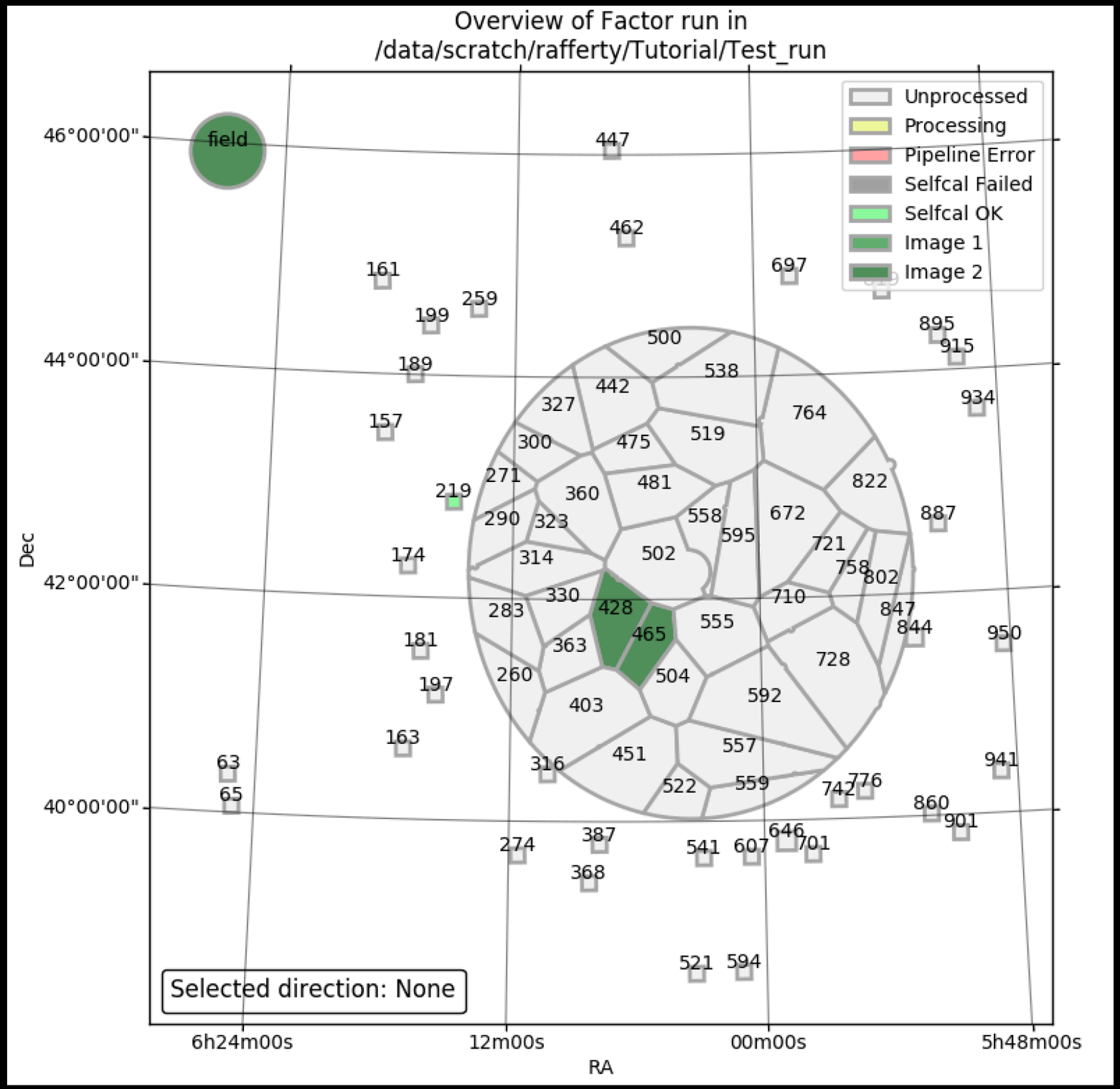
Tutorial:
Direction-Dependent Calibration
Part 3

Current State



Final Imaging

- Once selfcal has completed for all the facets being processed, Factor reimages the facets using the full bandwidth

- These are the final images, but they must be corrected for the primary beam attenuation

- So, once the reimaging is complete, Factor will mosaic the images together and correct them for the primary beam

Final Imaging

- Two images were made for each facet:

Image 1 is full resolution, Image2 is lower resolution

- The WSClean imaging parameters are set in the parset:

