NHSC/PACS Web Tutorials

Running PACS photometer pipelines

PACS-403 (for Hipe 13.0)

Level 1 to Level 2.5 processing: The Unimap pipeline

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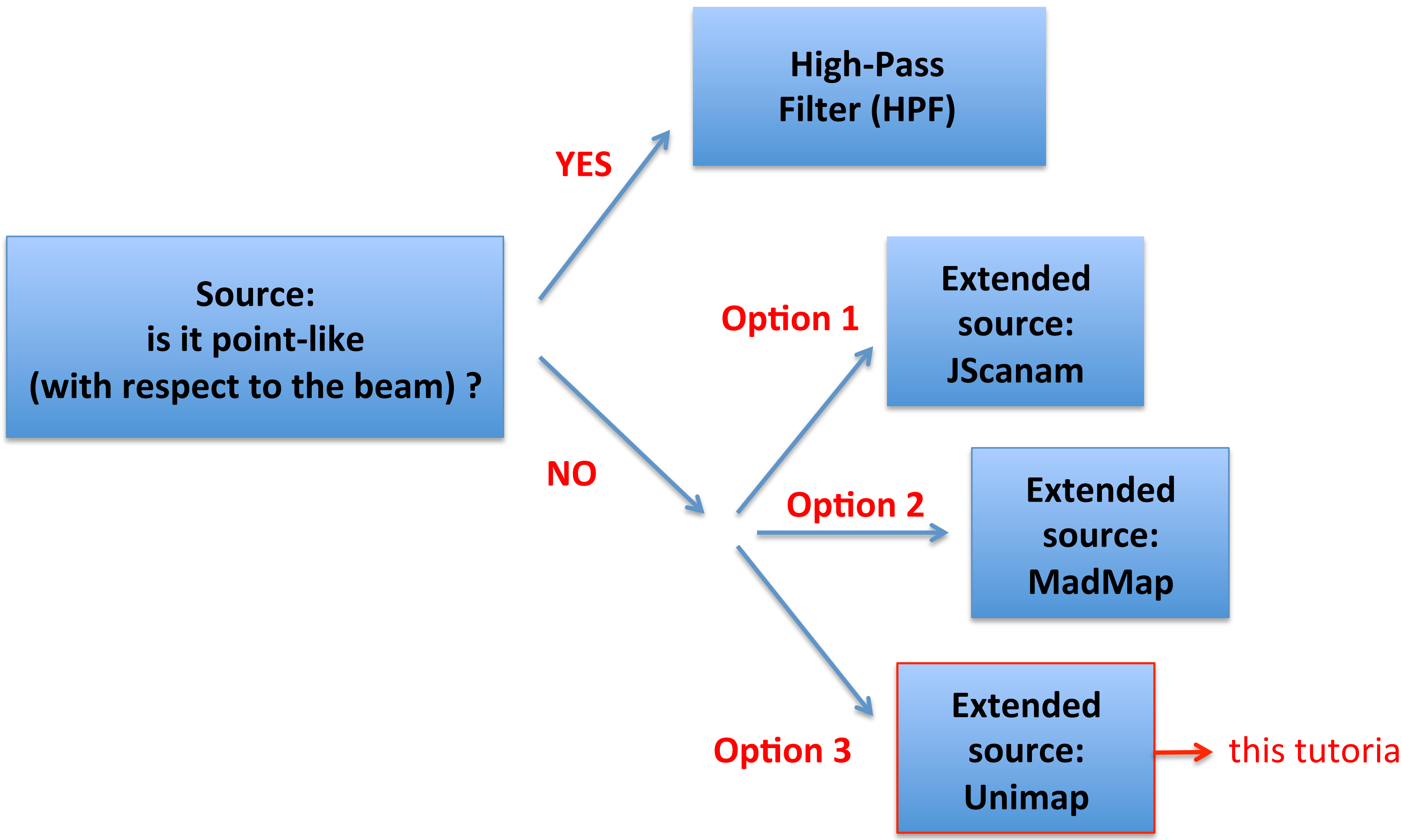
Level 0 to Level 1 processing:

NOTE: The pipeline is now very stable between Level 0 and Level 1, so there is no need to tweak the processing between the raw-data level (i.e. Level 0) and Level 1.

