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# Optical Signature Capability for STK

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# Acknowledgements And Contacts



- OPTISIG has been developed under the technical direction of the T&E Directorate/Data Analysis Division, U. S. Army Space and Missile Defense Command, Huntsville, Alabama
- The OPTISIG/STK interface software development was funded by Teledyne Corporate Independent Research and Development

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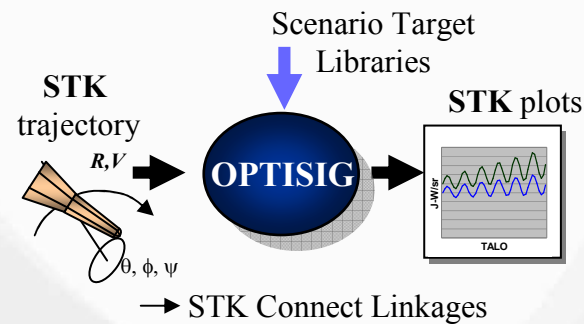


# Outline



**TELEDYNE  
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- OPTISIG Overview
- OPTISIG Heritage And Users
- The Physics of OPTISIG
- OPTISIG/STK Interface
- Simple Mission Planning Exercise
- Summary



  
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# OPTISIG Overview

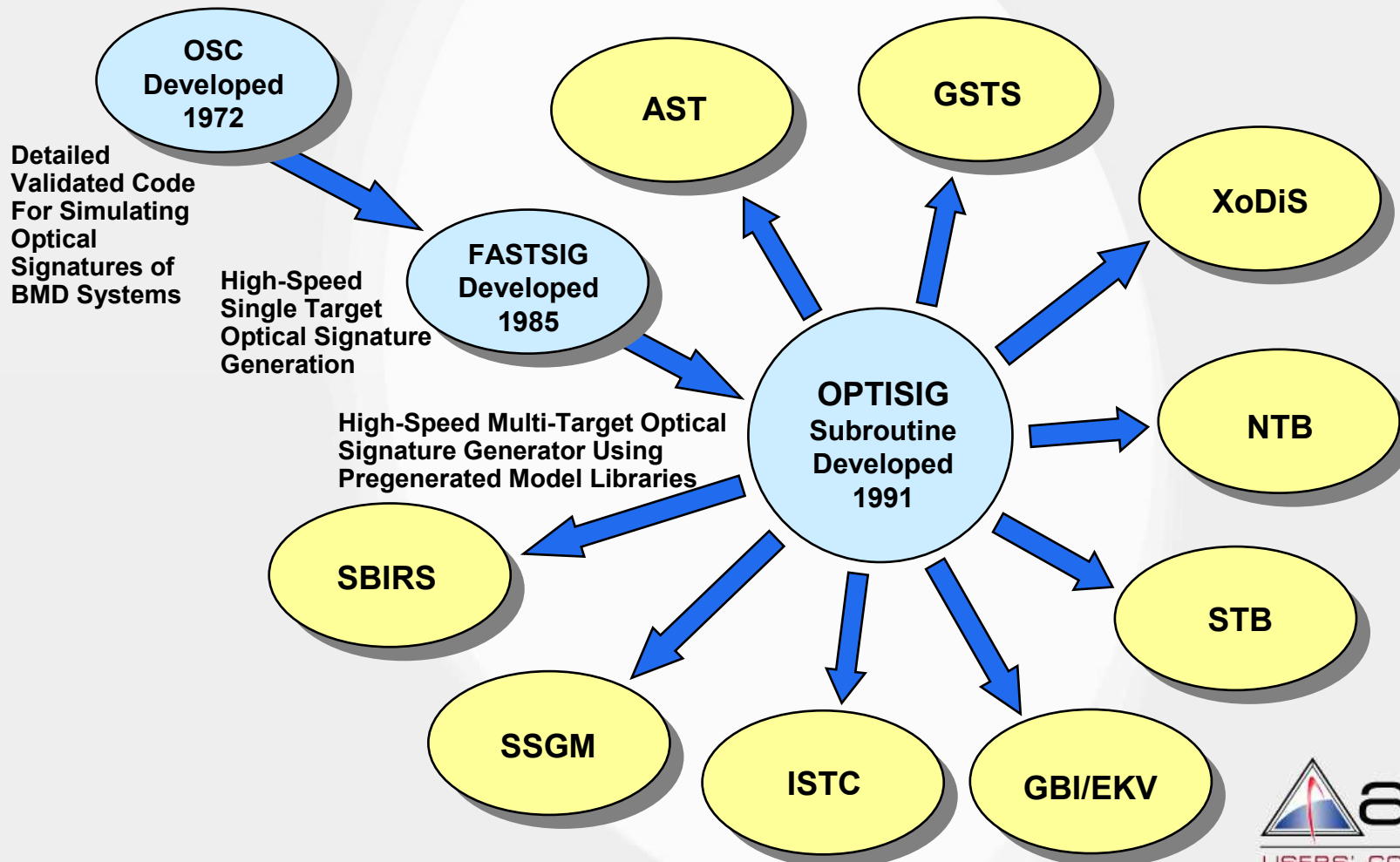
	<b>OPTISIG</b>
Structure	Fortran Subroutine ~30,000 Lines
Primary Applications	Multi-Target Threat Complex Generation, System Simulations, Discrimination Algorithm Development, Acquisition and Track Studies
Standardized Target Capability	Target Model Libraries Distributed With OPTISIG
Target Type	Axisymmetric Target Shapes Described by Cones, Cylinders, Spheres, Disks, Plates
Fidelity	High to Medium
Approximate Run Time	1 Sec Per Target

