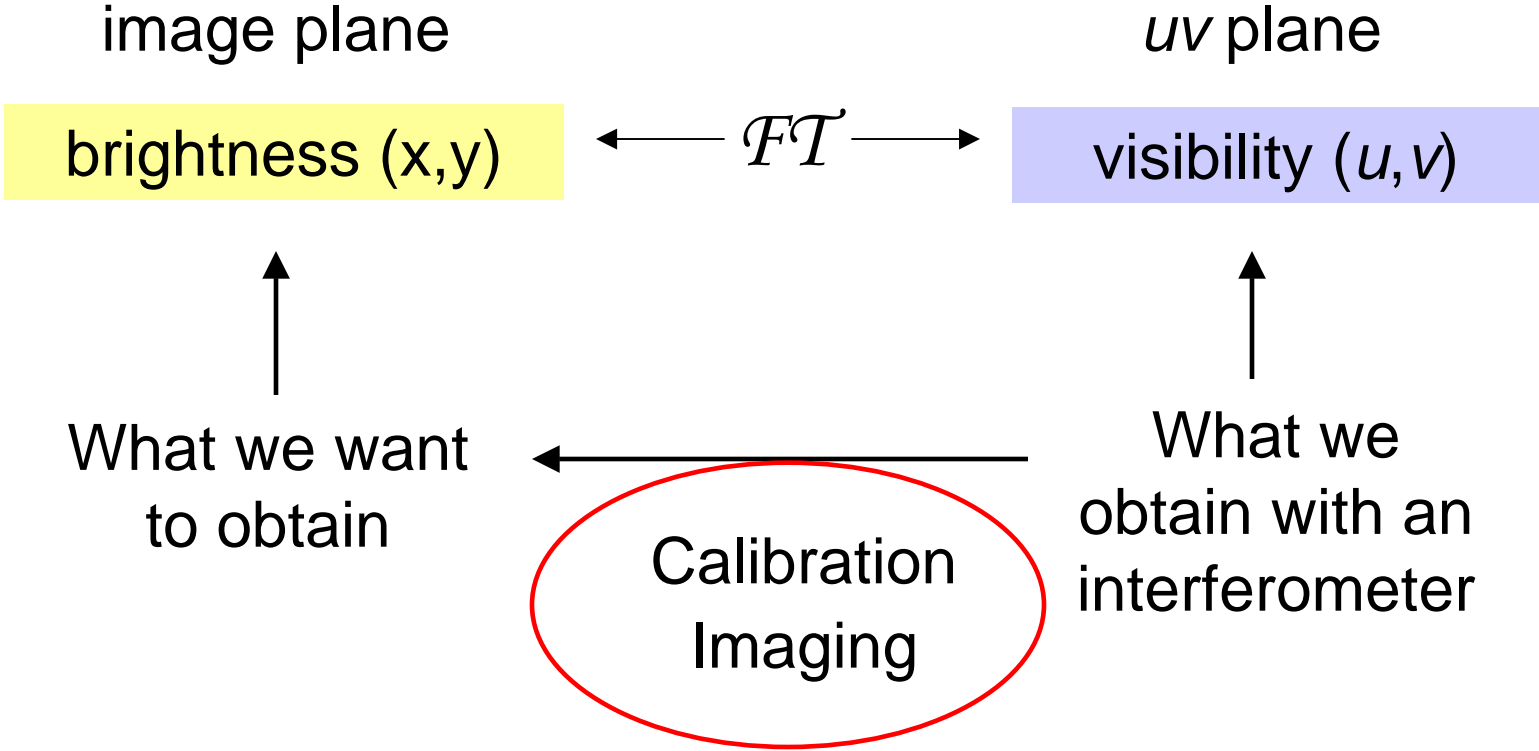


PdBI *UV*-Data Analysis and Imaging in practice



Arancha Castro-Carrizo

General Picture



General Picture

image plane

brightness (x,y)

uv plane

visibility (u,v) ^{instr}

\approx

Calibration

brightness (x,y) ^{uv}

Gridding

FFT

Cleaning

visibility (u,v)

- Data processed enough to have removed all instrumental contribution

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

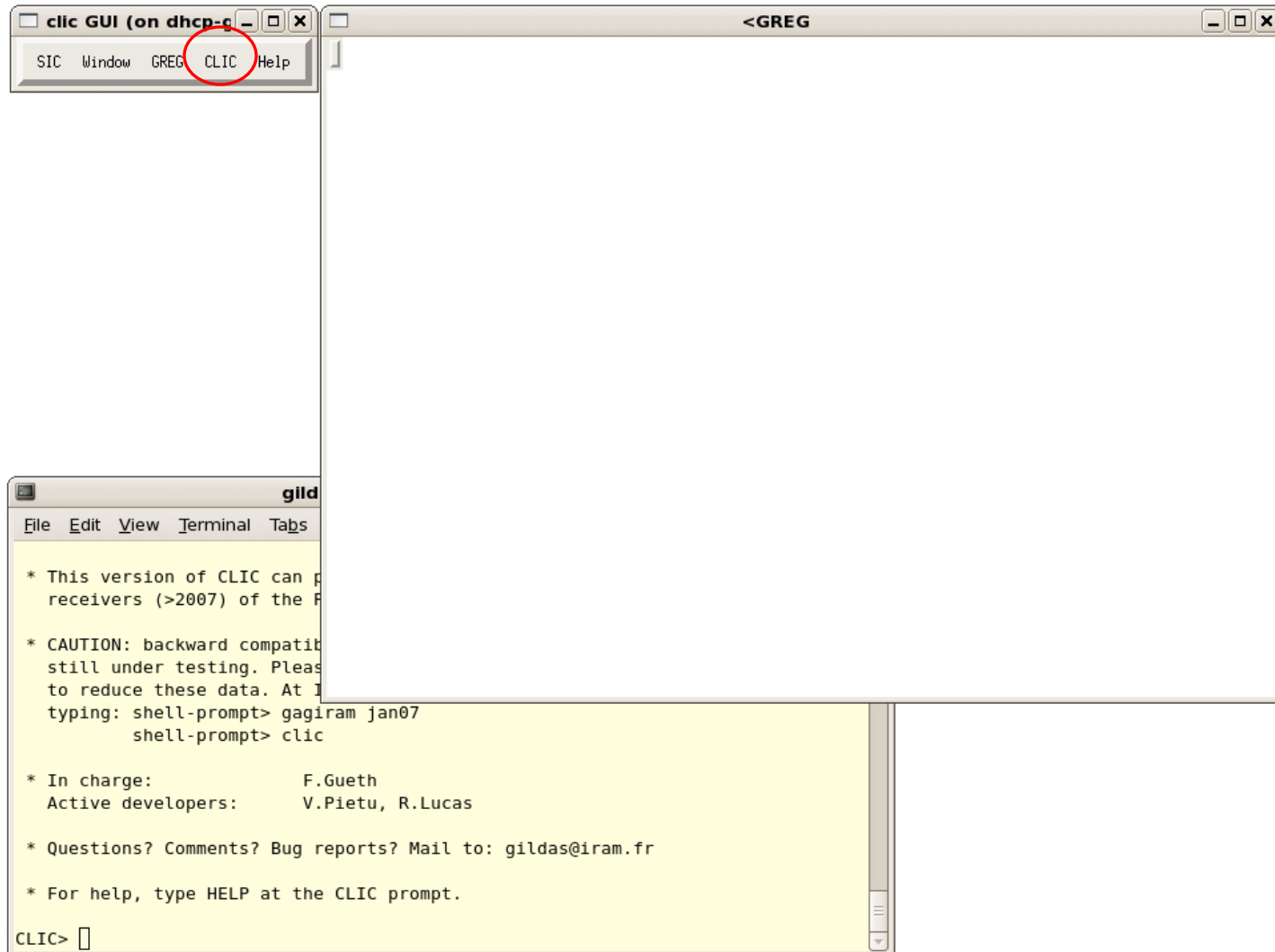
- Data not yet affected by the 'imaging process': assumptions, interpolations, computations, etc.

Summary

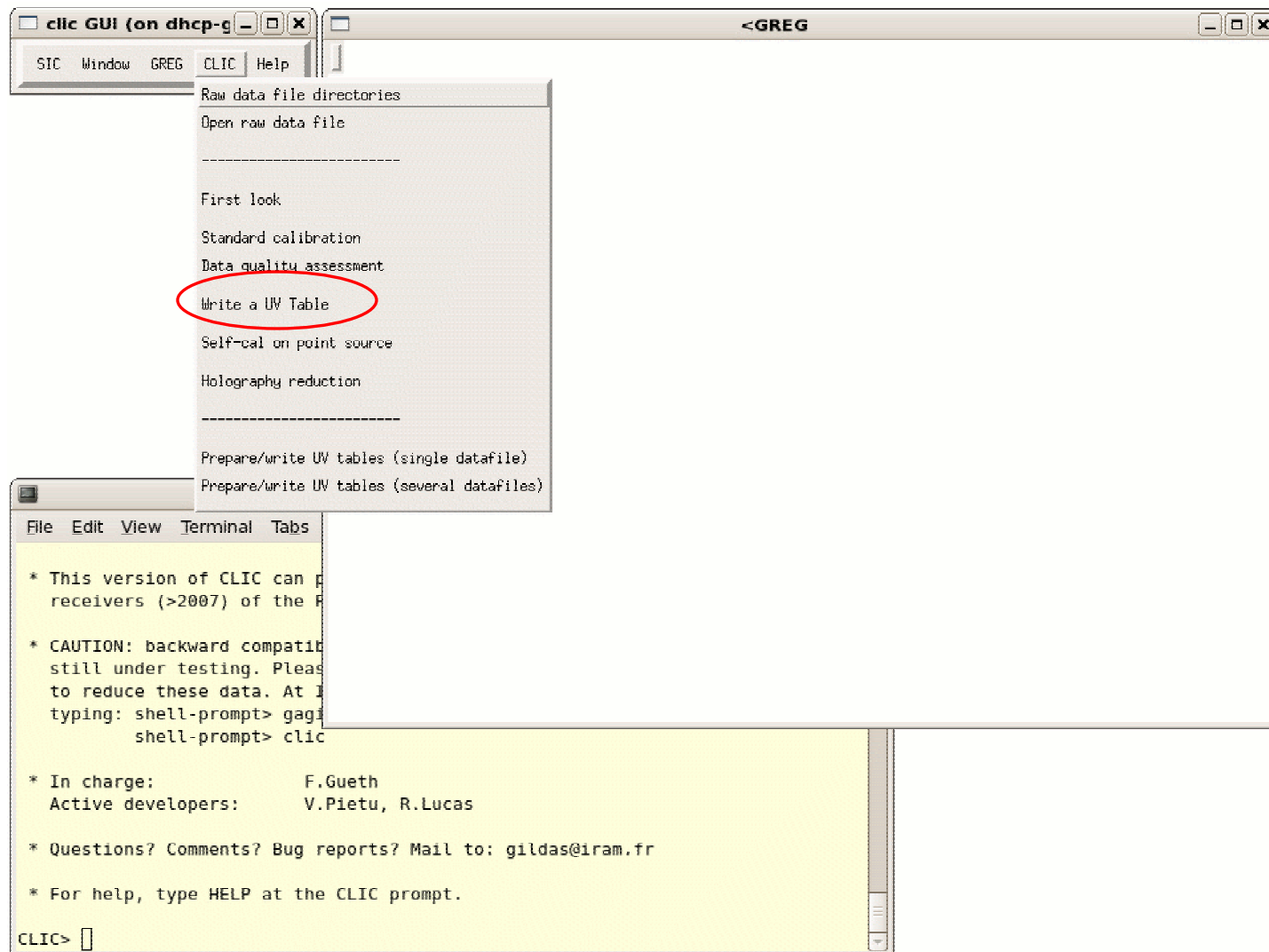
1. Let's create a uv -table, in **CLIC**
2. Data analysis, in **MAPPING**
 - Data analysis in the uv -plane
 - Imaging in practice (demo to be followed)
 - An inspection of the uv -data needed

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

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



Creating a *uv*-table; CLIC



Creating a *uv*-table; CLIC

Simple UV Table creation

GO ABORT HELP

CREATE THE TABLE

Use atm. phase correction? Yes

Input Data File Name ? File

Output UV Table Name ?

New Table? Yes

Source Name ?

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

First and last scan ?

Min. Data quality ? Choices

Receiver number ? Choices

Line or Continuum ? Choices

Band Used ? 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

Resampling parameters

Creating a uv-table; CLIC

Simple UV Table

GO ABORT

CREATE THE TABLE

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?

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: Line **Line parameters** Help

Resampling parameters: Resampling Resampling parameters Help

<GREG

Pencil Marker Lut Hardcopy Draw Zoom Zoom off Refresh Clear

Rest frequency (GHz) - LSB

86.4 86.2 86 85.8 85.6

Intermediate frequency at correlator input (MHz)

200 400 600 800 1000

LINE kk 86.000000 LSB LOW 6500.00 49 /RECEIVER 1 [V= 0.0 km/s]

Intermediate frequency at correlator input (MHz)

200 400 600 800 1000

Rest frequency (GHz) - LSB

86.4 86.2 86 85.8 85.6

Line parameters

Change line parameter? Yes

Line Name

Rest Frequency (MHz)

Go Dismiss Help

Creating a uv-table; CLIC

Simple UV Table creation

GO ABORT HELP

CREATE THE TABLE

Use atm. phase correction? Yes

Input Data File Name ? File

Output UV Table Name ?

New Table? Yes

Source Name ?

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

First and last scan ?

Min. Data quality ? Choices

Receiver number ? Choices

Line or Continuum ? Choices

Band Used ? 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

Resampling parameters

Resampling parameters

Resample spectral data ? Yes

New number of channels

New reference channel

Velocity at the reference channel

New resolution

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.hpt 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

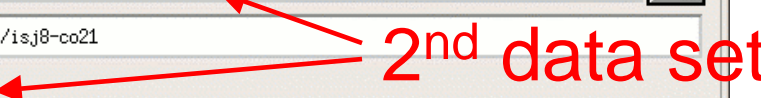
Use L08 ? No

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


```
ccarrizo@pctcp33:~  
File Edit View Terminal Tabs Help  
CLIC>  
CLIC> help table  
CLIC\TABLE Name [OLD|NEW  
[/RESAMPLE nc ref val in  
[/FREQUENCY name rest-freq  
[/NOCHECK [SOURCE|POINTING|PHASE|EPOCH]  
TABLE /RESAMPLE nc ref val in  
TABLE /FREQUENCY name rest-freq  
TABLE /NOCHECK [SOURCE|POINTING|PHASE|EPOCH]  
TABLE /DROP n1 n2 --- THIS OPTION IS OBSOLETE  
TABLE /COMPRESS tmax uvmax  
Additional Help Available:  
UVTABLE  
I-HELP, "table" is also a task, use "HELP TASK table" for more help  
CLIC>
```

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.

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

When processing each scan, CLIC checks whether a number of position parameters are consistent with those defined in the table header. Option /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 intended for building tables with inconsistent parameters (typical example is a different source name...). It is potentially dangerous and is to be used with caution.

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

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.

This command will create an output table. If the name is not given, the most recently created table will be used. The name may be OLD (default value) or NEW to create a new table.

The bands and subbands used in the table will be the same as in the original table. The weighting mode can be changed with the option /WEIGHTING.

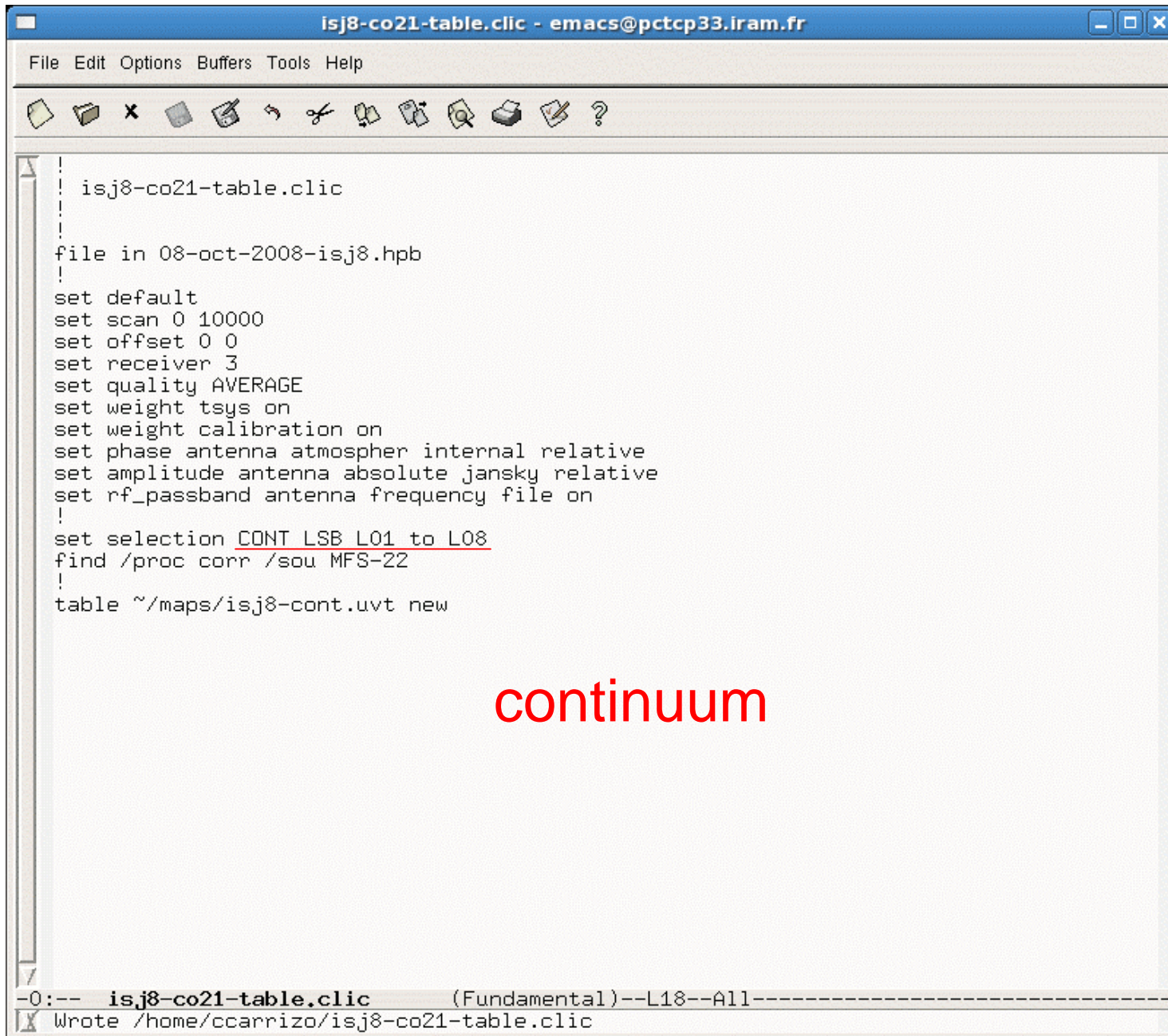
Option /RESAMPLE enables to resample the data (line data). 'nc' is the number of channels, 'ref' is the reference channel, 'val' is the velocity offset with respect to the rest frequency. 'code' is the code for the resolution, 'code' is 'code' if the units are in velocity units, 'code' is 'code' if the units are in velocity units.

