

# UAH Propulsion Research Center

## *Virtual Update*

October 16, 2020



Dr. Robert  
Frederick

DIRECTOR, PROPULSION  
RESEARCH CENTER

PROFESSOR, MECHANICAL &  
AEROSPACE ENGINEERING  
DEPARTMENT



<http://prc.uah.edu>

# AGENDA

- **Announcements**
- **Recognitions**
- **PRC Graduate Student Production History**



# *Announcements*

- PRC Laboratories Operating at 80-90% Capacity
- Office Staff Working 100% Remotely
- UAH Classes Taught Remotely and with Limited Exposure
- Overall a Record Research Year for UAH
- Still a Very Challenging Environment



# PRC Alumni News

**Promoted to Manager,  
Systems Engineering and  
Int. Office, NASA MSFC**



**Dr. Kent Chojnacki ,**  
**UAH PhD 1997**

**Named AIAA Associate Fellow**

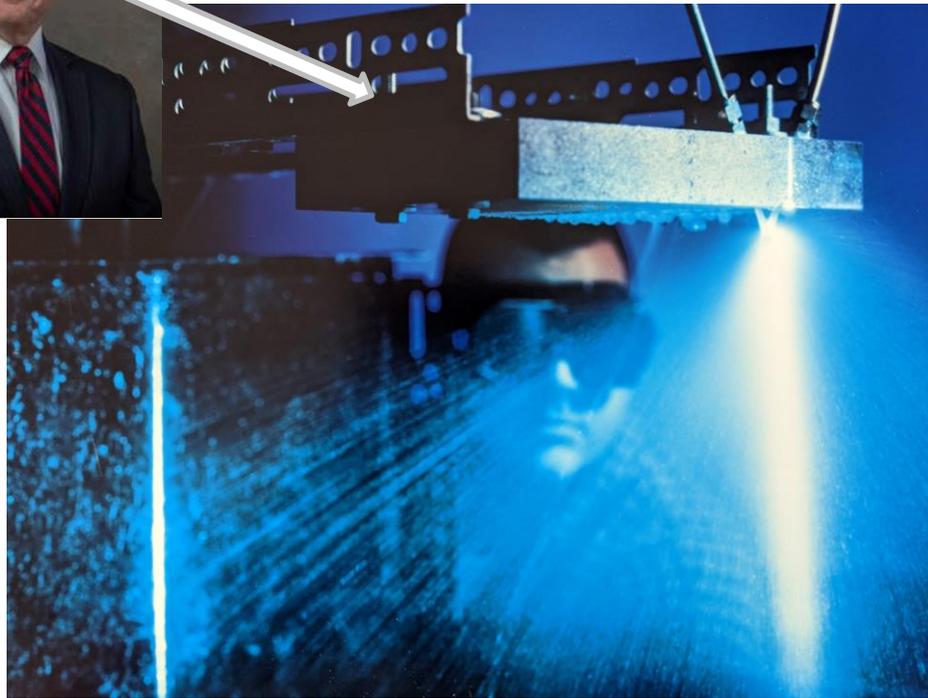


**Ms. Mary Beth Koelbl**  
**Deputy Director MSFC Engineering Dir.**  
**UAH 1991**



# PRC Alumni (Back in the Day)

**Kent Chojnacki**, "Atomization and Mixing of Impinging Non-Newtonian Jets," Ph.D. Dissertation, Mechanical and Aerospace Engineering Dept., The University of Alabama in Huntsville, Huntsville, AL, 1997



**Ms. Mary Beth Koelbl**  
*Survived Dr. Frederick's  
First Propulsion Class in 1991*



# PRC Researcher News – New AIAA Associate Fellows



Dr. L. Dale Thomas  
Professor/Eminent Scholar  
Industrial & Systems  
Engineering and  
Engineering Mgmt.



Dr. Chang-kwon Kang  
Associate Professor of MAE



Dr. Gabe Xu  
Associate Professor of MAE

*“Associate Fellows are persons who have accomplished or been in charge of important engineering or scientific work, or who have done work of outstanding merit or have otherwise made outstanding contributions to the arts, sciences, or technology of aeronautics or astronautics.”*

# *PRC Research News*

## *Rotating Detonation Engine test-fired for first time at UAH's Johnson Research Center*



**Evan Unruh**

Unruh, E., Michaela Spaulding, M., Lineberry, D., Kunning G. Xu, K.G., and Frederick, R., "Development of an Optically Accessible Racetrack-Type Rotating Detonation Rocket Engine," AIAA Paper 2020-3688, 2020.

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

## PRC Graduate Student Production History

AIAA Paper 2020-3803

Dr. Robert A. Frederick, Jr.

Director, UAH Propulsion Research Center  
Professor of Mechanical and Aerospace Engineering

Dr. Dale Thomas

Eminent Scholar in Systems Engineering  
Professor of Industrial and Systems Engineering

Dr. Phillip M. Ligrani

Eminent Scholar in Propulsion  
Professor of Mechanical and Aerospace Engineering



## **Objectives:**

- Present PRC Recent Achievements and A Comprehensive Graduate Production History

## **Scope:**

- I. Introduction
- II. Academic Infrastructure
- III. PRC Summary
- IV 2019 PRC Strategic Plan



# Propulsion Research Center Vision & Mission

- *Vision:* The PRC will be a major generator of talent and innovative solutions in propulsion and energy related technologies.
- *Mission:* PRC connects the Academic Research community with Industry & Government to advance basic science and technology development related to propulsion and energy.



