

# Millimetre Wave Laboratory of Finland – MilliLab

The Millimetre Wave Laboratory of Finland -, MilliLab provides unique services to the space industry and other businesses requiring expertise in the millimetre and submillimetre range at 30 to 2000 GHz. The laboratory was established in 1995 by VTT, Technical Research Centre of Finland and TKK, Helsinki University of Technology. MilliLab is also an ESA External Laboratory on Millimetre Wave Technology. MilliLab has an extensive range of circuit, component and antenna testing facilities.



## Focus areas:

### On-wafer noise parameters

MilliLab has state-of-the-art on-wafer noise parameter measurement setups for 50-100 GHz range. The wideband measurement data can be used to transistor or amplifier characterisation purposes. New noise models can be developed or existing models can be verified with the data. Accurate noise characterisation is a major factor for a successful low noise amplifier desing process.

### Hologram based compact antenna test range

MilliLab develops antenna and radar cross section measurements using hologram based compact antenna test range (CATR). The hologram is a binary interference pattern of the incoming spherical wavefront and the desired plane wave. MilliLab provides services for testing large mm-wave antennas, e.g. for space applications, in the customer premises since the hologram CATR is portable and can be custom designed.

### Power measurements

MilliLab maintains a primary power standard for frequency range of 110-170 GHz (D-band). The standard can be used to calibrate power correction factor of waveguide (WR-6) input power sensors. The power unit is maintained by three isothermal calorimeters. The precision of the power calibration is within 2 % with 95 % confidence level.

## OTHER MEASUREMENT FACILITIES

### On-wafer

- On-wafer S-parameter measurements up to 220 GHz
- On-wafer noise figure & gain measurements up to 110 GHz
- Semiconductor device parameter measurements
- On-wafer spectrum analysis up to 110 GHz
- On-wafer power measurements up to 110 GHz
- MEMS component testing
  - Reliability tests
  - In high vacuum and gas environment tests
  - Capacitance measurements

### Off-wafer (rectangular waveguide)

- S-parameters up to 700 GHz
- Noise figure up to 200 GHz
- Spectrum analysis up to 325 GHz
- Power measurements up to 1000 GHz

### Antenna measurements

- Anechoic chambers up to 200 GHz
- Near field scanning up to 300 GHz
- Feed horns and reflectors up to 700 GHz
  - Outdoor measurement range

### Material parameter measurements

- Free space transmission and reflection measurement system 5-110 GHz
- Open resonator measurement system for low-loss materials 100-500 GHz
- Frequency domain THz photomixer spectrometer, transmission (single sweeps) 0.2 – 2 THz

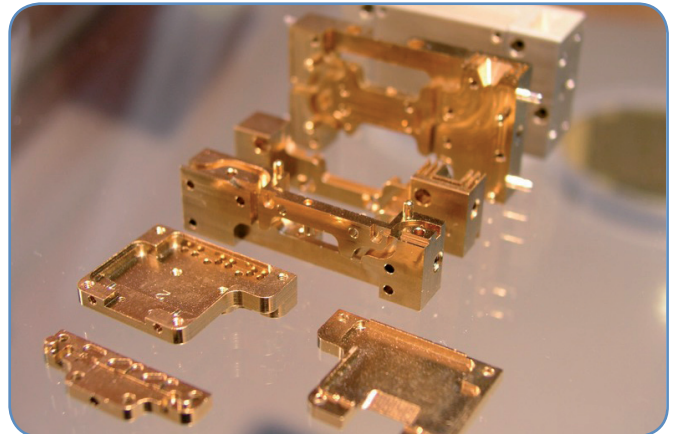
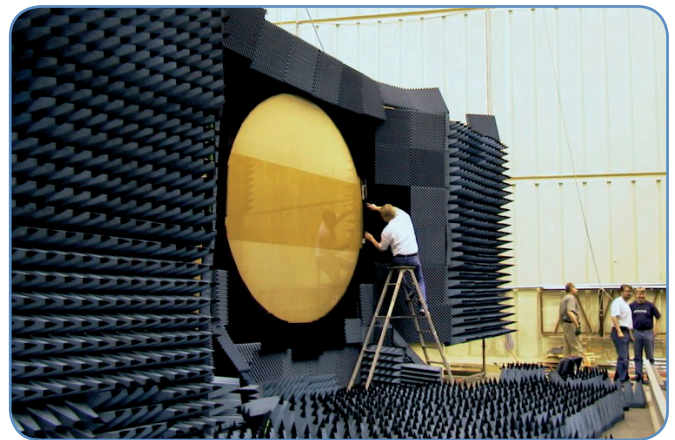
MilliLab provides services at millimetre wave frequencies in the fields of device modelling, device characterisation, millimetre wave measurement and testing as well as in research and development. In addition to measurement and test facilities, MilliLab has expertise on millimetre wave systems, components and circuits. Most recent activities in this area have been on:

- Millimetre wave MMIC designs for various applications
- Millimetre wave MEMS power sensors and impedance tuners
- Passive THz and millimetre wave imaging
- Low-loss dielectric waveguides
- Passive components for millimetre and sub-millimetre wave receivers

## MilliLab

### Cryogenic on-wafer measurements

MilliLab has an on-wafer cryogenic test chamber coolable down to 20 K. The facility is aided by a wide range of test equipment allowing convenient functional testing under cryogenic conditions. The main focus is on on-wafer S-parameter and noise figure measurements of small-size millimetre wave devices such as mixers, multipliers and amplifiers. However, the test setup can be adapted for small module testing as well.



### Additional information

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