



## SeaSonde Radial Site Release 6 **CrossLoopPatterner Application Guide**

Apr 21, 2009 ©Copyright CODAR Ocean Sensors, Ltd

CrossLoopPatterner is an utility for converting LOOP files to a SeaSonde Antenna Pattern file. CrossLoopPatterner can also produce Ideal Antenna Patterns. The pattern file is used to calibrate the SeaSonde to produce more accurate bearing.

The general method for creating an antenna pattern is:

1. Walk or Cruise a Transponder & GPS in front of the antennas on a arc during which the GPS track is recorded and the SeaSonde Radial Site records Time series data.
2. Download the GPS track info into the computer and use utility GPSTracker to convert the GPS lat, lon, time into bearing, time from the SeaSonde Radial Site. The output file is a TRAK\_XXXX\_YYYY\_MM\_DD\_HHMM.trak file.
3. Use SeaSonde Acquisition to import the Time Series data in the diagnostics mode to record the measured transponder peak and the associative bearing from the GPS track. The Output file is an antenna measurement and bearing over time called a LOOP "LOOP\_XXXX\_YYYY\_MM\_DD\_HHMM.loop" file.
4. Use CrossLoopPatterner to filter bad measurement points, adjust for time discrepancies, smooth, interpolate and output the final Pattern file to be used by SeaSonde Radial Processing software.

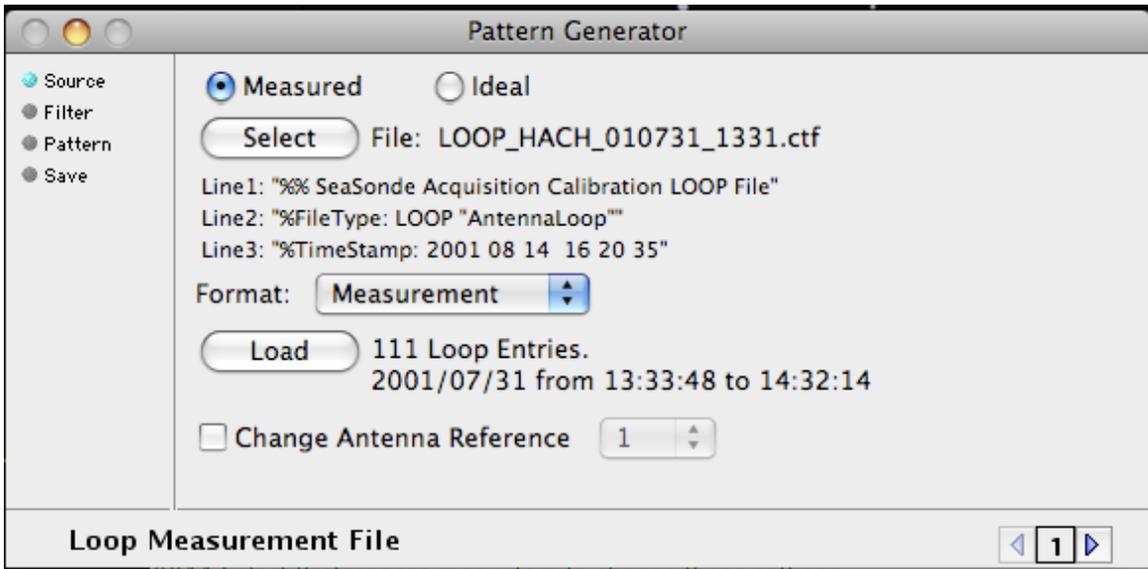
CrossLoopPatterner divides the task into four main sections or steps: Source, Filter, Pattern, Save.

Contents:

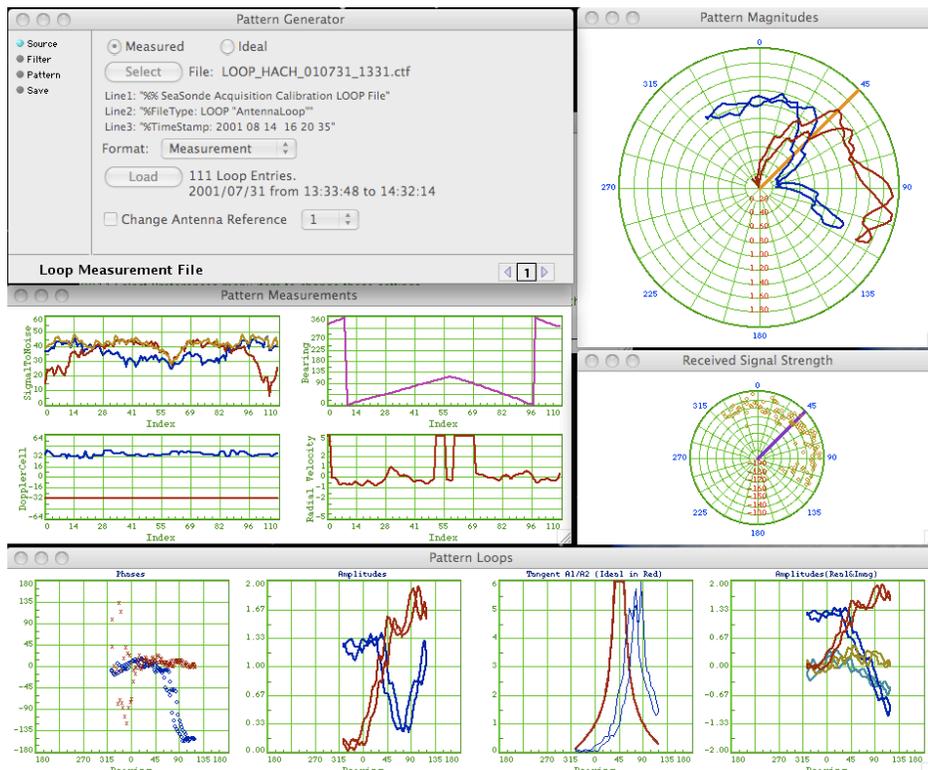
1. Source. Select the Source Loop File
2. Filter Filter out Unwanted Measurements
3. Pattern Reduce, Smooth, and/or Interpolate
4. Save Save the Pattern File
5. Ideal Generate an Ideal Pattern
6. Graphs About the Plots.

