

# PISCES LUNAR DUST FLIGHT EXPERIMENT **MoonRIDERS**

## BRIEFING TO SRR

Pacific International Space Center for Exploration Systems

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June 2016



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# PISCES MoonRIDERS

Research Investigating Dust Expulsion  
Removal Systems

**GOAL:** To develop, launch, fly and land on the moon a Hawaii High School student-built lunar surface experiment, in concert with technology from the NASA Kennedy Space Center as a hosted payload on one of the upcoming Google Lunar X-Prize (GLXP) launch

**WHEN:** GLXP launch in middle-late 2017





# MOONRIDERS

Build

Something

**INNOVATIVE**

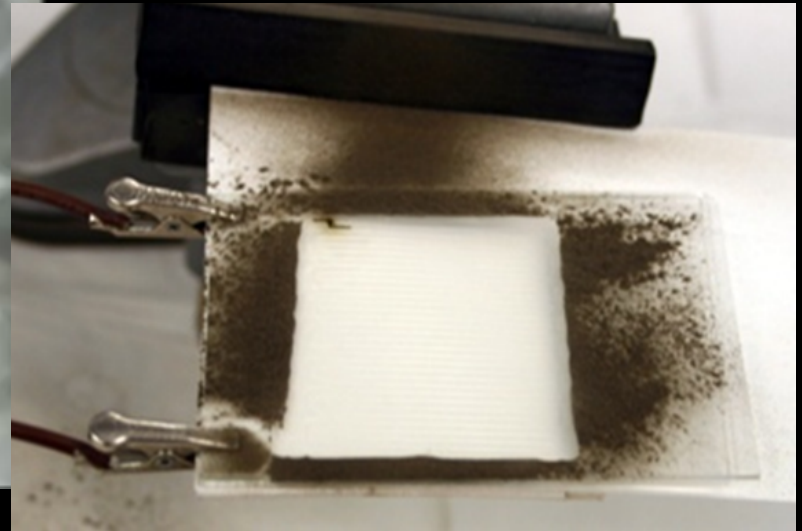


Do

Something

**BOLD**

# Electrodynamic Dust Shield technology





# EDS Repulsion Field Test with JSC-1a



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# MoonRIDERS

**WHAT:** to establish a joint flight test program between Hawaii high school students and NASA for the testing of critical dust removal technologies on the lunar surface.

**WHY:** (1) advance TRL of critical technology for surface systems

(2) to uniquely promote and encourage STEM education in Hawaii (ranked 46 percentile)





# MoonRIDERS

**WHO:** four unique strategic partners

1. **Academia/STEM:** Two (2) Hawaii High School Teams:
  - `Iolani HS / Private / Oahu
  - Kealakehe HS / DoE public / Big Island
2. **State:** Pacific International Space Center for Exploration Systems
3. **Federal:** NASA-Kennedy Space Center / SwampWorks
4. **Industry/Commercial Space:** Google Lunar X-Prize teams



# MoonRIDERS

## BUSINESS MODEL:

- Hosted-payload flight opportunity
- Setup a “no-exchange of funds”. Non-reimbursable SAA
  - Only hardware is exchanged (.....not money)
- NASA provides mentoring session on lunar dust, physics of EDS, moon, issues with dust, etc.





# Innovative Business Model

1. Proof-of-concept for flight testing of technology
  - Paving the way for one approach for mid-TRL flight test program on lunar surface
2. Low-cost, public private partnership (PPP)
3. Hosted-payload / Ride-share model
  - Not dedicated NASA launch
4. Supports both for testing for NASA technology advancement and STEM
5. Tie to LEAG measurement goals and SKGs
6. Leverages commercial and international lunar lander programs





# Innovative Business Model

Flexible approach where NASA isn't required to "fund all".

