Internal Report ITESRE 294/2000

COSMOSMOMAS EXPERIMENT at 15GHz: PRELIMINARY EVALUIATION OF THE SIDE LOBE RESPONSE

F.Villa[1], *R. Hoyland*[2]

[1] Istituto TESRE/CNR – Bologna (Italy)
[2] Insituto de Astrofisica de Canarias – La Laguna, Tenerife (Spain)

August 2000

COSMOSMOMAS EXPERIMENT at 15GHz: PRELIMINARY EVALUATION OF THE SIDE LOBES RESPONSE

F.Villa[1], *R. Hoyland*[2]

[1] Istituto TESRE/CNR – Bologna (Italy)
[2] Instituto de Astrofisica de Canarias – La Laguna, Tenerife (Spain)

August 2000

1. Summary

In this report the overall response of the optics of the COSMOSOMAS 15 GHz experiment is presented.
The calculations have been done with the GRASP8 software. The Physical Optics (PO) approach has been used. The scattering on the edges of both reflectors has been modelled with Physical Theory of Diffraction (PTD). The reflectors have been modelled as a perfect thin conductive surfaces.

2. Optical Layout and calculation parameters

The optical layout has been defined in [1] for the COSMOSMAS 15 GHz experiment. The optimal integration step grid on reflectors has been defined by convergency tets in order to assure the convercengy of the integrals for the field calculations.
The definition of the PO and PTD parameters in GRASP8 format are the following:

Parabolic Dish

```
POPTD_parabolic_dish_potter_15    standard_po
(
  frequency         : ref(freq15),
  scatterer         : ref(parabolic_dish),
  po_points         : struct(po1:   360,po2:  1000),
  ptd_points        : sequence
    (
    struct(edge:      1,ptd:  1500)
    ),
  factor            : struct(db:    0.000000000    ,deg:    0.000000000    ),
  spill_over        : on,
  ray_output        : none,
```

```
  coor_sys          : ref(Gobal),
  file_name         : parabolic_dish_potter_15_ptd.cur
)
```

Flat Mirror

```
POPTD_flat_mirror_potter_15       standard_po
(
  frequency         : ref(freq15),
  scatterer         : ref(flat_reflector),
  po_points         : struct(po1:   320,po2:   640),
  ptd_points        : sequence
    (
    struct(edge:     1,ptd:  1000)
    ),
  factor            : struct(db:    0.000000000    ,deg:    0.000000000    ),
  spill_over        : on,
  ray_output        : none,
  coor_sys          : ref(flat_mirror_system),
  file_name         : flat_mirror_potter_15_ptd.cur
)
```

The system coordinates are listed below and plotted in figure 1

- `(Xh,Yh,Zh):` Horn Coordinate System. The Zh axis is the axis of the horn and the origin is located at the horn aperture plane

- `(Xp,Yp,Zp):` Parabolic Dish Coordinate System. The Zp axis is toward the main beam direction (parallel to the parabola axis) and intersects the center of the aperture plane.

- `(Xf,Yf,Zf):` Flat Mirror Coordinate System. The Zf-axis is perpendicular to the flat mirror and intersects the center of the mirror.

- `(Xo,Yo,Zo):` Beam Coordinate System. The Zo-axis is toward the center of the main beam (calculated by Geometrical Optics) and the origin is at the origin of the Flat Mirror Coordinate System.

- `(Xz,Yz,Zz):` Zenith Coordinate System. The Zz-axis is pointed toward the local zenith (TEIDE Observatory) direction.

The first run of calculations have been done with the horn position not optimzed, i.e. with the reference plane for the phase normalisation at the horn aperture plane ("Horn not optimised" in figure captions). The second run of simulations have been performed with the phase center of the feed at the horn apex ("Horn optimised" in figure captions).

