Newsletter - February 2018

GPR-SLICE users,

We would like to welcome the following organizations to the GPR-SLICE community

- Concrete GPR LLC, Albany, Oregon (www.gprconrete.com)
- Power Tech Inc, Sequim, Washington (www.powertechvideo.com)
- Department of Engineering Science, University of Auckland, New Zealand
- Florida Geological Survey, Tallahassee, Florida
- Earth Dynamics LLC, Portland, Oregon (www.earthdyn.com)
- Horsley Archaeological Prospection LLC, Dekalb, Illinois (www.archpros.com)
- Utility Mapping Services Inc, Helena, Montana (www.umsi.us)
- Tennessee Valley Archaeological Research, Huntsville, Alabama
- Southern Geophysical Ltd, Christchurch, New Zealand
- Jason Hermann, Eberhard Karl University of Tubingen, Germany
- Dianex, France (www.dianex.fr)
- Department of Geosciences, Austin Peay State University, Tennessee
- Bess Test Lab, Fresno, California (www.besstestlab.com)
- Reticulated Python Construction Inc, Ontario, Canada
- Department of Historical Studies, Gothenburg University, Sweden
- National Institute of Water and Atmospheric Research, NIWA, New Zealand

- Earthscan Geoscience Ltd, British Columbia, Canada (www.earthscangeo.com)
- Ancient History and Archaeology, University of Leicester, United Kingdom
- GeoWave Solutions, Cumming, Georgia (www.geowavesolutions.com)
- Scadin Surveys Ltd, Belfast, Northern Ireland

In addition, TecnoTerra took their 3rd license for a new office in Tijuana, Mexico, the Southeast Archaeological Center of the National Park Service in Tallahassee Florida just acquired their 5th active license for just one field office, KB Surveys in the UK enhanced their GPR-SLICE license for multichannel acquisition. Multichannel licenses now represent 18% of all the active GPR-SLICE licenses.

GPRSIM Software licenses were delivered to:

- Dept of Geosciences, Austin Peay State University, Tennessee
- Bess Test Lab, Fresno, California
- China Railway Design Group Co Ltd, Tianjin

Software Updates

Among the most important or requested improvements added to GPR-SLICE v7.0 Software are:

- Hilbert Transform – peak response inversion threshold filter
- BlueBox Batch Options – Slice and Grd menu prompt + migration review
- Customized staggering file to adjust 2d image navigation
- Vector translation added to circular surveys – example of a cone survey
- Overlay of core information on 2d multi-radar displays

Hilbert Transform - peak response inversion threshold filter

A new filter was added to the Analytics menu and based on the post and request that Reid Davis from Concrete GPR made last week (www.gprconcrete.com). Reid asked if a filter were available that could identify the peak +/- pulse response of the migrated hyperbola that on viewing from a Hilbert space would invert the signal to classify those responses. A new filter operation identified as Hilbert + (for lack of a better icon at present,) will do exactly this (Figure 1). On Hilbert transforming the migrated radargram,

the software will test a set threshold placed in the menu and look for the sign of the peak pulse response on each individual scan. The Hilbert transform pulse will then be inverted should the signal waveform have a stronger negative pulse for that scan. The signal inversion will be done only on the signal above the set threshold. For this example, a 0.5 threshold worked best. A 0.5 threshold means all signals above 1/2 the maximum binary resolution of the radargram recording, e.g. for 16bits is 0.5*32768 and for 32 bits is 0.5*32768^2.

This new filter might possibly be utilized as a diagnostic for estimating phase inversions and to distinguish reflections from subsurface locations that have lower dielectrics (or even possibly voids) in the ground. The criteria currently used is just the peak signal responses so some care should be given to the interpretations. Also the peak response is searched scan-by-scan so some flipping of adjacent scans can occur that might appear as noise.

