

The VLA Pipeline Drew Medlin – 2022-10-12



- 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



- 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 realtime pipeline operations from early 2013 and until Sep 2015.



- 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



- Scripted pipelines for CASA versions through 5.3.0 also available
 - Provides more flexibility in how to use the pipeline, options suitable for spectral line datasets, mixed correlator set-ups, multi-band observations, etc.
 - Working to incorporate some of these into the CASA integrated pipeline



Will the Pipeline work for you?

- 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
 - Pipeline includes Hanning smoothing, RFI flagging, and weight calculations that may not be appropriate for (some) spectral line projects.
 - No polarization calibration (yet) but can use pipeline output as a starting point.*
 - Will probably work for data taken since May 2012, may work for earlier EVLA data, likely that extra flagging and editing are needed in these cases

*CASA 5.4.1 and later, requires that you have used the correct polarization intents when setting up the observations



Pipeline Requirements

- "Standard" Stokes I science SB means:
 - 128 MHz spws (64 MHz for L-band; default setup), but may work on other set-ups as well
 - Can work for narrower BWs, depends on the strength of the calibrators
 - Heuristics currently make some assumptions about the strength of the calibrators, in particular, the delay calibrator
 - currently requires the SNR=3 limit on initial gain calibration *per integration*
 - Contains correctly labeled and complete scan intents
 - And also that the observations have been set up correctly!



Pipeline Requirements

- Correct observation set-up
 - Independent of whether you want to run the pipeline!
 - Remember: simple observing set-ups are always easier to calibrate
 - Do not skimp on calibration to spend more time on your target you may end up not being able to calibrate the target data at all
 - Spending 3 minutes pointing could buy you more sensitivity than doubling the time on your target.



Pipeline Requirements

- Scan intents
 - The pipeline relies entirely on correct *scan intents* to be defined in each SB
 - In order for the pipeline to run successfully on an SB it must contain, *at minimum*, scans with the following intents:
 - A flux density scale calibrator scan that observes one of the primary calibrators (3C48, 3C138, 3C147, or 3C286)* – this will also be used as the delay and bandpass calibrator if no bandpass or delay calibrator is defined
 - Complex gain calibrator scans

*Some of these calibrators are variable (especially 3C48, 3C138), use 3C286 if possible



(Real-Time) Heuristics (I)

- Assuming requirements are met, the pipeline:
 - Loads the data (SDM-BDF \rightarrow 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.



(Real-Time) Heuristics (II)

- 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*
- *May want to modify inputs and/or omit entirely for spectral line.



https://casa.nrao.edu/Data/EVLA/Pipeline/S-CASA6.2.1/html/



Observation Overview

| Project | uid://evla/pdb/35621723 | F |
|------------------------|-------------------------|---|
| Principal Investigator | Dr. Emmanuel Momjian | c |
| Observation Start | 2018-10-04 05:41:35 UTC | 1 |
| Observation End | 2018-10-04 08:32:45 UTC | I |
| | | F |

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 | | | |
|--|-----------|--------------|---------------------|---------------------|-----------|----------|--------|---------|---------|
| 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.eb33_18826.58395.23719237269_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 |



A Home By Topic By Task

Project Code N/A

Session: default

TDRW0001.sb35624494.eb35628826

TDRW0001.sb35624494.eb35628826

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

Observation Execution Time

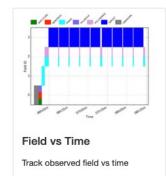
| Start Time | 2018-10-04 05:41:35 |
|------------------------------|---------------------|
| End Time | 2018-10-04 08:32:45 |
| Total Time on Source | 2:49:14 |
| Total Time on Science Target | 2:13:55 |

LISTOBS OUTPUT

Spatial Setup

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

Intent vs Time Track scan intent vs time



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] |

Sky Setup

Min Baseline

Antenna Setup

40.0 m

Min Elevation

36.89 degrees



A Home By Topic

By Task

Project Code N/A

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)
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                            ArravID = 0
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              05:47:35.0 - 05:48:30.0
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```



A Home By Topic

Session: default

TDRW0001.sb35624494.eb35628826

TDRW0001.sb35624494.eb35628826

listobs.txt

By Task

Project Code N/A

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

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Task Summaries

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| 20. ht/r_exportdata: Prepare pipeline data products for export 1.00 0.02:27 21. ht/_mstransform: Create science target MS 1.00 0.05:30 22. ht/_checkproductsize: Check product size 1.00 0.01:45 23. ht/_makeimilist: Set-up parameters for target aggregate continuum imaging 0.01:45 0.01:45 24. ht/_makeimages: Make target aggregate continuum imaging 0.01:45 0.01:45 25. ht/_pbcor: Pbcor 1.00 1.00 0.01:45 | 18. htf_makeimlist: Set-up parameters for phase calibrator & bandpass calibrator imaging | | | 1.00 | 0:00:35 |
| 21. ht/_mstransform: Create science target MS 1.00 0.05:30 22. ht/_checkproductsize: Check product size 1.00 0.01:45 23. ht/_mskeimilist: Set-up parameters for target aggregate continuum imaging 0.01:26 0.01:26 24. ht/_mskeimages: Make target aggregate continuum imaging 1.00 0.01:26 25. ht/_pbcor: Pbcor 1.00 1.33:50 | | | | 1.00 | 0:08:05 |
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| 24. ht/_makeimages: Make target aggregate continuum images 1.00 1:33:50 25. ht/v_pbcor: Pbcor No QA VM 0:00:04 | 22. hif_checkproductsize: Check product size | | | 1.00 | 0:01:45 |
| 25. hffv_pbcor: Pbcor | 23. htf_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 |
| 26. ht/v_exportdata: Prepare pipeline data products for export | 25. hifv_pbcor: Pbcor | No Q# | A | N/A | 0:00:04 |
| | 26. hifv_exportdata: Prepare pipeline data products for export | | | 1.00 | 0:02:40 |





- The following pipeline steps provide key checks for calibration quality:
 - hifv_flagdata
 deterministic flagged data fraction
 - hifv_testBPdcals
 hardware problems and other obs. issues

solution intervals for phase cals, input gain tables

fitted calibrator flux densities and spectral indices

final calibration tables applied to the data

- hifv_solint
- hifv_fluxboot
- hifv_finalcals
- hifv_plotsummary useful diagnostic plots of calibrated data



Go forward one page (೫→) Pull down to show history

Tasks in execution order 1. hifv_importdata

2. hifv_hanning
 3. hifv_flagdata
 4. hifv_vlasetjy

5. hífv_priorcals 6. hífv_testBPdcals 7. hífv_checkflag 8. hífv_semiFinalBPdcals 9. hífv_checkflag

10. hifv_solint 11. hifv_fluxboot

hifv_finalcals
 hifv_applycals
 hifv_checkflag
 hifv_targetflag
 hifv_statwt
 hifv_plotsummary

18. hif_makeimlist (cals)
 19. hif_makeimages (cals)

20. hífv_exportdata 21. híf_mstransform 22. híf_checkproductsize 23. híf_makeimiist (cont) 24. híf_makeimages (cont) 25. hífv_pbcor 26. hífv_exportdata By Task

Project Code N/A

BACK

3. VLA Deterministic Flagging

Flagging agents

| Measurement Set | ANOS | Shadowed Antennas | Unwanted Intents | Other Online Flags | Flagging Template | Autocorr | Edge Channels | Clipping | Quack | Baseband | Agent Commands |
|---|------|-------------------|------------------|--------------------|-------------------|----------|---------------|----------|-------|----------|----------------|
| TDRW0001.sb35624494.eb35628826.58395.23719237269.ms | ~ | * | * | * | × | * | * | - | - | - | View |

Flagging agent status per measurement set.