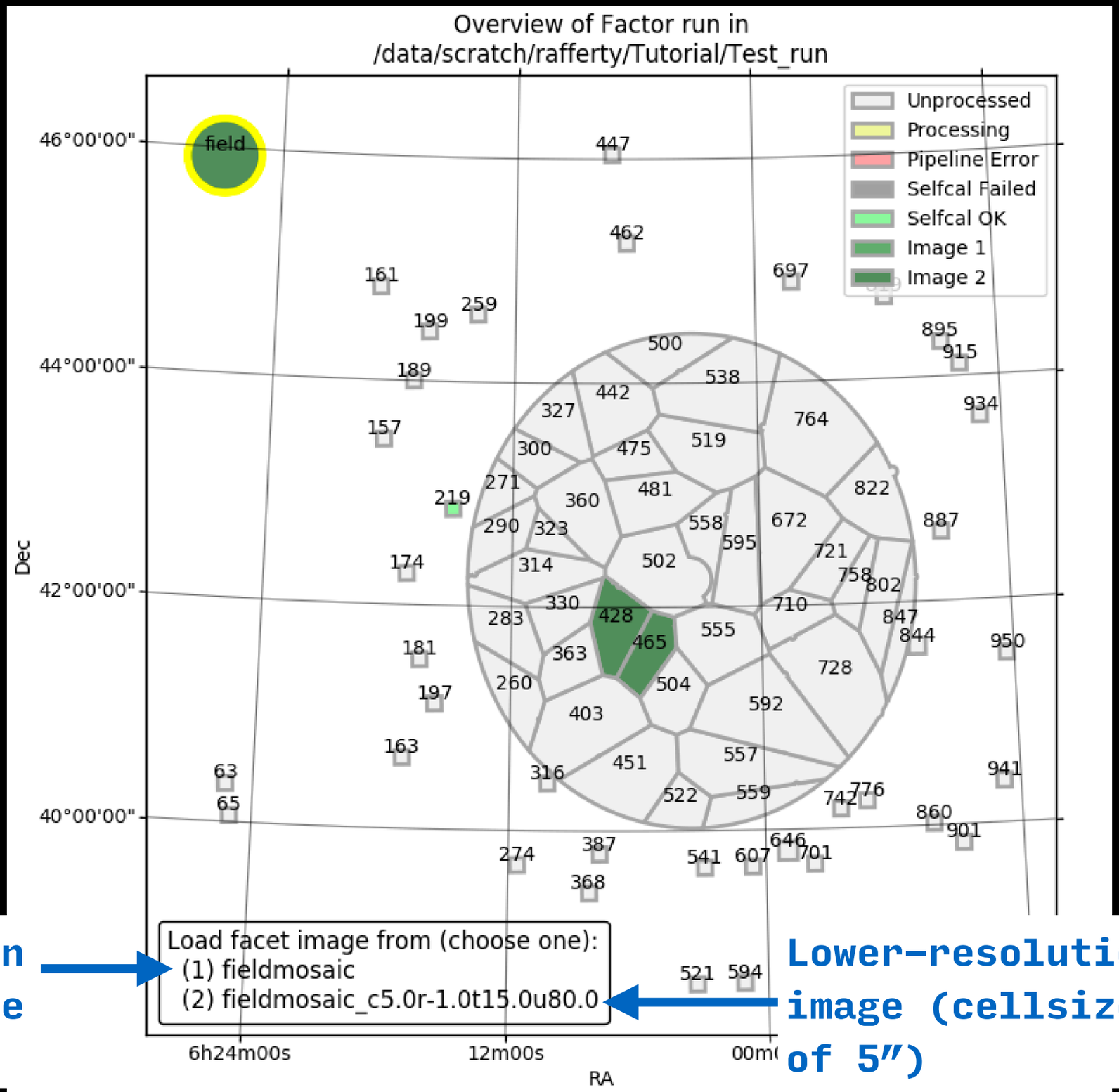
```
[imaging]
facet_cellsize_arcsec = [ 1.5,  5.0]
facet_robust          = [-0.5, -1.0]
facet_taper_arcsec    = [ 0.0, 15.0]
```

Image 1 **Image 2**

Final Mosaic

- Select the “field” direction (in the top-left corner)
- Hit the “i” key to list the available field images

Final Mosaic



Full-resolution image (cellsize of 1.5″)

Lower-resolution image (cellsize of 5″)

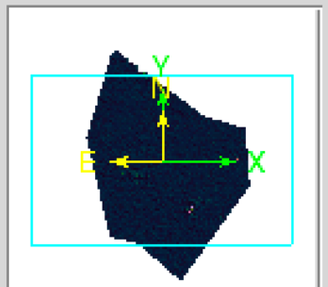
Final Mosaic

- Hit the “1” key to open the full-resolution image in ds9 (this may take a few seconds…)
- The facet regions should load automatically. If not, load them from the “Region” menu (from **`Factor_output/regions/facets_ds9.reg`**)

