NOEMA PIPELINEs

Arancha Castro-Carrizo

NOEMA PIPELINEs

- "Intelligent" software scripts to help in data analysis - based on CLIC (SIC) language

- Assessment of obtained data and projects is a task of the Science Operations Group (SOG) . NOEMA pipelines are tools developed within the SOG to use their expertise at the service of data and SOG duties

Different pipelines and software packages

- "**Current show**" - visualization of data and observing conditions during observations

- Analysis of **observing conditions** ('First Look' or 'show' file)
- **Data calibration** (including data assessment and imaging) both at the end of observations

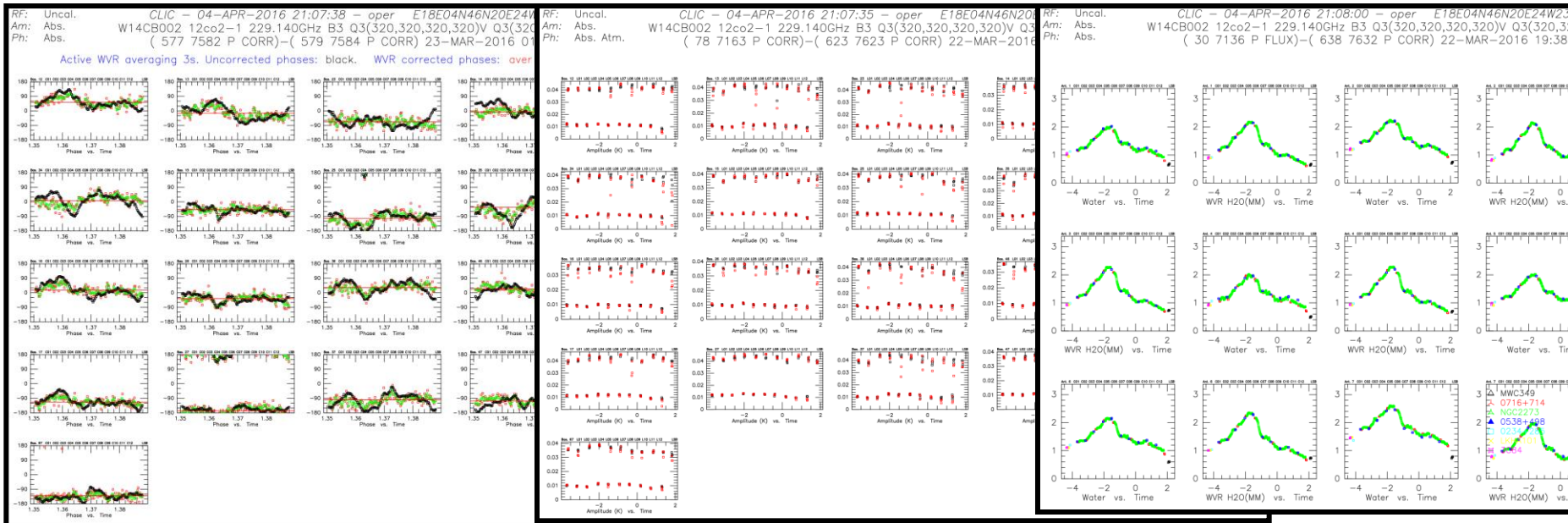
- **Instrument monitoring**

"Current show": real-time data visualization (preventive analysis)

To identify possible problems during the observations, or decide on next observations

For this we :

- 1) Visualize the observing conditions: phase stability, antenna efficiencies, wvr phase correction, water amount, etc

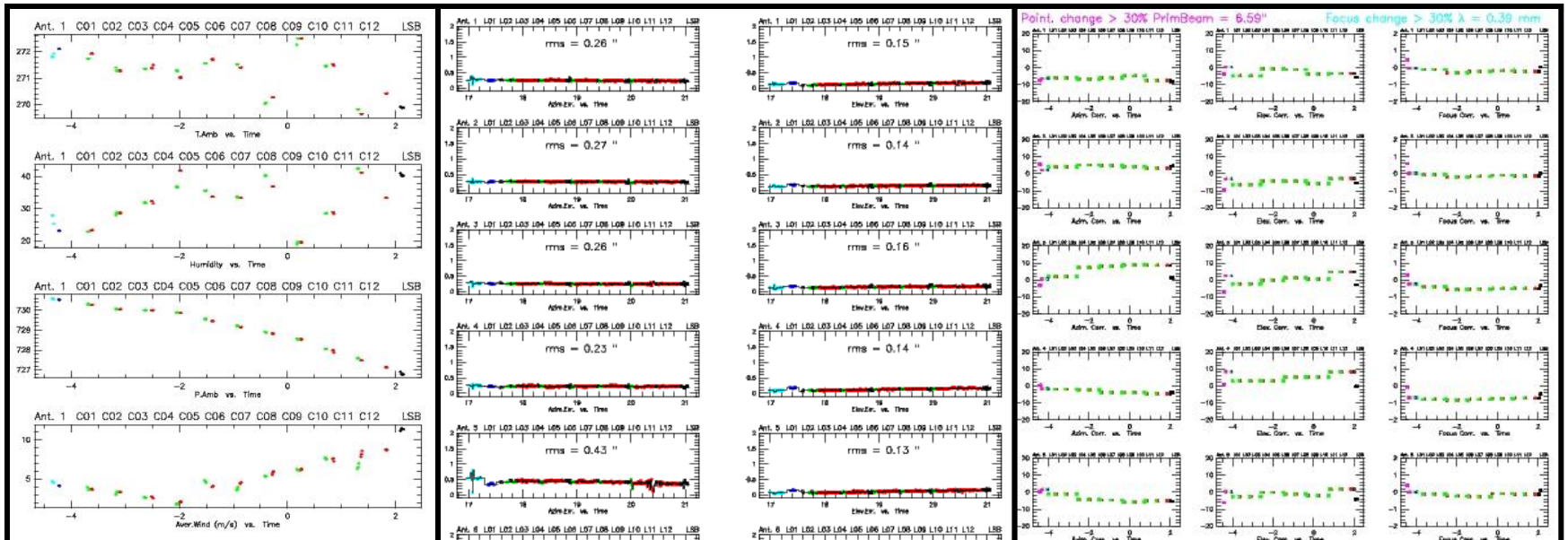


"Current show": real-time data visualization (preventive analysis)

To identify possible problems during the observations, or decide on next observations

For this we :

- 2) Monitor the behavior of hardware during the observations : Trec , Tsys, hardware flagged data, correlator tweaks, etc (~ 40 plots are generated to monitor the current observations)



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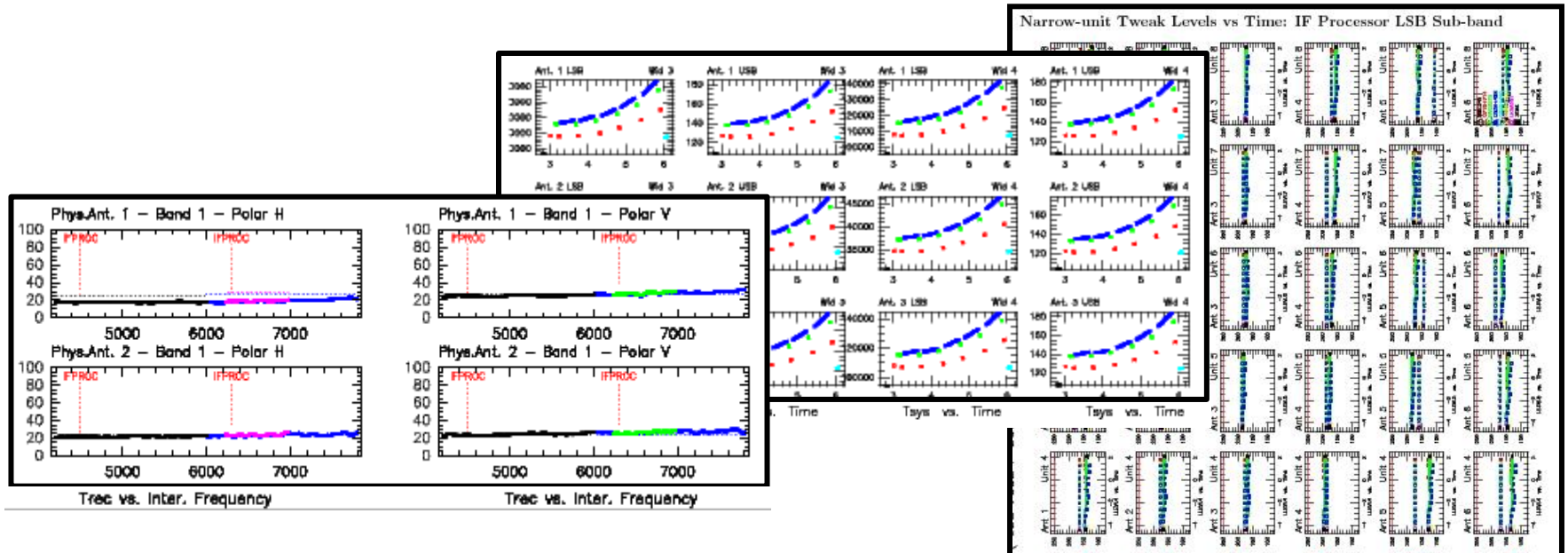


Different pipelines and software packages

- "Current show" - visualization of data and observing conditions during observations

Data Analysis

- Analysis of observing conditions (first look)
- Data calibration (including data assessment and imaging)

both at the end of observations

- Instrument monitori

2 uses :
@Observatory to decide about observations
@Grenoble to deliver to PI

Data analysis at the Observatory

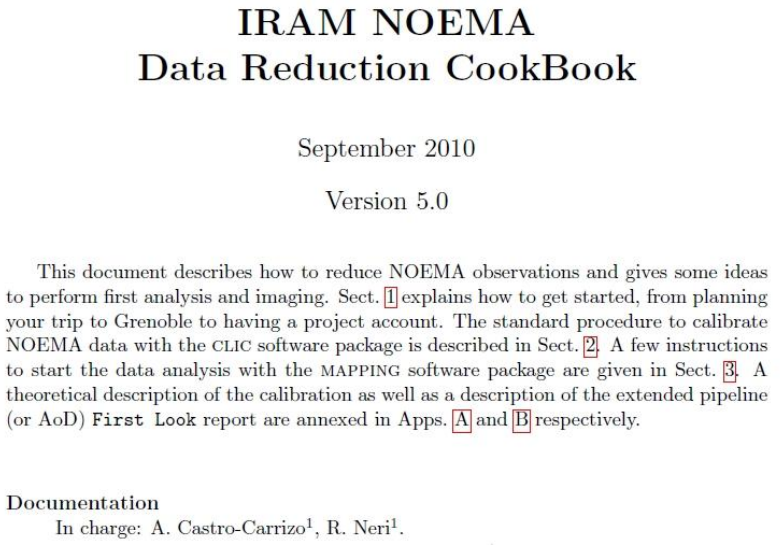
Analysis of **observing conditions** and **data calibration** are made by the CLIC **pipeline** script, launched automatically at the end of the observations

At the Observatory imaging tools are also launched by **@pipeline** to visualize the obtained data and decide on the status of the science project by adding all data

Data analysis at Grenoble by the PI

A similar analysis is performed at Grenoble by the PI with the help of the Local Contact. Even if the calibrated data in the archive must be very similar, we advice to repeat calibration at Grenoble with the PI

A document exists in GILDAS web (Documentation link, Data calibration section)



IRAM NOEMA
Data Reduction CookBook

September 2010

Version 5.0

This document describes how to reduce NOEMA observations and gives some ideas to perform first analysis and imaging. Sect. 1 explains how to get started, from planning your trip to Grenoble to having a project account. The standard procedure to calibrate NOEMA data with the CLIC software package is described in Sect. 2. A few instructions to start the data analysis with the MAPPING software package are given in Sect. 3. A theoretical description of the calibration as well as a description of the extended pipeline (or AoD) `First Look` report are annexed in Apps. A and B respectively.

Documentation
In charge: A. Castro-Carrizo[1], R. Neri[1].

Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

- **IPB** (filename.IPB) = raw NOEMA data (with real-time calibration, Tsys and Ta*, see Pietu presentation)
- **hpb** (filename.hpb) = calibration information obtained offline from AoD or PI calibration in CLIC
- **uvt** (filename.uvt) = source data in the uv-plane (see Montarges presentation)
- **lmv-clean** (filename.lmv-clean) = cleaned image maps ; lmv = dirty image maps (see Pety presentations)

Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

- **IPB** should not be modified (readable by CLIC) - large files
- **hpb** modified at each calibration, but no data in (processed by CLIC) - small files

IPB and hpb are both needed for calibration and uv-tables creation

- **uvt** contain calibrated data (with some recording about the original visibilities), created by CLIC, processed by MAPPING - moderate files (?)
- **lmv-clean** resulting images (grid+FT+cleaning), processed by MAPPING - moderate files (?)

Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

HOW DOES IT COMPARES WITH ALMA ?

- **ASDM** - IPB data (without Tsys calibration)
- **ms** - data + calibration → hpb
- **ms** - visibilities (no equivalent to simple uvt)
- **ms** - images (lmv, lmv-clean)

Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

With **@pipeline 'project' 'date'** in CLIC four blocks of scripts are executed, in the following order :

1. **Observing conditions (IPB)**
2. **Data calibration (IPB+hpb)**
3. **Visibility assessment (IPB+hpb)**
4. Imaging assessment (uvt+lmv-clean ; only @ Bure)

A document of ~ 60-70 pages is created to show at first data calibration (2), secondly a complete review of observing conditions (1), and at third a visibility assessment (3)

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Data analysis: IPB -> hpb

OBSERVING CONDITIONS

CALIBRATION

Project Data File 21-mar-2016-l
Observed on 22-MAR-2016 Configuration 7B
(E18E04N46N20E24W23W05)

Automatic calibration report by CLIC @ x_calib

March 22, 2016

Scan range:	0 to 10000
Use phase correction:	YES (22GHz)
Minimum quality:	AVERAGE
Auto. flag procedure:	YES (0 scans)
WVR interference check:	NO
Averaged polarization mode for amplitude calibration:	YES

	Receiver 3
Bandpass:	Excellent
Phase:	Correct
Seeing HOR:	0.27″
Seeing VER:	0.27″
Amplitude:	Good

1 Summary

1.1 Calibrators

Name	Flux (Jy) @209.8 GHz		Calibration	
3C84	14.56	*Computed*	*RF*	
LKHA101	0.51	*Fixed (model = 0.51)*		
3C273	11.89	*Computed*		
1418+546	2.54	*Computed*	*phase/amp*	*(detected polarization)*
MWC349	1.81	*Fixed (model = 1.81)*		

1.2 Efficiencies

Antenna 1 (A1)	31.4	Jy/K	(33.4 / 1.06)
Antenna 2 (A2)	30.2	Jy/K	(33.4 / 1.10)
Antenna 3 (A3)	29.2	Jy/K	(33.4 / 1.14)
Antenna 4 (A4)	37.7	Jy/K	(33.4 / 0.88)
Antenna 5 (A5)	29.5	Jy/K	(33.4 / 1.13)
Antenna 6 (A6)	32.1	Jy/K	(33.4 / 1.04)
Antenna 7 (A7)	24.1	Jy/K	(33.4 / 1.38)

1.3 Observed Source(s)

1 was observed for Hour Angles from -5.4 to 2.2 h
for a total of 5.2 h (420 scans)

1

Observed on 21-MAR-2016 configuration 7B
(E18E04N46N20E24W23W05)

Automatic Summary Report by CLIC @ x_show

March 22, 2016

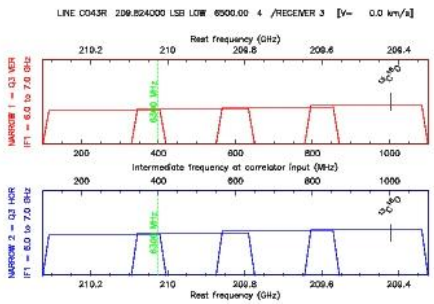
1 Summary

1.1 Spectral Configuration

Sky Frequency 209.824 GHz LSB

1.1.1 Narrow Band Correlator

unit	width	IF3 center	quarter	polar	narrow
L01	320	260	3	V	1
L02	320	490	3	V	1
L03	320	710	3	V	1
L04	320	940	3	V	1
L05	320	260	3	H	2
L06	320	490	3	H	2
L07	320	710	3	H	2
L08	320	940	3	H	2



VISIBILITY ASSESSMENT

Project
Observed on 21-MAR-2016

Automatic Visibility Quality Assessment Report
by CLIC @ x_visi

March 22, 2016

Project type:	MAPPING
Seeing limit:	$\leq 1''$
Amplitude loss:	$\leq 31.7\%$
Pointing error:	$\leq 30\%$ (FOV) $\simeq 7.2''$
Focus error:	$\leq 30\%$ (λ) $\simeq 0.4$ mm
Tracking error:	$\leq 10\%$ (FOV) $\simeq 2.4''$
Configuration(s):	1. E18E04N46N20E24W23W05

The three documents are compiled in pipeline-29-mar-2016-xxx.pdf

Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

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Data analysis: Observing conditions

Aimed to

- 1) identify possible problems that could condition the data reduction, and to
- 2) prevent that those are reproduced in future observations (for AoDs)

The analysis of 'Observing Conditions' can influence the calibration ⟹ executed just before Calibration Pipeline

Data analysis: Observing conditions

With plots of interest for all astronomers…

Observed on 21-MAR-2016 configuration 7B
(E18E04N46N20E24W23W05)

Automatic Summary Report by CLIC @ x_show

March 22, 2016

1 Summary

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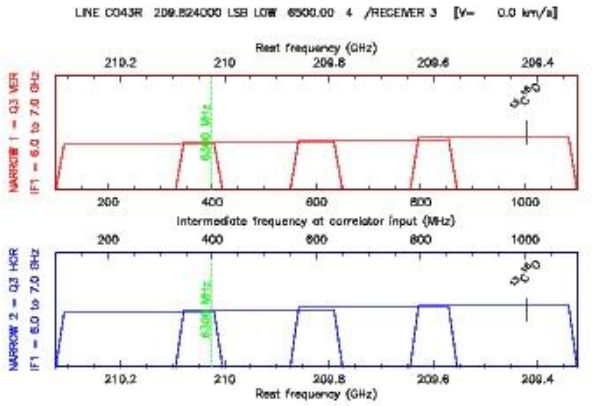
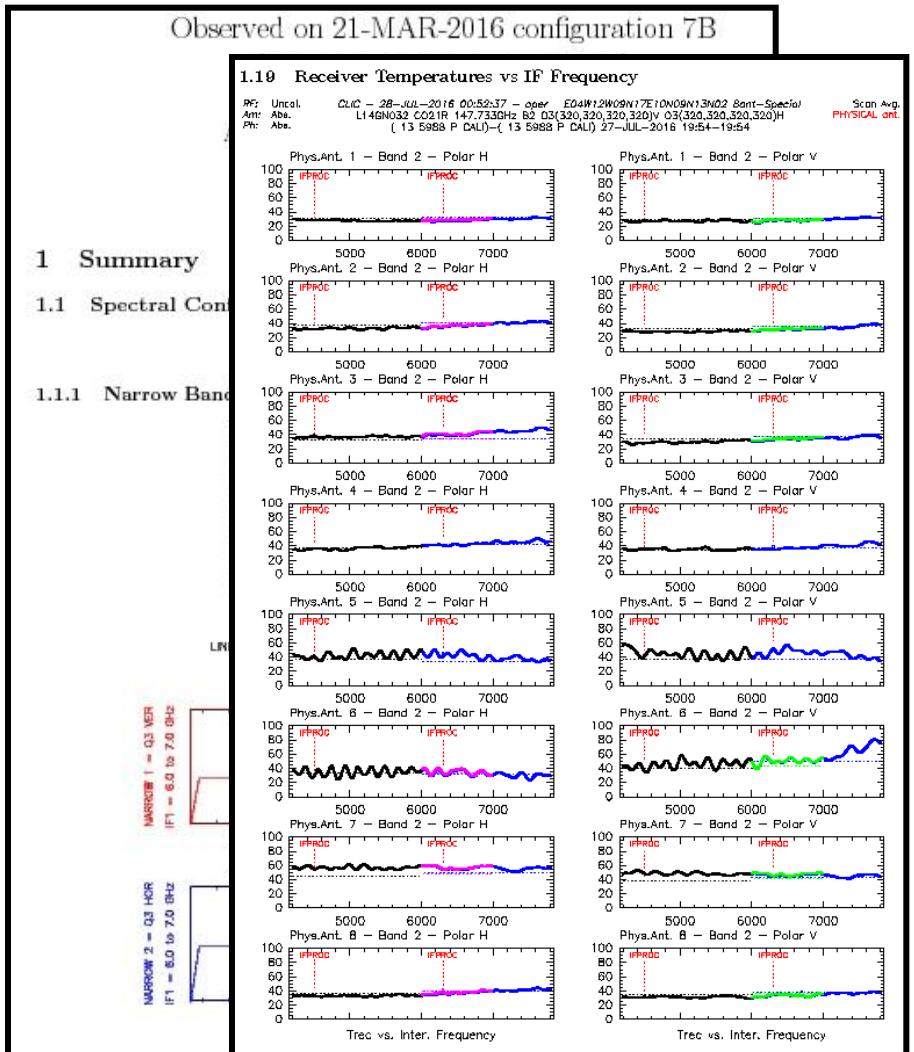


