

MAHD

Mid-Air Helicopter Deployment

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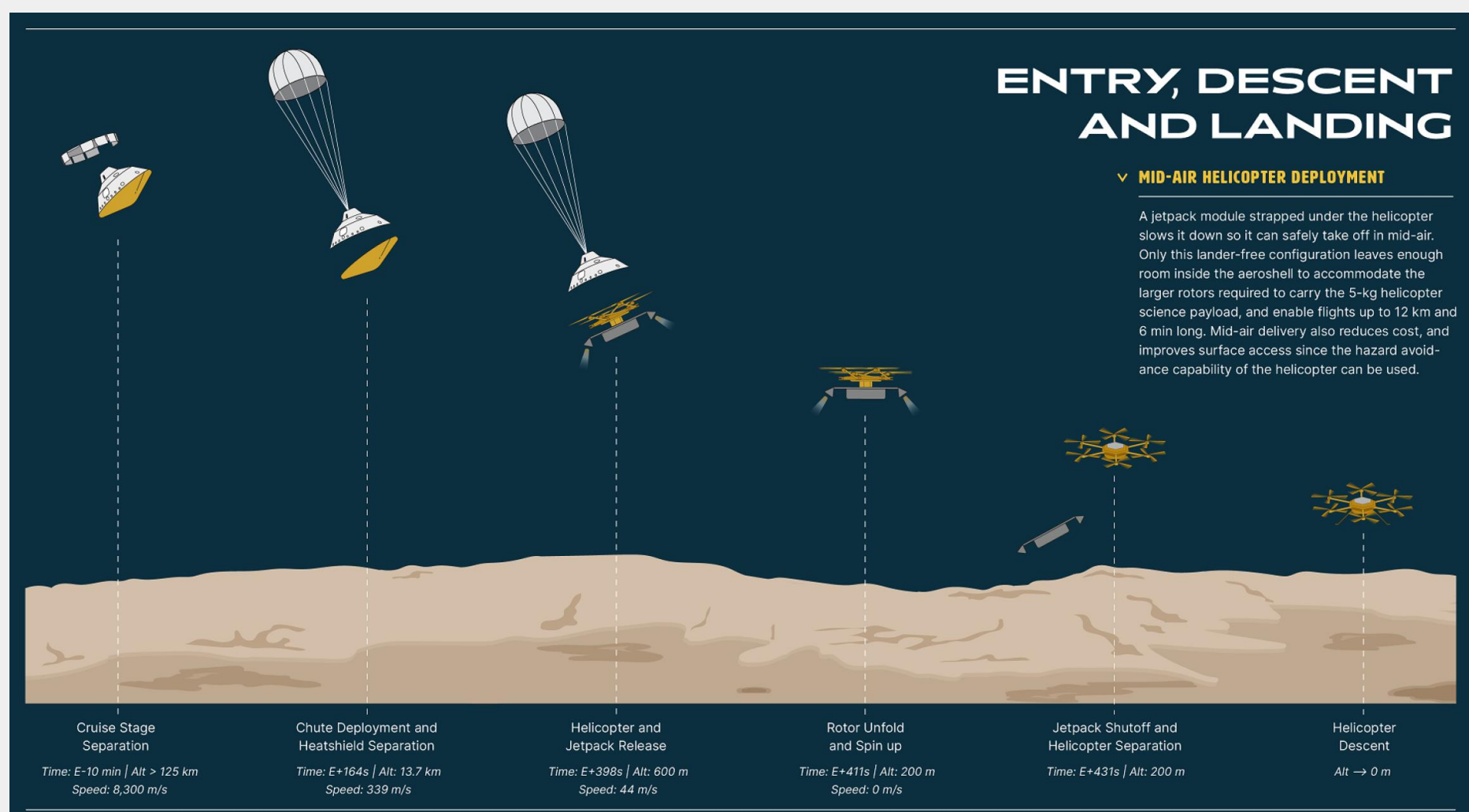
J. Raffel (Caltech), M. Leipold (355), J. Wanner (347), M. Devost (353), J. Izraelvitz (347), L.P. Tosi (347), L. Young (NASA ARC), P. Shah (ATA), A. Weiss (ATA), N. Reveles (ATA), J. Burdick (Caltech), M. Gharib (Caltech), J. Delaune (347)

The Concept

MAHD: Novel EDL technology using a jetpack to deliver a helicopter-only mission (e.g. Mars Science Helicopter (MSH)) on Mars.