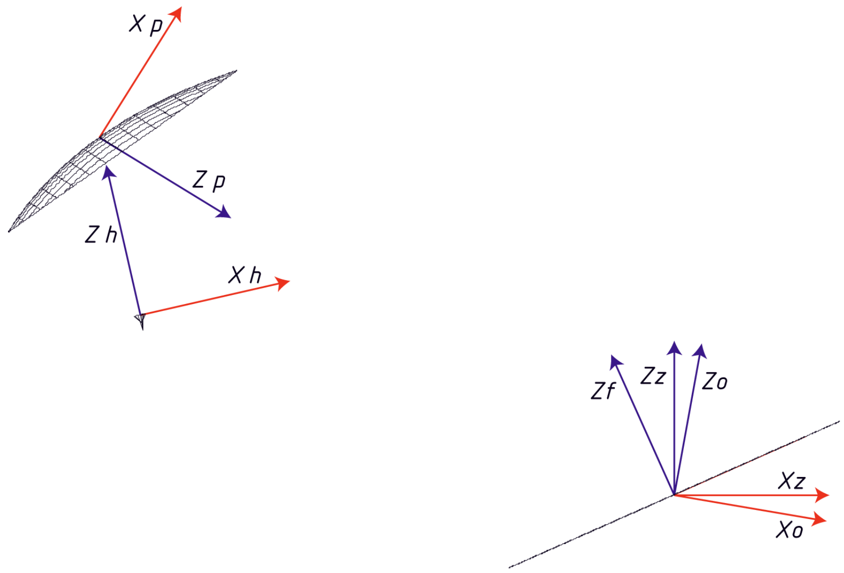

Fig. 1 *– Optical layout of COSMOSOMAS experiment at 15 GHz showing the Coordinate Reference Systems defined (see text for details).*

3. Calculations Results

The beam pattern has been calculated on the `(Xo,Yo,Zo)` system for three different cuts: ϕ=0°, ϕ=45° ,ϕ=90°. The angle ϕ is the azimuthal angle defined on the `(Xo,Yo,Zo)` system. ϕ=0° is the plane of symmetry of the optics (the drawing plane of Fig.1). The zenithal angle θ scans from -180° to 180° . Each plot represents a polar cut in ϕ. The Copolar component and the Cross polar components have been plotted in dBi as a function of the angle θ.
The ϕ=0° cut has been reported overlapping different copolar contributions: the field from the feed, the field from the parabolic dish and the overall field from the flat mirror in order to disentangle the contribution due to the various optical components.

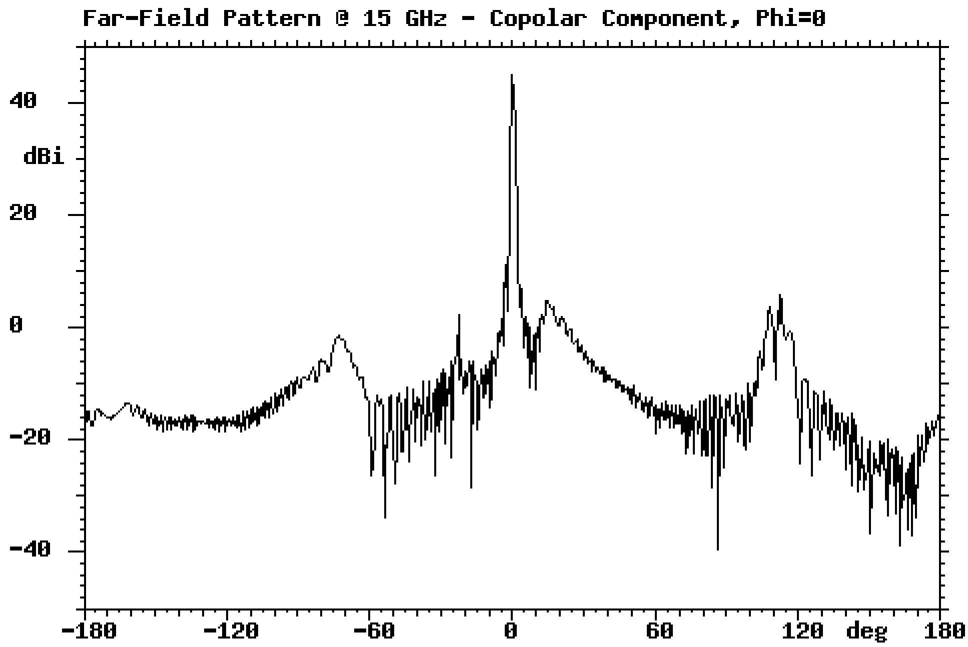

Fig. 2 *– Copolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment; cut at ϕ=0° . Horn not optimised.*

