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Laser Scanning System for Item Monitoring

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L. Curt Maxey
Timothy J. McIntyre
Peter J. Chiaro, Jr.

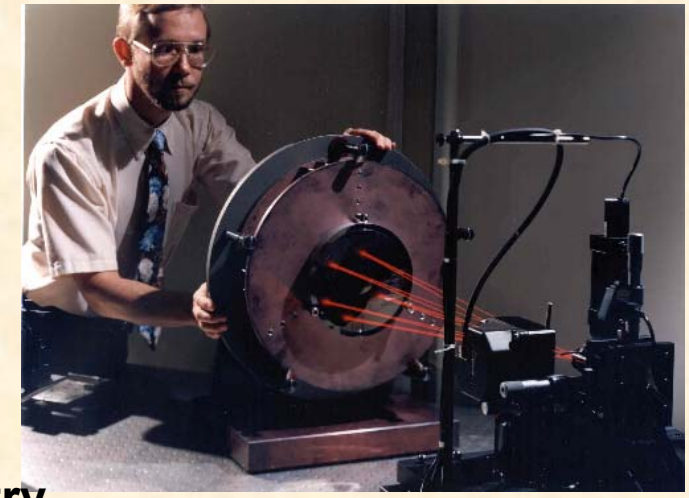
OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

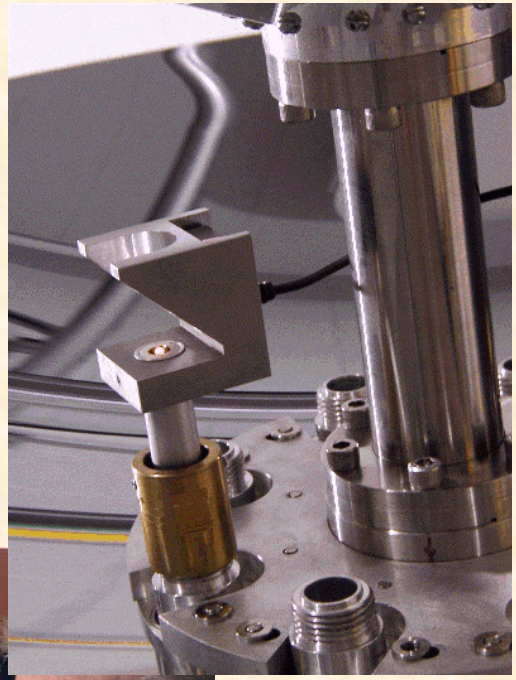
Laser Scanning Transceiver

- Related projects
- Conceptual descriptions
- Scanning methodologies
  - Target to target “point” scans
  - High resolution scan options
  - Field transceivers for data transfer
- System discussion items

Laser-based systems for sensors, metrology and alignment

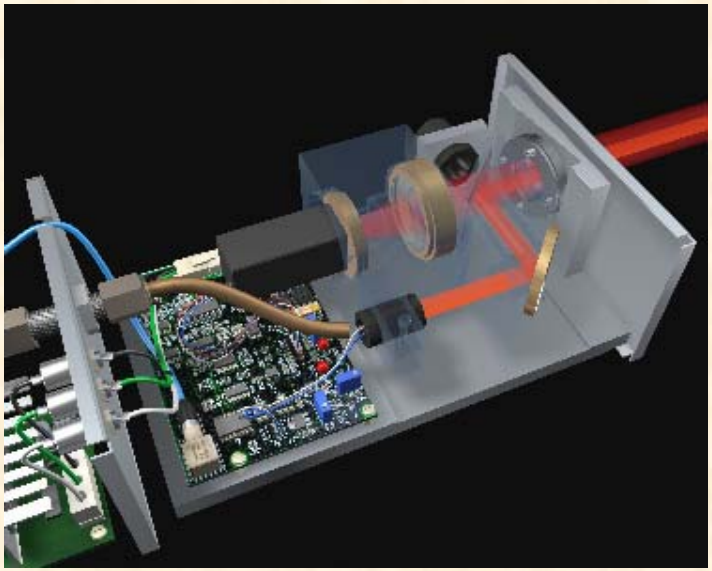
- **Interferometry**
- **Holography**
- **LIDAR**
- **Fiber sensors**
- **Laser micrometry**
- **Doppler anemometry**
- **Thermometry**





Phosphor Thermometry

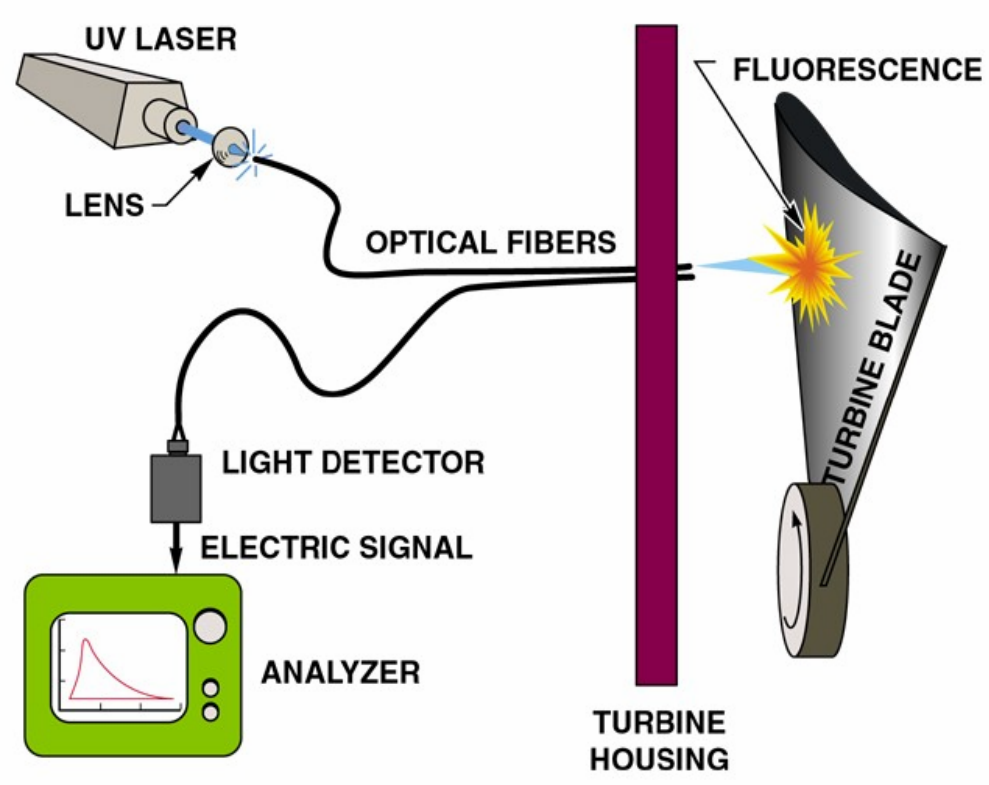
For temperature measurements in challenging environments

