

LEAG-ICEUM-SRR: October 31, 2008 @Cape Canaveral



Electrostatic Cleaner of Lunar Dust on Solar Panel and Optical Lens



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Outline

We are developing a self-cleaning device of lunar dust on a solar panel and optical lens utilizing electrostatic force.



originally developed for toner transport in laser printer

applied for lunar exploration

low power consumption with compact power supply

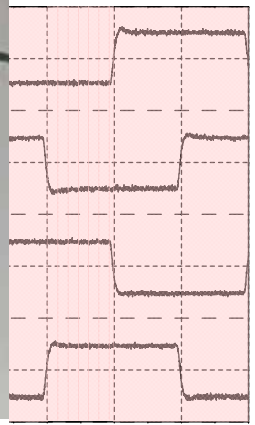
high cleaning performance with transparent ITO electrodes

effect of initial charge

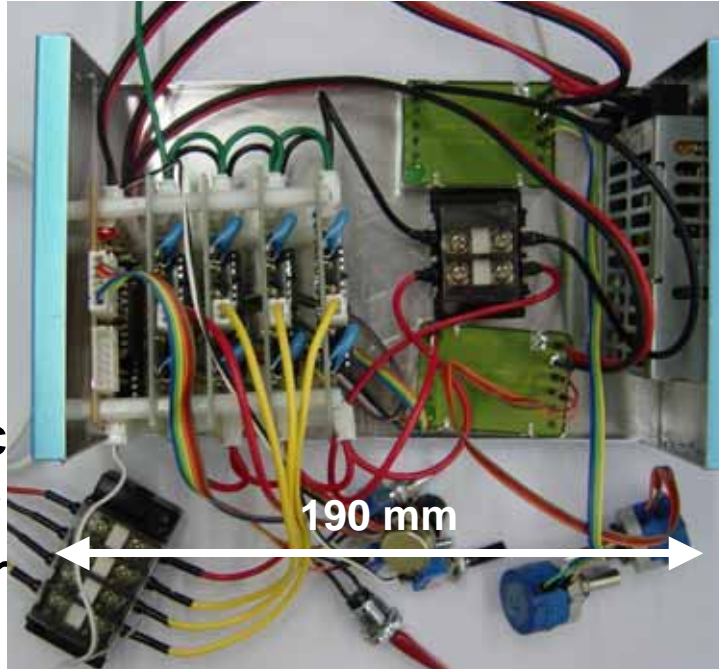
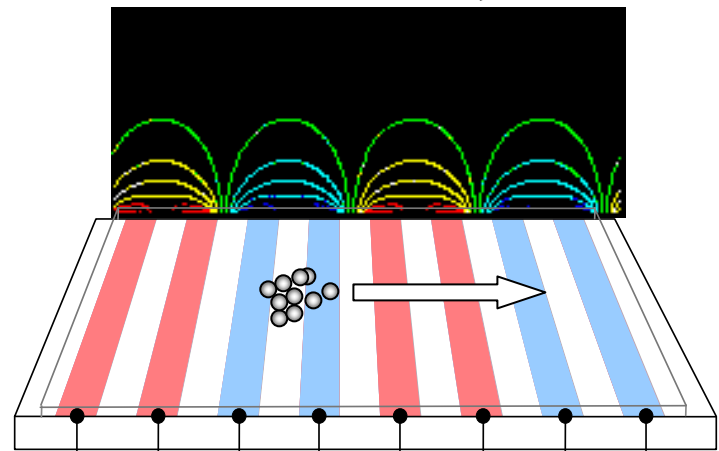
demonstration in lunar environment (vacuum and low gravity)

