Creating Test Environments for Assessing UAS Performance

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Perfect flight conditions… (Lugano, Switzerland)

... not so perfect flight conditions, but that is when UAS are most needed!
We need Test Environments in order to Assess UAS & UAM Performance

R&D
Testing
Rating and Certification

Day and night operations

Flying through cities
High altitude
Windy day
Adverse weather
Extreme temperatures
Specific winds

-°C +°C
Classical Climatic Facilities
Large Fans, Simple Flows

25’000 ft altitude
Winds up to 100 ft/s
Temperatures from –40°F to 140°F
In 2016, we developed* the concept of a Wind & Weather Facility in order to develop 21st century drones in Controllable and Repeatable Atmospheric Conditions

- No walls
- Small footprint
- Wind Shear
- Gusts
- Weather (rain, hail, dust, snow...)
- Actual drone
- Free-flying
- No support
- Emulated GPS


UAV & UAM are more like birds than aircrafts: they are small, fly unsteadily, and are subject to gusts and wind shears.
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**Wind Pixels** and **Wind Blocks**

Each wind pixel (fan) is individually controlled
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Wind Blocks = Lego Blocks

Wind Blocks can be setup in any arbitrary geometry
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Fine-Tuning and Reproducibility of Arbitrary Atmospheric Flows

Veisman, Dougherty, Gharib 2016
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Gusts & Shear

**Drone attitude**
- Pos x: 0.063 [m]
- Pos y: 1.201 [m]
- Pos z: 0.663 [m]
- Yaw: 178.022
- Pitch: 2.362 [°]
- Roll: 358.637

**Average speed**
- m/s: 2.3
- km/h: 8.4
- mph: 5.2
In 2017, WindShape delivered its first product to Caltech and NASA Jet Propulsion Laboratory Center for Autonomous Systems and Technologies (cast.caltech.edu)
Testing & Rating

Drone stays in place for optimal visual inspection & testing

Descent Stability

Stability in Arbitrary Winds

Flight in Windy Days

Stability in Urban Canyon Flows

Stability in Unpredictable Flows
Testing & Certification

Collaboration with
the Institute for Snow & Avalanche Research WSL – SLF
(Davos, Switzerland)
Next Steps

Characterize Actual UAS/UAM-Scale Meteorological Flows

«Teach» a WindShape Machine to Reproduce Meteorological Flows of Relevance to UAS/UAM Safety
Many Thanks from the WindShape Team!

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