

Deep Learning based Enhancement of TomoSAR Stacks

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Authors: Sergio Alejandro Serafin Garcia, Matteo Nannini, Gustavo Daniel Martin Del Campo Becerra, Ronny Hänsch, Andreas Reigber

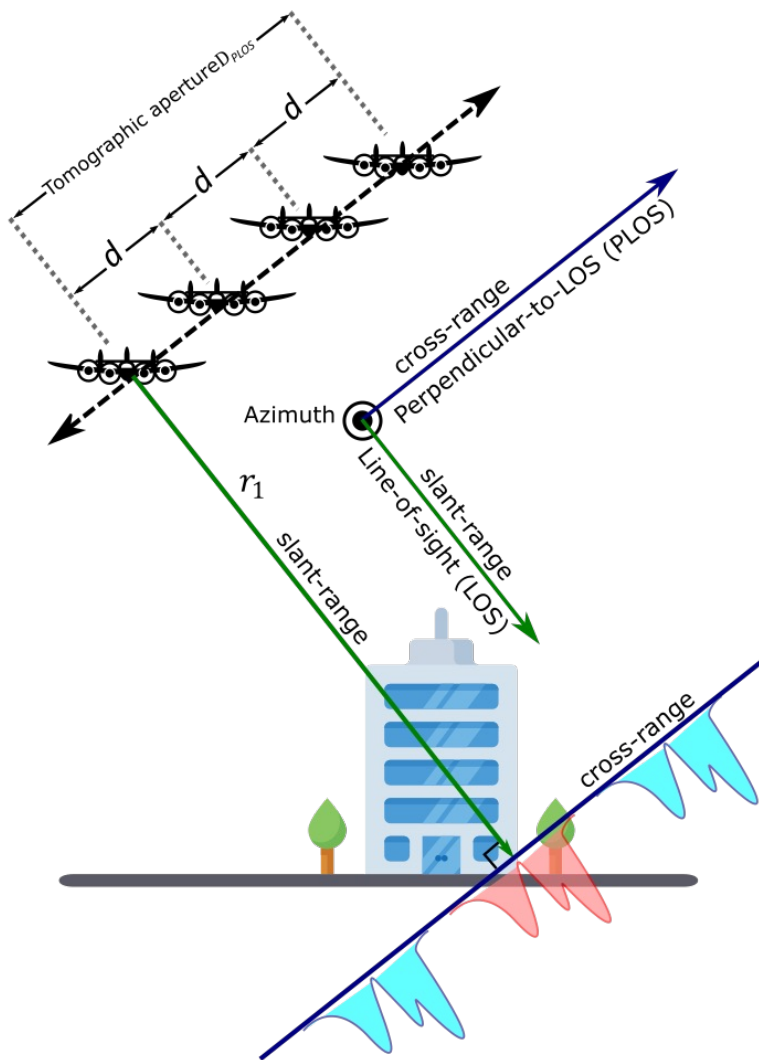
Organization: German Aerospace Center (DLR)



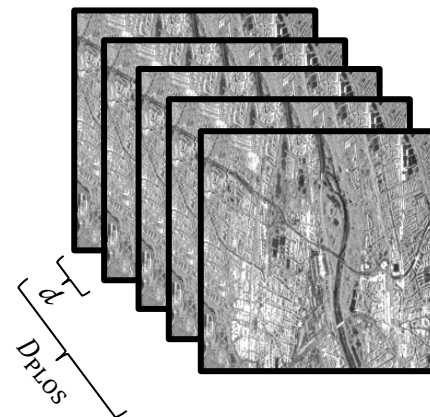
Knowledge for Tomorrow



TomoSAR geometry



TomoSAR stack



Attainable resolution [1]:

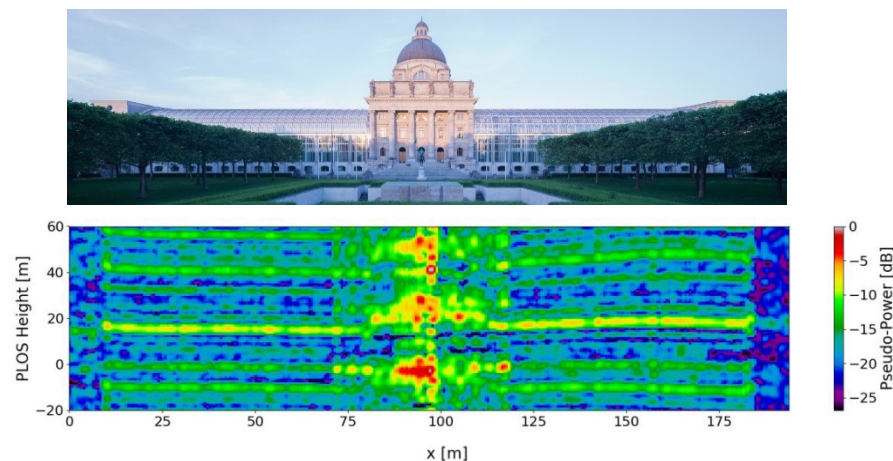
$$\rho_{PLOS} = \frac{(\text{wavelength})r_1}{2D_{PLOS}}$$

Ambiguity position [1]:

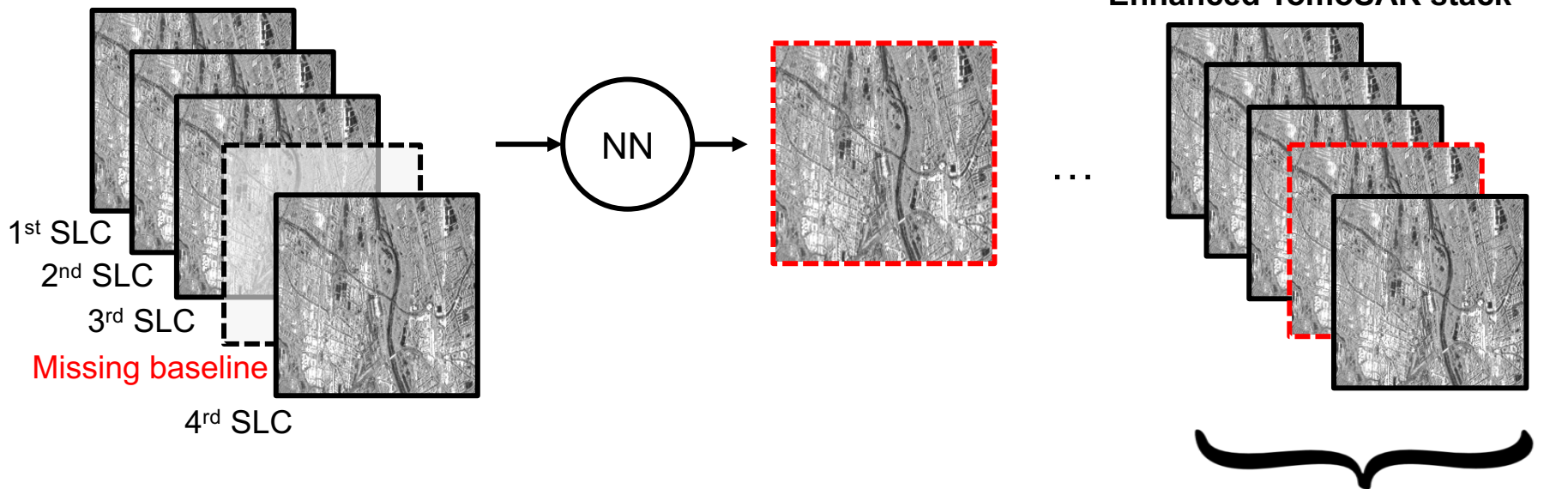
$$V_{PLOS} = \frac{(\text{wavelength})r_1}{2d}$$

