**The Florida Senate**

# COMMITTEE MEETING EXPANDED AGENDA

**MILITARY AFFAIRS, SPACE, AND DOMESTIC SECURITY**
**Senator Altman, Chair**
**Senator Hill, Vice Chair**

**MEETING DATE:** Thursday, April 14, 2011
**TIME:** 11:00 a.m.—12:30 p.m.
**PLACE:** *Mallory Horne Committee Room,* 37 Senate Office Building

**MEMBERS:** Senator Altman, Chair; Senator Hill, Vice Chair; Senators Bennett, Bullard, Jones, Sachs, and Storms

| TAB | BILL NO. and INTRODUCER | BILL DESCRIPTION and SENATE COMMITTEE ACTIONS | COMMITTEE ACTION |
|---|---|---|---|
| 1 | | Presentation on Commercial and Governmental Applications of Space-Based Technologies | Presented |
| 2 | | Discussion by Members on Potential Interim Reports | Discussed |

Florida Institute of Technology
High Tech with a Human Touch™

# Overview of Space Related Activities at the Florida Institute of Technology *with application to Florida and the United States*

## Presented to the Florida Senate Committee on Military Affairs, Space, and Domestic Security

**April 14, 2011**

**Dr. Daniel Kirk**
**Associate Professor**
**Mechanical and Aerospace Engineering**
**Florida Institute of Technology**

Florida Institute of Technology
High Tech with a Human Touch™

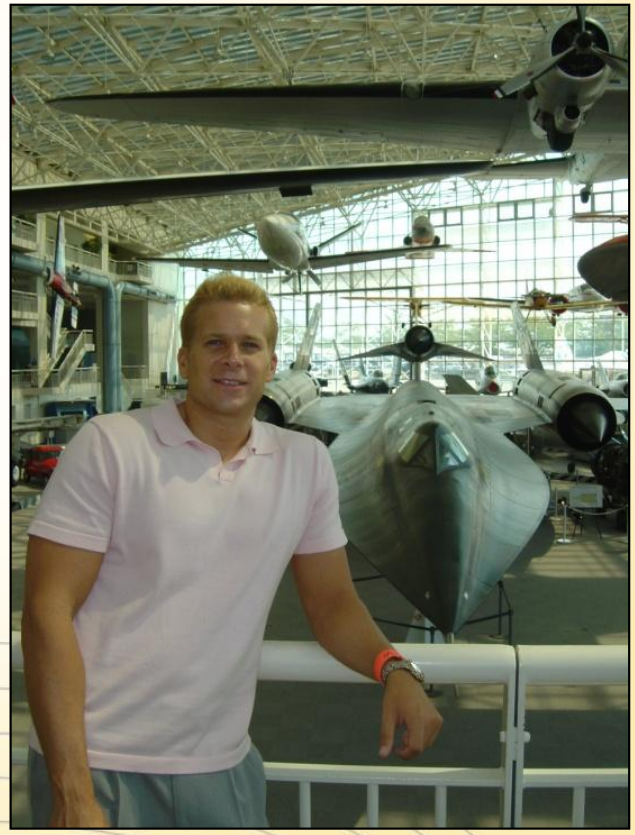
# Florida Senate Committee on Military Affairs, Space, and Domestic Security

- Chair: Senator Thad Altman (R, D24)
- Vice Chair: Senator Anthony C. "Tony" Hill, Sr. (D, D1)
- Senator Michael S. "Mike" Bennett (R, D21)
- Senator Larcenia J. Bullard (D, D39)
- Senator Dennis L. Jones, D.C. (R, D13)
- Senator Maria Lorts Sachs (D, D30)
- Senator Ronda Storms (R, D10)

Florida Institute of Technology
High Tech with a Human Touch™

# DANIEL KIRK

- Born May 4, 1975 in Milford, Connecticut
- PhD MIT 2002
- Joined Florida Tech January 2004
  - Assistant Professor: 2004 – 2009
  - Associate Professor: 2009 – Present
- Associate Fellow, American Institute of Aeronautics and Astronautics
- Boeing Welliver Faculty Fellow
- NASA Visiting Faculty Scholar
- Over $3M research from NASA, Air Force (AFOSR), Navy (ONR), Army, National Institute of Health (NIH), and National Science Foundation (NSF)
- 65 publications

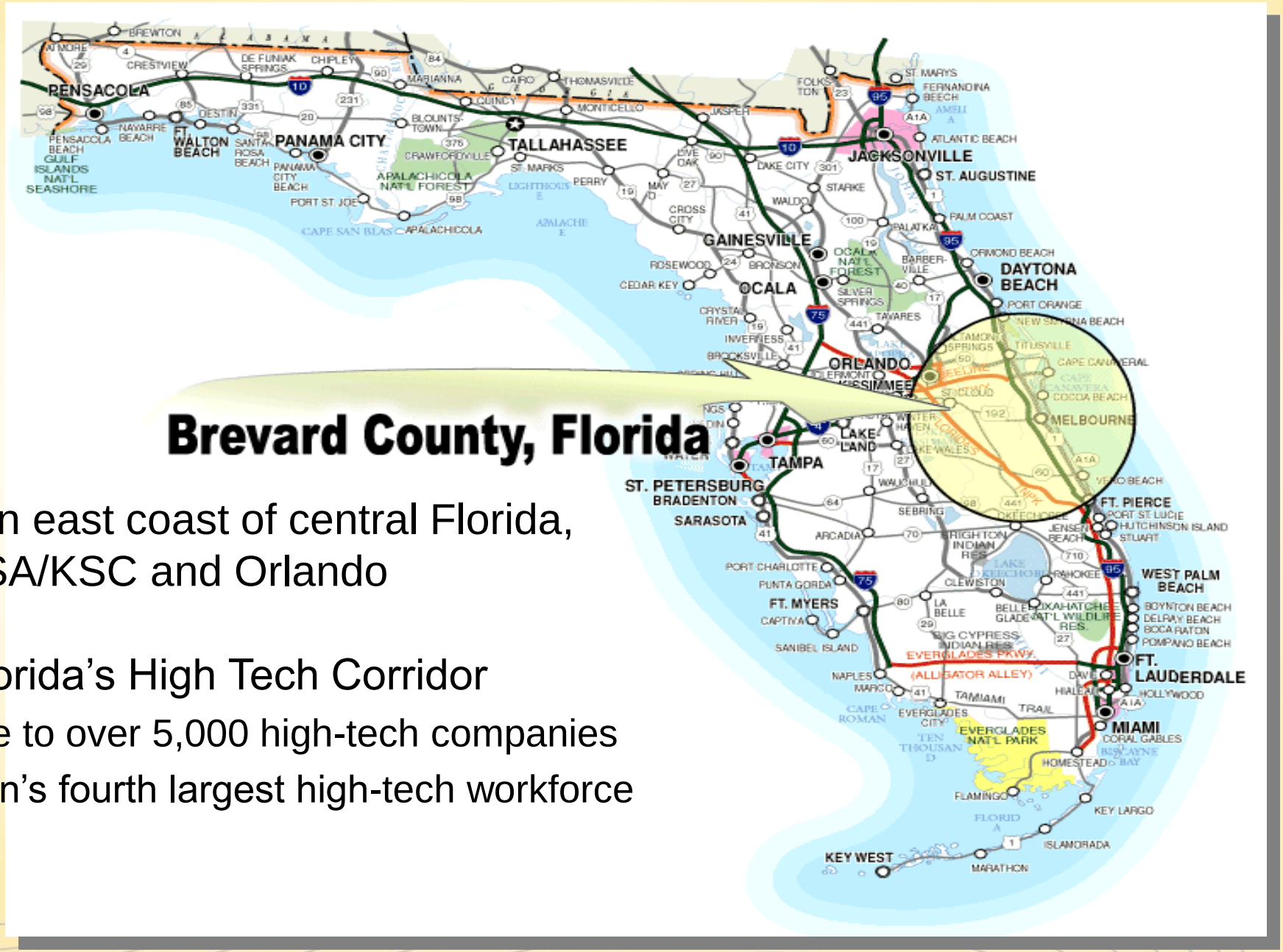


- Hobbies: tennis, surfing, marathons (8), triathlon (1), Chess,

Florida Institute of Technology
High Tech with a Human Touch™

# Overview of the Florida Institute of Technology

Florida Institute of Technology
High Tech with a Human Touch™




- Located in east coast of central Florida, near NASA/KSC and Orlando
- Within Florida's High Tech Corridor
  - Home to over 5,000 high-tech companies
  - Nation's fourth largest high-tech workforce

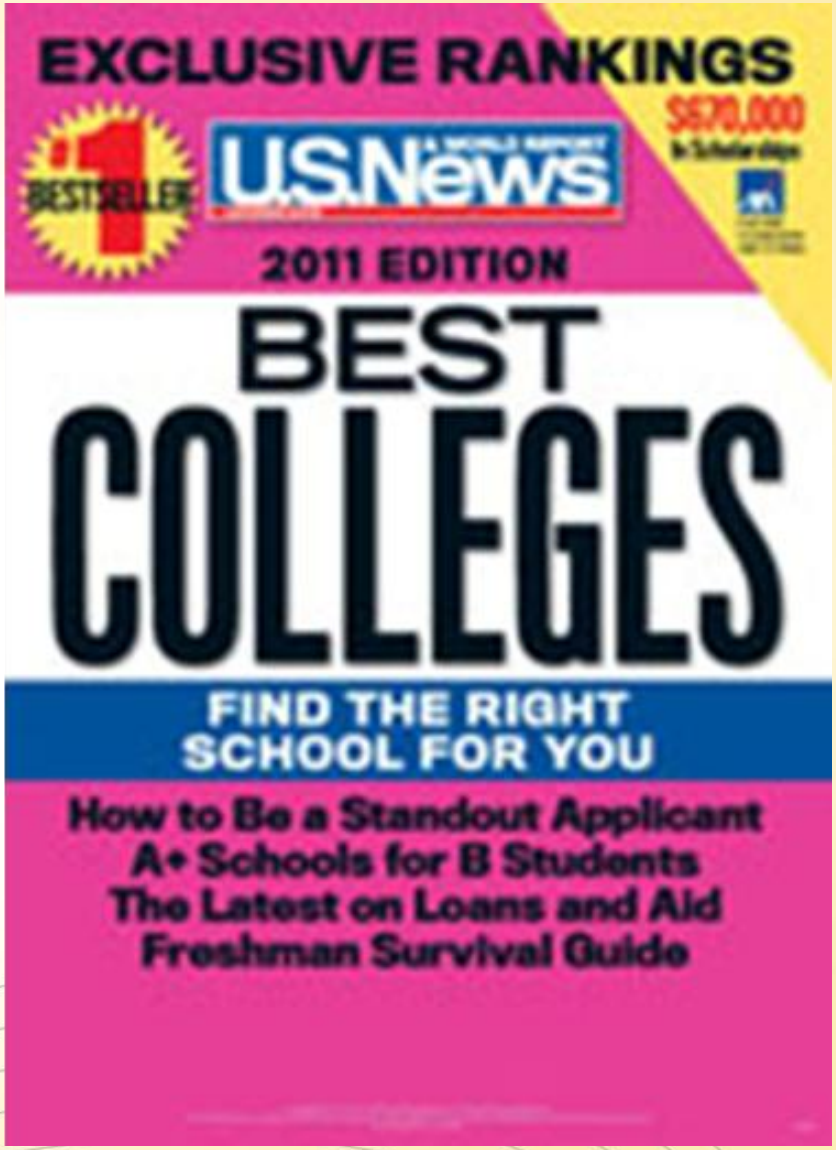
Florida Institute of Technology
High Tech with a Human Touch™

# Florida Tech Overview


- Founded in 1958
- Five colleges
  - Aeronautics
  - Business
  - Engineering
  - Psychology and Liberal Arts
  - Science
- Programs
  - 184 degree programs
  - 84 master's degrees
  - 23 doctoral degrees

Florida Institute of Technology
High Tech with a Human Touch™

August 2010 issue of *U.S. News & World Report* college rankings, the university was named a Tier 1 Best National University, among just 197 colleges and universities.



