Microsatellites—A Light in the Darkness

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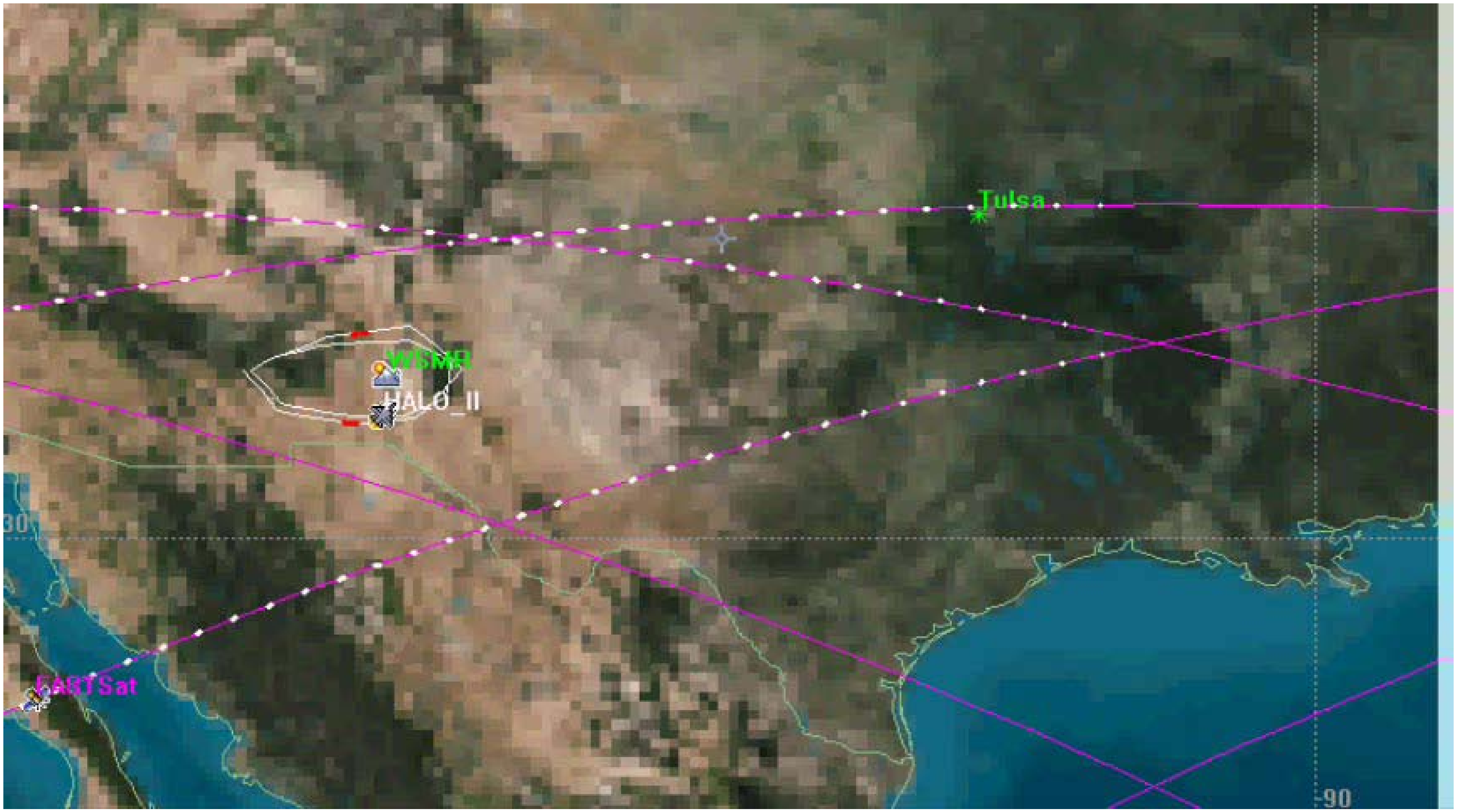
Lighting Up the Darkness