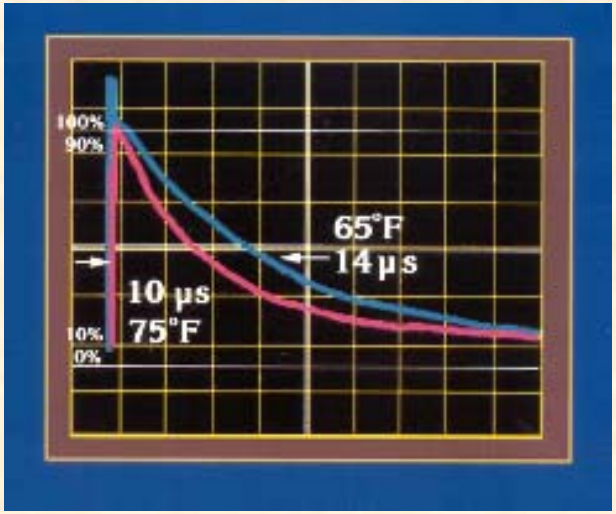


- **Galvaneal steel manufacturing**
- **Industrial furnaces**
- **Operating turbine engines**
- **Fuel cell monitoring**

Phosphor Thermometry

Temperature is sensed by measuring fluorescence properties of phosphors deposited on the surface(s) to be measured





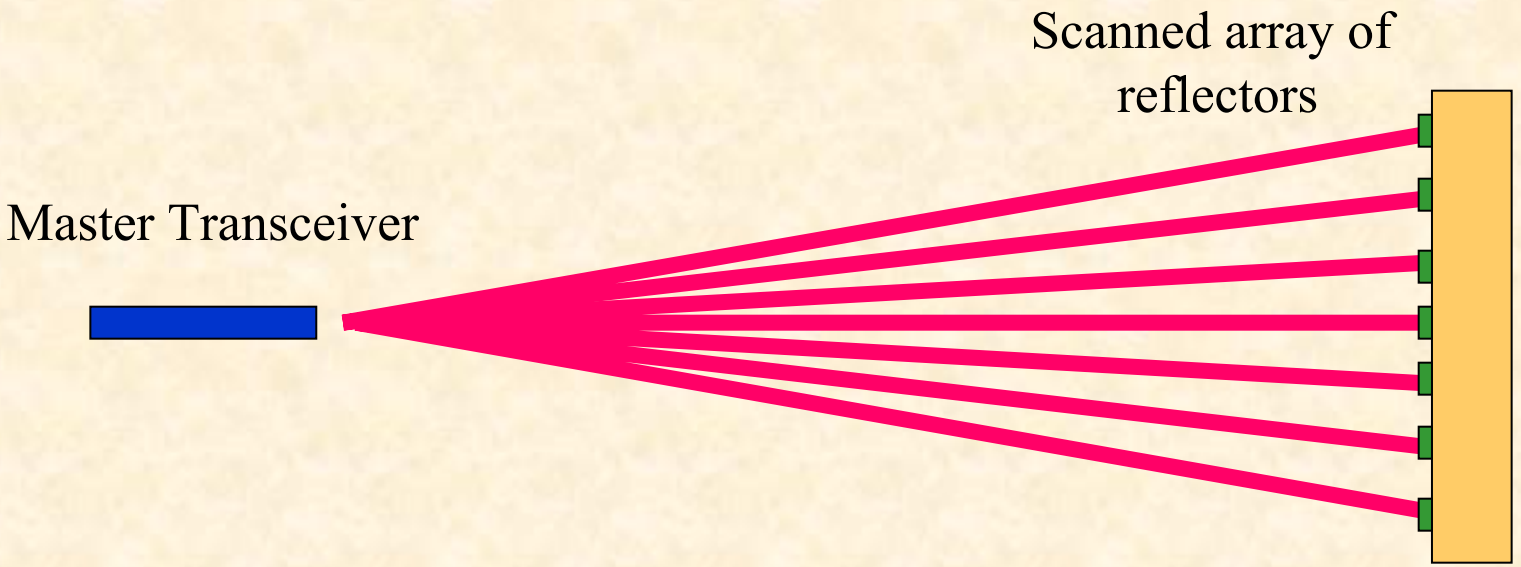
Fluorescence decay time decreases with increasing temperature

Scanning Transceiver conceptual description

Master transceiver - consists of laser, scanning system and photodetector

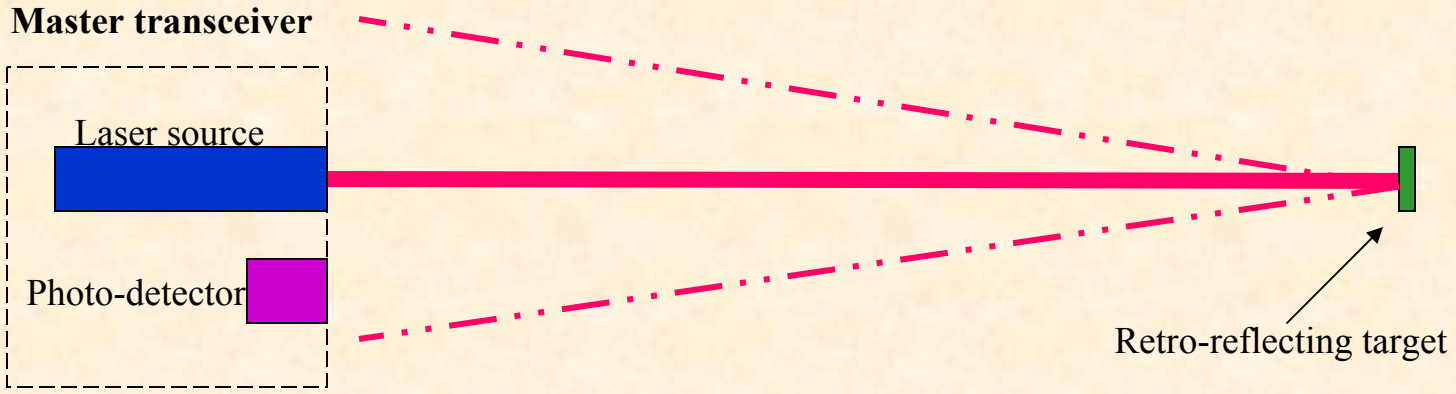
Retro-reflecting targets - return light to transceiver for analysis

Depending on scanning methodology and target complexity, the presence, position, identity, and operating conditions may be determined