# 1. Source

The first section Source is where you enter the LOOP file, Pattern file, or select 'Ideal' to start with. Select the radio button 'Ideal' if you want to switch to the ideal generator section.



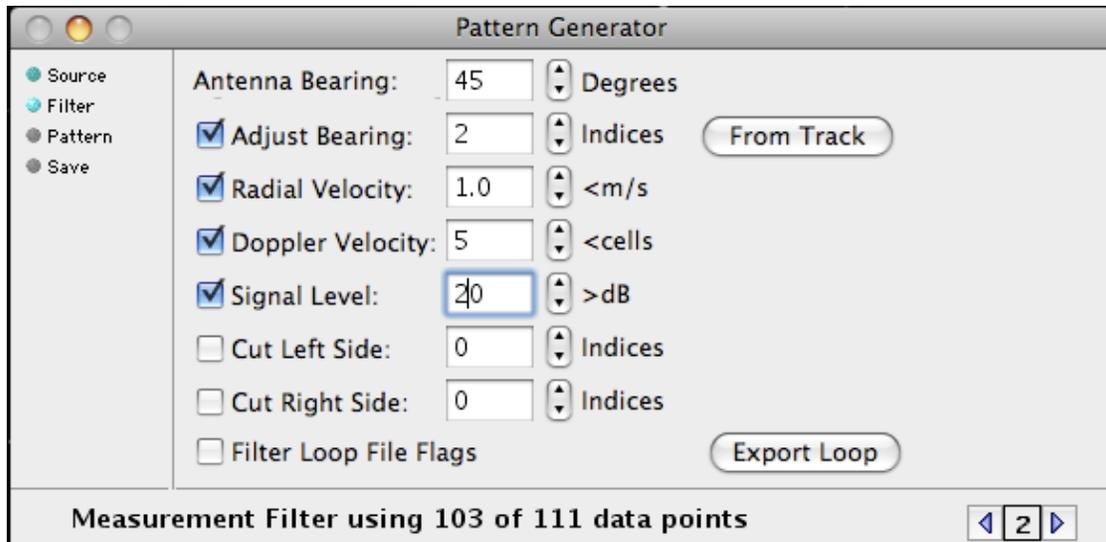
To select a source file, select the push button 'Select' or drag a LOOP file to the window, or drag a Loop file to the application's icon. Note, dragging a LOOP file to the applications icon will always take you back to the source section. CrossLoopPatterner will automatically load and identify the source file as a Measurement (LOOP) or Pattern file. If not a valid file, you will see '0 Loop Entries'. CrossLoopPatterner will show the first three lines of the file to help you identify the file. CrossLoopPatterner will then open several plots of the source data. The push button 'Load' will reload the source file, which is useful if it has been changed externally or in the next section you adjust the track timing and return to this section to revert to the original source. For the first time, all the graphs will open and plot the loop data.



You may then click on the right arrow to proceed to the Filter section.

## 2. Filter

The second section Filter is for removing unwanted measurement points.



Near each edit field is an up/down spin control allowing you to change the value and see real time graph updates. Filtered out points will disappear from the graphs and the control dialog shows how many points are still valid (above example shows 103 out of 111 points). Each filter is enabled by check marking the check box before the filter's name.

The **Antenna Bearing** field sets where the main lobe of loop 1 is pointing relative to True North Clockwise. (Note that all bearings in CrossLoopPatterner are handled as True North Clockwise). In the Pattern Magnitudes polar graph, the antenna bearing is plotted as an orange line. Note, changing the Antenna Bearing does not rotate the pattern loop data. Previous to SeaSonde OS X, the antenna bearing is not stored in the Loop. You will have to locate the Radial Site Header file and enter the bearing here or just drop the header file onto this window.

The **Adjust Bearing** field is a timing adjustment, which is covered in more detail below.

The **Radial Velocity** filter if enabled keeps all points, which have less than the entered velocity. The radial velocity is zero, if the Transponder kept a perfect arc relative to the SeaSonde Radial Site.

The **Doppler Velocity** filter keeps all points, which are less than plus/minus entered cells from average doppler velocity cell. The doppler velocity cell is the cell of the transponder peak measured in SeaSonde Acquisition. If the transponder momentarily dropped out, another signal might be accidentally recorded into the loop. You would want to filter these points out. Note that if the transponder velocity exceeds the max / min doppler cells it will wrap to the negative/positive doppler cell. In this case, CrossLoopPatterner will still calculate the average doppler cell making it a very poor filter.

The **Signal Level** filter will keep all points, which have a signal to noise ratio greater than the entered dB. It will remove any point in the monopole (orange in signal to noise graph) is less than this value. It will only remove points in which both loop 1 (red) and loop 2 (blue), which are less than this value. Each loop can be expected to drop in signal to noise near its null region, which happens at a +/-180 deg. from its main lobe (strongest signal).

