Radar Physics

Anthea J. Coster

Outline

Pulses and Waves - Pulsed Radar

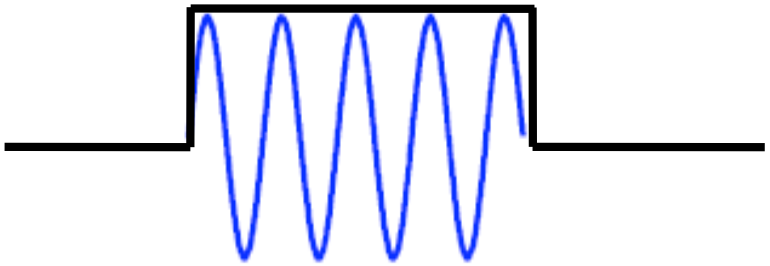
Range Resolution

Radar Waveforms, Pulsed compression

Detection of Signals in Noise

Coherent Integration

What the radar transmits: Pulses and waves

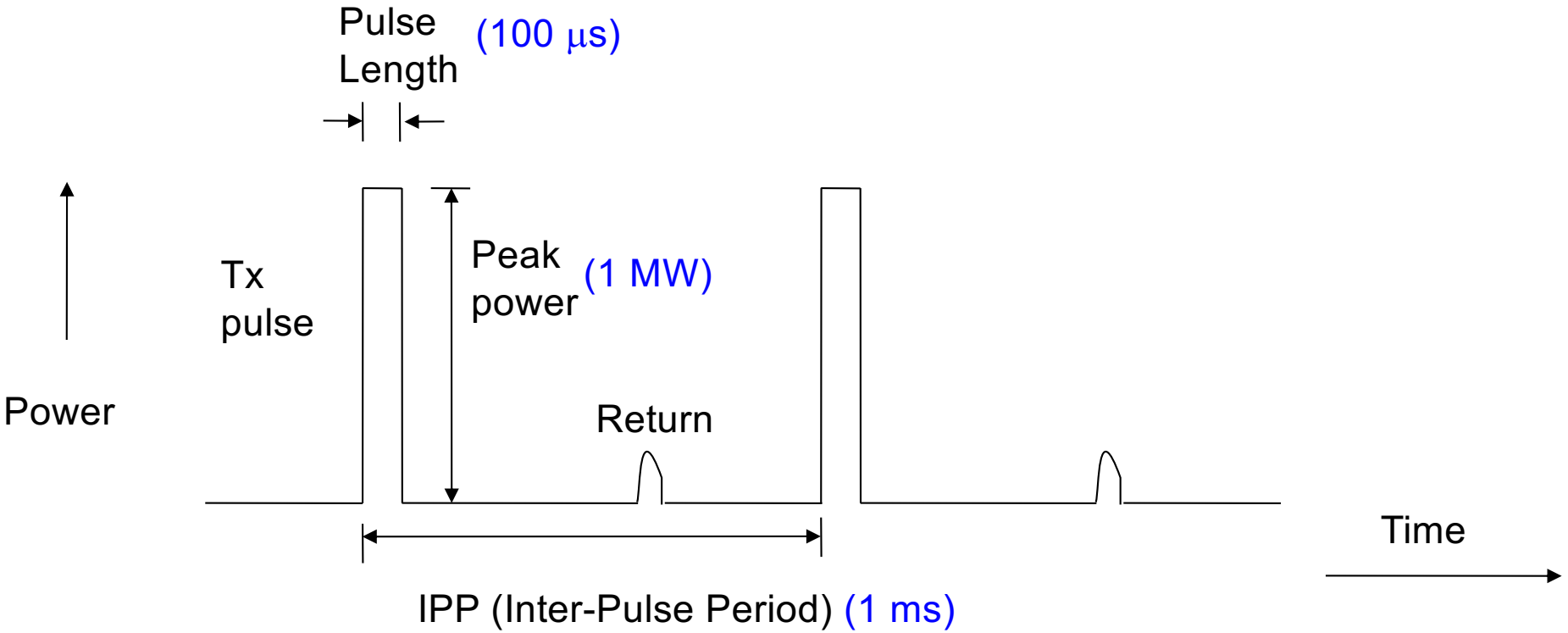


Cycles in a pulse.

