VLA Pipeline(s) & SRDP

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Slides courtesy of Drew Medlin (NRAO)

VLA Calibration Pipeline – Overview

- With the start of (Jansky) VLA Full Operations (January 2013), pipeline automatically run on all Scheduling Blocks as soon as the data are ingested into the archive (over 24,700 to date):
  - Deliver flagged and calibrated visibility data
  - You will self-calibrate and image visibility data to meet science goals, using resources at home institution or NRAO computing resources

- Automated pipeline should run correctly on all "standard" Stokes I science SBs; "standard" means:
  - 128 MHz spws, but may work on other set-ups as well
    - Some constraints on strength of calibrators needed
  - Contains correctly labeled and complete scan intents

→ at the minimum: flux density calibrator, complex gain calibrator

VLA Calibration Pipeline – Overview

- The pipeline successfully completes on ~96% of all science SBs observed on the VLA; whether the output can be used for science depends on the science goal, and whether the observations were correctly set up

Caveats:
spectral line projects,
& polarisation observations

- Current versions available:
  - CASA integrated pipeline: compatible with ALMA pipeline infrastructure, and used as real-time pipeline since Sep 2015
  - "scripted" pipeline: collection of python scripts that use CASA tasks wherever possible, but also uses toolkit calls; readable and easy to modify. It was the original VLA pipeline and in use in real-time pipeline operations from early 2013 and until Sep 2015.

VLA Calibration Pipeline – Overview

- Real-time pipeline at NRAO:
  - Minimal human intervention: Pipeline is run automatically on *every* science SB as it completes (not just "continuum")
  - Pipeline output undergoes basic quality assurance checks by NRAO staff, and detailed checks are made for most C-band and higher continuum; reports generated are archived as pipeline products

- At your home institution:
  - Instructions for installation and operation of the VLA CASA Calibration Pipeline are available at http://go.nrao.edu/vla-pipe
    - Uses CASA 6.2.1, similar to current real-time pipeline
    - See the VLA CASA pipeline guide at http://go.nrao.edu/vla-casa-tut

Pipeline Heuristics

- Assuming requirements are met, the pipeline:
  - Loads the data (SDM-BDF → MS)
  - Hanning smoothing*
  - Retrieves information about the observing set-up from the data
  - Applies deterministic flags (online flags, shadowed data, end channels of spectral windows, etc.)
  - Identifies primary calibrators and loads models

*May want to modify inputs and/or omit entirely for spectral line reductions, unless heavily impacted by RFI or dealing with a very strong spectral line feature.

Pipeline Heuristics

- Derives all prior calibrations (antenna position corrections, gain curves, atmospheric opacity, requantizer gains)
- Iteratively determines initial delay and bandpass solutions, including running RFLAG, and identifying system problems
- Derives initial gain solutions, does flux density bootstrapping and derives spectral index of all calibrators, sets models.
- Derives final delay, bandpass, and complex gain calibrations
- Applies all calibrations to the MS
- Runs RFLAG algorithm on all fields, including target*
- Runs statwt to derive proper relative weights per antenna/spw*

Pipeline Weblog

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Observation Overview

Project	uid://evla/pdb/35621723
Principal Investigator	Dr. Emmanuel Momjian
Observation Start	2018-10-04 05:41:35 UTC
Observation End	2018-10-04 08:32:45 UTC

Pipeline Summary

Pipeline Version	2021.2.0.128
CASA Version	6.2.1.7 (environment)
IERSeop2000 Version	0001.0151 (last date: 2021-08-01 00:00:00)
IERSpredict Version	0623.0600 (last date: 2022-01-01 00:00:00)
Pipeline Start	2021-11-16 15:08:01 UTC
Execution Duration	4:31:14

Observation Summary

			Time (UTC)			Baseline Length			
Measurement Set	**Receivers**	**Num Antennas**	**Start**	**End**	**On Target**	**Min**	**Max**	**RMS**	**Size**
Scheduling Block ID: uid://evla/pdbsb/35624494									
Session: default									
TDRW0001.sb35624494.eb35628826.58395.23719237269.ms	13cm (S)	27	2018-10-04 05:41:35	2018-10-04 08:32:45	2:13:55	40.0 m	1.0 km	441.9 m	11.7 GB
TDRW0001.sb35624494.eb35[illegible]8826.58395.23719237269_target.ms	13cm (S)	27	2018-10-04 06:04:00	2018-10-04 08:30:00	2:13:55	40.0 m	1.0 km	441.9 m	9.2 GB

Pipeline Weblog

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Session: default

TDRW0001.sb35624494.eb35628826

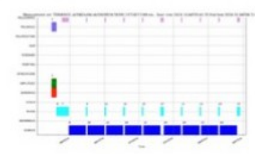
TDRW0001.sb35624494.eb35628826

Overview of 'TDRW0001.sb35624494.eb35628826.58395.23719237269.ms'

Observation Execution Time

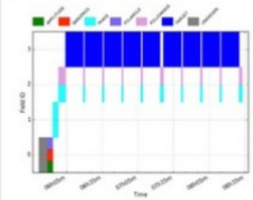
Start Time	2018-10-04 05:41:35
End Time	2018-10-04 08:32:45
Total Time on Source	2:49:14
Total Time on Science Target	2:13:55

LISTOBS OUTPUT



Intent vs Time

Track scan intent vs time



Field vs Time

Track observed field vs time

Spatial Setup

Science Targets	'3C75'
Calibrators	'0137+331=3C48', 'J0259+0747' and 'J2355+4950'

Spectral Setup

All Bands	'13cm (S)' and '6cm (C)'
Science Bands	'13cm (S)'
VLA Bands: Basebands: Freq range: [spws]	S: A0C0: 2.487 GHz to 3.511 GHz: [2,3,4,5,6,7,8,9]