Electrostatic Dust Cleaner System

traveling wave transport of particles



traveling wave



Switch
power
contr

190 mm

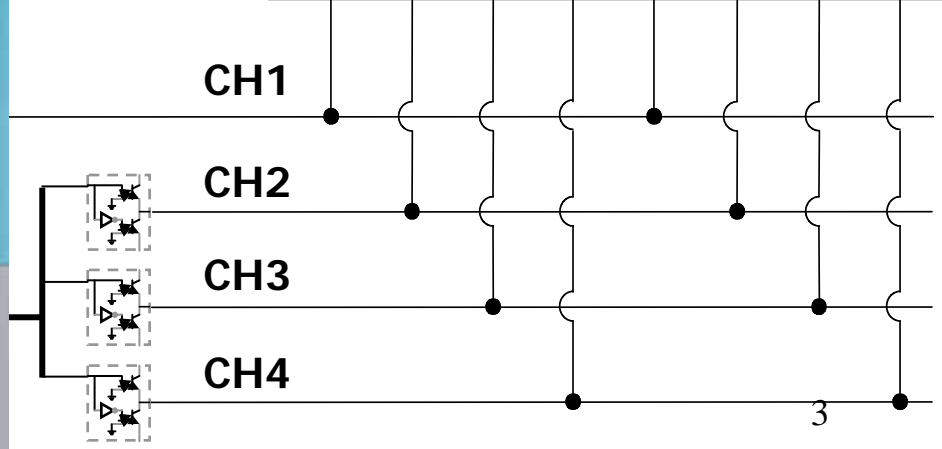
CH1

CH2

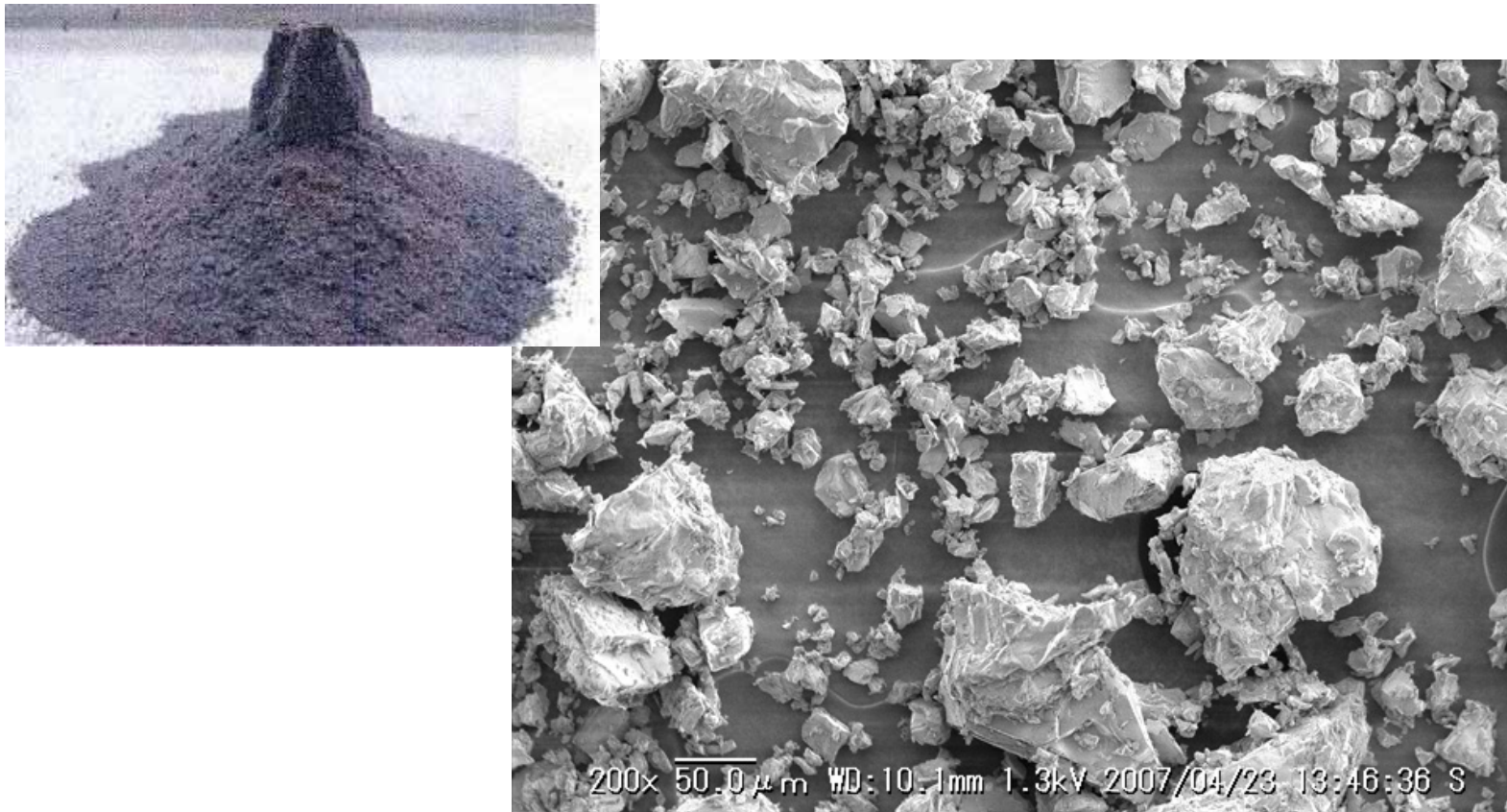
CH3

CH4

3



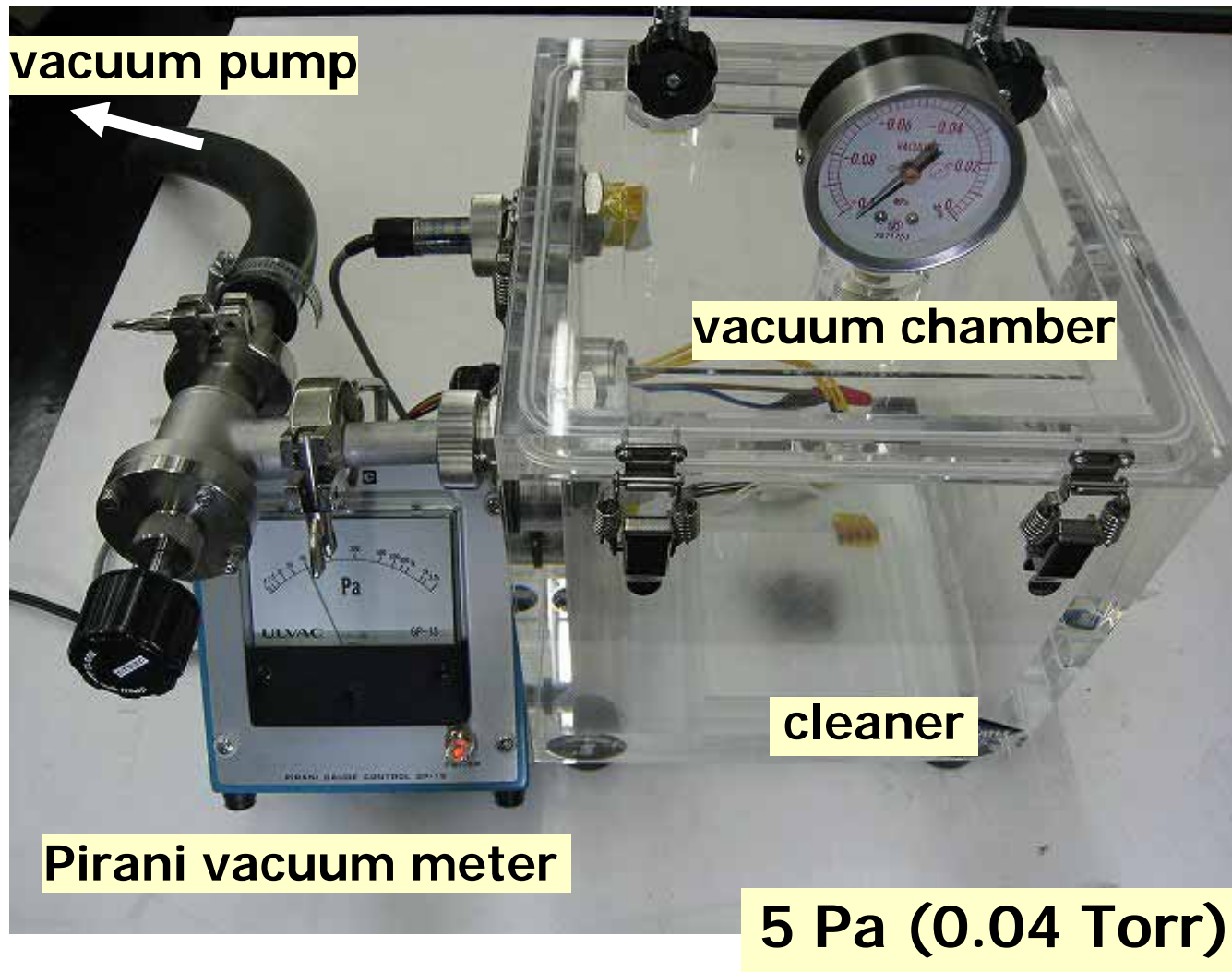
Photograph of Lunar Dust Simulant



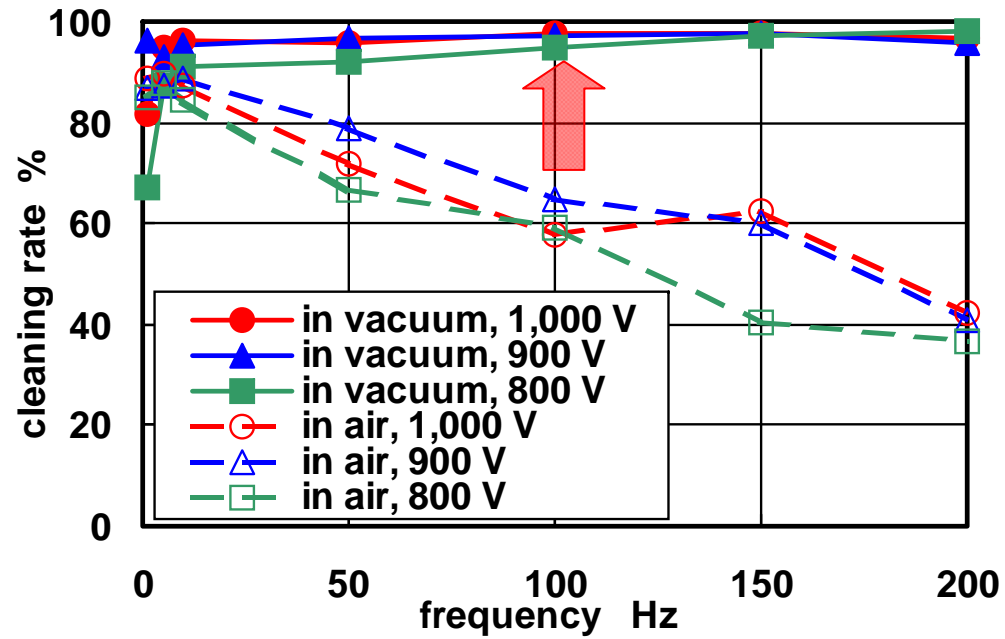
200X

Provided by Shimiz Corp.

Experiment in Vacuum Chamber



Cleaning Rate



in air (100 Hz)



in vacuum (100 Hz)

Numerical Simulation

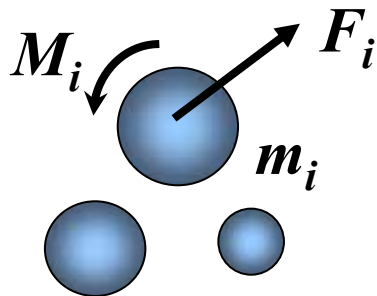
-calculated by Discrete Element Method-

$$m_i \ddot{\mathbf{x}}_i + 6\pi\eta R \dot{\mathbf{x}}_i = \mathbf{F}_{coulomb_i} + \mathbf{F}_{dipole_i} + \mathbf{F}_{mechanical_i} + \mathbf{F}_{adhesion} + m_i \mathbf{g}$$

(Air Drag) (Coulomb) (polarization) (collision) (adhesion) (gravity)