TomoSAR processing

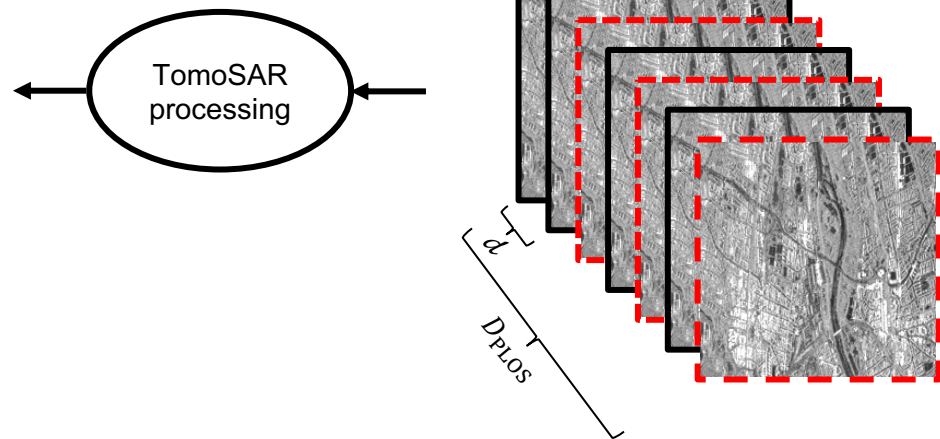
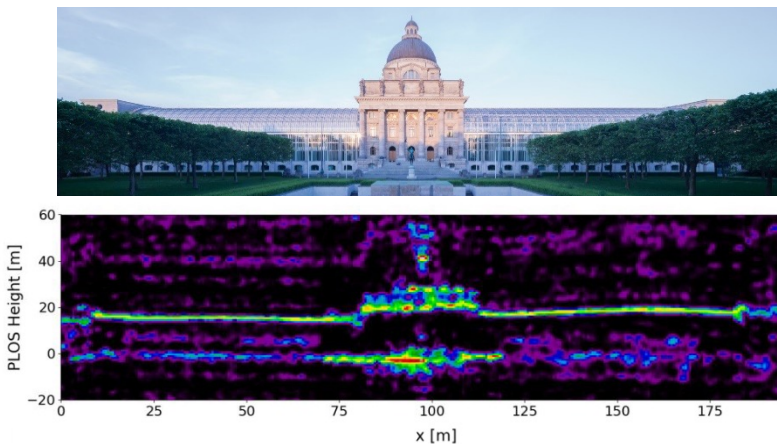
Tomograms



Enhancement of the TomoSAR stack



Tomograms with better resolution and ambiguity suppression



Experiment details

Inputs:

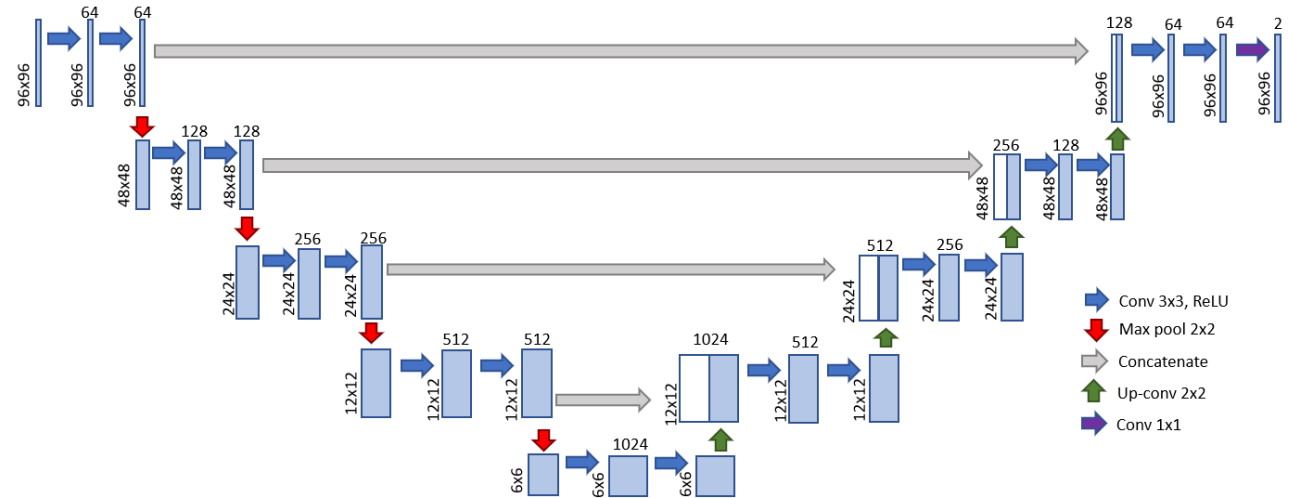
The SLC image from each baseline is represented with **3 channels**:

- Log(amplitude + 1)
- Normalized Real part
- Normalized Imaginary part

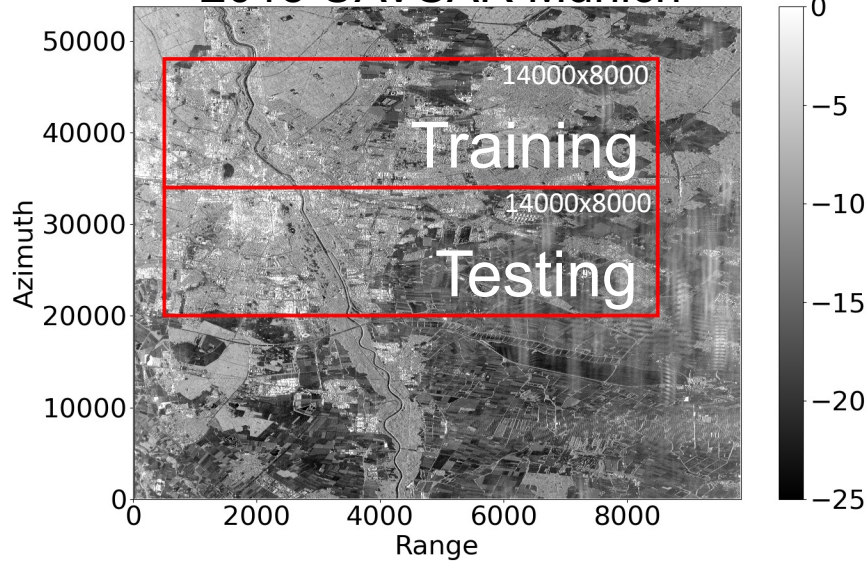
Outputs:

