SARMV3D-Imaging-3.0 Manual

SAR microwave vision three-dimensional imaging dataset 3.0 (SARMV3D-Imaging-3.0) contains three subsets: 1) Small UAV-borne full-polarization array-InSAR data subset; 2) Electromagnetic scattering data subset for typical scattering mechanisms; 3) Airborne array-InSAR data subset for typical targets.

[1] QIU Xiaolan, LUO Yitong, CHENG Yao, LIN Bei, YANG Hong, SAR Microwave Vision 3D imaging Dataset 3.0[OL]. Journal of Radars, 2024. https://radars.ac.cn/web/data/getData?newsColumnId=2f2748db-10ef-4ad0-bcc4-f087ce59b6f8&pageType=en

[2] QIU Xiaolan, JIAO Zekun, YANG Zhenli, et al. Key technology and preliminary progress of microwave vision 3D SAR experimental system[J]. Journal of Radars, 2022, 11(1): 1–19. doi: 10.12000/JR22027

[3] QIU Xiaolan, JIAO Zekun, PENG Lingxiao, et al. SARMV3D-1.0: Synthetic Aperture Radar Microwave Vision 3D Imaging Dataset[J]. Journal of Radars, 2021, 10(4): 485–498. doi: 10.12000/JR21112

1. Small UAV-borne Full-polarization Array-InSAR Data Subset

This subset contains the full-polarization array-InSAR data obtained by the MV3DSAR system in a certain area of Suzhou. This subset also provides optical oblique photography data and laser point cloud data for this area.

- The full-polarization array-InSAR data contains 8 sets of data taken from

different directions. The data captured in each azimuthal direction contains the single complex image data (.SLC), auxiliary file (.dat), and amplitude image (.tif) of the 4 interference channels under the 4 polarization channels. The relevant information is shown in Table 1 below.

Table 1 File details for each orientation (ID0_side1 orientation as an example)

File Name	Format	Description
AUX_0_022401_HH_R1 AUX_0_022401_HH_R2 AUX_0_022401_HH_R3 AUX_0_022401_HH_R4	dat	The auxiliary file of the 1-4 channels in the HH polarization;
AUX_0_022401_HV_R1 AUX_0_022401_HV_R2 AUX_0_022401_HV_R3 AUX_0_022401_HV_R4	dat	The auxiliary file of the 1-4 channels in the HV polarization;
AUX_0_022401_VH_R1 AUX_0_022401_VH_R2 AUX_0_022401_VH_R3 AUX_0_022401_VH_R4	dat	The auxiliary file of the 1-4 channels in the VH polarization;
AUX_0_022401_VV_R1 AUX_0_022401_VV_R2 AUX_0_022401_VV_R3 AUX_0_022401_VV_R4	dat	The auxiliary file of the 1-4 channels in the VV polarization;
SLC_0_022401_HH_R1 SLC_0_022401_HH_R2 SLC_0_022401_HH_R3 SLC_0_022401_HH_R4	slc	The single complex image of the 1-4 channels in the HH polarization;
SLC_0_022401_HV_R1 SLC_0_022401_HV_R2 SLC_0_022401_HV_R3 SLC_0_022401_HV_R4	slc	The single complex image of the 1-4 channels in the HV polarization;
SLC_0_022401_VH_R1 SLC_0_022401_VH_R2 SLC_0_022401_VH_R3 SLC_0_022401_VH_R4	slc	The single complex image of the 1-4 channels in the VH polarization;
SLC_0_022401_VV_R1 SLC_0_022401_VV_R2 SLC_0_022401_VV_R3 SLC_0_022401_VV_R4	slc	The single complex image of the 1-4 channels in the VV polarization;
IMAGE_0_022401_HH_R1 IMAGE_0_022401_HH_R2	tif	The amplitude image of the 1-4 channels in the HH polarization;

IMAGE_0_022401_HH_R3 IMAGE_0_022401_HH_R4		
IMAGE_0_022401_HV_R1 IMAGE_0_022401_HV_R2 IMAGE_0_022401_HV_R3 IMAGE_0_022401_HV_R4	tif	The amplitude image of the 1-4 channels in the HV polarization;
IMAGE_0_022401_VH_R1 IMAGE_0_022401_VH_R2 IMAGE_0_022401_VH_R3 IMAGE_0_022401_VH_R4	tif	The amplitude image of the 1-4 channels in the VH polarization;
IMAGE_0_022401_VV_R1 IMAGE_0_022401_VV_R2 IMAGE_0_022401_VV_R3 IMAGE_0_022401_VV_R4	tif	The amplitude image of the 1-4 channels in the VV polarization;

The radar parameters required for 3D imaging are stored in the auxiliary file (dat file), as shown in the following table. We also give code to read them: the 'read_AUX.m' file can be used to read a 'dat' file. The 'slc_read_float.m' file can be used to read a 'slc' file.

