Dual-Band Circular Polarized Signals Divider for Radiotelescope RT-32

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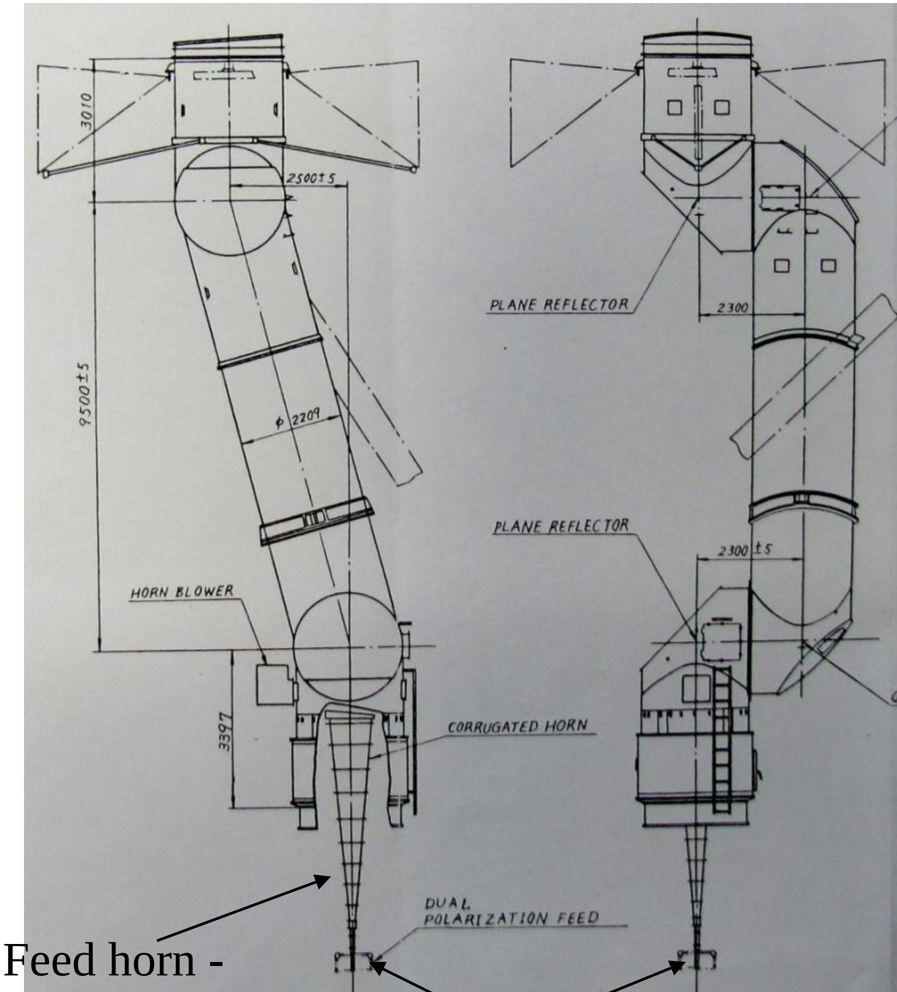
and RT-32 TEAM

Antenna MARK-4B and BWG system



Feed horn - corrugated horn

receiving waveguide

Beam-waveguide system schematic

PRIMARY REQUIREMENTS TO DESIGN OF THE RT-32 RECEIVING WAVEGUIDE SYSTEM

- To receive signals from the corrugated horn – BWG feed of the antenna system MARK-4B
- To receive and divide the signals of right and left circular polarization **simultaneously** in frequency bands: in C-range 4,7 - 6,8 GHz and in K-range 20-25 GHz
- To ensure as much as possible the reduction of return loss in receiving waveguide system (VSWR less than 1,3…1,4) and ohmic losses (no more than 0.2-0.3 dB)

VIEW OF THE CORRUGATED HORN OF THE ANTENNA SYSTEM MARK-4B

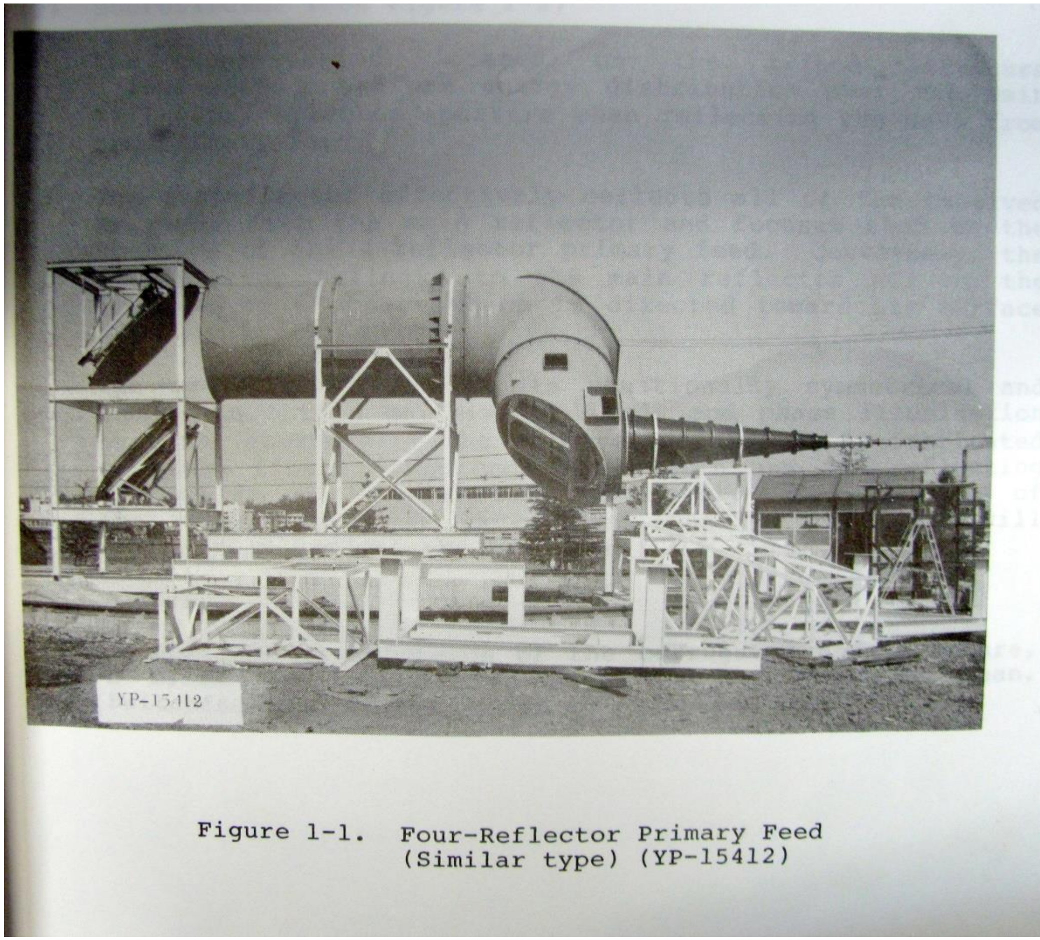
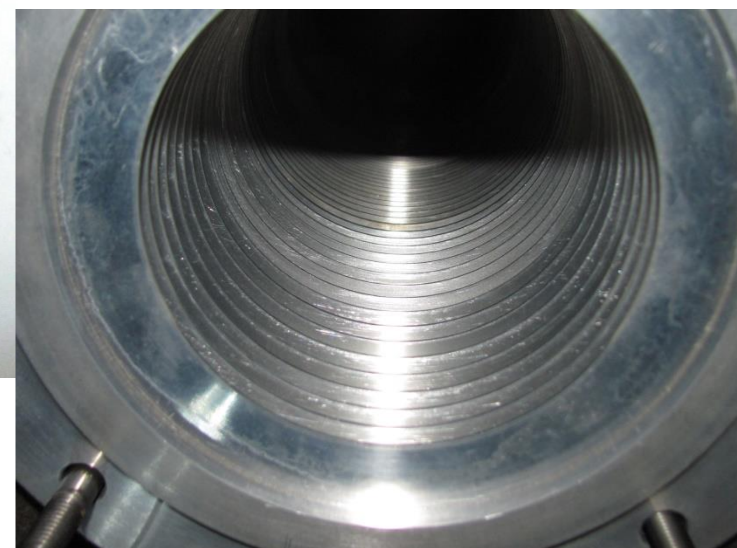
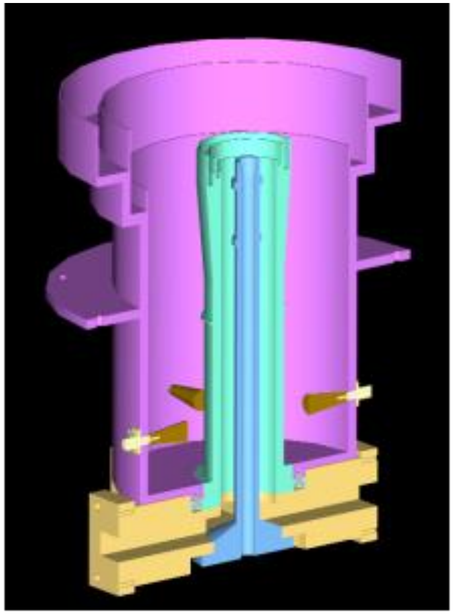
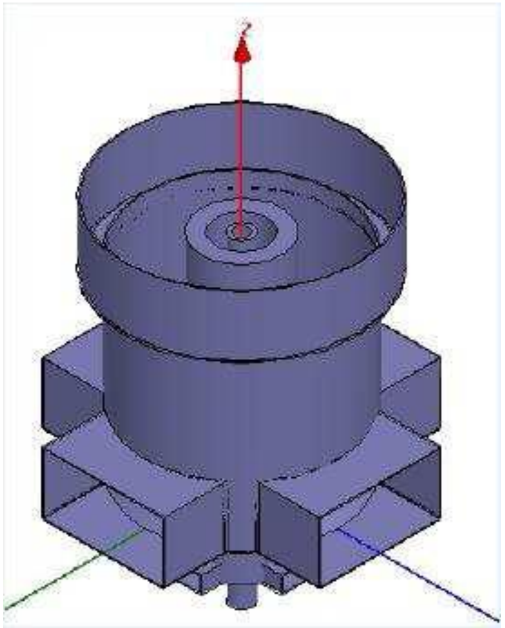


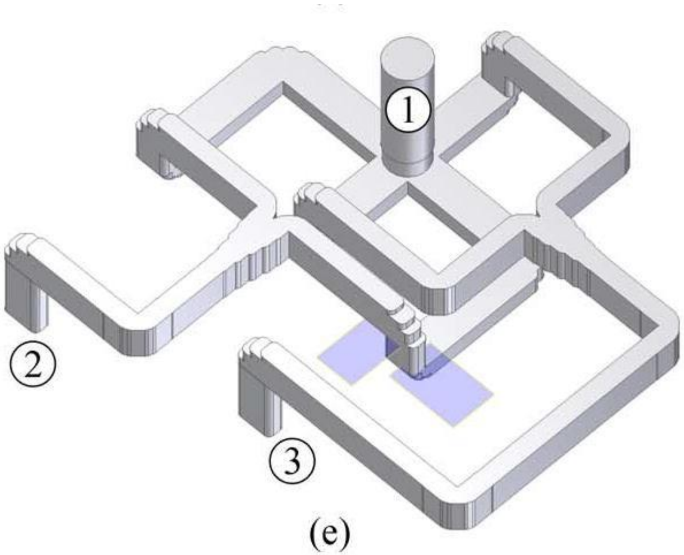
Figure 1-1. Four-Reflector Primary Feed
(Similar type) (YP-15412)



