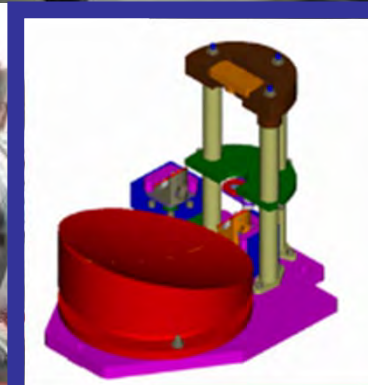
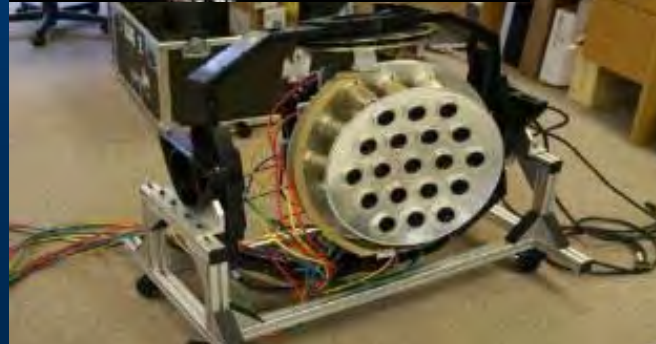
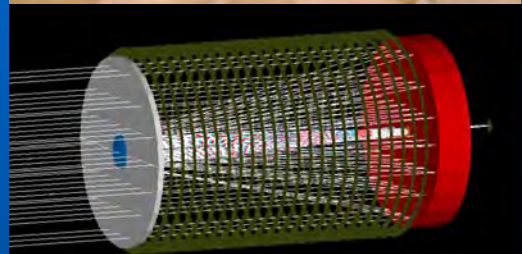


UAH CAO/NMDC Center for Applied Optics/ Nano&Micro Devices Center

Research advancing optical and
photonics science, design,
fabrication and testing

Building complex optical systems
and components for environments
from the lab to space



CAO Background

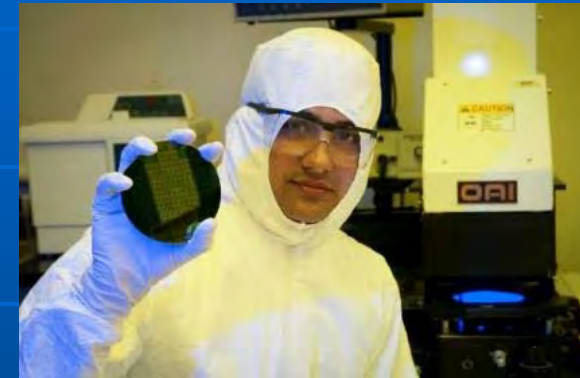


- Established in 1985 as a focal point of optics at UAH & in Alabama.
- NMDC Established in 2004
- CAO/NMDC merged in 2008
- Mission: advance research and education in optics and photonics science and engineering.
- Research Staff, Faculty, Affiliated faculty and students.
- 110,000sq ft Optics Building completed in 1991 with vibration-isolated laboratory core.
 - ~7000sq ft optics labs
 - ~7000sq ft clean rooms



NMDC

- 7000 sqft class 10,000 cleanroom
- Lithography, thin film dep., wet/dry etching, metrology
- Operates as a user facility for
 - ECE, MAE, ChE, Chem, PH, OSE
 - 7 local companies
 - ~\$145/hr
 - Full access during work hours
 - Extra fees for unusual materials
 - Can accommodate needs for proprietary work, but academic needs must be maintained



CAO: Classical Optics



■ Research Areas

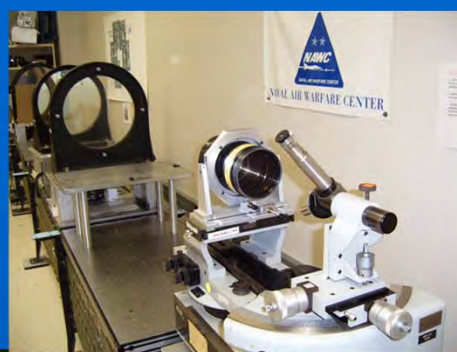
- Optical and Opto-mechanical System Design
- Optical Fabrication, Testing, Integration and Deployment
- Beam control, propagation characterization/ correction
- Radiometry, Radiometric Calibration & Polarimetry

■ Experience

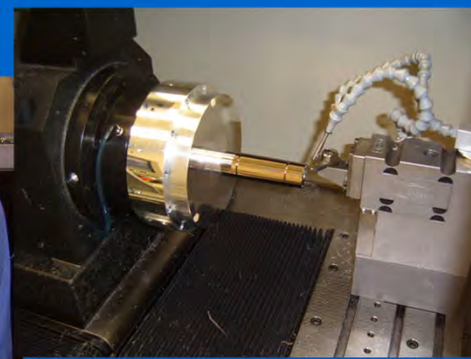
- Gamma-ray to THz
- Meter-class to micro-optics
- DoD, NASA, NSF and commercial customers
- Basic research through product development
- Education: Support of PhD program in Optical Science & Engineering

Optical Testing

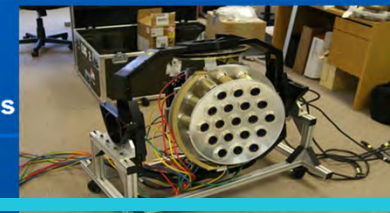
- Surface Metrology
- Component Quality
- Optical System Performance



Fabrication



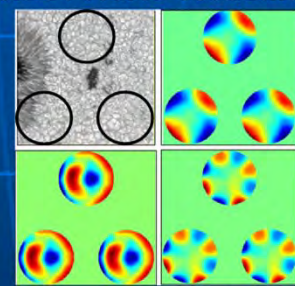
Components to Systems



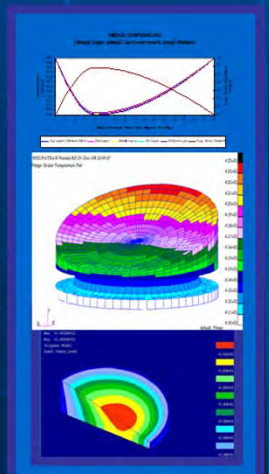
Analysis

- ZEMAX
- Code V
- ASAP
- FRED
- NASTRAN

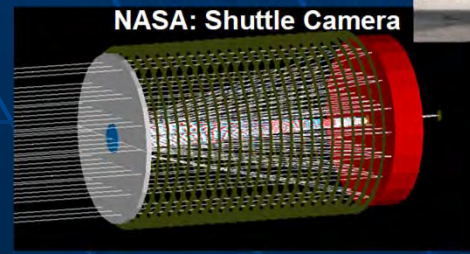
NSO: MCAO Modeling



NASA: WAVE



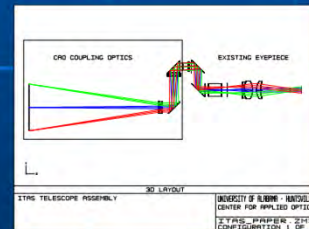
NASA: SPARCLE



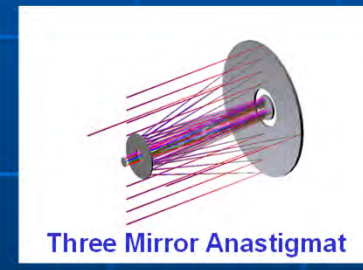
NASA: Shuttle Camera

Optical and Optomechanical Design

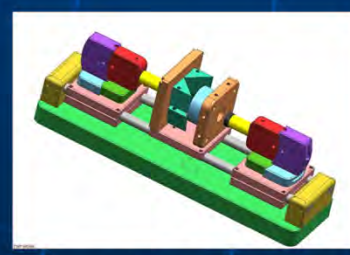
- ZEMAX
- CODE V
- Matlab
- Rhino



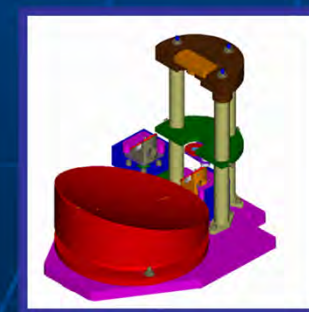
ITAS



Three Mirror Anastigmat



Thin Disk Laser



SPARCLE

Unique Fabrication Equipment

■ NSF-MRI

- Zeeko IRP-600X Freeform Polisher
 - Any shape or material
 - 600mm diameter free-form
 - 900mm diameter Rot. Sym.
 - 400mm vertical range



