October 2011

# **Ground Gain**

## **Measurement Procedure**

Addendum to the article "Ground Gain in Theory and Practice" published in DUBUS 3/2011

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### **Personal Notes**

### **1. Introduction**

As an addendum to the article "Ground Gain in Theory and Practice" published in the magazine **DUBUS 3/2011**, this document describes the measurement protocol steps to be performed in order to assess one's own Ground Gain geometry and magnitude or in a more general way one's own antenna elevation pattern in presence of ground effects. The emphasis is on 144 MHz but it could be applicable to other bands through some customization.

The following equipment is required :

- A SSB capable receiving chain with an AGC disabling capability.
- A computer ; any current one will do the job.
- A soundcard, either embedded in the computer or external.
- A link between the receiving chain audio output and the computer soundcard input (Line IN), with a way to adjust the audio level in between.

### 2. Preparation

### 2.1. Step 1 : extract the package content

Unzip the content of the package to the root directory C:\. Don't do it somewhere else (i.e. in another directory), otherwise the Excel macros devoted to data processing will fail to work. You will get a directory with the following structure :



In the different directories, you will find :

- Documentation :
  - The present document, *Ground Gain Measurement Procedure v1-0.pdf*
  - Precedings of the IRE Scatter Propagation Issue Part 1, IRE 1955 Part 1.pdf
  - Precedings of the IRE Scatter Propagation Issue Part 2, IRE 1955 Part 2.pdf
- Measurement campaigns :
  - Examples of real measurements
- Softwares :
  - Spectrum Lab v2.76 b8 (by DL4YHF), Spectrum Lab 2-76.zip
  - o Configuration file Ground Gain Measurement.usr for Spectrum Lab
  - GJTracker (by W7GJ), GJTRACKER.zip
- Tools :
  - *Ground Gain Geometry and Magnitude Calculator File.xlsm* which is a theoretical simulator (MS Excel 2007).
  - *Ground Gain Sun Noise Measurement Processing File.xlsm*, the file (MS Excel 2007) to process the sun noise measurement data records and its desktop shortcut.

### 2.2. Step 2 : install and configure Spectrum Lab

- Install Spectrum Lab in whatever directory (this one not necessarily C:\). I'm using Spectrum Lab under MS Windows XP SP2.
  - In the directory where Spectrum Lab is installed, create the following sub-directories :
    - Captures

٠

- o **Logging**
- Move the file *Ground Gain Measurement.usr* provided in the measurement package to the sub-directory *configurations* of Spectrum Lab.
- Start Spectrum Lab (icon on desktop).
- In the menu toolbar, select File > Load Settings From.. :
  - Go to the sub-directory *configurations* and choose the file *Ground Gain Measurement.usr*.
  - Click on **Open**.

| Look in: 🔒         | configurations              | 🚽 🗢 🖻 C                | * 💷 *               |
|--------------------|-----------------------------|------------------------|---------------------|
| Name               | *                           | Date mod               | lified              |
| gbr_cd.u           | isr<br>ounter.usr           | 14/01/200<br>23/04/201 | 07 21:12<br>1 20:22 |
| Ground             | Gain Measurement.usr        | 1/09/2011              | . 23:53             |
| HumFilt            | er50.usr                    | 23/11/200              | 3 08:46             |
| HumFilt            | er60.usr                    | 23/11/200              | 3 08:45             |
| •                  | III .                       | ]                      | ۲                   |
| file <u>n</u> ame: | Ground Gain Measurement.usr |                        | <u>O</u> pen        |
| iles of type:      | User Profiles (*.usr)       | •                      | Cancel              |
|                    |                             |                        | Help                |

This file contains the customized configuration required for the measurement. You need however some more own customization.

- In the menu toolbar, select Options > Audio settings, I/O device selection :
  - In the tab Audio I/O of the new window, select your own particular soundcard (Audio Input Device) amongst the list. According to your particular soundcard, it could be required to change also the Soundcard Sample Rate (e.g. 11025 Hz instead of 44100 Hz as for mine).
  - If you also want to listen (but it will just be noise), select the **Audio Output Device** too.
  - Click on **Apply** and **Close**.

| SpecLab Configuration and Display Control |   |                          |               |        |                             |  |  |  |  |
|---|---|--------------------------|---------------|--------|-----------------------------|--|--|--|--|
| TRX Control Memory                        | Filenames   | Wave Fi                  | iles 🗍 Marke  | ers    | System Freq-Resp            |  |  |  |  |
| Spectrum (1) (2) (3                       | 3)  (•  | 4) Radio                 | DF FFT        | A      | udio I/O AD/DA Server       |  |  |  |  |
| Audio Input Device                        | Audio Pr  | ocessing                 |               | _      | Samplerate Calibrator       |  |  |  |  |
| 0 Realtek AC97 Audio 🛛 🔻                  | Soundca   | ard Sample Ra            | ate 44100     | -      | Correct Frequency           |  |  |  |  |
| 6 drivers found                           | decim   | ate input SR k           | by 1          | •      |                             |  |  |  |  |
| Ctrl other sources >>                     | Sample R  | ate Calibratio           | n Table [Hz]  |        | Displayed Frequency         |  |  |  |  |
| Audio Output Device                       | Nominal   | Input calib              | Output calib  | ^      |                             |  |  |  |  |
| -1 (use default WAVE ou 🔻                 | 16000   | 16000.000                | 16000.000     |        | Calibrate Input S.R.        |  |  |  |  |
| 6 drivers found                           | 22050   | 22050.000                | 22050.000     |        |                             |  |  |  |  |
| r∰ Ctrl other destinations >>             | 32000   | 32000.000                | 32000.000     |        | Calibrate Output S.R.       |  |  |  |  |
|   | <u> </u>  | male to pomin            |               |        |                             |  |  |  |  |
| 16 <b>T</b> bits/sample                   | Presample to nominal output S.R. Drift Calibrator |                          |               |        |                             |  |  |  |  |
| Stereo Processing                         | j user  | anterenii sanı<br>Domina |               | uput   |                             |  |  |  |  |
| l♥ minimize ratency                       |   | Homine                   | a. 140000     | 112    | 💡 about SR calib.           |  |  |  |  |
| <u>iva input aujustment</u>               | Resa  | mpling quality           | high          | -      |                             |  |  |  |  |
|   |   |                          |               |        | Analyzay 4 shares 14 (1)    |  |  |  |  |
|   |   |                          | nown: Setting | is for | Analyser 1, channel 1 (L)   |  |  |  |  |
|   |   | ~                        | 🗸 Apply       |        | Close <b>?</b> <u>H</u> elp |  |  |  |  |

- In the menu toolbar, select **Options > System settings > Timezone, Time source, Timer Calibration**:
  - In the tab Loc, Timezone, Time source, set Local time MINUS UTC(GMT) according to your location.
  - Click on **Apply** and **Close**.

| SpecLab Configuration and Display Control 🛛 🛛 🔀  |
|--|
| Spectrum (1)      (2)      (3)      (4)       Radio DF       FFT       Audio I/O       AD/DA Server         TRX Control       Memory       Filenames       Wave Files       Markers       System       Freq-Resp   |
| Loc, Timezone, Time source       Timer calibration       HR-Timer-Test       ADC input calib       Misc. (1)         Timezone       Primary "Time"-Source       Current value:       17:27:08.2         -> Resulting system time in UTC:       Use audio-sampling clock (requires calib, best accuracy, almost no jitter, preferred)       Use high-resolution timer (jittery sometimes)         0       Use the PC's "system" time (worst jitter)         Default Receiver Location       (geographic position, used when GPS receiver not available)         50° 36 ' 34.3"N       004° 00 ' 22.1"'E         0       Maidenhead       @ deg",min',sec" |
| Shown: Settings for Analyser 1, channel 1 (L)  |

For example in Belgium in winter, we are at UTC+1h local time (UTC+2h in summer)  $\rightarrow$  e.g. UTC is 12:00, local time is 13:00 in winter (14:00 in summer). So, **Local time MINUS UTC(GMT)** is 1 (13-12) in winter and 2 in summer.

