

ESPTR: Pulsed Doppler Radar

Jacek Misiurewicz

April 12, 2010

By transmit waveform:

- ▶ Continuous wave
 - ▶ Doppler only (police, toilet, security...)
 - ▶ FMCW
 - ▶ Noise radars
- ▶ Pulsed
- ▶ Passive

By usage:

ATC Air Traffic Control

- ▶ Maritime: harbour, navigation
- ▶ Car mounted: parking, safety...
- ▶ Airborne: collision, meteo, fighter, Joint Stars, Bryza
- ▶ Satellite (EarthObservation)

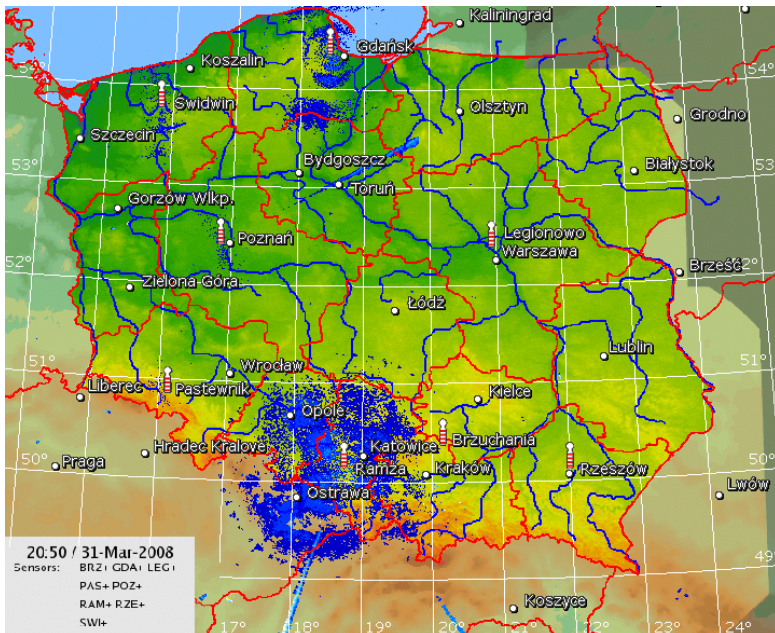
By scan: fixed, pivot, rotary, electronic (+ conformal)

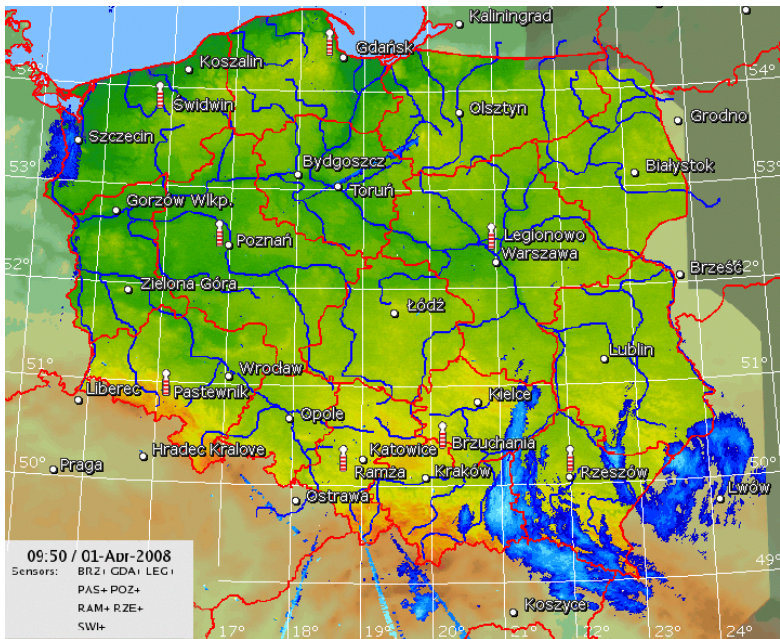
Search or tracking mode.

Meteo radar

- ▶ Imaging of water/ice in atmosphere
- ▶ Velocity, turbulence, wind profilers (VHF)

Techniques: Doppler, polarimetry, 3D imaging...