PFISR frequency = 449 MHz
Long pulse length = 480 μs
# of cycles = 215520 !

Radar waveforms modulate the waves with on-off sequence

Pulsed Radar



Duty cycle = Pulse Length/IPP (10%)
Average power = Peak power x Duty cycle (100 kW)
PRF (Pulse Repetition Frequency) = 1/IPP (1kHz)

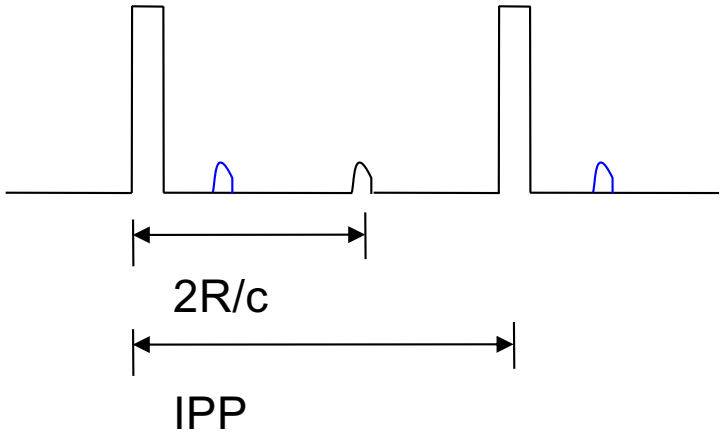
Duty cycle for a CW (continuous wave) radar 100%

Range Resolution

Range resolution is set by pulse length

Pulse length = τ_p , Range resolution = $c\tau_p/2$ for a single target.

Maximum unambiguous range



MUR = c*IPP/2

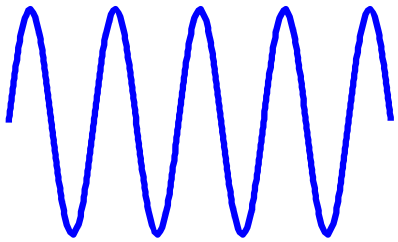
Pulse duration vs. Range resolution

Pulse Duration	Range Resolution
0.1 nsec	1.5 cm
1.0 nsec	15 cm
10 nsec	1.5 m
100 nsec	15 m
1 μsec	150 m
10 μsec	1.5 km
100 μsec	15 km
1 msec	150 km

What is a typical F region ISR pulselength?

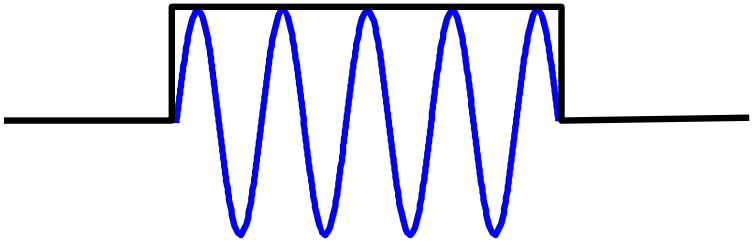
Radar Waveforms

What do radars transmit?



Waves?

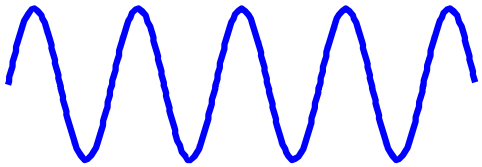
or Pulses?

