

## **Raumfahrtaktivitäten bei der IMST GmbH**

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IMST GmbH Kamp-Lintfort

## Information, Mobile, and Satellite Communication Techniques

*e-motion of wireless*



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# Short Overview

## Past projects

### **KANSAS (/EASTON)**

Antennas & RF components for satellites

### **ALCANT**

Antennas for maritime terminals

### **FAKT**

Antenna study on Sat-Com terminals

### **ASTRA**

Study on mobile low-cost Sat-Com terminals

### **MEMOS**

MEMs technology

## Ongoing projects

### **TerraSAR-X/TerraSAR-L**

Satellites for Earth Observation

### **INES**

Antennas for Sat-Com terminals

### **SANTANA**

Antennas for aeronautical Sat-Com terminals

### **KERAMIS**

Components for satellites based on LTCC

### **SANTANA II**

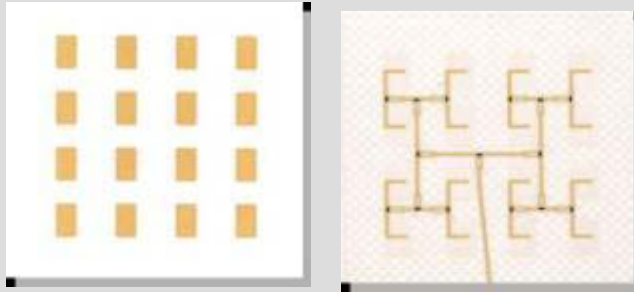
Demonstrator realisation & mobility tests



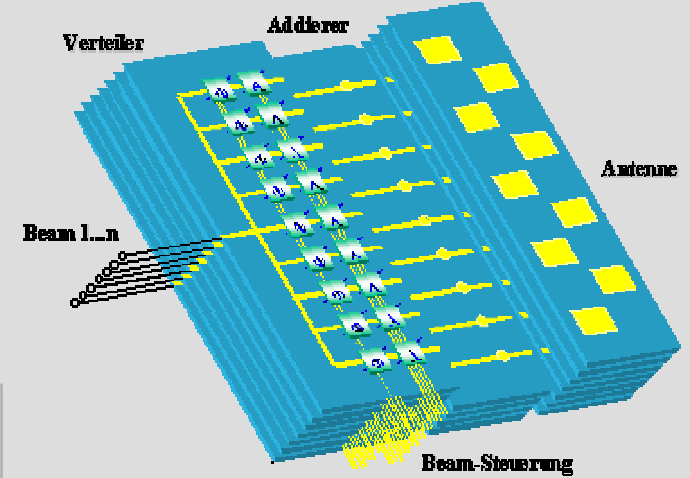
<i>KANSAS</i>	
Short description	Investigation of concepts and components of active antenna systems for future satellite communication systems
Time frame	1998-2001
Customer	DLR Bonn
Operating frequency	K/Ka-band
Partners	University of Hannover University of Karlsruhe

# Kansas: Topics

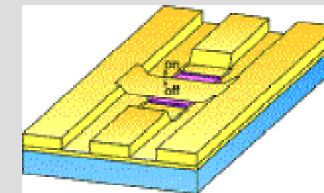
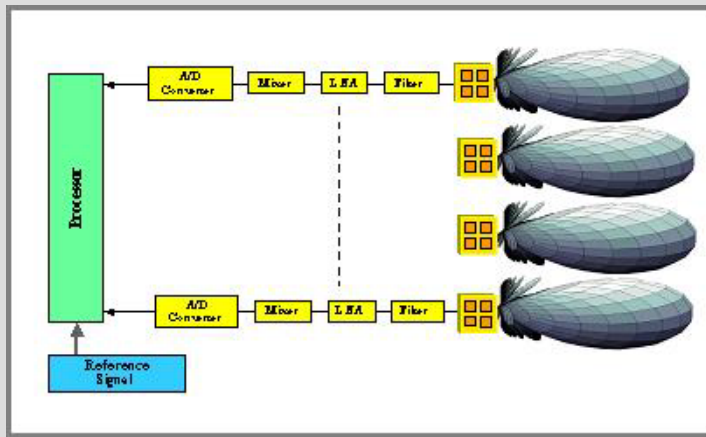
## LTCC-Materials