Data analysis: Observing conditions

With plots of interest for all astronomers…



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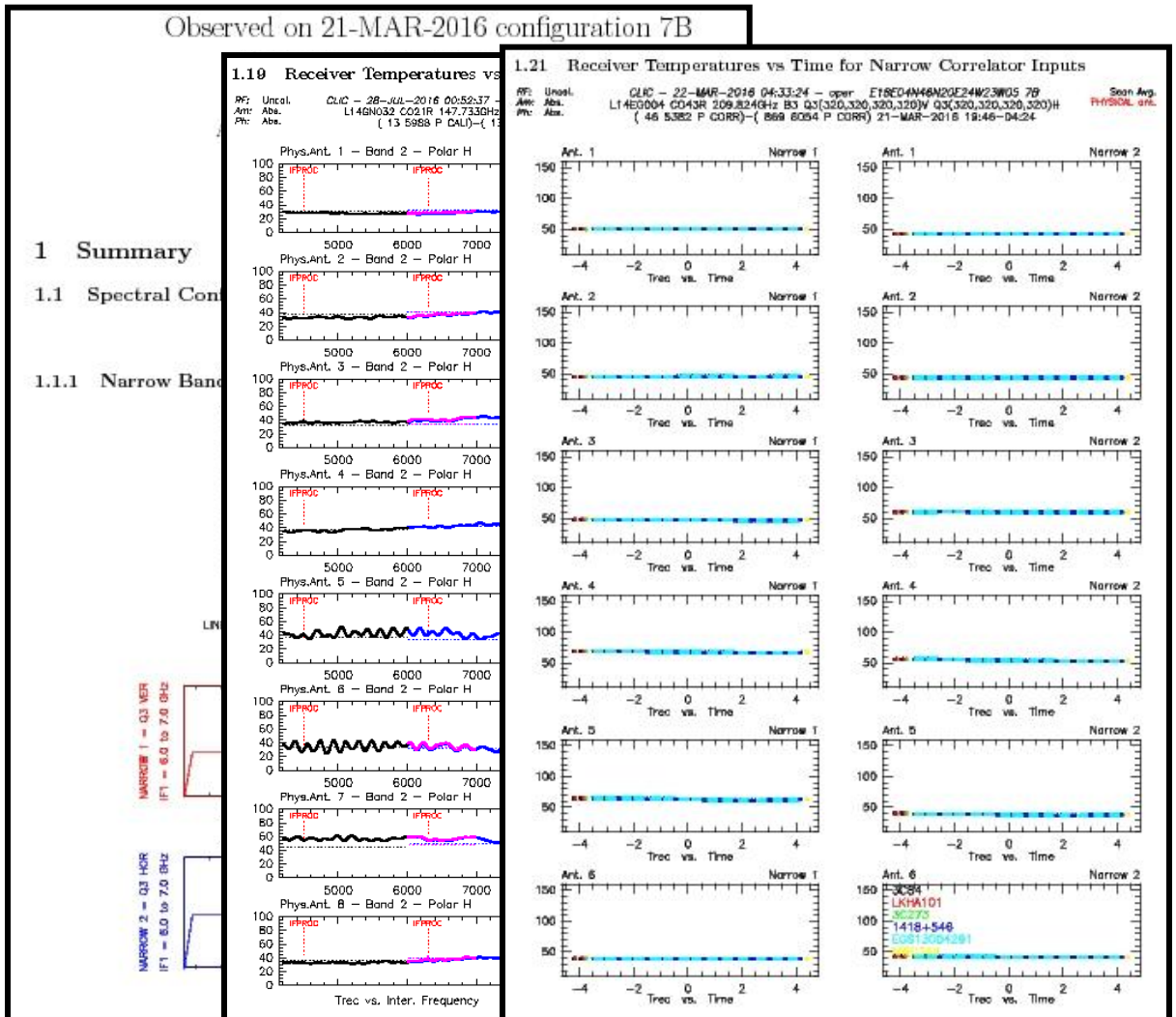
With plots of interest for all astronomers…



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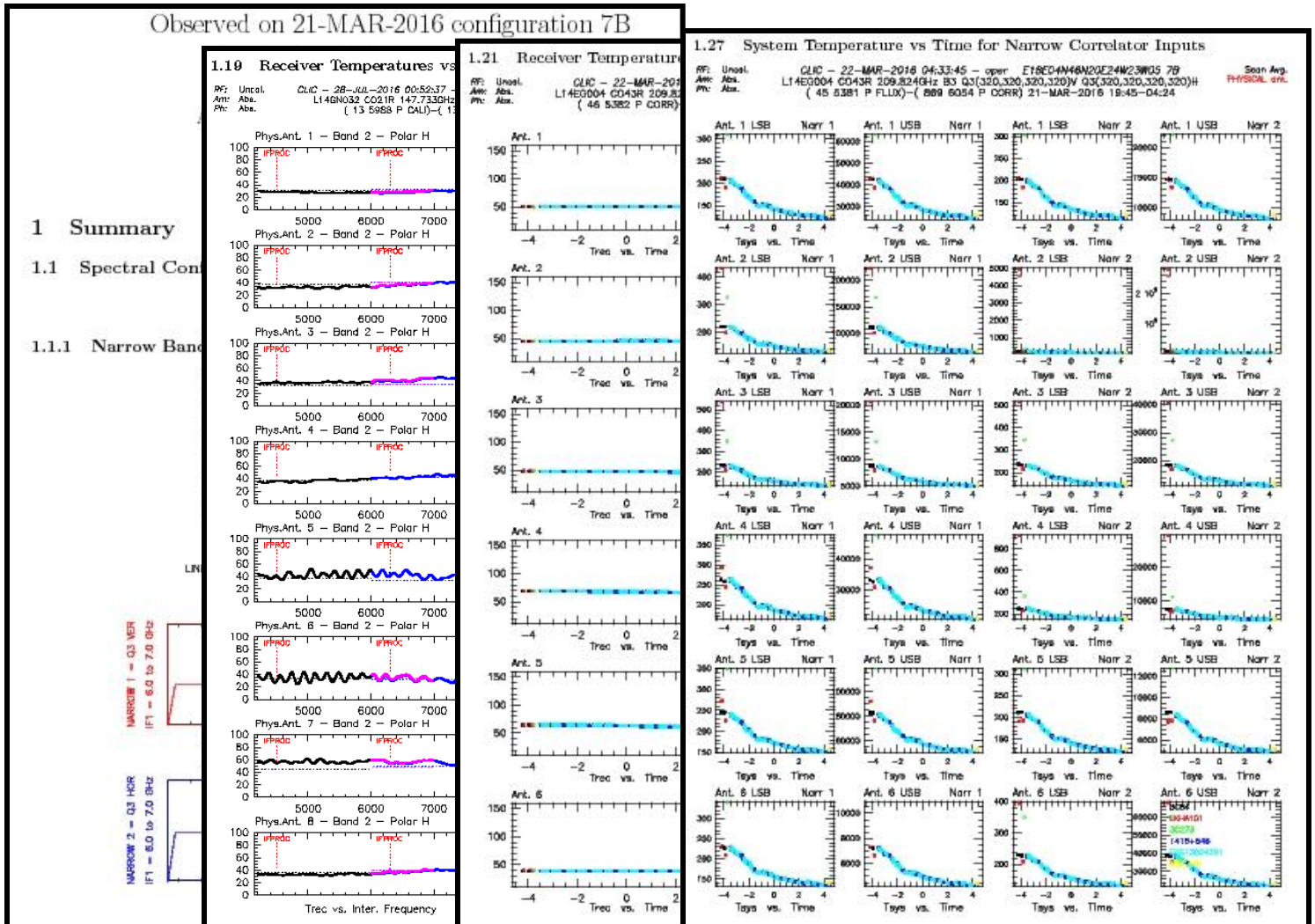

Data analysis: Observing conditions

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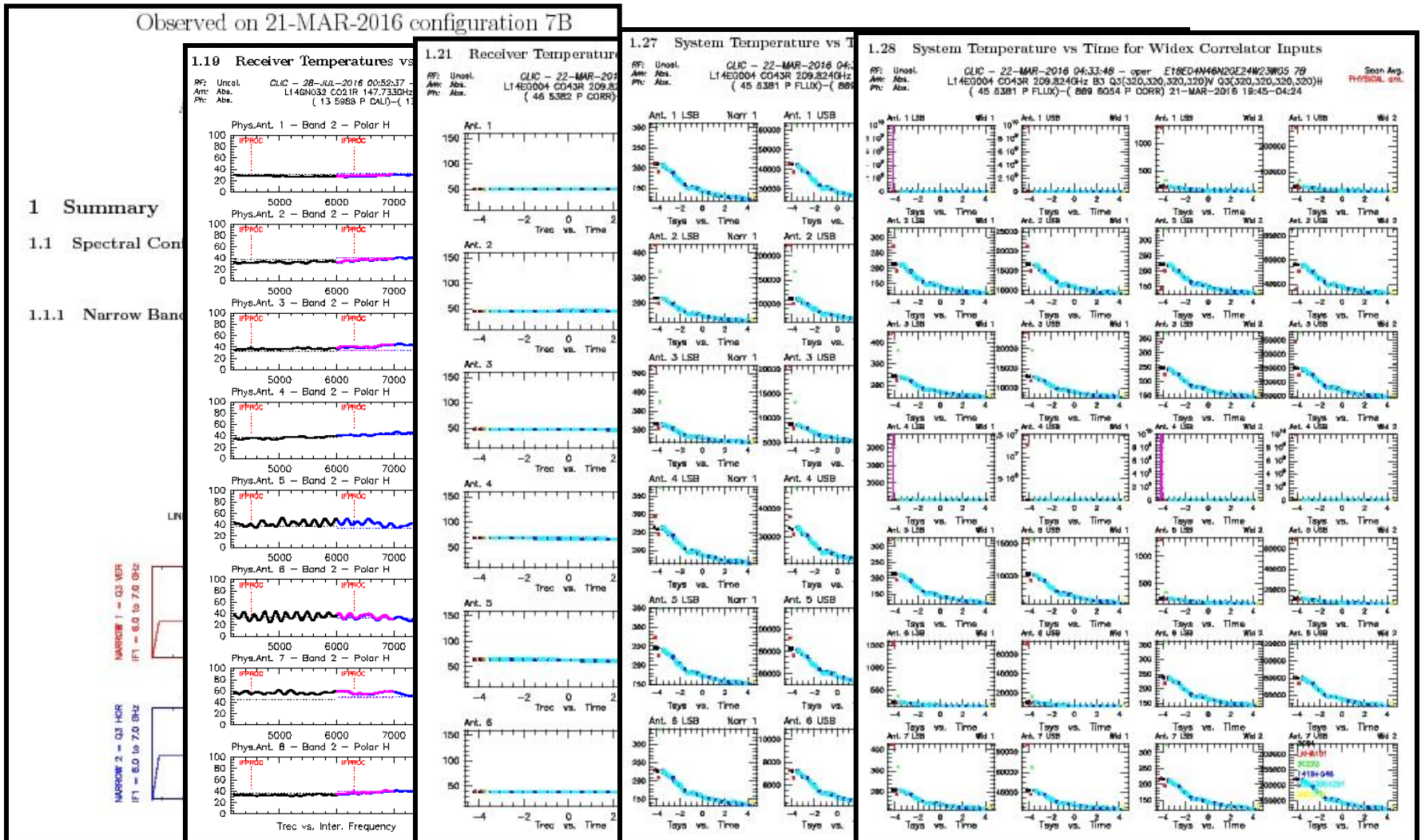

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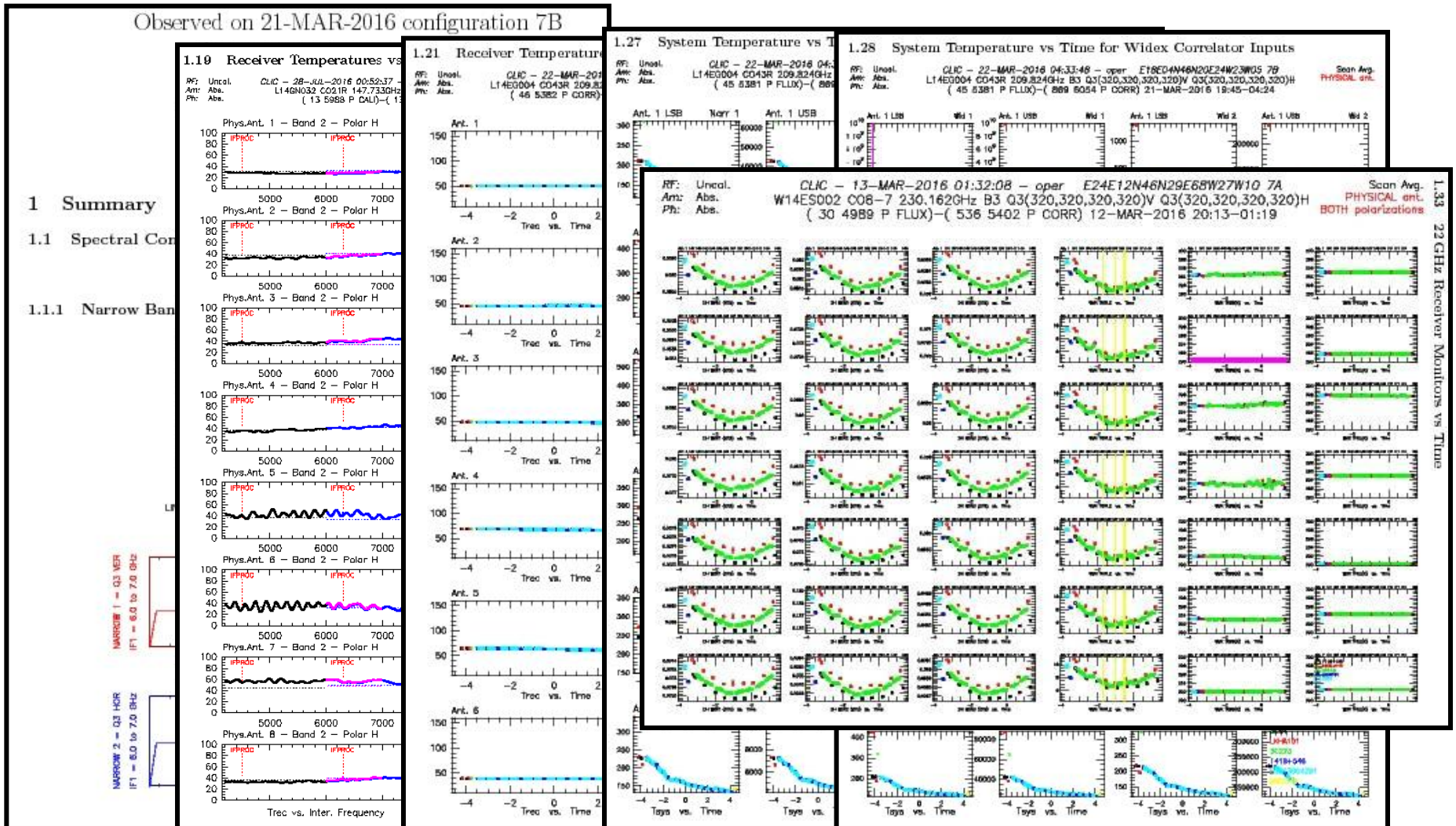
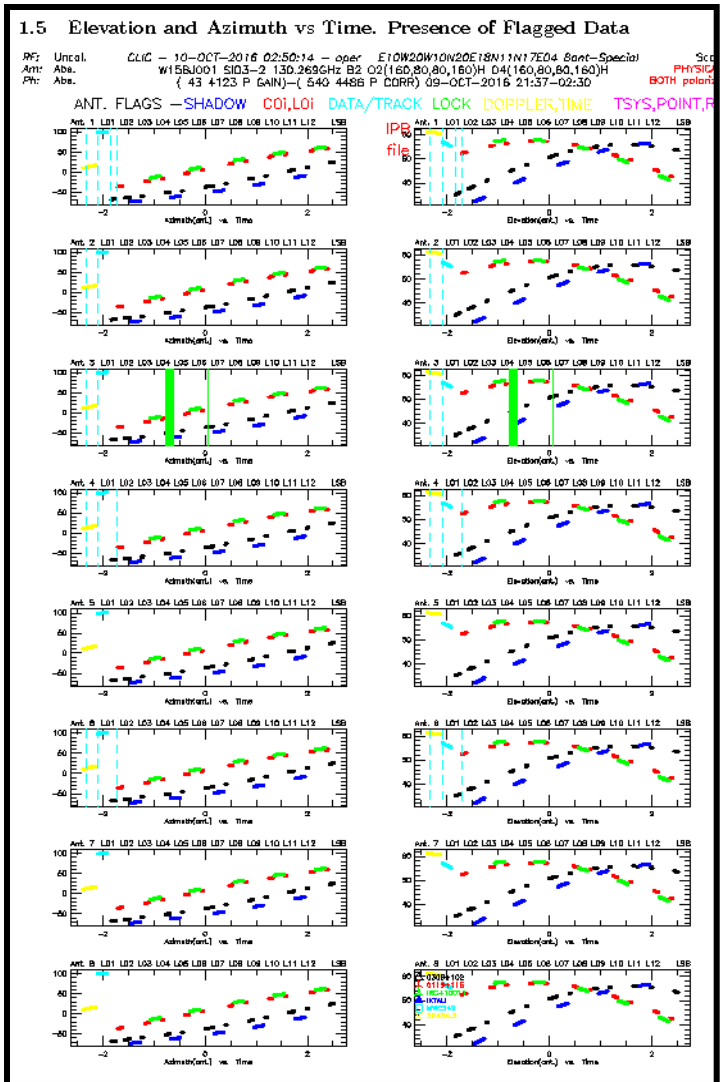


