

PdBI *uv*-data analysis in practice



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General Picture

image plane

uv plane

brightness (x,y)

$\longleftrightarrow \mathcal{FT} \longrightarrow$

visibility (u,v)



What we want



What we
obtain with an
interferometer

General Picture

image plane

uv plane

brightness (x,y)

visibility (u,v)^{instr} **IPB data**

\Leftrightarrow

Imv* (gdf)

↓
Calibration

↓ **hpb files**

brightness (x,y)^{uv}

Gridding
← FFT
Cleaning

visibility (u,v)^{obs} **uv-table**

• Data processed enough to have removed all instrumental contribution

• Data raw enough to access to observational characteristics: baseline, scan, weight, etc.

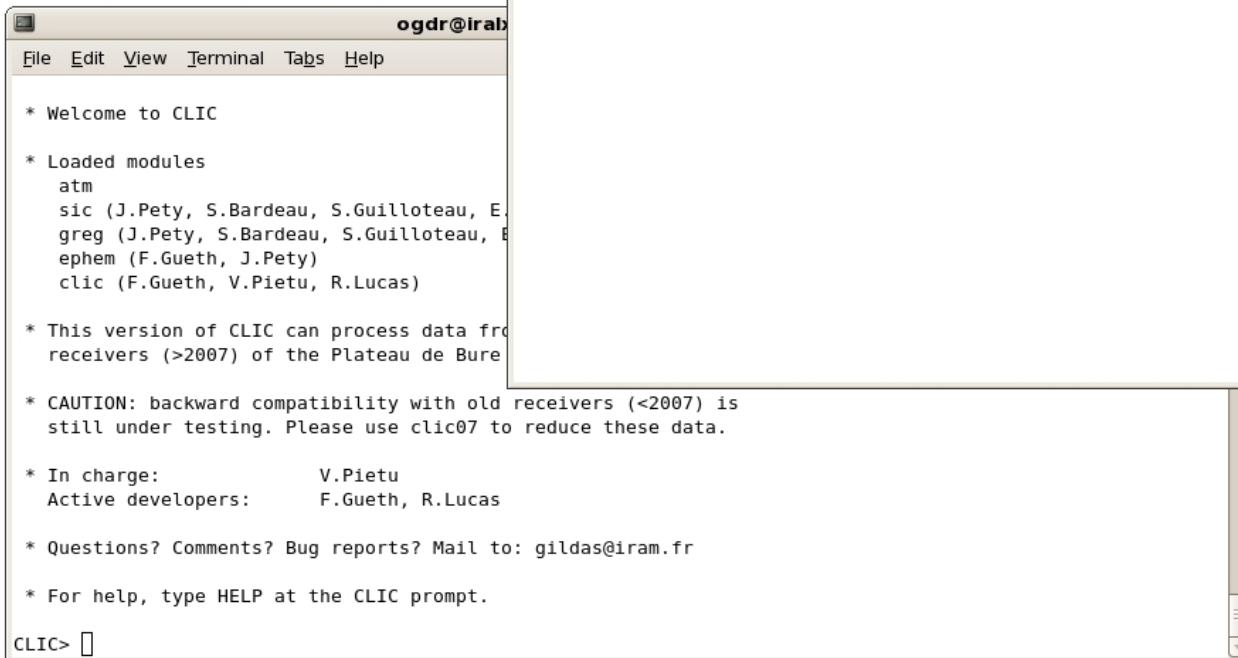
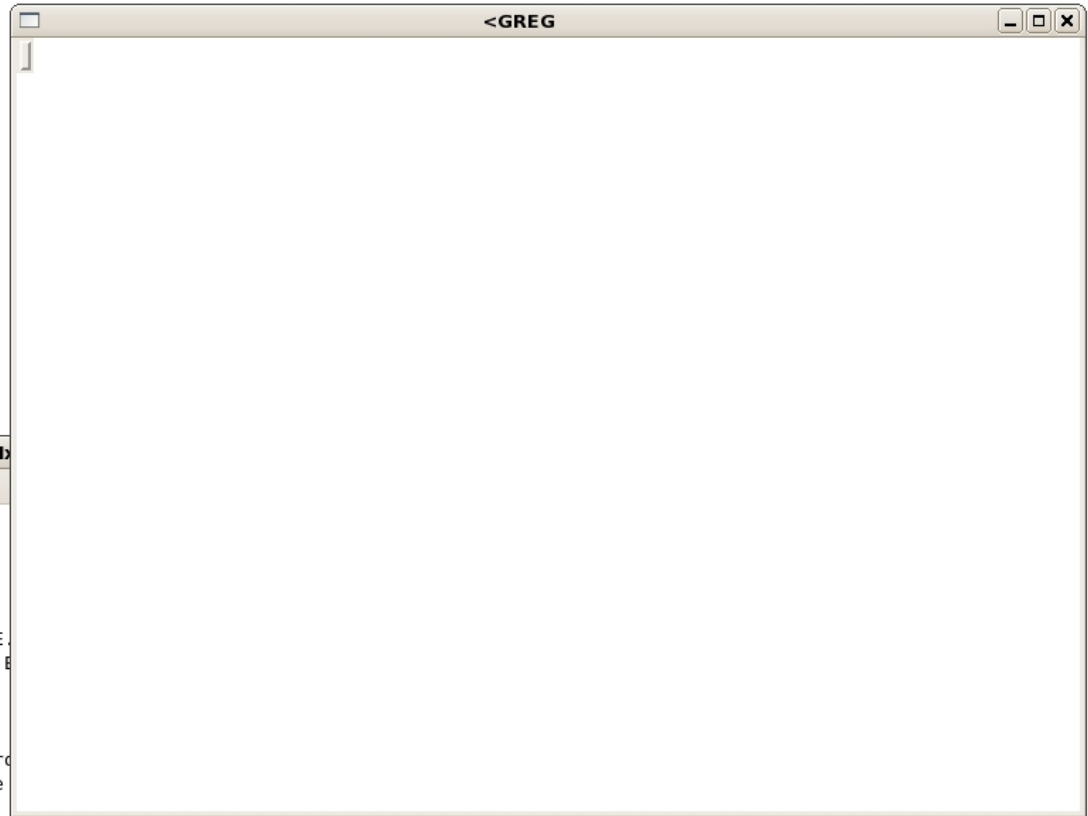
• Data not yet affected by the 'imaging process': assumptions, interpolations, computations, etc.

Summary

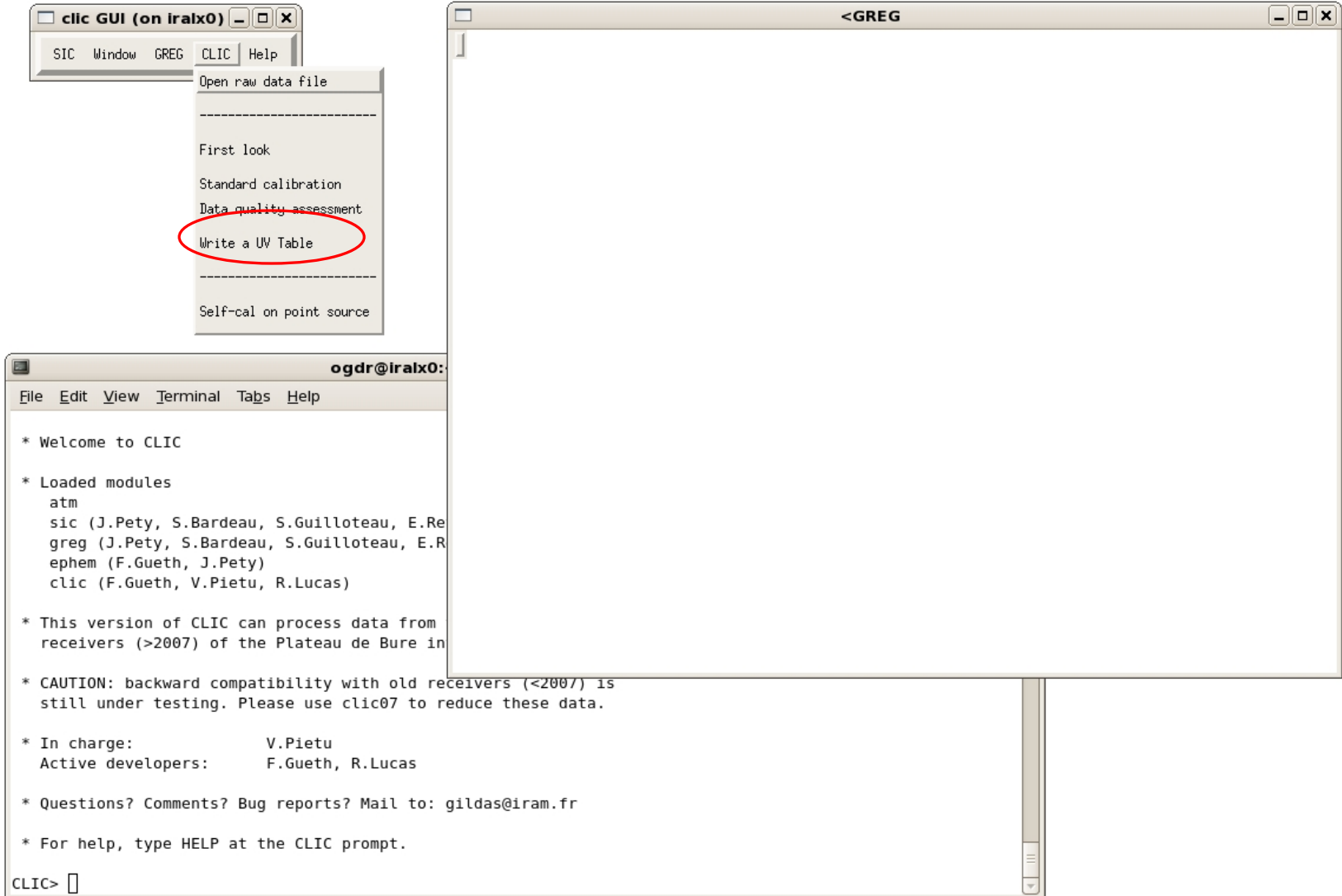
1. Let's create a uv -table, in **CLIC**
2. Data analysis, in **MAPPING**
 - Data analysis in the uv -plane
 - An inspection of the uv -data needed

Let's create a table ("mytable".uvt),
in CLIC

Creating a *uv*-table; **CLIC**



Creating a *uv*-table; CLIC



The image shows a graphical user interface (GUI) for CLIC and a terminal window. The GUI window, titled "cllc GUI (on iralx0)", has a menu bar with "SIC", "Window", "GREG", "CLIC", and "Help". The "CLIC" menu is open, showing options: "Open raw data file", "First look", "Standard calibration", "Data quality assessment", "Write a UV Table" (circled in red), and "Self-cal on point source". The terminal window, titled "ogdr@iralx0:", displays the following text:

```
File Edit View Terminal Tabs Help

* Welcome to CLIC

* Loaded modules
  atm
  sic (J.Pety, S.Bardeau, S.Guilloteau, E.Re
  greg (J.Pety, S.Bardeau, S.Guilloteau, E.R
  ephem (F.Gueth, J.Pety)
  clic (F.Gueth, V.Pietu, R.Lucas)

* This version of CLIC can process data from
  receivers (>2007) of the Plateau de Bure in

* CAUTION: backward compatibility with old receivers (<2007) is
  still under testing. Please use clic07 to reduce these data.

* In charge:          V.Pietu
  Active developers:  F.Gueth, R.Lucas

* Questions? Comments? Bug reports? Mail to: gildas@iram.fr

* For help, type HELP at the CLIC prompt.

CLIC> 
```

Creating a *uv*-table; CLIC

The image shows a graphical user interface for creating a UV table, titled "Simple UV Table creation (on iralx0)". The window has a title bar with standard window controls and buttons for "GO", "ABORT", and "HELP". Below the title bar is a tab labeled "CREATE THE TABLE".

The main area of the GUI contains several input fields and checkboxes:

- Use atm. phase correction?** Yes
- Input Data File Name:**
- Output UV Table Name:**
- New Table:** Yes
- Source Name:**
- R.A. & Dec. Offsets (for Mosaics):**
- First and last scan:**
- Receiver number:**
- Line or Continuum:**
- Band Used:**

Below these fields is a list of receiver channels (L01 to L12) with checkboxes:

- L01 Yes
- L02 No
- L03 No
- L04 No
- L05 Yes
- L06 No
- L07 No
- L08 No
- L09 No
- L10 No
- L11 No
- L12 No

At the bottom, there are two sections of buttons:

- Change line parameter:** No
- Resample spectral data:** No
- Line parameters:**
- Resampling parameters:**

To the left of the main GUI window, there is a terminal window with a menu bar (File, Edit, View, Te) and the following text:

```
* Loaded modules
  atm
  sic (J.Pety,
  greg (J.Pety,
  ephem (F.Gueth
  clic (F.Gueth

* This version of
  receivers (>20

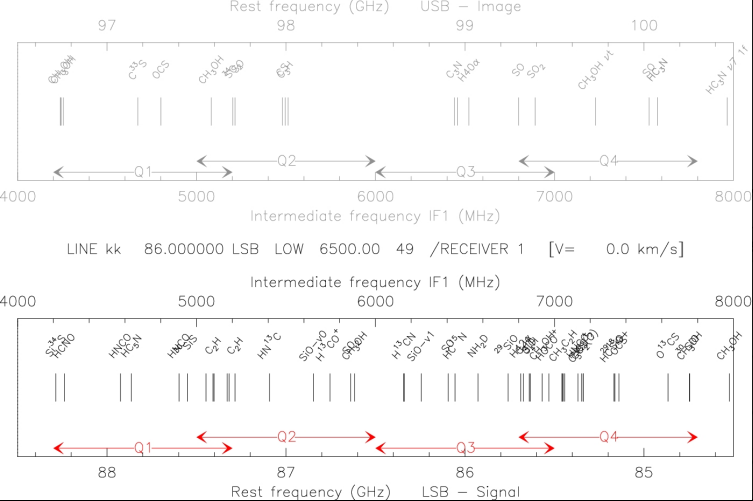
* CAUTION: backw
  still under te

* In charge:
  Active develop

* Questions? Com

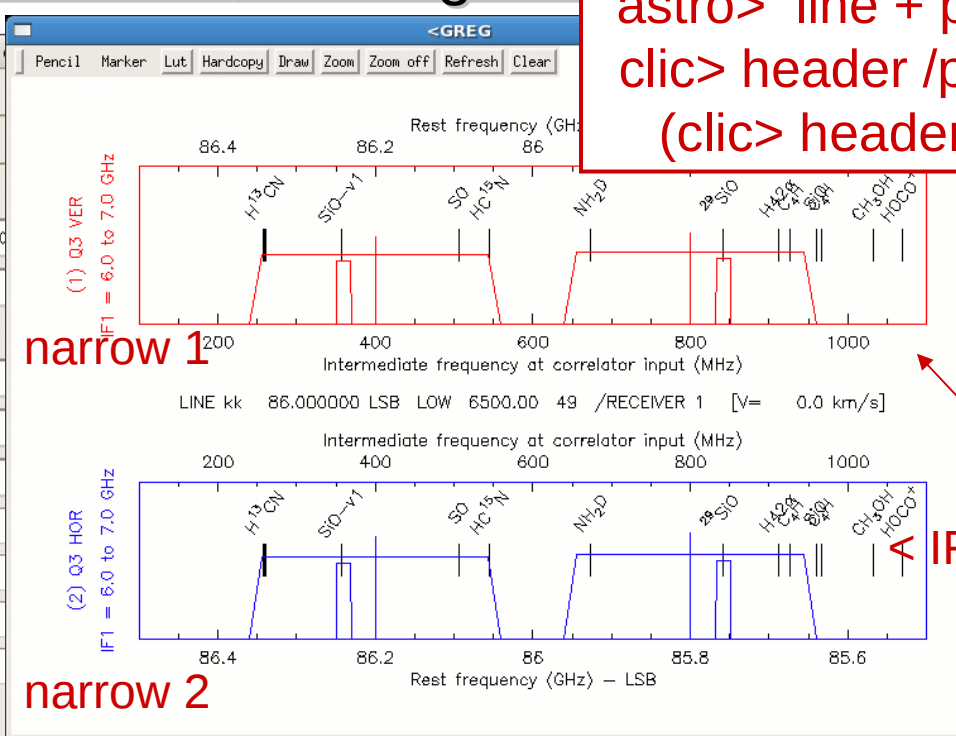
* For help, type

CLIC>
I-GREG, Re-allo
CLIC>
```

Creating a u... plot

astro> line + plot
 clic> header /plot
 (clic> header)



New Table? Yes

Source Name?

R.A. & Dec. Offsets (for Mosaics)?

First and last scan?

Min. Data quality?

Receiver number?

Line or Continuum?

Band Used?