Antenna Setup

Min Baseline	40.0 m

Sky Setup

Min Elevation	36.89 degrees

Pipeline Weblog

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Session: default

TDRW0001.sb35624494.eb35628826

TDRW0001.sb35624494.eb35628826

listobs.txt

BACK

```
================================================================================
           MeasurementSet Name:  /lustre/aoc/projects/srdp/pipeline-validation/6.2/shortSB-and-multiband/S-guide-621v7_tarball_1116/working/TDRW0001.sb35624494.
eb35628826.58395.23719237269.ms      MS Version 2
================================================================================
   Observer: Dr. Emmanuel Momjian     Project: uid://evla/pdb/35621723
Observation: EVLA
Data records: 5752188       Total elapsed time = 10270 seconds
   Observed from   04-Oct-2018/05:41:35.0   to   04-Oct-2018/08:32:45.0 (UTC)

   ObservationID = 0         ArrayID = 0
  Date        Timerange (UTC)          Scan  FldId FieldName             nRows     SpwIds   Average Interval(s)    ScanIntent
  04-Oct-2018/05:41:35.0 - 05:42:31.0     1      0 0137+331=3C48            39312  [0,1]  [1, 1] [SYSTEM_CONFIGURATION#UNSPECIFIED]
              05:42:32.0 - 05:47:30.0     2      0 0137+331=3C48           209196  [0,1]  [1, 1] [SYSTEM_CONFIGURATION#UNSPECIFIED]
              05:47:35.0 - 05:48:30.0     3      0 0137+331=3C48            30888  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [SYSTEM_CONFIGURATION#UNSPECIFIE
D]
              05:48:35.0 - 05:49:00.0     4      0 0137+331=3C48            14040  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [SYSTEM_CONFIGURATION#UNSPECIFIE
D]
              05:49:05.0 - 05:53:25.0     5      0 0137+331=3C48           146016  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [CALIBRATE_BANDPASS#UNSPECIFIED,C
ALIBRATE_FLUX#UNSPECIFIED,CALIBRATE_POL_ANGLE#UNSPECIFIED]
              05:53:30.0 - 05:57:55.0     6      1 J2355+4950              148824  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#UNSPECIFIED]
              05:58:00.0 - 06:03:55.0     7      2 J0259+0747              199368  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#UNSPECIFIED,CALIBRATE_POL_LEAKAGE#UNSPECIFIED]
              06:04:00.0 - 06:18:55.0     8      3 3C75                    502632  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [OBSERVE_TARGET#UNSPECIFIED]
              06:19:00.0 - 06:20:10.0     9      2 J0259+0747               39312  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#UNSPECIFIED,CALIBRATE_POL_LEAKAGE#UNSPECIFIED]
              06:20:15.0 - 06:35:05.0    10      3 3C75                    499824  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [OBSERVE_TARGET#UNSPECIFIED]
              06:35:10.0 - 06:36:20.0    11      2 J0259+0747               39312  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#UNSPECIFIED,CALIBRATE_POL_LEAKAGE#UNSPECIFIED]
              06:36:25.0 - 06:51:20.0    12      3 3C75                    502632  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [OBSERVE_TARGET#UNSPECIFIED]
              06:51:25.0 - 06:52:30.0    13      2 J0259+0747               36504  [2,3,4,5,6,7,8,9]  [5, 5, 5, 5, 5, 5, 5, 5] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
```

Pipeline Weblog

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Project Code N/A

Task Summaries

Task		QA Score	Duration
1. **hifv_importdata**: Register VLA measurement sets with the pipeline		1.00	0:08:34
2. **hifv_hanning**: VLA Hanning Smoothing	No QA	N/A	0:03:42
3. **hifv_flagdata**: VLA Deterministic flagging		1.00	0:06:18
4. **hifv_vlasetjy**: Set calibrator model visibilities		1.00	0:01:35
5. **hifv_priorcals**: Priorcals (gaincurves, opacities, antenna positions corrections, rq gains, and switched power)	No QA	N/A	0:27:51
6. **hifv_testBPdcals**: Initial test calibrations		1.00	0:05:35
7. **hifv_checkflag**: Checkflag summary		0.97	0:02:02
8. **hifv_semiFinalBPdcals**: Semi-final delay and bandpass calibrations		1.00	0:05:23
9. **hifv_checkflag**: Checkflag summary		1.00	0:06:41
10. **hifv_solint**: Determine solint and Test gain calibrations		1.00	0:03:01
11. **hifv_fluxboot**: Gain table for flux density bootstrapping		0.96	0:03:40
12. **hifv_finalcals**: Final Calibration Tables		1.00	0:09:42
13. **hifv_applycals**: Apply calibrations from context		1.00	0:05:20
14. **hifv_checkflag**: Checkflag summary		1.00	0:36:18
15. **hifv_targetflag**: Targetflag		1.00	0:06:40
16. **hifv_statwt**: Reweight visibilities		1.00	0:13:01
17. **hifv_plotsummary**: VLA Plot Summary		1.00	0:09:17
18. **hif_makeimlist**: Set-up parameters for phase calibrator & bandpass calibrator imaging		1.00	0:00:35
19. **hif_makeimages**: Make calibrator images		1.00	0:08:05
20. **hifv_exportdata**: Prepare pipeline data products for export		1.00	0:02:27
21. **hif_mstransform**: Create science target MS		1.00	0:05:30
22. **hif_checkproductsize**: Check product size		1.00	0:01:45
23. **hif_makeimlist**: Set-up parameters for target aggregate continuum imaging		1.00	0:01:26
24. **hif_makeimages**: Make target aggregate continuum images		1.00	1:33:50
25. **hifv_pbcor**: Pbcor	No QA	N/A	0:00:04
26. **hifv_exportdata**: Prepare pipeline data products for export		1.00	0:02:40

Pipeline Weblog

- The following pipeline steps provide key checks for calibration quality:
  - hifv_flagdata *deterministic flagged data fraction*
  - hifv_testBPdcals *hardware problems and other obs. issues*
  - hifv_solint *solution intervals for phase cals, input gain tables*
  - hifv_fluxboot *fitted calibrator flux densities and spectral indices*
  - hifv_finalcals *final calibration tables applied to the data*
  - hifv_plotsummary *useful diagnostic plots of calibrated data*

Deterministic Flagging (hifv_flagdata)

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Project Code N/A

Tasks in execution order

1. hifv_importdata
2. hifv_hanning
3. hifv_flagdata
4. hifv_vlasetjy
5. hifv_priorcals
6. hifv_testBPdcals
7. hifv_checkflag
8. hifv_semiFinalBPdcals
9. hifv_checkflag
10. hifv_solint
11. hifv_fluxboot
12. hifv_finalcals
13. hifv_applycals
14. hifv_checkflag
15. hifv_targetflag
16. hifv_statwt
17. hifv_plotsummary
18. hif_makeimlist (cals)
19. hif_makeimages (cals)
20. hifv_exportdata
21. hif_mstransform
22. hif_checkproductsize
23. hif_makeimlist (cont)
24. hif_makeimages (cont)
25. hifv_pbcor
26. hifv_exportdata

Data Selection (by intent)	Before Task	Flagging Agent (Total Vis)			Flagging Agent (Science Vis)							Total Science	Measurement Set
		ANOS	Shadowed Antennas	Unwanted Intents	Other Online Flags	Flagging Template	Autocorr	Edge Channels	Clipping	Quack	Baseband		TDRW0001.sb35624494.eb35628826.58395.23719237269.ms
All Data	3.125%	7.358%	0.000%	2.892%	0.850%	0.000%	0.000%	0.000%	0.000%	0.000%	3.598%	4.448%	4.448%
Science Spectral Windows	3.125%	5.831%	0.000%	0.595%	0.755%	0.000%	0.000%	0.000%	0.000%	0.000%	3.602%	4.357%	4.357%
Bandpass	3.125%	1.863%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	3.629%	3.629%	3.629%
Flux	3.125%	1.863%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	3.629%	3.629%	3.629%
Phase	3.125%	28.775%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	3.629%	3.629%	3.629%
Target	3.125%	1.948%	0.000%	0.000%	0.626%	0.000%	0.000%	0.000%	0.000%	0.000%	3.606%	4.232%	4.232%
TDRW0001.sb35624494.eb35628826.58395.23719237269.ms	3.125%	7.358%	0.000%	2.892%	0.850%	0.000%	0.000%	0.000%	0.000%	0.000%	3.598%	4.448%	

Summary of flagged data. Each cell states the amount of data flagged as a fraction of the specified data selection, with the *Flagging Agent* columns giving this information per flagging agent.

Flagging reason vs time

Plots of flagging reason vs time. The reasons for flagging the data are defined in the plot legend.

