

Absolute Flux Calibration

Melanie Krips

by Arancha Castro-Carrizo

Outline

- I. Primary/Secondary Flux Calibrators

- II. Practical Tips to Calibrate the Fluxes of your Sources

Motivation

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)

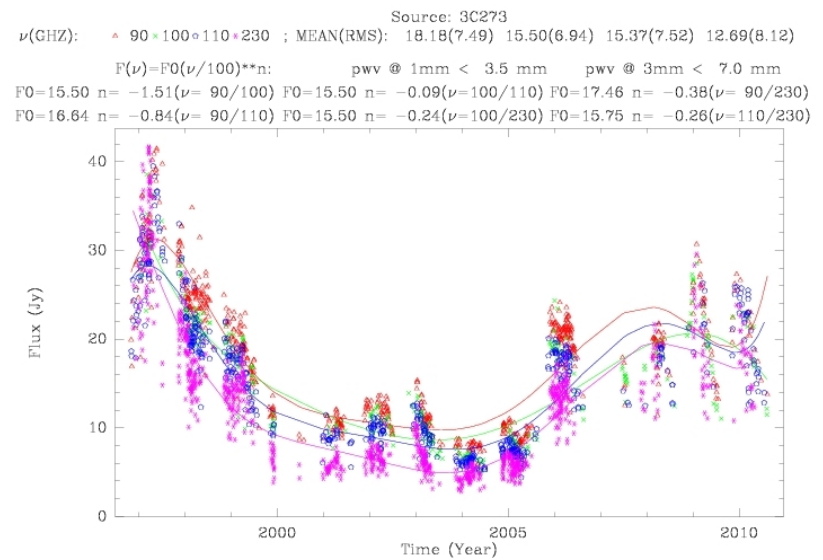
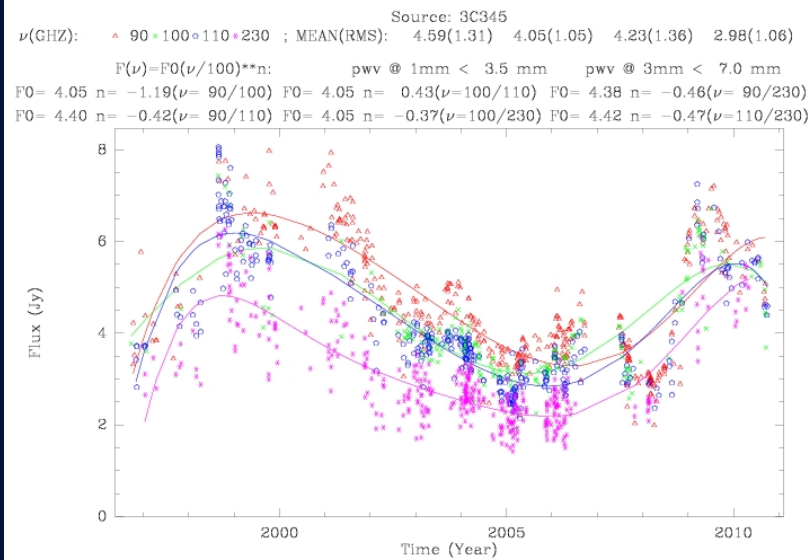
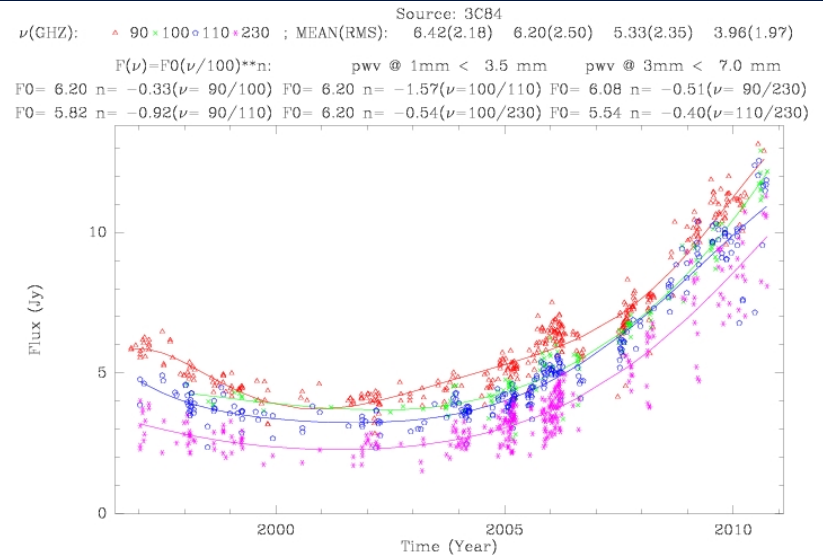
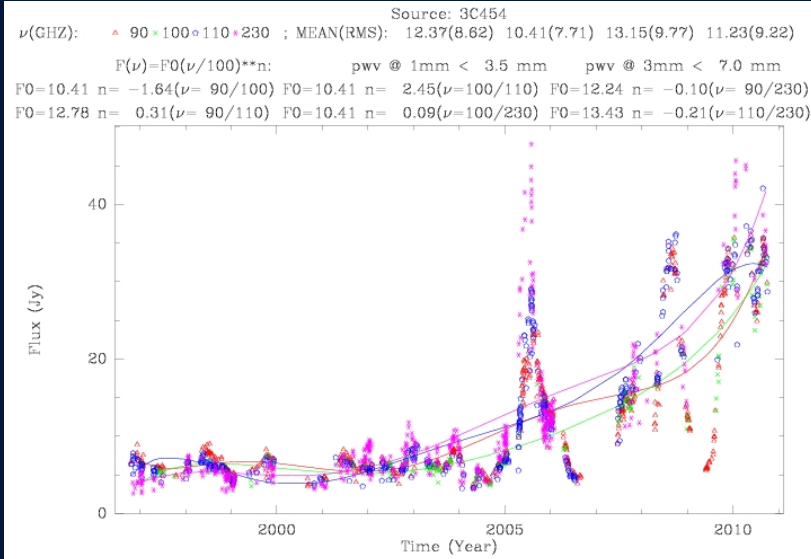
Flux Calibrators

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

Flux Calibrators

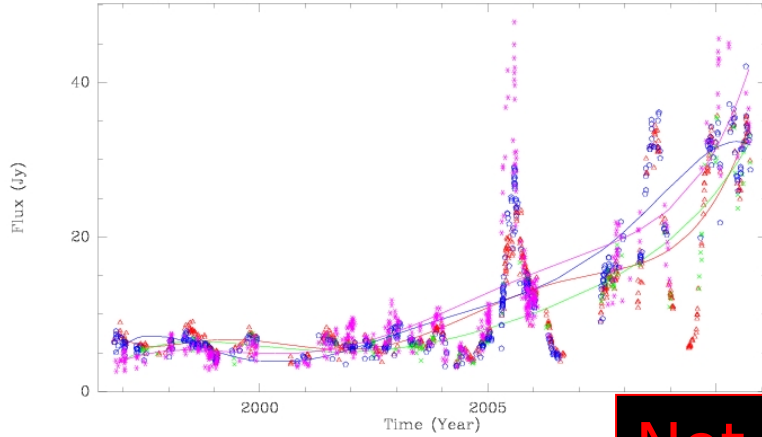
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Flux Calibrators: Quasars

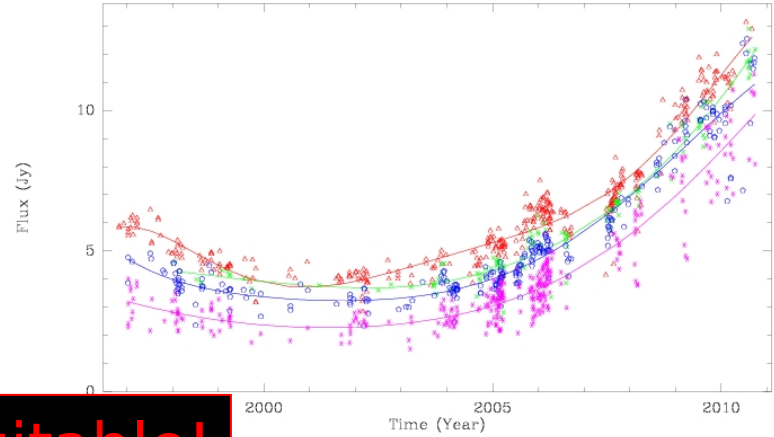


Flux Calibrators: Quasars

Source: 3C454
 ν (GHz): $\blacktriangle 90 \times 100 \times 110 \times 230$; MEAN(RMS): 12.37(8.62) 10.41(7.71) 13.15(9.77) 11.23(9.22)
 $F(\nu)=F_0(\nu/100)^{n}$: pwv @ 1mm < 3.5 mm pwv @ 3mm < 7.0 mm
 $F_0=10.41$ n = -1.64($\nu=90/100$) $F_0=10.41$ n = 2.45($\nu=100/110$) $F_0=12.24$ n = -0.10($\nu=90/230$)
 $F_0=12.78$ n = 0.31($\nu=90/110$) $F_0=10.41$ n = 0.09($\nu=100/230$) $F_0=13.43$ n = -0.21($\nu=110/230$)

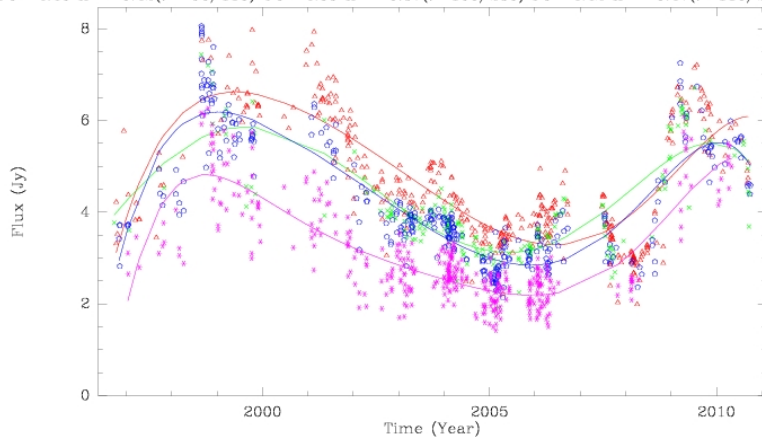


Source: 3C84
 ν (GHz): $\blacktriangle 90 \times 100 \times 110 \times 230$; MEAN(RMS): 6.42(2.18) 6.20(2.50) 5.33(2.35) 3.96(1.97)
 $F(\nu)=F_0(\nu/100)^{n}$: pwv @ 1mm < 3.5 mm pwv @ 3mm < 7.0 mm
 $F_0=6.20$ n = -0.33($\nu=90/100$) $F_0=6.20$ n = -1.57($\nu=100/110$) $F_0=6.08$ n = -0.51($\nu=90/230$)
 $F_0=5.82$ n = -0.92($\nu=90/110$) $F_0=6.20$ n = -0.54($\nu=100/230$) $F_0=5.54$ n = -0.40($\nu=110/230$)

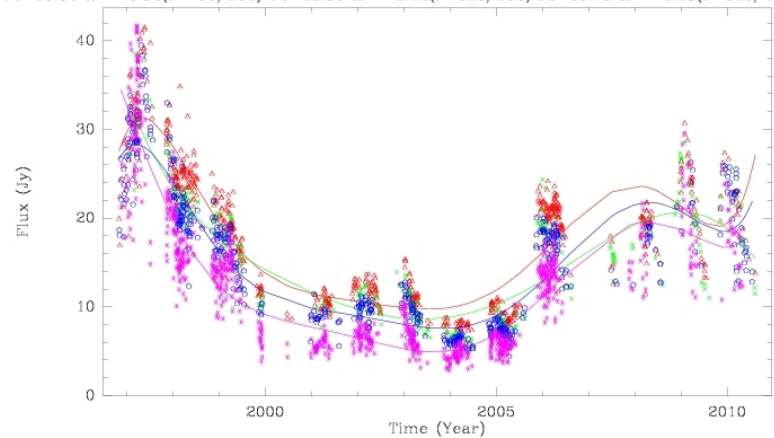


Not suitable!

Source: 3C345
 ν (GHz): $\blacktriangle 90 \times 100 \times 110 \times 230$; MEAN(RMS): 4.59(1.31) 4.05(1.05) 4.25(1.56) 2.95(1.06)
 $F(\nu)=F_0(\nu/100)^{n}$: pwv @ 1mm < 3.5 mm pwv @ 3mm < 7.0 mm
 $F_0=4.05$ n = -1.19($\nu=90/100$) $F_0=4.05$ n = 0.43($\nu=100/110$) $F_0=4.38$ n = -0.46($\nu=90/230$)
 $F_0=4.40$ n = -0.42($\nu=90/110$) $F_0=4.05$ n = -0.37($\nu=100/230$) $F_0=4.42$ n = -0.47($\nu=110/230$)



Source: 3C273
 ν (GHz): $\blacktriangle 90 \times 100 \times 110 \times 230$; MEAN(RMS): 18.18(7.49) 15.50(6.94) 15.37(7.52) 12.69(8.12)
 $F(\nu)=F_0(\nu/100)^{n}$: pwv @ 1mm < 3.5 mm pwv @ 3mm < 7.0 mm
 $F_0=15.50$ n = -1.51($\nu=90/100$) $F_0=15.50$ n = -0.09($\nu=100/110$) $F_0=17.46$ n = -0.38($\nu=90/230$)
 $F_0=16.64$ n = -0.84($\nu=90/110$) $F_0=15.50$ n = -0.24($\nu=100/230$) $F_0=15.75$ n = -0.26($\nu=110/230$)



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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
 - 3.) Some of them have broad molecular line absorption (e.g., Mars, Jupiter, Saturn)
 - 4.) Not always visible, i.e., more constraints due to sun-avoidance, short LST ranges



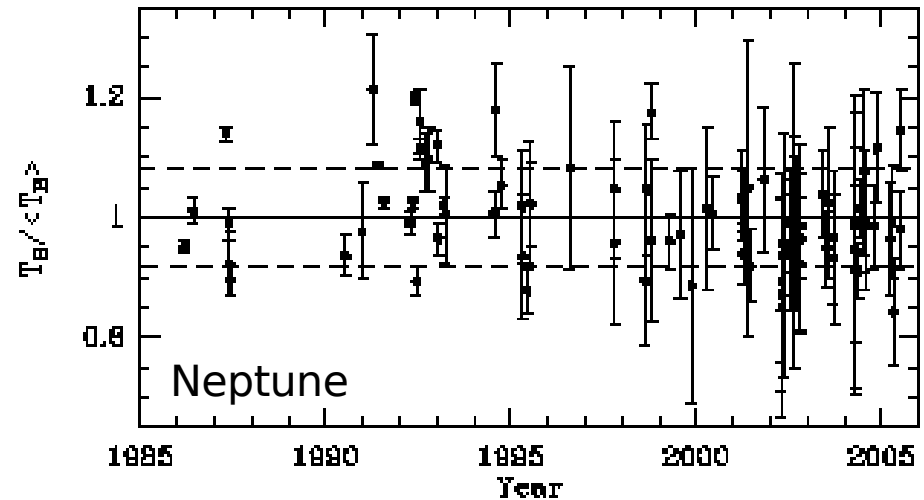
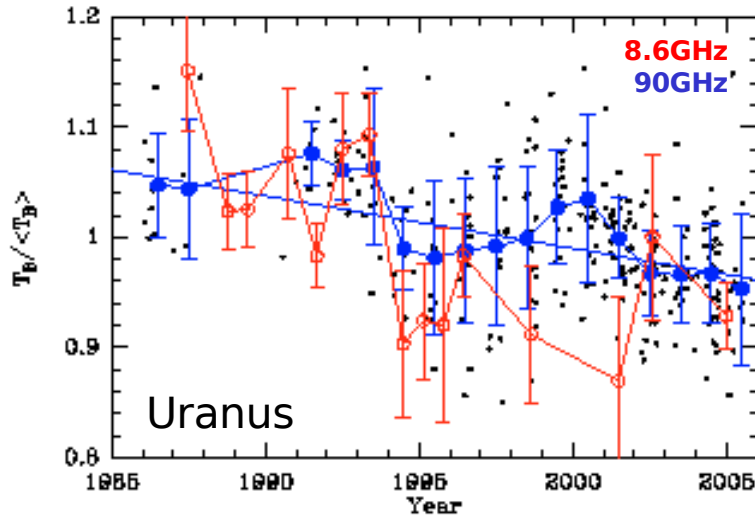
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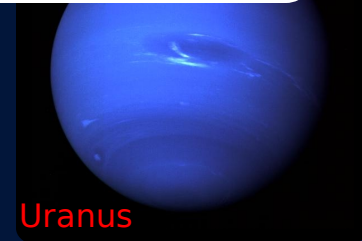


Flux Calibrators: Planets

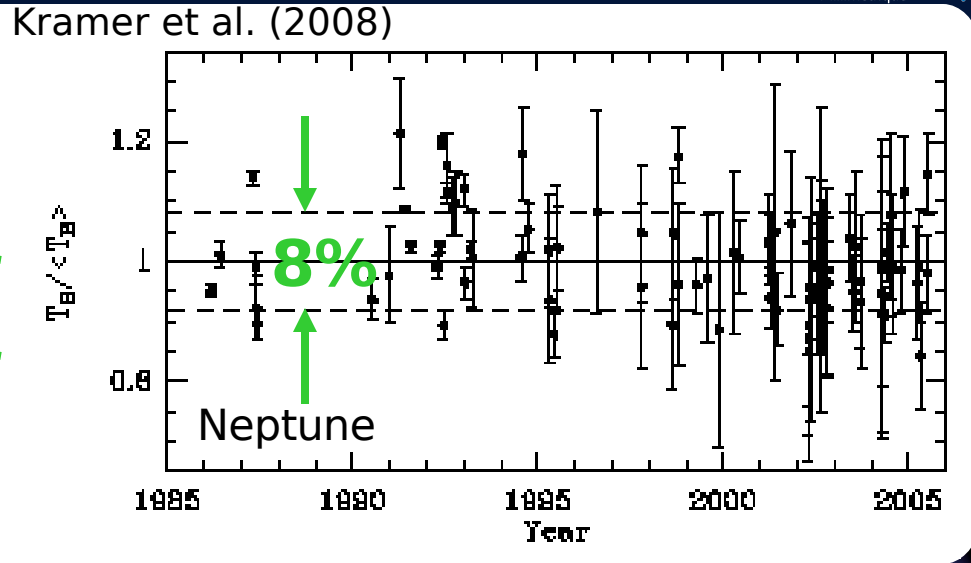
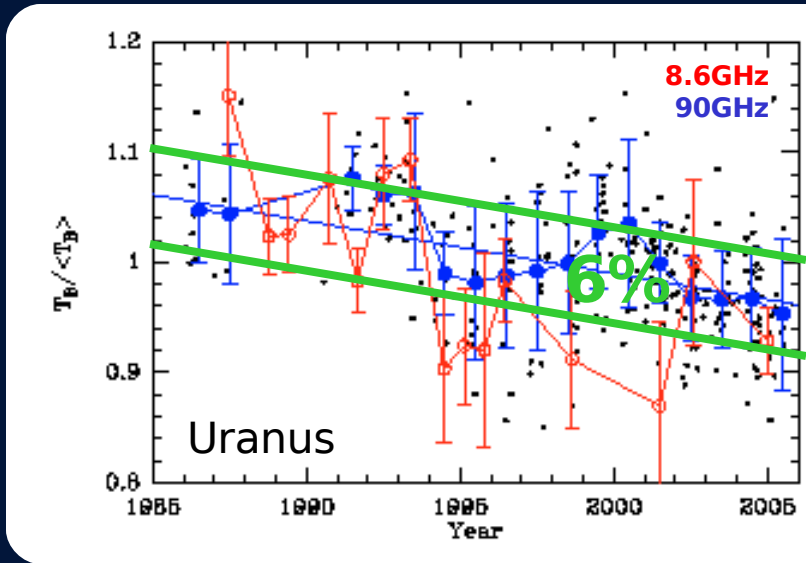
Kramer et al. (2008)



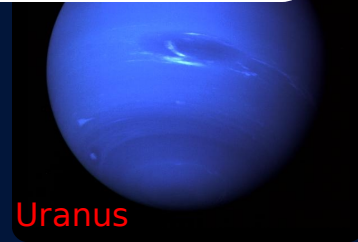
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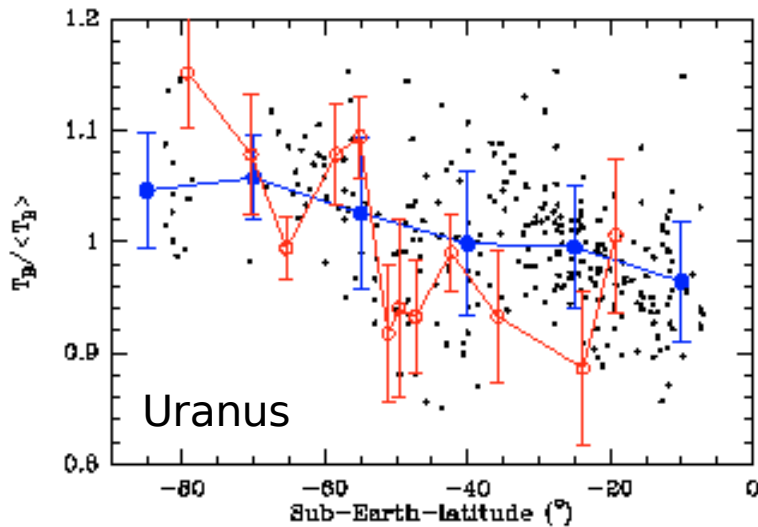
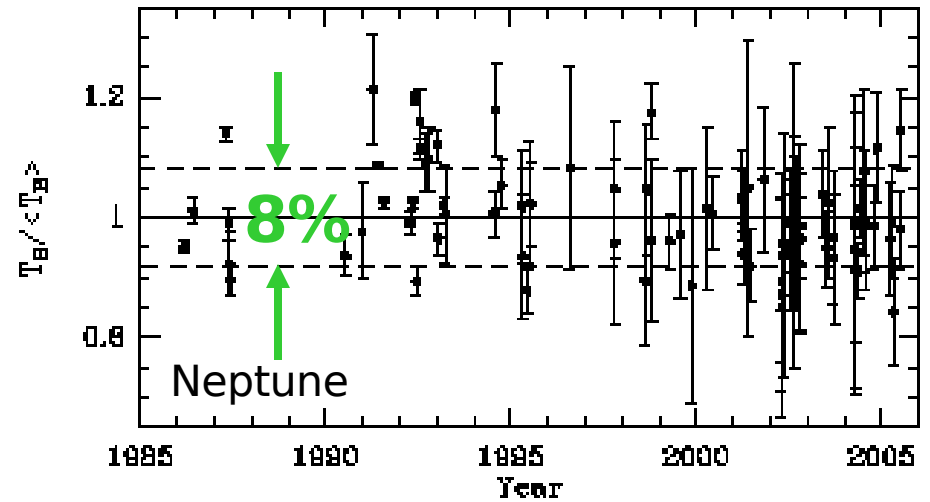
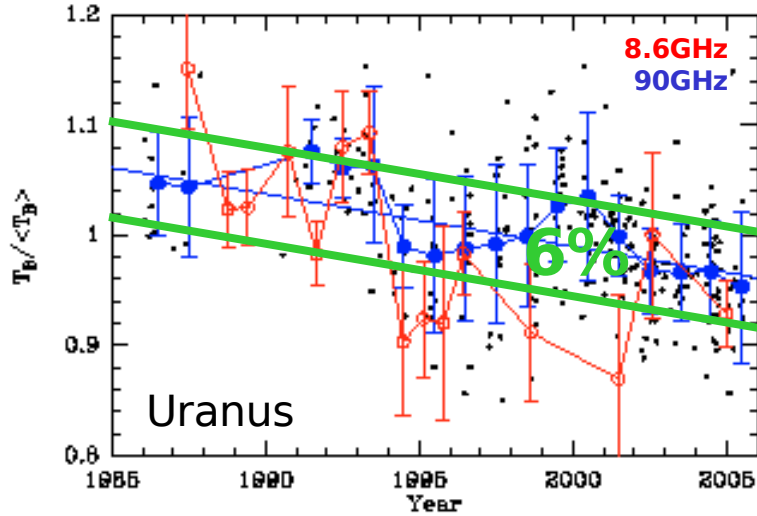


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Flux Calibrators: Planets

Kramer et al. (2008)



(e.g., Mars, Jupiter, Saturn) constraints due to sun-



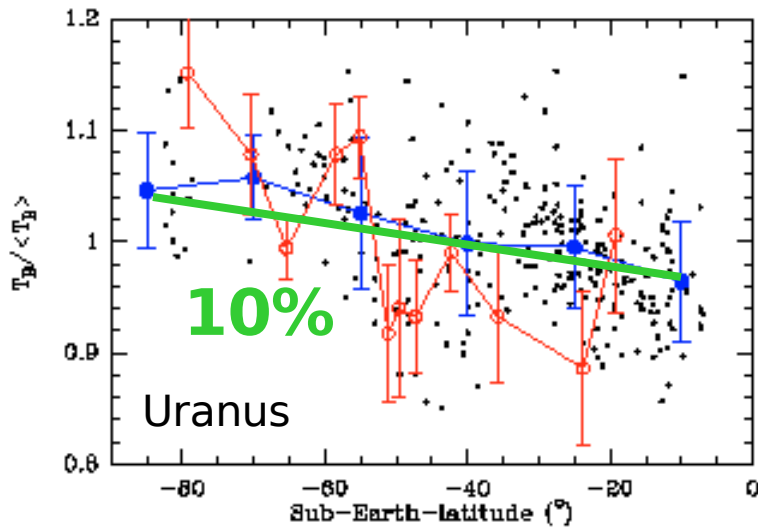
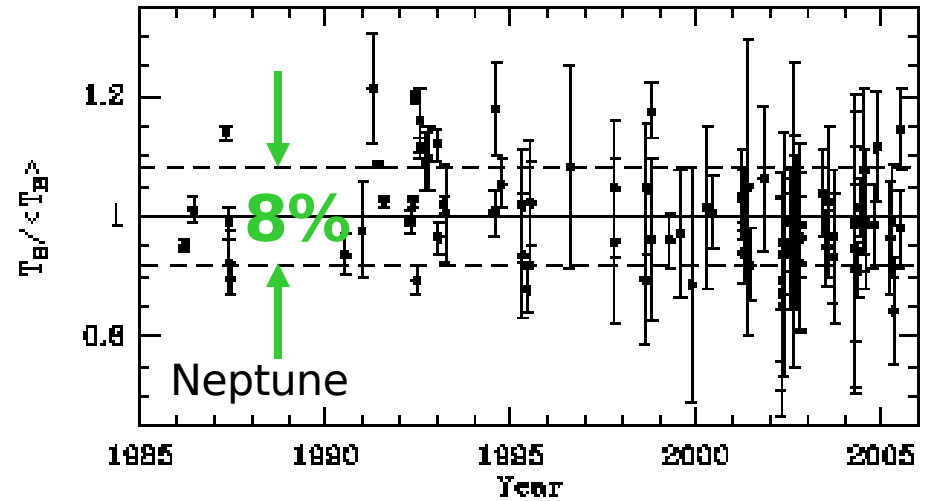
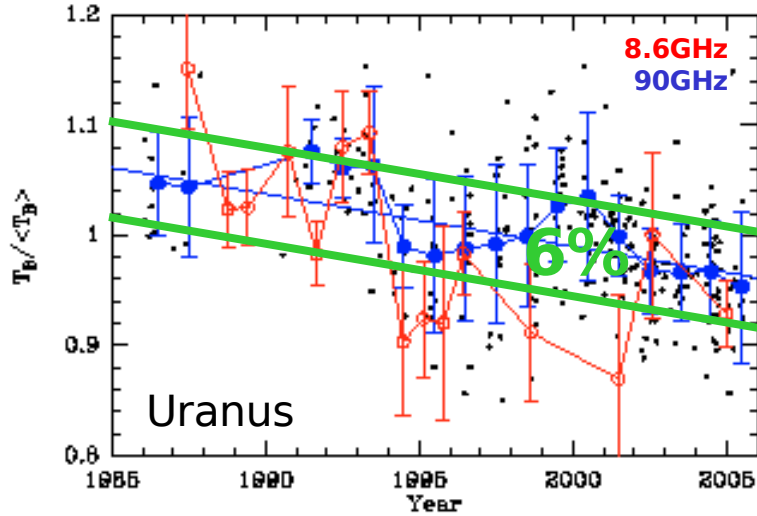
Uranus

Saturn

Neptune

Flux Calibrators: Planets

Kramer et al. (2008)



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Uranus

Saturn

Neptune

Flux Calibrators: Planets

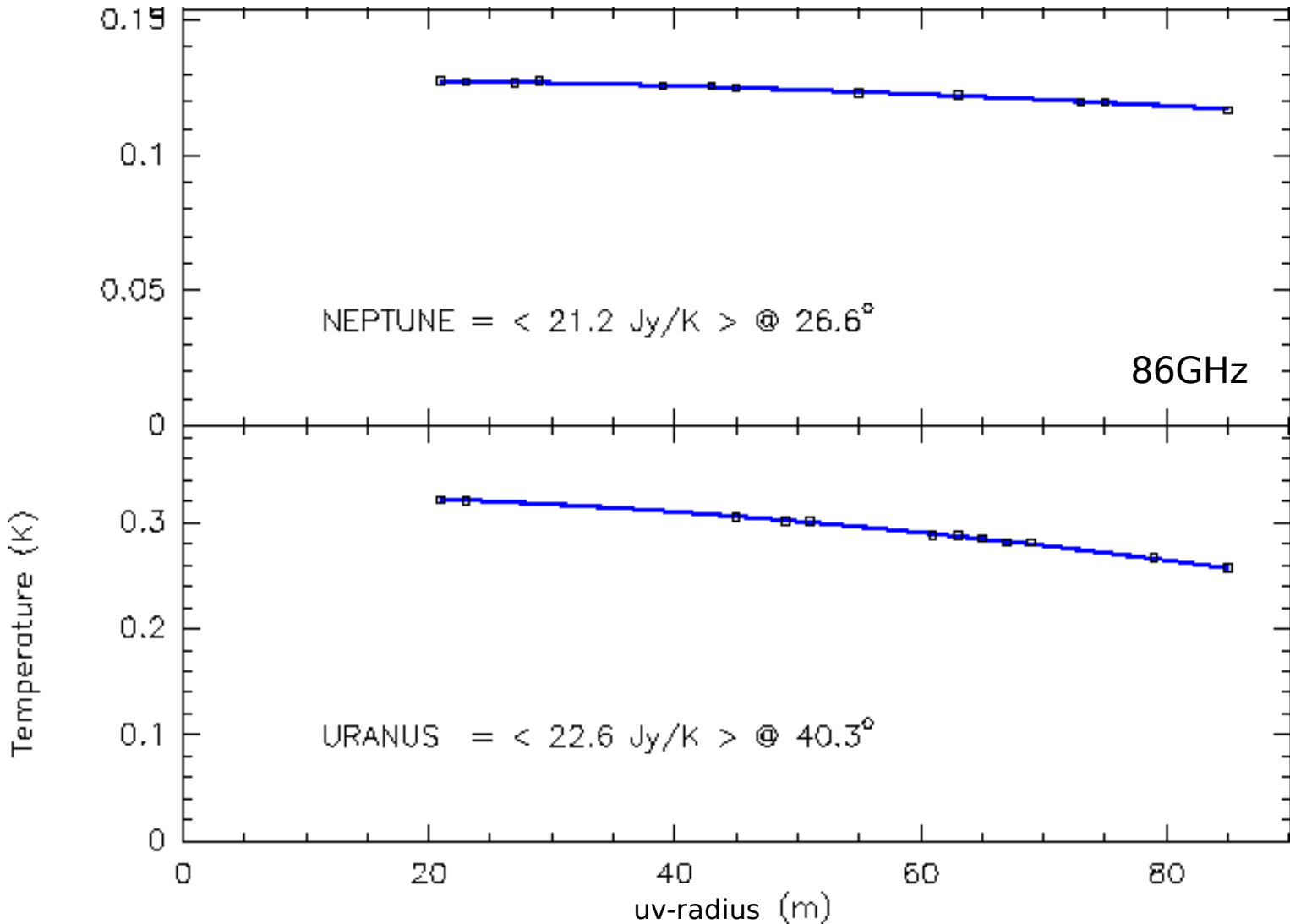
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- Contra:
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Flux Calibrators: Planets

- Pr
- m
- re

- Co
- 1.
- 2.
- 3.
- 4.



