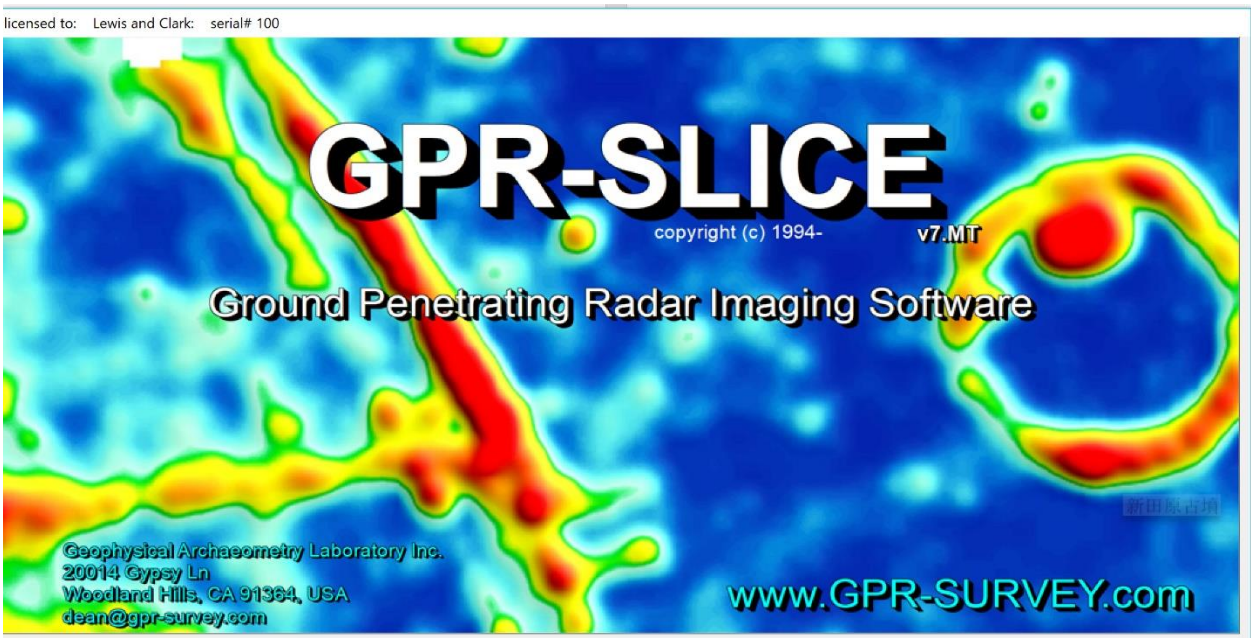
GPR-SLICE V7.MT

Ground Penetrating Radar Imaging Software



Quickstart User Manual

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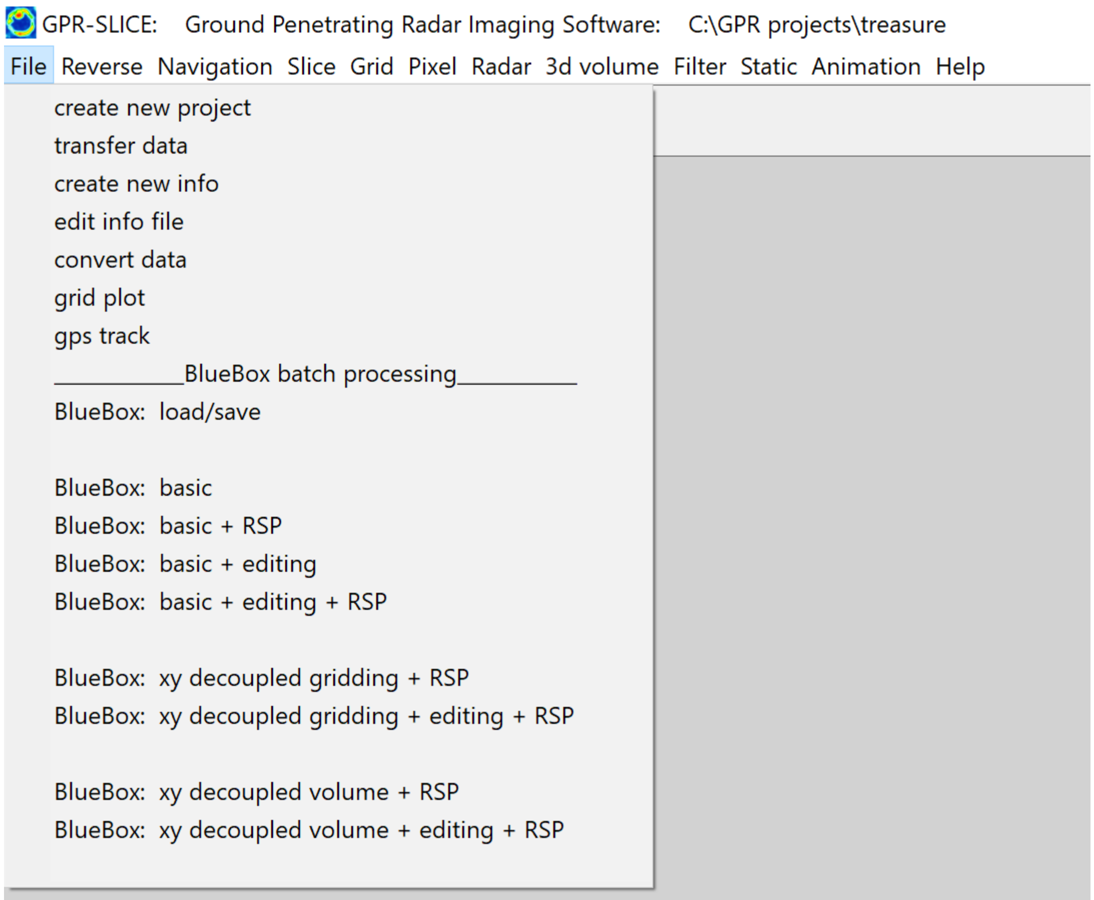
Quickstart Introduction: raw data to 3D volume



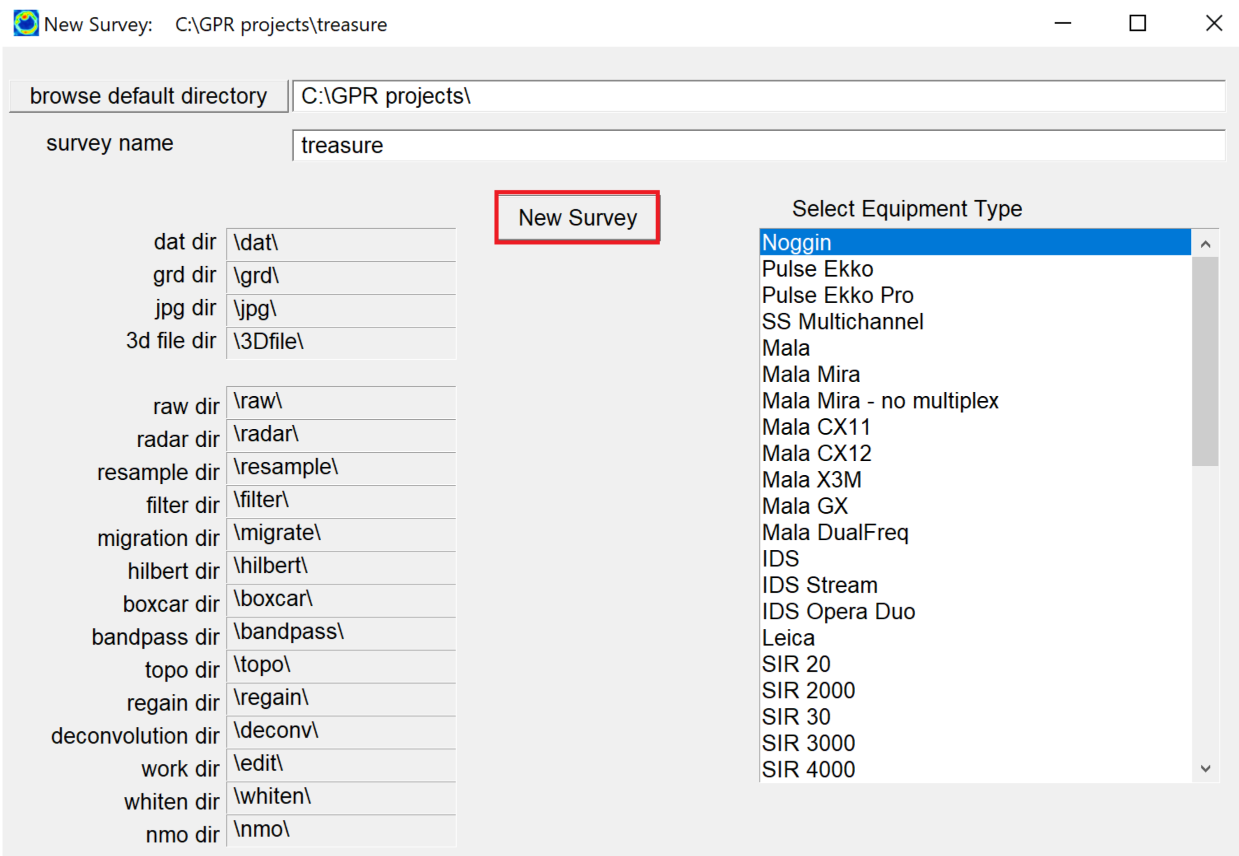
In this quickstart introduction to GPR-SLICE V7.MT Software, we are going to go through all the elementary steps needed to create 2D and 3D time slices. V7 was written for the flow of control moving from top to bottom in the pulldown menu, and then left to right. The 15 general steps to produce a series 2D time slices are:

STEP 1. create new project
2. transfer data
3. create new information file
4. edit info
5. convert data
6. reverse data (if necessary)
7. set, correct, or assign navigation
8. time 0 correction
9. spectra+gain
10. bandpass filtering
10a. Optional: migration, Hilbert transform

11. slice/xyz
12. gridding
13. grid smoothing
14. time slice display, transform adjustment, 3Dvolume generation
15. launch OpenGL Volume

