

Radar Practicum

Doppler processing

Oleg Krasnov

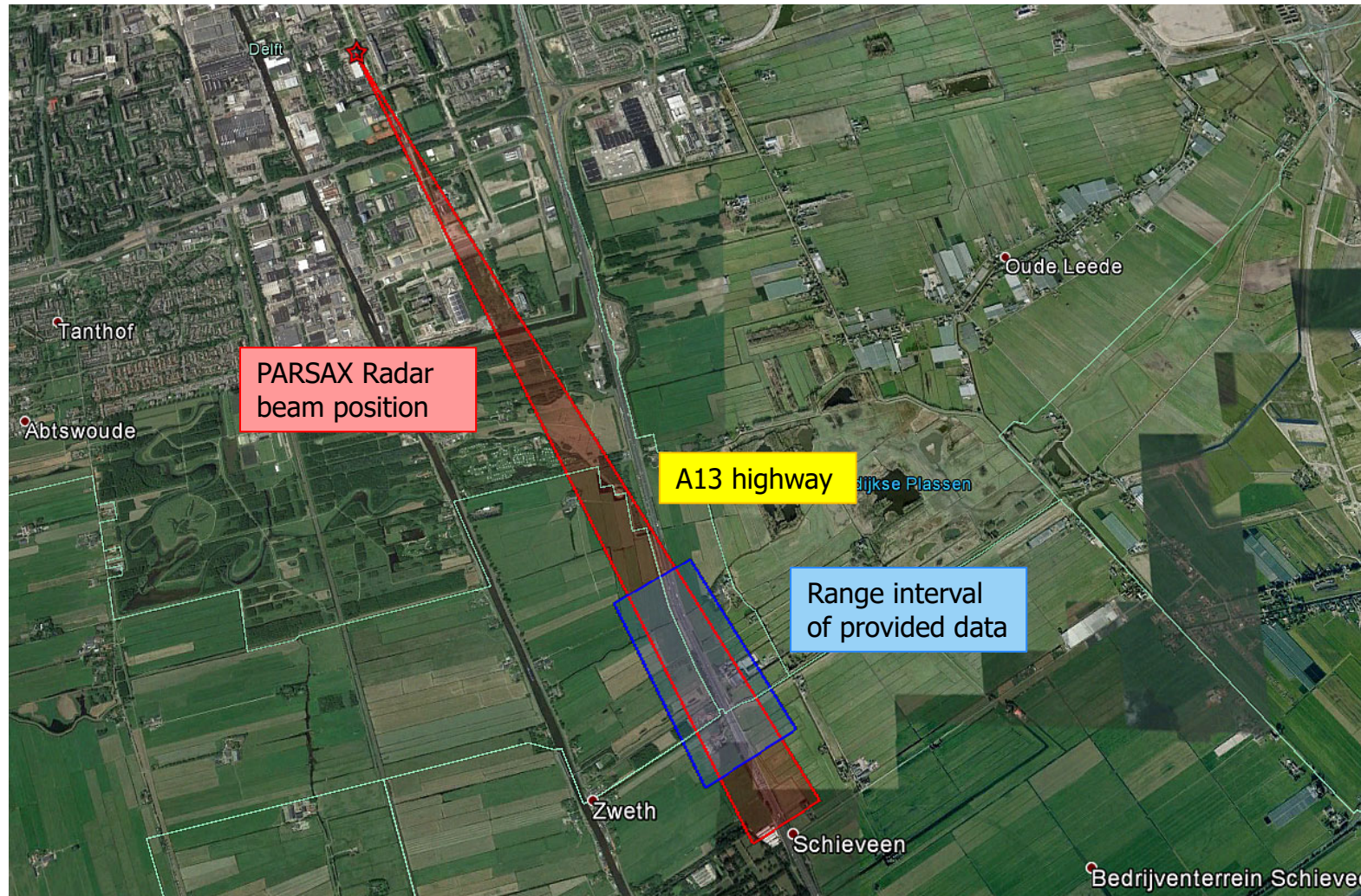
Assignment tasks

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
- Optional: usage of Doppler information on targets detection/clutter suppression



Measurement setup



Video



Data

- Measured with the PARSAX S-band Doppler radar;
- Bandwidth 45 MHz;
- PRI = 1 ms; PRF = 1 kHz;
- 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.

