Messdaten_Converter Anleitung

This short manual is intended to be a explanation of the use of the Program Messdaten_Converter in order to start using it right away. It does not cover development or debugging issues, neither more detailed explanation for the moment.

Interface description

The program has 5 modes of Data Analysis. It can read the format of the antenna measuring facility AMA (Antennen Messanlage) used in the group, the format delivered by the Fraunhofer Institut in Erlangen, the anechoic chamber's measurement format of the Institut für Hochfrequenztechnik & Radarsysteme, and the format of the HFSS simulations (the files have to be however modified, in order to eliminate spaces between real and imaginary parts).   The Selection of the Format were made in a Tab-like interface style. The options available for each format are varying. However, here we include an option of all of them, which are either available or not for each format.

- Folder: The first field of each mode, is the Directory Selection. Here, you have to choose the folder in which is the data.
- Antennen Anordnung: This panels offers the selection of the file or group of files to be processed for each element. It is very important to know that the elements file should be selected in the same orientation, as we could see the array from zenith. That means, the file/filegroup that represent the element being to the lower left from the center, if we see it from array zenith, should be the file of element 1, and so on. This element numbering correspond to the ordering from left to right (x-axis) and then down to up (y-axis).
- Channels/Polarizations: Sometimes one of the polarizations may have no real importance, and given the big amount of possible figure outputs, it can be selected which one polarization to output. In the AMA format, always are two channels, or polarizations written on each file, and the files usually do not specify which polarization corresponds to each data. That is why it has the option “Select Channel” and can be also specified to which polarization each channel corresponds.
- Measured points: This option is available just for the “AMA Dateien” option. This specifies which are the Phi and Theta points used in the measurements.
- Coordinates Origin: It specifies where is the center of the array considered in the above measurements. It is important for the correction of the Phase component, because it supports the Antenna array factor correction.
- Elements distance: Also important for the Antenna array factor correction, specifies the distance between elements in both directions.
- Output: Here, multiple options for plotting the Array patterns can be chosen.
- Export: In order to save the Patterns in Mat, Excel, or dat binary files.
- Phase Center Bias: This panel is made to detect big shifts on the array Phase patterns. It also includes the option to correct them. It calculates a center origin of an equivalent isotropic uniform phase antenna considering a certain solid angle of the phase front. The relative position of the antenna isotropic center to the element center, is called the Phase center. It calculates the phase center for different polarization-frequencies pairs available and propose a

value (the mean) for further correction for when we use the “Convert” button, which executes the core-program.

Format Requirements and procedure description

How to use the program is different for each kind of format. Concurrently this section is separated in the 5 available format reading options.

AMA Dateien

This option intends to read the AMA format made for an antenna array. This has the following assumptions:

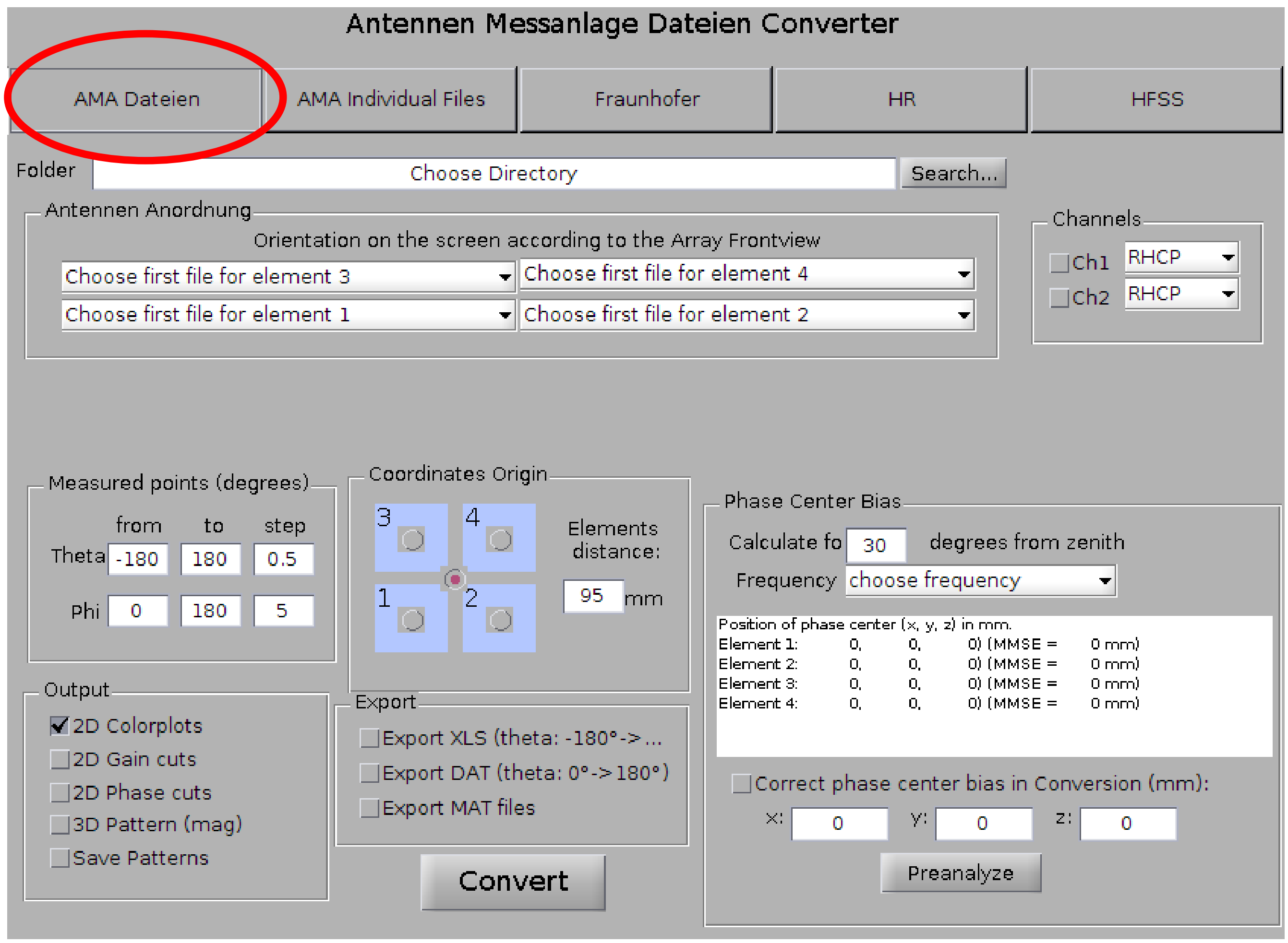
- The Array Pattern is read in multiple files, each file representing a Theta scan of the pattern of a single element, according to the spherical coordinate system. The Theta angle represents the antenna elevation (zero being in zenith) and the Phi angle represents the azimuth.
- The pattern of each antenna element, represent a group of files, each consisting of Theta scan for a Phi cut.
- All the files of an element should have the same filename, and a counting extension: *.001, *.002, *.003 and so on. It is important that the count begins from *.001.
- The number of files should be the same for each element.
- And the measuring points Phi values should be uniformely distributed.
- The measuring points Theta for each file should be the same.

Instructions

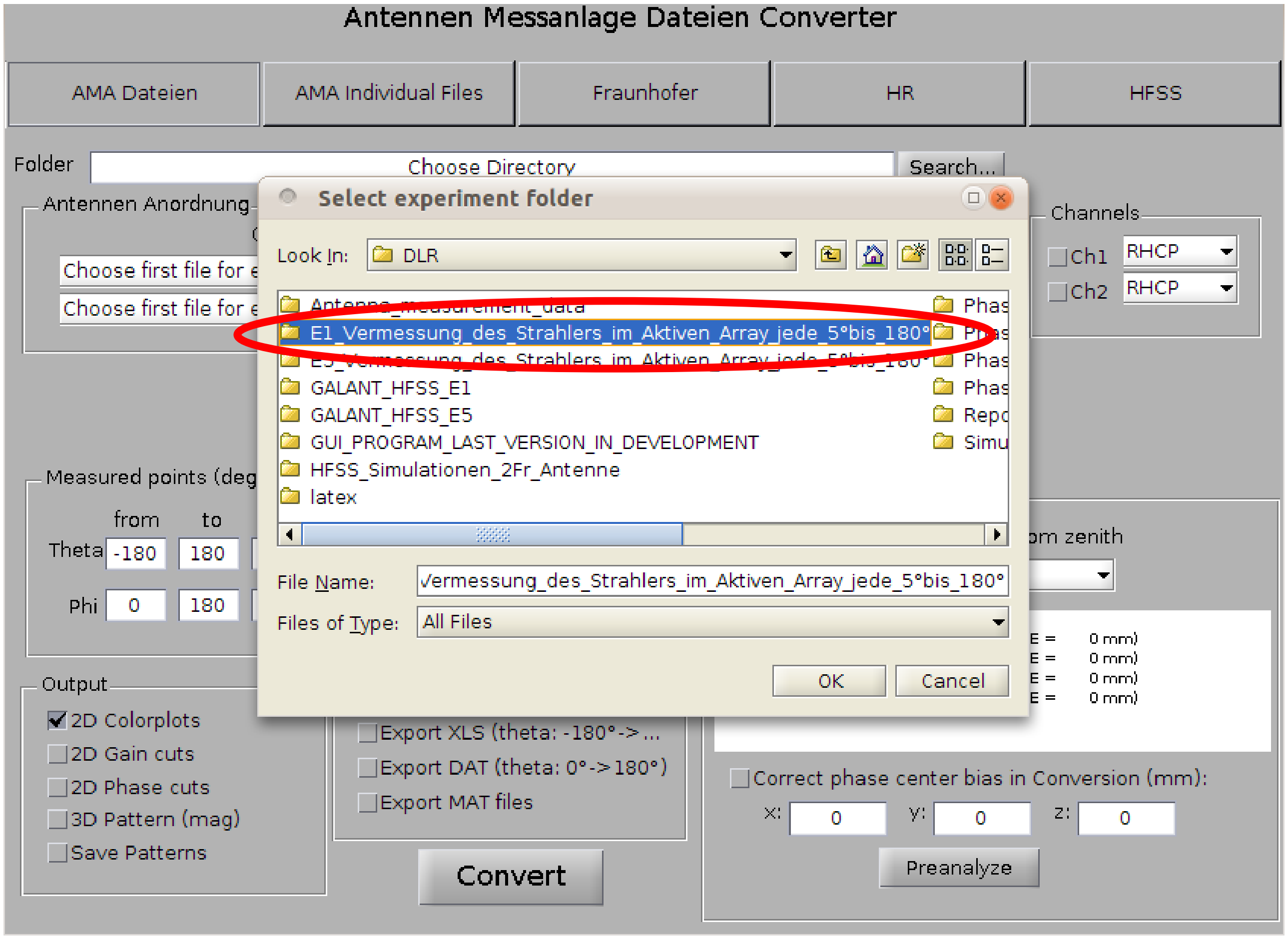
In this example instructions, we intend to open a folder containing the AMA measurements of the UNITAS antenna Array.

Instructions:

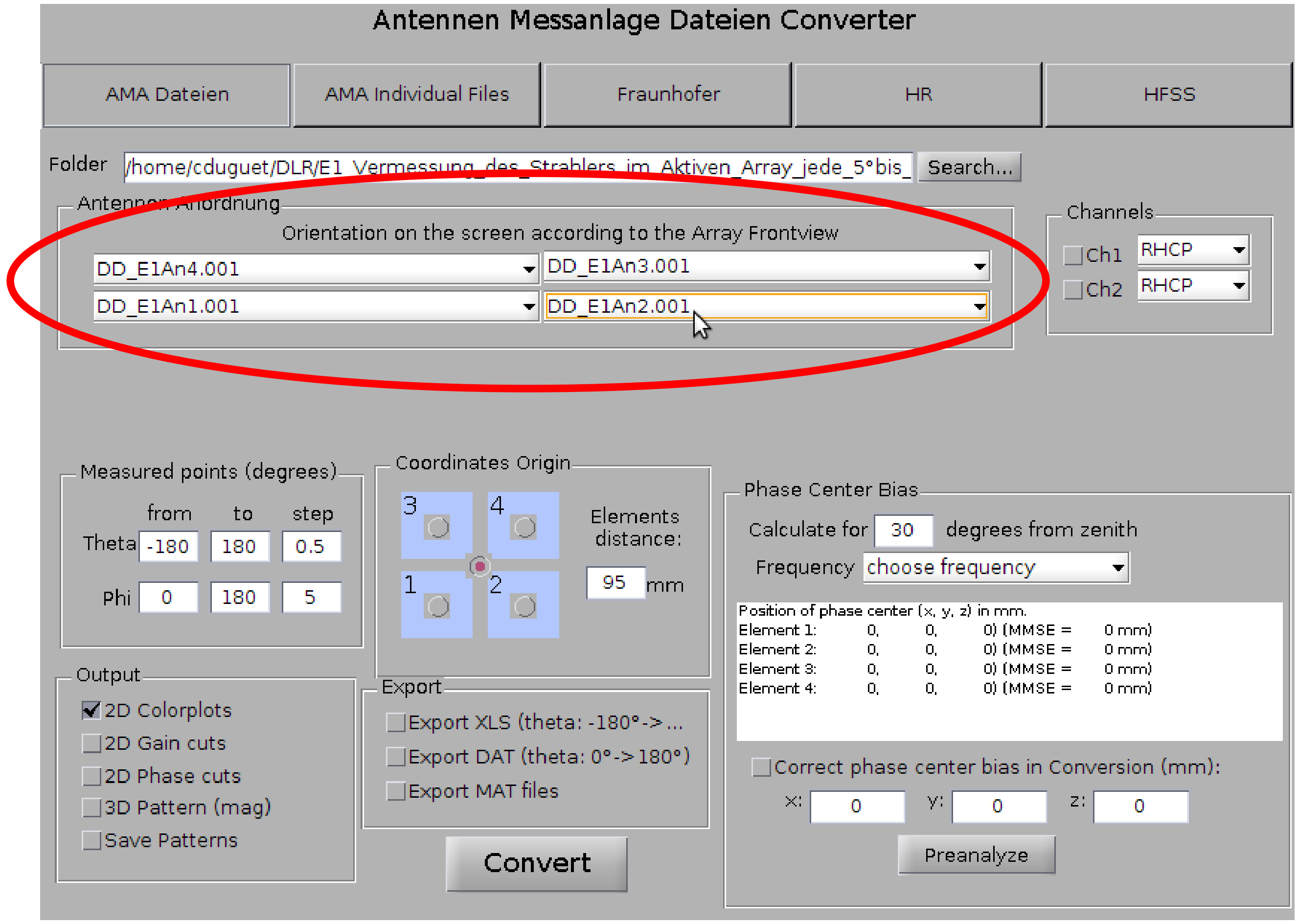
1. Execute the code “Messdaten_Converter.m” from a Matlab instance. It has to be in the same folder as “Messdaten_Converter.fig”. Then we see the interface, as shown in the figure below.



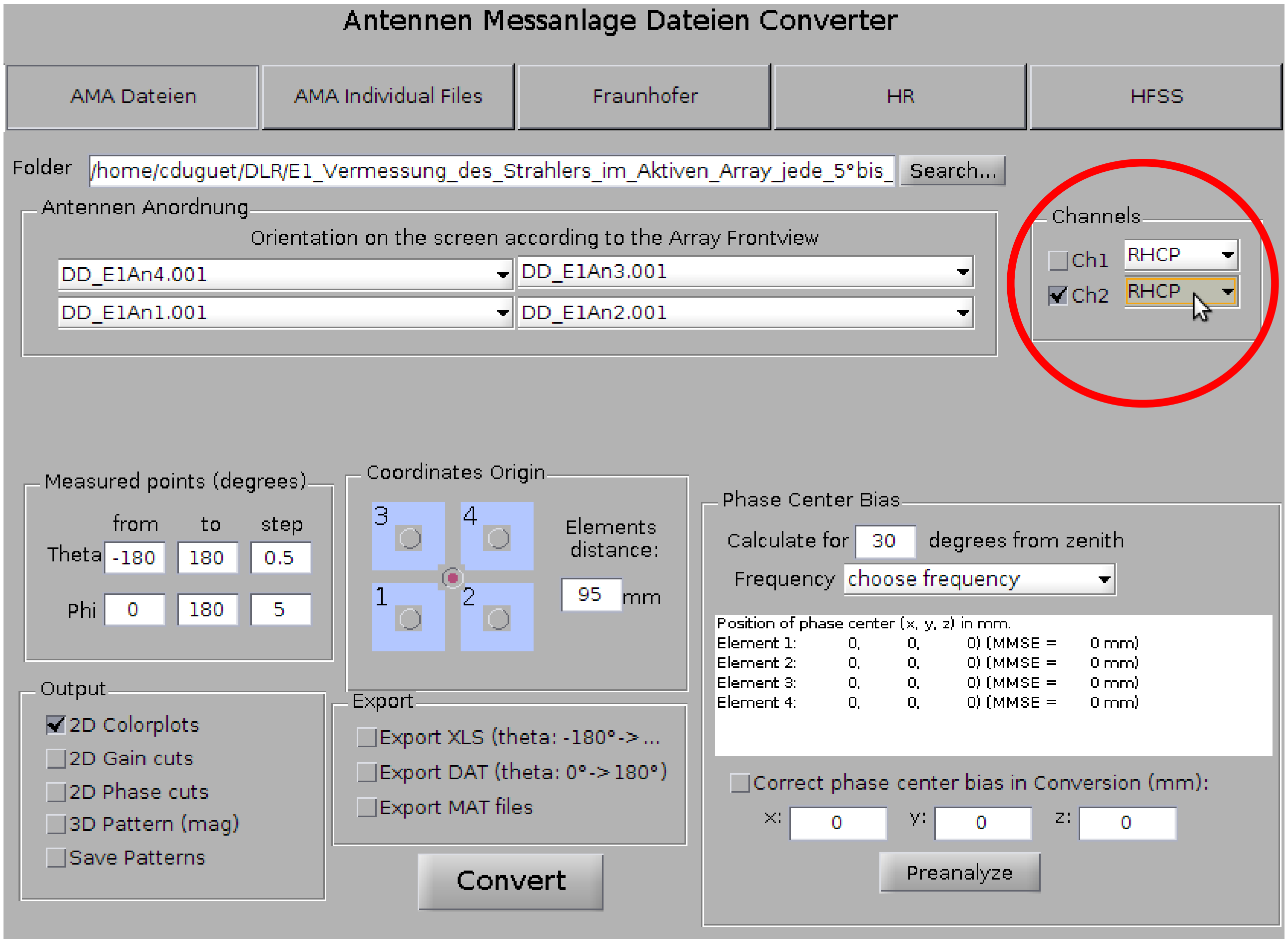
2. In Folder, press “Search” to look for a folder containing the data.



