

# **GPR-SLICE v7.MT Multichannel**

## Addendum Manual

(updated June 8, 2024)

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## **Introduction for Multi-Channel GPR Systems**

# **GPR-SLICE v7.0** Multi-Channel



photo courtesy of Daniela Hofmann, Entrys Group GeoRail Division, Germany www.entrys.de

high-frequency array STREAM 2 GHz





Photo courtesy of Gianfranco Morelli and Alex Novo, GeoStudi Astier (<u>www.geoastier.com</u>) and IDS of Italy

GPR-SLICE can process data from the following Multi-channel GPR systems, including:

Proceq IDS Mala 3D Radar Impulse Radar RPS Australia ISUNG GSSI SIR30 GPR-SLICE is completely integrated with all these manufacturers' proprietary GPS navigation format, including total station formats. Specialized buttons open up GPR-SLICE v7.MT software menus for users that have this additional license authorization. Fast 3D volume generation directly from processed radargrams, as well as BlueBox Batch runs is available for multi-channel licenses.

This addendum manual is provided since there are different set of operations required for each multichannel system. Most single channel systems are recorded with relatively coarse line spacing, and the user is relegated to use the slice/resample and gridding menus in GPR-SLICE to generate useful images. However, with multi-channel systems, because the density of lines is so fine, we can avoid slice/resample and gridding menus, and directly place processed radargrams from into a 3D volume for viewing in Open GL. The user of multi-channel systems can still use the slice/resample and gridding menus if so desired.

The last section of this manual will introduce the BlueBox Batch runs for the multi-channel systems.

## Multi-Channel General Operations:

The generalized operational steps for all the multi-channel systems are:

- 1) Import the filenames in the Create Info File menu, creating the infomain.dat (main track) and infochannels.dat (individual channels) profile information
- 2) Generate the navigation files in the Edit Info File menu for the main track
- 3) Generate the navigation files for each individual channel using the offset information from the GPS main track
- 4) Extract/Convert the multi-channel radargrams
- 5) Set the Navigation marker type in the Navigation Menu
- 6) Run Ons Editing process with the infochannels.dat
- 7) Using the infochannelsedit.dat file, run RSP including background filtering, bandpass+gain, Kirchoff migration and Hilbert transform
- 8) Compile the desired processed folder into a 3D binary volume in the Radargram 3D Volume Generation menu. For super large sites block gridding operations are used to set individual blocks to a convenient size, e.g. 50x50m depending on the channel density and the ultimate xy volume resolution desired.
- 9) Display the data in Open GL or the Pixel 2D multichannel menu, or for super large datasets using the Gridblock menus.

### Proceq GS9000

The basic process for setting up the navigation for the Proceq GS9000 multichannel system for the GX1 vv and hh channels and the GX2 vv arrays are shown:

1a) GX1 vv Array – 35 channels at 0.025cm spacing. Set the number of channels and the x, y and z offsets for the array and click the Help Set button in the Create New Info menu. After that clicking the Import – Create Info button with the multichannel general highlighted in the listbox. This will automatically create 2 information files infomain.dat which has the names of the channel 1 main track radargrams and infochannels which will contain the names of the individual channel radargrams.

Create Information File: d:\gpr projects\gs9 from alex\					- 🗆 ×
filename infochannels.dat Create Info	profile name	x offset	y offset	z offset	GPS/Nav
# of files 2	Nievelt001_L002_C001_20240413_034719.sgy	0.	0.	0.	0.
file identifier PROJECTFG010324_000 (eg. file_000)	Nievelt001_L003_C001_20240413_034719.sgy	0.	0.	0.	0.
file extension .sgy					
gps file ext		_	-	-	_
gps nmea \$GPGGA -					
name increment					
name increment 1					
			-		
cx cy cxy c ang c GPS c vector					
X start 0 X end 0					
Y start 0 Y end 0	Proceg SEGY - GS9000	×			
unit/marker 1 time window ns 24.95	infomain.dat and infochannels.dat profile information files generated				
samples/scan 500 resampled scans/mrk 25	momandat and mochannels.dat prome mormation mes generated				
		_			
binary resol. C 8 bit C 16 bit @ 32 bit	ОК				
file list		- J			
append name infochannels.dat Append					
append name infochannels.dat Append					
Import - Create Info					
*.* file extension					
*.* file identifier + extension  *.* multichannel general  next>					
vector_survey_information.dat <pre></pre>				-	_
		000			
Ntracks         2         y offset         0         x offset           Nchannels         35         z offset         0         x start	.025	1-GP3)			
offset file					
channel 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 2		0.45.0.475.0.0		5.0.0	
x offsets -0.425,-0.4,-0.375,-0.35,-0.325,-0.3,-0.275,-0.225,-0.225,-0.2,-0.175,-0. y offsets 00,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,		,0.15,0.175,0.2,	0.225,0.25,0.21	15,0.3	
z offsets 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0					
tr offsets	ularlarlarlariar.			_	

## 1b) GX2 hh array – 15 channels at 4.4cm separation

filename infomain.dat	Create Info		profile name	x offset	y offset	z offset	GPS/Nav
# of files 39			Carnuntum forum LF005_L001_C001_20240607_091319.sgy	0.	0.	0.	0.
ile identifier	(eg. file_000)		Carnuntum forum LF005_L002_C001_20240607_091319.sgy	0.	0.	0.	0.
e extension .sgy			Carnuntum forum LF005_L003_C001_20240607_091319.sgy	0.	0.	0.	0.
gps file extgps gps nmea \$GPGGA ▼			Carnuntum forum LF005_L004_C001_20240607_091319.sgy	0.	0.	0.	0.
gps linea SGPGGA V			Carnuntum forum LF005_L005_C001_20240607_091319.sgy	0.	0.	0.	0.
name increment			Carnuntum forum LF005_L006_C001_20240607_091319.sgy	0.	0.	0.	0.
name start 1			Carnuntum forum LF005_L007_C001_20240607_091319.sgy	0.	0.	0.	0.
	-		Carnuntum forum LF005_L008_C001_20240607_091319.sgy	0.	0.	0.	0.
=			Carnuntum forum LF005_L009_C001_20240607_091319.sgy	0.	0.	0.	0.
C y C xy C ang  GPS C ve	ctor		Carnuntum forum LF005_L010_C001_20240607_091319.sgy	0.	0.	0.	0.
· × ·			Carnuntum forum LF005 L011 C001 20240607 091319.sgy	0.	0.	0.	0.
art 0 X end 0			Carnuntum forum LF005_L012_C001_20240607_091319.sgy	0.	0.	0.	0.
art 0 Yend 0			Carnuntum forum LF005_L013_C001_20240607_091319.sgy	0.	0.	0.	0.
time and a second se			Carnuntum forum LF005 L014 C001 20240607 091319.sgy	0.	0.	0.	0.
unit/marker 1 time window	ns 83.5		Carnuntum Proceq SEGY - GS9000		X	0.	0.
amples/scan 501 resampled scans/	mrk 25		Carnuntum		~	0.	0.
inary resol. C 8 bit C 16 bit @ 32 bit			Carnuntum			0.	0.
file list	1		Carnuntum infomain.dat and infochannels.dat profile information	n files generated	1	0.	0.
	-		Carnuntum			0.	0.
			Carnuntum		_	0.	0.
pend name infomain.dat App	end		Carnuntum	OK		0.	0.
	lunarit Oracta	la fa	Carnuntum forum LF005_L022_C001_20240607_091319.sgy	0.	0.	0.	0.
ile extension	Import - Create	INTO	Carnuntum forum LF005 L023 C001 20240607 091319.sgy	0.	0.	0.	0.
ile identifier + extension nultichannel general	-		Carnuntum forum LF005_L024_C001_20240607_091319.sgy	0.	0.	0.	0.
tor survey information.dat		next>	Carnuntum forum LF005 L025 C001 20240607 091319.sgy	0.	0.	0.	0.
		<prev< td=""><td></td><td></td><td></td><td></td><td></td></prev<>					
Ntracks 39 Nchannels 15	y offset 0 z offset 0	x offset	.044 zig-zag (x or y surveys/non-	-GPS)			
fset file	z offset 0	x start	308 help set				
nnel 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 1							
fsets -0.308,-0.264,-0.22,-0.176,-0.13		38,0.132,	0.176,0.22,0.264,0.308			_	
fsets 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.	.,0.,0.						

## 1c) GX2 vv array – 11 channels at 0.075cm spacing

filename infochannels.dat	0	reate Info		profile name	x offset	y offset	z offset	GPS/Nav
# of files 39				Carnuntum forum LF005_L001_C001_20240607_091319.sgy	0.	0.	0.	0.
file identifier	(eg. file	_000)		Carnuntum forum LF005_L002_C001_20240607_091319.sgy	0.	0.	0.	0.
e extension .sgy				Carnuntum forum LF005 L003 C001 20240607 091319.sgy	0.	0.	0.	0.
gps file ext .gps				Carnuntum forum LF005_L004_C001_20240607_091319.sgy	0.	0.	0.	0.
gps nmea \$GPGGA 👻				Carnuntum forum LF005_L005_C001_20240607_091319.sgy	0.	0.	0.	0.
name increment				Carnuntum forum LF005 L006 C001 20240607 091319.sgy	0.	0.	0.	0.
name start 1				Carnuntum forum LF005_L007_C001_20240607_091319.sgy	0.	0.	0.	0.
				Carnuntum forum LF005 L008 C001 20240607 091319.sgy	0.	0.	0.	0.
				Carnuntum forum LF005 L009 C001 20240607 091319.sgy	0.	0.	0.	0.
⊂ C y C xy C ang ∈ GPS C vec	tor			Carnuntum forum LF005_L010_C001_20240607_091319.sgy	0.	0.	0.	0.
				Carnuntum forum LF005 L011 C001 20240607 091319.sgy	0.	0.	0.	0.
art 0 X end 0				Carnuntum forum LF005_L012_C001_20240607_091319.sgy	0.	0.	0.	0.
art 0 Yend 0				Carnuntum forum LF005_L013_C001_20240607_091319.sgy	0.	0.	0.	0.
Aline and a set of the				Carnuntum forum LF005 L014 C001 20240607 091319.sgy	0.	0.	0.	0.
unit/marker 1 time window	ns 83.5			Carnuntum forum LF005_L015_C001_20240607_091319.sgy	0.	0.	0.	0.
amples/scan 501 resampled scans/r	nrk 25			Carnuntu Proceg SEGY - GS9000		X	0.	0.
inary resol. C 8 bit C 16 bit @ 32 bit				Carnuntu			0.	0.
file list				Carnuntu			0.	0.
				infomain.dat and infochannels.dat profile information f	files generated		0.	0.
				Carnuntu			0.	0.
pend name infochannels.dat App	end			Carnuntu	ОК		0.	0.
		Import - Cre	ata Infa	Carnuntu	OK		0.	0.
file extension	<b>-</b> -	import - Cle	aternio	Carnuntum forum LF005_L023_C001_20240607_091319.sgy	0.	0.	0.	0.
file identifier + extension multichannel general	_		-	Carnuntum forum LF005_L024_C001_20240607_091319.sgy	0.	0.	0.	0.
tor_survey_information.dat			next> <prev< td=""><td>Carnuntum forum LF005_L025_C001_20240607_091319.sgy</td><td>0.</td><td>0.</td><td>0.</td><td>0.</td></prev<>	Carnuntum forum LF005_L025_C001_20240607_091319.sgy	0.	0.	0.	0.
Ntracks 39 Nchannels 11	y offset z offset	0	x offset x start	075 375 help set	-GPS)			
nnel 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11								
fsets -0.375,-0.3,-0.225,-0.15,-0.075,-0	0.,0.075,0.	15,0.225,0.3,0	375					
fsets 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0. fsets 0.0.0.0.0.0.0.0.0.0.0.0								
ffsets 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.								

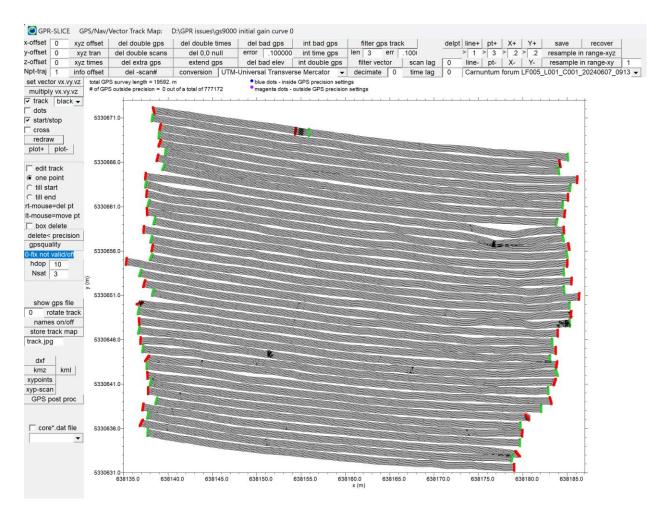
2) The next step is to generate the navigation with infomain.dat active in the Edit Info File menu. Clicking the Proceq to UTM will create the navigation for each swath.

nannels.dat nannelsedit.dat	profile name		x offset	y offset	z offset	GPS/NAV	divisio
ain.dat	1 Nievelt001_L002_C001_20240413_034719.sgy	C	0.	0.	0.	7245.	
	2 Nievelt001_L003_C001_20240413_034719.sgy	0	0.	0.	0.	7329.	
fomain.dat	3	0					
save edits	4	c				-	-
add xoff add yoff name +	5	c			-	-	
add zoff add col4 name -	6						
es xoff times yoff insert						_	
es zoff times col4 delete	7	c				_	
otate append chr del dn	8	0					
minGPS del chnnels del up	9	0					
	10	0					
	GPR-SLICE v7.MT \raw\*gps navigation files created	0					
segy get ts	12	0				-	
y get Nscan-1	13 ОК	с		-		-	
cii proceq to UTM	14	С		_			
icode array to nav	15	0				-	
mea to utm	16	0				-	
mea to nav 📧 big endian	17	C				-	-
Ittle endian	18	C			-		
vse x0x1y0y1 nav scalar 1		0		-		-	
xyz to nav 📧 segy utm	19			_		_	
s update list O segy lat/lon	20	C		_			
Il to utm show gps file	21	C		_			
ps get yaw show file header	22	0					
GPS to XY	23	0					
ing, X, Y, XY to GPS or Vector	24	0					
unit/marker 1	25	0					
time window (ns) 24.95					1	1	
samples/scan 500	next> <prev r="" sort="" td="" to<="" x0=""><td>x1 so</td><td></td><td>&gt;&gt; y sor</td><td></td><td></td><td></td></prev>	x1 so		>> y sor			
resampled scans/mark 25	del odd		x1	to y0	rev file		
binary 08 bit resol. 016 bit 632 bit	del even	0					
	recover x0-east	0		eoreference info irt/end utm of file			
xy Survey type: ang	sort multichannel y0-north x1-east	0	sta	inventio utm of the	eı		

3) Changing the information file to infochannels.dat and clicking the button Array to Nav will generate the individual channel navigation files based on the assigned X and Y offsets in the file.

	y offset	z offset	GPS/NAV	division
o -0.425	0.	0.	7245.	
c -0.4	0.	0.	7245.	
o -0.375	0.	0.	7245.	-
o -0.35	0.	0.	7245.	_
c -0.325	0.	0.	7245.	_
o -0.3	0.	0.	7245.	- E
o -0.275	0.	0.	7245.	- E
c -0.25	0.	0.	7245.	
c -0.225	0.	0.	7245.	
0 -0.2	0.	0.	7245.	
c -0.175	0.	0.	7245.	
0 -0.15	0.	0.	7245.	
×	0.	0.	7245.	
	0.	0.	7245.	
	0.	0.	7245.	
tion files created	0.	0.	7245.	
	0.	0.	7245.	
ОК	0.	0.	7245.	
C U.U20	0.	0.	7245.	
0.020	0.	0.	7245.	
0.075	0.	0.	7245.	
0.073	0.	0.	7245.	_
0.125	0.	0.	7245.	
	0.	0.	7245.	_
	0.	0.	7245.	
0.175	0.	0.	7245.	
sort x x >	> y sor	rt y y0 to y1	1	
x1 t	o y0	rev file		
	oroforonoo inf			
	ge ** star	georeference inf	georeference info ** start/end utm of file 1	georeference info ** start/end utm of file 1

#### An example of a GS9000 GX2 array GPS track is shown in the following figure:



After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for generalized signal processing for all multichannel GPR and how to compile these data to a 3D volume.

### Mala Mira

The basic processes for the Mala Mira multi-channel GPR systems are:

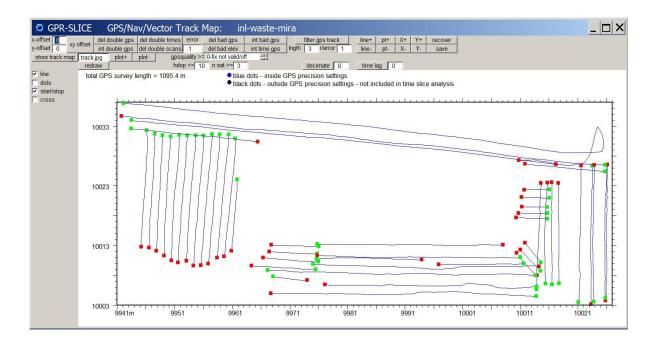
1) Set the channel numbers and the x,y and z offsets for the Mala Array. Then click the "Import – Create Info" button in the Create Info File menu with the multichannel general highlighted in the listbox. This will automatically create 2 information files, infomain.dat which has the names of the main track radargrams, and infochannels.dat which will contains the names of the demultiplexed individual channel radargrams with all the X and Y offsets properly noted and stored.

filename	info.dat	Create Info	profile name	x offset	y offset	z offset	GPS/Na
# of files	48		Warm_WASTE_000.rd3	0.	0.	0.	0.
file identifier	37rd	(eg. file_000)	Warm_WASTE_001.rd3	0.	0.	0.	0.
ile extension	.rd3		Warm_WASTE_002.rd3	0.	0.	0.	0.
gps file ext gps nmea	.gps \$GPGGA 👻		Warm_WASTE_003.rd3	0.	0.	0.	0.
ordinate sys	UTM-Universal Transverse M	lercator 👻	Warm_WASTE_004.rd3	0.	0.	0.	0.
name increr			Warm_WASTE_005.rd3	0.	0.	0.	0.
name			Warm_WASTE_006.rd3	0.	0.	0.	0.
— ITT		-	Warm_WASTE_007.rd3	0.	0.	0.	0.
=	# 7 2 2	2 ~	Warm_WASTE_008.rd3	0.	0.	0.	0.
хсу	C xy C ang C GPS C v	rector	Warm WASTE 009.rd3	0.	0.	0.	0.
			Warm WASTE 010.rd3	0.	0.	0.	0.
start 0	X end 9.5		Warm_WASTE_011.rd3	0.	0.	0.	0.
start 0	Y end 10		Warm WASTE 012.rd3	0.	0.	0.	0.
			Warm_WASTE_013.rd3	0.	0.	0.	0.
unit/marke	er 1 time windo	owins 0	Warm WASTE 014 rd2	0.	0.	0.	0.
samples/sca	n 0 resampled scans	s/mrk 32	Mala Mira		X	0.	0.
binary resol.	● 8 bit ← 16 bit ← 32 bi	+				0.	0.
		-	infomain.dat and infochannels.dat profile infor	mation files generated		0.	0.
file list	<u> </u>	<u>•</u>	moman.uat and mochannels.uat prome mon	mation mes generated			
						0.	0.
ppend name	info dat Ar	opend		ОК	1	0.	0.
		pend		OK		0.	0.
	a 8	<ul> <li>Import - Create Info</li> </ul>		•.		0.	0.
radargram e	extension dentifier + extension		Warm_WASTE_022.rd3	0.	0.	0.	0.
* multichanne	el general		next>   Warm_WASTE_023.rd3	0.	0.	0.	0.
ctor_survey_	information.dat	· -	<pre> Warm_WASTE_024.rd3</pre>	0.	0.	0.	0.
omma delimit offset file	ted Ntracks 48 Nchannels 16	y offset 0 z offset 0	x offset .08 x start6 help set				
annel	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11,	12, 13, 14, 15, 16					
	-0.6,-0.52,-0.44,-0.36,-0.28,-0.	2,-0.12,-0.04,0.04,0.12,0.2,0.	28,0.36,0.44,0.52,0.6				
offsets	0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0	,0.,0.,0.,0.					
	0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0						

- 2) The next operation is to extract all the radargrams from the main track names using the new Mira Extract button in the Edit Info File menu (shown previously). The extracted radargrams are directly placed into the \radar\ folder with the naming convention \*-N.rd3 where N is the channel number (the \raw\ folder is bypassed.)
- 3) After this the next operation is to click the Mira to Nav, which generates the \*.rd3.gps files of the main track. The GPS track menu can optionally be used to filter and condition the main GPS tracks should there be need error listed during track generation.

ochannelsedit.dat	^	profile name		x offset	y offset	z offset	GPS/NAV	divi
ochannelsedit1.dat omain.dat	× 1	-	- c	0.	0.	0.	29.	Г
man.aat	2		- 2	0.	0.	0.	28.	E F
infomain.dat	3		- `	0.	0.	0.	28.	
save edits			- 0			0.	-	
	4		_	0.	0.		27.	1.33
add xoff add zoff name add yoff add col4 name				0.	0.	0.	7.	E
add yoff add col4 name mes xof times zof inse	+			0.	0.	0.	9.	Г
mes vof times c4 dele	/			0.	0.	0.	7.	Г
rotate append chr del N	8	Warm_WASTE_007.rd3		0.	0.	0.	9.	Г
del channel	9	Warm_WASTE_008.rd3	С	0.	0.	0.	11.	Г
MALA get xy MALA get ts	10	Warm_WASTE_009.rd3	0	0.	0.	0.	78.	Г
MALA to utm	11	Warm_WASTE_010.rd3	- C	0.	0.	0.	11.	Г
MALA to nav	G	PS Navigation Files				×	84.	Г
/ala2 to utm		r S Navigation riles				~	1	
							52.	1
Mira extract							52. 19.	
Mira to nav		-						Г
Mira to nav Array to nav		GPR-SLICE v7.0 \raw\*.gps Mir	a na	vigation	files creat	ed	19. 16.	Г
ascii <u>Mira to nav</u> Array to nav unicode		GPR-SLICE v7.0 \raw\*.gps Mir	a na	vigation	files creat	ed	19. 16. 14.	
ascii Aira to nav Array to nav unicode nmea to utm		GPR-SLICE v7.0 \raw\*.gps Mir	a na	vigation	files creat	ed	19. 16. 14. 14.	
Mira to nav		GPR-SLICE v7.0 \raw\*.gps Mir	a na	vigation	files creat	ed	19.           16.           14.           14.           67.	
Mira to nav ascii Array to nav unicode nmea to utm nmea to nav rwse x0x1y0y1 xyz to nav		GPR-SLICE v7.0 \raw\*.gps Mir	a <mark>n</mark> a	vigation		red	19.       16.       14.       14.       67.       8.	
Mira to nav ascii Array to nav unicode nmea to utm nwse x0x1y0y1 xyz to nav gps get list		GPR-SLICE v7.0 \raw\*.gps Mir	a <mark>n</mark> a	vigation	files creat OK	ed	19.           16.           14.           67.           8.           9.	
Mira to nav           ascii         Array to nav           unicode			a <mark>n</mark> a	vigation			19.           16.           14.           67.           8.           9.           9.	
Mira to nav           ascii         Array to nav           unicode			a na	vigation		ed	19.           16.           14.           67.           8.           9.	
Mira to nav ascii Array to nav unicode nmea to utm nmea to nav nwse x0x1y0y1 xyz to nav gps get list II to utm gps get yaw show gps fil		Warm_WASTE_021.rd3			ОК		19.           16.           14.           67.           8.           9.           9.	
Mira to nav ascii Array to nav unicode nmea to utm mmea to nav wse x0x1y0y1 xyz to nav gps get list II to utm gps get yaw show gps fil Ang, X, Y, XY to Vector	a 22	Warm_WASTE_021.rd3 Warm_WASTE_022.rd3	C	0.	OK	0.	19.           16.           14.           67.           8.           9.           9.           26.	
Mira to nav ascii Array to nav unicode nmea to utm mmea to nav wse x0x1y0y1 xyz to nav gps get list li to utm gps get jaw show gps fil Ang, X, Y, XY to Vector unit/marker 1	22 23 24 25	Warm_WASTE_021.rd3 Warm_WASTE_022.rd3 Warm_WASTE_023.rd3		0.	OK	0.	19.           16.           14.           67.           8.           9.           9.           26.           62.	
Mira to nav       ascii     Array to nav       unicode     nmea to utm       nmea to nav     mse x0x1y0y1       xyz to nav     gps get list       Il to utm     Ito utm       gps get yaw     show gps fil       Ang, X, Y, XY to Vector     1       time window (ns)     100	22 23 24 25	Warm_WASTE_021.rd3 Warm_WASTE_022.rd3 Warm_WASTE_023.rd3 Warm_WASTE_024.rd3		0. 0. 0. 0.	OK	0. 0. 0.	19.           16.           14.           67.           8.           9.           26.           62.           34.           55.	
Mira to nav       ascii     Array to nav       unicode     nmea to utm       nmea to nav     mse x0x1y0y1       xyz to nav     gps get list       II to utm     II to utm       gps get yaw     show gps fill       Ang, X, Y, XY to Vector     100       samples/scan     450	22 23 24 25	Warm_WASTE_021.rd3 Warm_WASTE_022.rd3 Warm_WASTE_023.rd3		0. 0. 0. 0.	OK	0. 0. 0. 0. x>>y s	19.           16.           14.           67.           8.           9.           26.           62.           34.           55.           ort y         y0 to y	
Mira to nav       ascii     Array to nav       unicode     Inmea to utm       nmea to nav     Inmea to nav       wse x0x1y0y1     xyz to nav       gps get list     II to utm       Il to utm     gps get yaw       Ang, X, Y, XY to Vector     Inmex window (ns)       unit/marker     1       time window (ns)     100       samples/scan     450       resampled scans/mark     32	22 23 24 25	Warm_WASTE_021.rd3 Warm_WASTE_022.rd3 Warm_WASTE_023.rd3 Warm_WASTE_024.rd3		0. 0. 0. 0.	OK	0. 0. 0.	19.           16.           14.           67.           8.           9.           26.           62.           34.           55.	
Array to nav Array to nav unicode nmea to utm nmea to nav rwse x0x1y0y1 xyz to nav gps get list Il to utm gps get yaw show gps fil Ang, X, Y, XY to Vector unit/marker 1 time window (ns) 1000 samples/scan 450 resampled scans/mark 32 binary C 8 bit	22 23 24 4 25	Warm_WASTE_021.rd3         Warm_WASTE_022.rd3         Warm_WASTE_023.rd3         Warm_WASTE_024.rd3         next> <prev< td="">         del odd         del even</prev<>		0. 0. 0. 0.	OK	0. 0. 0. 0. x>>y s	19.           16.           14.           67.           8.           9.           26.           62.           34.           55.           ort y         y0 to y	_
Mira to nav Array to nav unicode nmea to utm nmea to nav invse x0x1y0y1 xyz to nav gps get list Il to utm gps get yaw Ang, X, Y, XY to Vector unit/marker 1 time window (ns) 100 samples/scan 450 resampled scans/mark 32 binary C 8 bit	22 23 24 4 25	Warm_WASTE_021.rd3         Warm_WASTE_022.rd3         Warm_WASTE_023.rd3         Warm_WASTE_024.rd3         next>		0. 0. 0. 0.	OK	0. 0. 0. 0. x>>y s	19.           16.           14.           67.           8.           9.           26.           62.           34.           55.           ort y         y0 to y	

