Analysis

Analysis routines (run on LINUX):
iman – IMage ANalysis; makes maps out of raw data files saved be the acquisition program (**ContImage**), can make movies, pictures of green, compresses and decompresses raw data files.

mapans – MAP ANalysis Single; map viewer, opens and modifies a map file saved by **iman**.

mapanm2 – MAP ANalysis Multiple 2; combines two maps (adds, subtracts, divides, or other).

binan – BIN ANalysis; opens, manipulates, and animates movies or binned frames made by **iman**.

Flow of data in a typical imaging experiment:

ContImage saves raw frames in a set of files ->
iman (depending on specified command line options) produces a map, binned frames (movies) or condition maps ->
mapans opens and manipulates maps made by iman ->
mapanm2 combines 2 maps to remove hemodynamic delay (the two maps are of opposite direction of stimulus flow) or to reduce noise (the two maps are made with identical stimulus) ->
mapans opens and manipulates maps combined by **mapanm2** and generates figures for printing or further editing.
binan animates and manipulates the binned frames produced by iman.

mapans

mapans – MAP ANalysis Single. The primary purpose of **mapans** is to view and manipulate maps generated by **iman**. In its functionality the **mapans** is somewhat similar to Adobe Photoshop. It provides limited editing functions and allows the user saving maps as PostScript files ready for printing or further editing by "professional" image editors such as Adobe Photoshop (Windowz) or Gimp (Linux). **Mapans** works only with one map at a time. **Mapanm2** (MAP ANalysis Multiple 2) should be used for operations, such as addition, subtraction or averaging, on two maps.

The program is evoked from the command line of a terminal with one (two for older version) required file name and options.

1. How to open maps with mapans

The program is evoked from the command line of a terminal with one file name and options (see Figure 1).

The following command line demonstrates the simplest use of **mapans**:

```
mapans  t_35l.0700.mapraw1_104_62_4741dt1
```

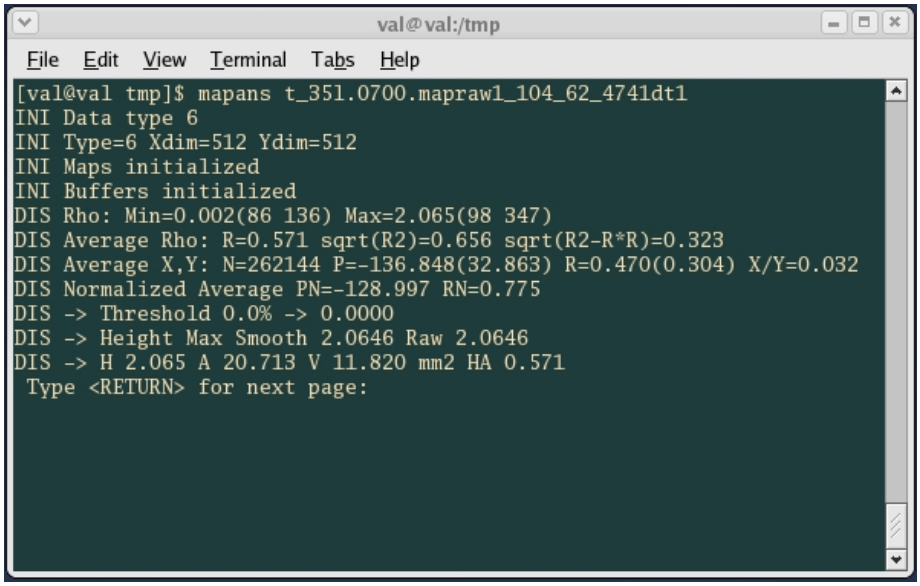

Figure 1. Terminal window evoking mapans. Simplest usage shown. The terminal window displays certain information about the map: X and Y dimensions, minimum and maximum values of the amplitude (Rho), mean and standard deviation of Rho, number of pixels in the map and so on.

