# Sensors Directorate and ATR Overview

***for Integrated Fusion, Performance Prediction, and Sensor Management for ATE MURI***

**21 July 2006**

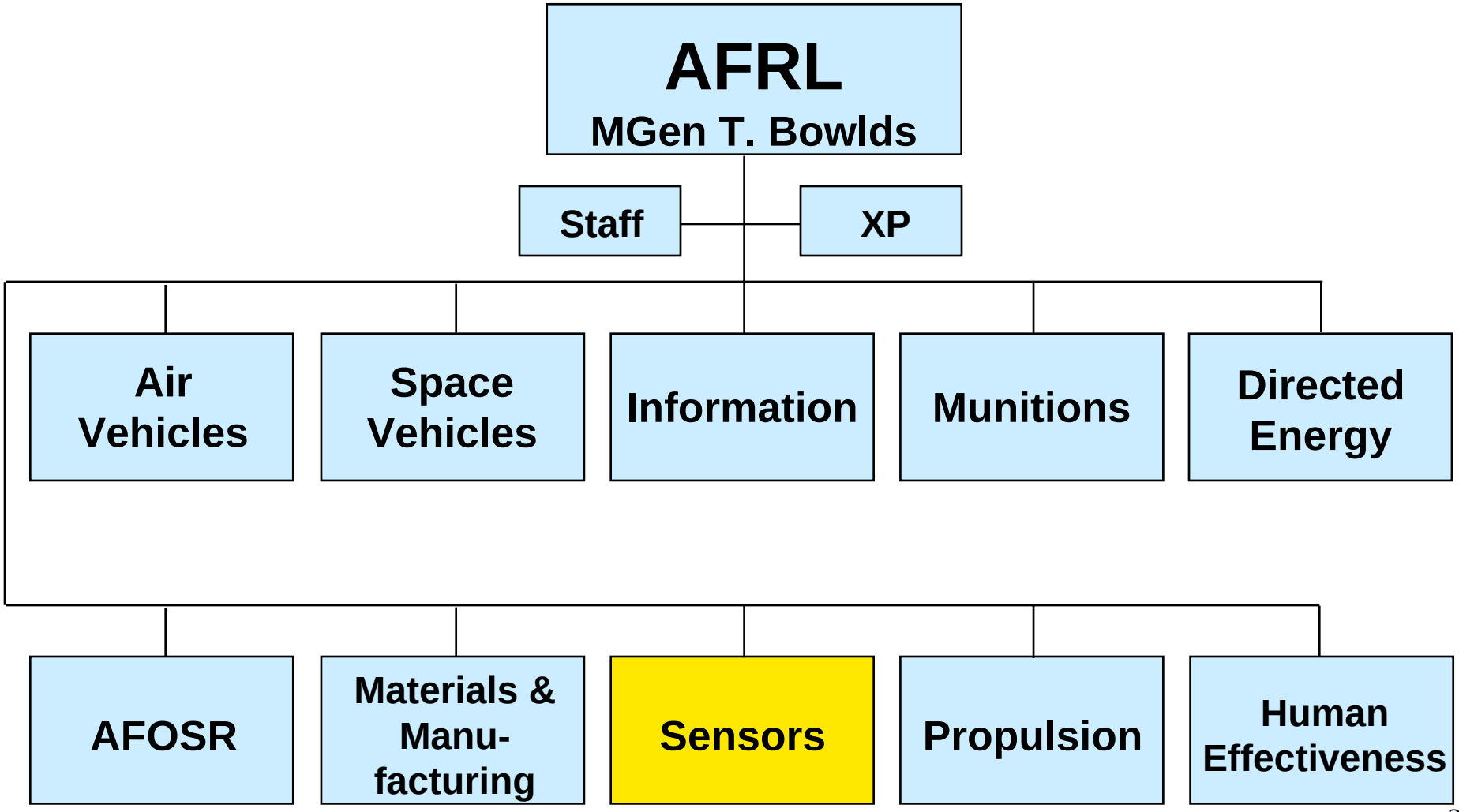
**Lori Westerkamp**

**Sensor ATR Technology Division**

**Sensors Directorate**

**Air Force Research Laboratory**

# AFRL
# Technology Directorates



# Sensors Directorate

## Our Mission

To lead the discovery, development, and integration of affordable sensor and countermeasure technologies for our warfighters.