SAOImage ds9

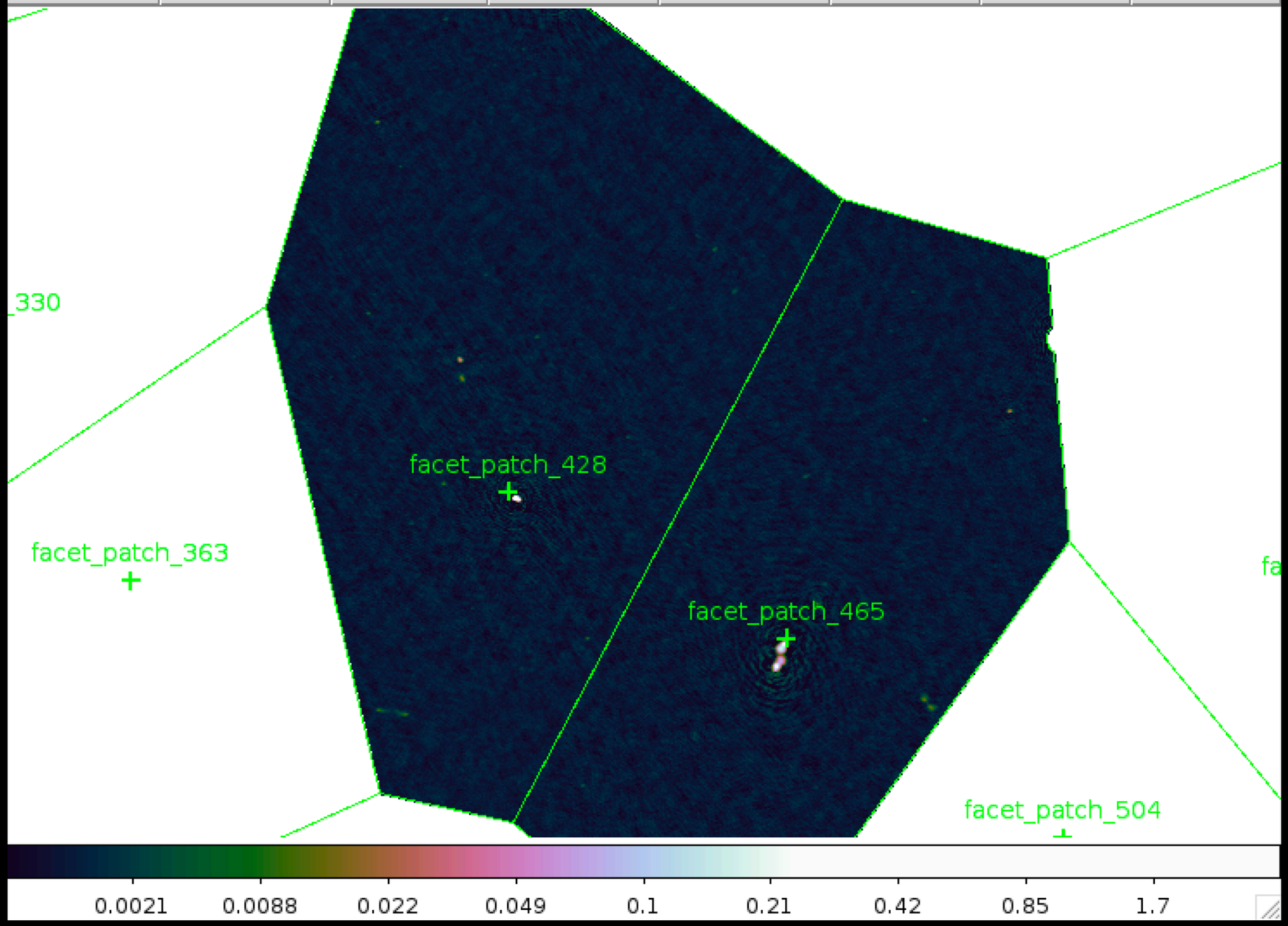
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help