Template Files

| | Other Online Flags | Flaggin | Flagging Template | | | |
|---|---|----------------------|-------------------|----------------------|--|--|
| Measurement Set | File | Number of Statements | File | Number of Statements | | |
| TDRW0001.sb35624494.eb35628826.58395.23719237269.ms | TDRW0001.sb35624494.eb35628826.58395.23719237269.flagonline.bxt | 678 | | | | |

Files used for template flagging steps.

Flagged data summary

| | | Flagging | Agent (Total V | is) | Flagging | Agent (Scie | nce Vis) | | | | | | Measurement Set |
|---|----------------|----------|----------------------|---------------------|--------------------------|----------------------|----------|------------------|----------|--------|----------|------------------|--|
| Data Selection (by intent) | Before Task | ANOS | Shadowed Antennas | Unwanted Intents | Other Online Flags | Flagging Template | Autocorr | Edge Channels | Clipping | Quack | Baseband | Total Science | TDRW0001.sb35624494.eb35628826.58395.23719237269.m |
| 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



A Home By Topic By Task

16. hifv_statwt 17. hifv_plotsummary

18. hif_makeimlist (cals)

20. hifv_exportdata 21. hif_mstransform

19. hif_makeimages (cals)

22, hif checkproductsize

23. hif_makeimlist (cont) 24. hif_makeimages (cont) 25. hifv_pbcor 26. hifv_exportdata

Project Code N/A

| Tasks in execution order | | | Flagging | Agent (Total V | /is) | Flagging Agent (Science Vis) | | | | | | | | Measurement Set |
|--------------------------|---|--------------|---------------|-----------------|---------------|------------------------------|--------------|--------------|---------------|----------------|------------|----------|---------|---|
| 1. hifv_importdata | | | | | | | | | | | | | | |
| 2. hifv_hanning | | Before | | Shadowed | Unwanted | Other Online | Flagging | | Edge | | | | Total | |
| 3. hifv_flagdata | Data Selection (by intent) | Task | ANOS | Antennas | Intents | Flags | Template | Autocorr | Channels | Clipping | Quack | Baseband | | TDRW0001.sb35624494.eb35628826.58395.23719237269.ms |
| 4. hifv_vlasetjy | | | | | | | | | | FF8 | | | | |
| 5. hifv_priorcals | 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% |
| 6. hifv_testBPdcals | 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% |
| 7. hifv_checkflag | | 0112070 | 0.00170 | 0.00070 | 0.00070 | 0110070 | 0.00070 | 0.00070 | 0.00070 | 0.00070 | 0.00070 | 0.00270 | 1.00770 | 100170 |
| 8. hifv_semiFinalBPdcals | 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% |
| 9. hifv_checkflag | 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% |
| 10. hifv_solint | | | | | | | | | | | | | | |
| 11. hifv_fluxboot | 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% |
| 12. hifv_finalcals | 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% |
| 13. hifv_applycals | | | | | | | | | | | | | | |
| 14. hifv_checkflag | 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% |) |
| 15. hifv_targetflag | Summary of flagged data. Each cell states the amount of data flag | uned as a fr | action of the | a specified dat | a selection w | ith the Elac | aina Agent c | olumne divir | a this inform | ation per flag | naina agen | | | |

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)



A Home By Topic By Task

15. hifv_targetflag

18. hif_makeimlist (cals)

20. hifv_exportdata 21. hif_mstransform

19. hif_makeimages (cals)

22, hif checkproductsize

23. hif_makeimlist (cont) 24. hif_makeimages (cont) 25. hifv_pbcor 26. hifv_exportdata

16. hifv_statwt 17. hifv_plotsummary Project Code N/A

| Tasks in execution order | | | Flagging | Agent (Total V | /is) | Flagging Agent (Science Vis) | | | | | | | | Measurement Set |
|--------------------------|---|----------|----------|----------------|---------|------------------------------|----------|----------|----------|----------|---------|----------|----------|---|
| 1. hifv_importdata | | | | | | | | | | | | | | |
| 2. hifv_hanning | | | | | | Other | | | | | | | | |
| 3. hifv_flagdata | | Before | | Shadowed | | Online | Flagging | | Edge | | | | Total | |
| 4. hifv_vlasetjy | Data Selection (by intent) | Task | ANOS | Antennas | Intents | Flags | Template | Autocorr | Channels | Clipping | Quack | Baseband | Science | TDRW0001.sb35624494.eb35628826.58395.23719237269.ms |
| 5. hifv_priorcals | 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% |
| 6. hifv_testBPdcals | 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% |
| 7. hifv_checkflag | Science Spectral Windows | 3.12370 | 3.63170 | 0.000% | 0.595% | 0.755% | 0.000% | 0.000% | 0.000% | 0.000% | 0.000% | 3.00270 | 4.337 70 | 4.33770 |
| 8. hifv_semiFinalBPdcals | 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% |
| 9. hifv_checkflag | 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% |
| 10. hifv_solint | | 0.112070 | 1100070 | 0.00070 | 0.00070 | 0100070 | 0100070 | 0100070 | 0.00070 | 0.00070 | 0.00070 | 0.0E070 | 0.02070 | 0.02070 |
| 11. hifv_fluxboot | 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% |
| 12. hifv_finalcals | 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% |
| 13. hifv_applycals | | | | | | | | | | | | | | |
| 14. hifv_checkflag | 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)



