newFASANT

Periodical structures

Benchmark: Periodical structures
Software Version: 6.2.7
Date: 22 Nov 18:52

Index

1. Description and objetives

The example presented in this paper is described in this section. The main goals of this example are also indicated. Images and figures of the geometry and the results are provided as well.

This example shows the creation of a periodical structure by using the existing primitives.

This case is generated using the ***Periodical Structures*** module. To get started, create a new Periodical Structures project by clicking on the ***New Project*** button and select the *PERIODICAL STRUCTURES* option.

1.1. Geometry creation

Since the elements of the periodical structures are small, it is recommended to work in centimeters or millimeters. The units can be modified in the bottom bar of the user interface. The measurement units used in this document are centimeters.

The user can choose from a wide range of geometries available for the generation of periodical structures. The most common are in the **Cell - FSS** Primitives menu, but it is possible to use other primitives defined in the Geometry menu.

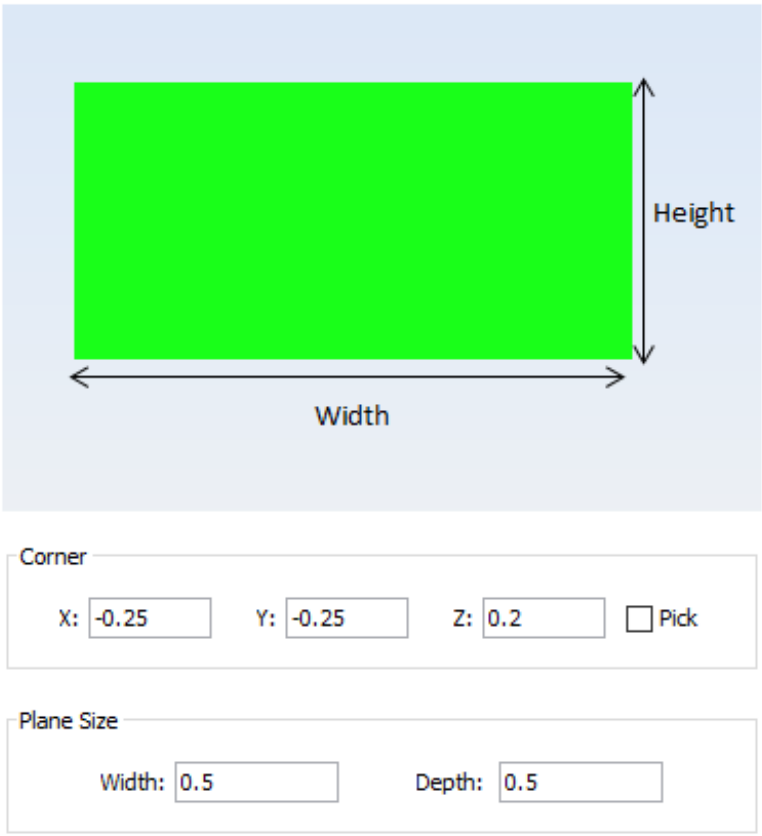
The unit cell must be defined. The cell is composed by a dielectric layer and a metal square patch at the top. The dielectric layer has a thickness of 0,2 centimeters.

In order to define the first interface (without geometry) create a point using the ***Geometry → Point → Single Point*** option. The point will be defined at the origin coordinates (0, 0, 0).

```
command> point
Select point on screen [x y z]: 0 0 0
```