File	L091539_SB244_uv_12A0F95E8t_133MHz.pre-cal_chur			
Object				
Value	nan			
fk5	α	6:04:05.192	δ	+41:44:22.702
Physical	X	2424.719	Y	1716.758
Image	X	2424.719	Y	1716.758
Frame 1	x	0.25		0 °



file edit view frame bin zoom scale color region wcs analysis help

zoom in zoom out zoom fit zoom 1/4 zoom 1/2 zoom 1 zoom 2 zoom 4



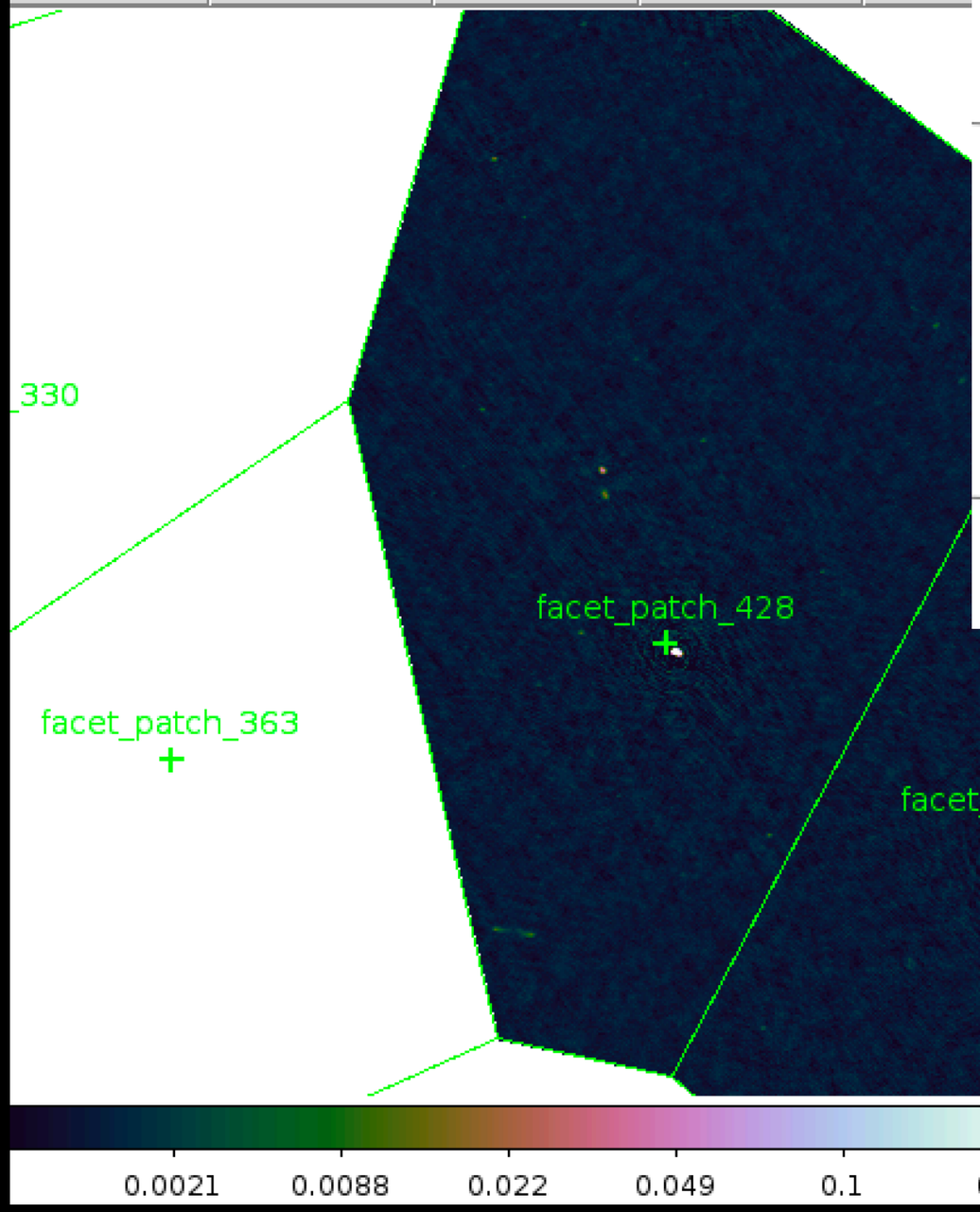
SAOImage ds9

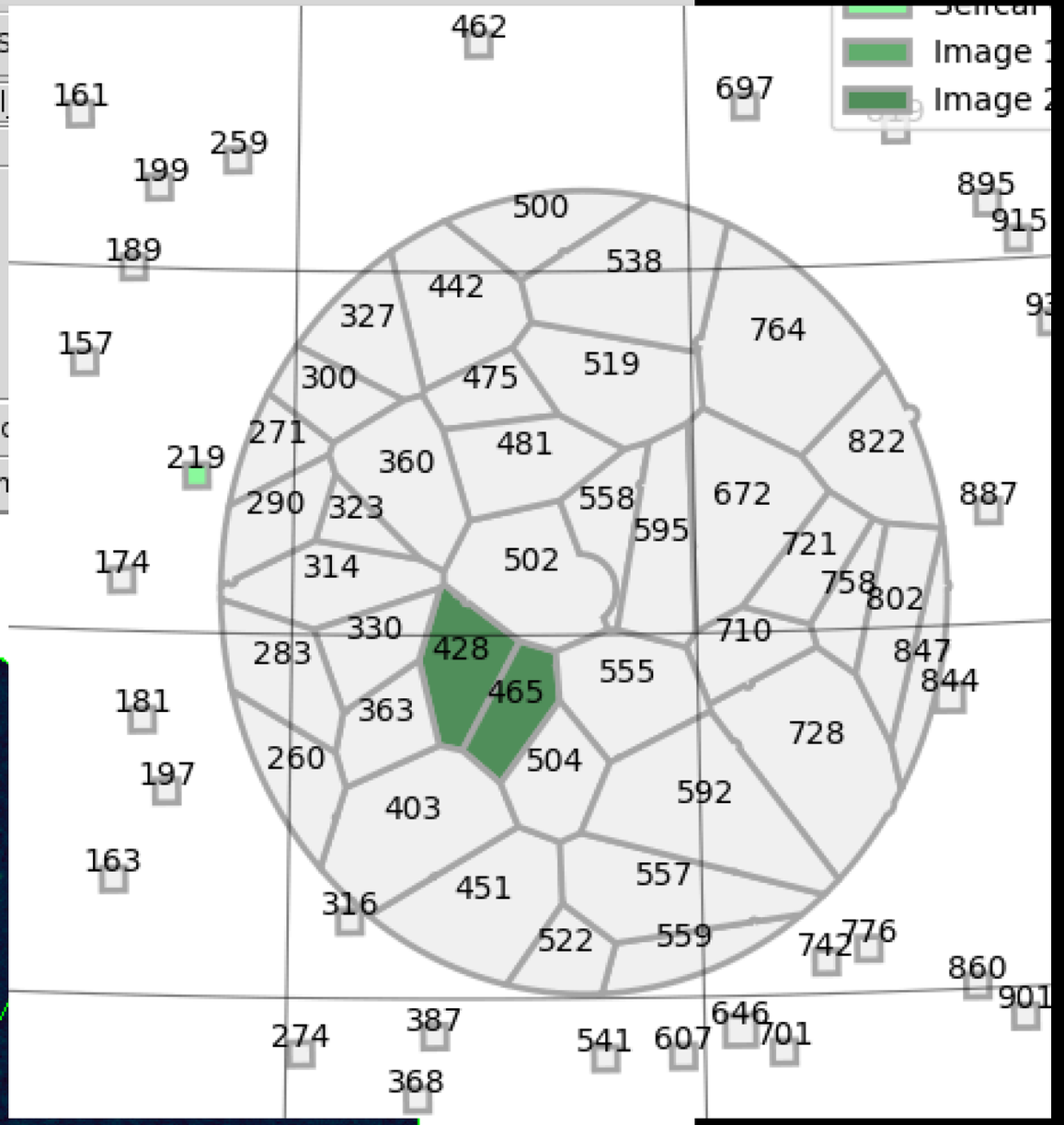
File Edit View Frame Bin Zoom Scale Color Region WCS

File	L091539_SB244_uv_12A0F95E8t_133MHz.pre-cal				
Object					
Value	nan				
fk5	α	6:04:05.192	δ	+41:44:22.702	
Physical	X	2424.719	Y	1716.758	
Image	X	2424.719	Y	1716.758	
Frame 1	x	0.25		0	°

file edit view frame bin zoom scale

zoom in zoom out zoom fit zoom 1/4 zoom





Final Mosaic

- Two mosaics are made for each set of imaging parameters:
  - **Factor_output/results/fieldmosaic/field/L091539_SB244_uv_12A0F95E8t_133MHz.pre-cal_chunk12.wsclean_image_full-image.correct_mosaic.pbcut.fits**

    Non-primary-beam corrected (“flat noise”). Loaded by checkfactor
  - **Factor_output/results/fieldmosaic/field/L091539_SB244_uv_12A0F95E8t_133MHz.pre-cal_chunk12.wsclean_image_full-image.correct_mosaic.pbcor.fits**

    Primary-beam corrected
- **Use the beam-corrected pbcor image for flux measurements**
  - You can use the flat-noise **pbcut** image during source detection, but usually not needed

Archiving the Results

- You can archive the results of a run using **`archivefactor`** tool:

```
$ archivefactor factor.parset archive_directory
```

- If you want to later resume a reduction from an archive, use the “-r” flag. Note that this will increase the size of the archive a lot!

