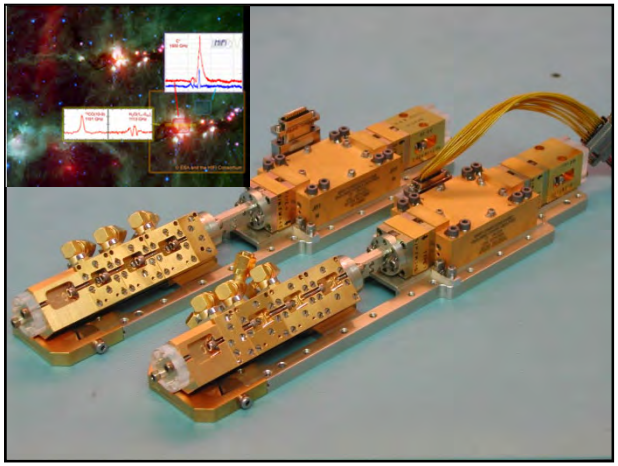
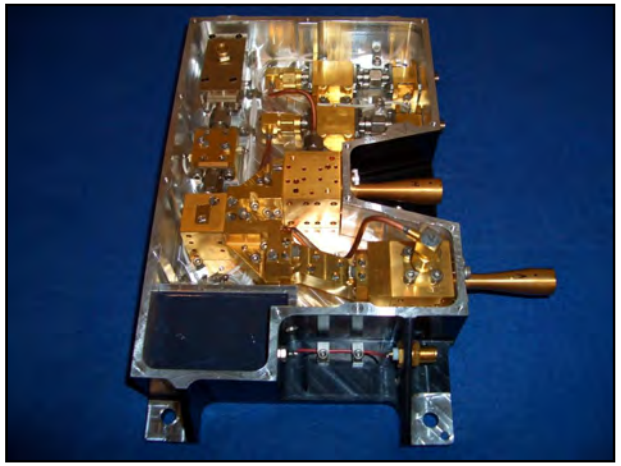
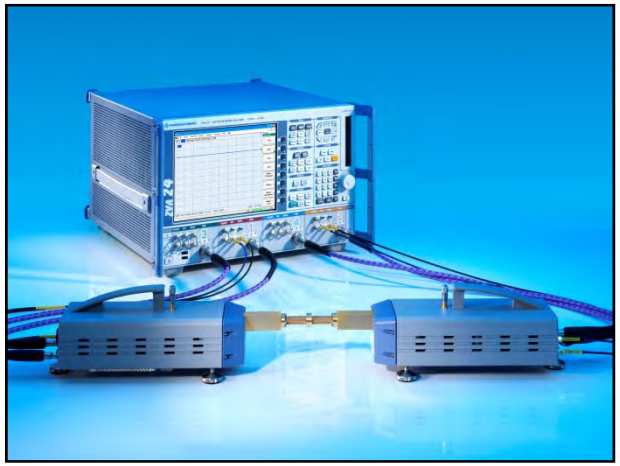
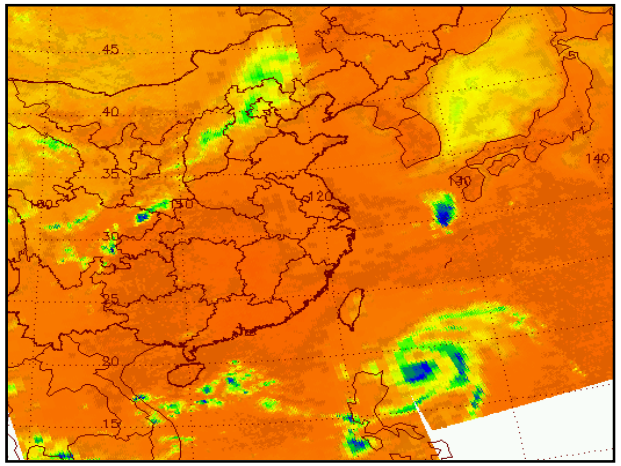
Radiometer Physics GmbH

Meckenheim, Germany

Microwave, sub-mm, THz
Turn-key radiometers, space technology Components,
design, scientific expertise

Radiometer Physics GmbH

- Founded 1973 by Dr. P. Zimmermann
- 40 (+) employees
- Design / fabrication of MW-radiometers (mm, sub-mm)
- Development of radiometer sub-systems (oscillators, mixers, waveguide components, planar networks, amplifiers, optics, etc.)

Active in the following fields:

- Radio Astronomy
- Plasma Physics
- ESR Spectroscopy
- **Remote Sensing**
- Space borne radiometers
- Network Analyzer Extensions

RPG GmbH Organization

Company Management

Managing Board
M. Lüders (R&S), Ch. Evers (R&S), Dr. T. Rose (RPG), A. Walber (RPG)

Managing Directors	Sales & Marketing	Business Development	Financials & Management Assistant
Dr. T. Rose, A. Walber	Dr. H. Czekala, R. Henneberger	Dr. H. Czekala, A. Walber, R. Henneberger, Dr. T. Rose	K. Ley

Business Divisions

Rohde & Schwarz OEM RF Systems & Comp.	Radiometer Systems	R&D Projects	FFTS Systems	Space Projects
A. Walber, J. Oelrichs	Dr. T. Rose, A. Mombauer, Dr. H. Czekala	R. Henneberger, Dr. M. Brandt, Dr. M. Philipp, Dr. B. Thomas	R. Henneberger	Dr. M. Brandt, Dr. M. Philipp R. Henneberger, Dr. H. Czekala

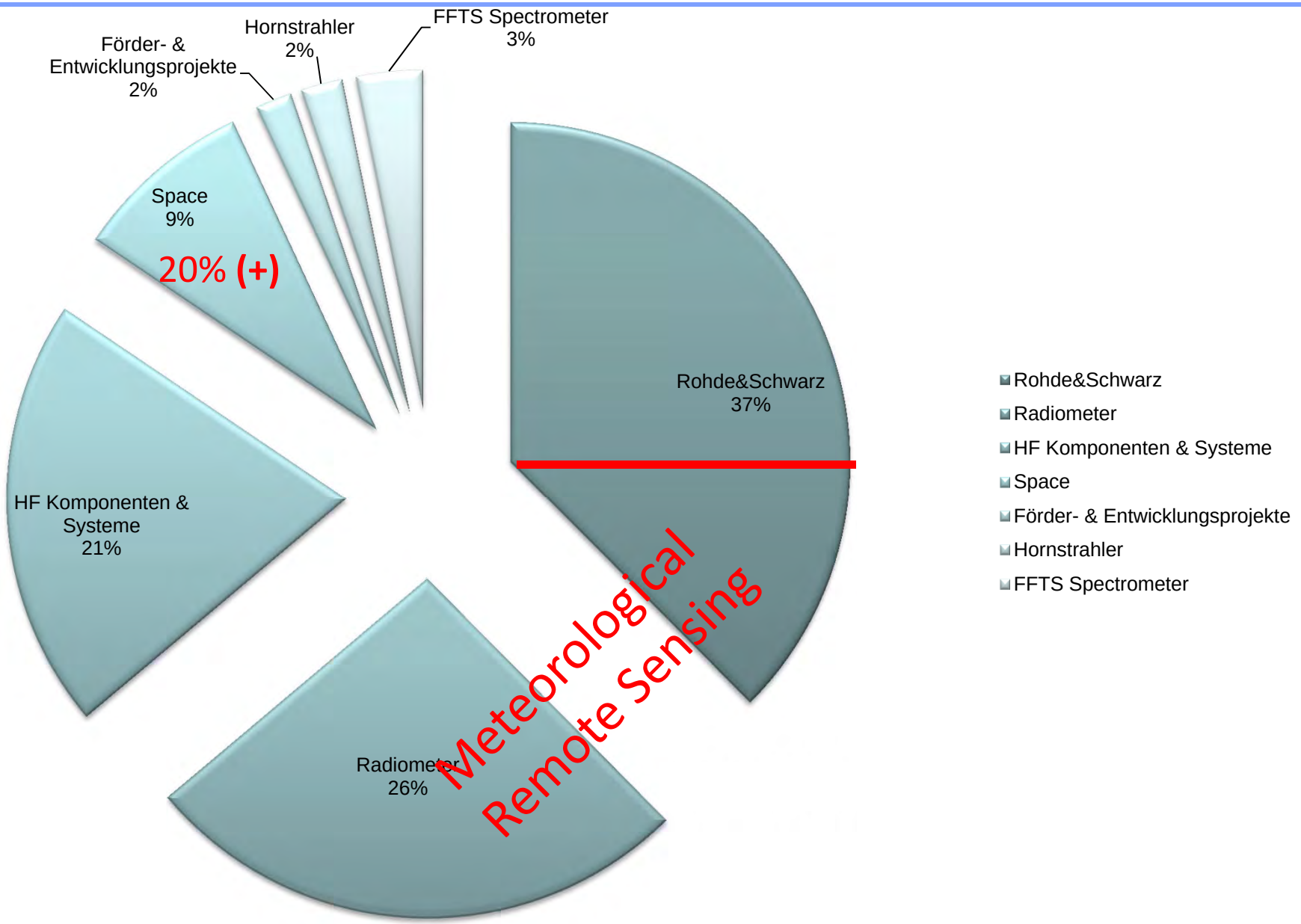
Operations & Activities

Design, Development & Analysis
- Component and System Development
- RF Component & Optics Simulations (CST, HFFS, ADS etc.)
- Space Environment Simulation & Analysis
- Meteorological Concepts & Retrievals
- Scientific Consultancy
- Software Development

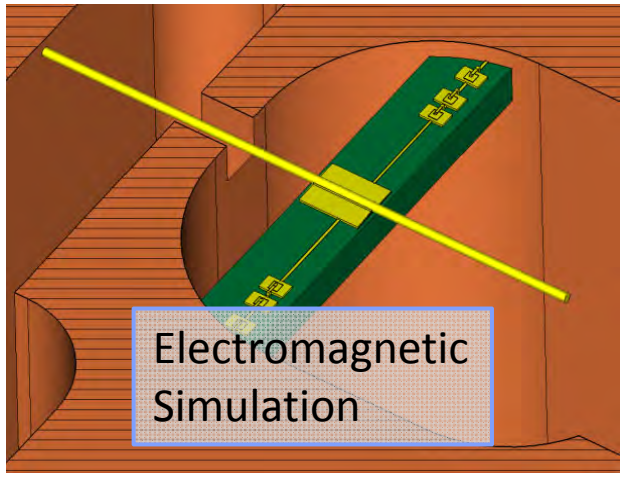
Manufacture & Integration
- Machine Shop
- Electroforming Facilities
- Clean Room MMIC Assembly
- RF Component Manufacturing
- R&S OEM Products Integration
- Meteorological Radiometer Integration
- Clean Room Space Product Integration