Data analysis: Observing conditions

With plots of interest to some astronomers…



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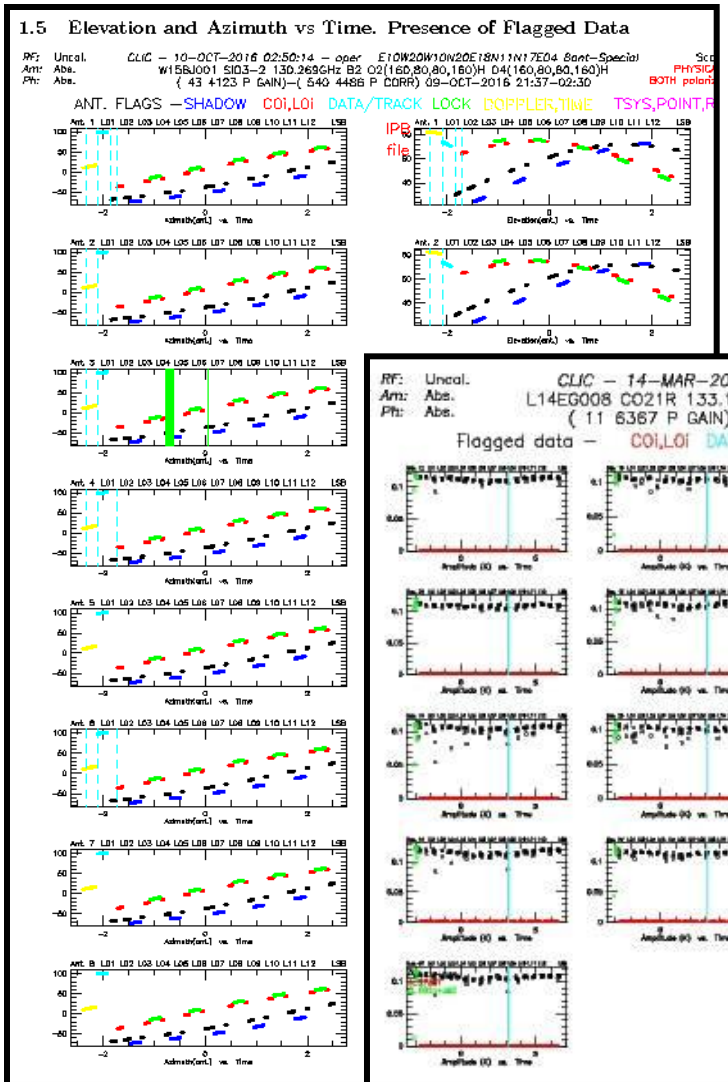

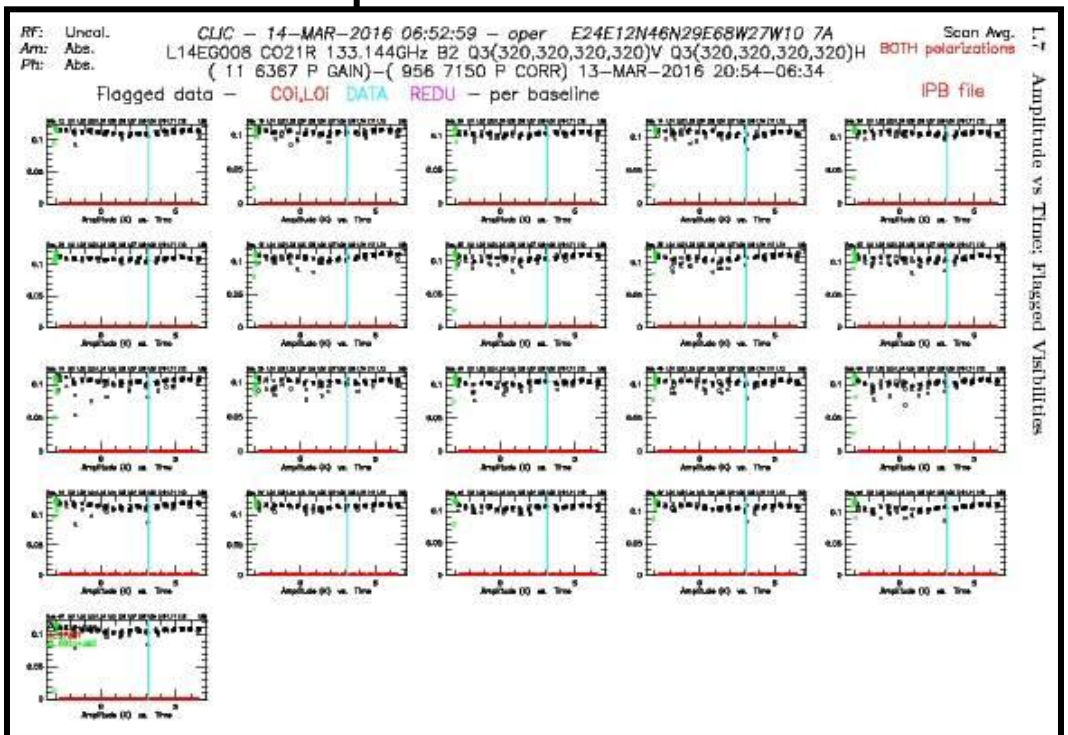

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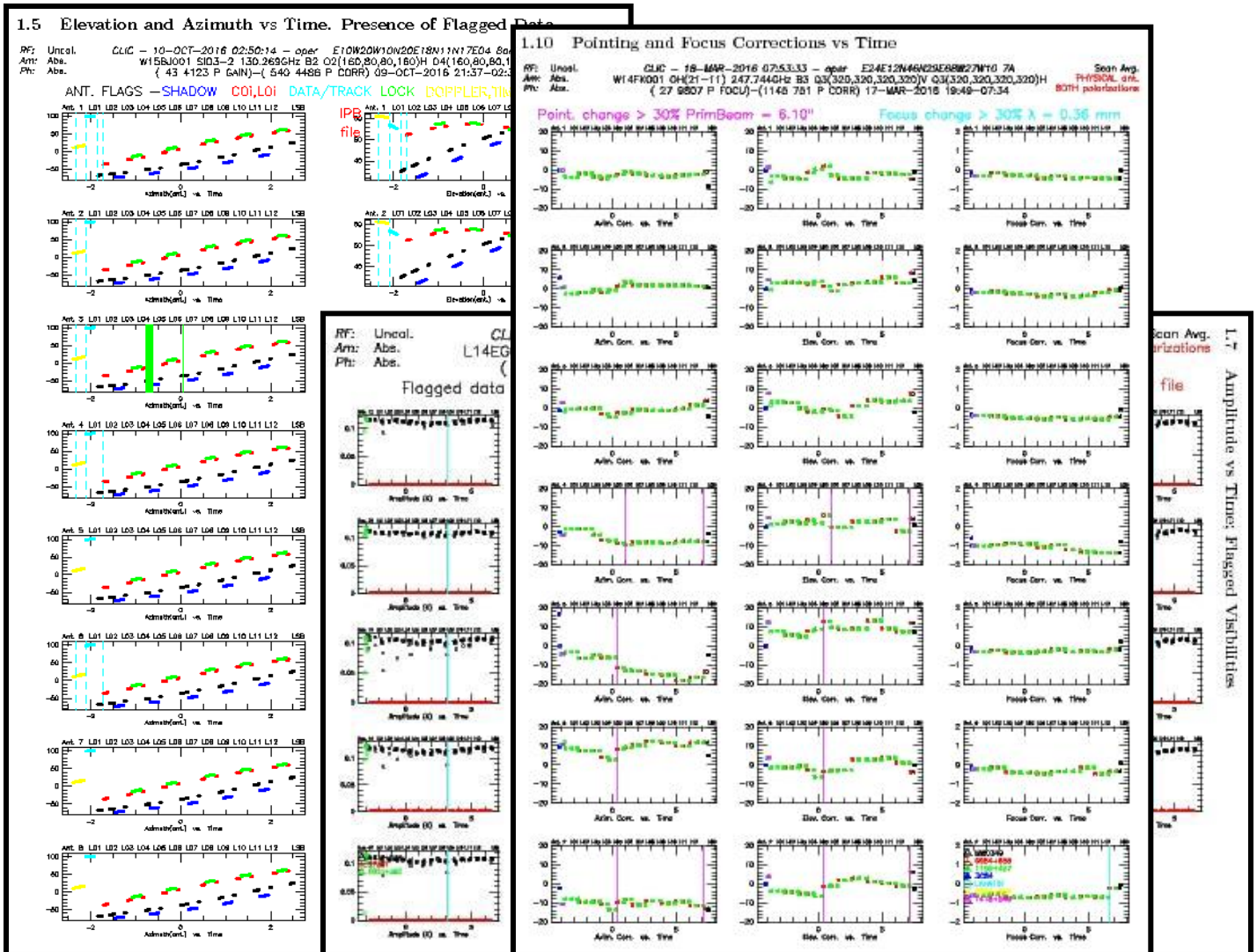

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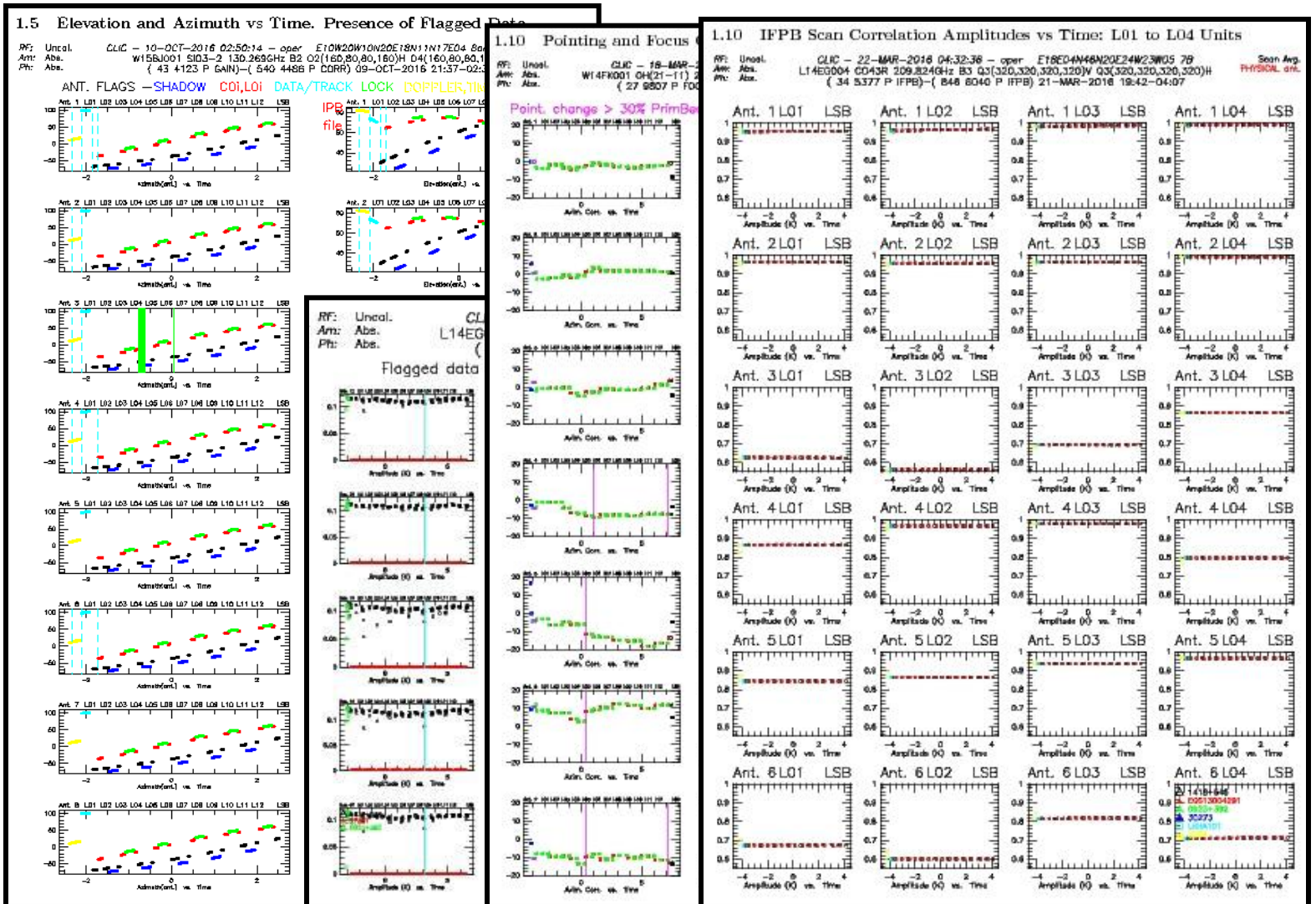

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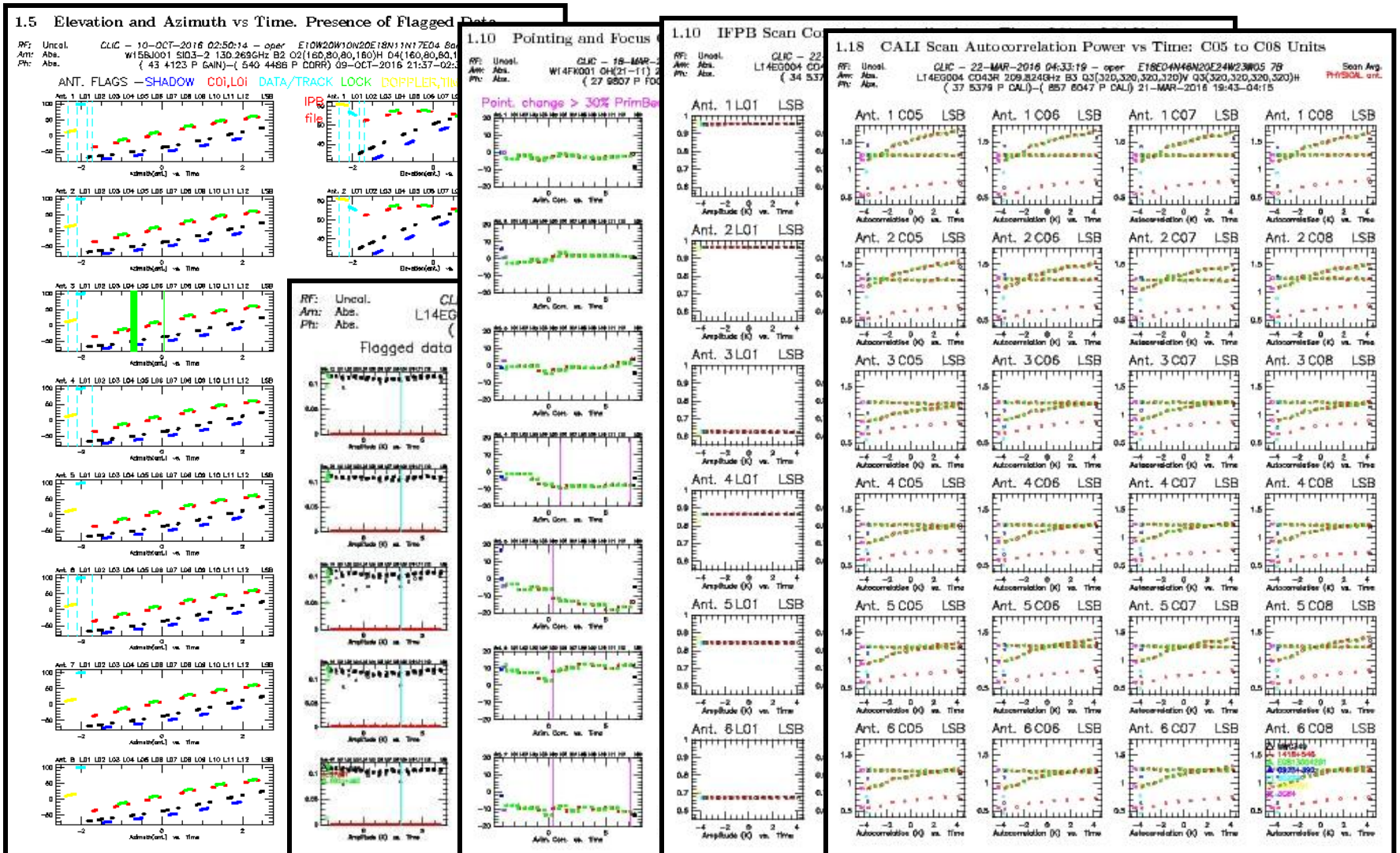
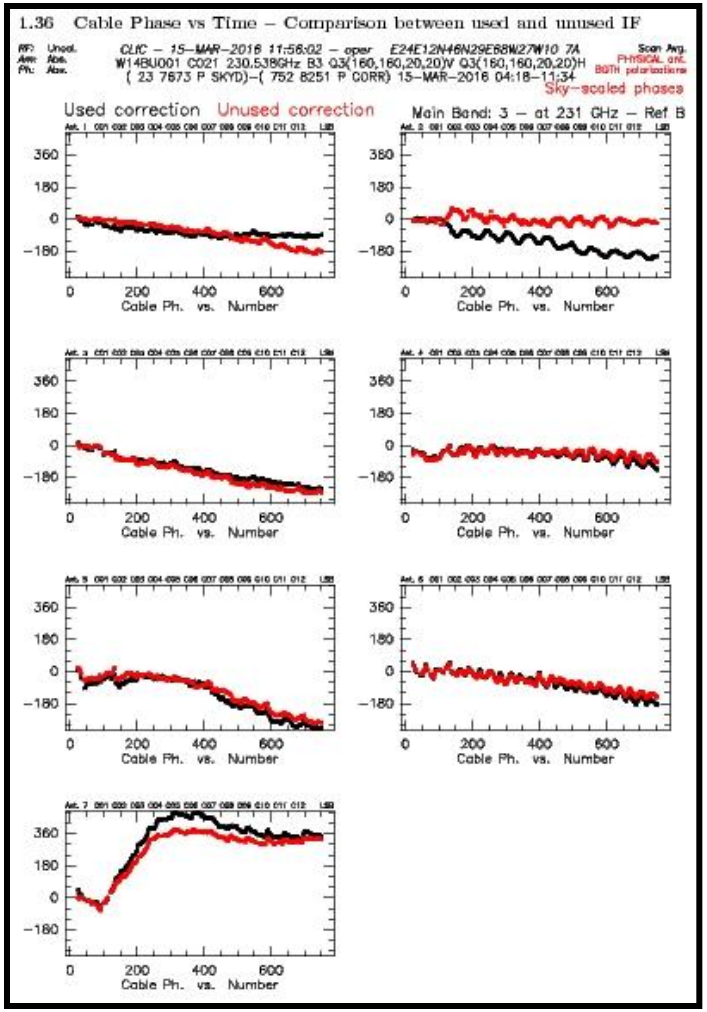


Data analysis: Observing conditions

With plots of interest to very few astronomers…



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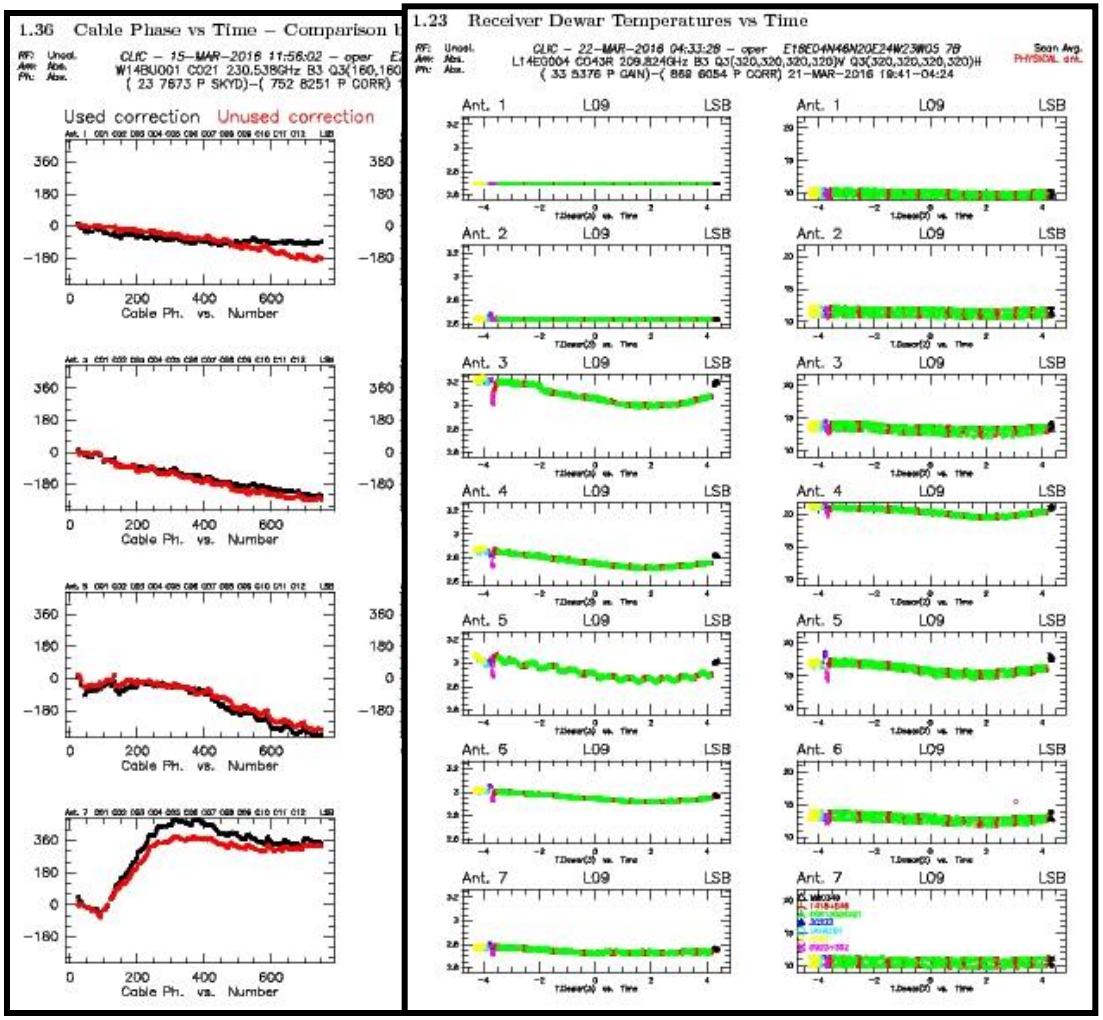

