Advanced Imaging Sensors

Uncooled Infrared

Three Dimensional Imaging

DARPA Tech '99

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Imaging Systems

DoD Requirements

- Long Range Targeting
- Target Identification
- Precision Strike
- Damage Assessment
- Sensor Matched to the Vehicle
  - Robotics
  - Micro-air Vehicles

Need for Precision Targeting

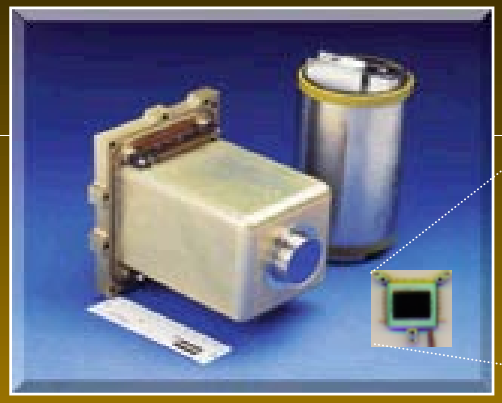
Advanced Imaging Sensors

Objectives:

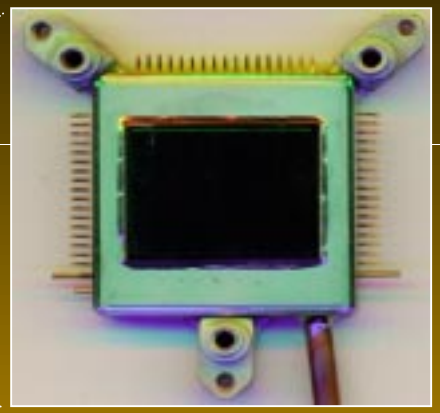
- Transform Most of IR Imaging from Cooled to Uncooled

- Add Precision Targeting
  - Short Wave IR
  - 3-D Imaging

Why Uncooled IR?



Cryogenic Sensor



Uncooled Flat Pack

- 20 x Power Reduction
- 10 x to 100 x Size Reduction
- 10 x Cost Reduction

Uncooled IR Applications

3-10X

Current	Emerging	Future
Rifle Sight	Missile Seeker	Target Acq.
Viewer	Unattended	Micro Sensor

1X *Performance* *20-70X*

Uncooled IR Payoff

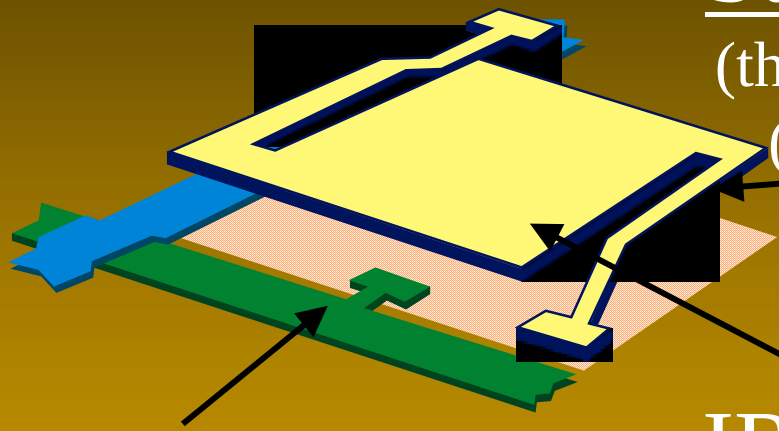
Missile Seeker

- Targeting Through the Missile
  - –15 lbs. Weight Savings
- 7x Cost Reduction

U-Sensor

- Low Weight
  - – 5-50 Grams
- Sensors for Novel Applications

Current Uncooled Detector



Support Arms

(thermal signal loss)
(micro-structure support)

Electronic Read-out

(low noise amplifier)
(high density unit cell)

