EUROPEAN ARC
ALMA Regional Centre

ALMA QA

What is quality assurance, what should I look for or look at?

Luke Maud - ESO - Garching

SPANISH
ALMA Days

18-20 February 2025, La Laguna, Tenerife, Spain

Outline

- **INTRO : Quality Assurance**
  - what is it?
  - what does the observatory do

- **PART 1 : Calibration**
  - how do I know what was done
  - the ‘important’ points
  - example cases

we’ll do a follow through with an online weblog

- **PART 2 : Imaging**
  - what images were made for my target(s)
  - can I use these or do I need to do more

In the next session

INTRO

ALMA Technical Handbook

an overview of all material ALMA related is here

Doc 11.3, version 1.4 | March 1st, 2024

ALMA Cycle 11 Technical Handbook

Chapter 11

Quality Assurance

The goal of ALMA Quality Assurance (QA) is to ensure that the data products delivered to the PIs meet the expected quality standards. That is, the delivered products have reached the desired control parameters outlined in the science goals (or is as close to them as possible), they are calibrated to the desired accuracy, and calibration and imaging artifacts are mitigated as much as possible.

The QA analysis will be based on a calibration plan that specifies the required observations and the intervals between observations, in order to monitor and calibrate system performance and environmental factors as they evolve with time. Furthermore, the analysis will also be used in (a) assessing the merging of data within each science goal taken with different configurations, (b) the inclusion of 7-m Array and TP Array data, and (c) the final image quality. Errors introduced by user supplied parameters, such as incorrect source coordinates, inadequate frequency setting (e.g. an incorrect redshift) or inadequate sensitivity limits (leading to an inadequate integration time or inadequate *uv*-plane coverage) are outside the scope of the ALMA QA, unless the error occurred due to faulty information or tools provided by the Observatory.

To be more efficient in detecting problems, ALMA QA has been divided into several stages that mimic the main steps of the data flow. The broad classification of this multi-layered QA approach is:

QA0: The first check and monitoring of the calibration and overall performance during and just after an observation, performed at Execution Block level.

QA0+: The first check of imaging performance, based on a simplified and fast scripted imaging QA. This is mainly used when the results from QA0 are unclear or marginal, and will also be available in the QA0 report in Cycle 11.

QA1: This involves the measurement and monitoring of performance parameters and telescope properties by the observatory, across different observations and projects.

QA2: Full calibration and generation of imaging products, normally using the ALMA Data Reduction Pipeline (hereafter, ALMA Pipeline).

QA3: Issues found with the data by the PI or ALMA staff after data delivery.

The QA process is handled by the Program Management Group (PMG) and the Data Management Group (DMG) at the JAO with significant contributions from ARC personnel, as well as the Array Performance Group (APG) at the JAO. The process is primarily implemented using the ALMA Quality Assurance (AQUA) Tool (see Section 11.7) and other software necessary for the assessment of data quality. Responsibility for data quality assurance rests with the Data Management Group Head within the Department of Science Operations

ALMA

more detail than I can cover here

NRAO

www.almascience.org

ip of ESO (representing its member states), NSF (USA) and NINS (Japan), together with NRC
d ASIAA (Taiwan), and KASI (Republic of Korea), in cooperation with the Republic of Chile.

INTRO

Quality Assurance

- **What is it :**

  - literally “quality assurance”

  - checks that are in place to ensure the products that finally get delivered to the PIs / Users are meeting the expected standard

imagine, if there were no checks at all….antennas might not be all working, the weather conditions might be poor…..the data might not even be useable…

INTRO

Quality Assurance

- **QA levels**

  - **QA0**: Check of the data recorded and the calibrators, and their performance right after the Execution is completed

Quality Assurance

- **QA levels**

  - **QA0**: Check of the data recorded and the calibrators, and their performance right after the Execution is completed

  - **QA0+**: First immediate calibration with ‘quick’ imaging of everything

Quality Assurance

- ## QA levels

  - **QA0**: Check of the data recorded and the calibrators, and their performance right after the Execution is completed

  - **QA0+**: First immediate calibration with ‘quick’ imaging of everything

  - **QA1**: behind the scenes longer terms stats harvested from QA0 pass data

Quality Assurance

- **QA levels**

  - **QA0**: Check of the data recorded and the calibrators, and their performance right after the Execution is completed

  - **QA0+**: First immediate calibration with ‘quick’ imaging of everything

  - **QA1**: behind the scenes longer terms stats harveste QA0 pass data

  - **QA2**: Full calibration and generator of imaging products - either by the ALMA Pipeline or by-hand, manually*

this is what we are interested in

*for special modes and/or difficult data

Quality Assurance

- **QA levels**

  - **QA0**: Check of the data recorded and the calibrators, and their performance right after the Execution is completed

  - **QA0+**: First immediate calibration with ‘quick’ imaging of everything

  - **QA1**: behind the scenes longer terms stats harveste
    QA0 pass data

  - **QA2**: Full calibration and generator of imaging products - either by the ALMA Pipeline or by-hand, manually*

  - **QA3**: if significant issues with data or imaging is found (by the observatory or users) later, a new analysis is opened

this is what we are interested in

*for special modes and/or difficult data

What does the observatory do?

- **QA0/QA0+ : The Astronomer on Duty - at the telescope**

  - Checks results for Atmospheric effects, Antenna issues, Signal issues, Correlator Issues, Observing issues (i.e. completeness)

  - Automated quick reduction shows images of the calibrators and target

  - If all checks are passed, the data are QA0 - Pass

  - If data al take correctly but very poor conditions these are **QA0-semi-pass**, cannot be calibrated to meet the expected standard

  - If data is part taken, no target, or instrument issues - essentially **QA0-Fail**

Ready for QA2 and to be “processed”

What does the observatory do?

- **QA2 : JAO and ARCs**
  - In recent years the **majority** (97% in last 2 cycles) of ALMA data are **calibrated** and **imaged** with the ALMA pipeline
  - The ALMA pipeline is run at the **ARC Regional Centers** (Europe, North America, East Asia) and the **Joint ALMA Observatory** (JAO) in Chile
  - A weblog serves as the **interface** for data analysts and users alike to **investigate** how the pipeline processing progressed and for **data analysts** to assess the quality
  - **QA2 pass - data delivered to the PI/user**
    - Must meet the Angular Resolution and Image Sensitivity
- **QA3 : JAO and ARCs**
  - deep dive into investigation and fixing of issues

What does the observatory do?

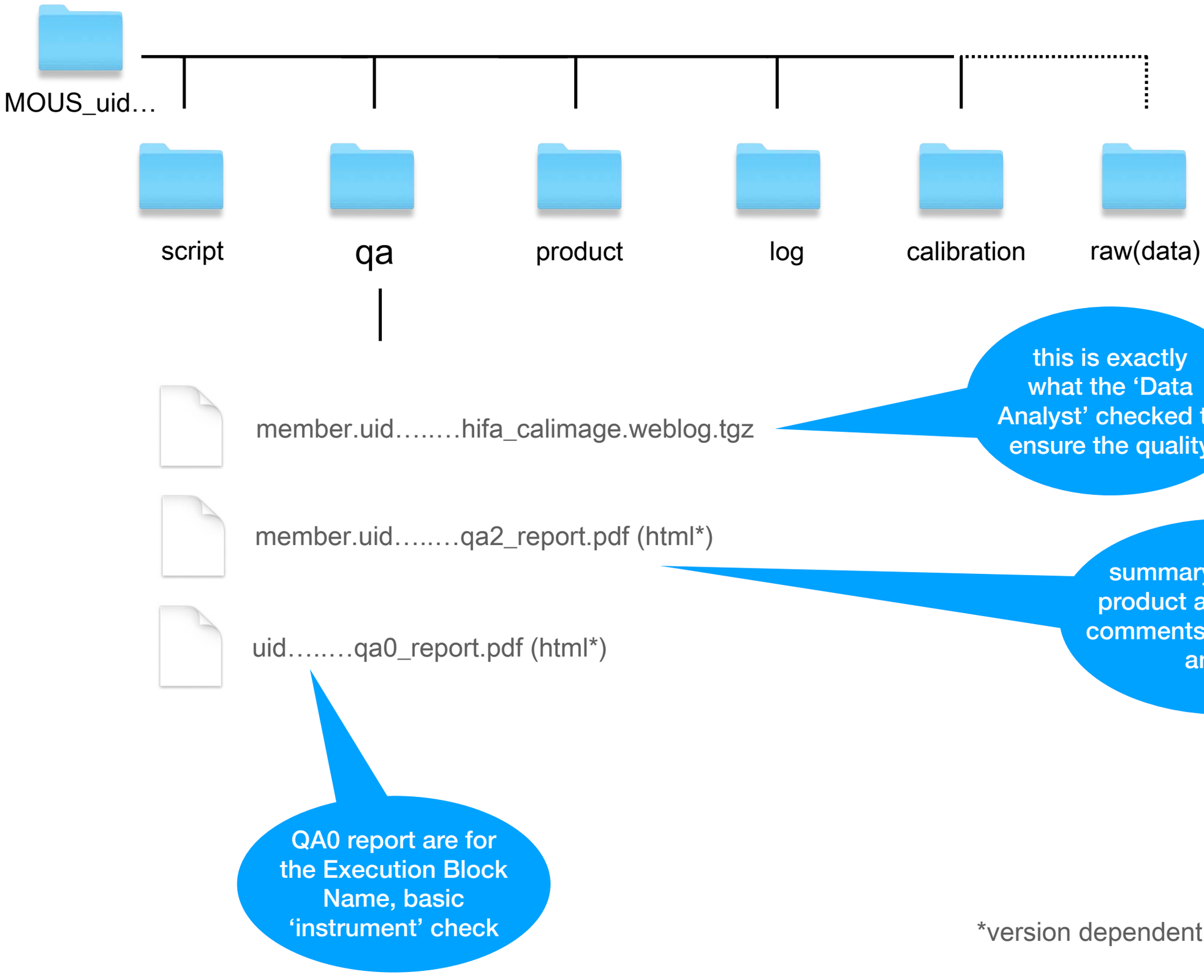
- **QA2 : JAO and ARCs**
  - In recent years the **majority** (9
    data are **calibrated** and **imag**
  - The ALMA pipeline is run at
    (Europe, North America, East
    Observatory (JAO) in Chile
  - A weblog serves as the **interfac** nd
    users alike to **investigate** how the pipeline processing
    progressed and for **data analysts** to assess the quality
  - **QA2 pass - data delivered to the PI/user**
    - Must meet the Angular Resolution and Image Sensitivity
- **QA3 : JAO and ARCs**
  - deep dive into investigation and fixing of issues

Starting in Cycle 10 (2023 Oct)
- data that are “good” are automatically assessed and not seen by an analyst

Any questions so far….?

PART 1 - Calibration

How do I know what was done



*version dependent (CASA/Pipeline)

PART 1 - Calibration

QA0 Report

QA0 Report

Execution Block Summary

Project Code	2017.1.00098.S	**SchedBlock**	G17.64+0_a_06_TM1
ExecBlock	uid://A002/Xc55c89/X120	**ExecBlock Status**	SUCCESS
QA0 Status	✔ Pass	**Exec. Fraction**	1.00
Repr. frequency	217.684 GHz (Sky)	**Band**	ALMA_RB_06
Array	12 [m]	**Baselines**	41m -- 14968m

Antennas

Antennas: 43 effective, 43 usable, 43 unflagged, 43 total. Expected for Cycle 5 : 43, minimum acceptable: 41
Band observed: 6. Highest recommended: 8-8

Weather

PWV 0.73 mm; Wind 12.65 m/s; Humidity 8.15 %; Pressure 556.47 hPa;
Phase rms: 77.929 microns

AOS Check comment

```
======== GoNogo/Handover/QA0 ========  v5.12
--------------------------------------------------------------------------
--------------------------------------------------------------------------
 ---- checking ASDM:  uid://A002/Xc55c89/X120
>/X120 checking Tsys/Trx:   6 ATMcals   B6  median:  Tsys 69.3K   Trx 42.8K
>/X120 checking pointing:   1 pointings. Max pointing offset 1.37 arcsec on DA42            No significant
pointing errors
>/X120 checking signal:   Median aperture efficiency 0.70 min/max= 0.56 0.85               No significant errors
in signal levels
>/X120 checking WVRs:   Median pwv  0.721 +- 0.058  mm              No significant wvr problems
>/X120 checking phases:
 Resolution:  0.027  arcsec   Baseline limit with good phase: 9855m.
  Antenna-based phaseCal differences:  21.79 degrees.  Max= 28.38 (DV03)
  Measured [& predicted] approximate fluxes:   Bandpass: 2.84 [ 3.73 ] Jy      Phase: 0.033 [ 0.040 ] Jy


- - - - - - - - - - - - - - - - - - - - - - - - Summary of system from SB - - - - - - - - - - - - - - - - - - - - - -
2017-10-04T21:28:23   uid://A002/Xc55c89/X120   band 6     Freq 233.033285342GHz
(1) Atmosphere :
   Median Tsys:  69.3 K
   Mean Zenith PWV:  0.72  +/- 0.06  mm
   Antenna-based phase differences on phaseCal: Q4= 21.8 degrees.
   Baseline-based phase fluctuations: mean= 165.9 microns ( 46.4 degrees) on baselines of 6500 m
   Median improvement in phase rms using WVRs: 1.71
(2) Antennas & system :
Issues with DA59  (FE#24)  -
 Scan 85 Pol 1 All spws :   Amplitude 60.6% of median
 1.2% of all cal data flagged

Issues with DV02  (FE#31)  -
 Scan 66 All spws & pols :   Amplitude 43.0% of median
 2.3% of all cal data flagged
 Dashboard status = C

Issues with DV04  (FE#21)  -
 Scan 3 spw 2 BB_3 P1 :   Amplitude 54.6% of median
 Scan 3 spw 3 BB_4 P1 :   Amplitude 54.7% of median
 0.6% of all cal data flagged

Issues with DV15  (FE#36)  -
 Scan 51 All spws & pols :   Phase noise 16.8x sigma on most baselines Amplitude 54.9% of median
```

Observing conditions

QA0 output

Summary statistic, e.g some antennas with higher than expected amplitudes

PART 1 - Calibration

QA2 Report

QA2 Report

Project information

Name	The Dust Disk in the O-Type Protostar G17.64+0.16
Code	2017.1.00098.S
PI	Luke Maud
Organization	Leiden Observatory, Leiden University
Co-Is	V. Allen, M. Beltran, H. Beuther, R. Cesaroni, T. Csengeri, W. de Wit, S. Etoka, G. Fuller, D. Galli, R. Galvan-Madrid, C. Goddi, T. Henning, M. Hoare, K. Johnston, P. Klaassen, R. Kuiper, N. Kumar, S. Lumsden, L. Moscadelli, J. Mottram, T. Peters, V. Rivilla, A. Sanchez-Monge, P. Schilke, L. Testi, F. van der Tak, S. Vig, C. Walmsley, H. Zinnecker

ObsUnitSet information

Name	Member OUS (G17.64+0.16)
QA2 Status	✔Pass
Member OUS Status ID	uid://A001/X1288/X59f
SchedBlock name	G17.64+0_a_06_TM1
SchedBlock UID	uid://A001/X1288/X59b
Array	TM1
Mode	Standard [Long baseline]
Band	ALMA_RB_06
Repr.Freq. (sky)	217.68 [GHz]
Spectral setup	FDM
Sources	G17.64+0.16
Other SBs in this Group OUS (Member OUS Status ID in brackets):	
Execution count	1.00 of 1 expected

Final QA2 comment

Processed using CASA 5.1.1
Imaging performed with tclean using briggs weighting of 1.5. An RMS higher than the requested is achieved with Briggs weighting with a robust value of 0.
After 2 runs of self-cal (only down to 30s), the noise level is 0.027 mJy with a beam 0.020" by 0.015".

RMS and beam size at representative frequency

Sensitivity goal	0.024 [mJy] over bandwidth 6000 [MHz]				
Angular resolution goal	0.016 - 0.024 [arcsec]				
Achieved RMS for desired bandwidth	0.027 [mJy]		**for continuum**	N/A	
Synthesized beam	**Mean (arcsec)**	0.017			
Major axis (arcsec)	0.020	**Minor axis (arcsec)**	0.015	**Position angle (deg)**	N/A

Execution blocks summary

EB	N Ant.	Start Time	End Time	ToS (sec)	Avg. Elev. (deg)	Trans. Elev.	Mean PWV (mm)	Phase RMS (deg)*	Min BL (m)	Max BL (m)	AR (")	MRS (")	EF
uid://A002/Xc55c89/X120	43	2017-10-04 21:28:	2017-10-04 22:34:	3937	0.0	0.0	0.7	77.051	41.4	14969.3	0.0	0.4	1.00

*WVR-corrected value averaged over all basebands and scans.

Manual reductions

CASA version	Report date
5.1.1	2018-01-10 14:50:41

My data

Comment from the analyst - this is now formalised since ~CASA 6.1.

