Cassegarin Antenna of 0.9m at 10.5GHZ

Zoran Mićić, Vladimir Smiljaković and Ivan Jovanović

***Abstract* – The paper presents analysis and simulation of a standard axially symmetric dual-reflectors Cassegrain antenna with minimal blockade, linear polarization (horizonatal and/or vertical), 0.9m diameter, operating from 10.2 to 10.7GHz range. Dimensions of the primary radiator and the subreflector of the antenna are optimized by WIPL-D – the program package for rapid and precise analysis of metallic and/or dielectric/magnetic structures in the frequency domain [1].**

***Keywords* – reflector antenna, Cassegrain, WIPL-D**

I. Antenna Description

The antenna, *Fig. 1*, consists of:
-parabolic reflector
-primary feed
-coaxial-waveguide adaptor
-subreflector supporting
-hyperbolic subreflector
-link housing case
-positioning mechanism

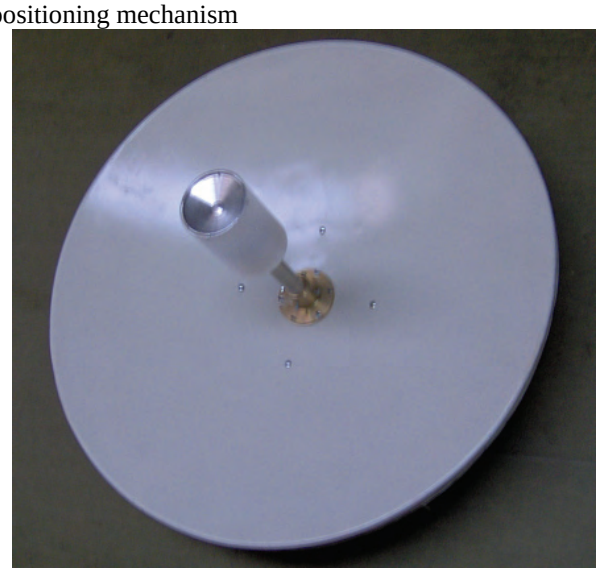

Fig. 1 Antenna parts

II Design Procedure

The antenna is designed using principles of microwave optics [2],[3],[4]:
According to known parameters:
D_{PR}- primary feed diameter
L_{FC}- distance from the phase center to the primary feed aperture
D_R- parabolic reflector diameter
F- focal length of the parabolic reflector
Θ-10dB radiation angle of the primary feed,
under condition of minimal blockade (equal shadow of the subreflector and the primary feed on the reflector), *Fig. 2*, we have determined the unknown parameters:
f- hyperbolic subreflector focal length
D_S- hyperbolic subreflector diameter
L_{RFC}- distance between the reflector center and the primary feed phase center
L_S- distance between the subreflector center and the primary feed phase center
a- major half-axis of the subreflector

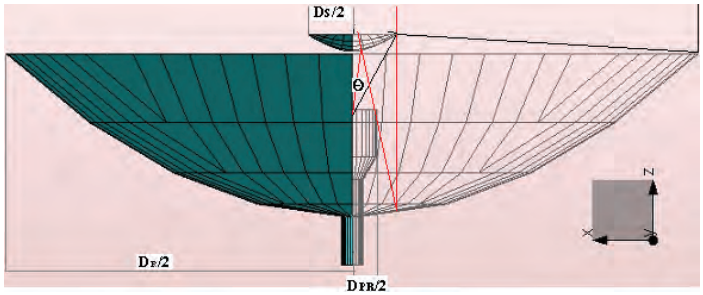

Fig. 2 *Position of the antenna parts.*

III Results of the WIPL-D Electromagnetic Analysis

Primary feed is a conical "dual mode" (TE_{11} i TM_{11}) horn antenna, *Fig. 3.*

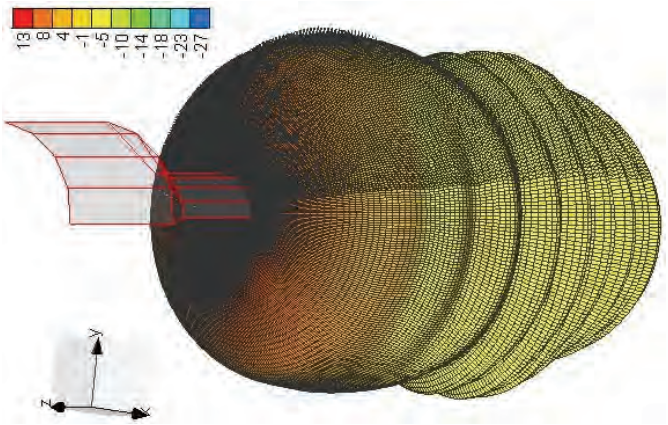

Fig. 3 – *WIPL-D model of the primary feed and its 3D radiation pattern.*

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Dimensions of the primary feed are optimized so to obtain the best possible symmetry correlation of the E- and H-plane radiation patterns, and the Θ-10dB radiation angle of about 55^0.

