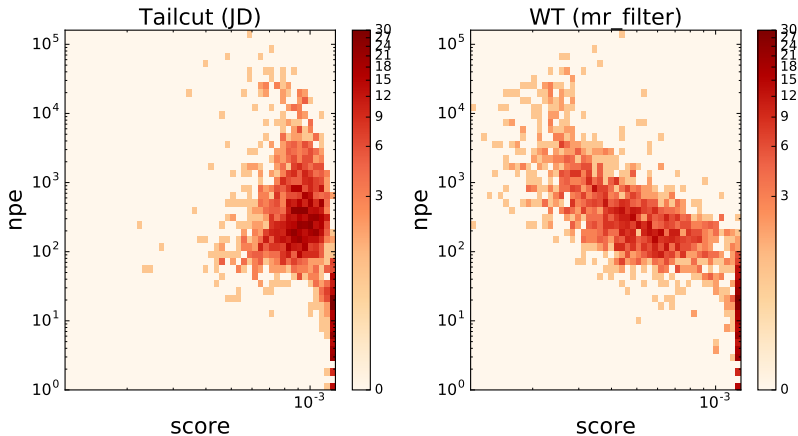


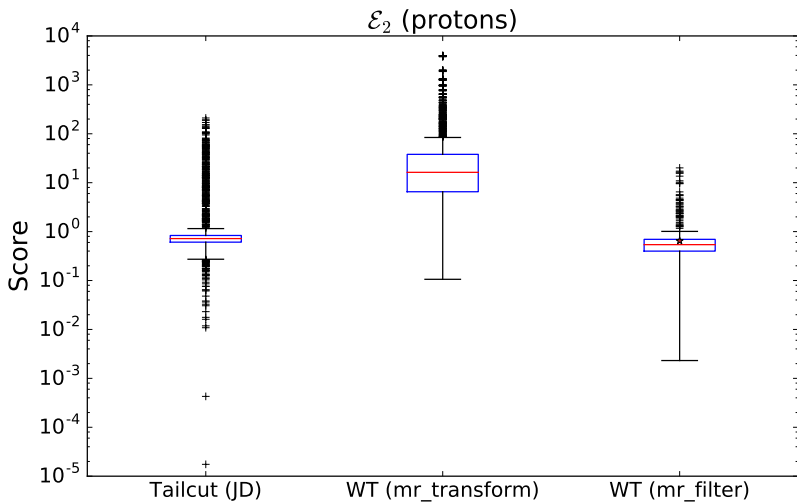


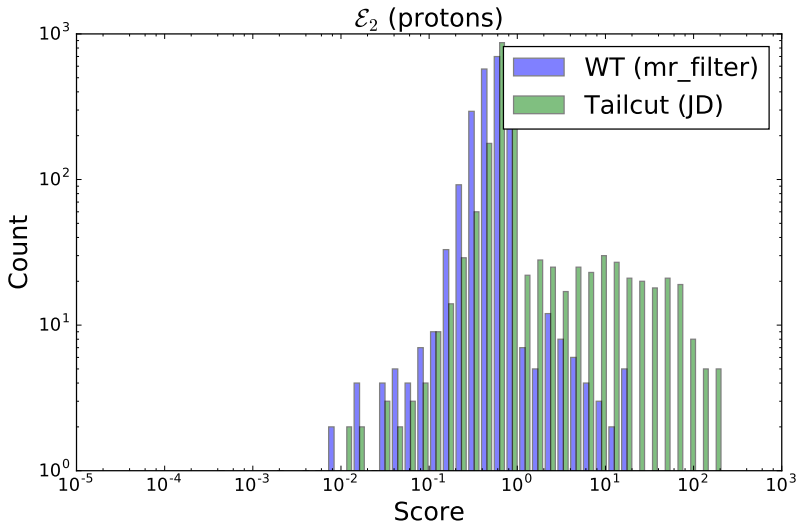
Protons

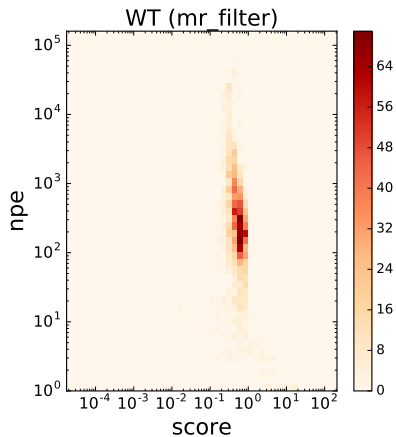
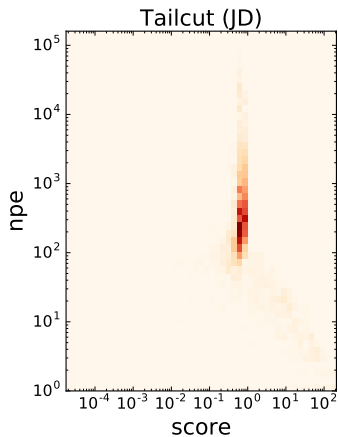


