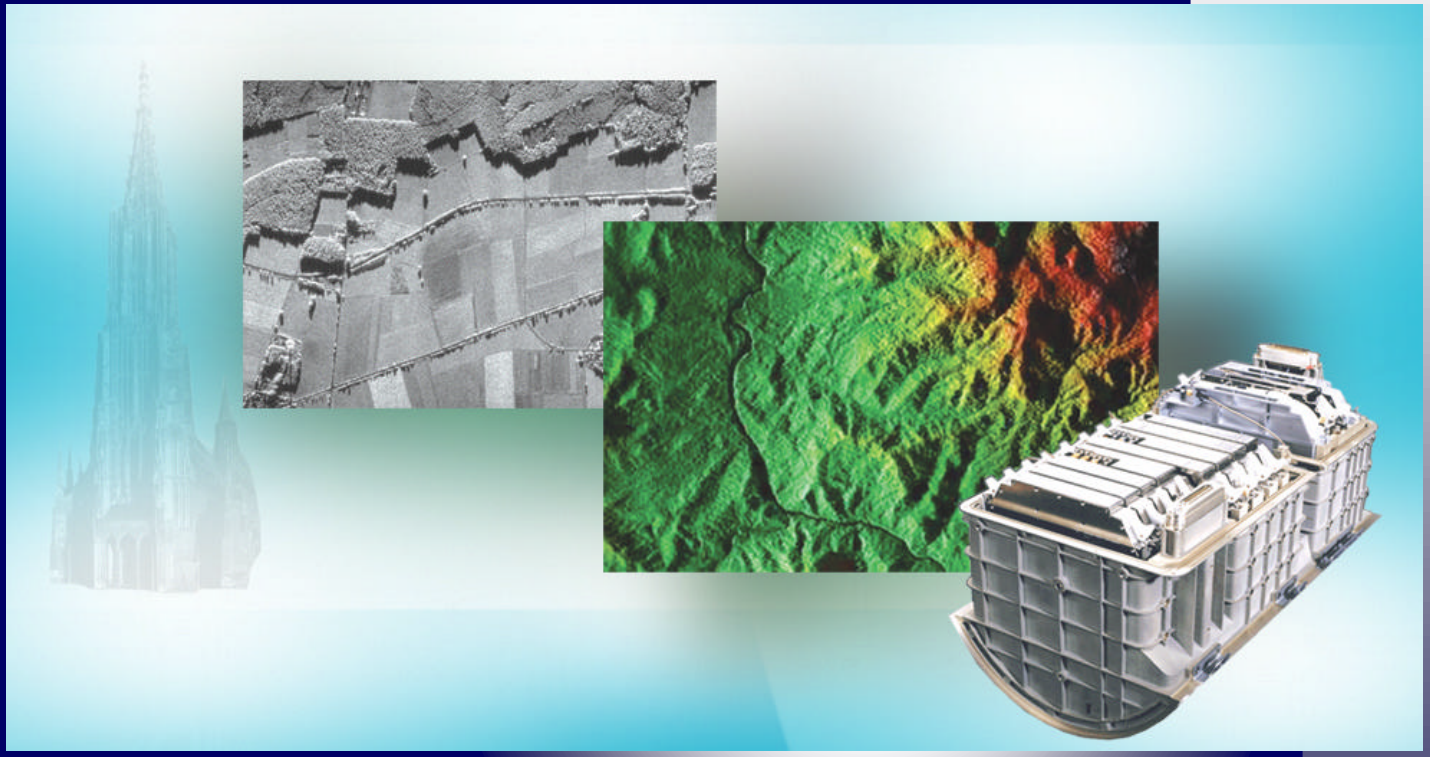
Airborne Systems

SAR for UAVs: Status, Technologies, Trends



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UAV 2002 Conference, Paris, 14 June

EADS Deutschland GmbH
Airborne Systems
Radar

Report Documentation Page

Form Approved
OMB No. 0704-0188

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1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
02 SEP 2003	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
SAR for UAVs: Status, Technologies, Trends	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **EADS Deutschland GmbH Airborne System**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001676, UAV 2002 conference & Exhibition., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**27**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

SAR for UAVs: Status, Technologies, Trends

Contents

- Introduction to SAR
- SAR Applications
- SAR Data Flow
- SAR Imaging, Multi-Mode SAR Benefits and Examples
- Operational Requirements,
  Performance Overview: Status, Trends
- New Generation SAR/MTI Sensor (SOSTAR-X)
- Technology Overview: Status, Trends

- MISAR, a mini SAR for TUAVs from EADS

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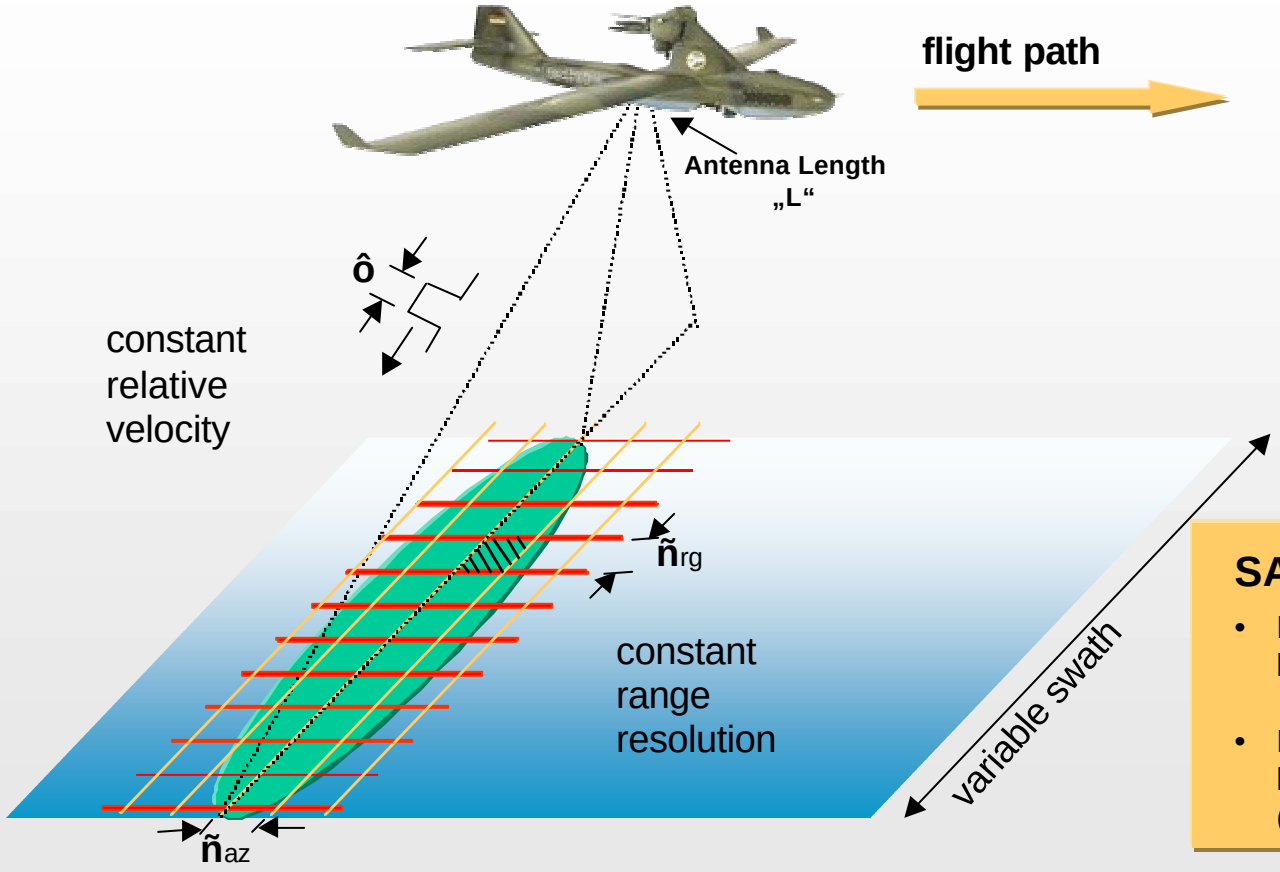
SAR Stripmap Mode



SAR Resolution

- Resolution across-track $\tilde{n}_{rg} = c * \hat{O}/2$ by high range resolution
- Resolution along-track $\tilde{n}_{az} = L/2$ by high resolution of relative velocity (doppler frequency)

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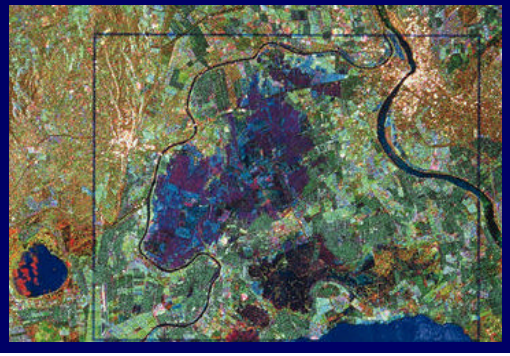
SAR Applications

SAR operates as an all-weather, day and night sensor, capable of penetrating cloudes, rain, smoke and fog

Applications, e.g.:

- **Surveillance and Reconnaissance**
  - SAR imaging, moving target identification (MTI)
  - Lenght measurement, target classification
  - Sea and border control
  - Thematic mapping, terrain contour mapping, area classification
- **Environmental Monitoring**
  - Pollution and forest control
  - Erosion and landslip control
  - Damage assessment, flooding and earth-quake monitoring