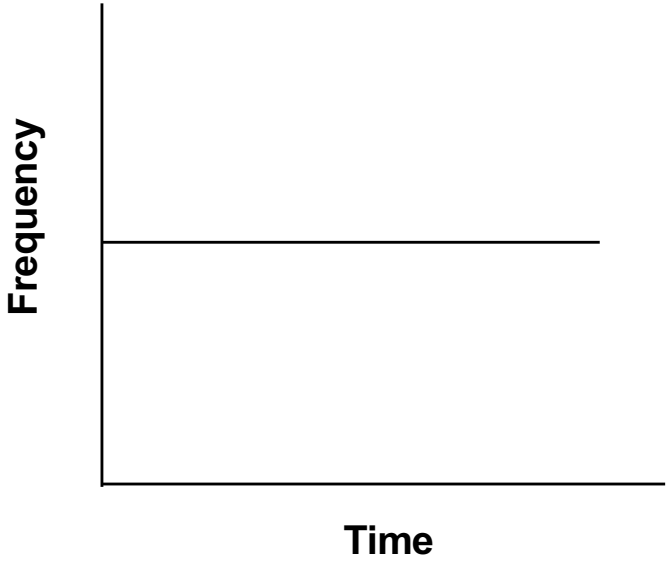


Waves, modulated by "on-off" action of pulse envelope

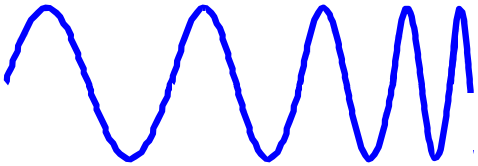
Radar Waveforms (cont'd.)