Point definition

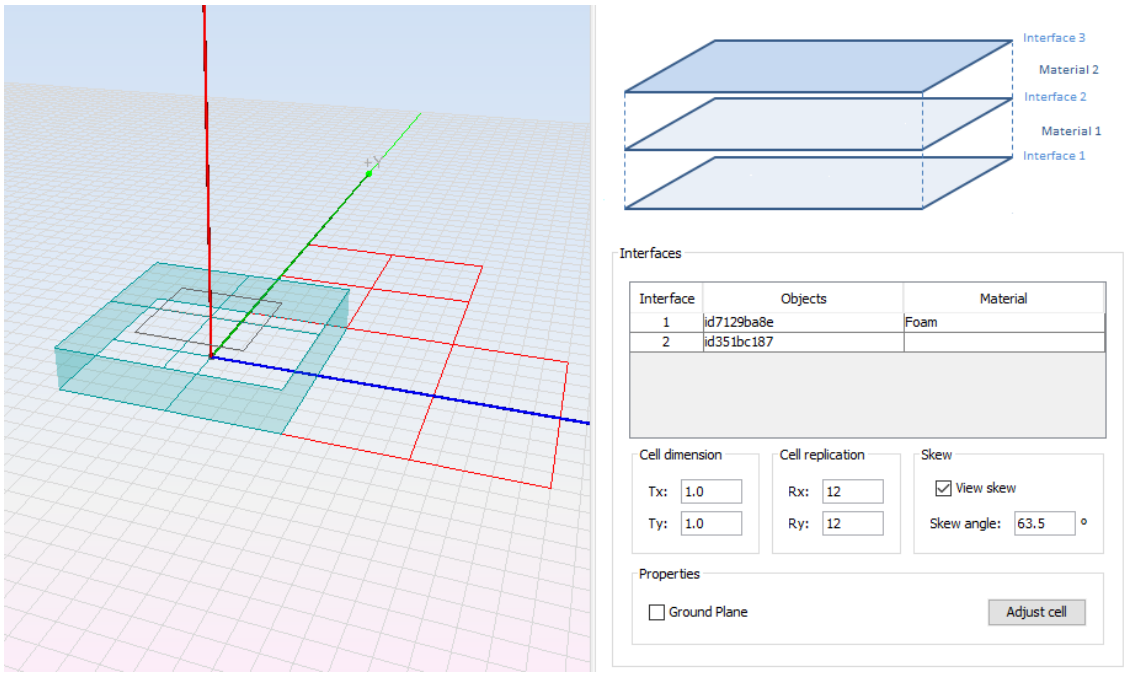
Then the metallic patch is defined using ***Cell → FSS Primitives → Plane***. This patch is centered at the origin at a height of 0.2 centimeters using the parameters shown in the next figure.



Metallic patch

1.2. Cell definition

After defining the geometrical elements, proceed to define the unit cell using the ***Cell → Define Cell*** menu. In this step the material is assigned to the layers. As many layers as different Z coordinates found in the geometry are defined.



Define cell

In this example the Foam material is assigned to the layer. The cell is defined with the dimensions set as 1.0 centimeters in the X axis and 1.0 centimeters in the Y axis. The number of replications of the unit cell are 12 cells in the X axis and 12 cells in the Y axis. The skew angle defines the angle of displacement from the Y-Axis to the replication cells. The assigned value is 63.5 degrees.

It is necessary to press the ***Save*** button to save the changes.

2. Set-up description

The main parameters recommended for the solution of this example are presented in this section.

Every parameter value is justified and also a brief overview about the implications of setting-up or changing the recommended value is also included.

Critical parameters are highlighted and also justified.

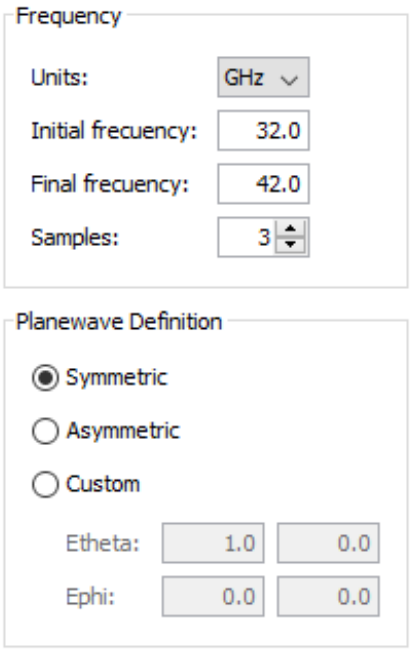
2.1. Simulation parameters

The main simulation parameters are explained in this section. The simulation parameters can be found under the ***Simulation → Parameters*** menu.

