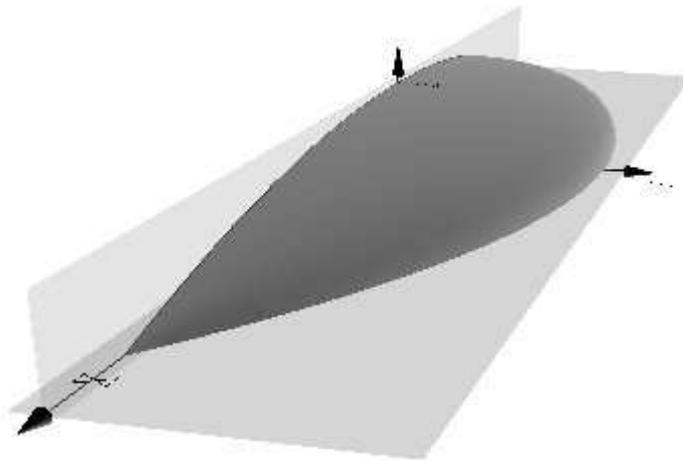


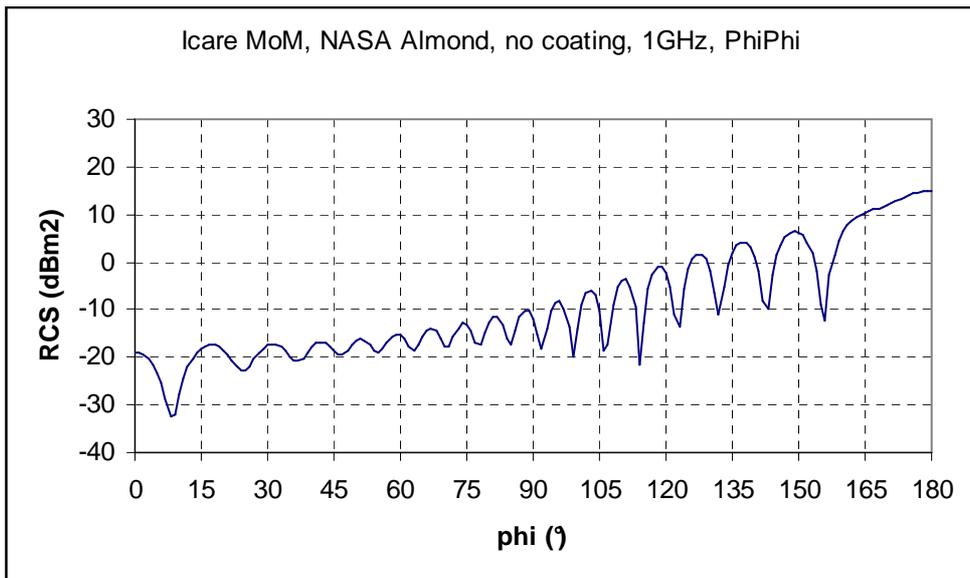
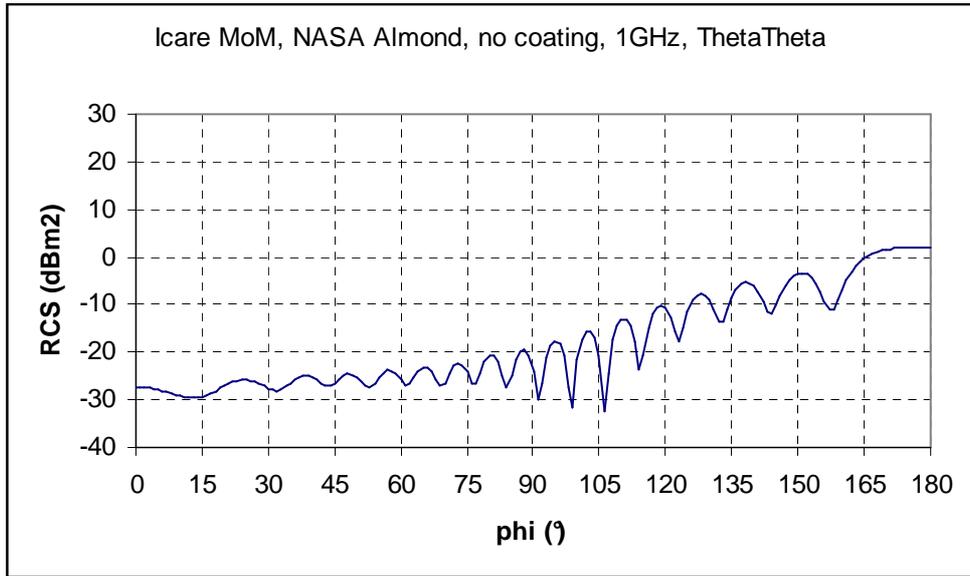
Test case 3 : Coated NASA Almond

IEEA CONTRIBUTION

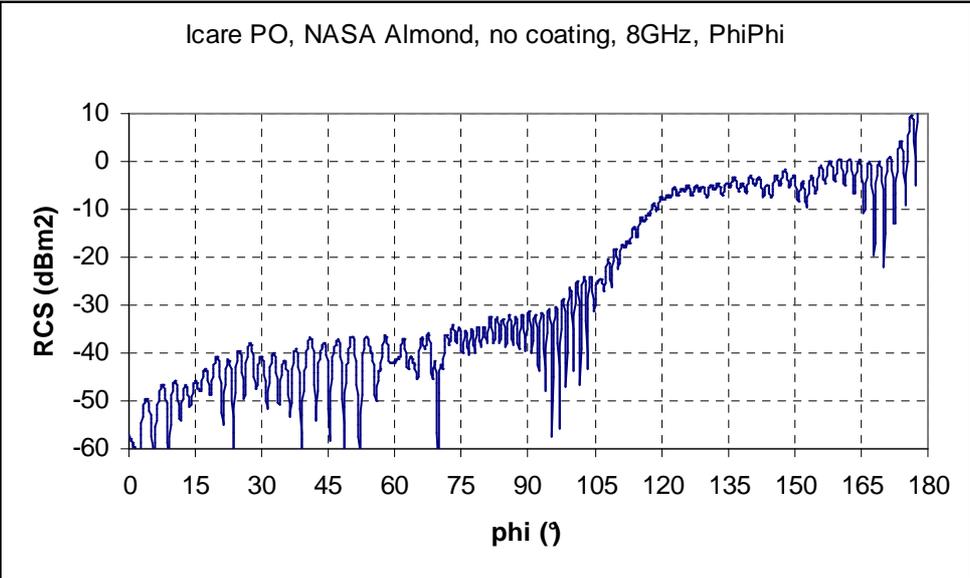
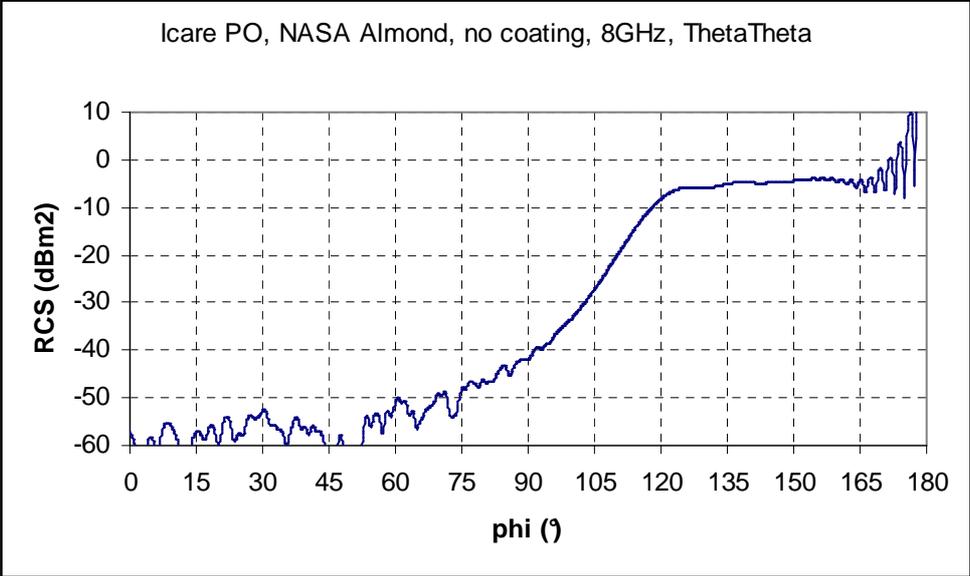
J-P Adam, Y. Béniguel

Icare is a MoM based computation code. A brief description is available in test 4 placyl IEEA contribution. Icare software allows using the symmetry planes of the structure. In the case of the NASA Almond, there are 2 symmetry planes. The number of triangles is reduced by a factor of 4. At 1 GHz, with a mean edge length of $\lambda/10$, the number of unknowns was 4000. The running time was 30 min on a standard PC (AMD processor 3500+, 2.21GHz, 1GB RAM).





At 8 GHz, the number of unknowns was too high for a standard PC. The PO module was used to overcome this limit. The number of triangles was 350000. The CPU time was about 4 min.



Test case 4 : PLACYL

IEEA/CEG CONTRIBUTION

Diffraction of a plane wave by a set of perfectly conducting half sphere and cylinder located over a perfectly conducting finite surface.