- OPTISIG provides optical signatures for missile systems and payloads between Visible and Long Wave Infrared
- Models targets from ascent through reentry
- Results verified to the Industry standard OSC code for typical target classes (RVs, replicas, balloons)

# OPTISIG Heritage And Users



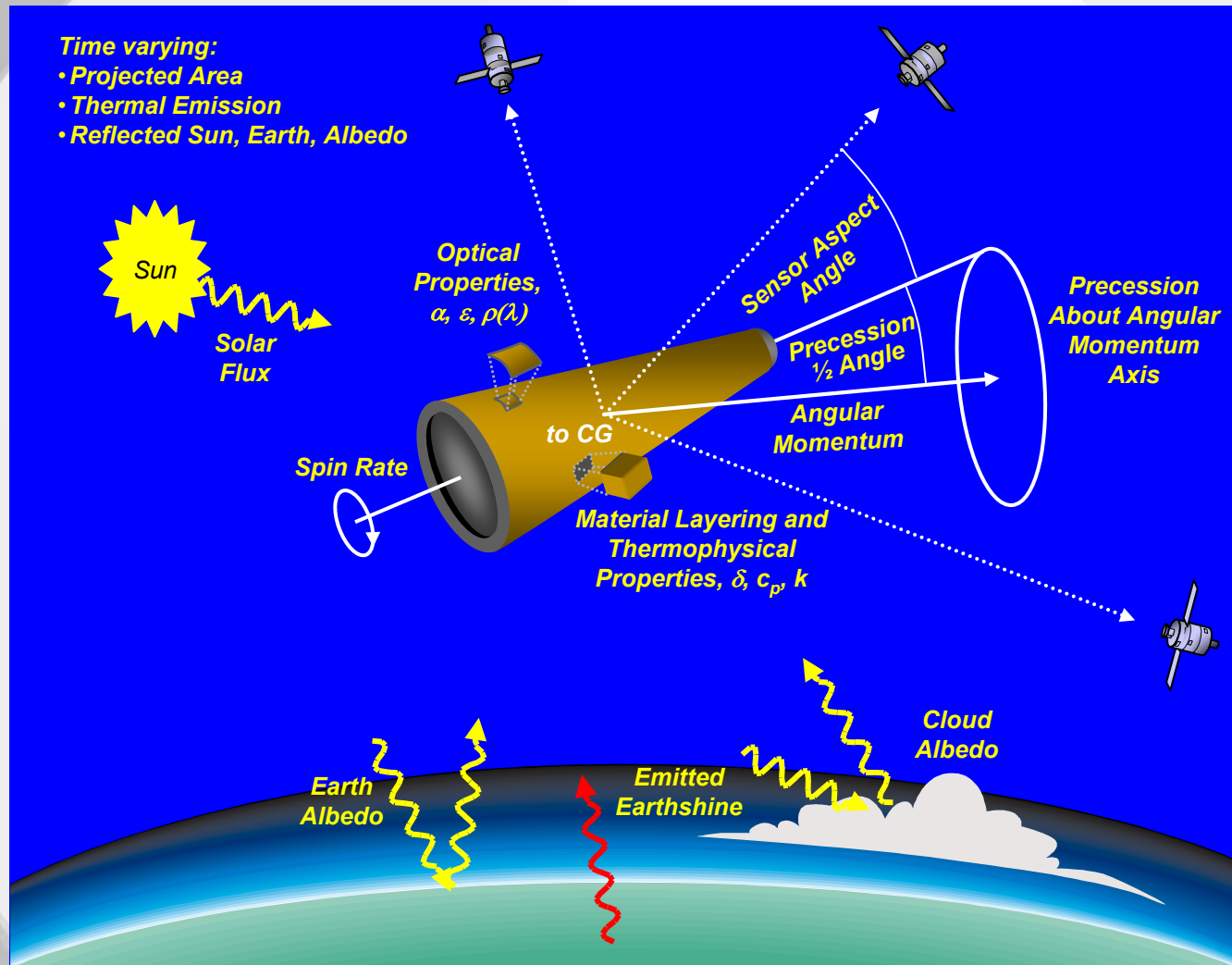
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# The Physics Of OPTISIG