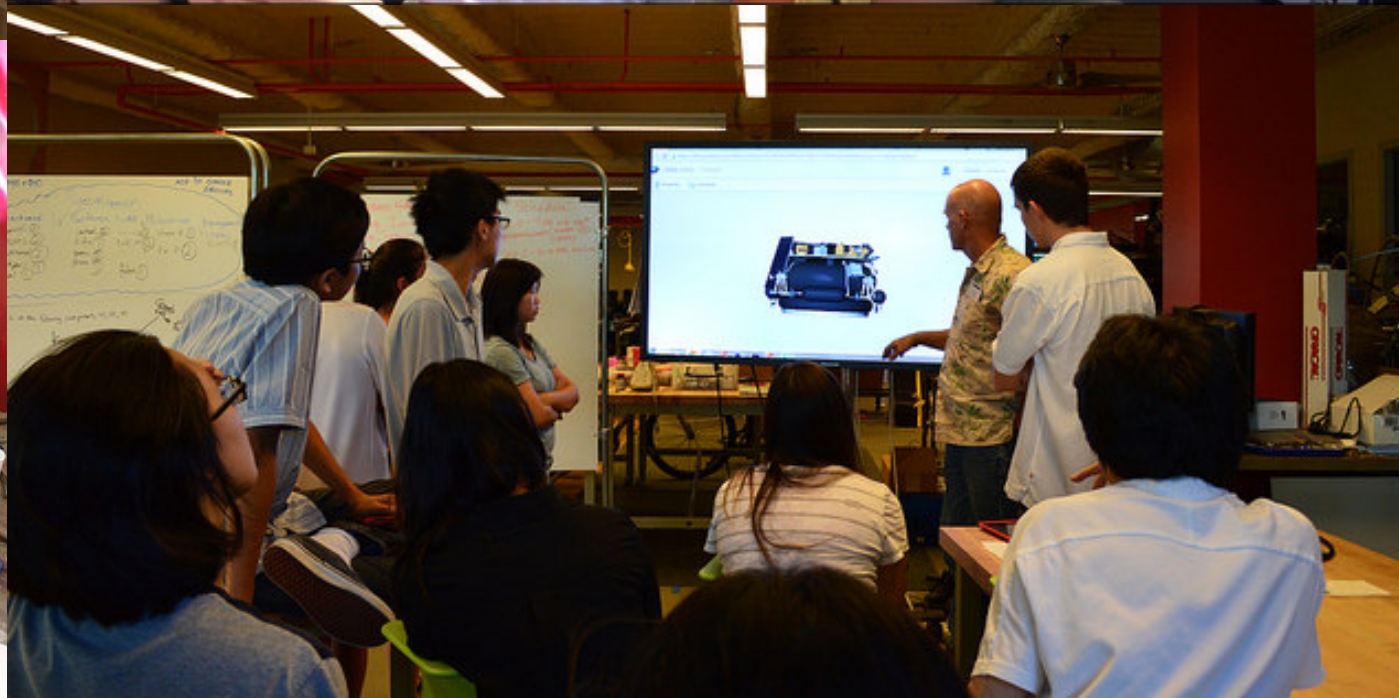
**Case 1** - group has all the DDTE costs covered but needs help with the integration costs.

(Example is MoonRIDERS-I)

**Case 2** - a group needs funding help with DDTE but has a free rider to the surface  
(Example of flying on SELENE-RP).



