Leading the Way in Propulsion for 25 Years

PROPULSION RESEARCH CENTER
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Propulsion Research and Academic Programs[2] at the University of Alabama in Huntsville

Dr. Robert A. Frederick, Jr.

Director, UAH Propulsion Research Center

Professor of Mechanical and Aerospace Engineering

Dr. Phillip M. Ligrani

Eminent Scholar in Propulsion

Professor of Mechanical and Aerospace Engineering

Dr. Dale Thomas

Eminent Scholar in Systems Engineering

Professor of Industrial and Systems Engineering

The University of Alabama in Huntsville

http://prc.uah.edu

UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Objectives:

- Present PRC Progress and Achievements

Scope:

- PRC Metrics
- Academic Programs
- Research Capabilities/Achievements 2016-17
- Future Directions

The University of Alabama in Huntsville (UAH)

UAH Research Institute Groundbreaking

Major General Francis Morrow, Dr. Werner von Braun, Research Institute Director John Patterson, and Alabama Governor, John Patterson
December 20, 1962

- 1961, Alabama legislature granted $3 million to seed the UAH Research Institute which grew into the University of Alabama in Huntsville
- 1991, UAH Forms a Propulsion Research Center which focuses propulsion activities into one research business unit
- 2016, PRC 25th Anniversary

- 2016, UAH Achieves
  - Over 80 million/year in research expenditures
  - 40 Ph.D.'s. and 350 Master's students
  - Top 10 Federally-funded Aero and Astro Engineering

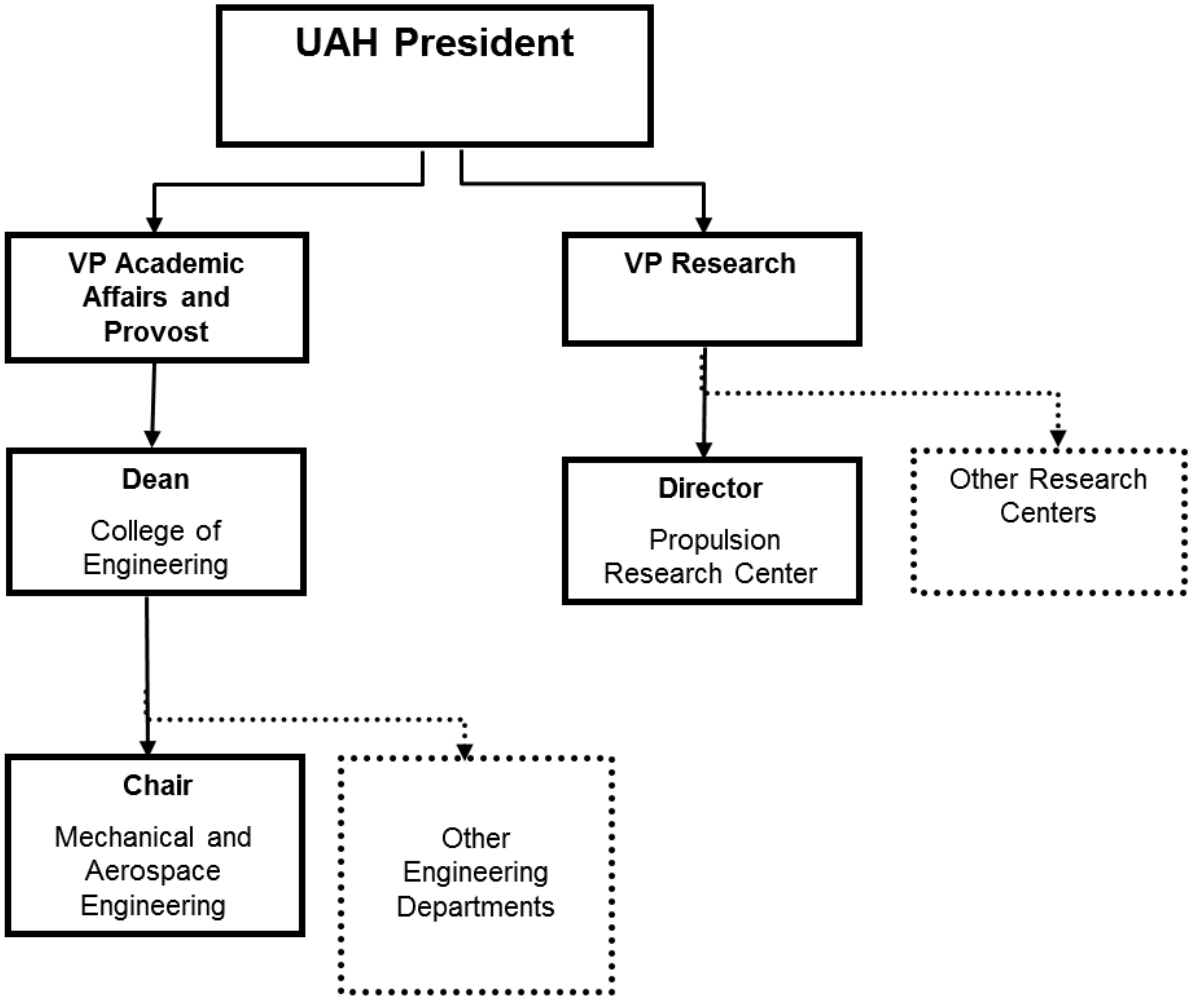
UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

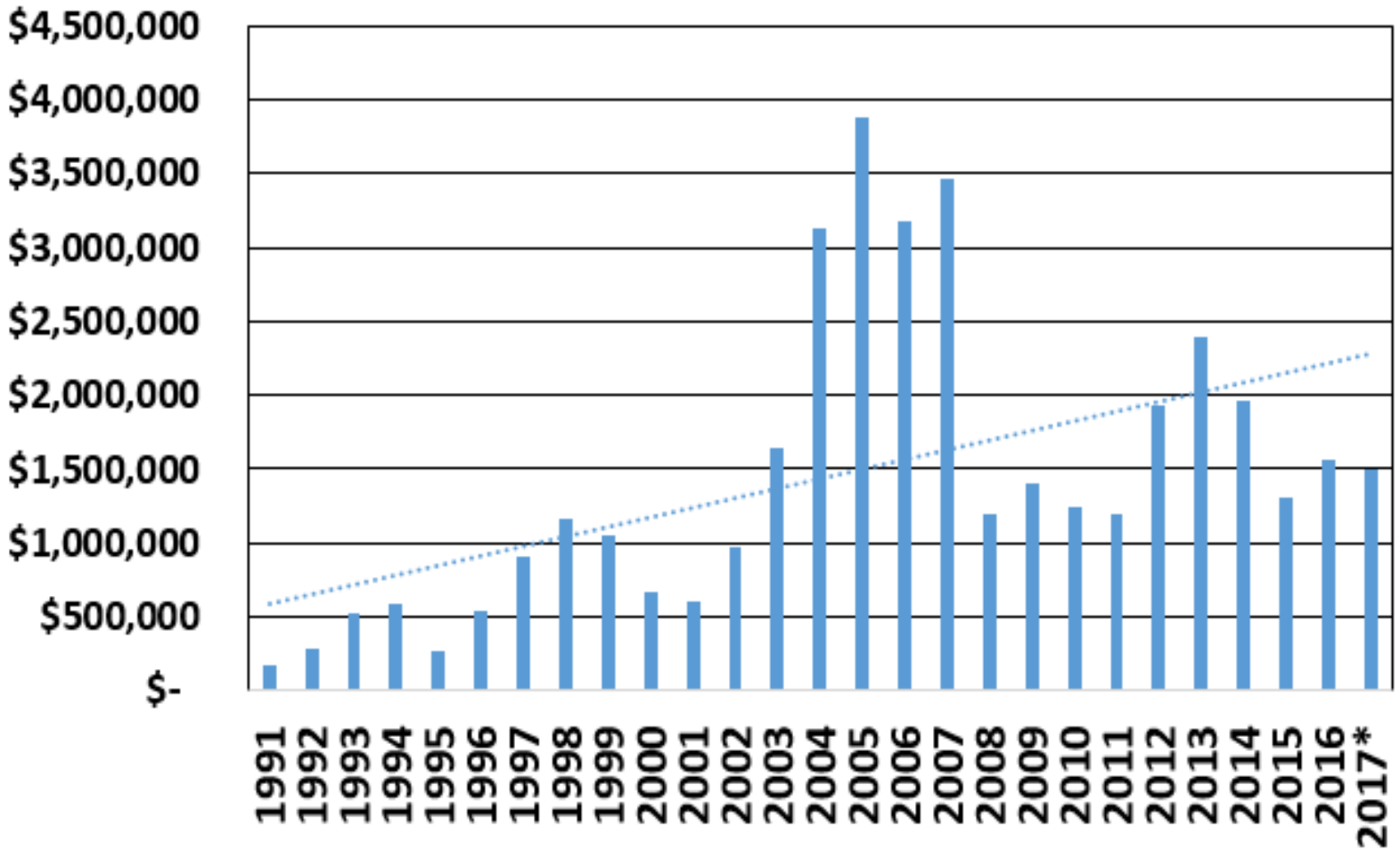
Mission and Strategy

- The PRC was established to provide an environment that connects the academic research community with the needs and concerns of the propulsion community, while promoting an interdisciplinary approach to solving propulsion problems.
- Collaborative Research Groups: Academia, Industry, Government
- Integrate a High-Quality Education with Scholarly Research Activity
  - Seek those externally funded efforts that would provide graduate students with material for theses and dissertations
  - Provide hands-on research opportunities and laboratories for the students
  - Develop new courses in propulsion and energy