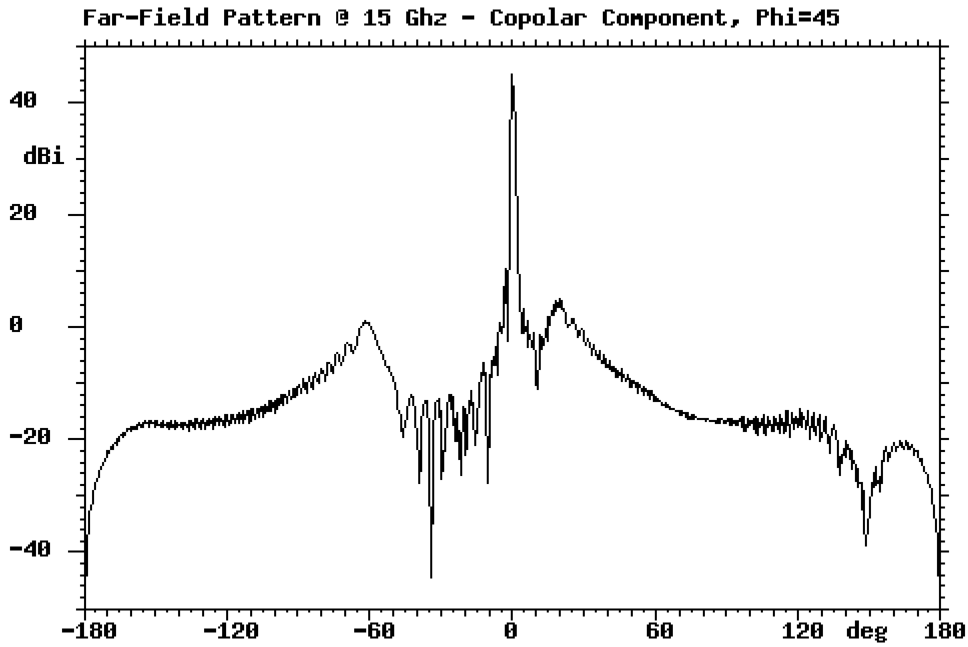

***Fig. 3** – Copolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment; cut at ϕ=45°. Horn not optimised.*

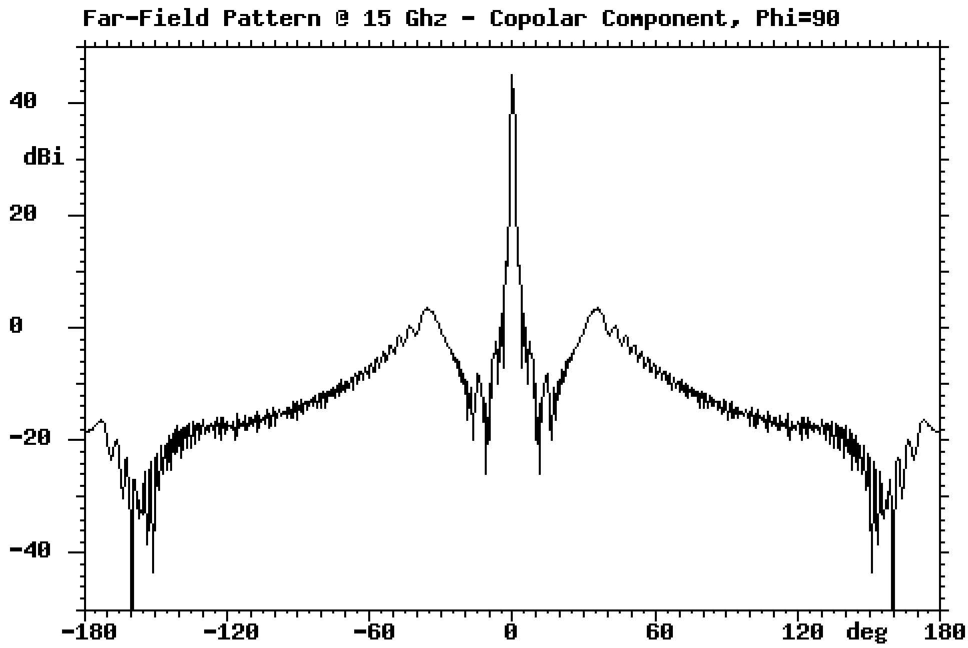

***Fig. 4** – Copolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment; cut at ϕ=90°. Horn not optimised.