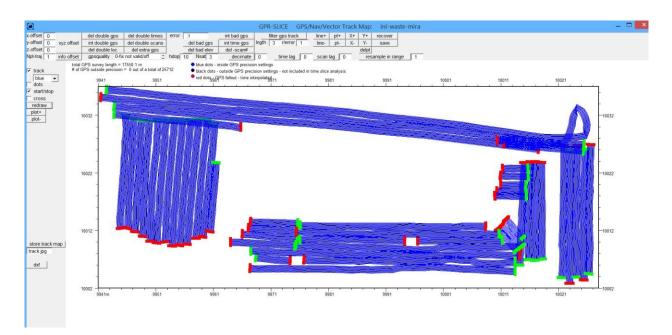
\*note: The Mira Extract button will be used normally for total station projects. For GPS projects, the user will set the GPS File Extension to the \*.cor file extension (in the Create New Info menu) and will click the Mala to UTM button in the Edit Info File menu for the navigation.



An example of the main track profile map is shown above. This particular example was made from 2 total station grids. The 2<sup>nd</sup> total station is reference to the first grid using Mala Mira tie-point log files that come with these collected datasets.

4) The next step is to highlight the infochannels.dat file back in the Edit Info File menu, and click the Array to Nav button to generate the individual channel tracks navigation (.rd3.gps files). The calculation includes the recorded offset in X and/or Y and employs monitoring the track orientation by looking at the trend between 2-3 adjacent GPS points. Note, that the X/Y offsets are stored in the first 2 columns of the information file for GPS or total station surveys.

	^		profile name		x offset	y offset	z offset	GPS/NAV	divisio
ifobak.dat ifochannels.dat		1	warm_waste_000-1.rd3	С	-0.6	0.35	0.	29.	
		2	warm_waste_000-2.rd3	с	-0.52	0.35	0.	29.	Г
infochannels.dat	t	3	warm_waste_000-3.rd3	c	-0.44	0.35	0.	29.	Г
save edits		4	warm_waste_000-4.rd3	c	-0.36	0.35	0.	29.	Г
add xoff a	dd zoff   name +	1 5	warm waste 000-5.rd3	c	-0.28	0.35	0.	29.	Г
.4 add yoff ad		6	warm_waste_000-6.rd3	c	-0.2	0.35	0.	29.	E
times xof time	es zof insert		warm waste 000-7.rd3		-0.12	0.35	0.	29.	Ē
times yof time	es c4 delete	8	warm_waste_000-8.rd3	C	-0.04	0.35	0.	29.	Ē
rotate appe	nd chr del Nth	- 9	warm_waste_000-9.rd3		0.04	0.35	0.	29.	Ē
	del channels					0.35	0.	29.	
MALA get xy MALA to utm	MALA get ts	] 10	warm_waste_000-10.rd3		0.12				
MALA to utrh MALA to nav		11	warm_waste_000-11.rd3	c	0.2	0.35	0.	29.	
unicode nmea to utm	Mira extract Mira to nav Array to nav	warm	_waste_000-1.rd3 - warm_	waste_06	58-16.rd3	*.gps nav	vigation <mark>f</mark> i	les create	d
© unicode nmea to utm nmea to nav brwse x0x1y0y1	Mira to nav	warm	_waste_000-1.rd3 - warm_	waste_06	58-16.rd3	*.gps nav	vigation fi	les create	d
C unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav	Mira to nav	warm	_waste_000-1.rd3 - warm_	waste_00	58-16.rd3	*.gps nav	vigation fi		d
C unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list	Mira to nav	warm <u>.</u>	_waste_000-1.rd3 - warm_	waste_06	58-16.rd3	*.gps nav	vigation fi	les create	d
C unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list Il to utm	Mira to nav Array to nav	warm.	_waste_000-1.rd3 - warm_	waste_06	58-16.rd3	*.gps nav	vigation fi		ď
C unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list	Mira to nav				ł			OK	ď
C unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list II to utm	Mira to nav Array to nav show gps file	23	warm_waste_001-7.rd3	د 	-0.12	0.35	0.	OK 28.	d
Unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list II to utm gps get yaw Ang, X, Y, X	Mira to nav Array to nav show gps file Y to Vector				-0.12 -0.04			OK	
innea to utm nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list li to utm gps get yaw Ang, X, Y, X unif	Mira to nav Array to nav show gps file Y to Vector Vmarker 1	23	warm_waste_001-7.rd3	د 	-0.12	0.35	0.	OK 28.	
Unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list II to utm gps get yaw Ang, X, Y, X unit time winc	Mira to nav Array to nav show gps file Y to Vector Vmarker 1	23	warm_waste_001-7.rd3 warm_waste_001-8.rd3	د 	-0.12 -0.04 0.04	0.35 0.35 0.35	0. 0. 0.	OK	
Unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps get list II to utm gps get yaw Ang, X, Y, X unit time winc	Mira to nav Array to nav show gps file Y to Vector Vmarker 1 fow (ns) 100.4 es/scan 450	23	warm_waste_001-7.rd3 warm_waste_001-8.rd3 warm_waste_001-9.rd3 next> <prevsort r<="" td=""><td>د </td><td>-0.12 -0.04 0.04</td><td>0.35 0.35 0.35 sortx</td><td>0. 0. 0.</td><td>OK 28. 28. 28.</td><td></td></prevsort>	د 	-0.12 -0.04 0.04	0.35 0.35 0.35 sortx	0. 0. 0.	OK 28. 28. 28.	
<ul> <li>unicode</li> <li>nmea to utm</li> <li>nmea to nav</li> <li>brwse x0x1y0y1</li> <li>xyz to nav</li> <li>gps get list</li> <li>II to utm</li> <li>gps get yaw</li> <li>Ang, X, Y, X</li> <li>unit</li> <li>time winc</li> <li>sample</li> <li>resampled scal</li> <li>binary C</li> </ul>	Mira to nav Array to nav Array to nav show gps file Y to Vector Umarker 1 dow (ns) 100.4 es/scan 450 ns/mark 32 ' 8 bit	23	warm_waste_001-7.rd3 warm_waste_001-8.rd3 warm_waste_001-9.rd3 next> <prev r<br="" sort="">del odd</prev>	د 	-0.12 -0.04 0.04	0.35 0.35 0.35 sortx	0. 0. 0. x>>y s	OK 28. 28. 28. 0rt y y0 to y	
nmea to nav brwse x0x1y0y1 xyz to nav gps get list li to utm gps get yaw Ang, X, Y, X unit time winc sample resampled sca binary C	Mira to nav Array to nav show gps file Y to Vector t/marker 1 1004 (ns) 100.4 es/scan 450 ns/mark 32	23	warm_waste_001-7.rd3 warm_waste_001-8.rd3 warm_waste_001-9.rd3 	د 	-0.12 -0.04 0.04	0.35 0.35 0.35 sortx	0. 0. 0. x>>y s	OK 28. 28. 28. 0rt y y0 to y	
unicode     nmea to utm     nmea to nav     brwse x0x1y0y1     xyz to nav     gps get list     li to utm     gps get yaw     Ang, X, Y, X     unit     time winc     sample     resampled scat     binary C	Mira to nav Array to nav Array to nav show gps file Y to Vector t/marker 1 dow (ns) 100.4 es/scan 450 ns/mark 32 ' 8 bit ' 16 bit ( 32 bit y ^	23	warm_waste_001-7.rd3 warm_waste_001-8.rd3 warm_waste_001-9.rd3 next> <prev r<br="" sort="">del odd</prev>	د 	-0.12 -0.04 0.04	0.35 0.35 0.35 sortx	0. 0. 0. x>>y s	OK 28. 28. 28. 0rt y y0 to y	



An example of the GPS track generated for all the individual channels following the x and y offsets is shown above.

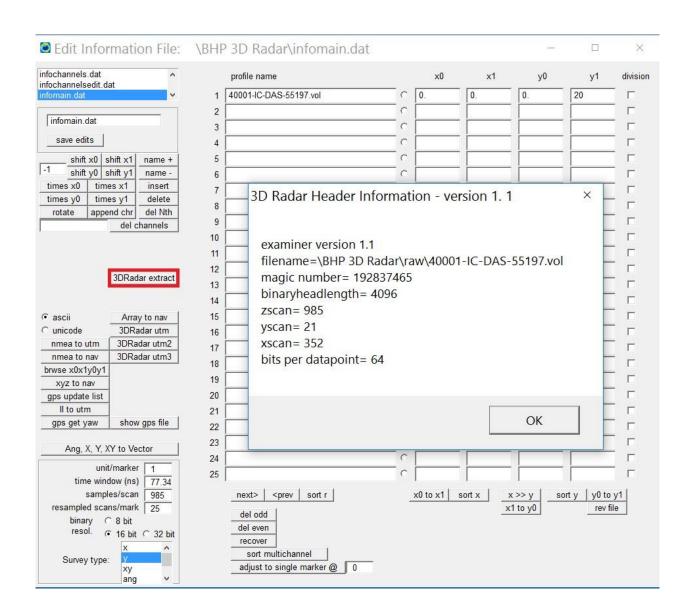
After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for signal processing for multichannel GPR and how to compile these data to a 3D volume.

## **3D Radar Geoscope/Kontur – VOL format**

 Set the survey type to GPS or X or Y, the number of channels, and the antenna separation and offsets. Click the "Import – Create Info" button. This will automatically create 2 information files, infomain.dat which has the names of the main track radargrams, and infochannels.dat which contains the names of the extracted individual channel radargrams with all the X and Y offsets, antenna separation, properly noted and stored.

	×0	x1	y0	y1
40001-ic-das-55197-1.vol	0.	0.	0.	20.
40001-ic-das-55197-2.vol	0.08	0.08	0.	20.
40001-ic-das-55197-3.vol	0.16	0.16	0.	20.
40001-ic-das-55197-4.vol	0.24	0.24	0.	20.
40001-ic-das-55197-5.vol	0.32	0.32	0.	20.
40001-ic-das-55197-6.vol	0.4	0.4	0.	20.
40001-ic-das-55197-7.vol	0.48	0.48	0.	20.
40001-ic-das-55197-8.vol	0.56	0.56	0.	20.
40001-ic-das-55197-9.vol	0.64	0.64	0.	20.
40001-ic-das-55197-10.vol	0.72	0.72	0.	20.
infomain.dat and infochannels	s.dat profile ir	nformatio	n files ge	enerated
	s.dat profile ir	nformatio	n files ge	OK
			n files ge	ОК
40001-ic-das-55197-20.vol 40001-ic-das-55197-21.vol	1.52	1.52 1.6		
40001-ic-das-55197-20.vol	1.52	1.52	0.	OK20.
40001-ic-das-55197-20.vol 40001-ic-das-55197-21.vol	1.52	1.52	0.	OK20.
40001-ic-das-55197-20.vol 40001-ic-das-55197-21.vol	1.52	1.52	0.	OK20.
40001-ic-das-55197-20.vol 40001-ic-das-55197-21.vol xt> rev xcoffset 08 c start 0 help set	1.52	1.52	0.	OK20.
	40001-ic-das-55197-5.vol 40001-ic-das-55197-6.vol 40001-ic-das-55197-7.vol 40001-ic-das-55197-8.vol 40001-ic-das-55197-9.vol 40001-ic-das-55197-10.vol D Radar	40001-ic-das-55197-5.vol         0.32           40001-ic-das-55197-6.vol         0.4           40001-ic-das-55197-7.vol         0.48           40001-ic-das-55197-7.vol         0.56           40001-ic-das-55197-8.vol         0.56           40001-ic-das-55197-9.vol         0.64           40001-ic-das-55197-9.vol         0.64           40001-ic-das-55197-10.vol         0.72	40001-ic-das-55197-5.vol         0.32         0.32           40001-ic-das-55197-6.vol         0.4         0.4           40001-ic-das-55197-7.vol         0.48         0.48           40001-ic-das-55197-8.vol         0.56         0.56           40001-ic-das-55197-9.vol         0.64         0.64           40001-ic-das-55197-9.vol         0.72         0.72	40001-ic-das-55197-5.vol         0.32         0.32         0.           40001-ic-das-55197-6.vol         0.4         0.4         0.           40001-ic-das-55197-7.vol         0.48         0.48         0.           40001-ic-das-55197-8.vol         0.56         0.56         0.           40001-ic-das-55197-9.vol         0.64         0.64         0.           40001-ic-das-55197-9.vol         0.72         0.72         0.

2) The next step the individual channels are extracted from the multiplexed radargrams listed in the infomain.dat file in the Edit Info File menu.



3) The next step is to make sure the infomain.dat file is highlighted in the Edit Info File menu. Then click the 3DRadar to UTM, which generates the \*.rd3.gps files of the main track and updates the number of GPS listings in the 4<sup>th</sup> column of the information file. The user can use the GPS track menu optionally to filter and condition the main GPS tracks should there be any need to or track warning messages come up. (For non-GPS surveys these buttons are not used and just the x0,x1,y0,y1 columns are used as the navigation).

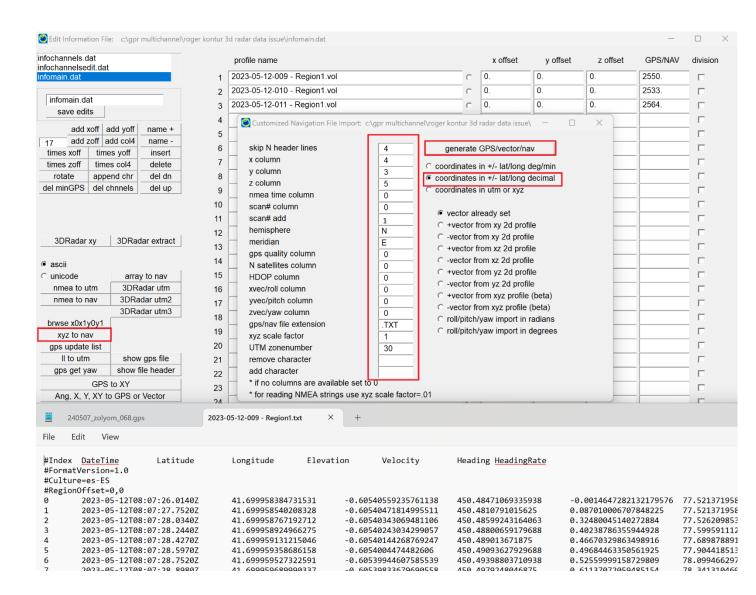
0	Edit Inform	ation File: C:\3DRada	r GP	S test∖infoi	main.dat		_ (	- ×
infochannels.dat		profile name		x offset	y offset	z offset	GPS/NAV	division
infomain dat	1 2013-	04-11-003-Region1-00u.vol	- C	0.	0.	0.	1064.	
	2		C					Γ
infomain.dat	3		C					
save edits	4		C					
shift x0 shift x1 name +	5		C					
0 shift y0 shift y1 name -	6		0					
times x0 times x1 insert	7	i i i i i i i i i i i i i i i i i i i	- c					
times y0 times y1 delete	8	3D Radar (	GPS N	Vavigation	Files	<		
Totale	9							
	10		*					
	11	GPR-SLICE v7.0 \raw	r.gps i	navigation III	es created			
	12	_				_		
3D Radar xy 3D Radar ts	13	-			ОК	7	<u></u>	
	14	-			UK			
NMEA to utm Array to nav	15			T	1			
NMEA to nav 3DRadar utm	16		С					
brwse x0x1y0y1 3DRadar utm2	17		- c					
xyz to nav	18		- C	<u> </u>				
GPS get list LL to UTM	19		- C				·	Г
LELIGOTIM	20		- c				·	Г
GPS get yaw	21		- c	<u> </u>				Γ
,	22		- c					Γ
Ang, X, Y, XY to Vector	23		- 0					
unit/marker 1	24		- c					_
time window ns 35	25		- c				· · · · · · · · · · · · · · · · · · ·	Г
samples/scan 216						1	1 1 01	
resampled scans/mark 32	nex	> <prev r<="" sort="" td=""><td>-</td><td>x0 to x1</td><td></td><td>so 1 to y0</td><td>rt y y0 to y rev file</td><td>-</td></prev>	-	x0 to x1		so 1 to y0	rt y y0 to y rev file	-
recompled receipt C. 0 hit C. 40 hit		odd			X		III	
resampled resol. C 8 bit  16 bit		even						
Survey type: ang	rec	over						
GPS Y	so	t multichannel						

Optionally for newer versions of 3D Radar \*.txt files are provided as the navigation formats. For these datasets the XYZtoNAV menu is needed to read the navigation and create the GPS files. In some case the full NMEA string is present and in other cases extracted NMEA components

3a) Full NMEA string \*.txt Kontur navigation files and how to generate \*.gps files using the XYZ to NAV operation:

ochannelsedit.dat omain.dat			profile name			x offset	y offset	z offset	GPS/NAV	divisior
	• ·	1	2019-05-30-018 - Region	n1.vol	- C	0.	0.	0.	33.	_
		2	2019-05-30-019 - Region	n1.vol	C	0.	0.	0.	40.	- E
infomain.dat		- 3	2019-05-30-020 - Region	n1 vol	-	0.	0.	0.	36.	- F
save edits		4	2019-05-30-021 - Region	100 100		0.	0.	0.	39.	
add col1 add co	3 name +	4				0.				
add col2 add col	4 name -	🕙 Cust	tomized Navigation File Impo	ort: c:\multichannel\b	prent pass 30	d radar demo\	-			_
times col1 times col2	insert	10.00								
times col3 times col4	delete	skip	N header lines	4	gen	erate GPS/v	ector/nav			
rotate append ch		x col	lumn	5	@ acordi	notos in 17 l	at/long deg/min			
lel minGPS del chnnel	5	у со	lumn	3			at/long decimal			
		z co		10		nates in utm				
			a time column	2	oooru	nates in dun	01 NJ2		-	
			n# column	0	vec	tor already s	et		-	- E
3DRadar xy 3DF	Radar extract	100000	isphere	N		ector from xy				
		meri	dian quality column	E 0	C -ve	ctor from xy	2d profile		-	
ascii			itellites column	0	C +ve	ector from xz	2d profile			
	rray to nav		OP column	0	C -ve	ctor from xz	2d profile			
	Radar utm		/roll column	0	C +ve	ector from yz	2d profile			
	Radar utm2		pitch column	0		ctor from yz				
	Radar utm3	zvec	/yaw column	0		-	profile (beta)			Г
brwse x0x1y0y1 xyz to nav		gps/	nav file extension	.txt			port in radians			_
gps update list		xyz s	scale factor	.01	C roll	/pitch/yaw in	port in degrees		-	
	ow gps file	UTN	1 zonenumber	40					-	- <u>-</u>
	w file header	remo	ove character	- Regior					-	_
gpo got jun ono									-	
Ang, X, Y, XY to GPS	or Vector		o columns are available s							
unit/mor		* for	reading NMEA strings use	e xyz scale factor=	:.01	4				
unit/mar time window (	· · · · · · · · · · · · · · · · · · ·	2019	-05-30-020.txt - Notepad						- 🗆	×
samples/so		File Edit	Format View Help							
resampled scans/m		1	gation Data Versio	on=1.0						^
binary C 8 bit		#Creat	ted: Examiner 3.2.	.1.33066 at T	hursday	, 04 July	2019 08:3	6:52		
	it @ 32 bit	1000 C C C C C C C C C C C C C C C C C C	isition ID: f0447c		-b45c-6	1cbdb13d	aa			
xy			ce Position: 0,0,0							
Survey type: ar	ig		A, 142410.20, 2456.9							
G	PS Y		A,142411.23,2456.9 A,142412.26,2456.9							
			A,142412.20,2456.9							
			A,142414.33,2456.9							
			A,142415.36,2456.9							

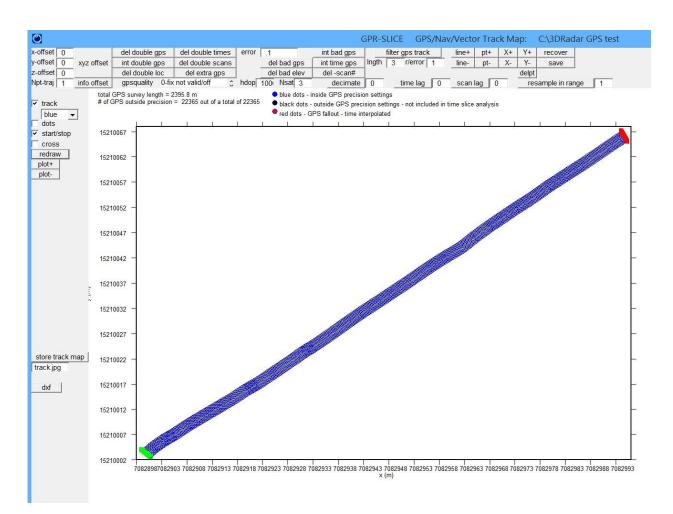
3b) Extracted NMEA components in the \*.txt Kontur Navigation files and how to generate \*.gps files using the XYZ to NAV operation:



4) The next step is to highlight the infochannels.dat file back in the Edit Info File menu, and click the Array to Nav button to generate the individual channel tracks navigation (.vol.gps files). The calculation includes the recorded offset in X and/or Y and employs monitoring the track orientation by looking at the trend between 2-3 adjacent GPS points.