The command opens a two panel window (display window) showing the phase map (top panel) and amplitude map (bottom panel) (see Figure 2).

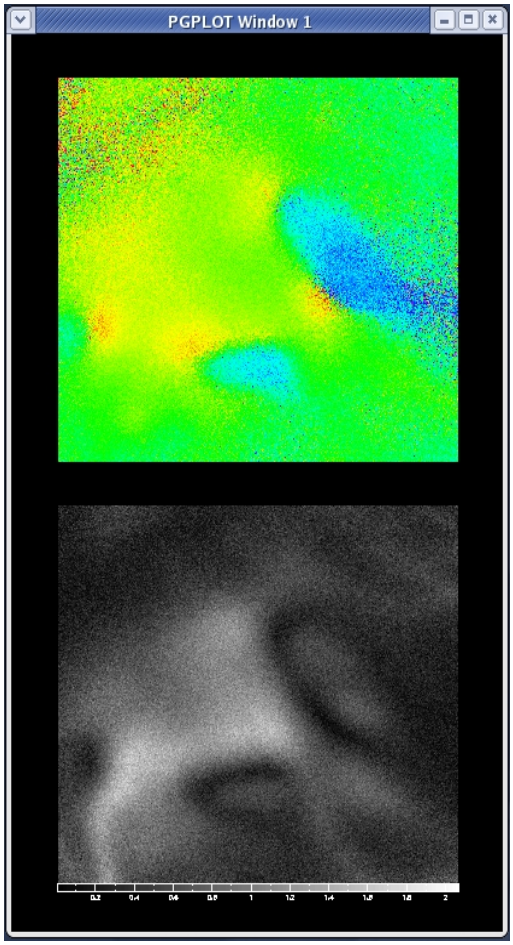

Figure 2. Mapans' display window showing the phase map (top) panel and the amplitude map (bottom panel). The amplitude panel has a gray-scale wedge attached.

In this simple example **mapans** displays the maps and prompts the user to press "Return" in the terminal window (Figure 1). After entering "Return" the display window is closed and the user is prompted with the following line: "Save map? (yY/n):" Entering "y" will save both panels in one file and entering "Y" will save the top panel only. After entering "y" or "Y" (the program exits if any other characters are entered) the user is prompted to input a file-name and file (device) type of the image to be saved in the following format: file-name/device. Entering "?" (question mark) will display available devices. The most commonly used device type is Vertical Color PostScript (VCPS). For the user's convenience **mapans** suggests a file-name (the map's file name with extension ".ps" attached) and device (VCPS) before the prompt. In the example above the suggested string is

```
t_35l.0700.mapraw1_104_62_4741dt1.ps/VCPS
```

The user can copy the string to the prompt and enter. If a different file-name or/and device is desired they should be entered at the prompt manually. **Mapans** exits after saving the figure.

2. How to open and edit maps with mapans

To use **mapans** in interactive mode, that allows editing, the option `-i` should be specified:

```
mapans -i -o6 t_35l.0700.mapraw1_104_62_4741dt1
```

The command opens an interactive window along with the display window (see Figure 3). Option `-o6`, used in this example, does not modify the maps; it accentuates the contrast of the amplitude map (see Appendix for further details on this and other options).

