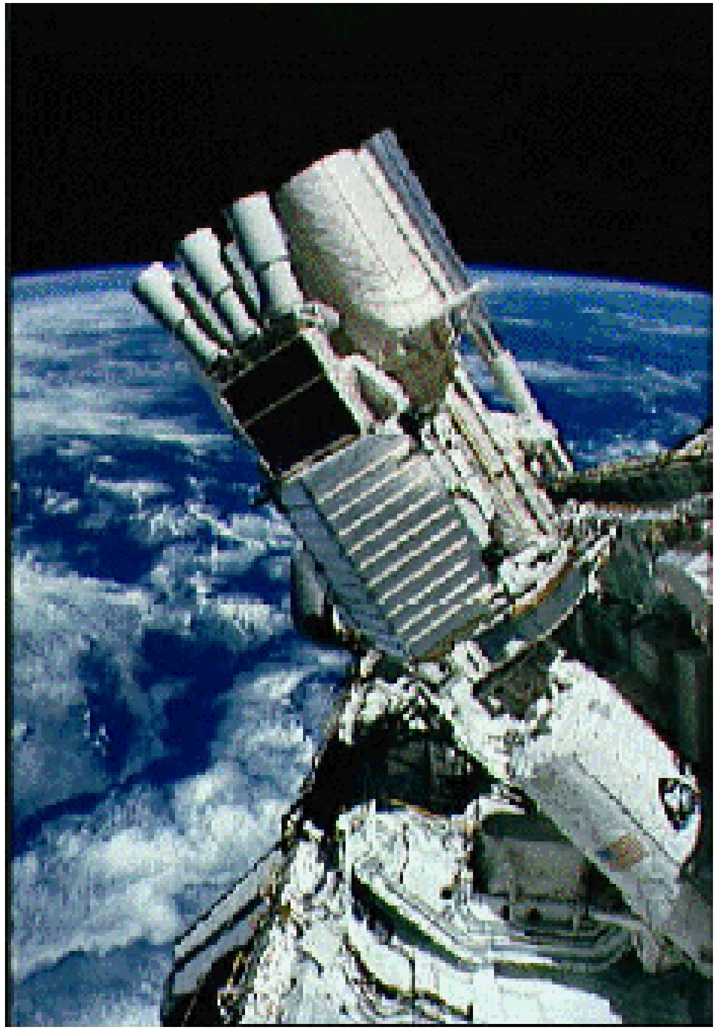
Adventures & Lessons in Aerospace Engineering: 34 Years at NASA Marshall Space Flight Center