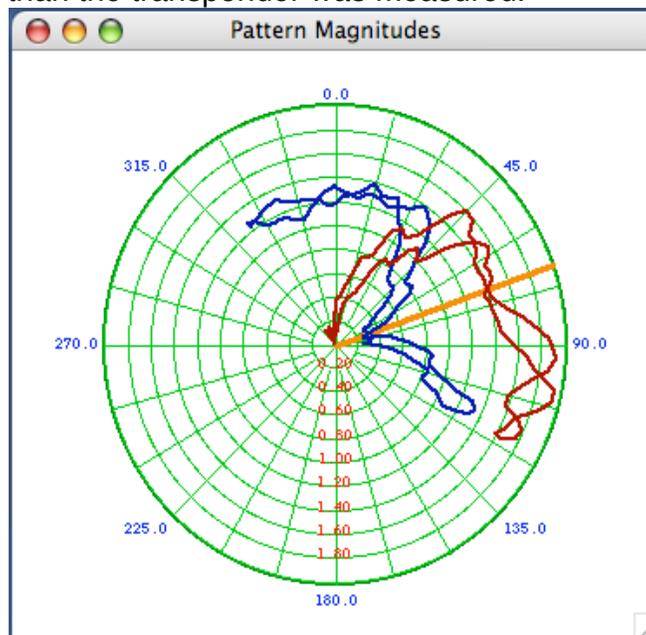
The **Cut Left Side** filter removes the entered number of points from the beginning of the loop file. Typically when start a transponder run the transponder may have been sitting still for while or setting up for the arc and you may not want to include the points. If you look at the Pattern Measurement graphs you can pick out the horizontal index you want to cut.

The **Cut Right Side** filter removes the entered number of points from the end of the loop file. If you look at the Pattern Measurement graphs you can pick out the horizontal index you want to cut.

The **Filter Loop File Flags** check box, if check marked, will remove any points whose Flag column value is not zero. SeaSondeAcquisition currently always sets this value to zero. It is still possible to hand edit the loop file to flag extra points you may wish to remove.

The **Export** Button will output a Loop file of the filtered data.

The **Adjust Bearing** field is a quick way to fix when the GPS Track timing did not match the Time Series data by a small error. This is typically only useful when the Transponder run was performed as both clockwise and counter-clockwise arcs. The back and forth run will show up in the pattern magnitude plots as a double image. This obvious error happens when the GPS track time is not synchronized with the Time Series data. This causes a calculated bearing result at a different time than the transponder was measured.

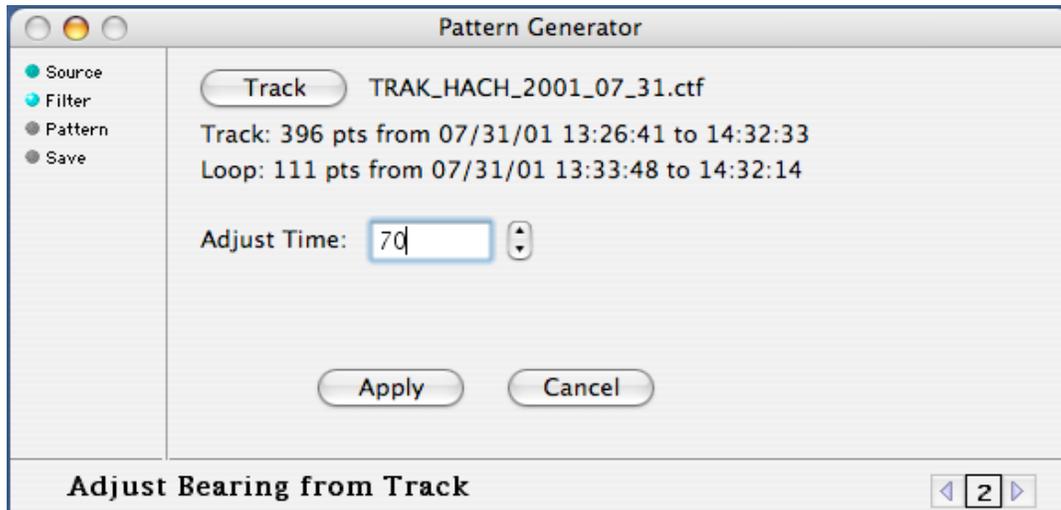


The above plot show a clockwise followed by a counter clockwise boat run in which the computer time was off by 70 seconds from the GPS time.

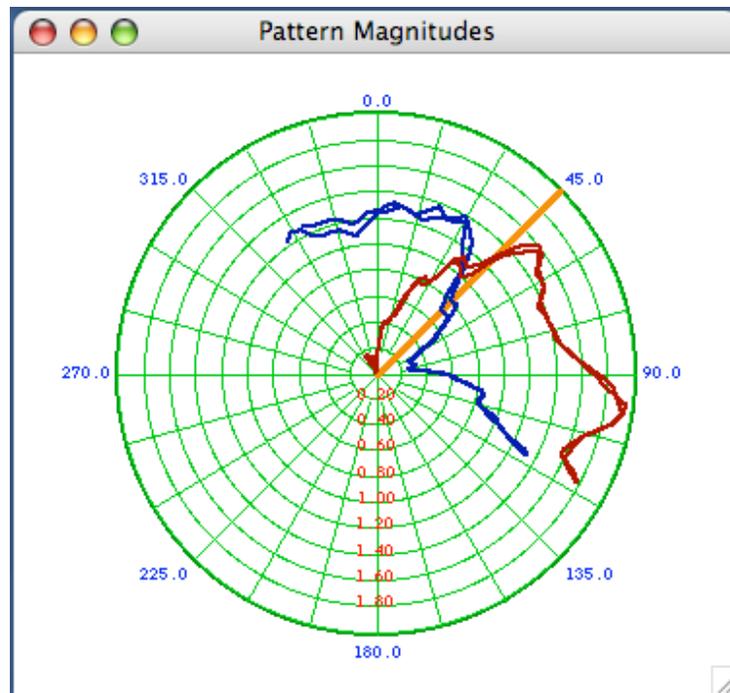
You can check mark the "**Adjust Bearing**" to enable and enter the number of indices to shift the bearings. Positive shifts them up; negative shifts them down. You should only use this method if the GPS track kept a steady radial velocity. If the GPS Track significantly slowed down,