۲	Edit Info	ormation File: C:\3DRadar G	iPS t	est\infoch	annels.dat		- 1	
infobak.dat		profile name		x offset	y offset	z offset	GPS/NAV	division
infochannelsedit.dat	1	2013-04-11-003-Region1-00u-1.vol	С	0.	0.	0.	1064.	Γ
	2	2013-04-11-003-Region1-00u-2.vol	С	0.12	0.	0.	1064.	Г
infochannels.dat	3	2013-04-11-003-Region1-00u-3.vol	С	0.24	0.	0.	1064.	Γ
save edits	4	2013-04-11-003-Region1-00u-4.vol	С	0.36	0.	0.	1064.	
shift x0 shift x1 name +	5	2013-04-11-003-Region1-00u-5.vol	0	0.48	0.	0.	1064.	Γ
0 shift y0 shift y1 name -	6	2013-04-11-003-Region1-00u-6.vol	С	0.6	0.	0.	1064.	Γ
times x0 times x1 insert	7	2013-04-11-003-Region1-00u-7.vol	C	0.72	0.	0.	1064.	Г
times y0 times y1 delete	8	2013-04-11-003-Region1-00u-8.vol	С	0.84	0.	0.	1064.	Γ
Totale	9	2013-04-11-003-Region1-00u-9.vol	С	0.96	0.	0.	1064.	Г
	10	2013-04-11-003-Region 1 000 10 vol	-	1.00		in .	1064	-
	11	2013-04-11-003-Region			GPS Filt	ering		×
	12	2013-04-11-003-Region						
3D Radar xy 3D Radar ts	13	2013-04-11-003-Region 21 files	vere	found contai	ning double G	PS points		
	14						the GPS track	menu
NMEA to utm Array to nav	15	2013-04-11-003-Region						
NMEA to nav 3DRadar utm	16	2013-04-11-003-Region						
brwse x0x1y0y1 3DRadar utm2	17	2013-04-11-003-Region						ок
xyz to nav	18	2013-04-11-003-Region						
GPS get list LL to UTM	19	2013-04-11-003-Region1-00u-19.vol	С	2.2	0.	0.	1064.	Г
	20	2013-04-11-003-Region1-00u-20.vol	С	2.32	0.	0.	1064.	Г
GPS get yaw	21	2013-04-11-003-Region1-00u-21.vol	0	2.44	0.	0.	1064.	Г
	22		С					Г
Ang, X, Y, XY to Vector	23		- c					Г
unit/marker 1	24		С			-		Г
time window ns 35	25		C					Г
samples/scan 216				0	. 1	1		. 1
resampled scans/mark 32		next> <prev r<="" sort="" td=""><td>-</td><td>x0 to x1</td><td>And Address of Concession, Name of Concession,</td><td>(&gt;&gt; y so 1 to y0</td><td>ort y y0 to y rev file</td><td></td></prev>	-	x0 to x1	And Address of Concession, Name of Concession,	(>> y so 1 to y0	ort y y0 to y rev file	
resampled resol. 🦳 8 bit 🔍 16 bit		del odd						
		del even recover						
Survey type: Xy ang GPS V		sort multichannel						

An example GPS track map for all the individual channels for this Geoscope dataset is shown below:



After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for signal processing for multichannel GPR and how to compile these data to a 3D volume.

## **3D Radar Geoscope/Kontur – SEGY format**

1) An alternate 3D Radar format available in late 2020 is a SEGY format. Each swath of data is written into a single SEGY file. The equipment format chosen is SEGY Multichannel Multipex.

🕘 GPR-SLICE Ground Penetrating Radar Imaging S	Software: C:\GPR multichan	nel\3D Radar SEGY format \	
File Reverse Navigation Slice Grid Pixel Radar 30		nation Help	
project folder option T radar open	2		
New Survey: C:\GPR multichannel\3D Radar S	SEGY format \	_	×
browse default directory C:\GPR multich	annel\		
survey name			_
	New Survey	Select Equipment Type	
dat dir		IDS Stream	^
grd dir		IDS Opera Duo IDS C-thrue	
jpg dir		Leica	
3d file dir		Ditchwitch	
		Subsite	
raw dir		SIR 20 SIR 2000	
radar dir		SIR 30	
resample dir		SIR 3000	
filter dir		SIR 4000 GSSI SSmini	
migration dir		GSSI SSMINI GSSI SSmini XT	
hilbert dir		GSSI DualFreq	
boxcar dir		US Radar	
bandpass dir		3D Radar RadarTeam	
topo dir		SEGY	
regain dir		SEG2	
deconvolution dir		SEGY Multichannel	
work dir		SEGY Multichannel Multiplex	× i
whiten dir			
nmo dir			

2) The infomain.dat and infochannels.dat are made similarly to the 3D Radar non-SEGY data. With infomain.dat active, the SEGY Demultiplex button is clicked which will separate each channel into its own SEGY file in the \raw\ folder:

fochannels.dat ^		profile name		x offset	y offset	z offset	GPS/NAV	divis
ifomain.dat v	1	2019-10-08-001 - Region1.sgy	c	0.	0.	0.	0.	
Information data	2		С					
infomain.dat save edits	3		С					Г
save edits	4		с		- i			
add xoff add yoff name +	5		- c	-				- F
2 add zoff add col4 name -			_	-		<u> </u>		-
times xoff times xoff insert	6		C	-	_		_	
times yoff times col4 delete	7		С					
rotate append chr del Nth	8		С					
el minGPS del chnnels	9	SEGY Multichannel Multiplex X	С					
	10		0		-		-	-
	10	** demultiplexing 20 SEGY channels	- c	-		_	-	
			_		_		_	_
segy get Nscan-1 segy get ts	12		C		_	_	_	
segy demultiplex	13	ОК	С					
ascii	14		С					
unicode segy to nav	15		c				_	- E
nmea to utm segy to nav2	16		- >				-	- E
nmea to nav  Gig endian				`			-	1000
C little endian	17			12 <u></u>	_			
brwse x0x1y0y1 nav scalar 1	18	** infochannels.dat SEGY demultiplexed file writ	ten					
xyz to nav  segy utm	19							
gps update list C segy lat/lon	20							
Il to utm show gps file	21	ОК						- E
gps get yaw show file header			C	r		-		
3F- 3 )	22		_			<u></u>		
Ang, X, Y, XY to GPS or Vector	23		С					
	24		C					
unit/marker 1	25		С					Г
time window (ns) 29.808				1	1	1		
samples/scan 369		next> <prev r<="" sort="" td=""><td></td><td>x0 to x1</td><td></td><td></td><td>ort y y0 to y</td><td></td></prev>		x0 to x1			ort y y0 to y	
resampled scans/mark 25		del odd			x	1 to y0	rev fil	e
binary C 8 bit		del even						
resol. <ul> <li>16 bit</li> <li>32 bit</li> </ul>		recover	x0-e			georeference in		
xy ^				north 0	** s	tart/end utm of	file 1	
Survey type: ang GPS ~		adjust to single marker @ 0	x1-e	east 0				
UPO *			y1-i	north 0	ut	m zone 31		

# 3) With infochannels.dat active the SEGY to NAV button is clicked to write the GPS navigation files from the SEGY trace headers:

nfo.dat nfobak.dat		^		profile name			x offset	y offset	z offset	GPS/NAV	divisio
fochannels.d	at	~	1	1-2019-10-08-001 -	Region1.sgy	C	0.	0.	0.	2947.	
			2	2-2019-10-08-001 -	Region1.sgy	с	0.	0.	0.	2947.	
infochanne			3	3-2019-10-08-001 -	Region1.sgy	c	0.	0.	0.	2947.	_
save edit	s		4	4-2019-10-08-001 -	Region1.sgy	c	0.	0.	0.	2947.	- E
	off add yoff	name +	5	5-2019-10-08-001 -	Region1.sgy	c	0.	0.	0.	2947.	
-	off add col4	name -	6	6-2019-10-08-001 -	Region1.sgy	- C	0.	0.	0.	2947.	
times xoff	times xoff	insert	7	7-2019-10-08-001 -		-	0.	0.	0.	2947.	
times yoff rotate	times col4 append chr	delete del Nth	8	8-2019-10-08-001 -	<u> </u>	C	0.	0.	0.	2947.	
del minGPS	del chnnels		9	9-2019-10-08-001 -		- C	0.	0.	0.	2947.	- <u>-</u>
			10	10-2019-10-08-001	0,0,	- 0	0.	0.	0.	2947.	- 2
			10	11-2019-10-08-001		- c	0.	0.	0.	2947.	
				12-2019-10-08-001	0 0,		0.	0.	0.	2947.	
segy get Nso	an-1 seg	y get ts	12	13-2019-10-08-001		-	0.	0.	0.	2947.	
	segy	demultiplex	13	A CONTRACTOR OF CONTRACTOR	0.07		0.	0.	0.	2947.	
ascii			14	14-2019-10-08-001		- 0	0.	0.	0.		
o unicode		y to nav	15	15-2019-10-08-001		_ C			100	2947.	
nmea to u nmea to n		y to nav2	16	16-2019-10-08-001		0	0.	0.	0.	2947.	
ninea to n	C little		17	17-2019-10-08-001	0	_ C	0.	0.	0.	2947.	
brwse x0x1			18	18-2019-10-08-001		C	0.	0.	0.	2947.	
xyz to na	v 🖲 segy	utm	19	19-2019-10-08-001	0 0,	С	0.	0.	0.	2947.	
gps update	list C segy	lat/lon	20	20-2019-10-08-001	- Region1.sgy	С	0.	0.	0.	2947.	
II to utm		w gps file	21			С					
gps get ya	aw show	file header	22		SEGY XY Header Navigation	×	1				
Ang X V	XY to GPS o	r Vector	23								
Ally, A, I			24		SEGY *.sgy.gps files generated	t					
	unit/marke		25								
un	ne window (ns samples/scar			next> <prev< td=""><td>ОК</td><td></td><td>x0 to x1</td><td>sort x</td><td>x &gt;&gt; y   so</td><td>orty v0 to y</td><td>v1  </td></prev<>	ОК		x0 to x1	sort x	x >> y   so	orty v0 to y	v1
resample	ed scans/mar	x 25		del odd	UK UK				(1 to y0	rev fil	
binar				del even		(	-				
reso	I TO DIL	○ 32 bit		recover		x0-ea			georeference in		
Current of	xy type ang	^				y0-n		** 9	start/end utm of	file 1	
Survey	type: GPS	÷		adjust to single	marker @ 0	x1-ea			tm zone 31		

## IDS Stream X, C, UP and DP

The basic processes for the IDS Stream and their family of different multichannel GPR systems (including the X, C, UP and DP systems) are:

1) Click the "Import – Create Info" button in the Create Info File menu with the multichannel general highlighted in the navigation listbox. This will automatically create 2 information files, infomain.dat which has the names of the main track radargrams, and infochannels.dat which contains the names of the individual channel radargrams with all the X and Y offsets properly noted and stored. Different X and Y offset may be needed for different IDS systems not listed here. Configurations for IDS Stream X, C, UP and DP and the HH and VV channels are also given in the next few screen shots as well.

**IDS Stream X configuration:** For a IDS Stream X there are 15 channels at approximately 12 cm separation between channels.

Create Information File: c:\kisatchie\stream-demo\					- 🗆 ×
filename infochannels.dat Create Info	profile name	x offset	y offset	z offset	GPS/Nav
# of files 6	LI010001.dt	0.	0.	0.	0.
file identifier bes000 (eg. file_000)	LI010002.dt	0.	0.	0.	0.
file extension .dt	LI010003.dt	0.	0.	0.	0.
gps file ext .gps	LI010004.dt	0.	0.	0.	0.
gps nmea SGPGGA 💌	LI010005.dt	0.	0.	0.	0.
	LI010006.dt	0.	0.	0.	0.
name increment 1					
Cx Cy Cxy C ang © GPS C vector					
X start 0 X end 0					
Y start 0 Y end 0	IDS Stream	×			
unit/marker 1 time window ns 100	infomain.dat and infochannels.dat profile information files generated				
samples/scan 512 resampled scans/mrk 25					
		1			
binary resol. ○ 8 bit ● 16 bit ○ 32 bit	ОК				
file list					
append name infochannels.dat Append					
Import - Create Info					
*.* file extension					
*.* file identifier + extension *.* multichannel general					
vector_survey_information.dat					
Ntracks 6 y offset37 x offset		PS)			
offset file Nchannels 15 z offset 0 x start	.84 help set				
channel 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15					
x offsets 0.84,0.72,0.6,0.48,0.36,0.24,0.12,0.,-0.12,-0.24,-0.36,-0.48,-0.6,-0.72					
y offsets -0.37,-0	-0.37,-0.37,-0.37			_	
z offsets 0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0				_	
11 0110010					

**IDS Stream C - VV configuration:** For a IDS Stream C there are 23 channels of VV polarization at approximately 4.4 cm separation between channels.

filename infomain.dat		Create Info	n	ofile name		x offset	y offset	z offset	GPS/Na
# of files 15		Create Into	P	onic nume		X Oliget	yonser	Zonoci	OI OI III
ile identifier 37rd	(8	g. file_000)							
e extension dt		g. mo_000)							
gps file ext .gps	-								
gps nmea \$GPGGA	-								
name increment 1	_								
name increment 1 name start 1	-								
	5 5								
$- \square H \not\land$	2 2								
	GPS C vector								
x cy cxy cang	GPS C vector								
tart 🚺 X end	0								
	V								
tart 0 Y end	0								
unit/marker 1	time window ns	54							
samples/scan 512 r	sampled scans/mrk 2	25							
	2 L								
oinary resol. ⊂ 8 bit @ 16	bit C 32 bit								
file list	-								
opend name infomain.dat	Append								
file extension		<ul> <li>Import - Creat</li> </ul>	e Info						
file identifier + extension									
multichannel general			next>						
ctor_survey_information.dat		· -	<prev< td=""><td></td><td></td><td></td><td></td><td></td><td></td></prev<>						
Ntrack		-	n effect	-	<b>F</b> -1	000			
Nuace Nchan		offset .25 offset 0	x offset .0434 x start058		I zig-zag (x or y	surveys/non-GPS)			
ffset file	neis 23 20	bilset 0	x start  058	help set					
	7, 8, 9, 10, 11, 12, 13,								
						4,0.6798,0.7232,0.7666,0	.81,0.8534,0.896	18	
ffsets 0.25.0.25.0.25.	0.25,0.25,0.25,0.25,0.2	25,0.25,0.25,0.25,0.25	0.25,0.25,0.25,0.2	5,0.25,0.25,0.25,0.25,	0.25,0.25,0.25				
	0.,0.,0.,0.,0.,0.,0.,0.								

**IDS Stream C HH configuration:** For a IDS Stream C there are 9 channels of HH polarization at approximately 9.6cm separation between channels.

filename infomain.dat	-	profile	name		x offset	y offset	z offset	GPS/Nav
# of files 0	Create Info	profile	name		X Oliset	y onset	2 Uliset	GFO/Nav
le identifier 37rd	(eg. file_000)							
e extension .dt	(eg. me_000)							
gps file ext _gps gps nmea \$GPGGA								
gps lillea SGPGGA -								
•								
name increment 1								
name start 1	-							
=								
х су сxy с ang е GPS с ve	ector							
Next Ca								
tart 0 X end 0								
tart 0 Y end 0								
L								
unit/marker 1 time window	v ns 10							
samples/scan 0 resampled scans	mrk 25							
	1111 25							
pinary resol. ⊂ 8 bit								
file list	7							
	_							
opend name infomain.dat Apr	pend							
· · · · · · · · · · · · · · · · · · ·								
	<ul> <li>Import - Creat</li> </ul>	e Info						
file extension								
file identifier + extension								
ctor survey information.dat	v -	next>						
		<prev< td=""><td></td><td></td><td></td><td></td><td></td><td></td></prev<>						
Ntracks 0	y offset .13	x offset .096		zig-zag (x or y surve)	/s/non-GPS)			
ffset file Nchannels 9	z offset 0	x start 0	help set					
nnel 25,26,27,28,29,30,31,32,33	1							
fsets 0.8,0.701,0.6,0.501,0.402,0.30	0 202 0 101 0 002							
ffsets 0.432,0.432,0.432,0.432,0.432,0.432,								
	,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0	1						

**IDS Stream UP – 200MHz/IDS Stream DP - HH configuration:** For a IDS Stream UP with 200 MHz antennae there are 10 channels in this example. On clicking the Import – Create Info button the software will indicate how many channels are contained in the \*.ogpr format. (Note, Stream UP and Stream DP have a self contained format with navigation and radargrams included in the \*.ogpr format. IDS Stream – HH configuration should use the IDS Stream UP – 200MHz equipment type)

filename	infomain.dat	Create Info	profile	e name	x offset	y offset	z offset	GPS/Nav
# of files	14	c.cato into	Swath001_	Array01.ogpr	0.	0.	0.	0.
file identifier	file000	(eg. file_000)	Swath002_	Array01.ogpr	0.	0.	0.	0.
le extension	.ogpr		Swath003	Array01.ogpr	0.	0.	0.	0.
gps file ext	.gps		Swath004	Array01.ogpr	0.	0.	0.	0.
gps nmea	\$GPGGA -			Array01.ogpr	0.	0.	0.	0.
name increr	mont 4			Array01.ogpr	0.	0.	0.	0.
name			_	Array01.ogpr	0.	0.	0.	0.
		-		Array01.ogpr	0.	0.	0.	0.
=	# A L L		_	Array01.ogpr	0.	0.	0.	0.
хсу	Cxy Cang ∈ GPS Cve	ctor		Array01.ogpr	0.	0.	0.	0.
			_	Array01.ogpr	0.	0.	0.	0.
tart 0	X end 48		_	Array01.ogpr	0.	0.	0.	0.
tart 0	Y end 24		_	Array01.ogpr	0.	0.	0.	0.
1			ondatio to_	i iliujo i ogpi	0.	0.	0.	<b>v</b> .
	n 512 resampled scans/		IDS Stream UP - 60	00 X coppr file	0.	0.	0.	0.
samples/sca	n 512 resampled scans/ 8 bit • 16 bit • 32 bit	mrk 25			0.	0.	0.	0.
samples/sca binary resol. file list	resampled scans	mrk 25		ected in the IDS Stream UP 600MHz *.ogpr file	0.	0.	0.	0.
samples/sca binary resol. file list opend name file extensioi	resampled scans/ 8 bit © 16 bit © 32 bit infomain.dat App	mrk 25	10 channels dete	ected in the IDS Stream UP 600MHz * ogpr file			0.	0.
samples/sca binary resol. ( file list ppend name file extension file identifier multichanne	n 512 resampled scans/ 8 bit  16 bit  32 bit infomain.dat + extension	mrk 25	10 channels dete	ected in the IDS Stream UP 600MHz * ogpr file OK IDS Stream UP - 600				0.
samples/sca pinary resol. ( file list opend name file extension file identifier multichanne stor_survey_	infomain.dat App exercision	mrk 25	te Info	ected in the IDS Stream UP 600MHz * ogpr file OK IDS Stream UP - 600	iles generated		0.	0.
amples/sca inary resol, dinary resol, file list ipend name file extension file identifier multichanne multichanne fiset file	resampled scans/ 8 bit  16 bit  32 bit infomain.dat restension reneral Information.dat Ntracks 14 Ntracks 14 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	y offset 0	te Info next> <pre> x offset 0 </pre>	ected in the IDS Stream UP 600MHz *.ogpr file OK IDS Stream UP - 600 infomain.dat and infochannels.dat profile information f	iles generated			0.
amples/sca inary resol. ( file list upend name file extension file identifier multichanne tor_survey_ ffset file _ nnel fsets _	512         resampled scans/           8 bit         6 16 bit         32 bit           infomain.dat         April           + extension information.dat         April           1. (ceneral information.dat         10           1. 2, 3, 4, 5, 6, 7, 8, 9, 10         0, 0, 0, 0, 0, 0, 0, 0.	y offset 0	te Info next> <pre> x offset 0 </pre>	ected in the IDS Stream UP 600MHz *.ogpr file OK IDS Stream UP - 600 infomain.dat and infochannels.dat profile information f	iles generated			
samples/sca binary resol. ( file list ppend name file extension file identifier multichanne ctor_survey_ offset file annel fifsets	resampled scans/ 8 bit  16 bit  32 bit infomain.dat restension reneral Information.dat Ntracks 14 Ntracks 14 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	y offset 0	te Info next> <pre> x offset 0 </pre>	ected in the IDS Stream UP 600MHz *.ogpr file OK IDS Stream UP - 600 infomain.dat and infochannels.dat profile information f	iles generated	0.	0.	0.

**IDS Stream UP – 600MHz/IDS Stream DP - VV configuration:** For a IDS Stream UP with 200 MHz antennae there are 19 channels in this example. On clicking the Import – Create Info button the software will indicate how many channels are contained in the \*.ogpr format. The IDS Stream DP VV (Note, Stream UP and Stream DP have a self contained format with navigation and radargrams included in the \*.ogpr format. IDS Stream DP – VV configuration should use the IDS Stream UP – 600MHz equipment type)

Create Informat	tion File: d:\gpr multichannel\stream u	/dn dr							- 🗆 ×
filename	infomain.dat	Create Info		profile nar	ne	x offset	y offset	z offset	GPS/Nav
# of files	13			Swath001_Arra	y02.ogpr	0.	0.	0.	0.
file identifier	file000	(eg. file_000)		Swath002_Arra	y02.ogpr	0.	0.	0.	0.
file extension	.ogpr			Swath003_Arra	y02.ogpr	0.	0.	0.	0.
gps file ext	.gps			Swath004_Arra	y02.ogpr	0.	0.	0.	0.
gps nmea	\$GPGGA 💌			Swath005_Arra	y02.ogpr	0.	0.	0.	0.
name incren	nent 1			Swath006_Arra	y02.ogpr	0.	0.	0.	0.
name s				Swath007_Arra	y02.ogpr	0.	0.	0.	0.
				Swath008_Arra	y02.ogpr	0.	0.	0.	0.
	$\mp \mp \lesssim \lesssim$			Swath009_Arra	y02.ogpr	0.	0.	0.	0.
сх су	⊂xy ⊂ ang ∈ GPS ⊂ vecto	or		Swath010 Arra	y02.ogpr	0.	0.	0.	0.
V start	V and 1			Swath011_Array	y02.ogpr	0.	0.	0.	0.
X start 0	X end 48			Swath012_Arra	y02.ogpr	0.	0.	0.	0.
Y start 0	Y end 24			Swath013_Arra	y02.ogpr	0.	0.	0.	0.
unit/marks	time window o								
unit/marke				IDS Stream UP - 20	0 ×				
samples/scar	n 512 resampled scans/mr	k 25							
binary resol.	0 8 bit ● 16 bit © 32 bit			19 channels deter	cted in the IDS Stream UP 200MHz *.ogpr file				
file list	•								
					OK				
							-		
append name	infomain.dat Appen	nd			IDS Stream UP - 200	>	<		
		Import - Create	. Infe		-				
*.* file extension		Import - Create			infomain.dat and infochannels.dat profile information	files generated			
*.* file identifier *.* multichannel		_							
vector_survey_i		-	next> <prev< td=""><td></td><td></td><td>ОК</td><td></td><td></td><td></td></prev<>			ОК			
	Ntracks 13 Nchannels 19	y offset 0 z offset 0	x offset x start	0	☐ zig-zag (x or y surveys/nor	-GPS)			
offset file				U	help set				
	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,								
	0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0							_	
	0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0.,0								
tr offsets									

2) For IDS Stream X and C: The next step is to work directly on the infochannels.dat file in the Edit Info File menu. Recent IDS Stream operation now generate \*.geox files with every radargram. Clicking the IDS Stream Geox button will read these files and place into \*.dt.gps format using this systems array navigation. (The GEOX files are the manufacturers navigation solution.

o.dat 🔨	profile nam	e		x offset	y offset	z offset	GPS/N/	AV divi
obak.dat ochannels.dat 🗸	1 LI010001.dt		С	-0.81	0.	0.	496.	- r
	2 LI020001.dt		С	-0.69	0.	0.	496.	- <sub>-</sub>
infochannels.dat	3 LI030001.dt		С	-0.57	0.	0.	496.	- r
save edits	4 LI040001.dt		С	-0.45	0.	0.	496.	- r
add xoff add yoff name +	5 LI050001.dt		С	-0.33	0.	0.	496.	- r
add zoff add col4 name -	6 LI060001.dt		С	-0.21	0.	0.	496.	- r
imes xof times yof insert	7 LI070001.dt		С	-0.09	0.	0.	496.	- r
imes zof times c4 delete	8 LI080001.dt		с	0.03	0.	0.	496.	- r
rotate append chr del Nth del channels	9 LI090001.dt		С	0.15	0.	0.	496.	- E
der channels	10 LI100001.dt		С	0.27	0.	0.	496.	- <sub>-</sub>
	11 LI110001.dt		С	0.39	0.	0.	496.	- <sub>-</sub>
	12 LI120001.dt		С	0.51	0.	0.	496.	
IDS get xy IDS get ts				0.01			< 496.	
	14 LI140001.	DS Stream				,	496.	
ascii Array to nav	15 LI150001.						496.	
unicode IDS geox	16 LI010002.						507.	
nmea to utm IDS gec	17 LI020002.	IDS Stream *.*.gps ma	de	from ge	ox naviga	ation	507.	
nmea to nav IDS Sstamp utm	18 LI030002.						507.	
rwse x0x1y0y1 IDS Sstamp nav	19 LI040002.						507.	
xyz to nav fix stream nav	20 LI050002.						507.	
gps update list Il to utm	21 LI060002.				O		507.	
gps get yaw show gps file	22 LI070002						507.	
	23 LI080002.dt		c	0.03	0.	0.	507.	
Ang, X, Y, XY to Vector			c	0.05	0.	0.	507.	
unit/marker 1			c	0.15	0.	0.	507.	
time window (ns) 100	25  LI100002.dt		5	0.27	0.	0.	1007.	
samples/scan 512	next>	<prev r<="" sort="" td=""><td></td><td>x0 to x1</td><td></td><td></td><td></td><td>o y1</td></prev>		x0 to x1				o y1
resampled scans/mark 25	del odd	1			X	1 to y0	rev	file
binary C 8 bit resol. I 16 bit C 32 bit	del even							
	recover							

2a) For IDS Stream X and C: Optional method for generating GPS navigation files is to click the IDS Gec button with infomain.dat highlighted. This will generate the navigation on the main track – channel 1 file.

