ISECG Lunar Polar Volatiles Virtual Workshop #4

JAXA's Study on Sample Acquisition

Experimental Study of Lunar Drilling and Particle Transport Systems

Sachiko WAKABAYASHI, Takeshi HOSHINO

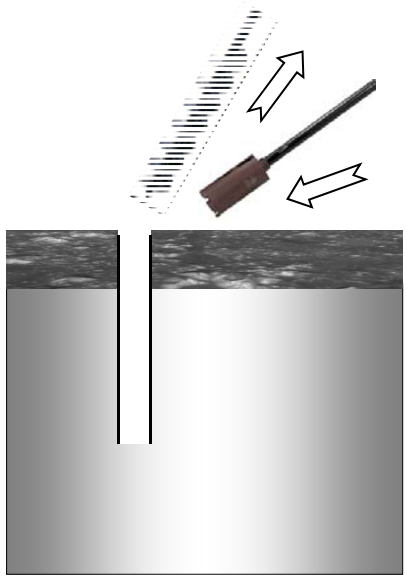
Japan Aerospace Exploration Agency (JAXA)

2016.9.14

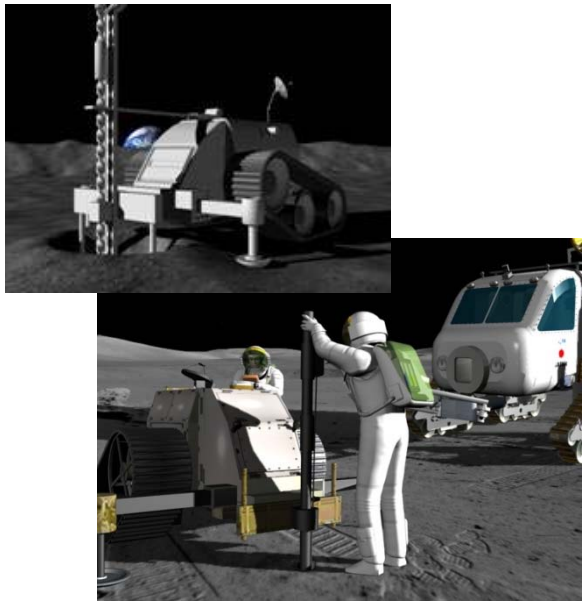
Experimental Study of Lunar Drilling for Sample Acquisition and Lunar Soil Mechanics Investigation

Near-term Target Applications and Drilling Requirements

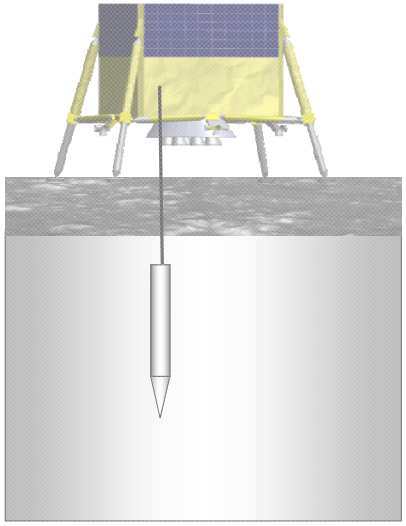
- Soil Mechanics investigation
  - about 1 m



