Radar Laboratory Assignment 01

ET4169 - Microwaves, Radar and Remote Sensing, Q3 2019-2020

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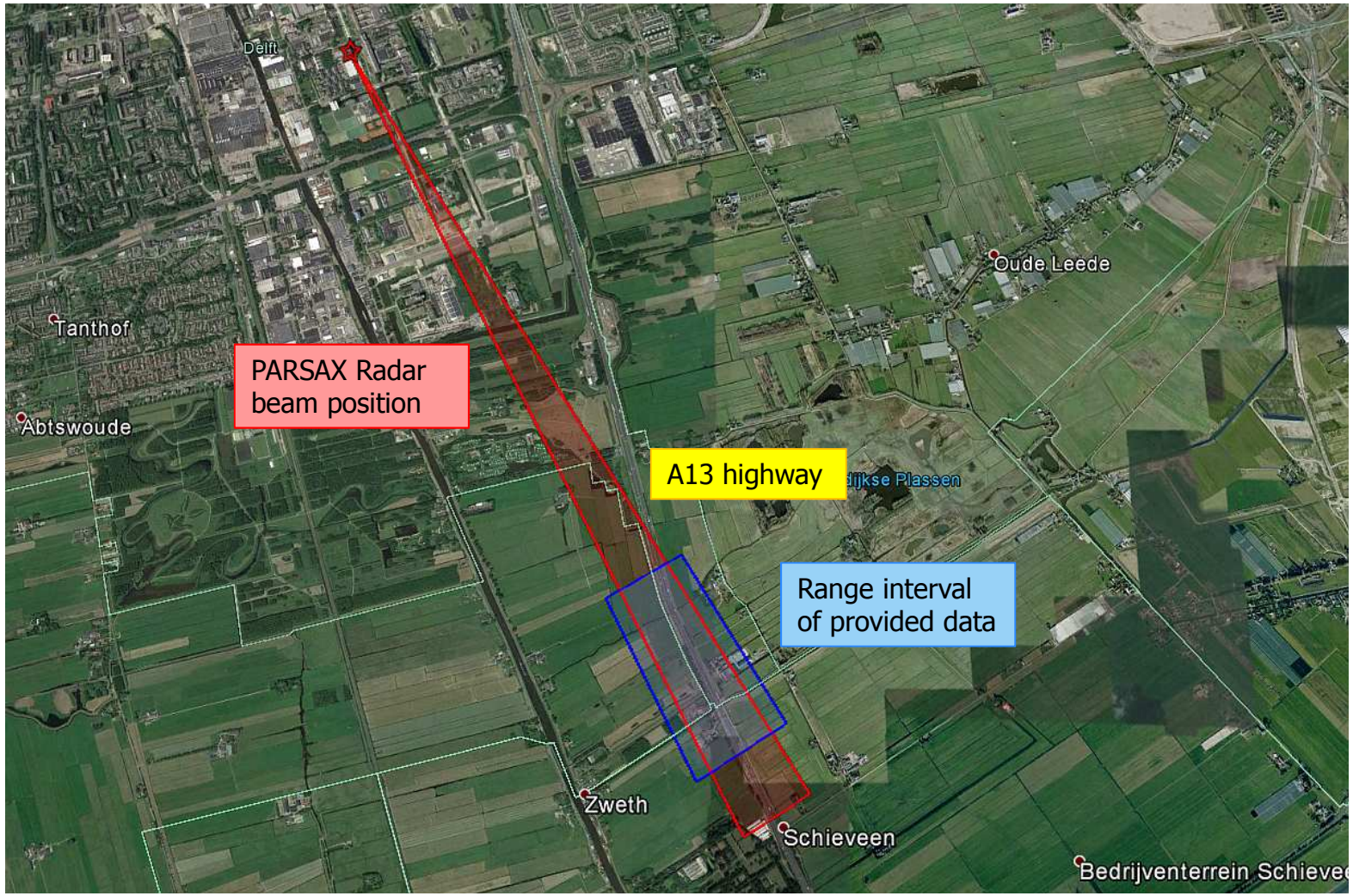
Assignment tasks

To study:

- Doppler processing of real signals
- The influence of integration time on Doppler processing results
- The influence of repetition time/interval (PRI/PRT) on Doppler processing results
- Moving Targets Indication - usage of Doppler information for targets detection/clutter suppression

Measurement setup



Video

Data

- Measured with the PARSAX S-band Doppler radar;
- Bandwidth 45 MHz;
- PRI 1 ms;
- Polarization: transmitter – H, receiver – H;
- Data are not calibrated
- Collected data presented as an array of complex amplitudes from 270 ranges measured with about 30000 repetitive pulses – Range-Slow time representation

MATLAB:

Load('HH_YYMMDD_HHMMSS_#.mat'); => vars Data_out, range

- Noise data file – radar does not transmit, only receives.