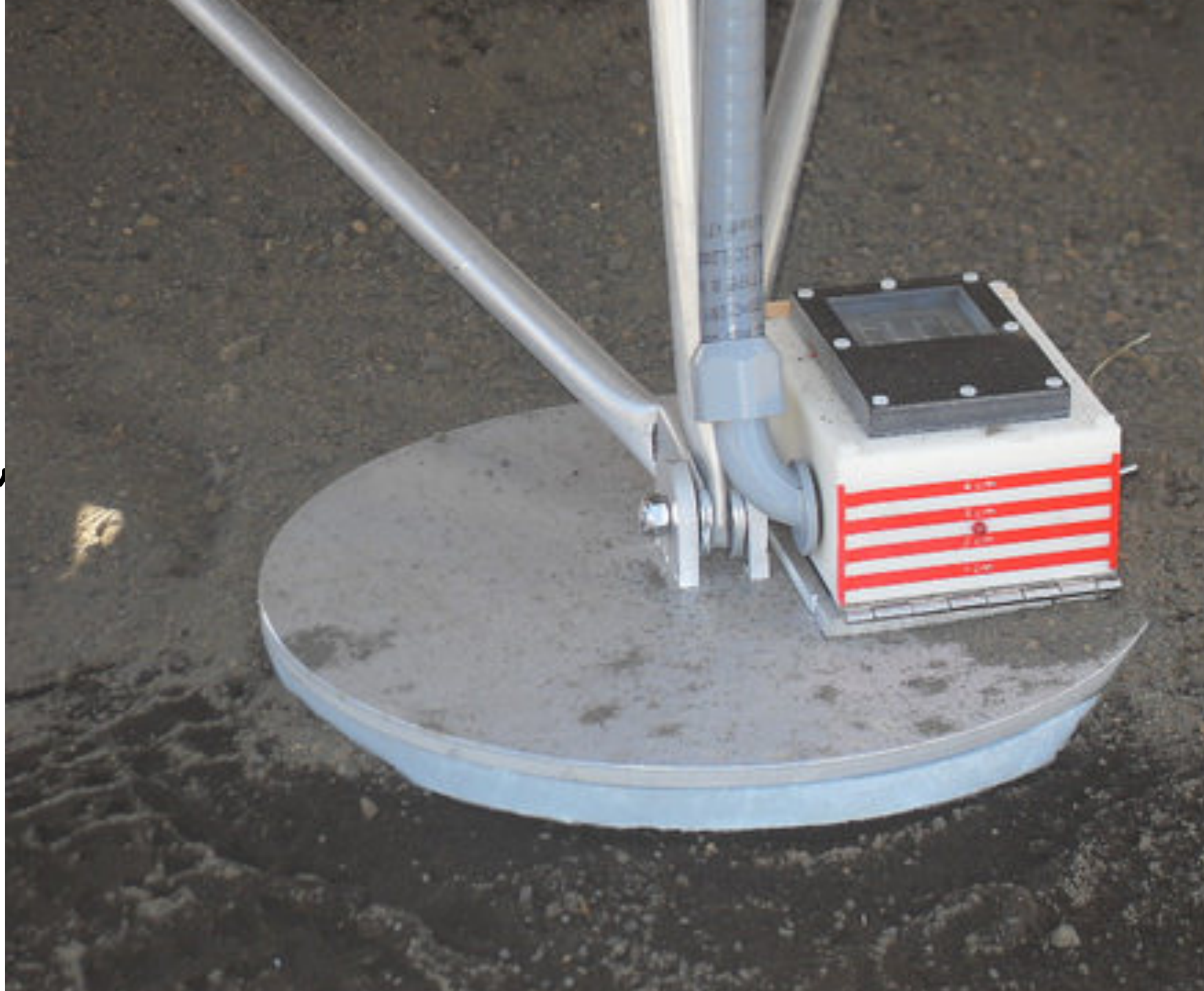






# March 2015 Dust Shield Field Tests

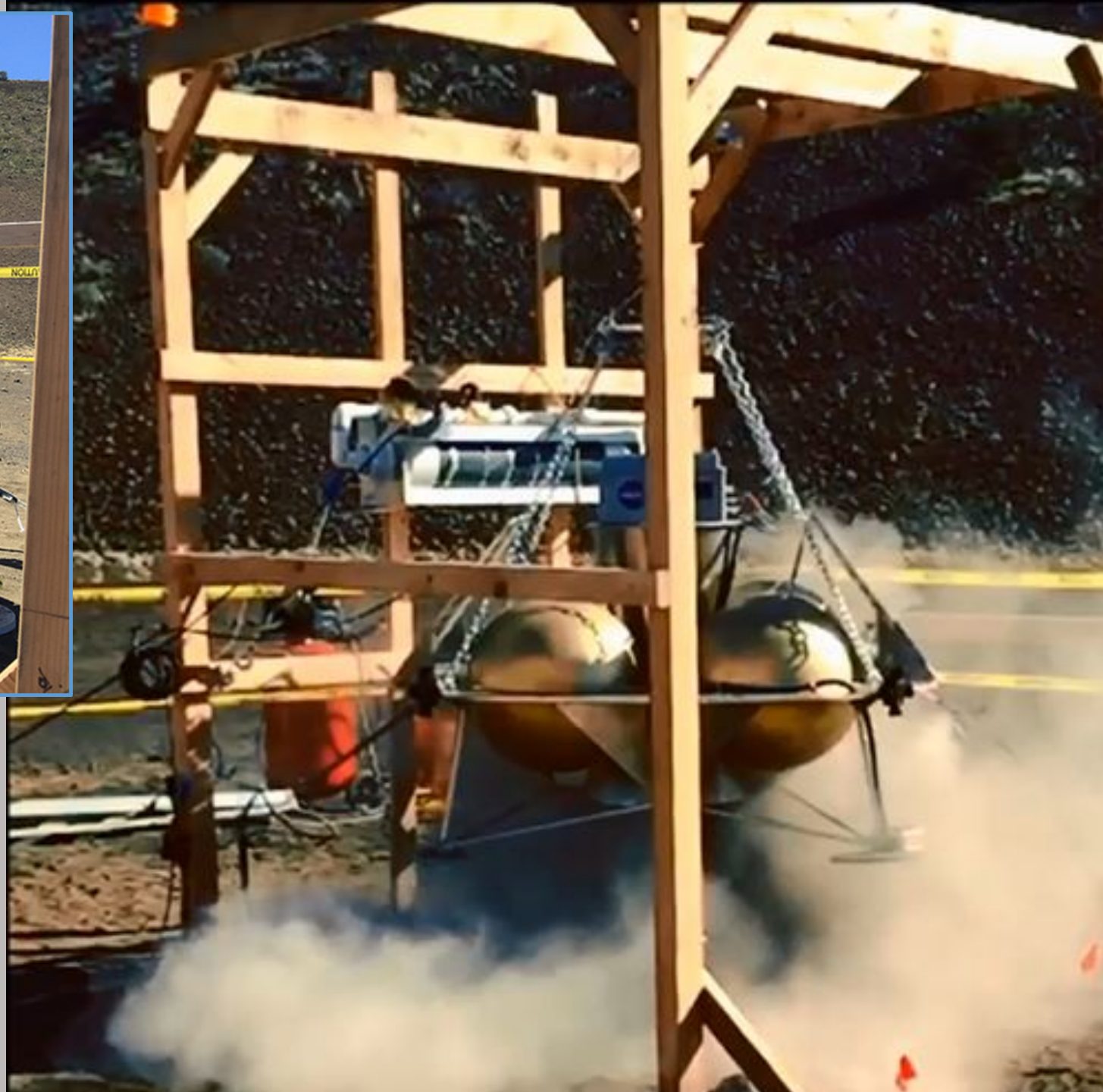
- assess locations,
- flight configurations,
- imagery methodology







Test Article in  
Gantry





Imagery  
data  
collection

pre/post  
EDS



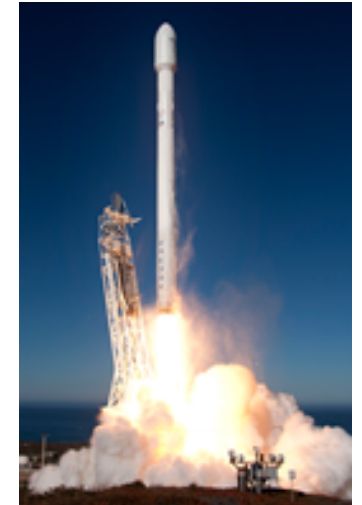


# EDS LUNAR LIGHTING TESTS

Assess lunar environment and lighting conditions for test site with regard to flight imaging configuration for EDS