Outline of this tutorial

- Slide 5 to 16: Unimap essence & how to run the ipipe script
- Slide 17: useful notes
- Slide 18: documentation

PACS Photometer Pipeline: 2 main branches

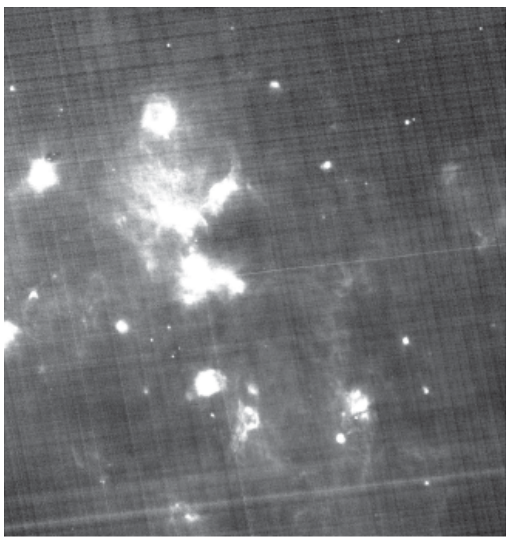


What is Unimap ?

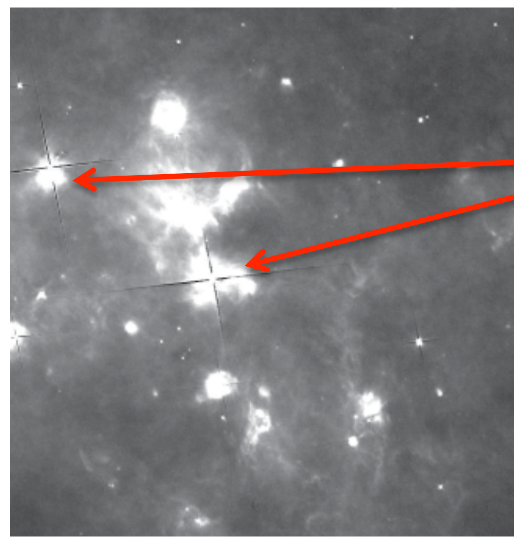
- As pointed out in the previous slide, Unimap allows the processing of PACS photometer data when the user wants to preserve extended emission.
- Unimap is a map maker based on the Generalized Least Square (GLS) approach, which is also the Maximum Likelihood (ML) method when the noise has Gaussian distribution.
- Unimap is written in Matlab. It has been developed and released by the DIET department of the University of Rome `La Sapienza'.
- The algorithm (Unimap v5.5.0) can be run within HIPE (since HIPE 13) as a `stand alone' package (to be installed separately).
- Home page: http://infocom.uniroma1.it/unimap/

What Does Unimap Do? (1)

1. The core of Unimap, the `GLS' algorithm, minimizes the effects of the low frequency `1/f' noise of individual bolometers (uncorrelated with each other). This is done in the Fourier domain, assuming the noise power spectra of bolometers do not change with time.



