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A Compact 300-GHz Receiver for Wireless Communications of Tens of Gigabits per Second

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Compact 300-GHz Receiver

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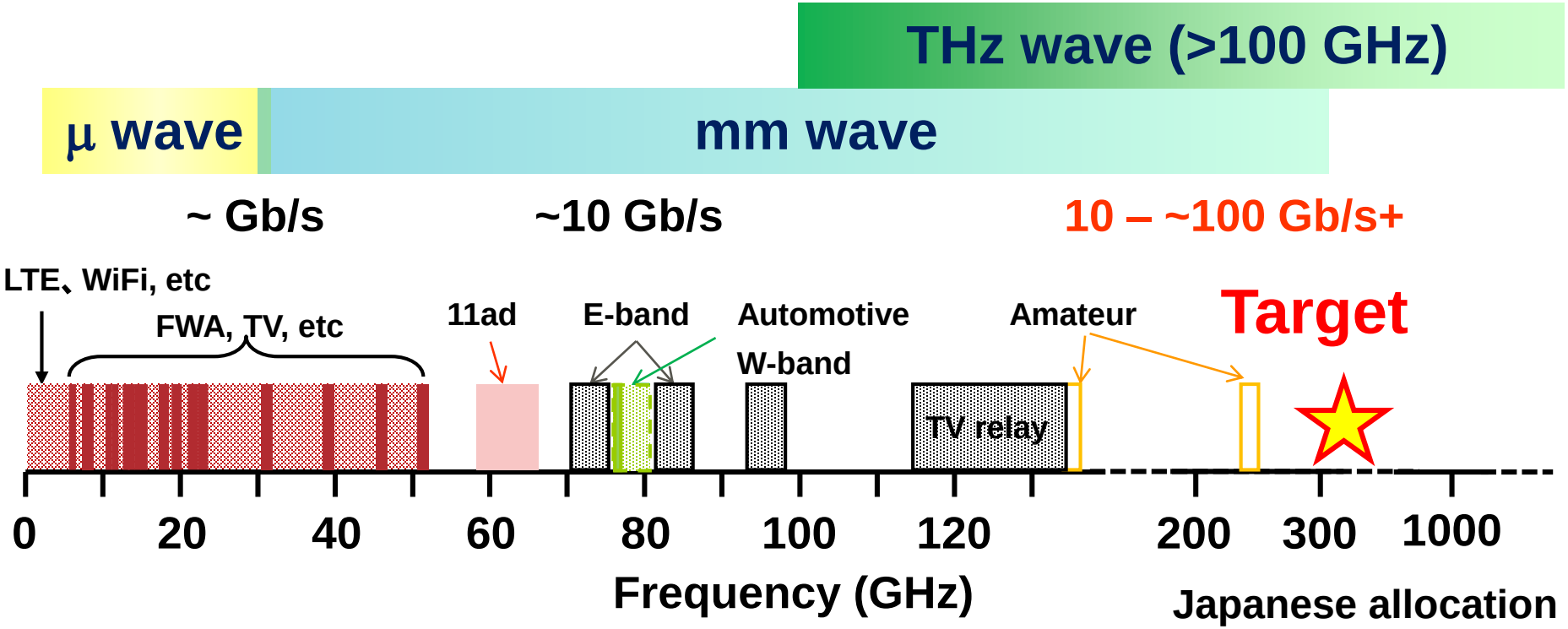
- Background
- Issues and developed technologies:
  - Devices (InP HEMTs)
  - ICs (low-noise amplifier, detector, IF amplifier)
  - Packaging
- Demonstration
- Summary

THz Wave

- Not allocated above 275 GHz
- 10-100 GHz bandwidth (BW) usable
- 100 Gb/s+ possible with simple modem
- Large atmospheric attenuation