■ NASA Grant

- Nanotech 250UPL Diamond Turning Lathe
 - Free form surfaces
 - 300mm diameter
 - 150mm length



Fabrication Examples



Upgraded Metrology

- New instrumentation to meet our metrology needs
 - Interferometer
 - 4D Accufiz
 - 6MPix, 4" with 12" expander, Visible
 - Surface Profiler
 - 4D NanoCam Sq
 - Surface roughness
 - CMM
 - Zeiss Accura
 - ~1m³ volume



Example Projects

Gigapixel Camera Program

Development



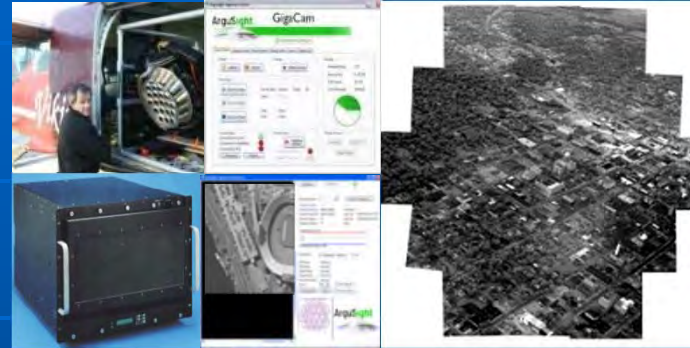
9/18/05
Knoxville, TN
7.6° x 7.6°

2005



3/30/06
Milwaukee, WI
> 21°

2006



2007 - 2009
Springfield, IL – FW, Gimbal
Yuma, AZ – FW & Rotary
> 34°

2007

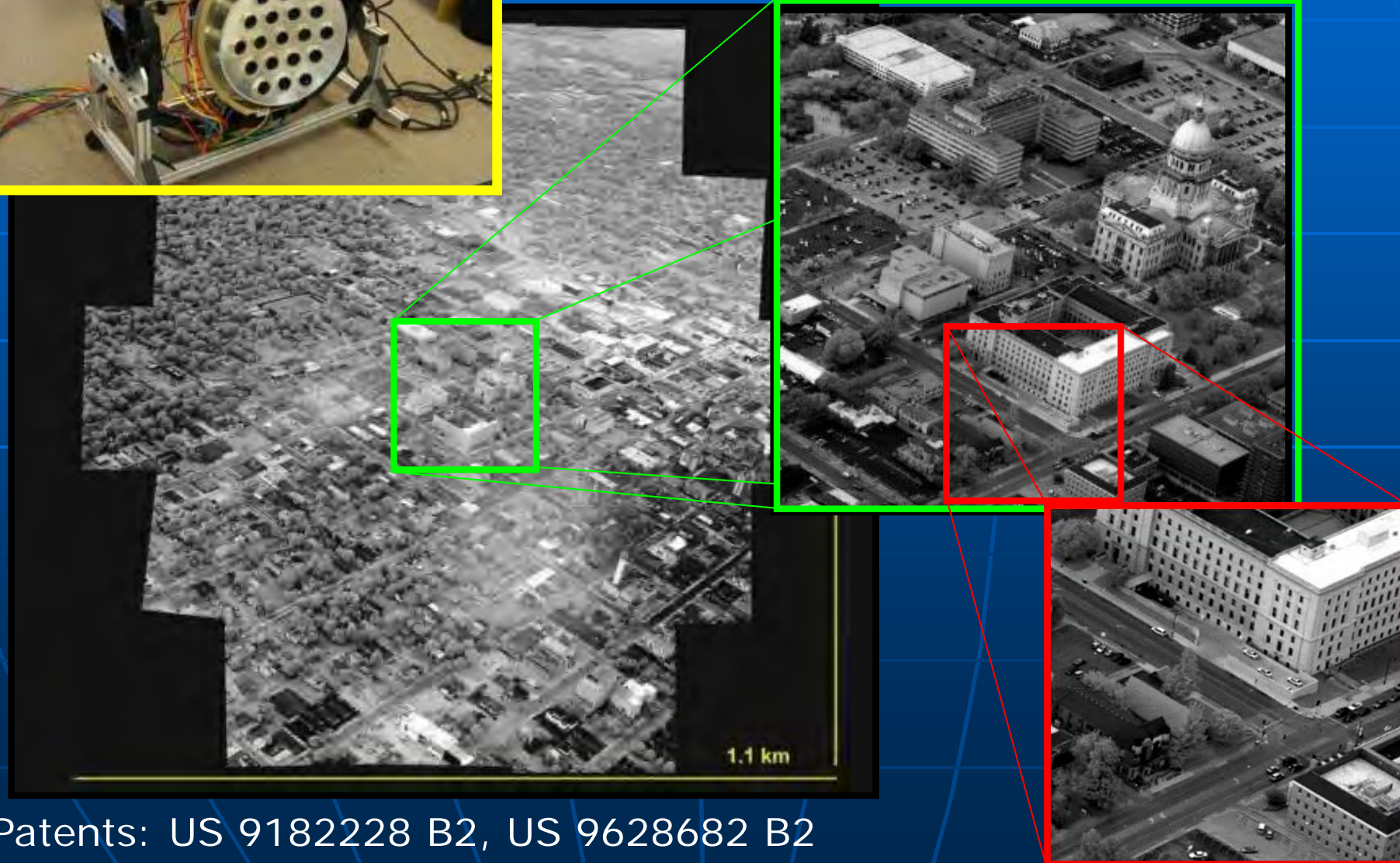
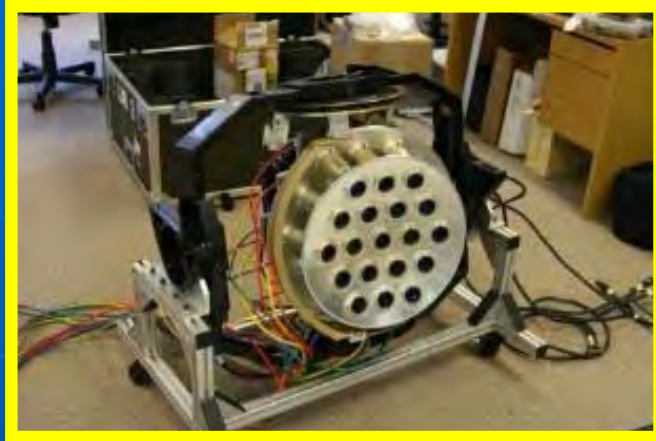
2008

2009.....

Fully
Operational
Data Collection

Gigapixel Camera Program

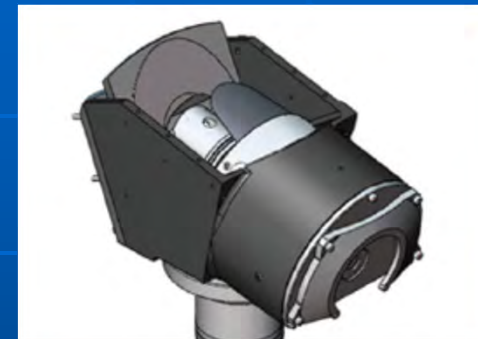
76MPix Movie Camera over Springfield, IL
35 degree FoV, 3500ft, Stabilized gimbal
~5" resolution, ~0.5mile diameter



Patents: US 9182228 B2, US 9628682 B2

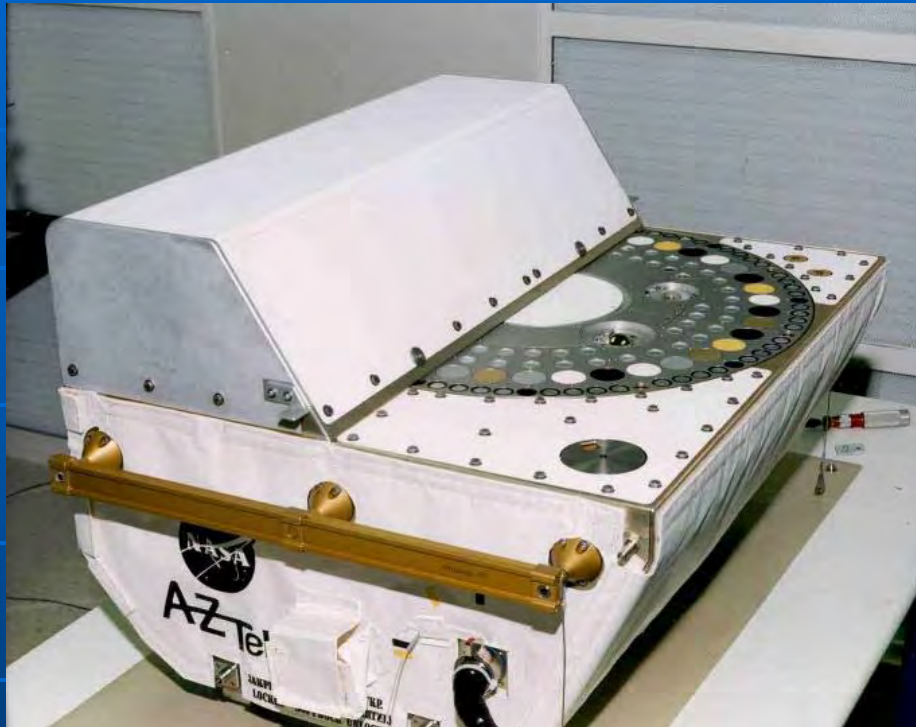
Reverse Engineer, Redesign and Certification: Northrop Grumman LN120G Star tracker