Flood after bursting of a dam

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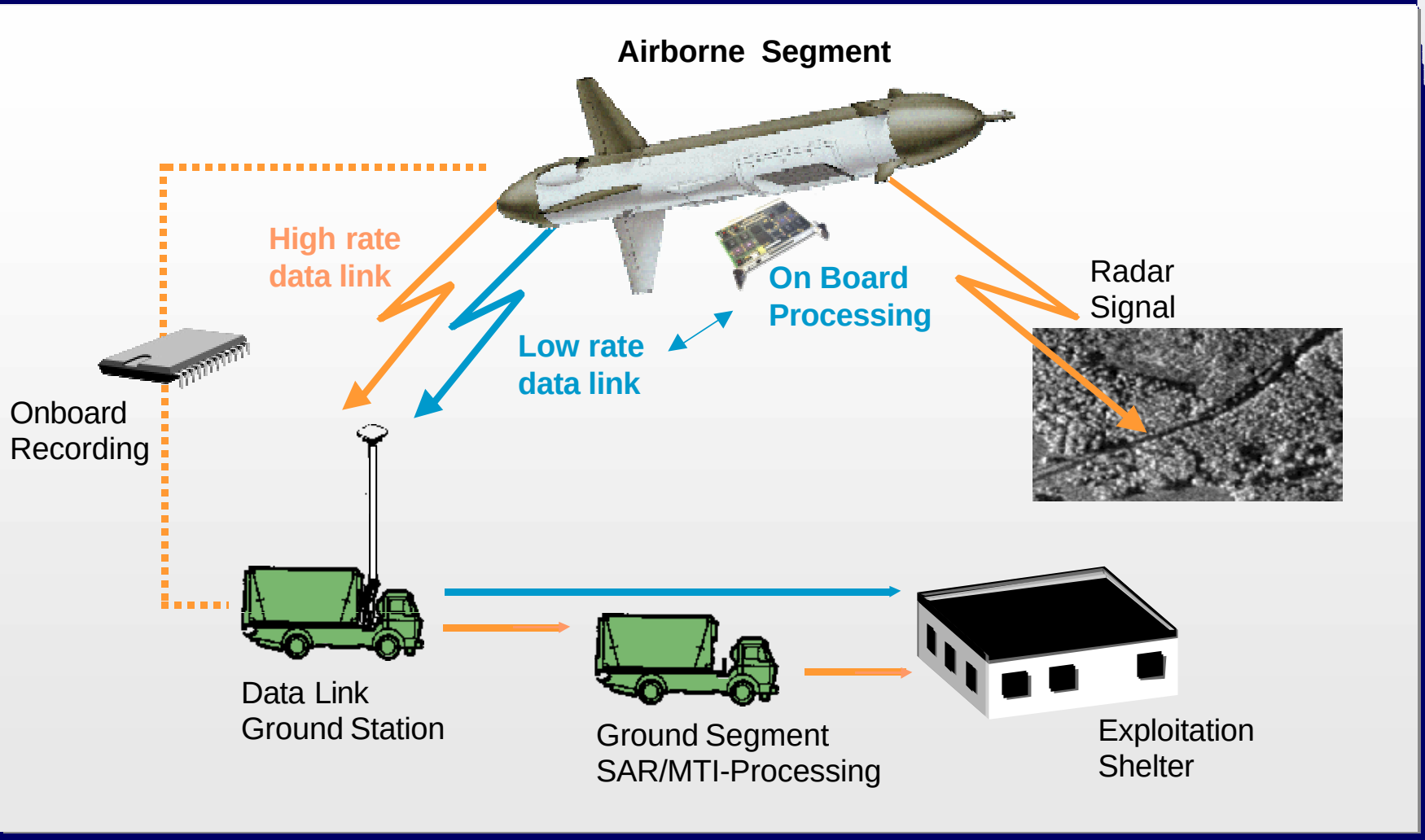
SAR Data Flow



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SAR Imaging

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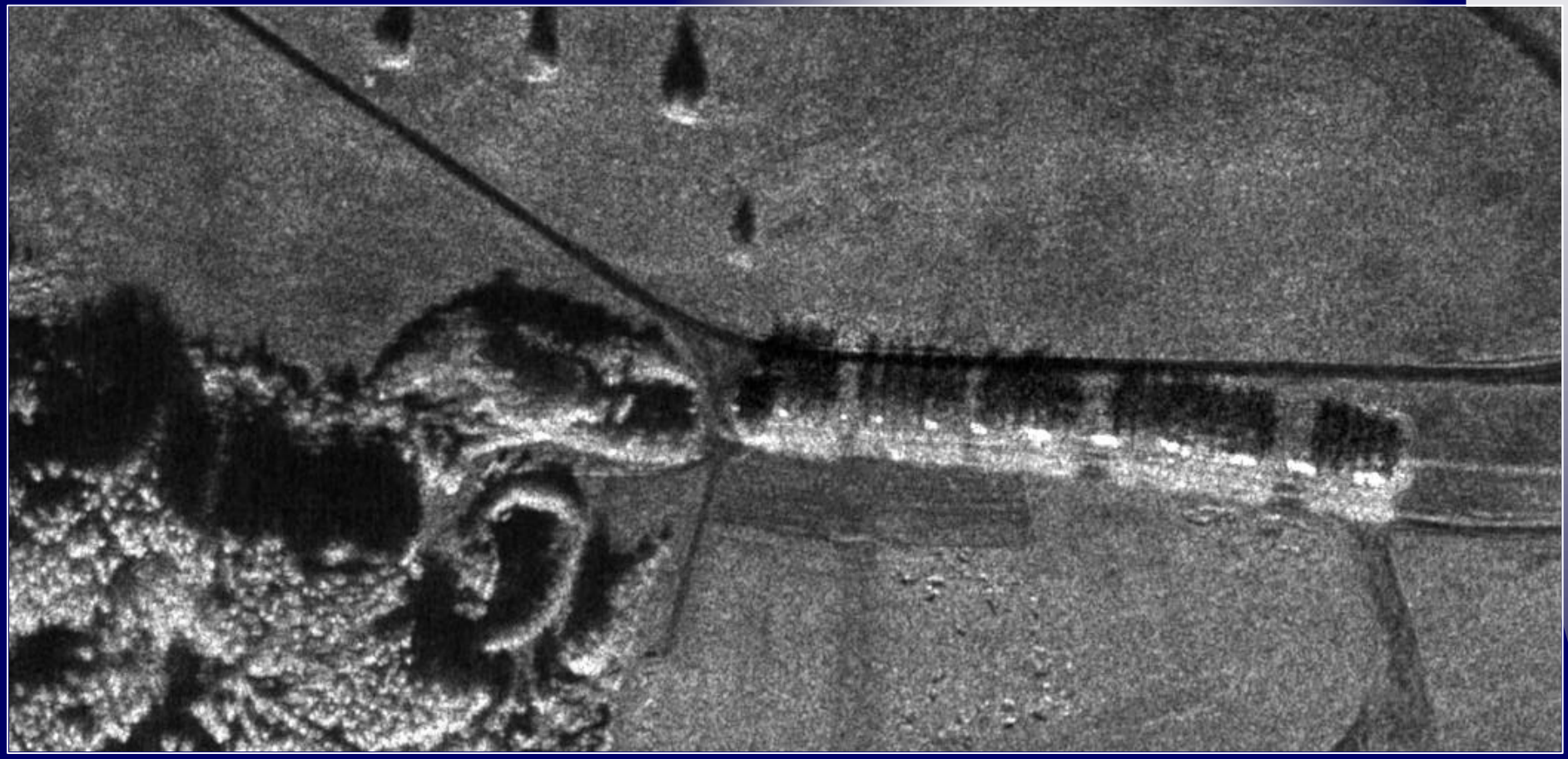
SAR Imaging

