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Understanding radar phenomenology of relocatable targets

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Remember Swynnerton (1/3)



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ZSU23-4



TLAR

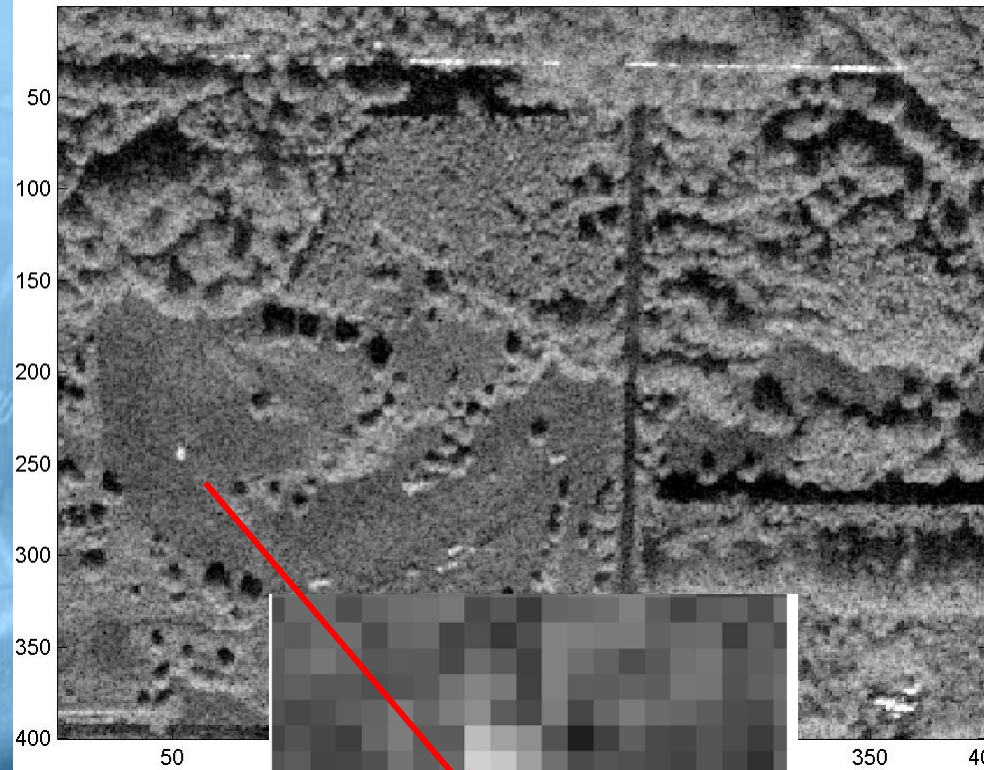


GECKO_SA8



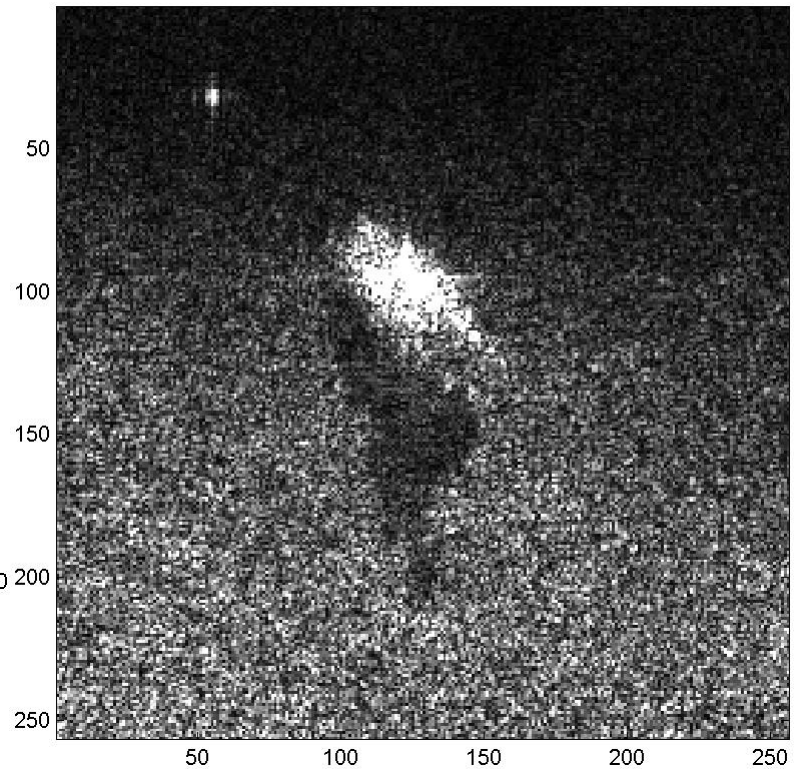
Remember Swynnerton(2/3) GECKO - SA8

Swynnerton - 1996 - Bande X - 1m resolution



Detection & Location

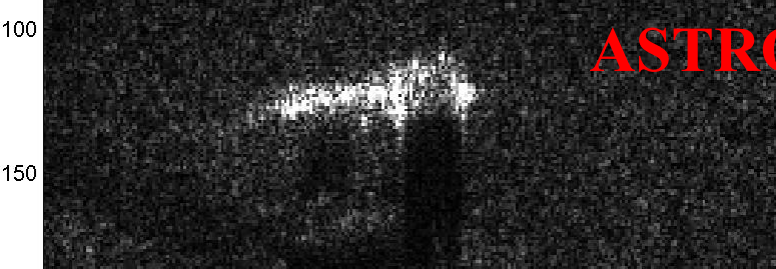
Swynnerton - Bande Ka - Between HR and THR