TDRW0001.sb35624494.eb35628826.58395.23719237269.ms

Pipeline QA

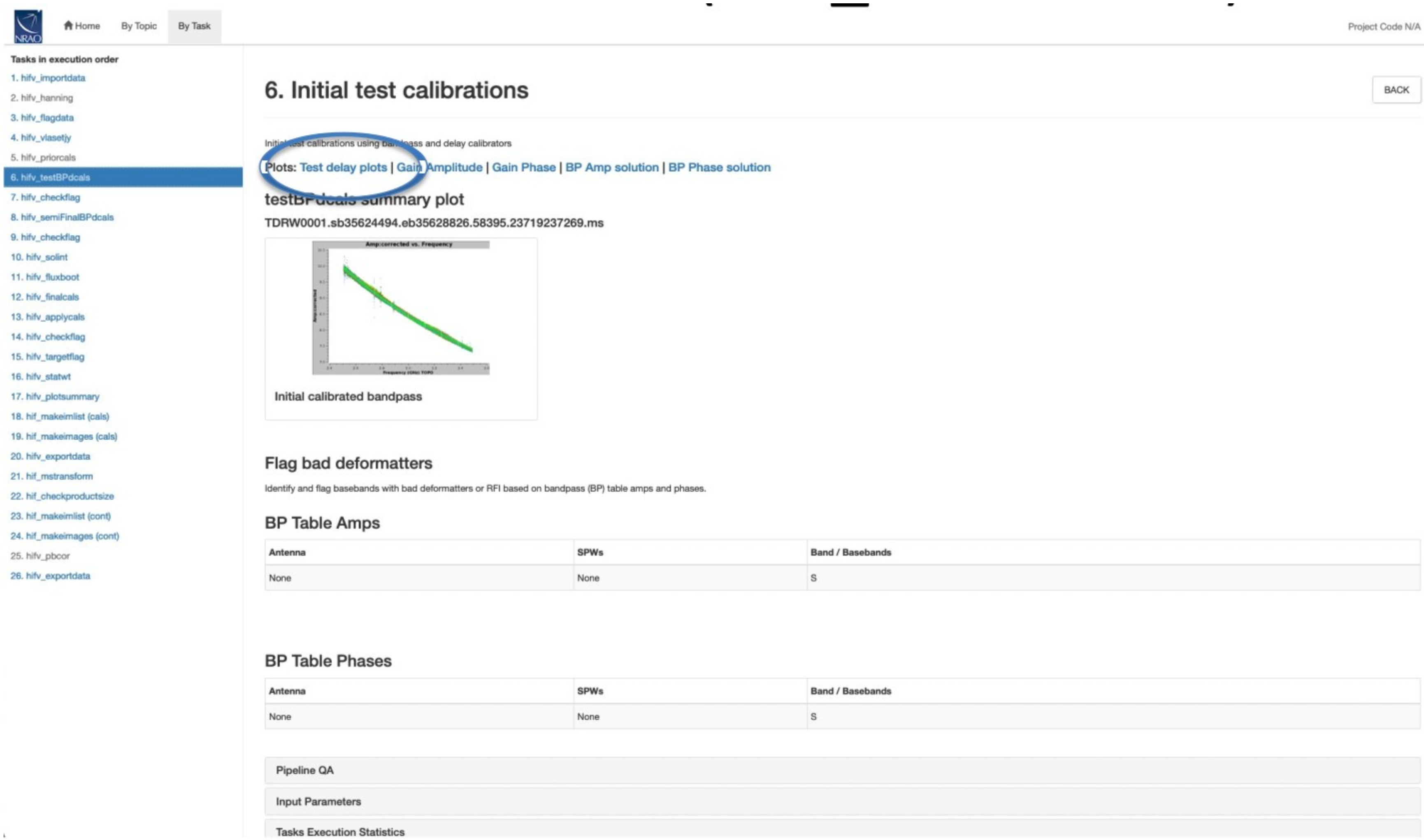
Input Parameters

Tasks Execution Statistics

CASA logs for stage 3

- View or download stage3/casapy.log (123.0 KB)

Hardware issues (hifv_testBPdcals)



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Project Code N/A

Tasks in execution order

1. hifv_importdata
2. hifv_hanning
3. hifv_flagdata
4. hifv_vlasetjy
5. hifv_priorcals
6. hifv_testBPdcals
7. hifv_checkflag
8. hifv_semiFinalBPdcals
9. hifv_checkflag
10. hifv_solint
11. hifv_fluxboot
12. hifv_finalcals
13. hifv_applycals
14. hifv_checkflag
15. hifv_targetflag
16. hifv_statwt
17. hifv_plotsummary
18. hif_makeimlist (cals)
19. hif_makeimages (cals)
20. hifv_exportdata
21. hif_mstransform
22. hif_checkproductsize
23. hif_makeimlist (cont)
24. hif_makeimages (cont)
25. hifv_pbcor
26. hifv_exportdata

6. Initial test calibrations

BACK

Initial test calibrations using bandpass and delay calibrators

Plots: Test delay plots | Gain Amplitude | Gain Phase | BP Amp solution | BP Phase solution

testBPdcals summary plot

TDRW0001.sb35624494.eb35628826.58395.23719237269.ms

Initial calibrated bandpass

Flag bad deformatters

Identify and flag basebands with bad deformatters or RFI based on bandpass (BP) table amps and phases.

BP Table Amps

Antenna	SPWs	Band / Basebands
None	None	S

BP Table Phases

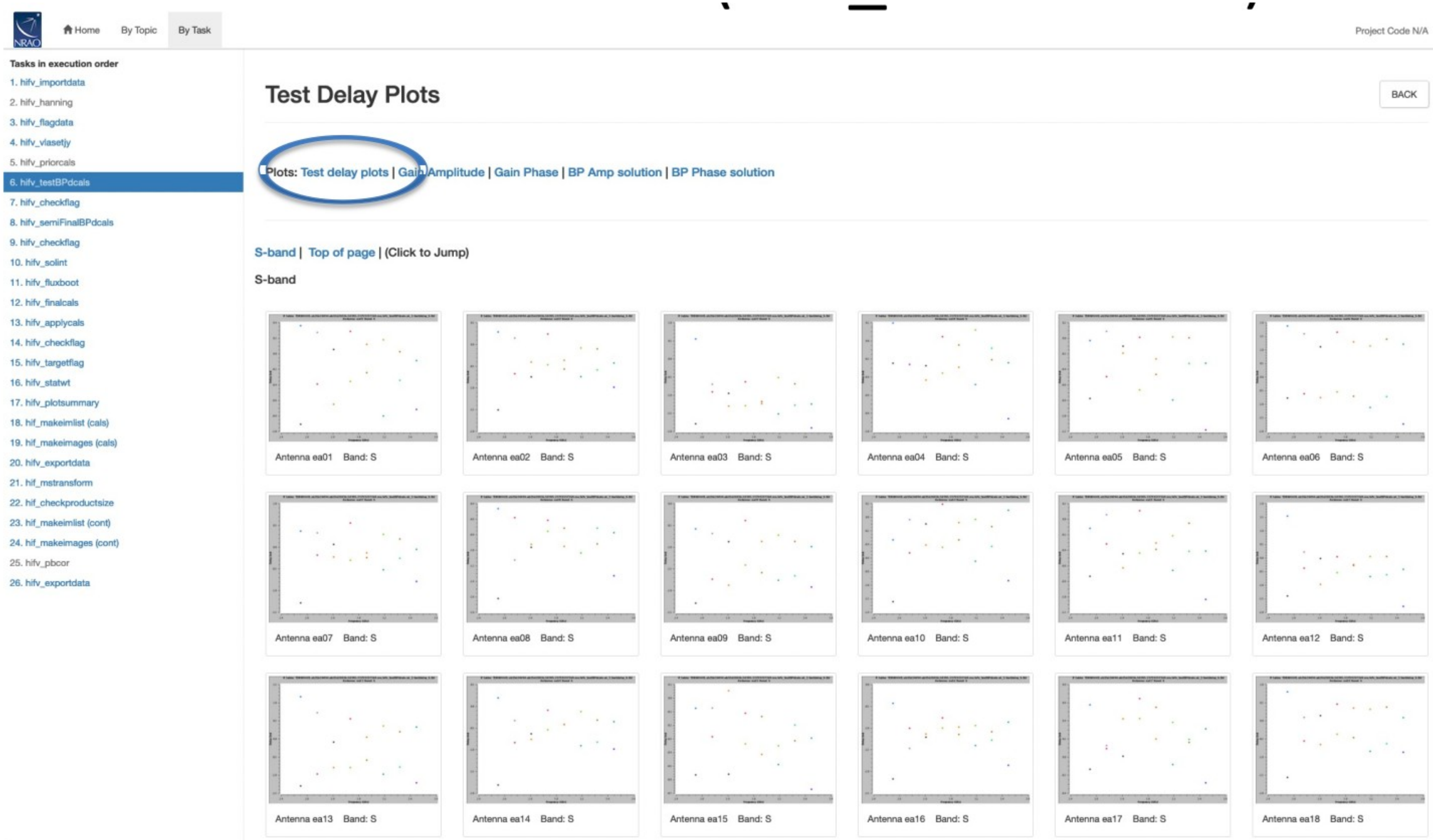
Antenna	SPWs	Band / Basebands
None	None	S

