RADAR Basics

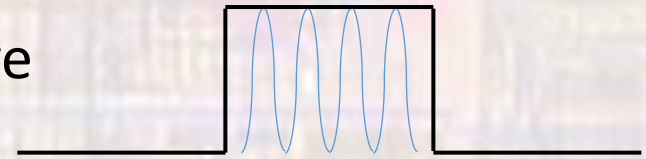
Last updated 3/27/24

RADAR Basics

- RADAR
  - RAdio Detection And Ranging
  - Early development in 1936
  - Significant advancements during WWII
    - Detect incoming bombers
    - Prevented Germany from achieving air superiority
- Key advantages
  - Long range
  - All weather
  - 3D target position detection
  - Can be mobile
  - Many variations achievable

RADAR Basics

- Basic idea
  - Transmit a focused pulsed radio wave
  - Detect the returning radio wave
  - Direction of transmit and time of arrival of the returned signal → location



target
(w/ cross section)

antenna

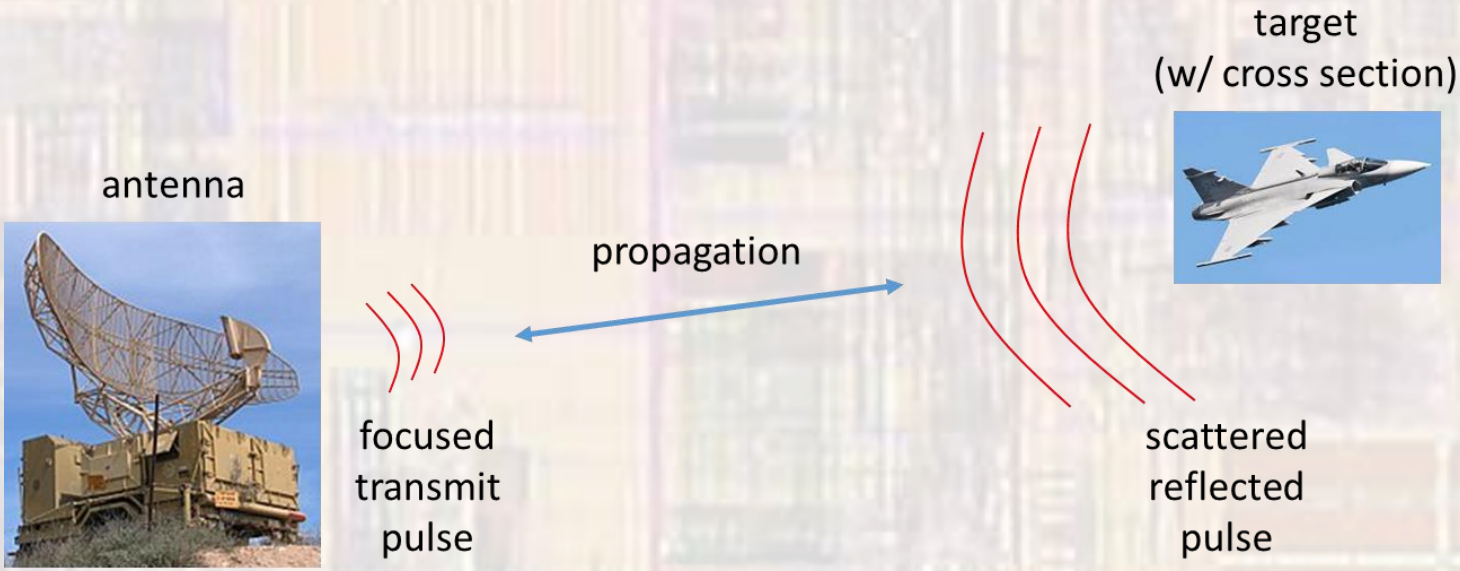
propagation

focused
transmit
pulse

scattered
reflected
pulse

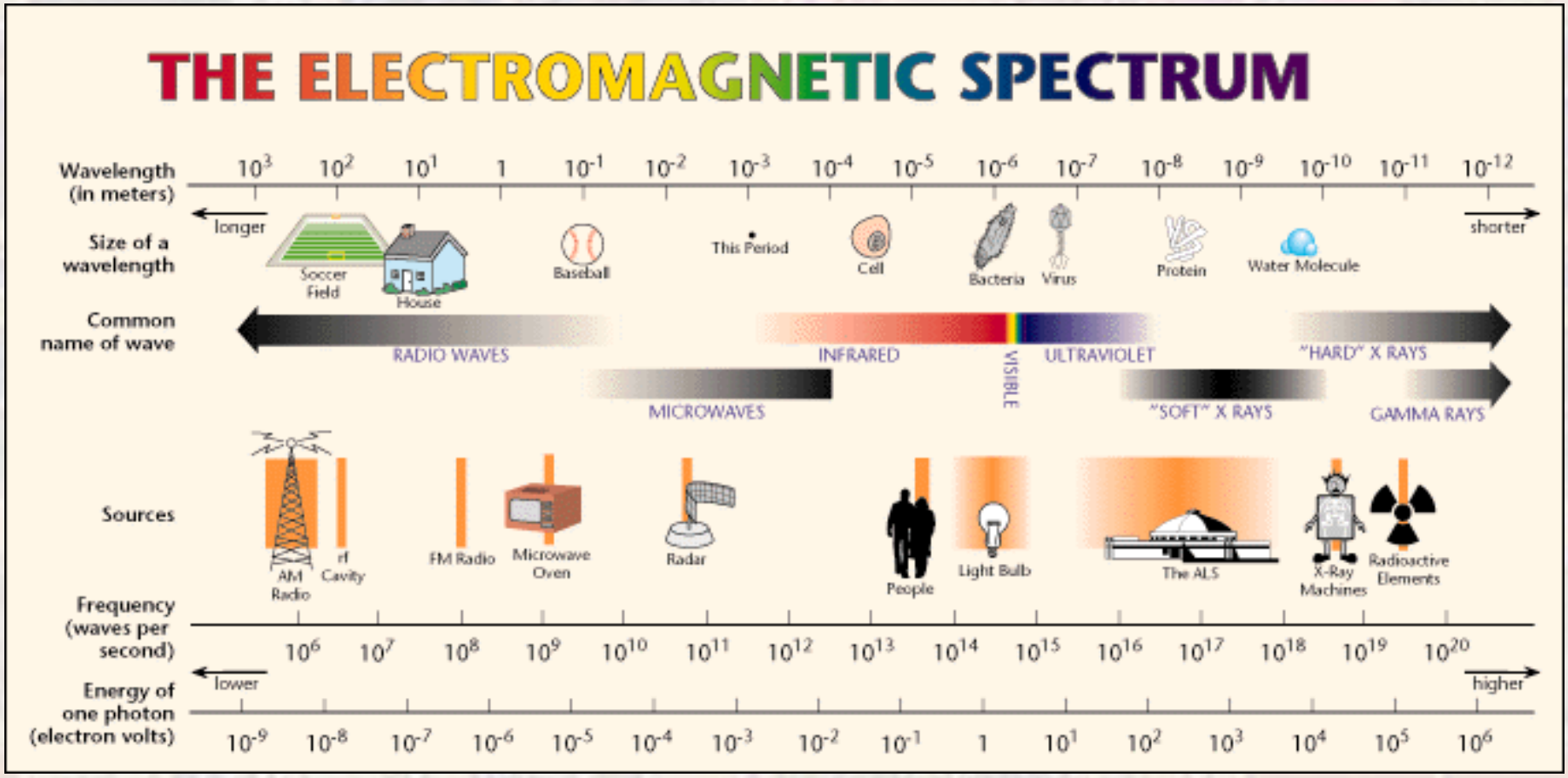
RADAR Basics

- Basic idea
  - Detect range
  - Detect azimuth (angle wrt north)
  - Detect elevation
  - Detect size (cross section)