For this example, set the frequency sweep from 32 GHz to 42 GHz with 3 samples. The frequencies of the simulation are, therefore, 32, 37, and 42 GHz.

If the cell is symmetric the user can be select the *Symmetric* radio button. This option is faster than the *Asymmetric* option but can only be applied to symmetrical cells. For asymmetric cells will be

used the *Asymmetric* radio button.



Simulation parameters

2.2. Solver parameters

The recommended values for the solver configuration are explained in this section.

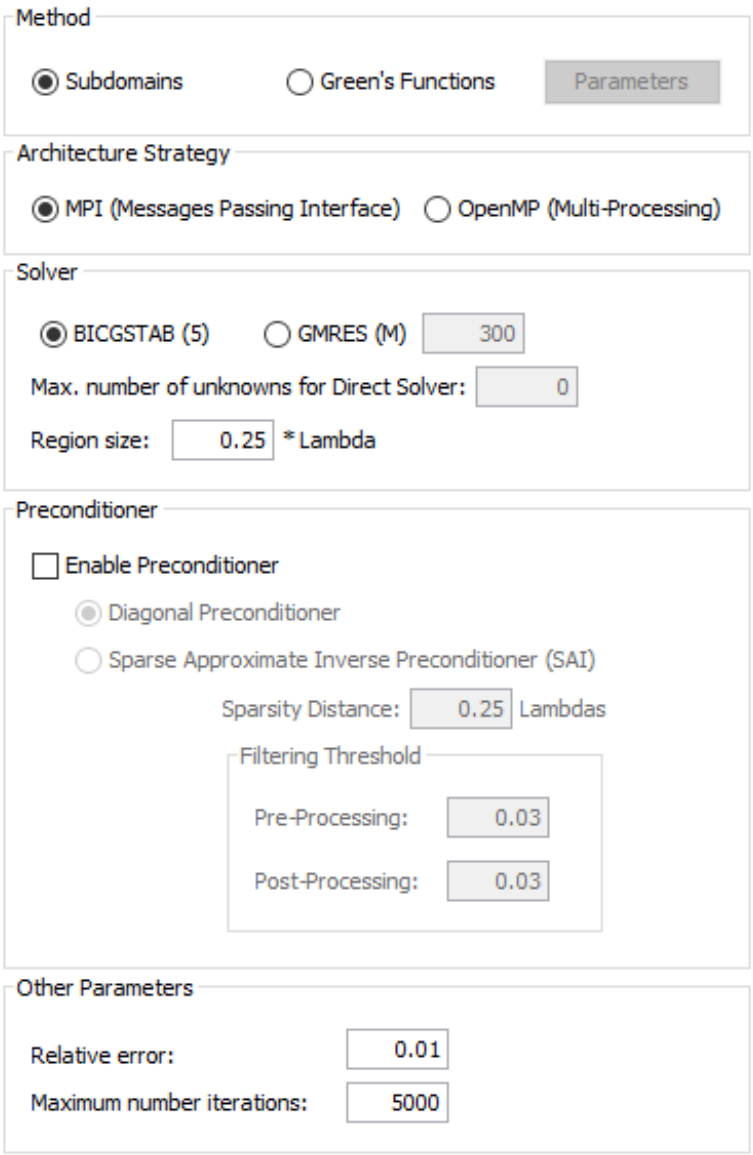
This example may be solved with the default parameters. The most important parameters within the ***Solver → Parameters*** panel are listed below:

- ***Method***: *Subdomains* is the default solver for periodical structures. *Green's Function* is another experimental approach to solve the problem calculating the integral of these functions.
- ***Architecture strategy***: both MPI and OpenMP provide similar results whenever the machine supports them, as OpenMP is not compatible with distributed memory systems. However OpenMP is more efficient in the cases when it can be applied.
- ***Solver***: Indicates the approach used to solve the linear system of equations. BICGSTAB (BiConjugate Gradient STAbilized method) and GMRES (Generalized Minimal Residual method) are available. If no convergence is achieved by using any of these methods try to use the other one. The Max. number of unknowns for the Direct Solver option is the threshold of the maximum allowed unknowns to compute the currents of the Method of Moments by using a direct solution method, instead of using the iterative process. In order to use always the iterative solver, this parameter can be set equal to zero. Note that the direct solution method may require huge memory and time resources when a large number of unknowns is considered.
- ***Preconditioner***: The user can enable the preconditioner to speed up the resolution of the problem with the *Enable Precondicioner* option. The user can choose between two different preconditioners:

- ***Diagonal preconditioner***: The diagonal preconditioner is fast to compute and requires a reduced amount of memory, although the improvement in the convergence rate it produces is normally moderate. This preconditioner it is only recommended when more than 8 divisions per wavelenth is set in the meshing process, as a lower number of divisions can reduce the convergence rate compared to not using any preconditioner.
- ***Sparse Approximate Inverse (SAI)***: This preconditioner will generally the results faster than the diagonal preconditioner. The Sparsity Distance, expressed in wavelengths (0.5 as the default value) indicates how accurately this preconditioner will resemble the inverse of the rigorous MoM matrix. Higher values will normally involve a faster convergence, but the memory required to store the preconditioner data will grow fast, non-linearly. We advice to keep the default value or increase it slightly in case of specially ill-conditioned systems.

Due to its numerical nature, the SAI preconditioner is better suited for the case of shared memory parallelization (OpenMP), while the conventional diagonal preconditioner can be used either for OpenMP or for the MPI paradigm.

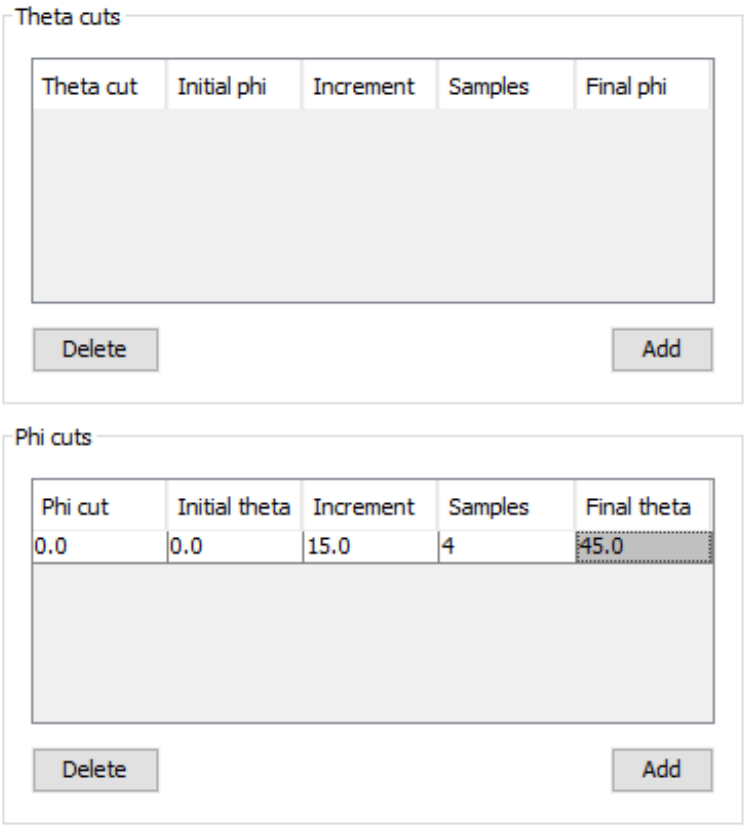
- ***Other parameters***: The *Relative error* may be reduced to ensure a higher accuracy in the resolution of the problem. At most an error of 0.01 or even smaller is specially recommended when the *SAI preconditioner* is selected.