The estimated SLC is represented with **2 channels**:

- Phase
- Log(amplitude + 1)



2015 UAVSAR Munich



- **L-band** (0.24 m wavelength)
- HH polarization
- Resolution of 1.66 m in range
- Resolution of 0.80 m in azimuth

Track	Flight altitude [m]
1	12500
2	12500 + 30
3	12500 + 90
4	12500 + 160
5	12500 + 240
6	12500 + 400
7	12500 + 600



Experiment details

Inputs:

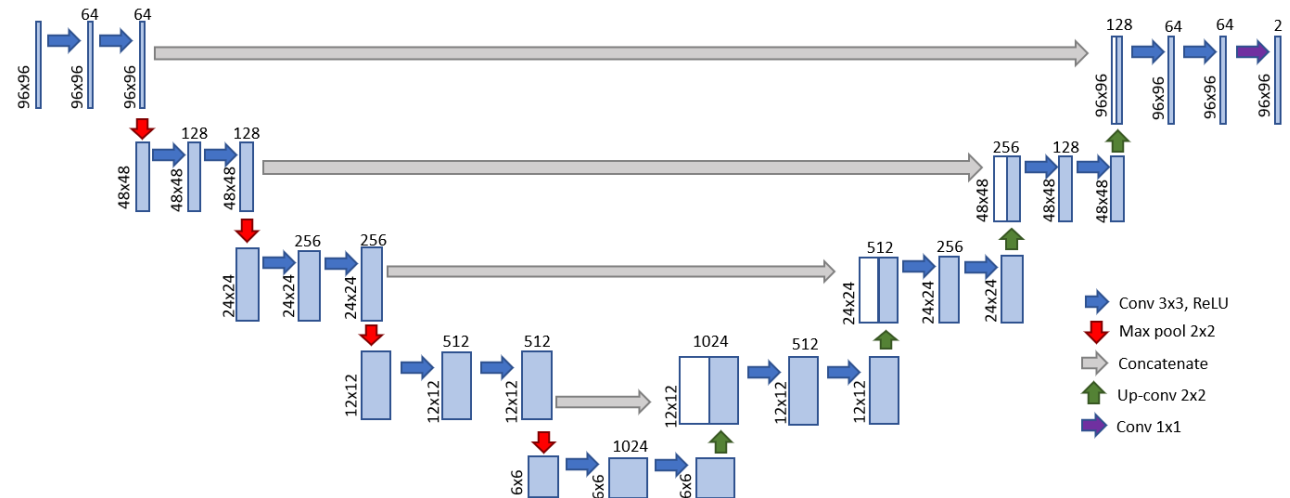
The SLC image from each baseline is represented with **3 channels**:

- Log(amplitude + 1)
- Normalized Real part
- Normalized Imaginary part

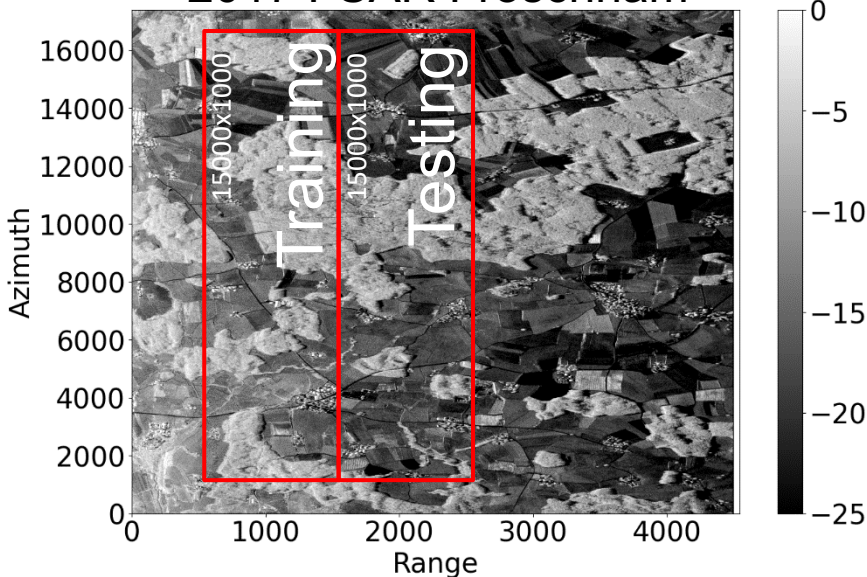
Outputs:

The estimated SLC is represented with **2 channels**:

- Phase
- Log(amplitude + 1)



2017 FSAR Froschham

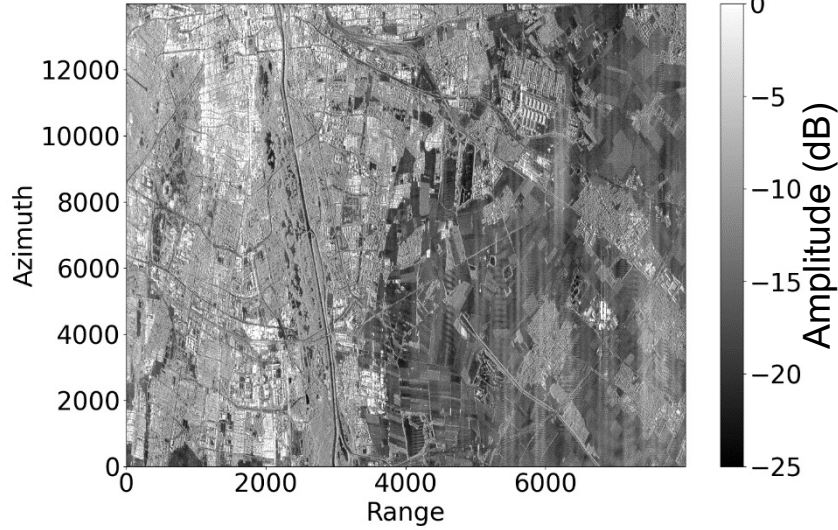


- **L-band** (0.226 m wavelength)
- HH polarization
- Resolution of 1.3 m in range
- Resolution of 0.6 m in azimuth
- Nominal height of **3720 m**
- **15 tracks evenly distributed** in a synthetic aperture of **70 m**