Florida Institute of Technology
High Tech with a Human Touch™

# Student Body

- Over 8,000 students on main campus, extended sites and online
- Representing all 50 states and more than 100 countries
- Small Student-faculty ratio
- Over 100 student organizations
- NCAA Division II varsity athletics competes in Sunshine State Conference

Florida Institute of Technology
High Tech with a Human Touch™

# Mechanical and Aerospace Engineering (MAE)

- Undergraduate enrollment – 525 (273 AE and 252 ME)
- Graduate enrollment – 89 (73 MS and 16 PhD)
- 15 full-time faculty (2 new faculty members in fall 2011)
- New biomedical engineering area of specialization under the Mechanical Engineering MS and PhD degree programs
- Nuclear technology area of emphasis started in fall 2009

- **A new graduate automotive engineering area of specialization starts in fall 2011 to support Rivian Motors, Rockledge, FL**

Florida Institute of Technology
High Tech with a Human Touch™

# Major MAE Employers in Florida

- Harris – HQ in Melbourne, employs 8,000 in Brevard
- Northrop-Grumman – employs 1,400 in Melbourne
- Boeing – employs ~1,000 in Brevard
- Siemens – employs 3,500-4,000 in Orlando
- DRS – est. 500 in Brevard
- NASA/KSC – 2,000 civil servants with large fraction of engineering positions
- Lockheed-Martin Missile & Fire Control – employs ~6,000 in central FL
- Pratt & Whitney

Florida Institute of Technology
High Tech with a Human Touch™

# International Collaborations

- Beihang Univ (Beijing University of Aeronautics and Astronautics), China
- Taiwan-Florida Higher Education Conferences
- Shanghai Dian Ji University, China
- Shanghai Electric Corp., China (a World 500 Corp.)
- 2+2 BSME programs with Huazhong University of Sci & Tech and Shanghai Ocean University since 2008
- Numerous universities in France, Belgium, and Germary

Florida Institute of Technology
High Tech with a Human Touch™

# Overview of Space Related Research

Florida Institute of Technology
High Tech with a Human Touch™

# Florida Senate Committee on Military Affairs, Space, and Domestic Security

http://www.flsenate.gov/Committees/Show/MS/

- Senate Committee on Military Affairs, Space and Domestic Security has oversight of all matters at state level pertaining to military, National Guard, and veterans' affairs

- Committee also oversees policy matters involving:
  - **Florida's aerospace industry as it relates to aerospace business development**
  - Emergency management
  - Homeland security

- Committee's jurisdiction of emergency management encompasses all aspects of emergency preparedness, response, recovery, and mitigation and jurisdiction of homeland security includes oversight of an annual federal funding process for domestic security projects in Florida and also oversight of seaport security issues for Florida's 14 seaports

Florida Institute of Technology
High Tech with a Human Touch™

# Key Themes

- Education (College and STEM) and Training
- Service to Brevard County, Central Florida, Florida, and United States
- World class research and application to benefit Florida and United States

Florida Institute of Technology
High Tech with a Human Touch™

# Key Themes *in context of…*

- **Changing and evolving landscape of space exploration**
  - End of Shuttle program (pro/con)
  - Dawn of commercial space transportation (pro/con)
  - NASA's role
  - Kennedy Space Center's role
- **National vision, pride, and enthusiasm**
- **"It's the Economy, economy, economy"**
  - Global economic climate
  - National economic climate
  - Central Florida economic climate, in one word: **JOBS**

- **How to create opportunities for Florida and US?**


**STS**


**Falcon 9**


# Center of Excellence *for* Commercial Space Transportation

- **Partnership between FAA, Universities and Industry**
- **10 year venture at $1 million per year**
- **University Participants (New Mexico – Florida Team)**
  - New Mexico State University
  - New Mexico Institute of Mining and Technology
  - **Florida Institute of Technology**
  - Florida Center for Advanced Aero-Propulsion (UF, FSU, UCF)
  - Stanford
  - University of Colorado
  - University of Texas

Building The Future Of Space Transportation Together

# Why a Center of Excellence?

1. Advance aerospace technology to meet current and future needs of U.S. commercial space transportation industry

2. Support FAA's mission to ensure protection of public, property, and national security and foreign policy interests of U.S. during commercial launch or reentry

3. Encourage, facilitate and promote U.S. commercial space transportation

Building The Future Of Space Transportation Together

# Areas of Research

1. Space Launch Operations and Traffic Management

2. Launch Vehicle Systems, Payloads, Technologies and Operations

3. Commercial Human Spaceflight

4. Space Commerce

5. Cross-Cutting Research

Building The Future Of Space Transportation Together

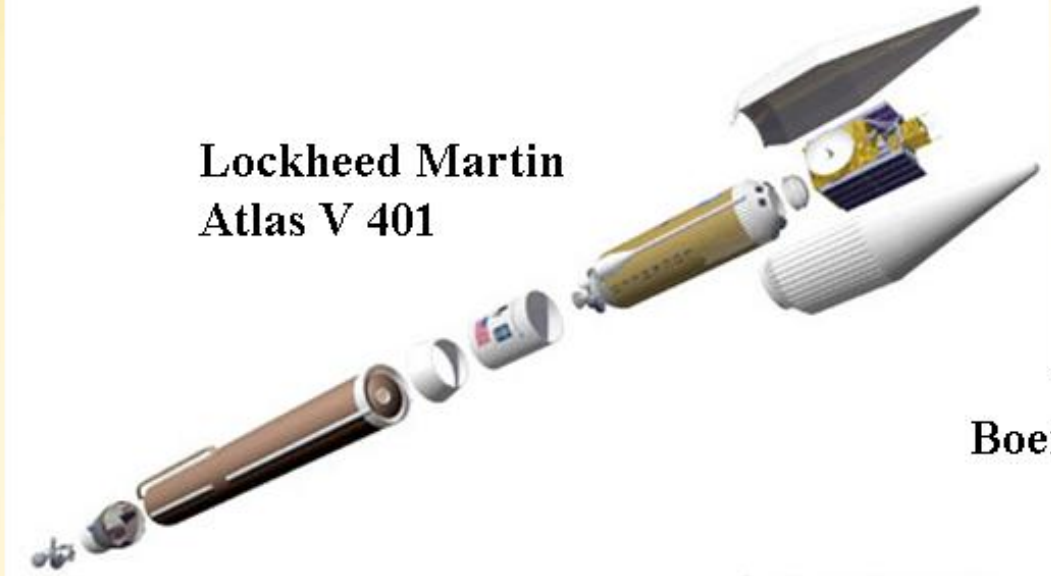
# Key Questions and Moving Forward

- How do we maximize Florida involvement?
- How can we leverage FAA COE CST for jobs, utilize KSC facilities, actively engage industry and keep public informed
- Space Florida commitment to cost match all Florida COE CST projects

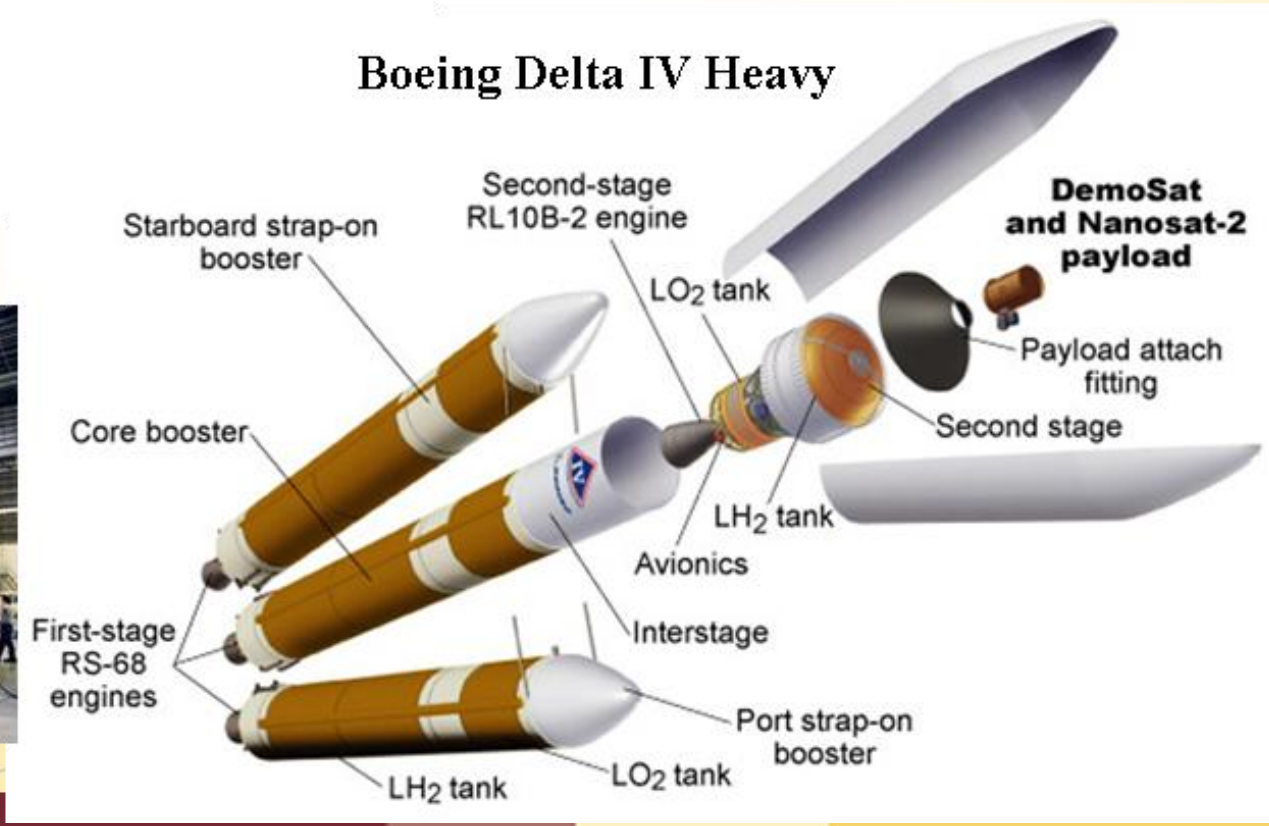
Florida Institute of Technology
High Tech with a Human Touch™