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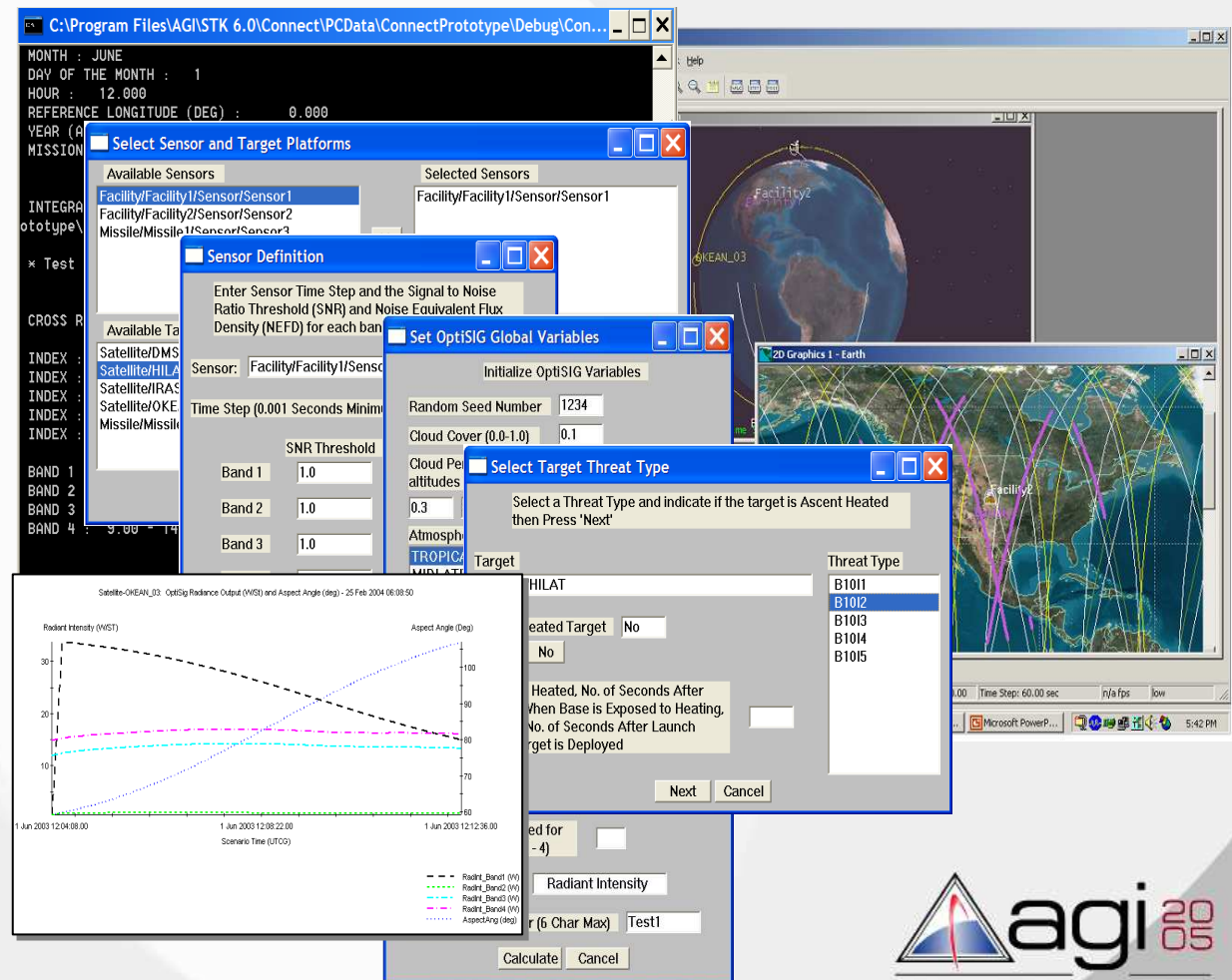