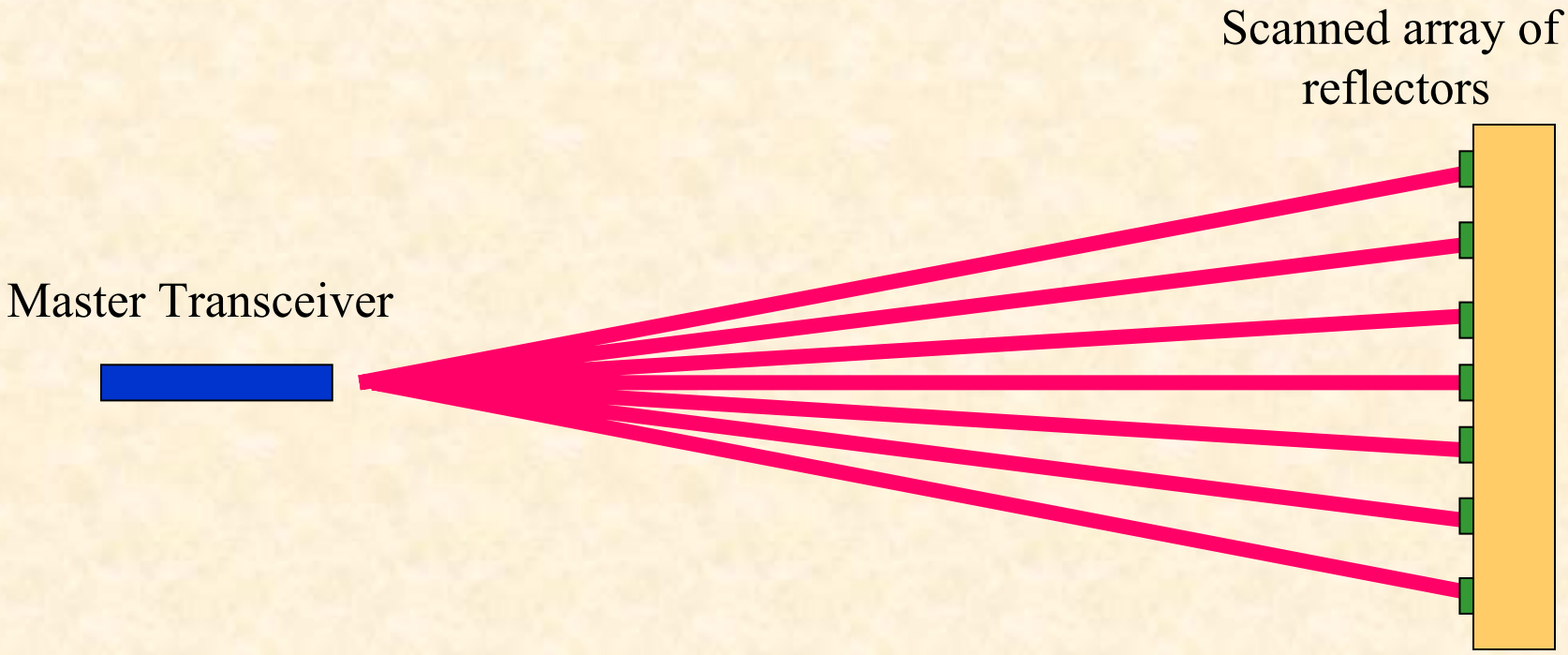


A diode laser and miniature scanning system comprise the heart of the master transceiver

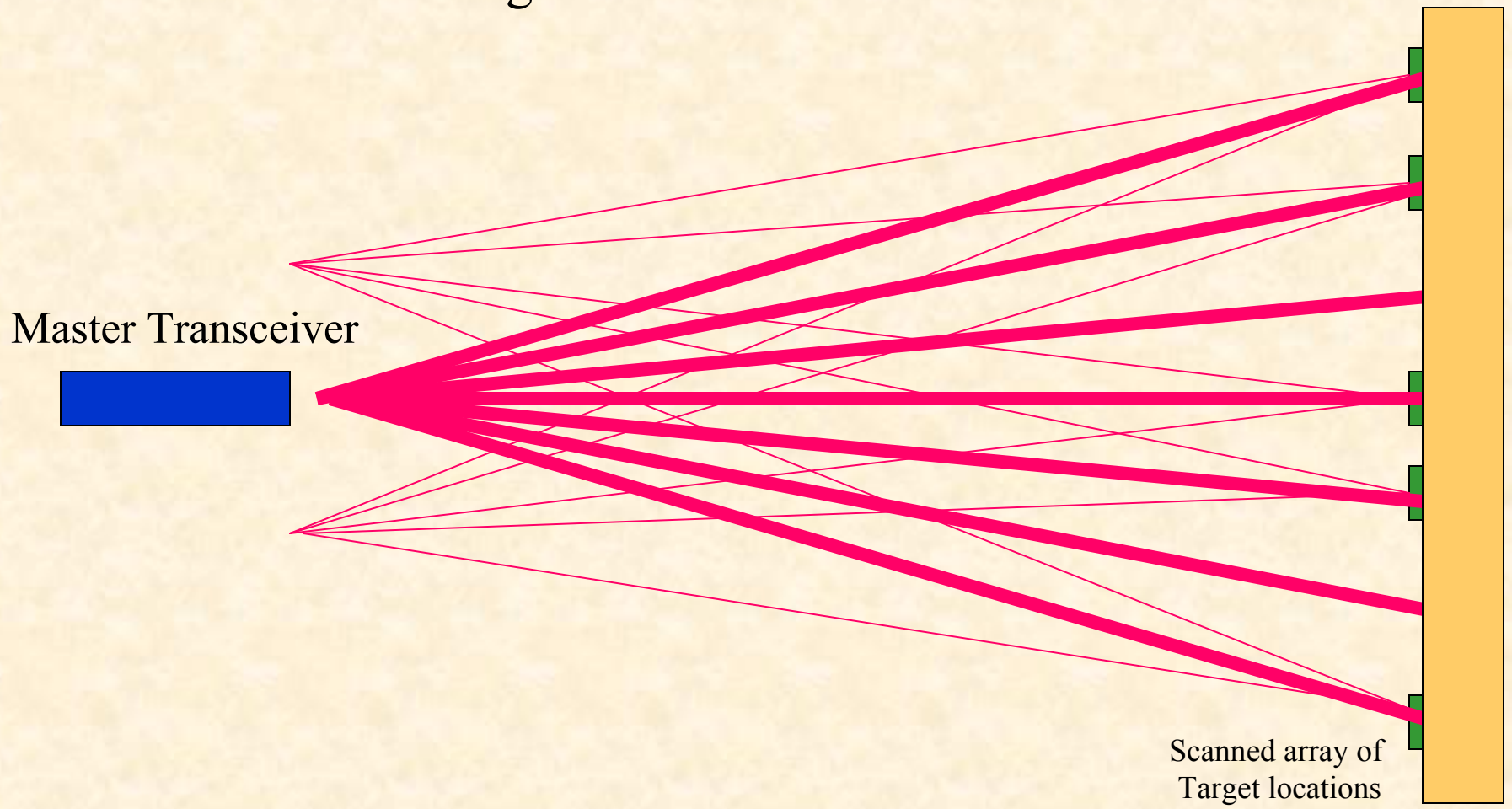
When light from the master transceiver's laser strikes
A retro-reflecting target, light is returned to the transceiver
And detected by the photo-detector for analysis