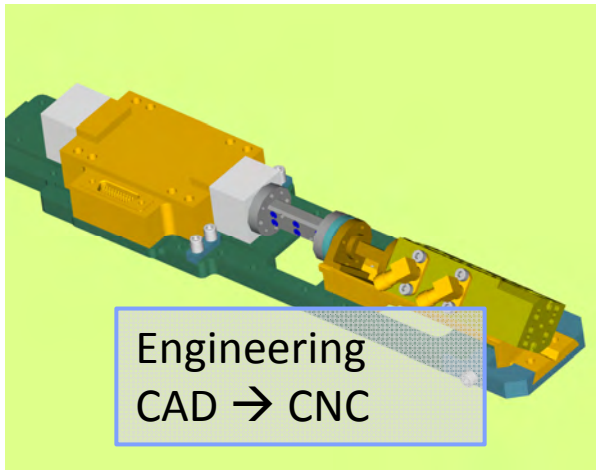
PA/QA, Test & Verification
- Manufacturing Process Control
- Semi-Automated ICD Verification
- RF Performance Testing
- RF Calibration
- Antenna Pattern Measurements
- R&S High-Rel BI & Thermal Cycle
- Environmental Testing

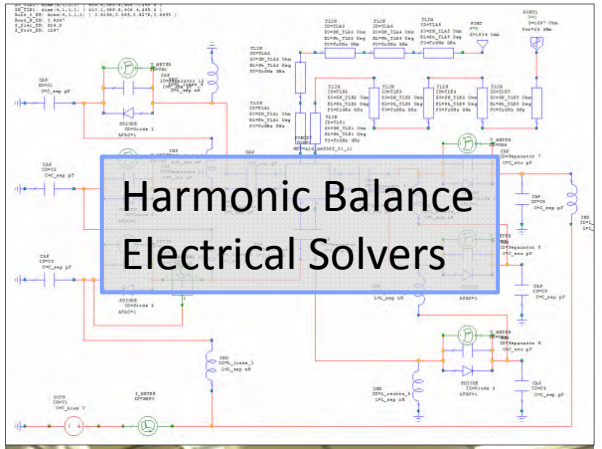
Fields of activity (2010)



Technology to Product

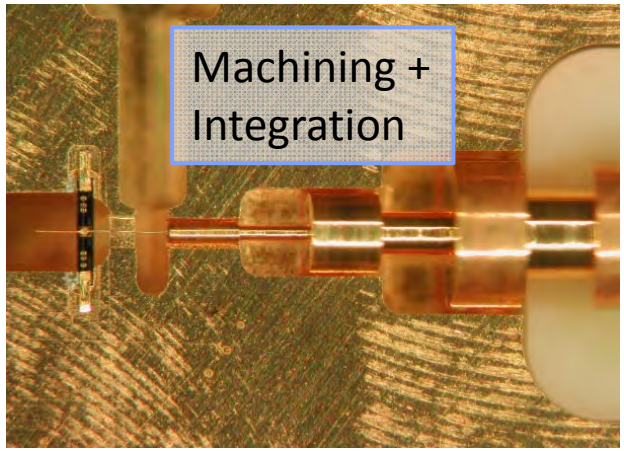


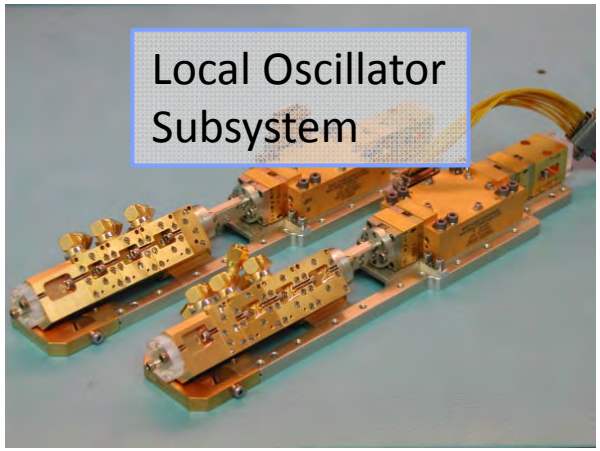




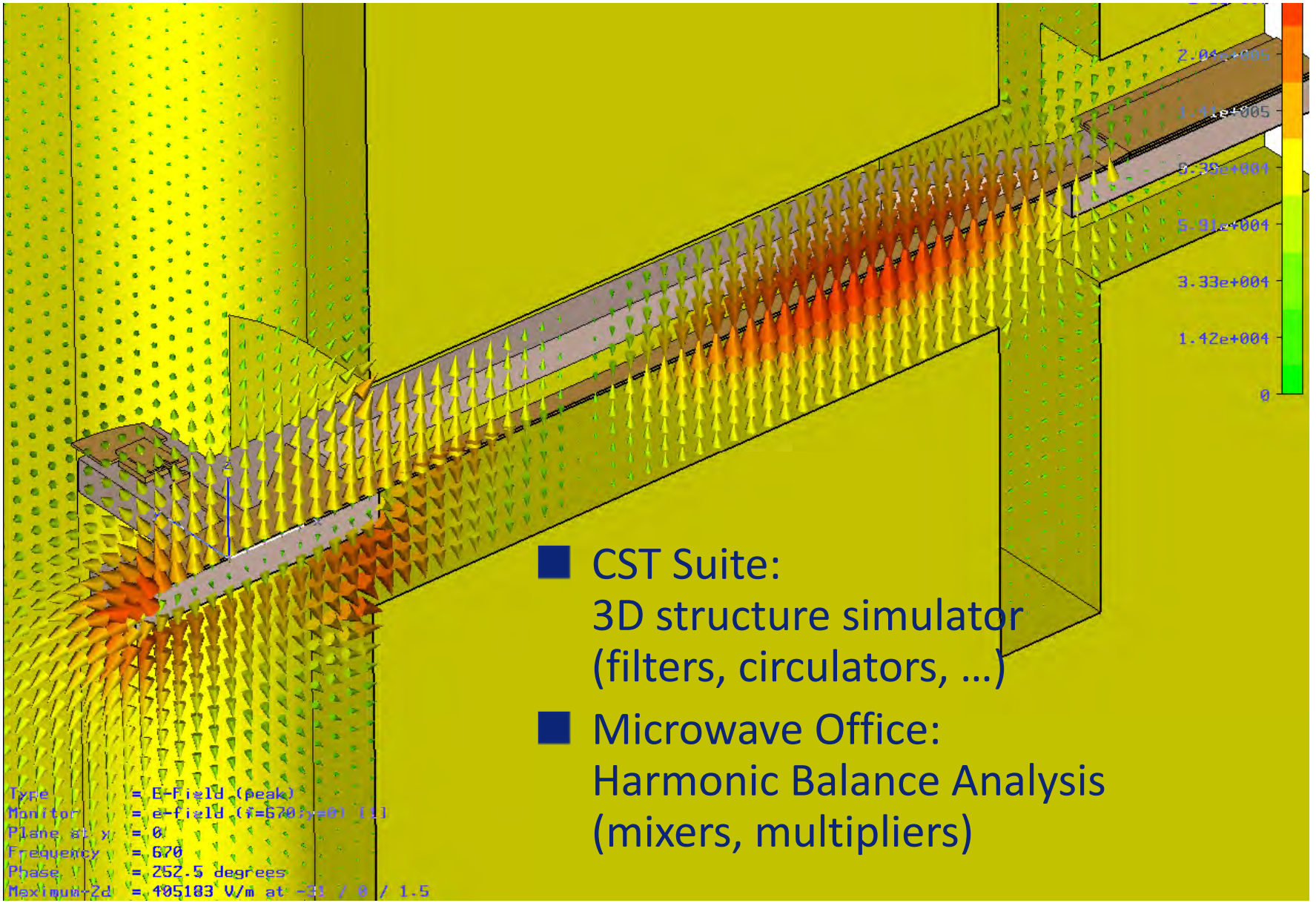
Knowledge, experience, precision and quality

- **Design**
- **Development**
- **Manufacture**
- **Integration and Test**



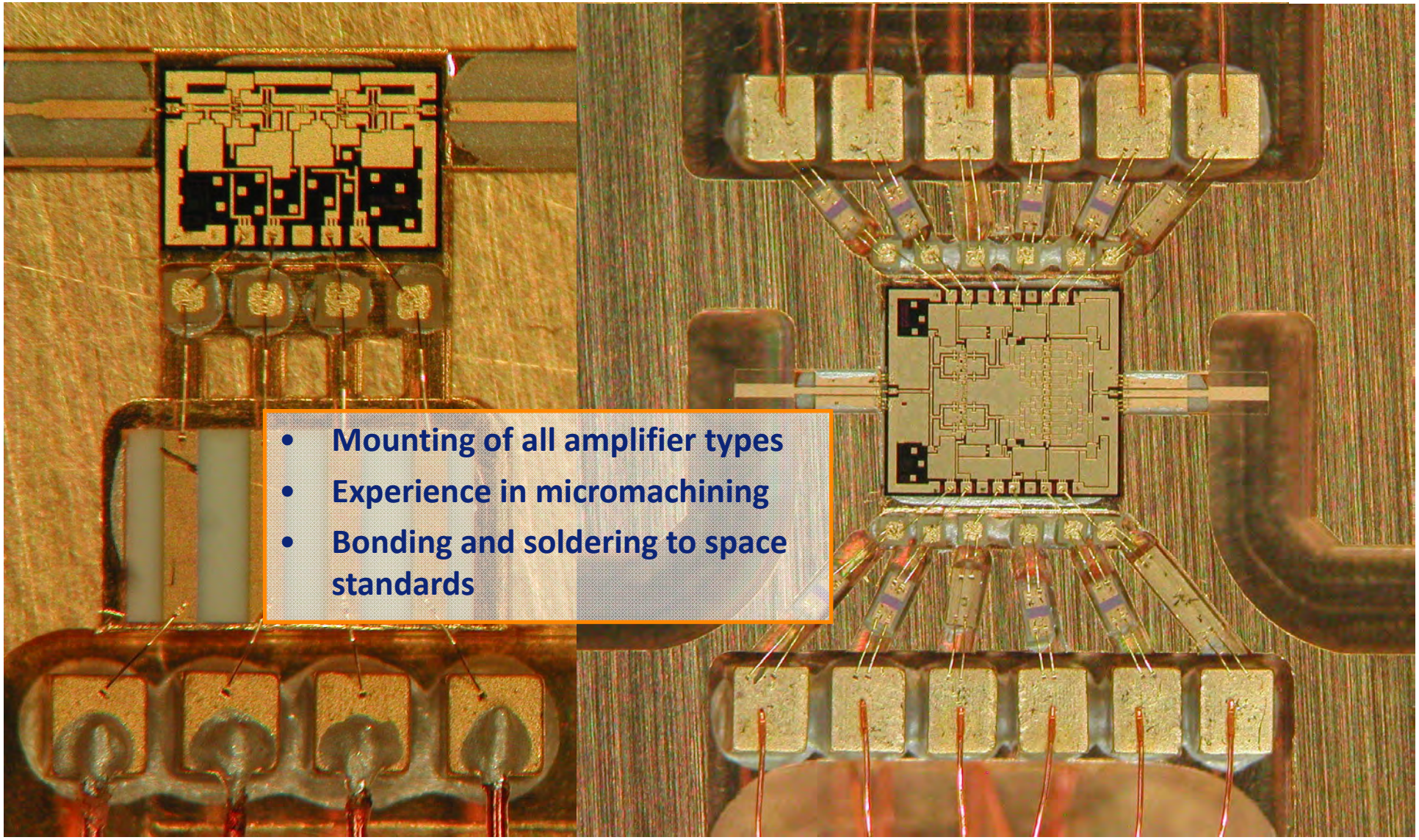


Simulation and Design Capabilities



- CST Suite:
  3D structure simulator
  (filters, circulators, …)
- Microwave Office:
  Harmonic Balance Analysis
  (mixers, multipliers)