Edit Inform	ation File:	c:\ki	satchie\stream-demo\inf	omain	.dat		1		×
nfochannelseditedit.d nfoflip.dat	lat 🔨		profile name		x offset	y offset	z offset	GPS/NAV	divisio
nfomain.dat	<b>~</b>	1	LI010001.dt	C	0.	0.	0.	12.	Г
		2	LI010002.dt	C	0.	0.	0.	12.	F
infomain.dat		3	LI010003.dt	С	0.	0.	0.	12.	
save edits		4	LI010004.dt	c	0.	0.	0.	13.	Г
add xoff add	voff name +	5	LI010005.dt	c	0.	0.	0.	13.	
1 add zoff add o		6	LI010006.dt	c	0.	0.	0.	13.	Г
times xof times y	/of insert	7		c	-		-		Е
times zof times o		8	2 <u></u>	c					Г
rotate append		9		c	-			-	Г
	del channels	10			-				E
		11	1 :						Ē
		12	12						E
IDS get xy	IDS get ts	12	1		-				Ē
		105							Ē
		14	l <u>.</u>						Ē
°ascii `unicode	Array to nav	15			-				
nmea to utm	IDS gec	16				ļ			<u> </u>
	S Sstamp utm	17		<u></u>					
	S Sstamp nav	18	<u></u>	C					
xyz to nav fi	ix stream nav	19		c					
gps update list		20		C					
II to utm		21		С					
gps get yaw	show gps file	22		C					
Ang, X, Y, XY t	a Vactor	23		C					Γ
		24		C					
unit/ma		25		C					Г
time window samples/:	And a second		next>   <prev r="" sort="" td=""  =""  <=""><td></td><td>x0 to x1</td><td>sort x   x</td><td>&gt;&gt; y   so</td><td>nty   y0 to y</td><td>al</td></prev>		x0 to x1	sort x   x	>> y   so	nty   y0 to y	al
resampled scans/r					X0 10 X1		1 to y0	rev file	
binary C 8	Sector States and Sector States		del odd						
resol. (• 10	6 bit 🤉 32 bit		del even						
	у ^		sort multichannel						
	xy ang		adjust to single marker @ 0	-					
	GPS V								

2b) IDS Stream X and C: After generating the main track, which can be edited if necessary in the GPS Track menu, the button Array to Nav is clicked with infochannels.dat file highlighted in the Edit Info File menu:

Edit Inforn	nation File:	c:\kisatch	nie\stream-demo\	infochanı	nels.dat		-		×
info.dat infobak.dat	^	profil	e name		x offset	y offset	z offset	GPS/NAV	divisio
infochannels.dat		1 LI010	001.dt	C	-0.81	0.	0.	12.	
		2 LI020	001.dt	С	-0.69	0.	0.	12.	Γ
infochannels.dat		3 LI030	001.dt	С	-0.57	0.	0.	12.	
save edits		4 LI040	001.dt	С	-0.45	0.	0.	12.	
add xoff add	d yoff name +	5 LI050	001.dt	С	-0.33	0.	0.	12.	
-1 add zoff add		6 LI060	001.dt	С	-0.21	0.	0.	12.	
times xof times		7 LI070	001.dt	C	-0.09	0.	0.	12.	
times zof times		8 LI080	001.dt	c	0.03	0.	0.	12.	Г
rotate append	d chr del Nth del channels	9 LI090	001.dt	C	0.15	0.	0.	12.	
	der enamiers	10 LI100	001.dt	c	0.27	0.	0.	12.	Г
		11 LI110	IDS Stream					×	Г
	Array to nav IDS geox IDS gec DS Sstamp utm	13 L1130 14 L1140 15 L1150 16 L1010 17 L1020 18 L1030	LI010001.dt - LI1	50006.dt *	.gps navi	gation file			
brwse x0x1y0y1   xyz to nav	IDS Sstamp nav fix stream nav	19 LI040	o				OK		Г
gps update list	IX Stream nav	20 LI050	0						Г
Il to utm		21 LI060	002.dt	c .	-0.21	0.	0.	12.	Г
gps get yaw	show gps file	22 LI070	002.dt	C	-0.09	0.	0.	12.	Г
		23 LI080	002.dt	С	0.03	0.	0.	12.	Г
Ang, X, Y, XY	to vector	24 LI090	002.dt	c	0.15	0.	0.	12.	Г
	marker 1	25 LI100	002.dt	С	0.27	0.	0.	12.	
	s/scan 512	del rec	tt>   <prev r="" sort=""  =""  <br="">l odd even cover sort multichannel   just to single marker @ 0</prev>		x0 to x1   :		>> y so 1 to y0	rty   y0 to y rev file	

\*\*\* Note: For IDS Stream C equipment, channels VV channels will have often twice as many recorded scans as the HH channels. Because the IDS navigation for GPS is tied to channel 1, the master navigation file has scan numbers for NMEA strings that are twice as many scan positions as that in the HH channels.

The button Fix Stream Nav should be clicked to correct for the navigation for the HH channels – which divides the scan number in the master navigation files by 2. It is unusual application in any multichannel equipment, but necessary since this manufacturer records different scan lengths for different channels.

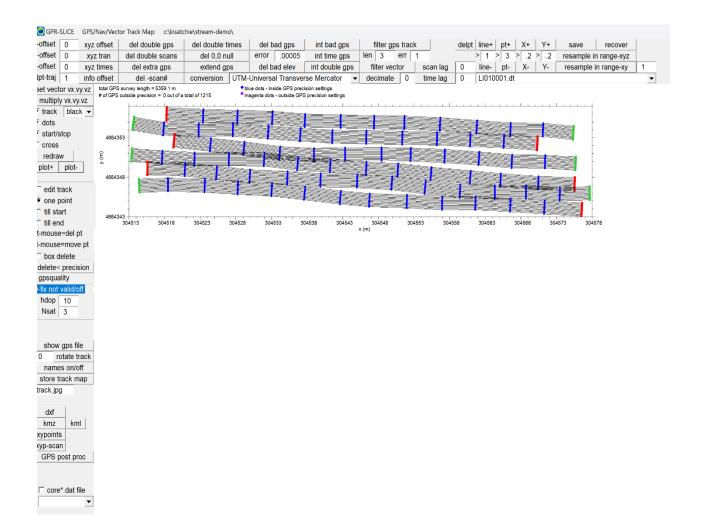
2a) IDS Stream UP and DP: Individual channels need to be extracted from the \*.ogpr format using the Stream UP extract operation. The will also automatically create the \*.GPS files for each individual channel.

ochannelseditvv.dat ochannelsvv.dat	profile name		x offset	y offset	z offset	GPS/NAV	division
omain.dat	1 Swath001_Array01.ogpr	(	0.	0.	0.	0.	
	2 Swath002_Array01.ogpr	(	0.	0.	0.	0.	
infomain.dat	3 Swath003_Array01.ogpr	(	0.	0.	0.	0.	
save edits	4 Swath004_Array01.ogpr	(	0.	0.	0.	0.	
add xoff add yoff name +	5 Swath005 Arrav01 odpr	(	0.	0.	0.	0.	
add zoff add col4 name -	IDS Stream UP Extract	(	0.	0.	0.	0.	- Γ
imes xoff times yoff insert imes zoff times col4 delete	input radargram		0.	0.	0.	0.	- E
rotate append chr del dn	Swath001_Array01.ogpr		0.	0.	0.	0.	- E
el minGPS del chnnels del up			0.	0.	0.	0.	- E
	channel radargrams *1- 19		0.	0.	0.	0.	- E
	swath001_array01-1, 19.ogpr			0.	0.	0.	
	processing scan			0.	0.	0.	- E
Stream UP extract	7213 geo-locations			0.	0.	0.	
"			0.	0.	0.	0.	
ascii unicode	cancel			0.	0.	0.	
nmea to utm				0.	0.	0.	
nmea to nav	1/ Swathut/_Altayut.ogpi			0.	0.	0.	
	18 Swath018_Array01.ogpr			0.	0.	0.	
prwse x0x1y0y1	19 Swath019_Array01.ogpr			0.	0.	0.	
xyz to nav gps update list	20 Swath020_Array01.ogpr			0.	0.	0.	
It to utm show gps file	21 Swath021 Array01.ogpr			0.	0.	0.	
gps get yaw show file header	22 Swath022_Array01.ogpr			0.	0.	0.	
GPS to XY	23 Swath023_Array01.ogpr			0.	0.	0.	
Ang, X, Y, XY to GPS or Vector	24 Swath024 Array01.ogpr			0.	0.	0.	
unit/marker 1	25 Swath025 Array01.ogpr			0.	0.	0.	
time window (ns) 39.894				1			
samples/scan 320	next> <prev r<="" sort="" td=""><td>x0 to x1</td><td></td><td>&gt;&gt; y sor</td><td></td><td></td><td></td></prev>	x0 to x1		>> y sor			
resampled scans/mark 25 binary C 8 bit	del odd		X1	to y0	rev file		
resol. <ul> <li>16 bit</li> <li>32 bit</li> </ul>	del even	x0-east 0	a	eoreference inf	0		
xy	recover	y0-north 0		rt/end utm of fi			
Survey type: ang		x1-east 0					

2b) IDS Stream UP and DP: After the extract operation is done the infochannels.dat file is then highlighted and the button GPS Update List is clicked to compile the number of GPS listings for each channel. The \*.ogpr contains navigation for each channel which is extracted.

o.dat obak.dat				profile name			x offset	y offset	z offset	GPS/NAV	division
ochannels.dat			1	swath001_array01-1.ogpr		0	0.	0.	0.	447.	
[			2	swath001_array01-2.ogpr		- c	0.	0.	0.	447.	
infochannels.dat save edits		3	swath001_array01-3.ogpr		- C	0.	0.	0.	447.		
		4	swath001_array01-4.ogpr		- c	0.	0.	0.	447.		
add xoff a	-	name +	5	swath001_array01-5.ogpr		- c	0.	0.	0.	447.	
add zoff a times xoff	dd col4	name - insert	6	swath001_array01-6.ogpr		- c	0.	0.	0.	447.	
	s col4	delete	7	swath001_array01-7.ogpr		- c	0.	0.	0.	447.	
	end chr	del dn	8	swath001_array01-8.ogpr		- c	0.	0.	0.	447.	
el minGPS del c	hnnels	del up	9	swath001_array01-9.ogpr		- c	0.	0.	0.	447.	
		10	swath001_array01-10.ogpr		- c	0.	0.	0.	447.		
			11	swath001_array01-11.ogpr		- c	0.	0.	0.	447.	
Stream UP extract		12	swath001_array01-12.ogpr		- c	0.	0.	0.	447.		
		13	swath001_array01-13.ogpr		- c	0.	0.	0.	447.		
ascii			14	swath001_array01-14.ogpr		- c	0.	0.	0.	447.	- E
unicode			15	swath001_array01-15.ogpr		- c	0.	0.	0.	447.	
nmea to utm	1		16	swath001_array01-16.ogpr		- c	0.	0.	0.	447.	
nmea to nav	]		17	swath001_array01-17.ogpr		- c	0.	0.	0.	447.	
	1		18	swath001_array01-18.ogpr		- c	0.	0.	0.	447.	_
brwse x0x1y0y1			19	swath001 array01-19.ogpr		- c	0.	0.	0.	447.	- <u>-</u>
xyz to nav gps update list	1		20	swath002 array01-1.ogpr		- c	0.	0.	0.	781.	- <u>-</u>
II to utm	show	gps file	21	swath002_array01-2.ogpr		- 0	0.	0.	0.	781.	- E
gps get yaw		ile header	22	swath002 array01-3.ogpr		- 0	0.	0.	0.	781.	
GPS	to XY		23	swath002 array01-4.ogpr		- 0	0.	0.	0.	781.	
Ang, X, Y, XY to	o GPS or	Vector	24	swath002_array01-5.ogpr		- 0	0.	0.	0.	781.	
un	it/marker	1	25	swath002_array01-6.ogpr		-0	0.	0.	0.	781.	- E
time window (ns) 39.892 samples/scan 320 resampled scans/mark 25 binary			next> <prev r<br="" sort="">del odd del even</prev>	x0 to x1		x = x1	>> y sort	rev file			
Survey type	ху			recover adjust to single marker @ 0	y0-north 0 x1-east 0			eoreference info t/end utm of fil			

#### An example of an IDS Stream X GPS track is shown below.



After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for generalized signal processing for all multichannel GPR and how to compile these data to a 3D volume.

#### Impulse Radar - Raptor

The basic processes for the 16 channel Impulse Radar Raptor multichannel system are:

- Use the "help set" with the channel descriptions including, Nchannels, xoffset, xstart set to the appropriate values. This will create the channel names and their offsets. Note, these values can be customized and edited manually should the channel separations or naming convention be different.
- Click the "Import Create Info" button in the Create Info File menu with the \*.\* multichannel general highlighted. This will create the infomain and infochannel information files.

Create Information File: c:\multichannel\impulse radar raptor					- 0
filename infochannels.dat Create Info	profile name	x offset	y offset	z offset	GPS/Nav
# of files 5	Ingo_001_A01.iprb	0.	0.	0.	0.
le identifier buried_objects_ydir_bscan_ (eg. file_000)	Ingo_002_A01.iprb	0.	0.	0.	0.
extension .iprb	Ingo_003_A01.iprb	0.	0.	0.	0.
gps file ext .cor	Ingo 004 A01.iprb	0.	0.	0.	0.
gps nmea \$GPGGA  rdinate sys UTM-Universal Transverse Mercator	Ingo_005_A01.iprb	0.	0.	0.	0.
	·				
name increment 1					
cy cxy c ang e GPS c vector					
art 0 X end 0					
art 0 Yend 0					
	Impulse Radar Raptor Multichannel	X			
unit/marker 1 time window ns 78,711	<ul> <li>Contraction of the second state o</li></ul>				
	informin det end infortennele det svefile information	- files approved			
	infomain.dat and infochannels.dat profile information	n files generated			
amples/scan 403 resampled scans/mrk 25	infomain.dat and infochannels.dat profile information	n files generated			
amples/scan 403 resampled scans/mrk 25 inary resol. © 8 bit © 16 bit © 32 bit	infomain.dat and infochannels.dat profile information	n files generated			
amples/scan 403 resampled scans/mrk 25	infomain.dat and infochannels.dat profile information				
amples/scan 403 resampled scans/mrk 25 inary resol. C 8 bit @ 16 bit C 32 bit	infomain.dat and infochannels.dat profile information				
amples/scan 403 resampled scans/mrk 25 inary resol.	infomain.dat and infochannels.dat profile information				
amples/scan 403 resampled scans/mrk 25 inary resol. 6 8 bit  16 bit  25 bit file list pend name infochannels.dat Append	infomain.dat and infochannels.dat profile information				
amples/scan 403 resampled scans/mrk 25 inary resol. 6 bit 6 16 bit 32 bit file list pend name infochannels.dat Append	infomain.dat and infochannels.dat profile information				
amples/scan 403 resampled scans/mrk 25 inary resol. 8 bit 16 bit 23 bit file list pend name infochannels.dat Append radargram extension Import - Create Info	infomain.dat and infochannels.dat profile information				
amples/scan 403 resampled scans/mrk 25 pinary resol. c 8 bit  6 16 bit  32 bit file list pend name infochannels.dat Append radargram extension radargram identifier + extension multichannel general	infomain.dat and infochannels.dat profile information				
samples/scan 403 resampled scans/mrk 25 pinary resol. C 8 bit C 16 bit C 32 bit file list ppend name infochannels.dat Append radargram extension radargram identifier + extension multichannel general					
amples/scan 403 resampled scans/mrk 25 inary resol. 8 bit 16 bit 32 bit file list information dat for_survey_information.dat Ntracks 5 v offset 0	ext>				
amples/scan 403 resampled scans/mrk 25 inary resol. 6 bit 6 16 bit 6 32 bit file list pend name infochannels.dat Append adargram extension adargram identifier + extension multicharmel general for_survey_information.dat mma delimited Ntracks 5 y offset 0 Ntracks 5 z offset 0	ext>				
amples/scan 403 resampled scans/mrk 25 inary resol. 6 bit • 16 bit • 32 bit file list pend name infochannels.dat Append adargram extension adargram identifier + extension nullichannel general or_survey_information.dat mma delimited Ntracks 5 y offset 0 tset file 16 v offset 0 tset file 2 offset 0	ext> prev x offset				
amples/scan 403 resampled scans/mrk 25 inary resol. 6 bit 6 bit 32 bit file list pend name infochannels.dat Append adargram extension adargram identifier + extension moltchannel general tor_survey_information.dat nma delimited Ntracks 5 y offset 0 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	x offset x start64 help set				
amples/scan 403 resampled scans/mrk 25 inary resol. 6 bit • 16 bit • 32 bit file list • 16 bit • 32 bit pend name infochannels.dat Append adargram identifier + extension adargram identifier + extension multichannel general tor_survey_information.dat • 0 0 0 fiset file 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 -0.64,-0.555,-0.47,-0.385,-0.3,-0.215,-0.13,-0.045,0.04,0,125,0.	x offset x start64 help set				
amples/scan 403 resampled scans/mrk 25 pinary resol. c 8 bit  6 16 bit  32 bit file list pend name infochannels.dat Append radargram extension radargram identifier + extension multichannel general tor_survey_information.dat mma delimited Ntracks 5 y offset 0 ffset file 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	x offset x start64 help set				

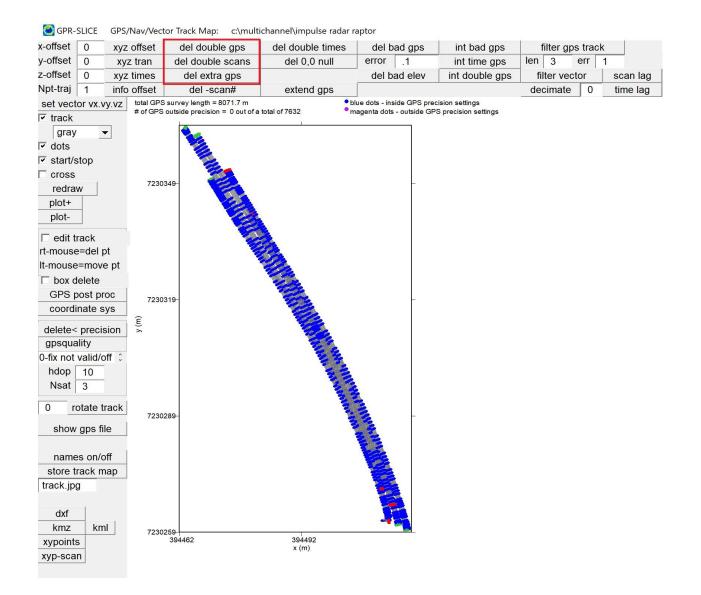
3) In the Edit Info File menu, click the "Raptor to utm" button with infomain.dat active to create the main track navigation. If navigation errors are reported those can be fixed in the GPS track first.

🕙 Edit Informati	ion File: c:\m	ultichannel\im	oulse radar raj	ptor\infomain.dat						-	
infochannels.da infochannelsed		^		profile name			x offset	y offset	z offset	GPS/NAV	division
infomain.dat	nt.uat	<b>~</b>	1	Ingo_001_A01.iprb	C	ſ	0.	0.	0.	128.	
			2	Ingo_002_A01.iprb	c	Ì	0.	0.	0.	116.	
infomain.dat			3	Ingo 003 A01.iprb			0.	0.	0.	86.	- F
save edite	S		4	Ingo_004_A01.iprb			0.	0.	0.	82.	
add x	off add yoff	name +		Ingo 005 A01.iprb			0.	0.	0.	60.	
	off add col4	name -	5	Ingo_005_A01.ipib		-	0.	0.	0.		
times xof	times yof	insert	6		c						
times zof	times col4	delete	7		0						
rotate	append chr	del Nth	8		C						
del minGPS	del chnnels		9		C						
			10		0				-	-	
Raptor to u	tm Ran	otor get ts	11			-					 _
Raptor to n		itor got to		Impulse Radar Raptor Multichan	nel GPS files		×				
			12				_			_	
			13	GPR-SLICE v7.0 \raw\*.iprb.gps r	avigation files created	d	_				_
e ascii			14								
unicode	Arra	ay to nav	15		ОК	-					Г
nmea to ut	tm		16		OK						
nmea to na	av		17		C				-		
filter nmea	a		18			ŀ			-		
brwse x0x1y					0	-					- <u>-</u>
xyz to nav			19			-			_		-
gps update		1	20		C						
II to utm		w gps file	21		C						
gps get ya	w show	file header	22		C						
	WV to ODO -		23		c						
Ang, X, Y,	XY to GPS of	or vector	24		c						
	unit/marke	er 1	25			ł			-		- F
	e window (ns		25			ļ		1.		1	
	samples/sca			next> <prev r<="" sort="" td=""><td></td><td>)</td><td>x0 to x1</td><td></td><td>-</td><td>ort y y0 to y</td><td>/1</td></prev>		)	x0 to x1		-	ort y y0 to y	/1
	ed scans/mar	k 25		del odd				x	1 to y0	rev fil	e
binary				del even							
resor				recover		-ea			georeference in		
0	xy	^		sort multichannel		-no		** s	tart/end utm of	file 1	
Survey	type: ang			adjust to single marker @		ea					
					y1	-no	rth 0	u	tm zone 34		

4) With infochannels.dat active, the user will then click the "Array to Nav" button to calculate the individual track for each channel based on the x-offset (and y-offset if set) in the information file.