## Our Vision

Robust sensors and adaptive countermeasures that guarantee complete freedom of air and space operations for our forces, and deny these capabilities to our adversaries at times and places of our choosing.

# Priority Warfighter Needs
## Being Addressed by Sensors Directorate

- **Sense, identify, and track all air and surface targets and threats world wide and in all weather**
- **Counter "difficult" targets (WMD, hidden, LO)**
- **Protect air and space assets**
- **Control the battlespace electromagnetic spectrum**
- **Rapidly prosecute time-critical targets and threats**

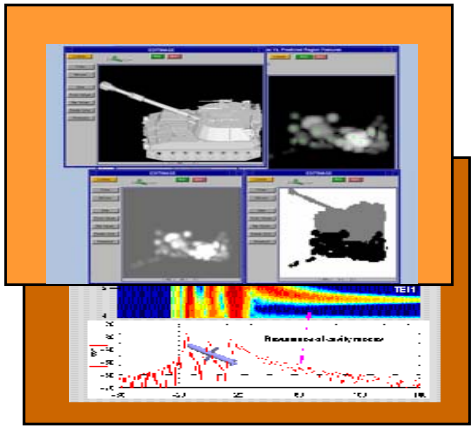
*Balance: Performance & Affordability*

# Sensors Directorate Technology Thrusts

## Radio Frequency Sensors & Countermeasures

## Electro-Optical Sensors & Countermeasures

## Automatic Target Recognition & Sensor Fusion



***Application Sub-thrusts***

- Battlespace Access
- Persistent ISR of the Battlespace
- Prosecution of Time Sensitive Targets

- Radio Frequency Apertures
- Algorithms & Phenomenology
- Digital Receivers & Exciters
- Reference Systems
- Components

- Transmitters & Receivers
- Phenomenology & Algorithms
- Optical Apertures

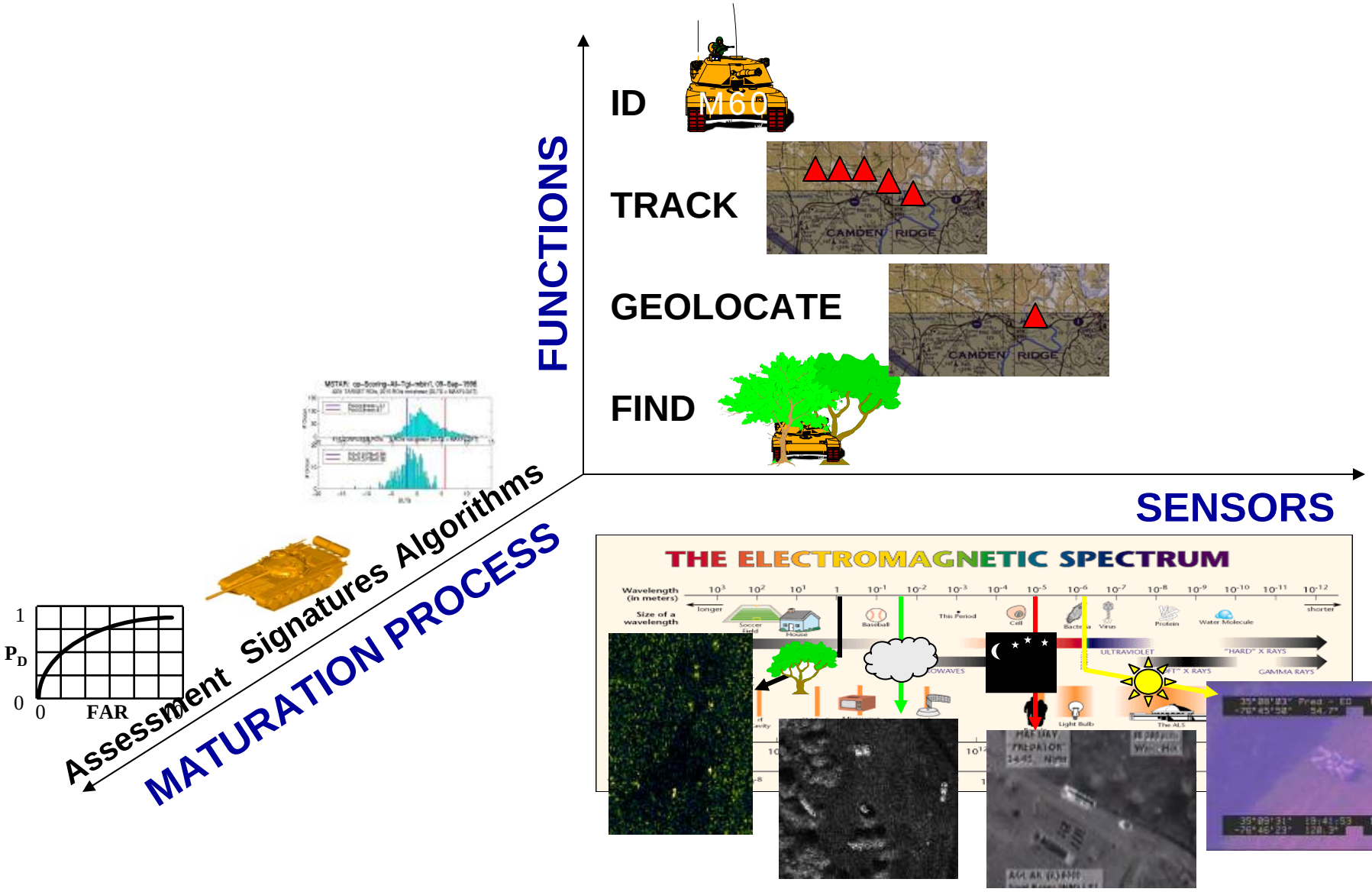
- Signatures & Modeling
- Assessment & Foundation
- Innovative Algorithms