- You can also use **`archivefactor`** to export the calibrated uv data for a facet (e.g., to image it in CASA):

```
$ archivefactor -d facet_patch_428 factor.parset archive_directory
```

  - Note that the facet must have been imaged first

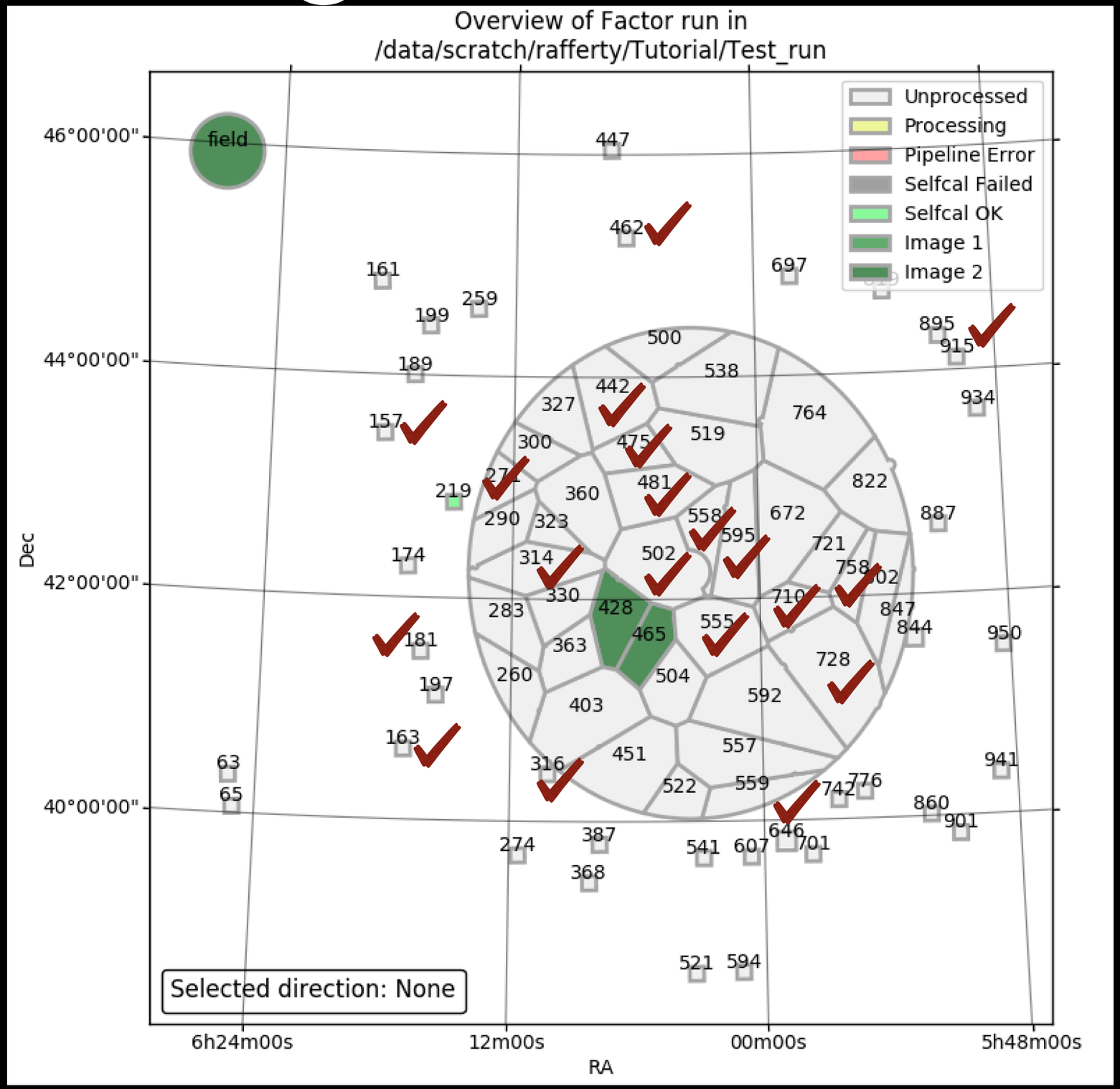
Doing a Real Run

- For a real run, you will typically want to process at least 10-15 facets using the full bandwidth
  - Process all the bright sources (S > 1 Jy)
  - Process all facets neighboring the target facet with S > 0.5 Jy

