VLASS Calibration Pipeline & Weblogs

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VLA CASA Calibration Pipeline

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

```
__rethrow_casa_exceptions = True
context = h_init()
context.set_state('ProjectSummary', 'proposal_code', 'VLA/')
context.set_state('ProjectSummary', 'observatory', 'Karl G. Jansky Very Large Array')
context.set_state('ProjectSummary', 'telescope', 'EVLA')
context.set_state('ProjectSummary', 'piname', 'unknown')
context.set_state('ProjectSummary', 'proposal_title', 'unknown')
try:
    hifv_importdata(vis=['17B-165.sb34260743.eb35145638.58173.456219988424'], session=['session_1'])
    hifv_hanning(pipelinemode="automatic")
    hifv_flagdata(intents='*POINTING*,*FOCUS*,*ATMOSPHERE*,*SIDEBAND_RATIO*,
                  *UNKNOWN*, *SYSTEM_CONFIGURATION*, *UNSPECIFIED#UNSPECIFIED*',
                  hm_tbuff='1.5int')
    hifv_vlasetjy(pipelinemode="automatic")
    hifv_priorcals(pipelinemode="automatic")
    hifv_testBPdcals(pipelinemode="automatic")
    hifv_flagbaddef(pipelinemode="automatic")
    hifv_checkflag(pipelinemode="automatic")
    hifv_semiFinalBPdcals(pipelinemode="automatic")
    hifv_checkflag(checkflagmode='semi')
    hifv_semiFinalBPdcals(pipelinemode="automatic")
    hifv_solint(pipelinemode="automatic")
    hifv_fluxboot(pipelinemode="automatic")
    hifv_finalcals(pipelinemode="automatic")
    hifv_applycals(pipelinemode="automatic")
    hifv_targetflag(intents='*CALIBRATE*,*TARGET*')
    hifv_statwt(pipelinemode="automatic")
    hifv_plotsummary(pipelinemode="automatic")
    hif_makeimlist(intent='PHASE,BANDPASS')
    hif_makeimages(hm_masking='none')
finally:
    h_save()
```

VLASS CASA Calibration Pipeline

https://safe.nrao.edu/vla/casa-release-5.1.0-74.el6.tgz

```
__rethrow_casa_exceptions = True
context = h_init()
context.set_state('ProjectSummary', 'proposal_code', 'VLA/TSKY0001')
context.set_state('ProjectSummary', 'observatory', 'Karl G. Jansky Very Large Array')
context.set_state('ProjectSummary', 'telescope', 'EVLA')
context.set_state('ProjectSummary', 'piname', 'unknown')
context.set_state('ProjectSummary', 'proposal_title', 'unknown')
try:
    hifv_importdata(vis=['VLASS1.1.sb35118798.eb35120996.58169.55511674768'], session=['session_1'])
    hifv_hanning(pipelinemode="automatic")
    hifv_flagdata(intents='*POINTING*,*FOCUS*,*ATMOSPHERE*,*SIDEBAND_RATIO*,
                  *UNKNOWN*, *SYSTEM_CONFIGURATION*, *UNSPECIFIED#UNSPECIFIED*',
                  hm_tbuff='manual', template=True, tbuff=0.225, fracspw=0.05,
                  quack=False)
    hifv_vlasetjy(pipelinemode="automatic")
    hifv_priorcals(swpow_spw='6,14', tecmaps=False)
    hifv_testBPdcals(refantignore='ea24')
    hifv_flagbaddef(pipelinemode="automatic")
    hifv_checkflag(checkflagmode='bpd')
    hifv_semiFinalBPdcals(refantignore='ea24')
    hifv_checkflag(checkflagmode='allcals')
    hifv_solint(refantignore='ea24', limit_short_solint=0.45)
    hifv_fluxboot2(refantignore='ea24')
    hifv_finalcals(refantignore='ea24')
    hifv_circfeedpolcal(pipelinemode="automatic")
    hifv_flagcal(pipelinemode="automatic")
    hifv_applycals(flagdetailedsum=False, flagsum=False, gainmap=True)
    hifv_checkflag(checkflagmode='target')
    hifv_statwt(pipelinemode="automatic")
    hifv_plotsummary(pipelinemode="automatic")
finally:
    h_save()
```

Modified Version of the VLA Continuum Pipeline

Many major and minor changes to the pipeline for VLASS.