The reference channel is the channel used for the offset 'val' in the table header or modified by option /OFFSET.

Resampling is done by decimating the data. Resampling is done in the Fourier space by cut-off frequencies. The decimation is done after decorrelation (due to on-line application of the decorrelation filter) to produce frequency channels. The shapes are:

- TBox = a box in delay
- Ppar = a parabola in delay
- FBox = a box in frequency
- FTri = a triangle in frequency

The width is the channel width.



```
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

-0:-- isj8-co21-table.clic (Fundamental)--L18--All-----
[X] Wrote /home/ccarrizo/isj8-co21-table.clic
```

continuum


```
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
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
```

```
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-----
[X]
```

Mosaic

2nd data set

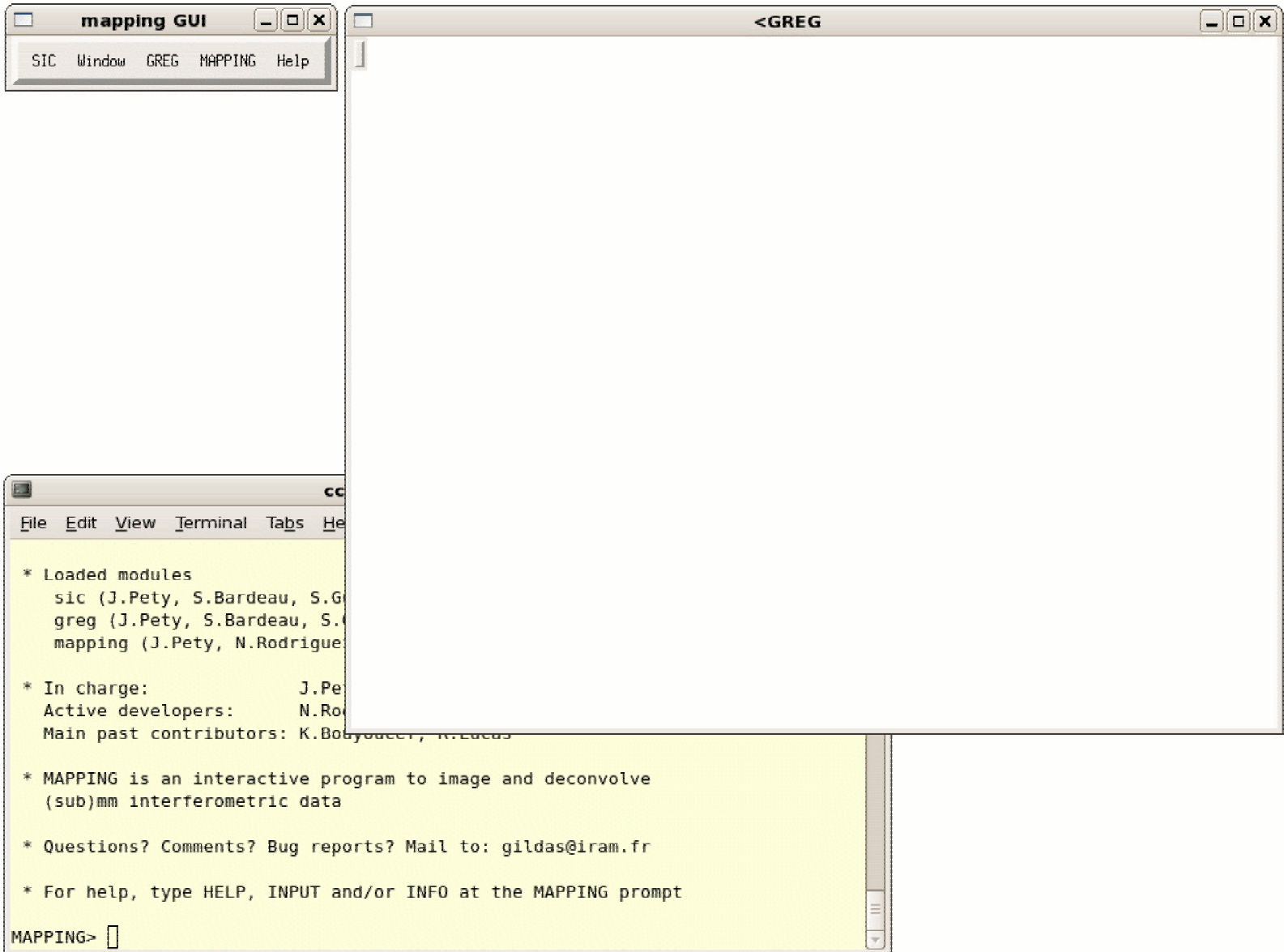
Created “mytable”.uvt, in **CLIC**



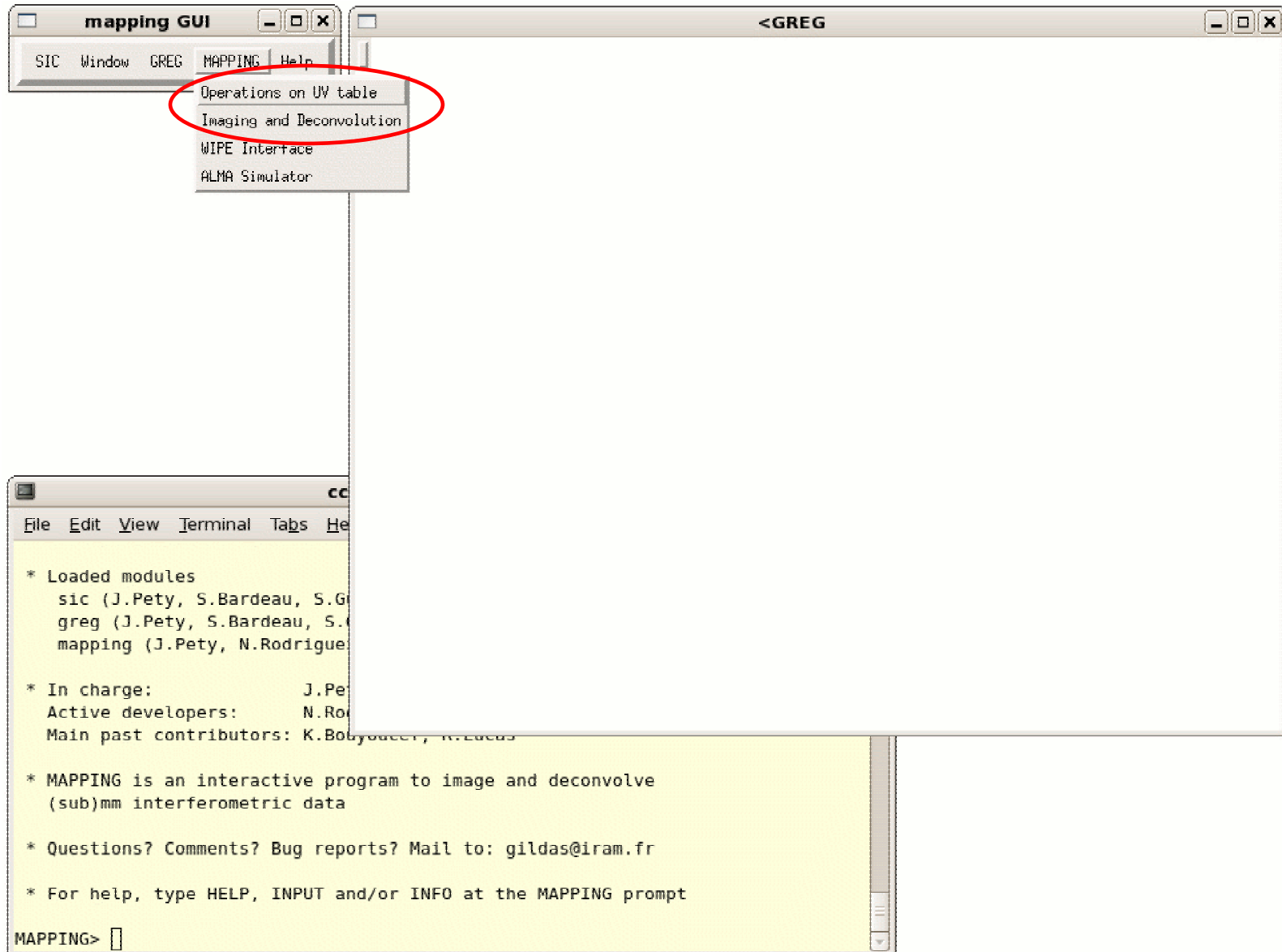
Analyze the data, in **MAPPING**

1. Data analysis in the uv -plane

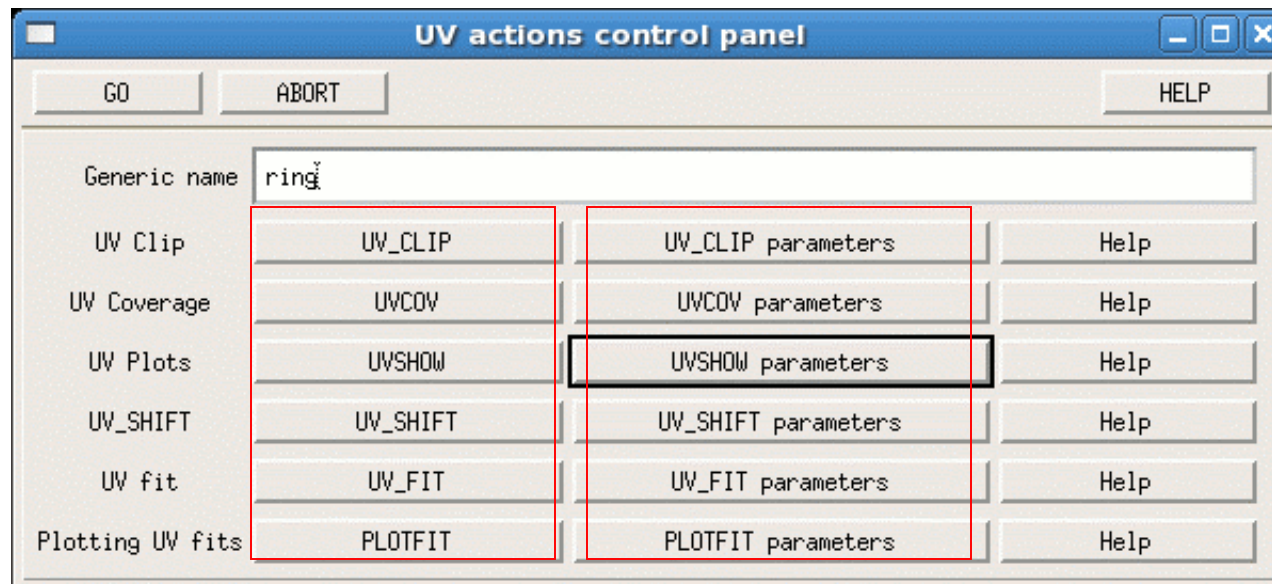
Data analysis in the *uv*-plane; **MAPPING**



