CW (Continuous Wave) radar

- Radar equation: $$P_r = \frac{P_t G_t A_r \sigma F^4}{(4\pi)^2 R_t^2 R_r^2}$$

Pulse radar: power transmitted in pulses (easy range measurement, but $P_{peak} \gg P_{mean}$)

CW radar: power transmitted continuously (easier for a solid state transmitter, $P_{peak} \approx P_{mean}$)

- CW problems:
  - receive during transmit
    (2 antennas or some tricks necessary)
  - how to measure distance with CW ?
    100% overlap of echoes → time encoding on CW needed

Police radar

- Very simple design – mixer is the 1st stage (single antenna possible!)
- Bands:
  - X (~10GHz)
  - K (~24 GHz)
  - Ka (~34 Ghz)
- Doppler freq: few kHz

  $c = 300000000$ [m/s]

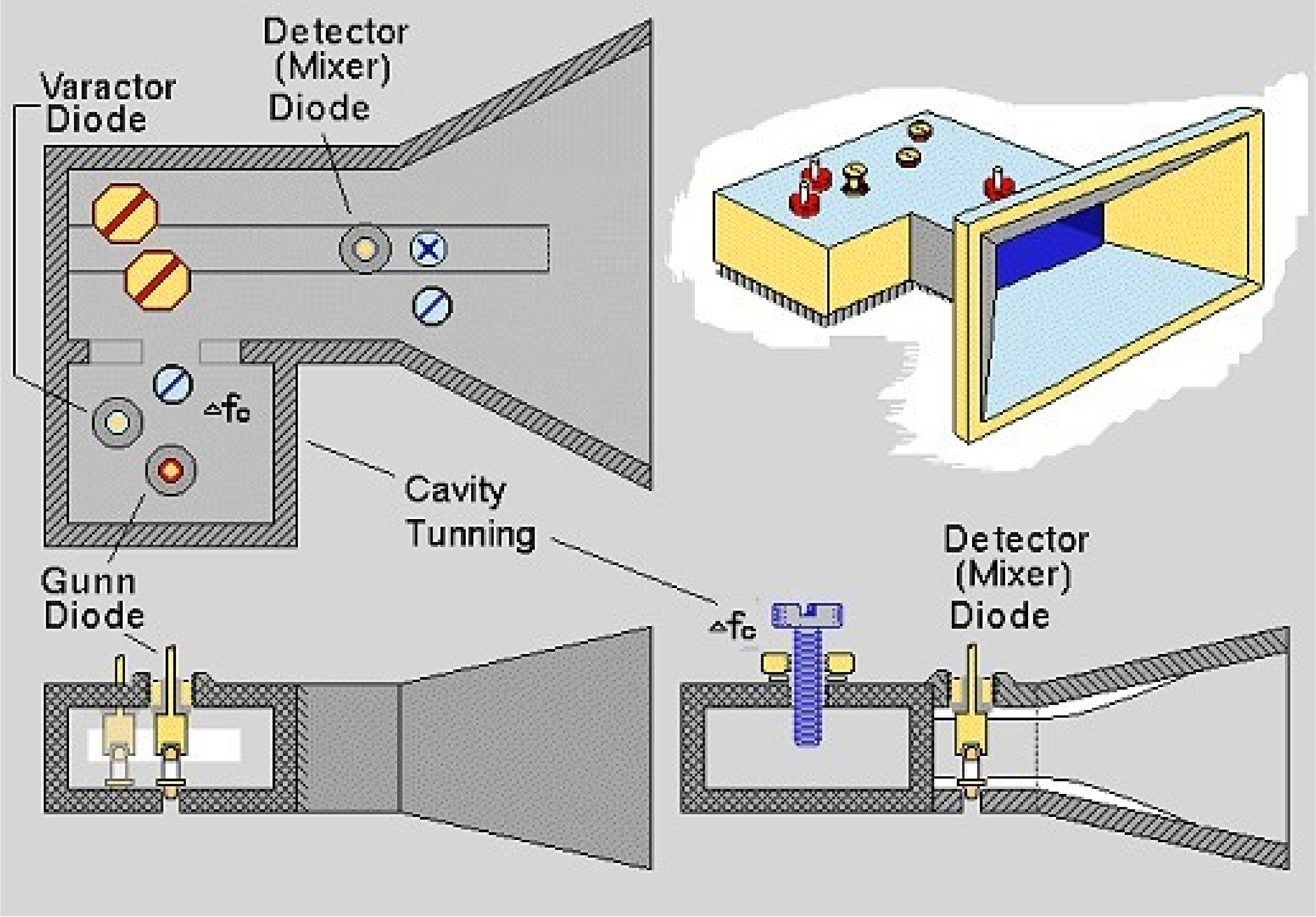
  $v=100$[km/h] = 27.778 [m/s]