- **hifv_flagdata**: Modified default behavior to adjust for OTF observing and to allow for flag templates that can be provided for known RFI.

  tbuff=0.225 *adds an additional buffer to the online flags, using 0.5*integration time to avoid flagging too much at the beginning of an OTF row.*

  fracspw=0.05 *flags 5% of the channels at each end of a spectral window (will be disabled for single epoch).*

  template=True *applies the flags provided in the flagtemplate file*

Modified Version of the VLA Continuum Pipeline

- *hifv_priorcals* (swpow_spw='6,14'): Plot only switched power for specified spectral windows.
- *hifv_checkflag*: Flag RFI for calibrators using 'tfcrop' and 'rflag' allow selecting only bandpass/delay calibrators (mode 'bpd') or all other calibrators (mode 'allcals').
- *hifv_solint*: Determine the solution interval for a scan-average equivalent and do test gain calibrations to establish a short solution interval. Added the ability to define a minimum short solution interval.
- *hifv_fluxboot2:* New VLASS informed version of fluxboot, that makes 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. Compared to hifv_fluxboot the RFI resilience was improved.

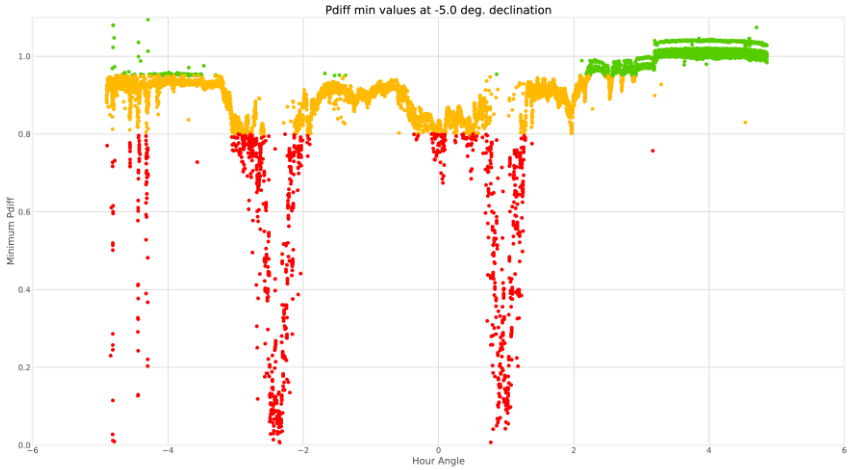
Modified Version of the VLA Continuum Pipeline

- *hifv_circfeedpolcal*: VLASS specific task that enables polarization calibration. More later.
- *hifv_flagcal*: Flagging of final calibration tables not included in standard pipeline.
- *hifv_applycals*: Small modifications to better deal with VLASS specific data, mainly related to flagging report. Match gain calibrators to target scans and run applycal in multiple steps, which we need to stop calibrations from other parts of the sky being applied to the target fields in cases where gaincal failed to get a solution for the local calibrator.
- Added option to ignore certain antennas to be used as reference antenna (refantignore).

More modifications to come for single epoch recalibration

- *hifv_priorcals:* generate calibration tables for ionospheric correction (tecmaps=True).
- *hifv_syspower:* New task which generates a switched power template to correct for gain compression due to strong interference, primarily by satellites. For quicklook we had a scripted version of this.

Example of gain compression at -5 deg. declination.



More modifications to come for recalibration

- ***hifv_finalcals:*** Allow to specify uvmin/uvmax for resolved calibrators.

- ***hifv_fluxboot2:*** Allow for higher order polynomial fits to calibrator spectra for higher accuracy flux bootstrapping.

- ***hifv_circfeedpolcal:*** Added solving multiband delays, use of short solint phase calibrator solutions for improved S/N. D-term table flagging of outlier solutions, addition of secondary polarization angle calibrator models, especially for 3C138 and J1800+7828. Allow selection of D-term calibration mode Df or Df+QU.