- Update 40 year old optics to meet form, fit, function
- Provided optical testing, design, and tolerancing support to NG supplier
- Completed in time to certify first unit in ~12 months
- Certified over 50 successful systems to date



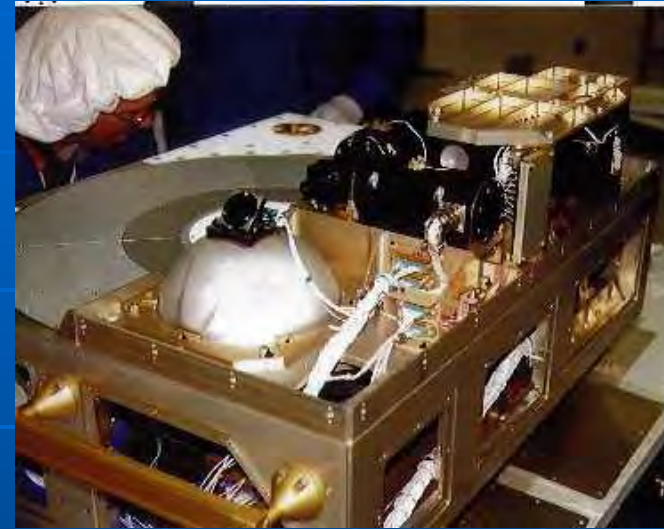
Images used with permission from Northrop Grumman

Total Integrated Scatter Experiment

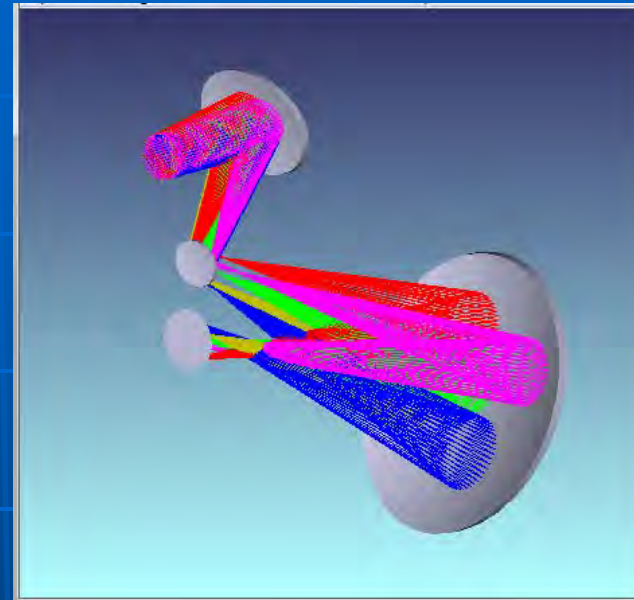
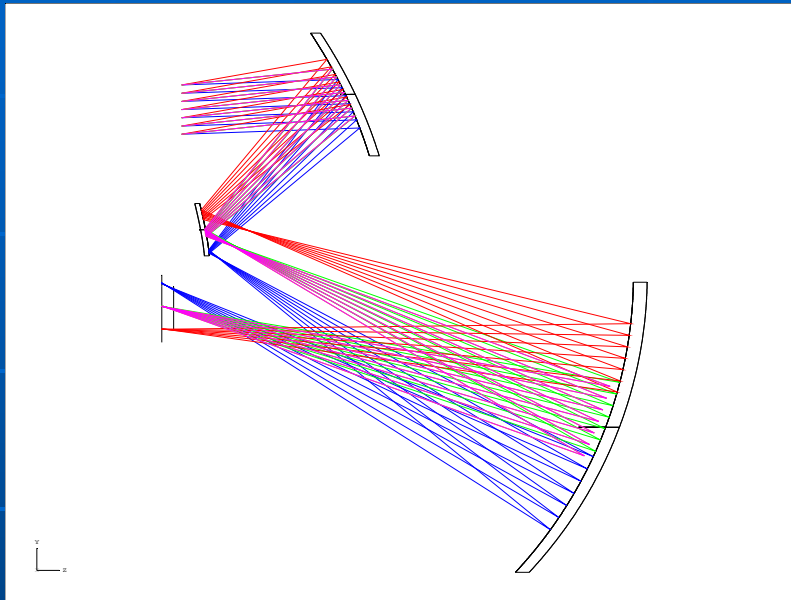


Part of the Optical Properties Monitor experiment.

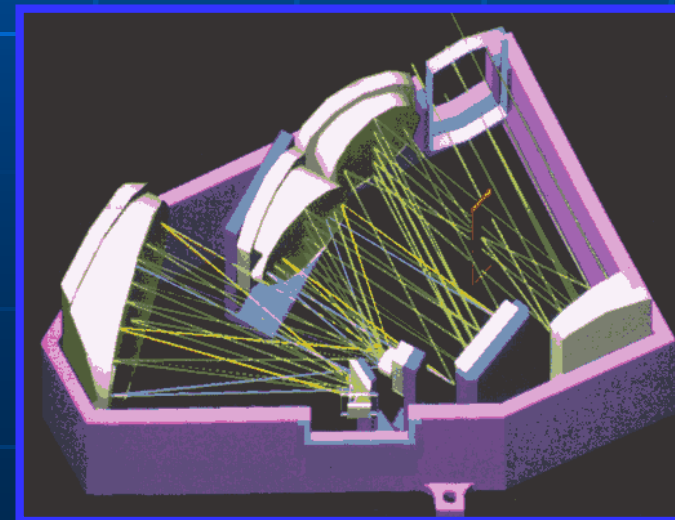
Measured space environmental effects on materials as a function of exposure time.



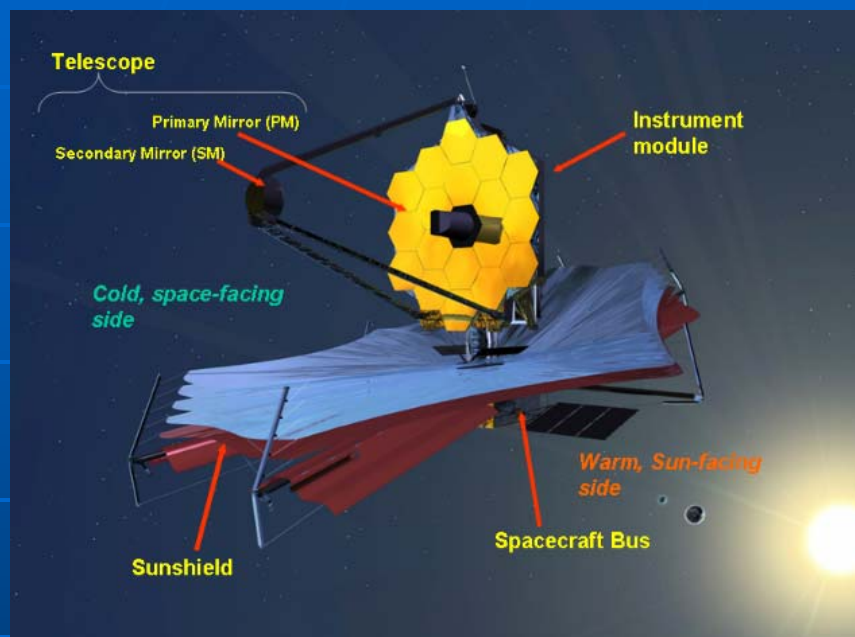
UVI: Ultraviolet Imager



Was in operation aboard the
POLAR spacecraft.