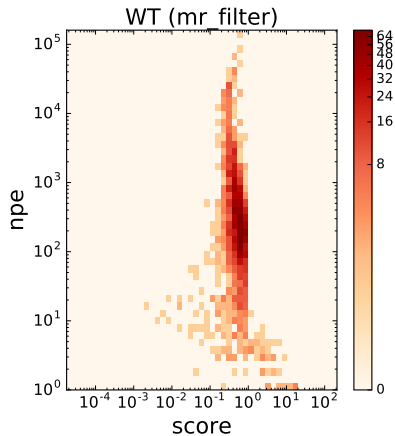
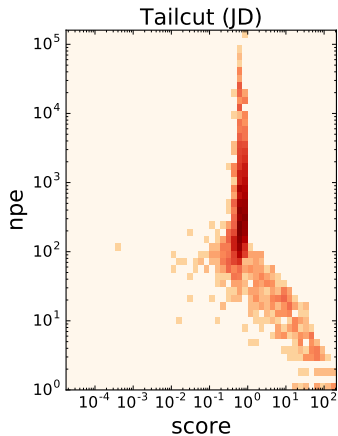


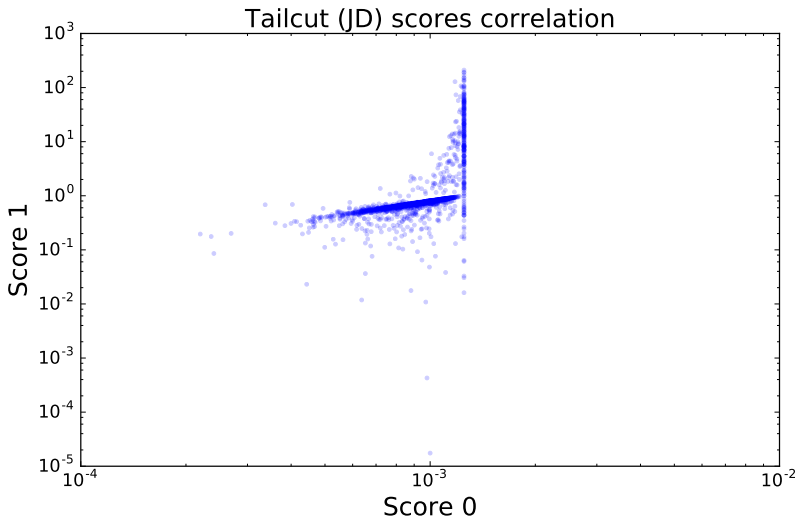
\mathcal{E}_1 (protons)

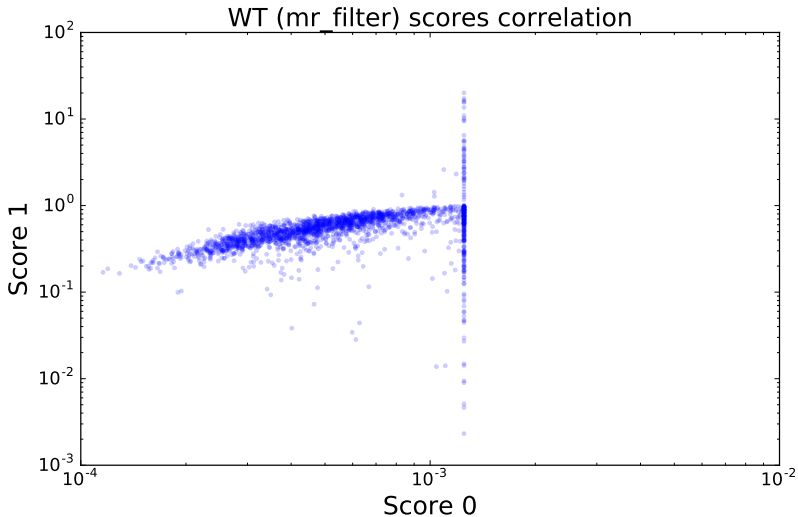




\mathcal{E}_2 (protons)