| | Pafore | | Chadaun | d House | stad Onlin | e Eleccio | Edee | 7 | |
|------------------------|-----------------------|-------------|---------|---------|------------|-----------|------|--------------|---|
| Data | | | | | | | | | TDRW0001.sb35624494.eb35628826.58395.2371 |
| All Da | | | | | | | | | 4.448% |
| | FOCUS_ERRC | OR OT ON | COLU | | | | | | N.44070 |
| Scien | SUBREFLECT | | SOUP | KCE | | | | | 4.357% |
| Band | | _ | | | | | | | 3.629% |
| ea28&&* - | | | | | | | | | 3.029% |
| Flux ea26&&* - | | | | | | | | | 3.629% |
| ea25&&* - ea24&&* - | | | | | | | | | |
| ea23&&* - | | | | | | | | | 3.629% |
| ea23&&* - | H 1 | | | | | | | | 4.232% |
| ea22&&* - | | | | | | | | | |
| ea20&&* - | | | | | | | | | |
| summe ea19&&* - | H 1 | | | | | | | | |
| ea18&&* - | HI - | | | | | ••• | | • | |
| Flac ea17&&* - | H : H · | | | | | | | • | |
| ea16&&* - | F: | | | | | | | 1 | |
| Plots of ea15&&* - | E: | | | | | | | • | |
| TDRV ea14&&* - | F: | | | | | | | • | |
| ea13&&* - | B : B . | | | | | | | | |
| ea12&&* - | | | | | | | | | |
| eal1&&* - | | | | | | | | | |
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| ea09&&* - | Et set | | | | | | | | |
| ea08&&* - | | | | | | | | | |
| ea06&&* - | H 1 | | | | | | | · · | |
| ea05&&* - | P 2 | | | | | | | | |
| ea04&&* - | E: | | | | | • • | | • | |
| ea03&&* - | HI - | | | | | | | • | |
| ea02&&* - | F : | | | •• | | • • | | 1 | |
| ea01&&* - | F: | | | | | | | • | |
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| last | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |





A Home

By Topic By Task

Project Code N/A

BACK

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. hify_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

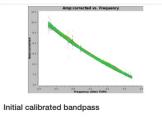
6. Initial test calibrations

est calibrations using ball bass and delay calibrators

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

testBr deals summary plot

TDRW0001.sb35624494.eb35628826.58395.23719237269.ms



Flag bad deformatters

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

BP Table Amps

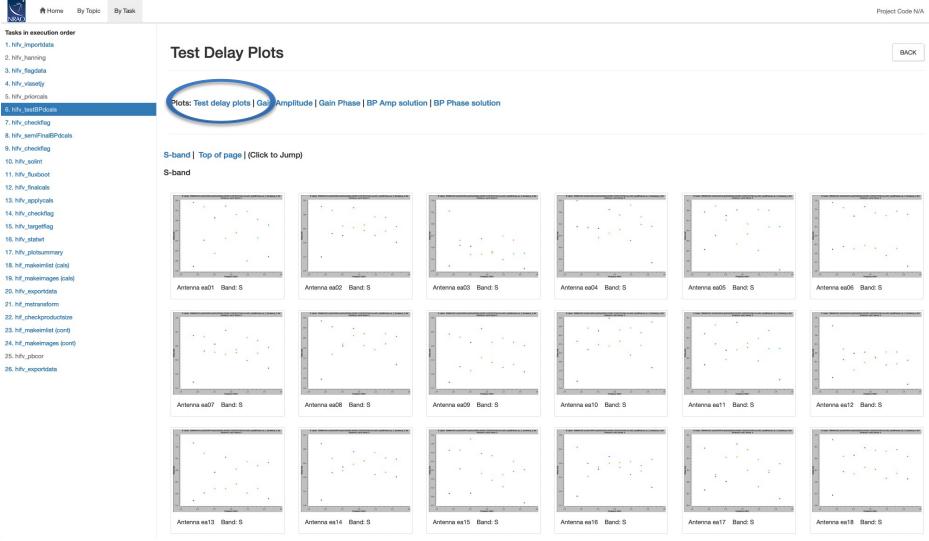
| Antenna | SPWs | Band / Basebands | | | | | |
|---------|------|------------------|--|--|--|--|--|
| None | None | S | | | | | |

BP Table Phases

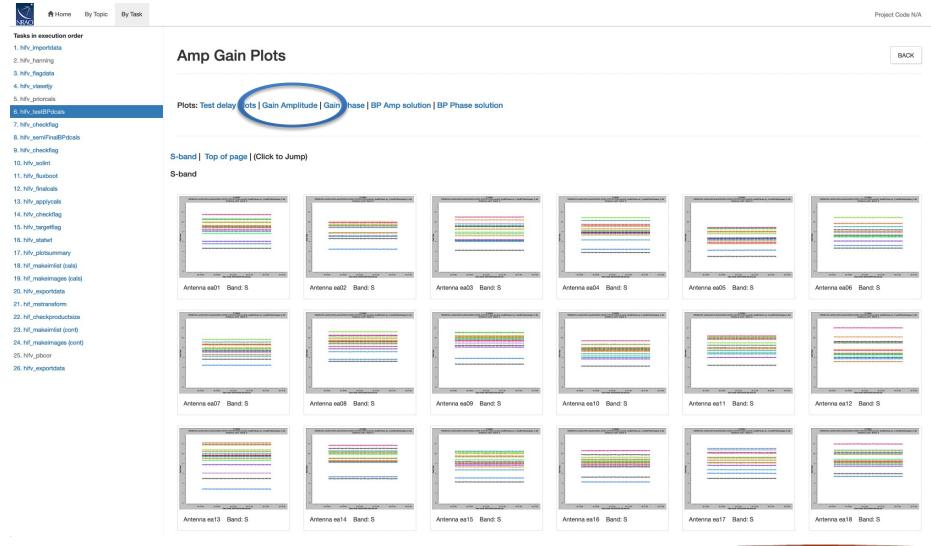
| Antenna | SPWs | Band / Basebands |
|----------------------------|------|------------------|
| None | None | S |
| | | |
| Pipeline QA | | |
| Input Parameters | | |
| Tasks Execution Statistics | | |