More modifications to come for recalibration

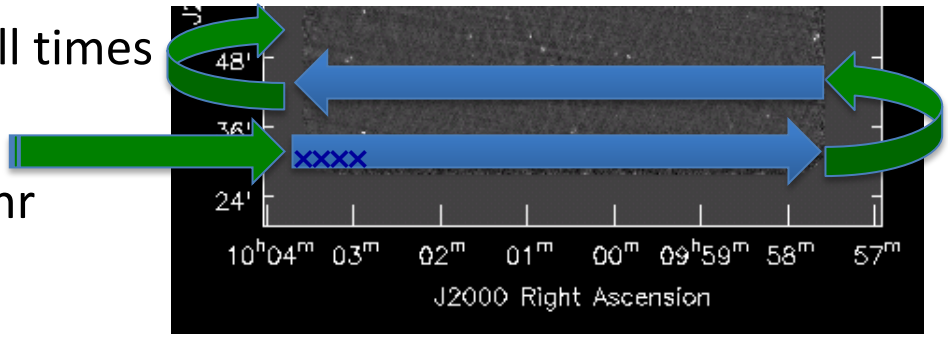
- *hifv_statwt2:* Transparent replacement for statwt with better control over flagging, and therefore make restoring calibration match the output of the pipeline. In the future more tunable in several ways (e.g. calculation based on residuals, per channel instead of per spectral window weights, robust statistics, etc.)

- *hifv_checkflag*: Further improvements to target field flagging to minimize the need to flag every single scheduling block after running through the pipeline.

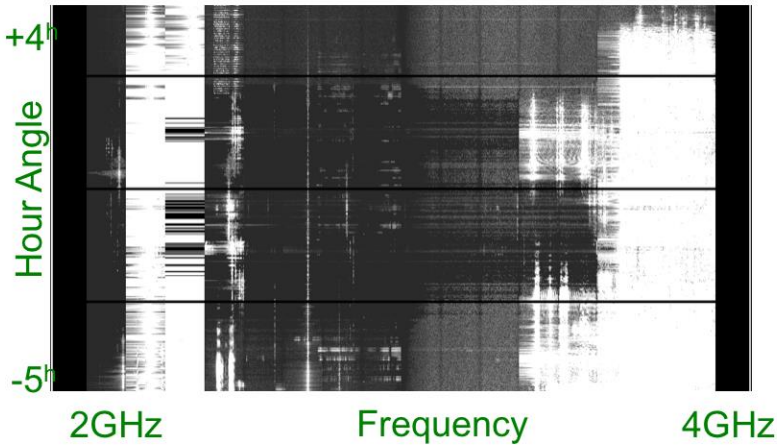
- Remove channel averaging in making temporary measurement sets of calibrators for deriving the gain calibrations (this was causing flux density offsets between spectral windows with different amounts of channel flagging)

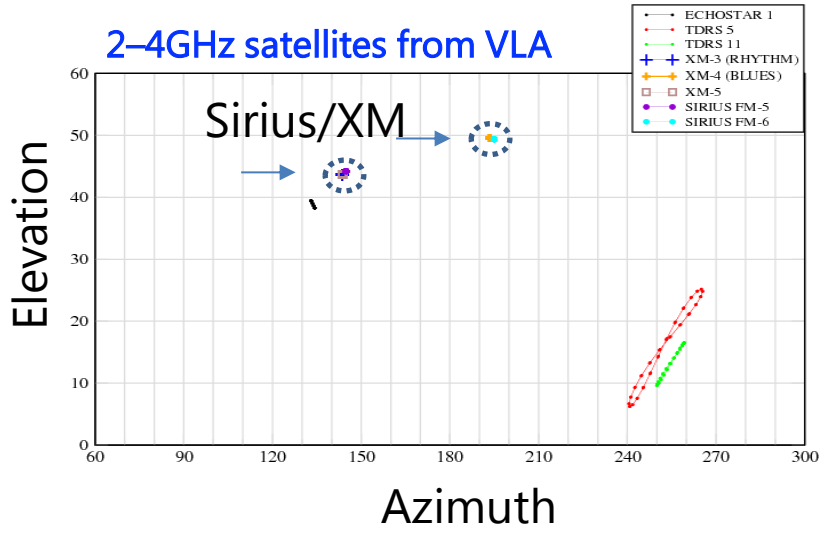
General Introduction to VLASS data

- Multi-epoch sky coverage enabled by On-The-Fly mosaicking
  - Scan telescopes across sky while taking array data
    - Very efficient for short dwell times
  - Scan rate 3.3’/s, row sep 7.2’
  - VLASS survey speed: ~20 deg^2/hr
  - Equivalent time-on-source: 5s