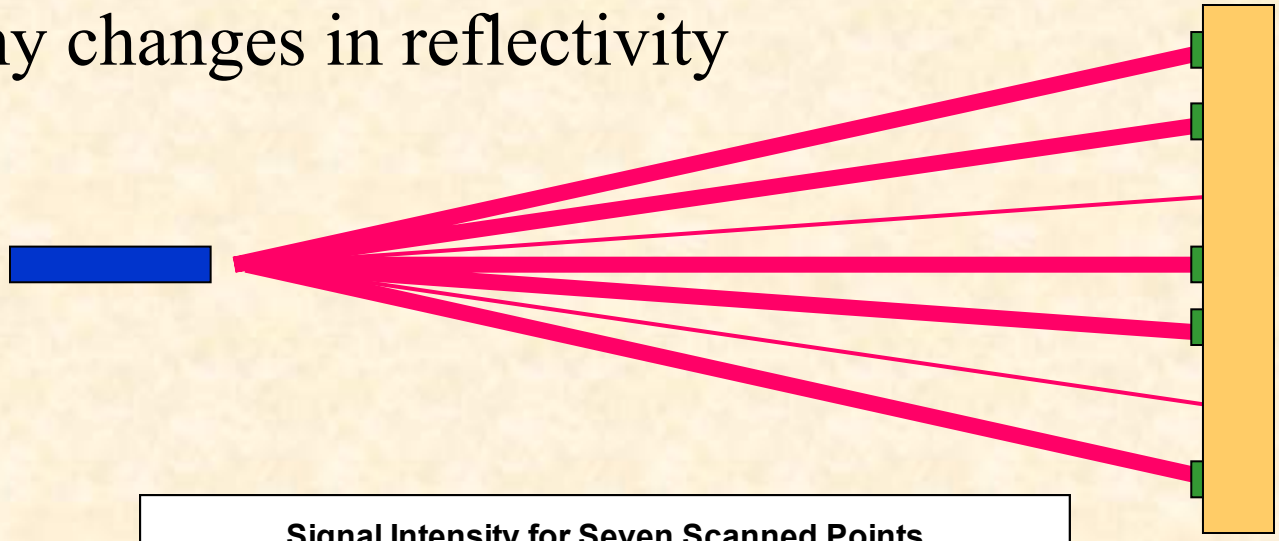
As the master transceiver scans multiple positions the light level returned from each position is quantified and stored for comparison

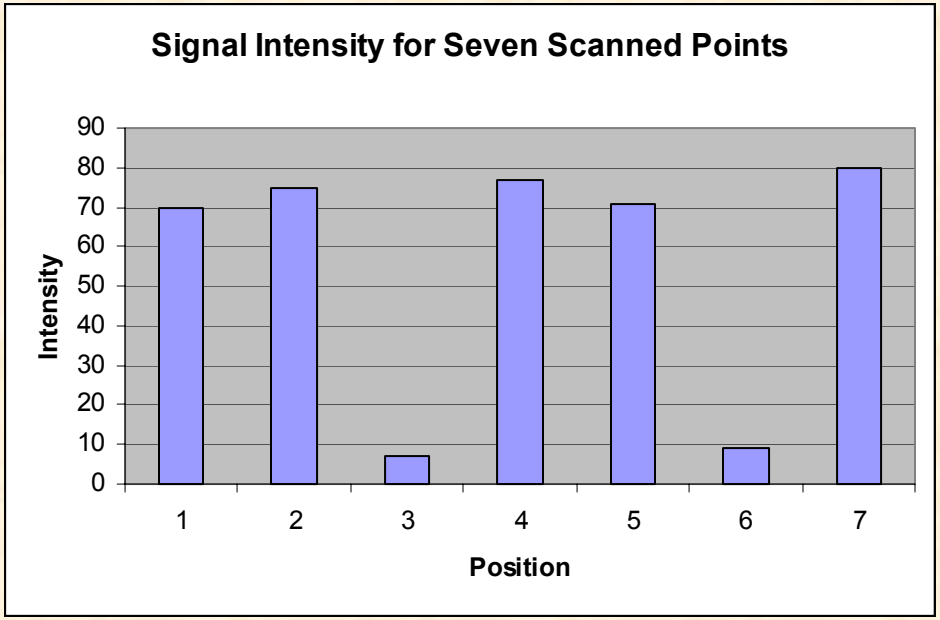


A target to target rapid scan is used to verify the presence of individual targets