What was achieved

How do I know what was done

- The ALMA pipeline…..
  - is comprised of **stages** to perform different tasks to calibrate and image data
  - performs a number of **heuristics** to do **automated flagging** and to generate quality assessment **scores** (**green**, **blue**, **yellow**, **red**) and **plots**
    - has been **updated** and **improved** throughout the ALMA Cycles to include new features
  - calibrates **per** Measurement Set (execution block)

INTRO

ALMA Pipeline Guide / Reference Manual

v.1.0 | Oct 2024

User Support:

ALMA Science Pipeline User's Guide for Release 2024.1.0.8, CASA 6.6.1-17, python3.8

Interferometric and Single-Dish Processing

Detailed explanation

ALMA

www.almascience.org

Pipeline Tasks Reference Manual

Release 2024.1.0.8

pipeline team

Tasks, parameters and brief expiation (doc string style)

Sep 16, 2024

INTRO

ALMA Pipeline Heuristics paper

Publications of the Astronomical Society of the Pacific, 135:074501 (58pp), 2023 July https://doi.org/10.1088/1538-3873/ace216

The ALMA Interferometric Pipeline Heuristics

Todd R. Hunter[1,2], Remy Indebetouw[1,3], Crystal L. Brogan[1,3], Kristin Berry[1], Chin-Shin Chang[4], Harold Francke[4], Vincent C. Geers[5], Laura Gómez[4], John E. Hibbard[1,3], Elizabeth M. Humphreys[4], Brian R. Kent[1], Amanda A. Kepley[1,3], Devaky Kunneriath[1], Andrew Lipnicky[1], Ryan A. Loomis[1,3], Brian S. Mason[1], Joseph S. Masters[1], Luke T. Maud[6], Dirk Muders[7], Jose Sabater[5,8], Kanako Sugimoto[9], László Szűcs[1,10], Eugene Vasiliev[5], Liza Videla[4], Eric Villard[6], Stewart J. Williams[5], Rui Xue[1], and Ilsang Yoon[1,3]
[1] National Radio Astronomy Observatory, 520 Edgemont Rd, Charlottesville, VA 22903, USA; thunter@nrao.edu
[2] Center for Astrophysics | Harvard & Smithsonian, Cambridge, MA 02138, USA
[3] Department of Astronomy, University of Virginia, P.O. Box 3818, Charlottesville, VA 22903, USA
[4] Joint ALMA Observatory, Alonso de Córdova 3107, Vitacura, Santiago 763-0355, Chile
[5] UK Astronomy Technology Centre, Royal Observatory Edinburgh, Blackford Hill, Edinburgh EH9 3HJ, UK
[6] ESO Headquarters, Karl-Schwarzschild-Str. 2, D-85748 Garching, Germany
[7] Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, D-53121, Bonn, Germany
[8] SUPA, Institute for Astronomy, University of Edinburgh, Royal Observatory, Blackford Hill, Edinburgh, EH9 3HJ, UK
[9] National Astronomical Observatory of Japan, National Institutes of Natural Sciences, 2-21-1 Osawa, Mitaka, Tokyo 181-8588, Japan
[10] Leibniz Supercomputing Centre, Boltzmannstraße 1, D-85748 Garching, Germany
Received 2023 April 21; accepted 2023 June 27; published 2023 July 24

Abstract

We describe the calibration and imaging heuristics developed and deployed in the Atacama Large Millimeter/submillimeter Array (ALMA) interferometric data processing pipeline, as of ALMA Cycle 9 operations. The pipeline software framework is written in Python, with each data reduction stage layered on top of tasks and toolkit functions provided by the Common Astronomy Software Applications package. This framework supports a variety of tasks for observatory operations, including science data quality assurance, observing mode commissioning, and user reprocessing. It supports ALMA and Very Large Array interferometric data along with ALMA and NRO 45 m single dish data, via different stages and heuristics. In addition to producing calibration tables, calibrated measurement sets, and cleaned images, the pipeline creates a WebLog which serves as the primary interface for verifying the quality assurance of the data by the observatory and for examining the contents of the data by the user. Following the adoption of the pipeline by ALMA Operations in 2014, the heuristics have been refined through annual prioritized development cycles, culminating in a new pipeline release aligned with the start of each ALMA Cycle of observations. Initial development focused on basic calibration and flagging heuristics (Cycles 2–3), followed by imaging heuristics (Cycles 4–5). Further refinement of the flagging and imaging heuristics, including the introduction of parallel processing, proceeded for Cycles 6–7. In the 2020 release, the algorithm to identify channels to use for continuum subtraction and imaging was substantially improved by the addition of a moment difference analysis. A spectral renormalization stage was added for the 2021 release (Cycle 8) to correct high spectral resolution visibility data acquired on targets exhibiting strong celestial line emission in their autocorrelation spectra. The calibration heuristics used in the low signal-to-noise regime were improved for the 2022 release (Cycle 9). In the two most recent Cycles, 97% of ALMA data sets were calibrated and imaged with the pipeline, ensuring long-term automated reproducibility of results. We conclude with a brief description of plans for future additions, including a self-calibration stage, support for multi-configuration imaging, and complete-

https://iopscience.iop.org/article/10.1088/1538-3873/ace216/pdf

1. Introduction

Located on the 5000 m plateau of Chajnantor in northern

PART 1 - Calibration

How do I know what was done

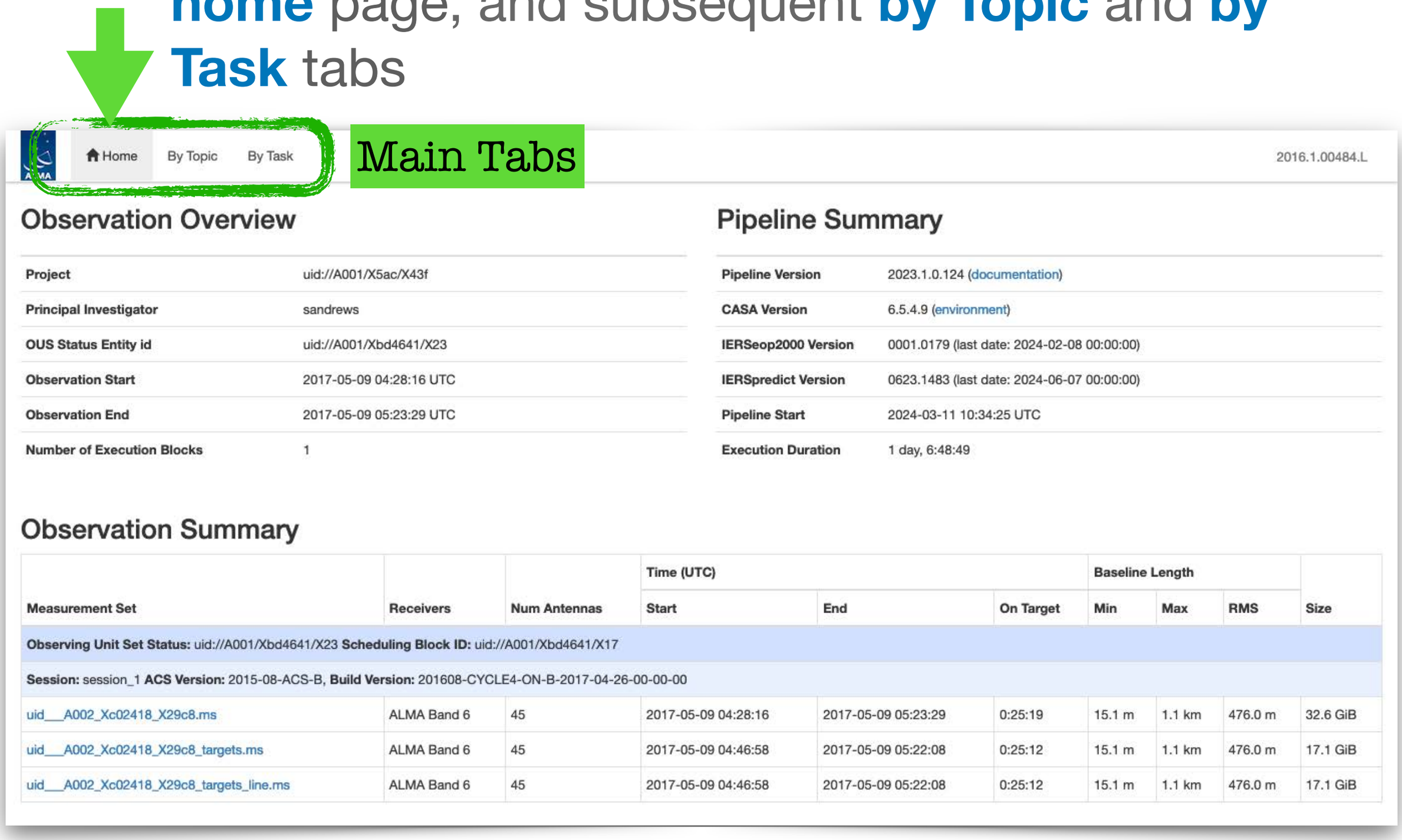
- **Recall,** we want to solve for instrumental and atmospheric variations to **calibrate** the data
  - **System Temperature** (Tsys) - instrumental amplitude scaling (K to Jy)
  - **Bandpass** - instrumental frequency response
  - **Amplitude** - the absolute flux/amp. scaling
  - **Gains** - temporal variations in amplitude and phase

so… all of this calibration **has been done**, with any flagging of bad data, then imaging

PART 1 - Calibration

The Weblog

- There is a main weblog landing page - the **home** page, and subsequent **by Topic** and **by Task** tabs



PART 1 - Calibration

The Weblog

- The **home** page reports much of the overview information…

Home | By Topic | By Task

Project Code: 2016.1.00484.L

Observation Overview

Project	uid://A001/X5ac/X43f
Principal Investigator	sandrews
OUS Status Entity id	uid://A001/Xbd4641/X23
Observation Start	2017-05-09 04:28:16 UTC
Observation End	2017-05-09 05:23:29 UTC
Number of Execution Blocks	1

PI

Dates

Pipeline Summary

Pipeline Version	2023.1.0.124 (documentation)
CASA Version	6.5.4.9 (environment)
IERSeop2000 Version	0001.0179 (last date: 2024-02-08 00:00:00)
IERSpredict Version	0623.1483 (last date: 2024-06-07 00:00:00)
Pipeline Start	2024-03-11 10:34:25 UTC
Execution Duration	1 day, 6:48:49

Versions

Observation Summary

Measurement Set	Receivers	Num Antennas	Time (UTC) Start	End	On Target	Baseline Length Min	Max	RMS	Size
Observing Unit Set Status: uid://A001/Xbd4641/X23 **Scheduling Block ID:** uid://A001/Xbd4641/X17									
Session … **Build Version:** …									
uid___A002_Xc02418_X29c8.ms			16	2017-05-09 05:23:29	0:25:19	15.1 m	1.1 km	476.0 m	32.6 GiB
uid___A002_Xc02418_X29c8_targets.ms	ALMA Band 6	45	2017-05-09 04:46:58	2017-05-09 05:22:08	0:25:12	15.1 m	1.1 km	476.0 m	17.1 GiB
uid___A002_Xc02418_X29c8_targets_line.ms	ALMA Band 6	45	2017-05-09 04:46:58	2017-05-09 05:22:08	0:25:12	15.1 m	1.1 km	476.0 m	17.1 GiB

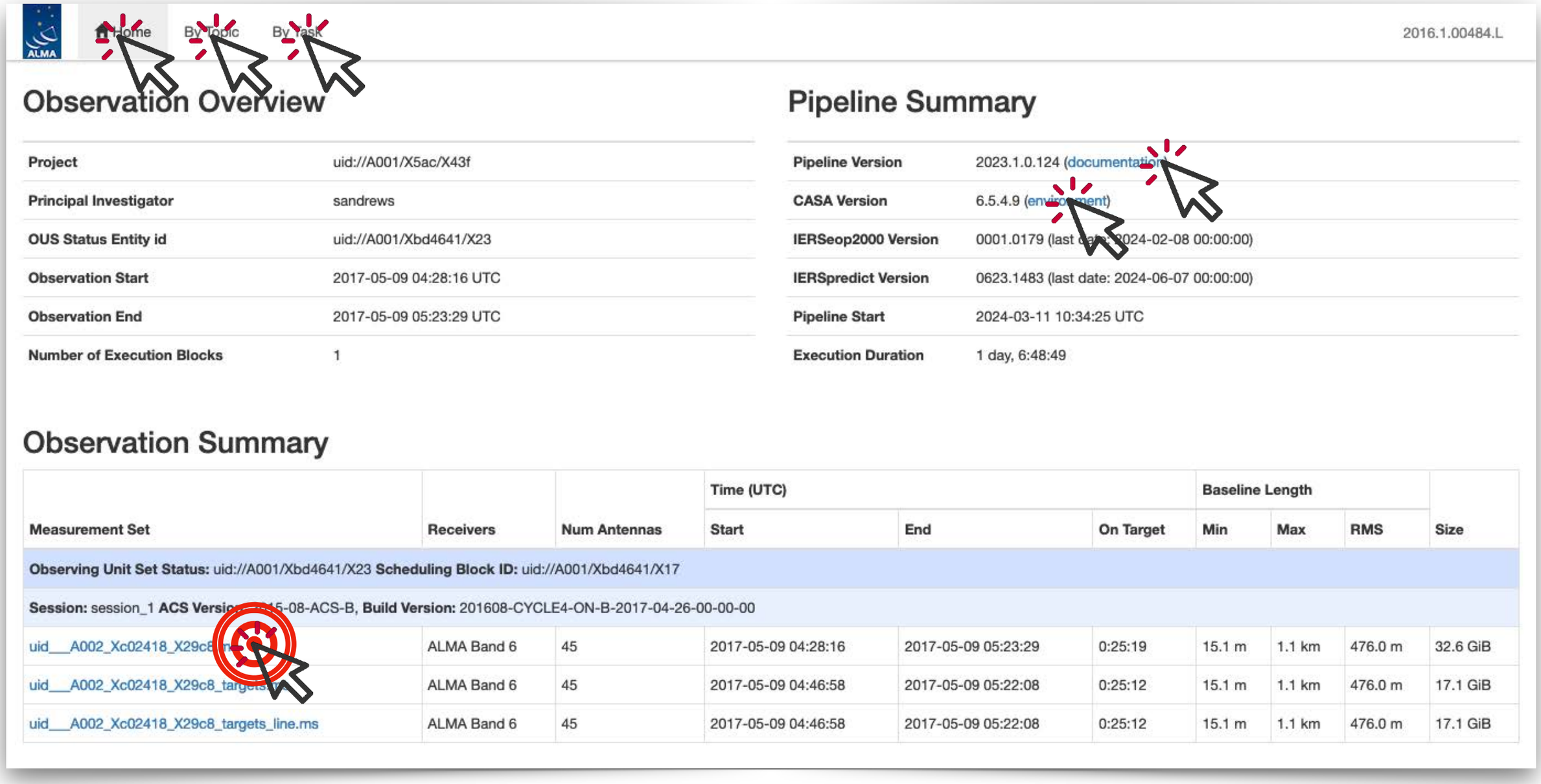
the Measurement Set

useful parameters

PART 1 - Calibration

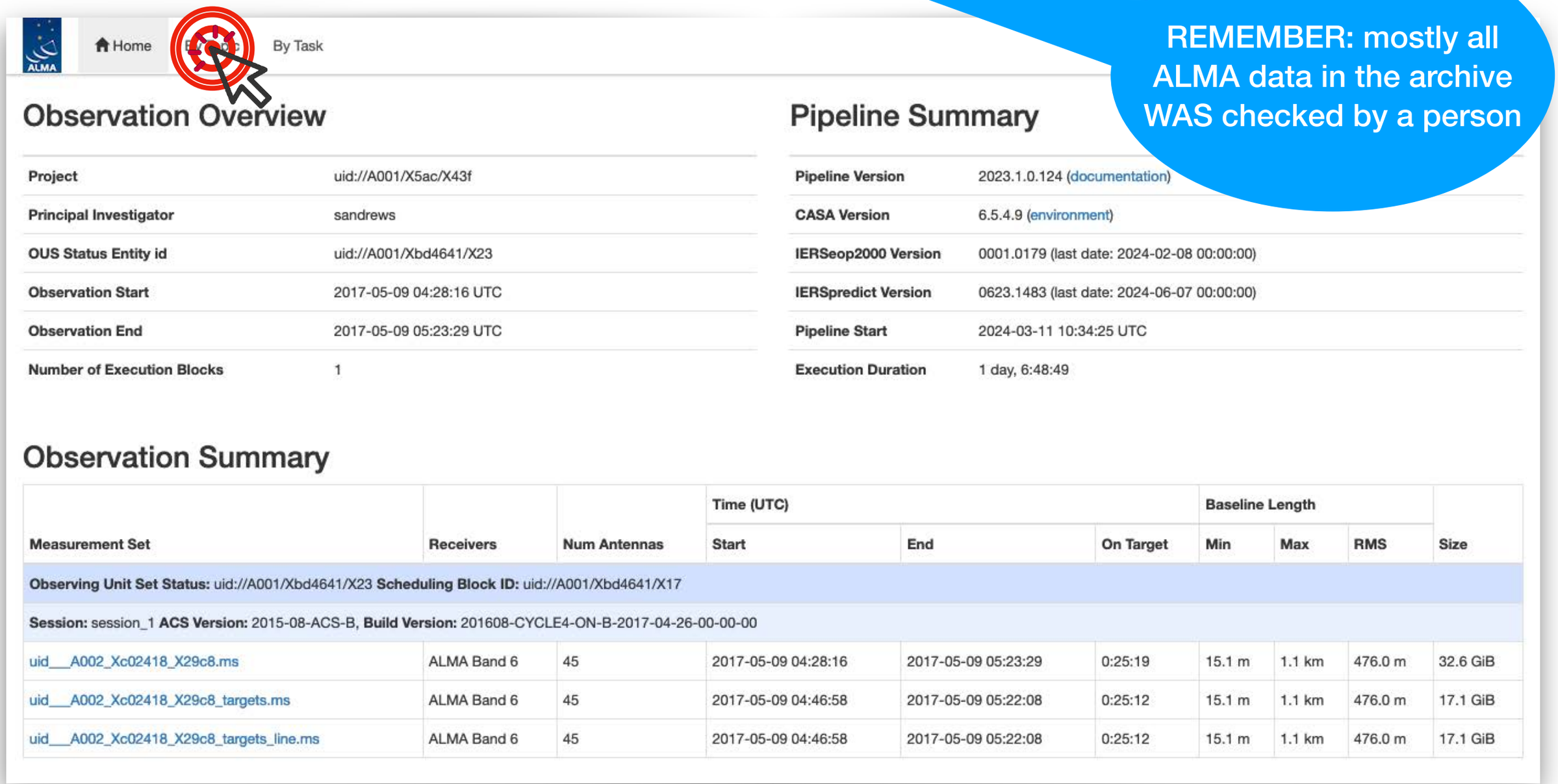
The Weblog

- All tabs can be **clicked** as can all **blue** text as to **navigate** the Weblog