- Sample acquisition
  - Less than 1 m



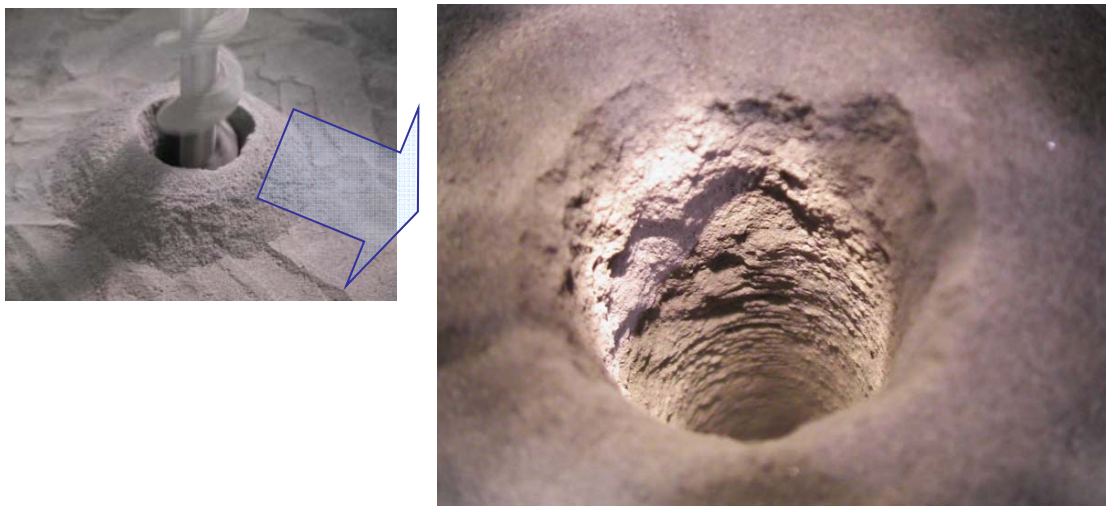
- Sensor Installation
  - One to several meters



One-meter drilling for dual purposes;
soil mechanics investigation and sample acquisition.

Measurement of Soil Parameters

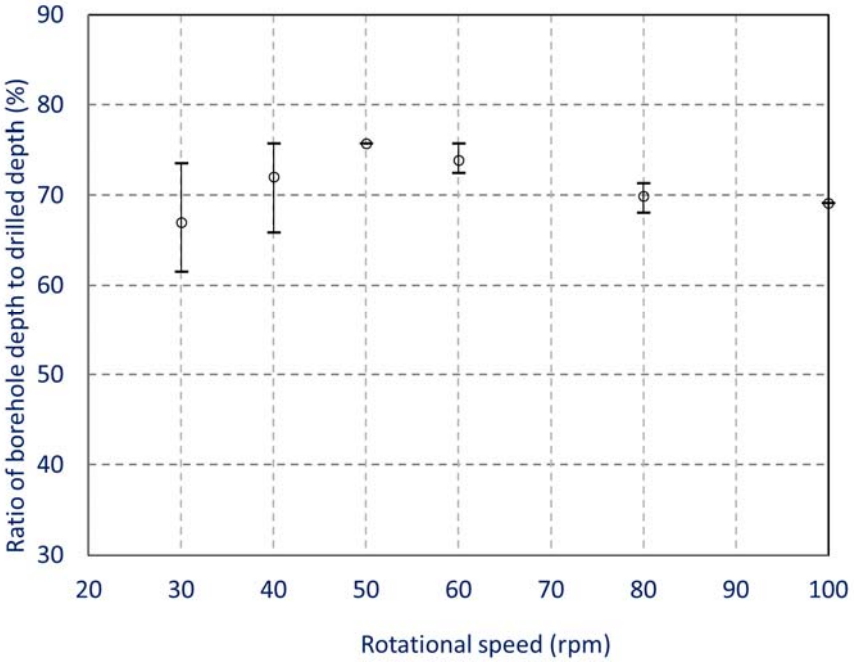
- Indirect measurement: reverse-estimation of soil parameters using a screw auger's force and torque information
- Direct measurement: measurement of soil deformation or strength characteristics using a shear testing tool, inserted into the borehole left after drilling.