Convoy „hiding“ beneath a row of trees



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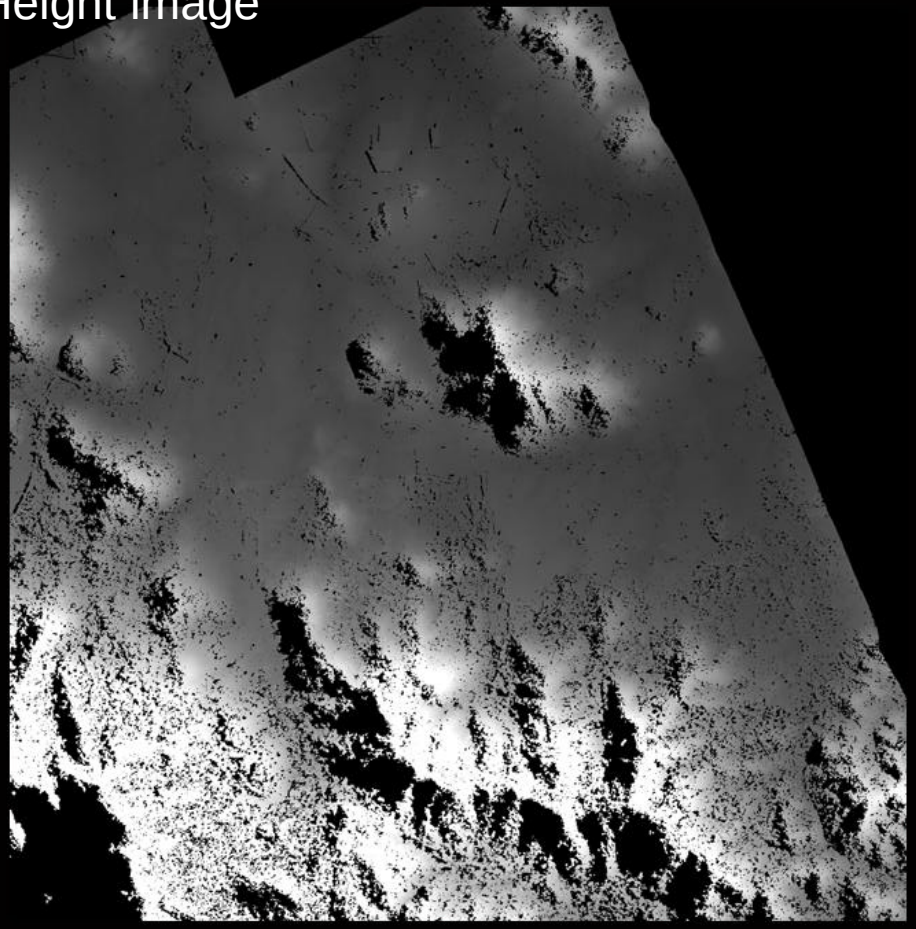
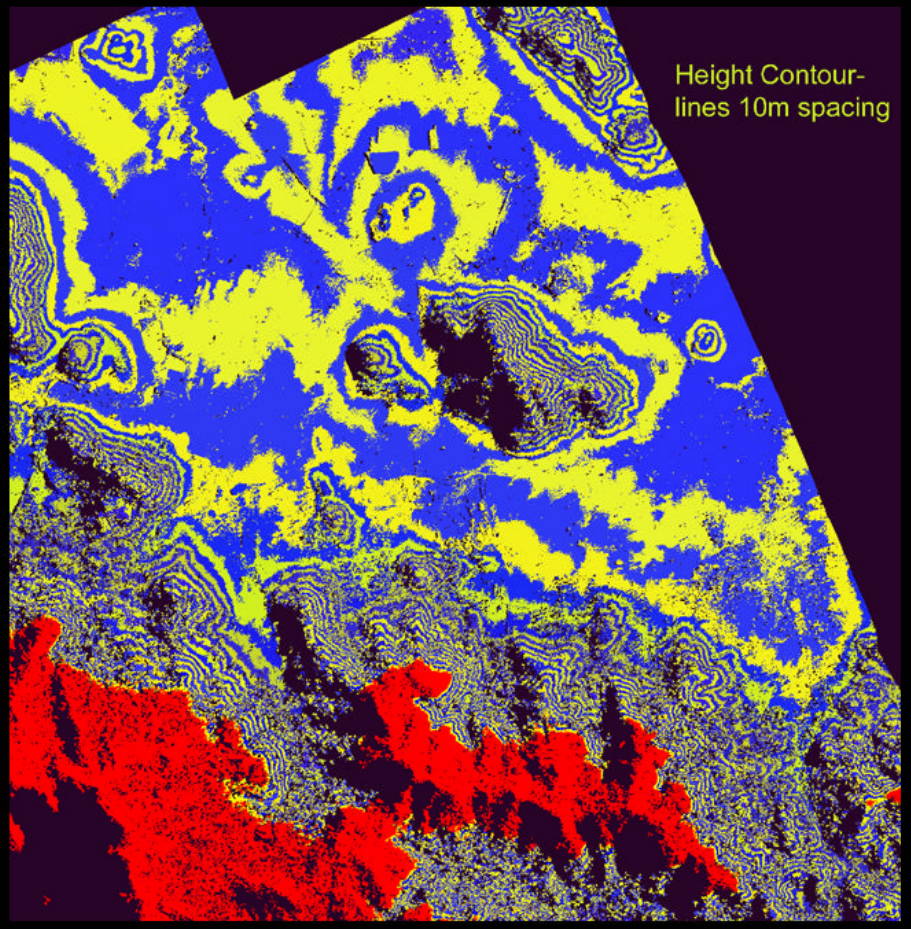
SAR Imaging

Height image



Grayscale



Height contour lines 10 m spacing

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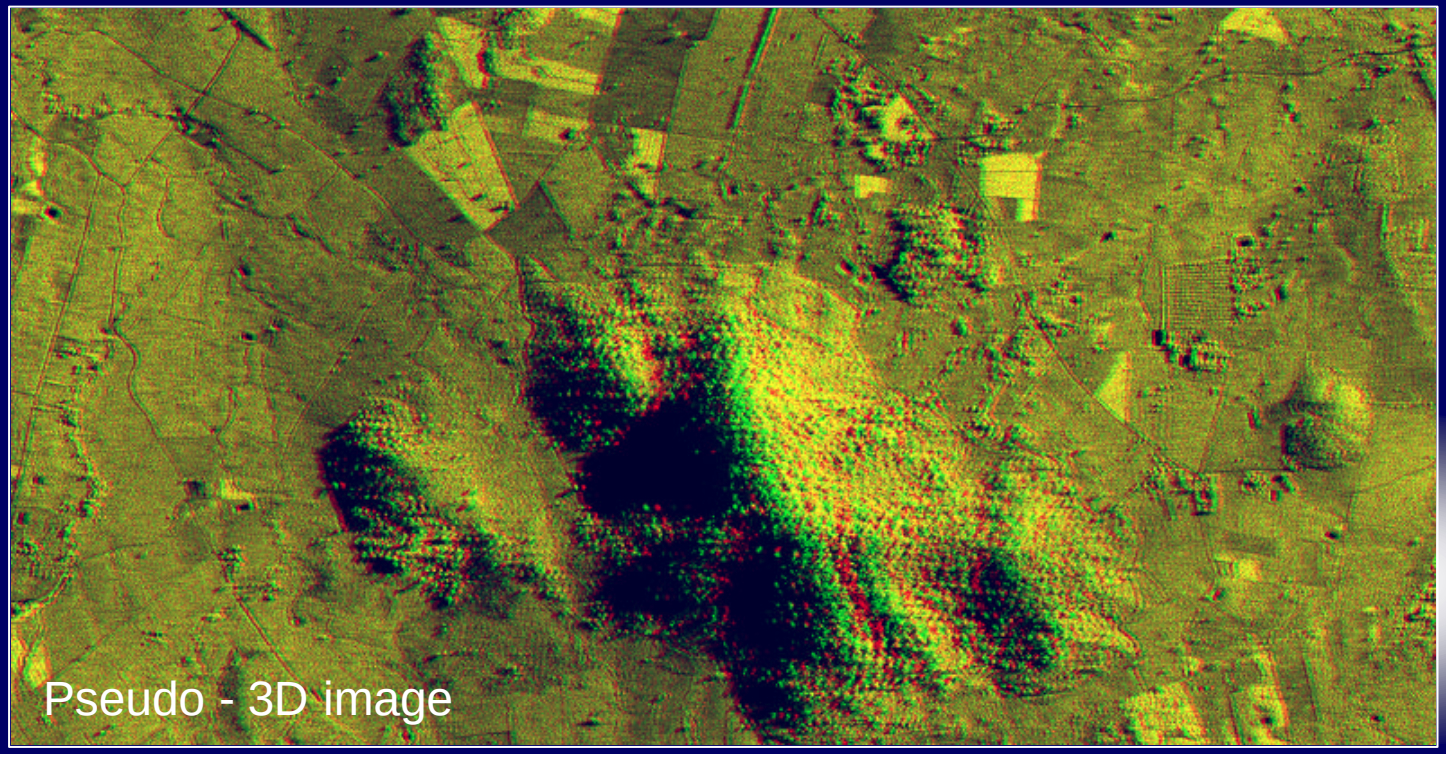
IFSAR

Interferometric SAR

Pseudo 3D images can be generated either by using two antennas located some distance from each other or by flying two passes of a UAV with one antenna

Benefit

Provides terrain elevations over large areas and is therefore inportant for UAV guidance. In addition: Generation of accurate surface profile maps