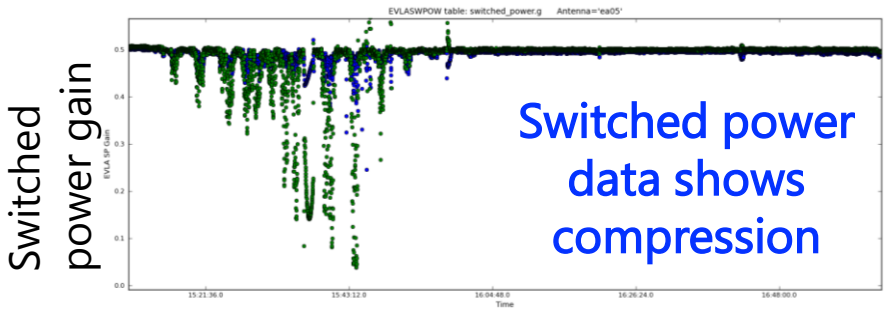
- RFI





RFI

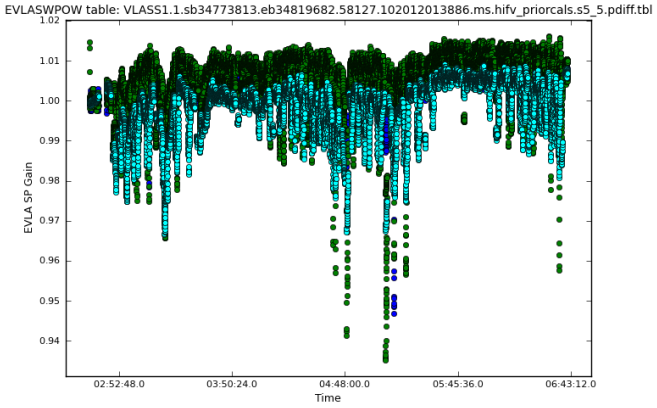
- Compression (identified in pilot data)
  - Affects entire baseband, not just spws containing RFI
  - Problem for much larger fraction of sky than originally thought
  - Special algorithm developed that can correct for moderate compression



Green: <5% compression
Yellow: 5–20 % compression
Red: >20% compression

Compression Corrections

Switched Power



Antenna positions

No antenna position corrections to apply.

Requantizer gains

Requantizer gains written to:

VLASS1.1.sb34773813.eb34819682.58127.102012013886.ms.hifv_priorcals.s5_5.rq.tbl

Switched Power plots

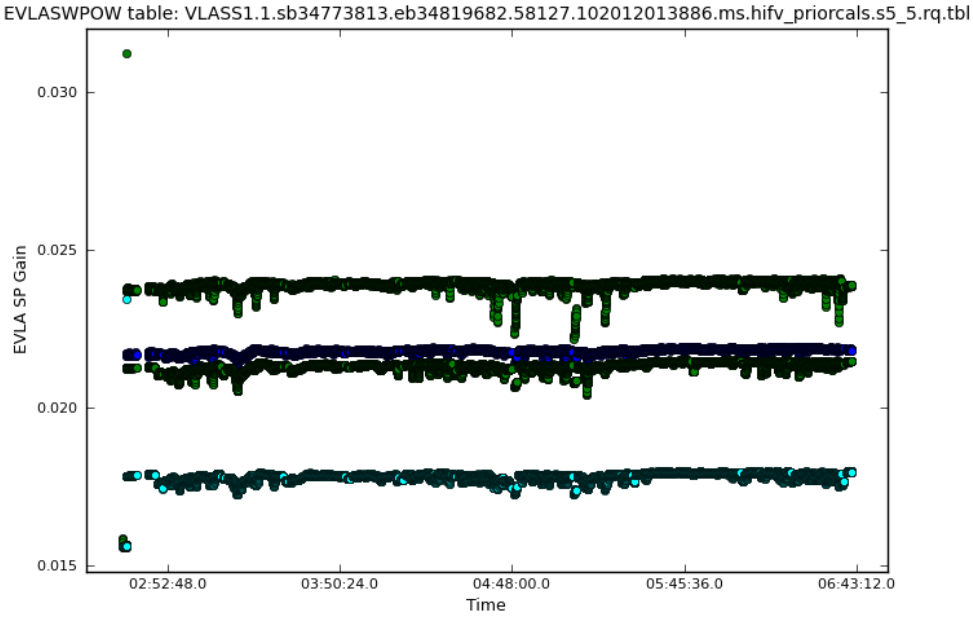
Switched Power table written to:

VLASS1.1.sb34773813.eb34819682.58127.102012013886.ms.hifv_priorcals.s5_6.swpow.tbl

This table is NOT applied or added to the pipeline context callibrary.