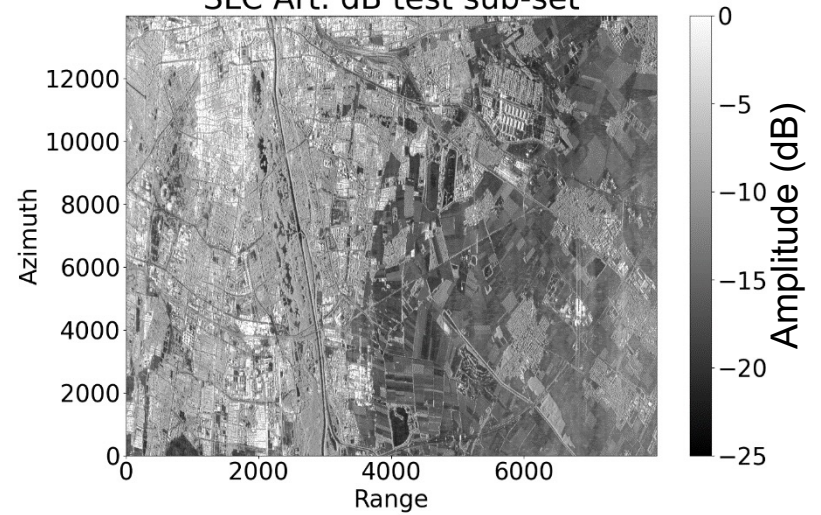


UAVSAR results

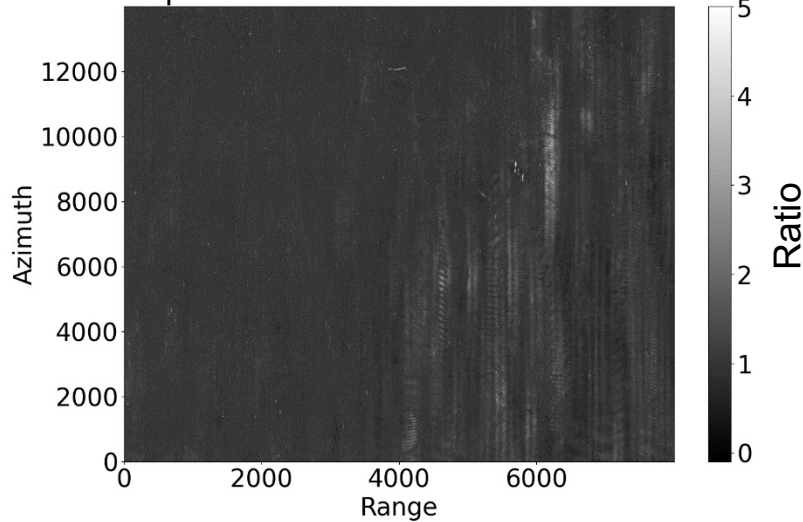
SLC Ori. dB test sub-set



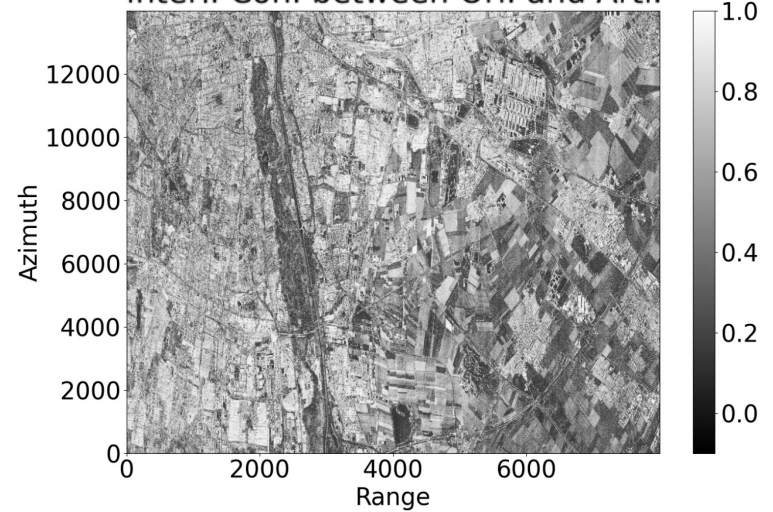
SLC Art. dB test sub-set



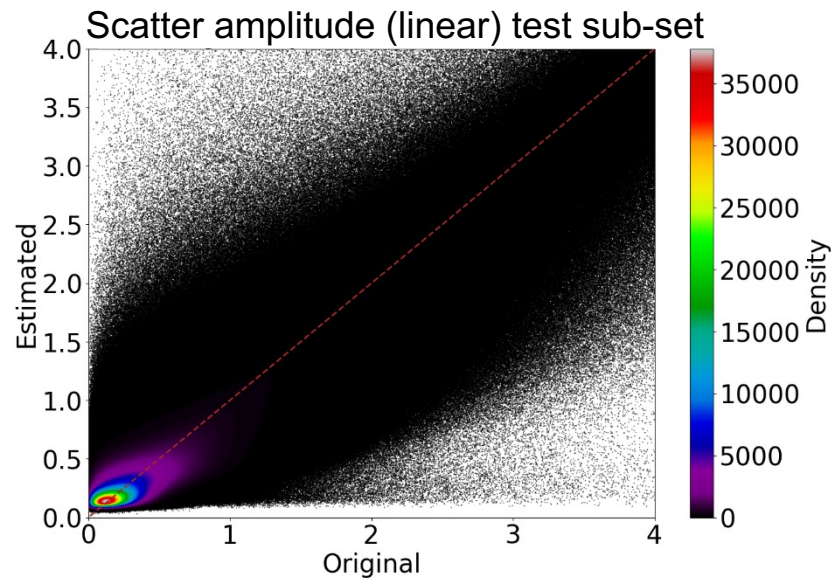
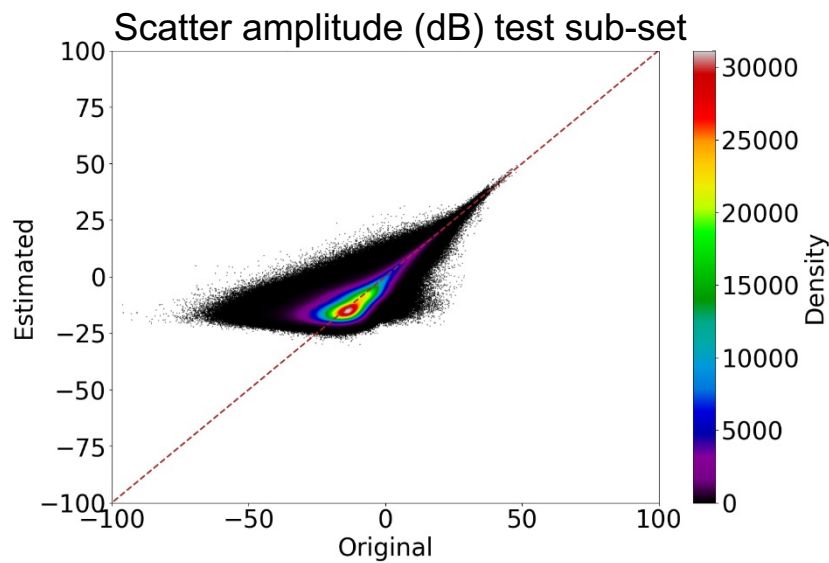
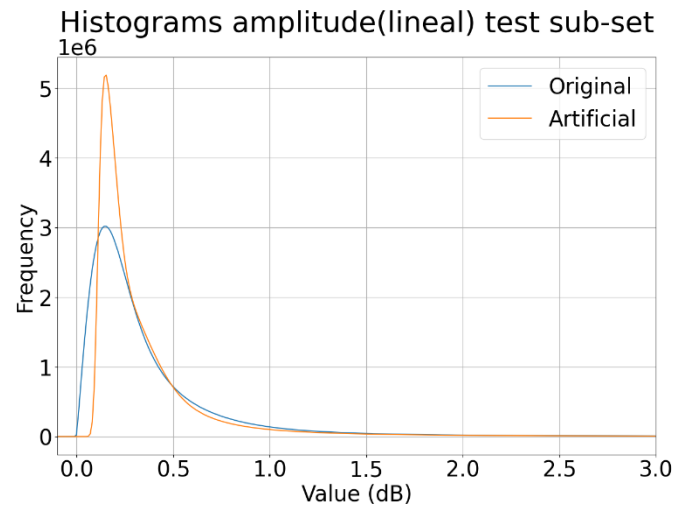
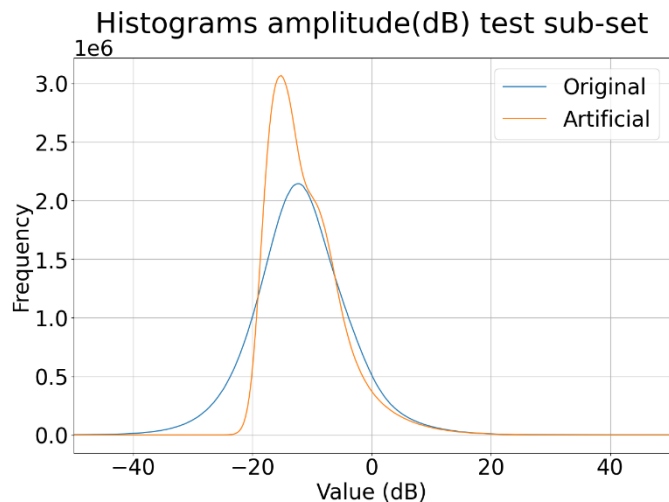
Amplitude ratio Ori. and Art. test sub-set



