

PISCES LUNAR DUST FLIGHT EXPERIMENT **MoonRIDERS**

BRIEFING TO SRR

Pacific International Space Center for Exploration Systems

Rob Kelso Executive Director, PISCES

June 2016



PACIFIC INTERNATIONAL SPACE CENTER FOR
EXPLORATION SYSTEMS | PISCES.HAWAII.GOV

PISCES MoonRIDERS

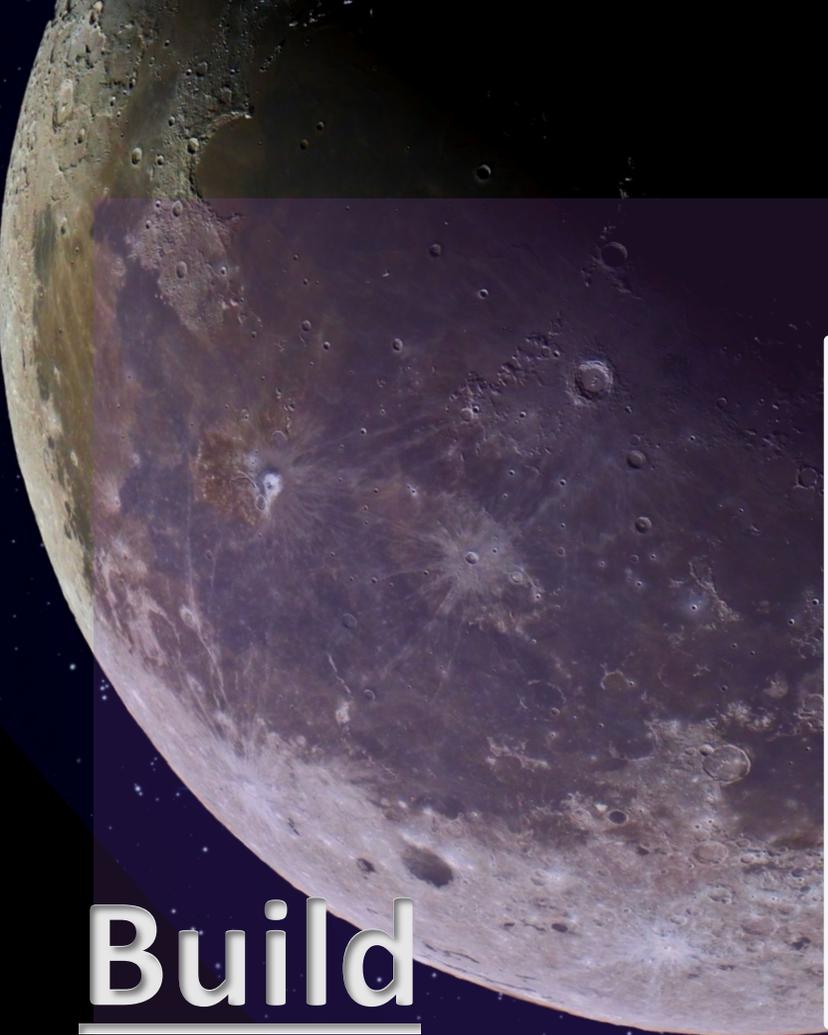
Research Investigating Dust Expulsion
Removal Systems