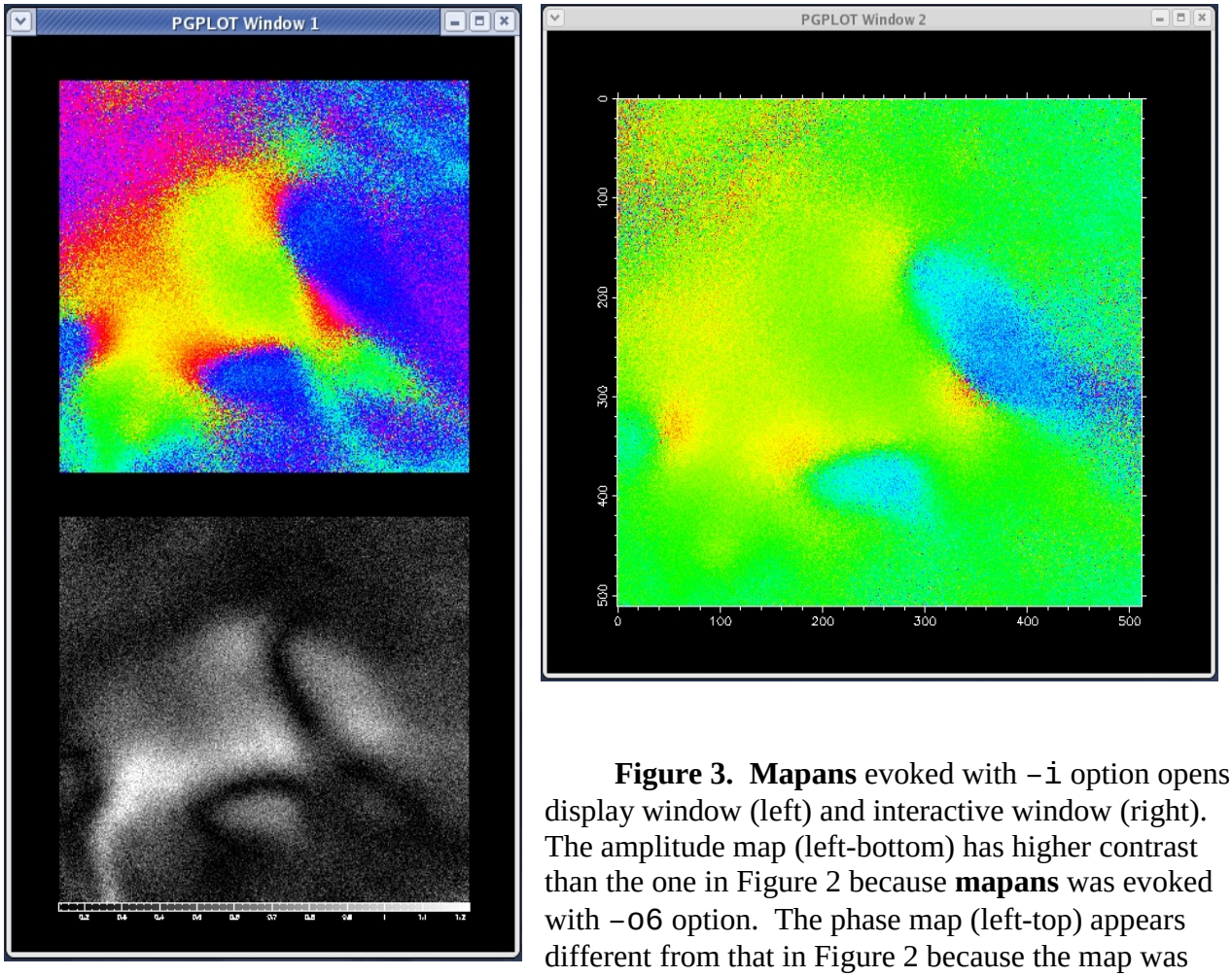

Figure 3. Mapans evoked with `-i` option opens display window (left) and interactive window (right). The amplitude map (left-bottom) has higher contrast than the one in Figure 2 because **mapans** was evoked with `-o6` option. The phase map (left-top) appears different from that in Figure 2 because the map was shifted by commands entered via the interactive window. The interactive window displays the phase map.

The interactive window is used to enter commands for map editing. The commands are entered via keyboard or mouse inputs. The mouse inputs can be done via the keyboard as well: left button click = "A", right button click = "X", and middle button click = "D". The cursor must be over the interactive window for the commands to be sent to **mapans**.

Mouse inputs:

Left button click ("A") – selects a pixel on the map under the cursor. The information about this pixel (X and Y coordinates, and values of the phase and amplitude) is displayed in the terminal used to evoke the program.