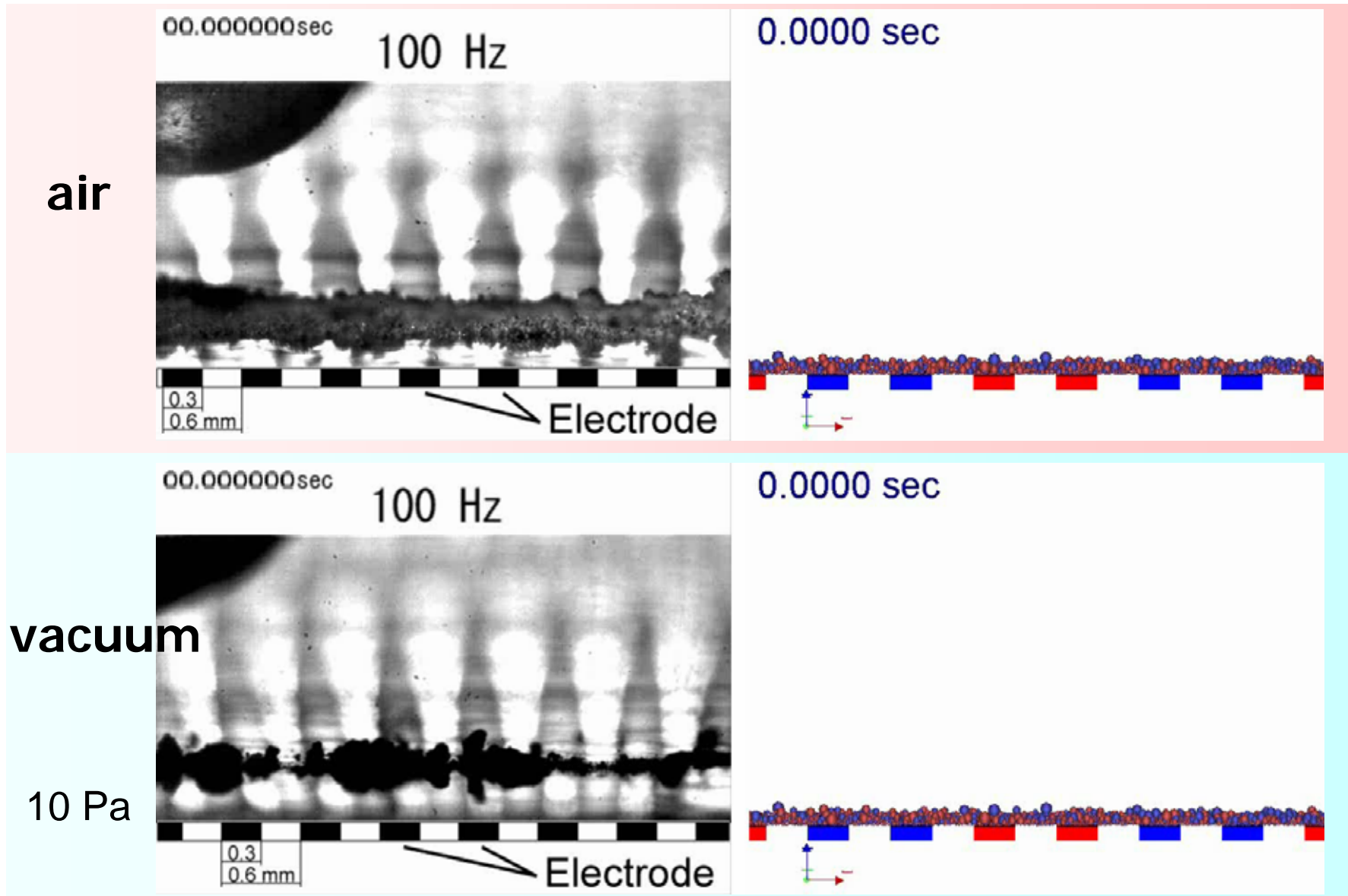
0, in vacuum

$$I_i \ddot{\theta}_i = M_{mechanical_i} + M_{friction_i}$$

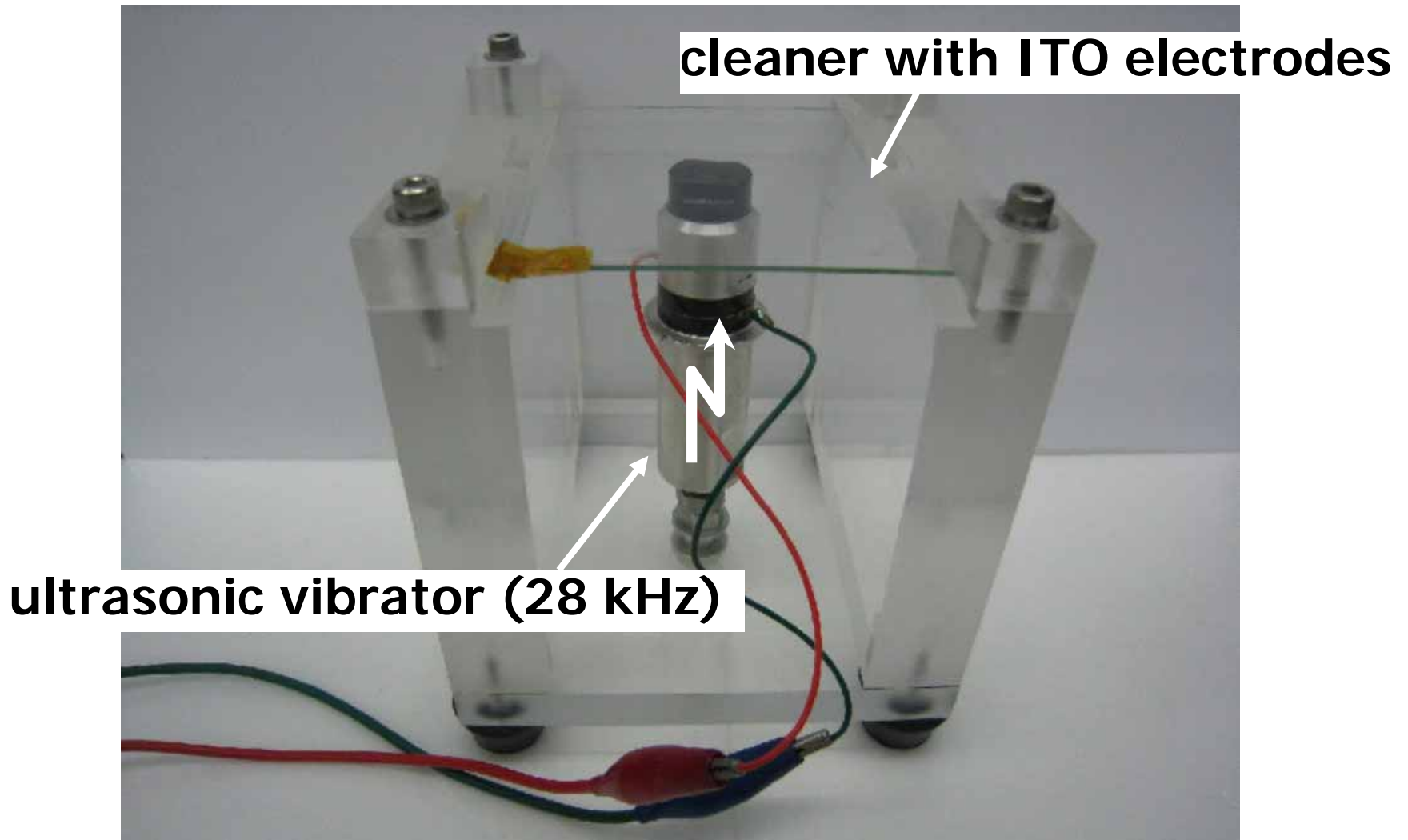


