

Electronically Tunable Terahertz Detector Using Plasmons

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In Partnership with:



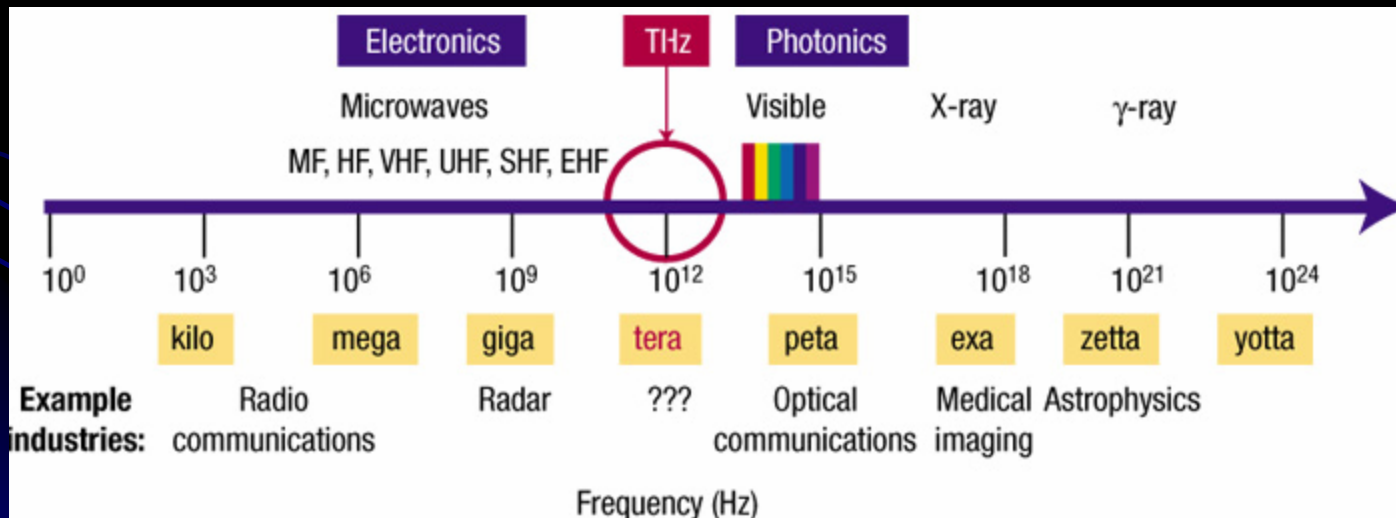
Why the need for THz research?

Technology Gap:

Gap between Electronics and Photonics.

Electronics fail to produce adequate power above several hundred GHz

Photonics fail to produce adequate power below several THz



*THz = Terahertz = 1 Trillion Cycles per second

THz Applications

Current technology operates at ~1-10GHz or ~1-10 billion bits per second

Terahertz frequencies operate at ~1-10 THz or ~1-10 trillion bits per second

Millimeter-wave radar images taken 9 km from a nuclear power plant can detect when the plant is operating (upper image) or idling (lower image).

<http://www.thznetwork.org>

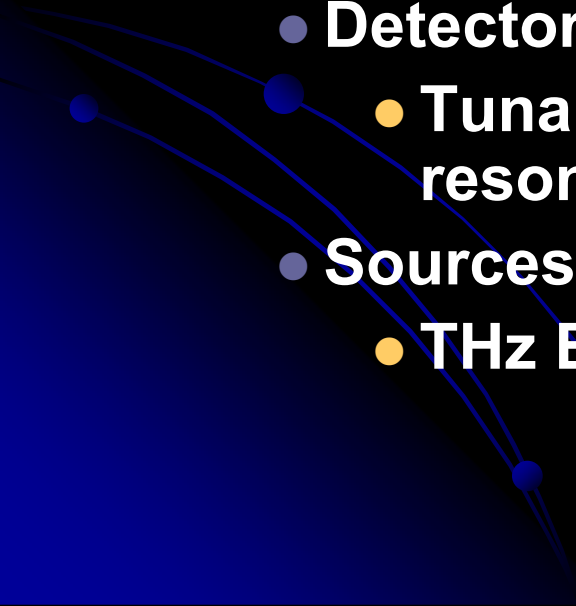
- **Technology applications**
 - **Information**
 - Ultra fast signal processing
 - Massive data transmission
 - **Environment**
 - Atmospheric sensing
 - **Defense**
 - Chemical/Biological agent detection
 - Digital radar
 - Imaging
 - Covert communication
 - Space-space
 - Short range battle field
 - **Unknown applications created by new technology**