*

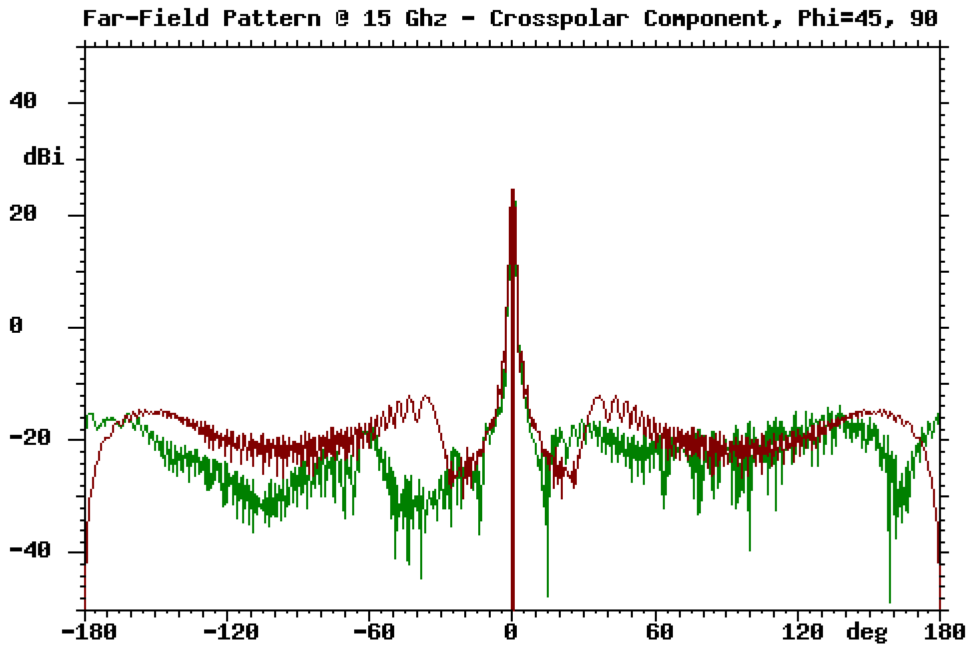

***Fig. 5** – Cross-polar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment. The green line represents the cut at ϕ=45° ; the red line is the cut for ϕ=90° . Horn not optimised.*