J-P Adam⁽¹⁾, D. Asfaux⁽¹⁾, Y. Béniguel⁽¹⁾, B. Pecqueux⁽²⁾, J-C Joly⁽²⁾

(1) IEEA, 13, Promenade Paul Doumer, 92400 Courbevoie

(2) Centre d'Etudes de Gramat, 46500 Gramat

1. MoM / PO

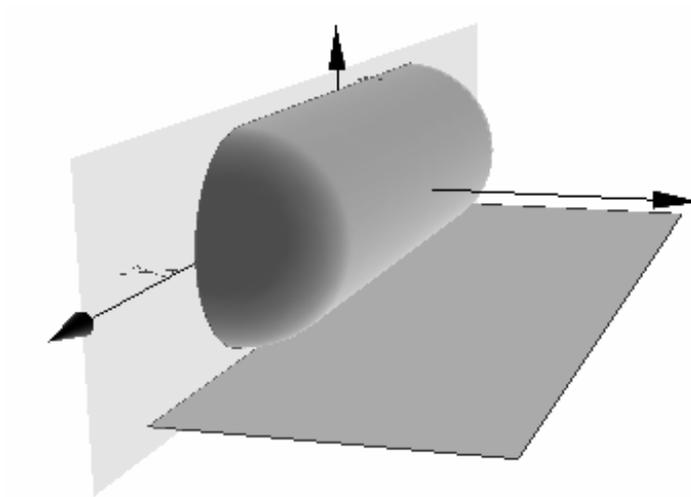
The results were obtained using MoM / PO code ICARE developed at IEEA. This code is a commercial tool. It is interfaced with GID mesh tool.

ICARE uses surface EFIE / MFIE formulation for analyzing general structures including dielectrics. Roof-top functions are used for describing geometries, which allows most flexibility for discretizing surfaces. It features highly accurate matrix computation routines, which improves accuracy of obtained results on sensitive parameters such like VSWR. It also features an out-of-core method for solving problems of any size. A LU / Cholesky block solver is used when linear systems exceed memory size of the computer used to run the calculations.

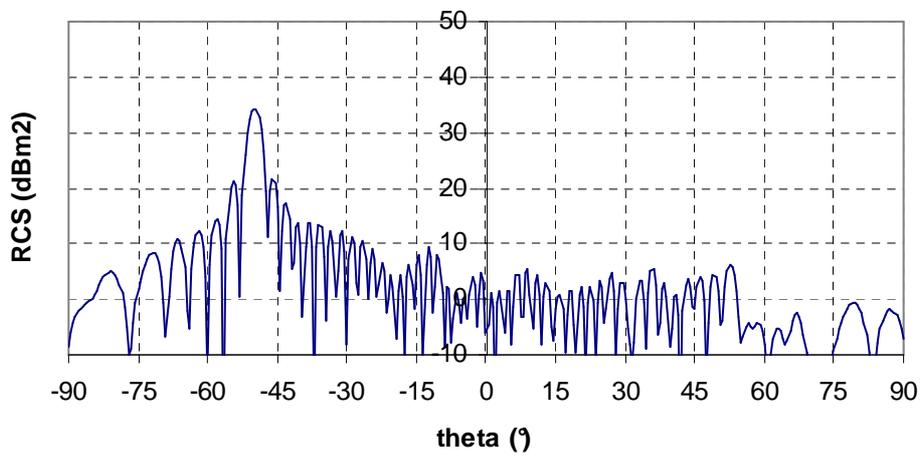
An optical physical optics method module is also available which allows treating large size objects.

Test case N°4 PLACYL results

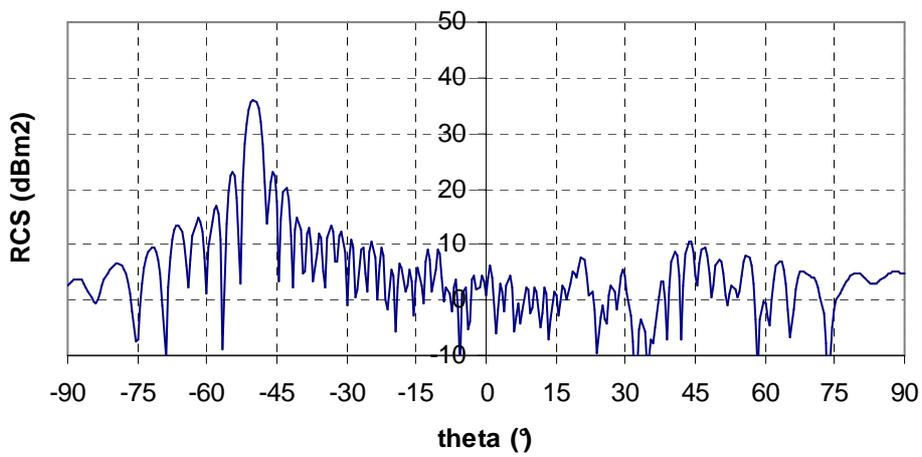
The calculation was done on a standard PC (AMD processor 3500+, 2.21GHz, 1GB RAM). Such a computer can't handle more than 10000 unknowns MoM problem. In order to drop the number of triangles, Icare can use the symmetries of the problem. This ability can only be applied for the bistatic RCS in the xoz plane, which is a symmetry plan (next figure). At 5 GHz, the mean edge length was about $\lambda/3$. The running time for the calculation was 7 h.



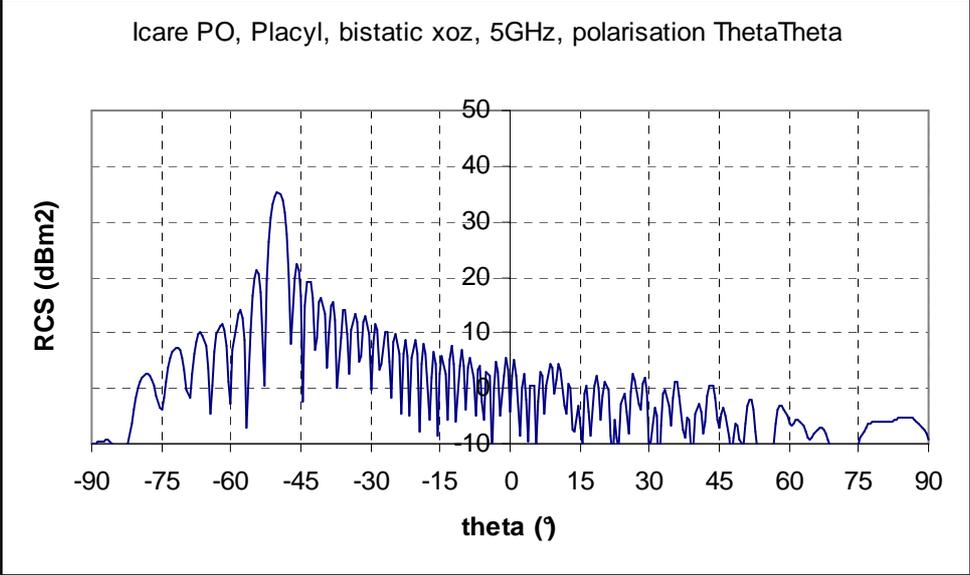
Icare MoM, Placyl, bistatic xoz, 5GHz, polarisation ThetaTheta



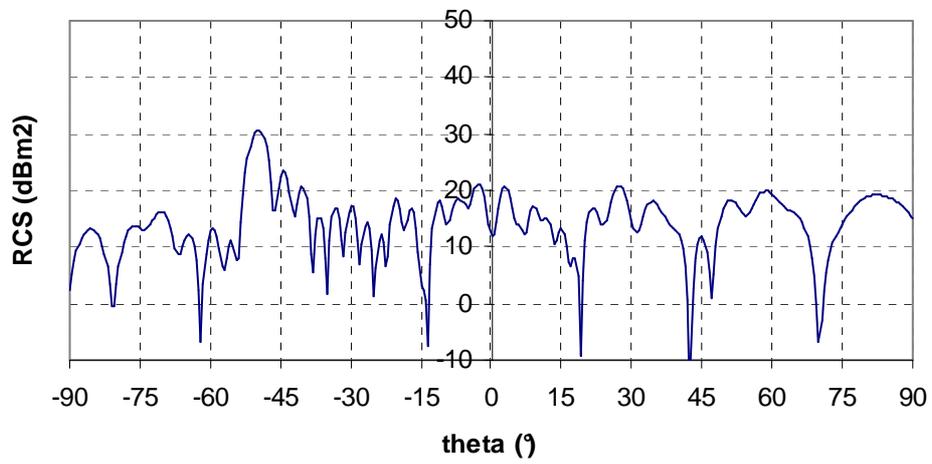
Icare MoM, Placyl, bistatic xoz, 5GHz, polarisation PhiPhi



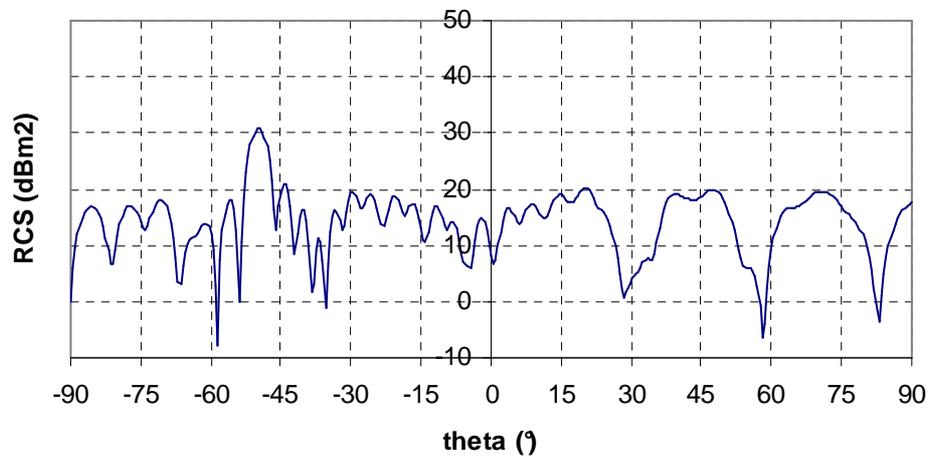
For the other cases, the physical optics method was used. At 5 GHz, the number of triangles was 60000, with a mean edge length of $\lambda/5$. The running time for one calculation was 45 min.



