



# **NHSC/PACS Web Tutorials**

## **Running PACS photometer pipelines**

### **PACS-403 (for Hipe 13.0)**

*Level 1 to Level 2.5 processing:  
The Unimap pipeline*

Prepared by Kevin Xu

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## *Level 0 to Level 1 processing:*

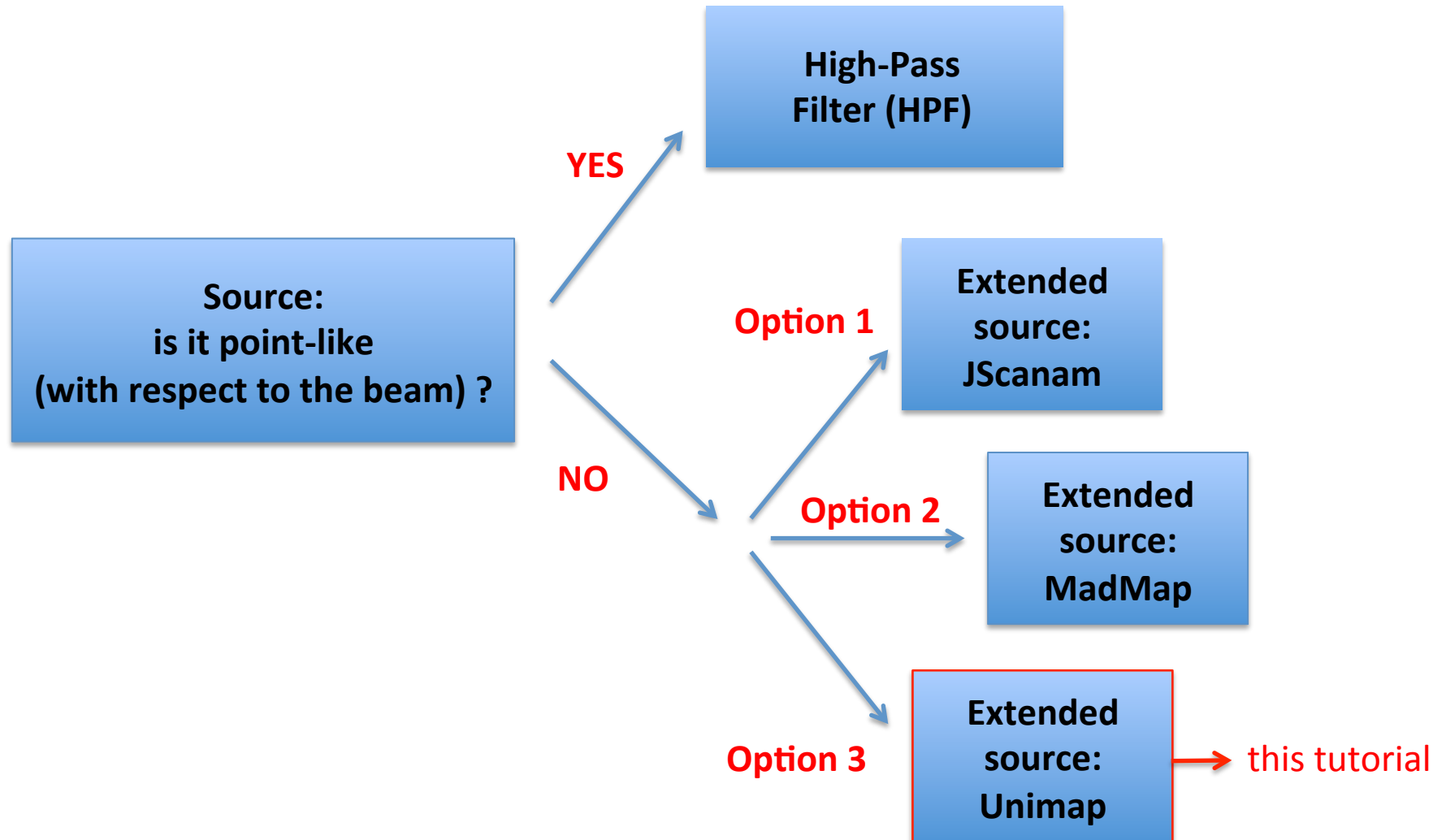
**NOTE:** The pipeline is now very stable between Level 0 and Level 1, so there is no need to tweak the processing between the raw-data level (i.e. Level 0) and Level 1.