PART 1 - Calibration
The Weblog

- Lets quickly look at the **by Topic,** this stage highlights notable **warnings** or **issues** and **identifies** possible stages to check



REMEMBER: mostly all ALMA data in the archive WAS checked by a person

PART 1 - Calibration

Home | By Topic | By Task | 2016.1.00484.L

QA Scores: Lowest by Topic

Quick overview of low scores

Topic	Lowest Scoring Task
Data Sets	26. **hifa_renorm**: Renorm
Calibration	17. **hifa_timegaincal**: Gain calibration
Flagging	19. **hif_applycal**: Apply calibrations from context
Imaging	23. **hif_makeimages**: Make check source images
Miscellaneous	5. **hif_refant**: Select reference antennas

The stages that pipeline identified as lowest

nothing is YELLOW or RED

Task Notifications: Warnings and Errors

Stage	Task		
2	hifa_flagdata	Warning	Undefined representative bandwidth for data set uid___A002_Xc02418_X29c
31	hif_findcont	Warning	Undefined representative bandwidth for data set uid___A002_Xc02418_X29c

stages with warnings

Flagging Summaries

uid___A002_Xc02418_X29c8.ms

flagging overview

Flagging percentages for Source name: AS_209, Intents: ATMOSPHERE,TARGET

spw	DA41	DA42	DA44	DA45	DA46	DA47	DA48	DA49	DA51	DA52	DA53	DA54	DA55	DA56	DA57	DA58	DA59	DA60	DA61	DA62	DA63	DA65	DV01	DV03	DV04	DV05	DV06	DV07
19	43.157	43.966	43.630	43.238	44.496	44.077	44.380	42.660	44.068	43.665	44.541	44.203	44.676		43.869	43.768	43.215	44.043	56.505	44.126	44.135	43.872	44.595	43.478	44.438	44.523	100.000	43.999
21	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129		39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	39.129	40.082	39.129	39.129
23	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	100.000	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	41.899	42.808	100.000	41.899
25	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	2.347	3.876	2.347	2.347

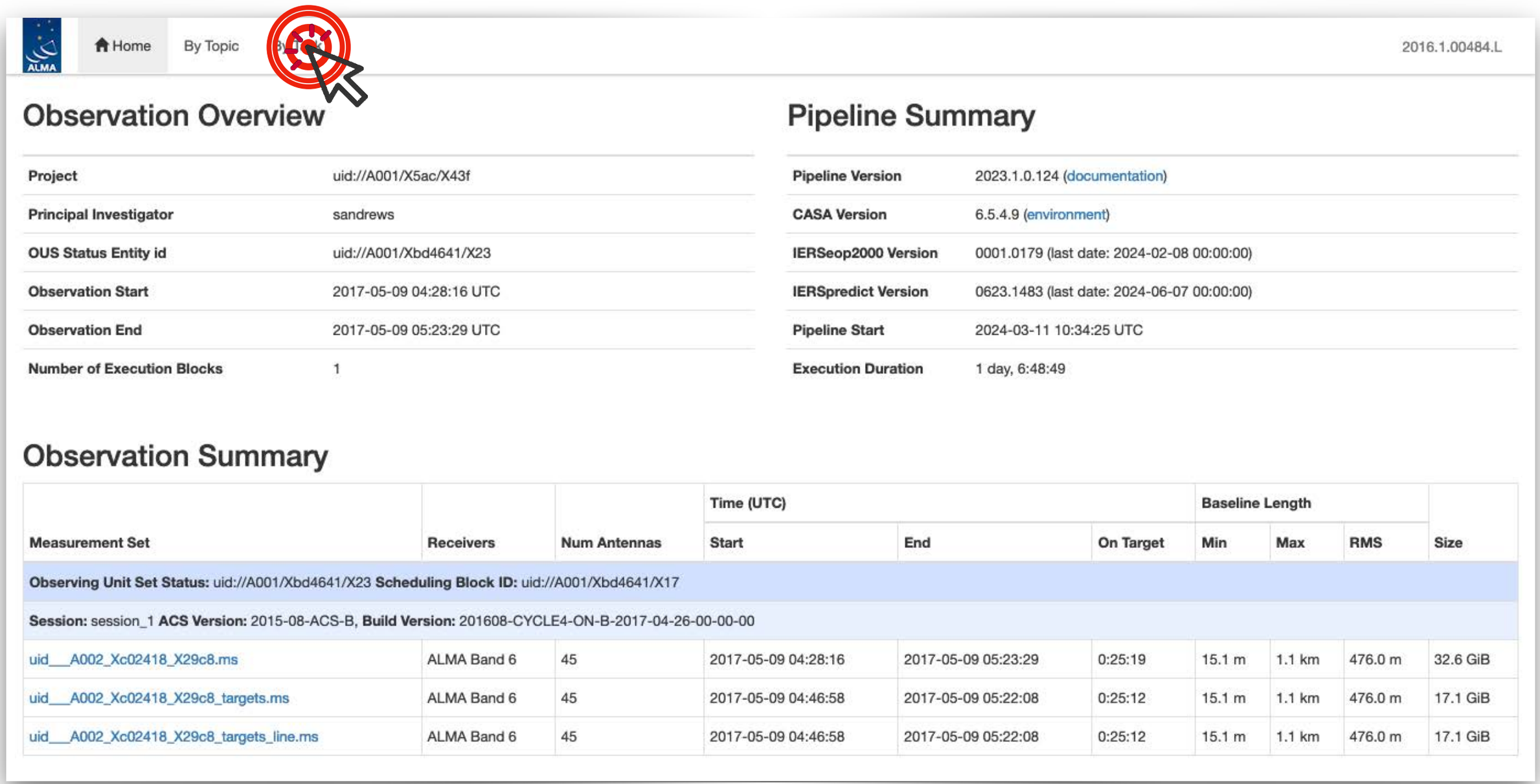
Flagging percentages for Source name: J1517-2422, Intents: ATMOSPHERE,BANDPASS,POINTING,WVR

spw	DA41	DA42	DA44	DA45	DA46	DA47	DA48	DA49	DA51	DA52	DA53	DA54	DA55	DA56	DA57	DA58	DA59	DA60	DA61	DA62	DA63	DA65	DV01	DV03	DV04	DV05	DV06	DV07
19	39.713	40.569	44.616	39.799	44.775	42.158	43.931	42.073	42.146	41.694	47.794	40.826	44.053	43.234	47.562	43.283	41.241	44.799	57.062	44.823	44.885	41.816	42.574	41.522	43.882	41.694	100.000	43.454
21	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	36.913	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	35.446	36.913	35.446
23	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	100.000	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	38.380	100.000	38.380
25	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222	2.222

PART 1 - Calibration

The Weblog

- Lets look at the **by Task**, which contains all the main pipeline stages in running order



Home | By Topic | By Task | 2016.1.00484.L

Task Summaries

Task	QA Score		Duration
1. **hifa_importdata**: Register measurement sets with the pipeline		1.00	0:10:16
2. **hifa_flagdata**: ALMA deterministic flagging		1.00	0:41:03
3. **hifa_fluxcalflag**: Flag spectral features in solar system flux calibrators		1.00	0:00:03
4. **hif_rawflagchans**: Flag channels in raw data		1.00	0:07:53
5. **hif_refant**: Select reference antennas		1.00	0:00:23
6. **h_tsyscal**: Calculate Tsys calibration		1.00	0:07:19
7. **hifa_tsysflag**: Flag Tsys calibration		1.00	0:09:24
8. **hifa_antpos**: Correct for antenna position offsets	Nonzero antenna position offsets	0.90	0:00:06
9. **hifa_wvrgcalflag**: Calculate and flag WVR calibration		1.00	0:17:46
10. **hif_lowgainflag**: Flag antennas with low gain		1.00	0:10:00
11. **hif_setmodels**: Set calibrator model visibilities		1.00	0:09:32
12. **hifa_bandpassflag**: Phase-up bandpass calibration and flagging		0.99	0:25:24
13. **hifa_bandpass**: Phase-up bandpass calibration		0.99	0:18:17
14. **hifa_spwphaseup**: Spw phase offsets calibration		1.00	0:05:15
15. **hifa_gfluxscaleflag**: Phased-up flux scale calibration + flagging		1.00	0:25:08
16. **hifa_gfluxscale**: Transfer fluxscale from amplitude calibrator		1.00	0:23:34
17. **hifa_timegaincal**: Gain calibration	Potential phase offset outliers	0.80	0:33:53
18. **hifa_targetflag**: Target outlier flagging		1.00	0:14:44
19. **hif_applycal**: Apply calibrations from context	Phase vs frequency slope outliers	0.90	0:43:48

note: more stages below these

Home | By Topic | By Task | 2016.1.00484.L

Task Summaries

Task	QA Score	Duration
1. **hifa_importdata**: Register measurement sets with the pipeline	1.00	0:10:16
2. **hifa_flagdata**: ALMA deterministic flagging	1.00	0:41:03
3. **hifa_fluxcalflag**: Flag spectral features in solar system flux calibrators	1.00	0:00:03
4. **hif_rawflagchans**: Flag channels in raw data	1.00	0:07:53
5. **hif_refant**: Select ref…	1.00	0:00:23
6. **h_tsyscal**: Calculate Tsys calibration	1.00	0:07:19
7. **hifa_tsysflag**: Flag Tsys calibration	1.00	0:09:24
8. **hifa_antpos**: Correct for … position offsets	0.90	0:00:06
9. **hifa_wvrgcalflag**: Calculate and flag …	1.00	0:17:46
10. **hif_lowgainflag**: Flag antennas with low gain	1.00	0:10:00
11. **hif_setmodels**: Set calibrator model visibilities	1.00	0:09:32
12. **hifa_bandpassflag**: Phase-up bandpass calibration and flagging	0.99	0:25:24
13. **hifa_bandpass**: Phase-up bandpass calibration	0.99	0:18:17
14. **hifa_spwphaseup**: Spw phase offsets calibration	1.00	0:05:15
15. **hifa_gfluxscaleflag**: Phased-up flux scale calibration + flagging	1.00	0:25:08
16. **hifa_gfluxscale**: Transfer fluxscale from amplitude calibrator	1.00	0:23:34
17. **hifa_timegaincal**: Gain calibration … phase offset outliers	0.80	0:33:53
18. **hifa_targetflag**: Target outlier flagging	1.00	0:14:44
19. **hif_applycal**: Apply calibrations from context — Phase vs frequency slope outliers	0.90	0:43:48

"hifa" - ALMA interferometry specific

"hif" - Interferometry - can be used by other telescopes

"h" - just means heuristic stage, can be used by other telescopes and not just interferometry

note: more stages below these

Home | By Topic | By Task | 2016.1.00484.L

Tas

tasks listed

scores

Task	QA Score	Duration
1. hifa_importdata: Register measurement sets with the pipeline	1.00	0:10:16
2. hifa_flagdata: ALMA deterministic flagging	1	
3. hifa_fluxcalflag: Flag spectral features in solar system flux calibrators	1	
4. hif_rawflagchans: Flag channels in raw data	1	
5. hif_refant: Select reference antennas	1	
6. hifa_tsyscal: Calculate Tsys calibration	1	
7. hifa_tsysflag: Flag Tsys calibration	1.00	0:09:24
8. hifa_antpos: Correct for antenna position offsets	0.90	0:00:06
9. hifa_wvrgcalflag: Calculate and flag WVR calibration	1.00	0:17:46
10. hif_lowgainflag: Flag antennas with low gain	1.00	0:10:00
11. hif_setmodels: Set calibrator model visibilities	1.00	0:09:32
12. hifa_bandpassflag: Phase-up bandpass calibration and flagging	0.99	0:25:24
13. hifa_bandpass: Phase-up bandpass calibration	0.99	0:18:17
14. hifa_spwphaseup: Spw phase offsets calibration		
15. hifa_gfluxscaleflag: Phased-up flux scale calibration + flagging		
16. hifa_gfluxscale: Transfer fluxscale from amplitude calibrator		
17. Potential phase offset outliers		
18.		
19. Phase vs frequency slope outliers	0.90	0:43:48

task short messages

Nonzero antenna position offsets

1.0 scores, all is good

BLUE scores, some notifications but no issues

informative symbols, notification, warnings and errors

The important points

- **AGAIN** - remember delivered data **all passed QA2**

i.e. no need to "go looking" for problems or things to flag

- **Note:** Pipeline scoring has been **updated** and **improved** over the years
  - **older** pipeline Weblogs might **not** have (as) **trustworthy** scores, or scores and warnings maybe slightly misleading
  - always check the version, and remember for pre-Cycle 10 (6.5.4 CASA), a **person always checked** the weblogs so they should always be without issues

The important points

- **System Temperature** (Tsys) - should looks sensible, related with the transmission
- **WVR** - shows the initial phase correction by the water vapour radiometer system
- **Bandpass** - there should be no spikes (birdies), regular structure/instrumental glitches
- **Amplitude** - the flux gains should be sensible when compared to ALMA's catalogue
- **Gains** - changes in amplitude and phase are trackable and smooth, no glitches/jumps

→ **Apply** - does all correct data look as expected

does not exist for ACA antennas

The scores and symbols

- Pipeline have defined scores on a traffic light scheme
  - **Green** - all is good with the stage (1.0)
  - **Blue** - some notifications, but otherwise good (0.66 < score <= 0.9*)
  - **Amber** - not ideal warning, maybe a problem (0.33 < score <= 0.66)
  - **Red** - likely a major issue and needs investigation (<=0.33)

*technically, anything with a notification is set to 0.9

Investigation time….

- Follow the web link to a weblog **you selected**
- There will be **~10-15 minutes** for you individually to examine a weblog to get:
  - Project Code
  - CASA Version
  - WVR improvement factor
  - Worst Score - in **calibration stages**
  - Phase calibrator flux in ***lowest index*** SpW
  - Identify any possible issues/warnings

I didn't show where to get any of these parameters

Investigation time….