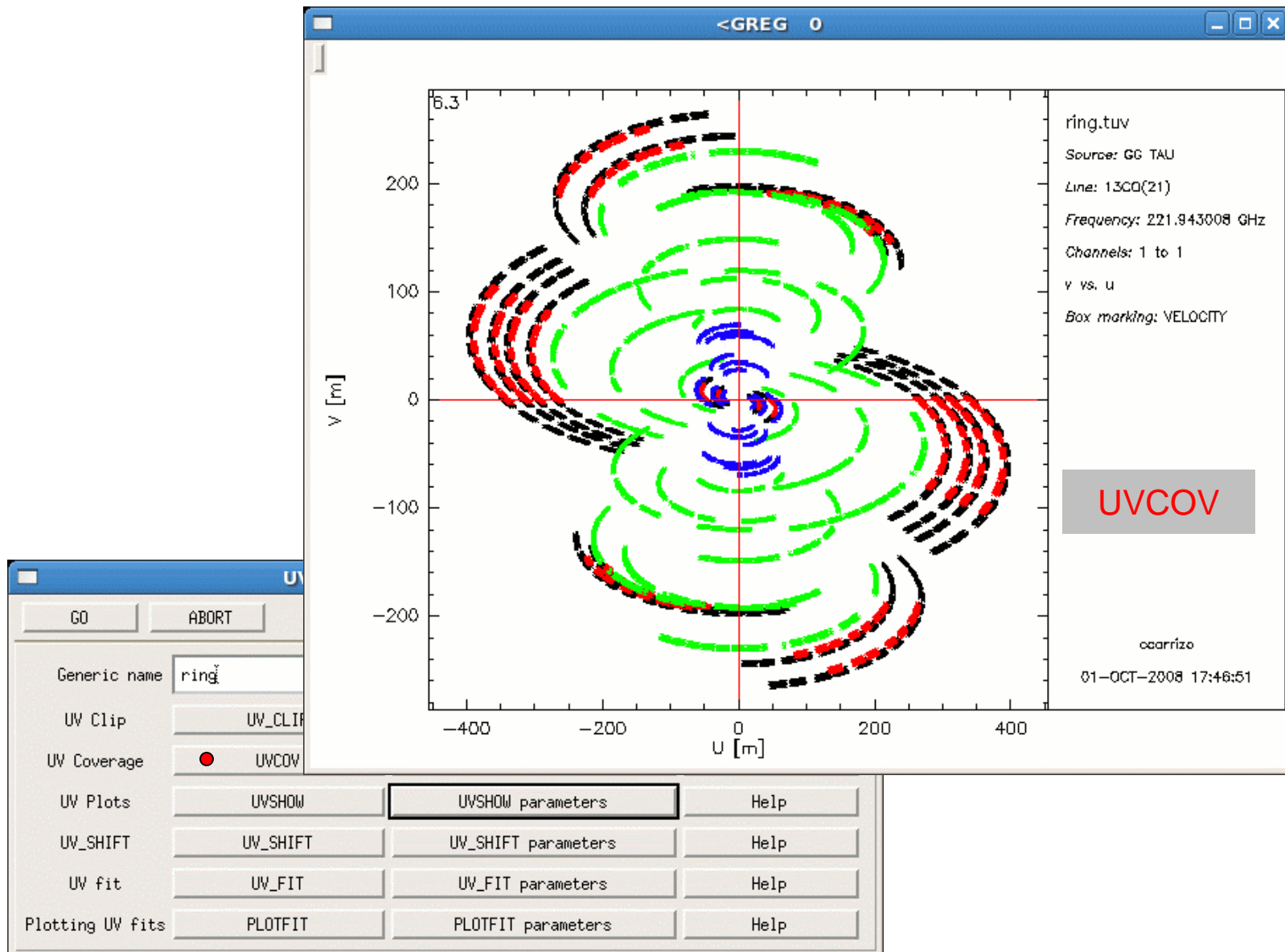
Data analysis in the uv -plane



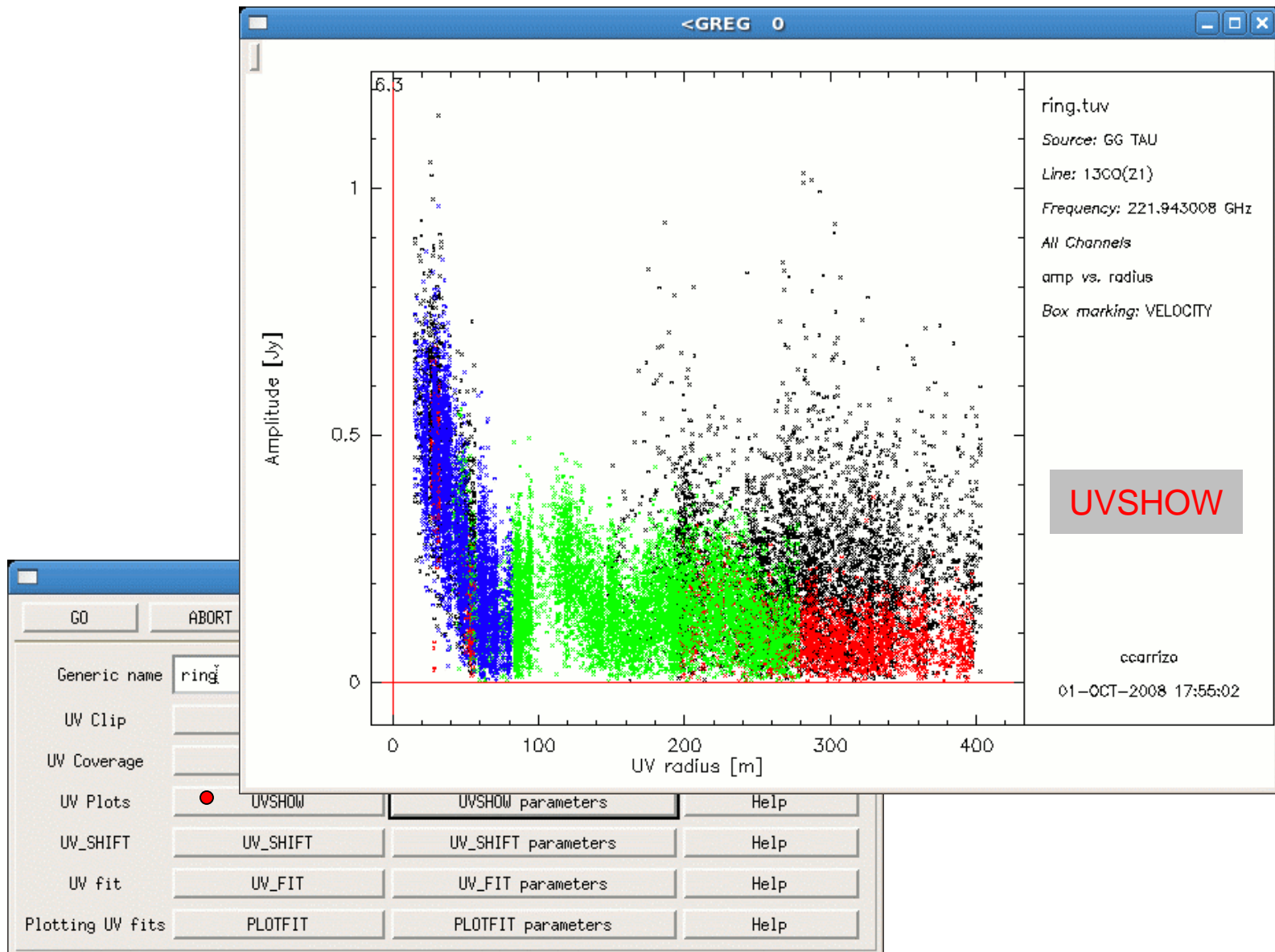
Data analysis in the *uv*-plane



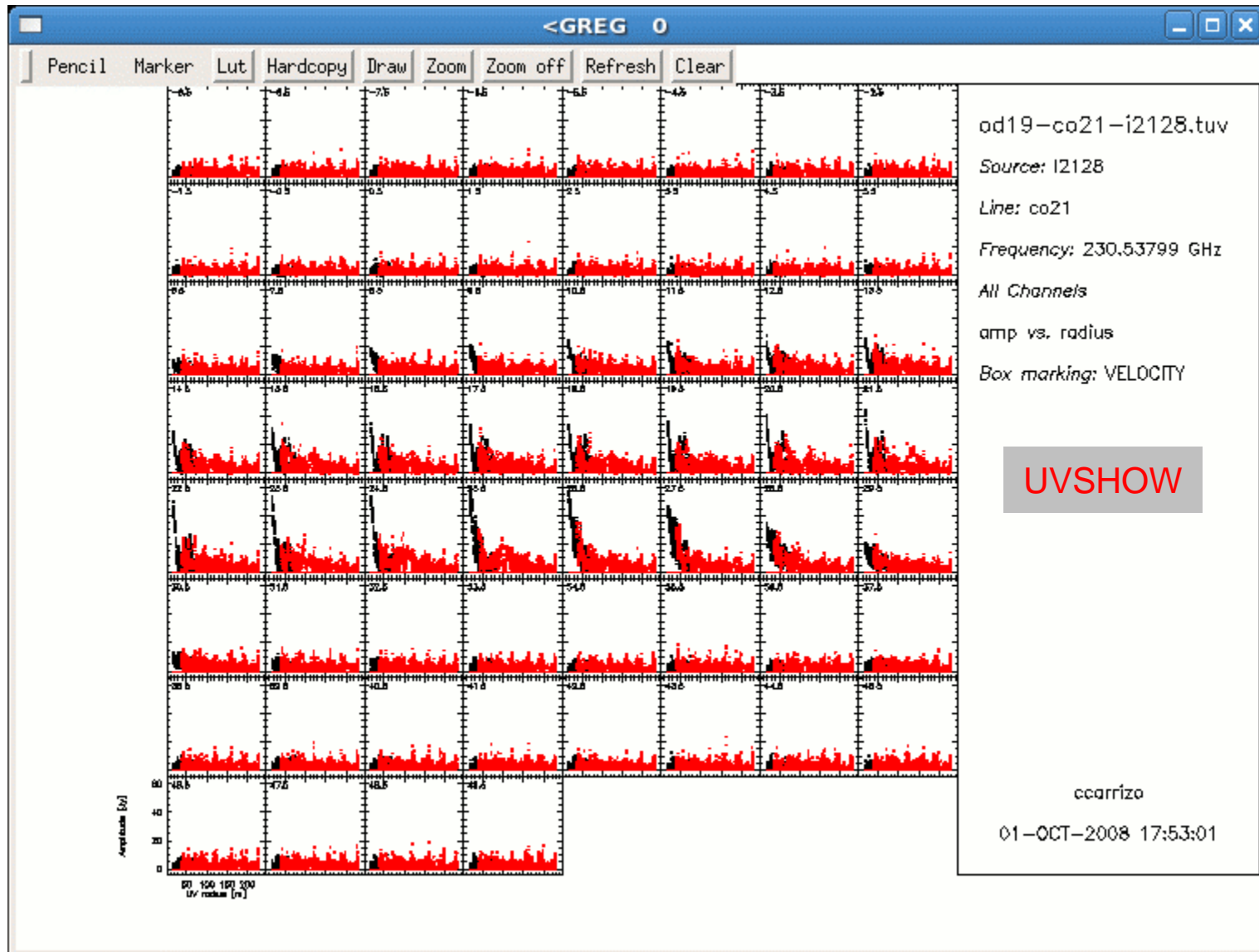
Data analysis in the *uv*-plane



Data analysis in the *uv*-plane



Data analysis in the *uv*-plane



Data analysis in the *uv*-plane

The image shows a graphical user interface for data analysis in the uv-plane. It features three main windows:

- UV actions control panel:** A window with a title bar and buttons for 'SIC', 'GO', 'ABORT', and 'HELP'. It contains a table of actions and their 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' row is highlighted with a red box. To the right of this panel is a plot area showing a scatter plot of data points and a text box with the following information:

```
ring.tuv
Source: GG TAU
Line: 1300(21)
Frequency: 221.943008 GHz
All Channels
amp vs. radius
Box marking: VELOCITY
```

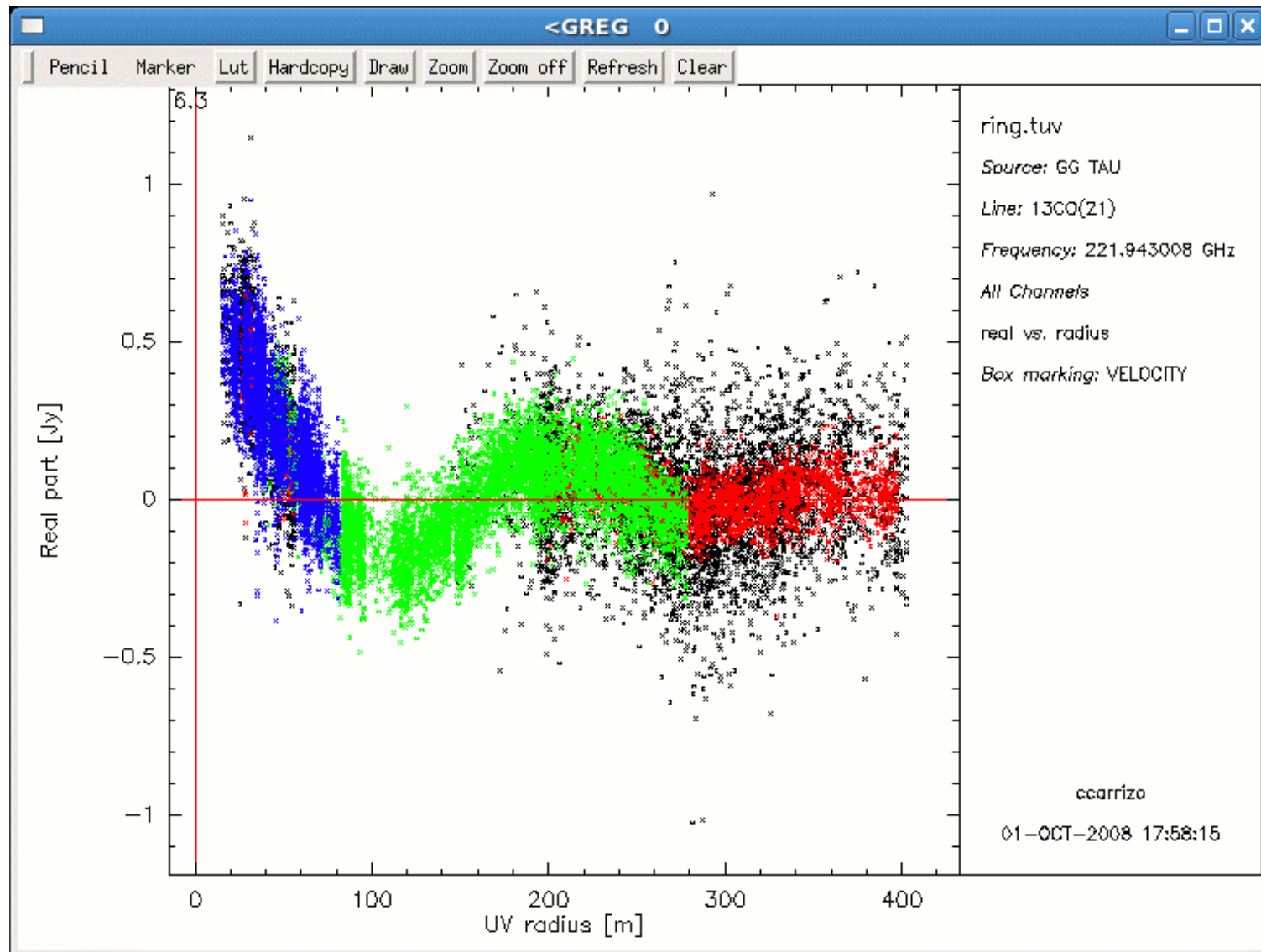
- UVSHOW parameters:** A dialog box for configuring the UVSHOW action. It includes fields for 'Generic name' (ring), 'X data' (radius), and 'Y data' (amp). It also has dropdown menus for 'First channel' and 'Last channel', and a 'Plot limits' field. Checkboxes are present for 'Plot model fit', 'Display zero level?', and 'Use one color per track?'. A 'Typical time separating 2 tracks [hrs]' field is set to 12. A 'Marker definition as in the SET MARKER command' field is set to '4 1 .1'. A dropdown menu is open, showing options: u, v, angle, radius, time, date, scan, number, amp, phase, real, imag, weight.
- Terminal:** A window with a menu bar (File, Edit, View, Terminal) and a text area containing the following text:

```
Map size
Map cell
Imaged Area

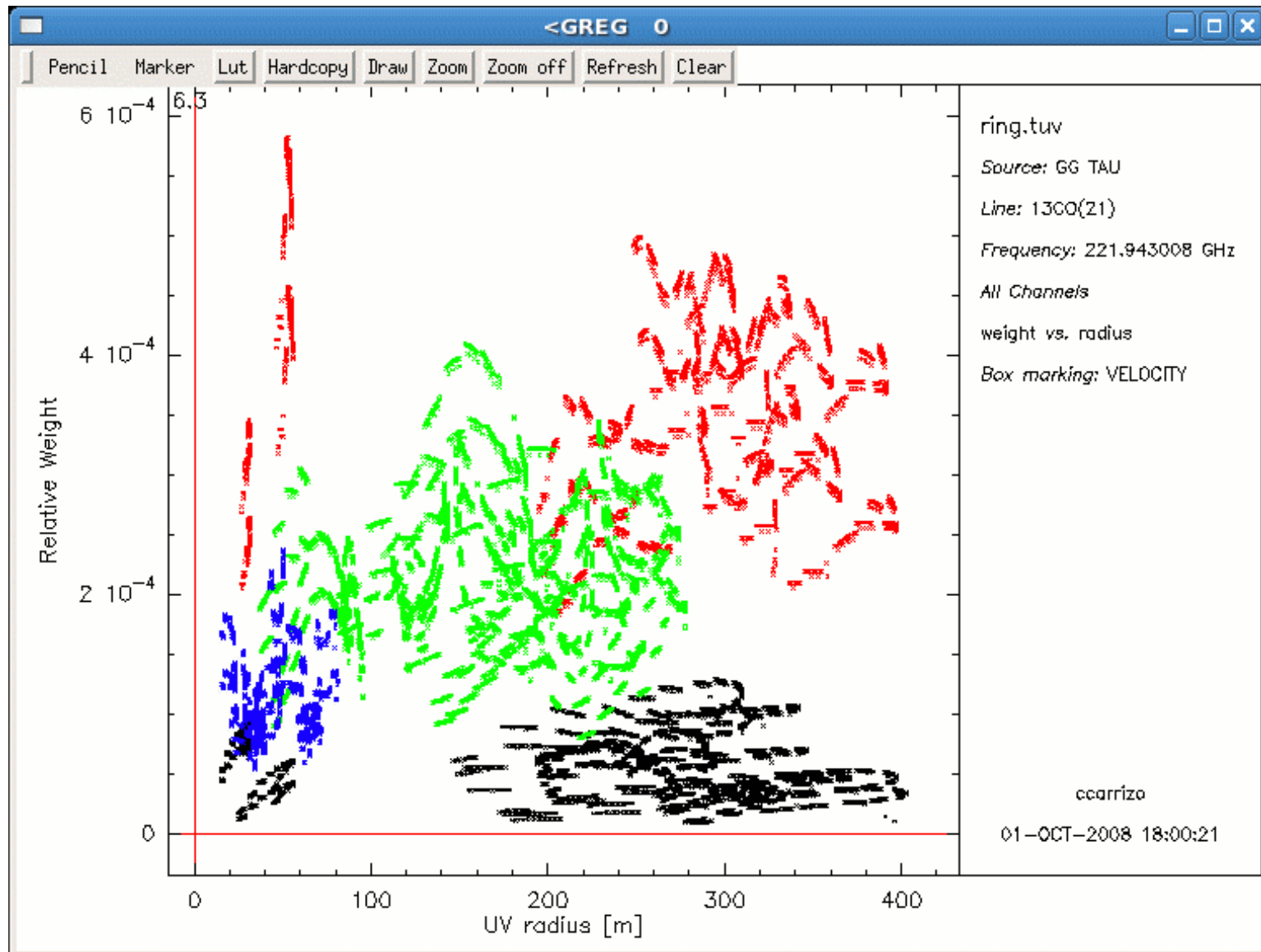
Still to be imaged
Still to be cleaned
I-GDF_RIH, Image file 1
U-GDF_RIH, UVT order :
W-GDF_RHSEC, Absent sec
W-GDF_RHSEC, Absent section
I-GDF_DAMS, Patching old
I-UVSHOW, Finding limits
I-UVSHOW, Number of found

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 software interface for data analysis. At the top, a window titled 'control panel' displays a plot of data points in the uv-plane. The plot area is mostly empty with a few scattered points. To the right of the plot, a text box provides the following information: 'ring.tuv', 'Source: GG TAU', 'Line: 1300(21)', 'Frequency: 221.943008 GHz', 'All Channels', 'amp vs. radius', and 'Box marking: VELOCITY'. Below the plot is a 'Choices' menu with a scrollable list of options: 'u', 'v', 'angle', 'radius', 'time', 'date', 'scan', 'number', 'amp', 'phase', 'real', 'imag', and 'weight'. The 'weight' option is currently selected. Below the menu is a 'Go' button. In the background, a terminal window shows the command sequence from the 'MAPPING' prompt, including 'go uvshow' and 'input uvshow'. The terminal also displays various status messages such as 'Map size', 'Map cell', 'Imaged Area', and 'Typical time separating 2 tracks [hrs] 12.0'.

Data analysis in the *uv*-plane

The image displays three overlapping windows from an astronomical software interface:

- UV actions control panel:** A window with buttons for 'GO', 'ABORT', and 'HELP'. It contains a table of actions with a red box highlighting the 'UV_SHIFT parameters' row.
- UV_SHIFT parameters:** A window for configuring the selected action, with fields for 'Generic name', 'Right Ascension', 'Declination', and 'Angle from North', and buttons for 'Go', 'Dismiss', and 'Help'.
- Terminal window:** A window showing the command-line interface with various status messages and a 'MAPPING>' prompt.

UV actions control panel details:

Action	Parameter	Parameters	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 details:

Field	Value
Generic name	ring
Right Ascension	:
Declination	:
Angle from North	0

Terminal window output:

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

Map size          512 x 512 pixets      512 x 512 pixets
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> █
```

Right panel details:

ring.tuv
Source: 6G TAU
Line: 13CO(21)
Frequency: 221.943008 GHz
All Channels
real vs. radius
Box marking: VELOCITY

01-OCT-2008 18:00:36

400

Data analysis in the *uv*-plane

The screenshot displays three windows from a software interface for data analysis in the *uv*-plane.

mapping GUI (top): A window titled "<GREG 0" with a menu bar (SIC, Window, GREG, MAPPING, Help) and a toolbar (Marker, Lut, Hardcopy, Draw, Zoom, Zoom off, Refresh, Clear). A plot area is visible on the right.

uv_shift (middle): A dialog box with buttons "GO", "ABORT", and "HELP". It contains the following fields:

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

Terminal (bottom): A window titled "ccarrizo@pctcp33:~" with a menu bar (File, Edit, View, Terminal, Tabs, Help). The terminal output is as follows:

```
Map size           Recommended      Used
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 ...
```

On the right side of the terminal window, there is a plot area with the following text: "943008 GHz", "VELOCITY", "rizo", and "01-OCT-2008 18:00:36". A horizontal axis is labeled "400".

