

VLA Pipeline, Weblog, Data Products Amy Kimball – NRAO Scientist



VLA Calibration Pipeline - Overview

- The 'real-time' pipeline is automatically run on all Scheduling Blocks (SBs) as soon as raw data are ingested in the archive:
 - Flagged and calibrated data are delivered to users
 - Pipeline should run correctly on 'standard' Stokes I science SBs
 - Output undergoes basic quality assurance (QA) checks by NRAO staff
 - Science-Ready Data Products (SRDP): detailed checks made for C-band and higher (≥ 4 GHz) continuum products; a few other restrictions
 - reports generated from SRDP QA are archived as pipeline products
 - basic images produced with new VLA *imaging* pipeline (more later)
 - For non-SRDP: imaging and self-calibration (if needed) are left to end users to perform at their local institution or on NRAO computing



NFW

VLA Calibration Pipeline - Overview

- Current versions available:
 - CASA integrated pipeline: compatible with ALMA pipeline infrastructure; used as real-time pipeline since Sep 2015
 - recommended pipeline version
 - Instructions for installation and operation are available at http://go.nrao.edu/vla-pipe
 - VLA CASA Pipeline Guide at http://go.nrao.edu/vla-casa-tut
 - "scripted" pipeline: collection of python scripts that use CASA tasks wherever possible, but also uses toolkit calls. It was the original VLA pipeline and used in real-time pipeline operations from 2013 until Sep 2015. No longer updated (since CASA 5.3)



Will the Calibration Pipeline work for you?

- The pipeline successfully completes on ~96% of VLA science SBs.
 Usefulness of output depends on science goals, observing setup
 - Intended for 128-MHz spws (64 MHz for L-band; default setup) but may work for narrower bandwidths as well
 - Requires SNR=3 limit on initial gain calibration *per integration*
 - No polarization calibration (yet) but can use pipeline output as a starting point.*
 - Will probably work for VLA data observed since May 2012. May work for earlier data, but likely that extra flagging/editing needed
 - * See polarization guide at <u>http://go.nrao.edu/vla-casa-tut</u> Requires CASA 5.4.1 or later, and correct polarization intents in the SB



Pipeline Requirements

- The pipeline relies on correct scan intents. To run correctly, SB must have *at minimum* 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. Determines flux density scaling (reliable to 5-10% depending on observing band).
 - Complex gain calibrator scans: scans should bracket science targets; used to calibrate atmospheric changes over time

*Some (especially 3C48, 3C138) are varying recently, use 3C286 if possible



Calibration Pipeline Heuristics

- Derives all prior calibrations (antenna position corrections, gain curves, atmospheric opacity, requantizer gains)
- Runs Hanning smoothing*
- Applies deterministic flags ("online" flags, shadowed antennas, spw edges*)
- 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 calibration tables
- 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.



Pipeline weblog - overview

- Pipeline weblog created in realtime (updates while running)
 - located in *pipeline-YYYYMMDDTHHMMSSS/html/index.html* in the working directory
- Diagnostic plots and tables for most stages
- CASA log file per task, or as a whole (can be large)
- Produces calibrator images per observing band
- The following example is used in our pipeline guide: <u>https://casaguides.nrao.edu/index.php?title=VLA-S-CASA_Pipeline-CASA6.4.1</u>



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



Observation Overview

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

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 28826.58395.23719237269_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

Antenna Setup

Min Baseline

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:	S: A0C0: 2.487 GHz to 3.511 GHz:
[spws]	[2,3,4,5,6,7,8,9]