# 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



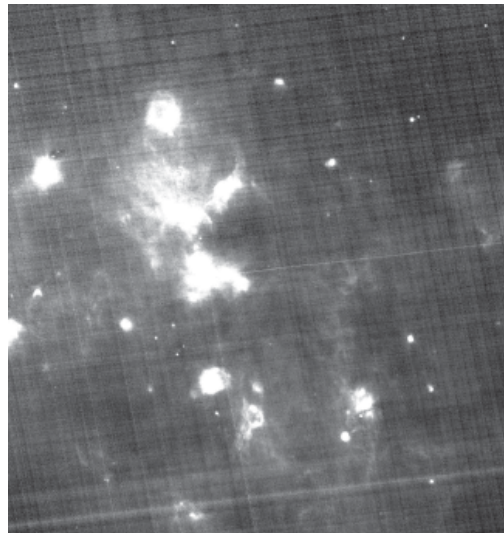


# What is Unimap ?

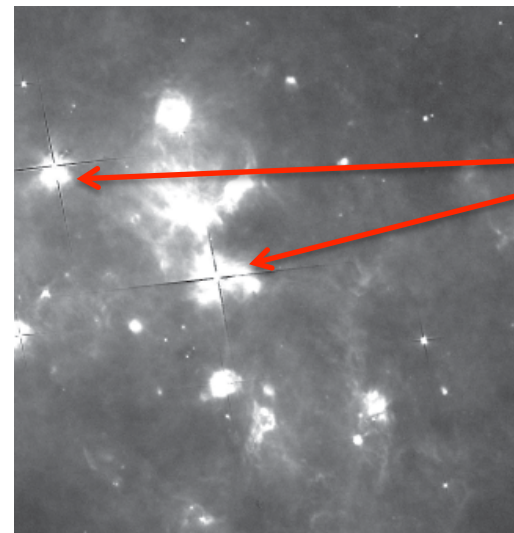
- As pointed out in the previous slide, Unimap allows the processing of PACS photometer data when the user wants to preserve extended emission.
- Unimap is a map maker based on the Generalized Least Square (GLS) approach, which is also the Maximum Likelihood (ML) method when the noise has Gaussian distribution.
- 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



