SAR Processing

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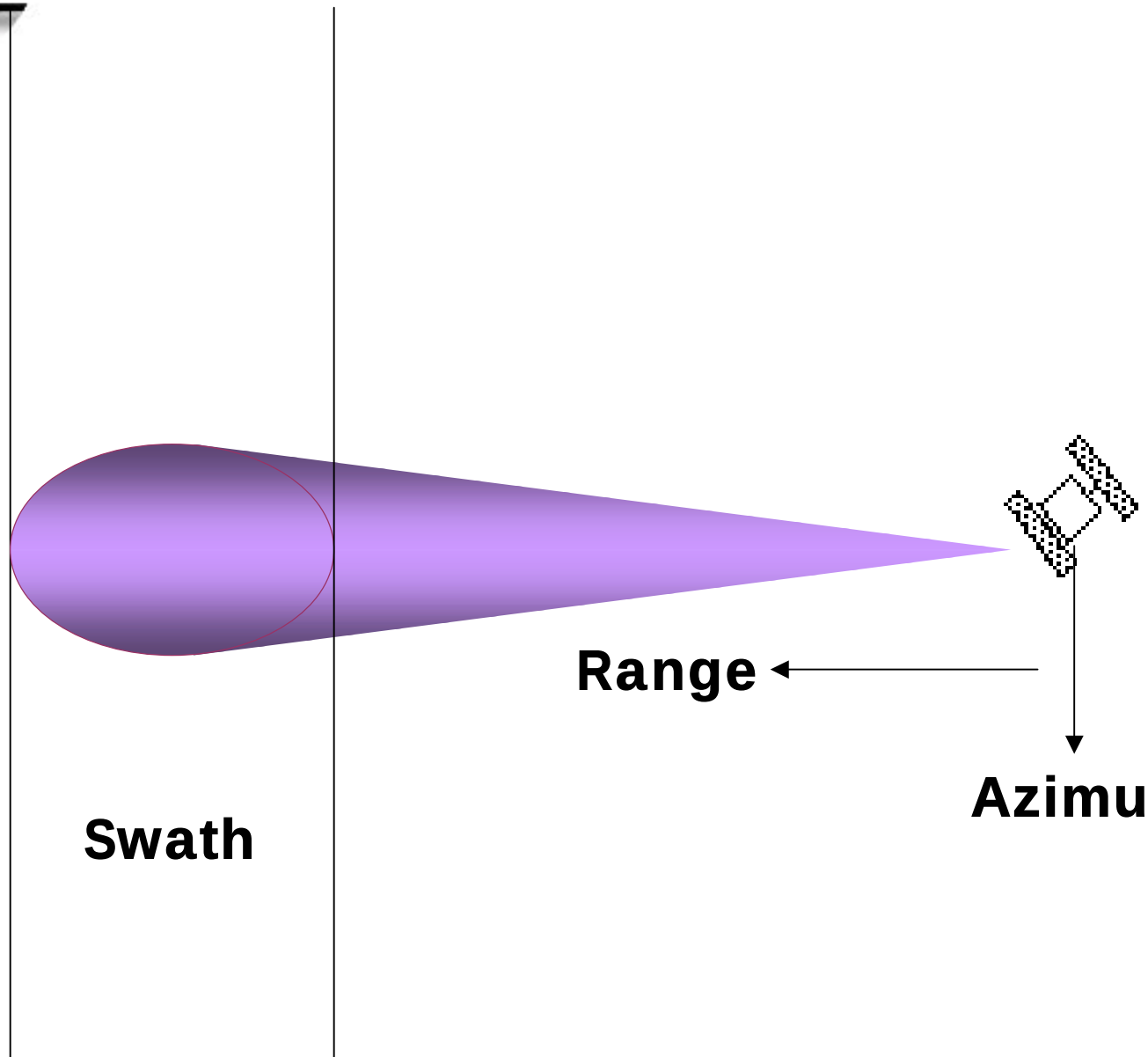
Outline

- Sonar Echoes
- Definitions
- What do we measure?
- Target detection
- Convolution
- Range compression
- Azimuth Compression