- https://almascience.eso.org/arcdistribution/ALMAschool/dataset1/html

- https://almascience.eso.org/arcdistribution/ALMAschool/dataset2/html

- https://almascience.eso.org/arcdistribution/ALMAschool/dataset3/html

Investigation time….*answers*

Dataset	Project Code	CASA Version	WVR Imp.	Lowest Score (cal)	Phase Cal. Flux	Other issues?
1						
2						
3						

Investigation time….*answers*

Dataset	Project Code	CASA Version	WVR Imp.	Lowest Score (cal)	Phase Cal. Flux	Other issues?
1	2017.A.00042.T	6.5.9	0.97	0.30 (import)	SpW 19 62 mJy	• ASDM imports no flux database • Phase Offsets • DV02 Bandpass strange
2	2018.1.00659.L	5.4.0	1.05 1.67	0.53 (WVR) *0.00 (Check Source Img.)*	SpW 25 142 mJy 148 mJy	○ Resolved Bandpass in X9a1 ○ Check source images scores
3	2019.1.00260.S	5.6.1	3.08	0.66 (Bandpassflag)	SpW 19 860 mJy	• DV24 outlier phase (diagnostic) • Outlier ant (phase) apply • Images*

learned - older weblogs have less information or differently placed

*trick question as we are looking at calibration
these data also had a correlator issue that an analyst found

PART 1 - Calibration

- The important points - **Tsys**

flags issued in the Tsys tables using heuristics

Tasks in execution order

1. hifa_importdata
2. hifa_flagdata
3. hifa_fluxcalflag
4. hif_rawflagchans
5. hif_refant
6. h_tsyscal
7. hifa_tsysflag
8. hifa_antpos
9. hifa_wvrgcalflag
10. hif_lowgainflag
11. hif_setmodels
12. hifa_bandpassflag
13. hifa_bandpass
14. hifa_spwphaseup
15. hifa_gfluxscaleflag
16. hifa_gfluxscale
17. hifa_timegaincal
18. hifa_targetflag
19. hif_applycal
20. hif_makeimlist (cals)
21. hif_makeimages (cals)
22. hif_makeimlist (checksrc)
23. hif_makeimages (checksrc)
24. hifa_imageprecheck
25. hif_checkproductsize
26. hifa_renorm
27. hifa_exportdata
28. hif_mstransform
29. hifa_flagtargets
30. hif_makeimlist (mfs)

7. Flag T_{sys} calibration

BACK

QA Score: 1.00 4.49% of data in uid___A002_Xc02418_X29c8.ms.h_tsyscal.s6_1.tsyscal.tbl was newly flagged

Contents

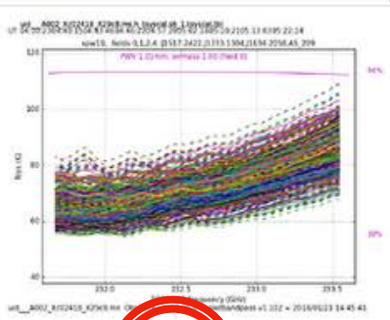
- T_{sys} after flagging
- Flagged data summary
- Flag step details
  - manual
  - nmedian
  - derivative
  - edgechans
  - fieldshape
  - birdies
  - toomany

can click to jump to flag summaries for heuristics

T_{sys} vs frequency after flagging

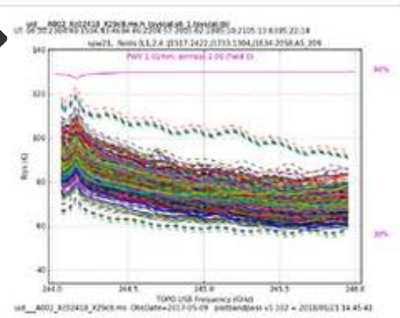
Plots of time-averaged T_{sys} vs frequency, colored by antenna.

uid___A002_Xc02418_X29c8.ms



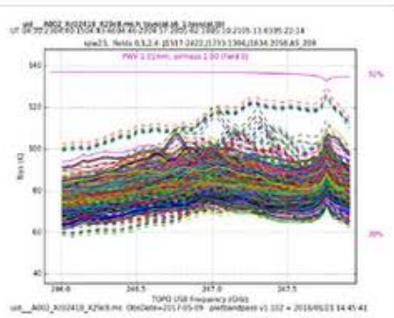
T_{sys} spw 15

Science spw 15.



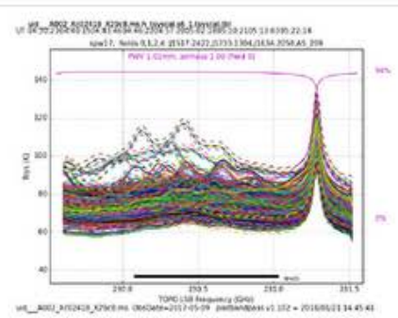
T_{sys} spw 21

Science spw 21.



T_{sys} spw 23

Science spw 23.



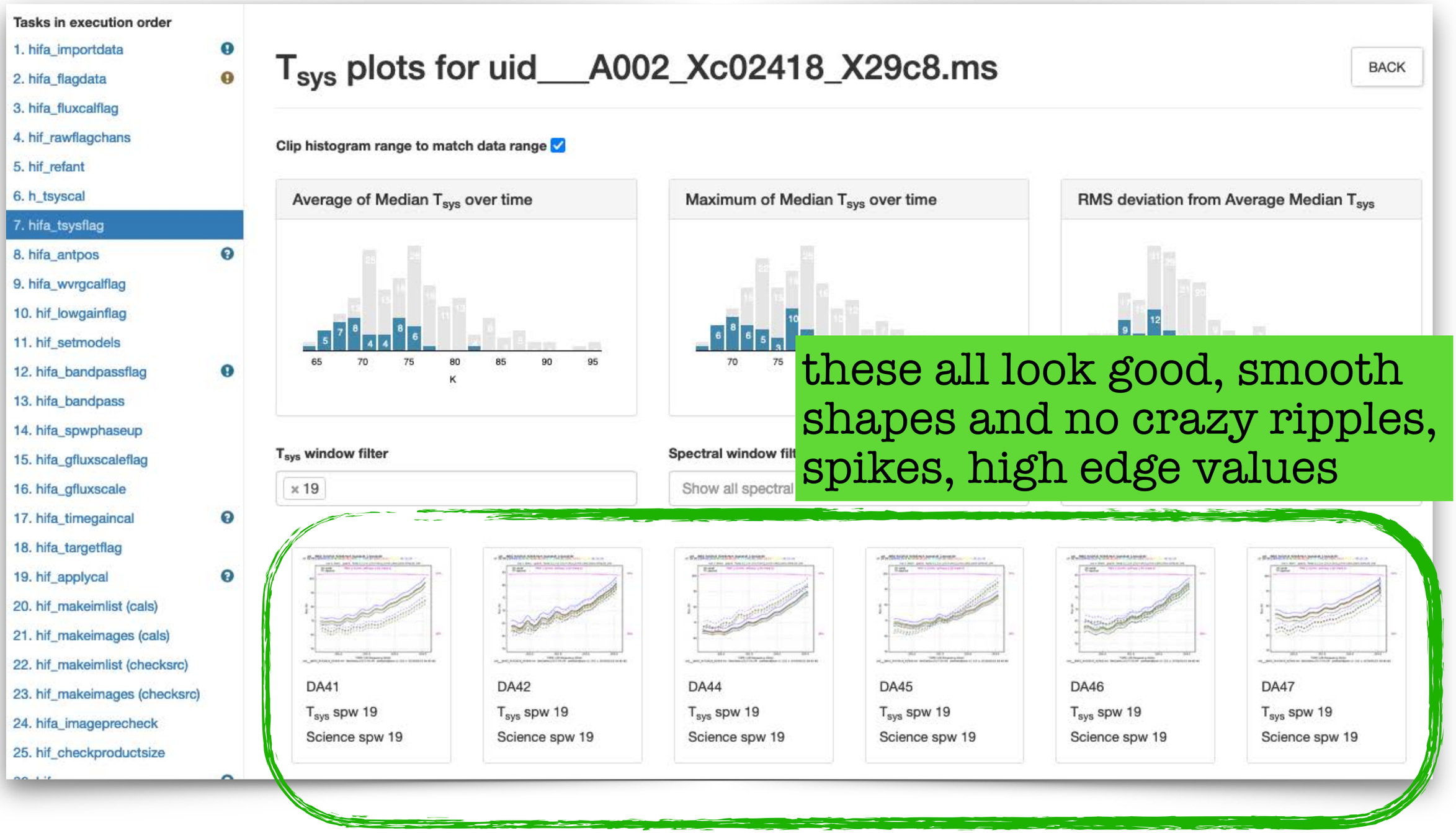
T_{sys} spw 17

Science spw 25.

can click to look at all plots, or plots per SpW

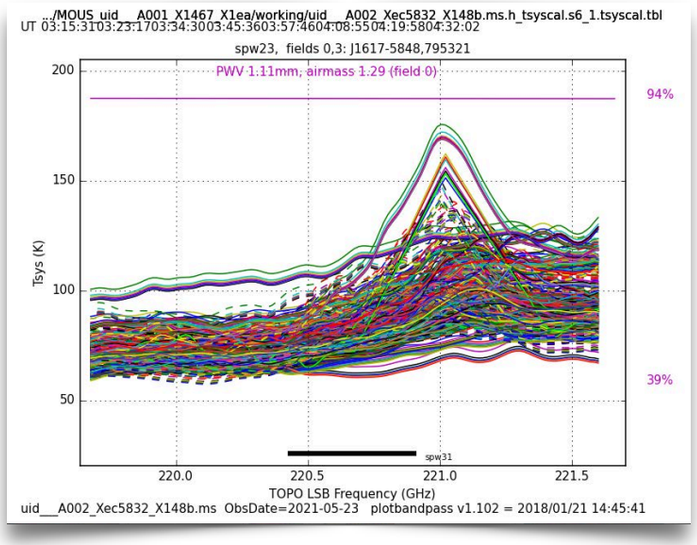
PART 1 - Calibration

- The important points - **Tsys**
  - We clicked to look at **only** SpW 19

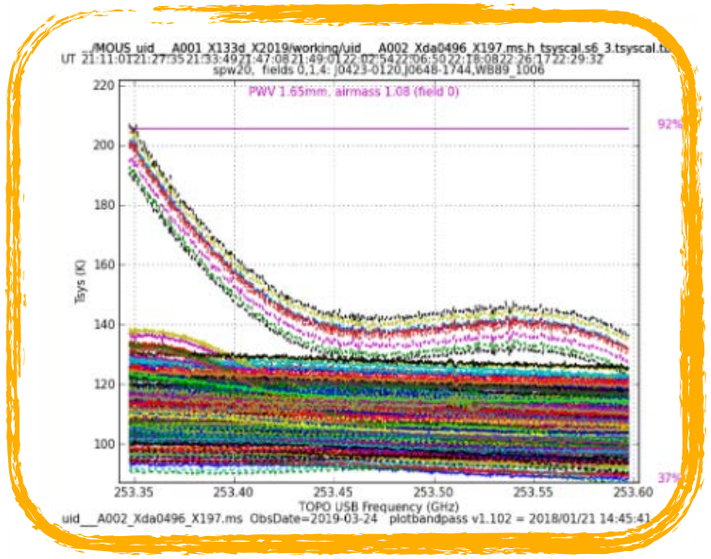


PART 1 - Calibration

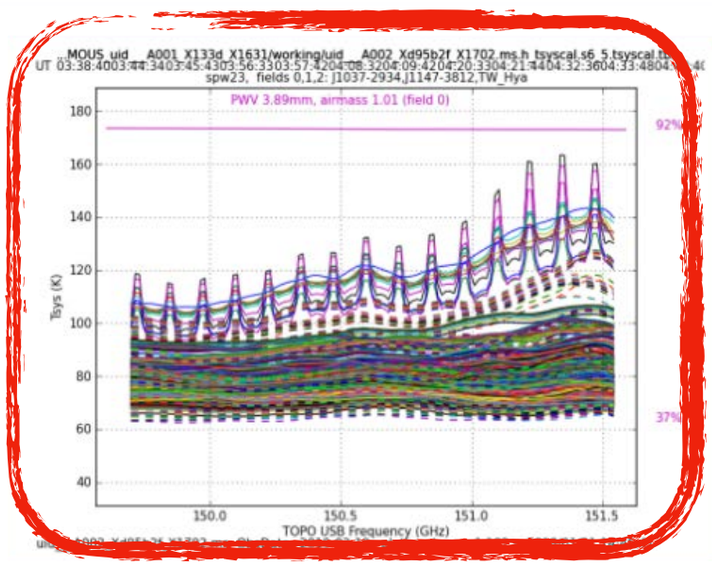
- The important points - **Tsys**



DV06 had some flagging that caused an unrealistic pyramid feature. Not a 'fail' issue - simply this antenna would be down weighted. But it can be fixed with heuristic adjustments

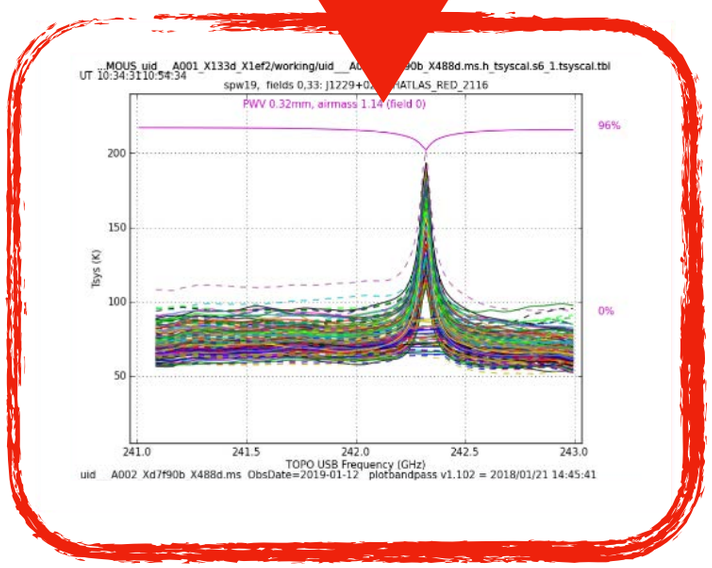


one antenna elevated, nothing to do, just follow the antenna in other stages to see if it is miss behaved

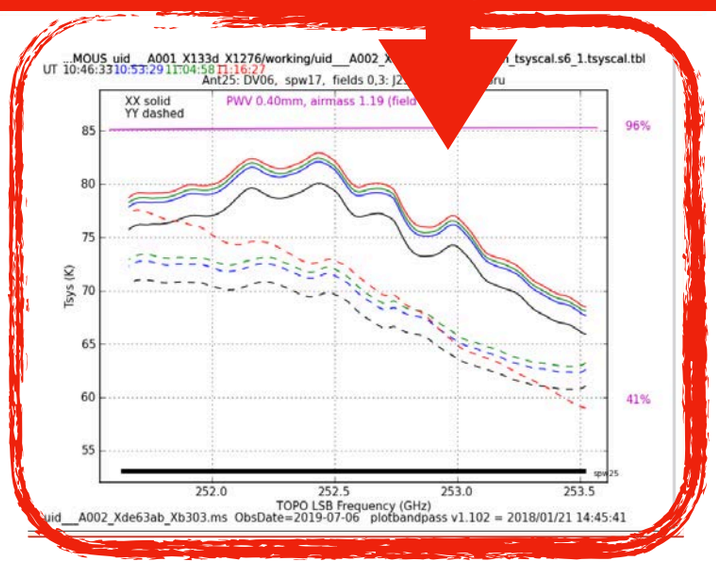


Regular oscillations and patterns are indicative of a bad antenna - it will probably be bad in other stages too, e.g. "hifa_bandpass"

older pipeline version sometimes over flagged the ATM lines in the Tsys, they should not be flagged otherwise the weightings are not correct

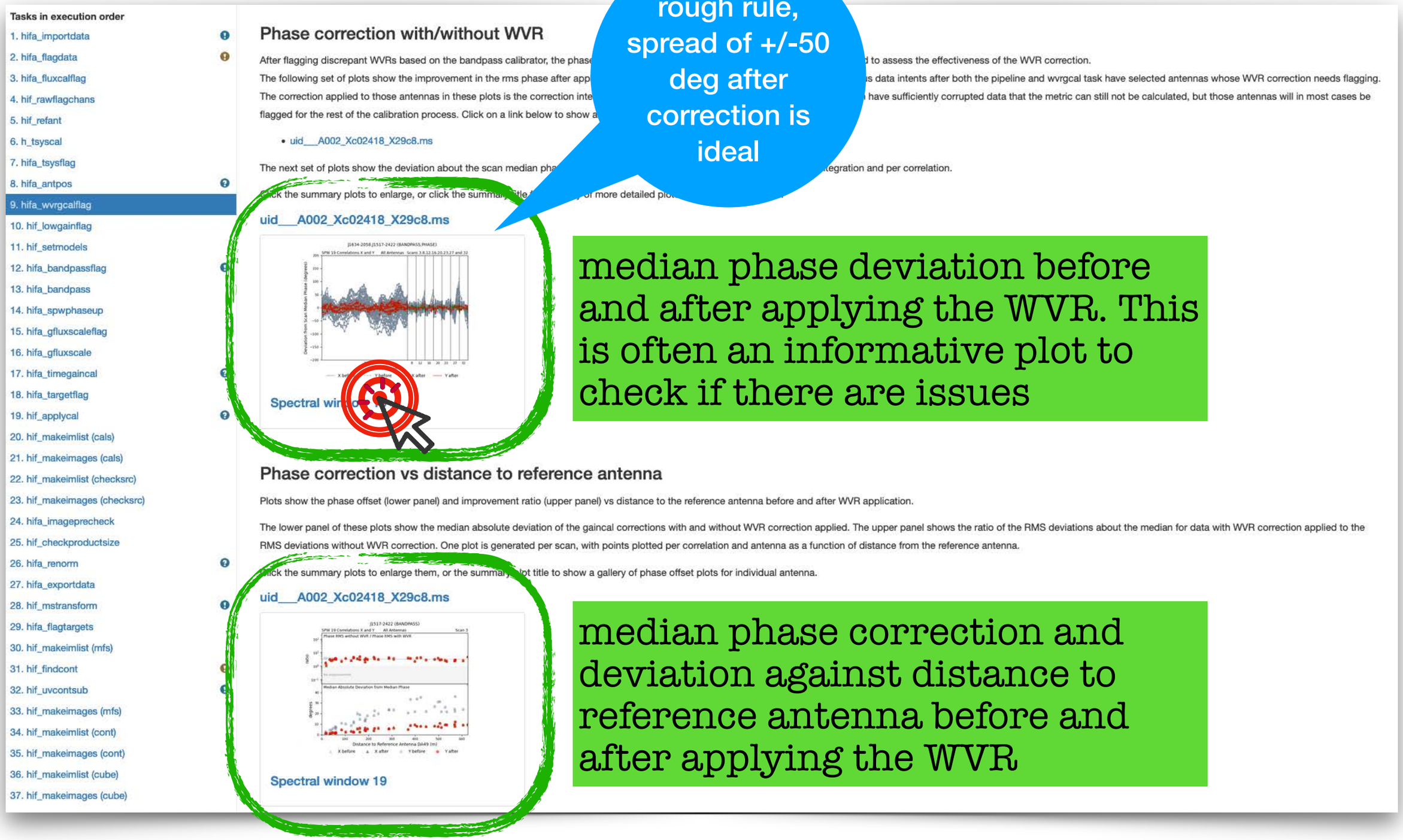


subtle issue that some scans have a different slope (red-dashed line), this indicated an instrumental issue (that got fixed at the telescope)