speeded up or stopped for more than a minute you may be introducing large bearing errors. It is much more accurate to use the "From Track" button which will switch you to a track adjustment section. You will need the GPS track, which corresponds to the Loop file.

The "From Track" section is from the "Filter" section 'Use Track' button to change the GPS Track bearing to Loop pattern timing alignment.



Select the "Track" button to select a track or drop the Track file onto this window. It will be loaded and the number of points and timing information will be shown. Change the Adjust time window to a positive or negative second adjustment to the track timing so that the CW and CCW transponder runs look like one.

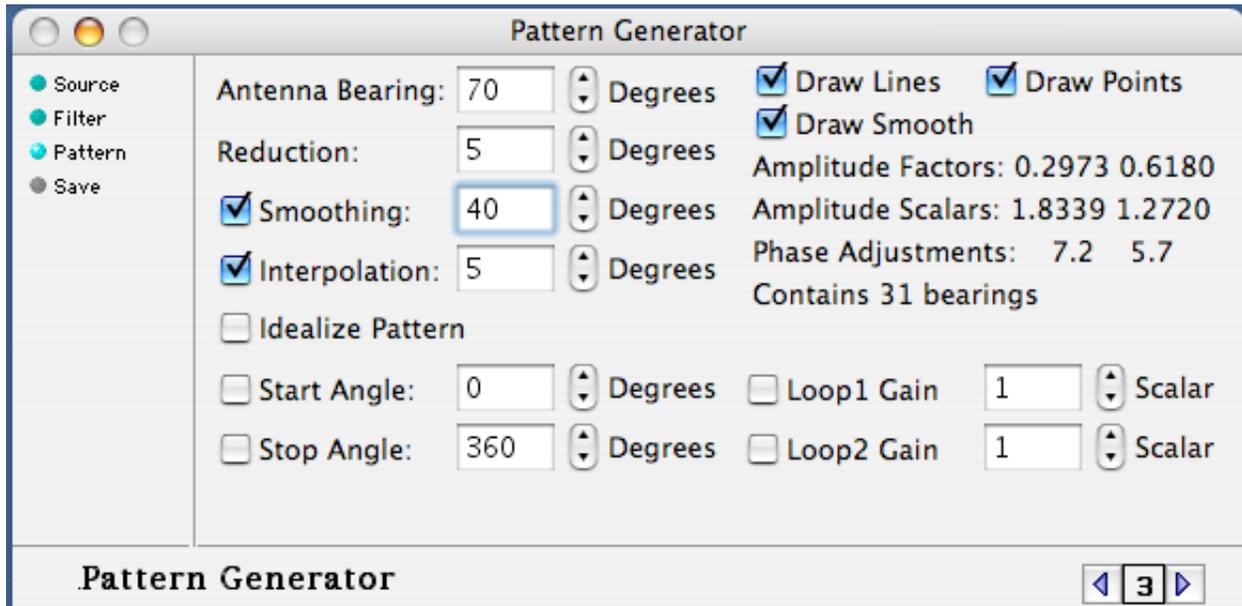


Click the 'Apply' button to keep this adjustment and return to the "Filter" section. To revert to the original after applying this time offset, you can click the left arrow in the "Filter" section to go back to the "Source" section and then click the "Load" button to reload the original Loop File. Click the 'Cancel' button to discard the offset and return to the "Filter" section.

To proceed to the "Save" section, select the right arrow at bottom right of the window.

### 3. Pattern

The "Pattern" section is for reducing, smoothing, and interpolation before saving the pattern.