Table 2 The Output Parameter of the 'read_AUX' Function

Parameter Name	Meaning	Unit	Note
height	Height of the image	m	
width	Width of the image	m	
Rmin	Near range	m	
Rbin	Interval in slant range	m	The slant range of x pixel: R = Rmin + x*Rbin
Abin	Interval in azimuth	m	
fdc	Doppler central frequency	Hz	
v	Flight speed	m/s	Uniform linear motion is assumed
lambda	Radar wavelength	m	
squintAngle	Squint angle	rad	
ta_ref	Azimuth time	s	
lat_ref	Flight track in latitude	degree	Ideal flight track in geographic

lng_ref	Flight track in longitude	degree	coordinates
alt_ref	Flight track in altitude	m	
x_ref	Flight track in x direction	m	Ideal flight track in body coordinate system (x direction parallel to flight direction)
y_ref	Flight track in y direction	m	
z_ref	Flight track in z direction	m	

Table 3 shows some parameters of the MV3DSAR system.

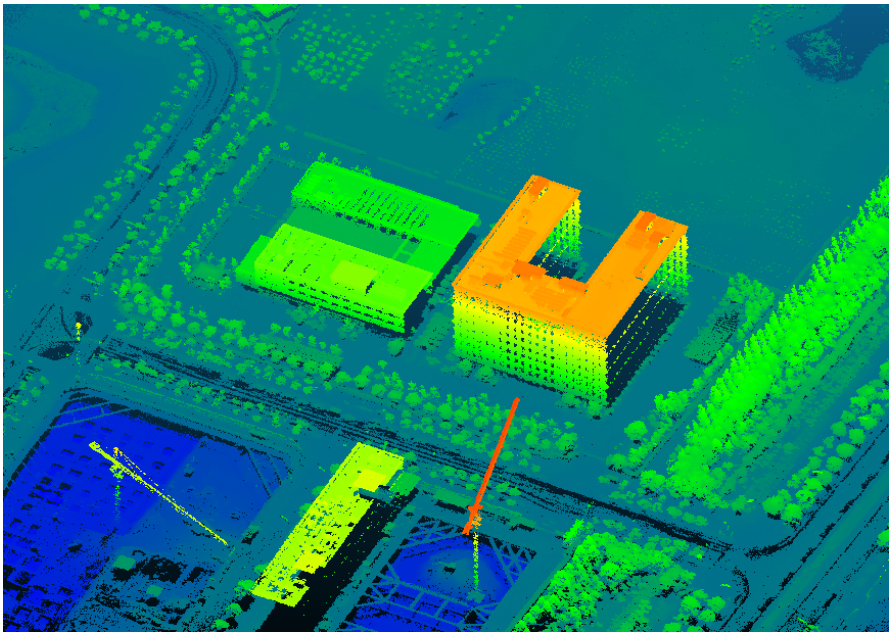
Table 3 Some Parameters of The MV3DSAR

No.	Parameter Name	Value
1	Center frequency	15.2 GHz
2	Signal form	FMCW
3	Polarization mode	HH
4	Signal bandwidth	1200MHz
5	Antenna size (single channel)	0.05m (pitch) × 0.32m (yaw)
6	Number of array interference channels	4
7	Resolution	better than 0.2m * 0.2m
8	Central viewing angle	45°

This subset also provides the initial SAR 3D point cloud (in the 'Suzhou_SAR_PointCloud' folder) as a reference result, which is rendered in pseudo-color based on Pauli-decomposition.

- Optical oblique photography data is stored in ‘osgb’ format and can be opened in commercial software such as OSGB Lab.

- Laser point cloud data is stored in ‘ply’ and ‘las’ format; ‘ply’ format data can be opened in commercial software such as CloudCompare; The data in ‘las’ format is geocoded and can be opened in commercial software such as GlobalMapper.