Pseudo - 3D image

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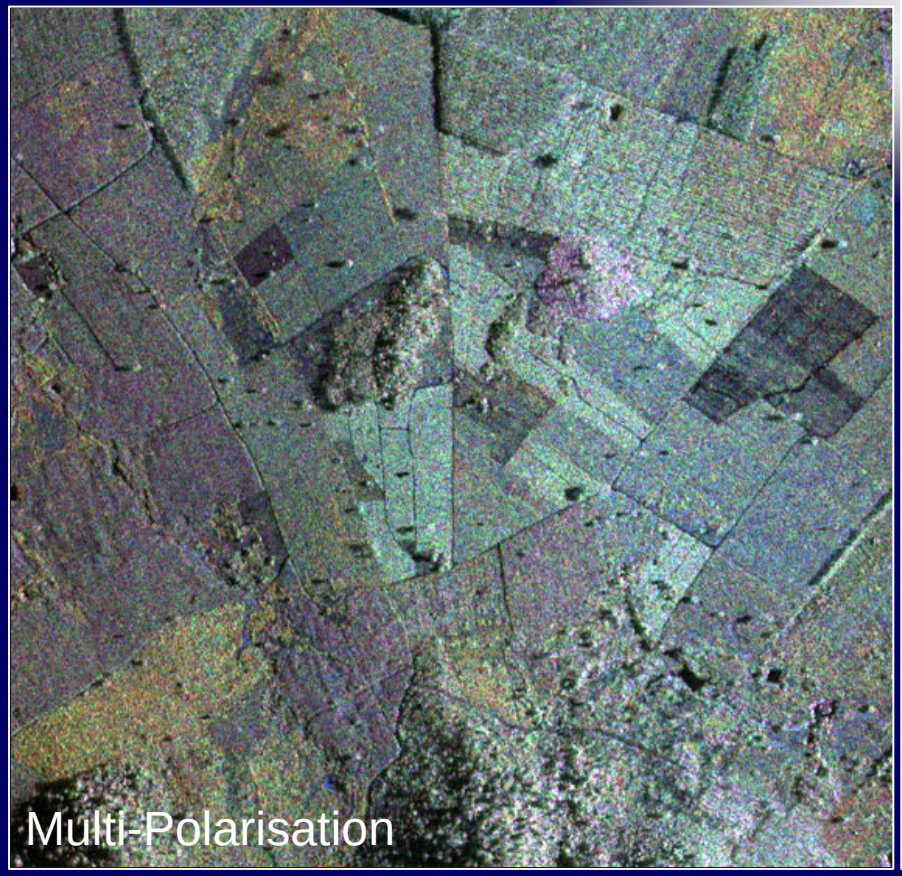
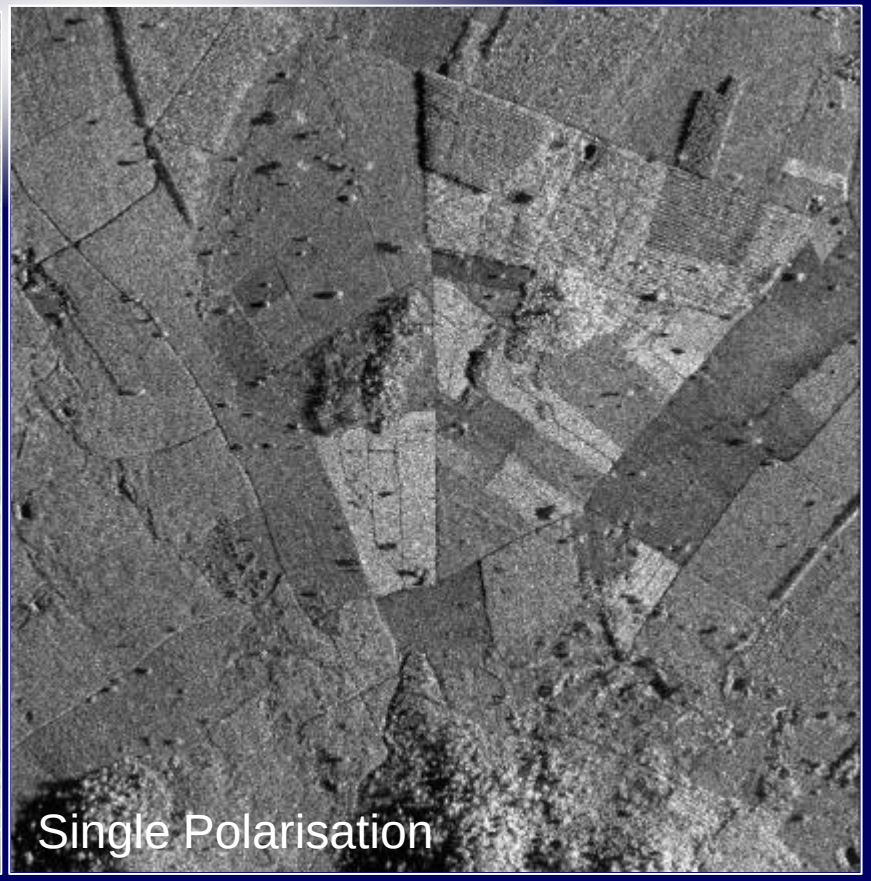
Multi-Polarisation SAR

SAR transmits and receives vertical and horizontal polarised signals (VV, VH, HH, HV)

Benefit

e.g. ground classification





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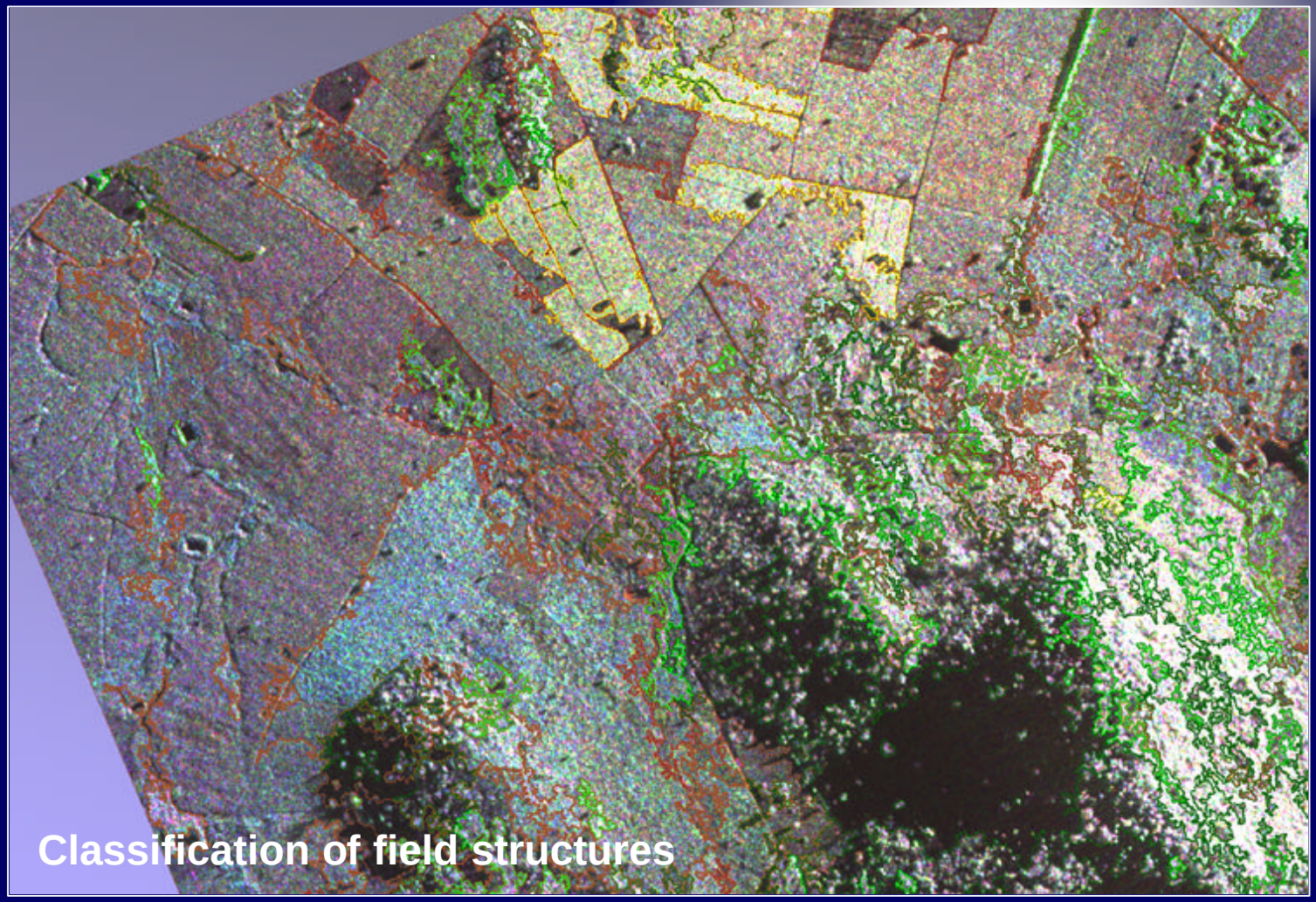
Multi - Polarisation SAR