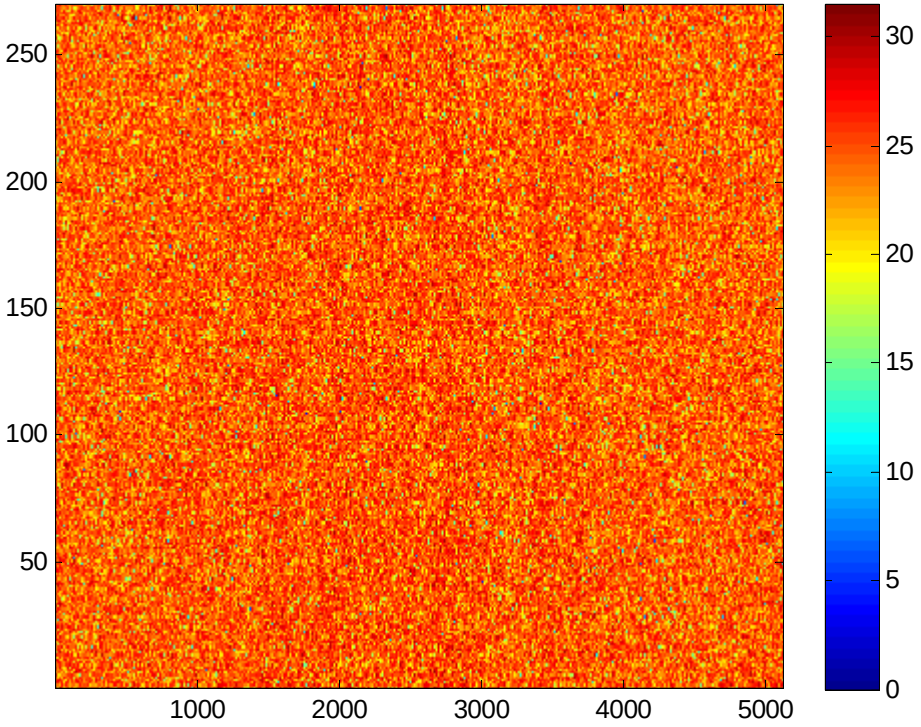
MATLAB:

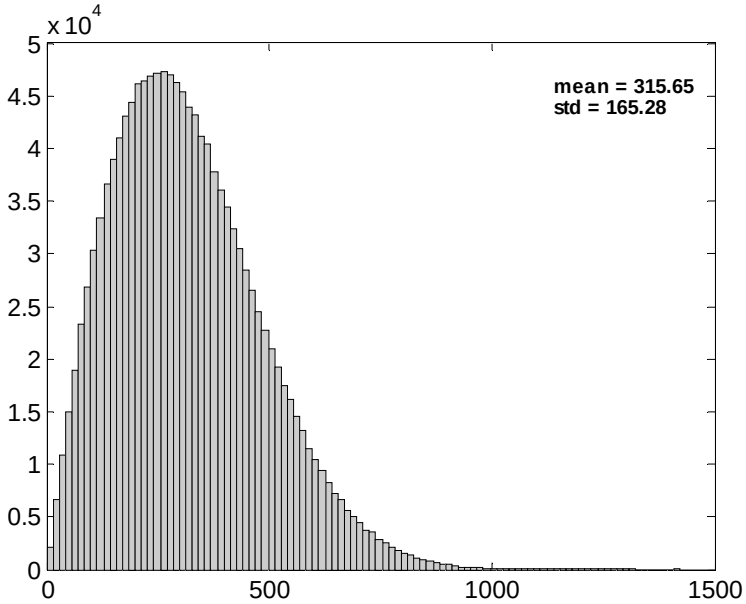
Load('NoiseFile.mat') ; => vars Data_out, range

- Video file, which is more-less synchronized with the radar observation.