Velocity measurement

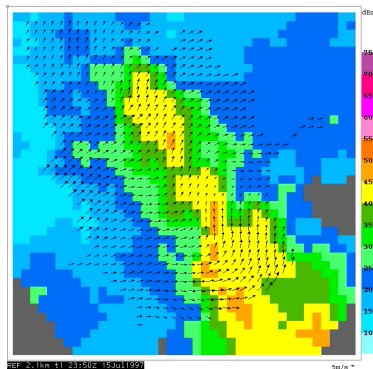
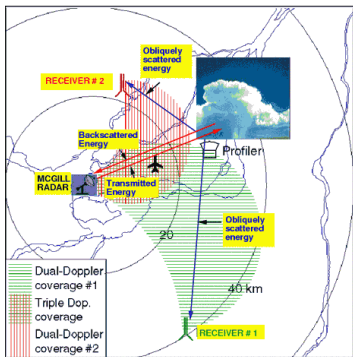
→ Doppler shift measurement

$$x_R(t) = A_T(t - R_0/c - vt/c) e^{j\phi_M(R_0/c + vt/c)} e^{j(\omega t)} e^{-j\omega(R_0/c)} e^{-j\omega vt/c}$$

Example: 10GHz, 70 m/s

- ▶ Min velocity: ground/sea/meteo clutter (ATC), time-on-target (METEO)
- ▶ Max velocity (frequency): (inverse of) modulation period

Bistatic radar network



dbZ: db w.r.t. 1 mm⁶ m⁻³ (number of drops per unit volume and the sixth power of drop diameter).

ATC radar

Transmitter: Pulsed chirp (or other modulation).

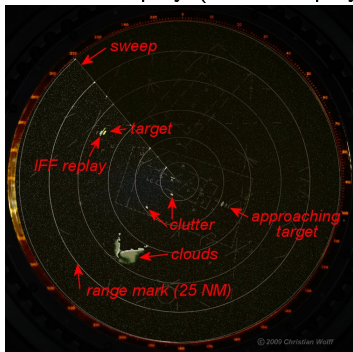
Common: Antenna, scan mechanism, waveguides, rotary joint, T/R switch

Receiver:

- ▶ Protection, LNA, mixer, IF, pulse compression, quadrature demodulation (sin/cos problem →@blackboard), range gate →range-azimuth plane
- ▶ Clutter filter, CFAR, detection, integration, 2nd threshold (→raw video)
- ▶ Object extraction (→plots)
- ▶ Track initiation, plot to track association, tracking (→tracks)

ATC radar display

→PPI display (other displays are history now)



(from radartutorial.eu)

MTI/MTD

- ▶ Clutter is low-pass (in a stationary radar): use a HF filter
- ▶ Blind speed problem → vary the PRF

MTI pulse-to-pulse stagger

MTD block stagger

Filter characteristics with stagger: poor!

→ variable coefficient filters

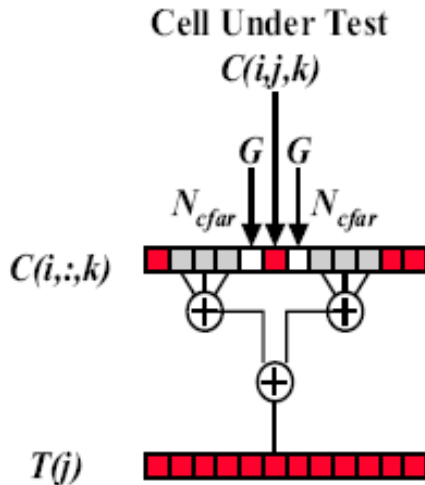
MTD: FFT filter bank (or equivalent)

Weather clutter: non-zero Doppler, complex filter coefficients, adaptive filters (MTI)

Velocity measurement (CRT with MTI or MTD).

CFAR

Constant False Alarm Rate



Pulse compression

BT product.

- ▶ Chirp (—→compression line, electromechanical filter)
- ▶ Bi- and polyphase
- ▶ Pseudorandom

Range sidelobes.

*Warning: some people use the term “compression” for “deramping”
—→ see the lecture on FMCW radar*

ECM/ECCM

Chaff.

Jamming: detection + diversity, agility.

Adaptive jamming/false echoes → pulse coding, pulse stagger