

Wireless and Information Technologies

Topics



- Automotive antenna and radio systems for terrestrial and satellite communications, sensor technology, satellite navigation and localisation
- Connected car, car-to-X, ITS-G5, mobile communications 5G
- Measurement and testing, modelling and realistic emulation of wireless propagation channels for different radio services
- Over-the-air end-to-end tests and evaluation of automotive radio systems in virtual radio environment
- EMC and human exposure in electromagnetic fields: Exposure measurement and assessment of vehicle internal and external radio services



Contact:

Univ.- Prof. Dr. rer. nat. habil. Matthias Hein
Director of the RF & Microwave Department
Phone: +49 3677 69-2832
Mail: matthias.hein@tu-ilmenau.de





VISTA: Virtual Road – Simulation and Test Area

The Virtual Road – Simulation and Test Area (VISTA) serves research, development and system evaluation of automotive radio services as well as for real time connection of test labs. The test area consists of a pyramid absorber-lined and air-conditioned shielded chamber of size 16 m × 12 m × 9 m.

The main frequency range from 400 up to 6,000 MHz is covered with 111 dual polarised antennas in the elevation range from -20° to $+90^\circ$. Radio services like DVB-T, GNSS, SDARS, LTE, and ITS-G5 operate in this range. The side frequency range from 70 up to 400 MHz is covered with 22 dual polarised antennas and enables to additionally address analogue and digital audio broadcast. The turntable has a diameter of 6.5 m and can be adjusted over 360° with 0.1° resolution. The maximal distance for EMC measurements is 5 m. A dynamometer with maximal mechanical load of 2,500 kg and a wheel base up to 3.5 m provides driving speeds up to 100 km/h.

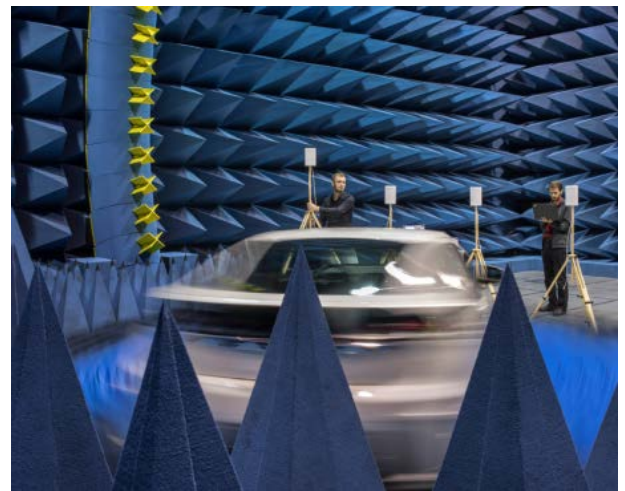




„VISTA – Virtual Road – Simulation- and Test Area“

- Combination of radio and automotive technological measurement methods (virtual reality, over-the-air)
- Emulation of environmental and operational conditions and their interactions
- Innovative connected mobility concepts (e.g. C2X, ITS, 5G): Automotive antennas, car sensor technology, EMC, human exposure, vehicle control, driver assistance, convergence of services: Mobile- and satellite communications, radar, navigation

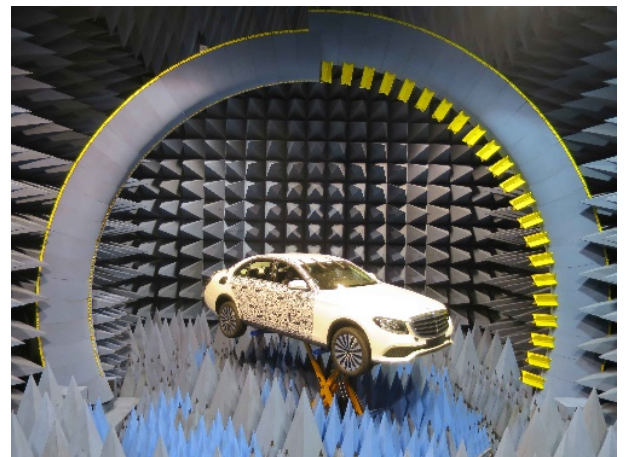
Shielded chamber	16 m × 12 m × 9 m
Frequency range	70...6000 MHz
Turntable	Ø 6.5 m, (360±0.1)°
EMC distance	≤ 5 m
Speed	≤ 100 km/h
Car wheel base	≤ 3.5 m, Mass load ≤ 2.5