Use VLC viewer

Noise data

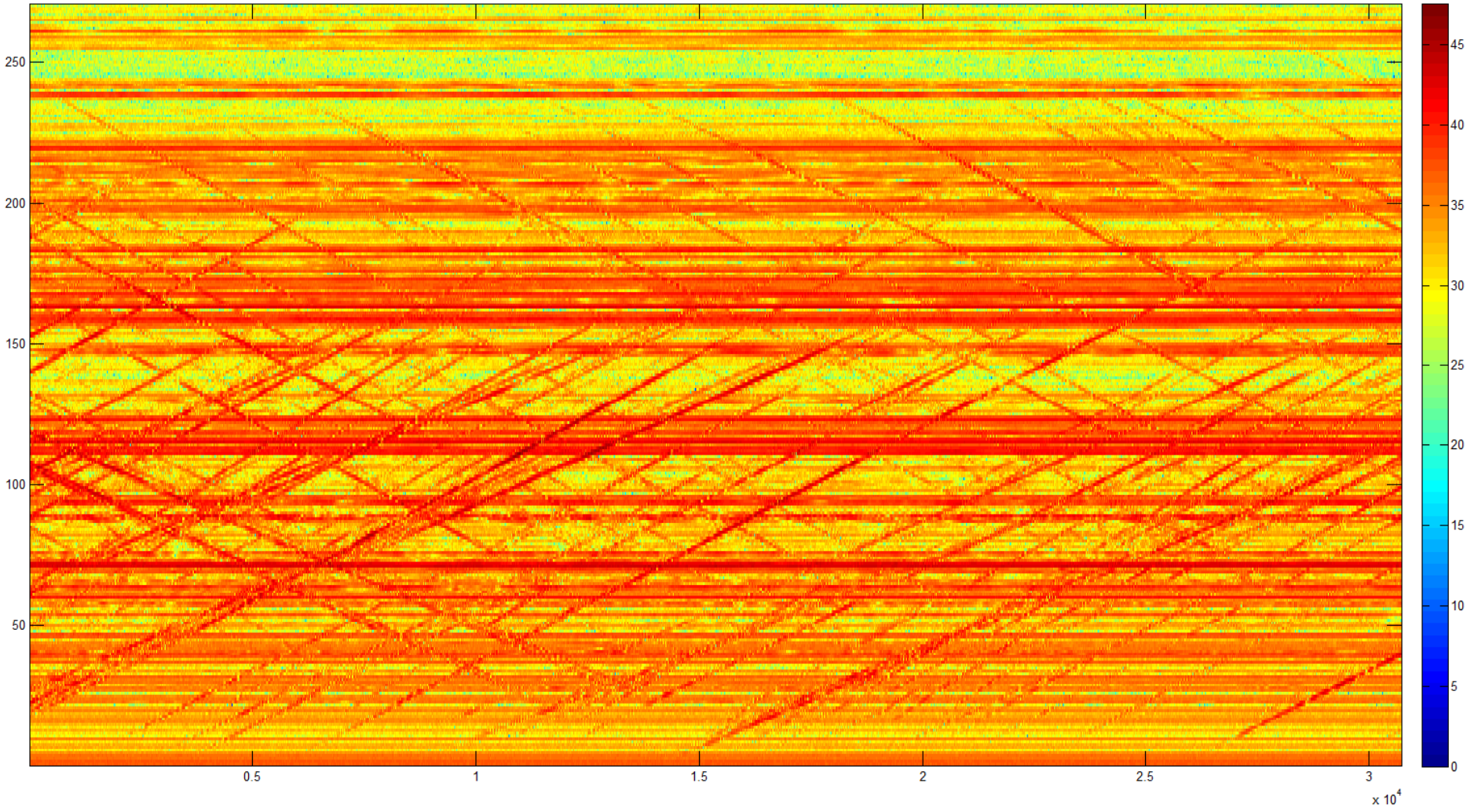

250
200
150
100
50
1000
2000
3000
4000
5000
30
25
20
15
10
5
0


x 10^4
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
500
1000
1500
mean = 315.65
std = 165.28

Plot the original data

```
img_file="*****"

hfig=figure;

imagesc(time_ind,range,db(abs(Data_out')))
colorbar
set(gca,'ydir','norm')
xlabel('Slow time, ms')
ylabel('Range, m')
title(['{',title_str,'}'])

print(hfig,'-dpng',img_file);
close(hfig);
```