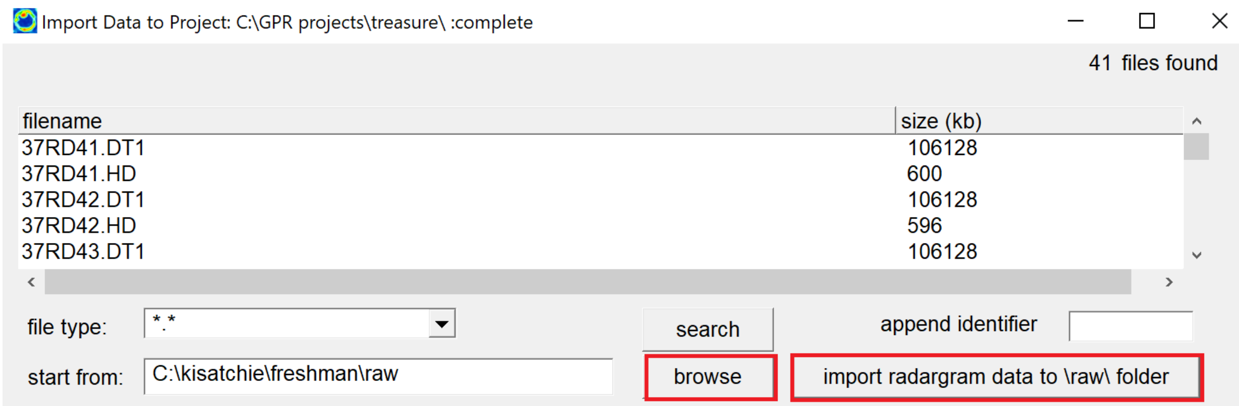
The first 5 steps are all contained in order within main Files menu.

Step 1. Create New Project



Clicking the Create New Project button will launch a dialog asking for a default directory and new project name as well as the GPR equipment type used. The user can first Browse for any folder, then type in a name for project. In the example above a project called “treasure” is created directly at c:\GPR projects \treasure\. Clicking the New Survey button will generate the project folder with 16 subfolders: 12 radargram folders for storing radargram signal processes and 4 other folders for imaging output. (In addition, two radargrams folders called work2 and work3 are made for future growth). The user can explicitly create projects on any separate external or internal hard drives.

Step 2. Transfer Data



After completing steps 1 the user needs to import data into the GPR-SLICE project folder. The transfer data option available in the Files menu is operated by:

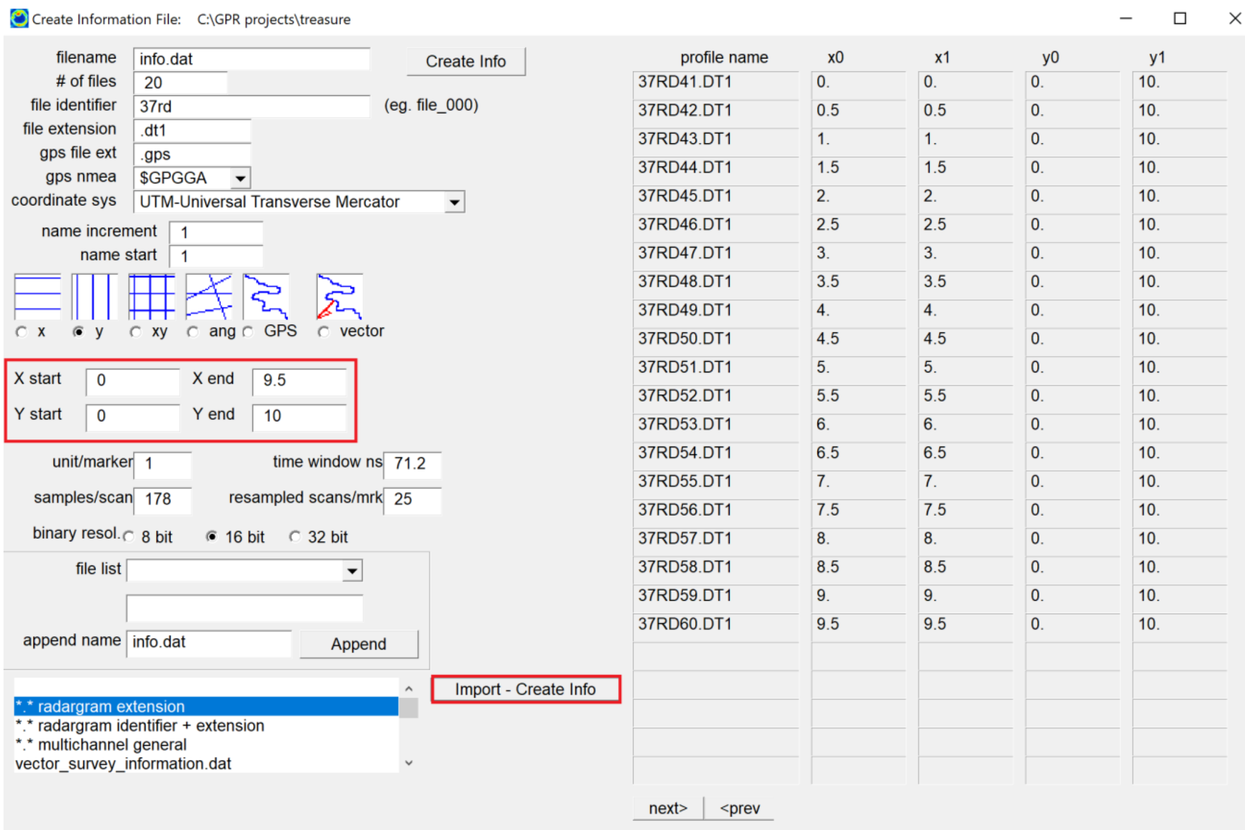
1) Click the Browse button to locate the root of the folder where the raw GPR data reside

2) Click the Search button to display the files into the dialog (optional)

3) Click the Import radargram data to \raw\folder button to begin transferring the raw data into the project.

Note: There is an option to import all the files from a survey with an Append identifier in the Transfer Data menu. This is useful when multiple grids nearby are to be combined into a single comprehensive process but when the separate grids might have the same filenames and unique names are needed.

Step 3. Create New Info



An information file is needed to detail the radar profile names and their location on the ground. For a perfect rectangular grid, there is a quick method to assign all the information.

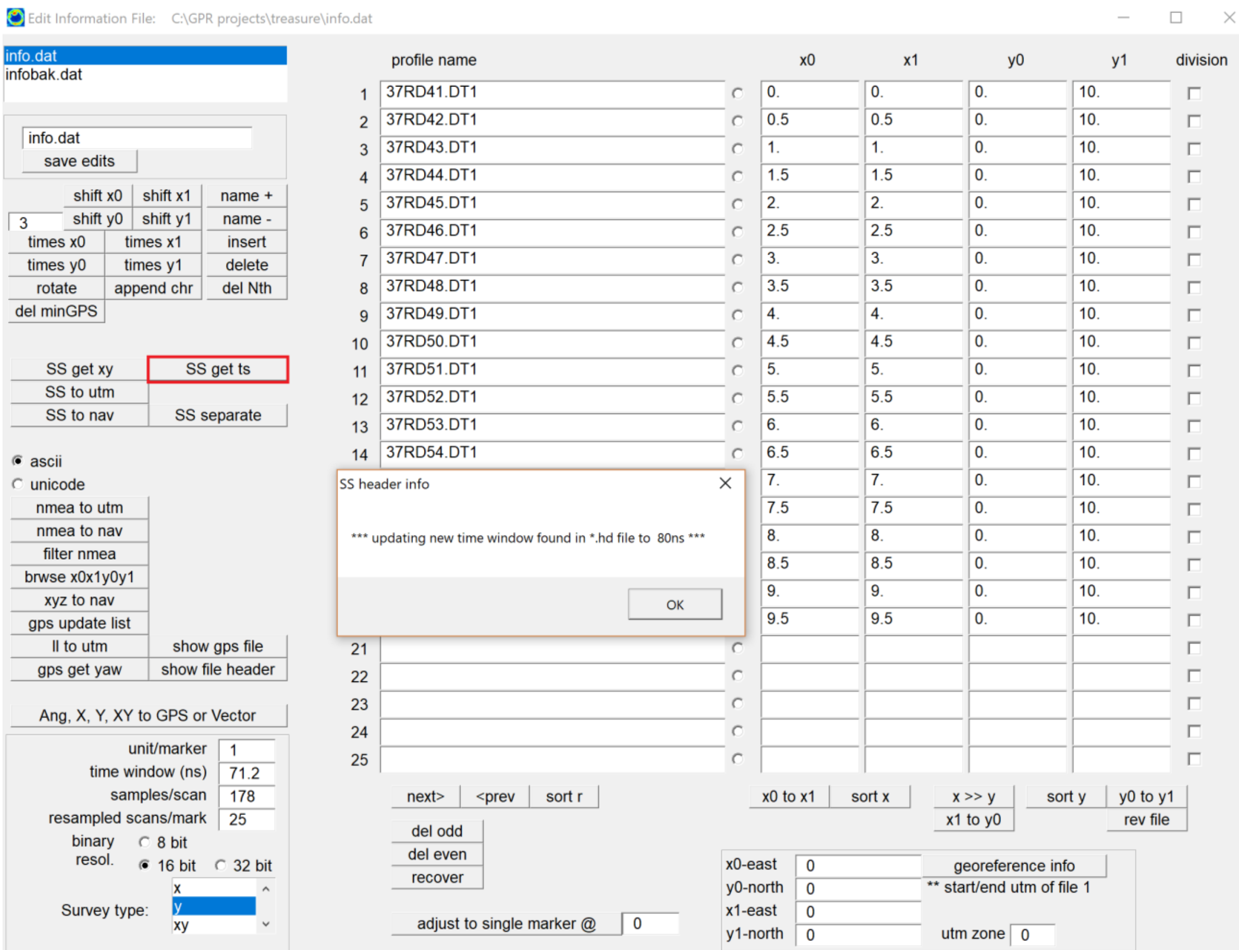
1) One first sets the info filename to create, the type of survey (x or y etc), the x start/end and y start/end

2) Click Import – Create Info button with *.* radargram extension highlighted in the option listbox.