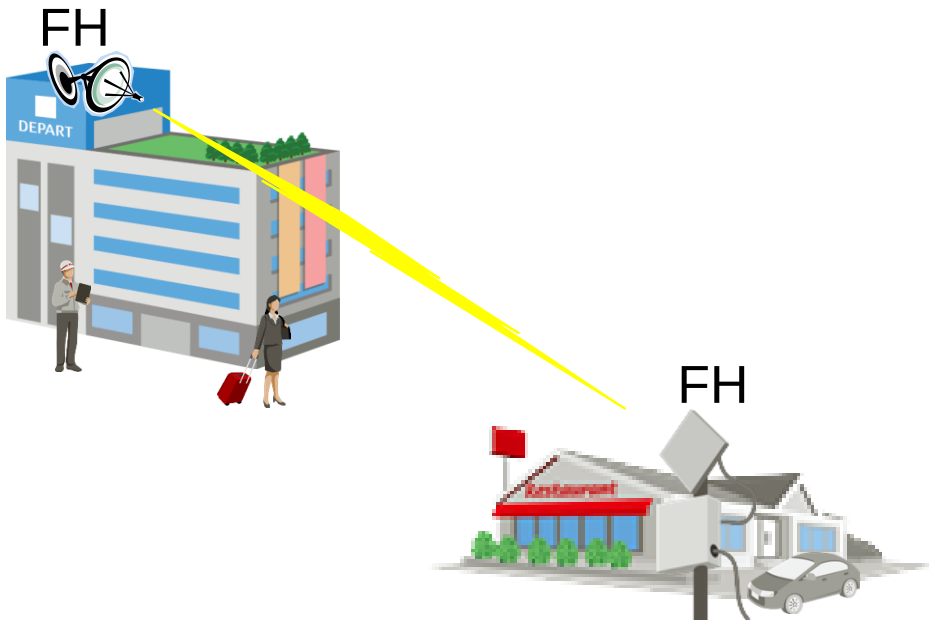


THz Use Cases

- Short-range service
  - Data downloader
  - Data exchanger
  - Data center

Data downloader

- Fixed wireless service



Front haul (FH) for cellular

Receiver Challenges for THz Downloader

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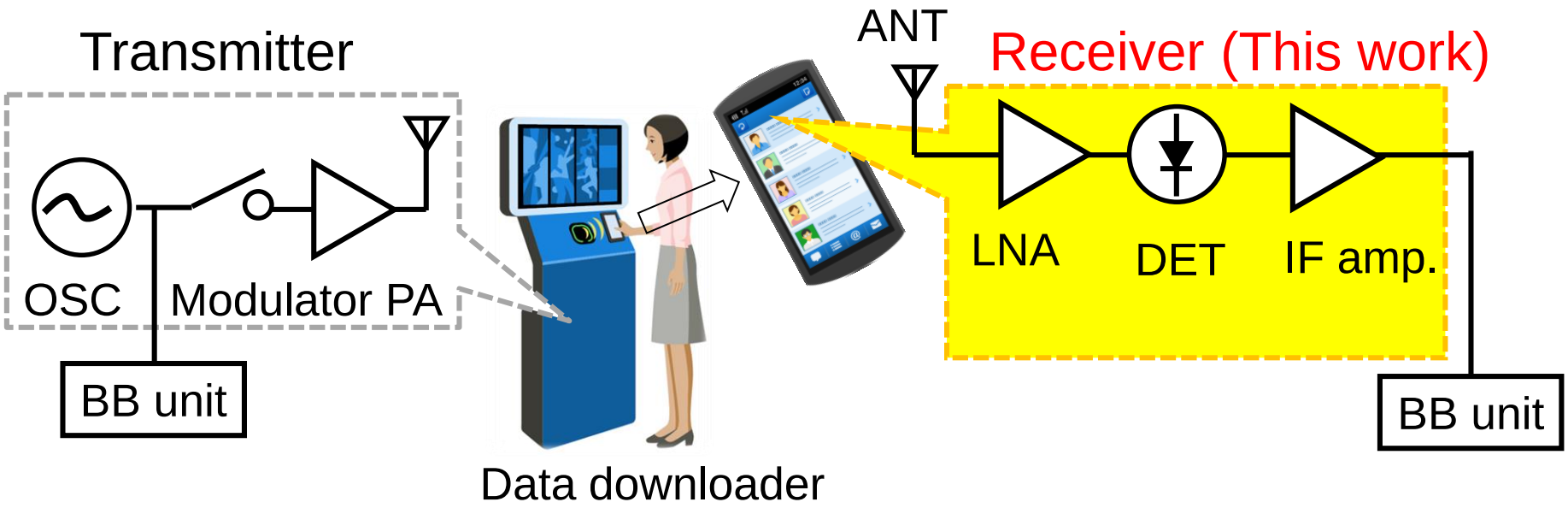
- Compact module with small antenna
  - High-f_{max} device
  - Low-noise amplifier (LNA)
  - Wide-band detector (DET)
  - Low-loss compact packaging