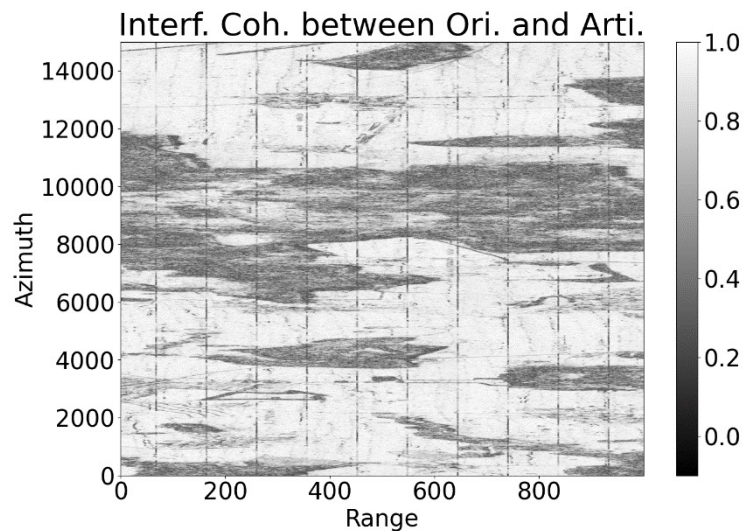
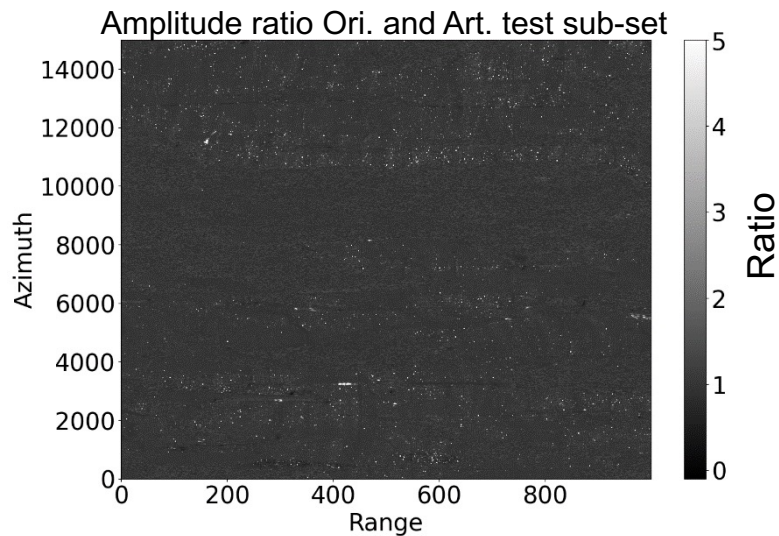
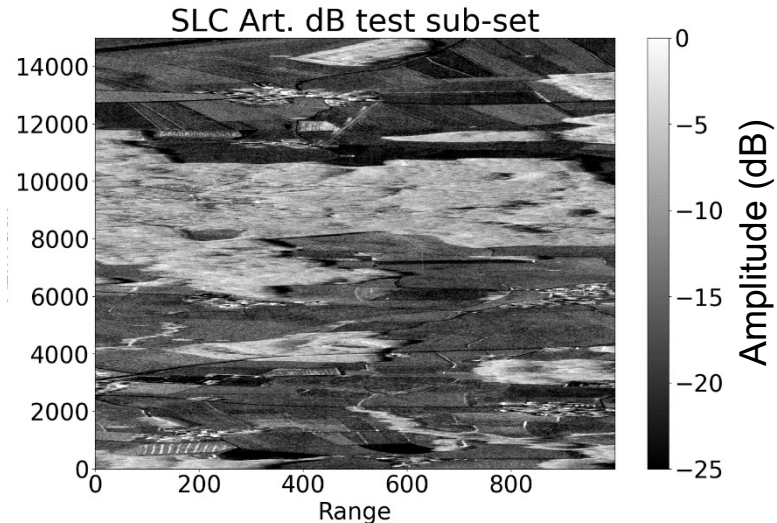
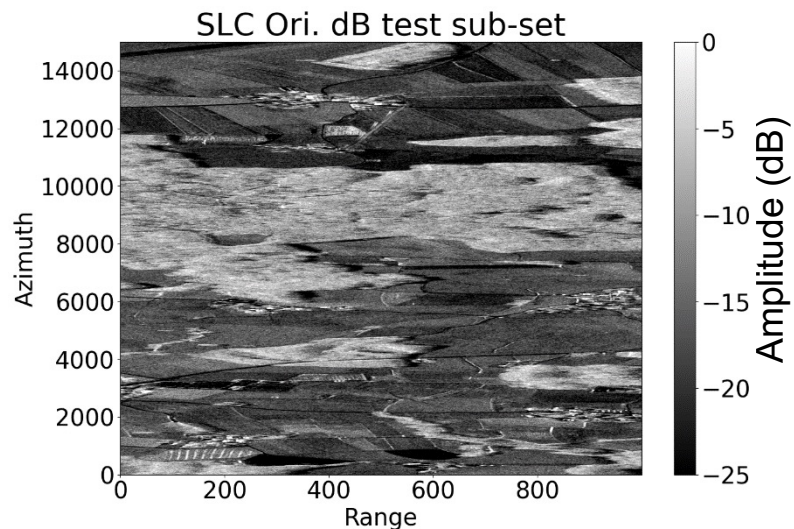
Interf. Coh. between Ori. and Arti.