Administrative Organization



PRC Expenditure History

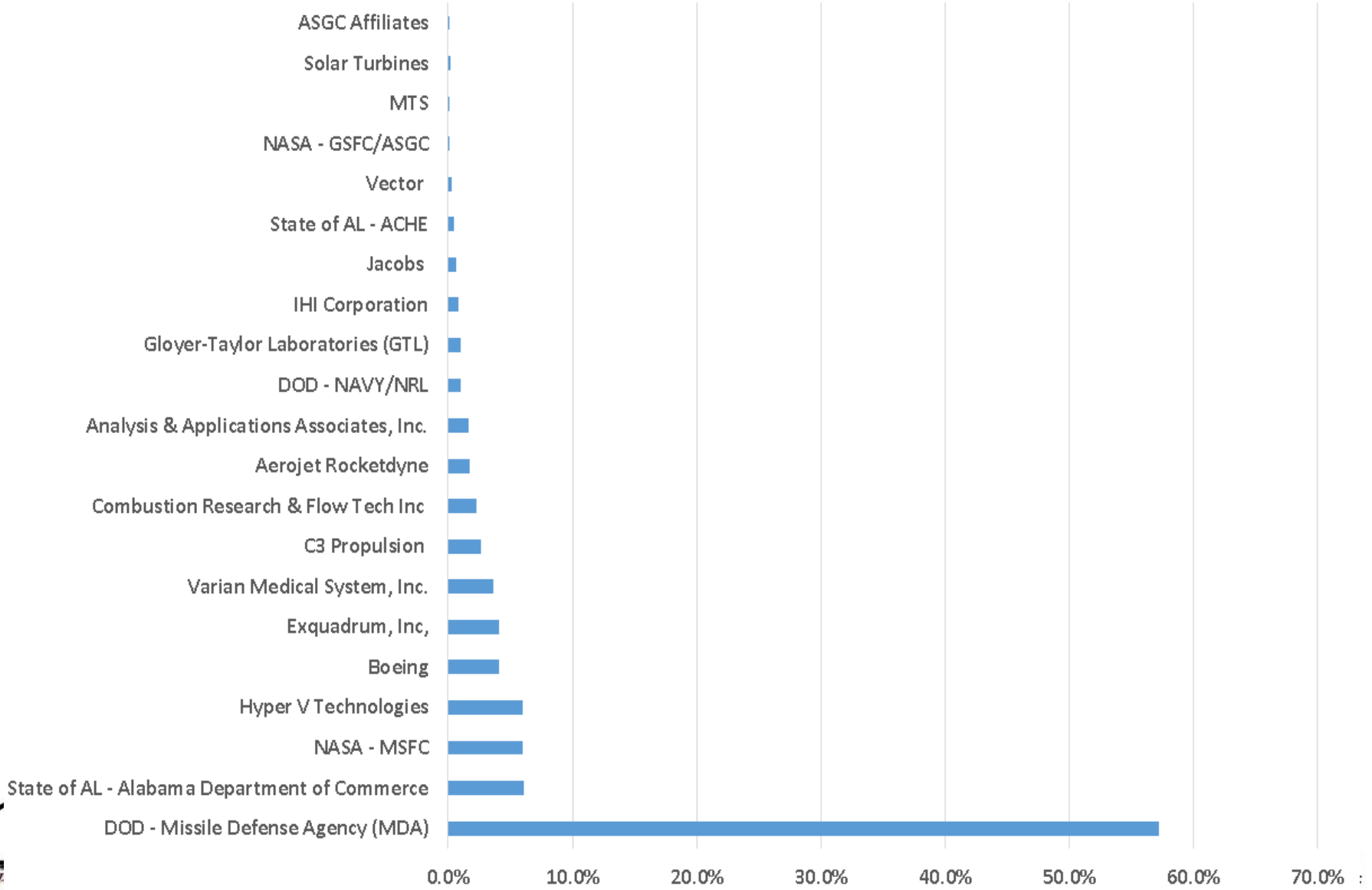


Total expenditures rose from $1.308 million (FY15) to $1.563 million (FY16). The research expenditure numbers do not include cost shares, internal university administrative funds, or UAH Foundation investments into the PRC

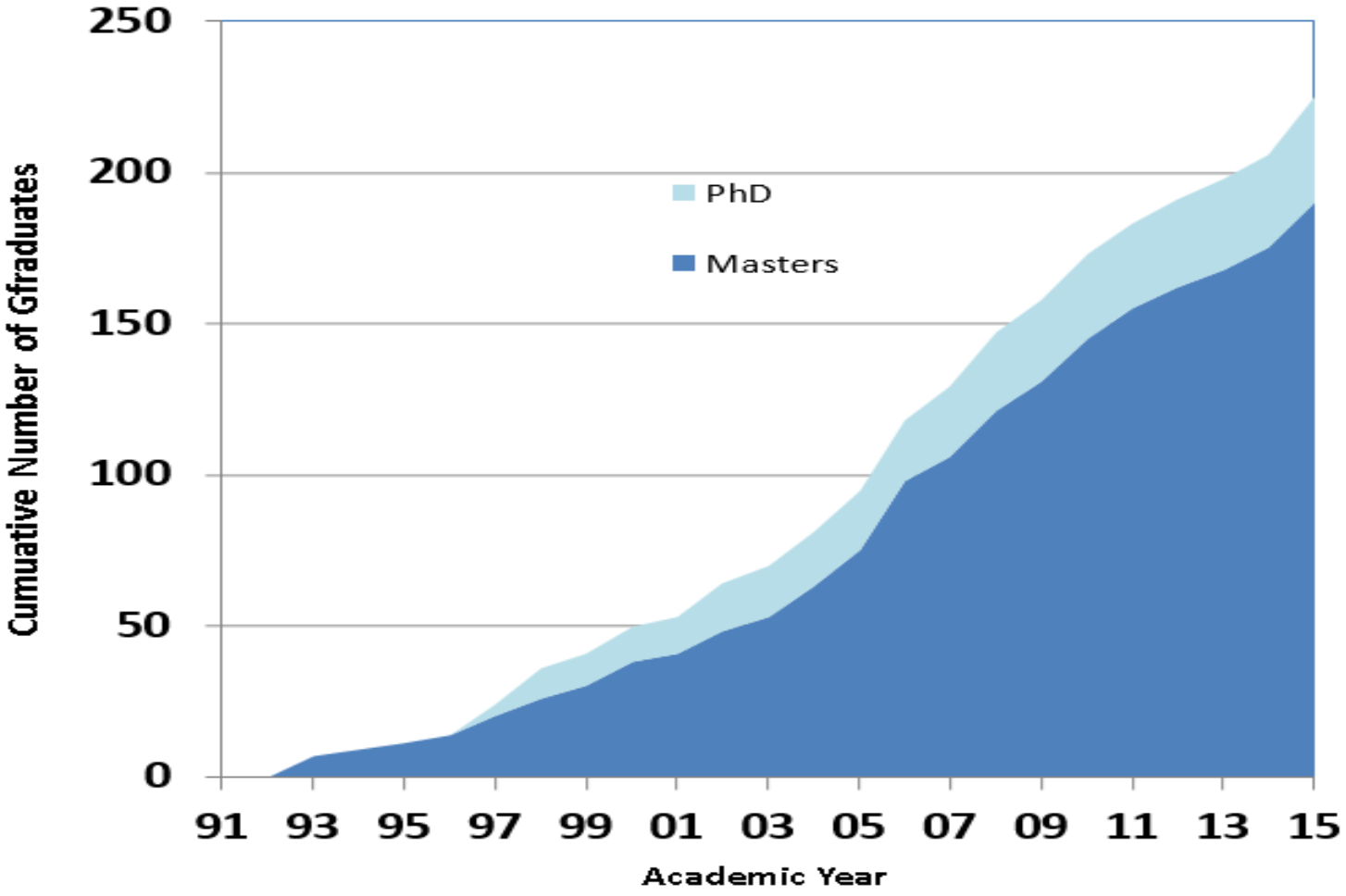
UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Expenditure Distribution 2016-17