Solver parameters

2.3. Output parameters

In the ***Output*** menu the user can set the ***observation directions***. The default configuration is a *phi* cut at 0 degrees. The initial *theta* value is 0 degrees and the final *theta* value is 45 degrees. The number of *samples* in theta is 4.

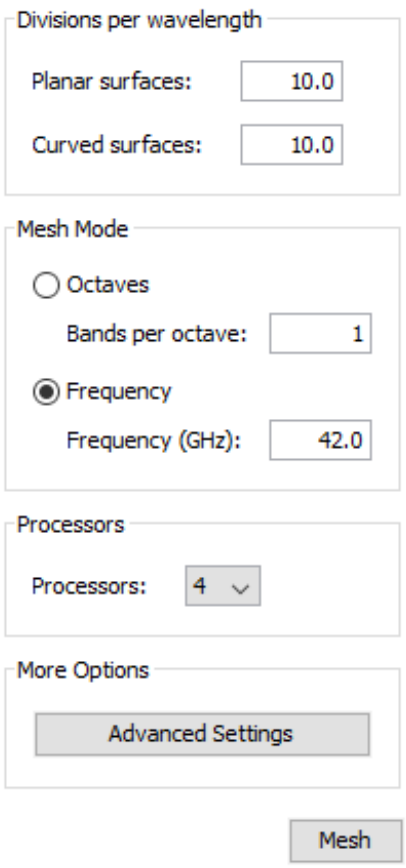


Observation directions

For *phi* = 0 degrees, the *theta* values are 0, 15, 30 and 45 degrees.