	^		profile name			x offset	y offset	z offset	GPS/NAV	divis
	×	1	Ingo_001_A01.iprb	(	-	0.64	0.	0.	128.	- -
		2	Ingo_001_A02.iprb	(	-	0.555	0.	0.	128.	
dat		3	Ingo_001_A03.iprb	(	-	0.47	0.	0.	128.	-
			Ingo 001 A04.iprb	(	-	0.385	0,	0.	128.	-
add yoff	name +		· ·			0.3	0	0	128	
add col4	name -					12.20.20			1.000000	
times yof	insert					500000000			- 2010 A.A.A.A.	
										_
	del Nth					127752522	100 100 100 100 100 100 100 100 100 100		1000000	
el chnneis		9								
		10		(						
	or get ts	11	Ingo_001_A11.iprb	(	0	.21	0.	0.	128.	
<u>,                                     </u>		12	Ingo_001_A12.iprb	(	0	.295	0.	0.	128.	
		13	Ingo_001_A13.iprb	(	0	.38	0.	0.	128.	Г
		14	Ingo_001_A14.iprb	(	0	.465	0.	0.	128.	
Arra	v to nav	15	Ingo_001_A15.iprb				0		128.	
		16	Ingo_001_A16.iprb	Impulse Radar Raptor Multichan	nel			^	128.	
		17	Ingo 002 A01.iprb						116.	- E
				Ingo_001_A01.iprb - Ingo_005_A	16.ipri	b *.gps navig	ation files created		116.	- E
'1									Terresco.	
							ОК			
									1.000	_
		(T-0)					_			
5110101	lie lieddei	22				and the second				
Y to GPS or	Vector	23		(						
		24	Ingo_002_A08.iprb	(	-	0.045	1.1111	0.	116.	
		25	Ingo_002_A09.iprb	(	0	.04	0.	0.	116.	
			nevt> cnrev	sort r	v	to v1	sort		ort v v0 to v	1
	2.2.2			ourt						
C 8 bit			del odd							
16 bit	C 32 bit			xC	-east	t 0		georeference in	nfo	
xy	^			y(	)-nort	h 0	** st	art/end utm of	file 1	
pe: ang			son mullichanr	narker @ 0	-east	t O				
	Array Array	at add yoff name + add col4 name - imes yof insert mes col4 delete opend chr del Nth el chnnels Array to nav Array to nav Array to nav 1 t show gps file show file header Y to GPS or Vector unit/marker 1 window (ns) 78.711 mples/scan 403 scans/mark 25 C 8 bit i S 32 bit xy ^ 1	add yoff       name +         add yoff       name +         add col4       name -         imes yof       insert         mes col4       delete         opend chr       del Nth         ael chnnels       9         n       Raptor get ts         11       12         12       13         14       12         15       16         16       17         1       19         1       19         1       19         1       19         1       20         show gps file       21         20       23         unit/marker       1         window (ns)       78.711         mples/scan       403         25       8 bit         * 16 bit       32 bit	iat       ingo_001_A01.iprb         iat       ingo_001_A02.iprb         iat       ingo_001_A03.iprb         add yoff       name +         add yoff       name +         add col4       name -         imes yof       insert         mes col4       delete         ppend chr       del Nth         el chnnels       ingo_001_A03.iprb         ingo_001_A06.iprb       ingo_001_A07.iprb         ingo_001_A07.iprb       ingo_001_A08.iprb         ingo_001_A07.iprb       ingo_001_A01.iprb         ingo_001_A07.iprb       ingo_001_A07.iprb         ingo_001_A01.iprb       ingo_001_A07.iprb         ingo_001_A01.iprb       ingo_001_A01.iprb         ingo_001_A01.iprb       ingo_001_A07.iprb         ingo_001_A13.iprb       ingo_001_A13.iprb         ingo_001_A13.iprb       ingo_001_A13.iprb         ingo_001_A141.iprb       ingo_002_A01.iprb         ingo_002_A01.iprb       ingo_002_A02.iprb         ingo_002_A03.iprb       ingo_002_A03.iprb         ingo_002_A03.iprb       ingo_002_A04.iprb         ingo_002_A03.iprb       ingo_002_A04.iprb         ingo_002_A04.iprb       ingo_002_A04.iprb         ingo_002_A03.iprb       ingo_002_A04.iprb	iat       Ingo_001_A01.iprb       c         iat       Ingo_001_A02.iprb       c         add yoff       name +       ingo_001_A03.iprb       c         add yoff       name +       ingo_001_A03.iprb       c         add yoff       name +       ingo_001_A04.iprb       c         imes yof       insert       ingo_001_A05.iprb       c         mes col4       delete       7       Ingo_001_A07.iprb       c         ppend chr       del Nth       8       Ingo_001_A09.iprb       c         at chnnels       9       Ingo_001_A01.iprb       c       c         1       Ingo_001_A10.iprb       c       c       c       c         1       Ingo_001_A11.iprb       c       c       c       c         1       Ingo_001_A13.iprb       c       c       c       c         1       Ingo_001_A16.iprb       ingo_001_A01.iprb       c       c       c         1       Ingo_002_A03.iprb       c       c       c       c       c         1       Ingo_002_A04.iprb       c       c       c       c       c       c         1       Ingo_002_A05.iprb       c       c       c	iat       ingo_001_A01.iprb       c       ingo_001_A02.iprb       c       ingo_001_A03.iprb         iat       ingo_001_A03.iprb       c       ingo_001_A04.iprb       c       ingo_001_A14.iprb       c       ingo_001_A14.iprb       c       ingo_001_A01.iprb       ingo_001_A01.iprb       ingo_001_A01.iprb       ingo_001_A01.iprb       ingo_001_A01.iprb       ingo_001_A01.iprb       ingo_001_A01.iprb       ingo_002_A03.iprb       ingo_002_A03.iprb       ingo_002_A03.iprb       ingo_002_A04.iprb       ingo_002_A04.iprb       ingo_002_A04.iprb       ingo_002_A04.iprb       ingo_002_A04.iprb       ingo_002_A04.iprb       ingo_002_A04.iprb       ingo_002_A04.i	Array to nav       1       Ingo_001_A01 iprb       c       -0.64         1       Ingo_001_A02 iprb       c       -0.555         3       Ingo_001_A03 iprb       c       -0.47         4       Ingo_001_A05 iprb       c       -0.33         imes yof       insert       c       -0.47         imes yof       insert       c       -0.33         imes cold       delete       ingo_001_A05 iprb       c       -0.33         1       Ingo_001_A05 iprb       c       -0.13         9       Ingo_001_A08 iprb       c       -0.045         9       Ingo_001_A09 iprb       c       -0.045         10       Ingo_001_A13 iprb       c       0.125         11       Ingo_001_A13 iprb       c       0.295         13       Ingo_001_A13 iprb       c       0.38         14       Ingo_001_A14 iprb       c       0.465         15       Ingo_001_A15 iprb       ingo_001_A01 iprb       r       0.465         14       Ingo_002_A03 iprb       ingo_001_A01 iprb       r       0.465         15       Ingo_002_A03 iprb       ingo_001_A01 iprb       r       -0.215         18       Ingo_002_A03 iprb </td <td>Ingo_001_A01.iprb         C         0.064         0.           iat         Ingo_001_A02.iprb         C         -0.655         0.           iat         Ingo_001_A03.iprb         C         -0.385         0.           iad yoff         name + add cold         ingo_001_A03.iprb         C         -0.33         0.           ingo_001_A06.iprb         C         -0.33         0.         0.         0.           imes yof         insert         Ingo_001_A06.iprb         C         -0.13         0.           imes yof         ingo_001_A09.iprb         C         -0.045         0.           ingo_001_A09.iprb         C         0.04         0.           ingo_001_A10.iprb         C         0.255         0.           ingo_001_A10.iprb         C         0.255         0.           ingo_001_A11.iprb         C         0.255         0.           ingo_001_A13.iprb         C         0.255         0.           ingo_001_A14.iprb         C         0.255         0.           ingo_002_A03.iprb         Ingo_001_A01.iprb         C         0.215           ingo_002_A03.iprb         Ingo_002_A03.iprb         Ingo_001_A01.iprb         0.           ingo_002_A03.iprb<td>Index         X lose         Y onset         Z lose           1         Ingo_001_A01.iprb         c         -0.64         0.         0.           1         Ingo_001_A03.iprb         c         -0.655         0.         0.           1         Ingo_001_A03.iprb         c         -0.47         0.         0.           2         Ingo_001_A04.iprb         c         -0.33         0.         0.           3         Ingo_001_A03.iprb         c         -0.33         0.         0.           3         Ingo_001_A04.iprb         c         -0.33         0.         0.           3         Ingo_001_A03.iprb         c         -0.13         0.         0.           9         Ingo_001_A03.iprb         c         -0.045         0.         0.           9         Ingo_001_A01.iprb         c         -0.045         0.         0.           1         Ingo_001_A11.iprb         c         0.215         0.         0.           1         Ingo_001_A11.iprb         c         0.235         0.         0.           1         Ingo_002_A03.iprb         c         0.465         0.         0.           1         Ingo_002_A03.iprb</td><td>Array to nav         Ingo_001_A03.iprb         C         0.64         0         128.           Ingo_001_A03.iprb         C         0.6555         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A05.iprb         C         0.3355         0.         0.         128.           Ingo_001_A05.iprb         C         0.33         0.         0.         128.           Ingo_001_A08.iprb         C         0.045         0.         128.           Ingo_001_A03.iprb         C         0.21         0.         128.           Ingo_001_A13.iprb         C         0.215         0</td></td>	Ingo_001_A01.iprb         C         0.064         0.           iat         Ingo_001_A02.iprb         C         -0.655         0.           iat         Ingo_001_A03.iprb         C         -0.385         0.           iad yoff         name + add cold         ingo_001_A03.iprb         C         -0.33         0.           ingo_001_A06.iprb         C         -0.33         0.         0.         0.           imes yof         insert         Ingo_001_A06.iprb         C         -0.13         0.           imes yof         ingo_001_A09.iprb         C         -0.045         0.           ingo_001_A09.iprb         C         0.04         0.           ingo_001_A10.iprb         C         0.255         0.           ingo_001_A10.iprb         C         0.255         0.           ingo_001_A11.iprb         C         0.255         0.           ingo_001_A13.iprb         C         0.255         0.           ingo_001_A14.iprb         C         0.255         0.           ingo_002_A03.iprb         Ingo_001_A01.iprb         C         0.215           ingo_002_A03.iprb         Ingo_002_A03.iprb         Ingo_001_A01.iprb         0.           ingo_002_A03.iprb <td>Index         X lose         Y onset         Z lose           1         Ingo_001_A01.iprb         c         -0.64         0.         0.           1         Ingo_001_A03.iprb         c         -0.655         0.         0.           1         Ingo_001_A03.iprb         c         -0.47         0.         0.           2         Ingo_001_A04.iprb         c         -0.33         0.         0.           3         Ingo_001_A03.iprb         c         -0.33         0.         0.           3         Ingo_001_A04.iprb         c         -0.33         0.         0.           3         Ingo_001_A03.iprb         c         -0.13         0.         0.           9         Ingo_001_A03.iprb         c         -0.045         0.         0.           9         Ingo_001_A01.iprb         c         -0.045         0.         0.           1         Ingo_001_A11.iprb         c         0.215         0.         0.           1         Ingo_001_A11.iprb         c         0.235         0.         0.           1         Ingo_002_A03.iprb         c         0.465         0.         0.           1         Ingo_002_A03.iprb</td> <td>Array to nav         Ingo_001_A03.iprb         C         0.64         0         128.           Ingo_001_A03.iprb         C         0.6555         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A05.iprb         C         0.3355         0.         0.         128.           Ingo_001_A05.iprb         C         0.33         0.         0.         128.           Ingo_001_A08.iprb         C         0.045         0.         128.           Ingo_001_A03.iprb         C         0.21         0.         128.           Ingo_001_A13.iprb         C         0.215         0</td>	Index         X lose         Y onset         Z lose           1         Ingo_001_A01.iprb         c         -0.64         0.         0.           1         Ingo_001_A03.iprb         c         -0.655         0.         0.           1         Ingo_001_A03.iprb         c         -0.47         0.         0.           2         Ingo_001_A04.iprb         c         -0.33         0.         0.           3         Ingo_001_A03.iprb         c         -0.33         0.         0.           3         Ingo_001_A04.iprb         c         -0.33         0.         0.           3         Ingo_001_A03.iprb         c         -0.13         0.         0.           9         Ingo_001_A03.iprb         c         -0.045         0.         0.           9         Ingo_001_A01.iprb         c         -0.045         0.         0.           1         Ingo_001_A11.iprb         c         0.215         0.         0.           1         Ingo_001_A11.iprb         c         0.235         0.         0.           1         Ingo_002_A03.iprb         c         0.465         0.         0.           1         Ingo_002_A03.iprb	Array to nav         Ingo_001_A03.iprb         C         0.64         0         128.           Ingo_001_A03.iprb         C         0.6555         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A03.iprb         C         0.3355         0.         0.         128.           Ingo_001_A05.iprb         C         0.3355         0.         0.         128.           Ingo_001_A05.iprb         C         0.33         0.         0.         128.           Ingo_001_A08.iprb         C         0.045         0.         128.           Ingo_001_A03.iprb         C         0.21         0.         128.           Ingo_001_A13.iprb         C         0.215         0

5) In the GPS track menu the complete Raptor navigation can be seen. For this particular data during computation of the navigation the software indicated that the number of GPS was double in some locations requiring the user to click the "Del Double GPS" button. Note, sometimes other navigation errors can exist which may require clicking the "Del Double Scans" (or even the "Del Extra GPS" button. The "Del Extra GPS" button requires that all the scans be converted before testing this navigation issue).



After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for generalized signal processing for all multichannel GPR and how to compile these data to a 3D volume.

#### GSSI SIR 30

The basic processes for the 1-4 channel GSSI SIR 30 multichannel system are:

Create New Info menu:

- Use the "help set" with the channel descriptions including, Nchannels, xoffset, xstart set to the appropriate values. This will create the channel names and their offsets. Note, these values can be customized and edited manually should the channel separations or naming convention be different.
- Click the "Import Create Info" button in the Create Info File menu with the \*.\* multichannel general highlighted. This will create the infomain and infochannel information files.

filename infochannel-1.dat	Create Info	profile name	x offset	y offset	z offset	GPS/Na
# of files 19		MSL 36802 M7_001.DZT	0.	0.	0.	0.
ile identifier 37rd.	(eg. file_000)	MSL 36802 M7_002.DZT	0.	0.	0.	0.
gps file ext .dzg		MSL 36802 M7_003.DZT	0.	0.	0.	0.
gps nmea \$GPGGA		MSL 36802 M7_004.DZT	0.	0.	0.	0.
		MSL 36802 M7_005.DZT	0.	0.	0.	0.
name increment		MSL 36802 M7_006.DZT	0.	0.	0.	0.
name start 1		MSL 36802 M7_007.DZT	0.	0.	0.	0.
	-	MSL 36802 M7_008.DZT	0.	0.	0.	0.
=	~	MSL 36802 M7_009.DZT	0.	0.	0.	0.
x C y C xy C ang C GPS (C y	vector	MSL 36802 M7_010.DZT	0.	0.	0.	0.
art 0 Xend 0	-	MSL 36802 M7_011.DZT	0.	0.	0.	0.
		MSL 36802 M7_012.DZT	0.	0.	0.	0.
art 0 Yend 10		MSL 36802 M7_013.DZT	0.	0.	0.	0.
unit/marker 1 time windo	ow ns 20	MSL 36802 M7_014.DZT	0.	0.	0.	0.
		MSL 36802 M7_015.DZT	0.	0.	0.	0.
amples/scan 512 resampled scan	s/mrk 25				0.	0.
nary resol. C 8 bit C 16 bit @ 32 b	it	SIR 30		×	0.	0.
file list	-				0.	0.
-	=	infomain.dat and infochannels.da	t profile information files gene	erated	0.	0.
pend name infochannel-1.dat A	ppend					
	Impart Create	1.46	c	ок —		
	Import - Create					
radargram extension	_					
radargram identifier + extension		next>				
	× —	COTON				
adargram identifier + extension nultichannel general tor_survey_information.dat	· _	<prev< td=""><td></td><td></td><td></td><td></td></prev<>				
adargram identifier + extension nultichannel general or_survey_information.dat Ntracks 19	y offset 0	x offset .25	☐ zig-zag (x or y surveys/no	on-GPS)		
adarğram identifier + extension nutlichannel general or_survey_information.dat Ntracks 19 Nchannels 4	· _		☐ zig-zag (x or y surveys/ne	on-GPS)		
adargram identifier + extension hultichannel general or_survey_information.dat Ntracks 19 Nchannels 4 inel 1, 2, 3, 4	y offset 0	x offset .25	☐ zig-zag (x or y surveys/no	on-GPS)		
adarğram identifier + extension nullichannel general or_survey_information.dat Ntracks 19 Nchannels 4	y offset 0	x offset .25	☐ zig-zag (x or y surveys/no	on-GPS)		

infomain.dat: contains the name of the main track 32 bit multiplexed radargrams infochannels.dat: contains the extract channels with -N.dat designation

Edit Info File menu:

- 3) highlight the infomain.dat file
- 4) click the GSSI to UTM button to generate the GPS on the main
- 5) click the Separate SIR30 button to extract the individual channels

fochannel-1edit.d fochannels.dat	at	^		profile name		x offset	y offset	z offset	GPS/NAV	divisio
fomain.dat		~	1	MSL 36802 M7_001.DZT	C	0.	0.	0.	164.	
			2	MSL 36802 M7 002.DZT	C	0.	0.	0.	182.	
infomain.dat			3	MSL 36802 M7 003.DZT	C	0.	0.	0.	173.	- E
save edits			4	MSL 36802 M7 004.DZT	C	0.	0.	0.	184.	
add xoff	add zoff	name +	5	MSL 36802 M7 005.DZT	C	0.	0.	0.	46.	- 2
10 add yoff a	dd col4	name -	6	MSL 36802 M7_006.DZT	C	0.	0.	0.	168.	
	es xoff	insert		MSL 36802 M7_007.DZT		0.	0.	0.	81.	- 100
	es col4	delete	7			100803	0.	0.	167.	
	end chr	del Nth	8	MSL 36802 M7_008.DZT	C	0.				
er minGPS der			9	MSL 36802 M7_009.DZT	C	0.	0.	0.	160.	
GSSI get xy	GS	SI get ts	10	MSL 36802 M7_010.DZT	0	0.	0.	0.	73.	
			11	MSL 36802 M7_011.DZT	С	0.	0.	0.	40.	
GSSI to utm	1		12	MSL 36802 M7_012.DZT	C	0.	0.	0.	100.	
GSSI to nav GSSI to utm2	-		13	MSL 36802 M7_013.DZT	0	0.	0.	0.	80.	
ascii			14	MSL 36802 M7_014.DZT	C	0.	0.	0.	168.	- E
unicode	Arra	ay to nav	15	MSL 36802 M7_015.DZT	C	0.	0.	0.	23.	E.
nmea to utm	-	rate SIR30	16	MSL 36802 M7 016.DZT	c	0.	0.	0.	63.	Г.
nmea to nav			17	MSL 36802 M7 017.DZT	C	0.	0.	0.	111.	- E
			18	MSL 36802 M7 018.DZT	C	0.	0.	0.	109.	
brwse x0x1y0y1			10	MSL 36802 M7 019.DZT		0.	0.	0.	59.	
xyz to nav	-			MOE 00002 M/ _010.021		0.				
gps update list		e1	20		C		_			
II to utm		v gps file file header	21		C		_			
gps get yaw	SHOW	lile fleader	22		0					
Ang, X, Y, XY	o GPS o	r Vector	23		0					
0, , ,	2		24		C					
	iit/marke idow (ns		25		C					
	oles/scar	·		next>   <prev r="" sort="" td=""  =""  <=""><td></td><td>x0 to x1</td><td>sort x</td><td>(&gt;&gt; y   so</td><td>ort y y0 to y</td><td>4</td></prev>		x0 to x1	sort x	(>> y   so	ort y y0 to y	4
resampled sc								1 to y0	rev fil	
	8 bit	.   20		del odd						<u> </u>
		@ 32 bit		del even	х0-е	ast 0		georeference ir	fo	
	ang	^		recover	y0-r	orth 0		art/end utm of		
Survey type	GPS	3		sort multichannel	x1-e	ast 0				

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- 6) set the information file to infochannels.dat
- 7) click the Array to Nav button to generate the individual GPS tracks for each extracted channel based on the xy offsets.
- 8) click on the infochannel-1.dat (or -2,-3,-4.dat) and begin standard processing....

fochannel-1.dat		<b>`</b>	profile name		x offset	y offset	z offset	GPS/NAV	divisi
fochannel-1edit.da fochannels.dat	at .	1	msl 36802 m7_001-1.dzt	c	-0.5	0.	0.	10.	
		2	msl 36802 m7_001-2.dzt	c	-0.25	0.	0.	10.	- E
infochannels.dat		3	msl 36802 m7 001-3.dzt	c	0.	0.	0.	10.	Г
save edits		4	msl 36802 m7 001-4.dzt	C	0.25	0.	0.	10.	Г
add xoff a		5	msl 36802 m7 002-1.dzt	C	-0.5	0.	0.	10.	- E
0 add yoff ad		6	 msl 36802 m7_002-2.dzt	c	-0.25	0.	0.	10.	
	es xoff insert	7	msl 36802 m7_002-3.dzt	C	0.	0.	0.	10.	
	s col4 delete end chr del Nth	8	msl 36802 m7_002-4.dzt	C	0.25	0.	0.	10.	- 2
el minGPS del c		9	msl 36802 m7_003-1.dzt	C	-0.5	0.	0.	10.	- 2
		9	msl 36802 m7_003-2.dzt		-0.25	0.	0.	10.	
GSSI get xy	GSSI get ts		msl 36802 m7_003-3.dzt		0.20	0.	0.	10.	
GSSI to utm	Ē.	11 10		C		0.	0.	10.	
GSSI to nav		12	msl 36802 m7_003-4.dzt	0	0.25				
GSSI to utm2		SIR 30	)			× }.	0.	10.	
ascii	4. C							10.	
ascii							0.		
unicode	Array to nav	] msl	36802 m7 001-1.dzt - msl 36802 m7 019-4	l.dzt *.gps navi	gation files	). ).	0.	10.	
unicode nmea to utm	Array to nav Separate SIR30	msl crea	36802 m7_001-1.dzt - msl 36802 m7_019-4 ted	1.dzt *.gps navi	gation files	). ). ).			
unicode				l.dzt *.gps navi	gation files	). ). ).	0.	10.	
unicode nmea to utm nmea to nav				1.dzt *.gps navi	gation files	). ). ). ).	0.	10. 10.	
unicode nmea to utm nmea to nav brwse x0x1y0y1				I.dzt *.gps navi	gation files OK	). ). ). ). ).	0. 0. 0.	10. 10. 10.	
unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav				4.dzt *.gps navi		). ). ). ). ). ). ).	0. 0. 0. 0.	10. 10. 10. 10.	
unicode nmea to utm nmea to nav brwse x0x1y0y1				4.dzt *.gps navi		). ). ). ). ). ). ). ).	0. 0. 0. 0. 0. 0.	10.         10.         10.         10.         10.         10.         10.	
unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps update list	Separate SIR30	_ crea	ted		ОК	). ). ). ). ). ). ). ). ).	0. 0. 0. 0. 0. 0. 0.	10.           10.           10.           10.           10.           10.           10.           10.	
unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw	Separate SIR30 show gps file show file header	_ crea	msl 36802 m7_006-1.dzt	[ 	OK		0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.	10.       10.       10.       10.       10.       10.       10.       10.       10.	
unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps update list II to utm	Separate SIR30 show gps file show file header	21 22 23	msl 36802 m7_006-1.dzt msl 36802 m7_006-2.dzt	[ C	ОК -0.5 -0.25	0.	0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.           0.	10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.	
unicode nmea to utm nmea to nav prwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw Ang, X, Y, XY to	Separate SIR30 show gps file show file header	21 22 23 24	msl 36802 m7_006-1.dzt msl 36802 m7_006-2.dzt msl 36802 m7_006-3.dzt msl 36802 m7_006-4.dzt	C C C	ОК -0.5 -0.25 0. 0.25	0. 0. 0.	0.           0.	10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.	
unicode nmea to utm nmea to nav prwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw Ang, X, Y, XY to uni time wind	Separate SIR30 show gps file show file header o GPS or Vector it/marker 1 dow (ns) 20	21 22 23	msl 36802 m7_006-1.dzt msl 36802 m7_006-2.dzt msl 36802 m7_006-3.dzt msl 36802 m7_006-4.dzt msl 36802 m7_007-1.dzt	[ C	OK -0.5 -0.25 0. 0.25 -0.5	0. 0. 0. 0.	0.           0.	10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.	
unicode nmea to utm nmea to nav orwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw Ang, X, Y, XY to uni time wind samp	Separate SIR30 show gps file show file header o GPS or Vector t/marker 1 dow (ns) 20 512	21 22 23 24	msl 36802 m7_006-1.dzt msl 36802 m7_006-2.dzt msl 36802 m7_006-3.dzt msl 36802 m7_006-4.dzt	C C C	OK -0.5 -0.25 0. 0.25 -0.5	0. 0. 0. 0. 0. sort x	0.           0.	10.           10.	
unicode nmea to utm nmea to nav nwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw Ang, X, Y, XY to uni time wind samp resampled sca	Separate SIR30 show gps file show file header o GPS or Vector it/marker 1 dow (ns) 20 les/scan 512 ans/mark 25	21 22 23 24	msl 36802 m7_006-1.dzt msl 36802 m7_006-2.dzt msl 36802 m7_006-3.dzt msl 36802 m7_006-4.dzt msl 36802 m7_007-1.dzt	C C C	OK -0.5 -0.25 0. 0.25 -0.5	0. 0. 0. 0. 0. sort x	0.           0.	10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.           10.	
unicode nmea to utm nmea to nav prwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw Ang, X, Y, XY to unit time wind samp resampled sca binary	show gps file show file headen o GPS or Vector tt/marker 1 dow (ns) 20 jeles/scan 512 ns/mark 25 ° 8 bit	21 22 23 24 25	msi 36802 m7_006-1.dzt           msi 36802 m7_006-2.dzt           msi 36802 m7_006-3.dzt           msi 36802 m7_006-4.dzt           msi 36802 m7_007-1.dzt           msi 36802 m7_007-1.dzt           next> <prev< td=""></prev<>		OK -0.5 -0.25 0. 0.25 -0.5 x0 to x1	0. 0. 0. 0. sort x	0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           10.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.           0.         0.	10.           rev file	
unicode nmea to utm nmea to nav brwse x0x1y0y1 xyz to nav gps update list II to utm gps get yaw Ang, X, Y, XY to unin time wind samp resampled sca binary	Separate SIR30 show gps file show file header o GPS or Vector it/marker 1 dow (ns) 20 les/scan 512 ans/mark 25	21 22 23 24 25	msl 36802 m7_006-1.dzt           msl 36802 m7_006-2.dzt           msl 36802 m7_006-3.dzt           msl 36802 m7_006-4.dzt           msl 36802 m7_007-1.dzt           next> <prev< td="">           sort r           del odd</prev<>	С С С С ХО-е	OK -0.5 -0.25 0. 0.25 -0.5 x0 to x1	0. 0. 0. 0. 0. x	0.           0.	10.           rev file	

### **RPS Multichannel**

The basic processes for RPS Multichannel systems from Australia are after the infomain.dat and infochannels.dat are made in the Create New Info menu :

1) Create the infomain and infochannels.dat file in the Create New Info menu.