The computer must be synchronized on a NTP time server (there are many softwares to achieve this, e.g. D4, Chronos, Meinberg,...).

- Finally, in the menu toolbar, select File > Save Settings As.. :
  - Replace *SETTINGS.INI* by *Ground Gain Measurement.usr* chosen in the list.
  - o Click on Save.

| Save in: 退 configurations          | - + 🖻 (                | * 📰 🕇               |
|------------------------------------|------------------------|---------------------|
| Name                               | Date mod               | lified              |
| gbr_cd.usr<br>GeigerCounter.usr    | 14/01/200<br>23/04/201 | 07 21:12<br>1 20:22 |
| Ground Gain Measurement.usr        | 2/09/2011<br>23/11/200 | 10:48<br>)3 08:46   |
|                                    | 23/11/200              | 15 U8:45 ·          |
| ile <u>n</u> ame: SETTINGS.INI     |                        | <u>S</u> ave        |
| ave as type: User Profiles (*.usr) | •                      | Cancel              |
|                                    |                        | Help                |

That is all, don't change anything else ; FFT, noise measurement formulas,... are already included in the *Ground Gain Measurement.usr* file.

• **Close** Spectrum Lab. For the subsequent measurements, Spectrum Lab is now configured once and for all.

### 2.3. Step 3 : install and configure GJTracker

- Install GJTracker (provided in the measurement package) on your computer, wherever you wish (in any directory).
- Start GJTracker and configure with your own data according to the following screenshot :

| GJTRACKER Versio |                 | GJTRACKER |                       |              |                  | End Date Apr - 2 - 2011 |                   |              |             |               |                  |                       |                |
|------------------|-----------------|-----------|-----------------------|--------------|------------------|-------------------------|-------------------|--------------|-------------|---------------|------------------|-----------------------|----------------|
| Display          | Callsign/Lookup | Locator   | Add                   | Deg          | Latitud<br>Min S | e<br>Sec                | Dir               | Deg          | Long<br>Min | jitude<br>Sec | Dir              | Deg<br>Above          | jrees<br>Below |
| ☑ Home           | ON4KHG          |           |                       | 50           | 36               | 34                      | N -               | 4            | 00          | 22            | E                | · -10                 | 90             |
| DX Stn           |                 |           |                       |              |                  |                         | •                 |              |             |               |                  | ·                     |                |
| Object<br>Sun    | ·               |           |                       |              |                  |                         |                   |              |             |               | [                | Operati<br>Planning   | on<br>•        |
| Increment 1      | Minutes ES      |           | Rcvr nois<br>temp deg | e 80<br>K 80 |                  | M<br>De                 | laximur<br>egrada | n dB<br>tion | 0           | C<br>F        | Compu<br>lours n | ter Clock<br>ninus UT | c 2            |
| Lines per out    | outpage 360 Re  | gion 1 🗸  | Units kn              | n - E        | Band 1           | 44 -                    | - Te              | ext Edi      | itor C      | :\wind        | ows\n            | otepad.e              | xe             |
|                  | RUN             | SET DEFA  | ULTS                  | RES          | START            | ·                       | H                 | HELP         |             |               | EXIT             | ·                     |                |

- Lines per output page : set to "3600" (to ease subsequent processing work).
- **Computer Clock Hours minus UTC** : set in the same way as for Spectrum Lab, explained in section 2.2.
- Click on **SET DEFAULTS**, so that at next start all but the date will remain the same. GJTracker is now installed once and for all.
- Exit (close) GJTracker.

### 3. Measurement

### 3.1. Step 1 : plan the measurement

As an example, let's define the measurement takes place on April 2<sup>nd</sup>, 2011.

- Open GJTracker.
- Set Start Date, then End Date to "Apr 2 2011".
- Click on **RUN**.

| GJTRACKER Ver | sion 2.0.9     |            |                          |                   |                |                   |             |                         |                     |                  | • X          |  |
|---------------|----------------|------------|--------------------------|-------------------|----------------|-------------------|-------------|-------------------------|---------------------|------------------|--------------|--|
| Start Date    | Apr • 2 • 2    |            | GJTRACKER                |                   |                |                   |             | End Date Apr - 2 - 2011 |                     |                  |              |  |
| Display       | Callsign/Looku | up Locator | Add D                    | Latitu<br>Deg Min | ide<br>Sec Dir | Dea               | Long<br>Min | itude<br>Sec            | Dir /               | Degr<br>Above    | ees<br>Below |  |
| ⊡ F Home      | ON4KHG         |            | 5                        | 50 36             | 34 N           | • 4               | 00          | 22                      | Е·                  | -10              | 90           |  |
|               | n              |            |                          |                   |                | •                 |             |                         |                     |                  |              |  |
| Objec         | x              |            |                          |                   |                |                   |             |                         | c                   | peratio          | n            |  |
| Sun           |                |            |                          |                   |                |                   |             |                         | Pla                 | inning           | •            |  |
| Increment     | Minutes E      | ESC Y -    | Rcvr noise<br>temp deg k | < <sup>80</sup>   | Maxi<br>Degr   | mum dB<br>adation | 0           | Co<br>Ho                | omputer<br>ours min | Clock<br>nus UT( | 2            |  |
| Lines per o   | utput page 360 | Region 1 - | Units km                 | - Band            | 144 -          | Text Ed           | litor C     | \windo                  | ws\note             | pad.ex           | e            |  |
|               | RUN            | SET DEFA   | ULTS                     | RESTAF            | ат [           | HELP              |             |                         | EXIT                | E.               |              |  |

• Here is an extract of the output text file :

| APR 2, 2<br>SATURDAY<br>JD: 24556  | 2011<br>553.5  | PO   | SITION C   | OF Sun FROM (  | DN4KHG | 50 ° 36' 34" N<br>4 ° 0 ' 22" E<br>(QTH:JO10xo) |
|--|--|--|--|--|--------|---|
| UTC AZ   | IMUTH  | ELEV   | DEC  | RT ASCN  |        |   |
| 0420<br>0421<br>0422<br>0423<br>0424<br>0425<br>0426<br>0427<br>0428<br>0429<br>0430<br>0431<br>0432<br>0433<br>0434<br>0435<br>0436<br>0437 | 69.8<br>70.0<br>70.2<br>70.4<br>70.6<br>70.8<br>71.0<br>71.2<br>71.4<br>71.6<br>71.8<br>72.0<br>72.2<br>72.4<br>72.6<br>73.0<br>73.2 | -9.9<br>-9.8<br>-9.6<br>-9.5<br>-9.3<br>-9.0<br>-8.9<br>-8.7<br>-8.6<br>-8.4<br>-8.2<br>-8.1<br>-7.9<br>-7.8<br>-7.5<br>-7.5<br>-7.3 | $\begin{array}{c} 4.8\\ 4.8\\ 4.8\\ 4.8\\ 4.8\\ 4.8\\ 4.8\\ 4.8\\$ | OH 44M<br>OH 44M |        |   |

• Save this file under the name Sun Az-El.txt in the directory C:\Sun Noise Measurement.