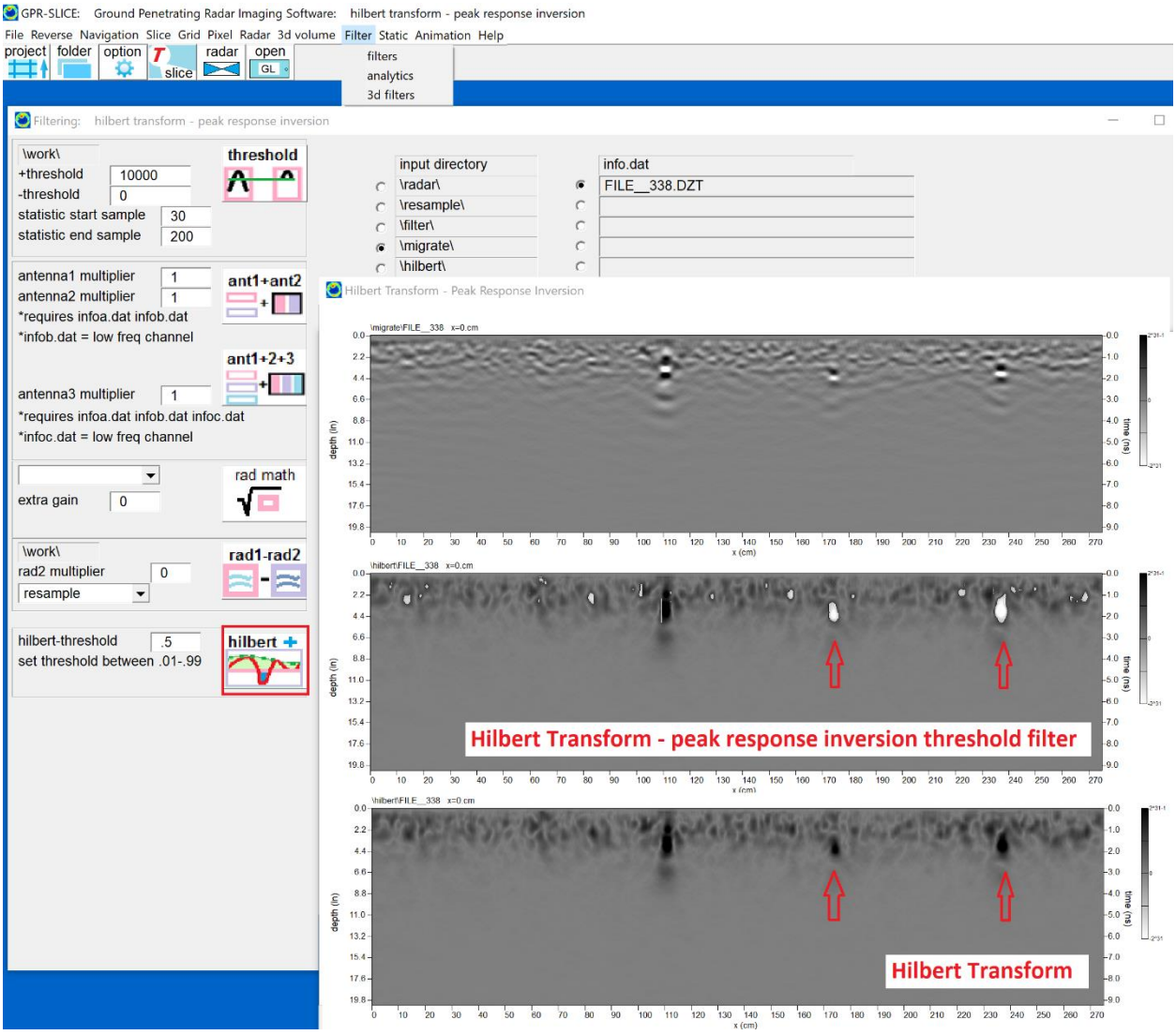

Figure 1. Location of the new Hilbert Transform peak response inversion filter.

GPR-SLICE new BlueBox Batch options - Slice and Grid menu prompt + migration preview

BlueBox Batch operations have been enhanced to allow the Slice and Grid menus to be previewed and adjusted and tested prior to continuing the batch run (Figure 2a,b). With the Slice and/or Grid checkboxes clicked on, these menus will be prompted and the user can set the number of slices/overlap/thickness etc. or with the Grid checkbox on the user can investigate the gridding settings such as the search/blank radius and the grid cell size. Start gridding can be launched and the grid quality previewed as well. If the grid settings are good, then exiting the menu will automatically restart the grid menu for the BlueBox operation.

The Search Hyperbola menu was also enhanced for the user to test the migration preview and adjust the velocities, migration aperture width or the overall migration gain in the menu before BlueBox operations are continued (screen shot 2). The migration preview will also keep the focused display shown for the preview so the quality of the migration can be easily viewed at the current display and scroll size.

For XY Decoupled Gridding Bluebox operations for concrete imaging the option to adjust slice operations during the batch run are provided - elliptical gridding settings need to be set prior to beginning this kind of processing.

The new settings elevate the BlueBox operation as a processing assistant and allows full adjustments to the processing settings during the batch run. For those just learning GPR-SLICE, the BlueBox Batch run such as Basic+Edit+RSP can help the user keep track of the order and the different menus that need to be entered to perform these complete processing operations.

It should be noted that BlueBox operations can be shared with other users by: 1) saving the BlueBox to a desired name which is written the c:\slice\v7.0\bluebox folder and has the *.blu extension, and 2) loading into another computer with the load/save button on the File pulldown menu.

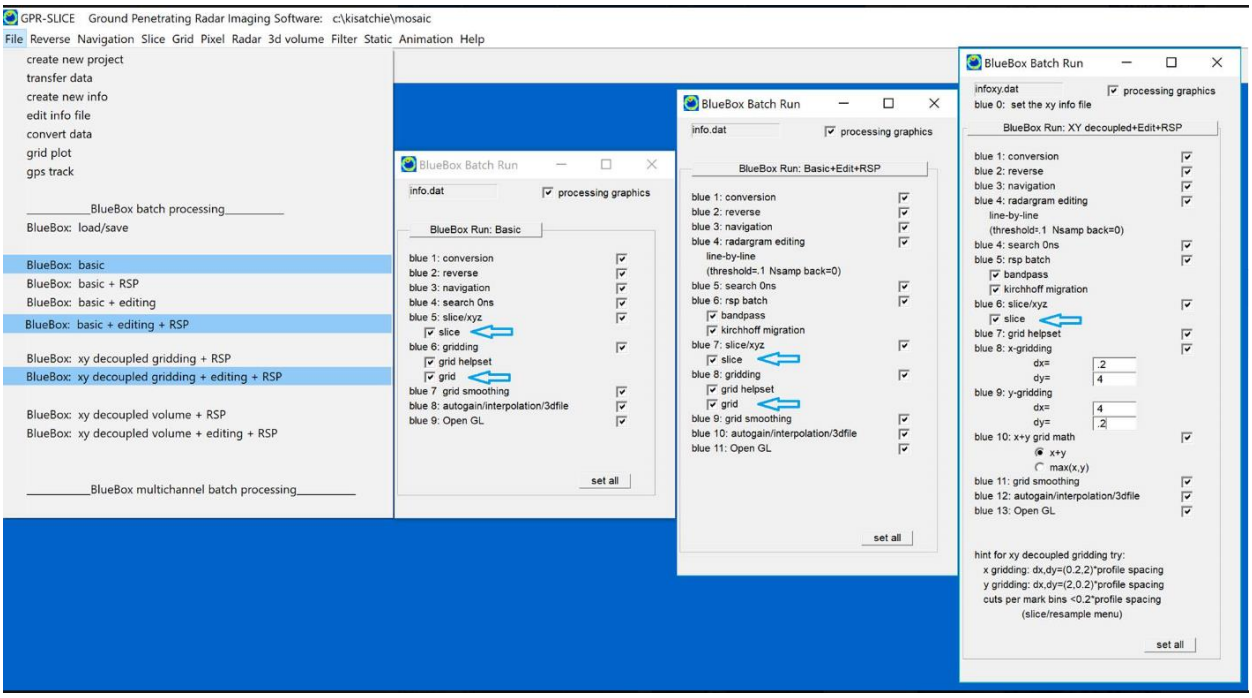

Figure 2a. New BlueBox batch operations to prompt for ability to set/preview slice and grid settings.