Antenna Measurements in VISTA

- Measurement of automotive antennas as mounted
- Radiation pattern, gain, XPD or AR
- Antenna arch with multi probe technology

Manufacturer	Satimo Industries SAS
Technology	Spherical near field measurement
Frequency range	70...6000 MHz
Probes (resolution)	111 at 400...6000 MHz (1°) 22 at 70...400 MHz (5°)
Max. object size	4 m (<220 MHz) 5.2 m (<3300 MHz) 3 m (5800 MHz)
Measurement time typ.	30 min for 3D pattern at up to 10 frequency points



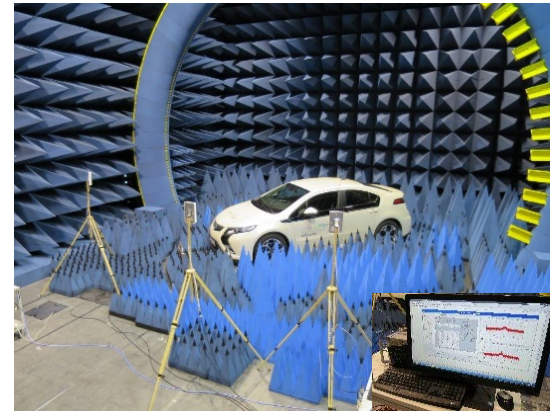
Wireless and Information Technologies

2. Measurement Systems



Radio Channel Emulation in VISTA

- Combined hardware and software-based radio channel emulation of mobile radio services (LTE, 5G, C2X) with over-the-air methods
- Emulation of ray clusters with the help of sectorized antenna arrays
- MIMO functionality
- Adjustment of Doppler shift, delay, and angular directions in terms of absolute values and spreads
- Measurement of quality relevant transmission parameters, e.g. uplink- and downlink throughput, RSRQ, RSRP, RSSI, CQI and SINR



Channel Sounder and Radio Channel Emulator

- Instrument: RUSK MIMO Channel Sounder
Manufacturer: Medav GmbH
- Specs:
- 240 MHz bandwidth
 - Up to 1 h real-time data storing
 - Fully programmable transmit signal
 - Multi band and multiple-sounder operation
 - Switched MIMO access
 - Frequency bands
2.0...2.2; 2.5...2.7; 3.4...3.6; 5.0...6.0 GHz
- Tests:
- MIMO channel sounding, BS-UE, AP-UE, D2D, including V2X;
 - Spatial-temporal characterisation,
 - High resolution multipath parameter estimation



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2. Measurement Systems



Human Exposure to RF Electromagnetic Fields

Instrument:	Handheld selective radiation meter
Model:	Narda SRM-3006
Frequency Range:	9 kHz to 6 GHz
Antenna:	Triaxial E-field antenna 27 MHz to 3 GHz
Special feature: measurements	Code selective UMTS and LTE
Tests:	Field measurements of electric field strengths for different radio services in terms of human exposure in RF electromagnetic fields



Human Exposure to ELF Fields

Instrument:	Combined E- and H- field analyser
Model:	Narda EHP-50F
Frequency range:	1 Hz to 400 kHz
Special feature:	Weighted peak assessment, FFT spectral analysis
Tests:	Field measurements of ELF electric and magnetic fields, e.g., at electrical power supply sites (overhead lines, transformer stations)



Wireless and Information Technologies

2. Measurement Systems



EMC Measurements

Pre-compliance EMC measurements of radiated and conducted emissions in VISTA

EMC chamber: Shielded semi-anechoic chamber, 16 m x 12 m x 9 m

Antenna mast: Measurement heights 1 ... 4 m

Instruments: EMI test receiver
Rohde & Schwarz ESR-7,
Artificial mains network
Rohde & Schwarz ENV432

Frequency range:
9 kHz ... 6 GHz

Measurement distance: 3... 5 m



Antenna Measurement Laboratory (complementary to VISTA)

Antenna characterisation through far field measurements, optionally nearfield – far field transformation if used as spherical near field scanner

Manufacturer: Nearfield Systems, Inc.