Existing technical solutions for multi-frequency waveguide system. Some examples



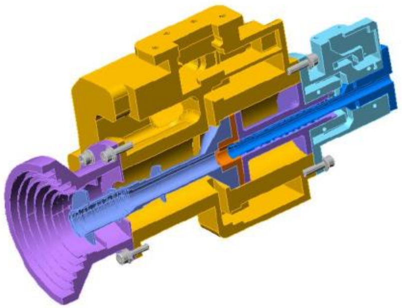




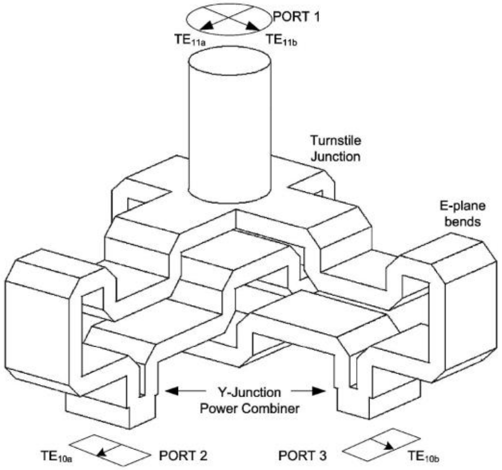
Design of 3-band antenna feed of RAEGE stations, SPAIN

Cryogenic OMT
Doug Henke, Stephane Claude

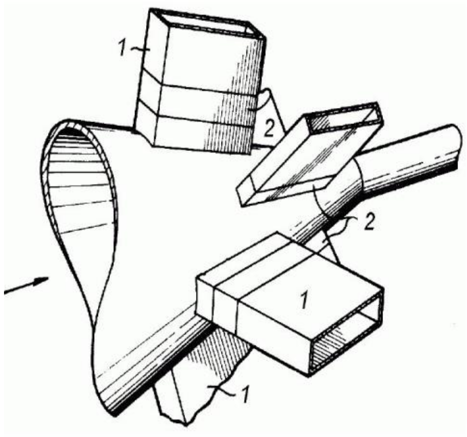
Existing technical solutions for multi-frequency waveguide system. Some examples



X/Ka-band feed-system
I.M. Davis, C. Granet, G. Pope, T. Mellor
BAE System Australia



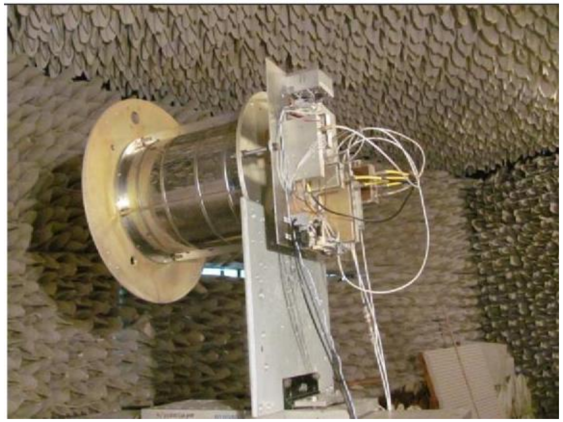
Cryogenic OMT
Juan Luis Cano de Diego, Tesis Doctoral

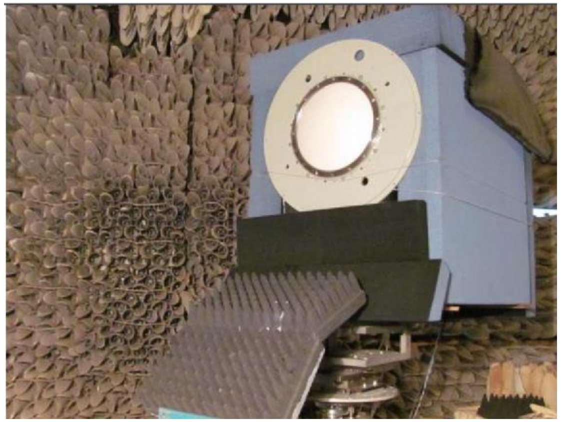


Branching Filter. Pat. US
Taceichi Y., Hashimoto T., et.al.

EXPERIENCE IN THE DEVELOPMENT OF MULTI-BAND REFLECTOR ANTENNA FEED AND WAVEGUIDE SYSTEM

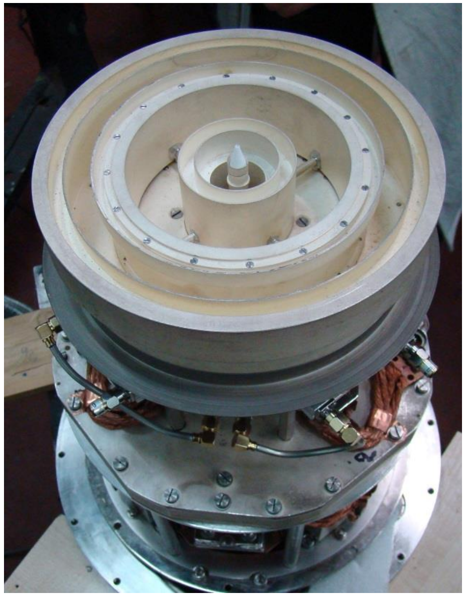
IRE NAS of Ukraine (our research group) and Private Joint Stock Company "Scientific and Production Enterprise "Saturn" have developed a tri-band C/X/Ka feed with separation of circular polarized signals for the two reflector short focus antenna of the German company Vertex Antennentechnic GmbH. The feed was used by "Saturn" for creating of the radiotelescope cryogenic receiving focal block