- Target Models
  - Shape Primitives
  - Thermal Properties
  - Optical Properties
- Natural Sources
  - Solar
  - Earthshine
  - Earth Albedo
  - Aerothermal
- Target Motion
  - Rigid Body Dynamics (Precession)

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# OPTISIG/STK Interface

- Windows application
- Can use the power of STK's flight and constraint algorithms
- Provides Radiant Intensities using an industry recognized tool (OPTISIG)
- Uses STK Connect linkages
- Can be utilized for mission planning and battle management exercises



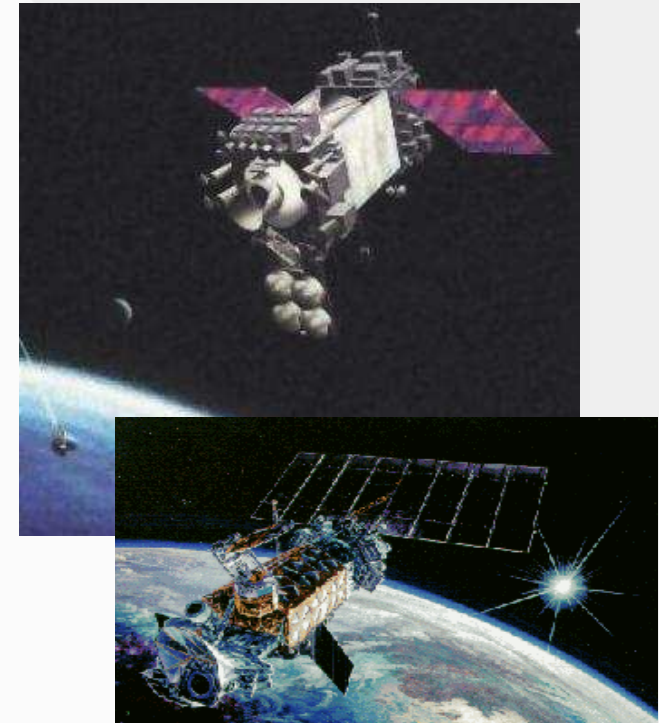
The screenshot displays the OPTISIG/STK interface with several windows open. The main window shows a 3D Earth model with a satellite and target. Overlaid windows include:

- Select Sensor and Target Platforms:** Lists available sensors and selected sensors.
- Sensor Definition:** Allows defining sensor parameters like Time Step, SNR Threshold, and NEFD.
- Set OptiSIG Global Variables:** Sets variables like Random Seed Number, Cloud Cover, and Cloud Percentages.
- Select Target Threat Type:** Selects a threat type (e.g., B1011, B1012) and indicates if the target is heated.
- Plot:** A line graph showing Radiant Intensity (WST) and Aspect Angle (Deg) over Scenario Time (UTCS).

The plot shows Radiant Intensity (WST) on the left y-axis (0 to 30) and Aspect Angle (Deg) on the right y-axis (60 to 180). The x-axis is Scenario Time (UTCS) from 1 Jun 2003 12:04:08.00 to 1 Jun 2003 12:12:38.00. The legend indicates: Radiant\_Band1 (W) (dashed black), Radiant\_Band2 (W) (dashed red), Radiant\_Band3 (W) (dashed blue), Radiant\_Sensor1 (W) (dotted green), and AspectAng (deg) (solid purple).