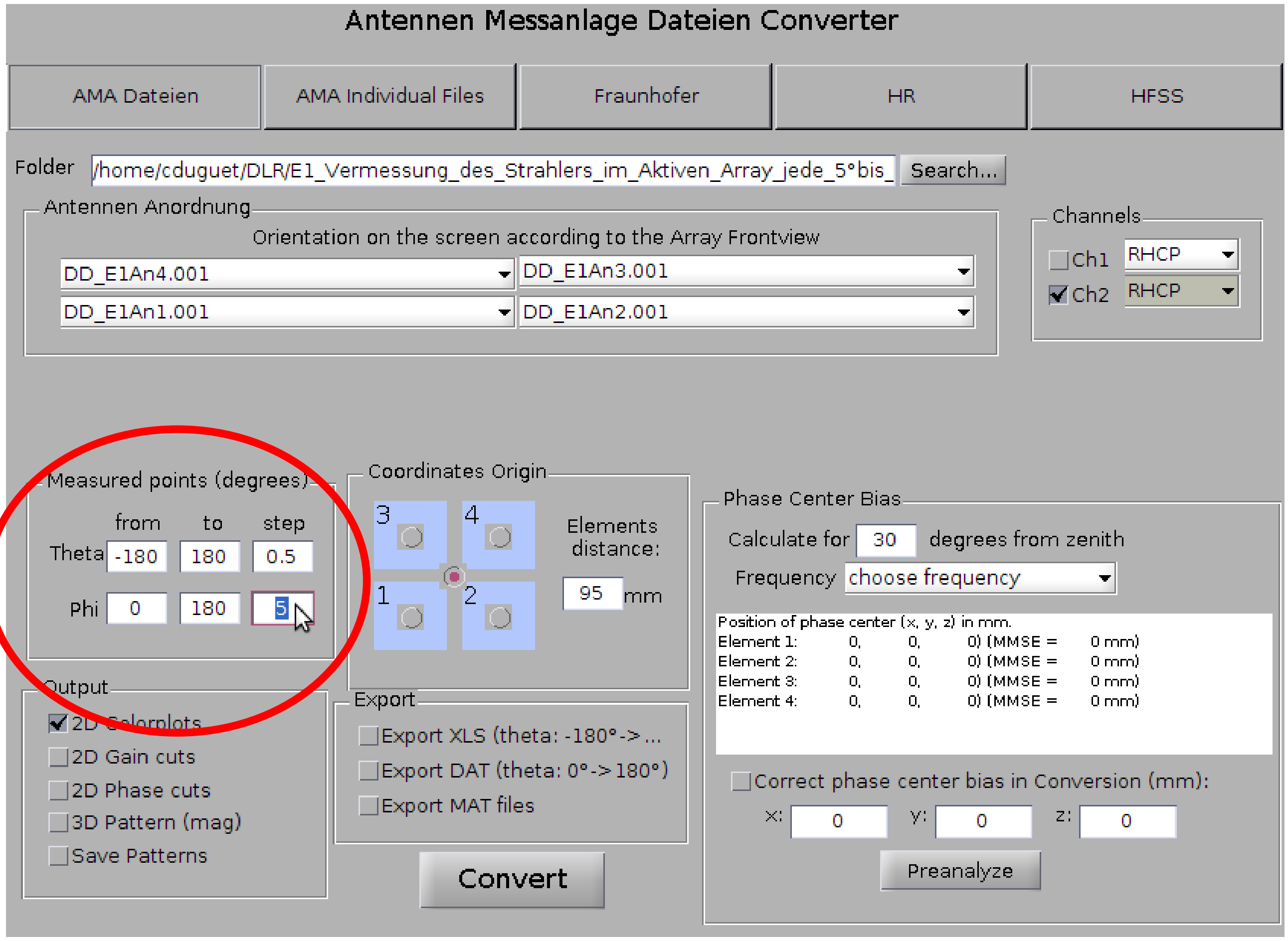
3. In the four pop-up menus, a list which includes all the files called "*.001" is shown. Choose the files which represents each element (Note: not always the file number or antenna numbering represents the same order as intended by this program.) Choose the elements in the Program interface as if they were seen from zenith of the array, with the x axis (Phi =0°, Theta=90°) horizontal, pointing to the right of the screen.



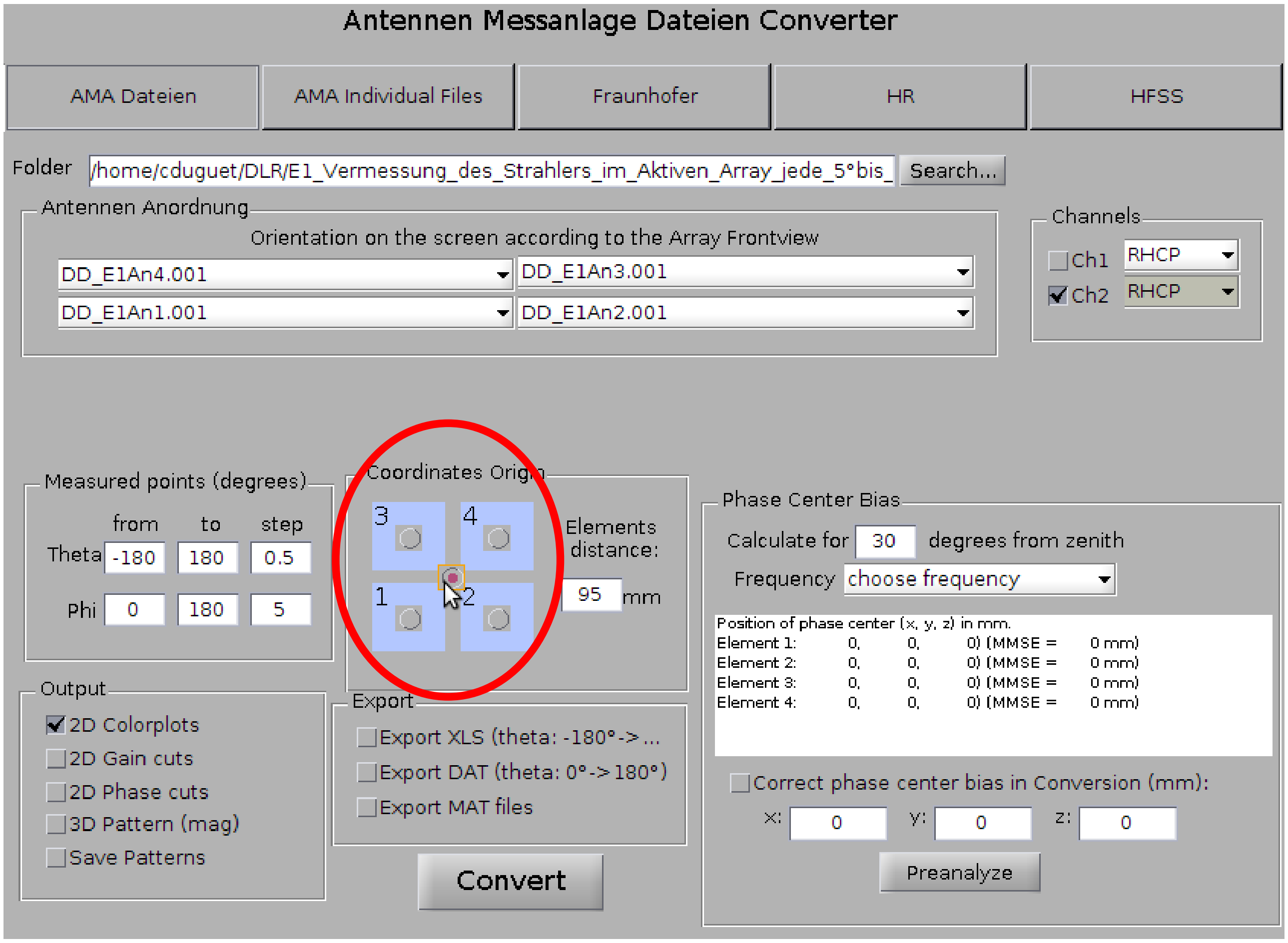
4. Choose at least one Channel to read, and choose its Polarization. Depending on the Polarization you choose, the Phase drag correction will be different.



5. Adjust the measurement points, for Theta and Phi. It is defined by the initial point, the last points, and the size of the interval.

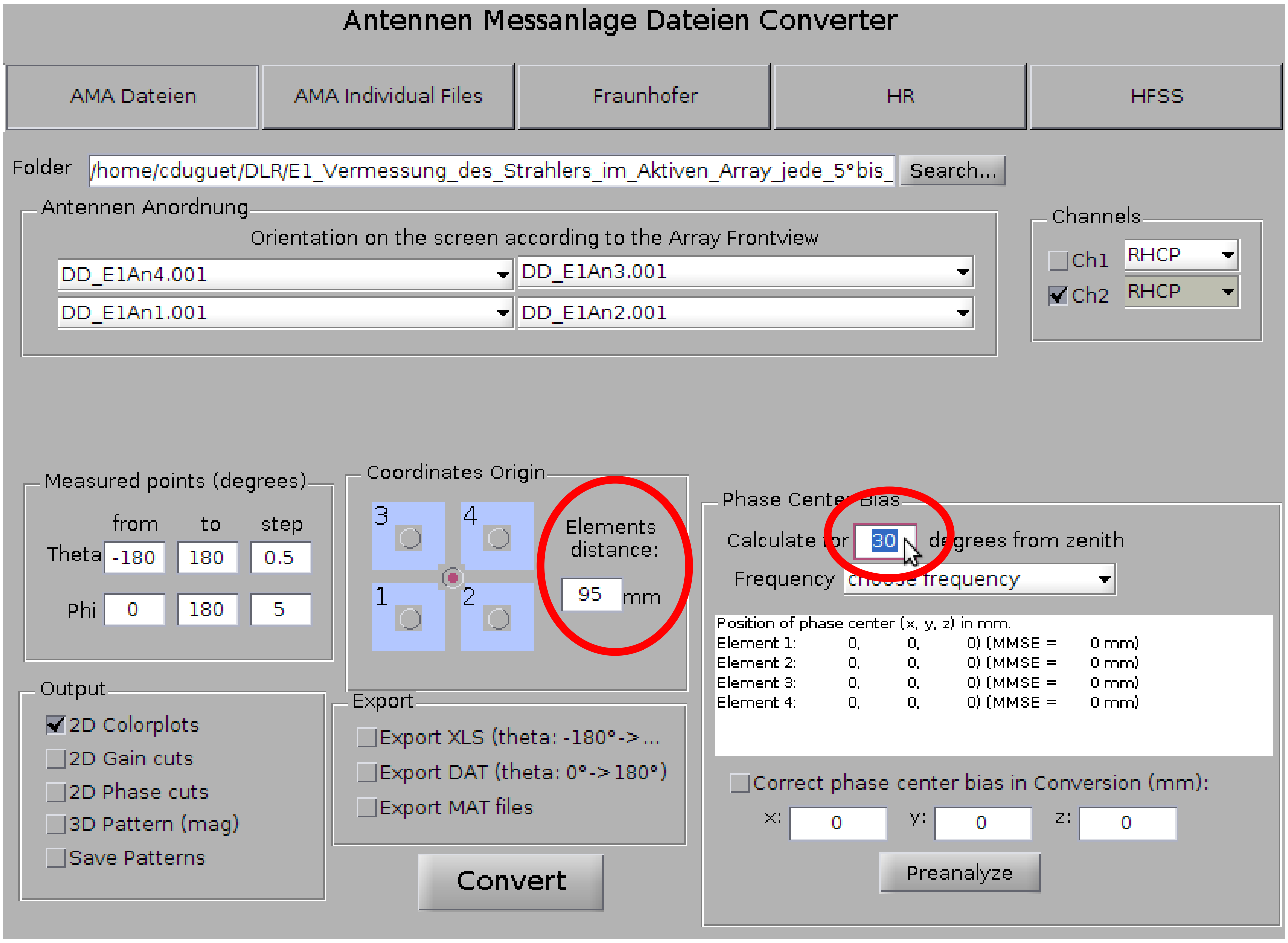


6. (Optional) In Coordinates Origin, choose the point of the array which represents the center of the measurements (note: usually all the measurements are made relative to the array center, so it is generally not necessary to change it). This affects all the phase measurements and the phase center estimations.

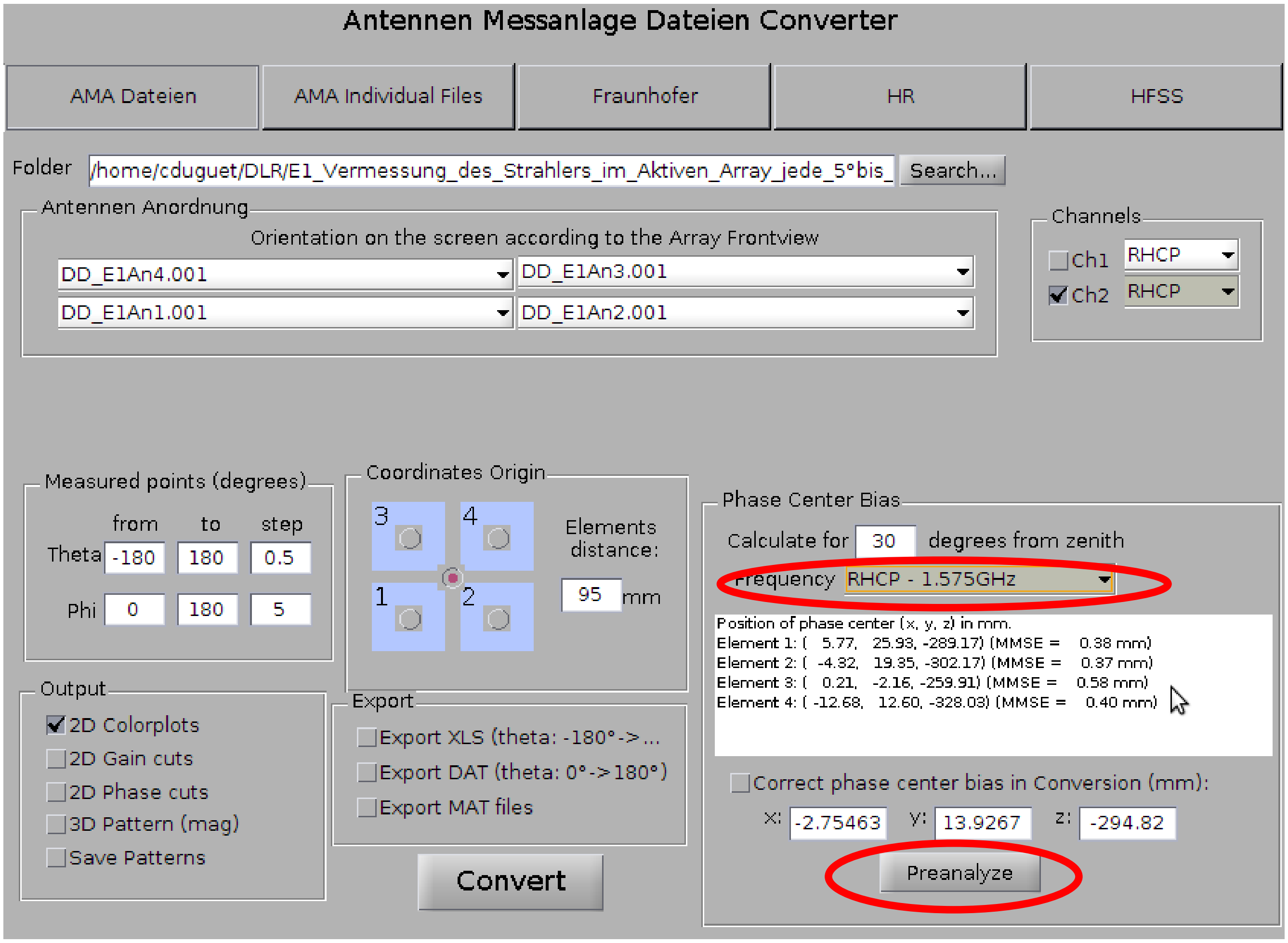


7. (Optional) Adjust the element distance, considered as the distance between two elements centers. This has an effect on the Phase array factor correction, and on the Phase center Bias calculation.

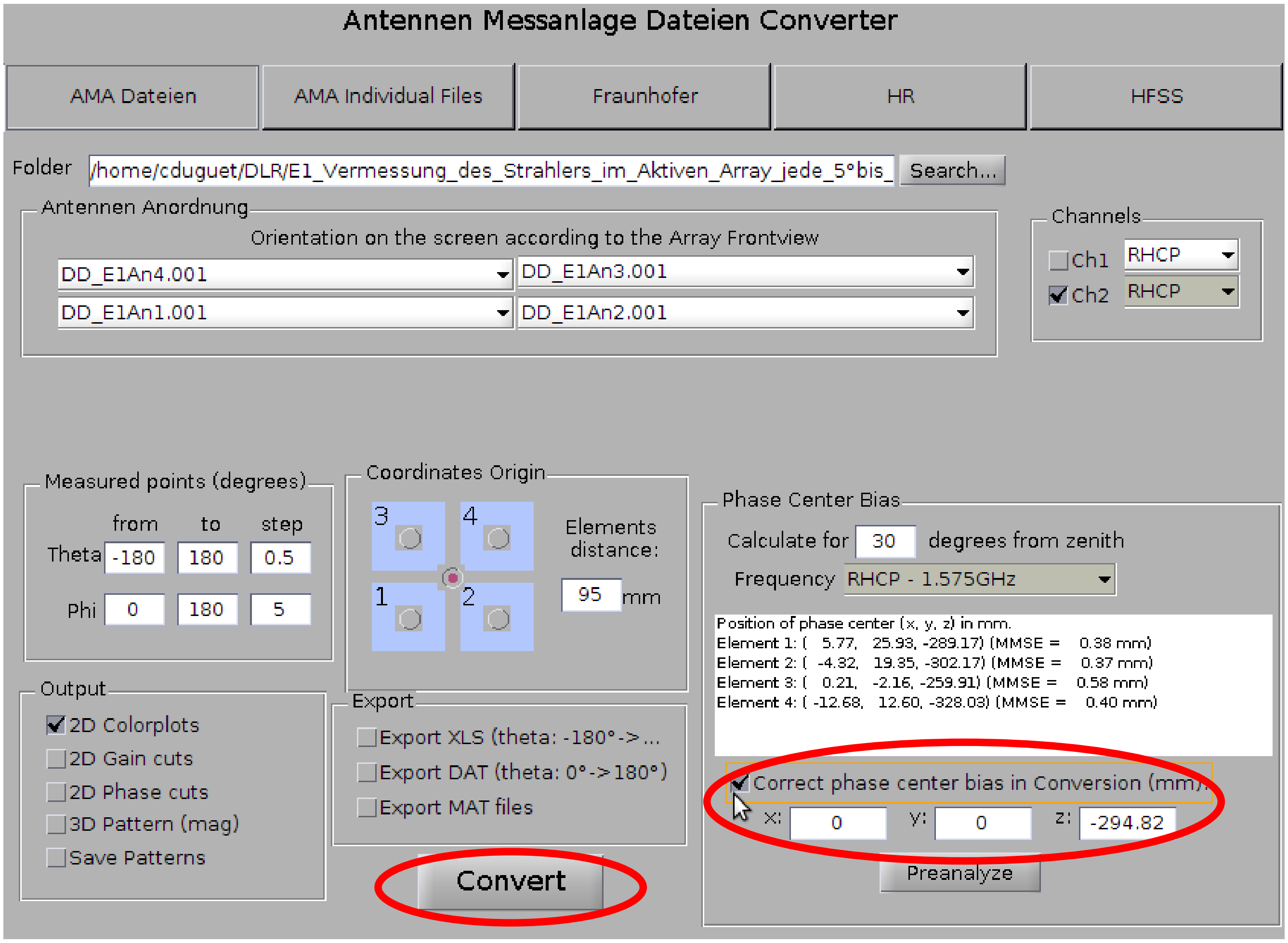
8. (Optional) In the Phase Center Bias panel, in "Calculate for ____ degrees from zenith", you choose the semiaperture of a cone centered in zenith, in which Region the Phase value is used to find a coherent isotropic antenna with the most equivalent phase distribution.