Low-noise THz Device Technology

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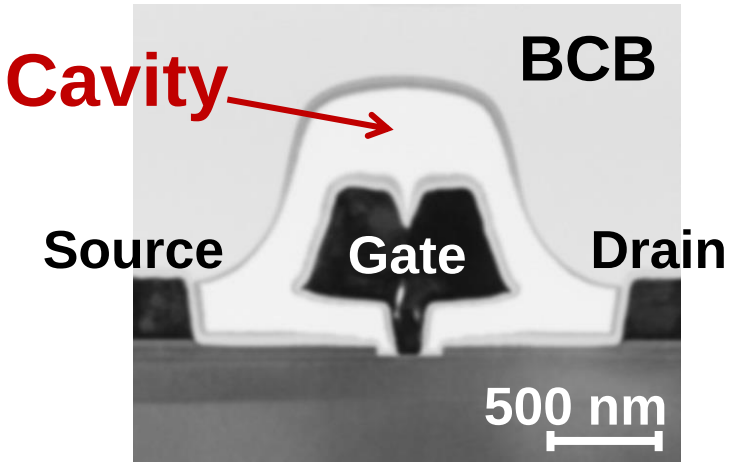
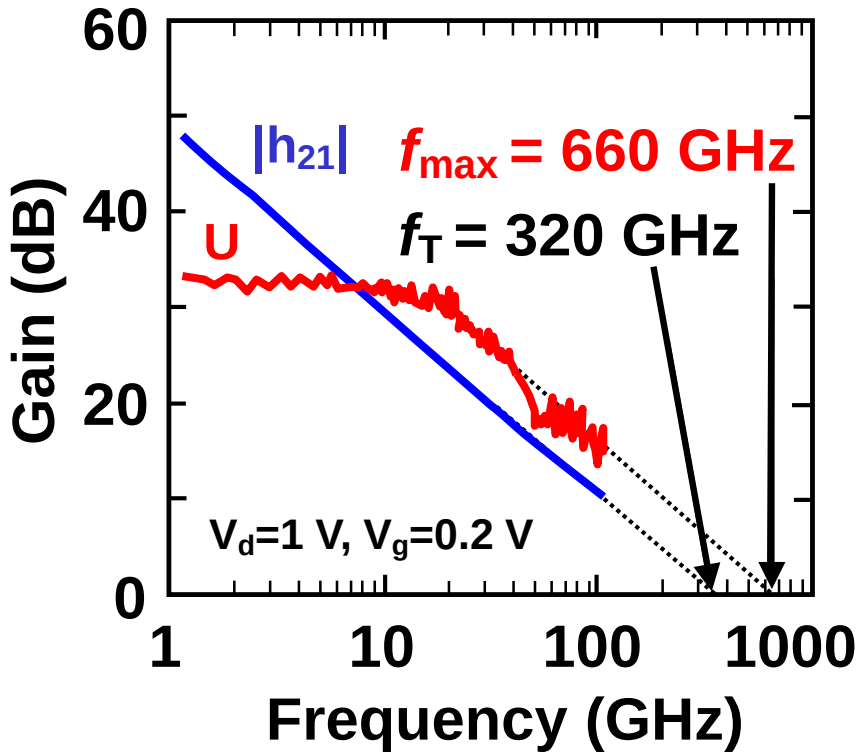
- 75-nm InP HEMT
  - Cavity structure
  - f_T / f_{max}: 320 GHz / 660 GHz
  - NF_{min} : 0.71 dB @94 GHz, 300K