The last option will create an information file called info.dat with the radargram file names and for this example a y survey. The option will automatically discover all the radargrams with the given file extension and place them across the ranges in x and y chosen.

(For GPS, one would set the survey to GPS and then click the Import – Create Info button).

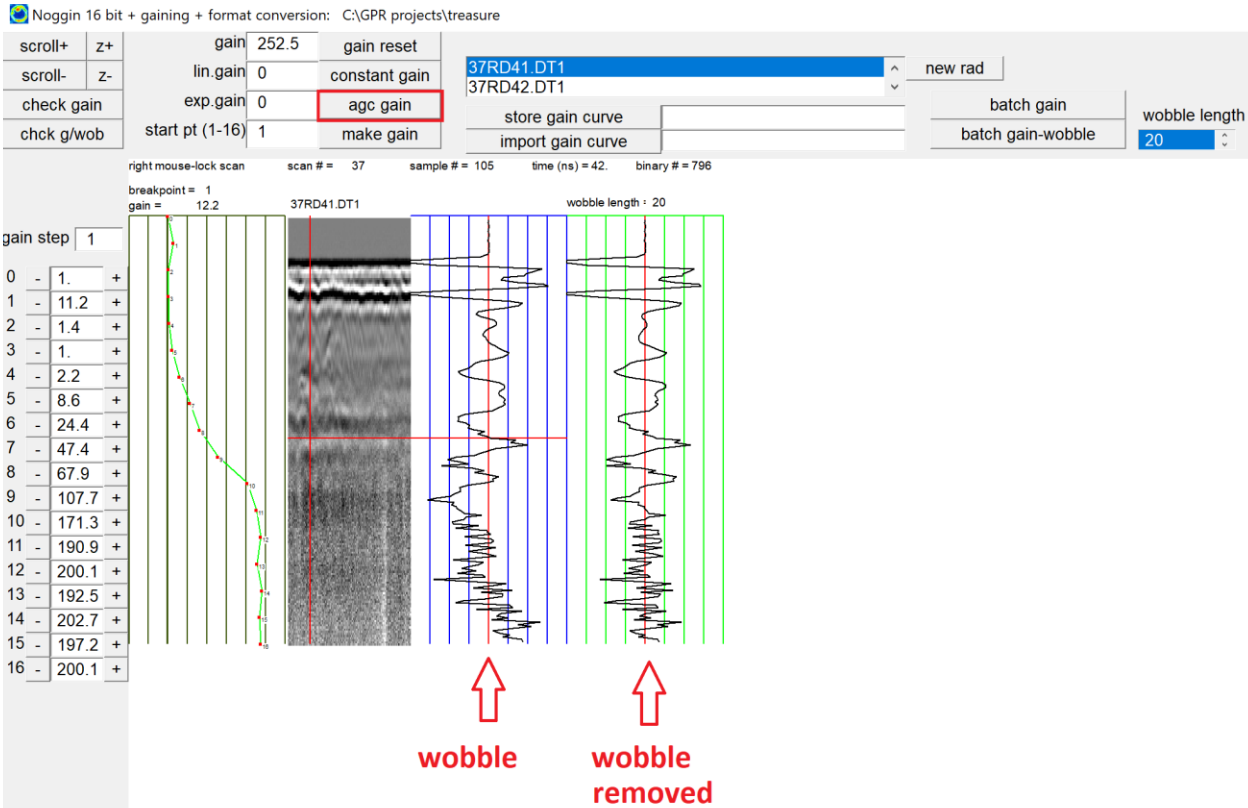
Step 4. Edit Information File



In the Edit Info File menu, the user can edit line length or redefine line lengths based on the survey wheel calibration. The first operation is to

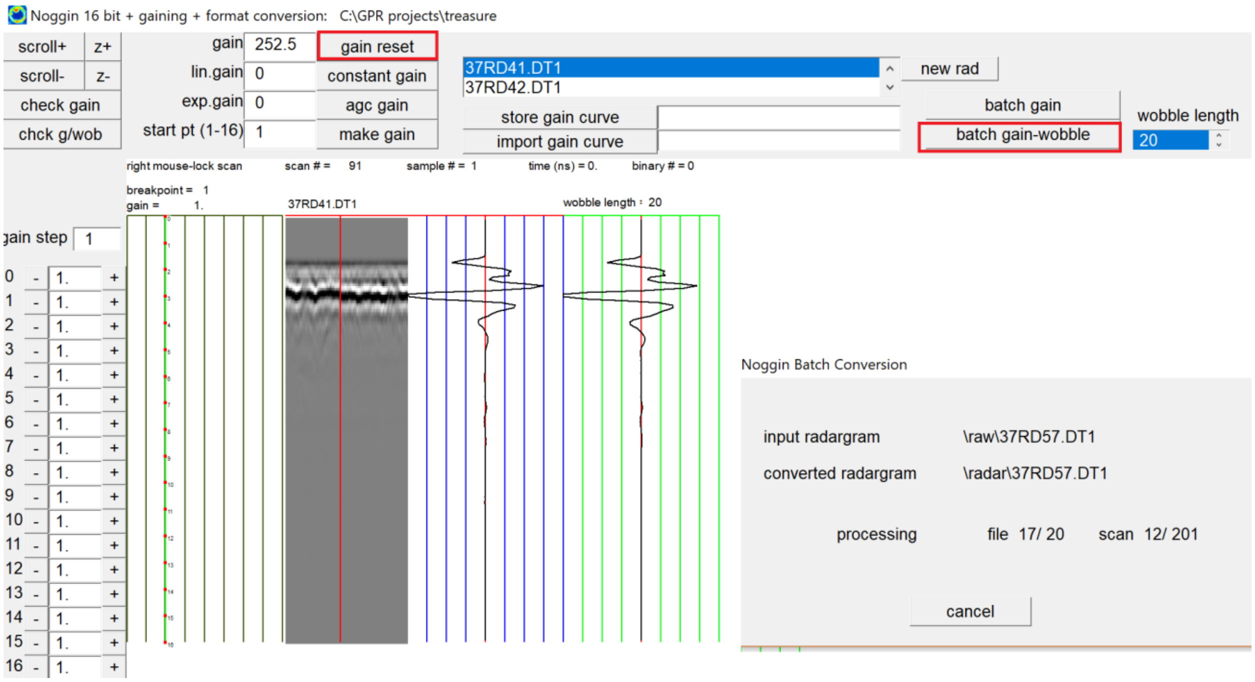
1) Click the button called ### Get TS which will read the radargram header to find the recording time window and the samples/scan for the radargram data. (Every manufacturer will have this similar button) The ### Get TS button will also test to make sure all the radargrams have identical recording parameters – if not it will return a warning
2) Optional: If the user wants to use the survey wheel calibration they can click the ### Get XY button which will read this information and based on the Optins menu set range unit, will place this information in the information column.
   Optional: For GPS surveys click the ### to UTM button for most manufacturers to generate the navigation files

Step 5. Convert Data



All GPR manufacturers' data needs to be converted to GPR-SLICE format. We typically will not apply any gain in this menu since we need to correct for time 0 across the dataset first. One can use this menu to optionally apply an AGC to look at the signal. If the signal shows a lot of dc-drift or wobble noise, they can use the button batch gain- wobble. If the data do not show dc noise, they can use just the button batch gain.

1) First click the AGC button to apply a gain to see if there is significant dc-drift and wobble noise. The example above shows significant wobble noise. So for this data we should apply a pre-conditioning to the data on conversion with batch gain – wobble button. However, we must not apply any gain during conversion. See next step.



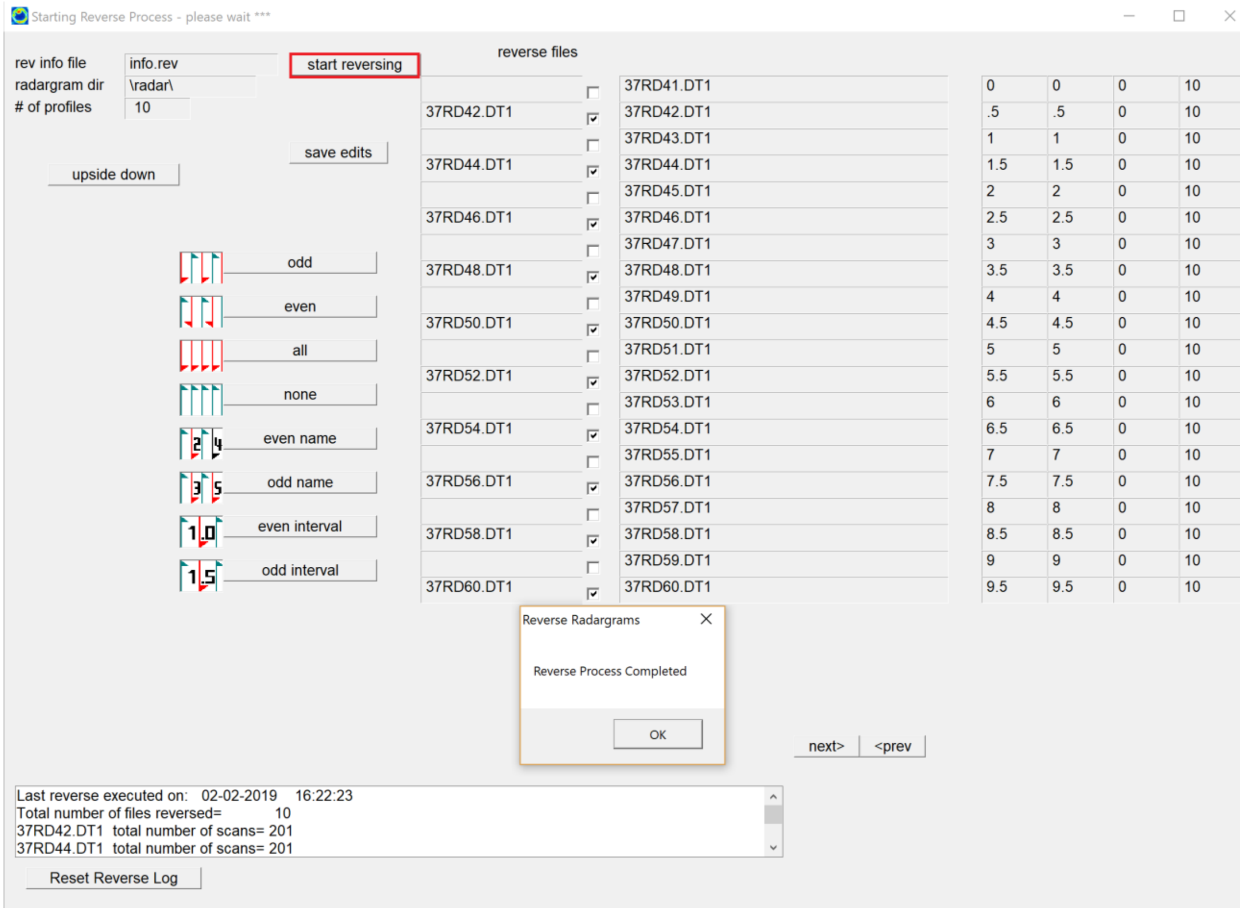
2) Click the gain reset button to remove all gaining on the radargram