  $\lambda=c/24e9 = 0.012500$ [m]

  $2*v/\lambda = 4444.4$ [Hz]

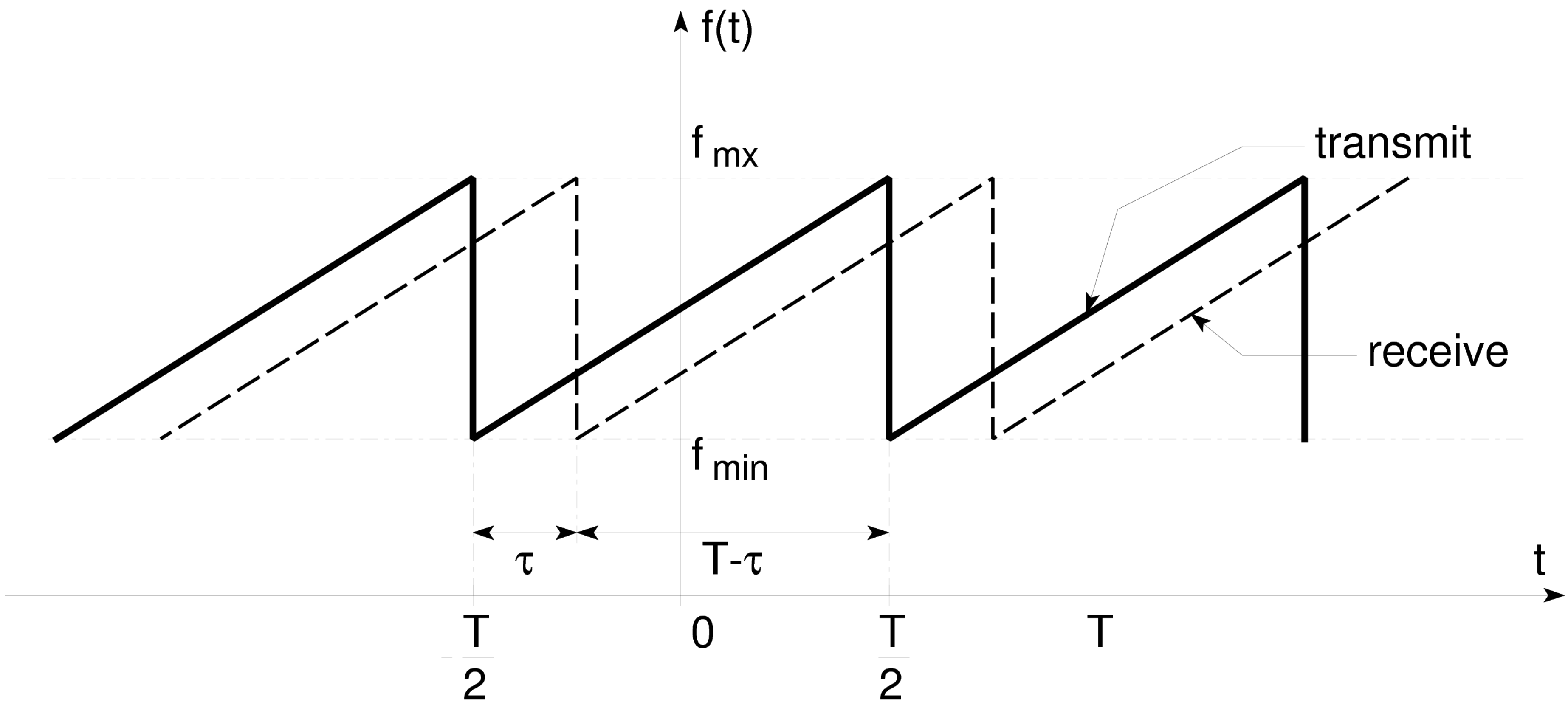

ZASILACZ
4618-8002
LADOWARKA
4618-8003-2

Simple head design example

