5 Appendix: Guide for Generating Images

The following documentation outlines how to generate a custom-image utilizing a VLASS observation of a source. For the first half of this documentation we will be looking at the high-powered quasar [HB89] 0805+046, known in this guide as J0807+0432.

The first step in generating a custom image is to identify the required measurement sets for which data is to be pulled from. The code for this is located at the following link to my Github repository. This file as well as the CSV defining tile locations located here, should be placed in a working directory. It is recommended that the user use an online iPython interface like a Jupyter Notebook or Google Collab. Although utilizing Python in a command-line setting will also work, it may require changes which are beyond the scope of this guide.

Running the code, and following the prompts to enter the Right Ascension and Declination in decimal degrees as well as an integer with the number of arcseconds for which we want to produce an image, we are given the output in Figure 5 identifying which measurement sets are required.

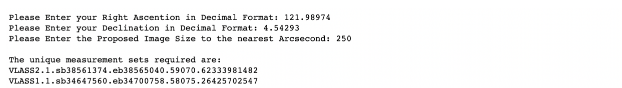


Figure 5: Prompts and Results Presented by the Jupyter Notebook

For the purposes of this guide, we will use the VLASS2.1.sb38561374.eb38565040.59070.62333981482 measurement set. To obtain our calibration products we will go to data.nrao.edu. Simply copying and pasting the string of our measurement set we are presented with the screen in Figure 6.

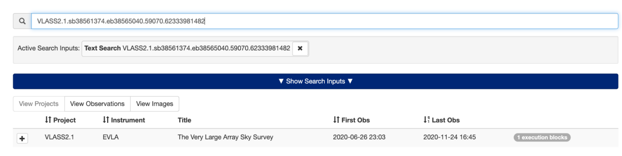


Figure 6: Copying and Pasting the Measurement Set Name into the Archive

Selecting the cross, the clipboard and "download" we are presented with the screen presented in Figure 7.

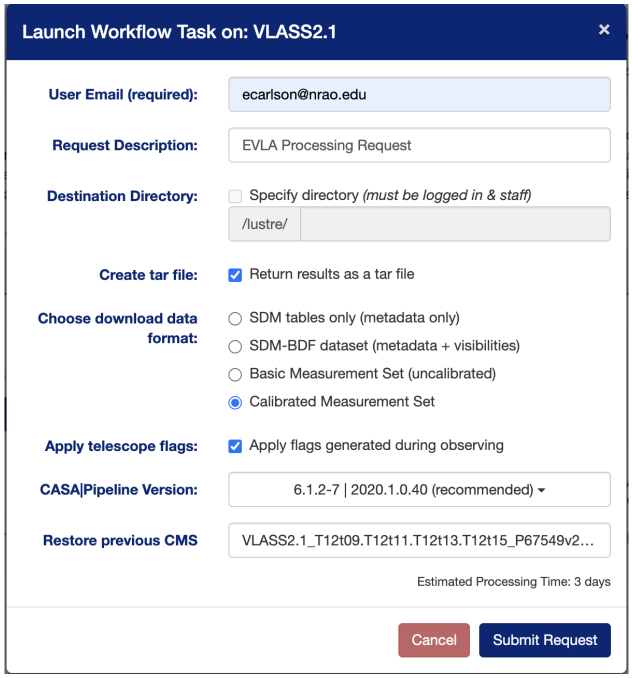
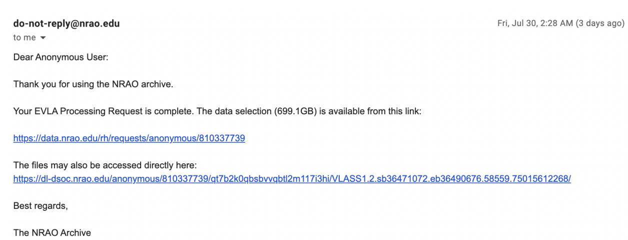


Figure 7: Copying and Pasting the Measurement Set Name into the Archive

We must then enter our email and submit the request.