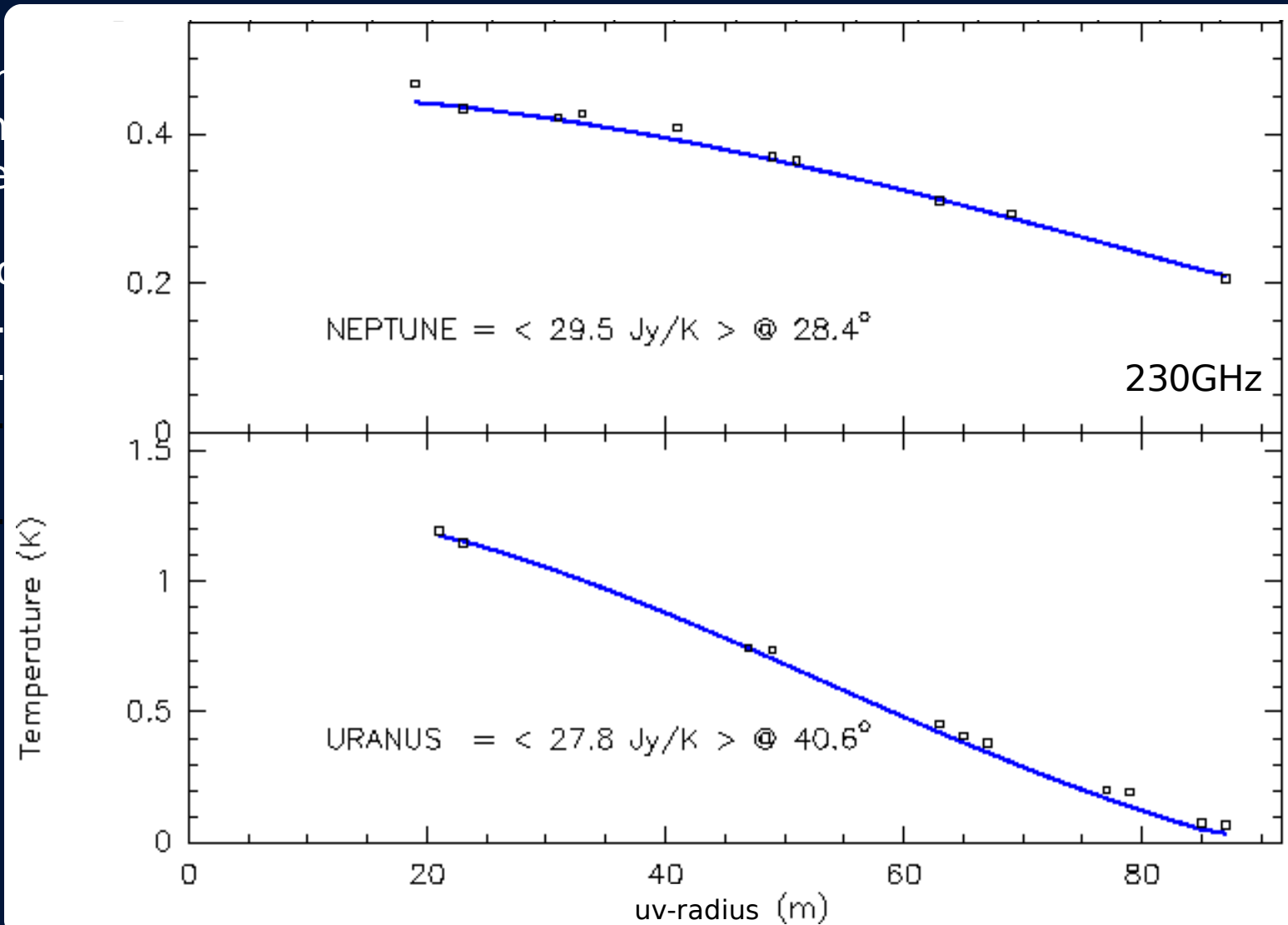
Jupiter

Saturn

Neptune

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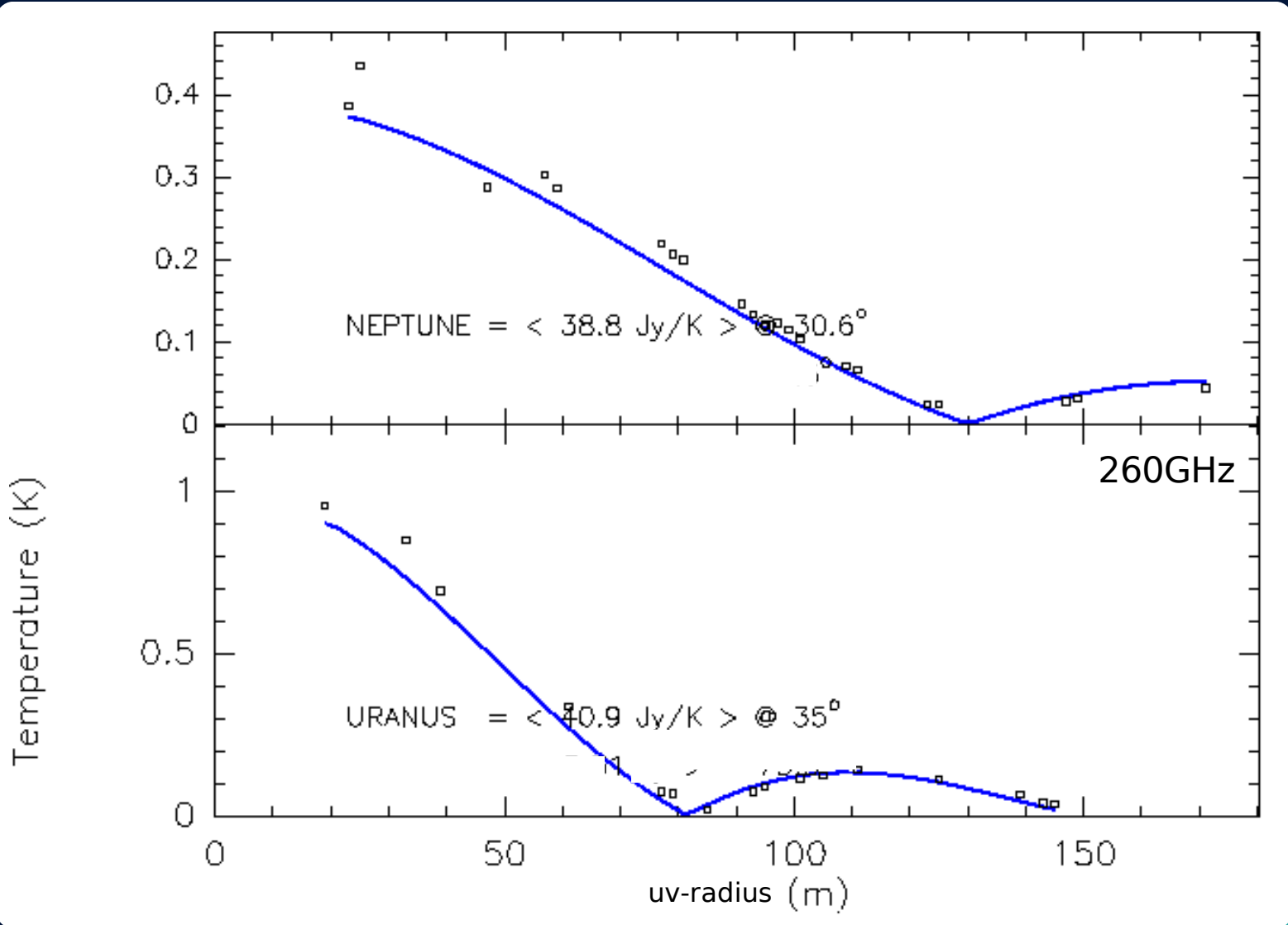
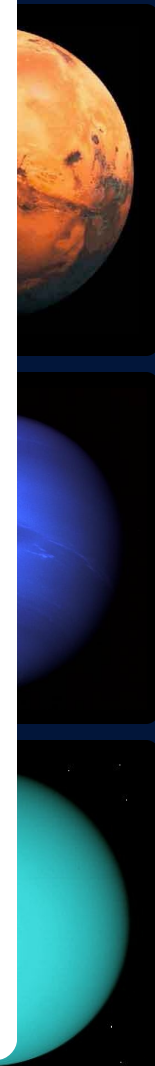
Jupiter

Saturn

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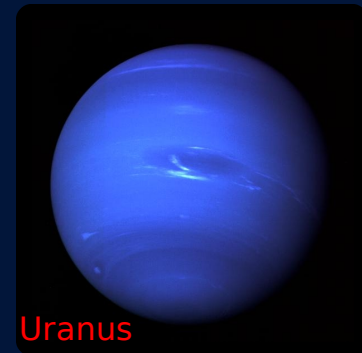
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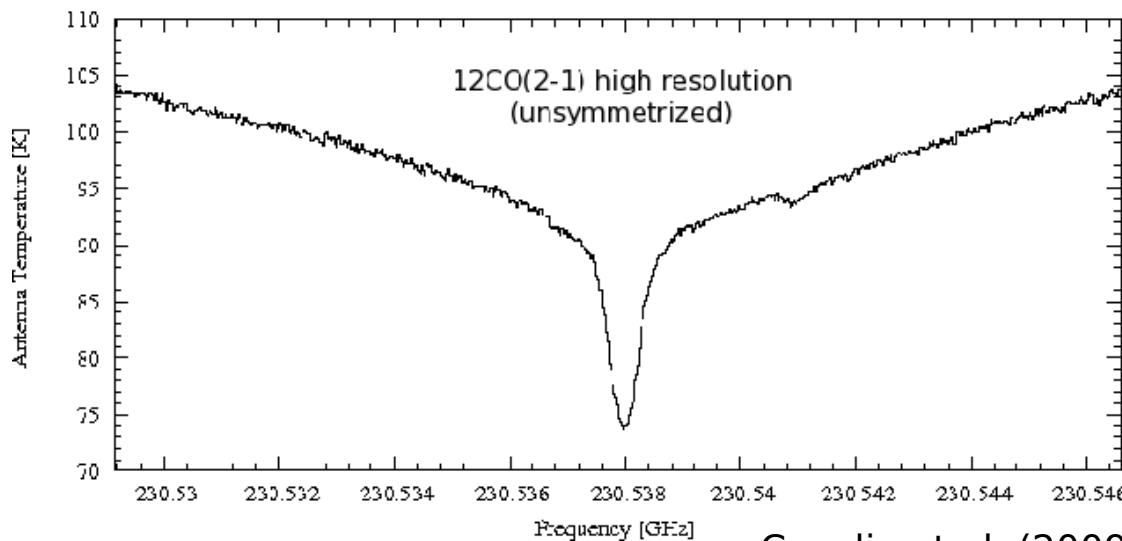
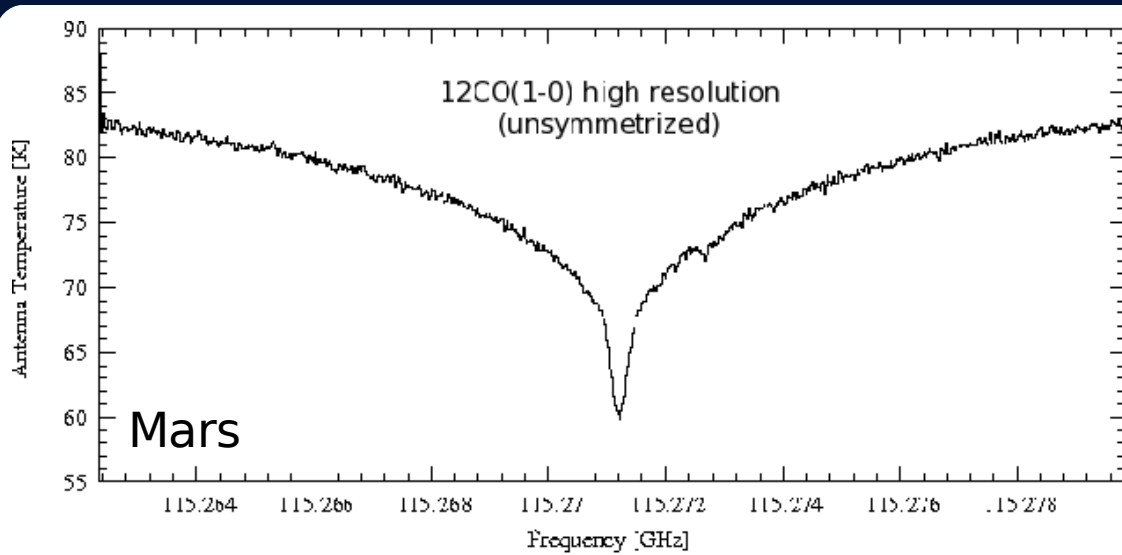
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Flux Calibrators: Planets

- Pro:
 - 1.) Fluxes
 - 2.) They s
 - 3.) Some
- Contra:
 - 1.) Fluxes
 - 2.) They s
 - 3.) Some
 - 4.) Not all

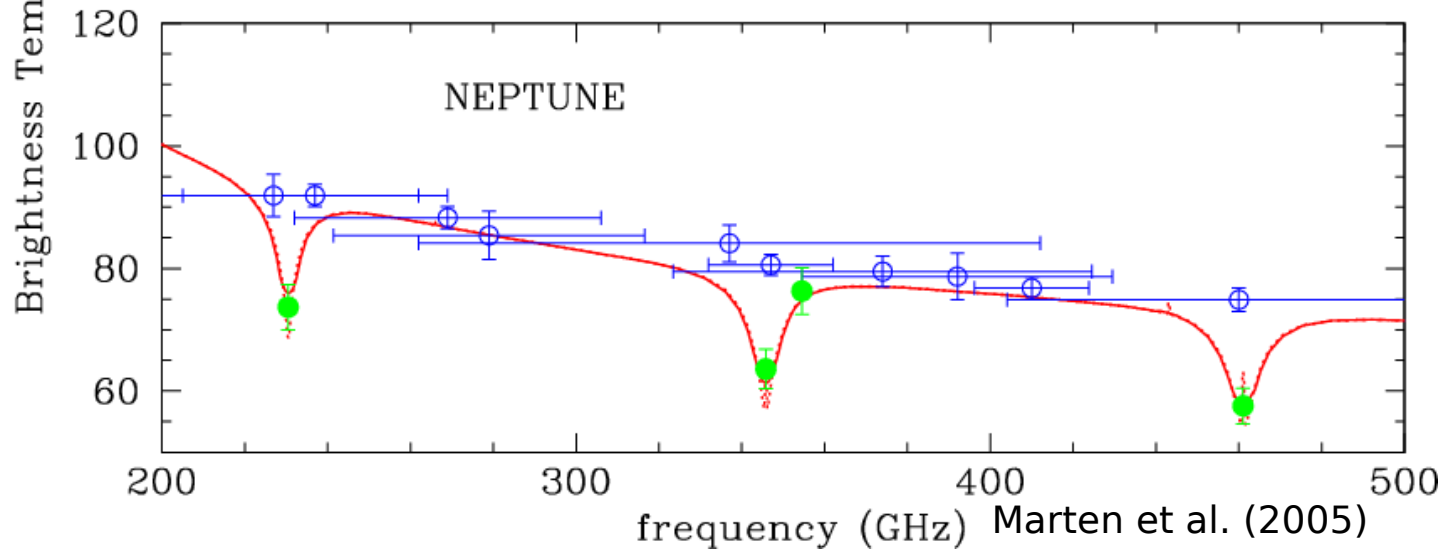
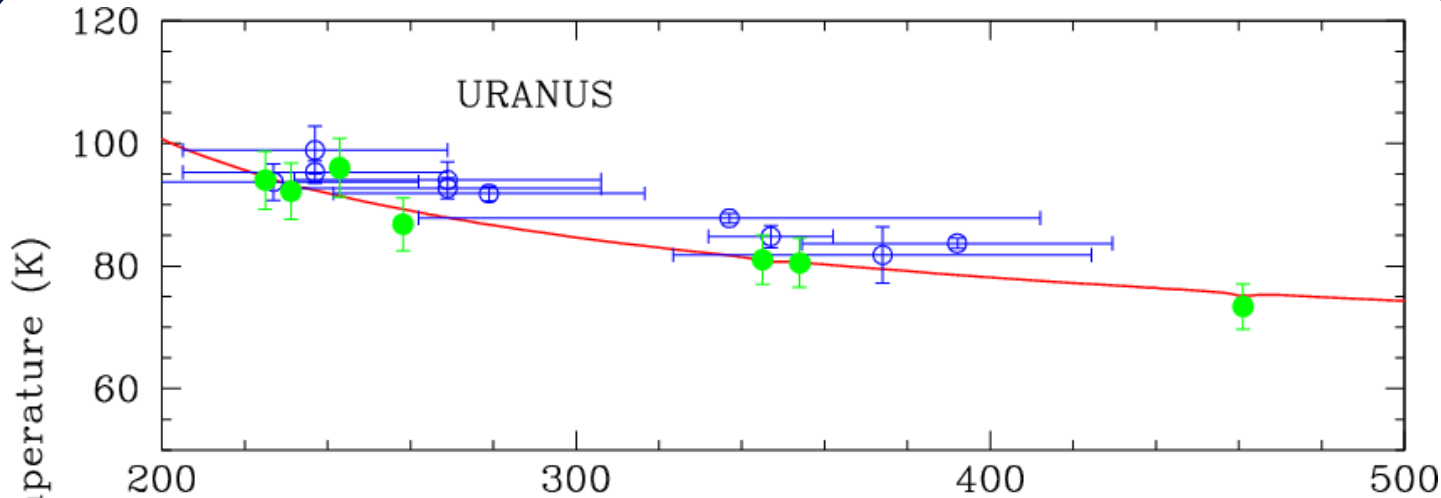


Cavalié et al. (2009)



Flux Calibrators: Planets

- Pro
- mo
- rea
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- 1.)
- 2.)
- 3.)
- 4.)

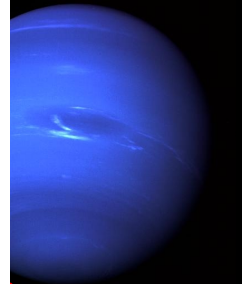
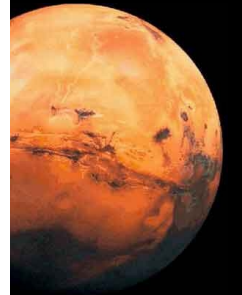


frequency (GHz) Marten et al. (2005)

Frequency [GHz]

Cavalié et al. (2009)

Neptune



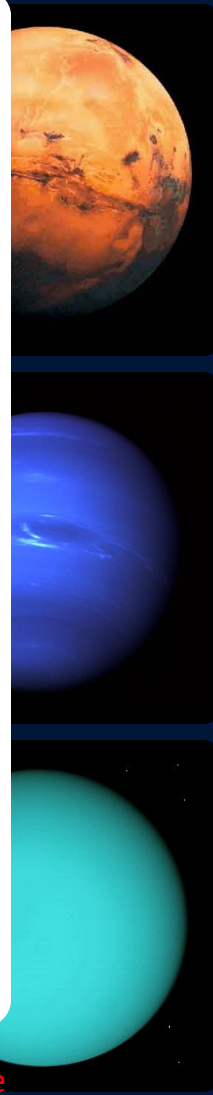
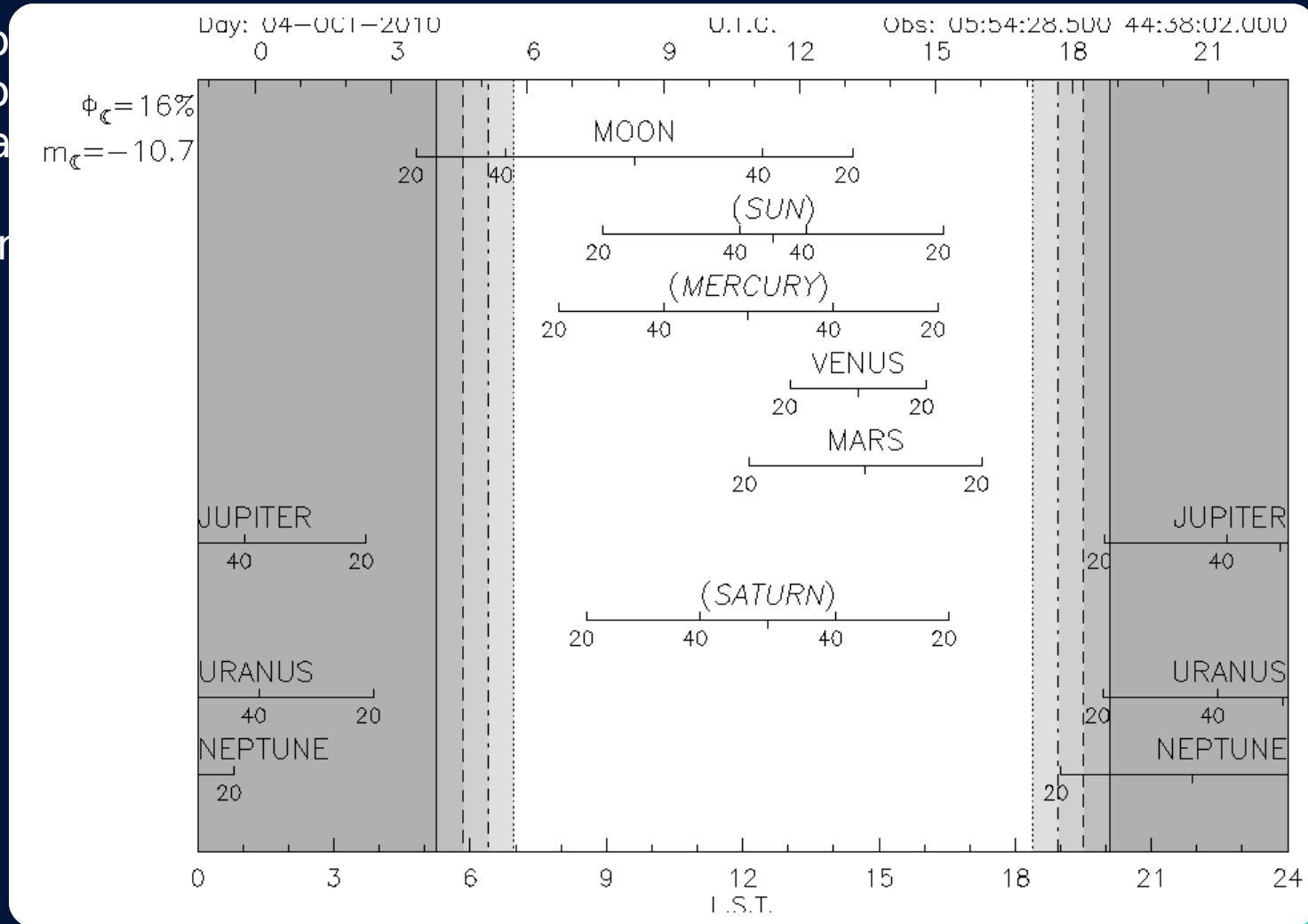
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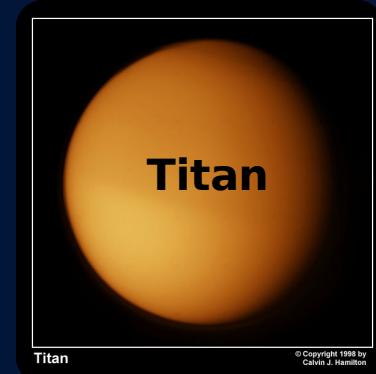
Jupiter Saturn Neptune

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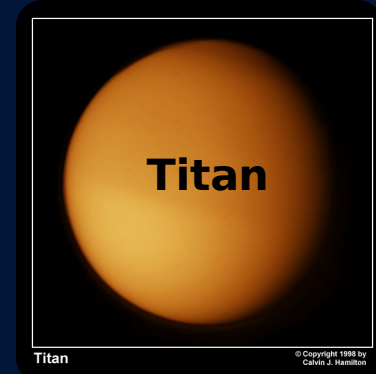
Flux Calibrators: Satellites

- Pro:
 - They are quite compact (hence better for extended configurations and/or higher frequencies than planets) and still sufficiently bright ($>500\text{mJy}@3\text{mm}$)
- Already regularly used at the SMA:
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



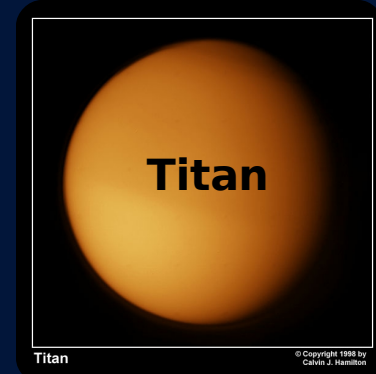
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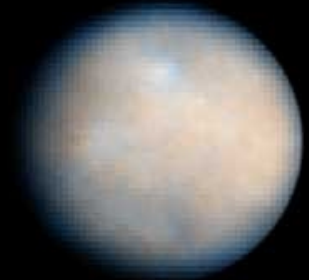
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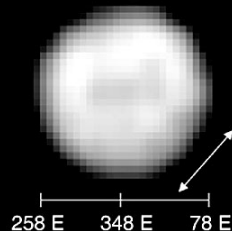
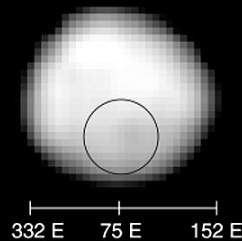
Flux Calibrators: Asteroids/Dwarf Planets

- Pro:
 - bright and relatively small solar bodies
- Contra:
 - Fluxes not (yet) well determined; some of them known to vary quite significantly within a day
 - irregular shapes

Ceres



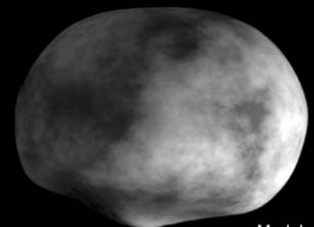
Palla



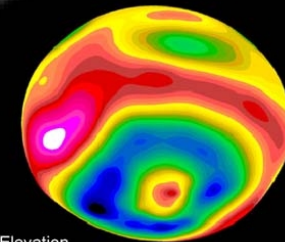
Vesta



HST

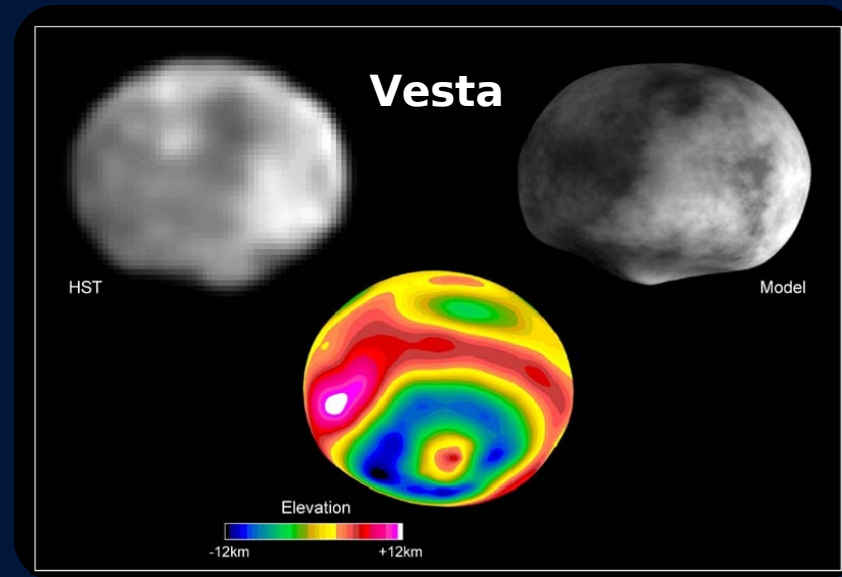
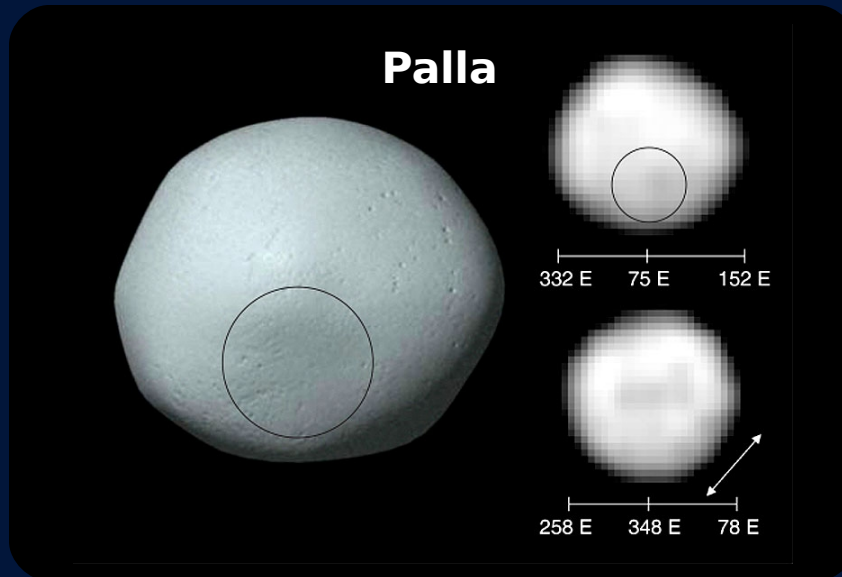


Model

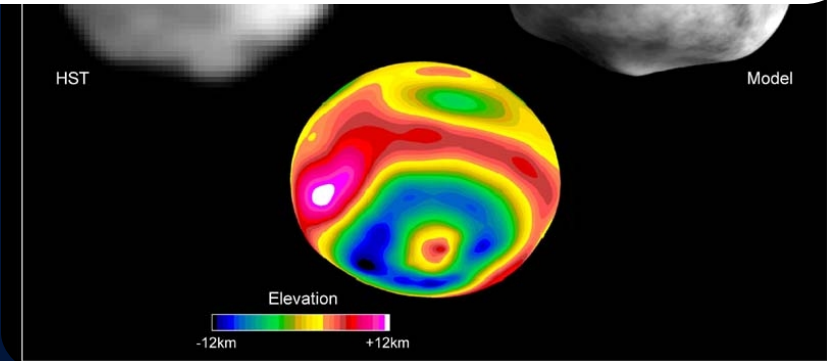
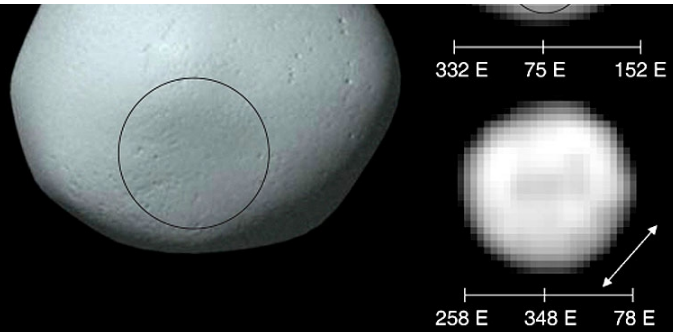
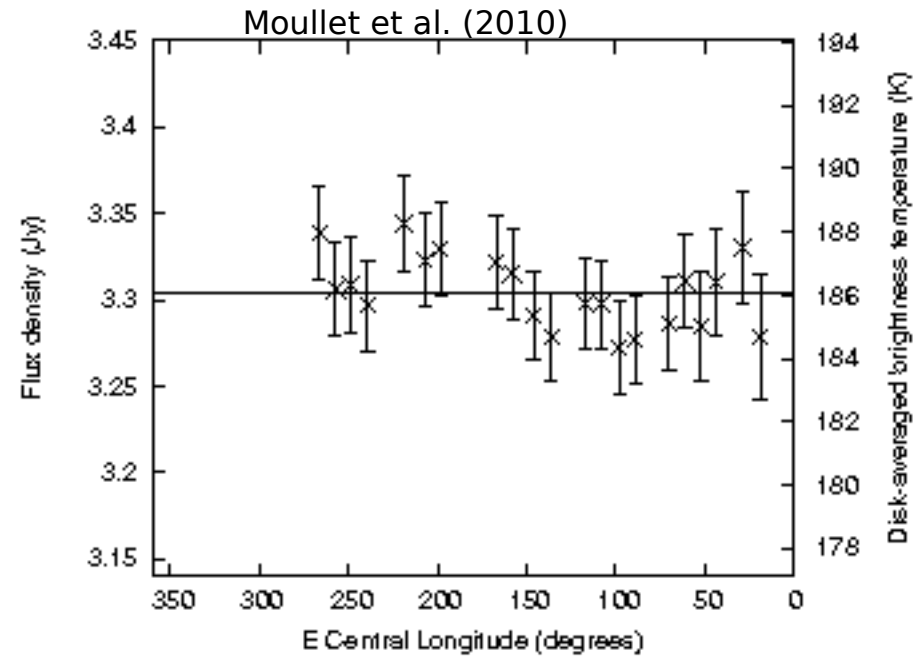
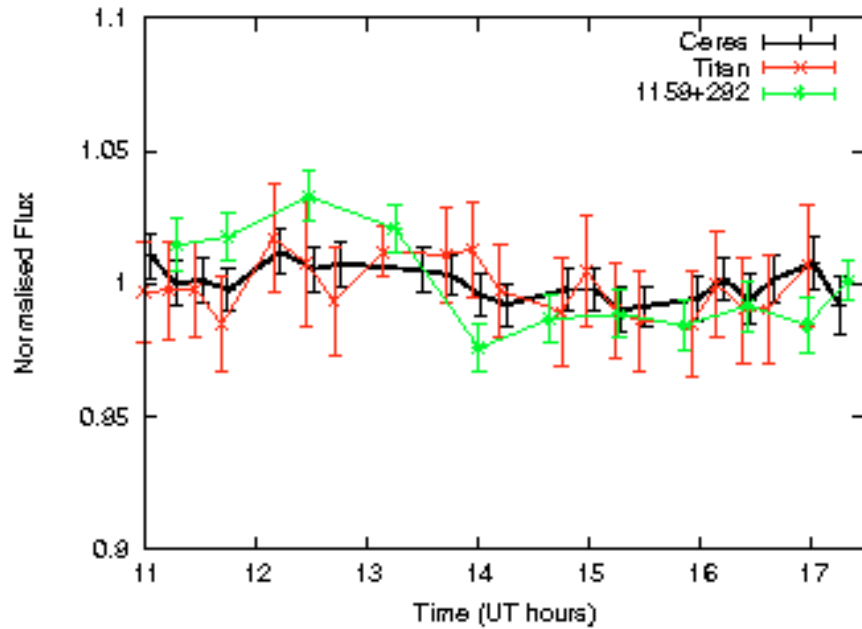


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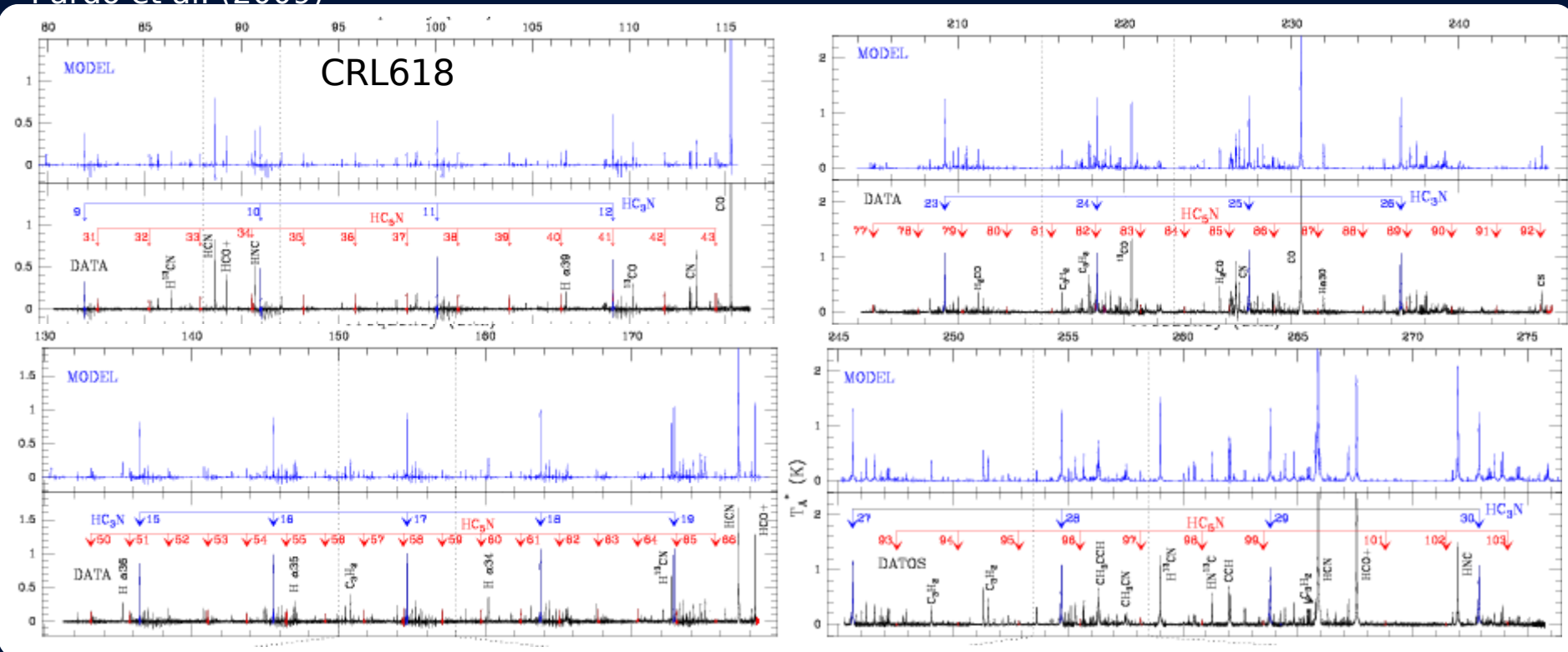
Flux Calibrators: Radio Stars

Number of radio bright stars:

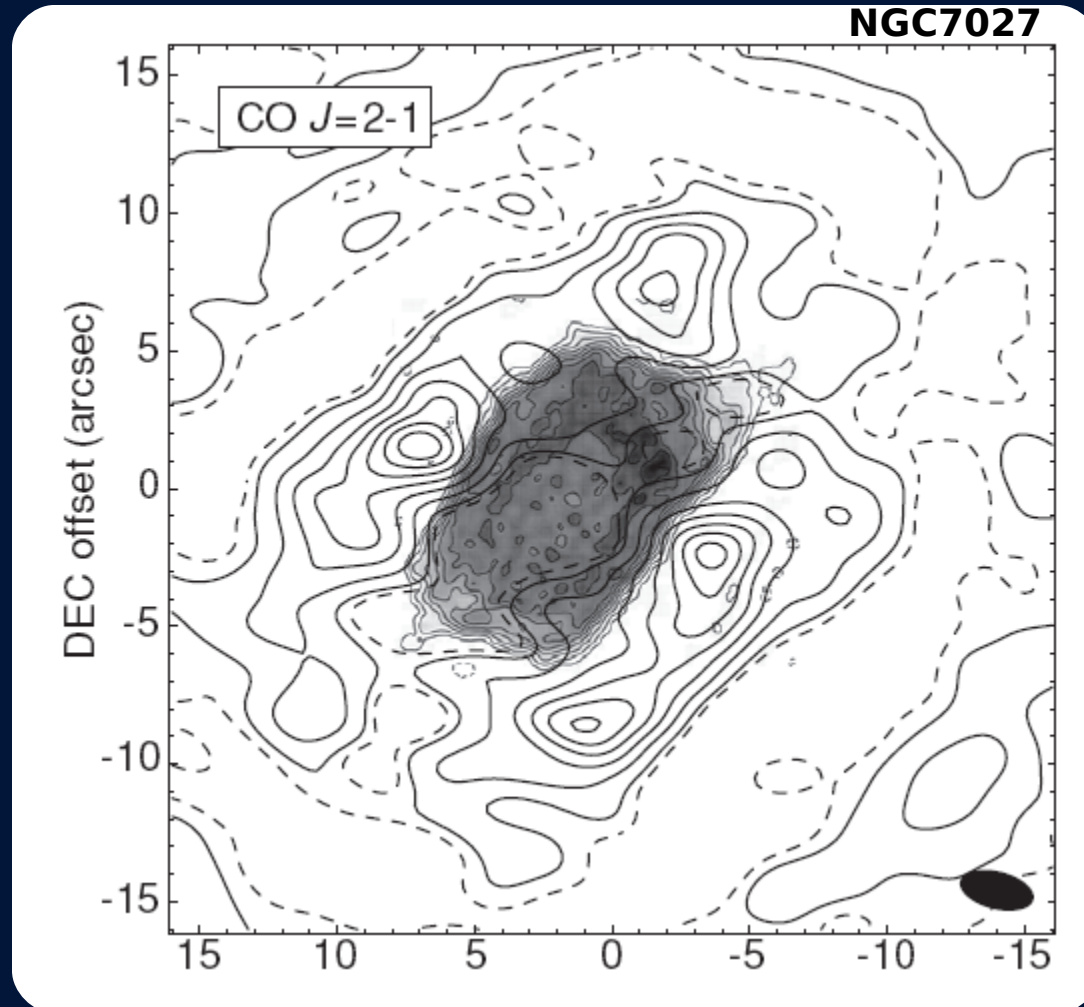
- MWC349 (binary star)
- CRL618 (PPN)
- W3OH (HII region)
- NGC7072 (young PN)
- NGC7538 (HII region)
- K3-50A (HII-region)
-

Flux Calibrators: Radio Stars

Pardo et al. (2009)

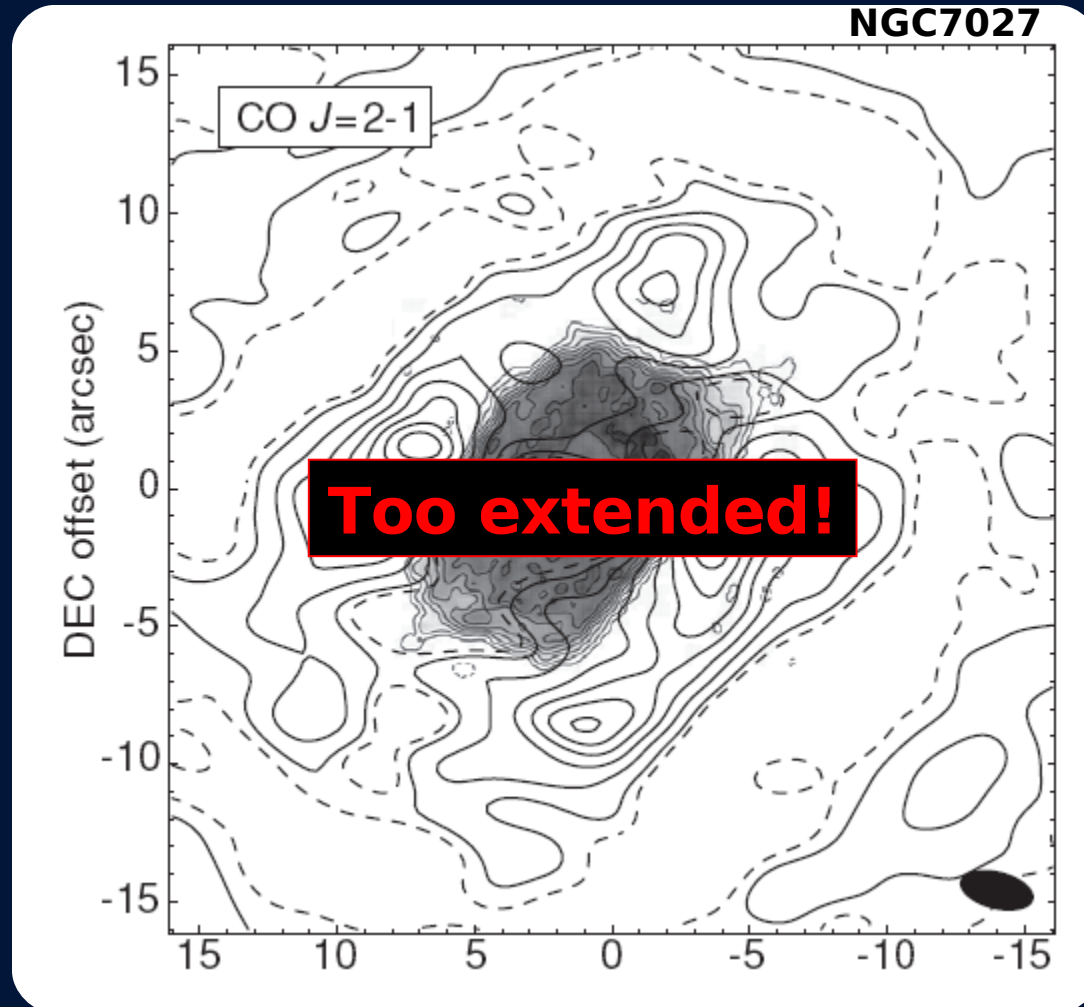


Flux Calibrators: Radio Stars



Nakashima et al. (2010)

Flux Calibrators: Radio Stars



Nakashima et al. (2010)

Flux Calibrators: Radio Stars

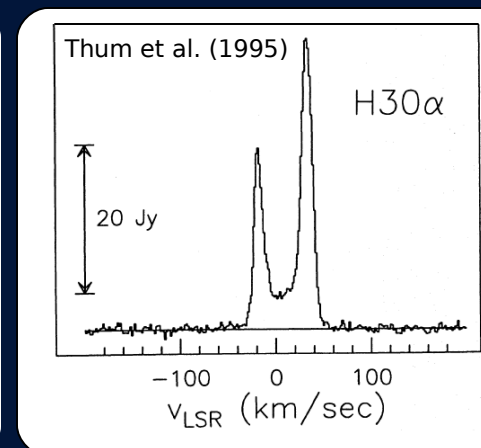
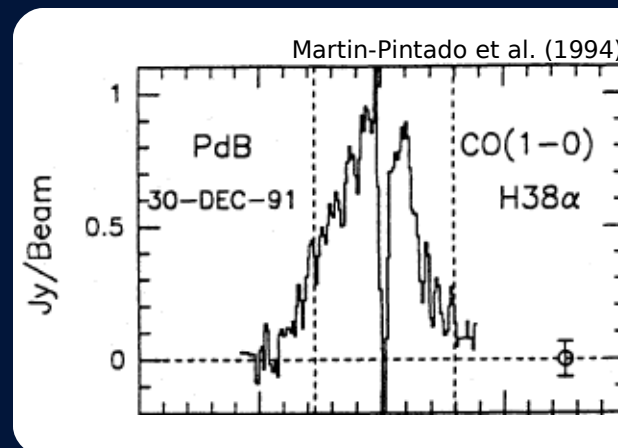
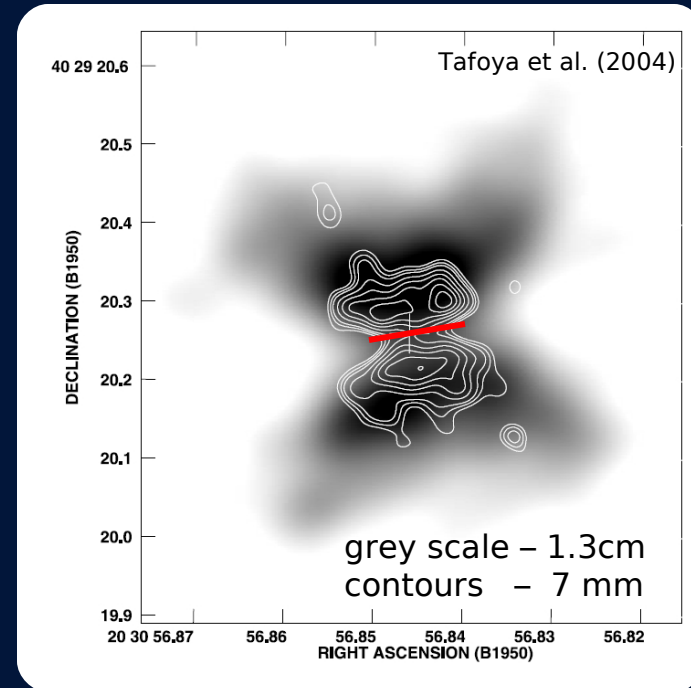
Number of radio bright stars:

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

Flux Calibrators: MWC349

Some facts:

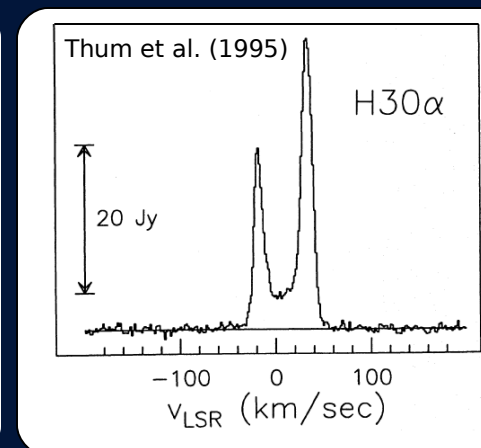
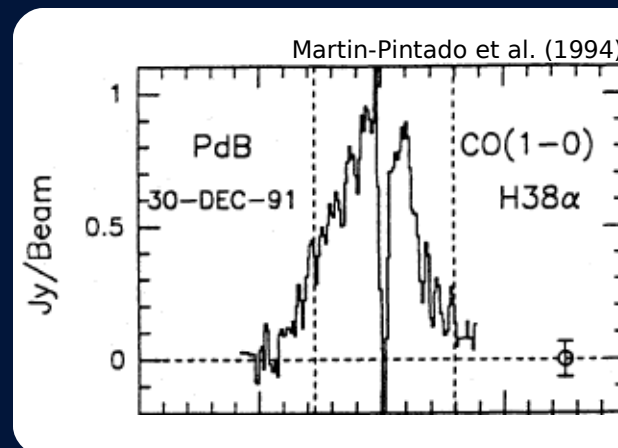
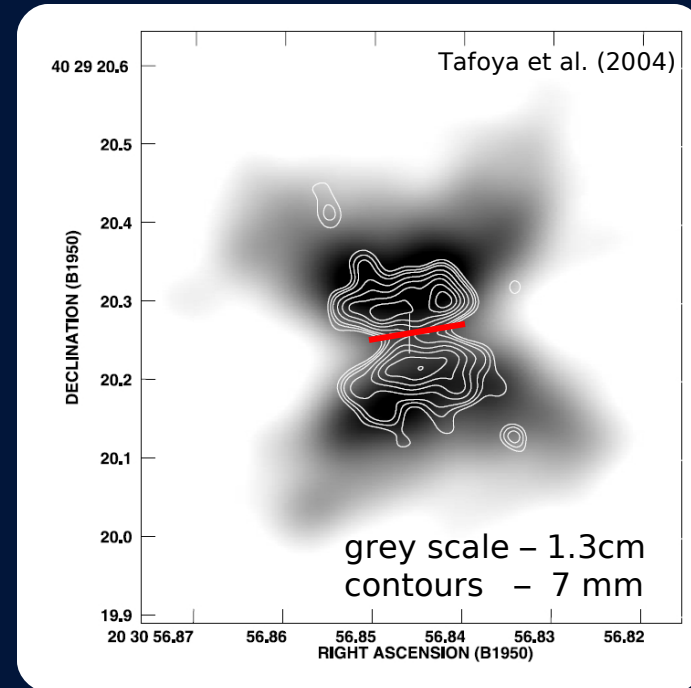
- binary stellar system:
MWC349A (Be) & MWC349B (B0 type III)
- the two stars are separated by $2.4'' \pm 0.1''$ and possibly interact
- MWC349A the brightest radio continuum star
- radio continuum produced by “ionised bipolar flow that photoevaporates from the surface of a neutral Keplerian disk”
- 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



Flux Calibrators: MWC349

Some facts:

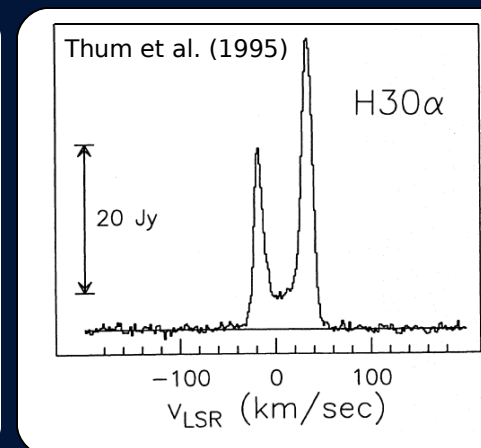
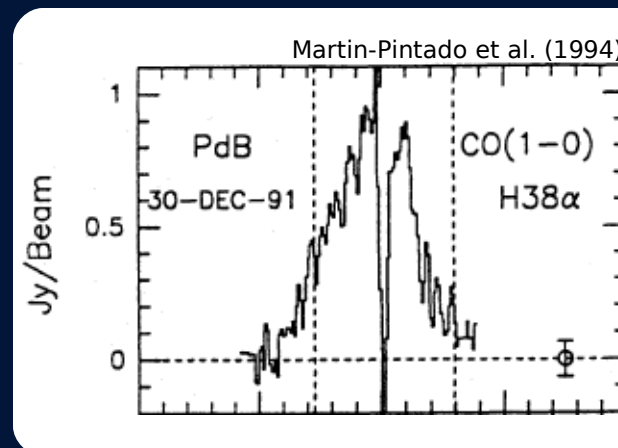
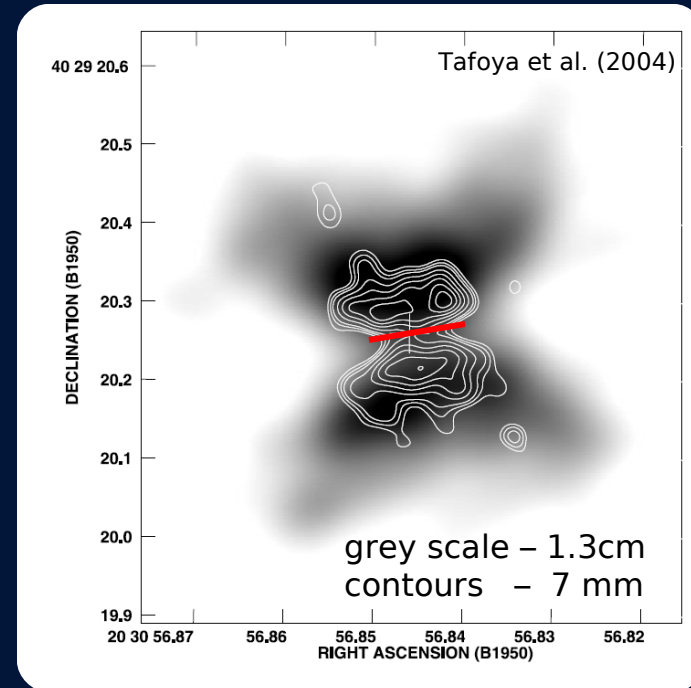
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- at declination of $>40\text{deg}$
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Flux Calibrators: MWC349

Some facts:

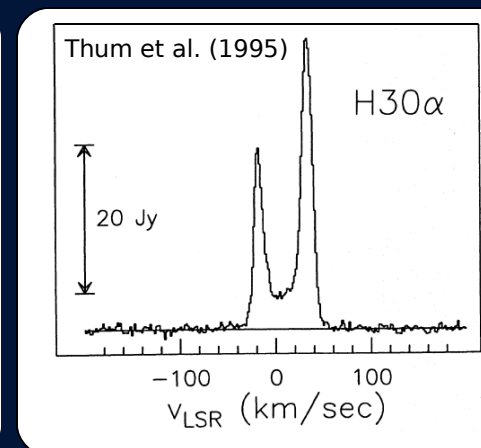
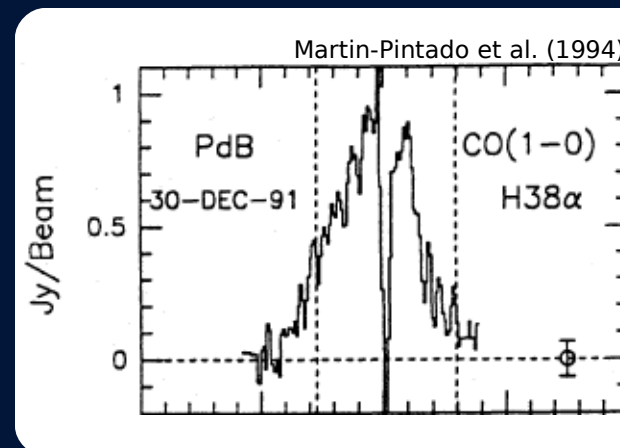
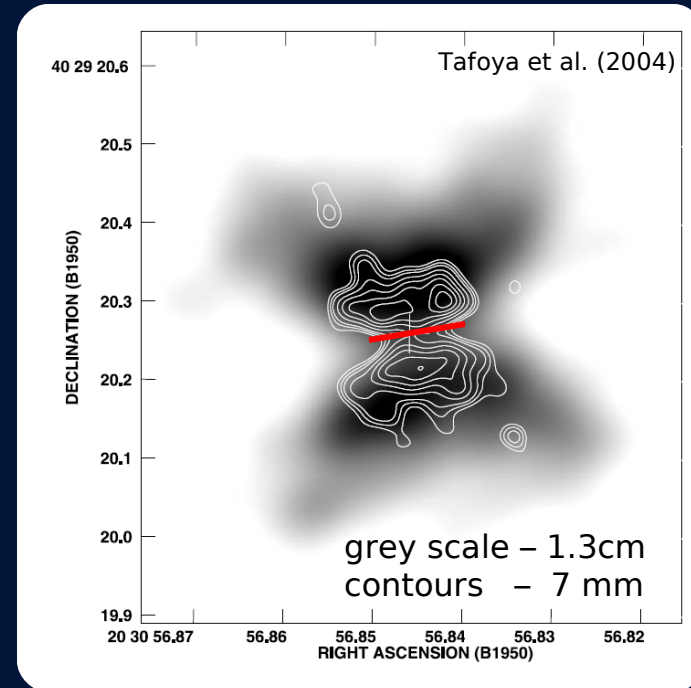
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- at declination of $>40\text{deg}$
-> visible for $\sim 13\text{h}$ per day



Flux Calibrators: MWC349

Some facts:

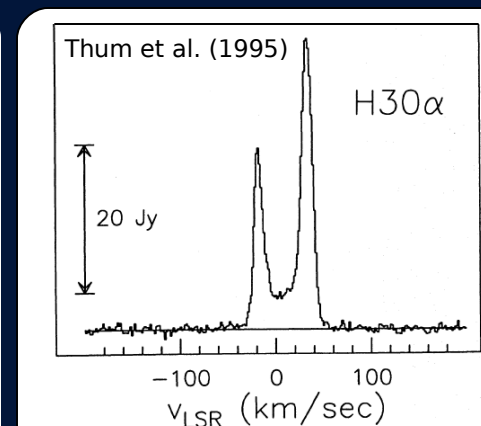
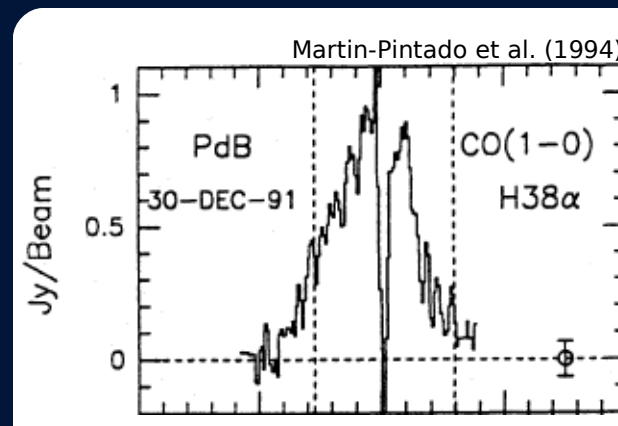
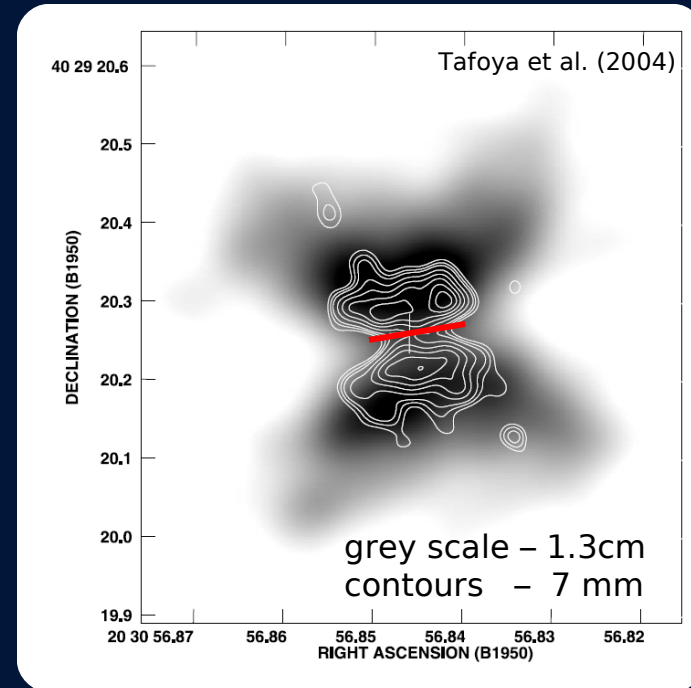
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- at declination of $>40\text{deg}$
-> visible for $\sim 13\text{h}$ per day



Flux Calibrators: MWC349

Some facts:

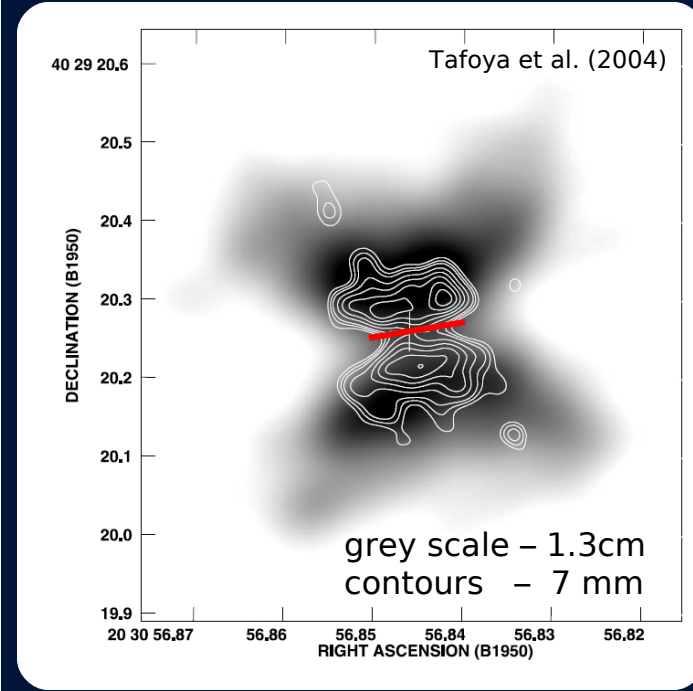
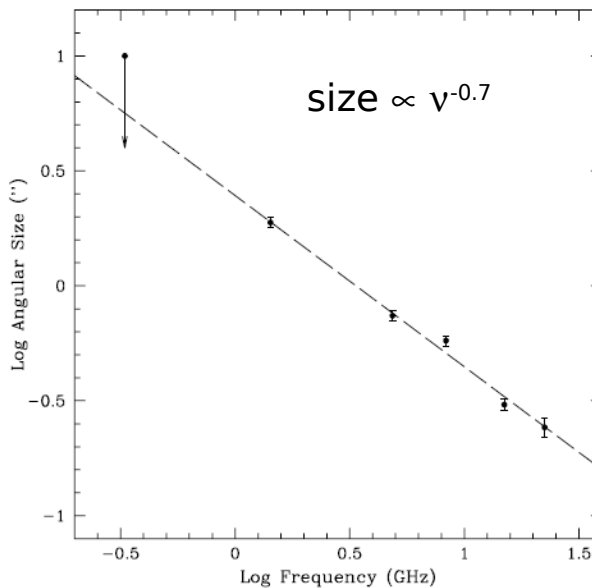
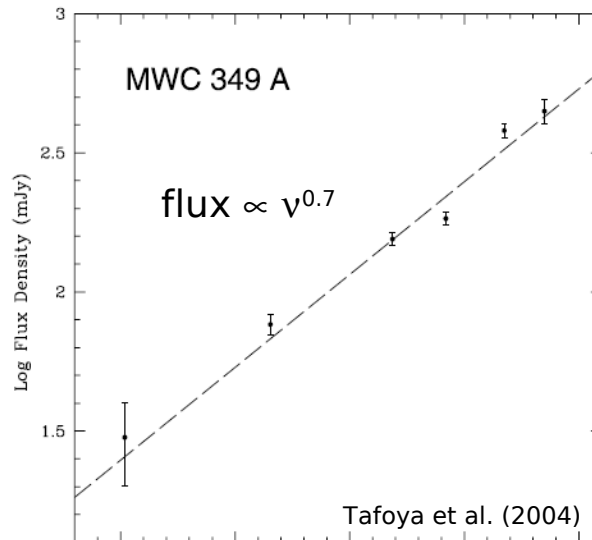
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MWC349A (Be) & MWC349B (B0 type III)
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- size of flow decreases with frequency
- strong but highly variable hydrogen maser emission (RRLs) from the near-edge-on disk ($\sim 0.065'' = 80\text{AU}@1.2\text{kpc}$)
- at declination of $>40\text{deg}$
-> visible for $\sim 13\text{h}$ per day



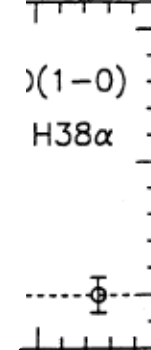
Flux Calibrators: MWC349

Some facts:

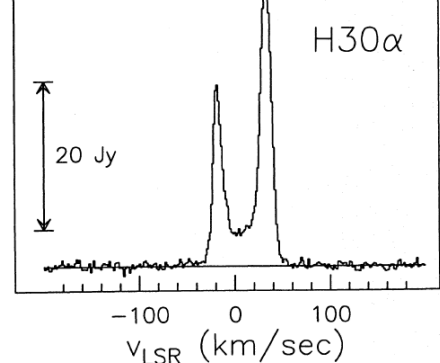
- binary stellar system
- MWC349A (Be) & MWC349B
- the two stars are seen to be possibly interact
- MWC349A the bright star
- radio continuum produced by flow that photoevaporates
- of a neutral Keplerian disk
- size of flow decreases with frequency
- strong but highly variable emission (RRLs) from MWC349B
- at declination of $>40^{\circ}$ -> visible for ~ 13 h day



Tafoya et al. (1994)



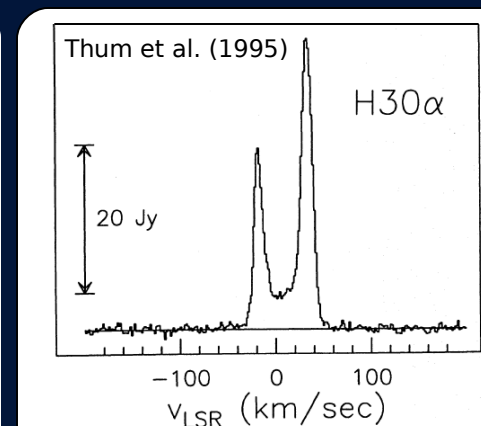
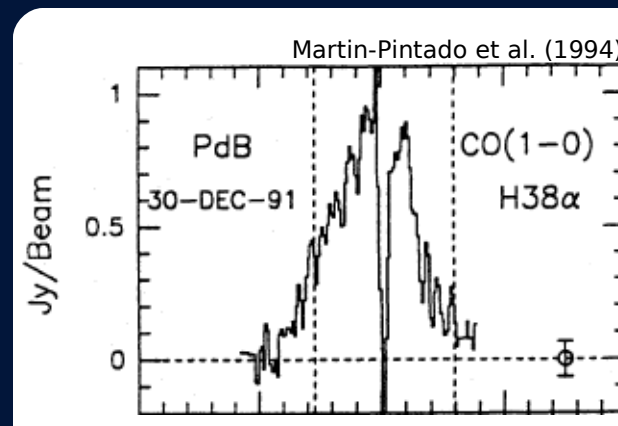
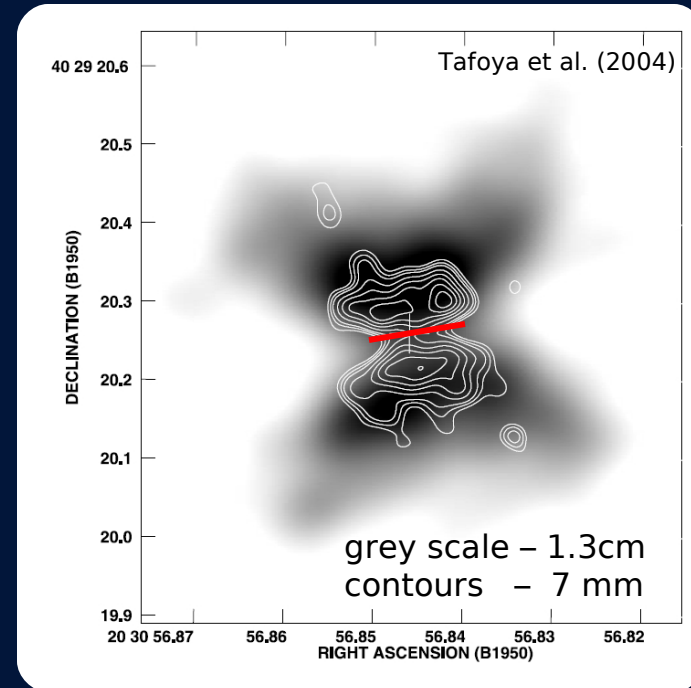
Thum et al. (1995)



Flux Calibrators: MWC349

Some facts:

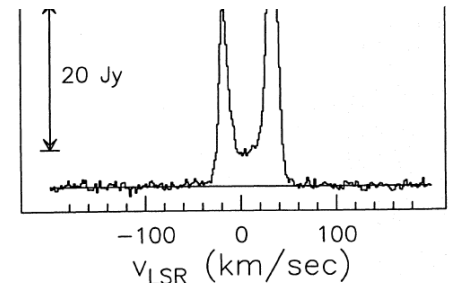
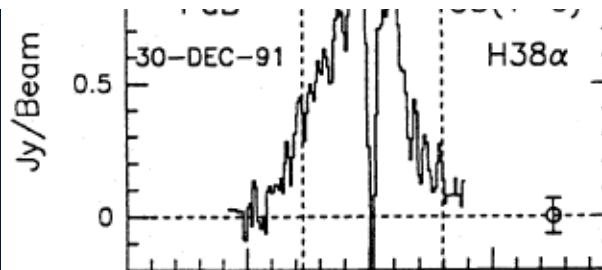
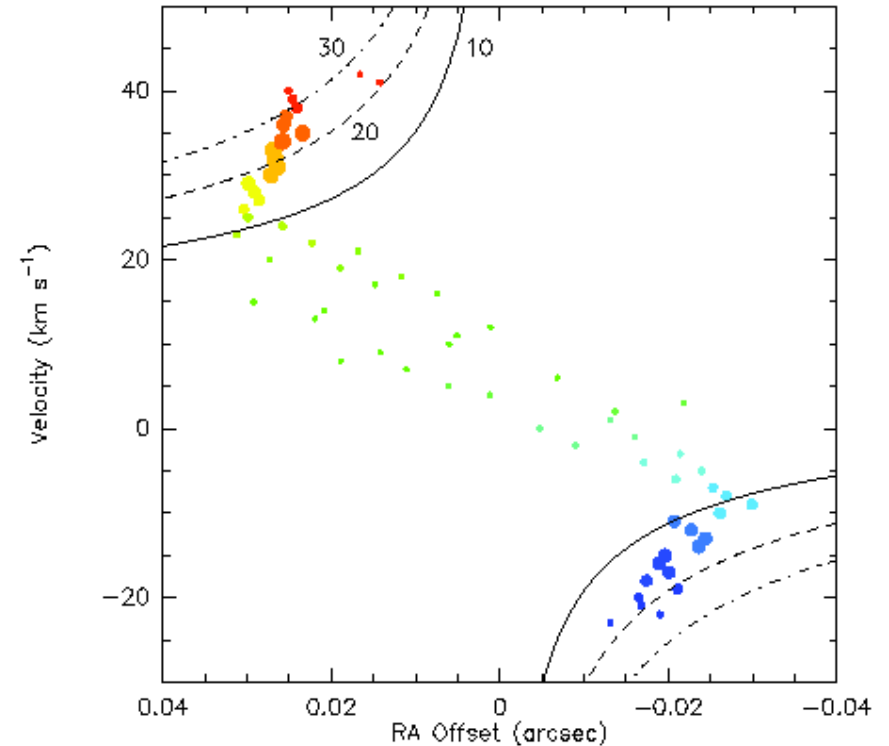
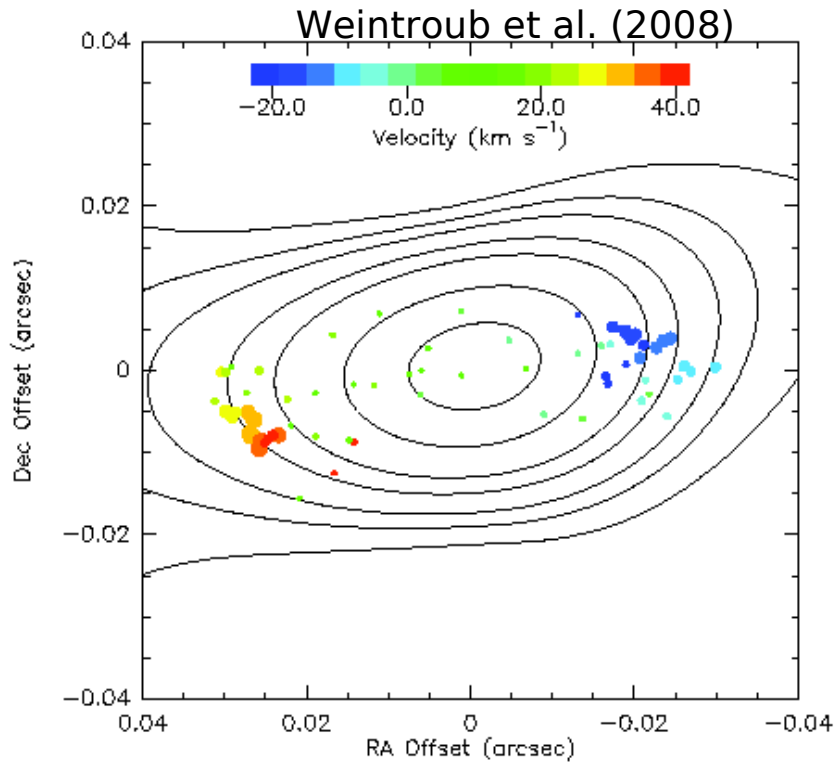
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- at declination of $>40\text{deg}$
-> visible for $\sim 13\text{h}$ per day