PART 1 - Calibration

- The important points - **WVR**



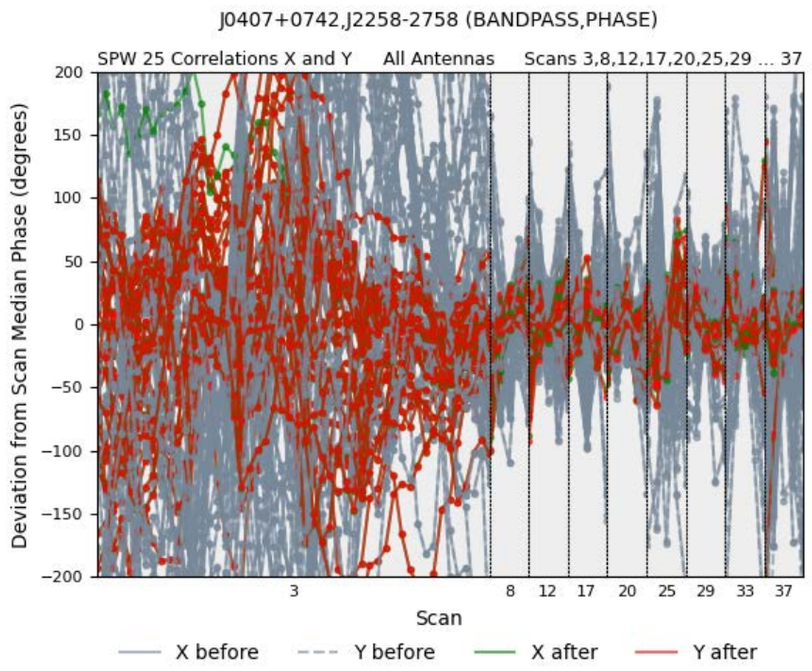
rough rule, spread of +/-50 deg after correction is ideal

median phase deviation before and after applying the WVR. This is often an informative plot to check if there are issues

median phase correction and deviation against distance to reference antenna before and after applying the WVR

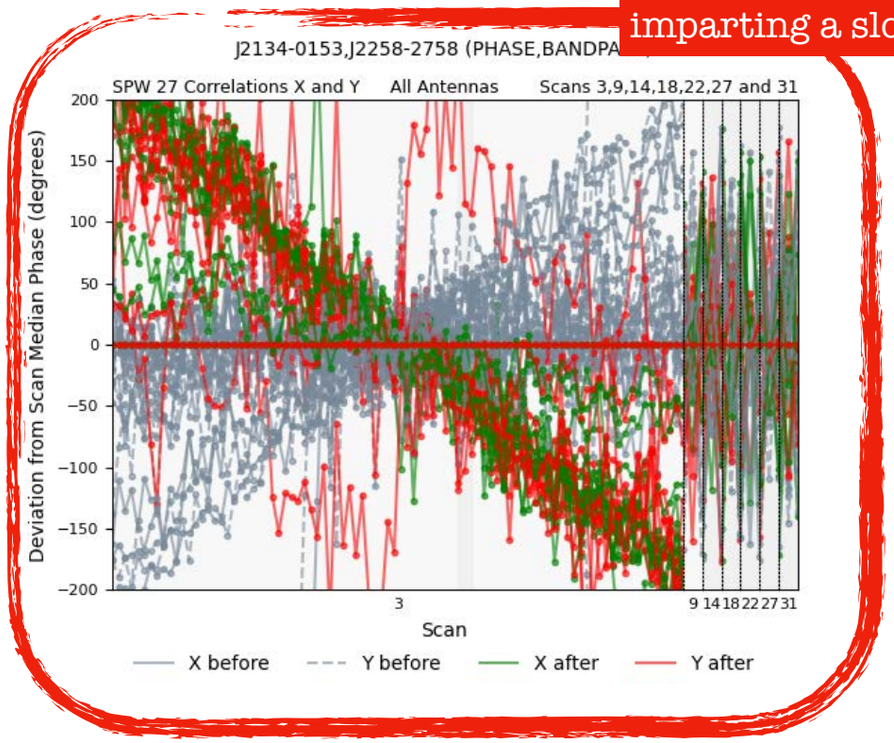
PART 1 - Calibration

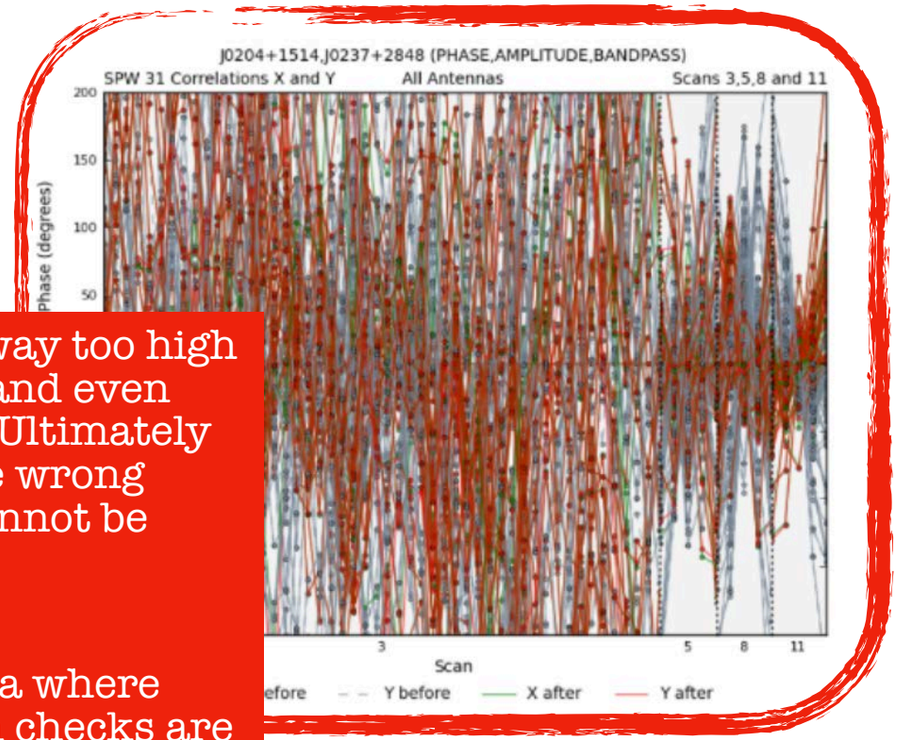
- The important points - **WVR**



phases are improved, but even after correction there is a huge spread. The phase RMS of these data is likely too high - if will also show in later stages (caveat self-calibration could help such data if it is possible)

something is going wrong, needs checking - in this case the reference antenna is imparting a slope and should be changed





the phase noise is simply way too high in these data, both before and even after the WVR correction. Ultimately these were observed in the wrong conditions and the data cannot be calibrated

(note these are testing data where sometimes strict condition checks are not necessary to follow)

QA0-semipass (do not get to QA2)

PART 1 - Calibration

- The important points - **Bandpass**

does the bandpass calibration also using heuristics to set the parameters

Plots

Plots show the bandpass correction applied to the target source. The first two plots show amplitude vs frequency; or ith mode score. The third plot shows phase vs frequency for the typical antenna.

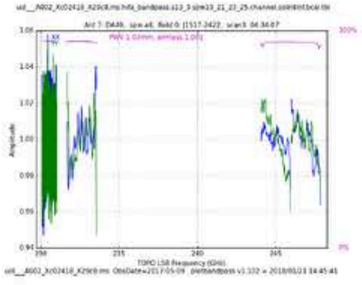
Click the summary plots to enlarge them, or the plot title to see see detailed plots per spectral window and antenna.

Can click to look at various sets of plots - these can also be filtered later for all (or selected) antennas/SpWs

uid___A002_Xc02418_X29c8.ms

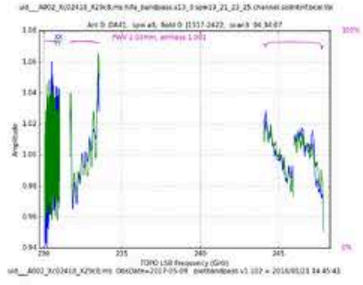
Amplitude vs frequency (show uid___A002_Xc02418_X29c8.ms)

The plots below show amplitude vs frequency for the bandpass correction, overlayed for [illegible] spectral windows and correlations. Click on the link above to show show detailed plots for all antennas, or on the links below to show plots with specific antennas preselected.



Reference antenna (DA49) (show DA49)

Amplitude vs frequency for the reference antenna (DA49). Click the link above to show detailed plots for DA49.



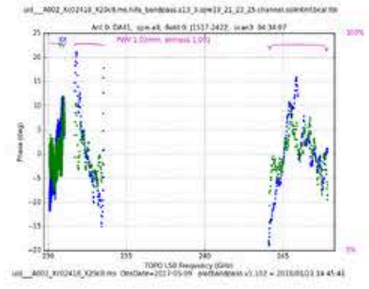
Typical antenna (DA41) (show DA41)

Amplitude vs frequency for a typical antenna (DA41). Click the link above to show detailed plots for DA41.

NB. random antenna until scores are working

Phase vs frequency (show uid___A002_Xc02418_X29c8.ms)

The plot below shows phase vs frequency for the bandpass correction, overlayed for all spectral windows and correlations. Click on the link above to show show phase vs frequency plots for all antennas, or on the link for just the typical antenna.

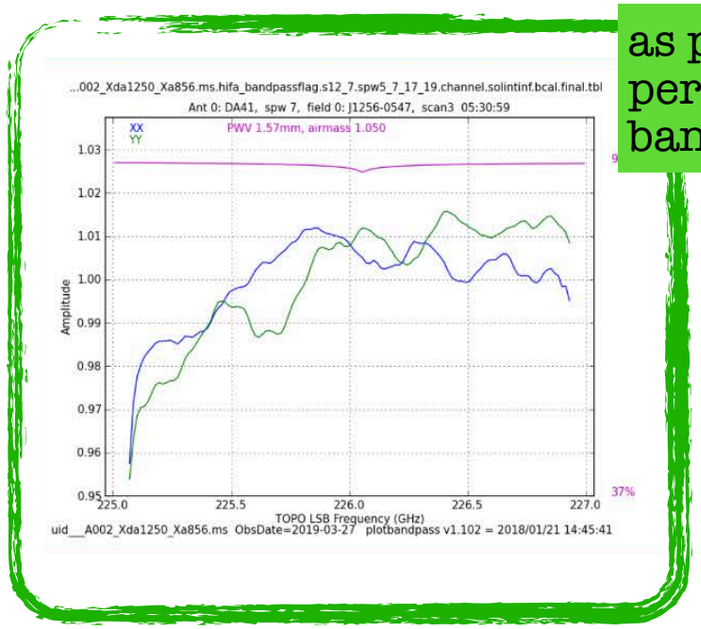


Typical antenna (DA41) (show DA41)

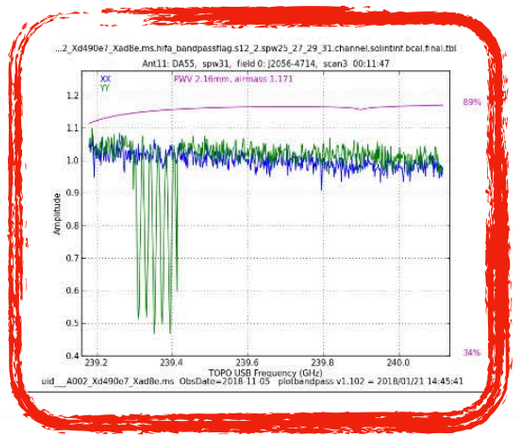
Phase vs frequency for a typical antenna (DA41). Click the link above to show detailed plots for DA41.

PART 1 - Calibration

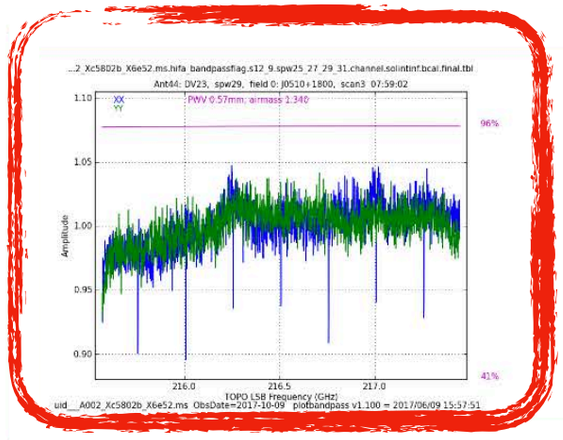
- The important points - **Bandpass**



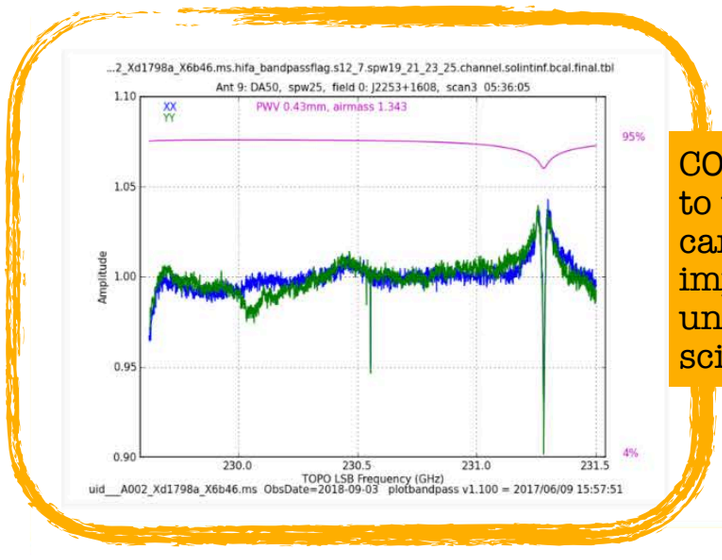
as previous, a perfectly normal bandpass



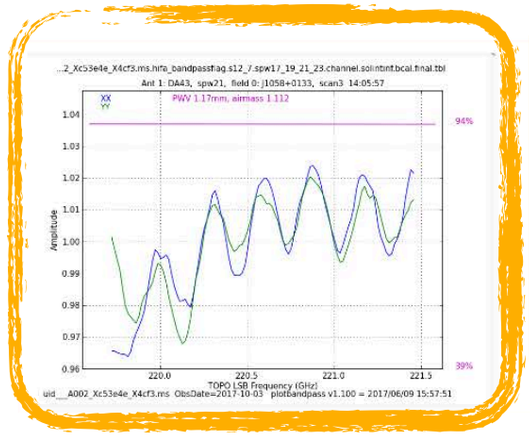
Issue related to only a specific section that effects only one reqion and only one polarisation. If the correlator - i.e. all data, then these cannot be use. If only one antenna flags might be enough



Correlator issue related to how SpW are made and the edges are not correctly handled. These data cannot be calibrated correctly

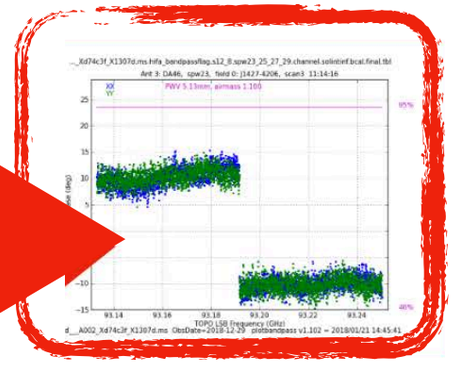


CO 230.X GHz 'dip' related to telluric emission. This cannot be helped but the impact must be carefully understood during the scientific work