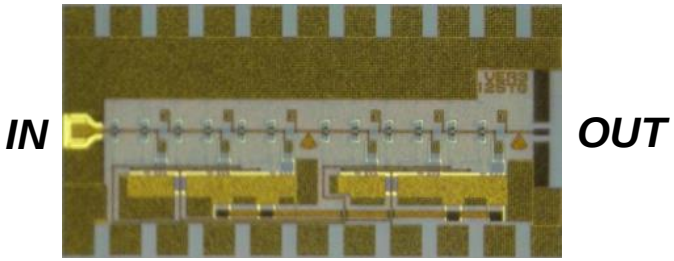


T. Takahashi *et al*., IEEE ED 2012

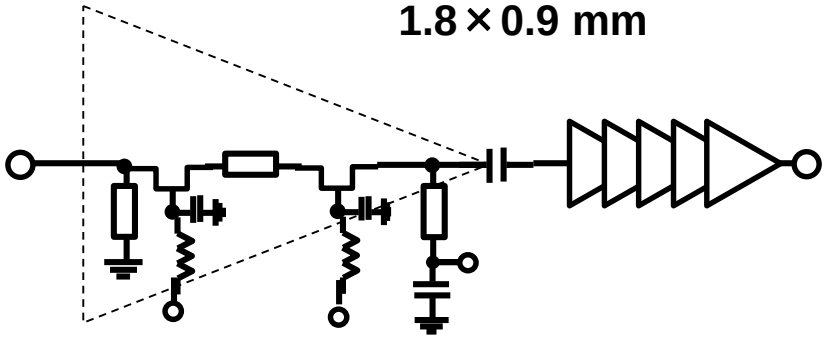


InP-HEMT Low-noise Amplifier (LNA)

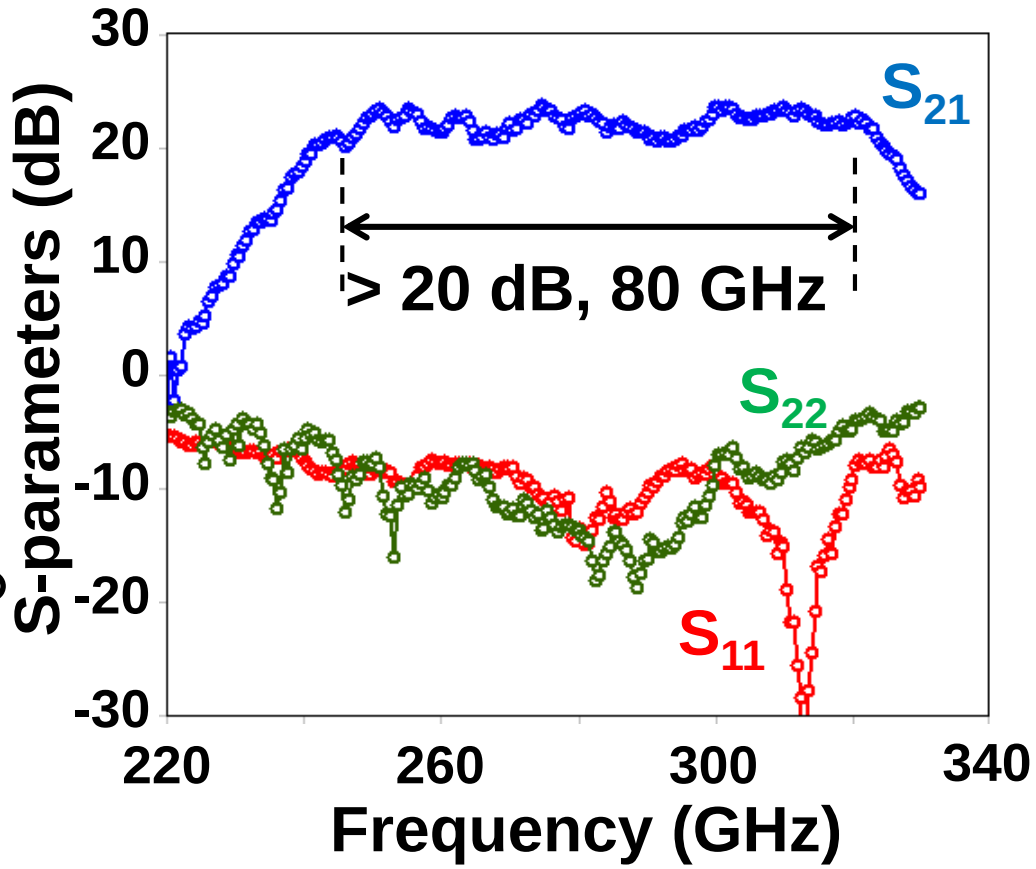
- Common-gate architecture for high gain and wide BW
- NF: 9.8 dB @300 GHz