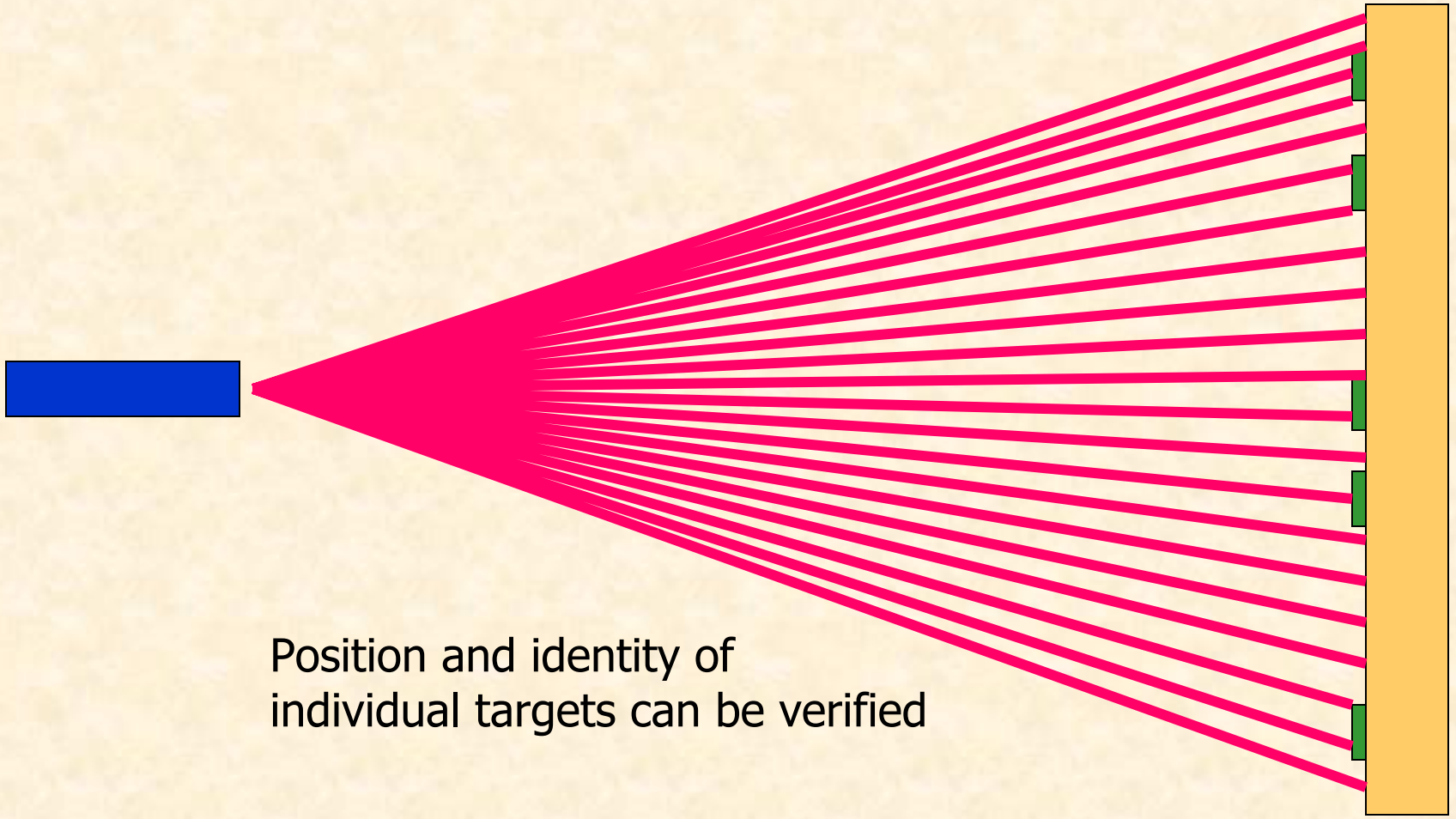


Signal intensity levels reveal presence of targets and any changes in reflectivity



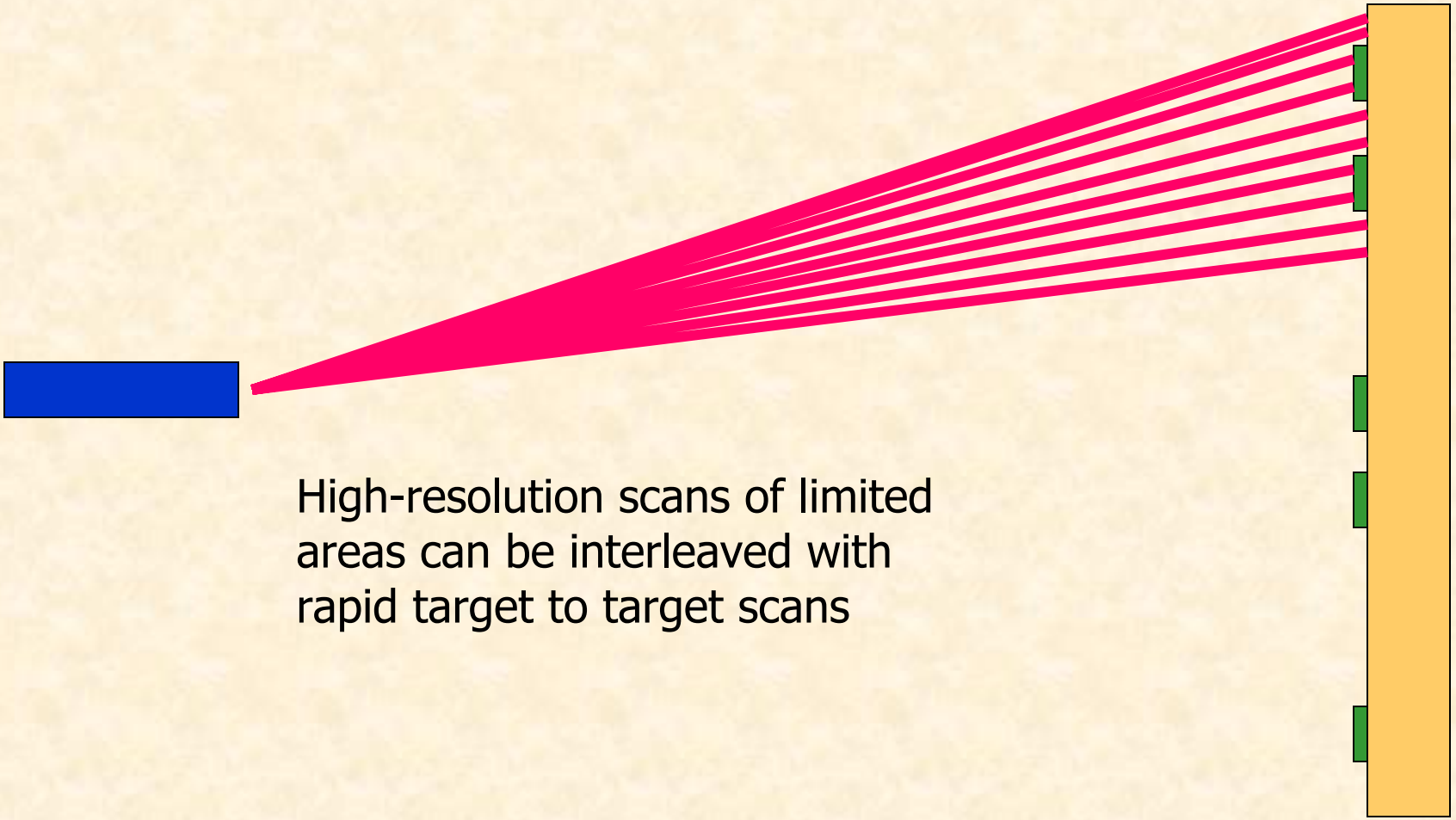


High-resolution scans can be used to determine more detailed information about the targets



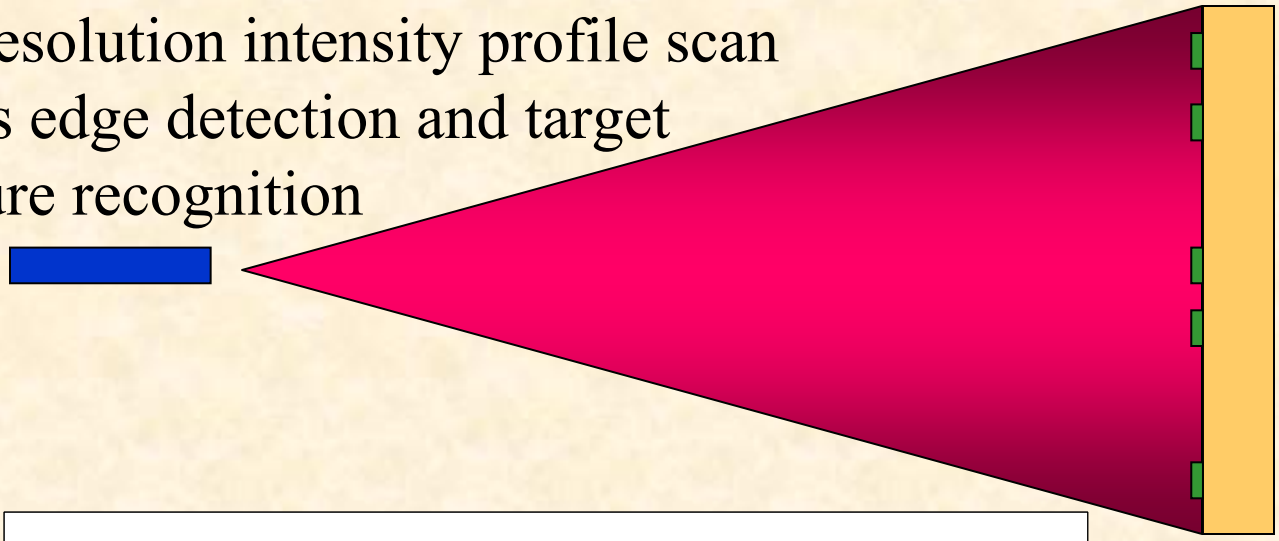
Position and identity of
individual targets can be verified