PRC Advanced Degrees Supported



UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

The UAH Aerospace Program

Department of Mechanical & Aerospace Engineering

- **BS in Aerospace Eng. and Mechanical Eng.**
- **MS and PhD in ME and Aerospace Systems Engineering.**
- **Expanded from 950 (AY15) to 1068 (AY16) total MAE undergraduates with anticipated 1200 (AY17)**
- **ME and Aero graduate students decreased from 170 (AY15) to 150 (AY16)**. Many are part-time and working at the Arsenal or Cummings Research Park
- **20 tenure-track faculty,** 4 non-tenure-track faculty members, and several part-time instructors teaching in the Mechanical and Aerospace degree programs
- **Among the top 10 federally-funded Aero and Astro Engineering Programs**
- **Contact:**

Dr. Keith Hollingsworth
keith.hollingsworth@uah.edu
Chair: Dept. of Mech. and Aero. Eng.

UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

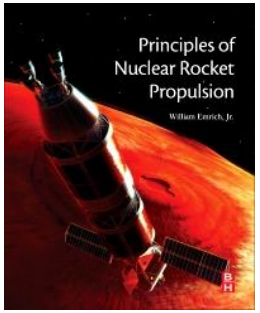
UAH Propulsion and Energy Courses

Dual-Level Undergrad/Graduate	AY 15-16	AY 16-17
MAE 343 – Compressible Aerodynamics		79
MAE 420/520 – Compressible Aero	49	
MAE 440/540 – Rocket Propulsion I	55	34
MAE 441/541 – Airbreathing Propulsion	17	38
MAE 444/544 – Intro. To Electric Prop.	22	0
MAE 468/568 – Eleme. of Spacecraft Des.	48	61
MAE 493/593 – Rocket Design	28	19
MAE 495/595 – Intro. To Nuclear Prop	0	21
TOTAL	**219**	**252**

MAE Graduate-Level	AY 15-16	AY 16-17
MAE 620 – Compressible Flow	21	11
MAE 640 – Rocket Propulsion II	0	21
MAE 633 – Tactical Missile Design I	0	0
MAE 644 – Adv. Solid Rocket Propulsion	22	0
MAE 645 – Combustion I	6	0
MAE 681 – Missile Trajectory Analysis	0	0
MAE 745 – Combustion II	0	0
MAE 795 – ST: Intro to Fusion Propulsion;	11	0
MAE 695/795 – ST Adv. Readings in Prop.	7	3
MAE 695 – Comb. Instability in Solid Rockets	15	0
MAE 695 – Liquid Rocket Engineering	20	0
TOTAL	**102**	**35**

Liquid Rocket Engineering

- **Liquid Rocket Engineering and Solid Propellant Instability Courses Added**
- **25 UAH Grad students and 15 Professional Development students participated**
- **5-Days of Intensive Lectures**
- **3 weeks of Additional Homework and Projects**



Principles of Nuclear Rocket Propulsion
1st Edition
Author: Dr. William Emrich, Jr.

UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAH Propulsion Research Center

Prof. R. Frederick, PhD, Director

Prof. D. Thomas, PhD, Asssociate Director

http://www.uah.edu/prc

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

A. Edmondson, MBA
Research Prog. Administrator/Budget Analyst
D. Battle SS4; M. Kitts, PRA; J. Prince SS3

Eminent Scholar In Propulsion
Prof. P. Ligrani, PhD

Aerospace Propulsion and Systems Integration Strategic Planning
Prof. D. Thomas, PhD. Eminent Scholar in Systems Engineering
Prof. P. Collopy, PhD, Chair of ISEEM Department
Prof. S. Mahalingam, PhD, Dean of the College of Engineering

Propulsion Laboratory and Safety
Dr. D. Lineberry, PhD, Laboratory Operations
T. Hall, Test Engineer

Energy & Power Systems
Prof. Phillip Ligrani, PhD

J. Blackmon, PhD
P. Collopy, PhD
K. Frendi, PhD
C. Kang, PhD
S. Mahalingam, PhD
G. Nelson, PhD
S. Rani, PhD
C. Sautter, PhD (RI)

D. Copeland, GRA; P. McInturff, GRA; C. Ren, GRA; Z. Ren, GRA; M. Su, GRA; M. Suzuki, GRA; S. R. Venga, GRA

M. Anderson, UGA; A. Click, UGA; D. Corey, UGA; A. Miller, UGA; R. Petrimoulx, UGA; W. Pico, UGA; D. Ritchie, UGA

Fusion Propulsion & Power
Prof. J. Cassibry, PhD

R. Cortez (RI)
W. Seidler, PhD

T. Englestad, PTGS
P. Giddens, OCE
D. Hewitt, PTGS
S. Kumar, GTA
M. Rogriguez, PTGS
K. Schillo, GRA
R. Tackett, PTGS
B. Taylor, PTGS
B. Winterling, GRA

Plasmas & Combustion
Prof. G. Xu, PhD

J. Cassibry , PhD
K. Frendi , PhD

R. Dextre, PTGS
R. Gott, GTA
E. Hopping, GRA
W. Manneschmidt, GRA
P. Salvador, GRA

N. Latan, UGA
N. Mann, UGA

Computational Modeling
Prof. S. Rani, PhD

F. Ewere, PhD (Lecturer)
K. Frendi , PhD
V. K. Gupta, PhD (PDF)
C. Kang , PhD
S. Mahalingam , PhD
S. Ravindran , PhD
B. Shotorban , PhD

R. Dhariwal, GRA
V. Rani, GTA
A. Wilson, GTA

Aerospace Materials & Structures
Prof. G. Nelson, PhD

K. Hazeli, PhD
M. Lin, PhD
C. Sautter, PhD (RI)
J. Schneider, PhD
G. Wang, PhD

J. Buckley, GRA
R. Chow, GRA
J. Indeck GRA
D. Kodali, GTA
Z. Meyers, GRA

G. Andrew, UGA
M. Frederick UGA
A. Minor UGA

Propellants & Energetics
Prof. R. Frederick, PhD

J. Baird, PhD
M. Banish, PhD
J. Blackmon, PhD
D. Lineberry , PhD
G. Xu , PhD
V. Braswell, OCE
S. Williams, OCE

C. Blankenship, PTGS; K. Bluestone, PTGS; C. Freeman, PTGS; A. Hiett, GRA; R. Hicks, GRA; D. Jones, GRA; S. Kumar, GTA; N. McFerrin, GRA A. Patel, GRA; R. Pereira, GTA; I. Rande, GTA; B. Winterling, GRA

J. Agnew, UGA
A. Creech, UGA

Propulsion System Technology Test-bed
D. Lineberry , PhD

B. Landrum, PhD
P. Ligrani, PhD
G. Wang , PhD

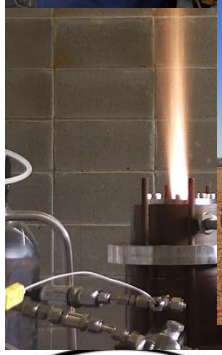
E. Tingley, GTA

M. Duchock, UGA
T. Ueno, UGA

GRA=Graduate Research Assistant; GTA=Graduate Teaching Assistant; OCE=On-Call Employee; PTGS=Part-Time Graduate Student; PRA=Propulsion Research Assistant; RI=Research Institute; SS3=Student Specialist III; SS4=Student Specialist IV; UGA=Undergraduate Assistant