It is important to respect the naming convention given here (both directory and file names), otherwise the processing macros in Excel won't work !

• **Exit** (close) GJTracker.

On April 2<sup>nd</sup>, 2011 for my location, the sun rises at 05:24 UTC (azimuth 82.4°) and sets at 18:12 UTC (azimuth 277.9°).

### 3.2. Step 2 : equipment warm-up

Equipment settings and conditions for a reliable measurement are as follows :

- Transceiver or receiver AGC (Automatic Gain Control) set to OFF.
- Transceiver or receiver set in SSB mode (200-2200Hz bandwidth required).
- Whole receiving chain (RX and soundcard) assumed to be linear.
- Transceiver or receiver Noise Blanker (NB) set to ON. The white noise to be measured is normally not altered by the NB, while the pulse noises (disturbing the measurement) will be suppressed.
- A clear frequency, not subject to disturbances (QRM).
- The whole station and computer powered ON at least 12 hours before performing the measurement, so that the whole setup is stable and at temperature during the measurement.
- Good weather with no wind or rain to avoid static noise.

### **3.3.** Step 3 : reference noise (N<sub>reference</sub>)

When the sun is below -10° elevation for a sun rise measurement or above +35° elevation for a sun set measurement :

• Connect a  $50\Omega$  load at the input of the RX chain, as depicted below :



If you are not using a transverter, consider placing a preamp. in front of the transceiver or receiver, particularly if this last is a commercial model, to overcome the possible poor sensitivity and to allow the small (sun) noise variations (few dB's) to be noticed. In this case, the RX chain will look like :



- Start Spectrum Lab.
- Adjust the audio level out of the transceiver or receiver to get the yellow curve on the spectrum window around -50/-60 dB (this is not critical). Once adjusted, don't touch it anymore during the course of the subsequent steps of the measurement.



• Adjust the colour palette sliders as you wish. Don't touch it anymore afterwards.



- In the menu toolbar, select File > Text file export > Export of calculated data :
  - In the tab Filename & Activation, type in the file name as shown on the screenshot below (*Nreference.txt*).
  - Click on Apply.

| Spectrum Lab – File Export Format  | X    |
|--|------|
| File Contents Filename & Activation Export of FFT results  |      |
| Export File #1: LoggingWreference.txt  |      |
| Export File #2:  |      |
|  |      |
| 🔲 power-fail safe  |      |
| ✓ Use write interval :         10.0         seconds, next write at:         11:17:05.8         Synchronize ! |      |
| Whenever a spectrum has been calculated, execute these commands:   |      |
|  | Test |
| Before writing a line to the export file, execute these commands:  |      |
|  | Test |
| After writing a line to the export file, execute these commands:   |      |
| export.value[3]=1  | Test |
|  |      |
| <ciick and="" here="" result="" test="" the="" watch=""></ciick>   |      |
| Menu 🤆 Apply 🗸 OK 🗶 Cancel 💡   | Help |

It is very important to click on **Apply**, otherwise the measurement will further proceed on the previously named file.

To effectively start the measurement :

- Check in the checkbox Active. The Size will start to grow.
- Leave the measurement running up to when the **Size** has reached around 500 to 1000 (not critical).

Active Size:671

• Uncheck the checkbox **Active** to stop the measurement.

You can click on **OK** to close the window, but it is not required at this stage to close this window ; leave it open.



### 3.4. Step 4 : background noise before sun noise measurement (N<sub>bgd</sub> PRE)

Once Step 3 is completed :

• Disconnect the  $50\Omega$  load and connect the antenna line. Don't forget to set the external (masthead) preamp. in by-pass mode.



• Rotate the antenna towards the first azimuth onto which N<sub>bgd</sub> has to be measured.

For the example given here, the azimuth span ranges from 65° to 140°. Let's start with 65°.

- Direct your antenna to 65° azimuth.
- In Spectrum Lab name the data to record as on the screenshot below (*Nbgd 65deg PRE.txt*).

| Spectrum Lab – File Export Format  | X              |
|--|----------------|
| File Contents Filename & Activation Export of FFT results                  |                |
| Export File #1: LoggingWbgd 65deg PRE.txt Cative Size:0                    |                |
| Export File #2:  |                |
|  |                |
| 🔽 power-fail safe  |                |
| Use write interval : 10.0 seconds, next write at: 11:17:05.8 Synchronize ! |                |
| Menever a spectrum has been calculated, even to these commands:            |                |
| vinenever a spectrum has been calculated, execute these commands.          | Test           |
| J<br>Before writing a line to the export file, execute these commands:     |                |
| Defore whiting a line to the export file, execute these commands.          | Test           |
| After writing a line to the export file, execute these commands:           |                |
| export.value[3]=1  | Test           |
|  |                |
| <click and="" here="" result="" test="" the="" watch=""></click>           |                |
|  |                |
| Menu 🤆 Apply 🗸 OK 🗶 Cancel \Upsilon  | ? <u>H</u> elp |
|  |                |

- Click on Apply
- Check the **Active** checkbox to start the measurement. The **Size** starts to grow every 10 seconds.
- Leave the measurement running until the **Size** has reached around 500 to 1000 (not critical).

Active Size:671

- Uncheck the checkbox to stop the measurement.
- Then rotate the antenna towards 70° :
  - Update the file name (now *Nbgd 70deg PRE.txt* instead of *Nbgd 65deg PRE.txt* as above).
  - Click on **Apply**.
  - Check the **Active** checkbox and uncheck it once the size has reached 500 to 1000.

And so on up to 140° azimuth, per 5° azimuth steps.

The overall sequence is as shown hereunder.

In the menu toolbar, select File > Text file export > Export of calculated data :

Name the data file to record (mandatorily as Nbgd xdeg PRE.txt ; x = 0 to 360).

Azimuth x+5°

- Click Apply.
  - Check in checkbox Active to start.
- • Once size has reached 500 to 1000, uncheck to stop.

### 3.5. Step 5 : sun noise (N<sub>sun</sub>)

Right after Step 4 has been performed, the sun should be around -5° elevation for a sun rise measurement or around 30° elevation for a sun set one. Measure the sun noise in tracking mode up to around 30° (sun rise) or down to around -5° elevation (sun set). "Tracking mode" suggests an automatic way for the antenna to follow the motion of the sun in azimuth ; otherwise, you need to manually adjust the antenna position from time to time.

