Effect of RADAR azimuthal rotation speed on Doppler velocity and direction estimation

- Tworit Kumar Dash

- Promoter (TU Delft): Prof. Dr. Alexander Yarovoy (Chairman, Ms3)
- Supervisor (TU Delft): Dr. Oleg Krasnov

TU Delft

Challenge

- When the radar beam on azimuth rotates very fast, the time on target at one direction in space is too low.
- The faster the radar rotates, the smaller are the time samples at one direction of space.

$$T_d = \frac{BW[rad]}{\Omega[rad\,.\,s^{-1}]}$$

Beamwidth

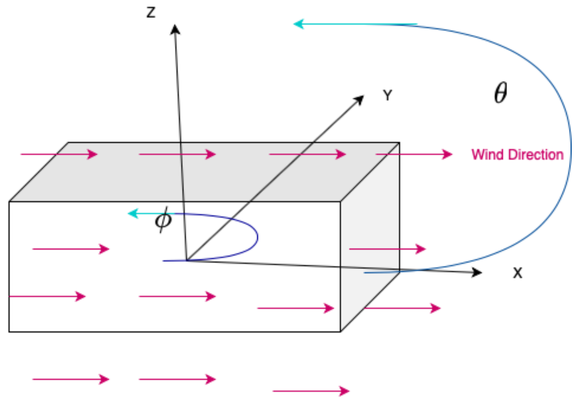
Rotation speed in radian/second

Time spent in one single Beamwidth in space

Model of Homogeneous wind

- Wind is considered homogeneous
- The elevation of the radar beam is fixed
- The wind velocity spectrum for ground truth is considered as a Gaussian shaped spectrum.

$$S(v) = \frac{1}{\sqrt{2\pi\sigma_v^2}} e^{\frac{-(v-\mu_v)^2}{2v\bar{\sigma}_v}}$$



Radar forward model

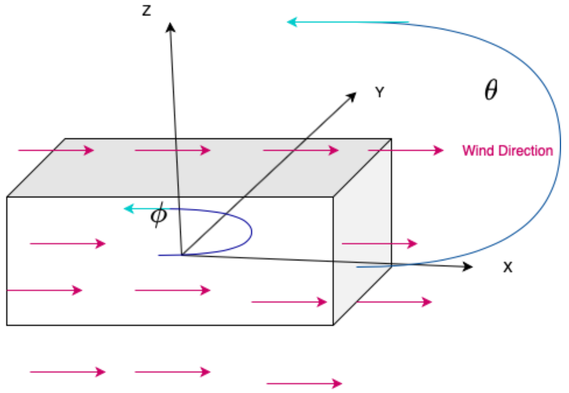
- The time domain signal is sampled based on the time on target direction.
- The phase is modified based on the observation direction

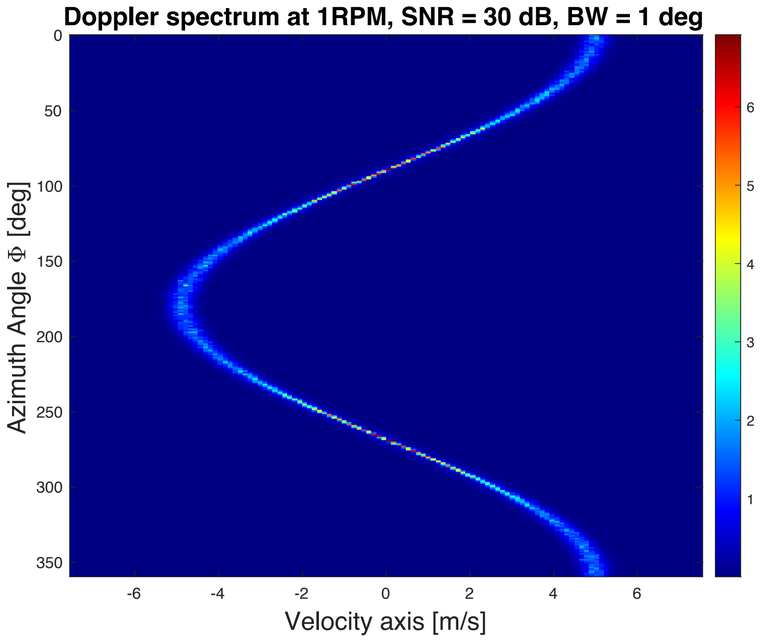
$$s_\Omega(t) = A(t)e^{j\Psi(t)\cos(\phi_{wind}-\phi(t))}$$