James Webb Space Telescope



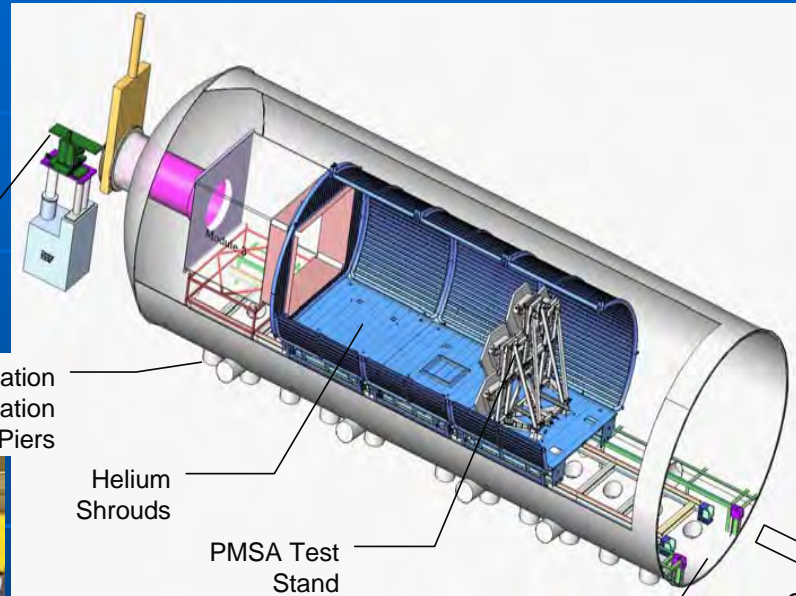
- First conceptual optical design
- Cryogenic mirror optical testing at MSFC:
 - Optical test system design & assembly
 - Test procedure development
 - Test operations
 - Data analysis

- Technology development mirrors
- 18 flight primary mirror segments
- Full telescope optical testing at JSC
 - Alignment & wavefront error measurement of primary mirror

JWST PMSA Testing



Optical Test Station

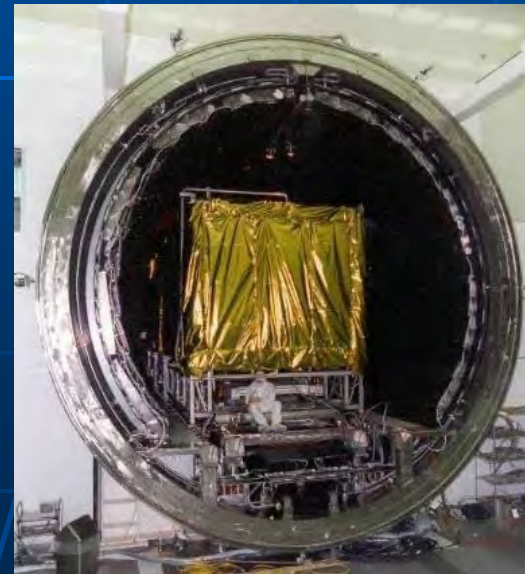


Vibration Isolation Piers

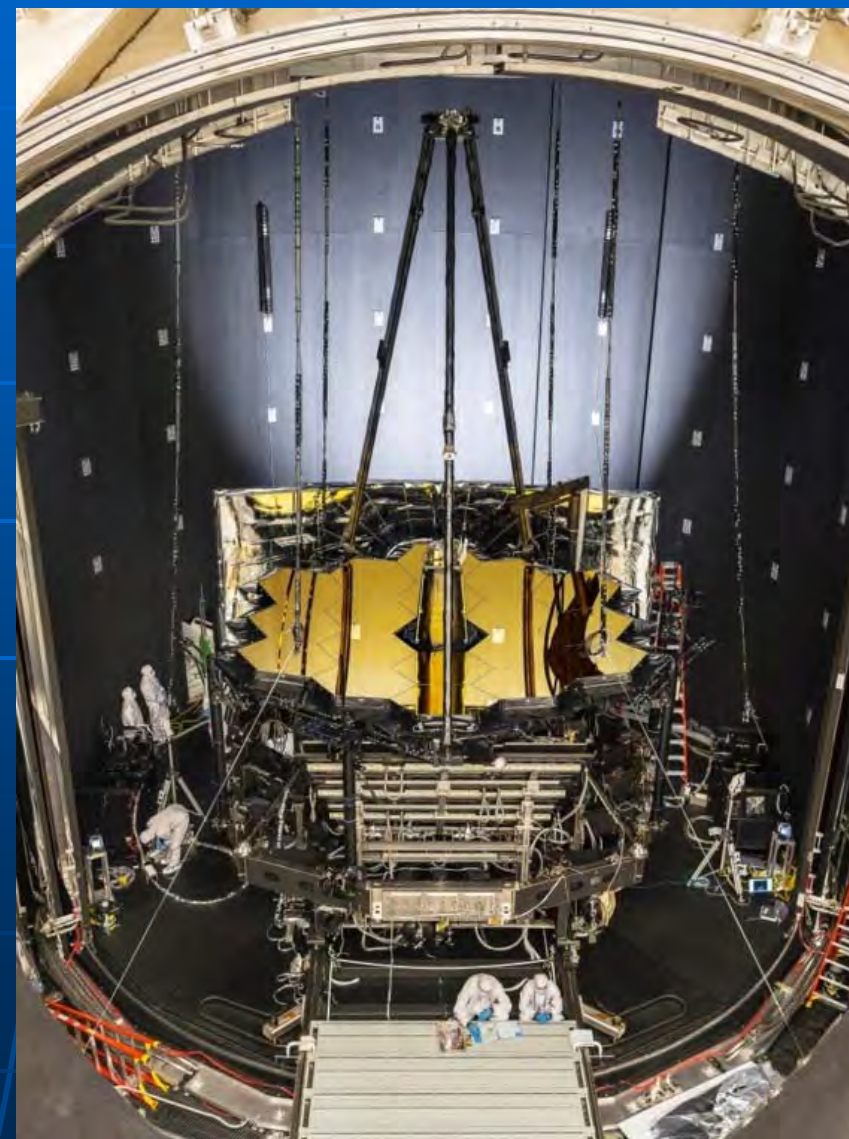
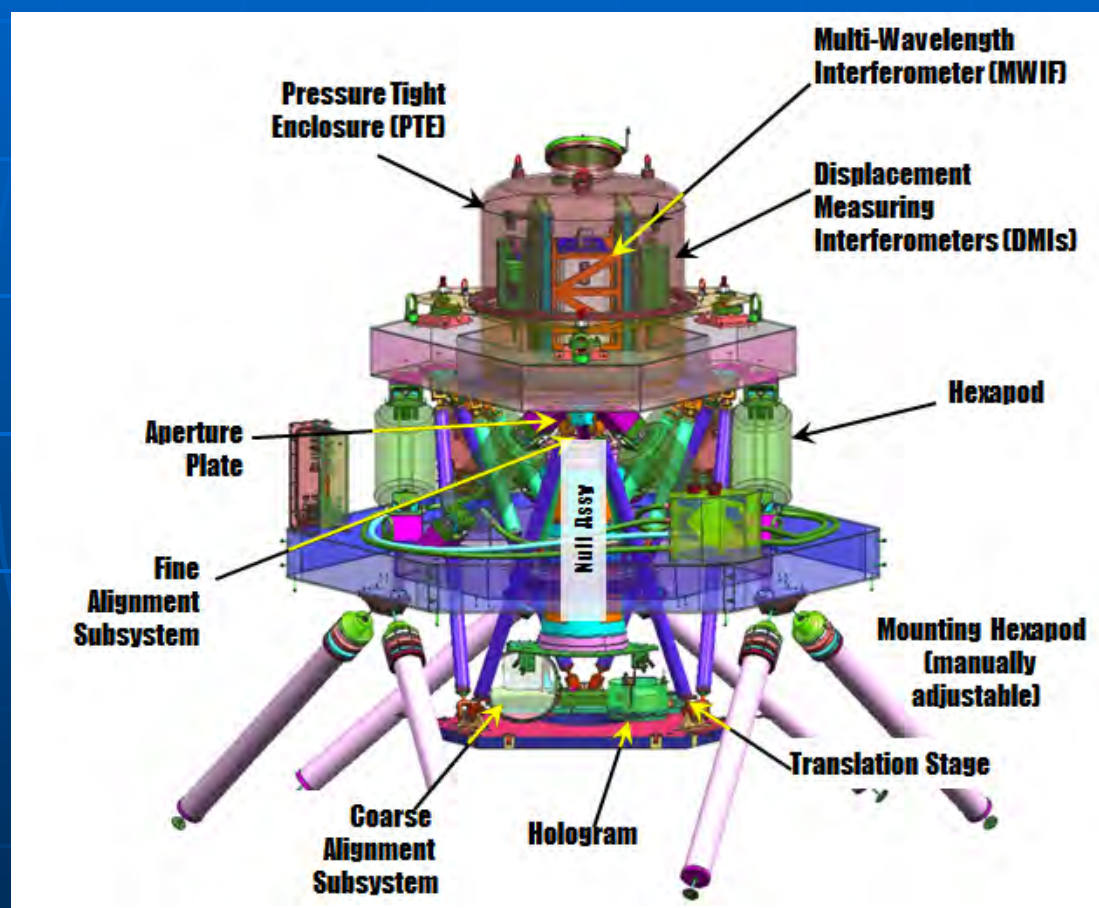
Helium Shrouds