Final Goals

- **Goals:**

- **Research and develop terahertz electronics (300 GHz – 10 THz)**

- **Objectives:**

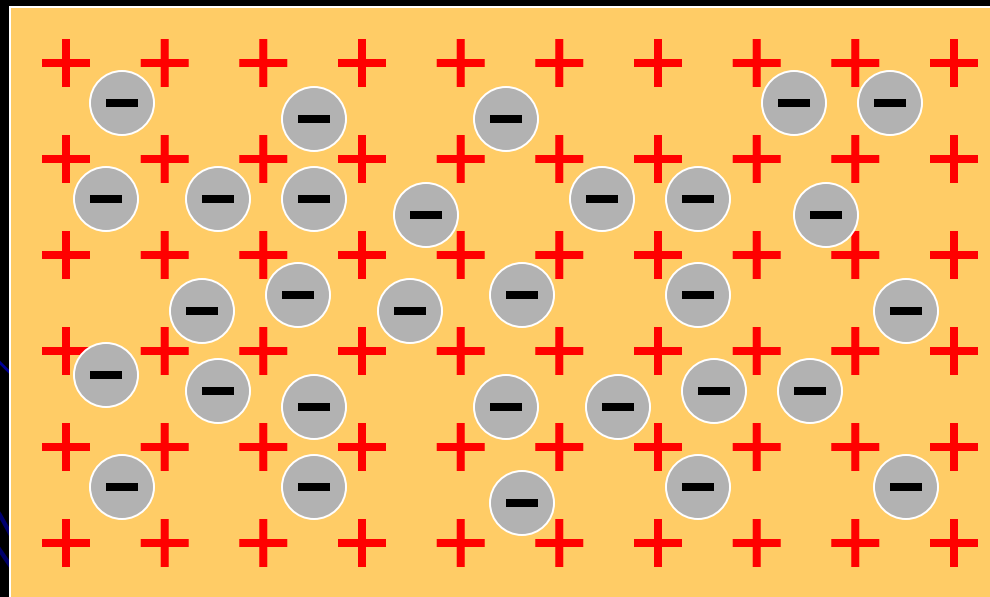
- **Nanoelectronics for THz sources and detectors.**
 - **Detectors**
 - **Tunable detectors for THz using plasmonic resonance**
 - **Sources**
 - **THz Bloch oscillator.**
- 