Doing a Real Run

```
facet_patch_428 6h06m58.2663s,41d41m05.4364s empty empty 0 0 0 LD empty empty empty False 0.0630167432052 5164.902
facet_patch_465 6h05m32.0635s,41d32m35.2269s empty empty 0 0 0 LD empty empty empty False 0.119815831353  3983.052
facet_patch_219 6h14m55.3294s,42d51m52.9319s empty empty 0 0 0 LD empty empty empty False 0.0871275710808 3064.898
facet_patch_181 6h16m21.593s,41d30m51.753s   empty empty 0 0 0 LD empty empty empty False 0.0849659868304 1977.998
facet_patch_646 5h58m58.3629s,39d48m37.4551s empty empty 0 0 0 LD empty empty empty False 0.167902036169  1965.264
facet_patch_728 5h56m52.6856s,41d44m42.1425s empty empty 0 0 0 LD empty empty empty False 0.0915769725428 1920.065
facet_patch_758 5h55m43.7777s,42d01m48.5151s empty empty 0 0 0 LD empty empty empty False 0.080999745687  1492.178
facet_patch_314 6h10m45.2455s,42d21m02.7874s empty empty 0 0 0 LD empty empty empty False 0.0744974807579 1389.868
facet_patch_915 5h49m54.812s,44d06m28.794s empty empty 0 0 0 LD empty empty empty False 0.0910266904803 1383.824
facet_patch_163 6h17m04.0673s,40d37m59.5432s empty empty 0 0 0 LD empty empty empty False 0.0605658575703 1295.521
facet_patch_316 6h10m12.2295s,40d25m27.1811s empty empty 0 0 0 LD empty empty empty False 0.0581381056526 1290.73
facet_patch_442 6h06m32.1832s,43d47m24.8448s empty empty 0 0 0 LD empty empty empty False 0.209474290284 1273.094
facet_patch_462 6h06m26.1941s,45d15m00.0726s empty empty 0 0 0 LD empty empty empty False 0.115869329898 1264.356
facet_patch_502 6h04m14.465s,42d21m17.927s empty empty 0 0 0 LD empty empty empty False 0.064784590398 1252.444
facet_patch_271 6h12m40.3568s,43d02m12.1519s empty empty 0 0 0 LD empty empty empty False 0.0989841397195 1178.017
facet_patch_157 6h18m24.3888s,43d28m20.7974s empty empty 0 0 0 LD empty empty empty False 0.072224340726 1159.302
facet_patch_475 6h05m14.1281s,43d17m45.835s empty empty 0 0 0 LD empty empty empty False 0.19832921434 1134.055
facet_patch_710 5h57m24.7225s,41d56m43.0299s empty empty 0 0 0 LD empty empty empty False 0.190095797313 1077.309
…
```