($i = 1, \dots, N$ N : number of particles)

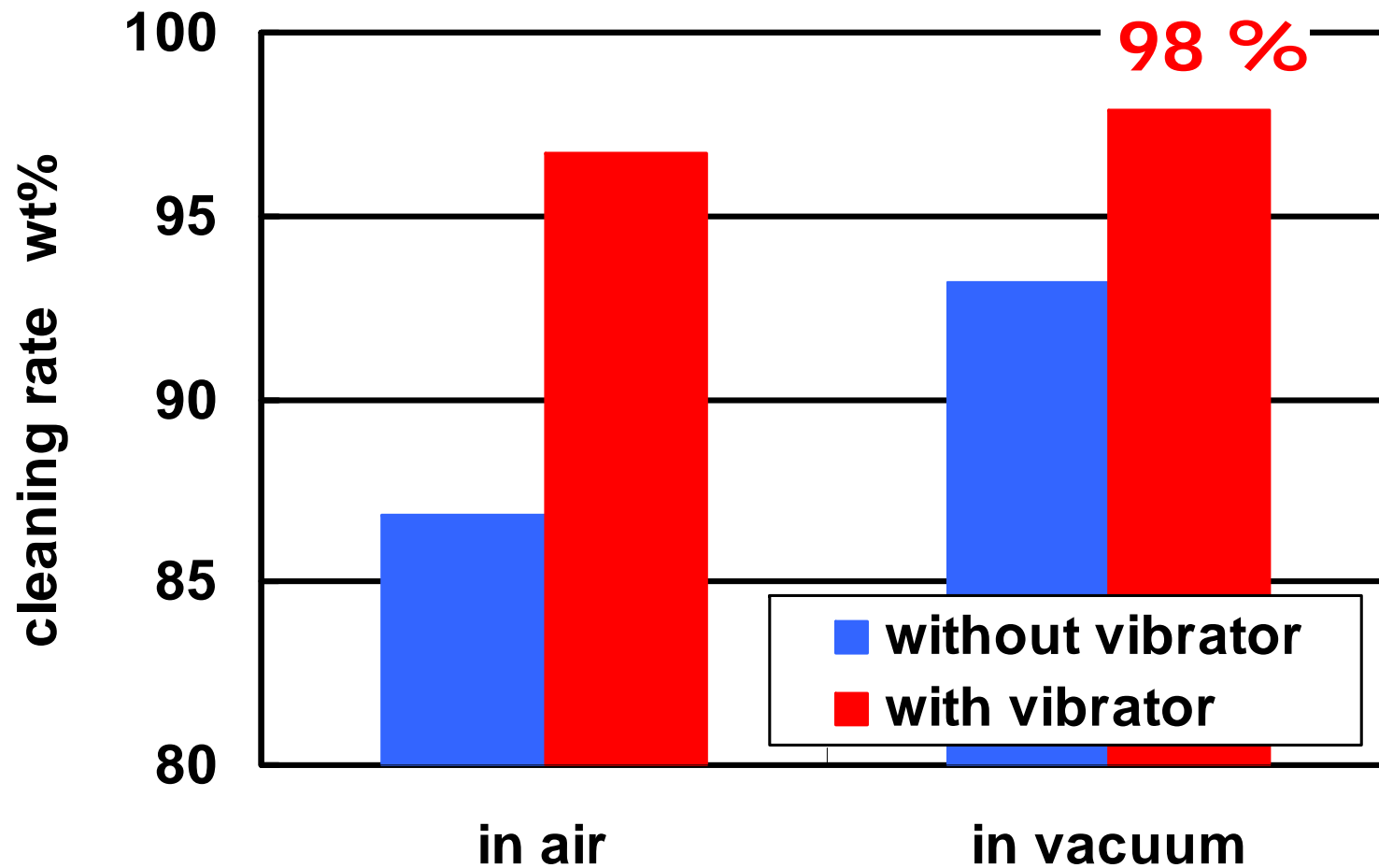
Transport of Particles in Air and Vacuum



