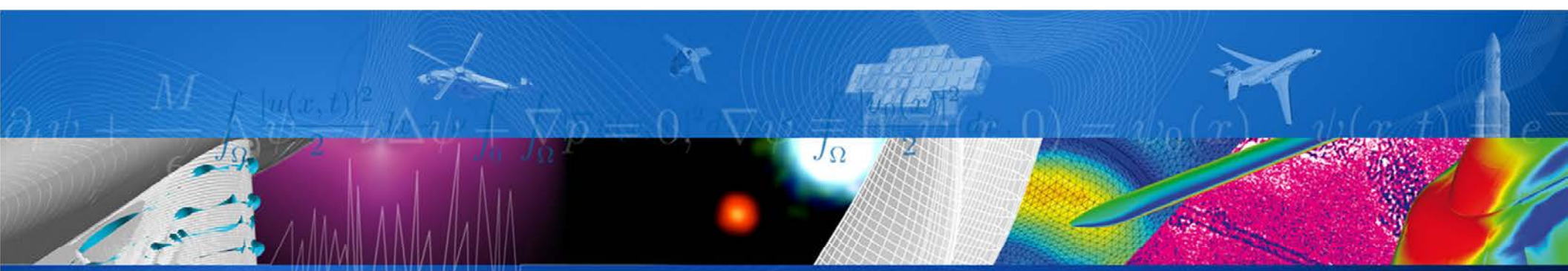

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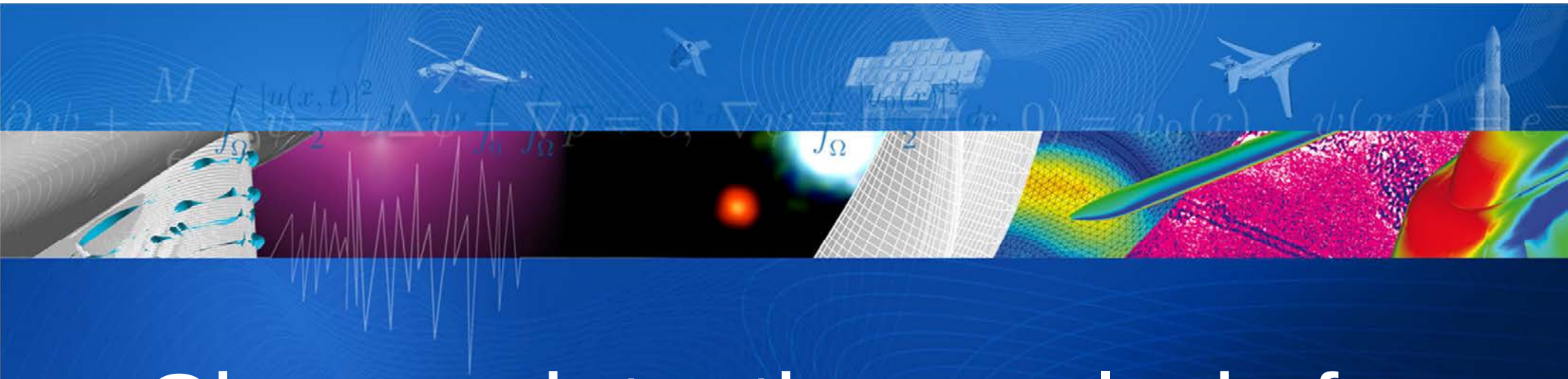

Change detection analysis for under-cover detection in L and UHF band

H. Oriot

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Outline

- Presentation of the experiment
- Change detection methodology
- UHF data analysis
- L band data analysis
- Conclusion

Context

TROPISAR project:

- ONERA project: polarimetric UHF measurements on tropical forest
- financed by ESA and CNES
- part of the BIOMASS project

TROPISAR dataset

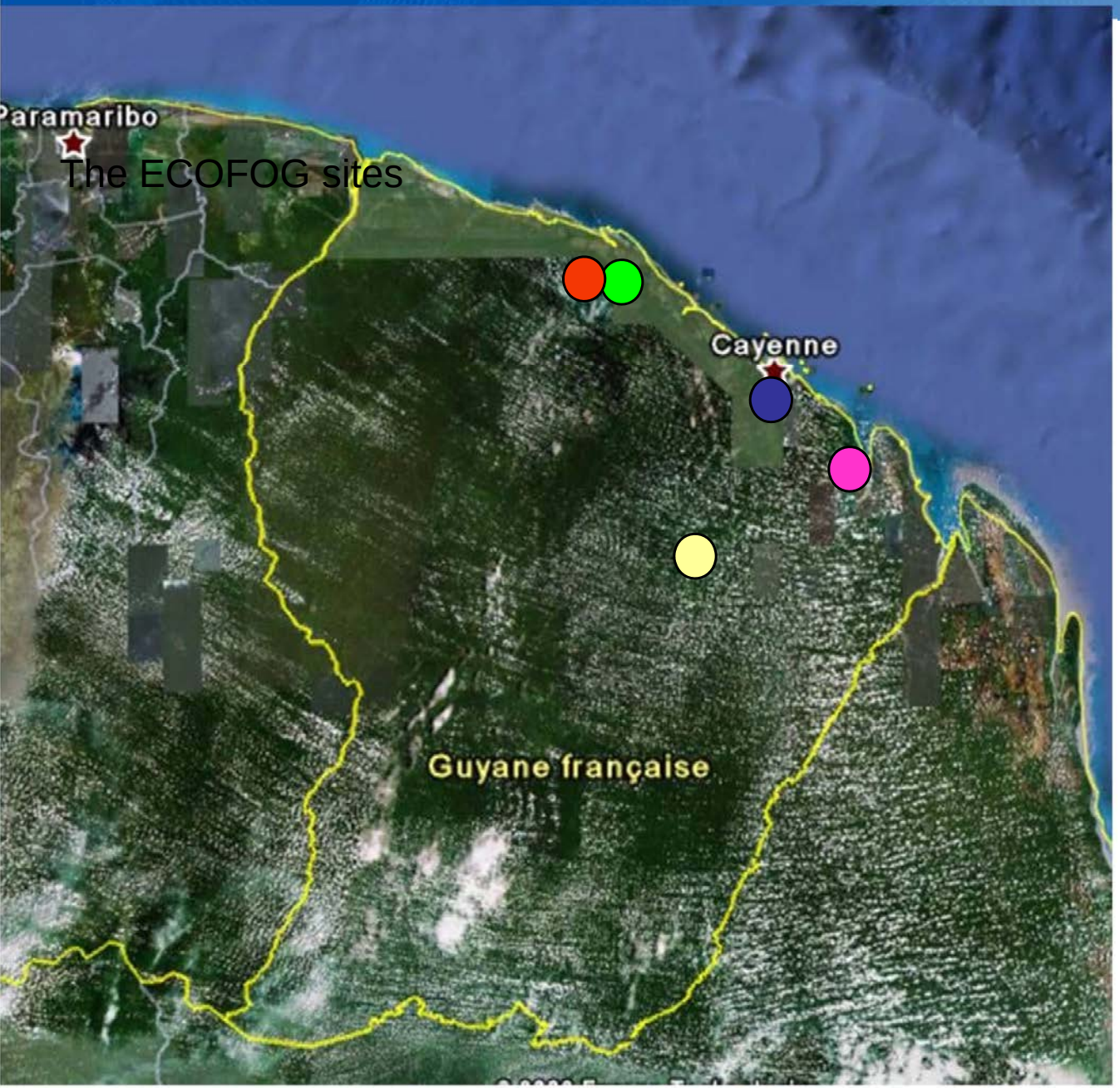
- Data acquired in the same geometry at different dates: interferometric dataset
- UHF + L polarimetric data
- Azimut resolution : 1.5 m
- Range resolution : 1.2 m
- Incidence angle: from 24° to 60°
- Images made available by ESA

SETHI: A radar system oriented towards civilian applications

FALCON 20 Aircraft
(AVDEF Company)
Adjustable incidence angle

RF Band	UHF	L	X
Frequency	220-460 MHz	1.3 GHz	9.5 GHz
Polarisation	Full polar	Full Polar	Full Polar
Resolution	65 cm	75 cm	10 cm

TROPISAR, the sites



The ECOFOG Sites

- Nouragues
- Paracou
- Arbocel

Calibration site

- Rochambeau

Other sites

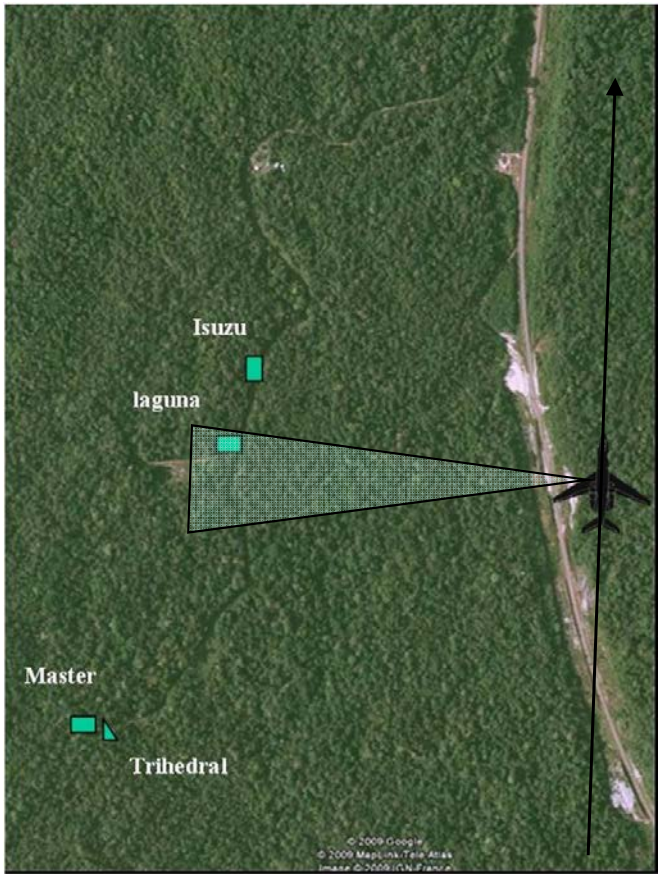
- Marais de Kaw
- Mangroves

Dataset used in this experiment

Image 208	14/08	ZB
Image 305	17/08	ZB
Image 402	24/08	ZB
Image 403	24/08	Delta h= 15 m Ha=100m
Image 405	24/08	Delta h= 45 m Ha=33m
Image 407	24/08	Delta h= 75 m Ha=20m
Image 506	30/08	ZB

Target deployment on the 24th of august

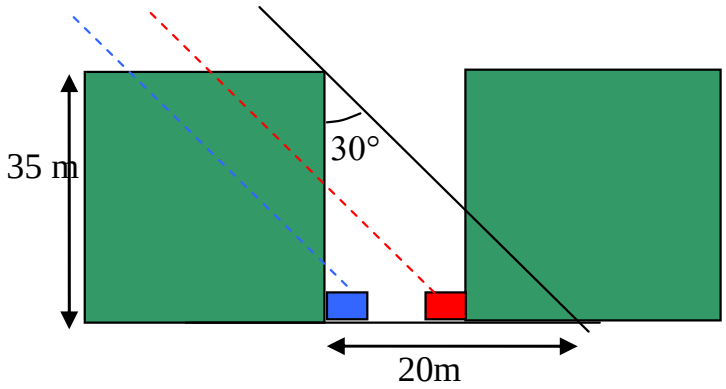
Isuzu: under cover but the wave is going through half of the forest height



Laguna: completely under cover

Master : may be not under cover (located in a small open area)

Corner reflector : under cover



Change detection algorithm (from Leslie Novak)