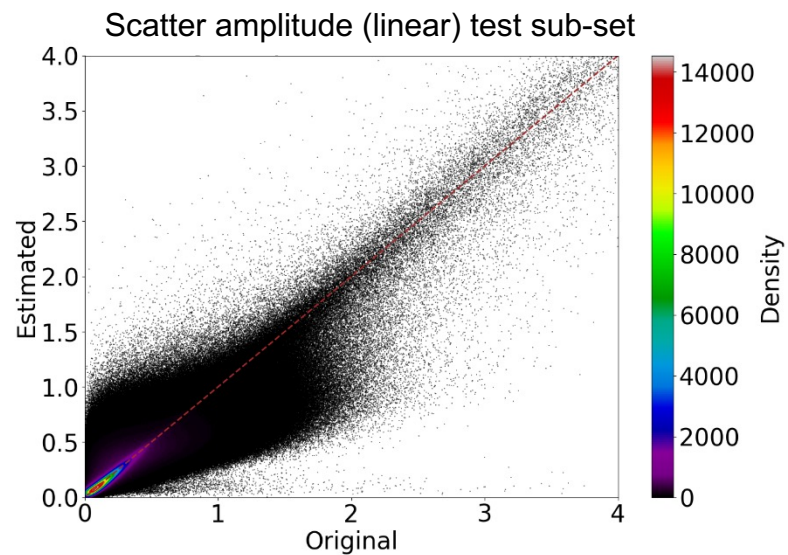
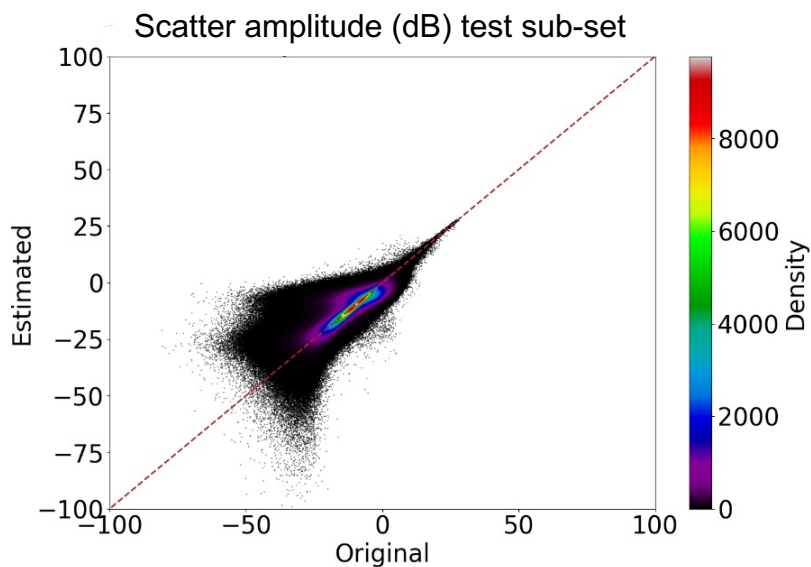
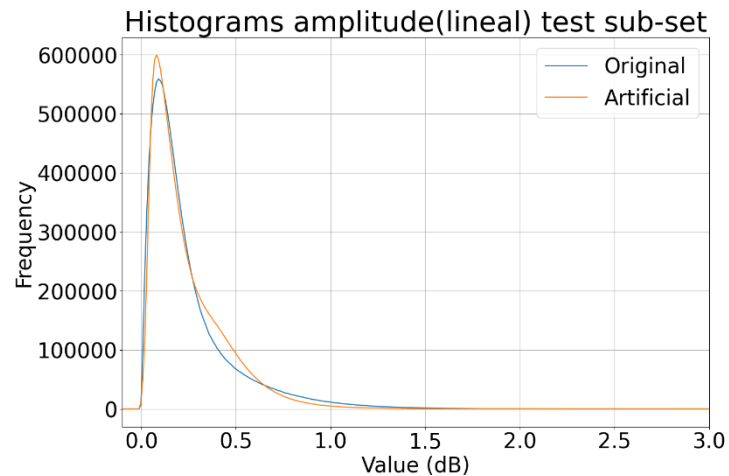
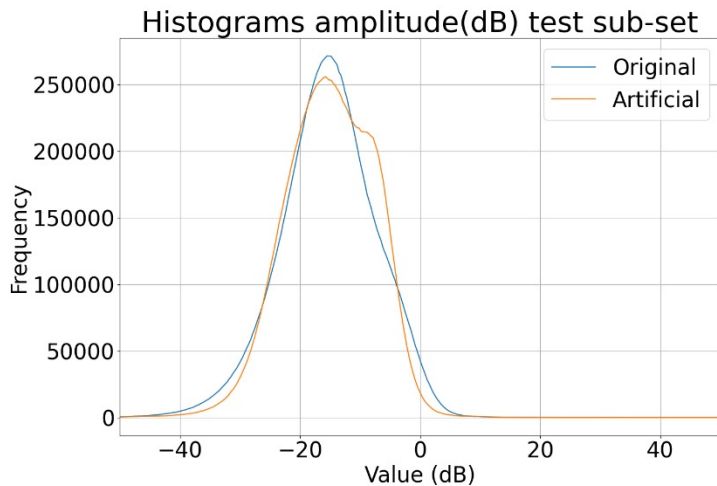
UAVSAR results