**Detection - Recognition ? - Identification ?
& Location**

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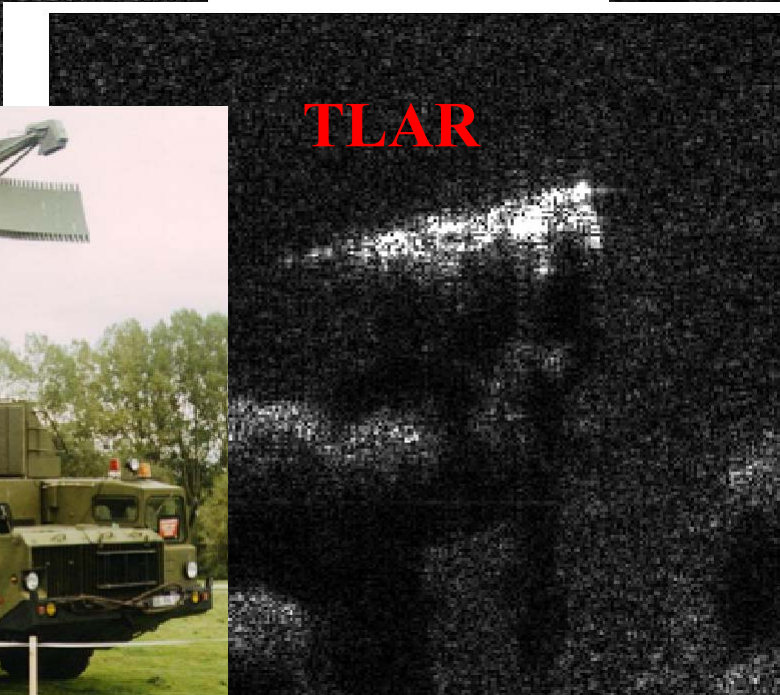
Remember Swynnerton (3/3)



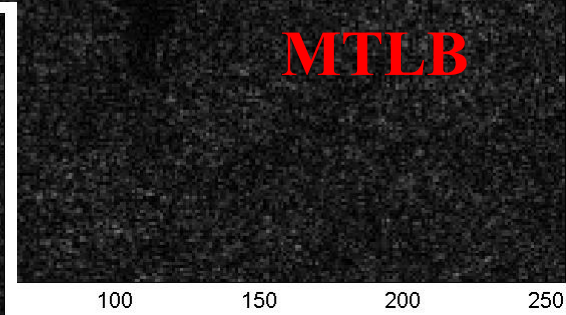
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**Ka waveform
between HR & THR**

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SAR Context

RAMSES Radar

Radar	P	L	S	X	Ku	Ka	W
Frequency (GHz)	0.43	1.3	3.2	9.5	14.3	35	95
Bandwidth (MHz)	75	200	300	1200	1200	1200	500

Better resolution for a higher quality SAR imager

But

What is the opinion of photo-interpreters ?

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What is a SAR image ?

- a 2D representation for a 3D vehicle,
- a compressed image,
- a bright area with more or less accurate contour, dominant scatterers
- a shadow or not,
- a geometric shape with different dynamic levels,
- the absence or the presence of such or such element (**versus resolution**)

& what is

Recognition : How do we recognise a target ?

- height, length and width,

➤ - shape, particular elements (wheels and their number, antenna,...)

➤ - material,

➤ - environment,

➤ **Identification** : Which features identify a target ?

➤ - position of elements between them

➤ - shape of particular elements (square, round,  NERA)

Strong impact of the target geometry

Phenomenological analysis

GECKO - First aspect angle



GECKO - Second aspect angle



SAR image is not an optical image but information about the target are on a SAR image



phenomenological analysis

Extract information from a SAR target image by

- describing physically the observed phenomena
- explaining the behaviour of the target versus configurations

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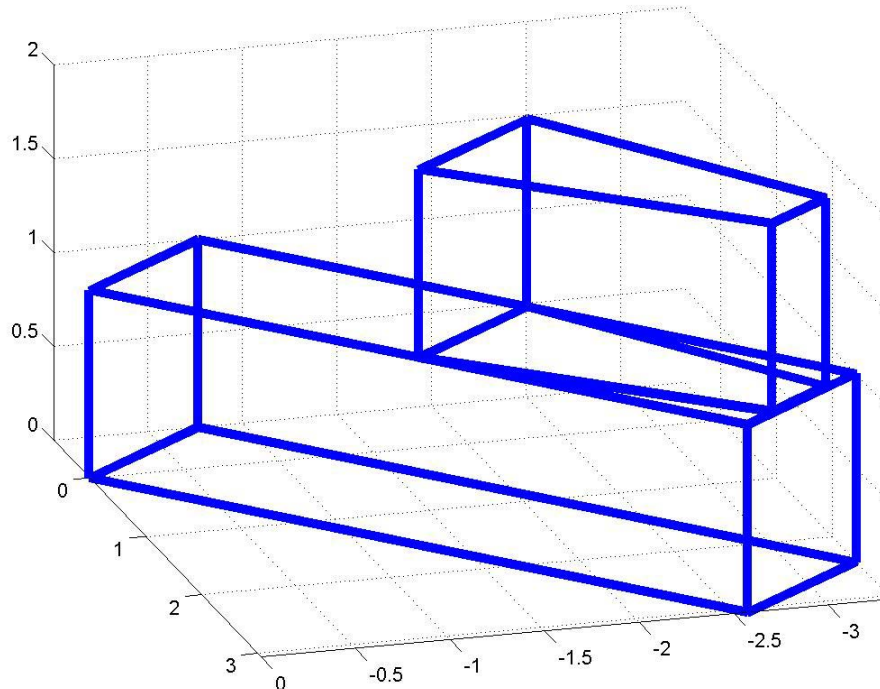
Methodology : Geometrical and physical approach

- **simulate** a target by selecting the most relevant features of a target (wheels, cabin,...)
- **calculate** the associated SAR image in the slant or ground range domain

Parameters :