9. (Optional) Press the Preanalyze Button. In the Matlab screen it shows how it is working. Wait until it is finished. It is important that after this step you click on frequency pop-up. Otherwise the correction values will not be updated.
10. (Optional) Afterwards, click on Frequency. A list containing the possible combination of the measured Polarizations and Frequencies appears. Choose the one for which you are interested. The white screen will show a dialog containing the estimated position of the Phase Center in coordinates x,y and z, and the Mean squared error of the calculations. Use the MSE as a criteria on how reliable is the estimation. The boxes under “Correct Phase Center bias” option will show a proposed phase center correction factor for the further Conversion stage. It just takes the average of the measurements for each element along the x,y,z components.



11. (Optional) Depending on the measurement interests, on can change the values of the phase center correction. In this case, just the z component correction is important, so we change the x and y values to 0. Check the “Correct phase center bias” box, which enables the phase center corrections.



12. Press "Convert". With the Output Panel options selected as their default, it will just show the 2D colorplots of the Gain and Phase. Another options can be selected, depending on the needs.
13. The 2D colorplots, considering the Phase center bias correction and without considering it, will look like the following.

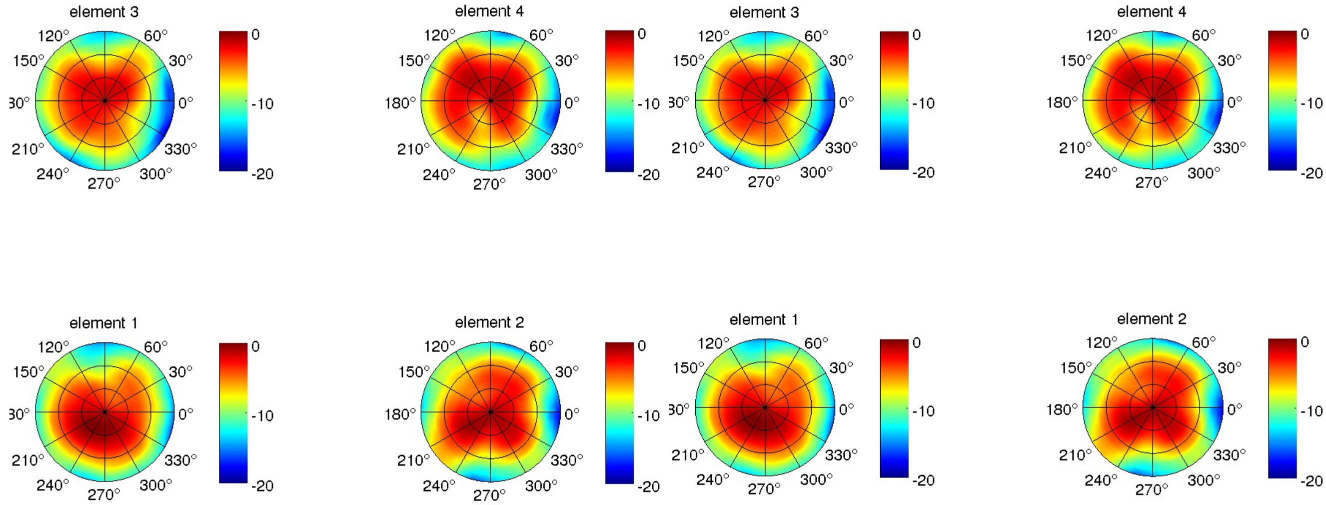


Illustration 1: 2D Contourplots example for the Gain in an array using AMA data. On the left, the four elements without Phase center correction, on the right, using Phase center correction.

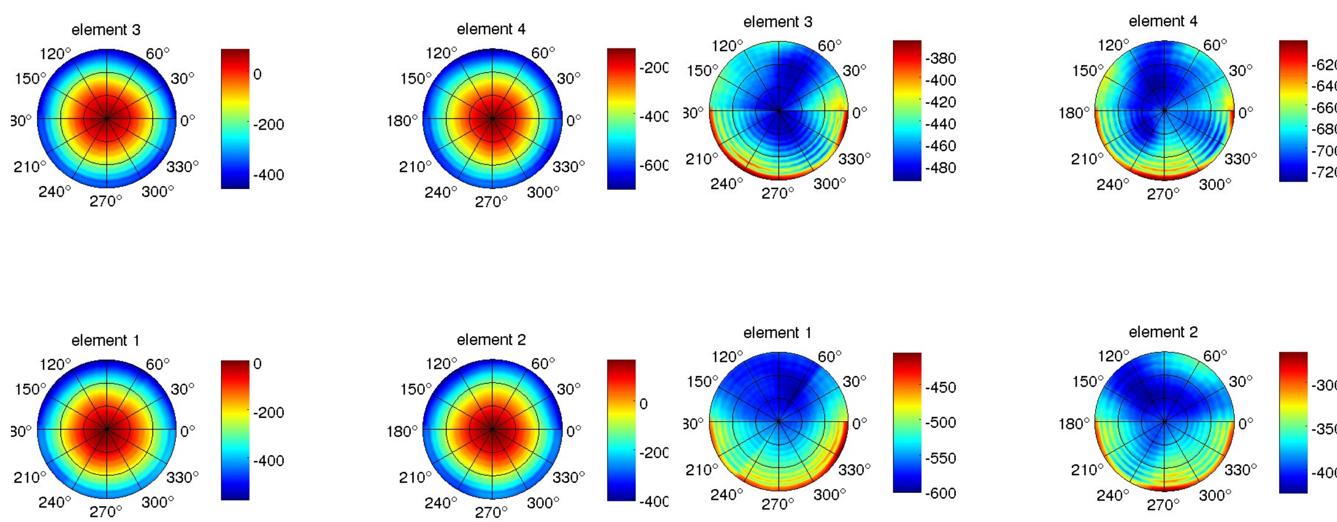
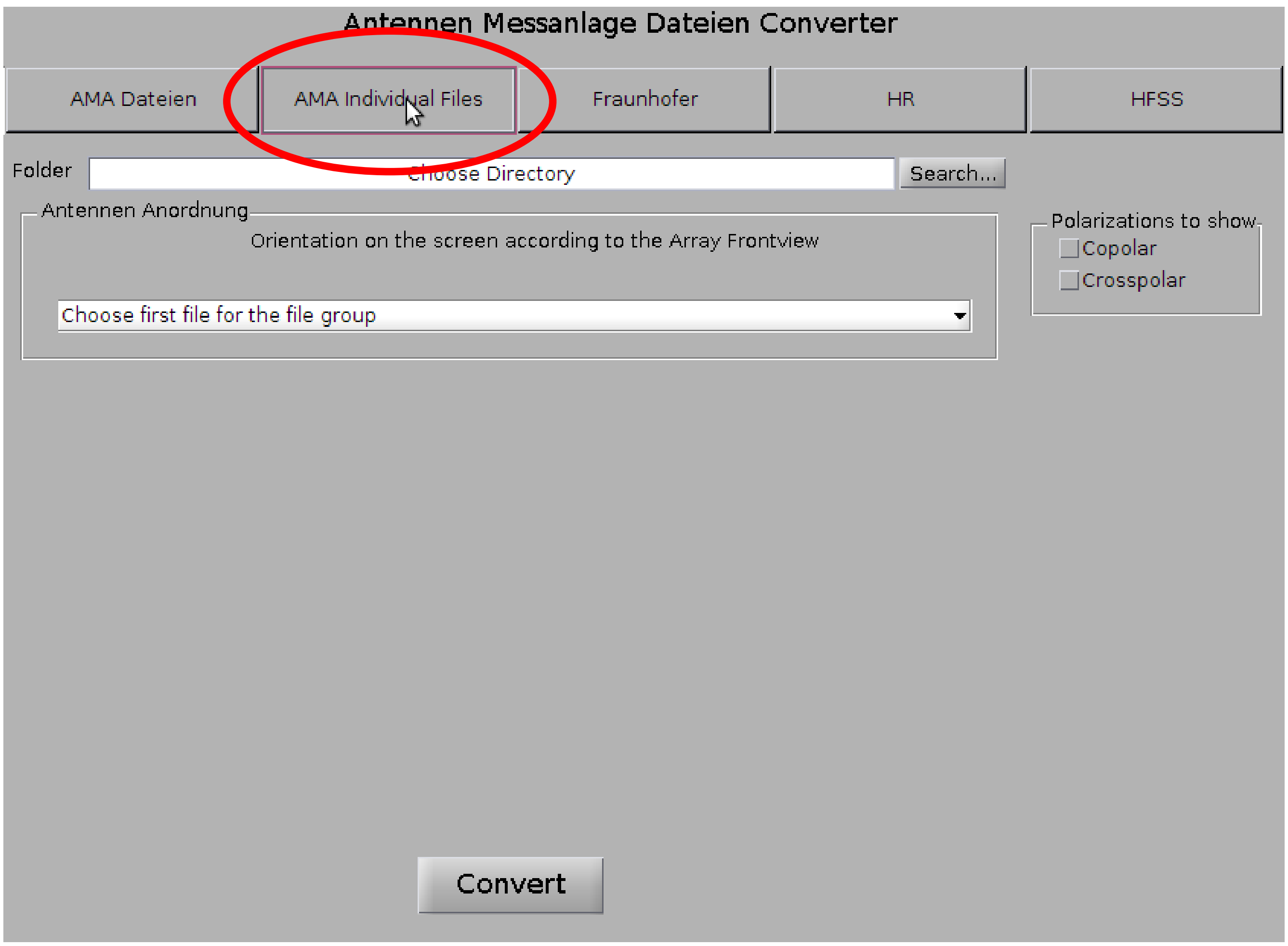


Illustration 2: 2D Contourplots example for the Phase of an array using AMA data. On the left, the four elements without Phase center correction, on the right, using Phase center correction.

AMA Individual files

The AMA Individual files option intends to read AMA files which do not necessarily fill the requirements for the AMA Dateien option. This means, they can be files for measurements along an assumed Theta coordinate. Every different file can be for wither different Phi cuts or frequency, or antenna. However, the requiremens of the Data to read must be the following.

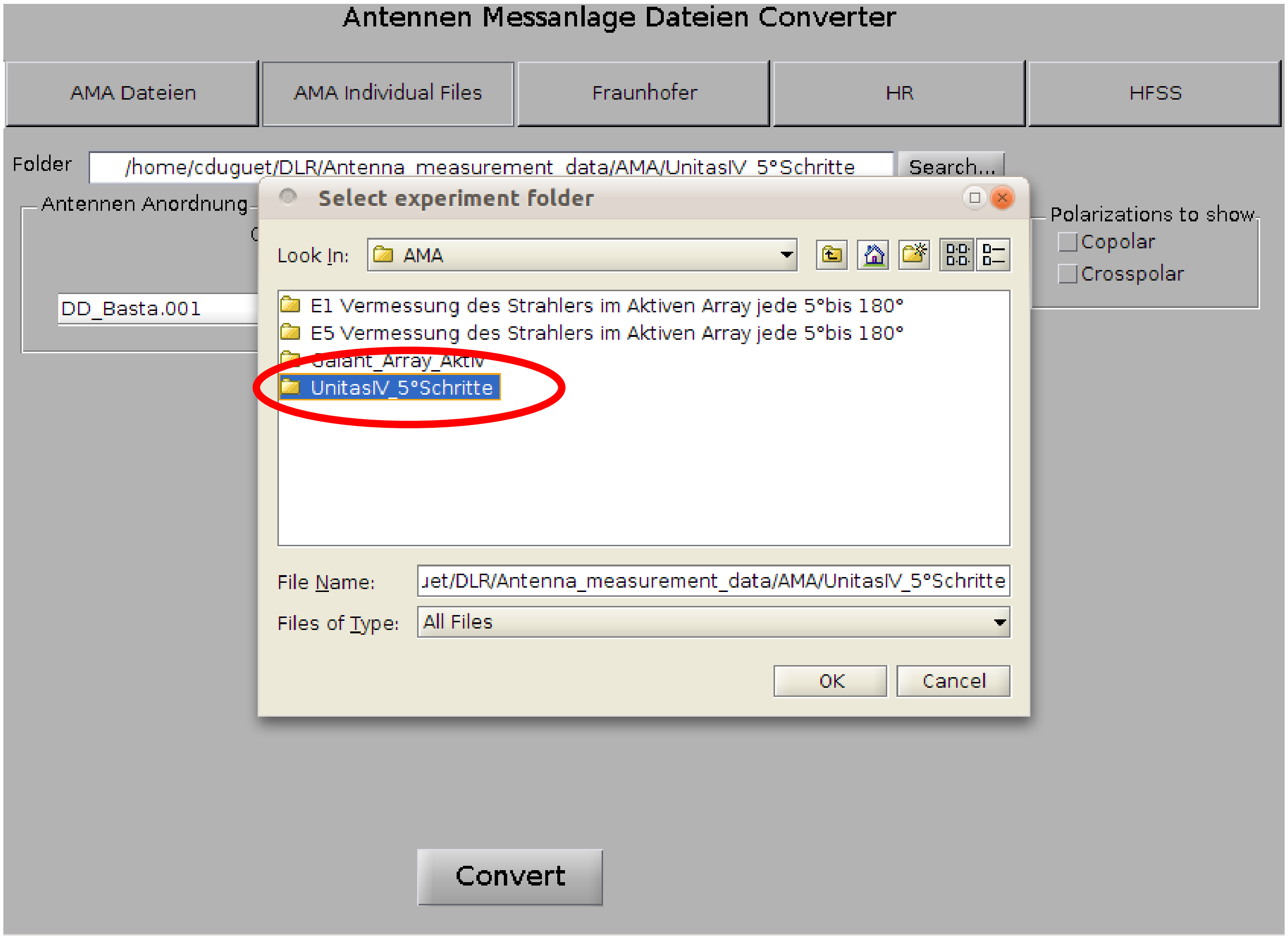
- The files have to be all in one folder, and they should have a common name, just chaging the extension number.
- The extension numbering should begin at "*.001" (or at least that file extension should be present).
- In the files, there should be two measurements sections made for 2 polarized data measurements, each one delimited by "BEGIN" before its first line and "END" after its last one. Each data section has two column fields, which represent the real and imaginary parts of the polarization component.



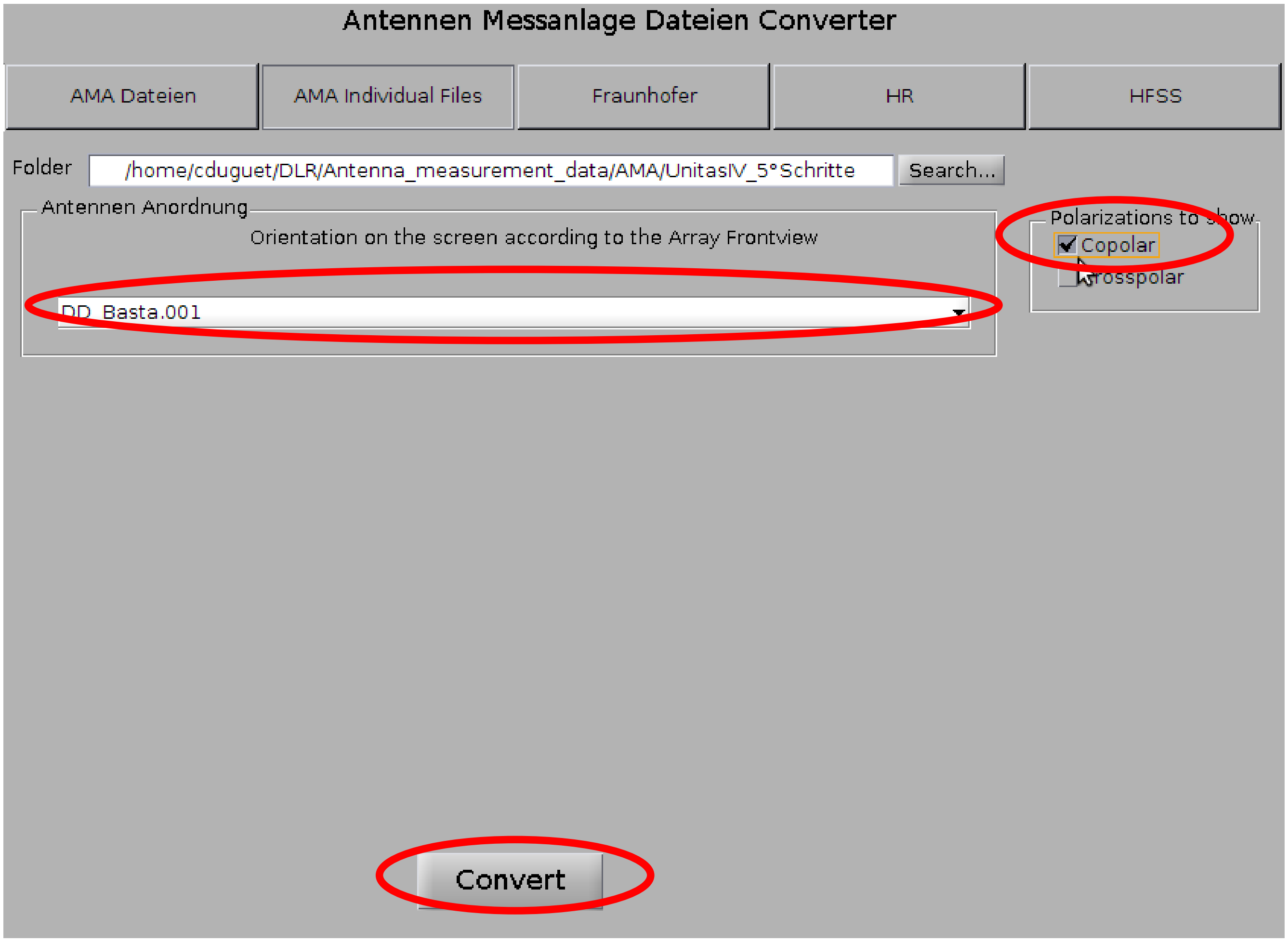
Instructions:

1. Here, we will open the data contained in the folder "Galant_Array_Aktiv". So first, once we

selected the “AMA Individual files” option, we open the folder .