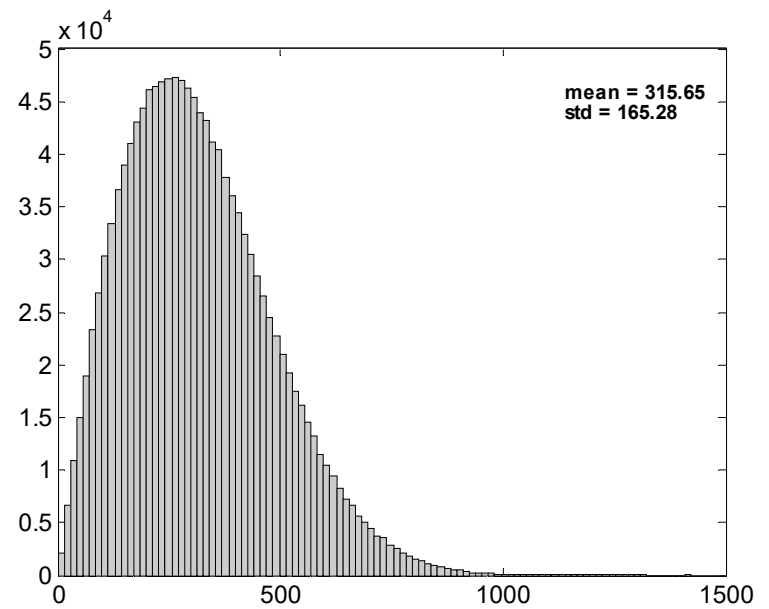
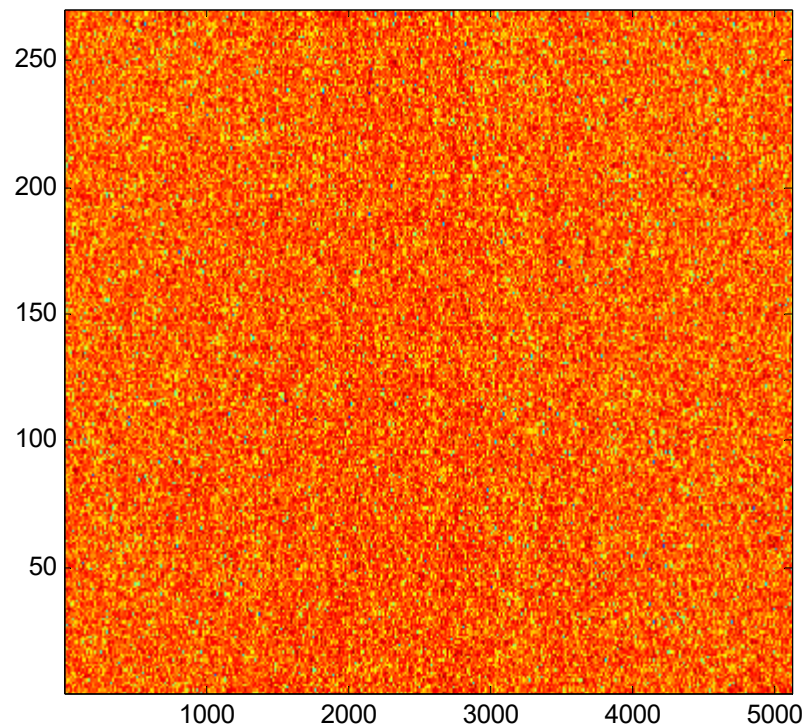
MATLAB:

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

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

Use VLC viewer

Noise data



Plot the original data

```
img_file="*****" % PNG file name to save the image
```

```
hfig=figure;
```

```
imagesc(time_ind,range,db(abs(Data_out)))
```

```
colorbar
```

```
set(gca,'ydir','norm')
```

```
xlabel('Slow time, ms')
```