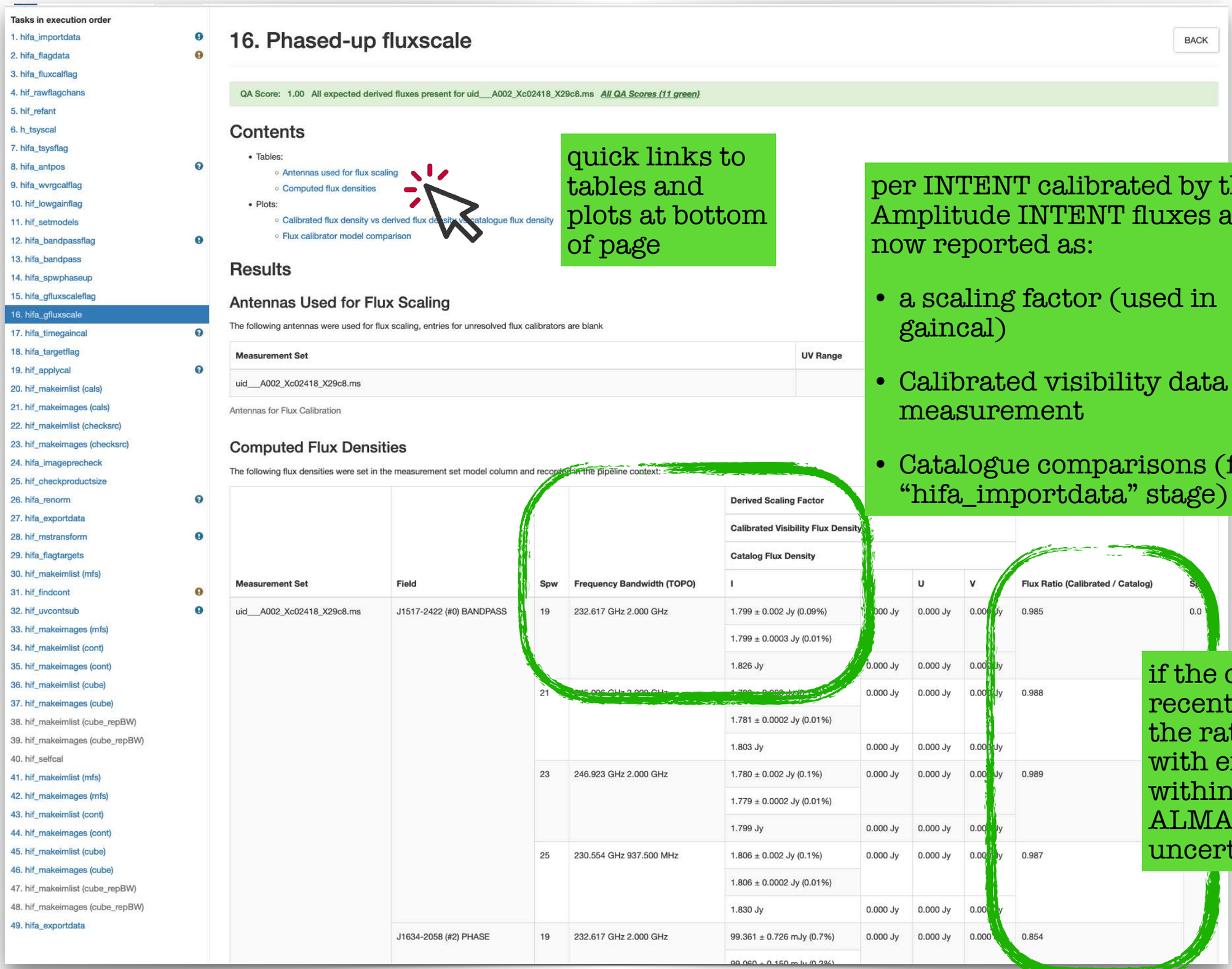
Instrumental issue causing a standing wave. Data might be ok, it is not guaranteed this is not transient - could be 'red' if this pattern seen in final target data

errors also in the phase vs frequency plots always check both. Here platforming in amplitude also leads to a step break in phase



PART 1 - Calibration

- The important points - **Amplitude**



quick links to tables and plots at bottom of page

per INTENT calibrated by the Amplitude INTENT fluxes are now reported as:

- a scaling factor (used in gaincal)
- Calibrated visibility data measurement
- Catalogue comparisons (from “hifa_importdata” stage)

if the catalogue value is recent (<10’s of days) the ratios should be 1.0 with errors generally be within the quoted ALMA flux uncertainties

PART 1 - Calibration

- The important points - **Amplitude**

Computed Flux Densities

The following flux densities were set in the measurement set model column and recorded in the pipeline context:

Measurement Set	Field	Spw	Frequency Bandwidth (TOPO)	Derived Scaling Factor / Calibrated Visibility Flux Density / Catalog Flux Density: I	Q	U	V	Flux Ratio (Calibrated / Catalog)	Spix
uid___A002_Xe79954_X5876.ms	J1407-4302 (#1) PHASE	25	261.862 GHz 58.594 MHz	155.734 ± 2.528 mJy (1.6%)	0.000 Jy	0.000 Jy	0.000 Jy	0.627	0.0
				130.859 ± 1.435 mJy (1.1%)					
				208.737 mJy	0.000 Jy	0.000 Jy	0.000 Jy		
		27	262.023 GHz 117.1	143.874 ± 2.050 mJy (1.4%)	0.000 Jy	0.000 Jy	0.000 Jy	0.636	
				132.659 ± 0.959 mJy (0.7%)					
				208.702 mJy	0.000 Jy	0.000 Jy	0.000 Jy		
		29	.594 MHz	155.052 ± 2.304 mJy (1.5%)	0.000 Jy	0.000 Jy	0.000 Jy	0.634	
				132.536 ± 1.351 mJy (1.0%)					
				209.080 mJy	0.000 Jy	0.000 Jy	0.000 Jy		
			.175 GHz 117.188 MHz	145.715 ± 2.316 mJy (1.6%)	0.000 Jy	0.000 Jy	0.000 Jy	0.639	
				133.934 ± 0.996 mJy (0.7%)					
				209.537 mJy	0.000 Jy	0.000 Jy	0.000 Jy		

the ratio is very different from 1.0 - the uncertainty at band 6 is 10%....

but the catalogue value is ***100 days old***, so that is probably wrong. Each SpW all get the same flux so this is ok… and…as long as the FLUX calibrator value is ***recent***

check “setmodels” or “importdata” stages (***flux.csv***)

PART 1 - Calibration

- The important points - **Amplitude**

J1145-6954 (#3) CHECK	47	801.613 GHz 937.500 MHz	1.052 ± 0.040 Jy (3.8%)			0.000 Jy	0.430
			301.109 ± 30.177 mJy (10.0%)				
			700.022 mJy			0.000 Jy	
	49	802.295 GHz 234.375 MHz	1.304 ± 0.044 Jy (3.3%)	0.000 Jy	0.000 Jy	0.000 Jy	0.285
			199.119 ± 41.787 mJy (21.0%)				
			699.812 mJy	0.000 Jy	0.000 Jy	0.000 Jy	
	51	802.471 GHz 234.375 MHz	1.301 ± 0.048 Jy (3.7%)	0.000 Jy	0.000 Jy	0.000 Jy	0.308
			215.308 ± 41.649 mJy (19.3%)				
			699.758 mJy	0.000 Jy	0.000 Jy	0.000 Jy	
	53	820.013 GHz 937.500 MHz	880.790 ± 42.941 mJy (4.9%)	0.000 Jy	0.000 Jy	0.000 Jy	0.439
			304.876 ± 24.597 mJy (8.1%)				
			694.437 mJy	0.000 Jy	0.000 Jy	0.000 Jy	
			(3.9%)	0.000 Jy	0.000 Jy	0.000 Jy	0.479
			(7.0%)				
				0.000 Jy	0.000 Jy	0.000 Jy	

scaling factor

visibility amp.

catalogue

NOTE: these are band 10 data, the highest and most difficult frequency to observe

the ratio is very different from 1.0 - but we know it is due to an **old** catalogue age

...but actually some SpW differ noticeably from the others and this needs to be investigated

Catalogue values differ - due to age as we've seen previously

But the **Scaling Factor** and **Calibrated visibility** values are also different

Technical point - Even though the fluxes are large, **0.5 Jy**, at Band 10, the stage "hifa_spwphaseup" shows only **a very low SNR of 10 all SPWs combined** (typical of all the higher frequency bands, 8, 9 and 10)

The calibrated visibility amplitudes is the most accurate representation of the source flux - if calibration is good then check the fluxes in the images

PART 1 - Calibration

- The important points - **Gains**

PHASE

all antenna summary plot, in some cases these can look "messy" as they are solutions to counteract the atmospheric variations - **longer baselines** and **higher frequencies** will "look" worse

as usual, can click plots, and blue links

AMPLITUDE

AMPLITUDE - should all be flat with time in general (or a smooth trend - no outliers)

Plots

Phase vs time

...how the phase correction to be applied to the target source. A plot is shown for each spectral window, with phase correction data points plotted per antenna and correlation as a function of time.

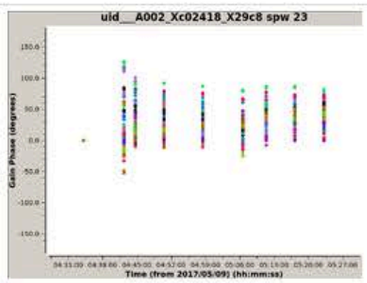
...e summary plots to enlarge them, or the spectral window heading to see detailed plots per spectral window and antenna.

uid___A002_Xc02418_X29c8.ms

Spectral windows default mapped for ...058 (PHASE).

Spectral window 19

...e, all antennas and correlations.

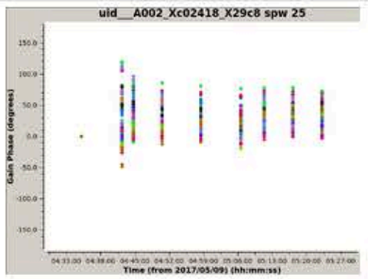


Spectral window 21

Phase vs time, all antennas and correlations.

Spectral window 23

Phase vs time, all antennas and correlations.



Spectral window 25

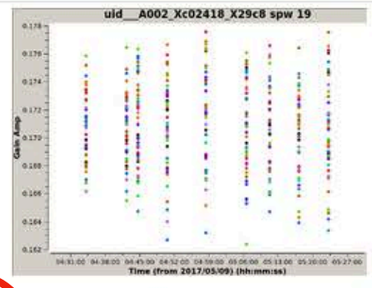
Phase vs time, all antennas and correlations.

Amplitude vs time

...plitude calibration to be applied to the target source. A plot is shown for each spectral window and each set of antennas with the same antenna diameter, with amplitude correction data points per antenna and correlation as a function of time.

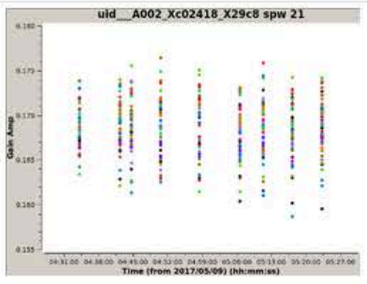
...plots to enlarge them, or the spectral window heading to see detailed plots per spectral window and antenna.

uid___A002_Xc02418_X29c8.ms



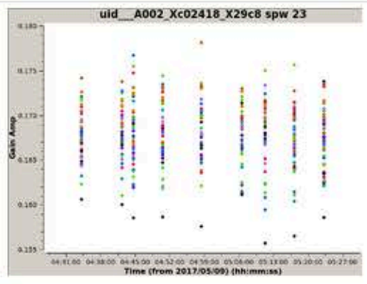
...l window 19

...time for spectral window 19, all correlations, all antennas.



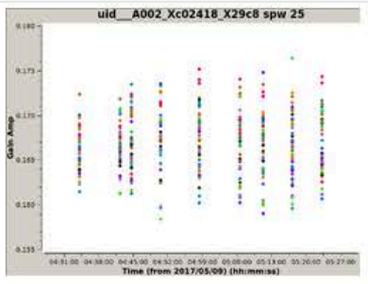
Spectral window 21

Amplitude vs time for spectral window 21, all correlations, all antennas.



Spectral window 23

Amplitude vs time for spectral window 23, all correlations, all antennas.



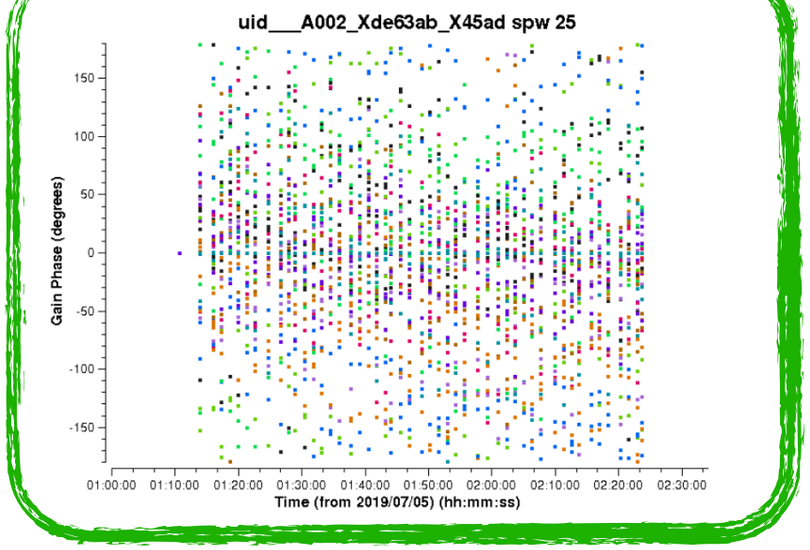
Spectral window 25

Amplitude vs time for spectral window 25, all correlations, all antennas.