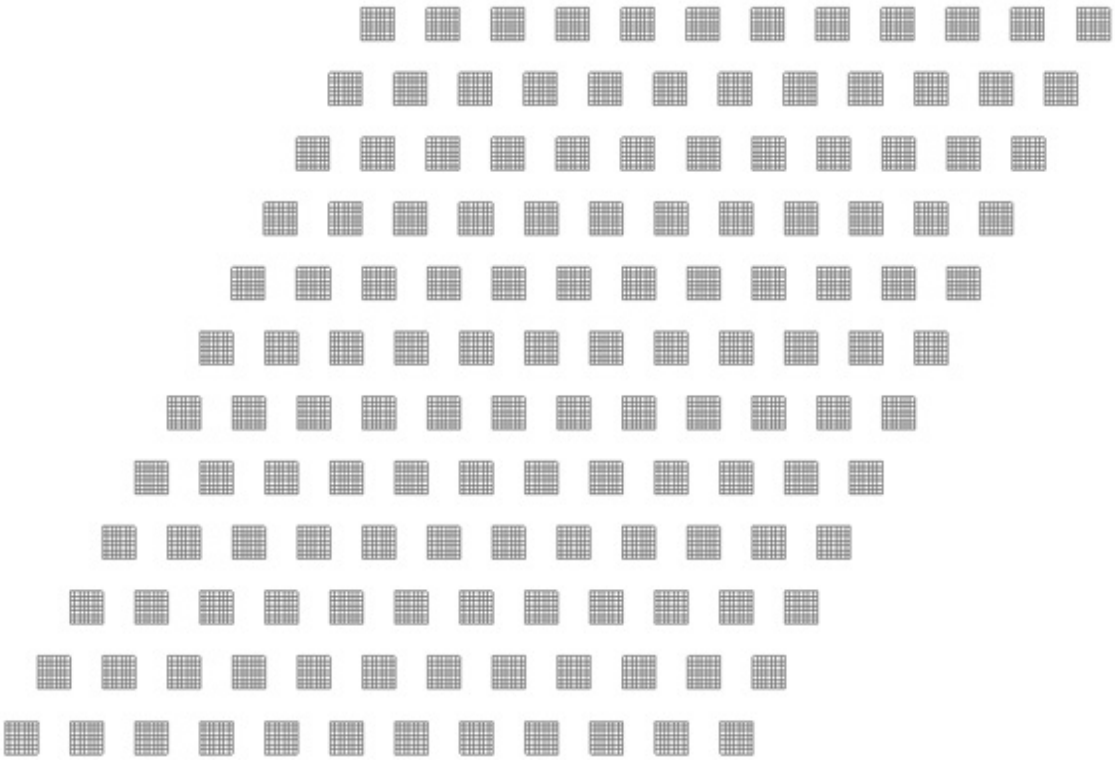
2.4. Meshing parameters

Regarding the meshing of the geometry, the only parameters that have been modified for this example is the ***number of processors*** that has been set to 4.



Meshing parameters

The resulting mesh is shown in the next figure.



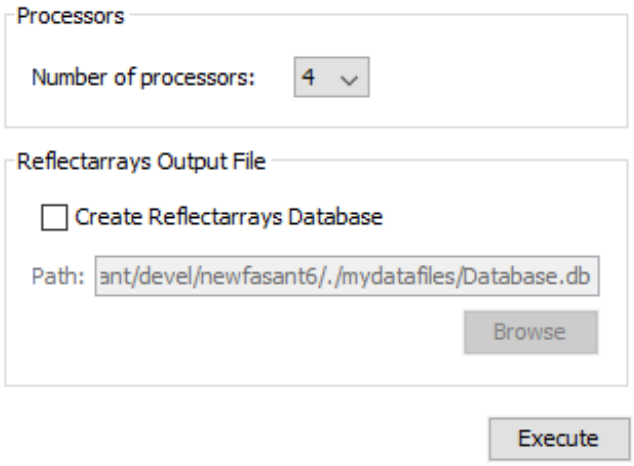
Mesh

2.5. Calculate parameters

In order to launch the simulation process for this example the **number of processors** has been set to 4.

The user can save the database of the simulation in order to create a reflectarray or a transmitarray. It is necessary to create a parametric simulation to generate different cells.

Note that the creation of the database for reflectarrays is disabled when the *Skew angle* has been set on the ***Define Cell*** parameters.