2. Electromagnetic Scattering Data Subset for Typical Scattering Mechanisms

This subset contains SAR data of different electromagnetic scatterers, including dihedral Angle, cylinder, sphere, paraboloid, etc., obtained by the full-polarization MV3DSAR system. The UAV flight track and scatterer placement area of the data are shown in the figure below. **The data is in the same format as subset 1.**

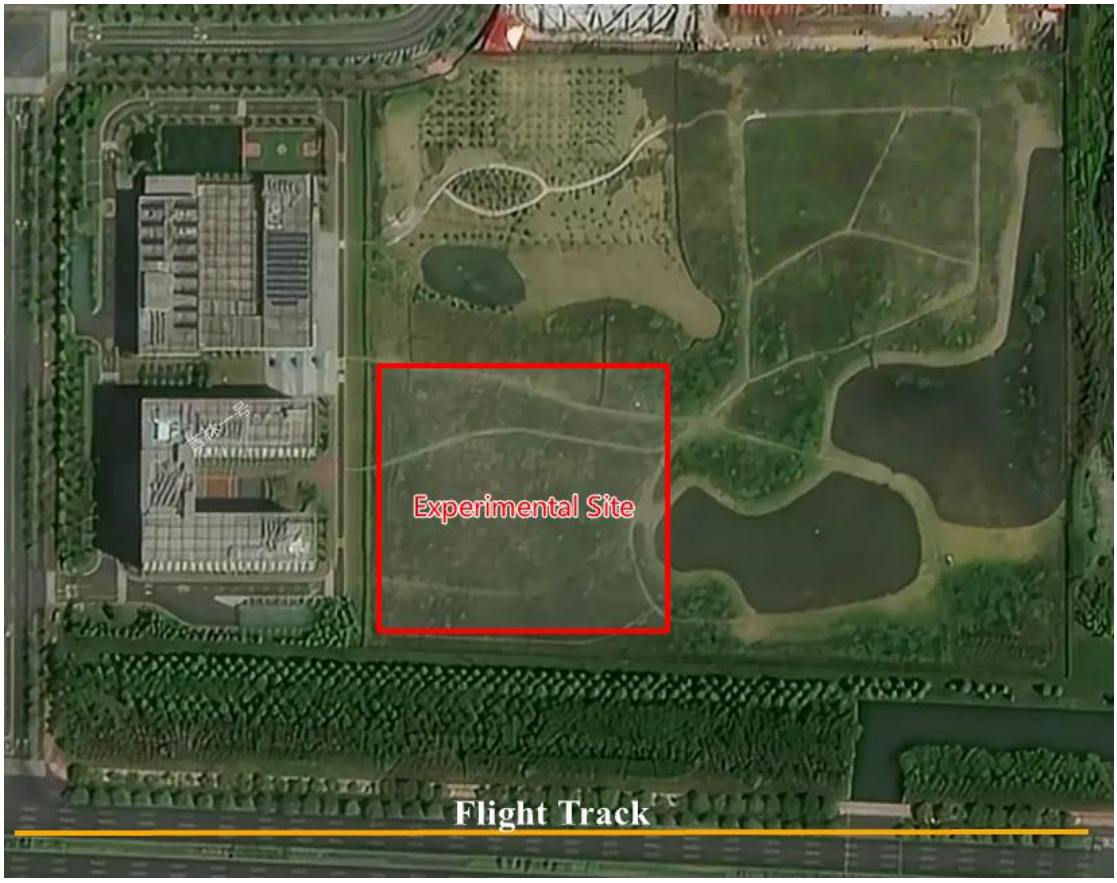


Figure 1 The Flight Track and Experiment Site

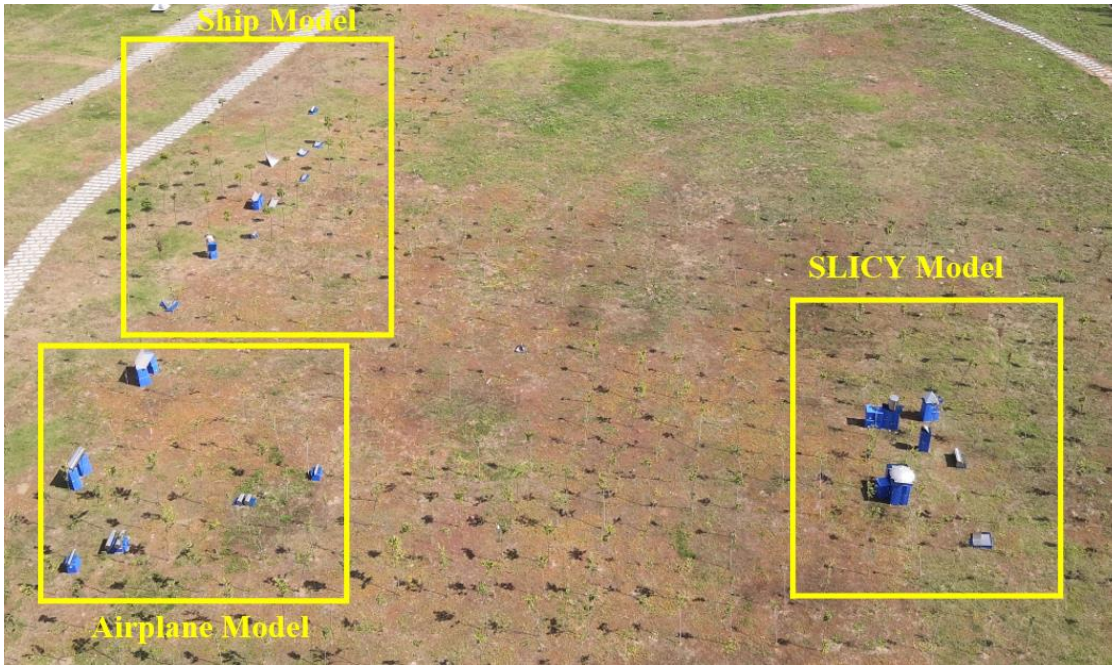


Figure 2 Placement of Scatterers