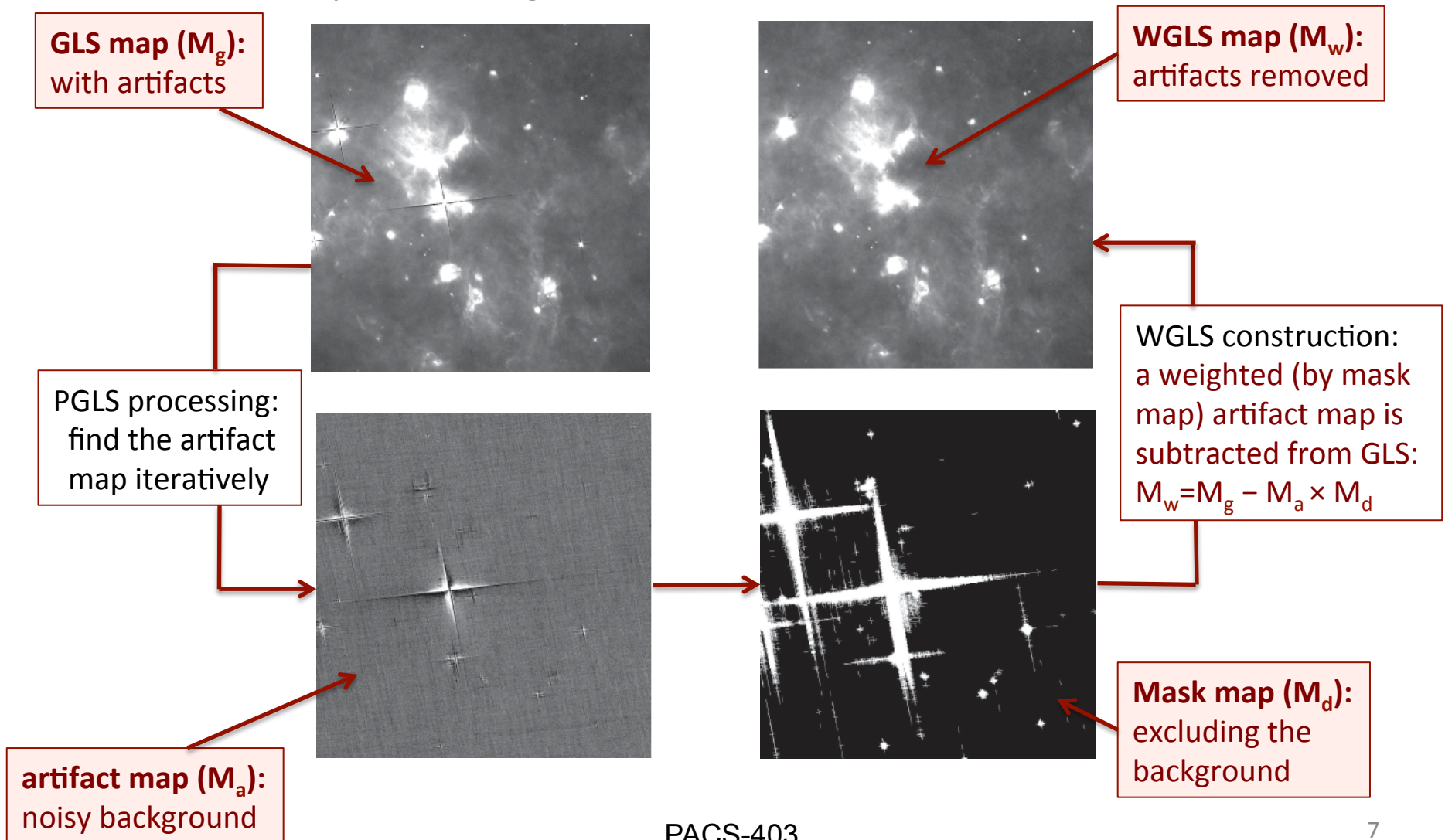
A GLS map: stripes are removed, but ...

**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 1<sup>st</sup> level deglitcher (finding spikes in timelines using high-pass filtering) and a 2<sup>nd</sup> 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)