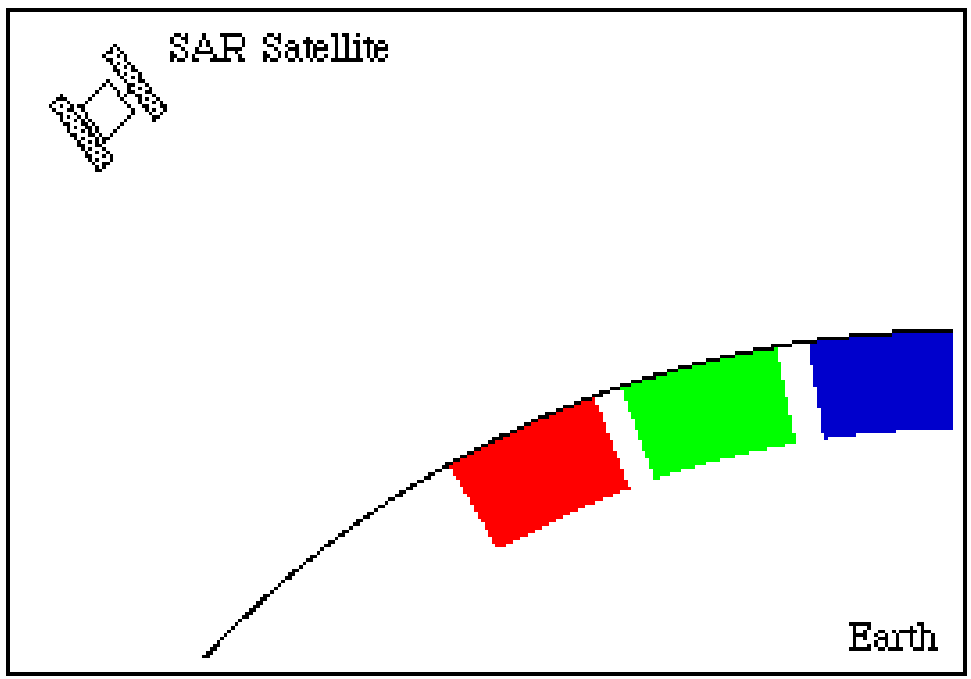
Sonar Echoes

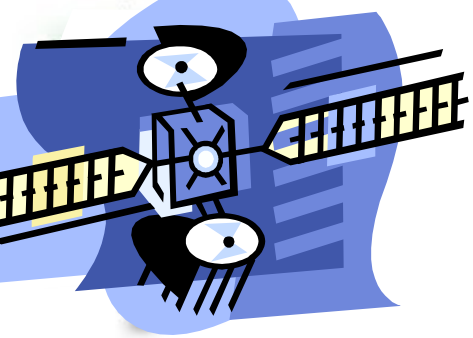
Some definitions



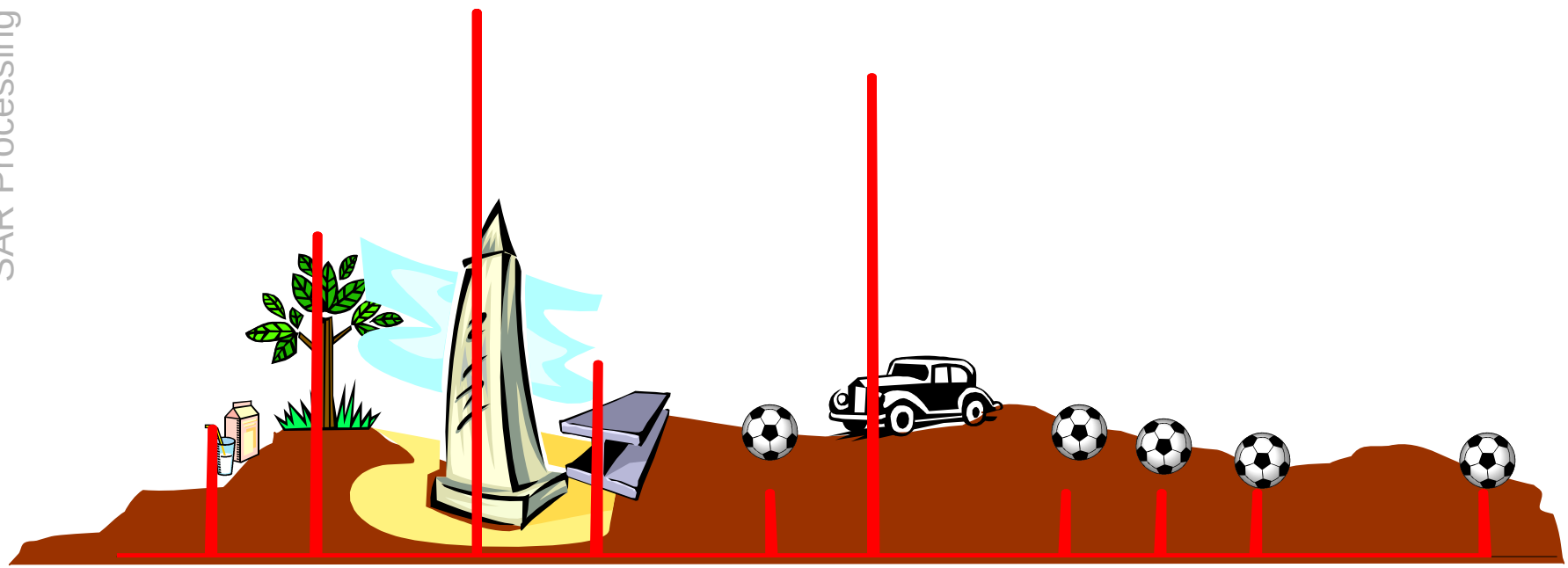
What do we measure?

- At the satellite
  - Radar signal strength as a function of time
- After processing
  - Radar Cross Section per piece of dirt