Use L01? No

Use L02? No

Use L03? No

Use L04? No

Use L05? Yes

Use L06? No

Use L07? No

Use L08? No

Change line parameter? Yes

Resample spectral data? No

Line parameters:

Resampling parameters:

Line parameters

Change line parameter? Yes

Line Name:

Rest Frequency (MHz):

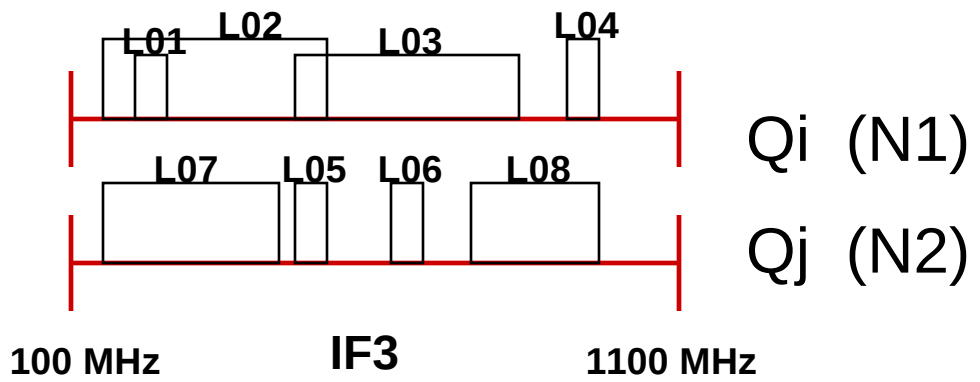
narrow 1

narrow 2

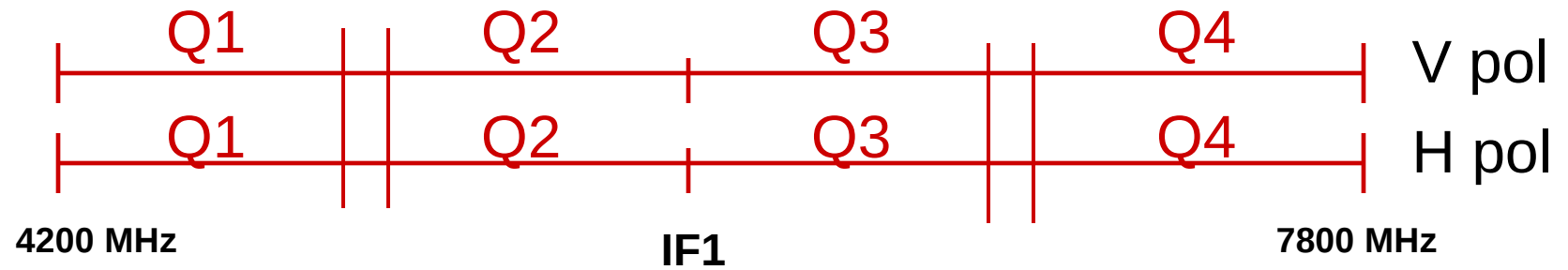
IF3 units

narrow Qi Qj

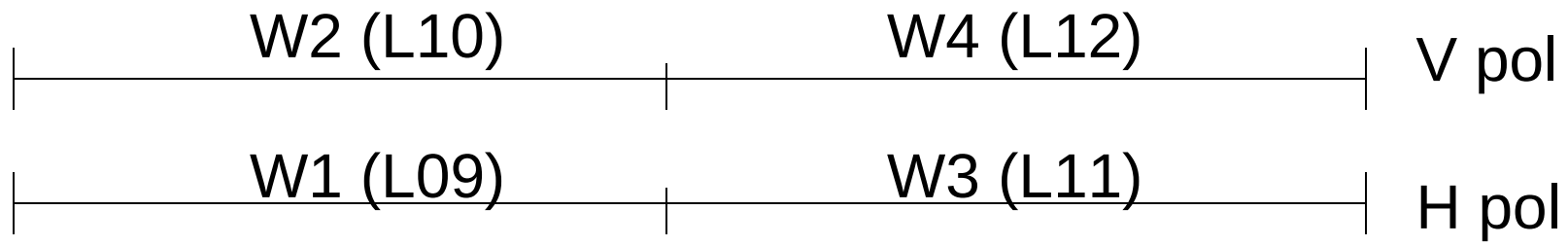
	Q1	Q2	Q3	Q4	
N1	H	H	V	V	
N2	V	V	H	H	



Narrow Band Correlator **CONFIG**



Wide Band Correlator **FIXED**



Creating a *uv*-table; CLIC

```
ogdr@iralx0:~/ischool/2010/isa8/reports
File Edit View Terminal Tabs Help
Phases are Degrees Jumpy
Amplitudes are relative to calibrator amplitude
Amplitude Calibration is antenna-based
Amplitudes are expressed in janskys
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
Phases are relative to calibrator phase
Phase Calibration is antenna-based
Phase reference is internal (same receiver)

Using real-time atmospheric phase correction, antennas 1 2 3 4 5 6
  (according to validation by STORE CORRECTION)
Using no off-line atmospheric phase correction, antennas 1 2 3 4 5 6

Phases are Degrees Jumpy
Amplitudes are relative to calibrator amplitude
Amplitude Calibration is antenna-based
Amplitudes are expressed in janskys
I-FILE,[6868] Found file /users/PdBdata/ogdr/ischool/2010/isa8/reports/11-apr-2007-isa8.hpb
Offset range : 0.0 to 0.0 and 0.0 to 0.0
Selected data quality is 4 (Average)
I-CLIC_SET,[6868] SWITCHING ON SET AVERAGE SCAN METHOD
Phases are Degrees Jumpy
Amplitudes are relative to calibrator amplitude
Amplitude Calibration is antenna-based
Amplitudes are expressed in janskys
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
Selection is LINE, LSB , L07
All frequencies selected.
I-CLIC, Primary beam size 58.76925 "
W-TABLE,[7537] Spectrum resampling is needed, obs. # 844 Scan 7537
W-TABLE,[7537] Frequency resolutions : 2.500000000000000 -0.858185138199841
W-TABLE,[7537] Reference channels : 13.9744529724121 15.0000000000000
W-TABLE,[7537] Number of channels : 116 30
I-TABLE,[6957] Table parameters for aqgl-sio.uvt:
I-TABLE,[6957] X_LINE = sio X_FREQ = 85759.144 X_VAL1 = 85743.342
I-TABLE,[6957] X_FRES = -0.858 X_VRES = 3.000 X_VOFF = 99.000
I-TABLE,[6957] NCHAN = 30 X_REF1 = 15.0000
I-TABLE,[6957] 5665 visibilities written (out of 5850 possible)
I-TABLE,[6957] Old size 5850 New 5665
CLIC>
```

CLIC

```
ogdr@iralx0:~/ischool/2010/isa8/reports
File Edit View Terminal Tabs Help
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
Phases are relative to calibrator phase
Phase Calibration is antenna-based
Phase reference is internal (same receiver)

Using real-time atmospheric phase correction, antennas 1 2 3 4 5 6
  (according to validation by STORE CORRECTION)
Using no off-line atmospheric phase correction, antennas 1 2 3 4 5 6

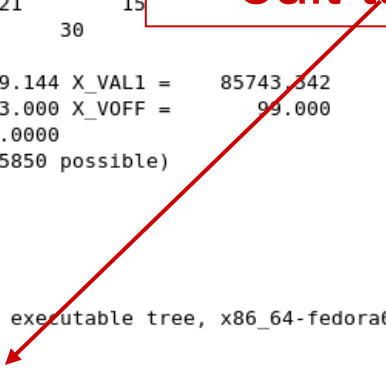
Phases are Degrees Jumpy
Amplitudes are relative to calibrator amplitude
Amplitude Calibration is antenna-based
Amplitudes are expressed in janskys
I-FILE,[6868] Found file /users/PdBdata/ogdr/ischool/2010/isa8/reports/11-apr-2007-isa8.hpb
Offset range : 0.0 to 0.0 and 0.0 to 0.0
Selected data quality is 4 (Average)
I-CLIC_SET,[6868] SWITCHING ON SET AVERAGE SCAN METHOD
Phases are Degrees Jumpy
Amplitudes are relative to calibrator amplitude
Amplitude Calibration is antenna-based
Amplitudes are expressed in janskys
RF Passband Calibration is applied
RF Passband Calibration is frequency dependent
RF Passband Calibration is antenna-based
RF Passband Calibration from input file
Selection is LINE, LSB , L07
All frequencies selected.
I-CLIC, Primary beam size 58.76925 "
W-TABLE,[7537] Spectrum resampling is needed, obs. # 844 Scan
W-TABLE,[7537] Frequency resolutions : 2.5000000000000000
W-TABLE,[7537] Reference channels : 13.9744529724121 15
W-TABLE,[7537] Number of channels : 116 30
I-TABLE,[6957] Table parameters for aagl-sio.uvt:
I-TABLE,[6957] X_LINE = sio X_FREQ = 85759.144 X_VAL1 = 85743.342
I-TABLE,[6957] X_FRES = -0.858 X_VRES = 3.000 X_VOFF = 99.000
I-TABLE,[6957] NCHAN = 30 X_REF1 = 15.0000
I-TABLE,[6957] 5665 visibilities written (out of 5850 possible)
I-TABLE,[6957] Old size 5850 New 5665
CLIC> sys
You are logged in on host iralx0.
Tue Oct 5 21:17:51 CEST 2010

Selecting GILDAS version: 27sep (27sep10 02:05 cest), executable tree, x86_64-fedora6-ifort

SIC# lrt *cllic
-rw-r----- 1 ogdr project 534 Oct 5 21:14 aagl-sio.uvt-table.cllic
SIC#
```

CLIC

Easy and faster
edit table script



isj8-co21-table.clic - emacs@pctcp33.iram.fr

File Edit Options Buffers Tools Help

isj8-co21-table.clic

```
! isj8-co21-table.clic
!
file in 08-oct-2008-isj8.hpb
!
set default
set scan 0 10000
set offset 0 0
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!
set selection LINE LSB L01 and L05
find /proc corr /sou MFS-22
!
table ~/maps/isj8-co21.uvt new /frequency C021 230538 /res 40 20 -30 2 velo
!
/
```

-0:-- isj8-co21-table.clic (Fundamental)--L21--A11-----

X Wrote /home/ccarrizo/isj8-co21-table.clic

Simple UV Table creation

GO ABORT HELP

CREATE THE TABLE

Use atm. phase correction? Yes

Input Data File Name ? /home/ccarrizo/24-dec-2008-isj8.hpb File

Output UV Table Name ? ~/maps/isj8-co21

New Table? No

Source Name ? MFS-22

R.A. & Dec. Offsets (for Mosaics)? 0 0

First and last scan ? 0 1000

Min. Data quality ? AVERAGE Choices

Receiver number ? 3 Choices

Line or Continuum ? LINE Choices

Band Used ? LSB Choices

Use L01 ? Yes

Use L02 ? No

Use L03 ? No

Use L04 ? No

Use L05 ? Yes

Use L06 ? No

Use L07 ? No

Use L08 ? No

Change line parameter ? No

Resample spectral data ? Yes

Line parameters Line Line parameters Help

Resampling parameters Resampling Resampling parameters Help

2nd data set

```
isj8-co21-table.clic - emacs@pctcp33.iram.fr
File Edit Options Buffers Tools Help
[Icons]
! isj8-co21-table.clic
file in 08-oct-2008-isj8.hpb
!
set default
set scan 0 10000
set offset 0 0
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!
set selection LINE LSB L01 and L05
find /proc corr /sou MFS-22
!
table ~/maps/isj8-co21.uvt new /frequency C021 230538 /res 40 20 -30 2 velo
!
█
file in 24-dec-2008-isj8.hpb
!
set default
set scan 0 10000
set offset 0 0
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!
set selection LINE LSB L01 and L05
find /proc corr /sou MFS-22
!
table ~/maps/isj8-co21.uvt old /frequency C021 230538 /res 40 20 -30 2 velo
!
/
-0:-- isj8-co21-table.clic (Fundamental)--L24--A11-----
[X] Wrote /home/ccarrizo/isj8-co21-table.clic
```

2nd data set


```
isj8-co21-table.clic - emacs@pctcp33.iram.fr
File Edit Options Buffers Tools Help
[Icons]
|
| isj8-co21-table.clic
|
| file in 08-oct-2008-isj8.hpb
|
| set default
| set scan 0 10000
| set offset 0 0
| set receiver 3
| set quality AVERAGE
| set weight tsys on
| set weight calibration on
| set phase antenna atmospher internal relative
| set amplitude antenna absolute jansky relative
| set rf_passband antenna frequency file on
|
| set selection LINE LSB L01 and L05
| find /proc corr /sou MFS-22
|
| table ~/maps/isj8-co21.uvt new /frequency CO21 230538 /res 40 20 -30 2 velo
|
| file in 24-dec-2008-isj8.hpb
|
| set phase noatm
| set scan 20 350
|
| find /proc corr /sou MFS-22
|
| table
|
| /
-0:-- isj8-co21-table.clic (Fundamental)--L28--A11-----
[X] Wrote /home/ccarrizo/isj8-co21-table.clic
```

```
CLIC>
CLIC> help table
CLIC\TABLE Name [OLD|NEW
[/RESAMPLE nc ref val ir
[/FREQUENCY name rest-fr
[/NOCHECK [SOURCE|POINTI

This command will create an
given, the most recently cre
may be OLD (default value i
or NEW to create a new table

The bands and subbands used
TION. The weighting mode can

TABLE /RESAMPLE nc ref val i

Option /RESAMPLE enable
line data). 'nc' is the
ence channel, 'val' t
respect to the rest freq
resolution, 'code' is '
are in velocity units, '

The reference channel th
to the offset 'val'
header or modified by op

Resampling is done by de
channel data. Resampli
Fourier space by cut-off
components, after decor
lator (due to on-line ap
produce frequency char
shapes are:
TBox = a box in delay
Ppar = a parabola in d
FBox = a box in freque
FTri = a triangle in
ter)
The width is the channel
1).
```

```
ccarrizo@pctcp33:~
File Edit View Terminal Tabs Help

Option /FFT is not recommended when joining together several subbands
to produce a single spectrum, with a limited number of broad channels.
In those cases using the FFT could produce a spectrum with "holes" at
the points between subbands with limited overlap.

TABLE /FREQUENCY name rest-freq

Option /FREQUENCY is used to redefine the rest frequency (in MHz) and
line name for the output table. The velocity scale is computed ac-
cordingly. This rest frequency will correspond to the reference chan-
nel in option RESAMPLE.

TABLE /NOCHECK [SOURCE|POINTING|PHASE|EPOCH]

When processing each scan, CLIC checks whether a number of position
parameters are consistent with those defined in the table header. Op-
tion /NOCHECK allows to switch off this checking. Arguments can be
given to switch off only part of the parameters (SOURCE name, POINTING
direction, PHASE center, EPOCH of coordinates). This option is intend-
ed for building tables with inconsistent parameters (typical exemple
is a different source name...). It is potentially dangerous and is to
be used with caution.

TABLE /DROP n1 n2 --- THIS OPTION IS OBSOLETE

Option /DROP enables to drop the first 'n1' and last 'n2' channels in
each subband of the OLD spectral correlator. For the NEW spectral cor-
relator (data taken since summer 1992), it is replaced by the commands
SET GIBBS and SET DRDP.

TABLE /COMPRESS tmax uvmax

Option /COMPRESS is used to compress the data before writing the
table. This works like the COMPRESS command, but no intermediate
file is written. Very seldom used.

Additional Help Available:
UVTABLE
I-HELP, "table" is also a task, use "HELP TASK table" for more help
CLIC>
```

isj8-co21-table.clic - emacs@pctcp33.iram.fr

File Edit Options Buffers Tools Help

isj8-co21-table.clic

```
file in 08-oct-2008-isj8.hpb
set default
set scan 0 10000
set offset 0 0
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!
set selection CONT LSB L01 to L08
find /proc corr /sou MFS-22
!
table ~/maps/isj8-cont.uvt new
```

continuum

-0:-- isj8-co21-table.clic (Fundamental)--L18--All-----

Wrote /home/ccarrizo/isj8-co21-table.clic

```
isj8-co21-table.clic - emacs@pctcp33.iram.fr
File Edit Options Buffers Tools Help
[Icons]
: isj8-co21-table.clic
:
file in 08-oct-2008-isj8.hpb
:
set default
set scan 0 10000
set offset 0 0
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!
set selection CONT LSB L01 to L08 /window 230538-480 230538-20 230538+20 230538+480
find /proc corr /sou MFS-22
!
table ~/maps/isj8-cont.uvt new █

                                remove line contribution

                                continuum

-0:-- isj8-co21-table.clic (Fundamental)--L21--A11-----
[X] Wrote /home/ccarrizo/isj8-co21-table.clic
```

```
isj8-co21-table.clic - emacs@pctcp33.iram.fr
File Edit Options Buffers Tools Help
[Icons]
isj8-co21-table.clic
file in 08-oct-2008-isj8.hpb
set default
set scan 0 10000
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!
set selection LINE LSB L01 to L08
!
set offset -8 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-1.uvt new /resa 40 20 -30 2 velo
!
set offset 0 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-2.uvt new /resa 40 20 -30 2 velo
!
set offset +8 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-3.uvt new /resa 40 20 -30 2 velo
/
-0:-- isj8-co21-table.clic (Fundamental)--L29--A11-----
[X] Wrote /home/ccarrizo/isj8-co21-table.clic
```

Mosaic

**a table for each offset
“tablename”- “i”.uvt**

```
isj8-co21-table.clic - emacs@pctcp33.iram.fr
File Edit Options Buffers Tools Help
[Icons]

! isj8-co21-table.clic

file in 08-oct-2008-isj8.hpb

set default
set scan 0 10000
set receiver 3
set quality AVERAGE
set weight tsys on
set weight calibration on
set phase antenna atmospher internal relative
set amplitude antenna absolute jansky relative
set rf_passband antenna frequency file on
!

set selection LINE LSB L01 to L08
!

set offset -8 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-1.uvt new /resa 40 20 -30 2 velo
!

set offset 0 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-2.uvt new /resa 40 20 -30 2 velo
!

set offset +8 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-3.uvt new /resa 40 20 -30 2 velo
!

file in 24-dec-2008-isj8.hpb

set offset -8 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-1.uvt old /resa 40 20 -30 2 velo
!

set offset 0 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-2.uvt old /resa 40 20 -30 2 velo
!

set offset +8 0
find /proc corr /sou MFS-22
table ~/maps/isj8-co21-3.uvt old /resa 40 20 -30 2 velo
!

-0:-- isj8-co21-table.clic (Fundamental)--L46--All-----
```