Pipeline QA

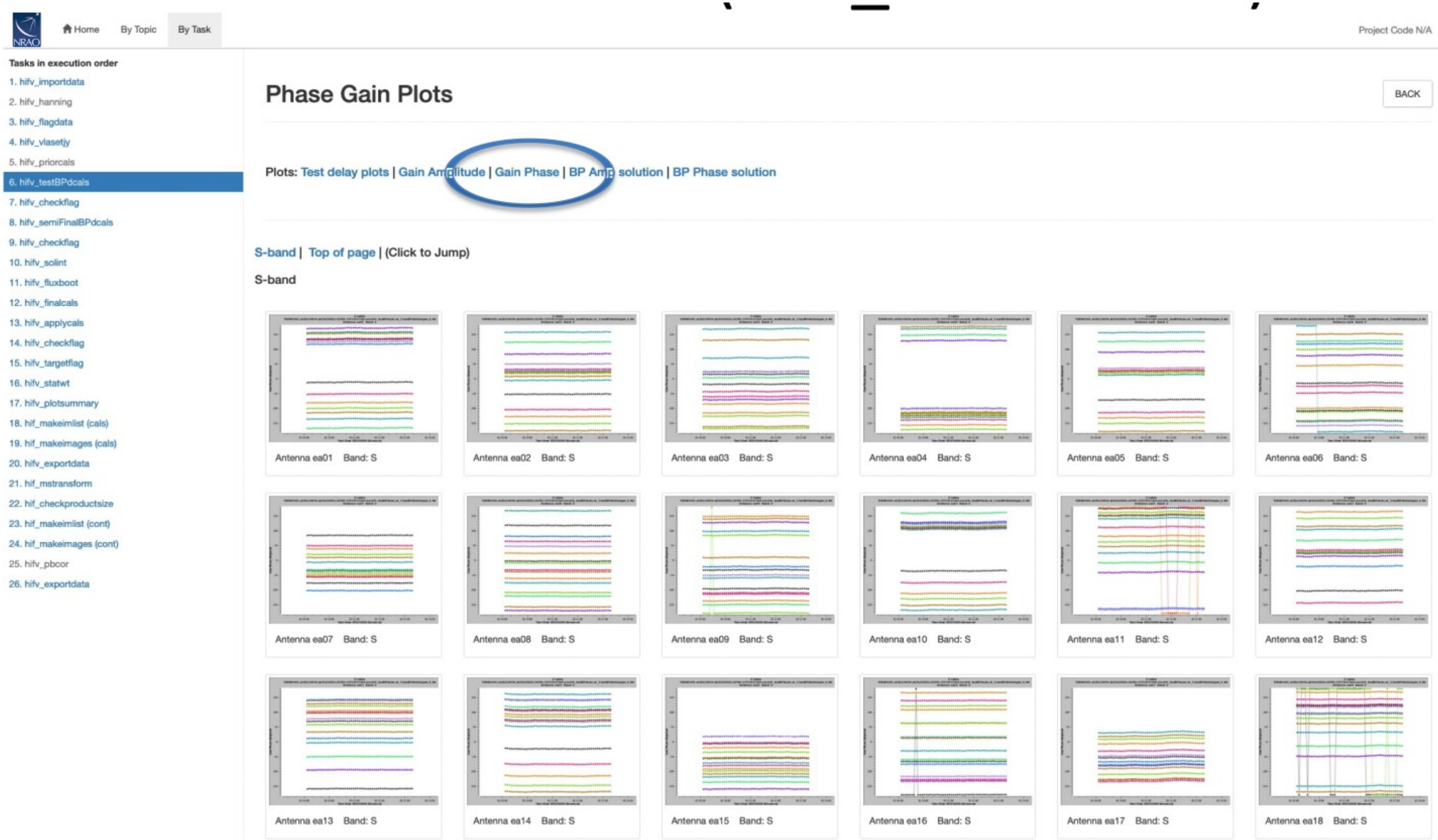
Input Parameters

Tasks Execution Statistics

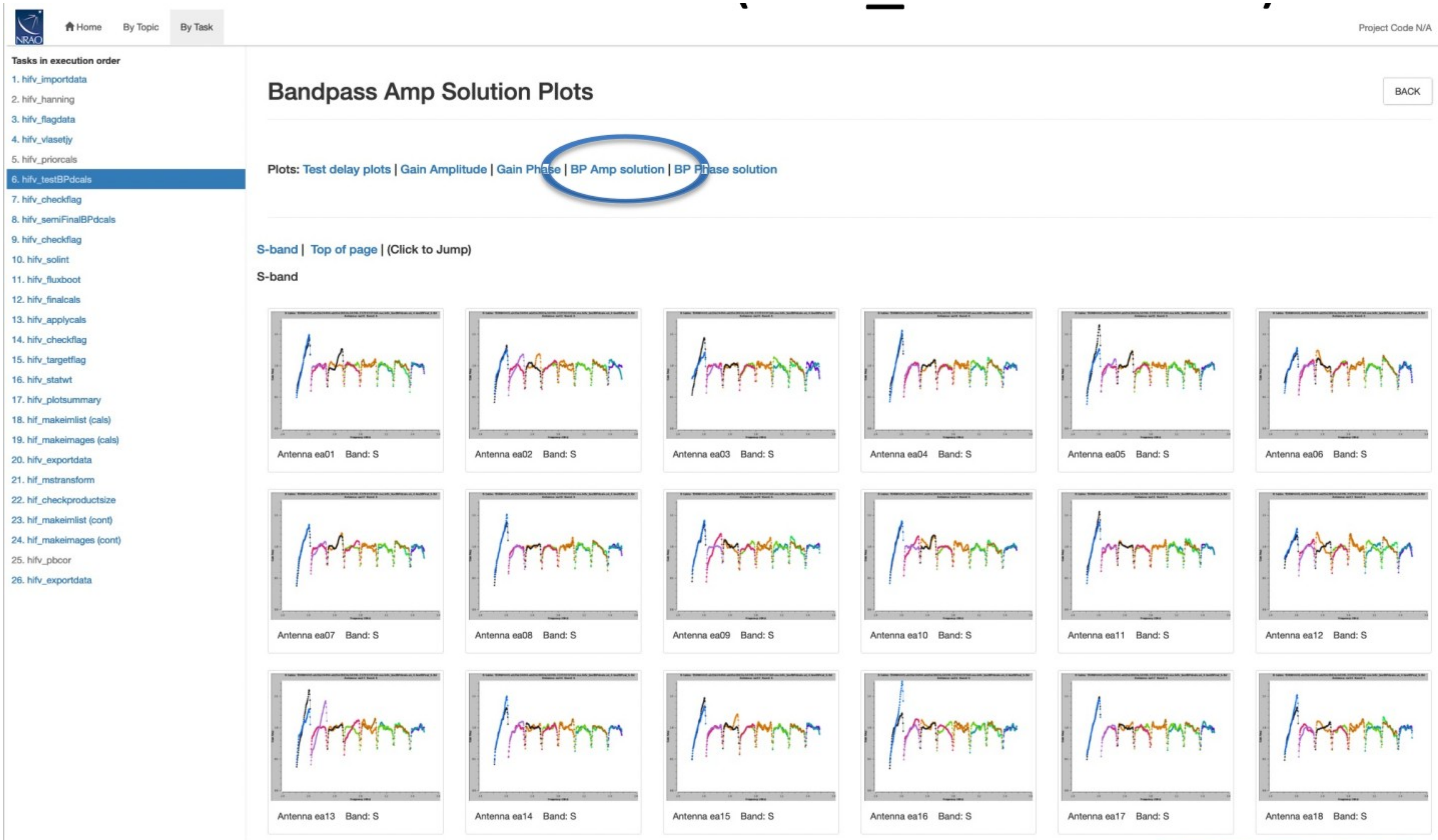
Hardware issues (hifv_testBPdcals)