A naïve map: stripes caused by 1/f noise



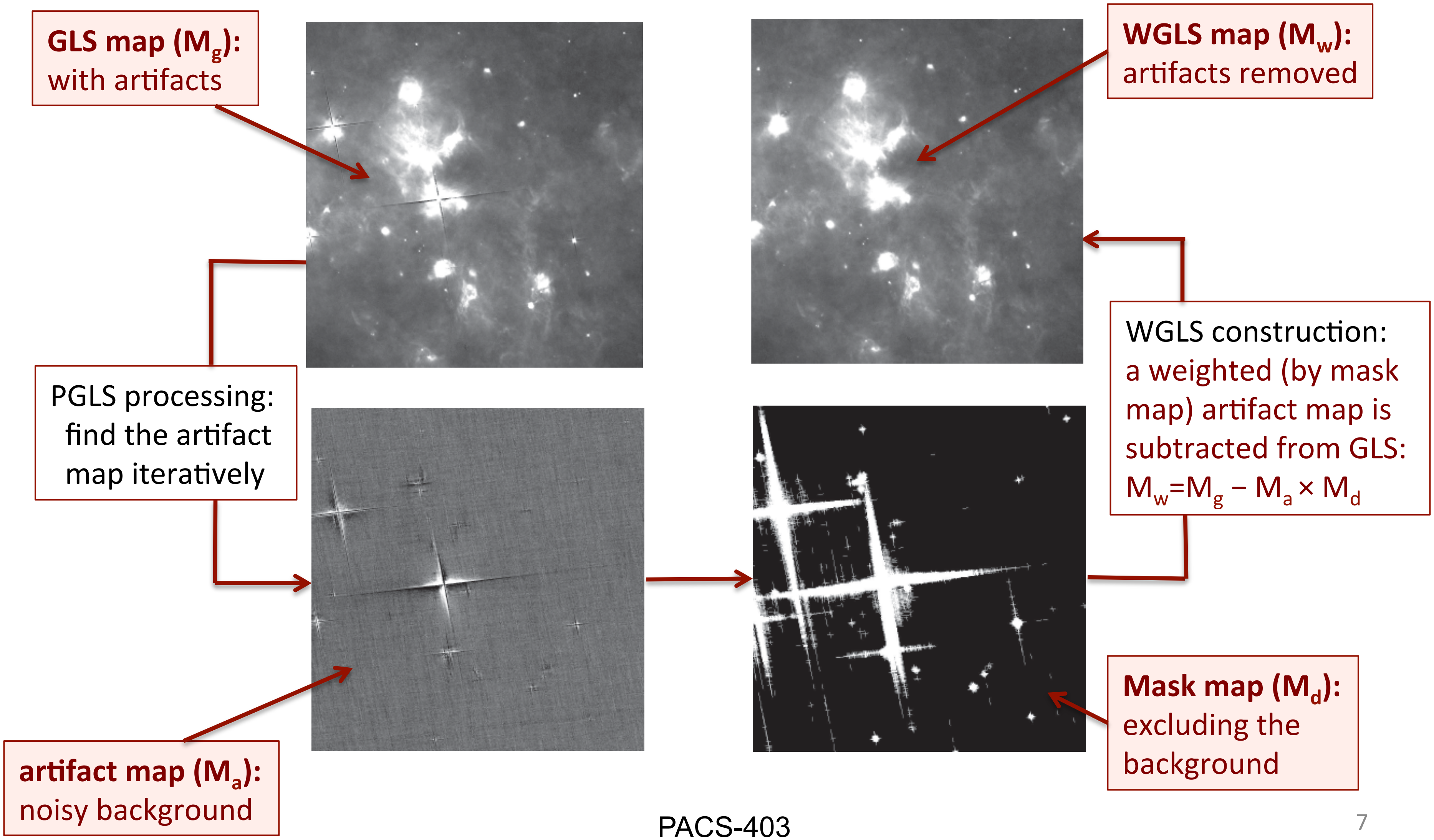
A GLS map: stripes are removed, but …

artifacts!!

FFT-associated ringing effect (in time domain) around bright sources

What Does Unimap Do? (2)

2. Post-processing (PGLS) to remove GLS artifacts.



What Does Unimap Do? (3)

3. In addition, exploiting the redundancy of the data (in particular the `cross scans'), it also performs `destriping'. This includes:
   - Removing offsets between scans of diff bolometers.
   - Removing very long term (longer than single scans) drifts of individual bolometers.
   - Removing long term drifts of entire bolometer arrays or sub-arrays (i.e. the `correlated noise').
4. Deglitching: It includes both a 1st level deglitcher (finding spikes in timelines using high-pass filtering) and a 2nd level deglitcher (identifying outliers in map pixels).