2. A list containing all the elements called “*.001” is shown. In this case, there is just one first file. However, all the files following this numbering will be processed.
3. Select at least one polarization to process.



4. Press “Convert”. The files will be processed and a 2D cartesian diagram will be plotted for each file and polarization. The screen will show how a file opens and closes everytime. It is because the number of figures produced is so large, that the figures are just being created for being saved in an autocreated “plots” subfolder. The figures are being saved in png and fig mode. Each of the figures contains as a prefix in their filename, the file from which it comes from.

   Additionally, another subfolder called “export” is being created. It contains an xls file version of the input file, including its header, their polarization measurements in complex rectangular mode and Gain/Phase mode.

   (IMPORTANT: The Excel files are created using an COM server instance of Microsoft Excel® which Matlab calls. For that, it is necessary to have Microsoft Excel installed and to have a Windows® as operative system. When using in other operative system, like Unix systems, the program will try to create comma separated files, which includes just data vector, with no labels.)

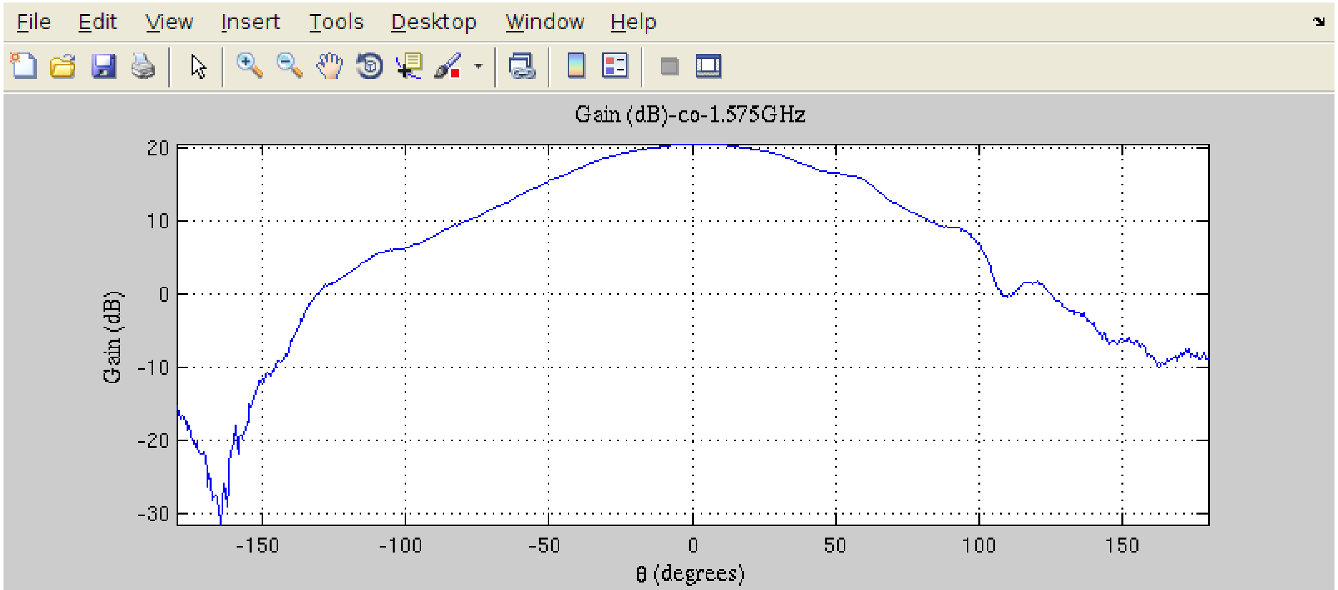


Illustration 3: AMA_individual: Gain diagram for one component first file.

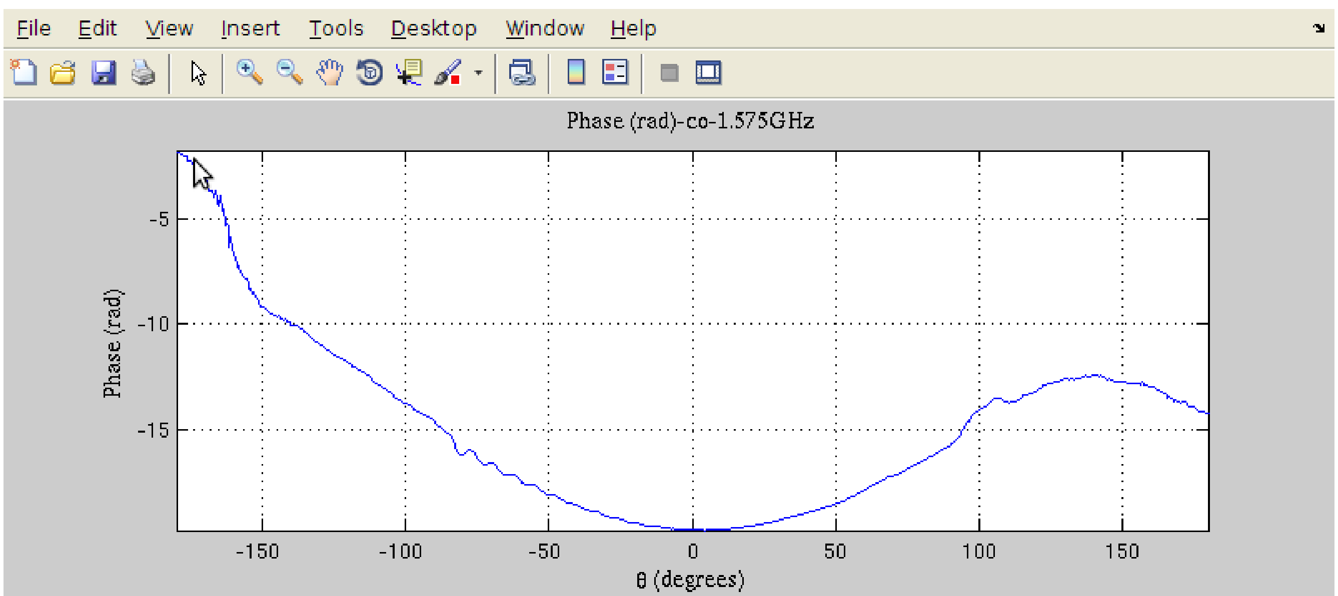


Illustration 4: AMA_individual: Phase diagram for one component first file.

Fraunhofer Data

This mode intends to read the measurement files made from the Fraunhofer Institut of Erlangen. It is made to read 4 files for a 2x2 antenna array. The more specific requirements are:

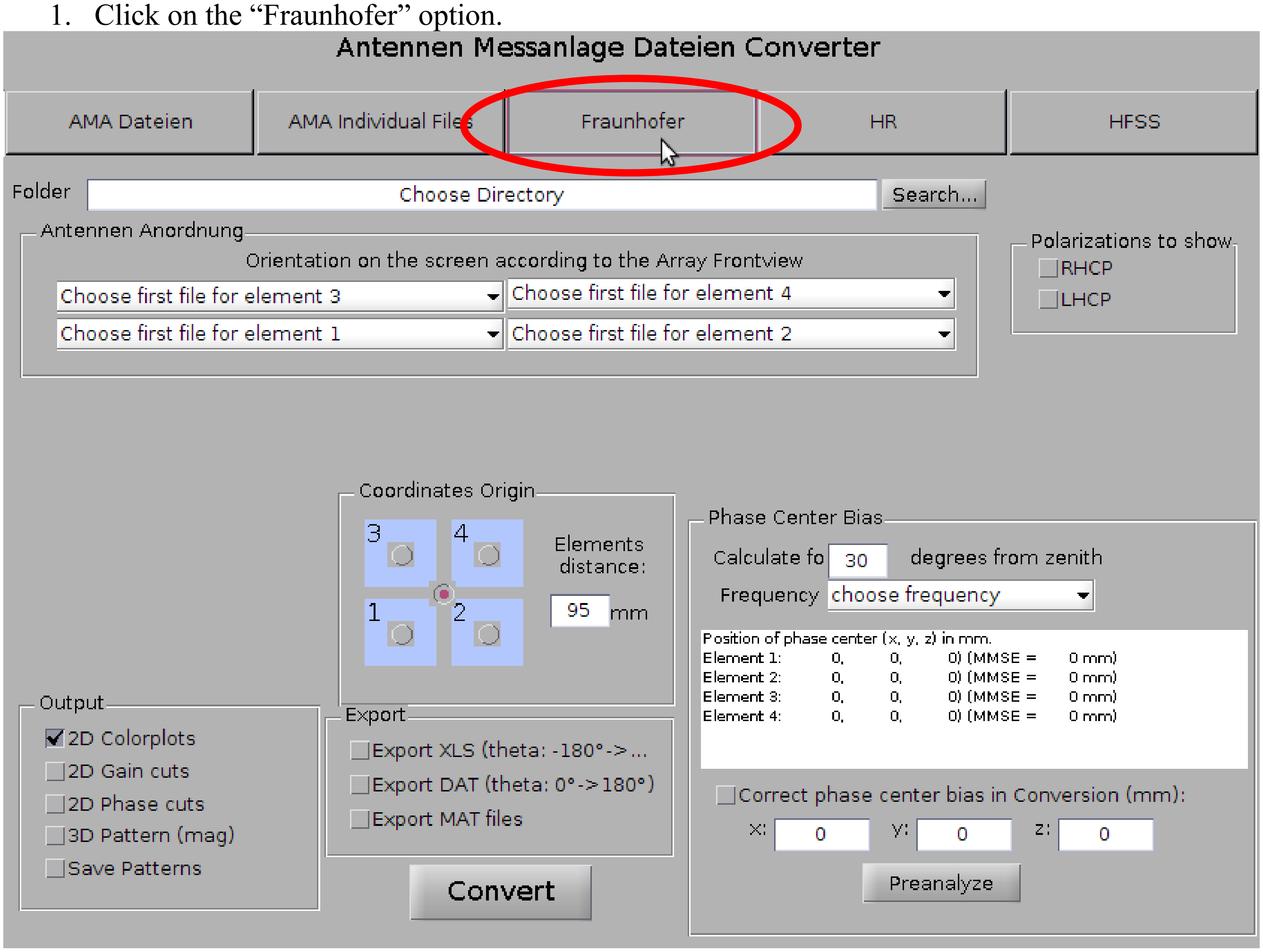
- The software reads in the case of Right Hand and Left Hand circular polarizations.
- The frequency information must be in Hz, MHz or GHz

- The Frequency information, Theta and Phi point measurements, Polarization sense and Unit specifications should be in the header, with a structure like the following example:

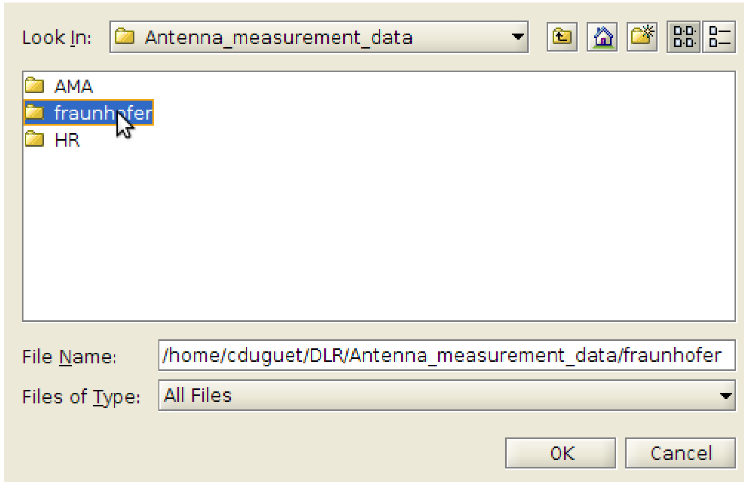
```
%%%%%%%%%%% %%%%%%%%%%%%%% %%%%%%%%%%%%%% %%%%%%%%%%%%%% %%%%%%%%%%%%%% %%%%%%%%%%%%%% %%%%%%%%%%%%%%
%Text version of
\\netapp01\hf\projekte\aktuell\Antennenmessung\Customer\DLR\NF_OEWG650_DLR_4facharray_SN01_Port1_03.NSI
%Measurement title:
%        FRAUNHOFER IIS
%        DESCRIPTION: DLR L-Band 4fach Patcharray S/N 01 Port 1
%        OPERATOR:BRJ - CONTINOUS PATH
%Measurement type:  5 (8=far-field theta-phi)
%Theta (deg)
%        Span = 180.00000  Center = 90.00000  #pts = 181
%        Start =  0  Stop =  180  Delta =  1
%Phi (deg)
%        Span = 360.00000  Center = 0.00000 #pts = 361
%        Start = -180  Stop =  180  Delta =  1
%Source setup: 0, 1
%FF sense (-1=RHCP,+1 LHCP,0=Linear):-1
%Far-field setup
%        Gain table file:
%        Calibration file:
%Units: GHz, degree, dB/dBil/dBic
%
```

Instructions:

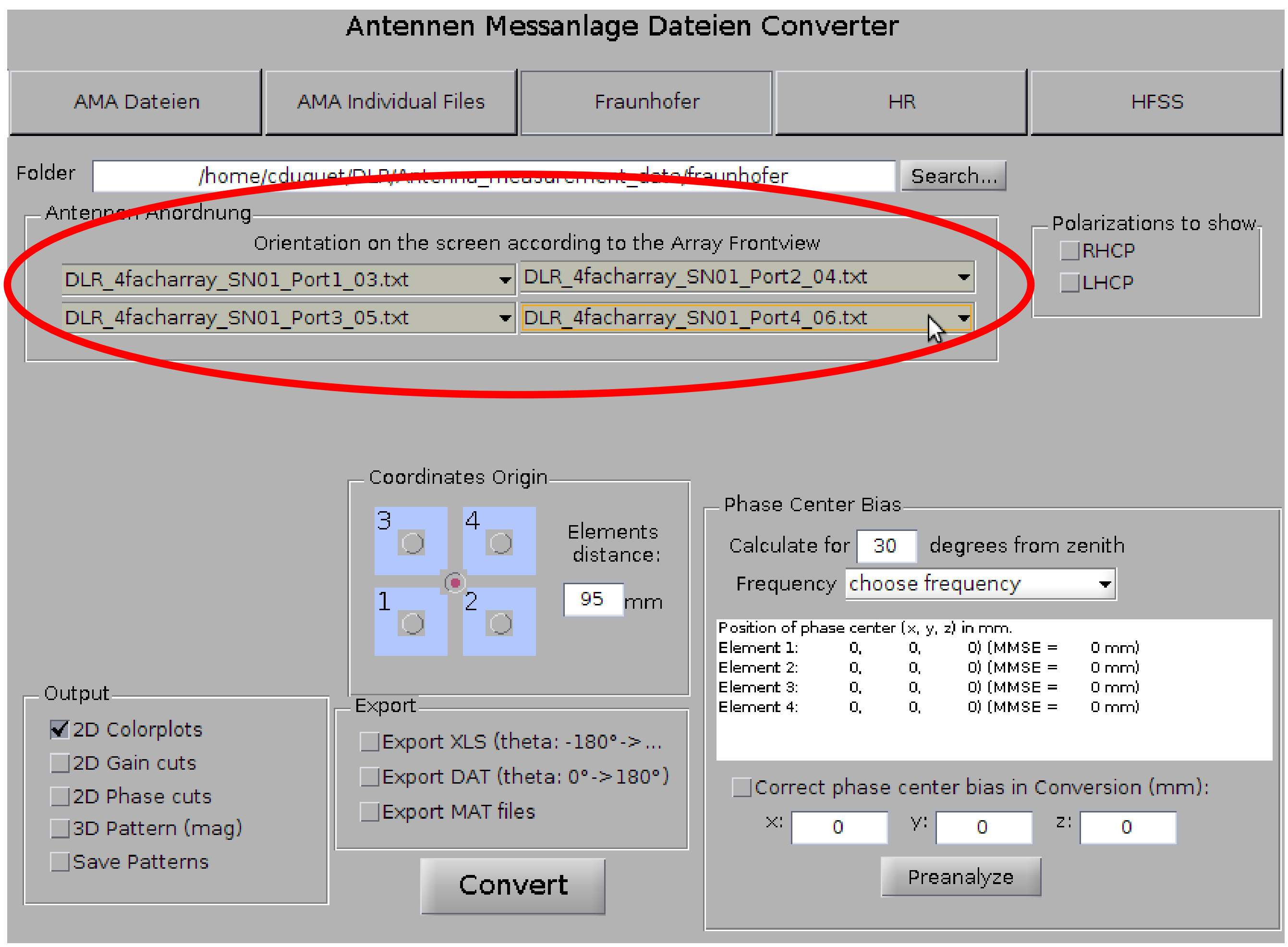
1. Click on the “Fraunhofer” option.