PMSA Test Stand

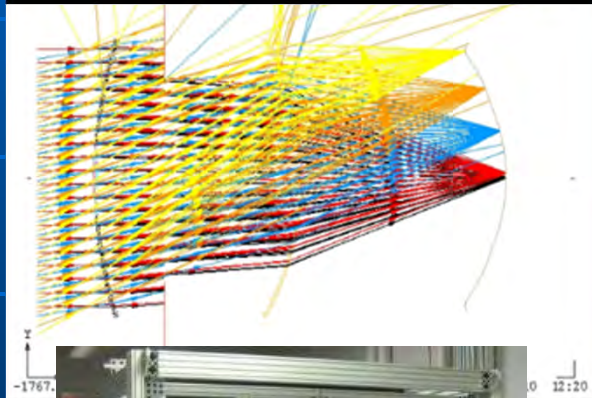
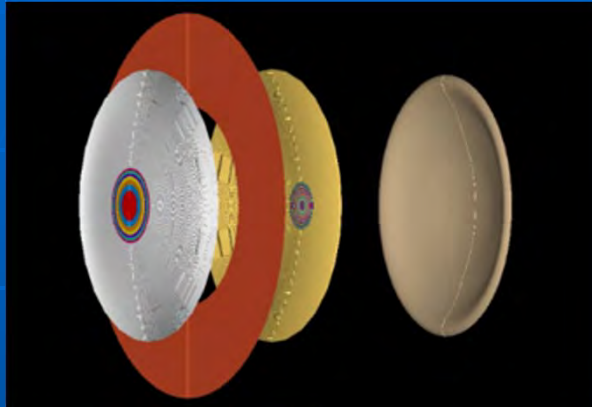
Dome Shown Removed



JWST Telescope Testing at JSC



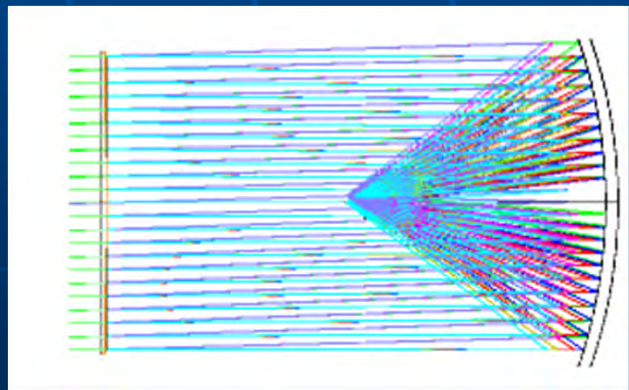
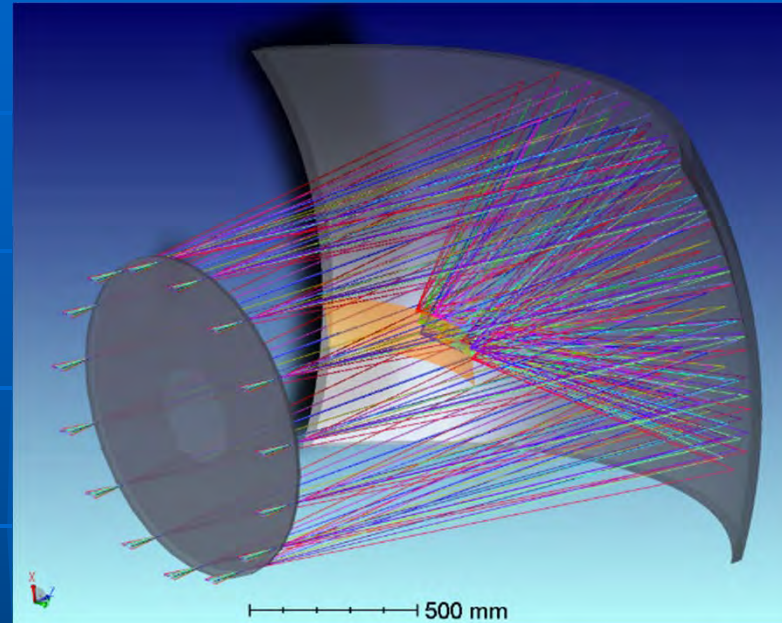
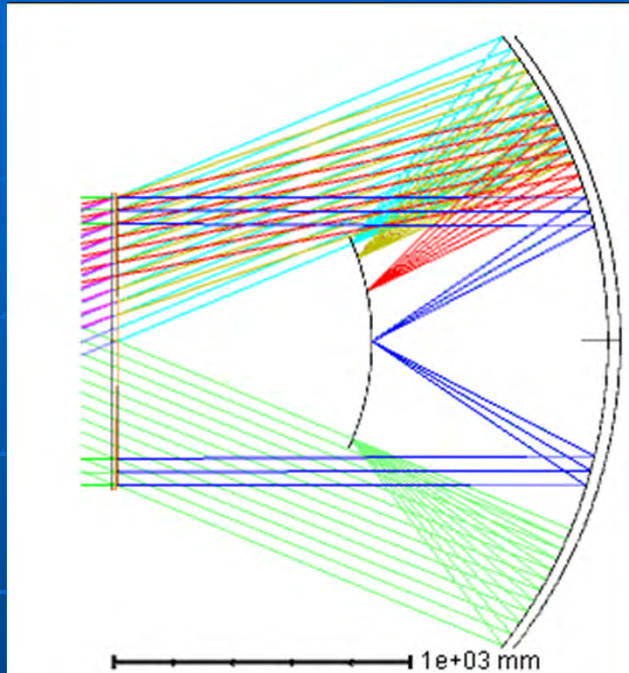
JEM EUSO



- Search for source of ultra-high energy cosmic particles
- Massive throughput
 - FoV ~50 degrees
 - EPD ~2m
 - F/1
- Fresnel lens design
 - Conceived at UAH
 - Extensive analysis
- UAH tested 1.5m optics

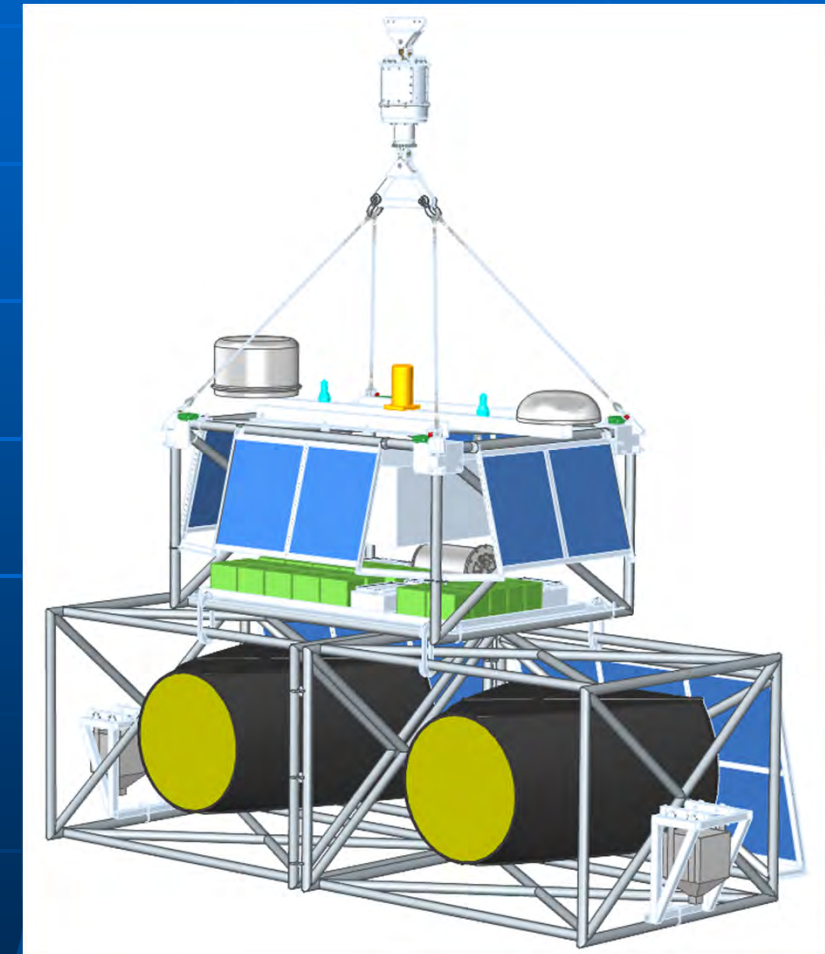
EUSO-SPB2

Second Generation Extreme Universe Space Observatory
on a Super-Pressure Balloon



One imager is recording fluorescence signatures from upwelling UHECR's (1 μ s).