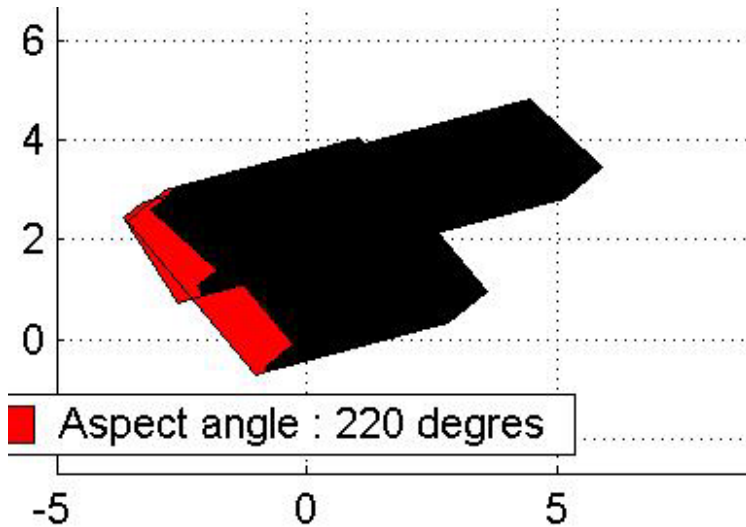
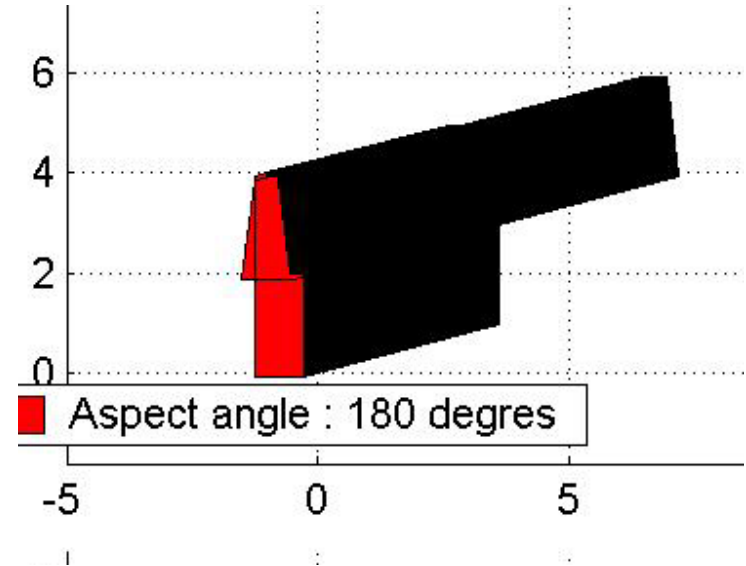
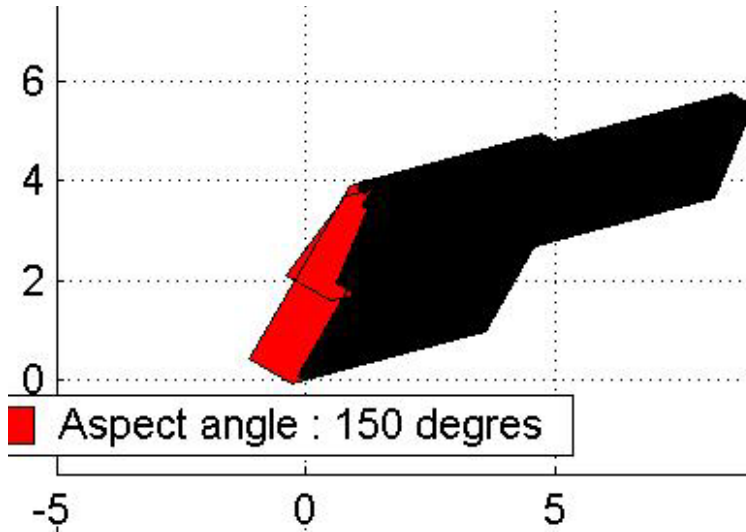
- **Operational conditions** : depression angle, radar band
- **Target characteristics** : type, aspect angle,
- **Environment** : grass, road, sea,...

A simple example



Radar image versus aspect angle

Depression angle : 15°



How to find an invariant ?

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Shadow Impact of the environment

Interests of shadow

- ☺ to estimate the height of the highest element of the target
- ☺ to estimate length or width of the target
- ☺ to have an idea of the shape of the target (wings of plane)
- ☺ to see element smaller than the resolution (gun of tank)

When do we have a shadow ?

Depends on

- the surface background - “*smooth to rough*”
- the radar band - “*X to Ka* “

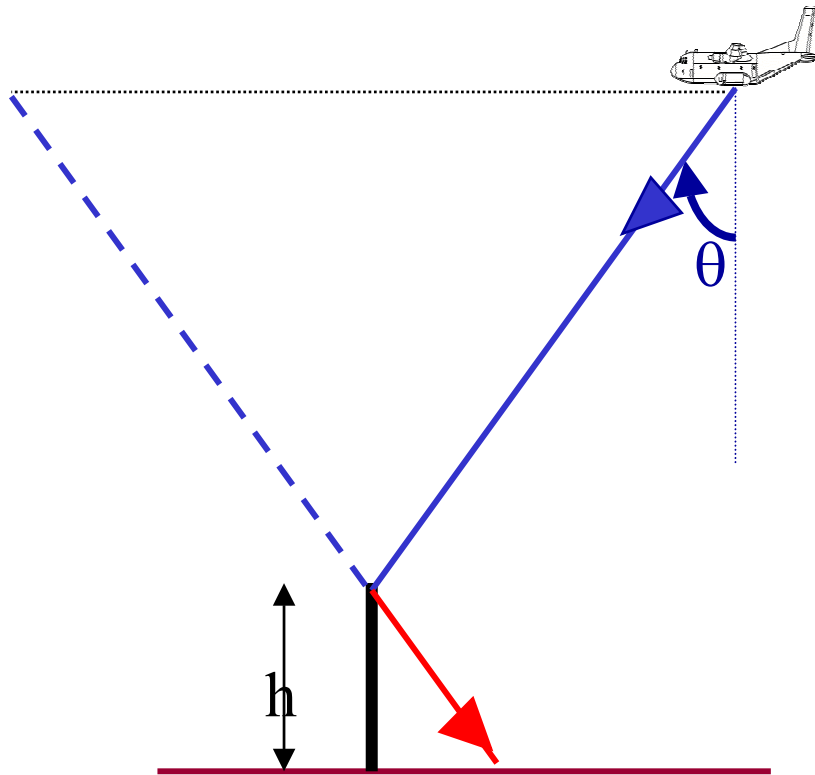
Without a shadow, a part of the information is absent but ...