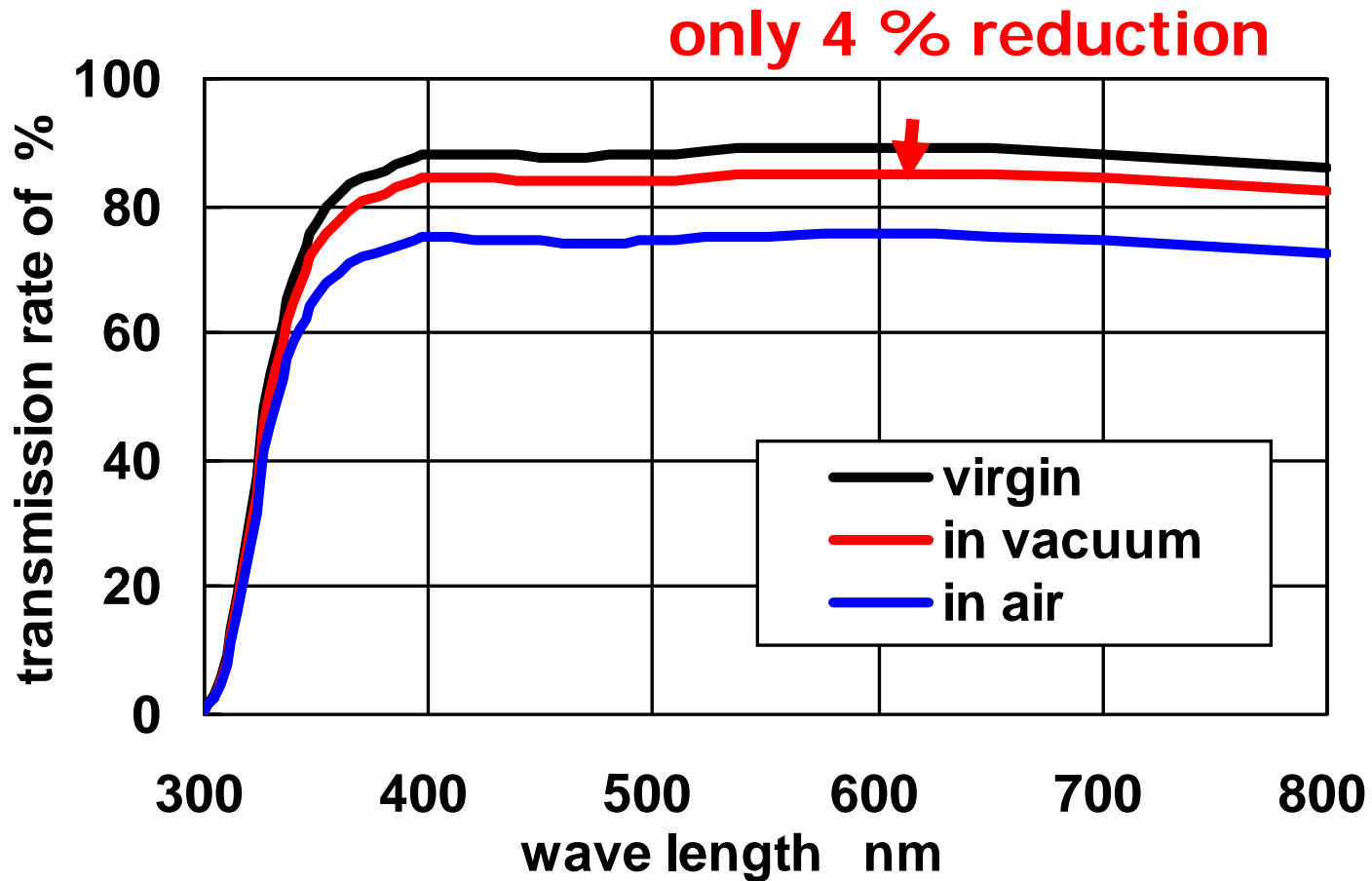
Cleaning Assisted by Ultrasonic Vibrator



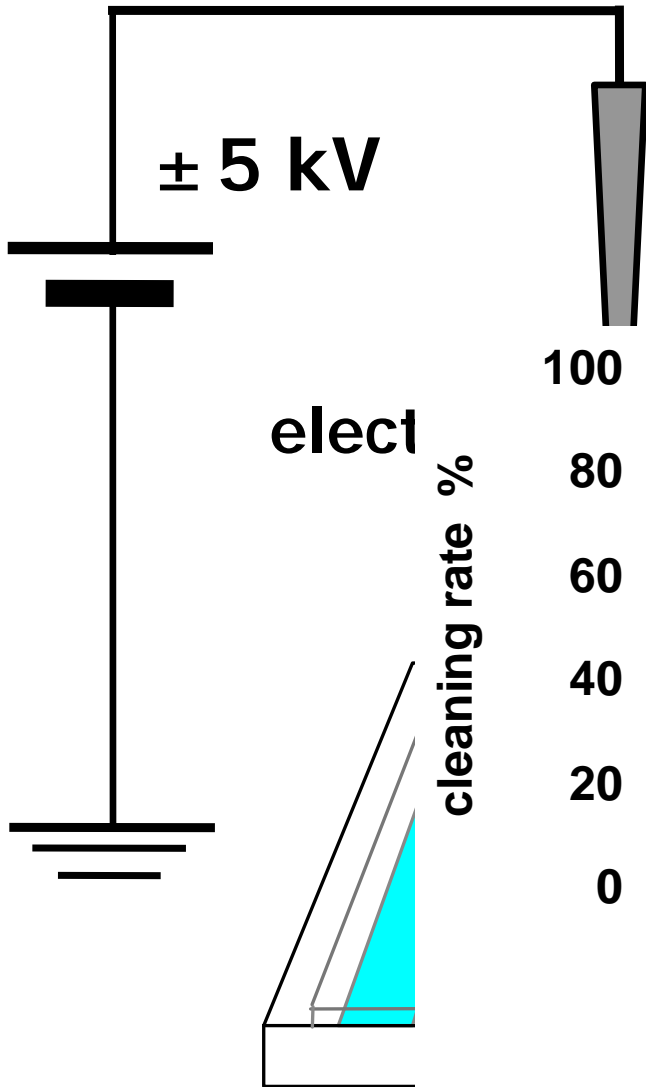
Improved Cleaning Performance with Ultrasonic Vibrator