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

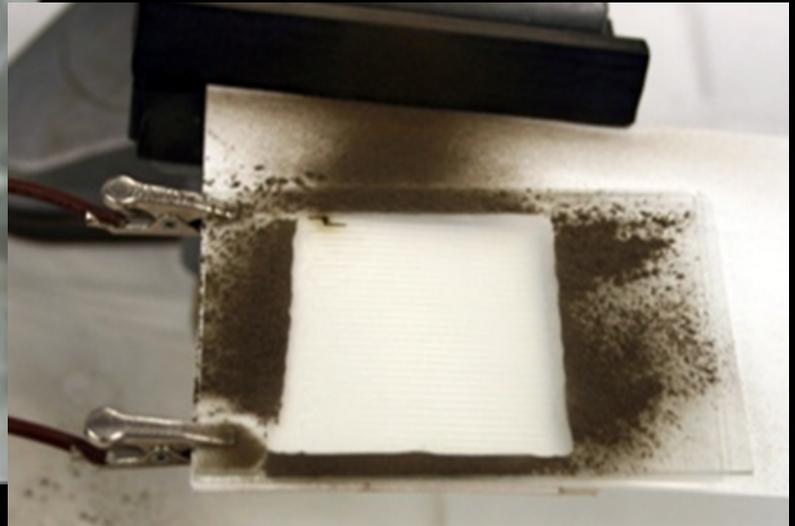
INNOVATIVE

Do

Something

BOLD

Electrodynamic Dust Shield technology



EDS Repulsion Field Test with JSC-1a



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

at PISCES (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.




PISCES

PACIFIC INTERNATIONAL SPACE CENTER FOR
EXPLORATION SYSTEMS | PISCES.HAWAII.GOV

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

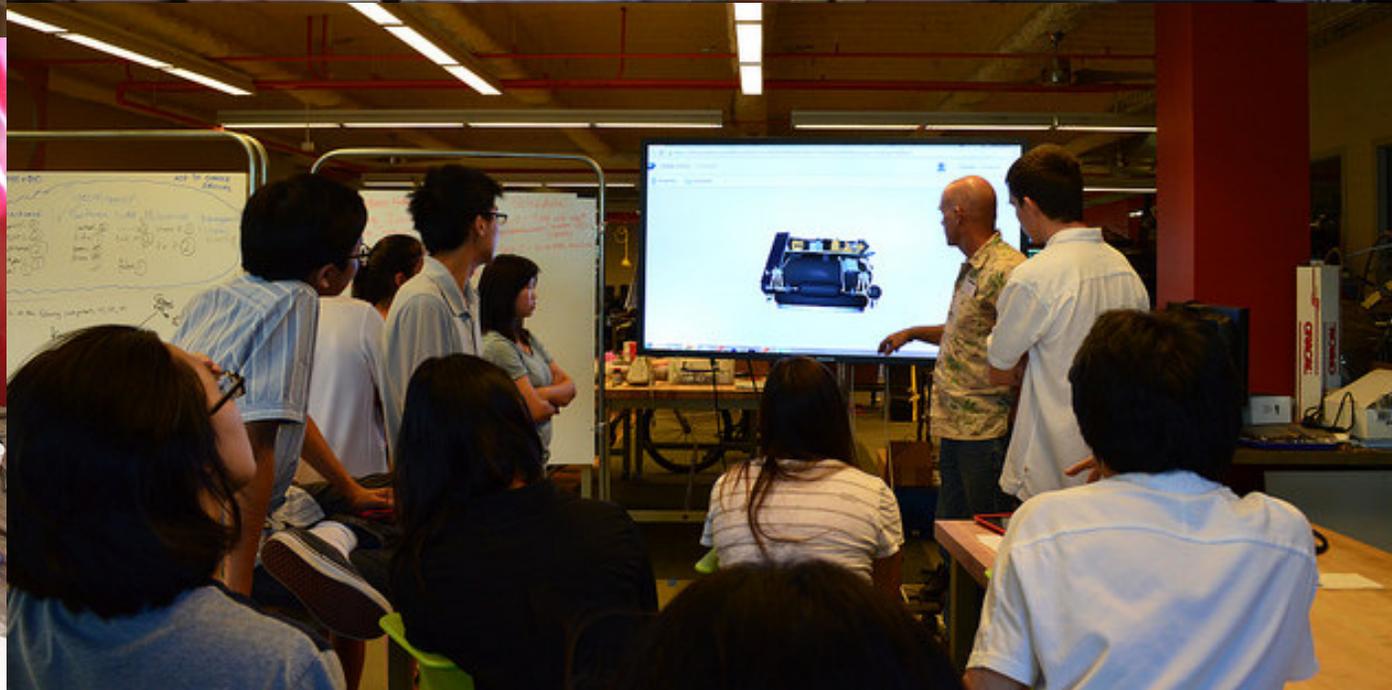
Flexible approach where NASA isn't required to "fund all".