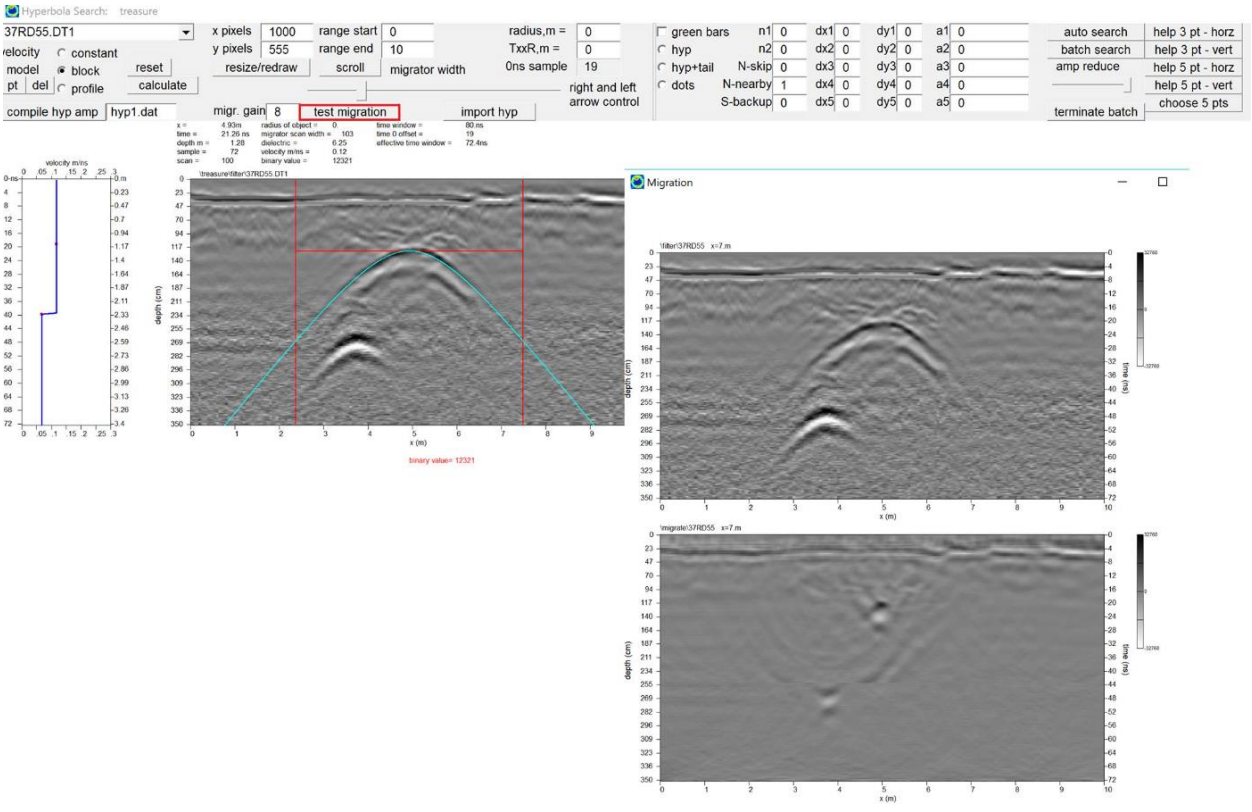

Figure 2b. New option to test migration during BlueBox or any operation.

GPR-SLICE new option - Customizable staggering file for correcting imported data

Import of outside geophysical such as magnetics, resistivity or EM profiler dataset, was placed into the software from many years ago at the request of users that wanted to show time slices along with other geophysical data and also to take advantage of the gridding capabilities in GPR-SLICE. The Grid menu in GPR-SLICE was recently enhanced to allow for correction of imported geophysical data that has variable staggering navigation issues.

Shown in the Figuew 3a is an example of importation of (GSSI Profiler) data into GPR-SLICE via the Import 2D Geophysical Data menu. This particular data has significant staggering/navigation issues which can be seen in the data. On import, the option to apply a constant stagger length is available. However, this data has several areas with different apparent staggering.

To provide a solution for non-constant staggering, a new flag value is available in the Grid menu to allow the user to import a customized_stagger_file.dat and to apply custom stagger lengths on each line. The customized_stagger_file.dat should have 2 columns: line#, stagger length to apply to the ascii data before gridding is done (Figure 3b). To assist the user in making this customized file, choosing a blanking radius that narrows the interpolation radius, the line data can be identified within the image (Figure 3c).

Although it could be time consuming to generate a proper file to apply customized staggering to, the benefits of correcting for this navigation error are clearly seen in the comparision between figure 1 and 2.. With this customization on the stagger length, severe errors in navigation from imported data can be fixed.

Note1: This correction is only available to data collected in a single direction, either x or y.

Note2: The new option is available for GPR time slices as well should constant staggering operations be insufficient