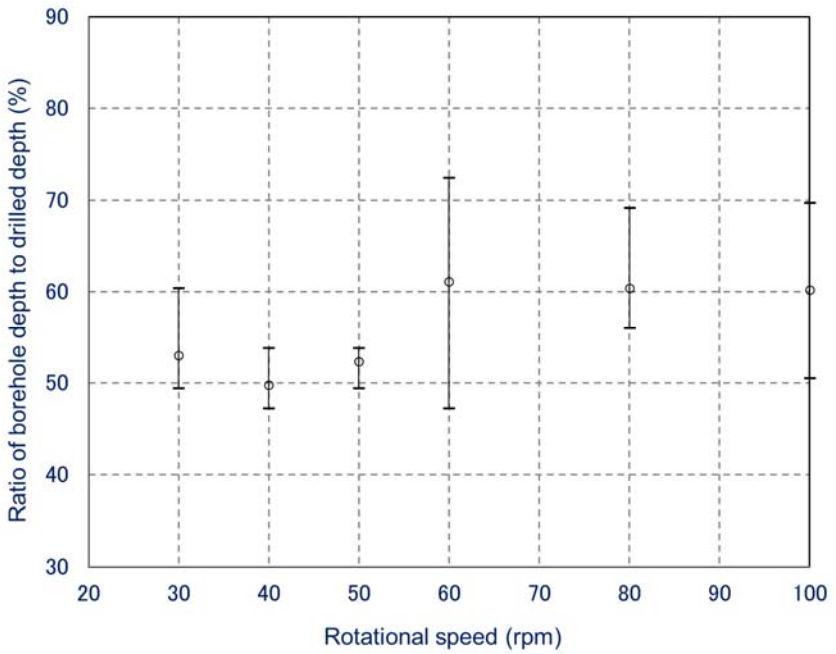
1-m borehole for direct measurement

Simple drilling leaves a self-supporting borehole due to the effect of compaction.

Borehole Stability Experiment



In the air



In the vacuum

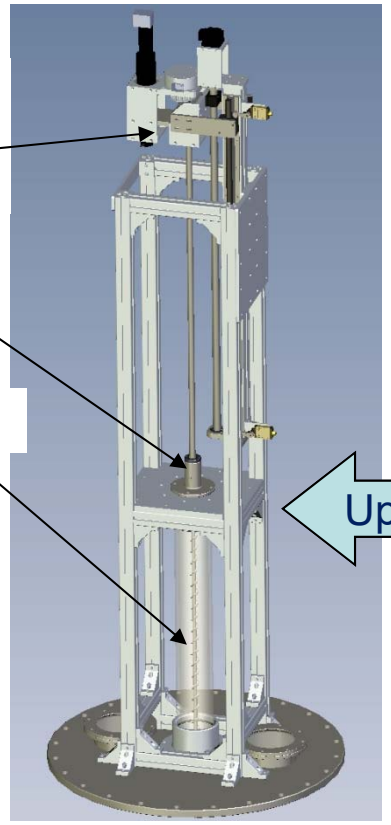
50 to 60 % of the drilled depth is left as a borehole in the vacuum. The ratio is lower than that in the air.