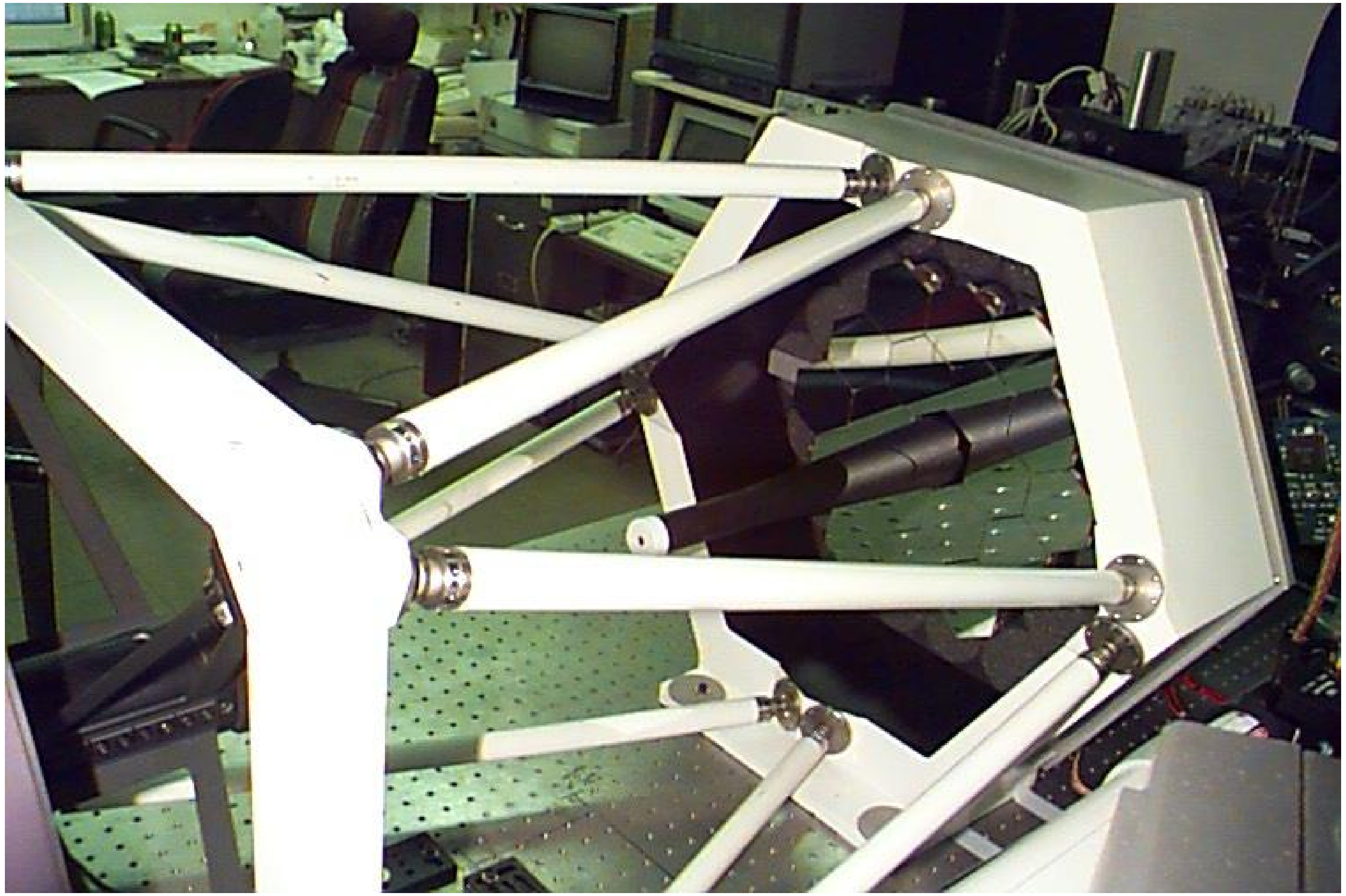
John Rakoczy
Chief, Control Systems Design & Analysis Branch
NASA MSFC

March 16, 2020

ASTRO-1 & ASTRO-2 Spacelab Missions (1990, 1995)



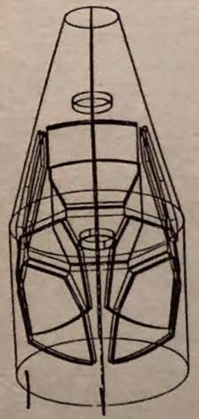
PAMELA – Phased Array Mirror Extendible Large Aperture

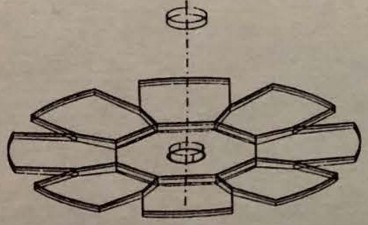


- 36-segment adaptive spherical primary mirror
- 0.5-meter aperture
- 7-cm segments
- Shack-Hartmann wavefront sensor
- Inductive edge sensors
- 5 kHz sample rate
- Tip/tilt/piston control via voice coil actuators
- Closed-loop bandwidth exceeding 100 Hz

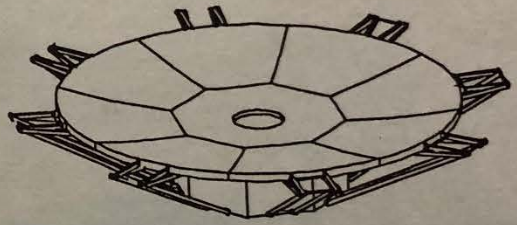
SYMPOSIUM ON OPTICAL SYSTEMS CONCEPTS AND TECHNOLOGY