# PRC 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





# UAH Propulsion Research Center

Prof. R. Frederick, PhD, Director  
Prof. D. Thomas, PhD, Deputy Director  
<https://www.uah.edu/prc>



A. Edmondson, MBA  
Research Prog. Administrator/Budget Analyst  
G. Cromartie, Program Coordinator; J. Crews, SS4; K. Neese, SS4

**Eminent Scholar In Propulsion**  
Prof. P. Ligrani, PhD

**Aerospace Propulsion Strategic Planning**  
Prof. D. Thomas, PhD, Eminent Scholar in Systems Engineering  
Prof. J. Swain, 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. P. Ligrani, PhD

**Fusion Propulsion & Power**  
Prof. J. Cassibry, PhD

**Plasmas & Combustion**  
Prof. G. Xu, PhD

**Propulsion Systems Integration**  
Prof. D. Thomas, PhD

**Computational Modeling**  
Prof. S. Rani, PhD

**Aerospace Materials & Structures**  
Prof. G. Nelson, PhD

**Propellants & Energetics**  
Prof. R. Frederick, PhD

**Propulsion System Technology Test-bed**  
Dr. D. Lineberry, PhD

- J. Blackmon, PhD
- P. Collopy, PhD
- K. Frendi, PhD
- C. Kang, PhD
- S. Mahalingam, PhD
- G. Nelson, PhD
- S. Rani, PhD
- A. Click, GRA
- H. Collopy, GRA
- M. Sampson, GRA
- G. Schmidt, GRA
- S. R. Vanga, GRA
- M. Cox, UGA
- K. Goethals, UGA
- M. Hockensmith, UGA
- J. Knox, UGA, C. Larson, UGA
- w. Manneschmidt, UGA
- J. McDonough, SS3
- E. McNabb, UGA
- J. Moseley, UGA, C. Smith, UGA

- A. Davis, OCE
- W. Seidler, OCE
- K. Schillo, OCE
- E. Burns, SS4
- S. Westrich, SS4
- P. Darakorn, GRA
- D. Hewitt, PTGS
- S. Kumar, GRA
- M. Rodriguez, PTGS
- N. Schilling, GRA
- R. Tackett, PTGS
- B. Taylor, PTGS
- S. Thompson, PTGS
- A. Vyas, GRA
- B. Winterling, GRA

- J. Cassibry, PhD
- K. Frendi, PhD
- N. Anderson PTGS
- W. Bickett, PTGS
- R. Gott, GRA
- M. Spaulding GRA
- A. Walsten, GRA
- Z. White, GRA
- M. Amara, UGA
- D. Brick, UGA
- S. Kaye, UAGM
- N. Laya, UGA
- B. Williams, UGA

- J. Cassibry, PhD
- A. Aueron, GRA
- S. Godshall, GRA
- L. Grumbach, PTGS
- V. Lopez, GRA
- N. Morris, GRA
- D. Nikitav, GRA
- S. Raghu, GTA
- S. Rawlins, GRA
- E. Wood, GRA
- Rountree, UGA
- A. Shah, UGA

- K. Frendi, PhD
- C. Kang, PhD
- S. Mahalingam, PhD
- S. Ravindran, PhD
- B. Shotorban, PhD
- A. Avad, GRA
- S. Basu, GRA

- K. Hazeli, PhD
- M. Lin, PhD
- J. Schneider, PhD
- G. Wang, PhD
- M. Angeles, SS4
- N. Ulmer, SS4
- P. Anantwar, GRA
- B. Bahramibabamiri, GRA
- J. Buckley, GRA
- J. Indeck, GRA
- D. Sandlin, PTGS
- A. Colbert, UGA
- T. Colbert, UGA

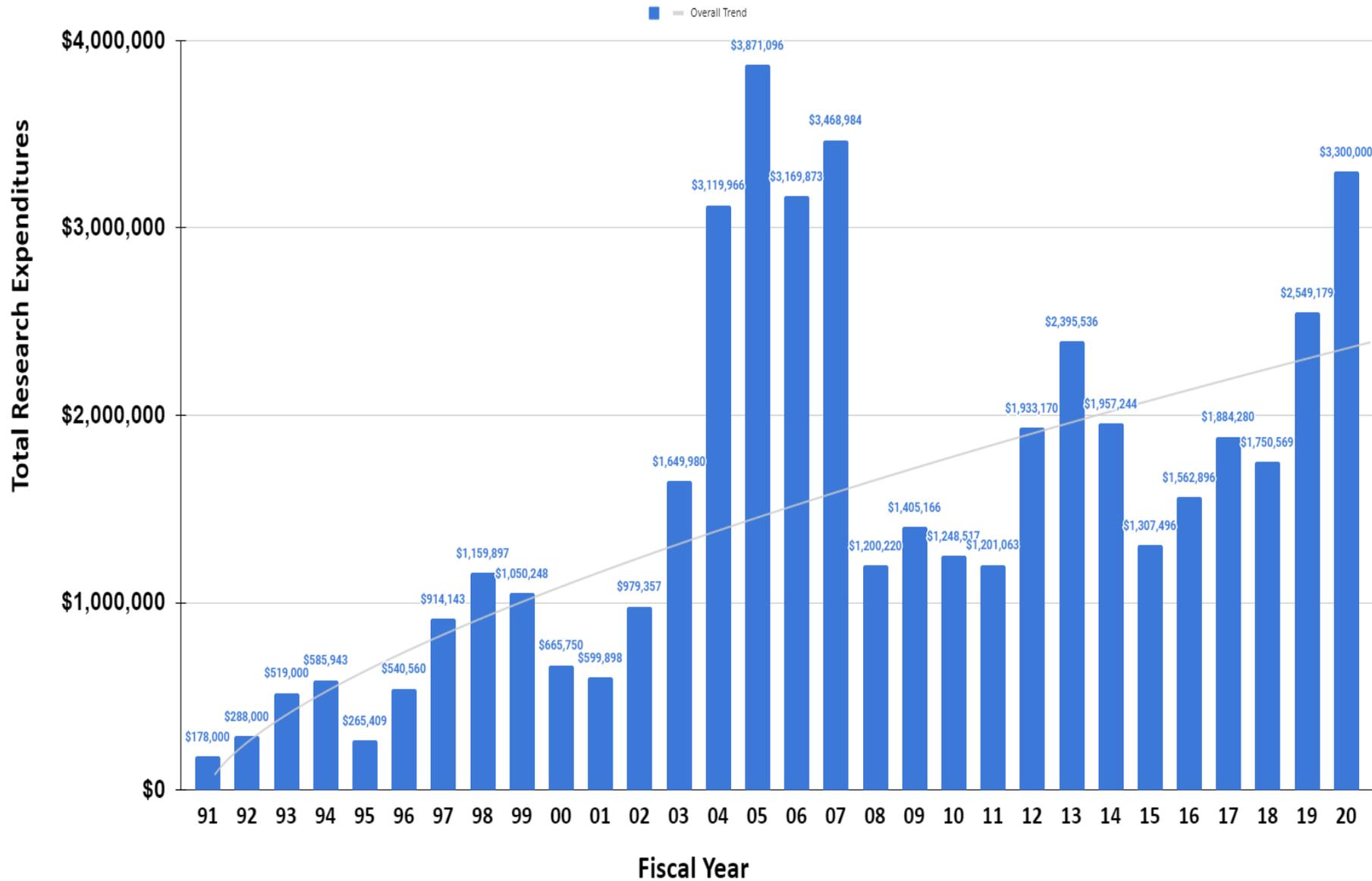
- J. Baird, PhD
- M. Banish, PhD
- J. Blackmon, PhD
- D. Lineberry, PhD
- G. Xu, PhD
- W. Knuth, OCE
- S. Williams, OCE
- S. Bluestone, PTGS
- D. Jones, GRA
- D. Haring, GRA
- S. Kumar, GTA
- J. Laub, PTGS
- A. Patel, GRA
- R. Pereira, GTA
- Randade, GTA
- E. Unruh, GRA
- A. Hunt, SS5
- T. Salverson, UGA, J. Willoughby, UGA