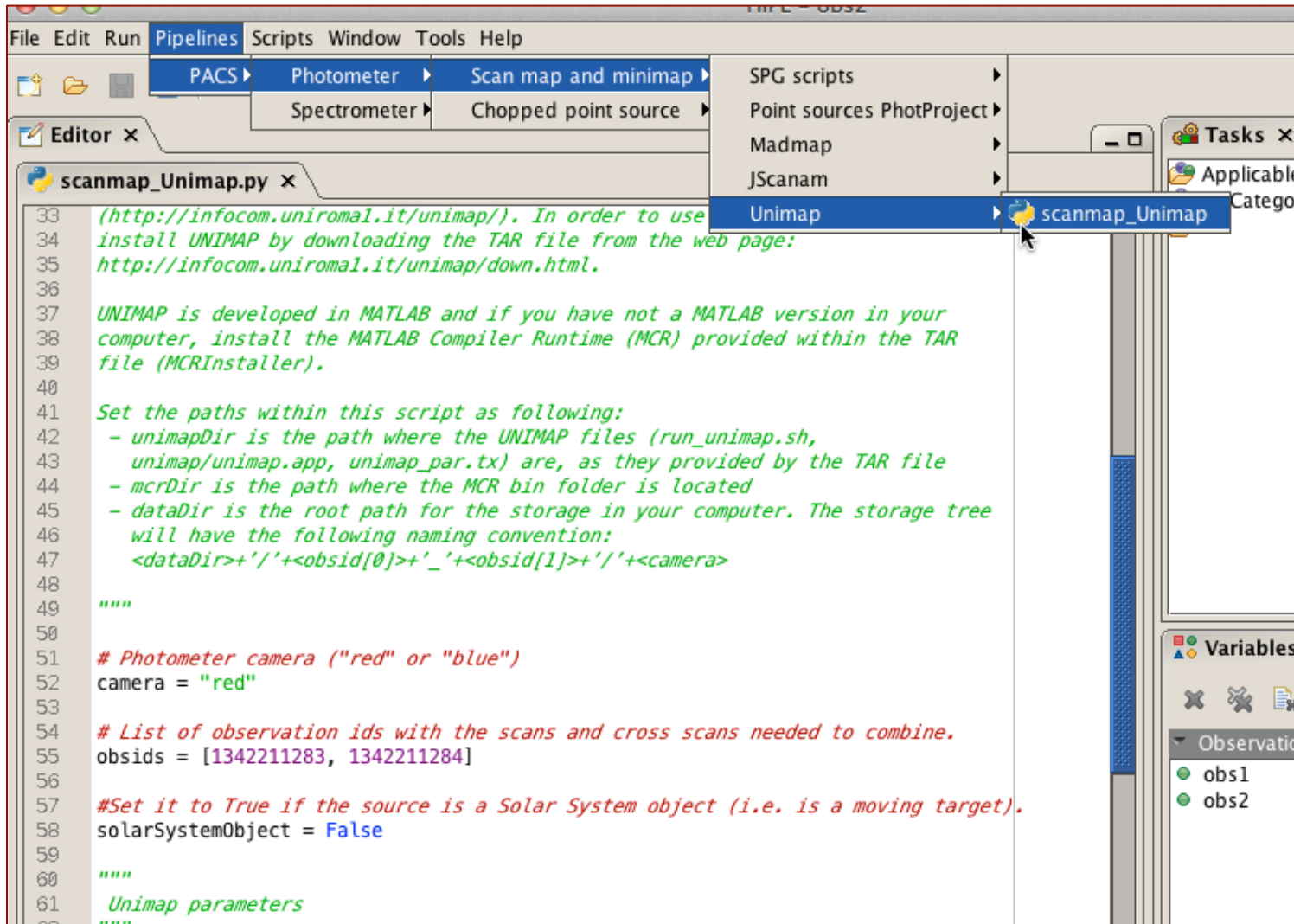
6. **GLS map-making.** This produces the GLS map and naïve map (i.e. `re-binned`).
7. **Post GLS processing (PGLS).** Deriving a (noisy) GLS artifact map and subtracting it from the GLS map, obtaining the PGLS map.
8. **WGLS.** This produces the WGLS map by subtracting a *weighted* GLS artifact map from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



```
33 (http://infocom.uniroma1.it/unimap/). In order to use
34 install UNIMAP by downloading the TAR file from the web page:
35 http://infocom.uniroma1.it/unimap/down.html.
36
37 UNIMAP is developed in MATLAB and if you have not a MATLAB version in your
38 computer, install the MATLAB Compiler Runtime (MCR) provided within the TAR
39 file (MCRInstaller).
40
41 Set the paths within this script as following:
42 - unimapDir is the path where the UNIMAP files (run_unimap.sh,
43   unimap/unimap.app, unimap_par.tx) are, as they provided by the TAR file
44 - mcrDir is the path where the MCR bin folder is located
45 - dataDir is the root path for the storage in your computer. The storage tree
46   will have the following naming convention:
47   <dataDir>+'/'+'<obsid[0]>+'_'+'<obsid[1]>+'/'+'<camera>
48
49 """"
50
51 # Photometer camera ("red" or "blue")
52 camera = "red"
53
54 # List of observation ids with the scans and cross scans needed to combine.
55 obsids = [1342211283, 1342211284]
56
57 #Set it to True if the source is a Solar System object (i.e. is a moving target).
58 solarSystemObject = False
59
60 """"
61 Unimap parameters
62 """"
```