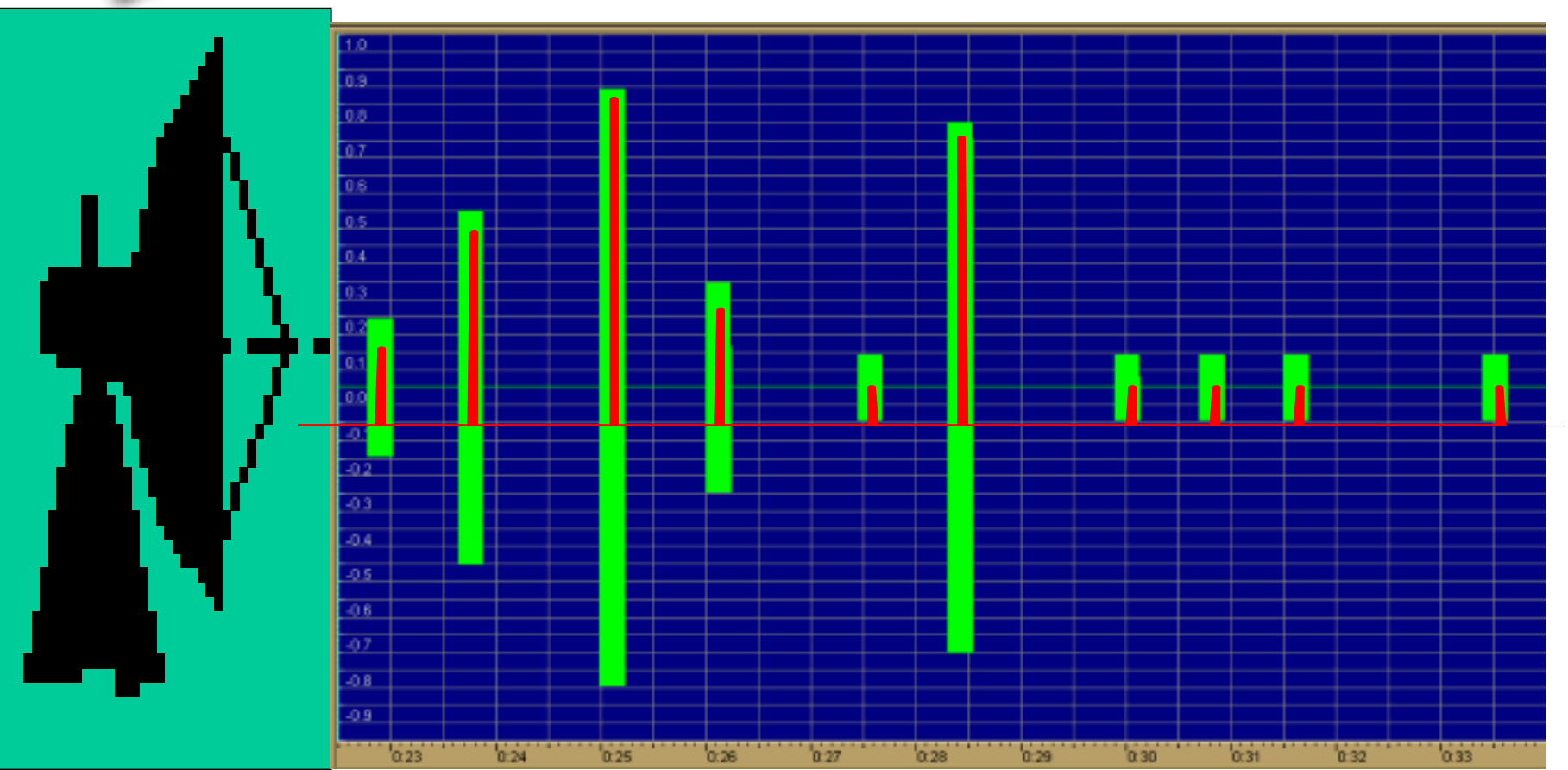




Target detection



Target detection: Short pulse



- Power problem
  - We need a short pulse for resolution
  - We need a lot of power for detection

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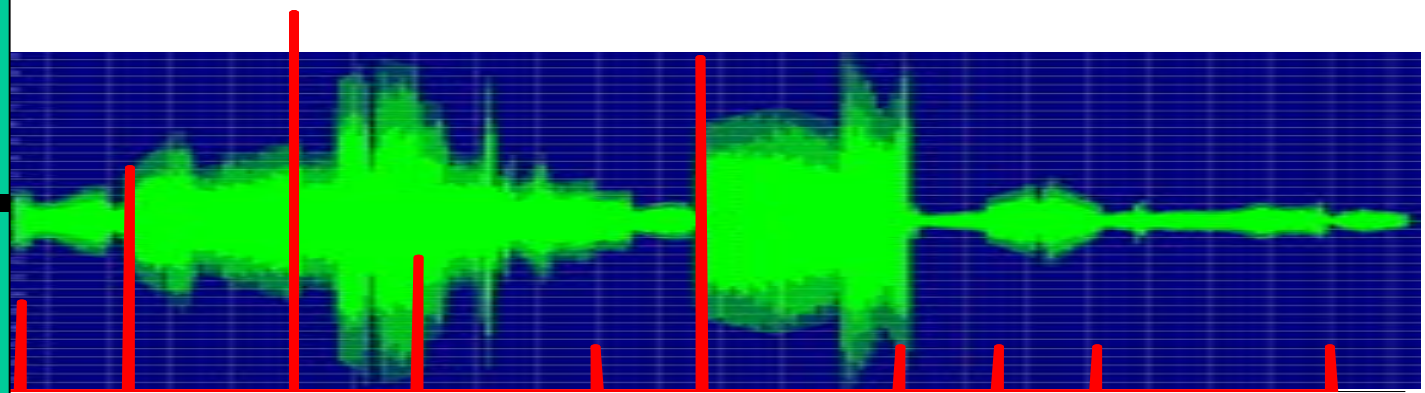
Target detection: Long pulse



- Power problem
  - We need a short pulse for resolution
  - **We need a lot of power for detection**