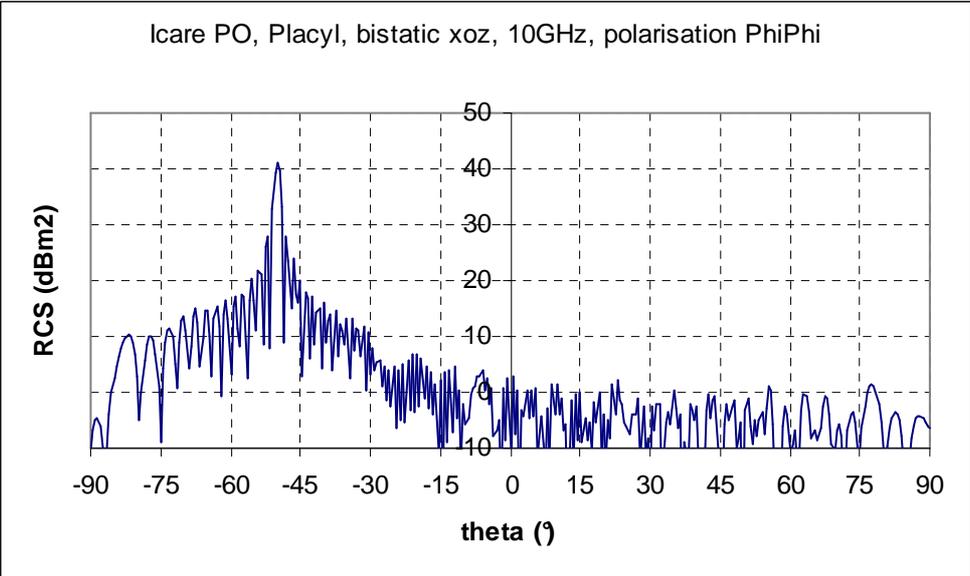
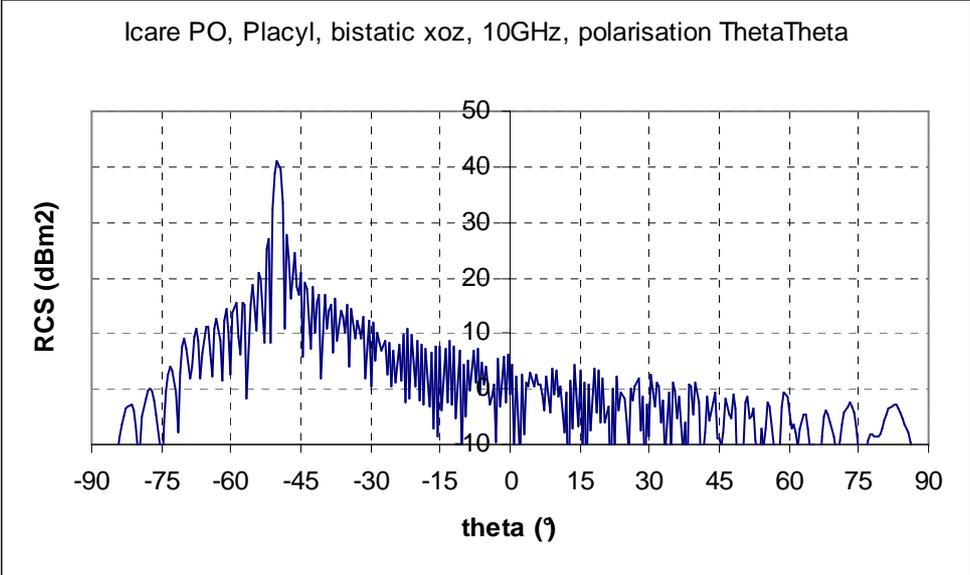
Icare PO, Placyl, bistatic yoz, 5GHz, polarisation ThetaTheta



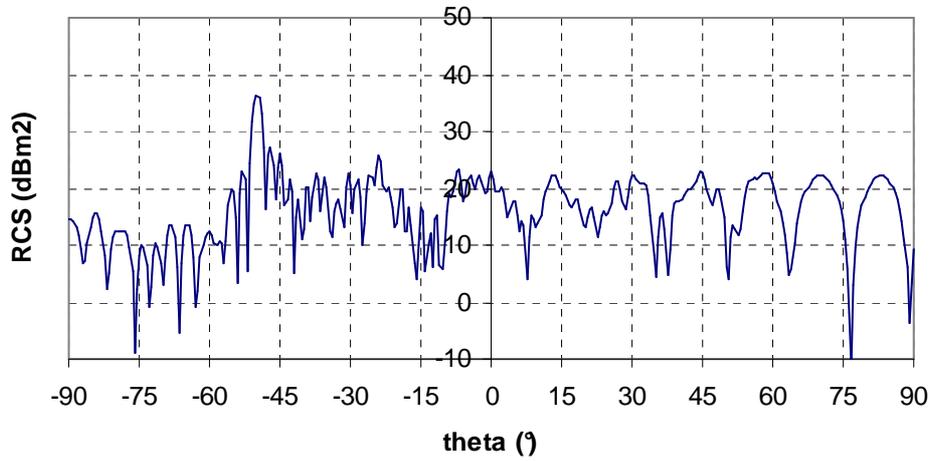
Icare PO, Placyl, bistatic yoz, 5GHz, polarisation PhiPhi



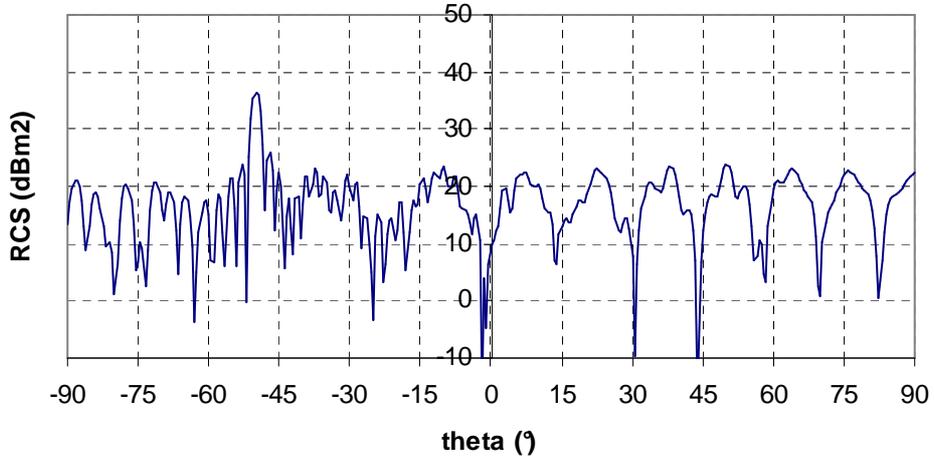
At 10 GHz, the number of triangles was 250000, with a mean edge length of $\lambda/5$. The running time for one calculation was 3 h.



Icare PO, Placyl, bistatic yoz, 10GHz, polarisation ThetaTheta



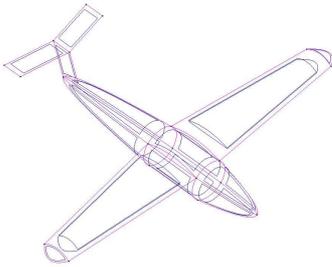
Icare PO, Placyl, bistatic yoz, 10GHz, polarisation PhiPhi



2. IDRA UTD ANTENNA ANALYSIS

IDRA is a UTD asymptotic code developed at IEEA. It is a commercial tool. It allows calculating the radiation of antennas located in the vicinity of electrically large structures. It is fully hybridized with the Graphical User Interface GID[®]. The Pre and Post-processing GID functionalities offer powerful tools allowing the user to design and select geometrical complex 3D structures, to define the electromagnetic data and to visualise the 2D and 3D results of simulation.

Graphical User Interface

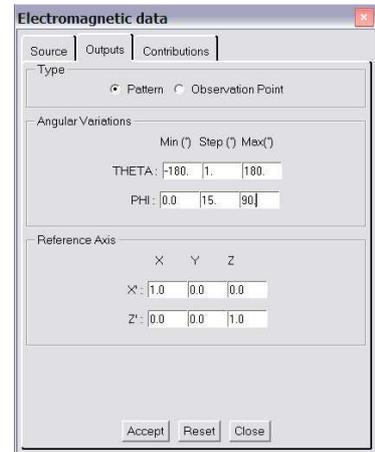


More than 200 graphical functionalities are accessible in GID[®]. The complex 3D objects design (CAD) is easily managed by the user, using the NURBS representation of surfaces. Common standard CAD formats can be imported (IGES, VDA) in IDRA.