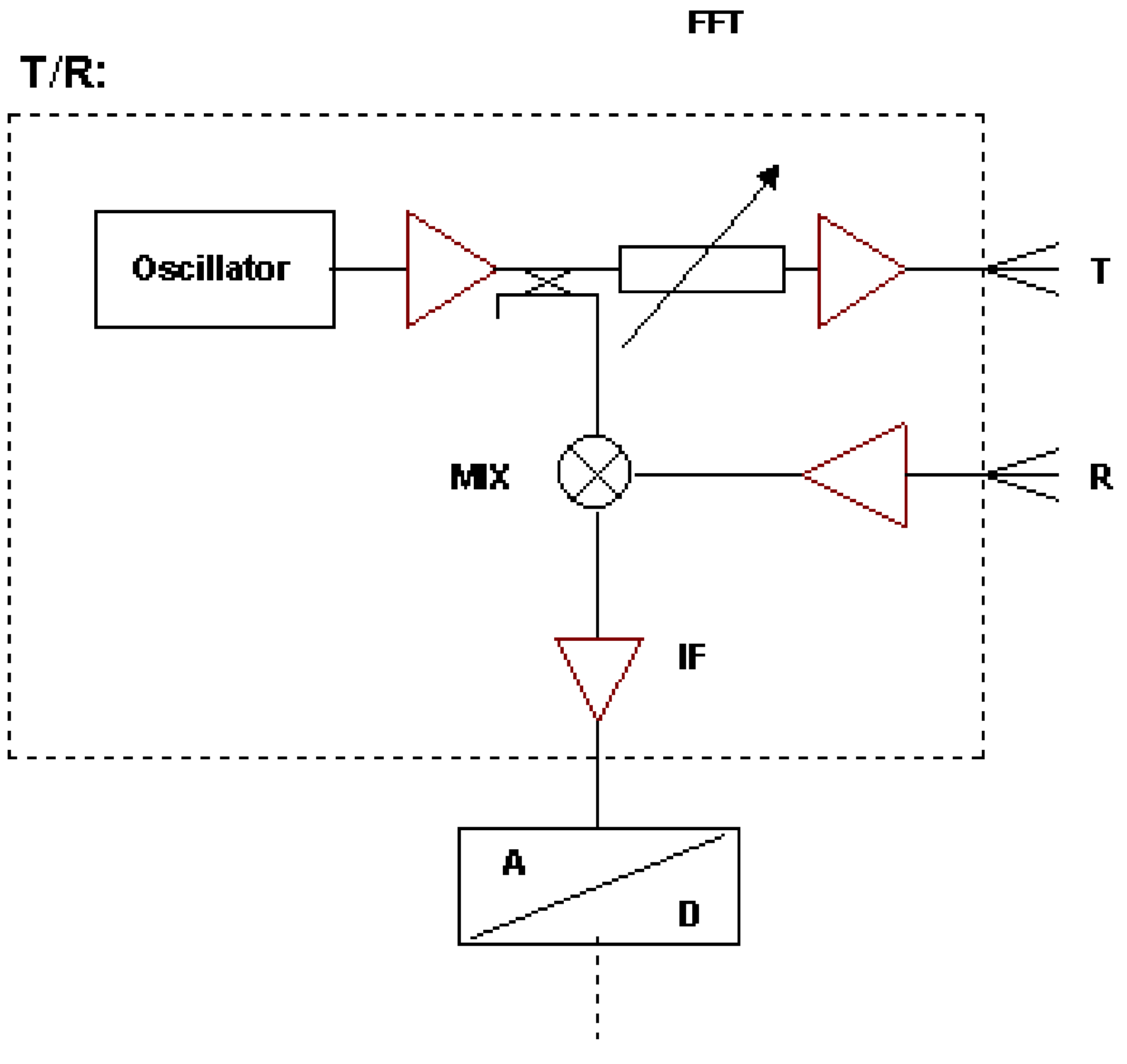


FMCW radar

- Measure distance: waveform coding
  - correlation receiver (or some tricks)
- LFM trick: a simple solution to processing