Hardware issues (hifv_testBPdcals)



Hardware issues (hifv_testBPdcals)



Flux density bootstrapping (hifv_fluxboot)

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Tasks in execution order

11. Flux density bootstrapping and spectral index fitting

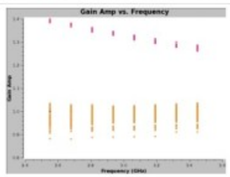
BACK

Make a gain table that includes gain and opacity corrections for final amp cal and for flux density bootstrapping.

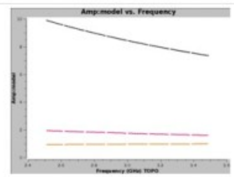
Fit the spectral index of calibrators with a power-law and put the fit in the model column.

Fluxboot summary plots

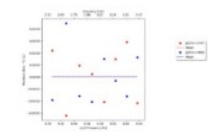
TDRW0001.sb35624494.eb35628826.58395.23719237269.ms



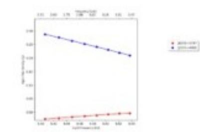
Caltable: fluxgaincal.g. Plot of amp vs. freq.



Model calibrator. Plot of amp vs. freq.



Fluxboot residuals vs. frequency



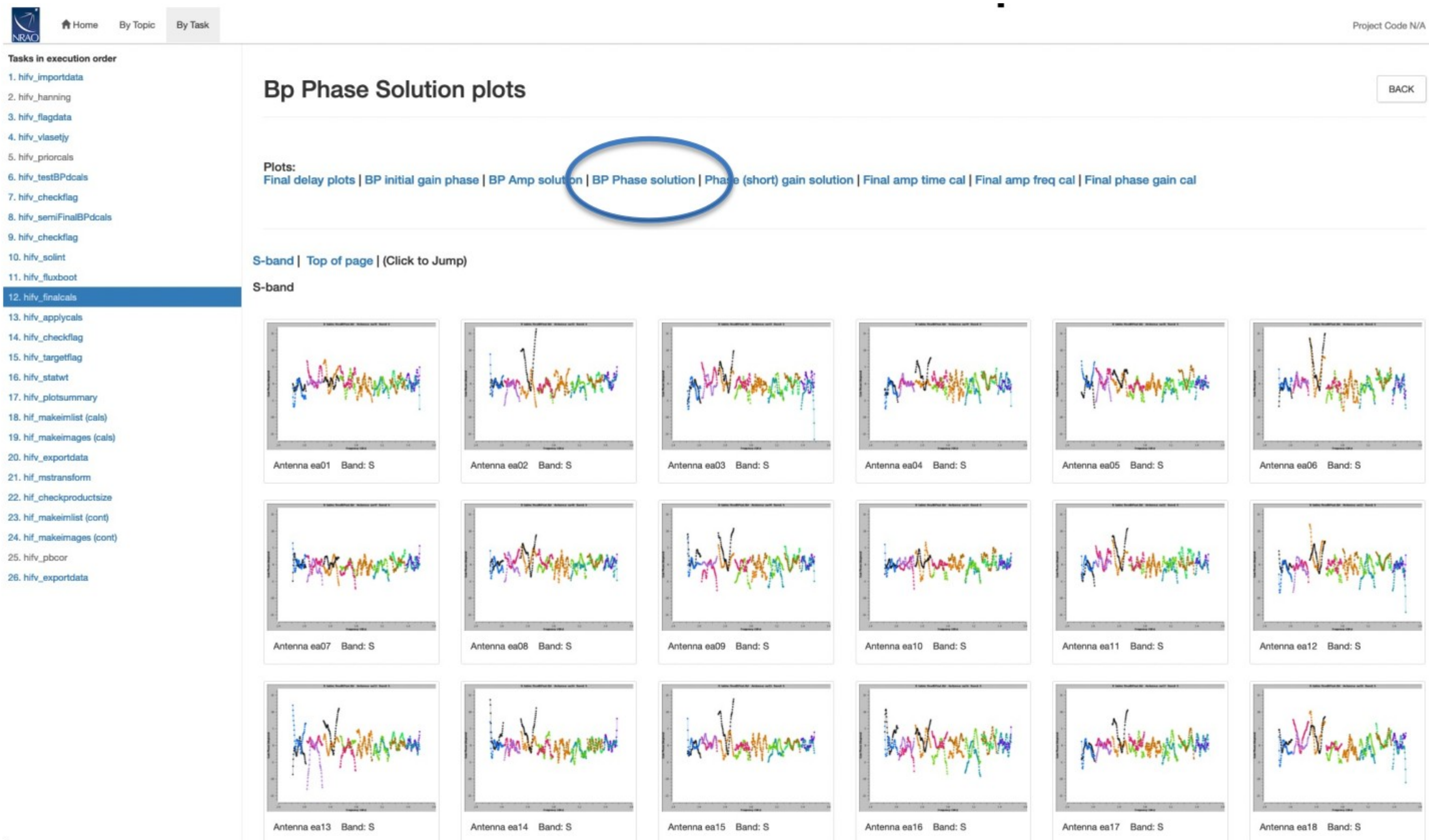
Flux vs. frequency

Source	Fit Order	Band	Band Center [GHz]	Flux density [Jy] (at Band Center)	Spectral Index	2nd order coeff	3rd order coeff	4th order coeff
J0259+0747	2	S	3.00000	0.97152 +/- 0.00072	0.16942 +/- 0.00518	-0.14589 +/- 0.13172	----	----
J2355+4950				1.76341 +/- 0.00077	-0.59833 +/- 0.00333	-0.19761 +/- 0.08241		