Position and length of the probe in the primary feed wavegude are determined by WIPL-D analyses resulting in return losses RL>19dB.

Complete antenna is modeled and optimized at 10.45GHz, using WIPL-D program package, *Fig.4*.

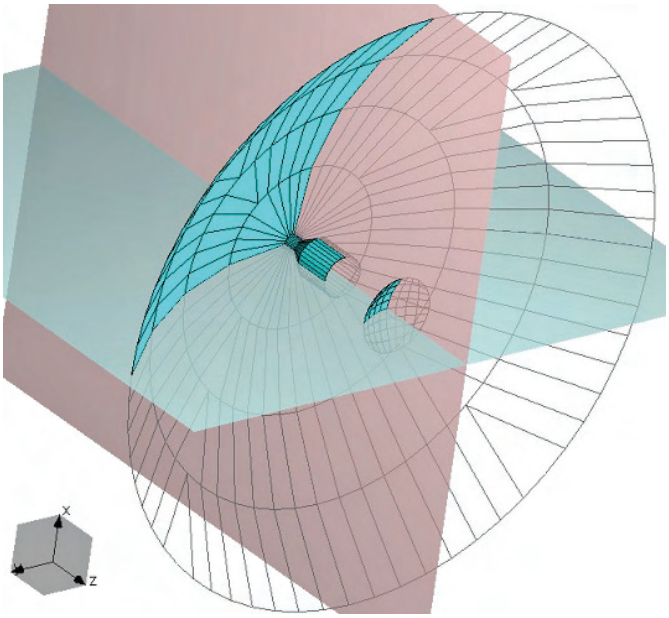

Fig. 4. *WIPL-D model of the antenna.*

Results of the WIPL-D analysis are shown in Table 1:

f [GHz]	***10.2***	***10.45***	***10.7***
G [dBi]	36.1	36.5	36.2
$FSLA^E$ [dB]	16.6	19.4	16.5
$FSLA^H$ [dB]	16.1	17.2	16.0
F/B [dB]	43.1	43.2	43.1
$HPBW^E$ [º]	2.1	2.1	2.05
$HPBW^H$ [°]	2.05	2.0	2.0
XPD [dB]	30	30	30

Table 1 *WIPL-D analysis results*

G- Antenna gain

FSLA- First side lobe attenuation

F/B- Front-to-back ratio

$HPBW^E$- Half-power beamwidth in E-plane

$HPBW^H$- Half-power beamwidth in H-plane

XPD –Cross polar discrimination

Spherical radiation patterns in E-plane (Φ=0) and H-plane (Φ=90) at the frequency f=10.45GHz are presented in *Fig. 5*.

First side lobe attenuations (FSLA) in H-plane (Φ=90), and E-plane (Φ=0) at the frequency of 10.45GHz are shown in *Fig. 6*. It can be seen that the position of first lobes are 3.3º/3.5º apart from the maximal radiation direction. HPBW angles in H- and E-plane are about 2.0º/2.1º (H/E).

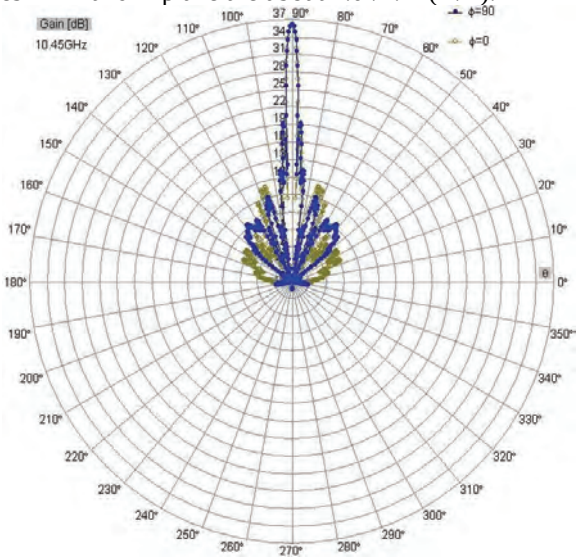

Fig. 5 *Spherical radiation patterns in H- and E-plane at f= 10.45GHz*

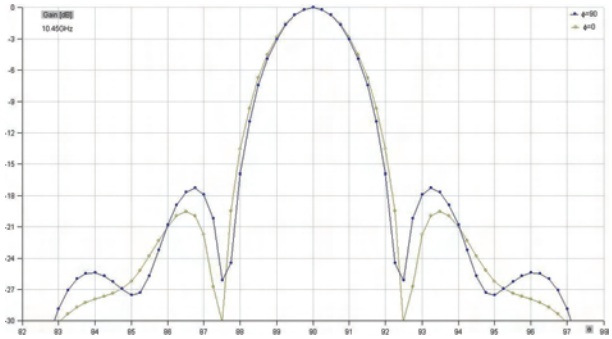

Fig. 6 *Main and first two side lobes in H- and E-plane at f= 10.45GHz*

Fig.7 (H-plane, Φ=90) and *Fig.8* (E-plane, Φ=0) present radiation patterns at the center as well as at lower and upper boundary of the operating frequncy range, in the left half-space of the antenna with ETSI RPE masks of class 1 and 2, [5], for frequency range 1. We can see that antenna belongs to class 1. For transferring the antenna into class 2, an absorber in the antenna shield is needed.