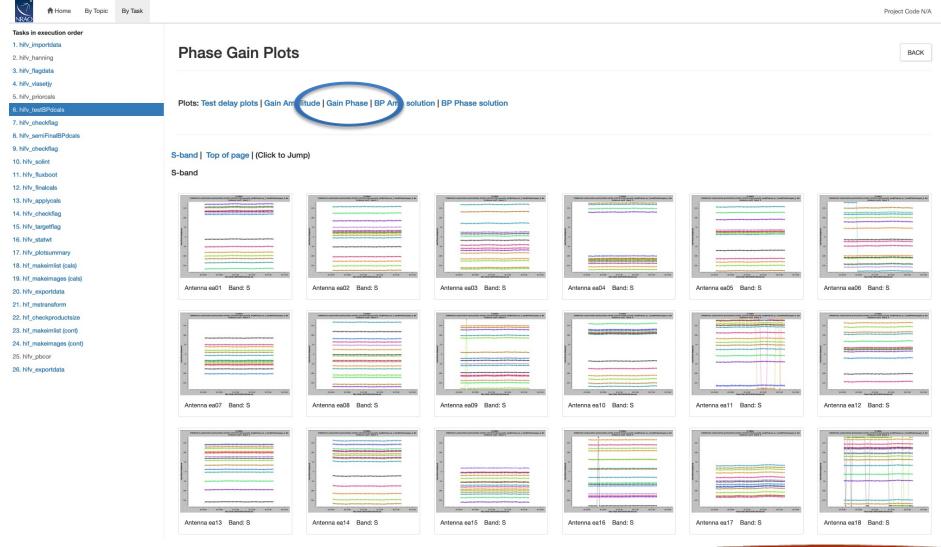




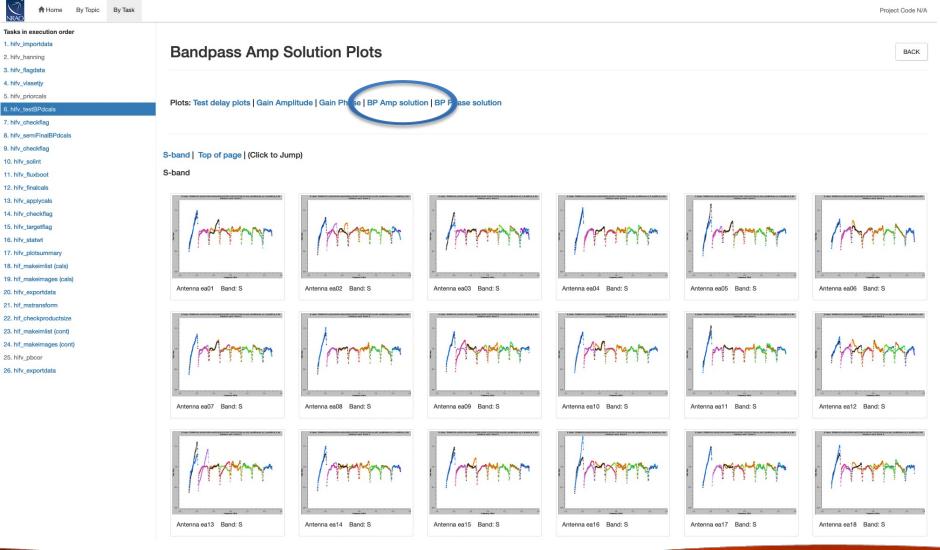




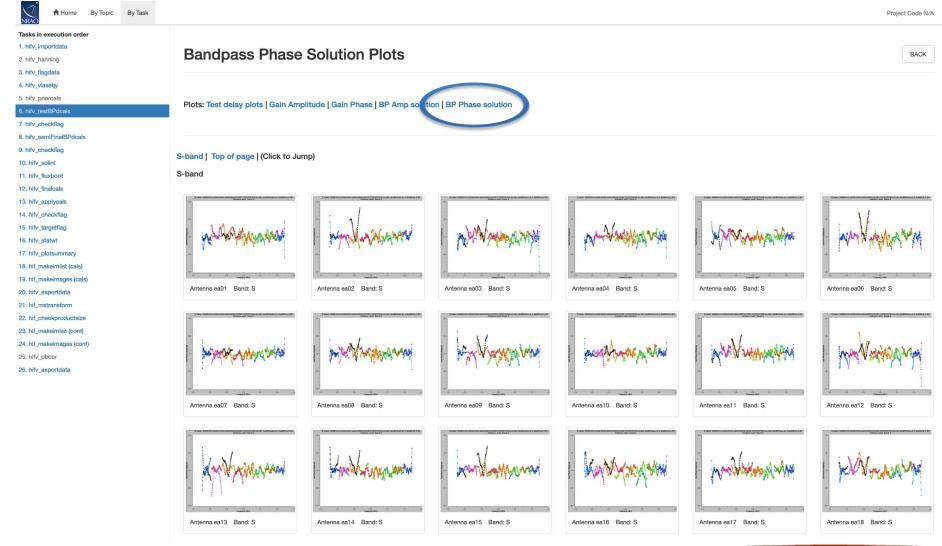














Gain Solution Intervals (hifv_solint)

A Home By Topic By Task

Project Code N/A

BACK

| 1. hifv_importdata | |
|--------------------|--|
| 2. hifv_hanning | |
| 3. hifv_flagdata | |
| 4. hifv_vlasetjy | |
| 5. hifv_priorcals | |

Tasks in execution order

6. hifv_testBPdcals

7. hifv_checkflag

8. hifv_semiFinalBPdcals

9. hifv_checkflag

10 biby or

11. hifv_fluxboot

12. hifv_finalcals

13. hifv_applycals

14. hifv_checkflag

15. hifv_targetflag

- 0

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

10. Solution Interval and test gain calibrations

| Determine the solution interval for a scan-average equivalent and occurst gain calibrations to establish a short solution interval. The long solution intervals per tund are: S band: 207.05s . The alter solution intervals per band that are used: S band: int . |
|--|
| Plot: Testgains amp plots) estgains phase plots Pipeline QA |
| Input Parameters |

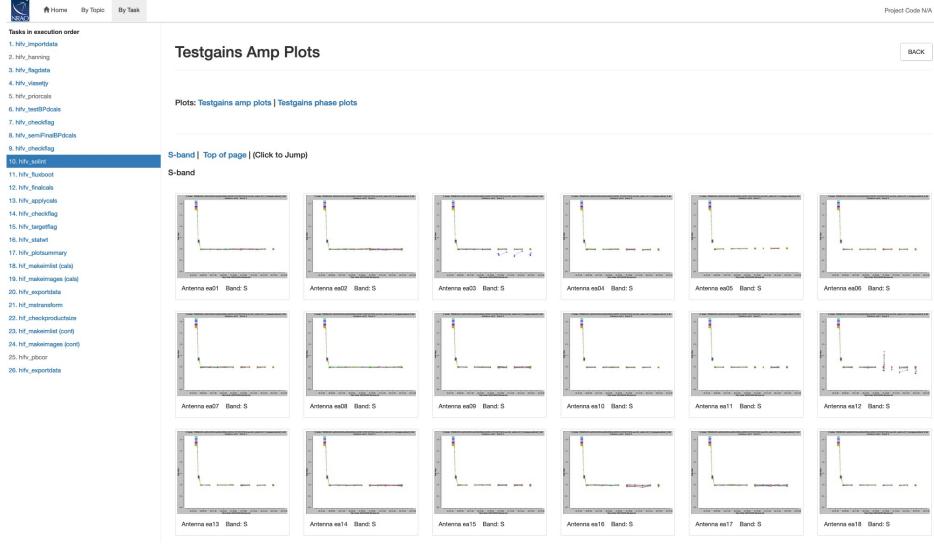
Tasks Execution Statistics

CASA logs for stage 10

View or download stage10/casapy.log (70.5 KB)



Gain Solution Intervals (hifv_solint)





NRAO

Flux Density Bootstrapping (hifv_fluxboot)