Amplifier bonding (clean room, space standards)



- Mounting of all amplifier types
- Experience in micromachining
- Bonding and soldering to space standards

Schottky Mixer and Multiplier Improvements

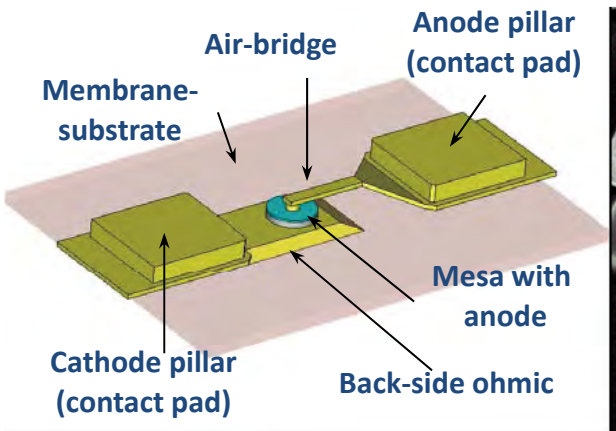
- Planar technology
- Discrete Schottky devices
- Semi-integrated and full integrated structures

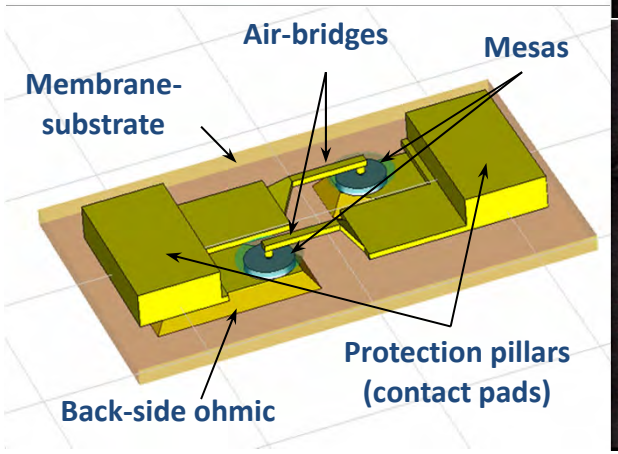
Two collaborations:

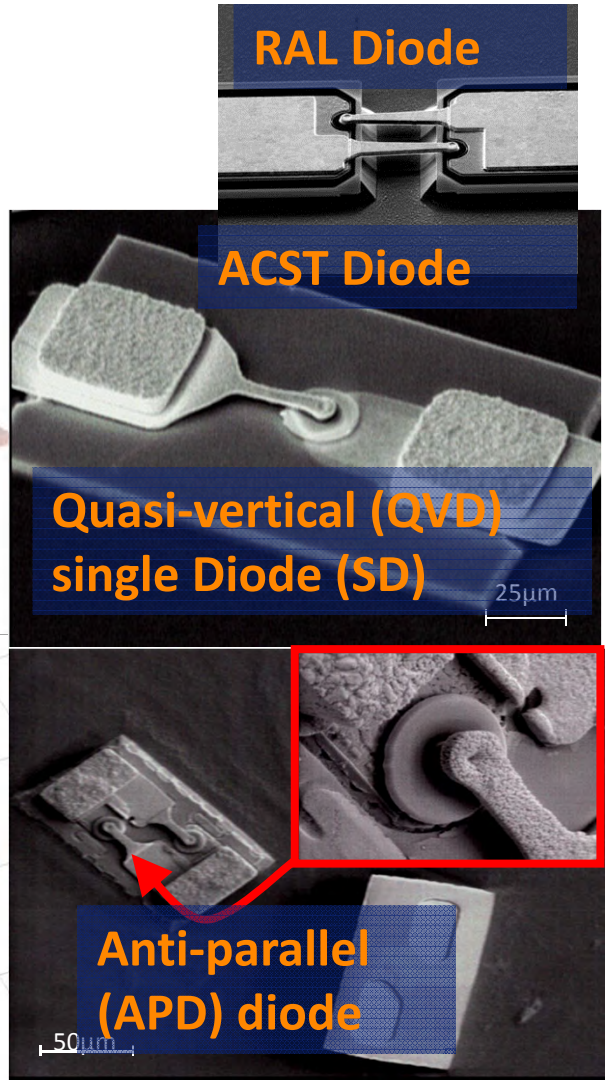
- STFC/RAL, UK
- ACST, Germany

Mandatory improvements for 800 to 1000 GHz circuit mountings:

- Reduced C_{j0}
- Reduced C_{str}
- Smaller size

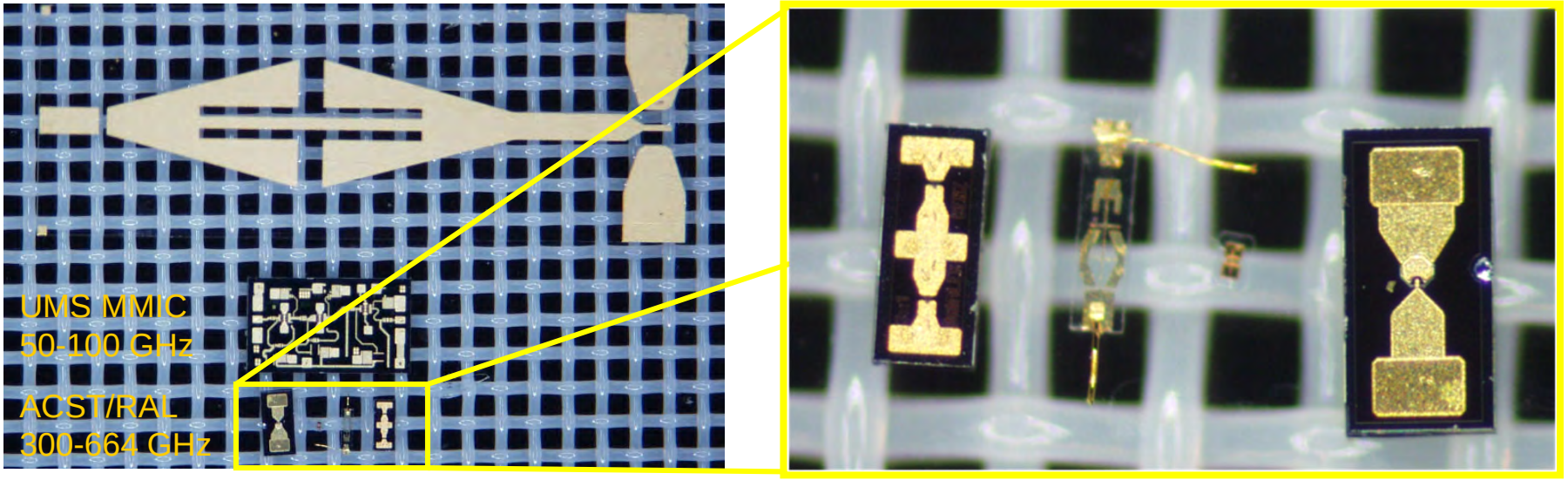


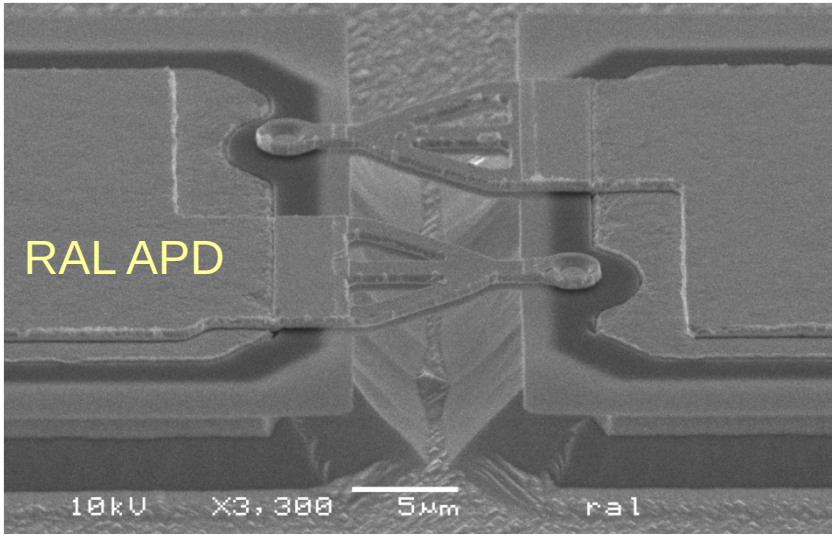


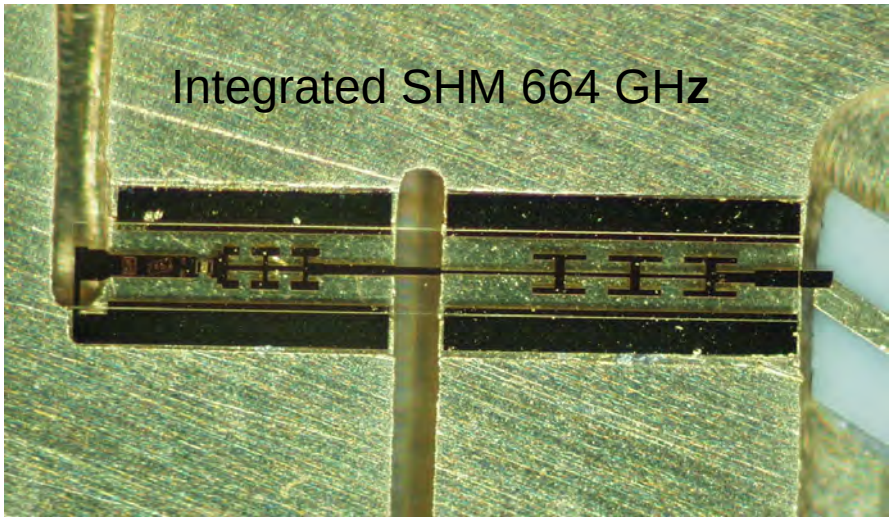


ESTEC Contract 22032/08/NL/JA: Sub-Millimeter Wave Receiver Front-End (at 664 GHz)
ESTEC Contract 21628/08/NL/GLC: Integrated Schottky Structures (at 664 GHz)