- Payload program established to address US Army space Science and Technology needs
- Overall program emphasis
  - Low-cost microsatellites
  - Rapid demonstration of new technology to support transition to acquisition programs
  - Collaboration with University of Hawaii/Sandia National Lab conducting booster development
- IR calibration source to support Missile Defense Agency airborne testbed operations selected as initial payload

Smaller, Faster, Cheaper

- Satellite concept:
  - 50 kg (15 kg payload)
  - Gravity boom stabilized
  - Yaw rotation during illumination

Microsat CONOPS

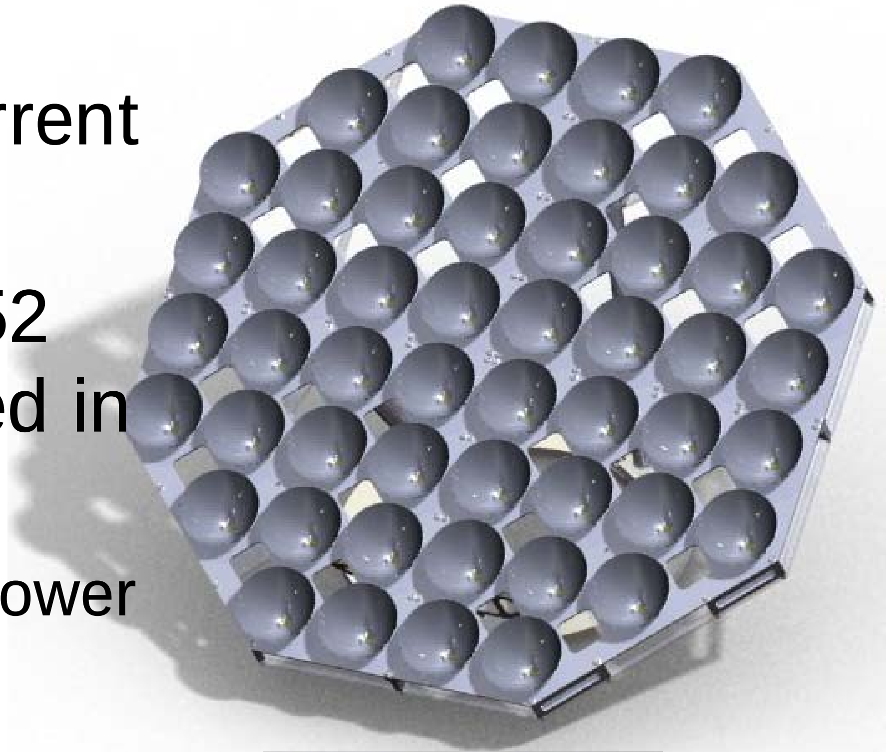


Smaller, Faster, Cheaper

- Satellite concept:
  - 50 kg (15 kg payload)
  - Gravity boom stabilized
  - Yaw rotation during illumination
- Command and control
  - Upload command set up to 24 hours before mission
  - Provide users with attitude and position data within 24 hours of mission

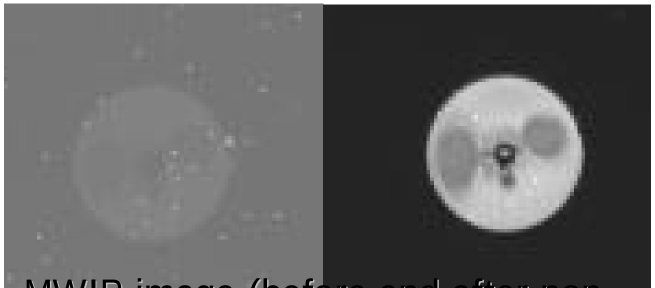
Not Just Another Star…

- Will replace/supplement current stellar calibration sources
- Current design consists of 52 thermal IR emitters mounted in 10 cm diameter reflectors
  - Approximately 375 W input power
  - LWIR and MWIR bands
  - Modified COTS emitter to reduce conduction losses (50%→5%)

