Silicon-Based THz Spectroscopy based on a Fully-Integrated Picosecond Impulse Radiator

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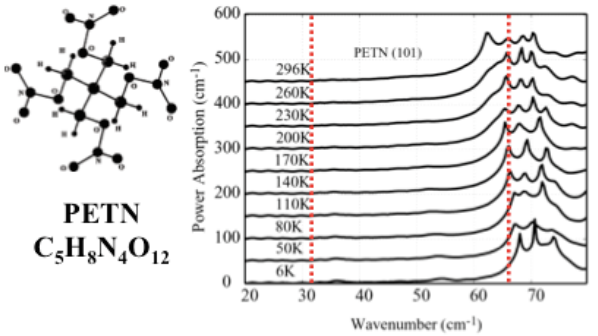
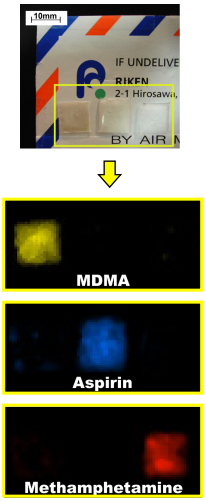
THz Chemical Detection:

- Vibrational spectroscopy
- Detection of narcotics, pharmaceuticals, explosive related chemicals
- PETN, RDX, RDX, 2,4-DNT
- Gas spectroscopy (e.g. H2S)

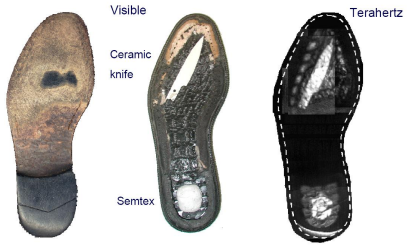


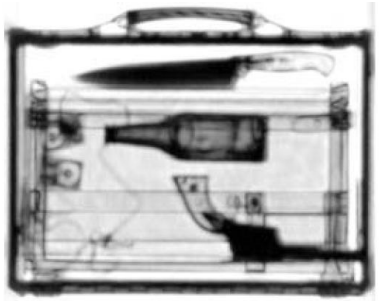
"white powder" in an envelope



THz Security Imaging:

- A powerful new imaging modality
- Complementary to X-ray imaging
- Spectroscopic identification of materials

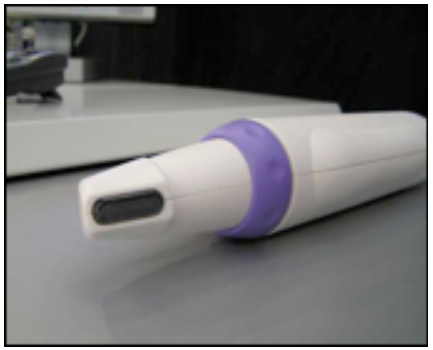




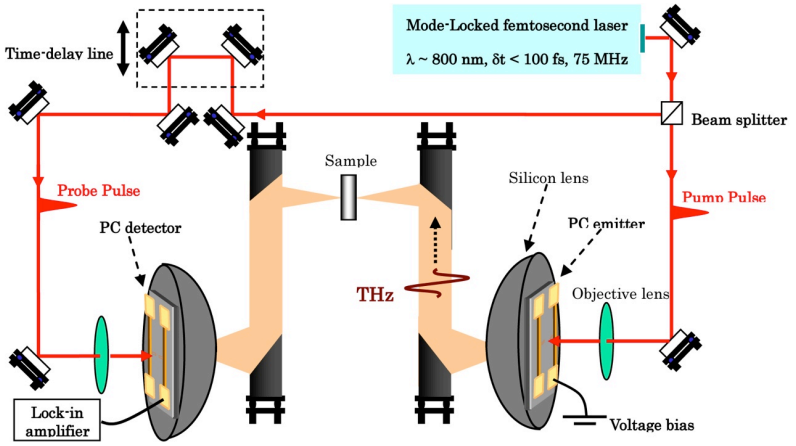
Conventional THz Spectrometers

Teraview's $300K solution

Teraview' s THz-TDS system cost: $300K [1]



THz probe [1]



