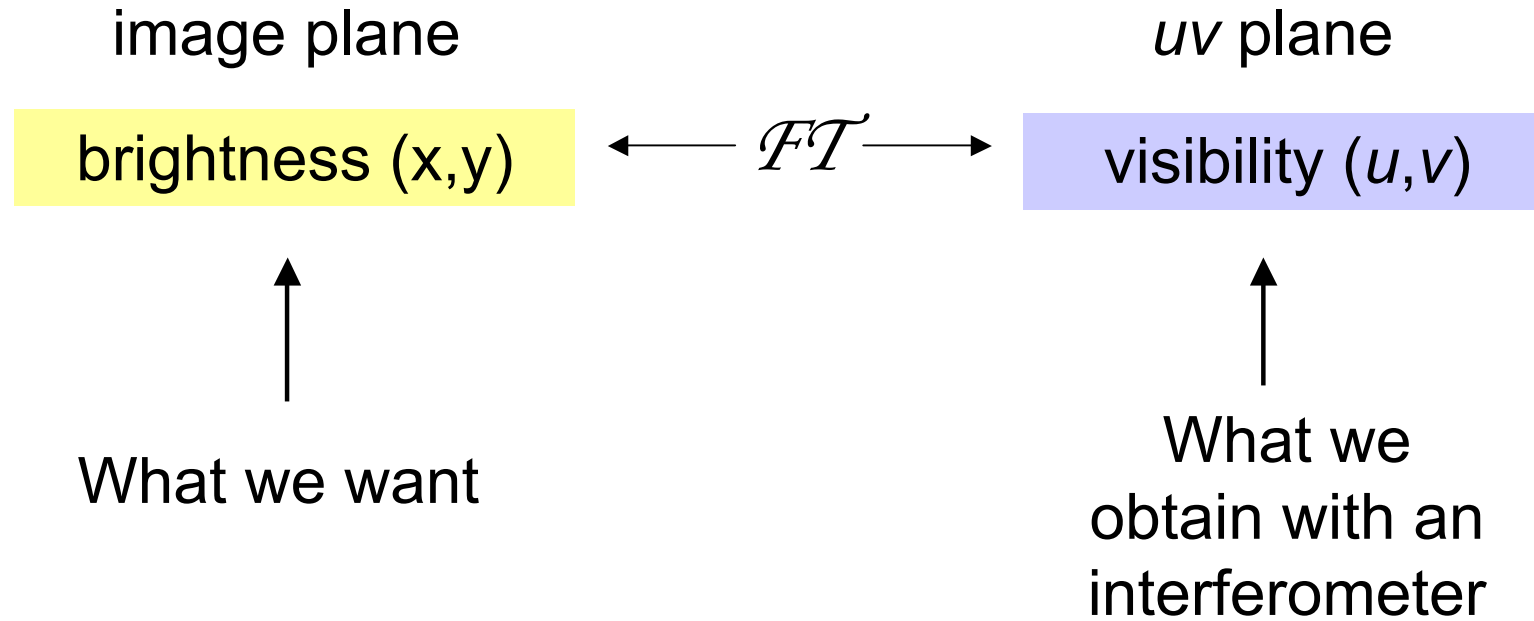


# PdBI *uv*-data analysis in practice



Chiara Feruglio  
A. Castro-Carrizo

# General Picture



# General Picture

image plane

brightness  $(x,y)$

$uv$  plane

visibility  $(u,v)$  <sup>instr</sup> **IPB data**

≈

**Imv\* (gdf)**

brightness  $(x,y)$   <sup>$uv$</sup>

↓  
Calibration

↓ **hpb files**

visibility  $(u,v)$  <sup>obs</sup> **uv-table**

Gridding

FFT

Cleaning

- Data processed enough to have removed all instrumental contribution

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

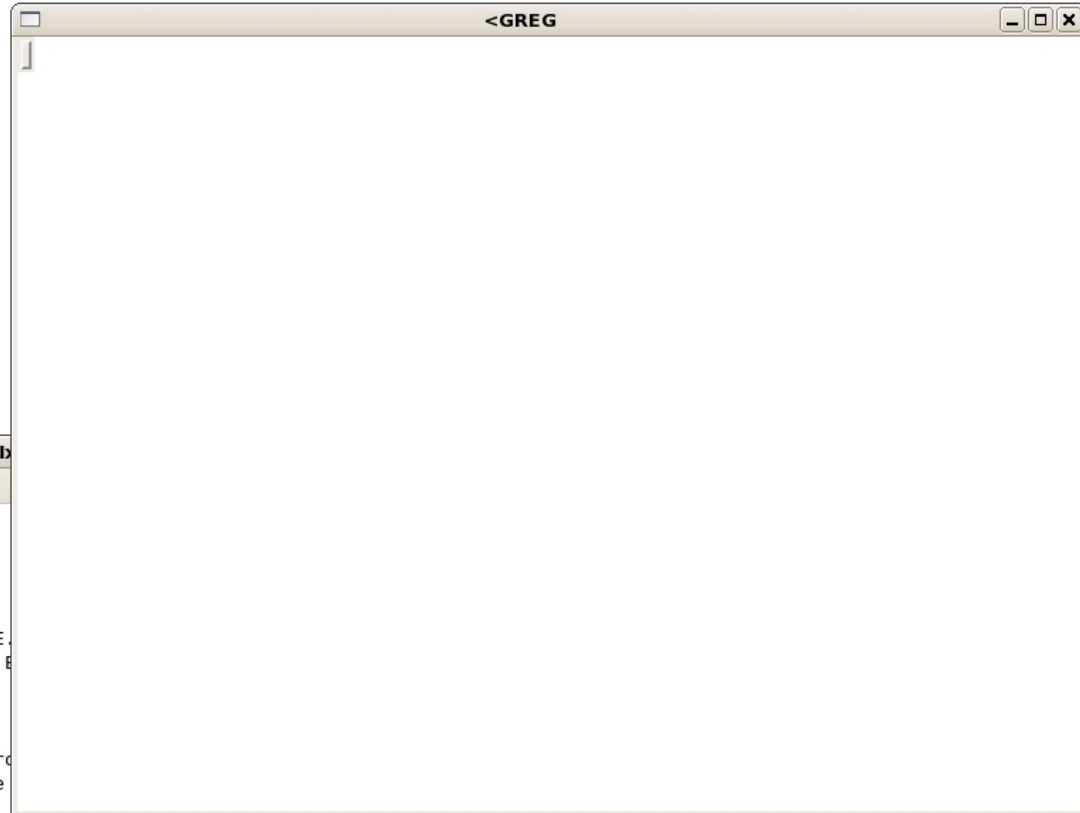
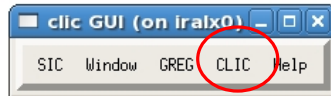
- Data not yet affected by the 'imaging process': assumptions, interpolations, computations, etc.

# 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

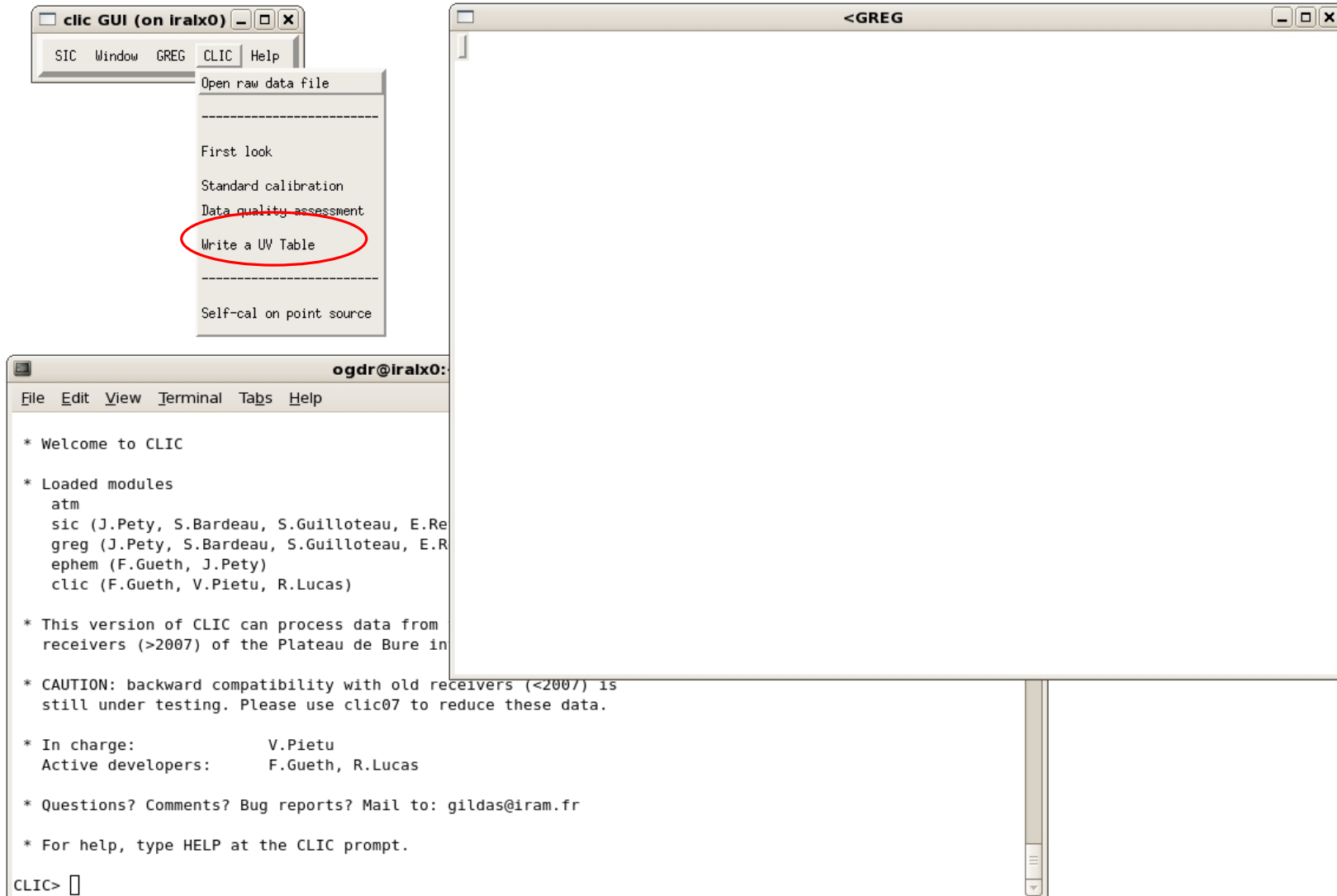
Let's create a table ("mytable".uvt),  
in **CLIC**