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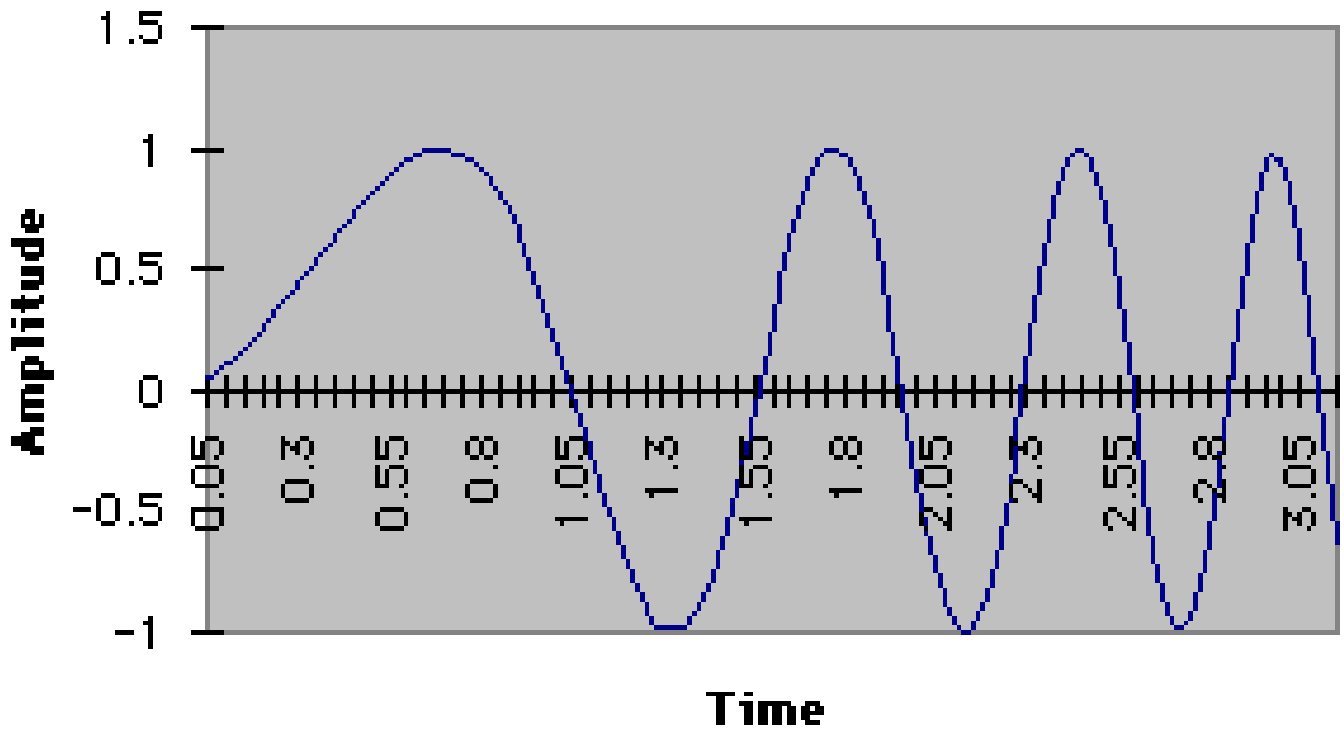
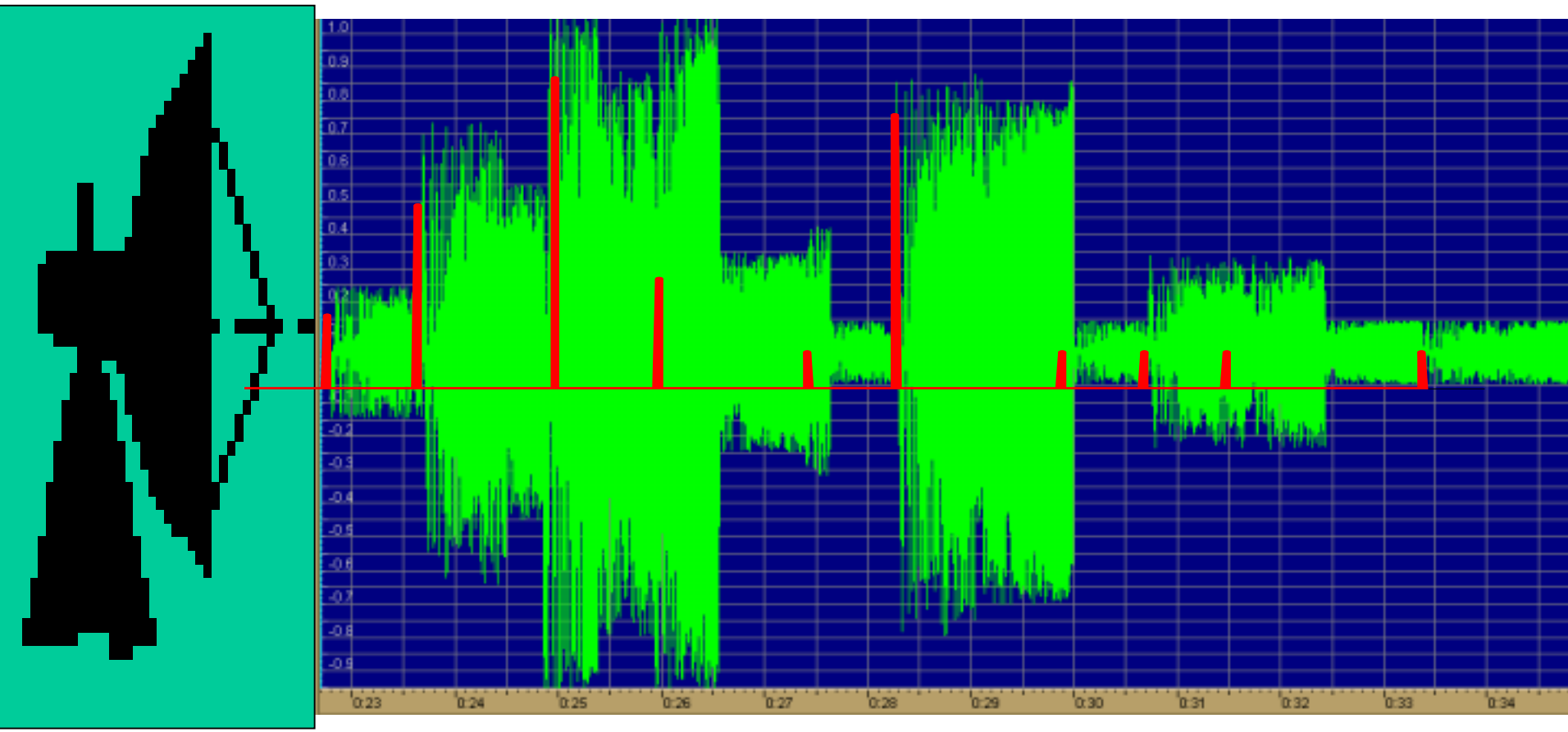
Target detection: Chirp

- Can go from low to high or high to low frequency
- Can be much more complicated