3) For this data click the batch gain – wobble button to convert the data with dc-drift / wobble removal which will remove the low frequency noise. The converted radargrams are written to the the \radar\ folder of the project

Optional: Some manufacturers that record 32bit radargram resolution, one can apply a constant gain across the data to see in the initial pulse. Typical 32 bit radargrams from GSSI are actually recorded with about 24-25 bits of resolution even though the data are 32 bit designation. To see the initial pulse in the window, one may need to apply a constant gain of 100-500 for it to graphically appear. Mala and UTSI 32 bit radargrams typically do not need any constant gain applied since these radargrams have more native resolution in the raw radargrams and the initial pulse will appear in this menu.

Note: Since 2013, GPR-SLICE has provided full 32 bit processing through all the menus in the software.

Step 6. Reverse Data (optional)

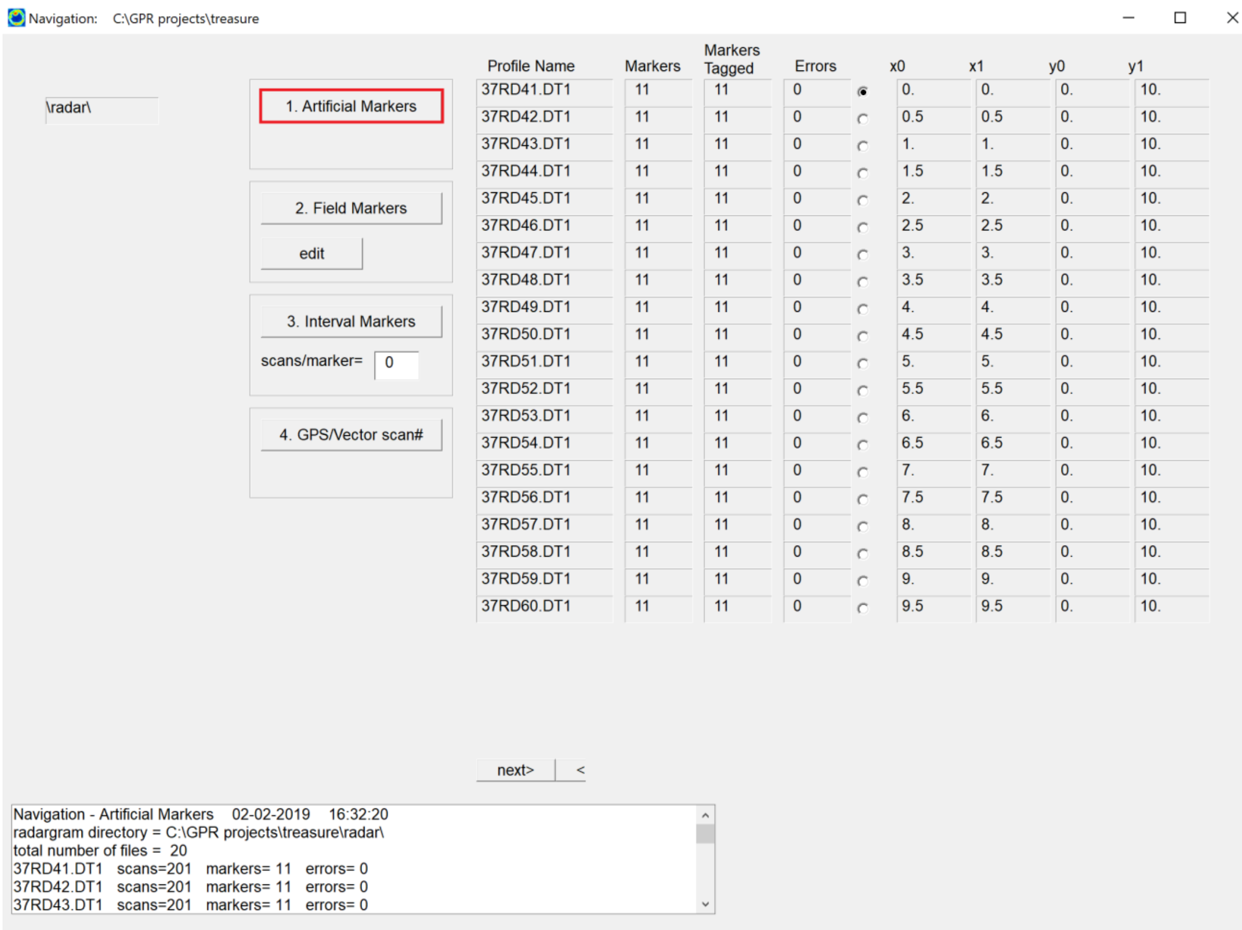


If radargrams in the field were collected in the reverse direction or in a zig-zag direction, the reverse process can be used to un-reverse them.

1) The radargrams that were collected in the opposite direction are checked on manually, or using some of the quick buttons available

2) Clicking the Start Reversing button will flip all the radargrams around that were collected in the opposite direction (and rewrite them in the \radar\ folder)

Step 7. Set Navigation

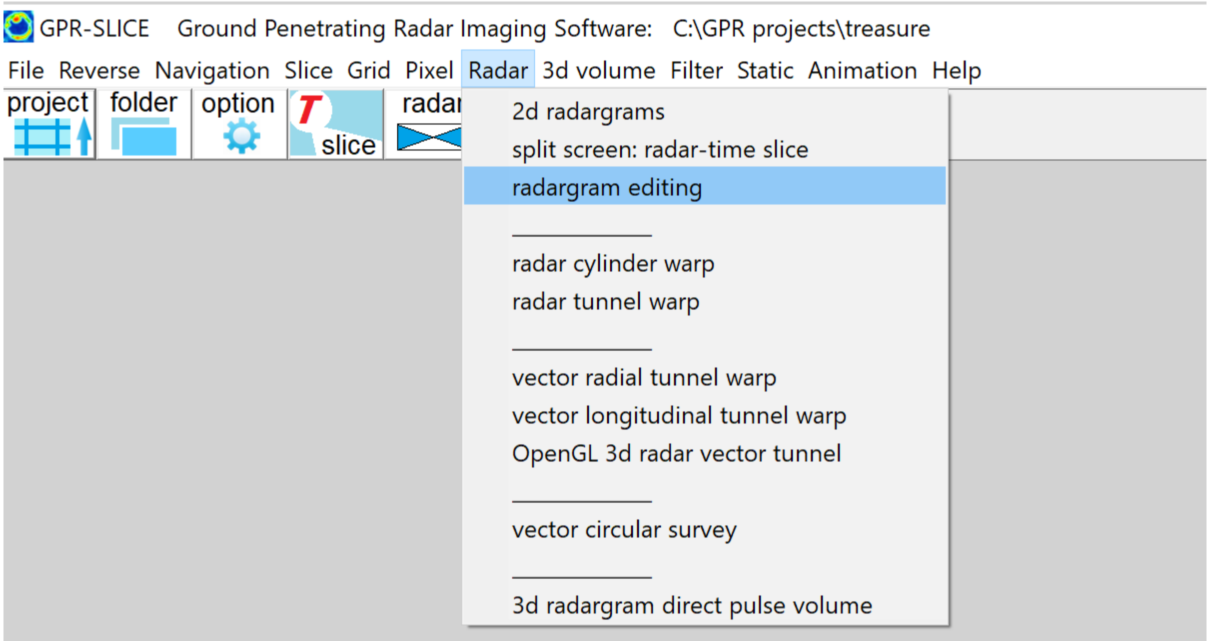


The next step is to set the navigation:

1) For data collected with a survey wheel the set navigation should always be Artificial Markers. This button will place marker tags on the scans to define the range units recorded. In this example, a 10 meter profile will have 11 markers assigned across the radargrams a 1 meters marks. (Note for fractional line lengths, the markers are located at fractional locations and not exactly 1 range unit)

2) Optional: For GPS surveys the user will click navigation options #4 GPS/Vector Scan # which will tag those scans with the synced GPS navigation.