Flux Calibrators: MWC349

Some facts:

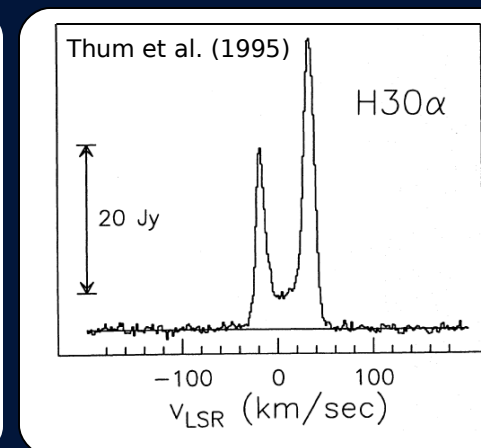
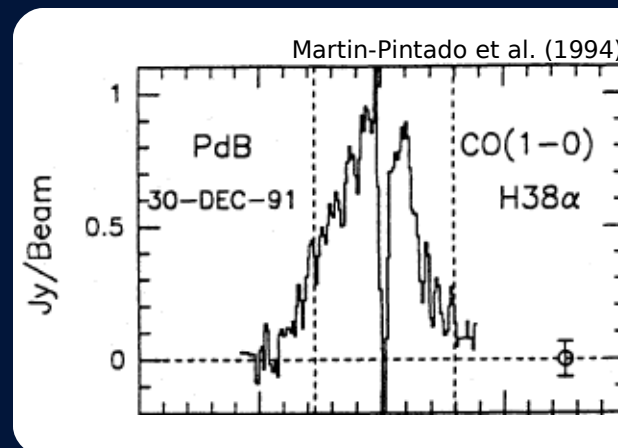
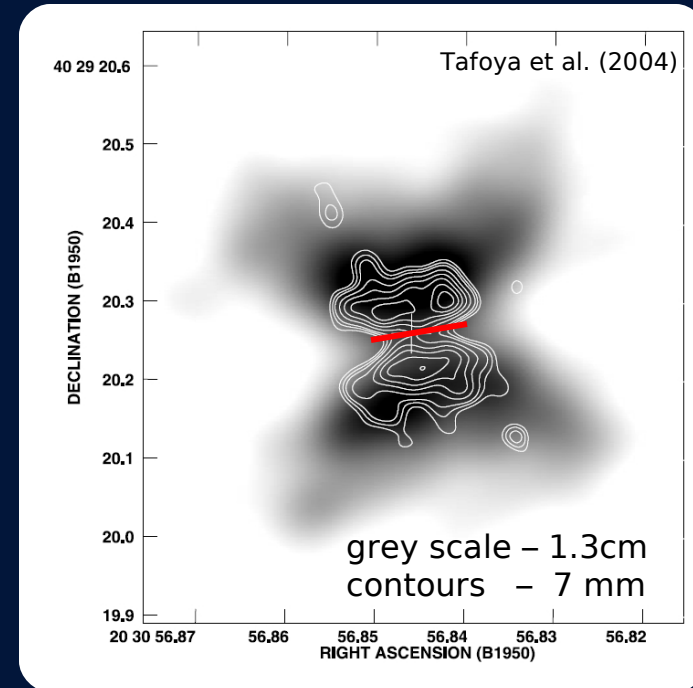
- binary stellar system



Flux Calibrators: MWC349

Some facts:

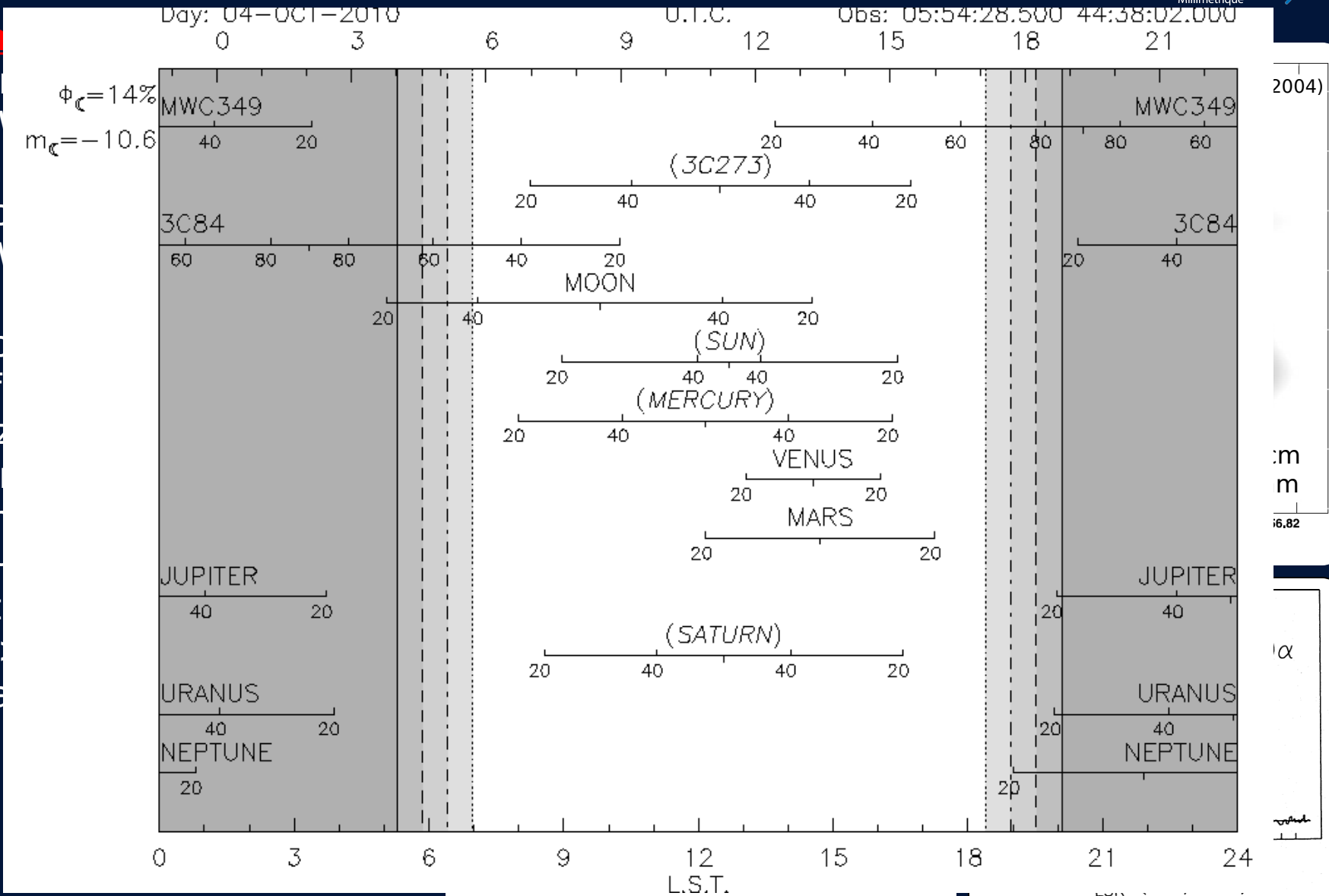
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- at declination of $>40\text{deg}$
 \Rightarrow visible for $\sim 13\text{h}$ per day



Flux Calibrators: MWC349

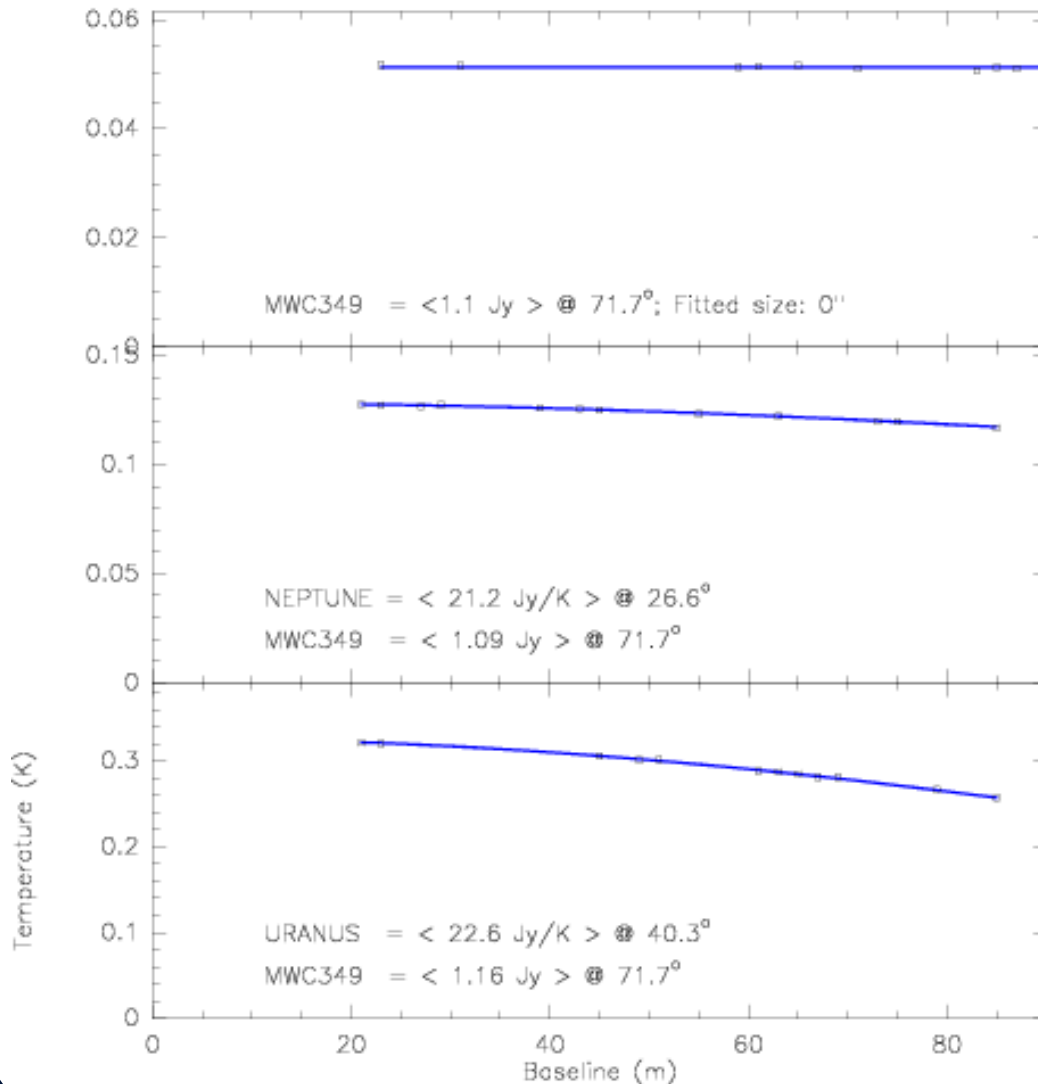
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How to calibrate a calibrator?

12-OCT-2008 @ 86.2 GHz (LO1REF=1853 MHz)



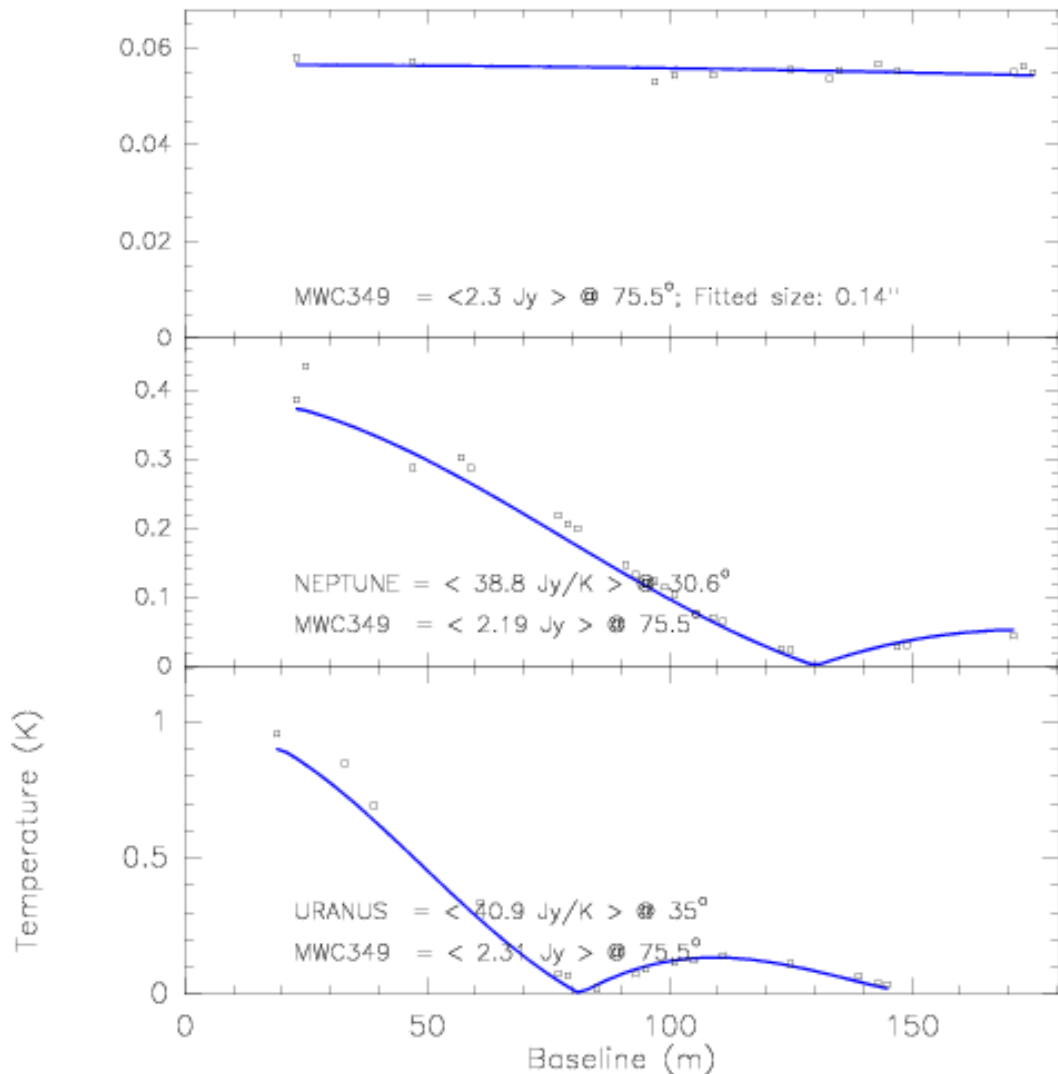
ANTENNA	3c454.3@46°	mwc349@72°
1	21.5 Jy/K	21.3 Jy/K
2	22.3 Jy/K	22.5 Jy/K
3	21.7 Jy/K	22.1 Jy/K
5	22.1 Jy/K	22.4 Jy/K
6	22 Jy/K	21.9 Jy/K
Weighted Av.	21.8 Jy/K	21.9 Jy/K

SOURCE	FLUX	MAJOR	MINOR	PA
URANUS	7.4	3.64	3.53	255
NEPTUNE	2.7	2.27	2.21	340
3c454.3	26.51	(Neptune)		
3c454.3	28.16	(Uranus)		

Flagged:
 L02 C02 for Line Frequency:86243MHz
 L03 C03 for Line Frequency:86243MHz
 L06 C06 for Line Frequency:86243MHz
 L07 C07 for Line Frequency:86243MHz

How to calibrate a calibrator?

16-NOV-2008 @ 260 GHz (LO1REF=1888 MHz)

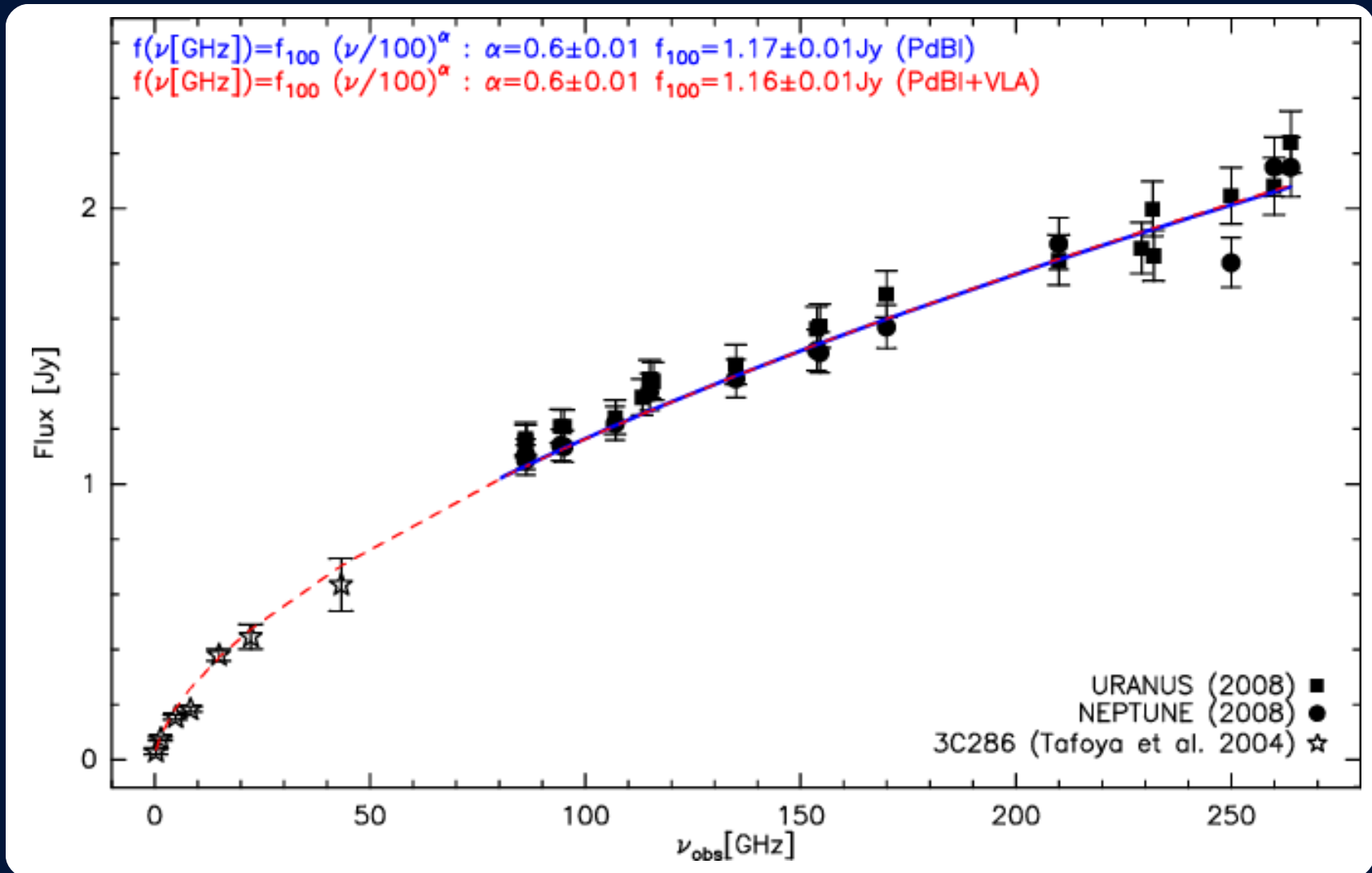


ANTENNA	3c454.3@52°	mwc349@75°
1	39.9 Jy/K	41.2 Jy/K
2	34.6 Jy/K	35.8 Jy/K
3	41.8 Jy/K	45.3 Jy/K
4	51.4 Jy/K	50.4 Jy/K
5	34.5 Jy/K	34.9 Jy/K
6	39.9 Jy/K	40.5 Jy/K

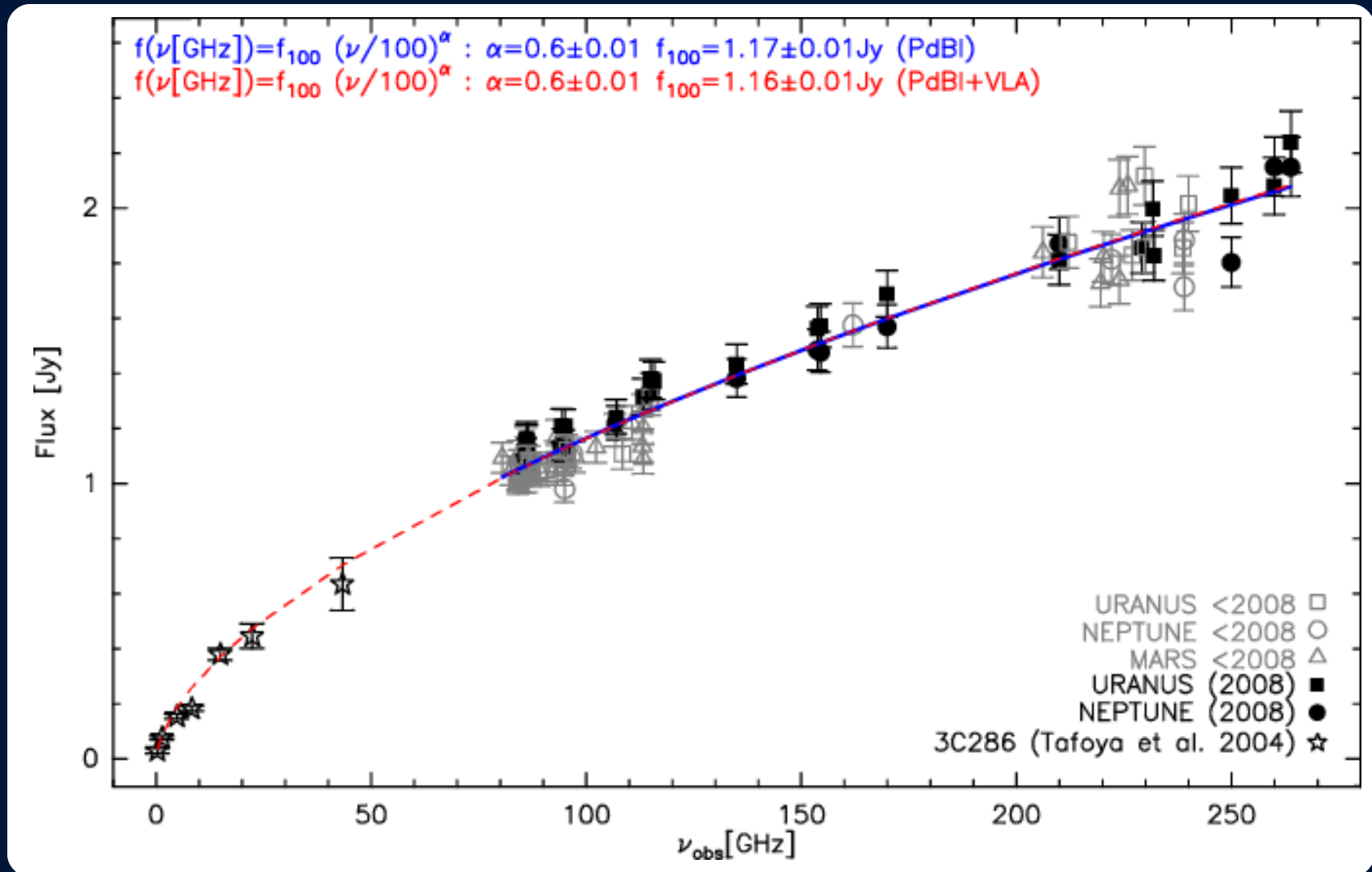
Weighted Av. 38 Jy/K 39.3 Jy/K

SOURCE	FLUX	MAJOR	MINOR	PA
URANUS	41.1	3.56	3.45	255
NEPTUNE	15.4	2.23	2.17	340
3c454.3	13.76	(Neptune)		
3c454.3	14.5	(Uranus)		

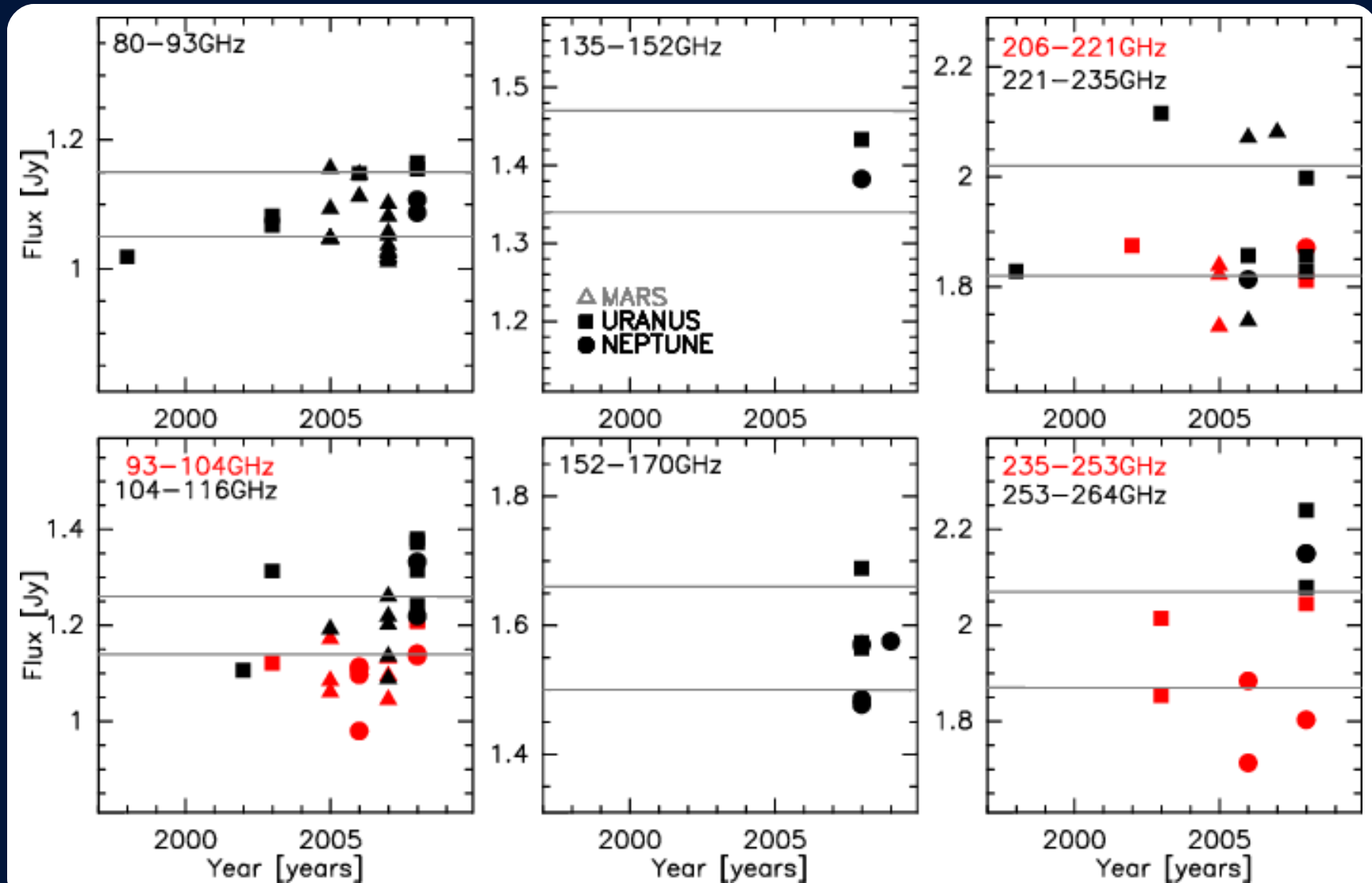
Flux of MWC348: SED



Flux of MWC348: SED

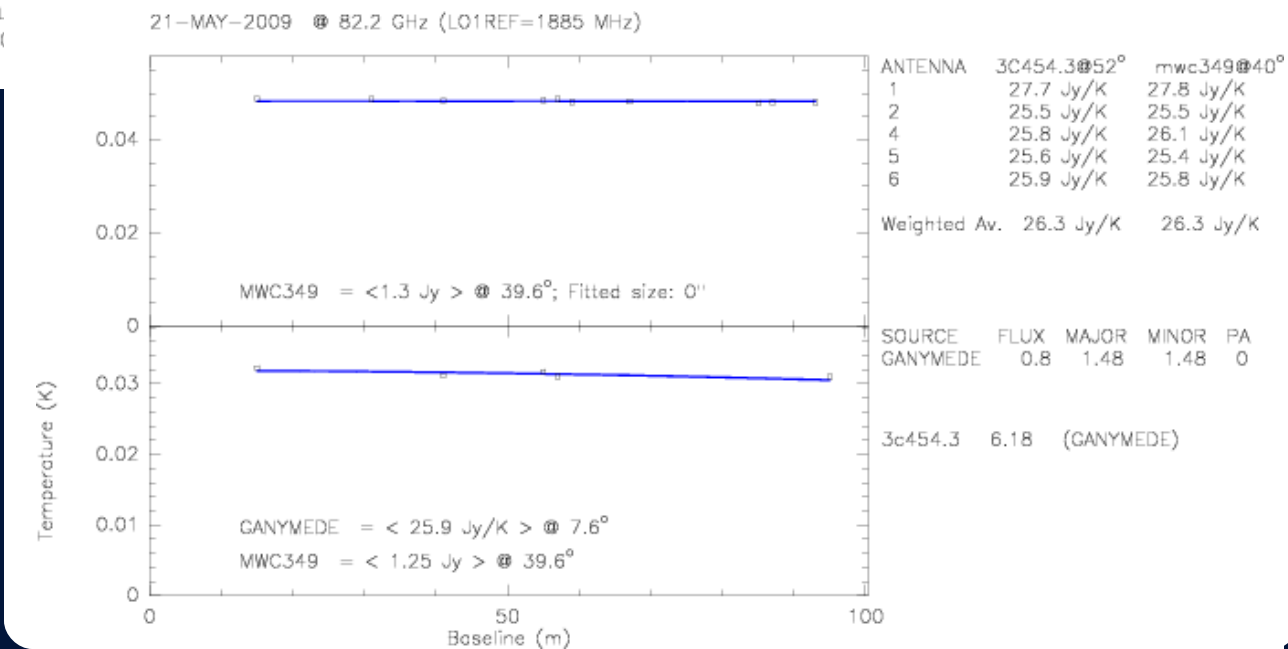
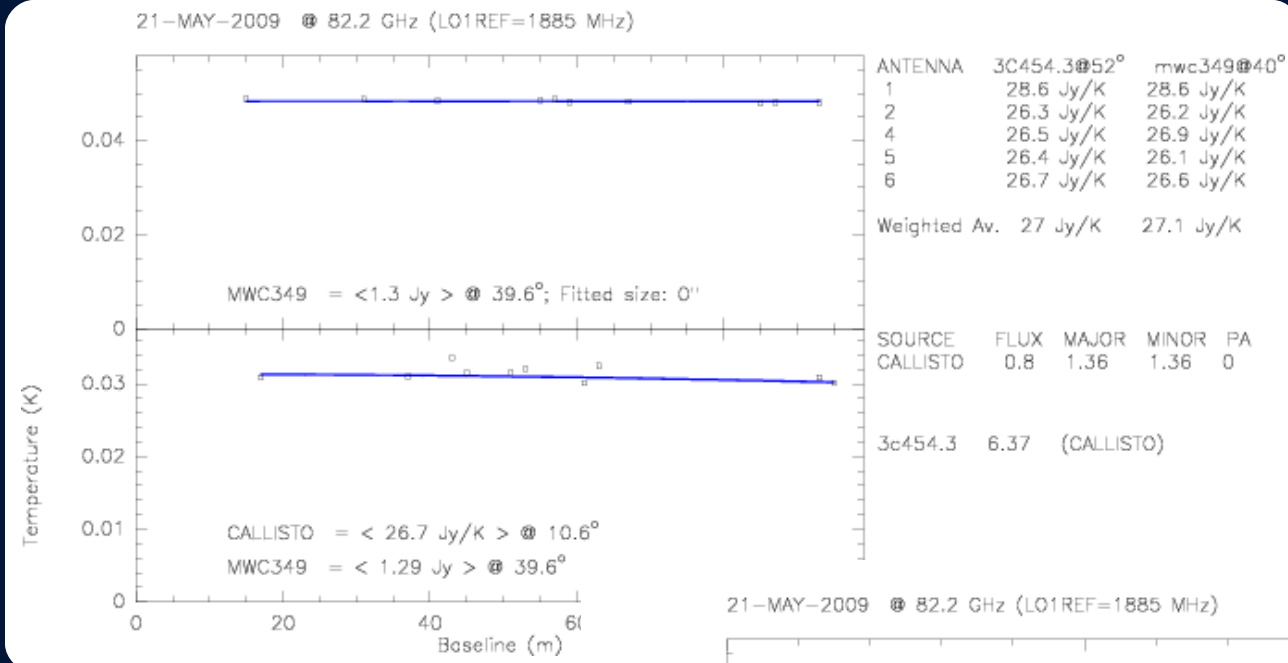


Flux of MWC348: Time variability?



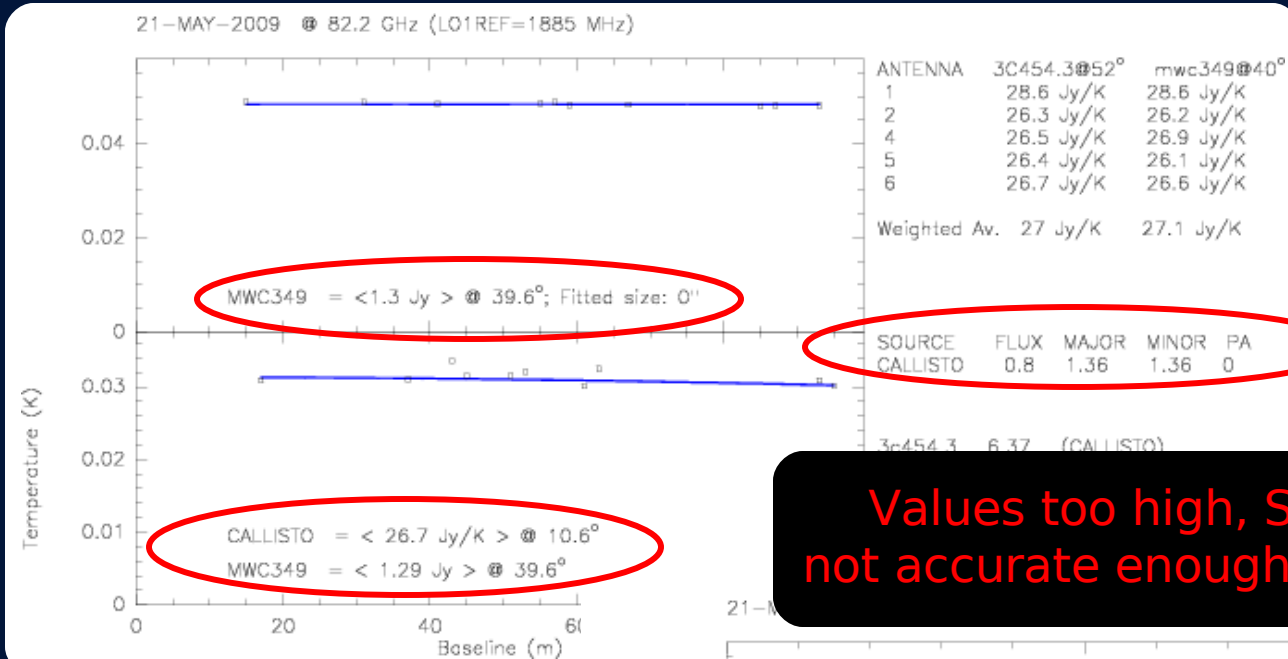
Flux of MWC348: Using satellites?

Using SMA model!