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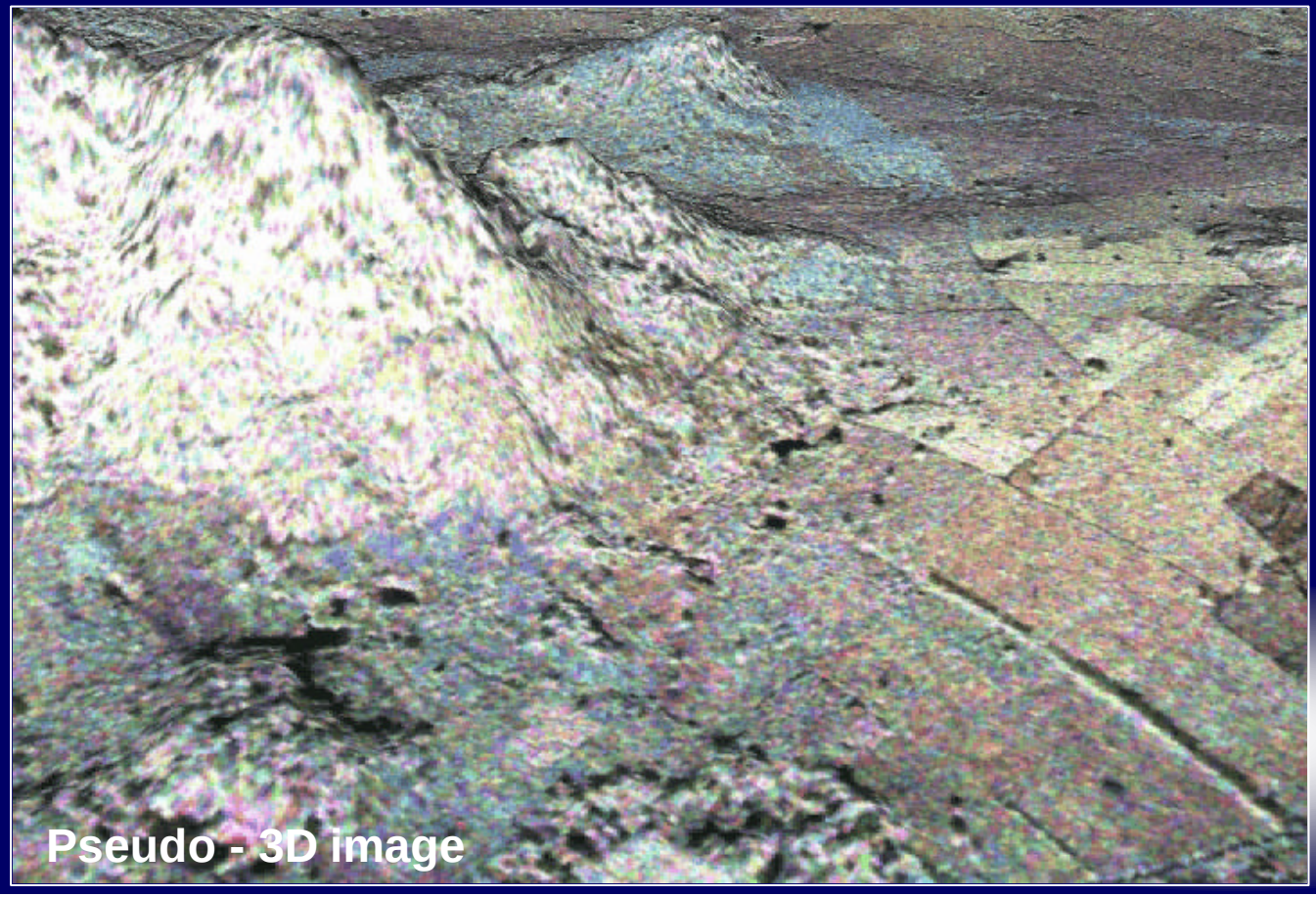
Combination of 3D Image and Multi-Polarisation SAR

Benefit

Combined generation of surface profiles and ground classification



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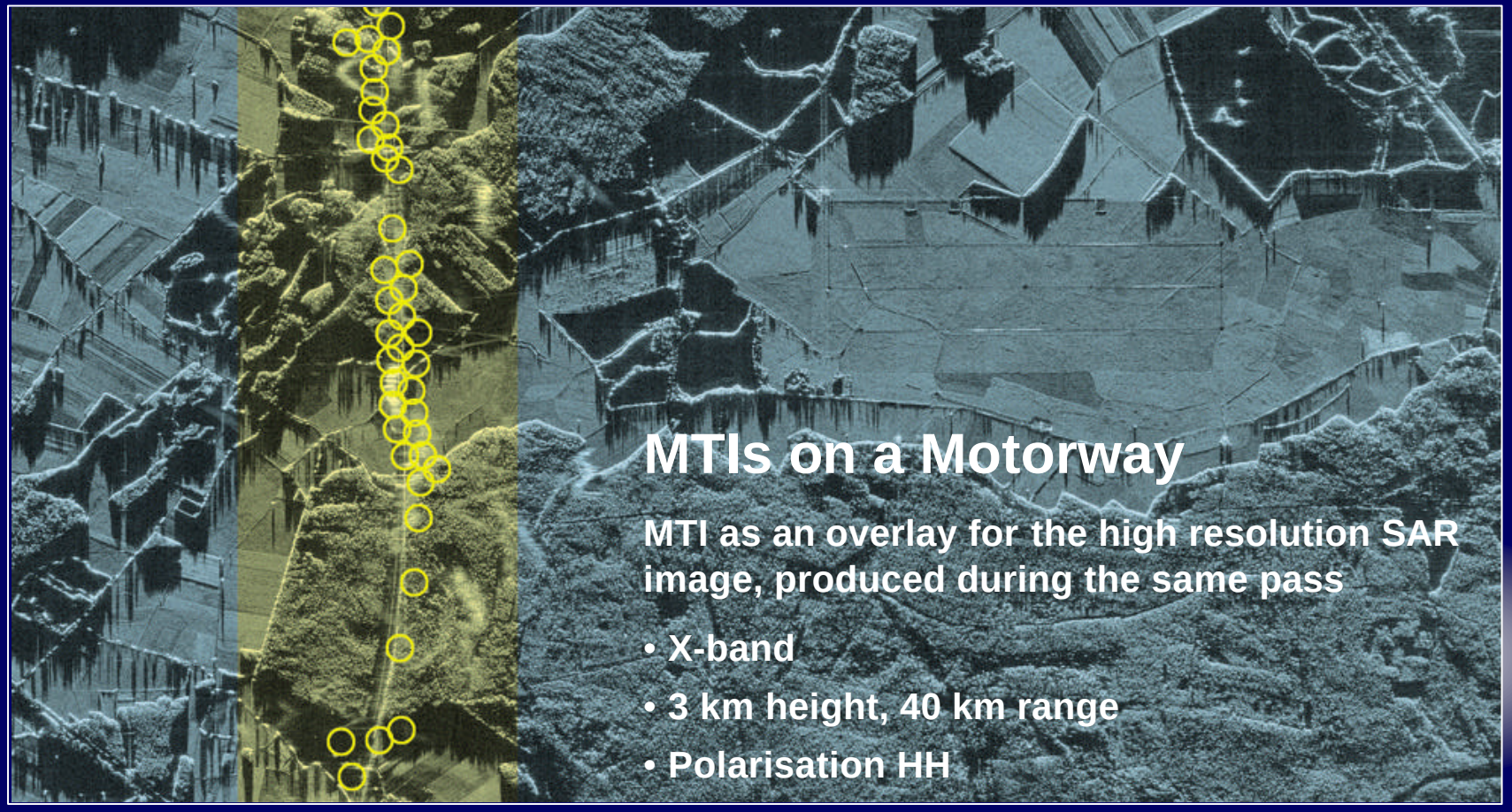
Combined, Simultaneous SAR/MTI Image

Benefit

Moving targets can be inserted simultaneously into the SAR images



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SAR Operational Requirements and Performance Overview

Status, Trends Example: SAR for TUAVs

Requirements and Performance		Status (typ.)	Trends (typ.)
Physical characteristics	• **Weight**	30 ... 160 lbs	< 10 ... 100 lbs
	• **Power**	200 ... 1200 W	< 100 ... 500 W
Operational characteristics	• **Ground speed**	30 … 250 m/sec	partially up to 0.95 mach
	• **Range (SAR/MTI)**	5 ... 30 km (in weather)	partially > 40 km
	• **Real time SAR-image processing**	on board/on ground	mainly on board
	• **Moding**	SAR Strip Map SAR Spot-Light MTI	+ partially simultaneous or interleaved operation modes **(multi-mode)**
Performance	• **Swath width**	800 m ... 1800 m	> 2,000 m
	• **Resolution**	1 ft ... 3 ft	0.5 ... 1.5 ft

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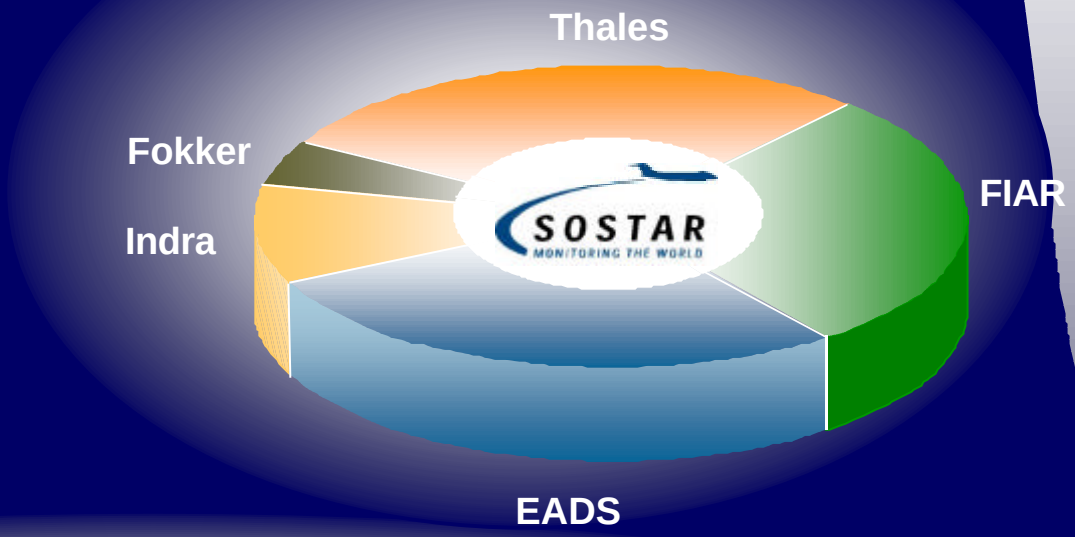
SOSTAR - X

(**S**tand-**O**ff **S**urveillance and **T**arget **A**cquisition **R**adar)

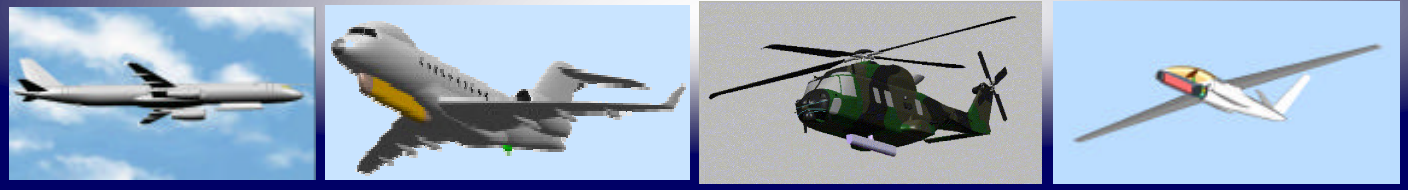
Demonstrator Program for AGS with a new generation SAR/MTI, e.g.