Once the antenna is set to the proper azimuth and ready to follow the motion of the sun, go to the menu toolbar of Spectrum Lab, select File > Text file export > Export of calculated data :

- Name the data file to record, mandatorily as *Nsun.txt*.
- Click on **Apply**.

| Spectrum Lab – File Export Format  | X    |
|--|------|
| File Contents Filename & Activation Export of FFT results  |      |
| Export File #1: LoggingWsun.txt  |      |
| Export File #2: Active Size:0  |      |
|  |      |
| 🔽 power-fail safe  |      |
| ✓ Use write interval :         10.0         seconds, next write at:         17:59:15.8         Synchronize ! |      |
| Whenever a spectrum has been calculated, execute these commands:   |      |
|  | Test |
| Before writing a line to the export file, execute these commands:  |      |
|  | Test |
| After writing a line to the export file, execute these commands:   |      |
| export.value[3]=1  | Test |
| caliat TEST and watch the regult here?   | —    |
| CITCA TEST and watch the result here?  |      |
| Menu K Apply V K K Cancel ?!   | Help |

- Check in checkbox **Active** to start (\*).
- Let the measurement running and once the sun is out of range, i.e. above 30° elevation (sun rise) or below -5° elevation (sun set), uncheck **Active** to stop.

This measurement can take several hours, according to your latitude and period of the year.

To allow identifying *a posteriori* if some disturbance occurred during the measurement, it is wise to activate screenshot captures <u>prior to start</u> the measurement (\*). To accomplish this, follow the steps below.

- In the menu toolbar, select File > Screen Capture > Screen Capture options.. :
  - In the tab Screen Capture, Set File Index to 1 and Filename to any name you want (no specific naming convention required here).
  - Click on **Apply**.

| 🔀 Screen Capture, Periodic and Scheduled Actions  | ×  |
|---|--|
| Periodic Actions       Scheduled Actions       Conditional Actions       Screen Capture       Ca         Screen Capture options       Include:       Include:       Include:       Include:       Include:         File index:       1       2       Color legend       RDF circle         Filename:       Captures\Capt Sun Rise 02042011-       RDF circle       RDF circle         show info in a solid box       pos Left,Bottom       stack vertical       Implement         "Date="+str("YYYY-MM-DD",now)+" Time="+str("hh:mm",now)       Implement       Implement         "Freq= "+str("###0.#",water.f_min)+""+str("###0.#",water.f_max)+" Hz"       Implement         Implement       Implement       Implement | File Format<br>File Format<br>BMP<br>FILE Format<br>DPG<br>JPEG Quality<br>80 %<br>Capture now<br>Update preview |
| Click here to update preview  |  |
| K Apply V Ok K Cancel ? Help  |  |

• In the tab **Periodic Actions**, check in the checkbox **active** and then **OK**.

| 🔀 Screen Capture, Periodic and Scheduled Actions 🛛 🔀   |
|--|
| Periodic Actions Scheduled Actions Conditional Actions Screen Capture Capture Macros                               |
| ▼ active From 00:00:00 to 23:59:59 Interval 00:12:00 (hh:mm:ss)  |
| Action macro(s) Example: capture   |
| capture  |
|  |
| Test ->  |
| Note: the 'capture' command may execute other macros<br>which are defined on the <u>screen capture macro</u> tab ! |
| 🔆 Apply 🗸 Ok 🕺 K Cancel 💡 Help   |

This will generate a screenshot capture named **Capt Sun Rise 02042011-1**. After 12 minutes, the next capture will be **Capt Sun Rise 02042011-2** and so on every 12 minutes throughout the whole measurement.

### 3.6. Step 6 : background noise after sun noise measurement (N<sub>bgd</sub> POST)

When the sun is out of influence (above +35° for a sun rise or below -10° elevation for a sun set), repeat exactly (over the same azimuth span) the measurement performed at step 4 but in the data file names, use here **POST** instead of **PRE**.

For example, *Nbgd 70deg PRE.txt* at step 4 will be now *Nbgd 70deg POST.txt*.

| Spectrum Lab – File Export Format   | ×                    |
|---|----------------------|
| File Contents Filename & Activation Export of FFT results   |                      |
| Export File #1: LoggingWbgd 70deg POST.txt  | Active Size:136      |
| Export File #2:   | C Active Size:0      |
| <ul> <li>power-fail safe</li> <li>✓ Use write interval : 10.0 seconds, next write at: 18:01:05.8</li> </ul> | Synchronize !        |
| Whenever a spectrum has been calculated, execute these commands:  |                      |
|   | Test                 |
| Before writing a line to the export file, execute these commands:   |                      |
|   | Test                 |
| After writing a line to the export file, execute these commands:  |                      |
| export.value[3]=1   | Test                 |
|   |                      |
| <pre><click and="" here="" result="" test="" the="" watch=""></click></pre>                                 |                      |
| Menu 🤆 Apply 🗸 OK   | Cancel <b>?</b> Help |

### 4. Post processing

### 4.1. Process the data files

Since the measurement data collection is now finished, we can move to the next step which is the process of the data.

- Copy the files included in the sub-directory *Logging* of Spectrum Lab to C:\Sun Noise Measurement.
- Delete these files from the same sub-directory *Logging* of Spectrum Lab, otherwise any future measurement will further proceed on the preceding files if these are not deleted.

In the directory C:\Sun Noise Measurement, you have now the following types of files :

| Sun Az-El.txt      | Azimuth & elevation of the sun  |
|--------------------|---|
| Nreference.txt     | Reference noise level when RX chain connected to a 50 $\Omega$ load (calibration) |
| Nbgd xdeg PRE.txt  | Background noise when RX chain connected to the antenna, <u>before</u> the sun    |
|                    | noise measurement, per 5° azimuth steps   |
| Nsun.txt           | Sun noise in manual or automatic tracking mode from -5° (sun rise) or 30°         |
|                    | (sun set) elevation to 30° (sun rise) or -5° (sun set) elevation                  |
| Nbgd xdeg POST.txt | Background noise when RX chain connected to the antenna, after the sun            |
|                    | noise measurement, per 5° azimuth steps   |

- In the sub-directory *Tools* provided with the package, open the file *Ground Gain Sun Noise Measurement Processing File.xlsm*.
- (1) : In the drop down lists on the left, select the measurement type, azimuth range and date.
- (2) : Click on **Clear All** prior to launch any new file upload.



| Azimuth | Action | File Name      |                 | Status |                  | Status |
|---------|--------|----------------|-----------------|--------|------------------|--------|
|         |        | Nsun.txt       | Upload File     |        |                  |        |
|         |        | Sun Az-El.txt  | Upload File     |        |                  |        |
|         |        | Nreference.txt | Upload File     |        |                  |        |
|         |        |                |                 |        |                  |        |
| 0       |        |                | Upload PRE File |        | Upload POST File |        |
| 5       |        |                | Upload PRE File |        | Upload POST File |        |
| 10      |        |                | Upload PRE File |        | Upload POST File |        |
| 15      |        |                | Upload PRE File |        | Upload POST File |        |
| 20      |        |                | Upload PRE File |        | Upload POST File |        |
| 25      |        |                | Upload PRE File |        | Upload POST File |        |
| 30      |        |                | Upload PRE File |        | Upload POST File |        |
| 35      |        |                | Upload PRE File |        | Upload POST File |        |
| 40      |        |                | Upload PRE File |        | Upload POST File |        |

- (3) : In the field File to upload, select alternatively :
  - Az. El., then click on Upload File in front of the corresponding file name (*Sun Az-El*), preceded by File to upload highlighted in orange in the column Action.