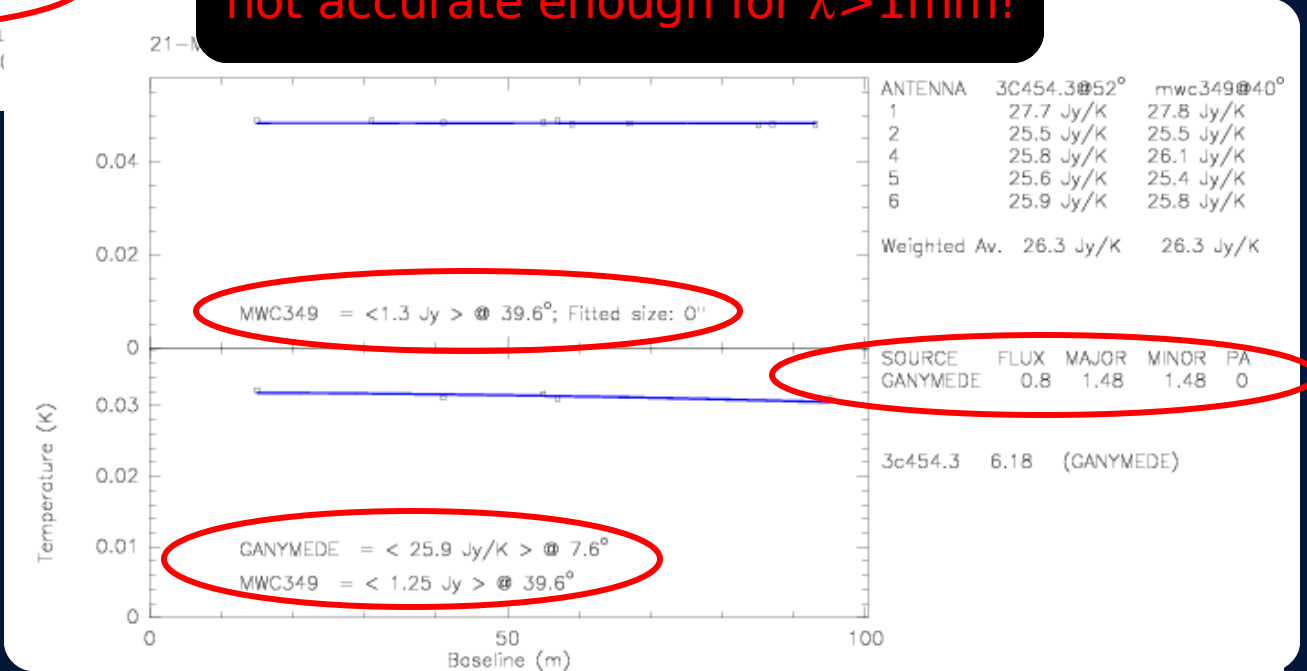


Flux of MWC348: Using satellites?

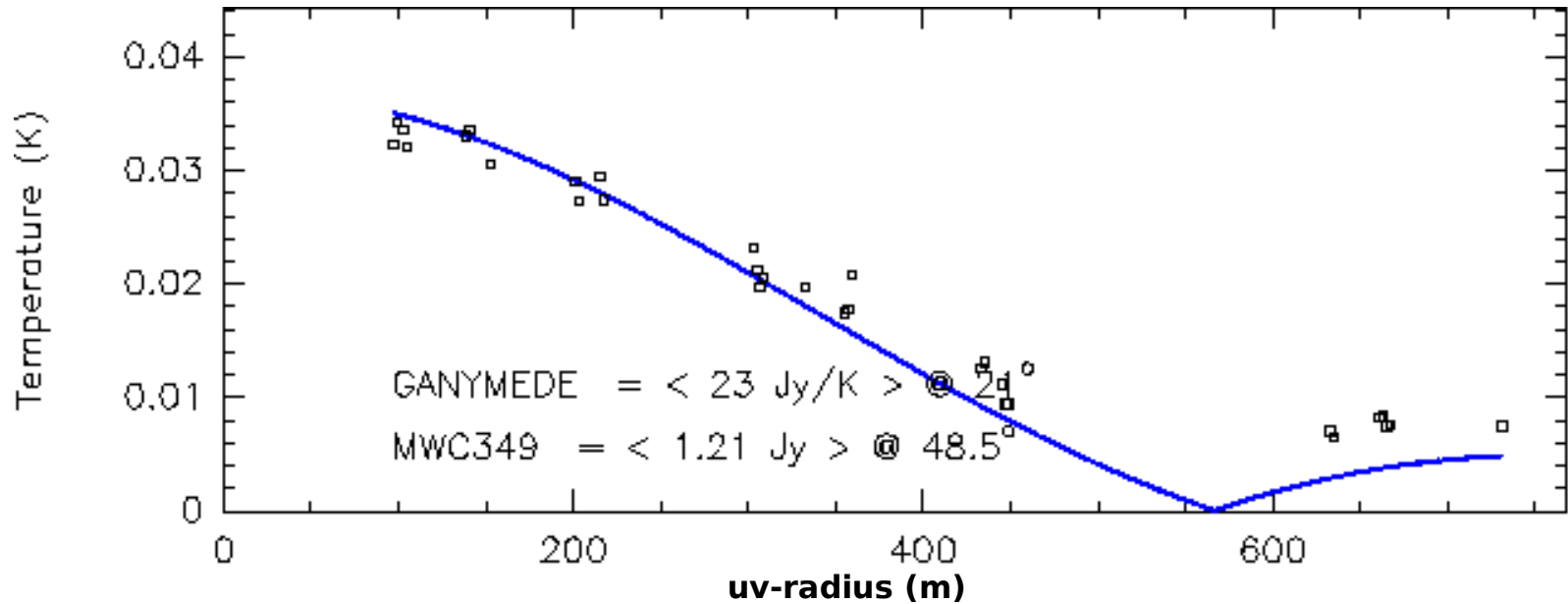
Using SMA model!



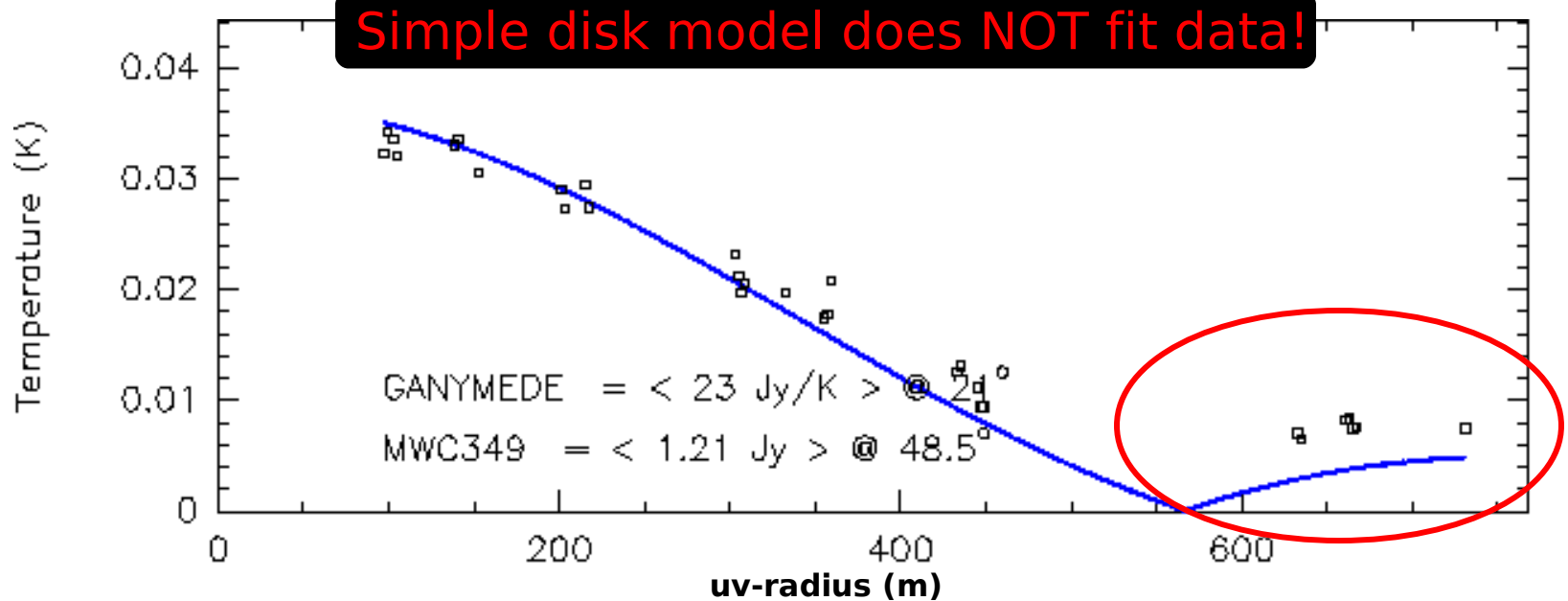
Values too high, SMA model not accurate enough for $\lambda > 1\text{mm}$!



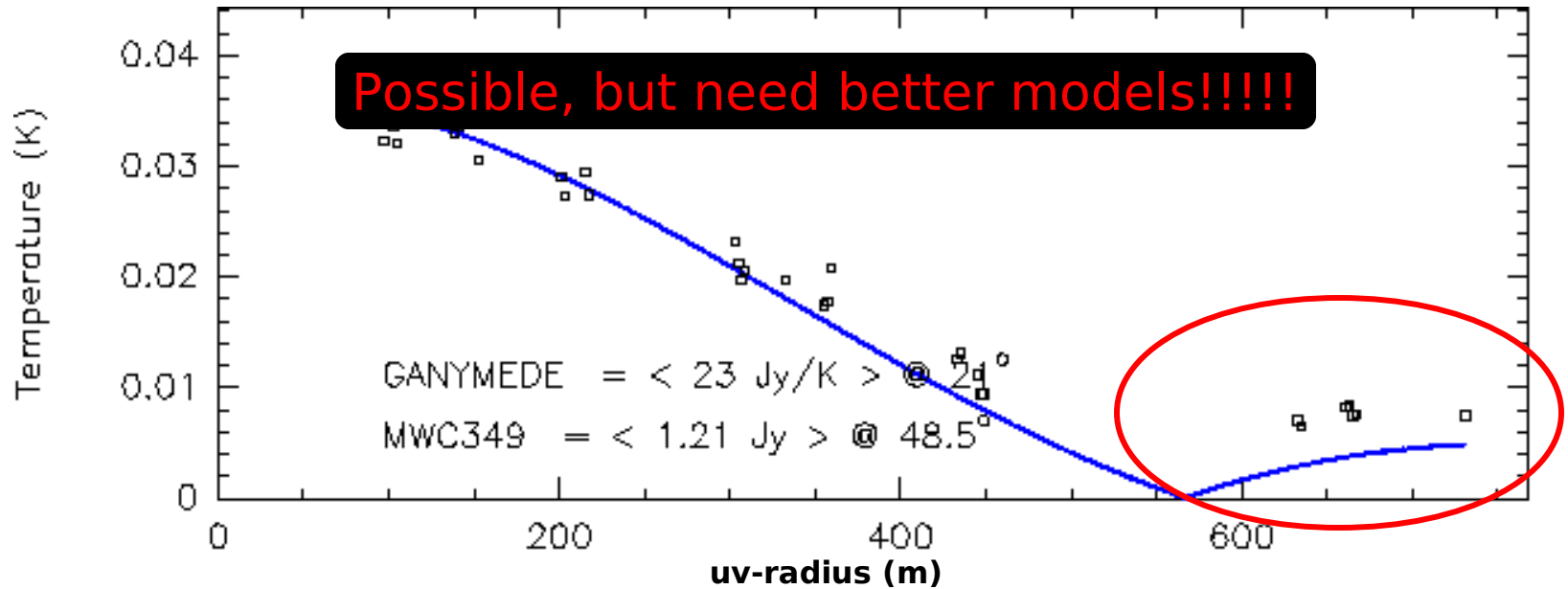
Flux of MWC348: Using satellites?



Flux of MWC348: Using satellites?

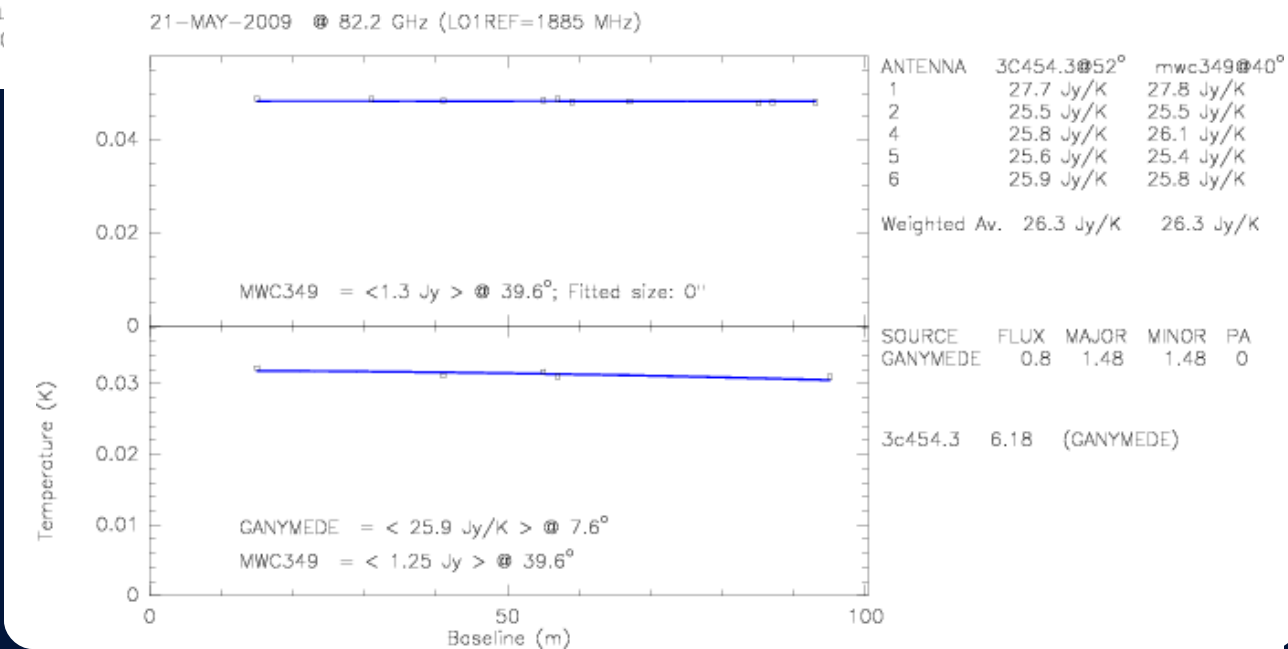
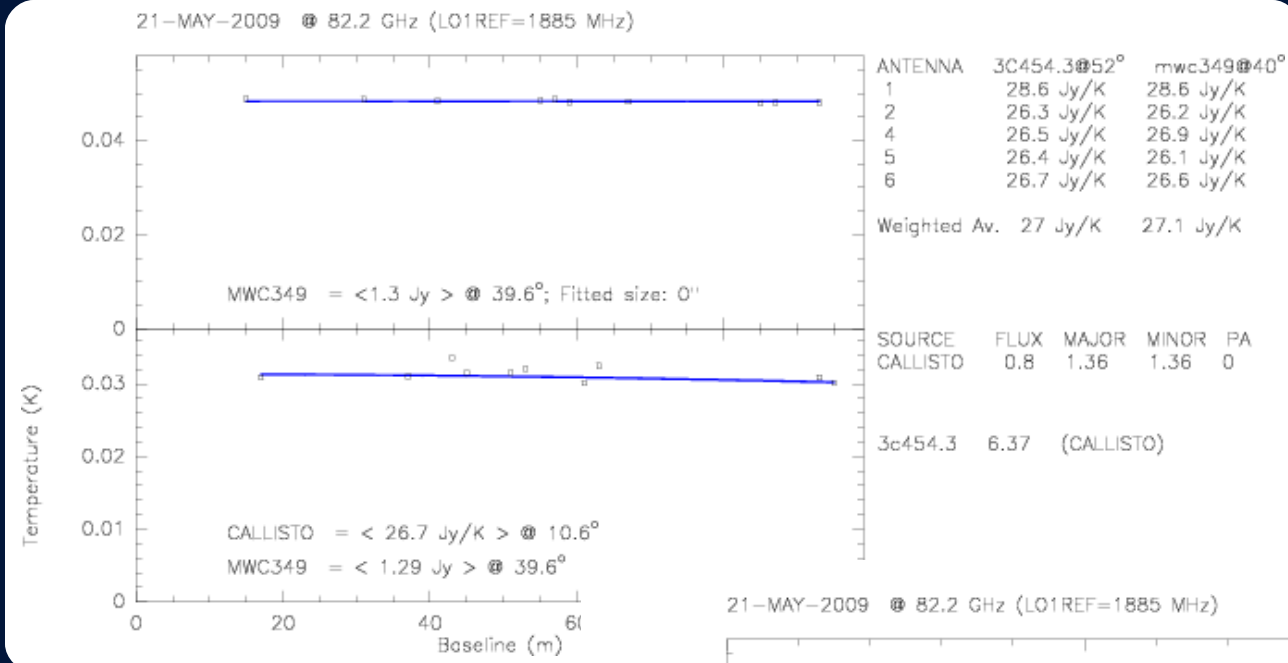


Flux of MWC348: Using satellites?

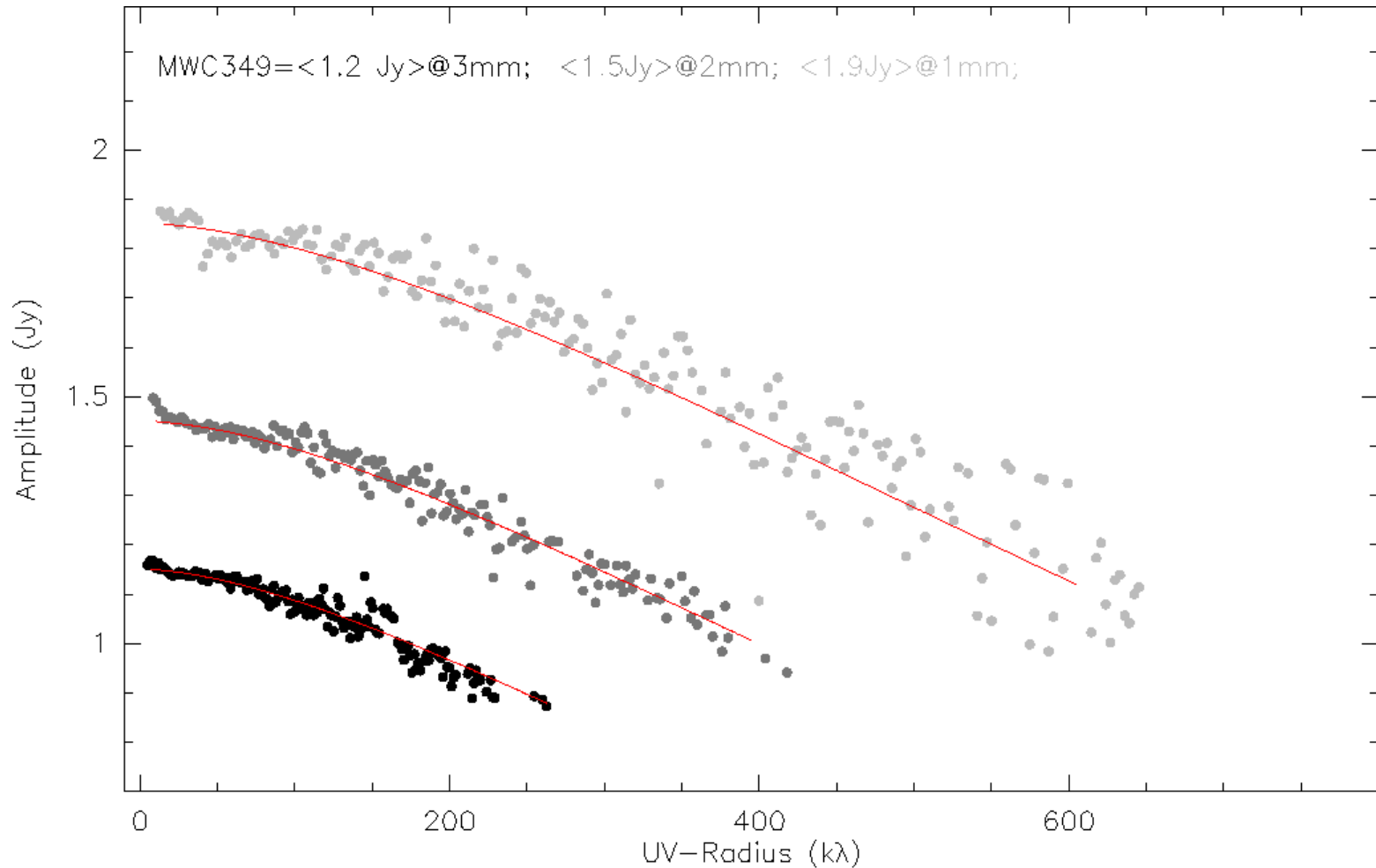


Flux of MWC348: Using satellites?

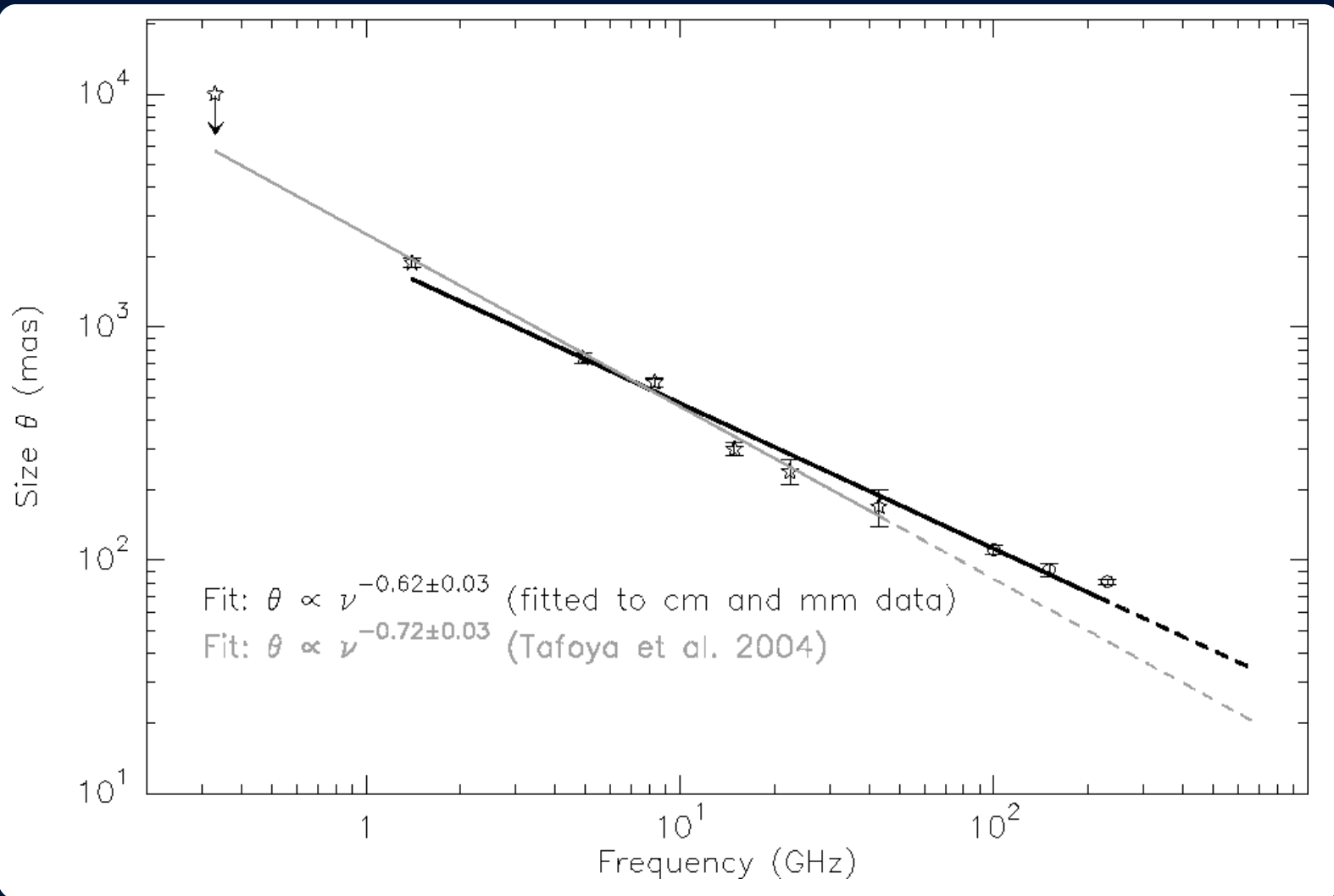
Using SMA model!



Size of MWC348



Size of MWC348

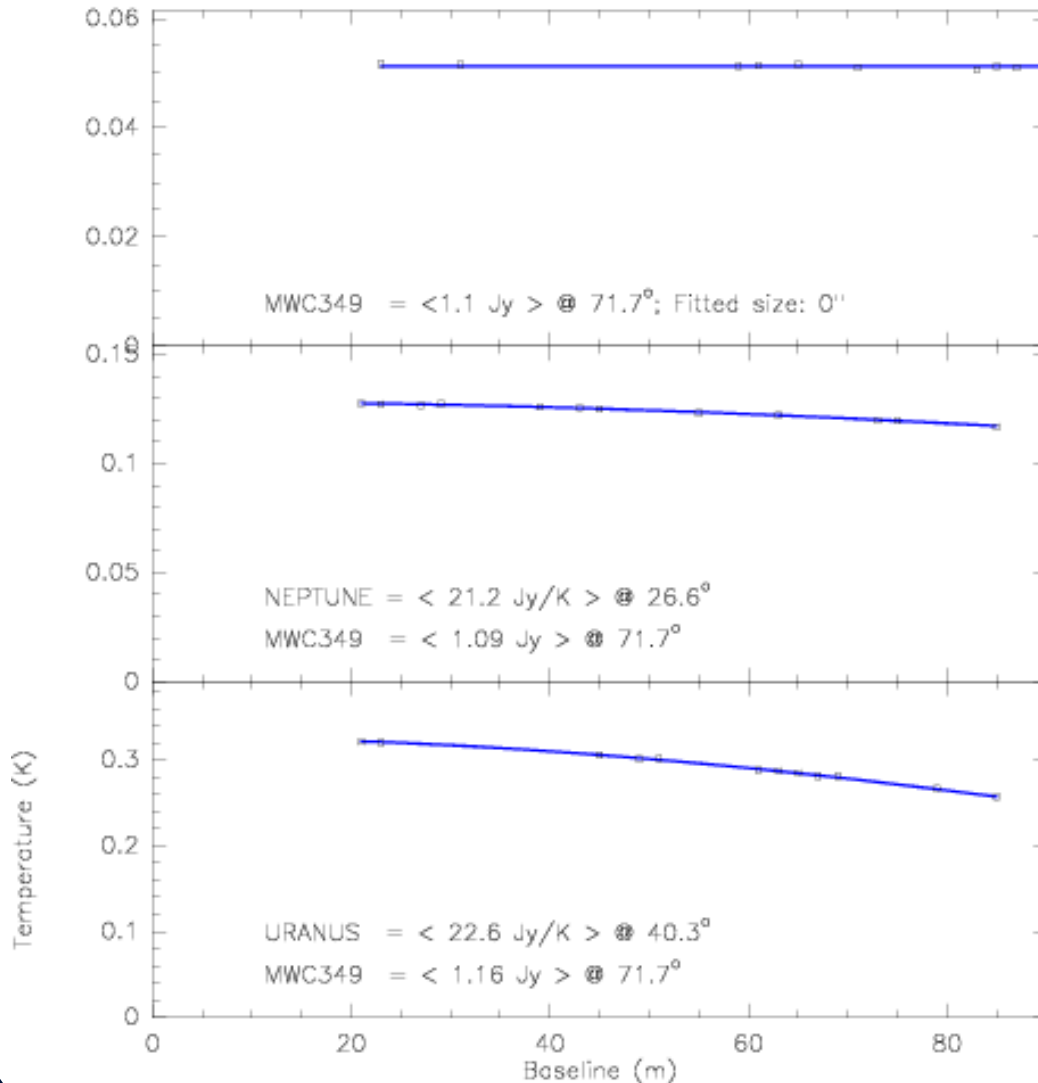


Primary Flux Calibrators

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

“By-product” of calibration

12-OCT-2008 @ 86.2 GHz (LO1REF=1853 MHz)



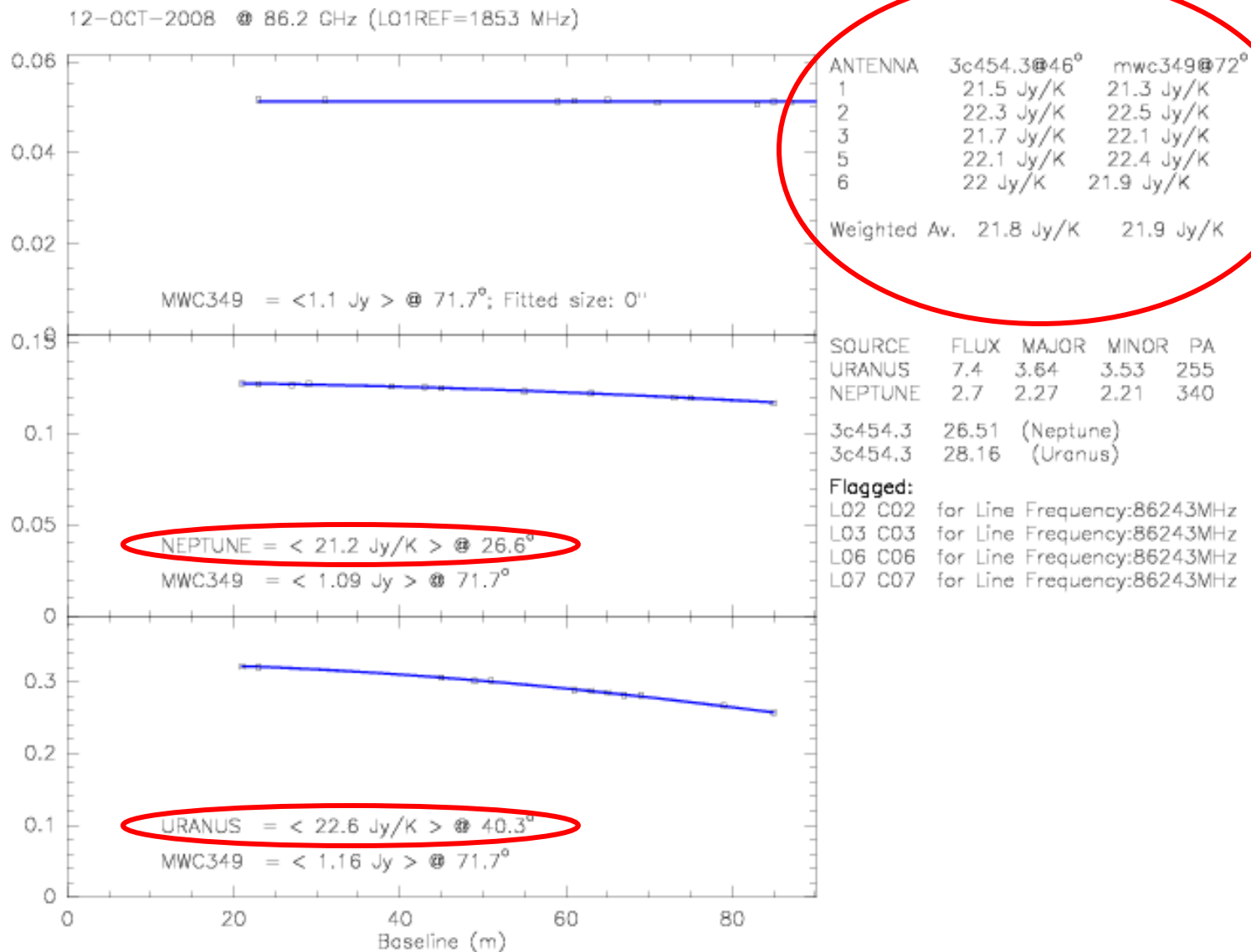
ANTENNA	3c454.3@46°	mwc349@72°
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3c454.3	26.51	(Neptune)		
3c454.3	28.16	(Uranus)		

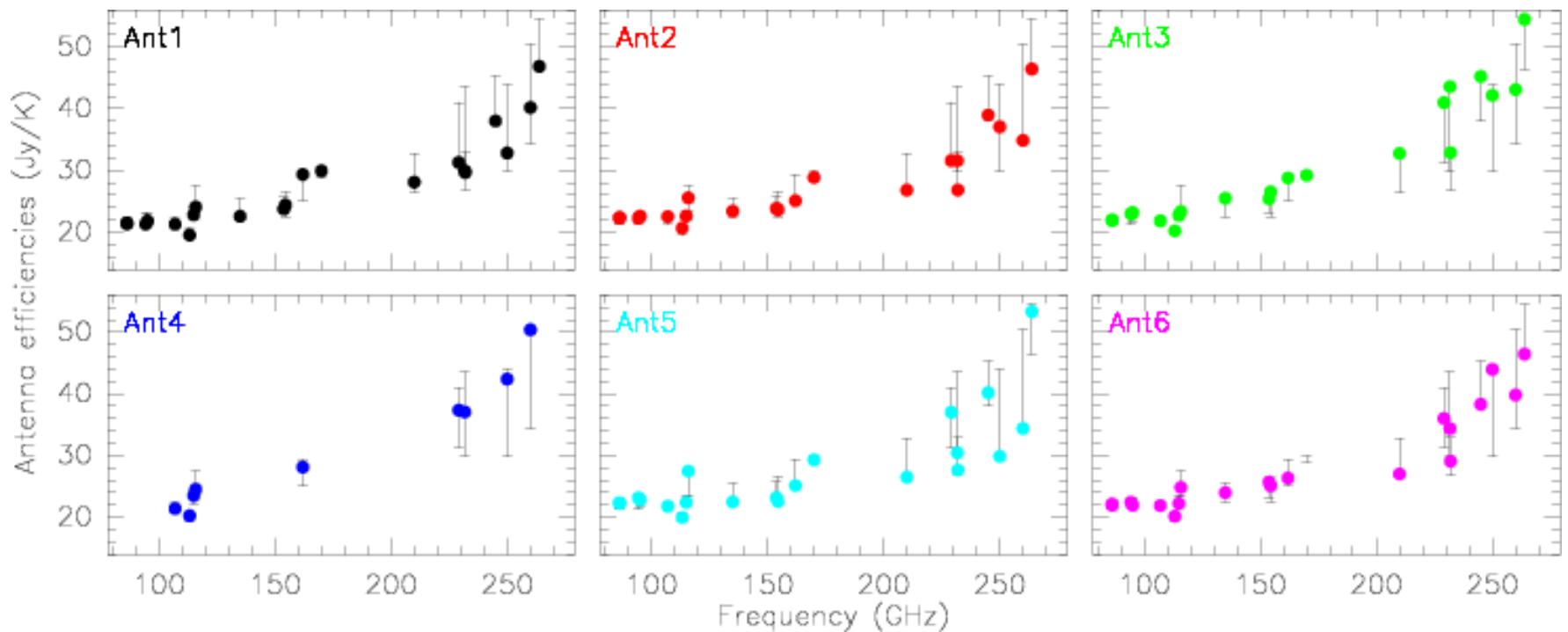
Flagged:

L02	C02	for Line Frequency:86243MHz
L03	C03	for Line Frequency:86243MHz
L06	C06	for Line Frequency:86243MHz
L07	C07	for Line Frequency:86243MHz

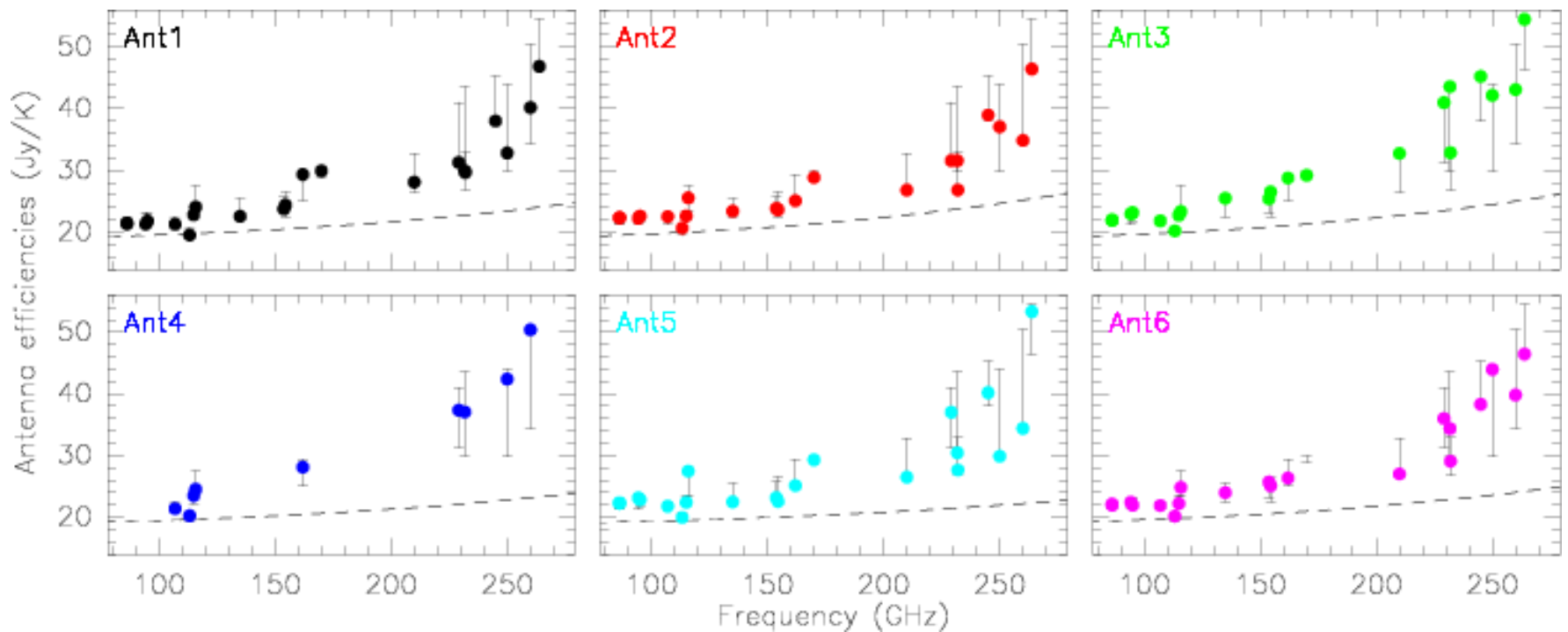
“By-product” of calibration: getting antenna efficiencies!