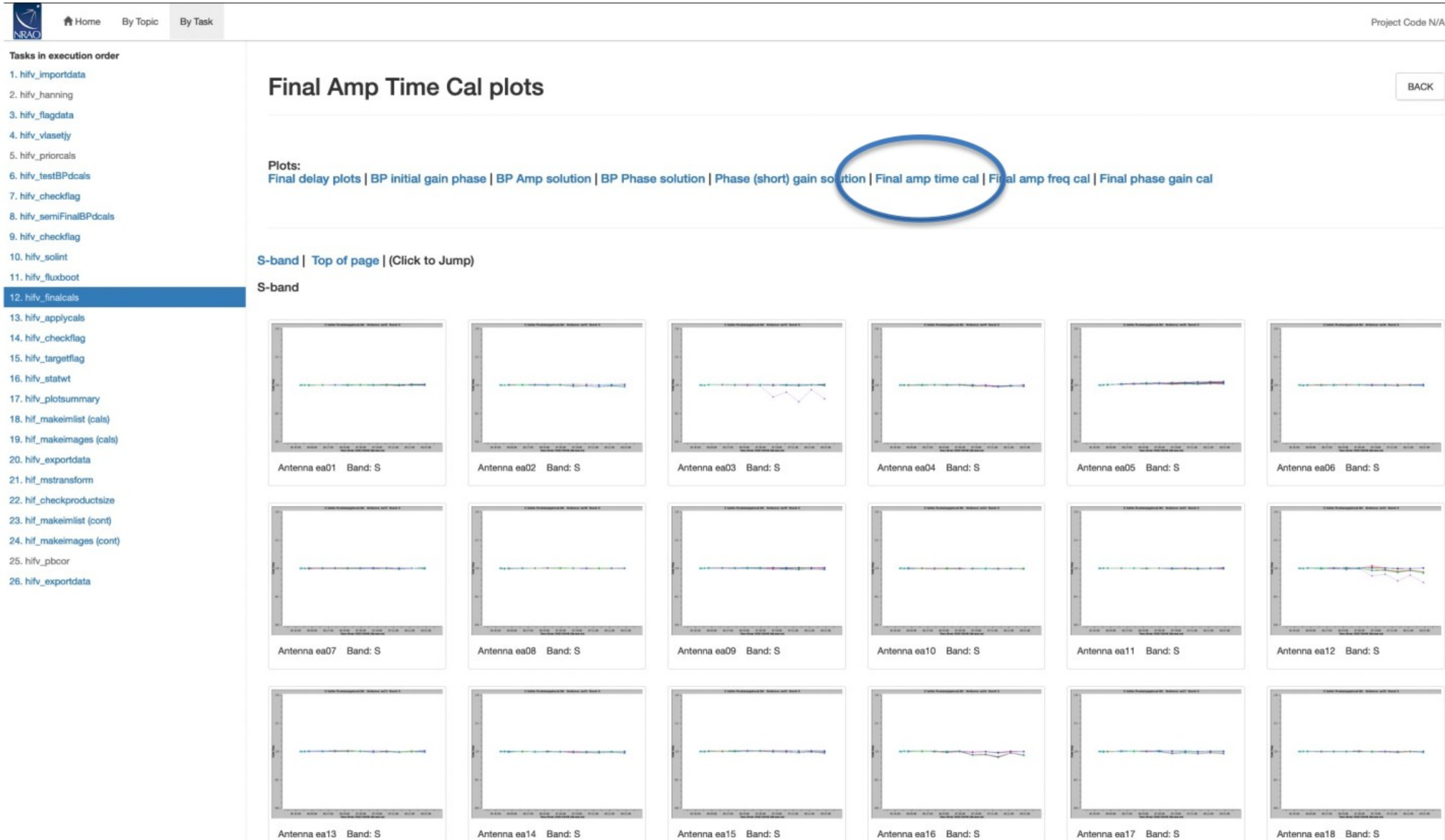
Table showing the flux density and spectral properties computed at each band center, based on the global coefficients of the fit across all bands.

Source	Frequency [GHz]	Data	Error	Fitted Data	Residual: Data-Fitted Data
J0259+0747	2.551	0.9447	0.002792	0.9436	0.001099
	2.679	0.9507	0.002612	0.9523	-0.001609
	2.807	0.9609	0.002617	0.9604	0.000483
	2.935	0.9680	0.002372	0.9679	0.000118
	3.063	0.9739	0.002462	0.9749	-0.001040
	3.191	0.9822	0.002410	0.9815	0.000744
	3.319	0.9891	0.002444	0.9877	0.001460
	3.447	0.9924	0.002332	0.9934	-0.001086
J2355+4950	2.551	1.9377	0.000822	1.9387	-0.000961
	2.679	1.8871	0.000859	1.8849	0.002237

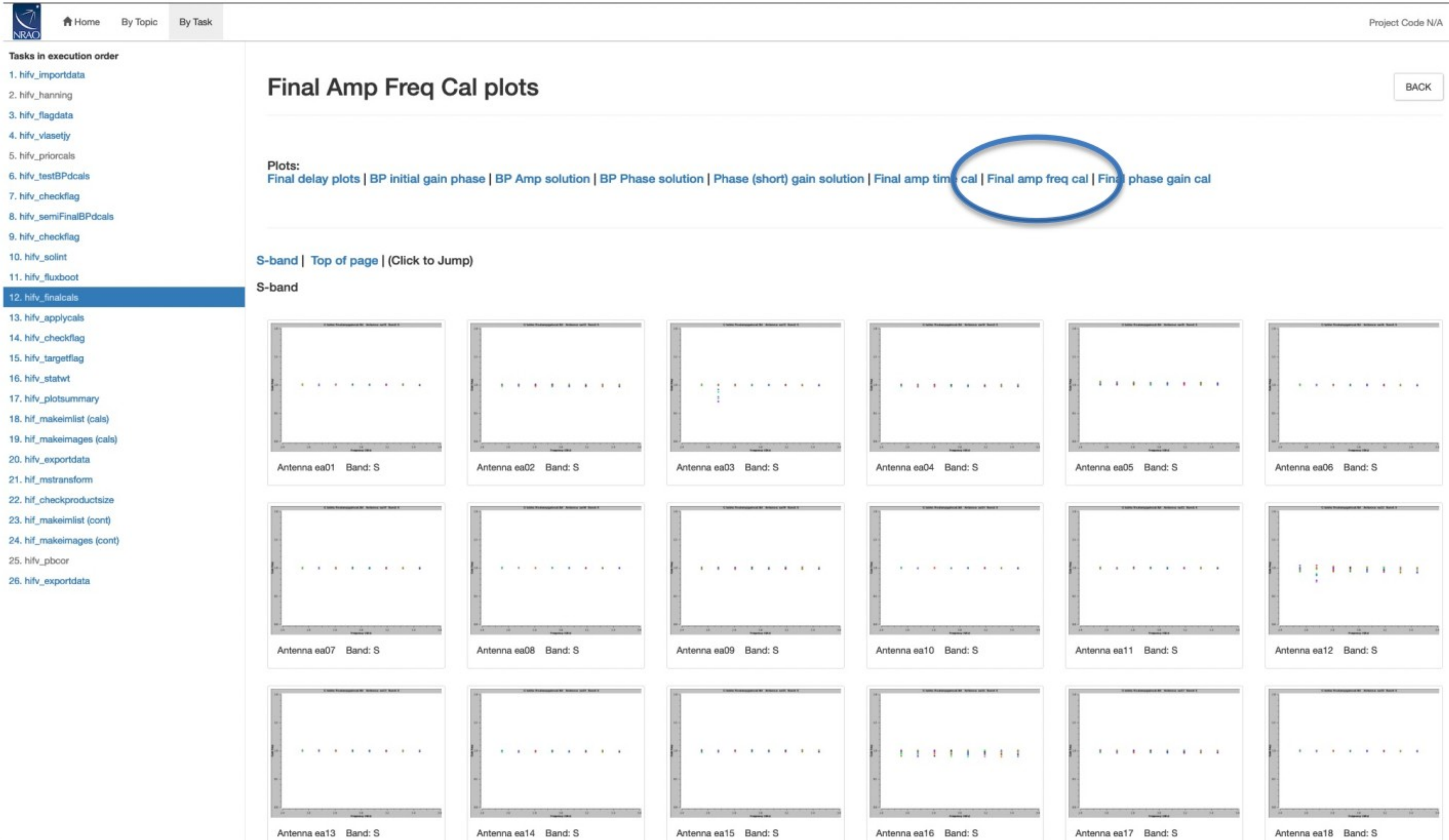
Final calibration tables (hifv_finalcals)