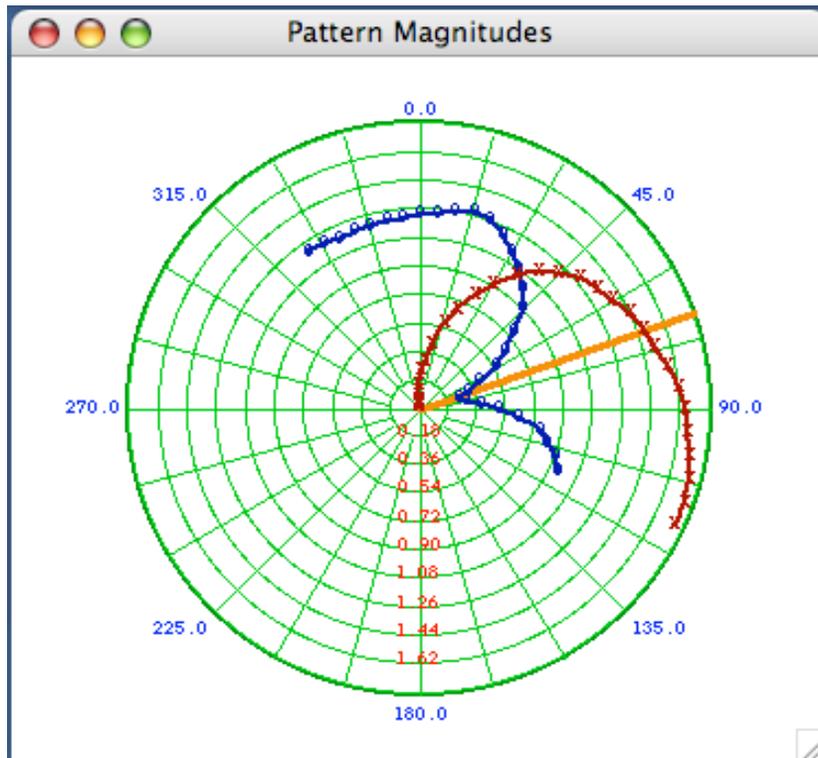


The **Antenna Bearing** entry allows you to still change the bearing here. It is important to have the right antenna bearing at the time of the Transponder measurement. The pattern is stored relative to the antenna bearing.

The **Reduction** entry averages and reduces the loop to the entered precision. The Reduction entry causes all bearings within +/- the reduction/2 to be averaged into one point. Without **Interpolation** enabled this will be the output degree resolution of the pattern. Typically SeaSonde uses 5 degrees. This step is always required so that duplicate points at the same bearing are always averaged down to a single point.

The **Smoothing** entry if enabled smoothes (averages) bearings over +/- the smoothing/2. It does not reduce the number of points like **Reduction** does.

CrossLoopPatterner applies, in order, first a reduction of 0.01 deg, then **Smoothing**, then the **Reduction** entry, then **Interpolation**, and lastly **Idealize Pattern**.



The **Interpolation** entry if enabled, it will fill in all points at the entered resolution. It is currently set to only interpolate between bearings at 30 deg or less apart. The interpolation is done using a cubic Bezier curve using the previous bearing and post bearing plus the two points be interpolated across (4 points). This is much the same as the **Draw Smooth** check box except that it is done on the real and imaginary parts of the pattern separately. As a test, create an ideal pattern at maximum resolution (20 deg) then go and enable Interpolation to 1 deg.

*(You should always turn on interpolation at the output resolution of your pattern; otherwise any missing bearings in the pattern will show up as missing radial spokes in the output.)*

The **Idealize Pattern** entry uses the calculated amplitudes and phases with antenna bearing to create an ideal pattern at the **Reduction** resolution. This is not normally done.

The **Draw Smooth** check box toggles drawing the graphs with a Bezier curve or straight line.

The **Draw Lines** check box toggles drawing lines (straight or curved) between the points on and off for the Pattern Magnitudes polar plot.

The **Draw Points** check box toggles drawing markers at the data points for the Pattern Magnitudes polar plot. (X's for Loop 1. O's for Loop 2).

The **Start Angle** entry allows you to cut off a portion of the pattern. You would only do this if you thought that part of the pattern was no good.

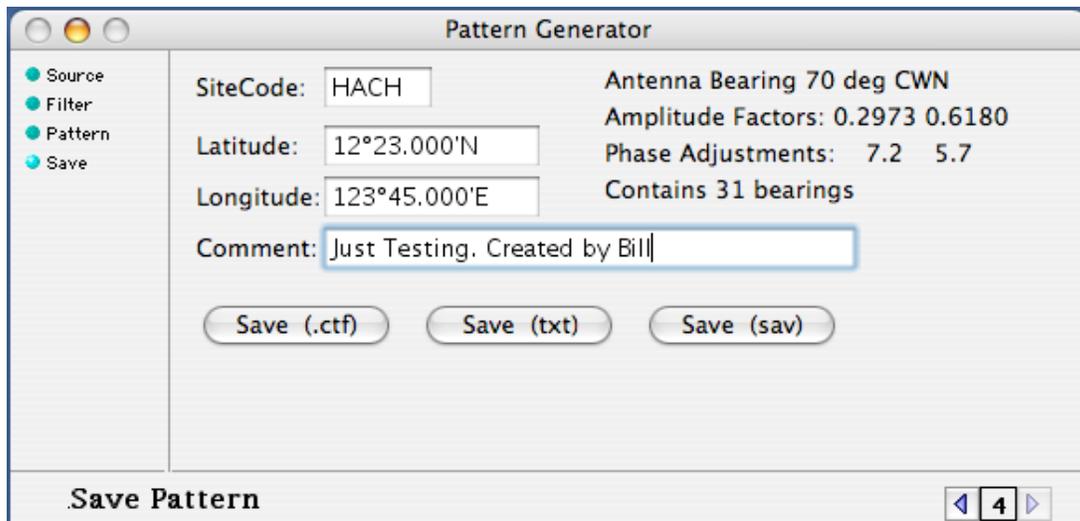
The **Stop Angle** entry allows you to cut off a portion of the pattern. You would only do this if you thought that part of the pattern was no good. The kept part of the pattern will be clockwise from the **Start Angle** to the **Stop Angle**.

The **Loop 1 Gain** and the **Loop 2 Gain** entries allow you to scale the loop magnitudes up or down. There is no reason to do this for normal patterns.

Select the right arrow at the lower right of the window to continue to the "Save" section.

## 4. Save

The Save section allows you to enter site info and a user comment before saving the pattern file.