## Feeding networks

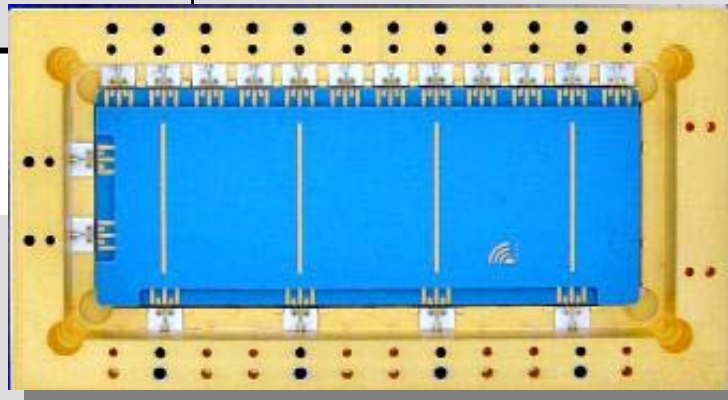


## Digital Beam Forming

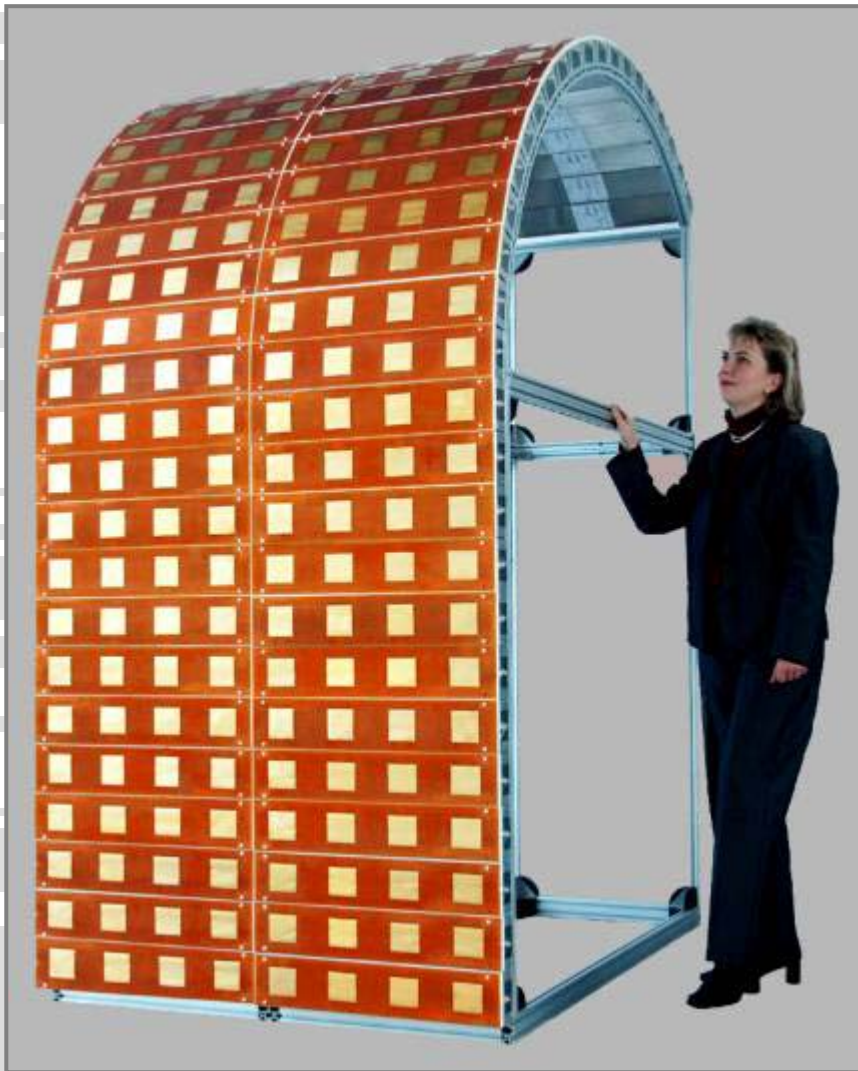


## MEMS

<i>EASTON</i>	
Short description	Development of Power-Divider-Networks and Integrated Antennas in Multilayer LTCC
Time frame	2000 - 2002
Customer	DLR Bonn
Operating frequency	Focus on 20 GHz
Partners	TU Ilmenau, TESAT Spacecom



<i>ALCANT</i>	
Short description	Development of an L-band electronically steerable active antenna for maritime applications
Time frame	1999-2001
Customer	DLR/BMBF Berlin
Operating frequency	L-band
Partners	University of Ulm University of Karlsruhe STN Atlas



## Details and Specifications

Conformal phased array for electronic beam steering in

- elevation and
- combined electronic and mechanical steering in azimuth.

- Antenna for L-Band satellite communication
- Frequency range 1,5 to 1,7 GHz
- 8,5 % total band width of antenna
- $G/T = -4$  dBK
- Beam steering capability
  - elevation:  $-10^\circ$  to  $100^\circ$  electrical
  - azimuth:  $4^\circ$  electrical,  $360^\circ$  mechanical

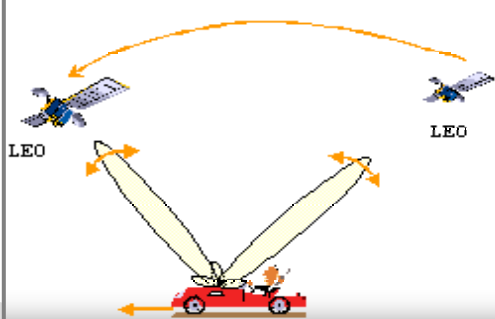
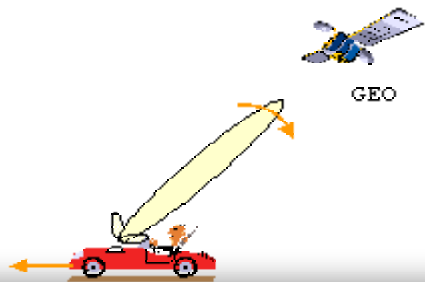
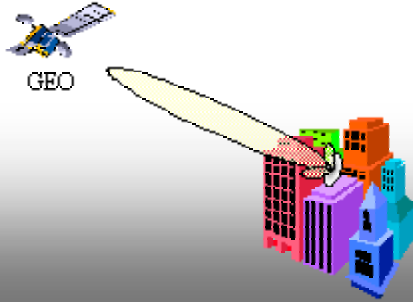
This project was supported by the German Ministry of Education and Science - BMBF in the ALCANT-SATCOM project 01AK007G/8.