System: NSI-800F-10x with nearfield measurement option NSI-SW5305

Shielded room: 8.9 m x 5.1 m x 5.1 m

Frequency range:
800 MHz ... 95 GHz

Maximum load of positioner: 10 kg

Measurement distance: 5 m

Angular resolution: 0.03°



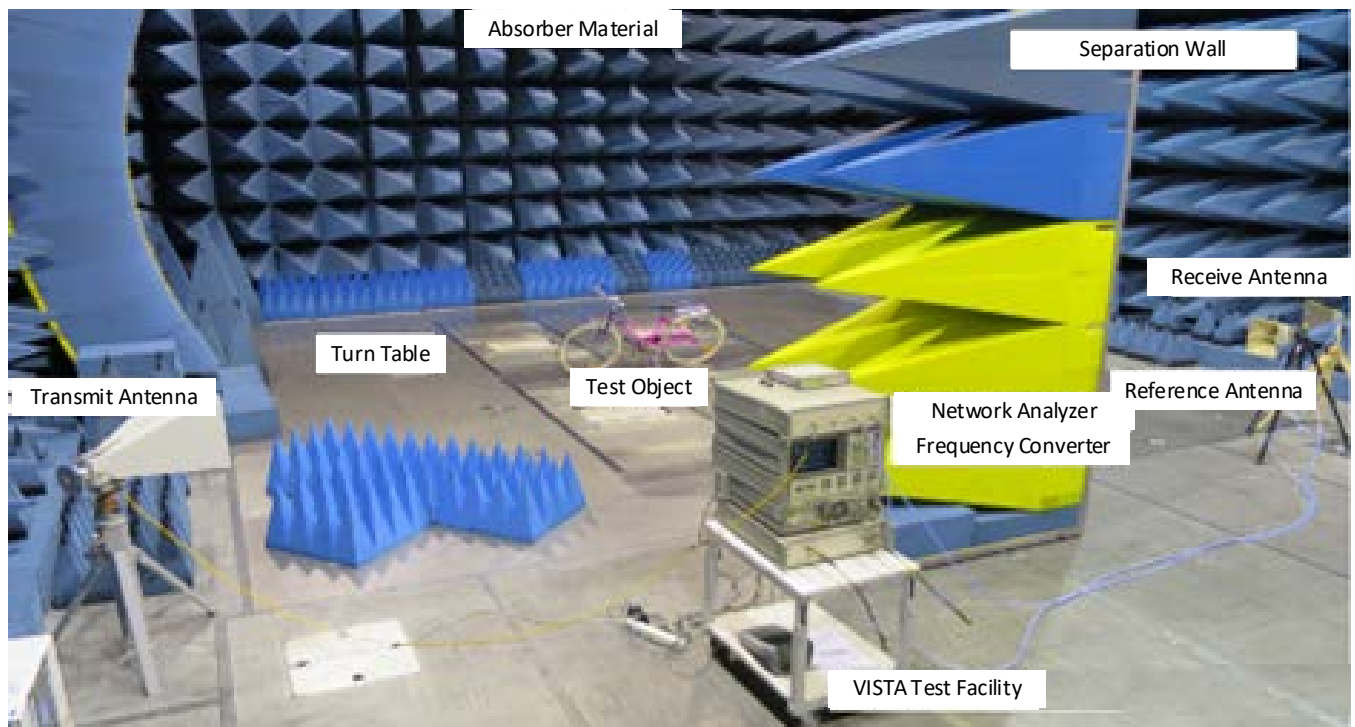
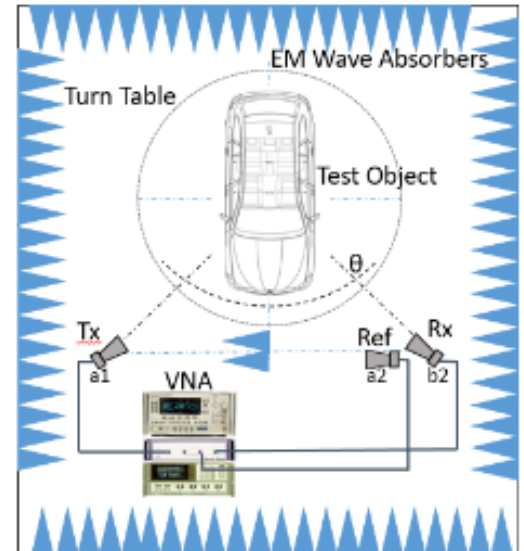
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2. Measurement Systems