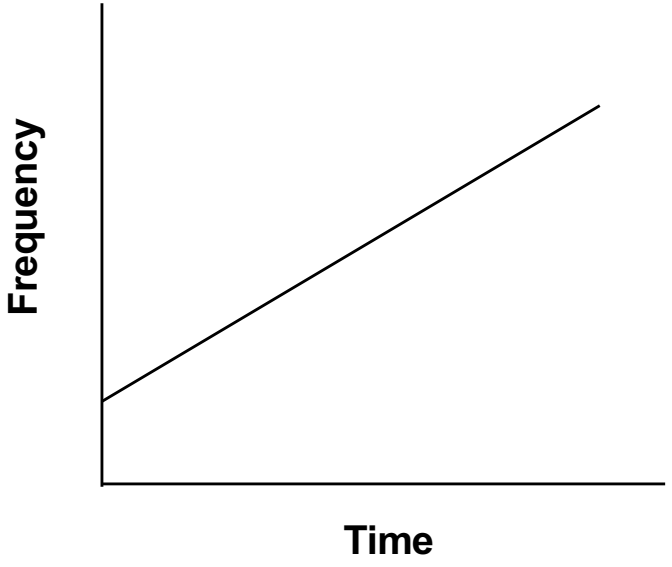
Pulse at single frequency





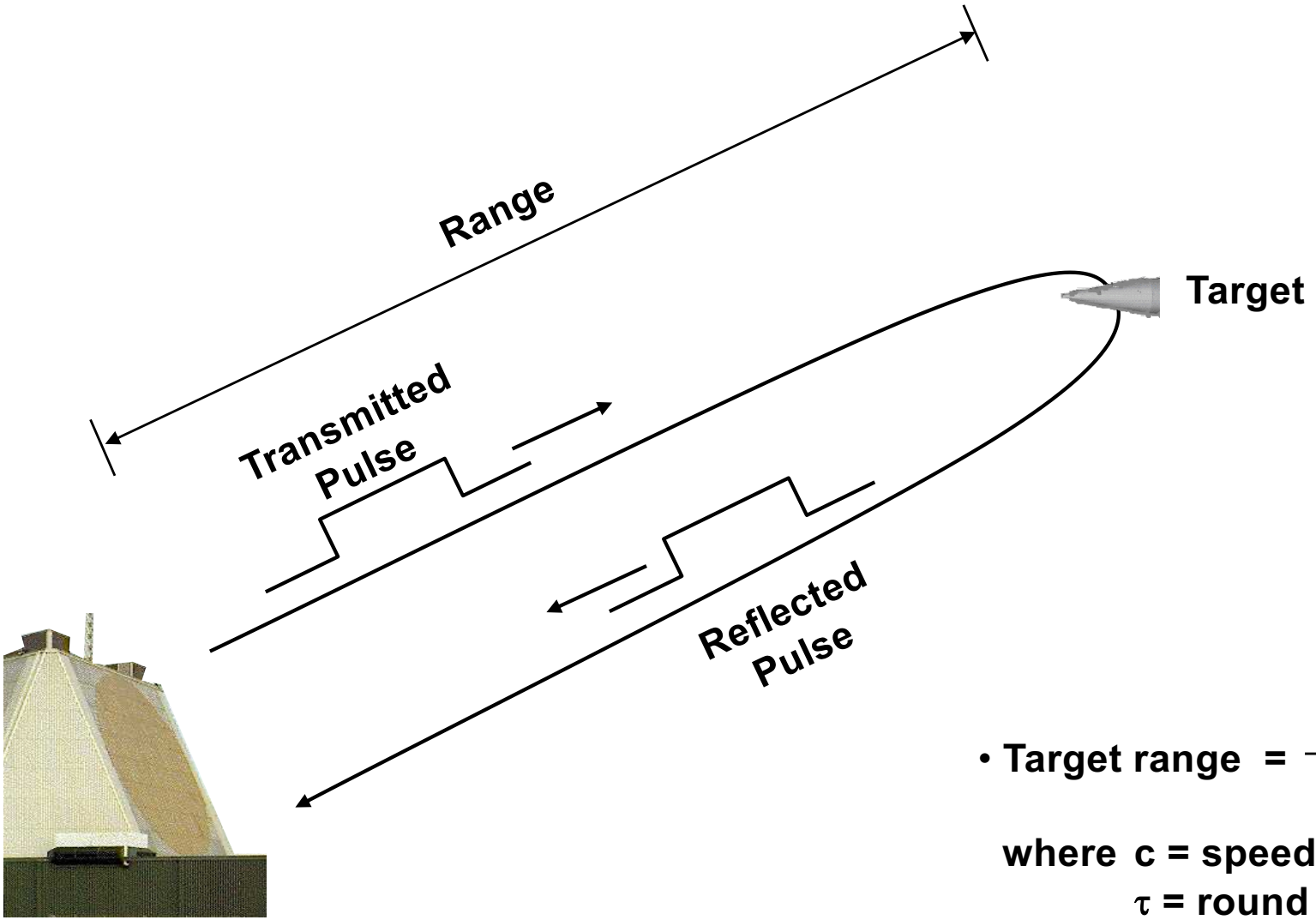
Pulse with changing frequency





Linear Frequency-Modulated (LFM) Waveform

Radar Range Measurement

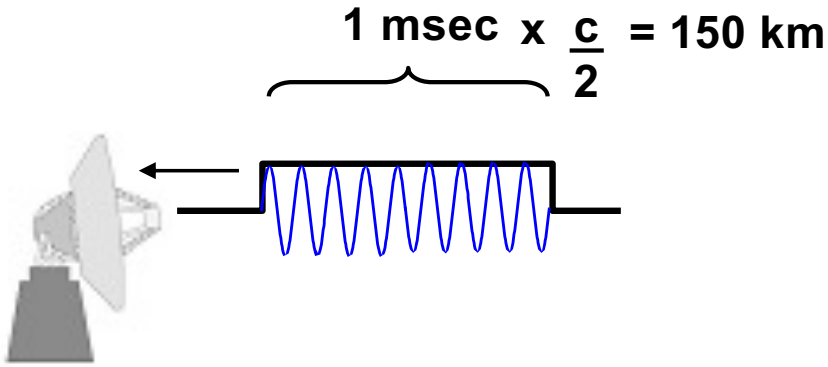