\mathcal{E}_2 (protons)





Energy conservation

Definition

Definition

Definition

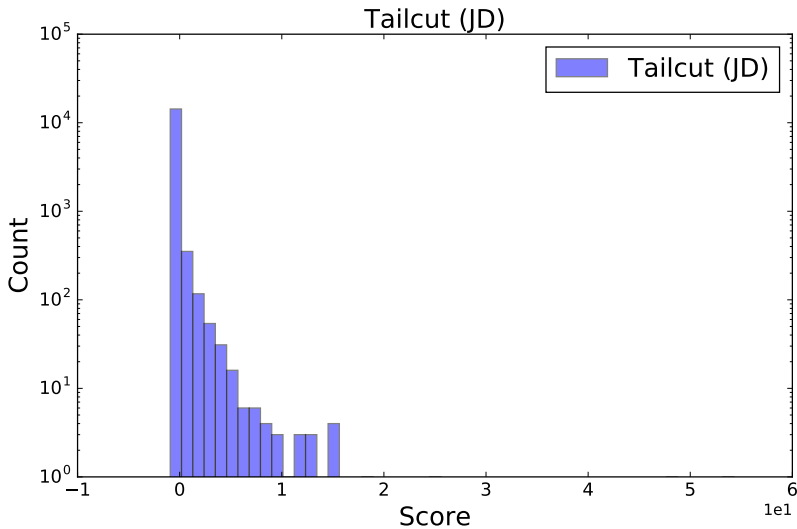
The error on energy is given by:

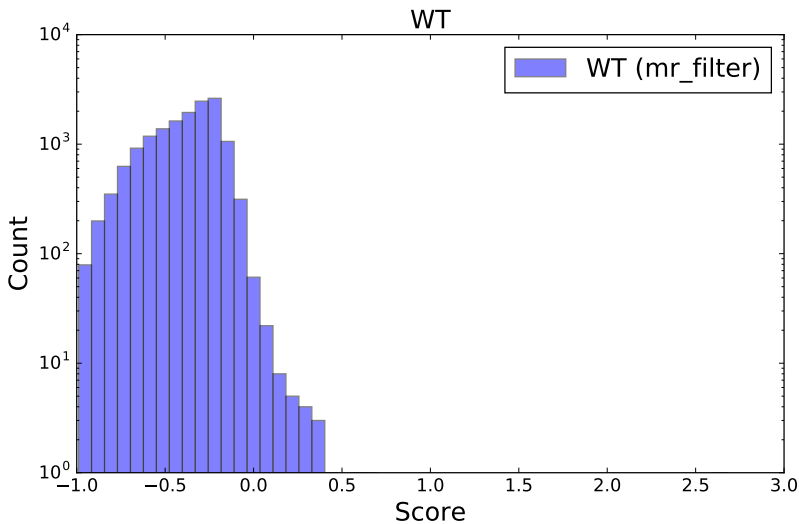
$$\frac{\sum_i \hat{\mathbf{s}}_i - \sum_i \mathbf{s}^*_i}{\sum_i \mathbf{s}^*_i}$$