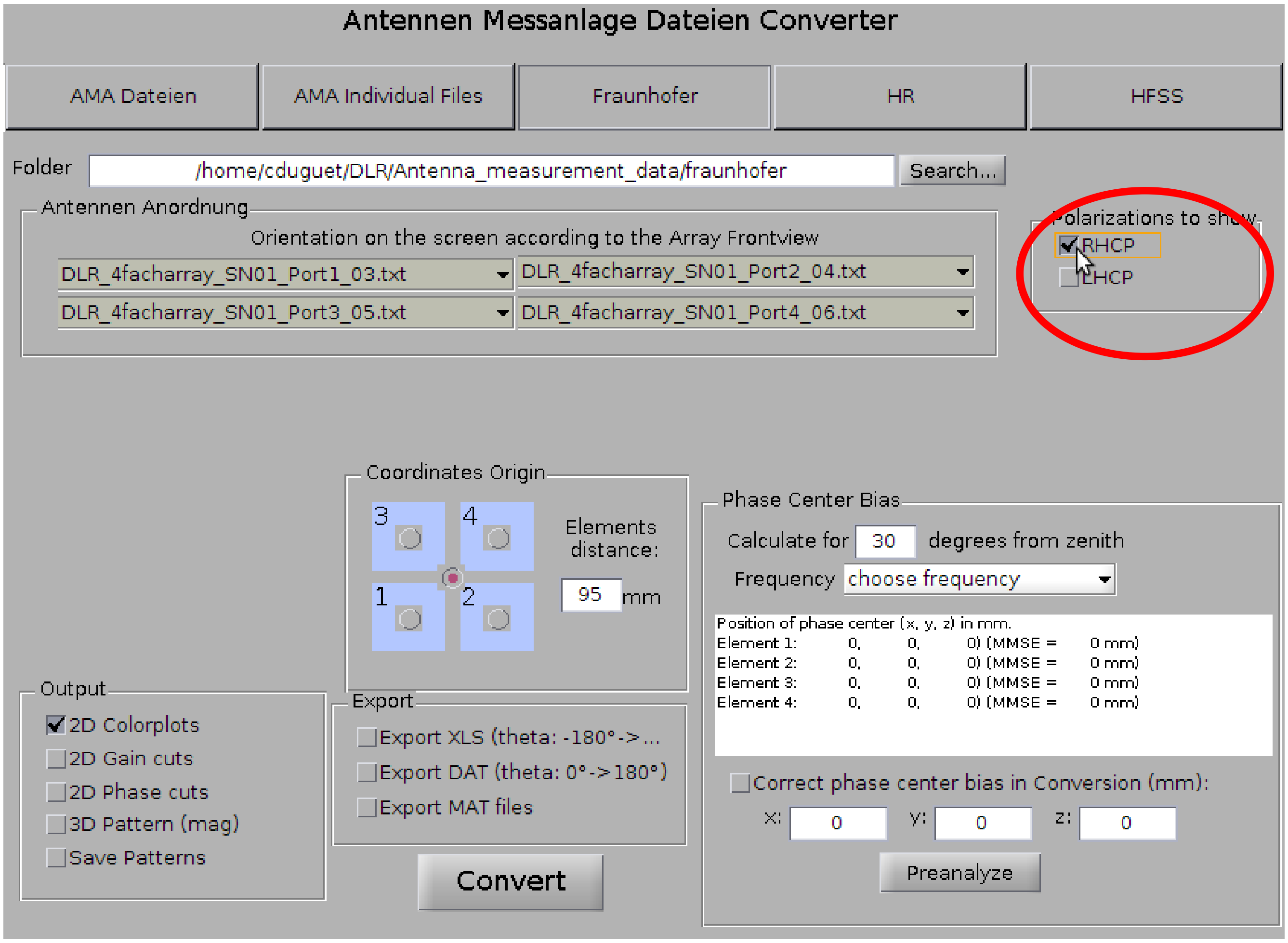
2. Click on “Choose folder” , and choose the folder of the Fraunhofer Data.



3. In the four pop-up menus, a list which includes all the files called "*.txt" is shown. Choose the files which represents each element. Choose the elements in the Program interface as if they were seen from zenith of the array, with the x axis (Phi =0°, Theta=90°) horizontal, pointing to the right of the screen. In the case of the Fraunhofer measurements the files were selected as shown below.

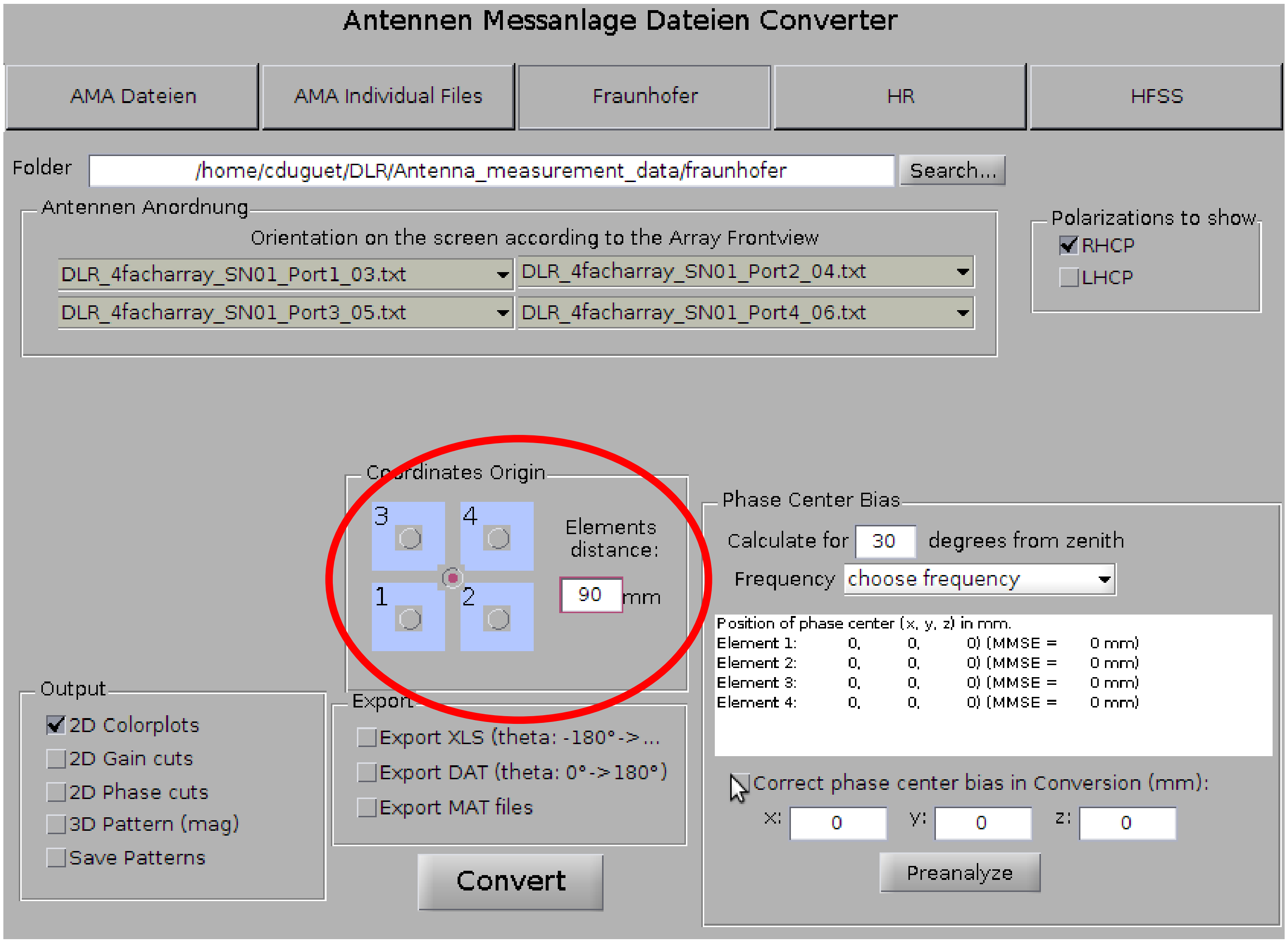


4. Choose at least one Polarization to read. Depending on the Polarization you choose, the Phase drag correction will be different.



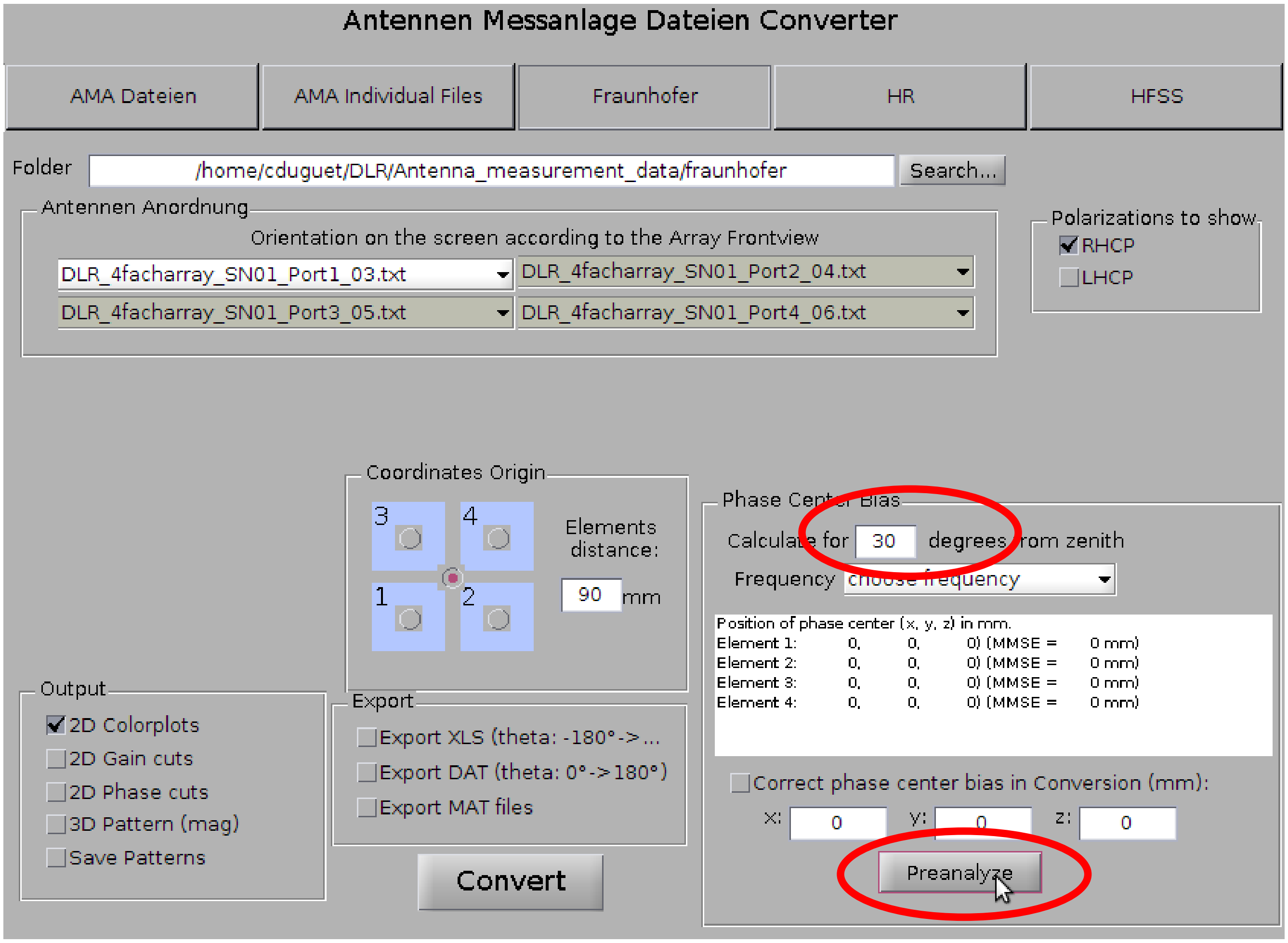
5. (Optional) In Coordinates Origin, choose the point of the array which represents the center of the measurements (note: usually all the measurements are made relative to the array center, so it is generally not necessary to change it). This affects all the phase measurements and the phase center estimations.

6. (Optional) Adjust the element distance, considered as the distance between two elements centers. This has an effect on the Phase array factor correction, and on the Phase center Bias calculation.

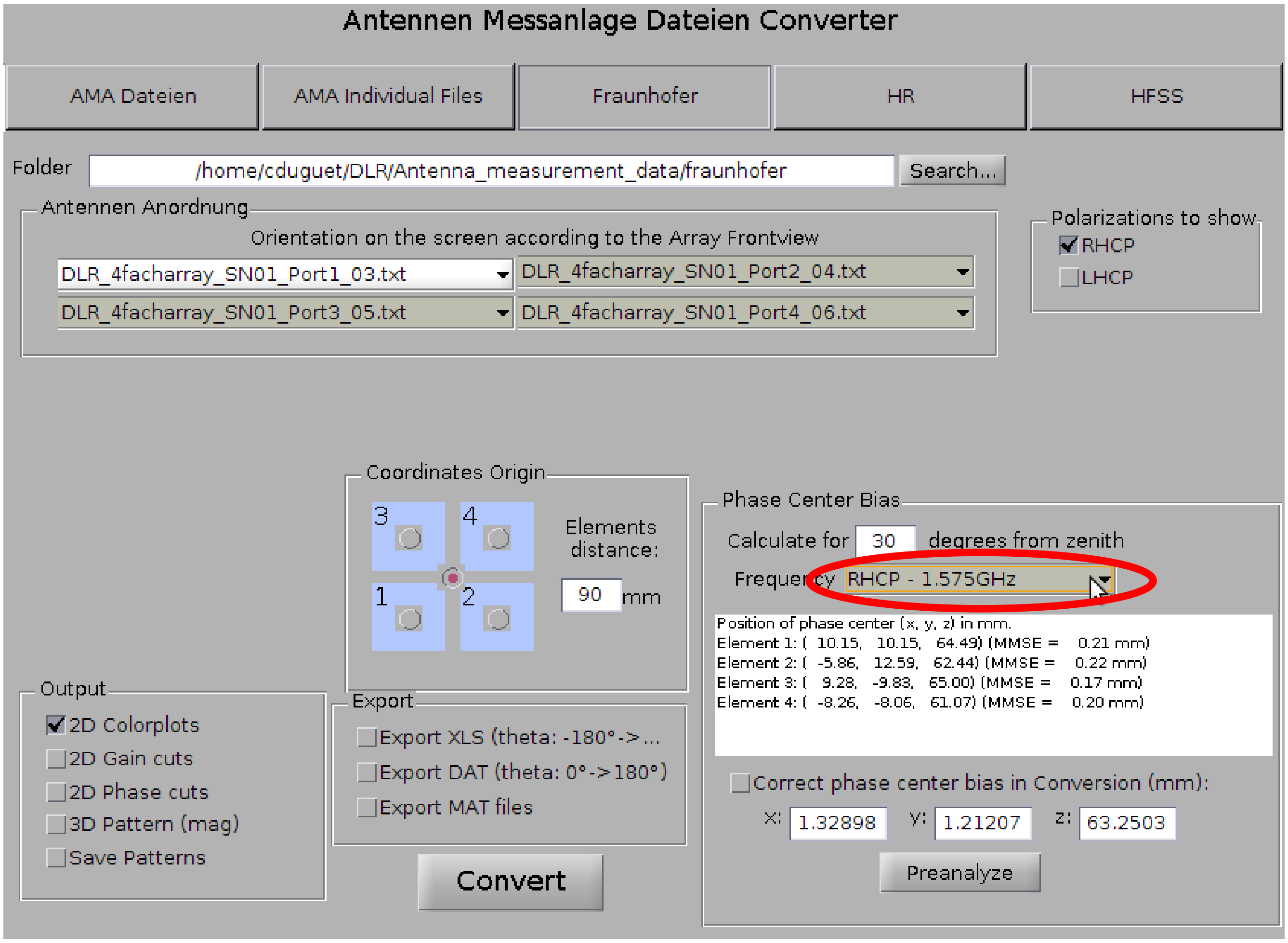


7. (Optional) In the Phase Center Bias panel, in "Calculate for ____ degrees from zenith", you choose the semiaperture of a cone centered in zenith, in which Region the Phase value is used to find a coherent isotropic antenna with the most equivalent phase distribution.

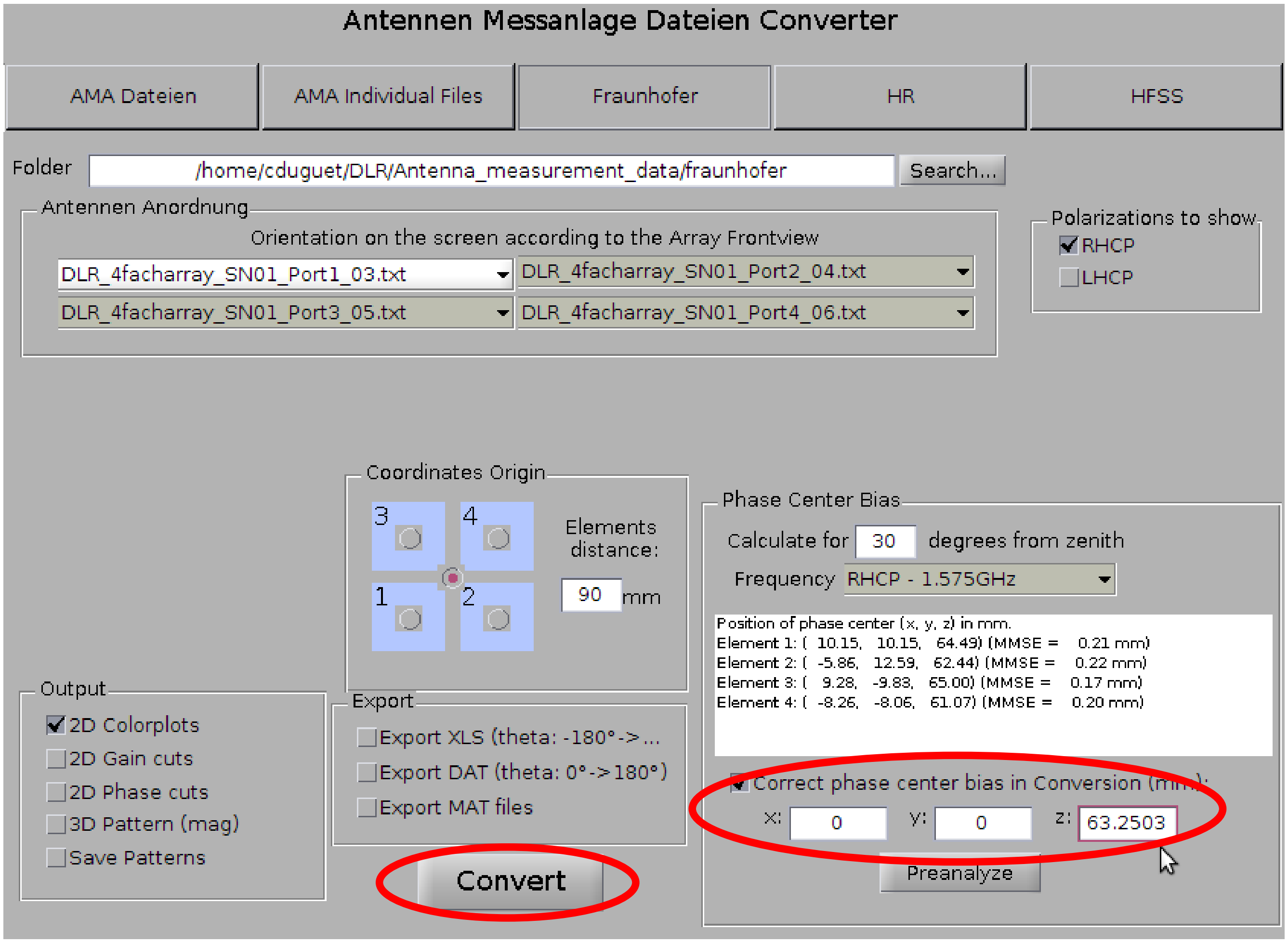
8. (Optional) Press the Preanalyze Button. In the Matlab screen it shows how it is working. Wait until it is finished. It is important that after this step you click on frequency pop-up. Otherwise the correction values will not be updated.