- **Approximate lighting conditions at time of landing**
- **Intensity of sunlight**
- **Camera locations relative to EDS**
- **November 2015 - RUN IMAGING TESTS AT SCHOOLS**
- **March 2016 - RECREATE TEST IN VACUUM CHAMBER AT KSC**

# MoonRIDERS Development, Test and Launch Integration Schedule



**LAUNCH!**  
**Late 2017**

**DRAFT**

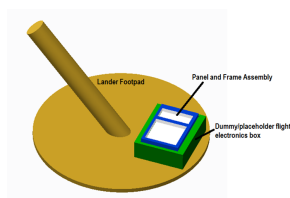


**March 2015**  
Engineering  
Field Test #1  
at PISCES Test  
Site



**Winter 2015**  
Payload  
customer  
contract for  
GLXP launch

Finalize  
design of  
final flight  
EDS unit



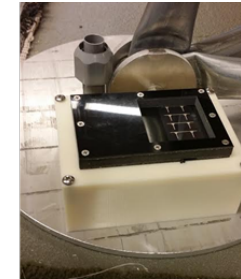
**Spring 2016**  
Engineering  
Test #2  
Image lab  
testing in  
vacuum  
chamber

Students @  
KSC

**Sept-Nov  
2016**  
Final  
Assembly  
& Test

**Dec/Jan**  
Flight  
Cert

**Feb  
2017**  
Delivery  
of flight  
unit



**March-June  
2017**  
Integration  
and test  
with  
spacecraft





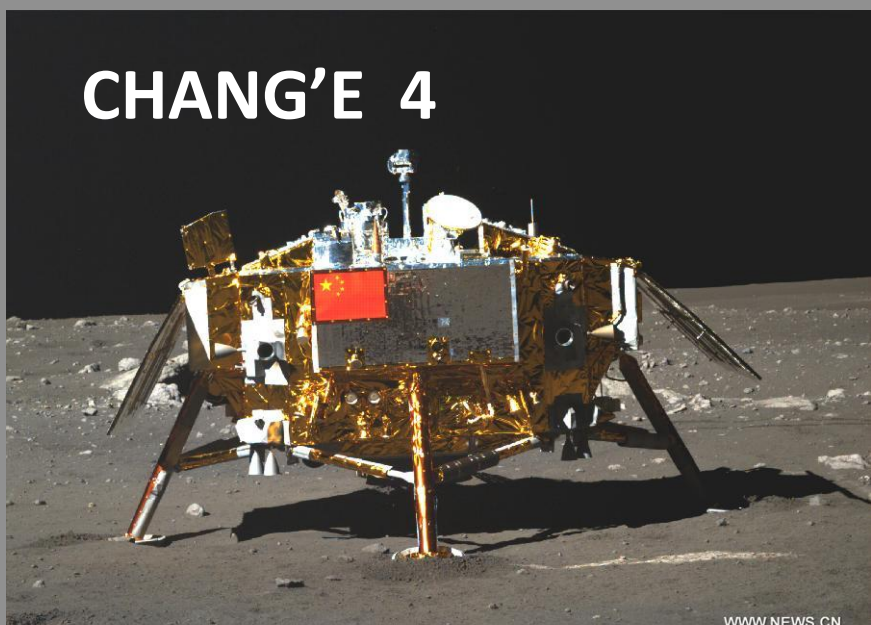
# Lunar MoonRIDERS-II



Assessing flight opportunity options for flight testing

- **SELENE-Resource Prospector** (2022) or **CHANG'E 4**
- Japan (China) University and Hawaii University working on joint experiment in technology for testing on Moon's surface

CHANG'E 4



SELENE - RP



**“GO FOR  
LAUNCH”**





A silhouette of a person wearing a cap and jacket, holding a remote control, stands on the right side of the frame. In the center, a drone is mounted on a tripod-like stand. The background shows a dark sky with a bright orange and yellow glow on the horizon, suggesting sunset or sunrise. The overall scene is dark and atmospheric.

Questions?