06/21/2017

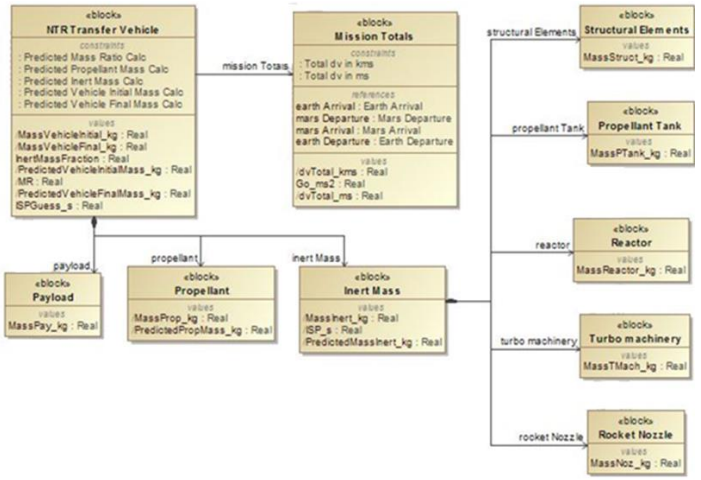

UAH
Propulsion Research Center



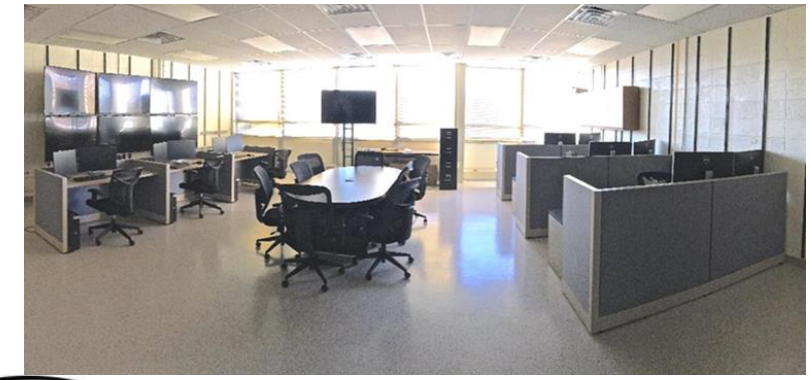

Rocket Hot-Fire
Test Cell
Leading the Way in Propulsion for 25 Years
UAH

Propulsion Systems Integration

SysML Block Definition Diagram of Nuclear Thermal Propulsion Powered Transfer Vehicle



Complex Systems Integration Laboratory



Expertise and Areas of Application:
Development of systems models which incorporate advanced propulsion technologies and scientific principles. Mission simulation to identify and resolve system integration issues and facilitate planning for technology infusion into operational system.

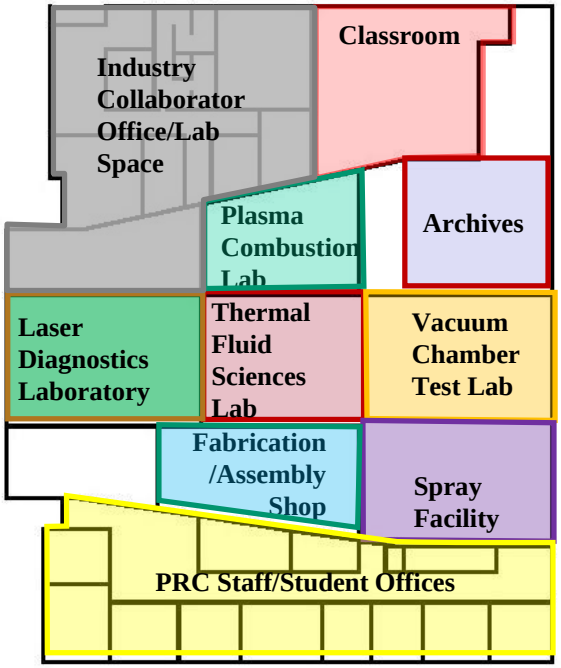
Recent Highlights:

- Systems Modeling for Nuclear Thermal Propulsion Powered Space Transportation Vehicle, NASA Marshall Space Flight Center

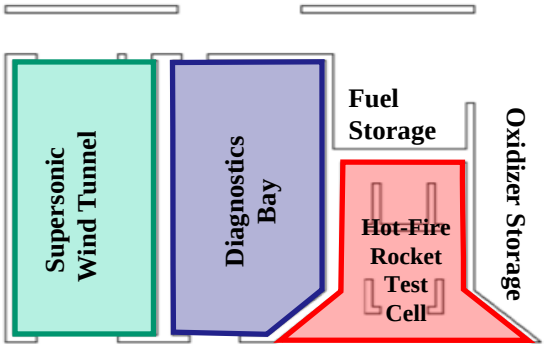
Contact:
• Dale Thomas, dale.thomas@uah.edu

Propulsion Laboratories

PRC Labs at the Johnson Research Center



PRC's Propulsion Test Facility



OTHER PRC	Location
High-Pressure Solid Propellant Lab	Material Science Building
Solar Thermal Lab	Blackmon Hall
Other UAH	**Location**
Adaptive Structures Lab	UAH Technology Hall
Advanced Manufacturing Processes Laboratory or AMPL.	Aerophysics Research Center, Redstone Arsenal
Charger One - Fusion Propulsion	Aerophysics Research Center, Redstone Arsenal
Complex Systems Integration Laboratory (CSIL)	UAH VBH
Mechanical of Materials Under Extreme Environments	UAH Optics Building
Transport, Reaction, and Energy Conversion Lab	UAH Shelby Center

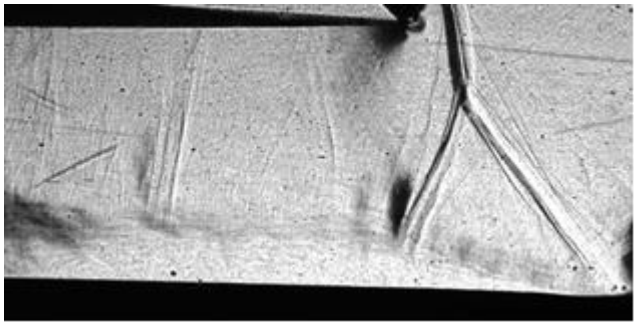
UAH Propulsion Research Center

Energy and Power Systems

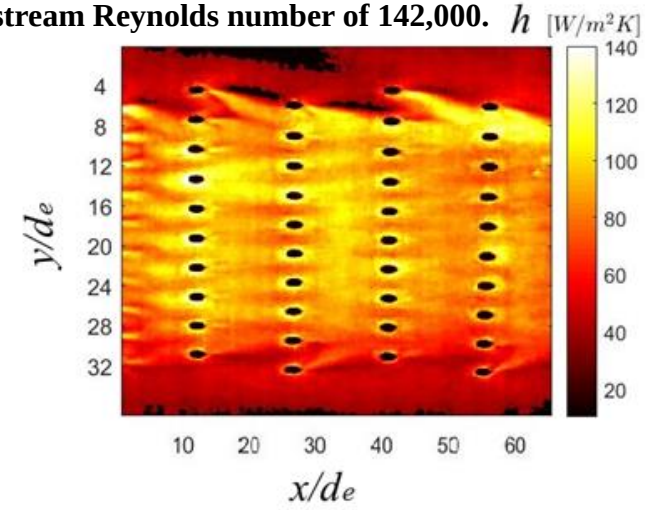
Sponsors: National Science Foundation, Solar Turbines Inc., IHI Corp., Alabama Innovation Fund, OVPRED of UAH, Arnold Engineering Development Center

Contact: Dr. Phil Ligrani:pml0006@uah.edu

Schlieren flow visualization image showing normal shock wave, including lambda foot, and separated turbulent boundary layer. Flow direction is from right to left. Choking flap is oriented at 3.7 degrees, and test section inlet Mach number is 1.54.



Surface, local heat transfer coefficient variation for hot side of effusion plate for BR=7.4 and mainstream Reynolds number of 142,000.



Research activities consider supersonic flows, flows and heat transfer within air breathing engine components, heat transfer augmentation technologies, and micro-scale and millimeter-scale flows, including the effects of elastic turbulence, and micro-scale slip from rarefaction.

