THE FUTURE OF LOW-SIGNATURE PLATFORMS

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THREAT DEVELOPMENT

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- Older radar systems were very range-capable
  - S-200

S-200 Bar Lock

S-200 Square Pair

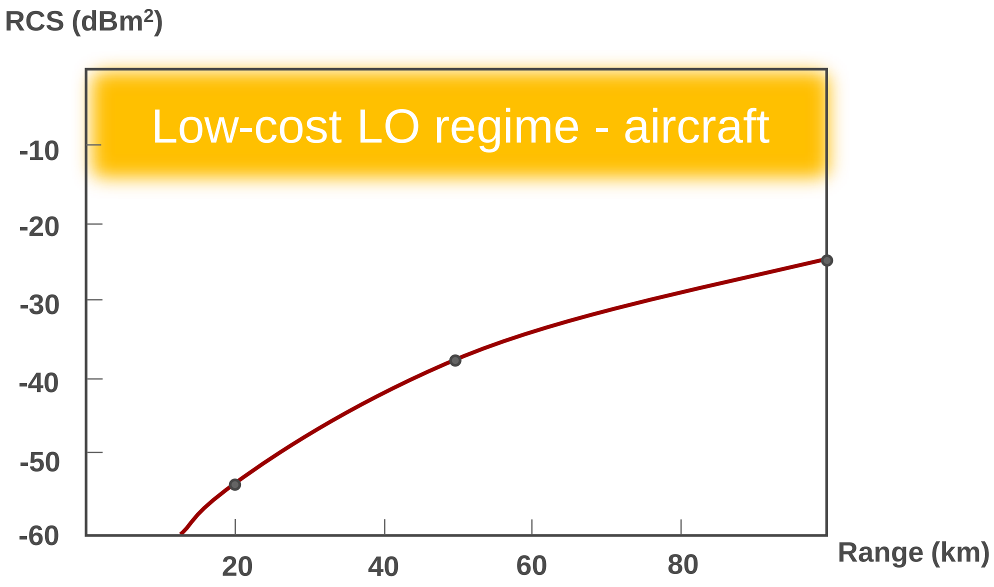
- Today´s systems do not reach significantly longer...
- ... but are still much better

THREAT DEVELOPMENT

- Improvements:
  - system bandwidth
  - target update rates
  - no. of tracked / engaged targets
  - waveform agility
  - multifunctionality (surv., tracking, fire control)
  - tracking capability
  - jamming resistance
    - flexible search patterns
    - frequency agility
    - sidel-lobe blanking
    - adaptive side-lobe cancellation

LO AIRCRAFT AGAINST LRSAM RADARS

- Reducing range
  - From: 450 km @ 0 dBm^2
  - To: Range km @ RCS dBm^2



- Not very meaningful to use low RCS against LRSAM
  - especially considering the low frequencies

- Thus termed:
  - AA - Anti-Access
  - AD - Area Denial

SRSAM TRENDS

- No. of missiles per firing unit increases
  - Tunguska 4
  - Tunguska 8
  - Pantsir 12
  - Morfei 36 (?)