Smooth surface and multi-path

Specular on a structure

optical geometry : plane mirror = structure




-  Incident Ray
-  Structure reflected ray

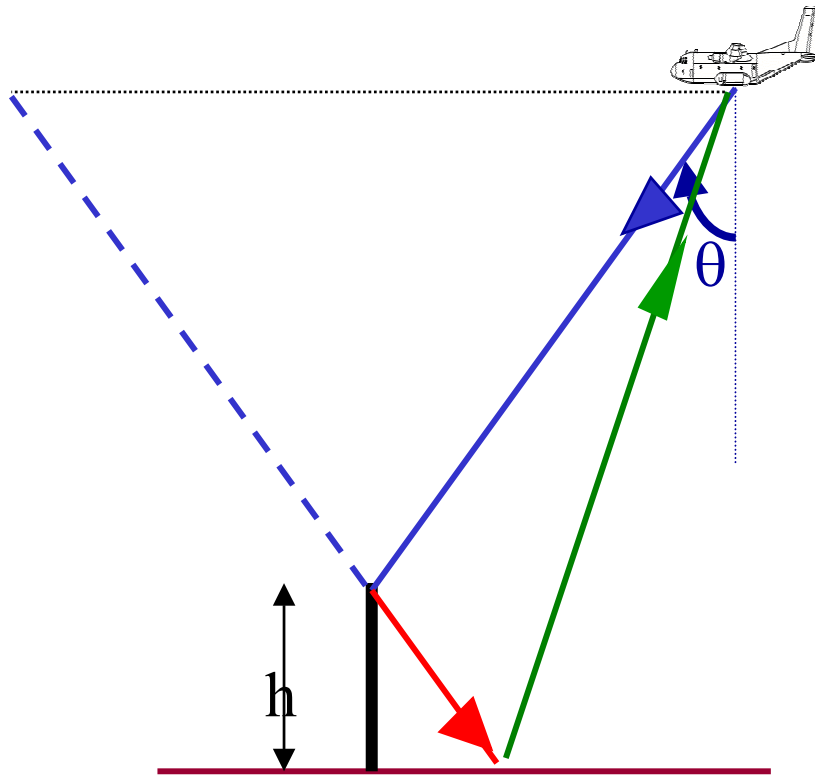


Smooth surface and multi-path

Specular on a structure

optical geometry : plane mirror = structure

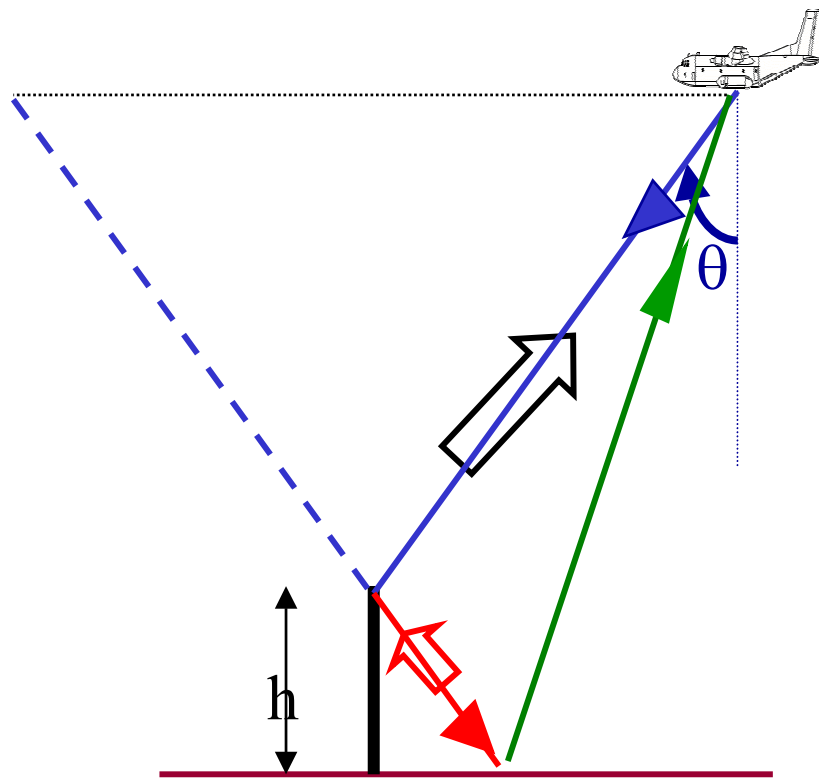
-  Incident Ray
-  Structure reflected ray
-  Surface reflected ray






Smooth surface and multi-path

Specular on a structure

optical geometry : plane mirror = structure



-  Incident Ray
-  Structure reflected ray
-  Surface reflected ray

 Direct Path d_0

 Two bounds multipath

 Three bounds multipath

$$d_0 < d_{2_bounds} < d_{3_bounds}$$

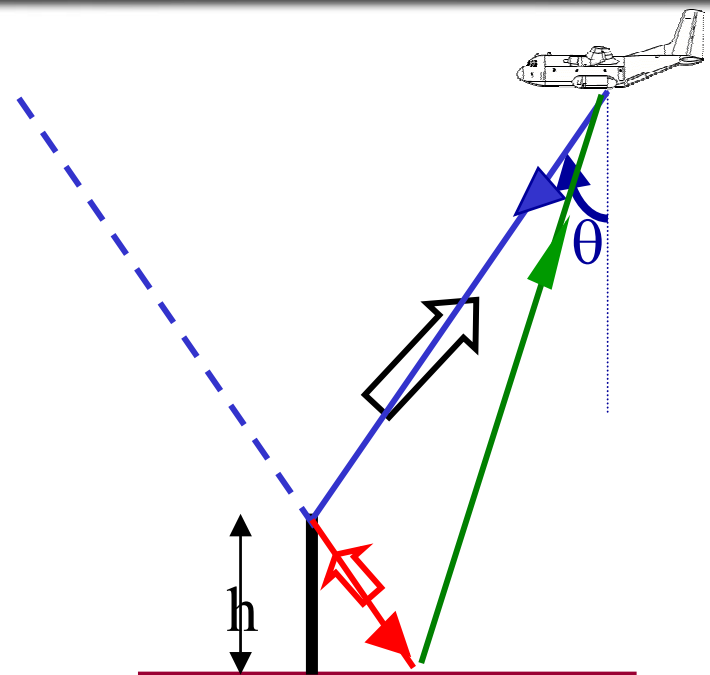
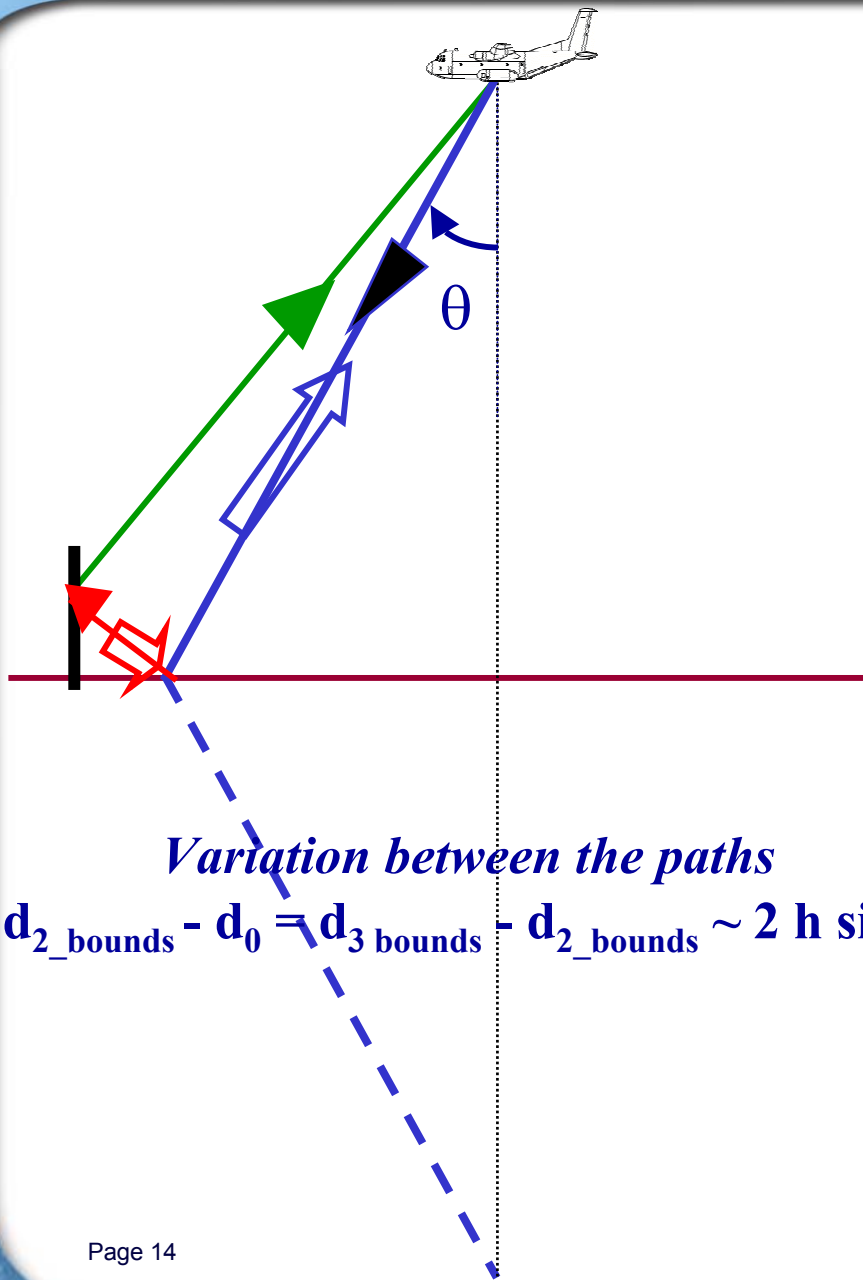
Ground specular