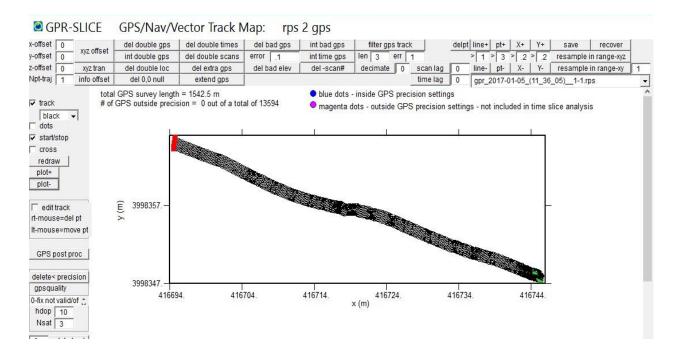
filename	Total and a star star	-		profile name	x offset	v offset	z offset	GPS/Na
# of files	infochannels.dat	Create Info		gpr_2017-01-05_(11_36_05)1.rps	0.	0.	0.	0.
e identifier	file-	-3		gpi_2017-01-05_(11_30_05)1.ips	0.	0.	0.	- 0.
g. a_000)		-				-	-	
file exter	C.dzt C.dt1 C.rd3( nsion C.dt C.gsf C.rd6(		stom			_	-	
IIIC EALER	C.dat C.rad C.rd7					_		
						_	_	
name increi	estart 1							
fiame	r Statt   1							
	HX22	gps filename ext						
	HH L-+ 12 Bu	.CSV						
хсу	City Clang @ GPS Clived							
tart -1.2	X end 1.2	\$GPGGA -						
1.1.2		R	PS M	ultichannel				
	Yend 20							
unit/marke	er 1 time window		infom	ain.dat and infochannels.da	t profile info	ormation f	iles gene	rated
unit/marke amples/sca	er 1 time window an 512 resampled scans/r		infom	ain.dat and infochannels.da	t profile info	ormation f	iles gene	rated
unit/marke	er 1 time window an 512 resampled scans/r		infom	ain.dat and infochannels.da	t profile infc	ormation f	iles gene	rated
unit/marke amples/sca binary resol.	er 1 time window an 512 resampled scans/r		infom	ain.dat and infochannels.da	t profile info	ormation f		
unit/marke amples/sca binary resol. file list	er 1 time window an 512 resampled scans/r · 8 bit • 16 bit • 32 bit t	nrk 25	infom	ain.dat and infochannels.da	t profile info	ormation f	iles gener	
unit/marke samples/sca binary resol. file list	er 1 time window an 512 resampled scans/r	nrk 25	infom	ain.dat and infochannels.da	t profile infc	ormation f		
unit/marke amples/sca binary resol. file list	er 1 time window an 512 resampled scans/r C 8 bit © 16 bit C 32 bit t v infochannels.dat App	nrk 25	infom	ain.dat and infochannels.da	t profile infc	prmation f		
unit/marke samples/sca binary resol. file list opend name * radargram	er 1 time window an 512 resampled scans/r C 8 bit © 16 bit C 32 bit t v infochannels.dat App	nrk 25	infom	ain.dat and infochannels.da	t profile info	prmation f		
unit/marke samples/sca binary resol. file list opend name * radargram * radargram	er 1 time window an 512 resampled scans/r 8 bit    16 bit    32 bit t    • 8 bit    16 bit    32 bit t    • 16 bit    42 bit extension identifier + extension identifier + extension	end Import - Create Info	infom	ain.dat and infochannels.da	t profile info	prmation f		
unit/marke samples/sca binary resol. file list ppend name * radargram * radargram	er 1 time window an 512 resampled scans/r	end Import - Create Info	]	ain.dat and infochannels.da	t profile info	prmation f		
unit/market samples/sca binary resol. file list opend name radargram radargram ctor_survey	er 1 time window an 512 resampled scans/r 8 bit   16 bit   32 bit t    • 8 bit   16 bit   32 bit t    • 16 bit   42 bit extension identifier + extension identifier + extension information.dat	end Import - Create Info	next>		t profile info	prmation f		
unit/marke amples/sca binary resol. file list spend name radargram multichann ctor_survey. pomma delim	er 1 time window an 512 resampled scans/r 8 bit   16 bit   32 bit t    • 8 bit   16 bit   32 bit t    • 16 bit   42 bit extension identifier + extension identifier + extension information.dat	nrk 25 end Import - Create Info	next> <prev< td=""><td>Aain.dat and infochannels.da </td><td>t profile info</td><td>prmation f</td><td></td><td></td></prev<>	Aain.dat and infochannels.da 	t profile info	prmation f		
unit/marke amples/sca pinary resol. file list pend name radargram multichann ctor_survey mma delim ffset file	er 1 time window an 512 resampled scans/r 8 bit © 16 bit © 32 bit t v infochannels.dat Appr extension identifier + extension identifier + extension identifier + extension identifier + 10 cm 20 cm	nrk 25 end Import - Create Info y offset 0 z offset 0	next> <prev x offset</prev 	.12 x gps pole 0		prmation f		
unit/marke amples/sca binary resol. file list pend name radargram multichann ctor_survey mma delim iffset file	er 1 time window an 512 resampled scans/r C 8 bit C 16 bit C 32 bit t infochannels.dat Appr extension identifier + extension identifier + extension identifier + extension identifier + extension identifier + 1 and a fill information.dat 1 information.dat 1 1,2,3,4,5,6,7,8,9,10,11,12	nrk 25 end Import - Create Info y offset 0 z offset 0 2, 13, 14	next> <prev x offset x start</prev 	.12         x gps pole         0           .75         y gps pole         0		prmation f		
unit/marke amples/sca binary resol. file list radargram	er 1 time window an 512 resampled scans/r	nrk 25 end y offset 0 z offset 0 2, 13, 14 15,-0.03,0.09,0.21,0.33,0.45	next> <prev x offset x start</prev 	.12         x gps pole         0           .75         y gps pole         0		prmation f		
unit/marke samples/sca binary resol. file list ppend name * radargram * multichann	er 1 time window an 512 resampled scans/r C 8 bit C 16 bit C 32 bit t infochannels.dat Appr extension identifier + extension identifier + extension identifier + extension identifier + extension identifier + 1 and a fill information.dat 1 information.dat 1 1,2,3,4,5,6,7,8,9,10,11,12	nrk 25 end y offset 0 z offset 0 2, 13, 14 15,-0.03,0.09,0.21,0.33,0.45	next> <prev x offset x start</prev 	.12         x gps pole         0           .75         y gps pole         0		prmation f		

- 2) Create the navigation using the RPS to UTM button. As of 4/13/17 RPS is still developing their file conventions, but there current \*.csv navigation files needs to have the same name as the main track names in the infomain.dat, but just with the \*.csv extention. Clicking RPS to UTM will generate the navigation files and do all the UTM conversions.
- 3) Extract RPS will demultiplex the main radargram and make individual radargram files names with the -1,-2, ... -N.rps extensions

for the second							
fochannels.dat /	profile name		x offset	y offset	z offset	GPS/NAV	divisio
fomain.dat	1 gpr_2017-01-05_(11_36_05)1.rps	C	0.	0.	0.	1511.	Γ
infomain.dat	2					·	
save edits	3				-	-	
add xoff   add yoff   name +							· -
1E-9 add zoff add col4 name -	6						Ē
times xof times yof insert	7	c			-	-	-
times zof times c4 delete	8						
rotate append chr del Nth						·	- E
del channels	9						
	10	C					
🛹 step1	step 2	C				-	
RPS to utm RPS get ts		C					Г
RPS to nav extract RPS	13	C					
	14	C					Г
ascii Array to nav	15	C					
unicode	16	С					
nmea to utm	17	С		- i			
nmea to nav	18	c			· · · · · ·		Г
brwse x0x1y0y1	19				·	·	
xyz to nav		c	-		-		
gps update list	20	10.00				-	
ll to utm gps get yaw show gps file	21	C					
gps get yaw show gps me	22	C					
Ang, X, Y, XY to Vector	23	C					Г
	24	C					Г
unit/marker 1	25	С					
time window (ns) 51.2 samples/scan 512	and the second sector						
samples/scan 512 resampled scans/mark 25	next> <prev r<="" sort="" td=""><td></td><td>x0 to x1</td><td></td><td>x &gt;&gt; y s 1 to y0</td><td>ort y y0 to y rev fil</td><td></td></prev>		x0 to x1		x >> y s 1 to y0	ort y y0 to y rev fil	
binary C 8 bit	del odd			X		revin	e
resol. <ul> <li>16 bit C 32 bit</li> </ul>	del even						
V A	recover						
Survey type: Xy	sort multichannel						
ang	adjust to single marker @ 0						

# 4) The next step is to generate the individual channel navigation using the Array to Nav button

			• 1	2 gps\infochannels.dat						
lfo.dat lfobak.dat		^		profile name		x offset	y offset	z offset	GPS/NAV	divis
ifochannels.dat		¥	1	gpr_2017-01-05_(11_36_05)1-1.rps	C	-0.75	0.	0.	970.	Г
			2	gpr_2017-01-05_(11_36_05)1-2.rps	C	-0.63	0.	0.	970.	Г
infochannels.da	t		3	gpr_2017-01-05_(11_36_05)1-3.rps	0	-0.51	0.	0.	970.	Γ
save edits			4	gpr_2017-01-05_(11_36_05)1-4.rps	С	-0.39	0.	0.	970.	Г
add xoff a	add yoff	name +	5	gpr_2017-01-05_(11_36_05)1-5.rps	- c	-0.27	0.	0.	970.	Г
1E-9 add zoff a	dd col4	name -	6	gpr_2017-01-05_(11_36_05)1-6.rps	С	-0.15	0.	0.	970.	Г
times xof tim	es yof	insert	7	gpr_2017-01-05_(11_36_05)1-7.rps	- C	-0.03	0.	0.	970.	Г
	es c4	delete	8	gpr 2017-01-05 (11 36 05) 1-8.rps	- c	0.09	0.	0.	970.	Г
	end chr	del Nth annels	9	gpr_2017-01-05_(11_36_05)1-9.rps	- c	0.21	0.	0.	970.	Г
	uerun	anneis	10	gpr_2017-01-05_(11_36_05)1-10.rps	- c	0.33	0.	0.	970.	E
			11	gpr 2017-01-05 (11 36 05) 1-11.rps	- c	0.45	0.	0.	970.	Г
			12	gpr_2017-01-05_(11_36_05)1-12.rps		0.57	0.	0.	970.	Ē
RPS to utm	RPS	get ts	13	gpr_2017-01-05_(11_36_05)1-13.rps		0.69	0.	0.	970.	Ē
RPS to nav	extrac	t RPS	14	gpr_2017-01-05_(11_36_05)1-14.rps		0.81	0.	0.	970.	Ē
			14	gpi_2017-01-05_(11_30_03)1-14.ips		0.01	0.	0.	570.	Г
ascii unicode	Array	to nav		I				- <u> </u>		
nmea to utm	1		16		- 2			-	-	
nmea to nav	1		17					<u> </u>		Γ
brwse x0x1y0y1	1		18							
xyz to nav	]		19		_ C		-			
gps update list			20		C					
II to utm		1	21		С		4.			Г
gps get yaw	show	gps file	22		С					Г
Ang, X, Y, X	V to Vecto	r	23		0					Г
			24		0					Г
	it/marker	1	25	, 	- c		<u> </u>	( <u> </u>	<u> </u>	Г
time win		51.2		, 				1		. 1
resampled sca	les/scan	512		next> <prev r<="" sort="" td=""><td></td><td>x0 to x1</td><td></td><td></td><td>orty y0 to y</td><td></td></prev>		x0 to x1			orty y0 to y	
	8 bit	25		del odd			X	1 to y0	rev fil	e
	• 16 bit	C 22 bit		del even						
	v	A		recover						
Survey type	1			sort multichannel						
ourvey type	ang			adjust to single marker @ 0						



#### An example of an RPS multichannel GPS track is shown below:

After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for generalized signal processing for all multichannel GPR and how to compile these data to a 3D volume.

## **ISUNG Multichannel**

The basic processes for ISUNG Multichannel systems from Korea are after the infomain.dat and infochannels.dat are made in the Create New Info menu:

 Create the infomain and infochannels.dat file in the Create New Info menu. One will need to set the Xoffset between channels and the Xstart value for channel. Also, the number of channels are set before the button Help Set is clicked.

	infochannels.dat	Create Info	profile name	x offset	y offset	z offset	GPS/Nav
# of files	1		N-TEST.t3r	0.	0.	0.	0.
file identifier	file000	(eg. file_000)					
le extension	.t3r						
gps file ext	.CSV						
gps nmea	\$GPGGA 💌						
ordinate sys	UTM-Universal Transverse N	Mercator 👻					
name incre	ment 1						
name	start 1						
	IIIXS S	5					
— [] []	HI I In 2	5					
хсу	⊂ xy ⊂ ang ∈ GPS ⊂ v	vector					
start 0	X end 9.5						
start 0	Y end 10						
1.	1.0						
unit/marke	er 1 time wind	low ns 60					
		Isung N					
			Multichannel	X			
samples/sca		ns/mrk 25	Multichannel	×			
	1	at 10/111 20		-			
binary resol.	⊂ 8 bit ⊂ 16 bit ● 32 bi	it infom	Multichannel	-			
	⊂ 8 bit ⊂ 16 bit ● 32 bi	at 10/111 20		-			
binary resol.	⊂ 8 bit ⊂ 16 bit ● 32 bi	it infom		-			
binary resol. file list	C 8 bit C 16 bit @ 32 bi	it infom	nain.dat and infochannels.dat profile information files generate	-			
binary resol. file list	C 8 bit C 16 bit @ 32 bi	it infom	nain.dat and infochannels.dat profile information files generate	-			
binary resol. file list append name	8 bit C 16 bit @ 32 bi	it infom	nain.dat and infochannels.dat profile information files generate	-			
binary resol. file list append name * radargram e	8 bit 16 bit 32 bi     infochannels.dat	it infom	nain.dat and infochannels.dat profile information files generate	-			
binary resol. file list append name * radargram e * radargram i	8 bit 16 bit 32 bit     infochannels.dat     A extension dentifier + extension	xppend	nain.dat and infochannels.dat profile information files generate OK Info	-			
binary resol. file list append name * radargram i * multichanne	8 bit 16 bit 32 bit     infochannels.dat     A extension dentifier + extension	ppend	Info Instruction Info Instruction Info Info Info Info Info Info Info In	-			
binary resol. file list append name * radargram i * multichanne	8 bit     16 bit     © 32 bit       infochannels.dat     A       extension     A       dentifier + extension     A       egeneral     A	ppend	Info				
binary resol. file list append name * radargram e * radargram e * multichanne ector_survey_	8 bit 16 bit 32 bi infochannels.dat A extension dentifier + extension el general information.dat	ppend Import - Create	Info  x offset 075 zig-zz	-	n-GPS)		
binary resol. file list append name * radargram e * radargram e * multichanne ector_survey_ omma delimit	8 bit     16 bit <ul> <li>32 bit</li> <li>16 bit</li> <li>32 bit</li> <li>16 bit</li> <li>32 bit</li> <li>16 bit</li> <li16 bit<="" li=""> <li16 bit<="" li=""> <li>16</li></li16></li16></ul>	ppend	Info		n-GPS)		
binary resol. file list append name * radargram in * madargram in * madar	8 bit 16 bit 32 bit     infochannels.dat     at     attension     dentifier + extension     dentifier + extension     dentifier textension	ppend Import - Create	Info Info Info Info Info Info Info Info		n-GPS)		
binary resol. file list ppend name radargram in "nullichanen routlichanen prouticor_survey_ omma delimit offset file_ annel	8 bit       16 bit <ul> <li>32 bit</li> <li>infochannels.dat</li> <li>A</li> </ul> infochannels.dat         A           extension         a           dentifier + extension         a           information.dat         A           ted         Ntracks           Nchannels         24           1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11           1         24, 5, 6, 7, 8, 9, 10, 11	it it infom i	Info Info Info Info Info Info Info Info	d g (x or y surveys/no		.787,0.862	
binary resol. file list append name * radargram e * radargram i * multichanne	8 bit         16 bit <ul></ul>	it it infom i	Info Info X offset 075 X offset 075 X offset 20, 21, 22, 23, 24	d g (x or y surveys/no		.787,0.862	

2) Next step is to extract the individual channels from the multiplexed radargrams from the infomain.dat file. The extracted channels are written to the \radar\ folder of the project.

Edit Information File	e: C:\multichannel\bus	an - isung multi	channel\infomain.dat					-	
nfochannels.dat nfochannelsedit.dat	^	1	profile name		x offset	y offset	z offset	GPS/NAV	divisi
nfomain.dat	~ ·	1 N	I-TEST.t3r	c	0.	0.	0.	0.	
		2			-		_	-	- E
infomain.dat		3		C	-				- E
save edits					-	_	_		
add xoff a	dd voff name +	4			-				
863 add zoff a		5		0					
.000	es yof insert	t3r Extract							
	s col4 delete	input rad	dargram						
rotate appe	end chr del Nth		EST.t3r					_	
del minGPS del c	hnnels		Londo				_	-	- E
		channel	radargrams *1- 24		-				
		n-te	st-ch-1, 24.t3r			_		-	- <u>-</u>
	Isung extract								-
L		process	ing scan						
		160	98						
ascii									
o unicode	Array to nav		cancel						Г
nmea to utm								-	- Γ
nmea to nav							_	-	- E
filter nmea		18			_	-			
brwse x0x1y0y1					-				
xyz to nav		19			-				- 5
gps update list		20		C					
II to utm	show gps file	21		C					
gps get yaw	show file header	22		C					
		23		С					
Ang, X, Y, XY to	GPS or Vector	24		- c	-			_	- E
uni	it/marker 1	25		- c	-				- <u>-</u>
time win	dow (ns) 60	25			1		1	1	- L
	les/scan 256	1	next> <prev r<="" sort="" td=""><td></td><td>x0 to x1</td><td>sort x</td><td>x &gt;&gt; y s</td><td>ort y y0 to</td><td>y1</td></prev>		x0 to x1	sort x	x >> y s	ort y y0 to	y1
resampled sca	and a second		del odd				x1 to y0	rev fi	e
	8 bit	-	del even						
resol.	16 bit @ 32 bit		recover	х0-е			georeference i		
	xy ^		sort multichannel	y0-n		**	start/end utm of	file 1	
Survey type:	GPS V		adjust to single marker @ 0	х1-е					
		-	adjust to single marker @	y1-n	orth 0	ı	utm zone 52		

3) Create the navigation using the XYZ to NAV button with the all the settings shown in the menu. This reads the \*.csv file containing all the information on the GPS navigation and will convert to GPR-SLICE format and make all the UTM conversions.

profile name			x offset	y offset	z offset	GPS/NAV	divisio
1 N-TEST.t3r		с	0.	0.	0.	89.	
2		с					
3		c	-		-		- г
		- c		_	-		- E
The second	. C:\multichannel\bi	isan - i	sung multichan	nel\ -	· □ ×	· ]	
		aburr r	sarig manenar	inor (			
skip N header lines			generate GPS	S/vector/nav	7	_	
and a second second second second	3		generate or c	orvector/nav	_		
	2						
z column	4			and the second	nal		
nmea time column	0	0 000	ordinates in ut	tm or xyz			
scan# column	1						- E
hemisphere	N	_					-
meridian	E					-	
gps quality column	0					-	- 11
N satellites column	0						
HDOP column	0	200	Tom pitorin yaw	import in degre	.63		
	0						
							Г
	0						Г.
	.CSV						
						-	
						-	
remove character	0						
* if no columno are quailable so	t to 0						
		11					
24	xyz scale lactor	, (		-	-	-	- E
25		- c		-			- E
23			1	1	1		
next> <prev r<="" sort="" td=""><td></td><td></td><td>x0 to x1</td><td>sort x</td><td><pre>&lt; &gt; y so</pre></td><td>orty y0 to y</td><td>y1</td></prev>			x0 to x1	sort x	<pre>&lt; &gt; y so</pre>	orty y0 to y	y1
del odd				x	1 to y0	rev fil	e
del even							
		х0-е	ast 0		georeference in	fo	
recover			-				
recover sort multichannel		y0-n x1-e	orth 0		art/end utm of t		
	1       N-TEST.t3r         2	1       N-TEST.t3r         2       3         3       4         Image: Customized Navigation File Import: C-\multichannel/bust skip N header lines x column y column z column nmea time column scan# column hemisphere meridian gps quality column N satellites column HDOP column xvec/roll column yvec/pitch column gps/nav file extension xyz scale factor UTM zonenumber remove character       Image: Description of the set	1       N-TEST.t3r         2	1       N-TEST.t3r       0         2       0       0         3       0       0         4       0       0         5       column       generate GPS         y column       2       0         z column       1       0         y column       2       0         a       0       0         y column       2       0         x column       1       1         y column       2       0         a cordinates in +       0       0         y column       <	1       N-TEST.t3r       0.       0.         2       0.       0.       0.         3       0.       0.       0.         4       0       0.       0.         5       Customized Navigation File Import: C:\multichannel\busan - isung multichannel\       0.       0.         skip N header lines       0       0.       0.       0.         y column       2       0.       0.       0.         y column       2       0.       0.       0.         y column       2       0.       0.       0.       0.         y column       2       4.       0.       0.       0.       0.         scan# column       1       1       0.	1       N-TEST.t3r       0.       0.       0.         2       0.       0.       0.       0.         3       0       0.       0.       0.         4       0       0.       0.       0.         4       0       0.       0.       0.         4       0       0.       0.       0.         4       0       0.       0.       0.         5       Customized Navigation File Import: C:\multichannel\busan - isung multichannel\       0.       0.         5       Customized Navigation File Import: C:\multichannel\busan - isung multichannel\       0.       0.       0.         5       Coordinates in +/- lat/long deg/min       0.       0.       0.       0.       0.         9       column       0. <td>1       N-TEST.13r       0       0       89.         2       0       0       0       89.         3       0       0       0       89.         4       0       0       0       0         4       0       0       0       0         4       0       0       0       0         2       0       1       0       0       0         2       0       1       0       0       0       0         2       0       1       0       0       0       0       0       0         3       0</td>	1       N-TEST.13r       0       0       89.         2       0       0       0       89.         3       0       0       0       89.         4       0       0       0       0         4       0       0       0       0         4       0       0       0       0         2       0       1       0       0       0         2       0       1       0       0       0       0         2       0       1       0       0       0       0       0       0         3       0

4) The next step is to generate the individual channel navigation using the Array to Nav button which reads all the offsets for each channel and computes the navigation.