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



```
ogdr@irab  
File Edit View Terminal Tabs Help  
  
* Welcome to CLIC  
  
* Loaded modules  
  atm  
  sic (J.Pety, S.Bardeau, S.Guilloteau, E.  
  greg (J.Pety, S.Bardeau, S.Guilloteau, E.  
  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  
  
* 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



# Creating a uv-table; CLIC

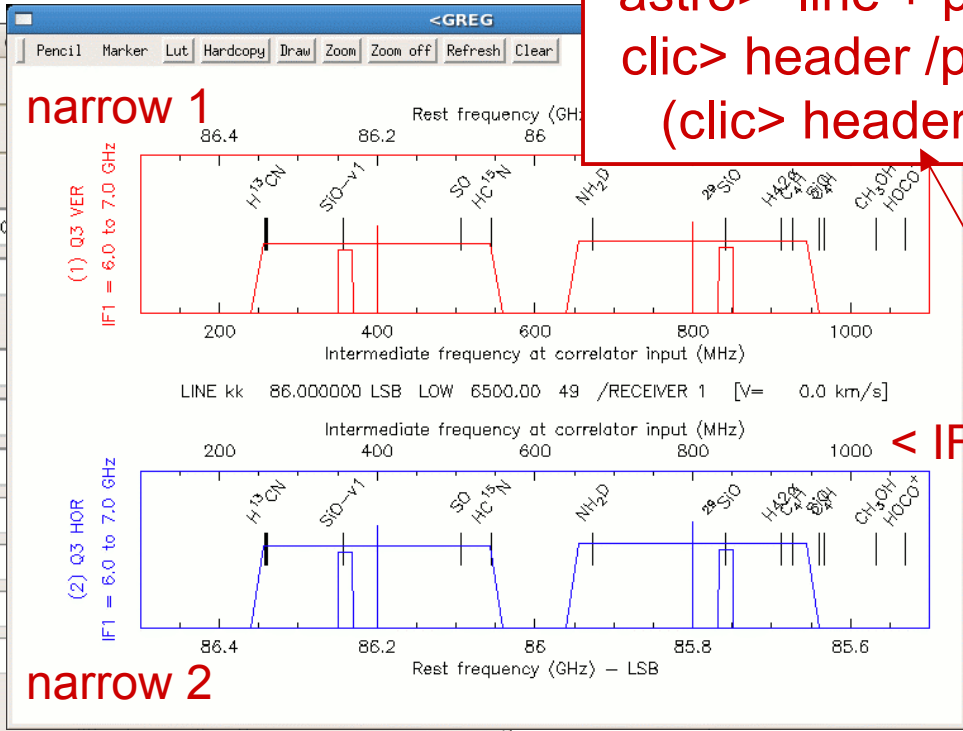
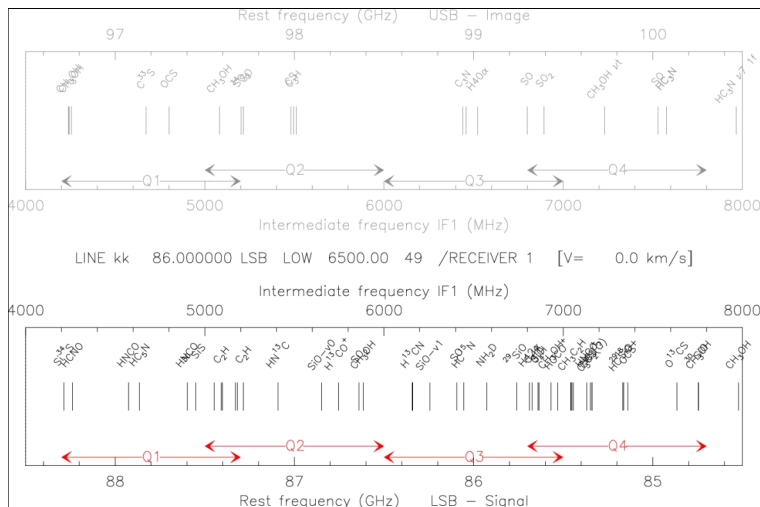
The screenshot displays the 'Simple UV Table creation (on iralx0)' GUI. The window title is 'Simple UV Table creation (on iralx0)'. It features a 'CREATE THE TABLE' section with various input fields and checkboxes. The 'Input Data File Name' is set to '/users/PdBdata/ogdr/ischool/2010/wide/20-jun-2010-wide.hpt'. The 'Output UV Table Name' is 'wide-co21.uvt'. The 'New Table' checkbox is checked. The 'Source Name' is 'MFS-10'. The 'R.A. & Dec. Offsets (for Mosaics)' is '0'. The 'First and last scan' is '0 10000'. The 'Receiver number' is '2'. The 'Line or Continuum' is 'LINE'. The 'Band Used' is 'LSB'. Below these fields is a list of line parameters (L01-L12) with checkboxes for 'Yes' or 'No'. The 'Narrow band Corr' section (L01-L08) is circled in green, and the 'WideX' section (L09-L12) is also circled in green. The 'Change line parameter' checkbox is checked. The 'Resample spectral data' checkbox is checked. At the bottom, there are buttons for 'Line parameters', 'Resampling parameters', and 'Help'. A terminal window on the left shows the CLIC command prompt with the following text:

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



# Creating a *variable* QIF

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



< IF3 units

New Table?  Yes

Source Name? MFS-22

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

First and last scan? 0 10000

Min. Data quality? AVERAGE

Receiver number? 1

Line or Continuum? LINE

Band Used? LSB

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

Line parameters

Change line parameter?  Yes

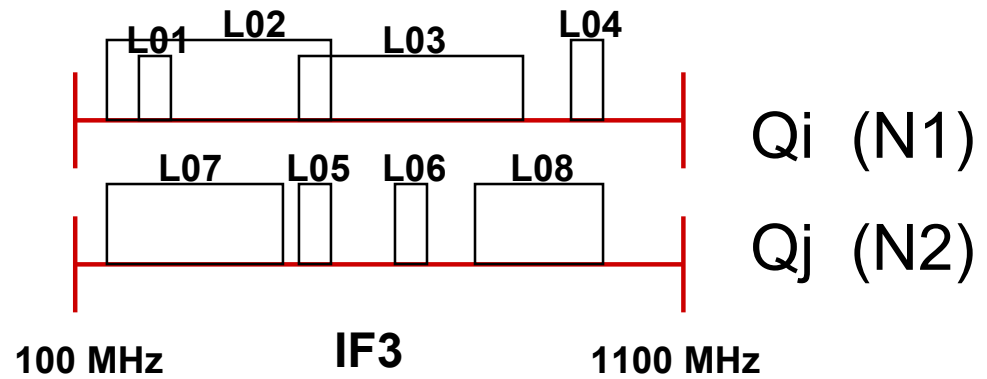
Line Name: 29sid

Rest Frequency (MHz): 85759.144

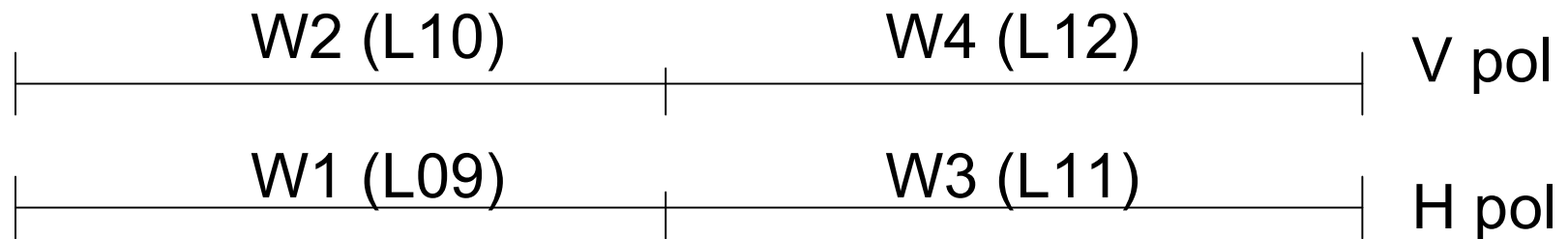
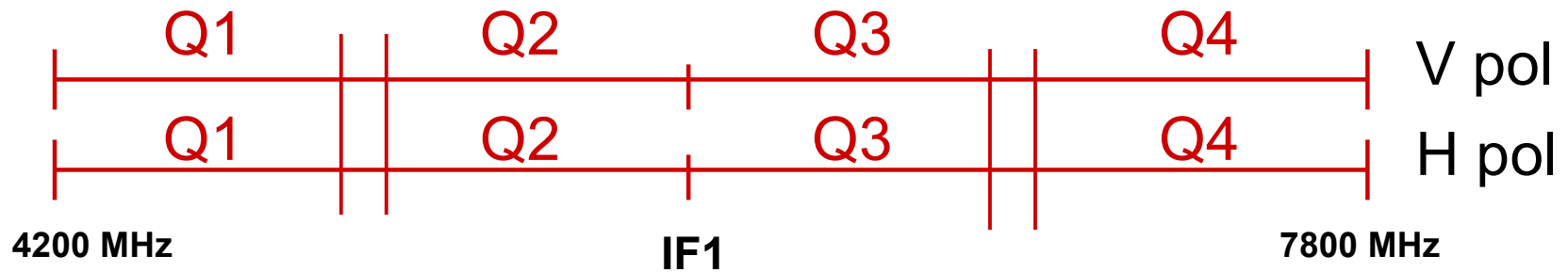
Go Dismiss Help

narrow  $Q_i$   $Q_j$

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



**Narrow Band Correlator** CONFIG



**Wide Band Correlator** FIXED

Talk of JM Winters tomorrow

# Creating a *uv*-table; CLIC

The screenshot displays the 'Simple UV Table creation' software interface. The main window has a title bar with standard window controls and buttons for 'GO', 'ABORT', and 'HELP'. Below the title bar is a 'CREATE THE TABLE' section. The main area contains several input fields and checkboxes:

- 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

At the bottom of the main window, there are two rows of buttons:

- Line parameters:
- Resampling parameters:

The 'Resampling parameters' window is overlaid on the main window. It has a title bar with standard window controls and buttons for 'Go', 'Dismiss', and 'Help'. The main area contains several input fields:

- Resample spectral data ?  Yes
- New number of channels
- New reference channel
- Velocity at the reference channel
- New resolution

```
ogdr@iraix0:~/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 afql-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 afgl-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 afgl-sio.uvt-table.cllic
SIC#
```

CLIC

Easy and faster  
edit table script

afgl-sio.uvt-table.cllic

```
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
```

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

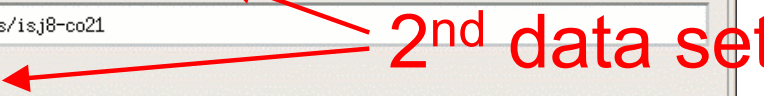
Use L08 ?  No

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

2<sup>nd</sup> data set



```
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 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
```

```
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-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).
```

```
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 DROP.

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

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

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

Mosaic

2<sup>nd</sup> data set

# Creating a uv-table

## Structure of uv tables

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 1<sup>st</sup> channel
- imaginary part 1<sup>st</sup> channel
- weight 1<sup>st</sup> channel

data at 1<sup>st</sup> channel

- real part for 2<sup>nd</sup> channel
- imaginary part 2<sup>nd</sup> channel
- ...