Expertise and Areas of Application

- **Supersonic Flow and Shock Wave Interaction Investigations**
- **Elastic Turbulence Investigations**
- **Double Wall Cooling Investigations**
- **Surface Roughness Effects on Impingement Array Surface Heat Transfer**
- **Internal Passage Heat Transfer Augmentation Methods and Associated Unsteady Flow Structural Characteristics**
- **Second Law Losses Around a Turbine Guide Vane**
- **Unsteady Milliscale Impingement Jets and Associated Vortices for Surface Heat Transfer Augmentation**
- **Dean Flow Dynamics and Cell Separations in Low-Aspect Ratio Spiral Microchannels**

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Fusion Propulsion Research

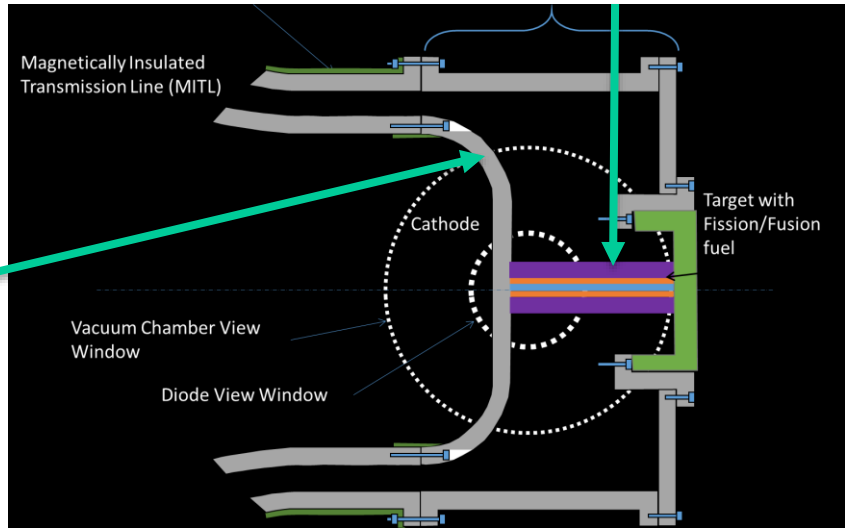
Round trip to Mars in 7 months (20 year development time)

Charger 1, 567 kJ pulsed power system

Front end of Charger 1

Expertise and Areas of Application

Advanced propulsion using fusion and fission/fusion hybrid technologies. Charger 1 delivers a pulse of 10^6 Volts at ~2 10^6 Amps to an electrical load. We are studying the use of lithium deuteride as the main fuel for the target.



Recent Highlights in :

- Delivery of system from L3, DTRA
- Refurbishment of 200 custom resistors, AL DOC
- Control system and Trigger systems, NASA MSFC
- Water deionization and oil systems, The Boeing Company

Contacts:

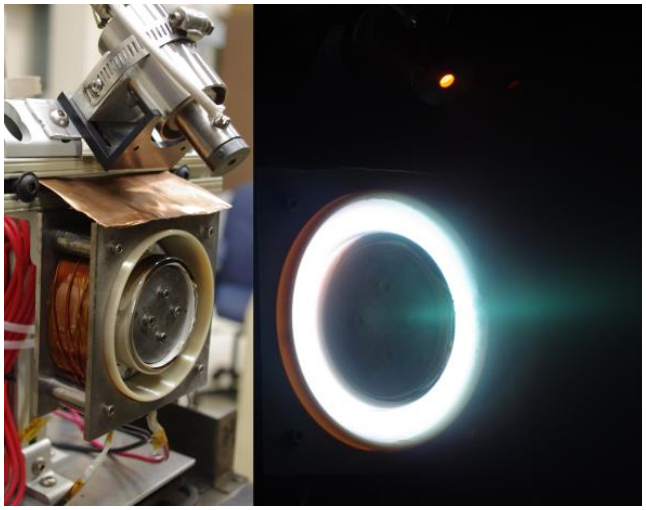
- Dr. Jason Cassibry, Jason.Cassibry@uah.edu
- Dr. William Seidler, was001@uah.edu

UAH Propulsion Research Center

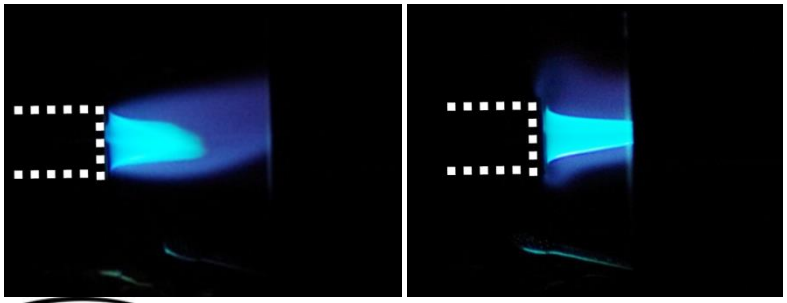
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Plasma and Combustion

Small Hall thruster with 3D printed parts



Active damping of Rijke tube theromacoustic instability with electric field



Expertise and Areas of Application

The three research directions include space electric propulsion, plasma-assisted combustion, and high-pressure microplasmas. Applications of the latter two include high efficiency low emissions engines, and plasma treatment of living tissue. Our research is experimental in nature operating at low and high pressure with rf, dc, and microwave power sources for plasma generation in a range of environments.

Recent Highlights

- 1st demonstration of electric field instability damping
- 1st Hall thruster with 3D printed parts
- Microplasma for diode laser gain project, SMDC
- 3D printing for Hall effect thruster project, NASA

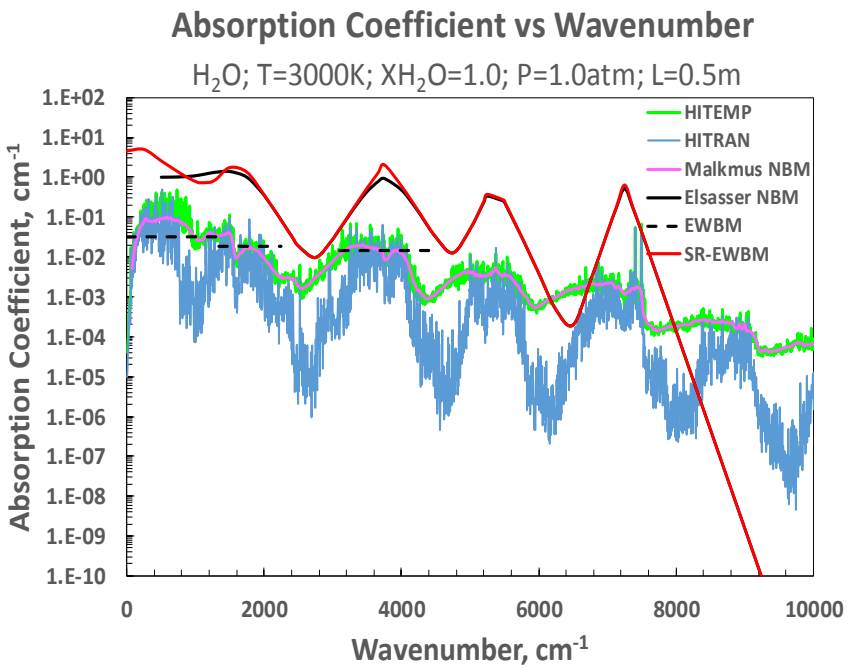
Contact:
- Gabe Xu, gabe.xu@uah.edu

UAH Propulsion Research Center

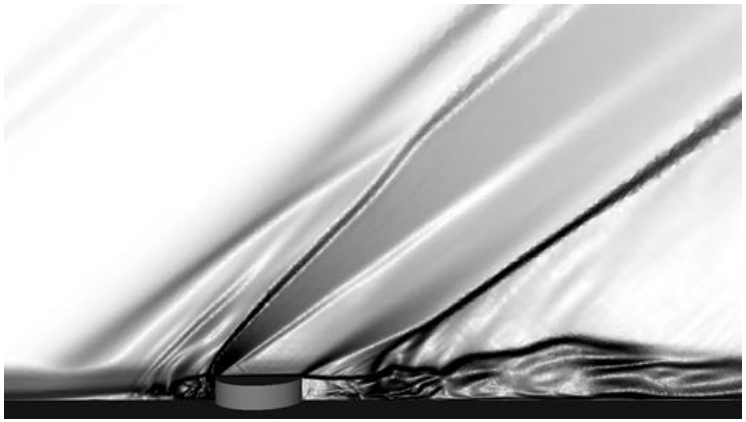
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Computational Modeling

Line-by-line Absorption Coefficients



Supersonic Flow Past a Surface Mounted Protuberance



Expertise and Areas of Application

Research expertise in computational modeling includes: applied computational fluid dynamics, computational transport phenomena,, combustion, radiative heat transfer, acoustics, fluid-structure-acoustic Interactions, and fluid flow control

Recent Highlights

- Spatial and Orientational Dynamics of Non-Spherical Particles in Turbulent Flows through Heterogeneous and CPU+GPU Supercomputing – Sponsor: UAH
- Multi-Scale Modeling of Radiative Heat Transfer in Hypersonic Flows – Sponsor: NASA EPSCoR
- "A Variable Step-size Control for Long Time Transient Simulation of Cryogenic Heat Transfer Problems Using Generalized Fluid System Sim. Program (GFSSP)-Sponsor: NASA MSFC
- Impact of Hypersonic Flight Environment on Electro-Optic/Infrared (EO/IR) Sensors- Sponsor: Analysis and Applications Associates, Inc.