***Enabling Sub-thrusts***

# Potential Growth Areas

- **Hidden Target Detection & Identification**
- **Automatic Target Recognition (ATR) & Sensor Fusion**
- **Electronic Warfare**
- **Time Critical Targeting (TCT)**

# ATR Scope


FUNCTIONS
ID
M60
TRACK
CAMDEN RIDGE
GEOLOCATE
CAMDEN RIDGE
FIND
SENSORS
THE ELECTROMAGNETIC SPECTRUM
MATURATION PROCESS
Signatures
Algorithms
Assessment
1
$P_D$
0
0
FAR

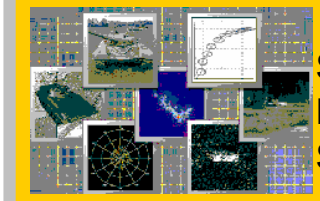
# ATR Approach

Characterized Performance
High Performance Computing
Operational Databases

## ASSESSMENT& FOUNDATION

COMPASE Center

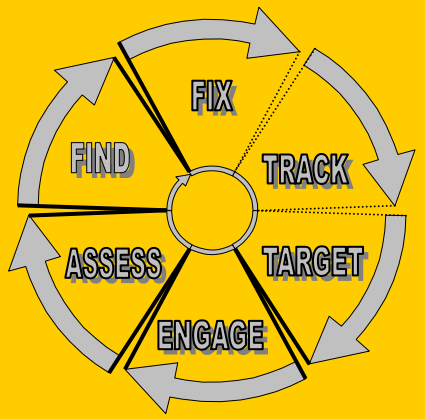
VDL VIRTUAL DISTRIBUTED LABORATORY



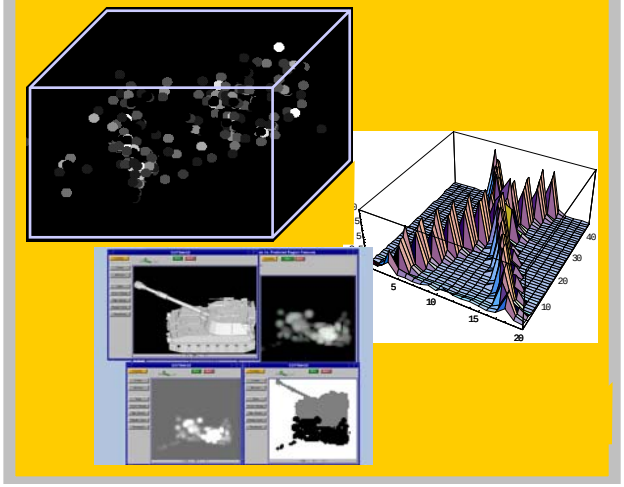
**Sensor Data Management System (SDMS)**