<i>FAKT</i>	
Short description	Study of antenna front-end technology for Ka-band broadband multimedia terminals
Time frame	2000-2001
Customer	DLR Bonn
Operating frequency	Ka-band
Partners	None

# FAKT: Topics

## User scenarios



## User classification



## User terminals



Portable



Mobile



Fixed

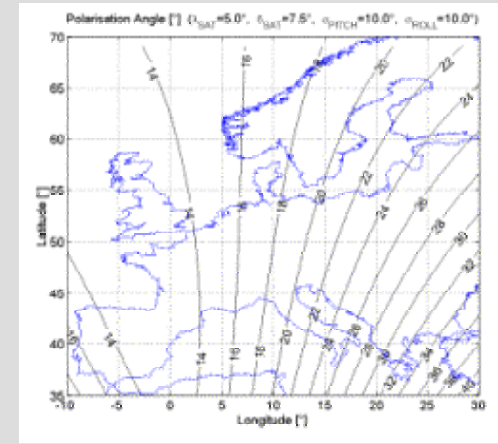
<i>ASTRA</i>	
Short description	Study of antenna front-end technology for low-cost Ku-band mobile terminals
Time frame	2001-2002
Customer	ESA/ESTEC
Operating frequency	Ku-band
Partners	ND-SatCom DLR Oberpfaffenhofen SES-ASTRA

# ASTRA: Topics

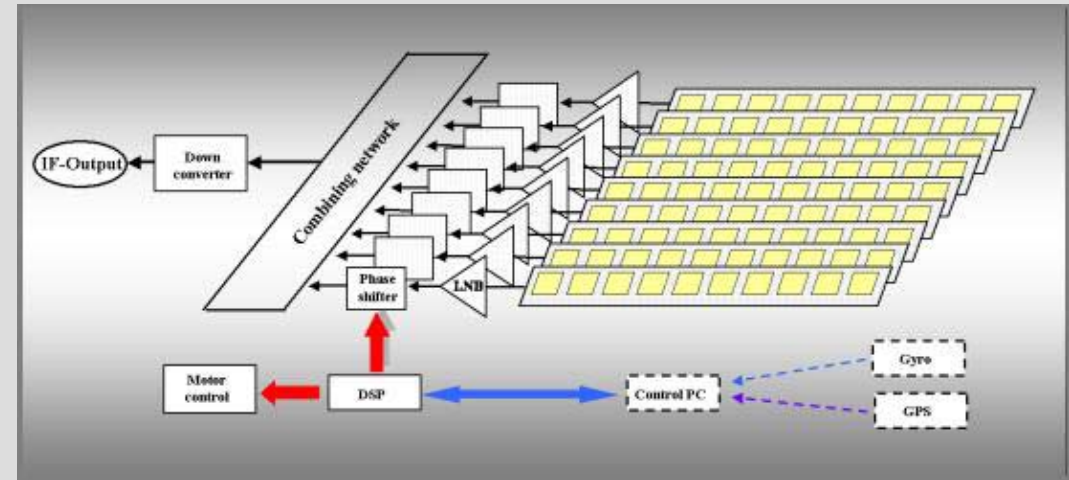


*Mobile  
use of  
end of  
life  
satellites*

*Coverage  
of  
ASTRA  
satellite*



*Hybrid  
steerable  
antenna*



<i>MEMOS</i>	
Short description	Design & realisation of innovative MEMS for high frequency / high power applications
Time frame	2001 - 2003
Customer	DaimlerChrysler (ESA/ESTEC)
Operating frequency	1-30 GHz
Partners	FEMWARE

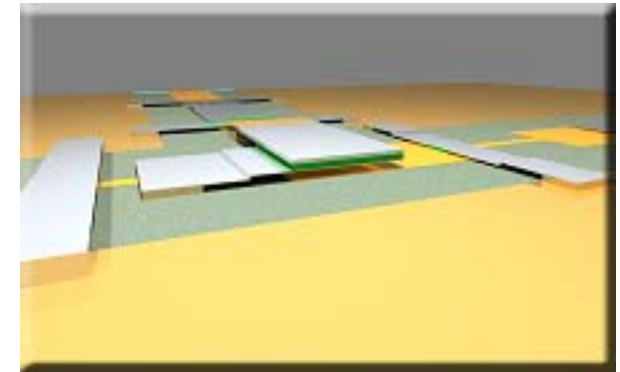
# Memos: New MEMS Switch Concepts



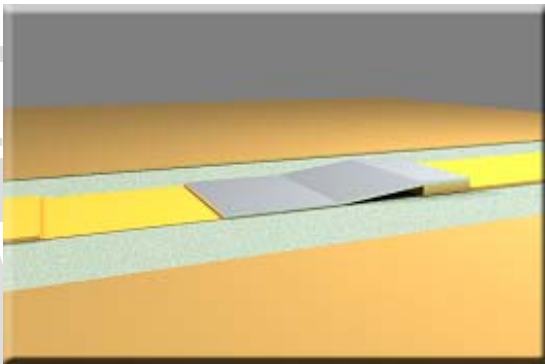
## Specifications

**Frequency range:** 1 to 30 GHz  
**Input power:** up to 10 W  
**Insertion loss:** < 0.4 dB  
**Isolation:** > 50 dB  
**Return loss:** > 20 dB  
**Actuation voltage:** < 50 V