IR Material

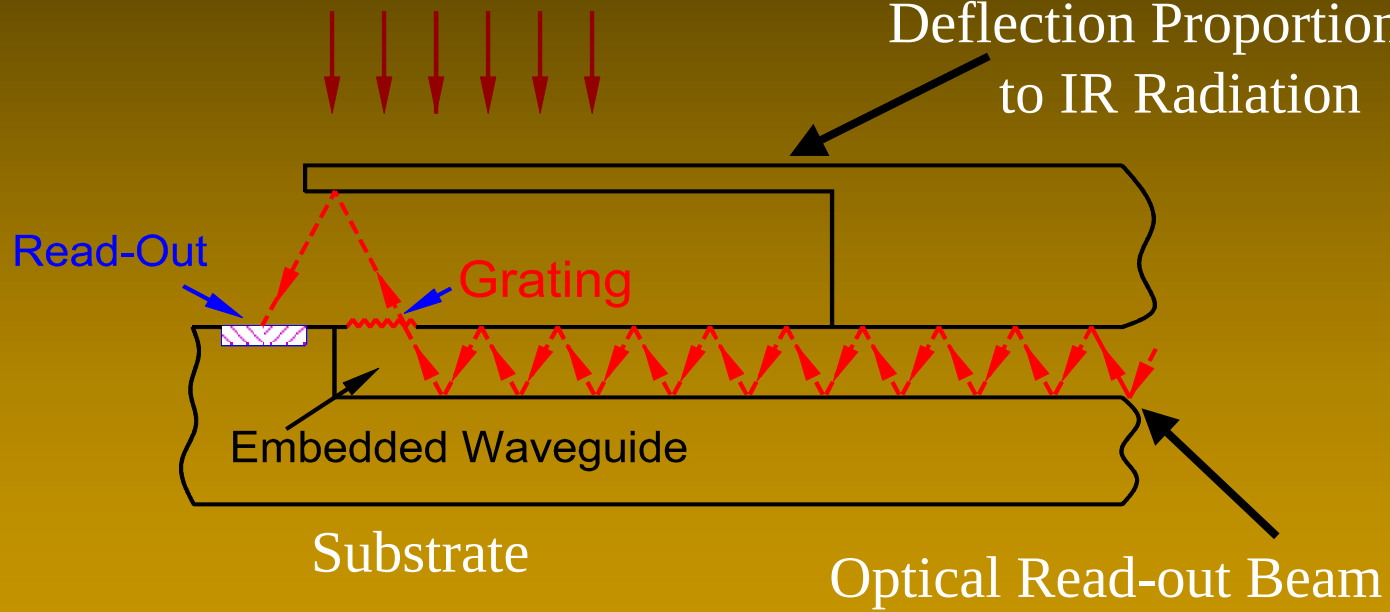
(optical absorption)
(one-over-f noise)

Thermal Detector Challenges

- Ideal Thermal Isolation
- Optical Absorption in Thin Layer
- Thermal Time Constant
- Non-Contact Read-out
- Electronic Compensation
- Array Technology