Electromagnetic Data Definition

The IDRA electromagnetic parameters are defined by :

- Source description (MoM, pattern, plane wave, arrays...)
- Selection of the electromagnetic contributions,
- Selection of the contributors (surfaces, wedges, vertices)
- Output data description.



Post-Processing

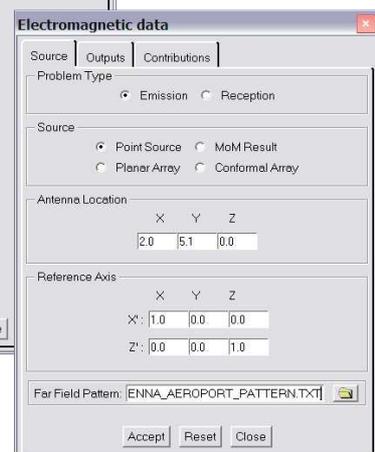
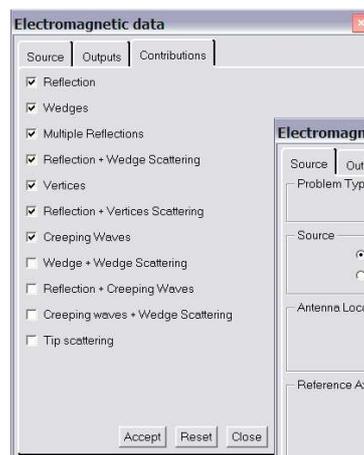
The IDRA interactive post-processing allows the user to visualise :

- 3D surface currents,
- 2D Radiation Patterns,
- Rays paths,

in the structure environment.

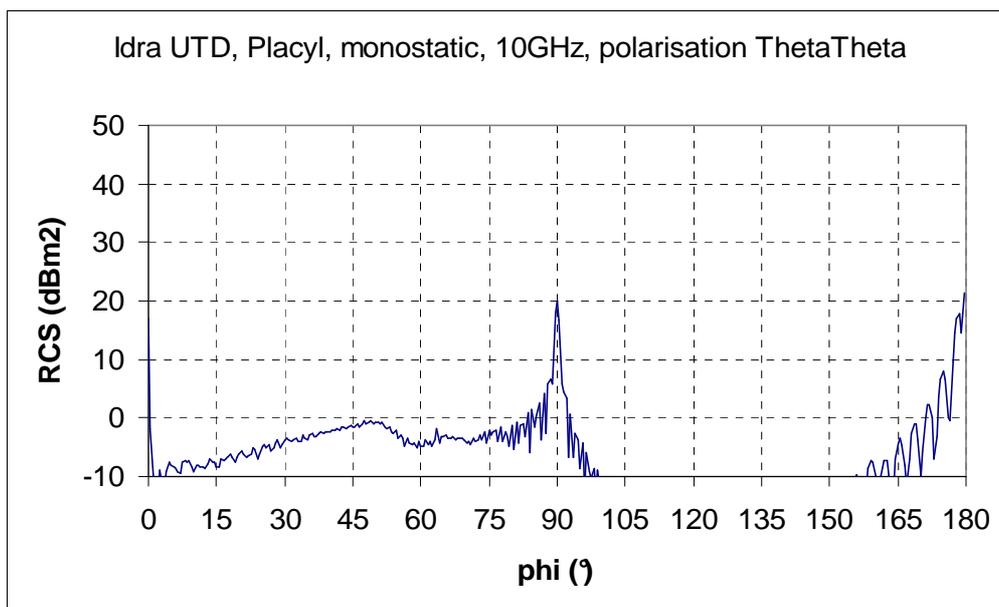
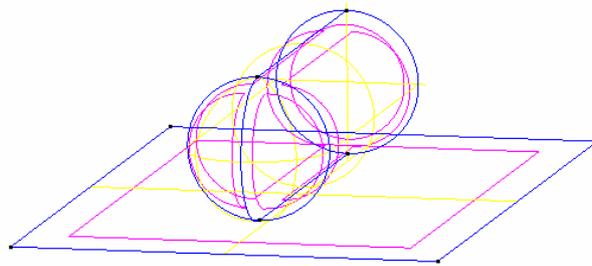
The physical analysis of the electromagnetic solution is easily accessible by independent selection of the :

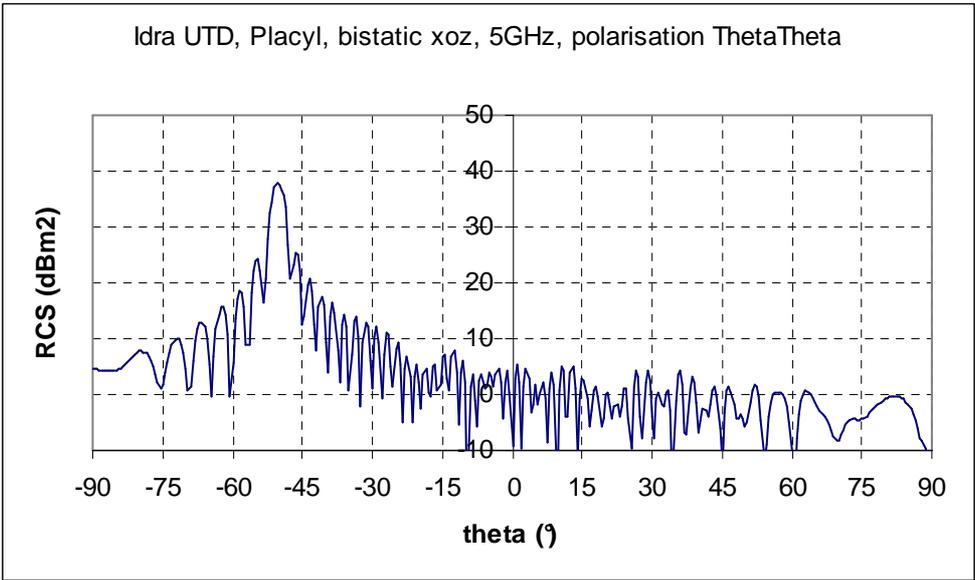
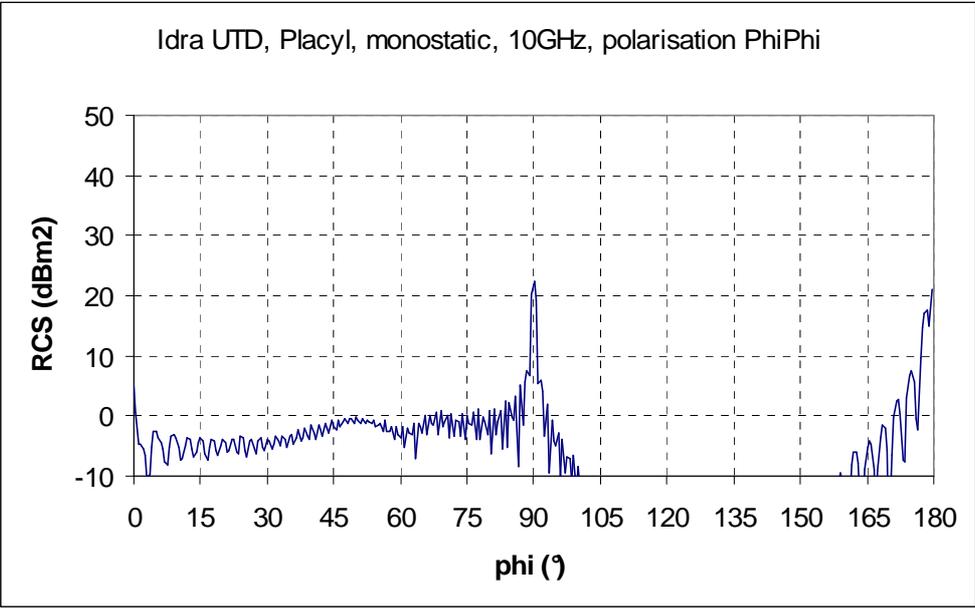
- electromagnetic contributions,
- geometrical contributors.