# Rocket Research

Lockheed Martin
Atlas V 401

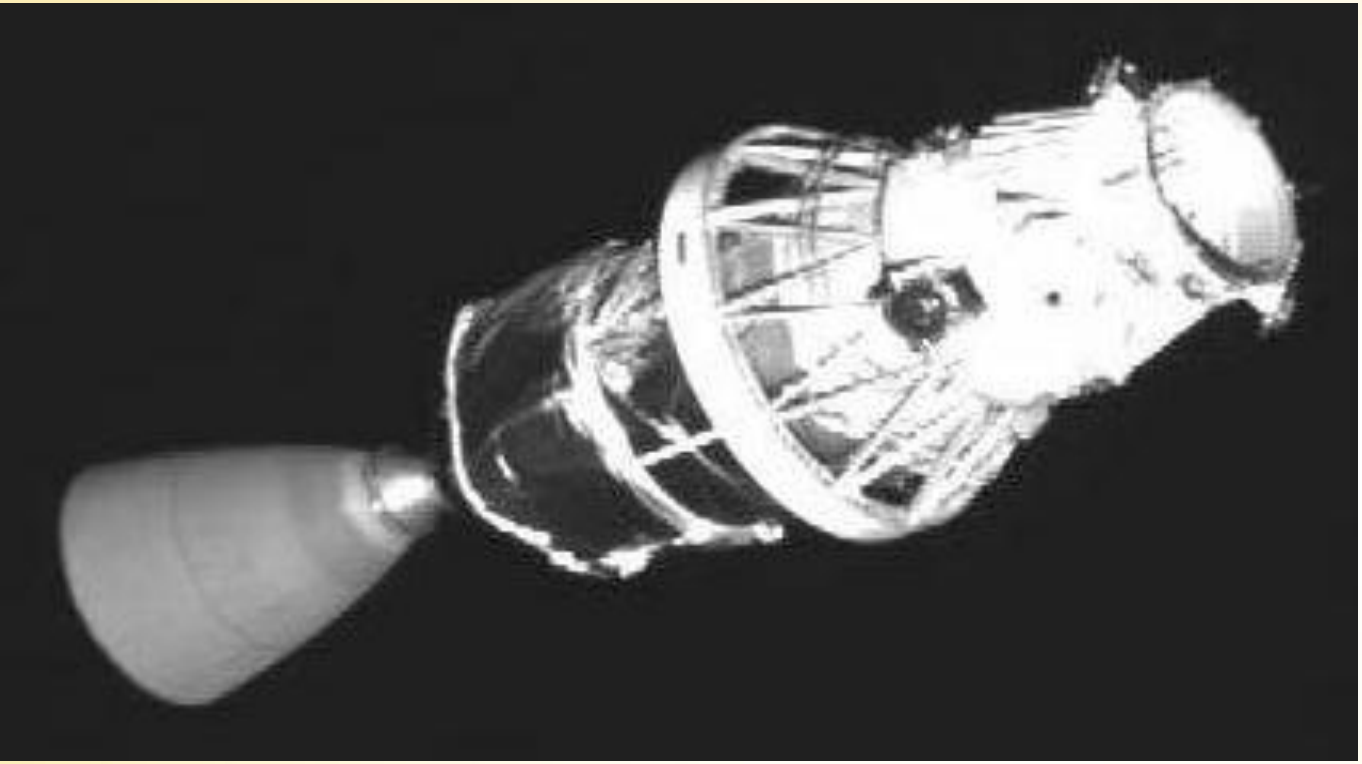


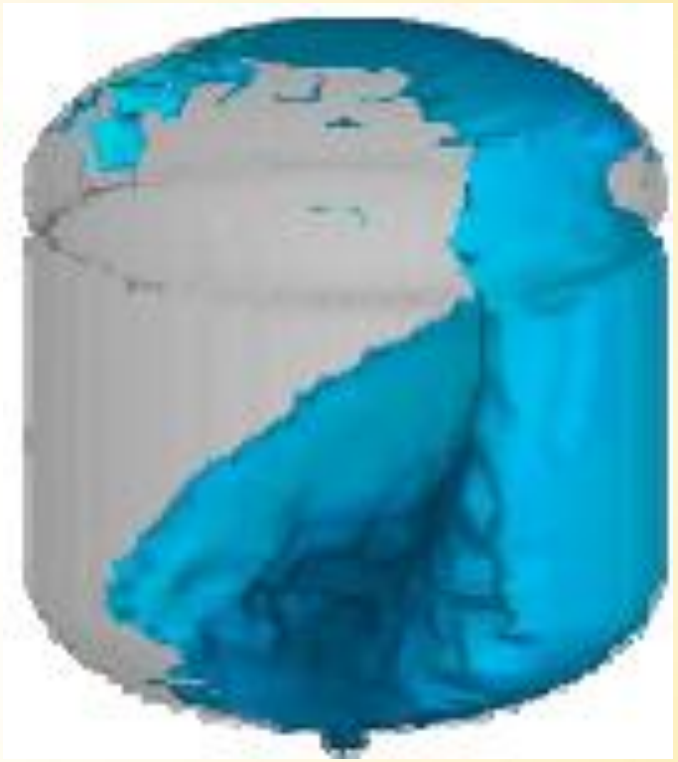
Boeing Delta IV Heavy



Florida Institute of Technology
High Tech with a Human Touch™

# Rocket Research

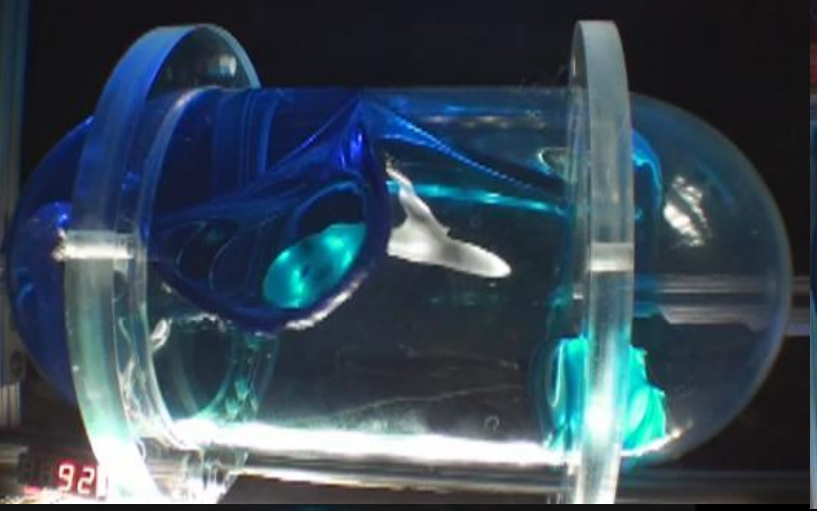


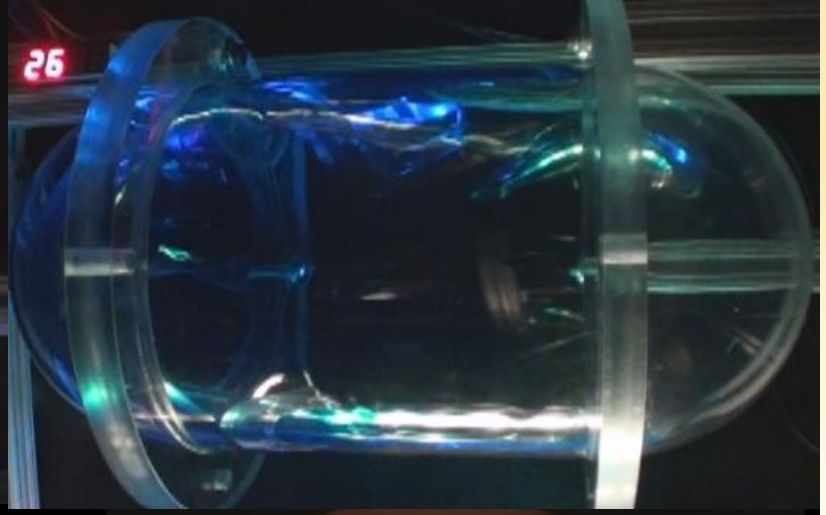


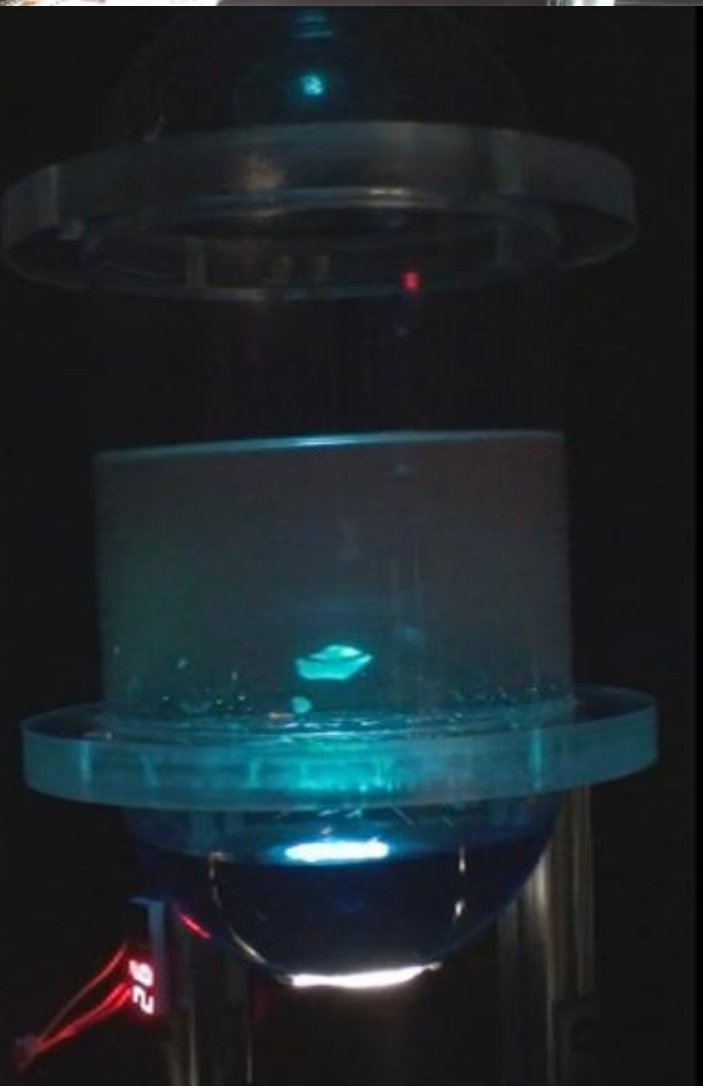
- What happens to propellants in space?
- How do we ensure spacecraft performance?
- How do we ensure mission success?