Sample pictures







Improved Schottky Diodes: VNA Extender

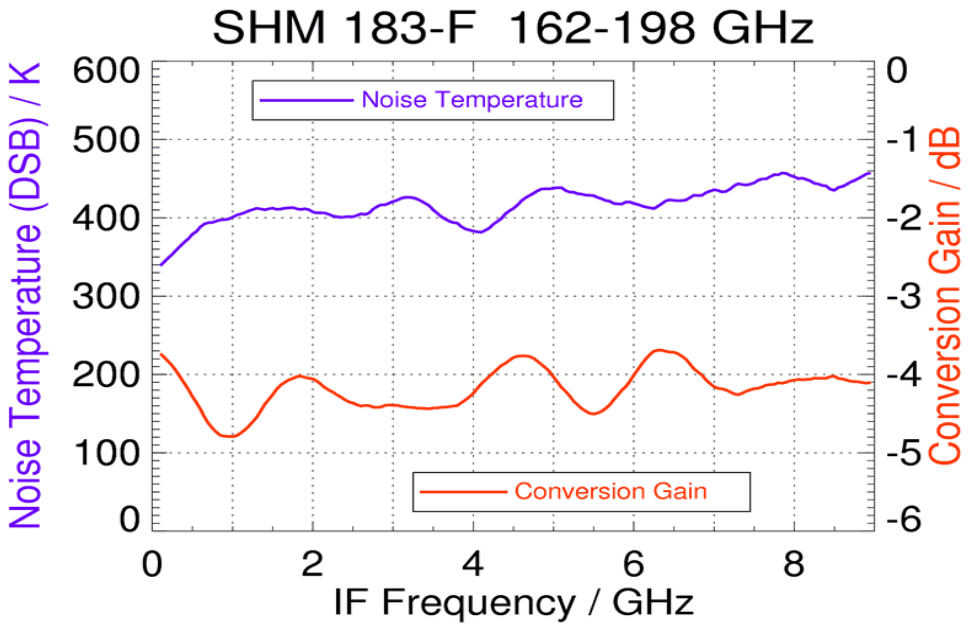
50 – 75 GHz
60 – 90 GHz
75 – 110 GHz
90 – 140 GHz
110 – 170 GHz
140 – 220 GHz
220 – 325 GHz
325 – 500 GHz
(500 – 750 GHz)

OEM
Network Analyzer
Frequency
Extenders
for
Rohde & Schwarz

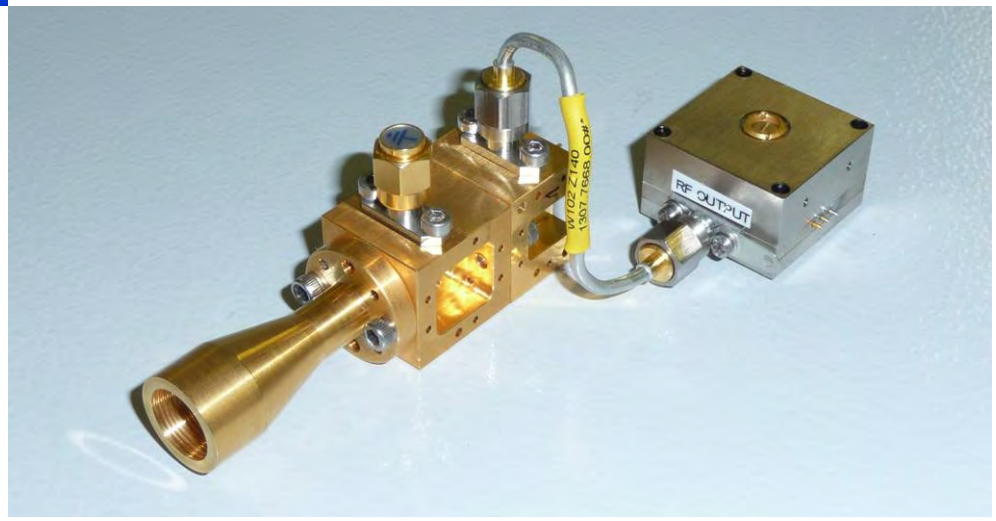
Improved Diodes: RPG sub-harmonic mixers

Art.-No.	RF Range [GHz]	DSB-Noise Temperature	Conversion Gain (DSB)	IF-Band-width	Required LO Power	Waveguide LO	RF
SHM118	104-132	500 K	-5 dB	> 16GHz	6 dBm	WR15	WR8
SHM137	110-165	500 K	-6 dB	> 20 GHz	4-7 dBm	WR12	WR6.5
SHM150	134-167	450 K	-6 dB	> 16 GHz	2 dBm	WR12	WR6.5
SHM183	167-200	430 K	-4 / -5 dB	> 16 GHz	4 dBm	WR10	WR5.1
SHM220	185-230	500 K	-6 dB			WR10	WR5.1
SHM280	265-295	700 K	-7 dB			WR6.5	WR3.4
SHM300	275-330	900 K	-7 dB			WR6.5	WR3.4
SHM340	310-360	1000 K	-6 / -7 dB			WR6.5	WR2.8
SHM424	400-440	1100 K	-7/ -8 dB			WR4.3	WR2.2
SHM664	644-680	1600 K	-8 dB			WR3.4	WR1.5

Receiver technology – 183 GHz example

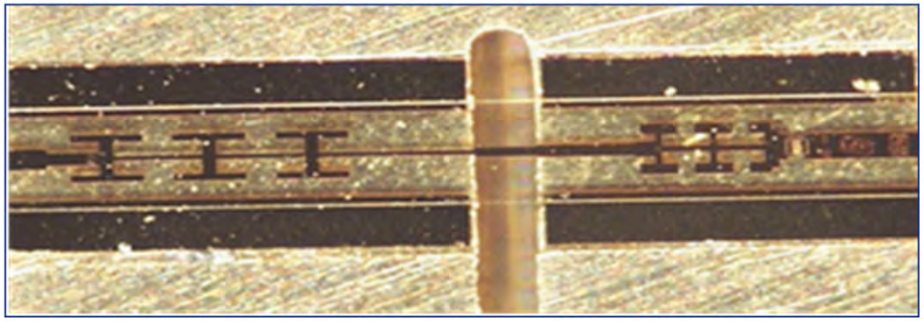


- Best 183 GHz receivers available
- Built in larger numbers
- Noise-injection calibration @183 (RPG only manufacturer world wide)
- All ALMA water vapor radiometers equipped with RPG mixers and feeds