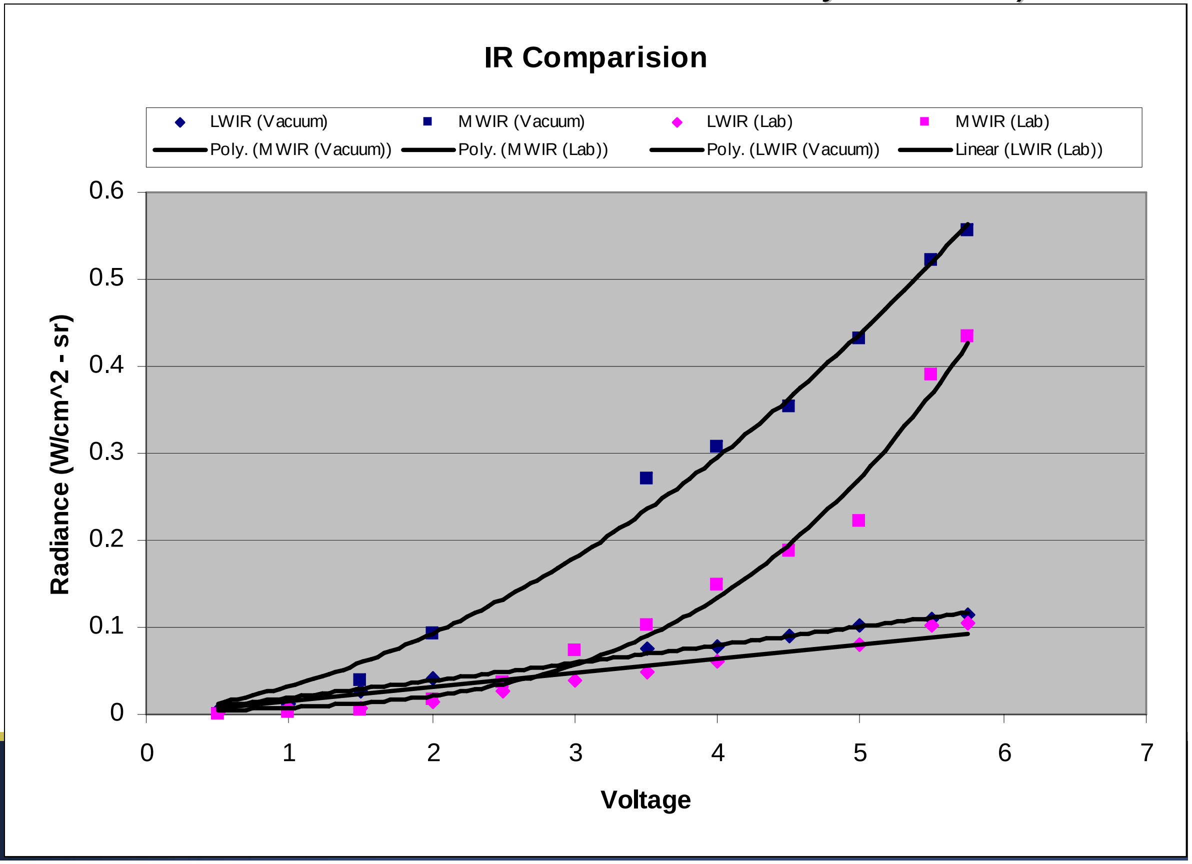


Metrics Give a Glowing Image

- Characterized emitters
  - Stability
  - Voltage response
  - Radiation profile
- Under laboratory and vacuum conditions