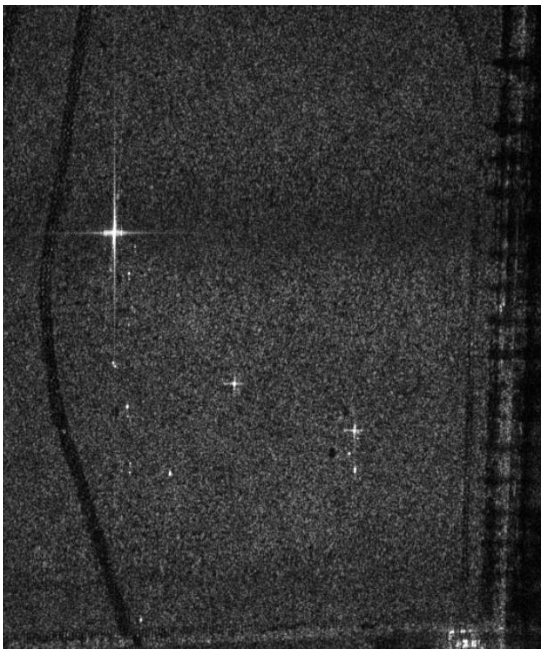


Figure 3 Scatterers in SAR images

The above experiment site has three models, namely SLICY modified model, airplane model and ship model. The detailed information for each model are described below.

- SLICY Modified Model

  The following diagram shows the position of each component of the SLICY model. According to the coordinate system shown in the diagram, the size,

position and orientation information of each component are shown in the following table. The coverage area of this model is about 30m×20m.