Target detection: Chirp pulse



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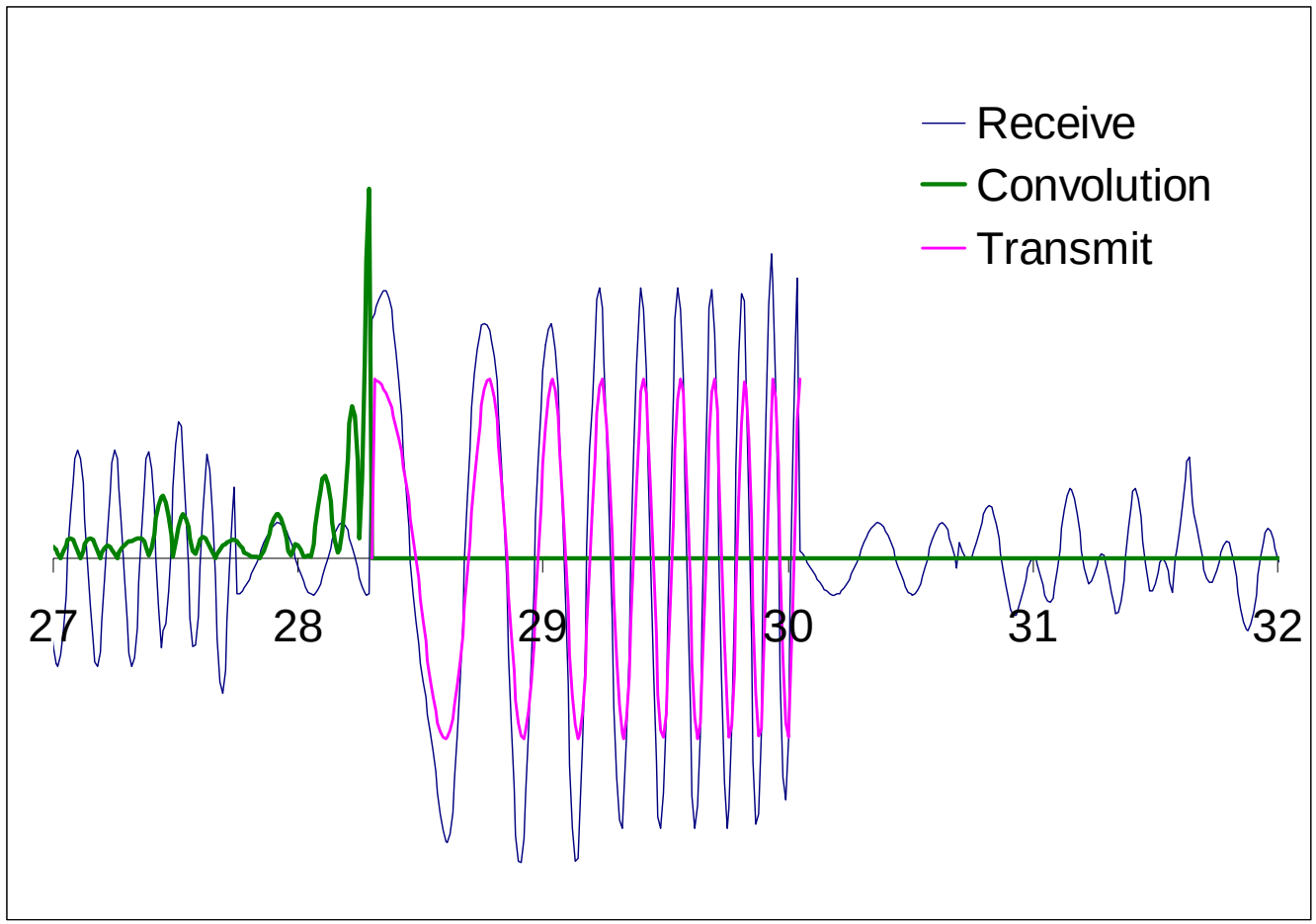
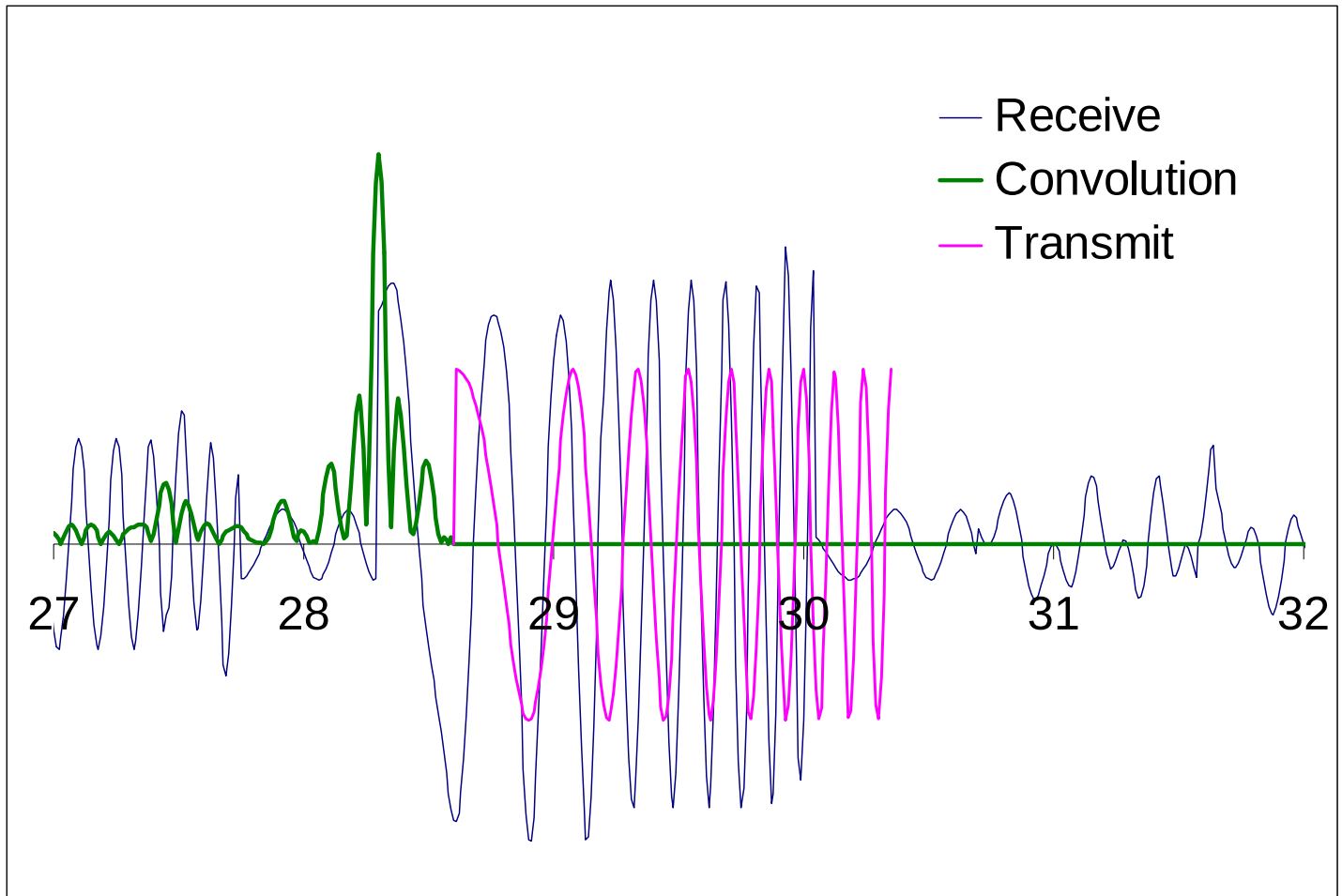
Convolution