Challenge Problems
Standard Metrics
ATR Theory

## FIND FIX TRACK & ID

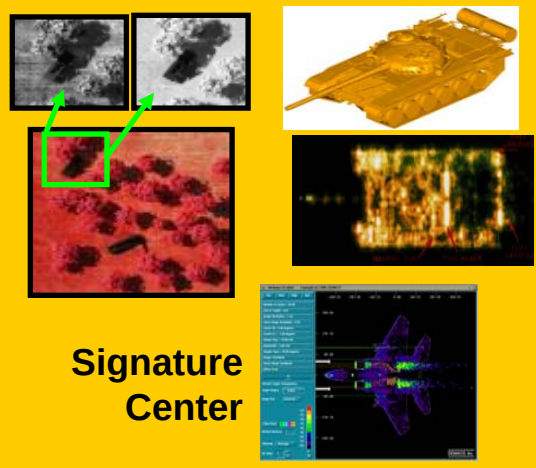



## INNOVATIVE ALGORITHMS



Operational Target
Models/Databases

## SIGNATURES & MODELING

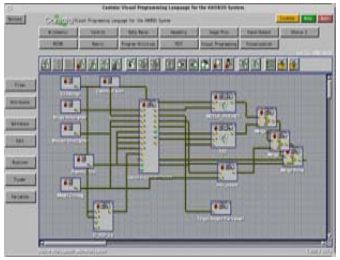


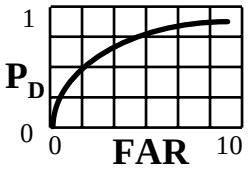
**Signature Center**

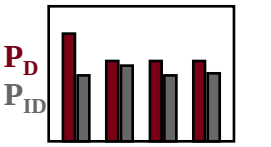
Phenomenology Exploration
EM Modeling
Synthetic Data