Florida Institute of Technology
High Tech with a Human Touch™

- **NASA FAST**: **F**acilitated **A**ccess to the **S**pace Environment for **T**echnology
- Rocket Propellant Studies at Zero Gravity
- 6 undergraduate and 2 graduate students flew on the ZeroG research aircraft
- Perform NASA research





# *Reduced Gravity Slosh Dynamics Study*

Florida Institute of Technology

*High Tech with a Human Touch™*

NASA

**F A S T**

*Illuminated by*

LightingScience®

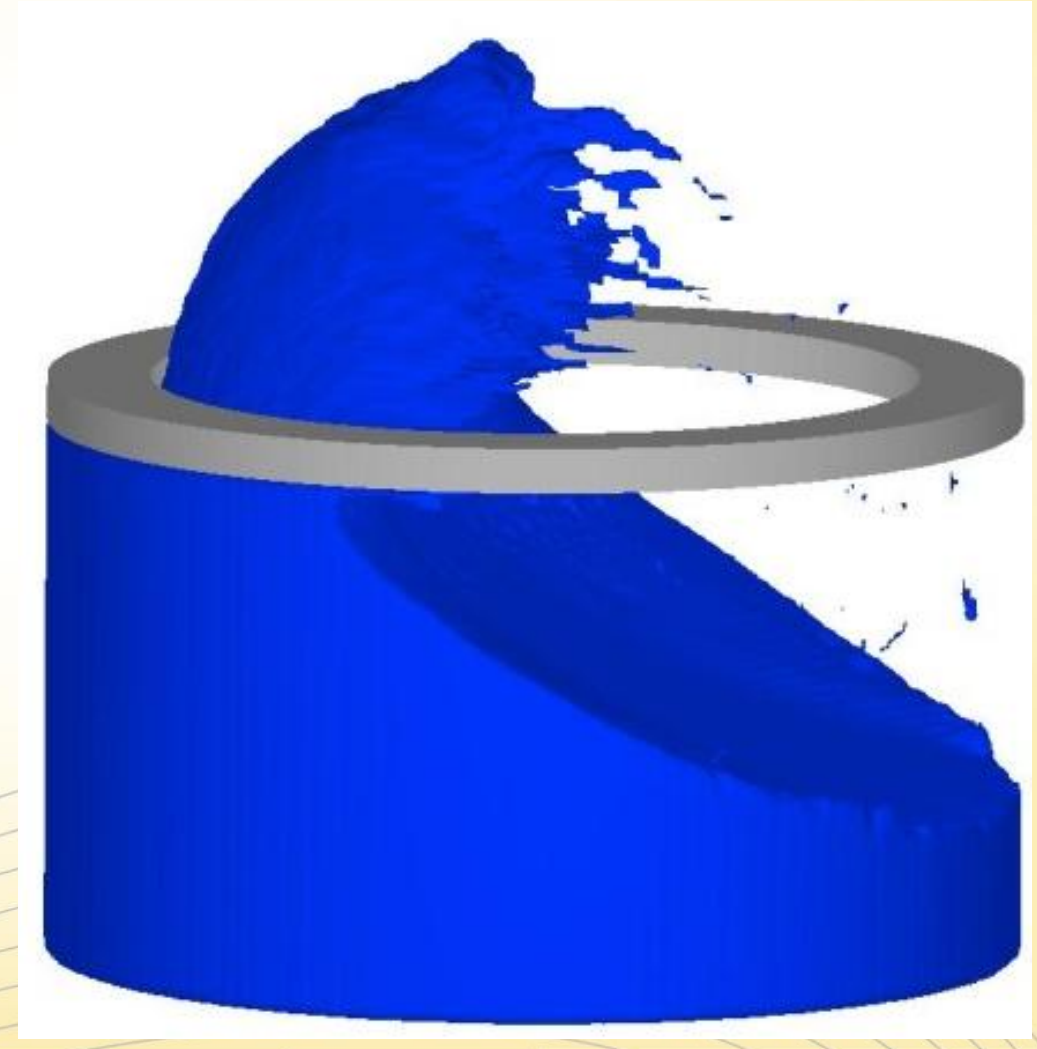
Changing the way the world experiences light.

Florida Institute of Technology
High Tech with a Human Touch™

# How good can we do?

**Experiment**

**Simulation**



Florida Institute of Technology
High Tech with a Human Touch™

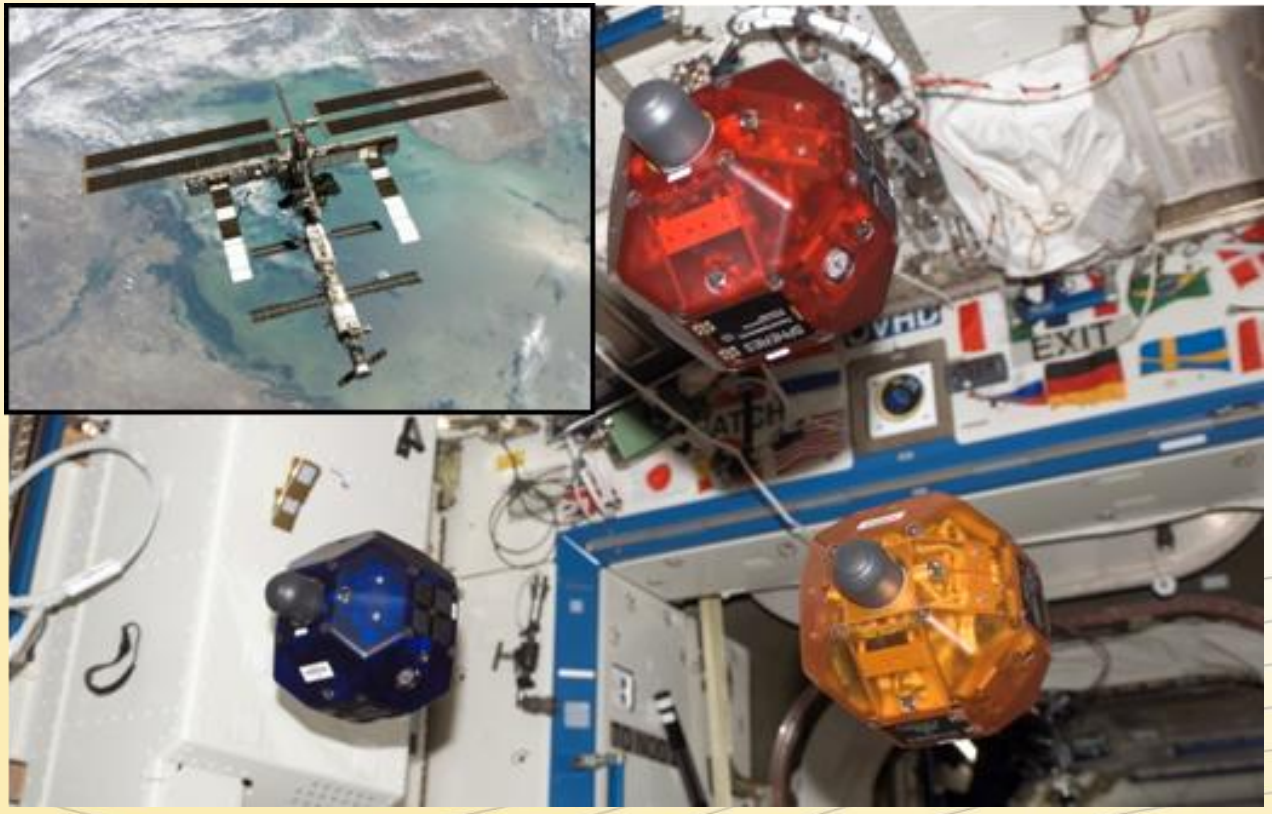
# Time Out!

- ***Why are you showing Florida Senators rocket propellant behavior in zero-gravity – don't they have better things to do with their time?!?***

- Example of NASA-industry-university collaboration
  - Better mission planning → reduced launch costs
  - Reduced launch costs → more launches
  - More launches → **more jobs**
- Example of student training and engagement
- Example ***'template'*** for success

Florida Institute of Technology
High Tech with a Human Touch™

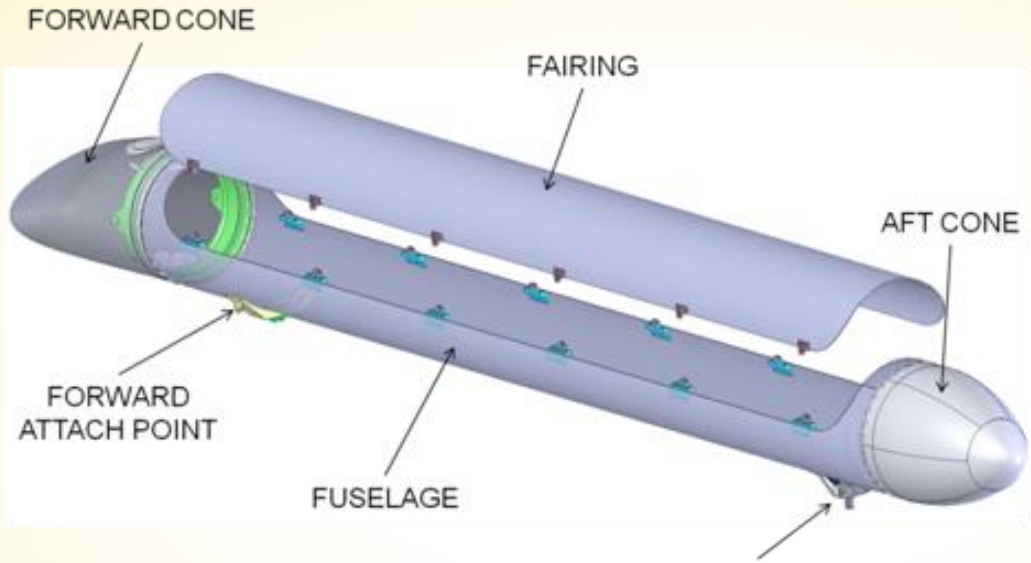
# Experiments on the International Space Station