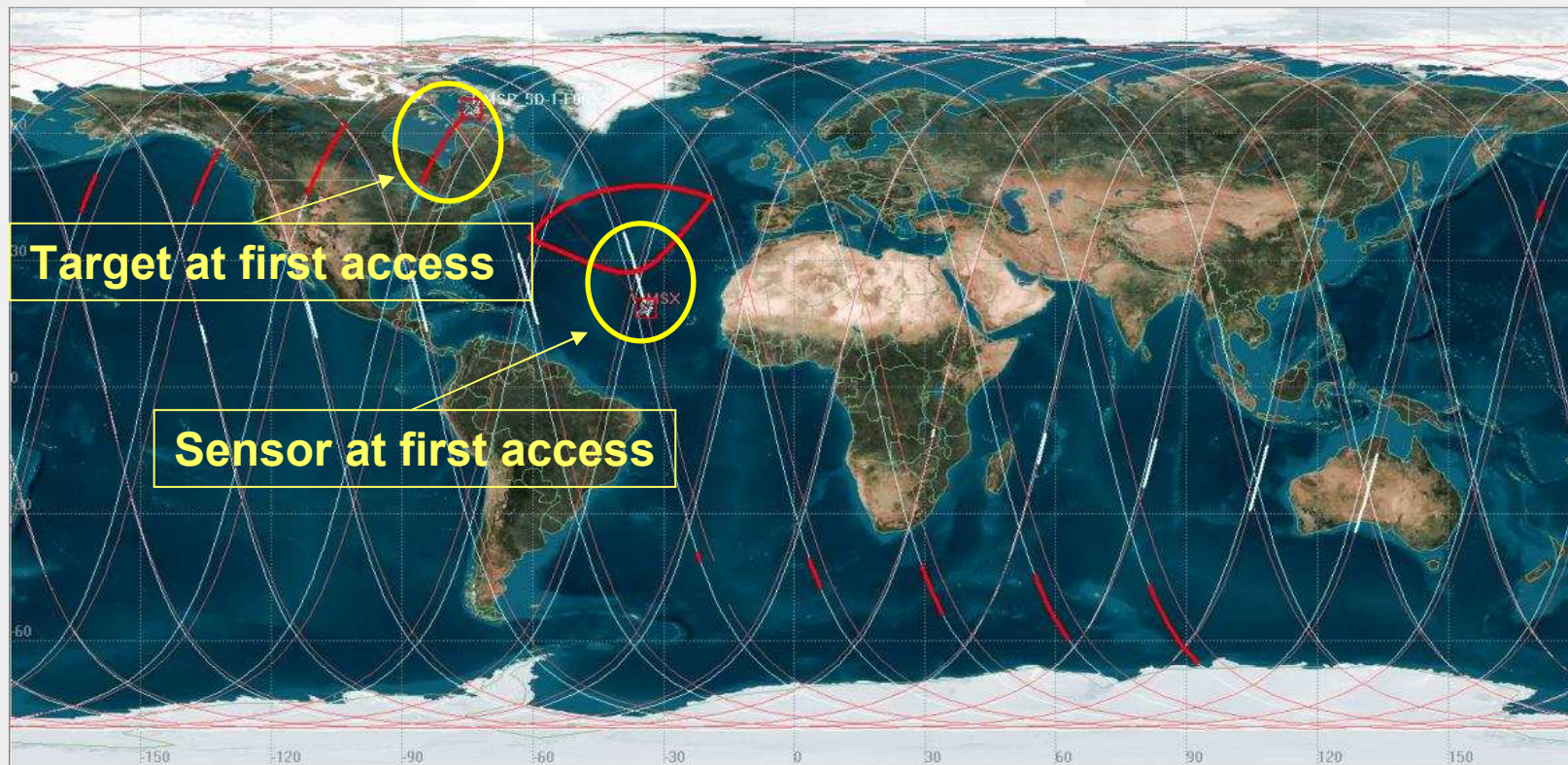
# Simple Mission Planning Exercise

- MSX Satellite (Sensor Platform)
  - Three Infrared detectors (hypothetical)
    - Short Wave IR
    - Medium Wave IR
    - Long Wave IR
  - Data Rate: 0.5 Hz
  - Noise Level:  $1e-18$  W/cm<sup>2</sup> (each band)
- DMSP\_5D-1-F06 Satellite (Target)
- Schedule mission for June 1, 2004
- Require at least 200 seconds of target viewing with a signal-to-noise ratio of at least 8.0



**Disclaimer:** All sensor parameters used in this exercise are fictitious, any resemblance to real sensors, living or dead, is purely coincidental.