- Target range $= \frac{c\tau}{2}$

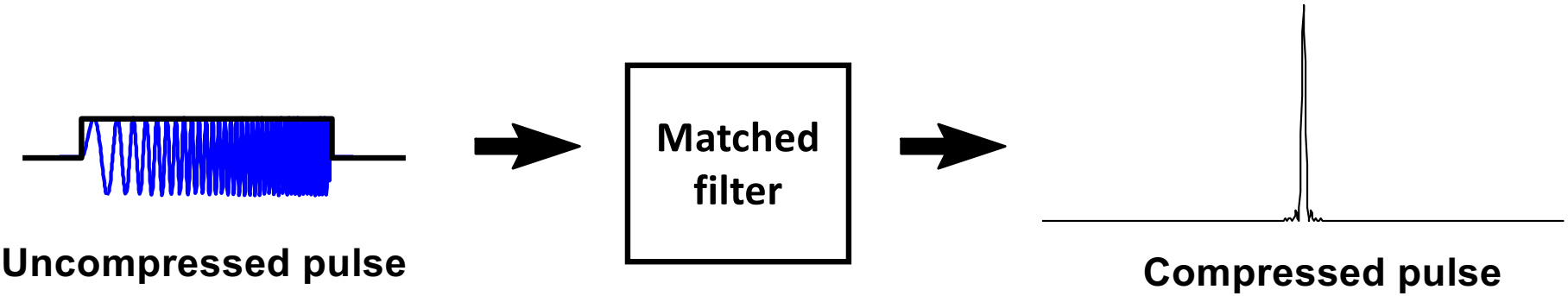
where c = speed of light
τ = round trip time

Signal Processing
Pulse Compression

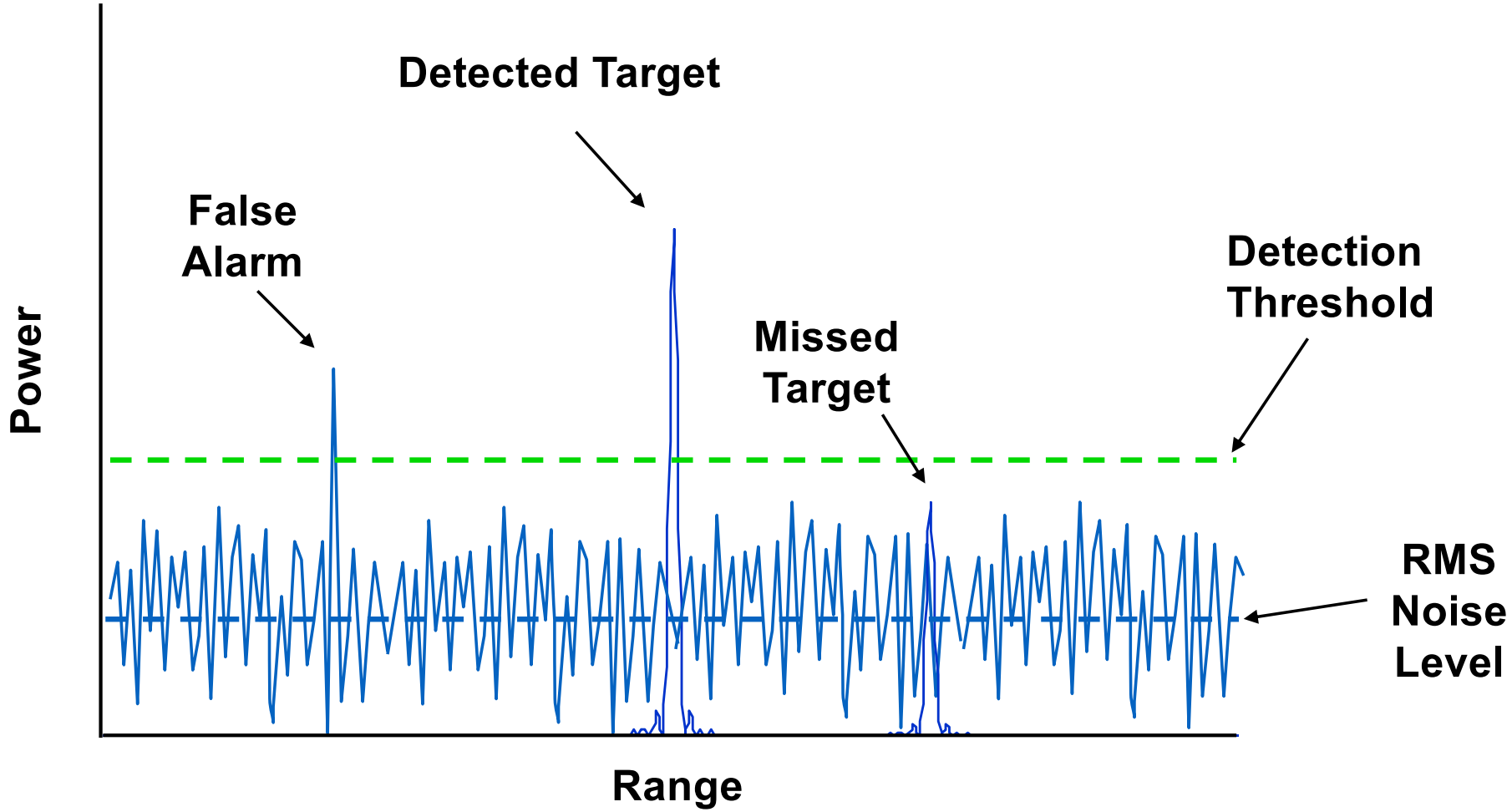
Problem: Pulse can be very long; does not allow accurate range measurement