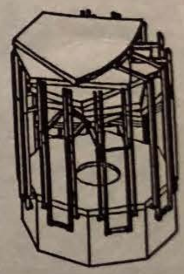
FOR THE NEXT GENERATION SPACE TELESCOPE



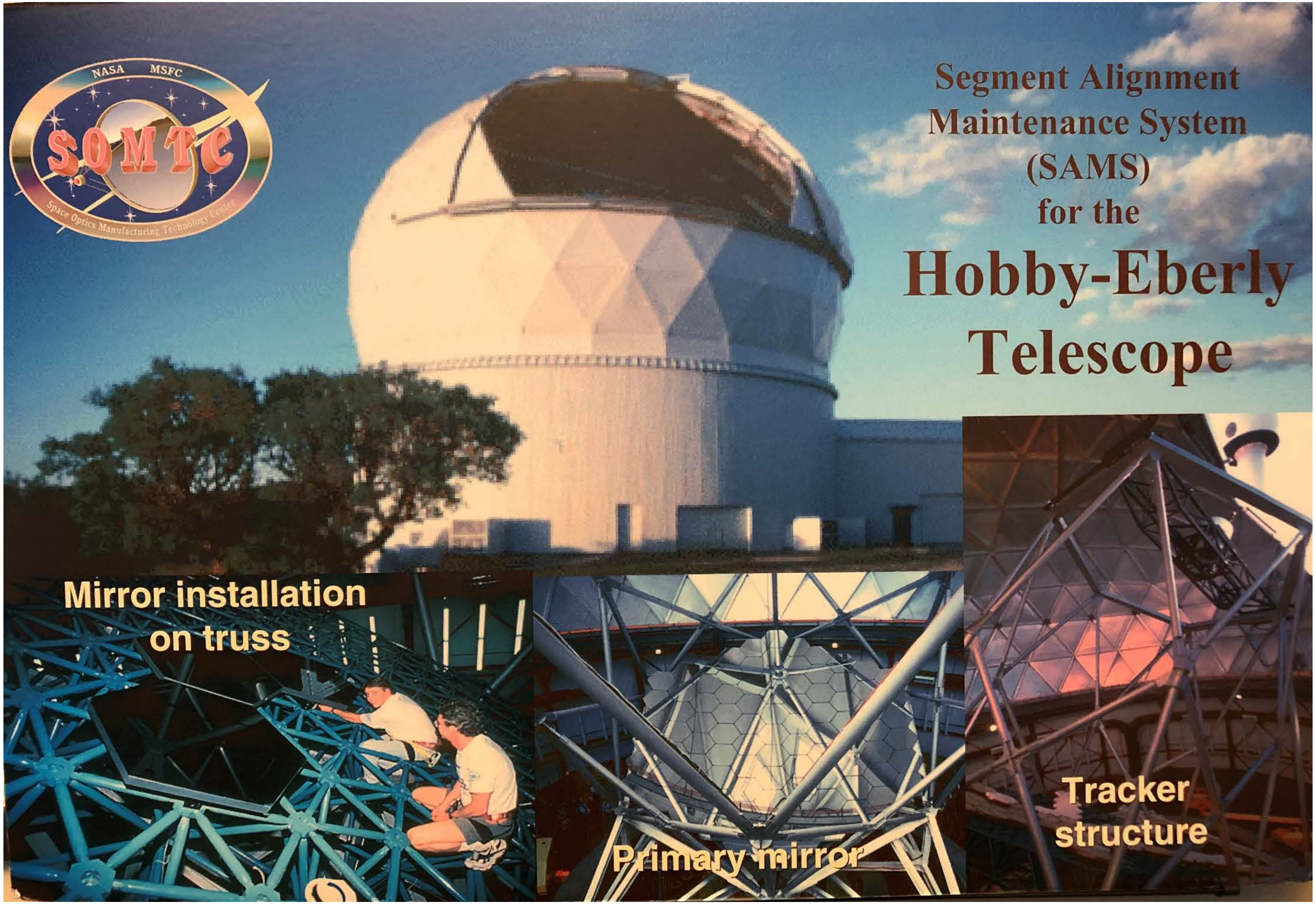


APRIL 15 - 17, 1996

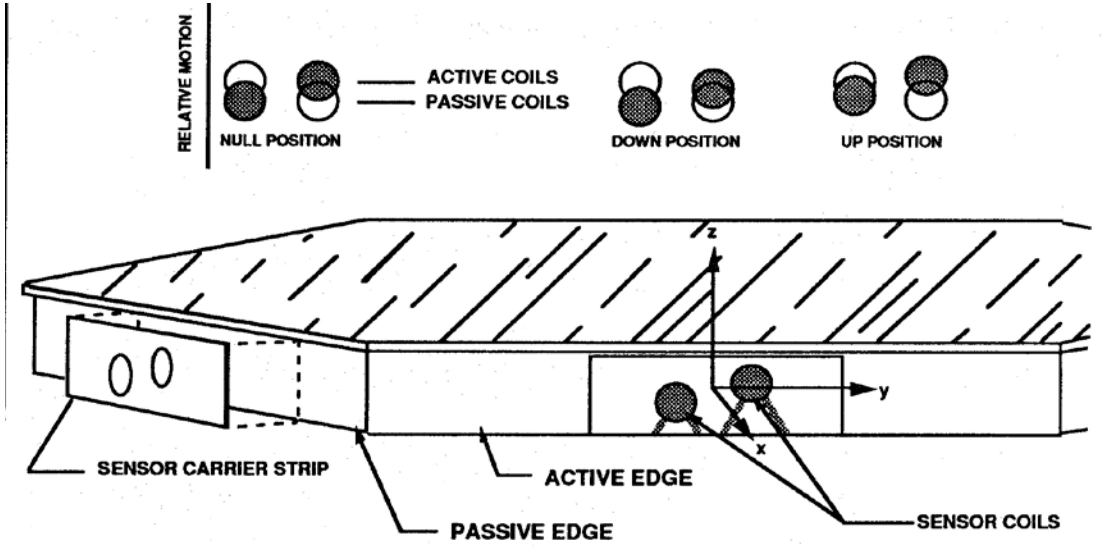


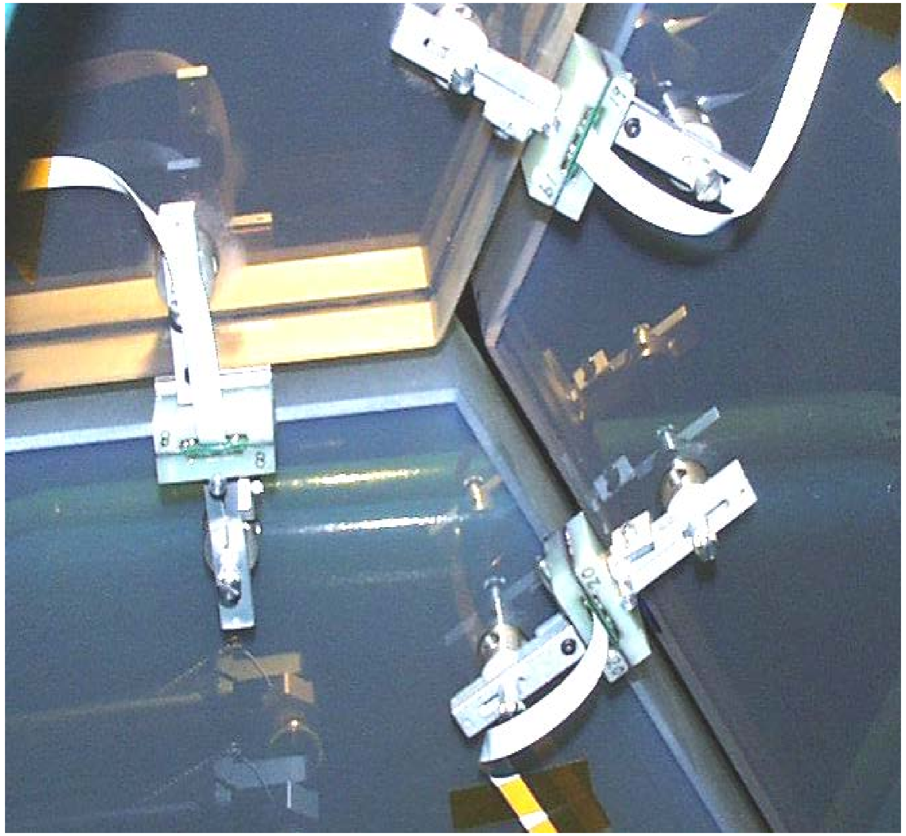


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, AL 35812


NASA MSFC
SOMTC
Space Optics Manufacturing Technology Center
Segment Alignment
Maintenance System
(SAMS)
for the
Hobby-Eberly
Telescope
Mirror installation
on truss
Primary mirror
Tracker
structure

Segment Alignment Maintenance System





US007050161B1

(12) **United States Patent**
Rakoczy

(10) **Patent No.:** **US 7,050,161 B1**
(45) **Date of Patent:** **May 23, 2006**

(54) **GLOBAL RADIUS OF CURVATURE ESTIMATION AND CONTROL SYSTEM FOR SEGMENTED MIRRORS**

(75) Inventor: **John M. Rakoczy**, Madison, AL (US)

(73) Assignee: **The United States of America as represented by the Administration of the National Aeronautics and Space Administration**, Washington, DC (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 520 days.