Major Steps Inside Unimap Task (1)

1. **Data loading**. Loading the Level 1 data (frames) and converting it to timelines (i.e. `TODs').
2. **Pre-processing**. This includes:
   - detect signal jumps and break each affected timeline into two, independent timelines;
   - remove the calibration blocks;
   - linearly interpolate flagged data.
3. **Deglitching.**
4. **Drift correction (`destriping').** The user can specify the polynomial order and whether the drift is to be corrected for every single bolometer or for a whole array/sub-array.
5. **Noise calculation.** Estimating the noise spectra of bolometers for the GLS calculations.

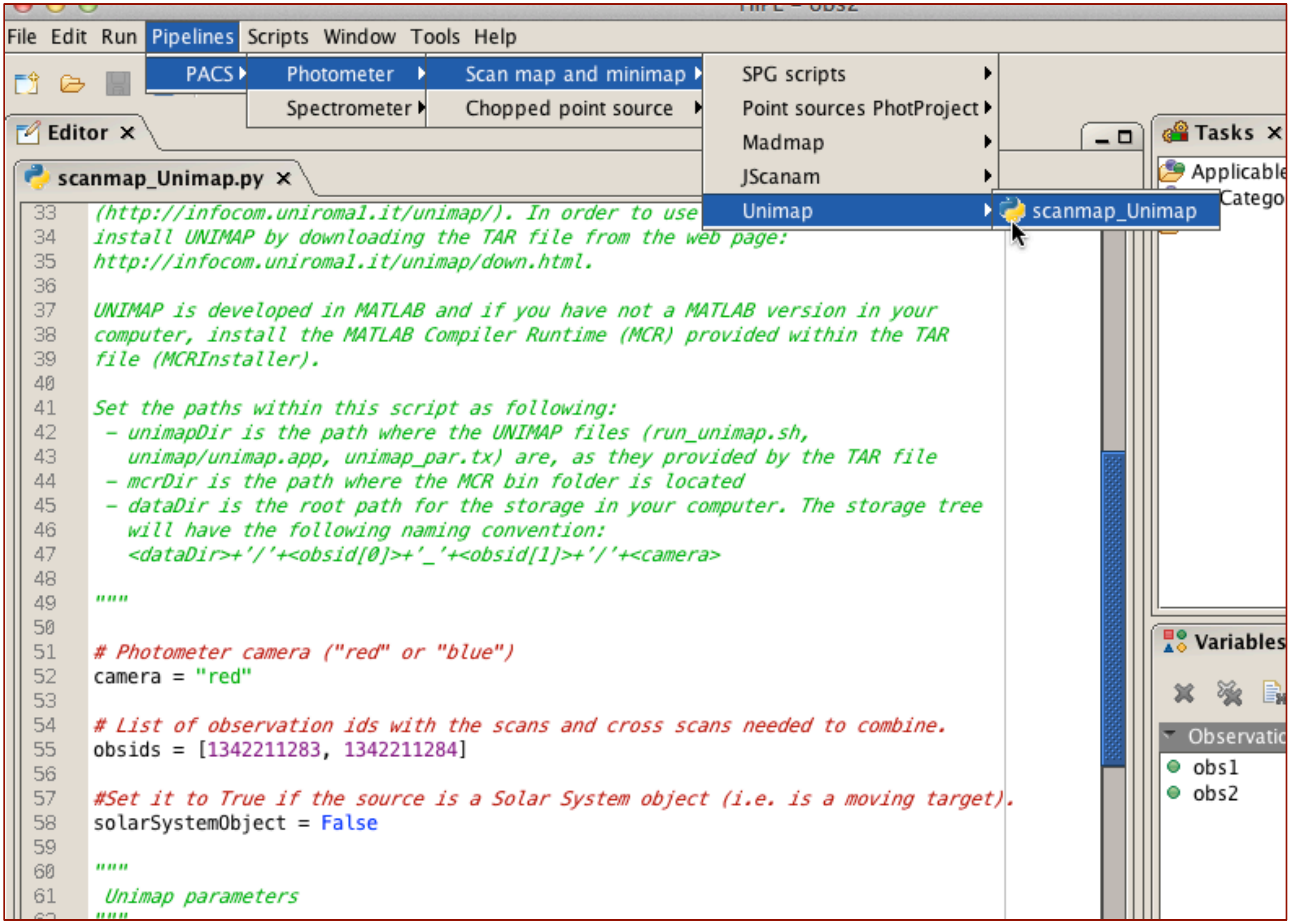
Major Steps Inside Unimap Task (2)