Calculate parameters

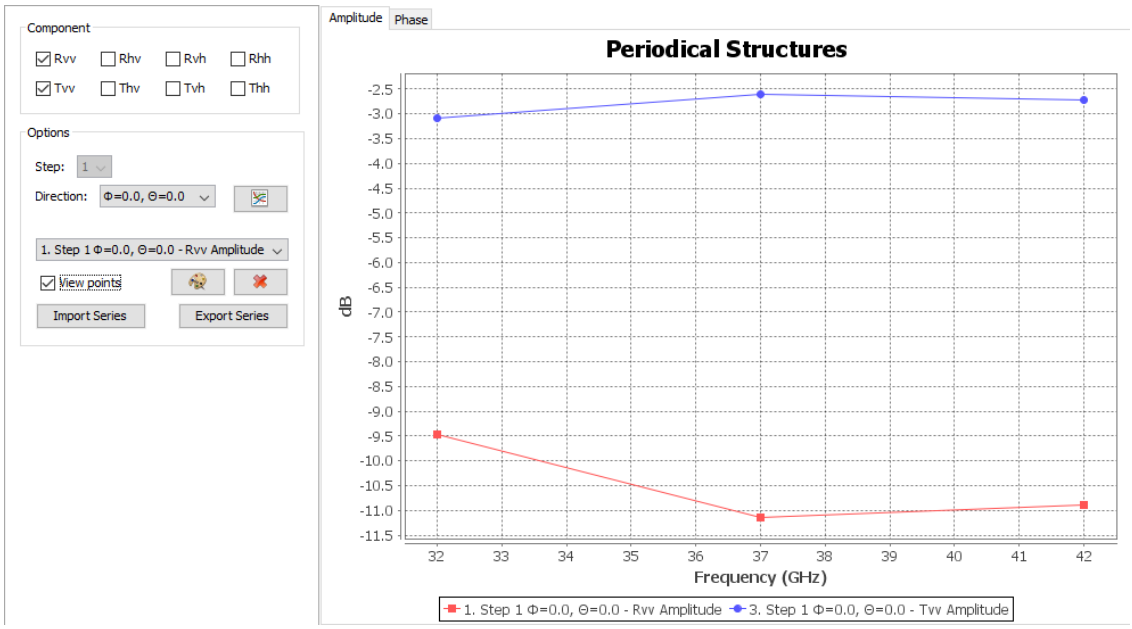
3. Results

The results obtained in this example are included in this section. The interface plots the results for 4 observation directions, according to the parameters previously specified in the ***Output*** menu.

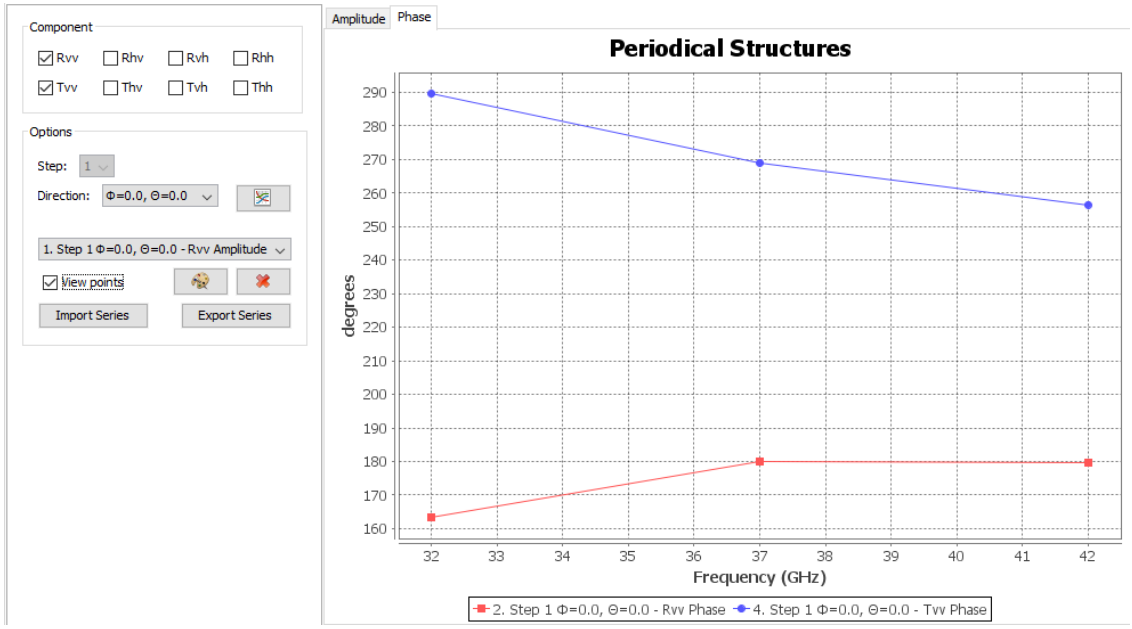
The reflection and transmission coefficients are represented by the frequency sweep. The tab panels represent the *Amplitude* and *Phase*.

The configuration options are:

- ***Component***: Select the Reflection/Transmition Vertical/Horizontal-Vertical/Horizontal component to represent in the chart.
- ***Options***: The step menu allows to select the parametric periodical structure. In this example the direction menu contains 4 observation directions. The right button adds the selected series to the Amplitude and Phase tabs. The bottom menu contains the visualized series. The buttons located at the bottom of the window allow the user to modify and delete the selected series. The Import Series and Export Series buttons can load and save the selected series of the chart.



Amplitude



Phase