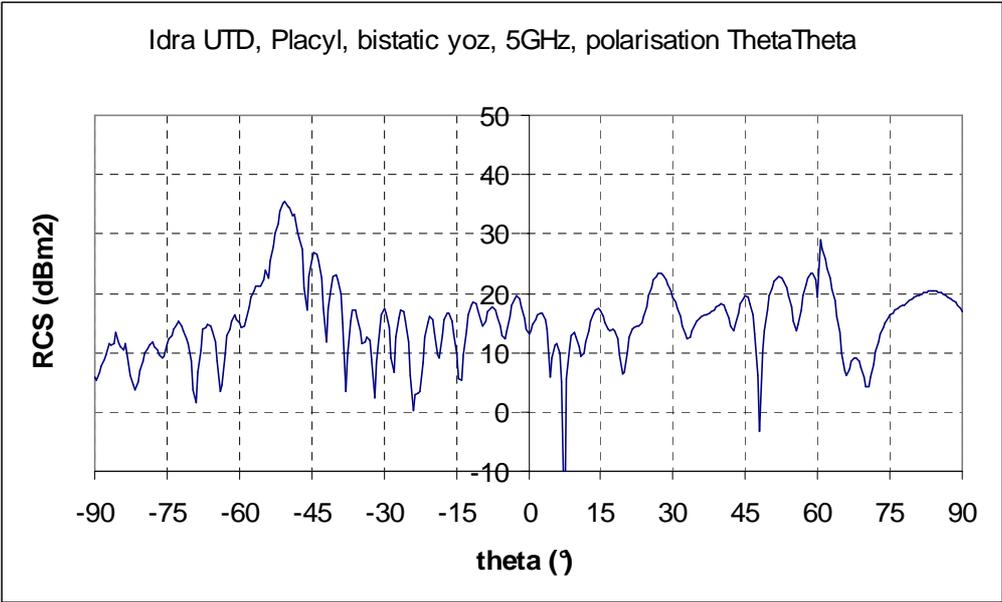
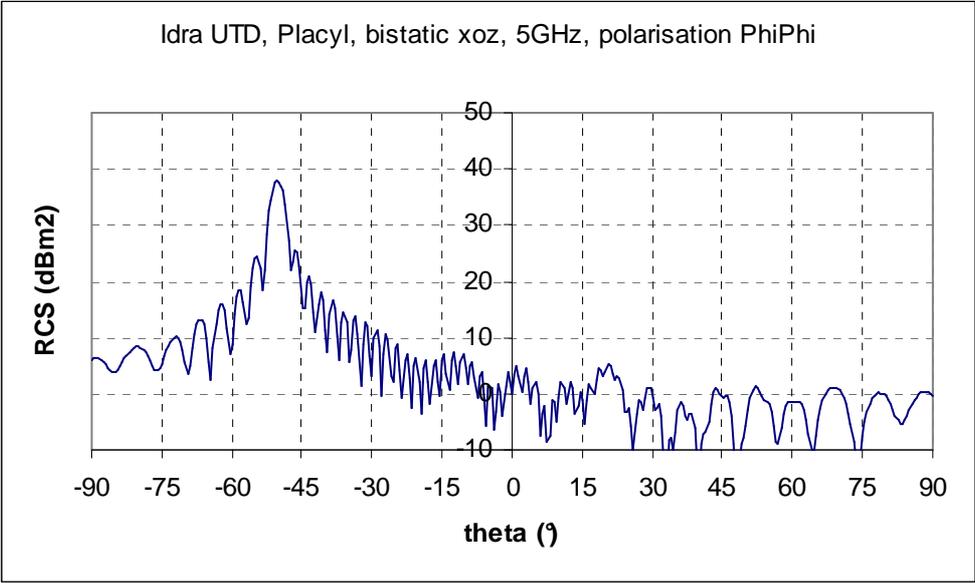


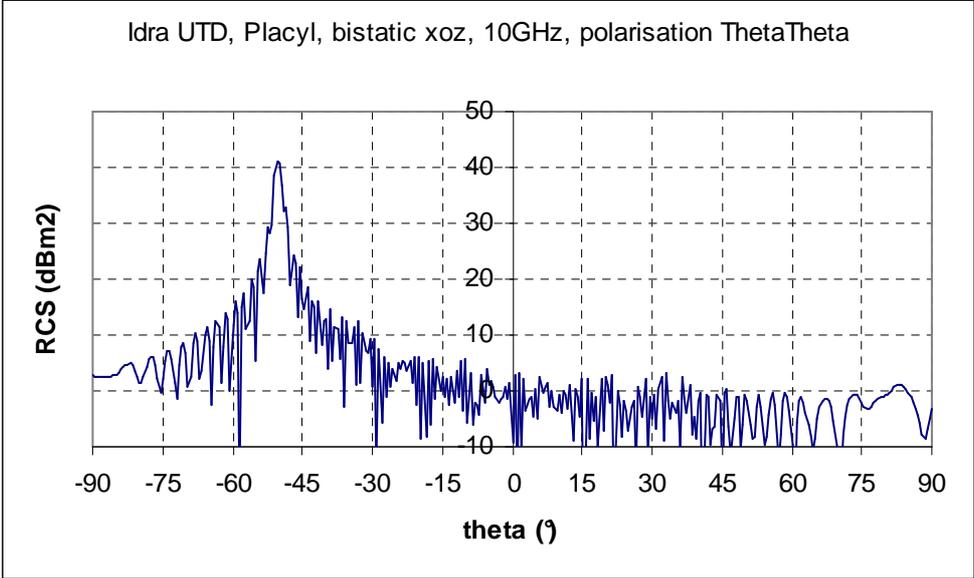
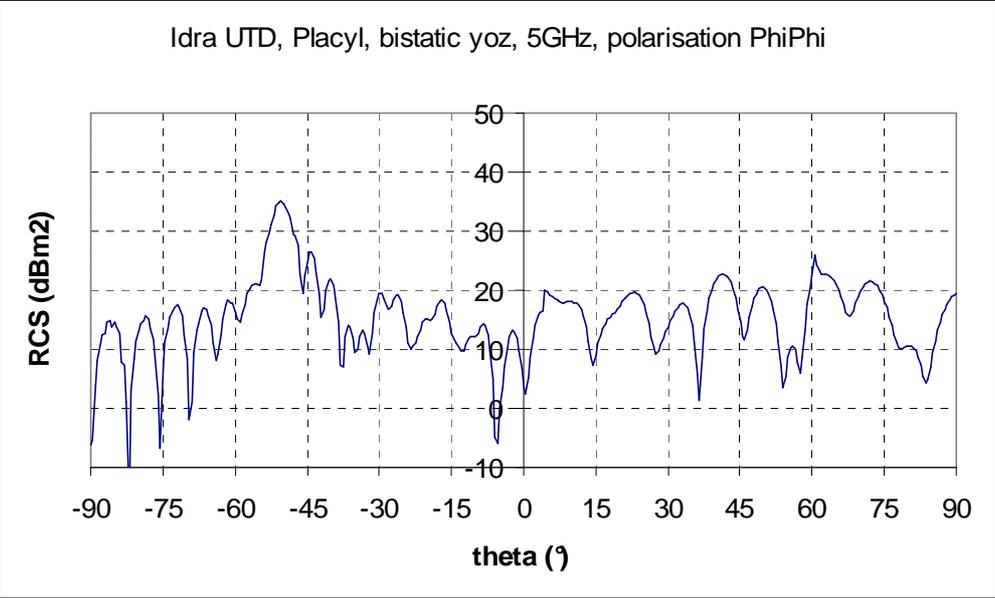
Test case N°4 PLACYL results

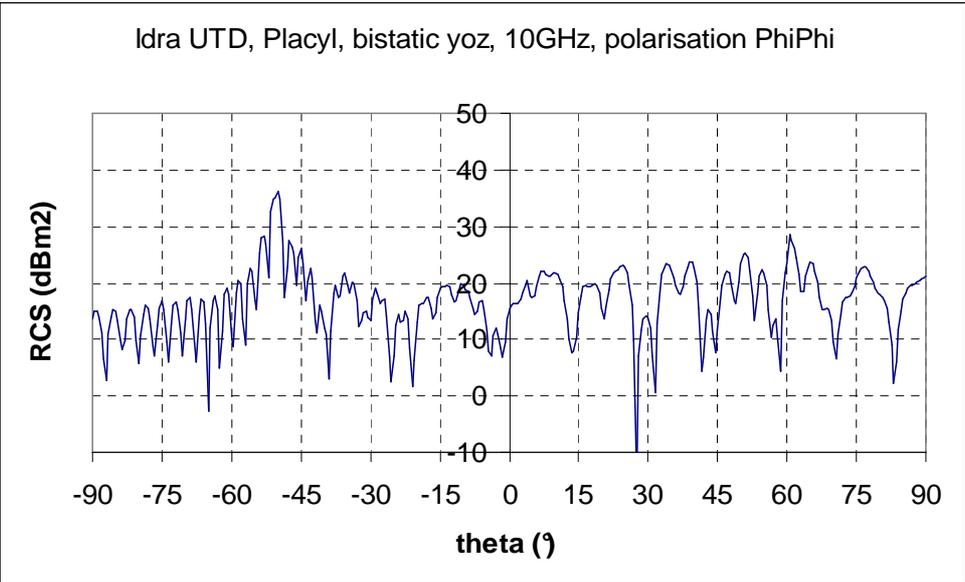
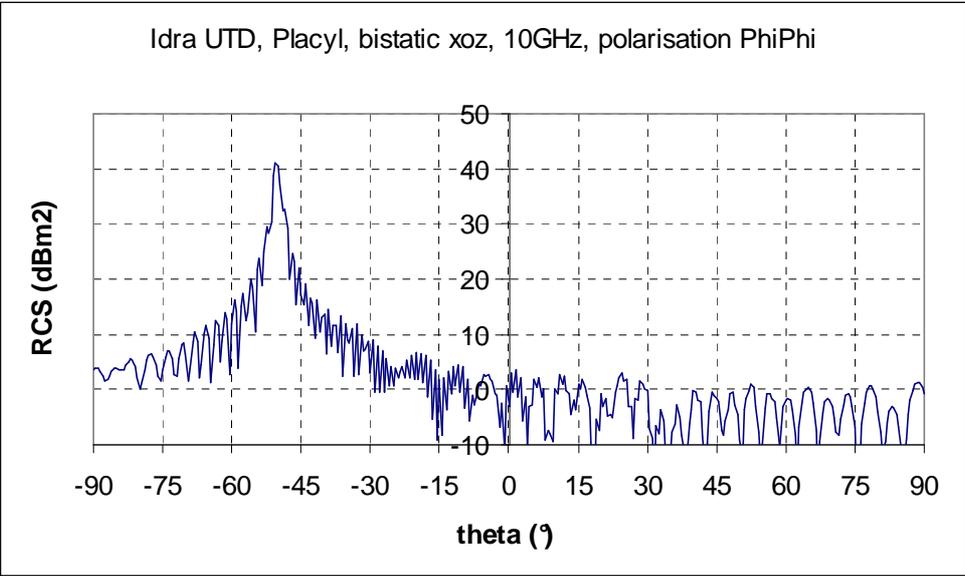
The calculation was done on a standard PC (AMD processor 3500+, 2.21GHz, 1GB RAM). The structure was modeled with 6 NURBS surfaces (next figure). Reflected rays, edge diffracted rays and corner diffracted rays were taken into account. Combinations of two of these simple rays were also computed. The computation time is frequency independent. It is about **1 min for all the following results**.