The screenshot shows a window titled "Pattern Generator" with a sidebar on the left containing four items: "Source", "Filter", "Pattern", and "Save". The "Save" item is selected. The main area contains the following fields and text:

SiteCode:	HACH	Antenna Bearing 70 deg CWN
Latitude:	12°23.000'N	Amplitude Factors: 0.2973 0.6180
Longitude:	123°45.000'E	Phase Adjustments: 7.2 5.7
Comment:	Just Testing. Created by Bill	

Below the fields are three buttons: "Save (.ctf)", "Save (txt)", and "Save (sav)". At the bottom of the window, there is a "Save Pattern" button and a page indicator showing "4" between left and right arrows.

The **SiteCode** entry is the four-character site name.

The **Latitude** entry is the latitude entry of the site for reference purposes.

The **Longitude** entry is the longitude entry of the site for reference purposes.

Drop a Header file onto this window to automatically update the **SiteCode**, **Lat** and **Lon** entries.

The **Comment** entry is a reference remark for the file.

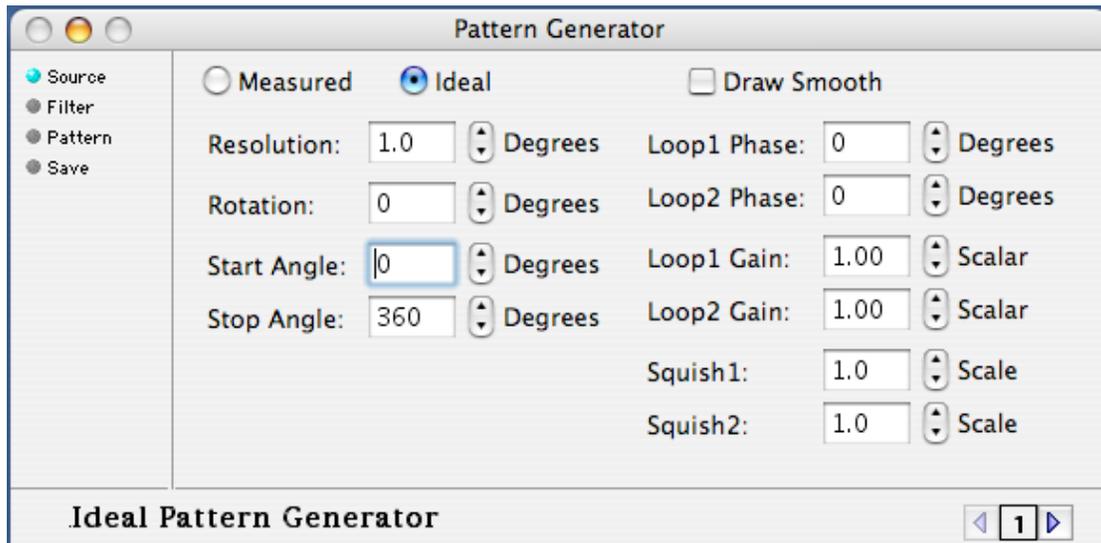
The **Save (.ctf)** button writes the Pattern file in the new CTF (CODAR Table Format) for Pattern files. (This format is not yet in use by the processing software.)

The **Save (txt)** button writes the Pattern as the current OS X format with unix linefeeds.

Release 6 uses 'IdealPattern.txt' for ideal and 'MeasPattern.txt' for calibrated antenna.

## 5. Ideal

The Ideal section allows you to create an ideal antenna pattern.



The **Measured** button will take you back to the main "Source" section.

The **Resolution** entry sets the bearing degree resolution of the pattern. Typical SeaSonde uses 5 degrees.

The **Rotation** entry will rotate the pattern. Although typically zero, this entry will not matter as the antenna pattern is always references to the SeaSonde Radial Site's bearing.

*Warning: Changing the following from the typical / default will create a non-standard ideal pattern. These are available for experimentation use only.*

The **Start Angle** entry sets the starting bearing angle of the pattern.

The **Stop Angle** entry sets the non-inclusive stopping bearing angle of the pattern. Typically, start and stop would be 0,360.

The **Loop1 Phase** entry changes the phase of loop 1. (Visible in the Pattern Measurement phase graph as red.)

The **Loop2 Phase** entry changes the phase of loop 2. (Visible in the Pattern Measurement phase graph as blue.)

The **Loop1 Gain** entry is multiplication factor on the magnitude of loop 1. Typical value is one.

The **Loop2 Gain** entry is multiplication factor on the magnitude of loop 2. Typical value is one.

The **Squish1** entry is a power factor on the magnitude of loop 1. Typical value is one. Values >1 apply a  $\text{pow}(\text{mag}, \text{squish})$  causing the circular lobe to narrow. Values <0 apply a  $\text{pow}(\text{mag}, 1/(-\text{squish}))$  cause the circular lobe to widen.

The **Squish2** entry is a power factor on the magnitude of loop 2. Typical value is one. Values >1 apply a  $\text{pow}(\text{mag}, \text{squish})$  causing the circular lobe to narrow. Values <0 apply a  $\text{pow}(\text{mag}, 1/(-\text{squish}))$  cause the circular lobe to widen.