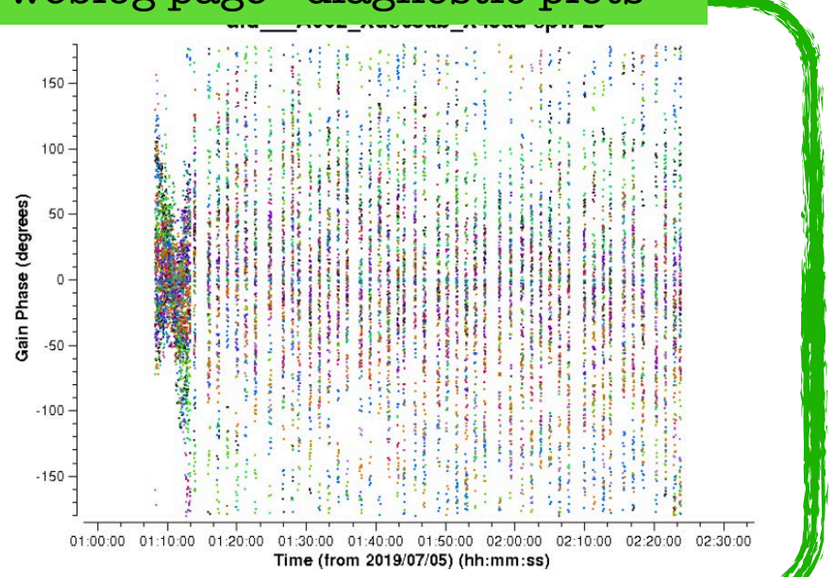
PART 1 - Calibration

- The important points - **Gains**

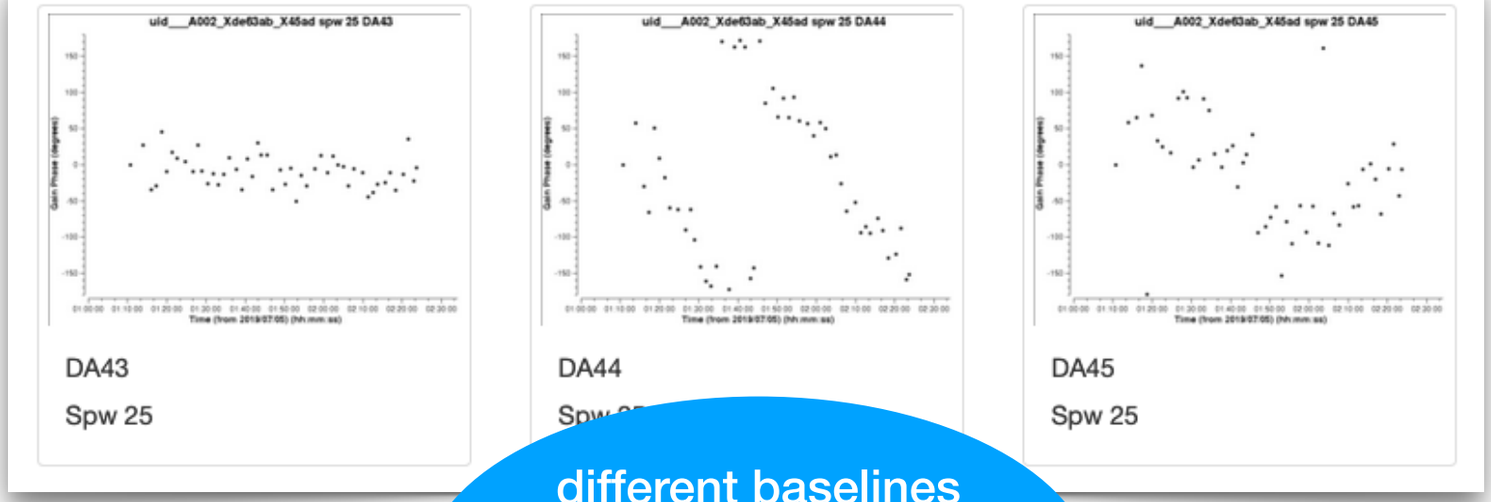
Per scan plot from main weblog page



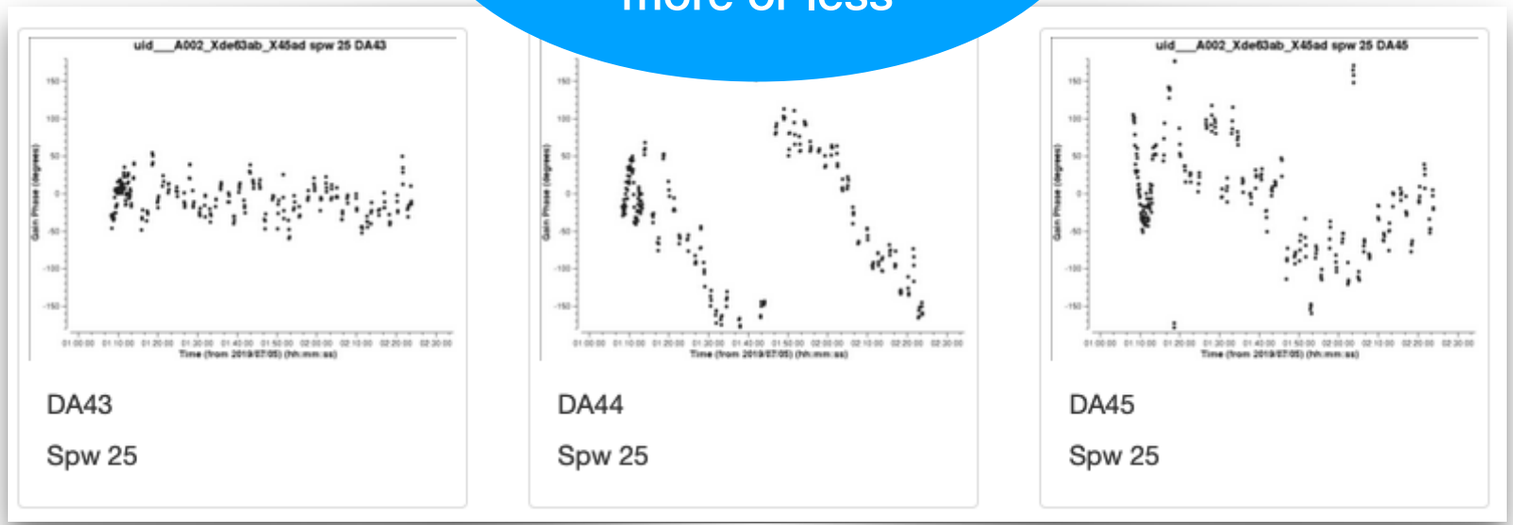
Per integration plot from main weblog page - diagnostic plots



examples of ALMA longest baselines dataset - “looked” messy but are ideal as we can see/track the phases



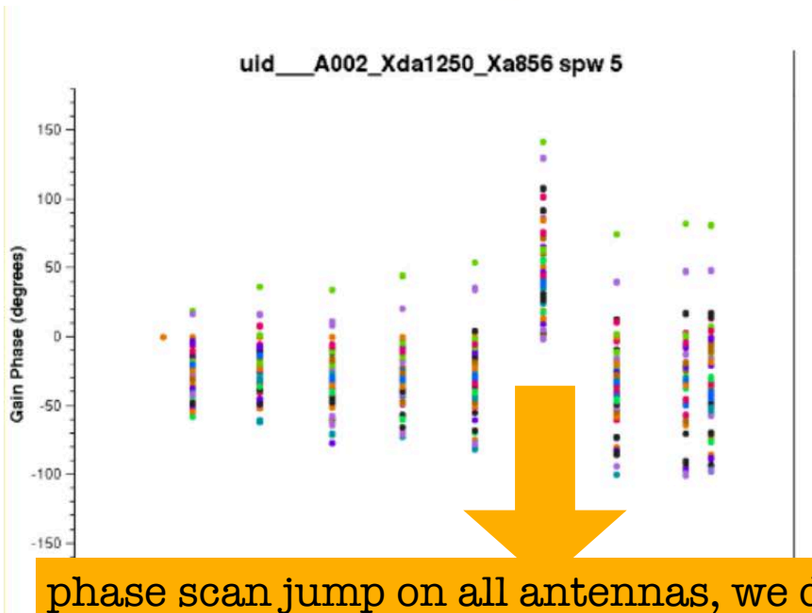
different baselines with different lengths see the atmospheric variations more or less



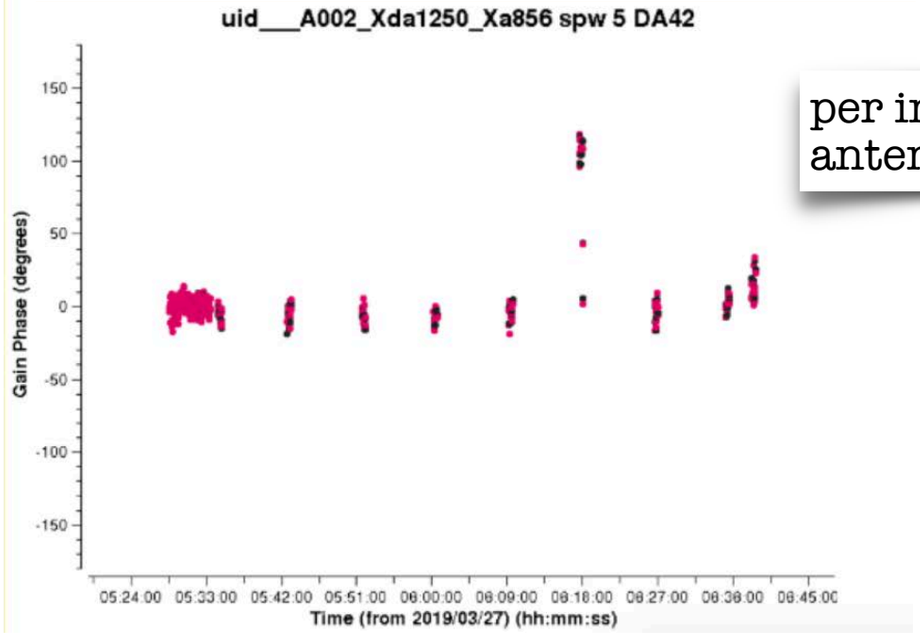
PART 1 - Calibration

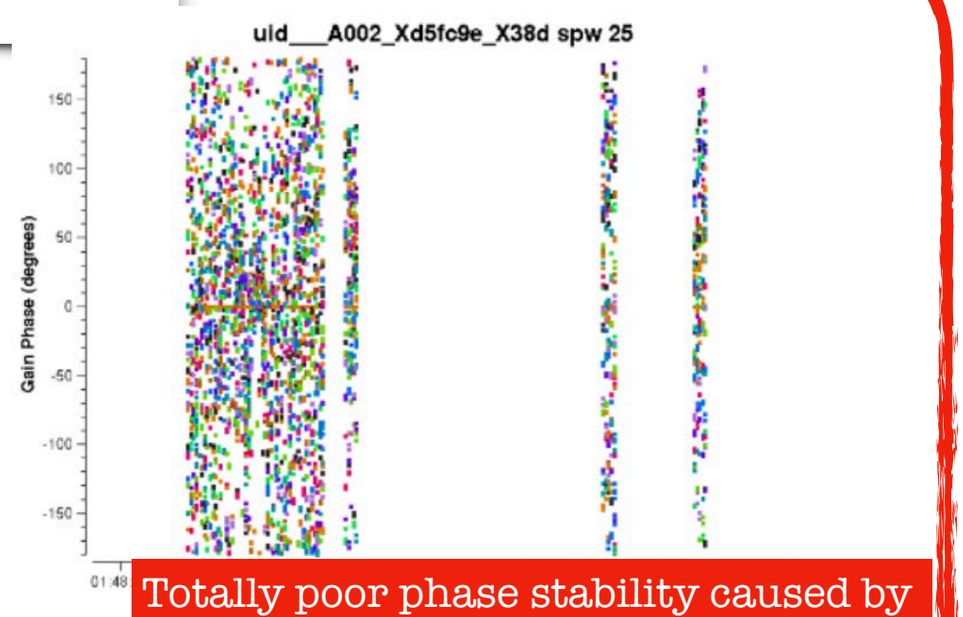
- The important points - **Gains**

per scan plot from main weblog page



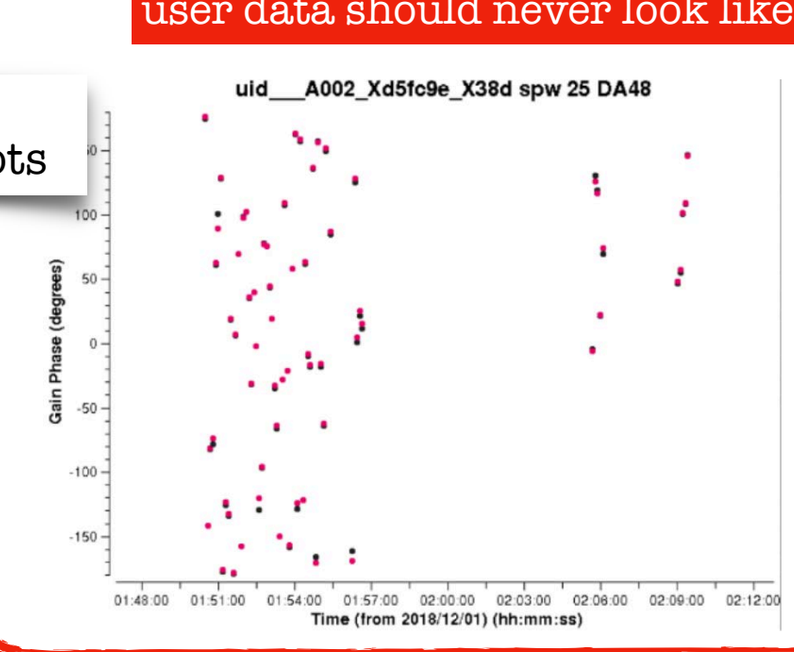
phase scan jump on all antennas, we do not know if this happened on the target(s) so it is safer to flag the scan and the target scans either side





Totally poor phase stability caused by variable atmosphere to be able to correctly interpolate the phases to a target and have reliable calibration - user data should never look like this

per integration for one antenna - diagnostic plots



QA0-semipass (do not get to QA2)

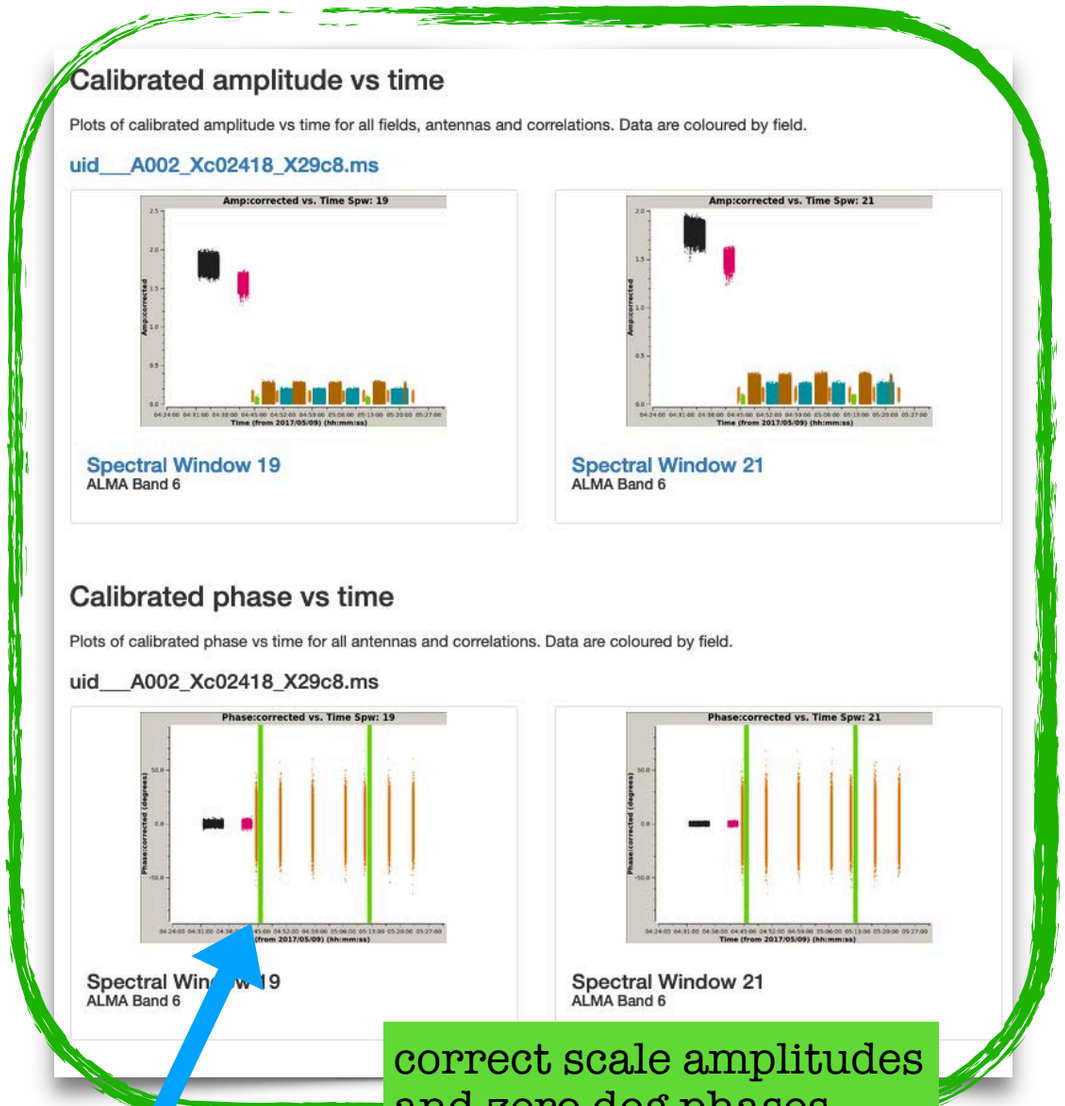
Is the calibration good?

- **Scores** - if most were green or blue, or there are explanations for other lower scores and all data looks good - then “yes” calibration is good
- **Applycal stage** - check that calibrators are as we expect
  - Point source = **zero phase, constant amplitude**
- **Images** - are images of the calibrators point-like, and is the target image made and without defects?