data at 2<sup>nd</sup> channel

Created “mytable”.uvt, in **CLIC**

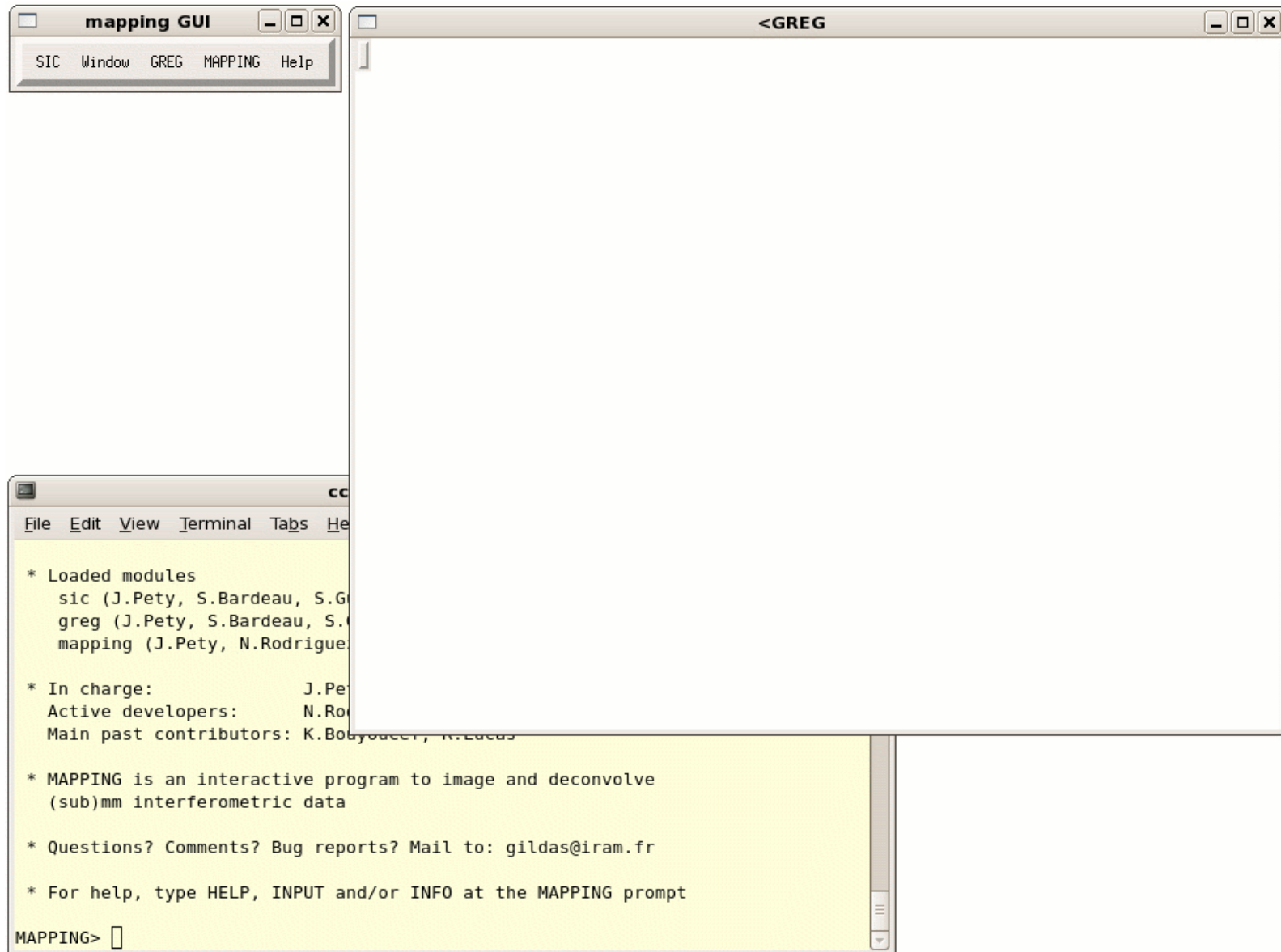


Analyze the data, in **MAPPING**

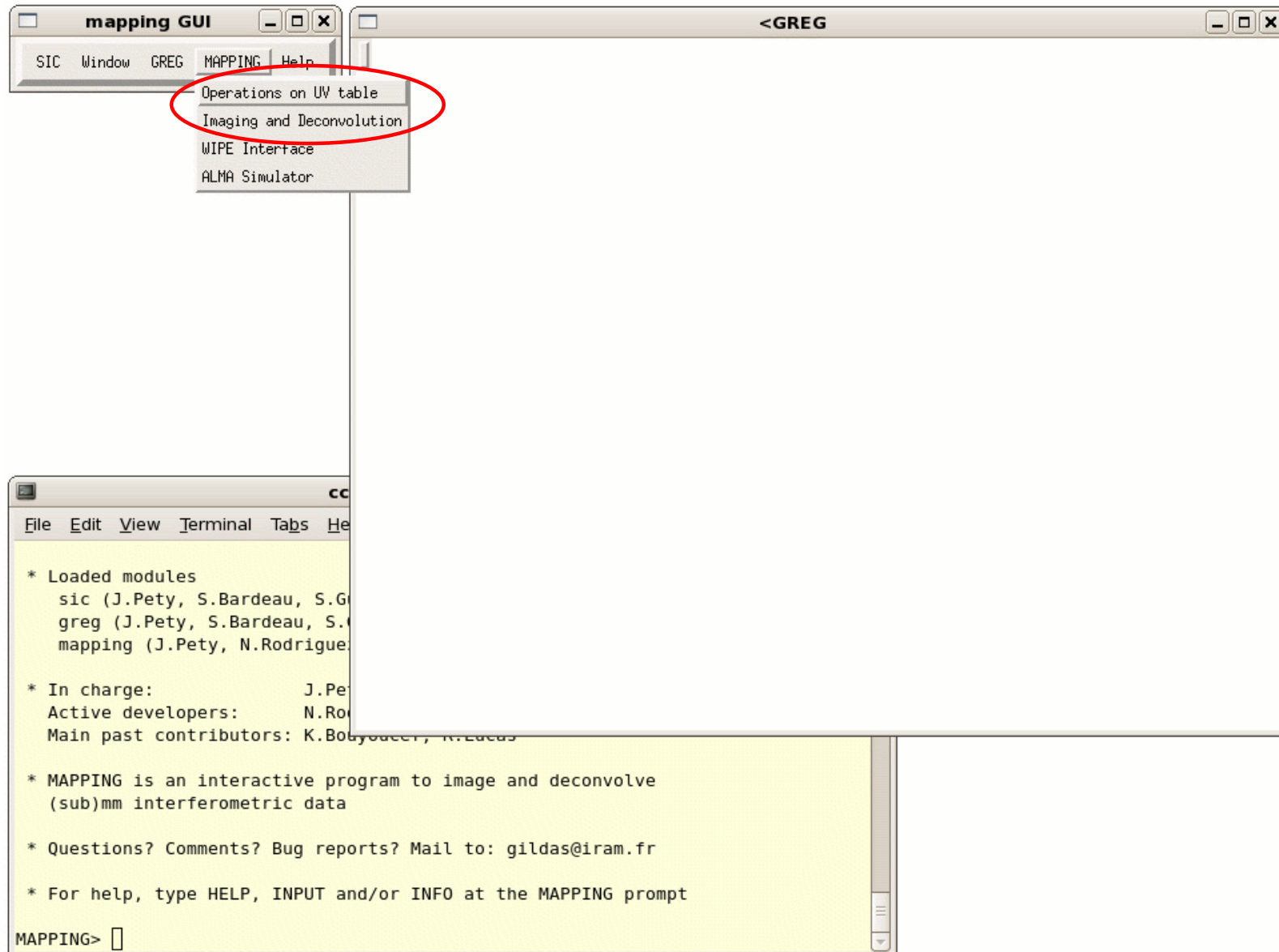


# 1. Data analysis in the $uv$ -plane

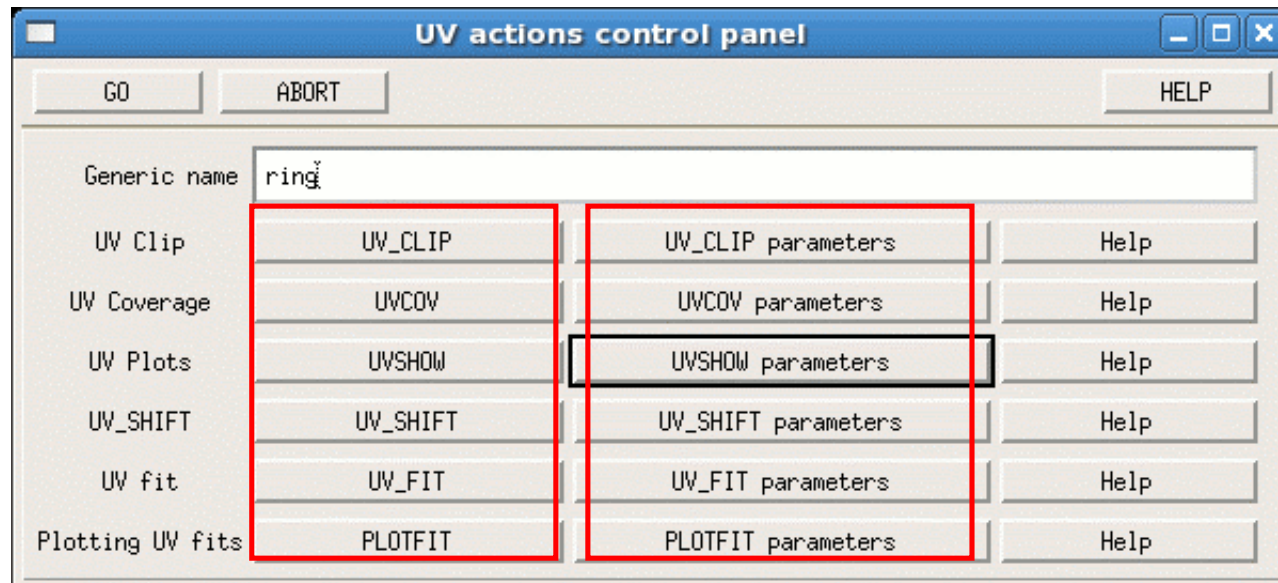
# Data analysis in the $uv$ -plane; **MAPPING**



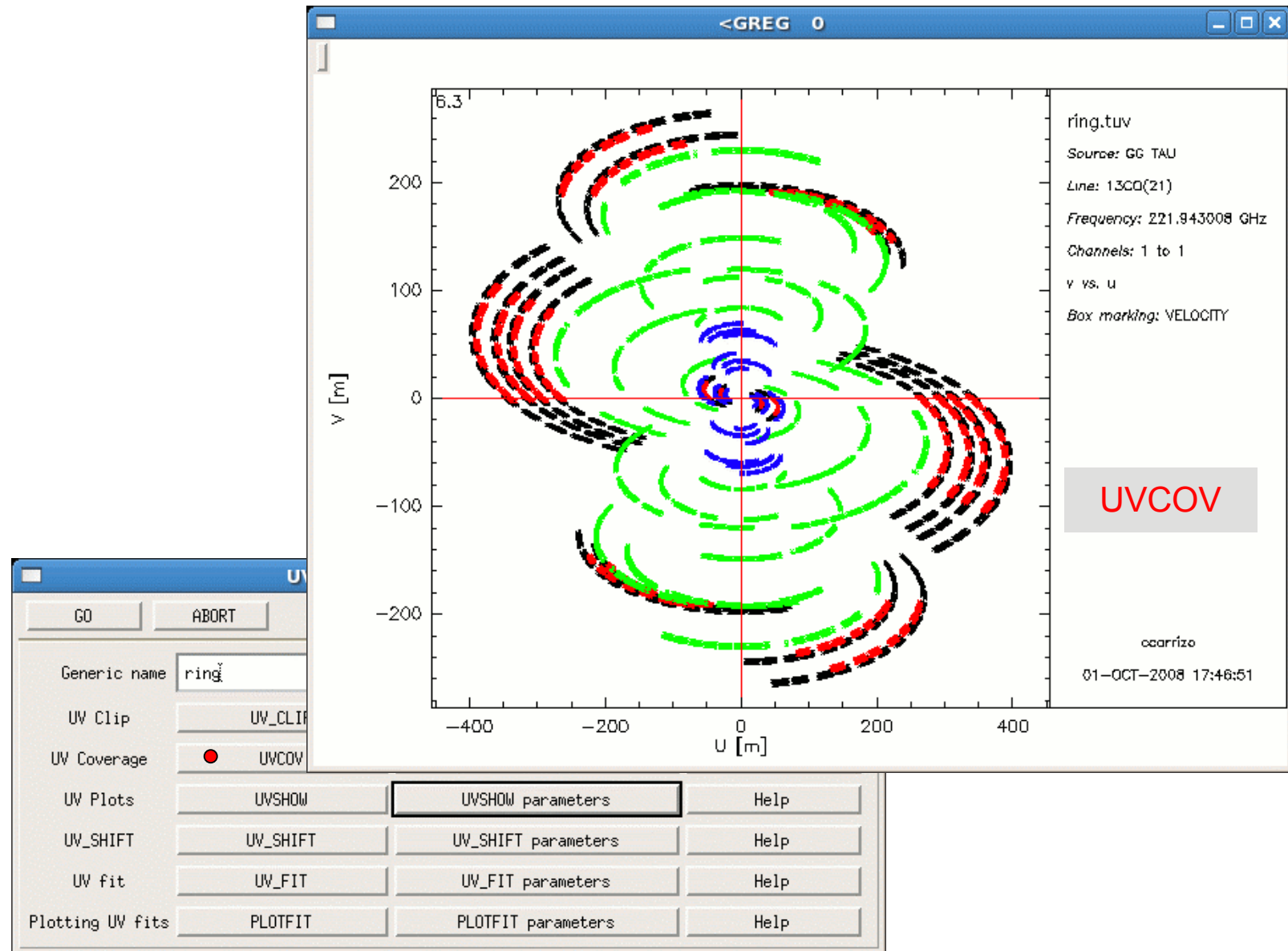
# Data analysis in the *uv*-plane



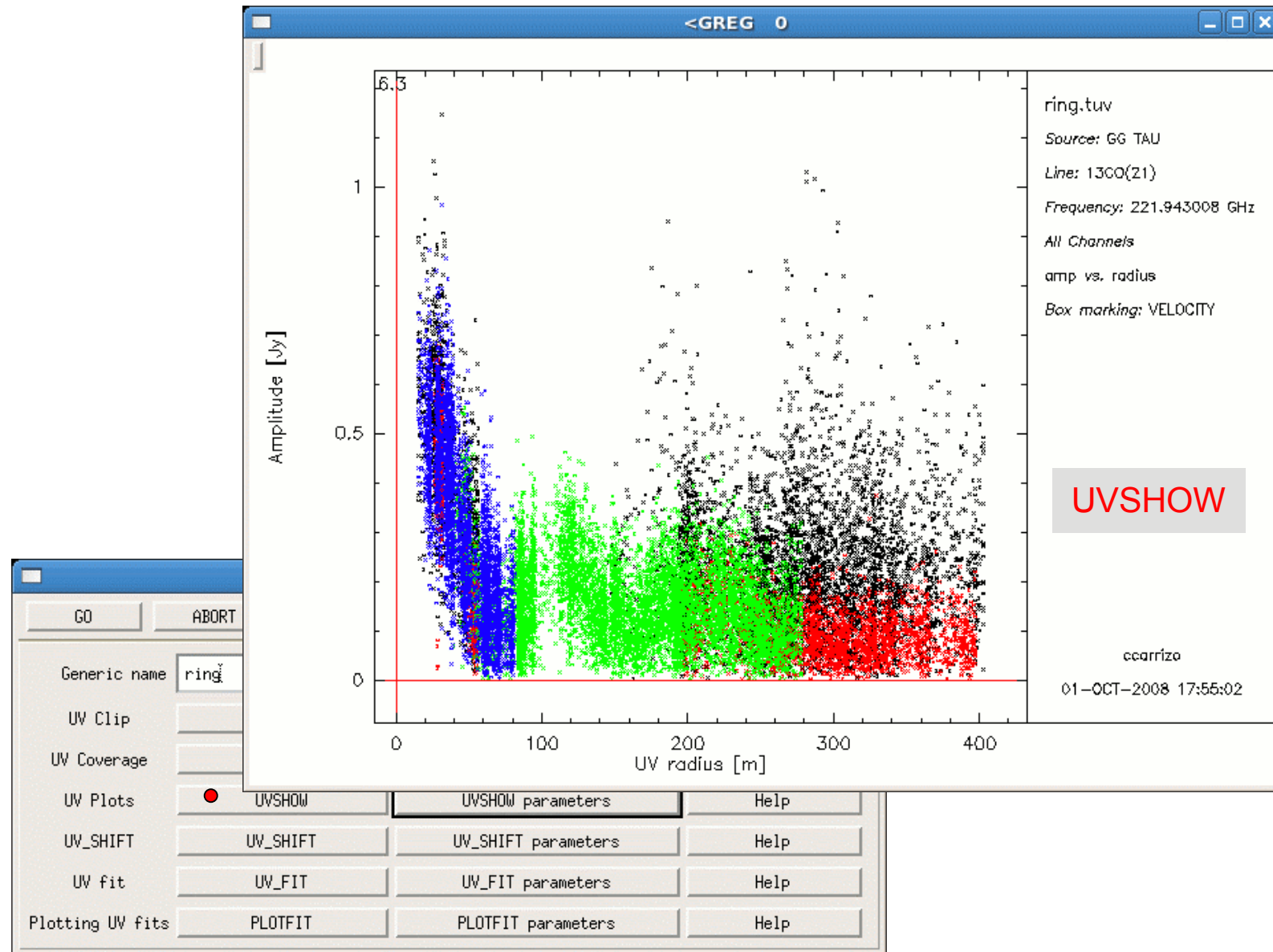
# Data analysis in the *uv*-plane



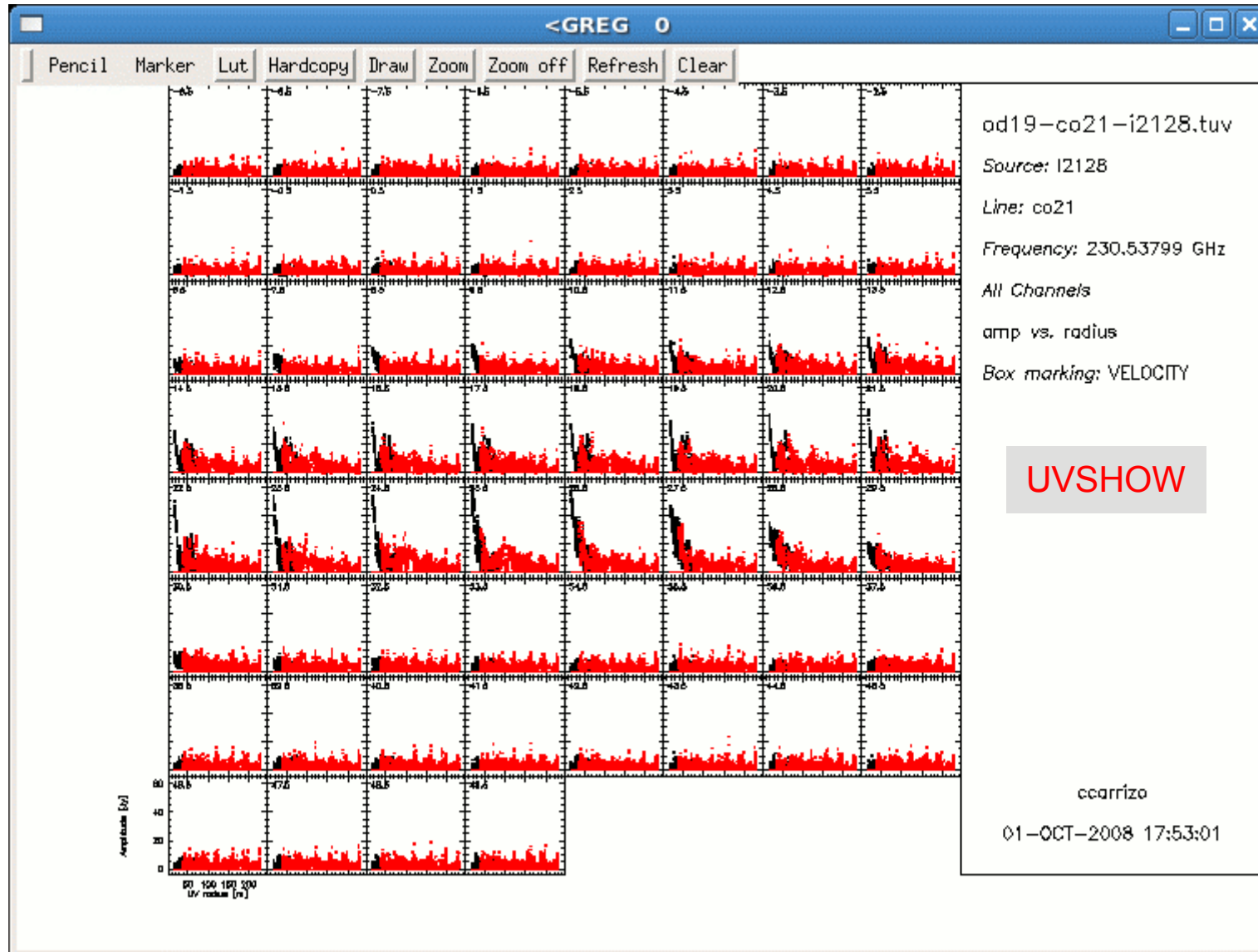
# Data analysis in the $uv$ -plane



# Data analysis in the *uv*-plane



# Data analysis in the *uv*-plane



# Data analysis in the *uv*-plane

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

- UV actions control panel:** A window with a menu bar (SIC, GO, ABORT, HELP) and a table of actions. The 'UV SHOW parameters' button is highlighted with a red box.
- UVSHOW parameters:** A dialog box for configuring the UVSHOW action. It includes fields for 'Generic name' (ring), 'X data' (radius), 'Y data' (amp), '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), and 'Marker definition as in the SET MARKER command' (4 1 .1). A 'Choices' menu is open, showing options like 'u', 'v', 'angle', 'radius', 'time', 'date', 'scan', 'number', 'amp', 'phase', 'real', 'imag', and 'weight'.
- Terminal:** A window showing the command prompt 'MAPPING>' and a list of map-related parameters and status messages.