9. (Optional) Afterwards, click on Frequency. A list containing the possible combination of the measured Polarizations and Frequencies appears. Choose the one for which you are interested. The white screen will show a dialog containing the estimated position of the Phase Center in coordinates x,y and z, and the Mean squared error of the calculations. Use the MSE as a criteria on how reliable is the estimation. The boxes under “Correct Phase Center bias” option will show a proposed phase center correction factor for the further Conversion stage. It just takes the average of the measurements for each element along the x,y,z components.



10. (Optional) Depending on the measurement interests, on can change the values of the phase center correction. In this case, just the z component correction is important, so we change the x and y values to 0. Check the "Correct phase center bias" box, which enables the phase center corrections.



11. Press "Convert". With the Output Panel options selected as their default, it will just show the 2D colorplots of the Gain and Phase. Another options can be selected, depending on the needs.

HR Data

This option was made to read the measurements made by the Institut für Hochfrequenztechnik & Radarsysteme of the DLR. It will read a Directory with different files for a 2x2 antenna array. The elements in the format fill the following requirements:

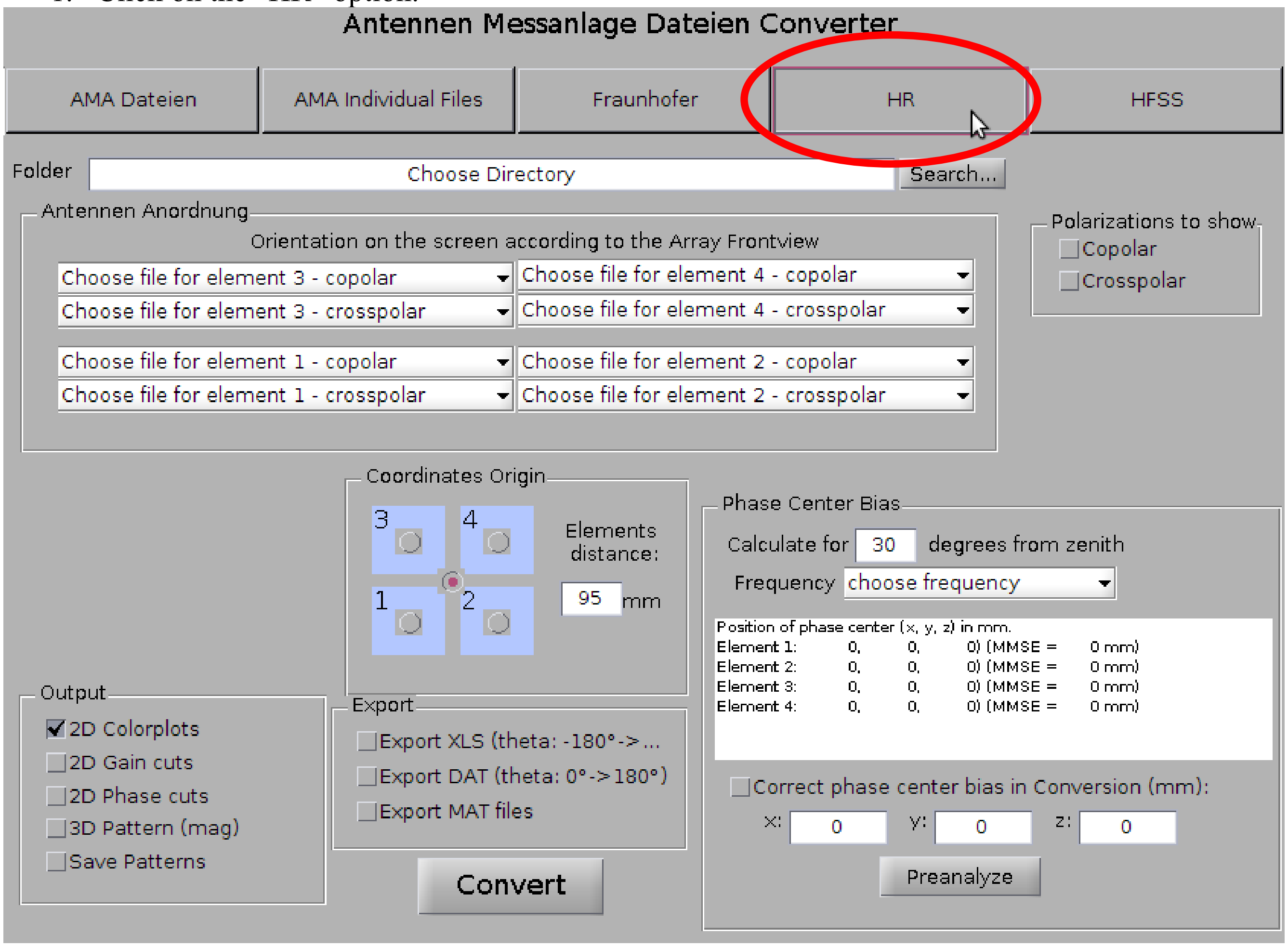
- There are 8 comma separated value files, one pair representing each antenna element. In each pair, one file contains the measurement for one polarization, and the other for its respective crosspolarization.
- The Phi and Theta measurement points are in degrees.
- The Magnitude or Gain is expressed in dB/dBi/dBd.
- The frequency is expressed in Hz, MHz or GHz.
- The Header of each file hast a format according to the following example:

```
"L-Ant_1_Feed_H_Roll-Az-t02cg2900rl3c.rep"
"L-Ant_1, Roll over Azimuth, Feed dreht mit. Start Feed H"
"LHC","i"
```

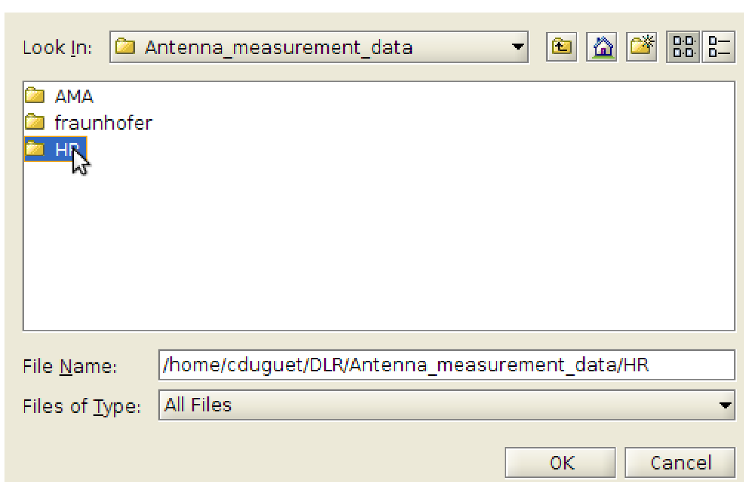
```
"Phi",0,180,"deg",181,"Equidistant"
"Theta",-180,180,"deg",361,"Equidistant"
"FREQUENCY",1.5654e+009,1.5854e+009,"Hz",5,"Equidistant"
"Phi (deg)","Theta (deg)","Log Mag (dBi)","Phase (deg)","FREQUENCY (Hz)"
```

Instructions:

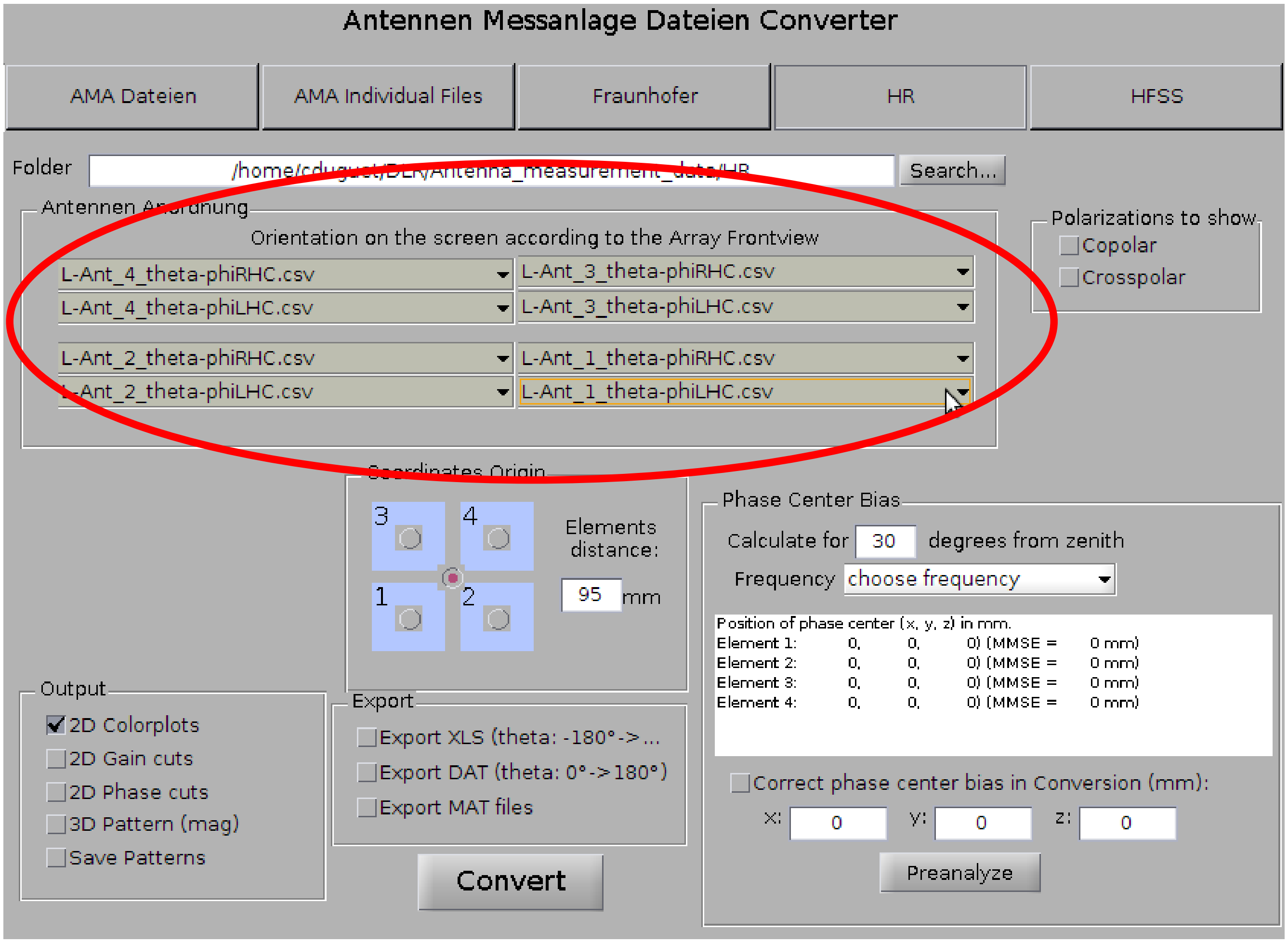
1. Click on the “HR” option.



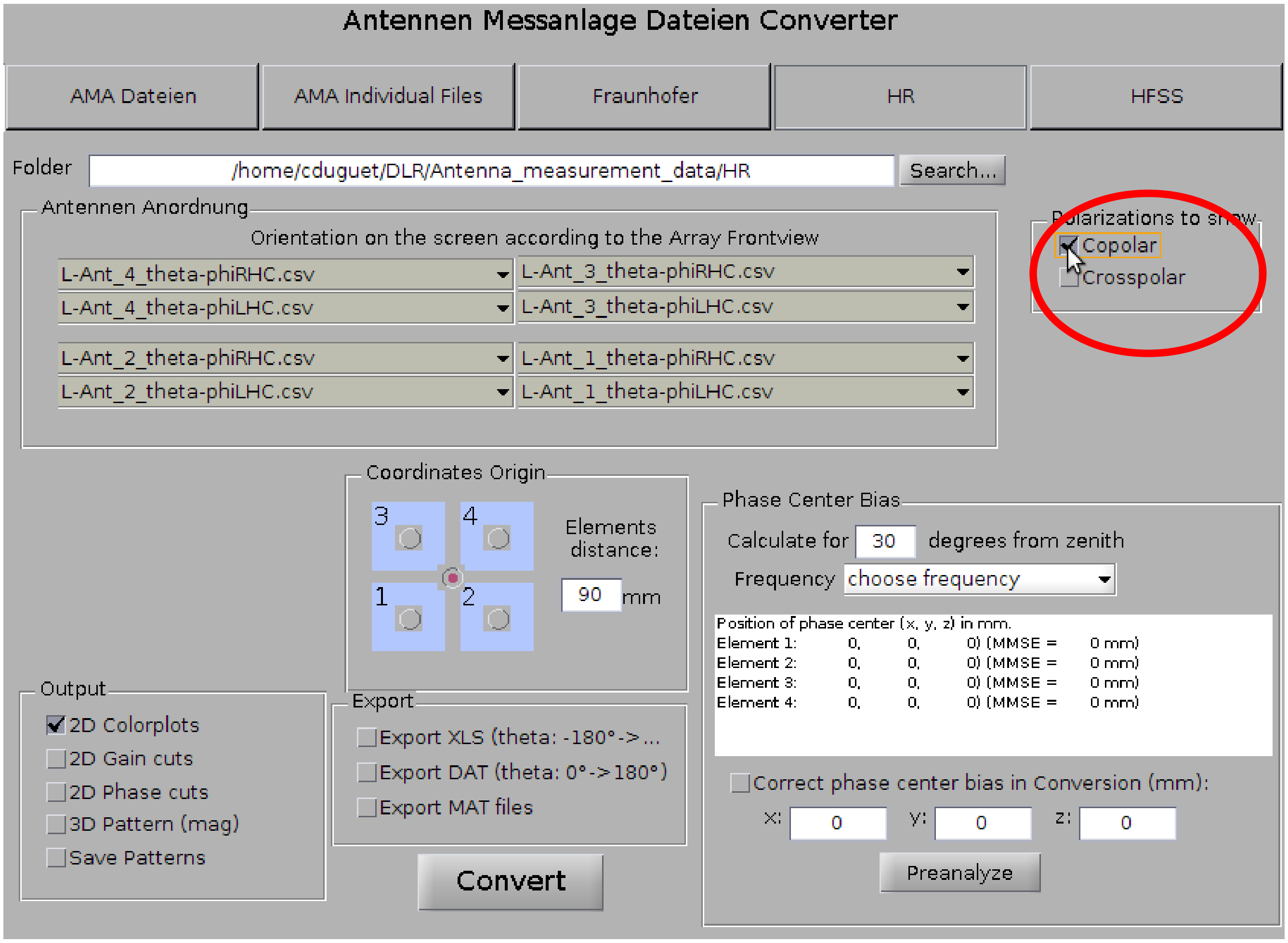
2. Click on “Choose folder” , and choose the folder of the HR Data.



3. In the four pop-up menus, a list which includes all the files called “*.csv” is shown. Choose the files which represents each element and each polarization. Choose the elements in the Program interface as if they were seen from zenith of the array, with the x axis (Phi =0°, Theta=90°) horizontal, pointing to the right of the screen. In the case of the HR measurements the files were selected as shown below.