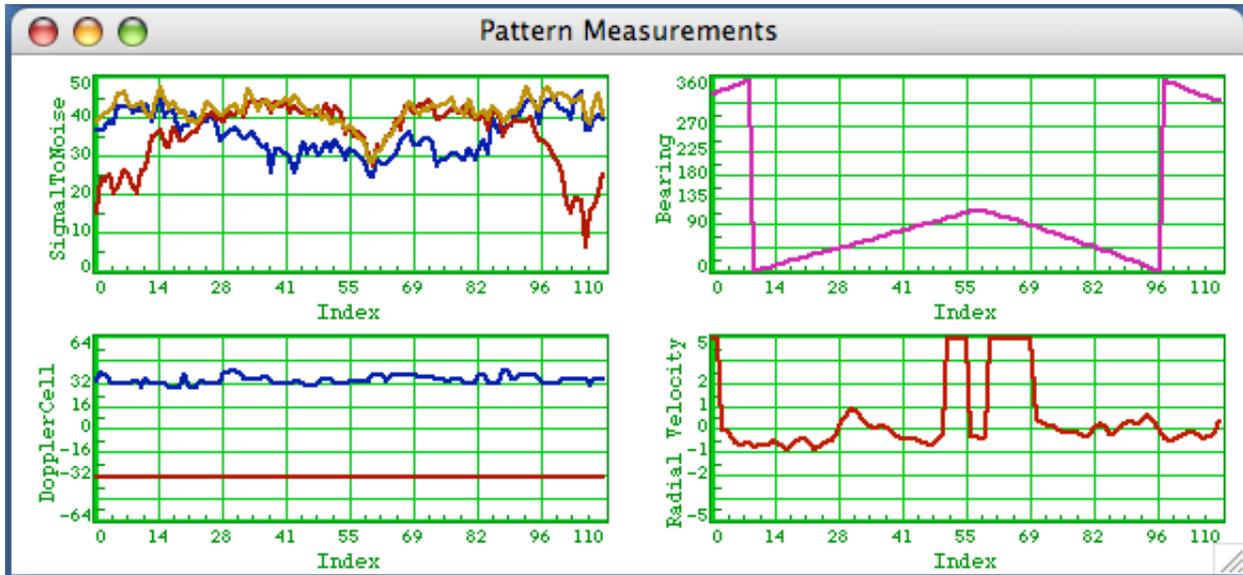
# 6. Graphs

The Pattern Measurements Graph window shows:

Signal to Noise (dB) for Loop 1 (red) Loop 2 (blue) Monopole (orange) vs the Loop file index.  
 Bearing (deg) (purple) vs the Loop file index.

DopplerCell (blue) vs Loop file index (Range Cells are in red on a different scale (0 to max range) vs the Loop file index.)

Radial Velocity (m/s) (red) vs the Loop file index.



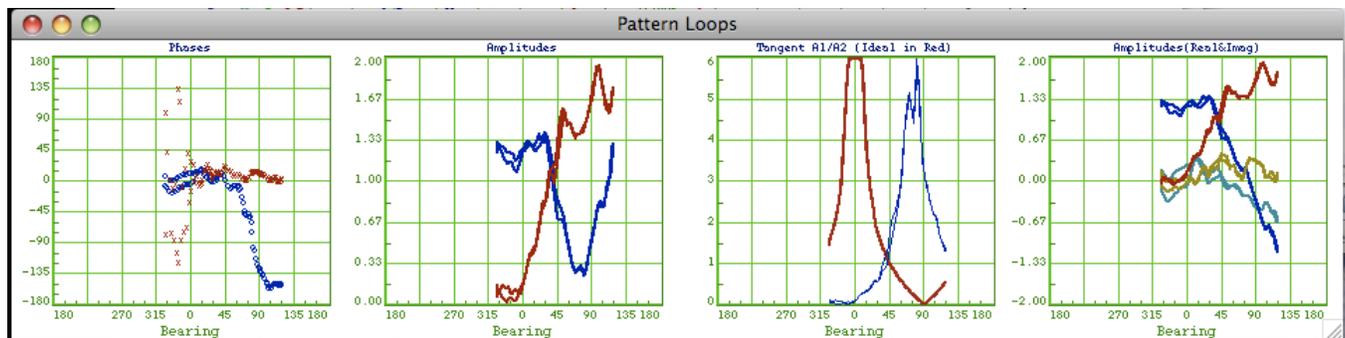
The Pattern Loops Graph window shows:

Phases (deg) for Loop 1 (red), Loop 2 (blue) vs bearing CW from North.

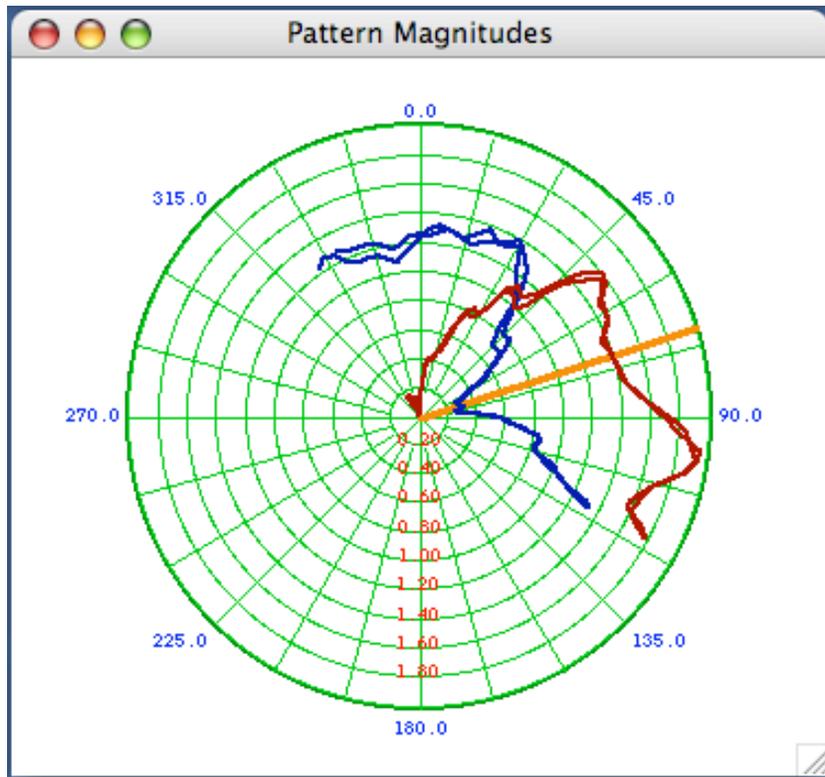
Amplitudes (ratio) for Loop 1 (red), Loop 2 (blue) vs bearing CW from North.