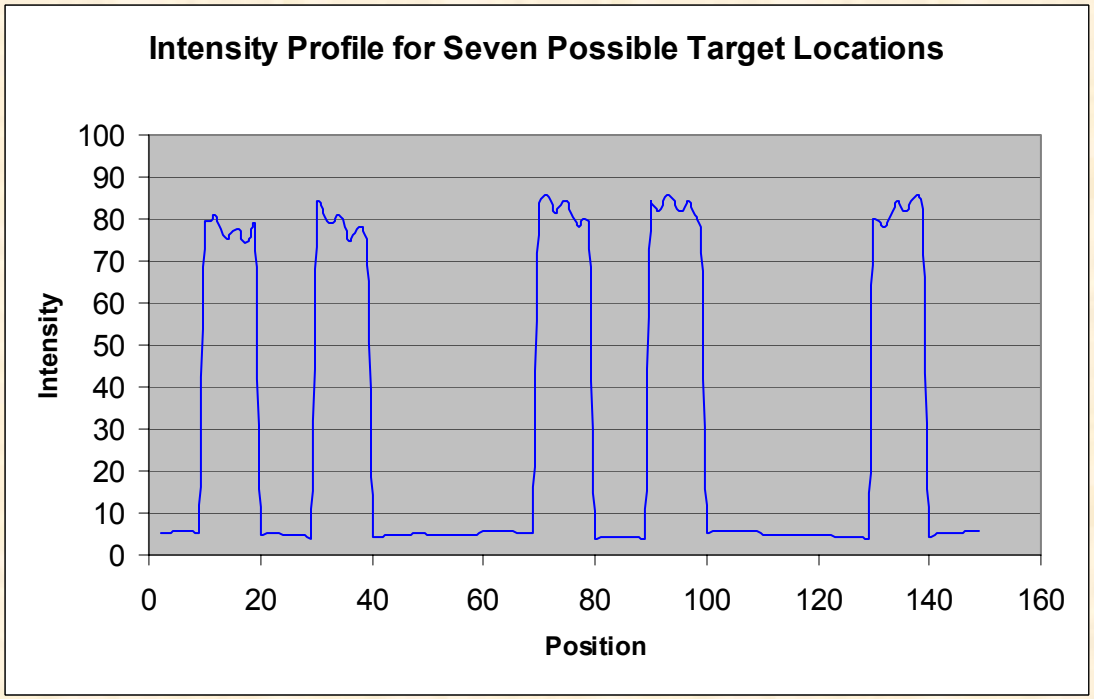
Scan resolution can be varied to accommodate information needs



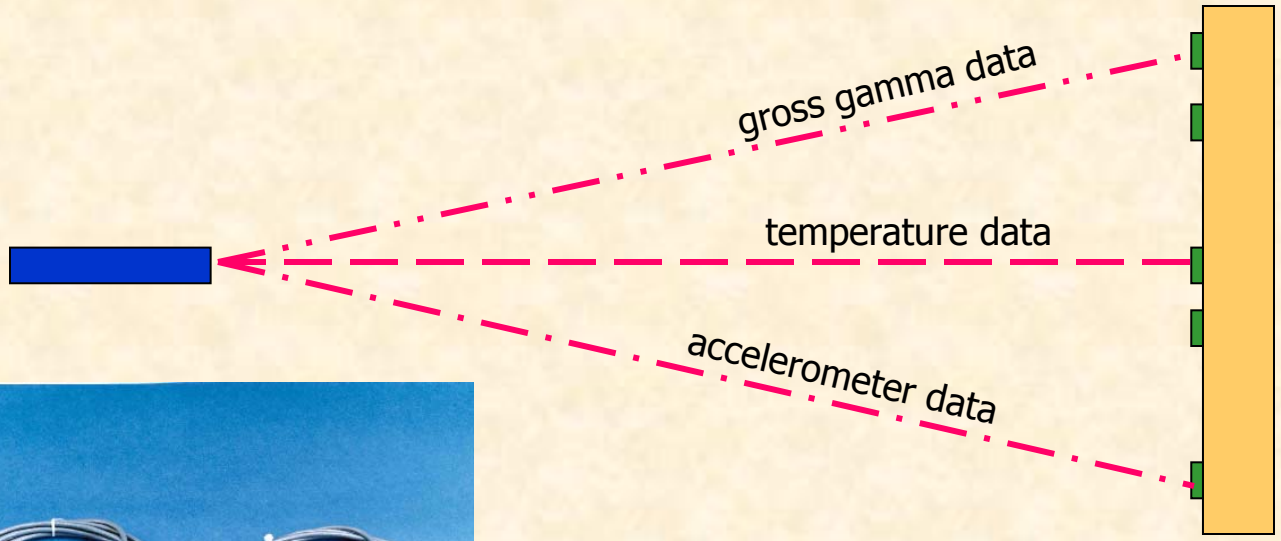
High-resolution scans of limited areas can be interleaved with rapid target to target scans

High-resolution intensity profile scan enables edge detection and target signature recognition