Resonant Frequency

Plasmon frequency dependence

$$f_p^2 \propto n$$

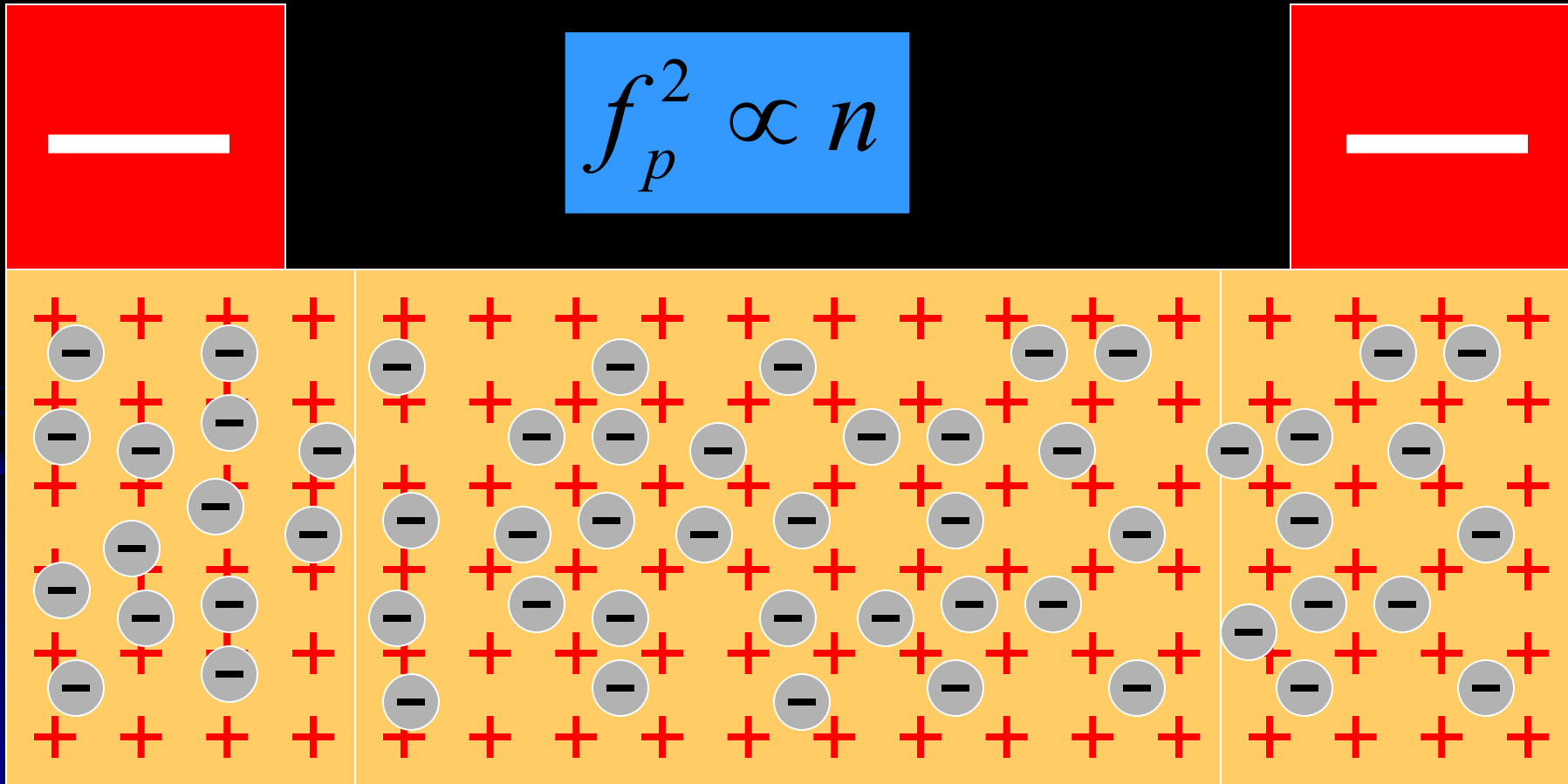
Electron
Density



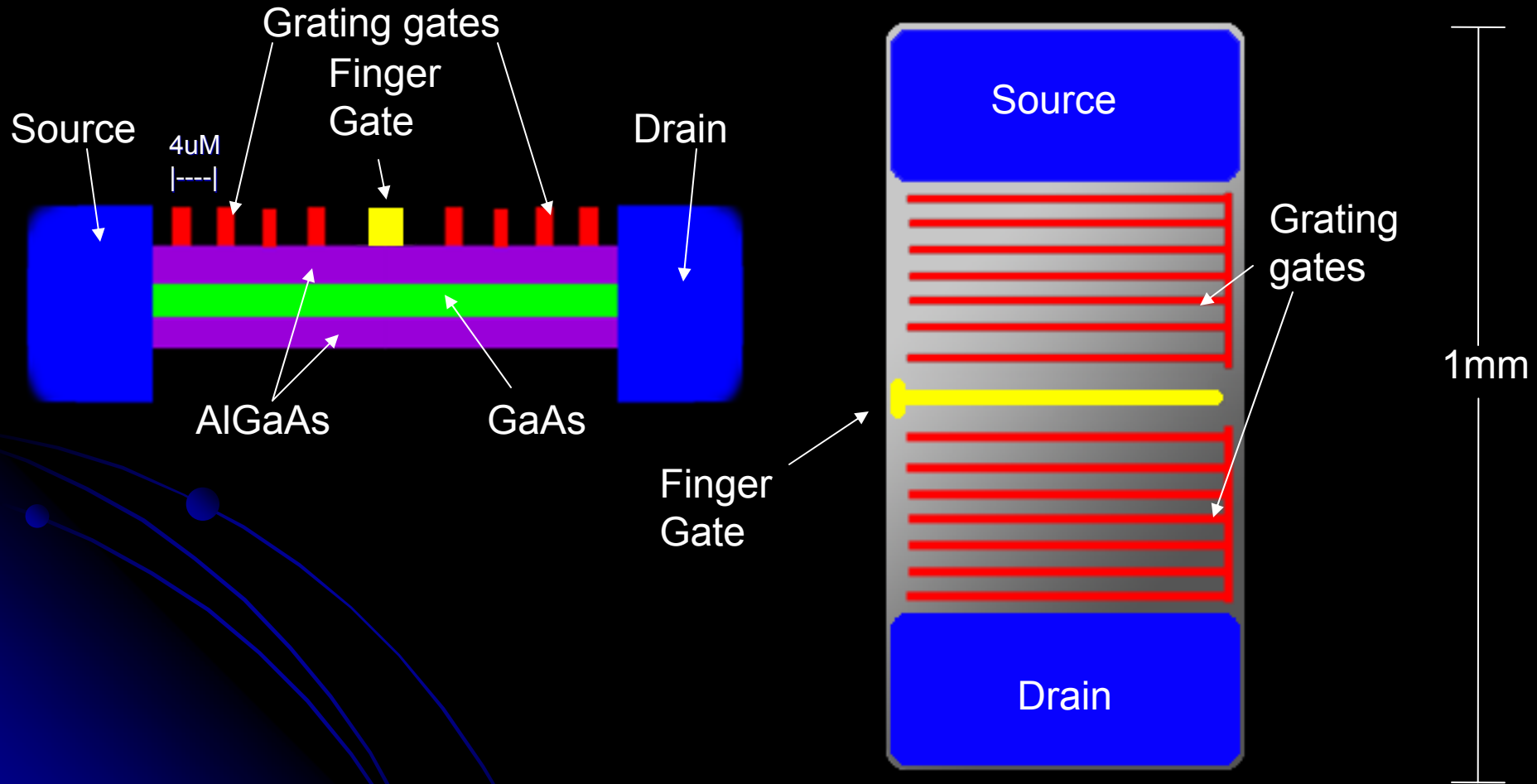
Resonant Frequency

Plasmon frequency dependence

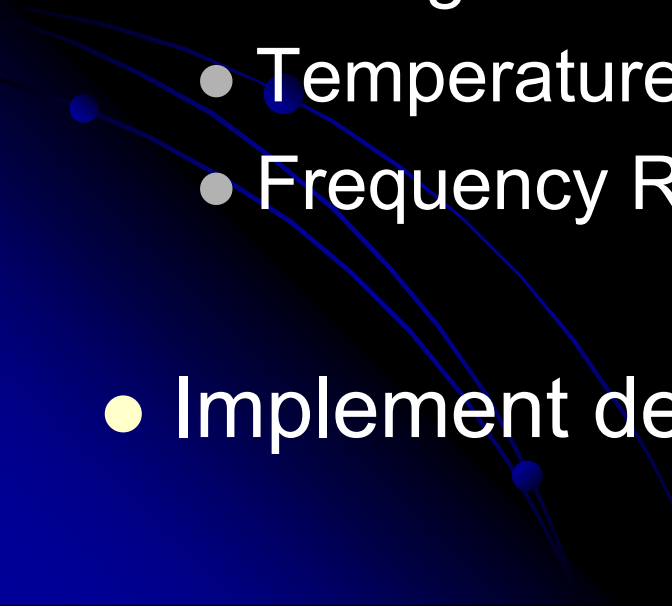
$$f_p^2 \propto n$$



The Split-Grating Gate Detector



Future Work

- Continue to chart device's behavior
 - Determine optimized settings:
 - Source/Drain Current
 - Wiring
 - Temperature
 - Frequency Range
 - Implement device into applications
- 