Project: Experimental risk reduction effort for using dedicated jetpack for Mid-Air Helicopter Delivery (MAHD).

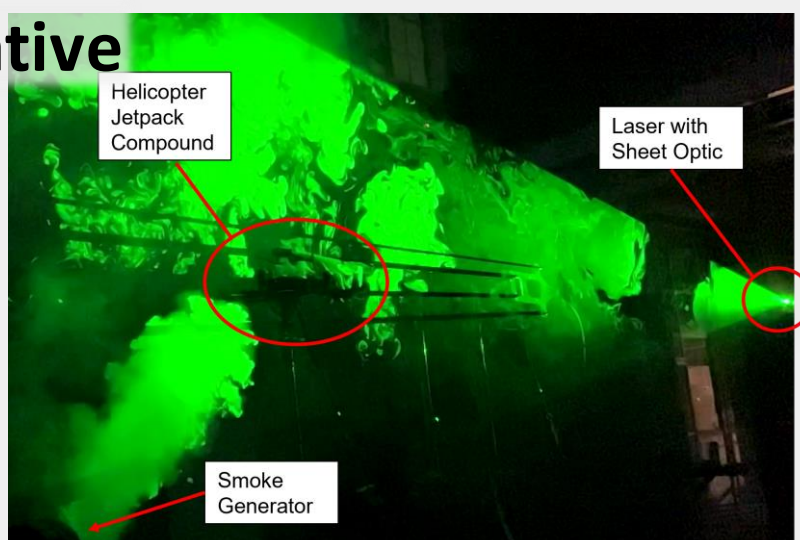
- Measure flow properties and force-torque in a scaled 1-atm / 1-g helicopter-jetpack experiment in Caltech's CAST wind tunnel facility.
- Model the flow using Computational Fluid Dynamics (CFD) simulations of both the Mars case and the experimental case.



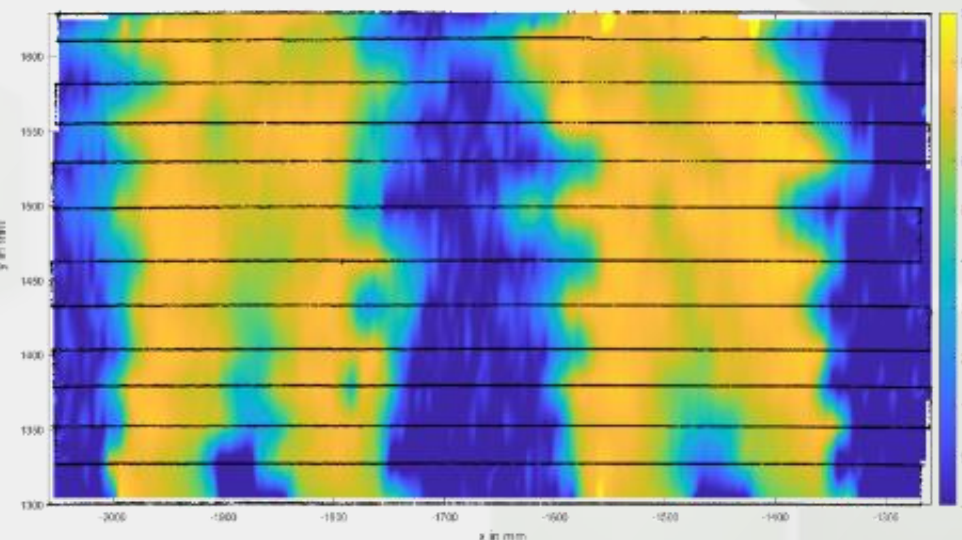
Flow Field Study

- Various flow visualization techniques to study flow field around helicopter-jetpack system
- Identify extent of jet-induced flow/flow field changes