Antenna and RCS measurements (RF, microwave & millimetre wave)

- Multiple frequency ranges covering a total range from 800 MHz to 95 GHz
- RCS measurements with fixed bistatic illumination scenarios in one plane (2D)
- Defined illumination of receiver systems with CW signals or a variety of application signals from mobile communications and satellite navigation
- OTA measurements with nearly realistic illumination by wave field synthesis
- Installed-performance measurements of cars on a turntable roller-dynamometer
- 3D bistatic RCS measurements in preparation



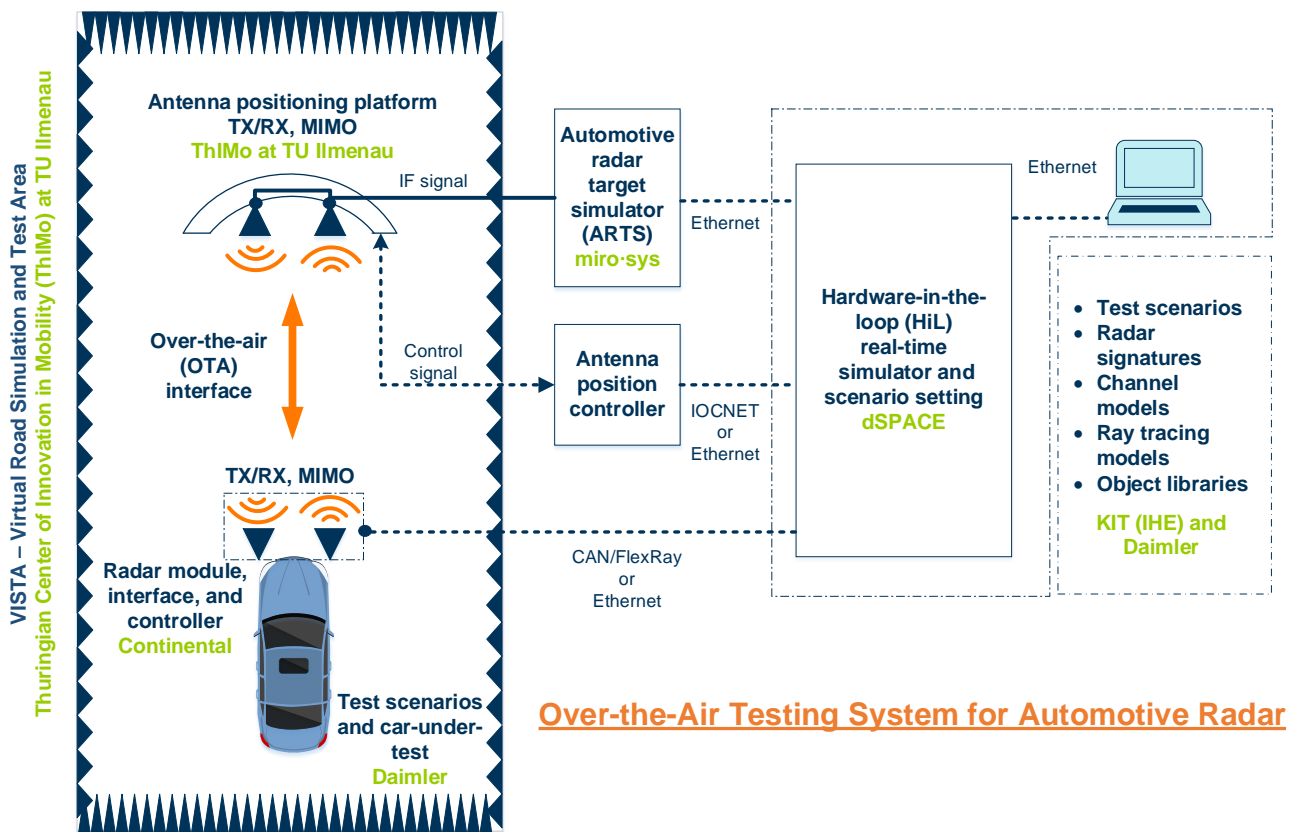
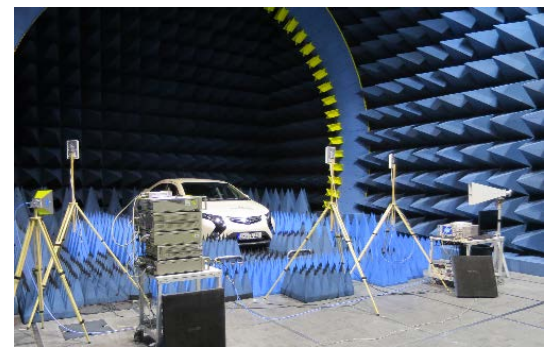
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2. Measurement Systems