6. **GLS map-making.** This produces the GLS map and naïve map (i.e. `re-binned’).
7. **Post GLS processing (PGLS).** Deriving a (noisy) GLS artifact map and subtracting it from the GLS map, obtaining the PGLS map.
8. **WGLS.** This produces the WGLS map by subtracting a *weighted* GLS artifact map from the GLS map. This is the default output image of Unimap.

How to Run Unimap Within HIPE?

- Unimap is NOT included in the HIPE package!!
- You need to download Unimap from:
  http://infocom.uniroma1.it/unimap/down.html
- Unpack the package in a designated directory.
- Follow the `readme' inside the package, and install the MATLAB Compiler Runtime (MCR; packed inside the Unimap package).
- Launch HIPE.
- Run the Unimap ipipe script (scanmap_unimap) found in the drop-down list of `Pipelines', which spawns the Unimap processing outside HIPE:

Where Is the Unimap ipipe Script ?



Running Unimap ipipe Script (1)

- The following parameters **must** be set before running the script:

```
"""

# Photometer camera ("red" or "blue")
camera = "red"

# List of observation ids with the scans and cross scans needed to combine.
obsids = [1342211283, 1342211284]
```

and:

```
# Unimap installation directory path
unimapDir = '/your/Unimap/directory'

# MATLAB MCR directory path
mcrDir = '/your/MATLAB/Compiler/Runtime/directory'

# root of the data directory. The pipeline output files will be created and
# saved in the following directory: dataDir/firstObsid_lastObsid_camera
dataDir = '/your/data/directory'
```

Running Unimap ipipe Script (2)

- If you want to change the default values of other parameters, follow the tips in the script.

Example:

This is the default. You can change it to a value more suitable to your data, e.g.
filterSizeInArcsec = 100.

```
"""
 Unimap parameters
"""
# pgls high pass filter size in arcseconds (default 0). If it's set to 0,
# Unimap will use a size equal to half the size of the shortest scanleg,
# with an upper limit of 500 arcsec
filterSizeInArcsec = 0.

# Starting image for the gls (default -1): 0 zero image, 1 rebin, 2 highpass.
# Unimap will select the optimal starting image if any other number is given.
startImage = -1
```