Middle button click ("D") – opens a window displaying the polar distribution of the map pixels (Figure 4). Pressing **q** over the distribution window will close it. Note that the interactive becomes inactive while the distribution window is open.

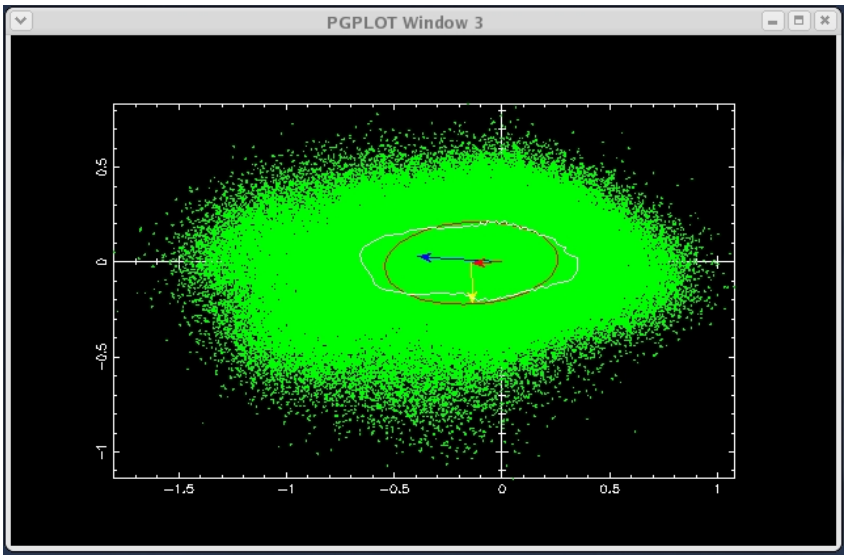

Figure 4. Scatter plot (distribution) window. White curve – angular distribution of pixels; red – PCA ellipse and its displacement from the center.

Keyboard inputs:

Note: all keyboard inputs are case sensitive.

h – prints out description of available commands in the terminal window.

Q – terminates the program.

q – quits the interactive mode and goes into the passive mode described in section **1**. The maps are saved as printable files in this mode.

S – saves the current map as a raw pixel map. The new saved map can be reopened with **mapans** for further modification. The file-name is automatically generated by appending "_a" (Analyzed) to the map's file-name. Repeated use of this command will overwrite the saved map. To avoid overwriting the new saved map should be renamed, preferably to a file with a suffix that reflects the editing performed on the map. E.g. if a map (*map-file-name*) was high-pass filtered with a kernel of 60 pixel radius (command line option `-H60`) the new saved file (*map-file-map_a*) can

renamed as *map-file-map_H60*. If the map being saved can be fitted in a smaller bounding box, the zero pixels outside the bounding box will be cropped, thus the new map will have smaller dimensions. The CropZerosOnSave toggle is set by **oC** command (see below).

m – sets manual pixel selection mode on. This mode allows precise selection of the map pixels. The function is similar to that provided by left-button-click. The coordinates of a pixel should be entered in the format X "Space" Y "Return" (or "Space"); e.g. "100 100 " this input selects the pixel with coordinates (100, 100) and outputs information about the pixel in the terminal window. The input is echoed in the terminal window. The manual selection mode is set off when the two coordinates are entered. The manual selection mode can be set off at any time by entering **q**.

c – sets crop mode on. The crop mode is used to select a region of interest from the full map. The selection is done via mouse left-button-clicks that define vertices of the region of interest. The precise coordinates can entered via the manual mode identical to the one used for manual pixel selection (see previous paragraph). Entering **m** sets the manual mode. To finish selection the user should press the right mouse button. This action closes the selected path by connection of the last and first vortices (see Figure 5). To clear selected vortices the user should click on the middle button.