Acknowledgments

- Sandia National Labs:

- Dr. Eric Shaner
- Dr. Mark Lee
- Dr. Mike Wanke
- Dr. John Reno

- INSET:

- Samantha Freeman
- Dr. Nick Arnold
- Liu-Yen Kramer
- Luke Bawazer
- Dr. Evelyn Hu

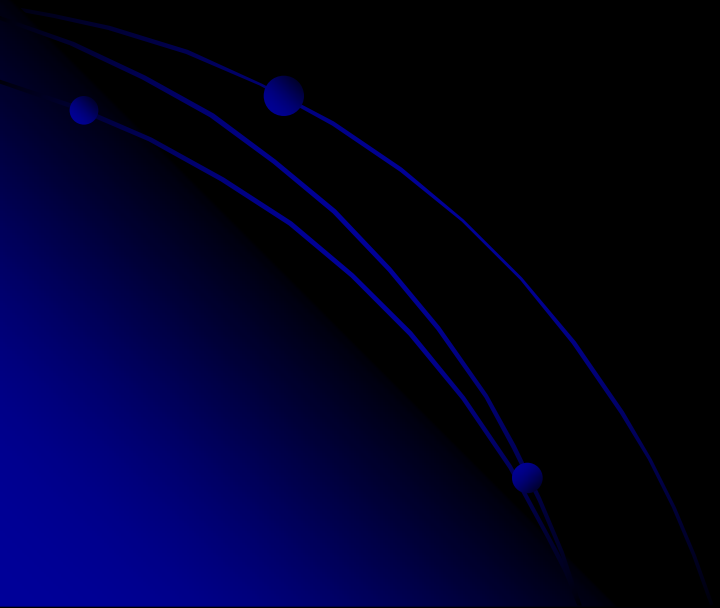
- The Allen Group:

- Dr. Jim Allen
- Greg Dyer
- Dr. Thomas Feil
- Dr. Alex Kozhanov
- Sean Haney
- Bill Sowerwine

- CUNY:

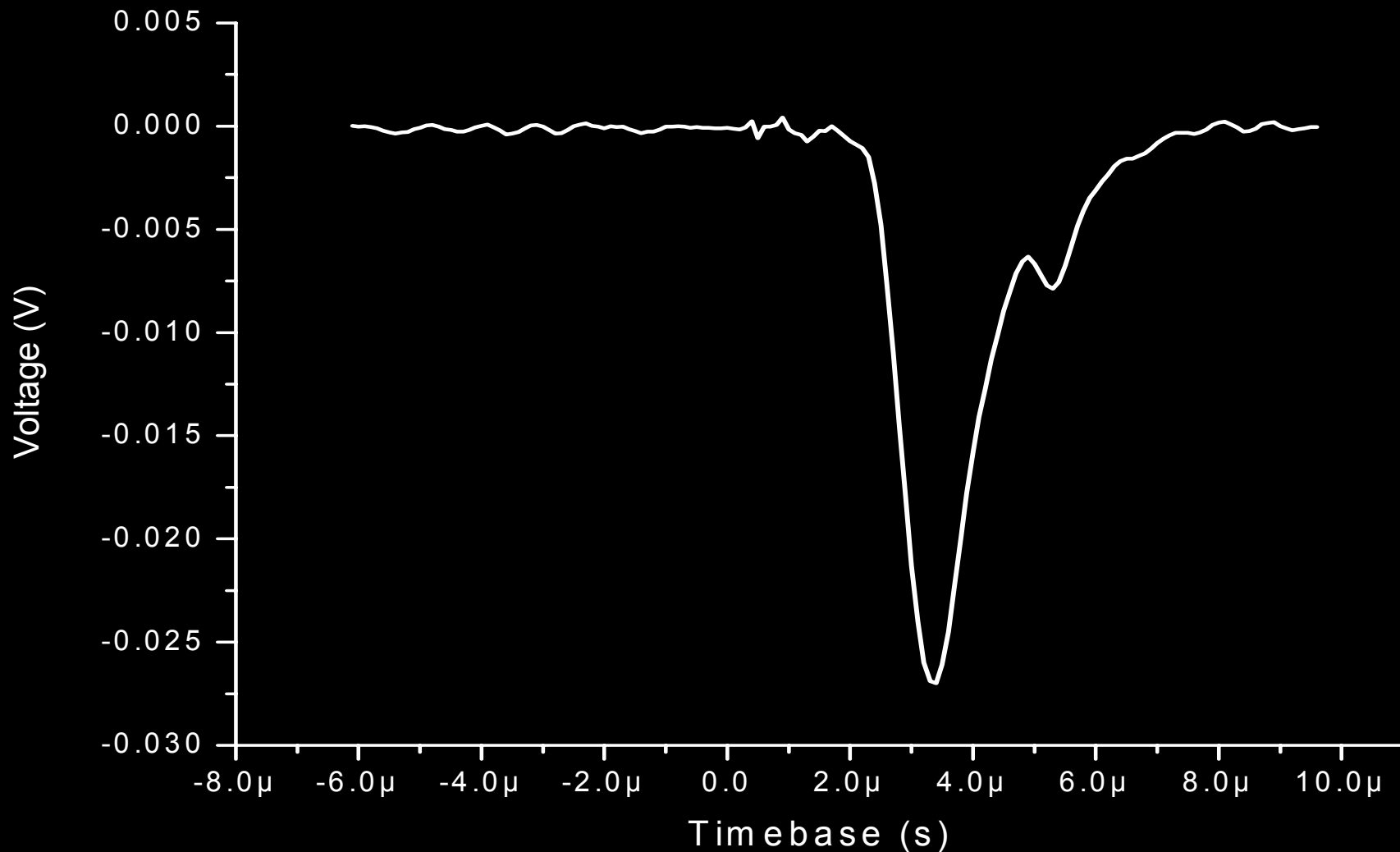
- Greg Aizin

Extra slides



Current Research

Voltage Response
Gate Voltage -500mV Current 10uA

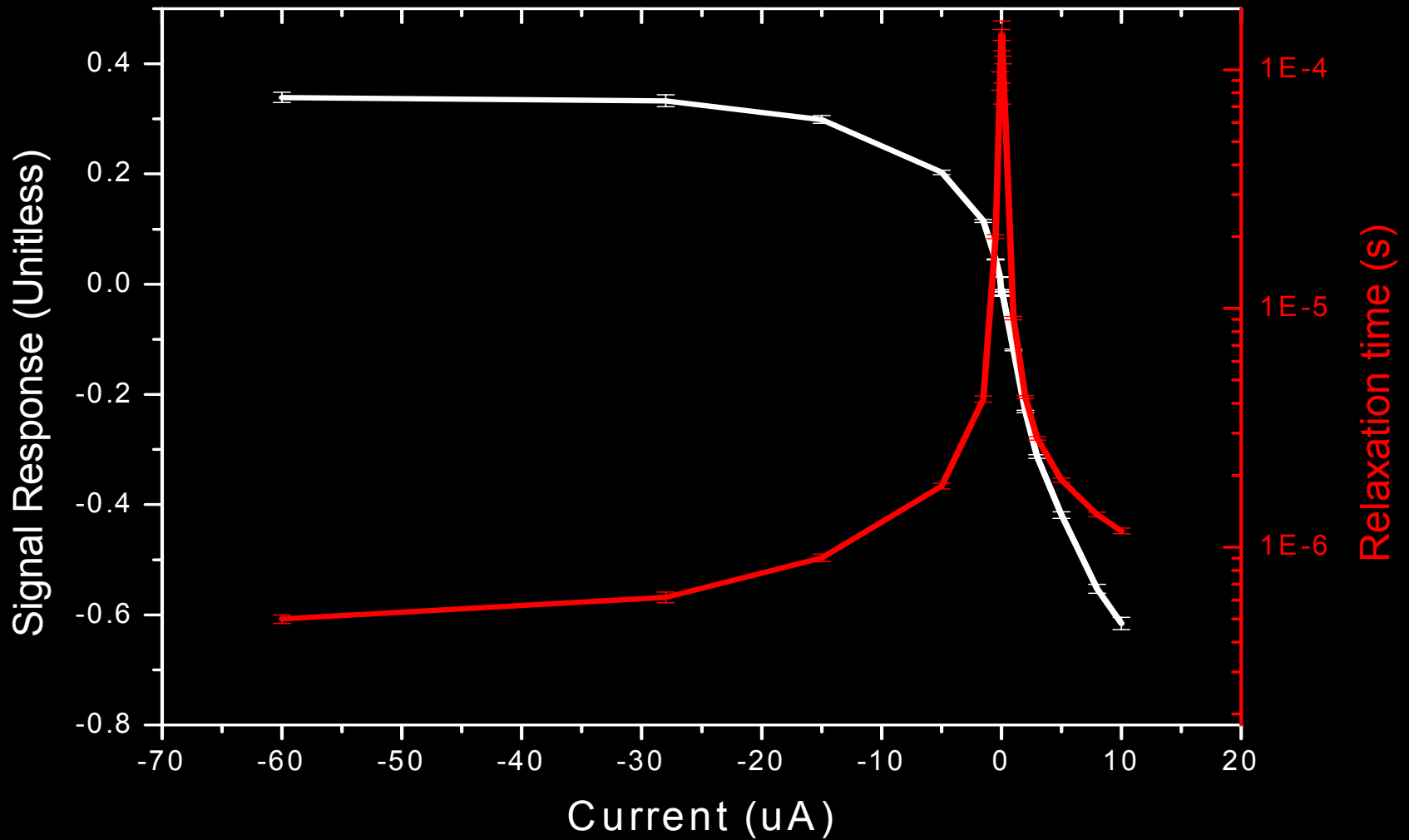


Current Research

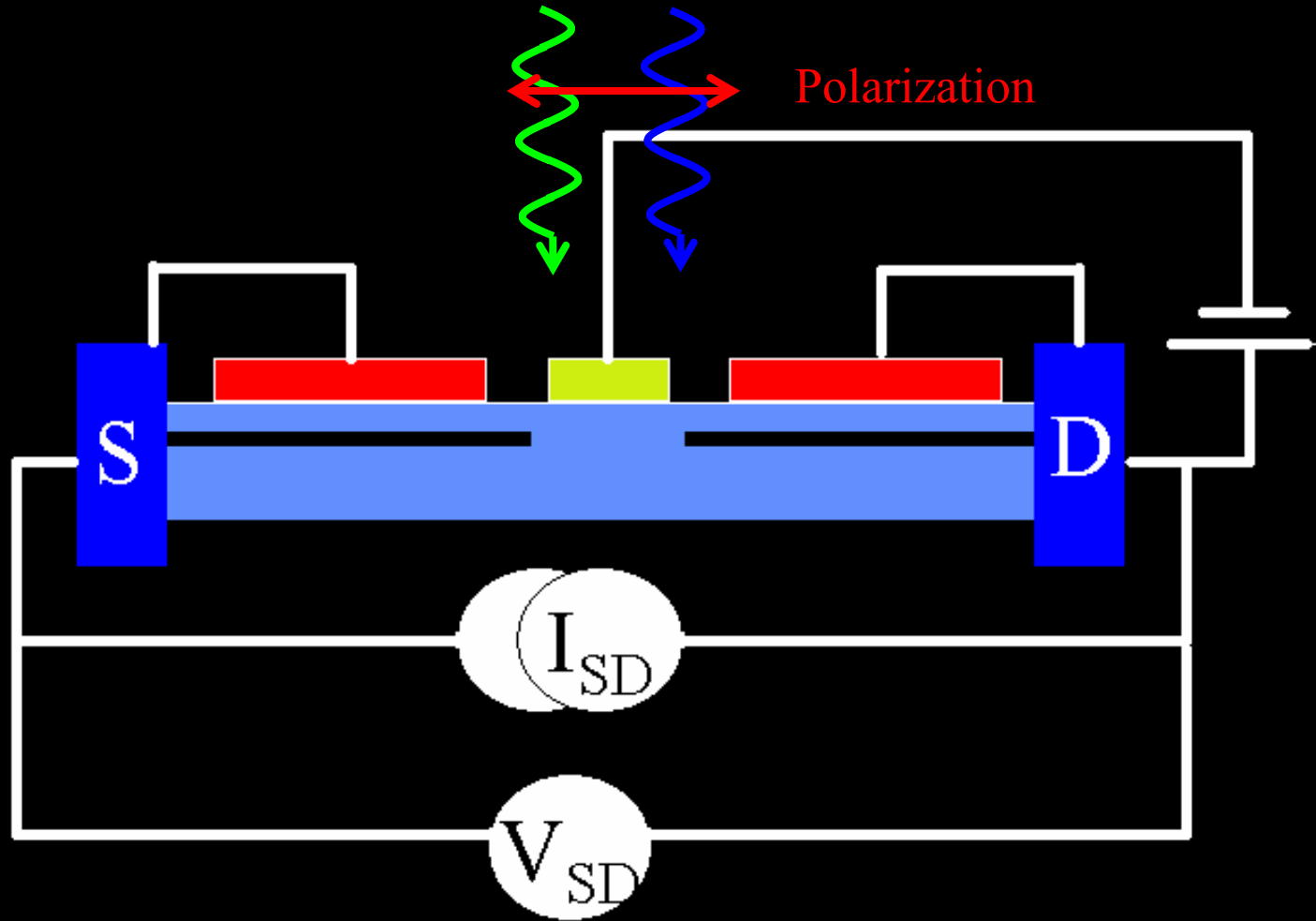
FEL 48 THz