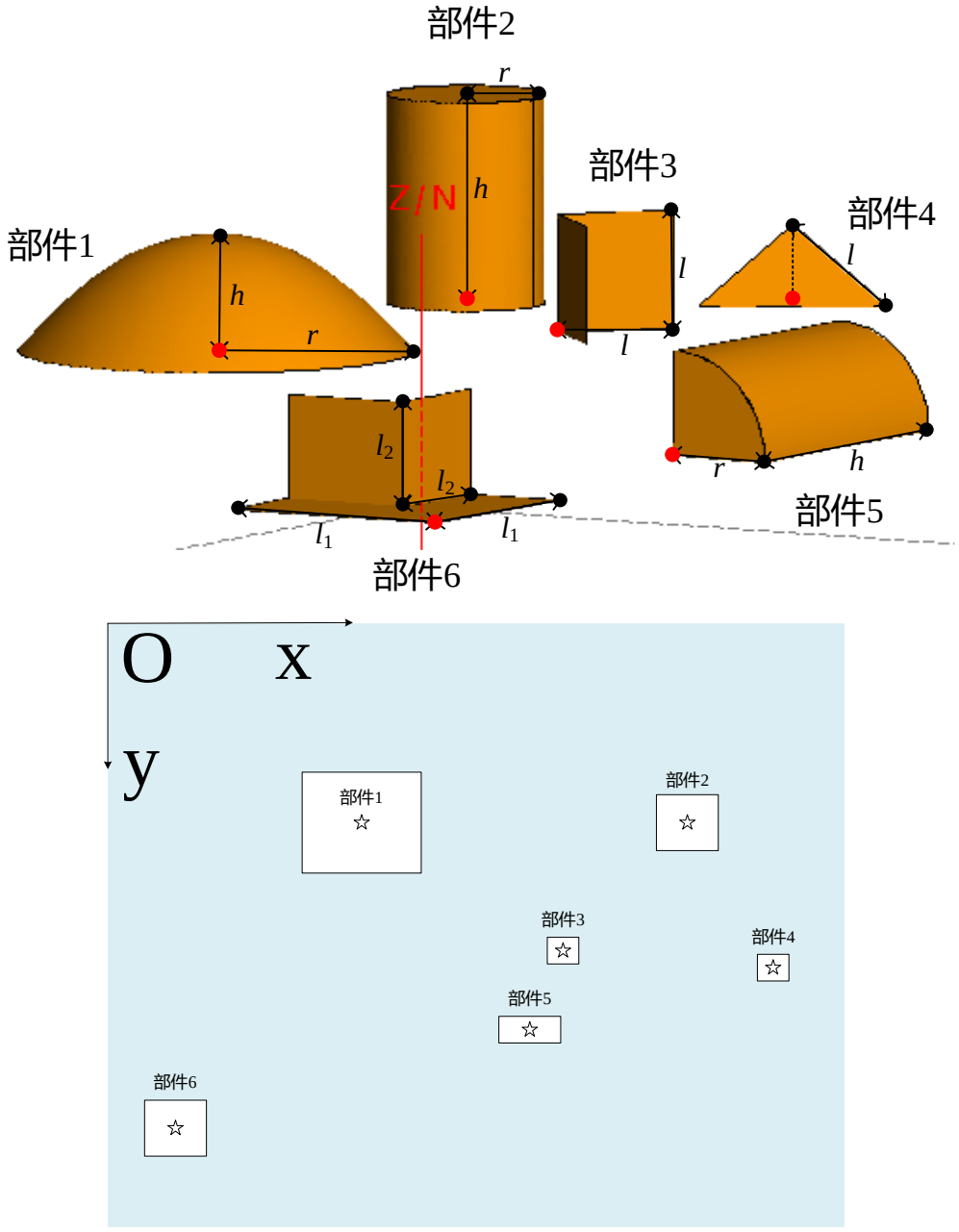


Figure 4 The Location of Each Component

Table 4 The Size and Coordinate Position of Each Component

Name	Size (*m*)	Position		
		X (*m*)	Y (*m*)	Z (*m*)
Component 1	*h*: 0.35 *r*: 0.60	13.18	10	1.20
Component 2	*h*: 0.64 *r*: 0.24	18.28	10	1.20

Component 3	l：0.40	16.33	12.10	1.20
Component 4	l：0.40	19.33	12.40	1.20
Component 5	h：1.00 r：0.40	15.73	13.60	0
Component 6	l_1：0.80 l_2：0.40	10	14.56	0

- Airplane Model

  The following diagram shows the position of each component of the airplane model. According to the coordinate system shown in the diagram, the size, position and orientation information of each component are shown in the following table. The coverage area of this model is about 30m×20m.

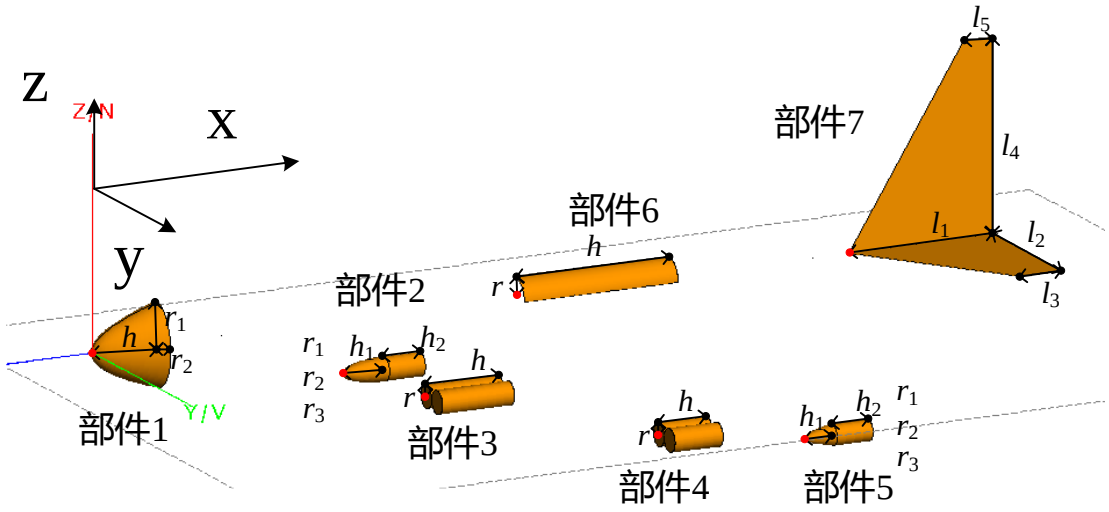


Figure 5 The Location of Each Component

Table 5 The Size and Coordinate Position of Each Component

Name	Size（m）	Position		
		X（m）	Y（m）	Z（m）
Component 1	h：0.85 r_1：0.50 r_2：0.35	0	0	1.10
Component 2	r_1：0.53 r_2：0.14 r_3：0.14 h_1：0.50 h_2：0.50	5.26	2．88	0.60