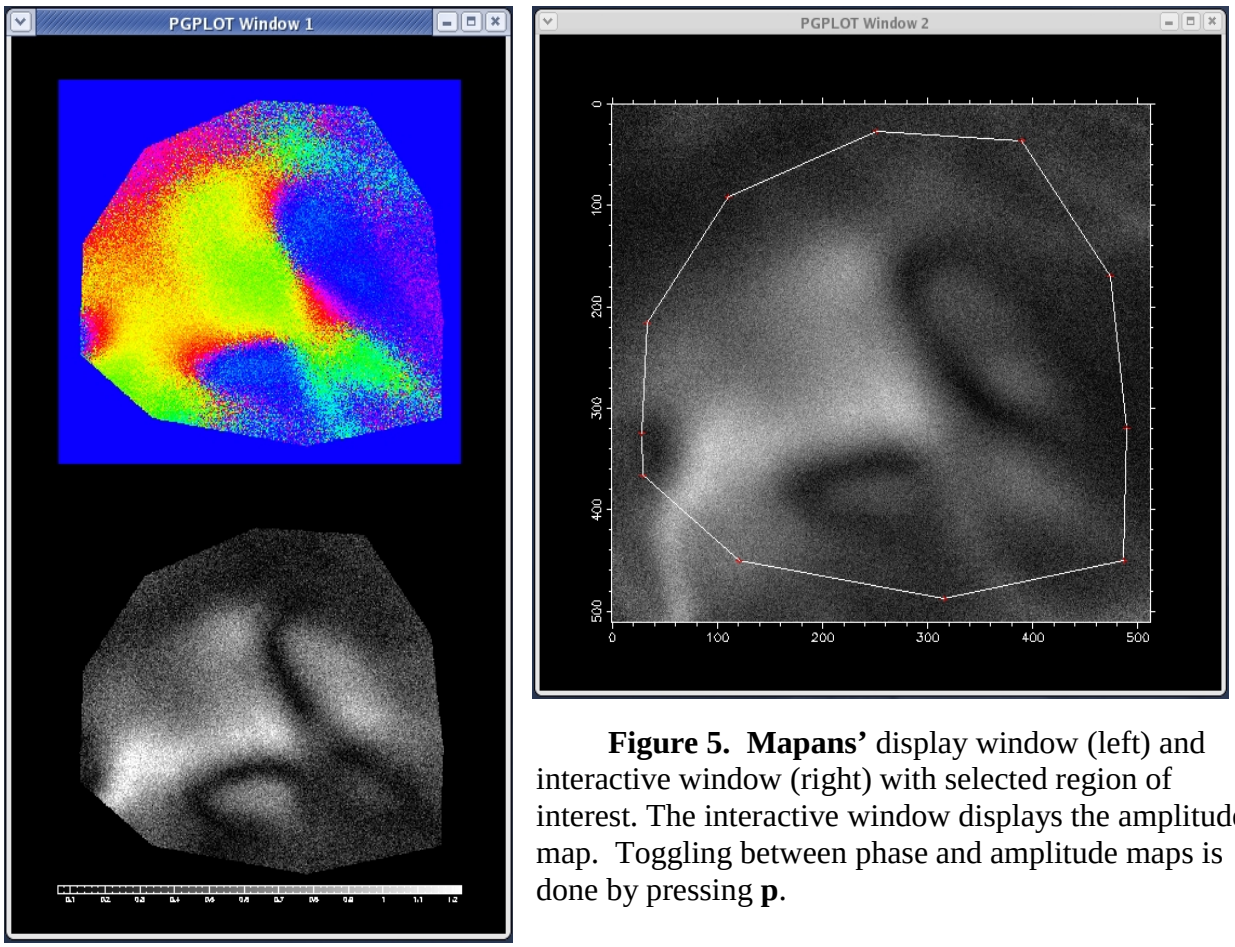

Figure 5. Mapans' display window (left) and interactive window (right) with selected region of interest. The interactive window displays the amplitude map. Toggling between phase and amplitude maps is done by pressing **p**.