(21) Appl. No.: **10/637,085**

(22) Filed: **Aug. 6, 2003**

(51) **Int. Cl.**
G01B 9/00 (2006.01)
G02B 5/08 (2006.01)

(52) **U.S. Cl.** **356/125**; 359/848; 359/849

(58) **Field of Classification Search** 356/125; 359/848, 849, 851
See application file for complete search history.

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John Rakoczy et al., "Global Radius-of-Curvature Estimation and Control for the Hobby-Eberly Telescope," Proceedings of the SPIE, 4837-79 ed., p. 681-692, (Aug. 22, 2002).

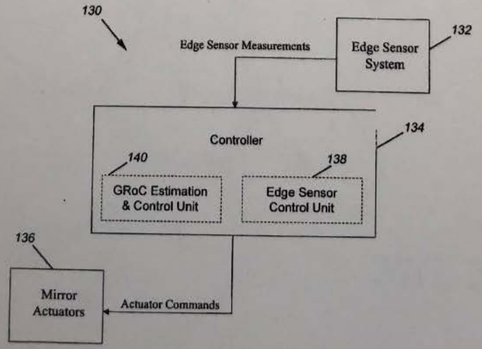
* cited by examiner

Primary Examiner—Hwa (Andrew) Lee
Assistant Examiner—Roy M. Punnoose
(74) *Attorney, Agent, or Firm*—James J. McGroary; Todd E. Marlette

(57) **ABSTRACT**

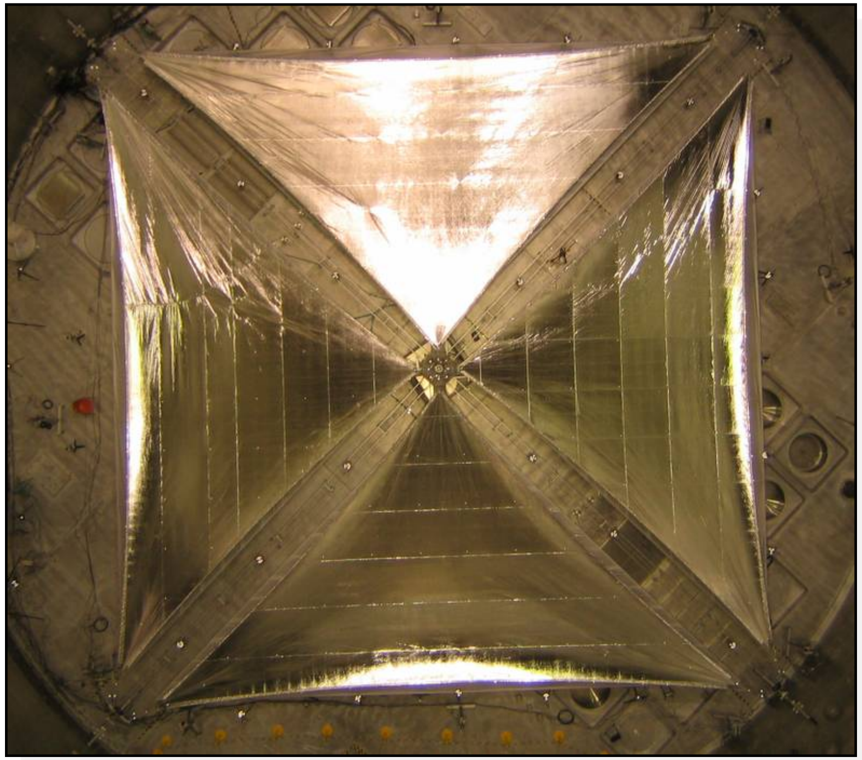
An apparatus controls positions of plural mirror segments in a segmented mirror with an edge sensor system and a controller. Current mirror segment edge sensor measurements and edge sensor reference measurements are compared with calculated edge sensor bias measurements representing a global radius of curvature. Accumulated prior actuator commands output from an edge sensor control unit are combined with an estimator matrix to form the edge sensor bias measurements. An optimal control matrix unit then accumulates the plurality of edge sensor error signals calculated by the summation unit and outputs the corresponding plurality of actuator commands. The plural mirror actuators respond to the actuator commands by moving respective positions of the mirror segments. A predetermined number of boundary conditions, corresponding to a plurality of hexagonal mirror locations, are removed to afford mathematical matrix calculation.