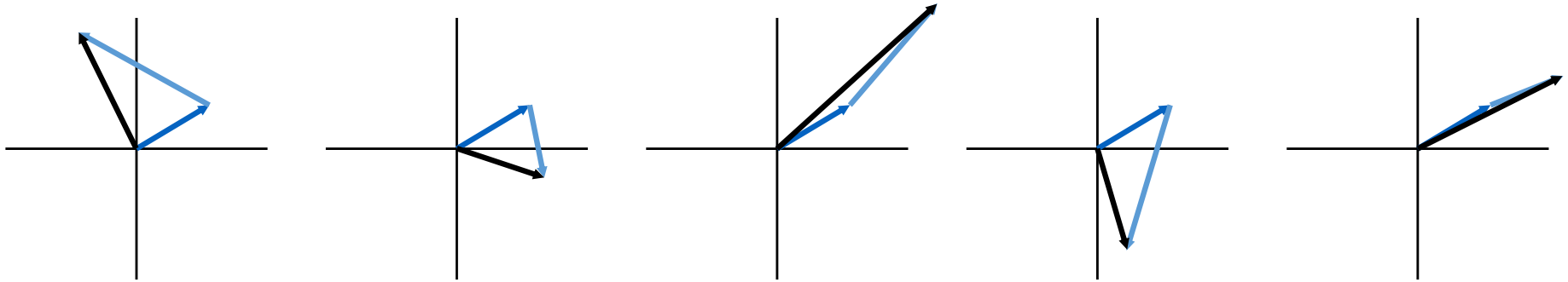
Solution: Use pulse with changing frequency and signal process using "matched filter"



Detection of Signals in Noise



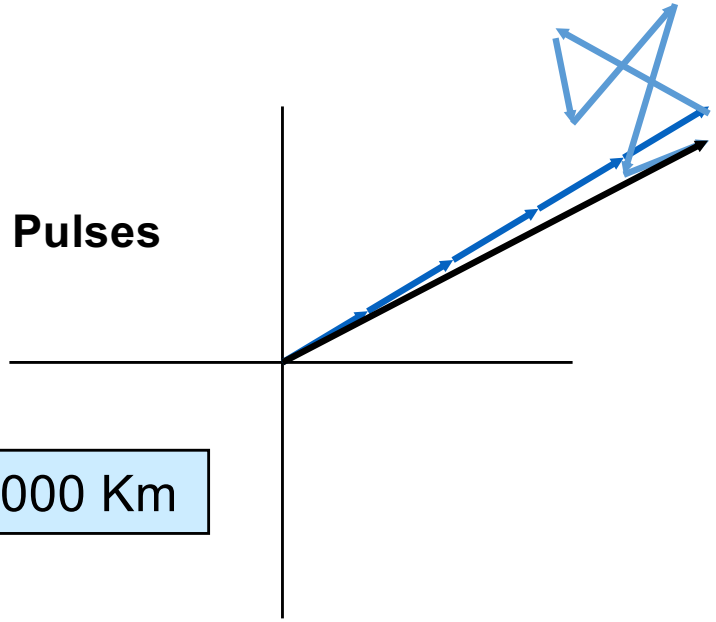
Coherent Integration



- Coherent target returns
- Noise samples at low SNR

- Resultant signal

Coherently Integrated Pulses



Deep space targets at 30,000 – 40,000 Km

Summary

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Range Resolution
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