A Home By Topic By Task Project Code N/A Tasks in execution order 1. hify importdata 11. Flux density bootstrapping and spectral index fitting BACK 2. hifv_hanning 3. hifv_flagdata 4. hifv_vlasetjy Make a gain table that includes gain and opacity corrections for final amp cal and for flux density bootstrapping. 5. hifv_priorcals Fit the spectral index of calibrators with a power-law and put the fit in the model column. 6. hifv testBPdcals 7. hifv_checkflag Fluxboot summary plots 8. hifv_semiFinalBPdcals TDRW0001.sb35624494.eb35628826.58395.23719237269.ms 9. hifv_checkflag Sain Amp vs. Frequency 11 240 275 288 342 354 355 347 100.000/1041 2.00 342 854 835 84 10. hifv_solint 1.1 1.1 11. hify fluxboot 12. hifv_finalcals 13. hifv_applycals 14. hifv_checkflag 15. hifv_targetflag Fluxboot residuals vs. frequency Flux vs. frequency 16, hify statwt 17. hifv_plotsummary Caltable: fluxgaincal.g. Plot of amp vs. freq. Model calibrator. Plot of amp vs. freq. 18. hif makeimlist (cals) 19. hif_makeimages (cals) Spectral Index 2nd order coeff 4th order coeff Source Fit Order Band Center [GHz] Flux density [Jy] (at Band Center) 3rd order coeff 20. hifv_exportdata Band 21, hif mstransform J0259+0747 S 3.00000 0.97152 +/- 0.00072 0.16942 +/- 0.00518 -0.14589 +/- 0.13172 22. hif_checkproductsize J2355+4950 1.76341 +/- 0.00077 -0.59833 +/- 0.00333 -0.19761 +/- 0.08241 23 hif makeimlist (cont) Table showing the flux density and spectral properties computed at each band center, based on the global coefficients of the fit across all bands. 24. hif_makeimages (cont) 25. hifv_pbcor Frequency [GHz] 26. hifv_exportdata Source Data Error Fitted Data **Residual: Data-Fitted Data** J0259+0747 2.551 0.9447 0.002792 0.9436 0.001099

| | | 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 |
| | | | | | | a search and the |
| | | | | | | |

0.002612

0.002617

0.002372

0.002462

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-0.001040



9th VLA Data Reduction Workshop

0.9507

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0.9680

0.9739

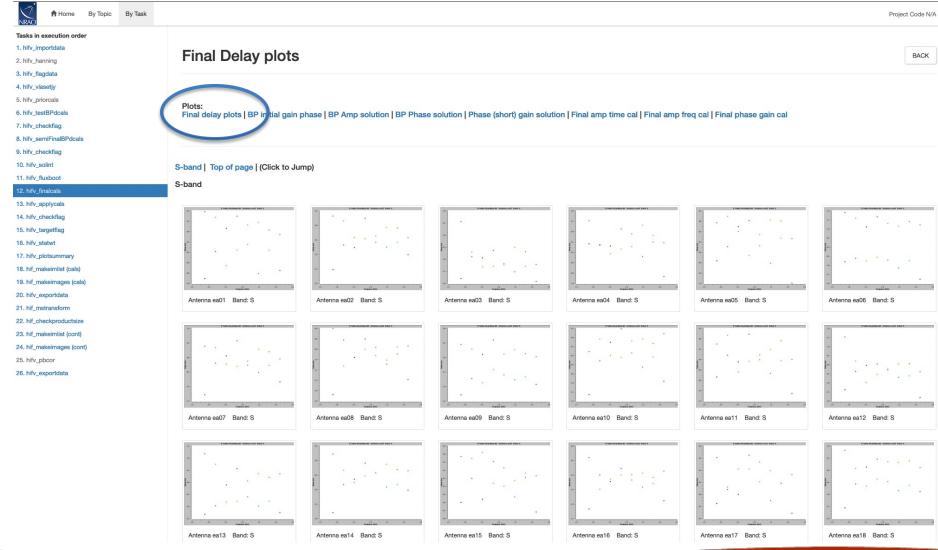
2.679

2.807

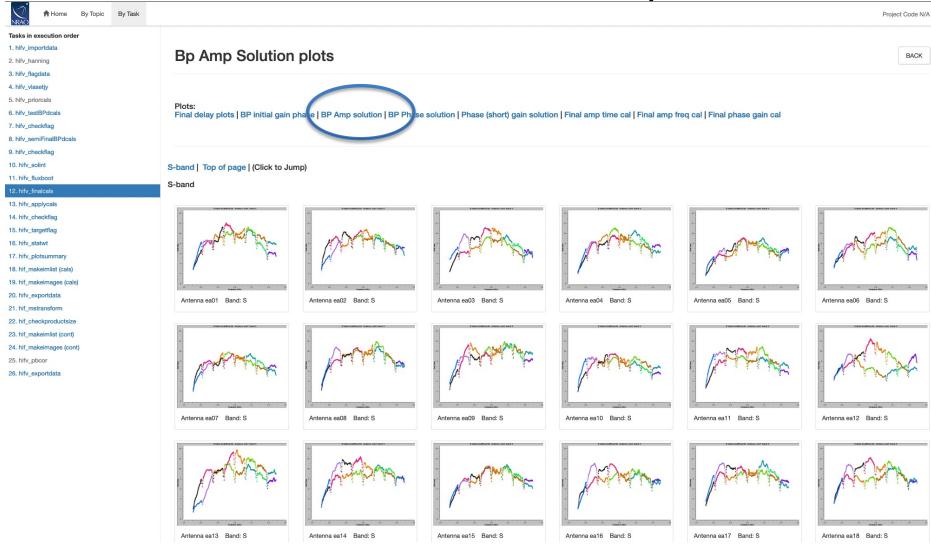
2 935

3.063

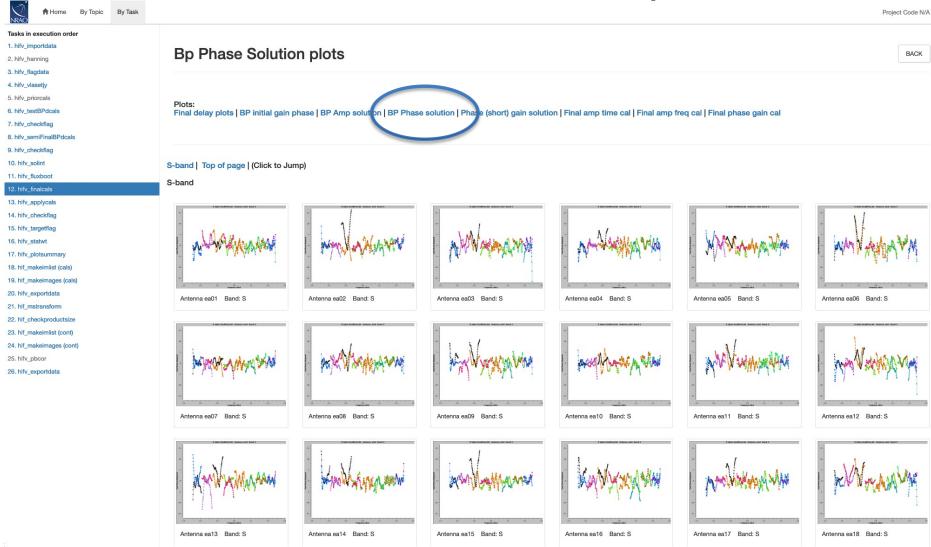
Final Calibration Tables (hifv_finalcals)