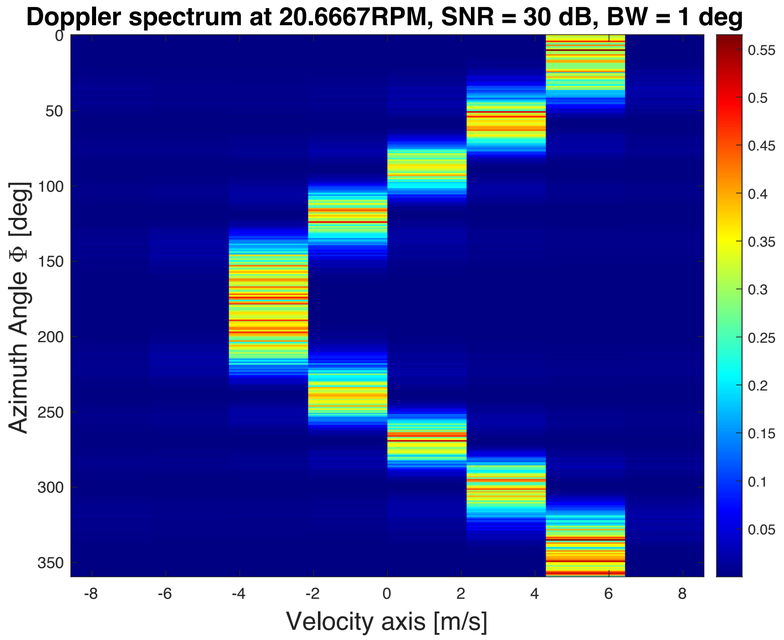
$$\phi(t) = \phi_0 + \Omega t$$

Preliminary Results

Ground Truth: $\mu = 5[m/s] \quad \sigma = 0.2[m/s] \quad \phi_{wind} = 0$





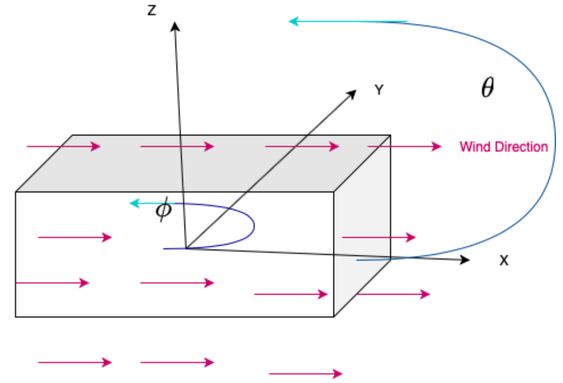


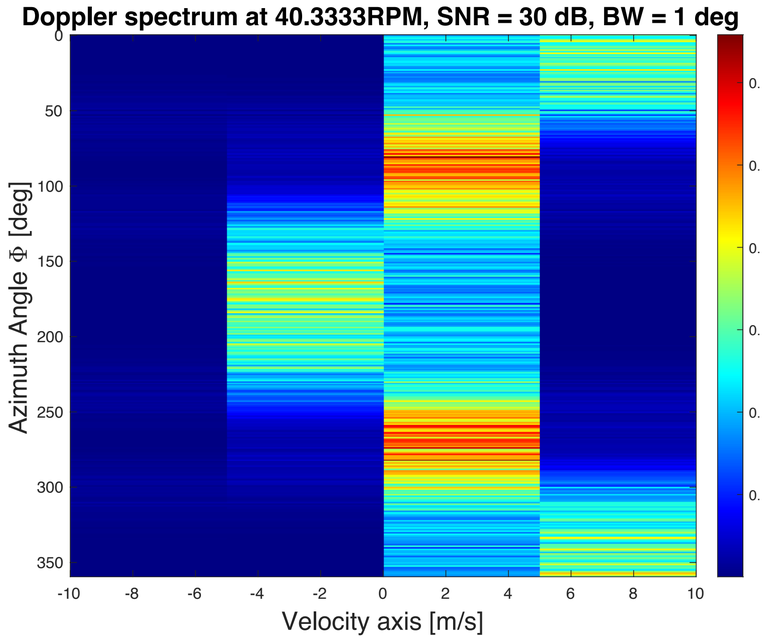
$\Omega[RPM]$	N_{bursts}	Samples for FFT processing
1	167	128
20	9	8
40	5	4
60	3	2

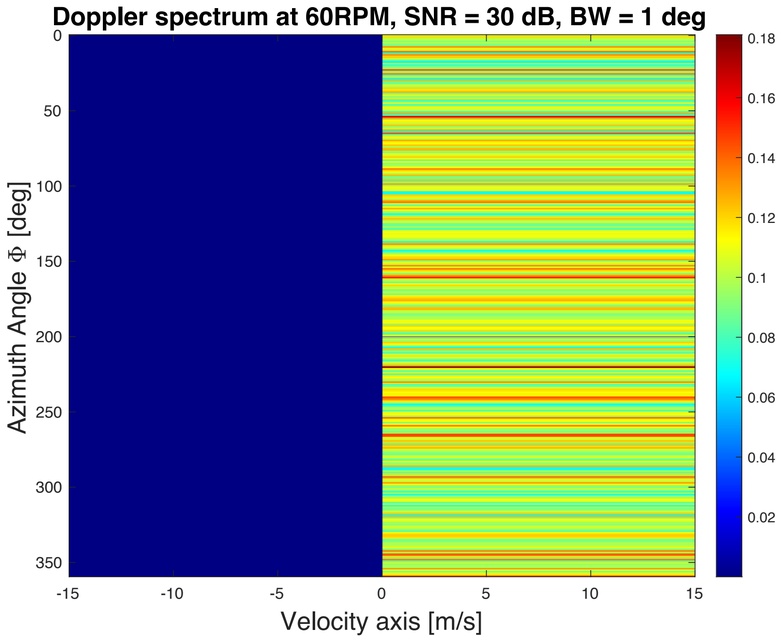
TU Delft

Preliminary Results

Ground Truth: $\mu = 5[m/s] \quad \sigma = 0.2[m/s] \quad \phi_{wind} = 0$







$\Omega[RPM]$	N_{bursts}	Samples for FFT processing
1	167	128
20	9	8
40	5	4
60	3	2

TU Delft

Short-term Goal of this model

- Find mean Doppler velocity and Doppler spectrum width as a function of :

$$V_{mean} = g(SNR, BW, \Omega)$$

$$\sigma_{width} = f(SNR, BW, \Omega)$$

- Error analysis of mean Doppler velocity and Doppler spectrum width as a function of the above mentioned quantities
- To develop an algorithm which estimates the direction of wind flow.