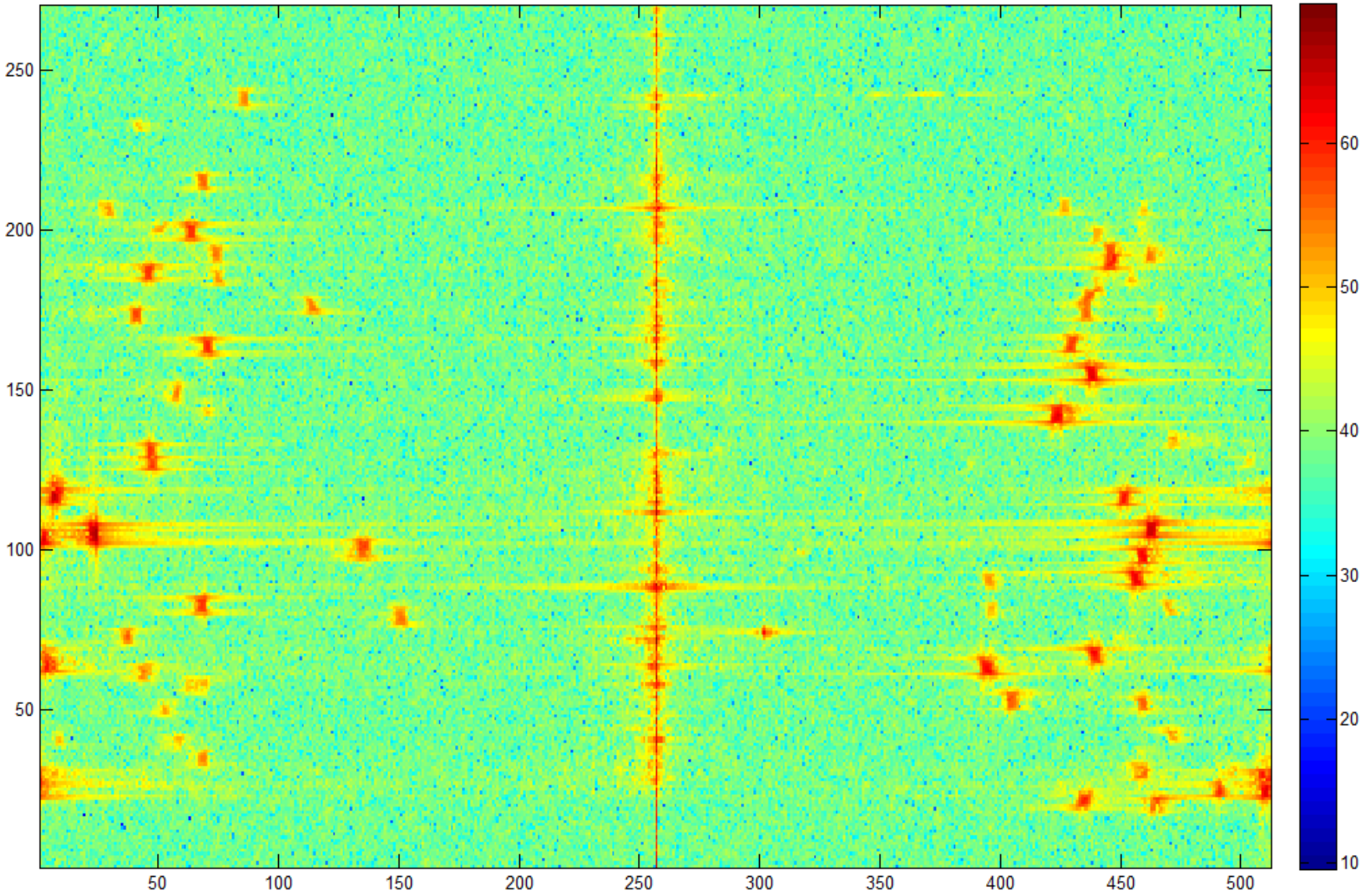
Range-Slow time



Doppler processing

```
N_Doppler=512; j=###;
start_time=1+N_Doppler*(j-1);

x=Data_out(start_time:start_time+N_Doppler-1,:);

RD=fftshift(fft(x, N_Doppler),1);
frequency=[-500:1000/(N_Doppler+1):500]; % how this has to be changed for diff PRF?

hfig=figure;
imagesc(frequency,range,db(abs(RD')))
colorbar
set(gca,'ydir','norm')
set(gca,'clim',[10,70]) % If you do not see the range-Doppler plane similar to slide 10,
                        % comment (or edit) the codeline set(gca,'clim',[10,70])
xlabel('Doppler frequency, ms')
ylabel('Range, m')
title(['{',title_str,' 1ms, burst ',num2str(j),'}'])
```