Testbed for system evaluation of automotive radar

- Digital radar target simulator
 - Automotive Radar Test System
 - Simulation of Doppler shift and variable RCS
 - Type: ITS-9510CRD ARTS
 - Frequency range: 75...82 GHz
 - Chirp processing bandwidth: 1000 MHz
 - Minimal Distance: 7.5 m
 - Maximal Distance: 700 m
 - Range increments: 5.6 cm
 - No. of transmit modules: 4
- Hardware-in-the-Loop (HiL) test system Scalexio E31275 with ControlDesk, ConfigurationDesk, and AutomationDesk
- Over-the-air tests for automotive radar systems in VISTA
- Spectral analysis up to 110 GHz including analysis of modulation content up to 4 GHz bandwidth



Over-the-Air Testing System for Automotive Radar



Microwave measurements

- Coaxial vector network analysers:
 - Agilent PNA-X N5242, 4-port test set, nonlinear measurement of von X parameters 10 MHz to 26.5 GHz,
 - Agilent PNA E8361A: 10 MHz to 67 GHz, 4 port test set 10 MHz to 50 GHz,
 - Pulse test set 200 MHz to 40 GHz;
 - Anritsu MS4630B (10 Hz to 300 MHz)
- Maury-tuner based noise parameter measurement system 1 GHz to 26.5 GHz
- Spectrum analysers
 - 50 GHz (Agilent PSA E4448A),
 - 26 GHz (Rohde & Schwarz FSEM),
 - 32 GHz (Anritsu MS2802A)
- Wafer prober measurements:
 - Suess PM4,
 - Cascade Summit 9000,
 - Evacuated wafer prober Suess MicroTec PMV150 with thermochuck (-40 to 150°C)
- Time domain reflectometer (Tektronix CSA 8000)
- Transient analyser (HP 70820A)
- 1-GHz 2-channel real time oscilloscope (Agilent DSO6102A),
- 11-GHz 4-channel real time oscilloscope (LeCroy SDA 11000),
- 70 GHz sampling oscilloscope (LeCroy SDA 100G)
- Signal source analyser 26.5 GHz (Rohde & Schwarz FSUP)
- Signal sources (e.g. Rohde & Schwarz SMP4 to 40 GHz, SMIQ06B to 6 GHz)
- Optical profilometer "Alicon infinite focus" (resolution: vertically 20 nm, horizontally 600 nm)
- Printed board prototyping with LPKF ProtoMat S103
- Nearfield scanner EMSCAN RFxpert RFX2-62 for quick measurement of the radiation characteristics of planar structures from 300 MHz to 6 GHz
- Compute server Windows und Linux based, available at computing centre of TU Ilmenau
- Simulation tools for CAD of RF circuits: MicroSim (Pspice), Serenade
- Simulation tools for 2D/3D microwave numerical field computations:
 - Keysight ADS, Ensemble (MoM), IE3D (MoM), Ansoft HFSS (FEM), CST Microwave Studio (FDTD) including state of the art desktop computers
- Data processing: MatLab with SimuLink tool boxes (The Mathworks)



