

# Absolute Flux Calibration

Melanie Krips

(by Arancha Castro-Carrizo)

- I. Primary/Secondary Flux Calibrators
- II. Practical Tips to Calibrate the Fluxes of your Sources

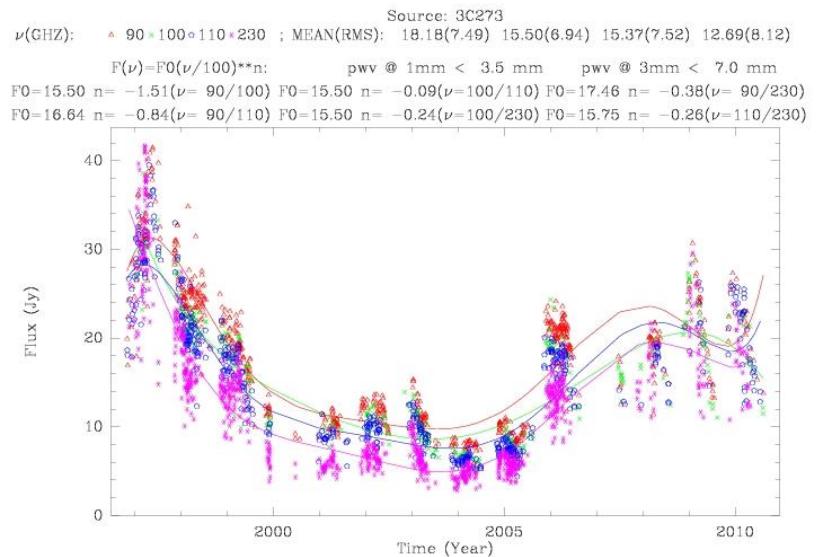
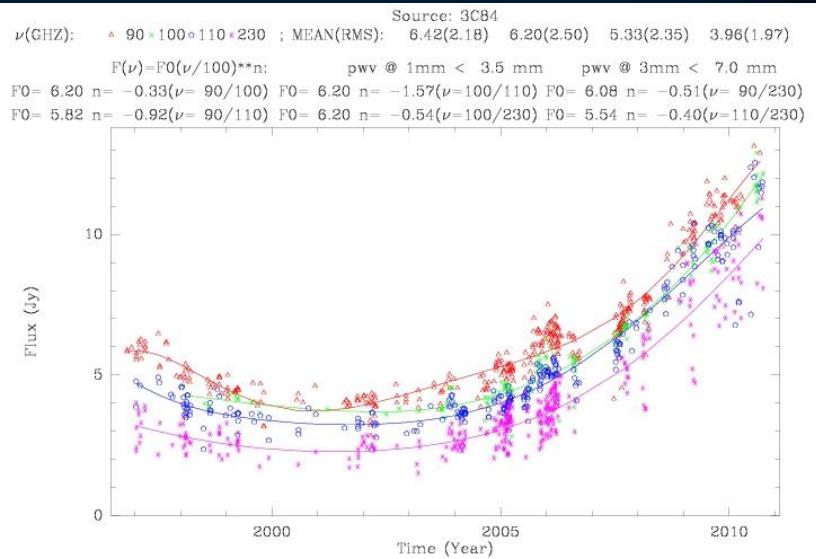
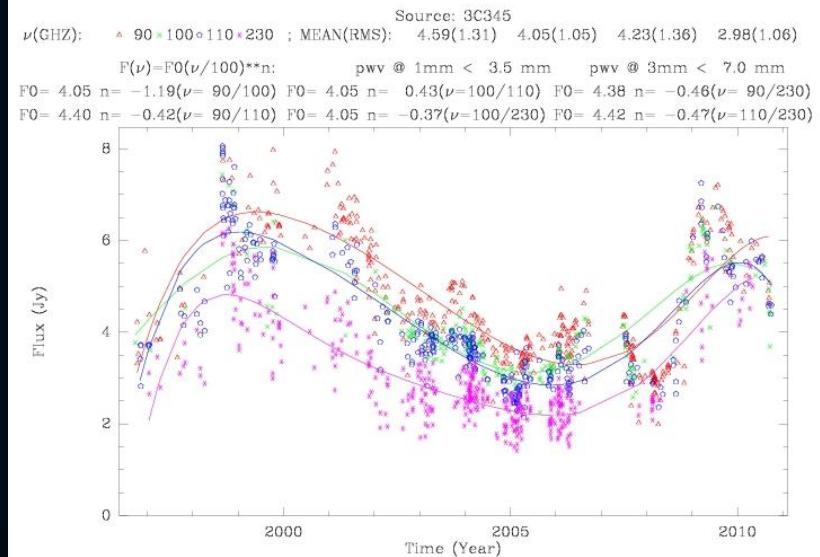
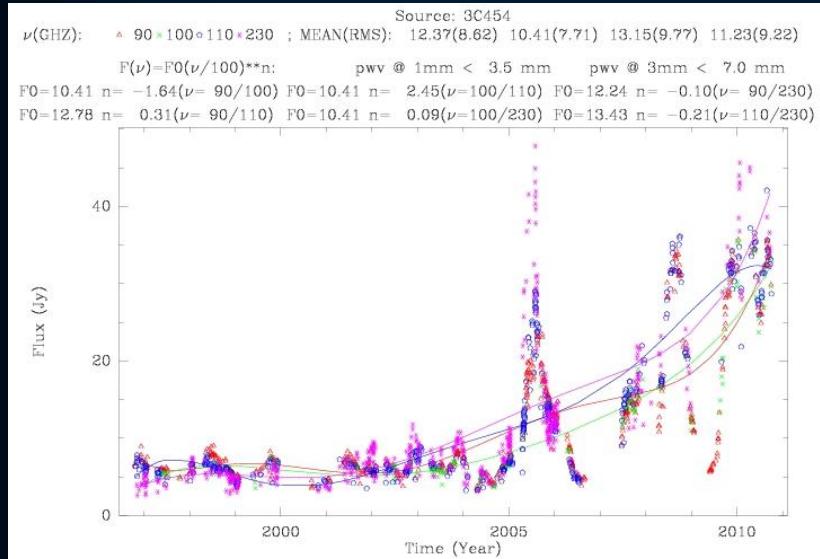
## **What do we want in a flux calibrator?**

- strong ( $>1$  Jy) emission at mm wavelengths
- compact ( $\ll 1''$ ) emission at mm wavelengths
- emission should not be variable in time
- preferentially with long LST range  
(i.e., high declination source)
- no or only little sun-avoidance
- preferentially well known properties  
(such as SED, size)

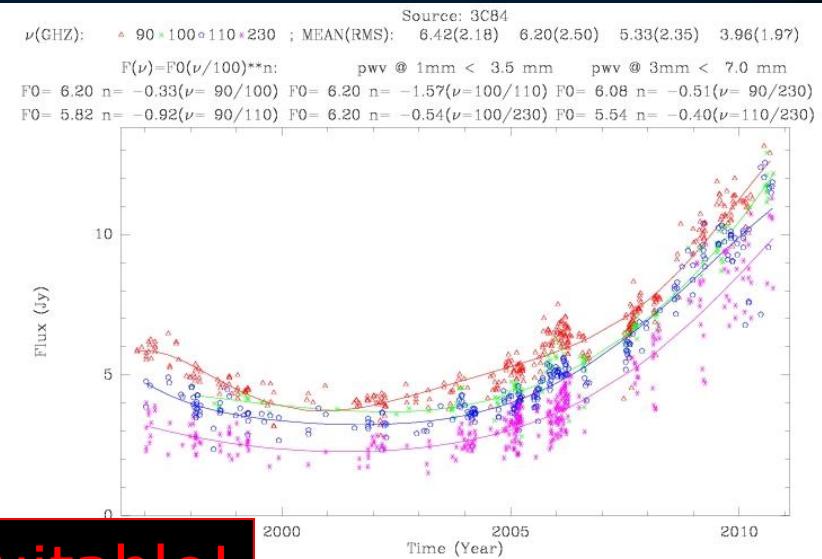
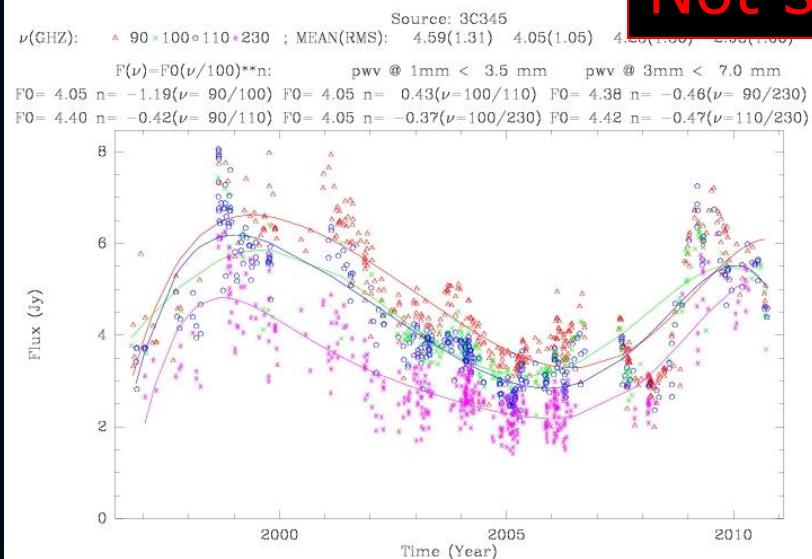
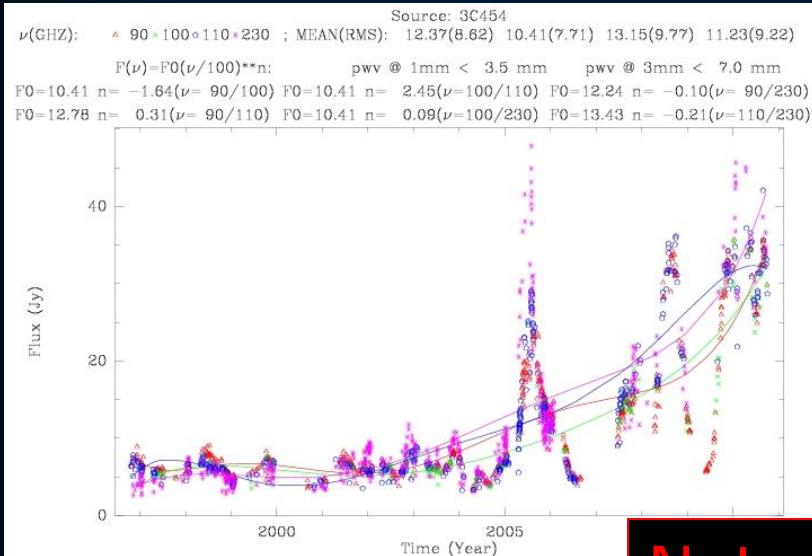
1. Quasars
2. Planets
3. Solar Bodies  
(Satellites, Asteroids,  
Dwarf Planets)
4. Radio Stars

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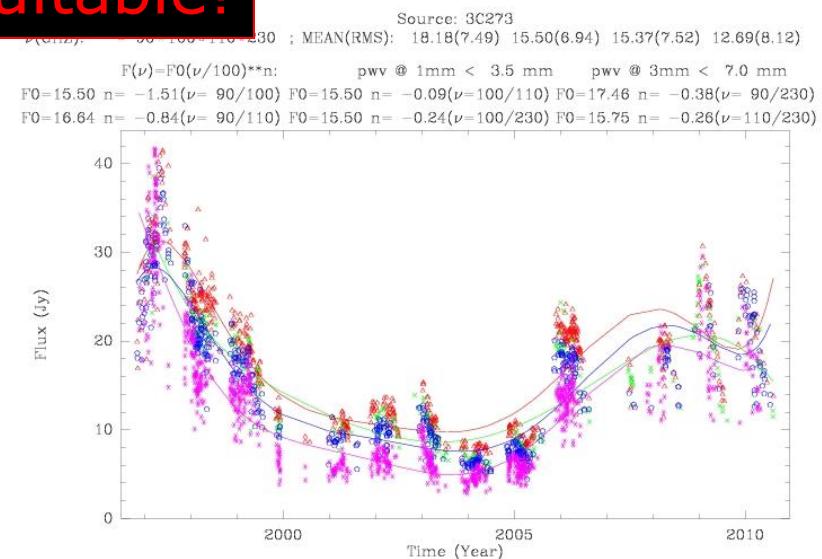
# Flux Calibrators: Quasars



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Not suitable!



1. Quasars
2. Planets
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(Satellites, Asteroids,  
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# Flux Calibrators: Planets

- Pro:  
most of the solar planets have strong mm-emission and reasonably well derived flux models
- Contra:
  - 1.) Fluxes not completely constant
  - 2.) They start to be resolved ( $\geq 3''$ ) already at 3mm
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  - 4.) Not always visible, i.e., more constraints due to sun-avoidance, short LST ranges

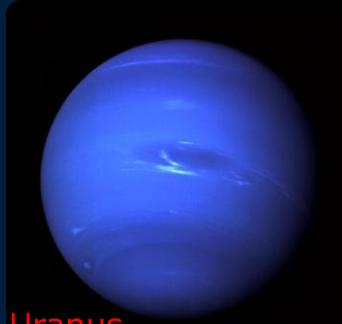


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Mars



Uranus



Jupiter

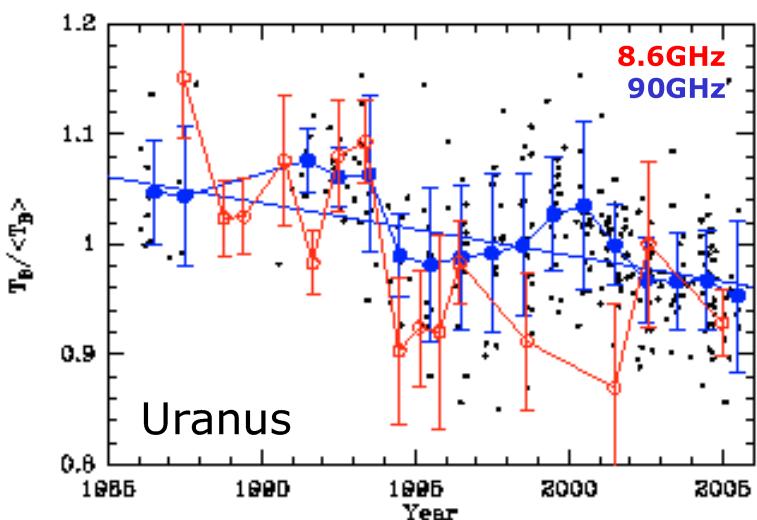


Saturn

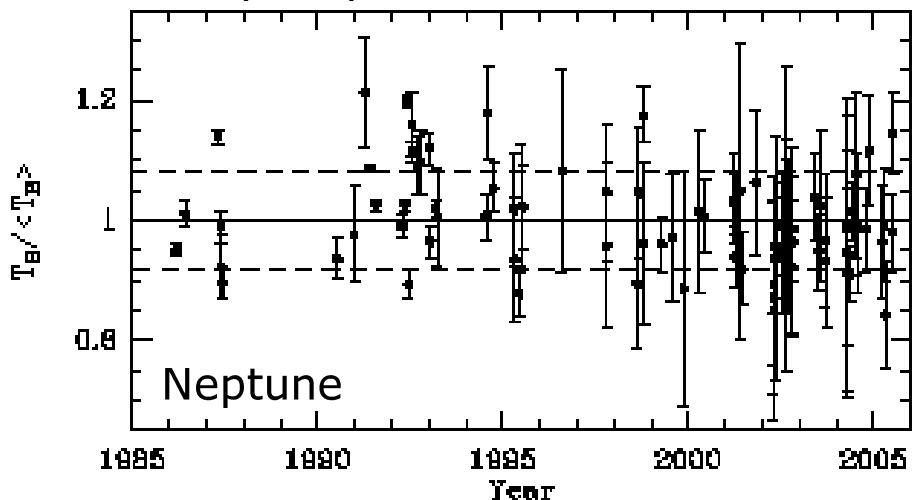


Neptune

# Flux Calibrators: Planets

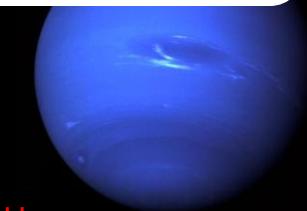


Kramer et al. (2008)



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Uranus



Jupiter

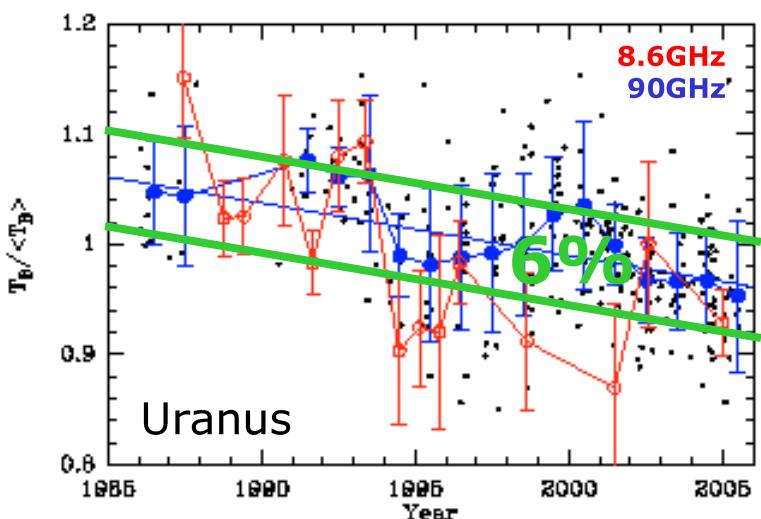


Saturn

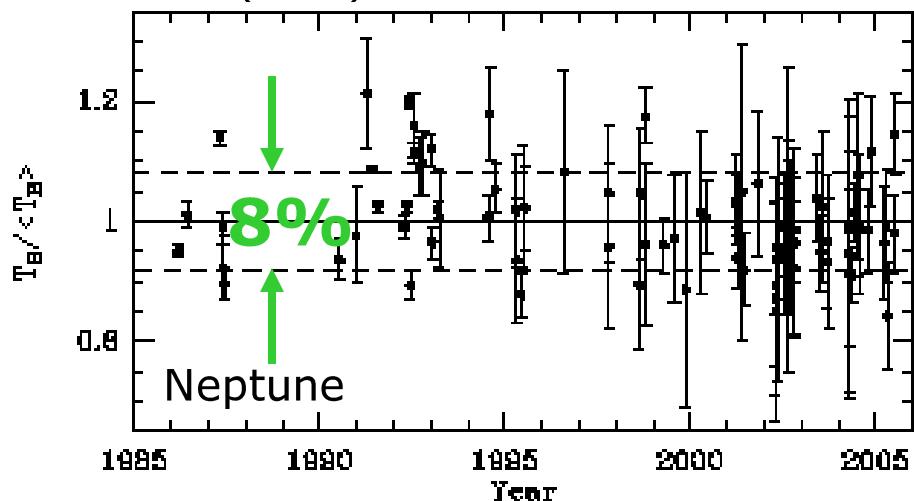


Neptune

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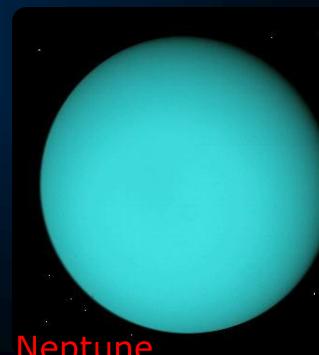
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Saturn

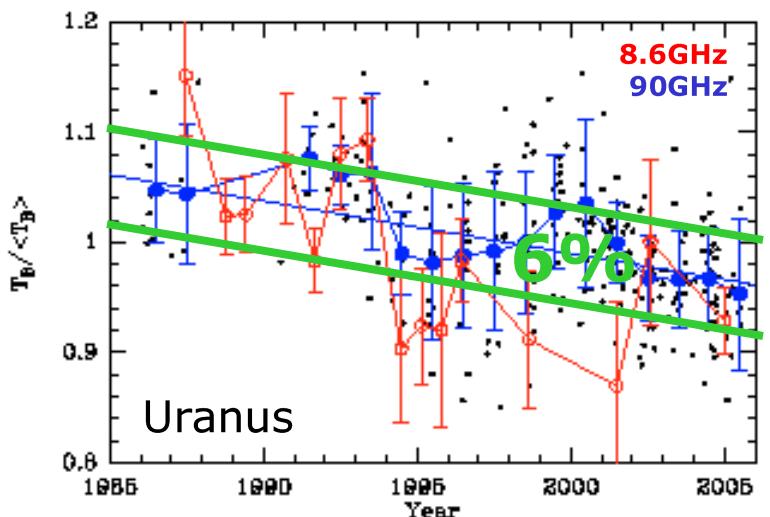


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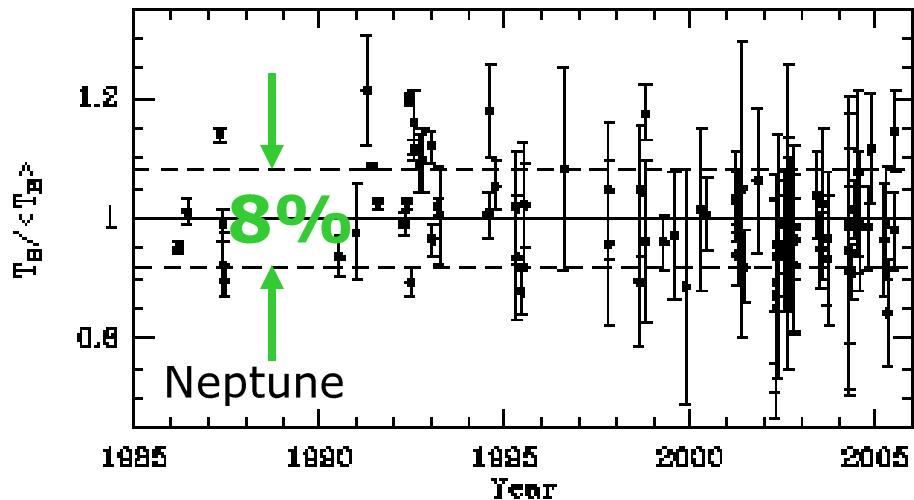


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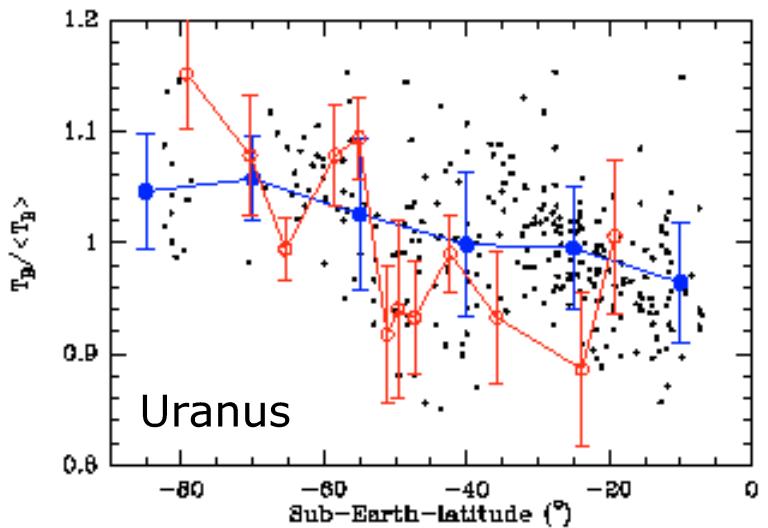
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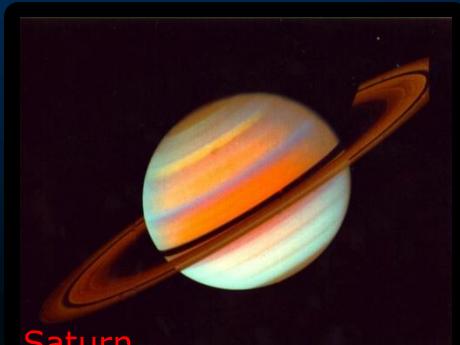
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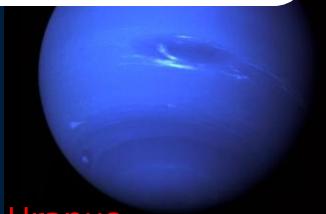
constraints due to sun-



Jupiter



Saturn

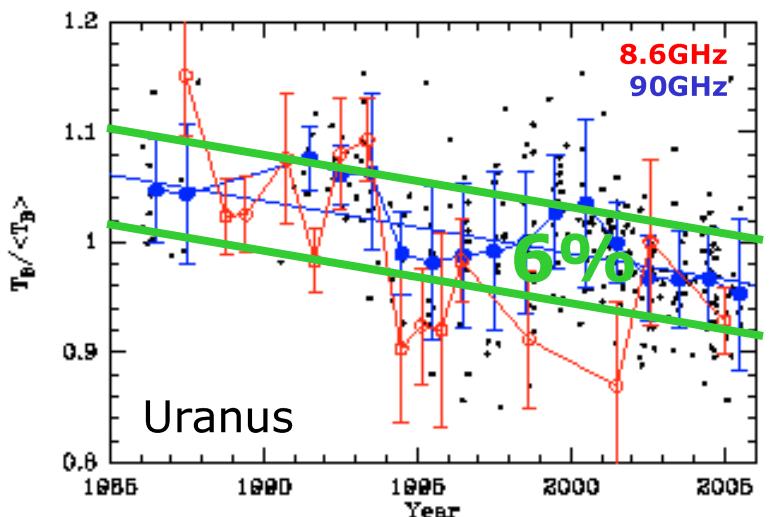


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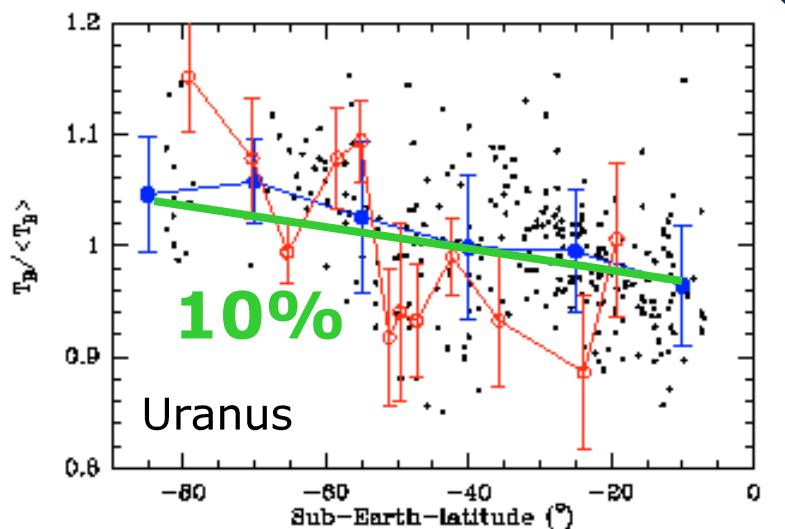
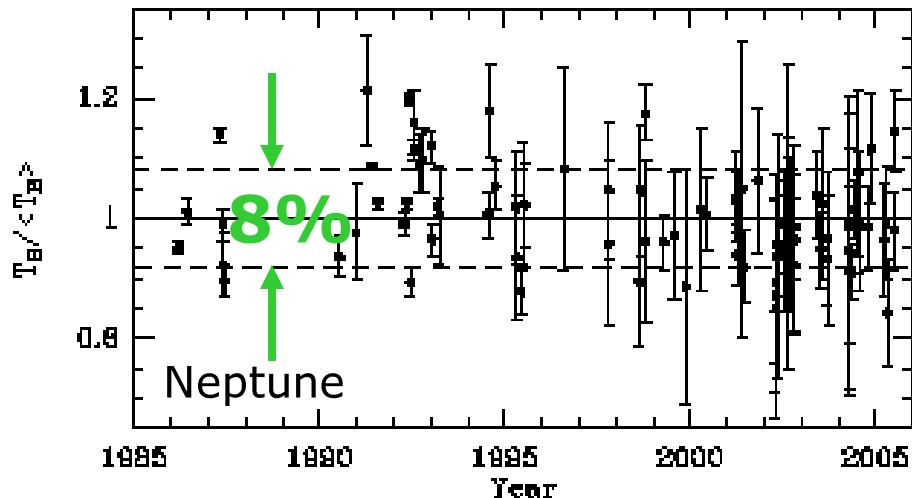
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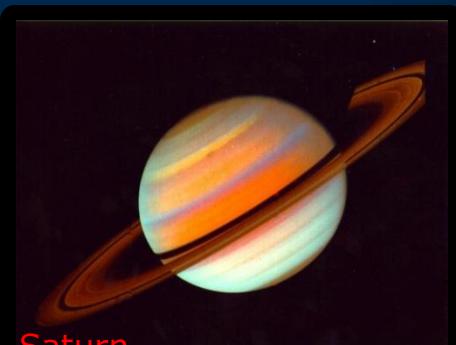
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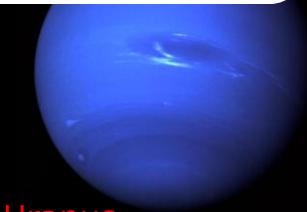
constraints due to sun-



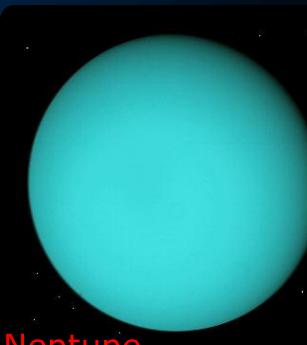
Jupiter



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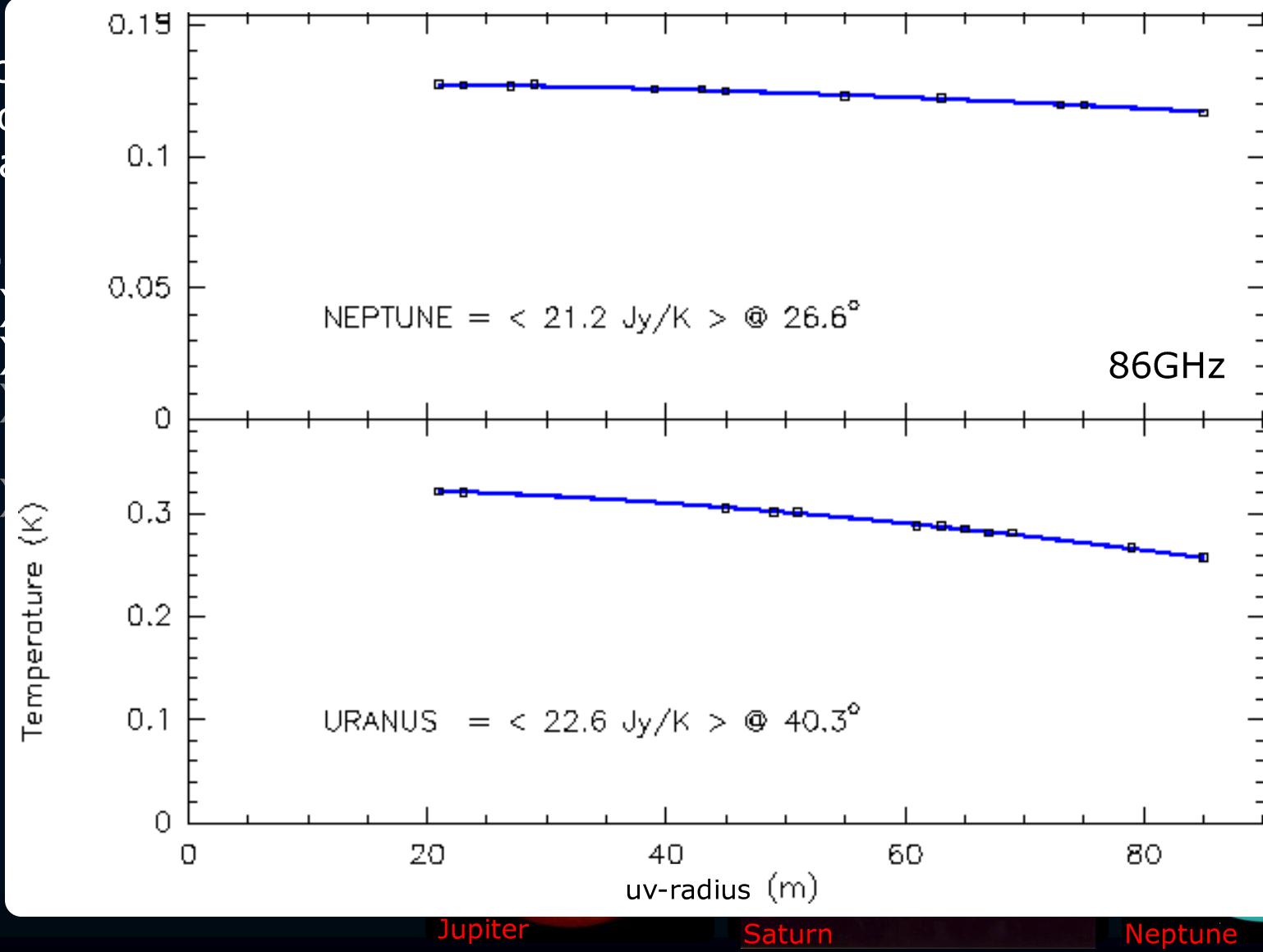
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- Pro  
mo  
rea

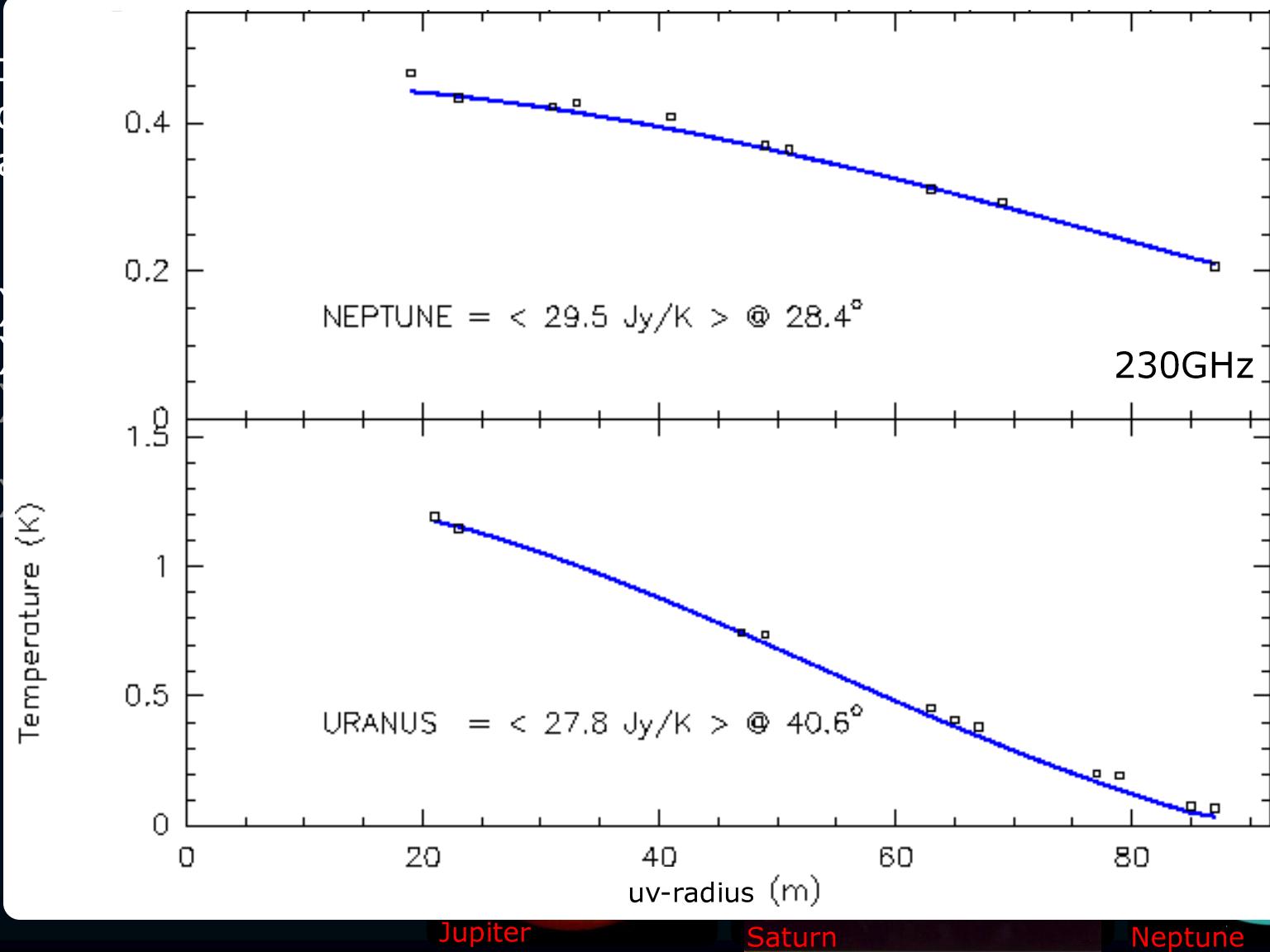
- Co  
1.  
2.  
3.  
4.