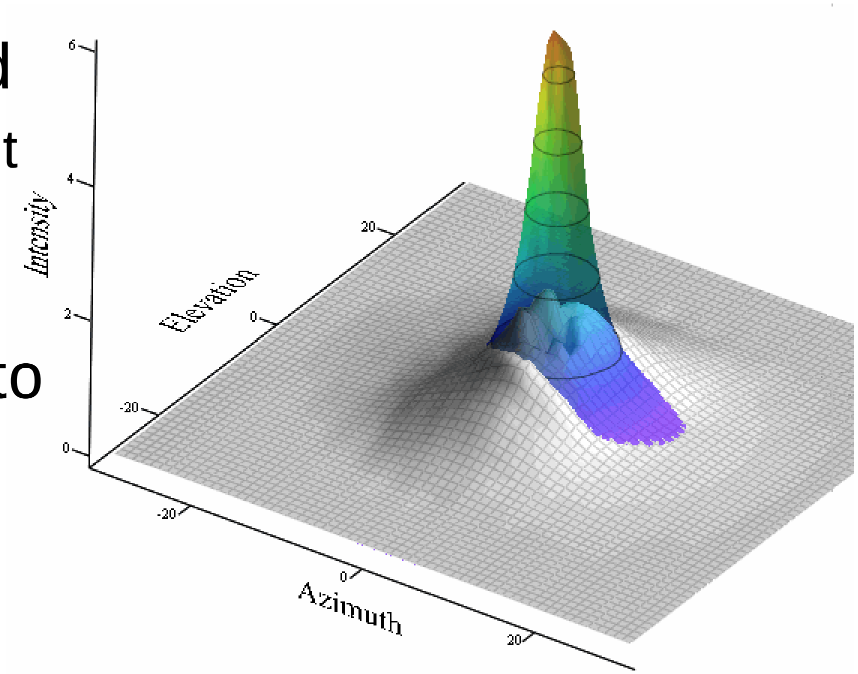


MWIR image (before and after non-uniformity correction)



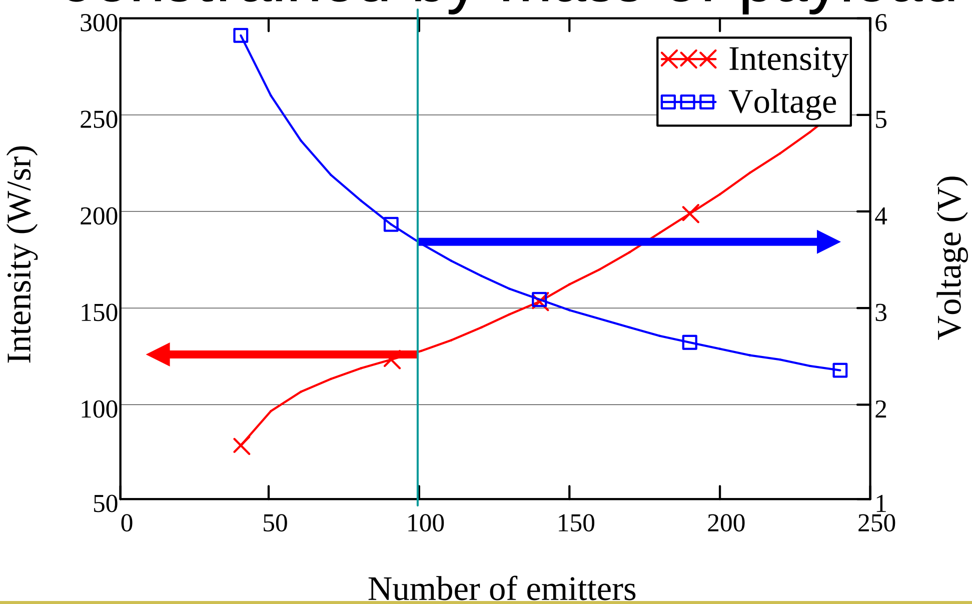
Need to Get (de-)Focused

- Minimum beam width determined by requirement on intensity accuracy and satellite pointing knowledge
- Focused beam was too collimated
  - Placed emitter 5 mm from focal point
  - Smooth, narrow beam replaced with irregular, broad beam
- Offset angle of each reflector 2° to average over irregularities