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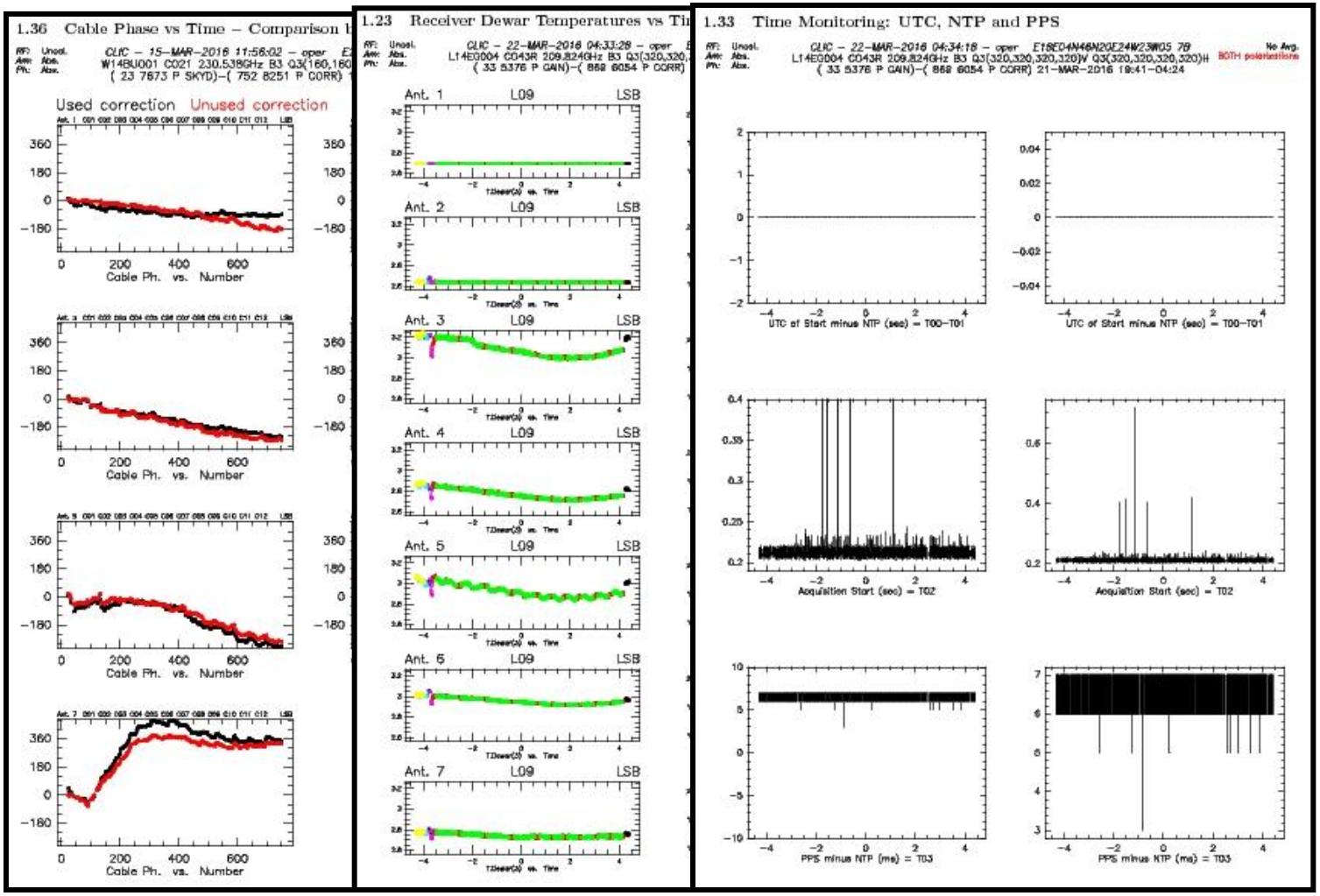
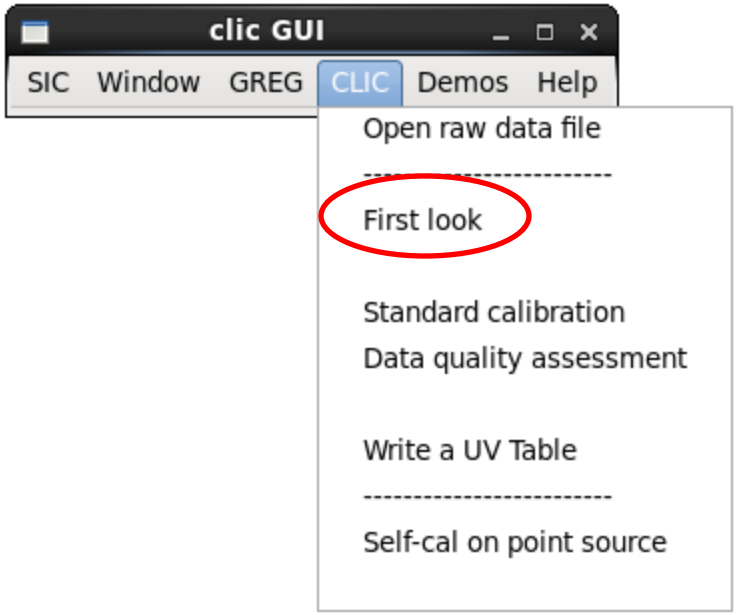


Data analysis: Observing conditions

A short very version of what the pipeline is including can be found in CLIC menu



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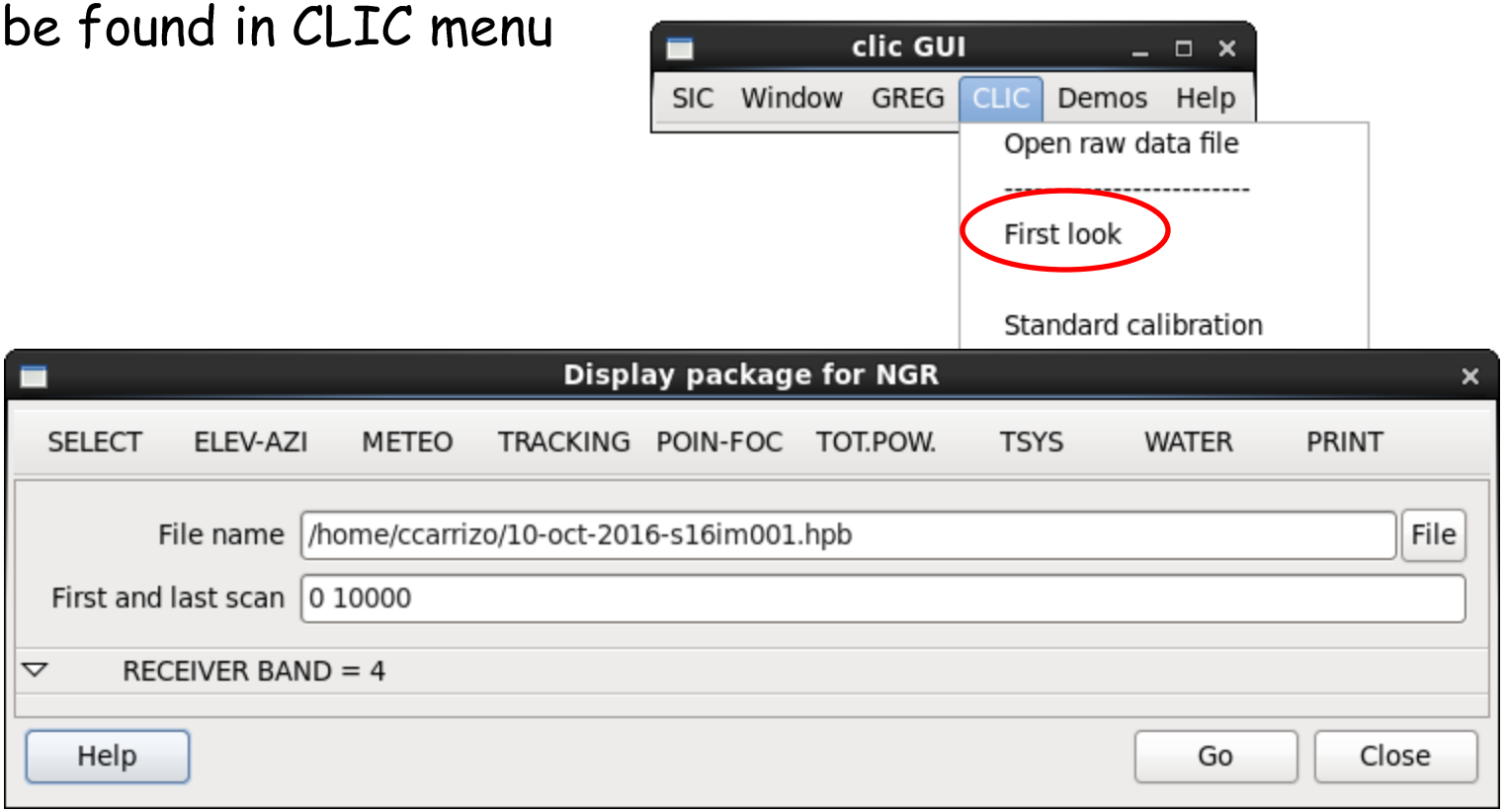

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Data analysis: Calibration

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
say "RF CALIBRATION"                        1
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

find /proc corr flux /sou 3C84
store phase /self
set phase rel
set x i_f
set y amp phase /lim 0 * * *

set bin 5
show bin

set narrow 1
plot
solve rf 12 20 /plot

set narrow 2
plot
solve rf 12 20 /plot

set wid 1
plot
solve rf 40 50 /plot

set wid 2
plot
solve rf 40 50 /plot

set wid 3
plot
solve rf 40 50 /plot

set wid 4
plot
solve rf 40 50 /plot

find /proc corr flux
store rf /band 'band'
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
say "PHASE CALIBRATION"                   2
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

set phase abs
set rf on
set y phase /lim * *
set x time
set sub line
find /proc corr flux /typ ph

set polar v
plot /id col
solve phase /plot

set polar h
plot /id col
solve phase /plot

find append /proc corr /typ o
store phase /band 'band'
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
say "FLUX CALIBRATION"                    3
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

set rf on
set phase rel atm
set amp scale
set y amp
set x time
set sub line

find /proc corr flux /ty ph
set polar both
plot /id col

set flux all /reset
set flux mwc349 1.35
show flux

solve flux
store flux

set rf on
set phase rel atm
set amp scale
set y amp
set x time
set sub line
plot /id col
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
say "AMPLITUDE CALIBRATION"                          4
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

find /proc corr flux /typ ph

set polar v
plot /id col
solve amp /plot

set polar h
plot /id col
solve amp /plot

find append /proc corr /typ o
store amp /band 'band'
```

For Calibration we do not need any pipeline

Calibration = Just some CLIC commands

Data analysis: Calibration

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
say "RF CALIBRATION"                         1
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

find /proc corr flux /sou 3C84
store phase /self
set phase rel
set x i_f
set y amp phase /lim 0 * * *

set bin 5
show bin

set narrow 1
plot
solve rf 12 20 /plot

set narrow 2
```

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
say "PHASE CALIBRATION"                2
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

set phase abs
set rf on
set y phase /lim * *
set x time
set sub line
find /proc corr flux /typ ph

set polar v
plot /id col
solve phase /plot

set polar h
plot /id col
solve phase /plot
```

For Calibration we do not need any pipeline

Calibration = Just some CLIC commands

A **pipeline** helps however to gain time, and also if :

- Not enough expertise
- Problems or characteristics are to be identified (e.g. polarized calibrator, non-optimum wvr-correction, different solutions for diff polars, etc)
- Decisions to be taken (e.g. for flux calibration, flags, etc)

Data analysis: Calibration

These VERIFICATIONS MAKE THE PIPELINE VERY STRONG, DIFFICULT TO DO IT BETTER IF ONLY WORKING BY HAND

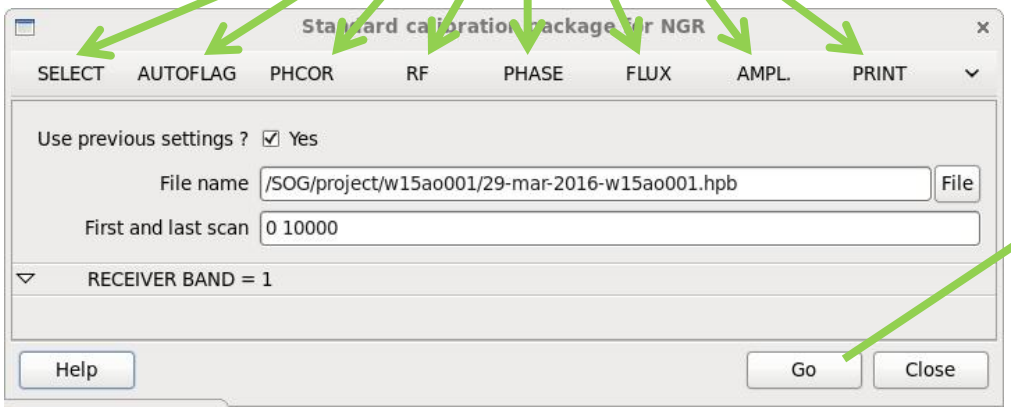
- Problems or characteristics are to be identified (e.g. polarized calibrator, non-optimum wvr-correction, different solutions for diff polars, etc)

- Decisions to be taken (e.g. for flux calibration, flags, etc)

Data analysis: Calibration

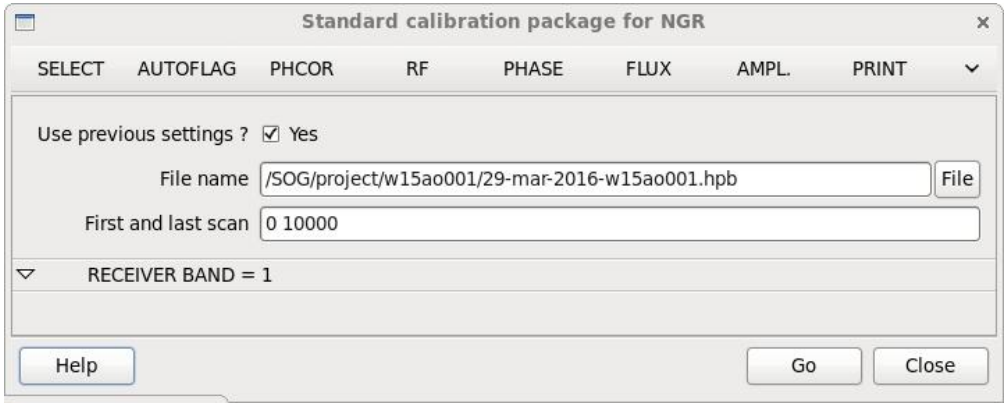
IN CLIC, the **Standard Calibration** widget uses a logic similar to that of the pipeline (same scripts), widgets giving to the user the possibility of interact.
@pipeline often uses more advanced solutions

Step by step, interacting by hand with semi-pipeline approach



GO: executes the entire data calibration **like the pipeline** does
(without the analysis of observing conditions)

Data analysis: Calibration

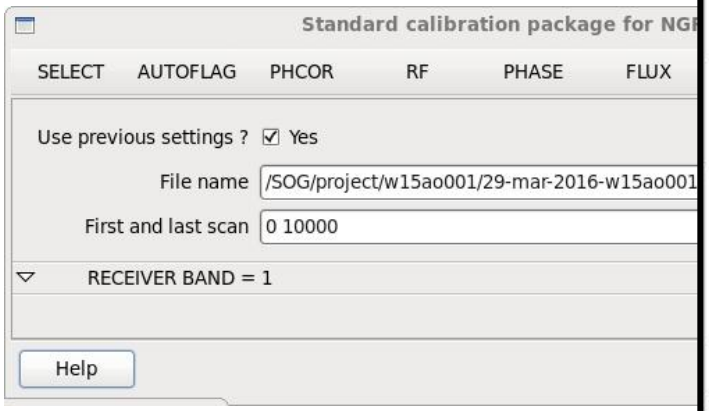


SELECT: to define needed variables at start, identify all calibrators, diff tuning ranges, and adopt previous settings if applicable.

Attention to <u>messages in the prompt</u> !!

Different variables to change the calibration default ("*do_atm*", "*phcal*", "*band_source*", "*do_avpha*", "*do_avpol*")

Data analy

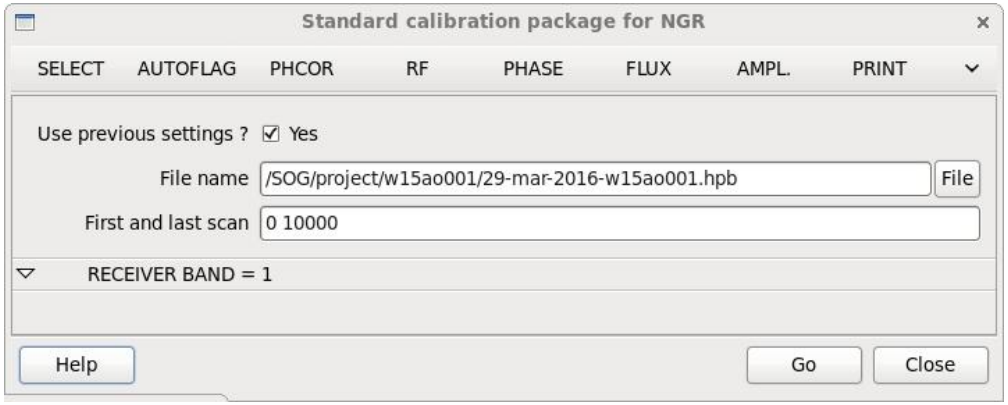


SELECT: to define needed
calibrators, diff tuning rang
applicable.

Attention to <u>messages in th</u>
Different variables to c
("*do_atm*", "*phcal*", "*ban*

```
-------------------------------------------------------
 Atmospheric phase correction is applied according to
 the PHCOR evaluation
 After SELECT you can disable it with: let do_atm no
 Phases are Degrees Continuous 10
-------------------------------------------------------
 The minimum quality required for data selection is
 AVERAGE. After SELECT you can change it with:
 let min_qual "quality_flag"
-------------------------------------------------------
 If no phase calibrator is found to be polarized, average
 polarization mode is not selected for amplitude calibration
 You can also change it with: let do_avpol yes
-------------------------------------------------------
 After a first phase calibration, the pipeline script may change the
 default phase calibration to happen in average polarization mode
 You can also change it with: let do_avpha yes
-------------------------------------------------------
 You can decide on the way to calibrate the phases and amplitudes
 of the FLUX and RF calibrators by introducing their names in the
 variable PHCAL (with 'let phcal "*"') and clicking again on SELECT
 This is important if the phases of the data obtained with H and V
 receivers are different (see last plots of the "FirstLook" report)
-------------------------------------------------------------

Building the flux list...
I-LISTE,[3106] Source #  1    3C84            7 Observations
I-LISTE,[3106] Source #  2    LKHA101        11 Observations
I-LISTE,[3106] Source #  3    1222+216       50 Observations
Source  1        3C84 Fluxes   0.00  0.00 12.96  0.00 Jy
Source  2     LKHA101 Fluxes   0.00  0.00  0.65  0.00 Jy
Source  3    1222+216 Fluxes   0.00  0.00  0.97  0.00 Jy
I-LISTE,[3530] Source #  1    3C84            7 Observations
I-LISTE,[3530] Source #  2    LKHA101        11 Observations
I-LISTE,[3530] Source #  3    1222+216       50 Observations