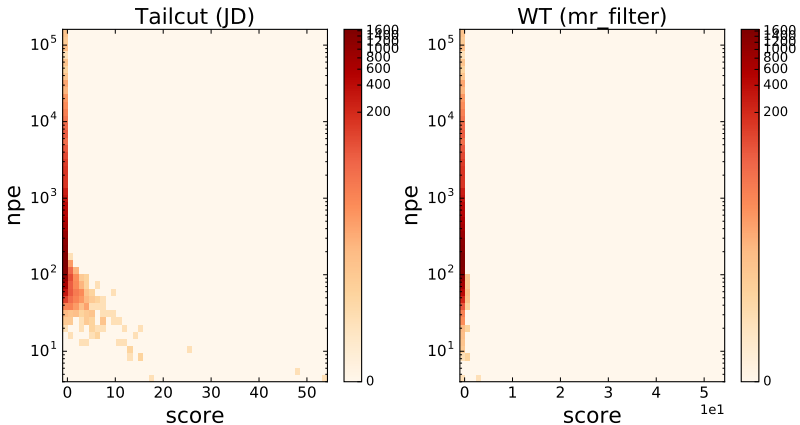
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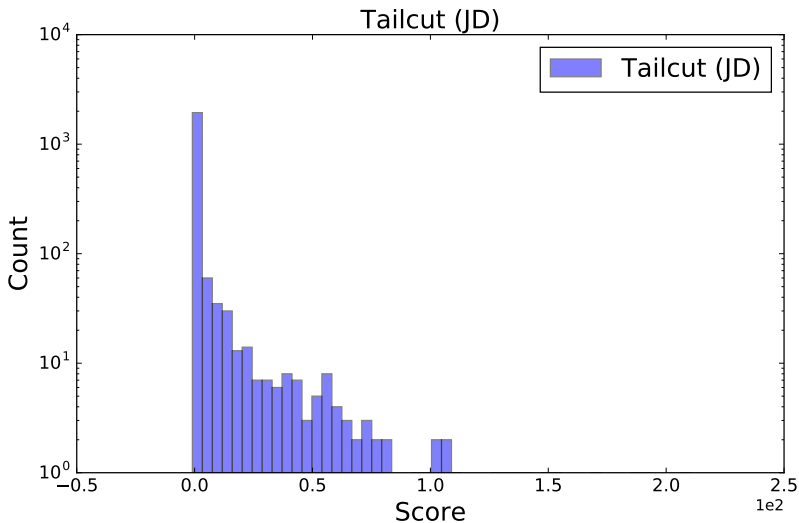
Gamma

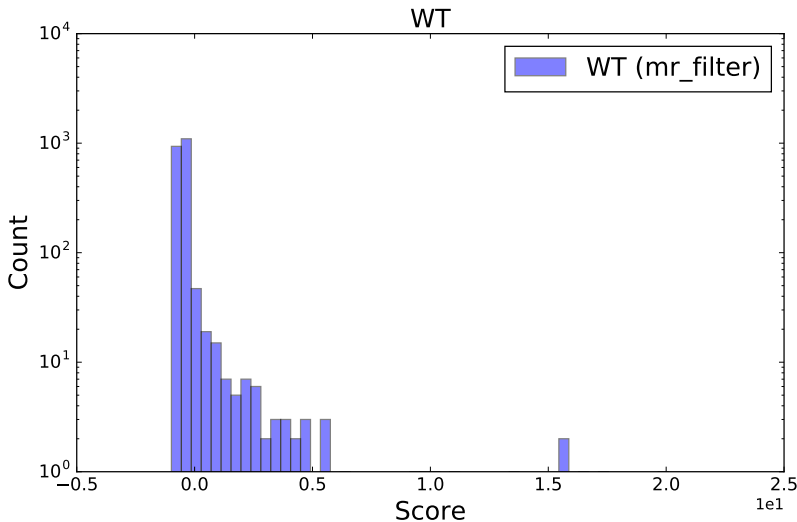




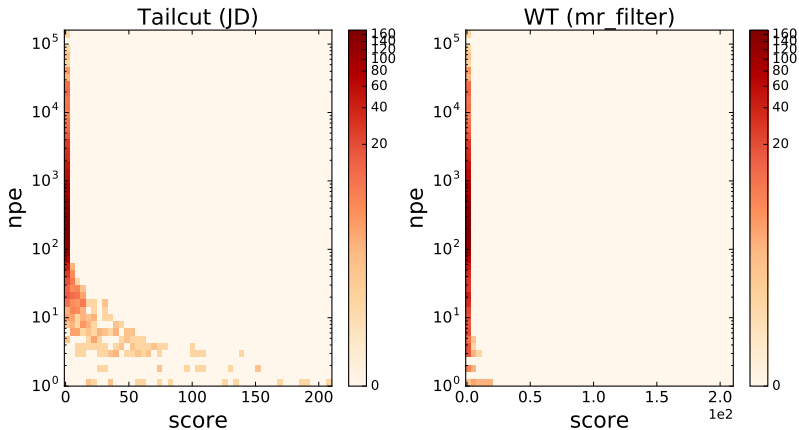
Energy conservation (γ)