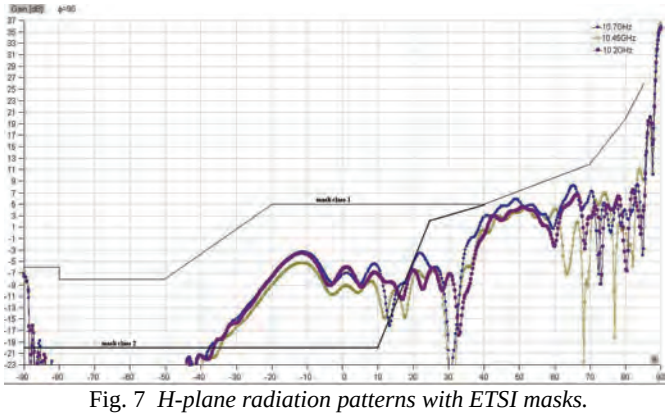

Fig. 7 *H-plane radiation patterns with ETSI masks.*

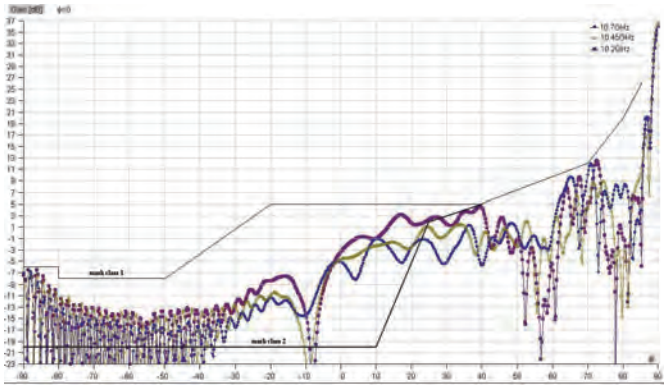

Fig. 8 *E-plane radiation patterns with ETSI masks.*

IV Technical Characteristics of the Antenna

Based on results of the analyses estimated technical characteristics of the antenna are:

- type: standard dual-reflectors Cassegrain antenna with 0.9m diameter, operating at 10.5GHz.
- manufacturer: IMTEL-Komunikacije a.d. Beograd
- parabolic reflector diameter D =0.9m
- reflector focal length/ diameter ratio (F/D)=0.4
- oparating frequency range: (10.2 - 10.7)GHz -ETSI frequency range 1 (3 -14GHz)
- G_{min}= 36.1dBi, ETSI Gain category 2 (high co-polar gain)
- ETSI RPE class 1, use in networks where there is a low interference potential
- XPD= 27dB, ETSI XPD category 1 (standard XPD)
- F/B =43dB
- FSLA = 16dB
- VSWRmax= 1. 38 (RL_{min}=16dB)
- HPBW=2.1º
- polarization: single or dual (H and/or V)
- inter port isolation ≥ 35dB for dual polarization
- cut off frequency $f_{cut\ off}$ =8.58GHz
- antenna input/output: 1/2 SMA 50Ω- connectors
- reactive near-field region: up to 2.1m in front of the antenna
- far-field Fraunhofer region >56.7m
- dimensions (mm) 950x950x700
- mass =20kg
- antenna color: white
- white aerodynamic cover
- cover attenuation: 1 dB
- tower / adapter requirements:
  - adapter (tube) ϕ 89
  - adapter deviation from the vertical position ≤0.2° (due to XPD)
  - under all conditions main beam axis deviation should be ≤0.3HPBW=0.6°
- mechanism for left-right azimuth tuning - coarse: 360°, fine: 10°
- mechanism for elevation tuning ±15° (optionally ±30°)
- the antenna operates under following environmental conditions:
  - temperature: from –45˚C to +60˚C
  - relative humidity: 100%
  - industrial atmosphere
  - UV radiation
  - wind speed: 200km/h with 25mm radial ice
  - rain, snow, hail, frosting, salt mist, condensation, fog, insects, birds
- possibility of ODU mounting on the back side of the antenna, in the link housing
- referent ETSI document EN 300833

V Conclusion

The paper presents analysis and simulation of standard axially symmetric dual-reflectors Cassegrain antenna with a minimal blockade, linear polarization (horizontal and/or vertical), having diameter of 0.9m and operating in the frequency range from 10.2 to 10.7GHz.

According to ETSI standard ETS 300 833 (antennas used in point-to-point digital radio relay systems), analyzed antenna belongs to:

1. Frequency range 1 (3-14GHz)
2. G category 2 (high co-polar gain G_{min} ≥32dBi)
3. RPE class 1 (antennas for use in networks where there is a low interference potential)
4. XPD category 2 (standard cross-Polar Discrimination)

Acknowledgements

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References

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