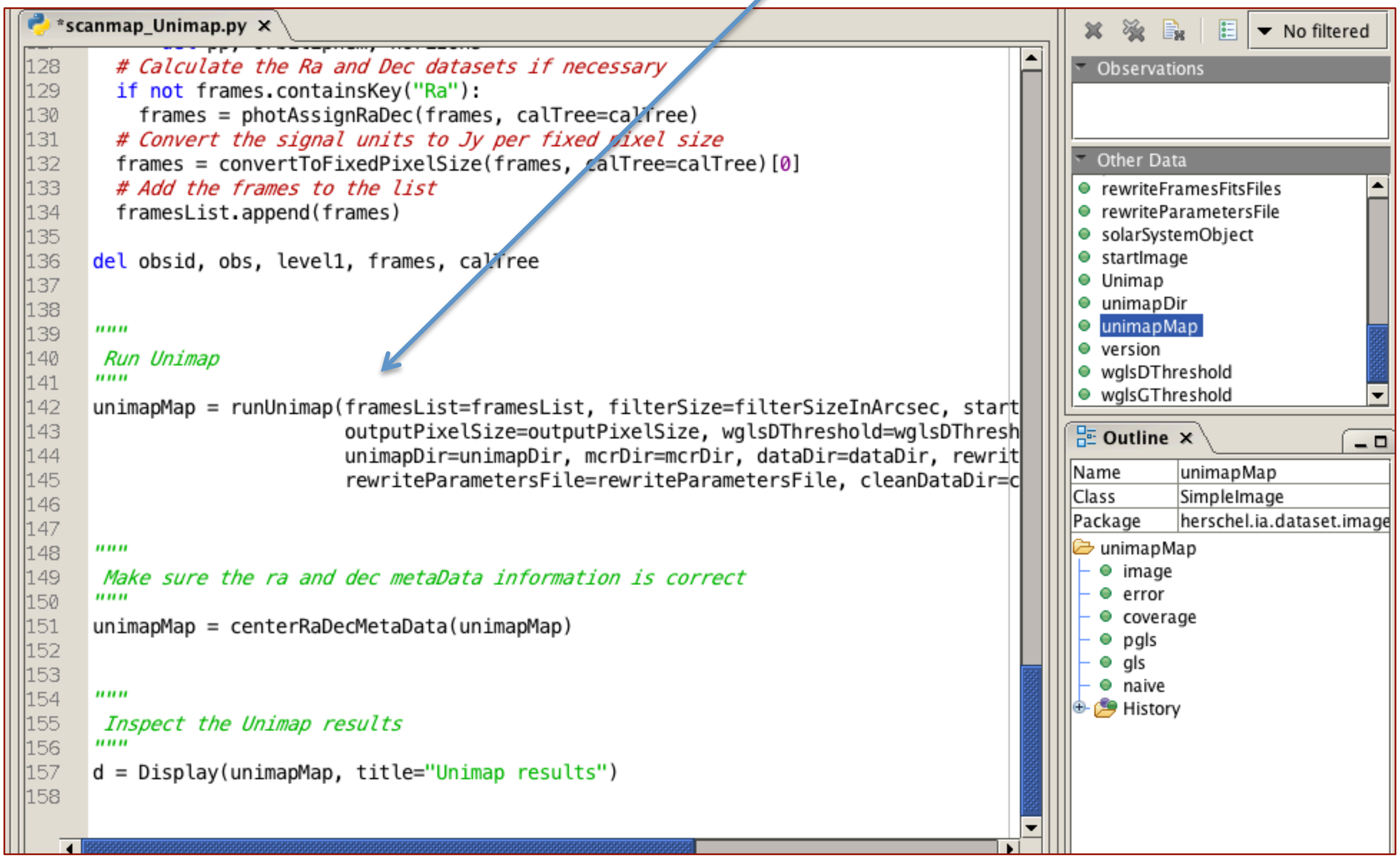
If your observation is for a Galactic star formation region, with bright extended emission covering most of the background, then naïve map (rebin) is a better starting image:

startImage = 1

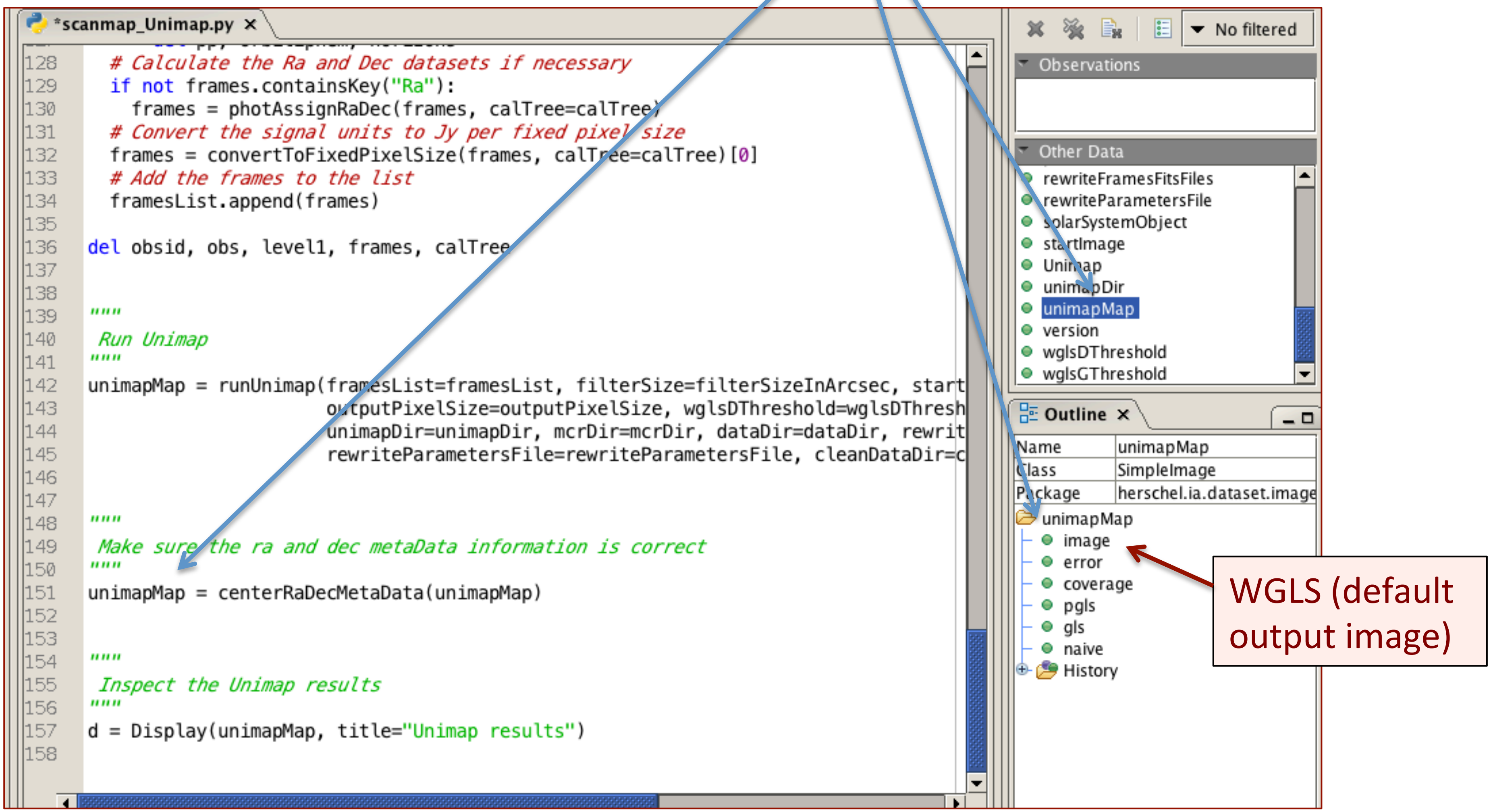
For cosmological surveys in dark fields, a good guess is:

startImage = 0

Unimap ipipe: Spawn Unimap processing outside HIPE



Unimap ipipe: Output



Useful Notes

- Unimap can process one OBSID at a time, it does not need a pair of OBSIDs. This is useful to process PACS photometer observations designed for having only one scan. For comparison, Jscanam and MADMap need a pair of OBSIDs.

- In some cases, for example when there are no bright point sources (therefore no strong GLS artifacts) in the map, the GLS is a better estimate of the true image than the WGLS. The latter could have higher noise than the former.

- The Unimap task is still being tweaked, and the ipipe script may present some changes in future versions of HIPE.

- The relative strength and weakness of the three different map-makers for extended sources listed on page 4 (i.e. JScanam, MadMap, and Unimap) have been extensively discussed in a report titled "PACS Map-making Tools: Update on Analysis and Benchmarking" (Paladini et al. 2014, http://herschel.esac.esa.int/twiki/pub/Public/PacsCalibrationWeb/pacs_mapmaking_report14_v2.pdf).

Documentation

For more information on Unimap, check:

- The Unimap User's Manual:

  http://infocom.uniroma1.it/unimap/unimap.pdf

Thank you !