# Flux Calibrators: Planets

- Probes  
model  
radio  
recesses

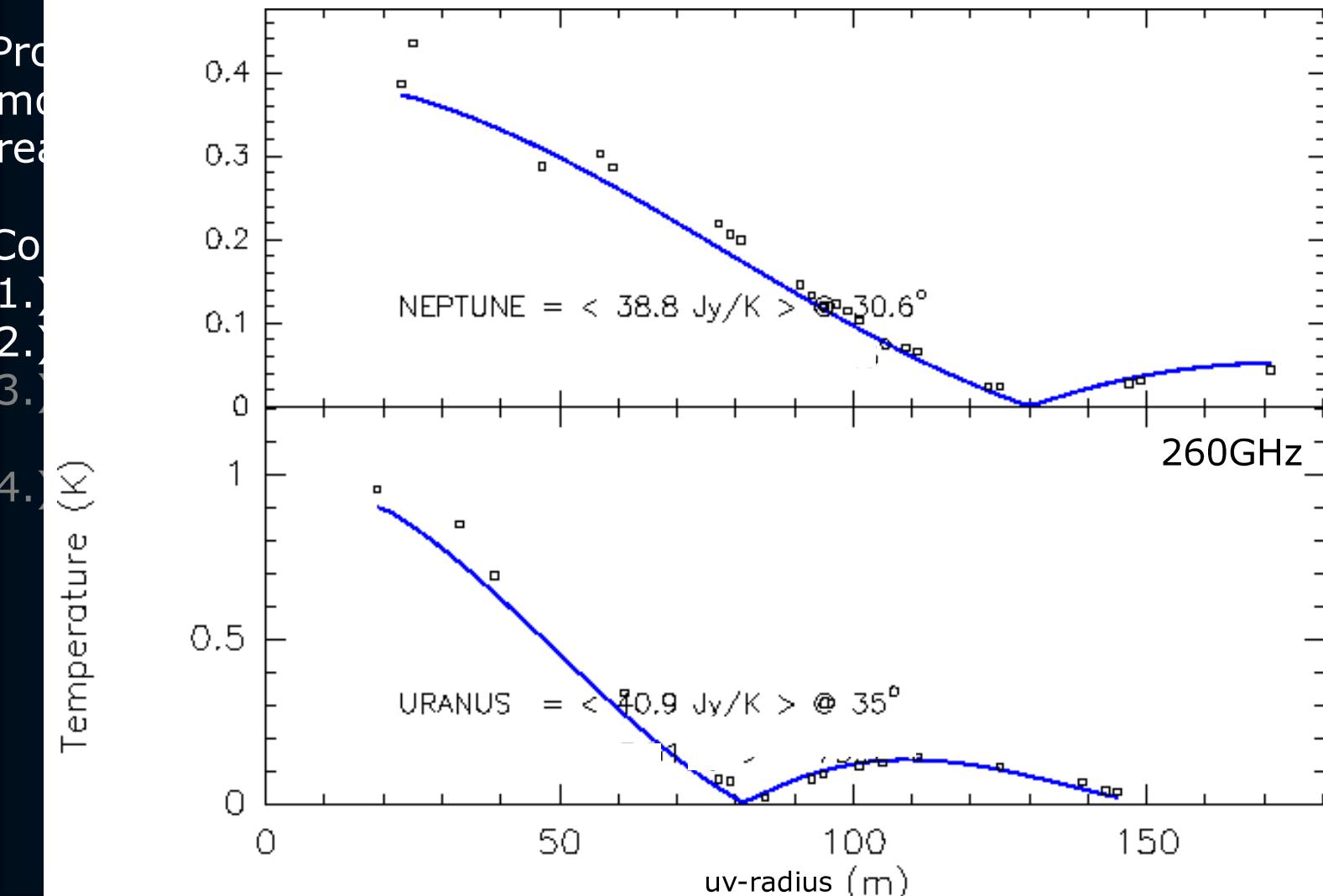
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1.  
2.  
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# Flux Calibrators: Planets

- Probes  
model  
radio  
recess

- Converge  
1.  
2.  
3.



Jupiter

Saturn

Neptune

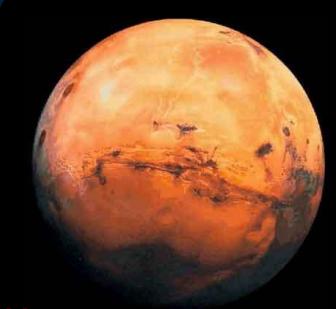
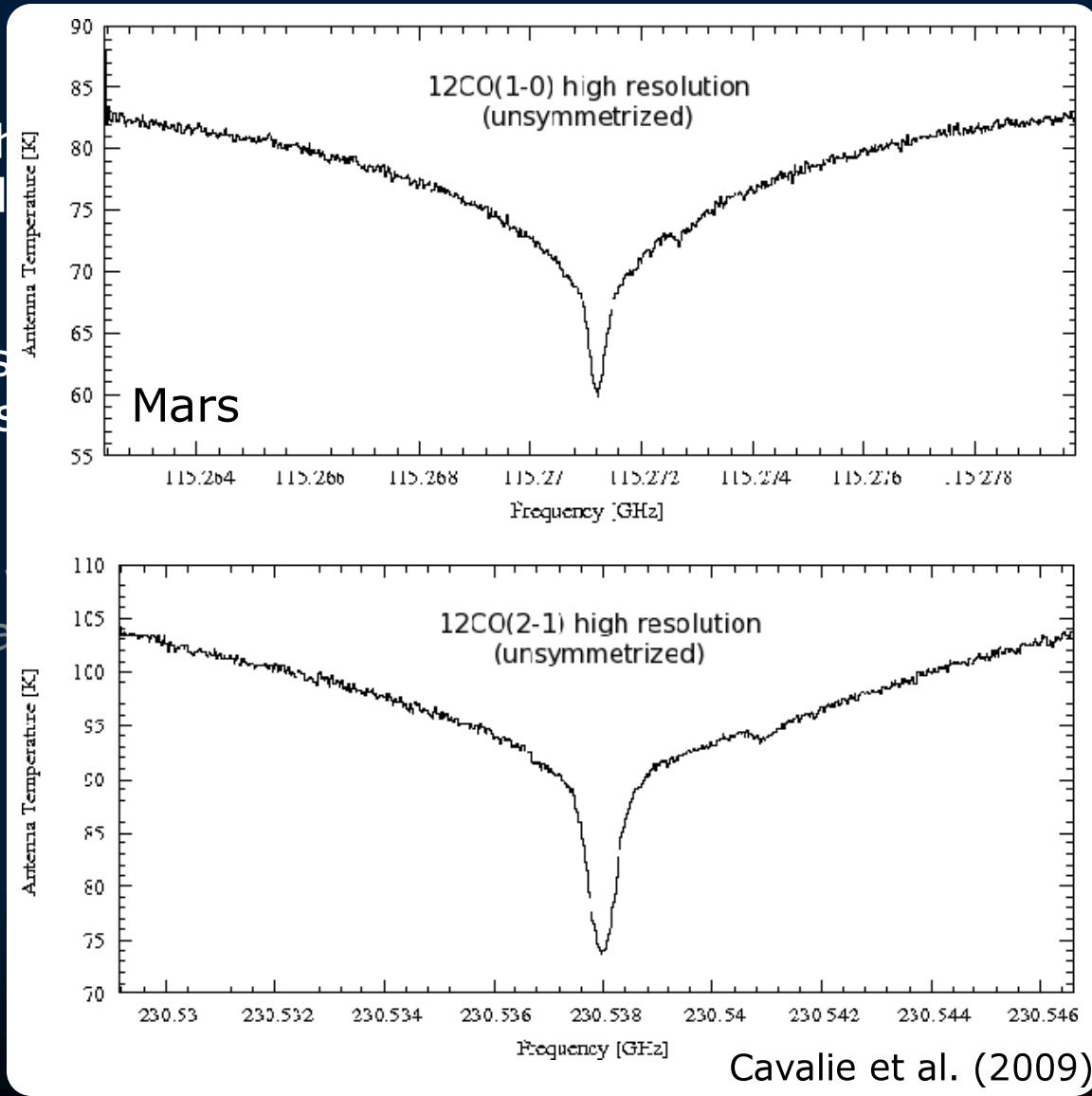
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# Flux Calibrators: Planets

- Pro:  
most of them reasonable
- Contra:
  - 1.) Fluxes
  - 2.) They sometimes have emission features
  - 3.) Some are very cold (e.g., Neptune)
  - 4.) Not all are available/available to avoid atmospheric absorption



Mars



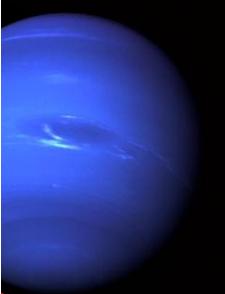
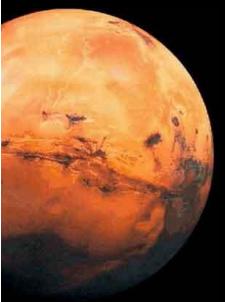
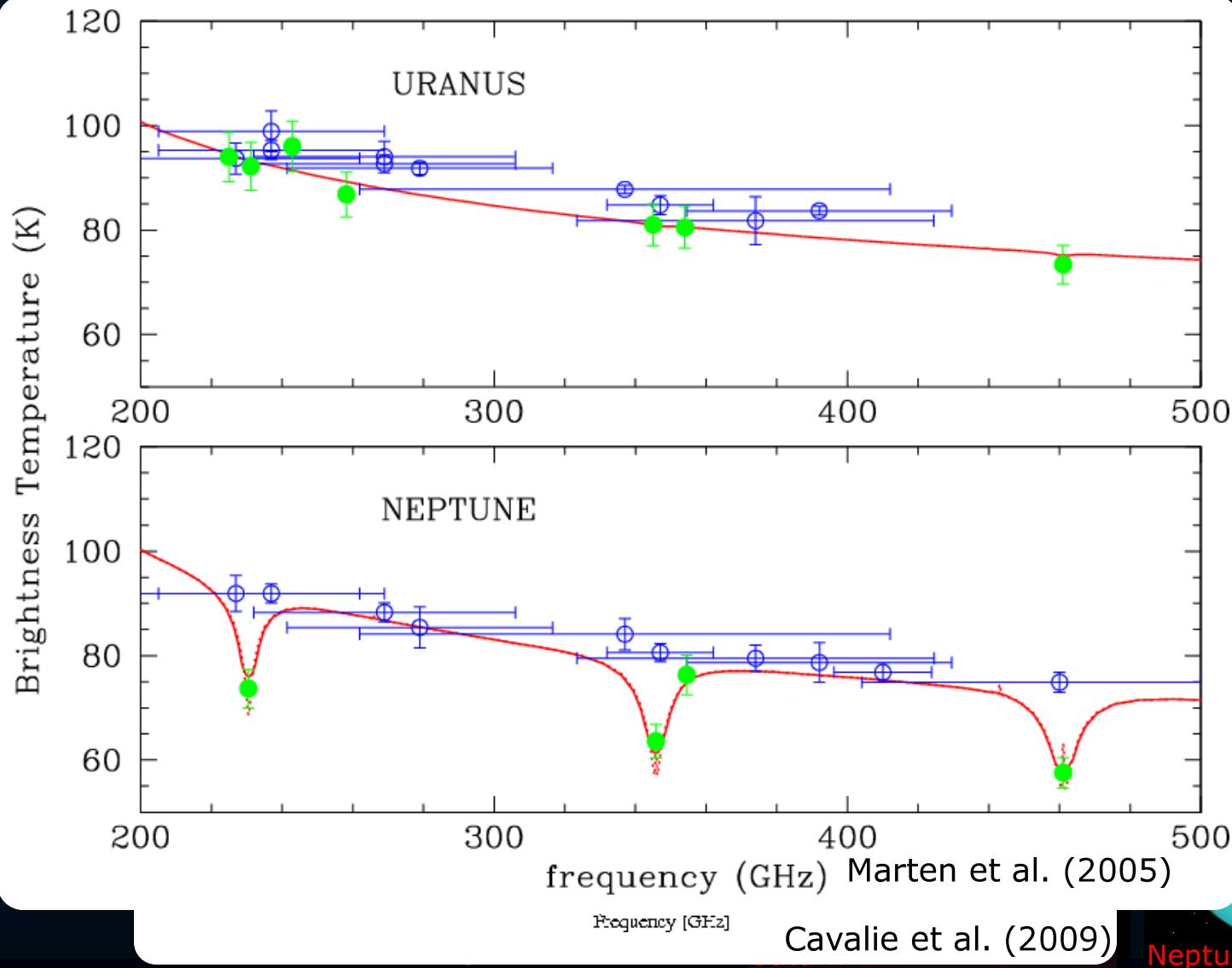
Uranus



Neptune

# Flux Calibrators: Planets

- Promotional material
- Corrections
- 1.)
- 2.)
- 3.)



Cavalle et al. (2009) Neptune

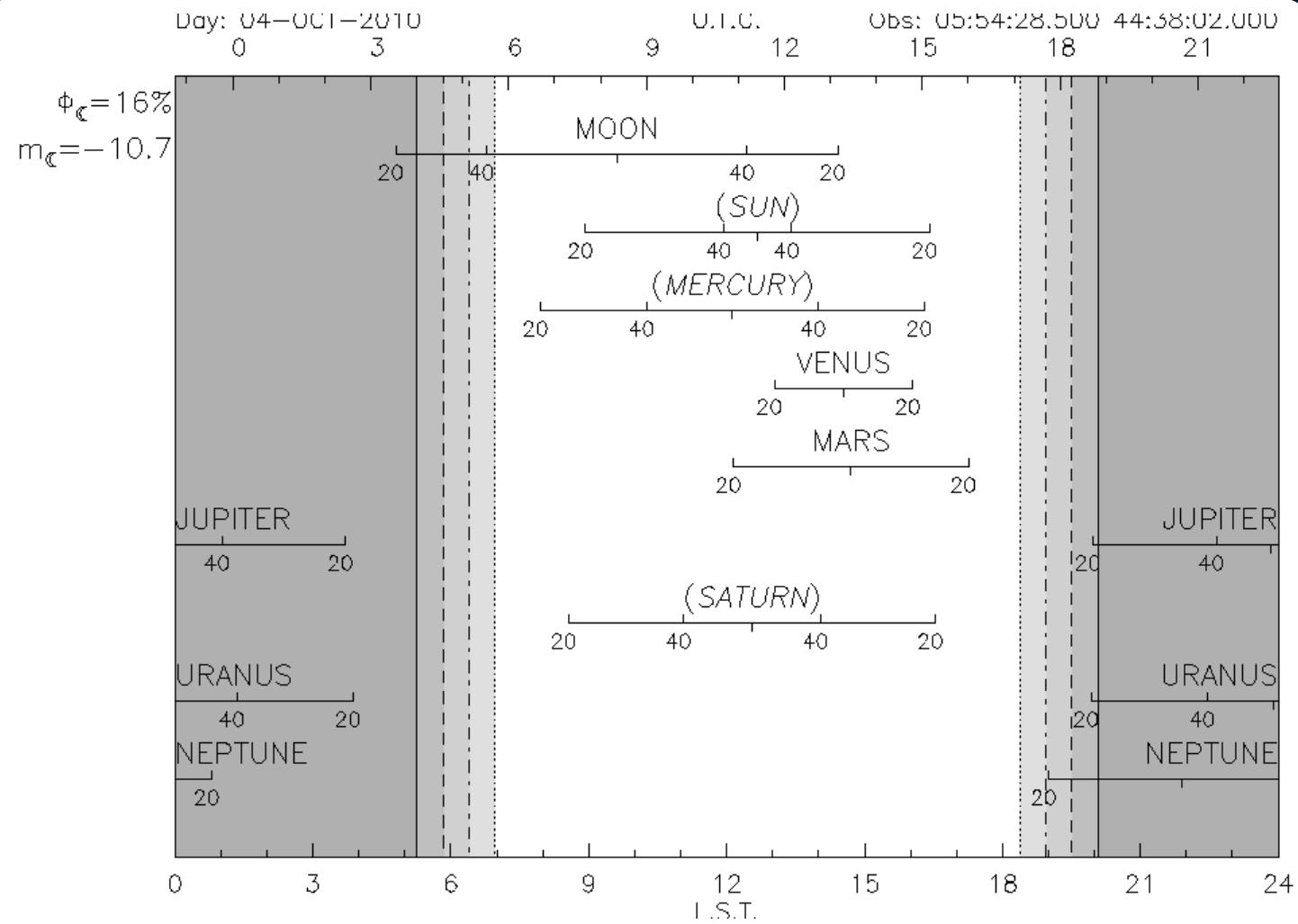
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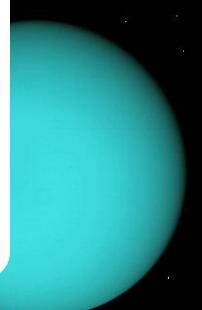
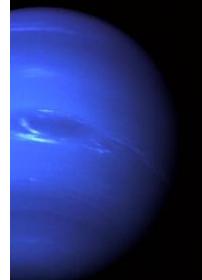
- Pros: most reasonable
- Cons:
  - 1.)
  - 2.)
  - 3.)
  - 4.)



Jupiter

Saturn

Neptune



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2. Planets
3. Solar Bodies  
(Satellites, Asteroids,  
Dwarf Planets)
4. Radio Stars

# Flux Calibrators: Satellites

- Pro:
  - They are quite compact (hence better for extended configurations and/or higher frequencies than planets) and still sufficiently bright (>500mJy@3mm)
- Already regularly used at the SMA & ALMA:  
Titan, Ganymede, Callisto
- Contra:
  - Titan also shows broad molecular lines
  - they are not always useable especially when they are too close to their 'mother'-planet (or each other); one needs at least 3xPB
  - flux models not as well constrained as for planets



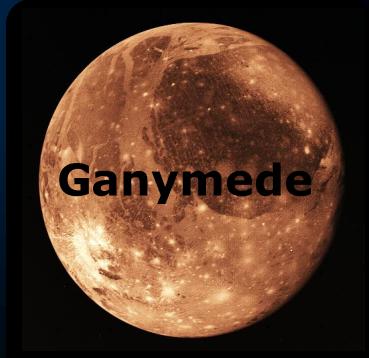
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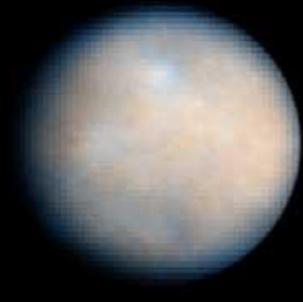
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# Flux Calibrators: Asteroids/Dwarf Planets

- Pro:
  - bright and relatively small solar bodies
- Contra:
  - Still uncertainties in their flux; some of them known to vary quite significantly within a day
  - irregular shapes

Ceres



Pallas



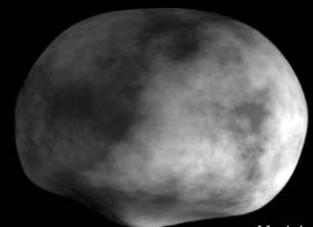
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258 E 348 E 78 E

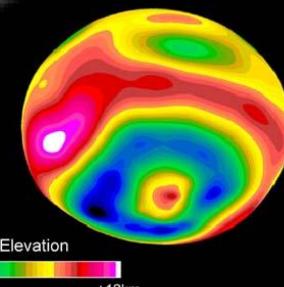
Vesta



HST



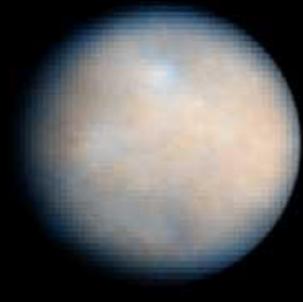
Model



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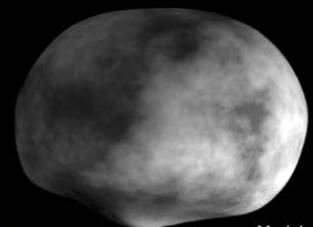
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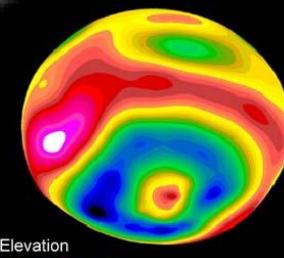
Vesta



HST



Model



Elevation  
-12km +12km

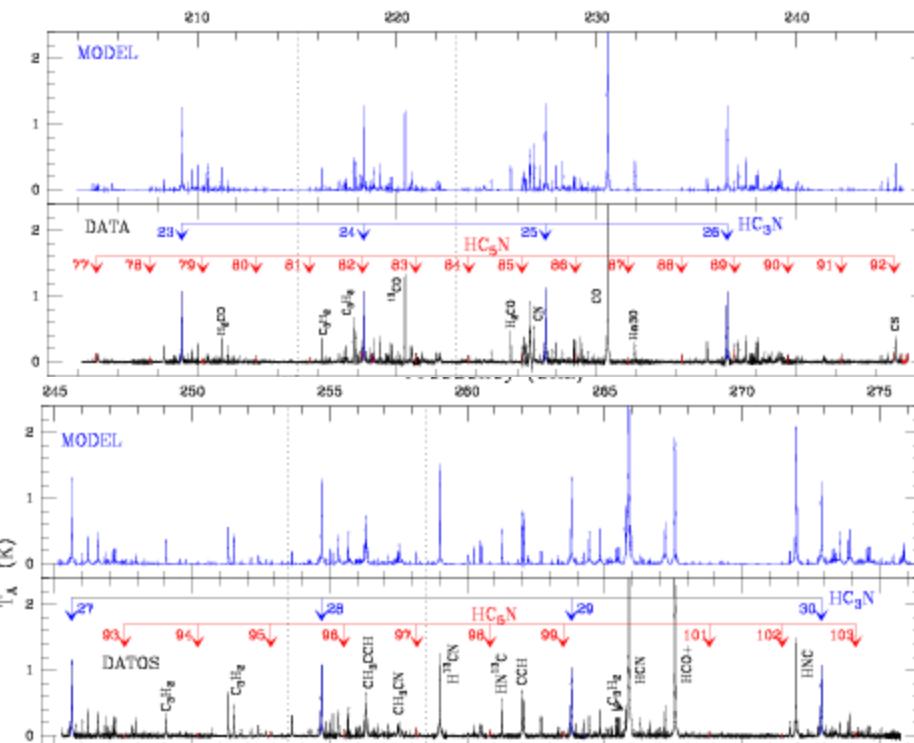
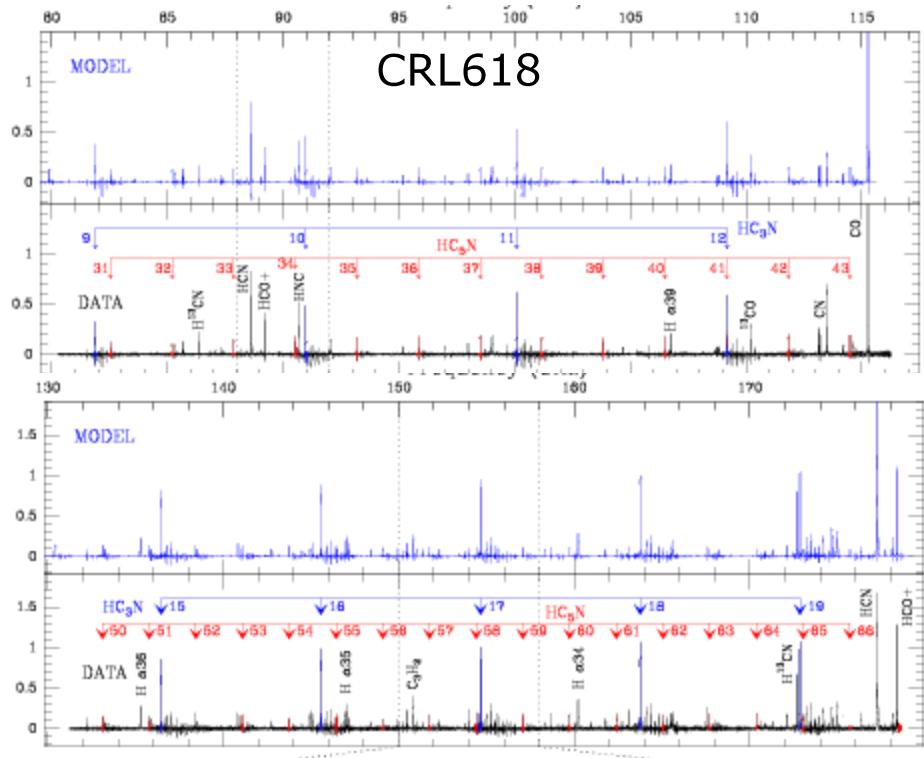
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4. Radio Stars

Radio bright stars:

- MWC349 (binary star)
- CRL618 (PPN)
- W3OH (HII region)
- NGC7072 (young PN)
- NGC7538 (HII region)
- K3-50A (HII-region)
- .....

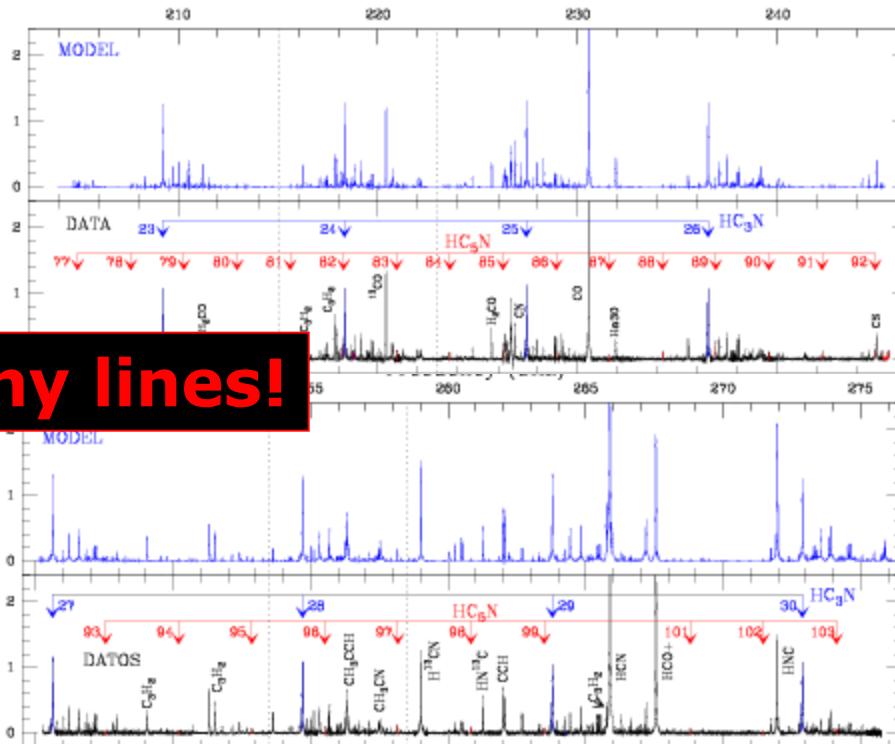
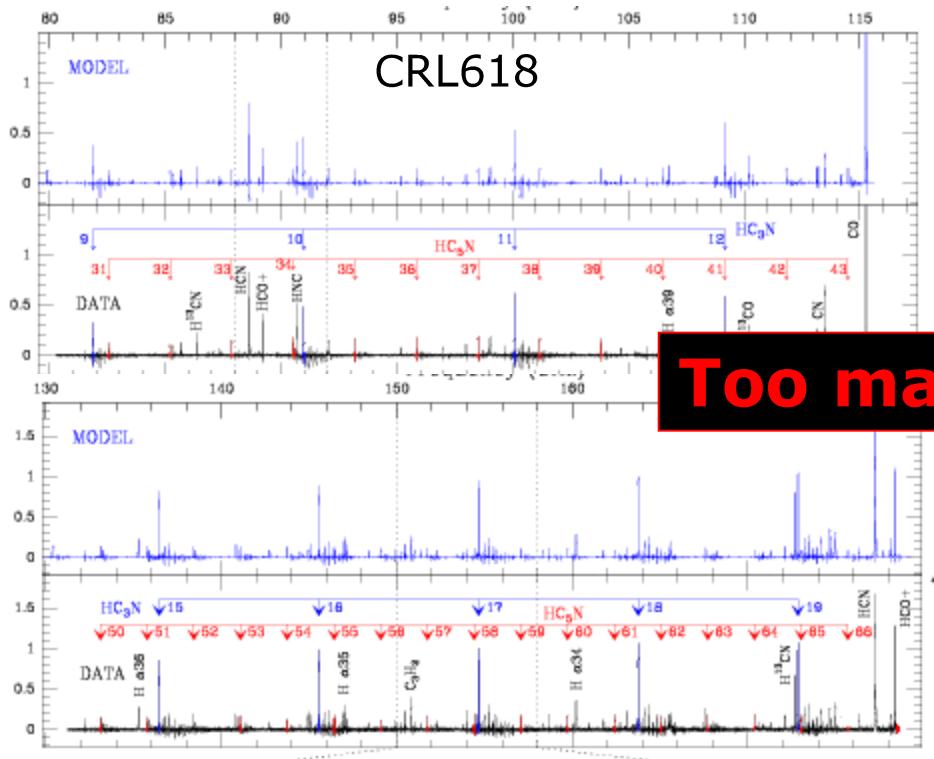
# Flux Calibrators: Radio Stars

Pardo et al. (2009)