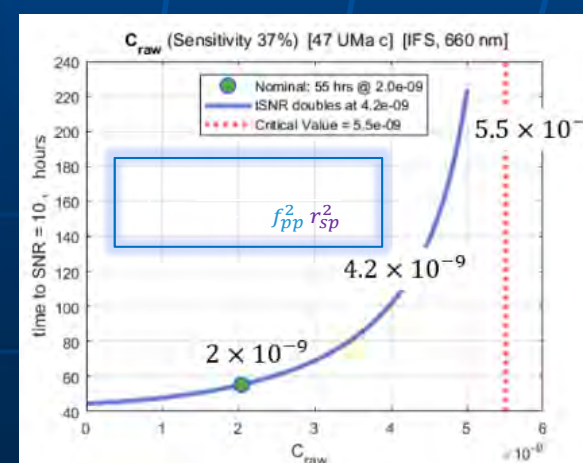
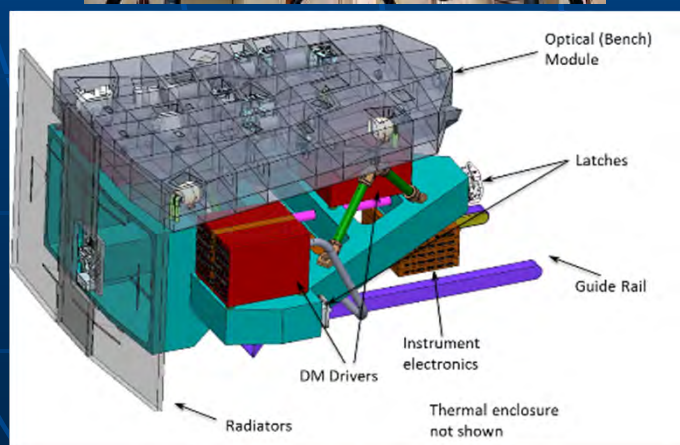
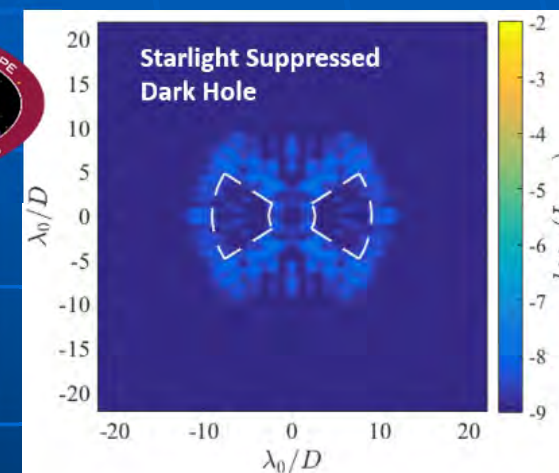
One imager is recording Cherenkov signatures from UHECR's (10ns).



WFIRST

The Wide-Field Infrared Survey Telescope (WFIRST)
Coronagraph System Engineering Performance Modeling
High Contrast ($1e9$) Imaging of exoplanets

- Mathematical framework for system engineering analysis
- Instrument performance modeling
- Signal to Noise Ratio, Exoplanet Science Yield
- Sensitivities to key instrument parameters
- Detector model



WAVE : Response to Columbia Accident Investigation Board

A collaboration with NASA MSFC
to design and build a telescope



to observe the Shuttle launch as
never seen before.



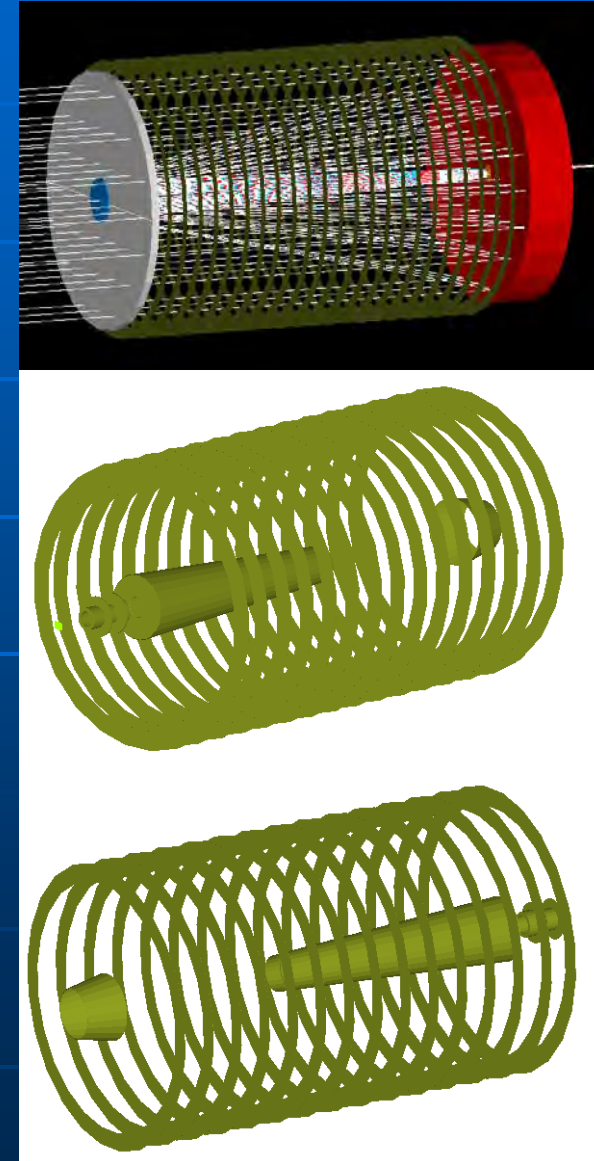
on a mobile platform



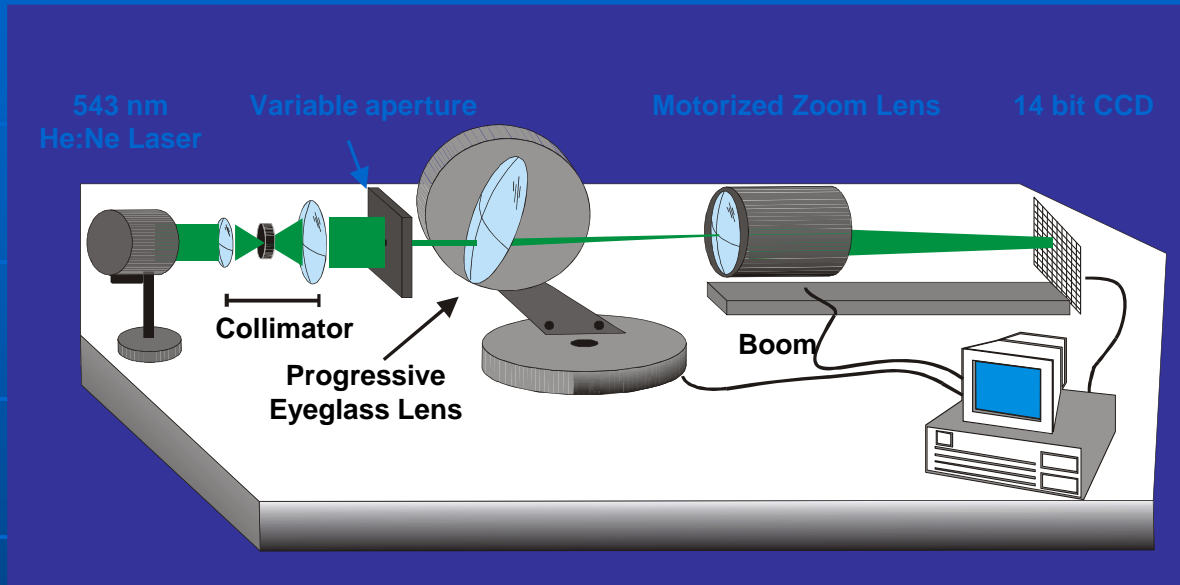
KSC Ground Camera: Response to Columbia Accident Investigation Board