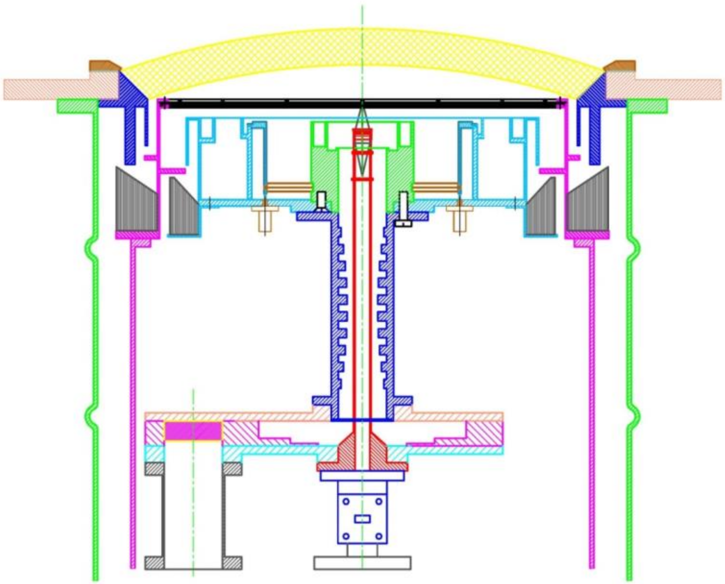


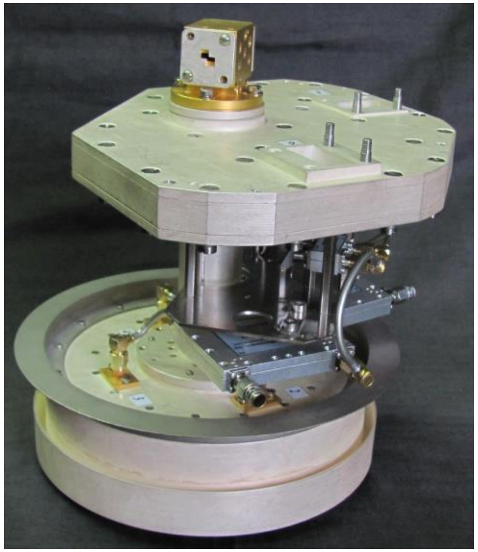


Measurements of the cryogenic receiving focal block in the anechoic chamber

EXPERIENCE IN THE DEVELOPMENT OF MULTI-BAND REFLECTOR ANTENNA FEED AND WAVEGUIDE SYSTEM

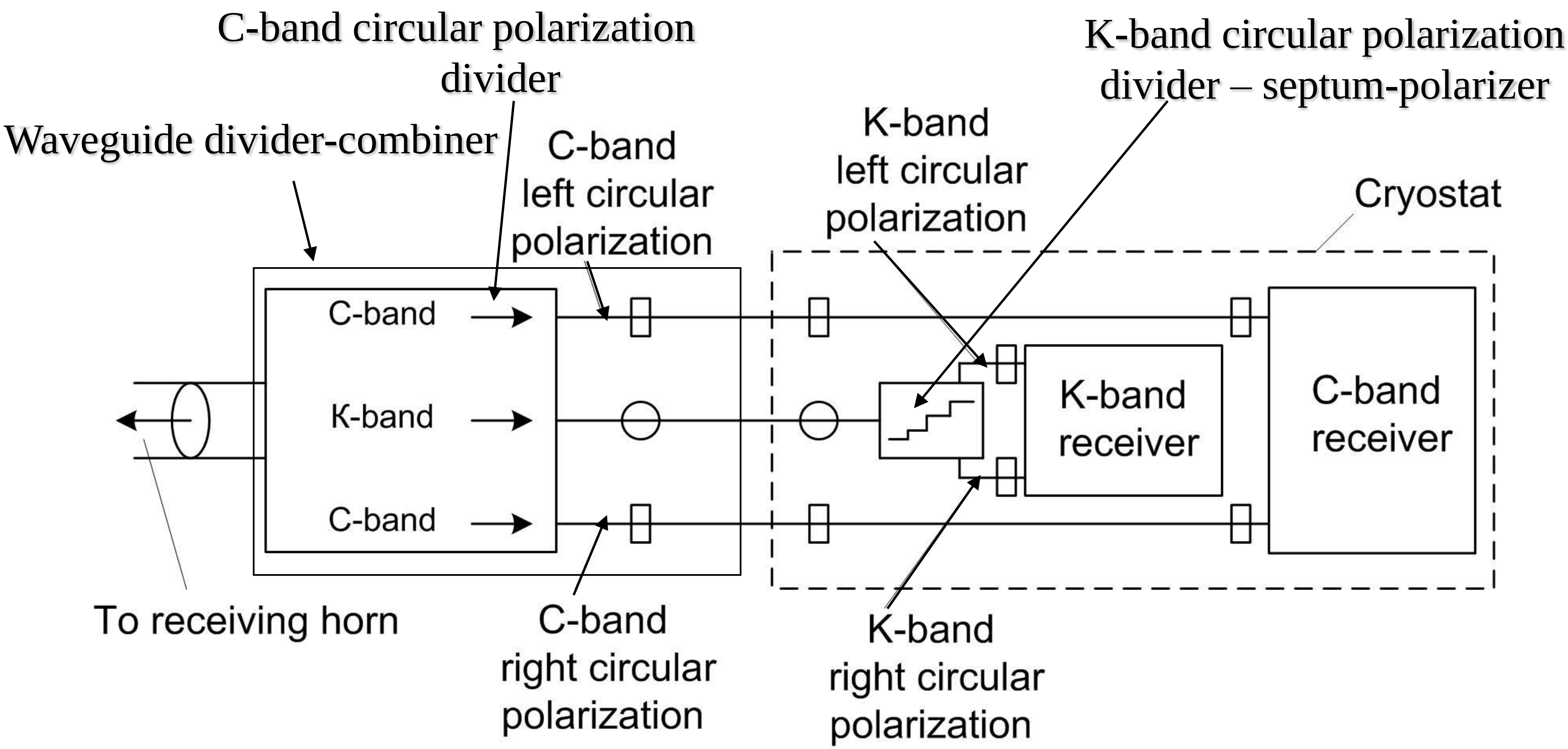




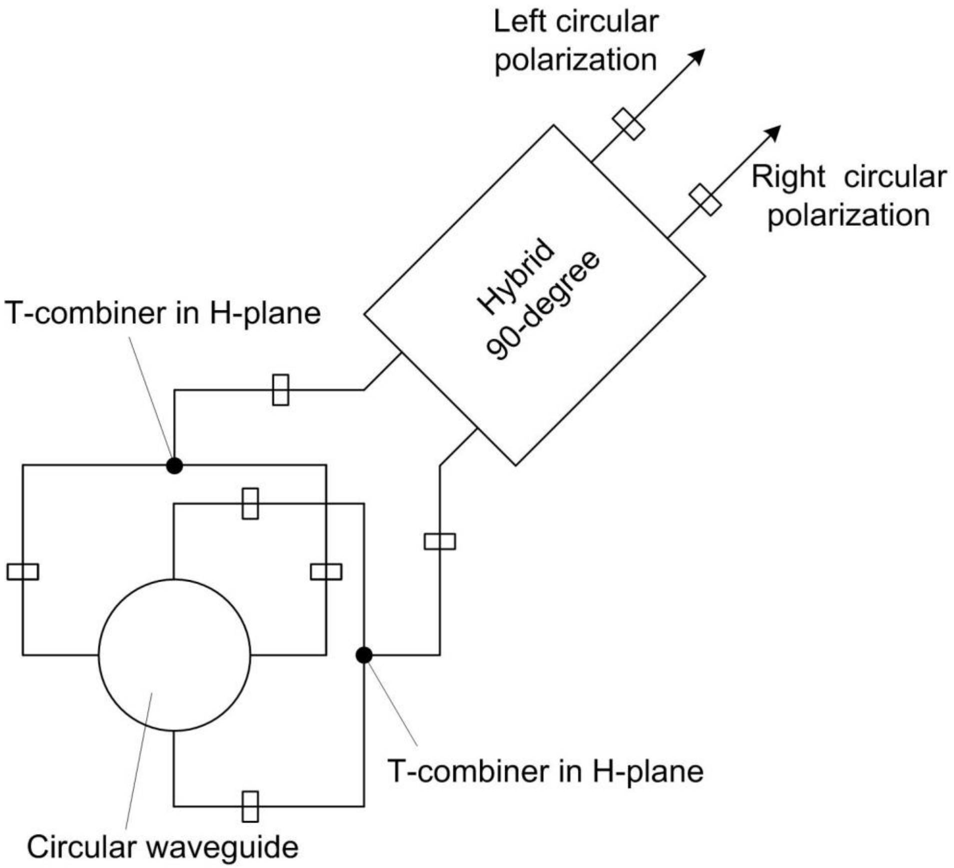


C/X/Ka feed with separation of circular polarized signals

DUAL BAND WAVEGUIDE SYSTEM FOR RADIO TELESCOPE RT-32

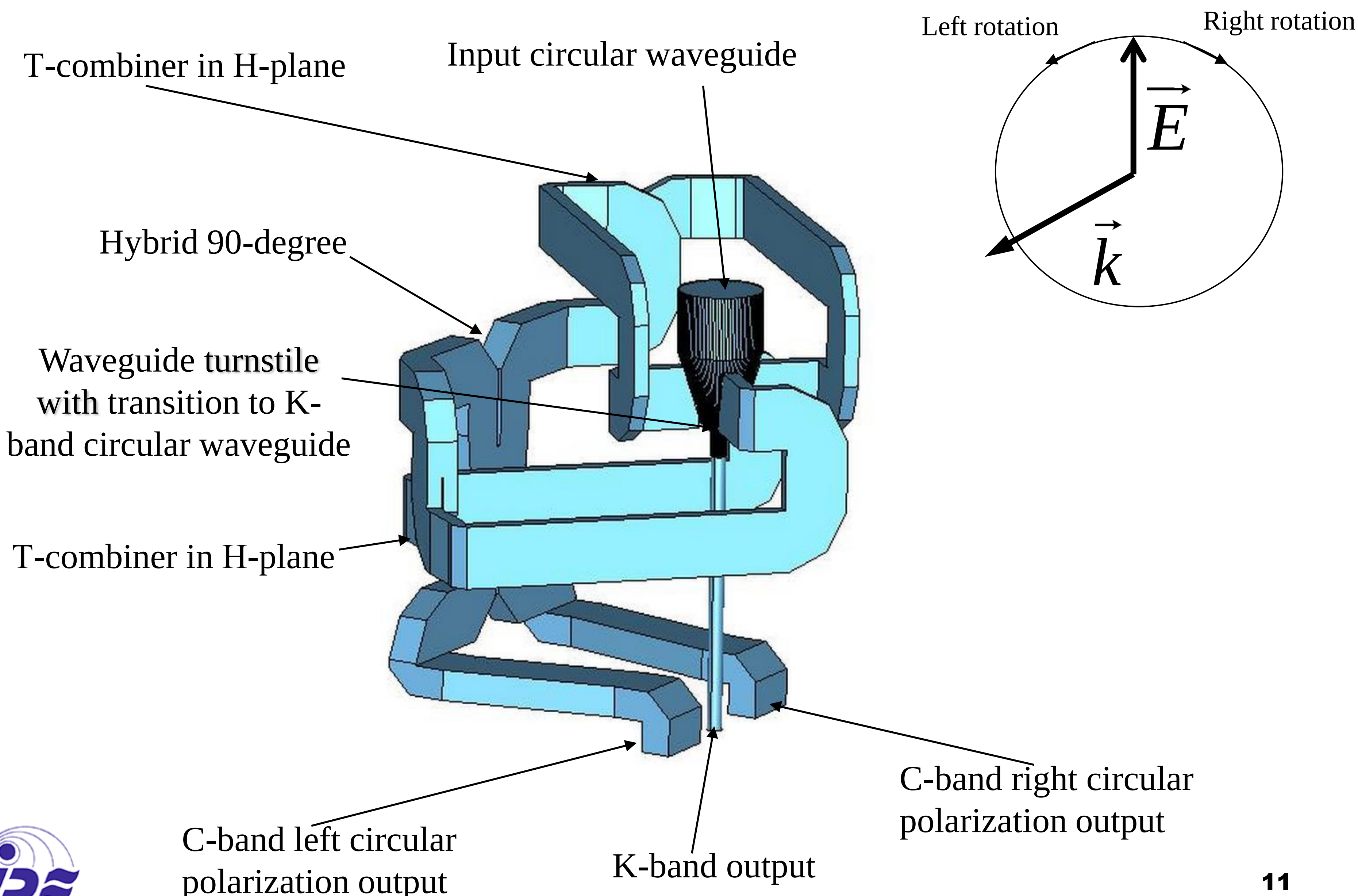


Schematic of receiving dual band waveguide system configuration



Schematic of C-band circular polarization divider

Waveguide divider-combiner

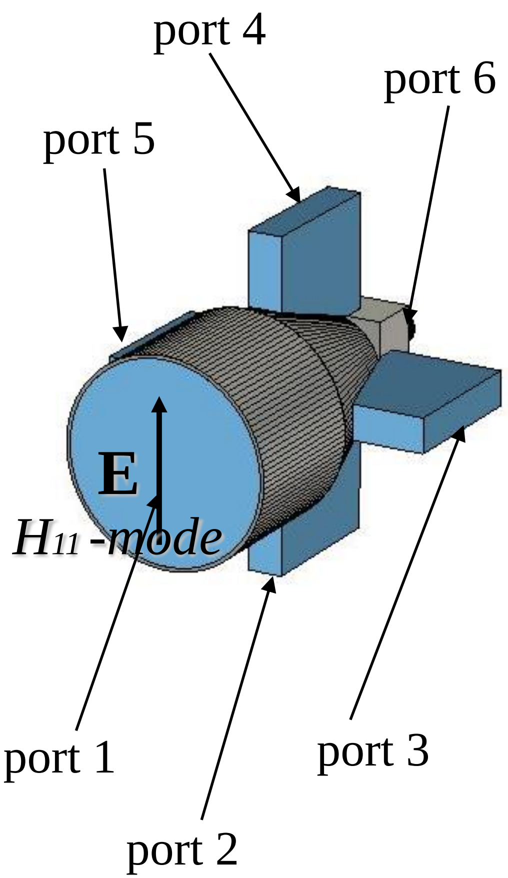


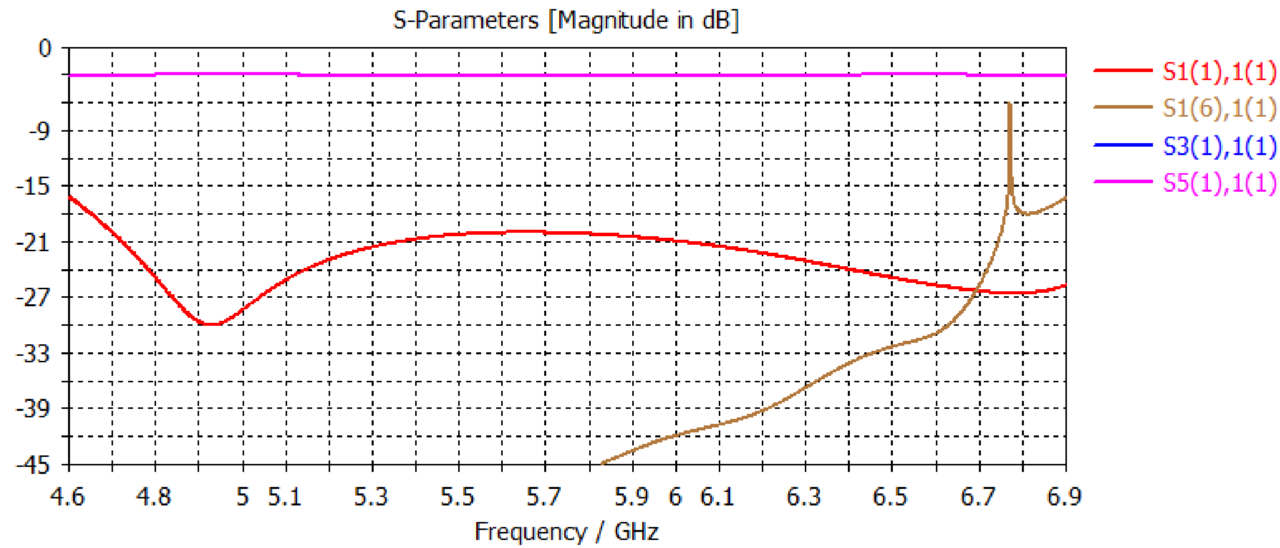
THE FOLLOWING DESIGN UNITS WERE DEVELOPED

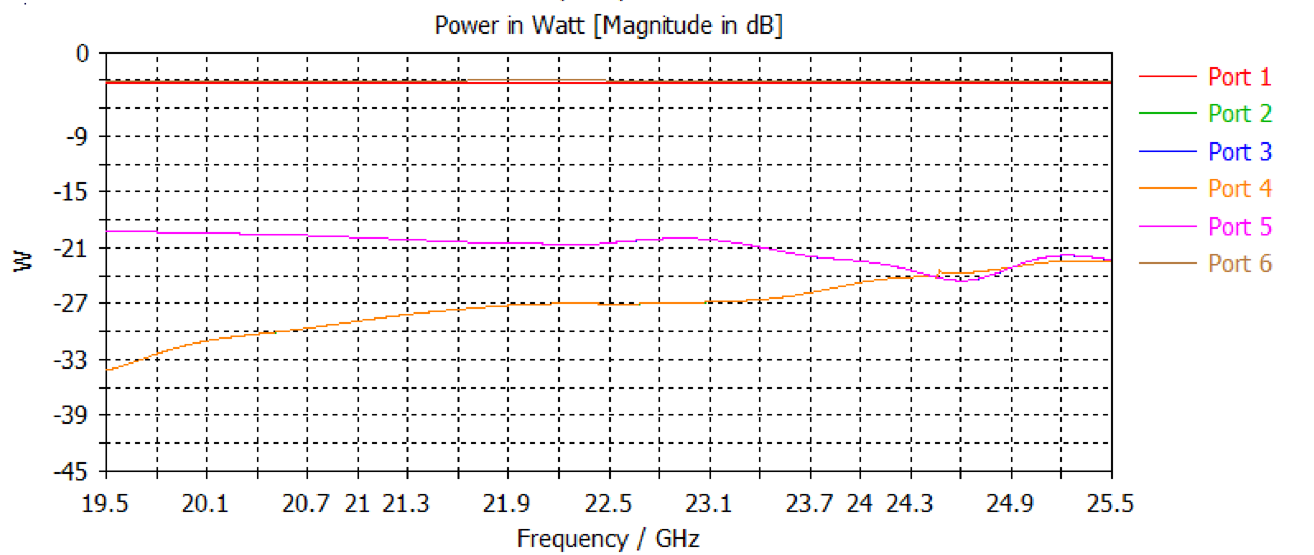
- Waveguide turnstile with transition to K-band circular waveguide.
- Hybrid 90-degree
- T-combiner in H-plane
- Waveguide twists for connection of the design units
- K-band circular polarization divider – septum-polarizer