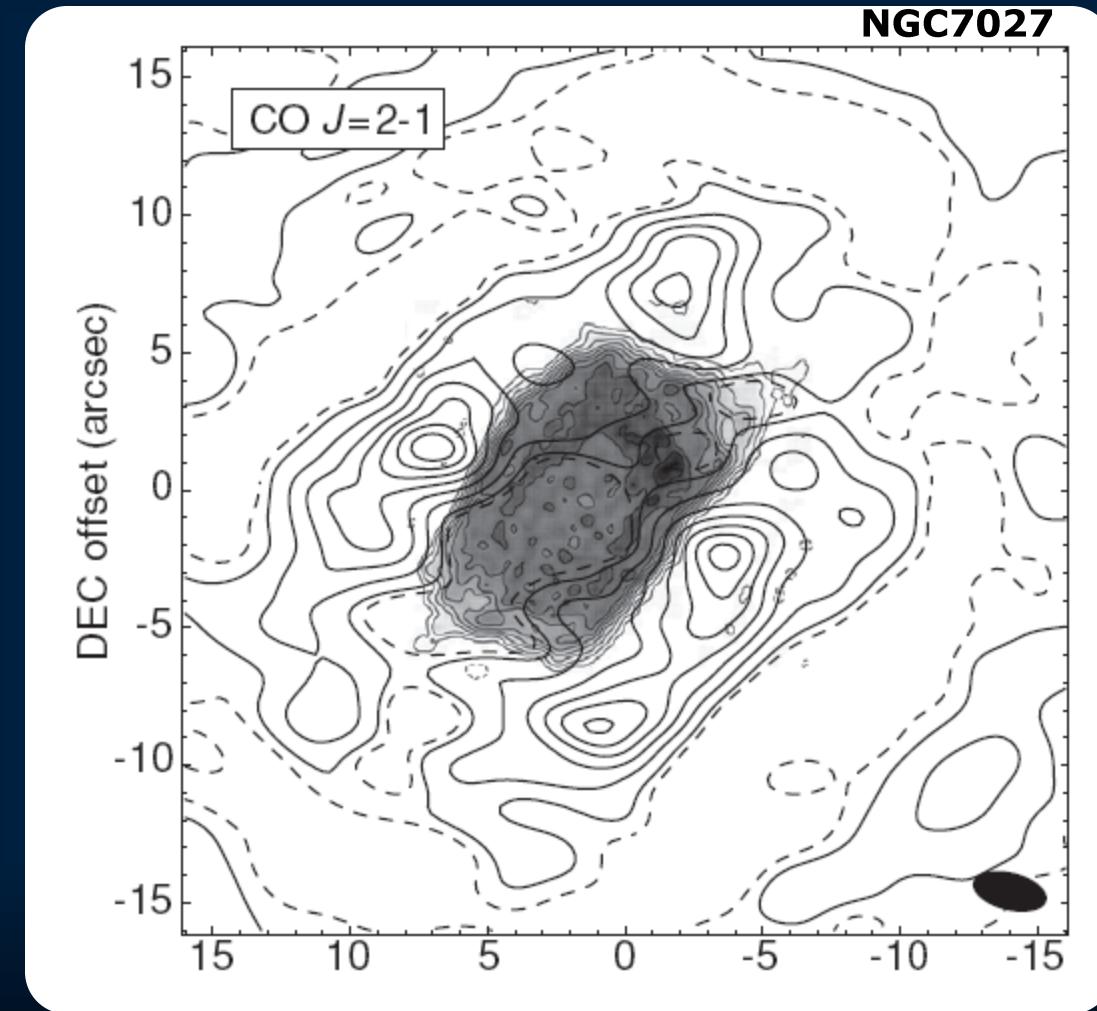


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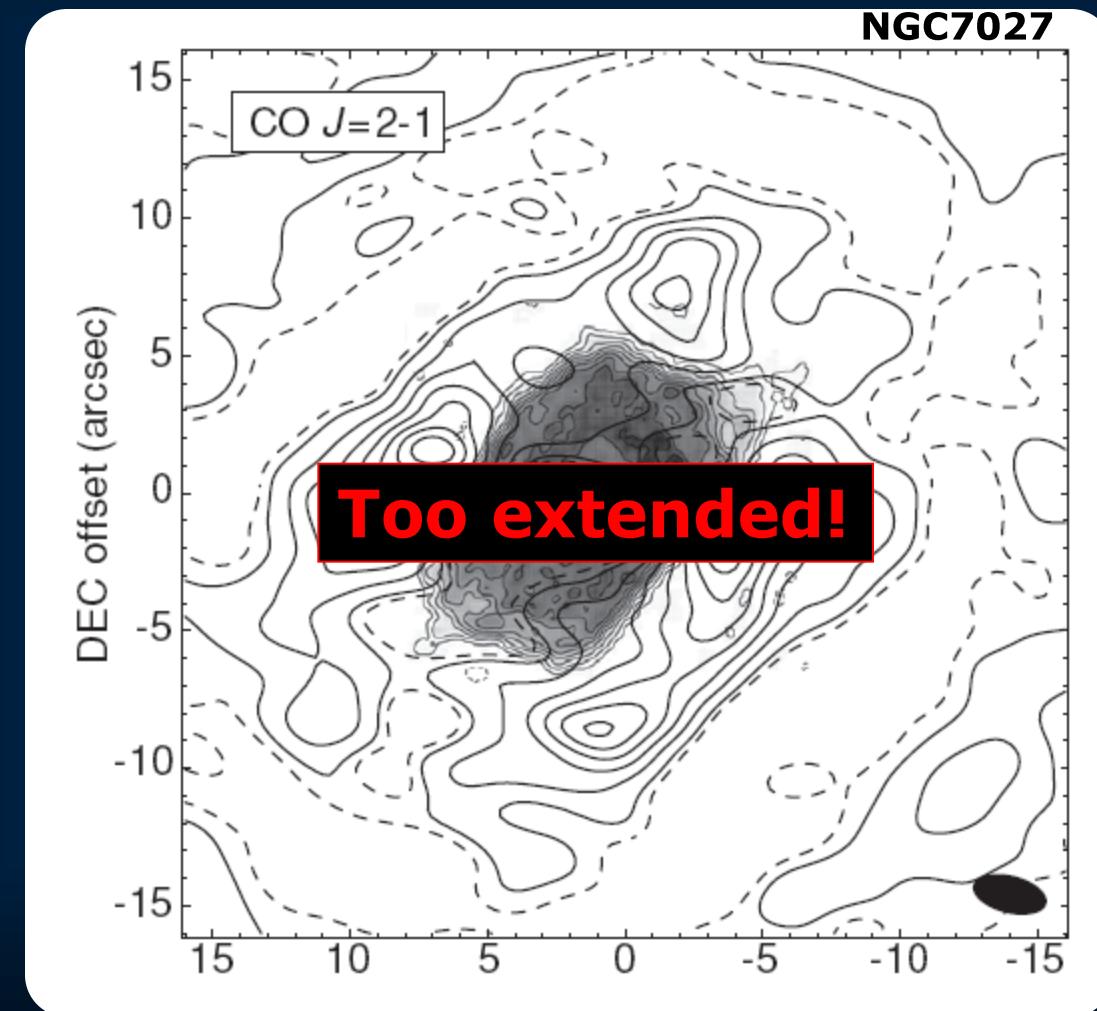


# Flux Calibrators: Radio Stars



Nakashima et al. (2010)

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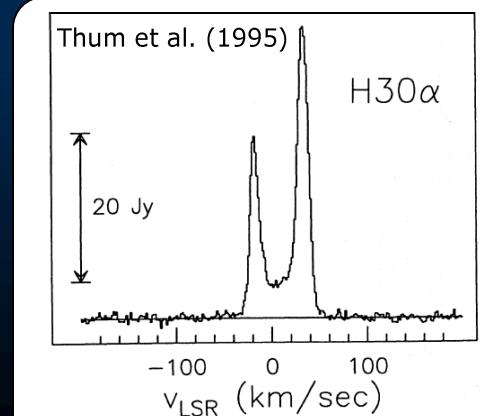
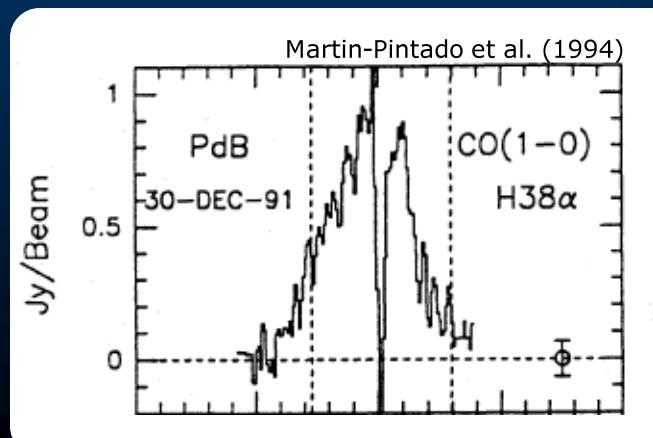
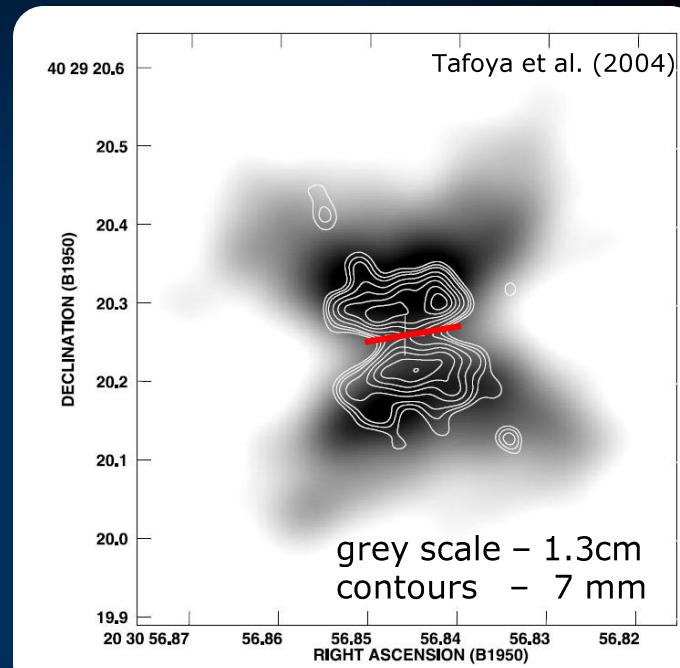
## Radio bright stars:

- MWC349
- CRL618
- W3OH
- NGC7072
- NGC7538
- K3-50A

# Flux Calibrators: MWC349

## Some facts:

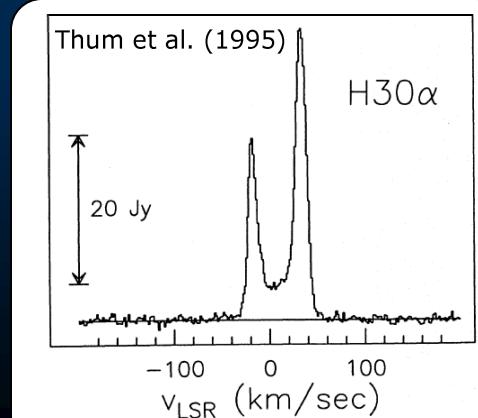
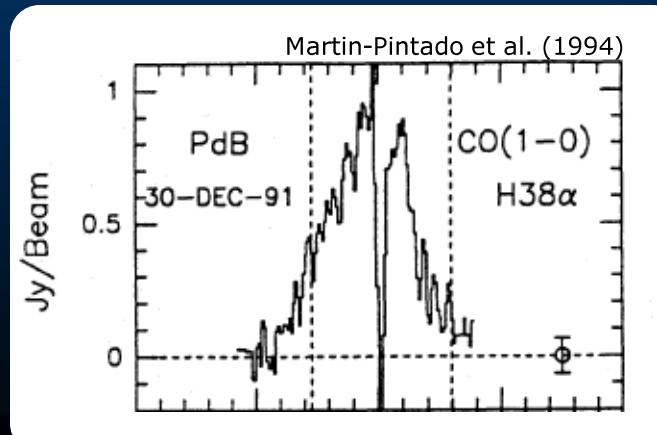
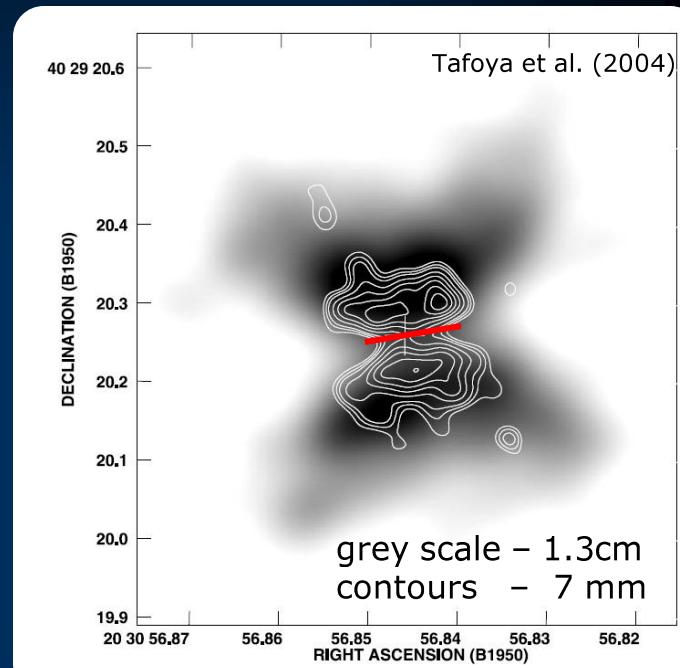
- binary stellar system:  
MWC349A (Be) & MWC349B (B0 type III)
- the two stars are separated by  $2.4'' \pm 0.1''$  and possibly interact
- MWC349A the brightest radio continuum star
- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ( $\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$ )
- at declination of  $> 40\text{deg}$   
-> visible for  $\sim 13\text{h}$  per day



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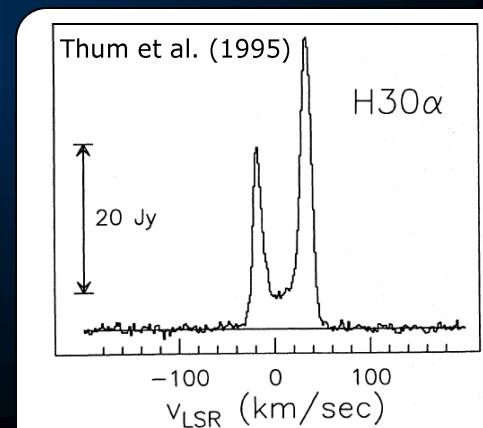
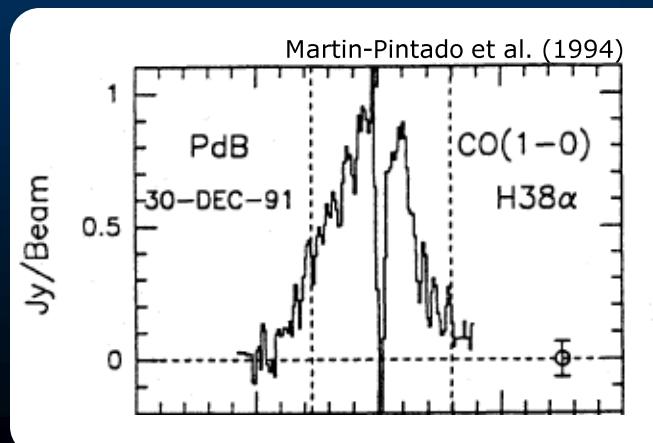
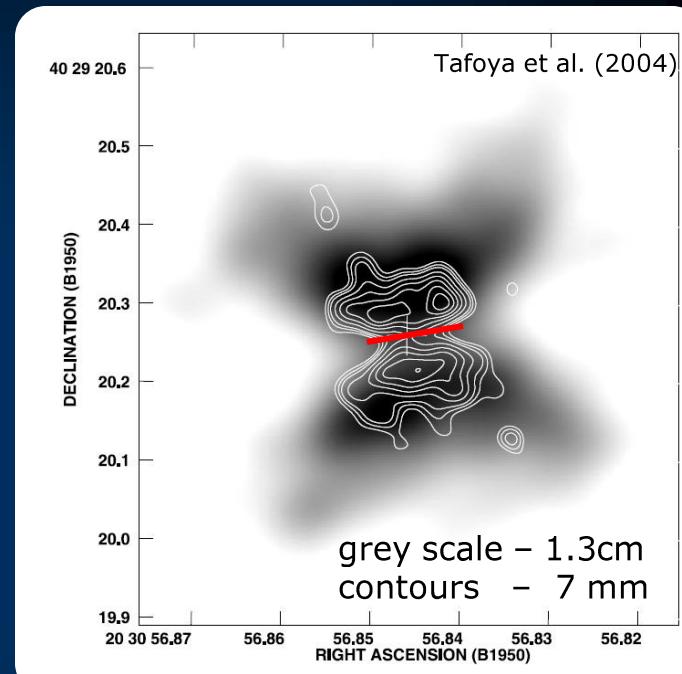
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- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ( $\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$ )
- at declination of  $> 40\text{deg}$   
-> visible for  $\sim 13\text{h}$  per day



# Flux Calibrators: MWC349

## Some facts:

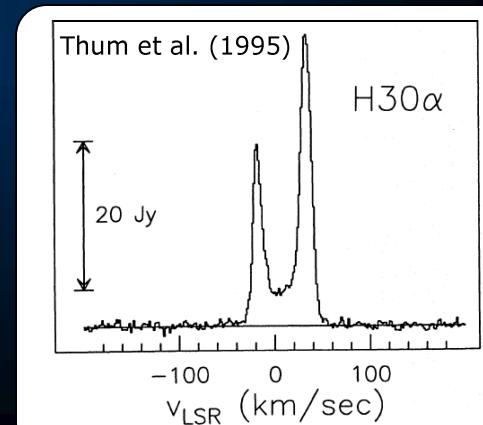
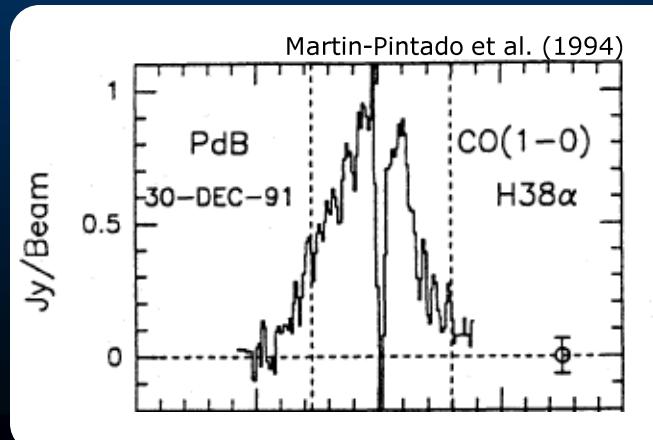
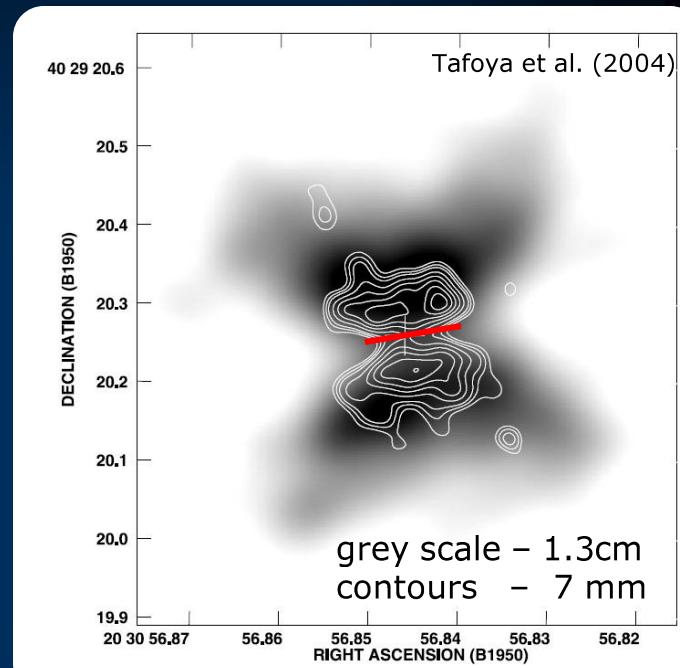
- binary stellar system:  
MWC349A (Be) & MWC349B (B0 type III)
- the two stars are separated by  $2.4'' \pm 0.1''$  and possibly interact
- MWC349A the brightest radio continuum star
- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ( $\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$ )
- at declination of  $> 40\text{deg}$   
-> visible for  $\sim 13\text{h}$  per day



# Flux Calibrators: MWC349

## Some facts:

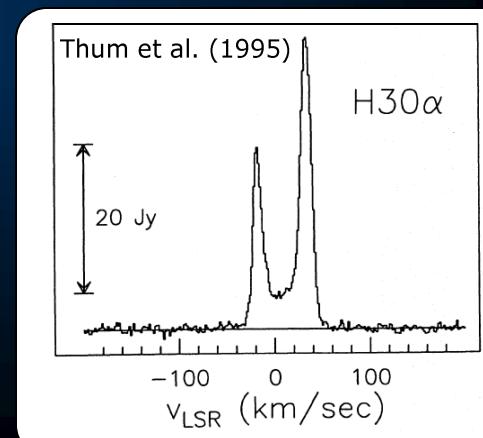
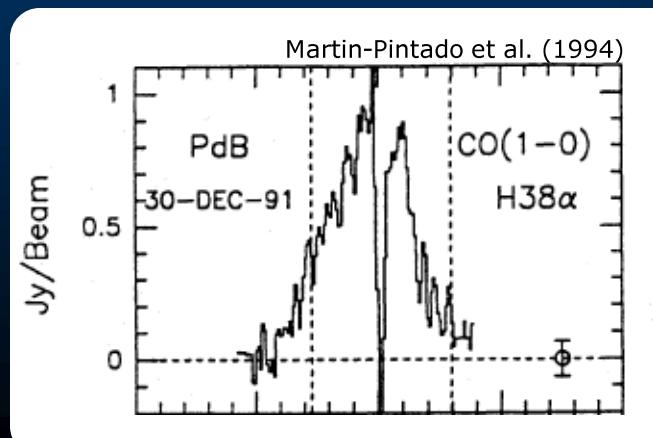
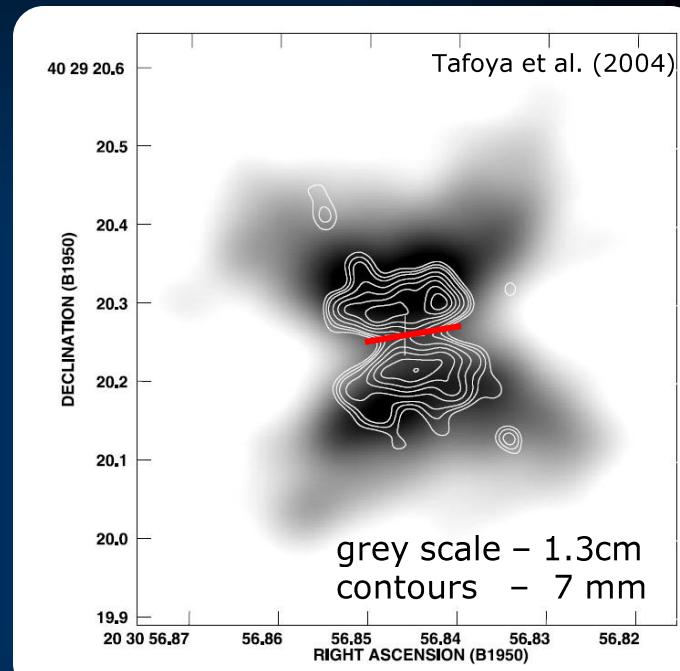
- binary stellar system:  
MWC349A (Be) & MWC349B (B0 type III)
- the two stars are separated by  $2.4'' \pm 0.1''$  and possibly interact
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- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ( $\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$ )
- at declination of  $> 40\text{deg}$   
-> visible for  $\sim 13\text{h}$  per day



# Flux Calibrators: MWC349

## Some facts:

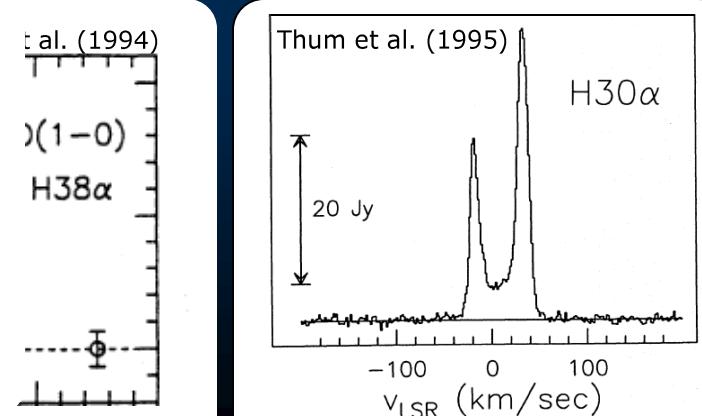
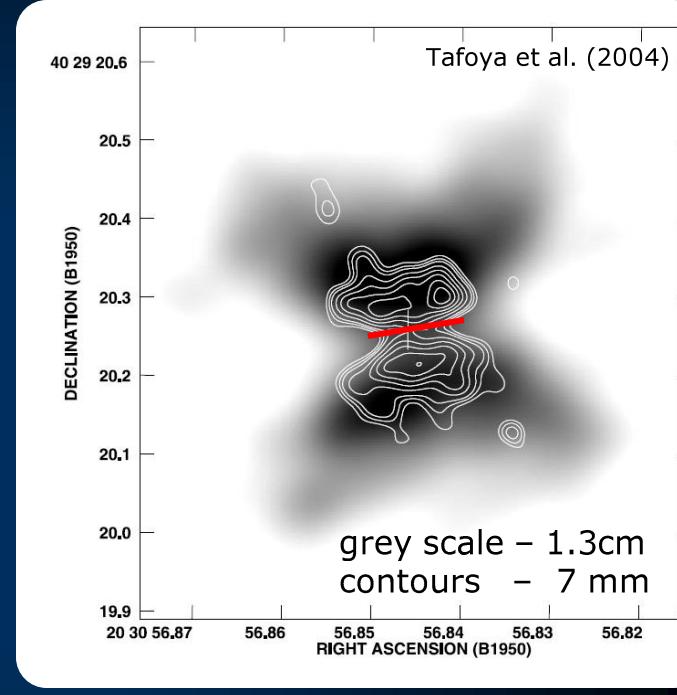
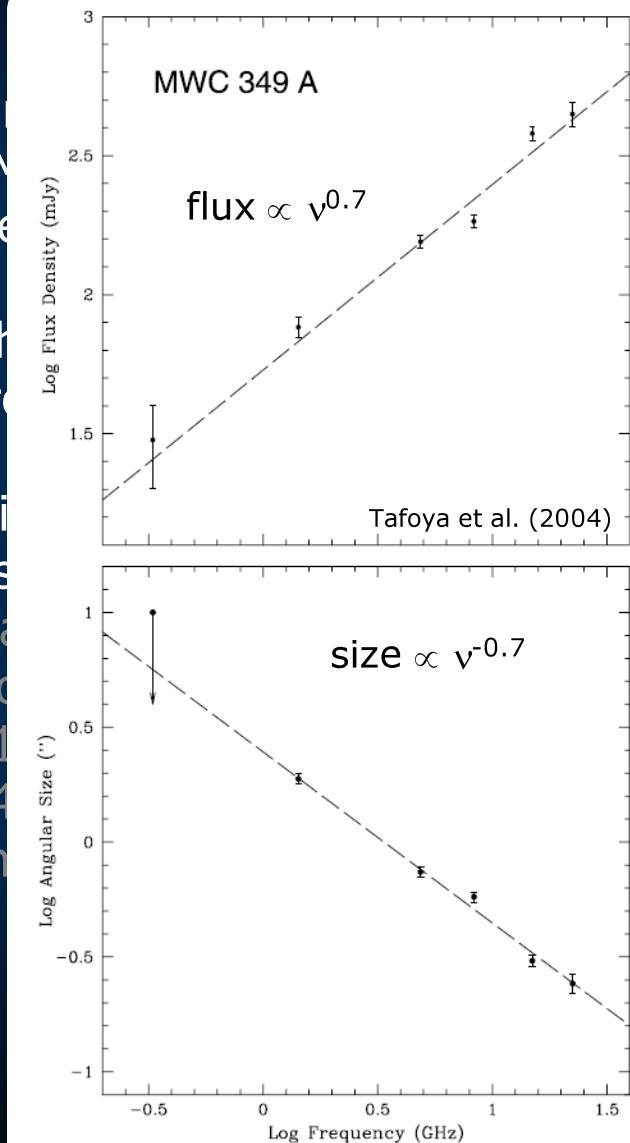
- binary stellar system:  
MWC349A (Be) & MWC349B (B0 type III)
- the two stars are separated by  $2.4'' \pm 0.1''$  and possibly interact
- MWC349A the brightest radio continuum star
- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ( $\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$ )
- at declination of  $> 40\text{deg}$   
-> visible for  $\sim 13\text{h}$  per day



# Flux Calibrators: MWC349

## Some facts:

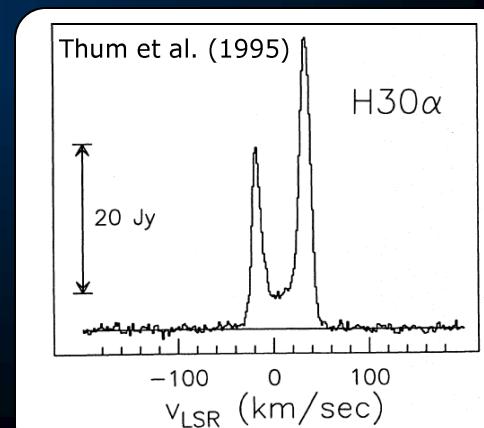
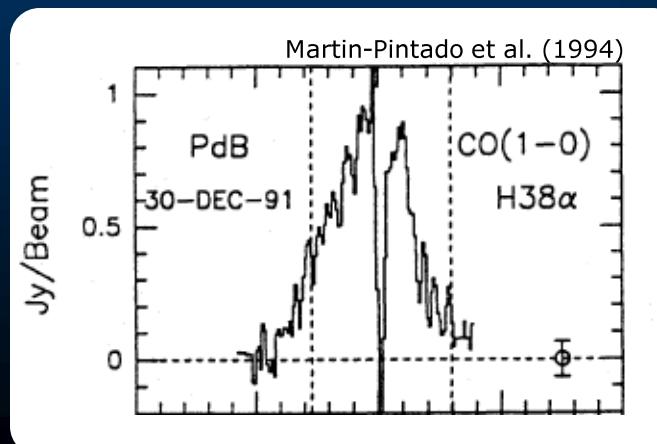
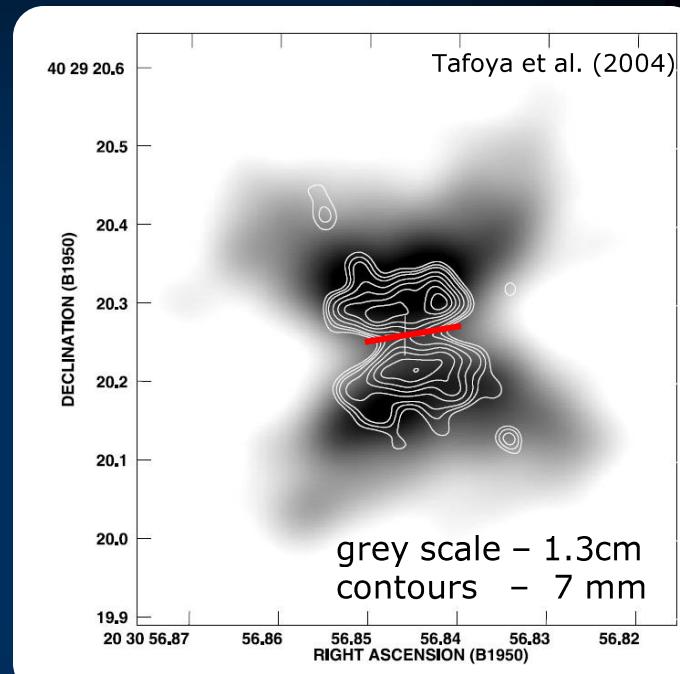
- binary stellar system MWC349A (Be) & MWC349B (O)
- the two stars are separated by ~1.5 AU and possibly interact
- MWC349A is the bright star
- radio continuum probe the outflow that photoevaporates the envelope of a neutral Keplerian disk
- size of flow decreases with frequency
- strong but highly variable radio emission (RRLs) from the central source ( $\sim 0.065'' = 80\text{AU} @ 1\text{pc}$ )
- at declination of  $>40^\circ$  it is visible for  $\sim 13\text{h}$  per day