PART 1 - Calibration

- Is the calibration good - **Applycal**

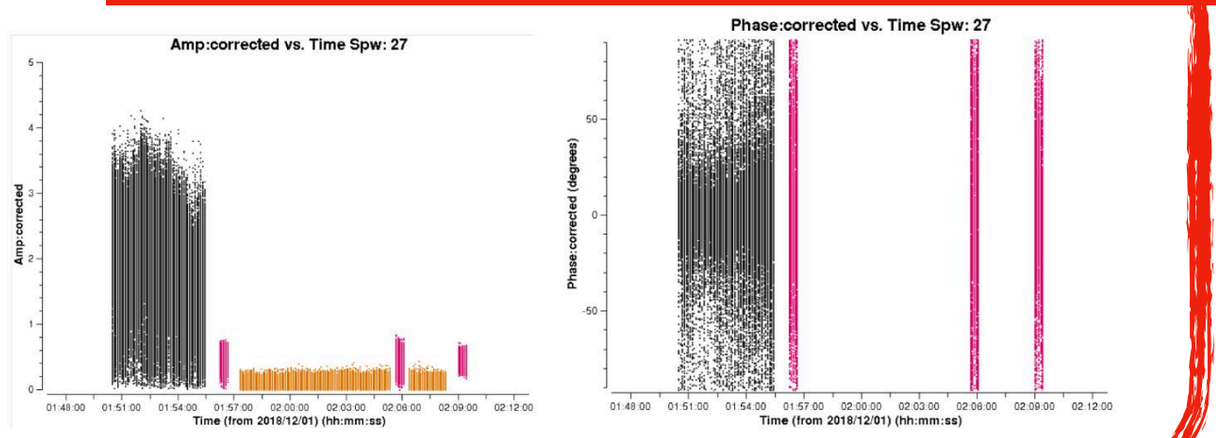
calibrators - amplitudes are constant and phases are zero (with time, frequency, and UV distance)

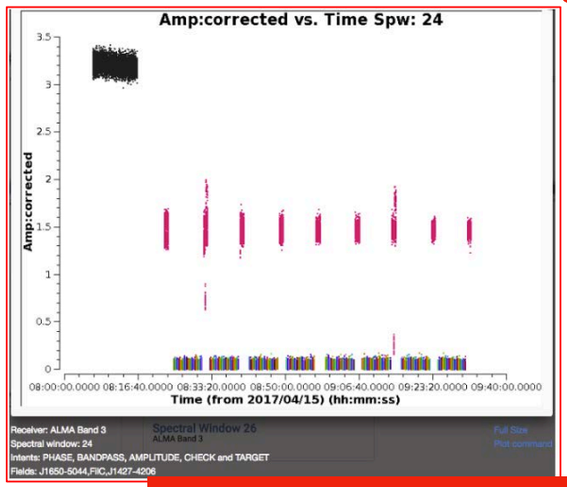


notice the check source is low SNR, so phases are not bad, just noisy - not a worry

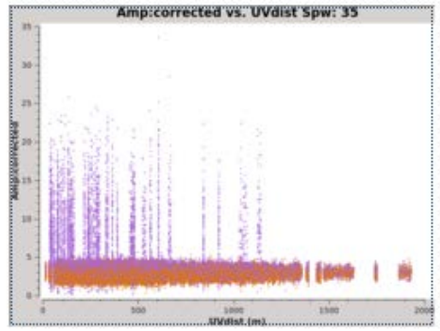
correct scale amplitudes and zero deg phases (average) with time for all fields

Totally poor phase stability and decoherence even in bright calibrators like the bandpass - useless data





Missed outliers on the phase calibrator, need to go back and find these and flag

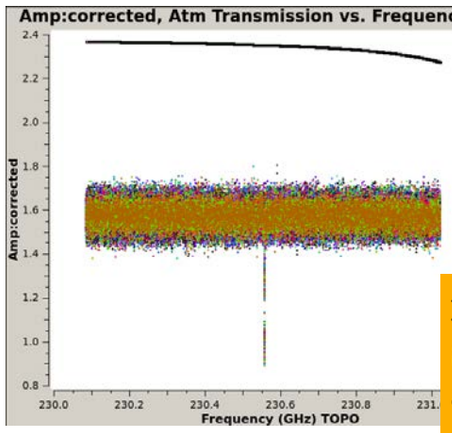


Missed outliers on the bandpass calibrator, need to go back and find these and flag

PART 1 - Calibration

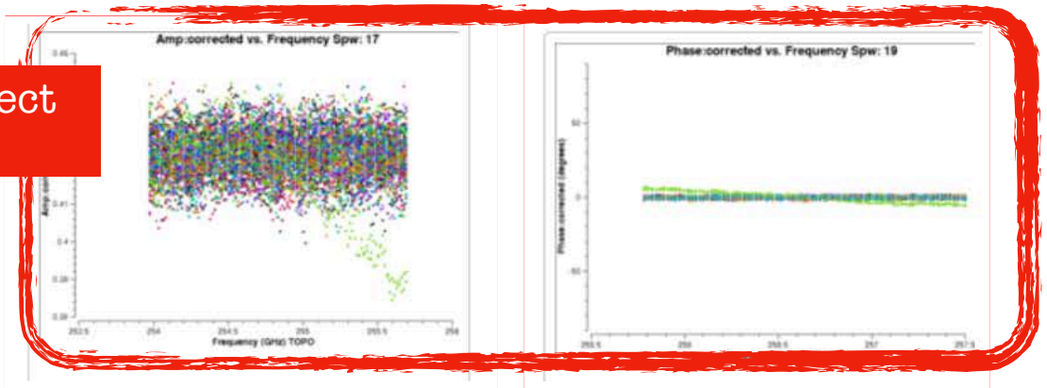
- Is the calibration good - **Applycal**

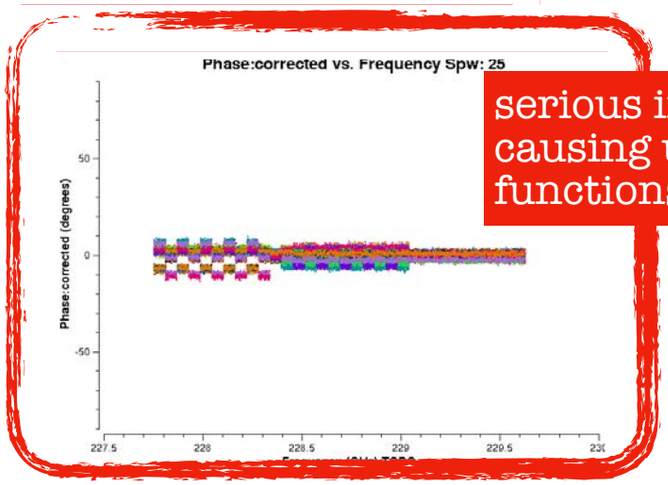
calibrators - amplitudes are constant and phases are zero (with time, frequency, and UV distance)



not ideal, the amplitude calibrator has some CO absorption. Likely so small, vs all channels, that the channel averaged amplitude gains will not change - but this could be flagged

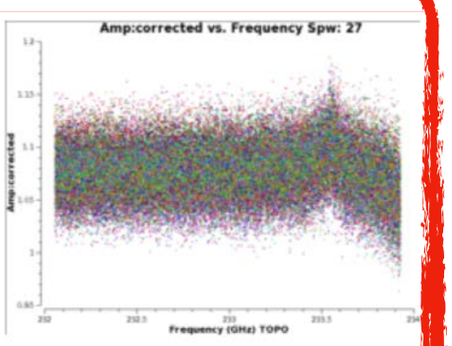
One antenna has incorrect gains (amp. and phase)





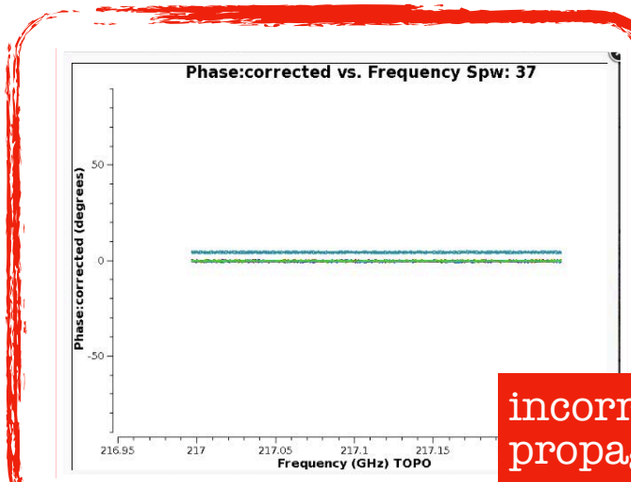
serious instrumental issues causing unnatural step functions in phases

amplitude on calibrators tails off at end of the SpW - **incorrect** Bandpass application



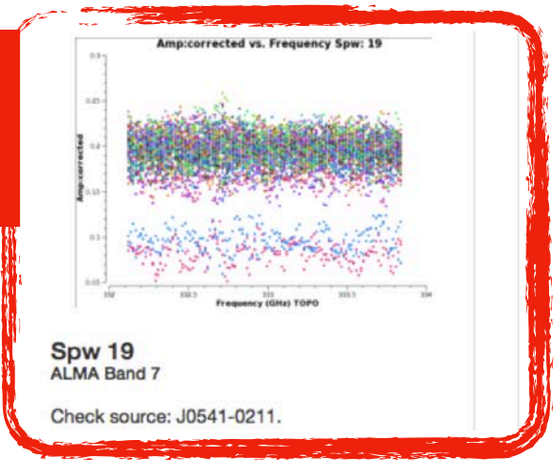
Spw 27
ALMA Band 6

Phase calibrator: J1058-8003.



incorrect phase offset that propagates to the CHECK source

One antenna has incorrect amplitude scaling which propagates to the CHECK source



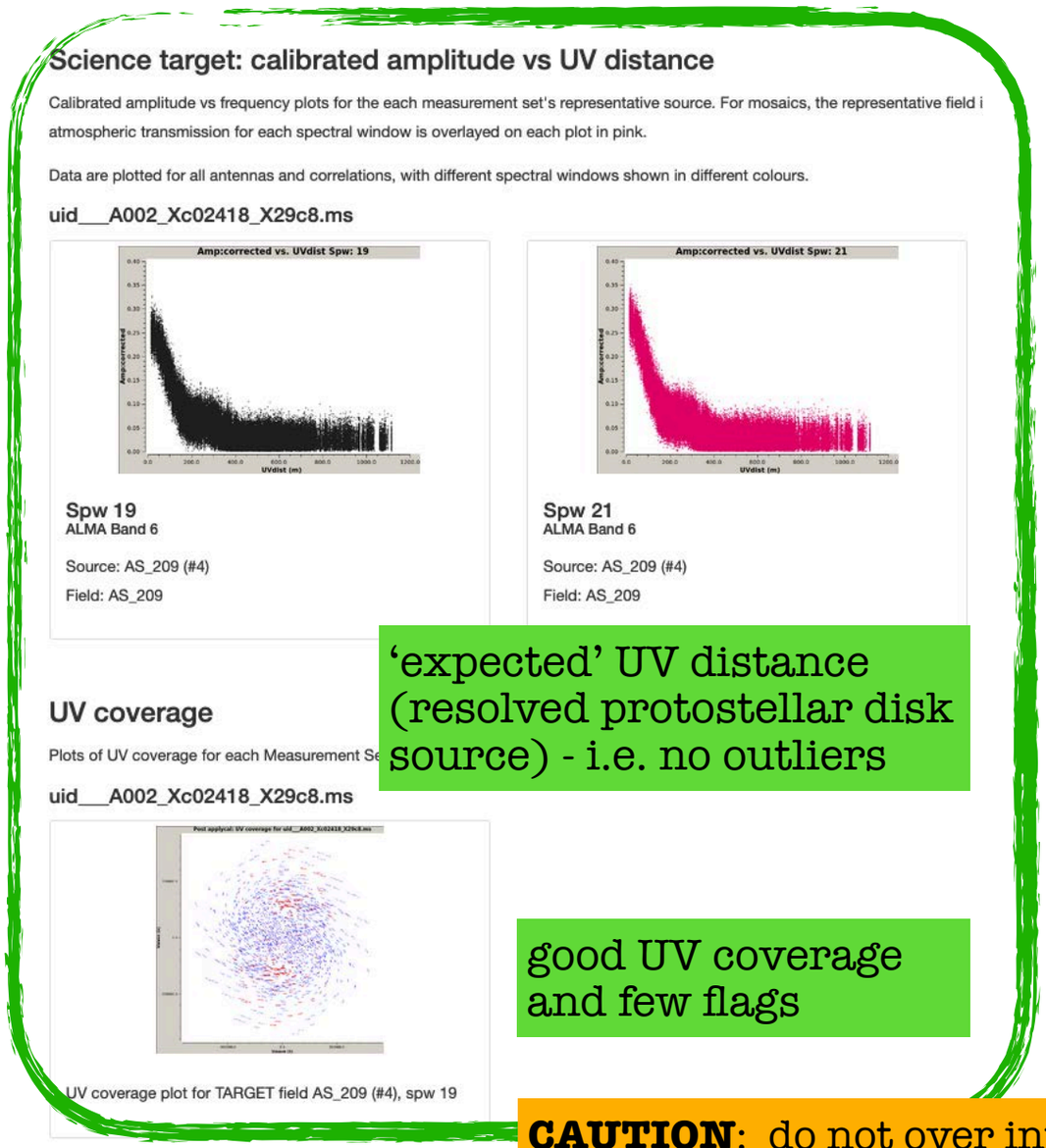
Spw 19
ALMA Band 7

Check source: J0541-0211.

PART 1 - Calibration

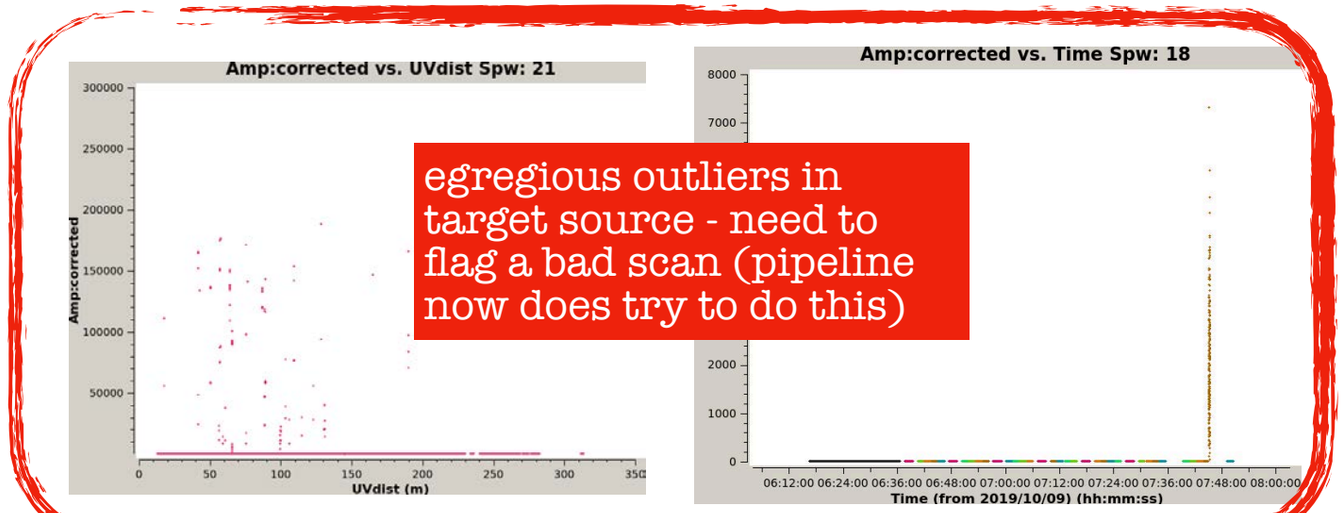
- Is the calibration good - **Applycal**

Science target(s) - can use these plots as proxy for line detections, confirm no huge outliers

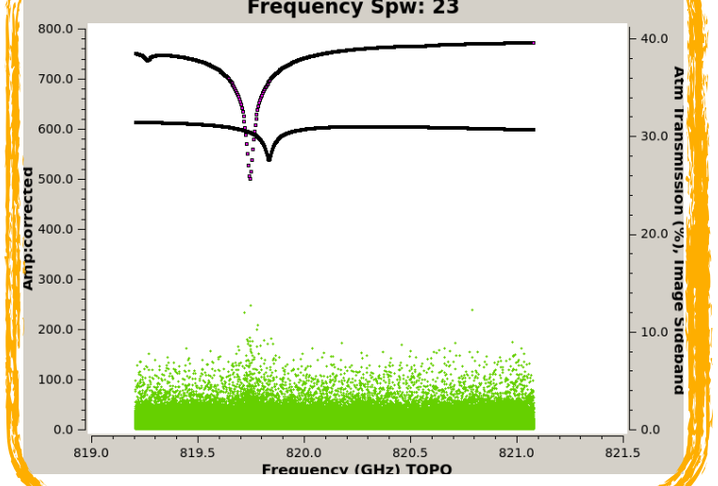


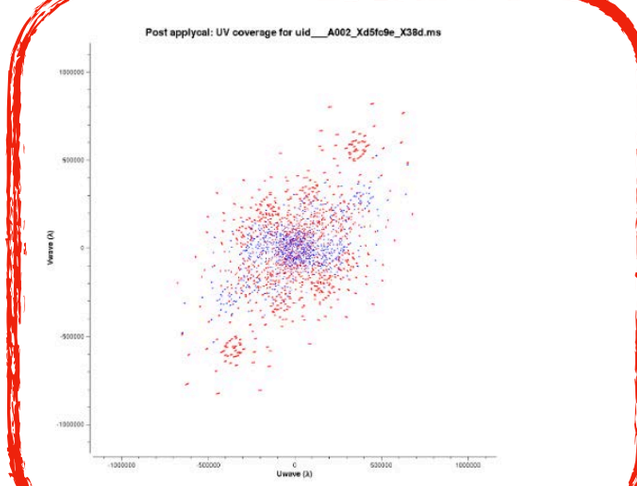
'expected' UV distance (resolved protostellar disk source) - i.e. no outliers

good UV coverage and few flags



egregious outliers in target source - need to flag a bad scan (pipeline now does try to do this)





probably too many flags, limited data use - will have been evident in flagging summaries

CAUTION: do not over interpret a signal in the SpWs as a line "detection" where there is an ATM line. Increase opacity reduces sensitivity (significantly in some cases) and because amplitude noise is only positive, this can look like at line

Concludes the calibration section - Any questions?

Firefox - viewing issues

- https://help.almascience.org/kb/articles/what-is-the-best-way-to-view-the-weblog

1. Inside CASA session, use:

> h_weblog

This opens a server to view, e.g.

> http://127.0.0.1:30000/main/pipeline=procedure_hifa_calimage/html/t1-1.html

2. Outside CASA in the untarred pipeline directory

> python3 -m http.server 8080 —bind 127.0.0.1

This opens a server to view, e.g.

> http://127.0.0.1:8080/index.html