1.8 × 0.9 mm

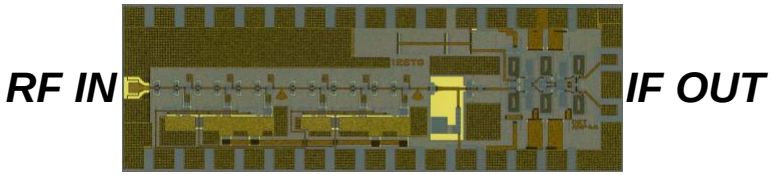


6-stage common-gate LNA

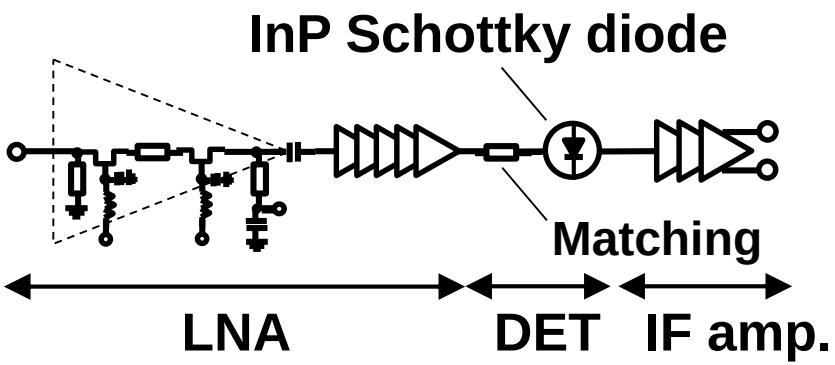


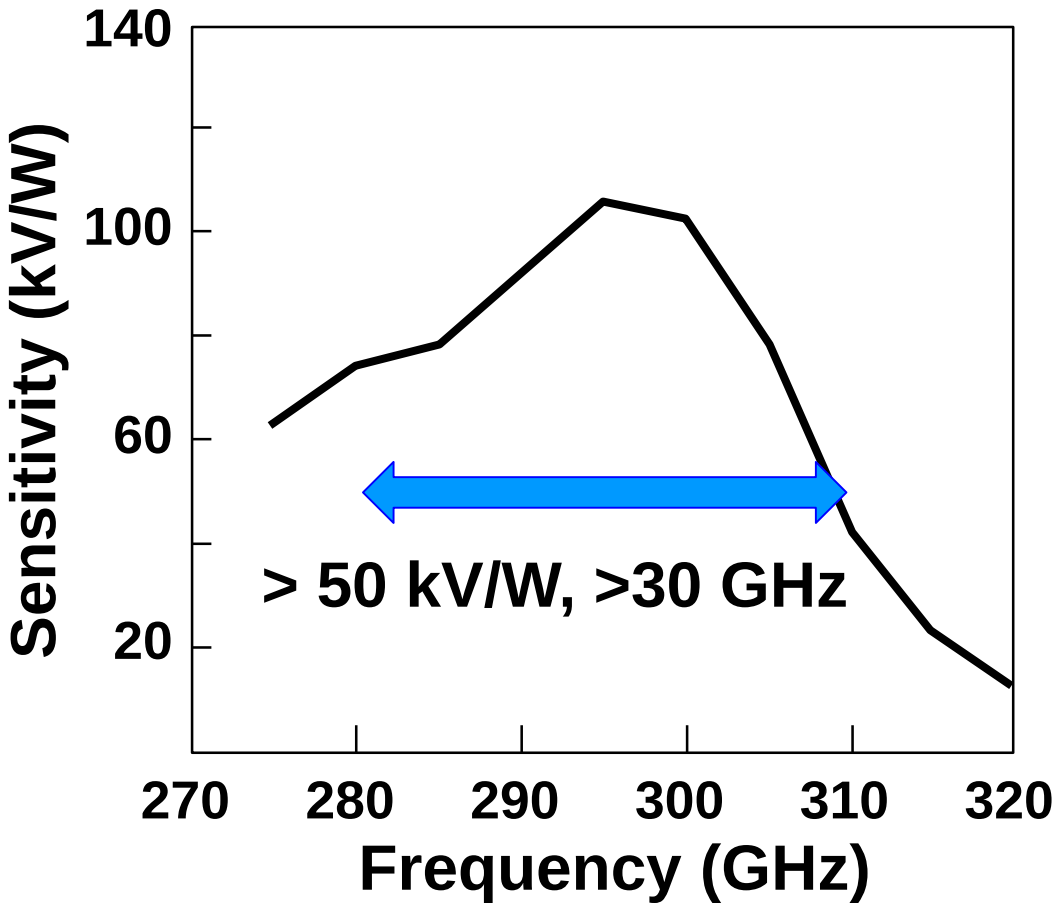
Wide-band Detector

- InP HEMT Schottky diode
- Wide-band differential IF amplifier
- All Integrated on 1 chip
- P_{diss}: 115 mW