# Flux Calibrators: MWC349

## Some facts:

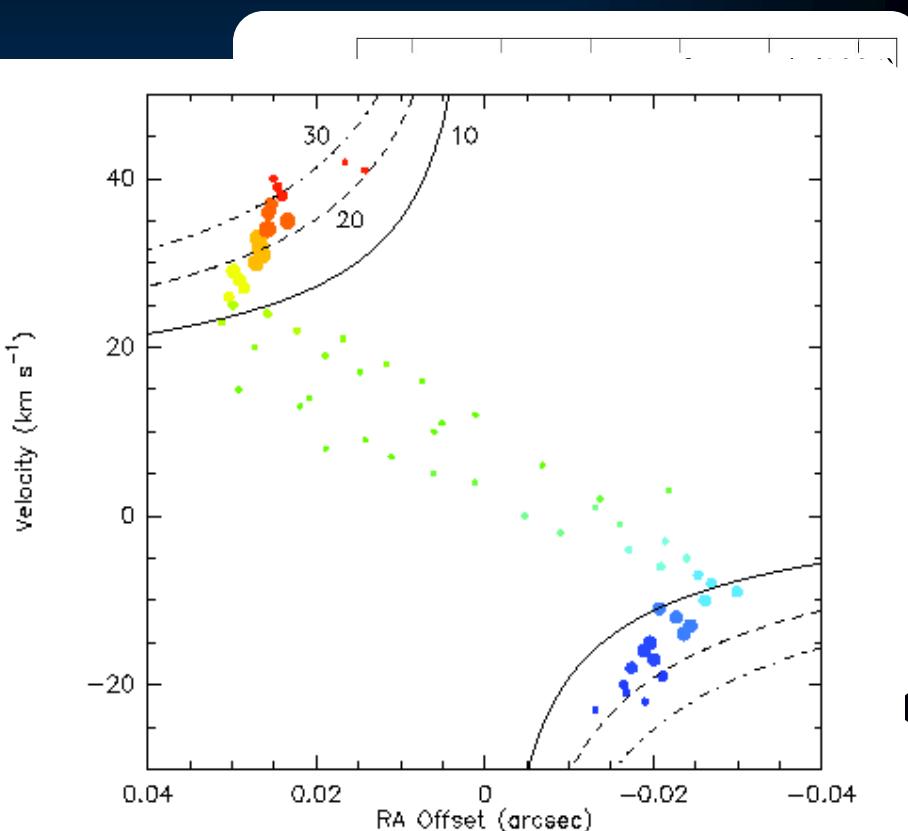
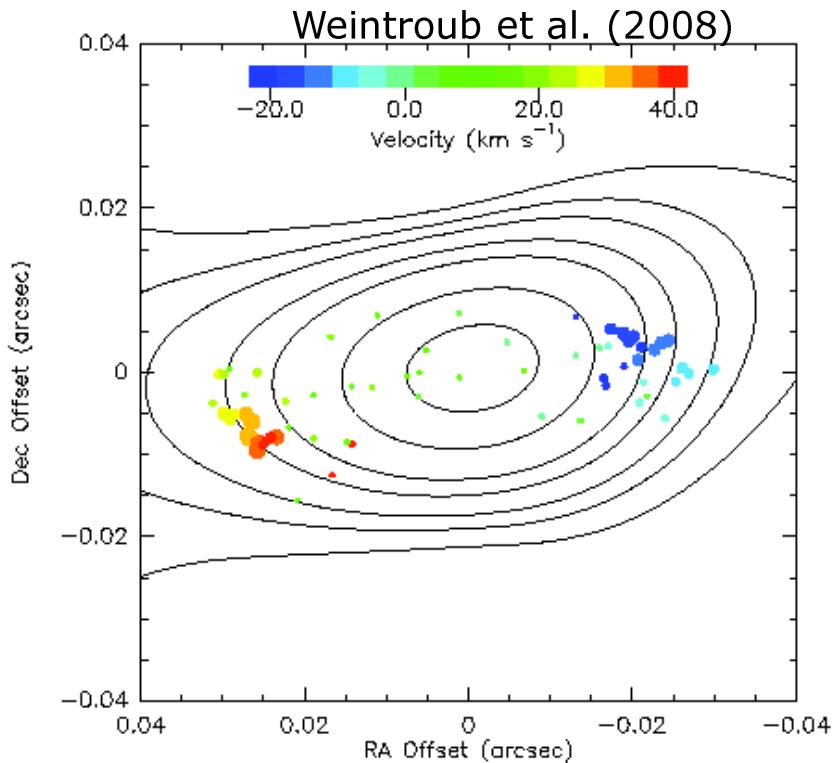
- binary stellar system:  
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- the two stars are separated by  $2.4'' \pm 0.1''$  and possibly interact
- MWC349A the brightest radio continuum star
- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ( $\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$ )
- at declination of  $> 40\text{deg}$   
-> visible for  $\sim 13\text{h}$  per day



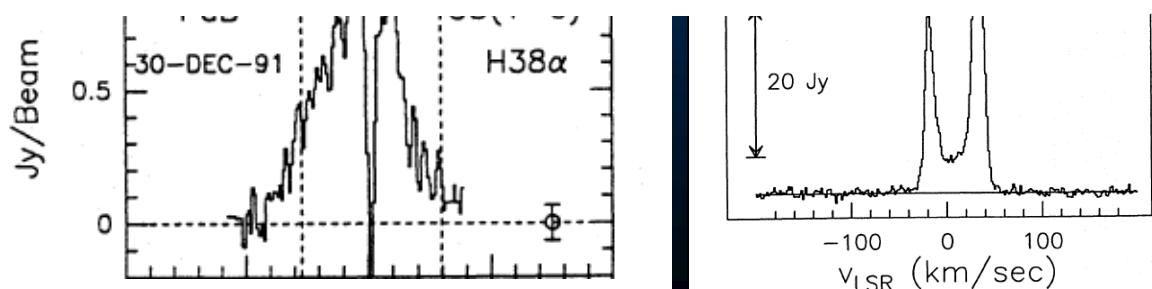
# Flux Calibrators: MWC349

## Some facts:

- binary stellar system:



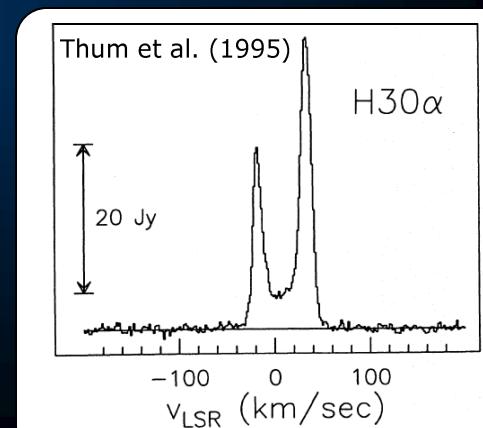
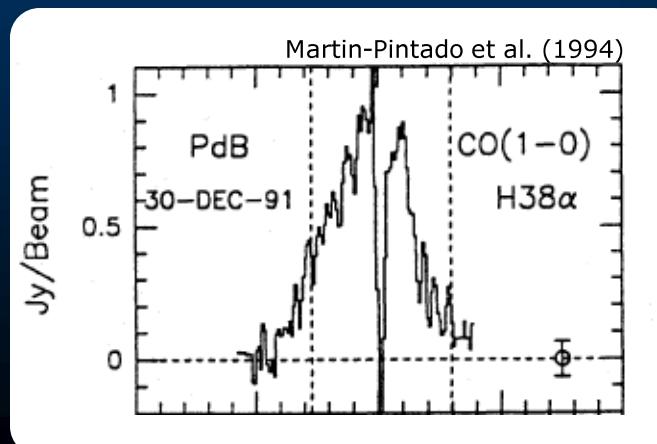
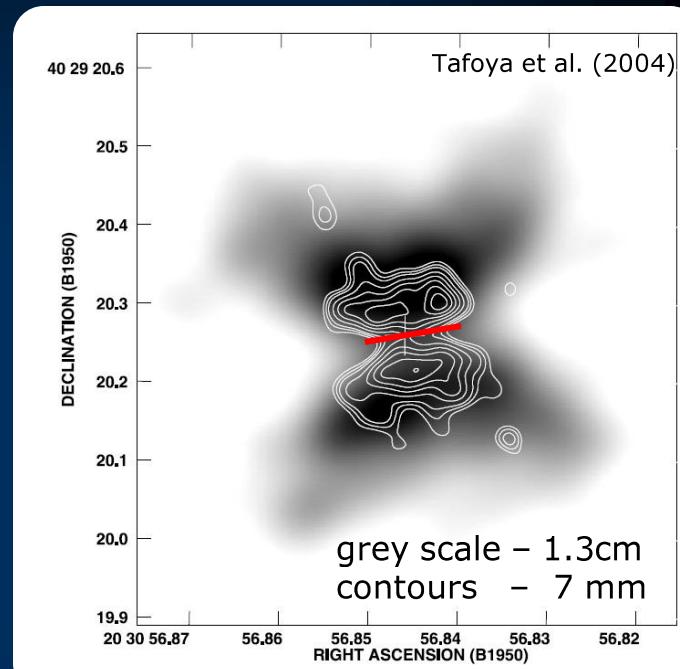
day



# Flux Calibrators: MWC349

## Some facts:

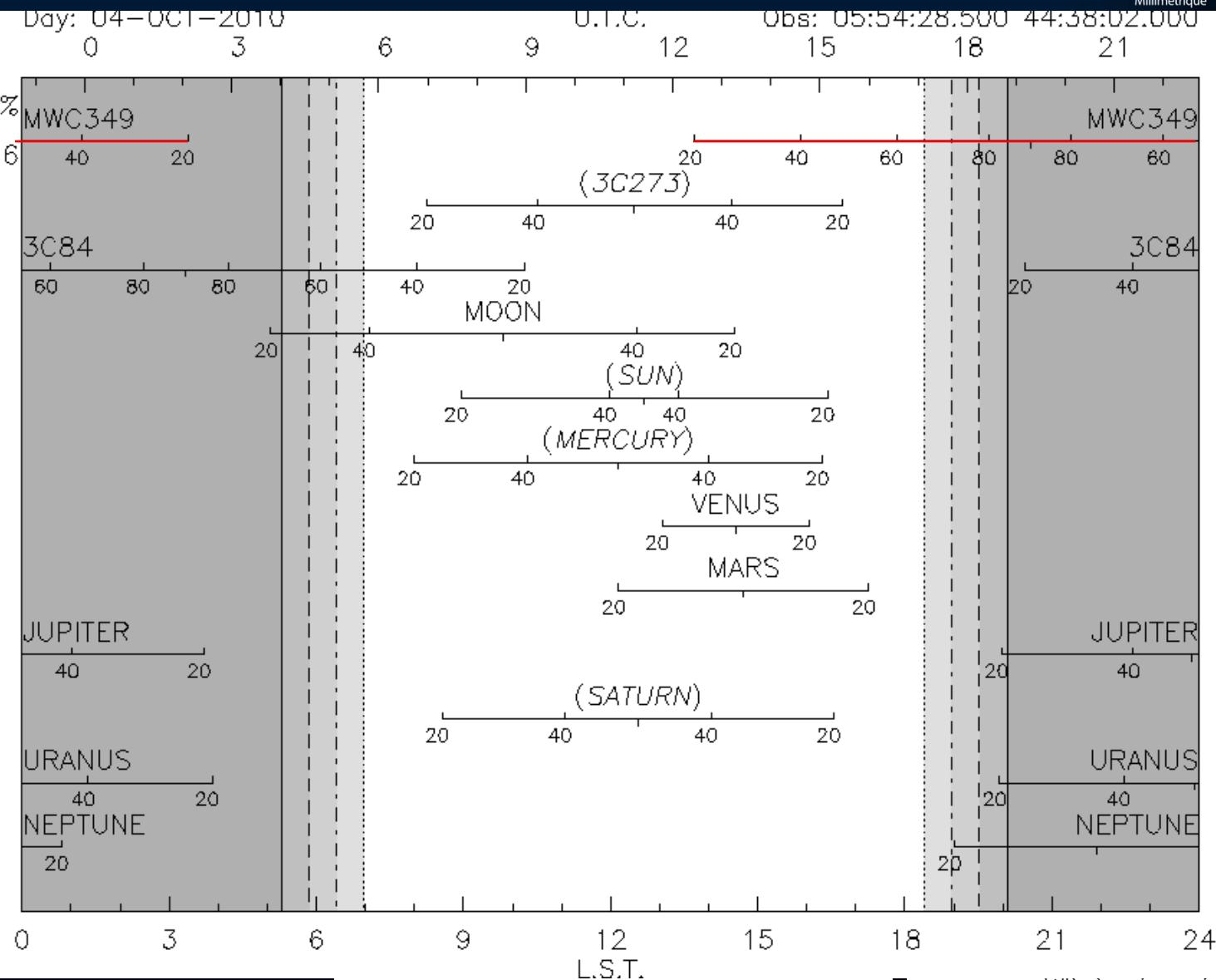
- binary stellar system:  
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- the two stars are separated by  $2.4'' \pm 0.1''$  and possibly interact
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- at declination of  $> 40\text{deg}$   
 $\Rightarrow$  visible for  $\sim 13\text{h}$  per day at Bure



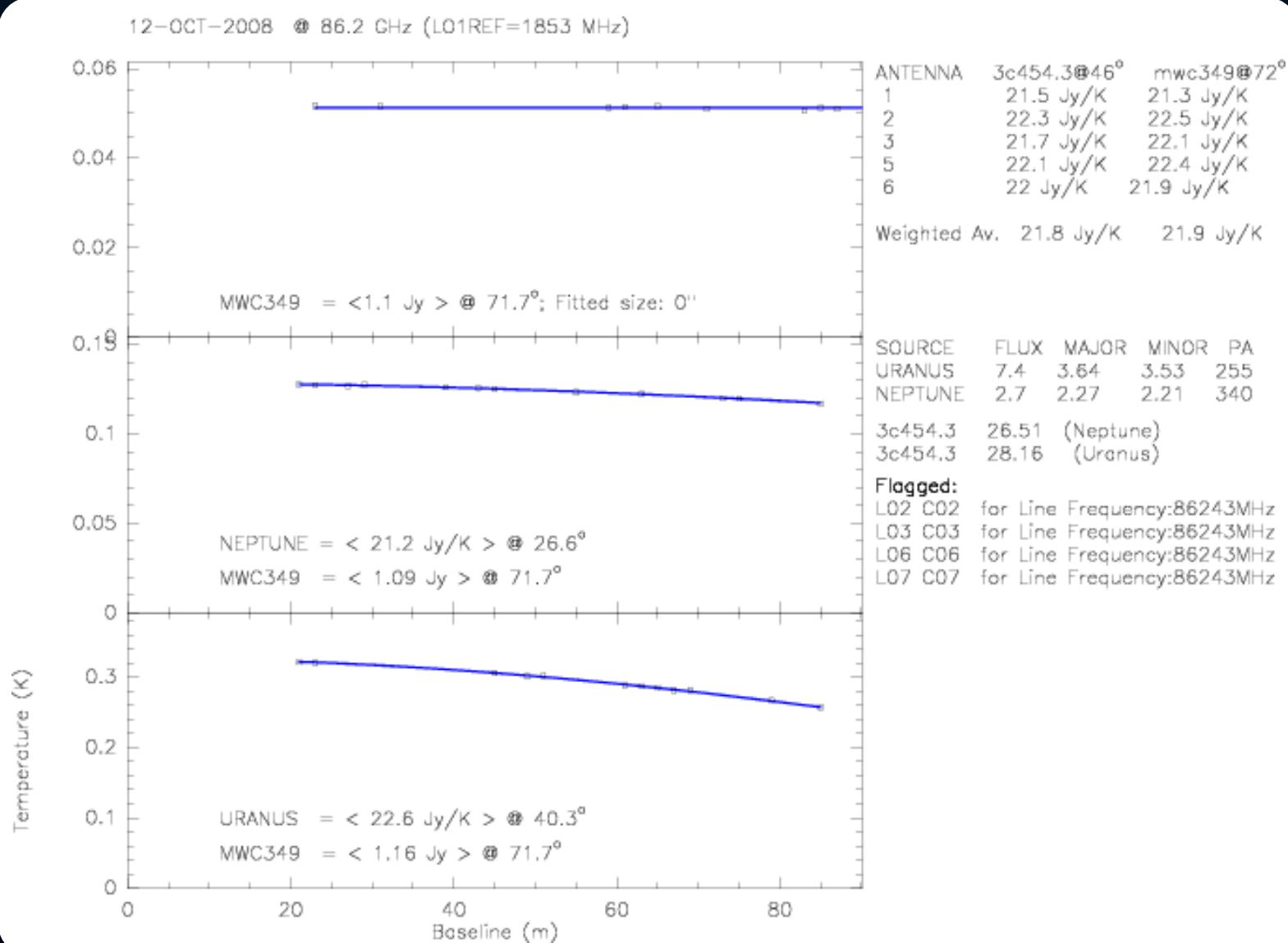
# Flux Calibrators: MWC349

## Sommaire

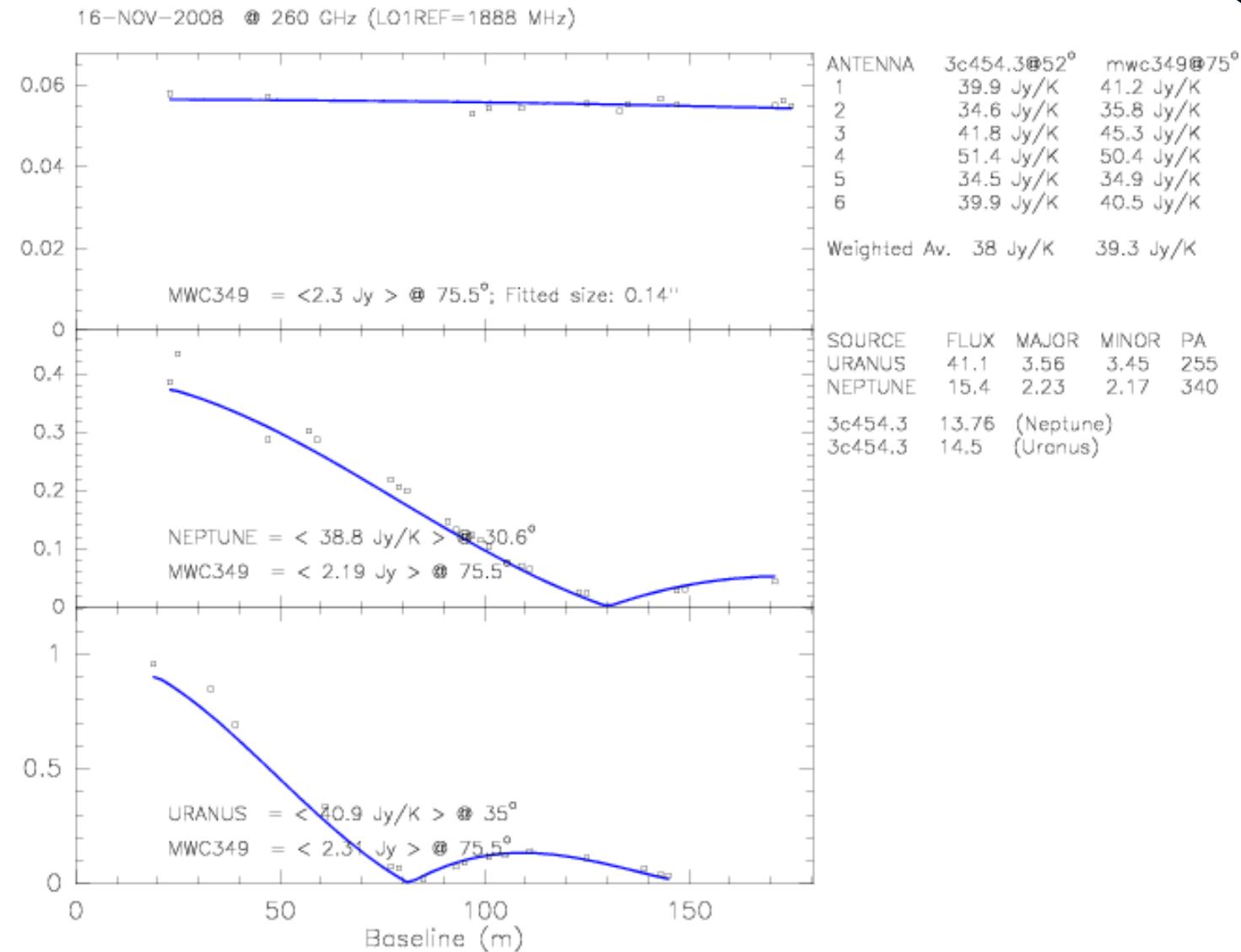
- binary
- MWC349
- the
- position
- MV
- radio
- flux
- of
- size
- structure
- energy
- (~)
- at
- =>
- data



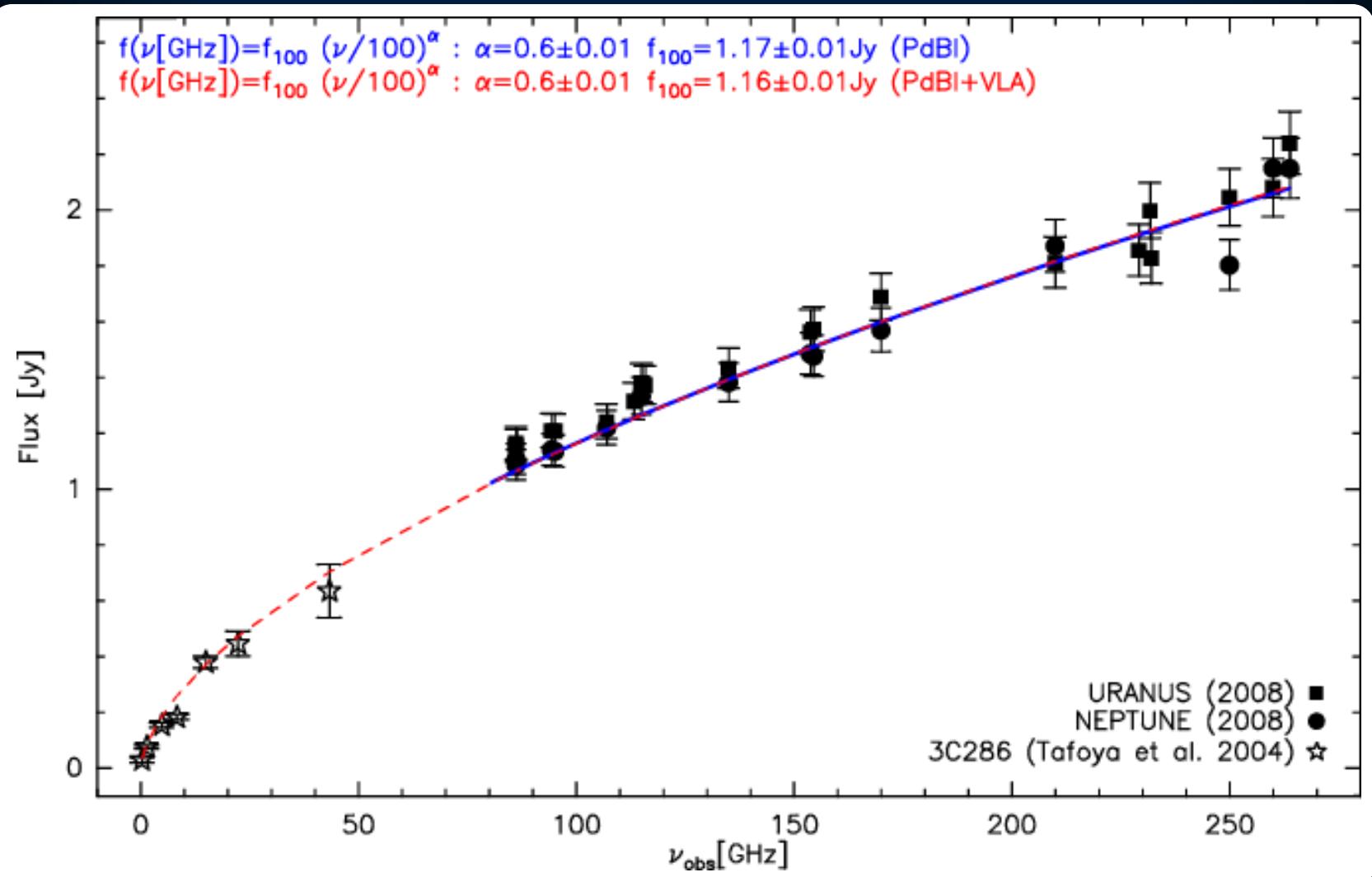
# How to calibrate a calibrator?



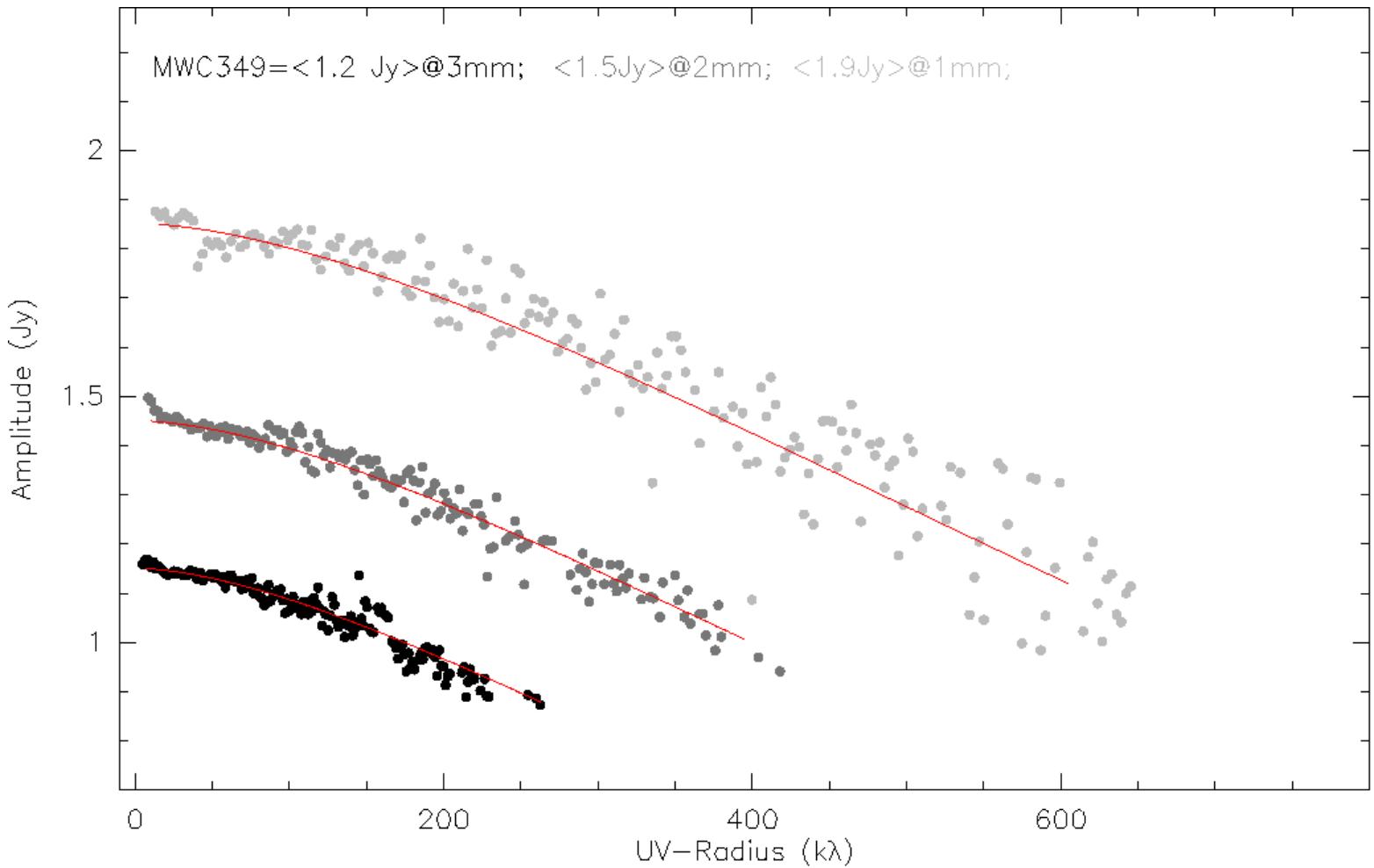
# How to calibrate a calibrator?



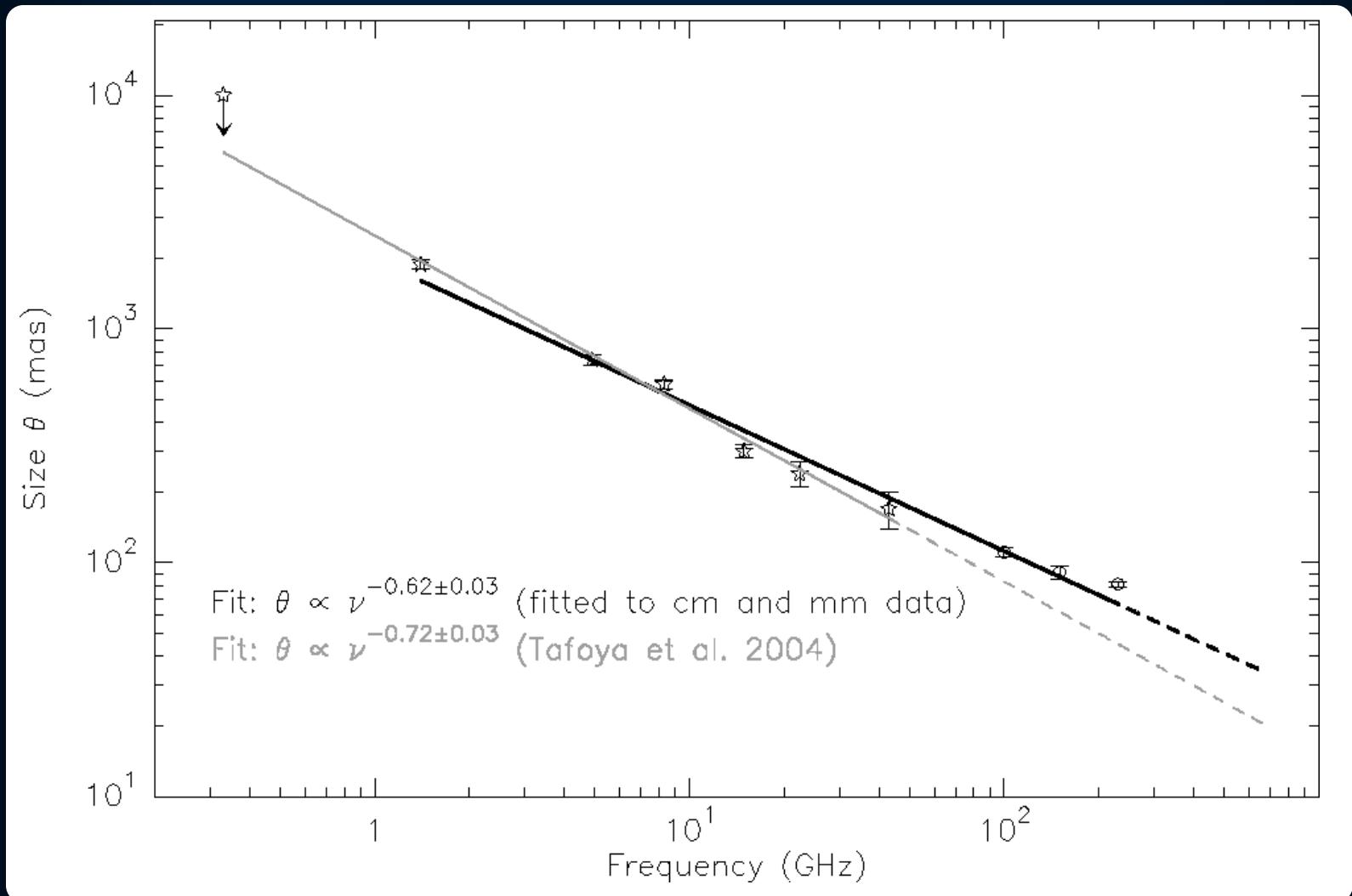
# Flux of MWC349: SED



# Size of MWC349



# Size of MWC349

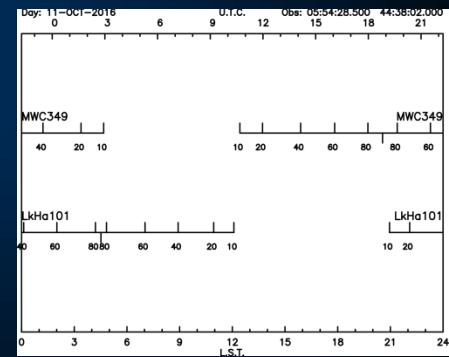


Reference radio bright stars:

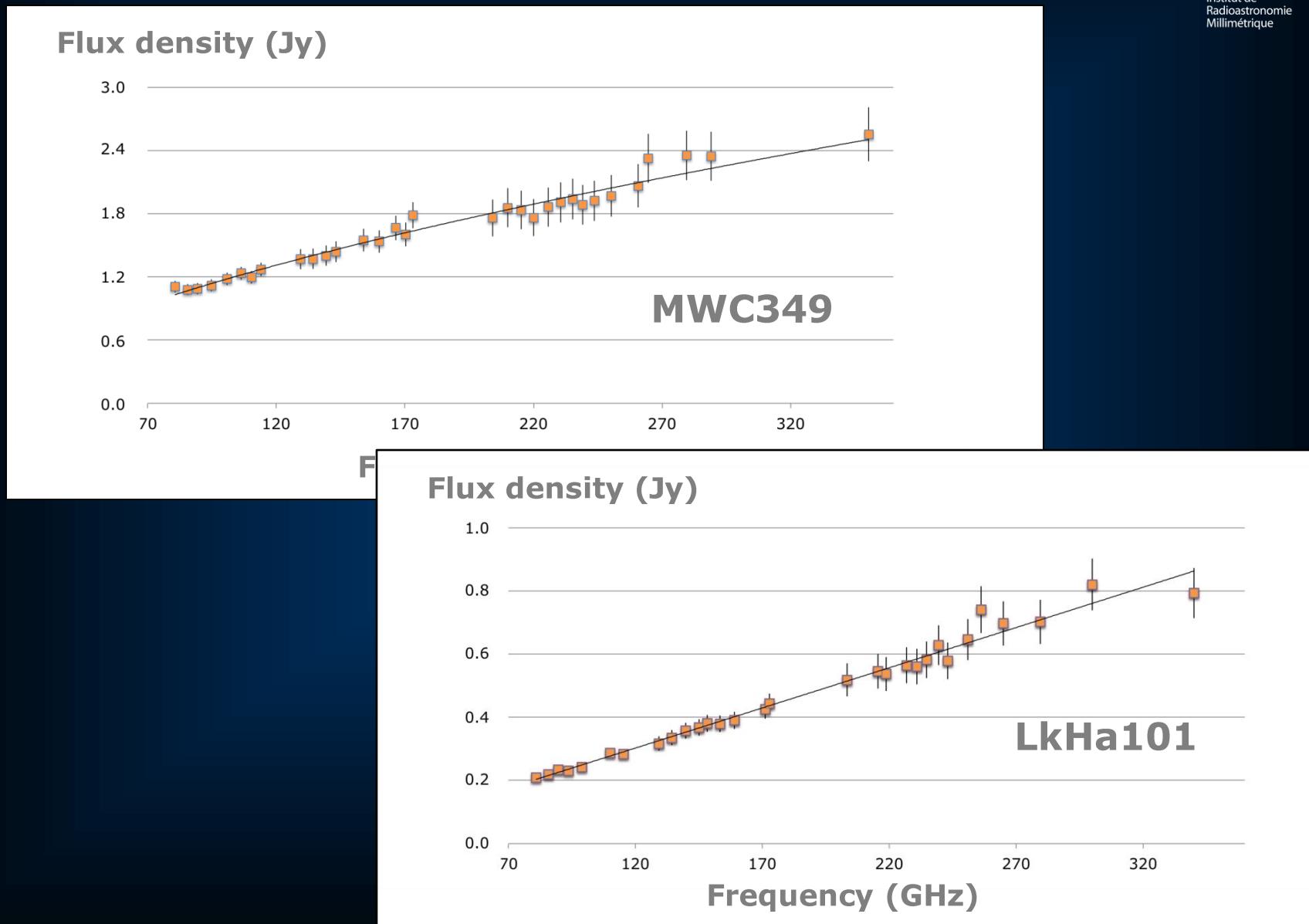
- MWC349

Reference radio bright stars:

- MWC349
- Since ~ 2013 we also use LkHa101
- LkHa101 covers the complementary observable LST
- 24h LST coverage with FLUX reference



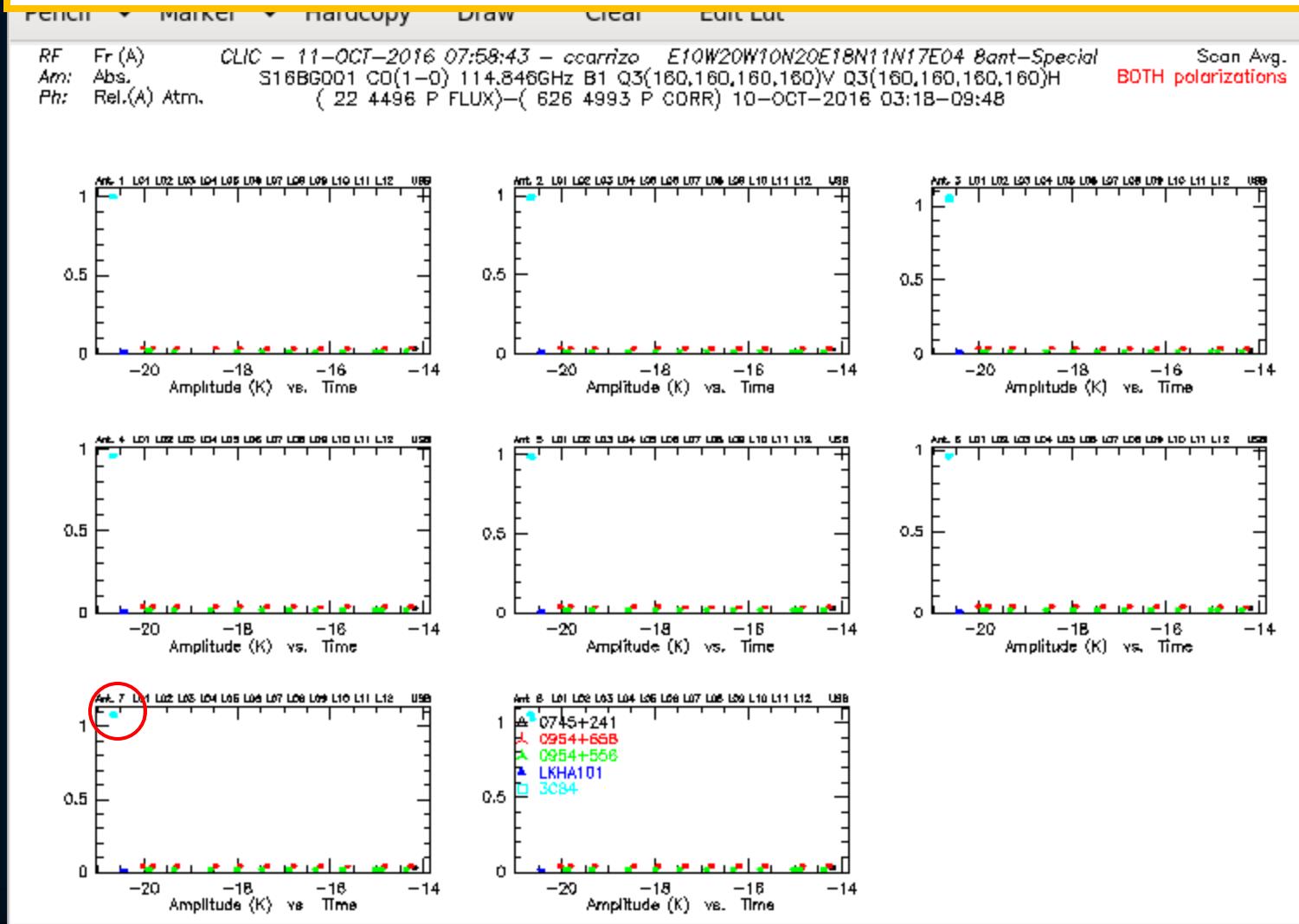
# Flux Calibrators: Radio Stars / our main references



1. Quasars
2. Planets
3. Solar Bodies  
(Satellites, Asteroids,  
Dwarf Planets)
4. Radio Stars

# Practical Tips

## Amplitudes vs time for all calibrators in Ta\* (K)



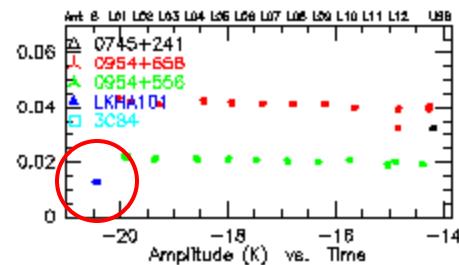
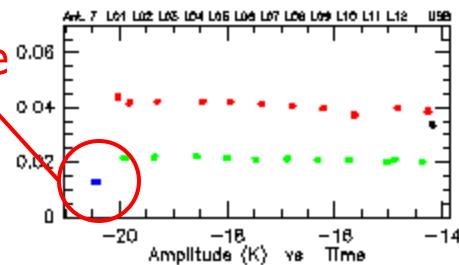
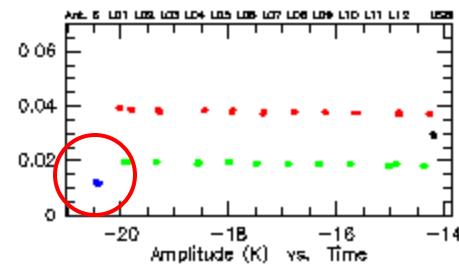
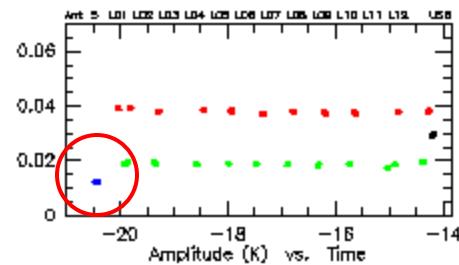
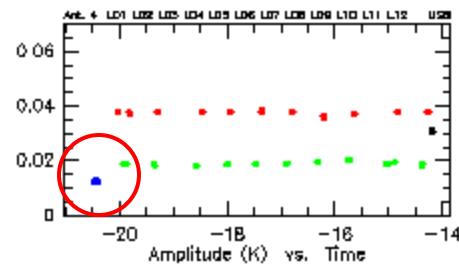
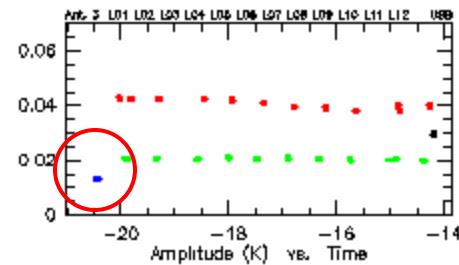
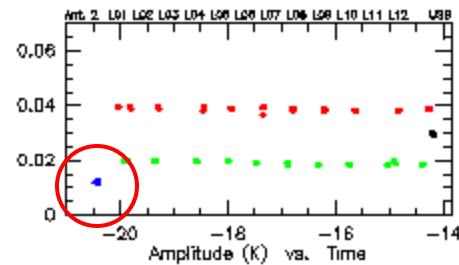
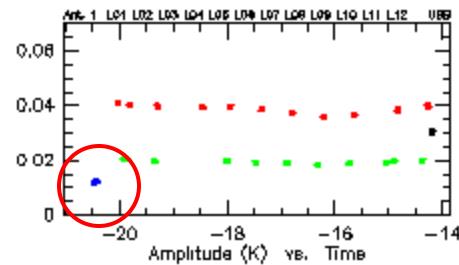
# Practical Tips

## Amplitudes vs time for all calibrators in Ta\* (K)

zoom

File Edit Marcopy Draw Clear Edit LUT  
CLIC - 11-OCT-2016 08:00:32 - ccarrizo E10W20W10N20E18N11N17E04 8ant-Special  
S16BG001 CO(1-0) 114.846GHz B1 Q3(160,160,160,160)V Q3(160,160,160,160)H  
( 22 4496 P FLUX)-( 626 4993 P CORR) 10-OCT-2016 03:18:09:48  
Scan Avg.  
**BOTH polarizations**

Ph: Rel.(A) Atm.

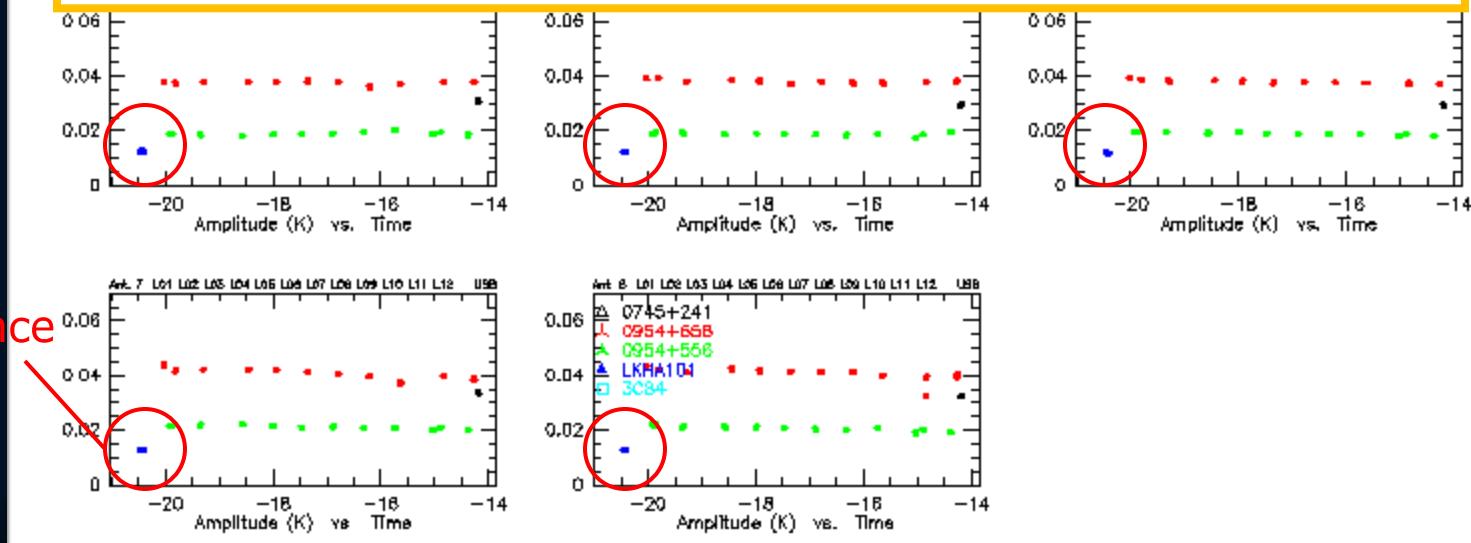


Flux  
reference

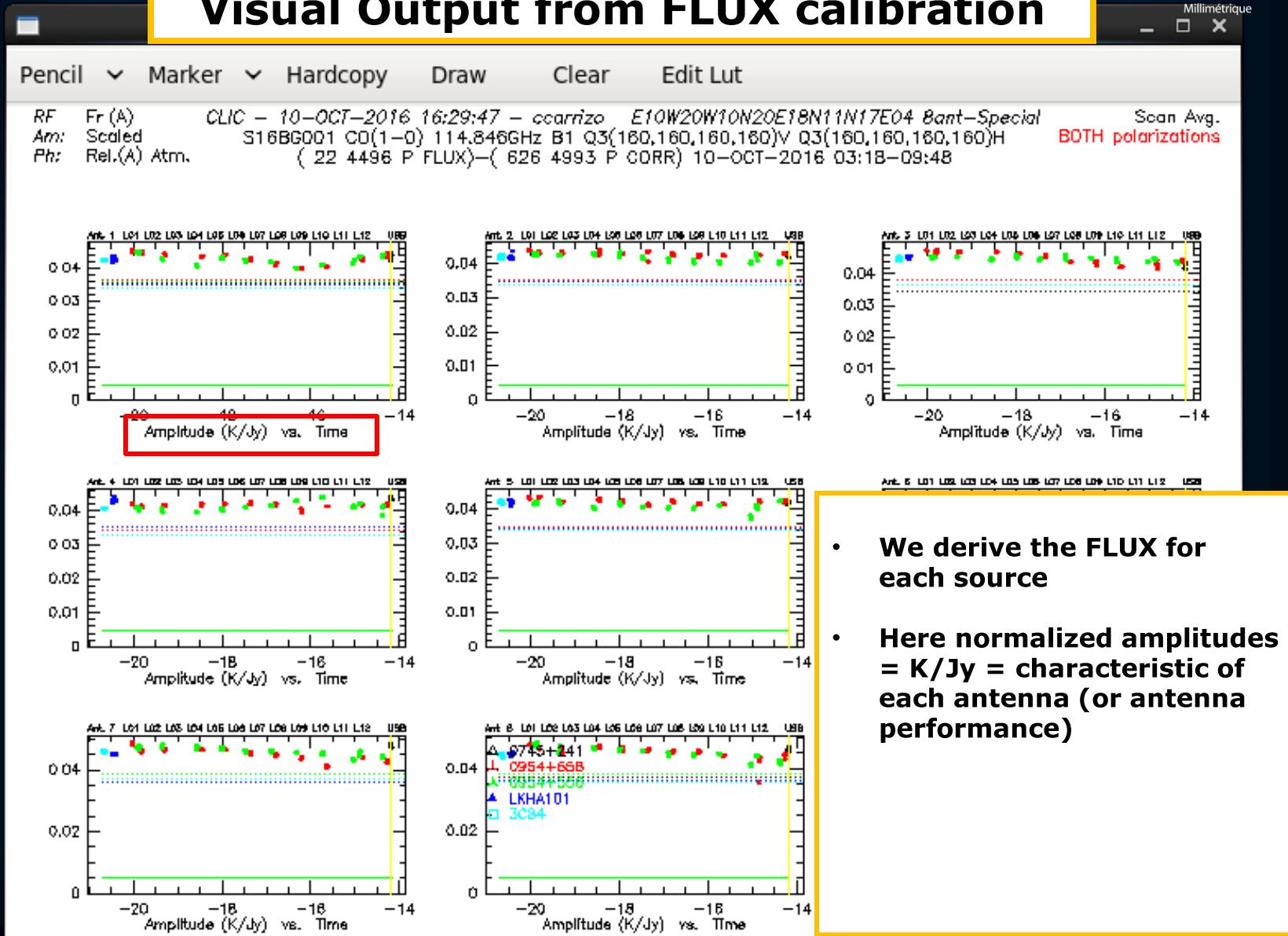
## Steps in flux calibration:

- 1) Fix the flux (Jy) of the reference calibrator
- 2) Estimate K/Jy factor (antenna efficiency)
- 3) Derive flux for other calibrators

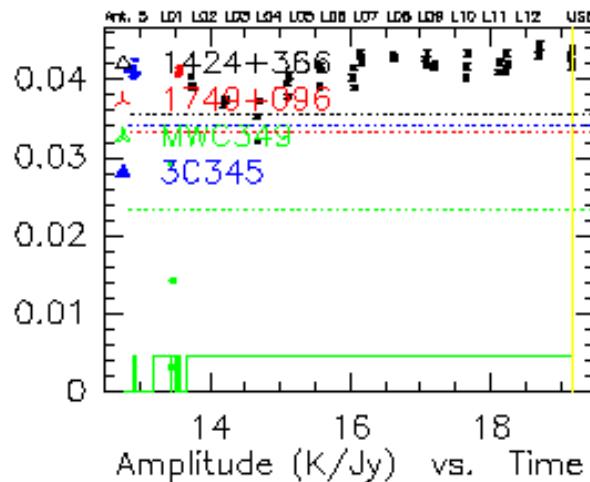
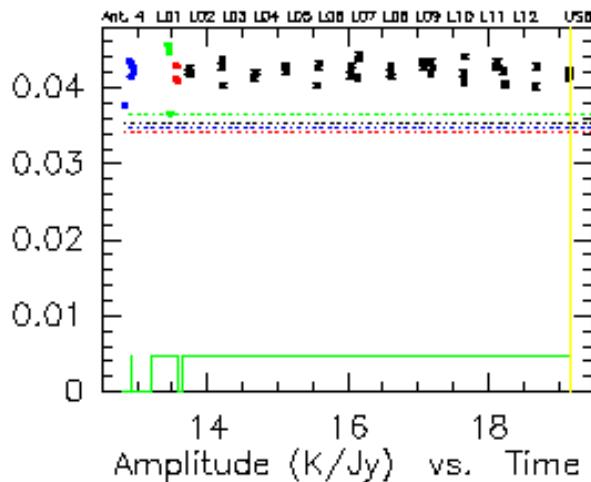
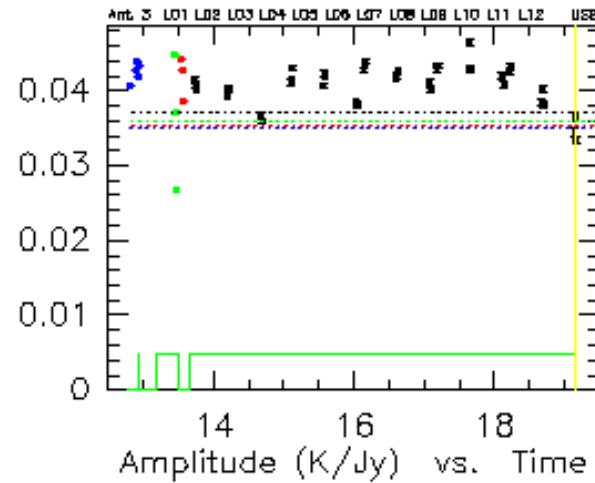
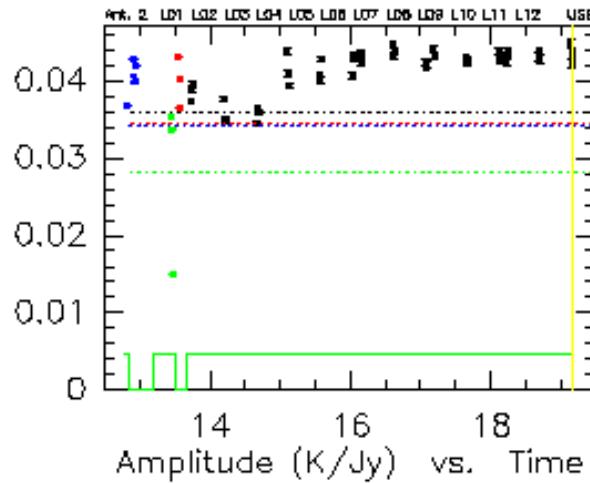
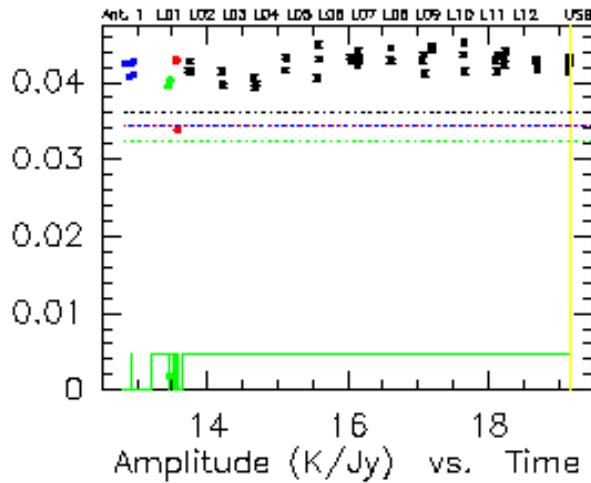
Final representation = normalized amplitudes = antenna efficiencies (Jy/K or K/Jy)



## Visual Output from FLUX calibration

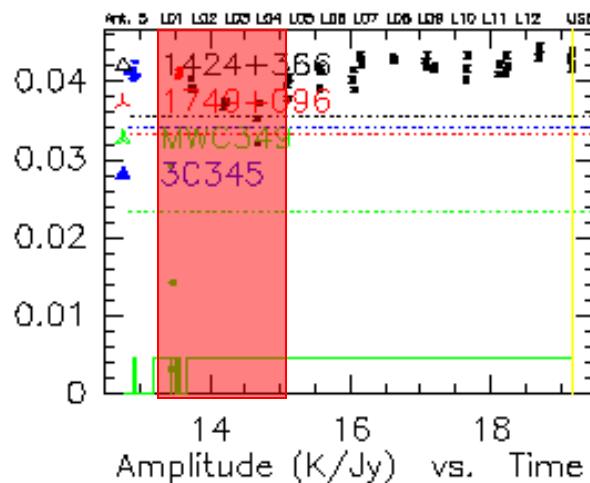
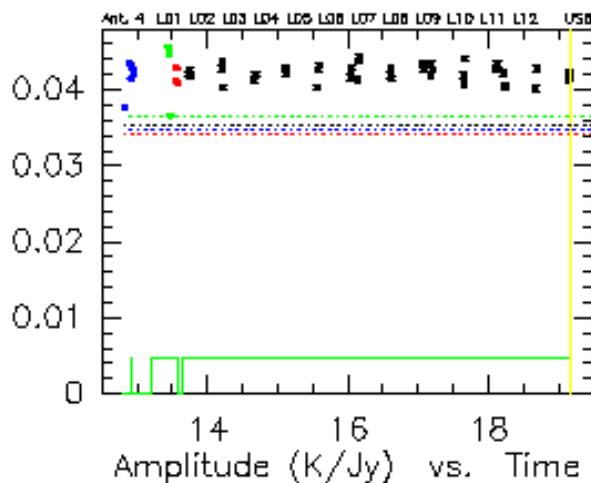
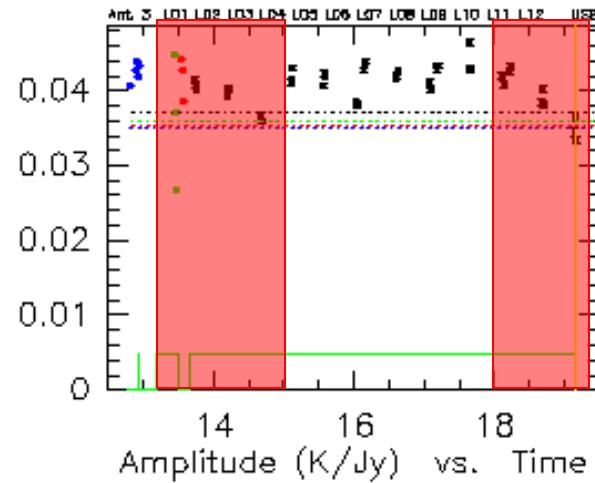
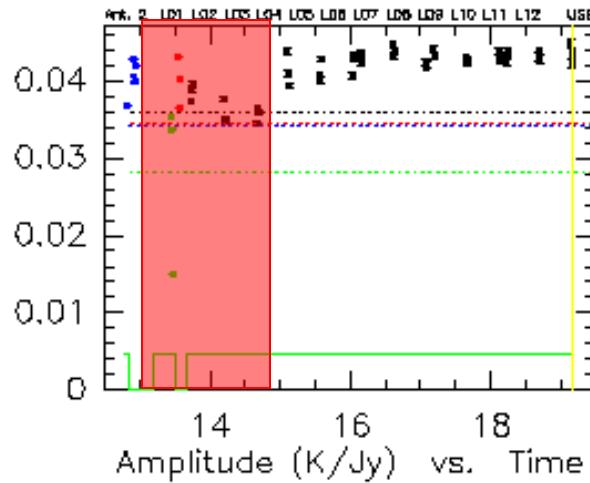
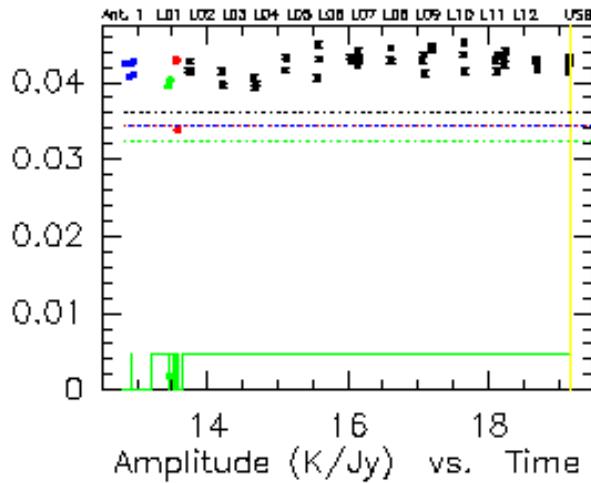


## Visual Output from FLUX calibration



- We derive the FLUX for each source
- Here normalized amplitudes = K/Jy = characteristic of each antenna (or antenna performance)
- If at some moment the performance/data are BAD and not representative – ignore that

## Visual Output from FLUX calibration



- We derive the FLUX for each source
- Here normalized amplitudes = K/Jy = characteristic of each antenna (or antenna performance)
- If at some moment the performance/data are BAD and not representative – ignore that

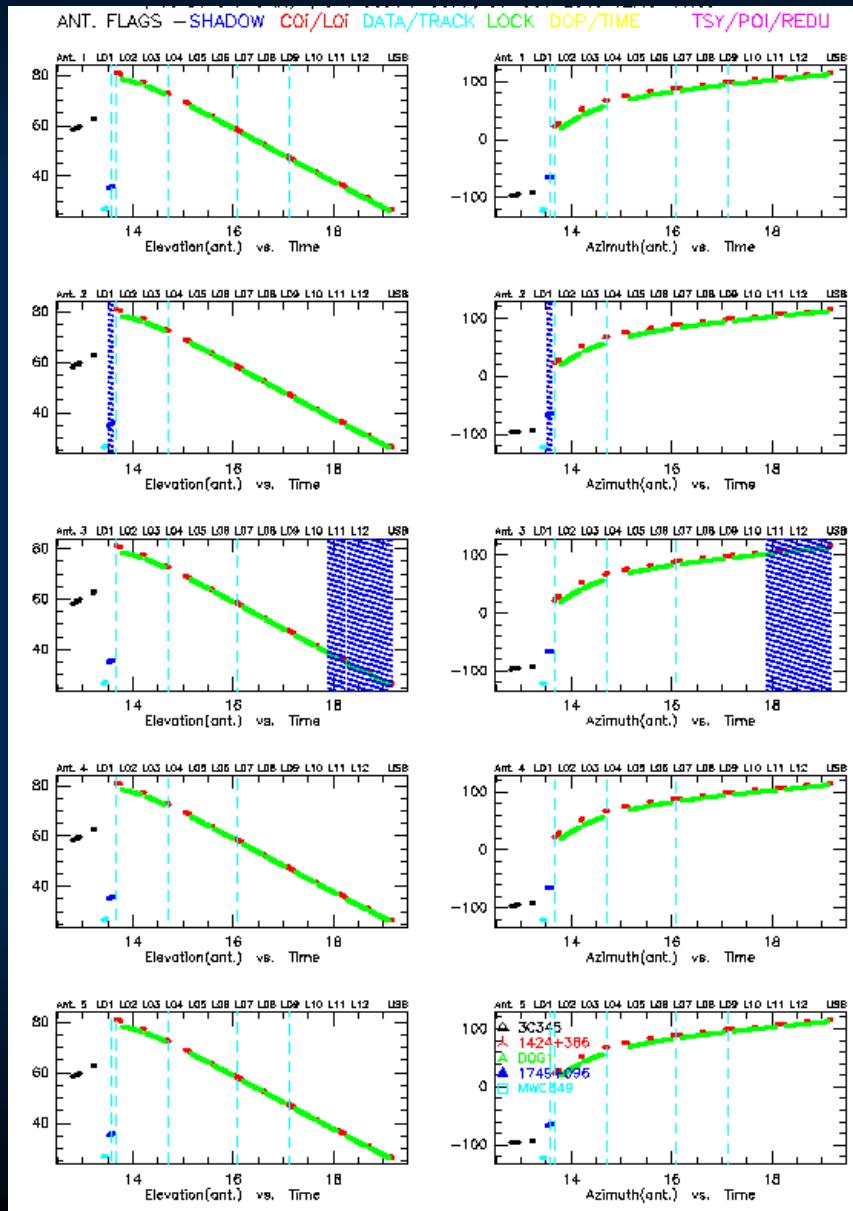
## Which are the issues to consider?

Checklist:

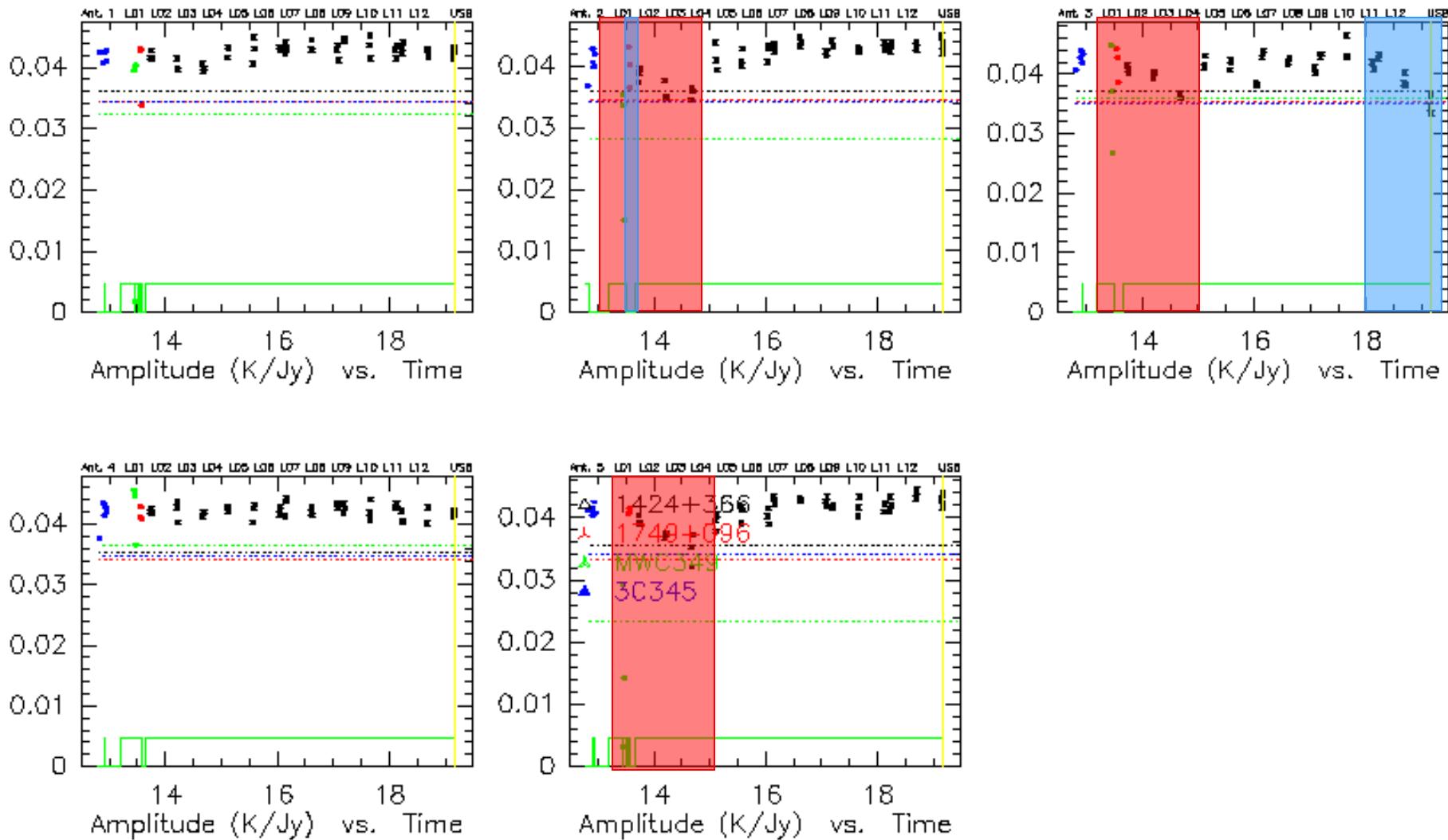
- Antenna Shadowing
- Pointing/Focus Problems
- Tracking Problems
- Noisy data
- Has Flux Calibrator Lines?
- Is Flux Calibrator Extended?
- Check Elevation of your source
- Check whether source is polarised  
(only important when using one polarisation)
- Do phases of different spectral windows overlap?