Doing a Real Run



Doing a Real Run

```
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facet_patch_475 6h05m14.1281s,43d17m45.835s empty empty 0 0 0 LD empty empty empty False 0.19832921434 1134.055
facet_patch_710 5h57m24.7225s,41d56m43.0299s empty empty 0 0 0 LD empty empty empty False 0.190095797313 1077.309
facet_patch_558 6h02m30.8589s,42d28m14.3675s empty empty 0 0 0 LD empty empty empty False 0.0466297438347 971.509
facet_patch_555 6h02m34.2174s,41d34m55.7849s empty empty 0 0 0 LD empty empty empty False 0.055672716695 895.137
facet_patch_595 6h01m21.445s,42d25m52.4703s empty empty 0 0 0 LD empty empty empty False 0.0449017992423 780.537
facet_patch_481 6h05m05.4216s,43d04m38.5389s empty empty 0 0 0 LD empty empty empty False 0.0450551331304 556.151
…
```
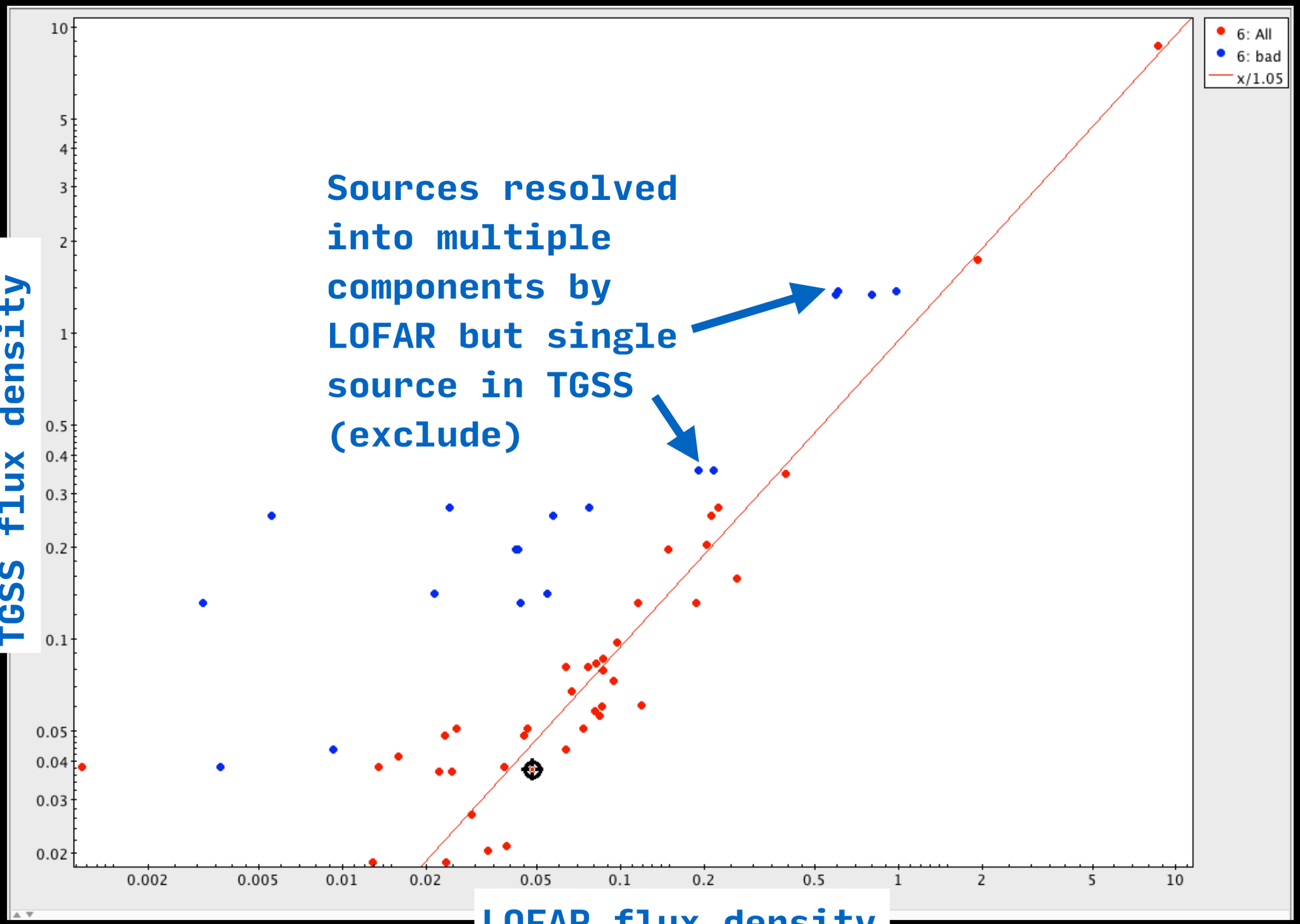

- Set **`ndir_process = 22`** under the **`[directions]`** section

Checking the Flux Scale

- Due to problems with the LOFAR beam model, the flux scale can be off by up to 15% or so
- You can check by comparing the flux densities of bright sources in the mosaic with the TGSS catalog:
  - Measure flux densities with PyBDSF
  - Use TOPCAT to cross match to TGSS
  - Find average ratio of fluxes for the bright, compact sources (i.e., those with smallest measurement error)

Checking the Flux Scale



Troubleshooting

- Selfcal fails:
  - Insufficient signal-to-noise on long baselines (i.e., not enough bright, compact emission) — use a different calibrator
  - Complex source — try supplying a starting model for the source (e.g., from a higher-frequency image)
- If the troublesome facet is your target, you can try to transfer solutions from the nearest successful calibrator
- **See the documentation and cookbook for more hints**

Troubleshooting

- If something goes wrong, check the logs. E.g.:
  - **`Factor_output/logs/facetselfcal/facet_patch_428.out.log`**
- Logs can be *very* large—the easiest way to find the error is to search backwards for the word “error”:
  - In emacs, do:
    - Hit CTRL-R
    - Type “error”
    - Hit CTRL-R repeatedly to search backwards

Troubleshooting

- Technical problems:
  - Check for similar issues (or raise a new one) on the Factor GitHub issues page at:
  - https://github.com/lofar-astron/factor/issues

Additional Features

- Supports multi-epoch datasets (interleaved or multiple nights)
- Some support for flagging of bad data
- Peeling of sources (must provide sky model)