2.5 × 0.8 mm

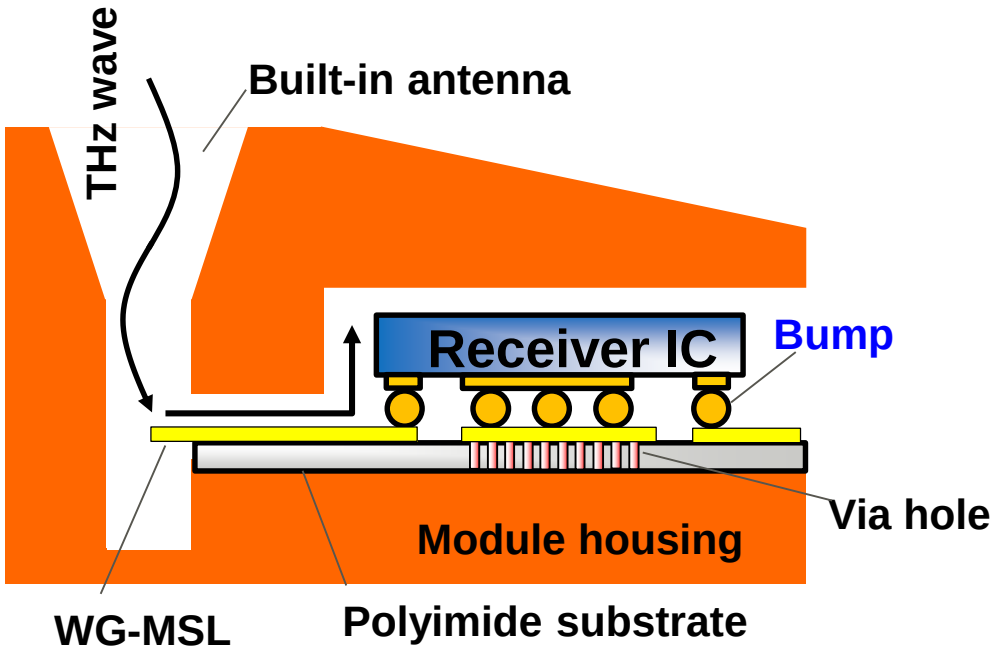




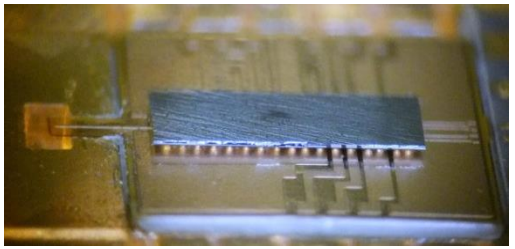
Integrated receiver IC

Low-loss Compact Packaging

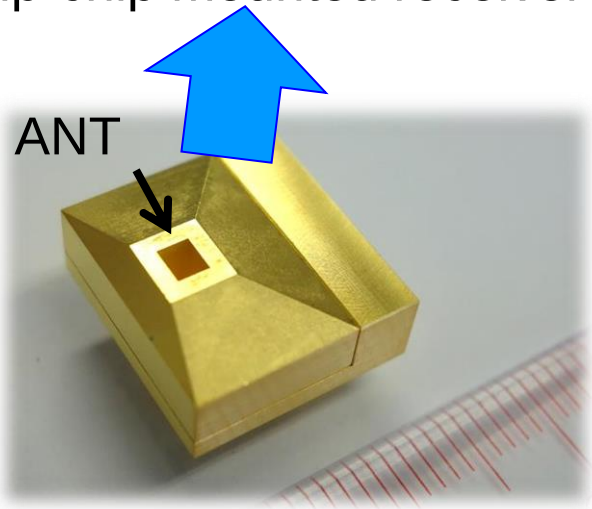
- Expanded flip-chip mounting to THz-band for the first time
  - Employing low-loss polyimide substrate
- Compact built-in horn antenna: 16 dBi
- Cubic capacity: 0.75 cm^3