Data analysis in the *uv*-plane

The screenshot displays the 'mapping GUI' interface. At the top, there is a menu bar with 'SIC', 'Window', 'GREG', 'MAPPING', and 'Help'. Below the menu bar is a toolbar with buttons for 'Marker', 'Lut', 'Hardcopy', 'Draw', 'Zoom', 'Zoom off', 'Refresh', and 'Clear'. The main window is titled '<GREG 0' and contains a plot area labeled 'ring.tuv'. In the foreground, the 'UV actions control panel' is visible, with buttons for 'GO' and 'ABORT'. Below these are several rows of controls: 'Generic name' (ring), 'UV Clip' (UV_CLIP), 'UV Coverage' (UVCOV), 'UV Plots' (UVSHOW), 'UV_SHIFT' (UV_SHIFT), and 'UV fit' (UV_FIT, which is highlighted with a red box and a red dot). At the bottom of this panel is a 'Plotting UV fits' button (PLOTFIT). To the right, the 'UV_FIT parameters' dialog box is open, showing fields for 'Generic name' (ring), 'First channel' (0), 'Last channel' (0), 'UV range(min, max) (meters)' (0 800), and 'Number of Functions (1 or 2)' (1). It lists two functions: 'Function 1: ring' and 'Function 2: point'. Each function has a 'Parameters' field (0 0 0 0 0 0 0), a 'Starting range' field (0 0 0 0 0 0 0), and a 'numb. of starts' field (0 0 0 0 0 0 0). There are also 'Subtract function' checkboxes (No) for each. A 'Choices' list on the right side of the dialog includes: point, c_gauss, e_gauss, c_disk, e_disk, ring, exp, power-2, power-3, and u_ring. At the bottom of the dialog are 'Go', 'Dismiss', and 'Help' buttons. In the bottom-left corner, a terminal window 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 screenshot displays the 'mapping GUI' interface. On the left, a terminal window shows the output of the 'mapping GUI' command, listing supported functions and their parameters. On the right, the 'UV_FIT parameters' dialog is open, showing configuration options for fitting functions. A red box highlights the 'Parameters' field in the dialog, and a red arrow points to the 'ring' function name in the 'function 1' dropdown, with the text 'often needed' next to it.

Terminal Output:

```
Variable FUNCTO1$ :
-----
TASK\CHARACTER "Function #1" FUNCTO1$

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 PARAMO1$ :
-----
TASK\REAL      "Parameters"      PARAMO1$[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.
```

UV_FIT parameters Dialog:

- Generic name: ring
- 1st channel: 0
- 2nd channel: 0
- Radius (meters): 0.000
- Channels (1 or 2): 1
- Function 1: ring (often needed)
- Parameters: 0 0 0 0 0 0 0
- Fitting range: 0 0 0 0 0 0 0
- Offset of starts: 0 0 0 0 0 0 0
- Use fit function: No
- Function 2: point
- Parameters: 0 0 0 0 0 0 0
- Fitting range: 0 0 0 0 0 0 0
- Offset of starts: 0 0 0 0 0 0 0
- Use fit function: No

Buttons: Dismiss, Help

Data analysis in the *uv*-plane

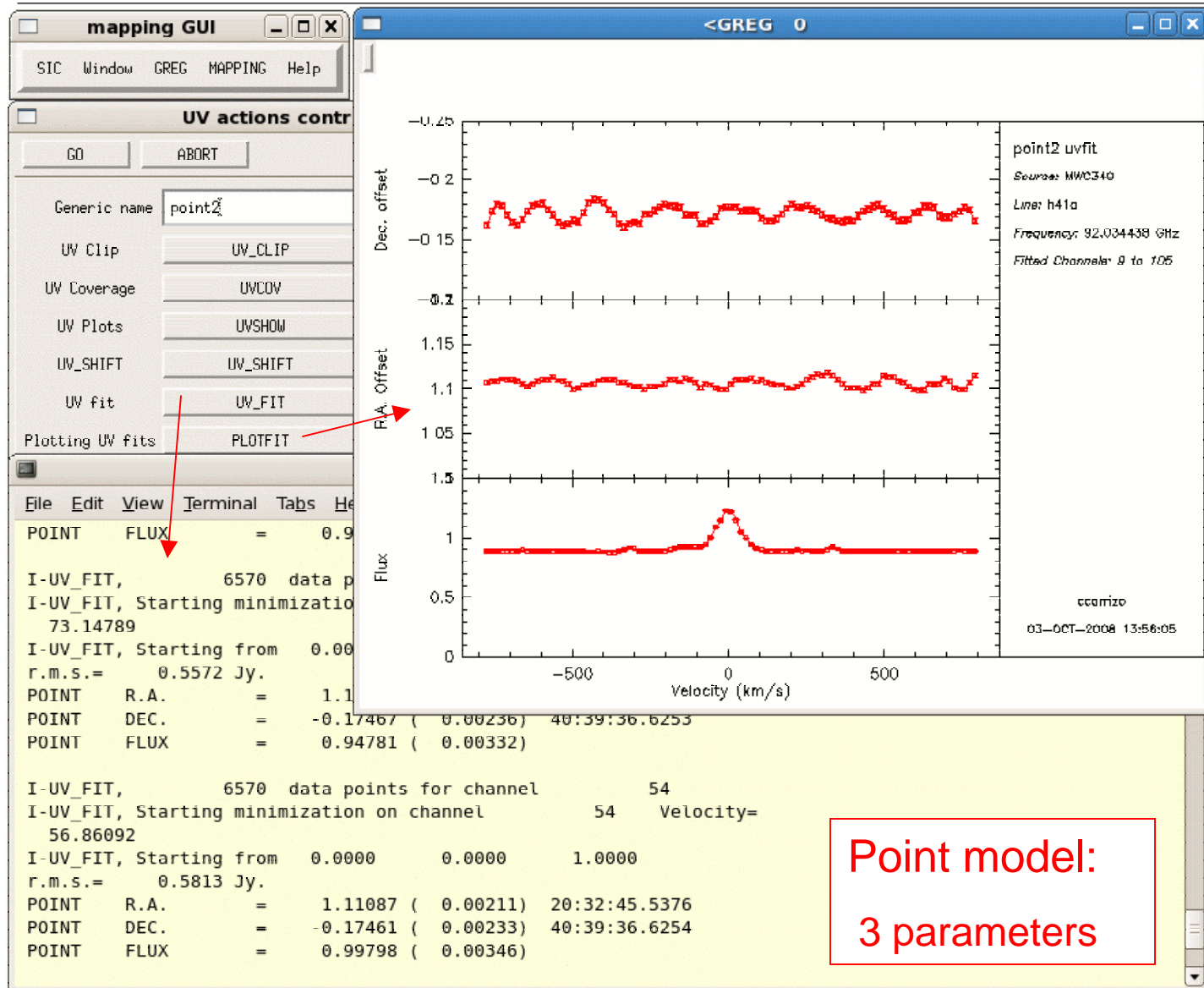
The image shows a screenshot of the MAPPING GUI with the PLOTFIT parameters dialog box open. The dialog box is titled "PLOTFIT parameters" and contains the following fields and options:

- 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 * μ (highlighted with a red box)
- X Parameter #2: freq * μ
- X Parameter #3: channel * μ
- X Parameter #4: ra * μ
- X Parameter #5: dec * μ
- X Parameter #6: flux * μ
- Number of parameters plotted along y axis: 3
- Y Parameter #1: ra * μ
- Y Parameter #2: dec * μ
- Y Parameter #3: flux * μ (highlighted with a red box)
- Y Parameter #4: major * μ
- Y Parameter #5: minor * μ
- Y Parameter #6: angle * μ
- 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 terminal window below shows the following text:

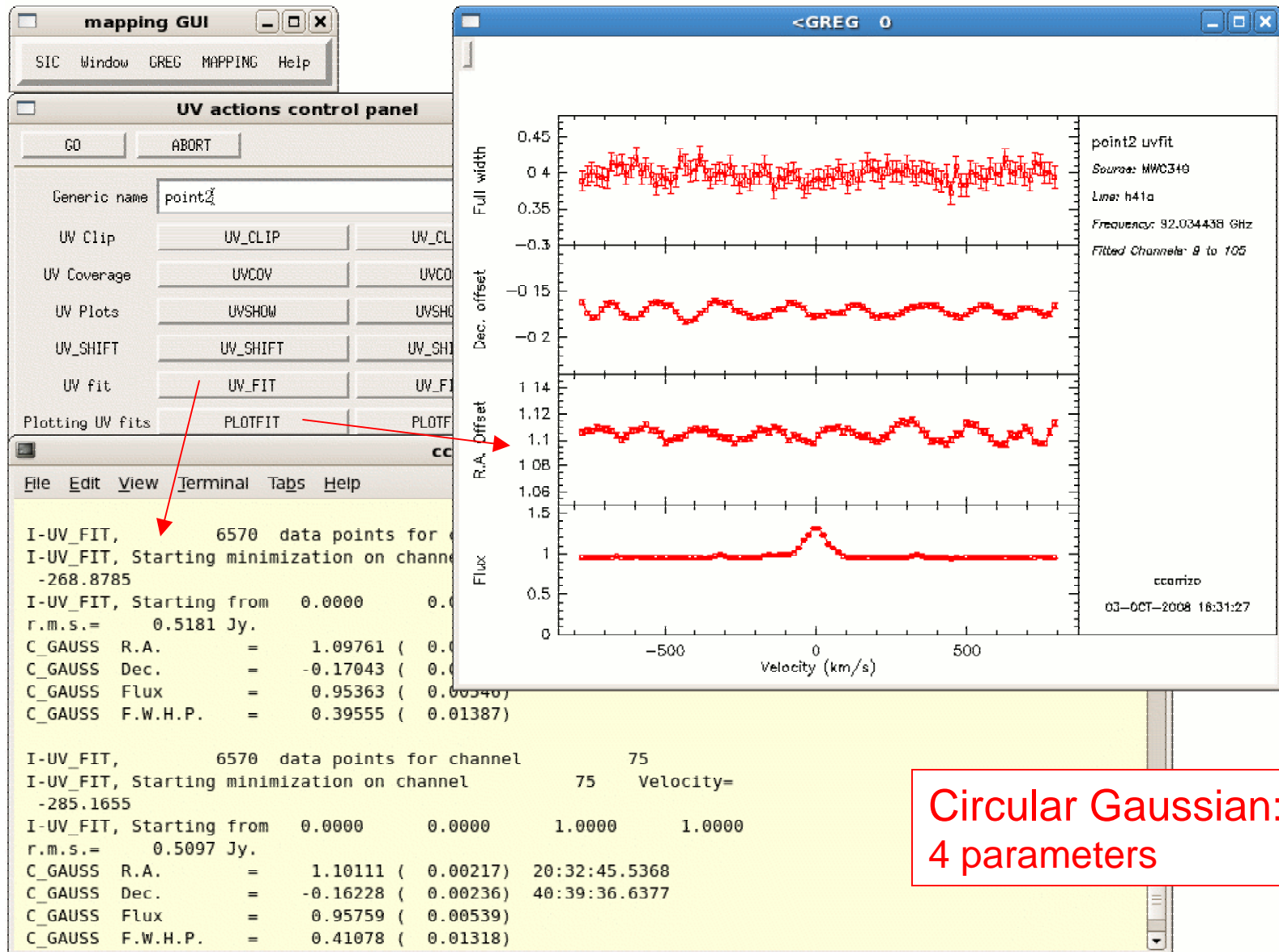
```
ccarrizo
File Edit View Terminal Tabs Help
* Loaded modules
  sic (J.Pety, S.Bardeau, S.Guillot)
  greg (J.Pety, S.Bardeau, S.Guillot)
  mapping (J.Pety, N.Rodriguez-Ferraz)
* In charge: J.Pety
  Active developers: N.Rodriguez-Ferraz
  Main past contributors: K.Bouyoucef
* MAPPING is an interactive program
  (sub)mm interferometric data
* Questions? Comments? Bug reports?
* For help, type HELP, INPUT and/or
MAPPING>
MAPPING> [ ]
```