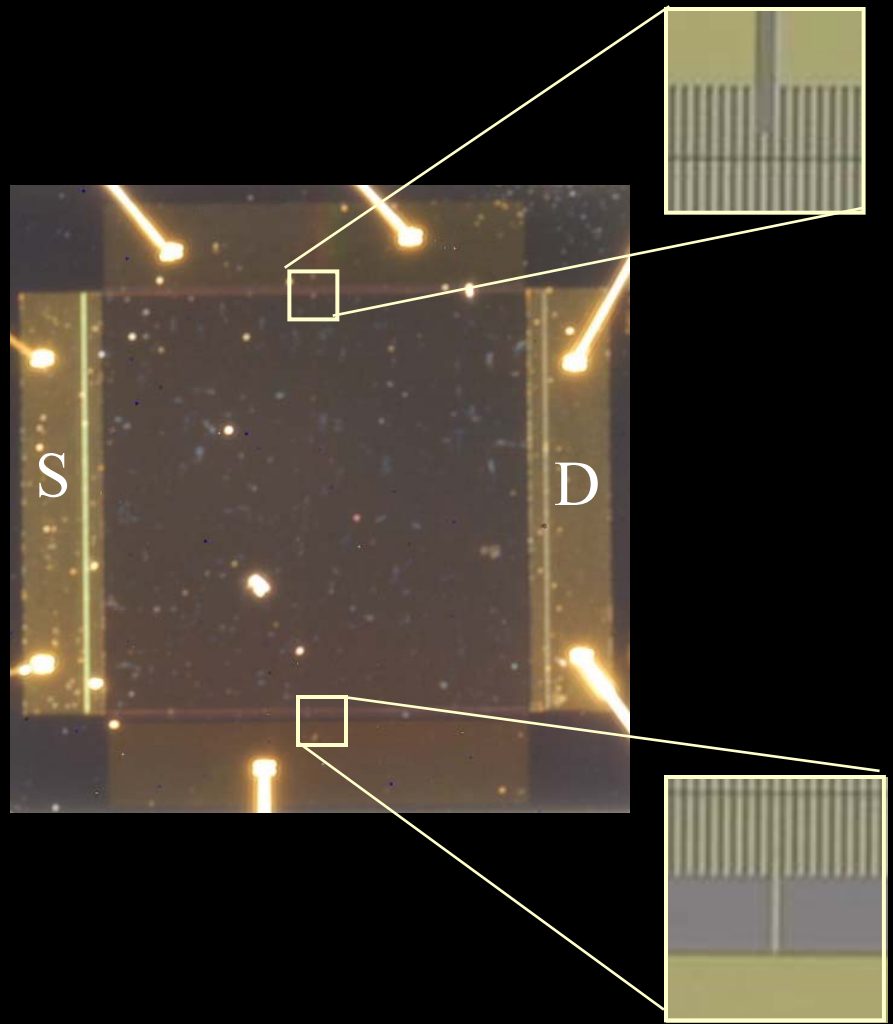
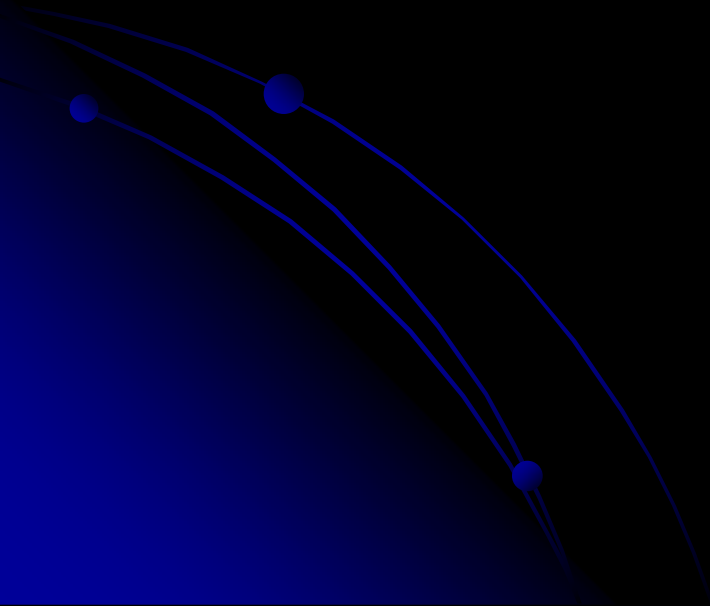
Signal response and relax time vs current

Vg: -500 mV, 20 K



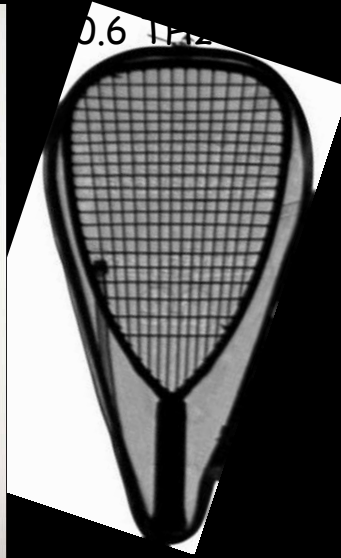
Wiring Diagram for Split-Grating Gate Detector





Diagram

Why Image in THZ?