Quantitative

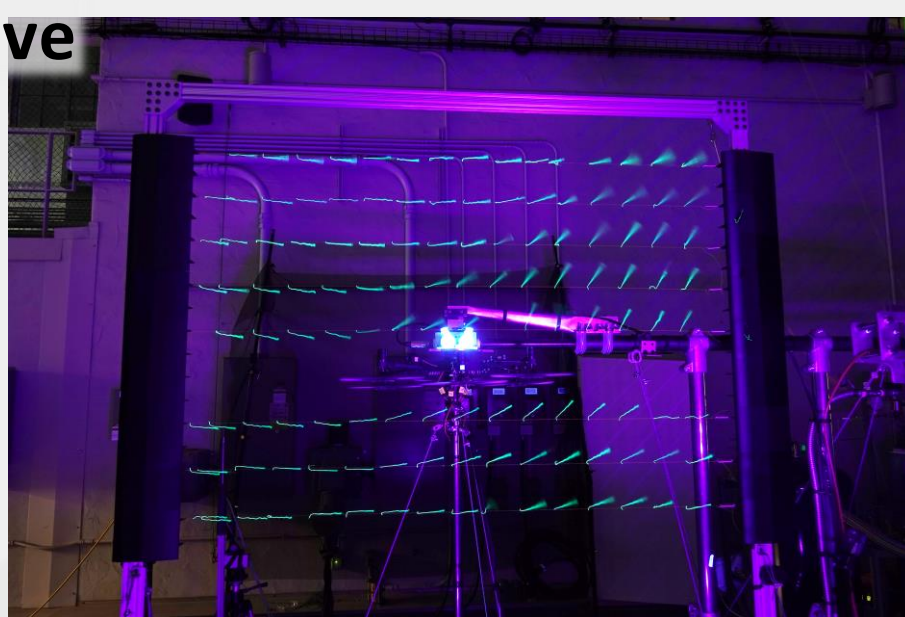


Smoke/PIV Flow Visualization