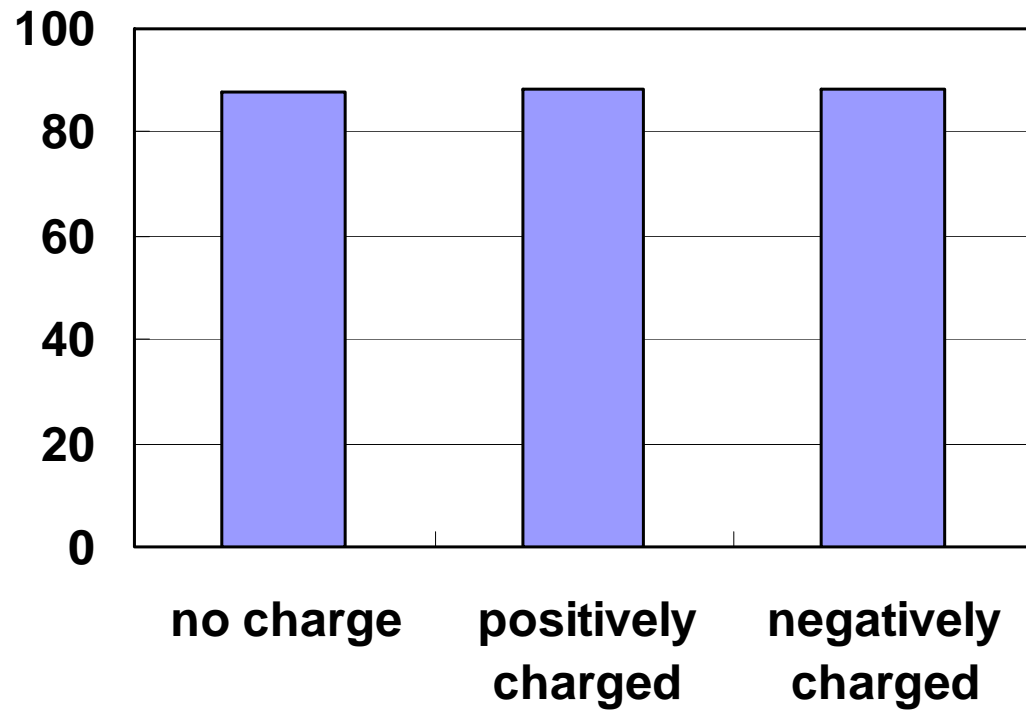
Transmission Rate of Light before/after Operation



Cleaning Performance of Initially Charged Dust



Initially charged dust can be cleaned successfully.



Cleaning Performance on the Moon

0.0000 sec



on the earth

- 700 V 10 Hz
- **1 G**
- **in air**

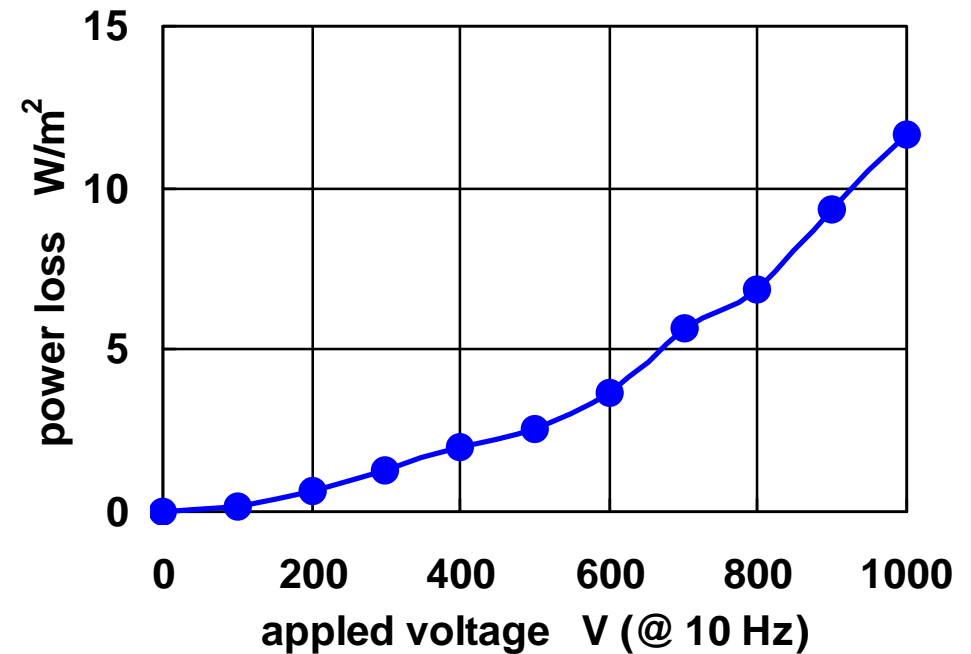
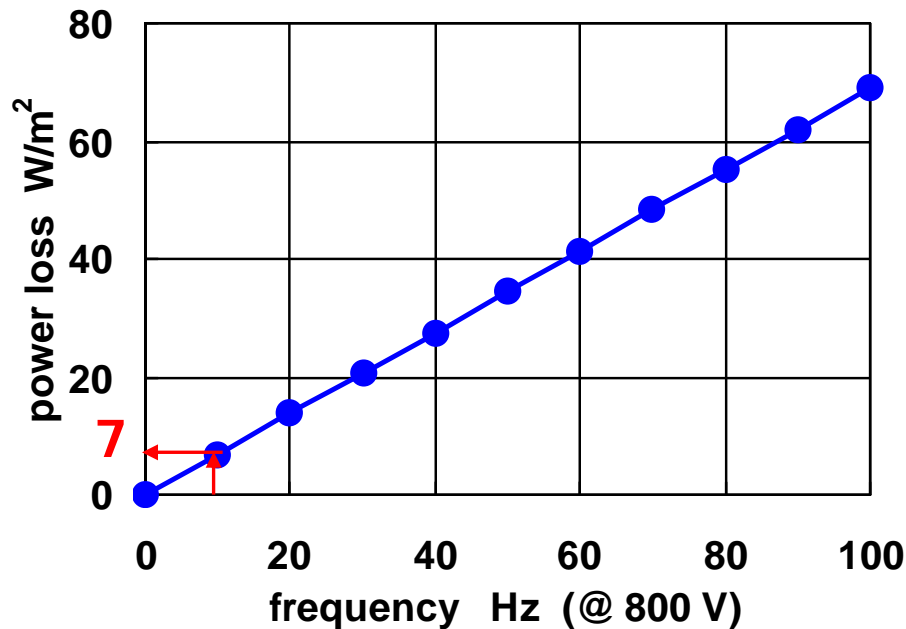
0.0000 sec