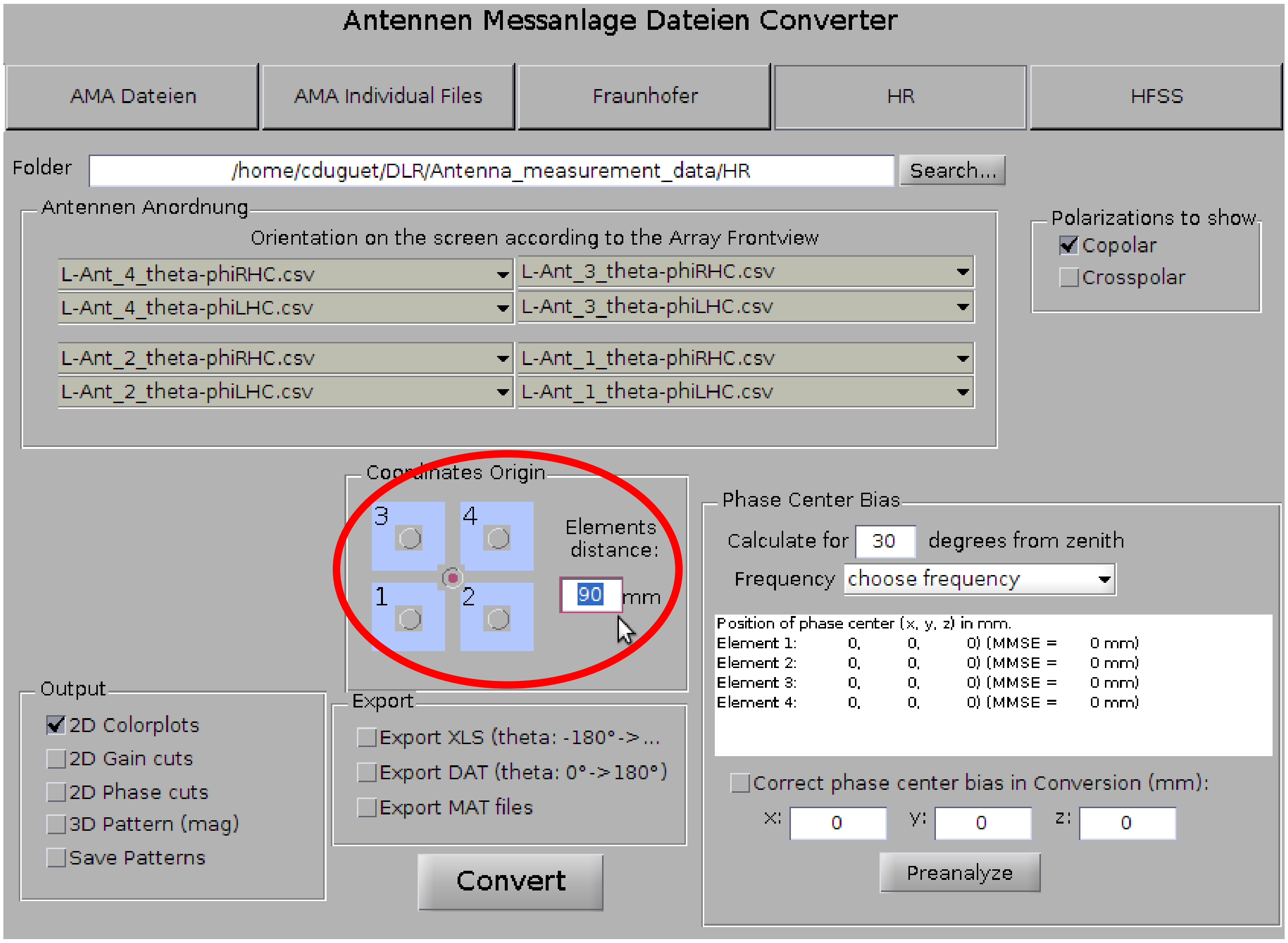


4. Choose at least one Polarization to read.



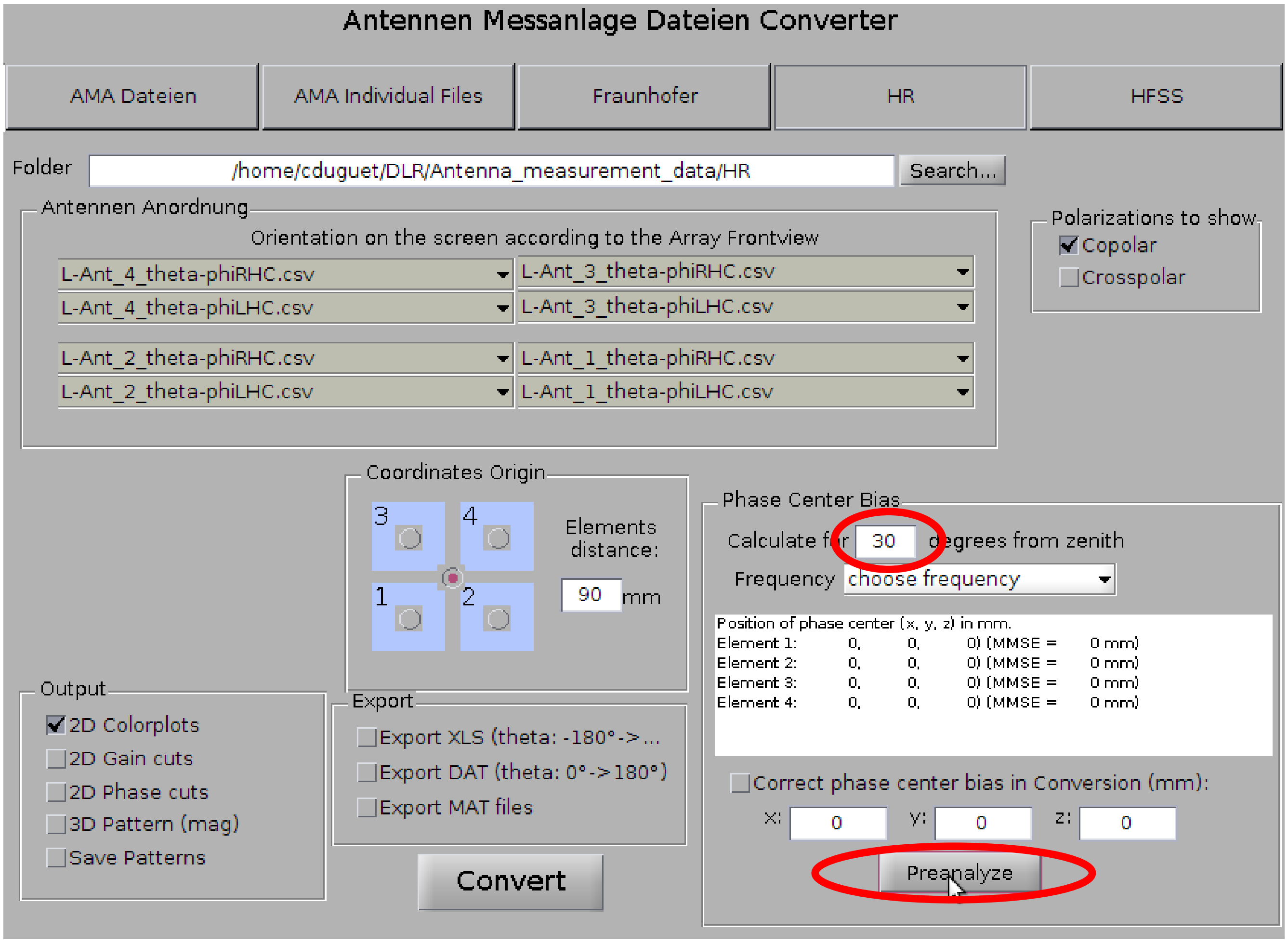
5. (Optional) In Coordinates Origin, choose the point of the array which represents the center of the measurements (note: usually all the measurements are made relative to the array center, so it is generally not necessary to change it). This affects all the phase measurements and the phase center estimations.

6. (Optional) Adjust the element distance, considered as the distance between two elements centers. This has an effect on the Phase array factor correction, and on the Phase center Bias calculation.



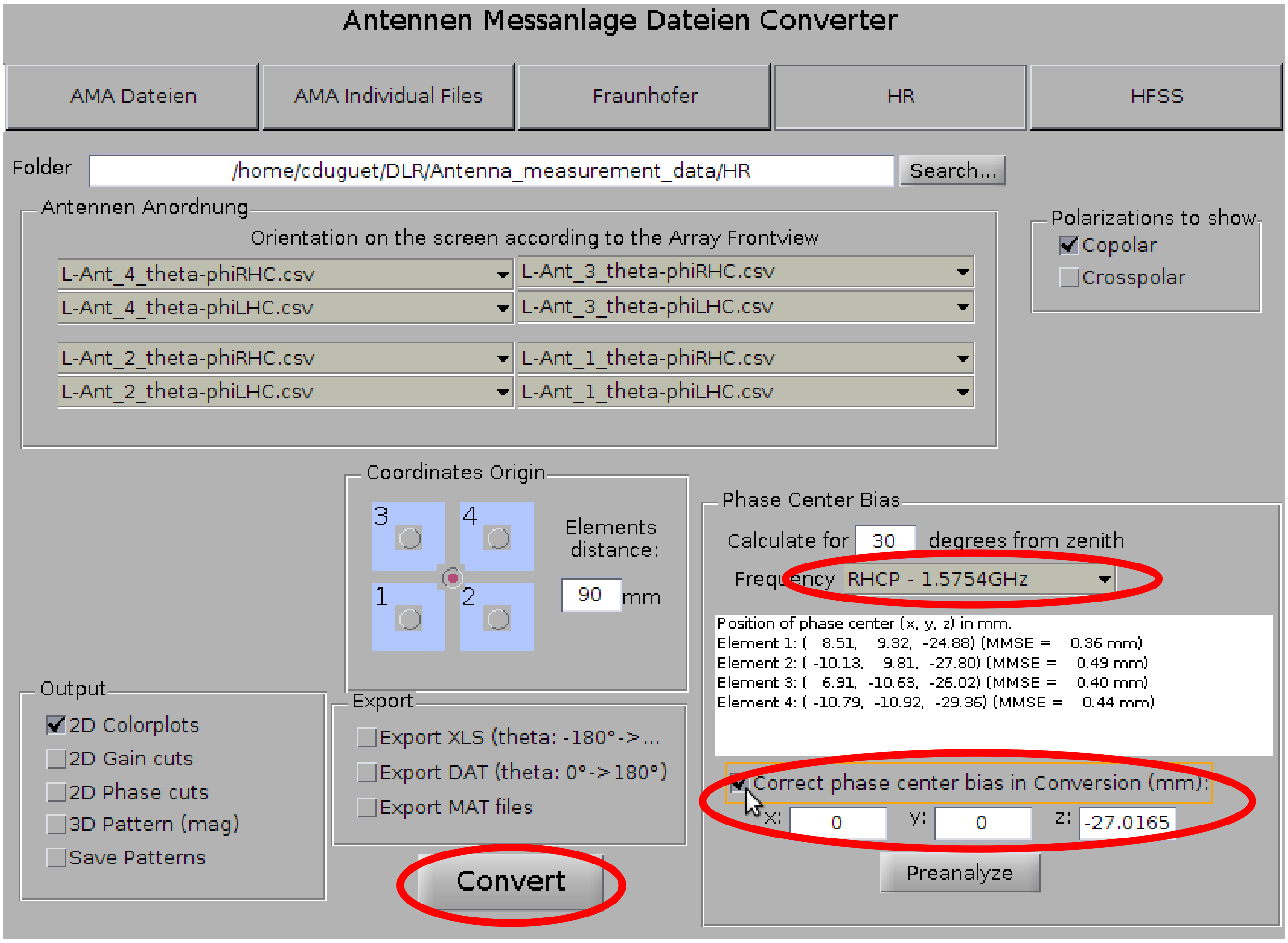
7. (Optional) In the Phase Center Bias panel, in “Calculate for ____ degrees from zenith”, you choose the semiaperture of a cone centered in zenith, in which Region the Phase value is used to find a coherent isotropic antenna with the most equivalent phase distribution.

8. (Optional) Press the Preanalyze Button. In the Matlab screen it shows how it is working. Wait until it is finished. It is important that after this step you click on frequency pop-up. Otherwise the correction values will not be updated.



9. (Optional) Afterwards, click on Frequency. A list containing the possible combination of the measured Polarizations and Frequencies appears. Choose the one for which you are interested. The white screen will show a dialog containing the estimated position of the Phase Center in coordinates x,y and z, and the Mean squared error of the calculations. Use the MSE as a criteria on how reliable is the estimation. The boxes under “Correct Phase Center bias” option will show a proposed phase center correction factor for the further Conversion stage. It just takes the average of the measurements for each element along the x,y,z components.

10. (Optional) Depending on the measurement interests, on can change the values of the phase center correction. In this case, just the z component correction is important, so we change the x and y values to 0. Check the “Correct phase center bias” box, which enables the phase center corrections.



11. Press “Convert”. With the Output Panel options selected as their default, it will just show the 2D colorplots of the Gain and Phase. Another options can be selected, depending on the needs.

HFSS Data

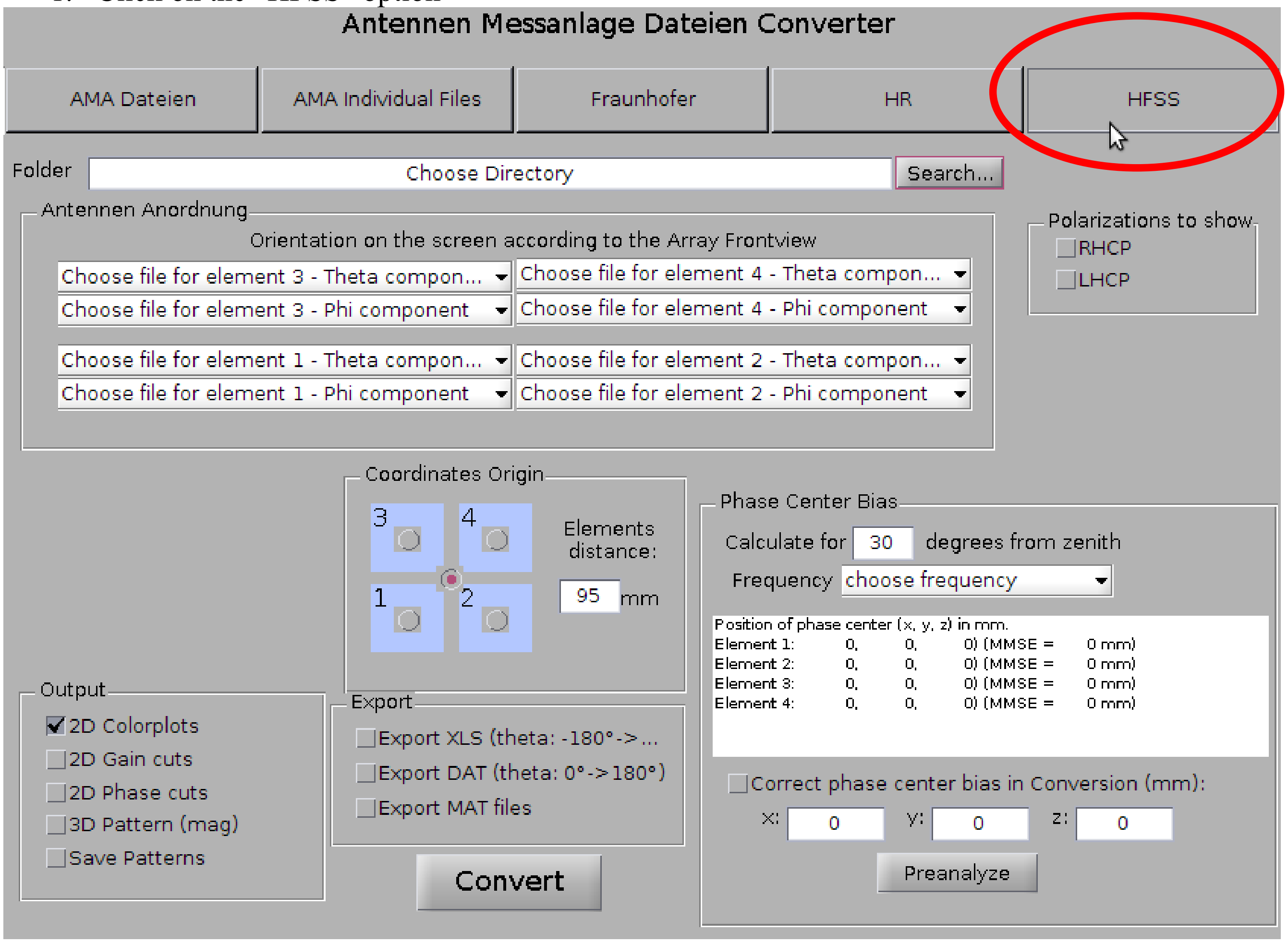
This mode intends to read the HFSS Data simulations. The HFSS data simulations of 2x2 arrays have to be in files which fill the following requirements:

- The results are saved in the two EM field components, the Theta field and the Phi field.
- There are 8 “*.tab” files, one pair representing each antenna element. In each pair, one file contains the measurement for the Theta component, and the other for the Phi component.
- The Phi and Theta measurement points are in degrees.
- The Magnitude or Gain is expressed in dB/dBi/dBd.
- The frequency is expressed in Hz, MHz or GHz.
- On each row in the file, the data contains the measurements for a certain Theta angle. The

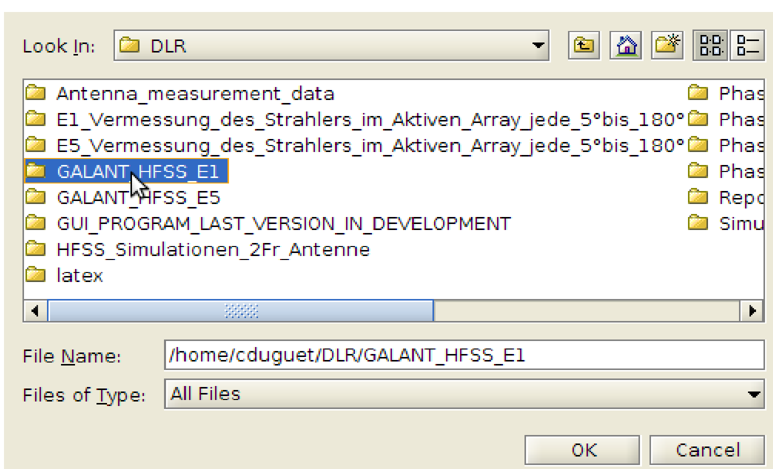
different Phi and frequency measurements are written along different columnns.