Mosaic

2nd data set

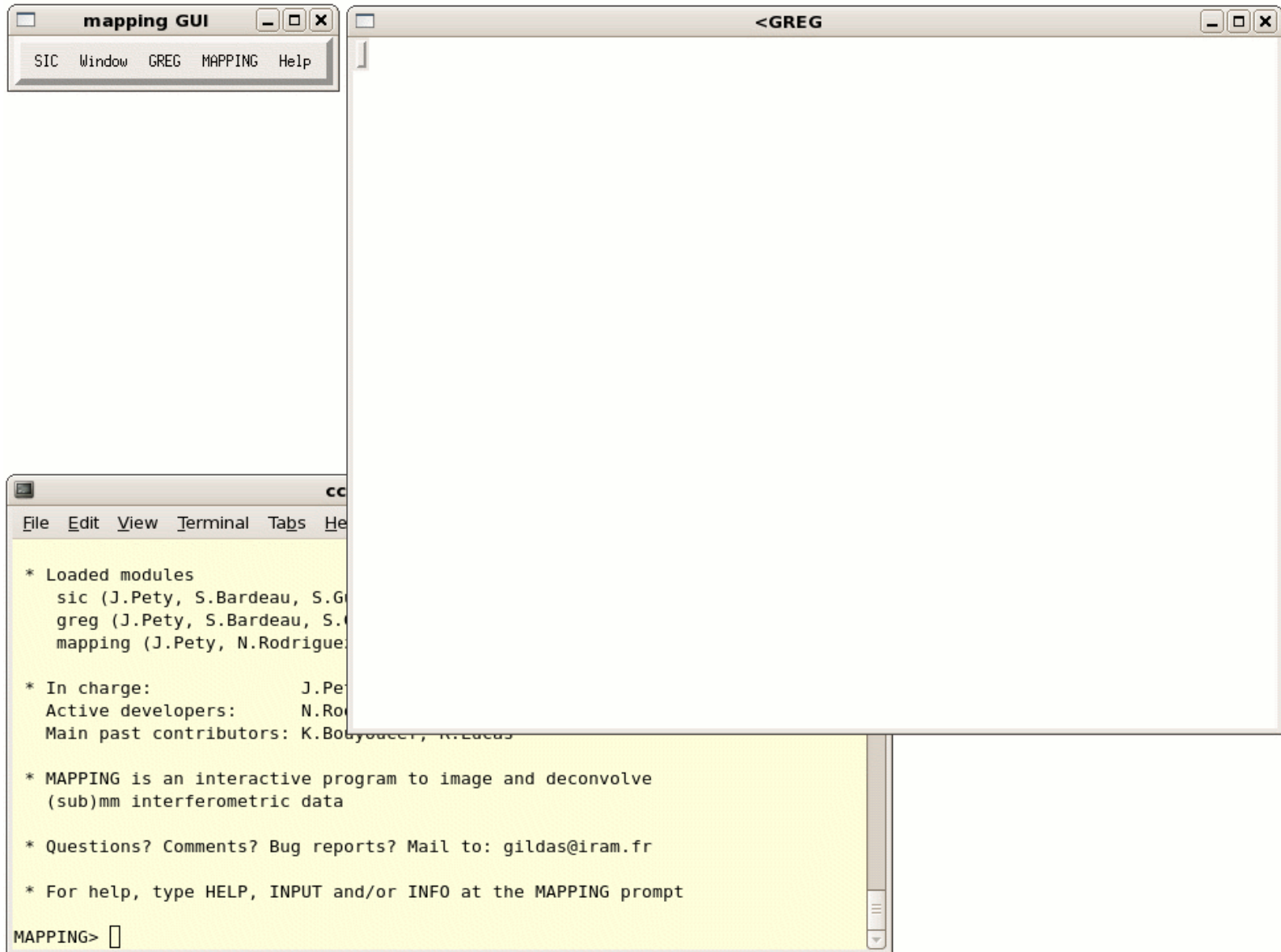
Created “mytable”.uvt, in **CLIC**



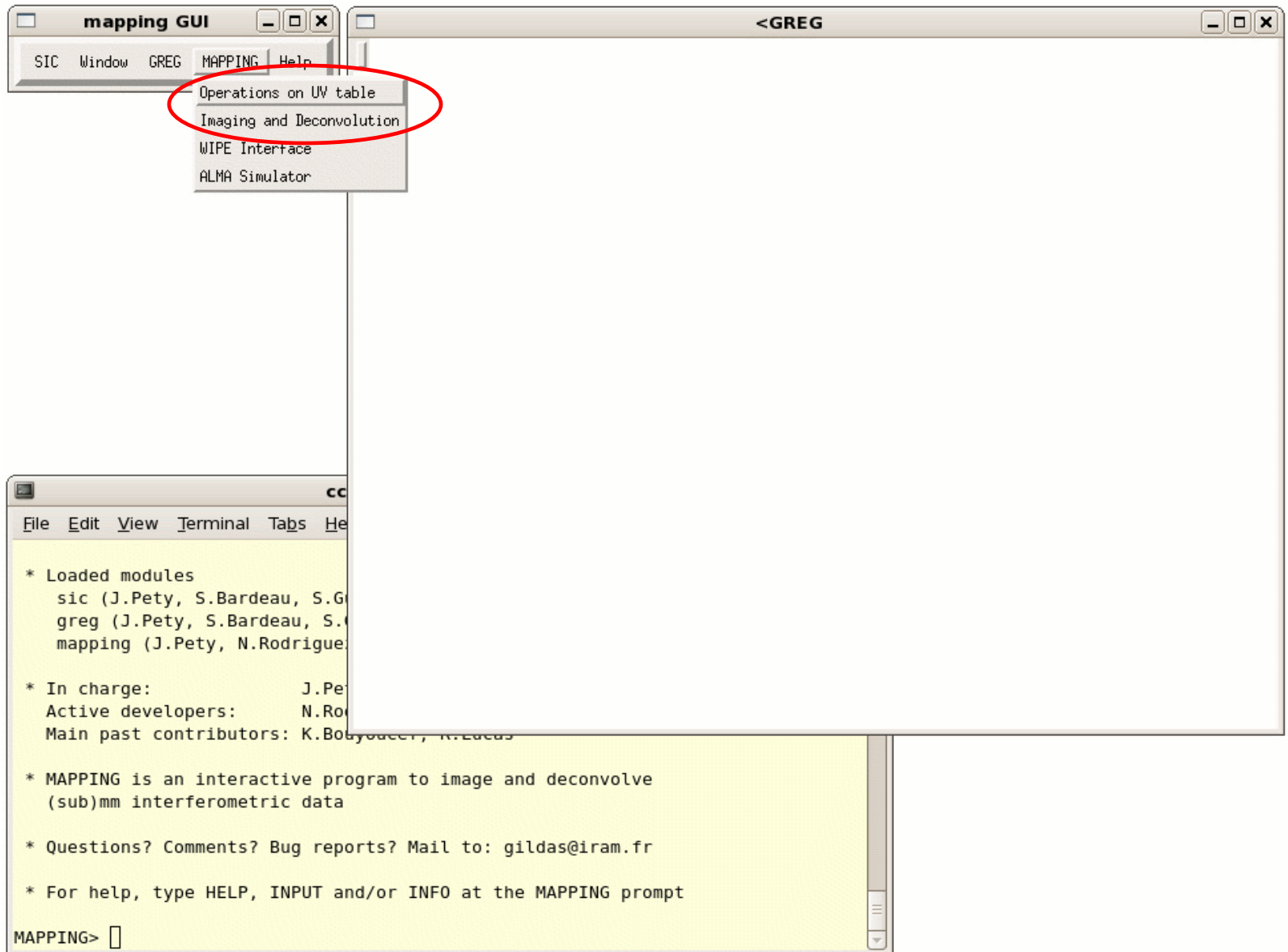
Analyze the data, in **MAPPING**

1. Data analysis in the uv -plane

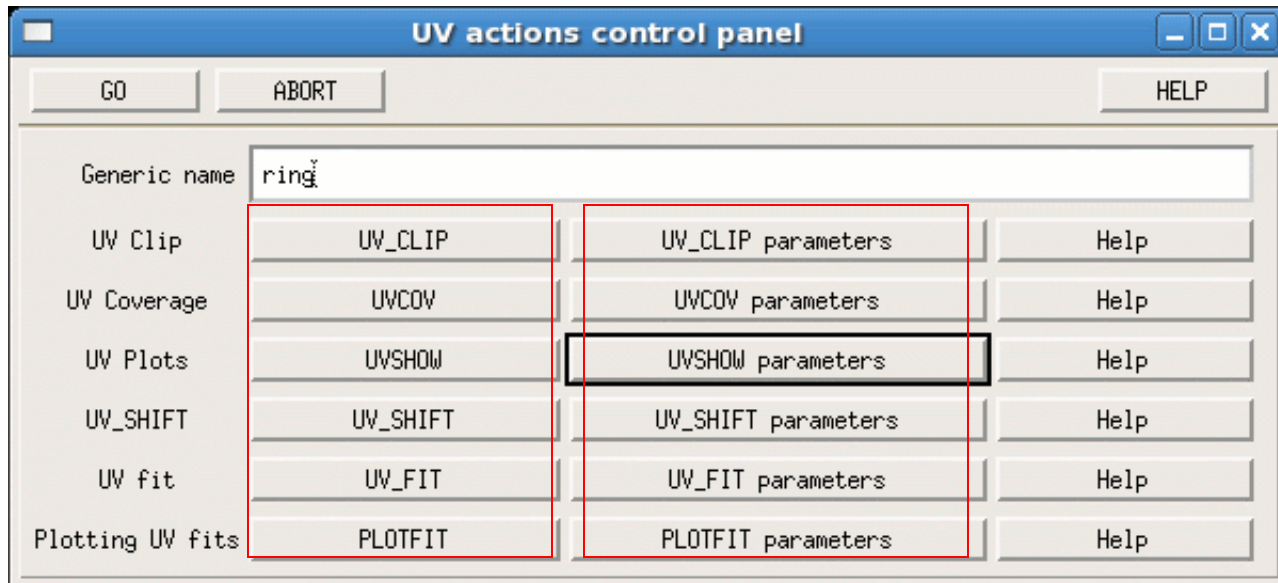
Data analysis in the *uv*-plane; **MAPPING**



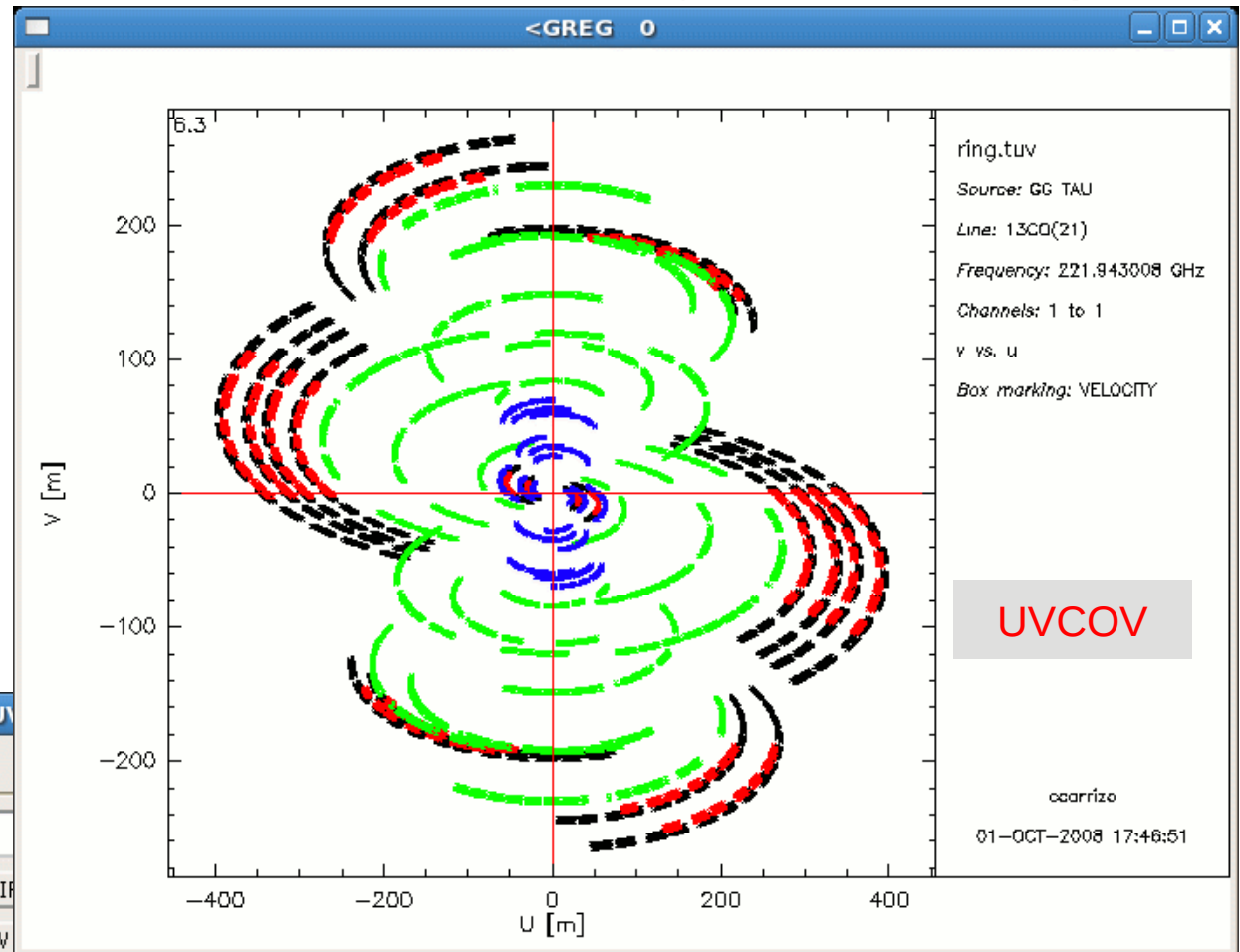
Data analysis in the *uv*-plane



Data analysis in the *uv*-plane



Data analysis in the *uv*-plane



GO ABORT

Generic name ring

UV Clip UV_CLIP

UV Coverage UVCOV

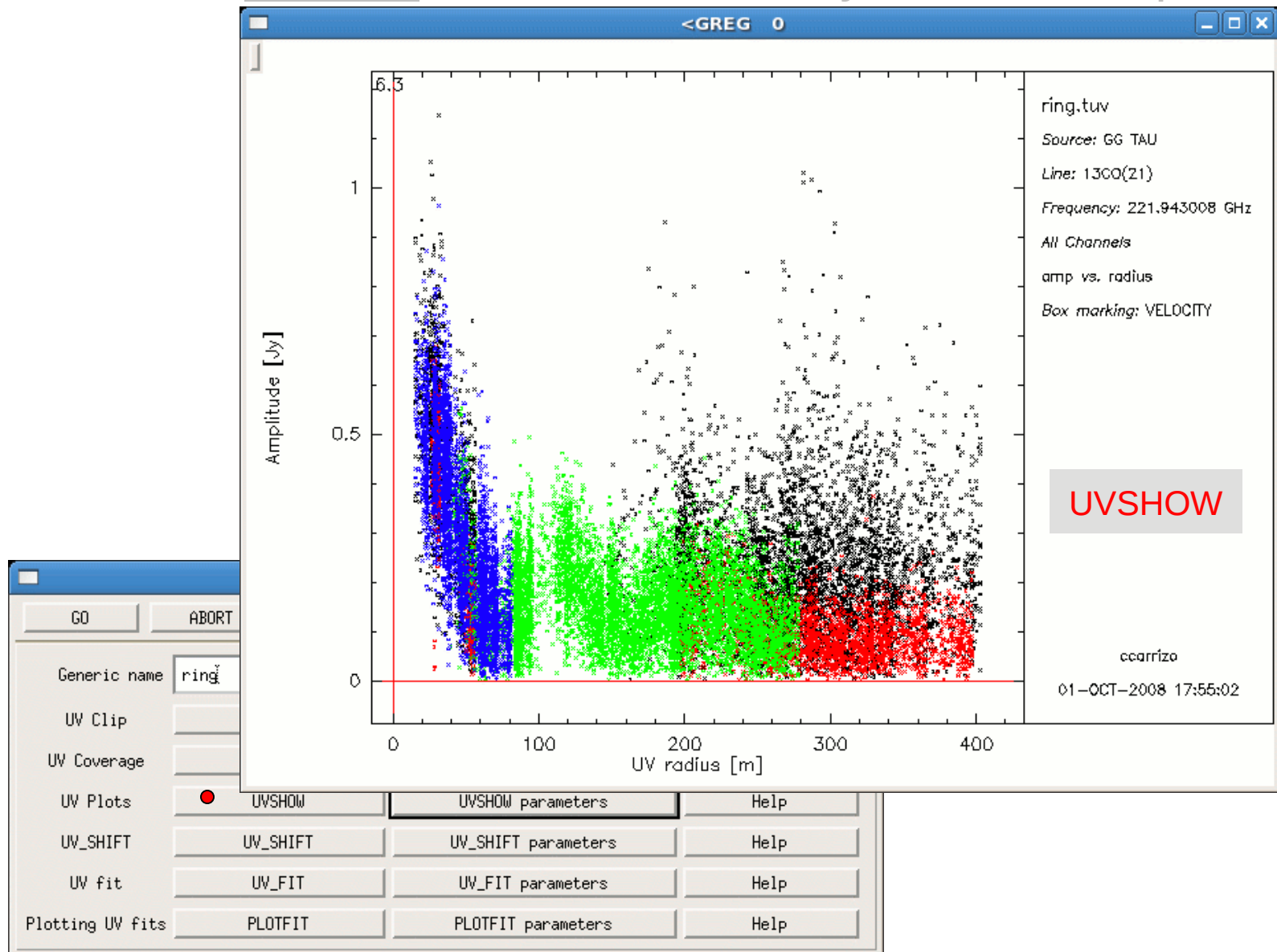
UV Plots UVSHOW **UVSHOW parameters** Help