- CAO Support
 - Optical design
 - Optomechanical design
 - Stray light control
- 24" Diameter
- Launch monitoring



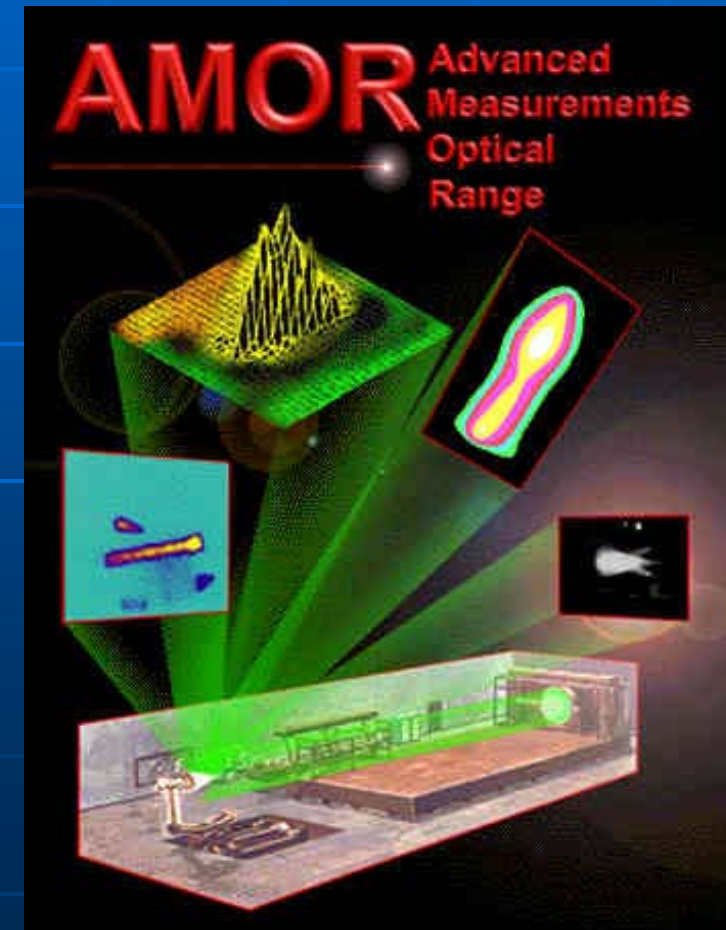
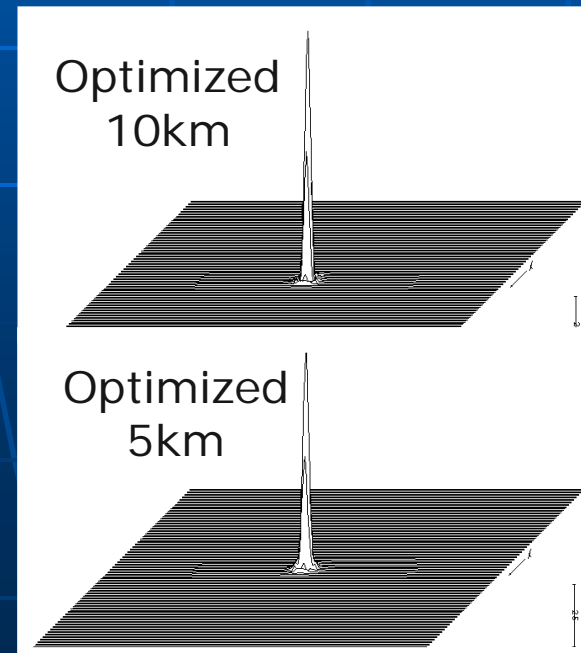
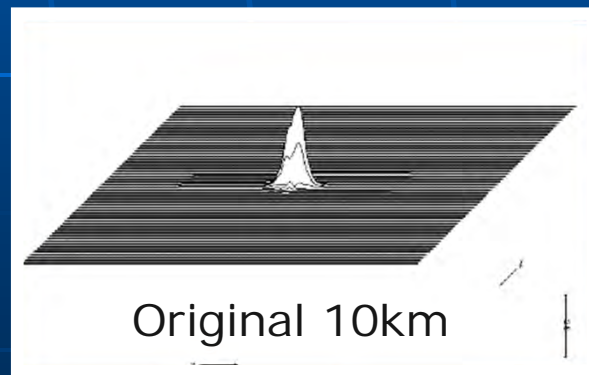
Spectacle Lens Image Mapper



- Direct optical measurements on lenses.
 - Mimics wearer geometry.
 - Measures PSF at best-focus using high-resolution CCD.
 - Fourier transforms PSF to MTF.
 - Predicts lens-limited visual acuity.
 - Also measures power, cylinder, & prism.
 - Automatic test produces data over full aperture of lens.
- Issue: Optical quality assessment methods have not kept pace with increasing complexity of Progressive Addition Lenses (PALs).
 - Need: Objective measure of PAL image quality over entire usable aperture of lens.
 - Solution: CAO developed & patented a Spectacle Lens Image Mapper for Johnson & Johnson Vision Products.

AMOR: Zoom Optics

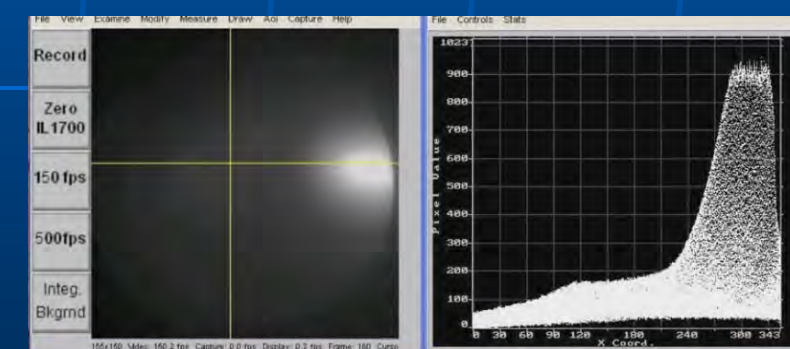
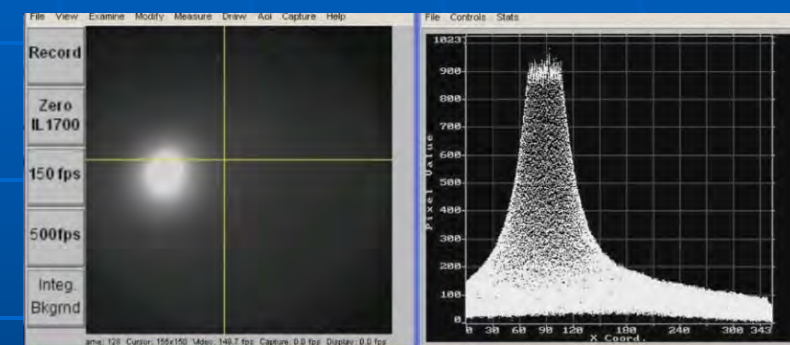
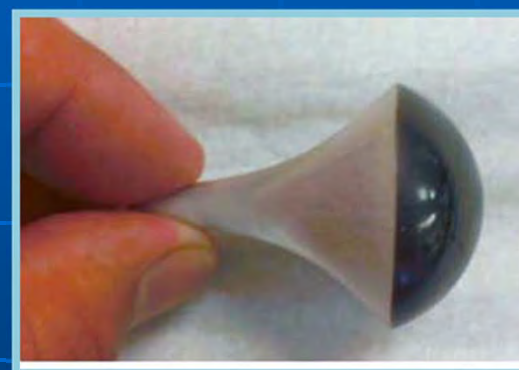
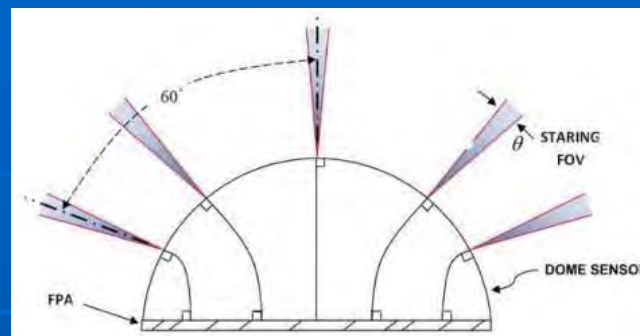
Developed and integrated zoom optics system:
Vis-NIR
Commercial lenses
Range simulation: 800km - 10km