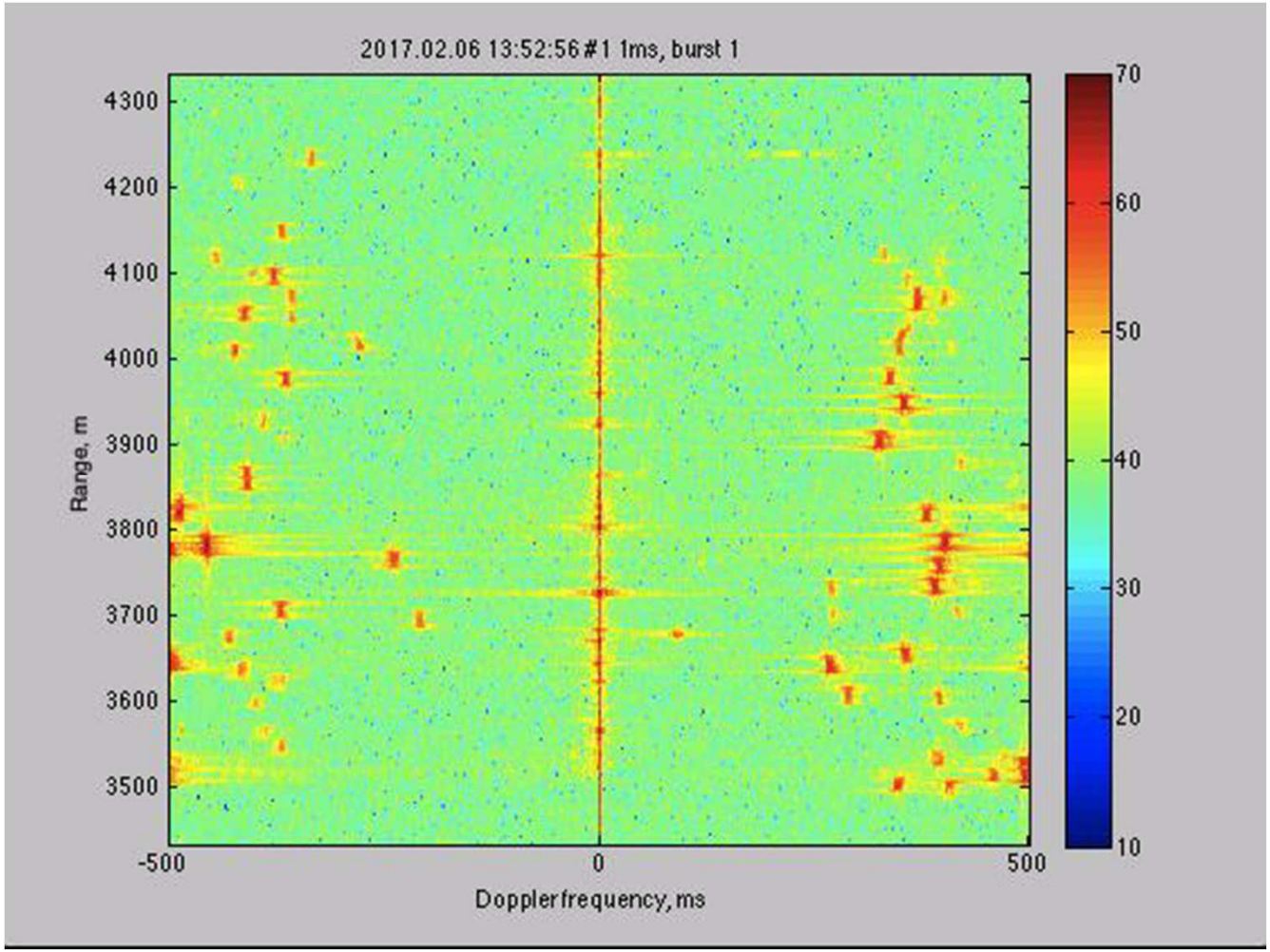
Range-Doppler plane



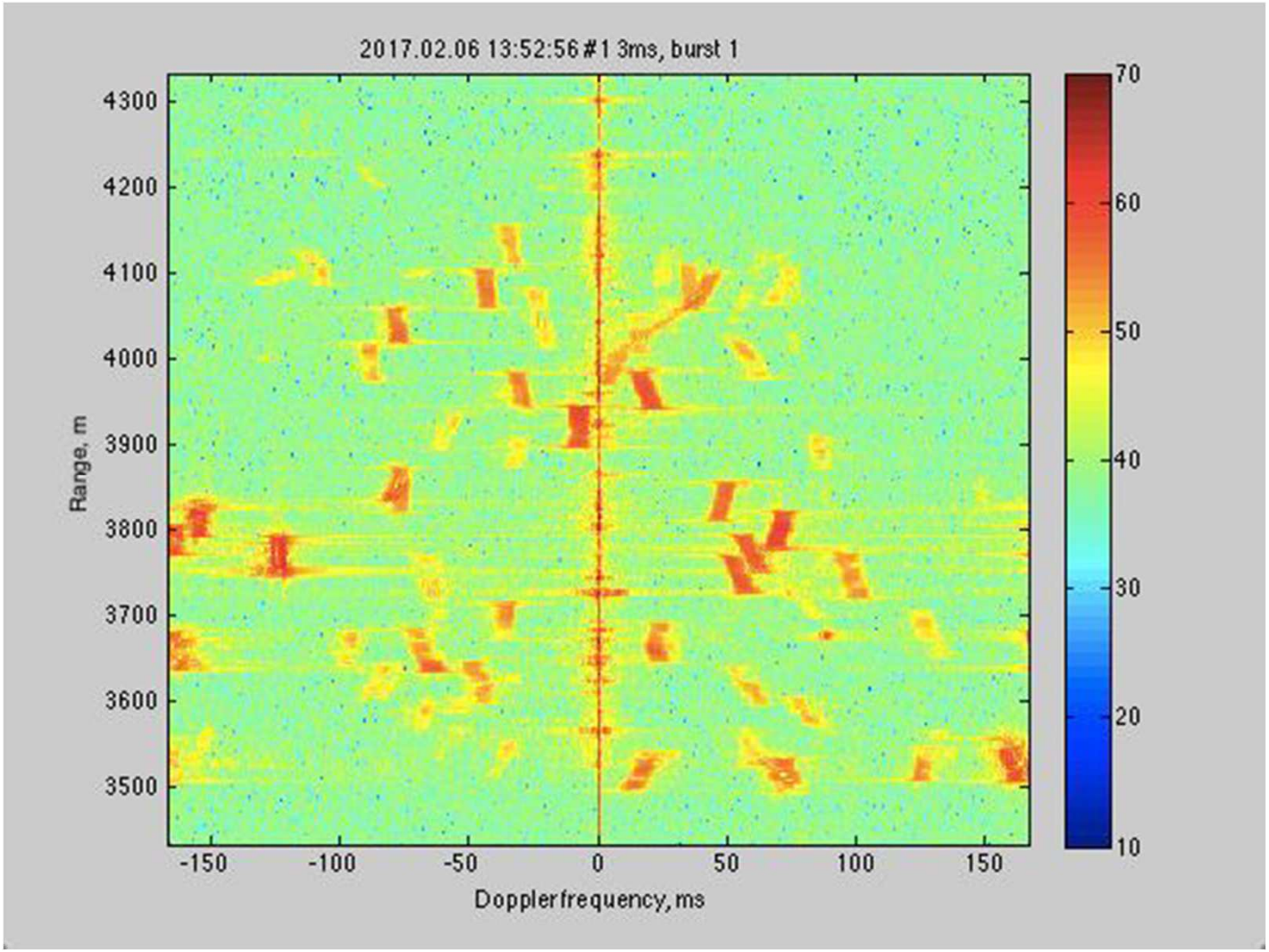
Video creation

```
video_file=[imgDir_video1,name,'.avi'];
writerObj = VideoWriter(video_file);
open(writerObj);

For j=1:59
        ****
        frame = getframe(hfig);
        writeVideo(writerObj,frame);
        close all
End

 close(writerObj);
```

Resulting video



Range-Doppler video for PRI=3



Tasks to do

- Play with different duration/length of Doppler processing N_Doppler (512,256,128,64,32,..)
  - Analyze the results (cars visibility, their velocity estimation precision)
  - Make a video(s) of sequential observations
  - Explain what you see, found pro and contra arguments for different N_Doppler

- Play with PRI
  - Original data – 1ms
  - How to change? PRI=2,3,4,…
    x=Data_out(start_time:PRI:start_time+PRI*N_Doppler-1,:);
  - What is Doppler ambiguity and velocity for every PRI?
  - Make a movie, explain what you see…

- **MTI implementation:** how can you filter out stable targets and improve cars visibility on range-slow time plot? How higher PRI will influence results?