Recommended bandpass calibrator 3C84 in scan range 1
Selected bandpass calibrator 3C84 in scan range 1

Selecting calibrators for phase and amplitude calibration...
Sources :
I-LISTE,[3103] Source #  1    NC.           300 Observations
Calibrators :
I-LISTE,[3524] Source #  1    1222+216       42 Observations
The recommended calibrator is   1222+216
which has been adopted for phase and amplitude calibration

USB tuning for receiver 3

CLIC>
```

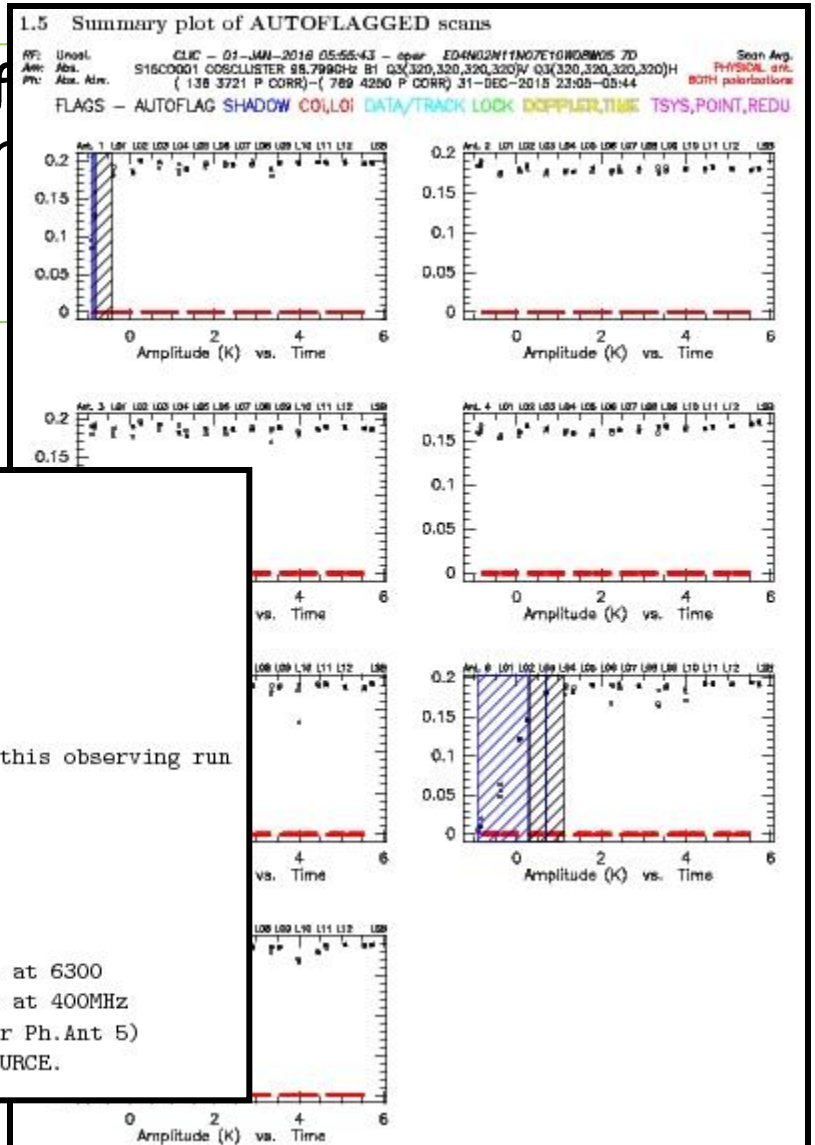
Data analysis: Calibration



AUTOFLAG: Verify in a database if known problems exist in the project and if other features are identified (source not surrounded by calibrators, spectral config change, presence of parasites, etc)

Data analysis: Calibration

AUTOFLAG: Verify in a database if the project and if other features ar surrounded by calibrators, spectral of parasites, etc)



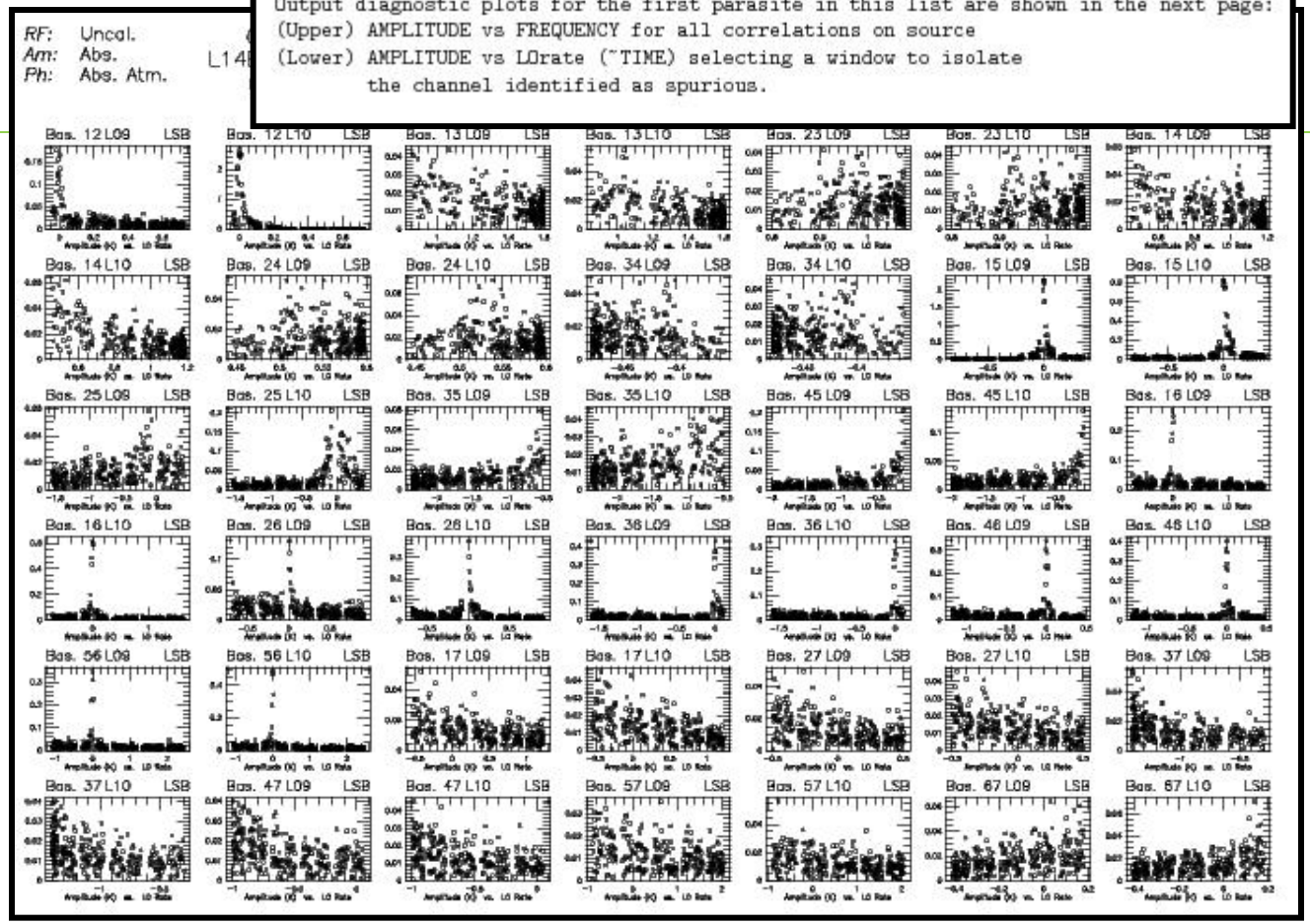
1.4 Calibration warnings:

```
! Spurious lines of unknown origin are detected in:
! Ant Nar/Wid  I_F freq   SKY freq  IF1 freq  IF2 freq  IF3 freq
!  #  cor_unit    MHz        MHz       MHz       MHz       MHz
   6   W  2    2868.16   134411.69   5231.84   2868.16   2868.16
   6   W  2    2870.12   134413.64   5229.88   2870.12   2870.12

 Possible spurious signals are identified in AUTOCORRELATIONS during this observing run
   6   W  2    2870.12   134413.64   5229.88   2870.12   2870.12
   6   W  2    2872.07   134415.59   5227.93   2872.07   2872.07
   6   W  2    2874.02   134417.55   5225.98   2874.02   2874.02
   3   W  4    2221.68   131965.20   7678.32   2221.68   2221.68
   3   W  4    2223.63   131967.16   7676.37   2223.63   2223.63
!
! Also, some known spurious lines triggered by the IF processor exist at 6300
! & 4500MHz IF1 freqs (at ~  133343.19 & 135143.19MHz), and sometimes at 400MHz
! from those (eg. at 6700MHZ IF1 freq [~ 132943.19 MHz in the sky] for Ph.Ant 5)
 NO spurious signals are identified in the average CORRELATIONS ON SOURCE.
```

Data analysis: Calibration

AUTOFLAG: Veri
the project and if
(source
change,

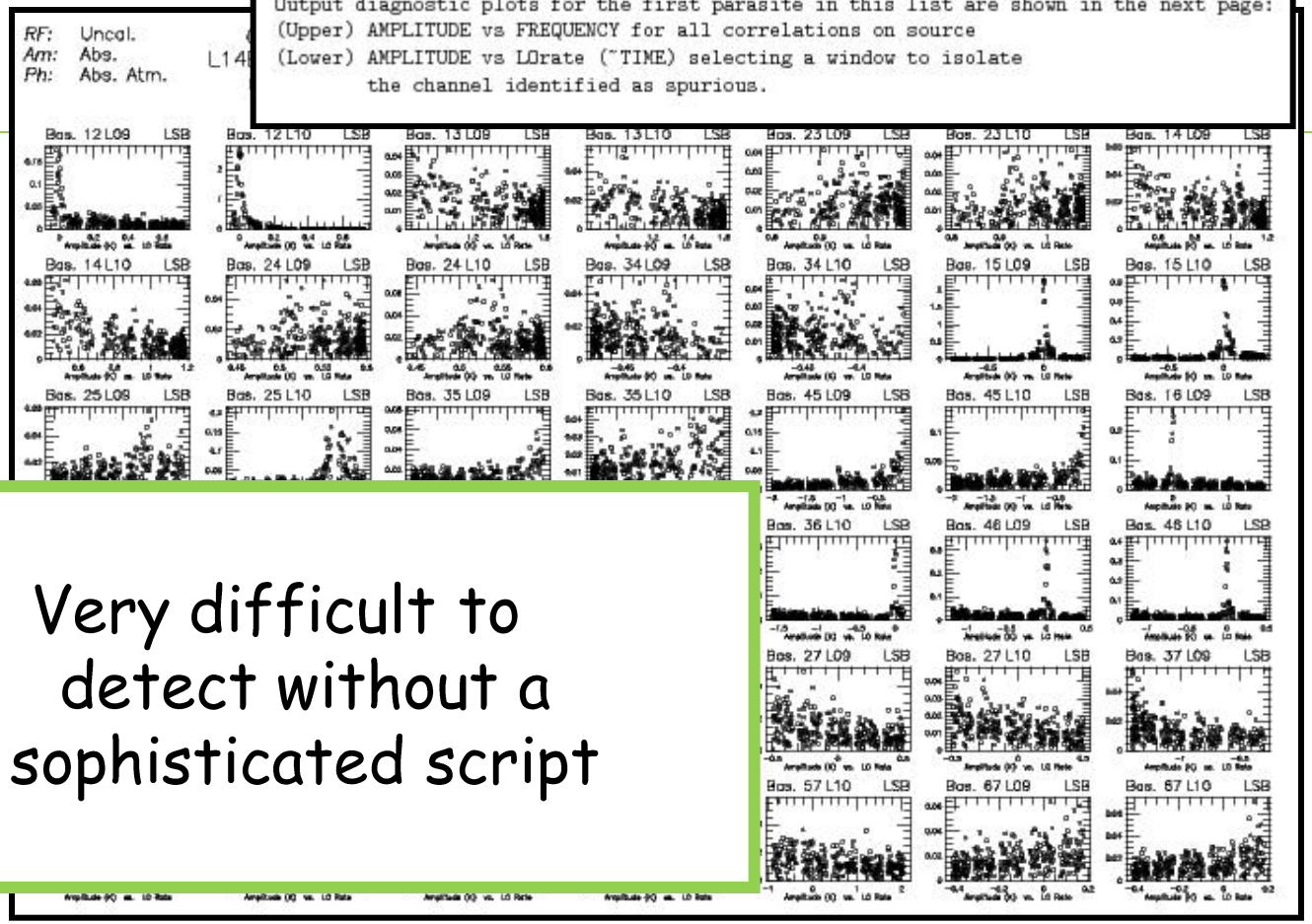
```
 Spurious signals are identified in the average CORRELATIONS ON SOURCE.
 Lines falling at the parasites frequencies should be carefully checked.
! Parasite search ONLY in WIDEX units (may be seen in other subbands)
!WIDEX  CHAN  IF1 freq    SKY freq   AMPvsFREQ  S/N AMPvsLORATE  S/N   LO_RATE(MAX)
!                MHz         MHz      # found         #found
LO9L10   179   5751.37   138748.81          4   24          12  269           0.00
 Output diagnostic plots for the first parasite in this list are shown in the next page:
 (Upper) AMPLITUDE vs FREQUENCY for all correlations on source
 (Lower) AMPLITUDE vs LOrate (~TIME) selecting a window to isolate
         the channel identified as spurious.
```



Data analysis: Calibration

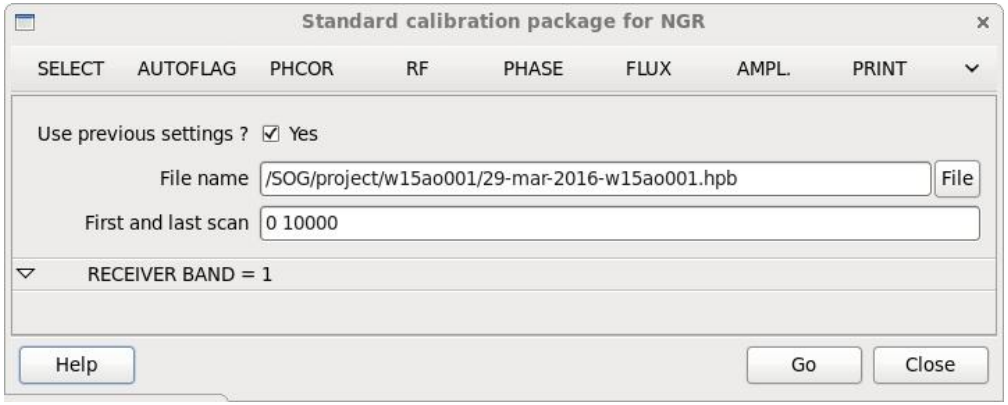
AUTOFLAG: Ver
the project and if
(source
change,

```
 Spurious signals are identified in the average CORRELATIONS ON SOURCE.
 Lines falling at the parasites frequencies should be carefully checked.
! Parasite search ONLY in WIDEX units (may be seen in other subbands)
!WIDEX  CHAN  IF1 freq    SKY freq   AMPvsFREQ  S/N AMPvsLORATE  S/N   LO_RATE(MAX)
!               MHz         MHz      # found         #found
L09L10   179   5751.37   138748.81          4   24          12  269           0.00
 Output diagnostic plots for the first parasite in this list are shown in the next page:
 (Upper) AMPLITUDE vs FREQUENCY for all correlations on source
 (Lower) AMPLITUDE vs LOrate (~TIME) selecting a window to isolate
         the channel identified as spurious.
```



Very difficult to detect without a sophisticated script

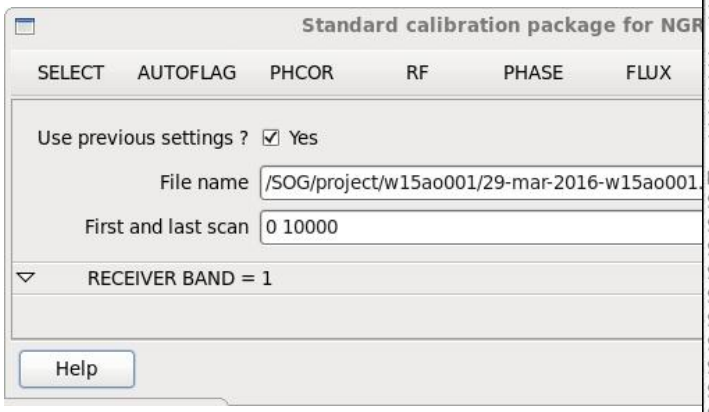
Data analysis: Calibration



PHCOR: Verify the quality of the WVR correction

Also, a polarization assessment is made for the phase calibrators, which will determine the mode for the Amplitude calibration

Data analysis: Calibration



PHCOR: Verify the quality

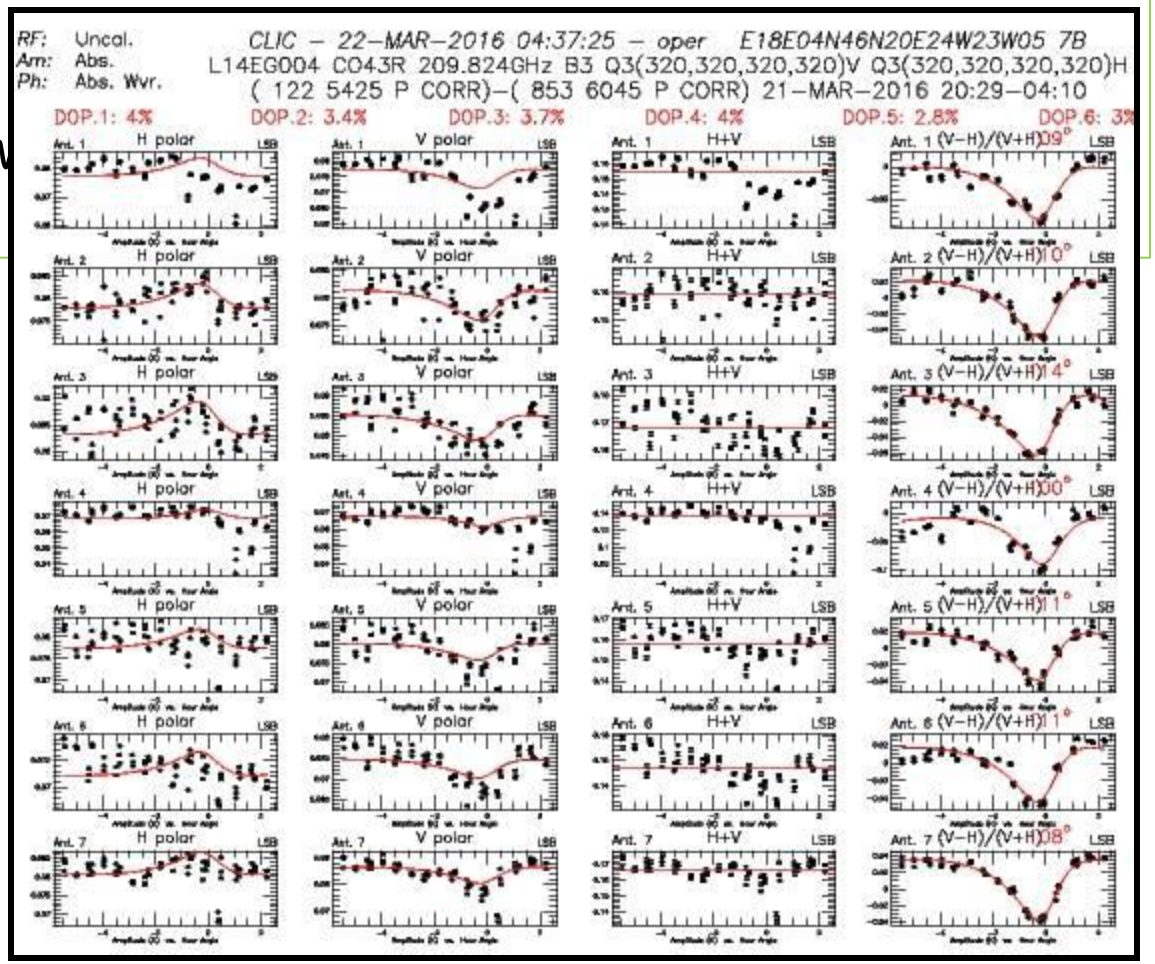
Also, a polarization assessm
calibrators, which will deter
calibration