- J. Winningham, M.S., CSE
- W. Hanks, GRA
- J. Agnew, UGA
- D. Battle, UGA
- M. Costa, UGA
- D. Long, UGA
- J. Venters, UGA
- MAE 490/491 Students---
- K. Caruso Jr., P. Day,
- J. Hart, M. Hockensmith,
- C. Hyder, J. Jacobs,
- J. Jordan, B. Lucke,
- R. Luke II, P. Martin,
- J. McIntosh, J. Moseley,
- R. O'Kraski, N. Roman,
- T. Salverson, W. Snyder,
- J. Zike

GRA=Graduate Research Assistant; GTA=Graduate Teaching Assistant; OCE=On-Call Employee; Post-Doctoral Fellow;  
PTGS=Part-Time Graduate Student; RI=Research Institute; SS3=Student Specialist III; SS4=Student Specialist IV; SS5=Student Specialist V  
UGA=Undergraduate Assistant, UAGM=Undergraduate Matrix  
02/06/2020



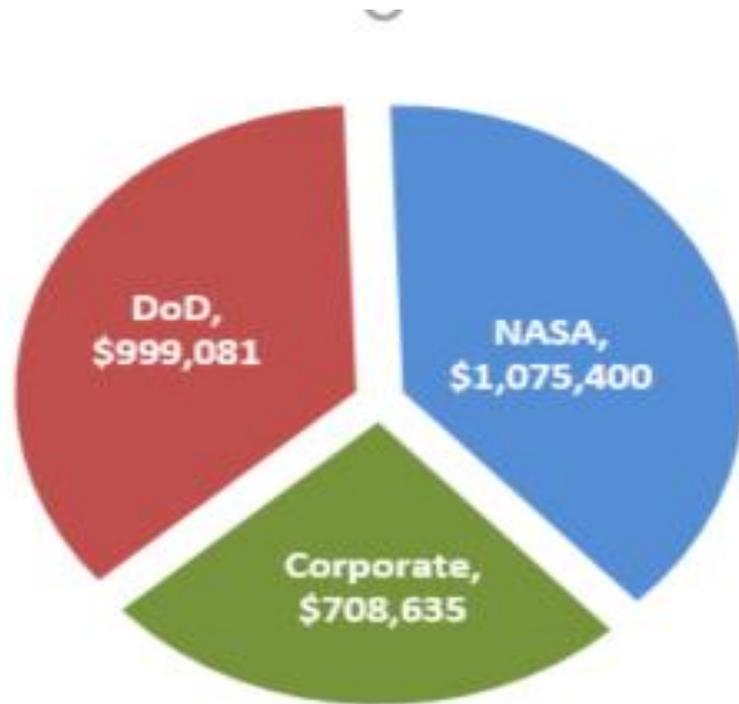
# PRC Research Expenditure History



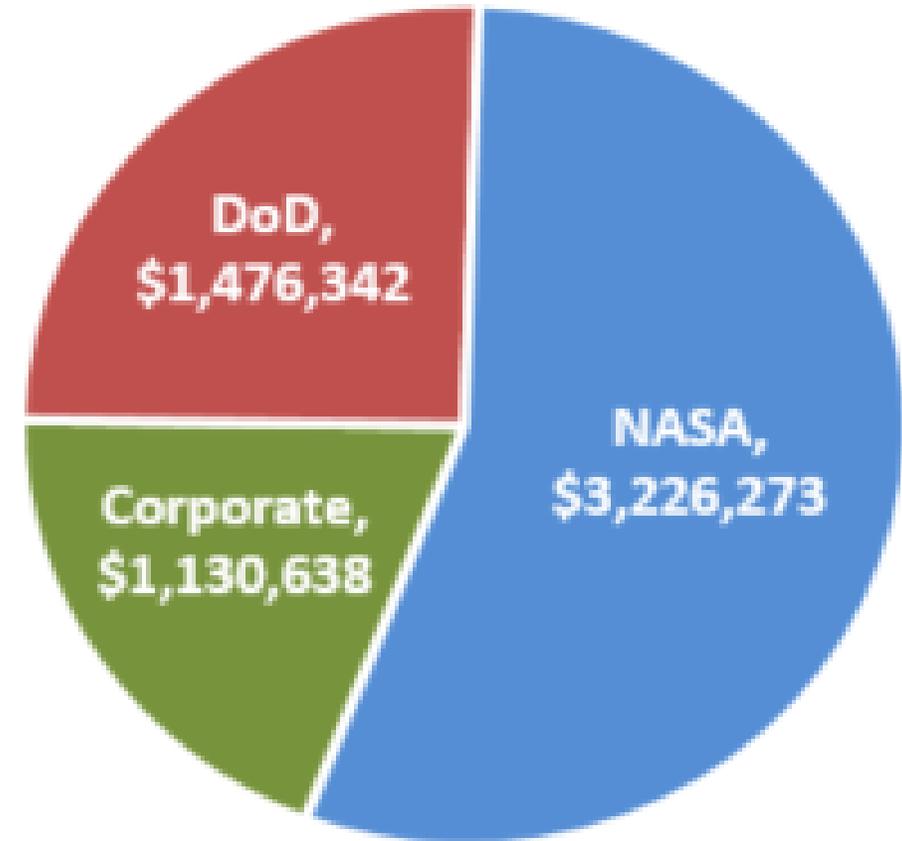
FY 19 shows a 33% increase over last year and the overall research portfolio has tripled in the past five years.