Final Cal Tables: bandpass



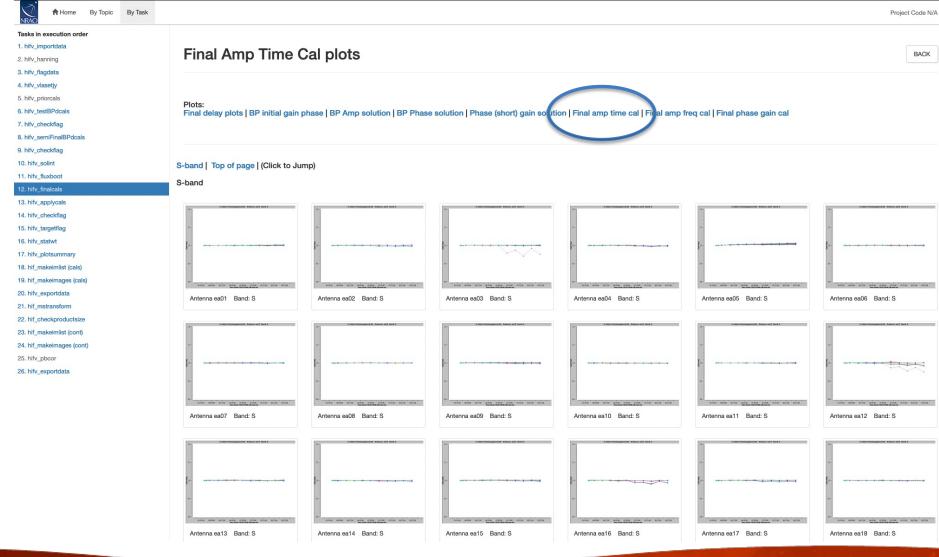
Final Cal Tables: bandpass





9th VLA Data Reduction Workshop

Final Cal Tables: amplitude and phase



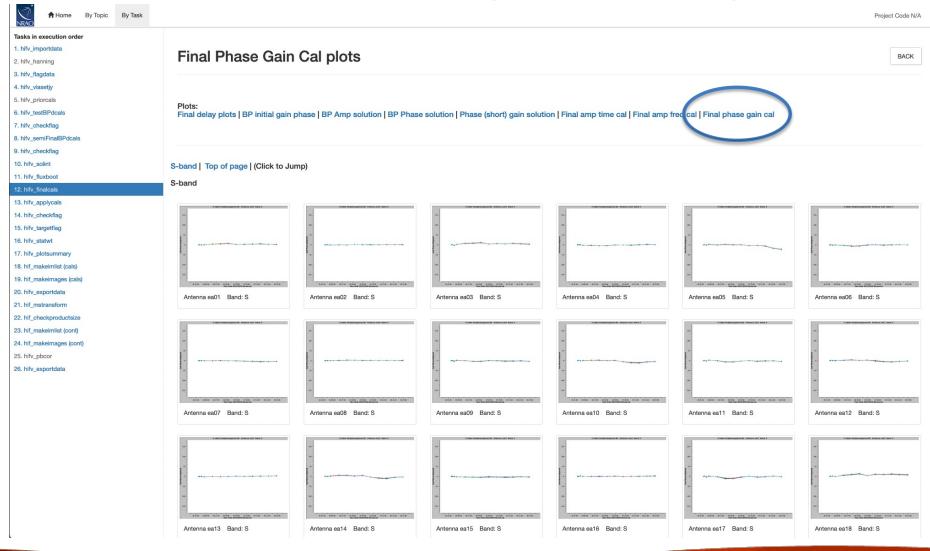


Final Cal Tables: amplitude and phase

| Home By Topic By Tas | k | | | | | Project Code N/A | | | | | | |
|---|--|--|--|--|---|---|--|--|--|--|--|--|
| Tasks in execution order 1. hifv_importdata | | | | | | BACK | | | | | | |
| 2. hifv_hanning | Final Amp Freq C | Final Amp Freq Cal plots | | | | | | | | | | |
| 3. hifv_flagdata | | | | | | | | | | | | |
| 4. hifv_vlasetjy | | | | | | | | | | | | |
| 5. hifv_priorcals | Plots: | Plots: | | | | | | | | | | |
| 6. ht/v_testBPdcals Final delay plots BP initial gain phase BP Amp solution BP Phase solution Phase (short) gain solution Final amp time cal Final amp freq cal Final phase gain cal 7. ht/v_checklag | | | | | | | | | | | | |
| 8. hifv_semiFinalBPdcals | | | | | | | | | | | | |
| 9. hifv_checkflag | | | | | | | | | | | | |
| 10. hifv_solint | S-band Top of page (Click to Ju | mp) | | | | | | | | | | |
| 11. hifv_fluxboot | S-band | | | | | | | | | | | |
| 12. hifv_finalcals | o baild | | | | | | | | | | | |
| 13. hifv_applycals | Characterization for Advance and And C | C Sales Tradespance Br. Antonia and Social S | Units Valampiparia M. Admire well hald 1 | Childre Tradeopplical Mr. Advance unit Total 1 | Uniter Examplatical Mr. Robust and Social V | Cluble Tradesquinted Mr. Antonia' and Tanit 1 | | | | | | |
| 14. hifv_checkflag | | | | | | | | | | | | |
| 15. hifv_targetflag 16. hifv_statwt | | | | | | | | | | | | |
| 17. hifv_plotsummary | · · · · · · · · · | | | | | | | | | | | |
| 18. hif_makeimlist (cals) | | | | an - | | | | | | | | |
| 19. hif_makeimages (cals) | ···· | ····· | | | | | | | | | | |
| 20. hifv_exportdata | Antenna ea01 Band: S | Antenna ea02 Band: S | Antenna ea03 Band: S | Antenna ea04 Band: S | Antenna ea05 Band: S | Antenna ea06 Band: S | | | | | | |
| 21. hif_mstransform | | | | | | | | | | | | |
| 22. hif_checkproductsize | Chain Scalegeord & Annual Sector | Childs Transpool & Advance of And V | 1 Mile Transporter M. Advert and Social | United Statespatical No. Science with Soci St. | The Designation in Adverse and Advert | Childe Transport & Adverse to The Child | | | | | | |
| 23. hif_makeimlist (cont) | | | | | | | | | | | | |
| 24. hif_makeimages (cont) 25. hifv_pbcor | 10 | | 13- | 10 | La- | 10 - | | | | | | |
| 26. hifv_exportdata | <u></u> | ga | | · · · · · · · · · | | F F F F F F F F F F | | | | | | |
| _ormin_onportaula | | | | - | 10- | | | | | | | |
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| | Antenna ea07 Band: S | Antenna ea08 Band: S | Antenna ea09 Band: S | Antenna ea10 Band: S | Antenna ea11 Band: S | Antenna ea12 Band: S | | | | | | |
| | Antenna eau7 Band: S | Antenna eau8 Band: S | Antenna eau9 Band: S | Antenna ea 10 Band: S | Antenna ea11 Band: S | Antenna ea12 Band: S | | | | | | |
| | Charles Transport New York With New York | G Mills Not exception & A Assess with Next S | (Mile Volampping M. Advance with And A | Child Linkepins IV Adver all her I | Units Endangedied M. Advance only And A | Chilles Tradesupplical IN: Achieve and Tand V | | | | | | |
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| | 10 10 10 10 10 10 10 10 10 10 10 10 10 1 | 14 14 14 14 14 14 | 10 10 10 10 10 10 10 | 20 10 10 10 10 10 10 | | JA JA JA JA JA JA JA | | | | | | |
| | Antenna ea13 Band: S | Antenna ea14 Band: S | Antenna ea15 Band: S | Antenna ea16 Band: S | Antenna ea17 Band: S | Antenna ea18 Band: S | | | | | | |
| | | | | | | | | | | | | |