UV_SHIFT UV_SHIFT parameters Help

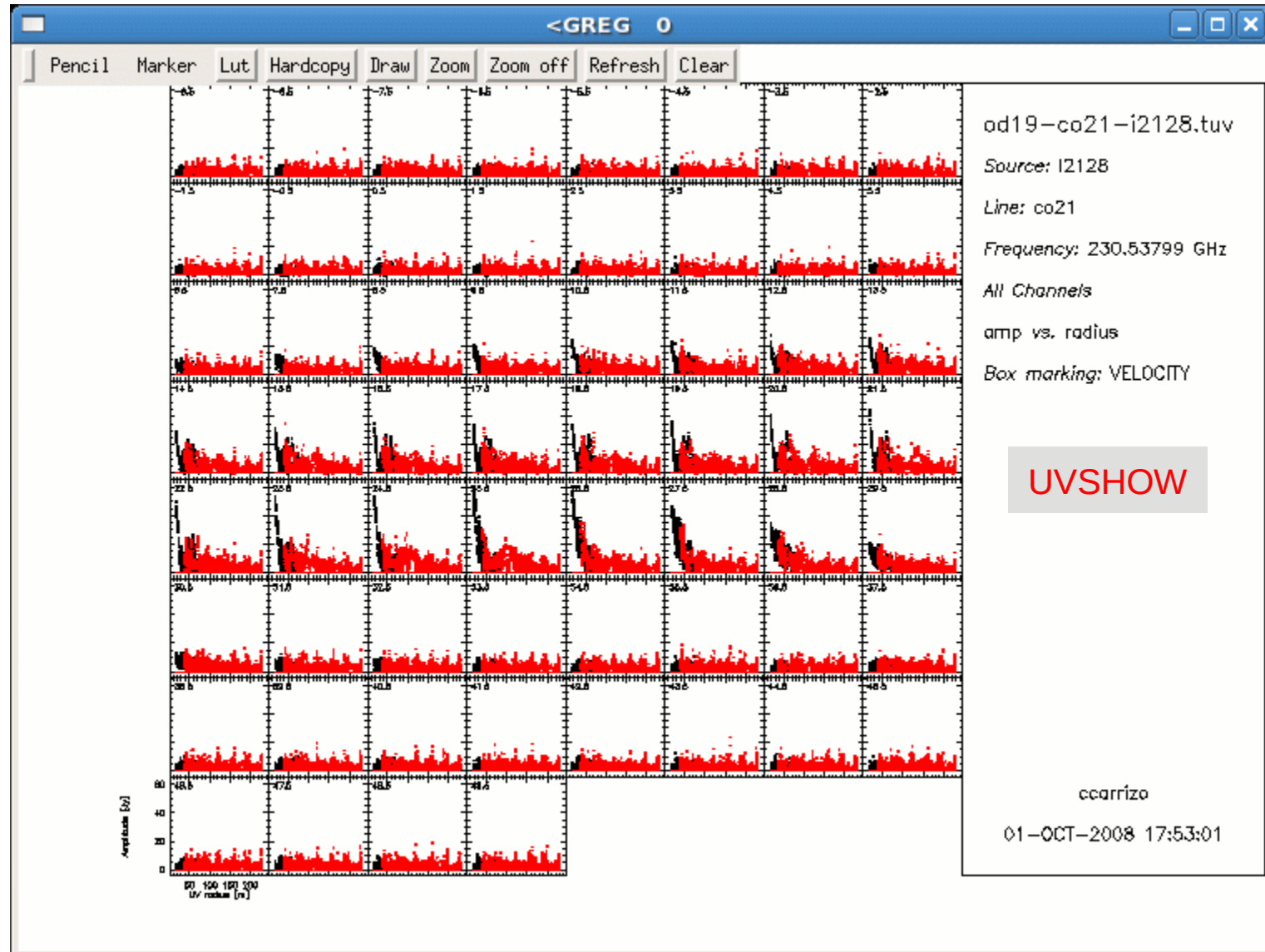
UV fit UV_FIT UV_FIT parameters Help

Plotting UV fits PLOTFIT PLOTFIT parameters Help

Data analysis in the *uv*-plane



Data analysis in the *uv*-plane



Data analysis in the *uv*-plane

The image displays a graphical user interface for astronomical data analysis, specifically for the *uv*-plane. It consists of three main windows:

- UV actions control panel:** A window with buttons for "GO", "ABORT", and "HELP". It contains a table of actions and parameters:

Action	Parameter	Help
UV Clip	UV_CLIP	UV_CLIP parameters
UV Coverage	UVCOV	UVCOV parameters
UV Plots	UVSHOW	UVSHOW parameters
UV_SHIFT	UV_SHIFT	UV_SHIFT parameters
UV fit	UV_FIT	UV_FIT parameters
Plotting UV fits	PLOTFIT	PLOTFIT parameters

The "UV SHOW parameters" dialog is open, showing the following settings:

- Generic name: ring
- X data: radius
- Y data: amp
- First channel: 0
- Last channel: 0
- Plot limits: 1
- Plot model fit: No
- Display zero level?: Yes
- Use one color per track?: Yes
- Typical time separating 2 tracks [hrs]: 12
- Marker definition as in the SET MARKER command: 4 1 .1

A dropdown menu for "Y data" is open, showing a list of options: u, v, angle, radius, time, date, scan, number, amp, phase, real, imag, weight.

The background window shows a plot of "amp vs. radius" with "Box marking: VELOCITY". The plot area contains several small 'x' markers.

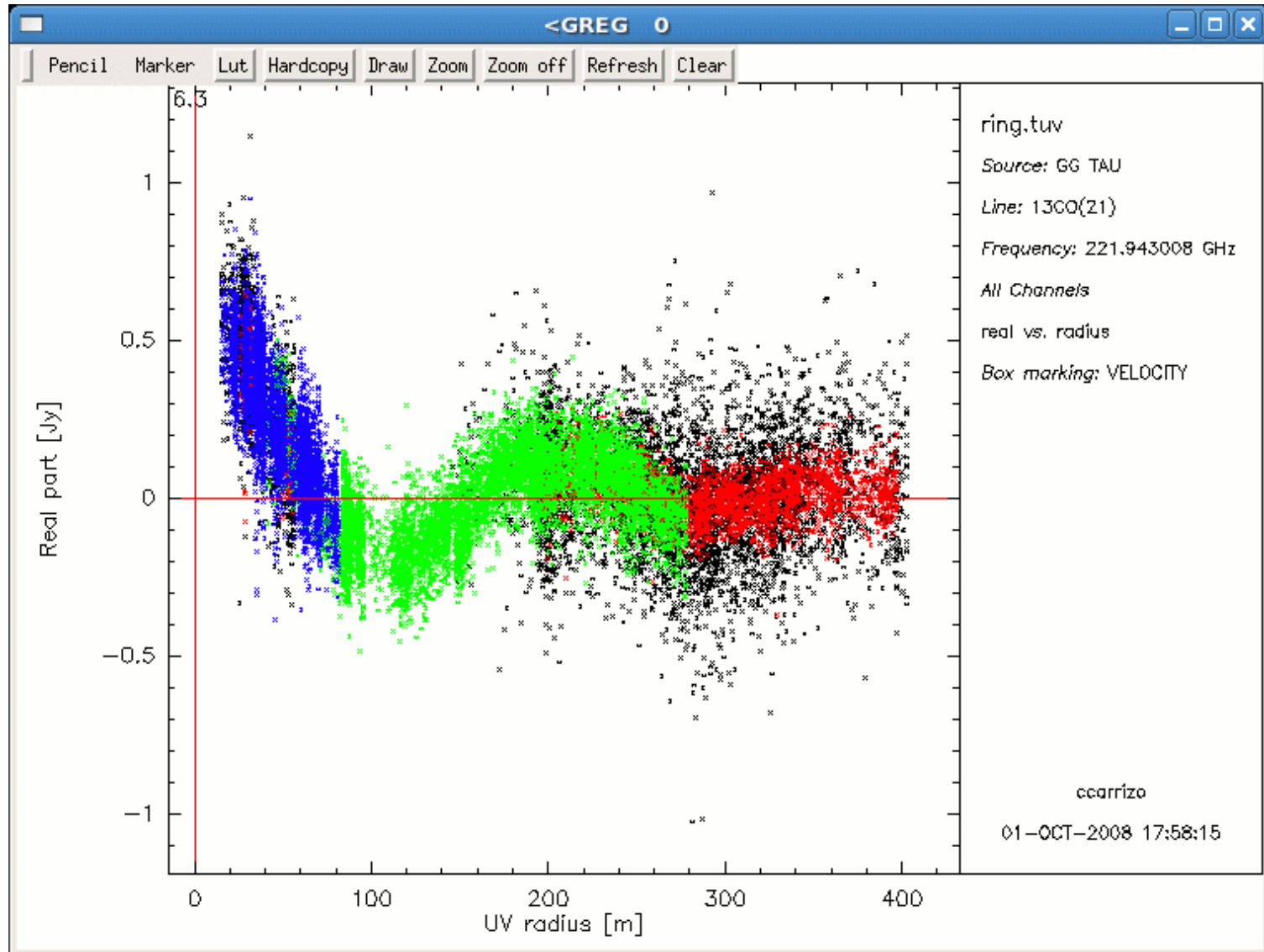
The terminal window in the bottom left shows the following output:

```
File Edit View Terminal
Map size
Map cell
Imaged Area

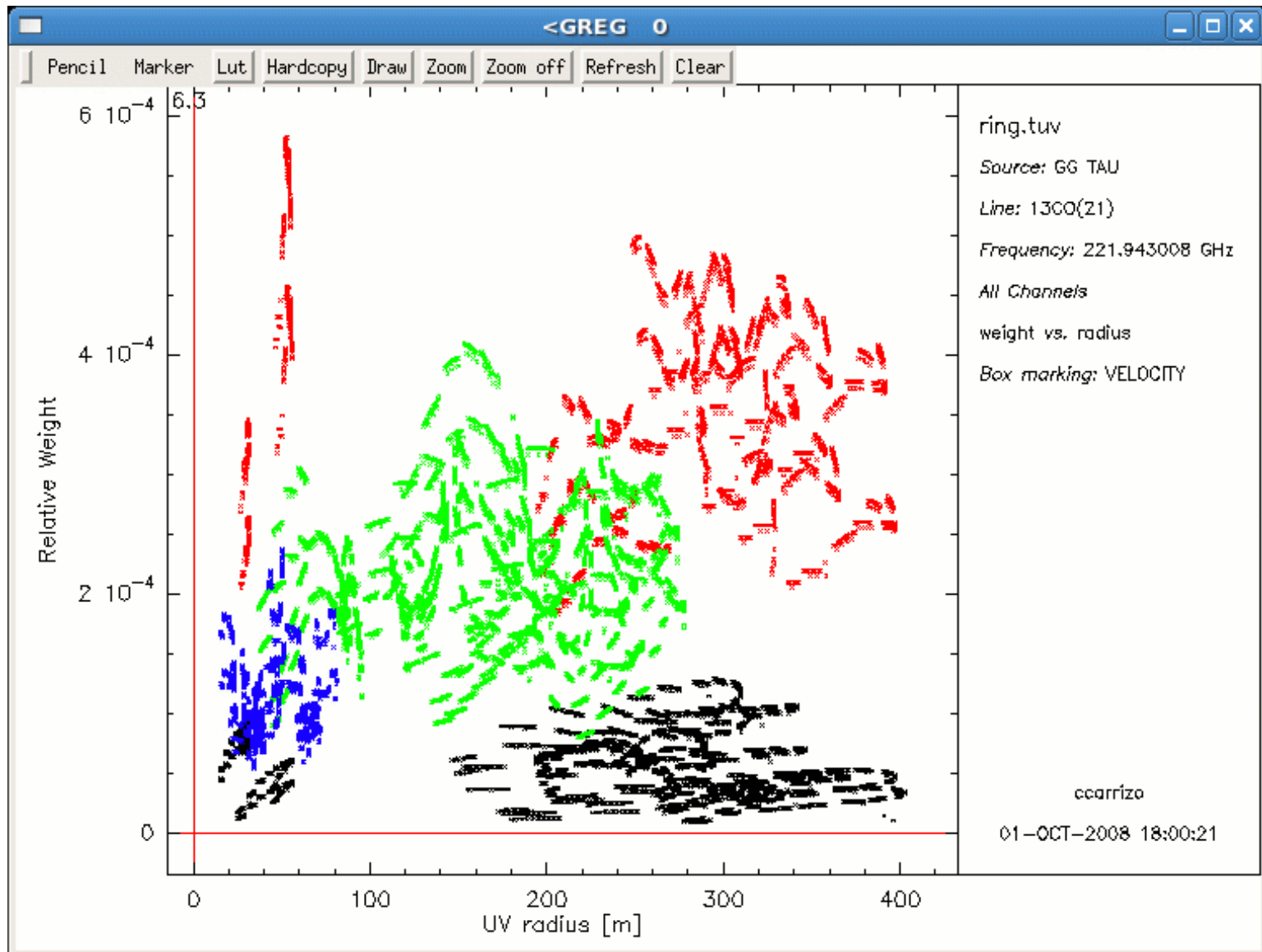
Still to be imaged
Still to be cleaned
I-GDF_RIH, Image file 1
U-GDF_RIH, UVT order :
W-GDF_RHSEC, Absent sec
W-GDF_RHSEC, Absent section
I-GDF_DAMS, Patching old
I-UVSHOW, Finding limits
I-UVSHOW, Number of found

W-UVALL, Obsolescent. Please
MAPPING>
MAPPING>
```

Data analysis in the uv -plane



Data analysis in the uv -plane



Data analysis in the *uv*-plane

With commands:

MAPPING> let first 12

MAPPING> let last 12

MAPPING> let ytype weight

MAPPING> let xtype radius

MAPPING> let error_bars yes

MAPPING> go uvshow

MAPPING> input uvshow

The screenshot shows a control panel window titled "control panel" with a plot area and a settings panel. The plot area displays a scatter plot of data points with error bars, labeled "ring.tuv". The settings panel includes fields for "First channel", "Last channel", "Plot limits", "Plot model fit", "Display zero level?", "Use one color per track?", "Typical time separating 2 tracks [hrs]", and "Marker definition as in the SET MARKER command". A dropdown menu is open, showing a list of options: "u", "v", "angle", "radius", "time", "date", "scan", "number", "amp", "phase", "real", "imag", and "weight". The "weight" option is selected. The control panel also has "Go", "Dismiss", and "Help" buttons.

ring.tuv
Source: GG TAU
Line: 13CO(21)
Frequency: 221.943008 GHz
All Channels
amp vs. radius
Box marking: VELOCITY

Choices
Choices
u
v
angle
radius
time
date
scan
number
amp
phase
real
imag
weight

Map size
Map cell
Imaged Area

Still to be imaged
Still to be cleaned
I-GDF_RIH, Image file i
U-GDF_RIH, UVT order :
W-GDF_RHSEC, Absent sec
W-GDF_RHSEC, Absent sectio
I-GDF_DAMS, Patching old
I-UVSHOW, Finding limits
I-UVSHOW, Number of found

W-UVALL, Obsolescent. Plea
MAPPING>
MAPPING> []

First channel
Last channel
Plot limits
Plot model fit No
Display zero level? Yes
Use one color per track? Yes
Typical time separating 2 tracks [hrs] 12
Marker definition as in the SET MARKER command 4 1 .1

Go Dismiss Help

Data analysis in the *uv*-plane

The image displays a software interface for uv-plane data analysis, consisting of several windows and a terminal window.

UV actions control panel

Buttons: SIC, GO, ABORT, HELP

Generic name: ring

UV Clip	UV_CLIP	UV_CLIP parameters	Help
UV Coverage	UVCOV	UVCOV parameters	Help
UV Plots	UVSHOW	UVSHOW parameters	Help
UV_SHIFT	UV_SHIFT	UV_SHIFT parameters	Help
UV fit	UV_FIT	UV_FIT parameters	Help
Plotting UV fits	PLOTFIT	PLOTFIT parameters	Help

UV_SHIFT parameters

Generic name: ring

Right Ascension: []

Declination: []

Angle from North: []

Buttons: Go, Dismiss, Help

Terminal Window

```
File Edit View Terminal
Phase center RA and
Field of view / La

Map size          512 x 512 pixels      512 x 512 pixels
Map cell          0.14 x 0.14 arcsec  0.14 x 0.14 arcsec
Imaged Area      71.7 x 71.7 arcsec

Still to be imaged
Still to be cleaned
I-GDF_RIH, Image file is [EEEEI to IEEEE]
U-GDF_RIH, UVT order : UV-DATA  RANDOM
W-GDF_RHSEC, Absent section NOISE
W-GDF_RHSEC, Absent section PROPERMOTION
I-GDF_DAMS, Patching old UV data weights
I-UVSHOW, Finding limits
I-UVSHOW, Number of found tracks: 4
MAPPING> [ ]
```

Plot Window

ring.tuv
Source: GG TAU
Line: 13CO(21)
Frequency: 221.943008 GHz
All Channels
real vs. radius
Box marking: VELOCITY

400

01-OCT-2008 18:00:36

Data analysis in the *uv*-plane

The screenshot displays the 'mapping GUI' window with a menu bar (SIC, Window, GREG, MAPPING, Help) and a toolbar (Marker, Lut, Hardcopy, Draw, Zoom, Zoom off, Refresh, Clear). A 'uv_shift' dialog box is open, showing the following fields:

- UV table to shift: ring
- Offset (YES) or Absolute (NO) position: No
- Phase center offset (in radians):
- R.A. center:
- Declination center:
- Angle:

Buttons for 'GO', 'ABORT', and 'HELP' are visible. The background shows a plot with labels '943008 GHz' and 'VELOCITY'. A 'rizo' label is also present.