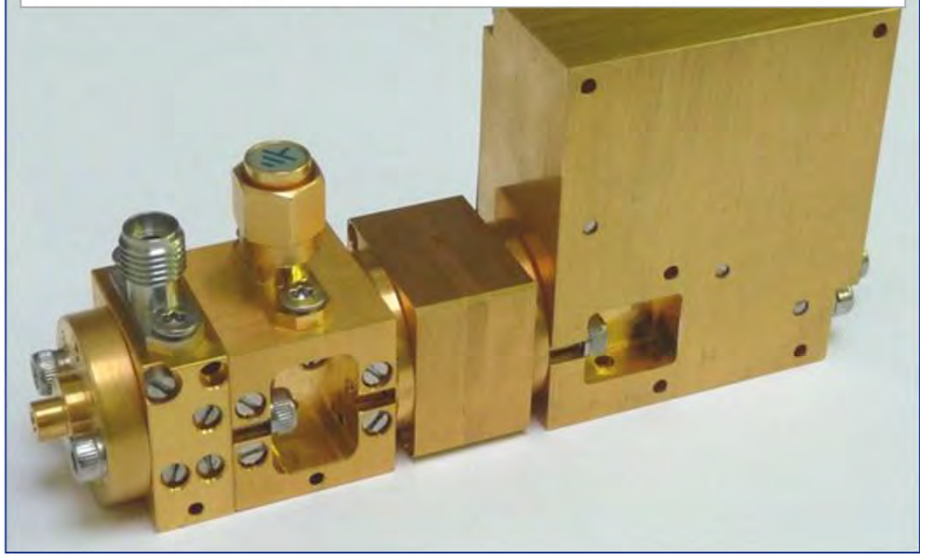


Space Products

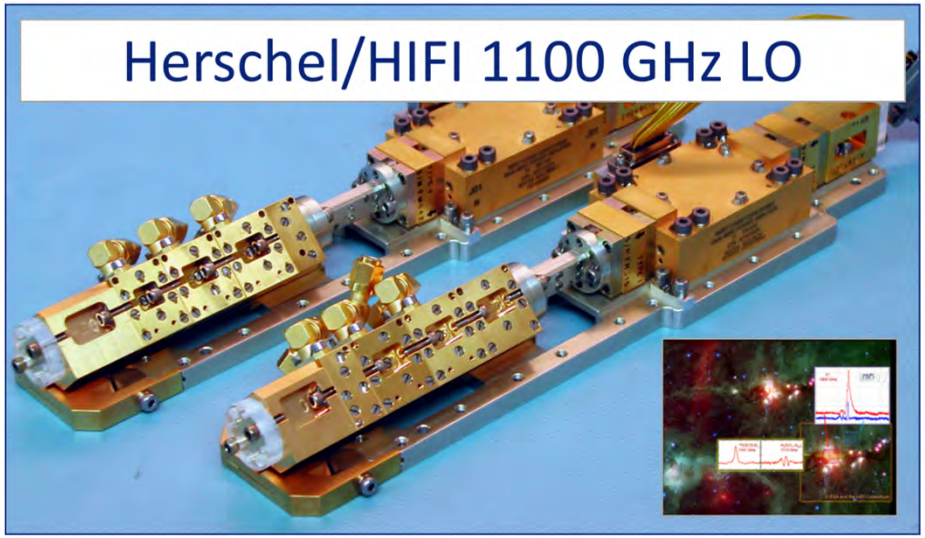
Integrated Structure SHM



664 GHz Receiver



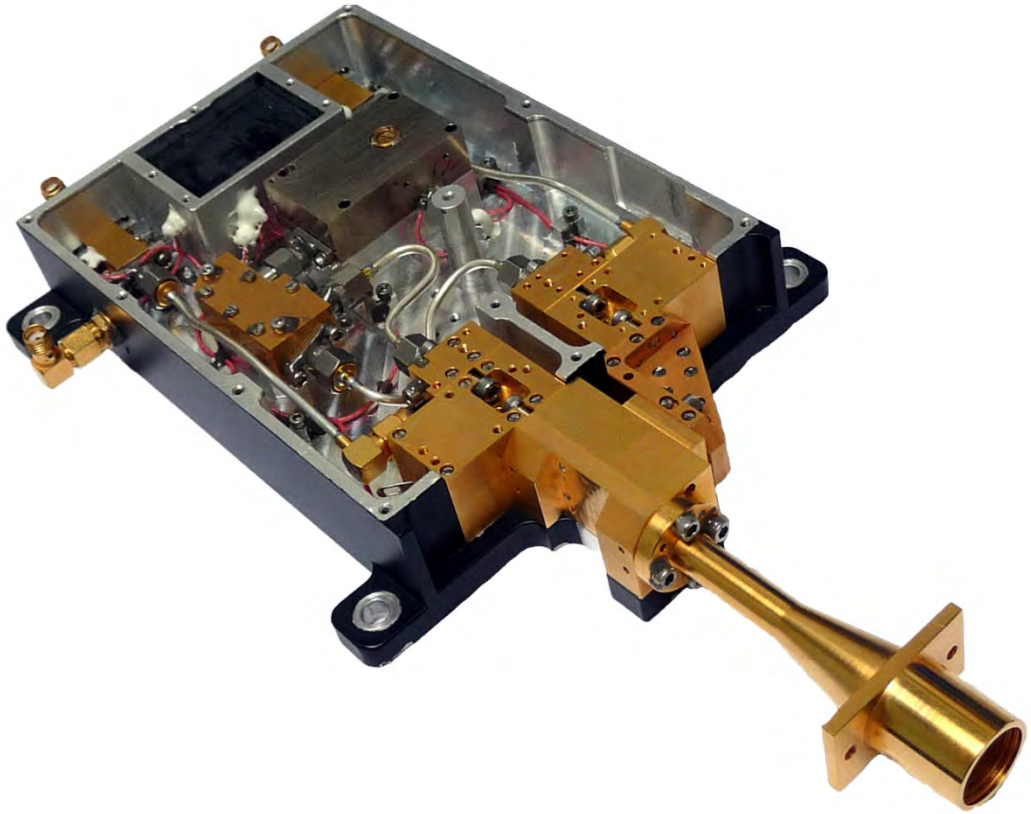
Herschel/HIFI 1100 GHz LO

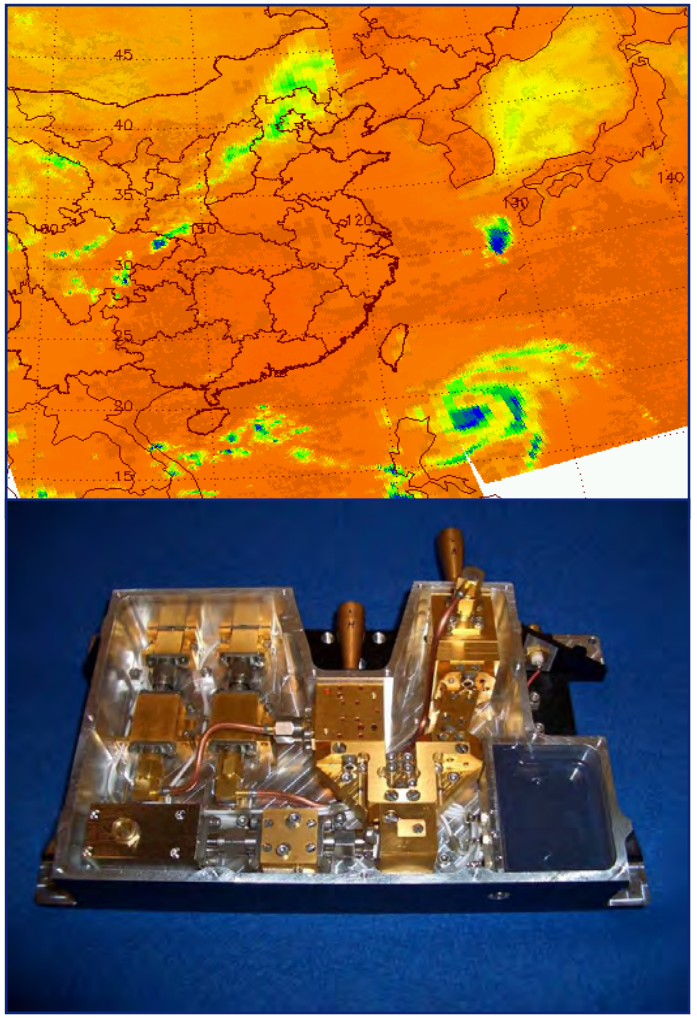


Examples of RPG contributions:

■ MLS	LO sources
■ ODIN	LO sources, mixers
■ HIFI (Herschel)	LO, up-converter
■ JEM/SMILES	LO at 360 GHZ, PLL
■ HY-2, FY1 – FY4	FE Imager/Sounder
■ SAPHIR	(MW sounder)
■ MADRAS	(MW Imager)

Space Products (II)

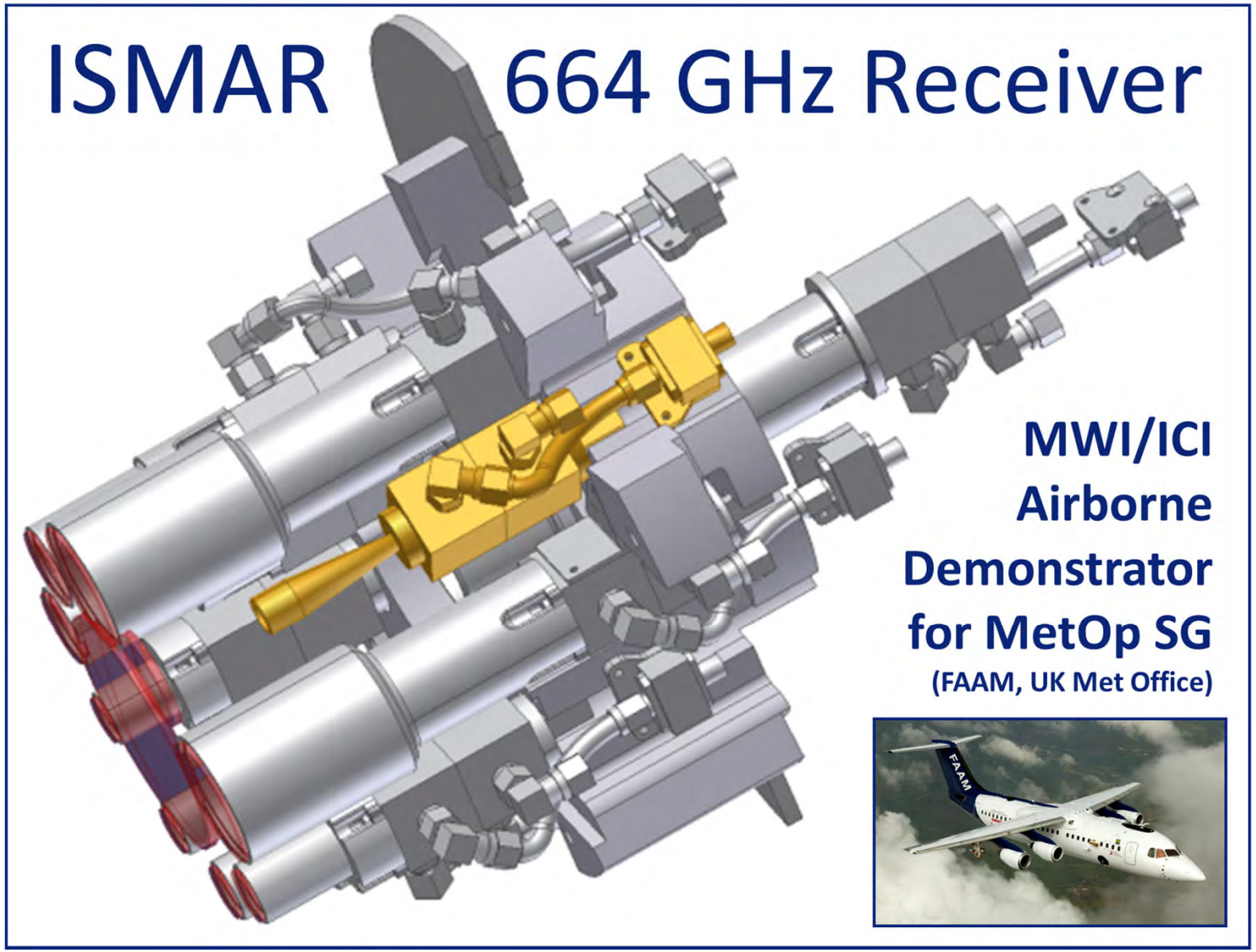




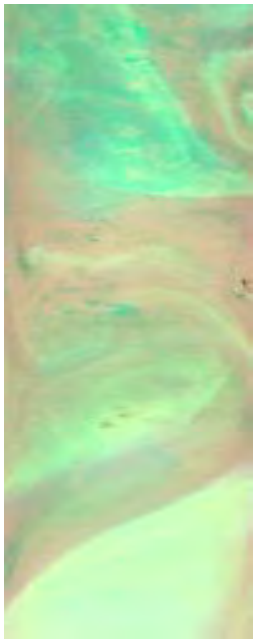
Space qualified front ends (China, FY-3):

- **90 GHz dual polarized receiver**
  OMT + LNA + (either Direct Detection or Heterodyne)
- **150 GHz dual polarized receiver: OMT + SHM**

Preparations for MetOp-SG Ice Cloud Imager



Space Products (III)