optical geometry : mirror plane = ground surface

Multipath

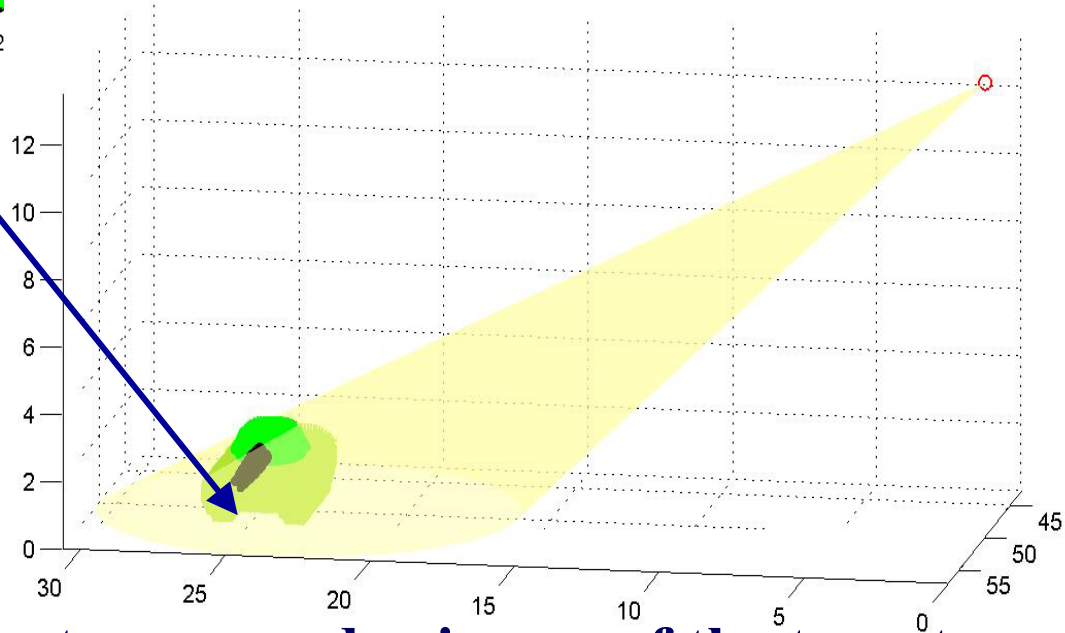
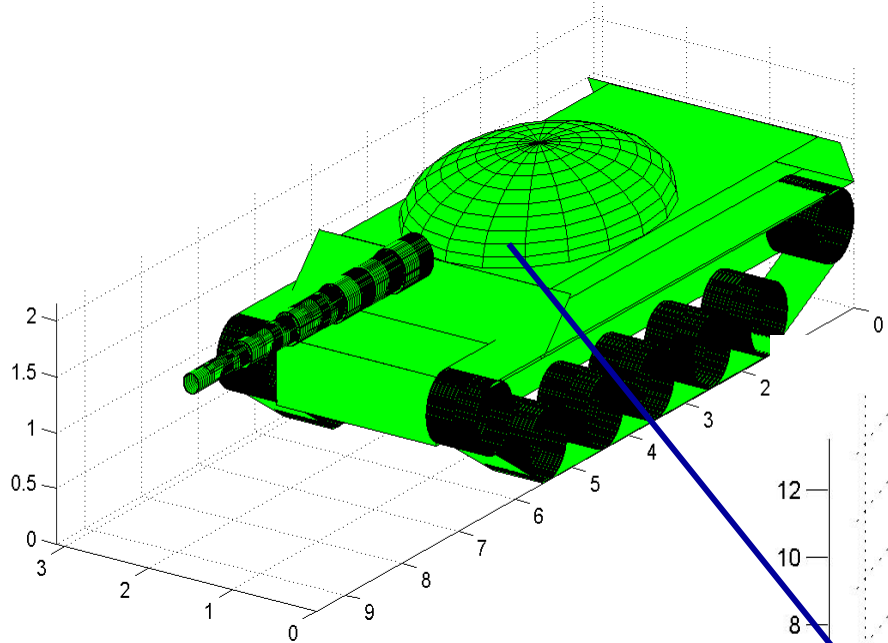
Structure specular