- Run simulation

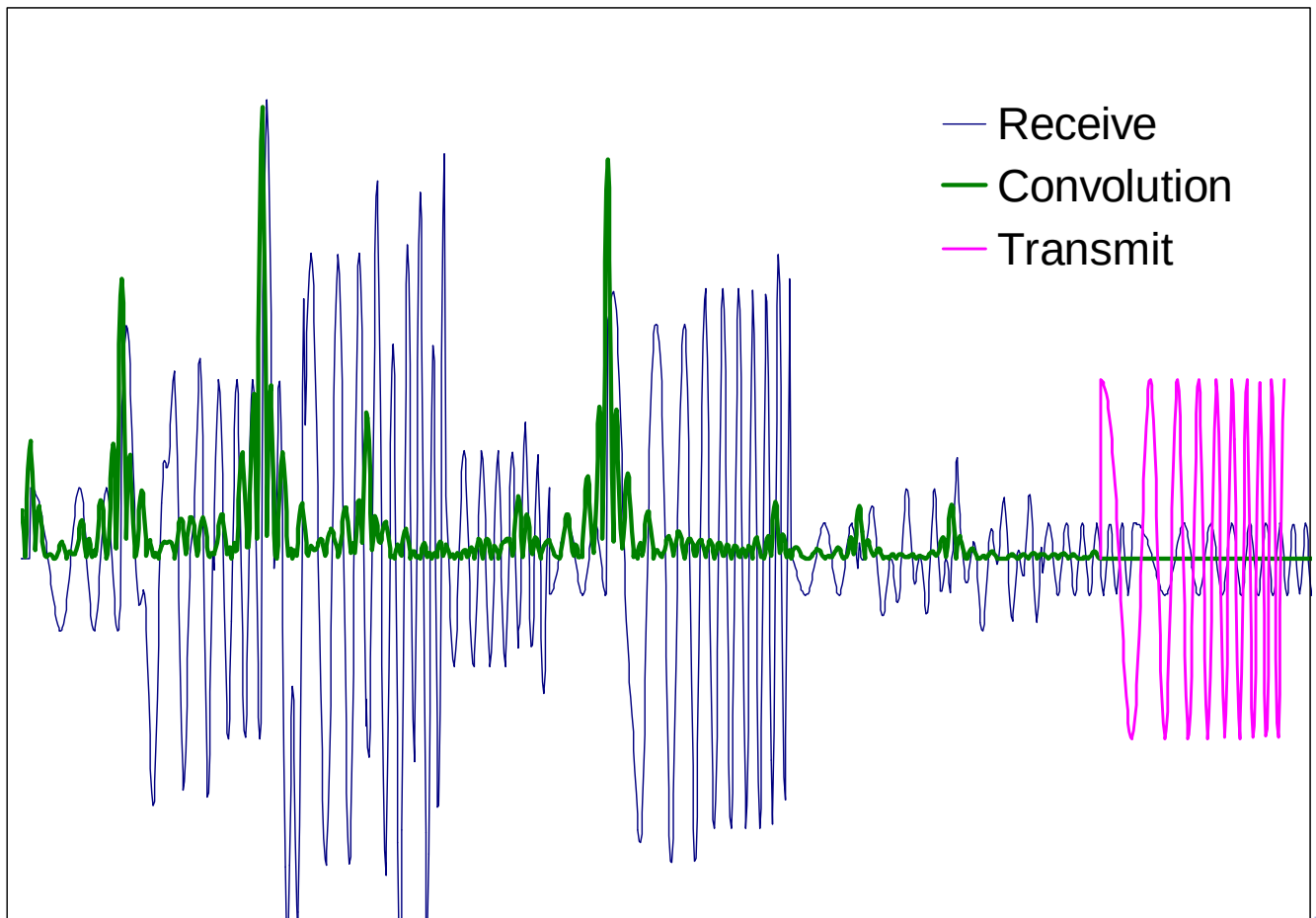
Convolution: Constructive interference



Convolution: Destructive interference

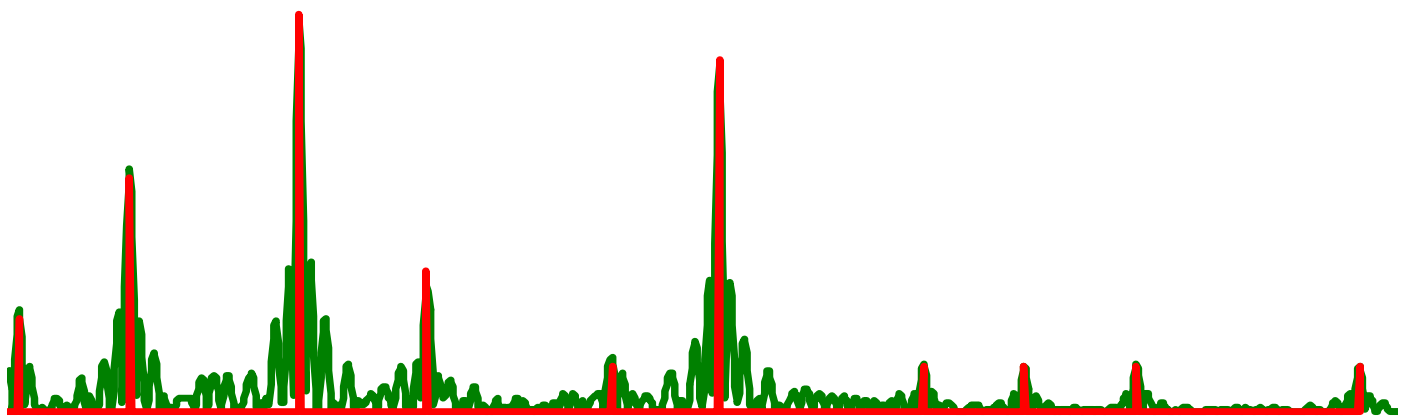


Convolution



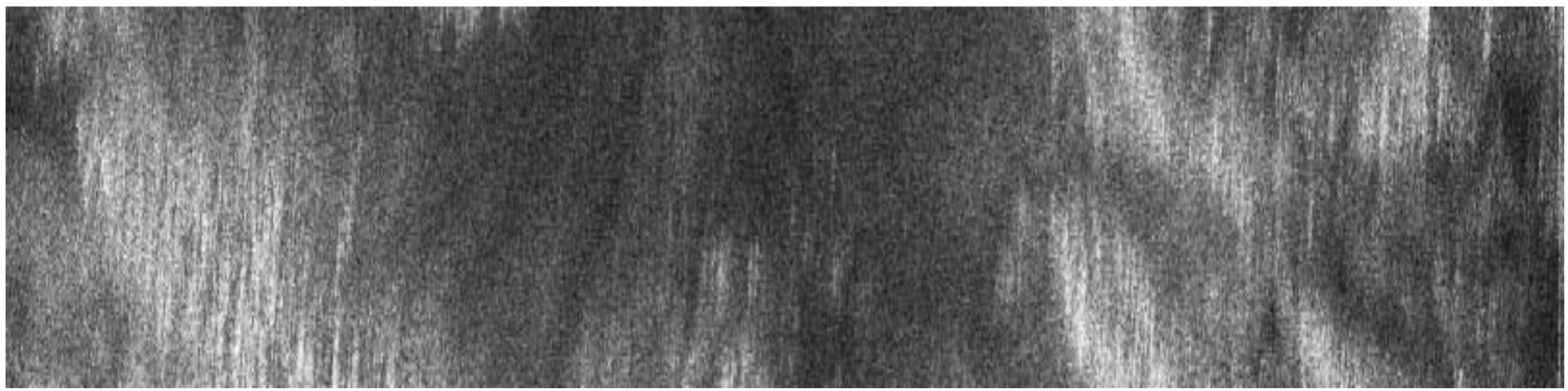
Range Compression

- Convolve the received range signal with the chirp you sent out.
- Range line looks similar to that of a short pulse – We have “compressed” the chirps in the signal to short pulses.