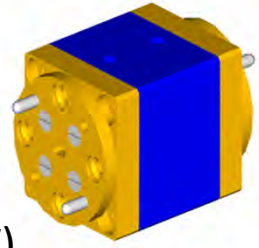


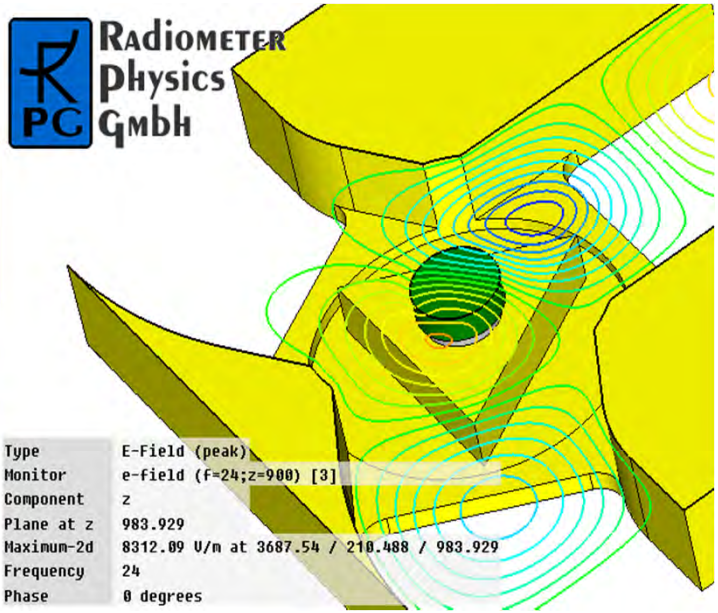

Space qualified front ends:

- 183 GHz (4 channels) for sensitive water vapour detection
- 90 GHz dual polarized receiver
- 150 GHz dual polarized receiver

Auto-Calibration Receivers

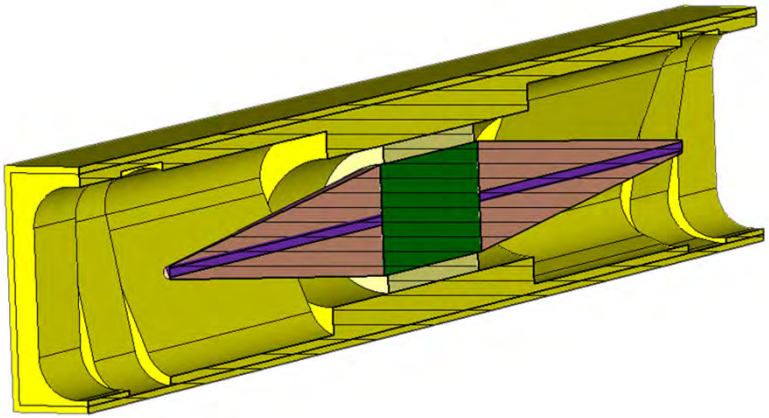
- Noise injection calibration up to 200 GHz
  - 7.000 K signal at 183 GHz with stable noise diode (15 dB ENR)
- Magnetically switched isolators: Dicke switching up to 150 GHz with low insertion loss (≤1.0 dB)
  - Fast switching with low currents (small thermal effects, 100 mA, 0.5 V)



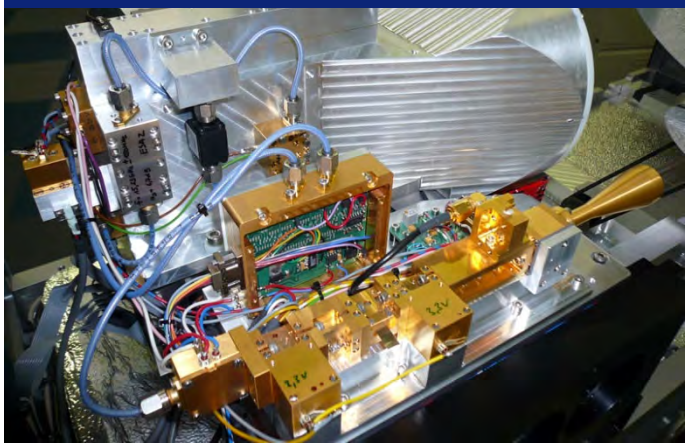


➔ Allan Variance Stability: 4.000 s

➔Less dependent on external calibration targets (LN2)!

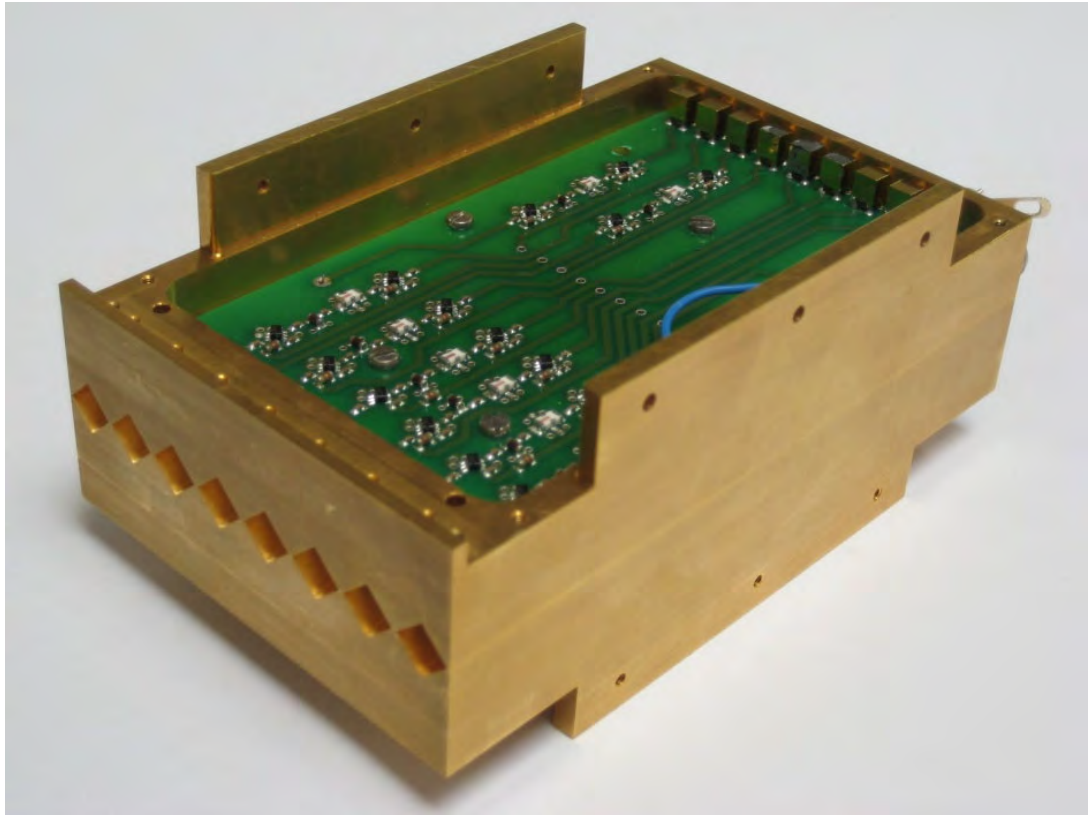


ESA-ATPROP 15 / 90 GHz



Sub-mm imaging receivers

- One-Pixel and Multipixel Receiver:



- FMCW Radar 75 to 325 GHz
- CW Radar
- 8-Pixel Array 230-320 GHz (ESA) and 8-Pixel Array 812 GHz,
- 4-Pixel Array 183 GHz
- Imaging, Security, Material Analysis, Science

Antenna Measurement Solutions

Transmit / Receive Systems, Spectrum Analyzer Solutions:

- Full-band

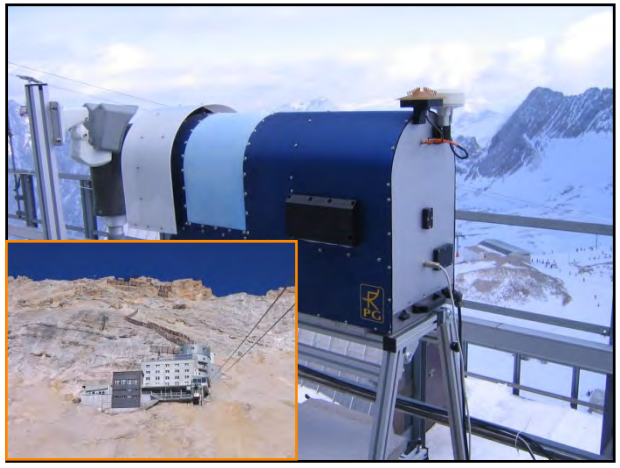
  50-75 GHz 60-90 GHz 75-110 GHz 110-170 GHz 140-220 GHz
  170-260 GHz 220-325 GHz 260-400 GHz 325-500 GHz

- High Dynamic Receivers available at

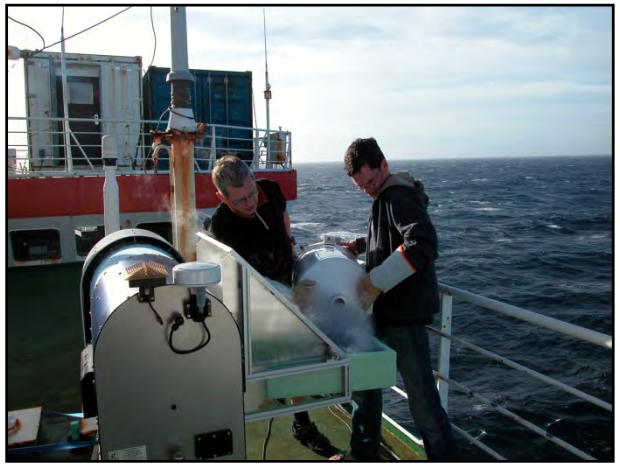
  90 GHz 183 GHz 220 GHz 324 GHz
  502 GHz 640 GHz

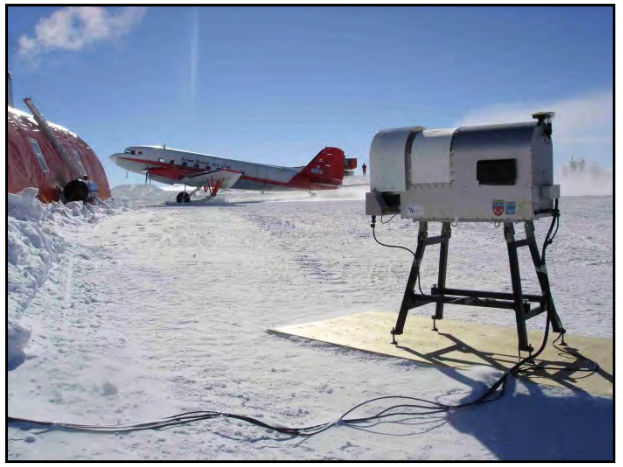
- For compact ranges (antenna measurement facilities, phase + amplitude)