# ATR Facilities

COMPASE Center

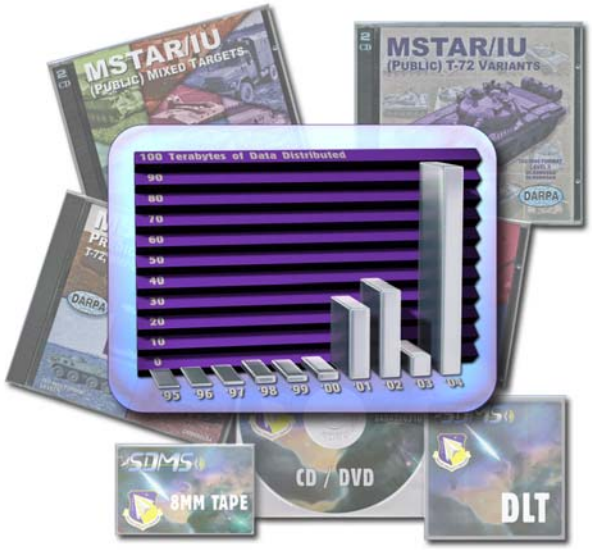




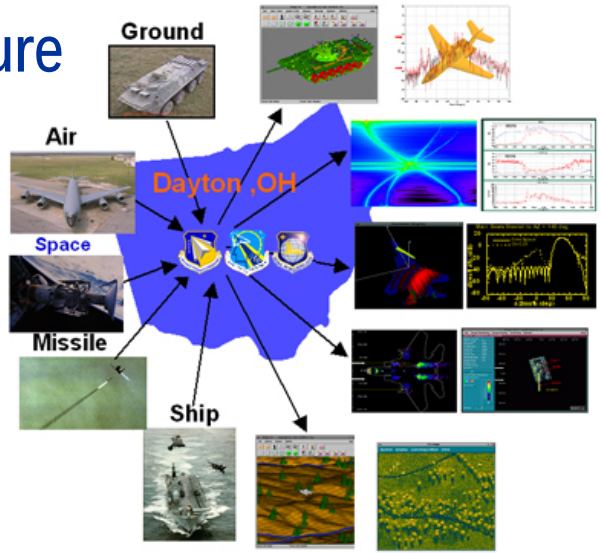

Sensor Resolution

## Advanced Recognition Capability (ARC) Facility

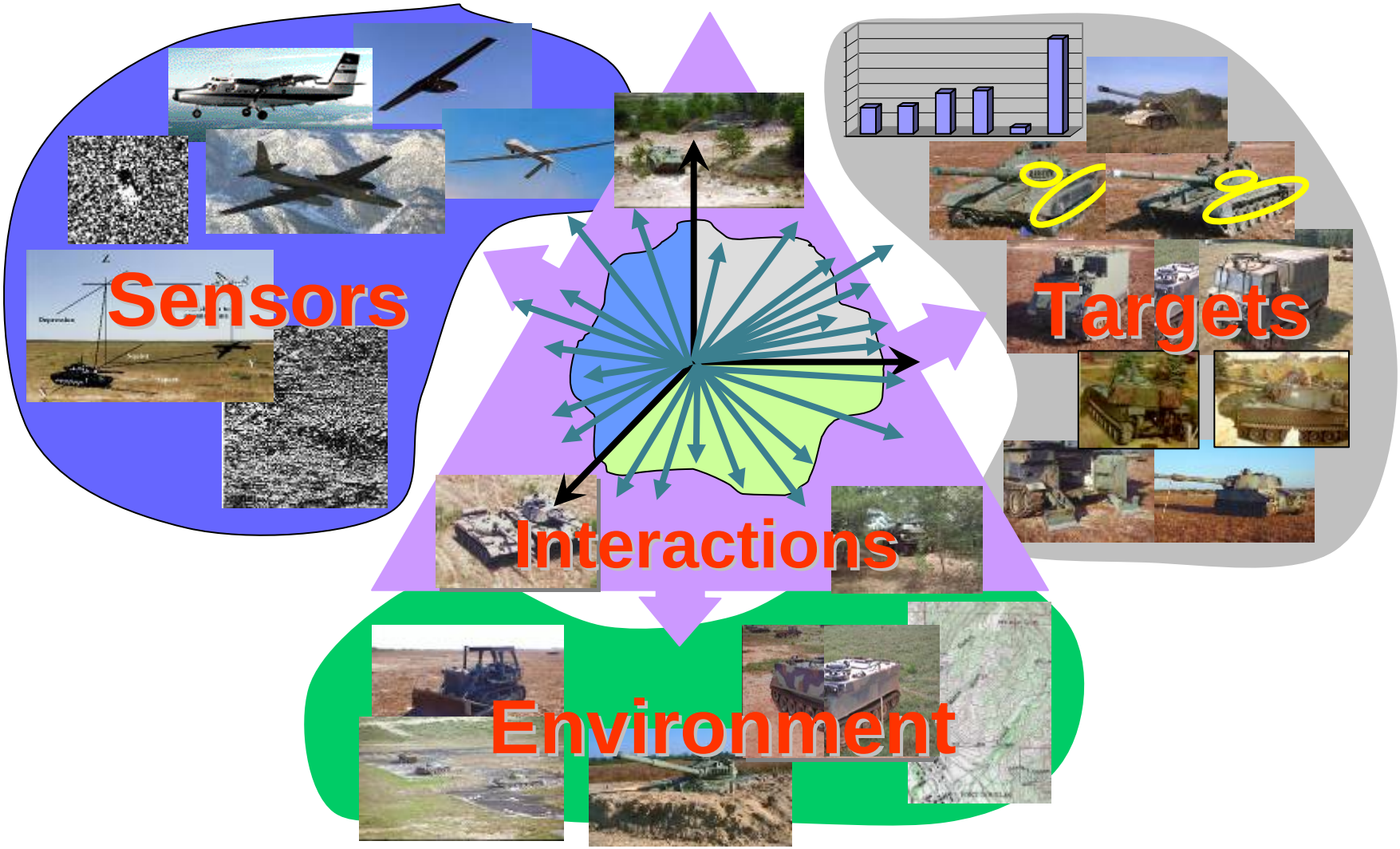