- Conclusion:
  - Dimensioning against saturation attacks

SRSAM TRENDS

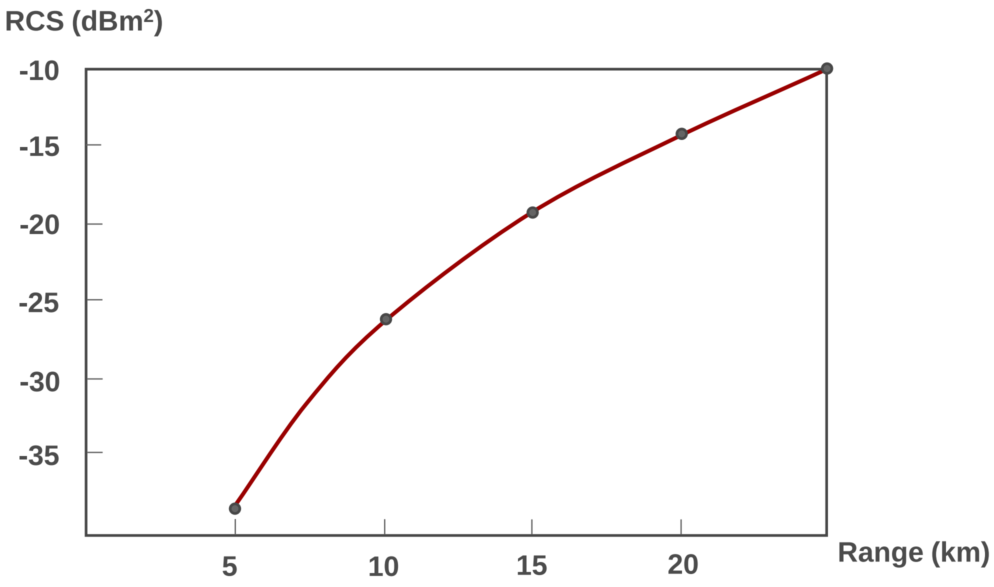
- Increased update rate

- Turret aiming => vertical launch
  - Tor, Morfei, MICA, IRIS T...

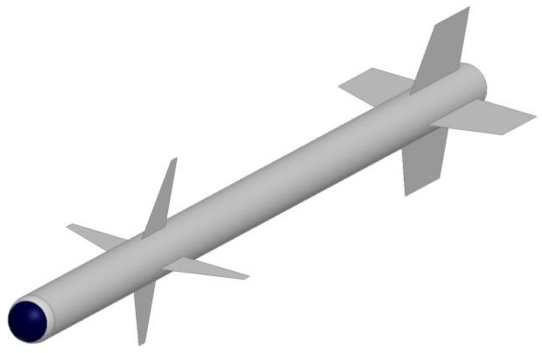
- Observation: response-time reduction
- Conclusion: dimensioning against:
  - high-velocity missiles
  - @ low altitudes
  - all directions

MISSILES AGAINST SRSAM RADARS

- Reducing range
  - From: 25 km @ -10 dBm²
  - To: Range km @ RCS dBm²



- Example:
  - RCS from hemispherical IR-window = -15 dBm²



- Conclusion:
  - Cruise missiles are viable candidates for RCS reduction

RCS OF MISSILES

MISSILES AGAINST SRSAM RADARS

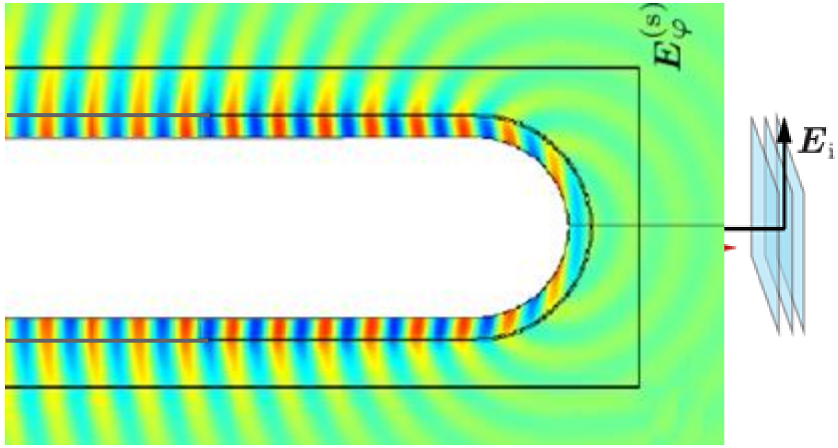
- Previous example: -25 dBm^2 <=> 10 km detection range
  - M 3 <=> 10 illuminations by a 1 s surv radar
  - M 4 <=> 7 illuminations by a 1 s surv radar
- Assume
  - 2 s response to firing
  - 30 g acceleration of SA missile
- SA missile hits after
  - 4.6 s @ 3.2 km range (M 3)
  - 4.1 s @ 2.5 km range (M 4)
- Conclusions:
  - close shave, no second chance
  - jamming + maneuvering can tip balance in cruise missile´s favour
  - *signature management of cruise missiles is meaningful*

MISSILE RADAR ABSORBERS

- High speed only in terminal phase
  - M 3-4 is well below plasma formation
- Some fibre composites might work, e.g. cyanate ester / quartz
  - T_g close to 400 °C
  - Low ε'_r and ε''_r , suitable for EM design
- Topics
  - edge scattering
  - grazing incidence
  - curved surfaces
    - frontal curvatures relatively small