```
CLIC>
I-CLIC_SET,[3038] Polarization mode: BOTH
 Selected data quality is   8 (Worst)
I-CLIC_MASK,[3530] Masked - Ant 1: SATURATI SHADOW, Ant 2: SATURATI SHADOW, Ant
I-CLIC_MASK,[3530] 5: SATURATI SHADOW, Ant 6: SATURATI SHADOW, Ant 7: SATURATI
I-STORE_CORRECTION,[3530] Using 0.050 as a fraction of amplitude for threshold
I-CLIC_MASK,[3524] Masked - no flags

Real-time atmospheric phase correction
Scans 3050 to 3050 : phase correction disabled (ant  1 2 3)
Scans 3051 to 3051 : phase correction disabled (ant  2 5 6 7)
Scans 3052 to 3052 : phase correction disabled (ant  1 2 3 4)
Scans 3054 to 3054 : phase correction disabled (ant  1 2 3 4 6 7)
Scans 3055 to 3055 : phase correction disabled (ant  6 7)
Scans 3056 to 3056 : phase correction disabled (ant  2 3 4 6 7)
Scans 3066 to 3066 : phase correction disabled (ant  2 7)
Scans 3069 to 3069 : phase correction disabled (ant  2 3 7)
Scans 3100 to 3100 : phase correction disabled (ant  1 2 3)
Scans 3106 to 3111 : phase correction disabled (ant  1 2 3)
Scans 3112 to 3112 : phase correction disabled (ant  1 2 3 6 7)
Scans 3113 to 3135 : phase correction disabled (ant  1 2 3 4 6 7)
Scans 3139 to 3139 : phase correction disabled (ant  1 2 6 7)
Scans 3140 to 3140 : phase correction disabled (ant  2 3 4 6 7)
Scans 3530 to 3530 : phase correction disabled (ant  2 7)