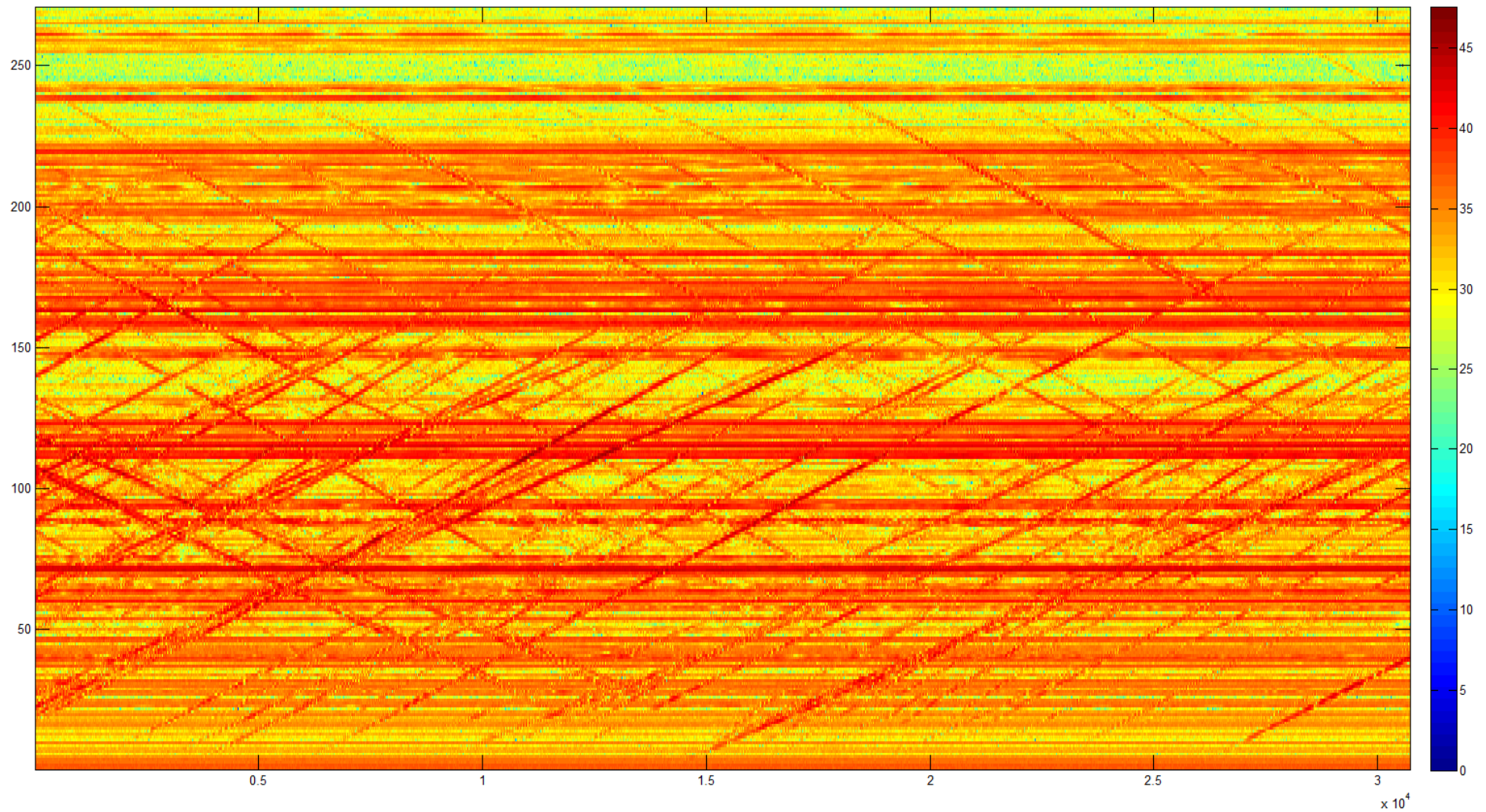
```
ylabel('Range, m')
```

```
title(['{',title_str,'}'])
```