Proton





Energy conservation (protons)



Conclusion

TODO

TODO

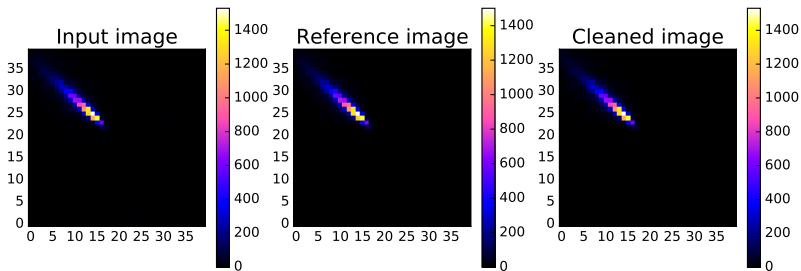
TODO

- ▶ use the ctapipe implementation for Tailcut (work in progress)
- ▶ add metadata into input FITS files (E_{MC} , ...) (work in progress)
- ▶ use these metadata to plot $\log(E_{MC})$ vs N_{pe} , score vs $\log(E_{MC})$, ... (almost done)
- ▶ plot the Chi^2
- ▶ tag images where the signal is on the border
- ▶ optimize meta parameters (multicriteria optimization) (work in progress)

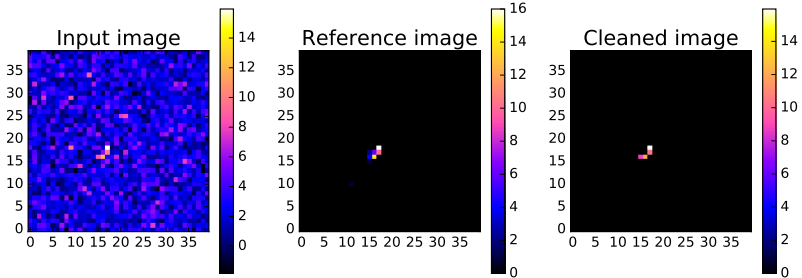
References I

Appendix

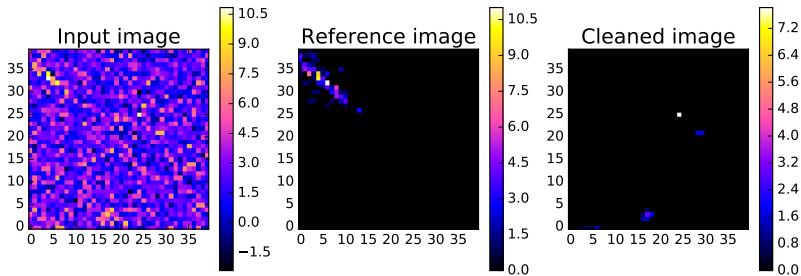
Good FFT example



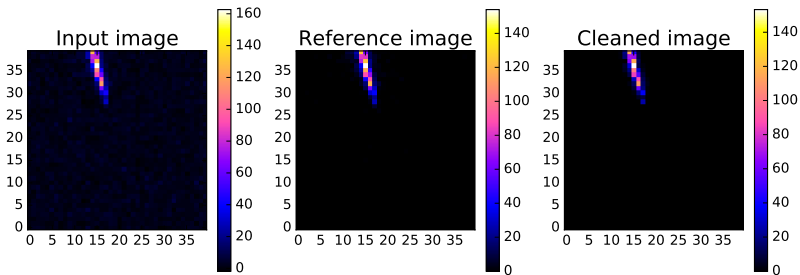
Good Tailcut example



Bad WT example

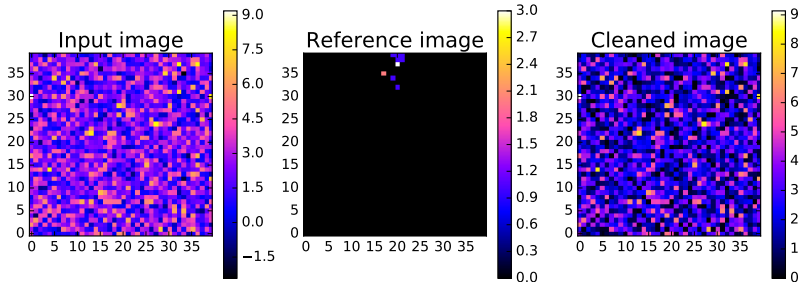


Good WT example

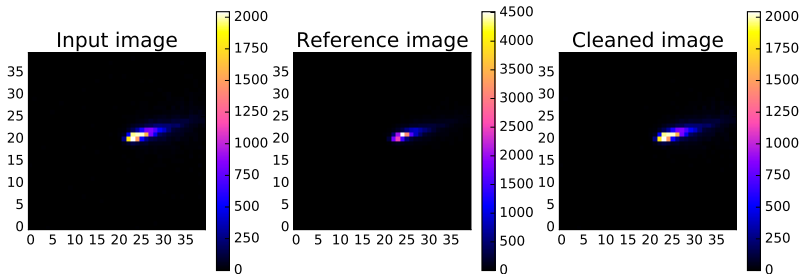


Examples: \mathcal{E}_2 with gamma photons

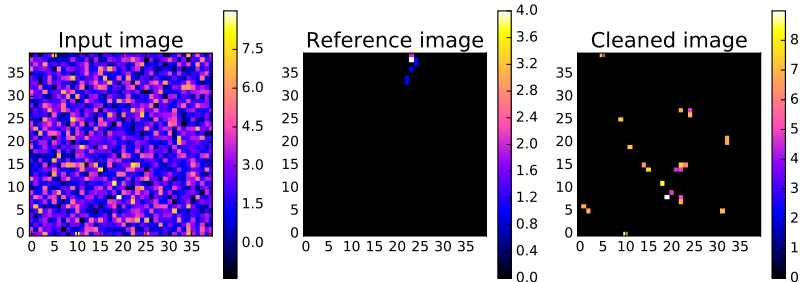
Bad FFT example



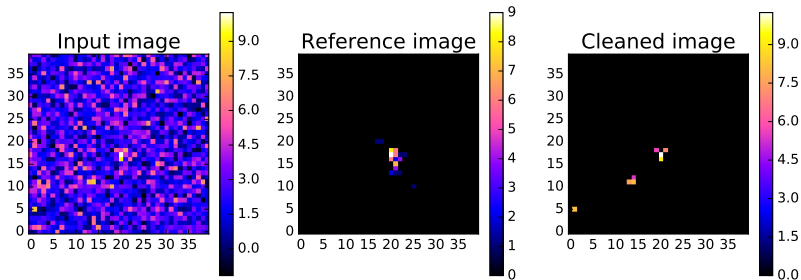
