





### 3. Simulation and Results

To validate the concept of describing the target by the co-null state set in a resonance mode context, a numerical example using a 2D wire model of aircraft is implemented. The modeled aircraft and the simulation values are depicted in Figure 1 and Table I, respectively. The simulated backscattered frequency-domain data were generated by method of moments algorithm (MoM) using FEKO [19]. The resultant backscattered was filtered by a Gaussian window to create the effect of a Gaussian shaped impulse and then the frequency data were transformed to the time-domain by Fourier transform.

Table I: Simulation values

parameter	Value
start Frequency	1.9 MHz
stop Frequency	1 GHz
number of frequency Points	512
excitation source voltage	1V
incidence direction	along u3-axis (normal)
wire radius	0.33cm
number of segments	83
SEM modal order	4
late-time on-set	10ns

Applying the MPOF to the FFT time response, four resonances are found approximately at the following frequencies: 150.4, 294.9, 441.5 and 519.5 MHz. Figure 2 shows that using the MoM, these resonances are found to correspond to mainly to sections of the mid, the nose-wings, the wings and the tails, respectively. The corresponding complex residues are depicted in Table II. Inserting the complex residues into (4) for each mode and then inserting each respective  $K_c$  into (7) and applying (9) and then solving, the co-pol null state set  $cn_1$  and  $cn_2$  at each mode is derived and listed in Table III. The co-pol null set at each resonance indicates that the target has different null set, and subsequently, different physical attributes. At the first resonance, the geometry is forecasted to be highly long (as  $|g_{cn1} \bullet g_{cn2}| = 1$ ) and tilted about  $45^\circ$  (as  $\frac{1}{2} \arctan(g_2/g_1) = 45^\circ$ ); and thus corresponding mainly to the mid section. As for the second to the fourth, they have similar co-null sets with dihedral property as  $|g_{cn1} \bullet g_{cn2}| \neq 1$ , forecasting a wing or a tail structure. However, all modes indicate that the target composite is symmetrical and  $45^\circ$  tilted. These physical attributes of the co-null at the dominant modes totally agree with what is a priori known about the target's shape.

Table II: The Scattering coefficients in terms of the Complex residues.

Mode order	$c_{11}$	$c_{12}$	$c_{22}$
1 <sup>st</sup>	0.49-0.13j	0.37-0.38j	-0.49+0.13j
2 <sup>nd</sup>	0.92+0.73j	0.28+0.11j	-0.92-0.73j
3 <sup>rd</sup>	-1.44+3.64j	0.64+0.03j	1.44-3.64j
4 <sup>th</sup>	-0.97-2.23j	-0.65+0.15j	-0.97-2.23j

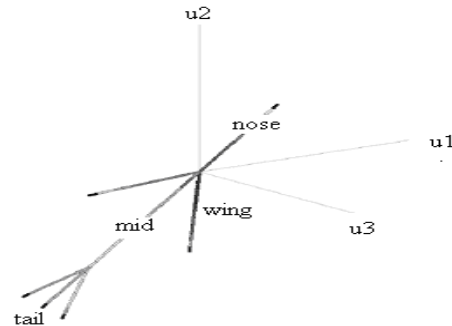
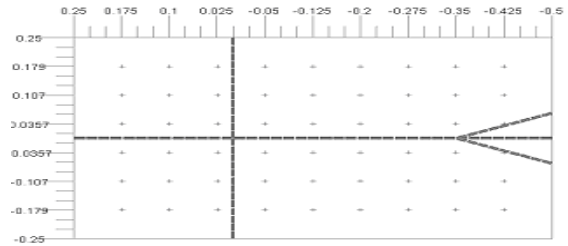


Figure 1: (Top inset) The geometries (in cm) of the aircraft model. The aircraft coordinates oriented by  $45^\circ$  about the  $u_1$ -axis, with the wings having dihedral angles of  $45^\circ$  each

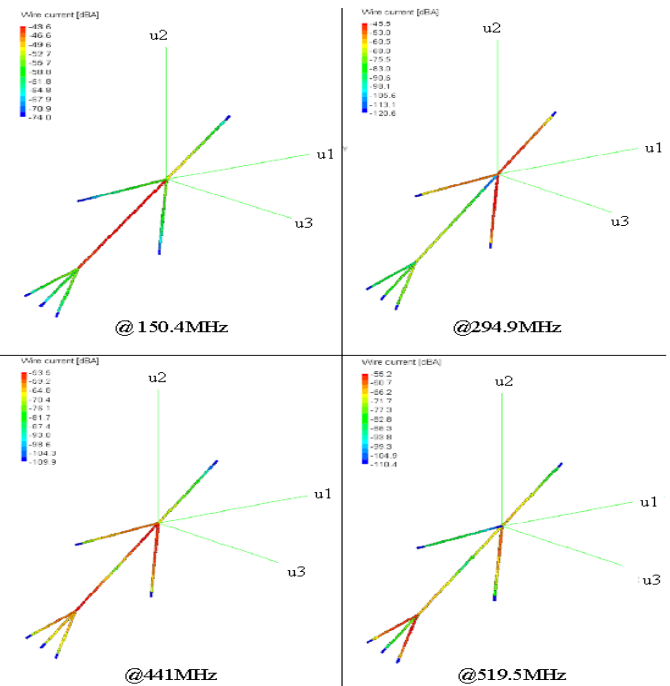


Figure 2: The current distribution for different resonant frequencies. In general, the dominant modes are related to a part of the model structure

Table III: The Co-null CPS reflects the target composite.

Mode order	CPS	$g_1$	$g_2$	$g_3$	Elongation $ g_{cn1} \bullet g_{cn2} $	Symmetry $\frac{1}{2} \arcsin(g_3)$	Tilt $\frac{1}{2} \arctan(g_2/g_1)$
1	$cn_1$	0	-1	0	1	0	45
	$cn_2$	0	-1	0			
2	$cn_1$	0	-0.26	0.97	0.87	0	45
	$cn_2$	0	-0.26	-0.97			
3	$cn_1$	0	-0.16	0.98	0.93	0	45
	$cn_2$	0	-0.16	-0.98			
4	$cn_1$	0	-0.27	0.96	0.88	0	45
	$cn_2$	0	-0.27	-0.96			