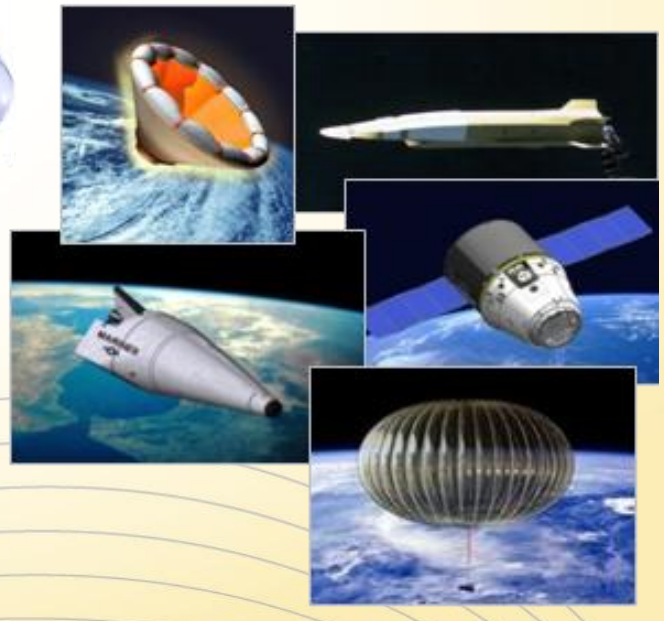

- Study liquid behavior for long periods of time
- More complex physics of zero-G
- Partnership between MIT, Florida Tech and NASA
- Ultimate recruiting tool
  - Passion for space
  - Energy for space
  - Excitement for space

Florida Institute of Technology
High Tech with a Human Touch™

# External Payload Carrier (XPC)


- *Military*
- *Commercial*
- *High Altitude, Hypersonic Aeronautics*
- *Microgravity*
- *Atmospheric -Exoatmospheric Research*
- *Reentry Vehicle Research*
- *Reusable technology (EELV Next Generation)*
- *Point to Point Applications*

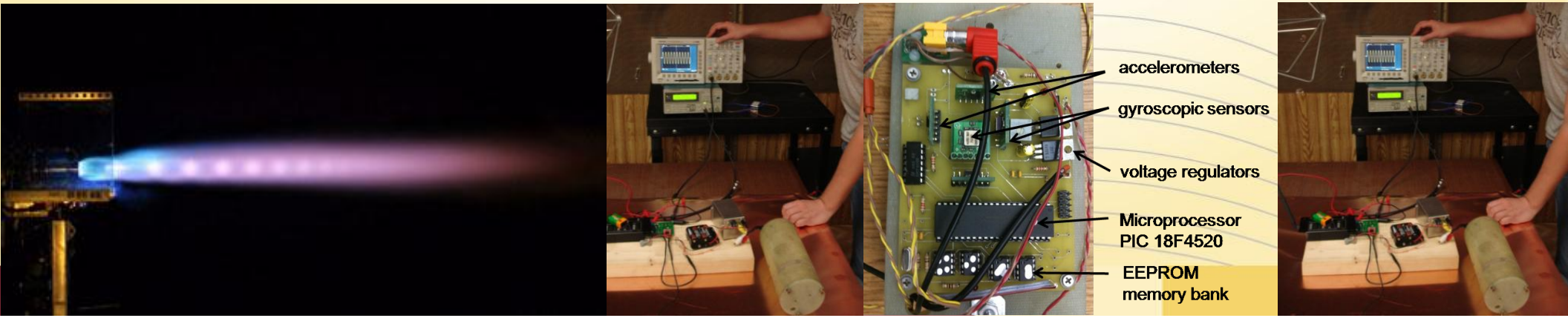


**SUBORBITAL HEAVY LIFT**

Florida Institute of Technology
High Tech with a Human Touch™

# Other NASA Projects

- Flight controls optimization
- Use of fiber optics for prediction and control of rocket bending during flight
- Propulsion system modeling
- Radio frequency and electromagnetic susceptibility
- Thermal systems modeling and heat transfer predictions



Florida Institute of Technology
High Tech with a Human Touch™

# Partnering with Small Business

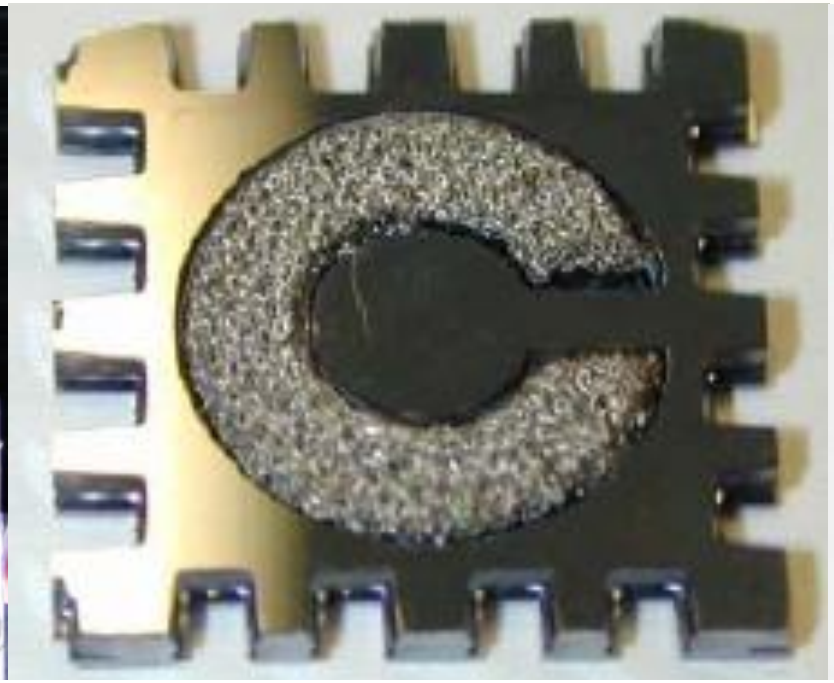
- **SBIR:** Small Business Innovation Research
- **STTR:** Small Business Technology Transfer

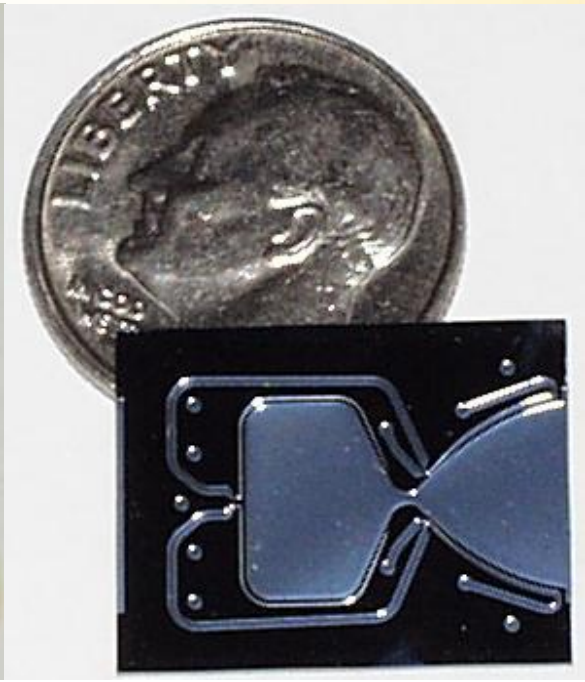
- WHY?
  - Help solve problems pertinent to Florida Small Businesses (Mainstream Engineering, Florida Turbine Technologies, Advanced Magnet Laboratory, etc.)
  - Increase capabilities
  - Attract to research to Florida
  - Increase employment opportunities
  - Training and education

Florida Institute of Technology
High Tech with a Human Touch™

# Florida Tech / Mainstream

- Fuel study to promote more efficient combustion
- Enable design of more efficiency engines
- Enable design of micro-combustion devices
- Sponsored by Office of Naval Research (ONR)

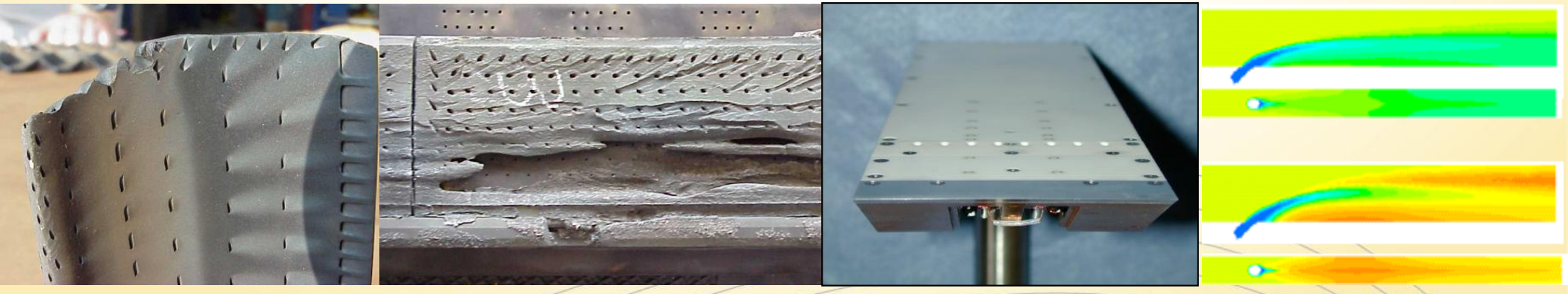




Florida Institute of Technology
High Tech with a Human Touch™

# Florida Tech / Mainstream

- Engine combustion study to improve airplane engine performance
- Increase durability and life of turbine engines
- Sponsored by Air Force Office of Scientific Research (AFOSR)



# Student Projects

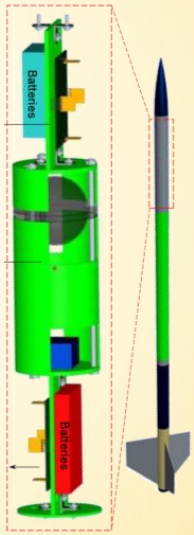
Florida Institute of Technology
High Tech with a Human Touch™

# Student Rocket Projects

- **JAMSTAR:** 84,000 ft altitude, 2-stage solid
- **Panther I:** First-ever student design and built rocket to fly from CCAFS
- Developing roadmap with Space Florida, SAIC, and AF 45th SW to enable companies to launch from CCAFS