**UV actions control panel details:**

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

**UVSHOW parameters details:**

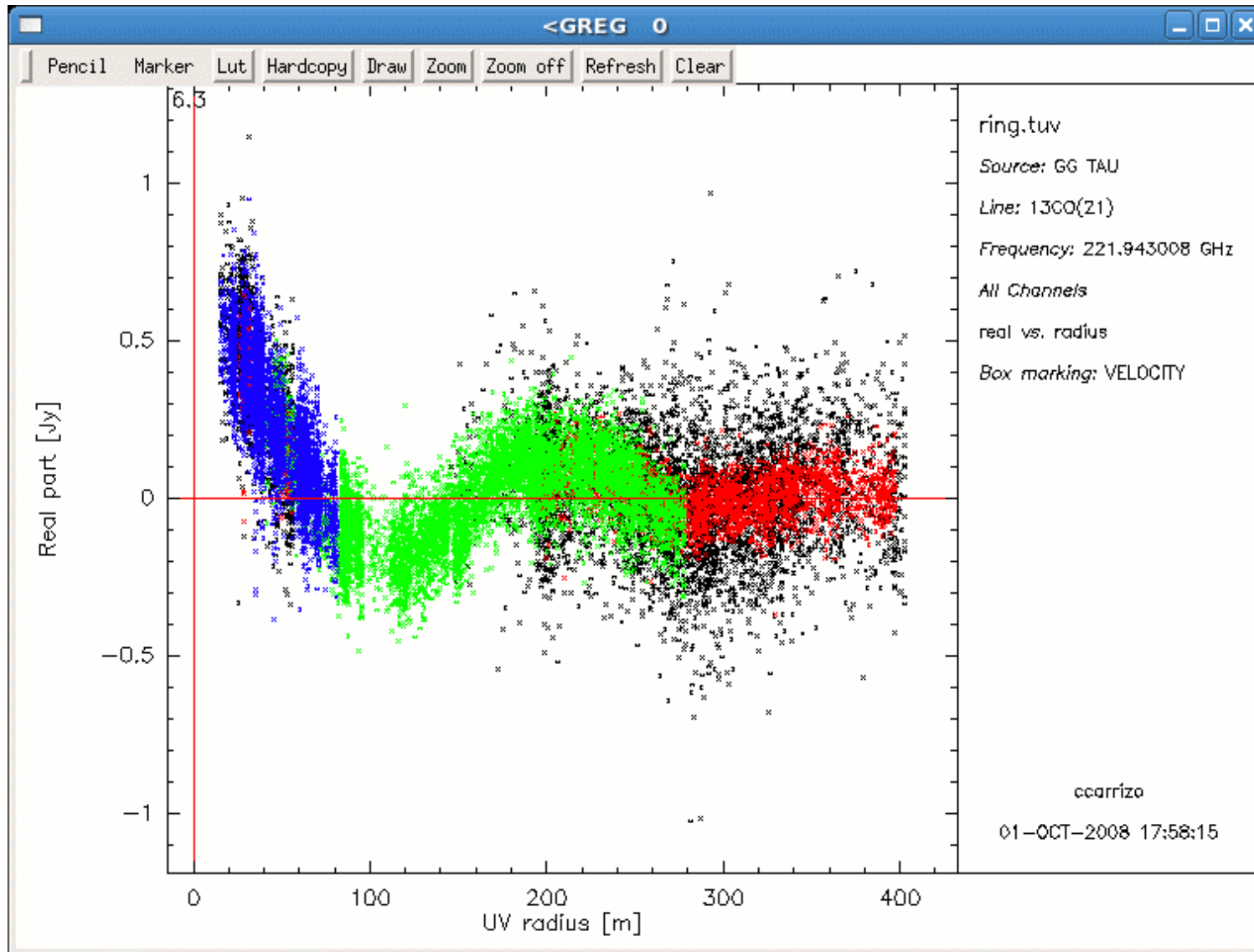
Generic name: ring  
X data: radius  
Y data: amp  
First channel: 0  
Last channel: 0  
Plot limits: 1  
Plot model fit:  No  
Display zero level?:  Yes  
Use one color per track?:  Yes  
Typical time separating 2 tracks [hrs]: 12  
Marker definition as in the SET MARKER command: 4 1 .1

**Terminal output:**

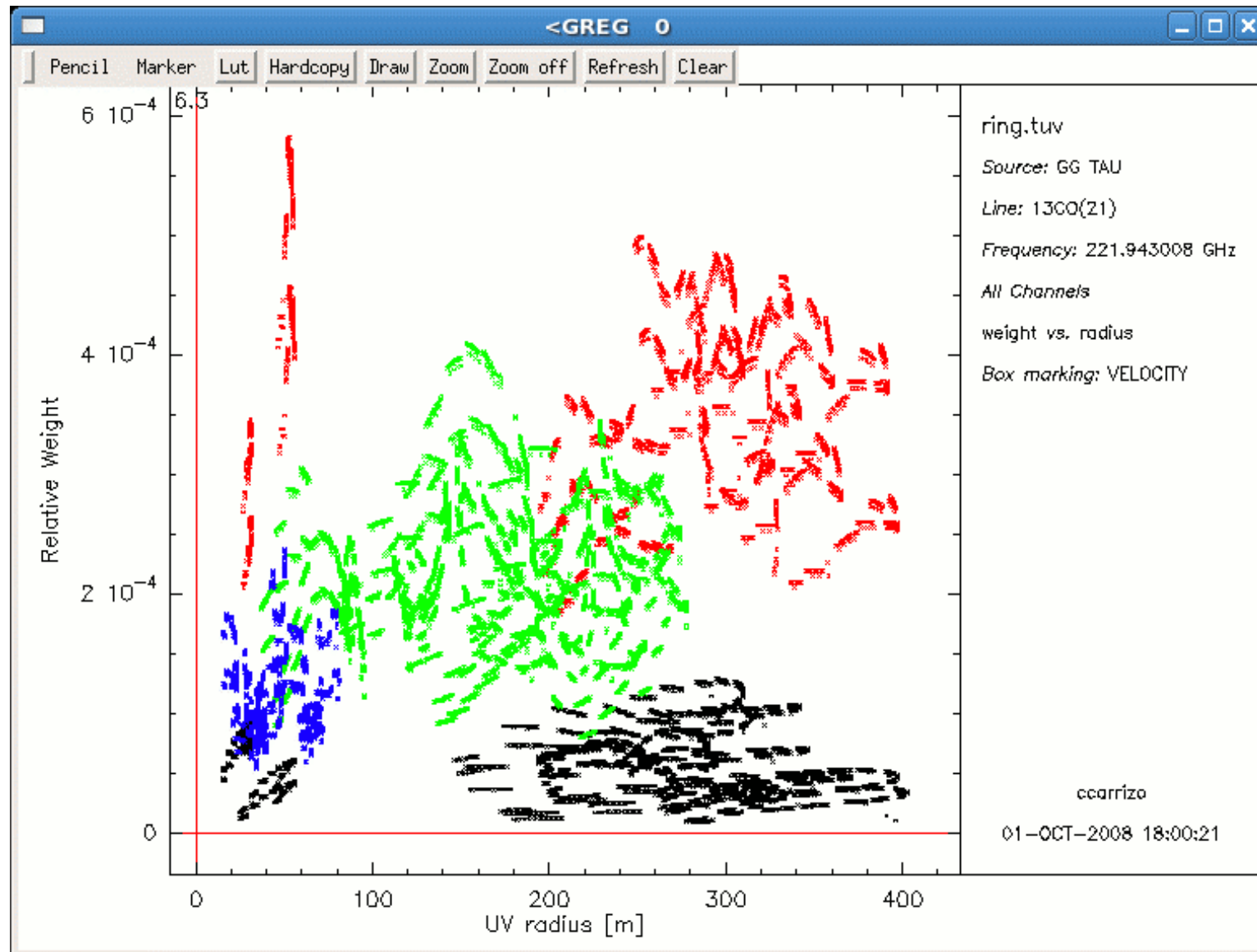
```
File Edit View Terminal
Map size
Map cell
Imaged Area
Still to be imaged
Still to be cleaned
I-GDF_RIH, Image file 1
U-GDF_RIH, UVT order :
W-GDF_RHSEC, Absent section
W-GDF_RHSEC, Absent section
I-GDF_DAMS, Patching old
I-UVSHOW, Finding limits
I-UVSHOW, Number of found
W-UVALL, Obsolescent. Please
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
```

control panel

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

Last channel 0

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

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 section  
I-GDF\_DAMS, Patching old U  
I-UVSHOW, Finding limits  
I-UVSHOW, Number of found

W-UVALL, Obsolescent. Plea  
MAPPING>  
MAPPING>

# Data analysis in the *uv*-plane

The image displays a software interface for uv-plane data analysis, consisting of several windows:

- UV actions control panel:** A window with a menu bar (SIC, GO, ABORT, HELP) and a list of actions. The 'UV\_SHIFT parameters' button is highlighted with a red box and a red dot. The generic name is 'ring'. To the right is a plot of the uv-plane with a list of parameters: ring.tuv, Source: GG TAU, Line: 13CO(21), Frequency: 221.943008 GHz, All Channels, real vs. radius, and Box marking: VELOCITY.
- UV\_SHIFT parameters:** A dialog box for configuring the selected action. It includes fields for Generic name (ring), Right Ascension, Declination, and Angle from North (0). Buttons for Go, Dismiss, and Help are at the bottom.
- Terminal window:** A window with a menu bar (File, Edit, View, Terminal) showing the following text:

```
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> [ ]
```

# Data analysis in the *uv*-plane

The screenshot displays three windows from a software interface:

- mapping GUI**: A window with a menu bar (SIC, Window, GREG, MAPPING, Help) and a toolbar (Marker, Lut, Hardcopy, Draw, Zoom, Zoom off, Refresh, Clear). The main area shows a plot with axes labeled "VELOCITY" and "943008 GHz".
- uv\_shift**: A dialog box with buttons "GO", "ABORT", and "HELP". It contains input fields for:
  - UV table to shift: `ring`
  - Offset (YES) or Absolute (NO) position:  No
  - Phase center offset (in radians): `0.000000`
  - R.A. center: `0.000000`
  - Declination center: `0.000000`
  - Angle: `0.000000`
- Terminal**: A window titled "ccarrizo@pctcp33:~" showing the following output:

```
File Edit View Terminal Tabs Help

Map size           Recommended      Used
Map cell           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. 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 title is '<GREG 0' and the file name is 'ring.tuv'. A 'UV actions control panel' is visible on the left, with buttons for 'GO' and 'ABORT'. Below these are several rows of controls, including 'Generic name' (ring), 'UV Clip' (UV\_CLIP), 'UV Coverage' (UVCOV), 'UV Plots' (UVSHOW), 'UV\_SHIFT' (UV\_SHIFT), 'UV fit' (UV\_FIT, highlighted with a red box and a red dot), and 'Plotting UV fits' (PLOTFIT). In the bottom left corner, there is a terminal window with 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> █
```

The 'UV\_FIT parameters' dialog box is open, showing the following fields:

- Generic name: ring
- First channel: 0
- Last channel: 0
- UV range(min, max) (meters): 0 800
- Number of Functions (1 or 2): 2
- Function 1: ring (with a 'Choices' dropdown menu showing options: point, c\_gauss, e\_gauss, c\_disk, e\_disk, ring, exp, power-2, power-3, u\_ring)
- Parameters: 0 0 0 0 0 0 0
- Starting range: 0 0 0 0 0 0 0
- numb. of starts: 0 0 0 0 0 0 0
- Subtract function:  No
- Function 2: point
- Parameters: 0 0 0 0 0 0 0
- Starting range: 0 0 0 0 0 0 0
- numb. of starts: 0 0 0 0 0 0 0
- Subtract function:  No

At the bottom of the dialog box are buttons for 'Go', 'Dismiss', and 'Help'.

# Data analysis in the *uv*-plane

The screenshot displays the 'mapping GUI' window with a sub-window titled 'UV\_FIT parameters'. The sub-window is divided into two main sections. The left section, titled 'Variable FUNCT01\$', lists supported functions for the fitting process. The right section, titled 'UV\_FIT parameters', contains input fields for function selection and parameter values.