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

```
close(hfig);
```

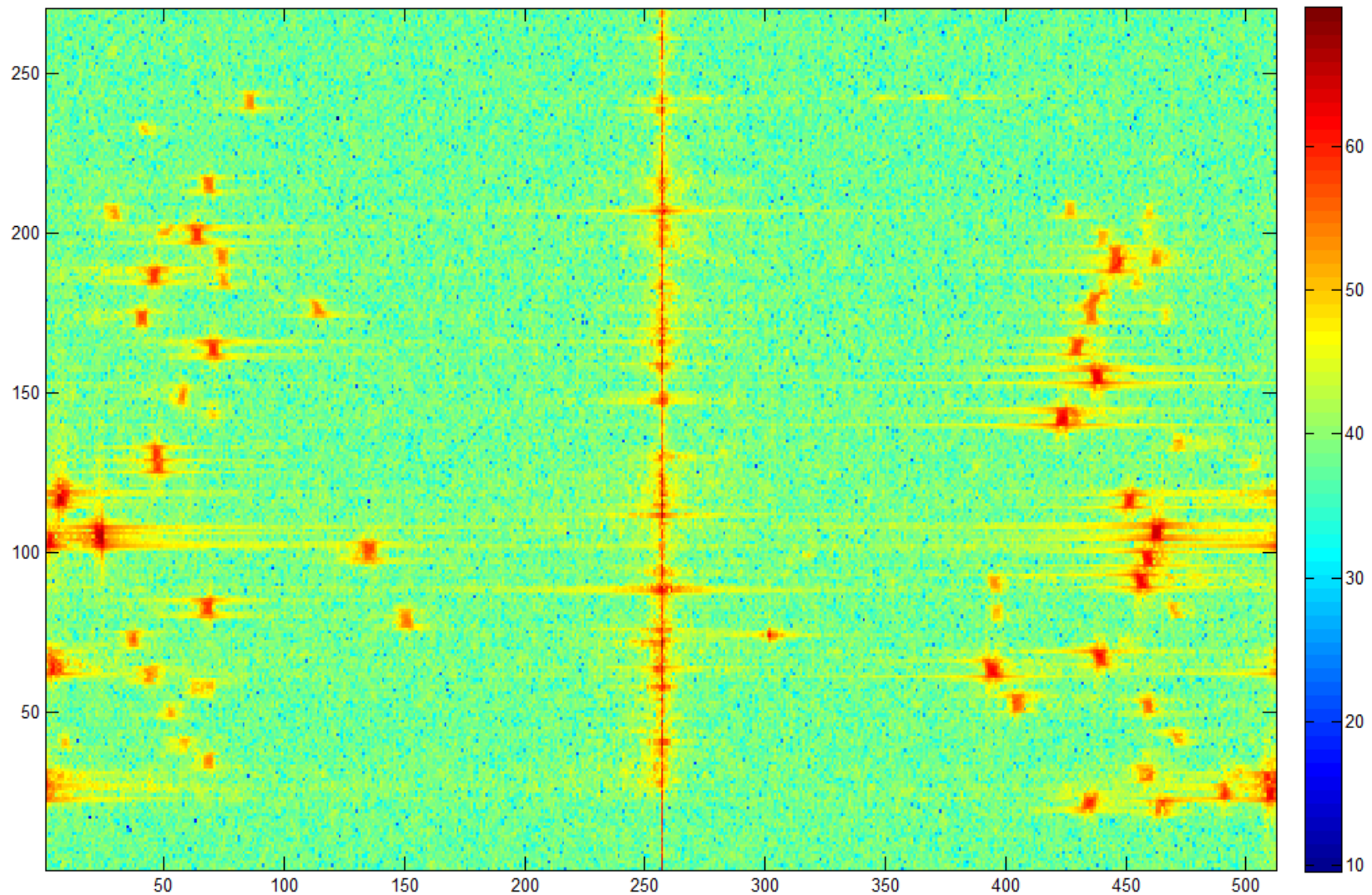
Range-Slow time



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];  
  