This action clears all selected vertices and allows the user reenter the vertices. Entering **q** at any time quits the crop mode. Two special sub-modes are provided for user's convenience: entering **c** after setting the crop mode selects all map, and entering **r** (Rectangle) allows quick selection of an rectangular region through entering its top-left and bottom-right coordinates. The four numbers (two pairs of coordinates) should be "Space" separated. The input is finished by entering "Space" or "Return".

n – shifts (Normalizes) every pixels of the map by the vector that is the average of all pixels in the selected region of interest. This command is used for removal of a constant bias (DC-bias) that is uniform over the entire map. The procedure typically is performed in the following manner. A small region of interest is selected outside the responsive areas (top region in the map shown in Figure 5). **n** is entered in the interactive window. The program removes the DC-bias by shifting the pixels inside the selected region by their average and saves the DC-bias. Further re-selections of regions of interest do not modify the saved DC-bias unless **n** is entered again. The entire map is selected either by choosing the whole map as a region of interest or simply by entering **c** twice. All pixels in the new region of interest will be shifted by the saved DC-bias value. Entering **0** nulls the DC-bias.

a<angle in degrees> – rotates every pixels' phase by **angle** degrees. Entering **0** nulls the **angle**.

i – transposes every pixels' phase. Transposition is changing of the sign of the phase. Entering **0** nulls the transposition. This is a binary operation, thus repeated twice produces no effect.

u<upper threshold %> – sets upper threshold for the amplitude. All pixels above the **upper threshold** are saturated. Entering **0** sets the **upper threshold** to 100%. This command does not modify the actual map. It affects the appearance of the displayed map and of the saved picture.

l<lower threshold %> – sets lower threshold for the amplitude. All pixels below the **lower threshold** are set to zero. Entering **0** sets the **lower threshold** to 0%. This command does not modify the actual map. It affects the appearance of the displayed map and of the saved picture.

0 (**zero**) – returns the map to its original state, i.e., nulls changes made by the following command: **c**, **n**, **a**, **i, l, and u**.

g – plots a section of the map along a line segment. After entering this command the user should identify a line segment by clicking twice (begin and end points) in the interactive window. After the second point is entered a new window is opened. This window (section window) displays the values of the phase, phase derivative, and amplitude along the selected line segment (see Figure 6). The section window is interactive. Entering **q** closes the section windows and returns the focus to the main interactive window. Entering **S** saves the phase and amplitude values along the section in two separate text files.