REFERENCE, then click on Upload File in front of the corresponding file name (*Nreference*), preceded by File to upload highlighted in orange in the column Action.
 PRE, then click on Upload File in front of the corresponding file name (*Nbgd xdeg PRE*), preceded by File to upload highlighted in orange in the column Action.

| 60  |                  |                     | Upload PRE File | Upload POST File |  |
|-----|------------------|---------------------|-----------------|------------------|--|
| 65  | File to upload : | Nbgd 65deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 70  | File to upload : | Nbgd 70deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 75  | File to upload : | Nbgd 75deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 80  | File to upload : | Nbgd 80deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 85  | File to upload : | Nbgd 85deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 90  | File to upload : | Nbgd 90deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 95  | File to upload : | Nbgd 95deg PRE.txt  | Upload PRE File | Upload POST File |  |
| 100 | File to upload : | Nbgd 100deg PRE.txt | Upload PRE File | Upload POST File |  |
| 105 | File to upload : | Nogd 105deg PRE txt | Upload PRE File | Upload POST File |  |
| 110 | File to upload : | Nbgd 110deg PRE.txt | Upload PRE File | Upload POST File |  |
| 115 | File to upload : | Nbgd 115deg PRE.txt | Upload PRE File | Upload POST File |  |
| 120 | File to upload : | Nbgd 120deg PRE.txt | Upload PRE File | Upload POST File |  |
| 125 | File to upload : | Nbgd 125deg PRE.txt | Upload PRE File | Upload POST File |  |
| 130 | File to upload : | Nbgd 130deg PRE.txt | Upload PRE File | Upload POST File |  |
| 135 | File to upload : | Nbgd 135deg PRE.txt | Upload PRE File | Upload POST File |  |
| 140 | File to upload : | Nbgd 140deg PRE.txt | Upload PRE File | Upload POST File |  |
| 145 |                  |                     | U. I. I DOG ST  | U. I. IROSTICI   |  |

- **SUN**, then click on **Upload File** in front of the corresponding file name (*Nsun*), preceded by **File to upload** highlighted in orange in the column **Action**.
- **POST**, then click on **Upload File** in front of the corresponding file name (*Nbgd xdeg POST*), preceded by **File to upload** highlighted in orange in the column **Action**.

|     |                  |                      | opiouurnerne    |   | opiouurostitie   |  |
|-----|------------------|----------------------|-----------------|---|------------------|--|
| 65  | File to upload : | Nbgd 65deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 70  | File to upload : | Nbgd 70deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 75  | File to upload : | Nbgd 75deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 80  | File to upload : | Nbgd 80deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 85  | File to upload : | Nbgd 85deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 90  | File to upload : | Nbgd 90deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 95  | File to upload : | Nbgd 95deg POST.txt  | Upload PRE File |   | Upload POST File |  |
| 100 | File to upload : | Nbgd 100deg POST.txt | Upload PRE File | × | Upload POST File |  |
| 105 | File to upload : | Nbga 105deg POST.txt | Upload PRE File |   | Upload POST File |  |
| 110 | File to upload : | Nbgd 110deg POST.txt | Upload PRE Eile |   | Upload POST File |  |
| 115 | File to upload : | Nbgd 115deg POST.txt | Upload PRE File |   | Upload POST File |  |
| 120 | File to upload : | Nbgd 120deg POST.txt | Upload PRE File |   | Upload POST File |  |
| 125 | File to upload : | Nbgd 125deg POST.txt | Upload PRE File |   | Upload POST File |  |
| 130 | File to upload : | Nbgd 130deg POST.txt | Upload PRE File |   | Upload POST File |  |
| 135 | File to upload : | Nbgd 135deg POST.txt | Upload PRE File |   | Upload POST File |  |
| 140 | File to upload : | Nbgd 140deg POST.txt | Upload PRE File |   | Upload POST File |  |
|     |                  |                      |                 |   |                  |  |

When the files are uploaded, the status becomes **File uploaded**, highlighted in green.

| Meas. Type :<br>Lowest azimuth :<br>Highest azimth :<br>Day :<br>Month :<br>Year : | Sun Rise | <u>Clear All</u> | File to upl | oad : POST 💌  | Process Files<br>RSF & Station Data (4) |
|--|----------|------------------|-------------|---------------|---|
| Azimuth  | Action   | File Name        |             | Status        | Status                                  |
|  |          | Nsun.txt         | Upload File | File uploaded |   |
|  |          | Sun Az-El.txt    | Upload File | File uploaded |   |
|  |          | Nreference.txt   | Upload File | File uploaded |   |

### • (4) : Click on **RSF & Station Data**, you get the following window :

| Ph<br>Pł | Frequency [MHz] :<br>ysical Temperature [*C] :<br>iysical Temperature [K] : | 144.3<br>17<br>290 | Ante     | nna<br>Jumper           | Preamp.          | Pream                    | rp. BP Filte        | ansverter<br>Ar Mixer | Amplifier                 | Feeder 2 | Transceiver |
|----------|---|--------------------|----------|-------------------------|------------------|--------------------------|---------------------|-----------------------|---------------------------|----------|-------------|
|          |   |                    |          |                         |                  |                          |                     |                       | ĸx                        |          |             |
|          |   |                    |          |                         |                  |                          | Sys                 | tem                   |                           |          |             |
|          |   |                    |          |                         |                  |                          |                     |                       |                           |          |             |
|          |   | Antenna            | Jumper   | Preamp.<br>(External)   | Feeder 1         | Preamp.<br>(Transverter) | Band-Pass<br>Filter | Mixer                 | (Post-mixer)<br>Amplifier | Feeder 2 | Transceiver |
|          | Gain G [dB(i)] :  | 16.30              | -0.10    | -0.10                   | -0.80            | 22.00                    | -2.00               | -7.00                 | 9.00                      | -4.00    |             |
|          | Gain g [ ] :  | 42.66              | 0.98     | 0.98                    | 0.83             | 158.49                   | 0.63                | 0.20                  | 7.94                      | 0.40     |             |
| [        | Noise Figure NF [dB] :  |                    | 0.10     | 0.10                    | 0.80             | 0.40                     | 2.00                | 7.00                  | 2.50                      | 4.00     | 6.00        |
| <u> </u> | Noise Factor f [ ] :  |                    | 1.02     | 1.02                    | 1.20             | 1.10                     | 1.58                | 5.01                  | 1.78                      | 2.51     | 3.98        |
| _ L      | Noise Temp. T [K] :   |                    | 6.75     | 6.75                    | 58.66            | 27.98                    | 169.62              | 1163.44               | 225.70                    | 438.45   | 864.51      |
|          | Tload [K] :   | 290.00             | F        | <b>(SF</b> 2800 [sfu] : | 108.0            | Type in the RSF28        | 00 from U.S. S      | W.P.C.                |                           |          |             |
|          | T(  | 250 /6             |          | PCF. [cfu] :            | 27.0             | Polync                   | imial method        |                       |                           |          |             |
|          | Nieference [K] :  | -61 11             |          | RSEv[sfu] :             | 71               | x = 144 (Polynomi        | al) or 50, 70, 1    | 44 (EME C             | alculator of VK3UA        | 40       |             |
|          | Melence[UD].  | 01.11              | Tant sun | Tant sun [K] :          | 377.48<br>374.93 | x - 144 (Folynolin       | a, or 50, 70, 1     | ++, (ENVE C           | nearator of VNJON         | "'       | Go Back     |