The terminal window shows the following output:

```
ccarrizo@pctcp33:~  
File Edit View Terminal Tabs Help  
  
Map size           Recommended      Used  
                   512 x 512 pixels 512 x 512 pixels  
Map cell           0.14 x 0.14 arcsec 0.14 x 0.14 arcsec  
Imaged Area       71.7 x 71.7 arcsec  
  
Still to be imaged  
Still to be cleaned  
I-GDF_RIH, Image file is [EEEE to IEEE]  
U-GDF_RIH, UVT order : UV-DATA  RANDOM  
W-GDF_RHSEC, Absent section NOISE  
W-GDF_RHSEC, Absent section PROPERMOTION  
I-GDF_DAMS, Patching old UV data weights  
I-UVSHOW, Finding limits  
I-UVSHOW, Number of found tracks: 4  
MAPPING> run uv_shift  
Waiting ...  
█
```

Data analysis in the *uv*-plane

The screenshot displays the 'mapping GUI' interface. The main window title is '<GREG 0'. The menu bar includes 'SIC', 'Window', 'GREG', 'MAPPING', and 'Help'. The toolbar contains 'Marker', 'Lut', 'Hardcopy', 'Draw', 'Zoom', 'Zoom off', 'Refresh', and 'Clear'. The file name 'ring.tuv' is visible in the top right.

The 'UV actions control panel' is open, showing several buttons: 'GO', 'ABORT', 'UV_CLIP', 'UV_COV', 'UV_SHOW', 'UV_SHIFT', 'UV_FIT' (highlighted with a red box and a red dot), and 'PLOTFIT'. The 'Generic name' field is set to 'ring'.

The 'UV_FIT parameters' dialog box is open, showing the following fields and values:

- Generic name: ring
- First channel: 0
- Last channel: 0
- UV range(min, max) (meters): 0 800
- Number of Functions (1 or 2): 1
- Function 1: ring
- Parameters: 0 0 0 0 0 0
- Starting range: 0 0 0 0 0 0
- numb. of starts: 0 0 0 0 0 0
- Subtract function: No
- Function 2: point
- Parameters: 0 0 0 0 0 0
- Starting range: 0 0 0 0 0 0
- numb. of starts: 0 0 0 0 0 0
- Subtract function: No

A 'Choices' list is visible on the right side of the dialog, containing: point, c_gauss, e_gauss, c_disk, e_disk, ring, exp, power-2, power-3, and u_ring.

The 'Go', 'Dismiss', and 'Help' buttons are at the bottom of the dialog.

The terminal window at the bottom left shows the following text:

```
File Edit View Terminal Tabs He
Map size
Map cell
Imaged Area

Still to be imaged
Still to be cleaned
I-GDF_RIH, Image file is [EEE
U-GDF_RIH, UVT order : UV-DATA
W-GDF_RHSEC, Absent section NO
W-GDF_RHSEC, Absent section PR
I-GDF_DAMS, Patching old UV da
I-UVSHOW, Finding limits
I-UVSHOW, Number of found trac
MAPPING> run uv_shift
Waiting ...
E-SIC, Aborted by user
MAPPING>
MAPPING> 
```

Data analysis in the *uv*-plane

The image shows two overlapping windows from the 'mapping GUI' application. The background window, titled 'mapping GUI', displays a list of supported functions for fitting. A red box highlights this list, which includes: POINT (Point source), E_GAUSS (Elliptical Gaussian source), C_GAUSS (Circular Gaussian sources), C_DISK (Circular Disk), E_DISK (Elliptical Disk (inclined)), RING (Annulus), EXPO (Exponential brightness), POWER-2 (B = 1/r^2), POWER-3 (B = 1/r^3), and E_RING (Elliptical Annulus (inclined)). Below the list, a 'Remark' states: 'See NF\$ for additional help'. The foreground window, titled 'UV_FIT parameters', is a dialog box for configuring a fit. It has a 'generic name' field set to 'ring'. Under 'function 1:', the 'ring' function is selected, and a red arrow points to it with the text 'often needed'. Below this, there are three rows of parameter fields: 'Parameters', 'fitting range', and 'of starts', each containing seven zero values. The dialog also includes 'Dismiss' and 'Help' buttons at the bottom.

```
Variable FUNCT01$ :  
-----  
TASK\CHARACTER "Function #1" FUNCT01$  
  
The type of the distribution required in the fitting process. Currently  
supported functions are:  
POINT      Point source  
E_GAUSS    Elliptical Gaussian source  
C_GAUSS    Circular Gaussian sources  
C_DISK     Circular Disk  
E_DISK     Elliptical Disk (inclined)  
RING       Annulus  
EXPO       Exponential brightness  
POWER-2    B = 1/r^2  
POWER-3    B = 1/r^3  
E_RING     Elliptical Annulus (inclined)  
Remark: See NF$ for additional help  
  
Variable PARAM01$ :  
-----  
TASK\REAL      "Parameters"      PARAM01$[7]  
  
Your guesses as input parameters for the fitting process. Six parameters  
have to be defined for each function. The parameter list used in the fit  
is:  
POINT      : Offset R.A., Offset Dec, Flux  
E_GAUSS    : Offset R.A., Offset Dec, Flux, Maj. diam., Min. diam., Pos Ang  
C_GAUSS    : Offset R.A., Offset Dec, Flux, Diameter  
C_DISK     : Offset R.A., Offset Dec, Flux, Diameter  
E_DISK     : Offset R.A., Offset Dec, Flux, Maj. diam., Min. diam., Pos Ang  
RING       : Offset R.A., Offset Dec, Flux, Inner Diameter, Outer Diameter  
EXPO       : Offset R.A., Offset Dec, Flux, Diameter  
POWER-2    : Offset R.A., Offset Dec, Flux, Diameter  
POWER-3    : Offset R.A., Offset Dec, Flux, Diameter  
E_RING     : Offset R.A., Offset Dec, Flux, Inner, Outer, Pos Ang, Ratio  
Note that if the guesses are not sufficiently accurate the fit may not  
converge.  
  
Variable PARAM02$ :  
-----  
TASK\REAL      "Parameters"      PARAM02$[7]
```

generic name ring

st channel 0

st channel 0

) (meters) 0 800

s (1 or 2) 1

function 1: ring **often needed** Choices

Parameters 0 0 0 0 0 0 0

fitting range 0 0 0 0 0 0 0

of starts 0 0 0 0 0 0 0

t function No

function 2: point Choices

Parameters 0 0 0 0 0 0 0

fitting range 0 0 0 0 0 0 0

of starts 0 0 0 0 0 0 0

t function No

Dismiss Help

Dismiss

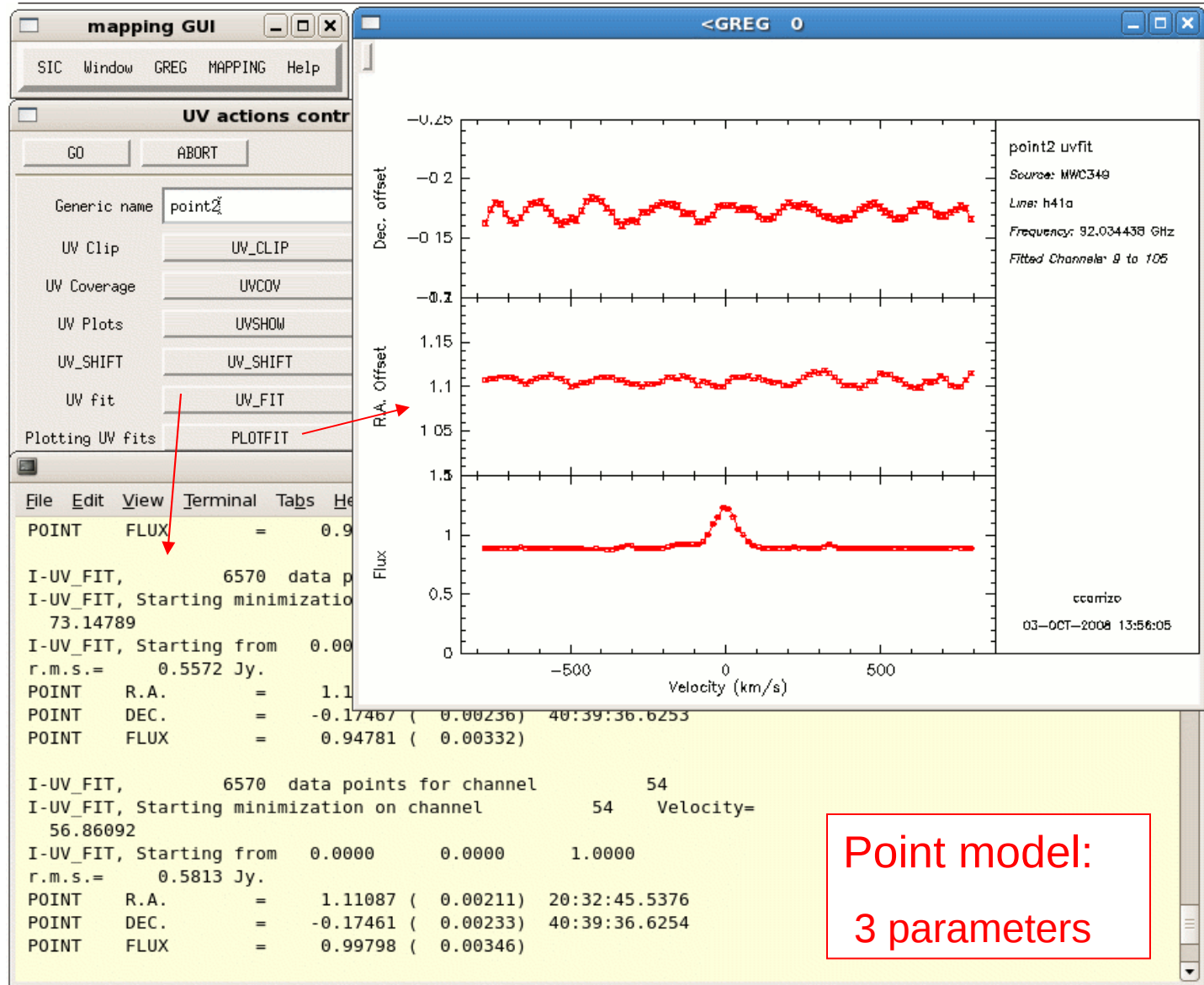
Data analysis in the *uv*-plane

The image shows a screenshot of the MAPPING GUI with the PLOTFIT parameters dialog box open. The dialog box is titled "PLOTFIT parameters" and contains the following fields and options:

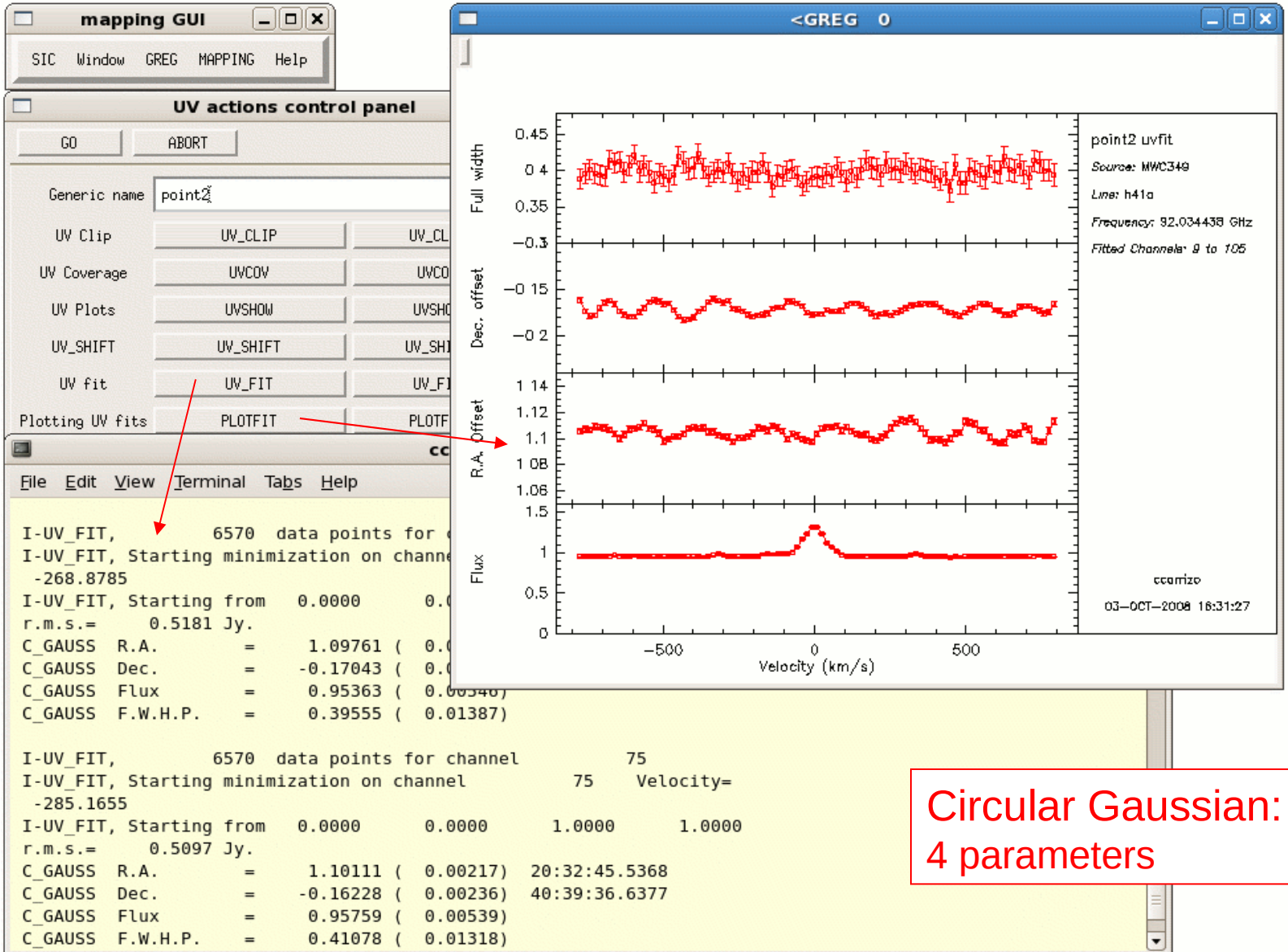
- Generic name: ring
- Number of fitted functions to be plotted: 1
- Order in which fitted functions are plotted: 1
- Number of parameters plotted along x axis: 1
- X Parameter #1: velo * σ_1
- X Parameter #2: freq * σ_1
- X Parameter #3: channel * σ_1
- X Parameter #4: ra * σ_1
- X Parameter #5: dec * σ_1
- X Parameter #6: flux * σ_1
- Number of parameters plotted along y axis: 3
- Y Parameter #1: ra * σ_1
- Y Parameter #2: dec * σ_1
- Y Parameter #3: flux * σ_1
- Y Parameter #4: major * σ_1
- Y Parameter #5: minor * σ_1
- Y Parameter #6: angle * σ_1
- First channel: 0
- Last channel: 0
- Plot error bars: Yes

The "mapping GUI" window in the background shows the "UV actions control" panel with the "PLOTFIT" button highlighted by a red box. The "ccarrizo" window shows the terminal output of the MAPPING program, including loaded modules (sic, greg, mapping), in-charge person (J.Pety), active developers (N.Rodriguez-Ferraz), and a list of contributors.