**Supported Functions (Left Panel):**

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
EXP0	Exponential brightness
POWER-2	B = 1/r <sup>2</sup>
POWER-3	B = 1/r <sup>3</sup>
E_RING	Elliptical Annulus (inclined)

Remark: See NF\$ for additional help

Variable PARAM01\$ :

TASK\REAL	"Parameters"	PARAM01\$[7]
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	
EXP0	: 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]
-----------	--------------	--------------

**UV\_FIT parameters (Right Panel):**

Generic name: ring

Start channel: 0

End channel: 0

Radius (meters): 0.800

Order (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

Order of starts: 0 0 0 0 0 0 0

Use function:  No

Function 2: point [Choices]

Parameters: 0 0 0 0 0 0 0

Fitting range: 0 0 0 0 0 0 0

Order of starts: 0 0 0 0 0 0 0

Use 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:

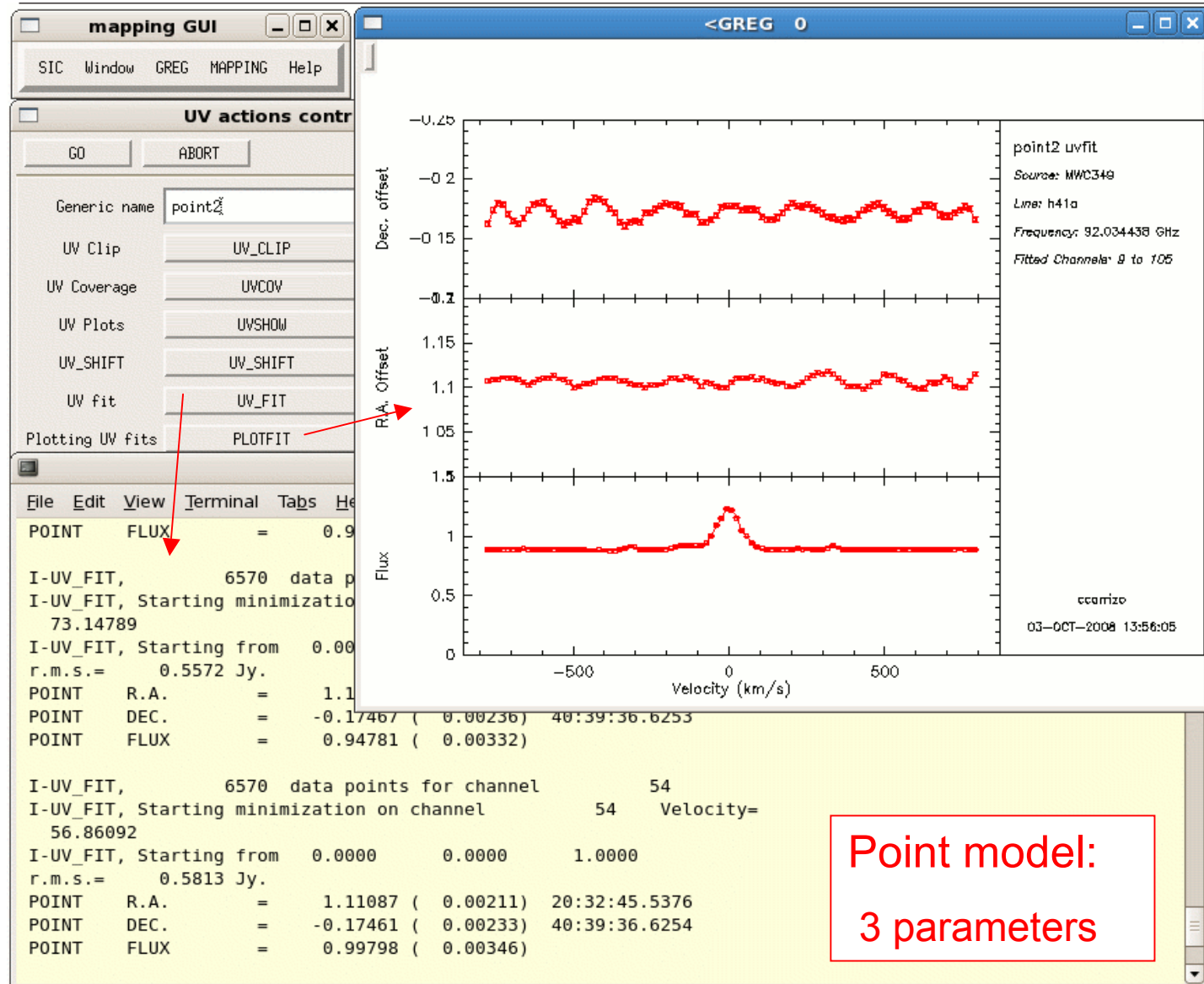
- Generic name: ring
- Number of fitted functions to be plotted: 1
- Order in which fitted functions are plotted: 1
- Number of parameters plotted along x axis: 1
- X Parameter #1: velo
- X Parameter #2: freq
- X Parameter #3: channel
- X Parameter #4: ra
- X Parameter #5: dec
- X Parameter #6: flux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

The "PLOTFIT" button in the "UV actions control" panel is highlighted with a red circle. The "ring" generic name and the "velo" X Parameter #1 field are also highlighted with red boxes. The "ccarrizo" terminal window shows the following text:

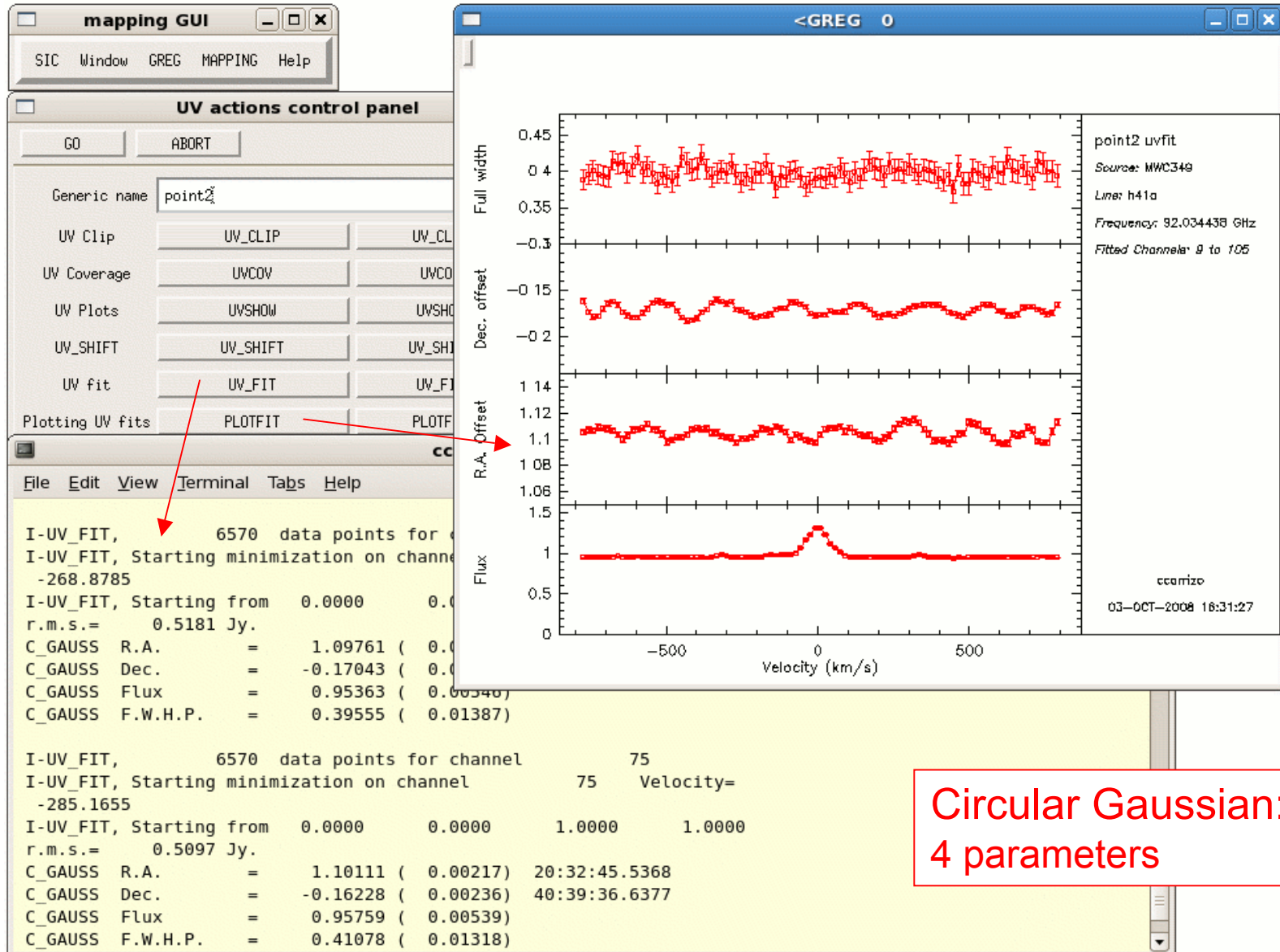
```
File Edit View Terminal Tabs Help
* Loaded modules
  sic (J.Pety, S.Bardeau, S.Guillot)
  greg (J.Pety, S.Bardeau, S.Guillot)
  mapping (J.Pety, N.Rodriguez-Ferraz)
* In charge: J.Pety
  Active developers: N.Rodriguez-Ferraz
  Main past contributors: K.Bouyoucef
* MAPPING is an interactive program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



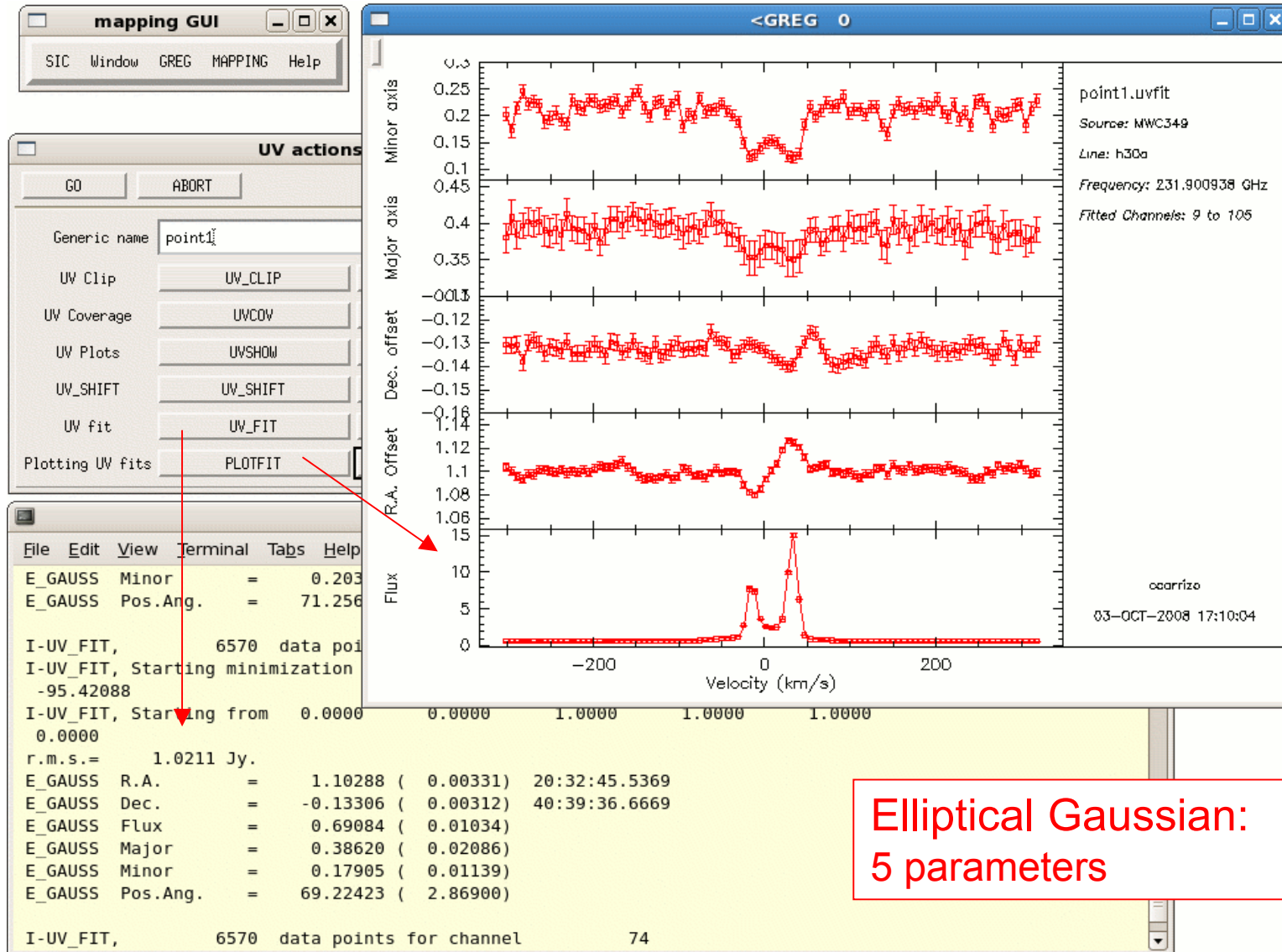
# Data analysis in the *uv*-plane



# Data analysis in the *uv*-plane

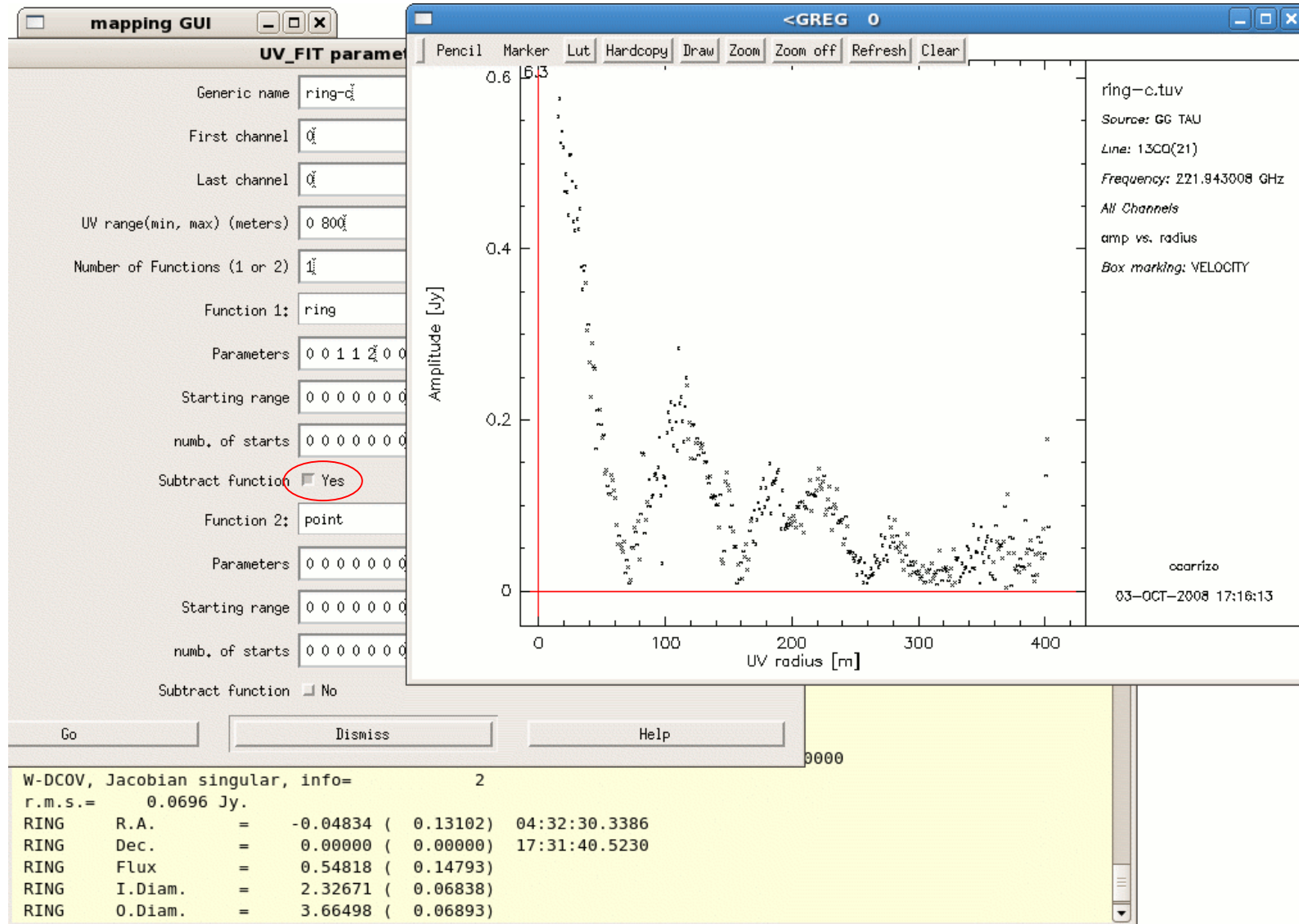


# Data analysis in the *uv*-plane

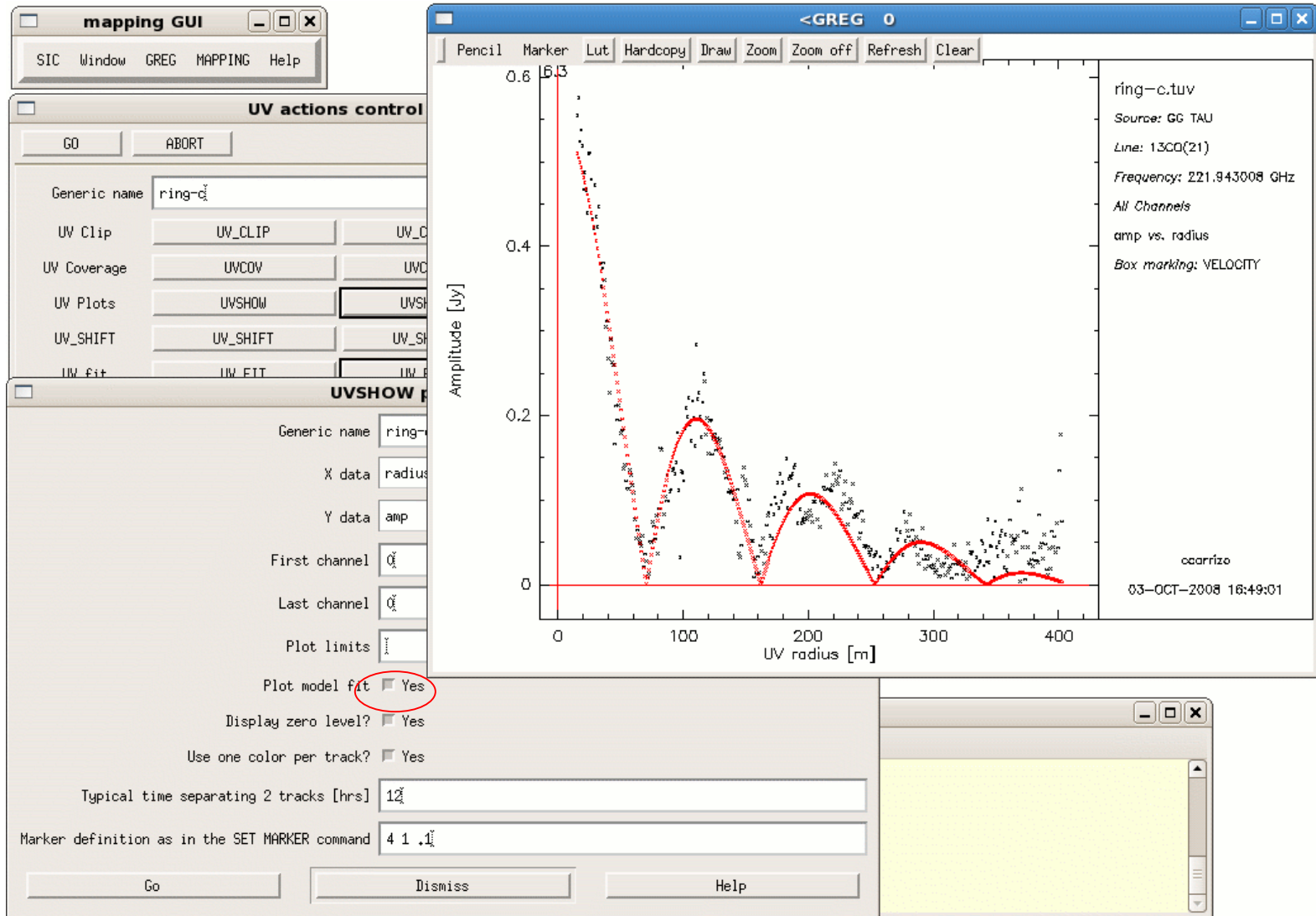


Elliptical Gaussian:  
5 parameters

# Data analysis in the *uv*-plane

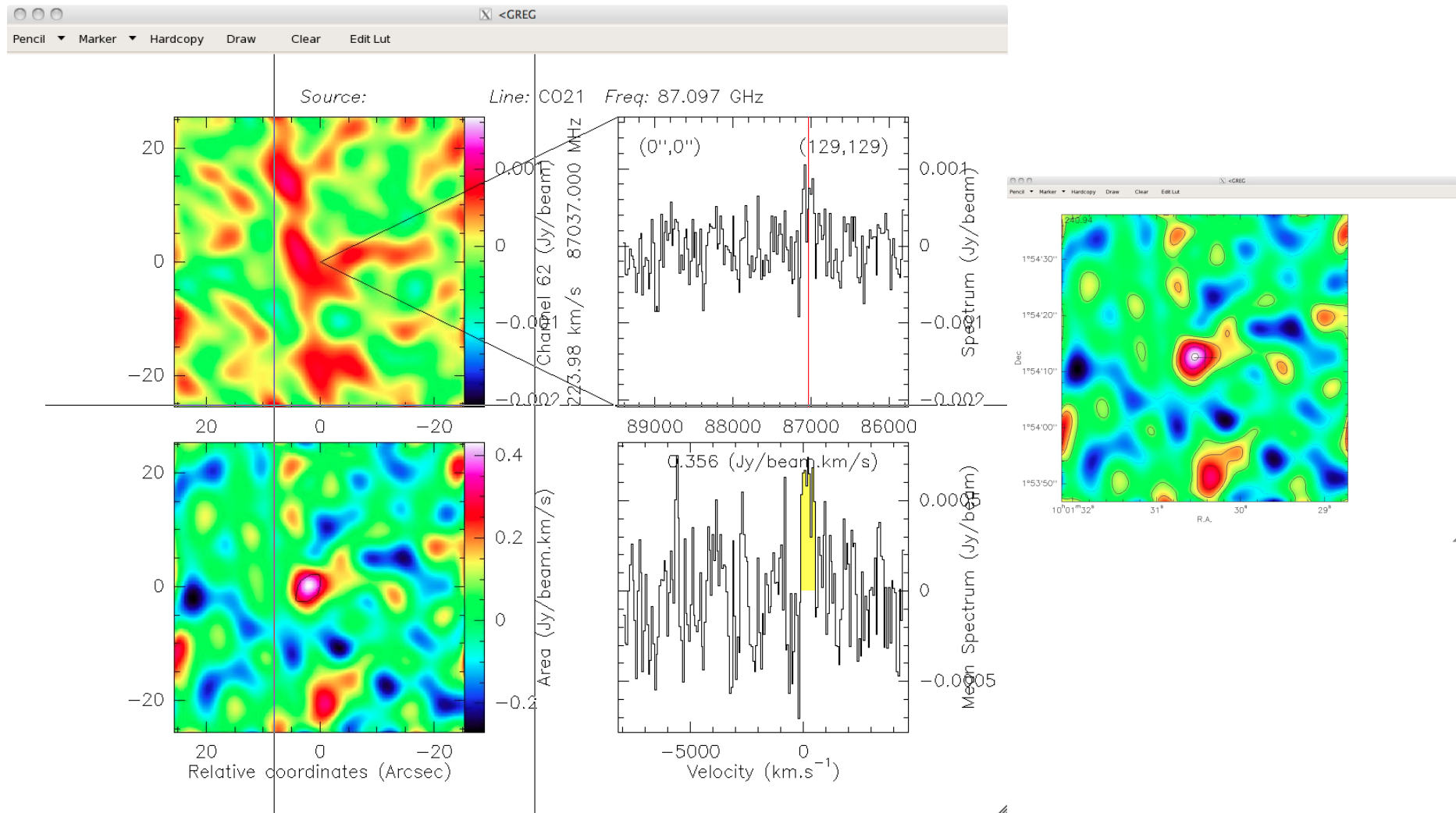


# Data analysis in the *uv*-plane



# Data analysis in the $uv$ -plane

## Example: detection project of distant galaxy (unresolved)



# Data analysis in the *uv*-plane

The screenshot displays a multi-windowed software interface for data analysis. The main window, titled 'mapping GUI', shows a terminal window with the following output:

```
Map cell      1.06 x 1.06 arcsec   1.06 x 1.06
Image Size   135.7 x 135.7 arcsec   135.7 x 135.7

Already imaged
Still to be cleaned
W-GDF, UNKNOWN Velocity type defaulted to LSR
I-GIO_RIH, File is [Native], Header Version 1 (32 bit)
W-GDF_READ_UVDATASET, Producing a UVT order
I-UVSHOW, Finding limits
I-UVSHOW, Number of Found tracks: 6
MAPPING>
I-RUN, Task uv_fit running, logfile is
I-RUN, /scratch/SOG/logs/uv_fit.gildas

I-GDF_STBL, Setting 1 starting blocks
UV_FIT Fortran-90 version
W-GDF, UNKNOWN Velocity type defaulted to LSR
I-GIO_RIH, File is [Native], Header Version 1 (32 bit)
I-UV_FIT, Creating fit table ch57-66-inte.uvfit

I-UV_FIT, 10273 data points for channel 1 1
I-UV_FIT, Starting minimization on channel 1 Velocity=
240.9437
I-UV_FIT, Starting from 0.0000 0.0000 1.00000E-02
r.m.s.= 0.0281 Jy
POINT R.A. = 2.08152 ( 0.53213) 10:01:30.9588
POINT DEC. = -0.19231 ( 0.49823) 01:54:12.3077
POINT FLUX = 0.00066 ( 0.00013)
Removing FUNCT01 10273 1
I-GIO_MIH, GDFBIG re-allocation 1
S-UV_FIT, Successful completion

I-RUN, Elapsed 0.2 User 0.2 System 0.1
I-RUN, Task uv_fit completed successfully
MAPPING> []
```

A dialog box titled 'UV\_FIT parameters' is open, showing the following settings:

- Generic name: ch57-66-inte
- First channel: 0
- Last channel: 0
- UV range(min, max) (meters): 0 800
- Number of Functions (1 or 2): 1
- Function 1: point
- Parameters: 0 0 0.01 0 0 0 0
- Starting range: 0 0 0 0 0 0
- numb. of starts: 0 0 0 0 0 0
- Subtract function:  Yes

The plot window, titled '<GREG', shows a scatter plot of Amplitude [Jy] versus UV radius [m]. The y-axis ranges from 0 to 0.2, and the x-axis ranges from 0 to 100. A horizontal red line is drawn at Amplitude = 0. The data points are colored and form a dense cloud between 0 and 800 meters UV radius, with a peak amplitude of approximately 0.2 Jy. A value '240.9' is displayed in the top left corner of the plot area.

## MAPPING procedures / tasks

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

also

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



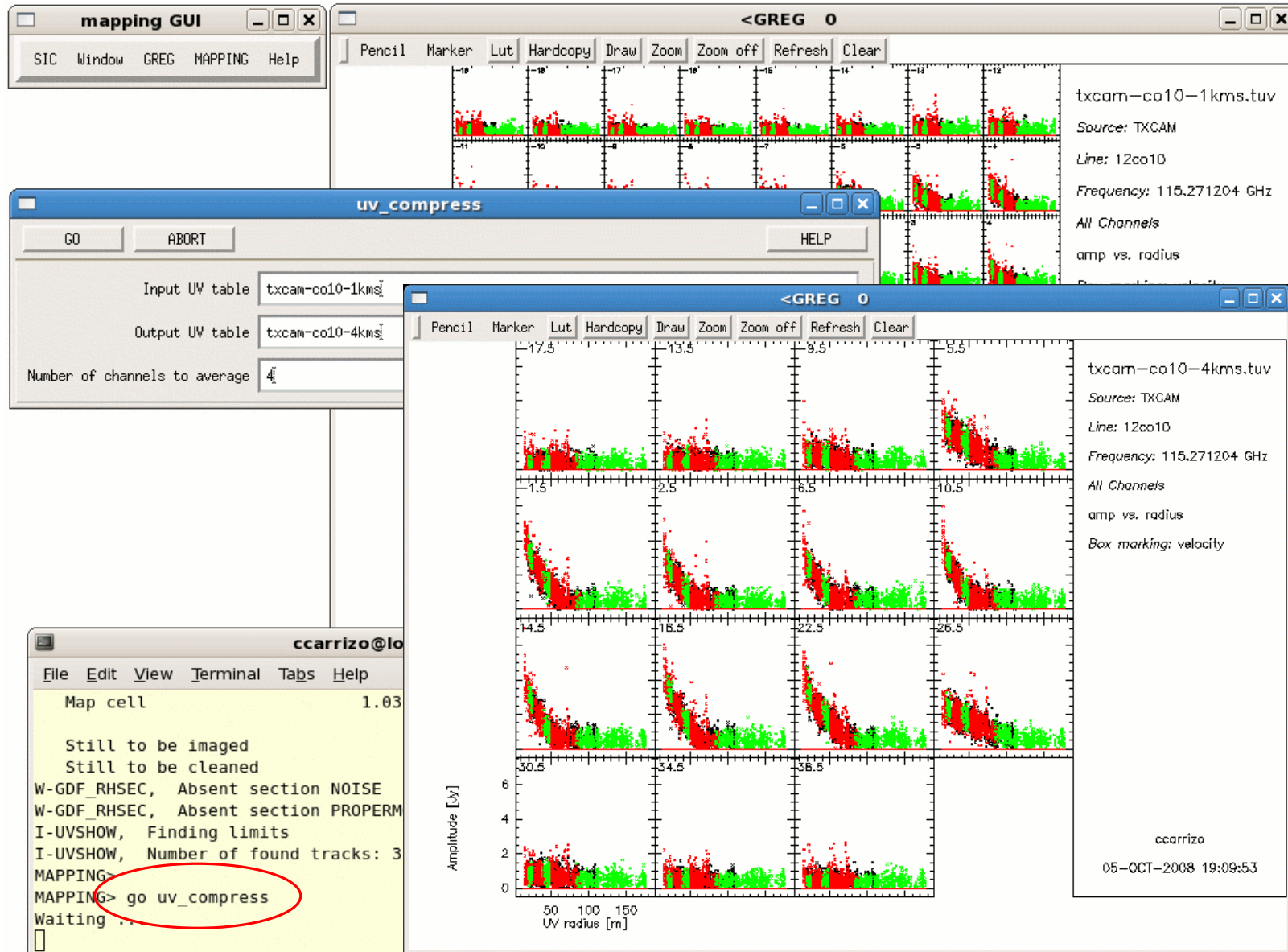
## Data analysis in the *uv*-plane