- According to your specific RX station data, fill in <u>only</u> the cells highlighted in yellow (all the others in grey show calculated figures). If you are not using a transverter, refer to the Annexes (section 6.1.).
- Select the RSF<sub>x</sub> (x is the frequency band) calculation method and fill in the associated RSF figure, prompted by a dynamic cell highlighted in dark red. Two methods are possible :
  - <u>Method 1</u>: a polynomial law that extrapolates the RSF<sub>2800</sub> (2800 MHz) down to 144 MHz, thanks to the data got from the U.S. Space Weather Prediction Centre website : <u>http://www.swpc.noaa.gov/ftpdir/lists/radio/rad.txt</u>

Example of a U.S. Space Weather Prediction Centre data :



 <u>Method 2</u>: data out of the EME Calculator of Doug, VK3UM. In this case, data for other bands than only 144 MHz are also available.

The software can be downloaded here : <u>http://vk3um.com</u>

If it is about using this software only to derive de RSF figures, there is no need to configure it, just install it anywhere on you computer.

In VK3UM EME Calculator, click on **GET IPV SFV DATA** at the top left of the window. A new window (**IPS Update**) appears. Click on **Current IPS Flux Data**.



The data got from the EME Calculator of VK3UM have proven to be more reliable in case of high or stormy solar activity.

- Click on **Go Back** at the bottom right of the window to come back to the previous window.
- In this previous window, click on **Process Files**.

| Meas. Type :<br>Lowest azimuth :<br>Highest azimth :<br>Day :<br>Month :<br>Year : | Sun Rise | Clear All      | File to up  | load : POST 💌 | Process Files<br>RSF & Station Data |
|--|----------|----------------|-------------|---------------|-------------------------------------|
| Azimuth  | Action   | File Name      |             | Status        | Status                              |
|  |          | Nsun.txt       | Upload File | File uploaded |                                     |
|  |          | Sun Az-El.txt  | Upload File | File uploaded |                                     |
|  |          | Nreference.txt | Upload File | File uploaded |                                     |

### 4.2. Publish the Report

Once the files are processed, you get two resulting charts. Here a manual operation is required on <u>both charts</u> before completion.

### 4.2.1. Sun rise measurement

In MS Excel (2007) :

 In the menu toolbar, select Layout > Axes > Primary Vertical Axis > More Primary Vertical Axis Options...

|  | • •  | A COLORED IN COLOR                                      |   | Chart Tools   |                                   | Gro   | und Gain Sun Noise Measure   |
|--|--|---|---|---|-----------------------------------|---|--|
| Home Insert  | Page Layout Form   | iulas Data Review                                       | View Dev  | eloper Design   | Layout                            | Format  |  |
| Chart Area<br>Wy Format Selection<br>Reset to Match Style<br>Current Selection | Picture Shapes<br>Text<br>Box<br>Insert                    | Chart Axis Legend<br>Title + Titles + + L<br>Labels     | Data Data<br>abels + Table +                          | Axes<br>Gridlines<br>Pl<br>Are                                    | ot Chart<br>a Wall *              | Chart 3-D<br>Floor * Rotation   | Trendline Lines Up/Dow<br>Bars +<br>Analysis   |
| Chart 1 ▼<br>A B C<br>1 (  | G f≈<br>D E<br>Ground Gain Mea                             | F G H<br>surement - Resulti                             | ng Charts   | Primary <u>Vertical A</u> Secondary Horizo      Secondary Vertica | xis →<br>ntal Axis →<br>Il Axis → | None<br>Do not<br>Show D<br>Display                                   | displ <mark>a</mark> y Axis<br>D <b>efault Axis</b><br>Axis with default order and   |
| 2 Publish Report<br>4 5 Azimuth min. : 77.9°                                   | Date : 02/04/2011<br>RSF144 : 7.1 (Polyn<br>Azimuth max. : | Meas. Type<br>omial) Frequency<br>116.4° Elevation min. | : Sun Rise <u>N</u><br>: 144.3 MHz<br>: -3.6° Elevati | ion max. : 25.9°  |                                   | Show A<br>Display<br>represe<br>Show A<br>Display<br>represe          | Axis in Thousands<br>Axis with numbers<br>inted in Thousands<br>Axis in Millions<br>Axis with numbers<br>inted in Millions |
| 7<br>8<br>9<br>10<br>113.9<br>113.9  |  |   |   | 25.4  |                                   | Show A<br>Display<br>represe<br>Show A<br>Display<br>Display<br>scale | txis in Billions<br>Axis with numbers<br>inted in Billions<br>txis with Log Scale<br>Axis using a log 10 based             |
| 12 111.9   |  |   |   | - 22.4  |                                   | More Prima  | ary Vertical Axis Options  |

- The window on right (Format Axis) pops up.
- Copy the **Azimuth min.** figure on the chart to the field **Minimum** in the Axis Options (here 77.9).
- Copy the **Azimuth max.** figure on the chart to the field **Maximum** in the Axis Options (here 116.4).
- $\circ$  Click on Close.

| is Options | Axis Options             |               |       |
|------------|--------------------------|---------------|-------|
| mber       | Minimum: 🔘 <u>A</u> uto  | Eixed         | 77.9  |
|            | Maximum: 🔘 A <u>u</u> to | Fixed         | 116.4 |
| Color      | Major unit: 🔘 Auto       | Fixed         | 2.0   |
| e Style    | Minor unit: 🔘 Auto       | • Fixed       | 1.0   |
| wob        | Values in reverse of     | order         |       |
| Format     | Logarithmic scale        | Base: 10      |       |
| gnment     | Display units: None      | -             |       |
| 1990)<br>  | Show display units       | label on char | rt    |
|            | Major tick mark type:    | Outside       | •     |
|            | Minor tick mark type:    | Outside       | •     |
|            | <u>Axis labels:</u>      | Next to Axi   | is 💌  |
|            | Horizontal axis crosses  |               |       |
|            | Axis value: 77.9         | 0             |       |
|            | Maximum axis valu        | e             |       |
|            |                          |               |       |
|            |                          |               |       |
|            |                          |               |       |
|            |                          |               |       |

• In the menu toolbar, select Layout > Axes > Secondary Vertical Axis > More Secondary Vertical Axis Options...