- MTI for Wide Area Surveillance
- Surveillance Swath SAR
- High Resolution Swath
- MTI Fast Sector Scan
- Mid Range Spot SAR
- Long Range Spot SAR
- MTI Classification Mode
- ISAR

  etc.



Platforms



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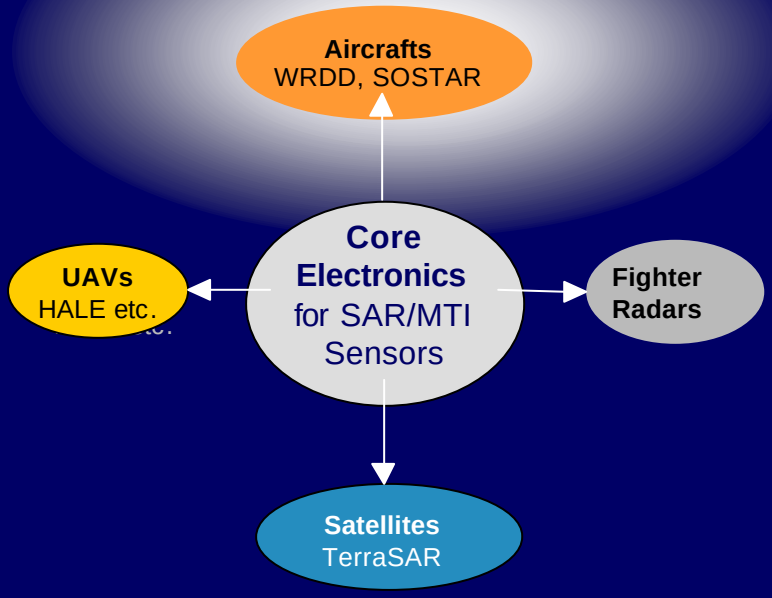
Technology: SAR Core Electronics

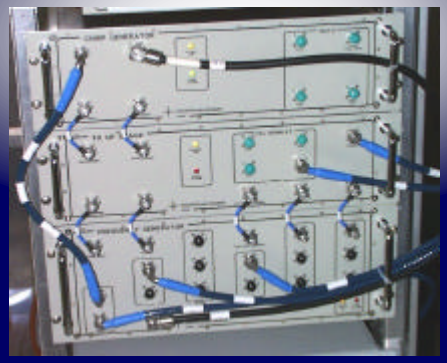
Common Functions

- Tx Signal Generation (chirp generation, up-conversion)
- Rx Signal Demodulation, Digitisation, Formatting
- Sensor Control and Frequency Generation

Applications



Technologies



Chirp Generation

Up-Conversion

Frequency Generation

Currently scaling down of the components for application on UAVs and satellites

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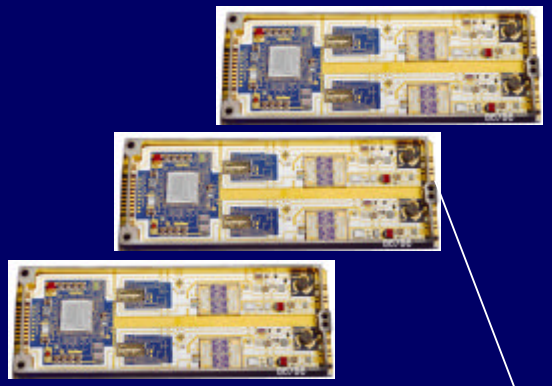
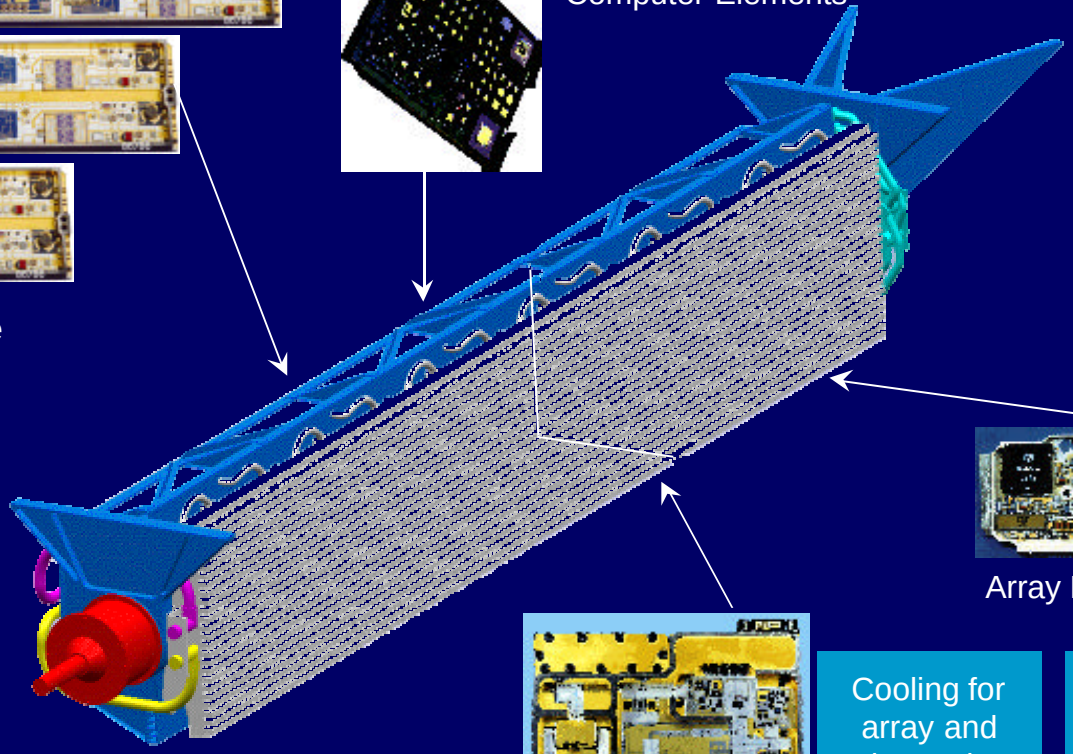
Technology: Antenna Components

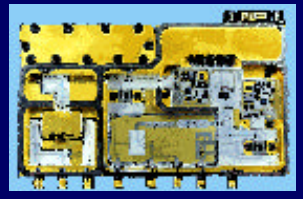


T/R Module

Beam Steering Computer Elements



Array Power Supplies



RF Converter

Cooling for array and electronics

Inertial Navigation Unit

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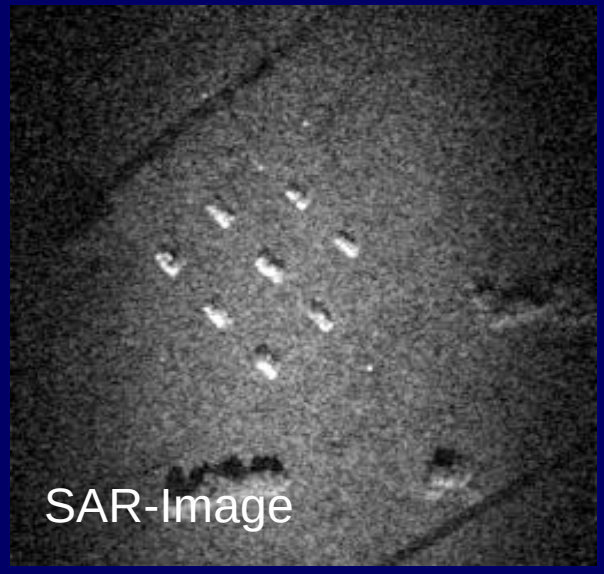
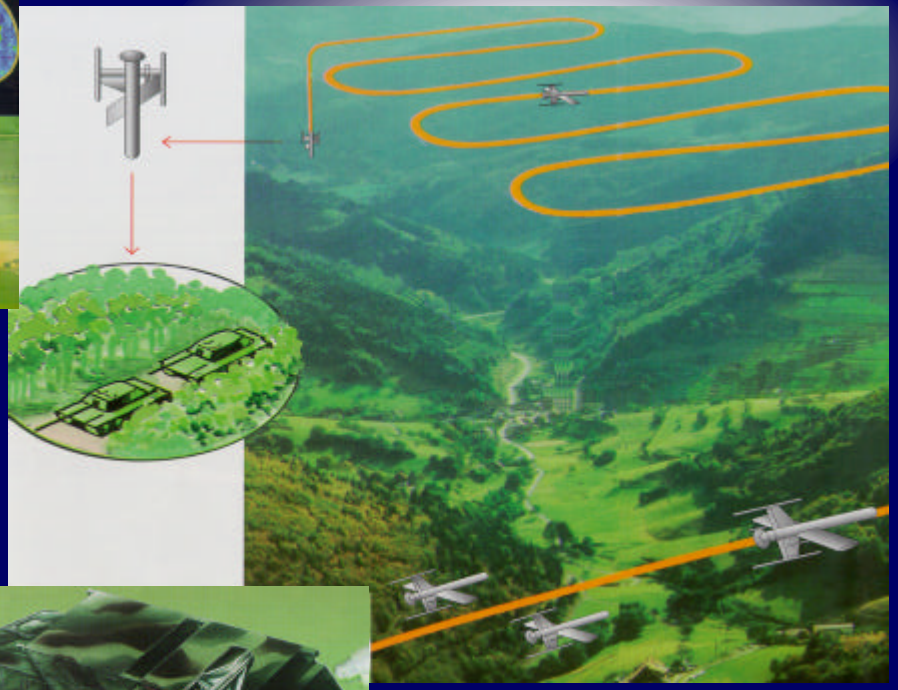
SAR Seeker German Army Combat Drone