Component 3	r：0.14 h：1.00	6.50	4.38	0.30
Component 4	r：0.14 h：0.60	10.40	8.78	0
Component 5	r_1：0.53 r_2：0.14 r_3：0.14 h_1：0.35 h_2：0.50	12.76	11.66	0.34
Component 6	r：0.25 h：1.50	11	0	1.10
Component 7	l_1：1.50 l_2：1.40 l_3：0.60 l_4：1.50 l_5：0.40	20.00	0	1.10

- Ship Model

The following diagram shows the position of each component of the ship model. According to the coordinate system shown in the diagram, the size, position and orientation information of each component are shown in the following table. The coverage area of this model is about 14m×3m.

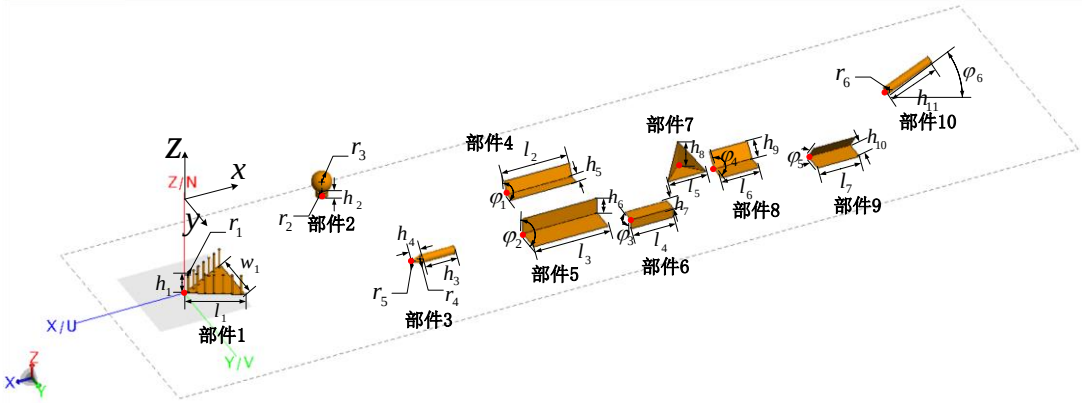


Figure 6 The Location of Each Component

Table 6 The Size and Coordinate Position of Each Component

Name	Size（m）	Position		
		X（m）	Y（m）	Z（m）
Component 1	h_1：0.35 r_1：0.02	0	0	0

	l_1: 1.00 w_1: 0.95			
Component 2	r_2: 0.1 r_3: 0.2 h_2: 0.1	2.64	0.24	1.10
Component 3	r_4: 0.07128 r_5: 0.02376 h_3: 0.60 h_4: 0.14844	3.73	0.94	0.10
Component 4	l_2: 1.20 h_5: 0.25 φ_1: 120°	5.64	0.53	0.60
Component 5	l_3: 1.36 h_6: 0.30 φ_2: 90°	5.76	0.90	0
Component 6	l_4: 0.77 h_7: 0.18 φ_3: 90°	7.54	1.30	0
Component 7	l_5: 0.71 h_8: 0.48	8.91	0.24	0
Component 8	l_6: 0.70 h_9: 0.28 φ_4: 130°	9.40	0.60	0
Component 9	l_7: 0.77 h_{10}: 0.36 φ_5: 60°	10.10	0.95	0
Component 10	r_6: 0.07 h_{11}: 0.90 φ_5: 30°	12.86	0	0.1

3. Airborne Array-InSAR Data Subset for Typical Targets

This subset provides 14 channels of airborne array-InSAR data, which includes three typical targets: car (Car_Target_Area folder), ship (Ship_Target_Area folder), and oil tank (OilTank_Target_Area folder).

The folder for each type of target contains single complex images (.slc), auxiliary files (.dat), amplitude images (.tif), image cropping information (Param.txt), and the initial SAR three-dimensional point cloud (*_Target_PointCloud.ply) for 14 interference channels.

The radar parameters required for 3D imaging are stored in the auxiliary file (dat file). We also give code to read them: the 'ParaReadV2.m' file can be used to read a 'dat' file. The 'slc_read_float.m' file can be used to read a 'slc' file.

Some examples of SAR data for this subset are given below.