| 0                          |                                 | 17 - (1  |                  | -) <del>-</del>                        |  |                   |                                   |                                       |          | Chart To                                   | ols                      |                    | Gro   | und Gain Su  | un Nois                            | e Measureme                |
|----------------------------|---------------------------------|--|------------------|--|--|-------------------|-----------------------------------|---------------------------------------|----------|--|--------------------------|--------------------|---|--|------------------------------------|----------------------------|
| C                          | н                               | me   | Insert           | Page Layout                            | Formulas                                 | Data              | Review                            | View                                  | Develope | r Design                                   | Layout                   | Form               | at  |  |                                    |                            |
| Se                         | Format S<br>Reset to<br>Current | ertical (V<br>election<br>Match Si<br>Selectio | tyle             | Picture Shapes                         | A<br>Text<br>Box<br>Chart<br>Title       | Axis<br>Titles    | Legend                            | Data Dat<br>Labels + Table            | Axes     | Gridlines                                  | Plot Char<br>Area + Wall | t Chart<br>Floor * | 3-D<br>Rotation   | Trendline  | Lines                              | Up/Down I<br>Bars * E      |
|                            | Cha                             | rt 1   | -                | ( fx                                   |  |                   | 54234 V+342                       |                                       |          | Primary <u>H</u> orizon<br>Primary Vertica | Axis                     |                    |   |  | 110110                             |                            |
|                            | A                               | В  | 0                | D                                      | E F                                      | G                 | Н                                 | T                                     | J dh     | Secondary Hor                              | izontal Axis             | ► N                | 0   | P  | 8                                  | Q                          |
| 2<br>3<br>4<br>5<br>6<br>7 | Pu<br>Azimut                    | i <mark>blish R</mark>                         | eport<br>: 77.9° | Date : 02/0<br>RSF144 : 7.1<br>Azimuth | 04/2011<br>(Polynomial)<br>max. : 116.4° | Me<br>Fr<br>Eleva | eas. Type<br>equency<br>tion min. | : Sun Rise<br>: 144.3 MH<br>: -3.6° E | New I    | Meas.<br>nax. : 25.9°                      |                          |                    | Show D<br>Display<br>labels<br>Show A<br>Display<br>in Thou | efault Axis<br>Axis with di<br>axis in Thou<br>Axis with ni<br>sands         | efault o<br><b>sands</b><br>umbers | rder and<br>represented    |
| 8<br>9<br>10               | 13                              | 13.9 -   | -                |  |  |                   |                                   |                                       | 2 1<br>  | - 25.4<br>- 24.4<br>- 23.4                 |                          |                    | Show A<br>Display<br>in Millio<br>Show A<br>Display         | Axis in Millio<br>Axis with n<br>ons<br><b>axis in Billio</b><br>Axis with n | ons<br>umbers<br>ns<br>umbers      | represented<br>represented |
| 12<br>13                   | 11                              | .11.9 -  |                  |  |  | -                 |                                   |                                       |          | - 22.4<br>- 21.4                           |                          | Log                | Show A<br>Display   | ns<br><b>xis with Lo</b><br>Axis using a                                     | g Scale<br>a log 10                | based scale                |
| 14                         |                                 | -  | -                | 1 =                                    | t  |                   |                                   |                                       | 1        | - 20.4                                     |                          | -                  | More Secor  | ndary Vertic   | al Axis C                          | Options                    |

- The window on right (Format Axis) pops up.
- Copy the Elevation min. figure on the chart to the field Minimum in the Axis Options (here -3.6).
- Copy the **Elevation max.** figure on the chart to the field **Maximum** in the Axis Options (here 25.9).
- Click on **Close**.

| 1.1        |                          |                  |      |  |  |  |  |  |
|------------|--------------------------|------------------|------|--|--|--|--|--|
| Number     | Minimum: 🔘 <u>A</u> uto  | Eixed            | -3.6 |  |  |  |  |  |
| =ill       | Maximum: 🔘 Auto          | Fixed            | 25.9 |  |  |  |  |  |
| ine Color  | Major unit: 🔘 Auto       | Fixed            | 1.0  |  |  |  |  |  |
| ine Style  | Minor unit: 🔘 Auto       | Fixed            | 1.0  |  |  |  |  |  |
| Shadow     |                          |                  |      |  |  |  |  |  |
| 3-D Format | Logarithmic scale        | <u>B</u> ase: 10 |      |  |  |  |  |  |
| Alianment  | Display units: None      | -                |      |  |  |  |  |  |
|            | Show display units       | label on char    | t    |  |  |  |  |  |
|            | Major tick mark type:    | Outside          | -    |  |  |  |  |  |
|            | Minor tick mark type:    | Outside          |      |  |  |  |  |  |
|            | <u>A</u> xis labels:     | Next to Axi      | s 💌  |  |  |  |  |  |
|            | Horizontal axis crosses  | s:               |      |  |  |  |  |  |
|            | Axis valu <u>e</u> : 0.0 |                  |      |  |  |  |  |  |
|            | Maximum axis valu        | ie               |      |  |  |  |  |  |
|            |                          |                  |      |  |  |  |  |  |
|            |                          |                  |      |  |  |  |  |  |
|            |                          |                  |      |  |  |  |  |  |
|            |                          |                  |      |  |  |  |  |  |

#### 4.2.2. Sun set measurement

Proceed exactly as described in section 4.2.1. ; the only difference is that in the window **Format Axis** which appears when you select **Layout** > **Axes** > **Primary Vertical Axis** > **More Primary Vertical Axis Options...** in MS Excel, you have to check in the checkbox **Values in reverse order**. Then **Close**.

| Axis Options | Axis Options                      |                  |       |  |  |
|--------------|-----------------------------------|------------------|-------|--|--|
| Number       | Minimum: O Auto                   | Eixed            | 228.2 |  |  |
| Fill         | Maximum: 💮 Auto                   | Fixed            | 275.2 |  |  |
| Line Color   | Major unit: 🛞 Auto                | Fixed            | 2.0   |  |  |
| Line Style   | Minor unit: 🔘 Auto                | • Fixed          | 1.0   |  |  |
| Shadow       | Values in reverse order           |                  |       |  |  |
| 3-D Format   | Logarithmic scale                 | <u>B</u> ase: 10 |       |  |  |
| Alianment    | Display units: None               |                  |       |  |  |
|              | Show display units label on chart |                  |       |  |  |
|              | Major tick mark type:             | Outside          | 1     |  |  |
|              | Minor tick mark type:             | Outside          | -     |  |  |
|              | Axis labels:                      | Next to Ax       | is 💌  |  |  |
|              | Horizontal axis crosses           |                  |       |  |  |
|              | O Axis valu <u>e</u> : 0          |                  |       |  |  |
|              | Maximum axis valu                 | e                |       |  |  |
|              |                                   |                  |       |  |  |

### 4.2.3. Completion

On the **Ground Gain** graph (the second resulting chart), the **Theoretical GG pattern** (purple dashed curve) shows by default the elevation pattern of a 12-element DK7ZB at 17.3m agl over a perfect and flat ground. You can change this and select another antenna type, type of ground, antenna height and a flat or downwards tilted ground.