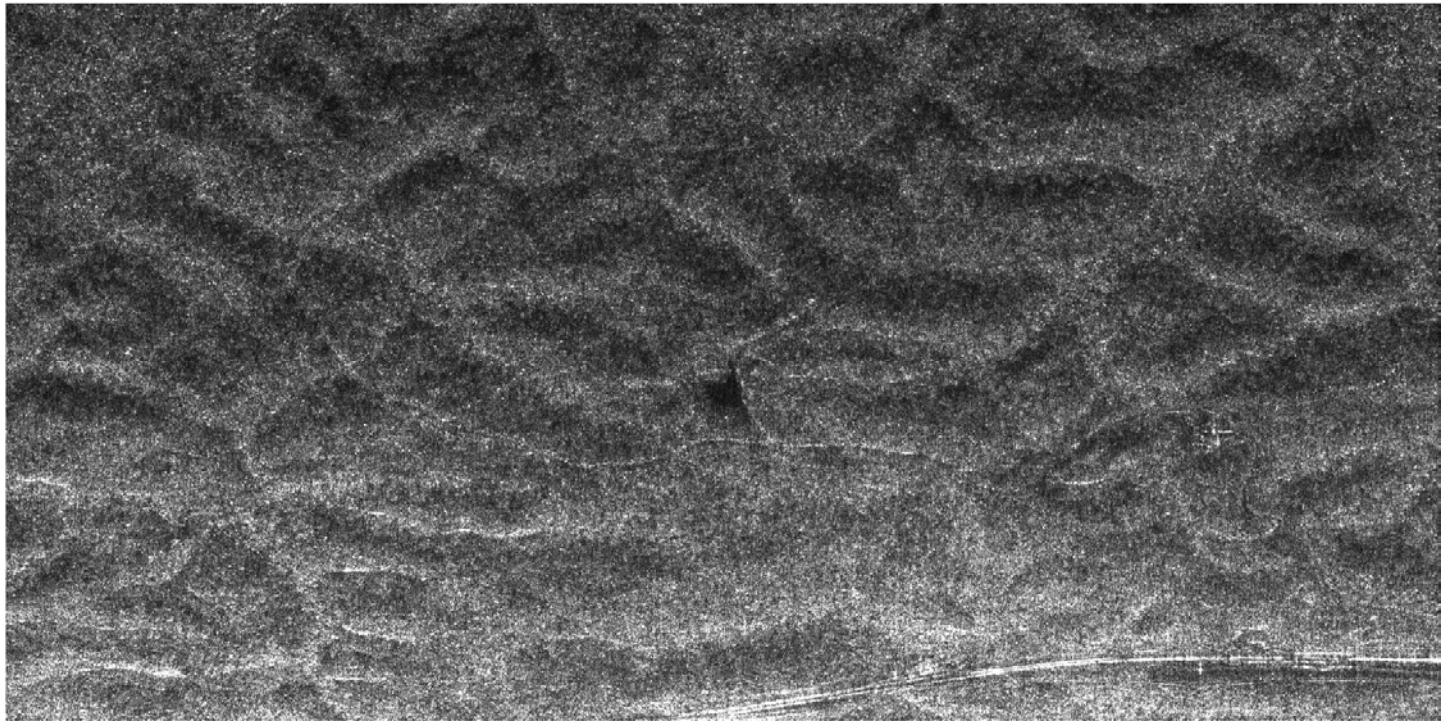
Mono polarisation criterion

$$Z_{i_0,j_0} = \frac{\sum_{i=i_0-N}^{i=i_0+N}\sum_{j=j_0-N}^{j=j_0+N}\left|S_2(i,j)\right|^2}{\sum_{i=i_0-N}^{i=i_0+N}\sum_{j=j_0-N}^{j=j_0+N}\left|S_1(i,j)\right|^2}$$

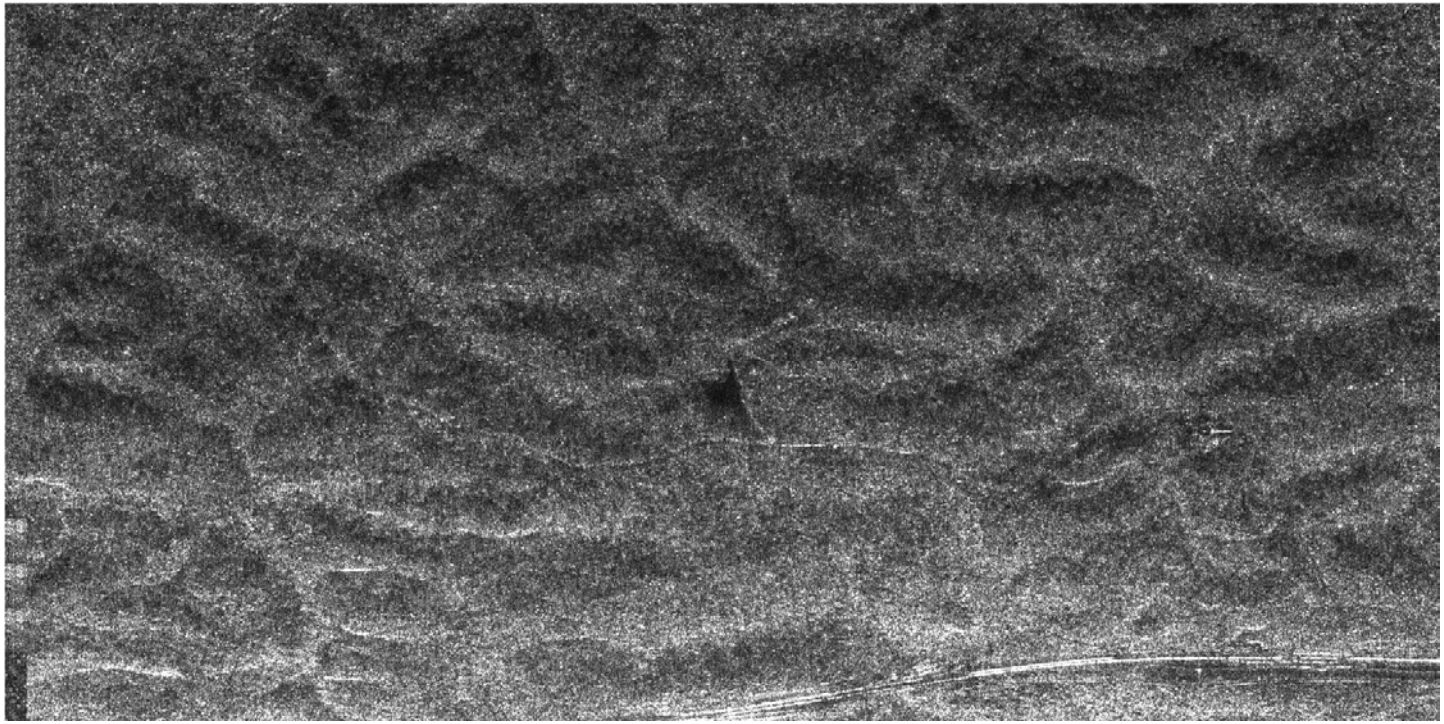
Polarimetric criterion

$$Z^{p}_{i_0,j_0} = \frac{\left|\sum_{i=i_0-N}^{i=i_0+N}\sum_{j=j_0-N}^{j=j_0+N} Cov_2(i,j)\right|}{\left|\sum_{i=i_0-N}^{i=i_0+N}\sum_{j=j_0-N}^{j=j_0+N} Cov_1(i,j)\right|} \quad \text{with} \quad Cov(i,j) = \begin{bmatrix} S_{Hh}(i,j).S^*_{Hh}(i,j) & S_{Hv}(i,j).S^*_{Hh}(i,j) & S_{Vv}(i,j).S^*_{Hh}(i,j) \\ S_{Hh}(i,j).S^*_{Hv}(i,j) & S_{Hv}(i,j).S^*_{Hv}(i,j) & S_{Vv}(i,j).S^*_{Hv}(i,j) \\ S_{Hh}(i,j).S^*_{Vv}(i,j) & S_{Hv}(i,j).S^*_{Vv}(i,j) & S_{Vv}(i,j).S^*_{Vv}(i,j) \end{bmatrix}$$