Data analysis in the *uv*-plane

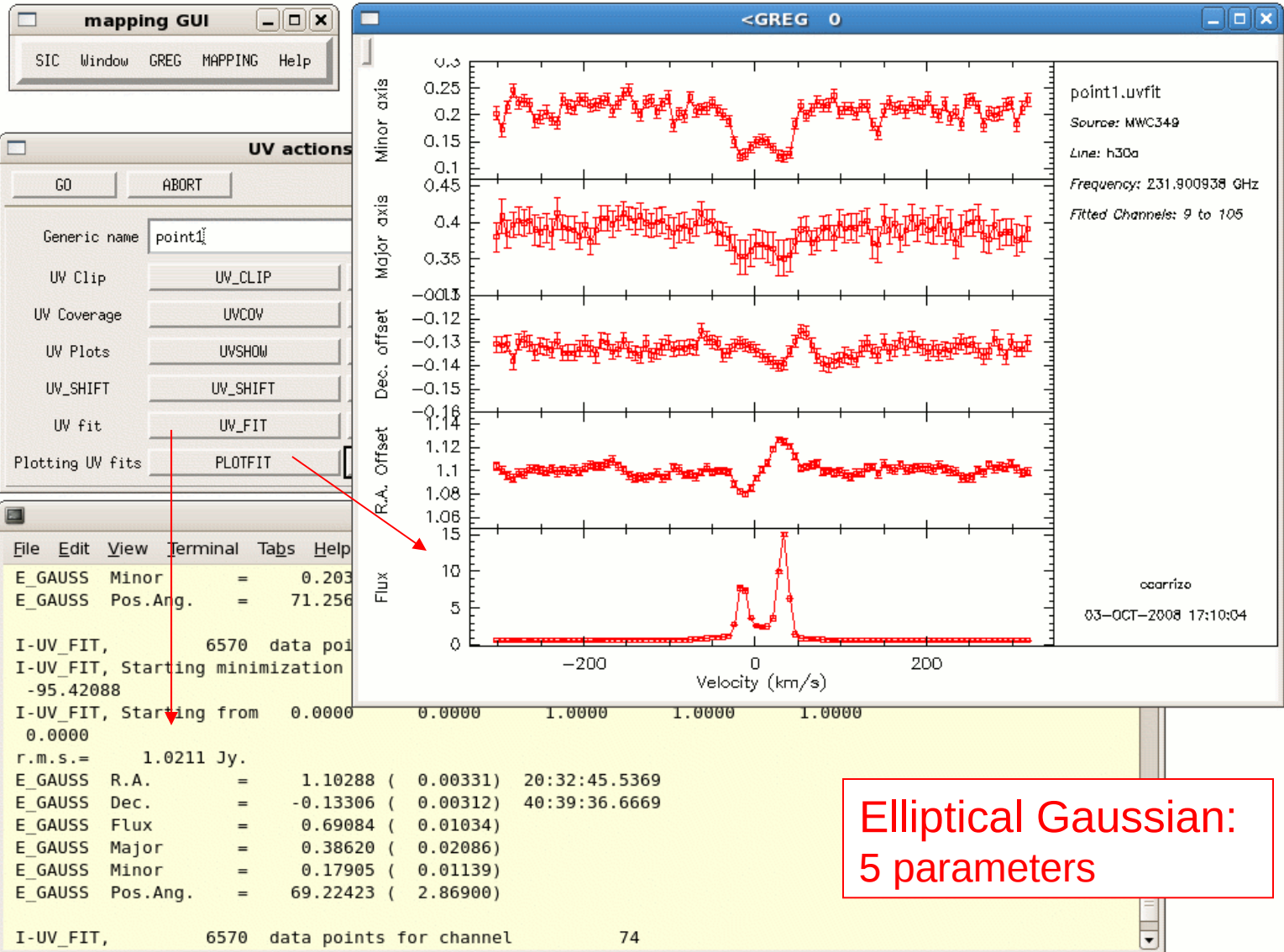


Data analysis in the *uv*-plane



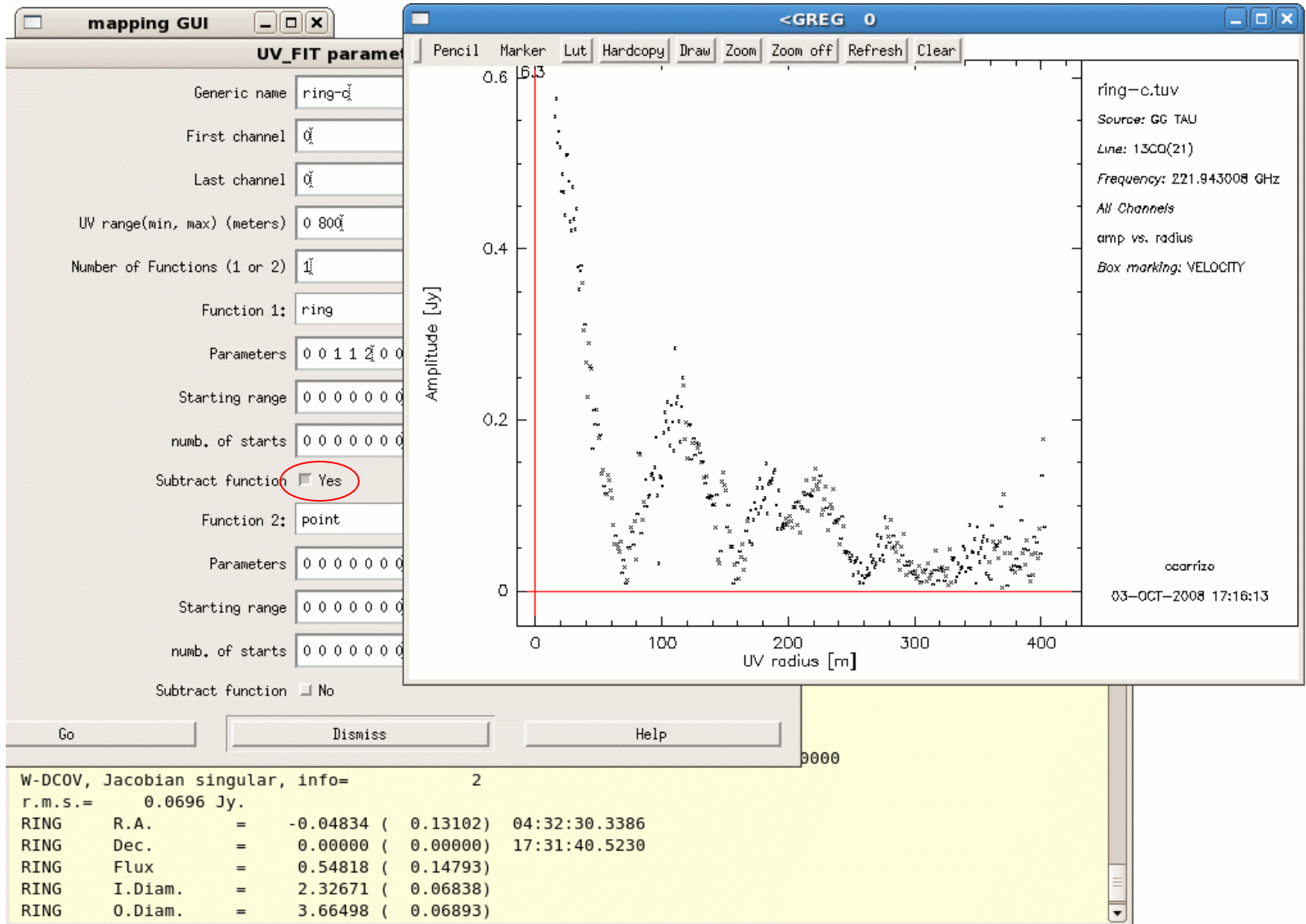
Circular Gaussian:
4 parameters

Data analysis in the *uv*-plane

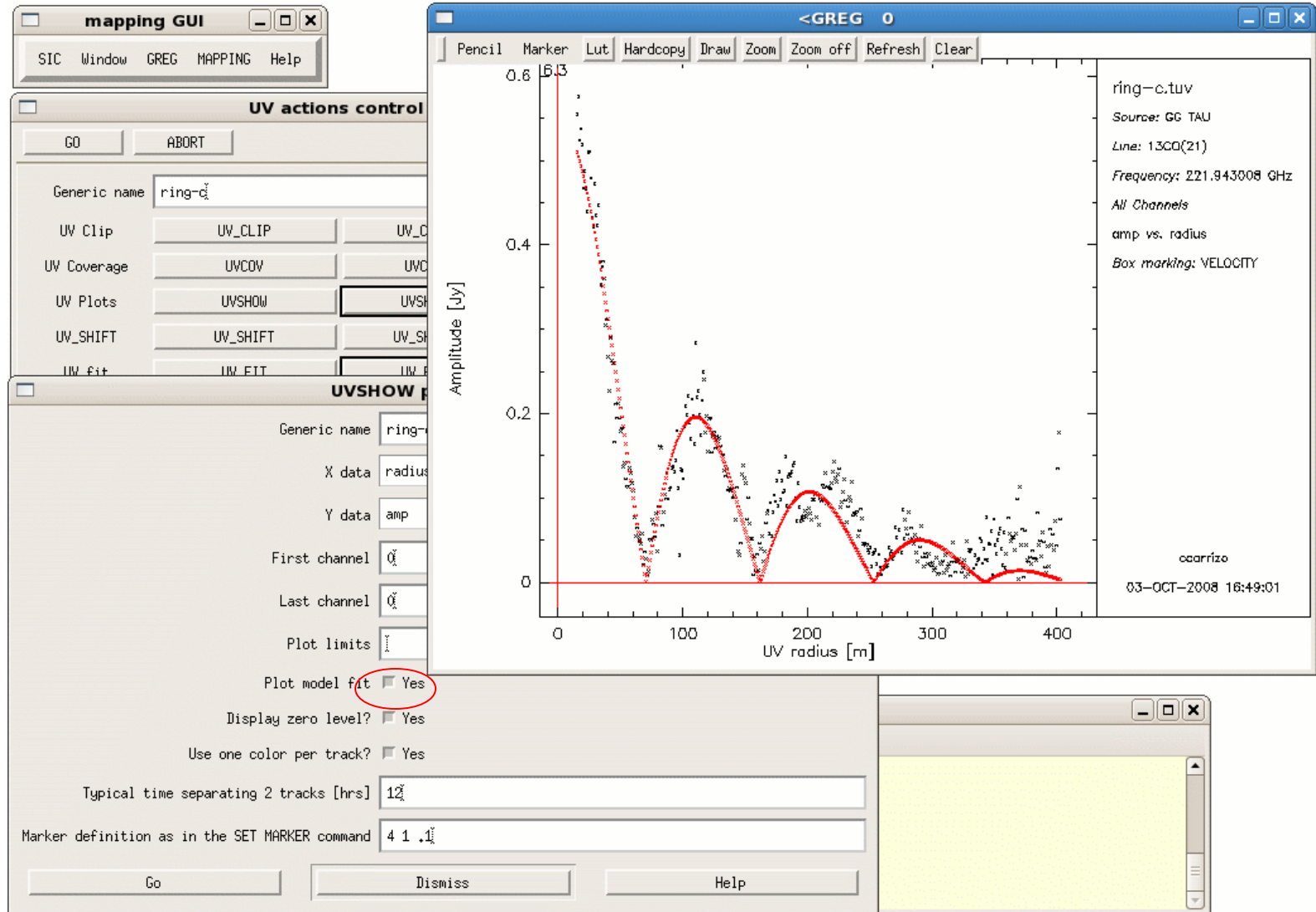


Elliptical Gaussian:
5 parameters

Data analysis in the *uv*-plane



Data analysis in the *uv*-plane



MAPPING procedures / tasks

```
MAPPING> go ...  
MAPPING> input ...
```

also

```
MAPPING> run ...  
MAPPING> help ...
```

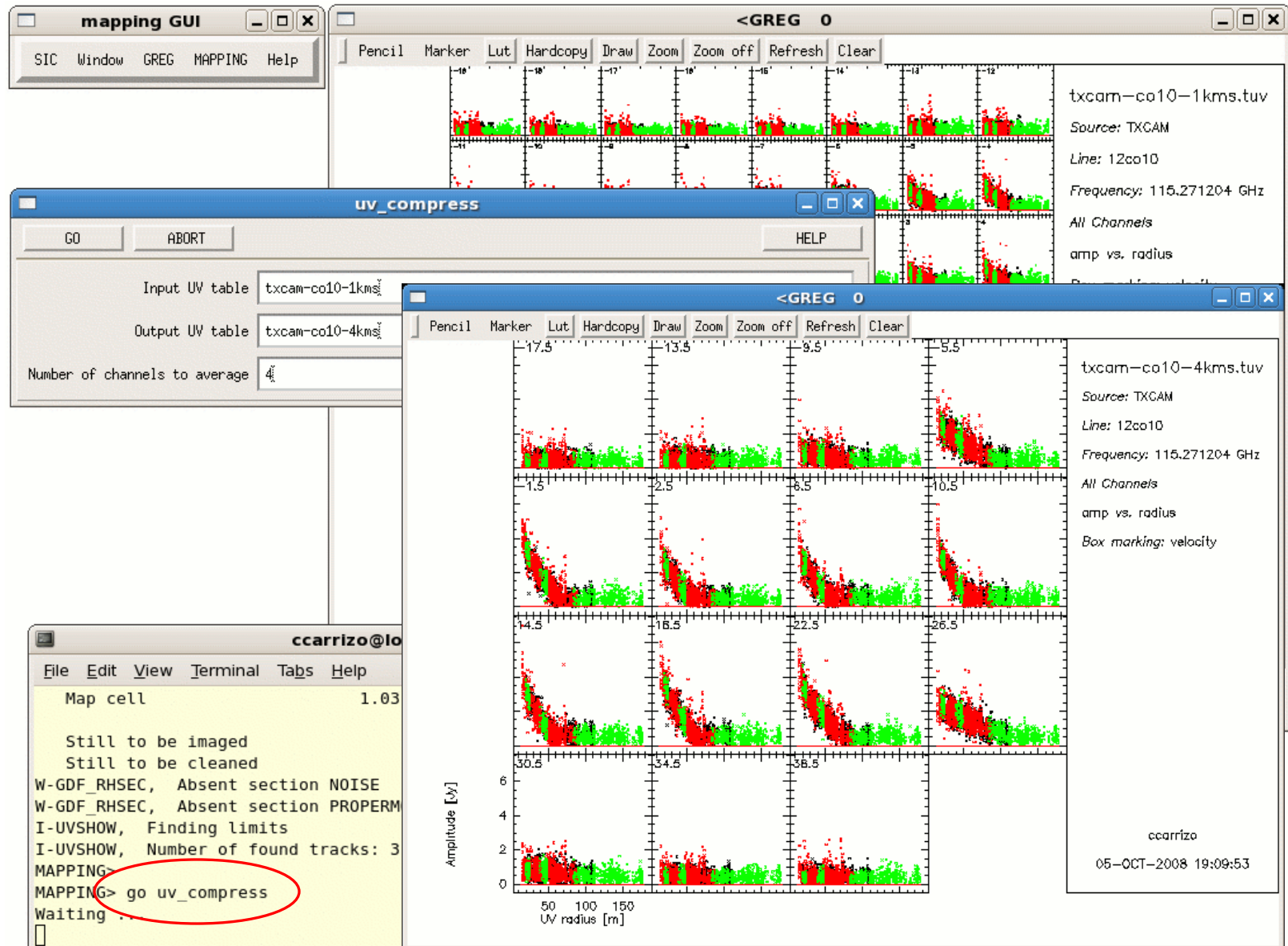
Data analysis in the *uv*-plane

```
MAPPING> go ... or run ...
```

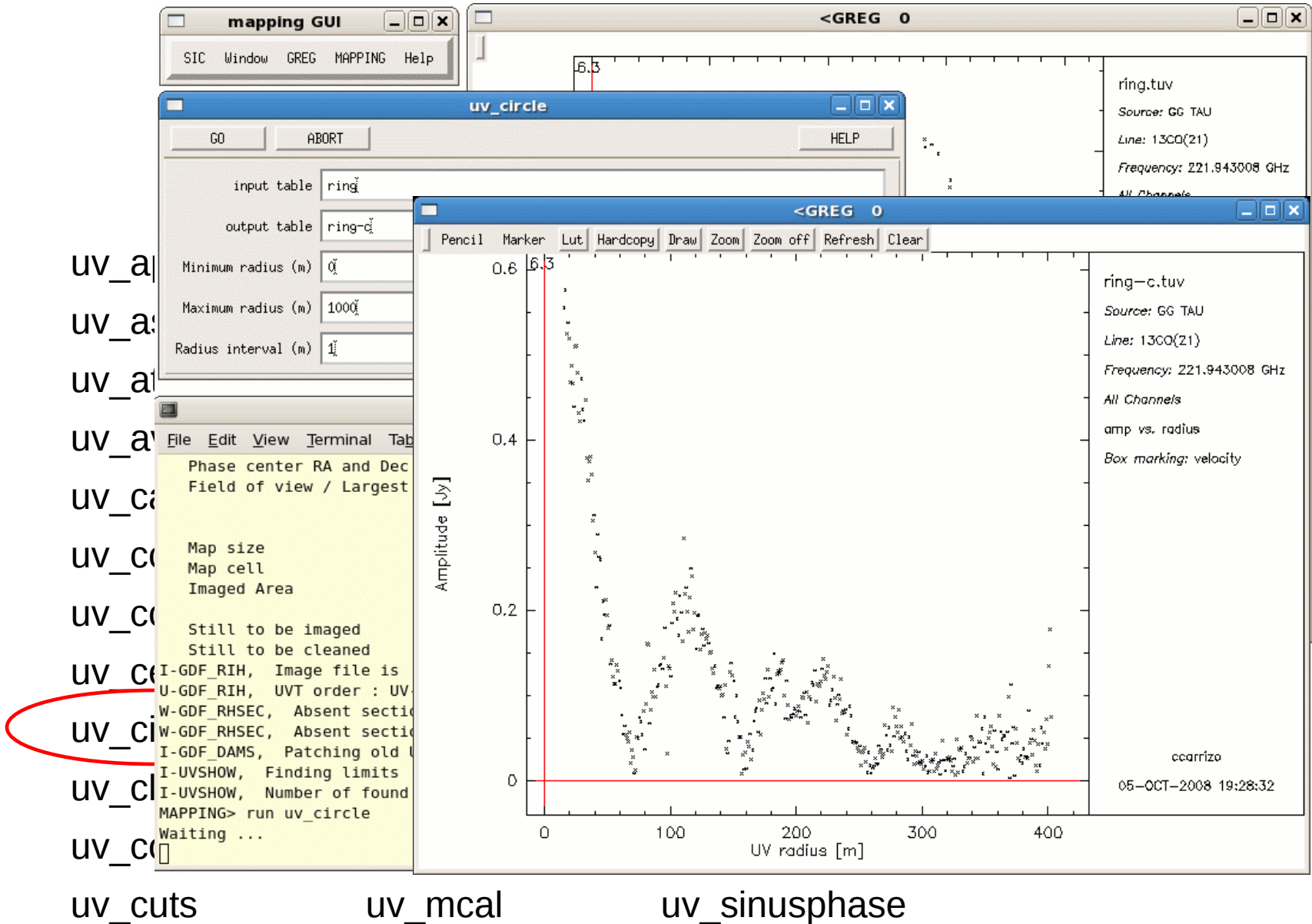
```
MAPPING> input ... or help ...
```

uv_applyphase	uv_dft	uv_merge	uv_solve
uv_ascal	uv_extract	uv_mflag	uv_sort
uv_atm	uv_fidelity	uv_model	uv_splitfield
uv_average	uv_fit-s	uv_mult	uv_stat
uv_cal	uv_flag	uv_noise	uv_subtract
uv_ccmodel	uv_fmodel	uv_observe	uv_table
uv_cct	uv_gain	uv_pointing	uv_timeaverage
uv_center	uv_hanning	uv_selfcal	uv_timebase
uv_circle	uv_hybrid	uv_shift	uv_track
uv_clip	uv_list	uv_short	uv_track_phase
uv_compress	uv_map	uv_single	uv_zero
uv_cuts	uv_mcal	uv_sinusphase	