		profile name		x offset	y offset	z offset	GPS/NAV	divisio
bak.dat 🗸 🗸	1	N-TEST-ch-1.t3r	c	-0.863	0.	0.	89.	
	2	N-TEST-ch-2.t3r	c	-0.788	0.	0.	89.	
nfochannels.dat	3	N-TEST-ch-3.t3r	c	-0.713	0.	0.	89.	Г
save edits	4	N-TEST-ch-4.t3r	c	-0.638	0.	0.	89.	- E
add xoff add yoff name +	5	N-TEST-ch-5.t3r	c	-0.563	0.	0.	89.	- E
63 add zoff add col4 name -	6	N-TEST-ch-6.t3r	c	-0.488	0.	0.	89.	- E
mes xof times yof insert	7	N-TEST-ch-7.t3r		-0.413	0.	0.	89.	
mes zof times col4 delete		N-TEST-ch-8.t3r		-0.338	0.	0.	89.	
rotate append chr del Nth minGPS del chnnels	8		C		1.254	100 C	A CONTRACT	
minges der chineis	9	N-TEST-ch-9.t3r	0	-0.263	0.	0.	89.	
	10	N-TEST-ch-10.t3r	C	-0.188	0.	0.	89.	
	11	N-TEST-ch-11.t3r	С	-0.113	0.	0.	89.	
Isung extract	12	N-TEST-ch-12.t3r	С	-0.038	0.	0.	89.	Г
	13	N-TEST-ch-13.t3r	С	0.037	0.	0.	89.	Г
ascii	14	N-TEST-ch-14.t3r	0	0.112	0.	0.	89.	
Inicode Array to nav	15	N-TEST-ch-15.t3r	с	0.187	0.	0.	89.	- -
nmea to utm	16	N-TEST-ch-16.t3r	c	0.262	0.	0.	89.	- E
nmea to nav	17	N-TEST-ch-17.t3r	c	0.337	0.	0.	89.	- F
filter nmea	18	N-TEST-ch-18.t3r	C	0.412	0.	0.	89.	- E
rwse x0x1y0y1	19	N-TEST-ch-19.t3r	C	0.487	0.	0.	89.	
xyz to nav		N-TEST-ch-20.t3r		0.562	0.	0.	89.	
It o utm show gps file	20	N-TEST-ch-21.t3r		0.637	0.	0.	89.	
gps get yaw show file header	21		C					
gps get yaw show he header	22	N-TEST-ch-22.t3r	C	0.712	0.	0.	89.	
Ang, X, Y, XY to GPS or Vector	23	N-TEST-ch-23.t3r	C	0.787	0.	0.	89.	
	24	N-TEST-ch-24.t3r	C	0.862	0.	0.	89.	
unit/marker 1 time window (ns) 60	25		С					Г
samples/scan 256		next> <prev r<="" sort="" td=""><td></td><td>x0 to x1</td><td>sort x</td><td>(&gt;&gt; y   so</td><td>ort y y0 to y</td><td>1</td></prev>		x0 to x1	sort x	(>> y   so	ort y y0 to y	1
resampled scans/mark 25			-			1 to y0	rev file	
binary C 8 bit		del odd						
resol. C 16 bit @ 32 bit		del even	х0-е	east 0		georeference ir	nfo	
xy		sort multichannel	y0-r	north 0	** st	art/end utm of	file 1	

An example of a single swath of an Isung multichannel GPS track is shown below:

Vindan       1. Artificial Markers       NTEST-ch-1.13r       90			Profile Name			1	Markers	Markers Tagged	Errors		x offset	y offset	z offset	GPS/I	NAV	
A. TEST-ch-12.tsr       90       C       -0.788       0.       0.       89.         A. TEST-ch-3.13r       90       C       -0.713       0.       0.       89.         A. TEST-ch-3.13r       90       C       -0.713       0.       0.       89.         A. TEST-ch-3.13r       Softest       0.       y.2 offset       0.       y.2 offset       0.       0.       89.         A. TEST-ch-6.13r       V-offset       0.       y.2 offset       0.       y.2 offset       0.       0.       89.         A. TEST-ch-6.13r       V-offset       0.       y.2 offset       0.       y.2 offset       0.       0.       89.         A. TEST-ch-6.13r       V-offset       0.       y.2 offset       0.       y.2 of			N-TEST-ch-1.t3r				90			•	-0.863	0.	0.	89.		
2. Field Markers       N-TEST-ch-5.13r       x-offset       0       xyz rafnet       del double gps       del double times       del bad gps       int bad gps       filter gps         edit       N-TEST-ch-6.13r       y-offset       0       xyz rafnet       del double gps       del double gps       del double gps       int bad gps       filter gps         .       N-TEST-ch-6.13r       y-offset       0       xyz rafnet       del double gps       del double gps       int bad gps       filter gps         .       N-TEST-ch-6.13r       y-offset       0       xyz rafnet       del double gps       del double gps       int bad gps       filter gps         .       N-TEST-ch-6.13r       y-offset       0       xyz rafnet       del extra gps       del bad gps       int bad gps       filter gps         .       N-TEST-ch-6.13r       Nyz times       del extra gps       del bad gps       del ad uble inters	\radar\	1. Artificial Markers	N-TEST-ch-2.t3r				90			c	-0.788	0.	0.	89.		
2. Field Markers       Image: Comparison of the second of th			N-TEST-ch-3.t3r				90			c	-0.713	0.	0.	89.		
2. Field Markers       N-TEST-ch-5.13r       x-offset       0       xyz tran       del double times       del bad gps       int bad gps       filter gps         edit       N-TEST-ch-6.13r       y-offset       0       xyz tran       del double scans       del load gps       int bad gps       filter gps         edit       N-TEST-ch-6.13r       y-offset       0       xyz tran       del double scans       del load elev       int bad gps       filter gps         3. Interval Markers       N-TEST-ch-9.13r       xoffset       0       xyz tran       del del scan#       extend gps       del bad elev       int bad gps       filter gps         3. Interval Markers       N-TEST-ch-9.13r       rstarts       rstarts       extend yps       extend yps       del astress traps       magents edg - soutids GPS precision satings         4. GPS/Vector scan#       N-TEST-ch-12.13r       r dots       rstarts/spg       soutids edg - soutids GPS precision satings       soutids edg - soutids GPS precision satings         9/0014 substarts       N-TEST-ch-12.13r       r dots       rstarts/spg       soutids edg - soutids deg			N-TEST-ch-4.t3r	Con Con	curer enc		T 1 14	C) II	· I		10.1			-		>
edit       N-TEST-ch-6.13r       y-offset       0       xyz tran       del double scans       del 0,0 null       error       1       int time gps       filler vecto         N-TEST-ch-7.13r       z-offset       0       xyz trans       del extra gps       del bad elev       int double gps       filler vecto         3. Interval Markers       N-TEST-ch-9.13r       N-TEST-ch-9.13r       v       tot GPS avecants       set vector vx.vy.v       filler double del del extra gps       del bad elev       int double gps       decimate         N-TEST-ch-9.13r       v       track       gray       v       del del del extra gps       decimate       set vector vx.vy.v       filler double del del extra gps       decimate       set vector vx.vy.v       del del extra gps       decimate       set vector vx.vy.v       filler double del del extra gps       decimate       set vector vx.vy.v       filler double del del extra gps       decimate       set vector vx.vy.v       filler double del del extra gps       decimate       set vector vx.vy.v       filler double del del extra gps       decimate       set vector vx.vy.v       filler double del del extra gps       set vector vx.vy.v       filler double del del extra gps       filler double del del extra gps       decimate       filler double del del extra gps       filler double del del extra gps       filler double del extra gps       filler double		2 Field Medicin	N-TEST-ch-5.t3r					ð					] inthed			
edit       N-TEST-ch-7.13r       z-offset       0       xyz times       del extra gps       del bad elev       int double gps       filter vecto         3. Interval Markers       N-TEST-ch-9.13r       Vector vx.vy.vz       wid CPS avergany magenta dog - soutisde CPS precision satings       text of a total of 2100		2. Field Markers	N-TEST-ch-6.t3r													gps tra err
3. Interval Markers       N.TEST-ch-18.13r       Npt-trait       1       info offset       del-scan#       extend gps       decimate         3. Interval Markers       N.TEST-ch-10.13r       recas		edit	N-TEST-ch-7.t3r						der 0,0	nun		and the second second				
3. Interval Markers       N.TEST-ch-19.13r       Self vector vx.vy.vz       Virack       Virack       Virack       magente deg = outlide GPB precision satings         4. GPS/Vector scan#       N.TEST-ch-11.13r       Virack       Virack<									extend	gps		buu olor	In double	o apo		
3. Interval Warkers       N-TEST-ch-10.13r       Image: Gray imag				set vect	tor vx.vy.vz	total GPS	survey lengt	h = 4092.4 m			blue dots - i	nside GPS prei	ision settings			
scans/marker= 0 N-TEST-ch-12.13r 4. GPS/Vector scan# N-TEST-ch-13.13r A. GPS/Vector scan# N-TEST-ch-13.13r N-TEST-ch-16.13r N-TEST-ch-16.13r N-TEST-ch-16.13r N-TEST-ch-16.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-19.13r N-TEST-ch-21.13r N-TEST-ch-22.13r N-TEST-ch-24.13r N-TEST		3. Interval Markers				# of GPS	outside precis	sion = 0 out of a	10121 01 21 00		magenta do	ts - outside GP	o precision settin	igs		
A. GPS/Vector scan#       N-TEST-ch-12.137       Cross         V-TEST-ch-13.137       redraw       redraw         N-TEST-ch-16.137       Plot+       plot-         N-TEST-ch-16.137       cord sys=UTM       ocord sys=UTM         N-TEST-ch-16.137       cord sys=UTM       ocord sys=UTM         N-TEST-ch-16.137       cord sys=UTM       ocord sys=UTM         N-TEST-ch-17.137       cord sys=UTM       ocord sys=UTM         N-TEST-ch-19.137       Г edit track       rhouse=del pt         N-TEST-ch-21.137       F odit track       stoo2020.0-         N-TEST-ch-21.137       Ibox delete       stoo2020.0-         N-TEST-ch-23.137       Qefate       stoo2020.0-         N-TEST-ch-23.137       Of sto valid/off 1       hdop 1000		scans/marker=			· •											
4. GPS/Vector scan#       N-TEST-ch-13.13r       cross         N-TEST-ch-14.13r       redraw         N-TEST-ch-16.13r       coord sys=UTM         coord sys=UTM       coord sys=UTM         coord sys=UTM       coordenate sys         N-TEST-ch-17.13r       coordenate sys         N-TEST-ch-18.13r       r= dit track         N-TEST-ch-19.13r       r= dit track         N-TEST-ch-20.13r       N-TEST-ch-20.13r         N-TEST-ch-21.13r       Doxdelete         N-TEST-ch-21.37       delete         N-TEST-ch-2.137       Dox delete         N-TEST-ch-2.137       delete         N-TEST-ch-2.2.137       delete         Mapsualtr       delete <td></td> <td>Scalismarker= 0</td> <td></td> <td></td> <td></td> <td>390032</td> <td>6 0 B</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>		Scalismarker= 0				390032	6 0 B									
4. GPS/Vector scan#       N-TEST-ch-14 13r       redraw       plot+       plot-					and a second											
N-TEST-ch-18.13r N-TEST-ch-19.13r N-TEST-ch-20.13r N-TEST-ch-22.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-24.13r N-TEST-ch-2		4. GPS/Vector scan#					2									
N-TEST-ch-18.13r N-TEST-ch-19.13r N-TEST-ch-20.13r N-TEST-ch-22.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-24					and the second se											
N-TEST-ch-18.13r N-TEST-ch-19.13r N-TEST-ch-20.13r N-TEST-ch-22.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-24.13r N-TEST-ch-2				2.20		390030	1.0									
N-TEST-ch-18.13r N-TEST-ch-19.13r N-TEST-ch-20.13r N-TEST-ch-22.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-23.13r N-TEST-ch-24.13r N-TEST-ch-2							15									
N-TEST-ch-19 13r N-TEST-ch-20 13r N-TEST-ch-21 13r N-TEST-ch-22 13r N-TEST-ch-23 13r N-TEST-ch-23 13r N-TEST-ch-23 13r N-TEST-ch-24 13r N-TEST-ch-2			N-TEST-ch-17.t3r				1									
N-TEST-oh-20.13r N-TEST-oh-20.13r N-TEST-oh-22.13r N-TEST-oh-22.13r N-TEST-oh-23.13r N-TEST-oh-23.13r N-TEST-oh-24			N-TEST-ch-18.t3r	-		390027	6.0-									
N-TEST-oh-20.13r N-TEST-oh-21.13r N-TEST-oh-21.13r N-TEST-oh-22.13r N-TEST-oh-22.13r N-TEST-oh-23.13r N-TEST-oh-23.13r N-TEST-oh-24.13r Drama delete / procession gsquality Ora not valid/off c hdop 1000			N-TEST-ch-19.t3r				E									
N-TEST-ch-21.13r □ box delete N-TEST-ch-22.13r delete precision N-TEST-ch-23.13r gpsquality N-TEST-ch-24.13r 0-fx not valid/off ≎ hdop 1000			N-TEST-ch-20.t3r	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		Ê	1									
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N-TEST-ch-24.13r 0-fix not valid/off hdop 1000			N-TEST-ch-22.t3r	delete-	precision	390025	1.0-									
N-1ES1-01-24.337 hdop 1000			N-TEST-ch-23.t3r													
hdop 1000			N-TEST-ch-24.t3r	AND ADDRESS	and the second se											
NSat 3						390022	6.0-									
next> <pre> <pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre></pre>			next> <nrev< td=""><td>Nsat</td><td>3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></nrev<>	Nsat	3											
Town has				-												
			el\radar\		01	390020	1.0-	[     ]     ]     [     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     [     ]     ]     ]     [     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     ]     [     ]     ]     ]     [     ]     ]     ]     ]     [     ]     ]     [     ]     ]     ]     ]     [     ]     ]     [     ]     ]     ]     [     ]     [     ]     ]     [     ]     [     ]     ]     [     ]     [     ]     [     ]     ]     [								
igation - GPS Scan Numbers 01-17-2020 08:36:35 argram directory = C:\multichannel\busan - isung multichannel\radar\ 90 rotate track			3375	name	es on/off			- E								
argram directory = C:\multichannel\busan - isung multichannel\radar\ I number of files = 24 <u>source</u> 2		=3403 markers= 90 lastscan tagged= 3	3375	store t	track map											
argram directory = C:\multichannel\busan - isung multichannel\radar\ I number of files = 24 EST-ch-13r scans=3403 markers= 90 lastscan tagged= 3375 EST-ch-21r scans=3403 markers= 90 lastscan tagged= 3375		-3403 markers= 90 lastscan tagged= 3	3375	track.jp	g	390017	6.0									
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argram directory = C:\multichannel/busan - isung multichannel/badar\     30k0 Ugo in the second				kmz												

After these steps continue to the section entitled: **Processing Operations for all Multi-Channel GPR Systems.** This will show the steps for generalized signal processing for all multichannel GPR and how to compile these data to a 3D volume.

#### Processing Operations for all Multi-Channel GPR Systems

The multi-channel data all require several radargram signal processes normally to get the best images. The user will want to apply standard signal processing such as scenarios. The most commonly recommend filters are:

- Ons radargram editing
- Background removal
- Spectra+Gain/Bandpass filtering
- Migration (as an optional filter)
- Hilbert transform (as an option)
- 3D radargram volume generation
- Interpolate empty voxel cells in 3D volume

The first 4 processes should always be implemented on the multichannel dataset as recommended. A new Spectral + Gain menu can also combine bandpass with real time gaining

#### **Ons Radargram Editing**

The Ons editing is a critical step. The user should experiment and view the Ons edited radargrams of the extracted channels to make sure their settings for the Ons triggering and detection look reasonably good. In this example above, a threshold of .2 on the peak response is set. If there is digital noise before the ground wave, the a few samples can be skipped on the radargram pulse to start the detection. In the example this value is currently set to 0 which means that detection will start on the top of the pulse at sample 1. The digital noise before the ground wave may vary from dataset or manufacturer to manufacturer. The triggering can also be brought back a few samples if desired using the backup N samples option in the menu to give a better estimate of the first recorded ground wave pulse. The settings for any particular dataset may need to be adjusted for the best results. There are several methods to detect the ground wave:

Method 1 – calculates a moving average on the pulse and the next sample value is N threshold higher then a the detection is made.

Method 2 – finds the first peak pulse above the threshold. If one wants to define the rise before or after the first peak, then the N backup should be set to an appropriate value.

Method 3 – finds the first zero crossing after the peak response is detected.

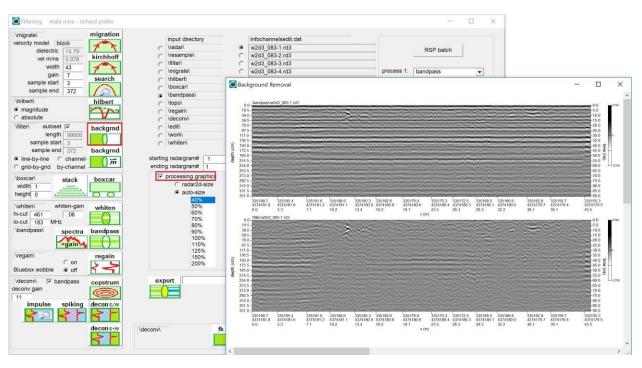
After the Ons editing is done, a new information file, infochannelsedit.dat is automatically generated which will have the new samples/scan of the Ons edited radargrams which are written to the \edit\ folder of the project. After completing the Ons editing process, the user needs to go back to the Edit Info File menu and click on the **infochannelsedit.dat** file as the active information file. A new option exists for the radargrams to be resampled to their original digitization as well.

dit\	truncate samples	input d	irectory	infochannels.dat
sample start 3	append	<ul> <li>\radar\</li> </ul>	lieotory	iniochannels.dat
end 399	ident	C \resample		
	,	C \filter\	<b>`</b>	LI010001.dt
edit\	truncate horizon1	C \migrate\		LI020001.dt
		C \hilbert\		LI030001.dt
edit\	auto Ons	C \boxcar\		LI040001.dt
٨	line-by-line +	C \bandpass	51	LI050001.dt
method	truncate	C \topo\		
method	auto Ons	○ \regain\	Line-by-line tir	me 0 offset X
1 2	scan-by-scan +	C \deconv\		
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<ul> <li>method 1: Nthreshol</li> <li>method 2: Npeak res</li> <li>method 3: Nzero cro</li> </ul>	sponse - Nsamp	#of radargram ✓ multithread pro ✓ processing gra	ocessing	LI150001.dt LI010002.dt LI020002.dt
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nmo\	normal moveout	12376		
/el (m/ns) .110	3			Yes No
TxRx (m) char	1: 0	BlueB		
append all rad	argrams	⊂ scan-by ● line-by-l		next> <prev< td=""></prev<>

#### **Background Filtering**

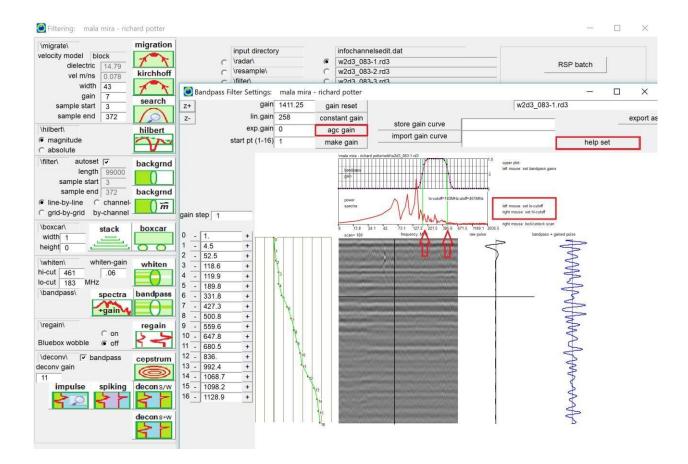
Background filtering is usually necessary for multi-channel systems to better balance the channels and to remove banding noises. The background filtering process is run on the \bandpass\ folder. Note, a long filter length – greater than the total length of the radargram – should normally be set here to insure that average scan removal across the entire radargram is calculated. With autoset engaged in the Filter menu (see the screen shot in the following diagram) for background filtering, an artificially high number of scans will be used to calculate the average scan across the entire radargram.

For multichannel processing, the average scan across the each individual radargram, or across all the individual channels in the whole project can be computed. Radio button options for setting the desired background calculation: line-by-line, or channel-by-channel can be defined. (Grid-by-grid is usually used for single channel surveys and computes the average scan across the whole grid. This operation is not recommended for multichannel datasets. Channel-by-channel background filtering may have advantages in preserving linear features.)



#### Spectra+Gain

The first step after radargram editing is to regain the individual channel radargrams by first entering the Spectra+Gain menu. IDS Stream and Mala Mira will normally have been collected as 16 bit ungained radargrams, so post processing gain is always required. 3D Radar Geoscope may have had gain applied depending if the data were pre-processed or not. GSSI Terravision is recorded with gain in the field. However, sometimes these data are not characteristically gained very well since the GPR systems here only have a limited number of gain points to generated gain during the recording. Normally, this data will need some slight adjustments, particularly below the ground wave to make better gaining on the data.

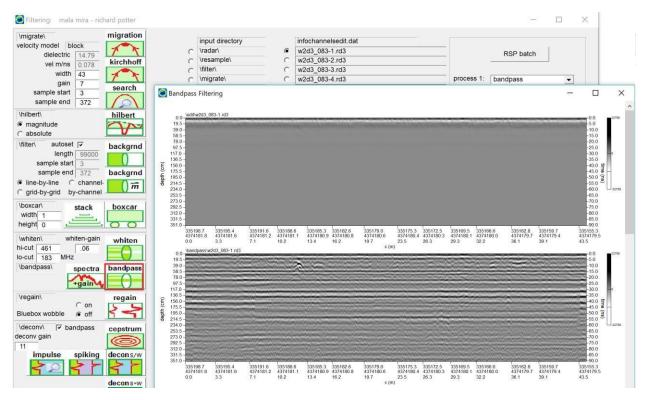


In the Spectra+Gain menu the first operation the user will do is click the AGC Gain button. After this they will then set the lo-cut and hi-cut bandpass

thresholds using the left and right mouse button on the power spectra plot. They will need to experiment what a good bandpass setting is needed for any given data. (This data in the example required a very narrow bandpass to throw away a lot of the low end noise. Typical data may not need such a drastic-narrow bandpass filtering). After they set the lo-cut and hi-cut thresholds, then clicking the Help Set button will design the bandpass curve to match the half power points of the desired bandpass settings.

#### **Bandpass**

Once the Spectra+Gain are set the user will then run the Bandpass operation in the Filter menu. The operation will run and batch and the user can view the original ungained radargram with the bandpass and simultaneous gain application during the processing. To save time the Processing Graphics checkbox in the Filter menu can be shut off to stop the graphic display...This checkbox can also be turned on at anytime to start/stop graphic previews during and run operation.



#### **3D Radargram Volume Generation**

After all the RSP including regaining, spectral whitening, and background filtering are completed and if migration and Hilbert transforms are used, 3D Radargram Volume Generation can commence. In this example the grid X,Y cells is set so that the effective grid cell size is slightly larger than the crossline separation of the antennas. Because of this, the initial 3D volume that is created will not have any gaps in the volume (unless the density of the radar pulses on the ground in the in-line direction). The menu wants the user to also set the total number of grid cells in Z direction. The full radargram pulse or some decimated sampling of the pulse can be used to generate the 3D volume.

The XY grid cells are normally set to closely match the cross line separation of the antennas in the multichannel system or slightly larger. However, cells sizes which are even smaller than the antenna separation can be used. In this instance, when the volume is initially made, there can be cells with no information written. A button called Interpolate GAP can be used in the menu to quickly interpolate nearest neighbors using an inverse distance algorithm at these cells to fill in the gap. A value of x search cells=1, y search cells=1 setting for interpolating the gap will look out 1 cell in each x and y directions to take an average of all cells found nearby with data. Values higher than one in either search direction can also be used in filling the gaps, particularly if grid cells smaller than the cross line separation is desired. The interpolated volume will have an append identifier of "int" automatically placed onto the new 3D volume name. There is also a button to smooth the compile 3D volume using a new 3x3x1 volume filter provided in the menu which will automatically add a "l" appended identifier onto the smoothed volume.

Optionally, the user can set the focus checkbox option on and generate a 3D volume with just a portion of the total area and depth of the volume. Often, if deeper data is noisy or the signal strength is attenuated, the sample end can be set to a value much shallower in depth. This can also help to make the 3D volume size more manageable if a good graphics card with a lot of memory is not available. In this example only 100 grid cells in Z are desired – which corresponds to about every 2nd sample of the digitized radar pulse which is 235 samples long after editing. The number of Z grid cells can be

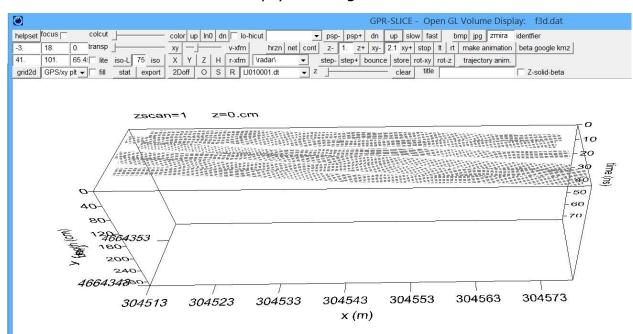
set to the exact sample length as well – generating a volume that is exactly the total resolution of the recorded pulse. Heavy volumes though, may sometimes have limits in Open GL if a good himemory graphics card is not be used.