Y. Kawano *et al.*, EuMC 2015



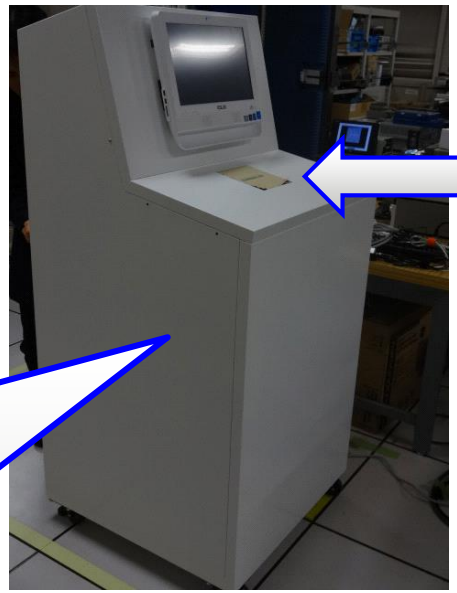
Flip-chip mounted receiver IC

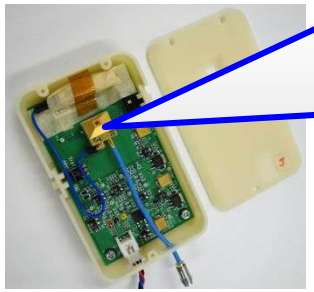


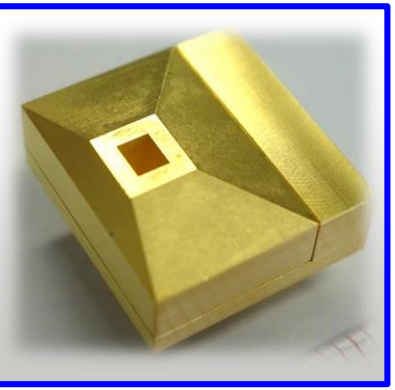
Receiver module

Downloader Demo

- Collaboration with NTT, NICT, and FUJITSU
- Physical rate: 20 Gb/s, effective rate: 16 Gb/s



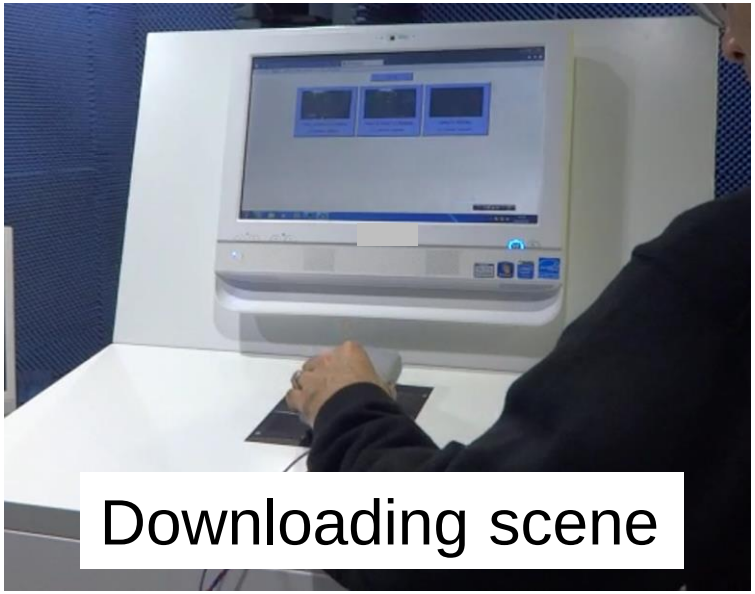




Hand-held receiver

Downloader server

Transmitter



Downloading scene

H. Song, H. Hamada *et al*., IEEE IMS 2016

Summary

FUJITSU