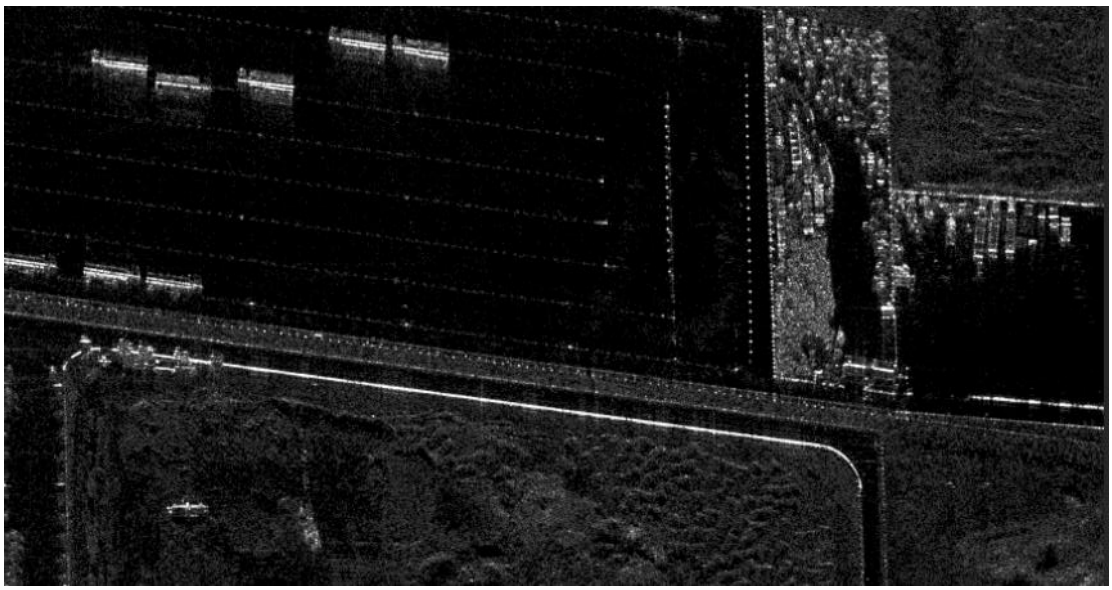


Figure 7 A SAR Image for Car Targets

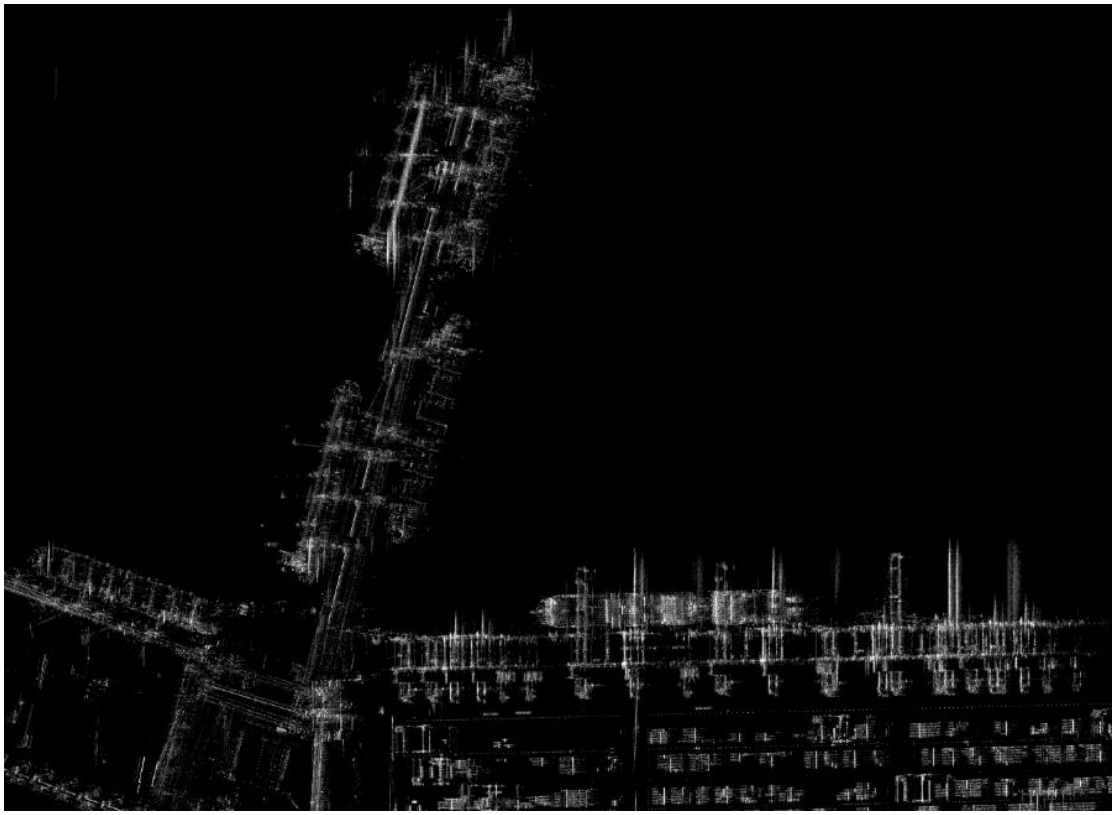