Sky Setup

Min Elevation

36.89 degrees



NRAO Community Day, Morelia, Sep 2023

40.0 m

A Home By Topi

By Topic By Task

Project Code N/A

Session: default

TDRW0001.sb35624494.eb35628826

TDRW0001.sb35624494.eb35628826

```
listobs.txt
```

BACK

eb35628826	5.58395.23719237269.ms M	S Versi	ion 2	vacidation/0.2	/shortsb-and-muttib	and/5-guide-o21V/_tarbatt_1116/working/lukwood1.50556.
Observe	er: Dr. Emmanuel Momjian I	Project	t: uid://evla/pdb/356217	23		
Observatio	on: EVLA					
Data recor	ds: 5752188 Total elaps	sed tim	ne = 10270 seconds			
Observe	ed from 04-Oct-2018/05:41:3	5.0 1	to 04-Oct-2018/08:32:4	5.0 (UTC)		
0bserva	ationID = 0 ArrayID =	0				
Date	Timerange (UTC)	Scan	FldId FieldName	nRows	SpwIds Average I	Interval(s) ScanIntent
04-0ct-2	2018/05:41:35.0 - 05:42:31.0	1	0 0137+331=3C48	39312	[0,1] [1, 1] [SYS	TEM_CONFIGURATION#UNSPECIFIED]
	05:42:32.0 - 05:47:30.0	2	0 0137+331=3C48	209196	[0,1] [1, 1] [SYS	TEM_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] [SYSTEM_CONFIGURATION#UNSPE
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#UNSPE
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#UNSPECI
ALIBRATE_F	LUX#UNSPECIFIED, CALIBRATE_PO	L_ANGLE	E#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#UNSPECIFIE
BRATE_PHAS	E#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#UNSPECIFIE
BRATE_PHAS	E#UNSPECIFIED, CALIBRATE_POL_	LEAKAGE	E#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#UNSPECIFIE
BRATE_PHAS	E#UNSPECIFIED, CALIBRATE_POL_	LEAKAGE	E#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#UNSPECIFIE
BRATE_PHAS	E#UNSPECIFIED, CALIBRATE_POL_	LEAKAGE	E#UNSPECIFIED]			
	06:36:25.0 - 06:51:20.0	12	3 3075	502632	[23456789]	[5 5 5 5 5 5 5 5] [OBSERVE TARGET#UNSPECTETED