## Sensor Data Management System (SDMS)

## Signature Center



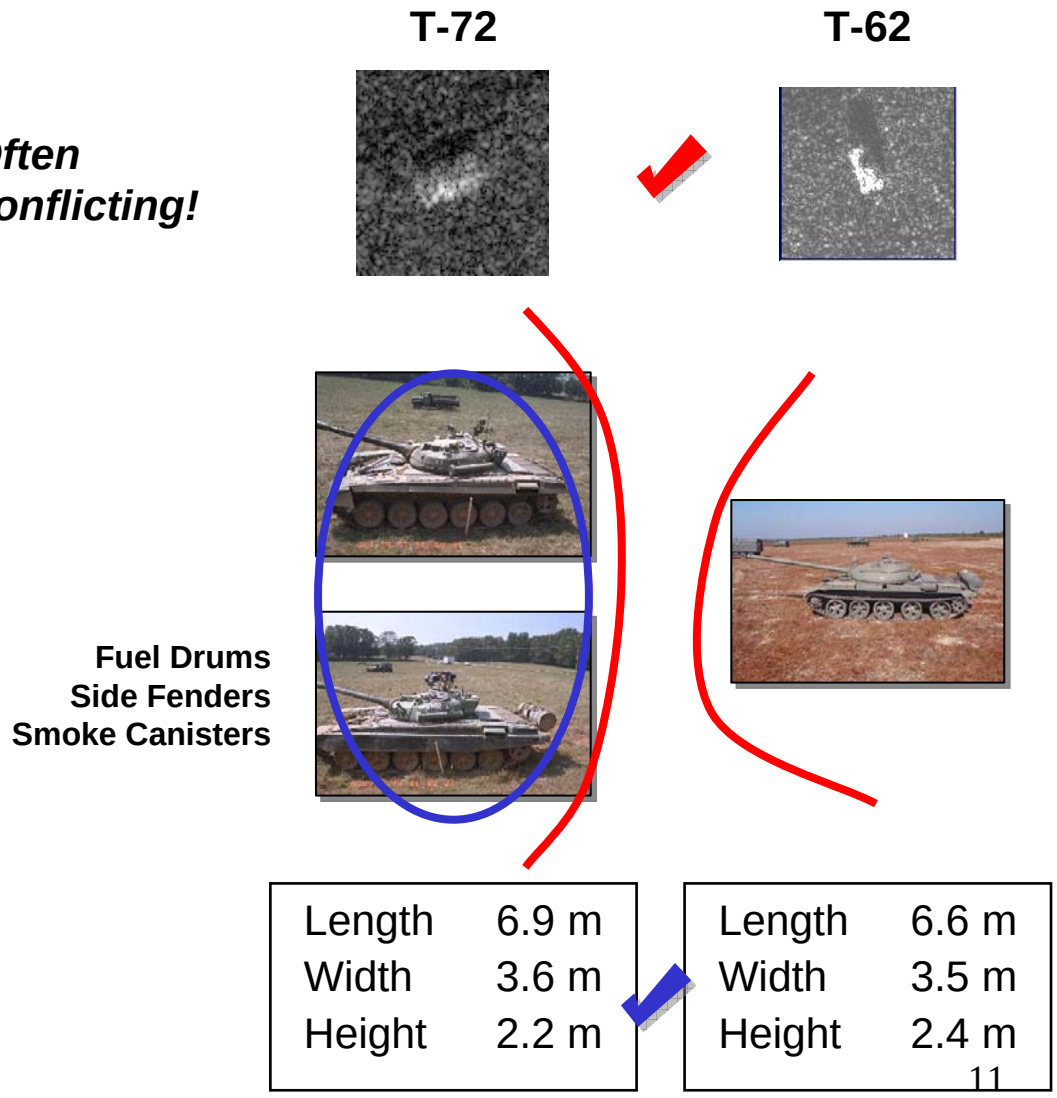
# Operating Conditions (OCs)



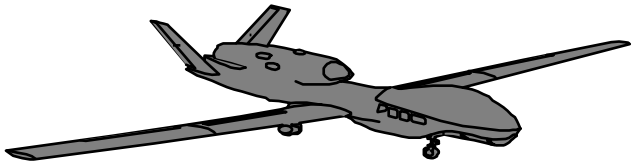
# How can we make ATR easier?