To achieve this, you have to :

• **Open** the file *Ground Gain Geometry and Magnitude Calculator File.xlsm* provided in the package (directory C:\Sun Noise Measurement\Tools).

|                               |              | Ground Gain - Simulator Spreadsheet   |
|-------------------------------|--------------|---|
|                               |              |   |
| Type of Ground :              | Average      |   |
| Conductivity $\sigma$ [S/m] : | 0.0075       |   |
| Permittivity Er :             | 12.5         |   |
| Freq [MHz] :                  | 144.0        |   |
| Height [m] :                  | 17.3         |   |
| Ground slope [°] :            | 0.0          | Ground Slope in front of Antenna. 0 for Flat or Negative for Downward Slope |
|                               |              |   |
|                               |              |   |
| Antenna Type :                | 12-element D | K7ZB 144  |
| Maximum F.S. Gain [dBi] :     | 16.37        | Other antenna Type in other antenna type name                               |

- Select the **Type of Ground** and **Antenna Type** and fill in the **Frequency**, **Height** and **Ground slope**. You have the choice between a few antenna types, ranging from a dipole to a stack of 2x12-element antennas (144 MHz).
- Save this file (don't change its name) in C:\Sun Noise Measurement\Tools (nowhere else) and close it.
- Come back to the currently open file (*Ground Gain Sun Noise Measurement Processing File.xlsm*) and click on **Refresh and Include Theoretical GG Pattern**.



It is also possible to import your own antenna pattern ; refer to the Annexes (section 6.2.).

• You can also include some comments in the report (at the bottom of the **Ground Gain** graph).

| RSF280 | ) = 108 (source U.S. S.W.P.C.).   |
|--------|---|
| Theore | tical GG patterm for a 12-element DK7ZB at 17.3m agl, over perfect flat groun |
|        |   |
|        |   |

• Click on **Publish Report** at the top of the page.

| G                   | Ground Gain Measurement - Resulting Charts |                        |                        |  |  |  |  |
|---------------------|--|------------------------|------------------------|--|--|--|--|
| Publish Report      | Date : 02/04/2011                          | Meas. Type : Sun Rise  | New Meas.              |  |  |  |  |
|                     | RSF144 : 7.1 (Polynomial)                  | Frequency : 144.3 Mł   | Hz                     |  |  |  |  |
| Azimuth min.: 77.9° | Azimuth max. : 116.4°                      | Elevation min. : -3.6° | Elevation max. : 25.9° |  |  |  |  |

You have now a file named *Ground Gain Sun Noise Measurement Processing File.pdf* in the directory C:\Sun Noise Measurement.

- Rename this file in a more explicit way, e.g. Ground Gain Sun Rise ddmmyyyy.pdf
- Move this file *Ground Gain Sun Rise ddmmyyyy.pdf*, together with the Sun Az-El.txt, Nreference.txt, Nbgd xdeg PRE.txt, Nsun.txt and Nbgd xdeg POST.txt files somewhere else on your computer (wherever you wish, no specific convention required here).
- Delete these files from C:\Sun Noise Measurement ; this is mandatory to avoid disturbing the future measurements.

### 5. Additional information

The **Ground Gain** graph indicates the geometry and magnitude of the Ground Gain lobes (or antenna elevation pattern) but only the magnitude of the first lobe (the less elevated one) is reliable, since the calculated sun noise rise ( $NR_{sun}$ ) is not weighted according to the free space antenna radiation pattern in the elevation plane. This will perhaps be updated in a future release of the tools.

To train how the file processing works, you can temporarily copy the measurement files provided as examples and available in the sub-directories (sorted by dates) part of the directory *Measurement Campaigns*.

### 6. Annexes

### 6.1. If not using a transverter

As written previously in this document, it is recommended to place a preamplifier in front of the transceiver (or receiver), all the more any external (masthead) preamplifier has to be set in by-pass mode to meet the calculation spreadsheets constraints.



### 6.2. Import your own antenna pattern

Explaining how to model antennas is beyond the scope of the present document. However, it is shown here how to export a <u>free space</u> elevation radiation pattern out of the modelling software MMANA-GAL (<u>http://hamsoft.ca/pages/mmana-gal.php</u>). Once your antenna has been modelled and its pattern calculated :

- In the menu toolbar of MMANA-GAL, select File > Table of Angle/Gain (\*.csv).
- In the new window which has pop up, enter the figures for the Azimuth and Zenith fields <u>exactly</u> as shown below.
- Enter the name **Other Antenna Pattern.csv** (and no other name, otherwise the processing macro won't work), to be saved under C:\Sun Noise Measurement (and nowhere else).
- Click on **OK**.
- Exit (Close) MMANA-GAL.

| Open (*.maa)                  | Far field plots          |                |                  |                 |                  |
|-------------------------------|--------------------------|----------------|------------------|-----------------|------------------|
| Reopen                        |                          |                |                  |                 |                  |
| Save (*.maa)                  |                          | Set of paramet | ers a table Angl | e/gain          |                  |
| Save as(*.maa)                | Y                        | Angle          | Start deg.       | Step deg.       | Num, of step     |
| Comments                      | 0                        |                | 0.0              | 0               |                  |
| Open far fields (*.mab)       |                          | Azimuth        | 0.0              | U               | U                |
| Save far fields (*.mab)       |                          | Zanith         | 00               | 0.1             | 001              |
| Open optimization log (*.mao) |                          | Zeniu          | 90               | 0.1             | 901              |
| Save optimization log (*.mao) | -10                      | C-\S           | in Noise Meas    | urement\Other A | ntenna Pattern c |
| Table of currents (*.csv)     |                          |                |                  |                 |                  |
| Table of near fields (*.csv)  | -20                      |                | OK               | Cance           |                  |
| Table of Angle/Gain (*.csv)   |                          |                |                  |                 |                  |
| Table F/SWR/Gain/Z (*.csv)    |                          |                |                  |                 |                  |
| Create list F/R/jX (*nwl)     | $\mathbb{H}(\mathbb{O})$ |                |                  |                 |                  |
|                               | - The Arris              |                |                  |                 |                  |

- (1) : In the file Ground Gain Geometry and Magnitude Calculator File.xlsm (see section 4.2.3.), select the Type of Ground, fill in the Frequency, Height and Ground slope.
- (2) : Select Antenna Type as "Other antenna".
- (3) : Replace "Name as you wish" in the cell highlighted in yellow by the name of the antenna to import (any name is allowed here, no specific convention required).
- (4) : Click on Import Other Antenna.
- Save this file (don't change its name) in C:\Sun Noise Measurement\Tools (nowhere else) • and **close** it.

| Type of Ground :              | Good        | • (1)   |      |
|-------------------------------|-------------|---|------|
| Conductivity $\sigma$ [S/m] : | 0.015       |   |      |
| Permittivity Er :             | 20          |   |      |
| Freq [MHz] :                  | 144.0       | (1)   |      |
| Height [m] :                  | 17.3        | (-)   |      |
| Ground slope [°] :            | 0.0         | Ground Slope in front of Antenna. 0 for Flat or Negative for Downward Slope |      |
|                               |             |   |      |
|                               |             |   |      |
| Antenna Type :                | Other anter | Import Other Antenna (4)  |      |
| Maximum F.S. Gain [dBi] :     |             | (2) (3) Name as you wish Type in other antenna type                         | name |
|                               |             |   |      |

Further proceed on the completion of the processing according to the explanation given in section 4.2.3.

Ground Gain - Simulator Spreadsheet