FSAR results



FSAR results

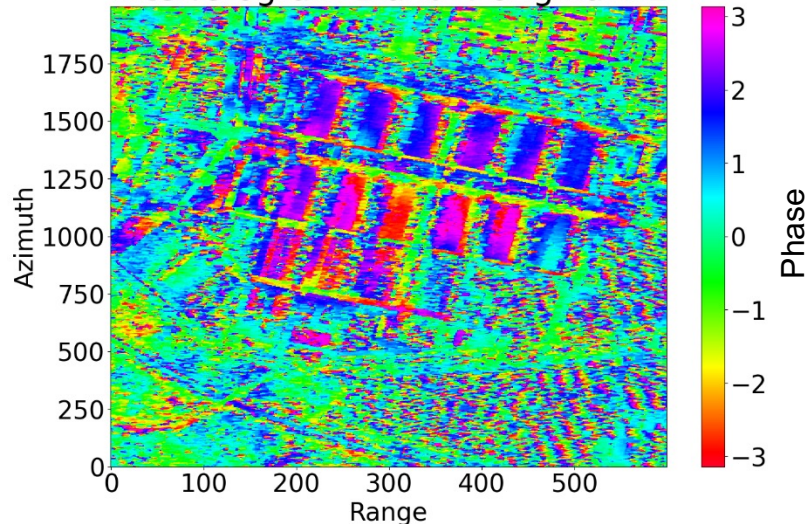


Interferometric validation

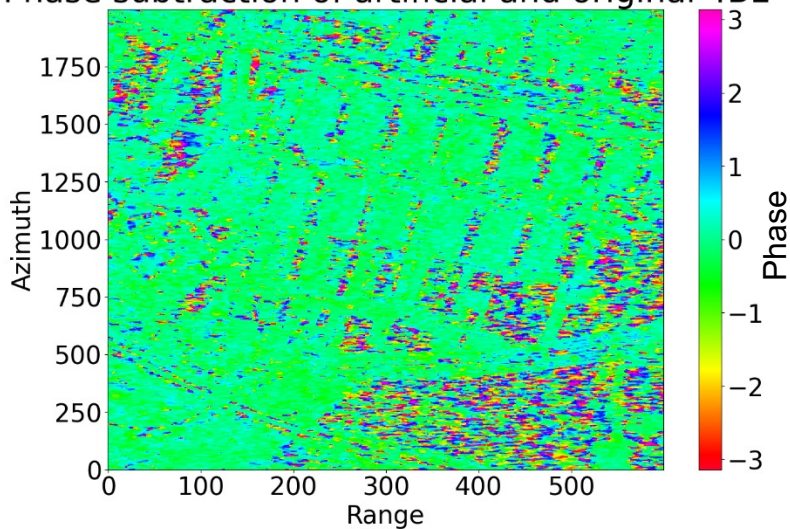
International Congress Center Munich



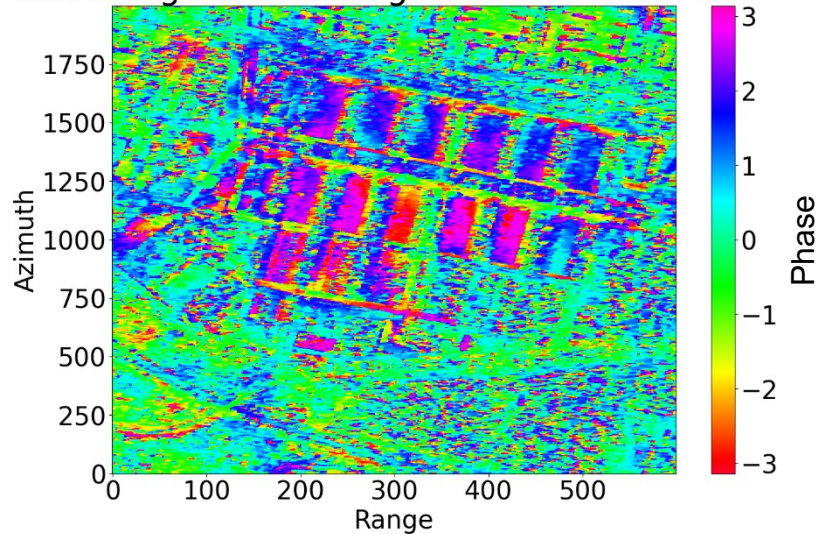
Interferogram 1 and 4 original BL



Phase subtraction of artificial and original 4BL



Interferogram 1 BL original and 4 BL artificial

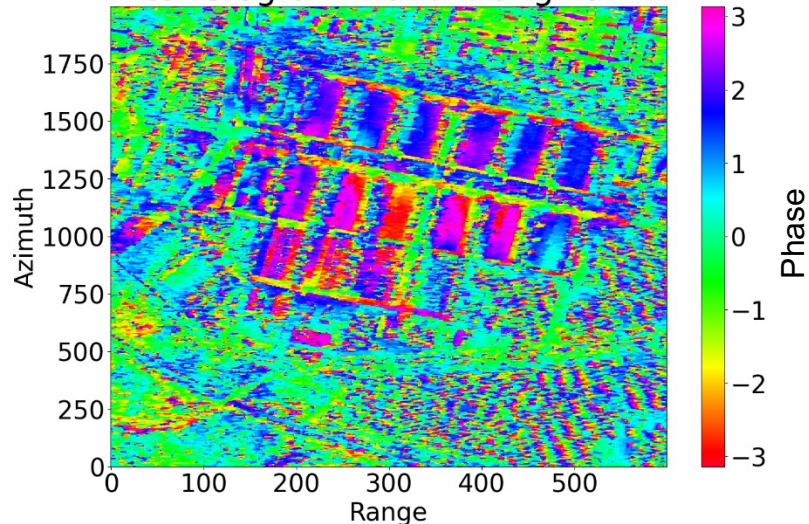


Interferometric validation

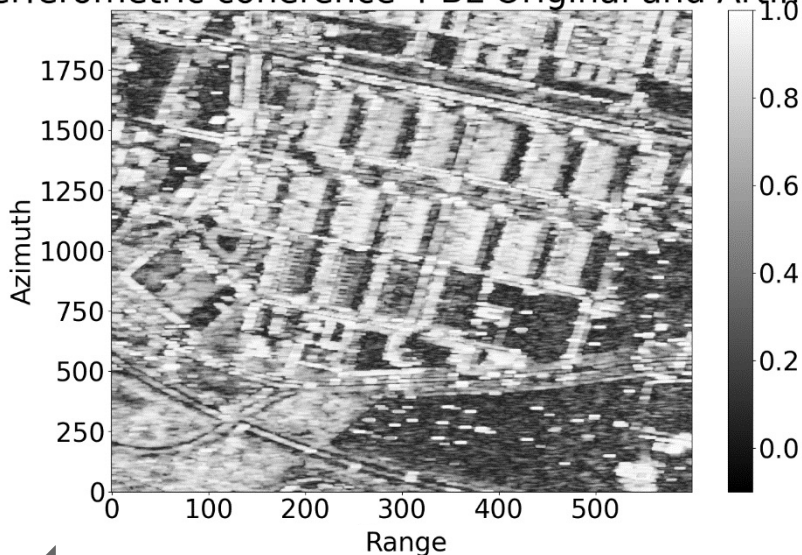
International Congress Center Munich



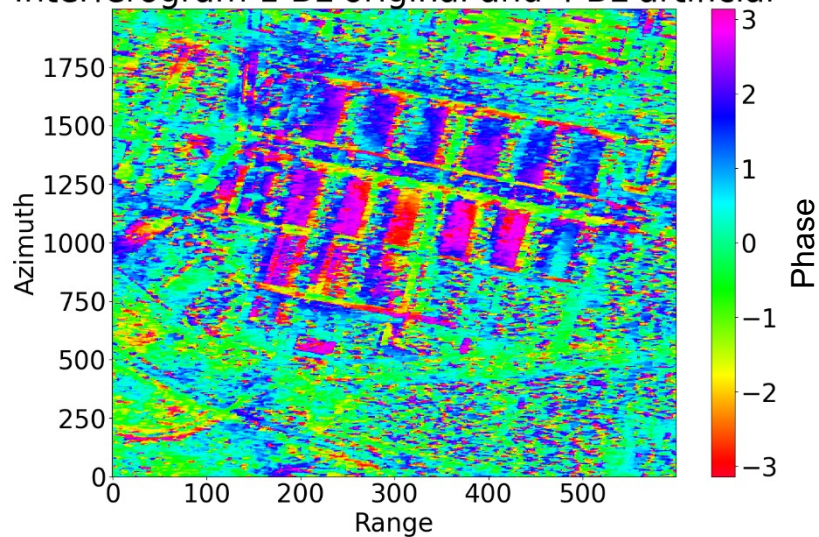
Interferogram 1 and 4 original BL



Interferometric coherence 4 BL Original and Artificial

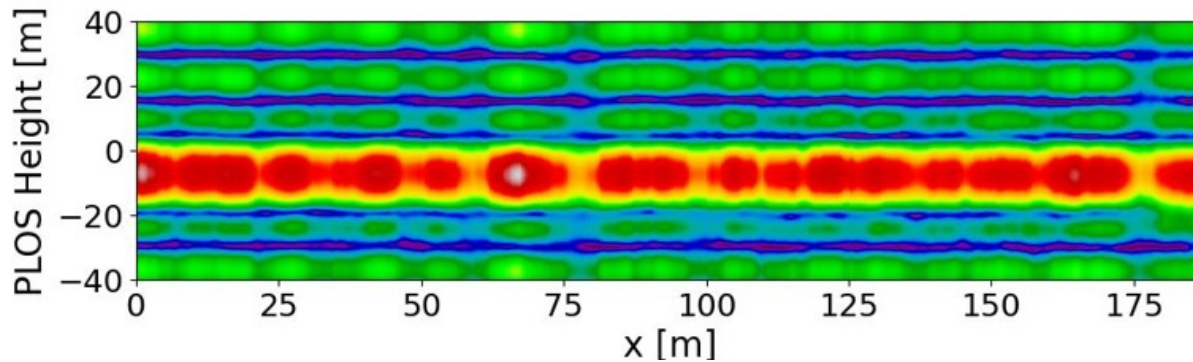
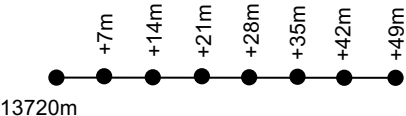