Ant. 1: real-time phase correction based on 22 GHz WVR
Ant. 2: real-time phase correction based on 22 GHz WVR
Ant. 3: real-time phase correction based on 22 GHz WVR
Ant. 4: real-time phase correction based on 22 GHz WVR
Ant. 5: real-time phase correction based on 22 GHz WVR
Ant. 6: real-time phase correction based on 22 GHz WVR
Ant. 7: real-time phase correction based on 22 GHz WVR
Checking for interference in WVR channels ...
 Y axis  : DH_WVR1 (CTS)       , * to  *
 Y axis  : DH_WVR2 (CTS)       , * to  *
 Y axis  : DH_WVR3 (CTS)       , * to  *
 All antennas selected:
 Logical | Physical | Station |  X Offset  |  Y Offset  |  Z Offset /99
    1    |    1     |   E04   |  -0.000000 |   0.000000 |   0.000000
    2    |    2     |   N02   |  -0.000692 |  -0.001628 |   0.001929
    3    |    3     |   N11   |   0.001134 |   0.001636 |  -0.000213
    4    |    4     |   N07   |   0.001731 |  -0.000648 |  -0.000923
    5    |    5     |   E10   |   0.001597 |   0.002325 |   0.001269
    6    |    6     |   W08   |   0.001015 |   0.001247 |  -0.002045
    7    |    7     |   W05   |   0.000740 |   0.001418 |  -0.000059
  0 in  364 scans
```

Data analysis: Calibration

PHCOR: Verify the quality of the WVR correction

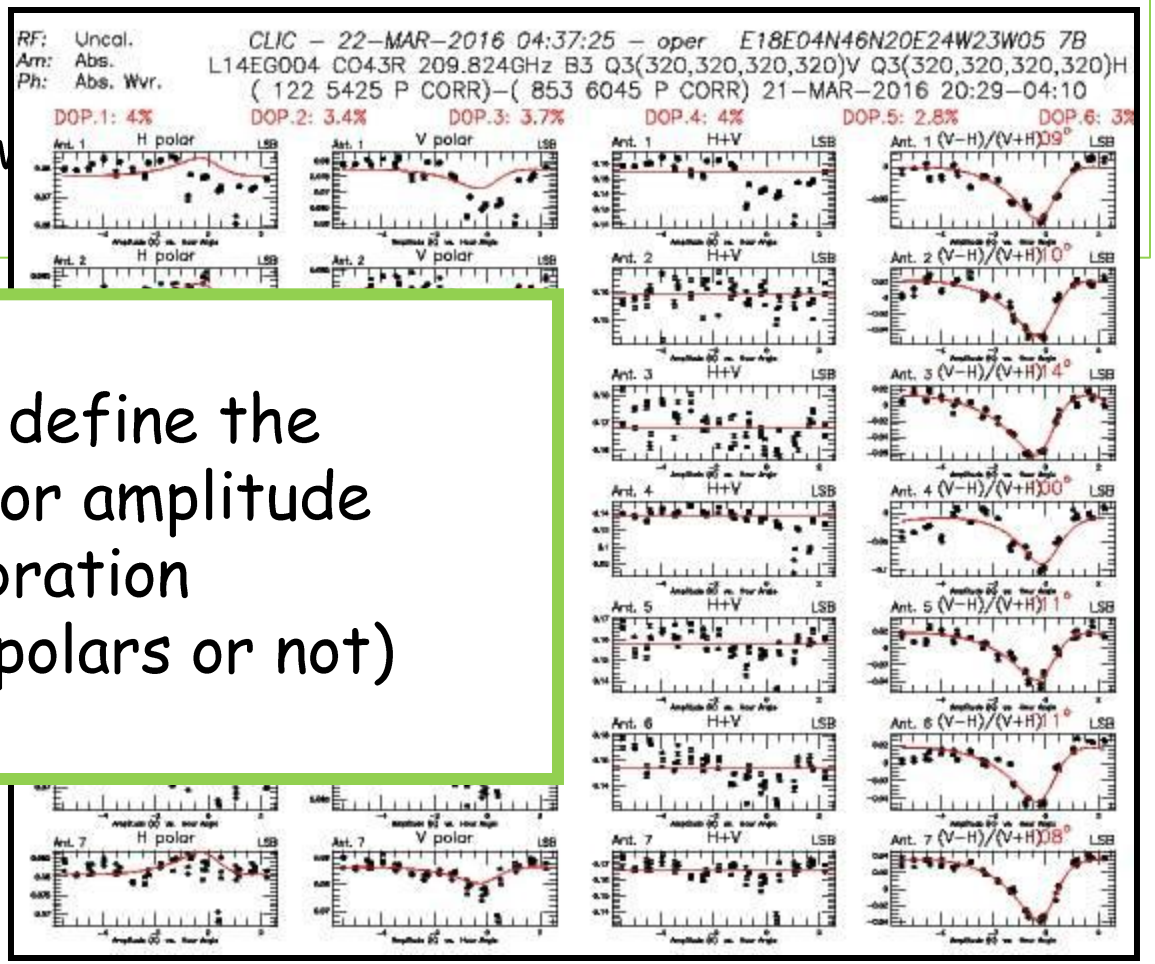
Also, a polarization
calibrators, which w
calibration



Data analysis: Calibration

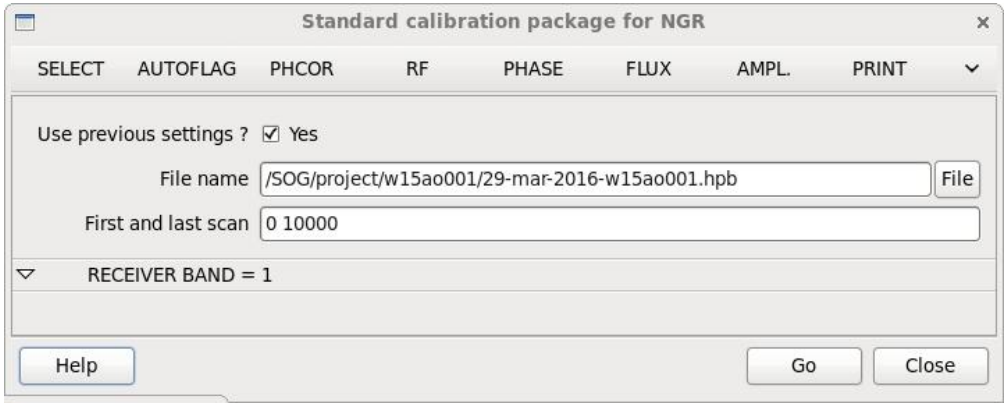
PHCOR: Verify the quality of the WVR correction

Also, a polarization
calibrators, which w
calibration



This will define the strategy for amplitude calibration (averaging polars or not)

Data analysis: Calibration



RF: Measure the receiver bandpass (RF) to calibrate the source data, for every spectral calibration unit (narrow and widex) and tuning (gain) range.

The selected RF calibrator in variable "band_source".

Possible parasites (instrumental or lines from calibrators) are searched and removed from calibration .

Data analysis: Calibration

RF:

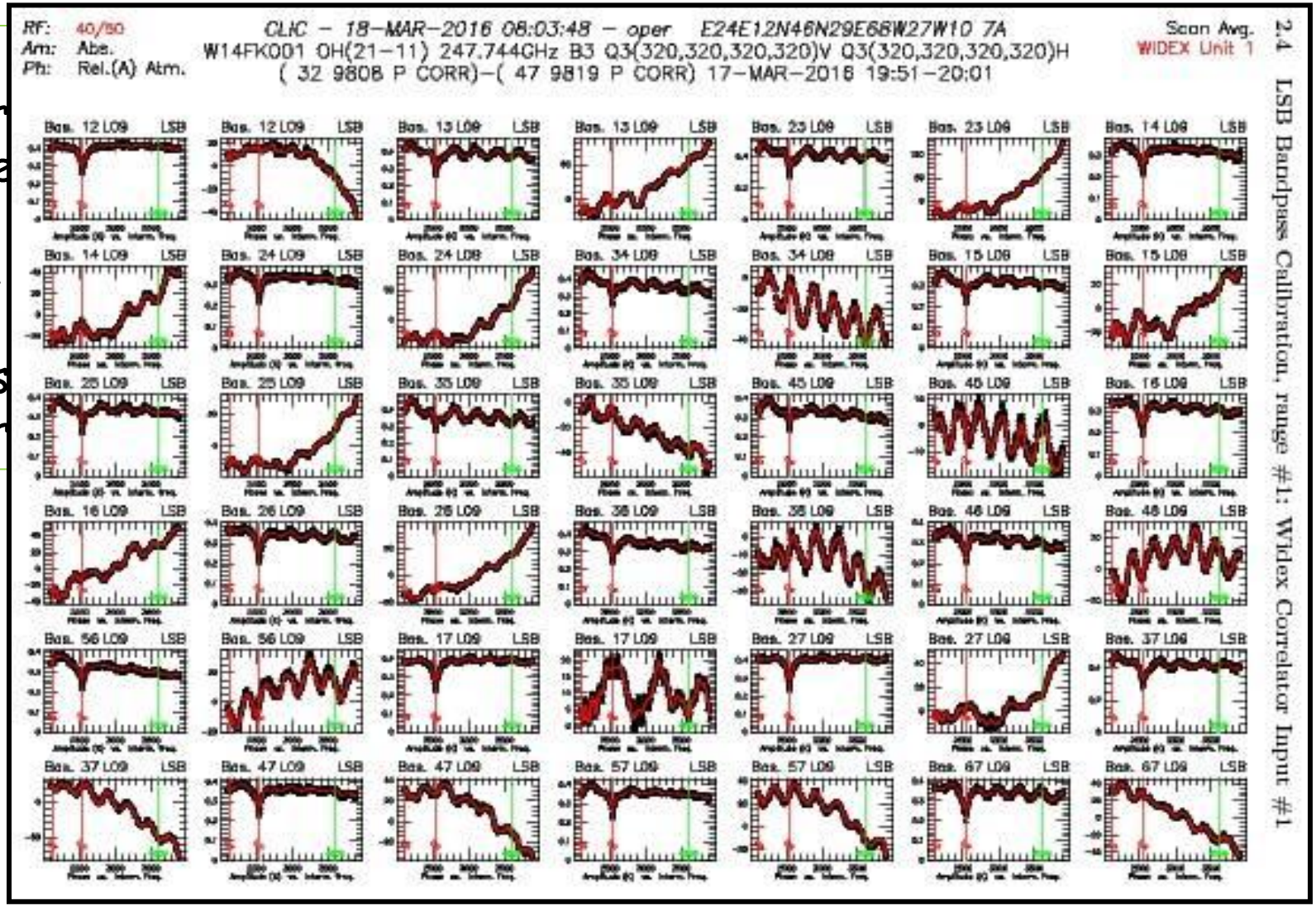
sour

wide

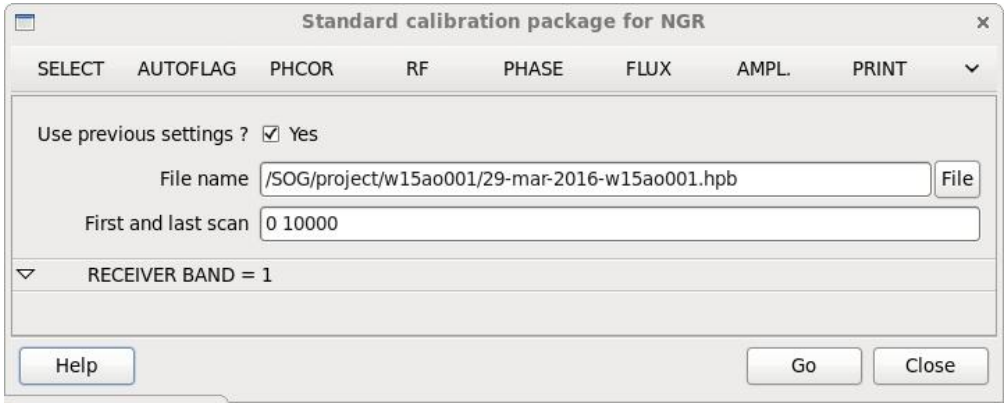
The

Poss

sear



Data analysis: Calibration



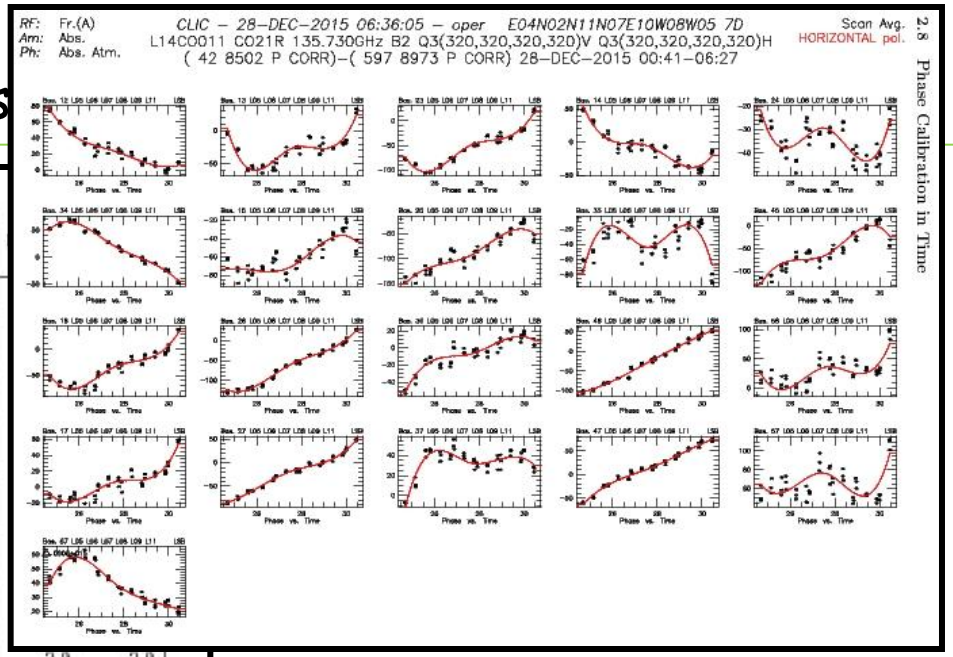
Phase: Remove instrumental phases in time by observing a close point-like source (phase=0).

A solution is searched per polarization or, if not satisfactory, for averaged polarizations

Data analysis: Calibration

Phase: Remove instrumental phases in time by observing a close point-like source (phase=0).

A solution is searched averaged polarizations



1.6 Time Calibration:

	Receiver 3	Phase r.m.s. Polar H (deg.)	Phase r.m.s. Polar V (deg.)	H−V Mean (deg.)	H−V Max. (deg.)		
Base 12	(112.0 m)	23.5	23.1	1.2	√		
Base 13	(428.0 m)	39.6	39.6	2.6	√		
Base 23	(378.0 m)	41.0	41.2	1.3	√		
Base 14	(241.0 m)	26.3	26.2	-0.2	√		
Base 24	(171.0 m)	22.9	22.9	-1.4	√		
Base 34	(208.0 m)	30.0	29.9	-2.7	√		
Base 15	(48.0 m)	13.6	13.8	-3.2	√		
Base 25	(160.0 m)	30.9	30.9	-4.5	√		
Base 35	(457.0 m)	40.9	40.9	-5.8	√		
Base 45	(280.0 m)	30.7	30.8	-3.0	√		
Base 16	(328.0 m)	37.7	37.8	0.5	√		
Base 26	(216.0 m)	31.3	31.4	-0.8	√		
Base 36	(366.0 m)	47.2	47.2	-2.1	√		
Base 46	(210.0 m)	29.7	29.8	0.7	√		
Base 56	(376.0 m)	43.4	43.8	3.7	√		
Base 17	(184.0 m)	25.5	25.4	-3.2	√		
Base 27	(72.0 m)	13.1	13.1	-4.4	√	2.9	2.9
Base 37	(360.0 m)	37.7	37.6	-5.8	√	3.2	3.2
Base 47	(155.0 m)	20.0	20.1	-3.0	√	4.3	4.3
Base 57	(232.0 m)	32.3	32.3	0.0	√	3.5	3.5
Base 67	(144.0 m)	23.4	23.6	-3.7	√	3.2	3.2

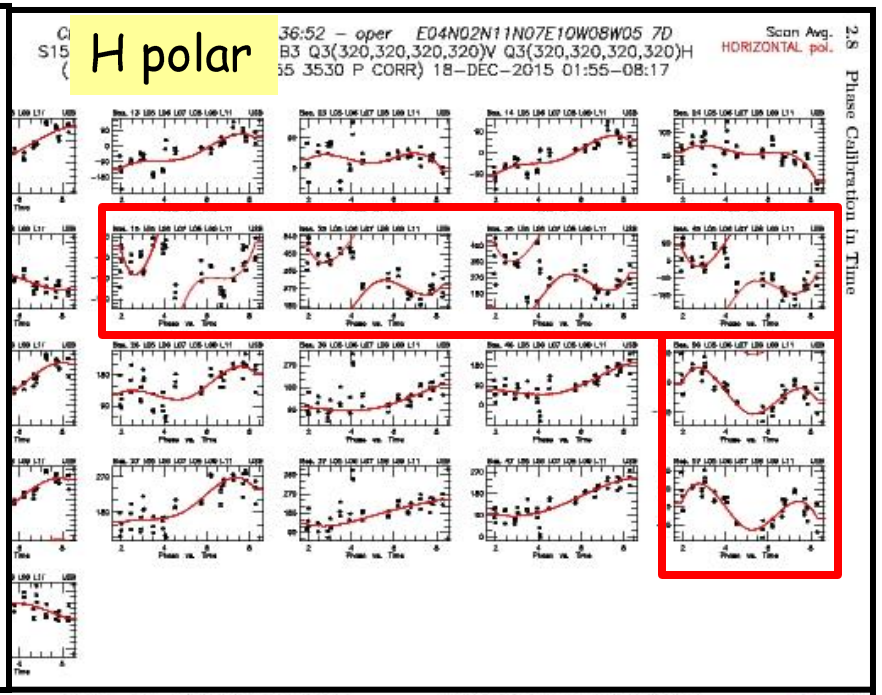
* Average of the H- and V-amplitudes

1.7 Time Calibration:†

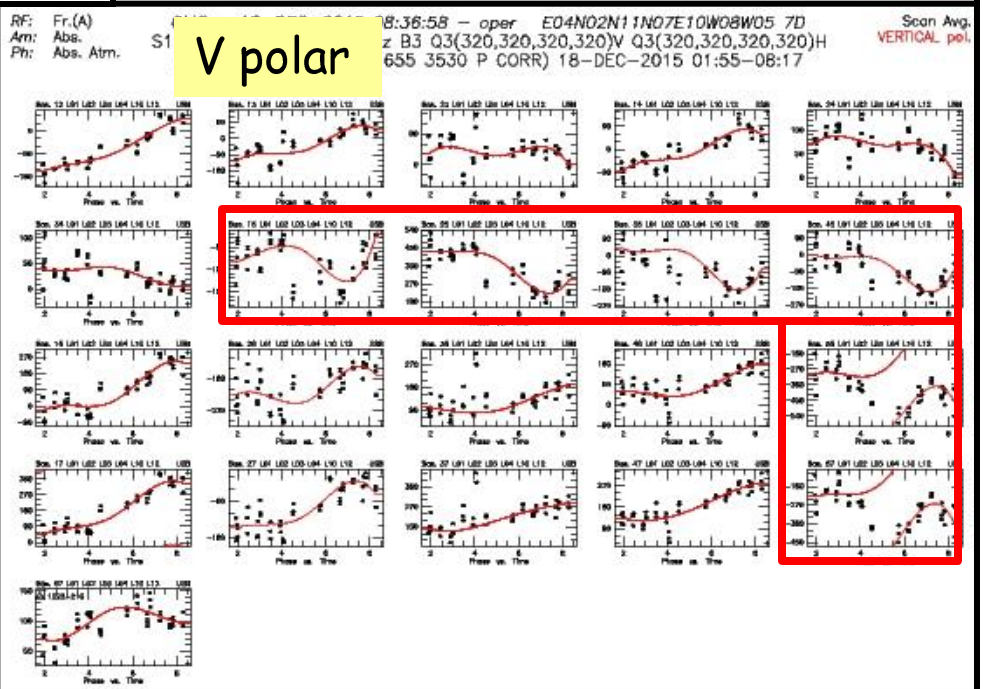
	Receiver 3	Phase r.m.s. Polar H (deg.)	Phase r.m.s. Polar V (deg.)	H−V Mean (deg.)	H−V Max. (deg.)	Ampl. Polar H (%)	Ampl. Polar V (%)
Base 12	(39.0 m)	26.0	26.1	7.	√	11.2	11.4
Base 13	(101.0 m)	49.4	49.0	-1.	√	9.3	9.1
Base 23	(72.0 m)	38.3	38.5	-9.	√	12.1	11.2
Base 14	(71.0 m)	30.5	30.0	-6.	√	9.6	11.8
Base 24	(40.0 m)	21.4	21.5	-13.	√	12.5	11.9
Base 34	(32.0 m)	24.1	23.4	-4.	√	12.0	11.9
Base 15	(48.0 m)	46.8	37.4	14.	170.2	8.7	9.5
Base 25	(86.0 m)	48.4	53.3	6.	179.1	14.8	16.1
Base 35	(133.0 m)	65.2	70.9	-20.	169.0	12.6	12.0
Base 45	(109.0 m)	52.1	56.1	20.	165.1	13.0	13.7
Base 16	(96.0 m)	47.6	47.3	0.	√	10.3	11.0
Base 26	(62.0 m)	35.4	36.1	-6.	√	14.5	14.8
Base 36	(94.0 m)	49.9	50.1	2.	√	10.6	11.5
Base 46	(73.0 m)	38.4	38.6	6.	√	11.4	11.7
Base 56	(144.0 m)	50.9	69.1	-27.	176.6	11.2	12.8
Base 17	(72.0 m)	36.2	36.2	-42.	√	10.7	10.2
Base 27	(39.0 m)	26.9	26.4	-50.	51.7	11.7	11.4
Base 37	(87.0 m)	47.7	47.7	-41.	√	10.8	10.4
Base 47	(60.0 m)	31.1	31.4	-36.	√	10.3	11.1
Base 57	(120.0 m)	46.5	63.6	-57.	157.2	11.8	13.1
Base 67	(24.0 m)	16.1	15.7	-43.	46.1	8.3	8.9

† Phase calibration averaged on H- and V-phases

H polar



V polar



1.7 Time Calibration:†

	Receiver 3	Phase r.m.s. Polar H (deg.)	Phase r.m.s. Polar V (deg.)	H−V Mean (deg.)	H−V Max. (deg.)	Ampl. Polar H (%)	Ampl. Polar V (%)
Base 12	(39.0 m)	26.0	26.1	7.	√	11.2	11.4
Base 13	(101.0 m)	49.4	49.0	-1.	√	9.3	9.1
Base 23	(72.0 m)	38.3	38.5	-9.	√	12.1	11.2
Base 14	(71.0 m)	30.5	30.0	-6.	√	9.6	11.8
Base 24	(40.0 m)	21.4	21.5	-13.	√	12.5	11.9
Base 34	(32.0 m)	24.1	23.4	-4.	√	12.0	11.9
Base 15	(48.0 m)	46.8	37.4	14.	170.2	8.7	9.5
Base 25	(86.0 m)	48.4	53.3	6.	179.1	14.8	16.1
Base 35	(133.0 m)	65.2	70.9	-20.	169.0	12.6	12.0
Base 45	(109.0 m)	52.1	56.1	20.	165.1	13.0	13.7
Base 16	(96.0 m)	47.6	47.3	0.	√	10.3	11.0
Base 26	(62.0 m)	35.4	36.1	-6.	√	14.5	14.8
Base 36	(94.0 m)	49.9	50.1	2.	√	10.6	11.5
Base 46	(73.0 m)	38.4	38.6	6.	√	11.4	11.7
Base 56	(144.0 m)	50.9	69.1	-27.	176.6	11.2	12.8
Base 17	(72.0 m)	36.2	36.2	-42.	√	10.7	10.2
Base 27	(39.0 m)	26.9	26.4	-50.	51.7	11.7	11.4
Base 37	(87.0 m)	47.7	47.7	-41.	√	10.8	10.4
Base 47	(60.0 m)	31.1	31.4	-36.	√	10.3	11.1
Base 57	(120.0 m)	46.5	63.6	-57.	157.2	11.8	13.1
Base 67	(24.0 m)	16.1	15.7	-43.	46.1	8.3	8.9

† Phase calibration averaged on H- and V-phases

H polar.

Scan Avg. HORIZONTAL pol.

Phase Calibration in Time

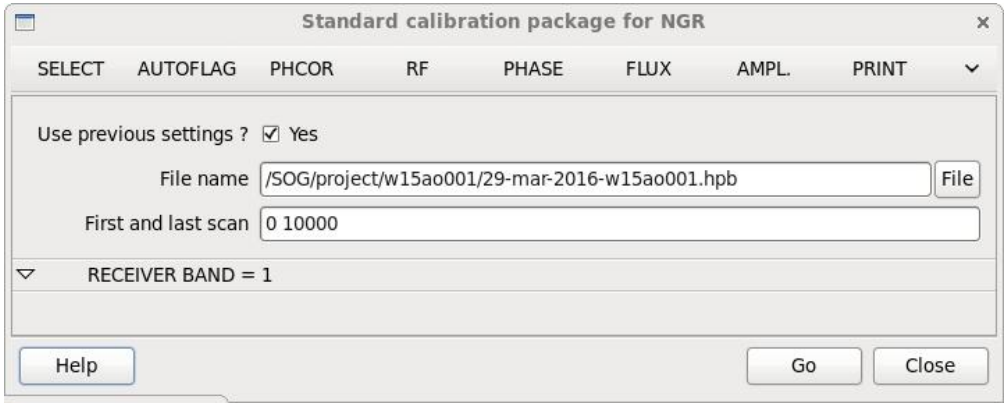
Averaged polar.

BOTH polarizations

V polar.

Scan Avg. VERTICAL pol.

Data analysis: Calibration



Flux: MWC349 and LKH401 are the current absolute references for NOEMA.

The acquisitions with less decorrelation are used as reference for flux calibration, removing possible contaminating lines

A monitoring of efficiencies is made to evaluate the validity of the flux calibration.

Data analysis: Calibration

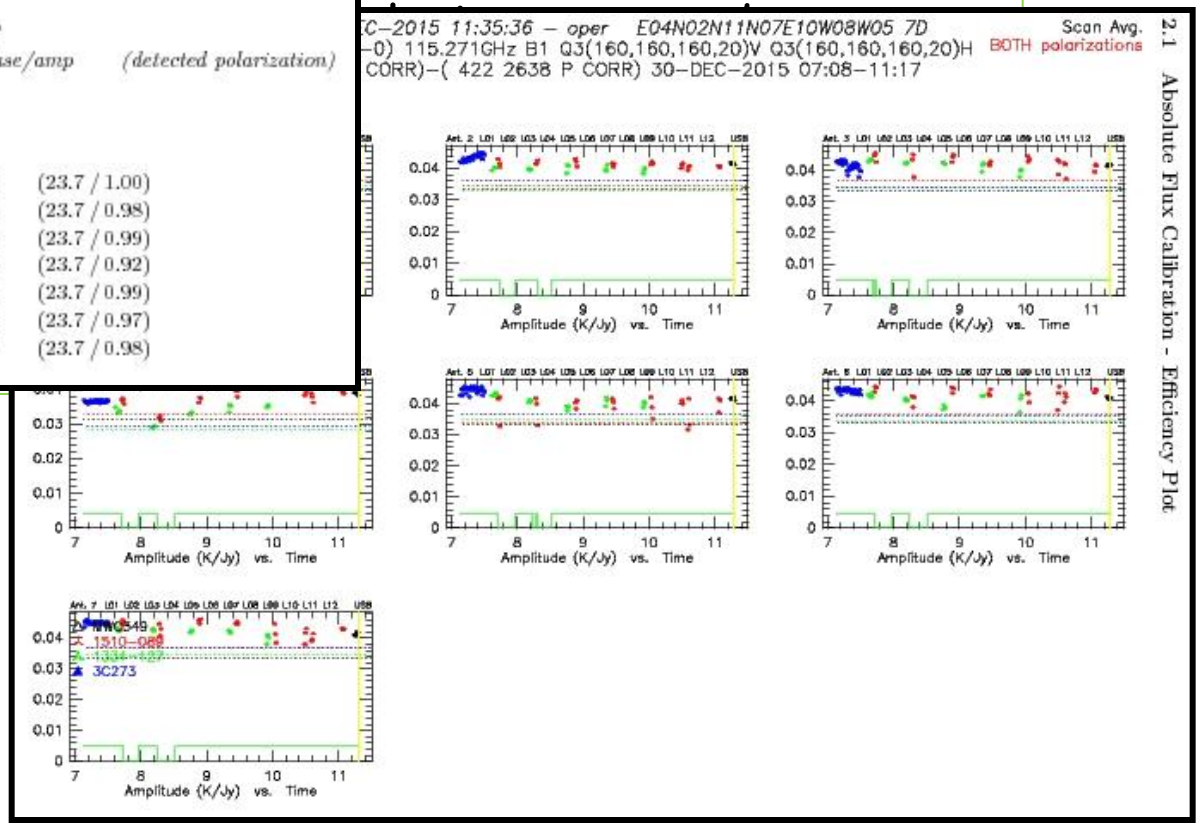
Flux: MWC349 and LKH401 are the current absolute references for NOEMA

1.1 Calibrators

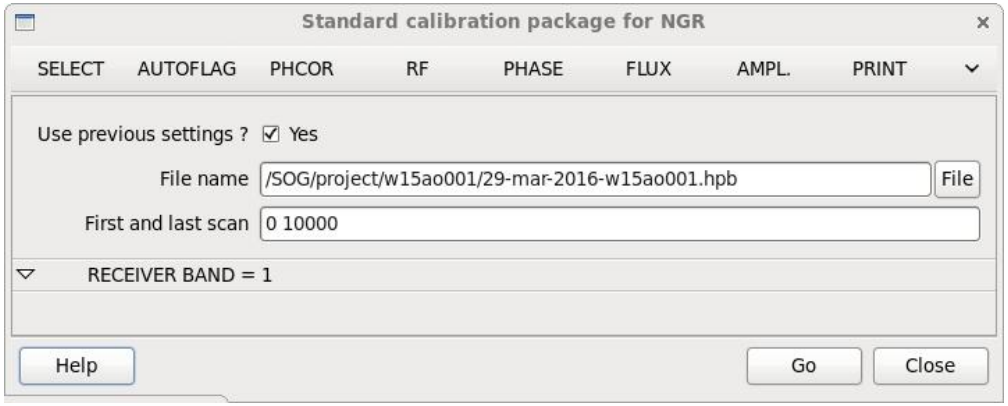