Data analysis in the uv -plane



Data analysis in the *uv*-plane



uv_a
uv_a
uv_a
uv_a
uv_c
uv_c
uv_c
uv_c
uv_c
uv_c
uv_c

uv_cuts

uv_mcal

uv_sinusphase

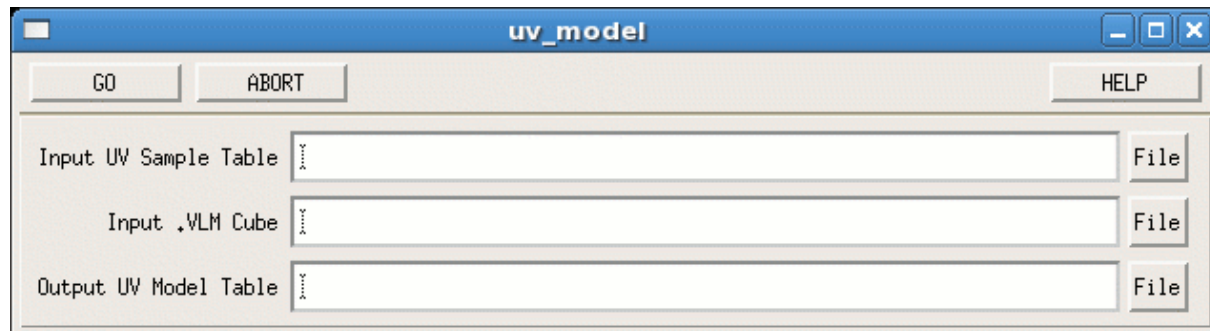
Data analysis in the *uv*-plane

```
MAPPING> go ... or run ...
```

```
MAPPING> input ... or help ...
```

uv_applyphase	uv_dft	uv_merge	uv_solve
uv_ascal	uv_extract	uv_mflag	uv_sort
uv_atm	uv_fidelity	uv_model	uv_splitfield

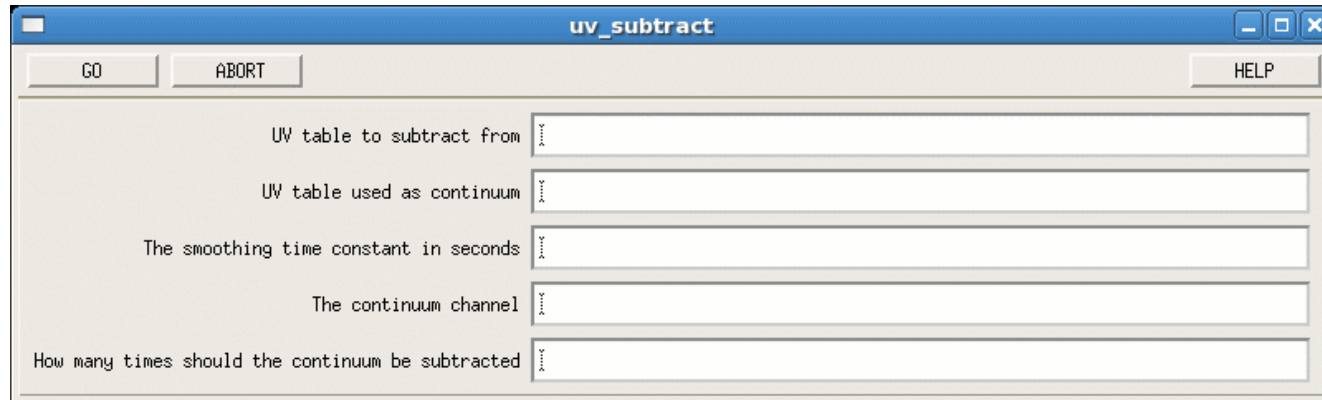
uv_averag
uv_cal
uv_ccmod
uv_cct
uv_center
uv_circle
uv_clip



To create a *uv* table from an image, e.g. a model

uv_compress	uv_map	uv_single	uv_zero
uv_cuts	uv_mcal	uv_sinusphase	

Data analysis in the *uv*-plane



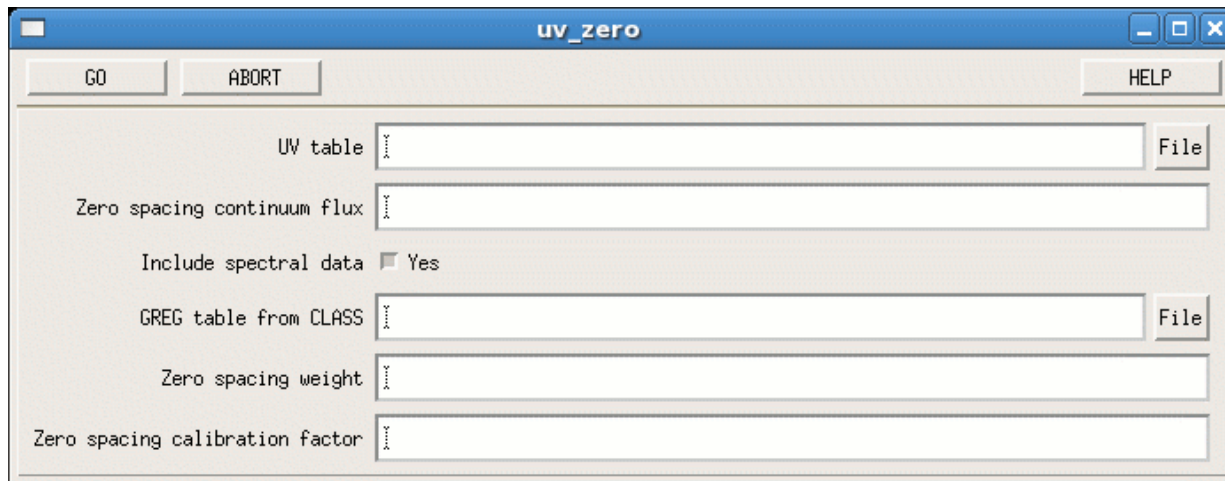
To subtract a time-averaged continuum *uv* table

uv_cal	uv_flag	uv_noise	uv_subtract
uv_ccmodel	uv_fmodel	uv_observe	uv_table
uv_cct	uv_gain	uv_pointing	uv_timeaverage
uv_center	uv_hanning	uv_selfcal	uv_timebase
uv_circle	uv_hybrid	uv_shift	uv_track
uv_clip	uv_list	uv_short	uv_track_phase
uv_compress	uv_map	uv_single	uv_zero
uv_cuts	uv_mcal	uv_sinusphase	

Data analysis in the *uv*-plane

```
MAPPING> go ... or run ...
```

```
MAPPING> input ... or help ...
```



solve

sort

splitfield

stat

subtract

table

timeaverage

timebase

track

To add a single-dish zero-spacing spectrum

uv_clip

uv_list

uv_short

uv_track_phase

uv_compress

uv_map

uv_single

uv_zero

uv_cuts

uv_mcal

uv_sinusphase

Data analysis in the uv -plane

uv tables are fully editable

Each visibility contains:

uv table [visib dimension, # visibilities]

- u in meters
- v in meters
- scan number
- observation date (CLASS number)
- time in seconds (since date above)
- start antenna in the baseline
- end antenna in the baseline

visib dimension = $7 + 3 \times (\# \text{ channels})$

7 visib. characteristics

- real part for 1st channel
- imaginary part 1st channel
- weight 1st

data at 1st channel

- real part for 2nd
- imaginary part 2nd
- ...

```
mapping> define table aa mytable.uvt write
mapping> let aa[8,2380] 6000
mapping> delete /variable aa
```

3. An inspection of the data in the *uv*-plane is recommended

(1) Passing directly from hpb → mapping

It may happen...

The screenshot displays the MAPPING software interface. On the left is the 'Mapping Control Panel' with various settings and buttons. The main window shows a map of the Chicyg-co21-mer-bad region, with a grid of values and a velocity contour plot. The map is titled 'chicyg-co21-mer-bad.l' and includes metadata such as 'Source: CHICYG', 'Line: 12CO21', 'Frequency: 230.53799 GHz', 'Beam: (no clean beam)', 'Level step: 200 Jy/beam', 'Box marking: VELOCITY', and 'Channels: [0,0]'. The map shows a grid of values ranging from -38 to 39, with a black box indicating a missing or masked region. The map is titled 'ccarrizo' and dated '25-SEP-2006 17:55:30'.

Mapping Control Panel

GO ABORT

READ

Generic name: chicyg-co21-mer-bad

Image type to show: DIRTY

First channel: 0

Last channel: 0

Mosaic from UV data: MOSAIC

Mapping from UV data: UV_MAP

Get support: SUPPORT

HOGBOM method: Hogbom

CLARK method: Clark

SDI method: Sdi

MRC method: Mrc

Multiscale method: Multi

Show image: SHOW

Map Window

chicyg-co21-mer-bad.l

Source: CHICYG

Line: 12CO21

Frequency: 230.53799 GHz

Beam: (no clean beam)

Level step: 200 Jy/beam

Box marking: VELOCITY

Channels: [0,0]

ccarrizo

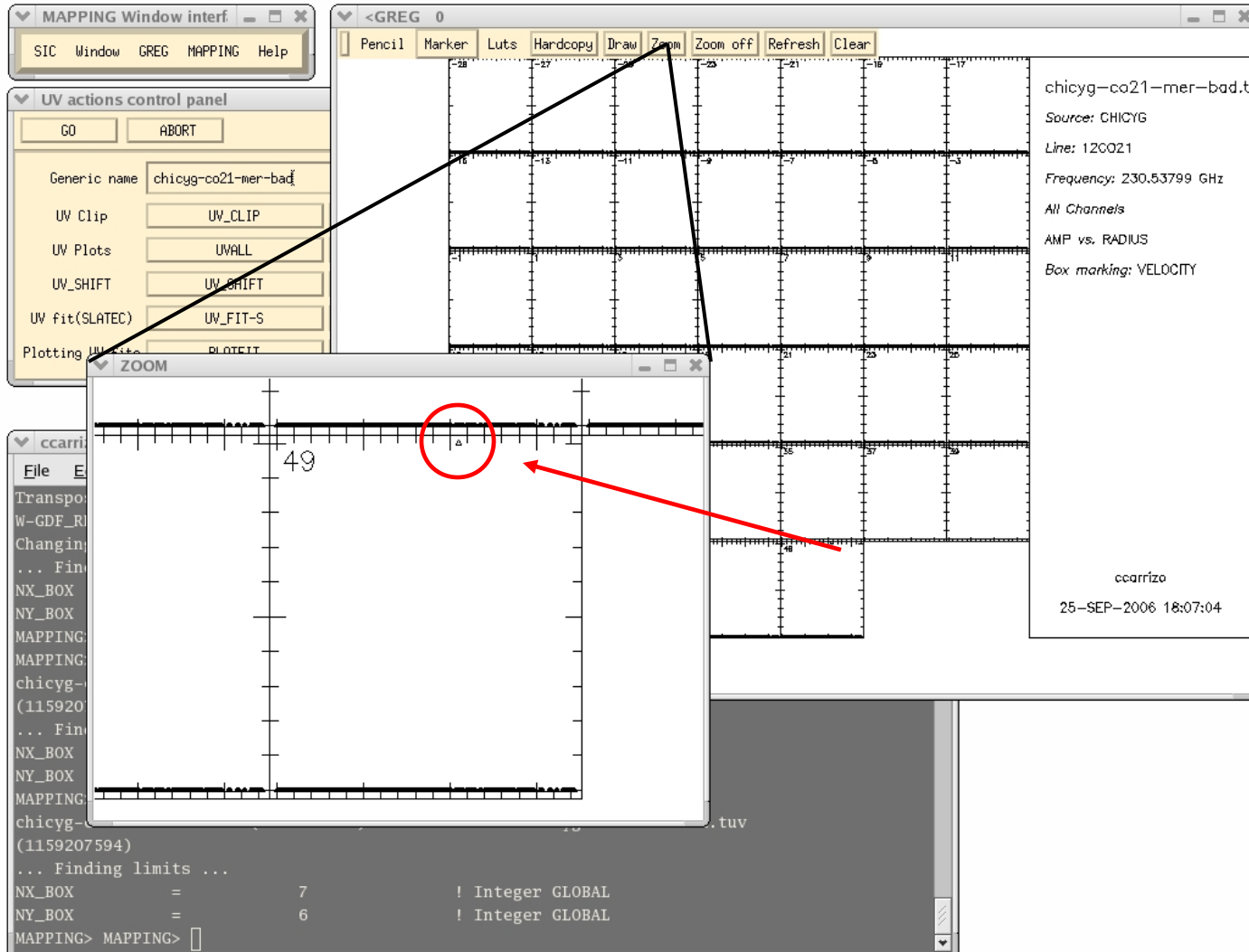
25-SEP-2006 17:55:30

```
I-UVMAP, Creating map file
I-UVMAP, Finished planes 1 to 40 CPU 0.00
I-UVMAP, Finished maps 0.00
S-UVMAP, Successful completion
MAPPING>
I-LEVELS, Contour levels are :
-1400. -1200. -1000. -800.0 -600.0
-400.0 -200.0 200.0 400.0 600.0
800.0 1000. 1200. 1400. 1600.
1800. 2000.
MAPPING> 
```

(1)

Passing directly from hpb → mapping

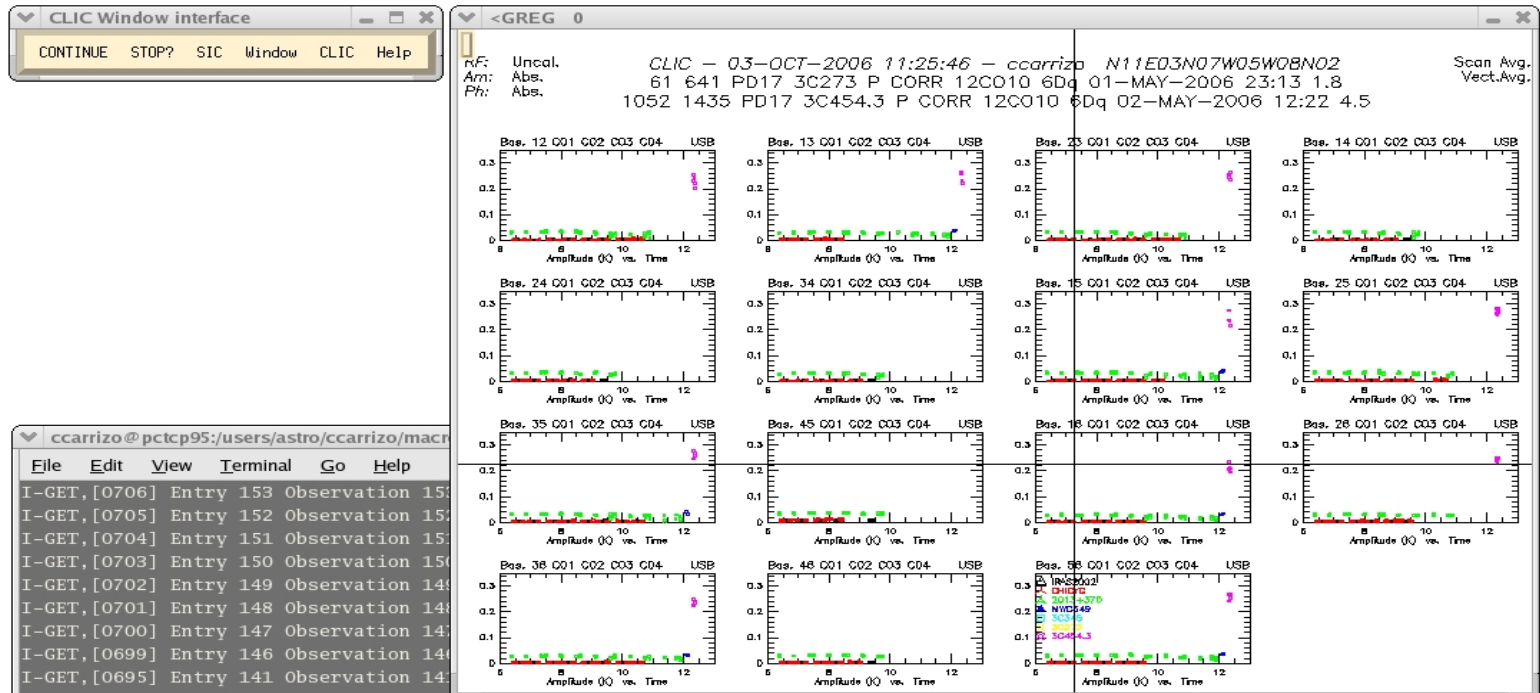
It may happen...