Data analysis in the *uv*-plane



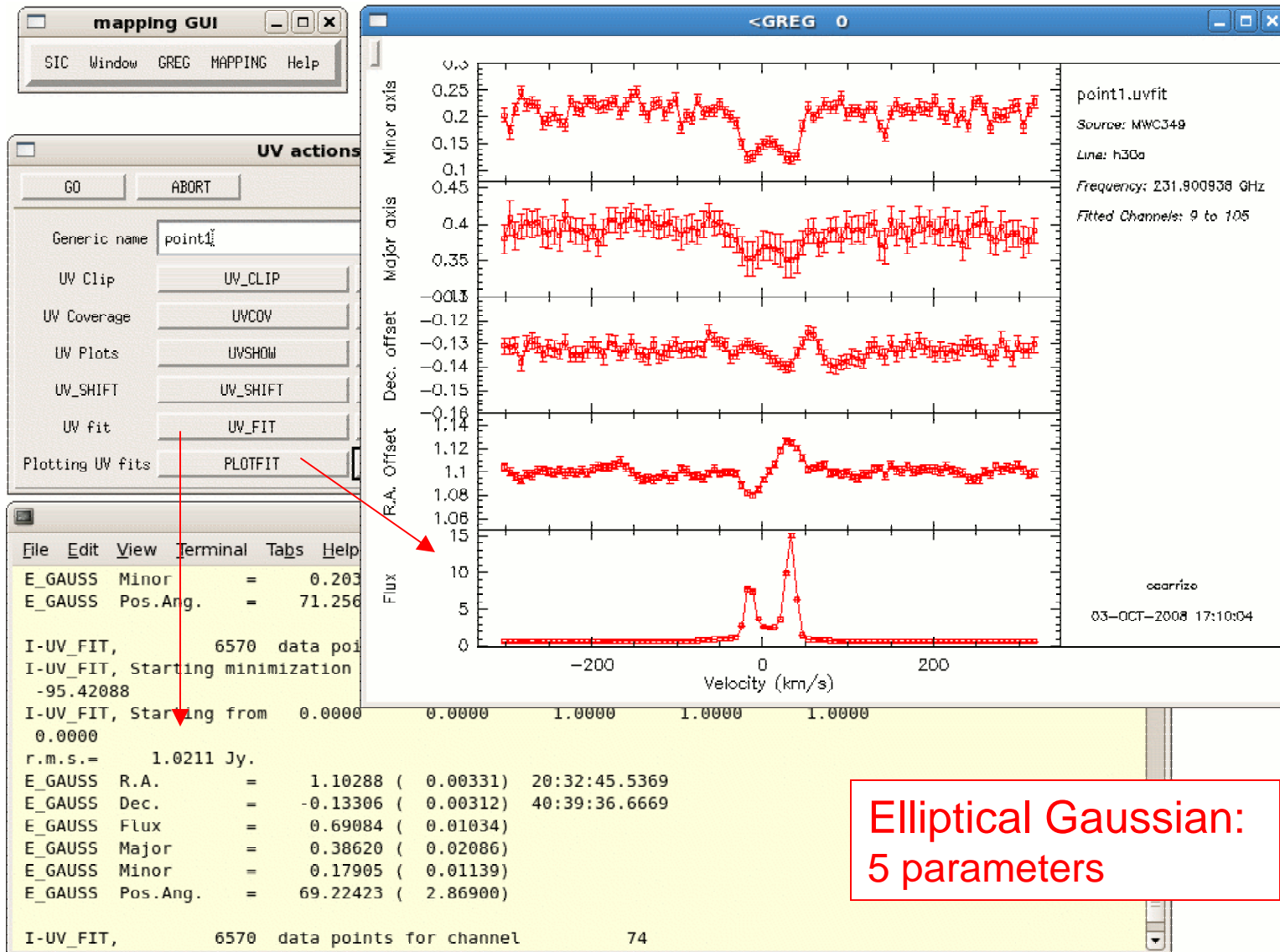
Point model:
3 parameters

Data analysis in the *uv*-plane



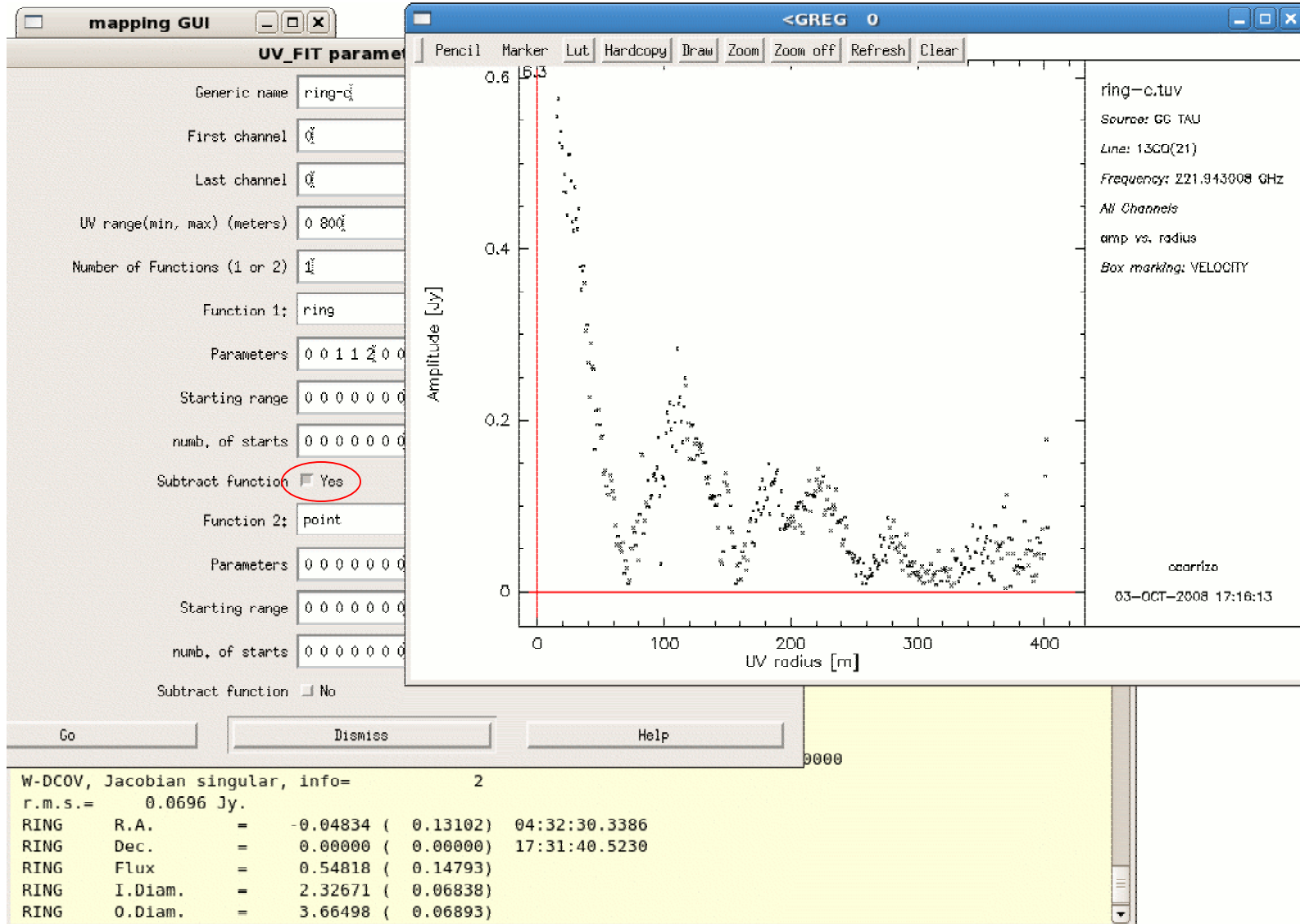
Circular Gaussian:
4 parameters

Data analysis in the *uv*-plane

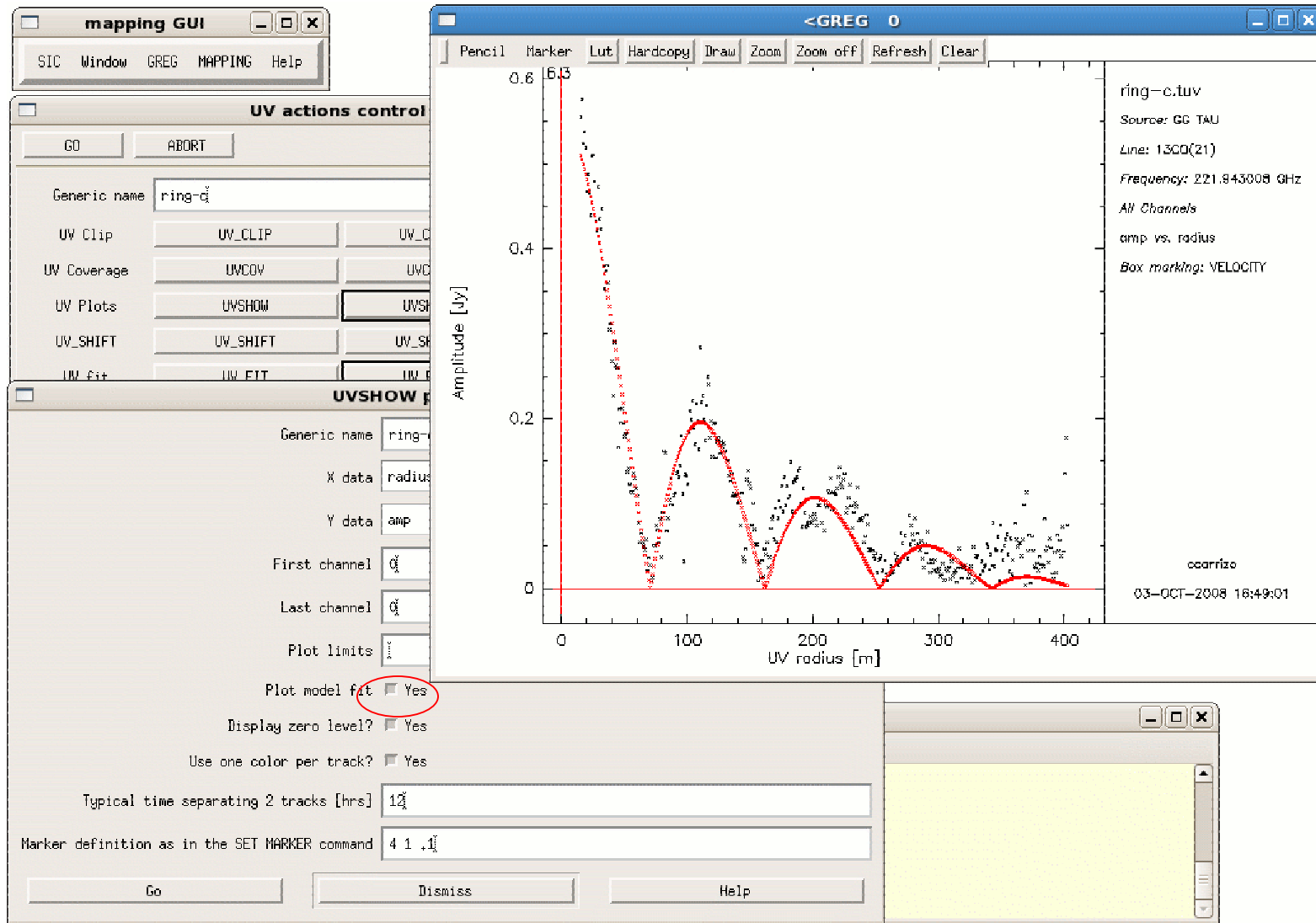


Elliptical Gaussian:
5 parameters

Data analysis in the uv -plane



Data analysis in the *uv*-plane



MAPPING procedures / tasks

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

also

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

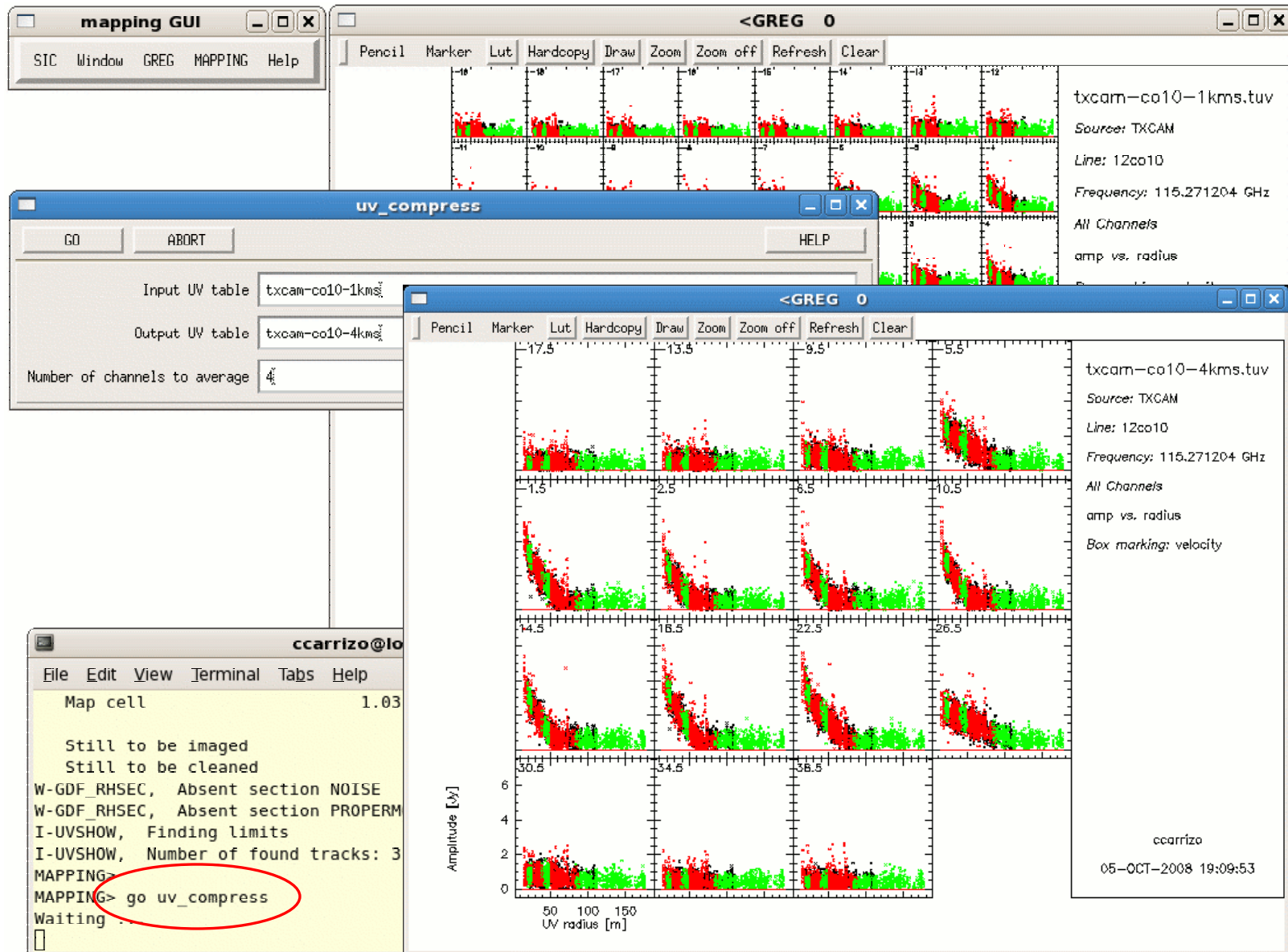
Data analysis in the *uv*-plane

```
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

The image displays a software interface for data analysis in the *uv*-plane. It consists of several windows:

- mapping GUI:** A window with a menu bar (SIC, Window, GREG, MAPPING, Help) and a main plot area.
- uv_circle:** A dialog box with fields for 'input table' (ring), 'output table' (ring-c), 'Minimum radius (m)' (0), 'Maximum radius (m)' (1000), and 'Radius interval (m)' (1). It has 'GO', 'ABORT', and 'HELP' buttons.
- Plot Window:** A window titled '<GREG 0' showing a plot of Amplitude [Jy] vs UV radius [m]. The plot shows a series of data points forming a ring-like structure. A red vertical line is drawn at UV radius = 6.3. The plot has a toolbar with 'Pencil', 'Marker', 'Lut', 'Hardcopy', 'Draw', 'Zoom', 'Zoom off', 'Refresh', and 'Clear' buttons. The right side of the plot window contains metadata: 'ring-c.tuv', 'Source: GG TAU', 'Line: 13CO(21)', 'Frequency: 221.943008 GHz', 'All Channels', 'amp vs. radius', 'Box marking: velocity', 'ccarrizo', and '05-OCT-2008 19:28:32'.
- Terminal Window:** A window titled 'Terminal Tab' showing a list of commands and their outputs. The command 'uv_circle' is circled in red. The output for 'uv_circle' is 'Waiting ...'.

At the bottom of the image, there are three labels: 'uv_cuts', 'uv_mcal', and '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_ascall

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

uv_compress

uv_map

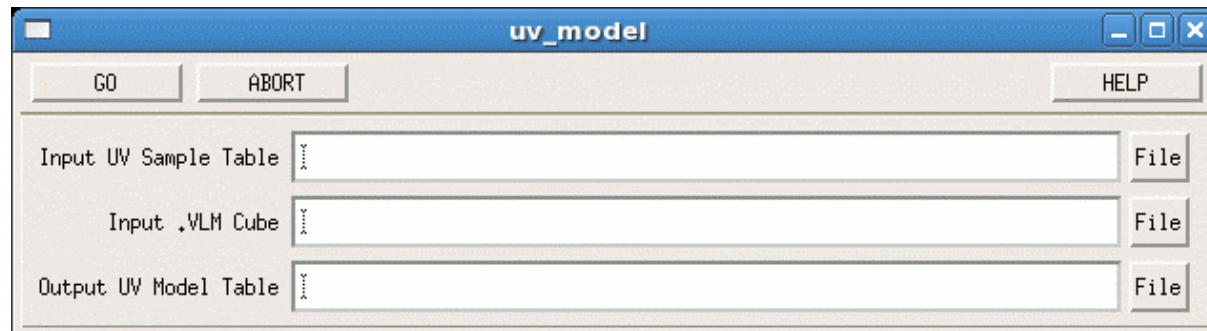
uv_single

uv_zero

uv_cuts

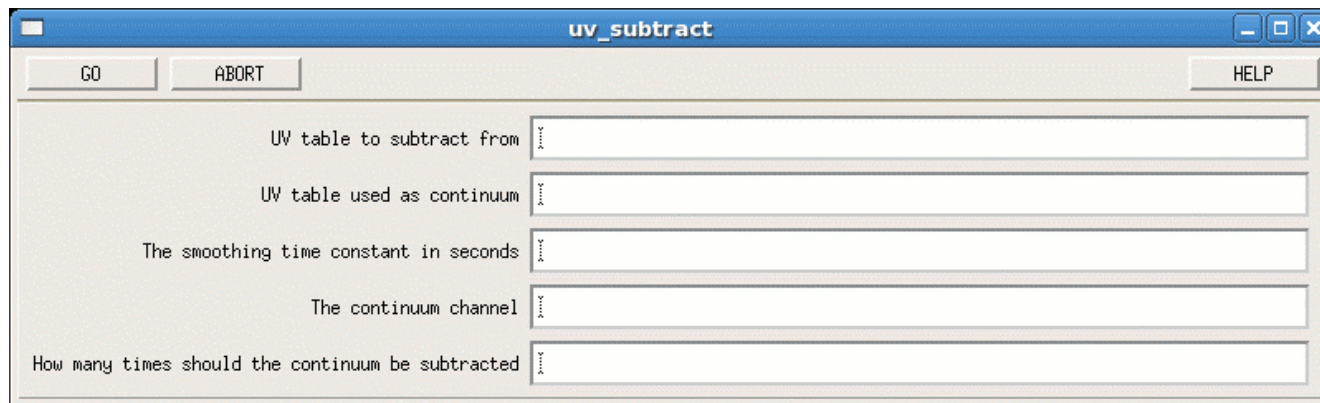
uv_mcal

uv_sinusphase



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

Data analysis in the *uv*-plane



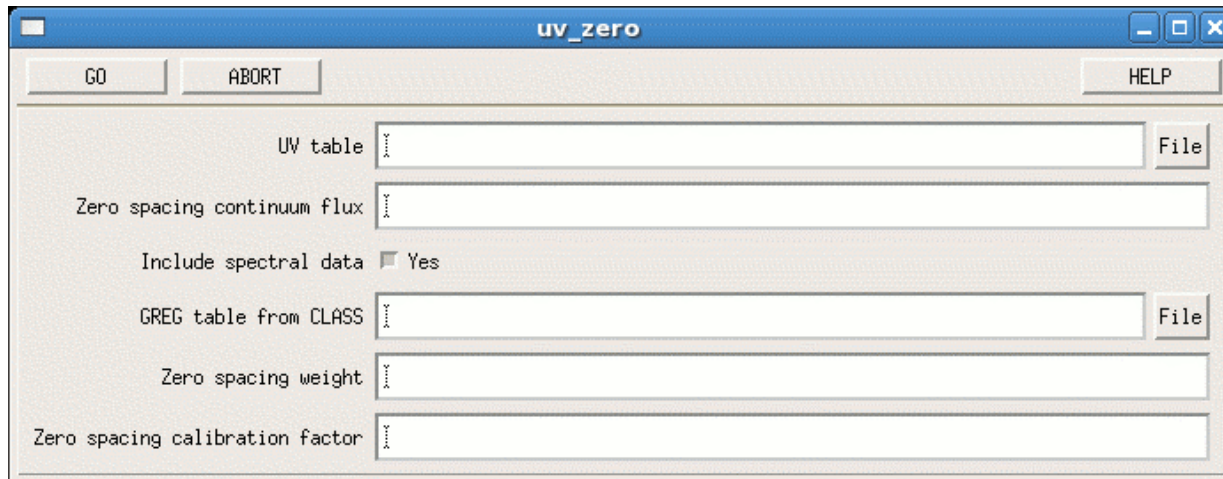
To subtract a time-averaged continuum *uv* table

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 ...



To add a single-dish zero-spacing spectrum

_solve
_sort
_splitfield
_stat
_subtract
_table
_timeaverage
_timebase
_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

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
- weight