Name	Flux (Jy) @115.3 GHz		Calibration	
3C273	13.99	*Computed*		
1334-127	3.18	*Computed*	*RF*	
1510-089	4.83	*Computed*	*phase/amp*	*(detected polarization)*
MWC349	1.26	*Fixed (model = 1.26)*		

1.2 Efficiencies

Antenna 1 (A1)	23.6	Jy/K	(23.7 / 1.00)
Antenna 2 (A2)	24.1	Jy/K	(23.7 / 0.98)
Antenna 3 (A3)	23.9	Jy/K	(23.7 / 0.99)
Antenna 4 (A4)	25.7	Jy/K	(23.7 / 0.92)
Antenna 5 (A5)	24.0	Jy/K	(23.7 / 0.99)
Antenna 6 (A6)	24.4	Jy/K	(23.7 / 0.97)
Antenna 7 (A7)	24.2	Jy/K	(23.7 / 0.98)



Data analysis: Calibration

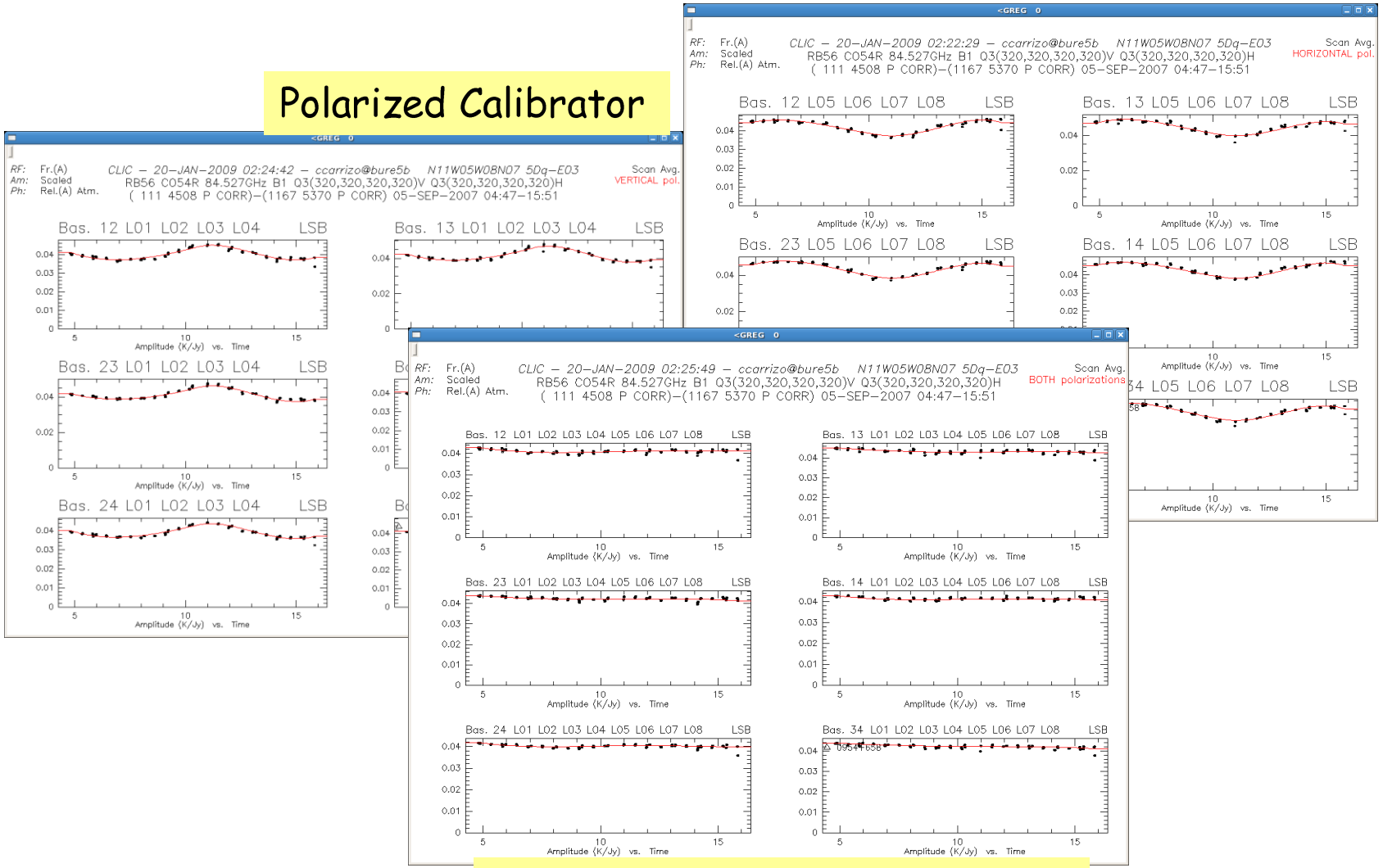


Ampl: Remove instrumental amplitudes in time by observing a close point-like source (constant amplitude).

Polarizations are averaged if phase calibrators are found to be polarized.

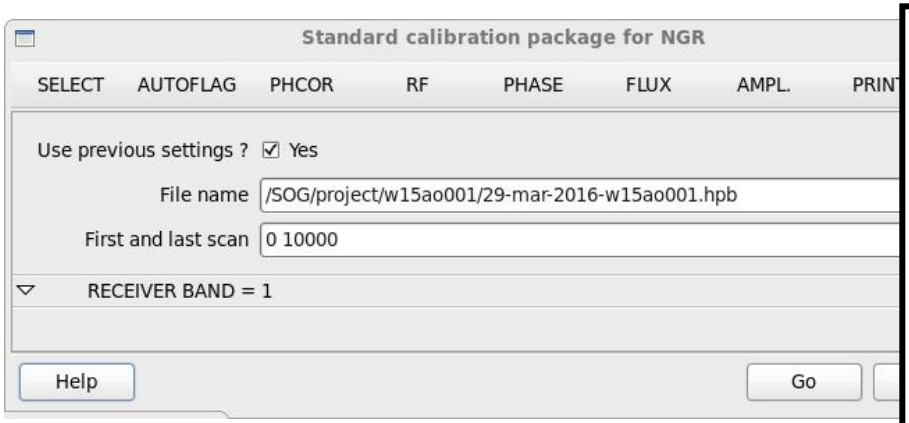
Data analysis: Calibration

Polarized Calibrator

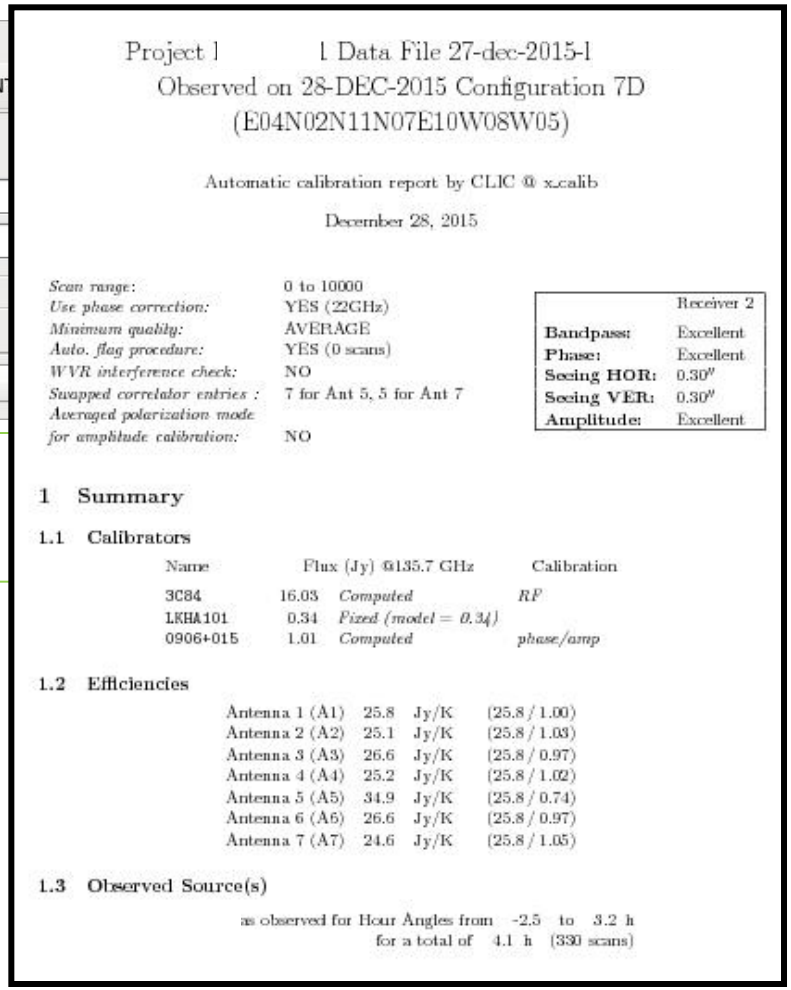


Pipeline choice: Averaged Polar

Data analysis: Calibration



Print: Print in a report the summary of choices and results



Project 1 1 Data File 27-dec-2015-1
Observed on 28-DEC-2015 Configuration 7D
(E04N02N11N07E10W08W05)

Automatic calibration report by CLIC @ x_calib

December 28, 2015

Scan range:	0 to 10000
Use phase correction:	YES (22GHz)
Minimum quality:	AVERAGE
Auto. flag procedure:	YES (0 scans)
WVR interference check:	NO
Swapped correlator entries :	7 for Ant 5, 5 for Ant 7
Averaged polarization mode for amplitude calibration:	NO

	Receiver 2
Bandpass:	Excellent
Phase:	Excellent
Seeing HOR:	0.30″
Seeing VER:	0.30″
Amplitude:	Excellent

1 Summary

1.1 Calibrators

Name	Flux (Jy) @135.7 GHz		Calibration
3C84	16.03	*Computed*	*RF*
LKHA101	0.34	*Fixed (model = 0.34)*	
0906+015	1.01	*Computed*	*phase/amp*

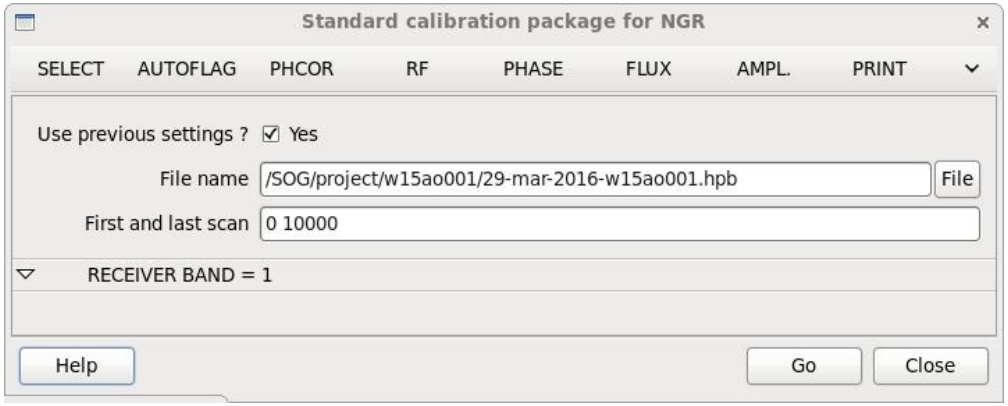
1.2 Efficiencies

Antenna 1 (A1)	25.8	Jy/K	(25.8 / 1.00)
Antenna 2 (A2)	25.1	Jy/K	(25.8 / 1.03)
Antenna 3 (A3)	26.6	Jy/K	(25.8 / 0.97)
Antenna 4 (A4)	25.2	Jy/K	(25.8 / 1.02)
Antenna 5 (A5)	34.9	Jy/K	(25.8 / 0.74)
Antenna 6 (A6)	26.6	Jy/K	(25.8 / 0.97)
Antenna 7 (A7)	24.6	Jy/K	(25.8 / 1.05)

1.3 Observed Source(s)

as observed for Hour Angles from -2.5 to 3.2 h
for a total of 4.1 h (330 scans)

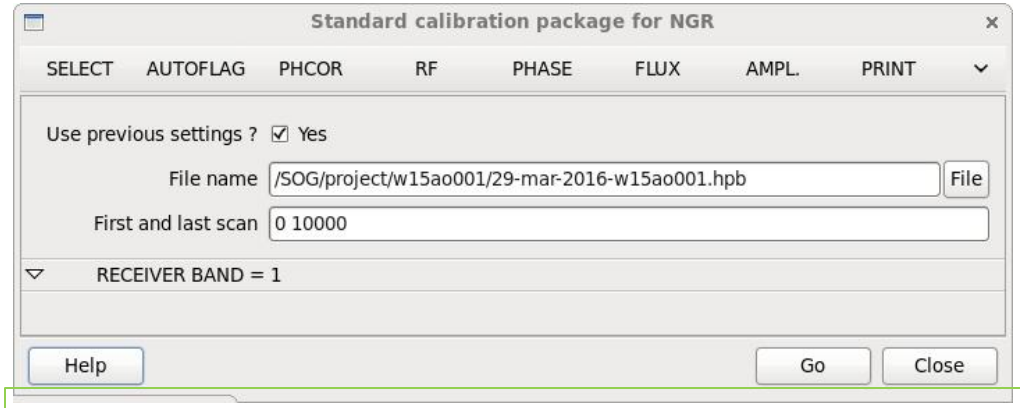
Other cases : Calibration



Repetition of a step after the Pipeline Calibration:

- Click on Select at first
- Click on the Calibration Step to repeat
- Go one by one through all the following steps

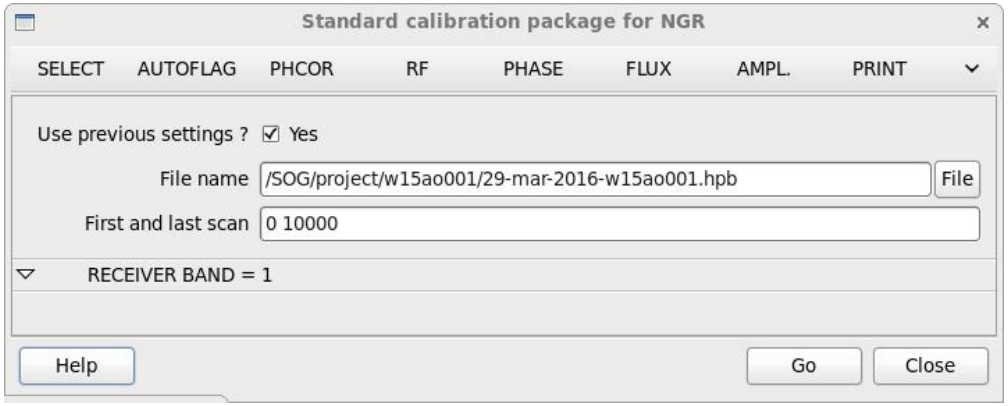
Other cases : Calibration



If some data are corrupted:

- Create a new hpb without those, or erase the corrupted data in the previous one (ex: find /scan #, store quality 9)
- Launch the "Pipeline" on the same track, or click on GO in the Standard Calibration

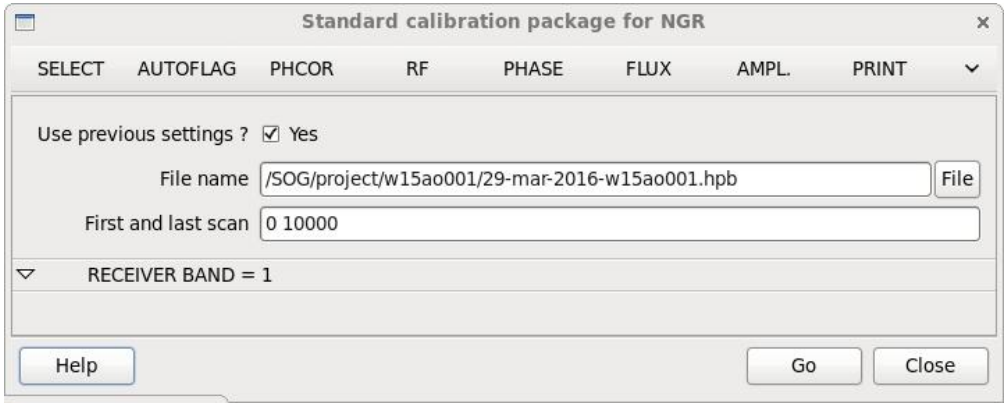
Other cases : Calibration



If a new baseline model is to be applied:

- Introduce the new baseline model in the hpb
- Launch the "Pipeline" on the same file

Other cases : Calibration



The pipeline can also be executed with new Settings:

- Repeat @pipeline

  or
- GO in Standard Calibration widget

Advice with "@pipeline": Calibration

If the pipeline is running :

do not stop it, or exit CLIC if you did it

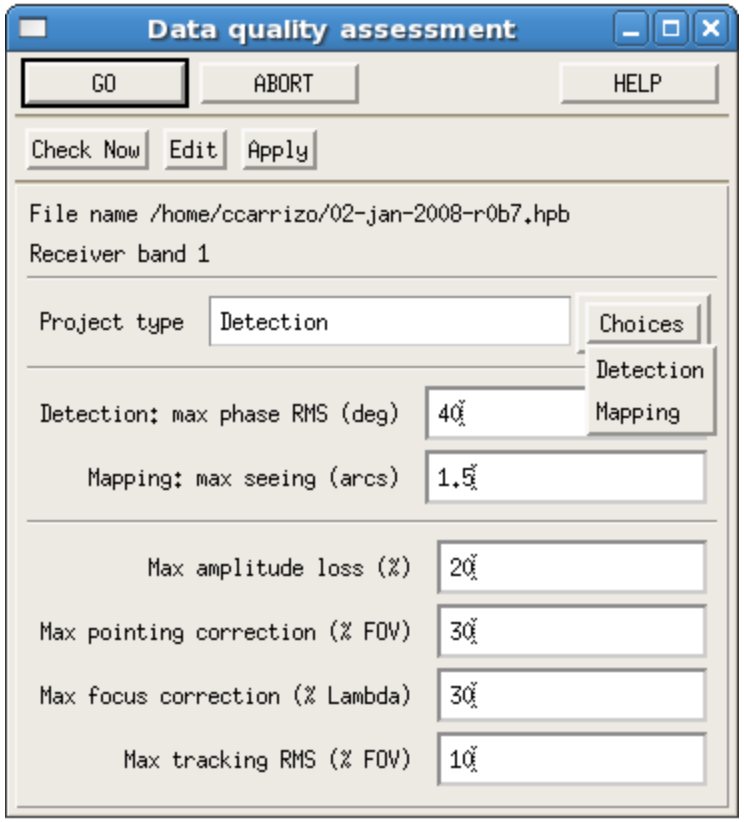
Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

With **@pipeline 'project' 'date'** four blocks are executed, in the following order:

1. Observing conditions (IPB)
2. Data calibration (IPB+hpb)
3. **Visibility assessment (IPB+hpb)**
4. Imaging assessment (uvt+lmv-clean ; only @ Bure)

A document of ~ 60-70 pages is created to show at first data calibration (2), secondly a complete review of observing conditions (1), and at third a visibility assessment (3)

Data analysis: Visibility Assessment



- Evaluation of the data quality in the UV plane, and flagging those data that do not satisfy defined quality limits
- Criteria are different for Detection and Mapping projects, but don't hesitate to adapt the default parameters to the needs of your project
- A report is created, and proposed flags are applied by the pipeline

Data analysis: Visibility Assessment

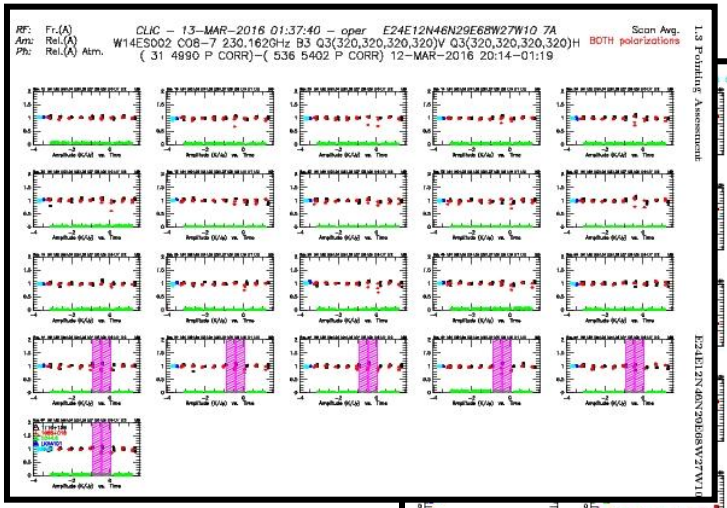
Project L14EG004
Observed on 21-MAR-2016

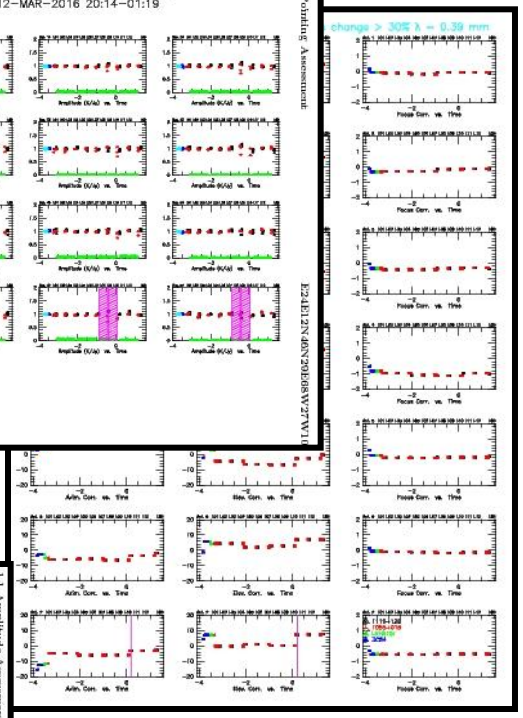
Automatic Visibility Quality Assessment Report
by CLIC @x_visi

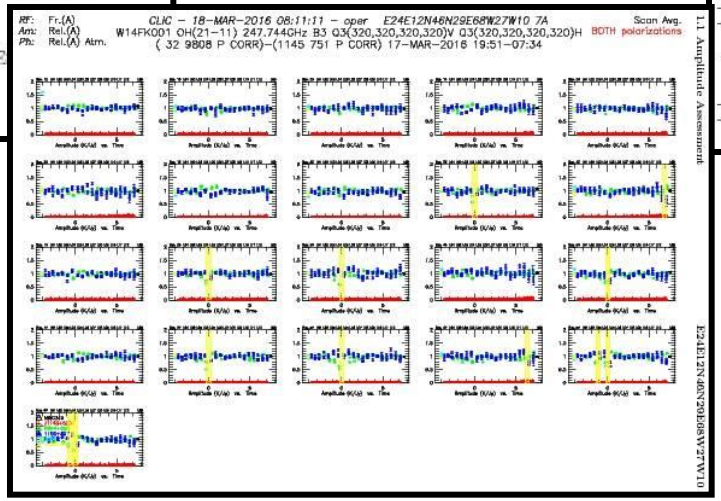
March 22, 2016

Project type:	MAPPING
Seeing limit:	$\leq 1''$
Amplitude loss:	$\leq 31.7\%$
Pointing error:	$\leq 30\%$ (FOV) $\simeq 7.2''$
Focus error:	$\leq 30\%$ (λ) $\simeq 0.4$ mm
Tracking error:	$\leq 10\%$ (FOV) $\simeq 2.4''$

Configuration(s): 1. E18E04N46N20E







Data analysis: from raw data to image (IPB -> hpb -> uvt -> lmv-clean)

With **@pipeline 'project' 'date'** four blocks are executed, in the following order:

1. Observing conditions (IPB)
2. Data calibration (IPB+hpb)
3. Visibility assessment (IPB+hpb)
4. Imaging assessment (uvt+lmv-clean ; only @ Bure)

A document of ~ 60-70 pages is created to show at first data calibration (2), secondly a complete review of observing conditions (1), and at third a visibility assessment (3)

Data analysis at the observatory: uvt -> lmv-clean

IMAGING ASSESSMENT

At the Observatory launched by '@pipeline' but compiled in independent documents

Automatic Detection Assessment Report by CLIC @ x_calib

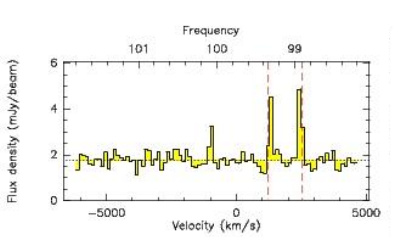
February 15, 2016

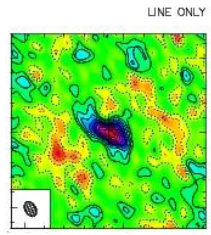
Global Assessment

PREVIOUS TRACKS			CUMULATED TRACKS		
OS time 6-antennas :	5.00	hrs	OS time 6-antennas :	8.67	hrs
OS time 7-antennas :	3.57	hrs	OS time 7-antennas :	6.20	hrs
R noise level :	0.445	mJy	R noise level :	0.240	mJy
I noise level :	0.445	mJy	I noise level :	0.241	mJy
T noise level :	0.376	mJy	T noise level :	0.223	mJy

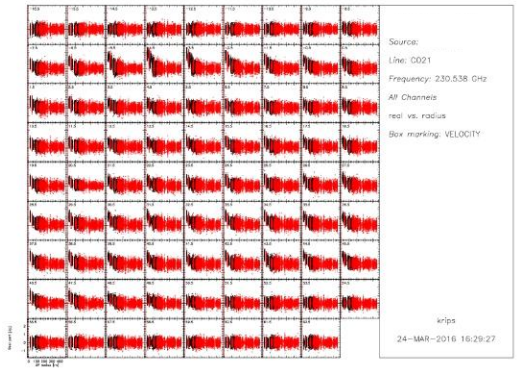
- requested total on-source time for 7 antennas is 5.2 hrs
- median sensitivities are for 40 MHz channels and 2 polarisation(s)
- requested sensitivity is 0.3 mJy for 40 MHz channels
- sensitivities in 33.3 MHz channels are 0.24 mJy (reached) and 0.34 mJy (requested)

Detection Assessment

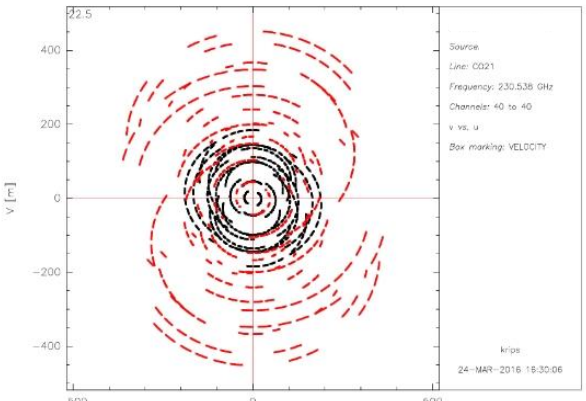




1.1 Data Real-part



1.3 UV Coverage



PIPELINEs in the future:

- With the arrival of Polyfix, a deep review will be made and a new architecture will be defined for the different pipelines. This is also motivated by the increase of data rate, which forces us to develop adapted optimized programs >>> Important changes will happen in the years to come

- A new pipeline working like the one we have today may not be available until many months after the installation of Polyfix.