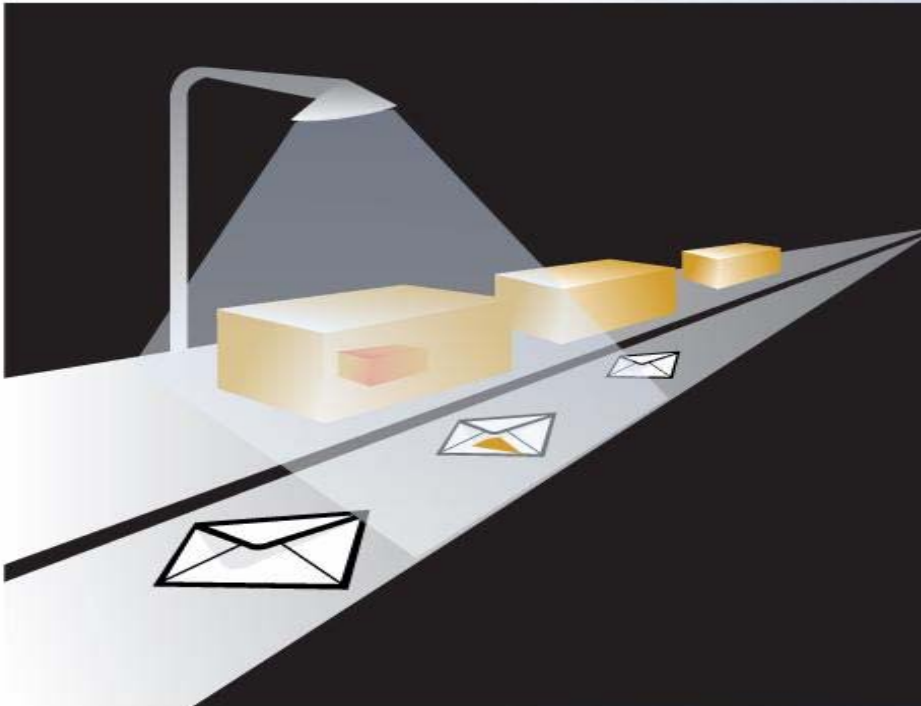


Can see through visibly opaque objects

THz has no or minimal health risk

Can use passive detection
(QinetiQ, UK, US)

Security



fingerprint chemical and biological terror materials in packages, envelopes or air