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

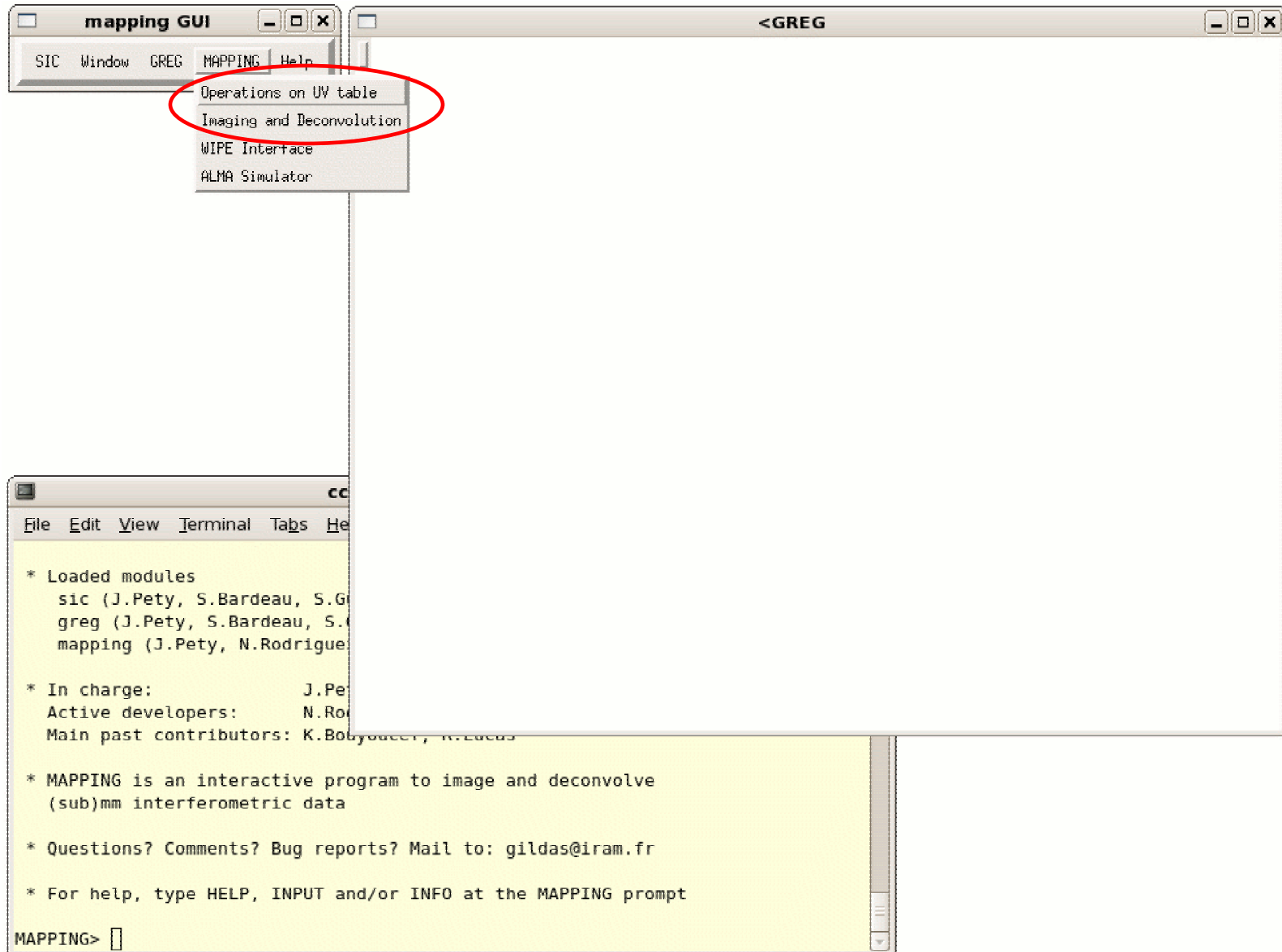
- real part for 2nd channel
- imaginary part 2nd channel
- ...

data at 2nd channel

2. Imaging in practice

(demo this afternoon)

Imaging in practice



Imaging in practice

Imaging and deconvolution (J.PETY)

GO ABORT HELP

SETUP UV COVER UVSHORT (all) UVMAP DIRTY SUPPORT (curs) HOGROM RESIDUALS VIEW

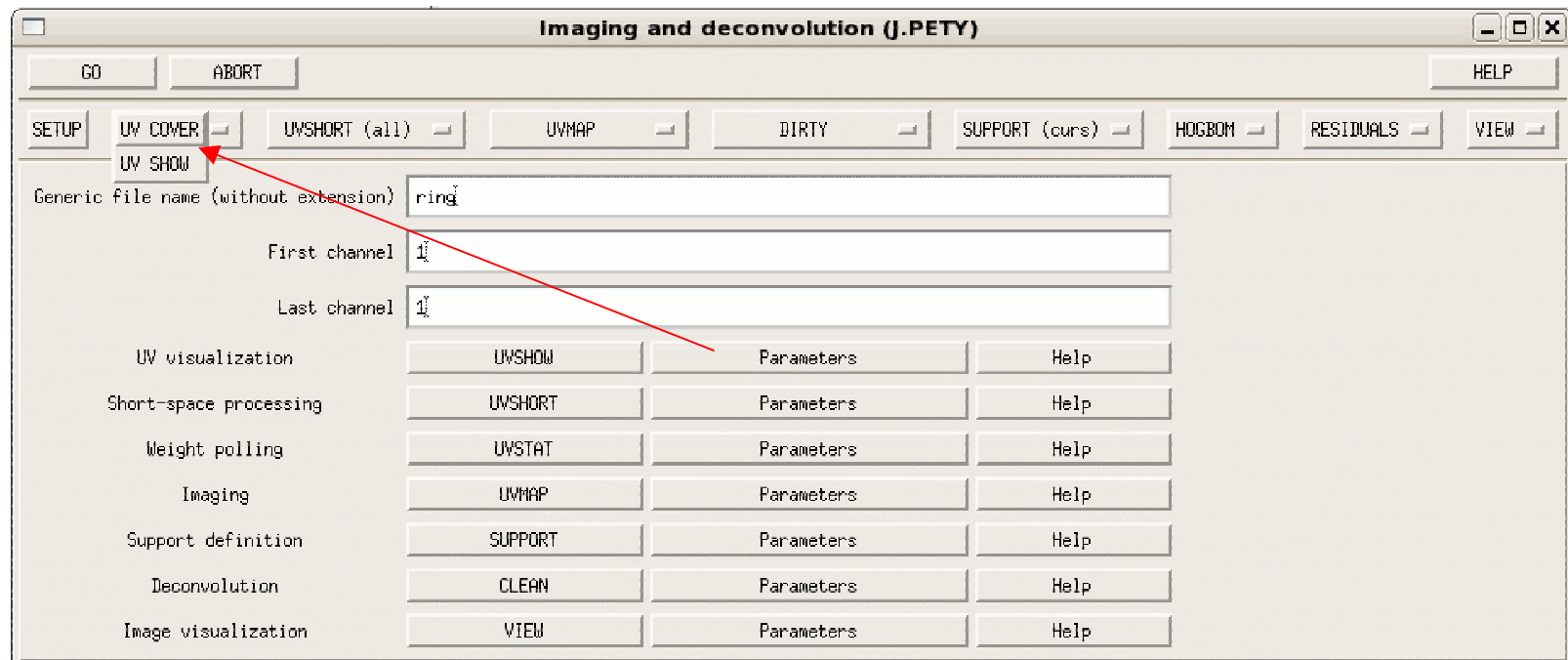
Generic file name (without extension) ring

First channel 0

Last channel 0

UV visualization	UVSHOW	Parameters	Help	= go uvshow
Short-space processing	UVSHORT	Parameters	Help	
Weight polling	UVSTAT	Parameters	Help	
Imaging	UVMAP	Parameters	Help	= go uvmap
Support definition	SUPPORT	Parameters	Help	= go support
Deconvolution	CLEAN	Parameters	Help	= go clean
Image visualization	VIEW	Parameters	Help	= go view / go bit

Imaging in practice



go uvshow

let name ring

let first 1

let xtype radius

let ytype amp, etc.

input uvshow

Imaging in practice

GO ABORT

SETUP UV COVER UVSHORT (all)

UVSHORT (setup)

Generic file name (with UVSHORT (table)

UVSHORT (merge)

UVSHORT (clear)

Last channel

UV visualization

Short-space processing

Weight polling

Imaging

Support definition

Deconvolution

Image visualization

UVSHORT Parameters

Main control parameters

all Choices

Single-Dish data unit * Choices

Additional SD amplitudes scaling factor 1

Additional SD weights scaling factor 1

K (Ta*)

K (Tmb)

Jy/Beam

Additional parameters for SPECIALISTS (Be careful...)

Parameters initialized at MAPPING start => Changeable anytime

Column of X coordinates 1

Column of Y coordinates 2

Column for weights 3

Range of velocity channels to grid 4

X-Y position tolerance [arcsec] 1

Minimum weight 0.01

Additional parameters for SPECIALISTS (Be careful...)

Parameters set during SETUP => Changeable between SETUP and TABLE CREATION

Single dish calibration factor 0

Interferometer primary beam size [arcsec] 0

Single Dish beam size [arcsec] 0

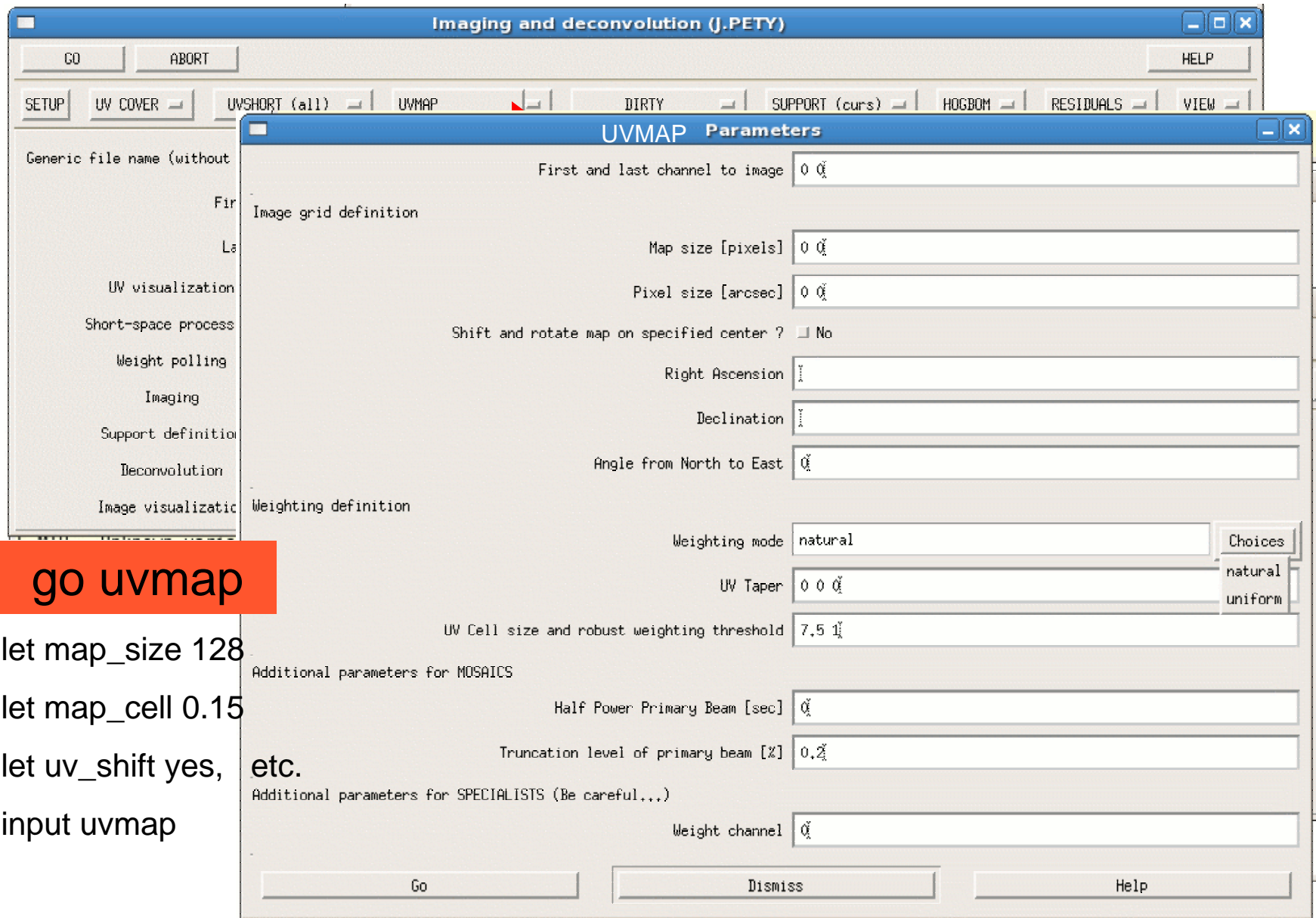
Interferometer antenna diameter [m] 0

Single Dish antenna diameter [m] 0

Single dish uv truncation radius [m] 0

Go Dismiss Help

Imaging in practice



let map_size 128

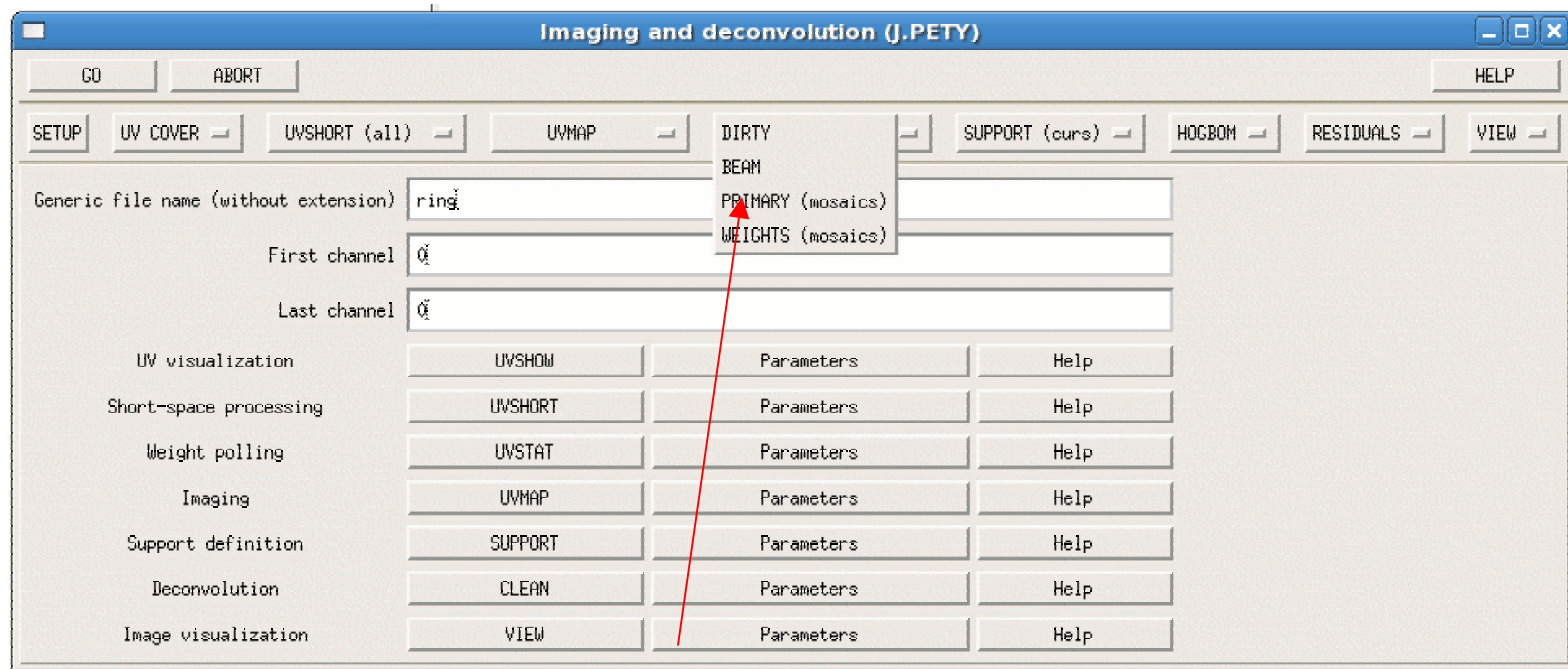
let map_cell 0.15

let uv_shift yes,

input uvmap

etc.

Imaging in practice



let type lmv

let type beam

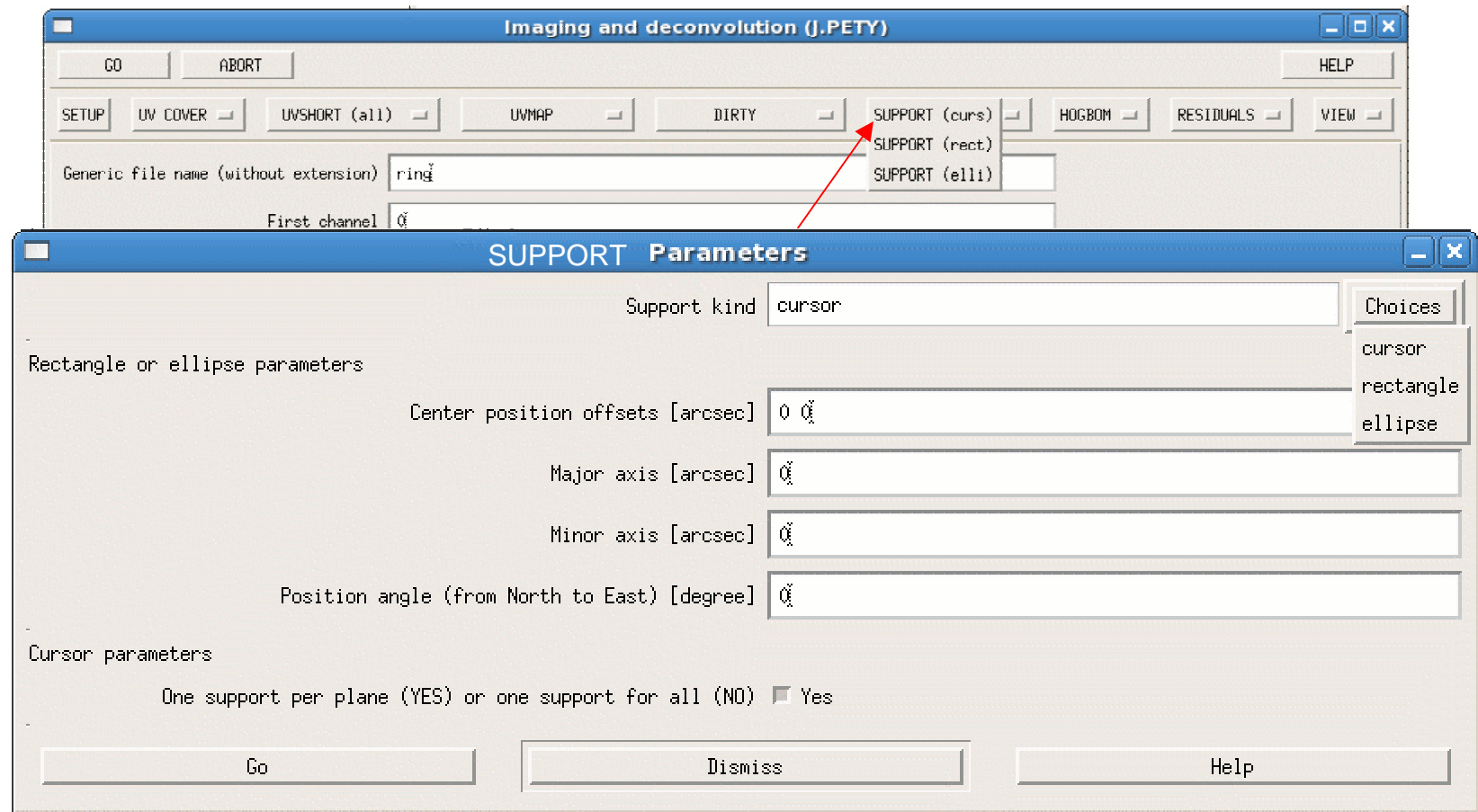
let size 60

let spacing 0.02 , etc

input bit

go bit

Imaging in practice



go support

let support%kind cursor

let support%oneperplane yes

Imaging in practice

GO ABORT

SETUP UV COVER UVSHORT

Generic file name (without extension)

First character

Last character

UV visualization

Short-space processing

Weight polling