- **Terahertz source:** Laser gated photo-conductive semiconductor emitter
- **Terahertz detector:** Laser gated photo-conductive semiconductor receiver
- **Laser Ti:** Sapphire ultrashort pulsed laser
- **Spectral range:** 60GHz – 3THz

Too Bulky (few m^3)

Too Heavy (~200kg)

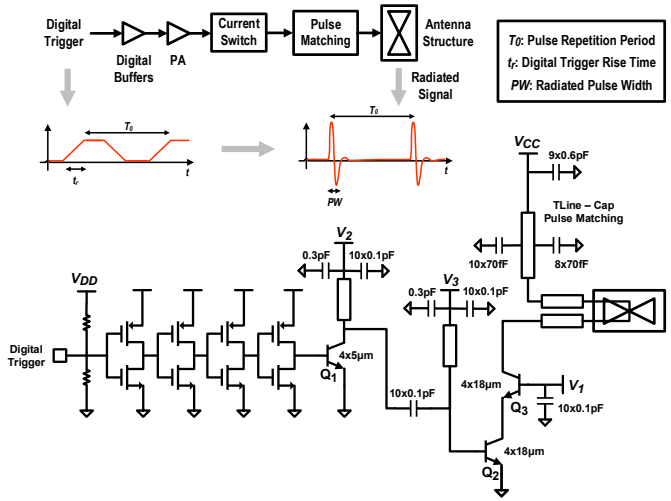
Too Expensive (~$300K)

Low Average Power (μW)

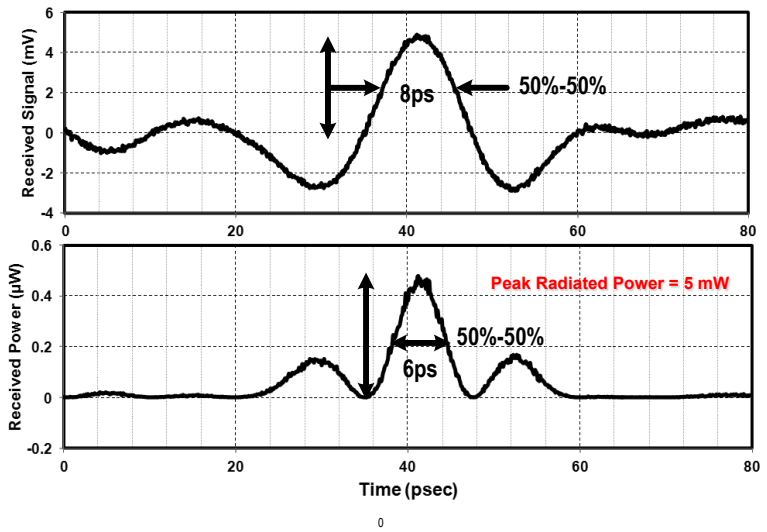
Too Slow (~1 hour)

Rice University's Sub-8psec Impulse Radiator

Direct Digital-to-Impulse Radiator

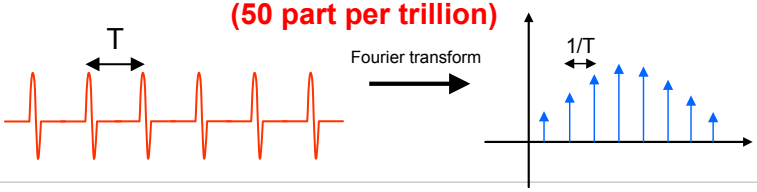


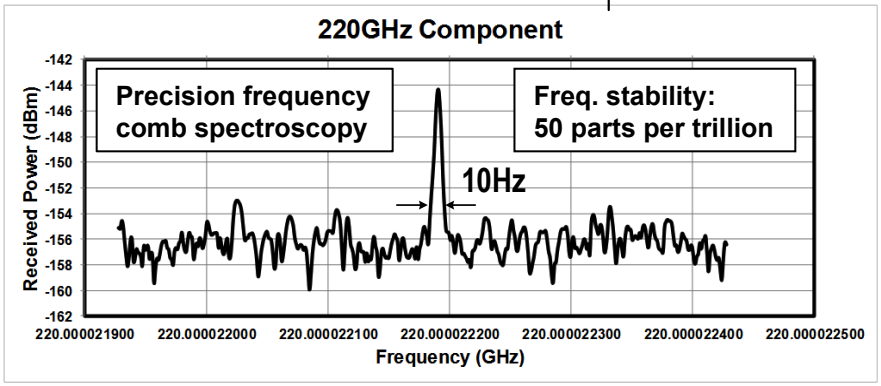
Shortest Pulse Ever Radiated from a Silicon Chip