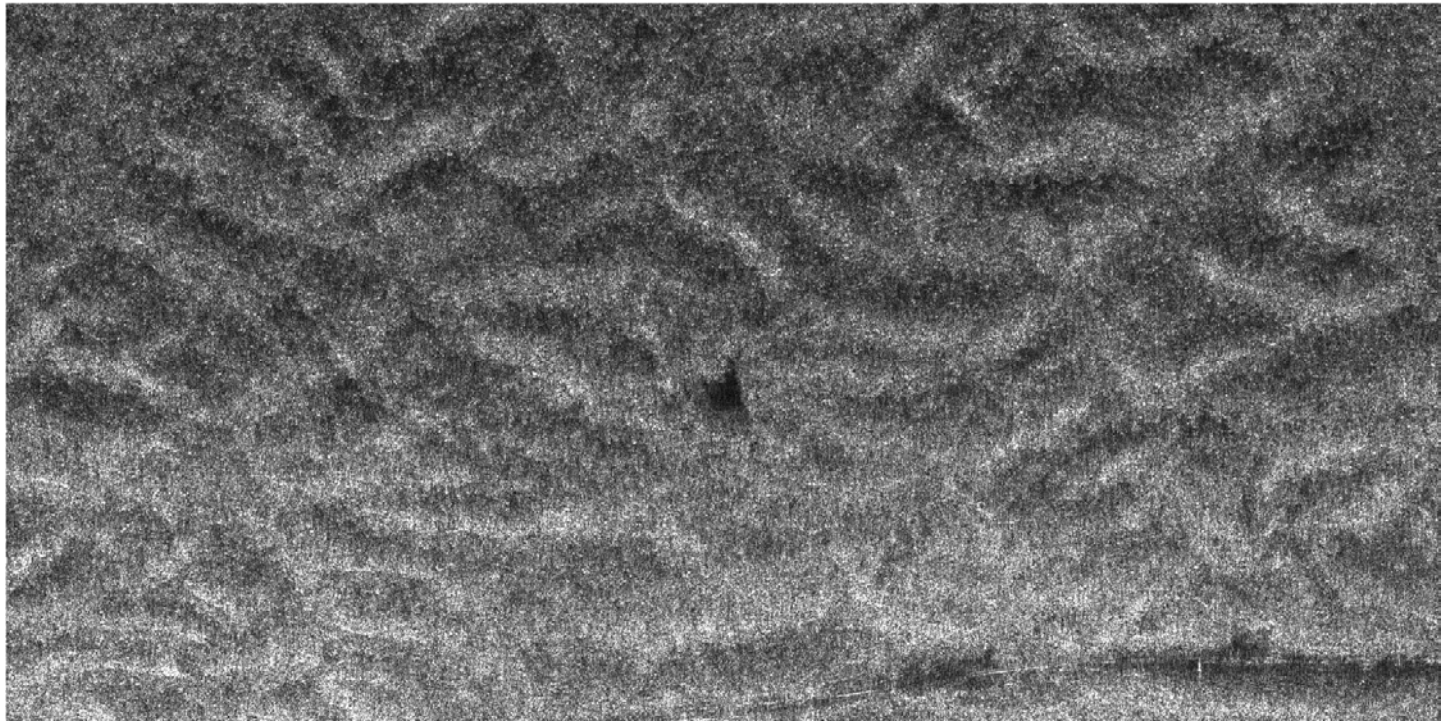
UHF – Hh – no target



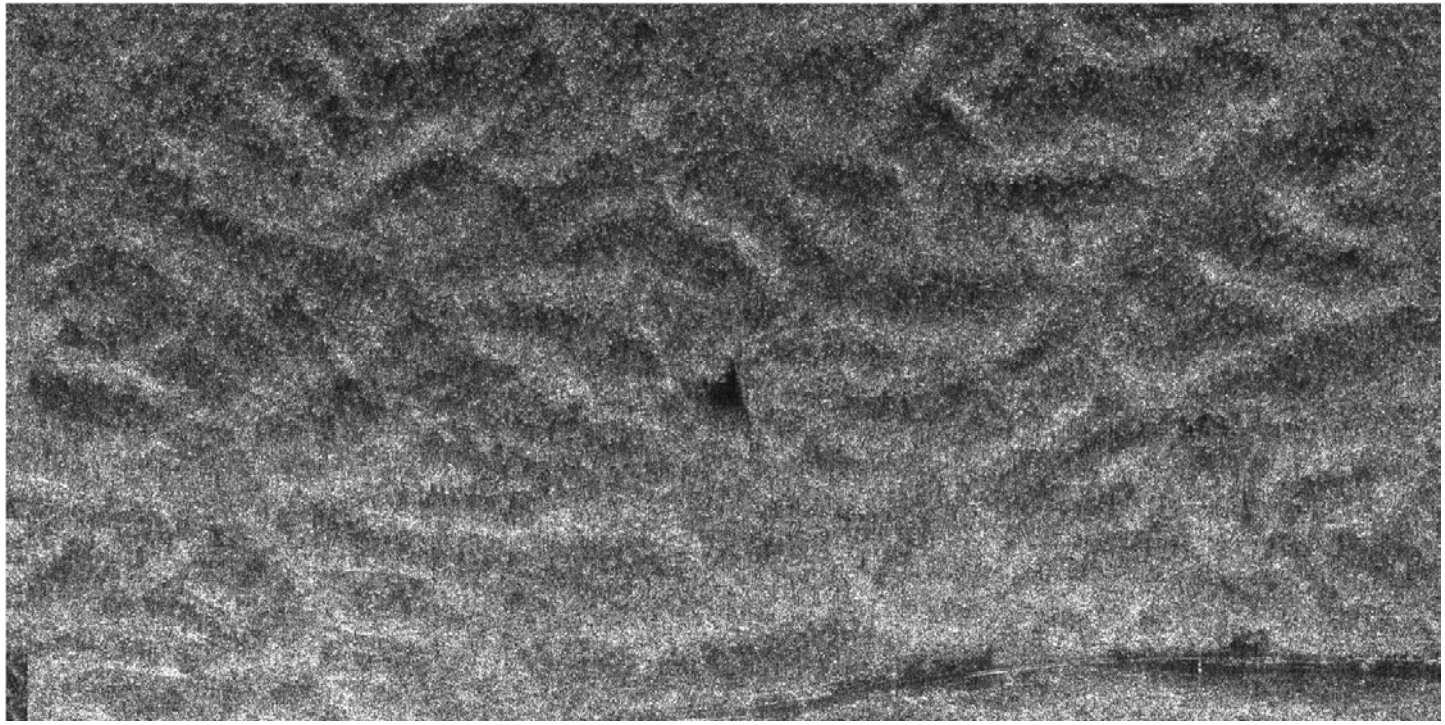
UHF – Hh – targets



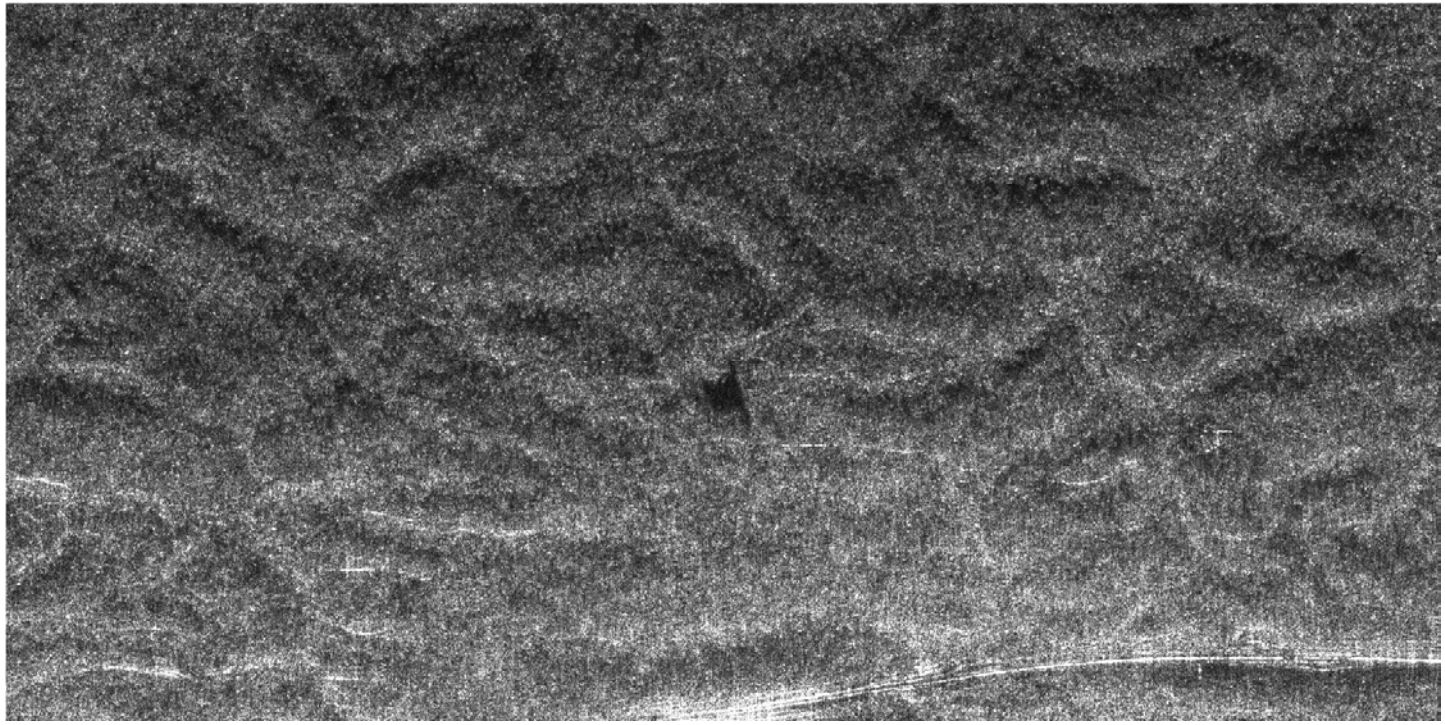
UHF – Hv – no target



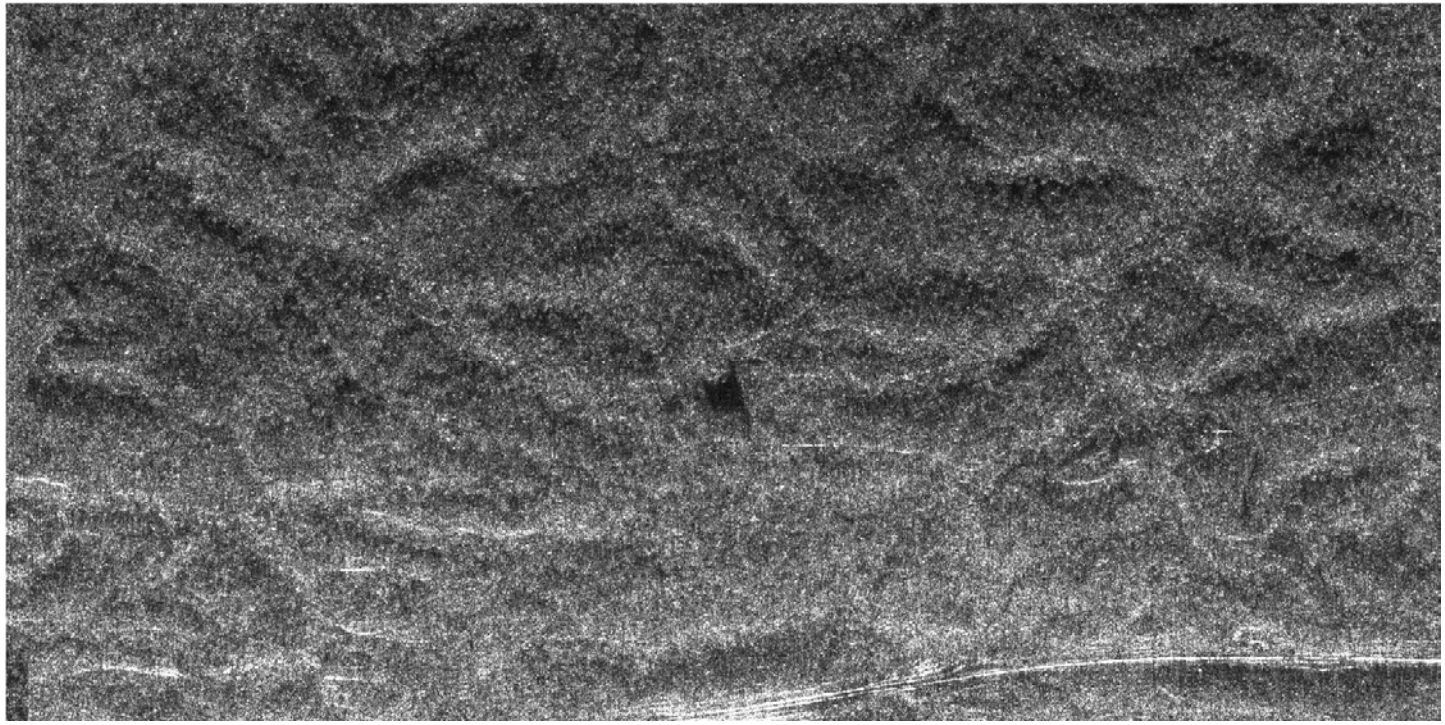
UHF – Hv – targets



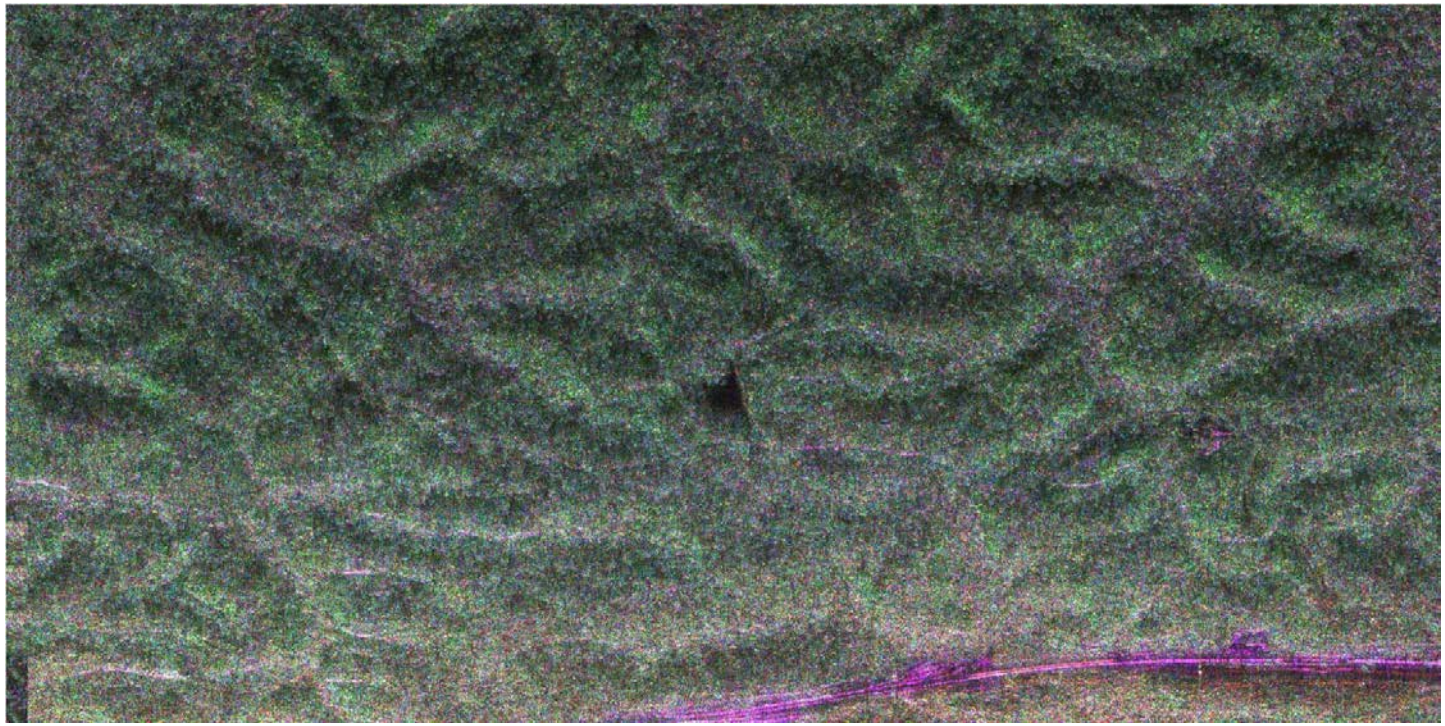
UHF – Vv – no target



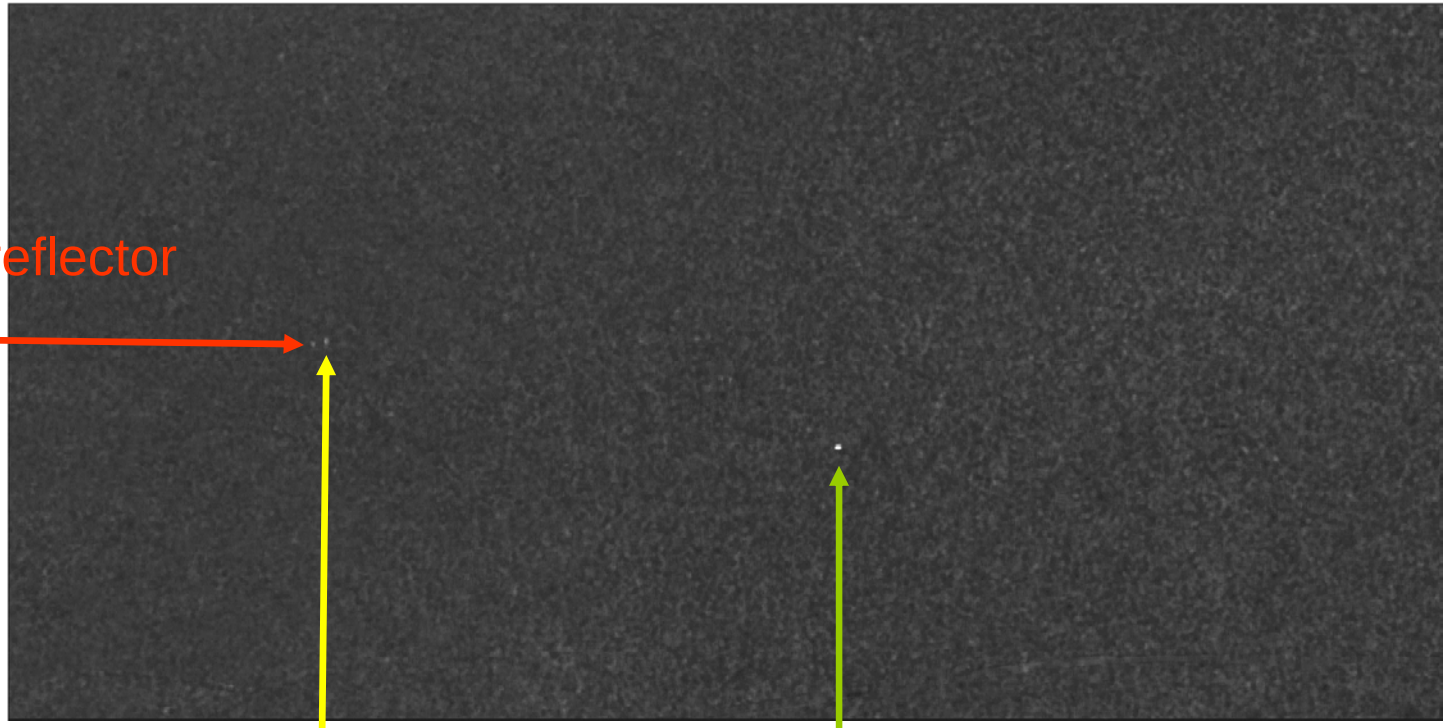