Final calibration tables (hifv_finalcals)



Final calibration tables (hifv_finalcals)



Summary plots (hifv_plotsummary)

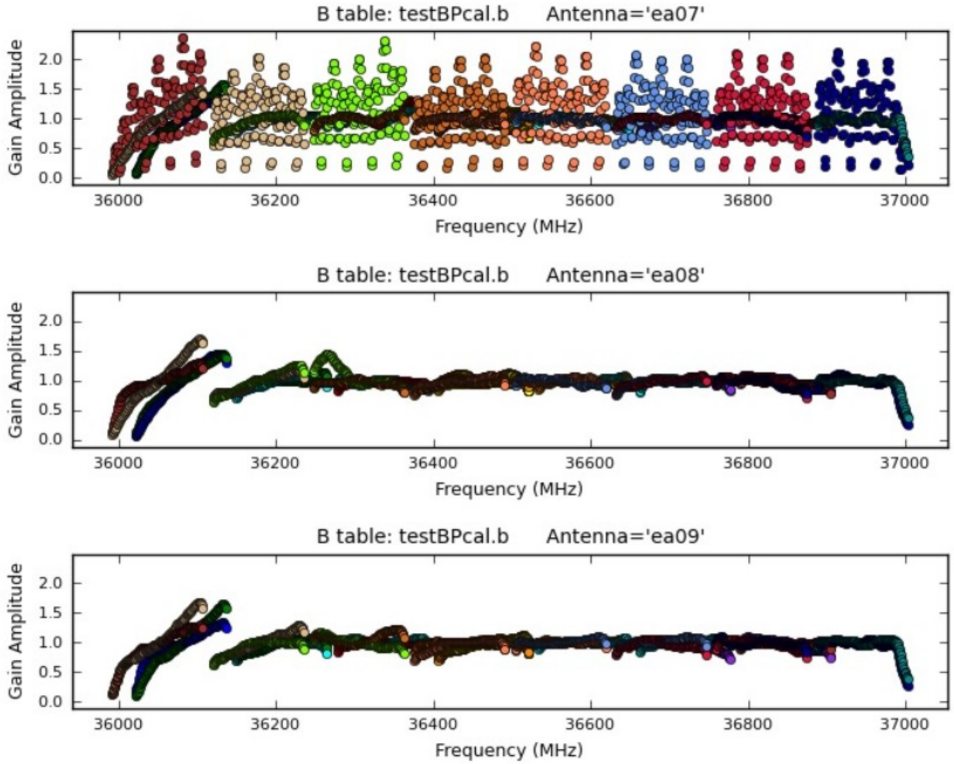
Known failure modes

- In general the pipeline does very well, but there are possible failure modes:
  - No flux density or gain calibrator intents defined, or flux density calibrator not one for which we have models
    - *work around in scripted pipeline*
  - Wrong scan intents
    - *modify Scan.xml in SDM; see https://science.nrao.edu/facilities/vla/data-processing/pipeline#section-28*
  - Does not always identify deformatter problems (but does NOT usually have false positives – L-band an exception)
    - *flag remaining bad spws*
  - Calibrators are too weak for given spw bandwidth
    - *heuristics have been developed and are being tested*