Final Cal Tables: amplitude and phase





Summary Plots (hifv_plotsummary)

A Home By Topic

By Task

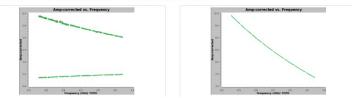
Project Code N/A

Tasks in execution order 1. hify_importdata 17. Plot Summary BACK 2. hifv_hanning 3. hifv_flagdata 4. hifv_vlasetjy **VLA Pipeline Summary Plots** 5. hify_priorcals Phase vs. time for all calibrators, Amp vs. UVwave for all calibrators, as well as a representative selection of fields with intent='TARGET' with Amp vs. UVwave plots. 6. hifv_testBPdcals TDRW0001.sb35624494.eb35628826.58395.23719237269.ms 7. hifv_checkflag Calibrated phase vs. time, all calibrators 8. hifv_semiFinalBPdcals Field 0, "0137+331=3C48" Band S Field 1, j2355+4950 Band S Field 2, J0259+0747 Band S MAGINE W. Y S -9. hifv_checkflag A STANDAR 10. hify_solint C & COLEMANNESSER 11. hify_fluxboot 12. hifv_finalcals the second and the second second ASSAULTING POOR TO DO IN 13. hifv_applycals 14. hifv_checkflag 15. hifv_targetflag All calibrators Band: All bands Field 0, "0137+331=3C48" Band: S Field 1, J2355+4950 Band: S Field 2, J0259+0747 Band: S 16, hify statwt 18. hif_makeimlist (cals) Field 3, 3C75 Band S 19. hif_makeimages (cals) 20. hifv_exportdata 21, hif mstransform 22, hif checkproductsize 23, hif makeimlist (cont) 24. hif_makeimages (cont) 25. hifv_pbcor Field 3, 3C75 Band: S 26. hifv_exportdata

Calibrated amplitude vs frequency

Plots of calibrated amplitude vs frequency for all antennas and correlations, coloured by antenna.

TDRW0001.sb35624494.eb35628826.58395.23719237269.ms





Pipeline Products and Outputs

- Flagged and Calibrated MS
- Final flag version and calibration tables (archived)
- Logs, including weblog used by quality assurance (QA) staff and QA report (archived).



9th VLA Data Reduction Workshop

Pipeline Products and Outputs

- The real-time pipeline produces a calibrated and flagged MS:
 - Calibrated MS may be requested through the archive <u>data.nrao.edu</u> (See next talk from Aaron!)
 - You may request a more detailed QA2 report from the data analysts (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, instructions for applying flags and calibration tables may be found at <u>http://go.nrao.edu/vla-pipe</u>



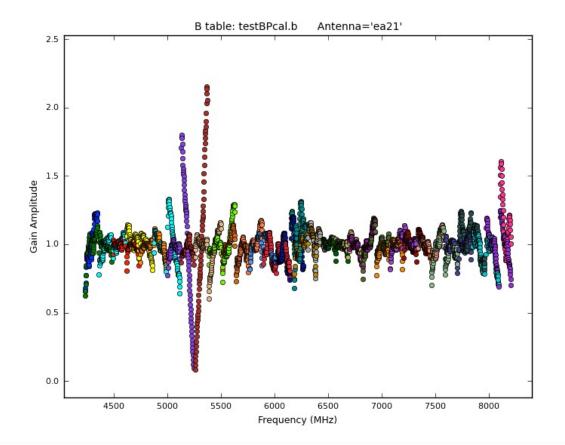
- In general the pipeline does very well, but there are possible failure modes:
 - No flux density or gain calibrator intents defined, or flux density calibrator not one for which we have models
 - work around in scripted pipeline
 - Wrong scan intents
 - modify Scan.xml in SDM; see https://science.nrao.edu/facilities/vla/dataprocessing/pipeline#section-28
 - 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



- 6.2.1 specific failure modes:
 - Fluxboot fitorder >2, fit order 2 used, not higher, incorrect flux scale
 - fixed in CASA+pipeline 6.4.1, available now
 - Some setups cause overly long short solution interval
 - *fixed in CASA+pipeline 6.4.1, available now*

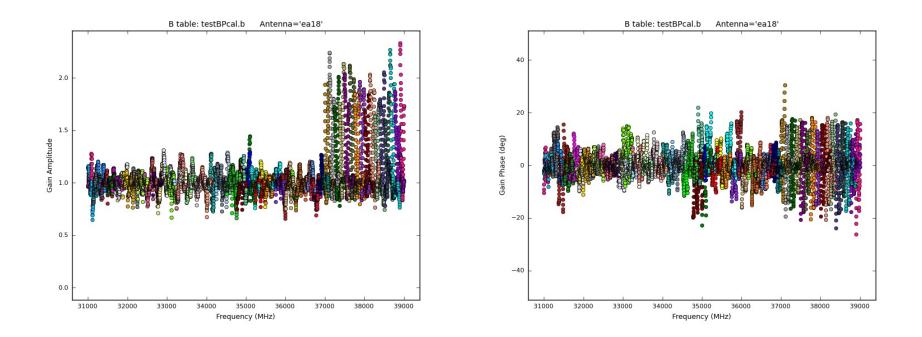


ea21 bandpass, bad data (DTS issue)