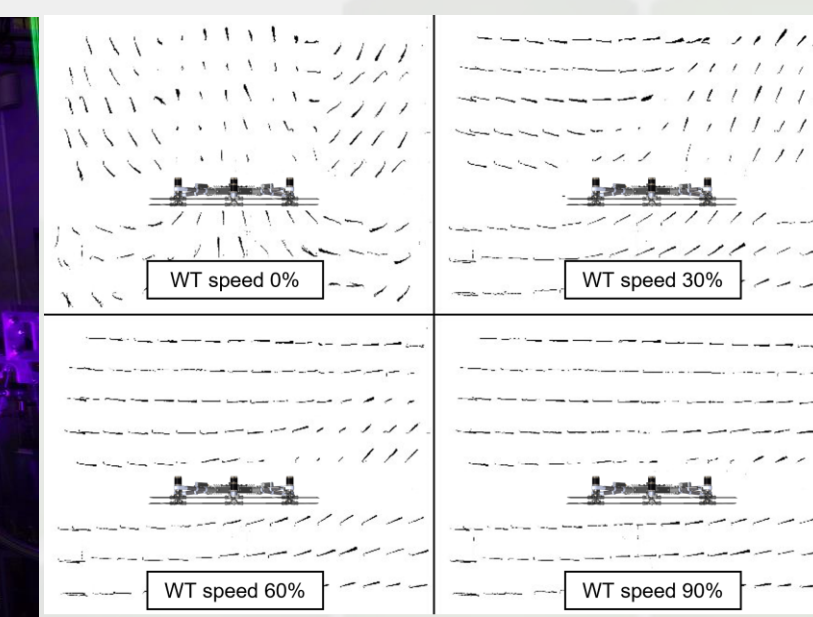


Pitot Tube Study

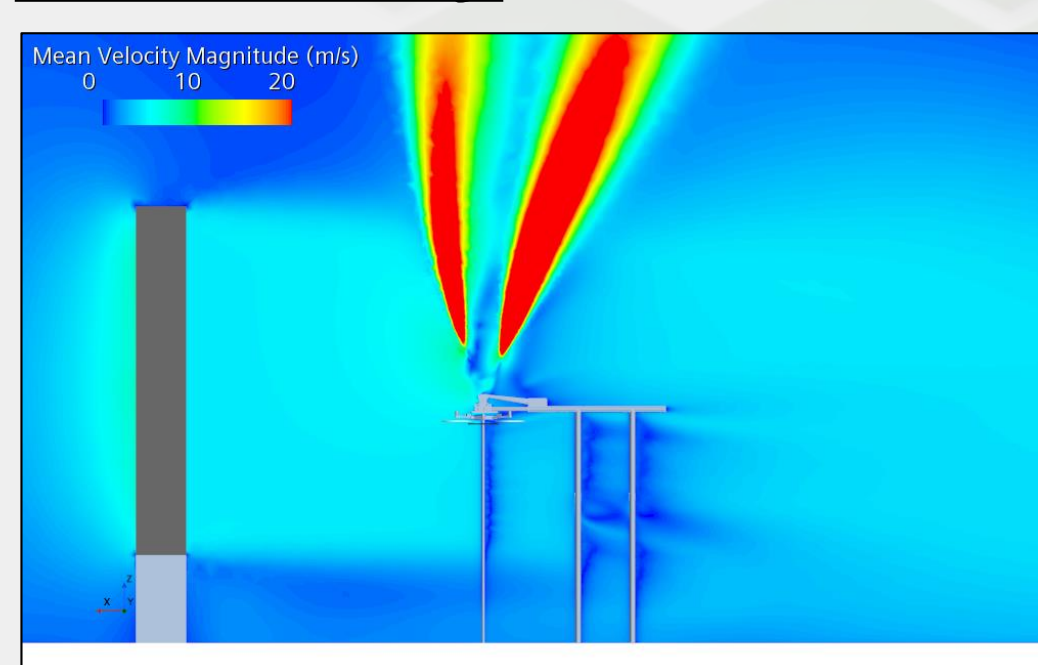