21 Claims, 14 Drawing Sheets



Mauna Kea Summit – SPIE conference 2002

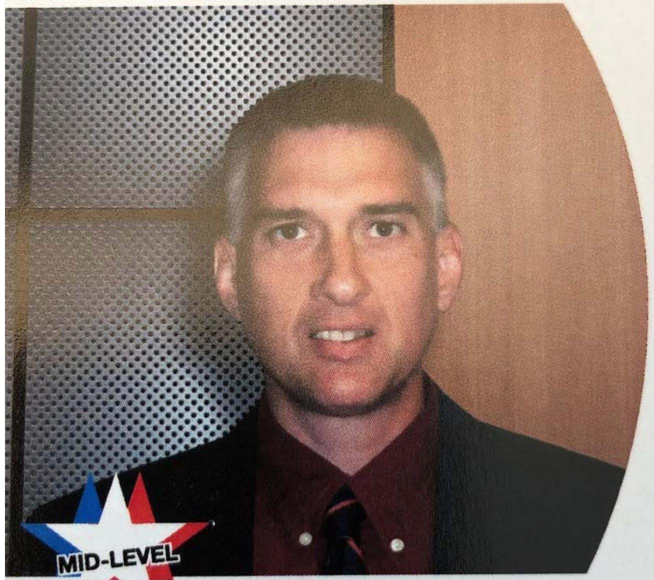
Solar Sailing ~ 2005



NASA Mid Level Leader Program 2010-2011

National Aeronautics and Space Administration

NASA



MID-LEVEL LEADER PROGRAM 2010

JOHN RAKOCZY

LEAD AEROSPACE ENGINEER, AST

'10

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E-MAIL: *john.m.rakoczy@nasa.gov*

HOMETOWN: Madison, AL
COLLEGE: Georgia Tech
ACQUIRED: 1985

John is a team leader in the Control Systems Design and Analysis Branch, leading Ares I Guidance, Navigation and Control algorithm/software integration. He served as the lead engineer for the Hobby-Eberly Telescope's Segment Alignment Maintenance System from 1999 to 2002. He has performed 10 years' research in active and adaptive optics and has experience in satellite attitude control, space telescope pointing control, flexible body dynamics, integrated modeling and analysis, solar sails, image processing, and optical pattern recognition. John started at NASA as a co-op student in 1985.

YEAR	CLUB	POSITION	LEVEL
1985–	MSFC	LEAD AEROSPACE ENGINEER, AST, NAVIGATION, GUIDANCE & CONTROL SYSTEMS	GS-14

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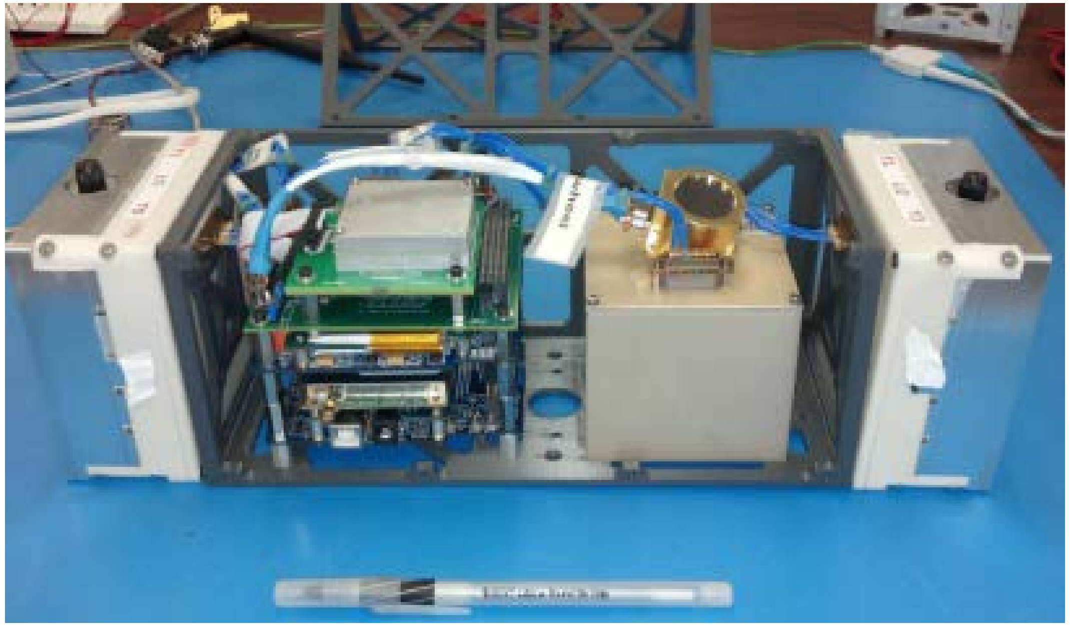
MLLLP Detail to KSC Summer 2010