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

(Example is MoonRIDERS-I)

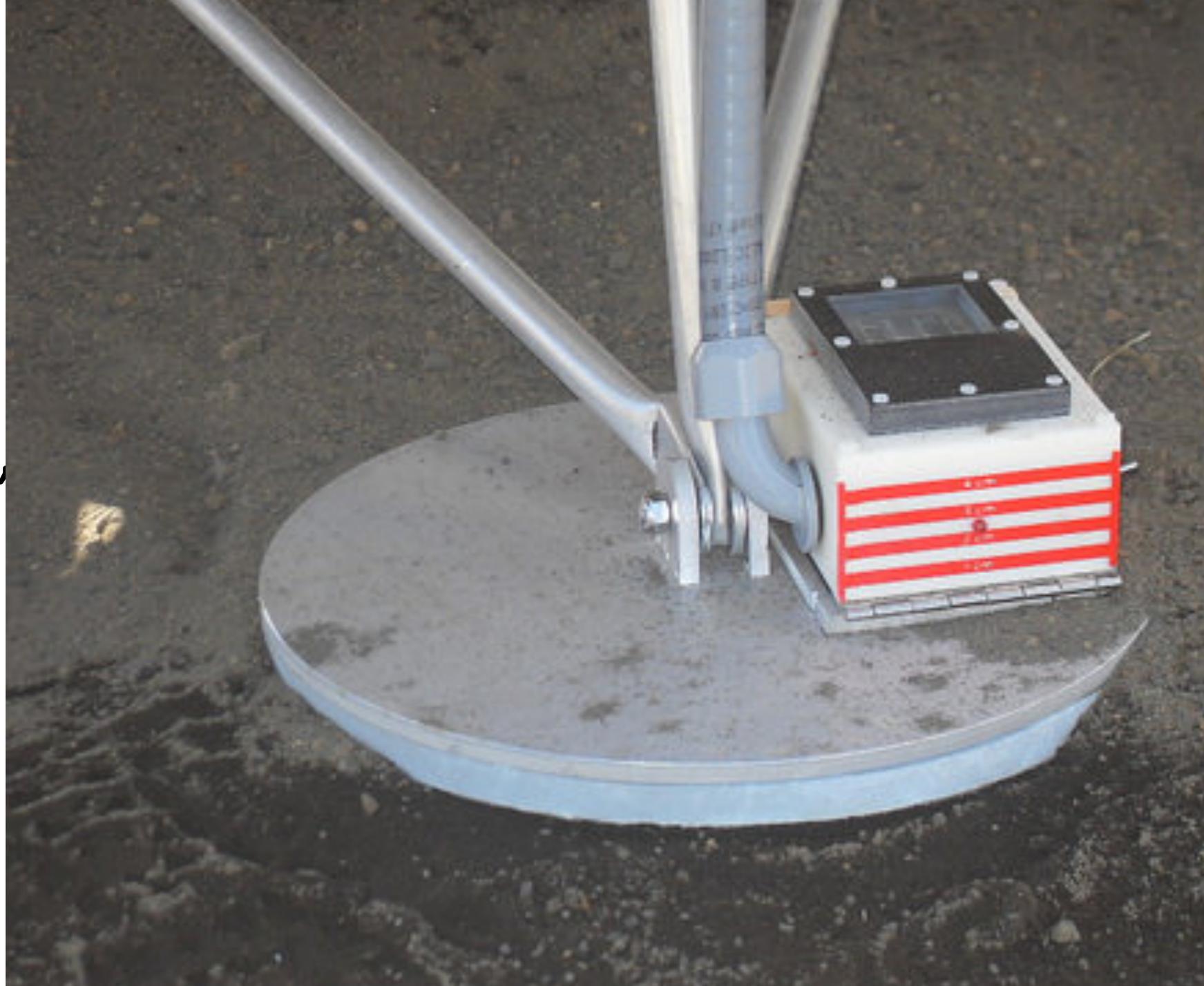
Case 2 - a group needs funding help with DDTE but has a free rider to the surface
(Example of flying on SELENE-RP).

