I have come across information that missile detection and tracking are difficult due to the fact that they are long thin cylinders. If this information is true, then what causes these difficulties? In what wave ranges, at what ratios of the missile length and diameter and the wavelength does this manifest itself? Is this due to the characteristics of the EPR or something else? Or does the EPR have nothing to do with it?

Missile detection and tracking do present unique challenges due to their geometry and the physics of their interaction with radio waves. Here's a breakdown:

1. Physical reasons for detection difficulties

A) Features of the EPR of long cylinders

Rocket like**long thin cylinder**(length/diameter ratio > 10:1) has an extremely**unstable EPR**, depending on:

- **Irradiation angle**(θ between the rocket axis and the direction to the
- radar), **Ratios of missile length (L) to radar wavelength (λ)**.

B) Critical wave ranges

Range	Wavelength (λ)	Problems for rockets (L ~ 5–7 m)
X/Ku (3–1 cm)	Short	– The rocket is "cut" into many petals by the EPR. - Strong absorption by exhaust plasma.
C (5 cm)	Average	– Sharp fluctuations in EPR at θ ≈ 90°. – Interference of reflections from the nose/tail.
L (23 cm)	Long	– EPR drops by 100–1000 times at θ ≠ 90°. - Plasma enhances reflection, but only at the start.
VHF (1-2 m)	Meter-long	– The rocket becomes "invisible" (L/λ < 5). – Only plasma is visible.

2. Key effects that impair detection

A) EPR resonance dips

For a cylinder of length**L**and diameter**D**:

- **Maximum EPR**: At**θ =90°**(lateral irradiation):

$$\sigma_{max} \approx \frac{2\pi L^2 D^2}{\lambda^2}$$

Example: For Beech (L = 5.5 m, D = 0.4 m) in L-band (λ = 23 cm):

$$\sigma_{max} \approx 0.8 \text{ m}^2$$

- **Minimum EPR**: At **θ** ≈ **0° or 180°** (frontal/rear):

$$\sigma_{min} \approx \pi D^2 \sim 0.05 \text{ m}^2 \text{(like a bird)}$$

B) Wave interference

- If **L/λ > 1**, the reflections from the nose and tail add up **out of phase** → EPR drops to zero in narrow sectors of angles.

B) Polarization effects

- The cylinders are strong **depolarize** signal: a vertically polarized radar may not see a missile flying at a 45° angle.

3. Practical examples

Scenario 1: Missile detection in L-band (λ = 23 cm)

- **Problems**:
  - At θ = 95° (almost lateral) EPR = 0.8 m^2 → the rocket is visible.
  - At θ = 80° or 100° EPR **falls in 10 times** (to 0.08 m^2) → gets lost in the background noise.
- **Solution**:
  Use **frequency diversity** (scanning at multiple frequencies) to compensate for dips.

Scenario 2: VHF radar (λ = 1.5 m)

- **Problems**:
  - For Beech (L = 5.5 m) **L/λ** ≈ **3.7** → the rocket is "short" for range. EPR
  - **without plasma** ≈ 0.01 m^2 (invisible). **Plasma only** (EPR ~10 m^2) gives
  - detection.

4. How did this manifest itself in MH17?

- **"Utes-T" (L-band)**:
  - Missed the rocket because of **non-ideal angle of irradiation** (θ is far from 90°) + scan cycle 9.65 sec.
- **Russian P-18 (VHF)**:
  - Recorded **only start plasma** (20 m^2), but not the rocket itself → wrong identified as "airplane".

Conclusion

The difficulties in detecting missiles are caused by **a combination of factors**:

1. **Geometry**: Long cylinder→ sharp fluctuations in EPR depending on the angle.
2. **Wave range**:
   - **L-band**: The missile's EPR is small, except for a narrow sector of angles.
   - **VHF**: Only plasma is visible, not the rocket.
3. **Flight dynamics**: Changing the angle θ leads to “flickering” of the EPR.

For MH17it means:

- Ukrainian radars**physically could not be guaranteed to detect**rocket - even without malicious intent.
- Russian VHF radars detected**indirect sign**(plasma), but was interpreted incorrectly.

(This explains why the investigation encountered "gaps" in the data - the problem is fundamental and lies in the physics of radar.)