Experimental Facility Simulating Lunar Environment

Driving and measurement part

Feed-through assembly

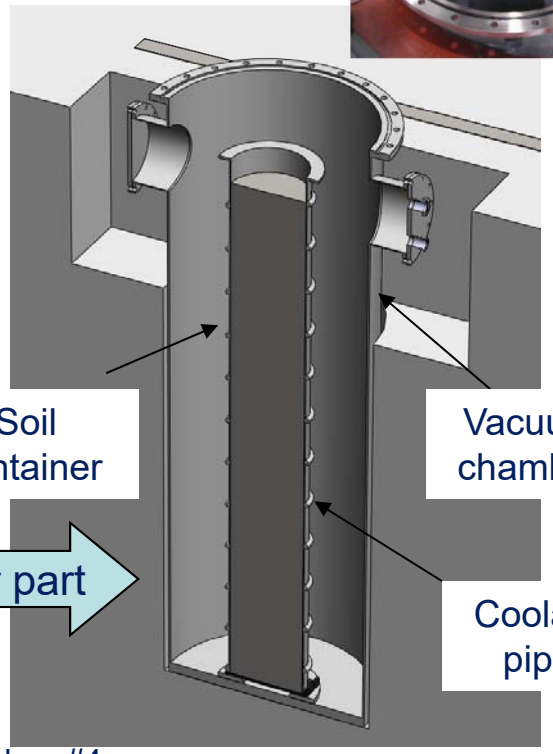
Standard auger

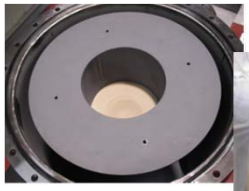


Upper part

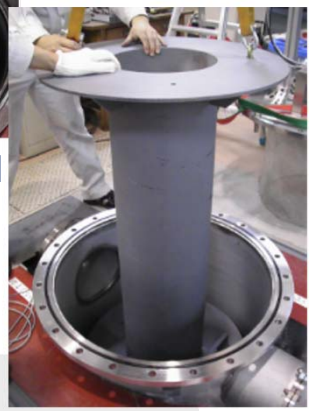
1m-drilling configuration

Lower part



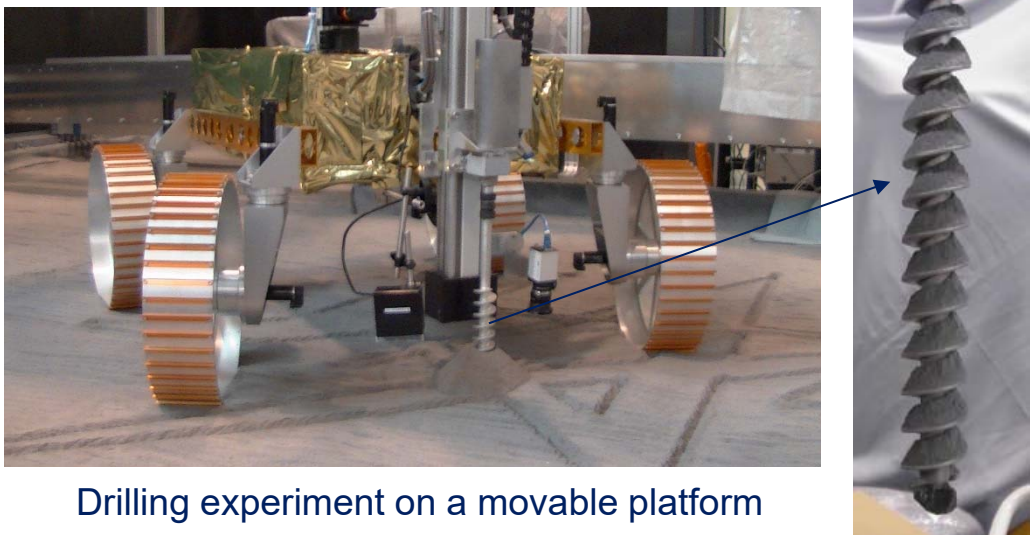


Placing a soil container in the vacuum chamber

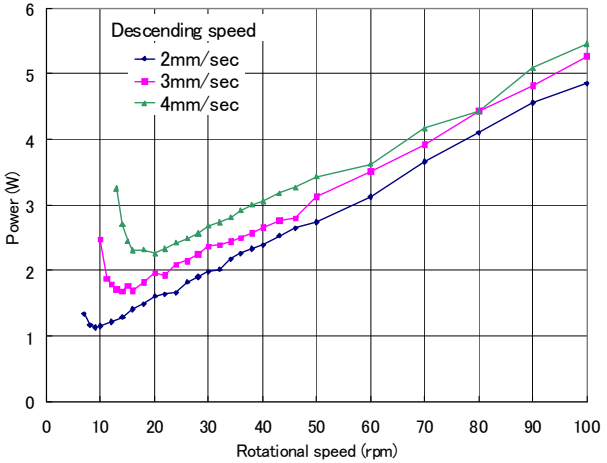


Sample Acquisition and Transfer using auger

- Excavating and transferring the subsurface sample to analyzing device
- Estimating required drilling power to estimate the heat generation which may affect the sample.
- Conducting reverse-estimation of soil parameters at the same time