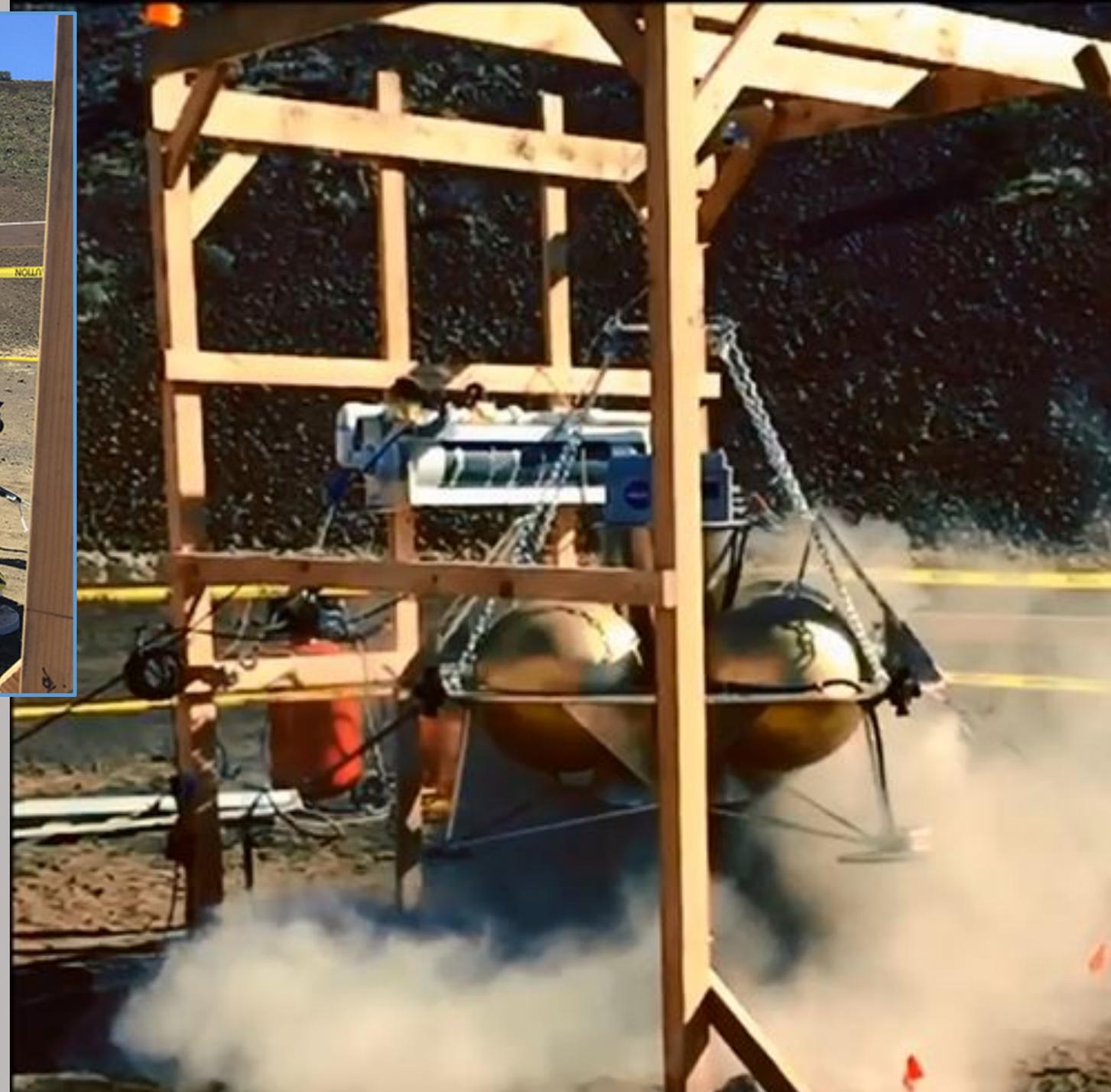




March 2015 Dust Shield Field Tests

- assess locations,
- flight configurations,
- imagery methodology





Test Article in
Gantry

Imagery
data
collection

pre/post
EDS



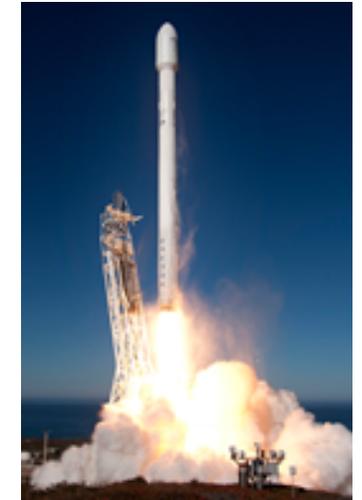
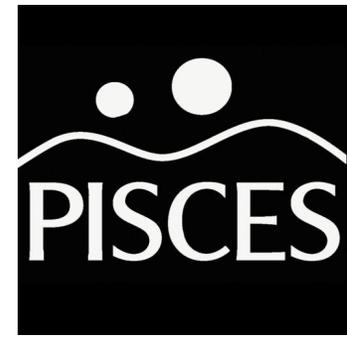
EDS LUNAR LIGHTING TESTS

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**

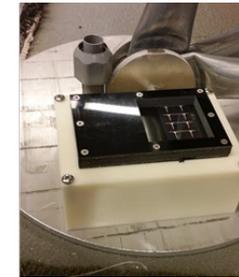
- **November 2015 - RUN IMAGING TESTS AT SCHOOLS**
- **March 2016 - RECREATE TEST IN VACUUM CHAMBER AT KSC**

MoonRIDERS Development, Test and Launch Integration Schedule



LAUNCH!
Late 2017

DRAFT

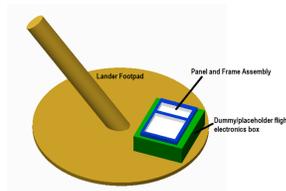


March-June 2017
Integration and test with spacecraft

Feb 2017
Delivery of flight unit

Dec/Jan
Flight Cert

Sept-Nov 2016
Final Assembly & Test



Spring 2016
Engineering Test #2
Image lab testing in vacuum chamber
Students @ KSC