(1)

Passing directly from hpb → mapping

It may happen... that there remain some wrong visibilities

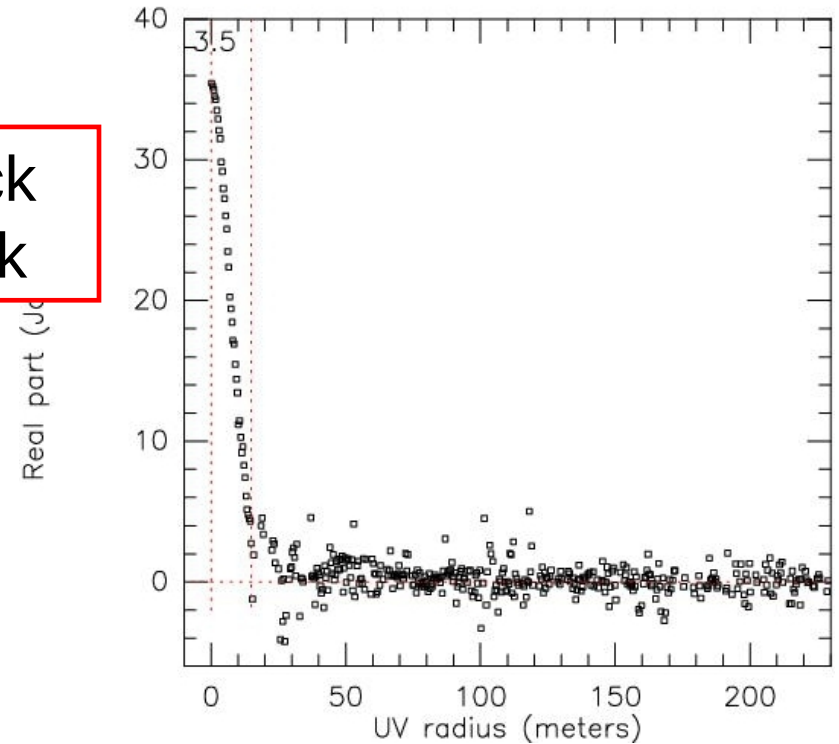
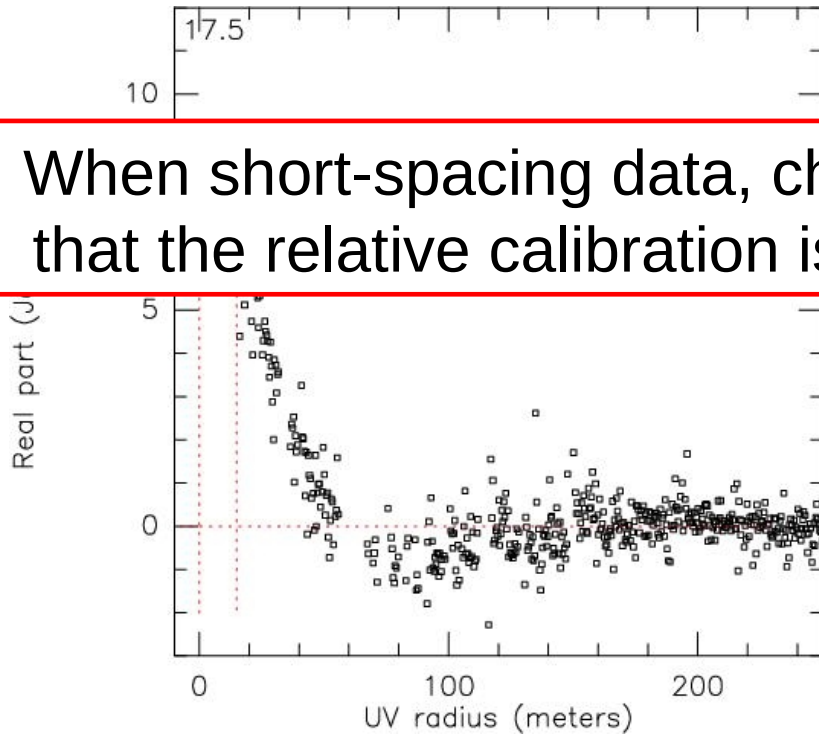


```
CLIC> find /proc corr /sou Betel /rece 2 /scans 1245 1255  
CLIC> store quality 9
```


(2)

Passing directly from hpb \rightarrow mapping

When short-spacing data, check that the relative calibration is ok



+ Short-spacing data

(3) Passing directly from hpb → mapping

Good practice: When cleaning (extended sources)...

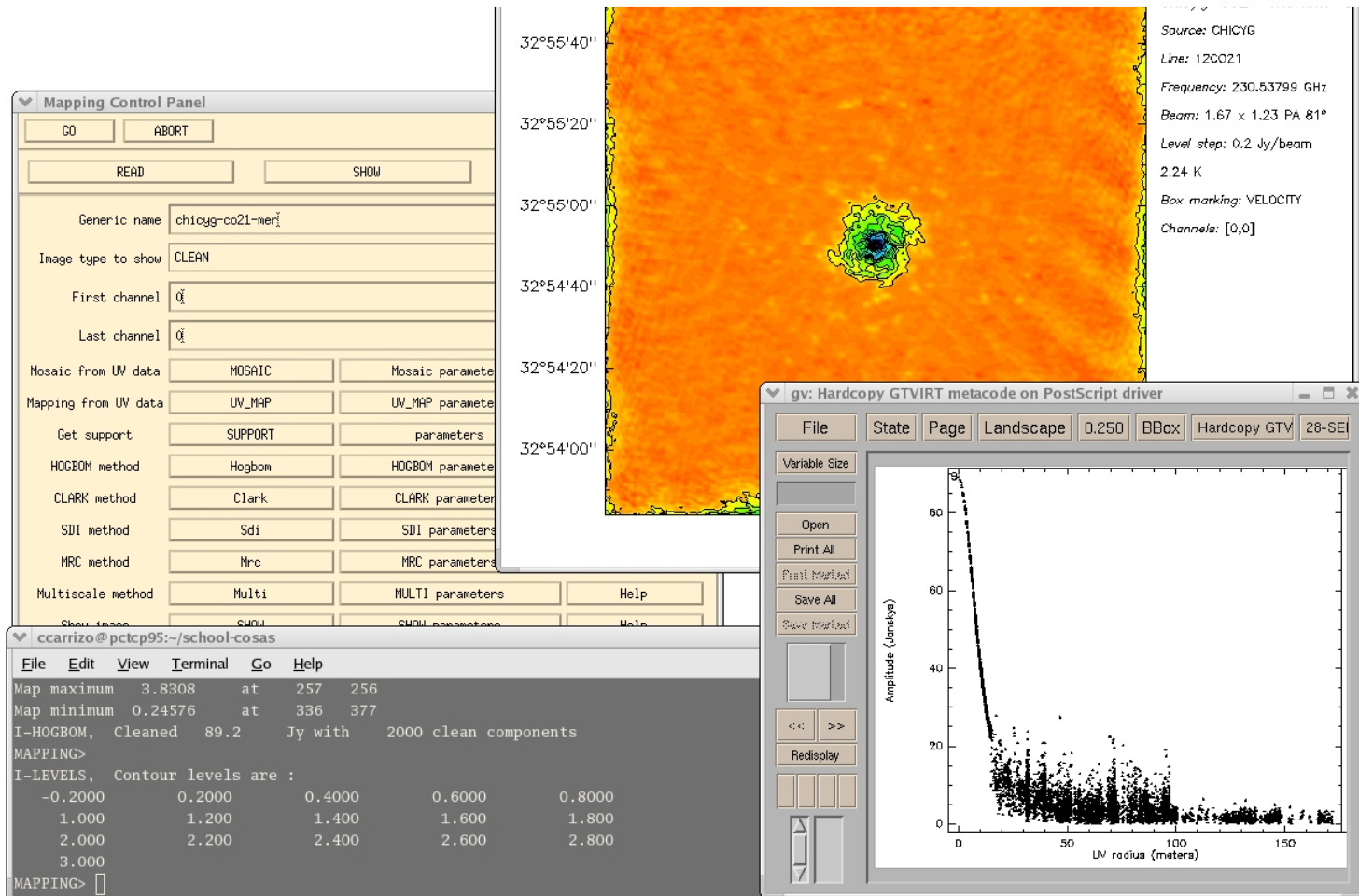
The screenshot displays a radio astronomy software interface with several windows:

- <FLUX 0**: A plot showing flux (0 to 100) versus iterations (0 to 2000). The flux rises sharply and plateaus around 100 after approximately 500 iterations.
- <GREG 0**: A window showing a cleaned map of a source. The map is color-coded (blue to red) and includes a coordinate grid. Parameters listed on the right include: Source: CHICYG, Line: 12CO21, Frequency: 230.53799 GHz, Beam: 21.86 x 0 PA 0°, Level step: 0.2 Jy/beam, Box marking: VELOCITY, Channels: [1,1].
- Parameter Panel**: A central panel with various settings for cleaning, including Beam Patch, Clean Beam major axis (sec), Clean Beam minor axis (sec), Clean Beam PA (deg E from N), MOSAIC: Min. weight for search, MOSAIC: Min. weight for restore, and Flux scale for display.
- Terminal Window**: A terminal window showing the output of the cleaning process:

```
ccarrizo@pctcp95:~/school-cosas
File Edit View Terminal Go Help
I-CLEAN, Could need 76653 iterations
Allocating 2000 components
Image & Beam planes 1 1
get_clean, before: 0.0000000E+00 0.0000000E+00 0.0000000E+00
I-CLEAN, Beam is 1.67" by 1.23" at PA 81.33 deg.
I-CLEAN, Errors ( 0.01) ( 0.01) ( 0.65)
Map maximum 3.8308 at 257 256
Map minimum 0.24576 at 336 377
I-HOGBOM, Cleaned 89.2 Jy with 2000 clean components
MAPPING>
```
- Plot Window**: A window titled "gv: Hardcopy GTVIRT metacode on PostScript driver" showing a plot of Amplitude (Janskys) versus UV radius (meters). The amplitude drops sharply from about 80 Jy at 0 meters to near zero by 50 meters.

(3) Passing directly from hpb → mapping

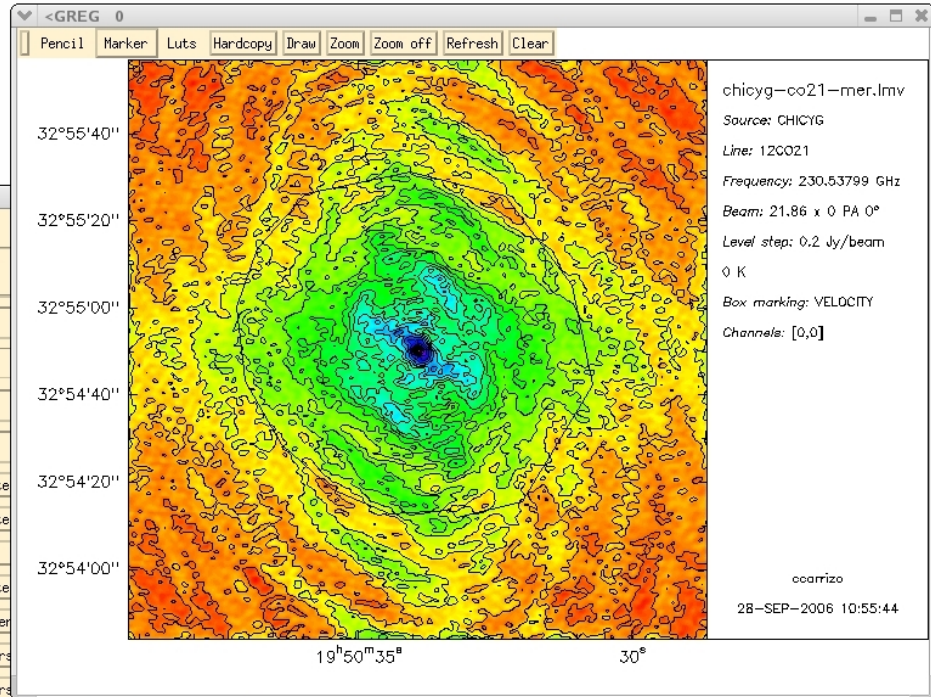
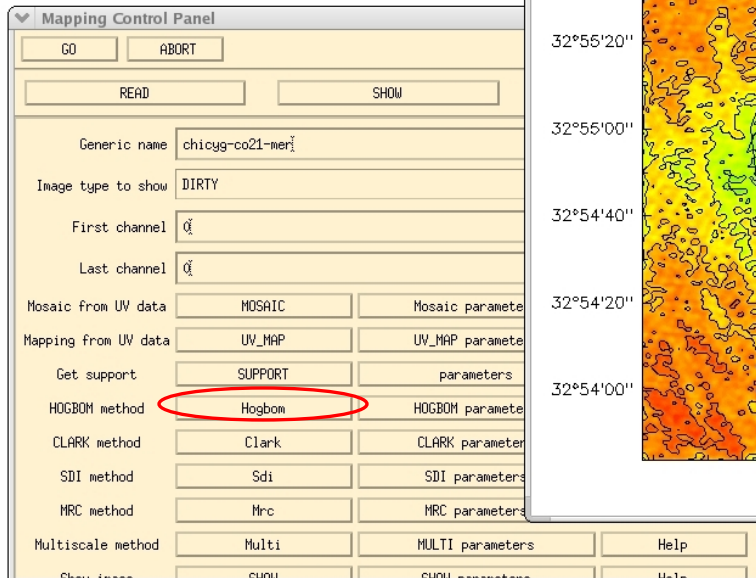
Good practice: When cleaning (extended sources) **verify that the flux obtained in the image plane coincides with that at the zero-spacing**



(3)

Passing directly from hpb → mapping

If not, it may happen...

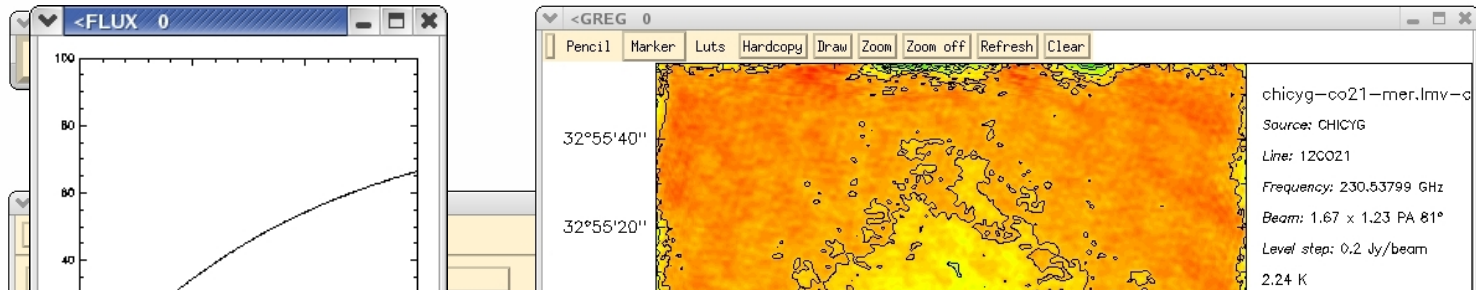


```
ccarrizo@pctcp95:~/school-cosas
File Edit View Terminal Go Help
MAPPING>
I-LEVELS, Contour levels are :
0.2000    0.4000    0.6000    0.8000    1.000
1.200     1.400     1.600     1.800     2.000
2.200     2.400     2.600     2.800     3.000
3.200     3.400     3.600     3.800
MAPPING> reca pol
MAPPING> pol chicyg-co21-mer-1.pol /plot
MAPPING> cle a
MAPPING>
```

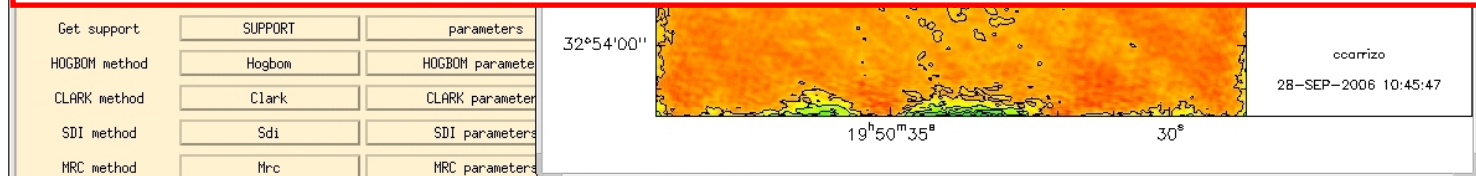
(3)

Passing directly from hpb → mapping

It may happen...



When cleaning (extended sources)
verify that the flux obtained in the image plane
coincides with that at the zero-spacing



```
File Edit View Terminal Go Help
Map maximum 3.8308 at 257 256
Map minimum 0.24576 at 336 377
I-HOGBOM, Cleaned 66.6 Jy with 300 clean components
MAPPING>
I-LEVELS, Contour levels are :
-0.2000 0.2000 0.4000 0.6000 0.8000
1.000 1.200 1.400 1.600 1.800
2.000 2.200 2.400 2.600 2.800
3.000 3.200
MAPPING> [ ]
```

To conclude:

- An inspection of data in the uv -plane is recommended for all the projects
- A detailed analysis in the uv -plane: detection, modeling of simple shapes, to check relative calibration, etc...