UHF – Vv – targets



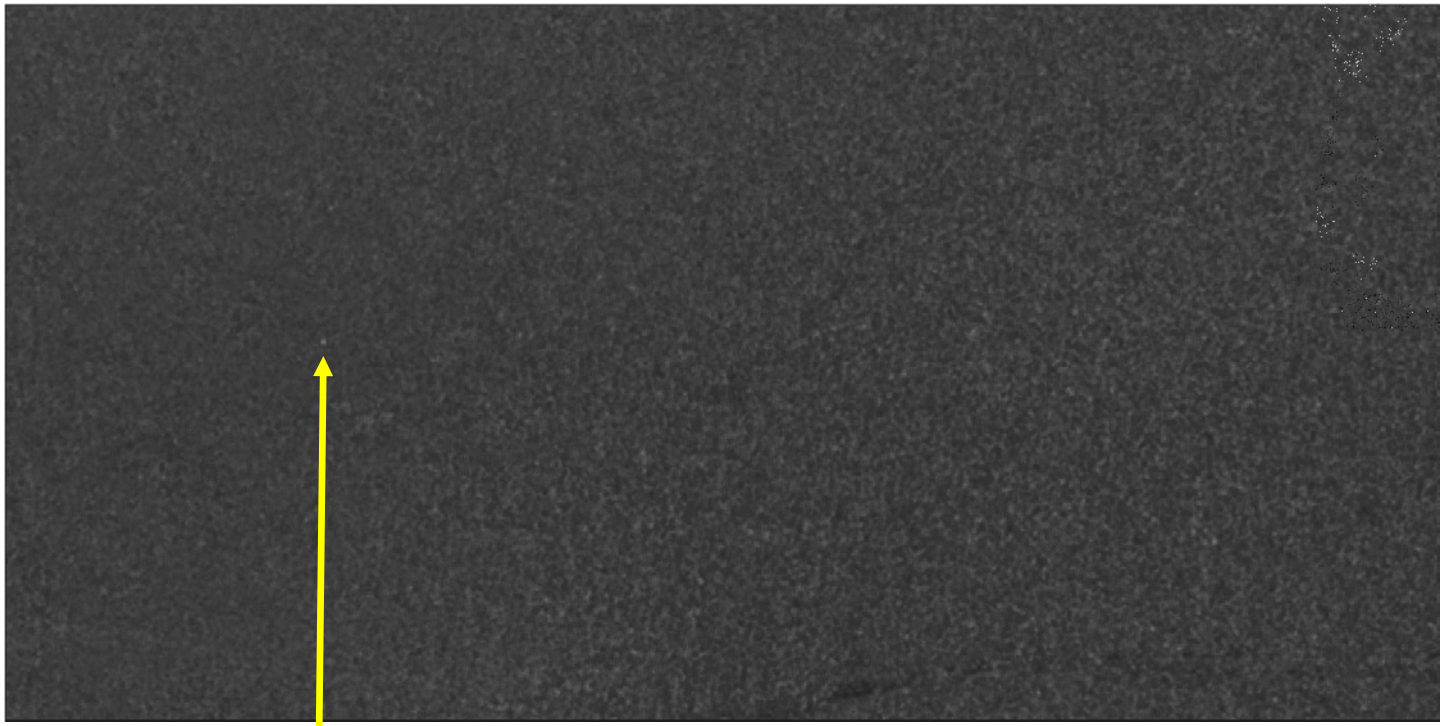
UHF polarimetric composition - targets



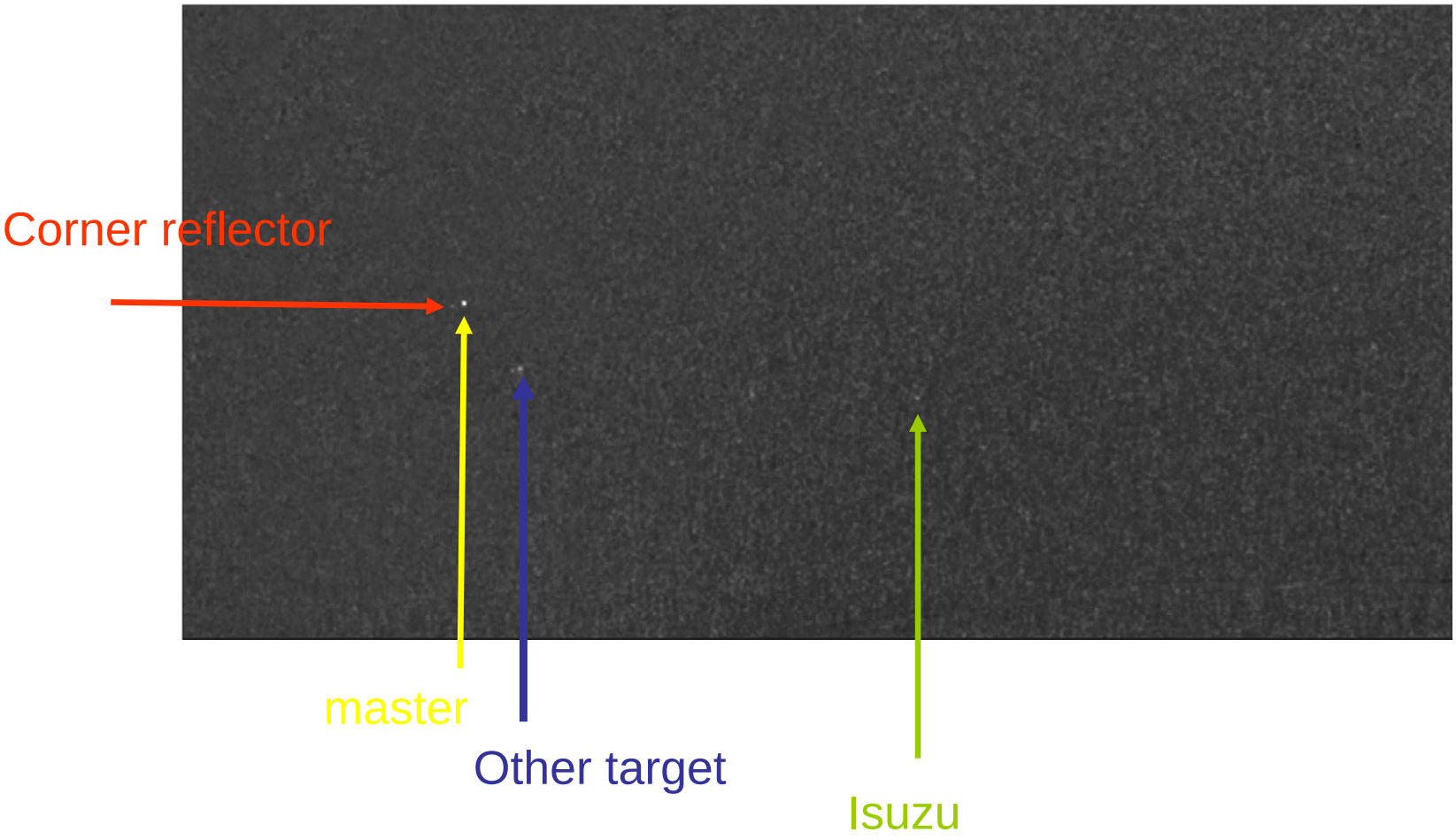
Hh Change Detection



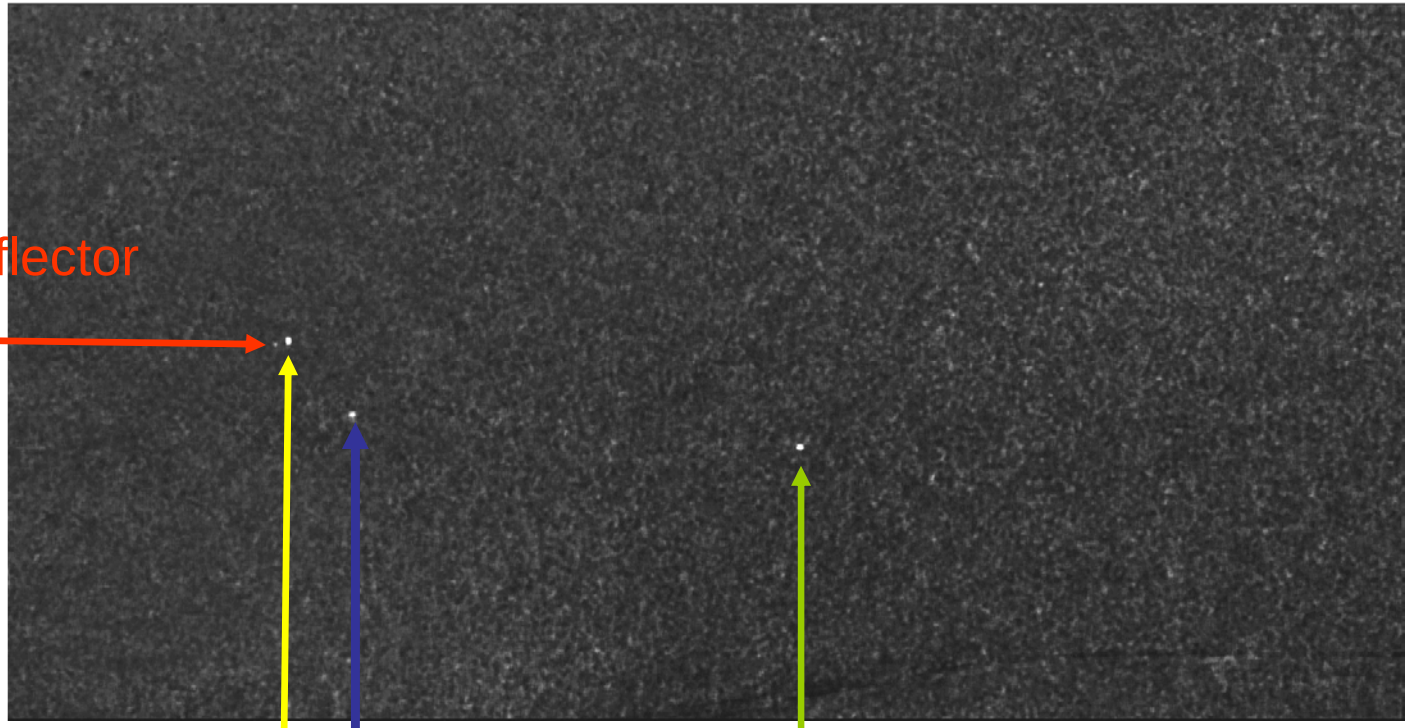
Hv Change Detection



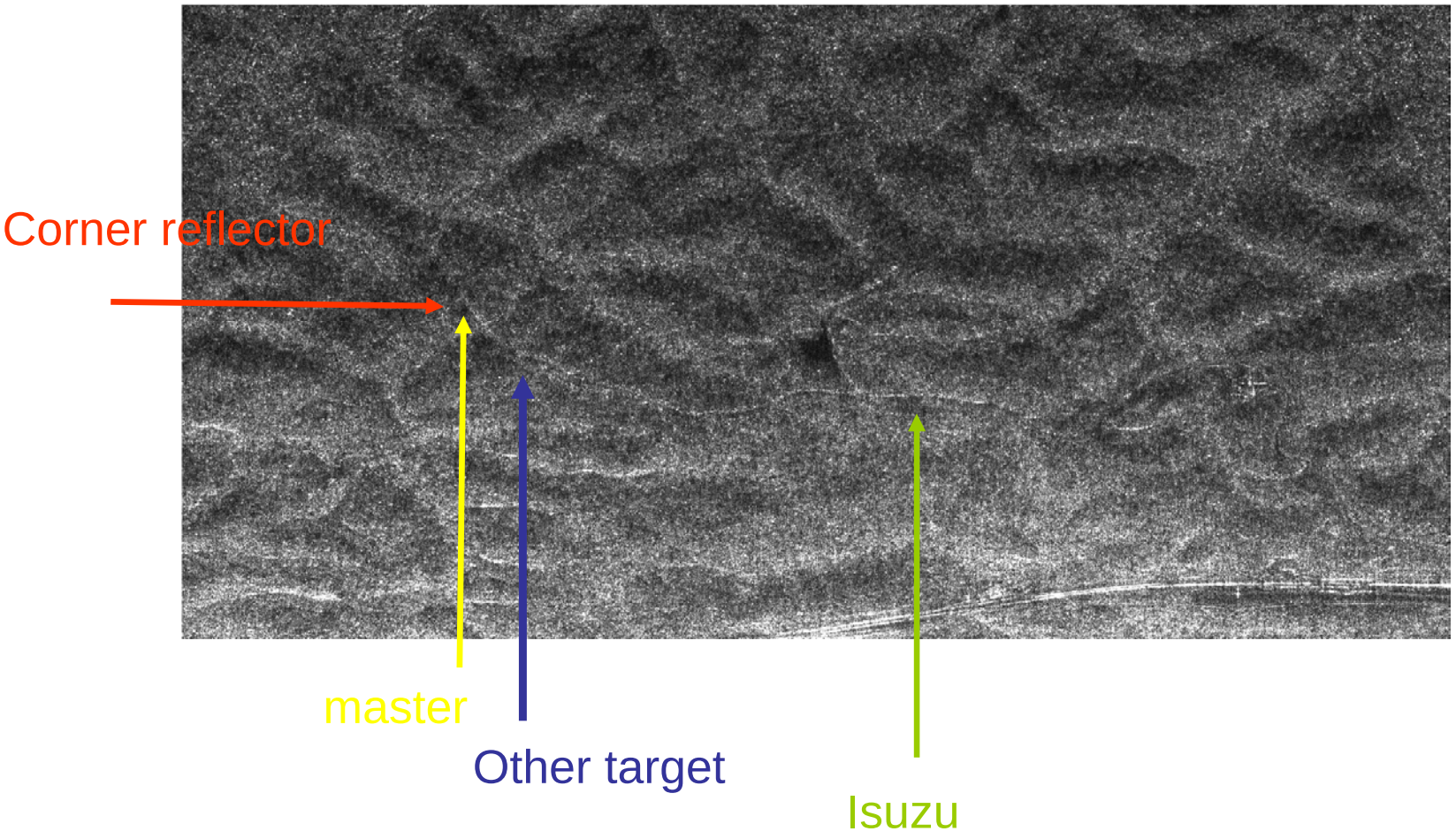
Vv Change Detection



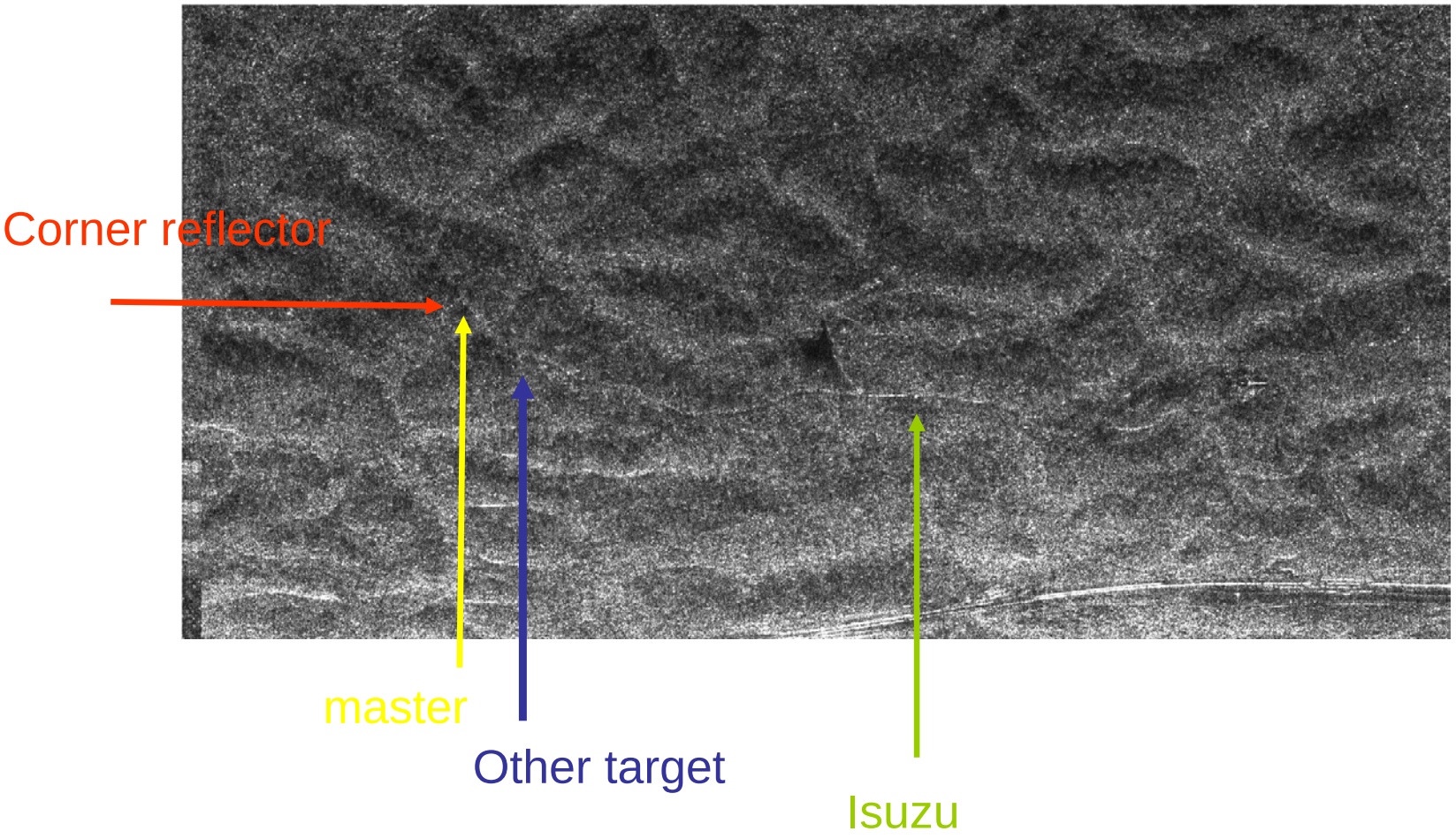