Examples of some issues

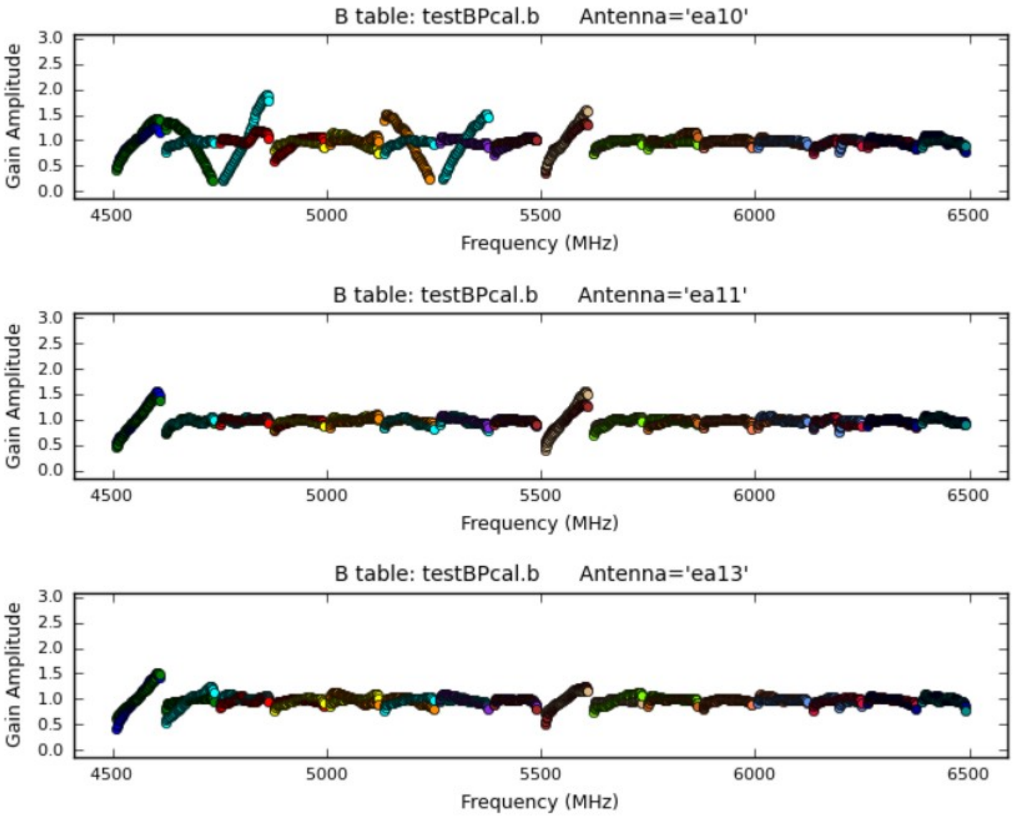
Digital transmission system

ea07 bandpass, bad data (DTS issue); ea08, ea09 OK



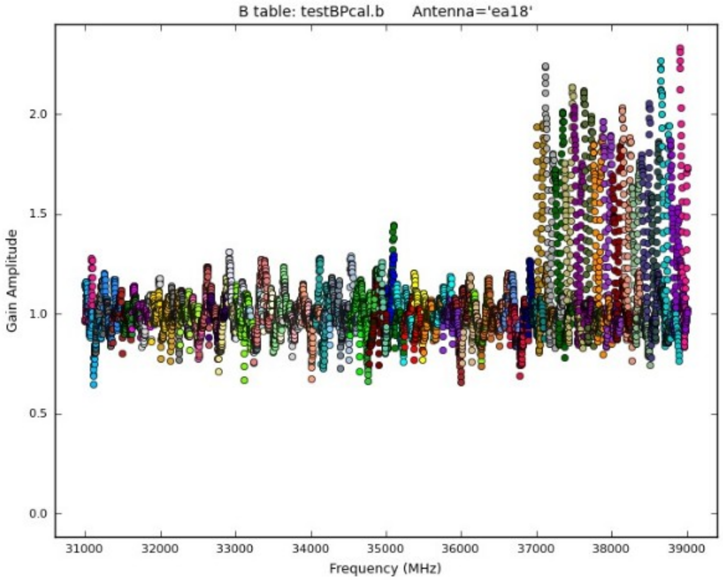
Examples of some issues

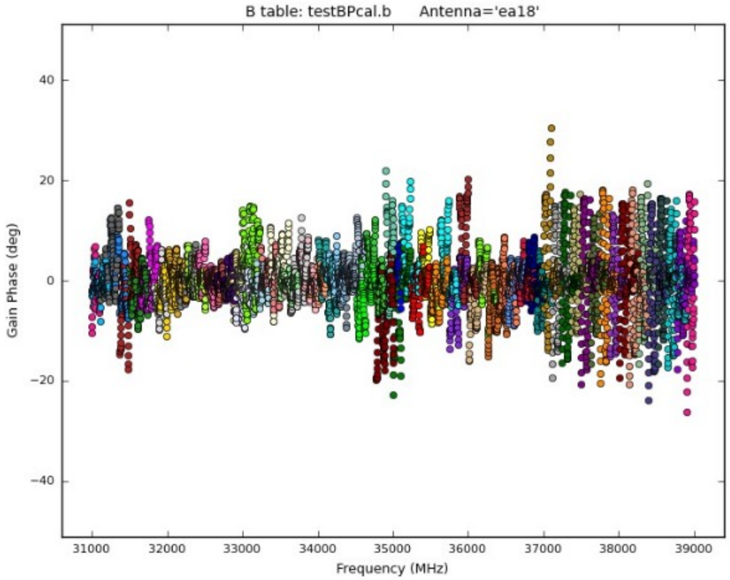
ea10 bandpass, bad data (DTS issue); ea11, ea12 OK



Examples of some issues

ea18 Amp **and** Phase affected (DTS issue for 37-39GHz)





Pipeline products and outputs

(1) Flagged and Calibrated MS (2) Final flag version and calibration tables (archived)
(3) Logs, incl. weblog used by quality assurance (QA) staff and QA report (archived)

The real-time pipeline produces a calibrated and flagged MS

→ Calibrated MS may be requested through the archive
https://data.nrao.edu

→ You may request a more detailed QA2 report from the Data Analysts
(https://help.nrao.edu/, Pipeline Department)

→ If you are happy with the pipeline calibration, then:
– Do further flagging if necessary
– Split out your target and image (imaging pipeline now available)

If you have the SDM or uncalibrated MS and the calibration and flag tables, then the pipeline calibration can be restored, see details at
http://go.nrao.edu/vla-pipe/

Science Ready Data Products (SRDP)

→ calibrated & imaged science ready data
→ initiative started in June 2019

https://science.nrao.edu/srdp/home

In early stages, at the moment supporting only:

- Continuum (Stokes I)
- C-band or higher frequency
- if SB setup and scan intents set correctly for pipeline
- only observations using 3C286 or 3C147 as flux density calibrators

Quality Assurance: NRAO Staff will check quality in detail, add extra flagging and rerun if necessary.

SRDP: VLA Imaging Pipeline

Home | By Topic | By Task | Project Code N/A

Tasks in execution order

1. hifv_importdata
2. hifv_hanning
3. hifv_flagdata
4. hifv_vlasetjy
5. hifv_priorcals
6. hifv_testBPdcals
7. hifv_checkflag
8. hifv_semiFinalBPdcals
9. hifv_checkflag
10. hifv_solint
11. hifv_fluxboot
12. hifv_finalcals
13. hifv_applycals
14. hifv_checkflag
15. hifv_targetflag
16. hifv_statwt
17. hifv_plotsummary
18. hif_makeimlist (cals)
19. hif_makeimages (cals)
20. hifv_exportdata
21. hif_mstransform
22. hif_checkproductsize
23. hif_makeimlist (cont)
24. hif_makeimages (cont)
25. hifv_pbcor
26. hifv_exportdata

25. Primary beam corrected images

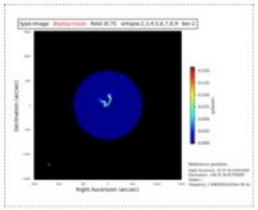
BACK

tt0 when multi-term

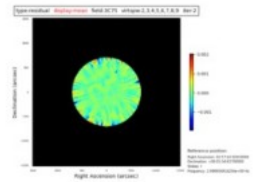
TDRW0001.sb35624494.eb35628826.58395.23719237269.ms

oussid.s24_0.3C75_sci.S_band.cont.I.iter2

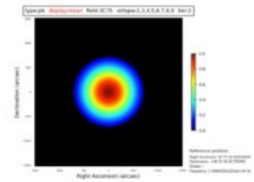
	restored	residual
maximum	1.5799e-01 Jy/beam	2.0434e-03 Jy/beam
minimum	-2.1028e-03 Jy/beam	-1.9549e-03 Jy/beam
sigma	8.3015e-03 Jy/beam	3.0272e-04 Jy/beam
MAD rms	2.6704e-04 Jy/beam	2.2466e-04 Jy/beam



oussid.s24_0.3C75_sci.S_band.cont.I.iter2.image.pbcor.tt0.sky.png



oussid.s24_0.3C75_sci.S_band.cont.I.iter2.image.residual.pbcor.tt0.sky.png



oussid.s24_0.3C75_sci.S_band.cont.I.iter2.pb.tt0.sky.png

Final notes

Viewing weblogs

The default security preferences in Firefox block weblogs on disk from being viewed directly

→ Need to change about:config: security.fileuri.strict_origin_policy to False

Starting the pipeline

Start with SDM-BDF raw data (MS possible, but online flags needed before)

Edit casa_pipescript.py file (standard one/template: https://science.nrao.edu/facilities/vla/data-processing/pipeline#the-casa-pipescript-py-file)

And to run it:

1. `> /path/to/casa/bin/casa --pipeline`
2. On NRAO machines: `> casa-pipe`
3. Or within CASA: `> execfile(`casa_pipescript.py')`

Final notes

Considerations before running pipeline

→ Disk space needed 3-4x raw data size, even more if imaging

→ Compute time: 30min to ... a few days (weeks)

→ If the default pipeline is appropriate for your science (e.g. scpectral lines, rerunning pipeline, etc)

VLA CASA Calibration Pipeline information at: http://go.nrao.edu/vla-pipe

→ CASA Integrated Pipeline & Scripted Pipeline available

NRAO HelpDesk: https://help.nrao.edu/

Submit your ticket under the Pipeline Department.

www.nrao.edu
science.nrao.edu
public.nrao.edu

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