# Current Award Distributions



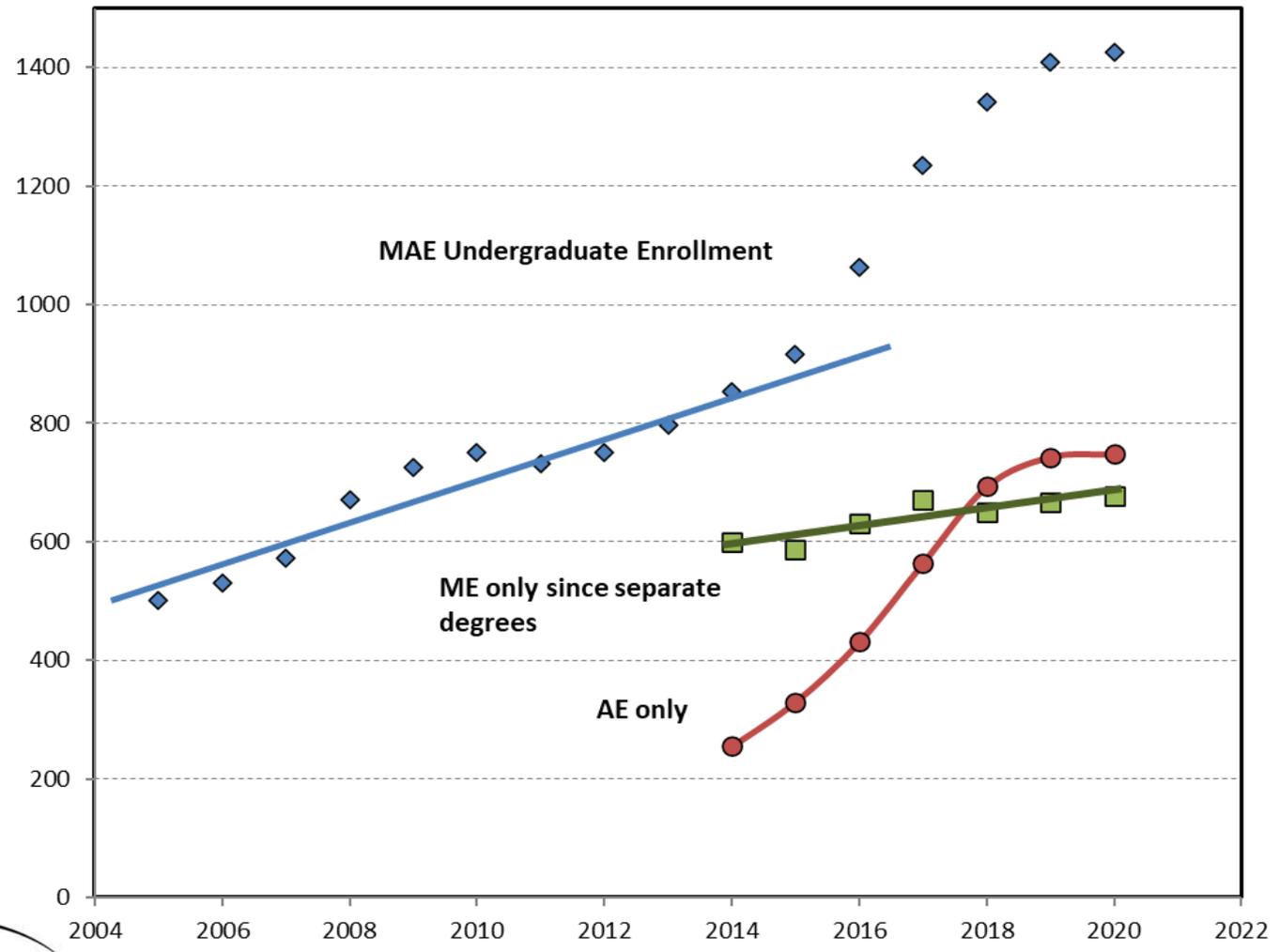
**(a) FY 20 New Awards**



**(b) FY 20 Total Authorizations**

# The UAH Aerospace Program

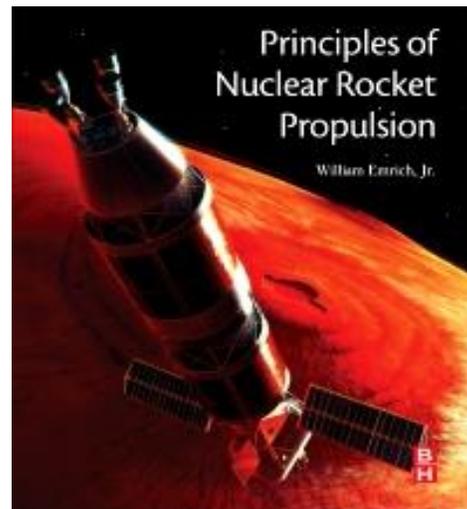
## Department of Mechanical & Aerospace Engineering



# UAH Propulsion and Energy Courses

Dual-Level Undergraduate/Graduate	AY 15- 16	AY 16- 17	AY 17- 18	AY 18- 19	AY 19- 20-
MAE 440/540 Rocket Propulsion I	55	34	67	79	110
MAE 441/541 Airbreathing Prop.	17	38	33	38	61
MAE 444/544 – Intro. To Electric Propulsion.	22	-	20	-	27
MAE 468/568–Elem. of Spacecraft Des,	56	62	87	99	122
MAE 490/491– Rocket Design	56	38	40	40	40