Polarimetric change detection



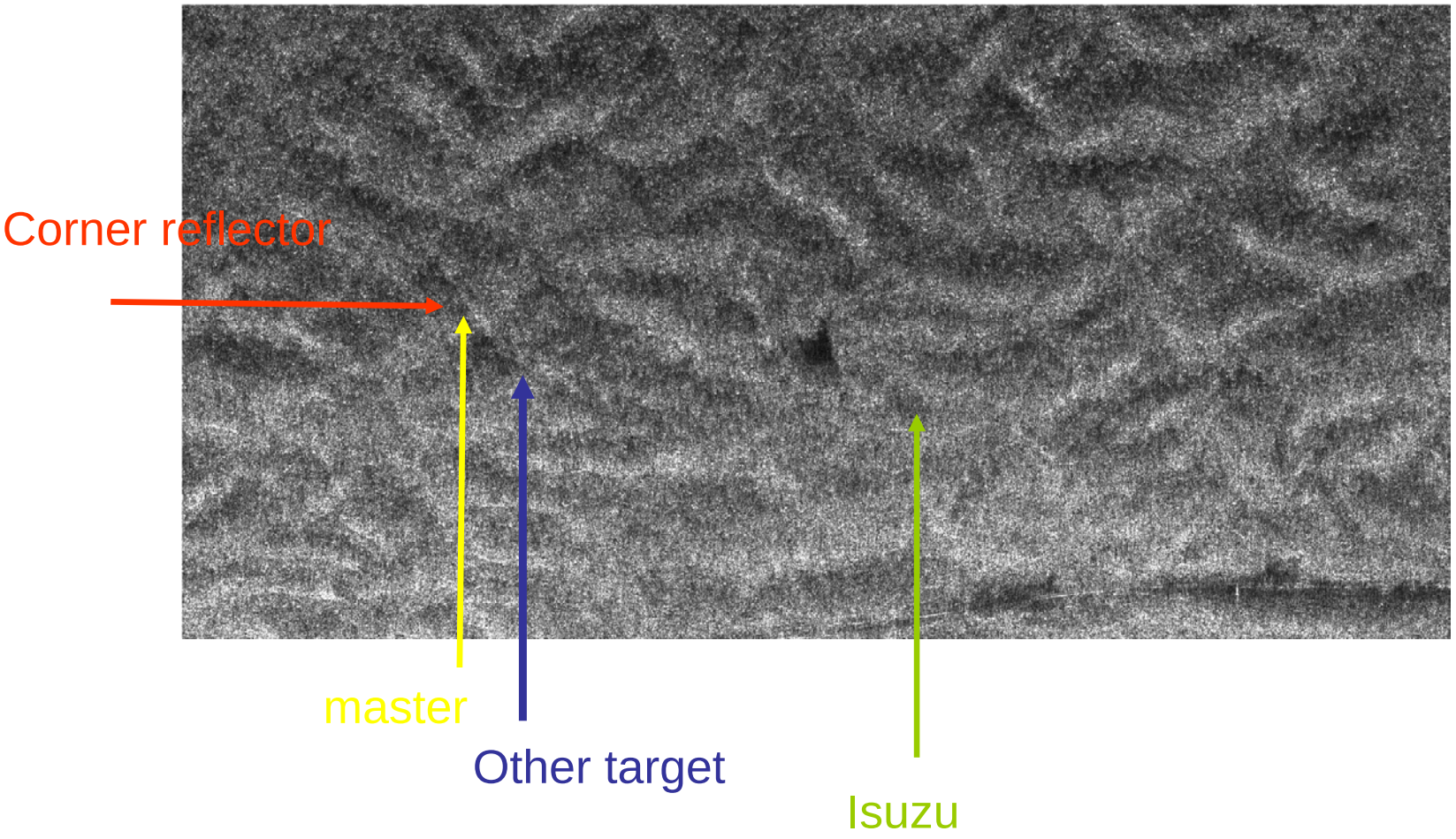
UHF - Hh – no target



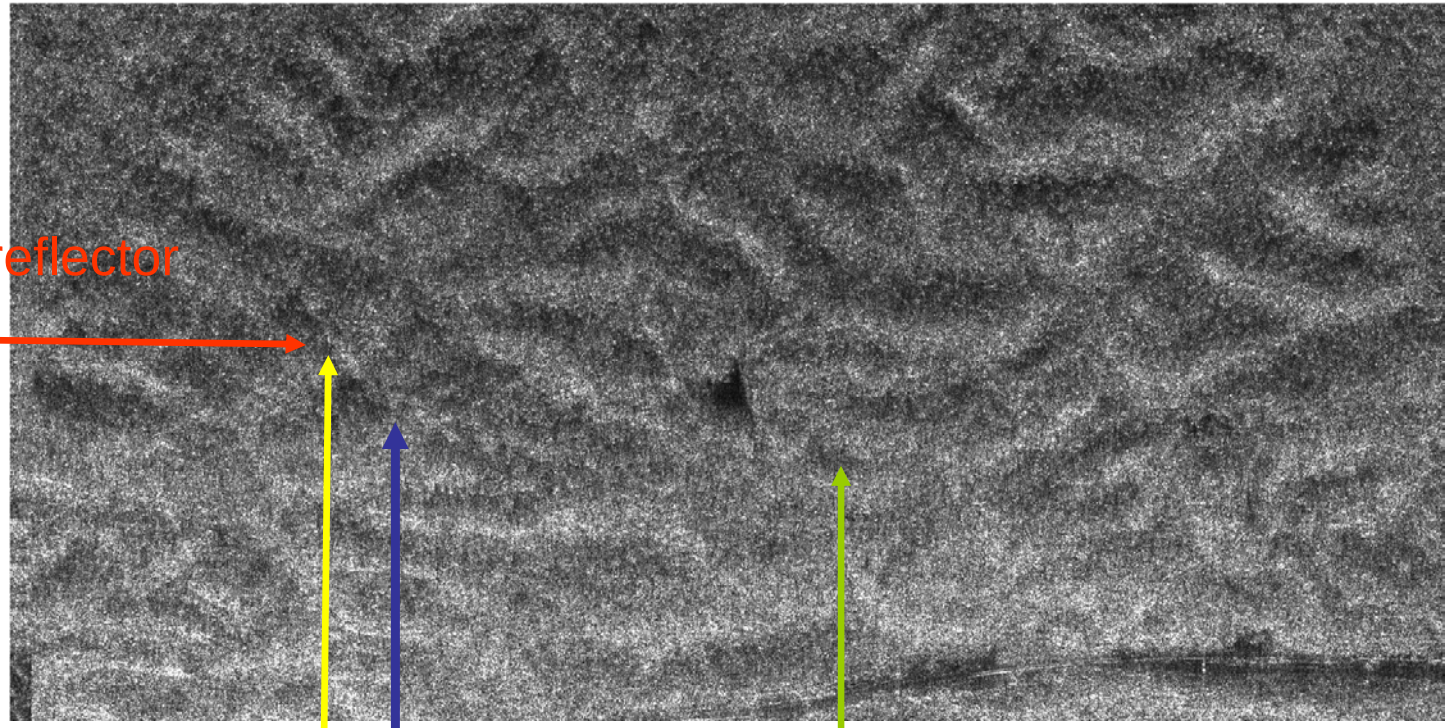
UHF – Hh - targets



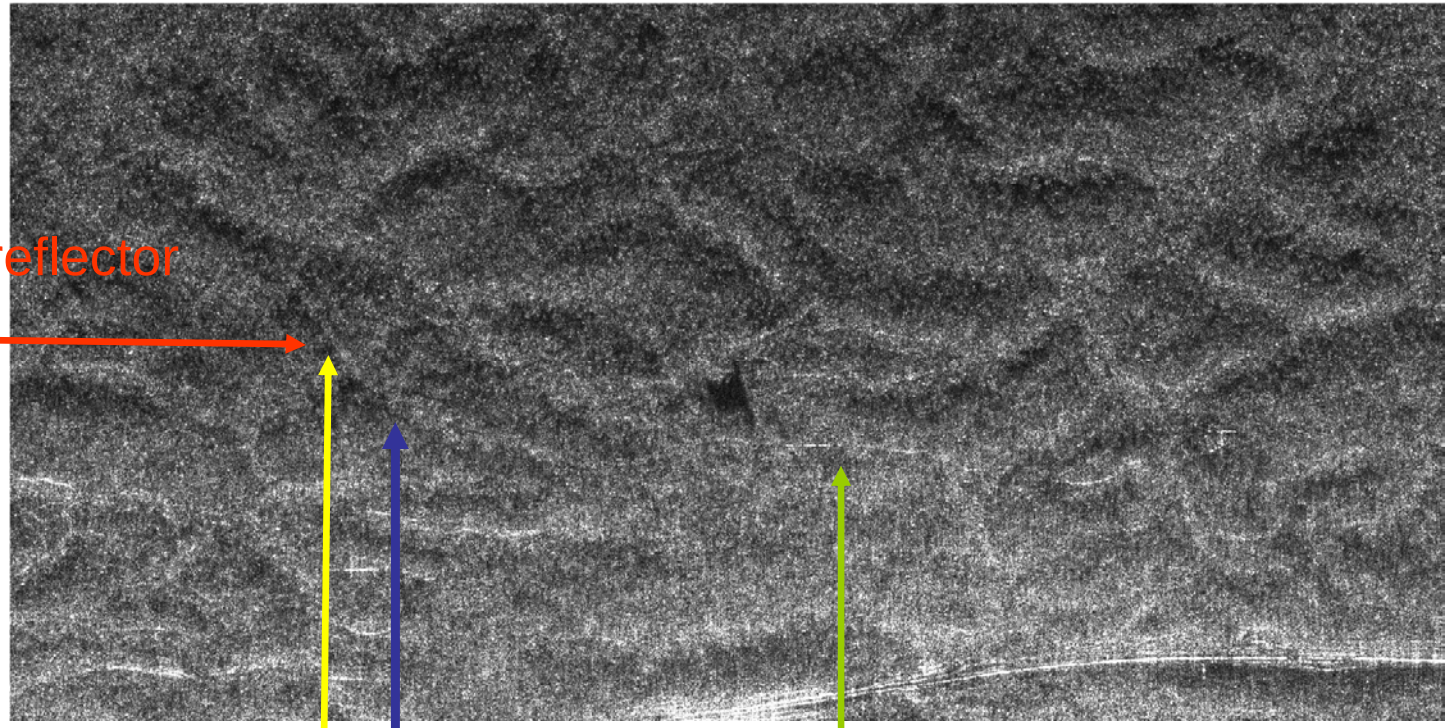
UHF – Hv – no target



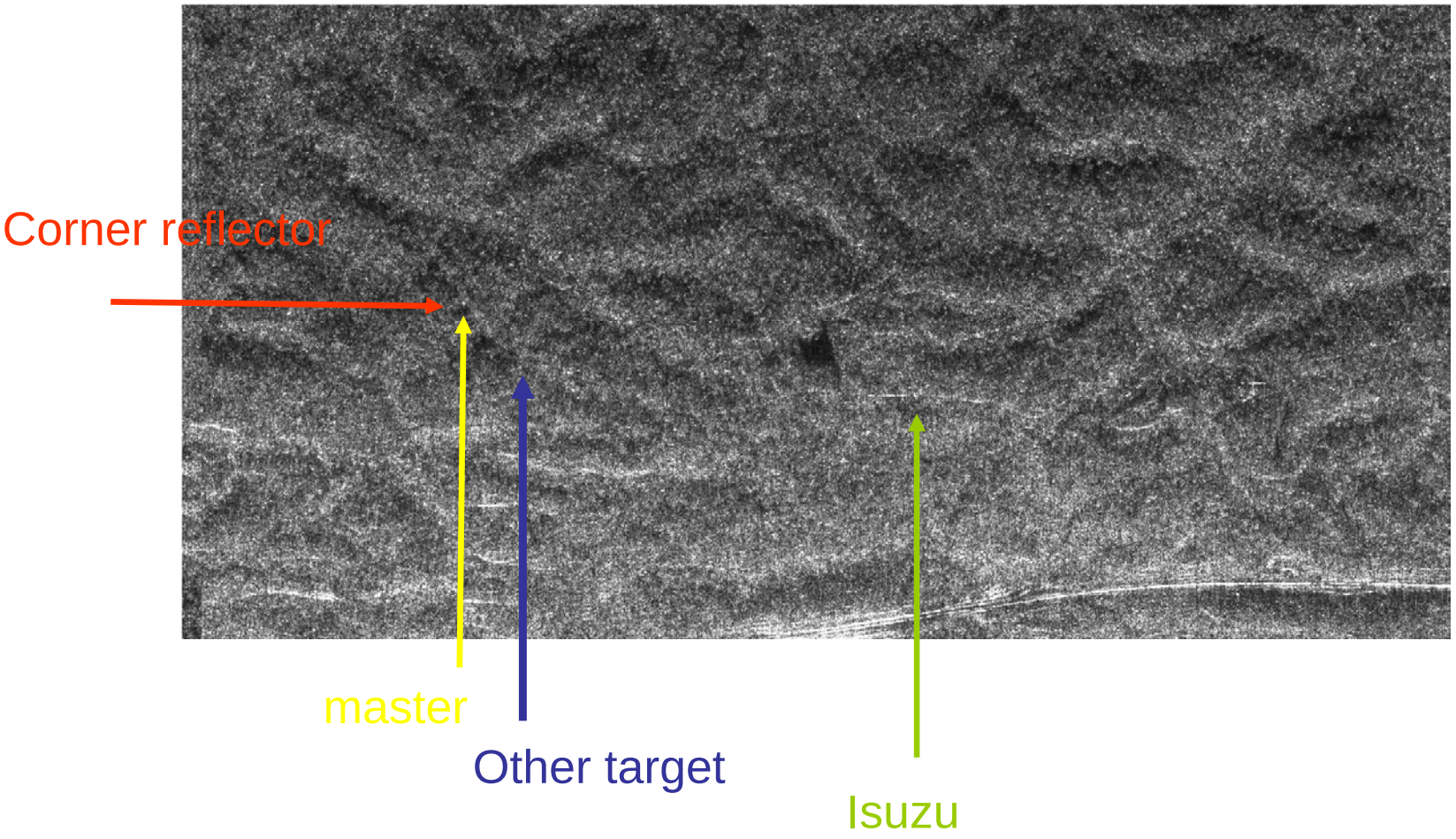
UHF – Hv - targets



UHF – Vv – no target



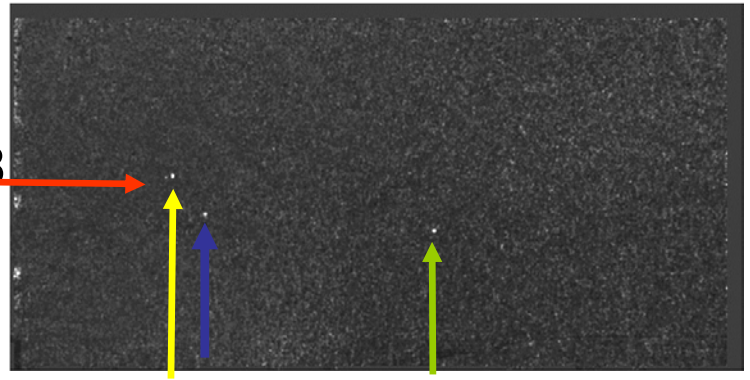
UHF – Vv - targets