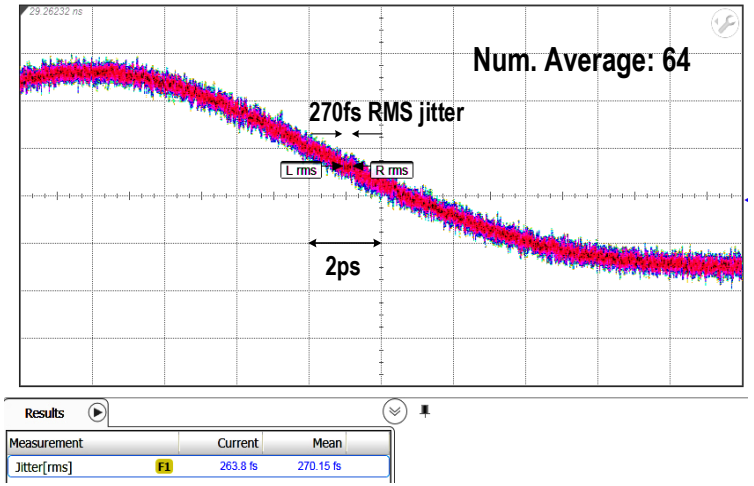
Precision Frequency-Comb Spectroscopy

(50 part per trillion)



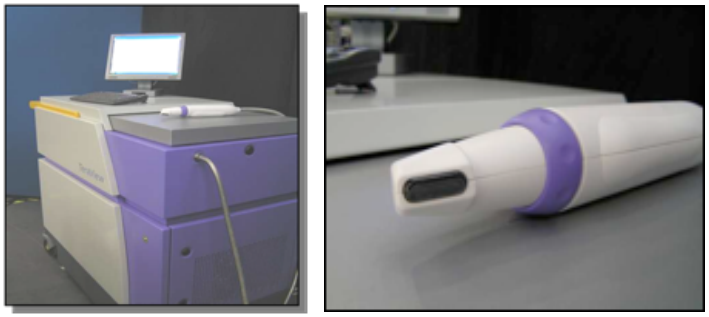


Record Timing Jitter

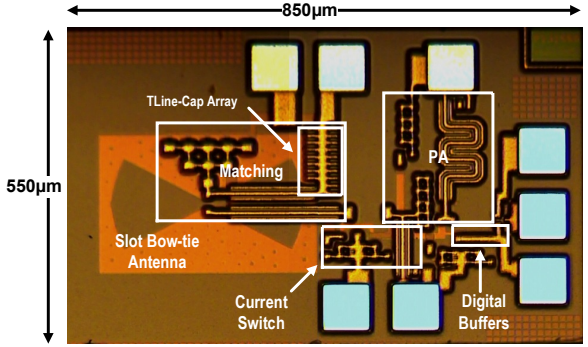


Comparison with Conventional THz Systems

Teraview's THz-TD Spectrometer



Rice University's p-sec Impulse Radiator



Cost: $300K	**300,000X**	Cost: $1
Weight: 200kg	**20,000X**	Weight: 0.01kg
Largest dimension: 2m	**2,000X**	Largest dimension: 1mm
Average radiated power: μW	**1,000X**	Average radiated power: mW

Pulse Width: 1psec ← ***Major Remaining Challenge*** → Pulse Width: 8psec

Main Objectives of the Proposed Project

- Reduce the duration of the radiated impulses to 1psec to enable high-precision THz spectroscopy
- Fabricate an improved transmitter chip to produce short pulses
- Fabricate a receiver (detector) microchip to detect THz pulses
- Build a portable prototype for standoff detection of trace chemical residues
- Push the scan rate to below 100msec