After connection of all units the entire designed waveguide system has been optimized by program CST

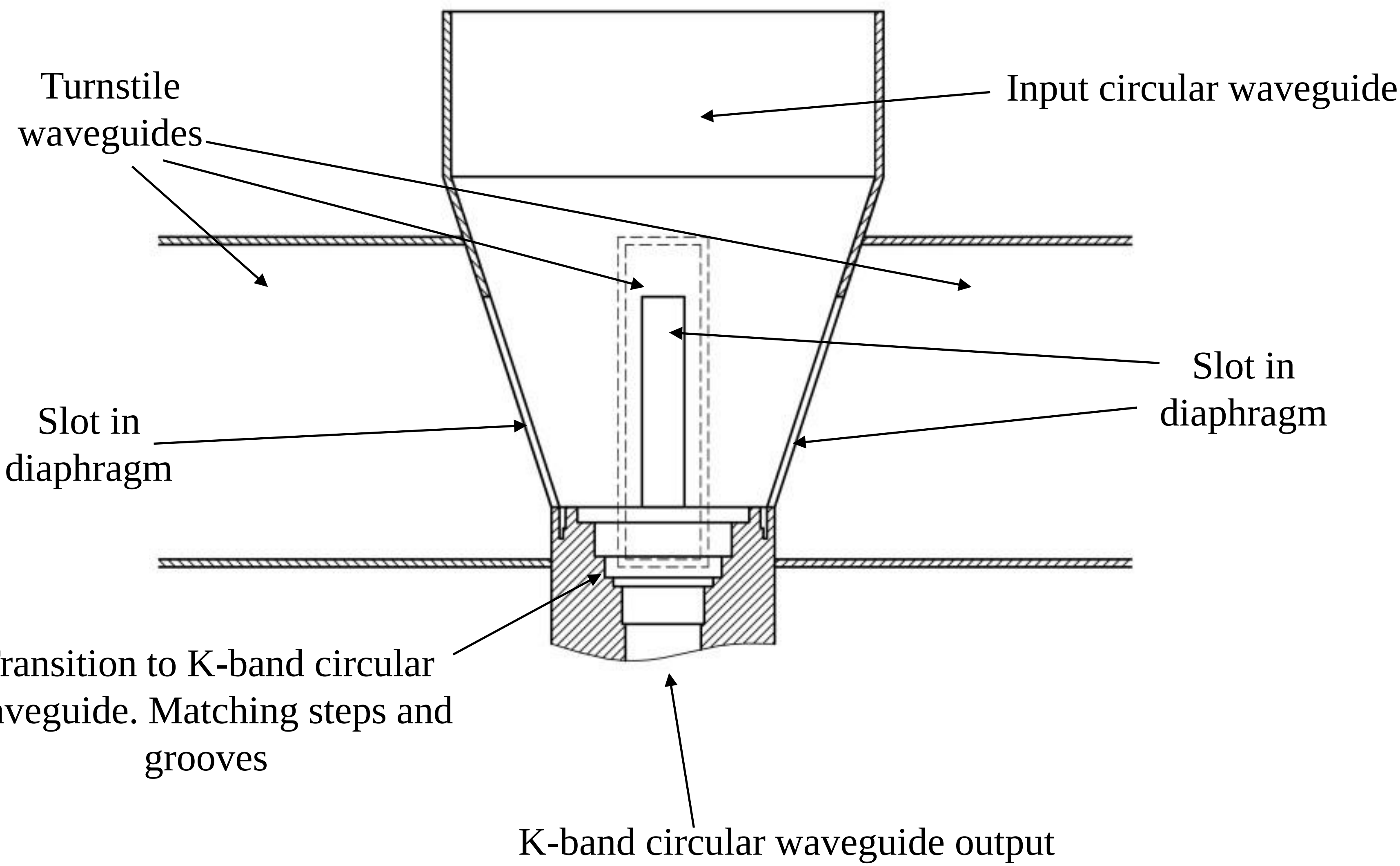
Waveguide turnstile



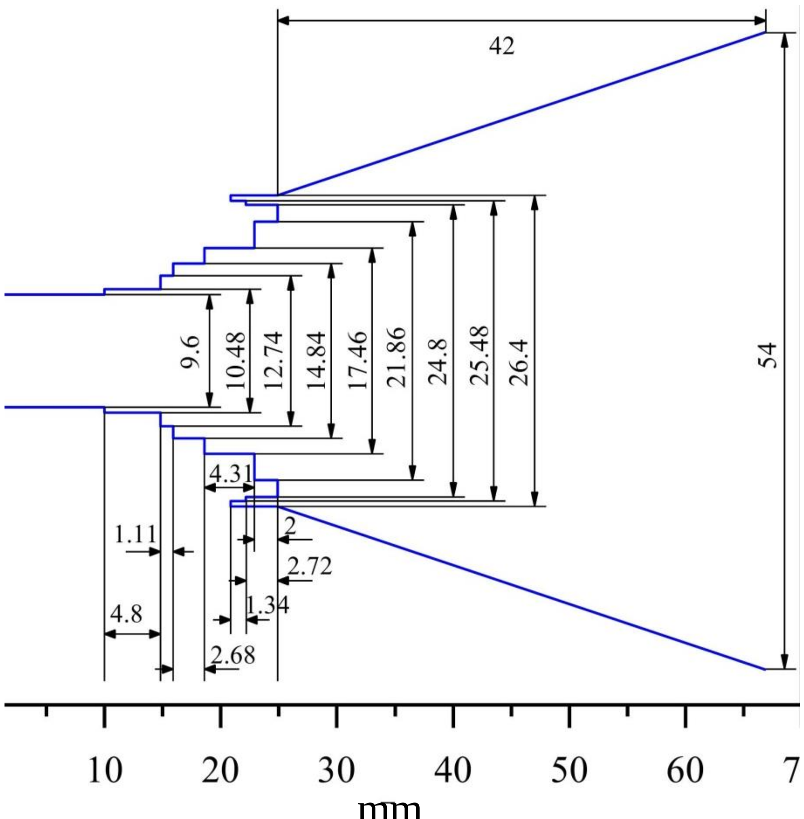


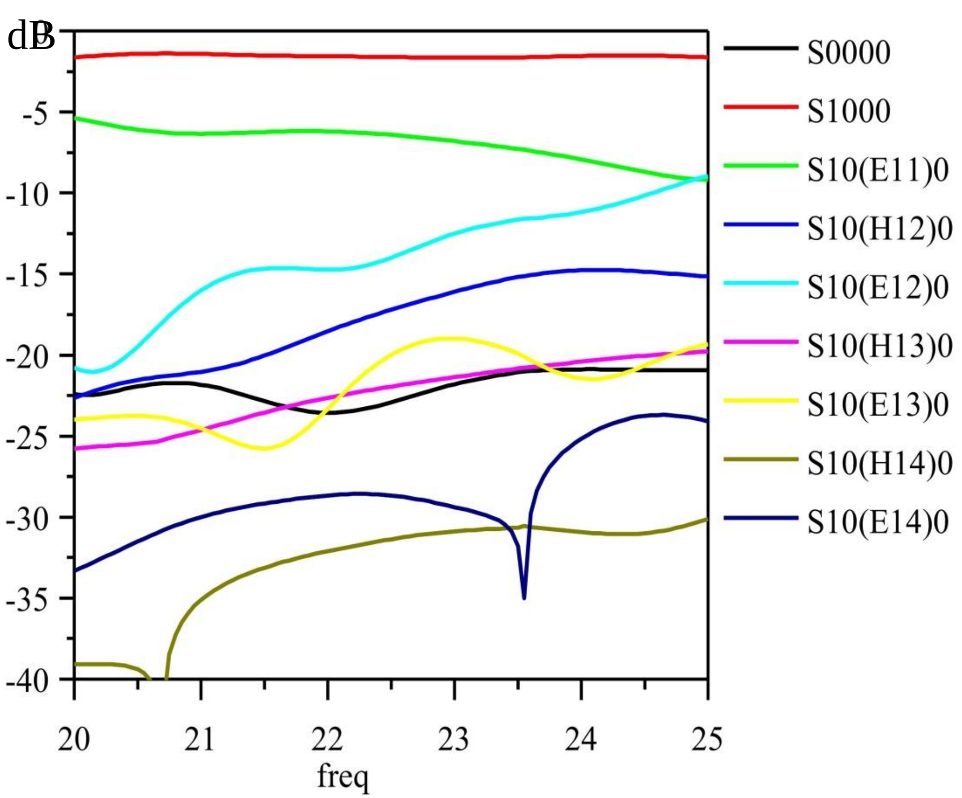


Waveguide turnstile cross-section

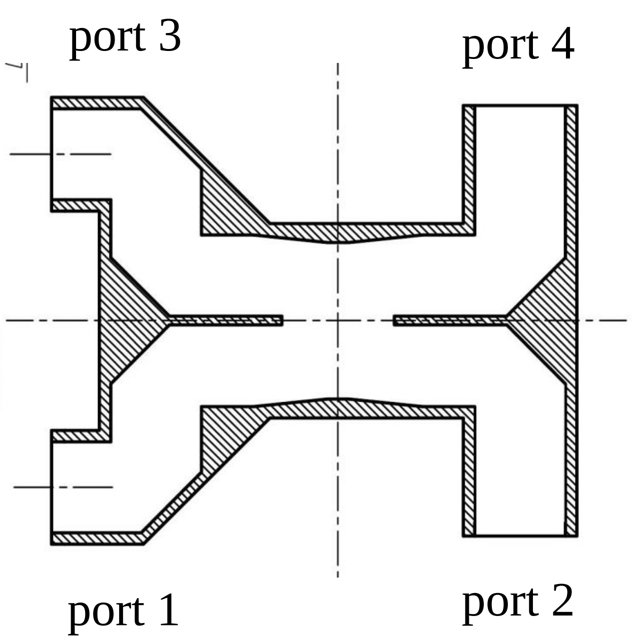


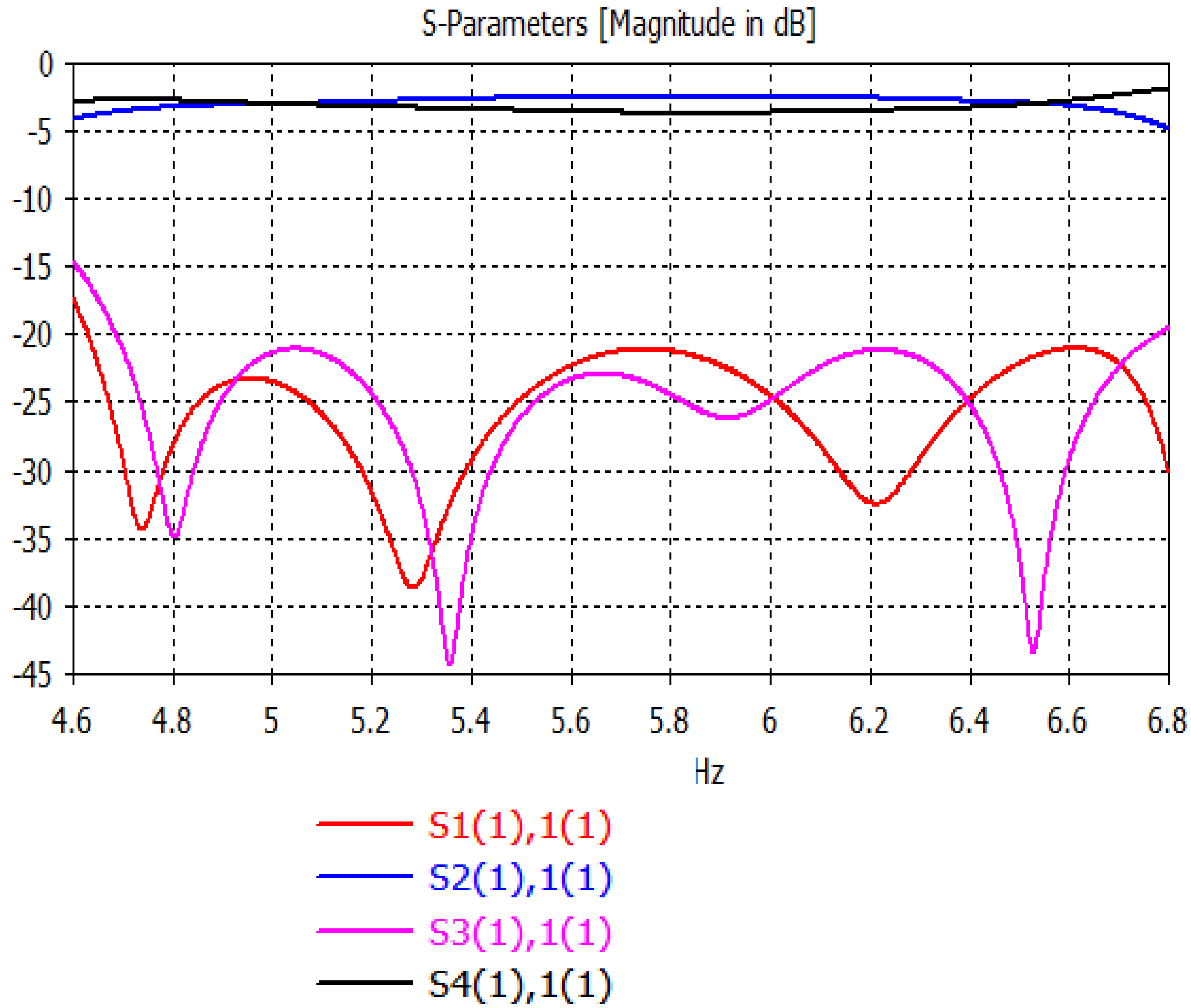
Design and optimization of the shape of the transition to a K-band