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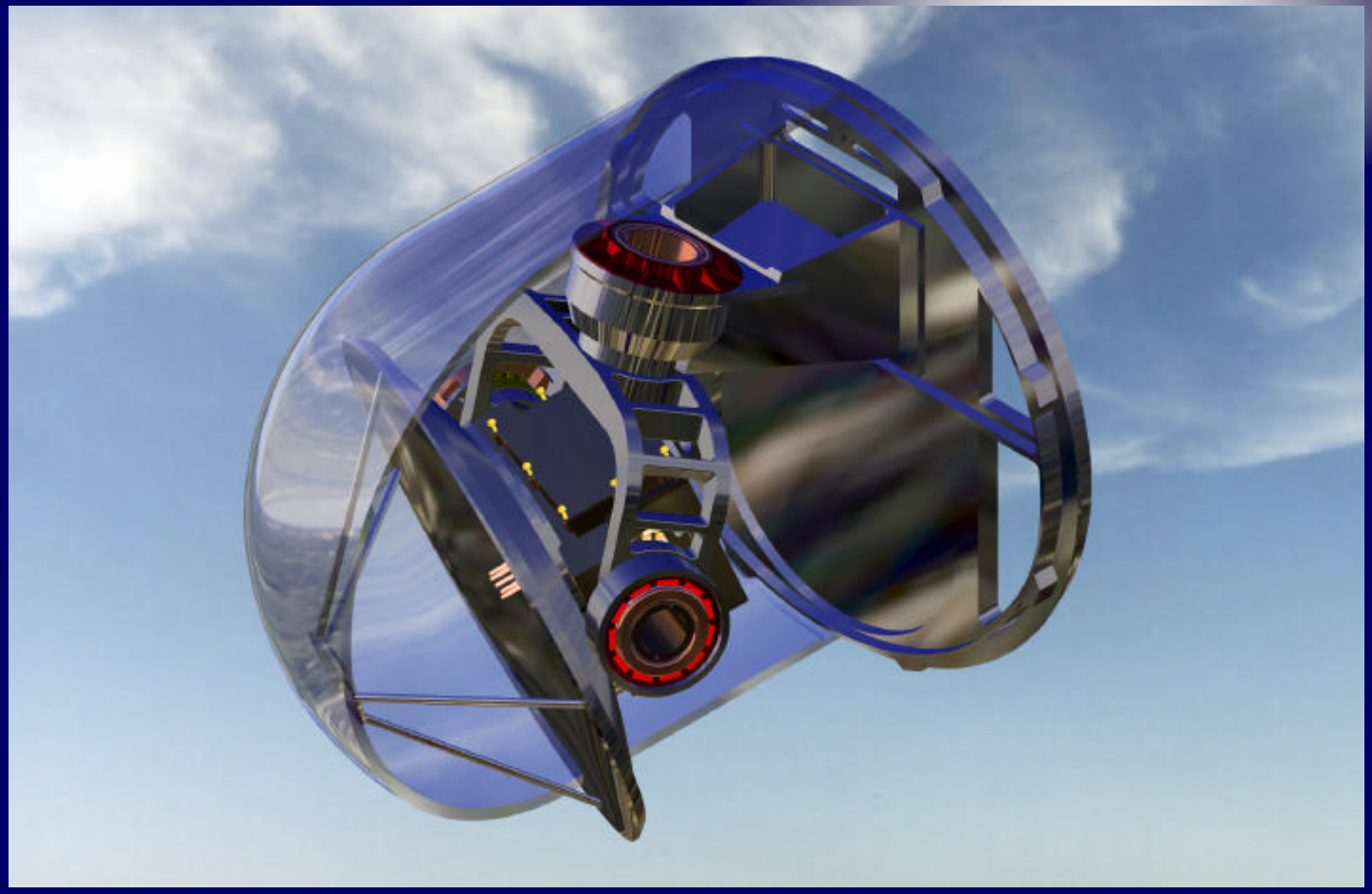
Antenna on Gimbal



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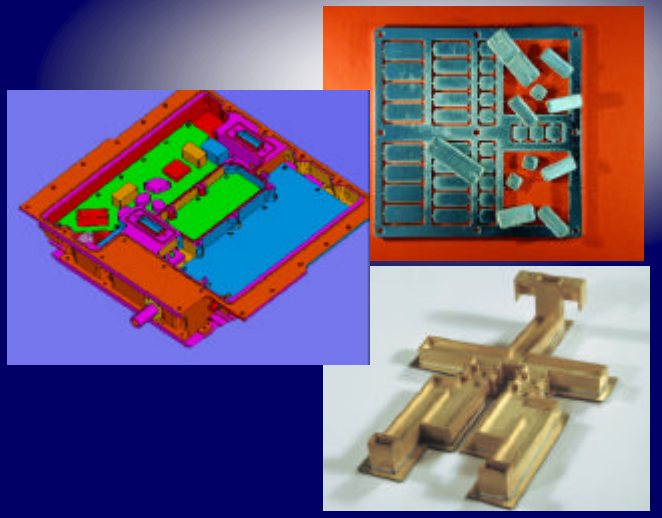
Advanced mmW Technologies

High precision plastic casting

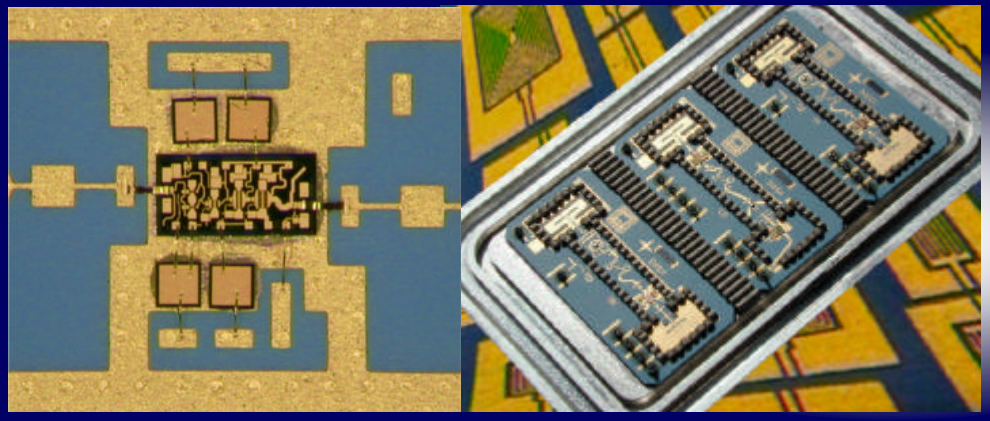
- mechanical structures
- housing, covering plate, wave-guide

Advantage: reduced mass, “low cost”



LTCC (low temperature cofired ceramics)

- highly integrated mmW multi-layers
- realisation of planar and three-dimensional structures