  - Detect speed (using doppler)



RADAR Basics

- RADAR frequencies

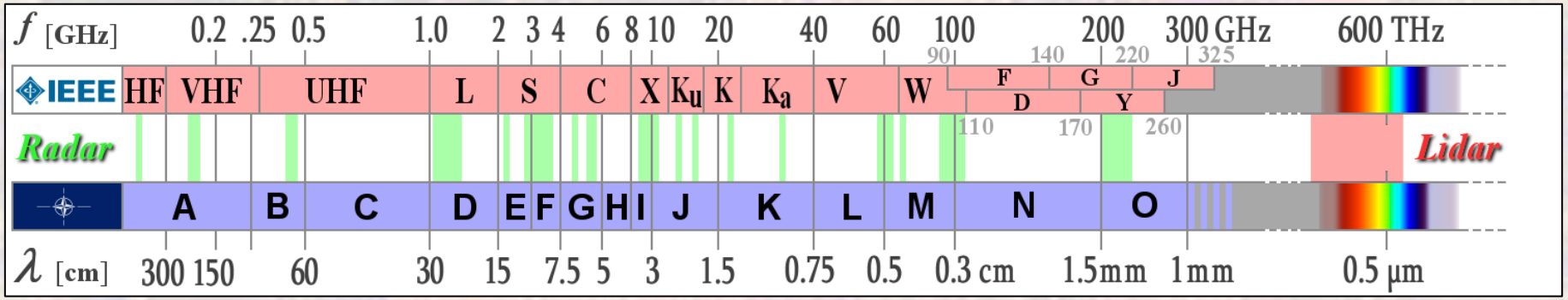


src: lbl.gov

RADAR

RADAR Basics

- RADAR frequency bands



Frequency Range	Wavelength Range	Band Name	Usage
3-30 MHz	10-100 m	HF	Coastal radar systems
30-300 MHz	1-10 m	VHF	Very long range
300-1000 MHz	0.3-1 m	UHF	Very long range
1-2 GHz	15-30 cm	L-band	Long range
2-4 GHz	7.5-15 cm	S-band	Terminal air traffic control, marine radar
4-8 GHz	3.75-7.5 cm	C-band	Satellite transponders, synthetic aperture radar
8-12 GHz	2.5-3.75 cm	X-band	Marine radar, weather, ground surveillance, synthetic aperture radar
12-18 GHz	1.67-2.5 cm	Ku-band	Satellite transponders
18-24 GHz	1.11-1.67 cm	K-band	Satellite transponders, radar guns, weather
24-40 GHz	0.75-1.11 cm	Ka-band	Mapping, surveillance

RADAR Basics

- RADAR equation
  - Trivial version

range = Ct/2

C = Speed of light = $3x10^8$m/s

t = time between transmit and return