36504 [2,3,4,5,6,7,8,9] [5, 5, 5, 5, 5, 5, 5] [CALIBRATE_AMPLI#UNSPECIFIED,CALI

NRAO Community Day, Morelia, Sep 2023

2 J0259+0747

06:51:25.0 - 06:52:30.0

13

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
```

Date	Timerange (UTC)	Scan	FldId FieldName	nRows	SpwIds Average Interval(s) ScanIntent
04-0ct-201	8/05:41:35.0 - 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] [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] [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] [CALIBRATE_BANDPASS#UNSPECIFIED,C
ALIBRATE_FLU	X#UNSPECIFIED,CALIBRATE_PO	L_ANGL	E#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] [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] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#	UNSPECIFIED, CALIBRATE_POL_	LEAKAG	E#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] [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] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#	UNSPECIFIED, CALIBRATE_POL_	LEAKAG	E#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] [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] [CALIBRATE_AMPLI#UNSPECIFIED,CALI
BRATE_PHASE#	UNSPECIFIED, CALIBRATE_POL_	LEAKAG	E#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



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	A	N/A	0:03:42
3. hífv_flagdata: VLA Deterministic flagging		1.00	0:06:18
4. hifv_vlasetjy: Set calibrator model visibilities		1.00	0:01:35
5. ht/v_priorcals: Priorcals (gaincurves, opacities, antenna positions corrections, rq gains, and switched power) No	A	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. hlfv_solint: Determine solint and Test gain calibrations		1.00	0:03:01
11. htfv_fluxboot: Gain table for flux density bootstrapping		0.96	0:03:40
12. htfv_finalcats: Final Calibration Tables		1.00	0:09:42
13. htfv_applycals: Apply calibrations from context		1.00	0:05:20
14. htfv_checkflag: Checkflag summary		1.00	0:36:18
15. hifv_targetflag: Targetflag		1.00	0:06:40
16. hlfv_statwt: Reweight visibilities		1.00	0:13:01
17. hifv_plotsummary: VLA Plot Summary		1.00	0:09:17
18. htf_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. htfv_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. hlf_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. hffv_pbcor: Pbcor	AC	N/A	0:00:04
26. htfv_exportdata: Prepare pipeline data products for export		1.00	0:02:40



- The following pipeline steps provide key checks for calibration quality:
 - hifv_flagdata
 - hifv_testBPdcals
 - hifv_solint
 - hifv_fluxboot
 - hifv_finalcals
 - hifv_plotsummary

deterministic flagged data fraction 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 useful diagnostic plots of calibrated data



Deterministic Flags (hifv_flagdata)

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

sks in execution order			Flagging Agent (Total Vis) Flagging Agent (Science Vis)								Measurement Set			
hifv_importdata														
. hifv_hanning						Other								
3. hifv_flagdata	Date Only Alex (inclusion)	Before	41100	Shadowed	Unwanted	Online	Flagging		Edge	0"	0	Developed	Total	
4. hifv_vlasetjy	Data Selection (by intent)	lask	ANUS	Antennas	Intents	Flags	Template	Autocorr	Channels	Clipping	Quack	Baseband	Science	TDHW0001.5D35624494.eD35628826.58395.23719237269.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	Calanaa Chaattal Windowa	2 1050/	E 9210/	0.000%	0.5050/	0.7550/	0.000%	0.000%	0.000%	0.000%	0.000%	2 6028/	4 2570/	4.9570/
7. hifv_checkflag	Science Spectral Windows	3.12370	3.03170	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														
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 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

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

lots: 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

Tasks in execution order 1. hifv_importdata 2. hifv_hanning 3. hifv_flagdata 4. hifv_vlasetly 5. hifv_priorcals 6. hifv_testBPdcals

7. hifv_checkflag 8. hifv_semiFinalBPdcals

9. hifv_checkflag

_

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 use the gain calibrations to establish a short solution interval. • The long solution intervals per bland that are used: S band: 207.05s . • The short solution intervals per bland that are used: S band: int .
Plots: Testgains amp plots Testgains phase plots
Pipeline QA
Input Parameters
Tasks Execution Statistics

CASA logs for stage 10

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



BACK

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 1 240 275 288 362 324 335 347 2.88 342 354 535 547 10. hifv_solint 1.1 1.1 11. hifv_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 Source Fit Order Band Center [GHz] Flux density [Jy] (at Band Center) 3rd order coeff 4th 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 **Residual: Data-Fitted Data** 26. hifv_exportdata Source Frequency [GHz] Data Error 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 Cal Tables: bandpass



Final Cal Tables: amplitude and phase





Final Cal Tables: amplitude and phase

NRAO Home By Topic By Task						Project Code N/A
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9. hifv_checkflag						
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11. hifv_fluxboot		·P)				
12. hifv_finalcals	S-band					
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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. hifv_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 HARENC'S & C 9. hifv_checkflag A STREET A State of the second second second 10. hify_solint · · · · · · · · C X COLEMANNA CONTRACTOR 11. hify_fluxboot 12. hifv_finalcals A State Barting and the second CHERRICAL POPULATION OF A 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) ield 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