Figure 8 A SAR Image for Ship Targets

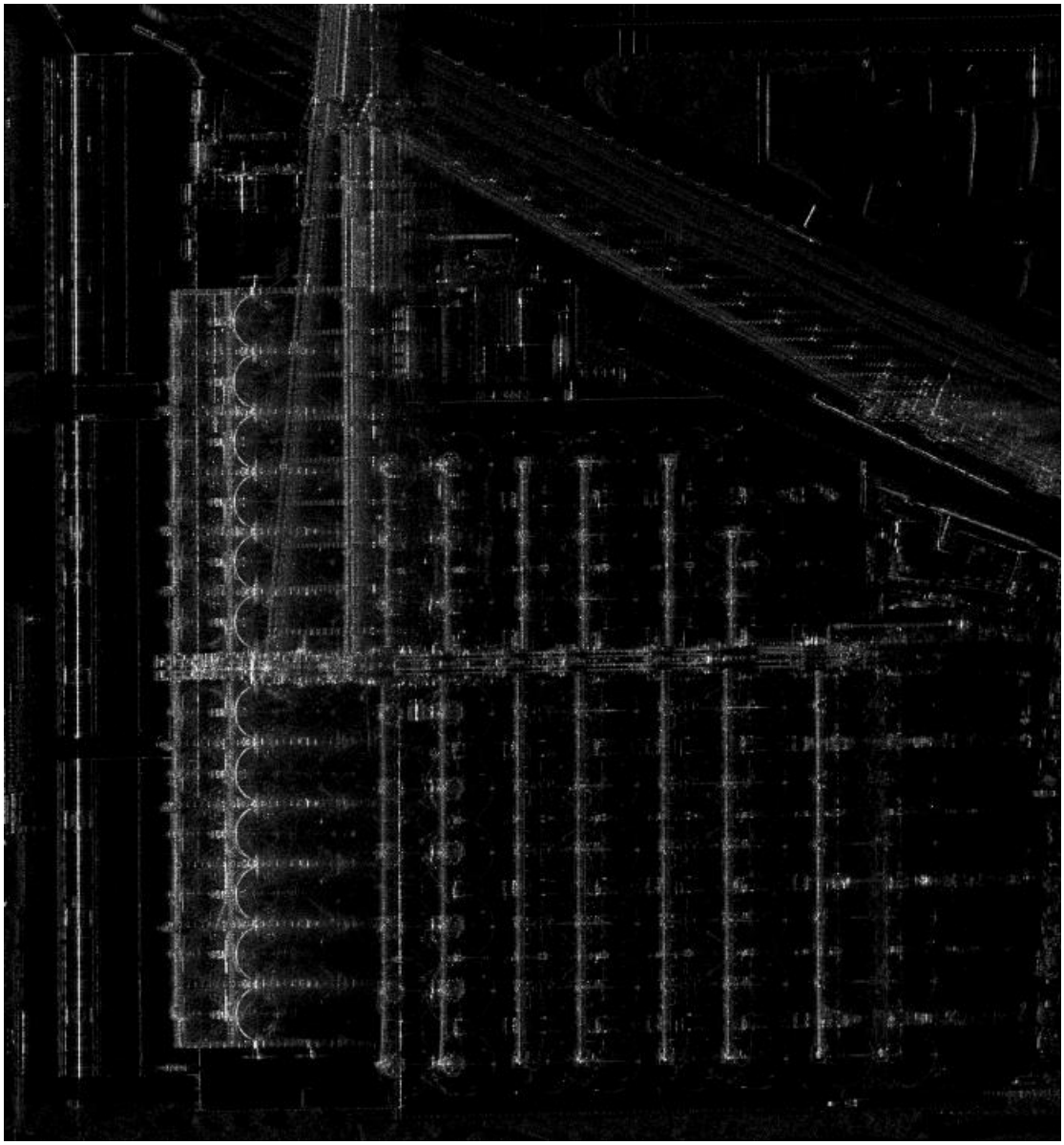


Figure 9 A SAR Image for Oil Tank Targets