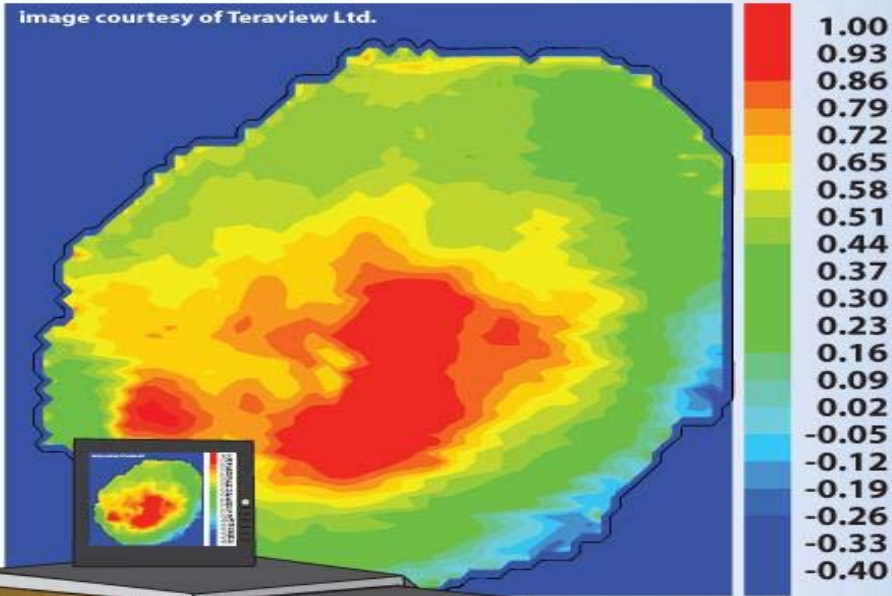
find concealed weapons



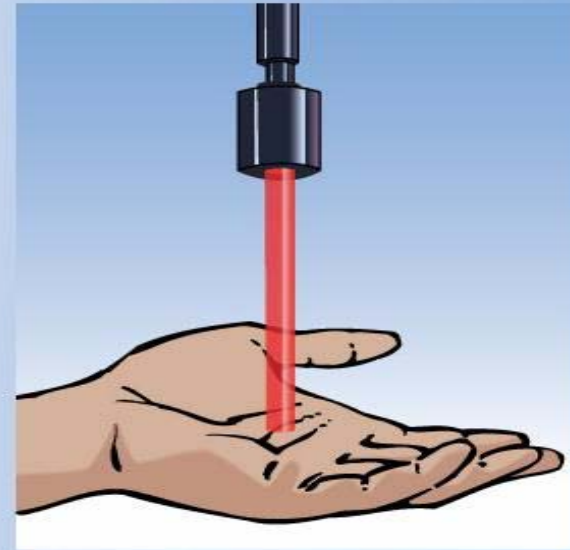
locate hidden explosives and land mines

Medical Imaging

Image courtesy of Teraview Ltd.



**improve
medical
imaging**

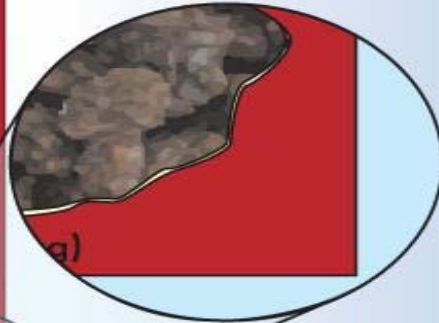
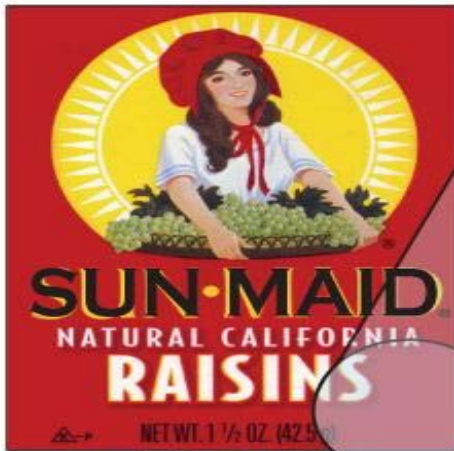


**diagnose
skin cancer**



**spot tooth erosion
earlier than x-rays**

Quality Assurance



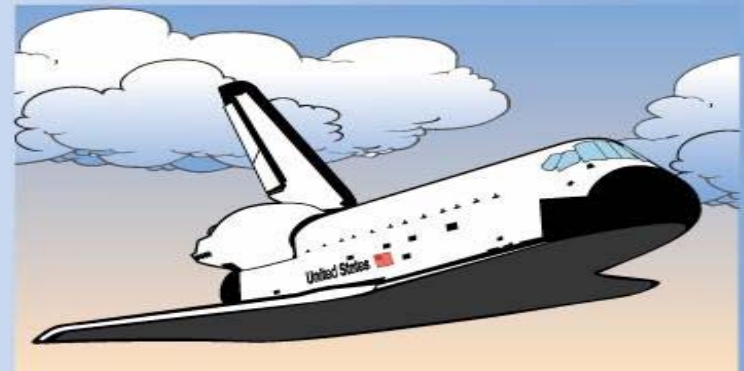
count items in packages



control quality of pharmaceuticals



help airline pilots navigate through fog



detect dangerous flaws in space shuttle components