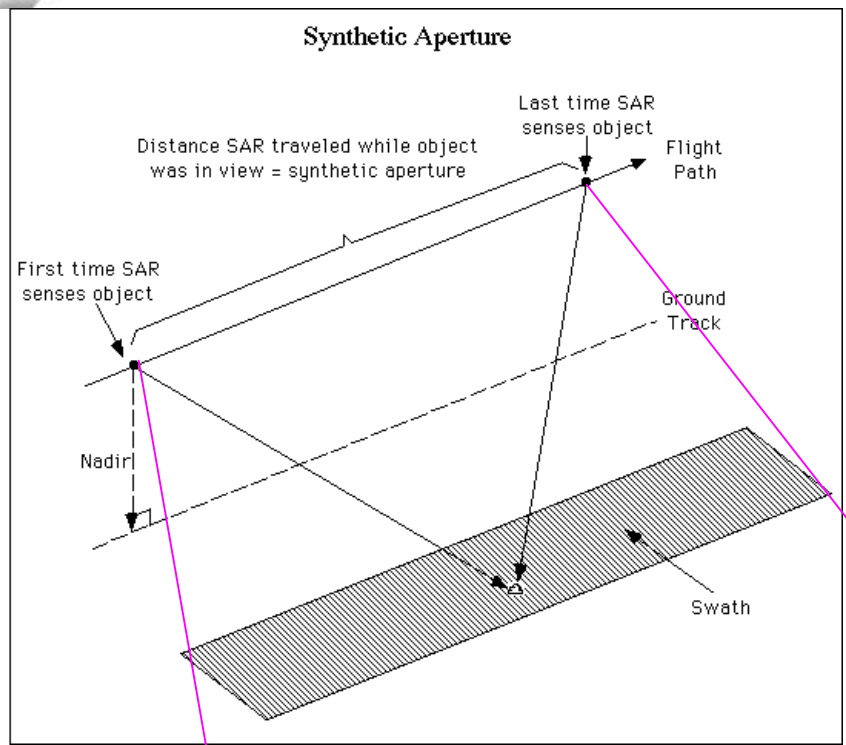


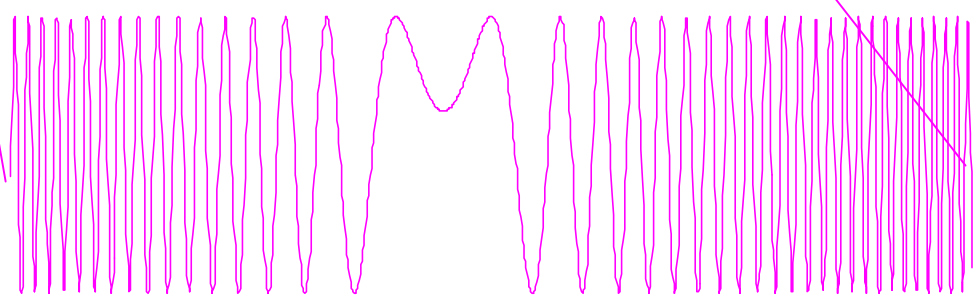
Azimuth: Real Aperture Radar

- Good resolution in range, poor resolution in azimuth



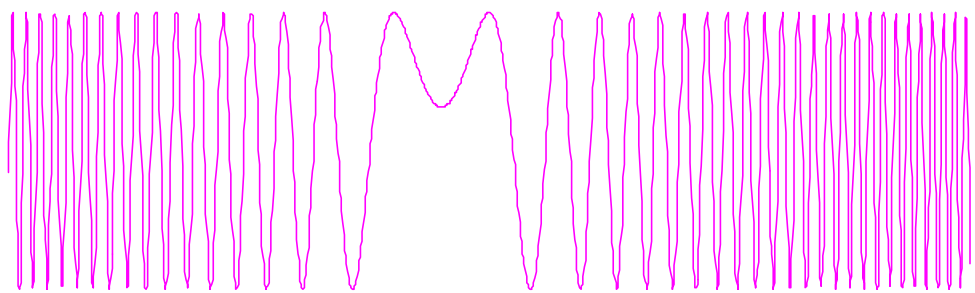
Azimuth: The Doppler effect



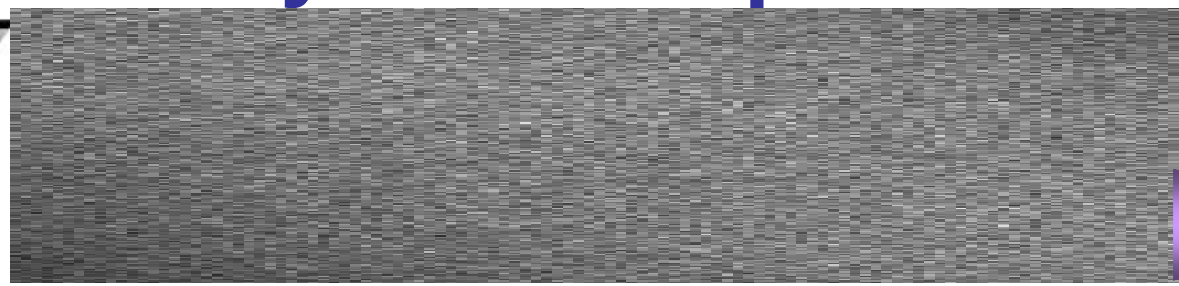


Azimuth compression

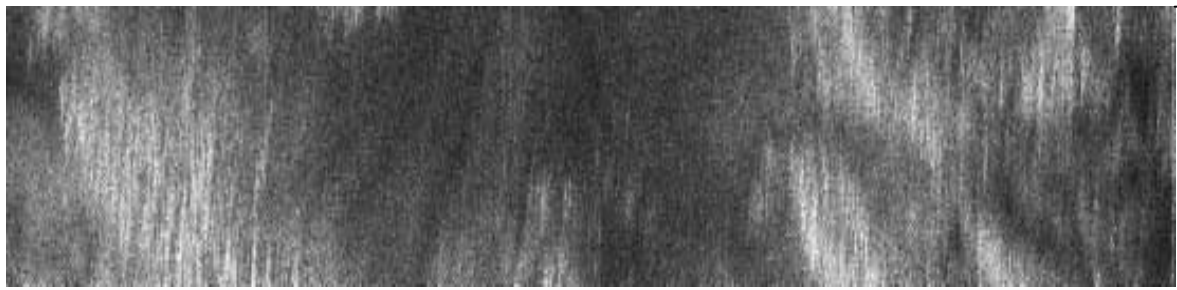
- Carl Wiley, in 1951, observed that two point targets at different azimuth positions, will have distinct Doppler frequency shifts. [Curlander, McDonough, 1991]