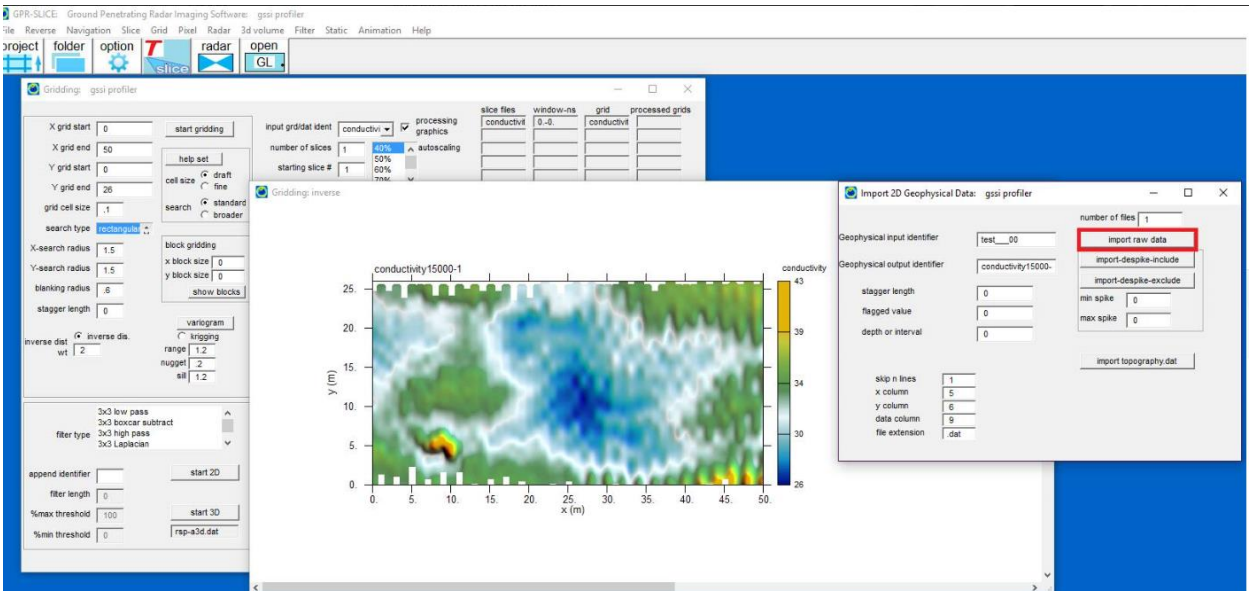

Figure 3a. Importation of 2d geophysical data with significant staggering observed after gridding.

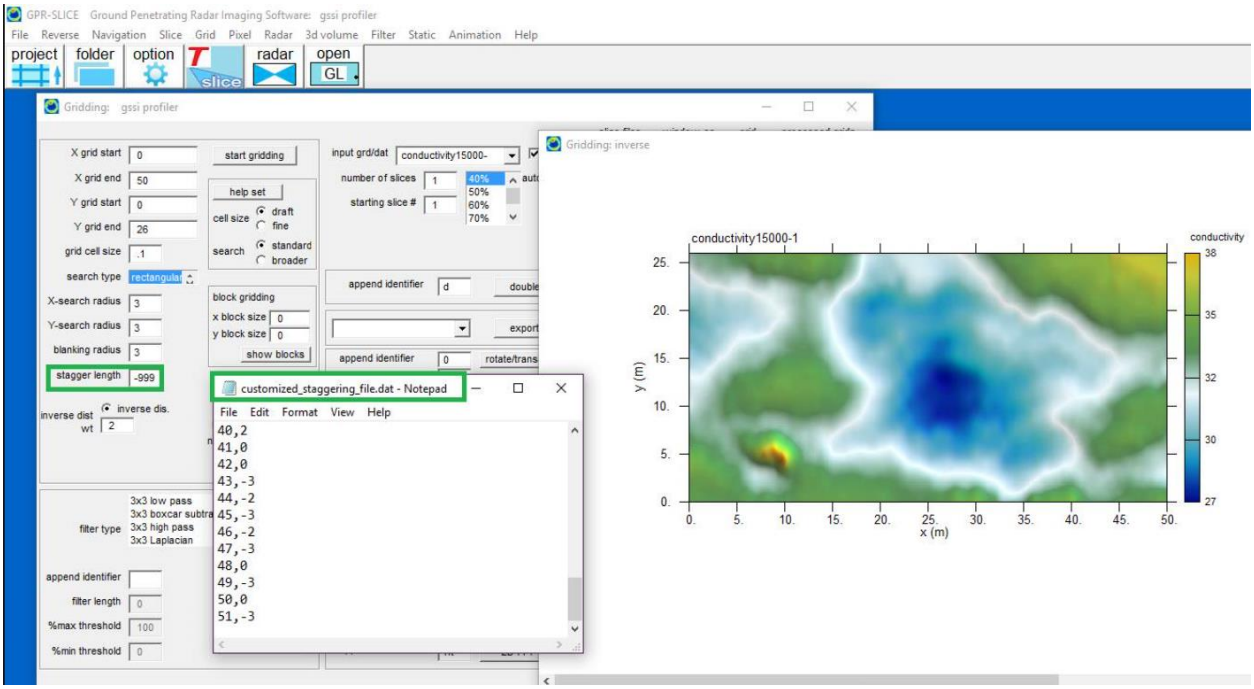

Figure 3b. Location of a flag in the grid menu to set up a customized_staggering_file.dat containing the set staggering of each line of data in the imported 2d geophysical data file.