Interferogram 1 BL original and 4 BL artificial

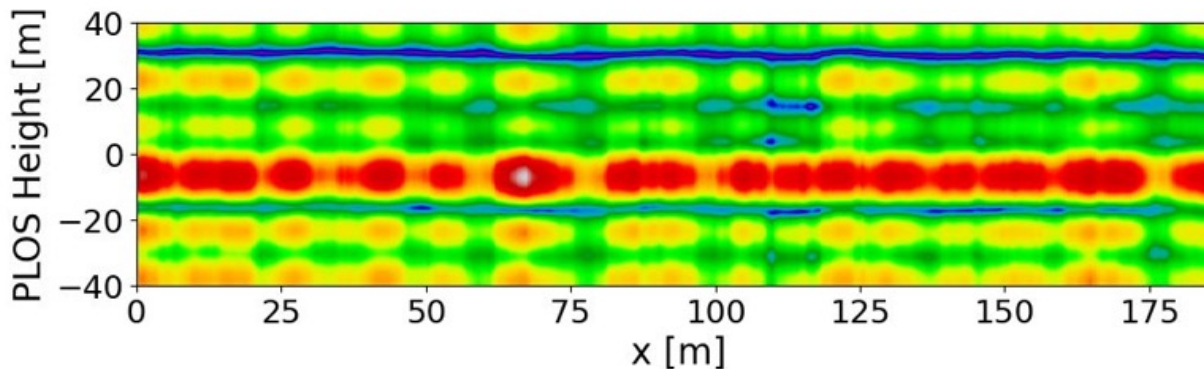
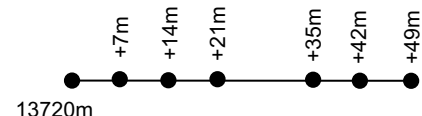


Tomographic experiments FSAR

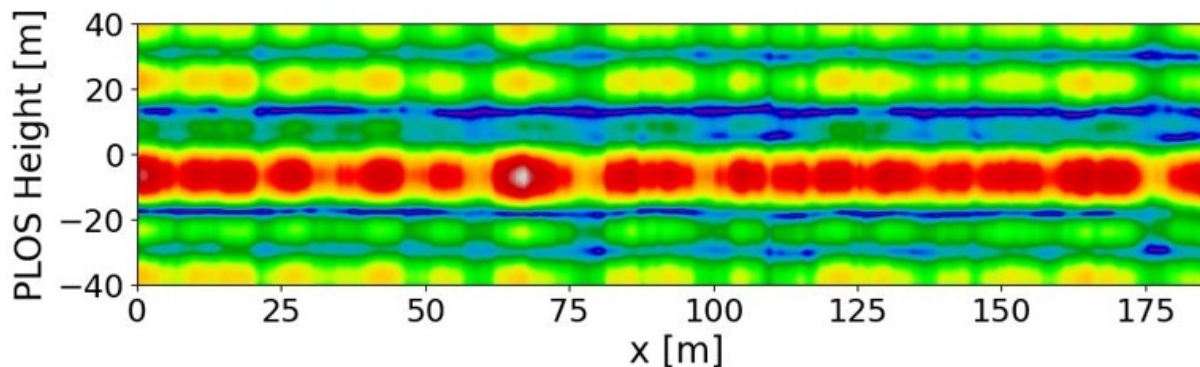
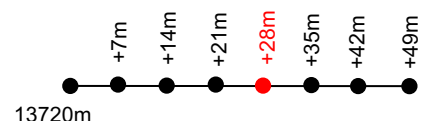
MSF



MSF



MSF



Conclusion

- According to the interferometric experiments made. The estimation of the phase is good enough in certain areas to perform tomography. Nonetheless, some problems need to be address before that.
- A decrees of the RF interference was observed in estimated SLCs
- First tomographic experiments show a small improvement.
- There is still work to do towards make the tomograms work when estimating more than one baseline.



Thanks!!!

Knowledge for Tomorrow