hfig=figure;  
imagesc(frequency,range,db(abs(RD')))  
colorbar  
set(gca,'ydir','norm')  
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);
```

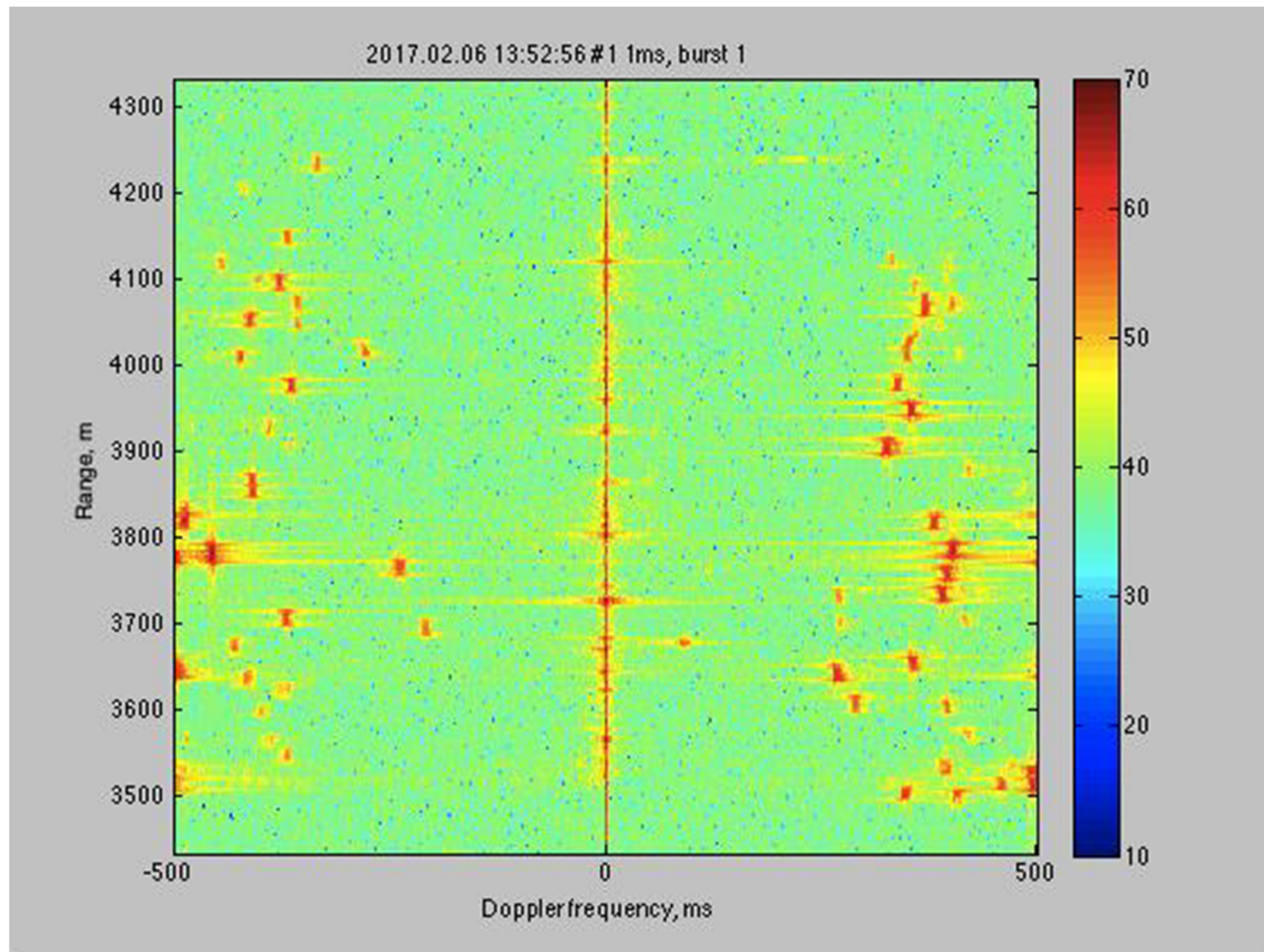
```
For j=1:59
```