Drilling experiment on a movable platform

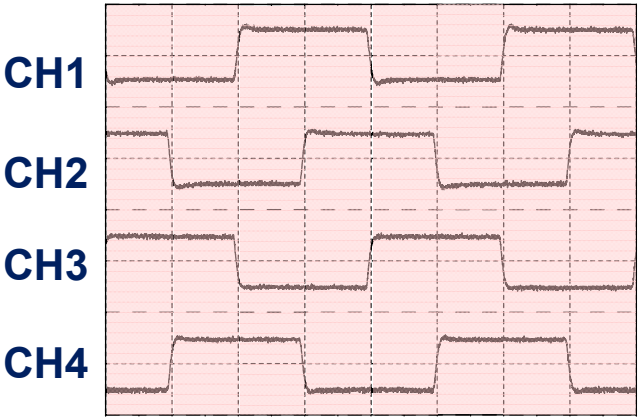


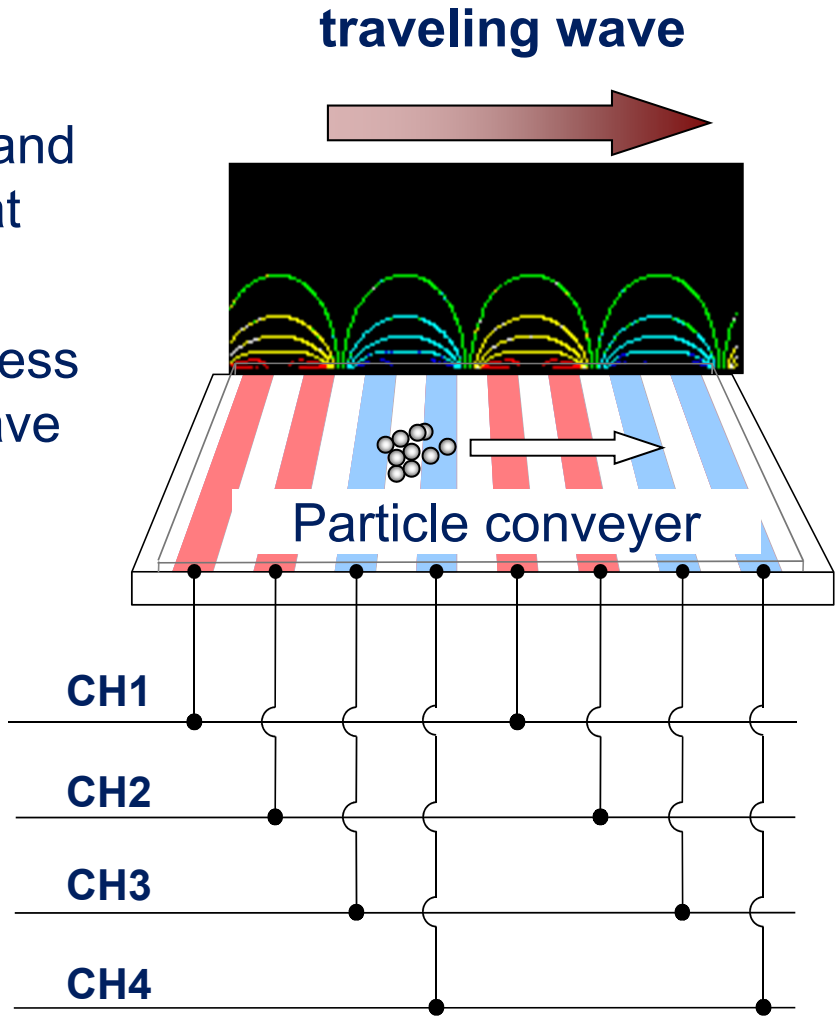
Relations of required power and rotational speed

Electrostatic Transport and Particle-Size Classification of Lunar Regolith

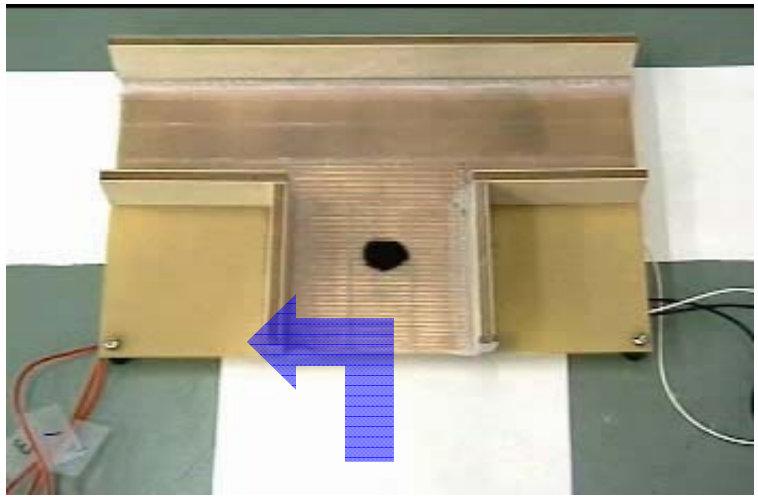
Electrostatic Transport and Particle-Size Classification of Lunar Regolith