UAH Graduate Course	AY 15 - 16	AY 16- 17	AY 17 - 18	AY 18- 19	AY 19- 20
MAE 620-Compressible Flow	21	11	30	26	14
MAE 640–Rocket Propulsion II	-	21	-	29	-
MAE 64 -Adv. Solid Rocket Propulsion	22	-	15	-	23
MAE 645 – Combustion I	6	-	19	-	13
MAE 695/795–ST: Adv. Readings in Prop.	7	3	2	3	5
MAE 695: ST Intro to Nuclear Propulsion	-	22	-	26	-
MAE 695-ST: Comb. Instab. in Solid Rockets	15	-	-	--	-
MAE 695- ST: Liquid Rocket Engineering	20	-	-	-	-
MAE 681 – Missile Trajectory Analysis	-	-	-	--	-
MAE 740-Aerothermodynamics	18	-	-	19	-
MAE 745 Combustion II	-	-	-	-	-
MAE 754 – Hypersonic Flow	-	11	-	25	-
MAE 795–ST: Intro. to Fusion Propulsion	11	-	16	-	17

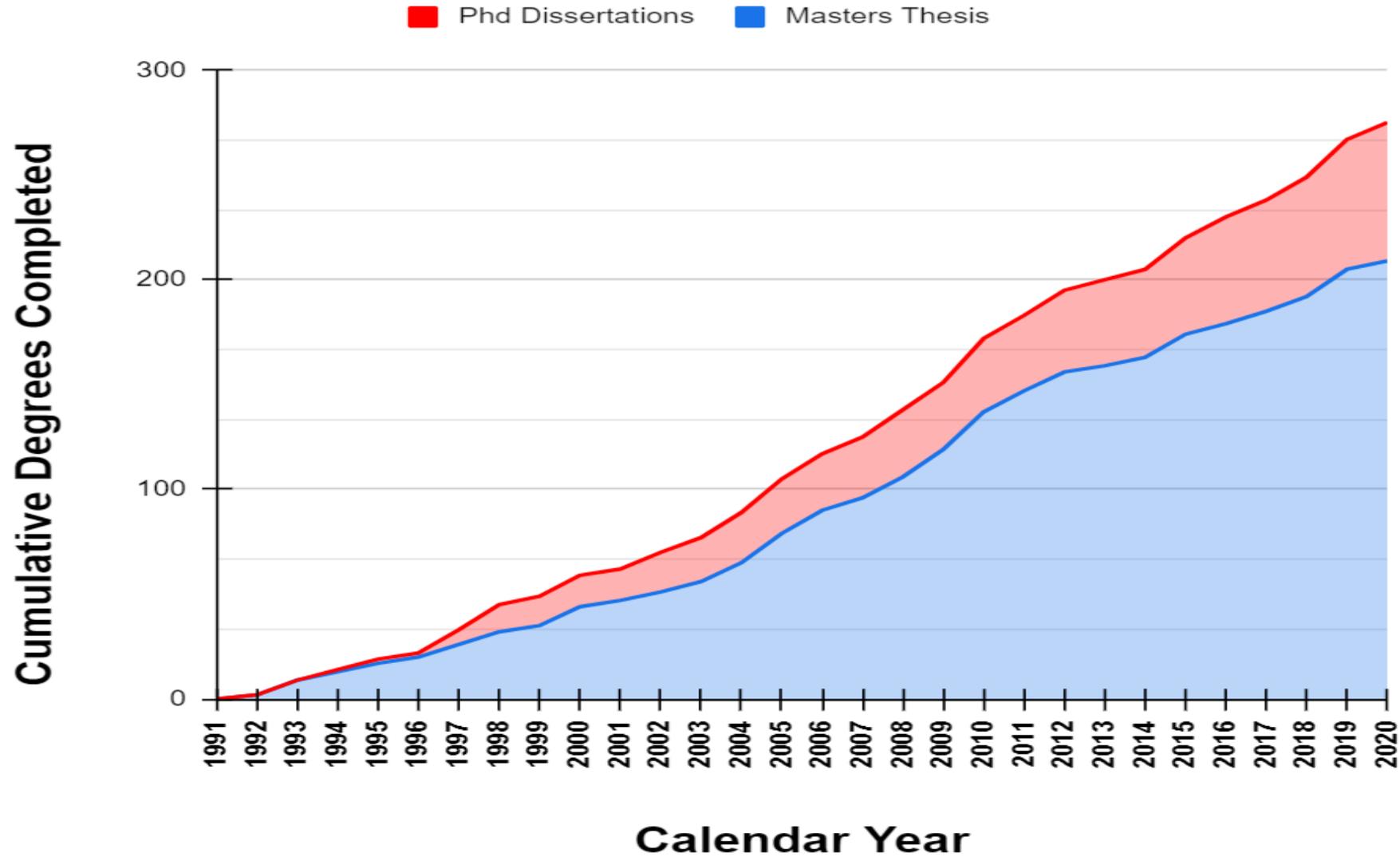


# PRC Graduate Student Production History

- Collect the student data since 1991
- Categorize each thesis and dissertation
- Verify the citation and advisor
- Verify the graduation year
- Categorize into technical areas
- Make first estimates of associated data