optical geometry : mirror plane = structure



Radar image of a tank

1- Modelisation of the main features of the target

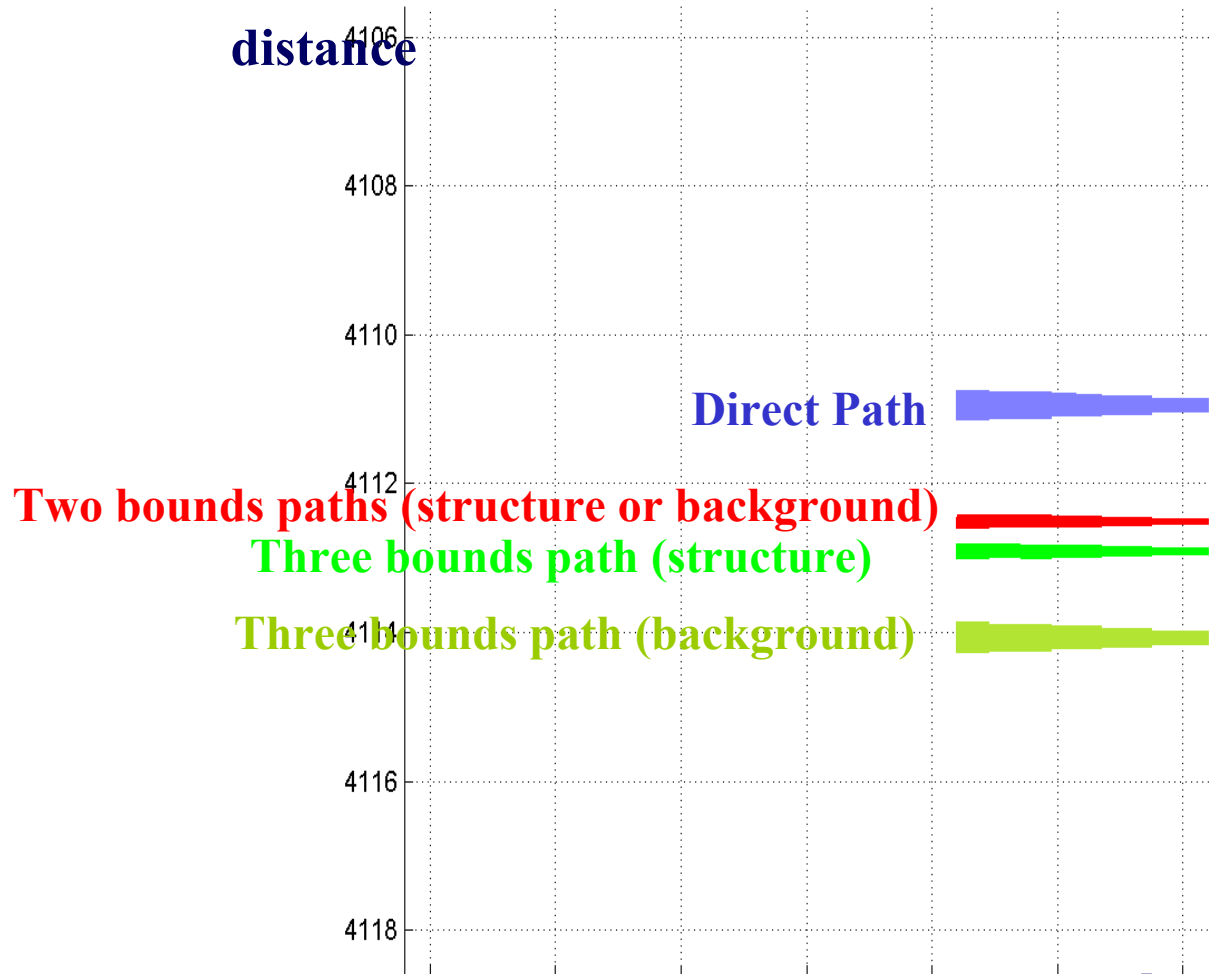


2- Simulation of the slant range radar image of the target