# Practical Tips: Shadowing

## First Look



# Practical Tips: Shadowing



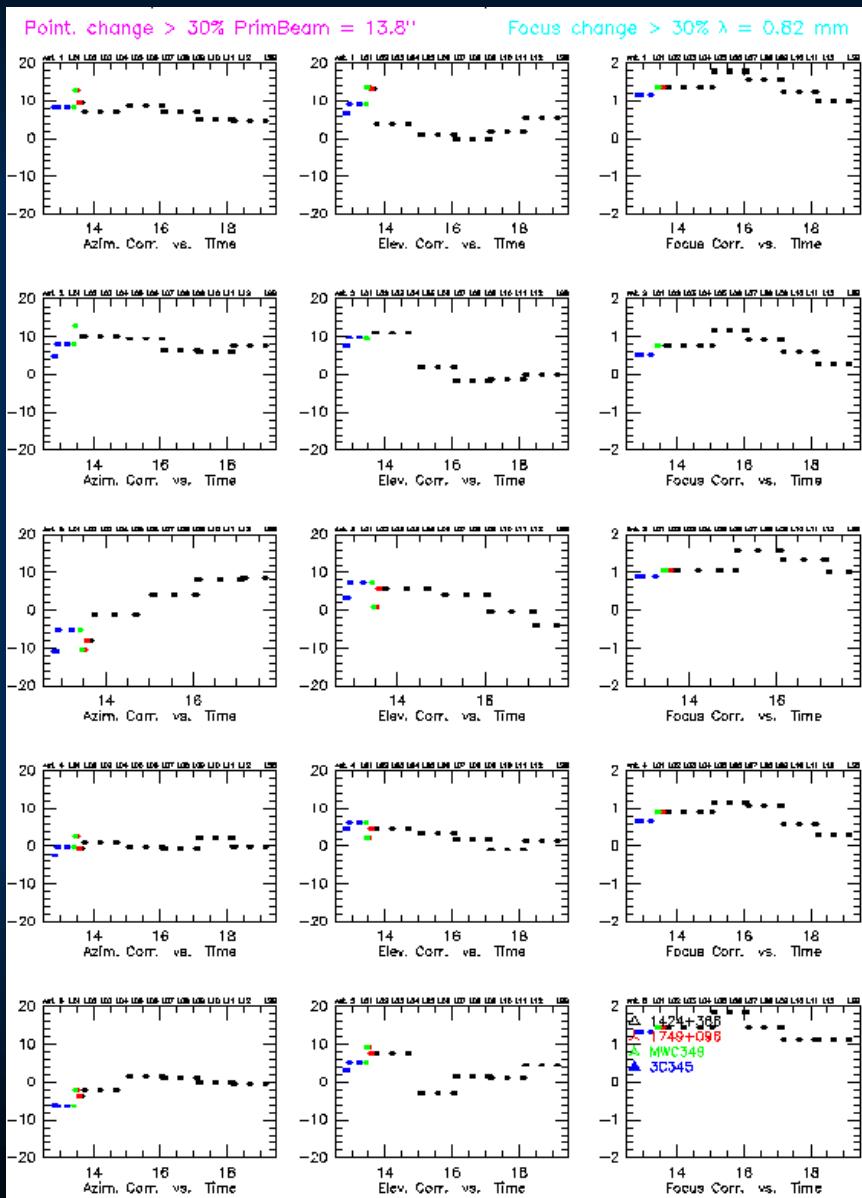
## Which are the issues to consider?

Checklist:

- Antenna Shadowing
- Pointing/Focus Problems
- Tracking Problems
- Noisy data
- Has Flux Calibrator Lines?
- Is Flux Calibrator Extended?
- Check Elevation of your source
- Check whether source is polarised  
(only important when using one polarisation)
- Do phases of different spectral windows overlap?

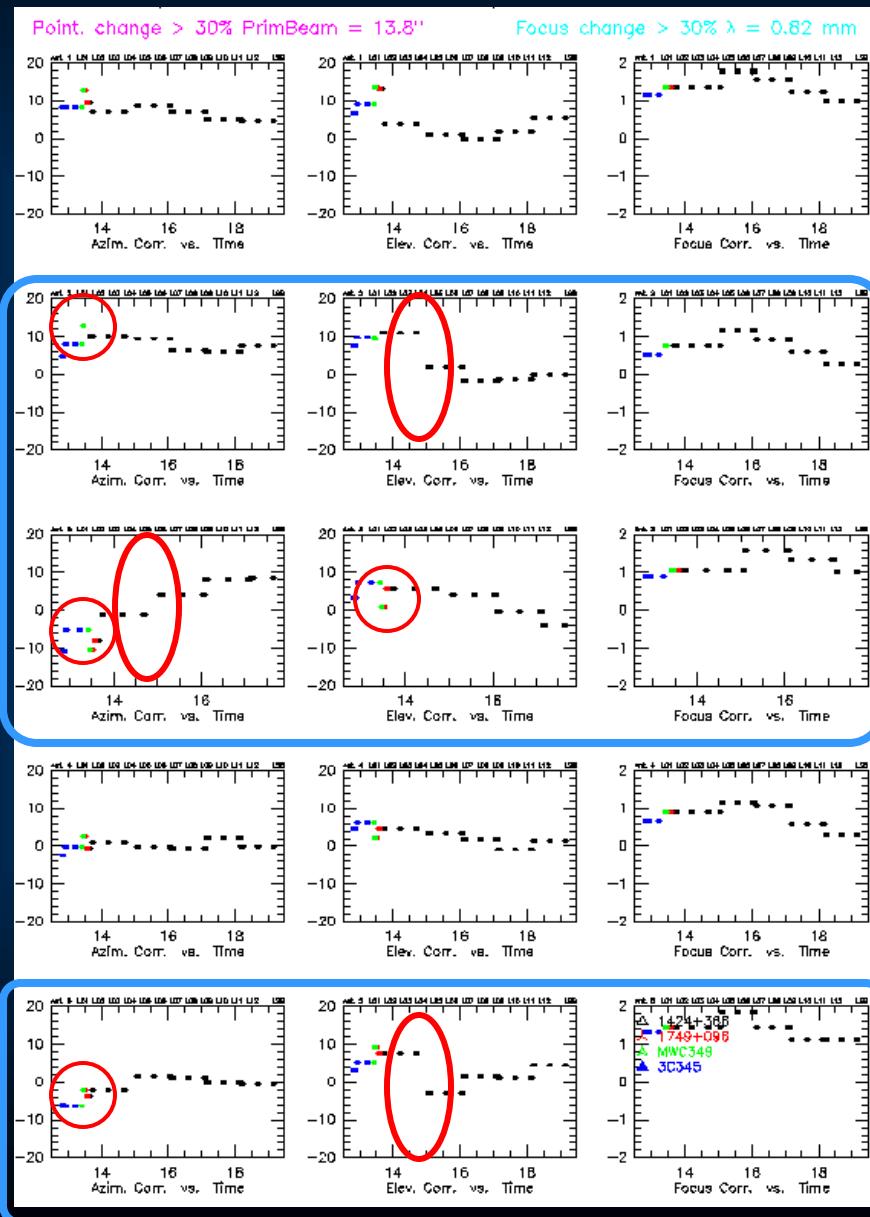
# Practical Tips: Pointing/Focus

## First Look

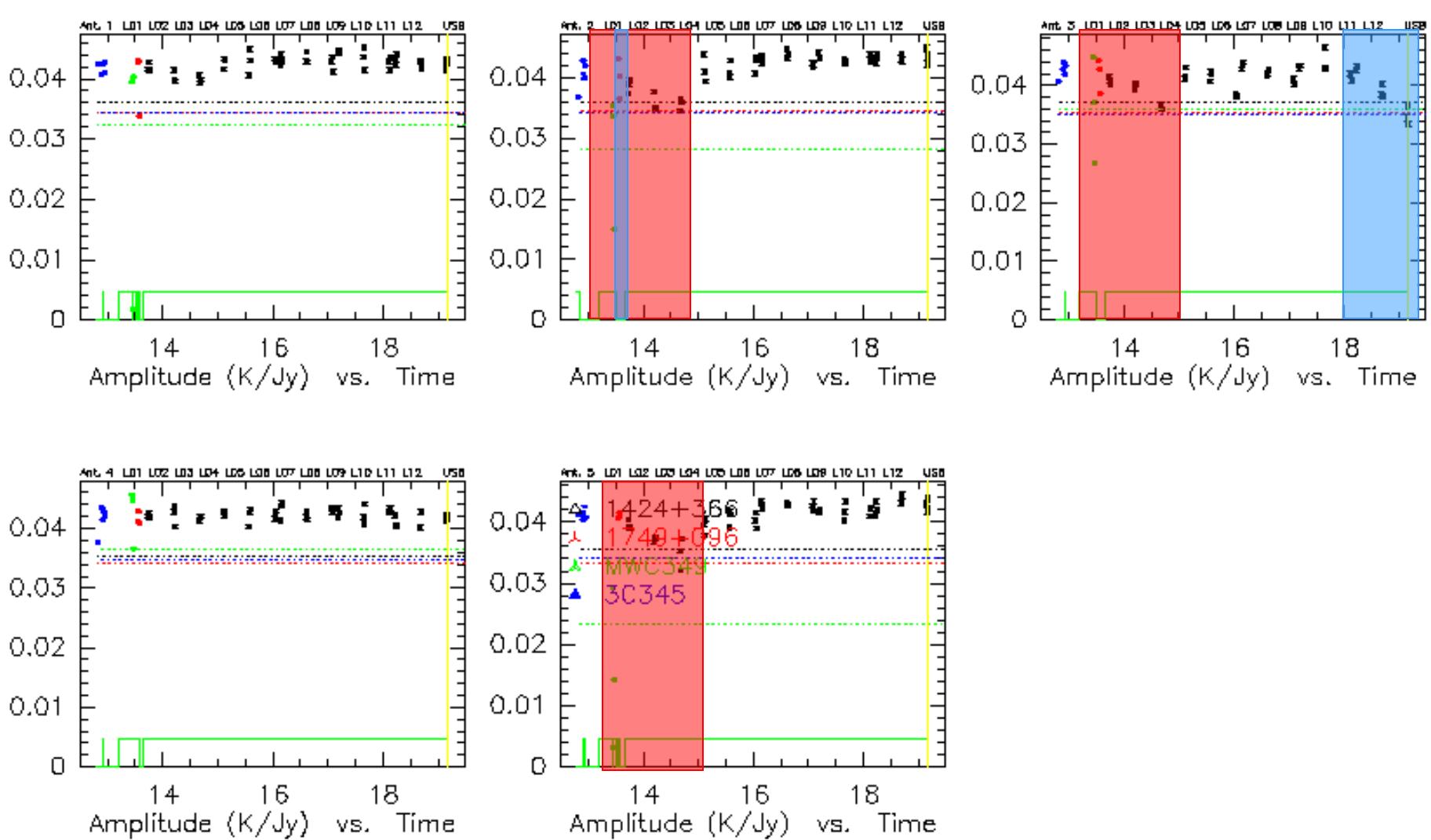


# Practical Tips: Pointing/Focus

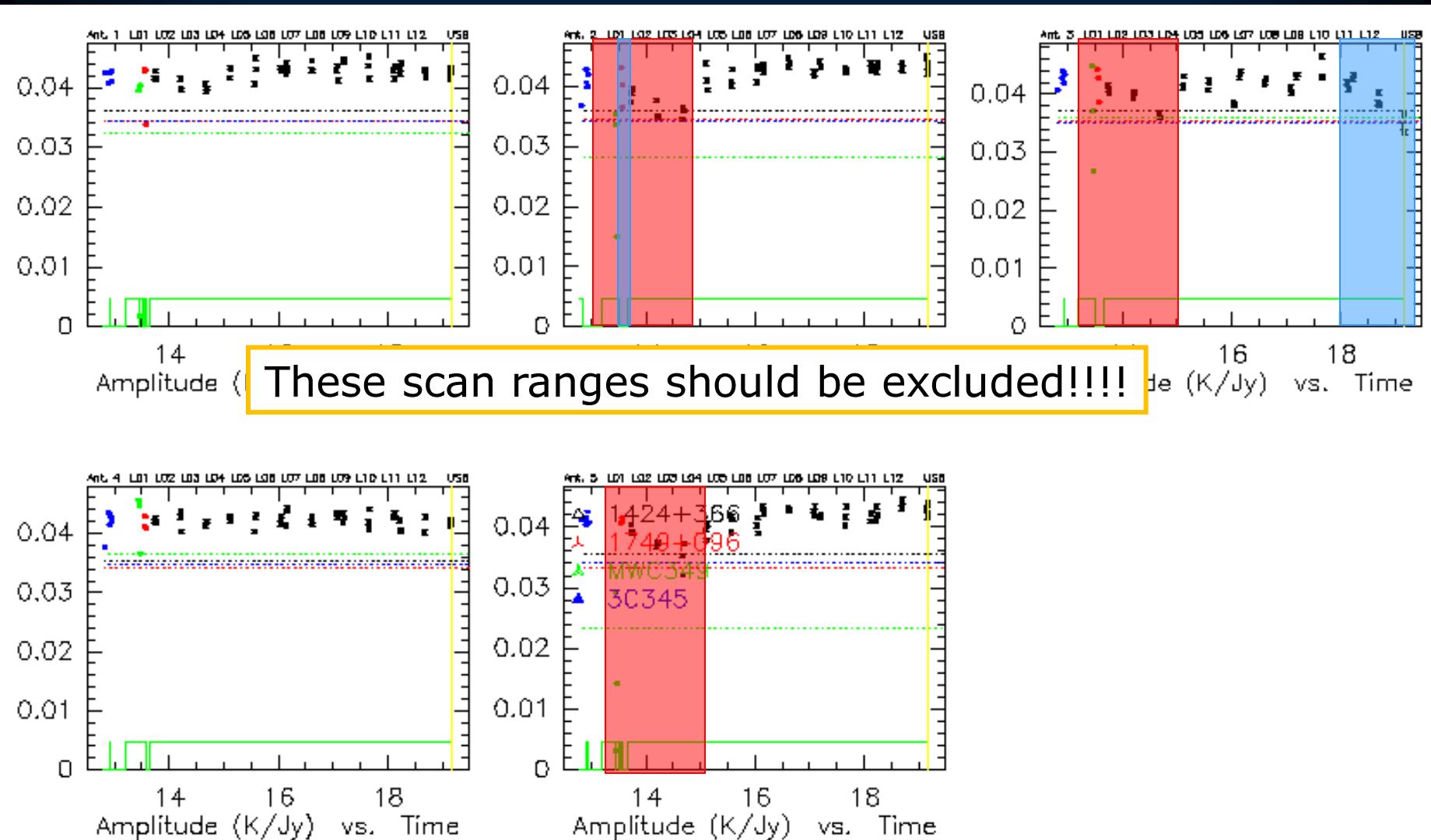
## First Look



# Practical Tips



# Practical Tips

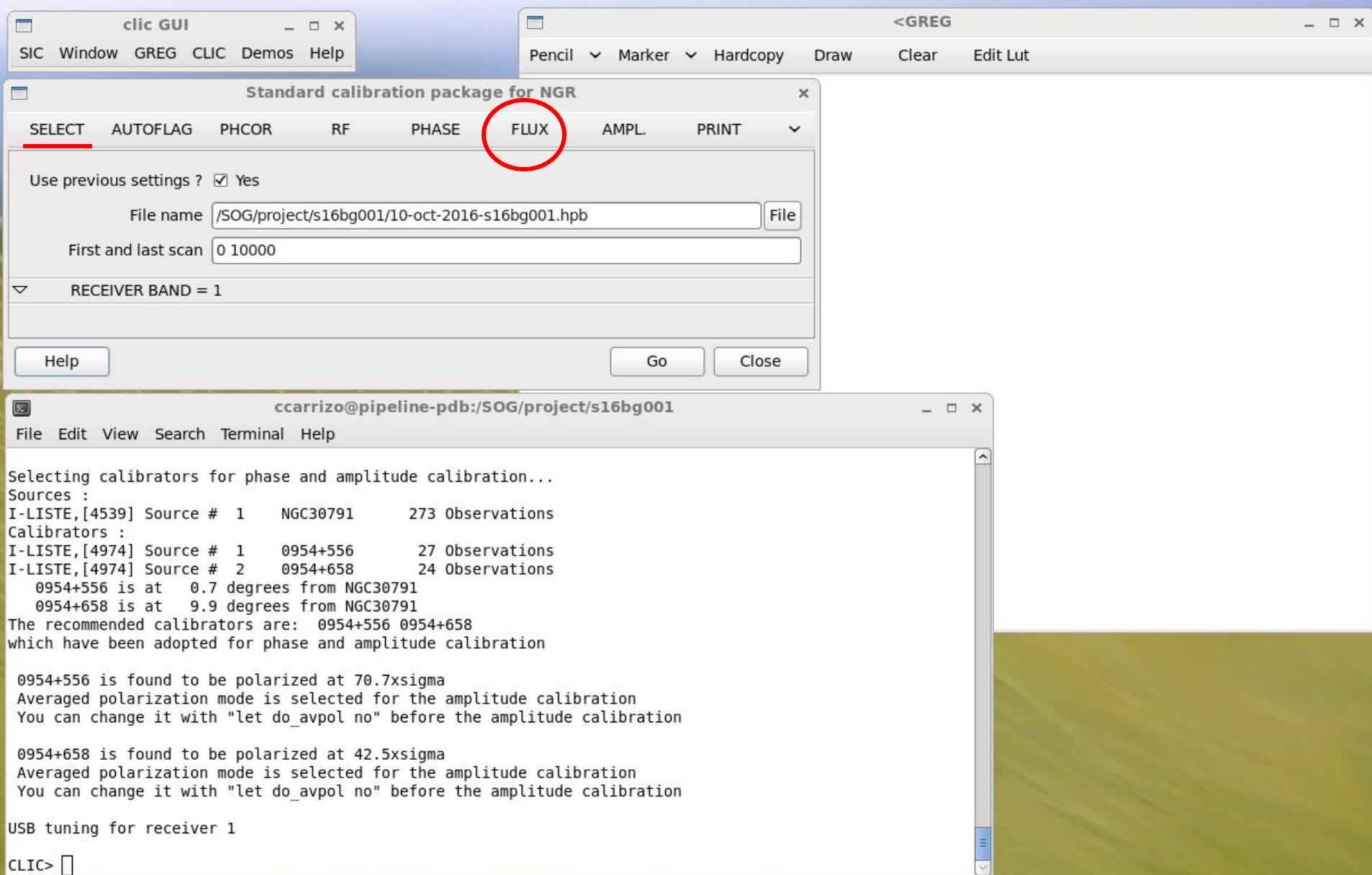


## Which are the issues to consider?

Checklist:

- Antenna Shadowing
- Pointing/Focus Problems
- Tracking Problems
- Noisy data
- Has Flux Calibrator Lines?
- Is Flux Calibrator Extended?
- Check Elevation of your source
- Check whether source is polarised  
(only important when using one polarisation)
- Do phases of different spectral windows overlap?

# Practical Tips: CLIC software tools



The screenshot displays two windows. The top window is the 'Standard calibration package for NGR' dialog from the 'clic GUI'. It has tabs for SELECT, AUTOFLAG, PHCOR, RF, PHASE, FLUX (which is circled in red), AMPL, and PRINT. Under the FLUX tab, there is a checkbox 'Use previous settings ?' followed by a checked 'Yes'. A file name is set to '/SOG/project/s16bg001/10-oct-2016-s16bg001.hpb' with a 'File' button. The 'First and last scan' field contains '0 10000'. A section labeled 'RECEIVER BAND = 1' is expanded. At the bottom are 'Help', 'Go', and 'Close' buttons. The bottom window is a terminal window titled 'ccarrizo@pipeline-pdb:/SOG/project/s16bg001'. It shows the following text:

```
Selecting calibrators for phase and amplitude calibration...
Sources :
I-LISTE,[4539] Source # 1 NGC30791 273 Observations
Calibrators :
I-LISTE,[4974] Source # 1 0954+556 27 Observations
I-LISTE,[4974] Source # 2 0954+658 24 Observations
 0954+556 is at 0.7 degrees from NGC30791
 0954+658 is at 9.9 degrees from NGC30791
The recommended calibrators are: 0954+556 0954+658
which have been adopted for phase and amplitude calibration

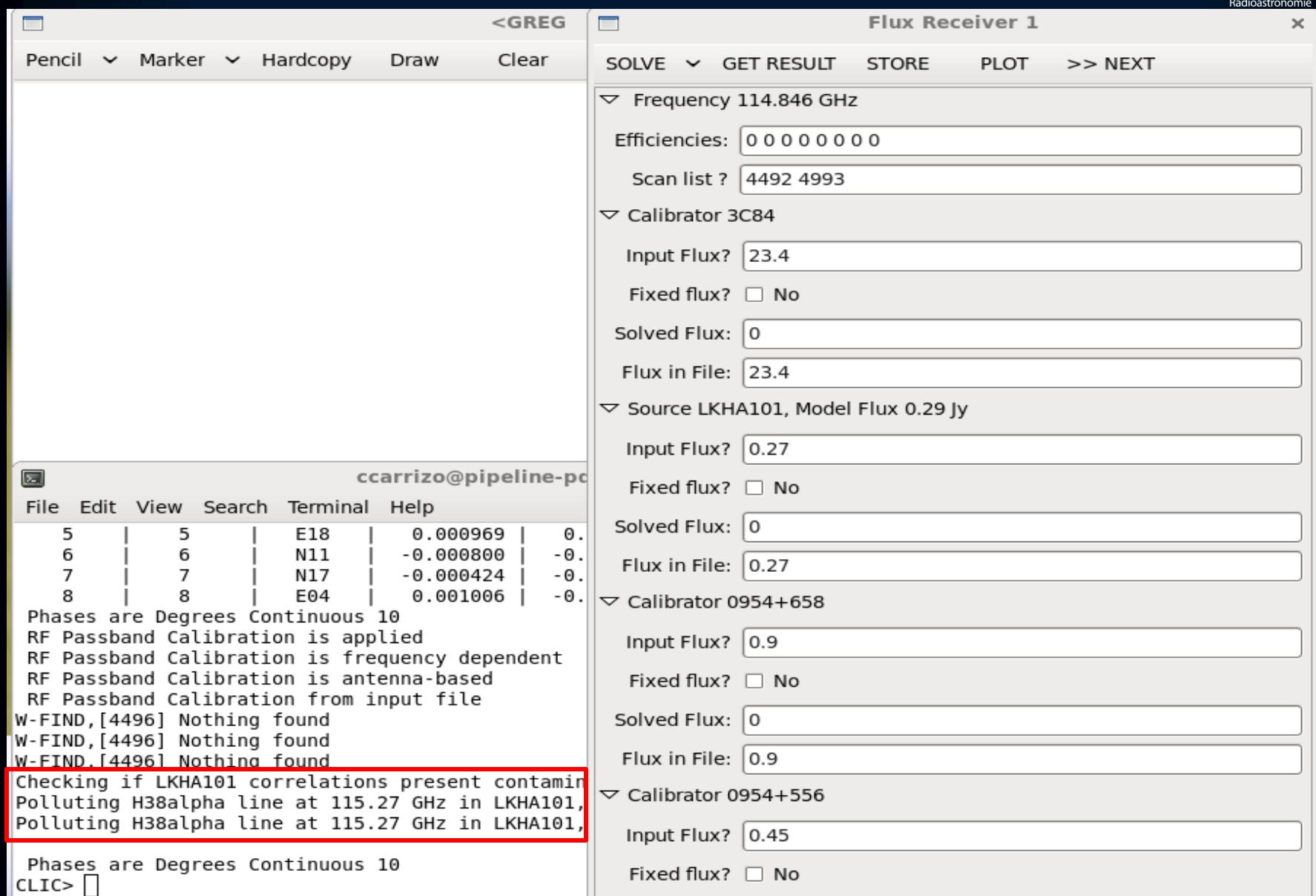
0954+556 is found to be polarized at 70.7xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

0954+658 is found to be polarized at 42.5xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

USB tuning for receiver 1

CLIC> 
```

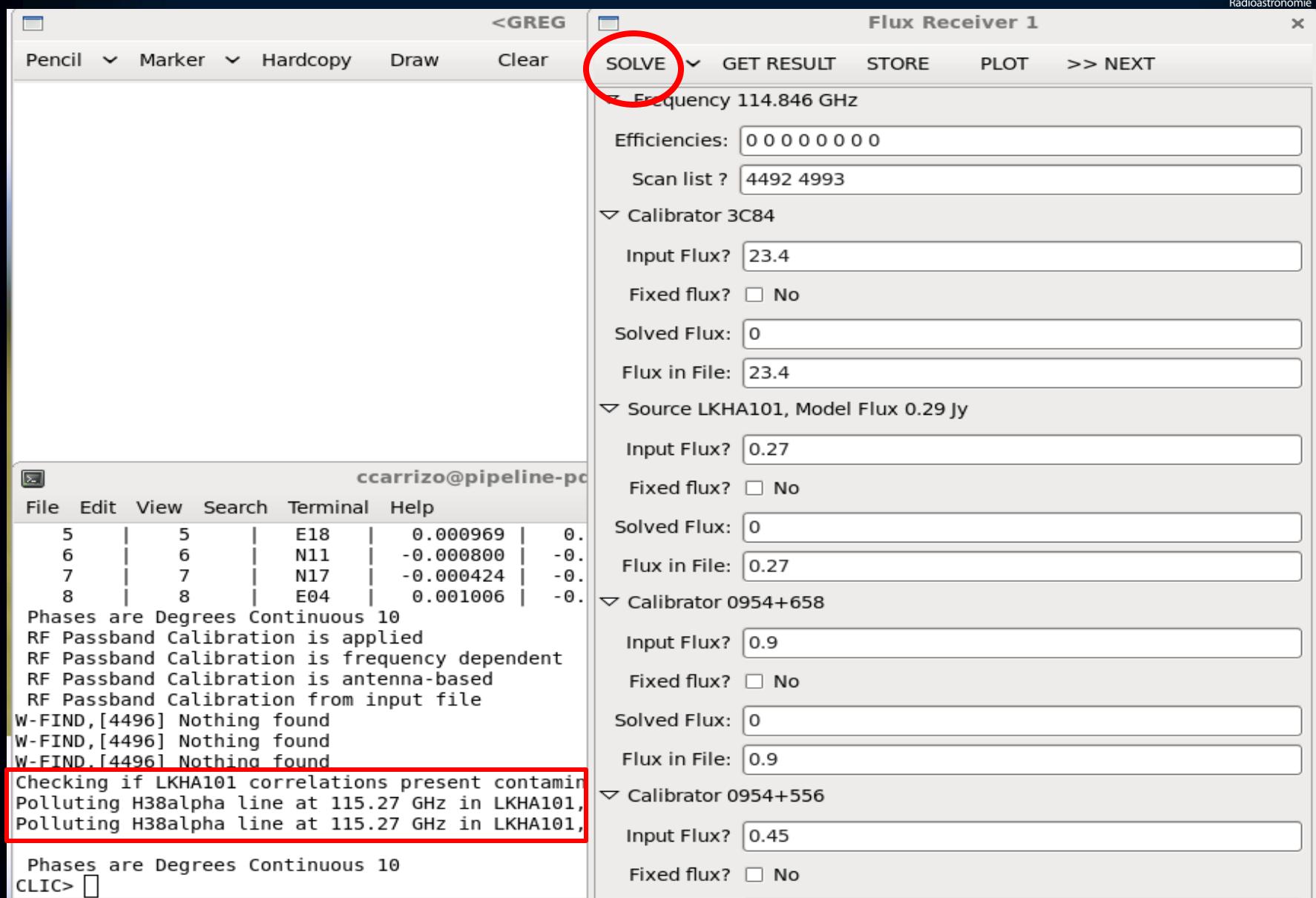
# Practical Tips: CLIC software tools



The image shows three windows side-by-side:

- GREG Window:** A menu bar with "Pencil", "Marker", "Hardcopy", "Draw", and "Clear".
- Flux Receiver 1 Window:** A menu bar with "SOLVE", "GET RESULT", "STORE", "PLOT", and ">> NEXT".
  - Frequency 114.846 GHz:** Efficiencies: 0 0 0 0 0 0 0, Scan list?: 4492 4993
  - Calibrator 3C84:** Input Flux?: 23.4, Fixed flux?  No, Solved Flux: 0, Flux in File: 23.4
  - Source LKHA101, Model Flux 0.29 Jy:** Input Flux?: 0.27, Fixed flux?  No, Solved Flux: 0, Flux in File: 0.27
  - Calibrator 0954+658:** Input Flux?: 0.9, Fixed flux?  No, Solved Flux: 0, Flux in File: 0.9
  - Calibrator 0954+556:** Input Flux?: 0.45, Fixed flux?  No
- Terminal Window:** ccarrizo@pipeline-pc
  - File Edit View Search Terminal Help
  - 5 | 5 | E18 | 0.000969 | 0.
  - 6 | 6 | N11 | -0.000800 | -0.
  - 7 | 7 | N17 | -0.000424 | -0.
  - 8 | 8 | E04 | 0.001006 | -0.
  - Phases are Degrees Continuous 10
  - RF Passband Calibration is applied
  - RF Passband Calibration is frequency dependent
  - RF Passband Calibration is antenna-based
  - RF Passband Calibration from input file
  - W-FIND, [4496] Nothing found
  - W-FIND, [4496] Nothing found
  - W-FIND, [4496] Nothing found
  - Checking if LKHA101 correlations present containing
  - Polluting H38alpha line at 115.27 GHz in LKHA101,
  - Polluting H38alpha line at 115.27 GHz in LKHA101,
  - Phases are Degrees Continuous 10
  - CLIC> □

# Practical Tips: CLIC software tools



The screenshot shows the CLIC software interface with two main windows and a terminal window.

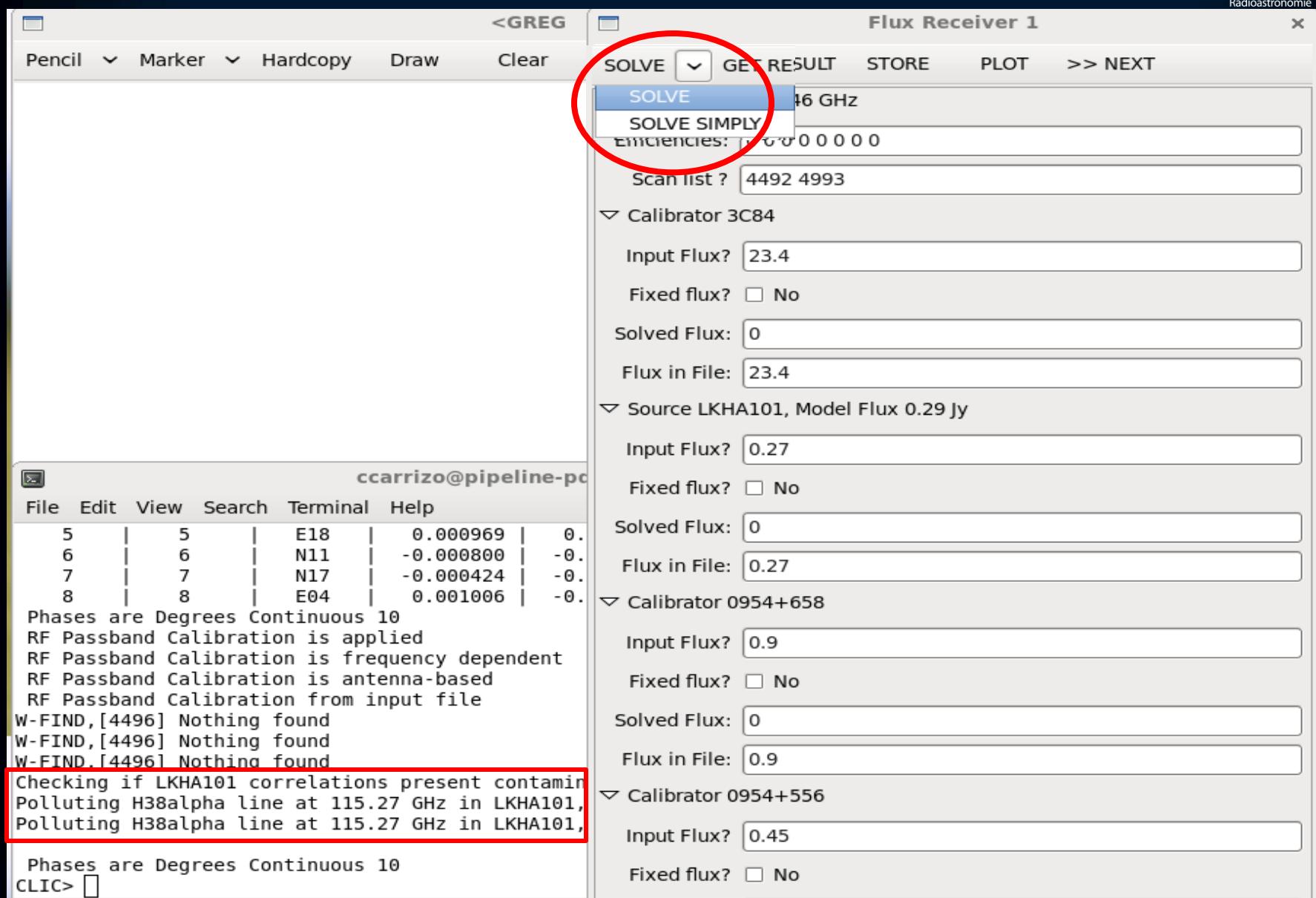
**GREG Window:** The top left window has a menu bar with "Pencil", "Marker", "Hardcopy", "Draw", and "Clear". The title bar says "<GREG".