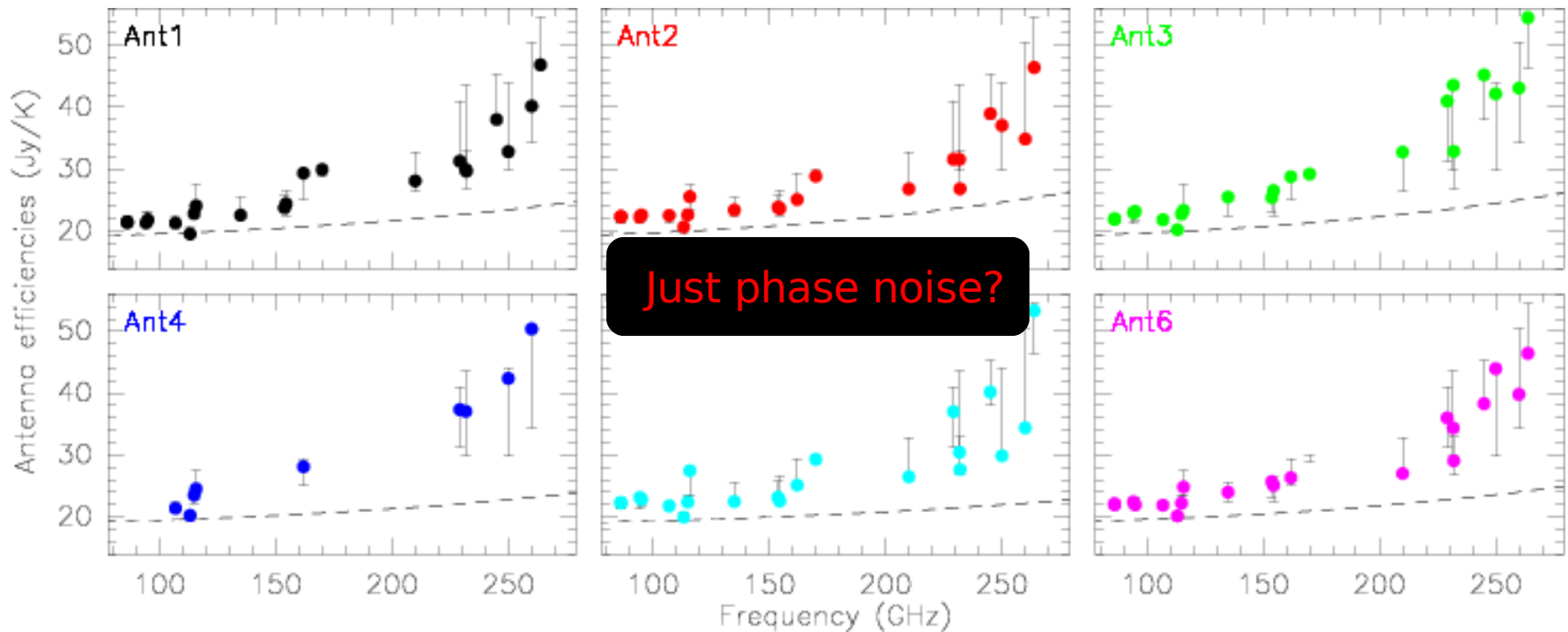
Antenna Efficiencies: Interferometrically



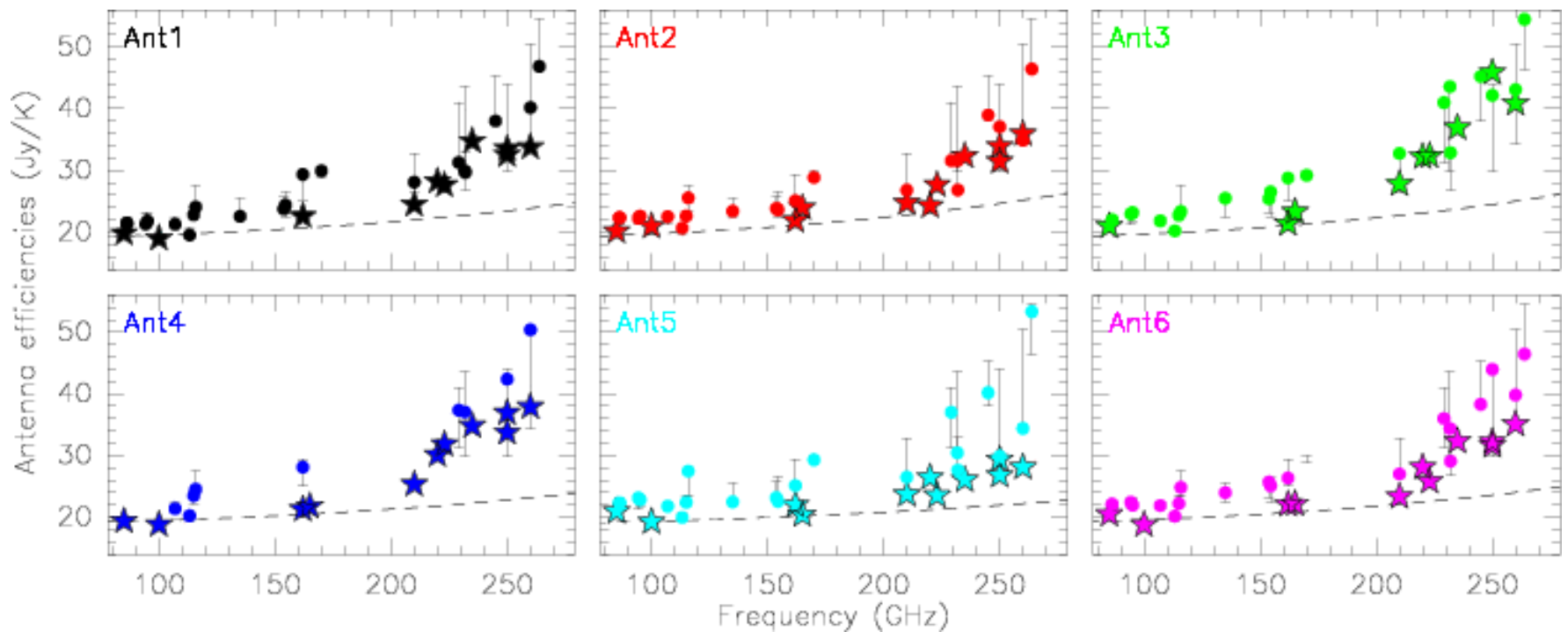
Antenna Efficiencies: Interferometrically + Holo



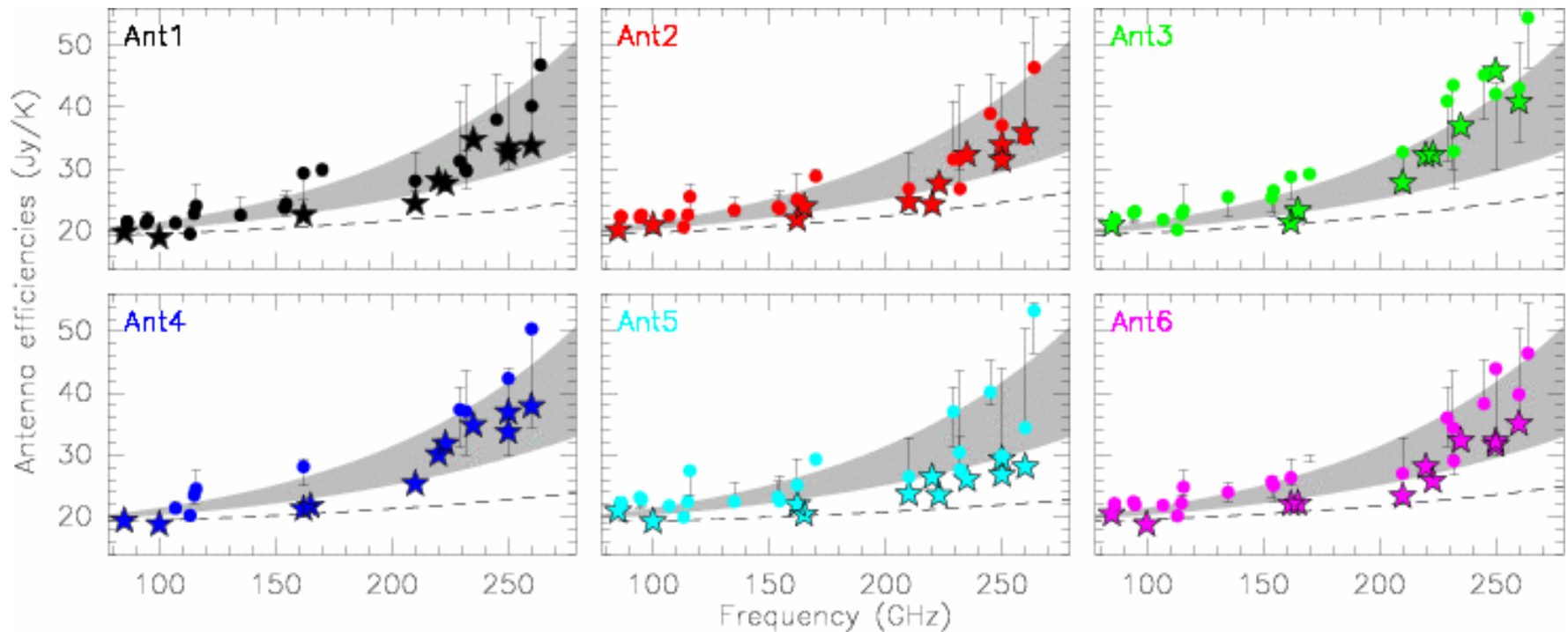
Antenna Efficiencies: Interferometrically + Holo



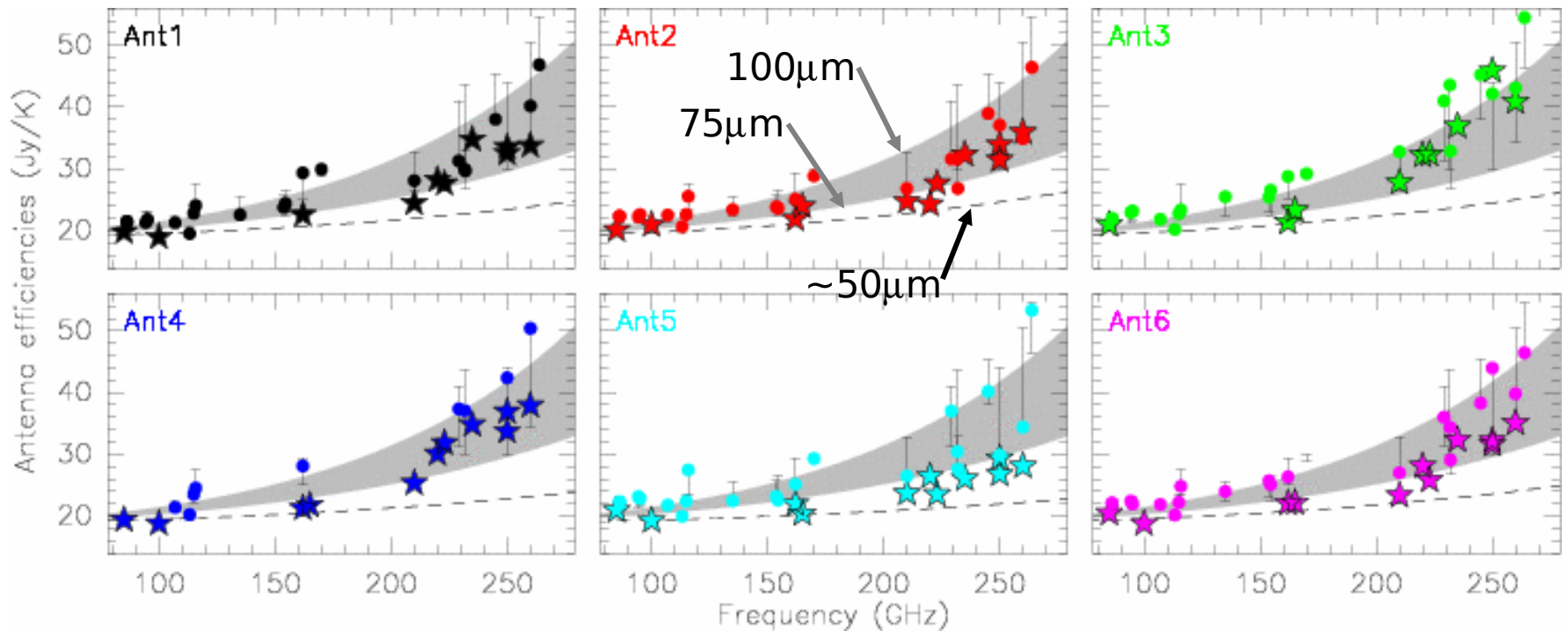
Antenna Efficiencies: Interferometrically + Holo + SD



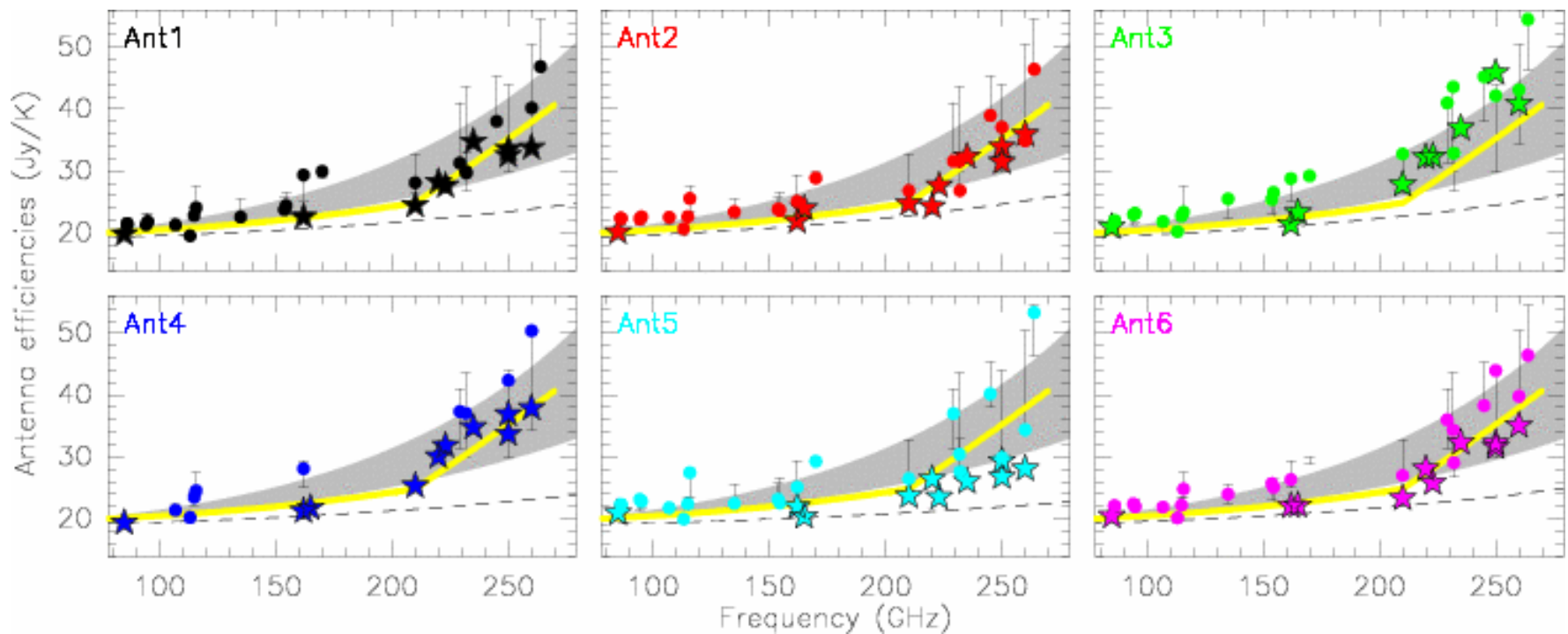
Antenna Efficiencies: Interferometrically + Holo + SD



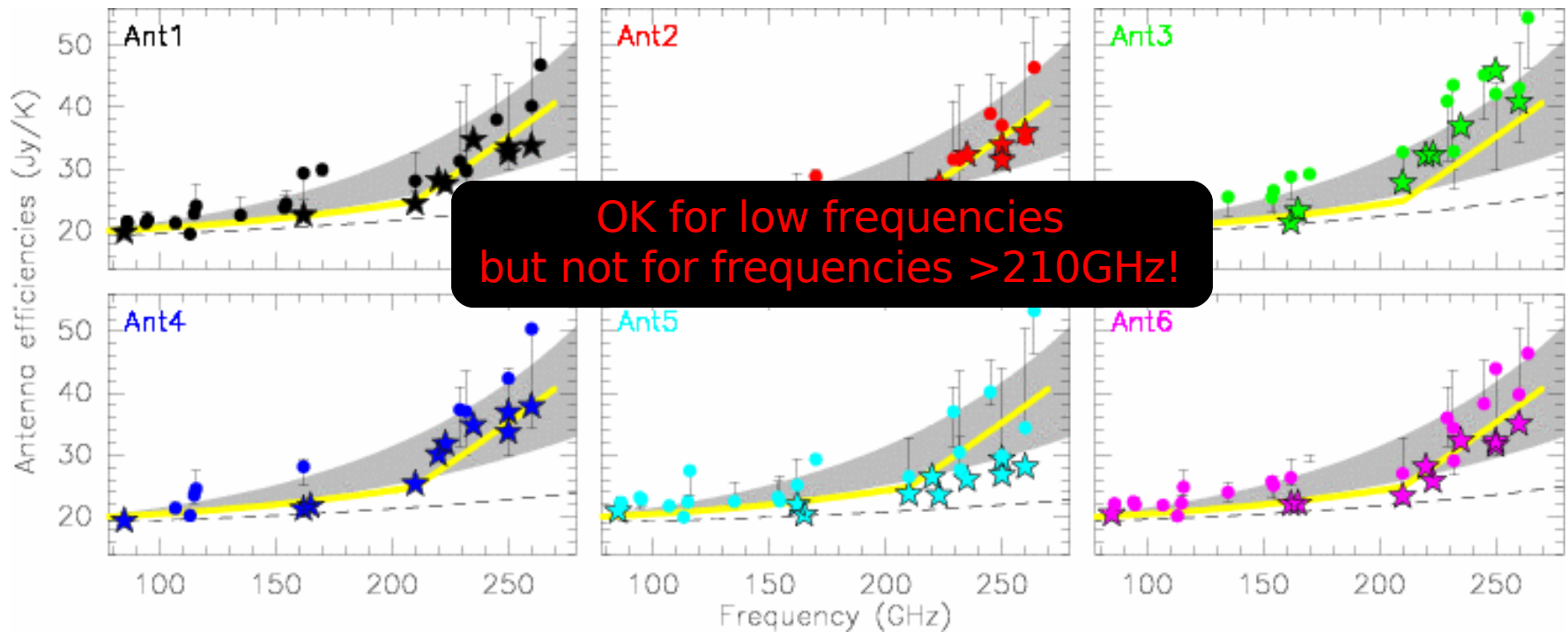
Antenna Efficiencies: Interferometrically + Holo + SD



Antenna Efficiencies: Interferometrically + Holo + SD



Antenna Efficiencies: Interferometrically + Holo + SD

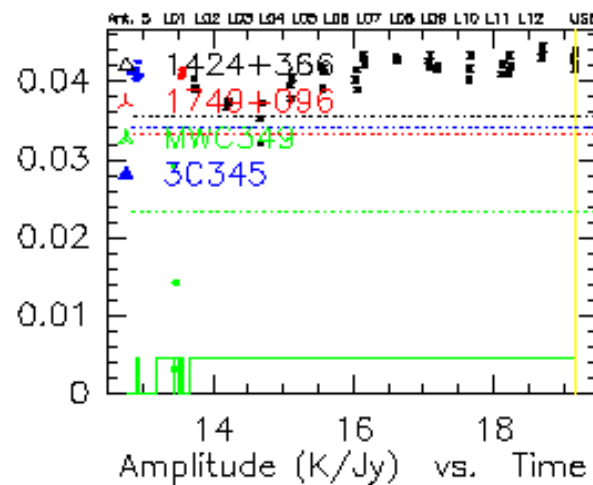
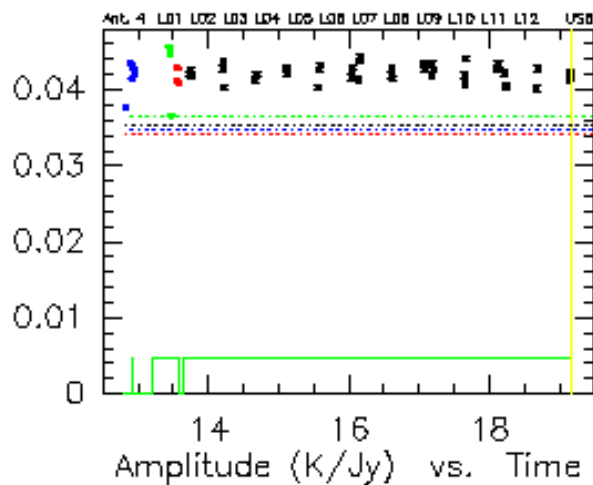
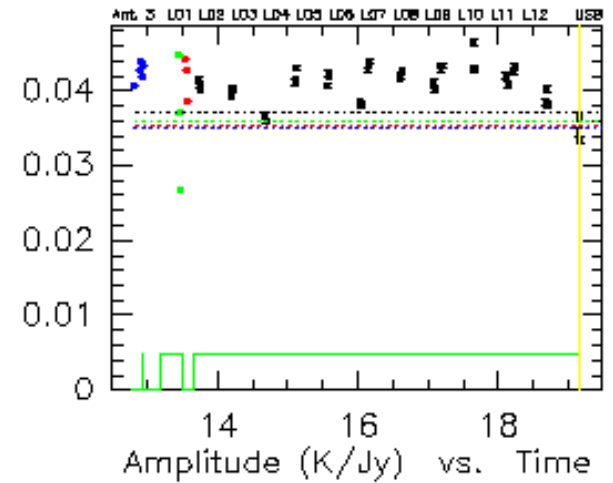
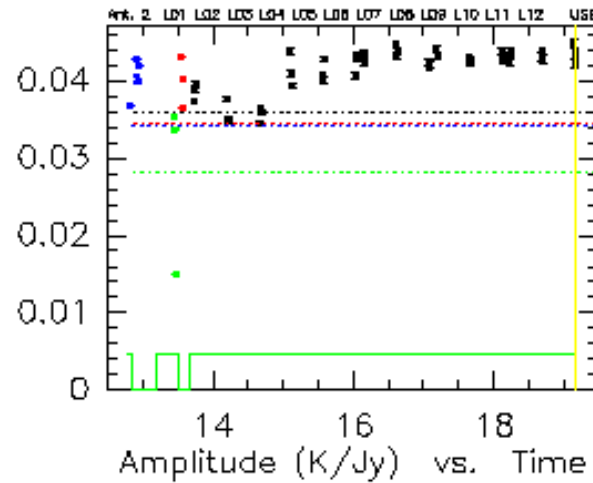
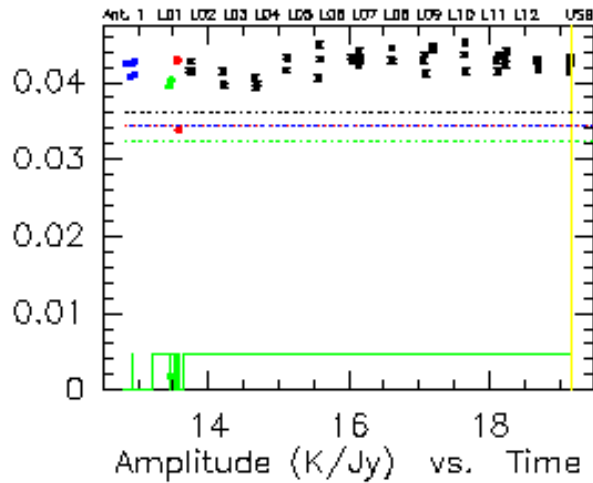


Practical Tips

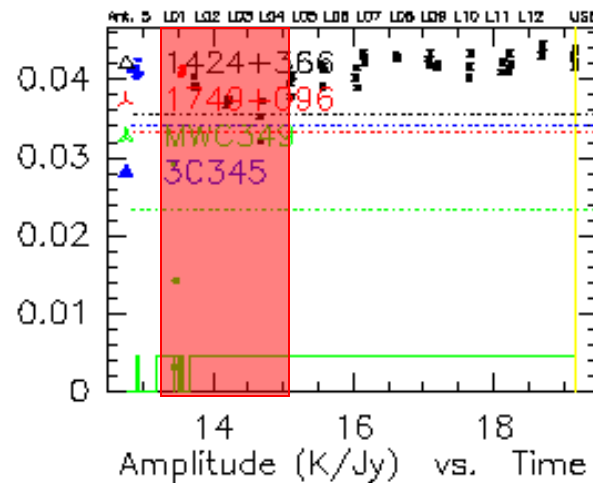
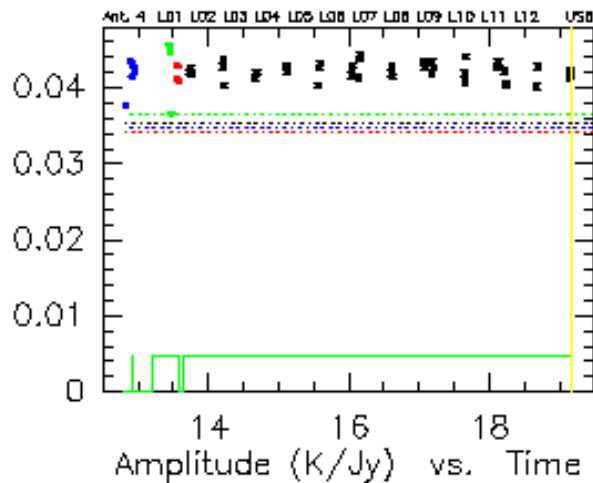
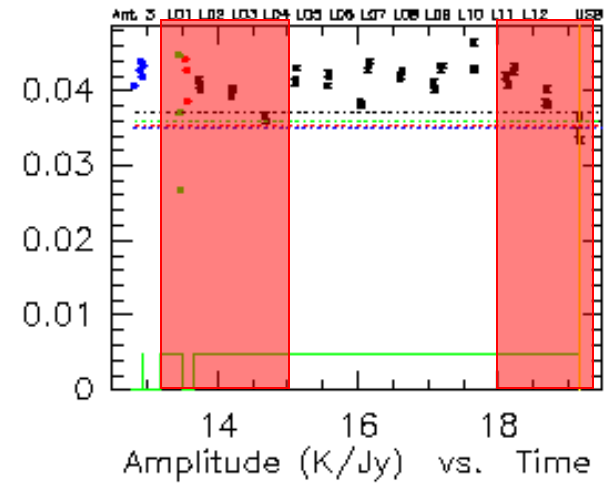
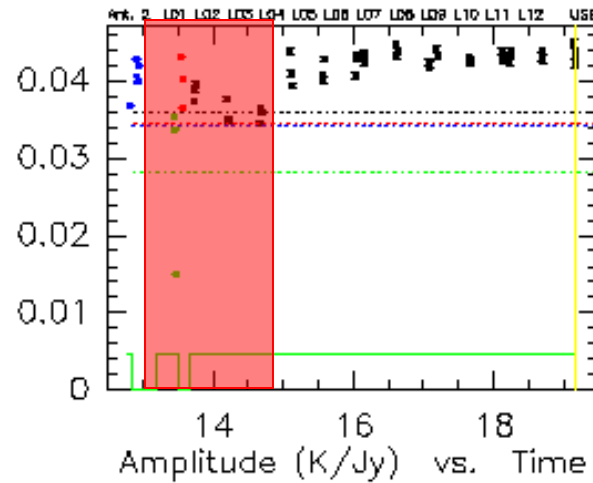
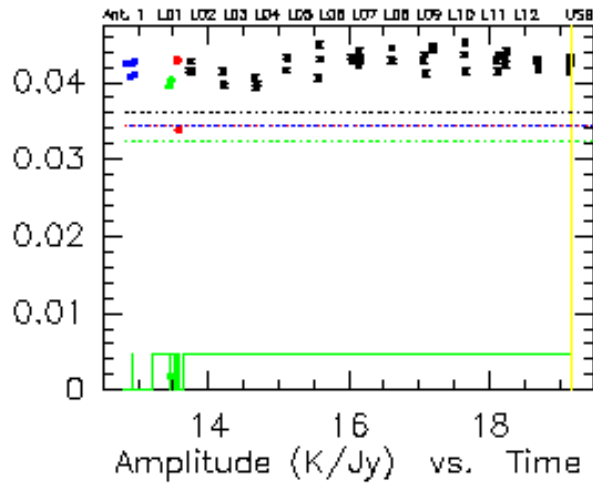
Checklist:

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

Practical Tips

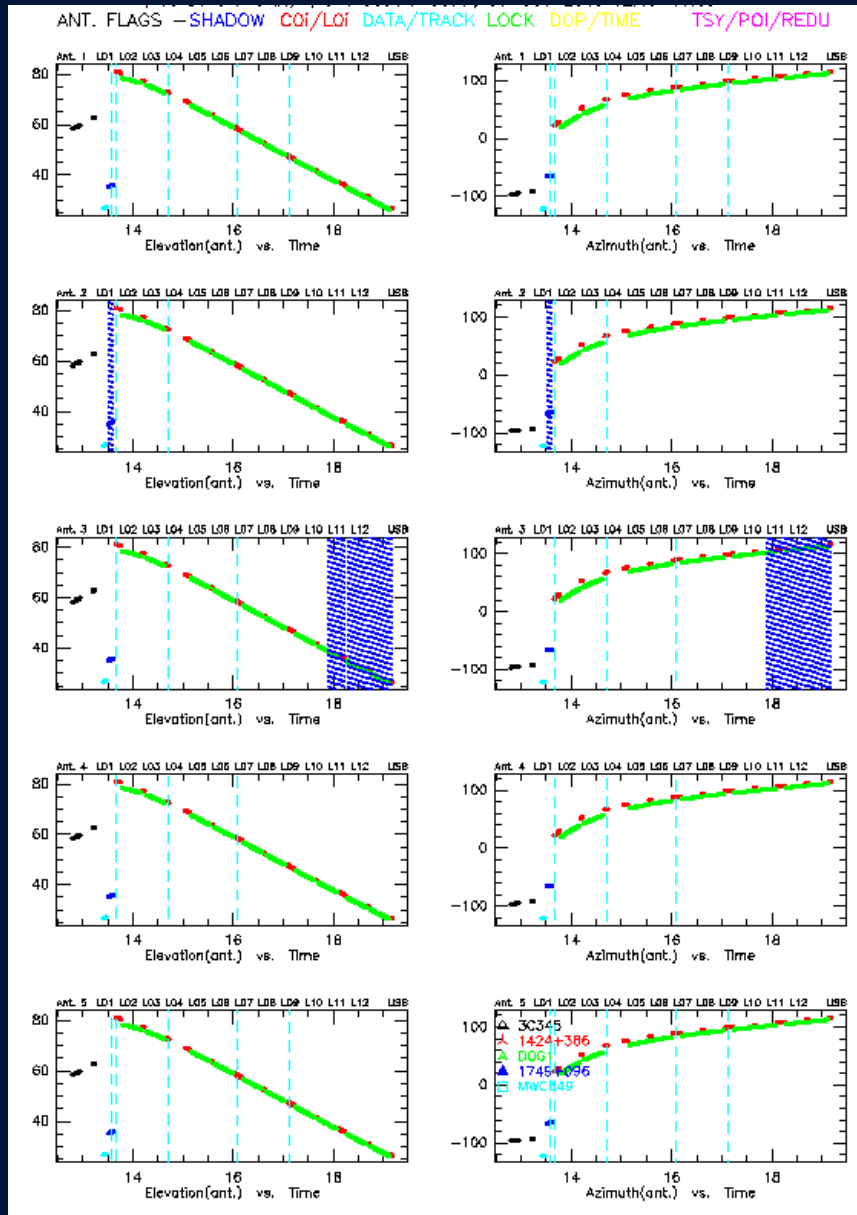


Practical Tips

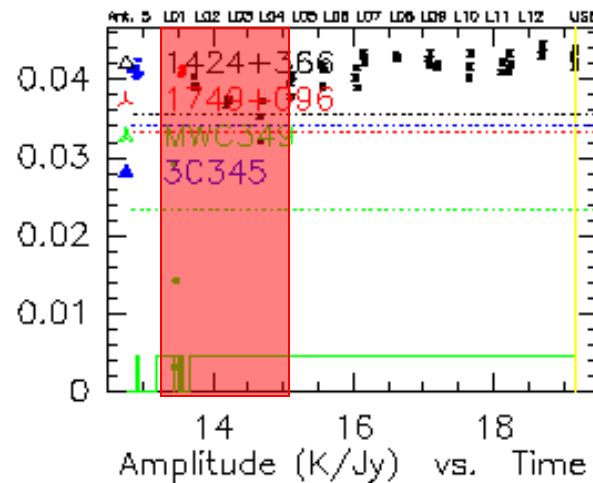
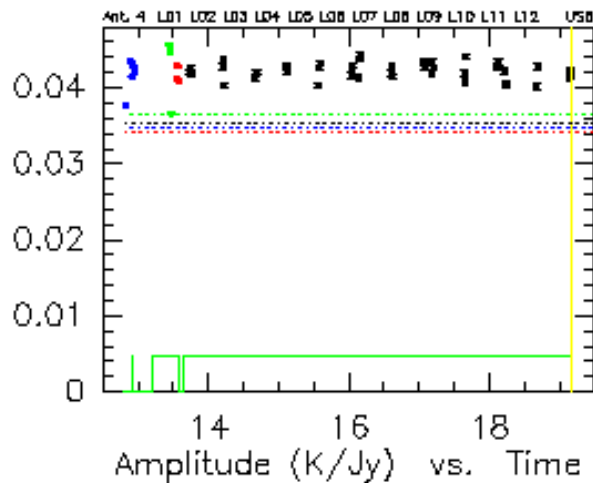
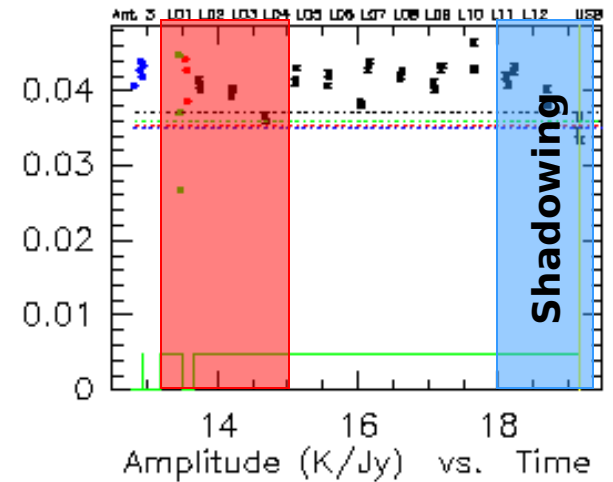
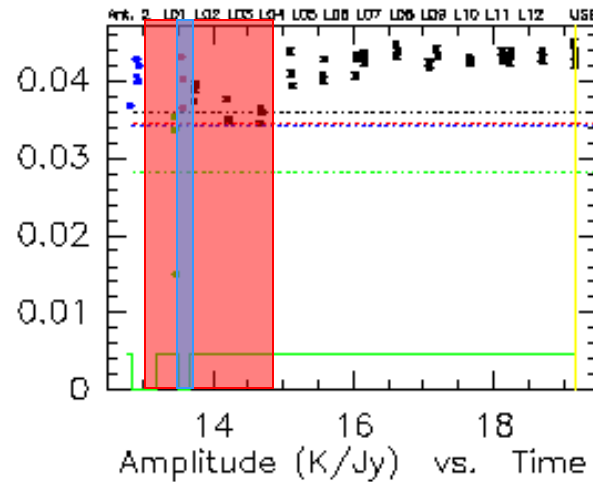
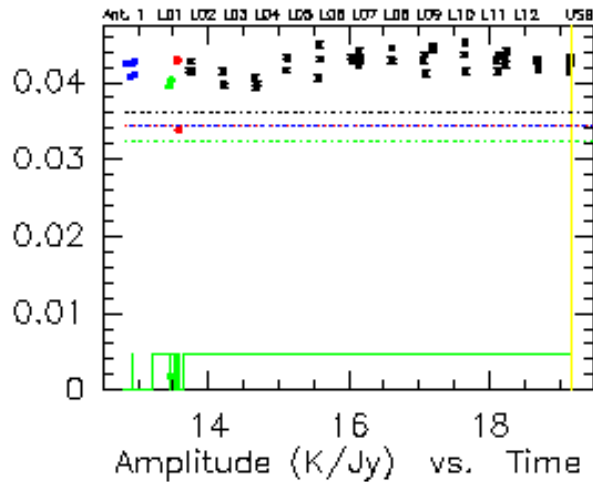