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Direct and multi paths

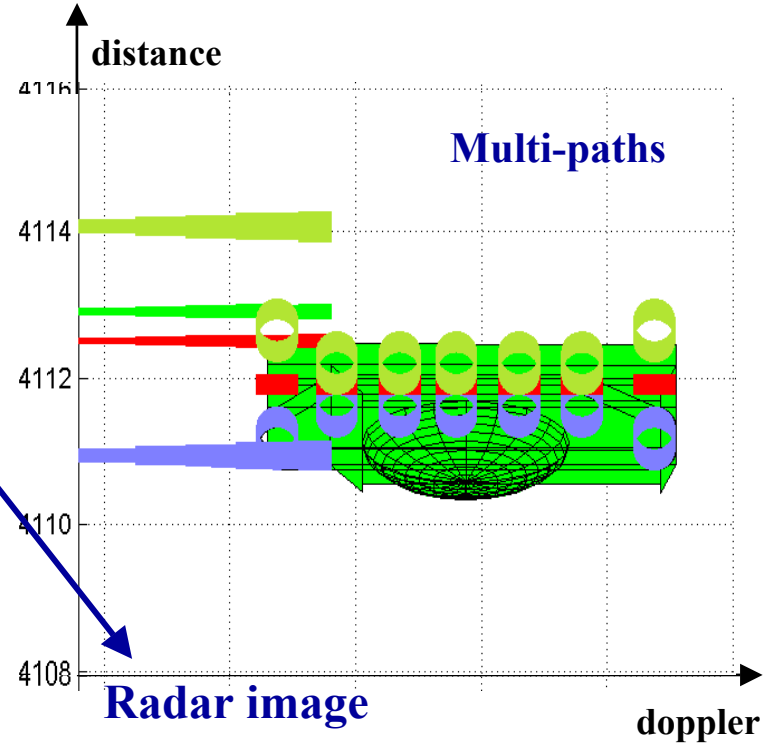
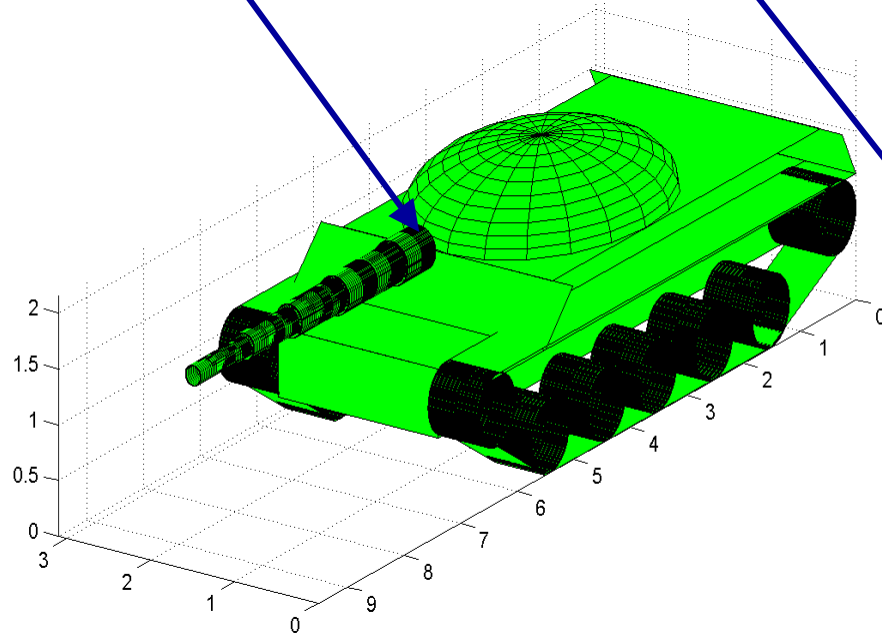
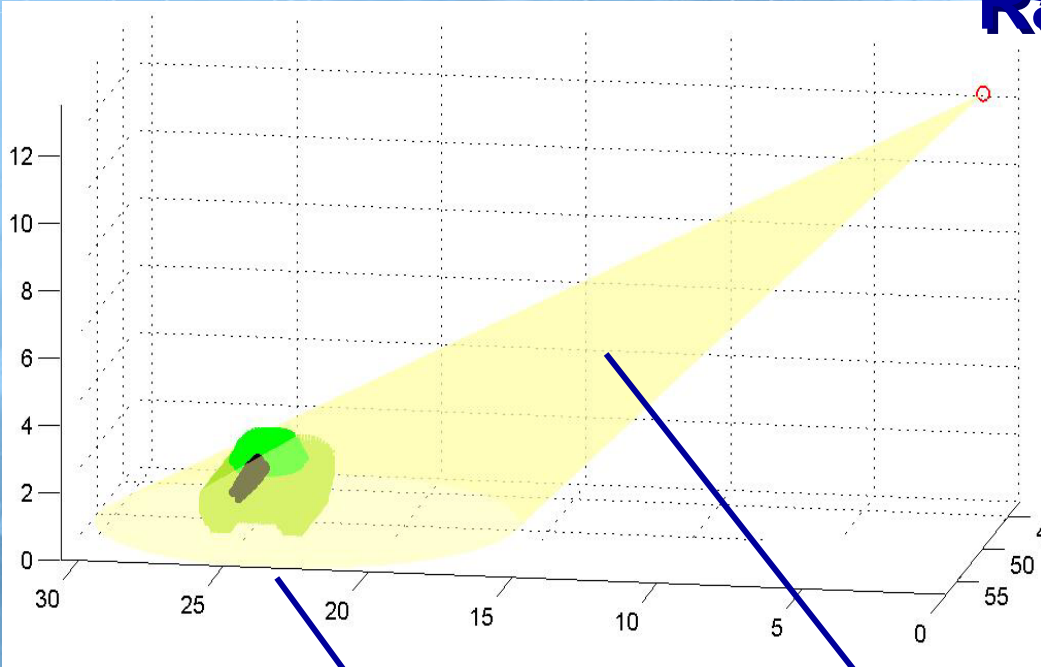
Example of the gun of the tank depression angle of 60°