# STK Predicts Multiple Accesses



- Sensor views target on ten separate occasions on 6/1/2004

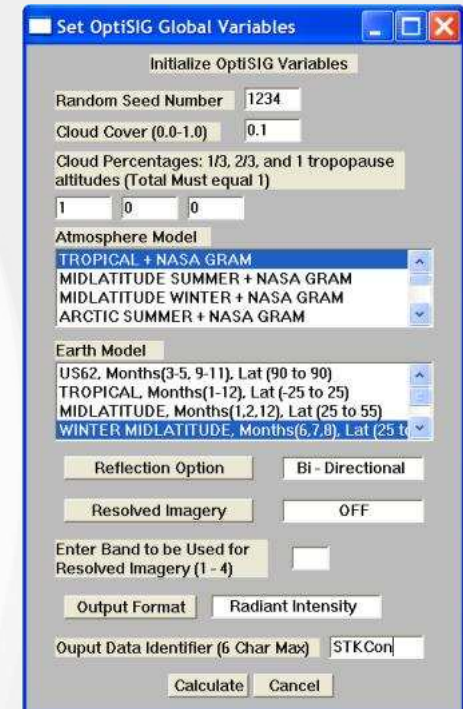
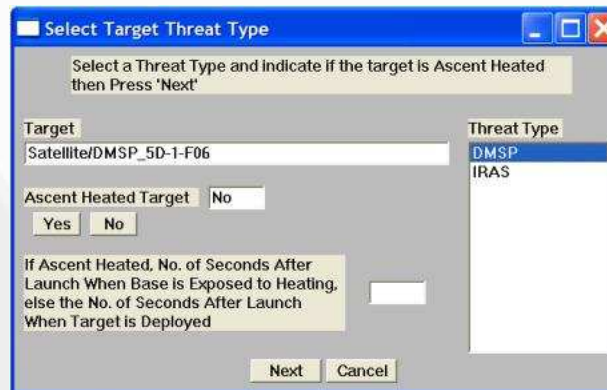
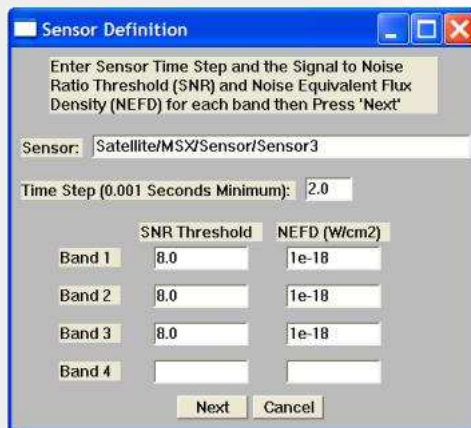
# STK Access Summary Report

Access	Start Time (UTCG)	Stop Time (UTCG)	Duration (sec)	
1	1 Jun 2004 00:16:51.404	1 Jun 2004 00:22:32.702	341.298 ★	
2	1 Jun 2004 01:07:59.307	1 Jun 2004 01:13:20.481	321.174 ★	
3	1 Jun 2004 01:59:22.814	1 Jun 2004 02:04:08.682	285.868 ★	
4	1 Jun 2004 02:50:32.394	1 Jun 2004 02:54:55.024	262.629 ★	
5	1 Jun 2004 03:41:57.888	1 Jun 2004 03:45:40.609	222.721 ★	
6	1 Jun 2004 04:33:09.218	1 Jun 2004 04:36:25.193	195.976	
7	1 Jun 2004 05:24:36.993	1 Jun 2004 05:27:07.560	150.567	
8	1 Jun 2004 06:15:50.282	1 Jun 2004 06:17:49.896	119.614	
9	1 Jun 2004 07:07:20.947	1 Jun 2004 07:08:28.054	67.106	
10	1 Jun 2004 07:58:36.658	1 Jun 2004 07:59:07.271	30.613	
<b>Global Statistics</b>				
<b>Min Duration</b>	10	1 Jun 2004 07:58:36.658	1 Jun 2004 07:59:07.271	30.613
<b>Max Duration</b>	1	1 Jun 2004 00:16:51.404	1 Jun 2004 00:22:32.702	341.298
<b>Mean Duration</b>				199.757
<b>Total Duration</b>				1997.567

- First five accesses satisfy 200 second viewing duration criteria
- Last five accesses are too short
- Run OPTISIG to check first five accesses for sufficient signal on the focal plane