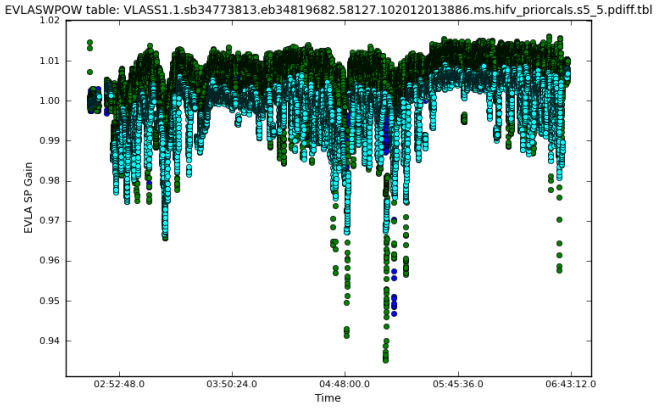
Switched Power Plots: SwPower SPgain plots | SwPower Tsys plots

Gain Adjustments due to Compression

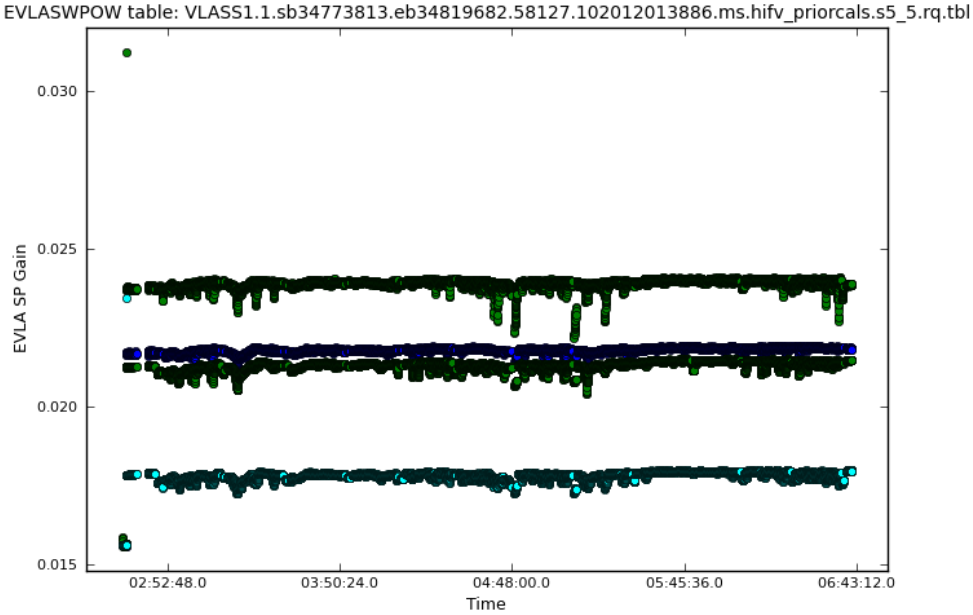


Compression Corrections

Switched Power



Gain Adjustments due to Compression



Antenna positions

No antenna position corrections to apply.

Requantizer gains

Requantizer gains written to:

VLASS1.1.sb34773813.eb34819682.58127.102012013886.ms.hifv_priorcals.s5_5.rq.tbl

Switched Power plots

Switched Power table written to:

VLASS1.1.sb34773813.eb34819682.58127.102012013886.ms.hifv_priorcals.s5_6.swpow.tbl

This table is NOT applied or added to the pipeline context callibrary.

Switched Power Plots: SwPower SPgain plots | SwPower Tsys plots | SwPower New RQ plots | SwPower Pdiff plots

Example VLASS weblog

VLASS1.1.sb34667861.eb34684334.58067.0700902199

- Tiles: T30t01, T29t01, T30t03, T29t03
- Flux Density Calibrator: 3C48
- Leakage Calibrator: J0626+8202 (0.9 Jy, unpolarized)
- Secondary RL phase calibrator: J1800+7828
- Ionosphere: 7.4 TECU average, 1.9 dTEC
- Notes: weak calibrators

Weblog link: https://archive-new.nrao.edu/vlass/weblog/calibration/VLASS1.1_T30t01.T29t01.T30t03.T29t03_P17071v1_2017_11_10T11_20_13.346/pipeline-20171110T162747/html/

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