



NASA's
Game Changing Technology
Industry Day
June 29-30, 2016



Affordable Vehicle Avionics

Presented by
Jim Cockrell

NASA Ames Research Center

TECHNOLOGY DRIVES EXPLORATION



Affordable Vehicle Avionics



The high cost of space launch relegates small spacecraft (CubeSats and tech demos) to launch opportunities as secondary payloads. They're unable to specify their own launch date or destination.

Several launch vehicle developers are attempting to reduce the cost of propulsion; but the high cost of avionics remains prohibitively expensive.

Affordable Vehicle Avionics (AVA) will demonstrate a self-contained guidance system that can be integrated and operated at a fraction of the recurring costs of existing units, ready to license to launch vehicle vendors.

Target values:

- \$10k to manufacture and test
- Well under \$100k to integrate with launcher
- Smaller than 1U CubeSat in size
- Less than 1 kg mass





AVA Solution to Low-Cost Launch



AVA approach to drastically reduce costs:

1. Use low-cost COTS MEMS IMU sensors
2. Increase navigation precision by fusing GPS and magnetometry with novel EKF propagation filter
3. Offer a “cookbook” approach to launch vehicle developers for integration and tests, via high-fidelity 6DOF rocket models
4. Validate navigation and control on early test flights
5. License technology to launch vehicle community

AVA enables launch providers to offer payload operators affordable rides to LEO

- Small payload operators can afford their own dedicated launch to LEO, when and where they need!





AVA Performance Tests

Preflight checks for FOP SL10 Test Launch



AVA inside
SL10
avionics bay

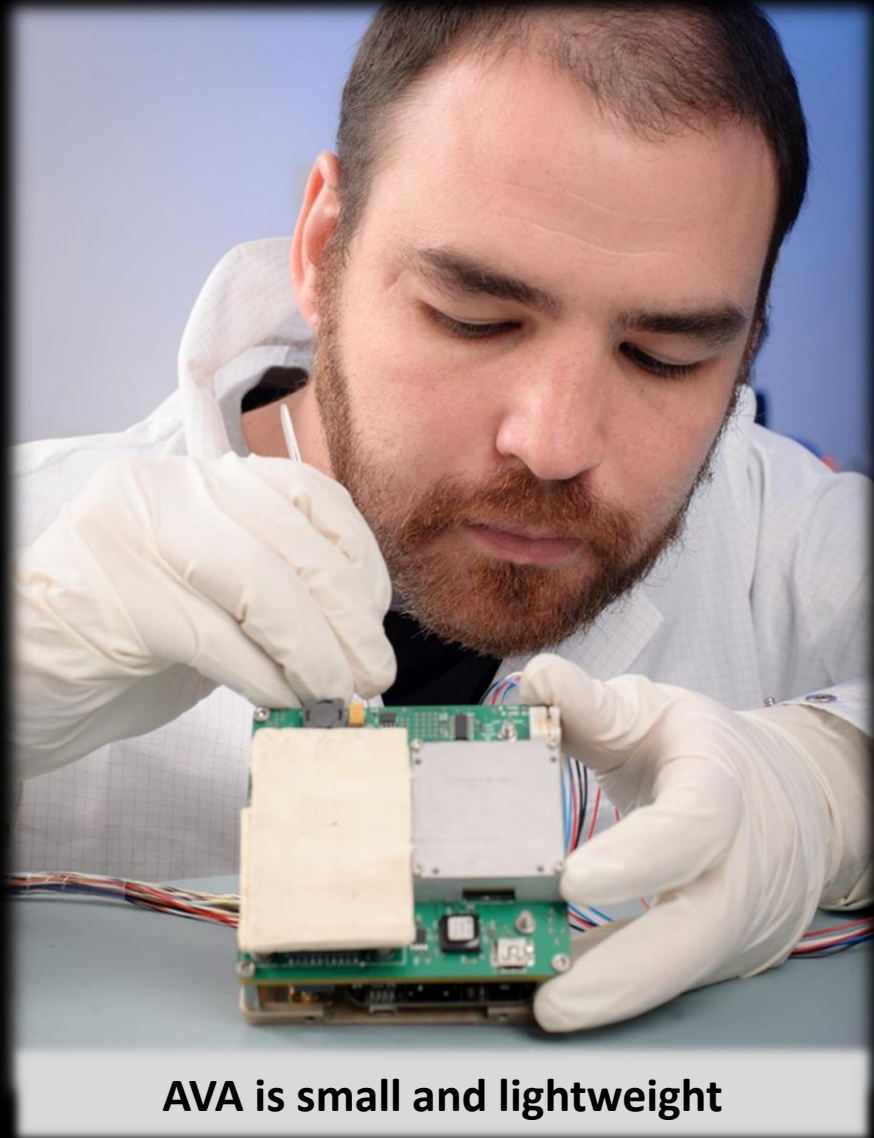


AVA
controls
attitude on
MSFC air
bearing





AVA Development



AVA is small and lightweight



**Self-contained and weighs 0.84 kg
Batteries included!**



AVA Partnerships and Next Steps



Current Partnerships

NASA ARC ADEPT	SR-1 mission. Flight data recorder during re-entry, descent tests
NASA MSFC NL2A	Small affordable launch vehicle. Test launch from Redstone range
UP Aerospace	NRSAA with ARC; Spyder 4-stage launch vehicle capable of LEO

Potential Customers

NASA Flight Opportunities Program	New capability of affordable flights to LEO, for small payload tests
Whittinghill Aerospace	Future development partnership possibilities
Garvey Spacecraft Corp	Various launch possibilities
Cube Cab	Air launch via KSC F104s operated by StarFighters. 3-stage vehicle, with ACS thrusters on 2nd stage.
TGV Rockets	Application on DARPA Low Cost Upper Stage Program and NASA Nano-Sat Launch Low Cost Stage Program

Next Steps

Nov 2016	AVA-controlled vehicle attitude stabilization test flight
Dec 2016	AVA-controlled vehicle attitude command test flight (commercial customer)
2017	Spyder 4-stage orbital vehicle development with UP A and MSFC



Contact Information



For more information about this technology or to discuss potential collaboration efforts:

Jim Cockrell
NASA Ames Research Center
James.J.Cockrell@nasa.gov
650-604-2553