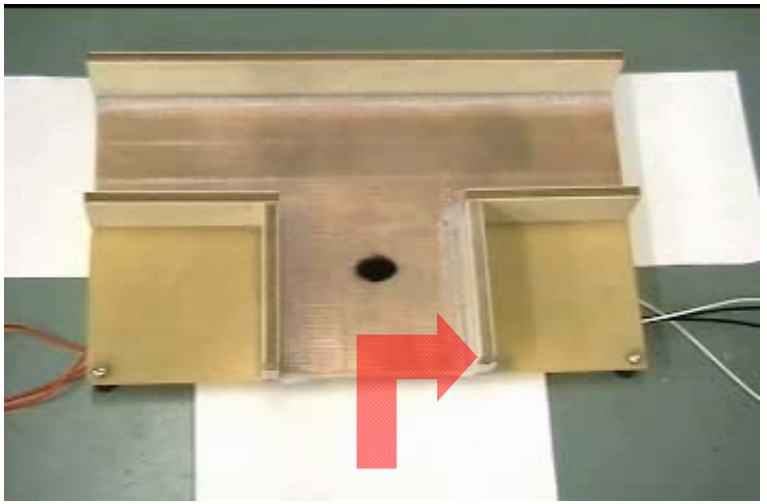
- Waseda univ. and JAXA have jointly studied on particle transport systems and particle-size classification systems that use electrostatic force
- These systems are simple, consume less power compared to other methods, have no mechanical moving parts, and is therefore highly reliable.