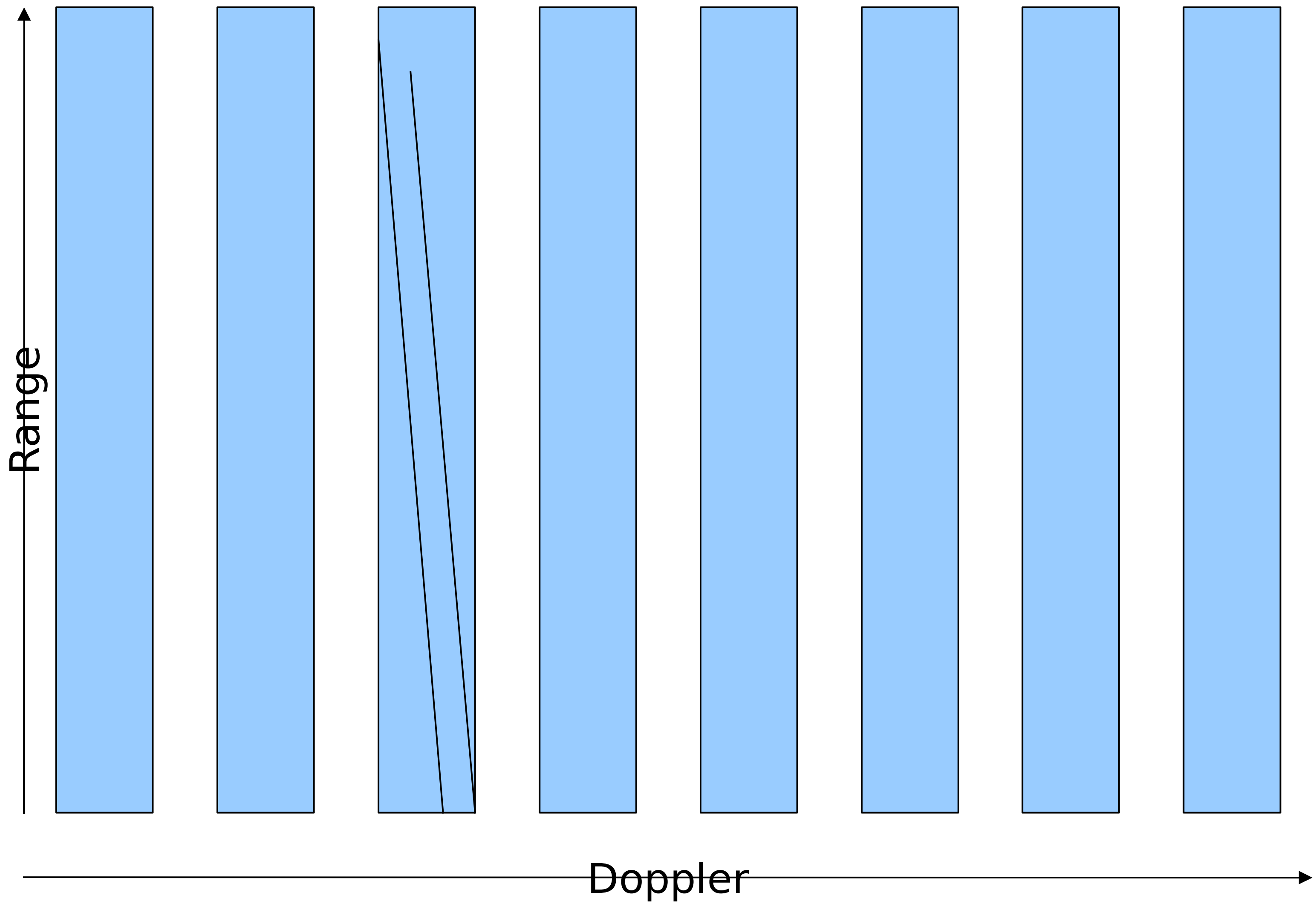
FMCW – two antennas



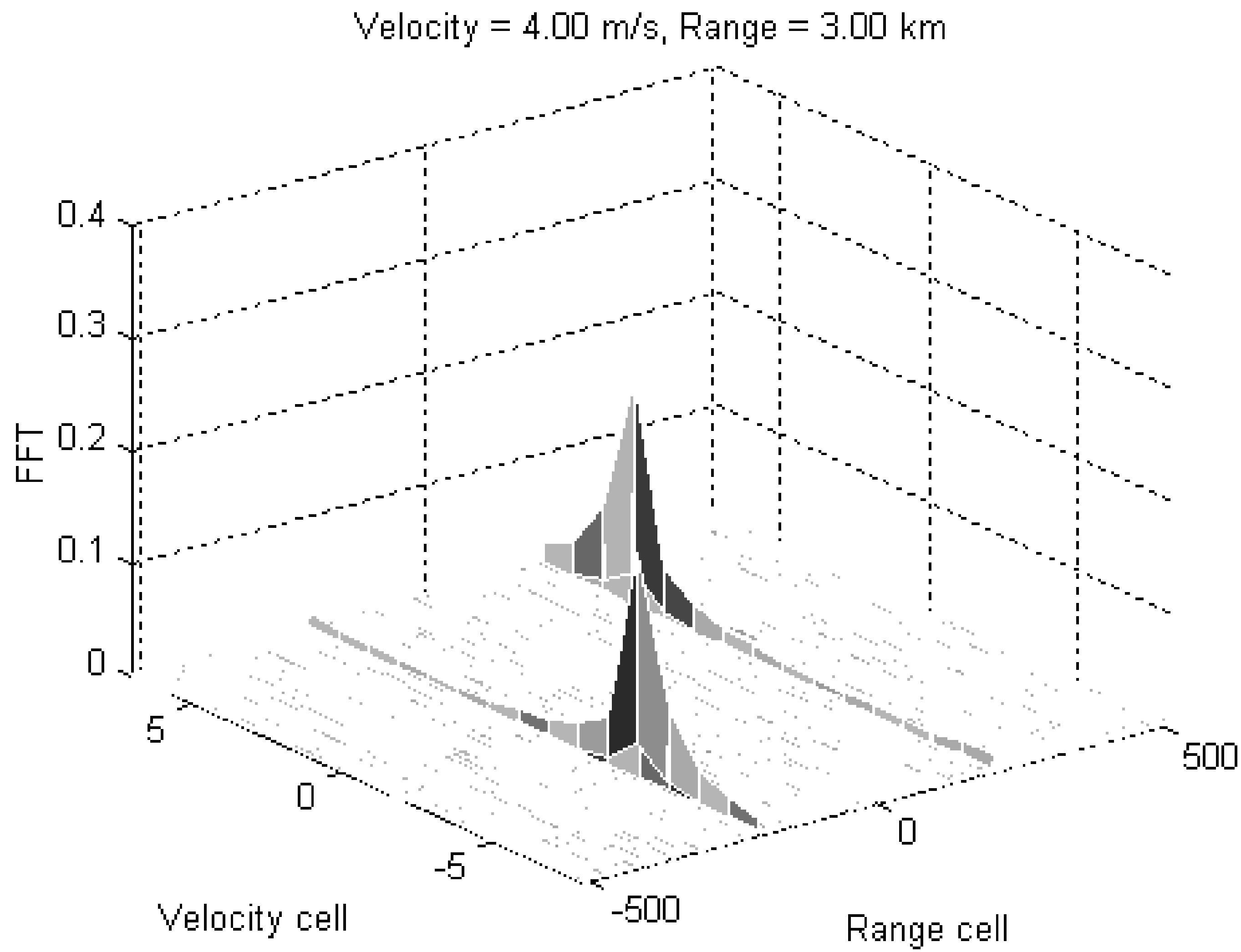
FMCW processing

- Range = difference frequency
  - FFT as the correlation receiver!
  - range gain steering = HP filter
- Velocity (Doppler) = phase drift between sweeps