Discovery


Discovery

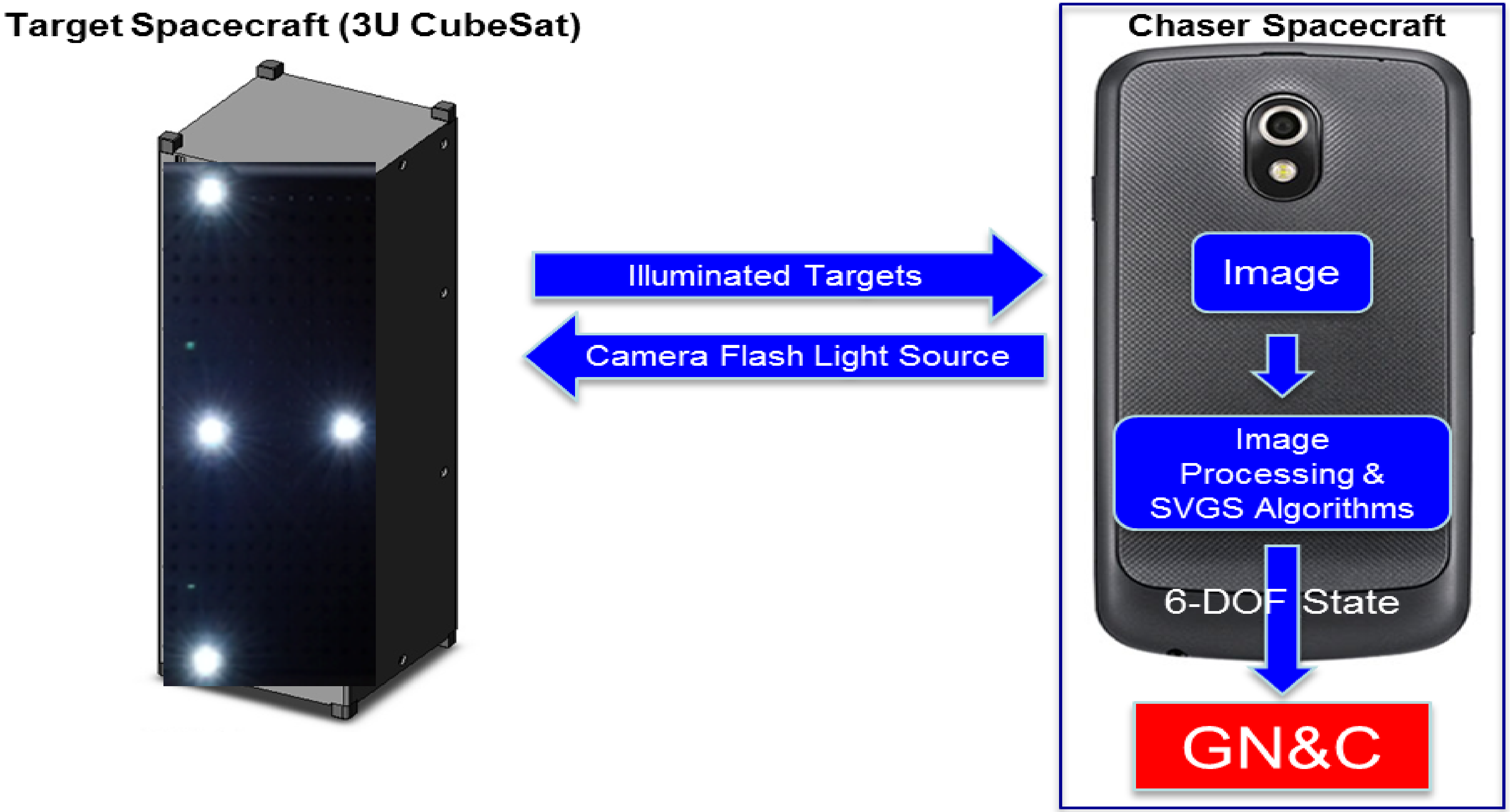
Small Satellite Attitude Control 2009-present