Qualitative



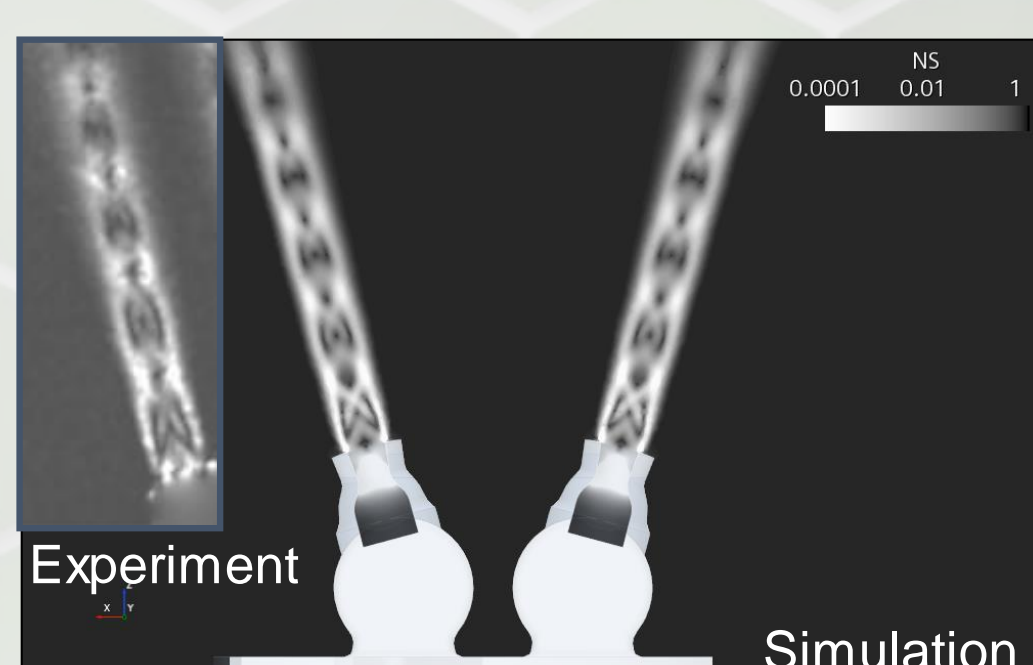
Tuft Analysis



CFD Study