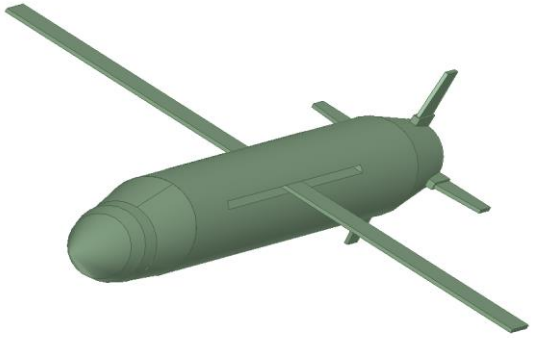
MISSILE RADAR ABSORBERS

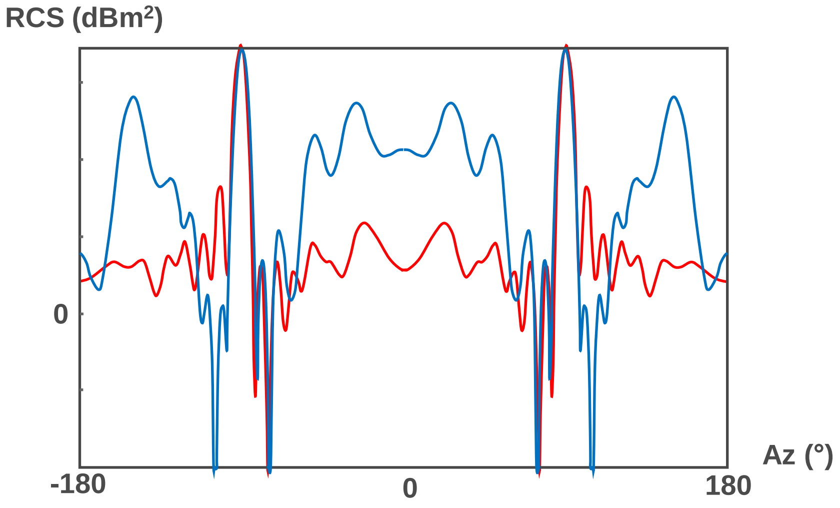
- NFFP6: *Signature management of low-altitude missiles*
  - Dr C Larsson, Saab Dynamics
  - Prof D Sjöberg, Lund University
- Problem:
  - Planar absorber designs are often used for curved surfaces
  - Absorber capacity degrades
- Highlights:
  - Resistive layers, magnetic layers, circuit-analog absorbers, bulk loss materials (*e.g.* doped foams)
  - Analytical models, full-wave simulations
  - Bulk loss absorbers *generally* better than thin-layer designs



WEAK SPOT

- Low-frequency radars?
  - High RCS against current cruise missiles
  - Would offset signature management





- Normally associated with LR-systems
  - Poor low-level function
  - Large <=> Low update rates
  - Aircraft integration very difficult

- Still: high RCS
  - Room for innovation!

AIRCRAFT RCS APPROACH

RCS IN FIGHTER COMBAT

$$M = \frac{P_{out} A_{ant}^2}{\sigma}$$

- Keeping everything else equal, the statistical outcome of a duel is noticeably affected by a figure-of-merit, *M* , that describes one's radar performance relative to one's RCS.
- Simplistically: Largest *M* wins
- Realistically: *M*-deficiency can be managed by radar discipline, numbers, tactics, co-operation, performance of other sensors, jammers and links, weapons performance, agility and unpredictability
- But that becomes increasingly harder as *dM* = *M* - *M* increases.
- Conclusion:
  - Keeping fighter RCS in check is and will be important

RCS IN FIGHTER COMBAT

- Cost control by requirement relaxation

- Develop RCS requirement against AEW and fighter radars

- "Spill-over" limits RCS at lower frequencies
  - higher UHF and upwards

- Develop tactics, EW and armament to handle remaining threats
  - VHF and lower UHF

RCS PRICE TAG

- Cost control by research

- Costs divided into
  - NRE
  - Production
  - Maintenance
- Other penalties
  - Sensor limitations
  - Interoperability issues
  - Weapons load
  - Availability
- But not
  - Flight envelope, maneuverability, action radius