Instructions:

1. Click on the “HFSS” option

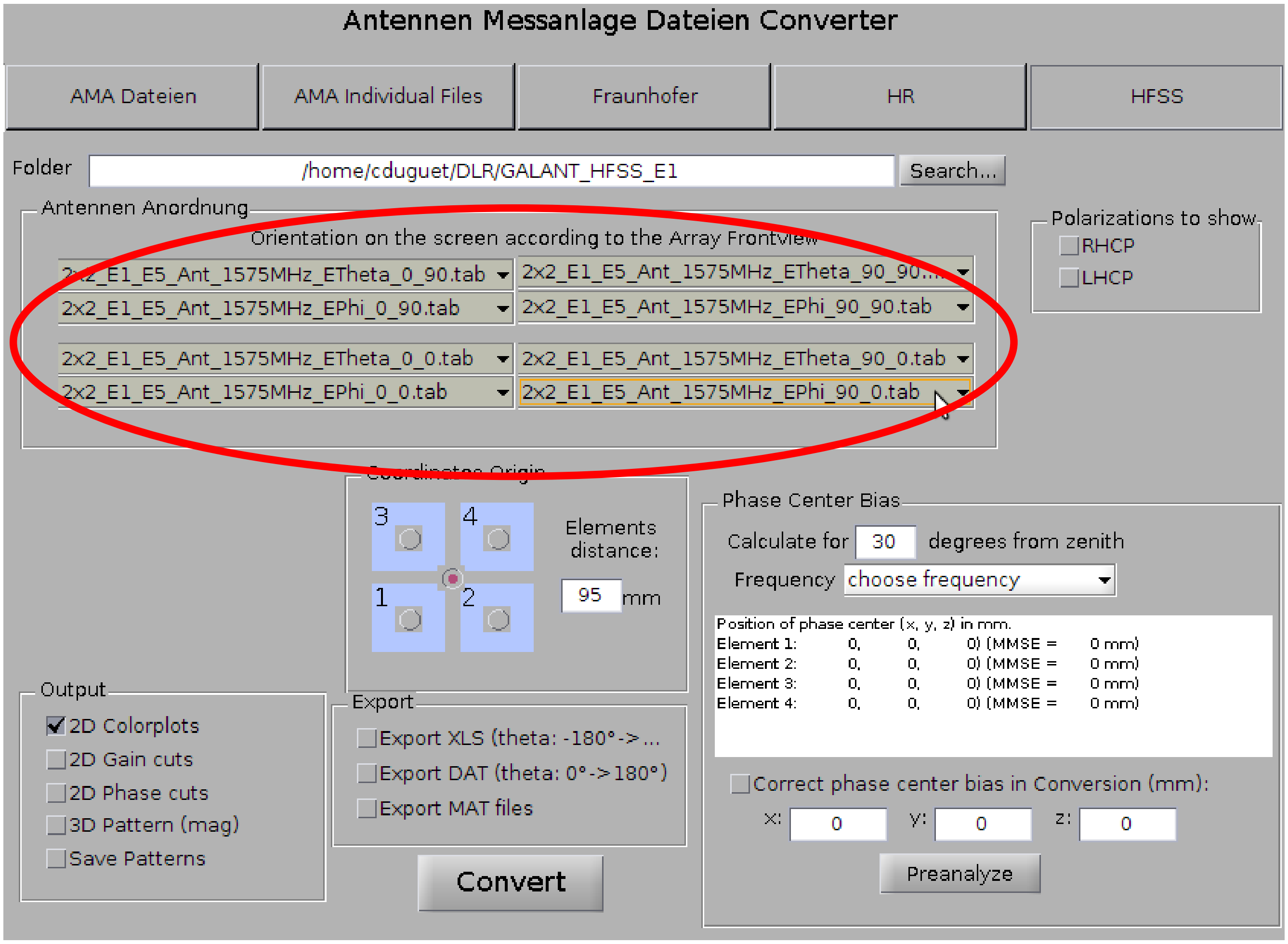


2. Click on “Choose folder” , and choose the folder of the HFSS Data.

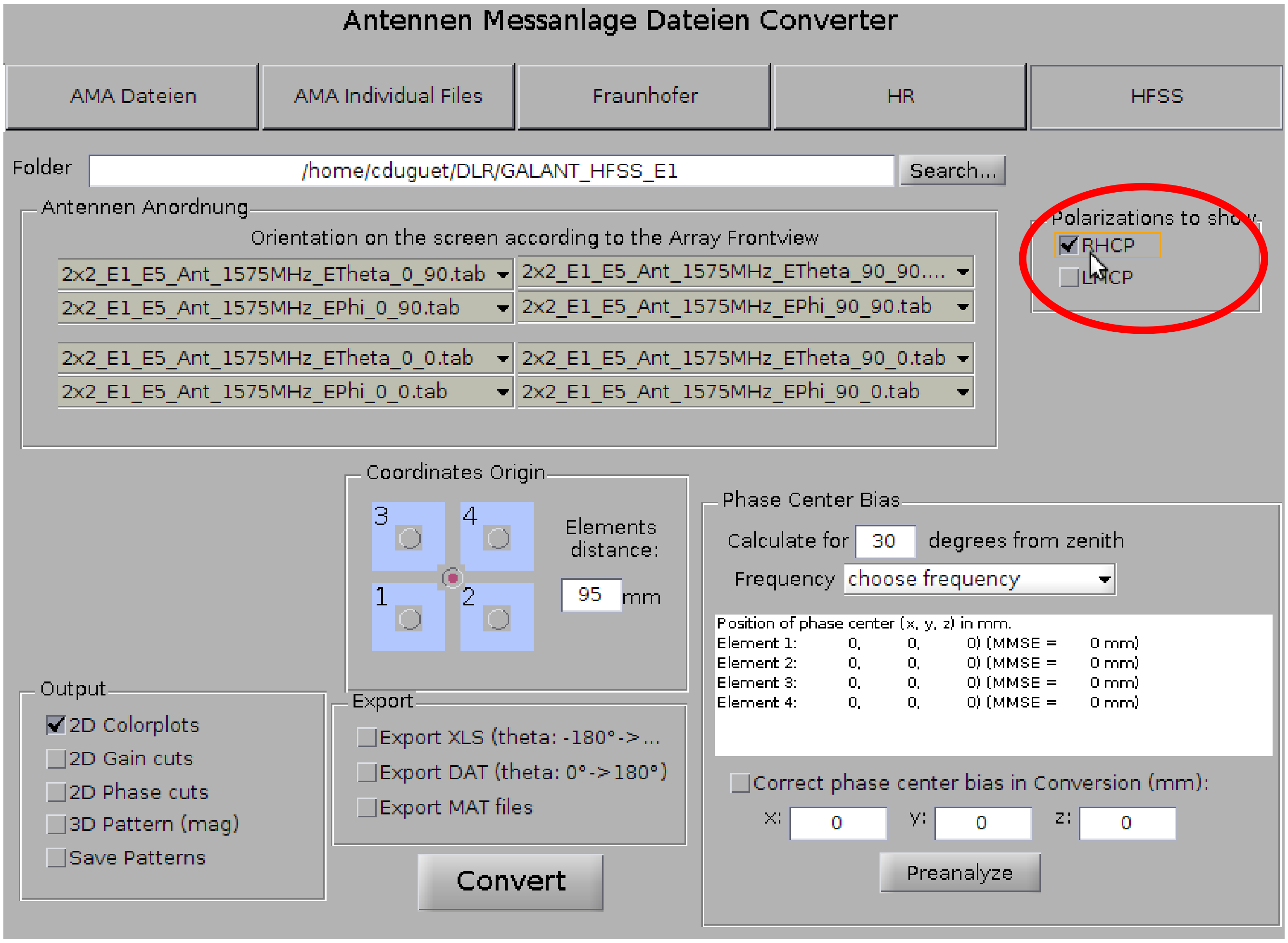


3. In the four pop-up menus, a list which includes all the files called “*.tab” is shown. Choose the

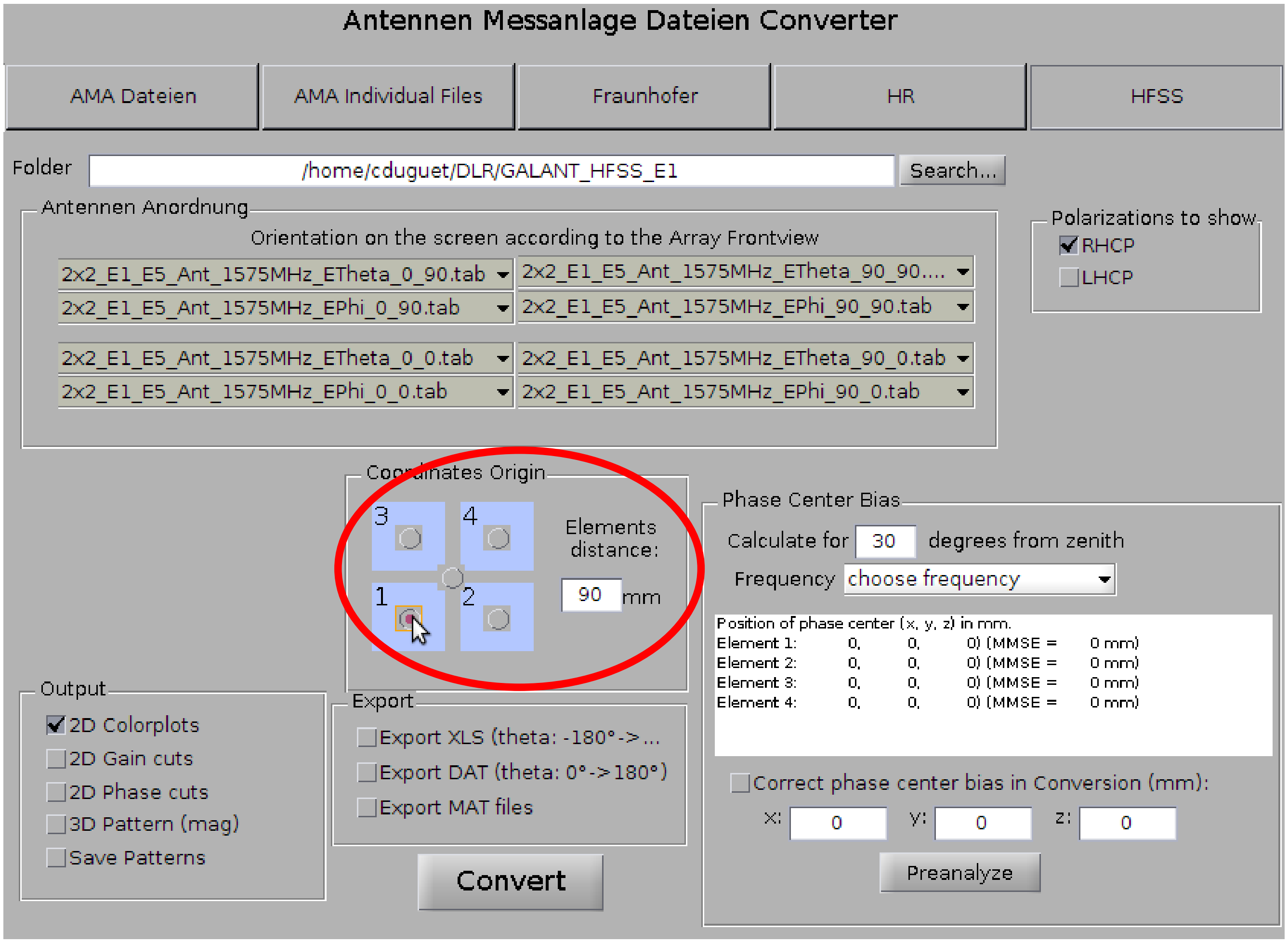
files which represents each element and each component. Choose the elements in the Program interface as if they were seen from zenith of the array, with the x axis (Phi =0°, Theta=90°) horizontal, pointing to the right of the screen. In the case of these HFSS measurements the files were selected as shown below.



4. Choose at least one Polarization to read.



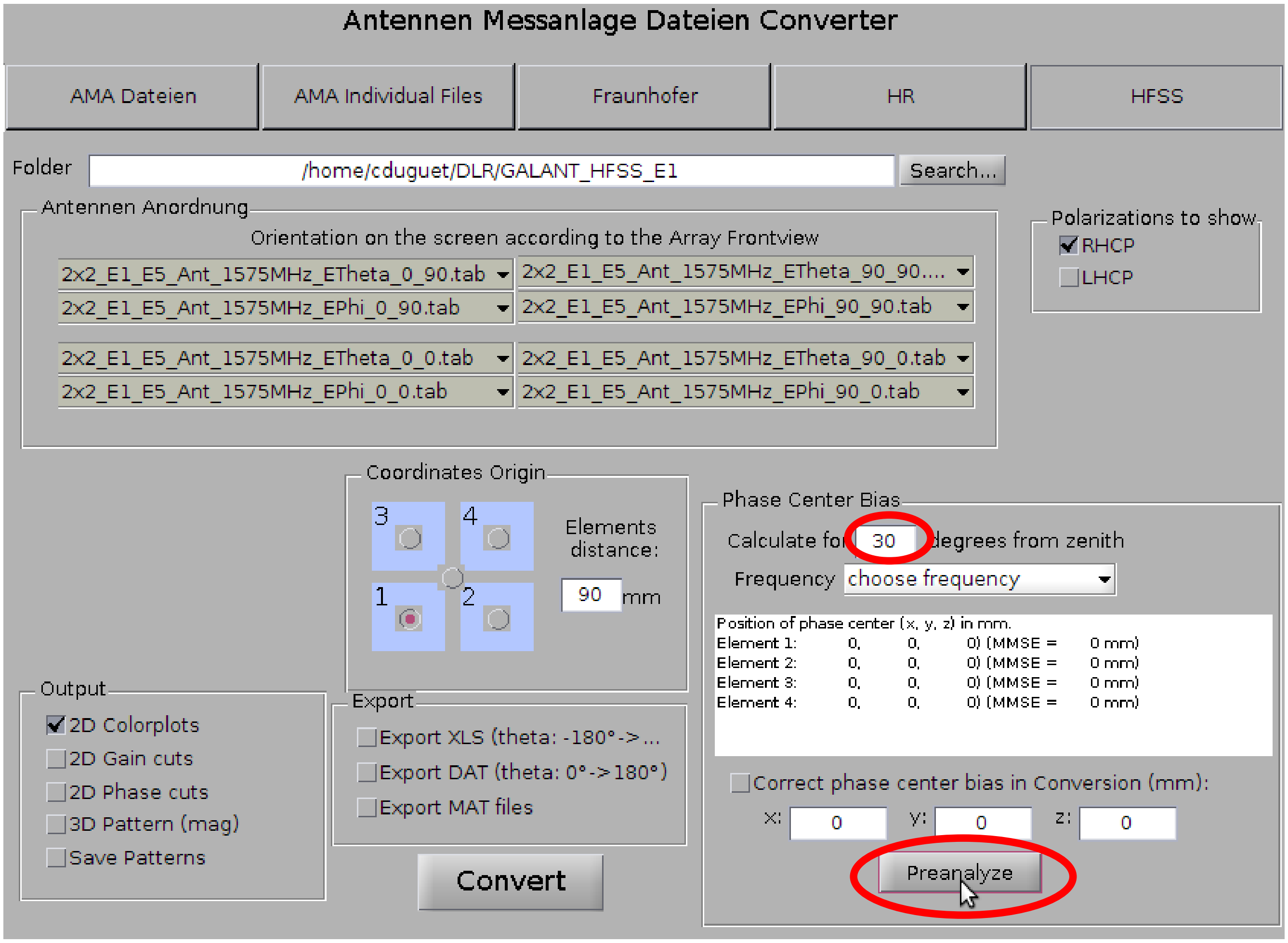
5. (Optional) In Coordinates Origin, choose the point of the array which represents the center of the measurements (note: usually all the measurements are made relative to the array center, so it is generally not necessary to change it). This affects all the phase measurements and the phase center estimations.



6. (Optional) Adjust the element distance, considered as the distance between two elements centers. This has an effect on the Phase array factor correction, and on the Phase center Bias calculation.

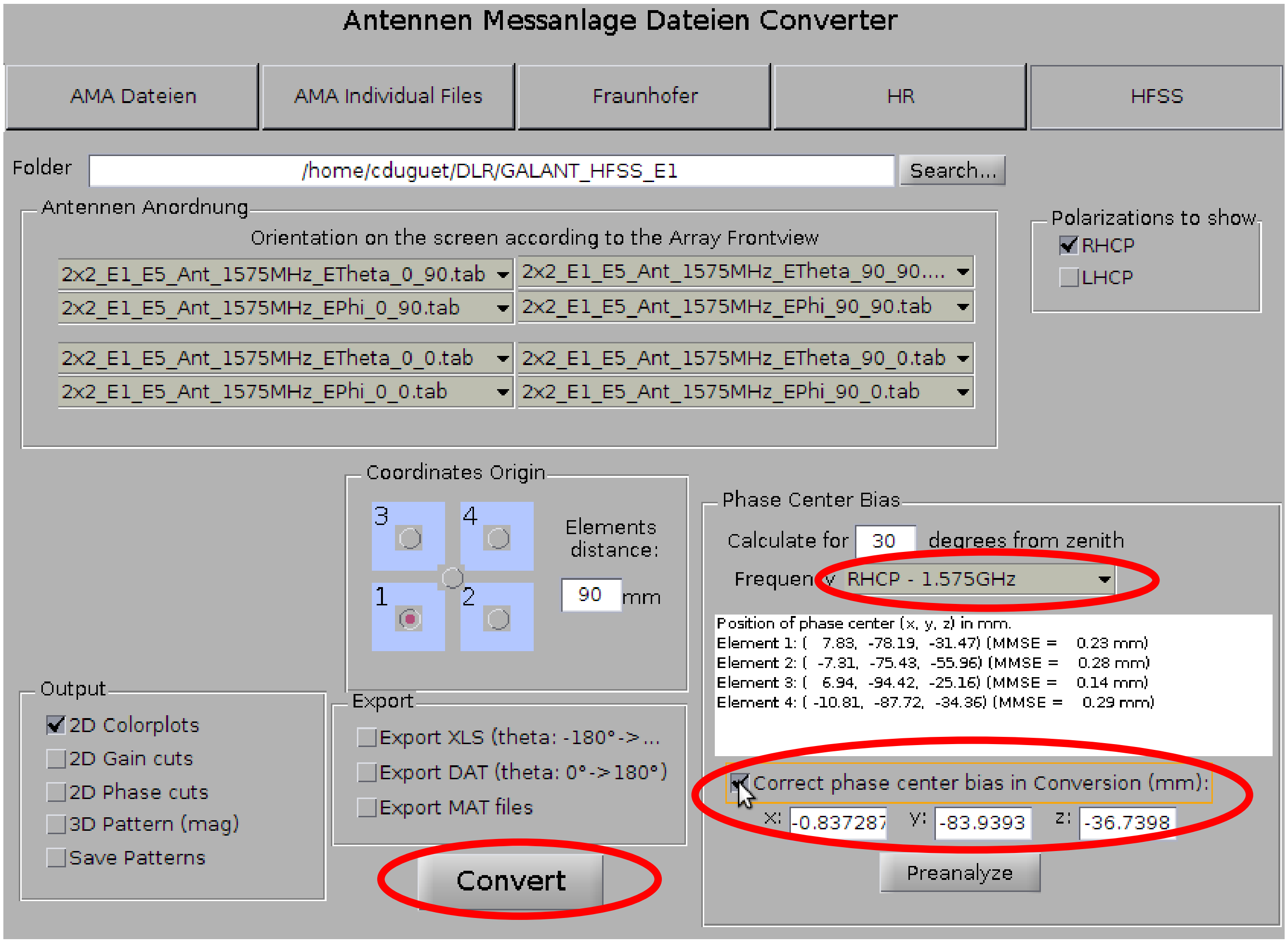
7. (Optional) In the Phase Center Bias panel, in "Calculate for ____ degrees from zenith", you choose the semiaperture of a cone centered in zenith, in which Region the Phase value is used to find a coherent isotropic antenna with the most equivalent phase distribution.

8. (Optional) Press the Preanalyze Button. In the Matlab screen it shows how it is working. Wait until it is finished. It is important that after this step you click on frequency pop-up. Otherwise the correction values will not be updated.



9. (Optional) Afterwards, click on Frequency. A list containing the possible combination of the measured Polarizations and Frequencies appears. Choose the one for which you are interested. The white screen will show a dialog containing the estimated position of the Phase Center in coordinates x,y and z, and the Mean squared error of the calculations. Use the MSE as a criteria on how reliable is the estimation. The boxes under "Correct Phase Center bias" option will show a proposed phase center correction factor for the further Conversion stage. It just takes the average of the measurements for each element along the x,y,z components.

10. (Optional) Depending on the measurement interests, on can change the values of the phase center correction. In this case, and in cases when we dont have much information about where was the coordinates origin in the measurements/simulations, it is convenient to let the program correct x and y components. Check the "Correct phase center bias" box, which enables the phase center corrections.



11. Press “Convert”. With the Output Panel options selected as their default, it will just show the 2D colorplots of the Gain and Phase. Another options can be selected, depending on the needs.