Winter 2015
Payload customer contract for GLXP launch

Finalize design of final flight EDS unit



March 2015
Engineering Field Test #1 at PISCES Test Site



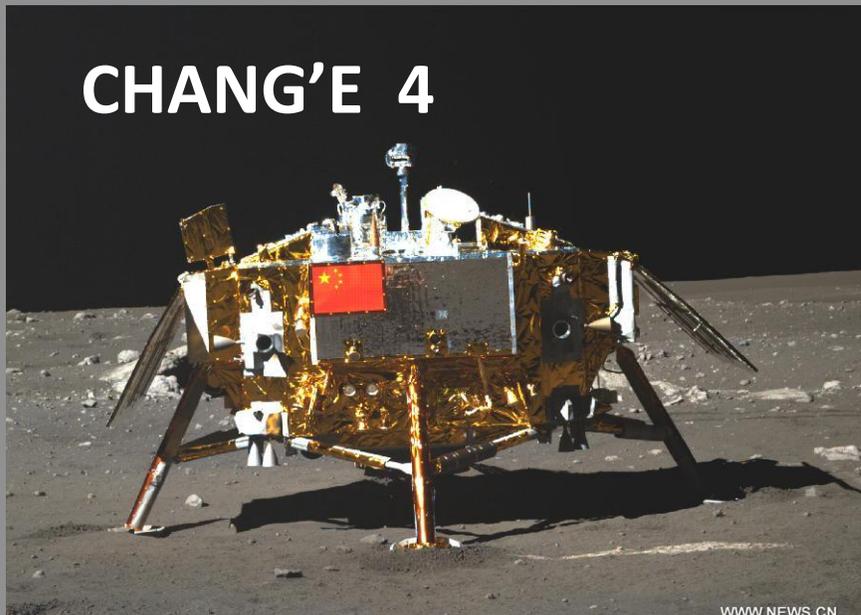
Lunar MoonRIDERS-II



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



WWW.NEWS.CN

SELENE - RP



**“GO FOR
LAUNCH”**

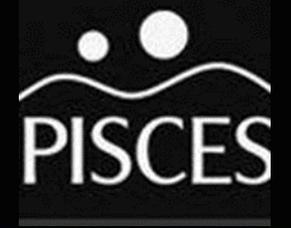


A silhouette of a person wearing a cap and jacket stands on the right, looking at a device. To their left is a piece of equipment on a tripod stand with a red light. The background is a dark sky with a bright orange and yellow horizon line. The word "Questions?" is written in white in the center.