Step 8. Time 0 correction



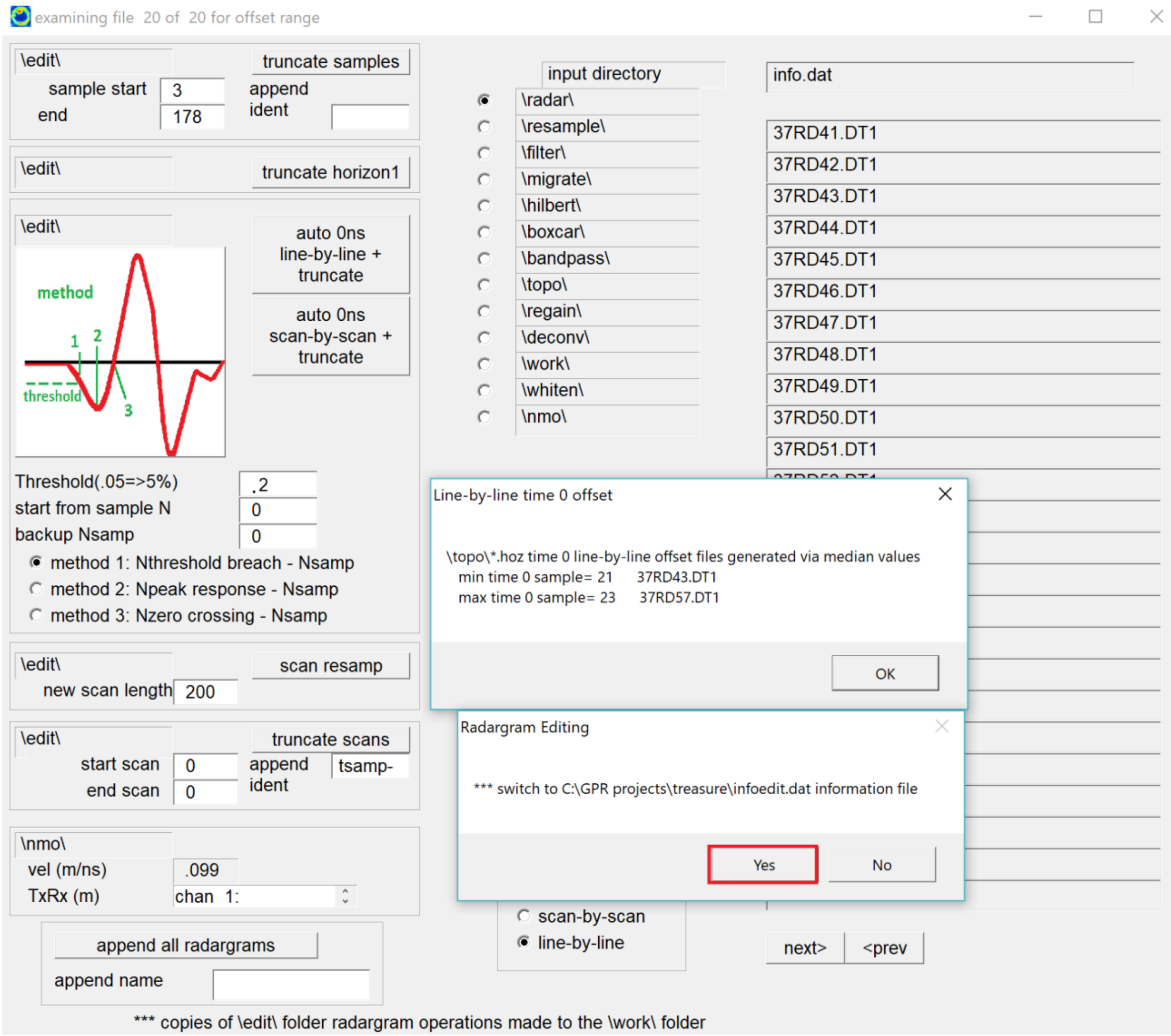
Time 0 must be edited from the radargrams before we can apply range gain. Open the Radargram Editing menu found on the main Radar pulldown menu:

1) Set the input directory (\radar\), the threshold for determining a time 0 trigger, and the method between 1-3 for defining the ground wave reflection. In this example, method 1, with a threshold of 0.2 (e.g. 20% of the maximum signal) is used to trigger time 0 detection.

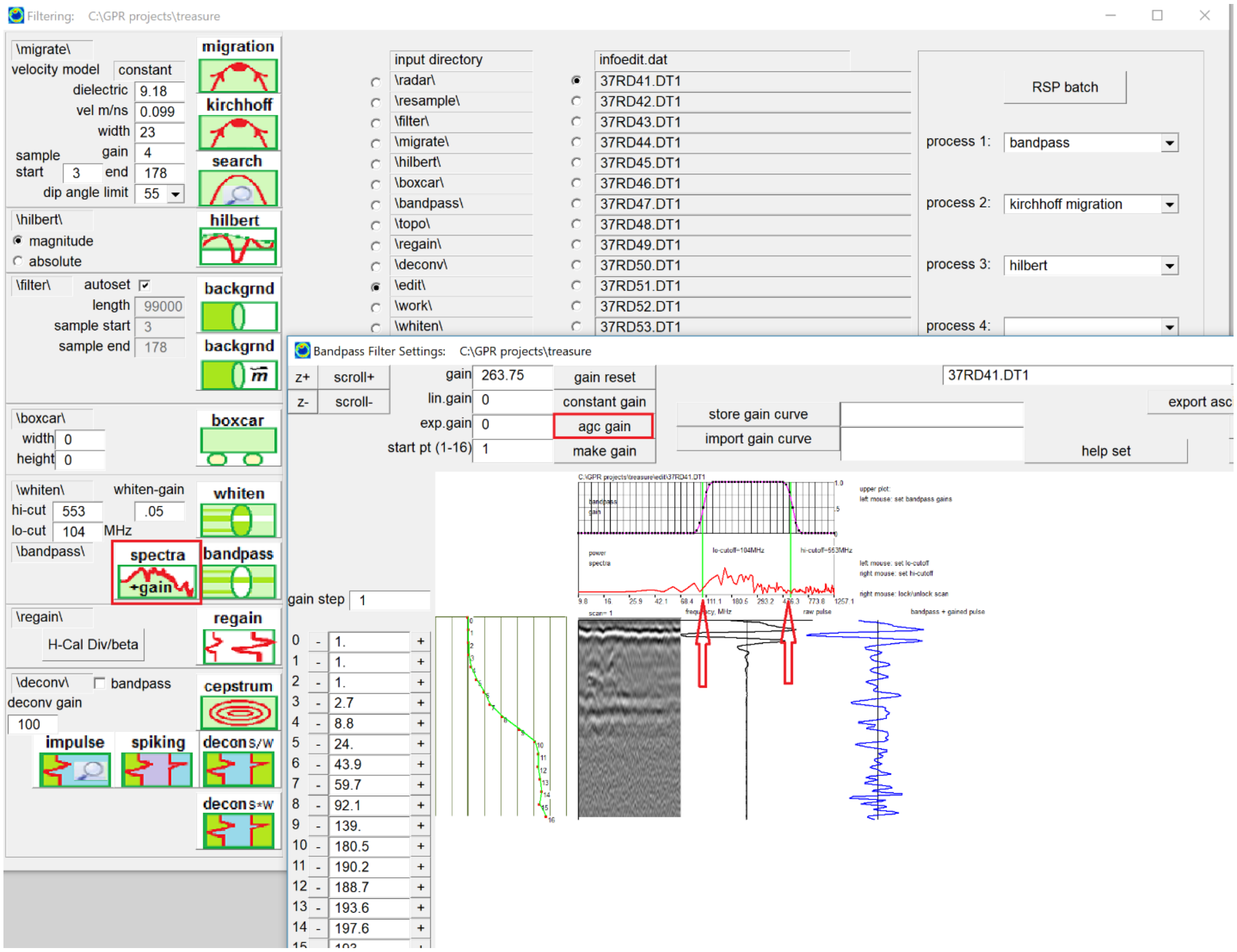
2) For data where time 0 is relatively constant along the radargrams, but time 0 might be changing between radargrams, the time 0 correction button Auto 0ns line-by-line truncate is clicked to detect time 0 and use the median value across each individual line.

3) After the time 0 is detected the software will prompt the user with the radargram profile with the minimum and maximum sample detection for time 0. Clicking the OK button in this message box the software will start time 0 correction. The graphic window can be engaged to see the time 0 editing process on each radargram.

4) If the user likes the time 0 editing operation, another message box comes up after deleting the graphic window and will ask the user if they want to update to the new infoedit.dat file. Click OK to do this (or no to redo time 0 corrections with different settings).


examining file 20 of 20 for offset range
\edit\
truncate samples
sample start 3
end 178
append
ident
\edit\
truncate horizon1
\edit\
auto 0ns line-by-line + truncate
auto 0ns scan-by-scan + truncate
method
1 2
threshold
3
Threshold(.05=>5%) .2
start from sample N 0
backup Nsamp 0
method 1: Nthreshold breach - Nsamp
method 2: Npeak response - Nsamp
method 3: Nzero crossing - Nsamp
\edit\
scan resamp
new scan length 200
\edit\
truncate scans
start scan 0
end scan 0
append
ident
tsamp-
\nmo\
vel (m/ns) .099
TxRx (m) chan 1:
append all radargrams
append name
input directory
\radar\
\resample\
\filter\
\migrate\
\hilbert\
\boxcar\
\bandpass\
\topo\
\regain\
\deconv\
\work\
\whiten\
\nmo\
info.dat
37RD41.DT1
37RD42.DT1
37RD43.DT1
37RD44.DT1
37RD45.DT1
37RD46.DT1
37RD47.DT1
37RD48.DT1
37RD49.DT1
37RD50.DT1
37RD51.DT1
Line-by-line time 0 offset
\topo*.hoz time 0 line-by-line offset files generated via median values
min time 0 sample= 21 37RD43.DT1
max time 0 sample= 23 37RD57.DT1
OK
Radargram Editing
*** switch to C:\GPR projects\treasure\infoedit.dat information file
Yes
No
scan-by-scan
line-by-line
next>
<prev
*** copies of \edit\ folder radargram operations made to the \work\ folder