Good FFT example



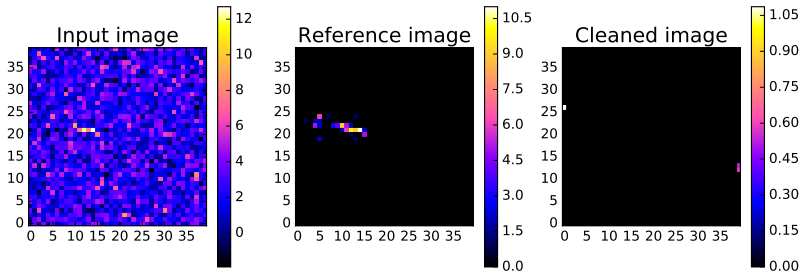
Bad Tailcut example



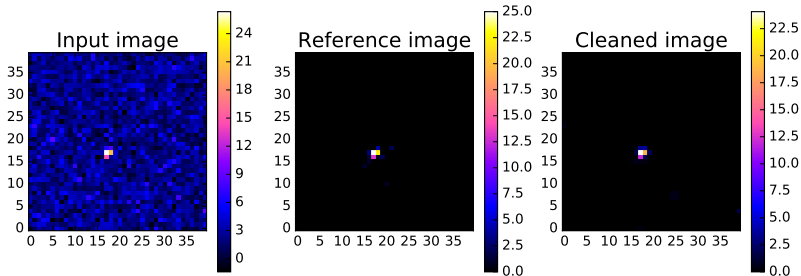
Good Tailcut example



Bad WT example

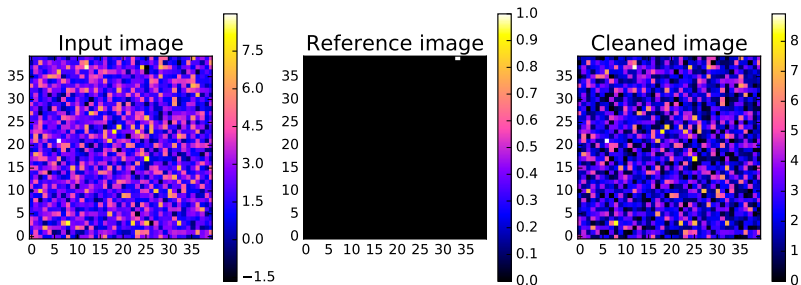


Good WT example

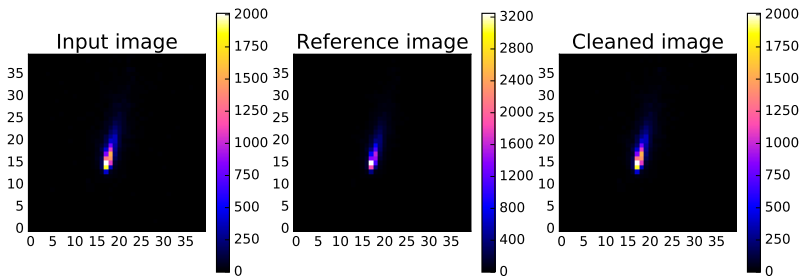


Examples: \mathcal{E}_1 with protons

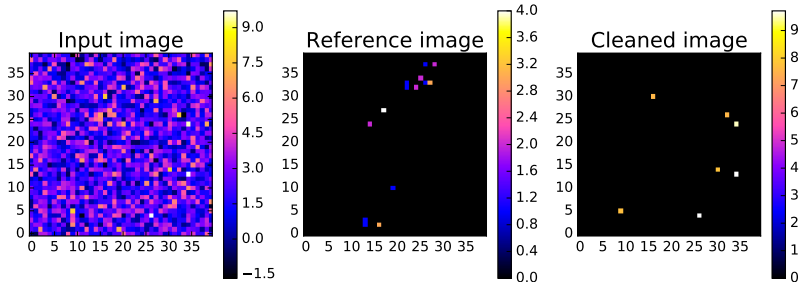
Bad FFT example



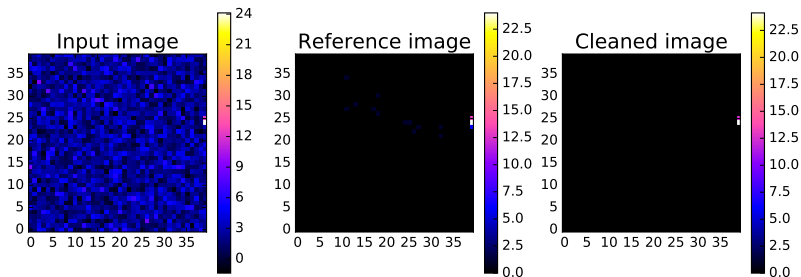
Good FFT example



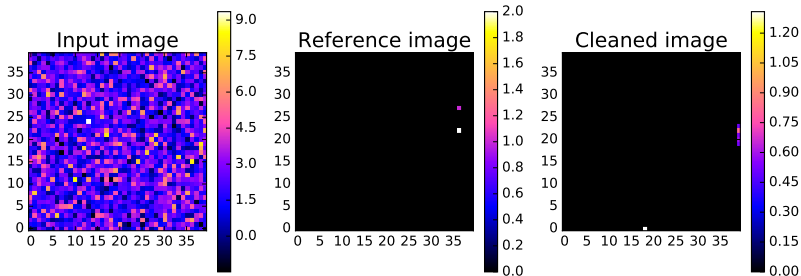