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

Iolani 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



KEALAKEHE HIGH SCHOOL ROBOTICS KAILUA-KONA HI

Tiki Techs 3880

Kulia I Ka Nu'u - Strive To Reach The Sun





DDTE Schedule for LFE/Moon RIDERS

DRAFT

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



Design/configure student ops control center

Payload contract with GLXP provider

IHS / KHS

- Post-test analysis
- Report/Briefing

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



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

Finalize design of flight EDS unit

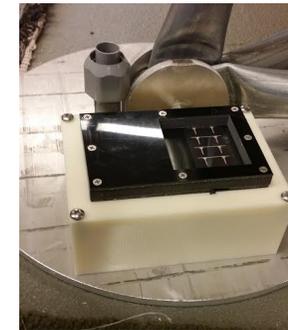


LFE EDS Test #2
Flight verification test
EDS Demo Unit
Oct. '15

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



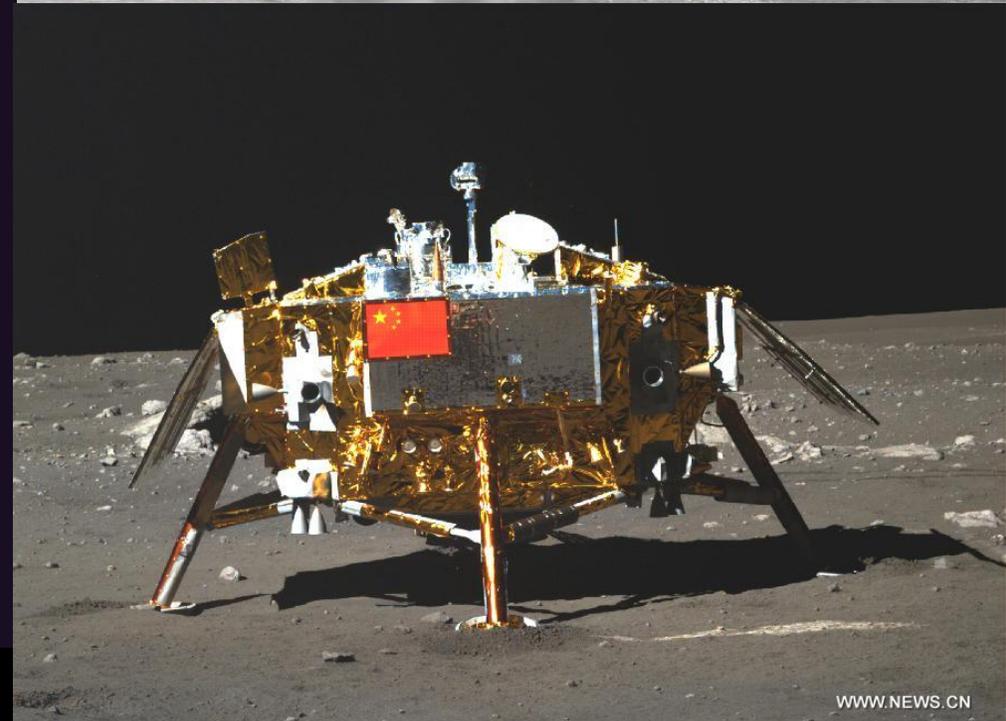