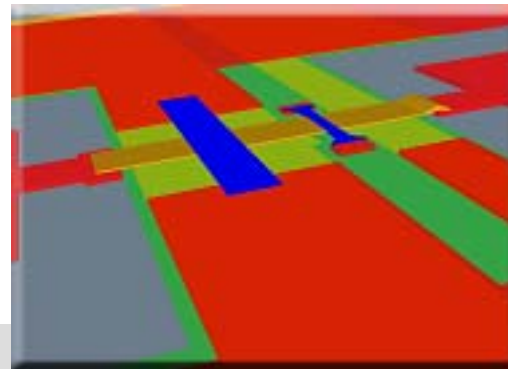
### Double Electrode SPDT Switch



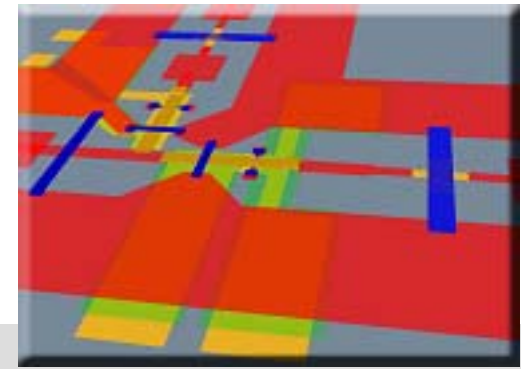
### Serial Capacitive Switch



### Toggle SPST Switch



### Toggle SPDT Switch



# Memos: MEMS 2 x 2 Matrix Design

## Specifications

Frequency range: 1 to 30 GHz

Input power: up to 10 W

Insertion loss: < 1 dB

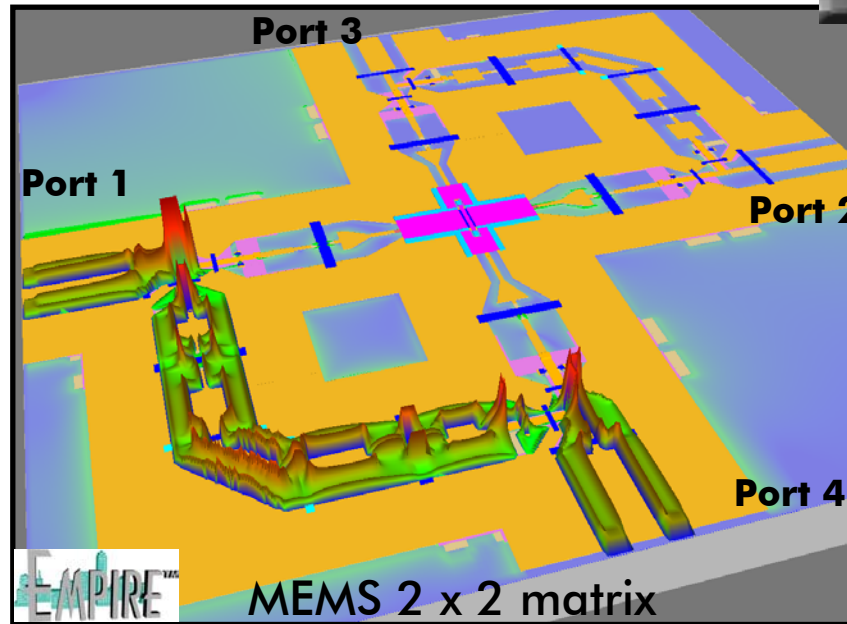
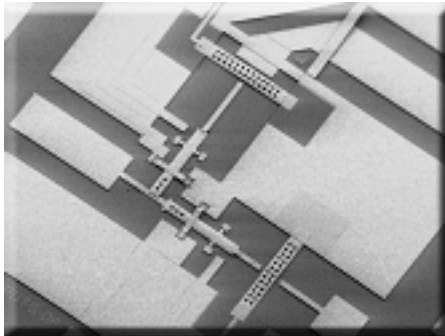
Isolation: > 40 dB

Return loss: > 20 dB

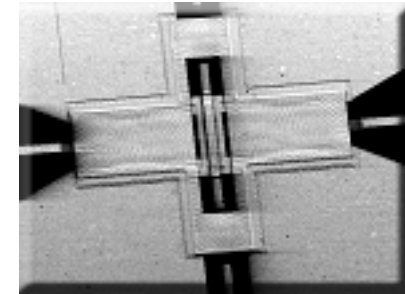
Optimised 90° Bend



Toggle SPDT Switch



Isolating RF Cross

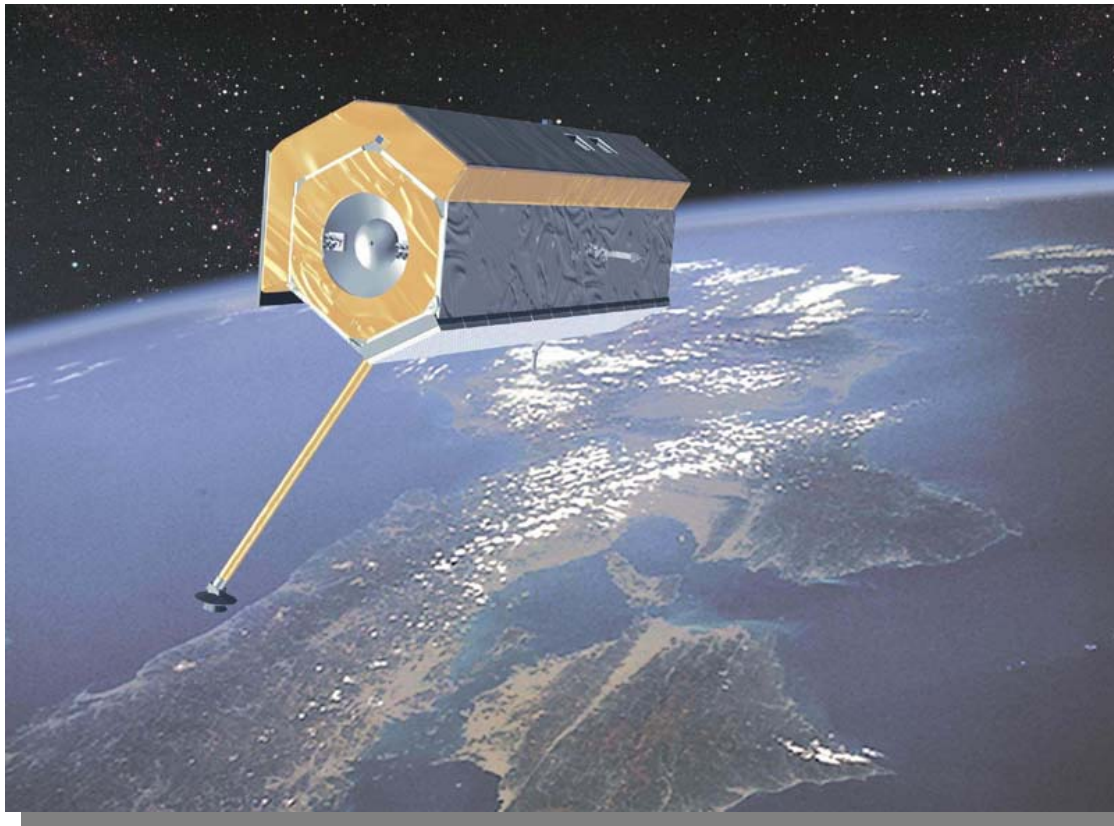


# Ongoing projects:



<i>TerraSAR-X</i>	
Short description	Satellites for earth observation, data for scientific and commercial use
Time frame	Satellite to be launched in 2005
Customer	EADS-ASTRIUM (DLR)
Operating frequency	X-Band (9.65 GHz)