Space Launch System

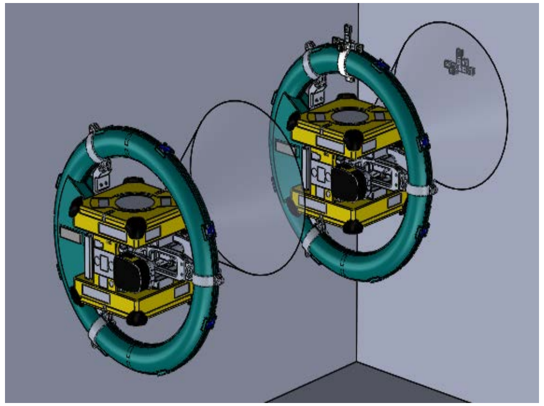
Human Landing Systems

Smartphone Video Guidance Sensor (SVGS)

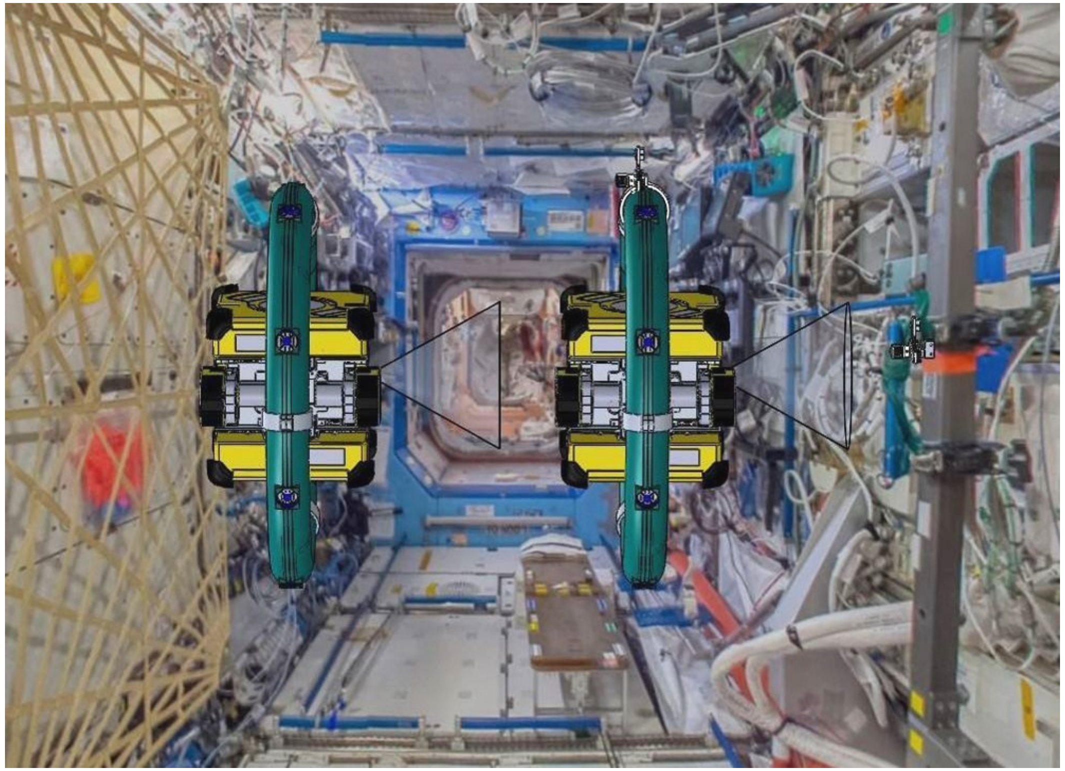


SVGS/RINGS Integration with Astrobee inside ISS Target 2022

ISS025E013445



Astrobee is successor ISS IVA vehicle after SPHERES is demanifested



Partnership with Florida Institute of Technology

Final Thoughts…….

- Reflections on being a supervisor (2015 – present)
- Communication skills are important
  - Written
  - Oral
- Don’t forget the Liberal Arts