Radiometer Products



Approx. 25 standalone multi-channel radiometers per year

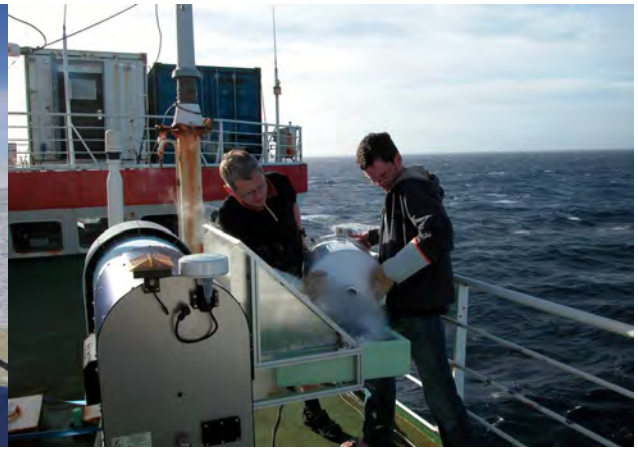




Radiometers Deployments

Lampedusa, Italy
(humid, hot, salty)

Dome-C, Antarctica
(3.300m, -25 to -80 °C)



Research Vessel “Polarstern”
(Atlantic Ocean)

ALMA site, Chile
(5.500m above sea level)

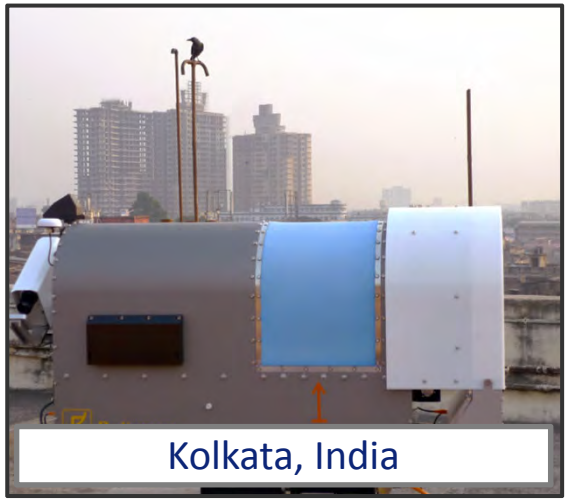
Zugspitze, Germany
(2.800m, -35 °C, 250km/h wind)

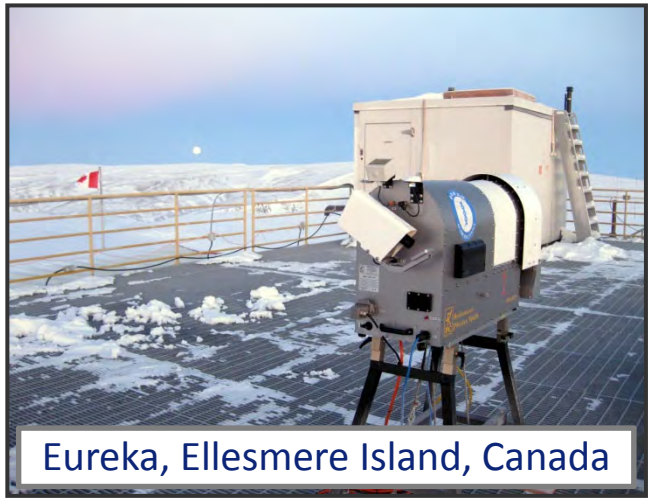
AMMA campaign, Benin
(West-Africa, hot climate, dust)

Radiometers Deployments


CAOS, Bangalore, India


Zugspitze, Germany, 2650 m asl

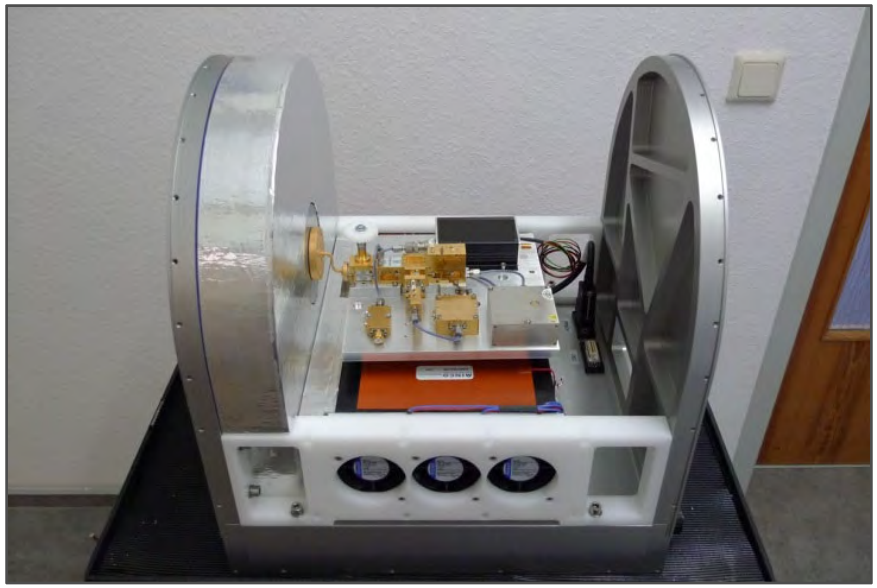

Kolkata, India

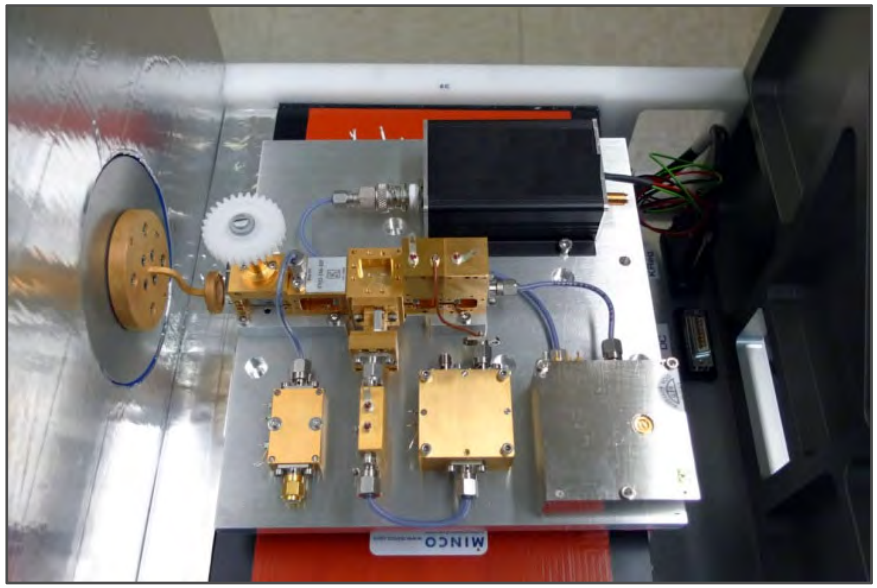

Eureka, Ellesmere Island, Canada

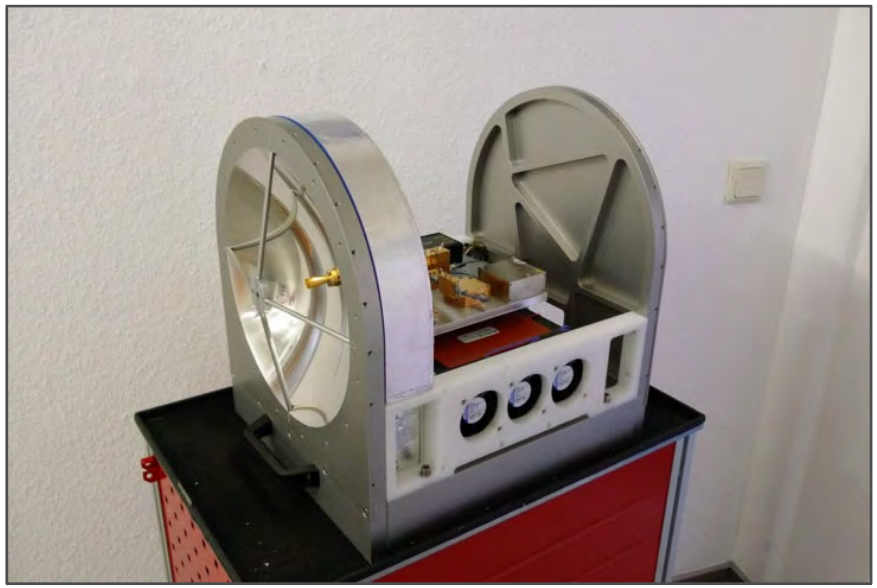

Ny-Alesund, Spitsbergen, Norway


Solar-Patroller (SST)