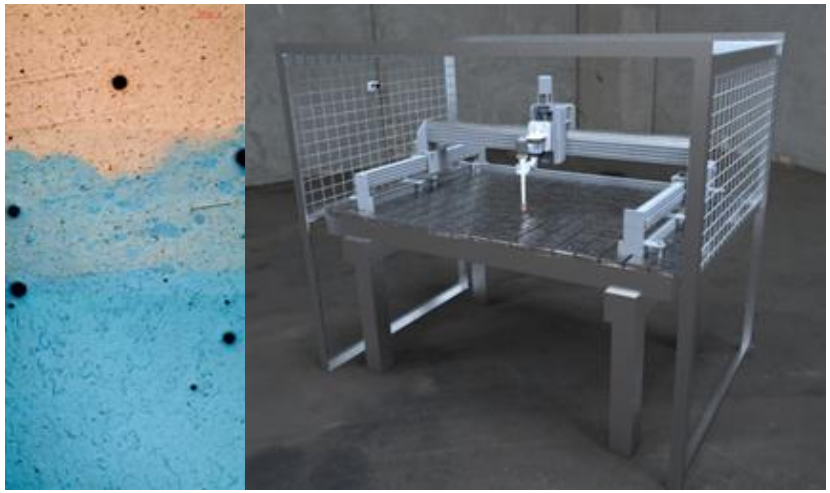
Contacts:

- Sarma Rani sarma.rani@uah.edu
- Kader Frendi kader.frendi@uah.edu
- S.S. Ravindran ravinds@uah.edu

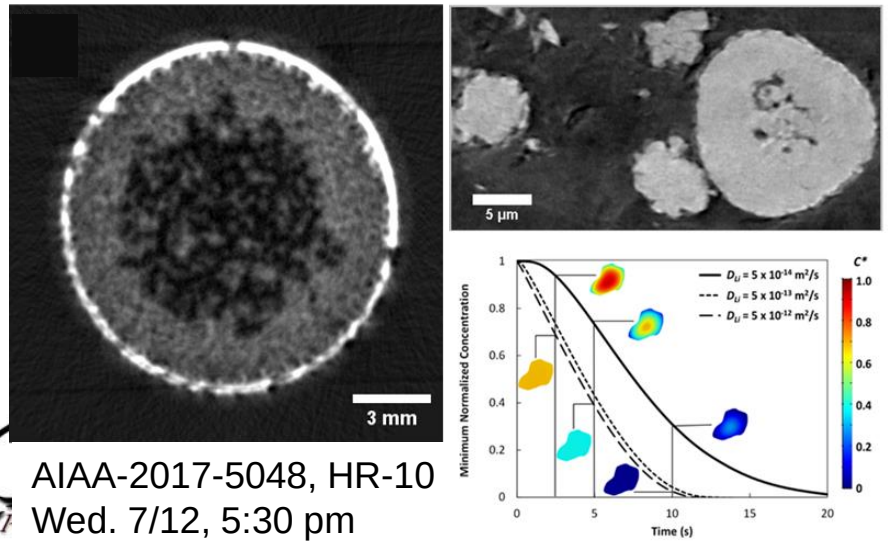
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Aerospace Materials and Structures

Cu-Inconel free form AM sample (left) and free form AM system developed in UAH Senior Design (right)



X-ray image of a porous hybrid motor (left) and Li-ion cathode image data with FEA model results (right)



AIAA-2017-5048, HR-10
Wed. 7/12, 5:30 pm

Expertise and Areas of Application

- Additive manufacturing of metals and alloys
- Materials for energy conversion and storage
- Material functionality under extreme environments
- Optical and X-ray imaging for materials characterization
- Multiscale materials characterization and analysis (mechanics, transport, multiphysics)

Recent Highlights:

- NASA and Navy STTRs supporting free form or direct metal deposition printing (Schneider)
- Continuum level, transient heat transfer modeling of AM builds
- NSF supporting X-ray studies of Li-ion battery microstructure and degradation (Nelson)
- Spectroscopic X-ray imaging of high capacity alloy anodes for Li-ion batteries (Nelson)
- Kinematic, kinetic, and dynamic descriptions of failure in critical structural materials (Hazeli)

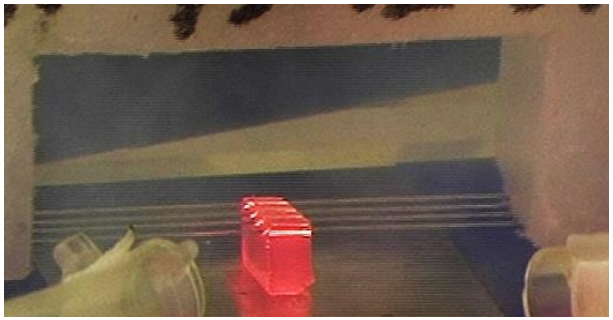
Contacts:

- Dr. George Nelson, george.nelson@uah.edu
- Dr. Judy Schneider, judith.schneider@uah.edu
- Dr. Kavan Hazeli, kavan.hazeli@uah.edu

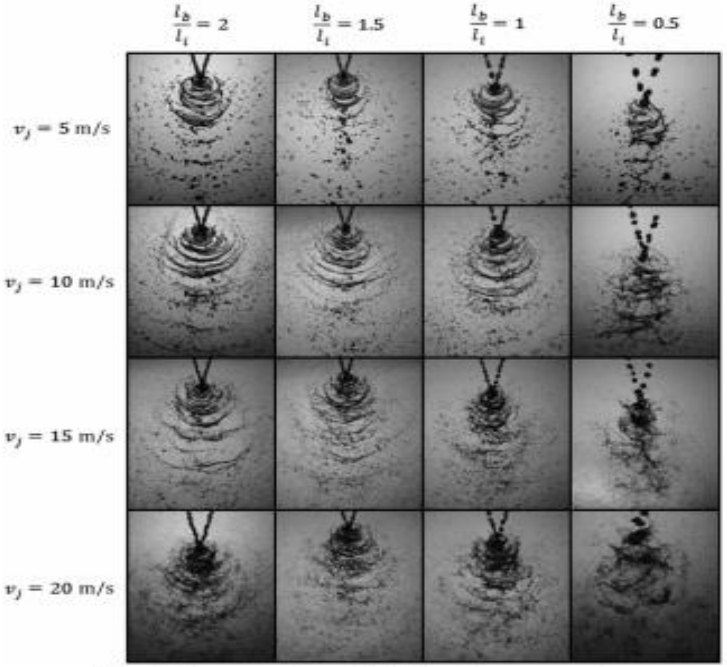
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

Propellants and Energetics

ESP Electrical Response Experiment



Effect of Jet Breakup Length on Like Doublet Injection



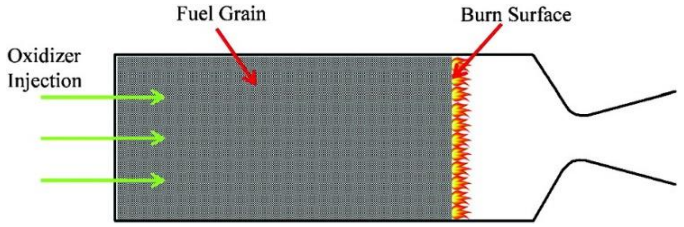
Expertise and Areas of Application

The Propellants and Energetics area incudes research into solid propellants, hybrid rocket fuels and oxidizers, gas and liquid rocket engines, injectors, micro thrusters. Areas of application include controllable solid rockets, self-pulsation of swirl-coaxial injectors, gas generator propellants, and modeling of electrolytic combustion.