0	3D Radargram Volume G	eneration: c:\kisatchie\stream-de	emo	- 🗆 🗡
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sample end 512	3d block creation	LI060001.dt		
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x end 304578.	y block size 0	LI080001.dt	0	\bandpass\
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Y end 4664357		LI100001.dt dargram3D File Creation: c:\kisa	~	\stream-demo
x search-cells 1 y search-cells 1 inverse dist wt 2 H_calibration_curve H_calibration_constant 1 2 3 4 5 1 1 1 1 1 1 11 12 13 14 15 1 1 1 1 1 1	smooth     Input       H_calibration_mar     Com       show cal     r       6     7     8       1     1     1       5     C	Directory \filter\ File LI010005.dt piling 3D File rad3d.dat Radar Size 650 x 140 x 125 ompilation Processing 68% Complete cancel LI080002.dt LI090002.dt LI090002.dt LI090002.dt LI090002.dt LI090002.dt LI090002.dt		

#### **Interpolate Gap**

The compilation of the 3D volume can also generate volume with a lot of missing cells. This can happen if the crossline spacing of the antennas in the array are larger than the grid cell size. However, it can also happen if the density of recording along the array track is less dense then the grid cell size in XY. An example of a volume that can be generated if some cells are empty is shown below. This is examined in the Open GL Volume – Texture Method menu. In regular Open GL menu the look can be different. The reason being is that the blending between cells with data is handled slightly different. For example, if a volume were generated with no location in the volume where adjacent cells had data, Open GL Volume – Texture Method may show some of the cells that were filled.

In any event, the data at the desired cell density needs to be interpolated to fill the gap. An inverse distance algorithm is used to only examine empty cells and to interpolate into that cell using the surrounding cells. A search search size of 1 cell in x and y instructs the operation to look out 1 cell in each direction from the empty cell to locate cells with data. Only 1 additional cell needs to be detected for the empty cell to get filled.

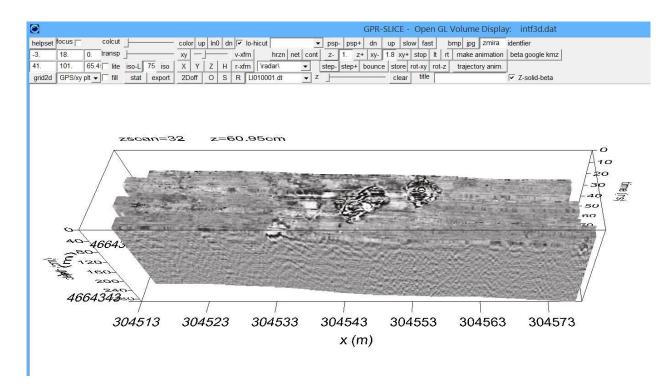


To fill in the gaps in the 3D volume, the Interpolate Gap operation is run. In this example, the x and y search-cells is set 1. The searching looks an equal distance in all directions to fine nearby cells that have data for the inverse distance interpolation. (Optionally, a button called Interpolate All can be used to recalculate all grid cells using nearest neighbor search and inverse distance). The inverse distance weighting exponent (same as in the Grid menu) can be set prior to interpolation. Lower exponents – e.g. 1 will give nearly equal weighting to all cells included whereas 2 or higher will weigh the closest cells higher.

٢	3	D Radargram Volu	me Gei	neration: c:\kisa	atchie\stream-de	mo	_ 🗆 🗡
3D filename ra	id3d.dat	create radar3	) file				
grid cells X,Y	650	0.1 Help Set		infochannels.da	t	_	h + 1
grid cells Z	125	xy cell size		LI010001.dt		C	\radar\
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samples to Ons	3	🗍 focus		LI030001.dt		۲	\filter\
sample start	3			LI040001.dt		C	\migrate\
sample end	512	0.111		LI050001.dt		C	\hilbert\
x start		3d block creatio	n	LI060001.dt		C	\boxcar\
	304513.	y block size 0	_	LI080001.dt		C	\bandpass\
x end	304578.	show blo	ocks	LI090001.dt		C	\topo\
y start	4664343.				-	1	
Y end	4664357.		3D f	ile gap interpola	tion fill: c:\kisa	tchi	e\stream-demo
x search-cells y search-cells inverse dist wt <u>H_calibration_</u> <u>1 2 3</u> <u>1 1 1 1</u> <u>11 12 13</u> <u>1 1 1 1</u>		interpolate gap interpolate all smooth H_calibration_man show cal re 6 7 8 9 1 1 1 1 1	Input I output 3D Vo		rad3d.dat intrad3d.dat 650 x 140 x 125 36% Complete		
				LI070002.dt			
				LI080002.dt			
				LI100002.dt			
				next> <prev< td=""><td></td><td></td><td></td></prev<>			

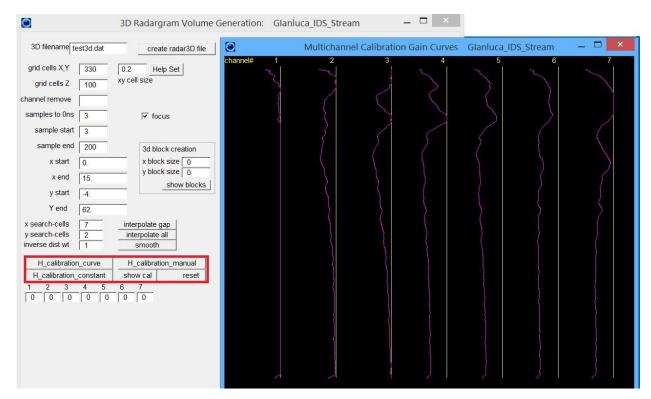
The hardwired identifier "int" gets appended onto the new interpolated 3D filename. This new filename must be selected in the Open GL Volume select 3D volume menu, as it is not automatically set to be the 3D volume for viewing.

An example of the previous dataset with interpolation is shown in the next figure:



#### Multichannel Calibration Gain Curves

Multichannel systems that are being manufactured can suffer from channel imbalances. Even identically manufactured antenna that appears to be identical can have varying gain and frequency responses as well as differences in directional responses. In an attempt to improve the gain balancing between multichannel systems, a new H-Calibration Curve operation is available in the 3D Radargram Volume Generation menu. The calibration gain curves should normally be generated from Hilbert transformed radargrams. This allows for the easiest gain comparison between the different channels. The calibration curves are normalized between the strongest channel at each sample in the digitized radar scan. An example of a 7 channel multichannel system and the calibration gain curves calculated between all the channels is shown in next figure. For this equipment it can be seen that channel 1 appears to be the strongest channel except at the top portions of the radar scan, where channel 3 is the strongest. In the generation of the 3D radargram volume, these gain curves will be applied to the corresponding channel during compilation. Should the user want to shut off using the calibration gain curves there is a Reset button which will set all the gain curves to 1 across the scan. A button called H-Calibration Manual allows the user to manually set variable constant gains across the gain curves and this will read the single channel slots in the menu to insert these values.



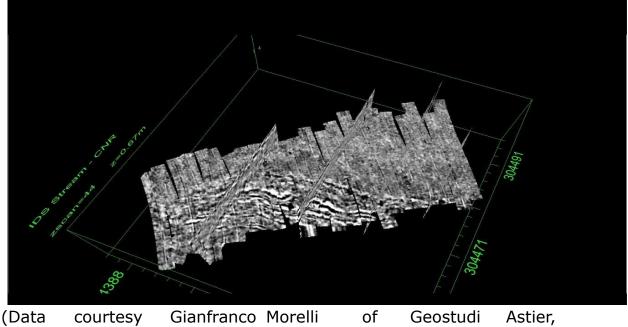
#### **Examples of Multi-Channel Imaging**

Examples of 3 manufacturers: the IDS Stream, Mala Mira, and the 3D Radar Geoscope and images generated from these multichannel systems are shown in Figures 2-4. The quality and resolution seen with the new capabilities in GPR-SLICE without slice/resample and gridding menu is now showing the true capabilities from these state-of-the-art multichannel systems. The manufacturers have solved a lot of engineering issues in the last 18 months which have significantly enhanced the balancing of individual antenna elements which has also greatly improved the image quality.

A recent survey done for a 1.5 hectare section of the Carnuntum site in Austria with 1232 radargrams was compiled to a 3D volume in just 75 seconds - after which viewing in Open GL Volume Texture Method menu could be easily accessed!

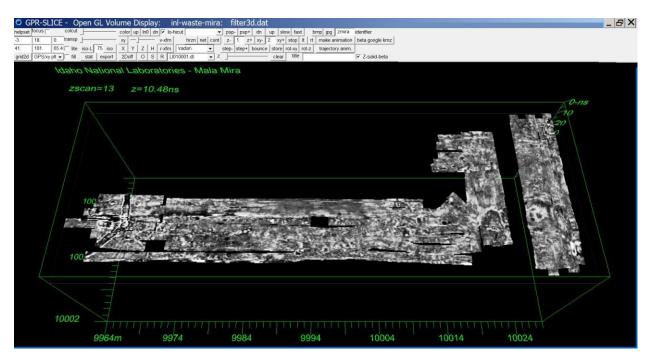
Here is a GPR-SLICE image of the data collected at Dr. Salvatore Piro's CNR Workshop ITABC in Rome made from the IDS Stream 15 channel/12 cm configured GPR system:

# **GPR-SLICE**<sup>©</sup> v7.0 **Multi-Channel**



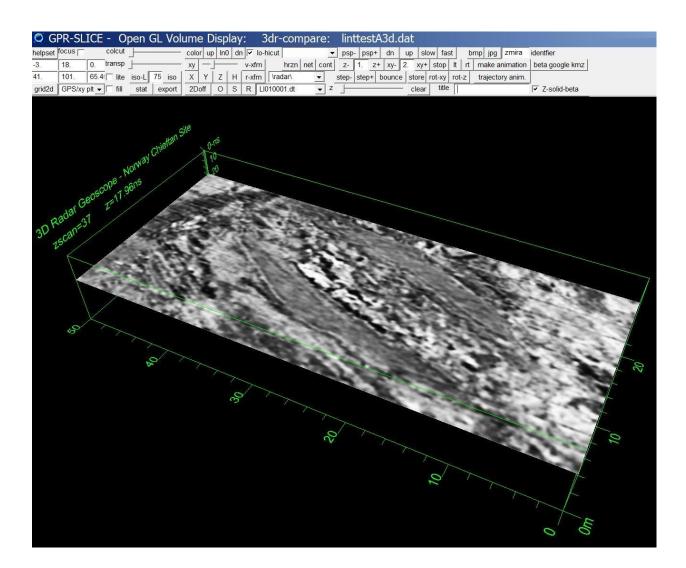
Italy, www.geostudiastier.com)

A GPR-SLICE image was generated from data collected at Idaho National Laboratories using the Mala Mira multichannel GPR system. This equipment was used in a 16channel/8cm antenna separation configuration:



(Data is courtesy of Shawn Williams, Idaho National Laboratories.)

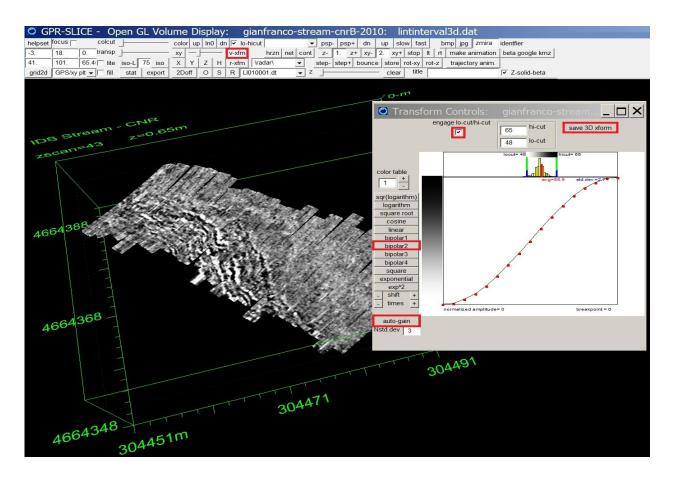
A GPR-SLICE image made from data collected at an archaeological site in Norway and using the 3D Radar Geoscope multichannel system is shown in the next screen shot. The equipment was configured in a 31 channel configuration with 5 cm separation between antenna. The image shown used only half the channels with similar frequency responses. (The data was collected by Kevin Barton of Landscape and Geophysical Services in Ireland and courtesy of 3D Radar Norway).



#### 3D Transform Setting in Open GL

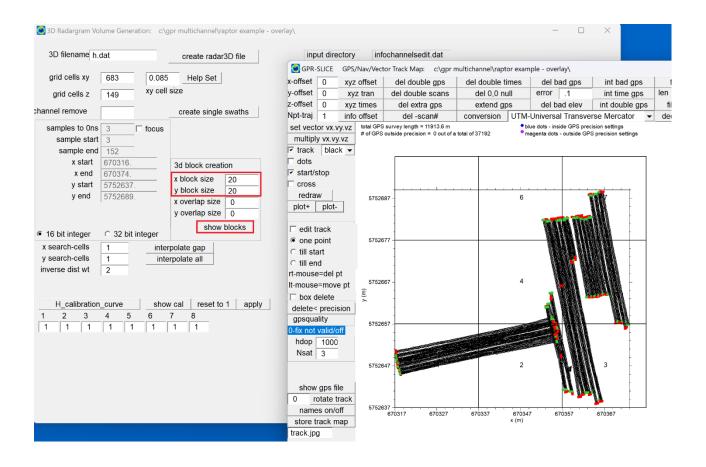
With the new 3D Radargram Volume Generation menu, it will be more common to also generate volumes of the processed pulses. For this reason, it was useful for GPR-SLICE to have additional transforms to optimize the colorization of pulse 3D volumes. Bipolar transforms 1-4 are now included in the 3D and 2D transform controls (see next screenshot). The bipolar settings are necessary to adequately colorized both positive and negative parts of the radar pulses. The quick bipolar buttons create a series of gradual to steep transform changes across the zero of the +/- pulse data.

In addition, there is a flag to engage or disengage the lo-cut/hi-cut threshold settings for N standard deviation from the histogram mean. This checkbox can be set directly within the 3D Transform menu, or it can be engaged/disengaged directly in the Open GL Volume menus. Each time the transform menu is exited or the lo-cut/hi-cut threshold is checked on or off directly in the Open GL menu, the transformed data volume needs to be re-read into memory.



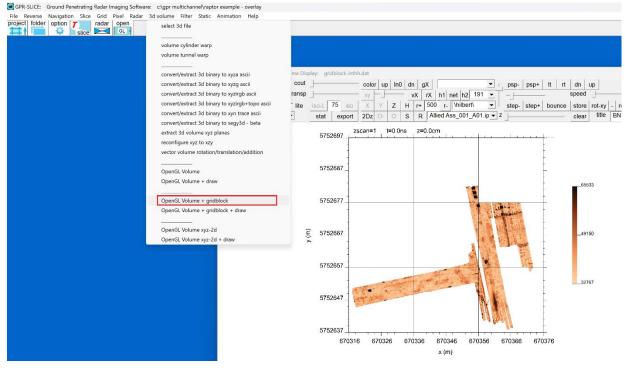
#### **Gridblock Operations**

When multichannel datasets get very large, the compilation of these sites to a single 3D volume will reach its memory limit. To overcome this GPR-SLICE was developed to create partition a site into equal size blocks and then to seamlessly put these blocks back together in OpenGL or in a specialized Pixel map menu. In particular when sites are above 100x100m or even less depending on the density of the multichannel array or the desired density to achieve in the 3D volume, the site can be broken into blocks of a convenient size, e.g. 50x50or 20x20m. The blocks can also be rectangular in length. An example of a block gridded site is shown in the diagram below. In this example the total site is represented by 7 blocks. On creating the 3D file, individual blocks with 1- to N- are appended to the 3D filename. The interpolate button will also automatically interpolate across the gridblock dataset and make a whole new set of 3D files with "int" appended to the filenames.

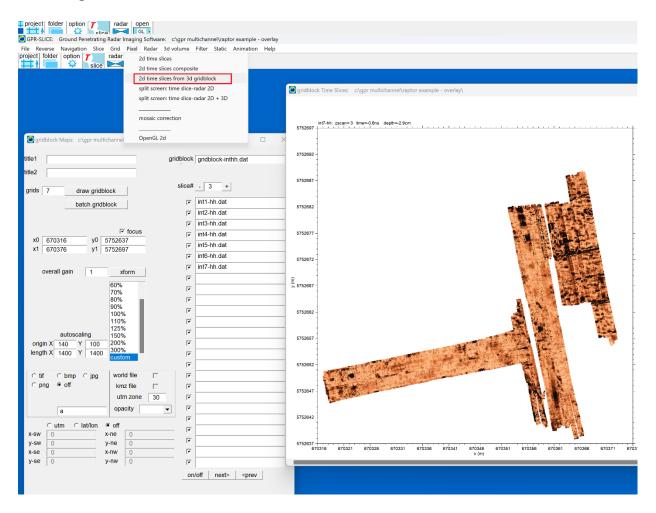


The individual blocks are available for opening separately in OpenGL. To show the entire gridblock dataset one will open the select 3D volume menu and highlight the gridblock dataset. Then they will use the OpenGL Volume + Gridblock operation to display the gridblock dataset in OpenGL. OpenGL displays in gridblock mode are limited to time slice displays. Isosurfaces and other features are disabled.

GPR-SLICE: Ground Penetrating Radar Imaging Softwar	e: c:\gpr multichannel\raptor example - overlay					
	3d volume Filter Static Animation Help					
project folder option 7 radar open	select 3d file					
	volume cylinder warp				_	×
	volume tunnel warp	🕙 3D Datasets		-		~
		3D Volume	BNG			- 1
	convert/extract 3d binary to xyza ascii	3D Volume	gridblock-h.dat			
	convert/extract 3d binary to xyzg ascii		gridblock-hh.dat			
	convert/extract 3d binary to xyzirgb ascii		gridblock-inth.dat gridblock-inthh.dat		_	
	convert/extract 3d binary to xyzirgb+topo ascii		h.dat			
	convert/extract 3d binary to xyn trace ascii		int1-h.dat			
	convert/extract 3d binary to segy3d - beta		int1-hh.dat int2-h.dat			
	extract 3d volume xyz planes					
	reconfigure xyz to xzy	volume size XYZ	708 x 708 x 149			
	vector volume rotation/translation/addition	X start	670316			
		X end	670376			
	OpenGL Volume					
	OpenGL Volume + draw	Y start	5752637			
		Y end	5752697			
	OpenGL Volume + gridblock	Z start.ns	0.			
	OpenGL Volume + gridblock + draw	Z start, lis	0.			
		Z end,ns	29.1			
	OpenGL Volume xyz-2d	data min	32767			
	OpenGL Volume xyz-2d + draw	data was	05500			
		data max	65533			
		resolution	16 bits			



There is also a menu in the Pixel Map pulldown to draw the gridblock dataset. In this menu the user can achieve almost any pixel size resolution up to nearly 65k pixels in both x and y. This menu should be used for making Google Earth or Arc GIS image files as the full resolution of the site can be achieved.



#### Multi-Channel BlueBox Batch Processing

Complete batch processing for all the multi-channel radar systems are available using BlueBox(c) Batch processing menu in the GPR-SLICE. The BlueBox – Customized RSP menu will handle the data processing from raw conversion all the way through signal processing and to compilation of a 3D volume. The BlueBox Batch runs can be launched with a single click of the mouse. The BlueBox Batch runs can include data demultiplexing for some manufacturers. The typical filters used in the Bluebox are:

- Background filter
- Bandpass + simultaneous gain
- Kirchoff migration
- Hilbert transform

Filtering: c:\kisatchie\stream-demo\			- 0
migrate\ migration	input directory	infochannels.dat	
elocity model constant	o \radar\	El010001.dt	DOD hateh
dielectric 4.83 kirchhoff	o \resample\	C Ll020001.dt	RSP batch
Ver minia 0. 137	c \filter\	C LI030001.dt	
width 71	c \migrate\	C LI040001.dt	process 1: background
ample gain 5 search	c \hilbert\	C LI050001.dt	
art 3 end 512	c \boxcar\	C LI060001.dt	
dip angle limit 35 👻 🚺 💭	c \bandpass\	C LI070001.dt	process 2: bandpass
ilbert\ hilbert	c \topo\	C LI080001.dt	
magnitude Katologi	c \regain\	C LI090001.dt	
absolute	o \deconv\	C LI100001.dt	process 3: kirchhoff migration
Iter\ autoset 💌 backgrnd	c \edit\	C LI110001.dt	
length 99000	c \work\	C LI120001.dt	
sample start 3	c \whiten\	C LI130001.dt	process 4: hilbert
sample end 512 backgrnd		C LI140001.dt	
		- C LI150001.dt	
() m	starting radargram# 1	C LI01002.dt	process 5:
	ending radargram# 90	C L1020002.dt	
bxcar boxcar	multithread processing	C LI030002.dt	
th 2 samp start 3	processing graphics	C LI040002.dt	process 6:
ght 2 samp end 512 🔽 🧰	40%	C L1050002.dt	
/hiten\ whiten-gain whiten	#of rows 2 50%	C L1060002.dt	
cut 633 .05	origin x 100 y 130 60%	C L1070002.dt	process 7:
cut 96 MHz	length x 1500 y 400 80%	C L1080002.dt	
	shift x 0 y 530 90%	C L1090002.dt	
andpass\ spectra bandpass	100%	C L1100002.dt	process 8:
+gain	110%	next>   <prev td=""  <=""><td>process 8:</td></prev>	process 8:
	125%		
egain\ norm regain	150% 200%		
	300%		
rm gain 1	custom		
Jalize gain 0.5			
alize gain 0.5 4	export	▼	and the l
			reset log
econv\ bp decons/w cepstrum		Filter Process: bandpass filter	
conv gain 🛛 📥 🔁 🦳			
00		last executed on: 07-15-2018 20:18:28	
impulse spiking decons∗w	\deconv\ fk fi	Iter info file= infochannelsedit.dat	
		input folder=\edit\ # of files= 90	
		# 01 mco- 50	

During the BlueBox Batch runs the user can prompt the software to show a menu to manually adjust settings before batch operations are continued. In particular, the Bandpass filtering + simultaneous gain the user can click the checkbox in front of

bandpass to set a proper gain curve and lo-cut and hi-cut frequency thresholds during the batch operations.

A typical BlueBox menu detailing all the steps for complete automatic processing from start to finish for a project is shown below:

😋 GPR-SLICE Ground Penetrating Radar Imaging Software: mala mira -	richard potter
File Reverse Navigation Slice Grid Pixel Radar 3d volume Filter Static	Animation Help
create new project	
transfer data	
create new info	
edit info file	🕑 BlueBox Batch Run — 🗆 🗙
convert data	infochannels.dat
grid plot	number of channels = 8
gps track	DiveDev Duni Mela Mira
	BlueBox Run: Mala Mira
BlueBox batch processing	user step 1: import \raw\ in Create Info File menu
BlueBox: load/save	
BlueBox: basic	user step 2: click Mira to Nav with infomain.dat in
BlueBox: basic + RSP	Edit Info File menu
BlueBox: basic + editing	user step 3: click Array to Nav with
BlueBox: basic + editing + RSP	infochannels.dat in Edit Info File menu
	user step 4: start the BlueBox Run
BlueBox: xy decoupled gridding + RSP	
BlueBox: xy decoupled gridding + editing + RSP	blue 1: extraction
BlueBox: xy decoupled volume + RSP	blue 2: conversion
BlueBox: xy decoupled volume + editing + RSP	(wobble on)
	blue 3: navigation
	blue 4: radargram editing
BlueBox multichannel batch processing	(threshold=.15 Nsamp back=0)
	blue 5: rsp batch
BlueBox: Mala Mira - customized RSP	l → bandpass
	background (nlen=99000 n1=3 n2=406) hilbert
	blue 5: radargram 3dvolume - prompt 🔽
	✓ help set (xy gridcellsize=.08)
	✓ interpolate gap (intx=1 inty=2)
	compiled folder=hilbert blue 6: Open GL
	blue 6: Open GL
	set all