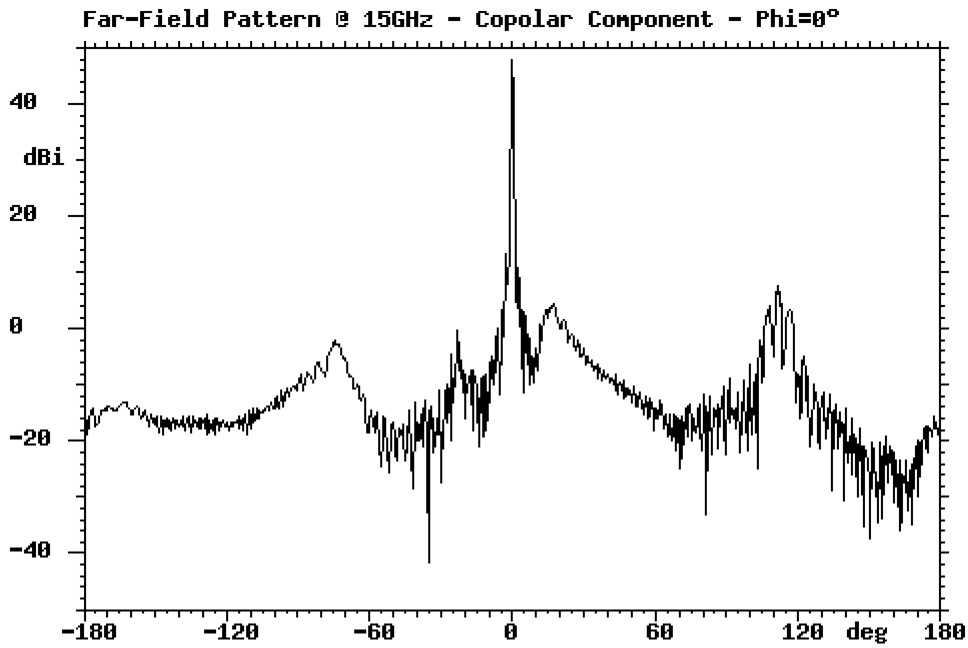

***Fig. 6** – Copolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment; cut at ϕ=0° . Horn optimised.*

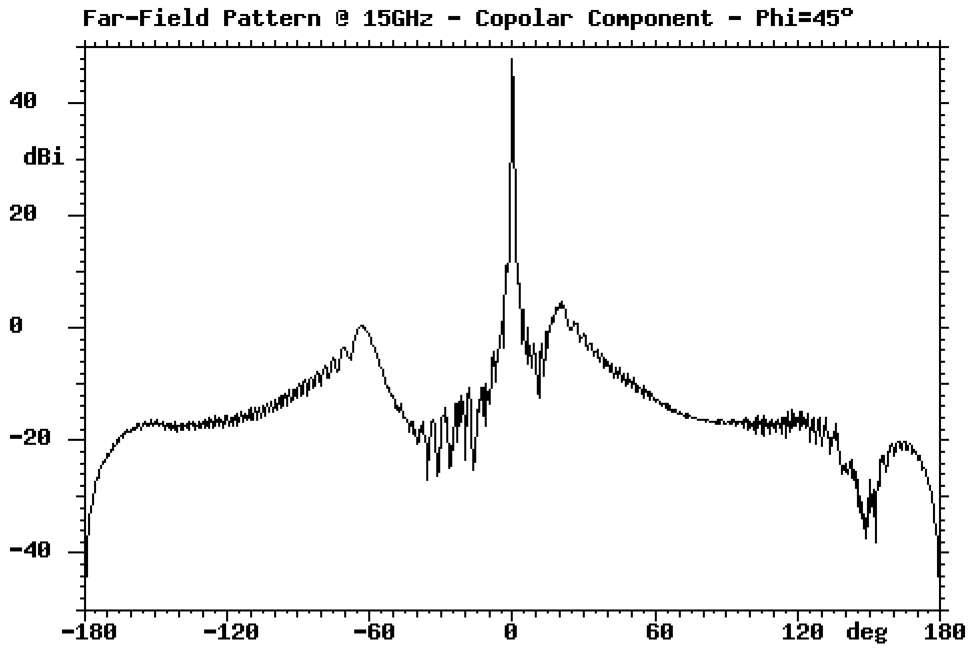

***Fig. 7** – Copolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment;* *cut at ϕ=45° . Horn optimised.*

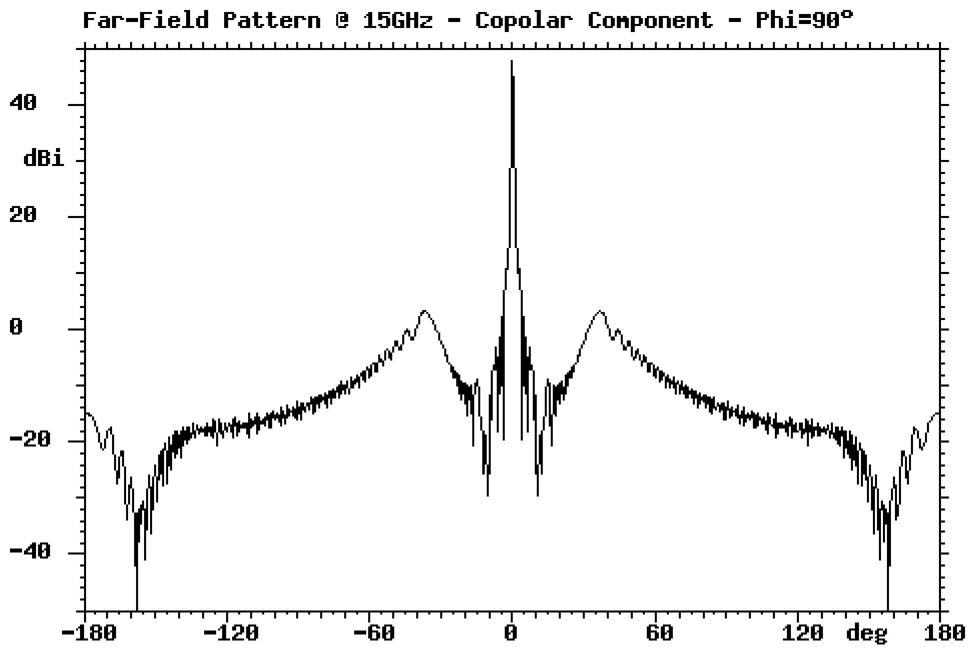

***Fig. 8** – Copolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment;* *cut at ϕ=90° . Horn optimised.*

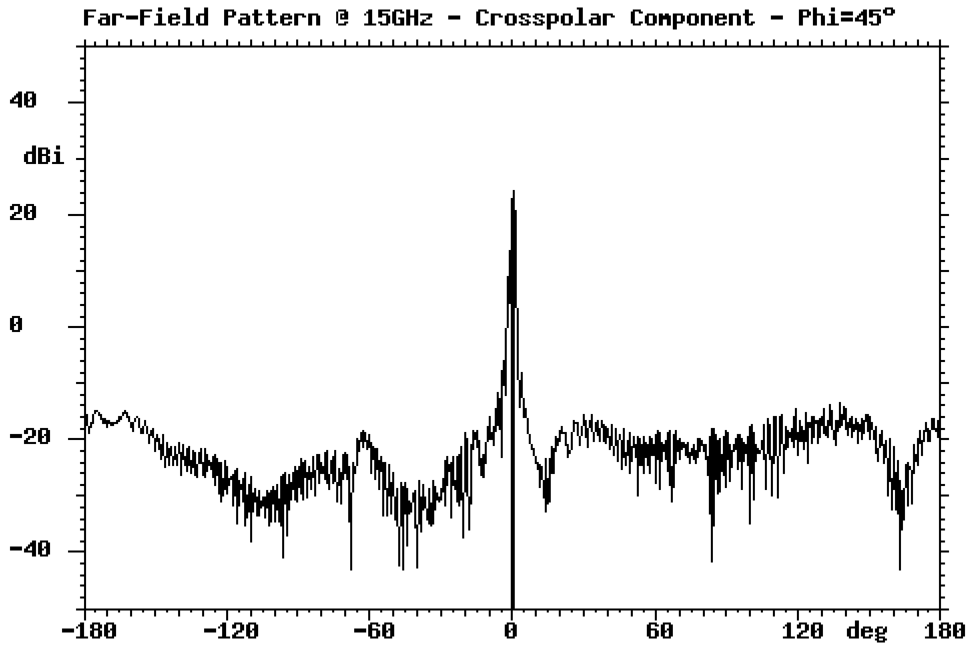

***Fig. 9** – Crosspolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment; cut at ϕ=45° . Horn optimised.*

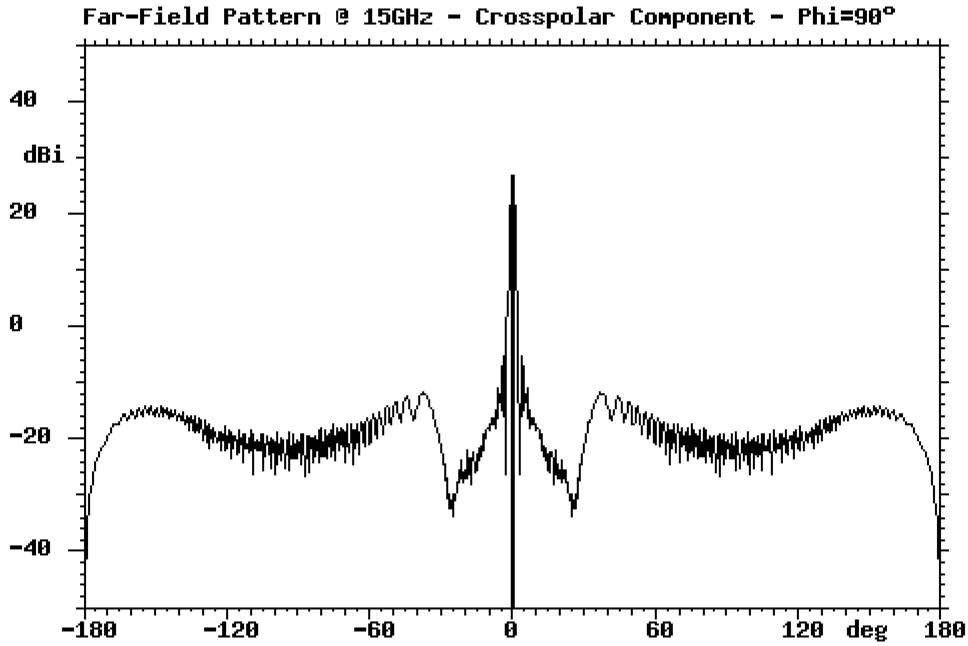