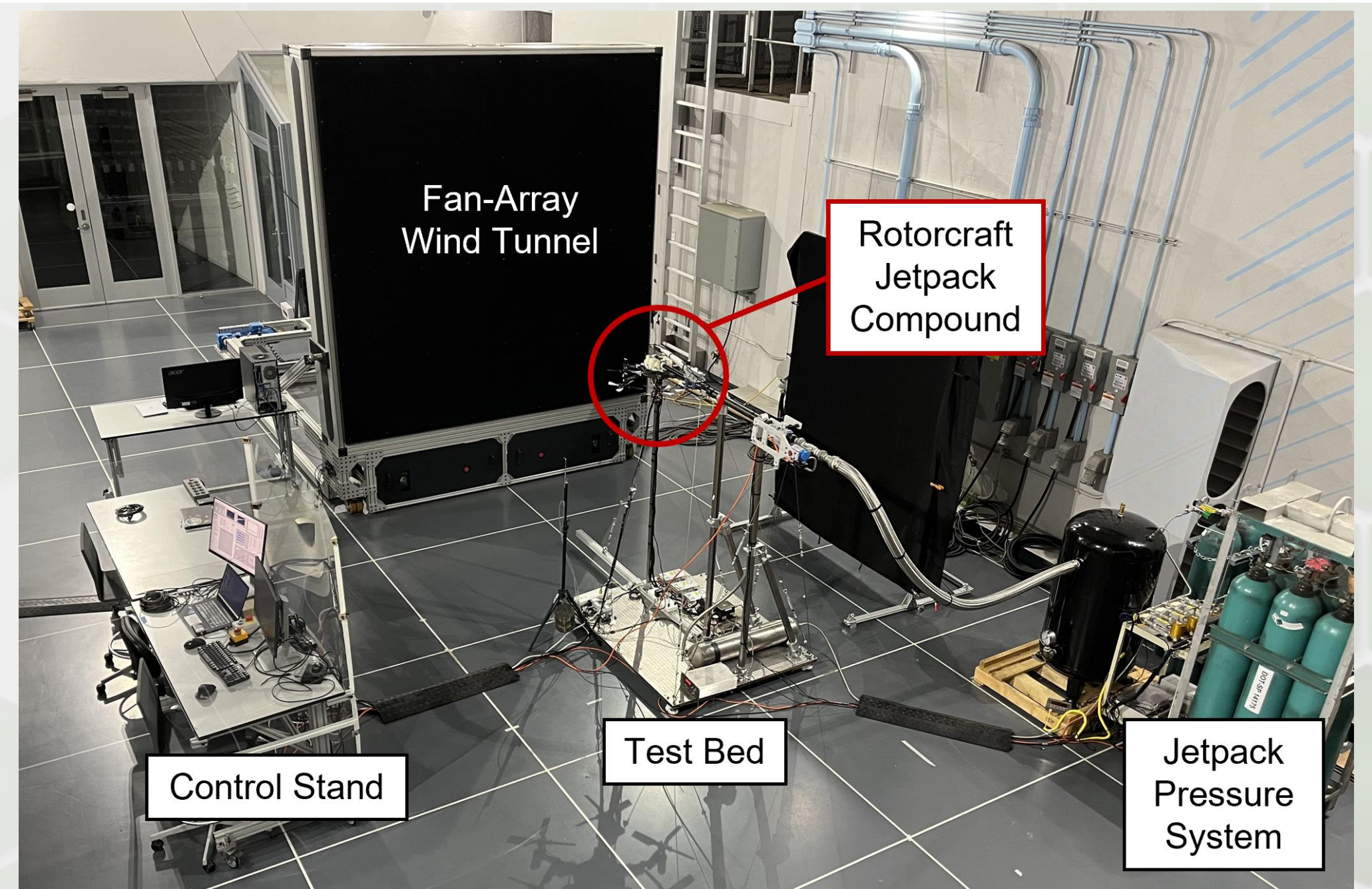
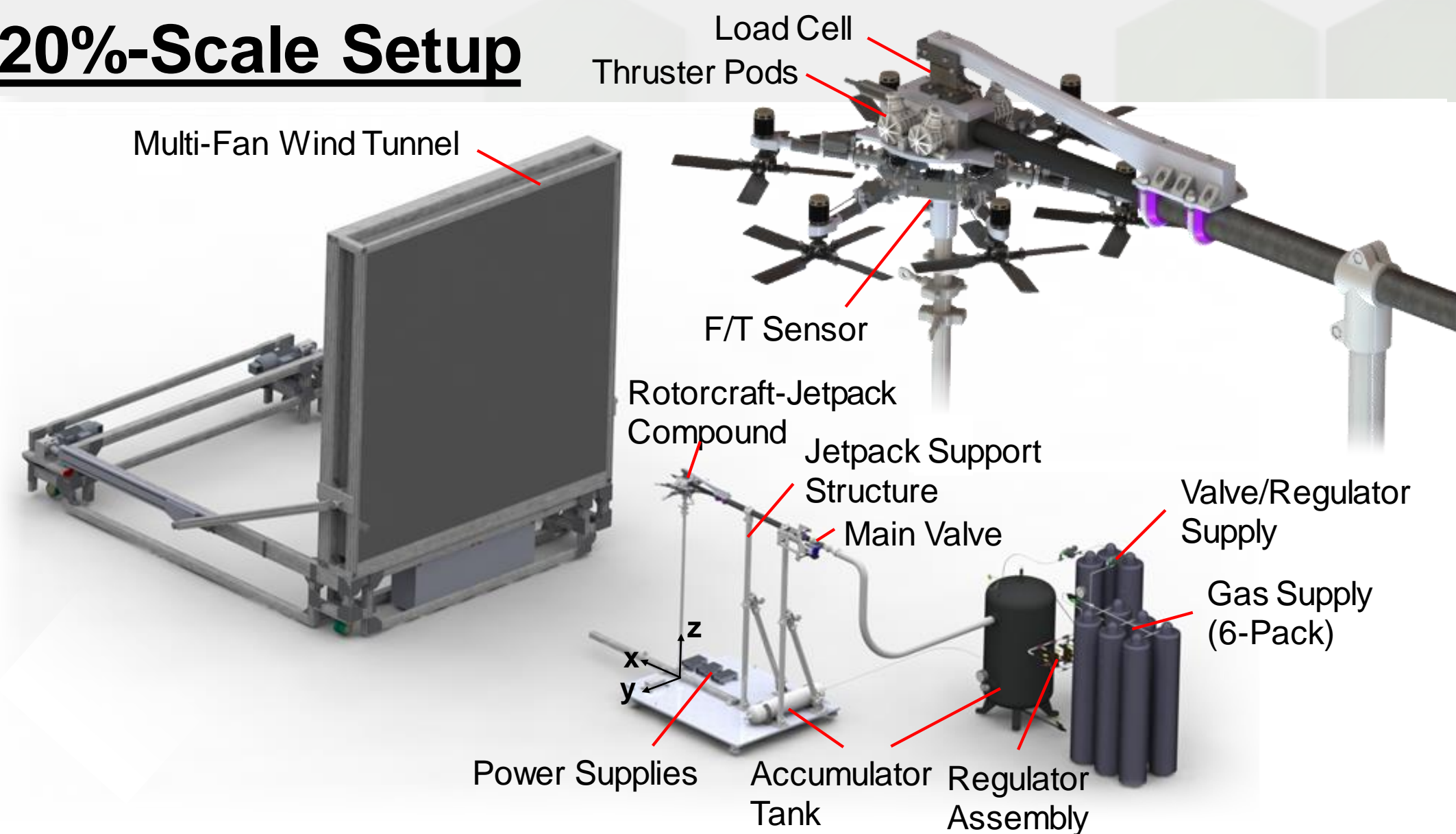