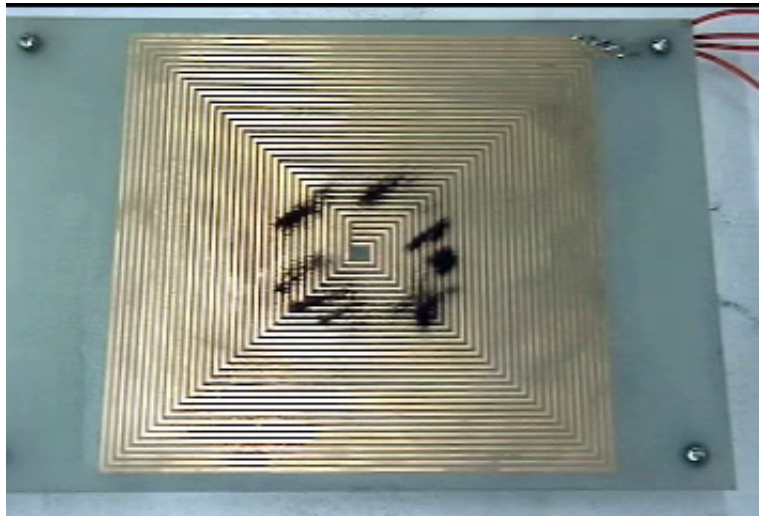


Example of Electrostatic Particle Transport

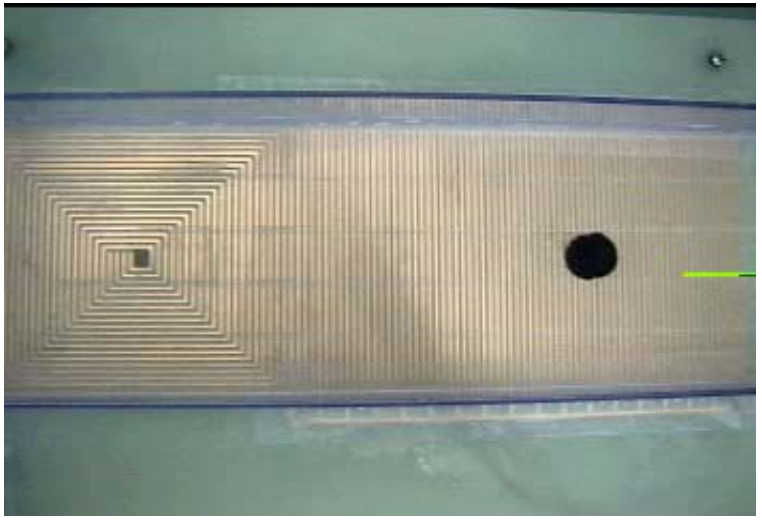




Curved Transport



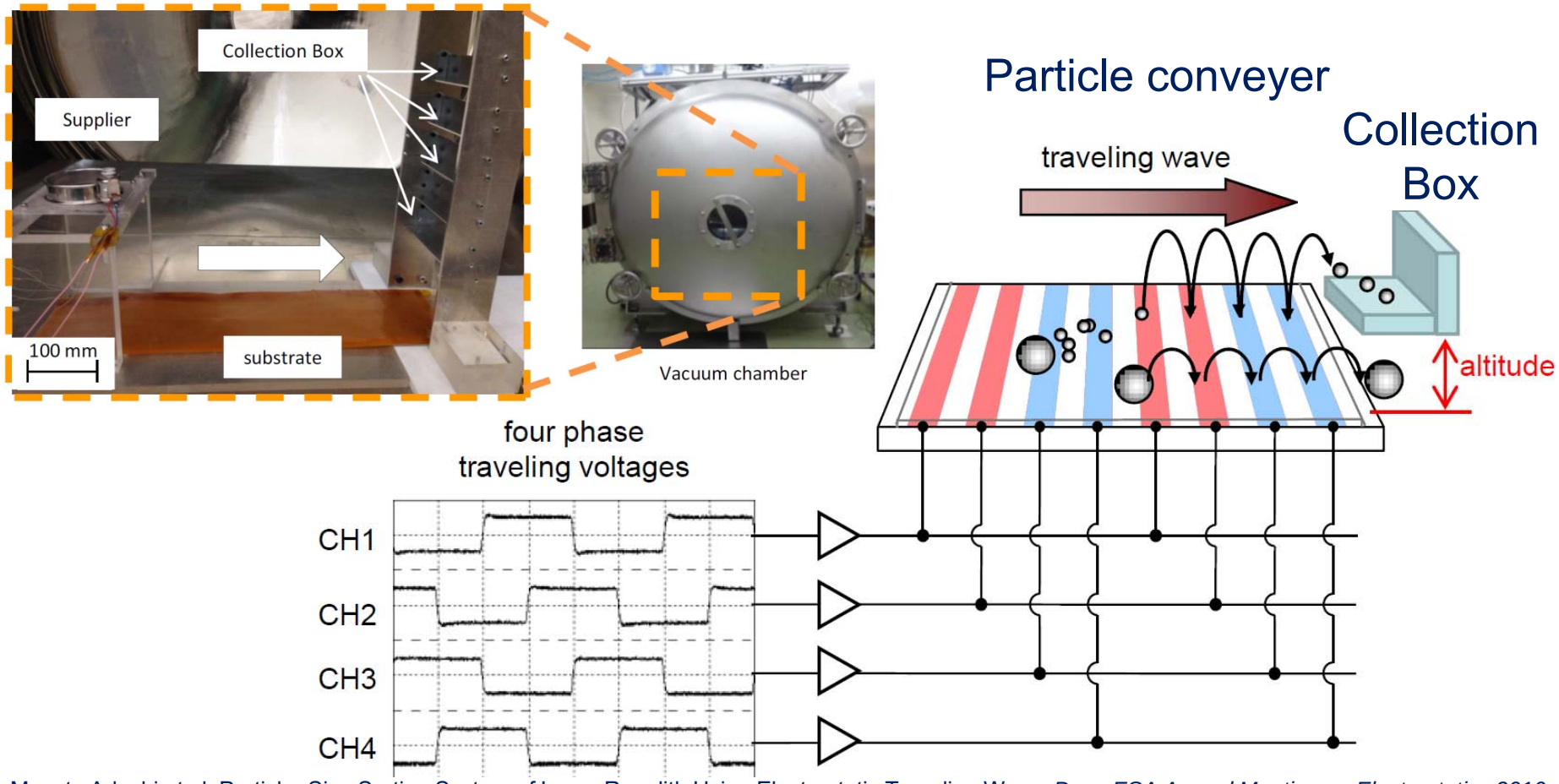
Gather



Transport and Gather

Particle-size classification systems

- We have also developed a particle-size sorting system of lunar regolith using an electrostatic force to extract resources from the regolith.
- To confirm the performance of the electrostatic size sorting system in a vacuum environment, we conducted experiments in a vacuum chamber.



Masato Adachi et al, Particle -Size Sorting System of Lunar Regolith Using Electrostatic Traveling Wave, *Proc. ESA Annual Meeting on Electrostatics 2016*