Calibration Pipeline Products and Outputs

(1) flagged and calibrated ms
(2) final flag version, calibration tables (archived)
(3) logs, weblog used by quality assurance (QA) staff, with QA notes (archived)
(4) casa_pipescript.py, casa_commands.log, casapy log file (archived)

- Accessing/using the calibration products:
 - Calibrated MS may be requested through the archive https://data.nrao.edu
 - You may request a more detailed QA2 report from NRAO staff (help.nrao.edu, Pipeline Department)
 - If you are happy with 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>



Considerations for Running

• Not all CASA versions include pipeline: (6.4.1 does)

https://casa.nrao.edu/casa_obtaining.shtml

- Run on SDM? (MS possible but make sure online flags applied)
- Disk space needed 3-4x raw data size, more if imaging
- Compute time: 30min to ... a few days (weeks for some images)
- Changes to casa_pipescript.py ? (Hanning smoothing, etc.)

(shell command line) /path/to/casa/bin/casa --pipeline (CASA command line) execfile(casa_pipescript.py)



Spectral line data

- Several steps in the real-time pipeline may not be appropriate for spectral line data: (may want to turn off for spectral line!)
 - Hanning smoothing (increases effective channel width)
 - Flags 5% of *each* spw edge and the first and last 10 channels of each baseband (*if known line position is not near spw edge, flagging okay*)
 - Last run of RFLAG on target (can eliminate your line as interference!)
 - Statwt calculates rms based on scatter of channels per spw, per visibility (will down-weight strong lines)
 - \Rightarrow Possible approach: run pipeline once with above options turned off. Then run with "cont.dat" file to avoid known lines for RFI flagging and statwt on
- With the above modifications, the pipeline will work with spectral line data as long as the calibrators are strong enough



VLA CASA Imaging Pipeline

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

- Developed for VLA *continuum* data; from ALMA imaging pipeline
- Produces a continuum image per target field, per observed band
- Pixel/cell size samples 4-5 times across synthesized beam
- Uses nterms=2 if fractional continuum bandwidth > 10%
- Uses tclean auto-masking; cleans to 4-sigma (nsigma parameter)
- For targets with significant extended emission: inner 5% of uvrange is omitted (to avoid deconvolution errors from poorly sampled structure)



Create science targets ms (hif_mstransform)

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asks in execution order		
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2. hifv_hanning	21. Oreate Science Targets Continuum	IT LINE Weasurement Sets IO
i. hifv_flagdata	Imaging	BACK
. hifv_vlasetjy		
. hifv_priorcals		
. hifv_syspower	QA Score: 1.00 The science targets cont+line ms file TDRW0001.sb35624494.eb35628826.	58395.23719237269_targets.ms for was created
/. hifv_testBPdcals		
3. hifv_checkflag	Results	<pre>CSDM name> targets</pre>
). hifv_semiFinalBPdcals	Science Targets Continuum+Line Measurement Sets	
10. hifv_checkflag	The following science target measurement sets were created for imaging	
1. hifv_solint		
2. hifv_fluxboot	Original Measurement Set Science T	argets Continuum+Line Measurement Set
hifv_finalcals	TDFW0001.sb35624494.eb35628826.58395.23719237269.ms TDFW000	1.sb35624494.eb35628826.58395.23719237269_targets.ms
4. hifv_applycals		
5. hifv_checkflag	Science target measurement sets	
6. hifv_statwt		
7. hifv_plotsummary	Input Parameters	
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3. hif_makeimlist (cont)	 view or download stagez //casapy.og (8.9 KiB) 	
4. hif_makeimages (cont)		
5. hifv_pbcor		
6. hifv exportdata		

lie:///Usersfott/Documents/pipeline/S-guide/6.4.1/S-guide-641v12_tarball_2022.64_0917/working/pipeline-procedure_hifv_calimage_cont/html/stage19/t2-4m_details-container.html



Image size (hif_checkproductsize)



Home By Topic	By Task		
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	scaled MAD		
	non-pbcor image RMS	69 uJy/beam	
	pbcor image max / min	146 / -1.34 mJy/beam	
	fractional bandwidth /	34%/2	
	nterms		



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	scaled MAD				
	non-pbcor image RMS	69 uJy/beam			
	pbcor image max / min	146 / -1.34 mJy/beam			
	fractional bandwidth /	34% / 2			
	nterms				











Primary beam corrected images (hifv_pbcor)



Imaging Pipeline Products and Outputs

- Continuum images for each science target in each band
 - pb-corrected image, pb image, clean mask, spectral index images (tt1, alpha, alpha-err) if relevant
- pipeline weblog, casa-log file, casa_pipescript.py, casa_commands.log file
- In the archive (*data.nrao.edu*):
 - main images (not primary-beam corrected) viewable with CARTA viewer!
 - data "download" provides the above ancillary images (when available); not visible in archive search (yet)





Future Pipeline Developments

- VLA Calibration pipeline
 - 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
 - Use of switched power data for determining data weights
- VLA Imaging pipeline
 - Self-calibration (currently provided for some SRDP imaging)
 - Improved heuristics to avoid including sidelobes in masks



Science Ready Data Products (SRDP)

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

- Calibrated and (basic) imaged science ready data
 - calibrations since June 2019
 - imaging **NEW** since January 2023
- Continuum (wide-bandwidth) only
- Currently only C band or higher frequency *(stay tuned...)*
- SB setup and scan intents set correctly for pipeline
- Currently only those using 3C286 or 3C147 as flux calibrator
- Staff check quality in more detail: extra flagging, rerun as needed



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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