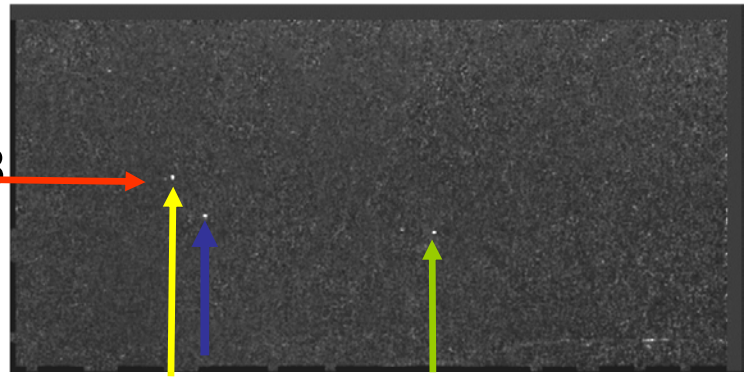
Band P - Polarimetric change detection : performances analysis

24/08

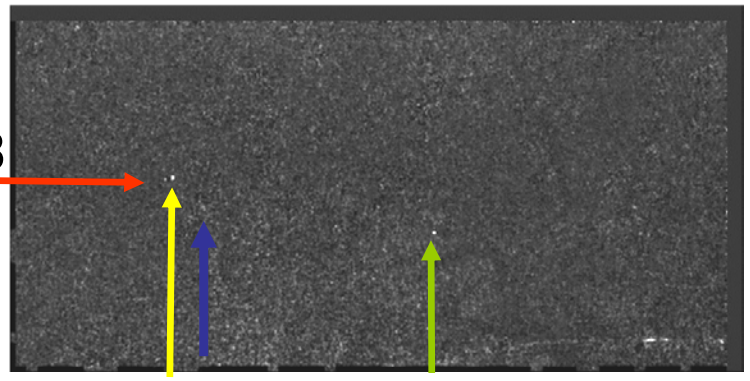
14/08



17/08

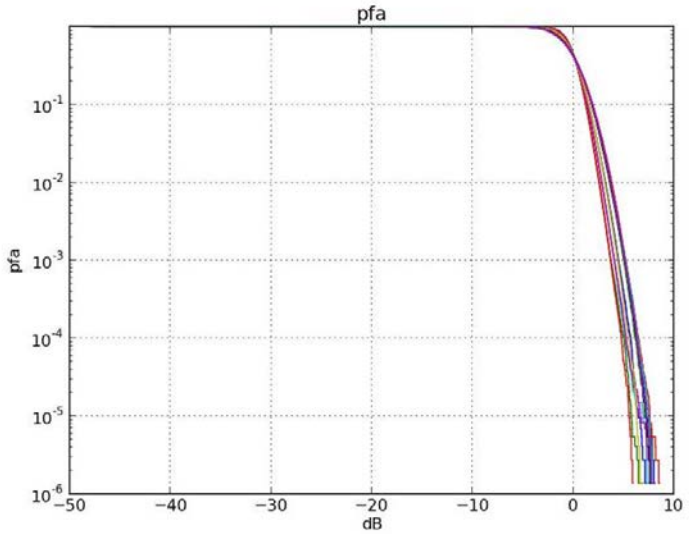


30/08

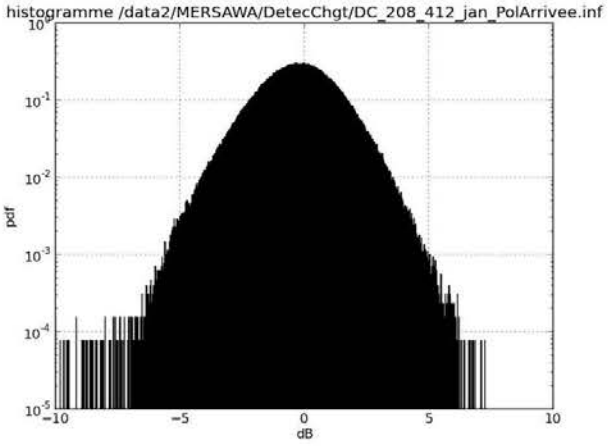


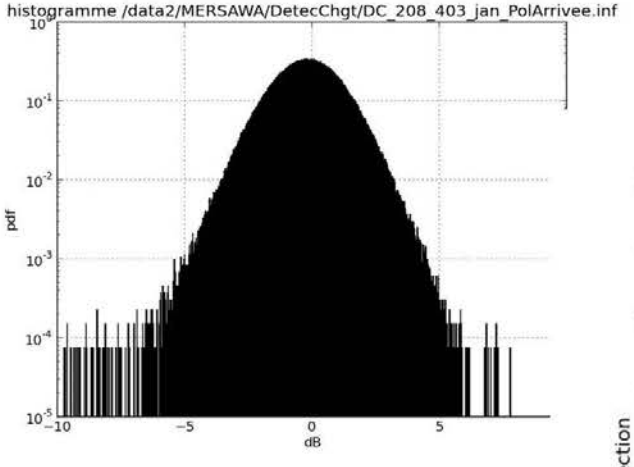
Polarimetric Change detection statistics