# PRC Advanced Degrees Supported

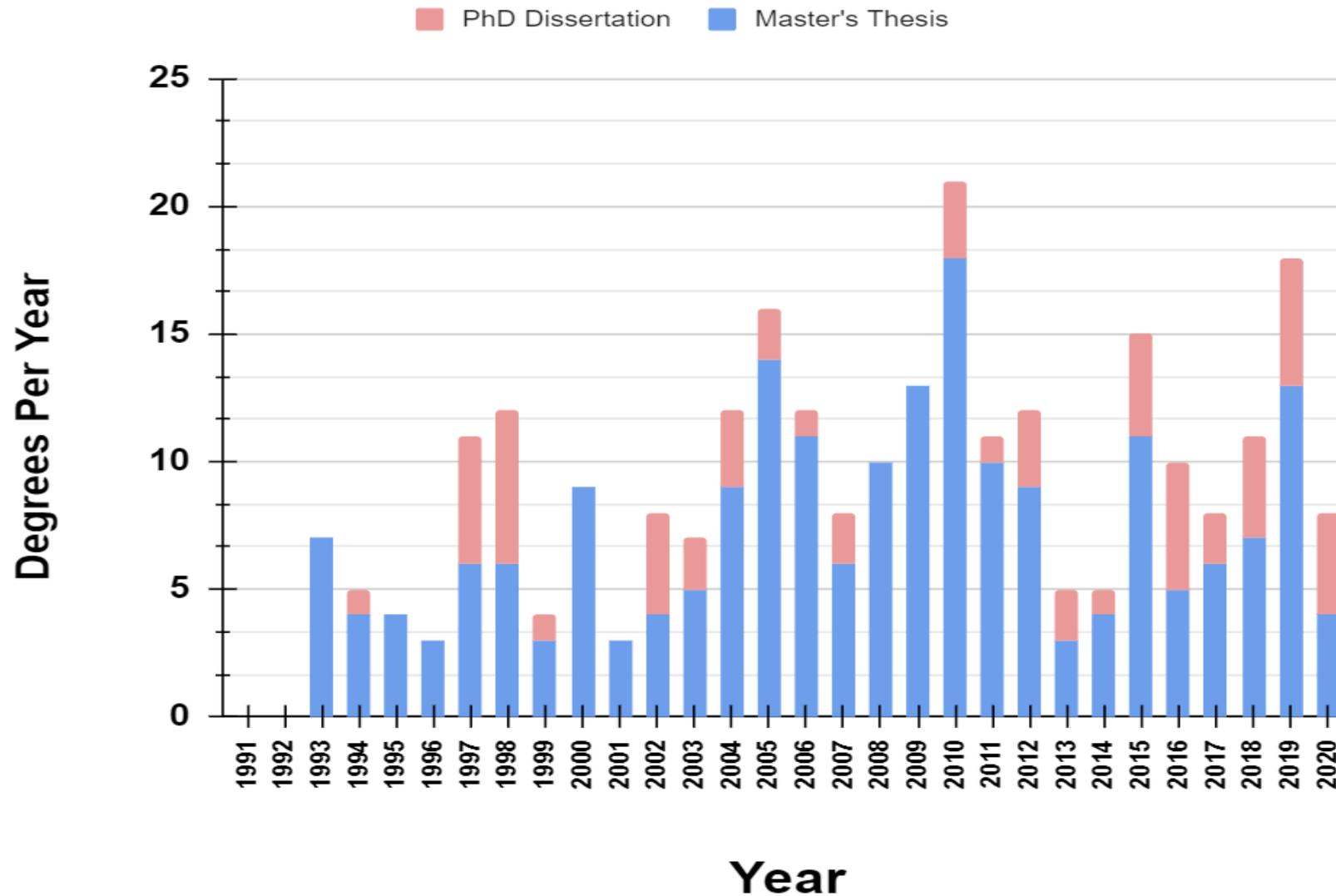


The total number of degrees is 274

- 67 Ph.D.s.
- 207 master's



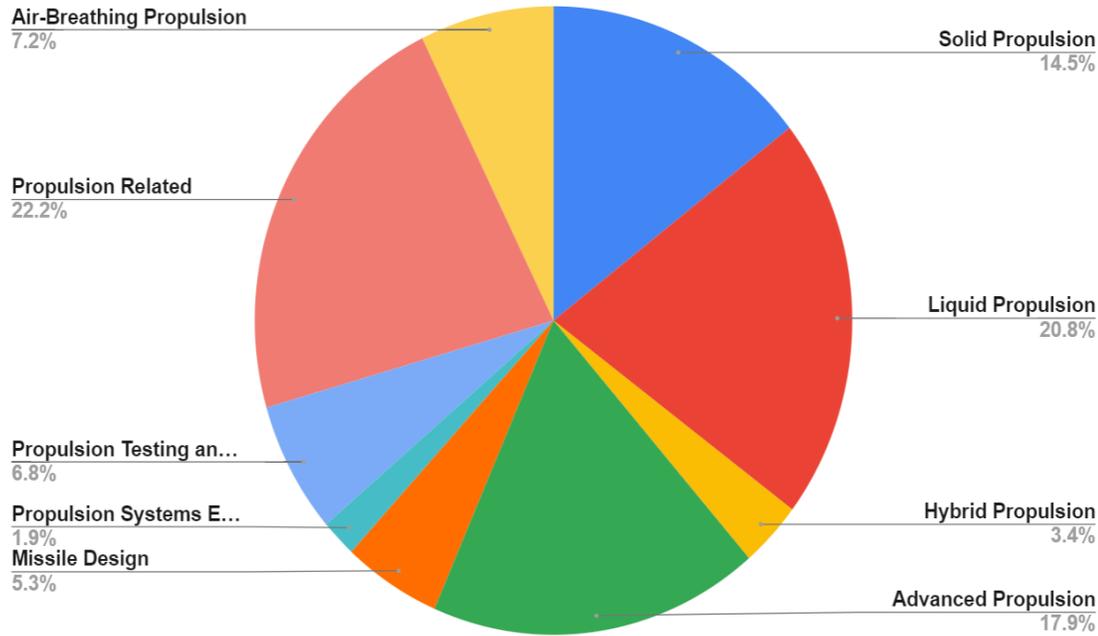
# PRC Advanced Degrees Supported



The highest year in 2010 produced 21 degrees. It is also noted that there has been a more sustained and consistent production of PhD over the last few years.