# TerraSAR-X: Earth observation



**TerraSAR-X**  
**@ 9.65 GHz**

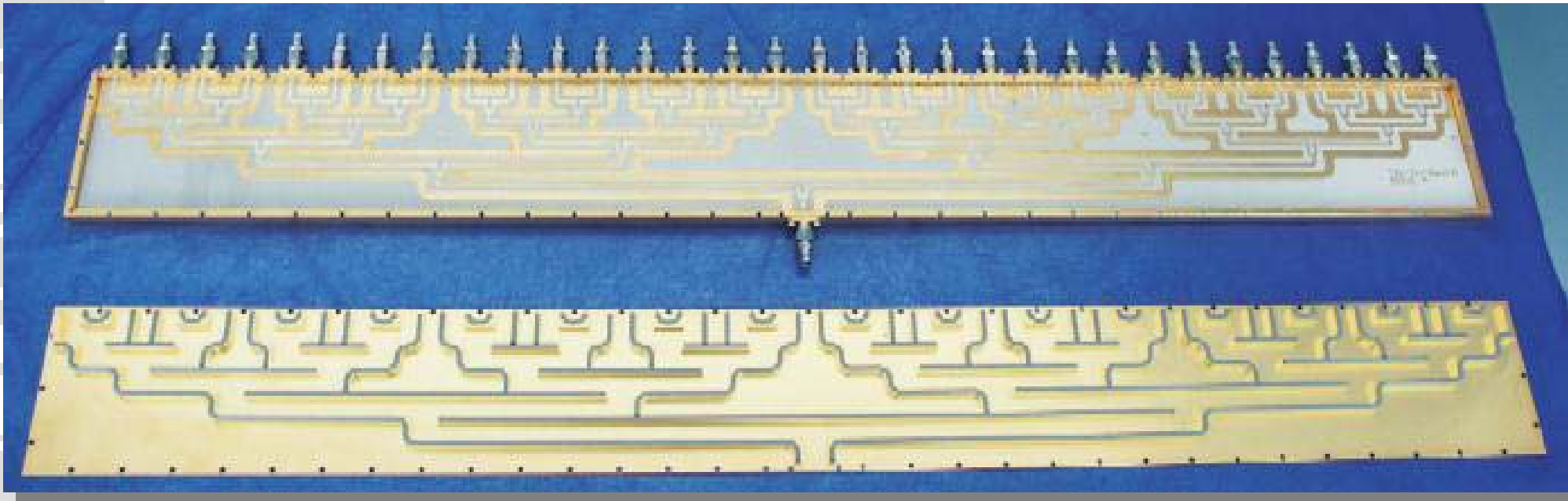
Artist's drawing of the satellite system TerraSAR.

© EADS Astrium

# TerraSAR-X: Network

## 1 : 32 Power Distribution Network

Cover with shielding channels (metal walls with conductive elastomer gaskets)

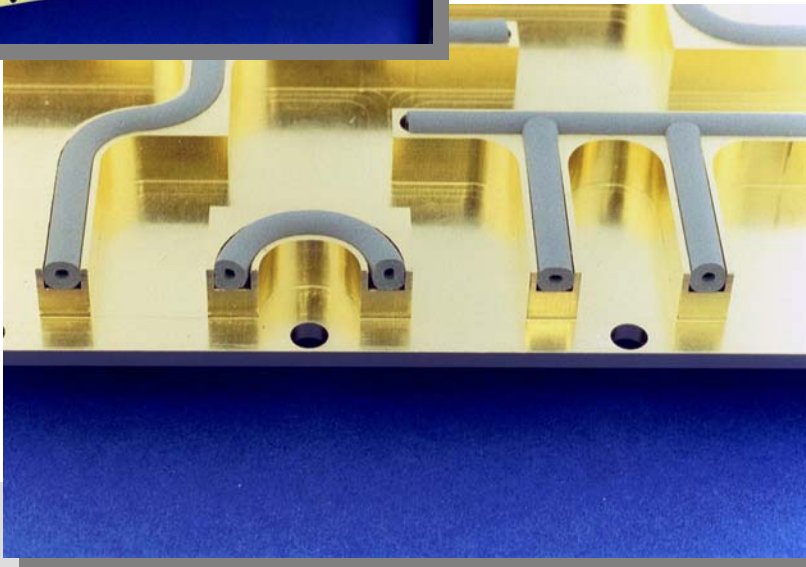
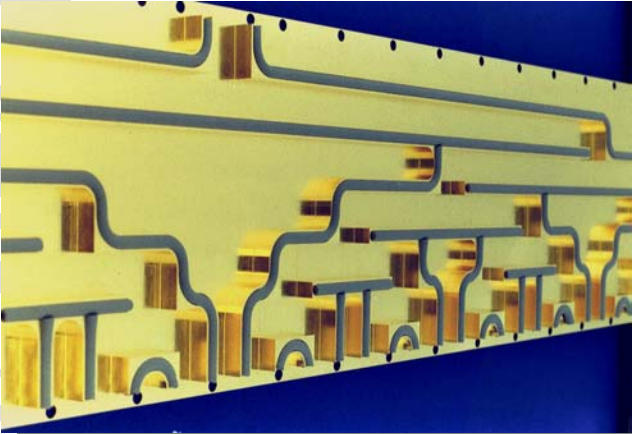