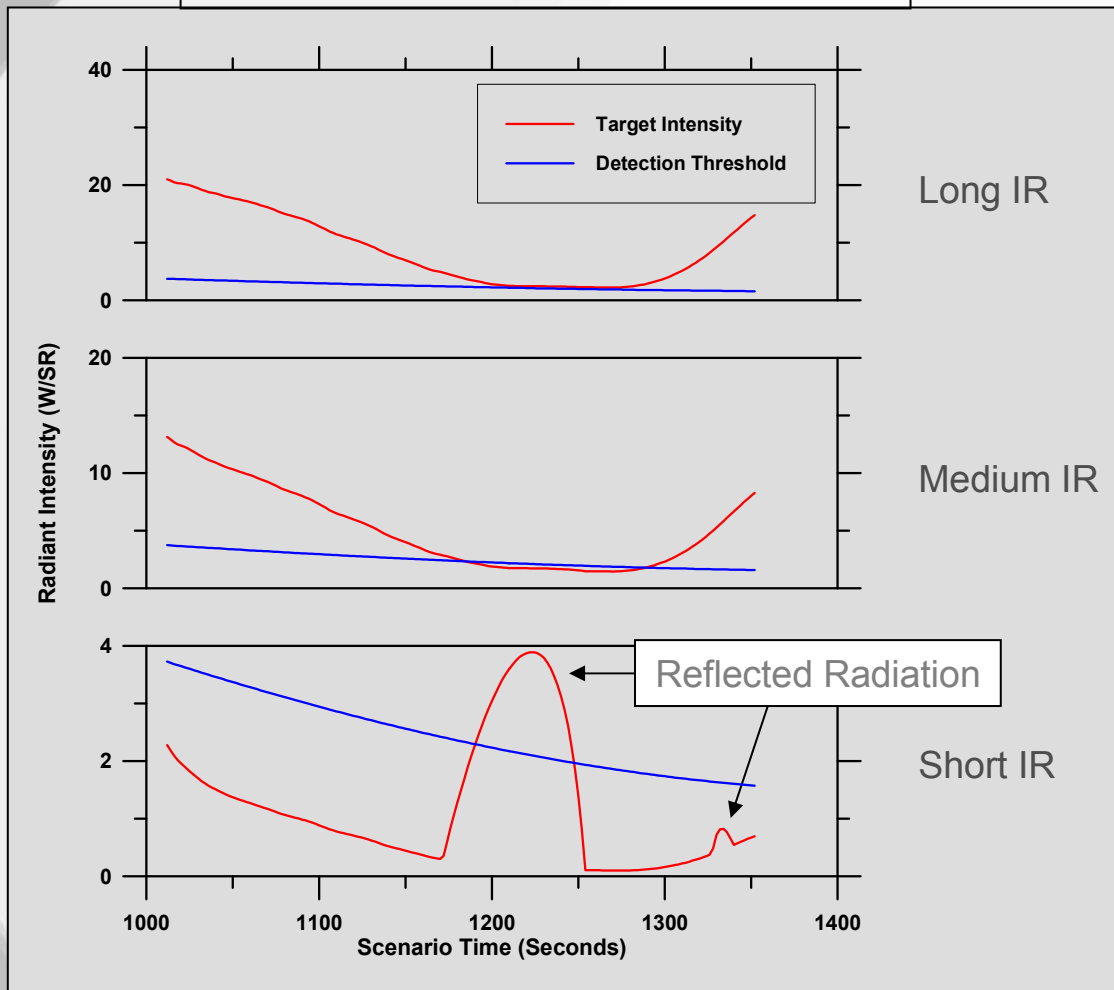
# Set Up OPTISIG Run

- Associate STK trajectories with OPTISIG sensors and targets
- Set up sensor noise and data rate parameters
- Set up OPTISIG environmental parameters