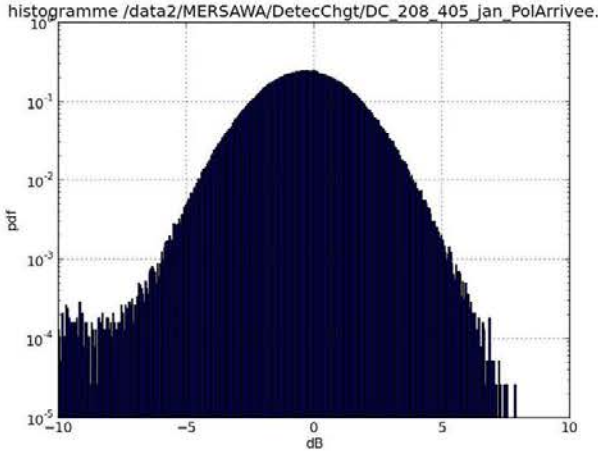
Target	mean	std
Isuzu	16 dB	+/-0.75 dB
Master	16.5 dB	+/-0.7 dB
Other target	10dB	+/-0.5 dB
Corner reflector	6dB	+/-1.4 dB
Clutter	0 dB	+/-1.4 dB

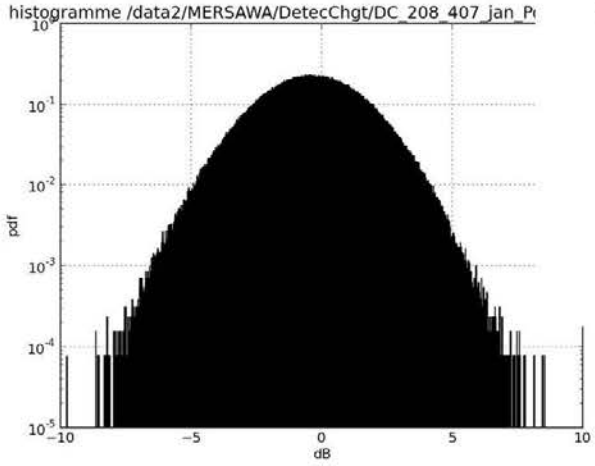


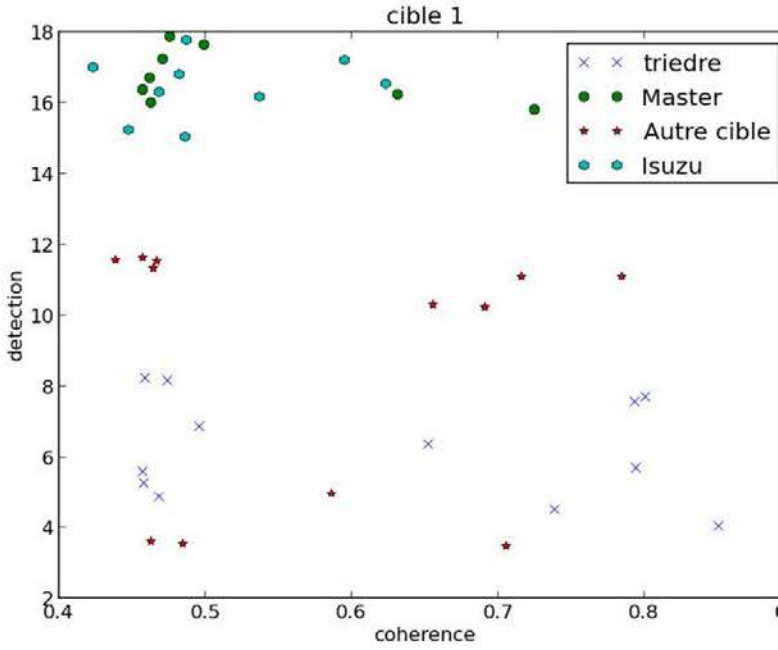
Polarimetric change detection analysis: clutter analysis / Base line





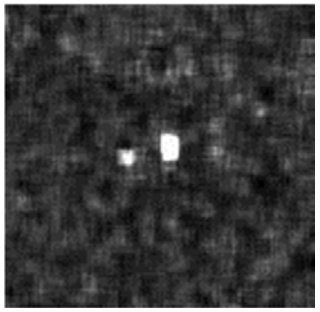




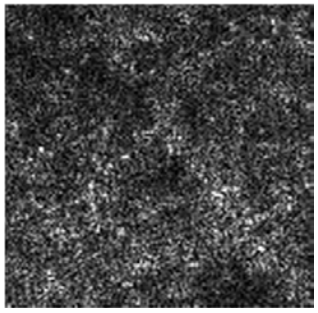


Measured forest attenuation

From change detection =>Precise location of the corner reflector



RCS measurements



Tropical forest attenuation measurements

P band, tropical forest -35m high, 30° incidence

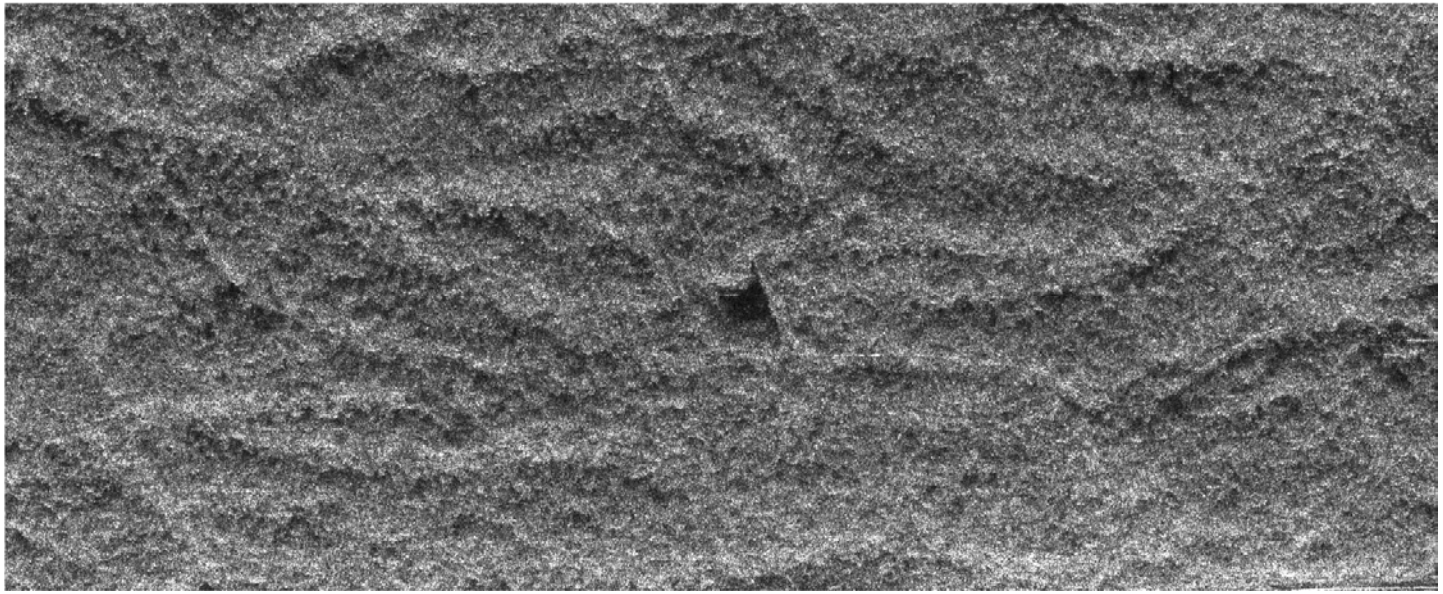
Average on 4 measurements

- 2 ways attenuation Hh: **-14dB +/- 0.5 dB**
- 2 ways attenuation Vv: **-17.6dB +/- 0.8 dB**

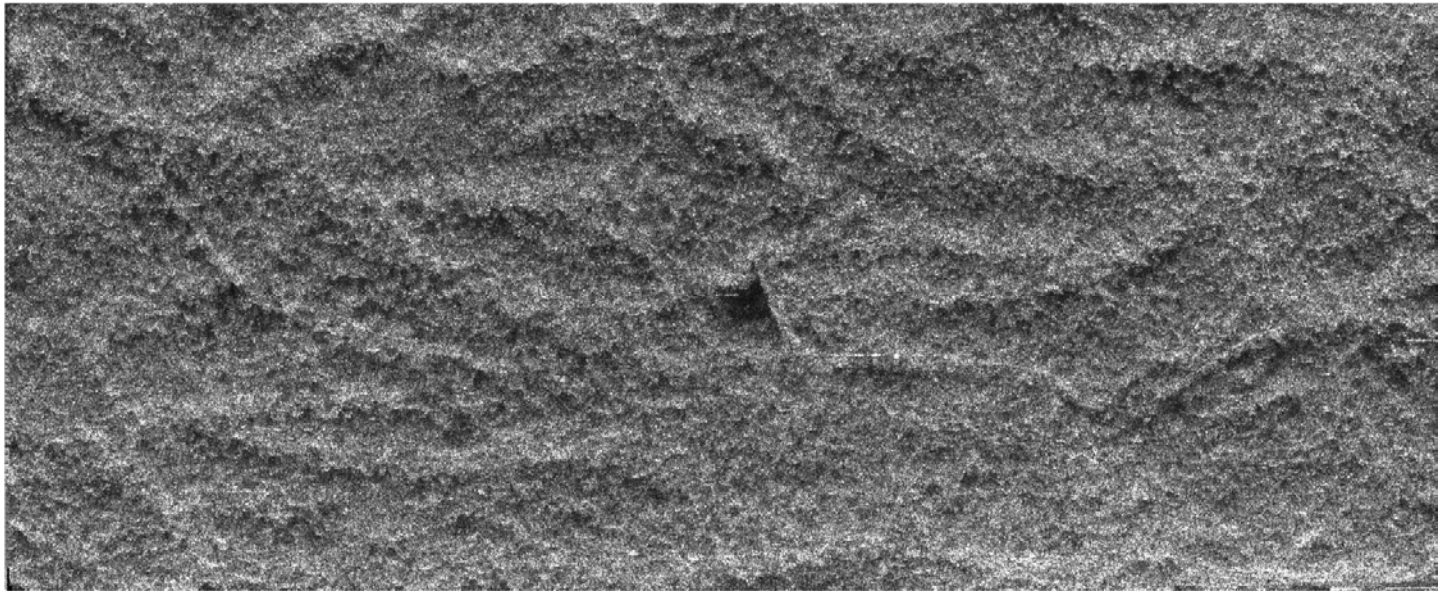
Dataset used in this experiment

Image 208	14/08	ZB
Image 305	17/08	ZB
Image 402	24/08	ZB
Image 403	24/08	Delta h= 15 m
Image 405	24/08	Delta h= 45 m
Image 407	24/08	Delta h= 75 m
Image 506	30/08	ZB