Microstrip on RO6002 with shielding vias (aluminium housing)

Dimensions: 695.6 mm x 72.4 mm x 5.5 mm

# TerraSAR-X: Shielding

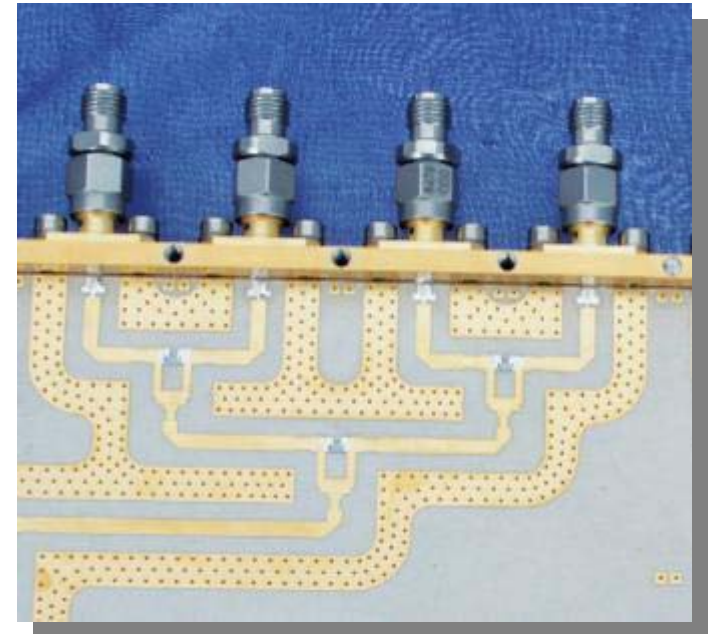
- Shielding
  - Conductive Elastomer Gaskets



Wilkinson Dividers

Microstrip Waveguides

Shielding Lines with Via Fences

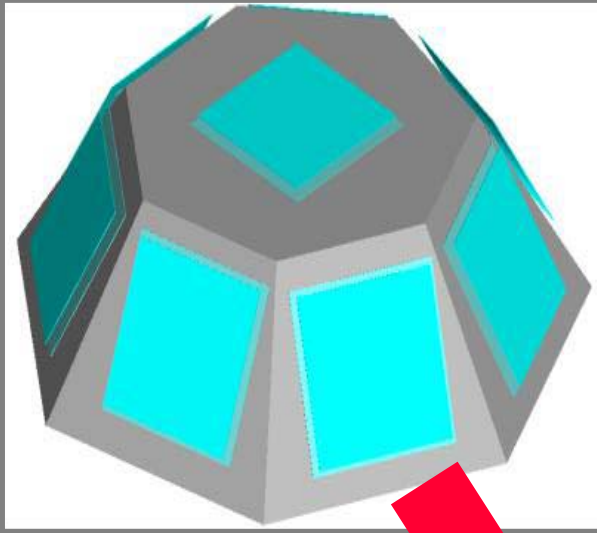


# TerraSAR-L

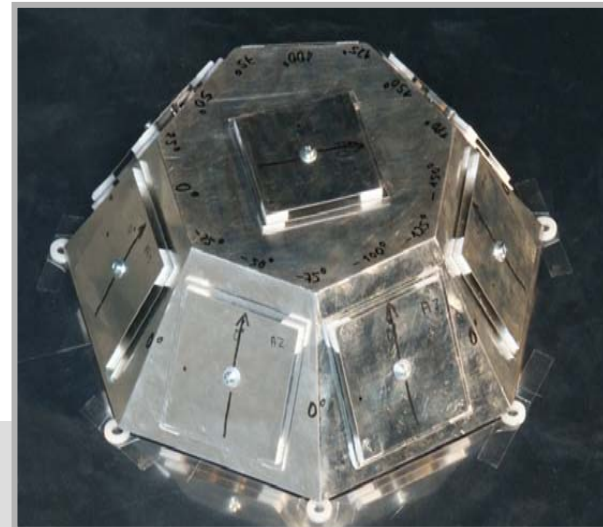
<i>TerraSAR-L</i>	
Short description	Satellites for earth observation, data for scientific and commercial use
Time frame	Start of Phase C/D in 2005
Customer	EADS-ASTRIUM (ESA/ESTEC)
Operating frequency	L-Band (1.26 GHz)

<i>INES</i>	
Short description	Development of an electronically steerable and automatically tracking antenna for multimedia applications for future BGUN satellite communications
Time frame	2002-2004
Customer	ESA/ESTEC
Operating frequency	L-band
Partners	NERA