```
    **** % do something and plot at hfig figure  
    frame = getframe(hfig);  
    writeVideo(writerObj,frame);  
    close all
```

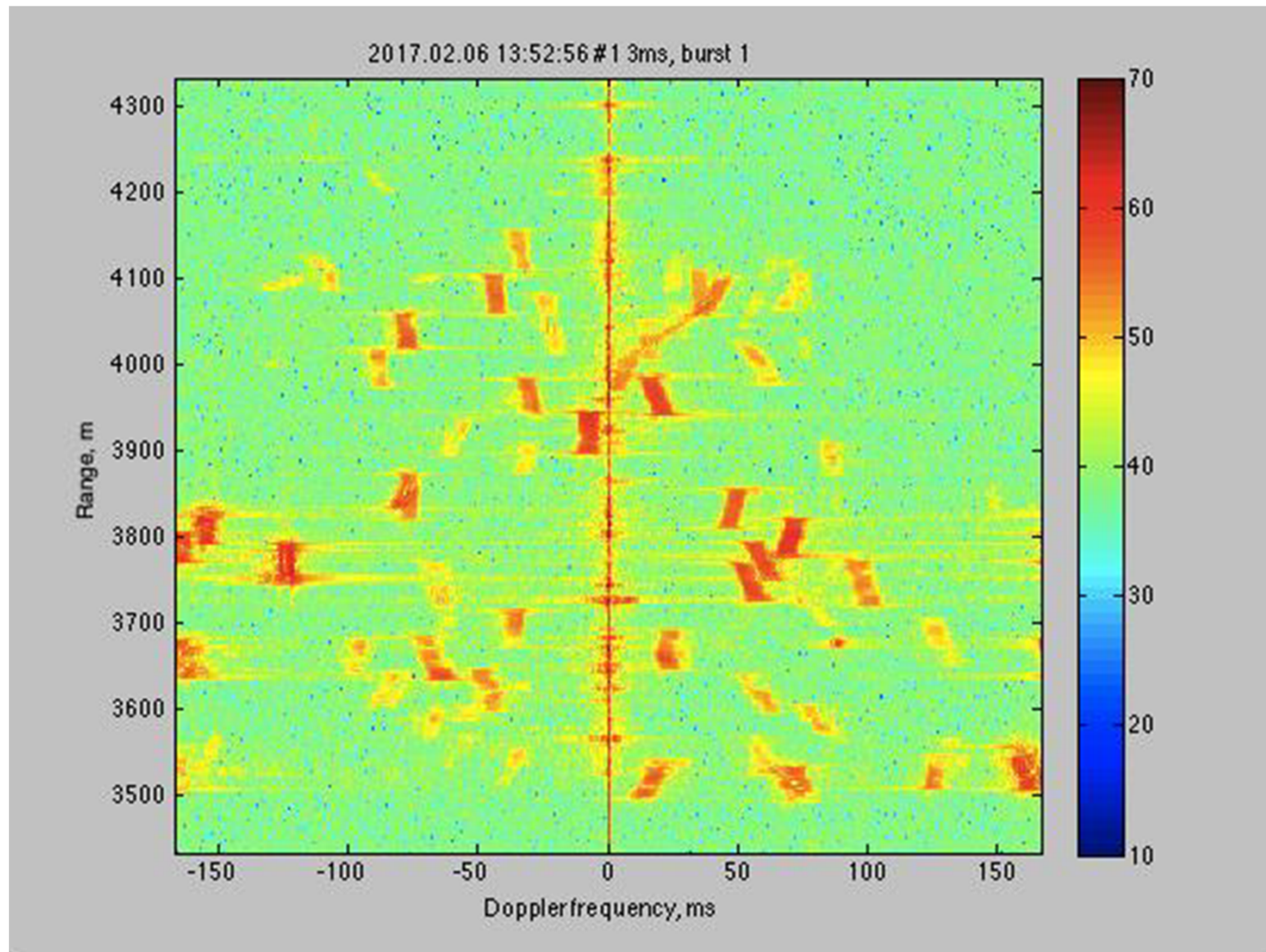
```
End
```

```
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? $\text{PRI}=2,3,4,\dots$
`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...
- **Optional:** how can you filter out stable targets and improve cars visibility on range-slow time plot? How higher PRI will influence results?