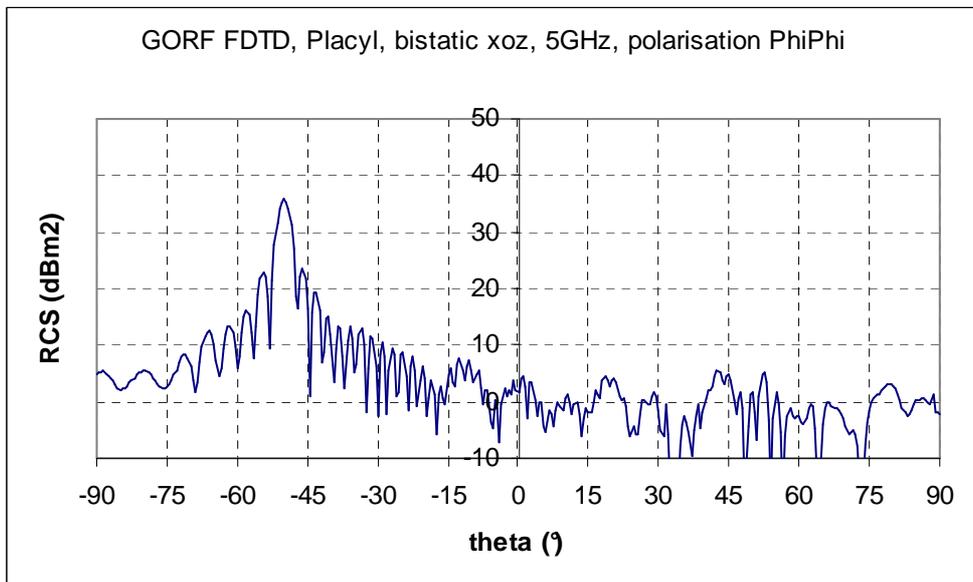
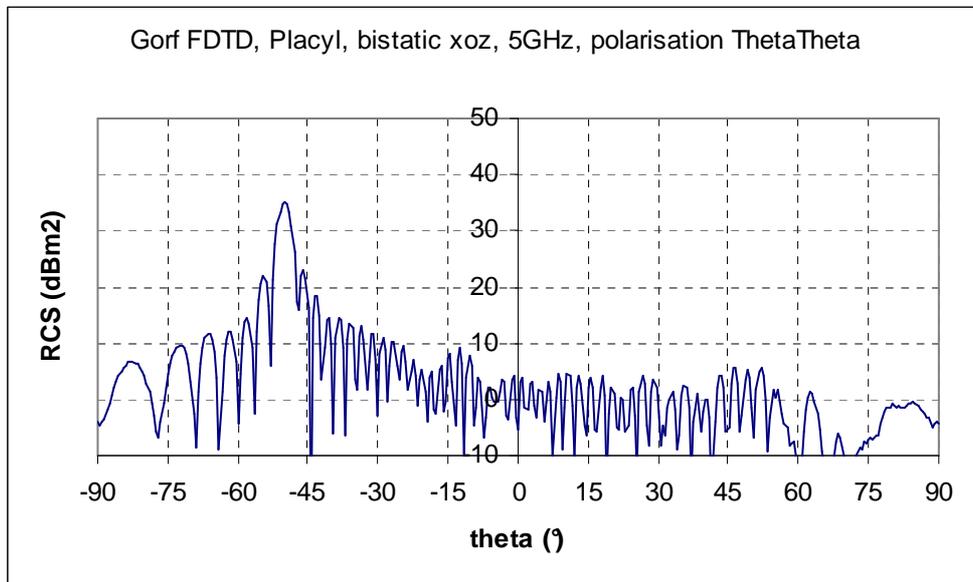


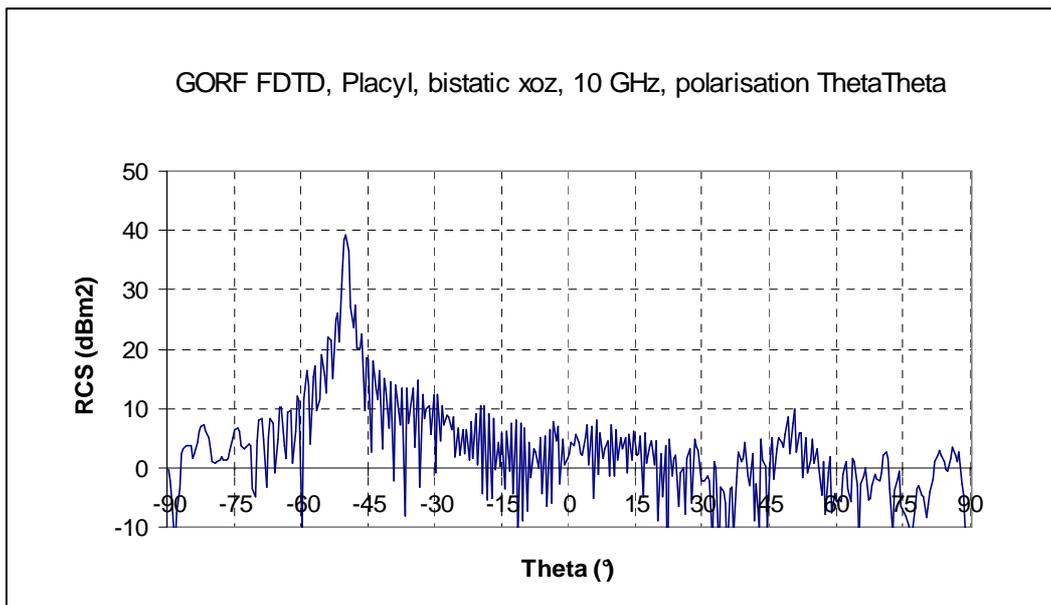
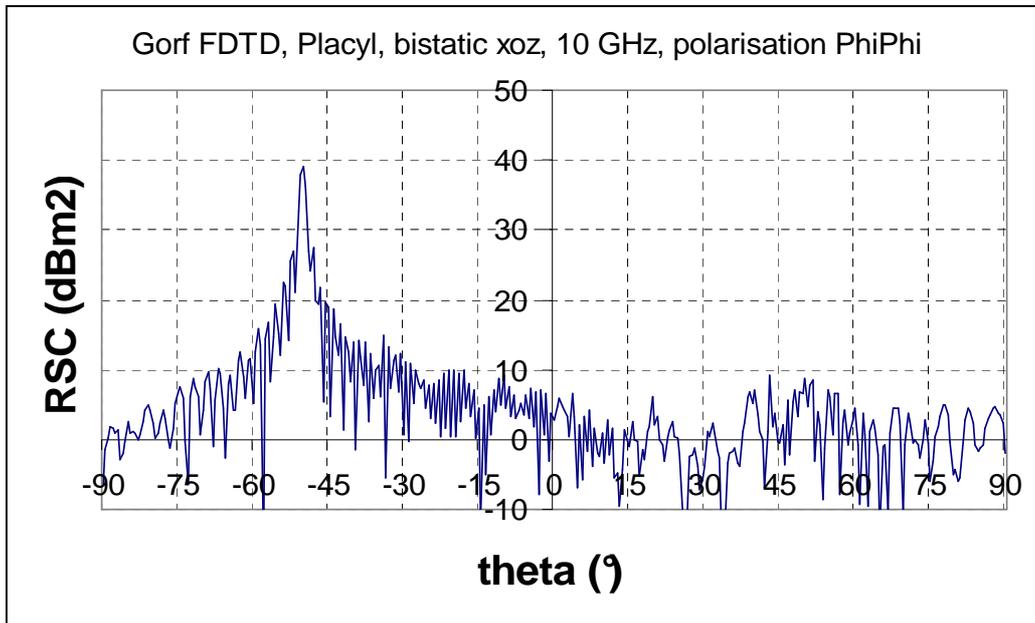
3. FDTD analysis

The FDTD analysis was performed using the code Gorf developed by DGA/CEG. IEEA has developed parts of this computation code.

PML are implemented to simulate an infinite space around the structure under test. Huygens surfaces are used to excite an incident plane wave. These surfaces separate the computation volume into 2 parts : total field inside, diffracted field outside. The diffracted field is the input of a near field / far field transformation. This transformation is done directly in the time domain. A Fourier Transform is used to extract a particular frequency from the computed far field signal.