circular waveguide was carried out by the mode matching method and by the method of generalized scattering matrices. Optimization was carried out according to the criterion of minimizing the reflection and the level of higher modes in the K-band by particle swarm optimization technique.



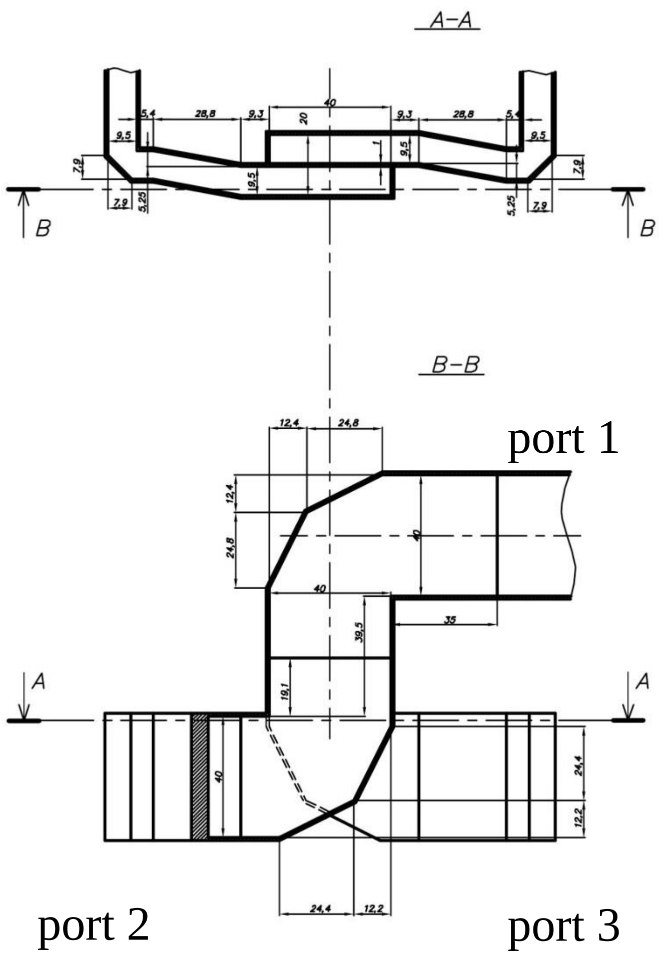


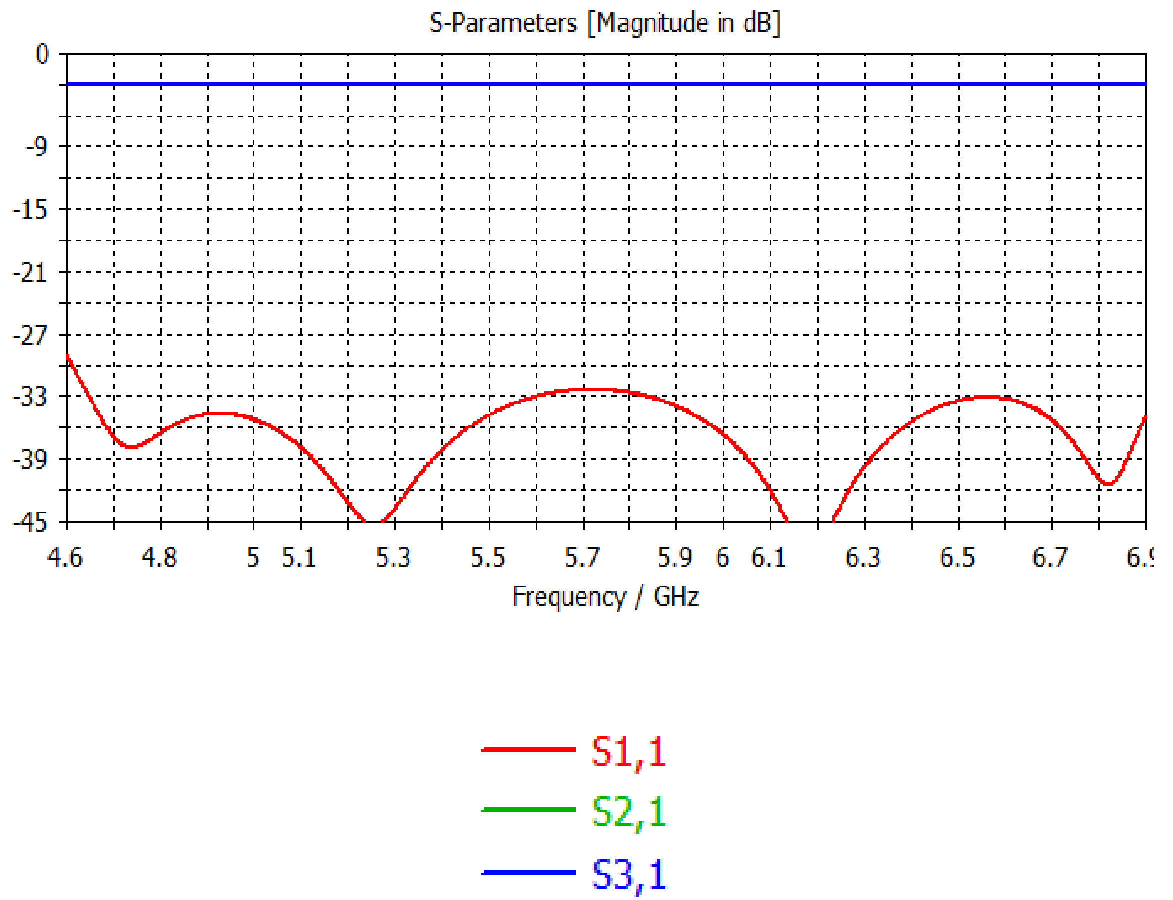
DESIGN AND OPTIMIZATION OF HYBRID 90-DEGREE. FINAL RESULTS