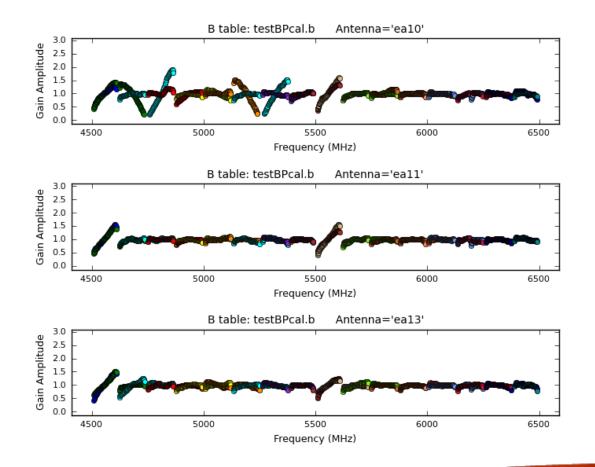


ea18 Amp and Phase affected (DTS issue for 37-39GHz)



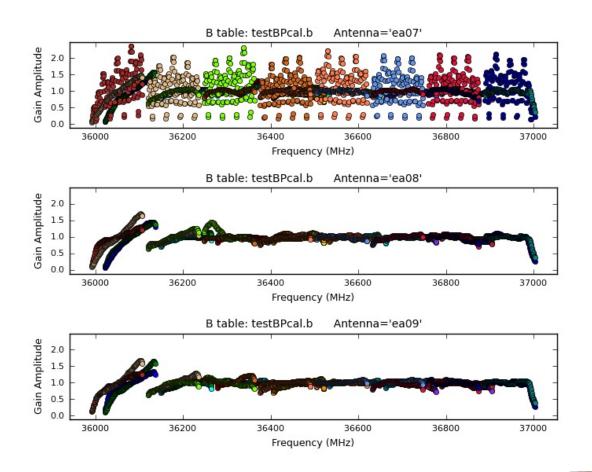


ea10 bandpass, bad data (DTS issue); ea11, ea12 OK





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





Science Ready Data Products (SRDP)

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

- Continuum only
- C band or higher frequency currently
- SB setup and scan intents set correctly for pipeline
- Currently only those using 3C286 or 3C147 as flux cal
- Staff check quality in more detail, add extra flagging and rerun



Imaging Pipeline

https://science.nrao.edu/facilities/vla/data-processing/pipeline/VIPL

| NRAO | Task | | | Project Code N/A |
|--|---|--|--|------------------|
| Tasks in execution order 1. hifv_importdata 2. hifv_hanning 3. hifv_flagdata | | | | BACK |
| 4. hifv_vlasetjy tt0 when multi-term 5. hifv_priorcals TDRW0001.sb35624494.eb35628826.58395.23719237269.ms | | | | |
| 7. hifv_checkflag | . hifv_checkflag oussid.s24_0.3C75_sci.S_band.cont.l.iter2 | | | |
| 8. hifv_semiFinalBPdcals 9. hifv_checkflag | rest | ored | residual | |
| 10. hifv_solint | maximum 1.57 | 99e-01 Jy/beam | 2.0434e-03 Jy/beam | |
| 11. hifv_fluxboot 12. hifv_finalcals | minimum -2.1 | 028e-03 Jy/beam | -1.9549e-03 Jy/beam | |
| 13. hifv_applycals | sigma 8.30 | 15e-03 Jy/beam | 3.0272e-04 Jy/beam | |
| 14. hifv_checkflag 15. hifv_targetflag | MAD rms 2.67 | 04e-04 Jy/beam | 2.2466e-04 Jy/beam | |
| 16. hifv_statwt 17. hifv_plotsummary 18. hif_makeimiist (cals) 19. hif_makeimages (cals) 20. hifv_exportdata | | Concentration designments from LCTP and particular LLLLLTLAT for 2 | | |
| 21. hif_mstransform 22. hif_checkproductsize 23. hif_makeimlist (cont) | | | | |
| 24. hif_makeimages (cont) 25. hifv_pbcor 26. hifv_exportdata | oussid.s24_0.3C75_sci.S_band.con t.l.iter2.image.pbcor.tt0.sky.png | oussid.s24_0.3C75_sci.S_band.con t.l.iter2.image.residual.pbcor.tt0.sk y.png | oussid.s24_0.3C75_sci.S_band.con t.l.iter2.pb.tt0.sky.png | |



Future Developments

- Support for spectral line observations
- Polarization calibration tested for VLA Sky Survey (S-band), need polarization calibrator models for other bands
- More robust flux density bootstrapping that flags outliers
- Improved RFI flagging and detection of system issues
- Use of switched power data for determining weights



Viewing Weblogs

- The default security preferences in Firefox block weblogs on disk from being viewed directly:
 - Go to about:config: security.fileuri.strict_origin_policy to False
 - In CASA h_weblog() should open a browser tab with weblog
 - Host them as a server would



Starting the Pipeline

- SDM-BDF (MS possible, but online flags needed before)
- casa_pipescript.py
- /path/to/casa/bin/casa --pipeline
- On NRAO machines: casa-pipe
- execfile(`casa_pipescript.py')
 - Wait ...



Considerations Before Running

- Disk space needed 3-4x raw data size, more if imaging
- Compute time: 30min to ... a few days (weeks)
- Setup correct to work with the pipeline?
- Hanning smoothing, other changes



Questions?

• VLA CASA Calibration Pipeline information at:

http://go.nrao.edu/vla-pipe

CASA Integrated Pipeline & Scripted Pipeline available

- Have Questions?
- Need Help?
- Report a bug?
- Use the NRAO HelpDesk: https://help.nrao.edu/
- Submit your ticket under the **Pipeline Department**.
- Please include specific details when submitting HelpDesk tickets.
 (Project code, SB number, CASA/PL versions, errors, etc.)







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Spectral line data

- Several steps in the real-time pipeline may not be appropriate for spectral line data:
 - Hanning smoothing (increases effective channel width)
 - Flags 5% of *each* spw edge and the first and last 10 channels of each baseband
 - Last run of RFLAG on target (may eliminate your line as interference!)
 - Statwt calculates rms based on scatter of channels per spw, per visibility; may want to run manually with channel selection turned on to eliminate use of channels containing line emission in calculating the rms

 \Rightarrow Specify a "cont.dat" file to avoid known lines for RFI flagging and statwt

• With the above modifications, the pipeline will work with spectral line data as long as the calibrators are strong enough



Mixed correlator set-ups

- With WIDAR capabilities it is common to observe both wide and narrow spws to obtain both continuum and spectral line data simultaneously or multiple receiver bands
 - A single heuristic (e.g., gain calibration solution interval) for entire dataset may not be appropriate
- Solution:
 - Run pipeline through application of deterministic flags, including Hanning smoothing if you are going to use it
 - Split the MS by spw and/or scans
 - Run pipeline on split MSs WITHOUT Hanning smoothing (you have already applied it, if you are going to use it)
 - Warning: output flagging statistics may not be correct