- **Panther II Heavy:** USLI competition in Huntsville, AL in summer 2009
  - Design rocket to fly as precisely as possible to 1 mile apogee
  - Perform science experiment (liquid slosh) for NASA KSC
  - Over 25 universities competed, won 1st place for payload
- Others: **S3**, **SOAR**, **Pink Panther** and **20** other rockets to support payloads

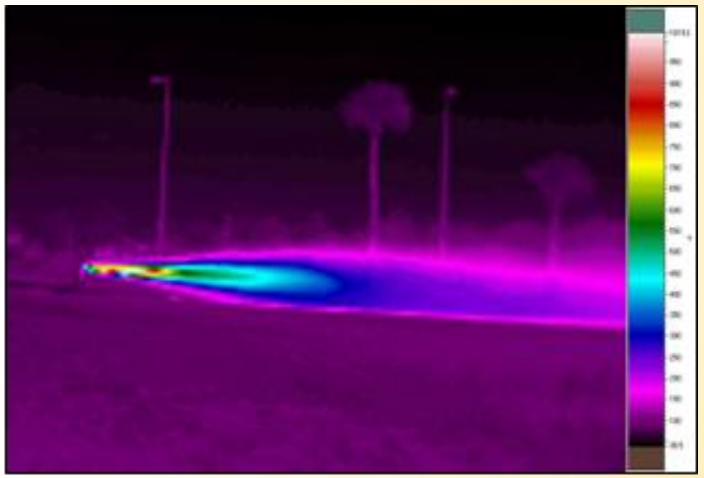
Florida Institute of Technology
High Tech with a Human Touch™

# Panther I Team

Florida Institute of Technology
High Tech with a Human Touch™

# Rocket Motor Testing

- Unique capability located at Florida Tech
- Used for Research and Teaching
- Partnering with companies to use facility



Solid rocket motor test firing

500 and 1,000 lb motors

Florida Institute of Technology
High Tech with a Human Touch™

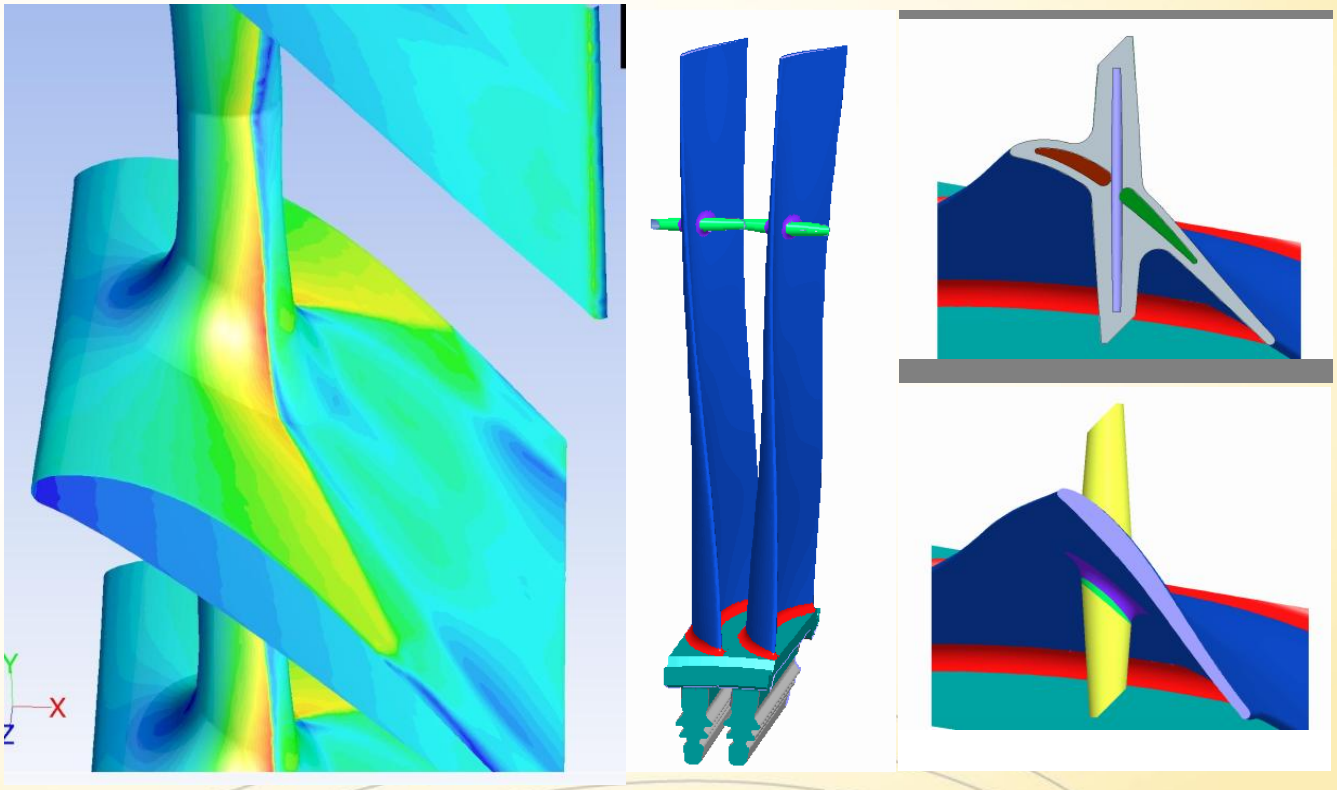
# Tanker Refueling Light System

- Develop an efficient LED lighting system to guide receiving aircraft pilot
- Partnership with Northrup Grumman
- 10 undergraduate students involved

Florida Institute of Technology
High Tech with a Human Touch™

# Gas Turbine Blade Design

- Students engaged in analysis and experimental design of advanced turbine blades
- Partnership with Siemens Power Generation, Orlando



Florida Institute of Technology
High Tech with a Human Touch™

# Student Competitions

- Number of team members: 8 (AE majors)
- Objective: Build a Blended Wing-Body UAV and compete in AIAA Student Competition
- Specifications
  - Wing Span 4 m
  - Cruise speed 50 m/s; electric power by two 95 N motors
  - Maximum Take-off Weight 100 kg
  - Maximum Range 800 km
- Competition: 1st place in the AIAA Region 2 (Southeastern U.S.) Student Conference (placed ahead of Georgia Tech)


Florida Institute of Technology
High Tech with a Human Touch™

# Florida Tech – NASA Jet Propulsion Laboratory (JPL) Collaboration

- New graduate degree option in Spacecraft Systems engineering
- Project and training commitment from JPL
- Interest from Harris, Boeing, NASA
- Available via distance learning

Florida Institute of Technology
High Tech with a Human Touch™

# Florida Senate Committee on Military Affairs, Space, and Domestic Security

http://www.flsenate.gov/Committees/Show/MS/

- Senate Committee on Military Affairs, Space and Domestic Security has oversight of all matters at state level pertaining to military, National Guard, and veterans' affairs

- Committee also oversees policy matters involving:
  - Florida's aerospace industry as it relates to aerospace business development
  - **Emergency management**
  - **Homeland security**

- Committee's jurisdiction of emergency management encompasses all aspects of emergency preparedness, response, recovery, and mitigation and jurisdiction of homeland security includes oversight of an annual federal funding process for domestic security projects in Florida and also oversight of seaport security issues for Florida's 14 seaports

Florida Institute of Technology
High Tech with a Human Touch™

# Harris Institute for Assured Information and Security Science

- Recognized for its work and numerous government and national foundation contracts
- Center for Security Science exists to further the study of science of security through education and world-class research.
- Current research projects include:
  - BITSI: Biologically Inspired Tactical Security Infrastructure
  - Illusio: Virtual environment detection
- Center is also in the process of developing a set of tools for general use in community

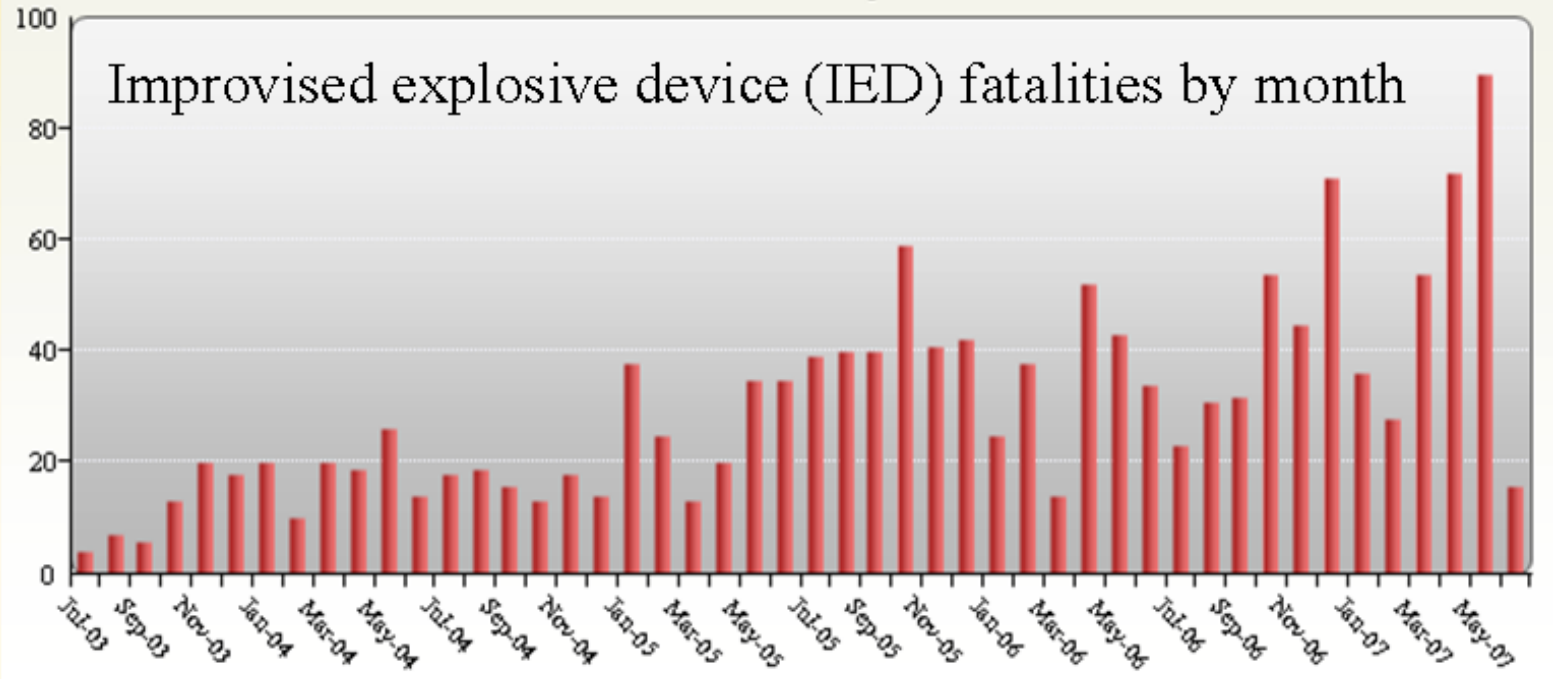
Florida Institute of Technology
High Tech with a Human Touch™