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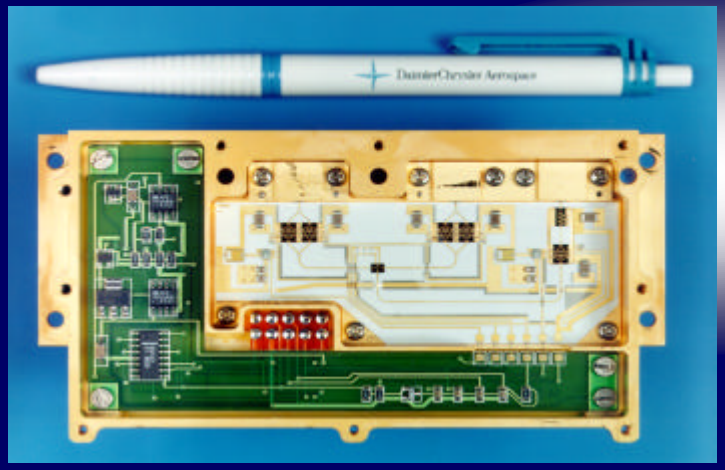
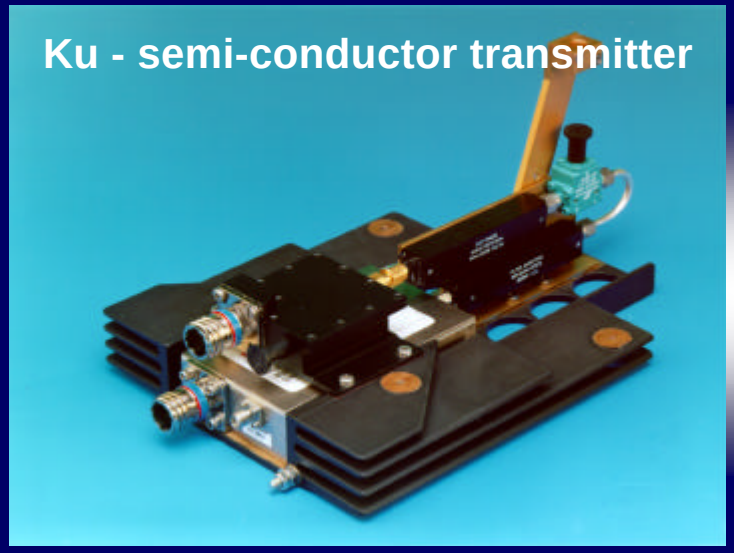
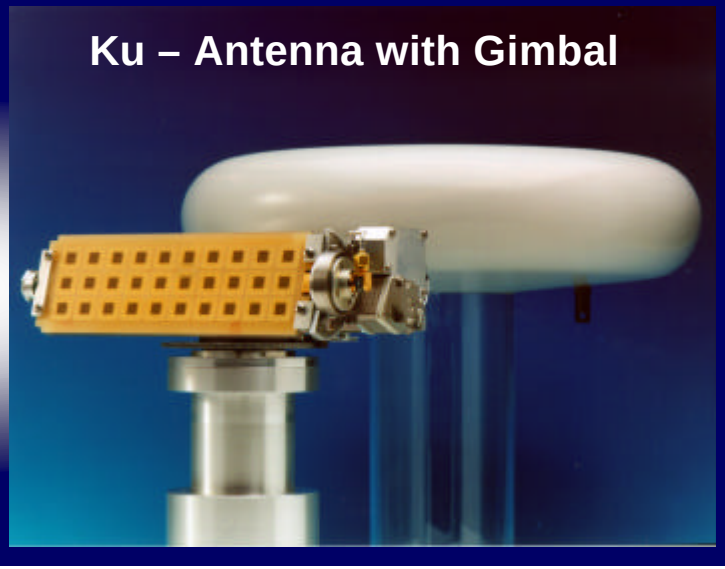
mmW Technology Examples



Ka - Transmitter Amplifier





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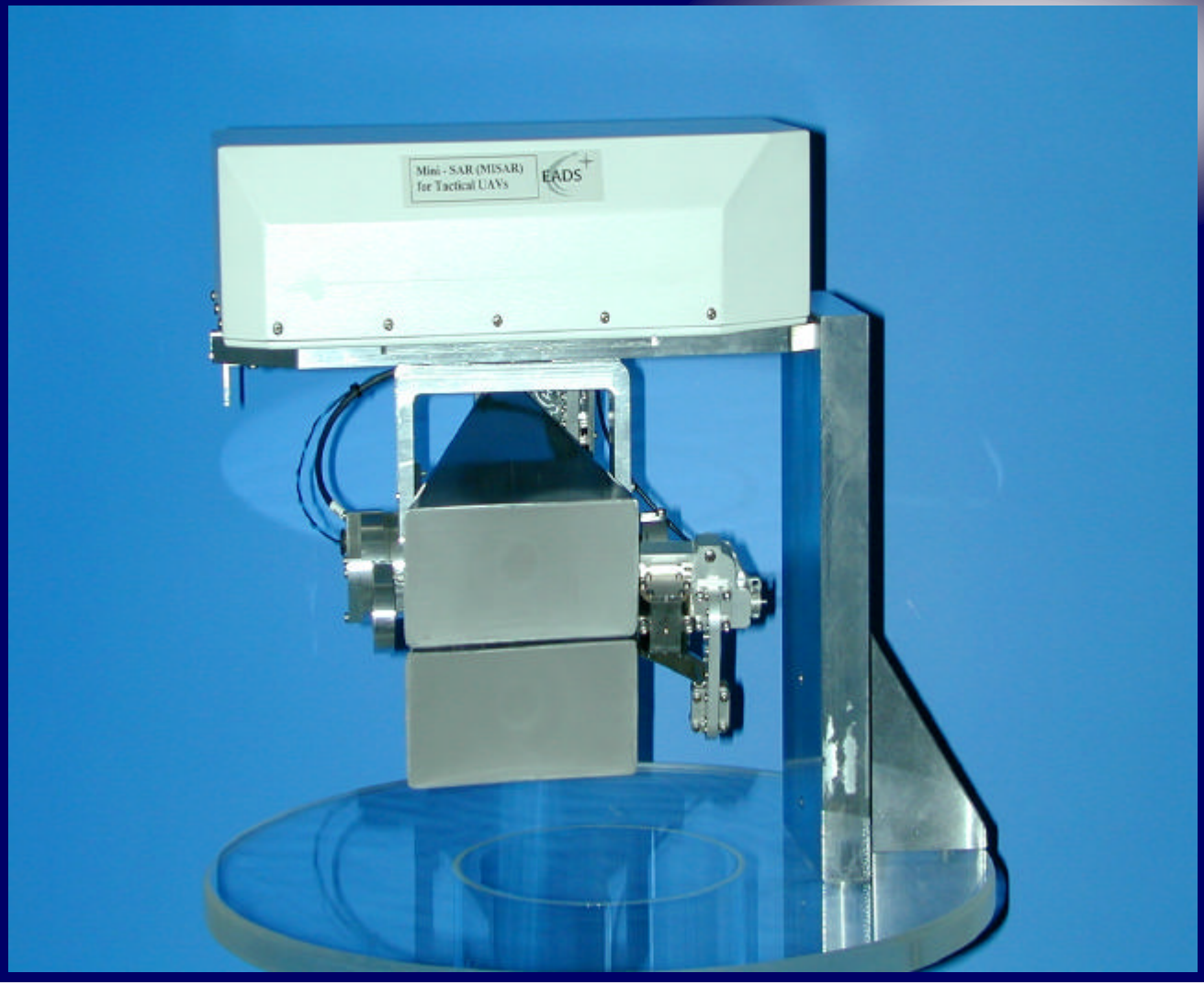
MISAR Model



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MISAR Model

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Technical Data MISAR

• Resolution	0.5 m
• Swath	500 m ... 2000 m
• Frequency	Ka-Band
• Power Consumption	< 50 W
• Weight	< 4 kg
• Volume	< 4 l

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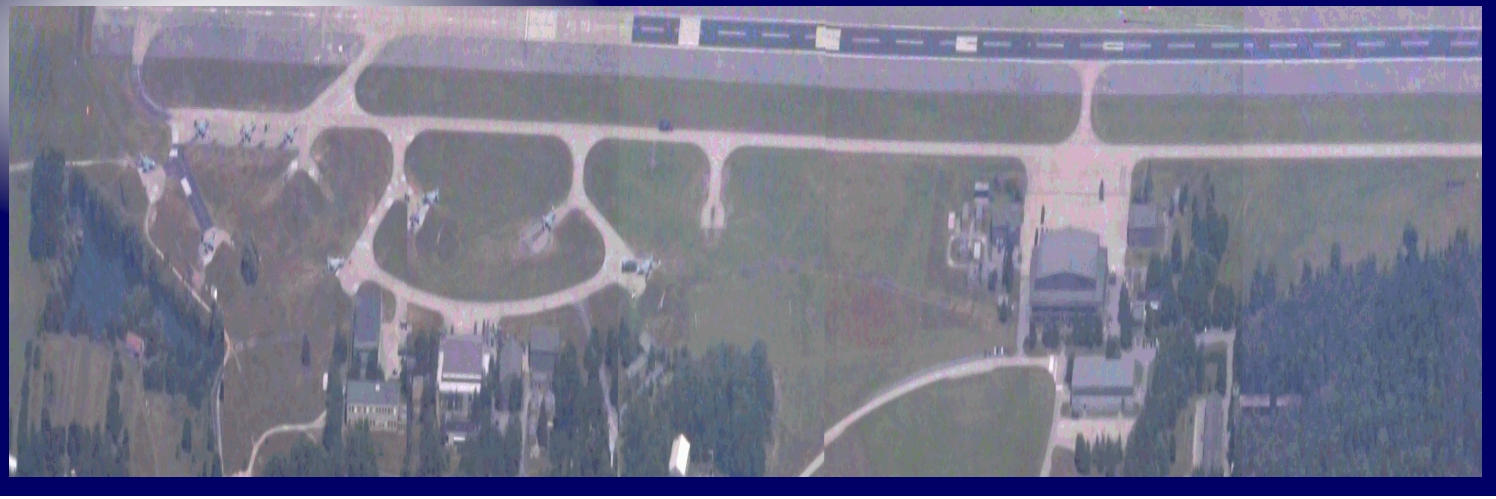
SAR-Image Airstrip Zone I

SAR-Image



Video-Image

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Summary MISAR

- SAR-Imagery for UAV with mmW-technology possible
- MISAR deliverable end of this year based on developed seeker for GERMAN Combat Drone
- EADS SAR-sensors easy to modify according to UAV payload specification
- Dedicated for low weight (4 ... 15 kg) / low volume (4 ... 50 l) payloads
- Mature with MTI-Mode

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