The structure of the Placyl was meshed with 4 mm cubes. The incident waveform was a gaussian curve. The duration of the simulation was 30 ns. The running time was about 24 h on 8 processors.





The same mesh was used for both frequencies 5 GHz and 10 GHz. It is $\lambda/15$ at 5 GHz and $\lambda/7.5$ at 10 GHz.

Test case 5

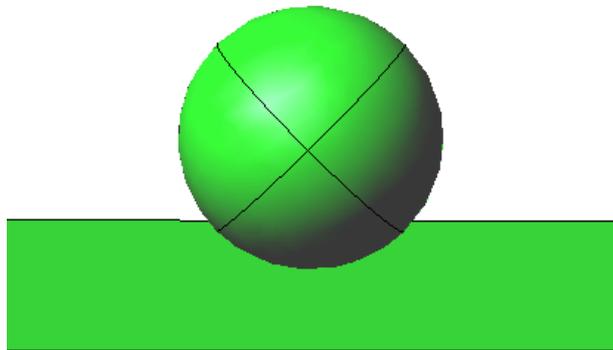
IEEA CONTRIBUTION

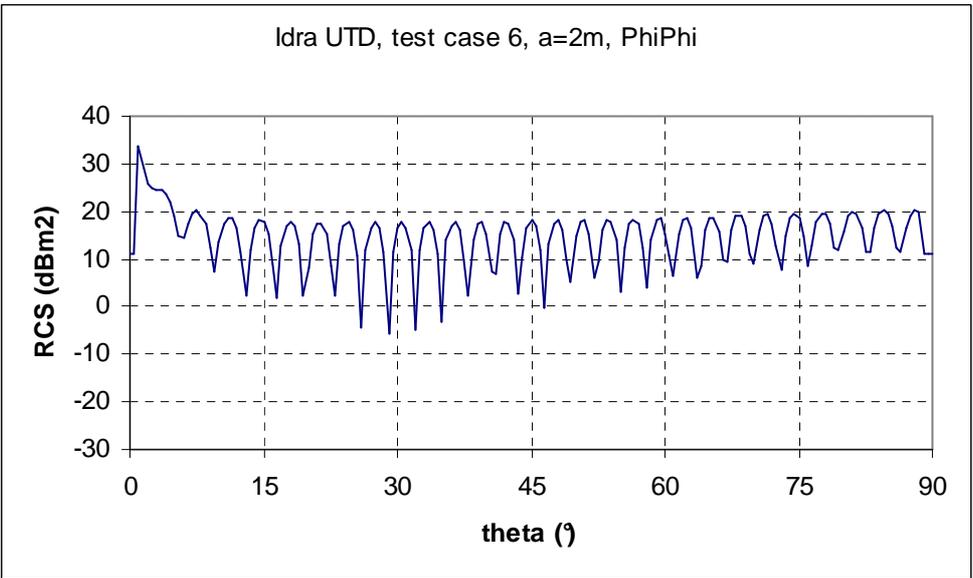
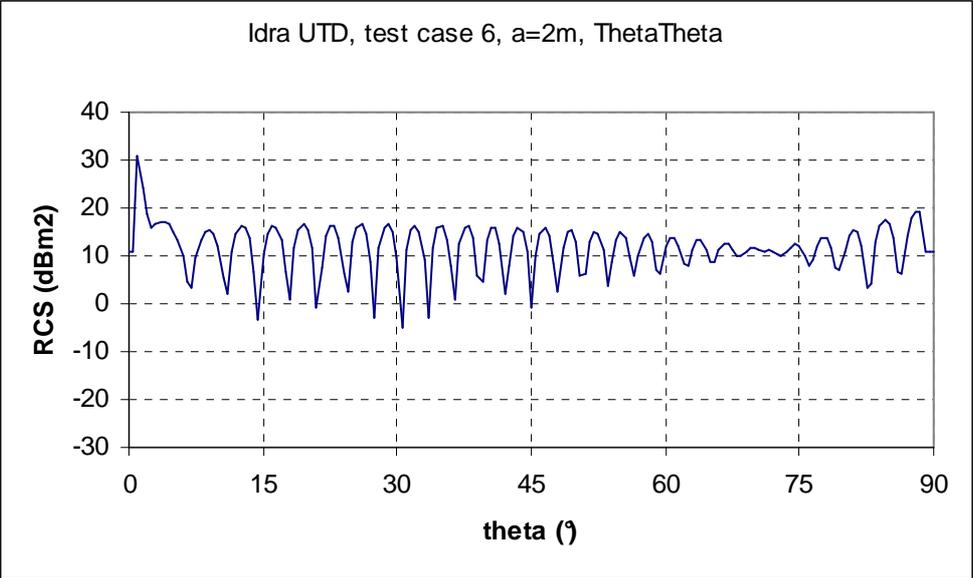
Diffraction of a plane wave by a sphere located above a multilayered dielectric or lossy media

J-P Adam

Idra is a UTD based computation code. A brief description is available in test 4 placyl IEEA contribution.

The sphere was modeled with 4 NURBS surfaces. The multilayered dielectric was simulated with Fresnel coefficients. Only reflected and doubly reflected rays were considered. The computation was very fast (a few seconds on a standard PC).





Test case 6

IEEA/CEG CONTRIBUTION

Finite tilted Grid in front of a cavity

J-P Adam ⁽¹⁾ , D. Asfaux ⁽¹⁾ , B. Pecqueux ⁽²⁾ , J-C Joly ⁽²⁾

(1) IEEA, 13 Promenade Paul Doumer, 92400 Courbevoie (Jean-pierre.adam@club-internet.fr)

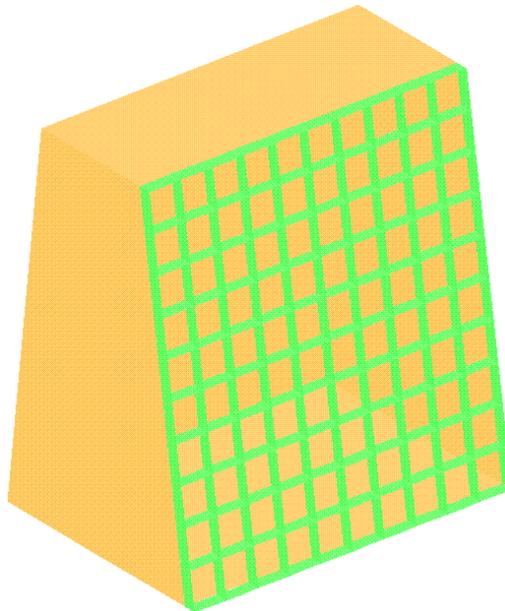
(2) Centre d'Etudes de Gramat, 46500 Gramat

The calculation was performed using code Gorf developed by DGA/CEG. IEEA has developed some parts of this computational code.

PML are implemented to simulate an infinite space around the structure under test. Huygens surfaces are used to excite an incident plane wave. These surfaces separate the computation volume into 2 parts : total field inside, diffracted field outside. The diffracted field is the input of a near field / far field transformation. This transformation is done directly in the time domain. A Fourier Transform is used to extract a particular frequency from the computed far field signal.

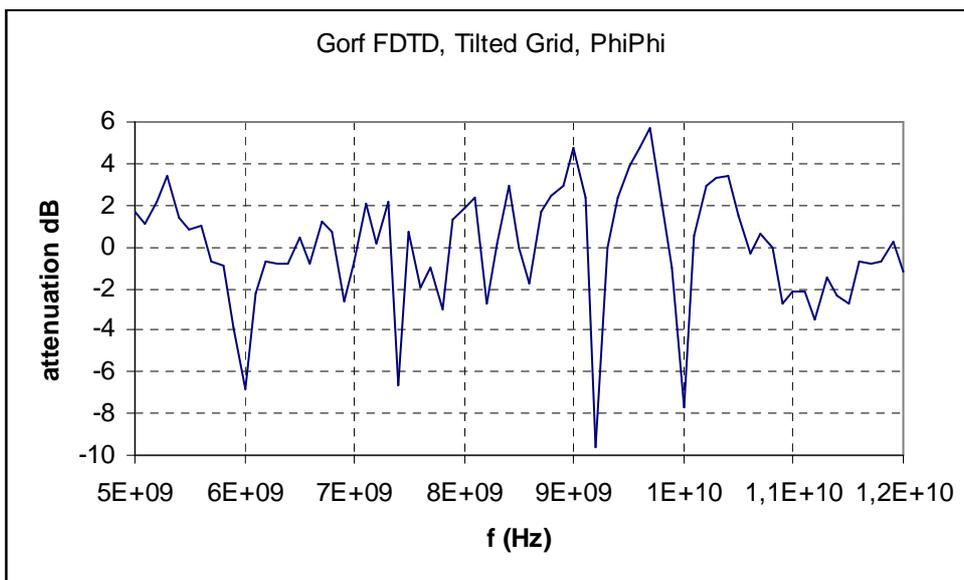
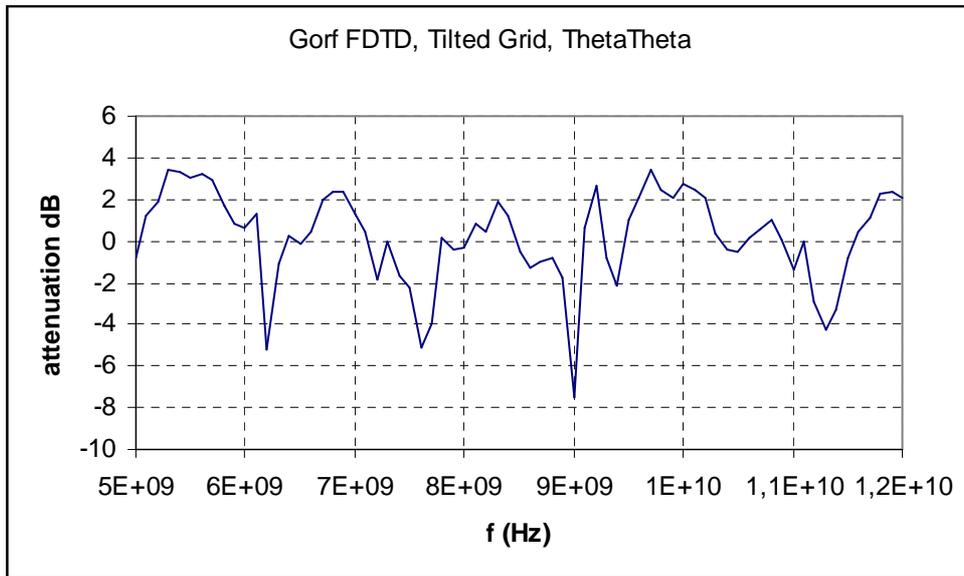
The structure was meshed with 1 mm cubes (34 million cubes). The incident waveform was a gaussian curve. The temporal duration was 20 ns. The running time was about 2 h on 32 processors.