- "Better" Features
  - Greater discriminating power
  - Less variability
- "Better" Data
  - Resolution, dwell, persistence, …
  - Multiple sources (modes, looks, phenomenologies)

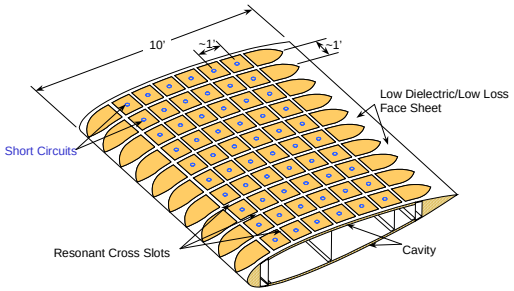
***Often conflicting!***

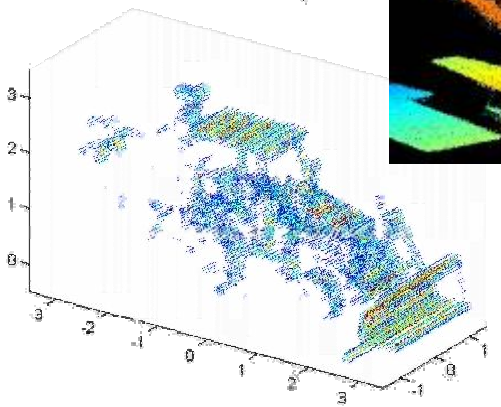


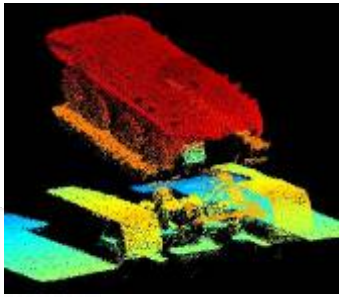
# ATR-Driven Sensing



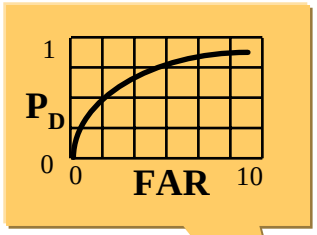
Cueing, Prioritization for the Human



# ‘Clear Box’ View of ATR



Target

Environment

Sensor

Detect
Track
Geolocate
ID

ATR
Decisions

Human
Decisions

Feature
Extractor

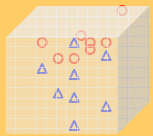
Discriminator

Target
Knowledge

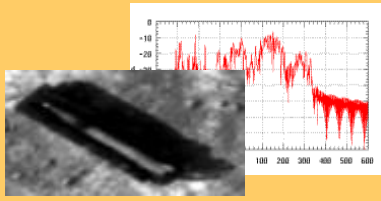
Decision
Rule

Target
Models &
Database

Target Knowledge



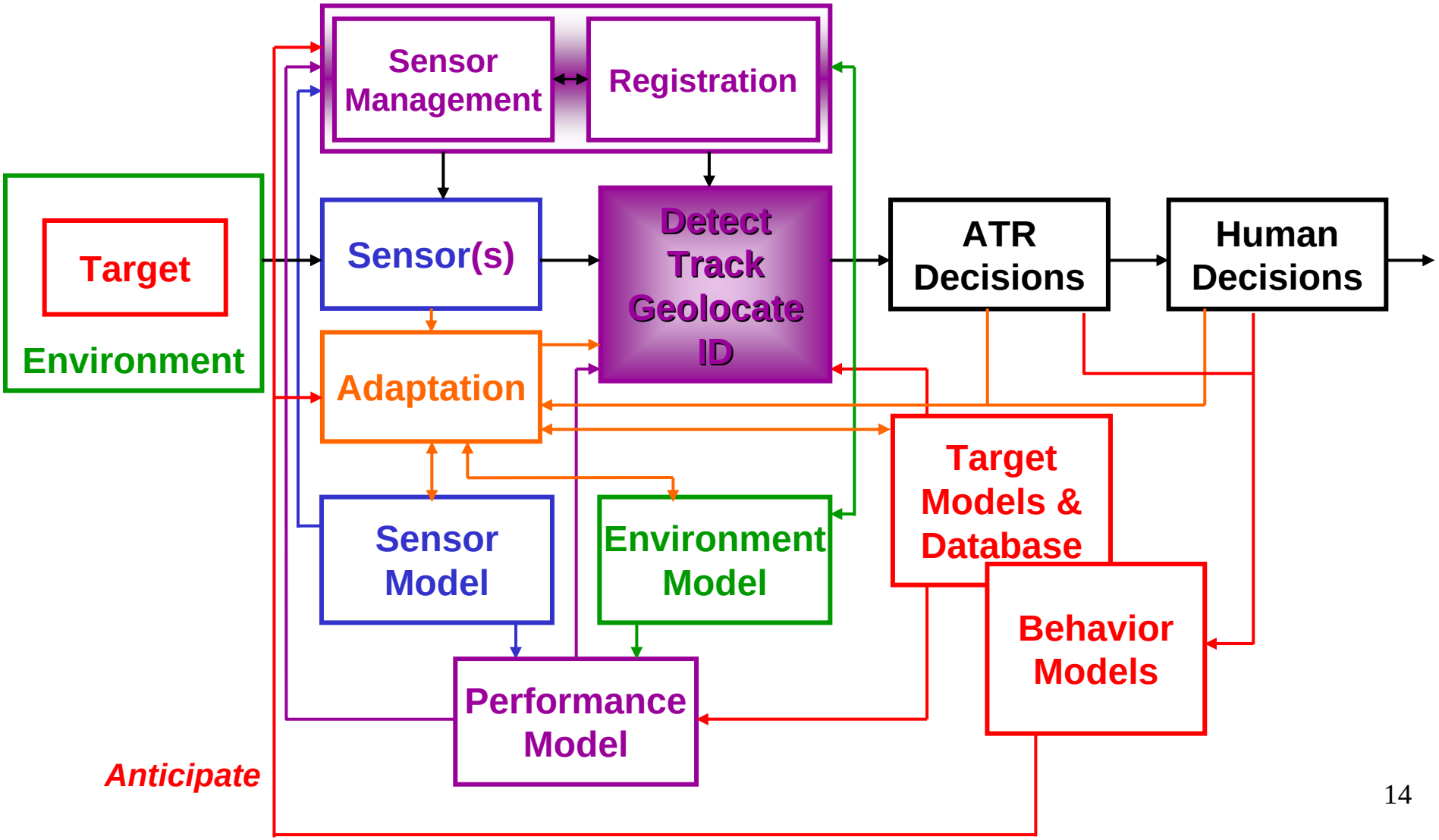
Trained
Features



Templates

Models

# Multiple Sensor ATR



# ATR Theory Goals

- Performance Prediction
  - Algorithm (or feature) dependent
  - As a function of sensing, target, and environment conditions
  - Tool for developers (how will this new feature help?), “maturers” (does this work well enough for my application?), and users (is this system going to work in my scenario today?)
- Performance Bounds
  - Algorithm independent performance limits
  - As a function of sensing, target, and environment conditions
  - Is the limit the algorithm (keep working) or the sensor (motivate sensor improvements)?
- Performance Models
  - Packaged tools from Performance Prediction usable by sensor management and fusion algorithms to weigh sensor contribution

# Growing ATR Complexity

Targets

Dismounts

Civilian Vehicles

Military Vehicles

Aircraft

Smaller
More Variable

Tougher Clutter
More Obscuration

Environments

Open

Forested

Urban

Detect

Track

ID

More Specific

Function