Flow Field: Jets + Wind Tunnel

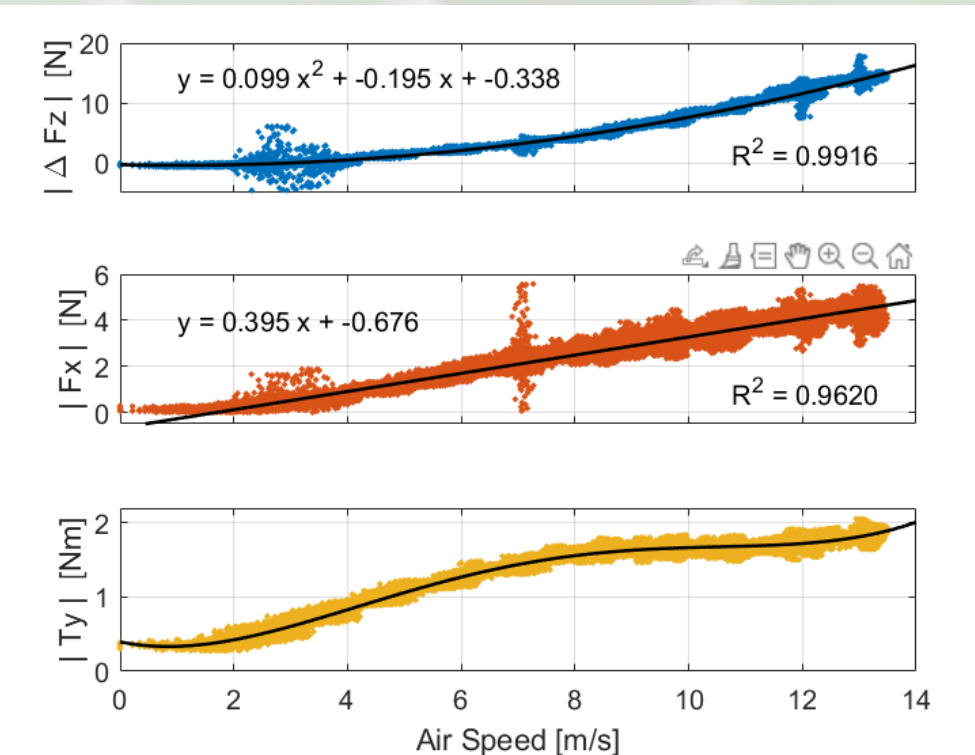
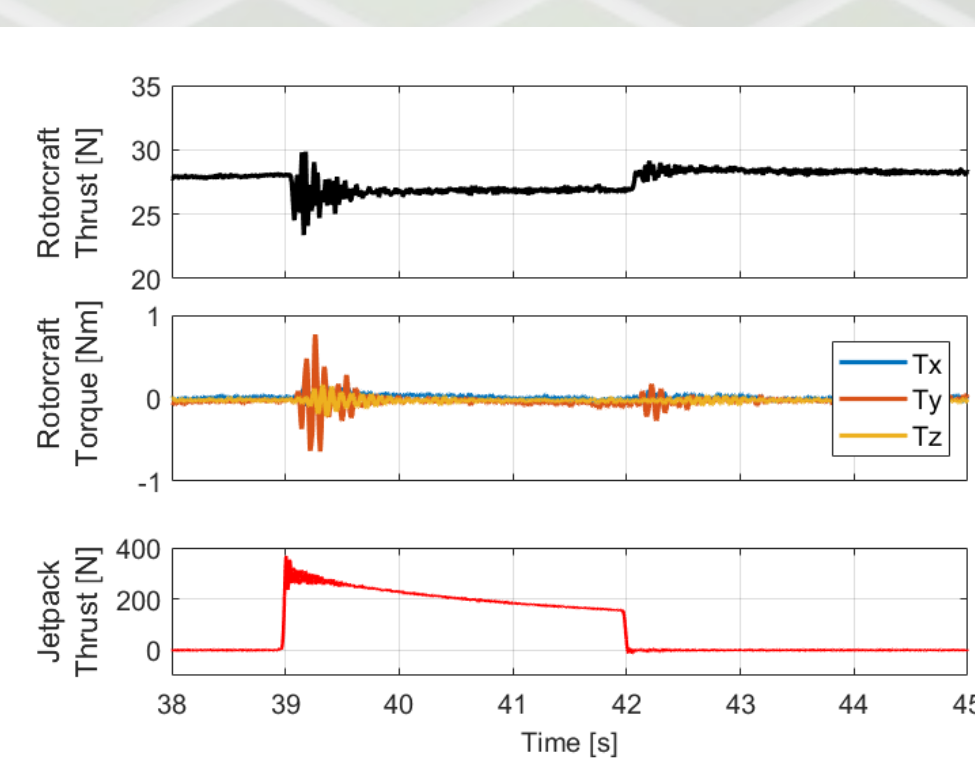


Jet Structure (Density Crosscut)

20%-Scale Setup



Results



Aerodynamic Jetpack-Heli Interference:

- Heli performance only marginally affected by jetpack operation → max: 3.5% thrust loss
- Minimal flow related oscillations in the rotor performance
- Flow field: minor changes on average flow field with jet operation

Rotorcraft Wind Sensing:

- In-flight sensing of non-hover conditions using integrated F/T sensor
- Correlation between rotorcraft forces/moments & wind speed for accurate wind speed sensing
- Enabling rotorcraft trimming under wind-influence for safe take-off

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Publications:

Veismann et al., "Study of Rotor-Jetpack-Wind Aerodynamic Interaction for Mid-Air Helicopter Delivery on Mars". IEEE Aerospace Conference, Big Sky, Montana, March 2023.

Delaune et al., "Jetpack Concept for Mid-Air Helicopter Delivery at Mars" presentation, IPPW, September 2022.

Delaune et al., "Mid-Air Helicopter Delivery at Mars Using a Jetpack". IEEE Aerospace Conference, Big Sky, Montana, March 2022.

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