Practical Tips: Shadowing

First Look

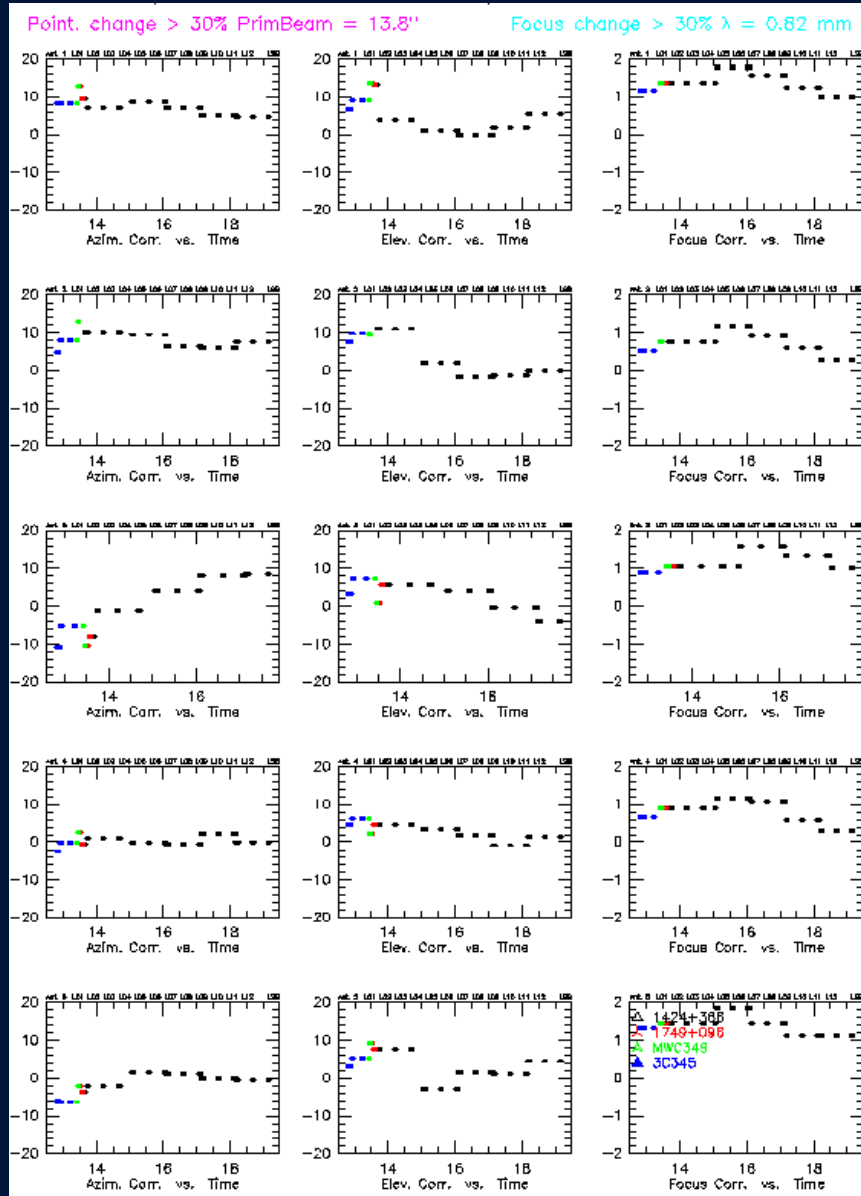


Practical Tips: Shadowing



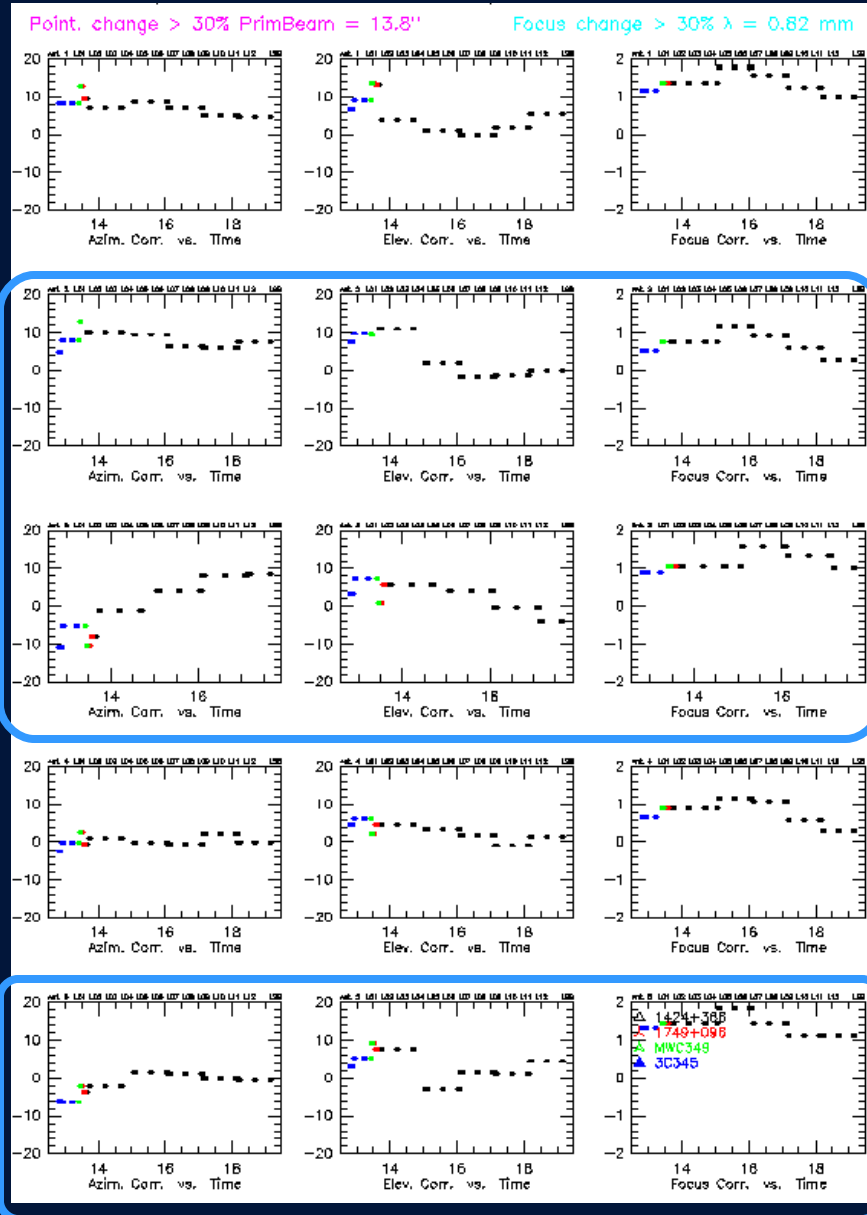
Practical Tips: Pointing/Focus

First Look



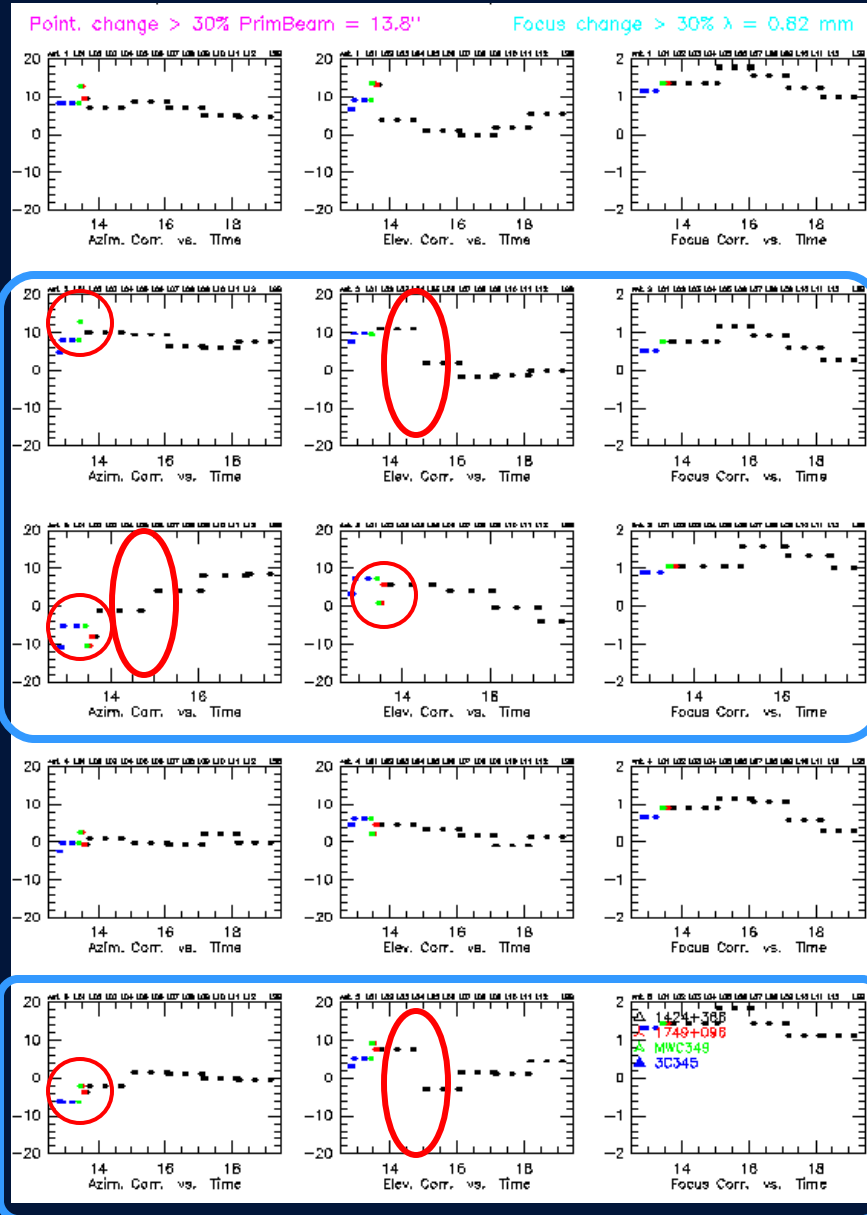
Practical Tips : Pointing/Focus

First Look



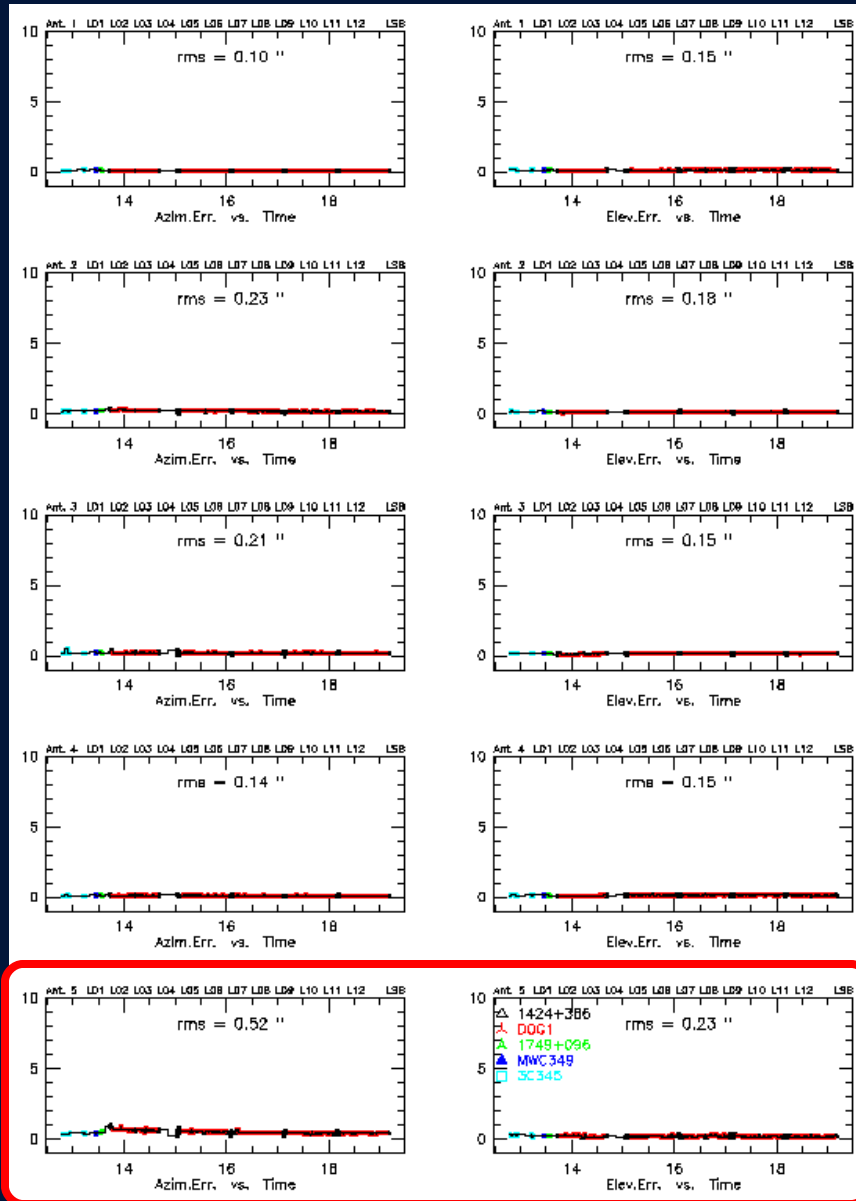
Practical Tips : Pointing/Focus

First Look

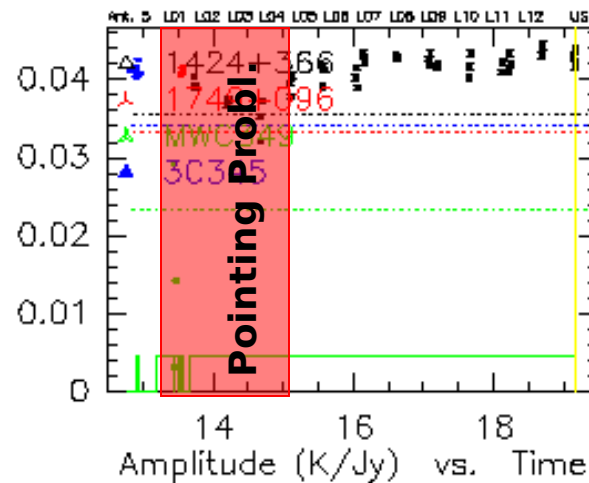
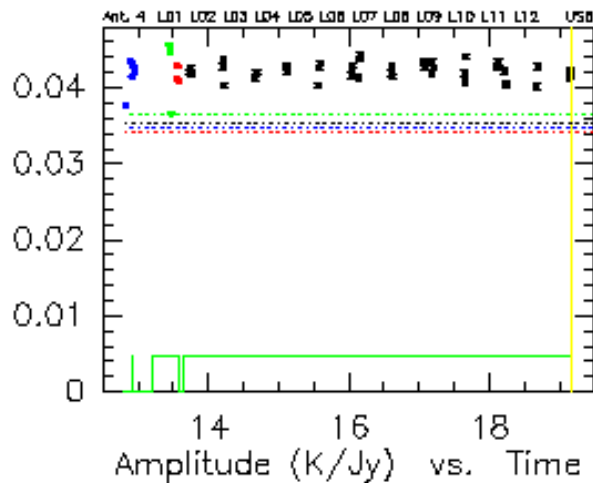
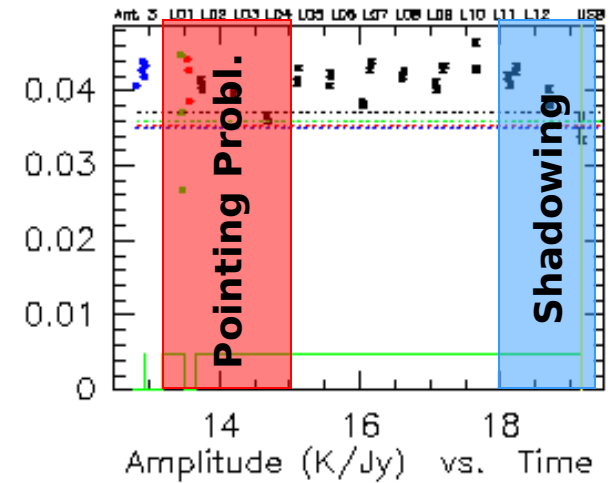
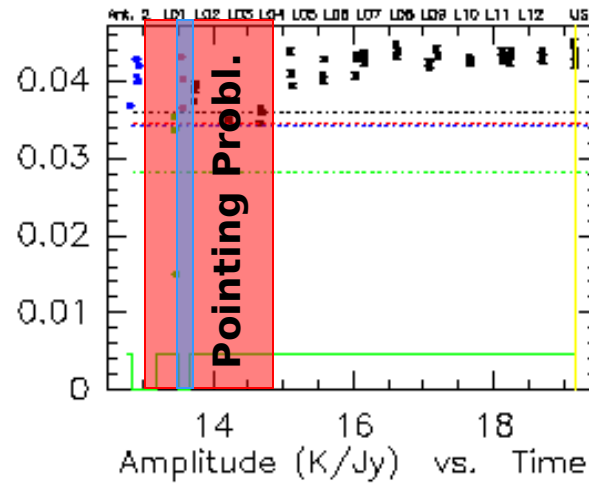
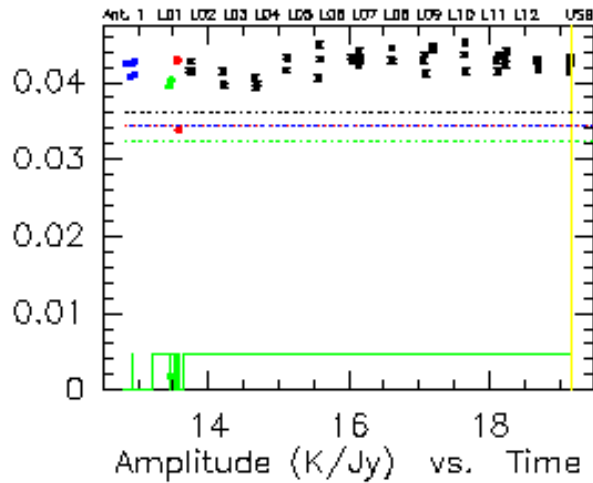


Practical Tips: Tracking

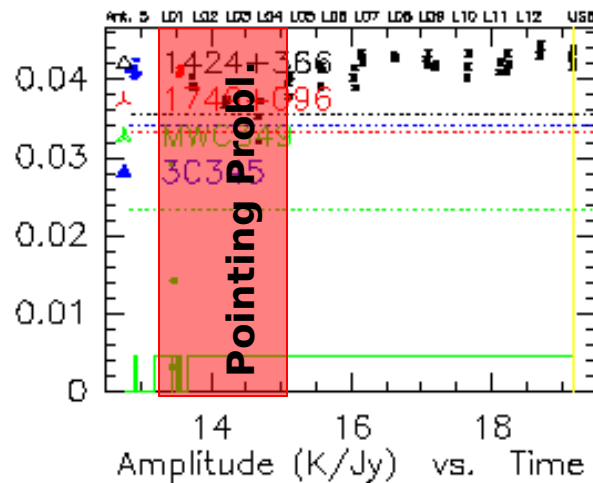
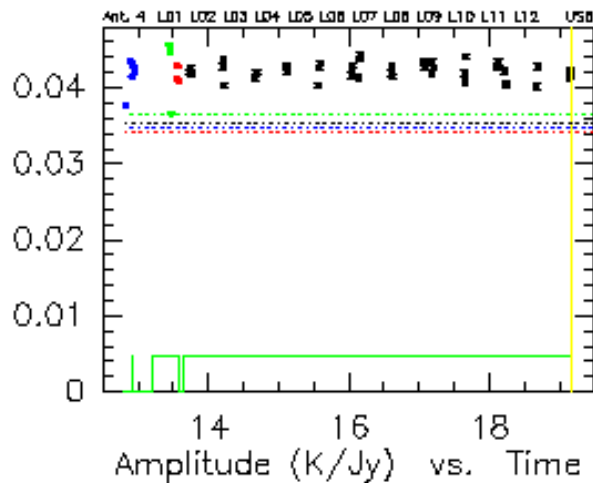
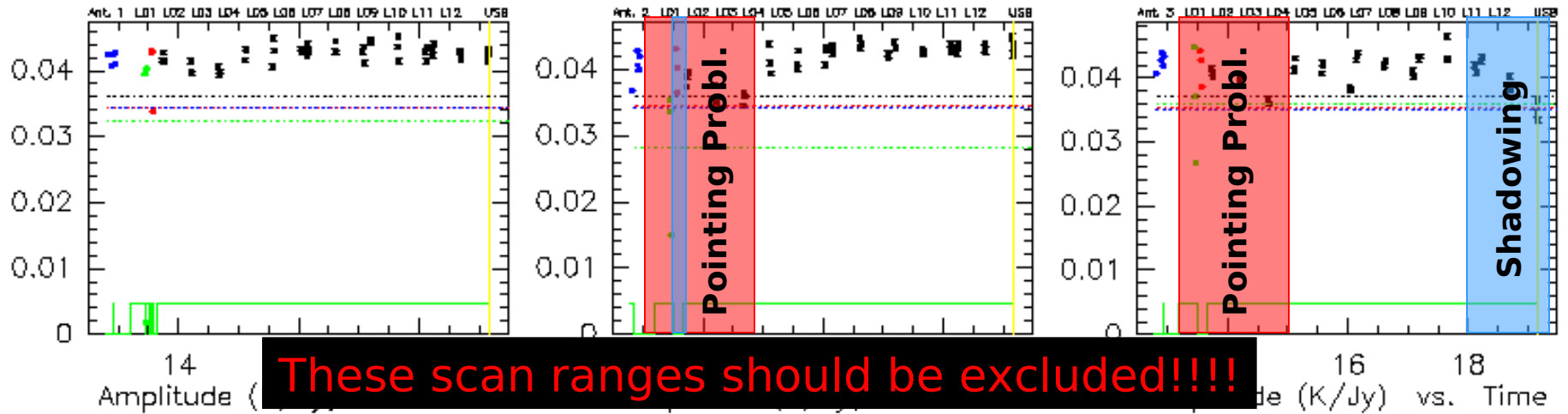
First Look



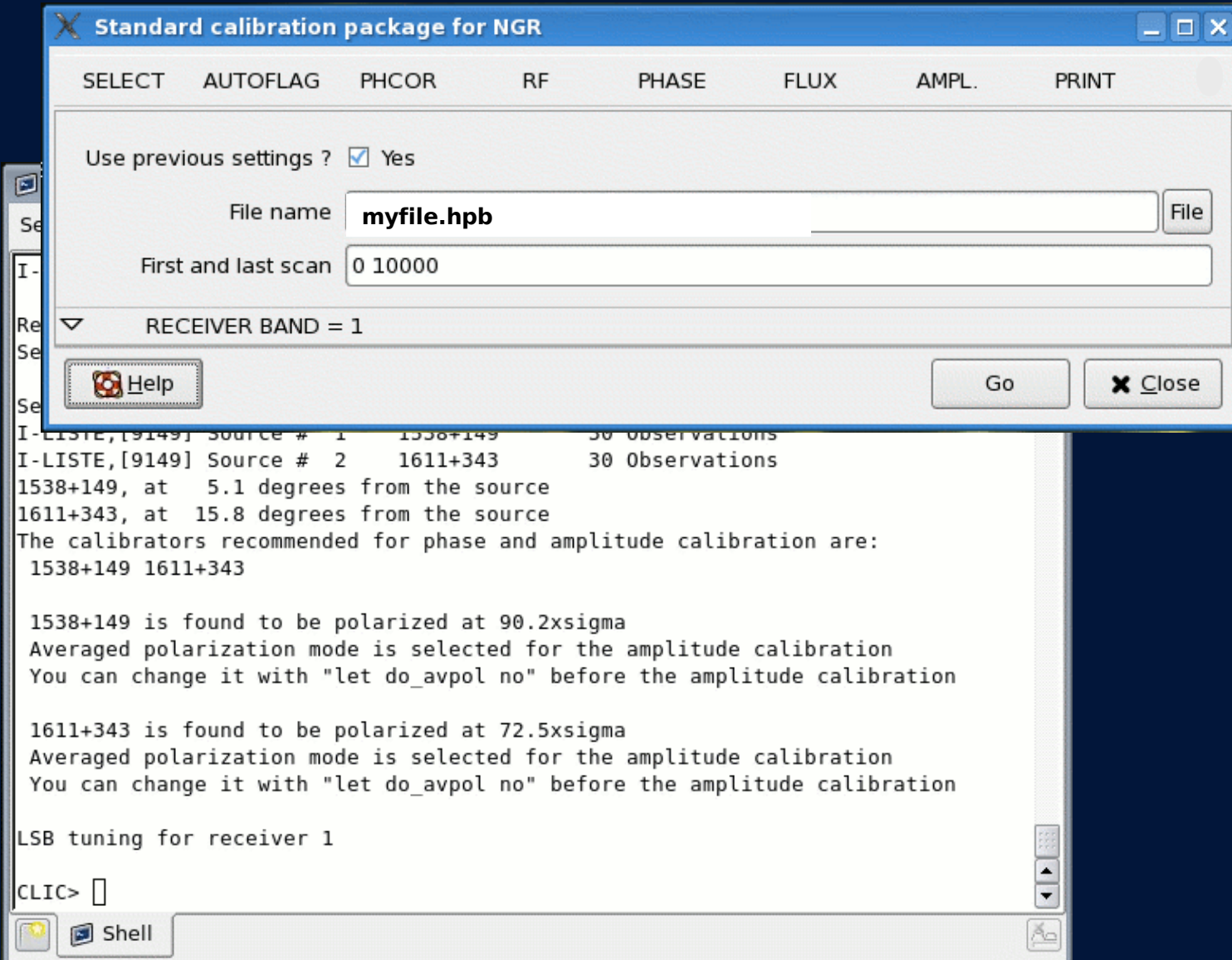
Practical Tips



Practical Tips



Motivation



Standard calibration package for NGR

SELECT AUTOFLAG PHCOR RF PHASE FLUX AMPL. PRINT

Use previous settings ? Yes

File name File

First and last scan

RECEIVER BAND = 1

Help Go Close

```

I-LISTE,[9149] Source # 1 1538+149 30 observations
I-LISTE,[9149] Source # 2 1611+343 30 Observations
1538+149, at 5.1 degrees from the source
1611+343, at 15.8 degrees from the source
The calibrators recommended for phase and amplitude calibration are:
1538+149 1611+343

1538+149 is found to be polarized at 90.2xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

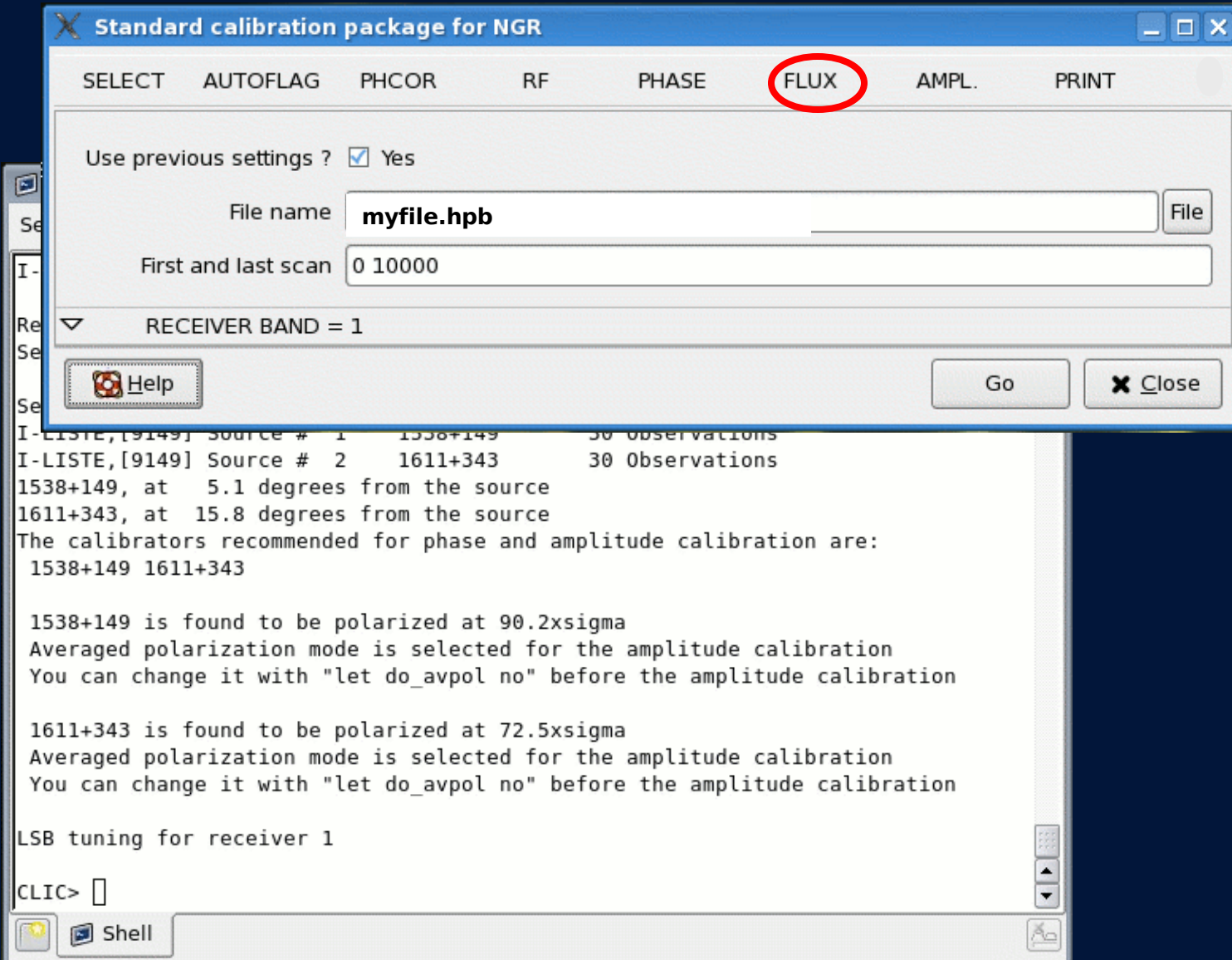
1611+343 is found to be polarized at 72.5xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

LSB tuning for receiver 1

CLIC>
  
```

Shell

Motivation



The screenshot shows a terminal window with a dialog box titled "Standard calibration package for NGR" overlaid on top. The dialog box has a menu bar with options: SELECT, AUTOFLAG, PHCOR, RF, PHASE, **FLUX** (circled in red), AMPL., and PRINT. Below the menu bar, there is a checkbox "Use previous settings ?" which is checked and labeled "Yes". There is a "File name" field containing "myfile.hpb" and a "File" button. Below that is a "First and last scan" field containing "0 10000". At the bottom of the dialog, there is a dropdown menu showing "RECEIVER BAND = 1", a "Help" button, and "Go" and "Close" buttons.