Backup

# PISCES Strategic Plan Objective



TECHNOLOGY DEVELOPMENT / DUAL-USE TECHNOLOGY IN:

1. Basaltic construction (R&D)
2. PISCES Planetary Rover systems upgrade/integration
3. Expand the PISCES Planetary Analogue Test Site (PPATS)
4. **PISCES lunar surface flight experiment – MoonRIDERS**
5. International Robotics Mining Competition in Hawaii - PRISM
6. NASA Laser Communications Relay Demonstration (LCRD) and ground terminal
7. Workforce Development – Intern and recently started Coop Program







# Hardware Fabrication of the Lander Mockups

**ʻIolani High School** – Astrobotic mockup (1/2-scale)







# **PISCES Volcanic Test Site - Mauna Kea**





# Test Article in Gantry

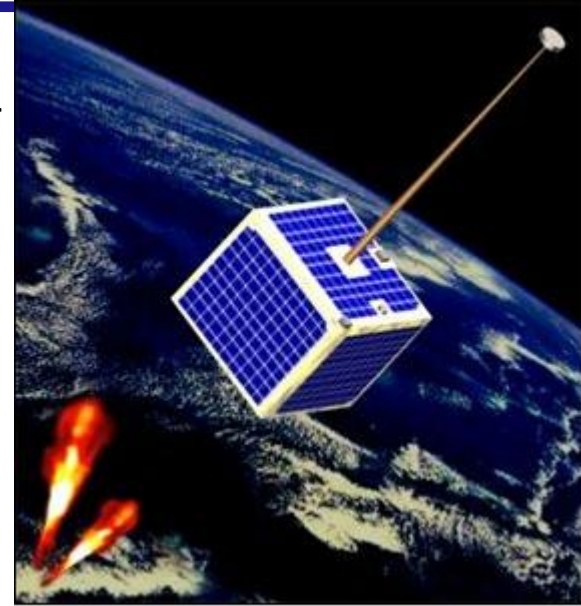




**Thanks to JAXA...Japan universities  
have successfully launched several 50kg  
cubesats**

- H2 Ride-share launch capability
- “free” for Japan academic institutions

SPRITE –SAT  
RISING-2 SAT



# Possible timeline with PISCES & JAXA/ISAS for assessing joint Hawaii/Japan university flight experiment

TIME	EVENT
2016	PISCES / JAXA ISAS AO TO UNIVERSITIES
2017	INITIATE STUDIES OF PROMISING TECHNOLOGY DEMONSTRATIONS BY THE TWO UNIVERSITIES
2018	DESIGN/DEVELOPMENT
2019	ASSEMBLY/TEST OF FLIGHT UNIT
2020	DELIVERY TO LAUNCH SITE, LAUNCH TO LUNAR SURFACE

Proposed



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# DDTE Schedule for LFE/Moon RIDERS

**DRAFT**

IHS / KHS

- Post-test analysis
- Report/Briefing

Payload  
contract with  
GLXP provider

Design/configure  
student ops  
control center



**EDS integr into S/C**

- Integration and test between EDS and S/C
- Delivery to launch site
- Mating to launch veh

Engineering integration, ICS, analysis between S/C and EDS

2016



LFE EDS Test #1 (KHS , IHS)  
Engineering assessment  
EDS Engr Unit #1  
Mar.16-20

Finalize design of  
flight EDS unit

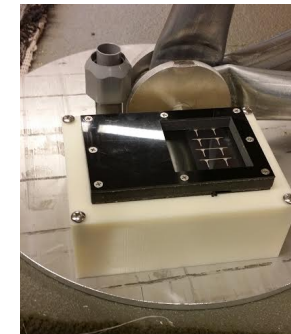


LFE EDS Test #2  
Flight verification test  
EDS Demo Unit  
Oct. '15

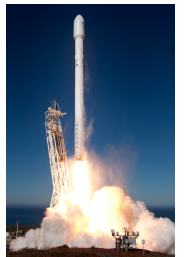
IHS/KHS build  
frames for  
Demo unit.