***Fig. 10** – Crosspolar Far-Field Beam Pattern of the COSMOSOMAS 15GHz experiment; cut at ϕ=45° . Horn optimised.*

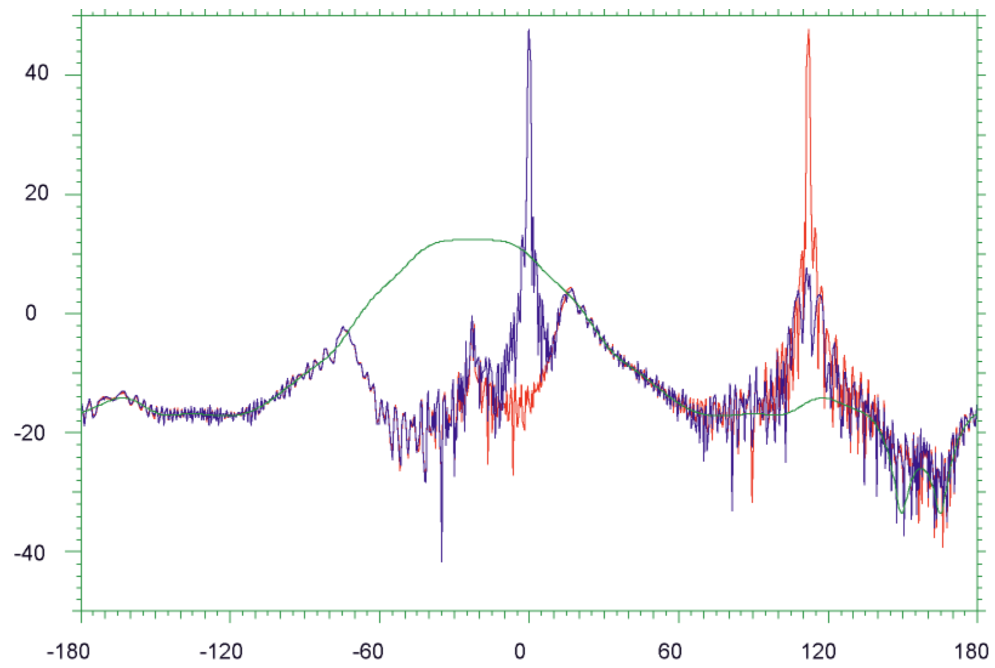

***Fig. 11** – Contribution to the Far-Field pattern at ϕ=0° ϕ for different components. Green line: feed pattern; Red line: pattern from the Parabolic Dish; Blue line: overall pattern form the Flat Mirror.*

4. Conclusions

Preliminary calculations of the antenna response at large angles from the boresight direction have been obtained for the COSMOSOMAS 15GHz experiment. The calculation have been limited at three azimuthal cuts showing the main contribution to the spillover. This study has to be considered as a preliminary approach to the complete characterisation of the system. Further calculation are in progress to simulate a complete 3D pattern around the antenna system.

5. References

[1] F.Villa, R. Hoyland, *COSMOSMOMAS Experiment at 15GHz: Far Field Main Beam Response,* Internal Report ITESRE 292/2000

[2] *GRASP8 Software User Manual, Version 8.1*
TICRA Technical Report S-894-01, 1999

[3] *Technical Description of GRASP8*
TICRA Technical Report S-894-02, 1999