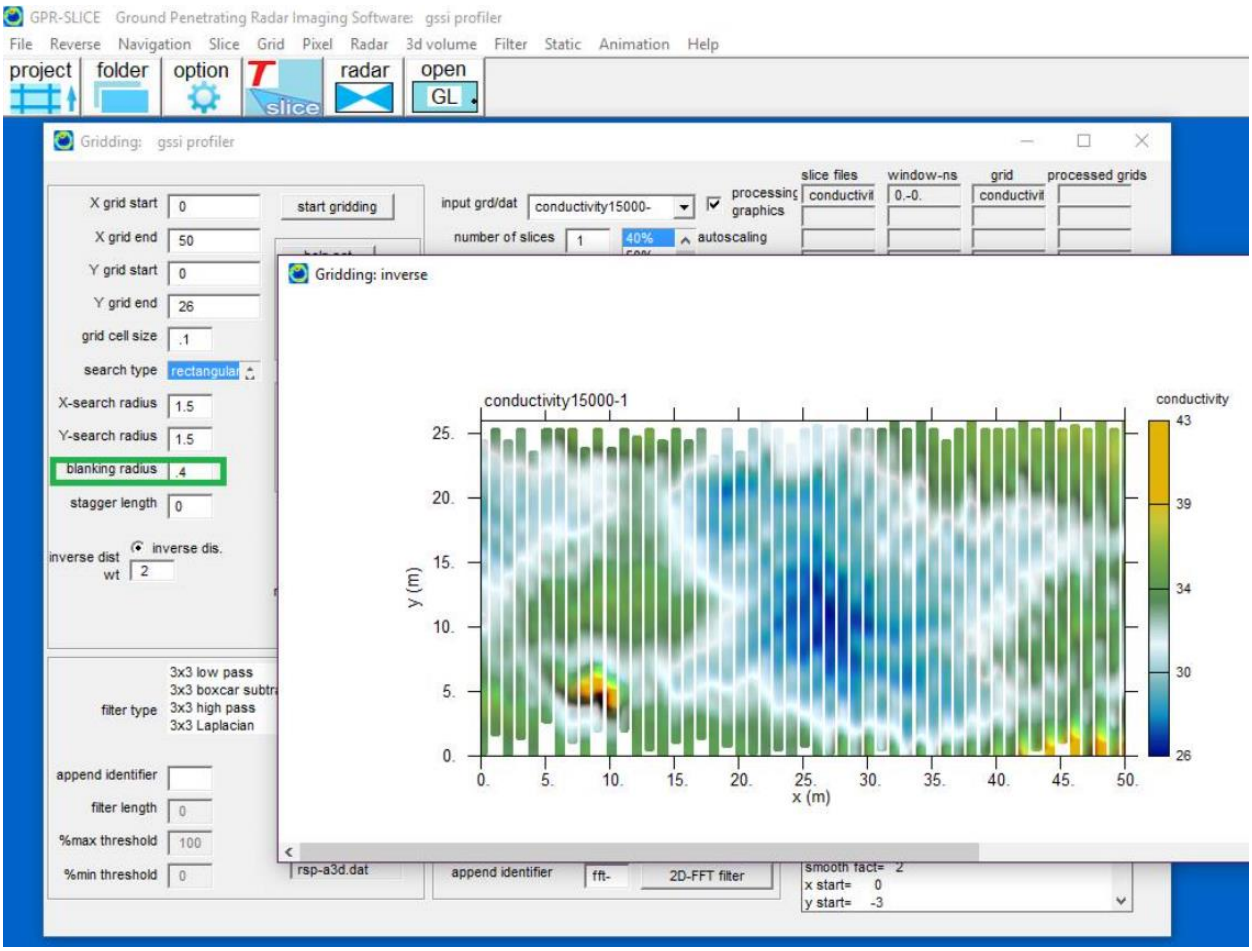

Figure 3c. By adjusting the blanking radius, one can observe the line data that has been imported, allowing for easier visualization in creating the customized_staggering_file.dat.

GPR-SLICE new option - vector translation added to circular surveys

Recently, Michael Neal at GeoScan in Canada was surveying on the inside of bleach plant reactor that has a cone shape. The orientation of the scan vectors can now be adjusted to account for a cone shape.

The steps involved are to first use the Vector Circular Survey menu and set up the elevations, radius, and the survey angles for each radargram. In this example the cone structure changes from a radius of 15 meters at bottom of the cone structure to a radius of 7.5 meters at the top of the structure which is 15 meters. Clicking the Vector button will generate the circular shaped radargrams along the cone structure (Figure 4a).

Note however, that since the antenna is in contact with the surface of the cone, that scans are not projected horizontal but must be directed normal to

the surface. To adjust for this, a new option at the bottom of the Vector Circular Survey menu allows a constant vector translation to be added. For this example since the radius change of the cone is 7.5 meters over 15, the vz vector should be changed to 0.5 (7.5/15) to account for the radar scan projections in the downward vertical (Figure 4b). Note, that each individual radargram itself now has a "cone" shape from the survey being done on a cone!

This vector data can also be sliced with the vector-xyza setting and then imported into the Import 3D Geophysical data to generate a volume (Figure 4c). For this data since the ground wave is so much stronger than the subsurface reflections, the complete outside of the cone is illuminated with an isosurface.

GPR-SLICE provides the vector settings for a variety of simple geometric features. However, should there be geometric features that were surveyed that are not available in the software, the user can always set the vector which are columns 9,10, 11 in the vector *.gps files that contain the navigation with their own script to determine the surface normal of these structures.

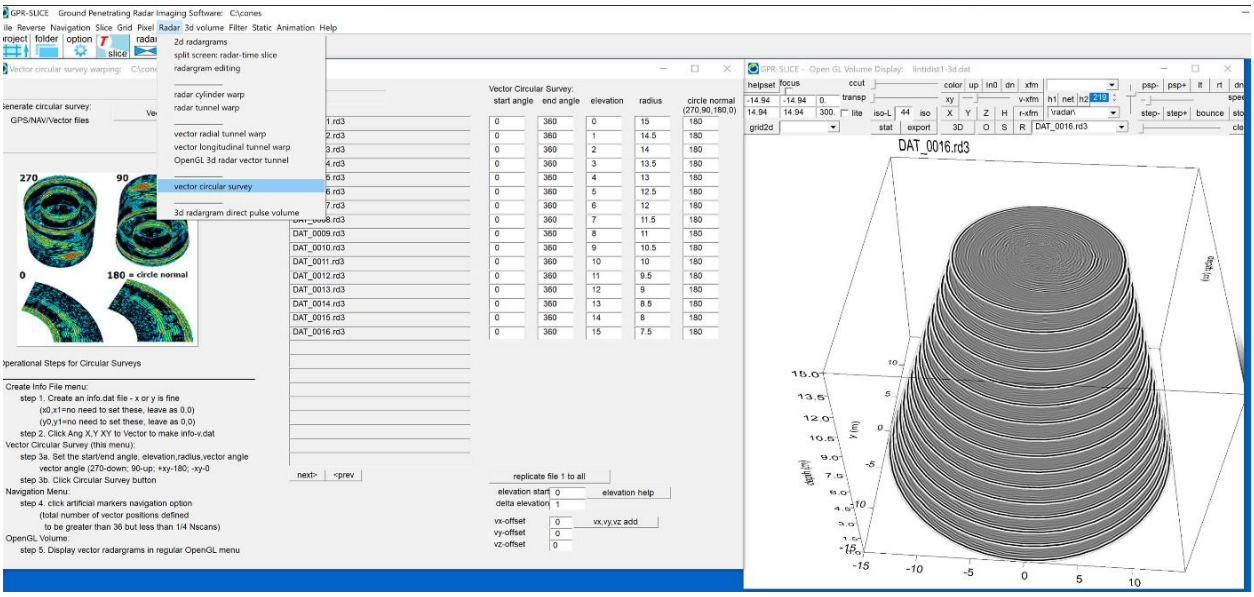

Figure 4a. An example of the settings applied for surveying on a cone using the vector adjustment made in the Vector Circular Survey menu.