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doppler

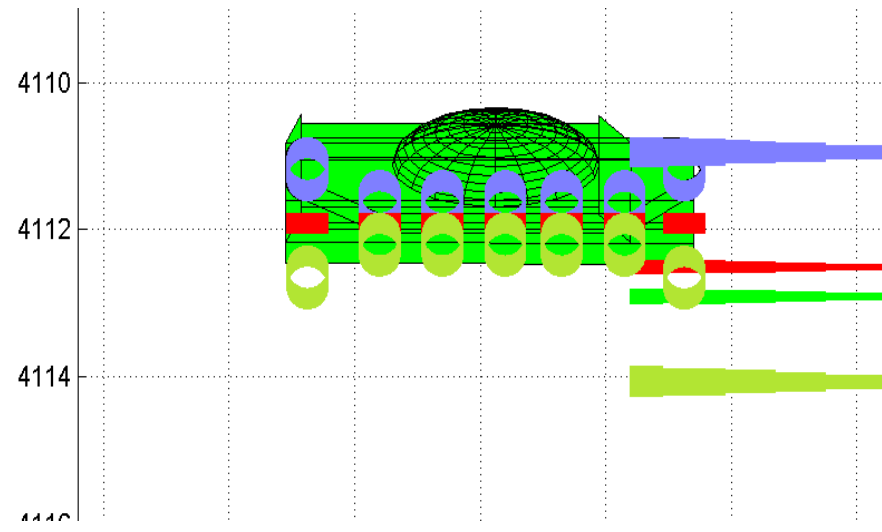
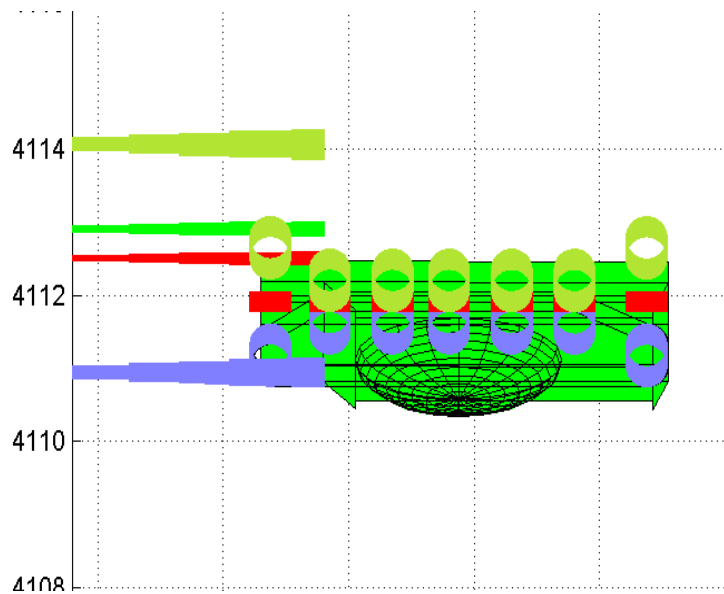
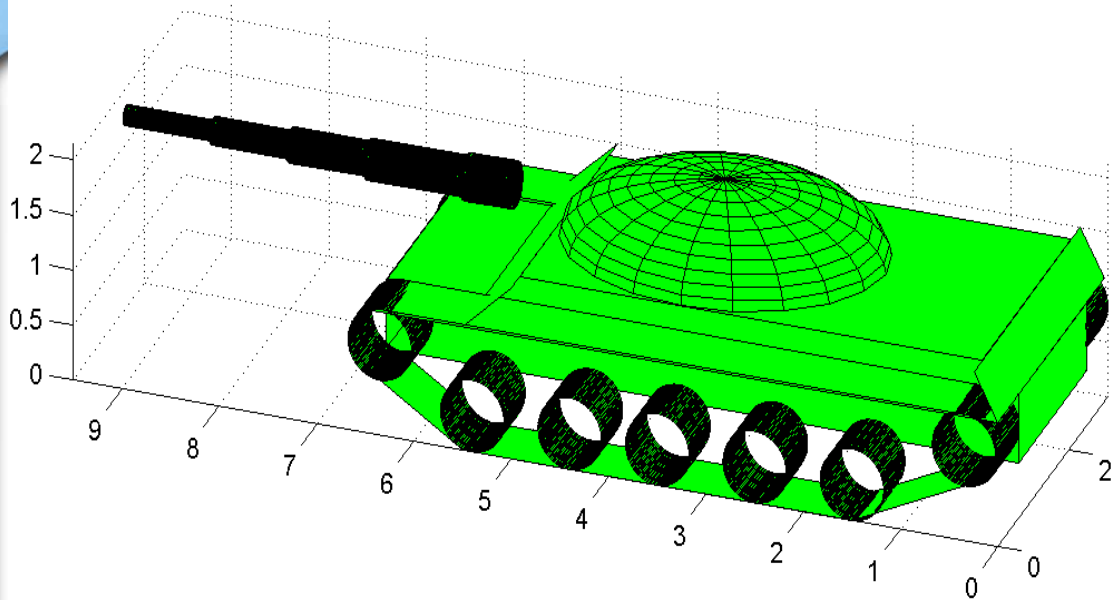
Radar image of a tank



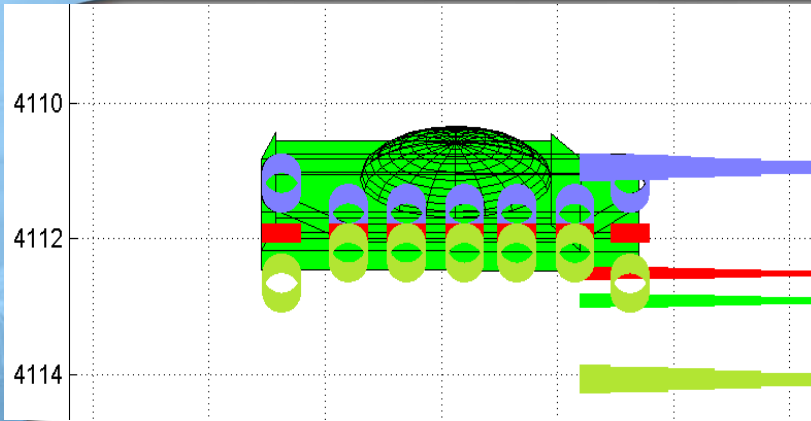
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Simulation of Radar image

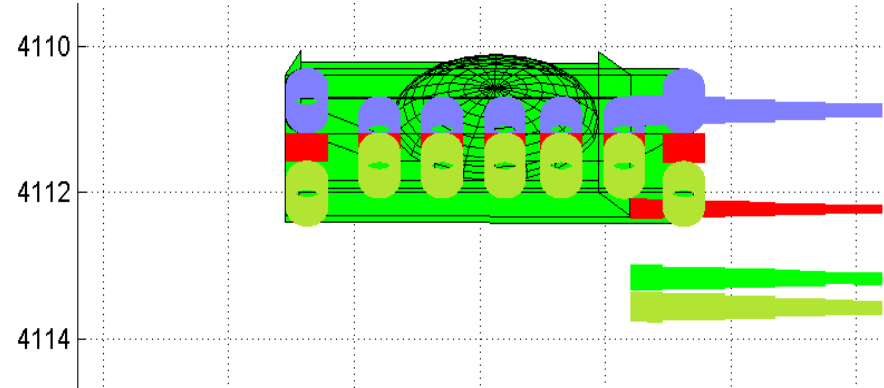
Vue 3D du char



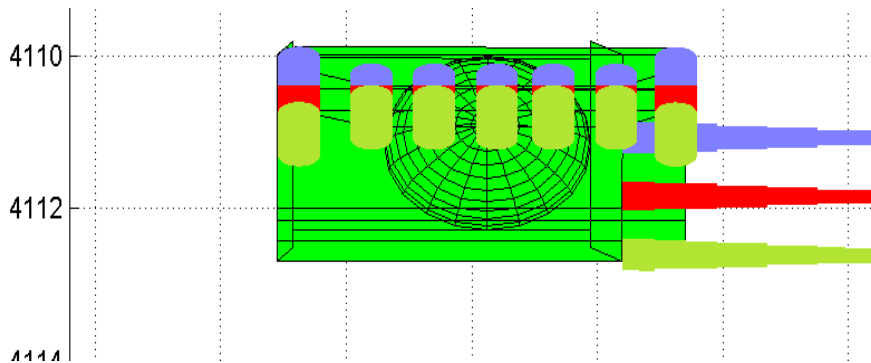
Impact of the depression angle



60°



50°



30°

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CONCLUSION

Detection - Location

➡ Yes

Recognition and Identification

➡ some interesting results with HR image

- Analyse the radar scene with the shadow, the layover,..
- Extract information from shadow
- Extract information from multi-paths

don't forget the geometry, the physics and the environment

And with Very High Resolution ...

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*This paper was received as a PowerPoint
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