Not Black Magic—Just a Blackbody

- Factors subject to trade: voltage, number of emitters, array normal, altitude, inclination
- Cooler is better for LWIR
  - Provides greater irradiance for given input power
  - Constrained by mass of payload



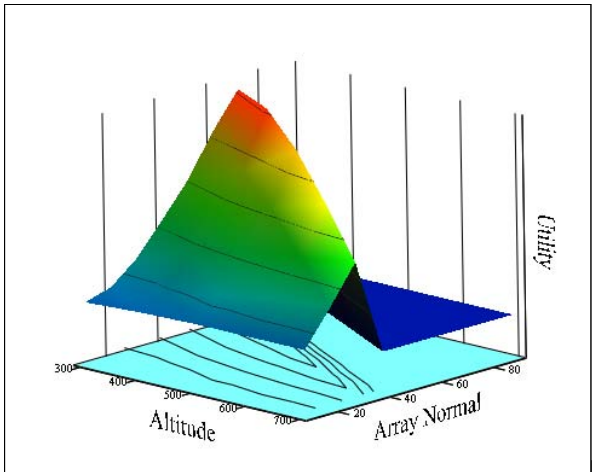
Example trade for 400 W input power

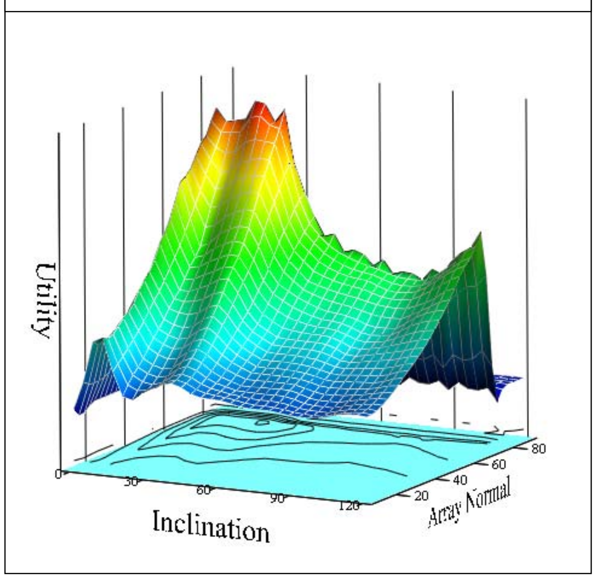
A larger number of emitters run at lower voltage yields higher intensity for a fixed input power

Optimal—It's Not Optional

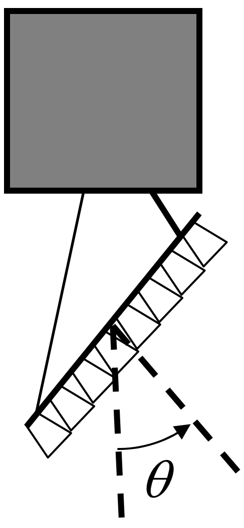
- Maximize total utility of system
  - Valid contact consists of minimum irradiance for set duration
    - Considered threshold and goal irradiance levels
    - No added value for contacts beyond minimum duration
  - Contact value based on location
    - Test areas outside continental US: 1.0 point
    - Test areas inside continental US: 0.8 point
    - Maintenance facility: 0.2 point
  - Estimate atmospheric effects at high altitudes
  - Run model for 100 days and calculate total utility