Launch / Lunar Landing

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

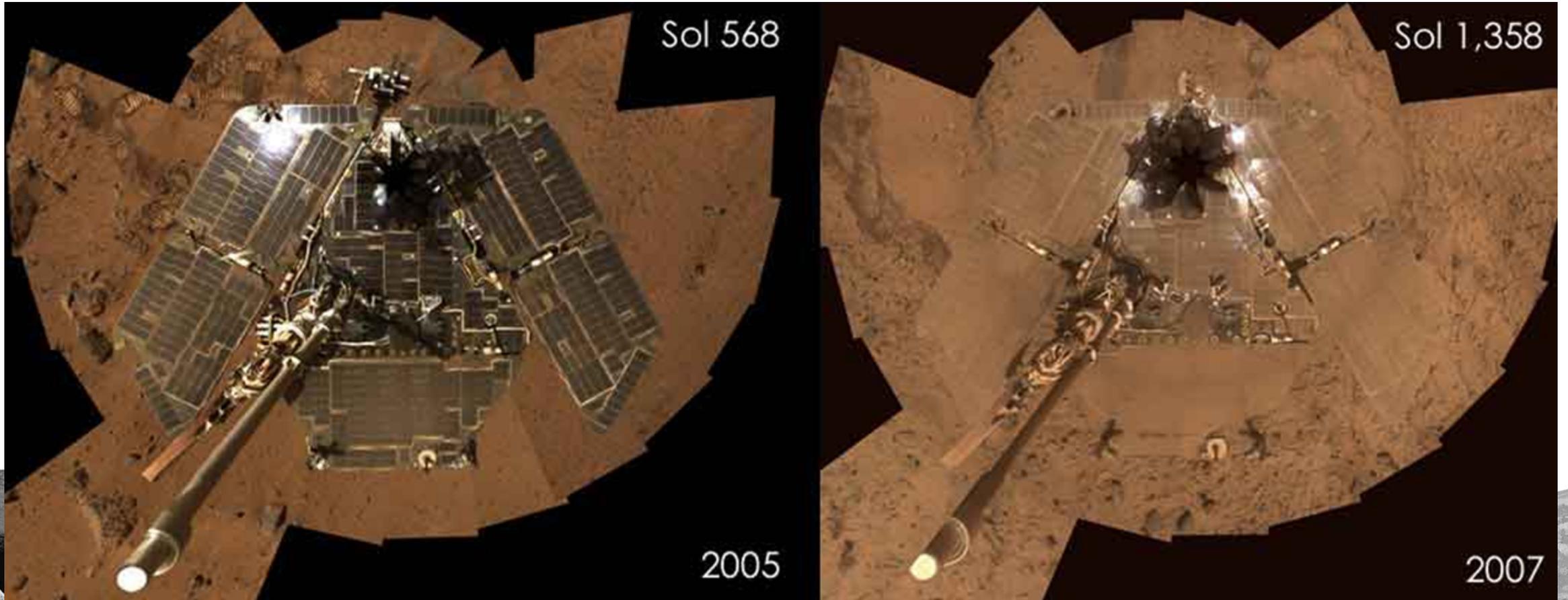
UPDATE

- 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

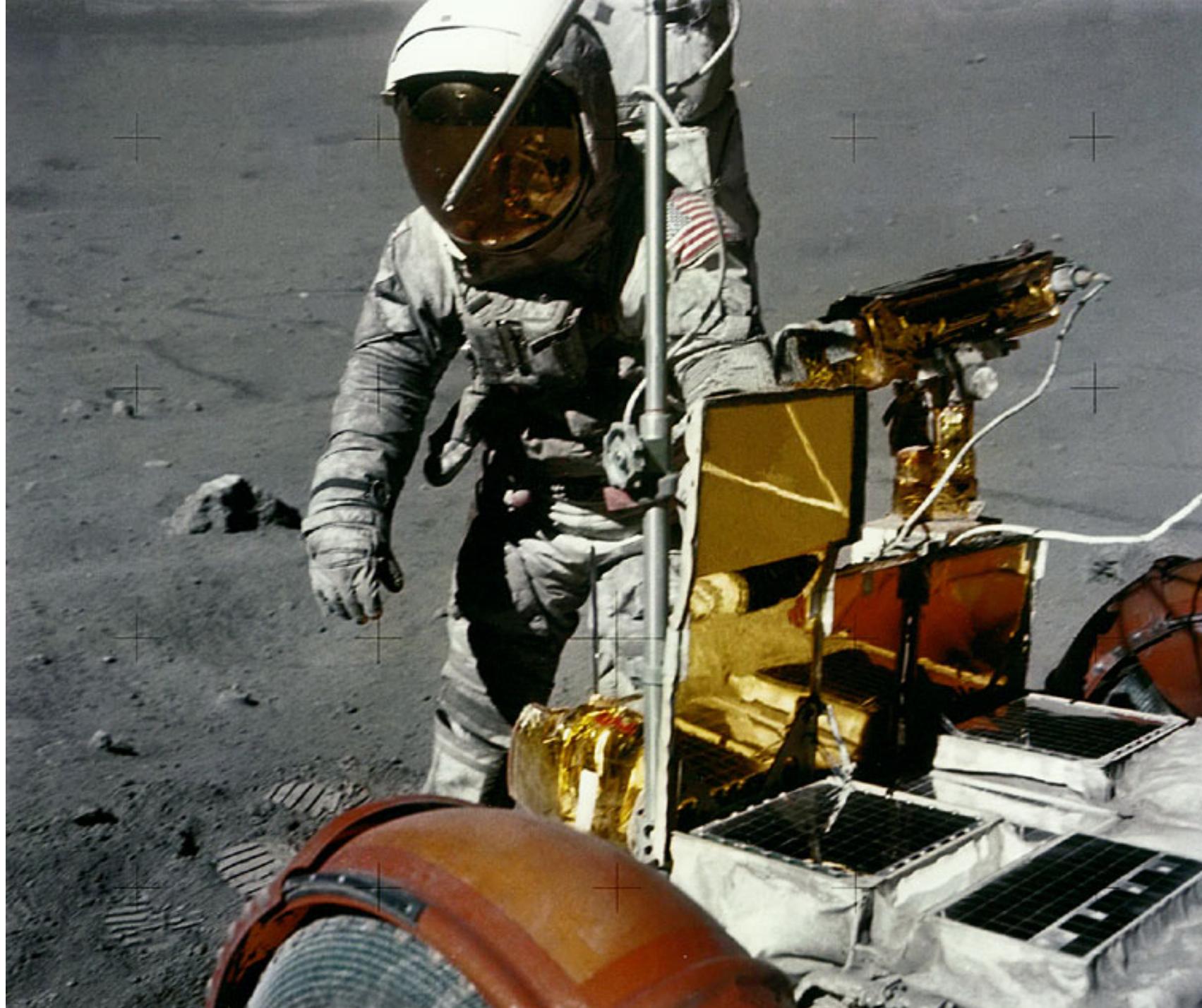
At the conclusion of Apollo 17's mission in December 1972, moonwalking suits and space helmets are covered by lunar dust



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.