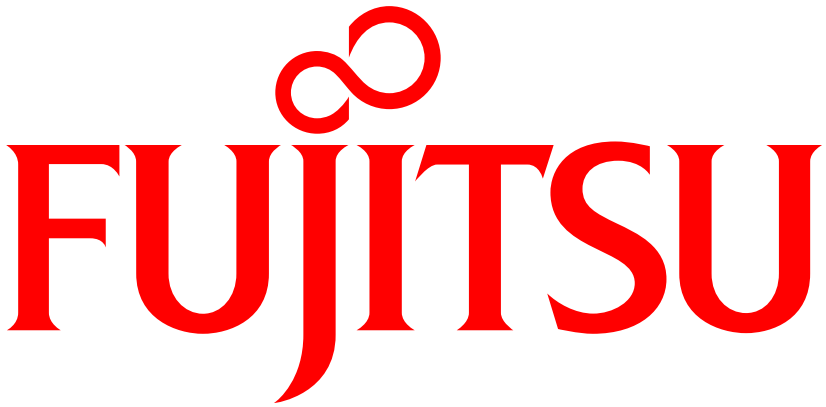
Compact THz receiver for 20-Gb/s data transmission

- 75-nm InP HEMT f_{max}: 660 GHz
- 1-chip receiver IC
- Low-loss flip-chip mounting technique
- Cubic volume: 0.75 cm^3

Instantaneous downloader demo

- 300 GHz, 20 Gb/s
- Only 2 sec. for 1-DVD data (4GB)

This work was jointly established by NTT, NICT, and FUJITSU, and was supported in part by the research and development of the Ministry of Internal Affairs and Communication, Japan



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