**Flux Receiver 1 Window:** The top right window has a menu bar with "SOLVE", "GET RESULT", "STORE", "PLOT", and ">> NEXT". The title bar says "Flux Receiver 1". A red circle highlights the "SOLVE" button. The window contains the following settings:

- Frequency: 114.846 GHz
- Efficiencies: 0 0 0 0 0 0 0 0
- Scan list?: 4492 4993
- Calibrator 3C84:**
  - Input Flux?: 23.4
  - Fixed flux?  No
  - Solved Flux: 0
  - Flux in File: 23.4
- Source LKHA101, Model Flux 0.29 Jy:**
  - Input Flux? 0.27
  - Fixed flux?  No
  - Solved Flux: 0
  - Flux in File: 0.27
- Calibrator 0954+658:**
  - Input Flux? 0.9
  - Fixed flux?  No
  - Solved Flux: 0
  - Flux in File: 0.9
- Calibrator 0954+556:**
  - Input Flux? 0.45
  - Fixed flux?  No

```
ccarrizo@pipeline-pc
File Edit View Search Terminal Help
5 | 5 | E18 | 0.000969 | 0.
6 | 6 | N11 | -0.000800 | -0.
7 | 7 | N17 | -0.000424 | -0.
8 | 8 | E04 | 0.001006 | -0.
Phases are Degrees Continuous 10
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
W-FIND,[4496] Nothing found
W-FIND,[4496] Nothing found
W-FIND,[4496] Nothing found
Checking if LKHA101 correlations present containing
Polluting H3alpha line at 115.27 GHz in LKHA101,
Polluting H3alpha line at 115.27 GHz in LKHA101,
Phases are Degrees Continuous 10
CLIC>
```

# Practical Tips: CLIC software tools



The screenshot shows the CLIC software interface with two main windows:

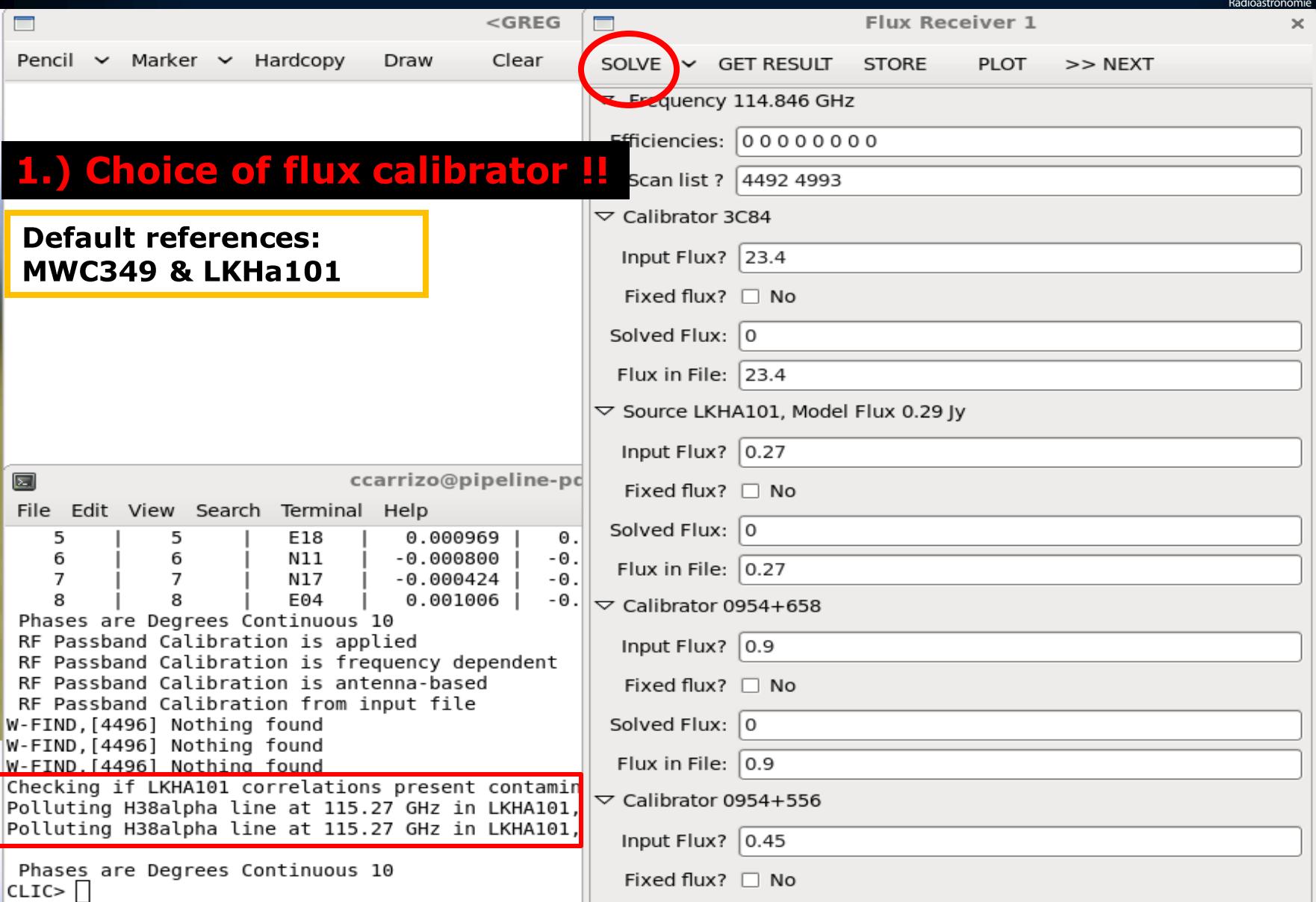
- Flux Receiver 1 Window:** This window is highlighted with a red circle around the "SOLVE" button. It contains the following fields:
  - SOLVE dropdown menu: SOLVE (selected), SOLVE SIMPLY, GET RESULT, STORE, PLOT, >> NEXT.
  - Frequency: 46 GHz
  - Efficiencies: 0 0 0 0 0 0
  - Scan list?: 4492 4993
  - Calibrator 3C84:
    - Input Flux?: 23.4
    - Fixed flux?  No
    - Solved Flux: 0
    - Flux in File: 23.4
  - Source LKHA101, Model Flux 0.29 Jy:
    - Input Flux?: 0.27
    - Fixed flux?  No
    - Solved Flux: 0
    - Flux in File: 0.27
  - Calibrator 0954+658:
    - Input Flux?: 0.9
    - Fixed flux?  No
    - Solved Flux: 0
    - Flux in File: 0.9
  - Calibrator 0954+556:
    - Input Flux?: 0.45
    - Fixed flux?  No
- Terminal Window:** This window shows command-line output from the terminal. A red box highlights the last few lines of text:

```
ccarrizo@pipeline-pc
File Edit View Search Terminal Help
5 | 5 | E18 | 0.000969 | 0.
6 | 6 | N11 | -0.000800 | -0.
7 | 7 | N17 | -0.000424 | -0.
8 | 8 | E04 | 0.001006 | -0.
Phases are Degrees Continuous 10
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
W-FIND,[4496] Nothing found
W-FIND,[4496] Nothing found
W-FIND,[4496] Nothing found
Checking if LKHA101 correlations present contamin
Polluting H3alpha line at 115.27 GHz in LKHA101,
Polluting H3alpha line at 115.27 GHz in LKHA101,
Phases are Degrees Continuous 10
CLIC>
```

# Practical Tips: CLIC software tools

**1.) Choice of flux calibrator !!**

**Default references:  
MWC349 & LKHa101**



The screenshot shows the Flux Receiver 1 software interface. At the top, there is a menu bar with options like Pencil, Marker, Hardcopy, Draw, Clear, SOLVE (circled in red), GET RESULT, STORE, PLOT, and >> NEXT. Below the menu, there are fields for Frequency (set to 114.846 GHz), Efficiencies (0 0 0 0 0 0 0), and Scan list (4492 4993). The interface is divided into sections for different calibrators:

- Calibrator 3C84:** Input Flux? 23.4, Fixed flux?  No, Solved Flux: 0, Flux in File: 23.4.
- Source LKHA101, Model Flux 0.29 Jy:** Input Flux? 0.27, Fixed flux?  No, Solved Flux: 0, Flux in File: 0.27.
- Calibrator 0954+658:** Input Flux? 0.9, Fixed flux?  No, Solved Flux: 0, Flux in File: 0.9.
- Calibrator 0954+556:** Input Flux? 0.45, Fixed flux?  No.

Below the software interface, there is a terminal window showing the command-line output of the CLIC software. The output includes calibration information, phase settings, and a warning about a contaminating H38alpha line at 115.27 GHz in LKHA101.

```
ccarrizo@pipeline-pc
File Edit View Search Terminal Help
5 | 5 | E18 | 0.000969 | 0.
6 | 6 | N11 | -0.000800 | -0.
7 | 7 | N17 | -0.000424 | -0.
8 | 8 | E04 | 0.001006 | -0.
Phases are Degrees Continuous 10
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
W-FIND, [4496] Nothing found
W-FIND, [4496] Nothing found
W-FIND, [4496] Nothing found
Checking if LKHA101 correlations present containing
Polluting H38alpha line at 115.27 GHz in LKHA101,
Polluting H38alpha line at 115.27 GHz in LKHA101,
Phases are Degrees Continuous 10
CLIC>
```

# Practical Tips: CLIC software tools

**1.) Choice of flux calibrator !!**

**Default references:  
MWC349 & LKHa101**

The screenshot shows the CLIC software interface. On the left, there is a terminal window displaying log messages related to antenna selection and flux calibration. On the right, there are two windows: one titled '<GREG>' showing amplitude vs. time plots for various antennas, and another titled 'Flux Receiver 1' showing flux calibration parameters for different calibrators. A red box highlights the 'Source LKHA101, Model Flux 0.29 Jy' section in the 'Flux Receiver 1' window, and the word 'default' is written next to it.

File Edit View Search Terminal Help

Logical antennas

I-SET,[4502] Message display level set to

I-HARDCOPY, tmpipe/10-oct-2016-s16bg001-eff-1.ps

I-FIND,[4502] New generation receivers data

I-FIND,[4502] 83 observations found

W-FIND,[4502] Nothing found

W-FIND,[4502] Nothing found

W-FIND,[4502] Nothing found

Y axis : Amplitude , 0.00 to \*

I-CLIC\_MASK,[4496] Masked - no flags

Dotted colored lines show the thresholds below which are ignored for flux calibration.

Calibration results can be plotted after flux st

CLIC>

**<GREG>**

Pencil Marker Hardcopy Draw Clear

RF Fr (A) CLIC - 10-OCT-2016 18:50:40 - ccarrizo E1  
Am: Scaled S16BG001 C0(1-0) 114.846GHz B1 Q3(180,  
Ph: Rel.(A) Atm. ( 22 4496 P FLUX)-( 626 4993 P CO

**Flux Receiver 1**

SOLVE GET RESULT STORE PLOT >> NEXT

Frequency 114.846 GHz

Efficiencies: 23.46 23.74 22.07 23.18 23.96 24.2 22.14 22.32

Scan list ? 4492 4993

Calibrator 3C84

Input Flux? 23.4

Fixed flux?  No

Solved Flux: 23.545

Flux in File: 23.4

Source LKHA101, Model Flux 0.29 Jy

Input Flux? 0.29

Fixed flux?  Yes

Solved Flux: 0.29

Flux in File: 0.27

Calibrator 0954+658

Input Flux? 0.9

Fixed flux?  No

Solved Flux: 0.905

Flux in File: 0.9

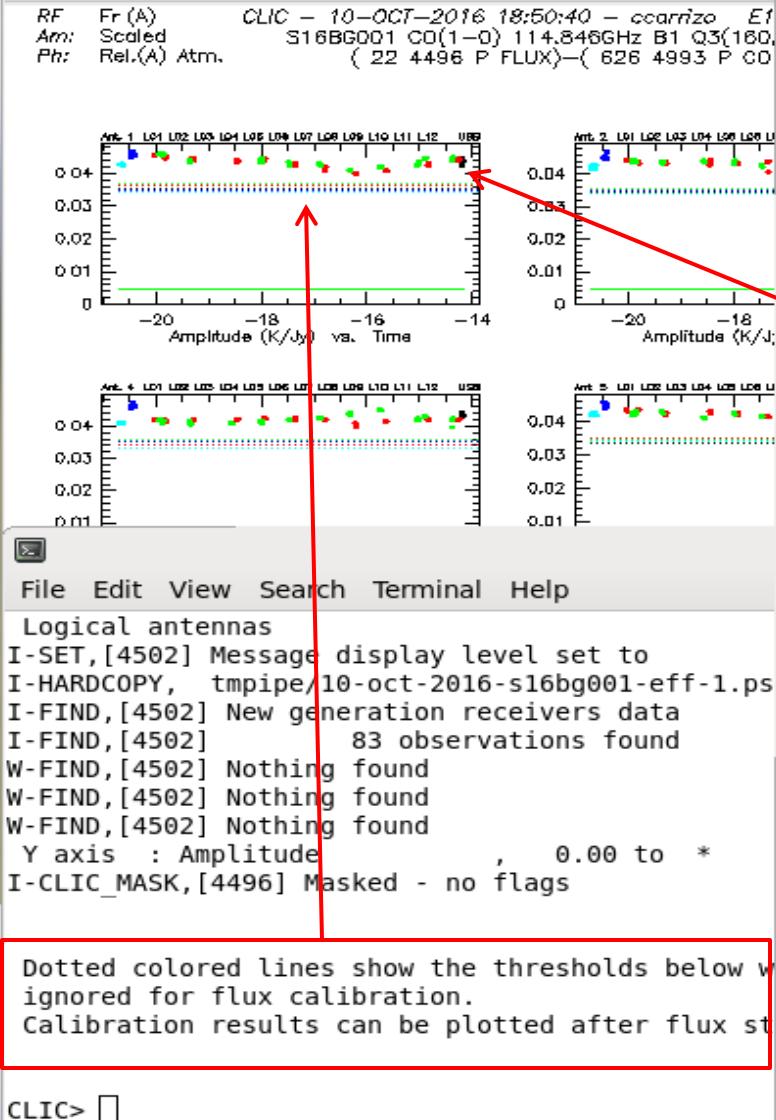
Calibrator 0954+556

Input Flux? 0.45

Fixed flux?  No

# Practical Tips: CLIC software tools

## 2.) Exclude bad data !!



**<GREG**      **SOLVE**      **GET RESULT**      **STORE**      **PLOT**      **>> NEXT**

**Frequency 114.846 GHz**

Efficiencies: 23.46 23.74 22.07 23.18 23.96 24.2 22.14 22.32

Scan list ? 4492 4993

**Calibrator 3C84**

Input Flux? 23.4

Fixed flux?  No

Solved Flux: 23.545

Flux in File: 23.4

**Source LKHA101, Model Flux 0.29 Jy**

Input Flux? 0.29

Fixed flux?  Yes

Solved Flux: 0.29

Flux in File: 0.27

**Calibrator 0954+658**

Input Flux? 0.9

Fixed flux?  No

Solved Flux: 0.905

Flux in File: 0.9

**Calibrator 0954+556**

Input Flux? 0.45

Fixed flux?  No

default

# Practical Tips: CLIC software tools

The screenshot shows two windows side-by-side. The left window, titled '<GREG', contains a menu bar with 'Pencil', 'Marker', 'Hardcopy', 'Draw', and 'Clear'. Below the menu are three plots showing Amplitude (K/Jy) vs. Time for Antennas 1, 2, 4, and 5. The right window, titled 'Flux Receiver 1', has a menu bar with 'SOLVE', 'GET RESULT', 'STORE', 'PLOT', and '>> NEXT'. It displays calibration parameters for Frequency 114.846 GHz, including Efficiencies (23.46, 23.74, 22.07, 23.18, 23.96, 24.2, 22.14, 22.32), Scan list (4492, 4993), and Calibrator 3C84 settings (Input Flux 23.4, Fixed flux? No, Solved Flux 23.545). It also shows Flux in File (23.4) and a Source LKHA101, Model Flux 0.29 Jy entry. A terminal window at the bottom shows command-line history related to flux calibration sources and array dimensions.

**Always interesting information in prompt**

```
3C84 may be considered for flux calibration
LKHA101 may be considered for flux calibration
0954+658 may be considered for flux calibration
0954+556 may be considered for flux calibration

CALIB_FLAGGED      is a logical Array      of dimensions  5
F F F F F
CAL_SOURCE        is a character* 20 Array      of dimensions  5
3C84
LKHA101
0954+658
0954+556
0745+241
Source LKHA101, Model Flux 0.29 Jy
Phases are Degrees Continuous 10
I-CLIC_MASK,[4525] Masked - Ant 1: SHADOW, Ant 2: SHADOW, Ant 3: SHADOW, Ant 4: SHADOW, Ant 5: SHADOW, Ant
```

# Practical Tips: CLIC software tools

## 3.) Check Antenna efficiencies and found source fluxes !!!

Am: Scaled Ph: Rel.(A) Atm. S16BG001 CO(1-0) 114.846GHz B1 Q3(180, ( 22 4496 P FLUX)-( 626 4993 P CO

Efficiencies: 23.46 23.74 22.07 23.18 23.96 24.2 22.14 22.32

Scan list ? 4492 4993

Calibrator 3C84

Input Flux? 23.4

Fixed flux?  No

Solved Flux: 23.545

Flux in File: 23.4

Source LKHA101, Model Flux 0.29 Jy

Input Flux? 0.29

ccarrizo@pipeline-pdb:/\$OG/project/s16bg001

File Edit View Search Terminal Help

Flux and efficiency result for receiver 1 at 114.8 GHz:

	in file	solve flux
3C84	read: 23.40 Jy	found: 23.55 Jy
LKHA101	read: 0.27 Jy	fixed: 0.29 Jy (model: 0.29 Jy)
0954+658	read: 0.90 Jy	found: 0.91 Jy
0954+556	read: 0.45 Jy	found: 0.46 Jy
0745+241	read: 0.70 Jy	found: 0.70 Jy

Antenna	(A#)	Efficiency	Model Flux
Antenna 1	(A1)	23.5 Jy/K ( 1.01)	0.29 Jy
Antenna 2	(A2)	23.7 Jy/K ( 1.00)	0.29 Jy
Antenna 3	(A3)	22.1 Jy/K ( 1.07)	0.29 Jy
Antenna 4	(A4)	23.2 Jy/K ( 1.02)	0.29 Jy
Antenna 5	(A5)	24.0 Jy/K ( 0.99)	0.29 Jy
Antenna 6	(A6)	24.2 Jy/K ( 0.98)	0.29 Jy
Antenna 7	(A7)	22.1 Jy/K ( 1.07)	0.29 Jy
Antenna 8	(A8)	22.3 Jy/K ( 1.06)	0.29 Jy

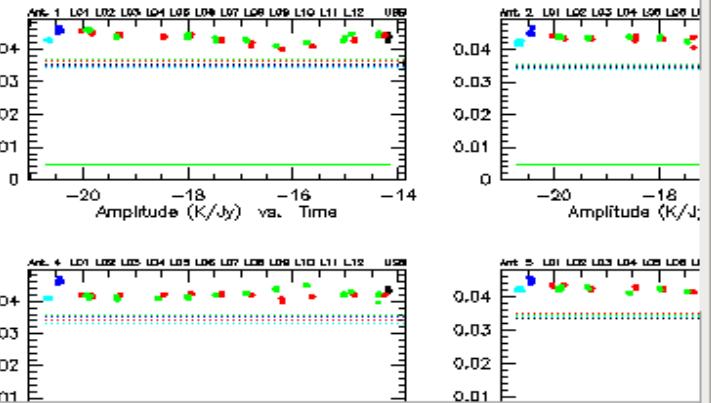
Always interesting information in prompt

# Practical Tips: CLIC software tools

**<GREG**

Pencil ▾ Marker ▾ Hardcopy Draw Clear

RF Fr (A) CLIC - 10-OCT-2016 18:50:40 - ccarrizo E1  
 Am: Scaled S16BG001 CO(1-0) 114.846GHz B1 Q3(180,  
 Ph: Rel.(A) Atm. ( 22 4496 P FLUX)-( 626 4993 P CO)



ccarrizo@pipeline-pc

```

File Edit View Search Terminal Help
I-SET,[4502] Message display level set to
I-HARDCOPY, tmpipe/10-oct-2016-s16bg001-eff-1.ps
I-FIND,[4502] New generation receivers data
I-FIND,[4502] 83 observations found
W-FIND,[4502] Nothing found
W-FIND,[4502] Nothing found
W-FIND,[4502] Nothing found
Y axis : Amplitude , 0.00 to *
I-CLIC_MASK,[4496] Masked - no flags

Dotted colored lines show the thresholds below which are ignored for flux calibration.
Calibration results can be plotted after flux station
    
```

CLIC>

**Flux Receiver 1**

SOLVE ▾ GET RESULT STORE PLOT >> NEXT

Frequency 114.846 GHz

Efficiencies: 23.46 23.74 22.07 23.18 23.96 24.2 22.14 22.32

Scan list ? 4492 4993

Calibrator 3C84

Input Flux? 23.545

Fixed flux?  No

Solved Flux: 23.545

Flux in File: 23.4

Source LKHA101, Model Flux 0.29 Jy

Input Flux? 0.29

Fixed flux?  Yes

Solved Flux: 0.29

Flux in File: 0.27

Calibrator 0954+658

Input Flux? 0.905

Fixed flux?  No

Solved Flux: 0.905

Flux in File: 0.9

Calibrator 0954+556

Input Flux? 0.46

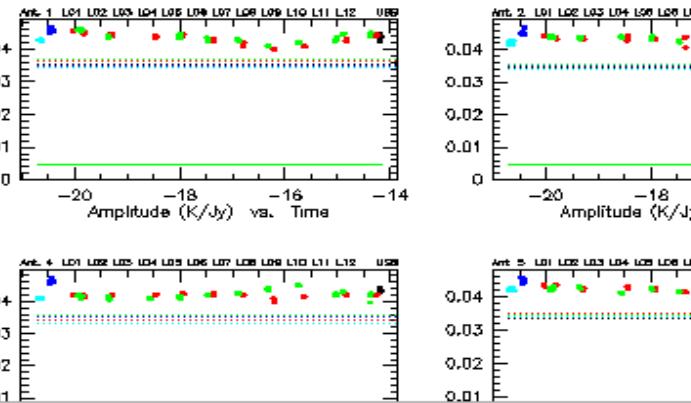
Fixed flux?  No

# Practical Tips: CLIC software tools

**<GREG**

Pencil ▾ Marker ▾ Hardcopy Draw Clear

RF Fr (A) CLIC - 10-OCT-2016 18:50:40 - ccarrizo EF  
 Am: Scaled S16BC001 CD(1-0) 114.846GHz B1 Q3(160,  
 Ph: Rel.(A) Atm. ( 22 4496 P FLUX)-( 626 4993 P CO



**ccarrizo@pipeline-pc**

```

File Edit View Search Terminal Help
I-WRITE_SCAN,[4496] FLUX 22 Updated ( 45 r
Rebuilding the Flux list for Receiver 1 ...
I-FIND,[4496] New generation receivers data
I-FIND,[4496] 7 observations found
Source 1 3C84 Flux 23.55 Jy at 114.8 GHz
I-FIND,[4496] New generation receivers data
I-FIND,[4496] 6 observations found
Source 2 LKHA101 Flux 0.29 Jy at 114.8 GHz
I-FIND,[4508] New generation receivers data
I-FIND,[4508] 32 observations found
Source 3 0954+658 Flux 0.91 Jy at 114.8 GHz
I-FIND,[4519] New generation receivers data
I-FIND,[4519] 35 observations found
Source 4 0954+556 Flux 0.46 Jy at 114.8 GHz
I-FIND,[4525] New generation receivers data
I-FIND,[4525] 3 observations found
Source 5 0745+241 Flux 0.70 Jy at 114.8 GHz
  
```

**Flux Receiver 1**

SOLVE ▾ GET RESULT STORE PLOT >> NEXT

Frequency 114.846 GHz

Efficiencies: 23.46 23.74 22.07 23.18 23.96 24.2 22.14 22.32

Scan list ? 4492 4993

Calibrator 3C84

Input Flux? 23.545

Fixed flux?  No

Solved Flux: 23.545

Flux in File: 23.545

Source LKHA101, Model Flux 0.29 Jy

Input Flux? 0.29

Fixed flux?  Yes

Solved Flux: 0.29

Flux in File: 0.29

Calibrator 0954+658

Input Flux? 0.905

Fixed flux?  No

Solved Flux: 0.905

Flux in File: 0.905

Calibrator 0954+556

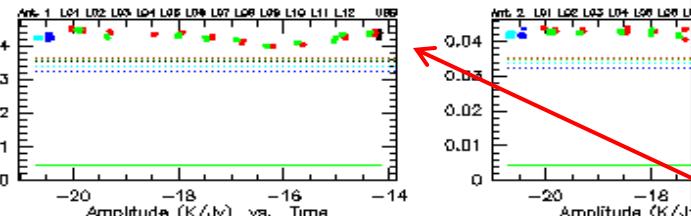
Input Flux? 0.46

Fixed flux?  No

# Practical Tips: CLIC software tools

Pencil ▾ Marker ▾ Hardcopy Draw Clear

RF Fr (A) CLIC - 10-OCT-2016 19:05:53 - ccarrizo Eff S16BG001 CO(1-0) 114.846GHz B1 Q3(180, Ph: Rel.(A) Atm. ( 22 4496 P FLUX)-( 626 4993 P CO



Am. 1 L01 L02 L03 L04 L05 L06 L07 L08 L09 L10 L11 L12 UBB

Am. 2 L01 L02 L03 L04 L05 L06 L07 L08 L09 L10 L11 L12 UBB

Am. 4 L01 L02 L03 L04 L05 L06 L07 L08 L09 L10 L11 L12 UBB

Am. 5 L01 L02 L03 L04 L05 L06 L07 L08 L09 L10 L11 L12 UBB

SOLVE ▾ GET RESULT STORE **PLOT** >> NEXT

Frequency 114.846 GHz

Efficiencies: 23.46 23.74 22.07 23.18 23.96 24.2 22.14 22.32

Scan list ? 4492 4993

Calibrator 3C84

Input Flux? 23.545

Fixed flux?  No

Solved Flux: 23.545

Flux in File: 23.545

Source LKHA101, Model Flux 0.29 Jy

Input Flux? 0.29

Fixed flux?  Yes

Solved Flux: 0.29

Flux in File: 0.29

Calibrator 0954+658

Input Flux? 0.905

Fixed flux?  No

Solved Flux: 0.905

Flux in File: 0.905

Calibrator 0954+556

Input Flux? 0.46

Fixed flux?  No

ccarrizo@pipeline-pc

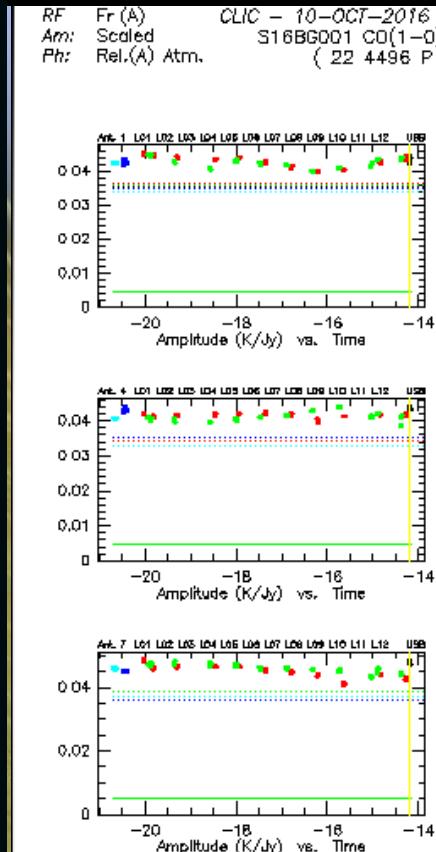
File Edit View Search Terminal Help

```

W-LIMITS, No range in Y
Plot type is BARS
Logical antennas
I-SET,[4993] Message display level set to
I-SET,[4502] Message display level set to
I-HARDCOPY, tmpipe/10-oct-2016-s16bg001-eff-1.ps
I-FIND,[4502] New generation receivers data
I-FIND,[4502] 83 observations found
W-FIND,[4502] Nothing found
W-FIND,[4502] Nothing found
W-FIND,[4502] Nothing found
Y axis : Amplitude , 0.00 to *
CLIC> 
```

# Practical Tips: CLIC software tools

## 3.) Check Antenna efficiencies and found source fluxes !!!



You can change it with "let do\_avpol no" before the amplitude calibration

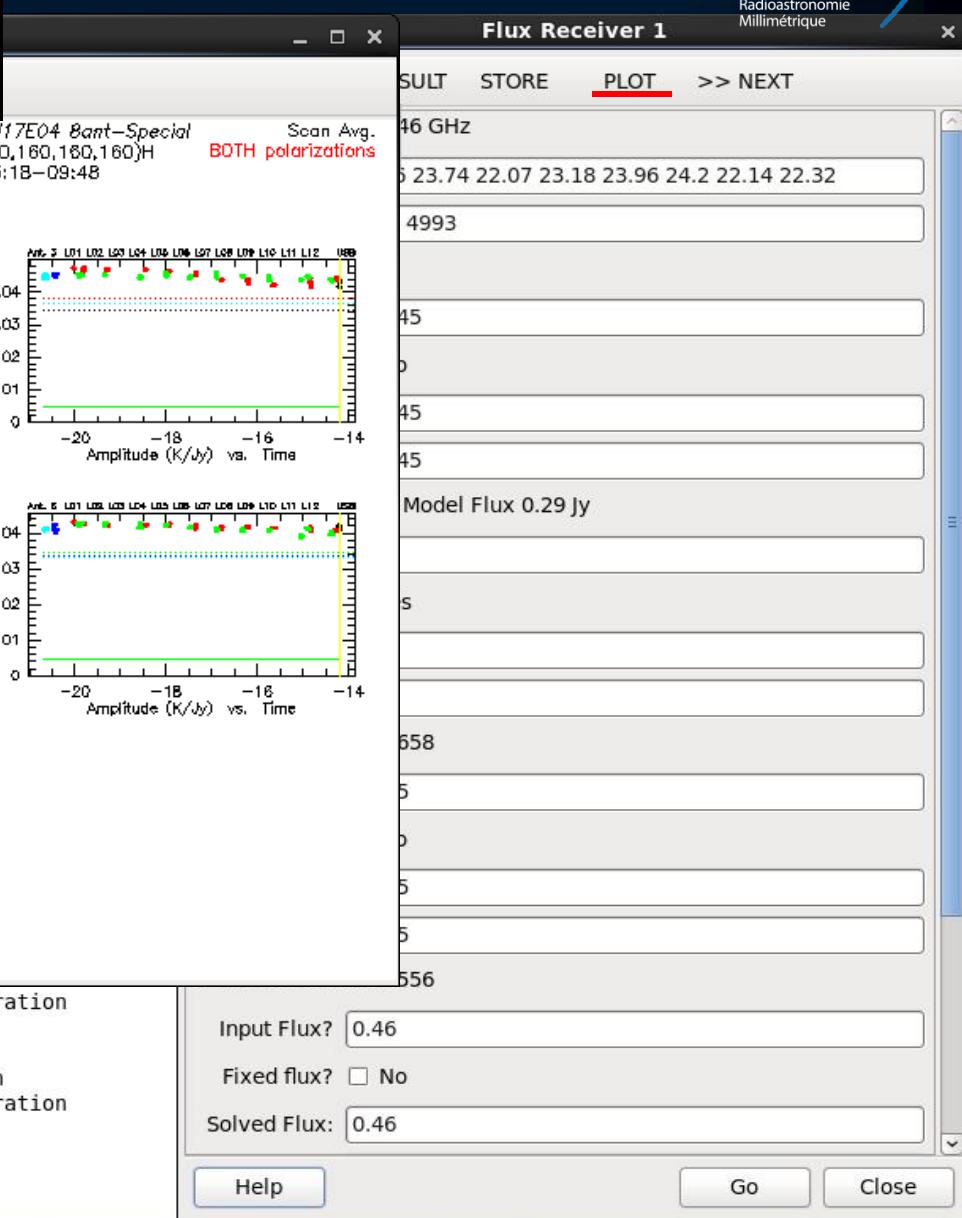
0954+658 is found to be polarized at 42.5xsigma