Imaging

Support definition

Deconvolution

Image visualization

go clean

let method hogbom

let myclean%support yes

let myclean%show yes

let fres 0.02, etc

input clean

CLEAN Parameters

Deconvolution method: hogbom

Use the support previously defined by SUPPORT? No

Show dirty image and cumulative flux during cleaning? No

Keep separate versions of cleaned results per deconvolution method? No

Stopping criteria

Max abs. residual: 0

Frac. abs. residual: 0.025000000372529

Max. number of iterations: 0

Max. number of major cycles: 50

Parameters to tune the display during deconvolution

Flux scale: 0

Display kind at each major cycle: residual

Additional parameters for MOSAICS

Min. weight for search [???]: 0.20000000298023

Min. weight for restore [???]: 0.20000000298023

Additional parameters for SPECIALISTS (Be careful...)

Loop gain: 0.20000000298023

MRC smoothing factor: 0

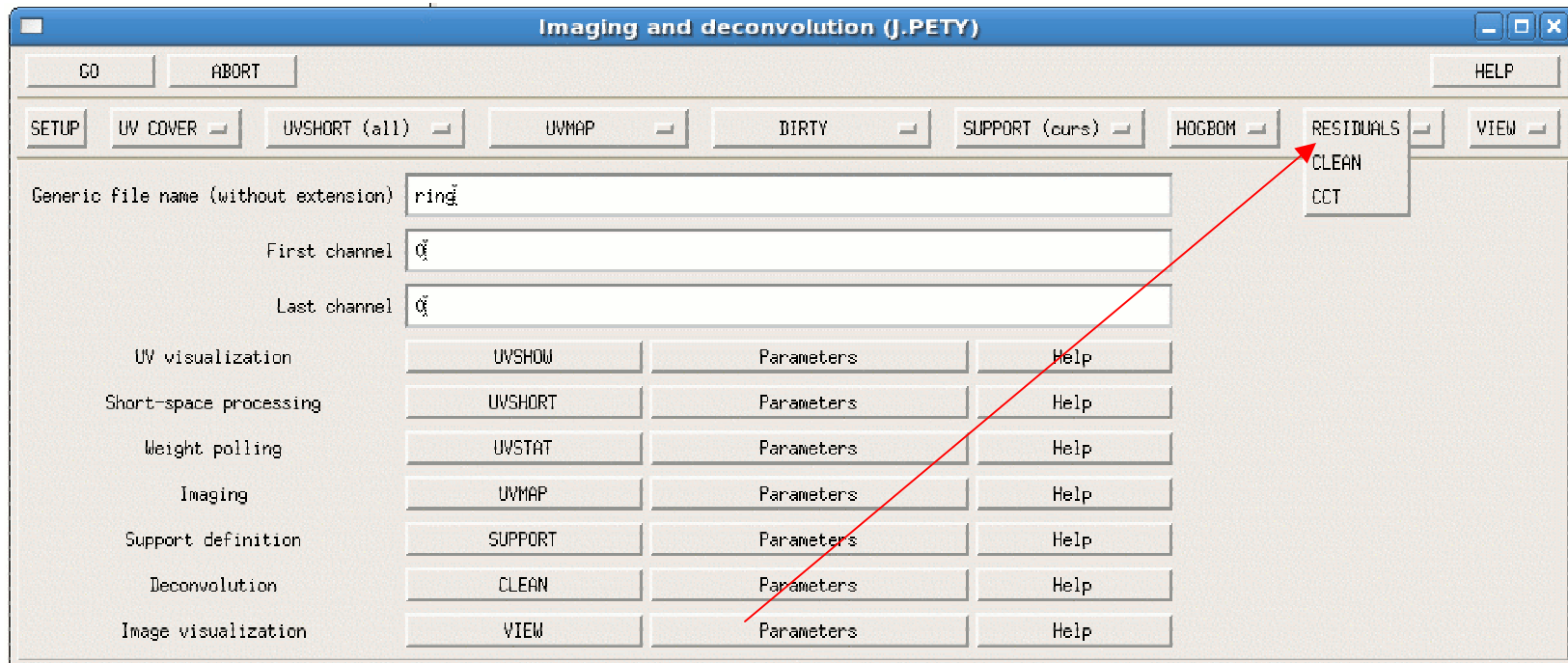
MULTI smoothing factor: 1.7320507764816

Bottom Left corner: 0

Top Right corner: 0

Go Dismiss Help

Imaging in practice



go bit

let type lmv-res

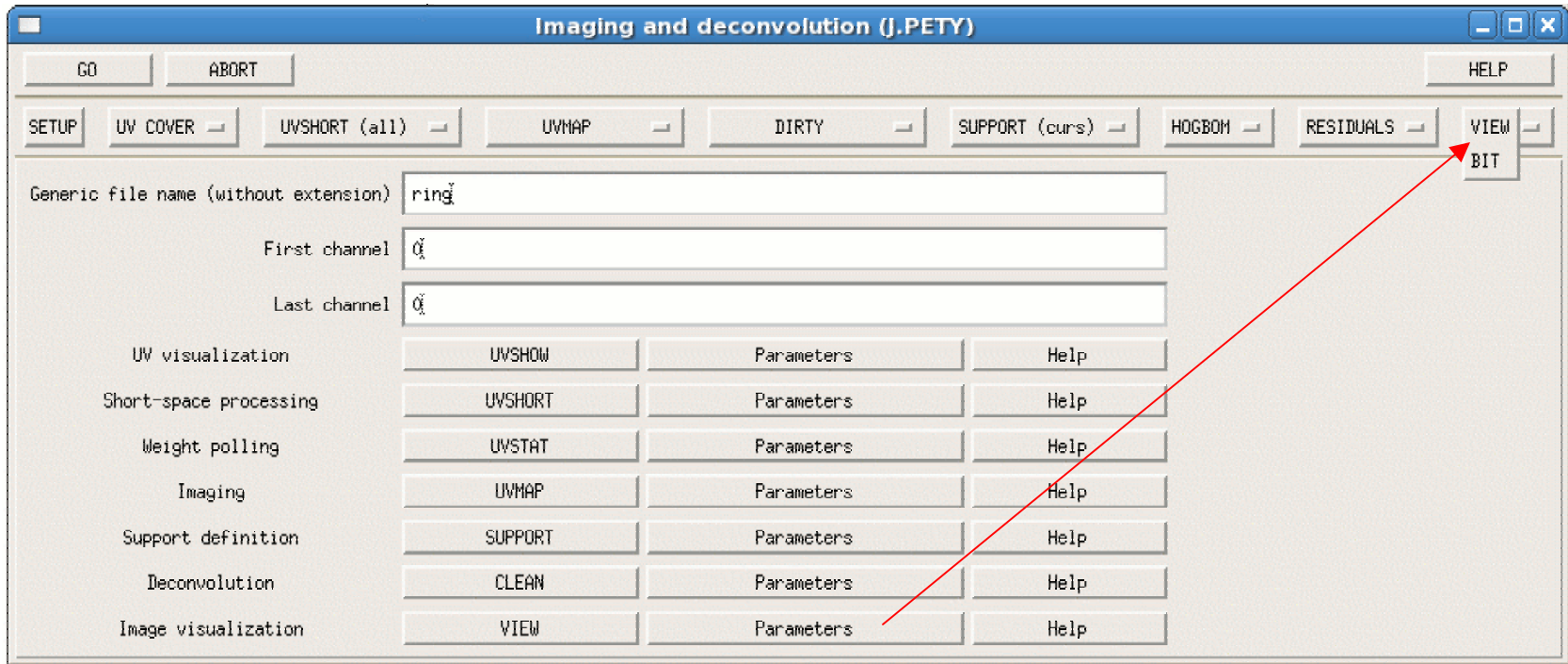
let type lmv-clean

let size 60

let spacing 0.02 , etc

input bit

Imaging in practice



go view
go bit

let name ring

let type lmv-clean

let size 60

let spacing 0.02 , etc

input bit / input view

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, which is divided into three main sections:

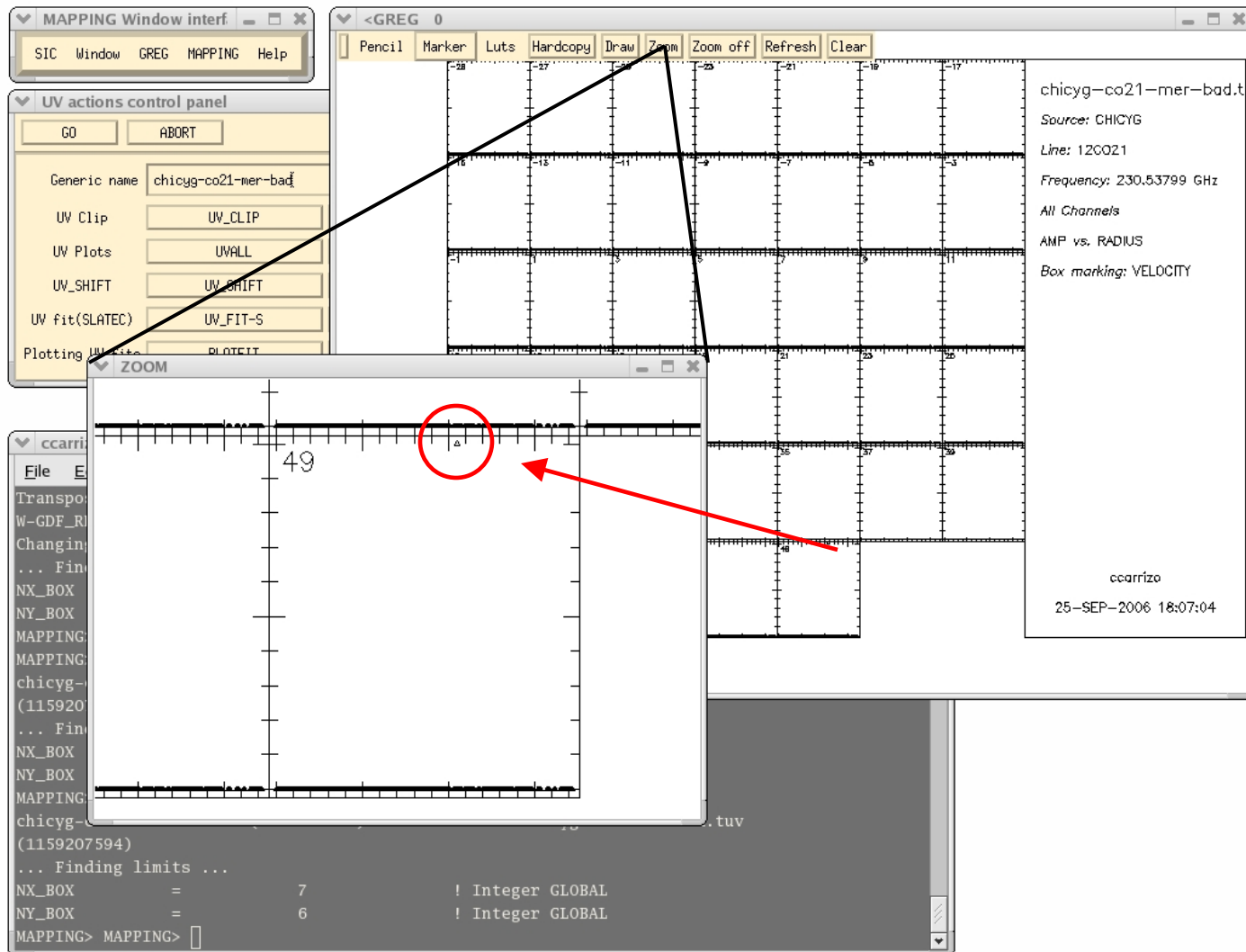
- MAPPING Control Panel:** This panel contains various controls for the mapping process. It includes buttons for "GO", "ABORT", and "READ". Below these are input fields for "Generic name" (set to "chicyg-co21-mer-bad"), "Image type to show" (set to "DIRTY"), "First channel" (set to "0"), and "Last channel" (set to "0"). There are also dropdown menus for "Mosaic from UV data" (set to "MOSAIC"), "Mapping from UV data" (set to "UV_MAP"), "Get support" (set to "SUPPORT"), "HOGBOM method" (set to "Hogbom"), "CLARK method" (set to "Clark"), "SDI method" (set to "Sdi"), "MRC method" (set to "Mrc"), "Multiscale method" (set to "Multi"), and "Show image" (set to "SHOW").
- <GREG 0 Map Window:** This window shows a 2D map of the sky. The map is a grid of green squares, with a black square in the bottom right corner. The axes are labeled with coordinates: the x-axis ranges from 16 to 33, and the y-axis ranges from 32 to 34. The map is titled "chicyg-co21-mer-bad.l" and includes the following metadata: "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 user "ccarrizo" is credited, and the date and time are "25-SEP-2006 17:55:30".
- Terminal Window:** This window shows the output of the mapping process. The text is as follows:

```
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

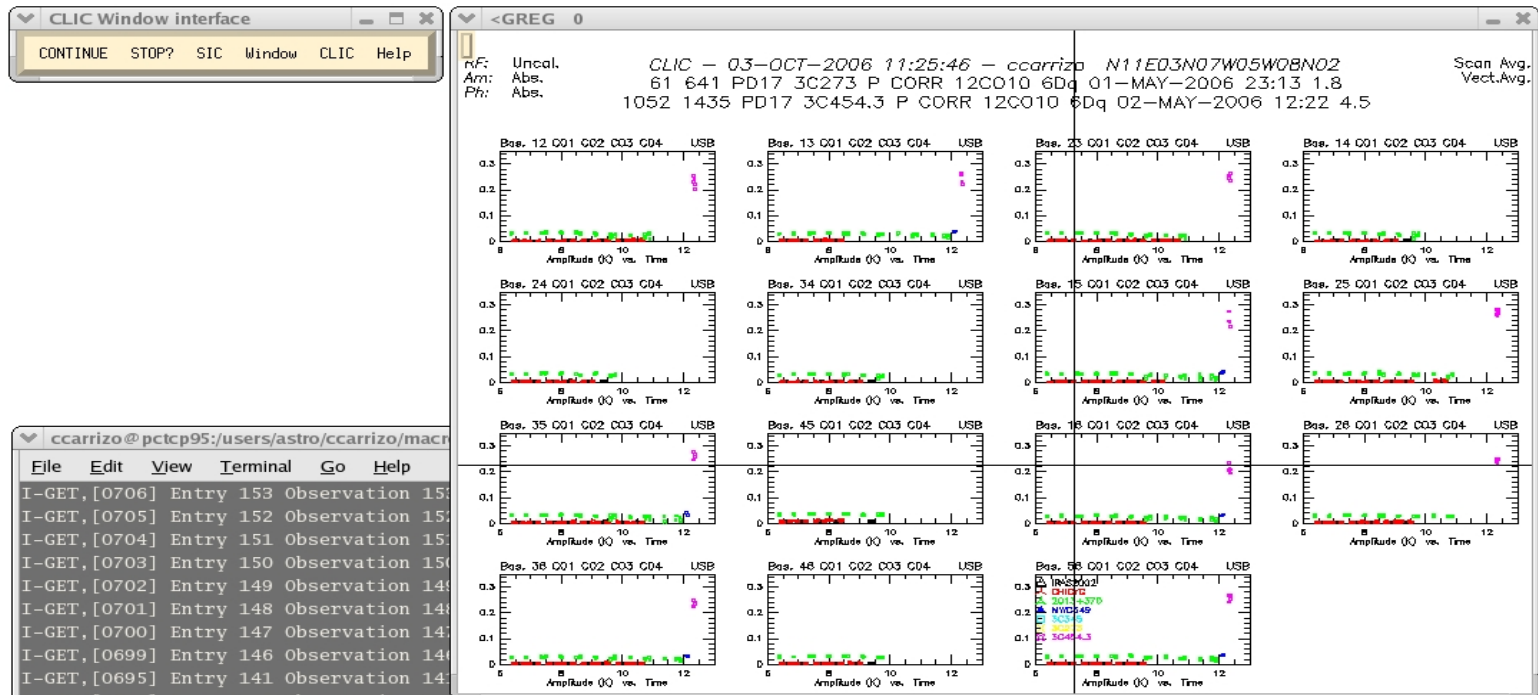
It may happen...



(1)

Passing directly from hpb → mapping

It may happen... that it remains a wrong visibility

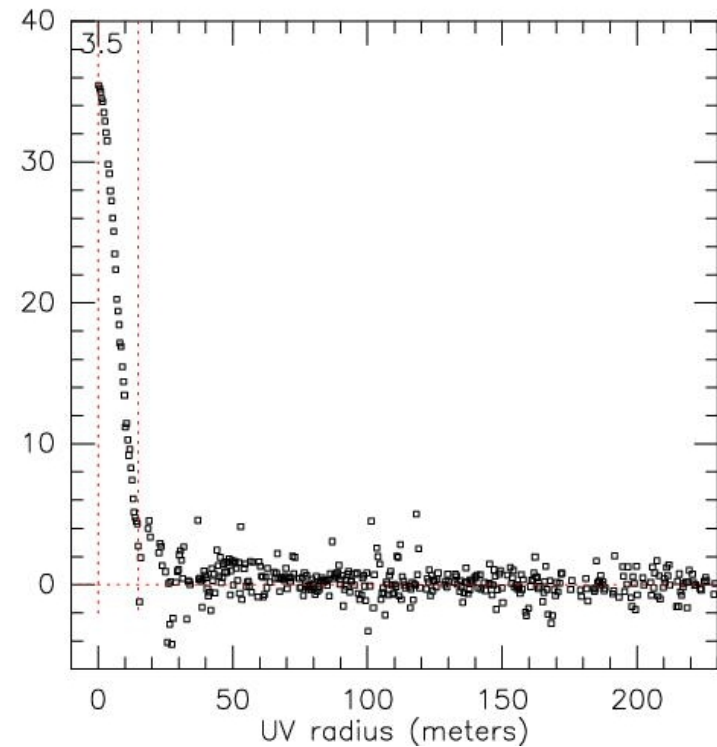
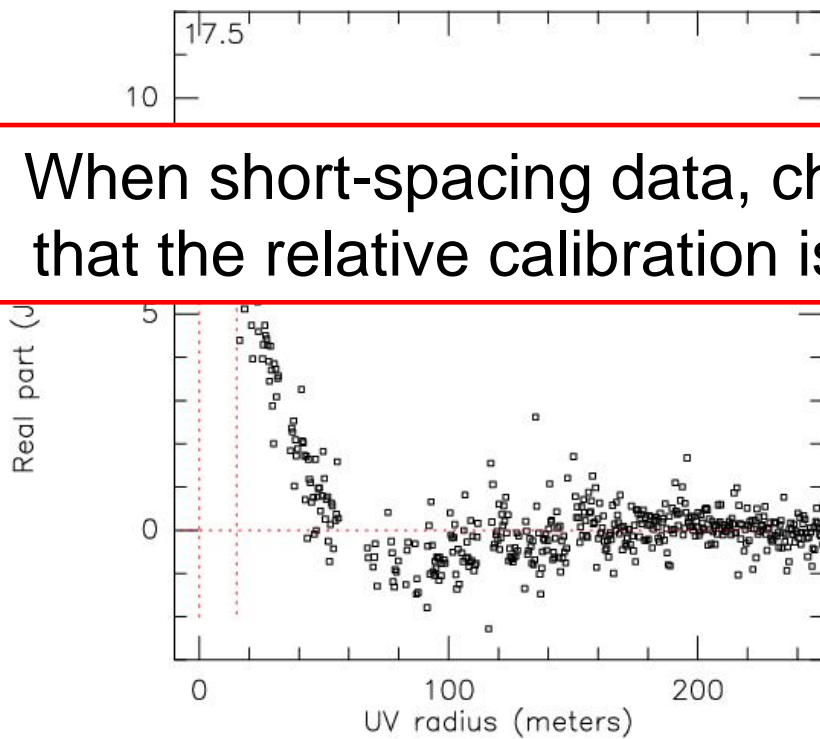


```
CLIC> find /proc corr /sou Betel /rece 2 /scans 1245 1255  
CLIC> store quality 9
```


(2)

Passing directly from hpb → mapping

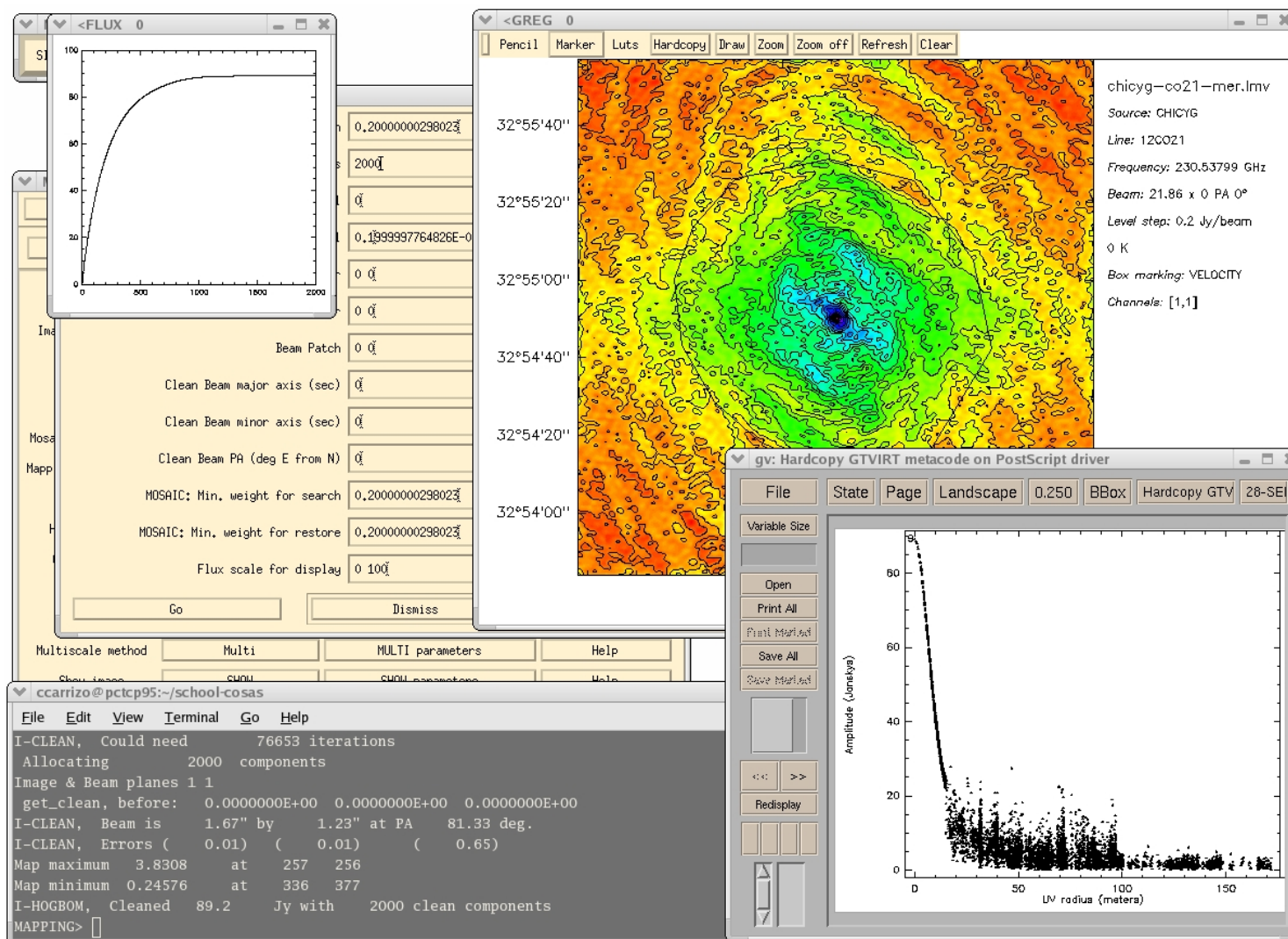
When short-spacing data, check that the relative calibration is ok



+ Short-spacing data

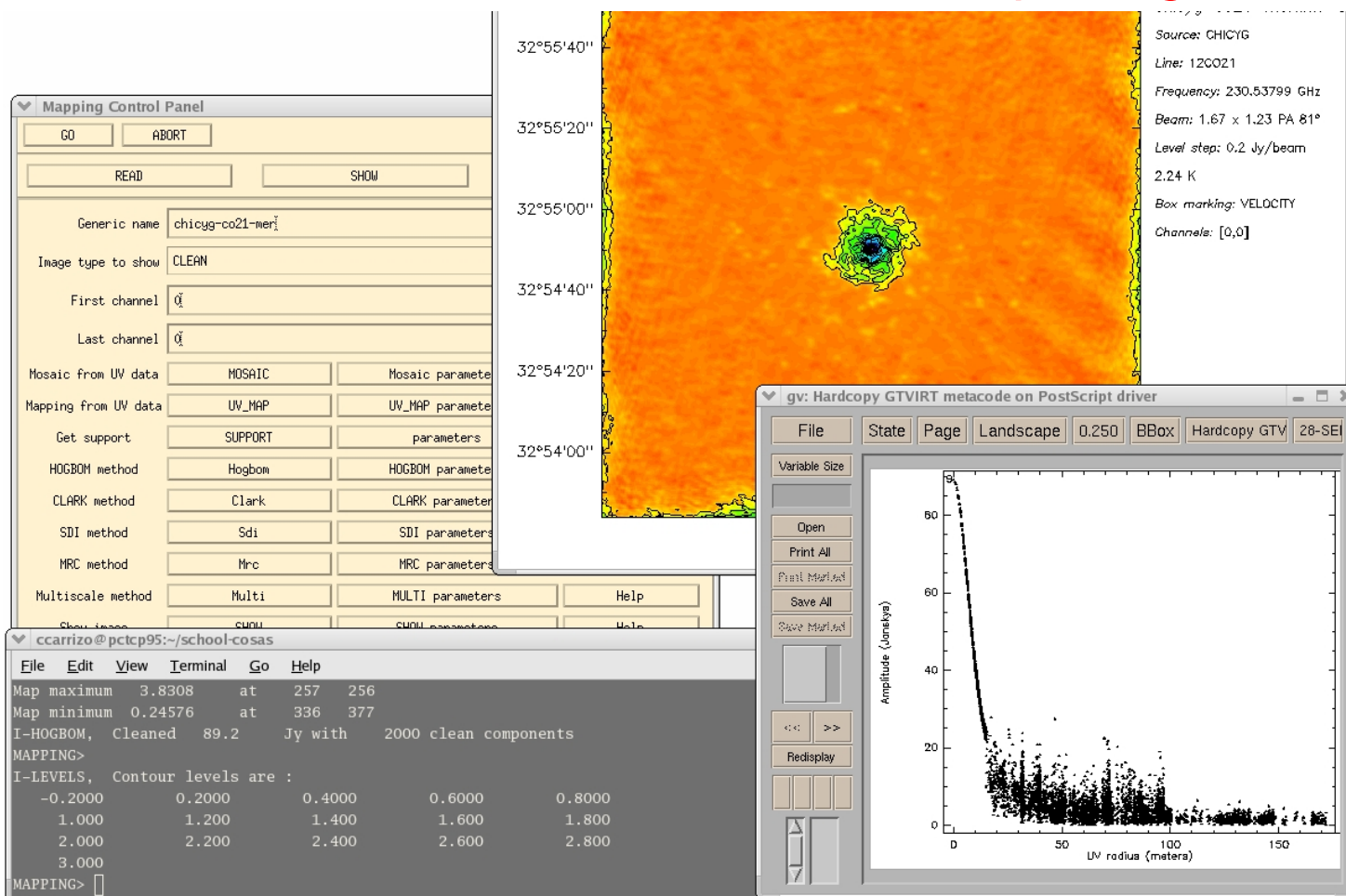
(3) Passing directly from hpb → mapping

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



(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...

The image displays a software interface for astronomical data mapping, consisting of three main windows:

- MAPPING Window interf**: A small menu bar with options: SIC, Window, GREG, MAPPING, Help.
- Mapping Control Panel**: A control panel with buttons for GO, ABORT, READ, and SHOW. It contains several input fields and method selection buttons:
 - Generic name: `chicyg-co21-mer`
 - Image type to show: `DIRTY`
 - First channel: `0`
 - Last channel: `0`
 - Mosaic from UV data: `MOSAIC` (Mosaic parameters)
 - Mapping from UV data: `UV_MAP` (UV_MAP parameters)
 - Get support: `SUPPORT` (parameters)
 - HOGBOM method: **Hogbon** (HOGBOM parameters) - This option is circled in red.
 - CLARK method: `Clark` (CLARK parameters)
 - SDI method: `Sdi` (SDI parameters)
 - MRC method: `Mrc` (MRC parameters)
 - Multiscale method: `Multi` (MULTI parameters)
- <GREG 0**: A window displaying a spectral line map. The map shows a central peak with concentric contours, color-coded from blue (low intensity) to red (high intensity). The axes are labeled with coordinates: `32°55'40"` to `32°54'00"` on the vertical axis and `19h50m35s` to `30s` on the horizontal axis. To the right of the map, technical details are listed:
 - chicyg-co21-mer.lmv
 - Source: CHICYG
 - Line: 12CO21
 - Frequency: 230.53799 GHz
 - Beam: 21.86 x 0 PA 0°
 - Level step: 0.2 Jy/beam
 - 0 K
 - Box marking: VELOCITY
 - Channels: [0,0]
 - ccarrizo
 - 28-SEP-2006 10:55:44
- Terminal**: A terminal window showing the execution of the mapping software:

```
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...

The screenshot displays several windows from an astronomical software package. At the top left, a window titled '<FLUX 0' shows a plot of flux versus position. To its right, a window titled '<GREG 0' displays a color-coded image of a source with overlaid contours. A red-bordered box is superimposed over the center of the image, containing the following text:

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

Below the image, a panel shows various cleaning methods and their parameters:

Get support	SUPPORT	parameters
HOGBOM method	Hogbom	HOGBOM parameters
CLARK method	Clark	CLARK parameters
SDI method	Sdi	SDI parameters
MRC method	Mrc	MRC parameters
Multiscale method	Multi	MULTI parameters
Show image	SHOW	SHOW parameters

At the bottom, a terminal window shows the following output:

```
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
- About imaging, this afternoon more...