Flight production build of EDS  
flight unit

- KSC: flight avionics, EDS
- IHS/KHS: flight frame
- Integration
- Environmental test
- Flight certification



Delivery of Flight  
EDS to spacecraft  
Mid-Aug '16



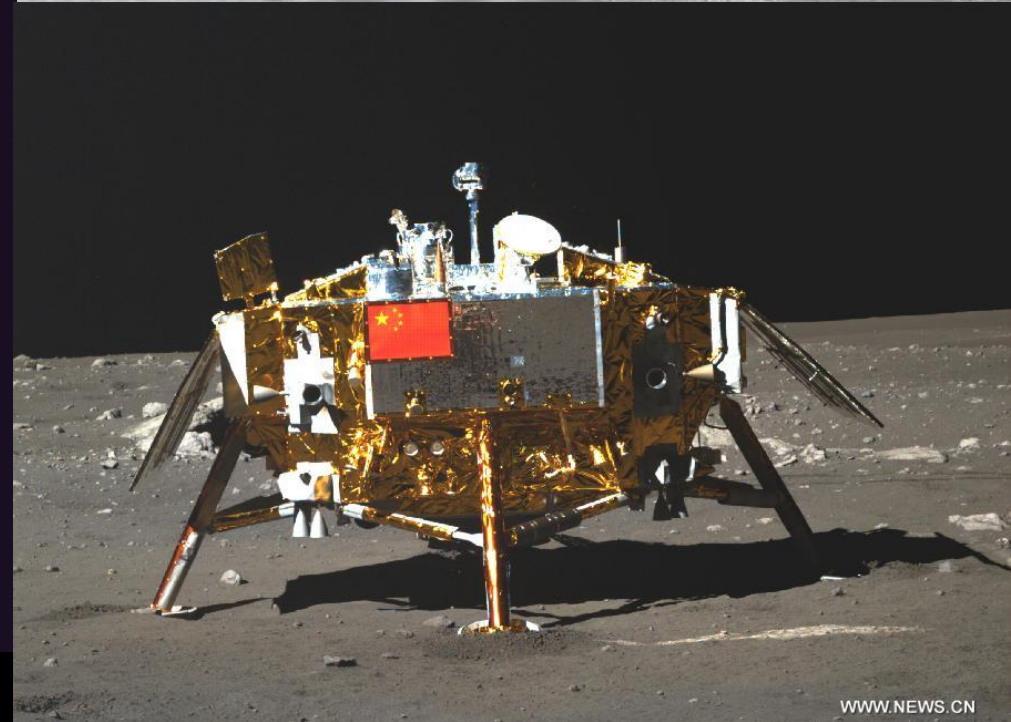
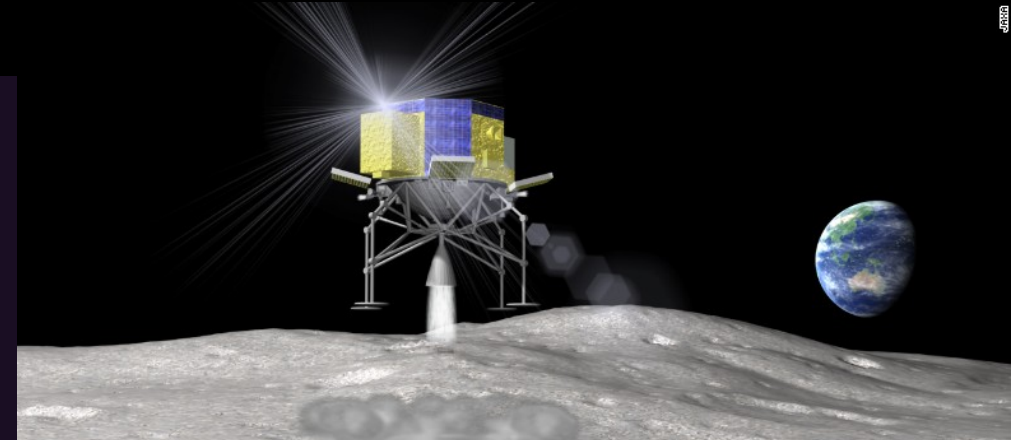
Launch /  
Lunar  
Landing