Averaged polarization mode is selected for the amplitude calibration

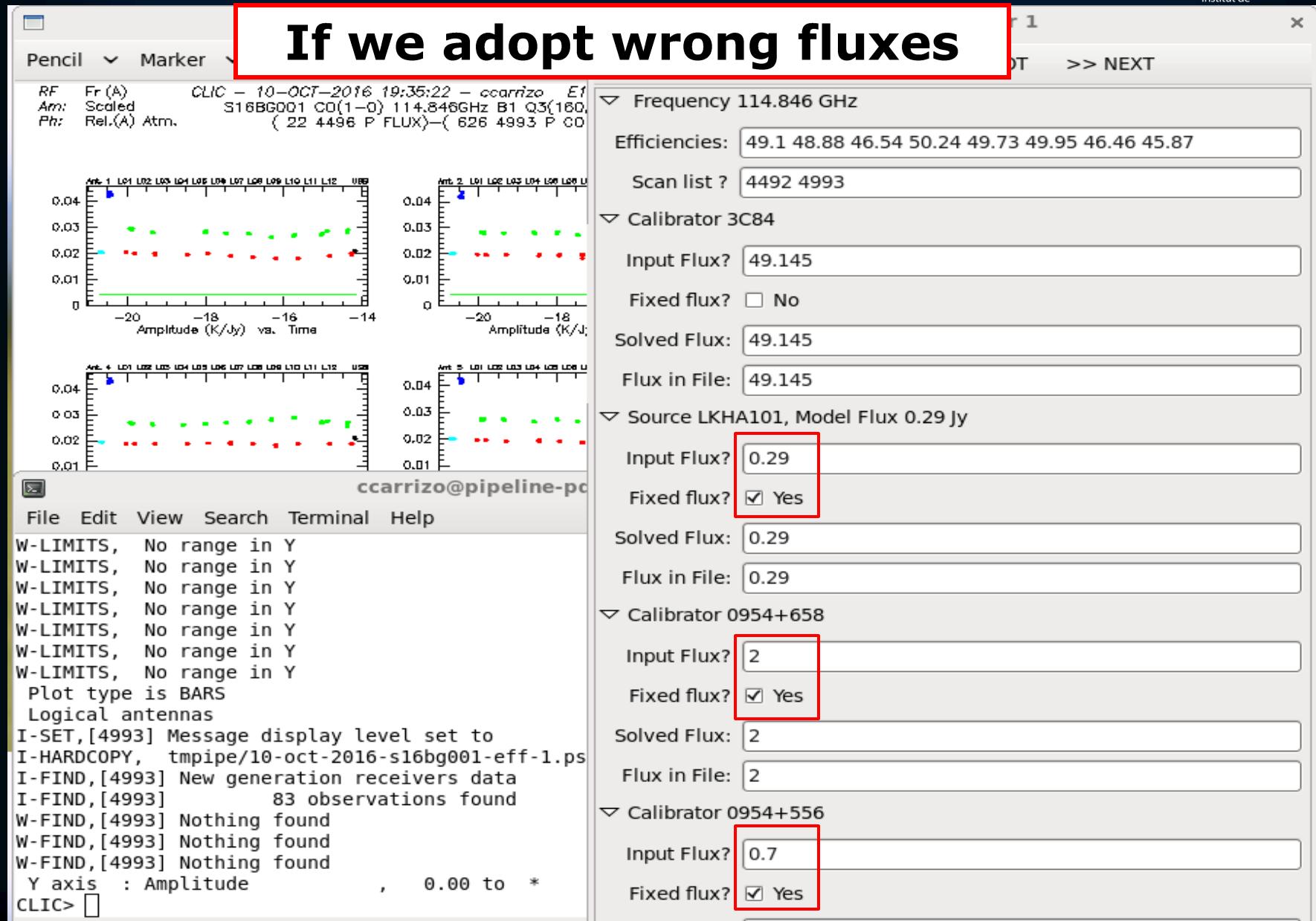
You can change it with "let do\_avpol no" before the amplitude calibration

USB tuning for receiver 1

CLIC>

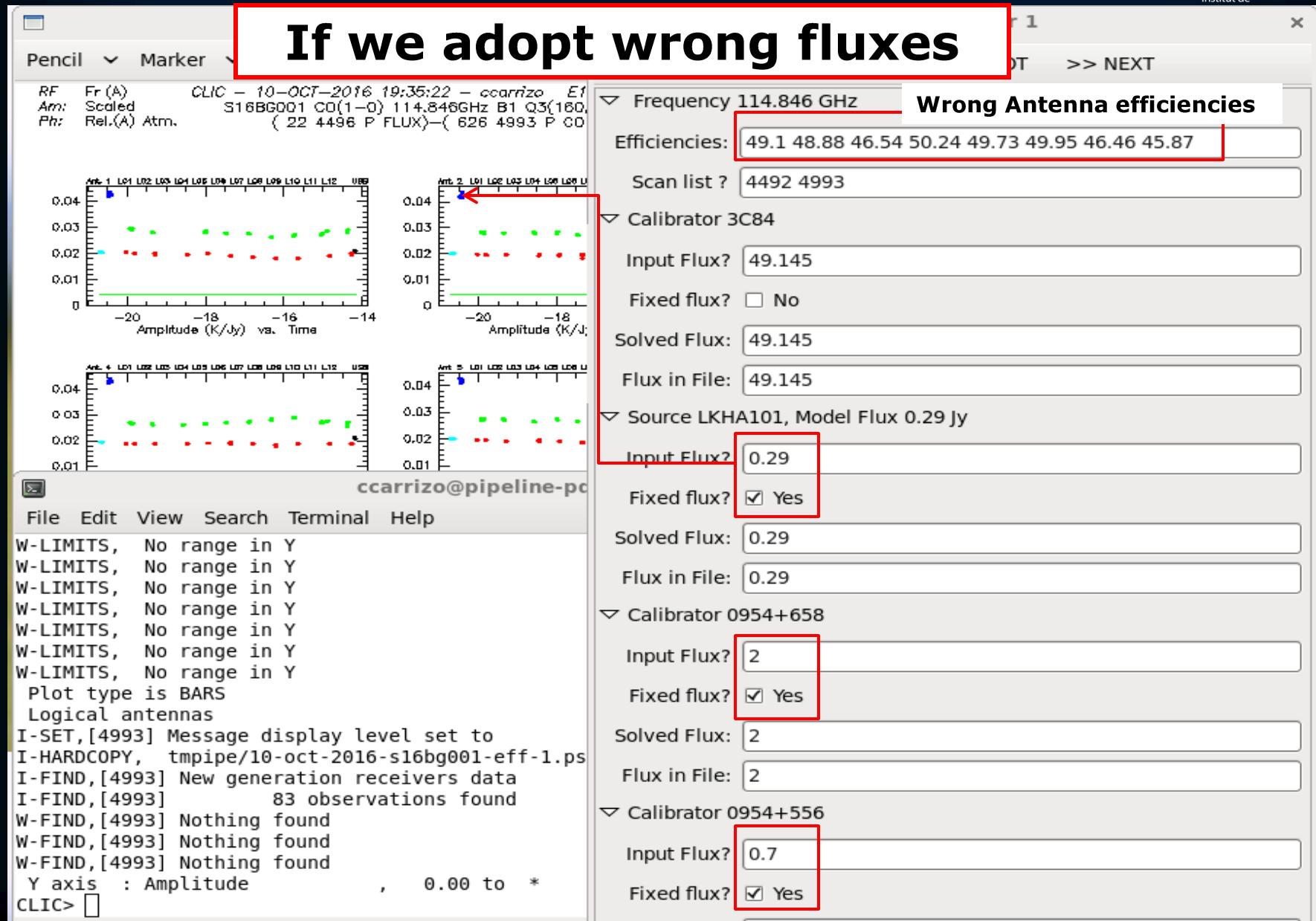


# Practical Tips: CLIC software tools



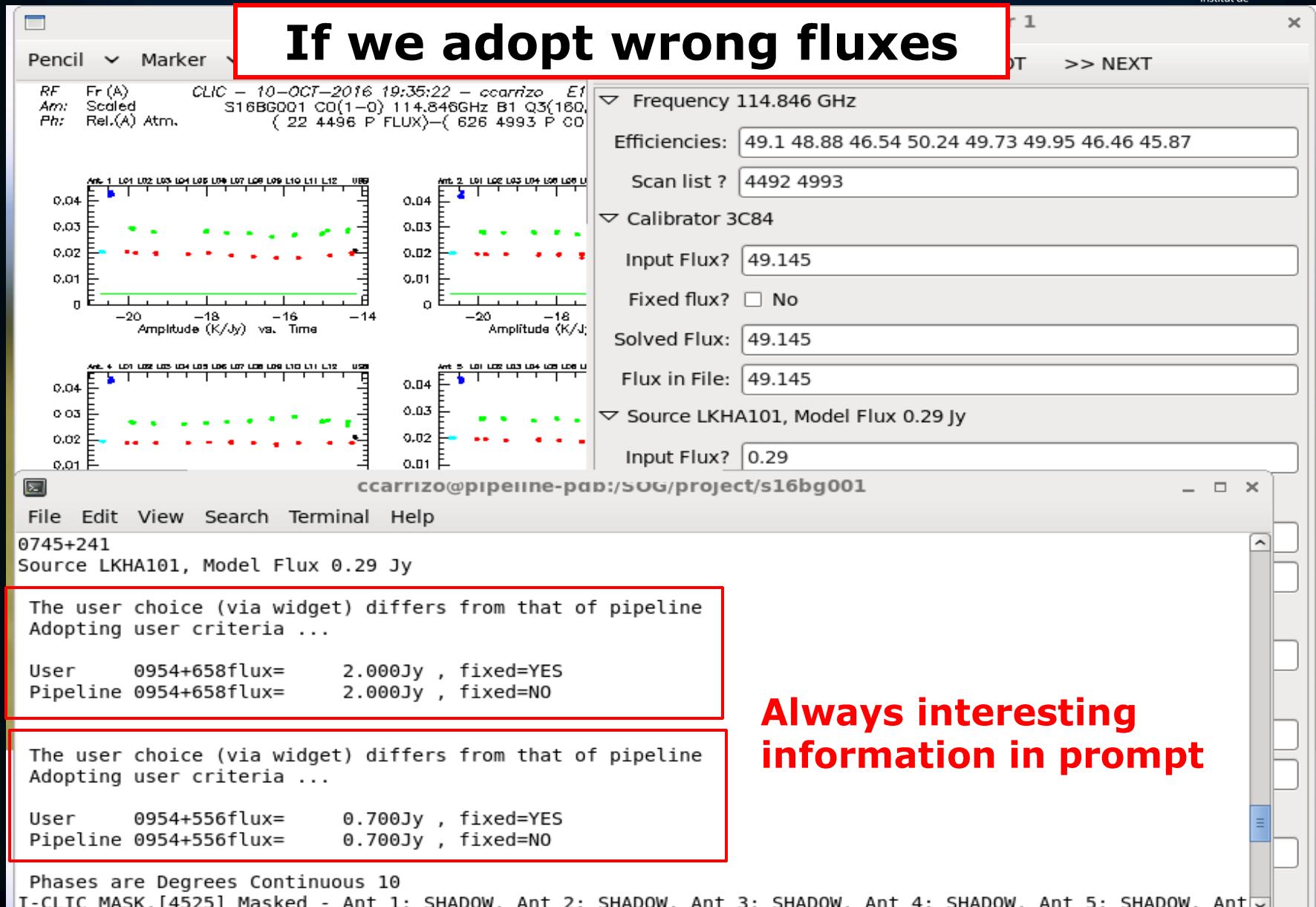
# Practical Tips: CLIC software tools

## If we adopt wrong fluxes



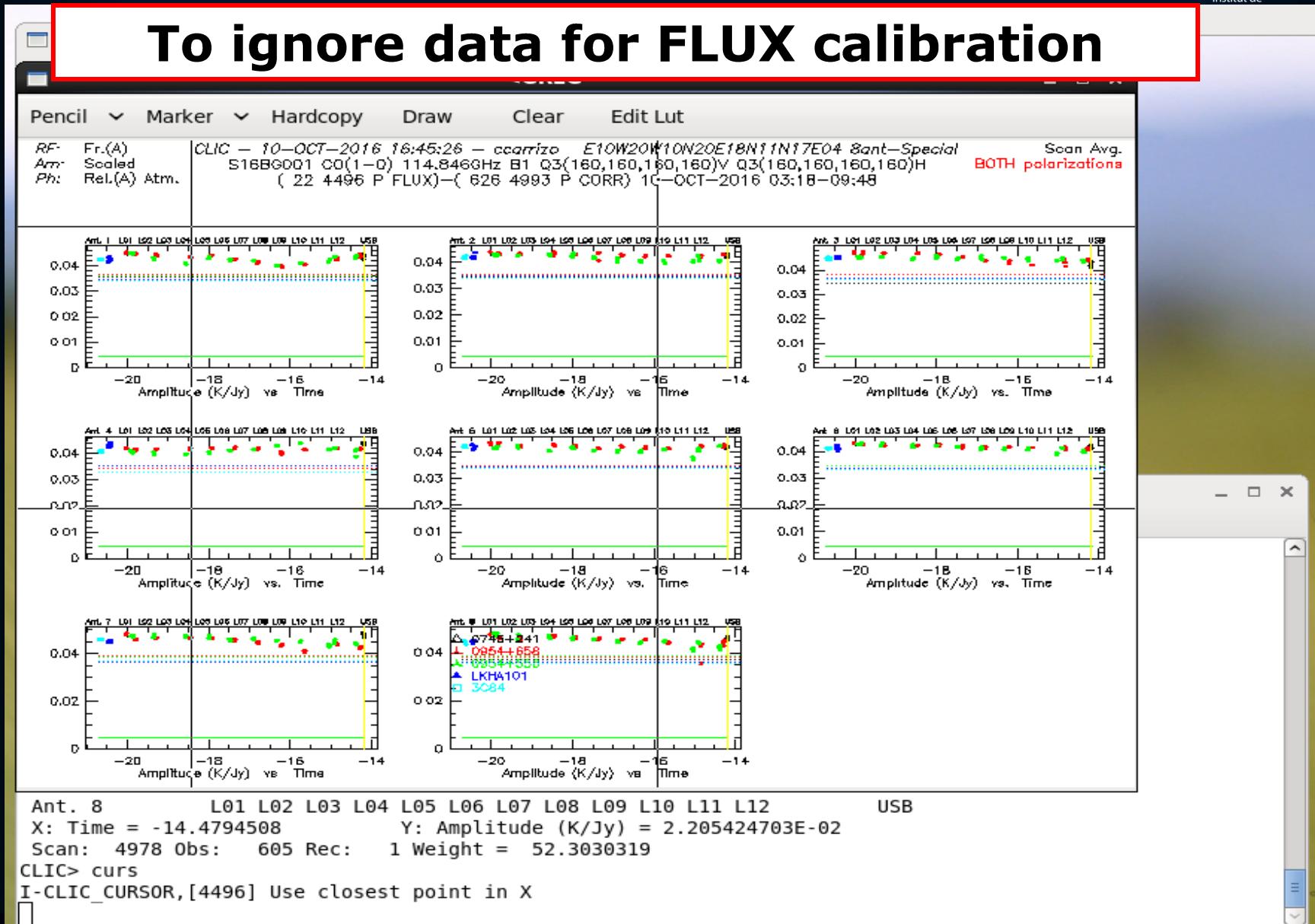
# Practical Tips: CLIC software tools

If we adopt wrong fluxes

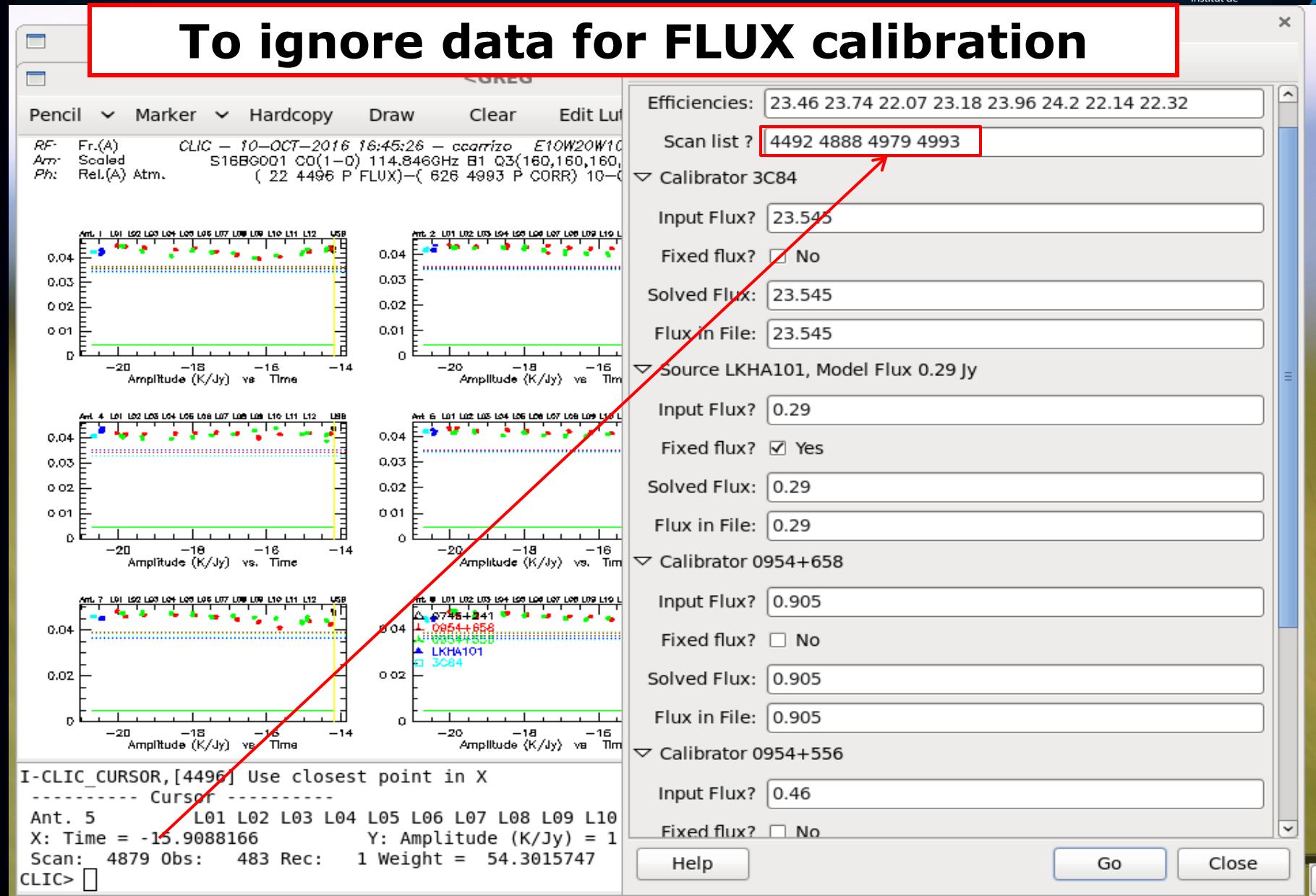


# Practical Tips: CLIC software tools

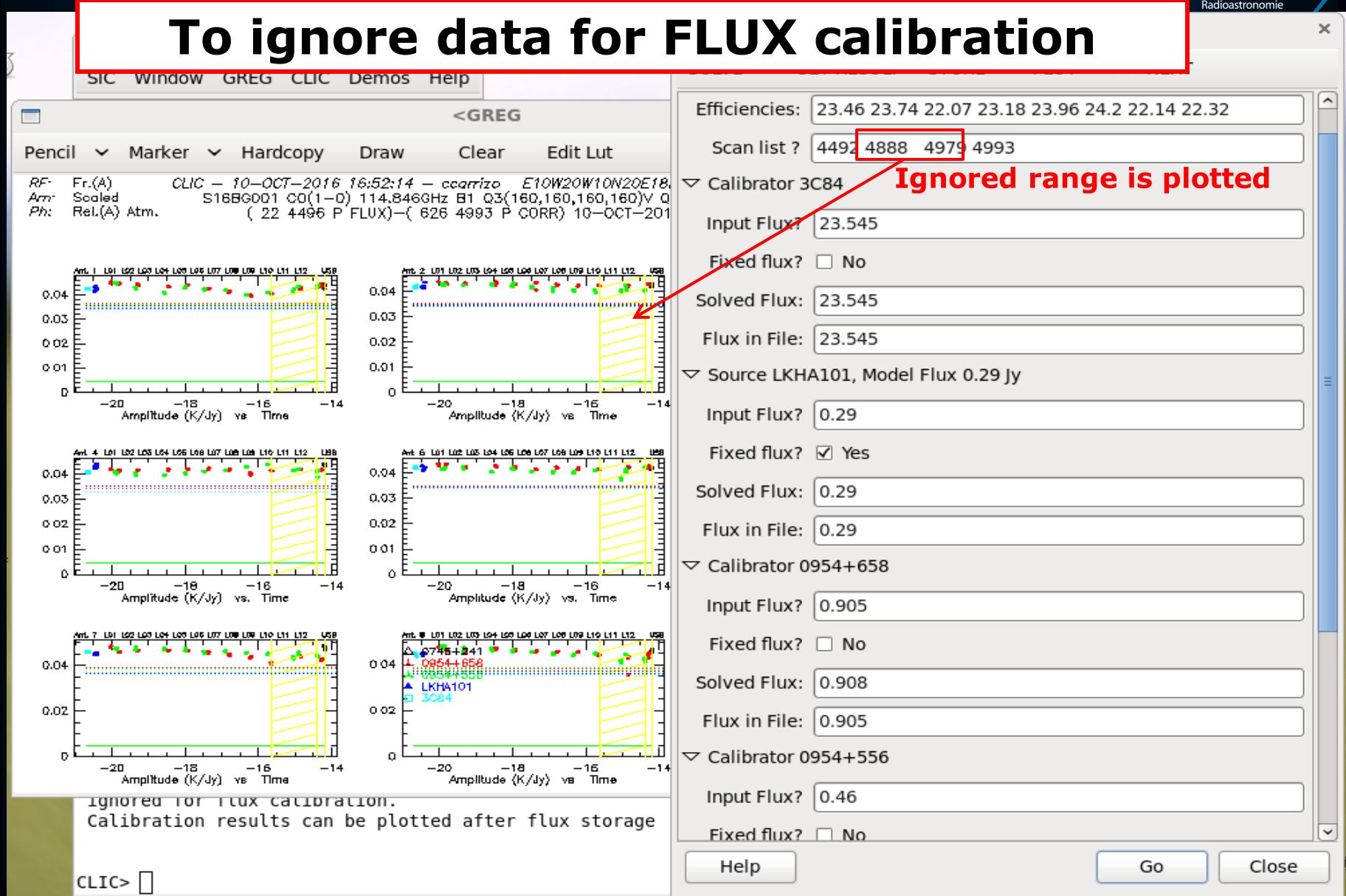
## To ignore data for FLUX calibration



## To ignore data for FLUX calibration



## To ignore data for FLUX calibration



# Practical Tips: CLIC software tools

## Special case: FLUX reference not used

The screenshot shows two windows side-by-side. The top window is titled 'Flux Receiver 1' and contains tabs for 'SELECT', 'AUTOFAG', 'PHCOR', 'RF', 'PHASE', and 'FLUX'. A red box highlights the 'FLUX' tab. Below it, there's a checkbox for 'Use previous settings ?' followed by 'Yes'. The bottom window is a terminal window titled 'krips@bure6b:~/project/w04c - Shell - Konsole'. It displays a log of flux calibration steps. A red box highlights several lines in the log:

- 3C345 is not considered for flux calibration, since phases are too instable
- MWC349 is not considered for flux calibration, since phases are too instable
- CALIB\_FLAGGED is a logical Array of dimensions 5
- F T T F F
- CAL\_SOURCE is a character\* 20 Array of dimensions 5
- J1310+323
- 3C345
- MWC349
- 1538+149
- 1611+343
- Source MWC349, Model Flux 1.13 Jy

Below these, four identical lines are shown:

- No calibrator is considered for flux calibration ..., fixing the strongest
- No calibrator is considered for flux calibration ..., fixing the strongest
- No calibrator is considered for flux calibration ..., fixing the strongest
- No calibrator is considered for flux calibration ..., fixing the strongest

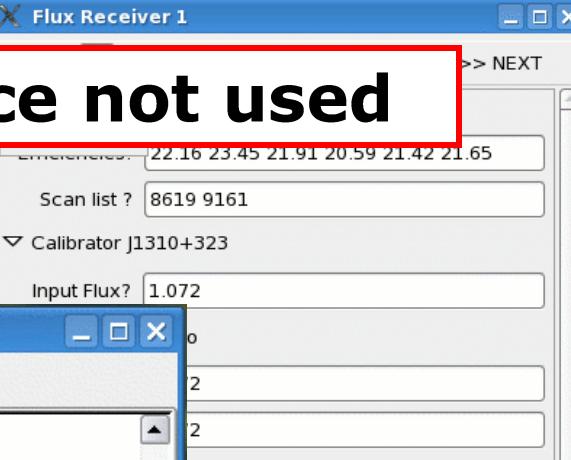
At the bottom, the log continues:

- The flux of 1611+343 is fixed to 2.185 Jy
- Phases are Degrees Continuous 10

A yellow box with a black border and an arrow points from the text 'Here the reference is not used --> a more complex case' to the 'MWC349' entry in the log.

## Special case: FLUX reference not used

### 3.) Check Antenna efficiencies and found source fluxes !!!



```
I-SOLVE_FLUX,[9161] 1611+343 Aver. 2.1850 +- .0001
I-CLIC_MASK,[9161] Masked - no flags

Flux and efficiency result for receiver 1 at 90.8 GHz:
```

	in file	solve flux
J1310+323	read: 1.07 Jy	found: 1.07 Jy
3C345	read: 3.17 Jy	found: 3.17 Jy
MWC349	read: 0.91 Jy	found: 0.88 Jy (model: 1.13 Jy)
1538+149	read: 0.69 Jy	found: 0.69 Jy
1611+343	read: 2.19 Jy	fixed: 2.19 Jy

```
Antenna 1 (A1) 22.2 Jy/K ( 0.99)
Antenna 2 (A2) 23.4 Jy/K ( 0.93)
Antenna 3 (A3) 21.9 Jy/K ( 1.00)
Antenna 4 (A4) 20.6 Jy/K ( 1.06)
Antenna 5 (A5) 21.4 Jy/K ( 1.02)
Antenna 6 (A6) 21.7 Jy/K ( 1.01)

Phases are Degrees Continuous 10
I-CLIC_MASK,[8636] Masked - Ant 1: SHADOW, Ant 2: SHADOW, Ant 3: SHADOW, Ant 4: SHADOW, Ant 5: SHADOW, Ant 6: SHADOW
Plot type is BARS
```

- Be critical, to understand why MWC349 is not used : e.g. briefly degraded conditions, perhaps due to source elevation or changing weather, which is not representative of the track.
- If the conditions are representative of the track, MWC349 should be used

- Other sources can be used otherwise as reference: in this case **flux monitorings**, plus information coming from additional tracks should be considered
- Our knowledge about antenna efficiencies should also be used (**SOG will support you**)

# Practical Tips: CLIC software tools

X Standard calibration package for NGR

SELECT AUTOFLA

Use previous setting

krips@bure6b:~/project

Session Edit View Book

```
I-LISTE,[8620] Source # 1 J1310+323      1 Observations
I-LISTE,[8620] Source # 2 3C345          4 Observations
I-LISTE,[8620] Source # 3 MWC349          3 Observations
I-LISTE,[8620] Source # 4 1538+149        36 Observations
I-LISTE,[8620] Source # 5 1611+343        36 Observations
I-SOLVE_FLUX,[8620] Average fluxes will use the best 3 antennas
Amplitudes are absolute
Amplitude Calibration is antenna-based
Amplitudes are divided by assumed calibrator flux
Amplitudes are expressed in kelvins
I-SCALING,[8637] MWC349      has known structure
I-SCALING,[8638] MWC349      has known structure
I-SOLVE_FLUX,[9161] Reference sources:
I-SOLVE_FLUX,[9161] 1611+343   Flux =  2.1850 Jy
I-SOLVE_FLUX,[9161] Average efficiencies:
I-SOLVE_FLUX,[9161] Ant. 1  22.165 +- 0.003 Jy/K ( 0.99)
I-SOLVE_FLUX,[9161] Ant. 2  23.452 +- 0.003 Jy/K ( 0.93)
I-SOLVE_FLUX,[9161] Ant. 3  21.911 +- 0.003 Jy/K ( 1.00)
I-SOLVE_FLUX,[9161] Ant. 4  20.588 +- 0.002 Jy/K ( 1.06)
I-SOLVE_FLUX,[9161] Ant. 5  21.419 +- 0.003 Jy/K ( 1.02)
I-SOLVE_FLUX,[9161] Ant. 6  21.648 +- 0.003 Jy/K ( 1.01)
I-SOLVE_FLUX,[9161] Sources, Fluxes and errors :
I-SOLVE_FLUX,[9161] J1310+323   Ant 1  1.3902 +- .0016
```

X Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

SOLVE SIMPL Y 0.8 GHz

23.45 21.91 20.59 21.42 21.65

9161

323

1

0

1

1

Model Flux 1.13 Jy

8

0

8

8

149

8

0

8

8

343

Go Close

Shell

A yellow box highlights the text "It automatically considers extension of MWC349!"

A red box highlights the two lines: I-SCALING,[8637] MWC349 has known structure and I-SCALING,[8638] MWC349 has known structure.

# Practical Tips: CLIC software tools

X Standard calibration package for NGR

SELECT AUTOFLAG

Use previous settings ? [ ]

krips@bure6b:~/project/w04

Session Edit View Bookmark

```
I-LISTE,[8620] Source # 1 J1310+323      1 Observations
I-LISTE,[8620] Source # 2 3C345          4 Observations
I-LISTE,[8620] Source # 3 MWC349          3 Observations
I-LISTE,[8620] Source # 4 1538+149        36 Observations
I-LISTE,[8620] Source # 5 1611+343        36 Observations
I-SOLVE_FLUX,[8620] Average fluxes will use the best 3 antennas
Amplitudes are absolute
Amplitude Calibration is antenna-based
Amplitudes are divided by assumed calibrator flux
Amplitudes are expressed in kelvins
I-SCALING,[8637] MWC349      has known structure
I-SCALING,[8638] MWC349      has known structure
I-SOLVE_FLUX,[9161] Reference sources:
I-SOLVE_FLUX,[9161] 1611+343   Flux =  2.1850 Jy
I-SOLVE_FLUX,[9161] Average efficiencies:
I-SOLVE_FLUX,[9161] Ant. 1 22.165 +- 0.003 Jy/K ( 0.99)
I-SOLVE_FLUX,[9161] Ant. 2 23.452 +- 0.003 Jy/K ( 0.93)
I-SOLVE_FLUX,[9161] Ant. 3 21.911 +- 0.003 Jy/K ( 1.00)
I-SOLVE_FLUX,[9161] Ant. 4 20.588 +- 0.002 Jy/K ( 1.06)
I-SOLVE_FLUX,[9161] Ant. 5 21.419 +- 0.003 Jy/K ( 1.02)
I-SOLVE_FLUX,[9161] Ant. 6 21.648 +- 0.003 Jy/K ( 1.01)
I-SOLVE_FLUX,[9161] Sources, Fluxes and errors :
I-SOLVE_FLUX,[9161] J1310+323   Ant 1  1.3902 +- .0016
```

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

SOLVE SIMPLY

0.8 GHz

22.16 23.45 21.91 20.59 21.42 21.65

8619 9161

1310+323

1.072

0

2

1

0

1

1

Model Flux 1.13 Jy

8

0

8

8

149

8

0

8

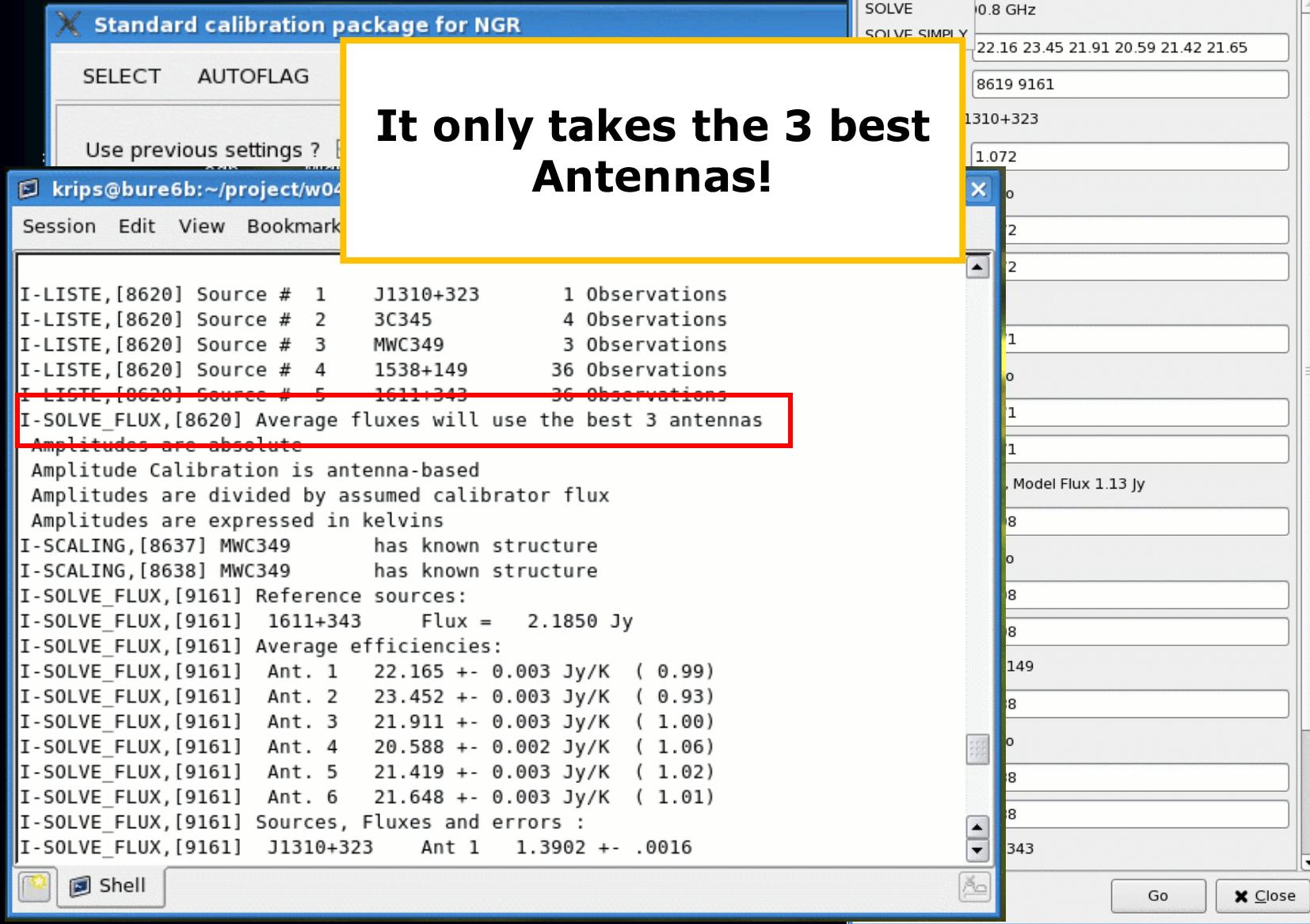
8

8

343

Go Close

It only takes the 3 best Antennas!



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Questions?