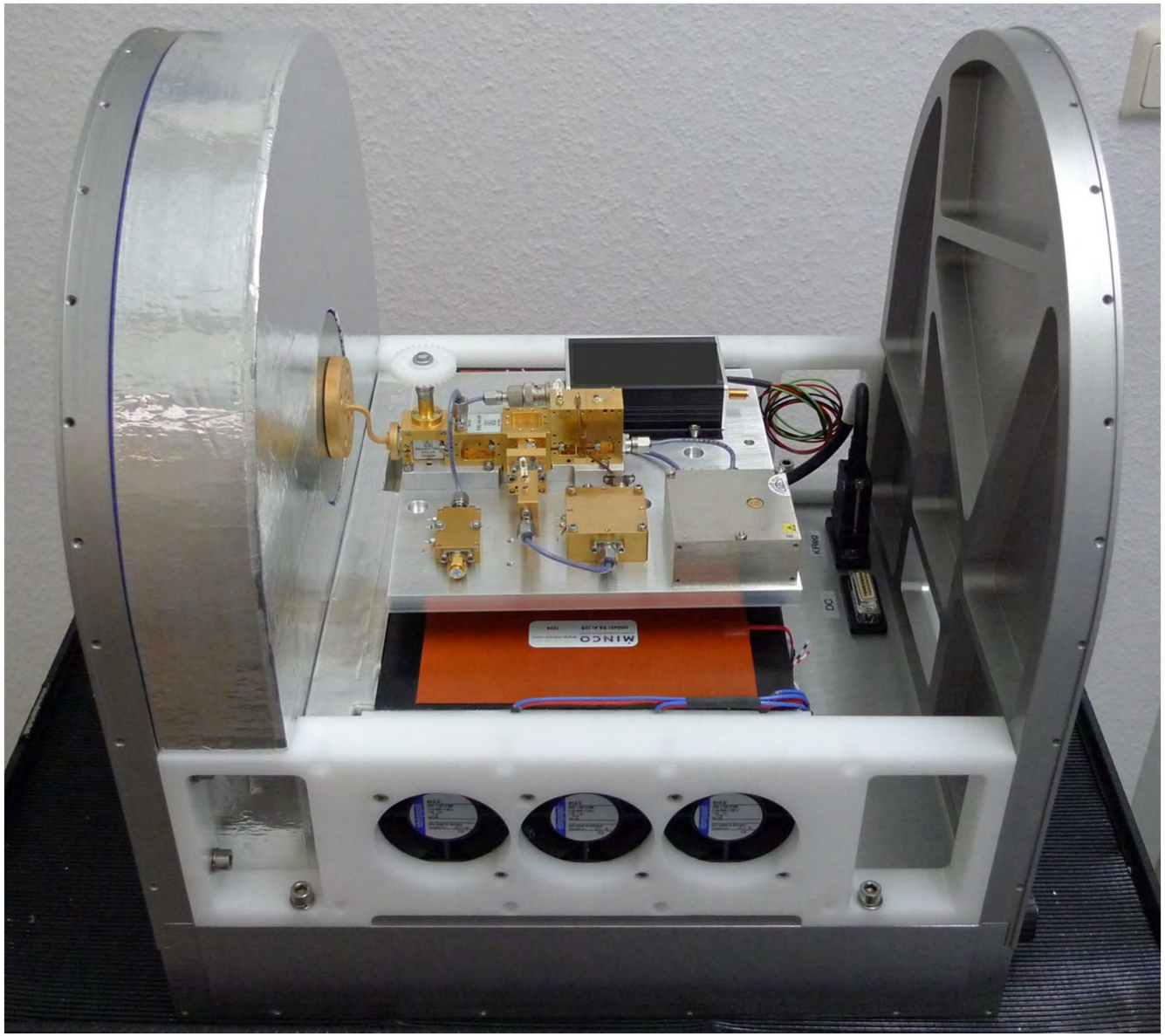
MWSC: Scintillomter @160 GHz for Latent Heat Flux







MWSC Integration



RPG-FMCW-94

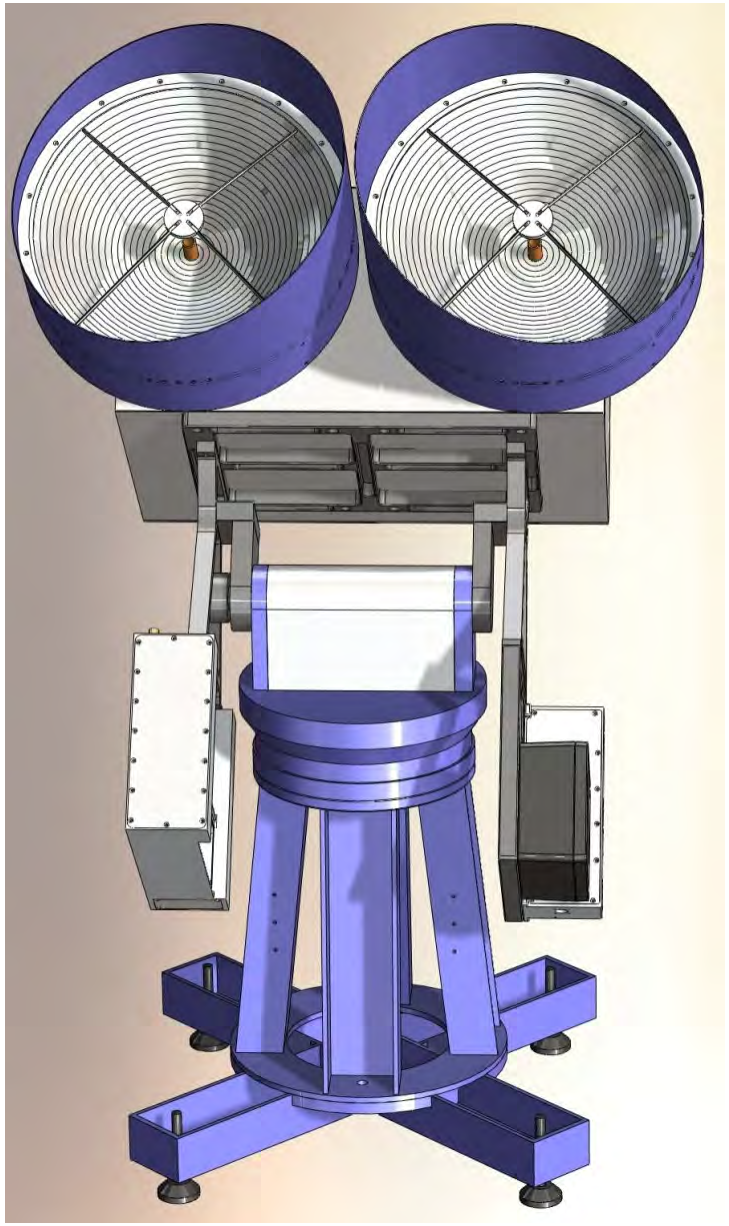
RPG-FMCW-94-DP

A Cloud Radar by RPG

- Frequency Modulated, Continuous Wave, 94 GHz
- Low mode for fog, high mode up to 12 km
- Re-using RPG technology from Tx/Rx systems and network analysis
- Re-using instrument infrastructure (housing, steering, control, data processing) from microwave radiometers
- Supported by Fraunhofer Institute for RF Technology and Radar (FhG-FHR, Wachtberg, Germany, formerly FGAN)

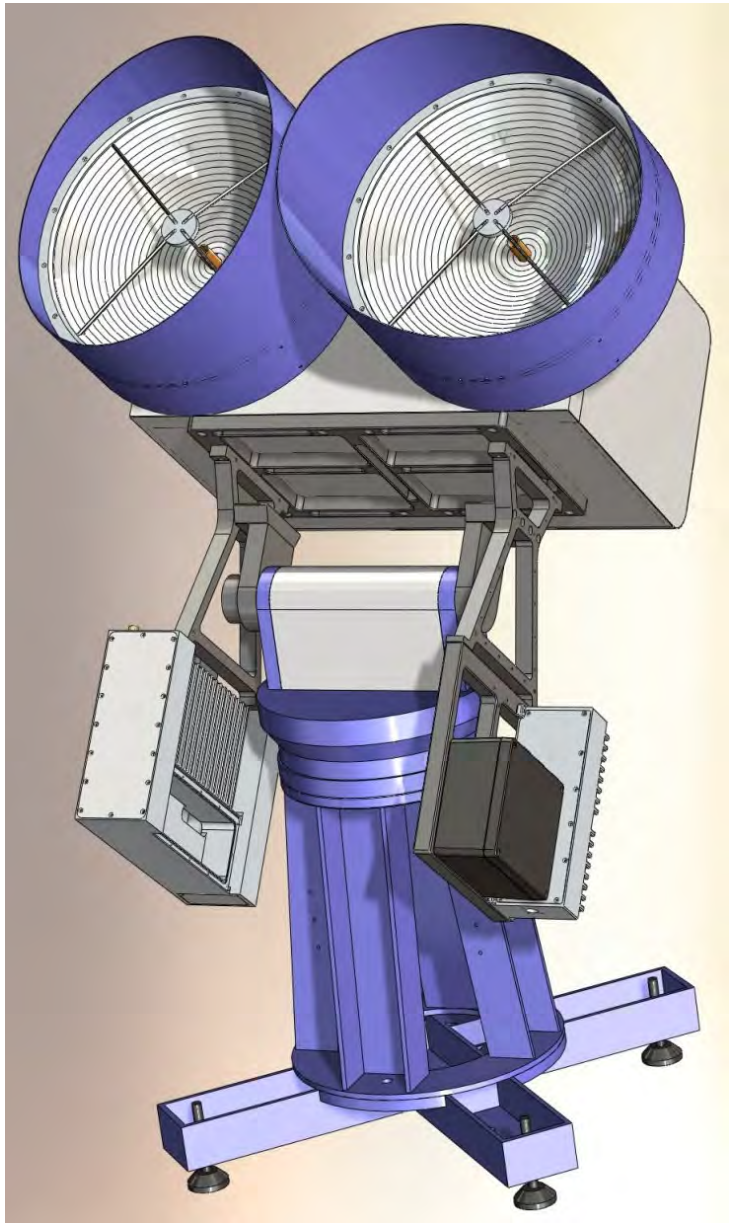
Availability: Mid of 2013

RPG-FMCW-94 Specifications (I)



Operating Frequency:	94 GHz +/-150 MHz
IF Range:	0.5 MHz to 1.3 MHz
Continuous Power:	500 mW (Solid State)
T/R Type:	Bi-static
Antenna Diameter:	500 mm
Gain:	52 dB
Chirp Rate:	100 / sec
Chirp Variations:	7
Passive LWP Channel:	89 Ghz (optional)
Dynamic Range:	-100 dBz to +20 dBz

RPG-FMCW-94 Specifications (II)



Ranging:	10 m to 12 km
Sampling Rate:	1 / 4 seconds
Vertical Resolution:	1 m (r: 10m - 600 m)
	2 m (r: 0.6 – 1.0 km)
	4 m (r: 1.0 – 2.5 km)
	8 m (r: 2.5 – 5.0 km)
	16 m (r: 5.0 – 12.0 km)
Doppler Resolution:	+/- 15 cm/sec
Polarisation:	v / h (optional)

Availability: Mid of 2013

Possible extensions by

- Additional frequencies
- Passive microwave channels
- Polarisation options

Reference Customers (selected)

- ESA-ESTEC
- NASA/JPL
- EADS-Astrium
- Thales-Alenia Space
- SRON (Netherlands)
- CNES (France)
- DLR (Gerrmany)
- Chinese Space Agency (CAS, CSSAR, …)
- IRAM
- NIST (National Institute for Standards, USA)
- PTB (German institute for standards)
- CNRS (France)
- ESO (European Southern Observatory)
- Rohde & Schwarz
- AB-millimetre
- Aerospace Corporation (USA)
- US Air Force, AFRL Research Labs
- ROKAF (South-Korean Air Force)
- ARM (Atmospheric Radiation Monitoring, USA)
- KMA (Korean weather service)
- CNRS (France)
- UK Met Office
- KNMI (The Netherlands weather service)
- Meteo Swiss (Switzerland)
- Polish weather service
- Numerous Universities world wide
- AWI Alfred Wegener Institute f. Polar Research
- Numerous Universities and Research Institutions