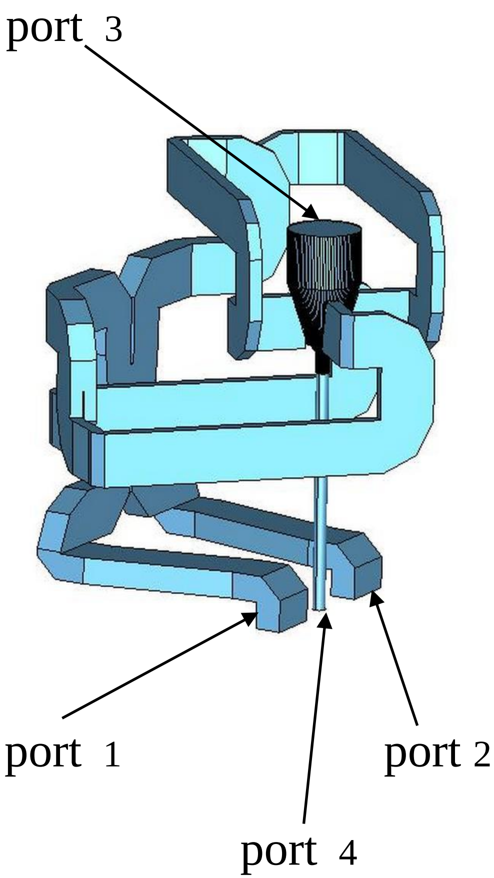


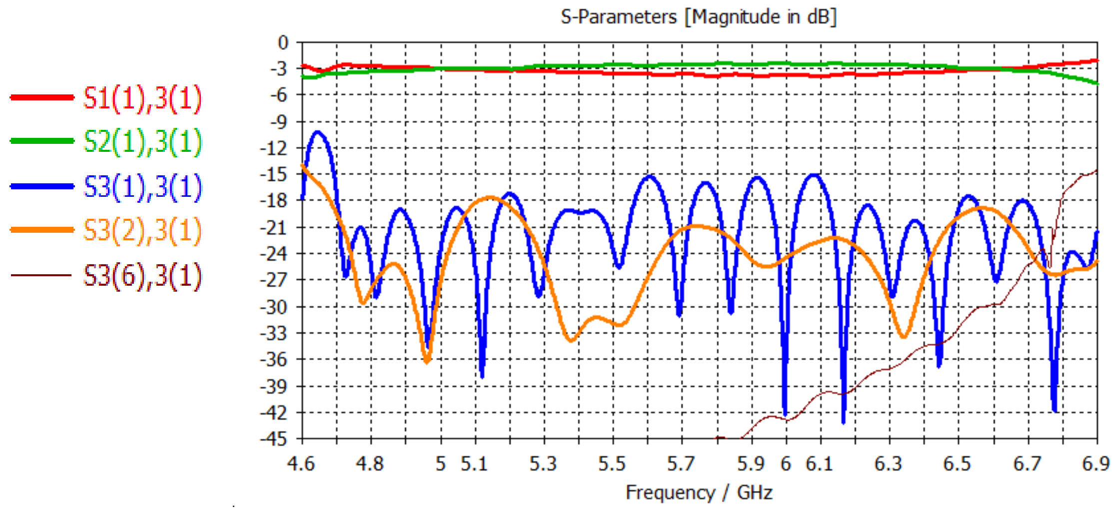
DESIGN AND OPTIMIZATION OF THE T-COMBINER IN *H*-PLANE. FINAL RESULTS

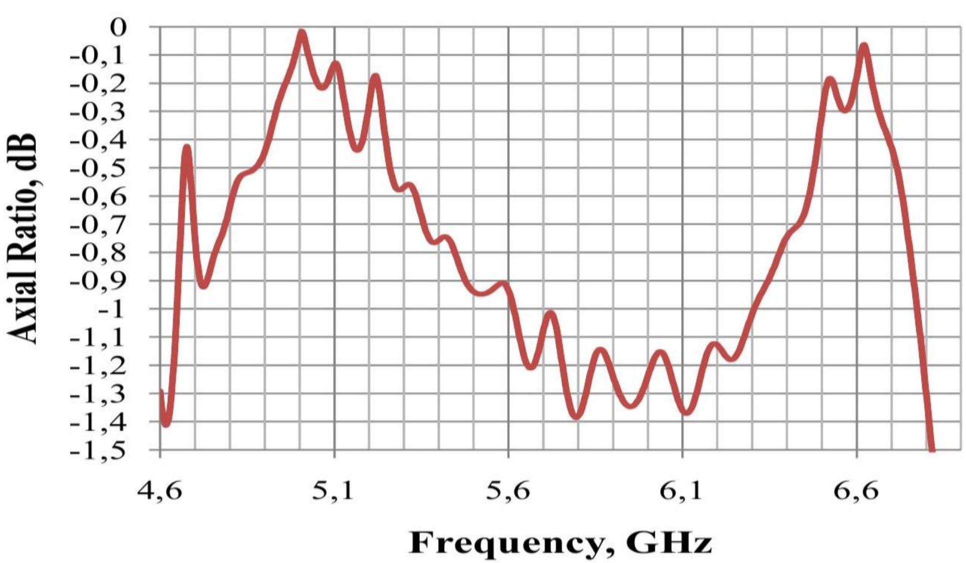




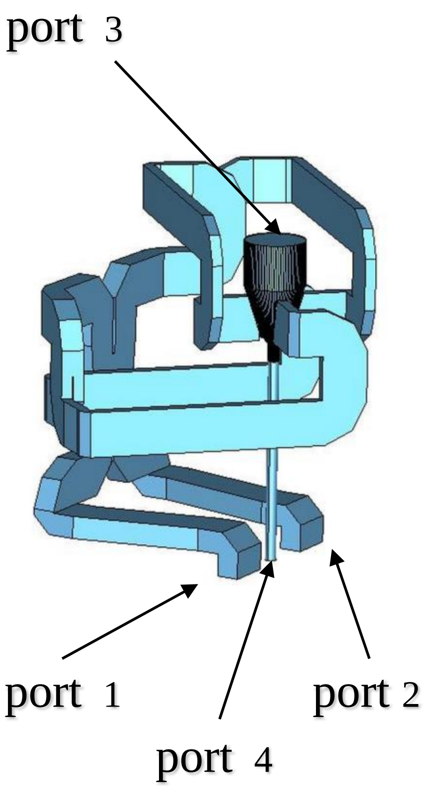
Waveguide divider-combiner characteristics in C-band



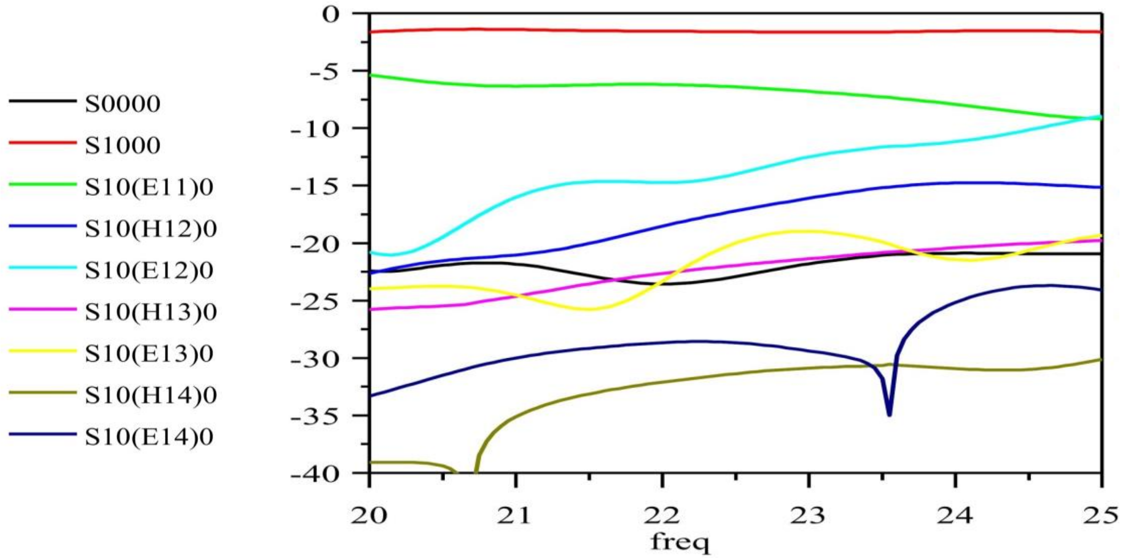


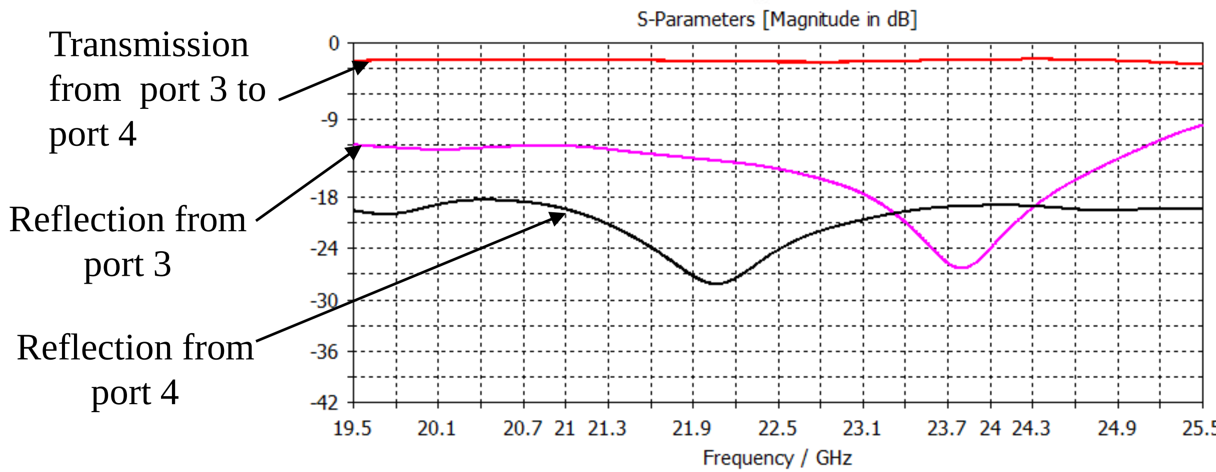


Waveguide divider-combiner characteristics in K-band



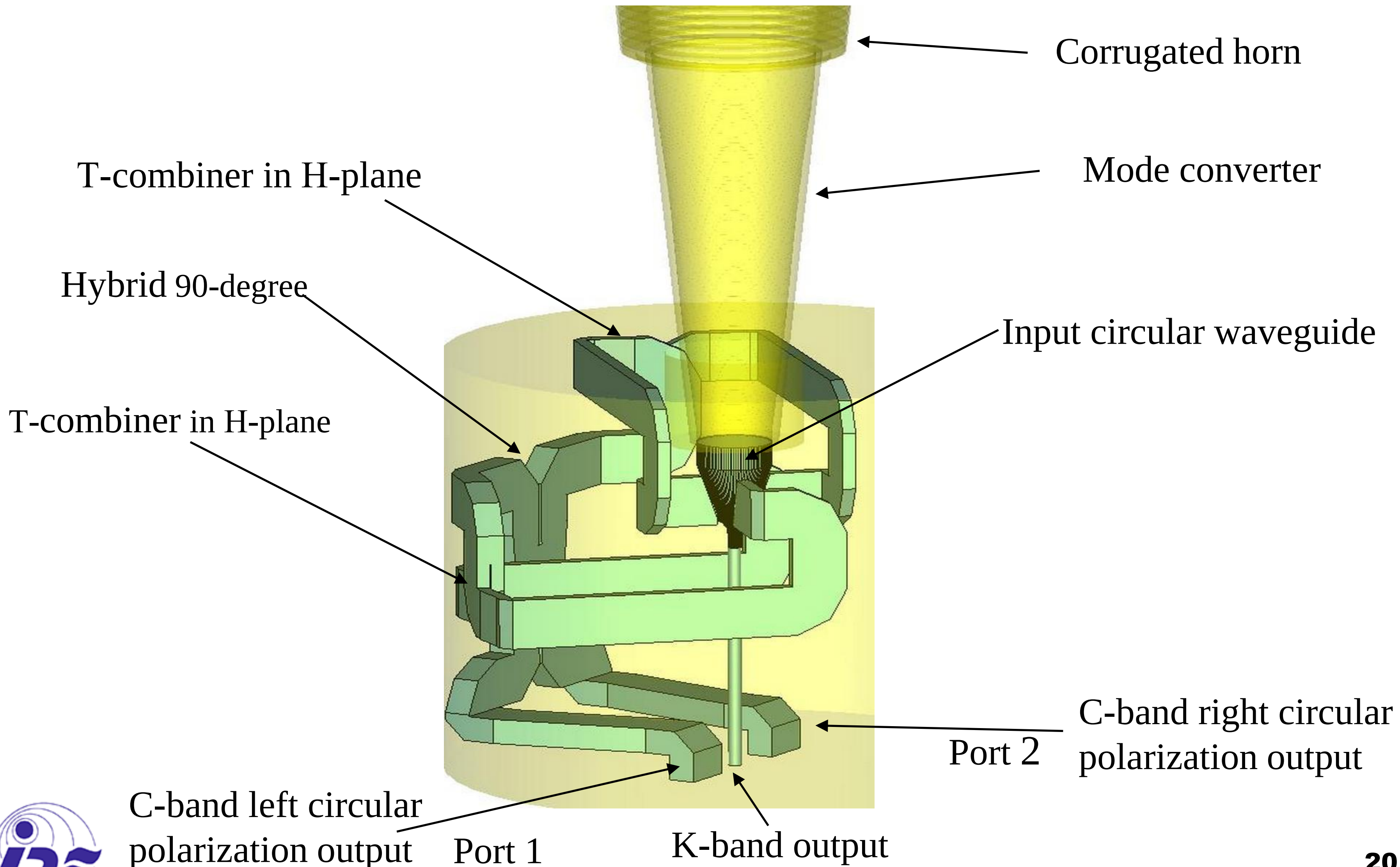
calculated by the mode matching method





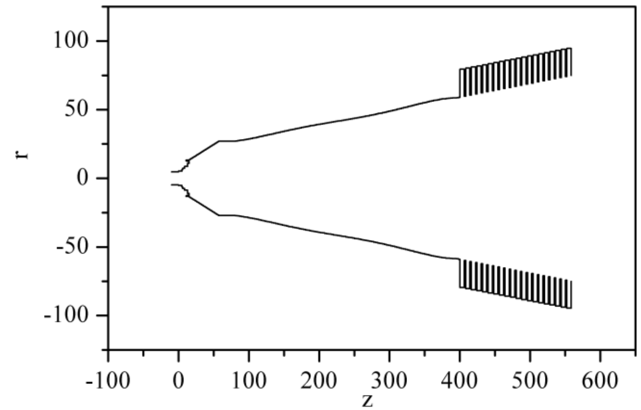
calculated by the program CST

Waveguide divider-combiner connected to corrugated horn



Design and optimization of the shape of the transition between divider-combiner output cone and corrugated horn was carried out by mode matching and of generalized scattering matrices method. Optimization was carried out according to the criterion of minimizing the reflection and the level of higher modes in the C- and K- bands.