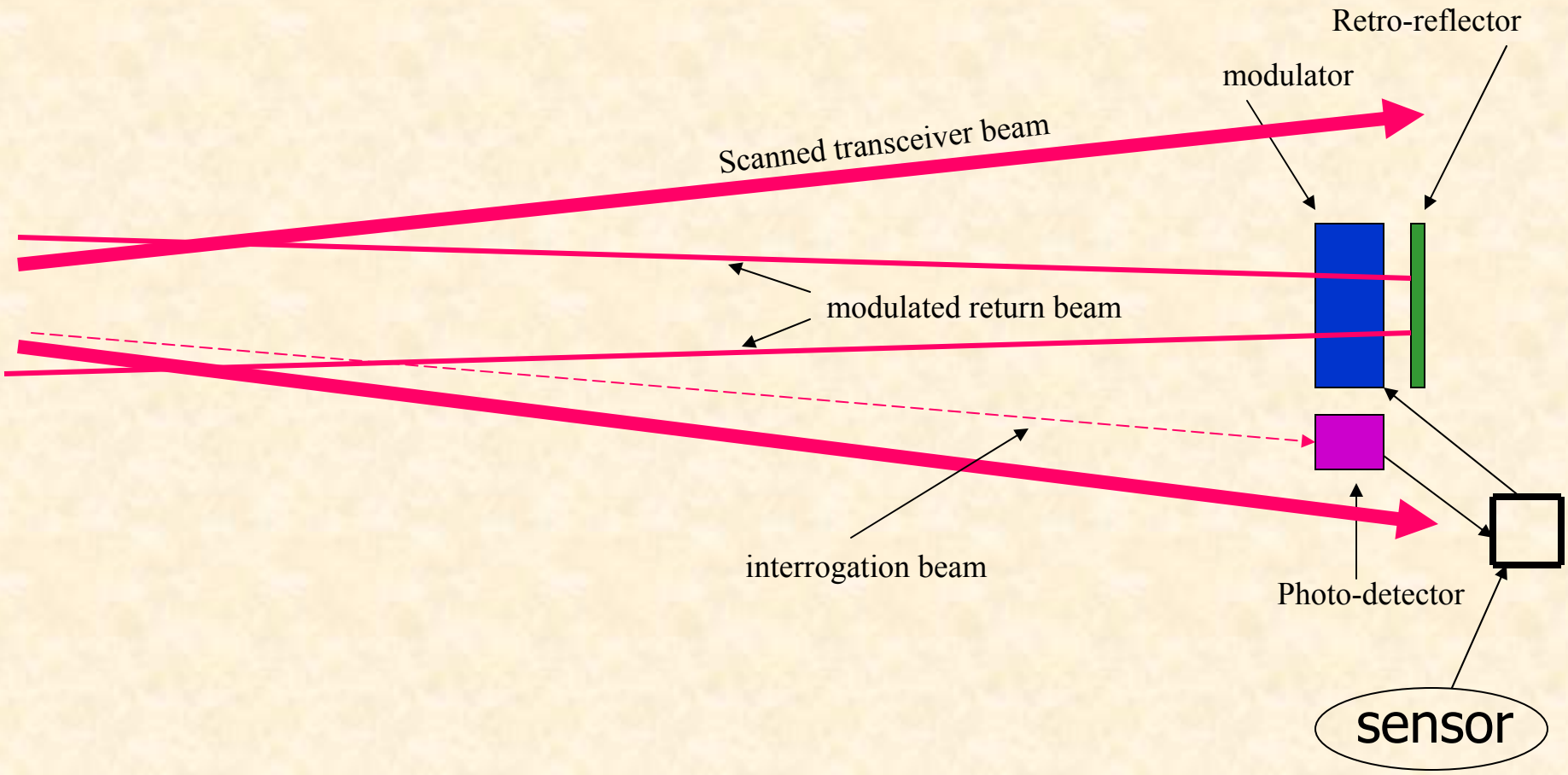


An array of modulated “field transceivers” can provide operating condition data in response to specific requests from the master transceiver

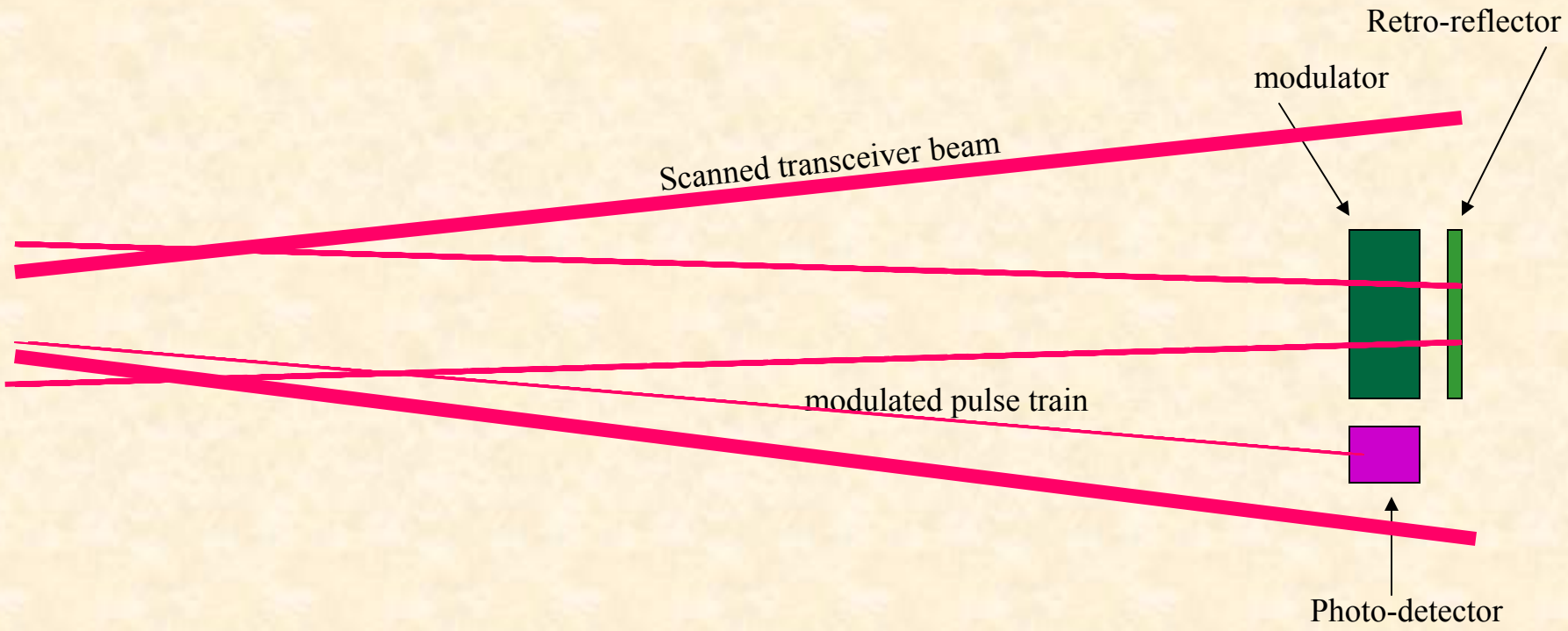


Examples of low-cost, low-power “3-wire” sensors

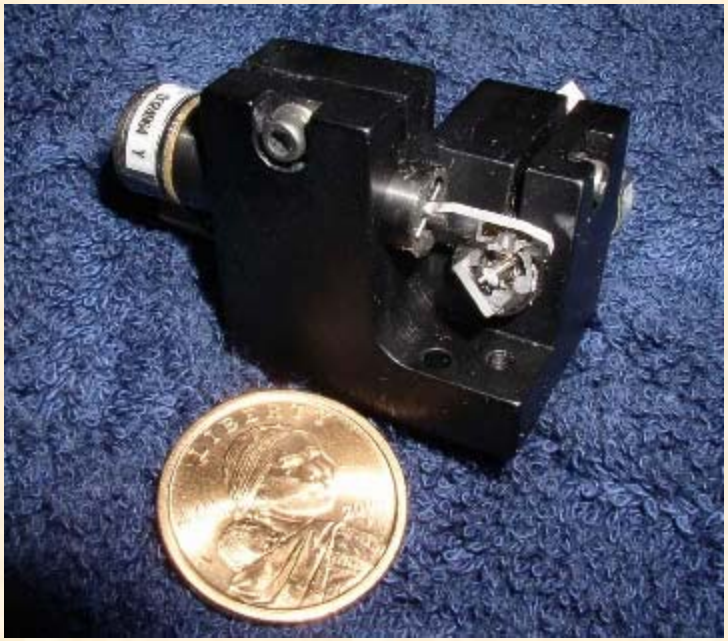
Modulated retroreflecting "field transceiver" is achieved Through a modulating element and a photo-sensor