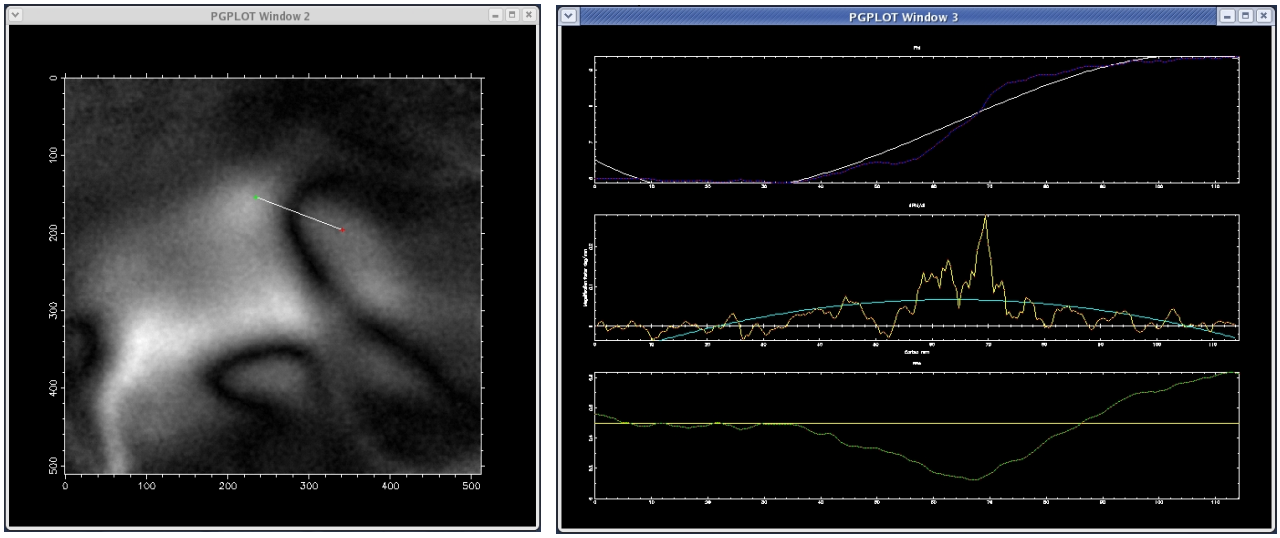

Figure 6. (**Left**) **Mapans'** interactive window with identified line segment. Red point corresponds to the beginning and the green one to the end of the segment. (**Right**) (Top panel) Plot of the phase values (shown in blue) along the segment. The white curve is a cubic fit. (Middle panel) Plot of the phase's derivative (shown in yellow). The cyan curve is a quadratic fit. (Bottom panel) Plot of the amplitude (shown in green). The yellow line shows the standard deviation of the amplitude.

O – toggles the phase map displayed in the display window between phase and polar map (Figure 7). Amplitude of response modulates the lightness of the color representation of pixels in the polar map and the hue is the same as in the phase map.

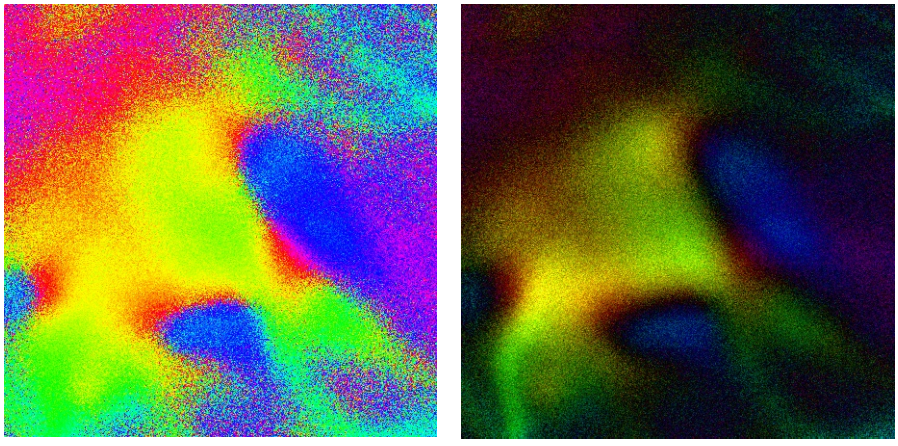

Figure 7. (**Left**) Phase map. (**Right**) Polar map.

p – toggles the map displayed in the interactive window between phase and amplitude map.

o – sets extended option mode. Other (extended) commands are entered by first pressing **o** and then entering another character. Most of these commands are simple toggles.

Extended commands (selected):

h – prints out description of available extended commands in the terminal window .

q – quits the extended command selection mode.

w – toggle, plot color wedge bellow the phase map (see Figure 8).

b – toggle, plot gray-scale wedge bellow the amplitude map.

l – toggle, plot large color and gray-scale wedges.

C – toggle, plot color wedge bellow the phase map.

m – toggle, mark pixels where the amplitude reaches minimum (green) and maximum (red).