After the archive applies the calibration tables, which will take roughly 3-4 days if we request that the file be delivered as a tarball or 1-2 days if we will use wget recursively, we will receive an email similar to the one in Figure 8.


do-not-reply@nrao.edu
Fri, Jul 30, 2:28 AM (3 days ago)
to me

Dear Anonymous User:

Thank you for using the NRAO archive.

Your EVLA Processing Request is complete. The data selection (699.1GB) is available from this link:

https://data.nrao.edu/rh/requests/anonymous/810337739

The files may also be accessed directly here:
https://dl-dsoc.nrao.edu/anonymous/810337739/qt7b2k0qbsbvvqbtl2m117i3hi/VLASS1.2.sb36471072.eb36490676.58559.75015612268/

Best regards,

The NRAO Archive

Figure 8: A sample email provided by the archive alerting the user their data is ready.

Logging into our NRAO compute cluster account, we can use the *wget* command to transfer our data to a working directory. For the case below (which is a different measurement set and a unique location from what the user will receive) is:

```
wget -r  https://dl-dsoc.nrao.edu/anonymous/810337739/
    qt7b2k0qbsbvvqbtl2m117i3hi/VLASS2.1.sb38561374.eb38565040
    .59070.62333981482
```

Once the data has transferred (generally >100 minutes), we can begin to run some of our custom scripts before we begin the VLASS pipeline. The first of these scripts is used to identify what fields are required. To utilize the script, located here, the user must first open a version of casa containing the pipeline. This must be done in the working directory containing the VLASS measurement set.

Additionally, the user must have also generated a text file which will contain their list of image parameters. The text file should contain the desired image name, image center, image mode and image size. To calculate the image size this Python script can be used. If a custom cell size is to be selected it must be put into the image parameters file. A sample of a complete image parameters file is located here. This text file must also be in the working directory.

Once these preliminary steps are complete, the user can copy and paste the carlson_editimlist_prep.py file into CASA to initialize the function. The user should then run the following command:

```
field_list = carlson_editimlist_prep('VLASS2.1.sb38561374.eb38565040
    .59070.62333981482.ms', 500, 'J2000 08:07:57.5 +04.32.34.6', matchregex
    =['^0', '^1', '^2'])
```

Where the first argument is the string for the measurement set, the second is an integer with the desired image size in arcseconds and the desired phase center. The matchregex argument should be left as the default value.

Once the script is done running, the user can now run the split command on the original dataset and remove it from disk. This is done using the following command:

```
split(vis = 'VLASS2.1.sb38561374.eb38565040.59070.62333981482.ms', outputvis =
     'name_for_ms.ms', field = field_list)
```

Now that the data has been properly split off, the user can now run a normal VLASS SE imaging pipeline script with the exception of custom image parameters. To complete this, the user must generate a working directory with the following structure:

```
SourceName
├── working
└── products
    ├── command_script.py
    ├── run_SE_SourceName.sh
    └── image_parameter.list
```

Examples of the command script, run script and image parameter script are located here. To calculate the required image size, the user must first choose a cell size. The default for quick-look images is 1 arcsecond with the default for Single Epoch images being 0.6 arcseconds. Once the cell size has been determined, the user must then calculate an image size using the following formula:

$$P = (I + 1000)/C \tag{1}$$

Where I is the image size in arcseconds, C is the cell size in arcseconds and P is the image size in pixels. It is this value P which is appended to the image_parameter.list file. It is important to note that *tclean* is optimized for imsize values that are even and factorizable by 2,3,5,7 only. A helpful tool to assist with determining the proper image size is located here.

Once the directory structure, image parameter list, command script and shell script are properly formatted, the user can now submit a non-interactive job using the methodology outline here. Upon the completion of the run, the user should inspect the weblog for warnings and errors. Interpreting and troubleshooting errors during the VLASS imaging pipeline should be directed to the NRAO help desk.

References

Comrie, A., Wang, K.-S., Hsu, S.-C., et al. 2021, CARTA: The Cube Analysis and Rendering Tool for Astronomy, v2.0.0, Zenodo, doi:10.5281/zenodo.3377984

Gobeille, D. B., Wardle, J. F. C., & Cheung, C. C. 2014, arXiv e-prints, arXiv:1406.4797

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