- We can compress the pulse in azimuth in the same fashion we compressed it in range.
- Convolve an azimuth line with the azimuth reference function:



Synthetic Aperture Radar

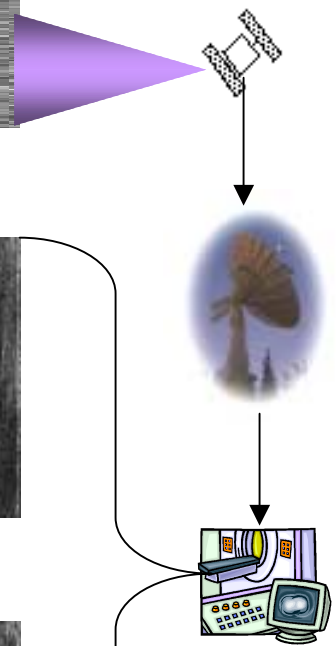


- Raw data



- Range compressed

- Azimuth compressed



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Questions?

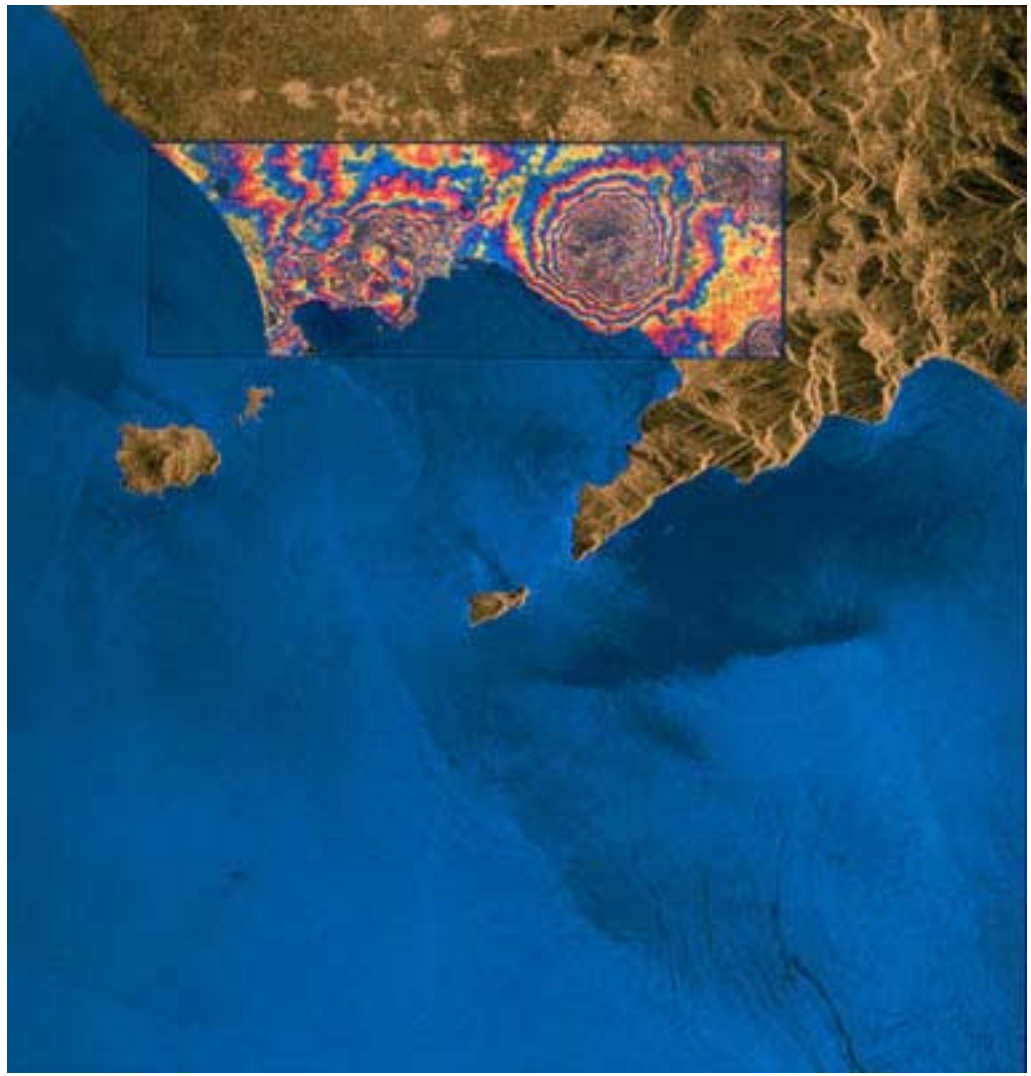

Image from ESA's website at
http://ravel.esrin.esa.it/images/EarthObservation/corv_257.jpg