```
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

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\_ccmoc

uv\_cct

uv\_center

uv\_circle

uv\_clip

uv\_compress

uv\_map

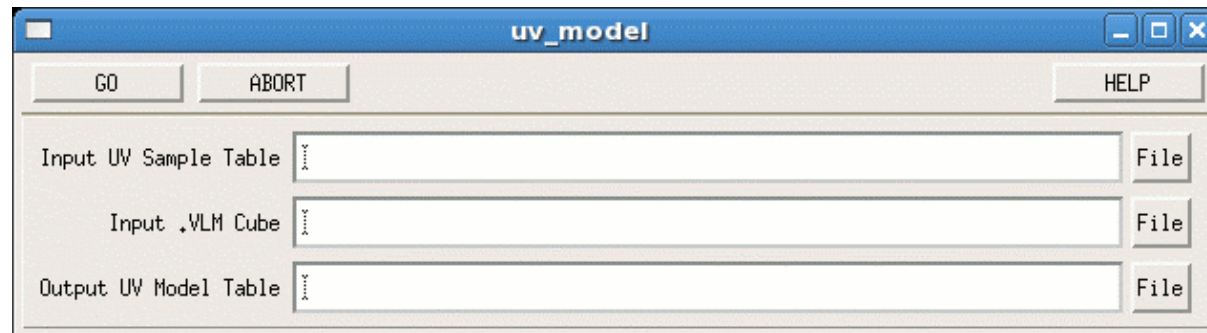
uv\_single

uv\_zero

uv\_cuts

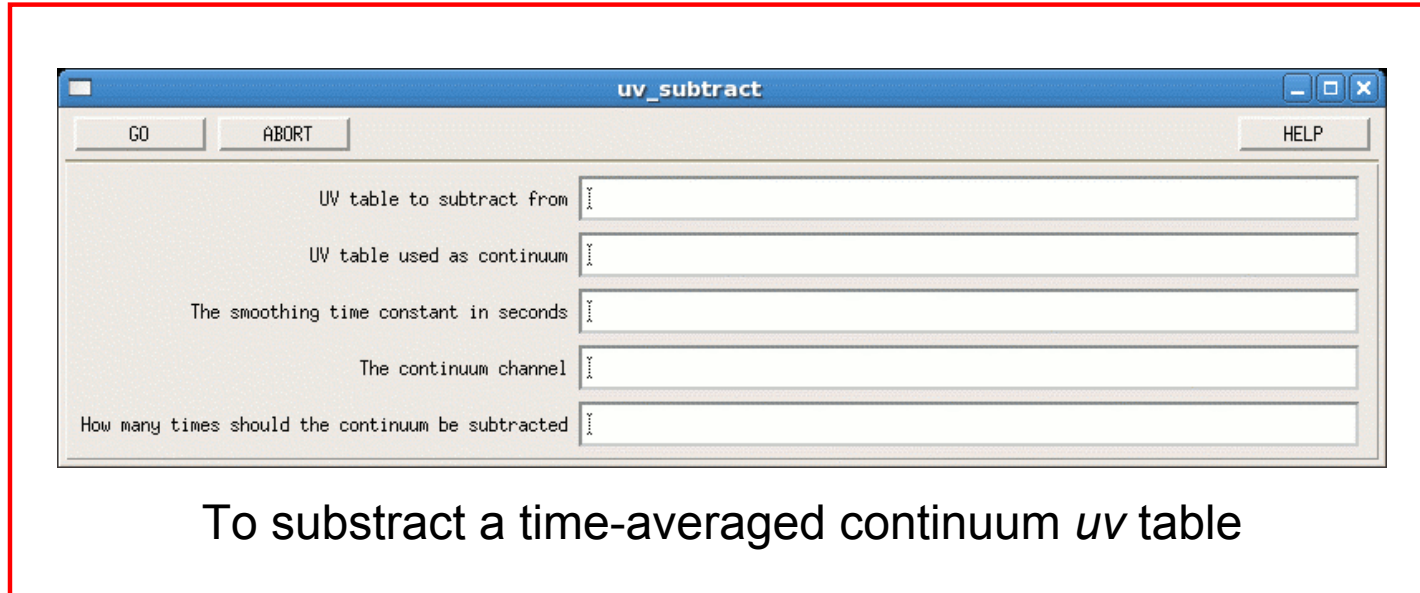
uv\_mcal

uv\_sinusphase



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

# Data analysis in the *uv*-plane



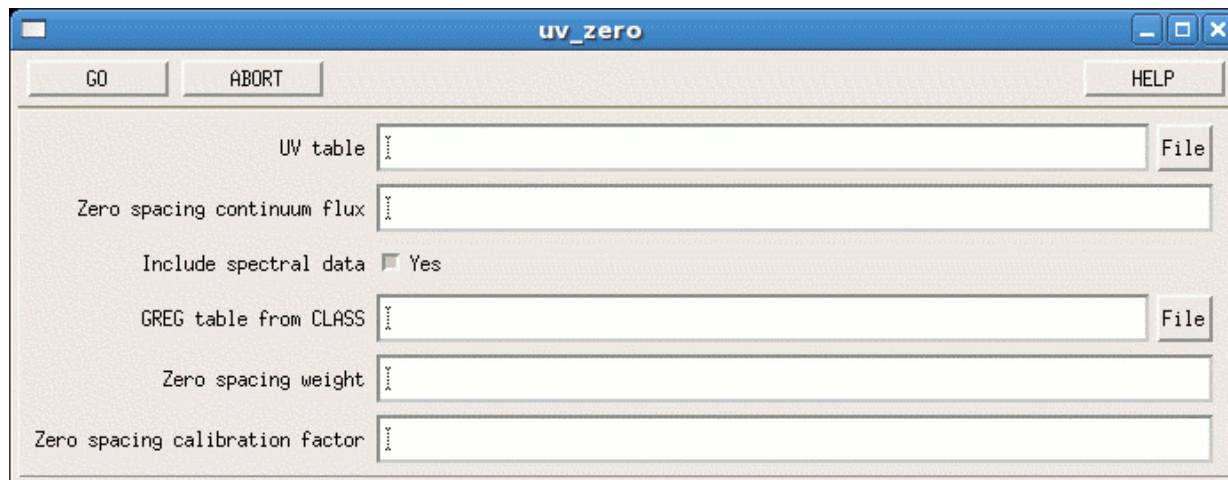
d

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\_track\_phase

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 x (# channels)

7 visib. characteristics

- real part for
- imaginary part for
- weight
- real part for
- imaginary part for
- ...

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

2<sup>nd</sup> channel

data at 2<sup>nd</sup> channel

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 and settings. It includes buttons for "GO", "ABORT", and "READ". The "Generic name" is set to "chicyg-co21-mer-bad". The "Image type to show" is "DIRTY". The "First channel" and "Last channel" are both set to "0". The "Mosaic from UV data" is set to "MOSAIC", and the "Mapping from UV data" is set to "UV\_MAP". Other methods like "HOGBOM", "CLARK", "SDI", "MRC", and "Multiscale" are also available.
- Map Window:** This window shows a grid of data points. The grid is mostly green, indicating successful data points, but there is a black rectangular area in the bottom right corner, likely representing missing or corrupted data. The axes are labeled with coordinates: longitude (19° 30' 30" to 30") and latitude (32° 55' 00" to 32° 54' 00").
- Terminal Window:** This window shows the command-line output of the software. It displays the following text:

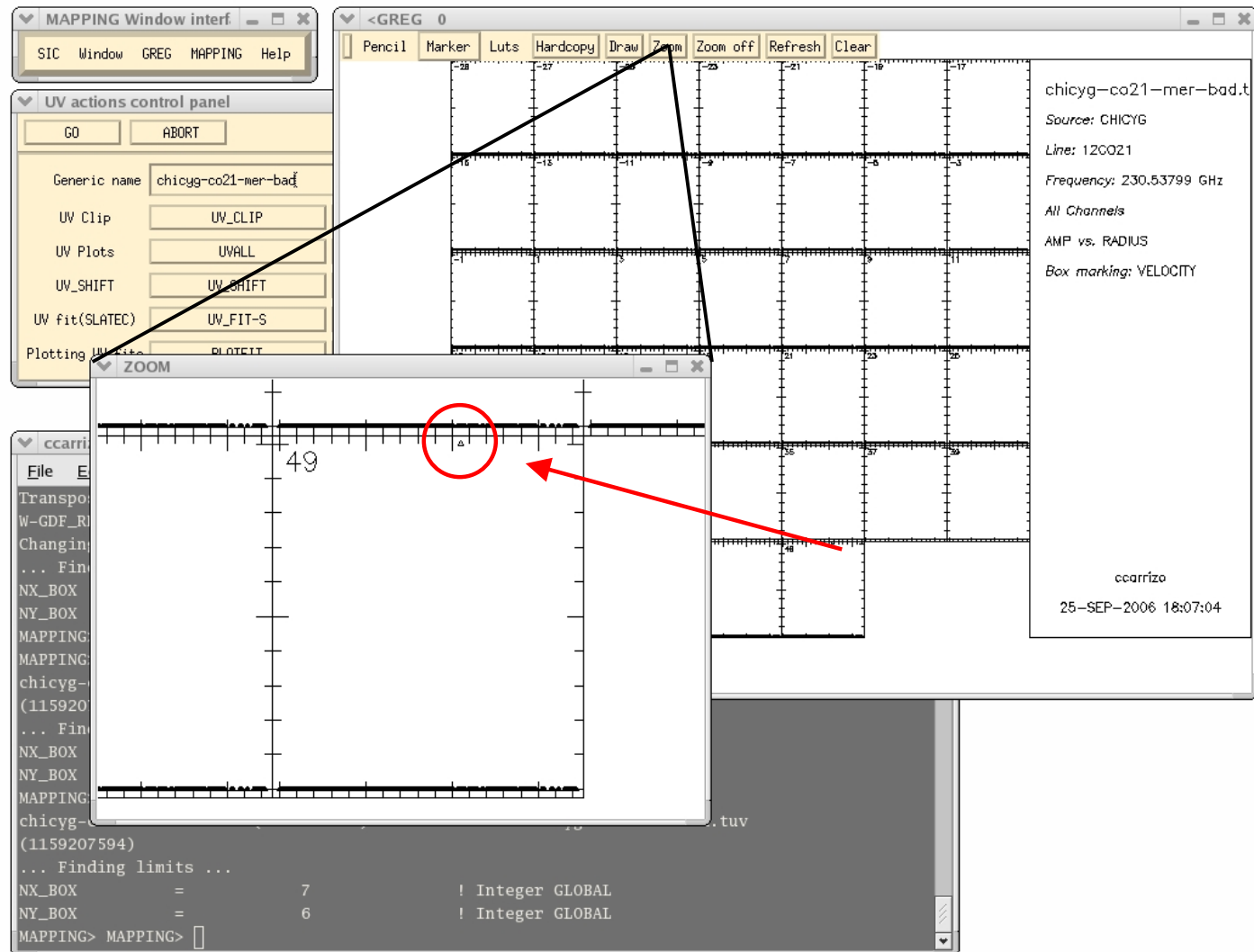
```
I-UVMAP, Creating map file
I-UVMAP, Finished planes 1 to 40 CPU 0.00
I-UVMAP, Finished maps 0.00
S-UVMAP, Successful completion
MAPPING>
I-LEVELS, Contour levels are :
-1400.    -1200.    -1000.    -800.0    -600.0
-400.0    -200.0    200.0    400.0    600.0
800.0    1000.    1200.    1400.    1600.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

Additional information on the right side of the map window includes:  
chicyg-co21-mer-bad.l  
Source: CHICYG  
Line: 12C021  
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

(1)

# Passing directly from hpb → mapping

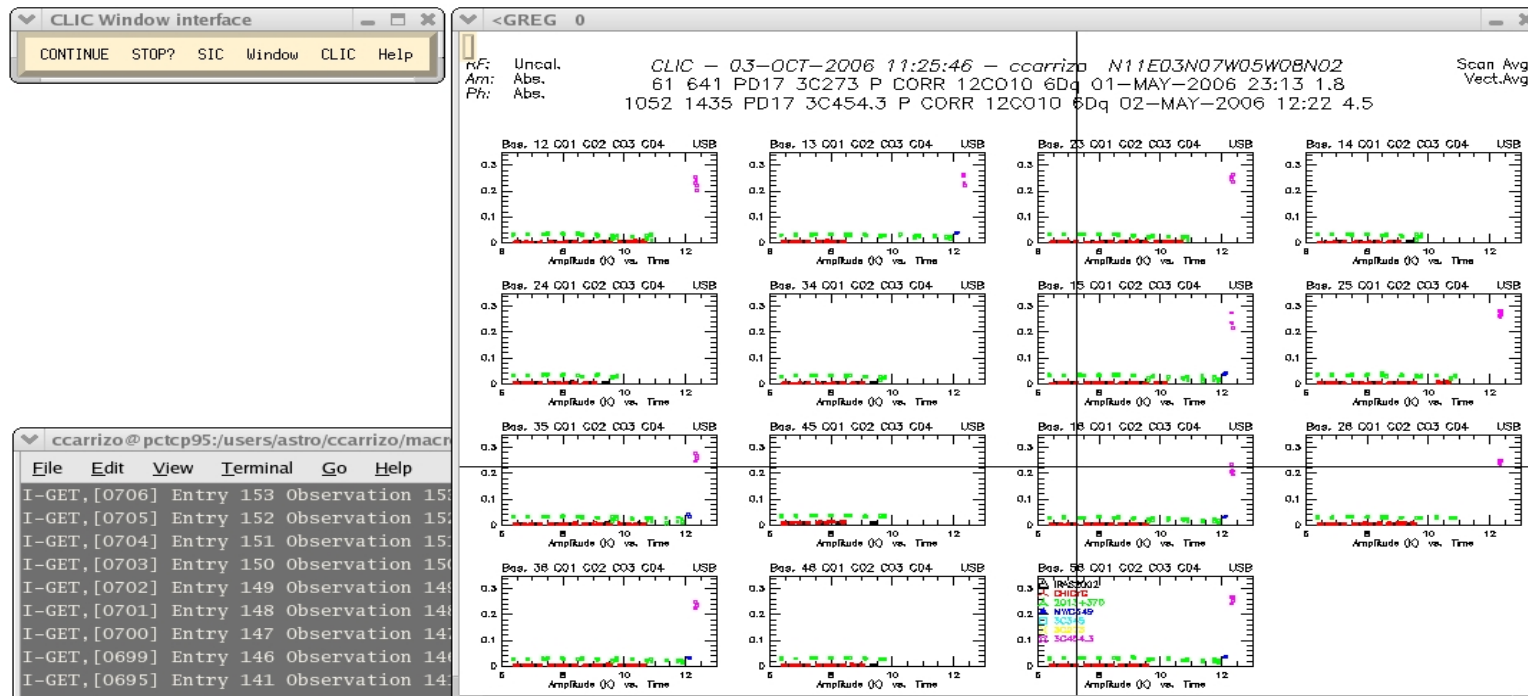
It may happen...



(1)

# Passing directly from hpb → mapping

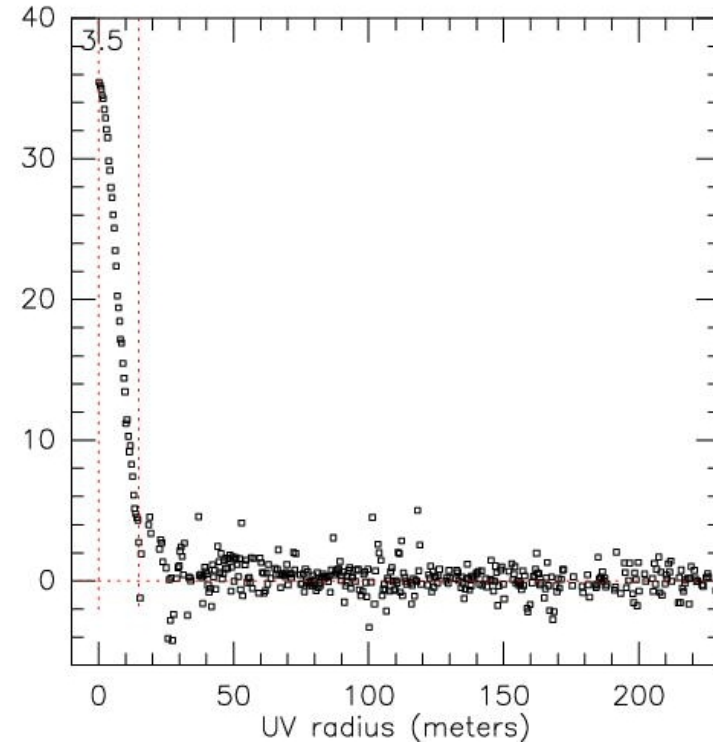
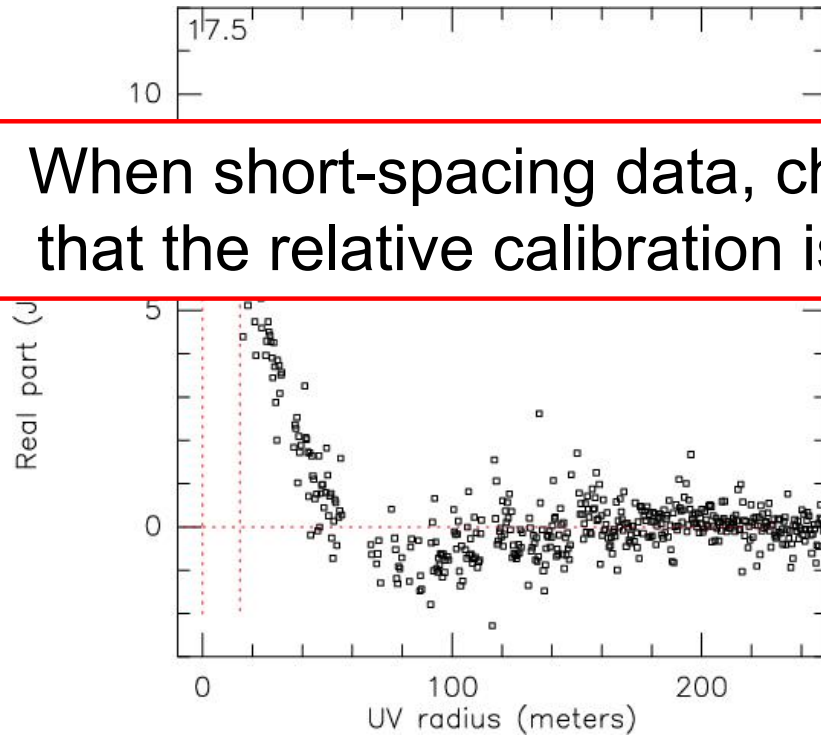
It may happen... that there remain some wrong visibilities



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

(2) Passing directly from hpb → mapping

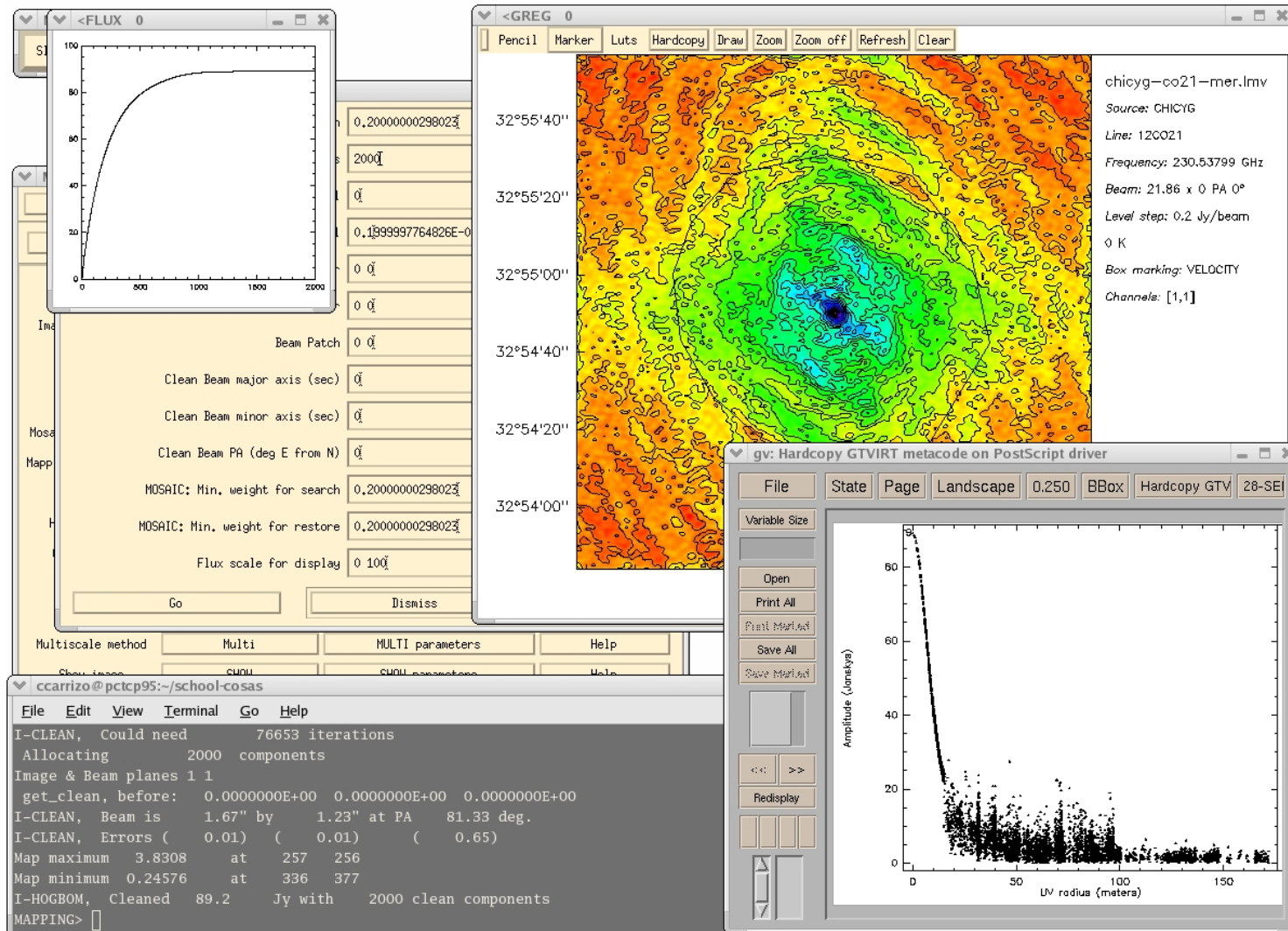
When short-spacing data, check that the relative calibration is ok



+ Short-spacing data

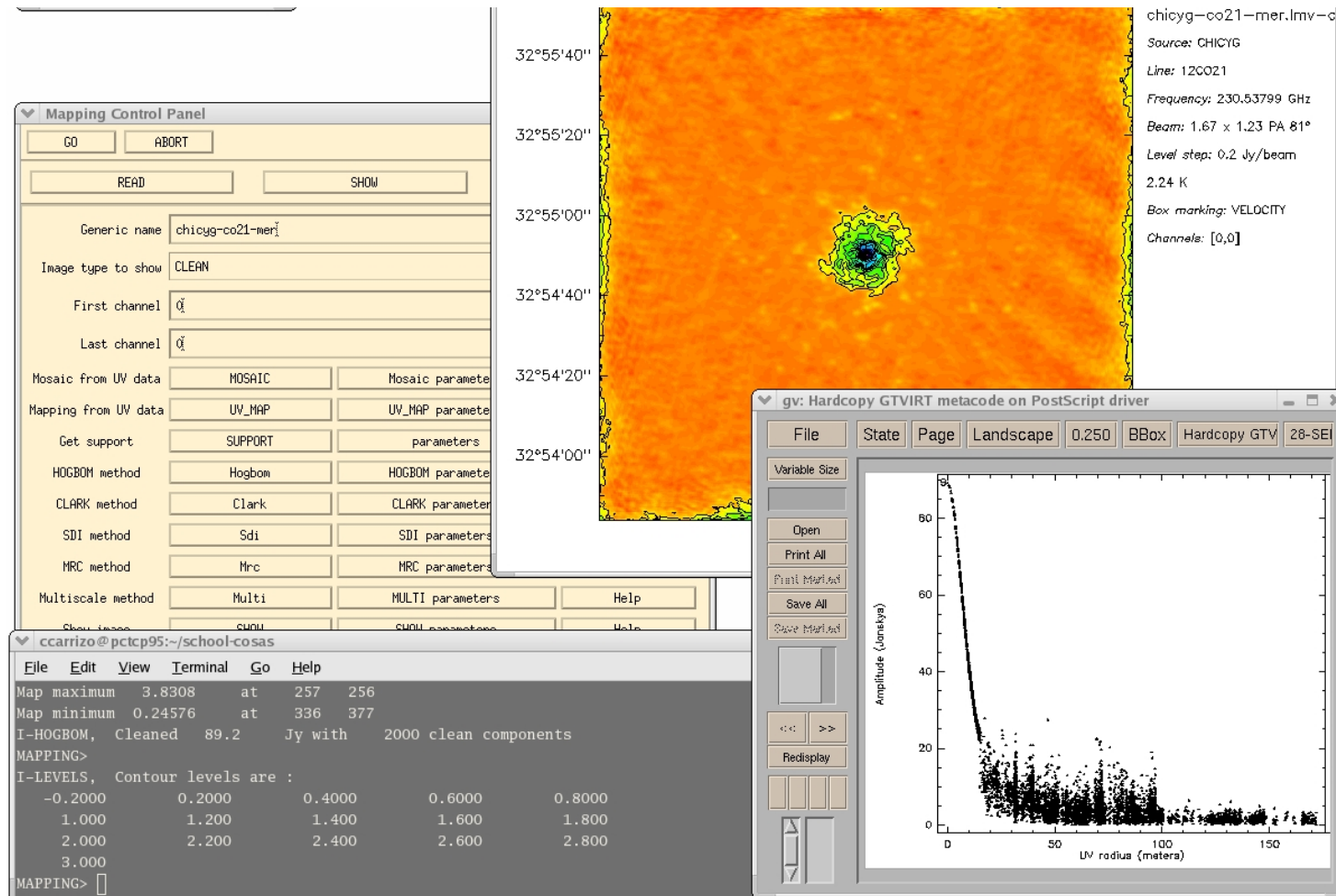
### (3) Passing directly from hpb → mapping

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 radio astronomy data processing, consisting of three main windows:

- MAPPING Window interf**: A 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: `Q`
  - Last channel: `Q`
  - Mosaic from UV data: `MOSAIC`
  - Mapping from UV data: `UV_MAP`
  - Get support: `SUPPORT` (highlighted with a red circle)
  - HOGBOM method: `Hogbon` (highlighted with a red circle)
  - CLARK method: `Clark`
  - SDI method: `Sdi`
  - MRC method: `Mrc`
  - Multiscale method: `Multi`
- <GREG 0**: A window displaying a spectral line map. The map shows a central source with concentric contours, color-coded from blue (low intensity) to red (high intensity). The axes are labeled with celestial coordinates: Right Ascension from  $19^{\text{h}}50^{\text{m}}35^{\text{s}}$  to  $30^{\text{s}}$  and Declination from  $32^{\circ}54'00''$  to  $32^{\circ}55'40''$ . On the right side, technical parameters are listed:
  - chicyg-co21-mer.lm
  - 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 process:

```
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 image displays a screenshot of astronomical software. On the left, a window titled '<FLUX 0' shows a plot of flux versus position. On the right, a window titled '<GREG 0' shows a contour map of a source. A red-bordered box is overlaid on the contour map with 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 contour map, there is a table of cleaning methods:

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...