# What's Next? MoonRIDERS-II / III

Assessing flight opportunity options for international instrument collaborations with both the Hanyang *University, Seoul*

- Japanese/JAXA – SLIM / 2018 or SELENE-RP
  - “Smart Lander for Investigating Moon”
  - 120 kg spacecraft
- China/CNSA - Chang'E-4 / 2019
  - Lander/rover; lunar farside

Coordination of scientific goals between roadmaps leading to instrument candidates.



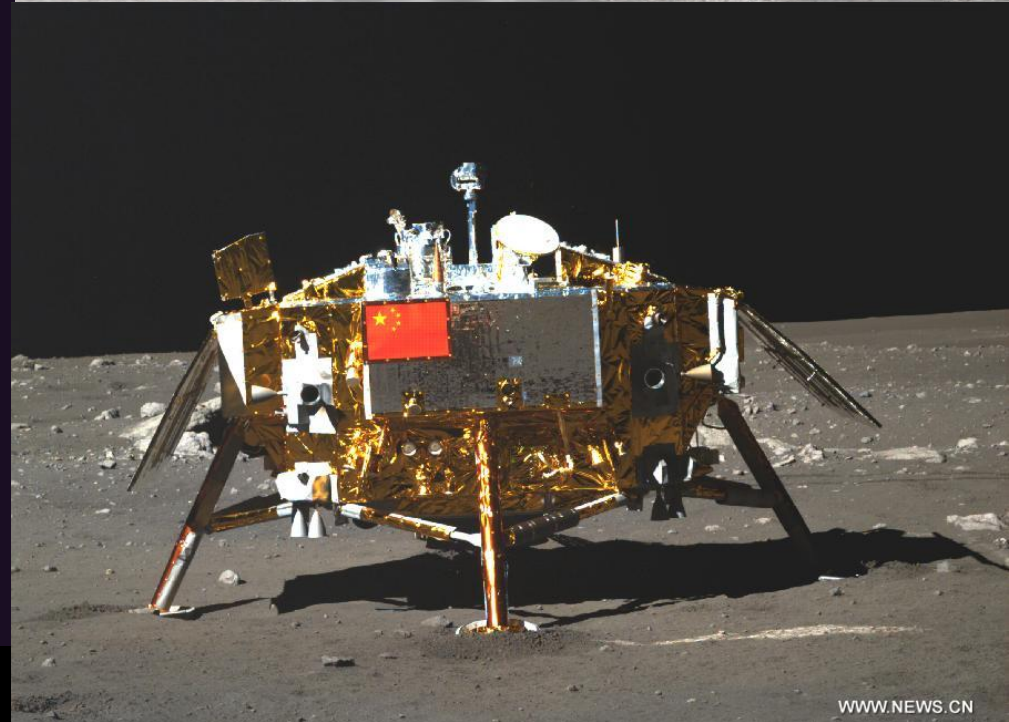


# What's Next? MoonRIDERS-II / III

## UPDATE

- A new partnership between US college & Hanyang University, Seoul, ROK
- (no Korean lander identified – yet)

Coordination of scientific goals between roadmaps leading to instrument candidates.





# Dust is a significant issue for systems on Moon and Mars.





# The Dust Problem

At the conclusion of Apollo 17's mission in December 1972, moonwalking suits and space helmets are covered by lunar dust





Dust...Dust  
everywhere



Dust on Apollo 12 camera





- The Electrodynamic Dust Shield technology being developed at the Electrostatics and Surface Physics Laboratory is based on the electric curtain concept developed at NASA in 1967 and later by the University of Tokyo.
- Currently, the Electrostatics and Surface Physics Laboratory is developing the Electrodynamic Dust Shield to prevent dust accumulation on spacesuits, thermal radiators, solar panels, optical instruments, and viewports for future lunar and Mars exploration activities.