Recent Highlights:

- Electric Solid Propellant Experiments - MDA
- Electrolytic Combustion Modeling – MDA
- Impinging Injector Study – Alabama Space Grant
- Self-Pulsation of Swirl Coaxial Inj.–Von Braun Fellowship
- Porous Hybrid Rocket Motors – SMDC/SMART Fellowship

Porous Hybrid Rocket



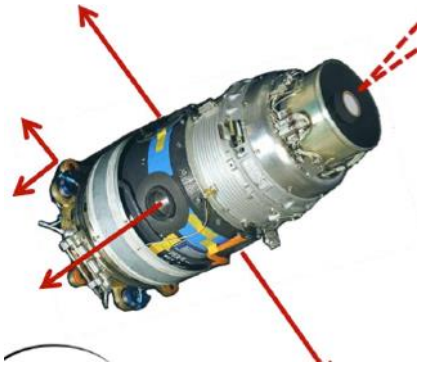
Contact: Robert Frederick Robert.Frederick@UAH.edu

2016 Ph.D's
Dr. Chad Eberhart,
Dr. Matthew Hitt, and Dr. Brian Sweeney

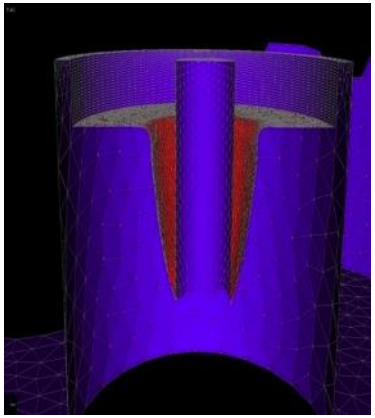
UAH Missile Defense Agency Program

UAH Innovative Propulsion and Power Technology

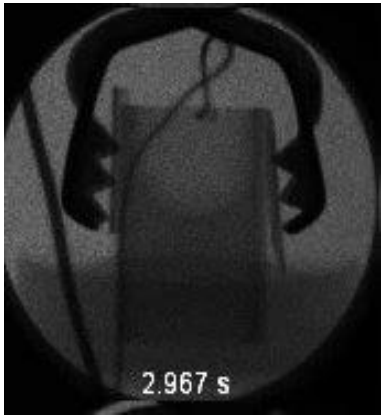
- **Emerging Technology Assessments**
- **Physics-based Modeling and Simulation**
- **Laboratory-based Evaluation**



Divert Propulsion for Kill Vehicle

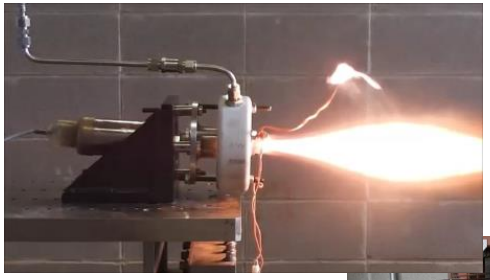


Controllable Solids Advanced Simulation



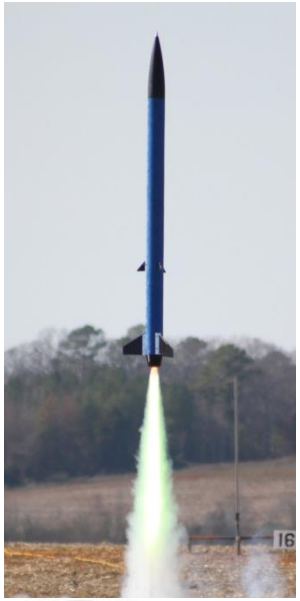
Controllable Solids X-Ray Movies

Propulsion System Technology Testbed



AM Aft injected Vortex Hybrid Engine

LOX – RP Engine on Test Stand



UAH Student Launch Team

Expertise and Areas of Application

Research in this area includes highly-instrumented assessment of combustors and components in solid, hybrid, gas, and liquid propellant systems with application –oriented propellants and operating conditions. Extensive experience in custom built sounding rockets and payload integration.

Recent Highlights:

- Ground testing of LOX, N_2O, RP-1, and methane propellants, AP composite solid rocket motors, and HTPB based, plastic, and paraffin hybrid motor grains.
- Design, fabrication, and testing of additive manufactured components in rocket engines
- Active roll/counter roll control on sounding rocket flight using aerodynamic surfaces
- Upper stage engine LRE igniter design and characterization
- Investing $500K in Test Stand upgrades

Recent Customers:

Gloyer-Taylor Laboratories, NASA MSFC, Vector Space Systems, C3 Propulsion, and the Missile Defense Agency.

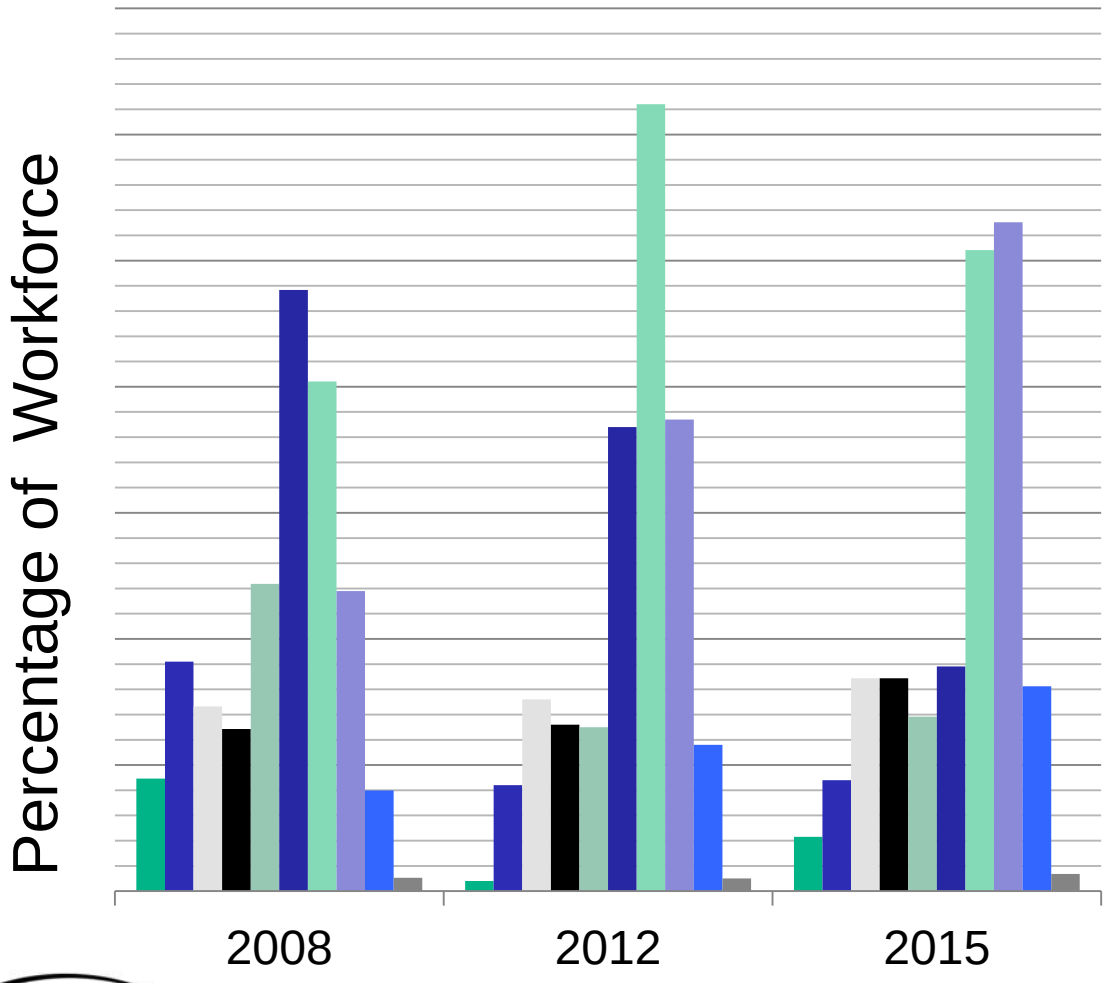
Contact: David Lineberry
David.Lineberry@uah.edu

UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

A PURRPOSE AND STRATEGY FOR THE FUTURE

Propulsion Workforce is Aging



- Workforce is Aging
- Downsizing exacerbates proportion of older workforce
- Young workforce presently underrepresented (< 30 age group reduced from 14% to 6.5%)
- Recognize necessity of ensuring skills, knowledge & experience transfer to a younger workforce

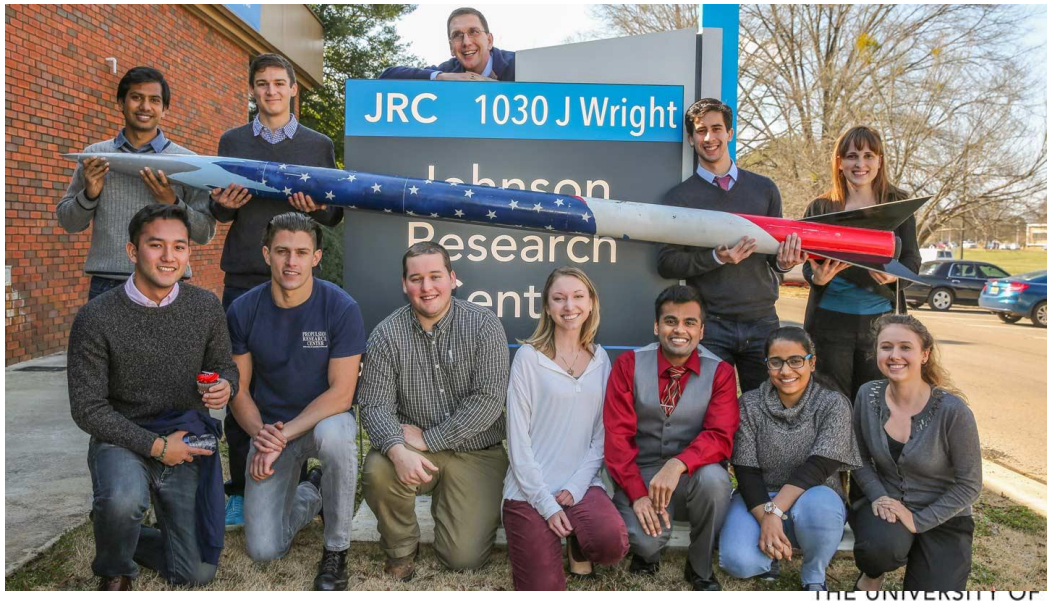
Emphasis on Relationships

- ***"Keep relationships more important than tasks or problems…"***

  Dr. Robert Frederick,
  PRC Director

- *"The reputation of the center will, in large part, be established by the students we produce," and our mission is to, "to provide an environment that connects communities."*

  Dr. Clark. Hawk
  PRC Founding Director



Strategies for PRC Growth

- Teambuilding/Alliances
  - Build Relationships with Faculty and Students and Invest in Their Success
  - Build Alliances with Government and Regional Universities
  - Produce International-Class Graduates

- Research Growth Areas
  - Propulsion Test Capability for MDA Systems – Dr. David Lineberry
  - Supersonic Wind Tunnel - Dr. Phil Ligrani
  - UAH Charger One, Fusion Propulsion Research – Dr. Jason Cassibry
  - Additive Manufacturing of Propulsion Components – Dr. Judy Schneider
  - Propulsion Systems Engineering Research – Dr. Dale Thomas
  - Energy Storage Technologies – Dr. George Nelson

UAH Propulsion Research Center

Mission

PRC connects the Academic Research Community with Industry & Government to advance basic science and technology development related to propulsion and energy.

PRC Strategic Vision 2020

The PRC will be a major generator of talent and innovative solutions in propulsion and energy related technologies.

Leading the Way in Propulsion for 25 years

Contact:
Dr. Robert A. Frederick, Jr.
Robert.Frederick@uah.edu
Cell 256-503-4909

UAH Propulsion Research Center

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

UAH Propulsion Research Center

Prof. R. Frederick, PhD, Director

Prof. D. Thomas, PhD, Asssociate Director

http://www.uah.edu/prc

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

A. Edmondson, MBA
Research Prog. Administrator/Budget Analyst
D. Battle SS4; M. Kitts, PRA; J. Prince SS3

Eminent Scholar In Propulsion
Prof. P. Ligrani, PhD

Aerospace Propulsion and Systems Integration Strategic Planning
Prof. D. Thomas, PhD. Eminent Scholar in Systems Engineering
Prof. P. Collopy, PhD, Chair of ISEEM Department
Prof. S. Mahalingam, PhD, Dean of the College of Engineering

Propulsion Laboratory and Safety
Dr. D. Lineberry, PhD, Laboratory Operations
T. Hall, Test Engineer

Energy & Power Systems
Prof. Phillip Ligrani, PhD

J. Blackmon, PhD
P. Collopy, PhD
K. Frendi, PhD
C. Kang, PhD
S. Mahalingam, PhD
G. Nelson, PhD
S. Rani, PhD
C. Sautter, PhD (RI)

D. Copeland, GRA; P. McInturff, GRA; C. Ren, GRA; Z. Ren, GRA; M. Su, GRA; M. Suzuki, GRA; S. R. Venga, GRA

M. Anderson, UGA; A. Click, UGA; D. Corey, UGA; A. Miller, UGA; R. Petrimoulx, UGA; W. Pico, UGA; D. Ritchie, UGA

Fusion Propulsion & Power
Prof. J. Cassibry, PhD

R. Cortez (RI)
W. Seidler, PhD

T. Englestad, PTGS
P. Giddens, OCE
D. Hewitt, PTGS
S. Kumar, GTA
M. Rogriguez, PTGS
K. Schillo, GRA
R. Tackett, PTGS
B. Taylor, PTGS
B. Winterling, GRA

Plasmas & Combustion
Prof. G. Xu, PhD

J. Cassibry , PhD
K. Frendi , PhD

R. Dextre, PTGS
R. Gott, GTA
E. Hopping, GRA
W. Manneschmidt, GRA
P. Salvador, GRA

N. Latan, UGA
N. Mann, UGA

Computational Modeling
Prof. S. Rani, PhD

F. Ewere, PhD (Lecturer)
K. Frendi , PhD
V. K. Gupta, PhD (PDF)
C. Kang , PhD
S. Mahalingam , PhD
S. Ravindran , PhD
B. Shotorban , PhD

R. Dhariwal, GRA
V. Rani, GTA
A. Wilson, GTA

Aerospace Materials & Structures
Prof. G. Nelson, PhD

K. Hazeli, PhD
M. Lin, PhD
C. Sautter, PhD (RI)
J. Schneider, PhD
G. Wang, PhD

J. Buckley, GRA
R. Chow, GRA
J. Indeck GRA
D. Kodali, GTA
Z. Meyers, GRA

G. Andrew, UGA
M. Frederick UGA
A. Minor UGA

Propellants & Energetics
Prof. R. Frederick, PhD

J. Baird, PhD
M. Banish, PhD
J. Blackmon, PhD
D. Lineberry , PhD
G. Xu , PhD
V. Braswell, OCE
S. Williams, OCE

C. Blankenship, PTGS; K. Bluestone, PTGS; C. Freeman, PTGS; A. Hiett, GRA; R. Hicks, GRA; D. Jones, GRA; S. Kumar, GTA; N. McFerrin, GRA A. Patel, GRA; R. Pereira, GTA; I. Rande, GTA; B. Winterling, GRA

J. Agnew, UGA
A. Creech, UGA

Propulsion System Technology Test-bed
D. Lineberry , PhD

B. Landrum, PhD
P. Ligrani, PhD
G. Wang , PhD

E. Tingley, GTA

M. Duchock, UGA
T. Ueno, UGA

GRA=Graduate Research Assistant; GTA=Graduate Teaching Assistant; OCE=On-Call Employee; PTGS=Part-Time Graduate Student; PRA=Propulsion Research Assistant; RI=Research Institute; SS3=Student Specialist III; SS4=Student Specialist IV; UGA=Undergraduate Assistant

06/21/2017

Propulsion Research and Academic Programs at the University of Alabama in Huntsville

Dr. Robert A. Frederick, Jr.
Director, UAH Propulsion Research Center
Professor of Mechanical and Aerospace Engineering

Dr. Phillip M. Ligrani
Eminent Scholar in Propulsion
Professor of Mechanical and Aerospace Engineering

Dr. Dale Thomas
Eminent Scholar in Systems Engineering
Professor of Industrial and Systems Engineering

The University of Alabama in Huntsville
http://prc.uah.edu