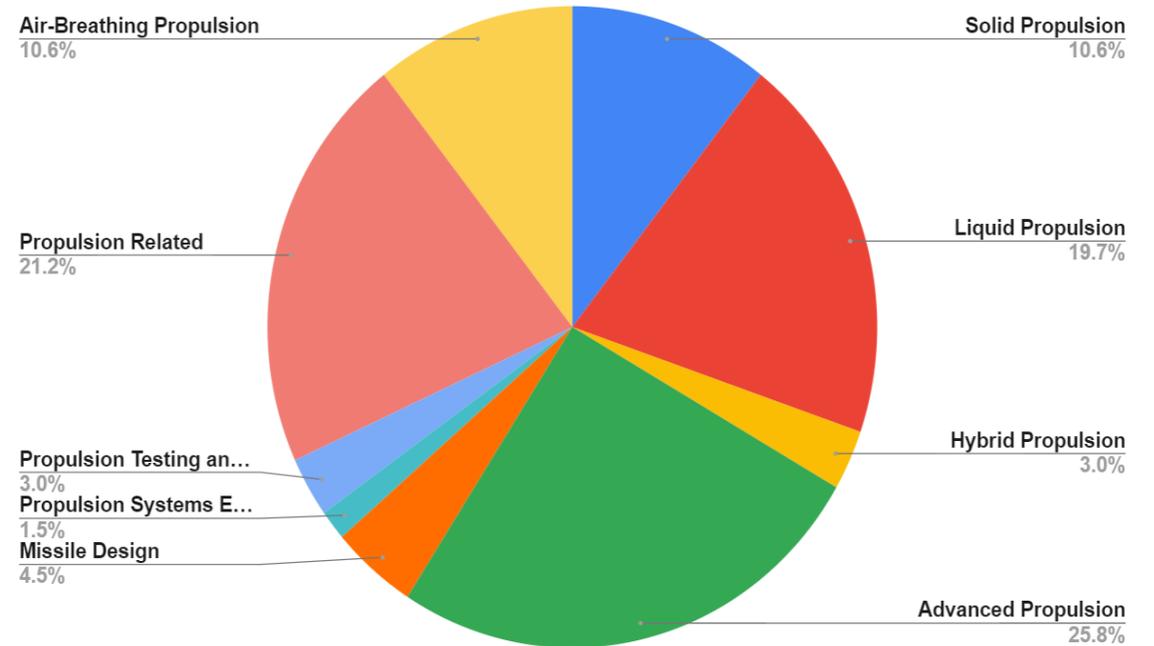
# Distribution by Technical Areas

Master's Thesis



Master's

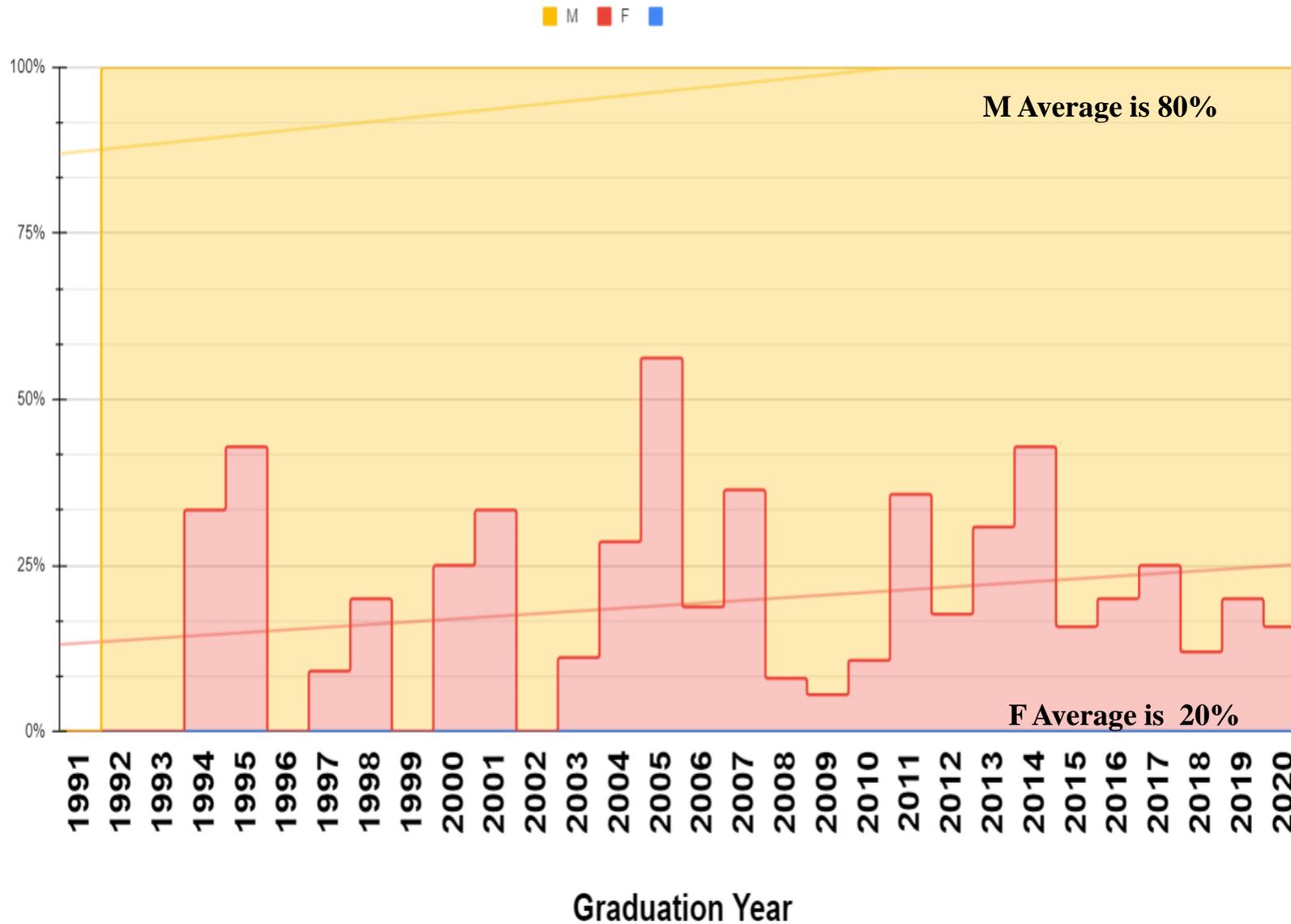
Doctoral Dissertations



Ph.Ds

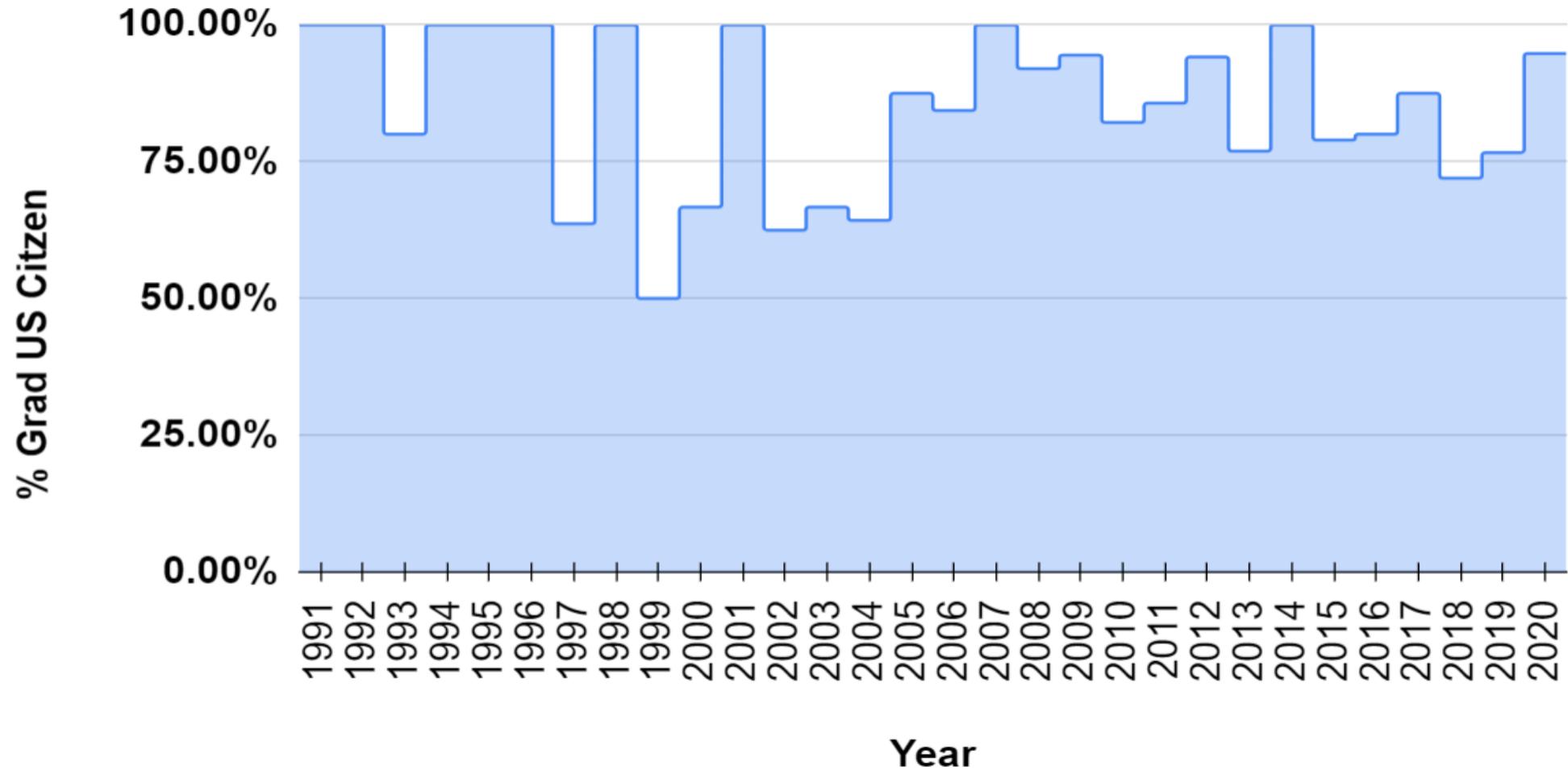


# Advanced Degrees by M and F



# Distribution by Nationality

% Grad US Citizen vs. Year (overall 83%)



# 2019-2020 UAH NASA Student Launch Team



The University of Alabama in Huntsville (UAH) earned first place in project safety and third place overall in competition at a COVID-shortened national 2020 NASA Student Launch.

# People Make the Difference



**Propulsion Research Center faculty, staff, students, colleagues, and friends at the fall 2019 Recognition of Graduates Reception and the spring g 2020 (Zoom Land). “Keep relationships more important than tasks or problems” – Dr. Robert A. Frederick, Jr., Director, UAH Propulsion Research Center.**




**Dr. Robert Frederick**  
 DIRECTOR, PROPULSION RESEARCH CENTER  
 PROFESSOR, MECHANICAL & AEROSPACE ENGINEERING DEPARTMENT



# Remarks

- The UAH PRC stands poised to build upon a rich legacy of research advances in propulsion.
- One of our original strategies was to pursue funding support for projects that would support students.
- The faculty associated with the PRC have followed that vision and could produce 300 graduates with advanced degrees on propulsion topics in the first 30 years (projecting to next year).
- If we also project 30 years of total expenditures at \$50 million, that averages to about \$170,000 per degree.
- The strategy forward will focus on continuing a legacy of excellence in traditional student production in the propulsion arena, equipping the future workforce for success in their future careers.



# Acknowledgements

- The authors acknowledge Mrs. Gabriel Cromartie, Jacqueline Crews, Kaitlin Neese, and James Venters for their significant and diligent work in collecting and organizing data on the past graduates. The authors acknowledge the inputs and contributions of the faculty, staff, students, and graduates of the Propulsion Research Center for providing valuable inputs and suggestions for this paper. Dr. Keith Hollingsworth, Chairman of the Mechanical and Aerospace Engineering Department, provided valuable inputs on the academic programs. Thanks to Anna Frederick for copy-editing the document.
- The support of the UAH Office of Vice President for Research and the UAH College of Engineering are gratefully acknowledged. Thanks also go to our recent sponsors mentioned in this paper. Grateful acknowledgements to all those potential new collaborators who teamed with us to write proposals last year that will fund future students and researchers at the PRC.





## *PRC Alumni Relations Team*

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*Kaitlin Neese*



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