# Traumatic Brain Injury Research

- Partnership between Florida Tech, Banyan Biomarkers, University of Florida, National Institute of Health, Army and Navy

- **GOAL:** How to save lives and treat soldiers exposed to blasts

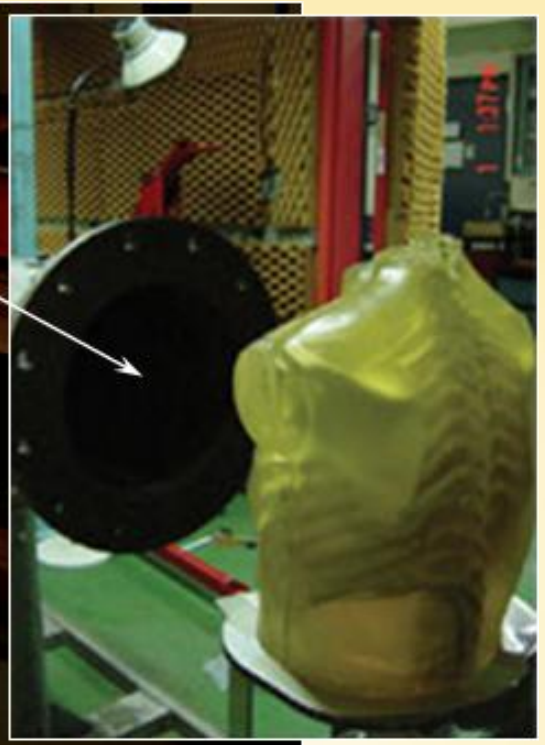
# Alarming Statistics!




- **Over 50% of all combat injuries in Iraq are blast injuries**
- Approximately 8-25% of persons with blast-related injuries die
- 2003: Defense and Veterans Head Injury Program screened 155 injured soldiers from Iraq 62% found to have brain injury
- Army data shows 59% of patients exposed to blast diagnosed with TBI
  - 56% considered moderate or severe, and 44% are mild

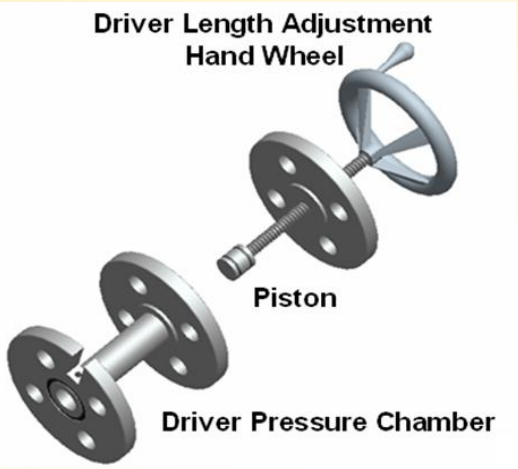
## Walter Reed Shock Tunnel Facility: 30.5 cm (12 in) D

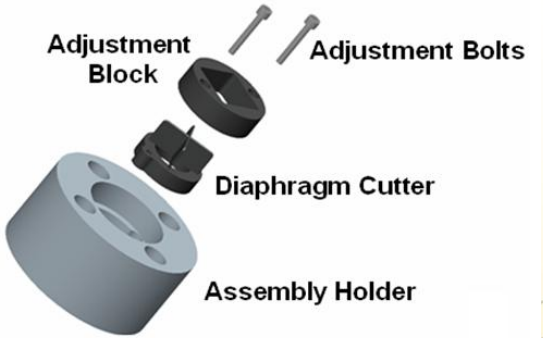
Instrumented thoracic model undergoing shock impulse from pressurized shock tube
http://www.nrl.navy.mil/content.php?P=04REVIEW156



Florida Tech Shock Tube Facility
7.5 m (25 ft) L, 15 cm (6 in) D, Reflection Type Tunnel

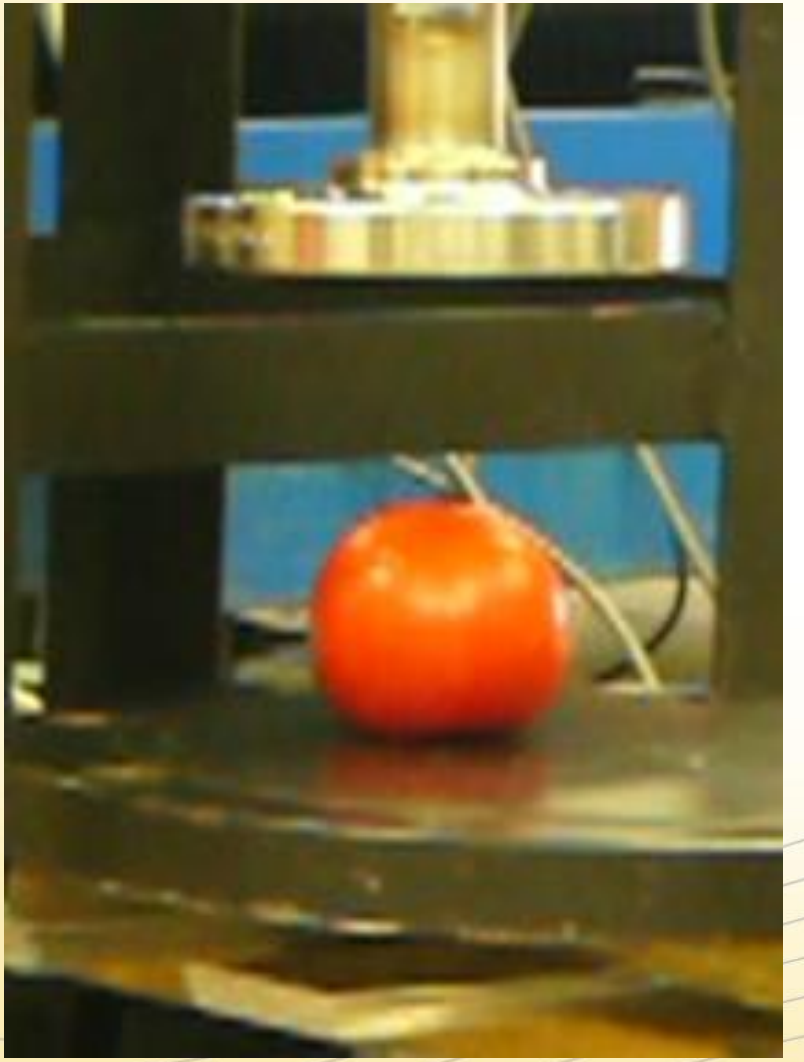
Florida Institute of Technology
High Tech with a Human Touch™