Radius approximation by a polynomial of the fifth degree

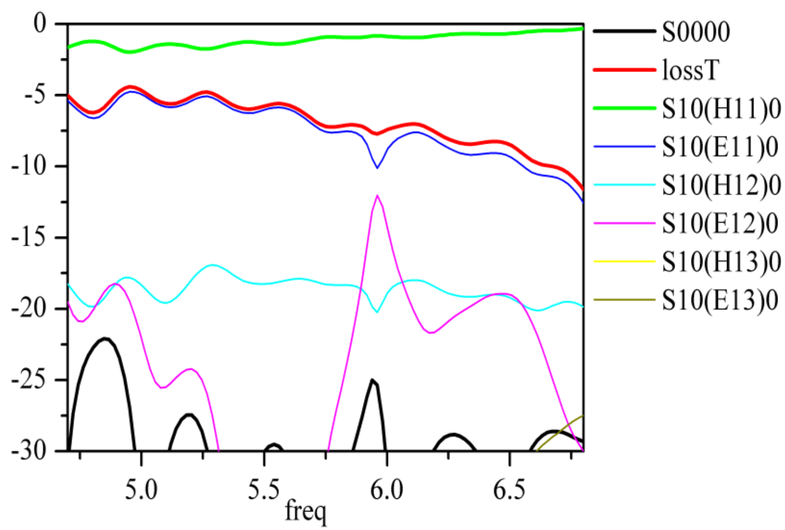


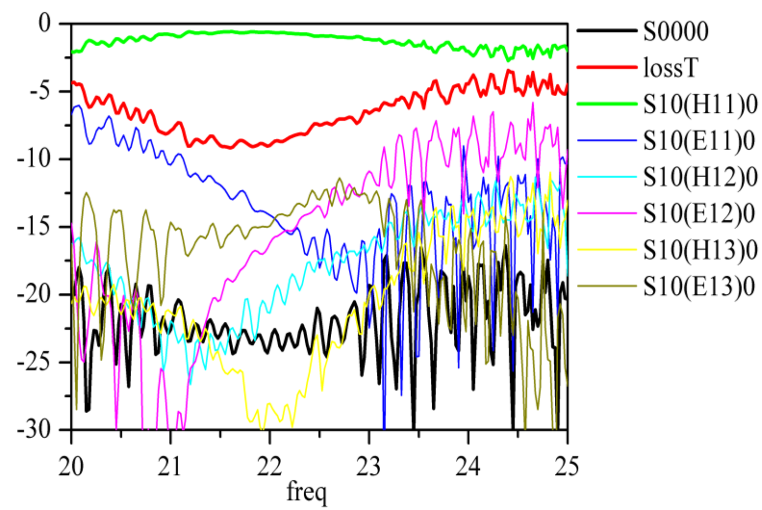
$a0$=27.0457871 $a2$=154.3225334 $a4$=602.7198203

$a1$=15.8997734 $a3$=-485.0374026 $a5$=-256.3813047

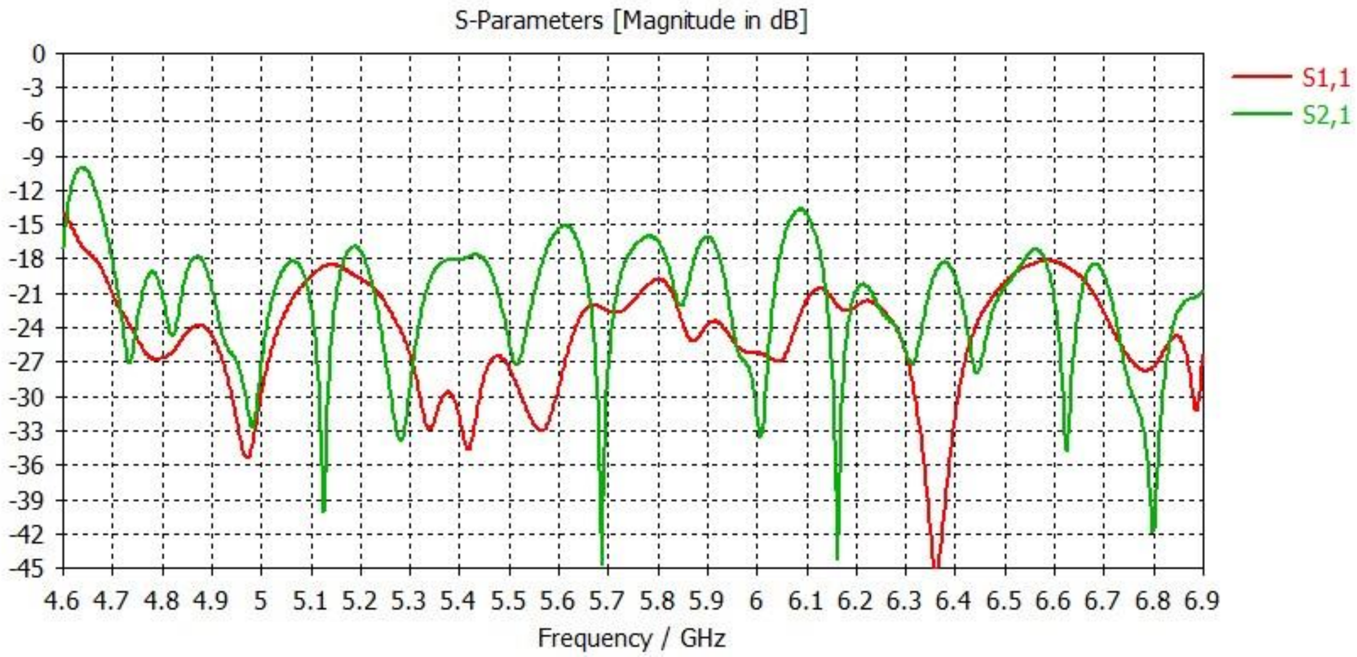
$$r_i = \sum_{n=0}^{5} a_n \left(\frac{i-1}{N-1}\right)^n =$$

$$= a_0 + \frac{i-1}{N-1}\left(a_1 + \frac{i-1}{N-1}\left(a_2 + \frac{i-1}{N-1}\left(a_3 + \frac{i-1}{N-1}\left(a_4 + a_5\frac{i-1}{N-1}\right)\right)\right)\right), \quad i = 1, 2, \ldots, N,$$

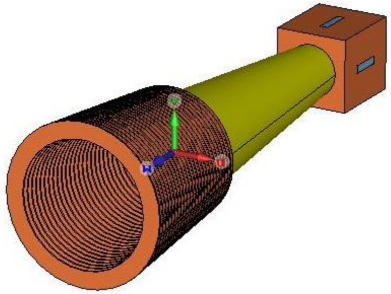


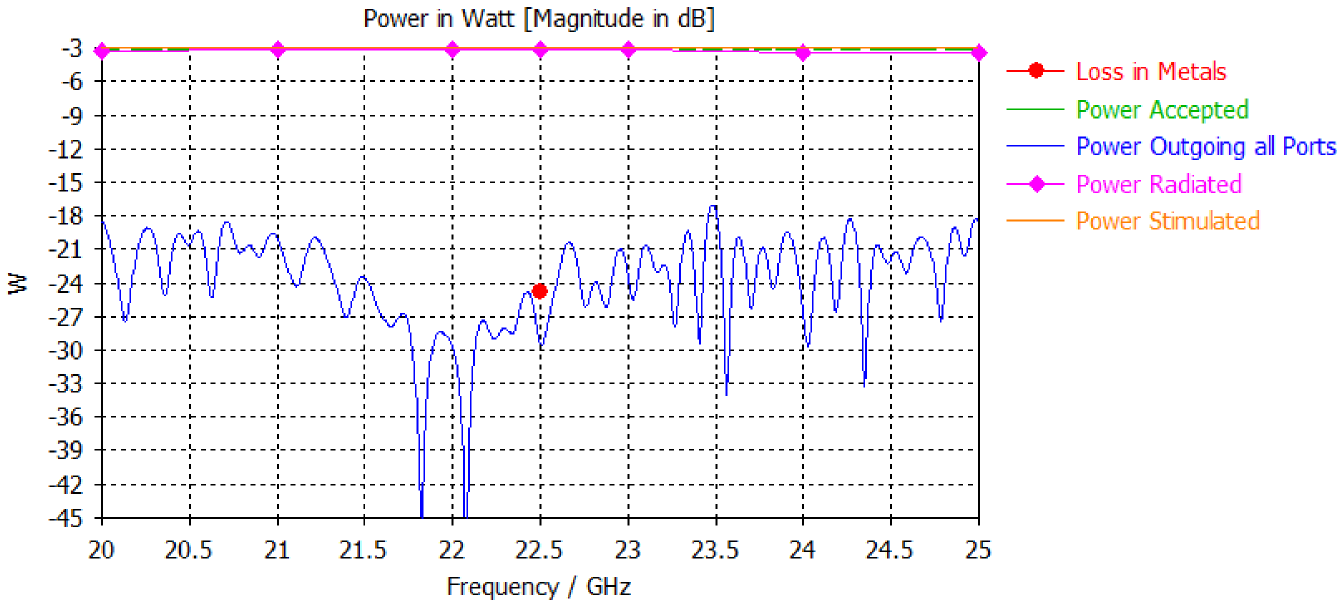


Characteristics of waveguide divider-combiner connected to corrugated horn, 25 grooves taken into account

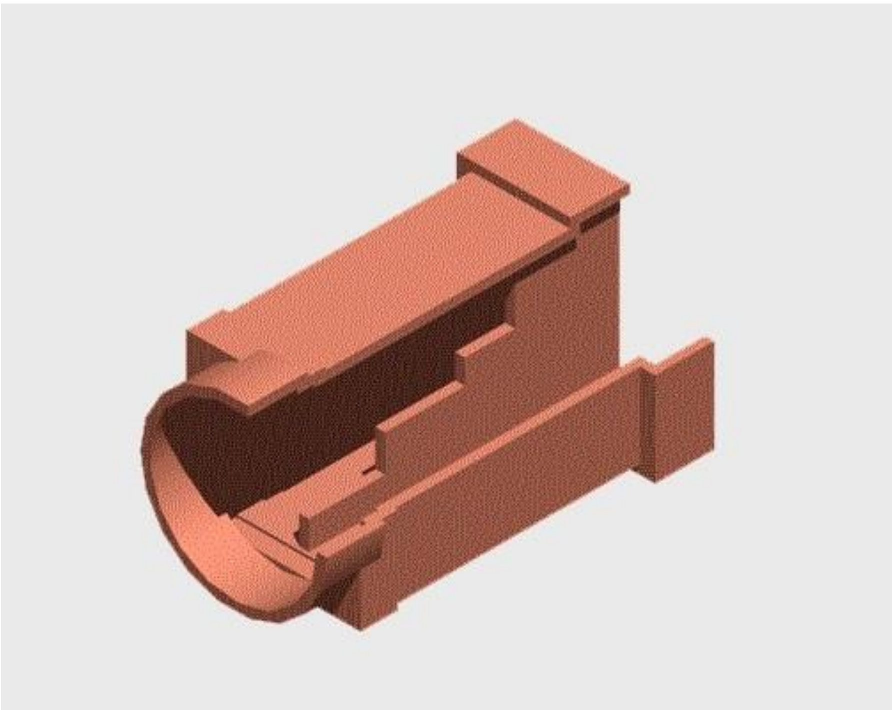


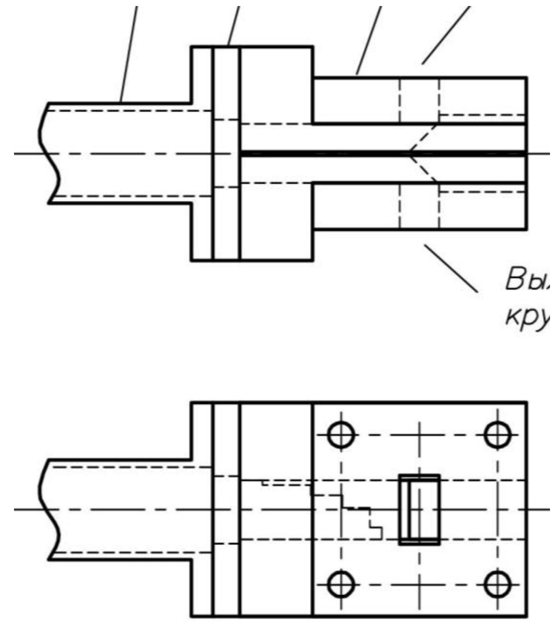
Model of waveguide turnstile connected to corrugated horn