# OPTISIG Results (Access Interval 1)

1 Jun 2004 00:16:51.404 1 Jun 2004 00:22:32.702



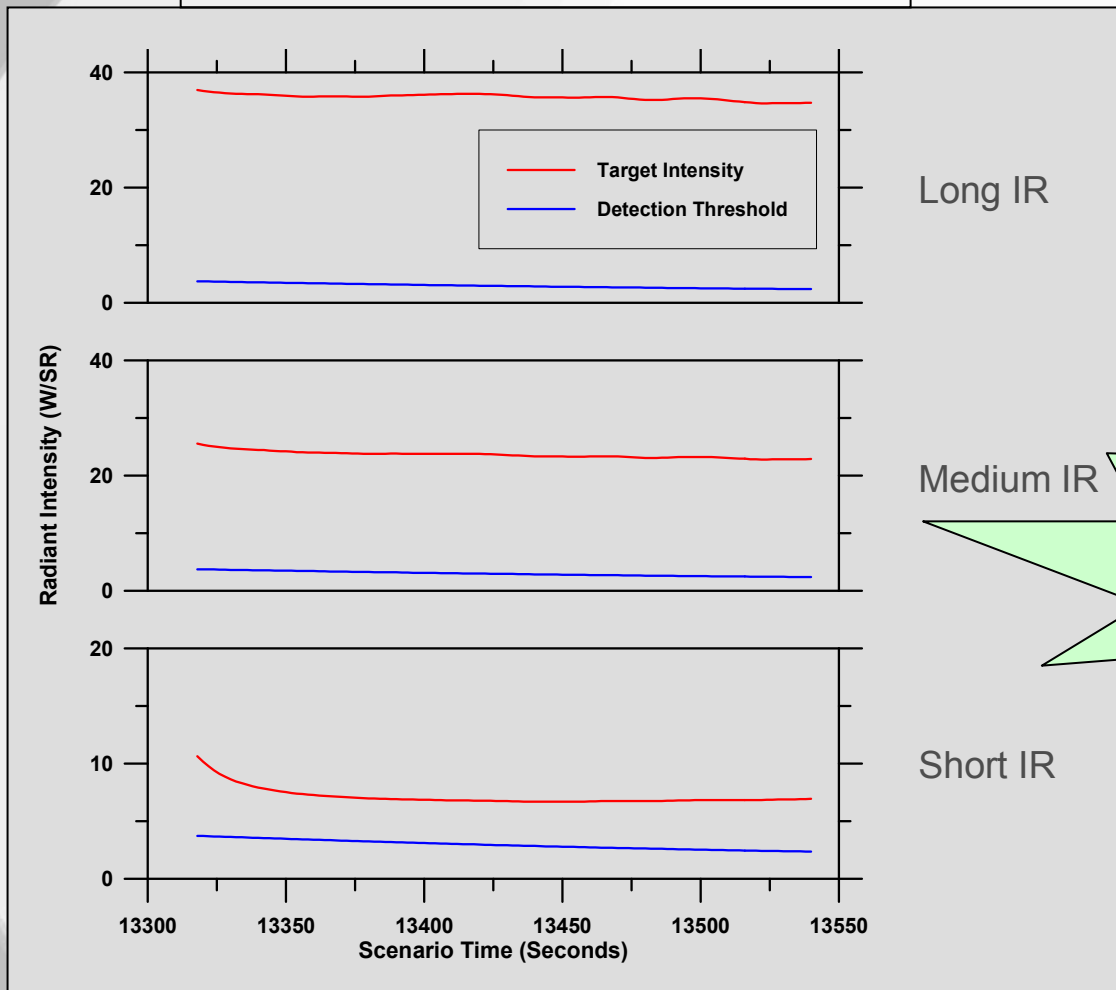
- Access interval 1
  - Yields data above 8.0 SNR threshold
  - Not sufficient for 200 second duration
- Short IR band shows off OPTISIG's ability to model reflected radiation from Sun & Earth
- Access intervals 2, 3, and 4 show similar threshold deficiencies

# OPTISIG Results (Access Interval 5)



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1 Jun 2004 03:41:57.888 1 Jun 2004 03:45:40.609



- Access interval 5
  - Each sensor band yields data above required threshold for the entire interval

- Only access meeting or exceeding mission requirements

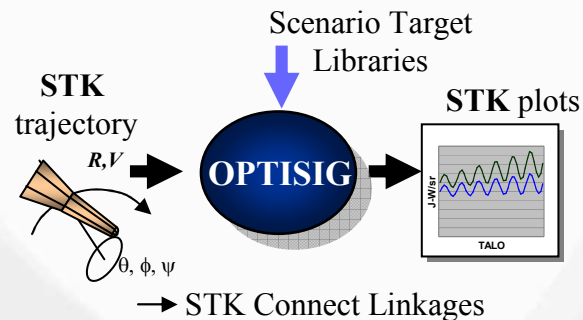


# Summary



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- OPTISIG/STK is a Windows driven application
- Allows the user to utilize the power of STK's flight and constraint analysis algorithms
- Provides optical radiant intensities via the use of an industry recognized prediction tool (OPTISIG)
- Interface is established via STK Connect linkages
- Can be utilized for mission planning and battle management exercises



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