Patented Technologies

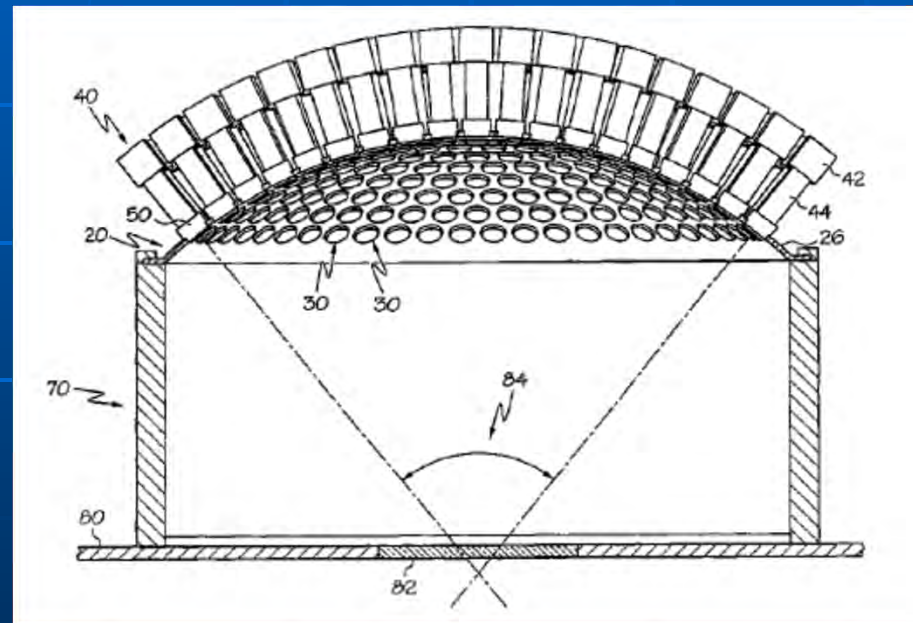
Directional Dome Sensor

- Fiber-taper based
- Prototypes tested
 - Lab testing
 - In-the-field
 - Yuma, Test of opportunity
 - "Sensed" an RPG launch



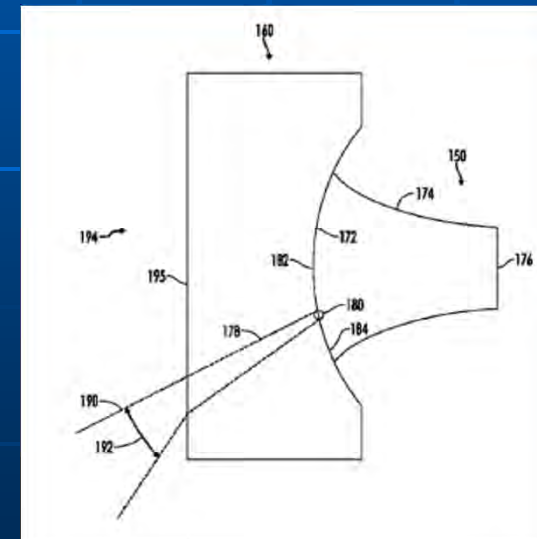
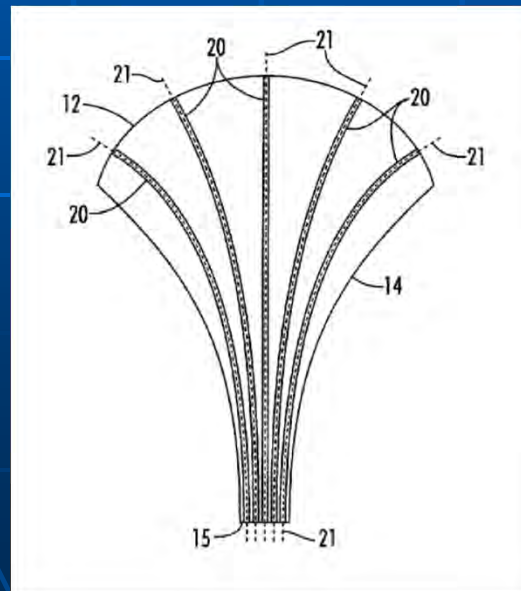
Giga-pixel Camera

- Multi-lens array system and method (US9,182,228)
 - Pollock, Reardon, Rogers, Underwood, Egnal, Wilburn, Pitalo



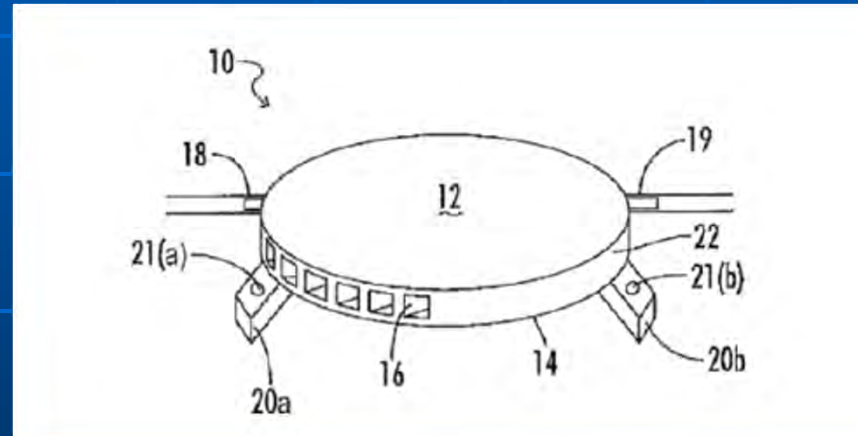
Dragonfly

- Fiber optic directional sensor and method (US8,817,271)
 - Geary
- Fiber optic directional sensor with wide-field optical field expanding element and method (US9,804,251)
 - Reardon



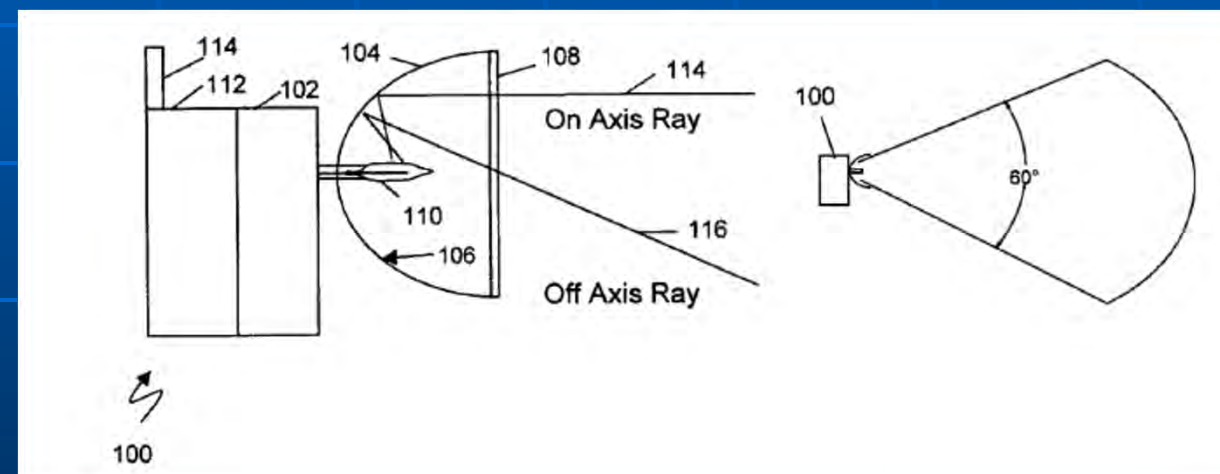
Cooled/ Adaptive Metal Mirror

- Lightweight Adaptive Metal Cooled Mirror (US10,359,603 B1)
 - Reardon



UVC-band Fire Sensor

- Optical flame detection system and method (US7,541,938)
 - Engelhaupt



Summary



- Proven experience in

Conceiving

Designing

Fabricating

Assembling

Testing

& Integrating optical systems that work.

And training the next generation of Optics researchers.