Ideal Thermal Device

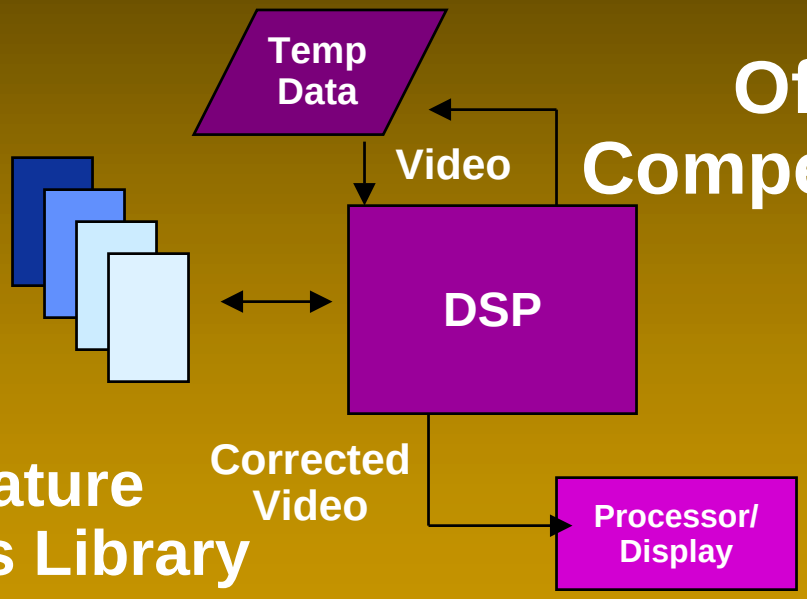
Concept



Thermal Sensitive Pixel

Uncooled IR Camera System

Uncooled FPA



Offset Compensation

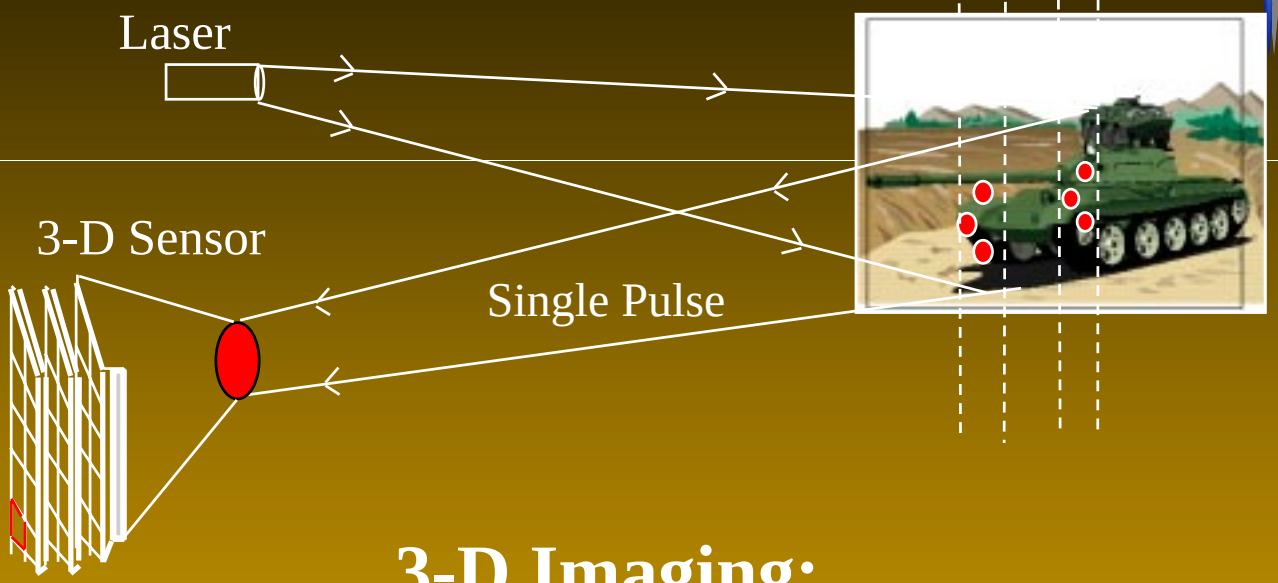
Temperature Coefficients Library

Electronic Temperature Compensation Approach

Signal Processing

- Temperature Compensation
  - Milli-Degree Accuracy
  - Coefficient Library
- Large Dynamic Range
  - On-Chip Correction/Anti-Blooming
  - Local Contrast Enhancement
  - Linearity Over Scene Temperatures

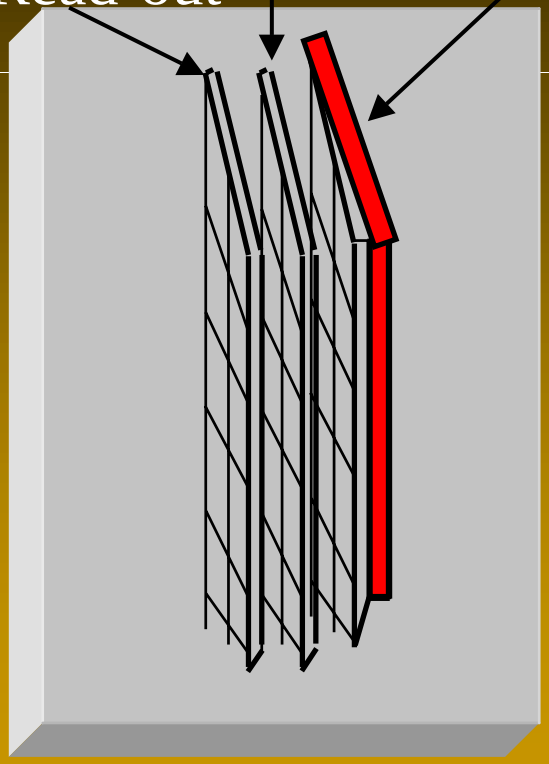
Precision Targeting



3-D Imaging:

- Adds Pixels on Target
- Aspect Invariant
- Wave Length Flexibility
- Camouflage Penetration
- Minimum Platform Stabilization

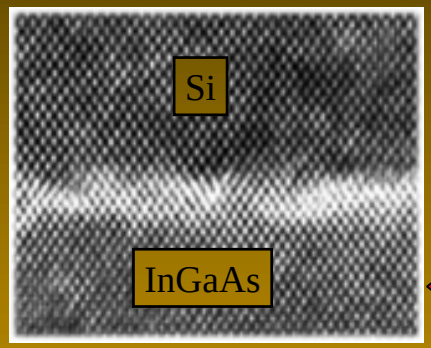
3-D Technology



Challenges

- SWIR Detection with Internal Gain
- High Quantum Efficiency
- High Speed (Gigahertz) Imaging Sampling
- Low Noise Pre-amp.
- Output Format (A/Ds)
- Gain/Bias Control Feedback

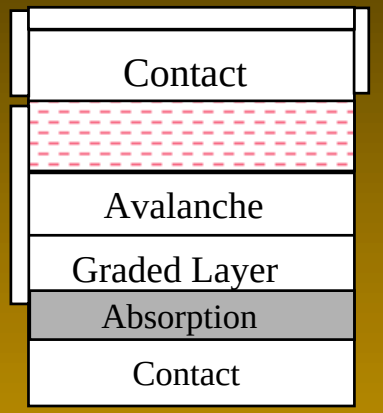
High Speed Devices with Gain-concepts



Wafer Fusion Bonding

Gain

Sensing



Grown Structure

Separate Gain & Sensing Regions

Summary

- Uncooled IR Dramatically Expands Applications
- Ten Times Performance Increase Necessary for Uncooled IR
- Precision Targeting with Unique 3-D Imaging Devices