  - second FFT for velocity distinguishing
- Range-Doppler plane

Range & Doppler FFT

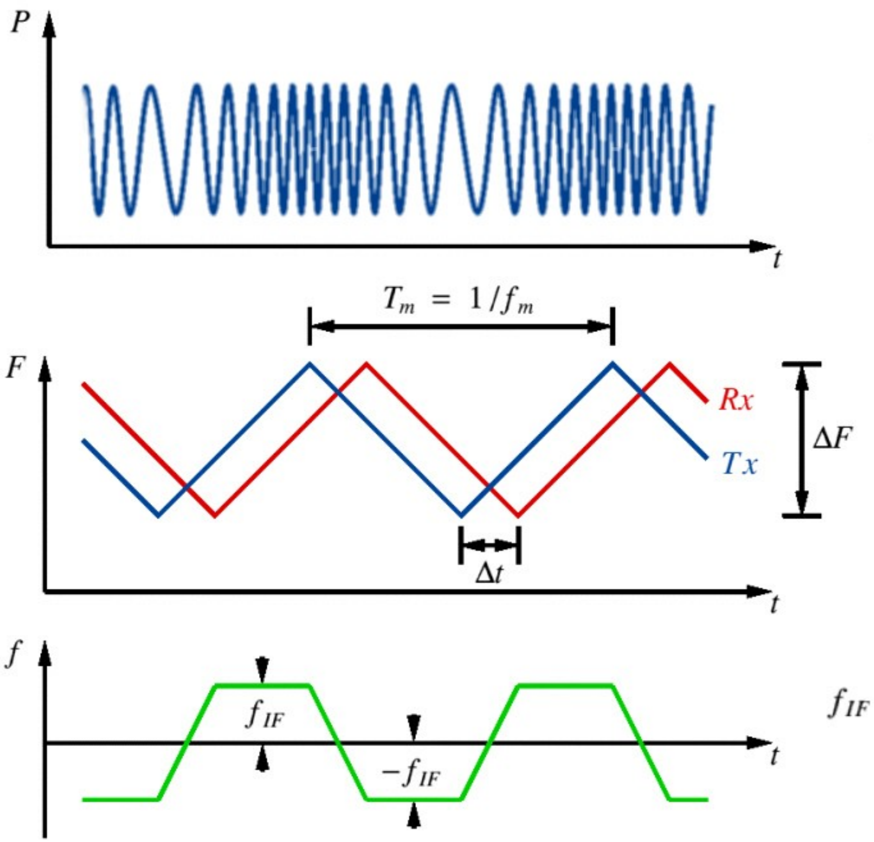


Range-Doppler plane



Fast targets

- Doppler freq. adds to range freq. (problem!)



$$\frac{dF}{dt} = \frac{2\Delta F}{T_m}$$

$$R = \frac{c\,\Delta t}{2}$$

$$f_{IF} = \frac{4\,\Delta F\, f_m\, R}{c}$$

sum = doppler
difference = range

Grand designs

Other FMCW applications

- Radar altimeter
- Anti-collision radar
- Level meters
- microdoppler:
  - human detection
  - object classification