Tangent  $\tan(\text{Loop1}/\text{Loop2})$  (blue) (ideal tangent is in red)

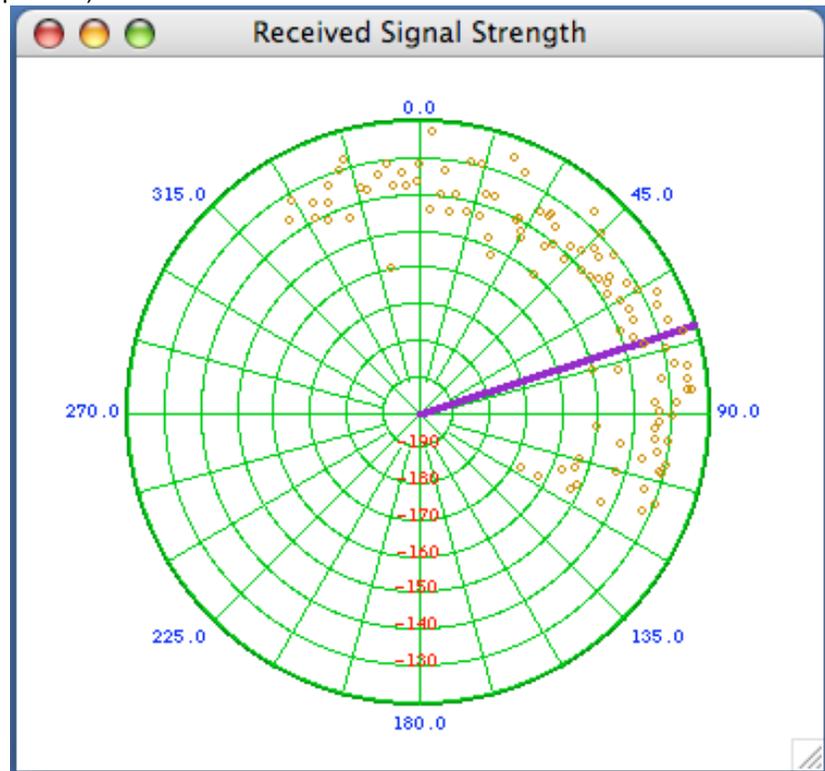
Amplitudes of I & Q (Loop 1 I is red, Q is Yellow, Loop 2 I is Blue, Q is Cyan)



The Pattern Magnitudes Graph window shows:  
Amplitudes (ratio) for Loop 1 (red), Loop 2 (blue) vs bearing CW from North.  
Antenna Bearing (orange line)



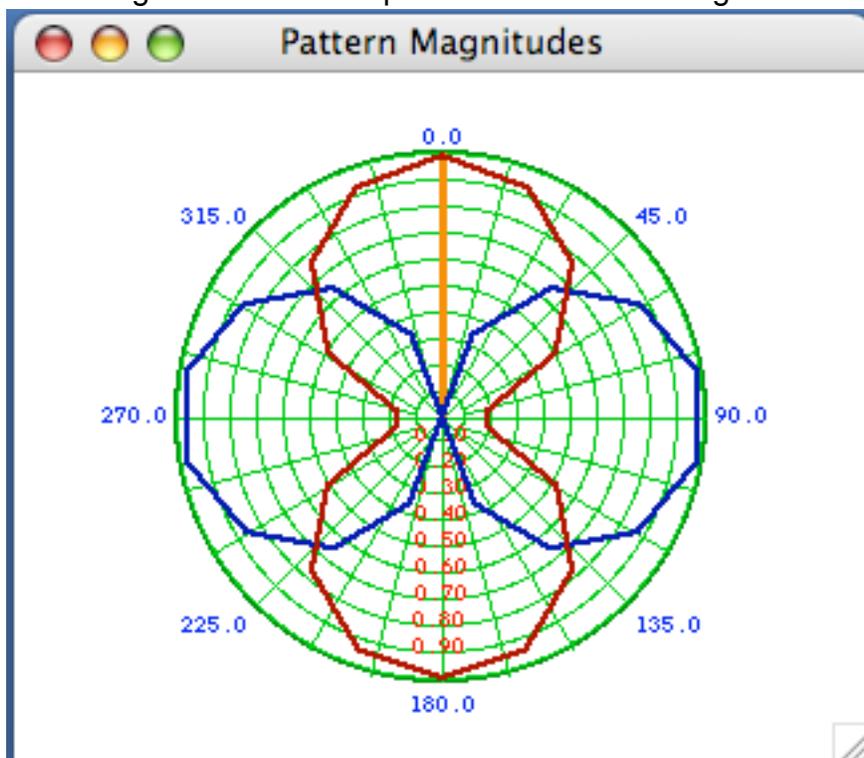
The Signal Strength Graph window shows:  
Measured Monopole Signal Strength (dBm) (orange 'o's) vs bearing CW from North.  
Antenna Bearing (purple line)





## Example of Interpolation

20 deg resolution Ideal pattern drawn with straight lines



after 1 deg interpolation drawn with straight lines

