Suggested Richardson-Lucy Imaging Parameters for Data Challenge 1

This document contains suggested parameters for imaging various simulated sources with COSIpy’s Richardson-Lucy deconvolution algorithm.

Note: These are not necessarily the only, nor the best, parameters for running the algorithm successfully. They were determined via trial-and-error in COSIpy development and are included here for reference.

Furthermore, this is not an exhaustive list of tests! Users should feel free to try imaging only the Crab, only Cygnus X-1, or combining the Crab Nebula with the 511 keV emission, for example. One can use this table as a guide for further study. Another possibility is to test the imaging with different response simulations, e.g. how do all combined sources appear using the 1809 keV response as opposed to the continuum response?

The point sources, 511 keV, and 26Al sources below are understood to be simulated at 10x their true fluxes. The Ling BG is scaled to the observed background during the 2016 flight.

“All combined sources” = point sources + 511 keV + 26Al simulations

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | fitted\_bg | map\_init | iterations | afl\_scl |
| Point sourcesa | 1E-6 | 1.0 | 150 | 2000 |
| Point sources + Ling BGa | 0.9 | 0.01 | 150 | 2000 |
| 511 keVb | 1E-6 | 0.01 | 150 | 1000 |
| 511 keV + Ling BGb | 0.99 | 0.01 | 150 | 1000 |
| 26Alc | 1E-6 | 0.1 | 150\* | 2000 |
| 26Al + Ling BGc | 0.9 | 0.01 | 150 | 2000 |
| All combined sourcesa | 1E-6 | 1.0 | 150 | 1000 |
| All combined sources + Ling BGa | 0.9 | 0.01 | 150 | 1000 |
| All combined sourcesb | 1E-6 | 0.01 | 150 | 2000 |
| All combined sources + Ling BGb | 0.9 | 0.01 | 150 | 1000 |
| All combined sourcesc | 1E-6 | 0.1 | 150 | 1000 |
| All combined sources + Ling BGc | 0.9 | 0.01 | 150 | 1000 |

aContinuum response, ebin = 2

b511 keV response

c1809 keV response

\*has been seen to fail after ~108 iterations, but the resulting image is reasonable.

Expected images

A sample of expected images in provided. Note that the exact image may vary depending on the number of iterations, chosen parameters, exposure masking, color scale of the image, etc. Unless otherwise noted, the color scale is linear.

*511 keV without, with Ling BG:*

Using the 511 keV response

Chart

Description automatically generatedA picture containing chart

Description automatically generated

*26Al without, with Ling BG:*

Using the 1809 keV response

A picture containing chart

Description automatically generatedDiagram

Description automatically generated

*Point sources without, with Ling BG:*

Using the continuum response, energy bin = 2 (325-480 keV).

Color scale in both images set to PowerNorm(0.6667) to more clearly show the sources.

Diagram

Description automatically generated with low confidenceChart, diagram

Description automatically generated

*All sources (511 keV, 1809 keV, point sources) without, with Ling BG:*

Using the continuum response, energy bin = 2 (325-480 keV).

Chart

Description automatically generatedChart

Description automatically generated