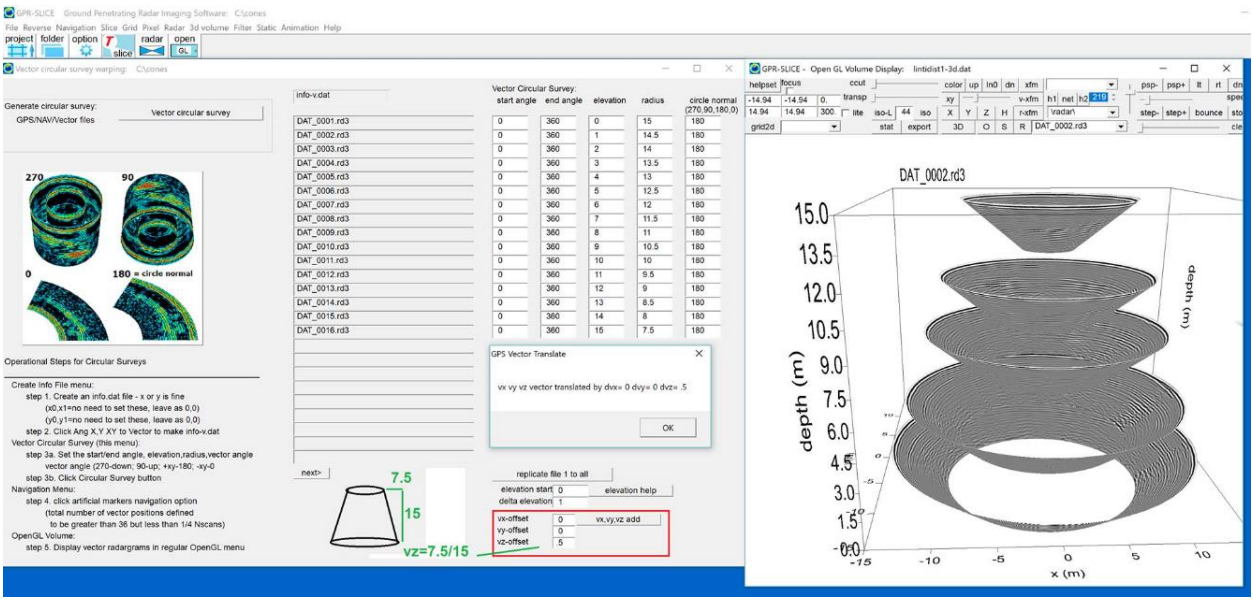

Figure 4b. To further adjust the vector based on the attitude the antenna has on the slope cone surface, options are available in the enhanced Vector Circular Survey menu.

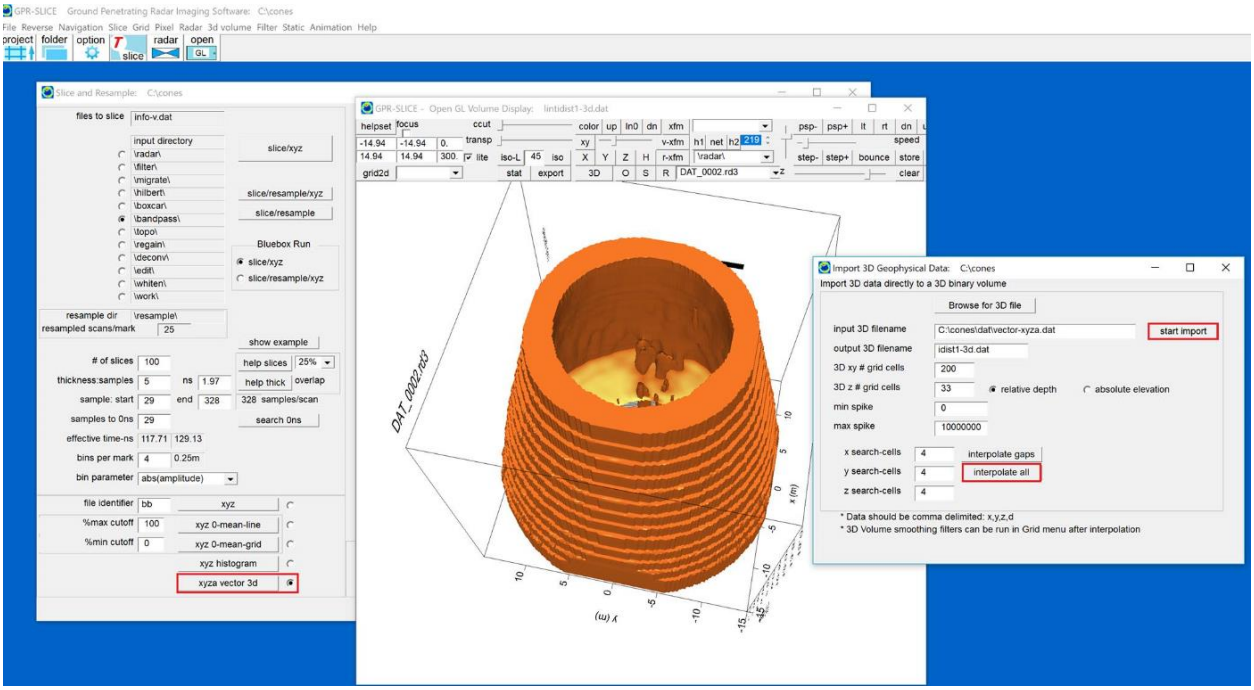

Figure 4c. An example of slicing the vector cone data and then importing the 3d vector files into the 3d geophysical menu for 3d interpolation.