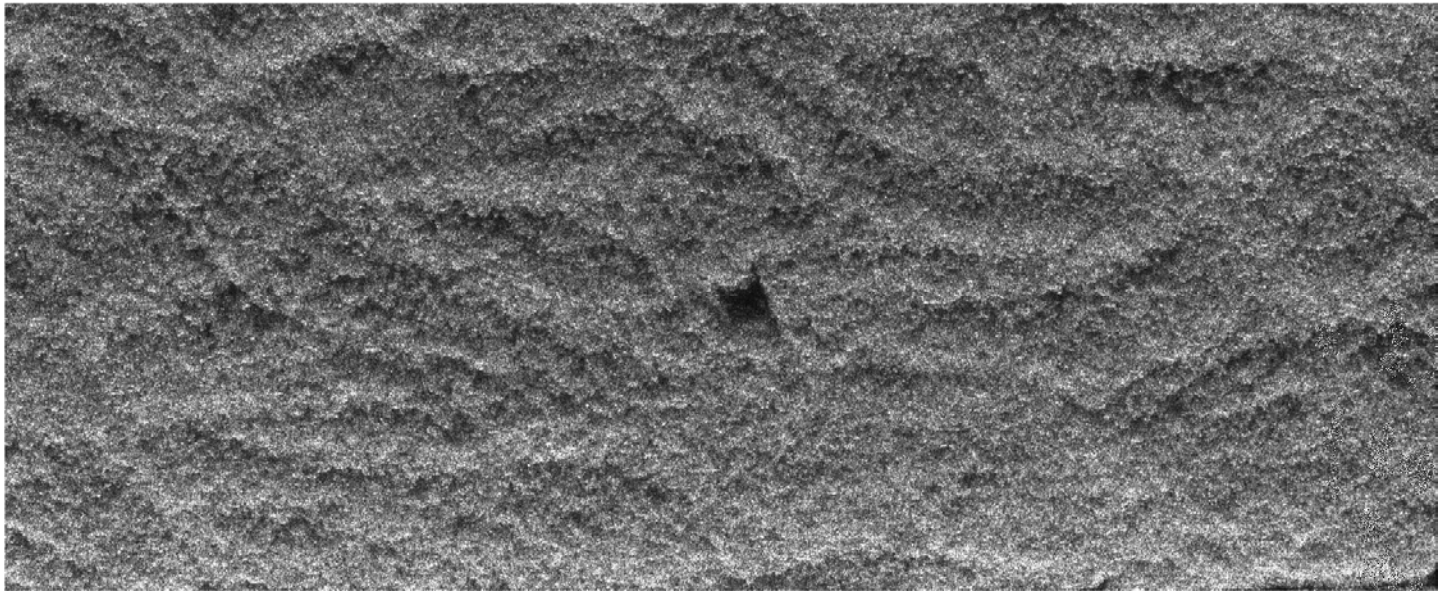
L band Hh no target



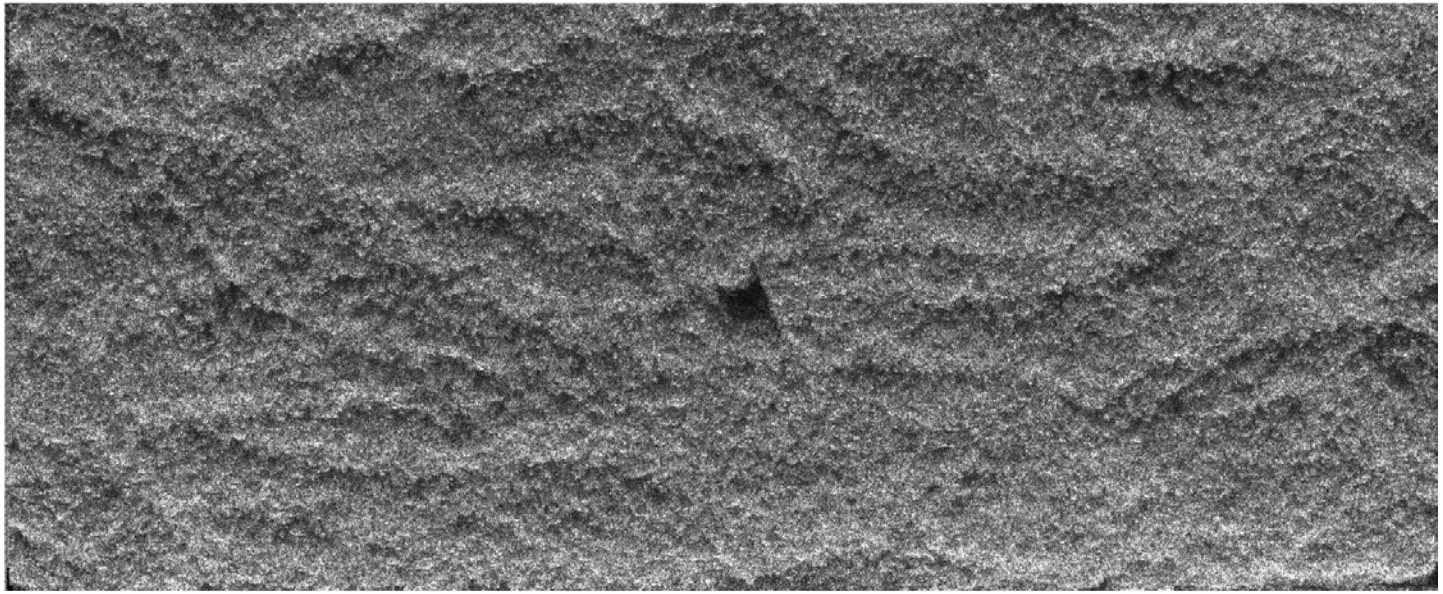
L band Hh with targets



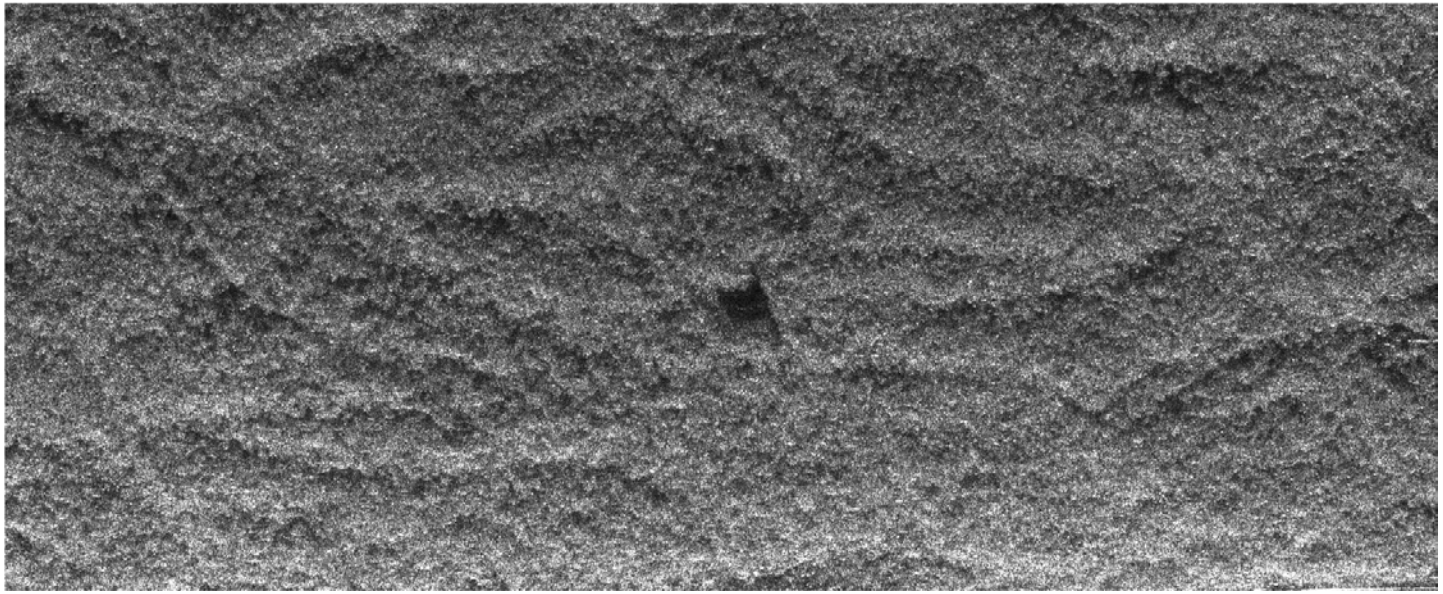
L band Hv no target



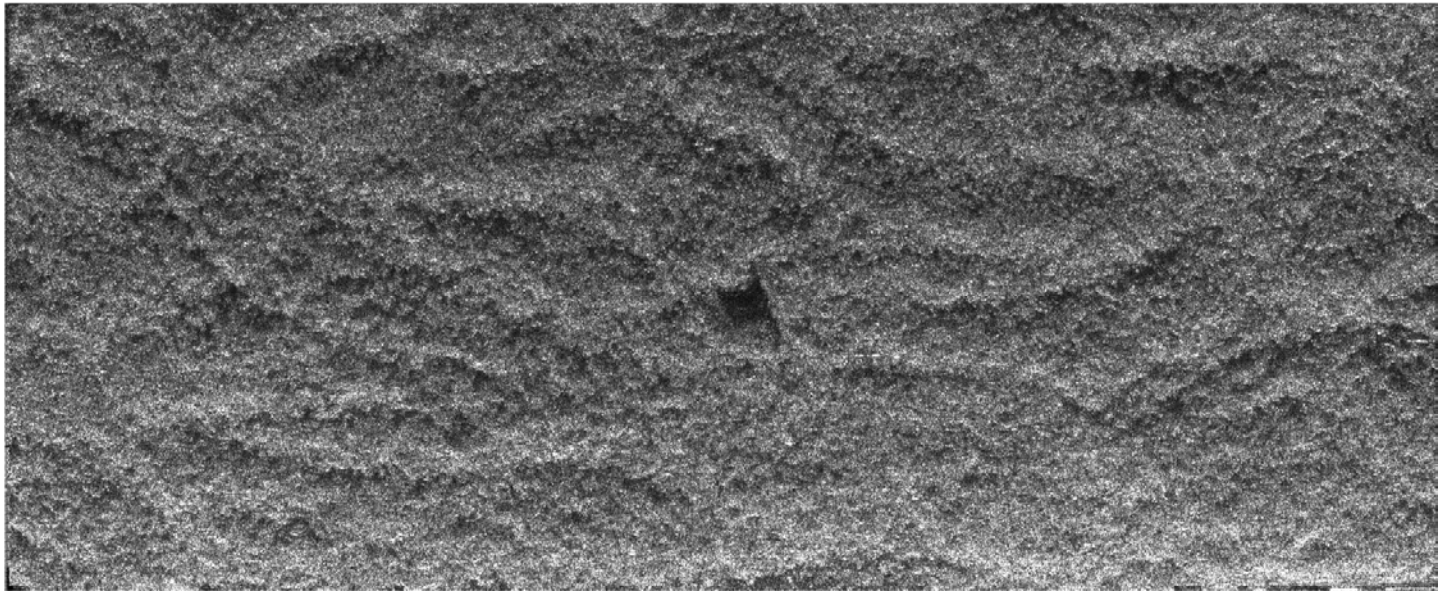
L band Hv with targets



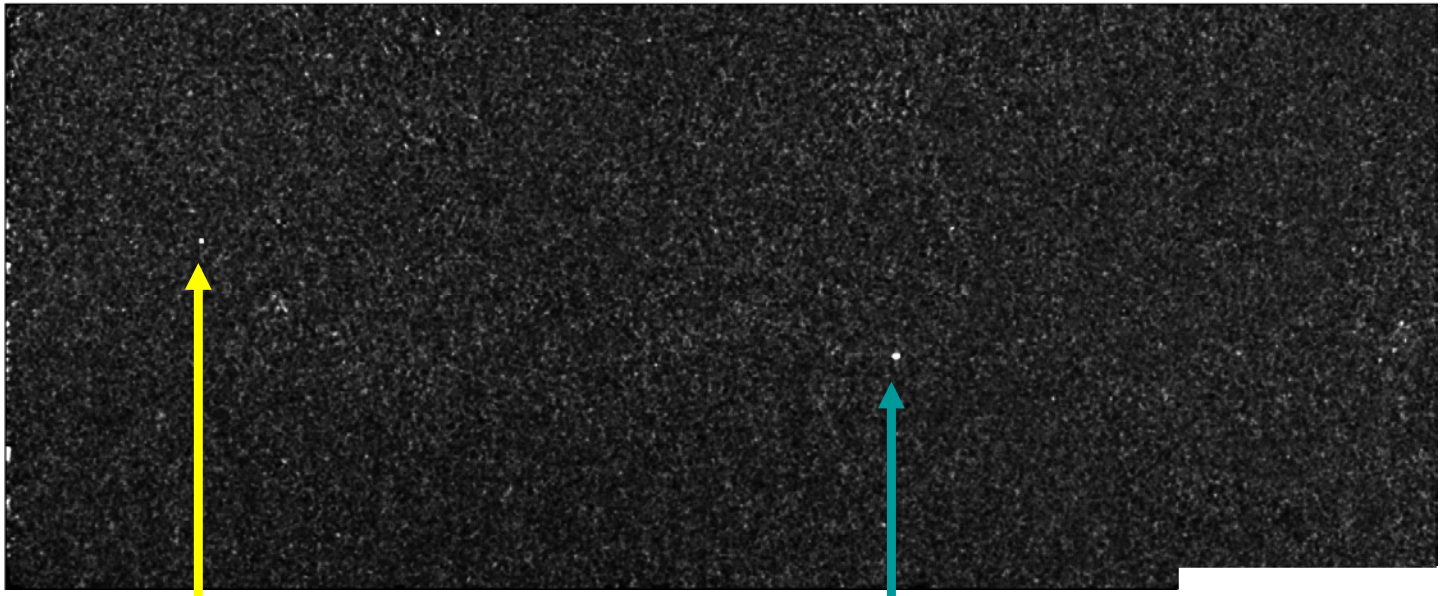
L band Vv no target



L band Vv with targets

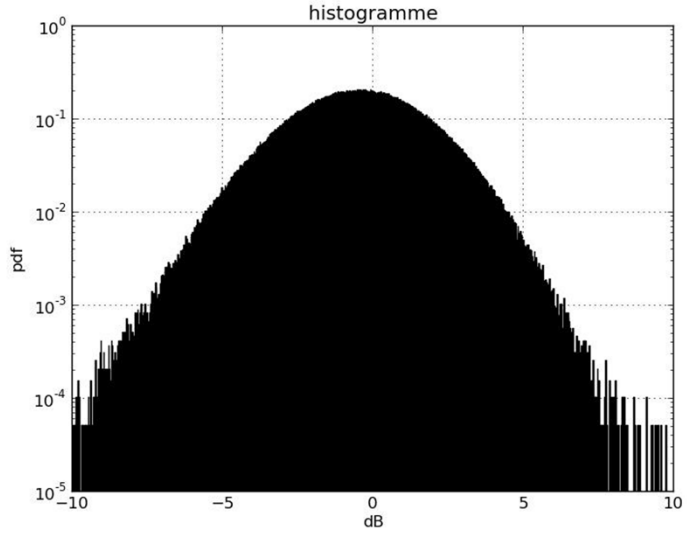


Bande L – Polarimetric change detection : 402 - 506



Master : 15 dB

Isuzu : 26 dB



Conclusion

Application of Novak's polarimetric change detection to the TROPISAR dataset

- 3/4 detected target in P band with no false alarms
- 2/3 detected target in L band
- Under cover detection
- Robustness versus volumic and temporal decorrelation

Measurement of attenuation in P band