Modulated retroreflecting "field transceiver" is achieved Through a modulating element and a photo-sensor



Miniature scanner provides wide angular range, high resolution and rapid scan capabilities

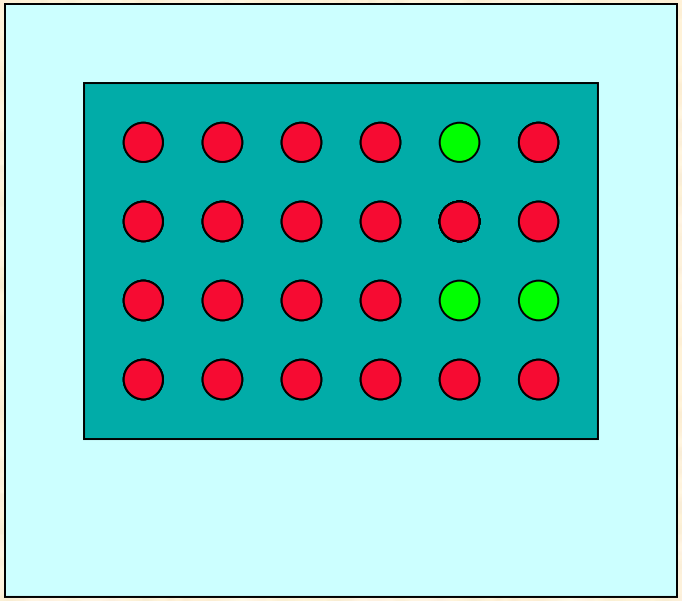


- -30° to +30° optical deflection in x and y
- 8 micro-radian resolution
- Small-angle step response time 150μs
- Large-angle step response time 1ms

At a distance of twenty meters, 1000 points distributed over a 530 square meter area scanned in approximately one second

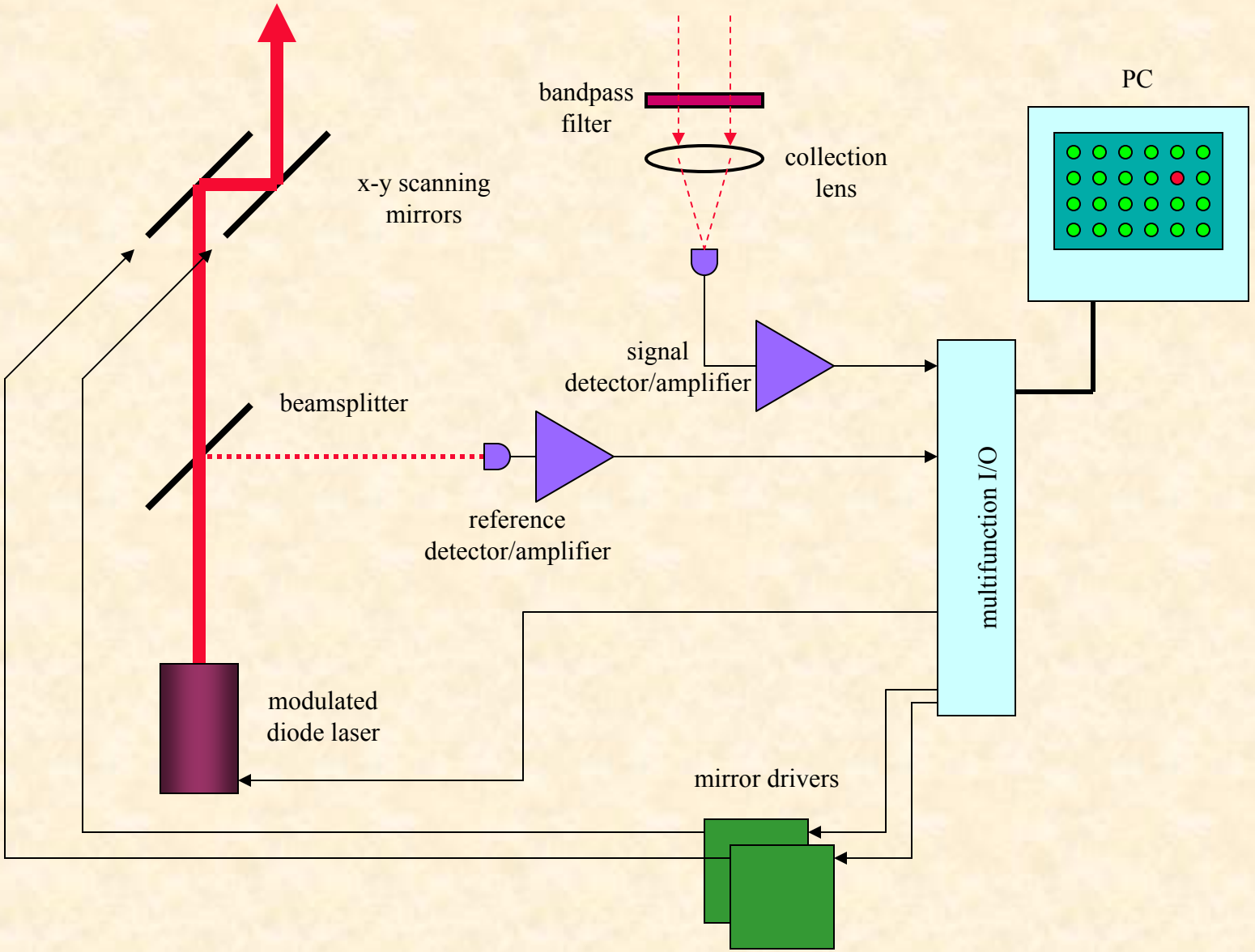
When system parameter limits are exceeded, data is logged and user interface indicates affected items

Parameter limit examples:
-Point reflection intensity
-Edge location change
-Target signature variation



Time and duration of anomalies are recorded in event data file

Persistent anomalies trigger notification of facility personnel and/or monitoring organization



Schematic Diagram of Laser Scanning System

Practical system technical considerations

- Scanning methodologies and implementations
- Target design and manufacturing
- Edge detection resolution limitations
- Beam divergence and spot size
- User interface design
- Signal to noise considerations
- …

Practical system implementation considerations

- Alarm management philosophy and implementation
- Physical system geometries and their scalability
- Assessment of application environments
- Database management
- Facility integration - standards and protocols
- …