GPR-SLICE new option - overlay of cores on multi-radar 2D displays

A new checkbox in the Options menu will allow the overlay of core file information onto regular surveys or GPS surveys (Figure 5). For GPS surveys, the closest point of approach is used to place the core information on the radar profiles. For regular surveys, the distance setting in the core file along the profile is used to locate the core plot.

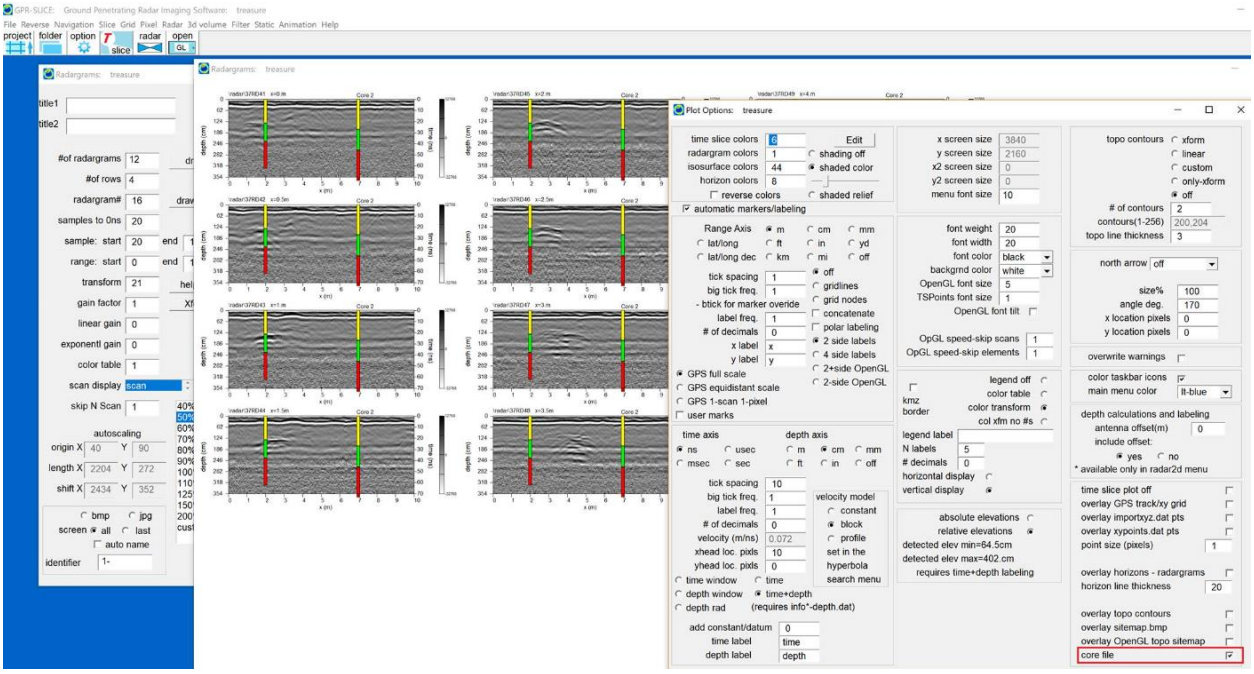

Figure 5. Location of a new flag to allow plotting of cores onto the multi-radar display menu.

Other features and options added to GPR-SLICE include:

- Vector help XYZ button added to Import 3D Geodata menu to create equal voxel size in each dimension
- OpenGL Volume sitemap bitmap overlay speed overlay increased with block reading
- Lat/Long deg/minutes/seconds import added on the XYZ to NAV button in the Edit Info File menu
- Quad color blending in OpenGL for GPS radargrams to add smoother displays for low density radargrams
- Compilation of all the depth information for all the active horizons to a single file called \dat\xyzdallN.dat

- Direct time slice files to 3D volume without interpolation or transform engagement button added to the Pixel Map menu - useful for pulse imaging data where single sample thickness slices have been generated
- GPS track multiplication of columns added to GPS track menu
- Quick buttons to set longitudinal angle added to Vector Longitudinal Radar menu
- Vector longitudinal and radial menus step-by-step menu procedure updated
- Search Hyperbola menu and hyperbola width sensitivity increased 5 times using the mousewheel.
- User mark display on 2d radargrams adjusted to start above the radar plot
- Radar jpg/bmp output auto-naming checkbox added to Radargram menu following the profile name plus and append identifier option
- Variable velocity profile depth labeling added to Slice/Resample menu tables and also Pixel Map labeling
- Vector_survey_information.dat file import in the Create New Info file menu will now create vector for an arbitrary 3D line with rotation angle normal to the arbitrary line set in the
- Option range unit read in on import of Mala survey wheel calibration
- Fix to read SIR 4000 DZG files that are run on without carriage returns
- Warning message for Mala Get TS button if identical digitization on the samples/scan not found
- Auto-naming Pixel Map identifier that names jpg/bmp/tif etc output via the time window and depth horizon for time slices - useful for georeferenced images that do not have labeling to identify the slicing windows on viewing in ARC GIS or Google Earth

Events

GPR-SLICE has been used in many episodes of the TV series, "Secrets of the Underground" in 2017 and the software results appear separately in the OpenGL menu and also together and integrated with lidar and ERT in point cloud software. The surveys were conducted by Stefan Burns, formerly at Subtronics in Martinez California.