View of the meshed structure :



The diagrams show the value of the “Grid attenuation” computed as follows :

$$10 \log_{10} \left(\frac{|E^s(\text{cavity_with_grid})|}{|E^s(\text{cavity_without_grid})|} \right)$$



Test case 7 : GPS Antenna

IEEA CONTRIBUTION

Y. Béniguel, J-P Adam

IEEA, 13, Promenade Paul Doumer, 92400 Courbevoie
beniguel@ieea.fr

1. Analysis Tool

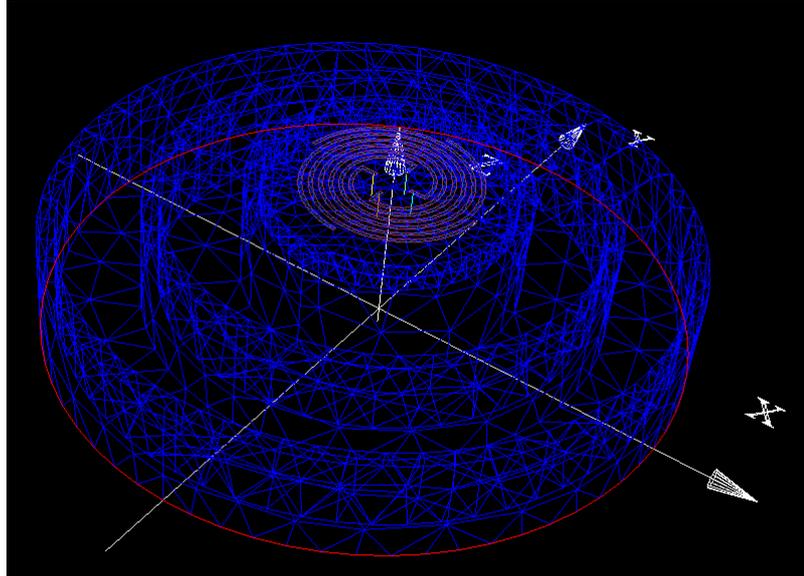
The results were obtained using the antenna analysis antenna code ICARE developed at IEEA. This code is a commercial tool. It is interfaced with GID mesh tool.

ICARE uses surface EFIE / MFIE formulation for analyzing general structures including dielectrics. Roof-top functions are used for describing geometries, which allows most flexibility for discretizing surfaces. It features highly accurate matrix computation routines, which improves accuracy of obtained results on sensitive parameters such like VSWR. It also features an out-of-core method for solving problems of any size. A LU / Cholesky block solver is used when linear systems exceed memory size of the computer used to run the calculations.

An optical physical optics method module is also available which allows treating large size objects.

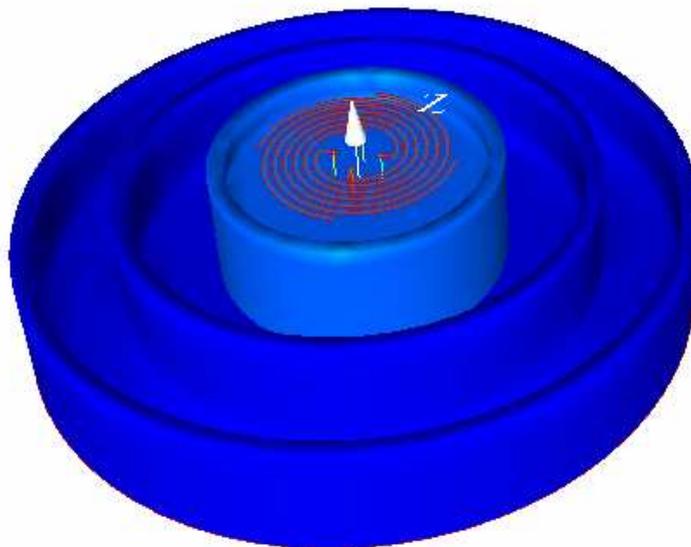
2. Antenna Mesh

The calculation was performed considering an air substrate. The mesh used was composed of 2470 triangles (3800 unknowns).

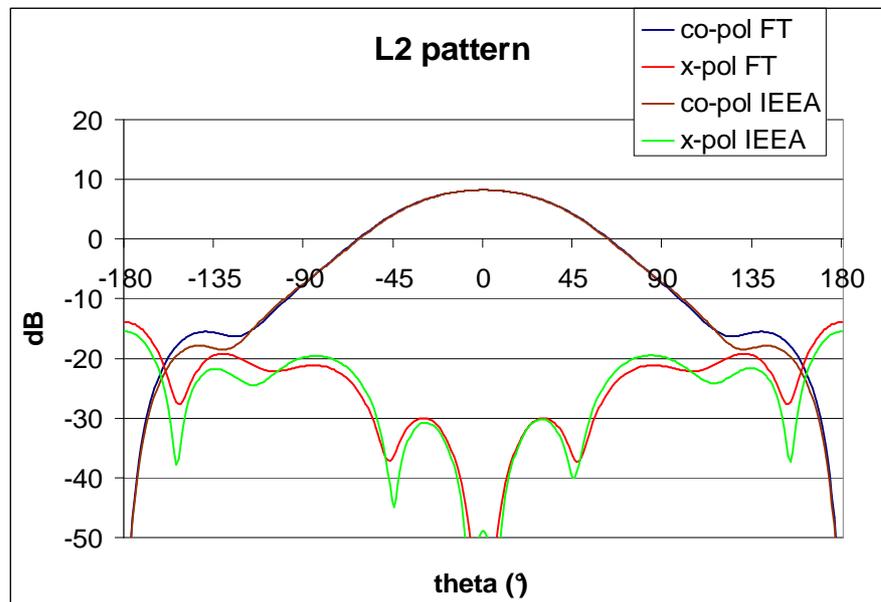
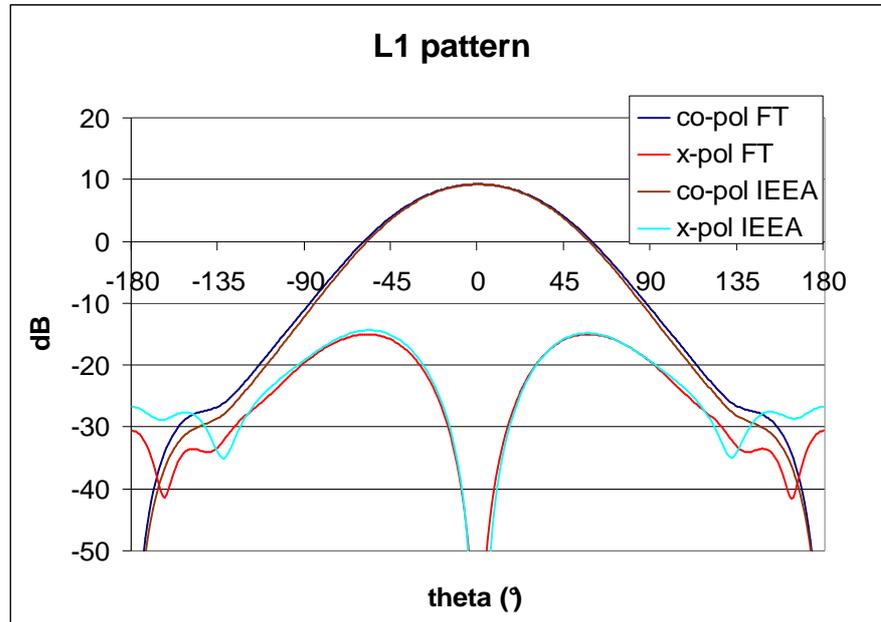


3. Source region

The coaxial conductor was not modelled. A unitary voltage source has been placed at the point where the inner conductor reaches the cavity. The conductors inside the cavity were considered as wire elements. They are electrically connected to the spiral (see figure below).



4. Far field patterns



5. S matrix comparisons