## Running Unimap ipipe Script (1)

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

```
49  ""
50
51  # Photometer camera ("red" or "blue")
52  camera = "red"
53
54  # List of observation ids with the scans and cross scans needed to combine.
55  obsids = [1342211283, 1342211284]
56
```

and:

```
81
82  # Unimap installation directory path
83  unimapDir = '/your/Unimap/directory'
84
85  # MATLAB MCR directory path
86  mcrDir = '/your/MATLAB/Compiler/Runtime/directory'
87
88  # root of the data directory. The pipeline output files will be created and
89  # saved in the following directory: dataDir/firstObsid_lastObsid_camera
90  dataDir = '/your/data/directory'
91
```

## 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`.

```
60  """"
61  Unimap parameters
62  """"
63  # ppls high pass filter size in arcseconds (default 0). If it's set to 0,
64  # Unimap will use a size equal to half the size of the shortest scanleg,
65  # with an upper limit of 500 arcsec
66  filterSizeInArcsec = 0.
67
68  # Starting image for the gls (default -1): 0 zero image, 1 rebin, 2 highpass.
69  # Unimap will select the optimal starting image if any other number is given.
70  startImage = -1
71
```

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



```
*scanmap_Unimap.py x
128 # Calculate the Ra and Dec datasets if necessary
129 if not frames.containsKey("Ra"):
130     frames = photAssignRaDec(frames, calTree=calTree)
131 # Convert the signal units to Jy per fixed pixel size
132 frames = convertToFixedPixelSize(frames, calTree=calTree)[0]
133 # Add the frames to the list
134 framesList.append(frames)
135
136 del obsid, obs, levell, frames, calTree
137
138
139 """
140 Run Unimap
141 """
142 unimapMap = runUnimap(framesList=framesList, filterSize=filterSizeInArcsec, start
143                      outputPixelSize=outputPixelSize, wglSDThreshold=wglSDThresh
144                      unimapDir=unimapDir, mcrDir=mcrDir, dataDir=dataDir, writ
145                      rewriteParametersFile=rewriteParametersFile, cleanDataDir=c
146
147
148 """
149 Make sure the ra and dec metaData information is correct
150 """
151 unimapMap = centerRaDecMetaData(unimapMap)
152
153
154 """
155 Inspect the Unimap results
156 """
157 d = Display(unimapMap, title="Unimap results")
158
```

Observations

Other Data

- rewriteFramesFitsFiles
- rewriteParametersFile
- solarSystemObject
- startImage
- Unimap
- unimapDir
- unimapMap**
- version
- wglSDThreshold
- wglGThreshold

Outline x

Name	unimapMap
Class	SimpleImage
Package	herschel.ia.dataset.image

- unimapMap
  - image
  - error
  - coverage
  - pgls
  - gls
  - naive
  - History



# Unimap ipipe: Output

```
*scanmap_Unimap.py x
128 # Calculate the Ra and Dec datasets if necessary
129 if not frames.containsKey("Ra"):
130     frames = photAssignRaDec(frames, calTree=calTree)
131 # Convert the signal units to Jy per fixed pixel size
132 frames = convertToFixedPixelSize(frames, calTree=calTree)[0]
133 # Add the frames to the list
134 framesList.append(frames)
135
136 del obsid, obs, levell, frames, calTree
137
138
139 """
140 Run Unimap
141 """
142 unimapMap = runUnimap(framesList=framesList, filterSize=filterSizeInArcsec, start
143                      outputPixelSize=outputPixelSize, wglSDThreshold=wglSDThresh
144                      unimapDir=unimapDir, mcrDir=mcrDir, dataDir=dataDir, rewrit
145                      rewriteParametersFile=rewriteParametersFile, cleanDataDir=c
146
147
148 """
149 Make sure the ra and dec metaData information is correct
150 """
151 unimapMap = centerRaDecMetaData(unimapMap)
152
153
154 """
155 Inspect the Unimap results
156 """
157 d = Display(unimapMap, title="Unimap results")
158
```

Observations

Other Data

- rewriteFramesFitsFiles
- rewriteParametersFile
- SolarSystemObject
- startImage
- Unimap
- unimapDir
- unimapMap**
- version
- wglSDThreshold
- wglGThreshold

Name	unimapMap
Class	SimpleImage
Package	herschel.ia.dataset.image

- unimapMap
  - image
  - error
  - coverage
  - pglS
  - glS
  - naive
  - History

WGLS (default output image)





# 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](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 !**