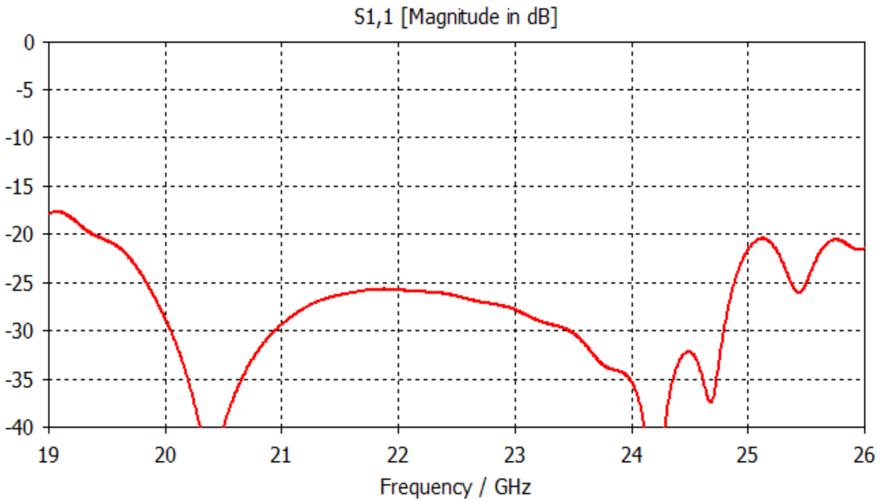


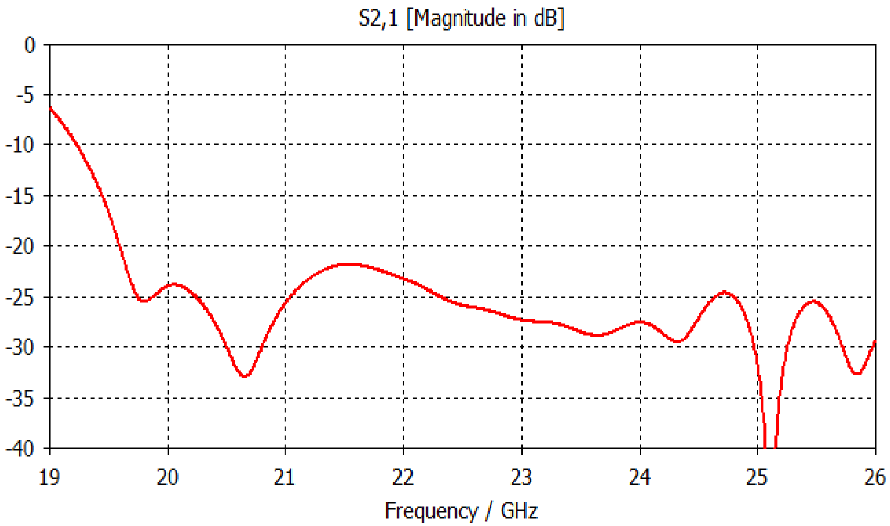


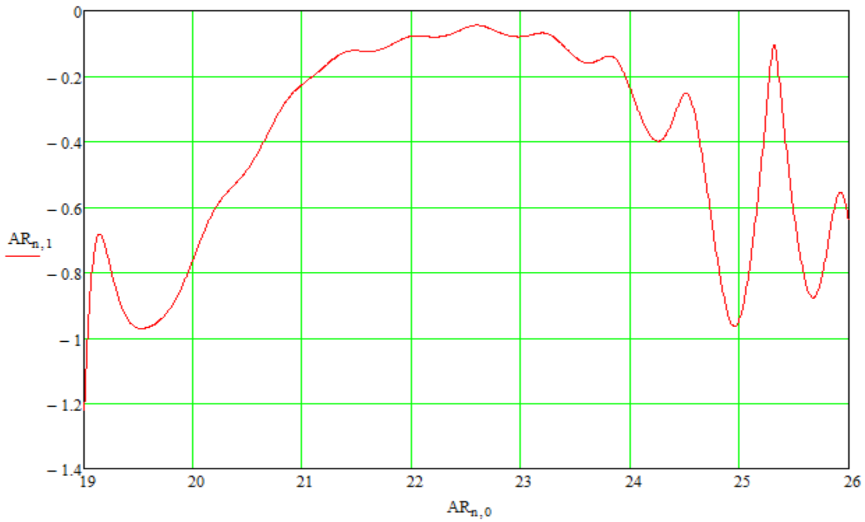
Septum-polarizer K-band (20 – 25 GHz) design



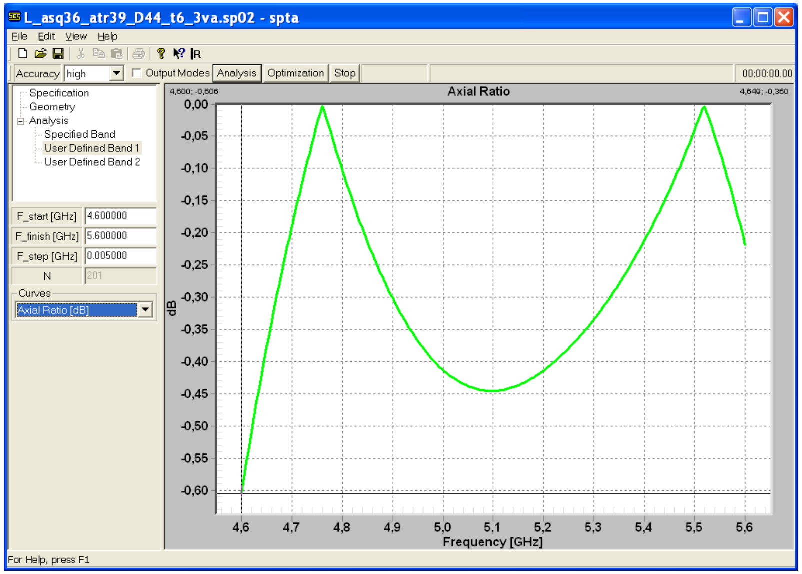


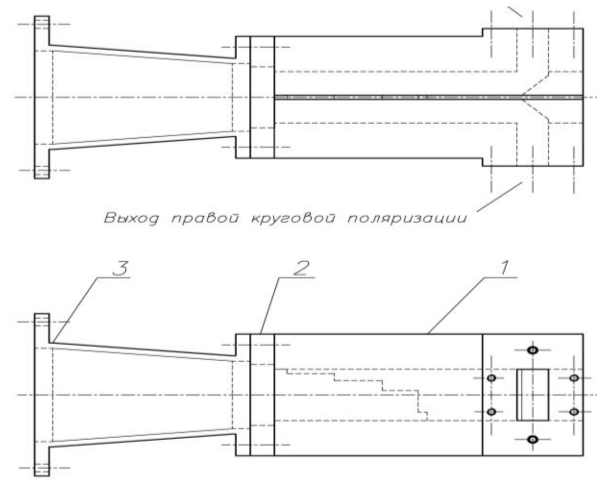

S1,1 [Magnitude in dB]
0
-5
-10
-15
-20
-25
-30
-35
-40
19
20
21
22
23
24
25
26
Frequency / GHz

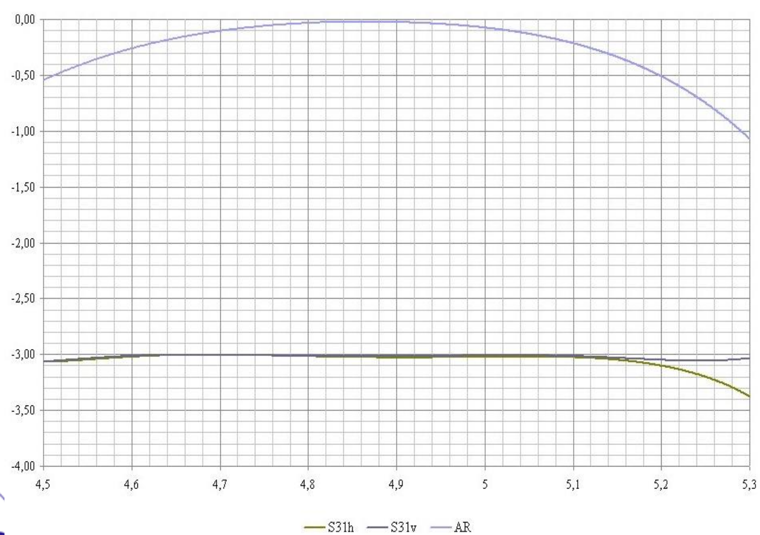

S2,1 [Magnitude in dB]
0
-5
-10
-15
-20
-25
-30
-35
-40
19
20
21
22
23
24
25
26
Frequency / GHz

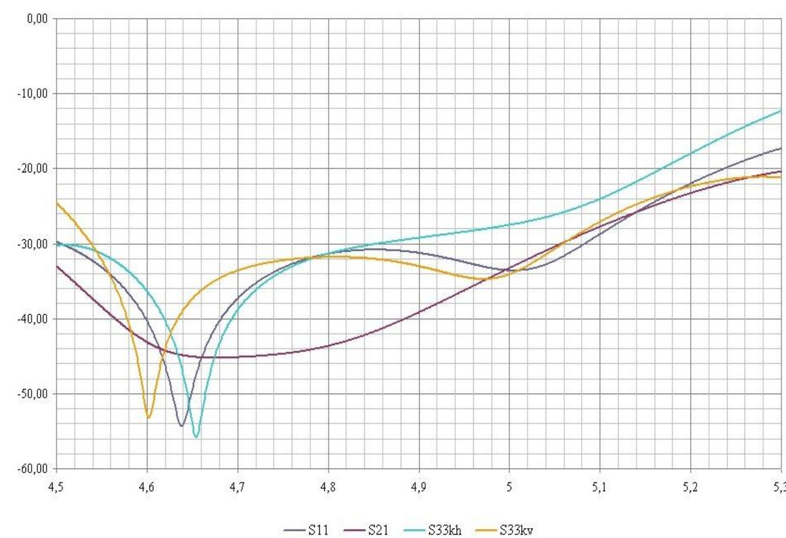

0
− 0.2
− 0.4
− 0.6
− 0.8
− 1
− 1.2
− 1.4
$AR_{n,1}$
19
20
21
22
23
24
25
26
$AR_{n,0}$

Septum-polarizer C-band (4,6 – 5,1 GHz) experimental receiving system design









THANKS FOR YOUR ATTENTION