GPR-SLICE imagery is also being used is some of the first GPR drone surveys being conducted by Radarteam Sweden and a heavyduty drone maker in Latvia, SHP-Engineering. Here is a link to a test survey. We were given permission to show the measurement of bathymetry made with GPR-SLICE from a drone that was flown at 20 m over a frozen lake in Sweden (Figure 6). Using a 70 MHz Subecho antenna that was able to stack 32000 scan/second,

GPR/GPS lines were collected and reflection from the bathymetry of the lake could be measured. One of the key points is that the hyper-stacking of the GPR scans increase the signal to noise ratio significantly and allows for the success of this air launched survey.

https://www.youtube.com/watch?v=BY5A5QzSciM&feature=youtu.be

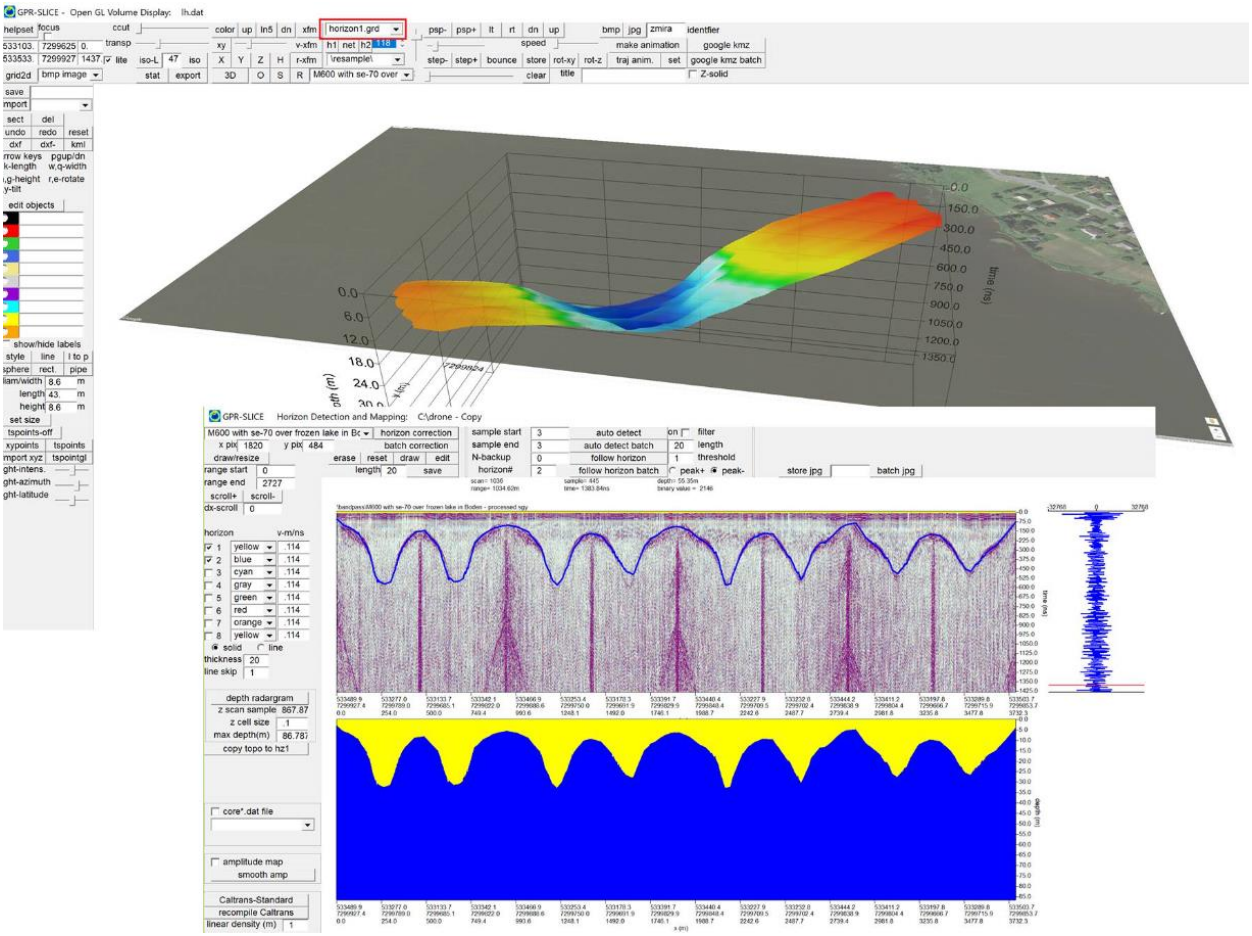

Figure 6. Example of a GPR drone survey over a frozen lake in Sweden along with bathymetry processing in GPR-SLICE. An overlay of the bathymetry surface on a Google Map in the OpenGL menu. (Data courtesy of RadarTeam Sweden and SHP-Engineering drone manufacturer in Latvia)

Other manufacturers such as GeoScanners in Sweden are also experimenting with GPR drone deployment and have videos of their successful surveys on Facebook as well.

The third round of GPR surveys inside King Tuts tomb are being conducted in search of possible hidden chambers/corridors behind the northern and western walls. Dr. Gianluca Catanzariti is one of our top GPR-SLICE users that

utilizes full vector imaging and is part of the crew (standing in the corner with the dark goatee and the grayer goatee from Professor Luigi Zambuelli of the Polytechnic University of Turino in Italy in link below. Luigi is also one of the top worldwide experts on GPR imaging of monuments and historical structures and he also has a small section in the book GPR Remote Sensing in Archaeology entitled "GPR measurements of an Ancient Egyptian Statue" (p153-157). Also involved in the surveys are Gianfranco Morelli of GeoStudi in Italy and his company has also been a long time GPR-SLICE user and have 2 multichannel licenses).

https://news.nationalgeographic.com/2018/02/king-tut-tomb-hidden-chamber-scan-egypt/?utm_source=Facebook&utm_medium=Social&utm_content=link_fbp20180202news-kingtuttombscans&utm_campaign=Content&sf181081453=1

Facebook Forum

The Facebook Forum for GPR-SLICE has been actively used and is a useful resource for finding more in-depth answers and discussion on relevant GPR-SLICE software topics. All the new options to GPR-SLICE were first introduced in Facebook and this newsletter just represents and catalogue of some of the important new features added. Additional user discussion and more in-depth explanations are available in the GPR-SLICE Facebook group. If you have not yet joined the GPR-SLICE facebook page, I would encourage you to do so at:

https://www.facebook.com/groups/gpr.slice/

There are currently 627 active members in the GPR-SLICE FB group.

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