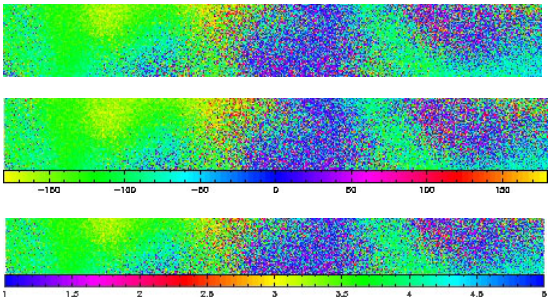

Figure 8. The same phase map with different color wedges. (**Top**) No color wedge. (**Middle**) Default color wedge. It shows the phase color coding in degrees. Command **oW** toggles this wedge. (**Bottom**) Auditory color wedge. It shows a shifted color wedge (command line option `-a`) with annotation corresponding to the stimulus range (option `-A1,5`).

Appendix

Frequently used options.

`-h` – print list of options and exit.
`-i` – interactive mode; display interactive window along with the display window.
`-o<float>` – find min and max values of the amplitude map in the averaged map (radius of the kernel is provided after the option) rather than in the raw map. Used for displaying the amplitude map only. E.g. `-o6`
`-L<float>` – low-pass filter map. `float` = the radius of the kernel. E.g. `–L3`
The filtering is performed with a circular box filter.
`-H<float>` – high-pass filter map. `float` = the radius of the kernel. E.g. `–H50`
The filtering is performed with a circular box filter. This operation is slow. It is recommended to save the map after filtering and restart **mapans** with the new map for further analysis and modifications.
`-R<integer>` – rotate the map by 90* `integer` degrees counter-clock. E.g. `–R1`
`-J<integer>` – flip the map along vertical (1), horizontal (2), or both (3) axes.
`-a` – shift the color wedge so that the beginning of a cycle (phase=0, coded as blue) appears at the left-most end of the color wedge (see Figure 7). This option is used for auditory maps. By default the blue (phase=0) appears in the center of the color wedge (used for visual maps).
`-A<float(min),float(max),[char*(units)]> -` annotate the color wedge. `min` is the minimum and `max` is the maximum of the stimulation range. Units (e.g. kHz) are optional. The wedge is annotated in linear manner. For auditory maps obtained with exponentially raising or falling frequencies the `min` and `max` are logarithms of the corresponding min and max stimulation frequencies. E.g. `–A1,5` for the range of stimulation from 2 to 32 kHz.
`-w<float>` – size of the display window (in inches). The generated figures (e.g. PS files) have the same size.

Full list of options

The list of options may not be complete. Type `mapans –h` for a complete list of options for your system.

```
 -A <float(min),float(max),[char*(units)]> - do wedge annotation
(default off)
 -B - load blank image
 -C [0,1] -  color scheme (default 0)
 -D [1,2,3] - display mode (default 1)
 -E <float> - sectioning smooth radius (default 1.000000)
 -F [1,2,3] - field display mode (default off)
 -H <float> - high-pass filter domain (default 0.000000)
 -I <float> - contours initial angle in degrees (default 0.000000)
 -J <int> - inverse maps X 1 Y 2 (default off)
 -L <float> - low-pass filter domain (default 0.000000)
 -M <float> - phase scale factor (default none=1)
 -O <float> - smooth contours radius (default 0.000000)
 -P <float> - period (deg) for phase transformation (default off)
 -R <int> - rotate maps by <int>*90deg (default off)
 -S [1,2,3] - save mode (default 1)
 -W <float,float,float> - cut wedge (Stim,Pre Blank,Post Blank)
 -Z <float> pixel size in microns (default transform off)
 -a do wedge shift (used for auditory) (default off)
 -b <int> spatial binning (default 1)
 -c <int> countour scheme (default 9)
 -d <int[,float]> number of countour lines and contour spacing
(default 0)
 -f <filename> - needs two (X and Y components) or one (XY in one
file)files
 -h - print this help
 -i interactive image manipulation (default off)
 -m - mark min/max sites (default off)
 -o <float> - chop radius (default 0.000000)
 -p - do pinwheel analysis (default off)
 -r - remove bias (default off)
 -s - save response dump (default off)
 -t - do discontinuous phase (default off)
 -v - verbose mode (default off)
 -w <float> - window size (default 5.000000)
 -z - draw zero lines (default off)
```