# INES: Topics



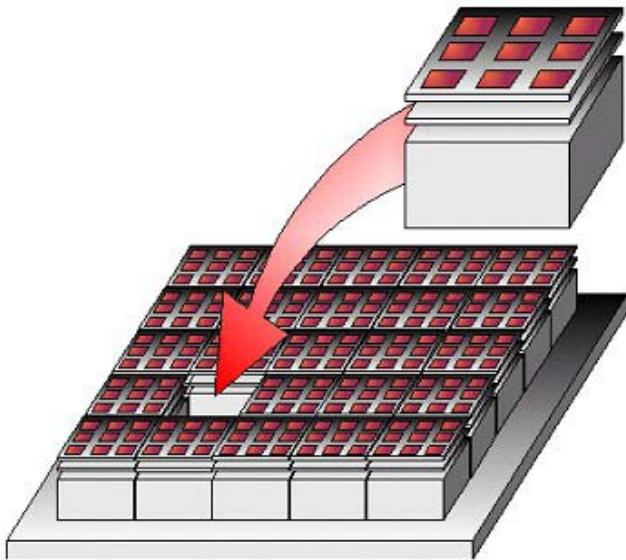
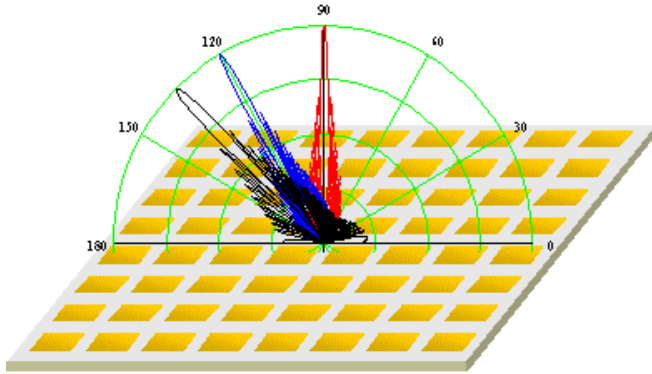
- ✓ **IN**expensive **E**arth Station Antenna
- ✓ BGUN satellite communication
- ✓ circularly polarised, stacked patches
- ✓ electronically switchable
- ✓ for maritime or vehicular applications



<i>SANTANA</i>	
Short description	Development of electronically steerable (DBF), bi-directional satellite terminal in Ka-Band for broadband aeronautical applications
Time frame	2001-2003
Customer	DLR Bonn
Operating frequency	K/Ka-band
Partners	University of Braunschweig DLR Oberpfaffenhofen Astrium



# SANTANA: Topics

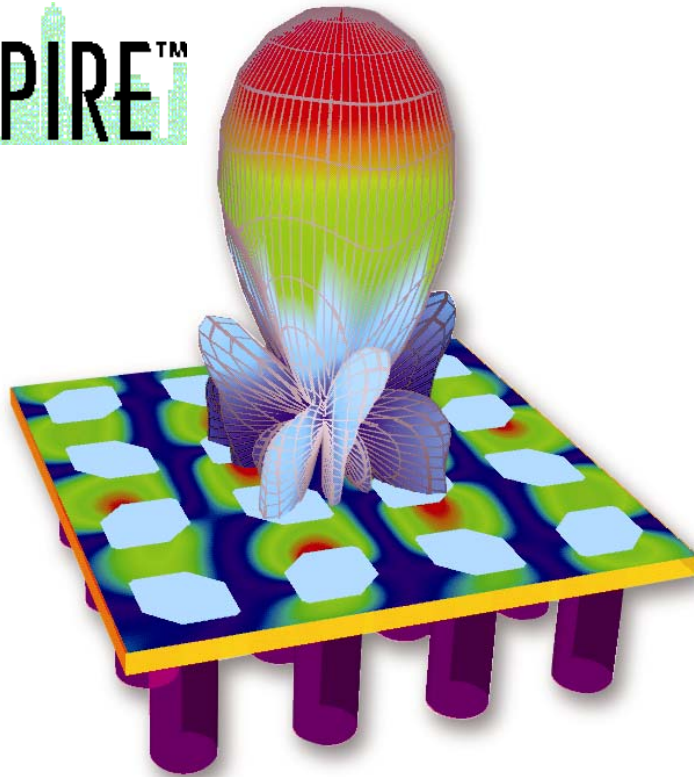


- ✓ Ka-Band
- ✓ bi-directional broadband communication with satellite
- ✓ for aeronautical applications
- ✓ modular approach
- ✓ circular polarization
- ✓ sequential rotation of elements
- ✓ Digital Beam Forming

# SANTANA: Results

## Simulation model & Farfield pattern

EMPIRE™



## Hardware

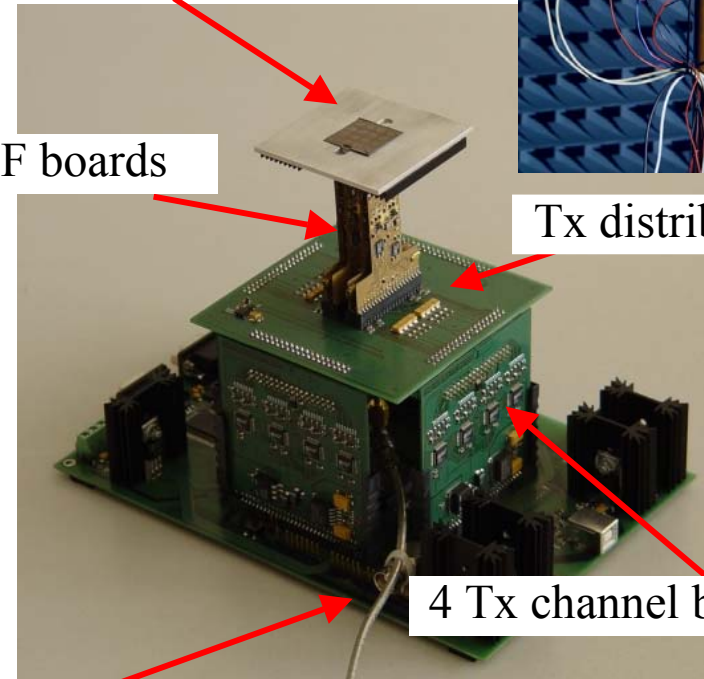
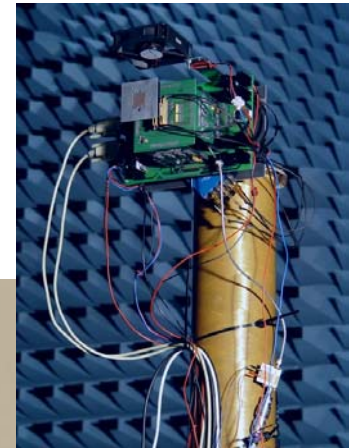
RF front-end with 16 antennas