Trade Study—It's Not Just Normal



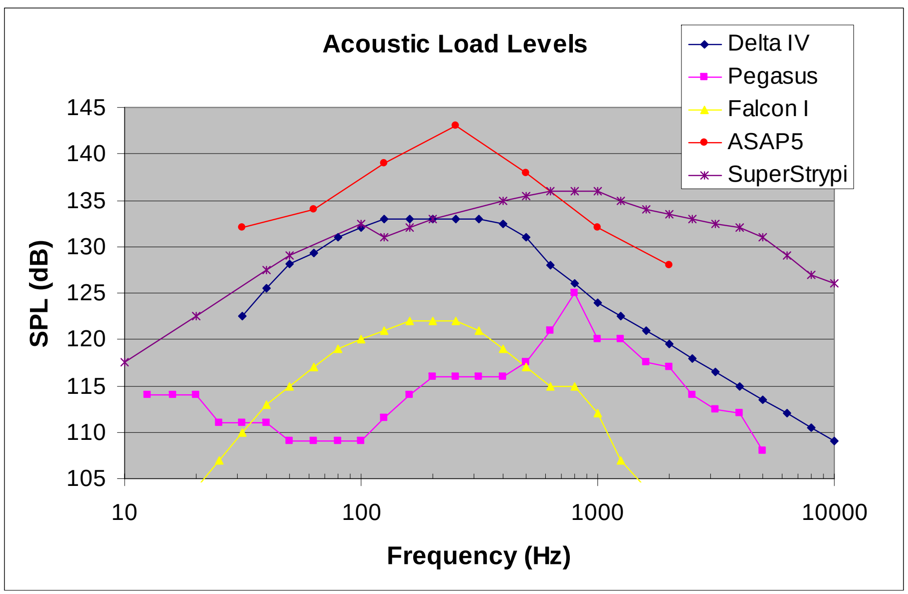


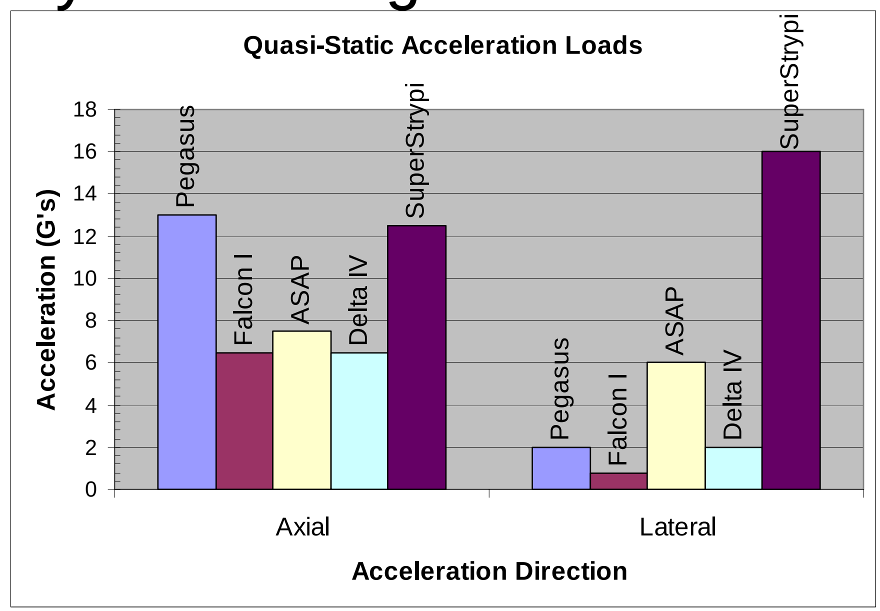
- Altitude—lower is better!
- Array normal (see diagram)
  - Max value constrained by atmospheric and $1/R^2$ losses
  - Drops precipitously above optimum value
- Inclination
  - Optimum value ~30°, balancing low and mid-latitude target sites



Space Qualification Plan

- Envelope environments for launch conditions
  - Solution to launch vehicle uncertainty
  - Super Strypi environment among the most arduous
  - Spin stabilization particularly demanding





Calibration Payload On Target

- All modeling providing acceptable results
  - Static/dynamic loading
  - Thermal
  - Electrical
  - Orbital
- Fabrication of structure to begin this month

Moving forward to support Army science and technology needs