Bad Tailcut example



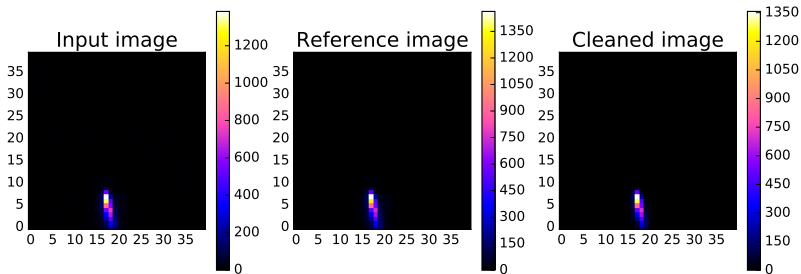
Good Tailcut example



Bad WT example

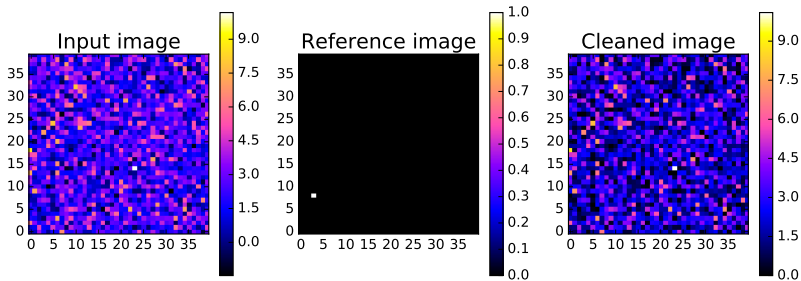


Good WT example

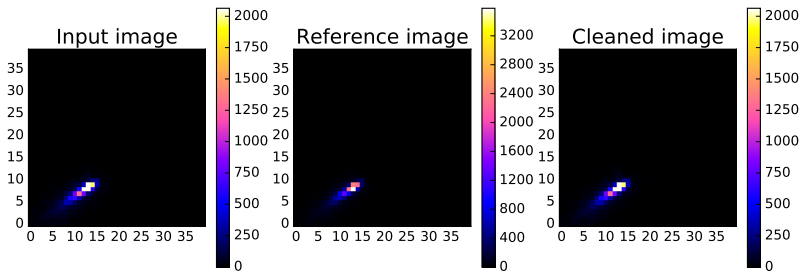


Examples: \mathcal{E}_2 with protons

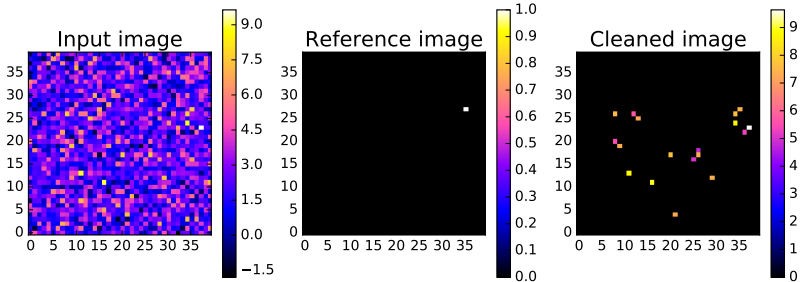
Bad FFT example



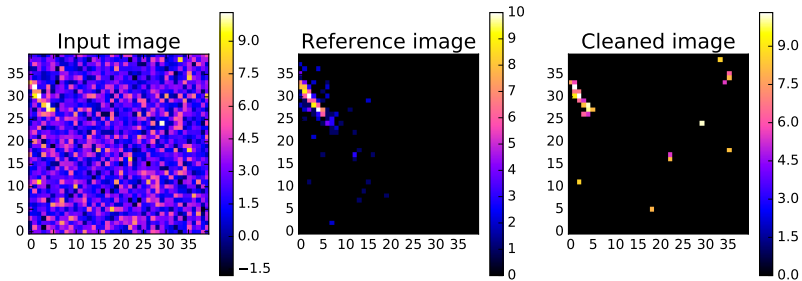
Good FFT example



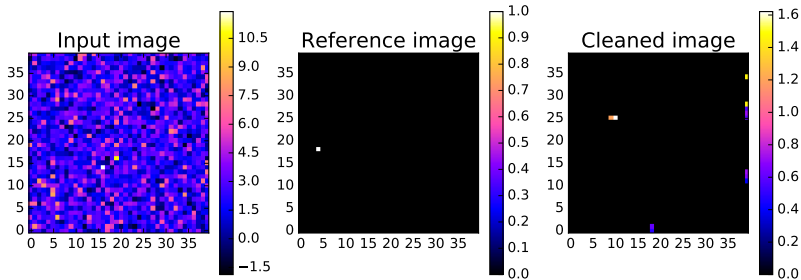
Bad Tailcut example



Good Tailcut example



Bad WT example



Good WT example