4 IF boards

Tx distribution

4 Tx channel boards

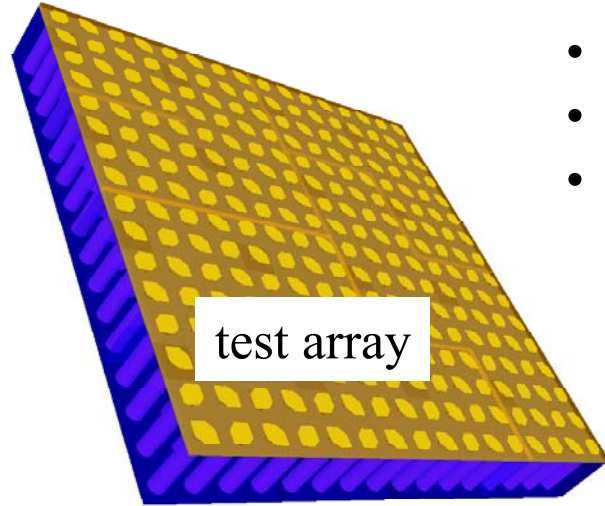
Baseband  
mainboard



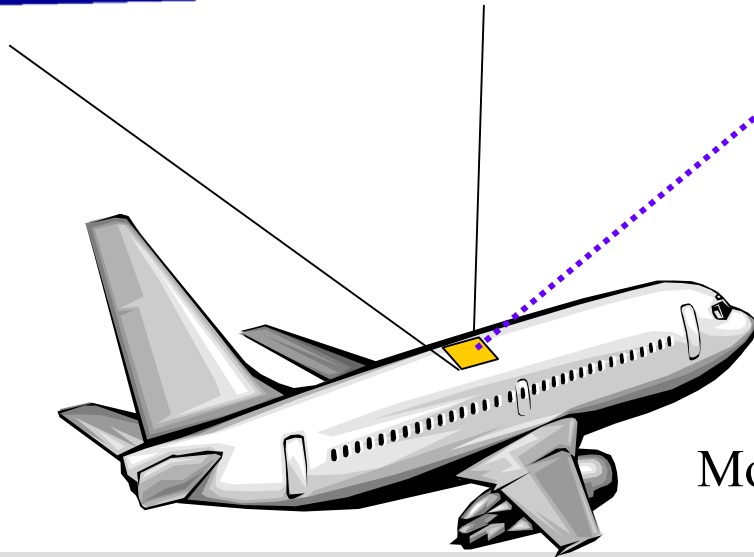
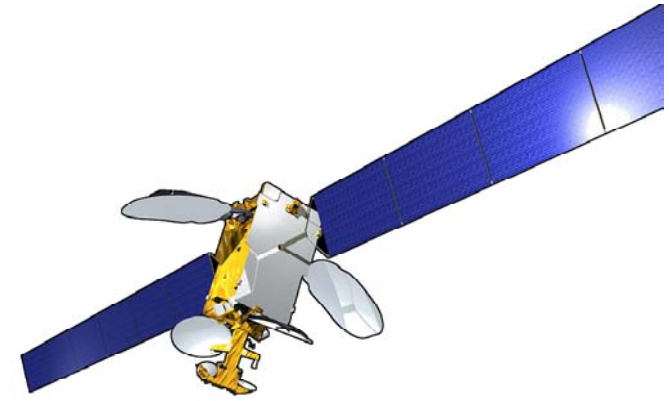
# SANTANA II

<i>SANTANA II</i>	
Short description	Realisation & testing of array antenna using digital beamforming
Time frame	2003-2006
Customer	DLR Bonn
Operating frequency	K/Ka-band
Partners	University of Braunschweig DLR Oberpfaffenhofen Astrium

# SANTANA II: topics & vision



- Realisation of modular a
- hardware optimisation
- **Vision: mobility test**



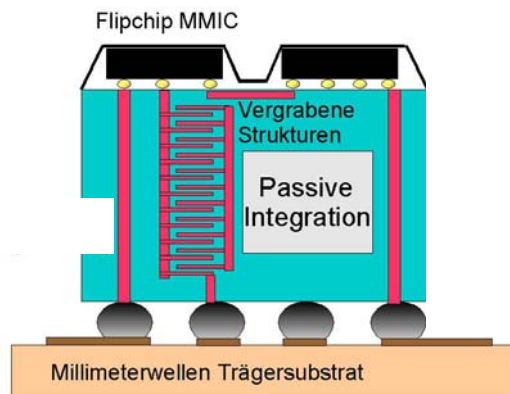
TEST Scenario

Mobile device

<i>KERAMIS</i>	
Short description	Innovative low-cost microwave components for satellite communication based on LTCC
Time frame	2003 - 2006
Customer	DLR Bonn
Operating frequency	Focus on 20 GHz
Partners	TU Ilmenau, TU Braunschweig MSE, TESAT Spacecom Radeberger Hybrid Electronic GmbH

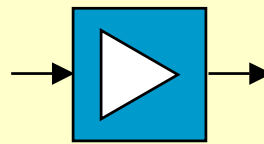
# KERAMIS: Topics

LTCC  
Technology  
Development  
and  
Optimization



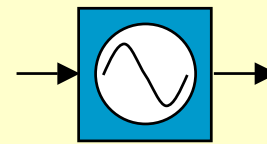
## 3 Demonstrator Modules

Power  
Amplifier



LTCC +  
GaAs

Oscillator



LTCC +  
SiGe

Reconfigurable  
Switch Matrix



digital Logic

Hermetical Housing

## IMST activities:

- Concepts for antennas and front-ends for satellite systems
- Research & development on innovative materials and technologies
- Hardware components for satellites and for end-user terminals
- Smart antennas using electronic beam steering / digital beamforming