

AEROSPACE ENGINEERING TEXAS A&M UNIVERSITY

Chancellor Century Council

TAMUS NATIONAL SECURITY AND HYPERSONICS

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Outline



- TAMUS Vision in National Security and Hypersonics
- Role of the Aerospace Engineering
 Department
- Two High Impact Projects
 - University Consortium for Applied
 Hypersonics
 - Boundary Layer Turbulence (BOLT II) Flight Experiment



TAMUS Vision in National Security and Hypersonics



- Leadership: Chancellor Sharp, President Banks, and Vice Chancellor and Dean Hurtado are providing the vision and drive for Texas A&M to lead in National Security, *including applied hypersonics*
- **RELLIS Campus:** Houses the Bush Combat Development Complex
 - Army Future Command: \$65M CRA → \$98M IDIQ (Banks, Hurtado)
 - Ballistic (Hypersonics), Aero-Optics (Directed Energy), and Materials (Hypervelocity Impact) Range (BAM)





BAM is a one-of-a-kind national resource to help lead the U.S. in the development of new hypersonic flight and directed energy systems

Aerospace Engineering Department



- Aerospace Engineering Department: Over the last 20 years, TAMU aerospace has emerged as an internationally renowned program in hypersonics (as well as in other topics, including Space)
 - Student Enrollment: $25x25 \rightarrow$ Doubled to 720 Undergraduates (Soph Sen), 250 Graduates
 - Faculty: CRI/GURI → Increased from 30 TTF (2 NAE) to 40 TTF (7 NAE, now at 5)
 - **Research Funding:** Strategic Leveraging \rightarrow Nearly quadrupled from \$4.8M (2015) to \$18M (2021)



OUSD(R&E) JHTO University Consortium for Applied Hypersonics



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DOD 5-year \$100M Consortium: Meeting U.S. requirements in hypersonic

science, technology, and workforce.

- TEES was selected to manage the DoD Joint Hypersonic Transitions Office UCAH (\$10M, R. Bowersox, PI)
 - o 278 Member Institutes
 - o 1600 Professionals, 500 Students
- To date, \$60M has been awarded (in Year 3)
 - TAMU faculty lead on 4 and co-PI on 5 others for \$4.4M (2nd highest)
- "UCAH Technical Exchange" will take place in College Station on March 14 – 16, 2023.



"The University Consortium at Texas A&M is an extension of the JHTO" - *G. Bussey (Inaugural JHTO Director)*

TEES Led Hypersonic Flight Test: Boundary Layer Turbulence (BOLT II)



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- TAMU/CUBRC: R. Bowersox (PI), H. Reed, E. White, H. Kostak, 1LT J. Wirth, E. Swinny, D. Mullen, A. Dufrene, T. Wadhams
- **Objective:** Three-year effort to create a benchmark dataset for hypersonic heating (400 sensors)
 - Assess current modeling & simulation and ground test
 - Promote external engagement and workforce development





We gratefully acknowledge the AFOSR, AFRL, OUSD(R&E), and Lockheed Martin Corporation for sponsoring this research.

BOLT II Flight Experiment



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Just Another TEES Success Story



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- BOLT II was a successful example of the synthesis modeling, simulation, ground test, and *flight experiment* to advance our basic knowledge for hypersonic viscous flows.
 - Data were released to the public on Jan. 23 24, 2023 at the American Institute of Aeronautics and Astronautics SCITECH Forum.

"The BOLT II flight experiment exceeded all expectations." Dr. Sarah Popkin (Program Officer, AFOSR)

"Hypersonics at Texas A&M means National leaders addressing National Security." Dr. John Hurtado (Vice Chancellor and Dean)



Back-ups



Background: National Aerothermochemistry and Hypersonics Laboratory (NAL) | Experimental Facilities



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NAL Mission: Support basic and applied research in hypersonic aerothermochemistry, with applications in aerodynamics and propulsion (Dir. R. Bowersox)

 Hypersonic viscous flows, high enthalpy non-equilibrium gases and plasmas, surface reactions, scramjet mixing and flame holding, hypersonic wind tunnel design, advanced laser diagnostic development, and flight test.





Fuller, Hsu, Sanchez-Gonzalez, Srinivasan

Mach 6 Quiet Tunnel

- M = 6, Re/m = 7.0 11.5 x 10^6 (Quiet)
- 40 sec run time
- Nozzle Exit Diameter: 0.18 m



Actively Controlled Exp. Tunnel

- -M = 5 8, Re/m = 0.2 10 x 10⁶
- 40 sec run time
- Nozzle Exit: 0.23 x 0.36 m



Hypervelocity Exp. Tunnel

- U = 1 8 km/s, Re/m = 0.1 100 x 10⁶
- Flight matched to 5 km/s
- Nozzle Exit Diameter: 0.92 m (3.0 ft)



Background: National Aerothermochemistry and Hypersonics Laboratory (NAL) | Diagnostics, Computations



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- Diagnostics (NAL & ALLEMO):
 - Laser, optical, and molecular diagnostics:
 - MHz rate sampling
 - Molecular Tagging Velocimetry
 - Internal molecular temperatures
 - Density and species
 - Atomic species, plasma properties
 - Surface diagnostics for:
 - Heat transfer, skin friction
 - High frequency surface pressure

Computations:

- Flow physics (DNS)
- Reduced order modeling (RANS/LES)
- Aerodynamic database generation
- Chemical kinetics