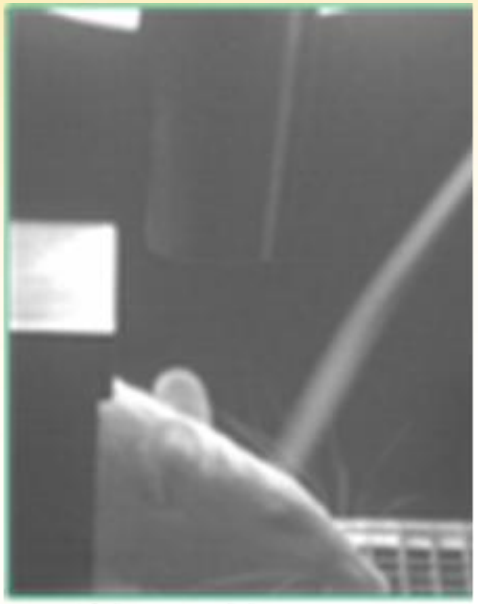

Florida Institute of Technology
High Tech with a Human Touch™

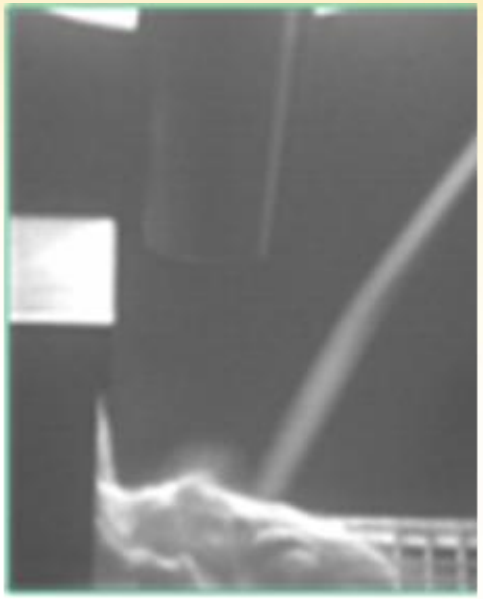
BANYAN BIOMARKERS®



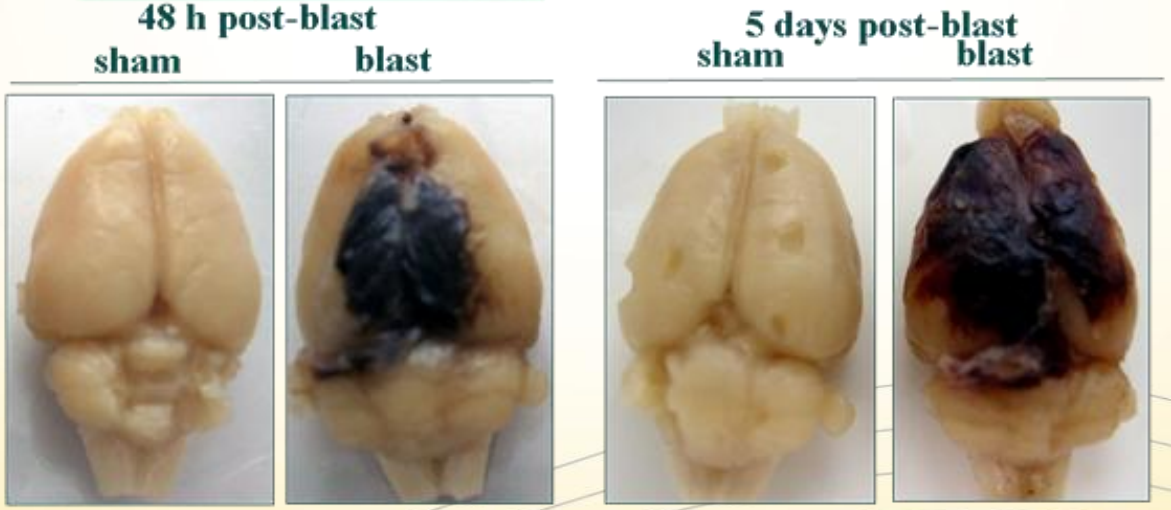
BANYAN BIOMARKERS®

t = 0





t = 2 ms



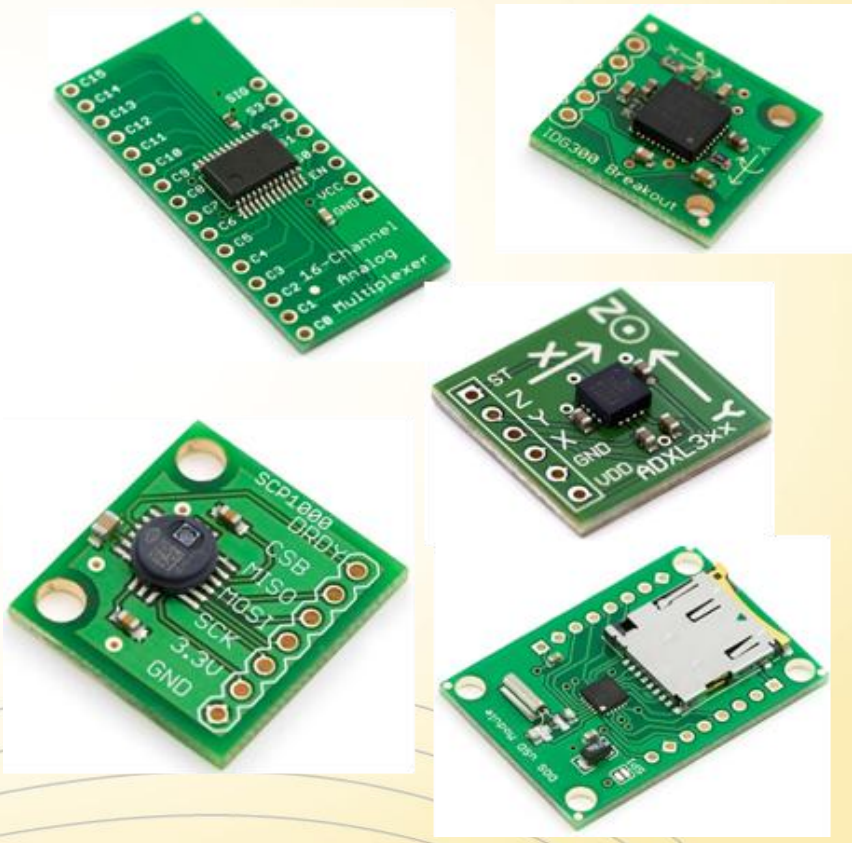

- Working with consortium to develop suite of biomarkers to characterize blast impact within minutes in-field
- Development of models of blast wave interaction with viscoelastic targets

Florida Institute of Technology
High Tech with a Human Touch™

BANYAN BIOMARKERS®

# In-Field Diagnostics

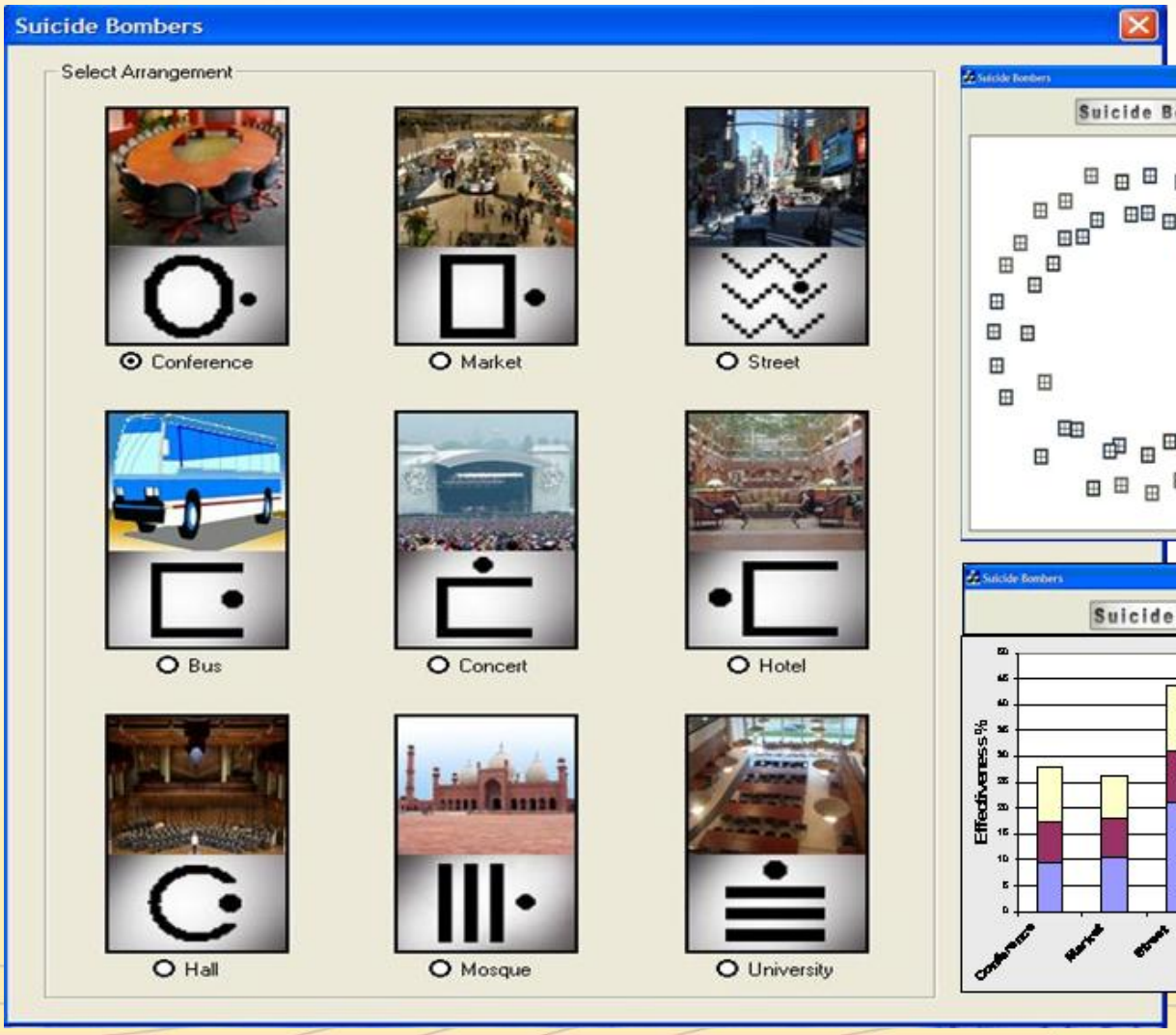
- State-of-the-art MEMS IC technology to record cumulative exposure to blasts waves and peak blast overpressure in real time:
  - Transmission of blast exposure to medical staff using wireless
  - Display of blast and impulse exposure (peak and cumulative) to soldier
- Device is small enough to be built-in vests, safety gear, vehicles, etc.
- Small, light weight (less than 1 lb), low-cost, rapid-response, modular units

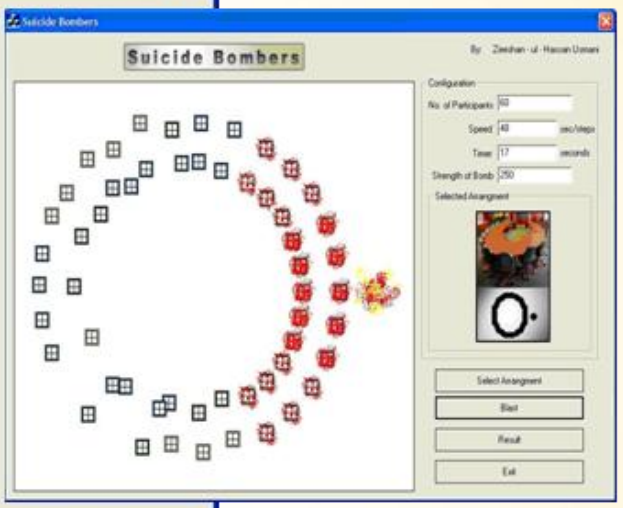


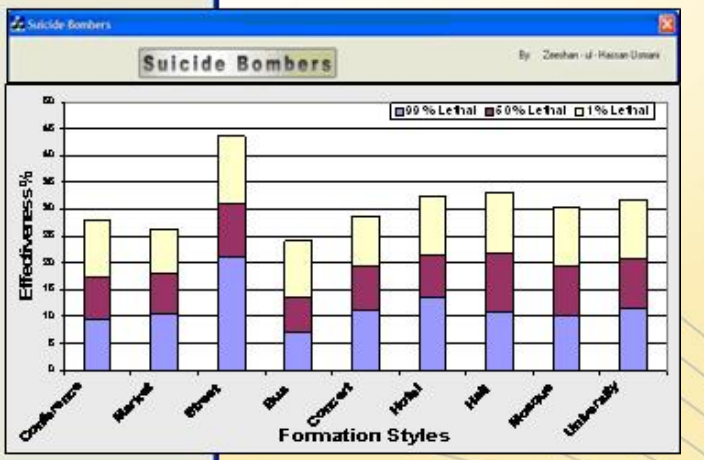
Florida Institute of Technology
High Tech with a Human Touch™

BANYAN BIOMARKERS®

# Suicide Bombing Attack Modeling



Florida Institute of Technology
High Tech with a Human Touch™

# Concluding Remarks

- Florida Tech as a leading research institution that is eager to partner with **industry**, **government** and **other universities** to support Florida-centric growth objectives

- Opportunities exist in complex new landscape of space exploration – ***HOWEVER*** – careful strategy is needed for best ways to leverage existing opportunities… and to create new ones

- Invitation to come and visit Florida Tech to meet students, faculty, local industry representatives, etc.

# Supplemental Slides

Building The Future Of Space Transportation Together

# Specific Projects

- Promotion of research, policy and educational activities
- Improve spaceport operations
- Improve airspace integration
- Improve propulsion and materials technologies
- Improve understanding of payload form-factors and related technologies
- Improve understanding of human accommodation to spaceflight
- Improve understanding of business environment
- How to synthesize government, business (big and small) and academia?