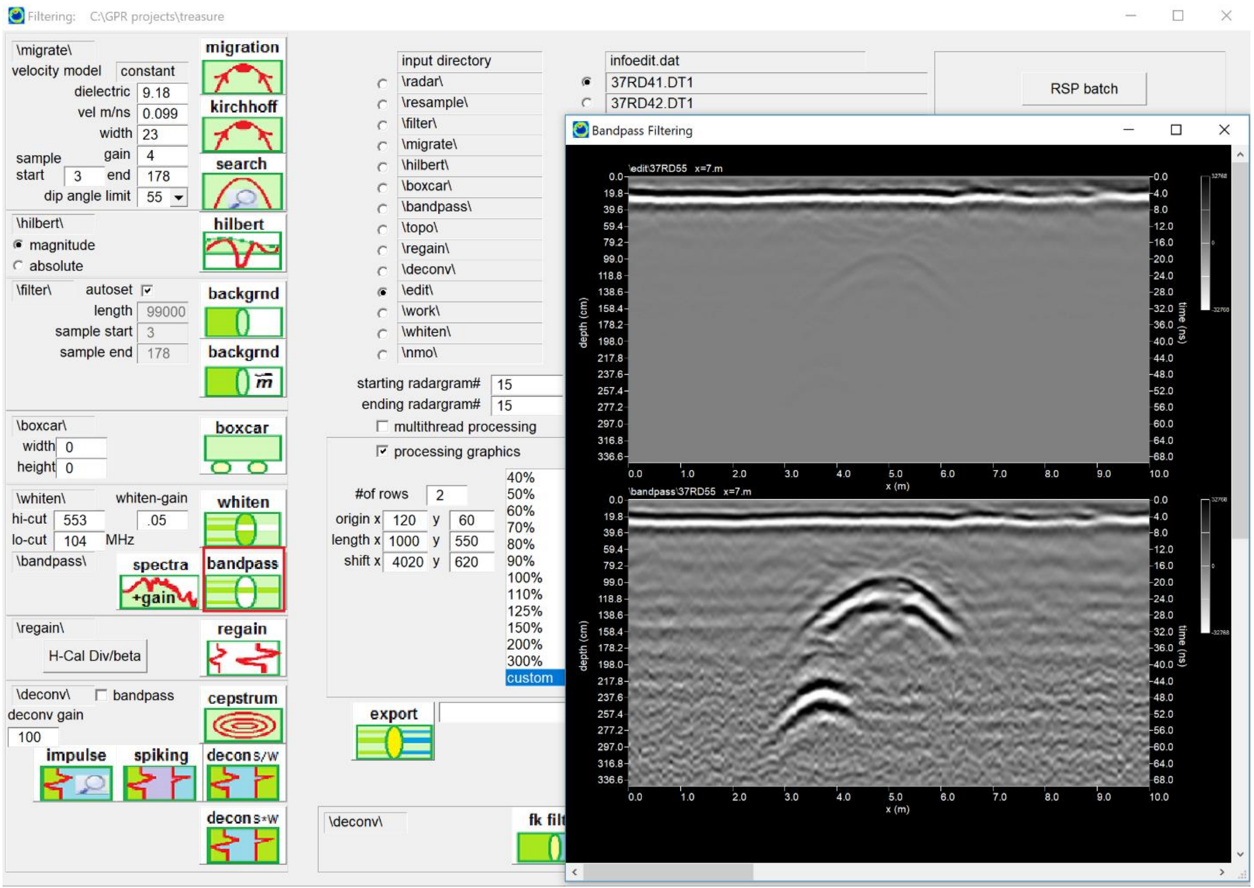
Step 9. Spectra+Gain settings



Range gain and bandpass filters need to be applied to the radargrams via the Spectra+Gain menu.

1) Enter the Spectra+Gain menu and click the AGC Gain button to make a possible gain curve. Adjust the gain curve manually if so desired
2) Set the lo-cut and hi-cut frequencies desired to bandpass the radargramsusing the left mouse button and the right mouse button the red plot – spectral curve

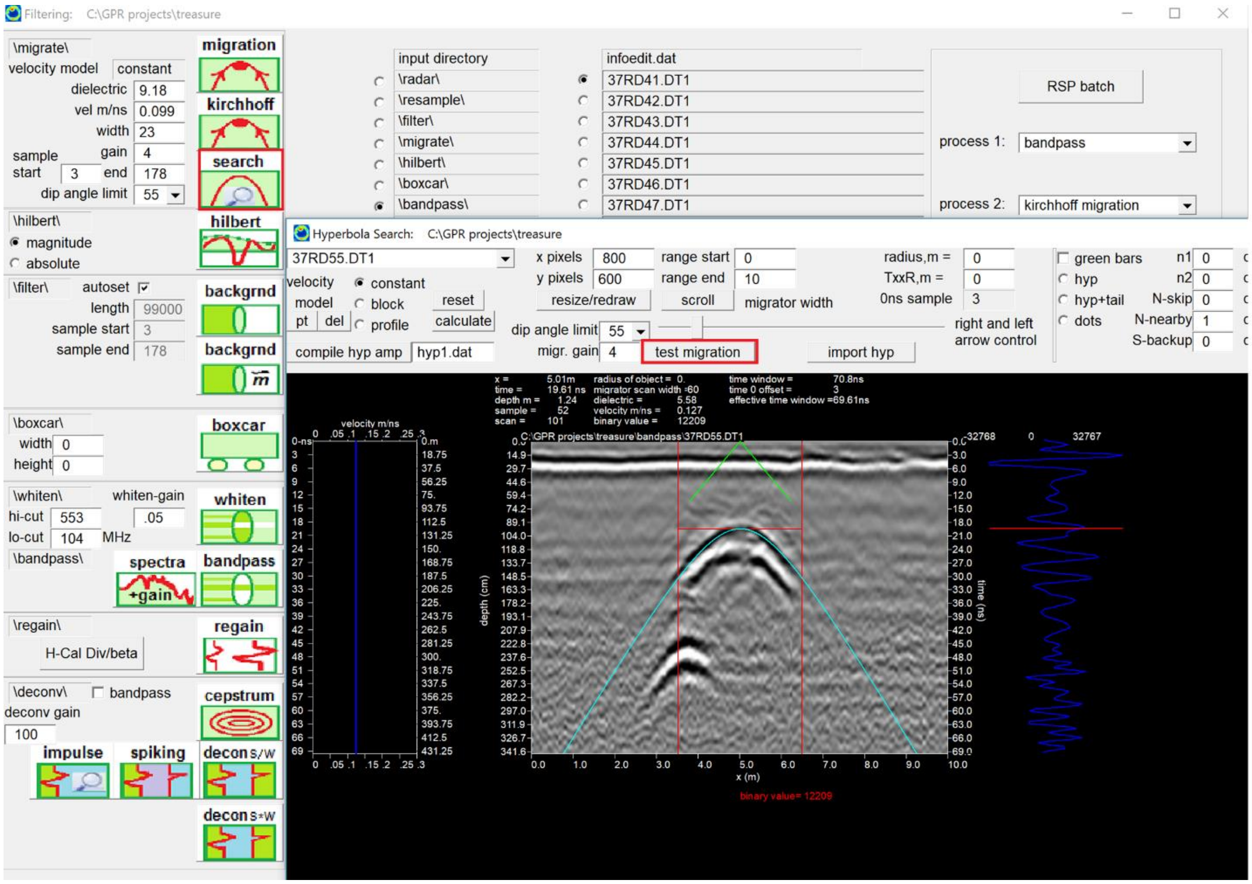
Step 10a. Bandpass Filtering



With the spectra+gain setting made the next step is to run bandpass filters on all the data:

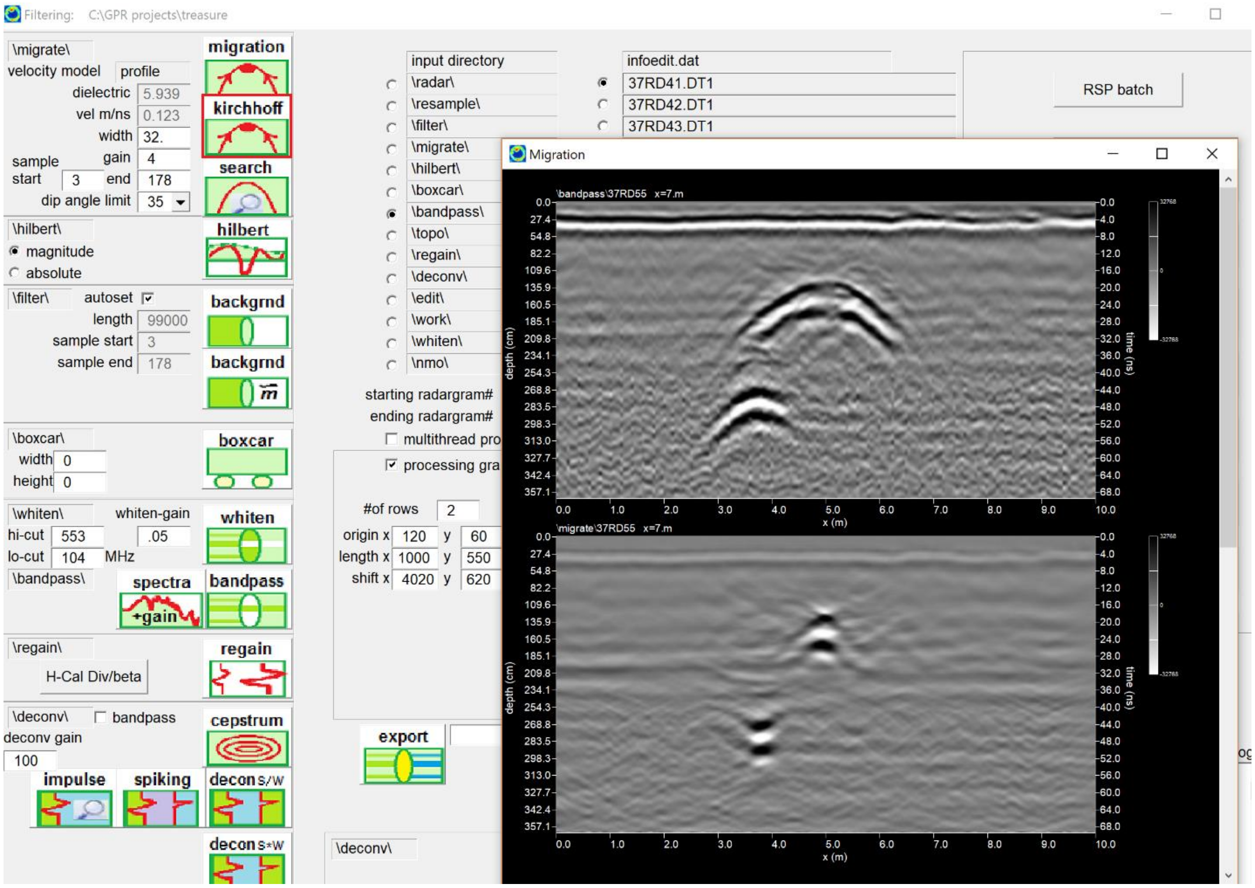
1) In the Filter menu clicking the bandpass button will apply range gain and simulataneous bandpass filtering. The processed radargrams are written to the \bandpass\ folder of the project.