The terminal output below the dialog box shows the following text:

```
I-LISTE,[9149] Source # 1 1538+149 30 observations
I-LISTE,[9149] Source # 2 1611+343 30 Observations
1538+149, at 5.1 degrees from the source
1611+343, at 15.8 degrees from the source
The calibrators recommended for phase and amplitude calibration are:
1538+149 1611+343

1538+149 is found to be polarized at 90.2xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

1611+343 is found to be polarized at 72.5xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

LSB tuning for receiver 1

CLIC> █
```

Motivation

Standard calibration package for NGR


SELECT AUTOFLAG PHCOR RF PHASE **FLUX**

Use previous settings ? Yes

File name **myfile.hpb**

First and last scan 0 10000

RECEIVER BAND = 1

 Help

```


I-LISTE,[9149] Source # 1   1538+149   30 observations
I-LISTE,[9149] Source # 2   1611+343   30 observations
1538+149, at   5.1 degrees from the source
1611+343, at   15.8 degrees from the source
The calibrators recommended for phase and amplitude calibration are:
1538+149 1611+343

1538+149 is found to be polarized at 90.2xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibr

1611+343 is found to be polarized at 72.5xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibr

LSB tuning for receiver 1

CLIC> █
  
```

 Shell

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

Frequency 90.8 GHz

Efficiencies: 22.16 23.45 21.91 20.59 21.42 21.65

Scan list ? 8619 9161

Calibrator J1310+323

Input Flux? 1.072

Fixed flux? No

Solved Flux: 1.072

Flux in File: 1.072

Calibrator 3C345

Input Flux? 3.171

Fixed flux? No

Solved Flux: 3.171

Flux in File: 3.171

Source MWC349, Model Flux 1.13 Jy

Input Flux? 0.908

Fixed flux? No

Solved Flux: 0.908

Flux in File: 0.908

Calibrator 1538+149


Input Flux? 0.688


Fixed flux? No

Solved Flux: 0.688

Flux in File: 0.688

Calibrator 1611+343

 Help

Go  Close

Motivation

Standard calibration package for NGR


SELECT AUTOFLAG PHCOR RF PHASE **FLUX**

Use previous settings ? Yes

File name **myfile.hpb**

First and last scan 0 10000

RECEIVER BAND = 1

 Help

```

I-LISTE,[9149] Source # 1   1538+149   30 observations
I-LISTE,[9149] Source # 2   1611+343   30 observations
1538+149, at   5.1 degrees from the source
1611+343, at   15.8 degrees from the source
The calibrators recommended for phase and amplitude calibration are:
1538+149 1611+343

1538+149 is found to be polarized at 90.2xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibr

1611+343 is found to be polarized at 72.5xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibr

LSB tuning for receiver 1

CLIC> █
  
```

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

Frequency 90.8 GHz

Efficiencies: 22.16 23.45 21.91 20.59 21.42 21.65

Scan list ? 8619 9161

Calibrator J1310+323

Input Flux? 1.072

Fixed flux? No

Solved Flux: 1.072

Flux in File: 1.072

Calibrator 3C345

Input Flux? 3.171

Fixed flux? No

Solved Flux: 3.171

Flux in File: 3.171

Source MWC349, Model Flux 1.13 Jy

Input Flux? 0.908

Fixed flux? No

Solved Flux: 0.908

Flux in File: 0.908

Calibrator 1538+149



Input Flux? 0.688

Fixed flux? No

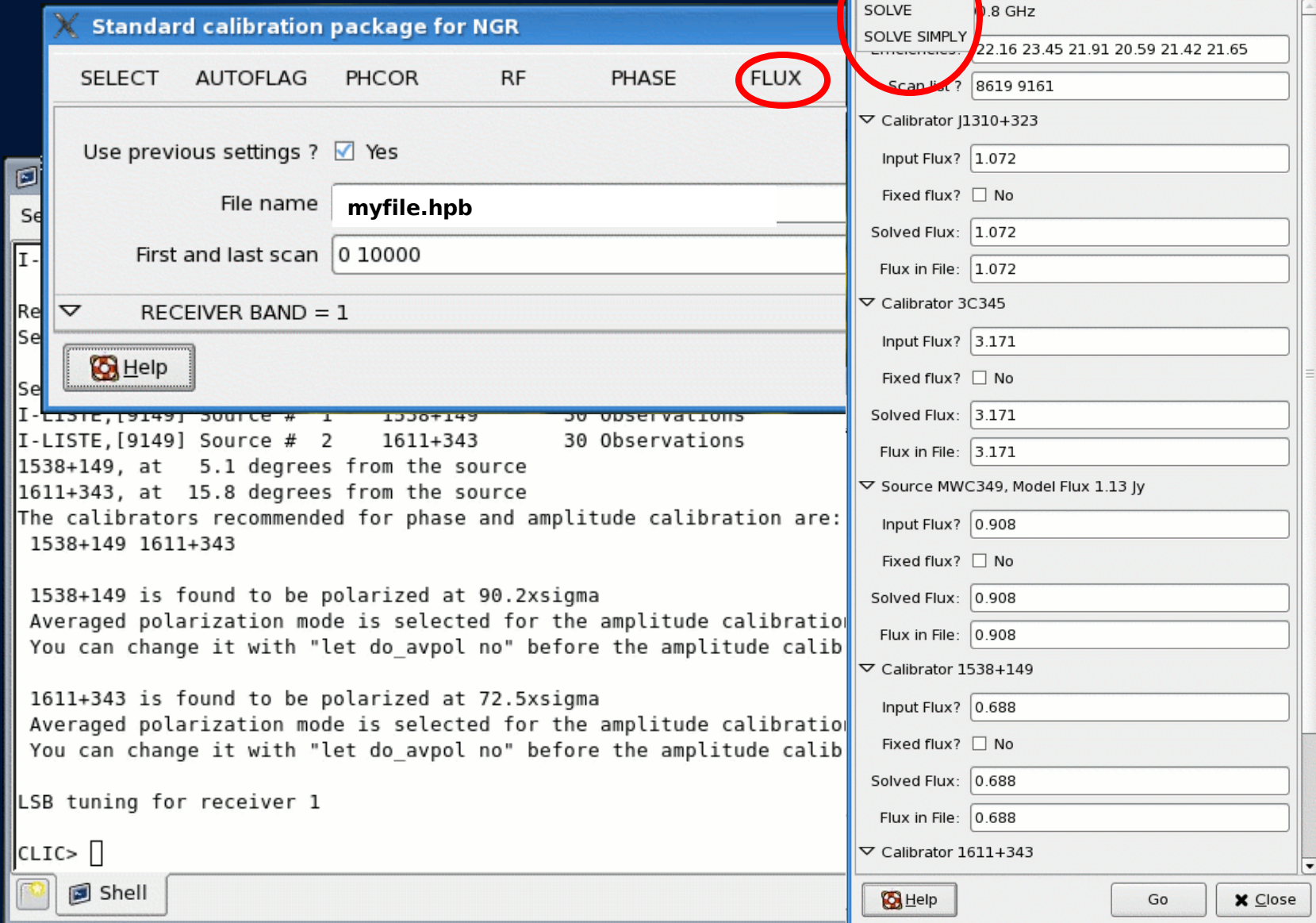
Solved Flux: 0.688

Flux in File: 0.688

Calibrator 1611+343

 Help Go  Close

Motivation



Standard calibration package for NGR

SELECT AUTOFLAG PHCOR RF PHASE **FLUX**

Use previous settings ? Yes

File name **myfile.hpb**

First and last scan 0 10000

RECEIVER BAND = 1

Help

```

I-LISTE,[9149] Source # 1 1538+149 30 observations
I-LISTE,[9149] Source # 2 1611+343 30 observations
1538+149, at 5.1 degrees from the source
1611+343, at 15.8 degrees from the source
The calibrators recommended for phase and amplitude calibration are:
1538+149 1611+343

1538+149 is found to be polarized at 90.2xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

1611+343 is found to be polarized at 72.5xsigma
Averaged polarization mode is selected for the amplitude calibration
You can change it with "let do_avpol no" before the amplitude calibration

LSB tuning for receiver 1

CLIC>
  
```

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

SOLVE 10.8 GHz

SOLVE SIMPLY

Emergence 22.16 23.45 21.91 20.59 21.42 21.65

Scan list? 8619 9161

Calibrator J1310+323

Input Flux? 1.072

Fixed flux? No

Solved Flux: 1.072

Flux in File: 1.072

Calibrator 3C345

Input Flux? 3.171

Fixed flux? No

Solved Flux: 3.171

Flux in File: 3.171

Source MWC349, Model Flux 1.13 Jy

Input Flux? 0.908

Fixed flux? No

Solved Flux: 0.908

Flux in File: 0.908

Calibrator 1538+149

Input Flux? 0.688

Fixed flux? No

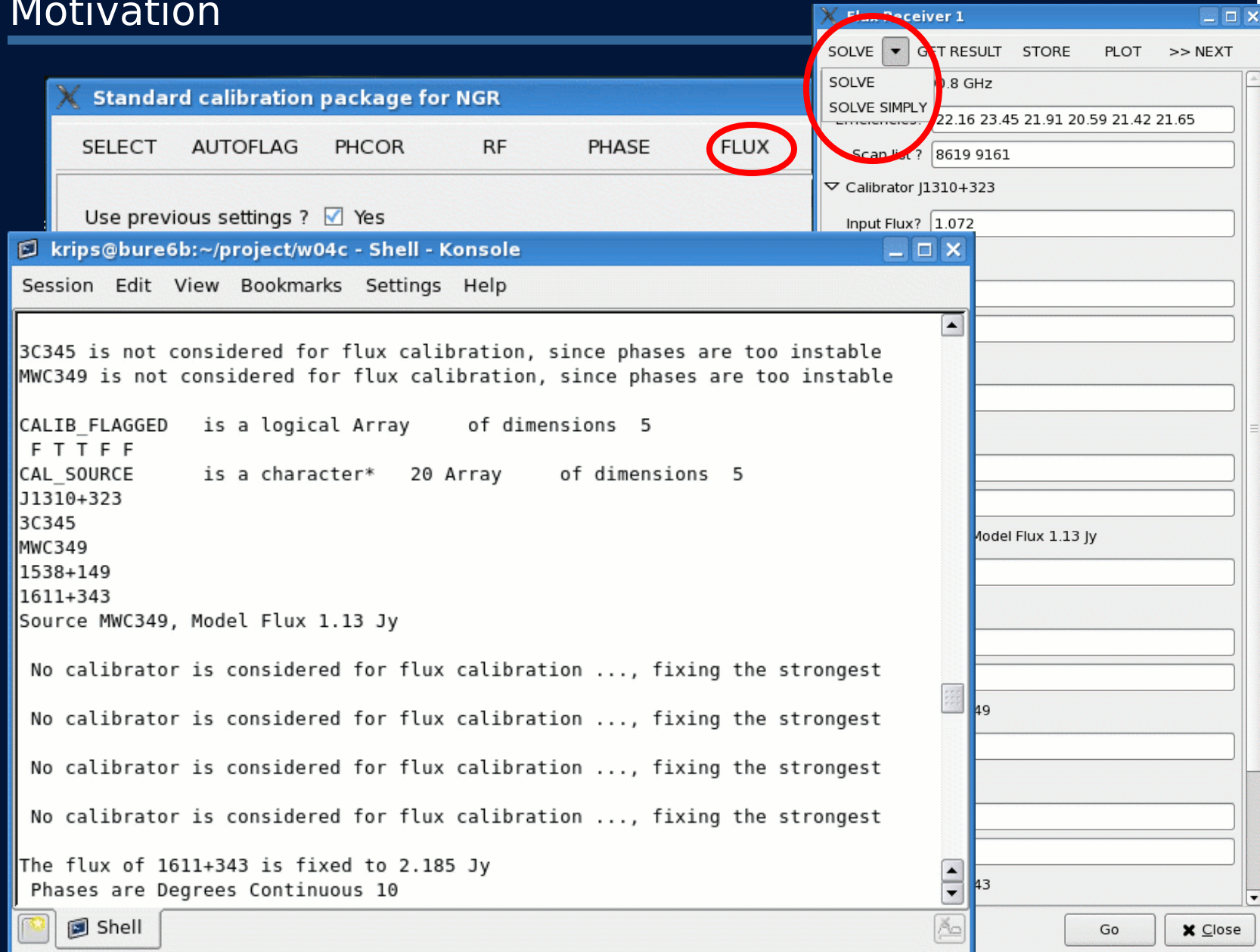
Solved Flux: 0.688

Flux in File: 0.688

Calibrator 1611+343

Help Go Close

Motivation



The screenshot illustrates the motivation for flux calibration in a radio astronomy software environment. It shows three main components:

- Standard calibration package for NGR:** A window with tabs for SELECT, AUTOFLAG, PHCOR, RF, PHASE, and **FLUX** (highlighted with a red circle). The 'FLUX' tab is active, showing options like 'Use previous settings ?' (checked) and 'Yes'.
- Flux Receiver 1:** A dialog box with a 'SOLVE' dropdown menu (highlighted with a red circle) and a 'GET RESULT' button. It displays parameters such as 'SOLVE' (0.8 GHz), 'SOLVE SIMPLY', 'Scan list?' (8619 9161), 'Calibrator J1310+323', and 'Input Flux?' (1.072). A 'Model Flux 1.13 Jy' is also indicated.
- Terminal Window:** A shell window showing the output of the calibration process. It reports that sources 3C345 and MWC349 are not considered for flux calibration due to unstable phases. It lists sources and their model fluxes:

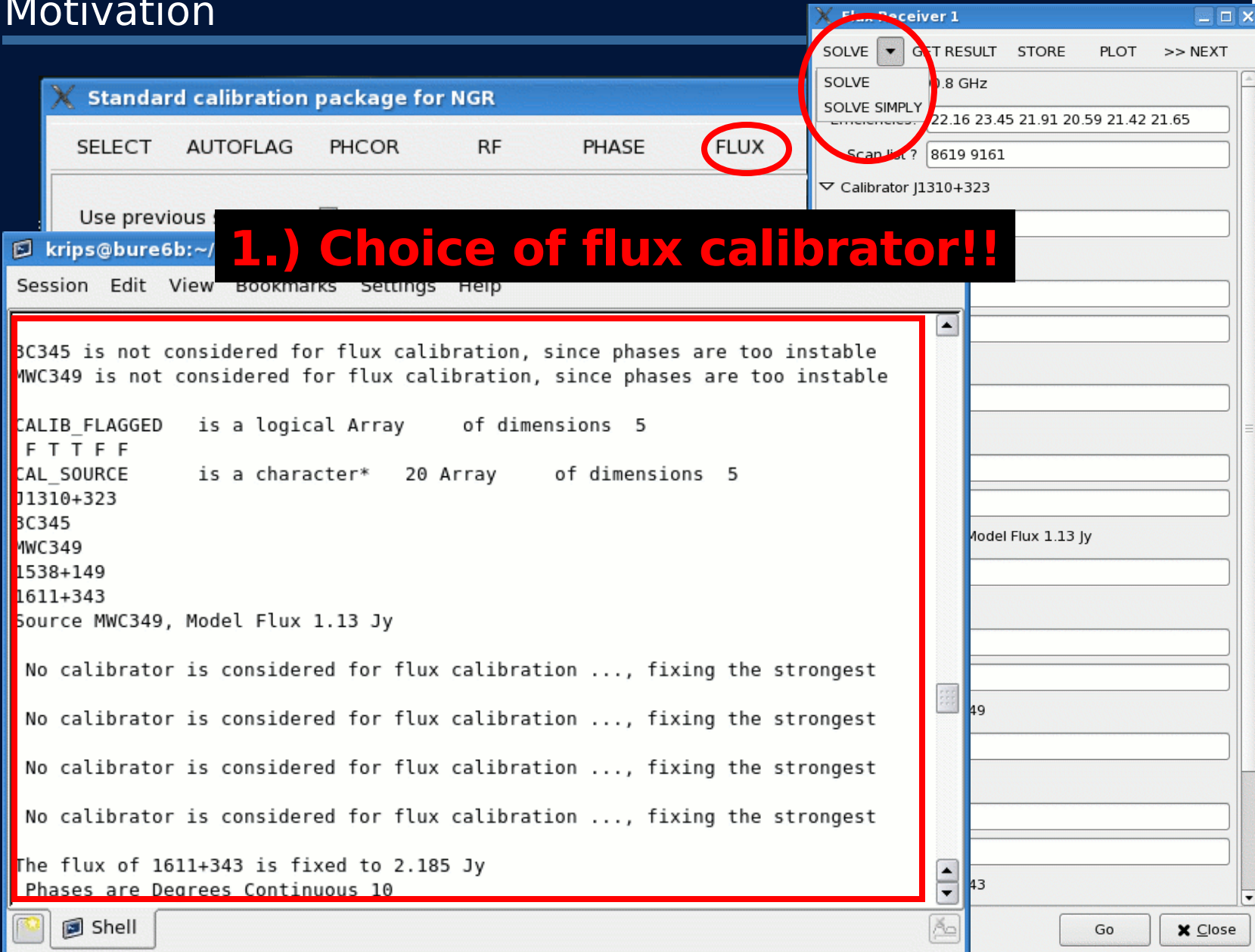

```

      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

      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

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


Motivation



1.) Choice of flux calibrator!!

```

BC345 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
BC345
MWC349
1538+149
1611+343
Source MWC349, Model Flux 1.13 Jy

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

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

Motivation

Standard calibration

SELECT AUTO

Use previous settings

File

First and last

RECEIVER

Help

CAL_SOURCE 15

J1310+323

3C345

MWC349

1538+149

1611+343

Source MWC349, Mode

No calibrator is c

No calibrator is c

No calibrator is c

No calibrator is c

The flux of 1611+34

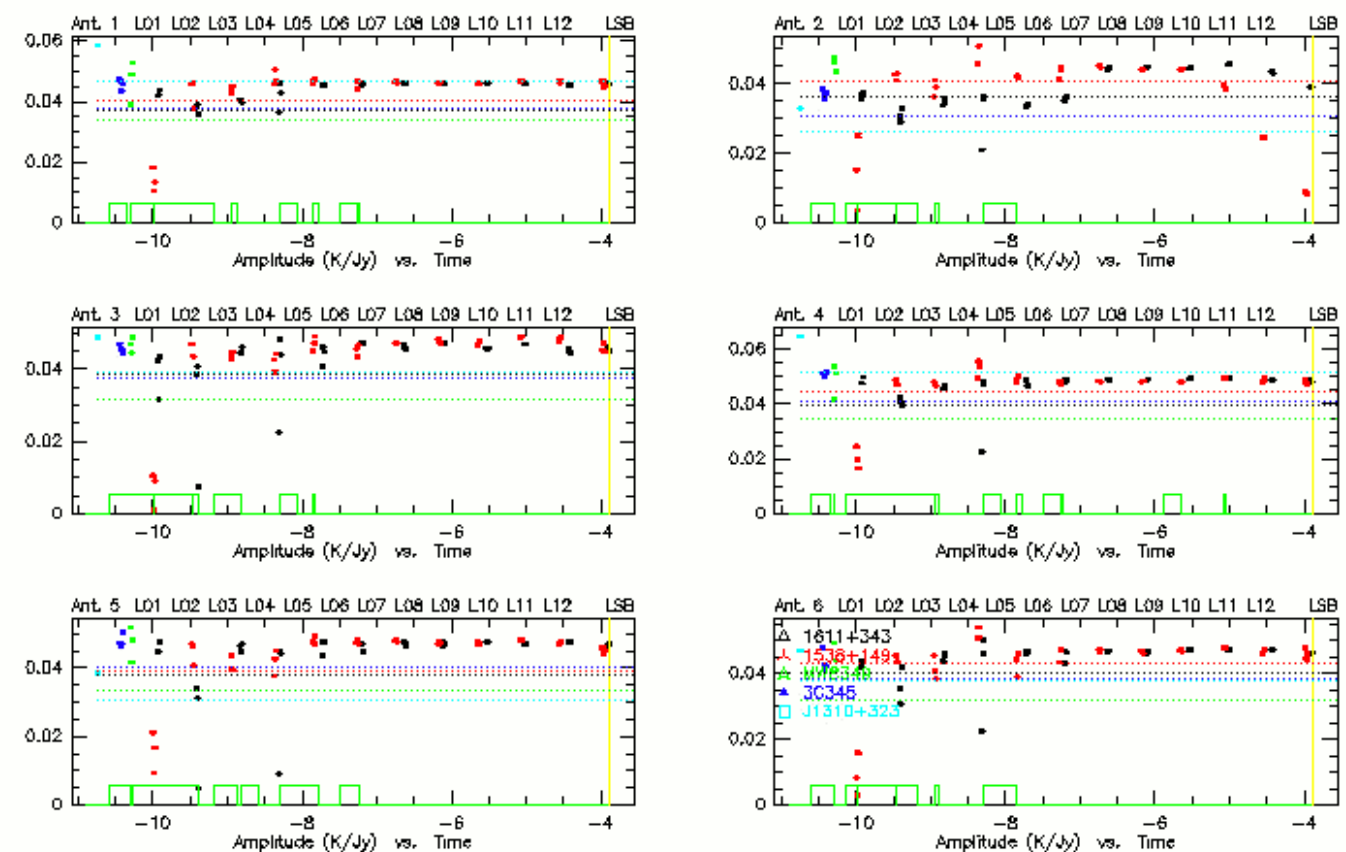
Phases are Degrees

<GREG

Pencil Marker Hardcopy Draw Clear Edit Lut

RF: Fr.(A)
Am: Scaled
Ph: Rel.(A) Atm

Scan Avg.
BOTH polarizations



Shell

Help

Go

Close

Motivation

Standard cali

SELECT AUTO

Use previous se

File

First and la

RECEIVER

Help

CAL_SOURCE 15

J1310+323

3C345

MWC349

1538+149

1611+343

Source MWC349, Mode

No calibrator is c

No calibrator is c

No calibrator is c

No calibrator is c

The flux of 1611+34

Phases are Degrees

<GREG

Pencil Marker Hardcopy Draw Clear Edit Lut

RF: Fr.(A)
Am: Scaled
Ph: Rel.(A) Atm

Scan Avg.
BOTH polarizations

2.) Exclude bad fluxes!!



Amplitude (K/Jy) vs. Time

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

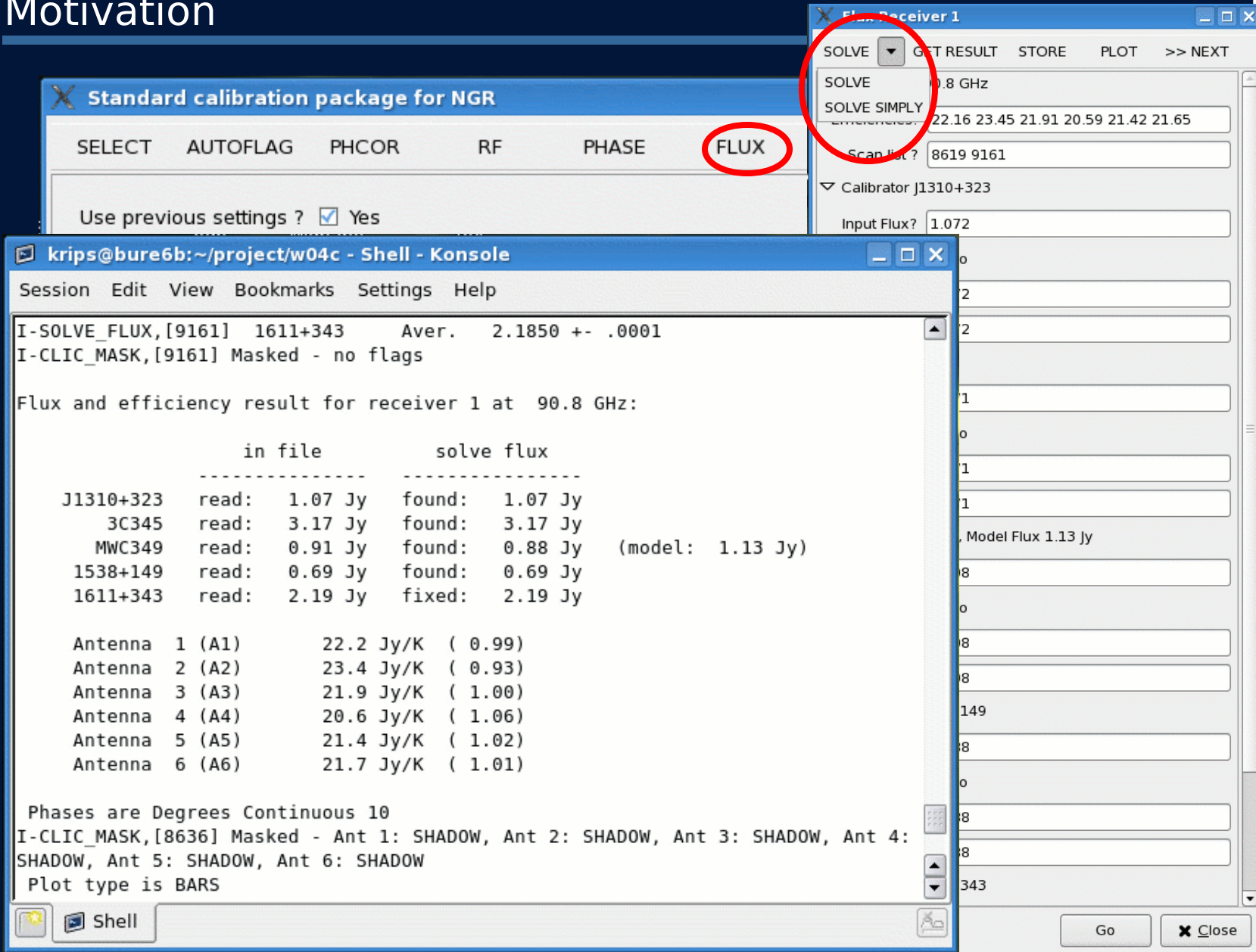
Shell

Help

Go

Close

Motivation



The screenshot shows a software interface for flux calibration. The main window is titled "Standard calibration package for NGR" and has a menu bar with options: SELECT, AUTOFLAG, PHCOR, RF, PHASE, and **FLUX** (circled in red). Below the menu bar, there is a checkbox for "Use previous settings ?" which is checked and labeled "Yes".

A secondary window titled "Flux Receiver 1" is open, showing a "SOLVE" dropdown menu with "90.8 GHz" selected. Below this, there are fields for "SOLVE SIMPLY" (with values 22.16, 23.45, 21.91, 20.59, 21.42, 21.65), "Scan list?" (with values 8619, 9161), and "Calibrator J1310+323". The "Input Flux?" field is set to 1.072.

In the foreground, a terminal window titled "krips@bure6b:~/project/w04c - Shell - Konsole" displays the following output:

```
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
```

Motivation

**3.) Check Antenna efficiencies
And found source fluxes!!!**

Standard calibration package for NGR

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

SOLVE 90.8 GHz

SOLVE SIMPLY

1 20.59 21.42 21.65

krips@bure6b:~/project/w04c - Shell - Konsole

Session Edit View Bookmarks Settings Help

```
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:
```

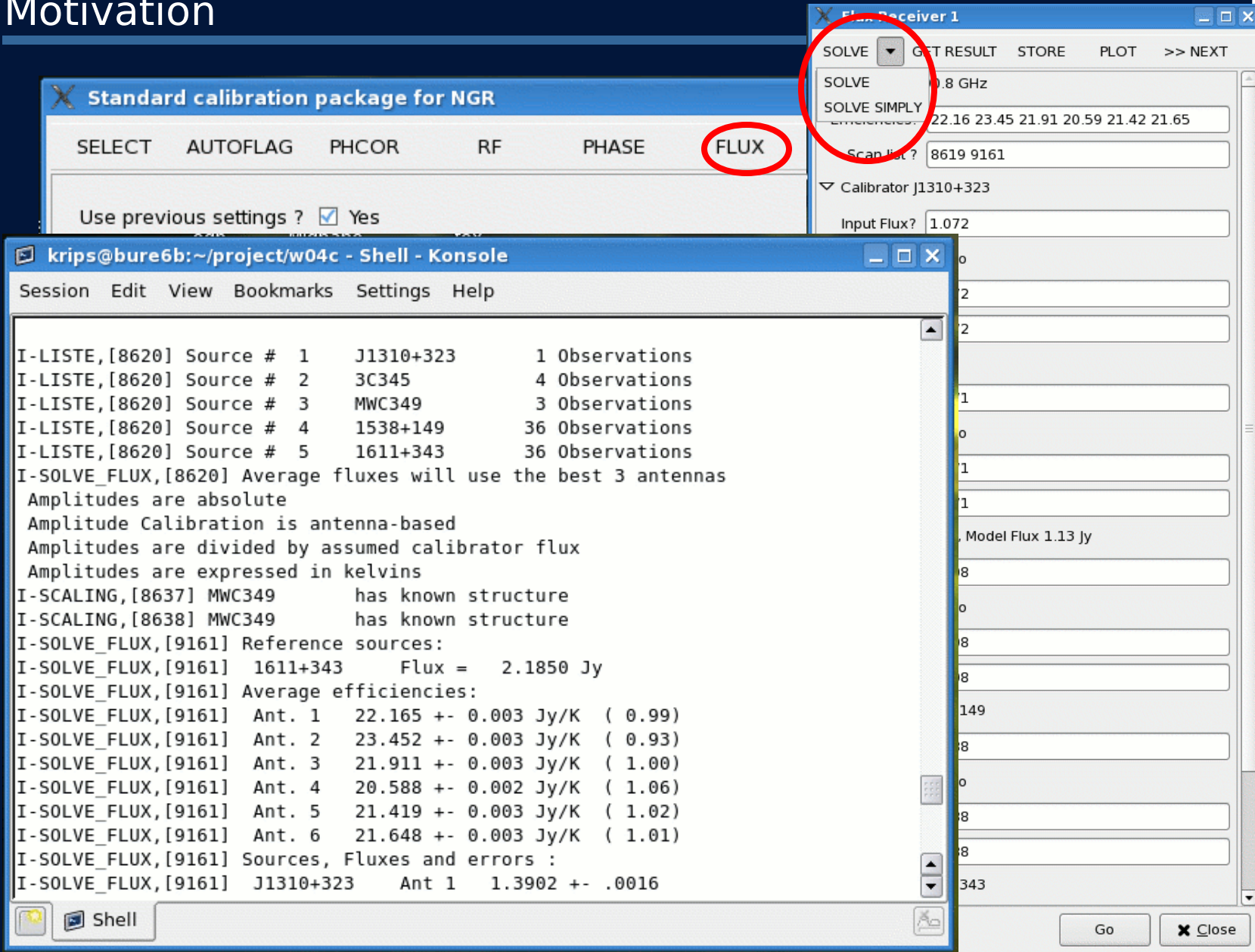
	in file	solve flux		
J1310+323	read: 1.07 Jy	found: 1.07 Jy		
3C345	read: 3.17 Jy	found: 3.17 Jy		
MWC349	read: 0.91 Jy	found: 0.88 Jy	(model: 1.13 Jy)	
1538+149	read: 0.69 Jy	found: 0.69 Jy		
1611+343	read: 2.19 Jy	fixed: 2.19 Jy		
Antenna 1 (A1)	22.2 Jy/K	(0.99)		
Antenna 2 (A2)	23.4 Jy/K	(0.93)		
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
```

Go Close

Motivation



The screenshot shows a software interface for flux calibration. The main window has a menu bar with options: SELECT, AUTOFLAG, PHCOR, RF, PHASE, and **FLUX** (circled in red). Below the menu bar, there is a checkbox for "Use previous settings ?" which is checked and labeled "Yes".

A secondary window titled "Flux Receiver 1" is open, showing a "SOLVE" dropdown menu with "SOLVE" selected (circled in red). Other options include "GET RESULT", "STORE", "PLOT", and ">> NEXT". The window displays the following information:

- SOLVE: 0.8 GHz
- SOLVE SIMPLY: 22.16 23.45 21.91 20.59 21.42 21.65
- Scan list? 8619 9161
- Calibrator J1310+323
- Input Flux? 1.072

A terminal window titled "krips@bure6b:~/project/w04c - Shell - Konsole" is open, displaying the following output:

```

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
  
```

Motivation

It only takes the three best Antennas!

krips@bure6b:~/project/w04c - Shell - Konsole

Session Edit View Bookmarks Settings Help

```

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 10.8 GHz

SOLVE SIMPLY

21.91 20.59 21.42 21.65

Go

Close

Motivation

It automatically considers extension of MWC349!

Standard calibration package for NGR

SELECT AUTOFL

Use previous settings

Flux Receiver 1

SOLVE GET RESULT STORE PLOT >> NEXT

SOLVE 10.8 GHz

SOLVE SIMPLY

3.45 21.91 20.59 21.42 21.65

161

3

0

2

2

1

0

1

1

Model Flux 1.13 Jy

8

0

8

8

149

8

0

8

8

343

Go

Close

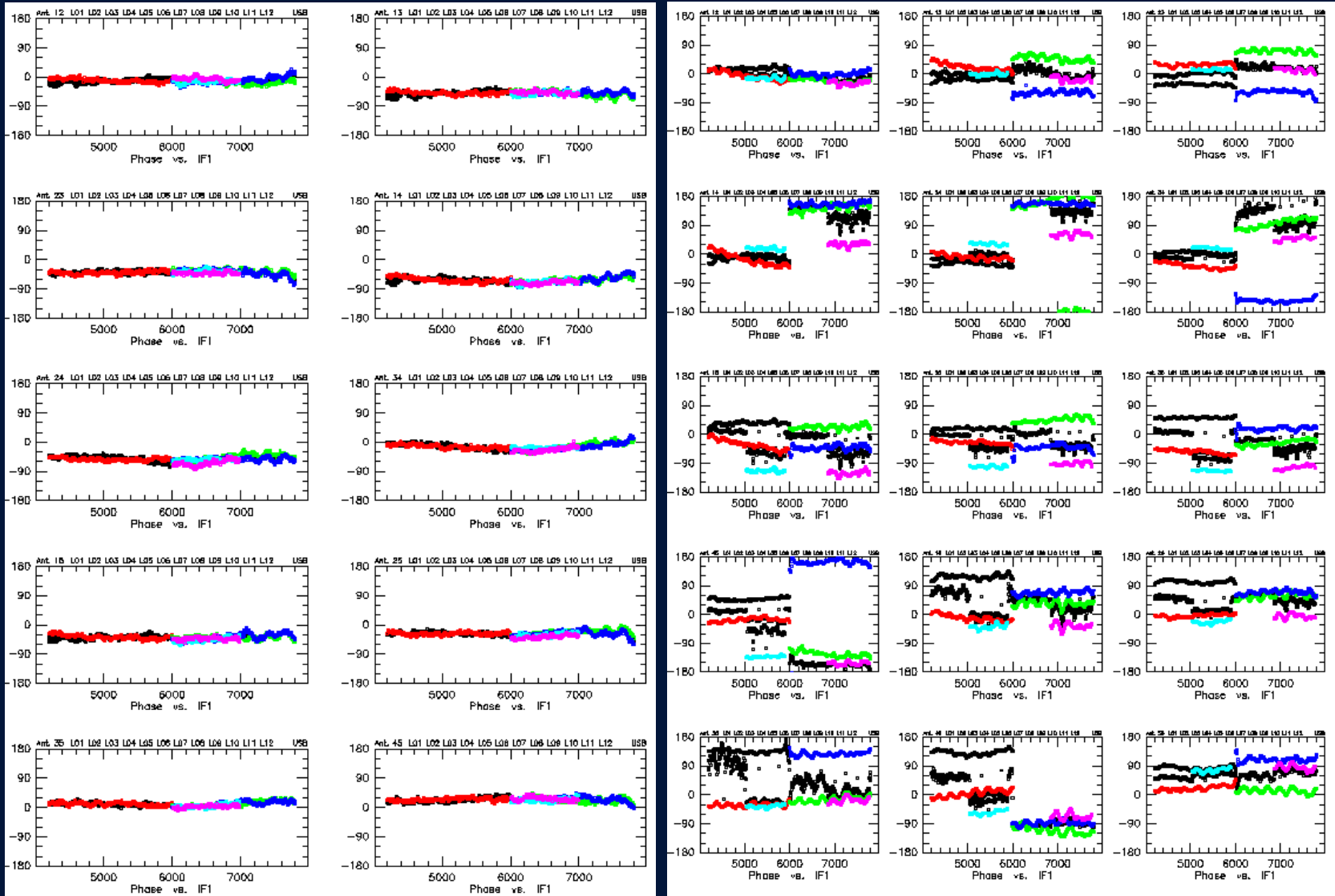
krips@bure6b:~/project/w04c - Shell - Konsole

Session Edit View Bookmarks Settings Help

```

I-LISTE,[8620] Source # 1 J1310+323 1 Observations
I-LISTE,[8620] Source # 2 3C345 4 Observations
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```


Practical Tips



Questions?