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2. Measurement Systems



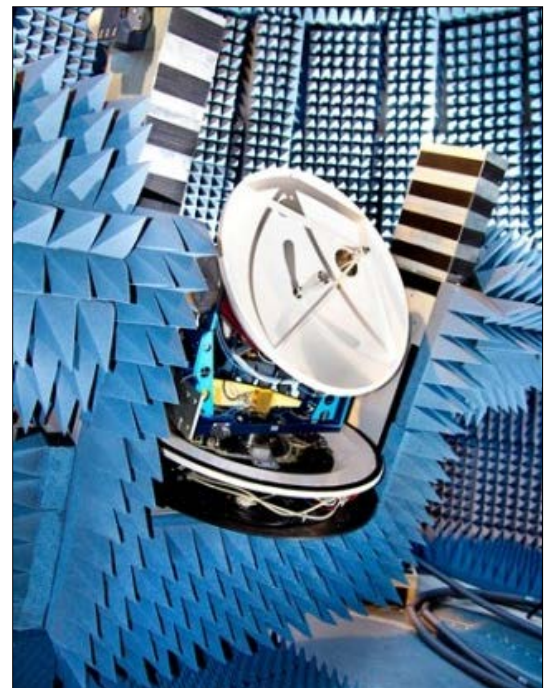
FORTE (Facility for over-the-air research and testing) by Fraunhofer IIS



- Far field test bed for satellite communication with mechanical movement and channel emulators
- Over-the-air test bed for mobile communication
- Wave field synthesis for electrically small test objects for terrestrial and satellite based radio communication

Detailed information:

<https://www.iis.fraunhofer.de/en/profil/standorte/forte.html>



Wireless and Information Technologies

2. Measurement Systems



FORTE (Facility for Over-the-Air Research and Testing) at Fraunhofer IIS



Test facility hosting the two research platforms
“SatCom” and “MIMO-OTA”

“Satcom”

- Testing of SatCom on the move (SOTM) transceivers for:
 - European Space Agency (ESA) type approvals
 - Global VSAT Forum type approvals
 - Eutelsat type approvals
 - Industrial projects
- Components
 - Motion Emulator, Inclination: $\pm 45^\circ$
Speed: $300^\circ/s$ Acceleration: $1000^\circ/s^2$
 - 50 m antenna tower to mount satellites for elevations of 16° or 24°

“MIMO-OTA”

- Testing of MIMO transceivers up to 6 GHz targeting:
 - Mobile broadband (incl. LTE Testbed, 5G)
 - GNSS
 - Industrial communications
 - V2V und V2I
- Approaches
 - Wavefield synthesis for smaller test objects
 - Wireless cable for bigger test objects (e.g. vehicles)
- Technical parameters
 - Frequency range: 70 MHz – 6 GHz
 - Bandwidth : 80 MHz
 - RF Output: +10 dBm
 - Connectivity: 12 Inputs x 32 Outputs =384 Channels

Further information

<https://www.iis.fraunhofer.de/en/profil/standorte/forte.html>