Step 10b. Optional Processing

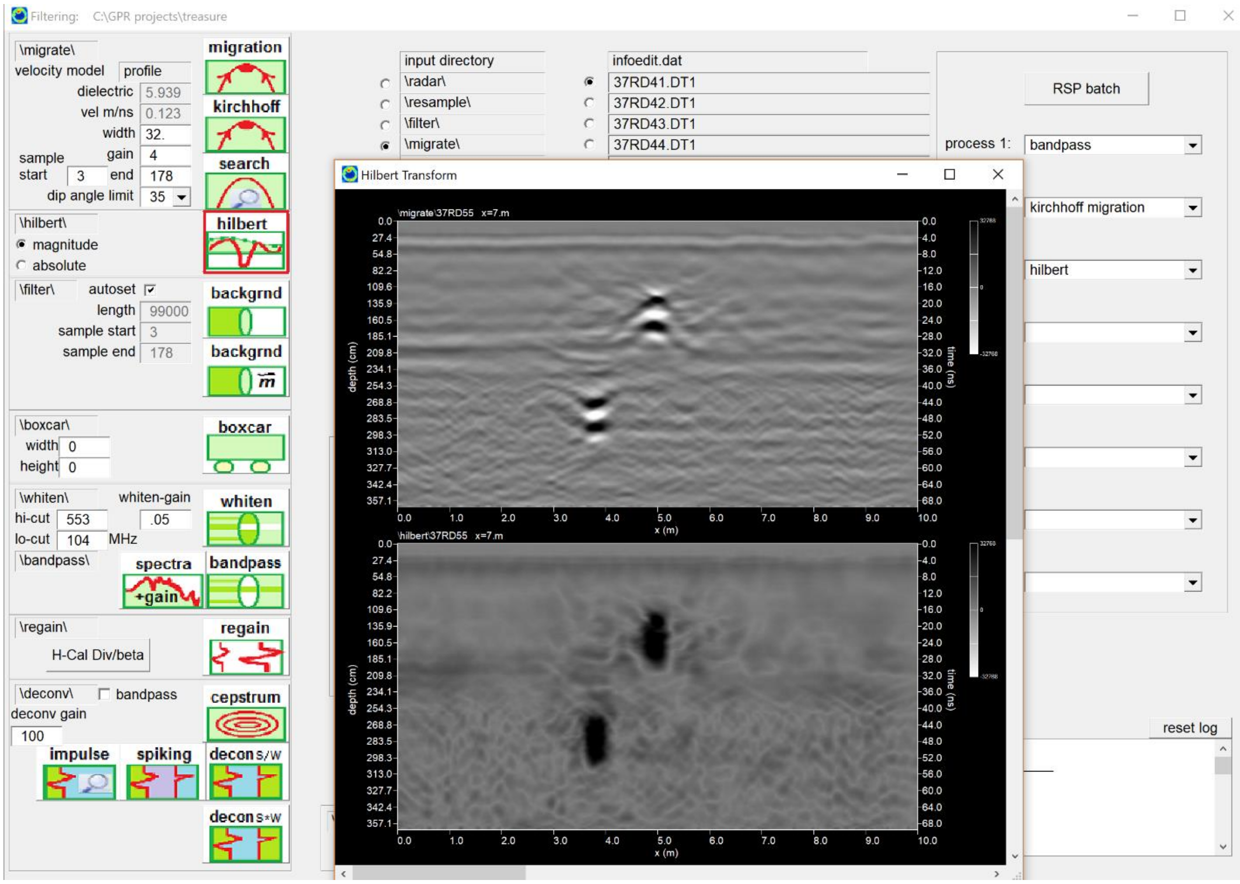


There are many radargram signal processes that can be applied in GPR-SLICE Software. For this data one can optionally do migration and perhaps Hilbert transforms before making time slices

1) For migration, first enter the Search menu to set the hyperbola matching with the mouse or mousewheel and also set the migrator aperture with the slider bar. The radargram size can be adjusted with the X and Y pixels settings if necessary. (The velocity model can be constant, profile or a block velocity model.   To chose profile or block velocity models, the user can use the right mouse clicks at different depths in the radargam followed by clicking the Calculate button to set the velocity model. For simple constant velocity models the user simply leaves the velocity model on constant and choses a velocity with the mouse before exiting the menu)



2) Optional: With the velocity set one can click the Test Migration button to preview how the migration will look. If it looks good, then proceed to run migration in the main Filter menu across all the radargrams in the info file. Diffraction stack migration or Kirchhoff migration are available. Kirchhoff is recommended.

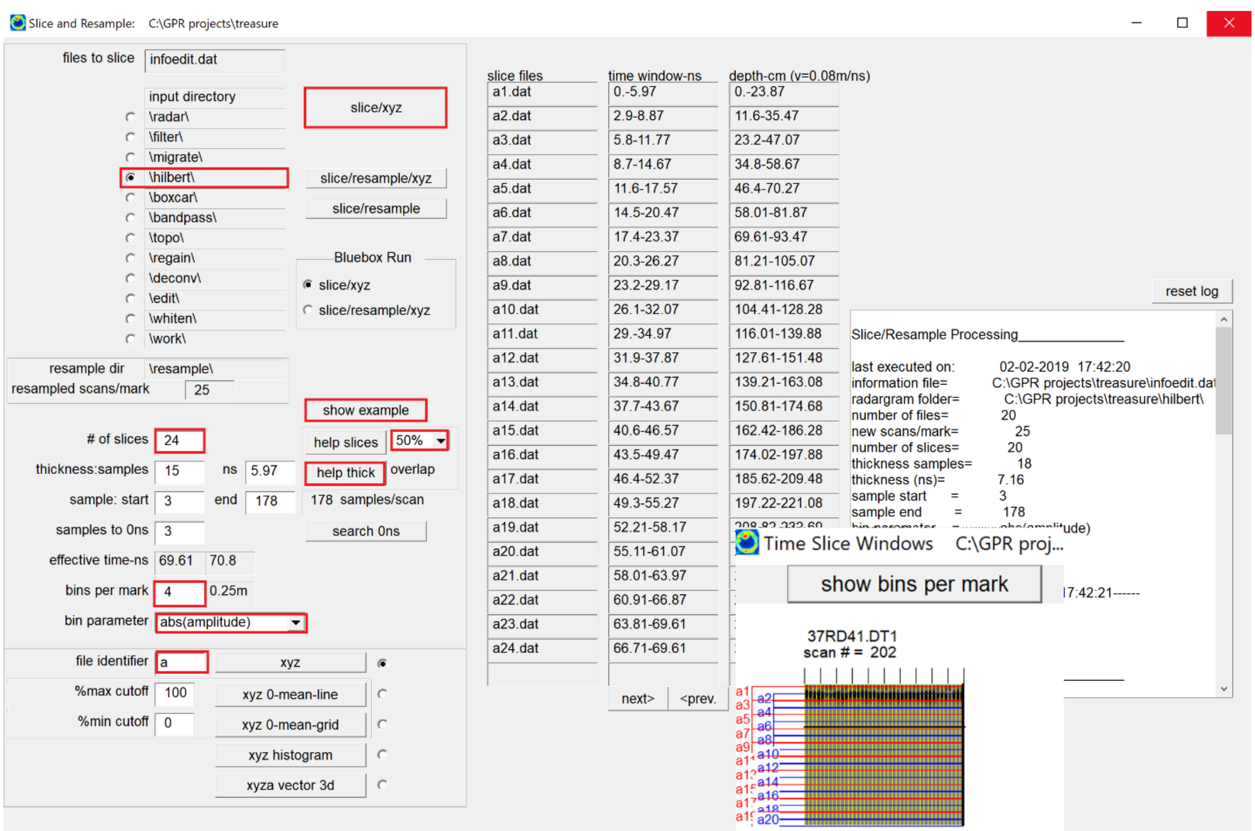


3) Optional: Apply a Hilbert transform to the migrated radargram data.

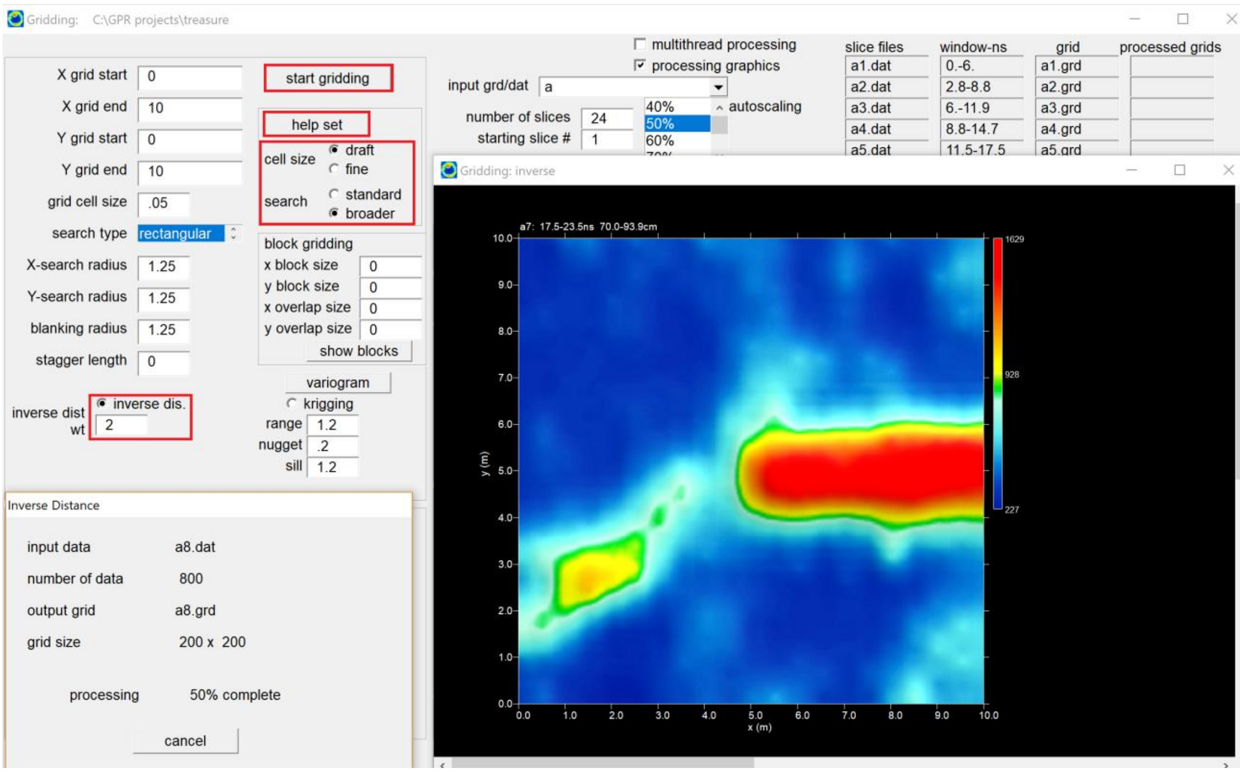
Step 11. Slice / XYZ

Step 11 is the heart of GPR-SLICE operations for coarsely spaced single channel sureys, where time slice datasets are created. The user can apply time slice analysis to any radargram folder for which they have done processing. In this example, time slicing will be applied to the \hilbert\ folder. The general steps are:

1) Set the radar folder to slice
2) set the time slice overlap (in this example 50% overlap)
3) set the number of time slices
4) click Help Thick to set thickness
5) set the bins per mark (in this example 4)
6) set bin parameter - usually abs(amplitude)
   5a) optional: click the Show Example button to see the slice overlap and binning settings
7) set the identifier to name the time slices
8) start the slice/xyz process



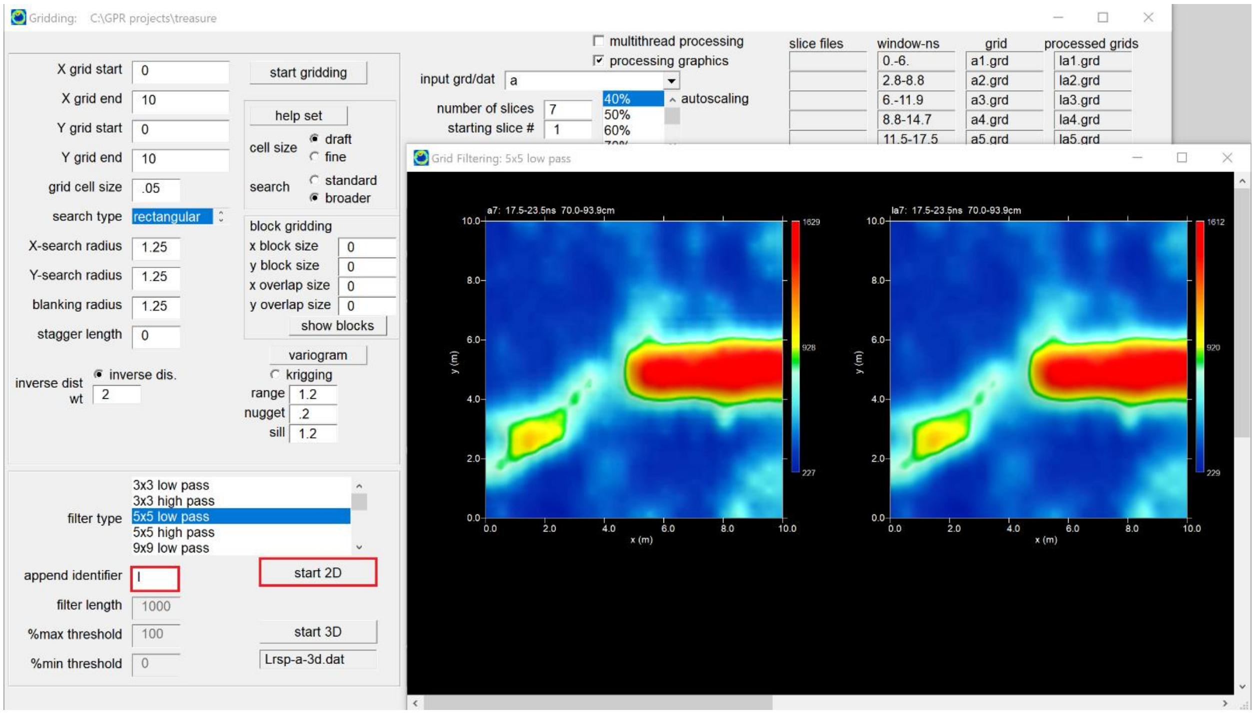
Step 12. Grid the Time Slice *.dat Files



The next step to create time slice pixel maps is the gridding process. The grid processing will interpolate between the xyz data to make time slice grids/pixel maps. The time slice grids that get created can be made with very fine or coarse cell sizes. In above example inverse distance interpolation is highlight. The gridding steps are:

1) Choose inverse distance interpolation and smoothing factor of 2
   Optional: one can choose Kriging interpolation – for this one needs to also use the Variogram button to set the appropriate parameters (range, sill and nugget)
2) Set the cell size draft quality (for example) and broader search
3) Click help set button which will automatically choose set gridding values such as the start and end values for the grid, the cell size, search and blanking radii
4) Clicking the start gridding to begin the gridding process.

Step 13. Apply Low Pass Filter to Time Slices



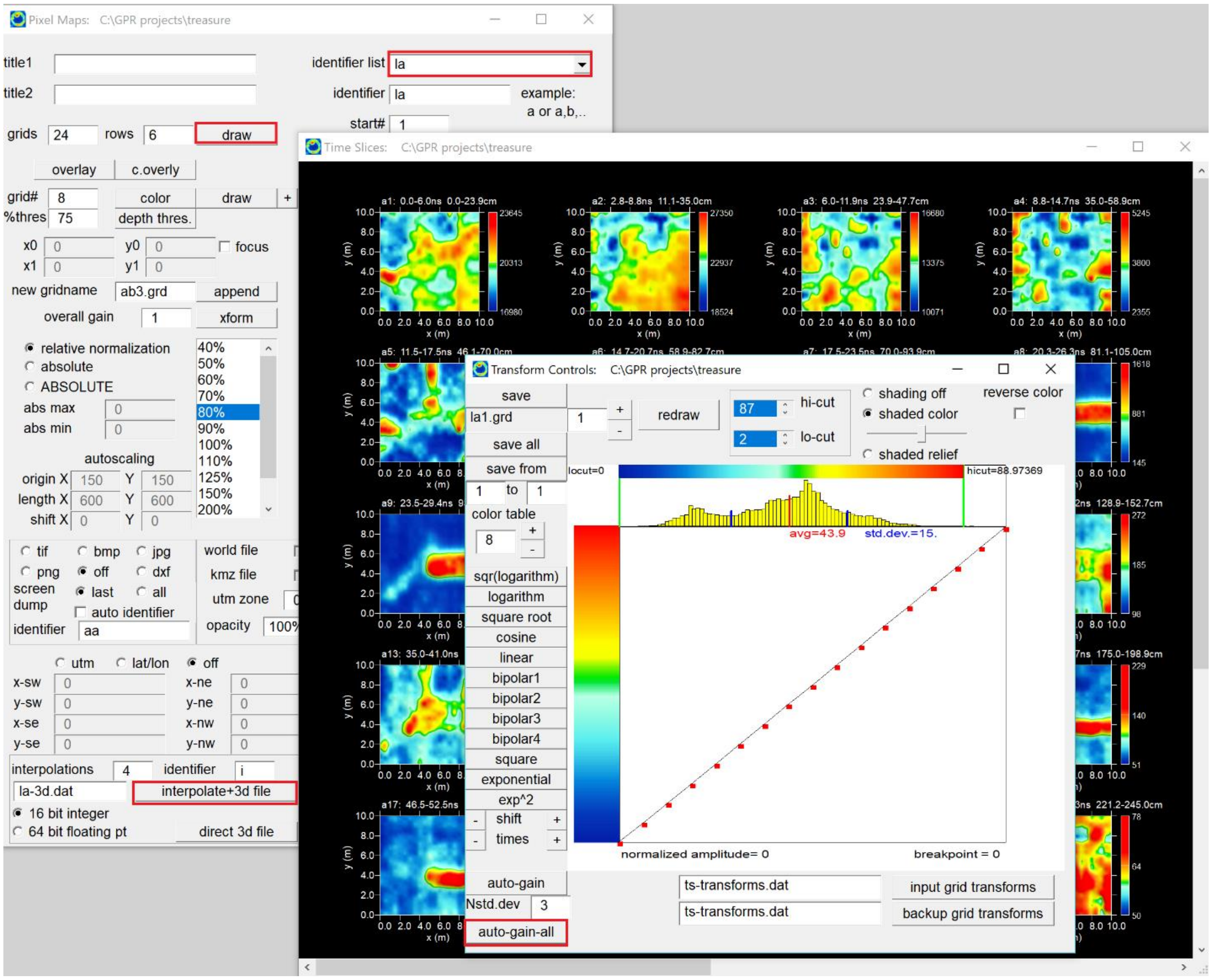
To remove gridding noises a 3x3 or 5x5 low pass grid filter can be applied the raw time slices. Click the desire filter in the Filter Type listbox, set the append identifier (e.g. to "l" for low pass) and click the 2D filter button. The filtering process will append the letter "l" to all the smoothed grids.

1) Set the Append Identifier for the grid filter smoothing

2) Choose the desired low pass filter (usually 3x3 or 5x5 low pass)

3) Click the Start 2D filter button

Step 14. Display Time Slices, Adjust Transforms and Generate 3D Volume



The final quickstart step is to display the 2d time slice dataset created in the GRID menu. The user can enter Pixel Map, which is conveniently available on the task bar at ***T*-slice** as well as in the PIXEL pull-down menu.

1. Choose the desired grid set identifier listbox
2. Draw the time slices to the screen using a desired number of rows and screen size
3. Left click the graphic to bring up the transform menu
4. Click the Auto-Gain-All button to set balanced – normalized transforms
5. Click the Interpolate+3D File button to generate a 3D volume

Step 15. Launch OpenGL Volume