on the moon

- 700 V 10 Hz
- **1/6 G**
- **in vacuum**

Power Consumption @ 1 m² cleaner



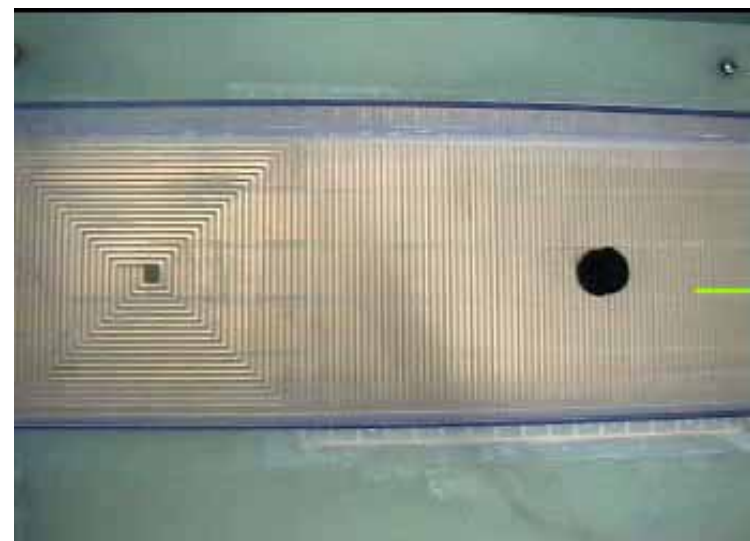
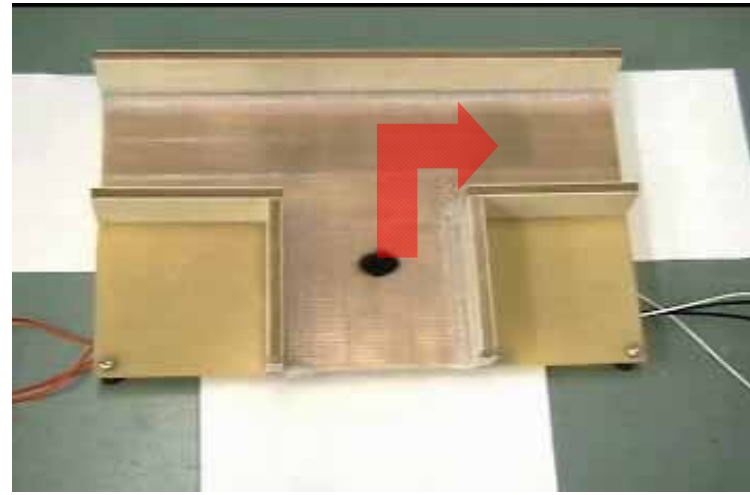
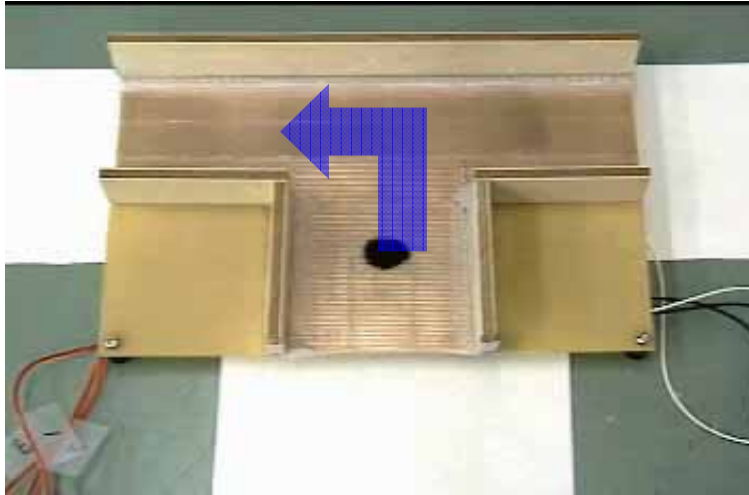
**estimated power consumption:
7 W × 30 sec. = 0.06 Wh for 1 m² cleaner**

Concluding Remarks

Numerical and experimental investigations were carried out on the electrostatic transport of particles to apply for the cleaning of lunar soil and dust.

- ✓ compact & light power supply
- ✓ transparent IOT conveyer
- ✓ demonstration in vacuum
- ✓ high cleaning performance
- ✓ effect of initial charge
- ✓ high transparency
- ✓ performance prediction on the moon
- ✓ low power consumption

Application of Electrostatic Particle Transport for Lunar Resource Utilization



Thank you for your attention.

For more information

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Waseda University

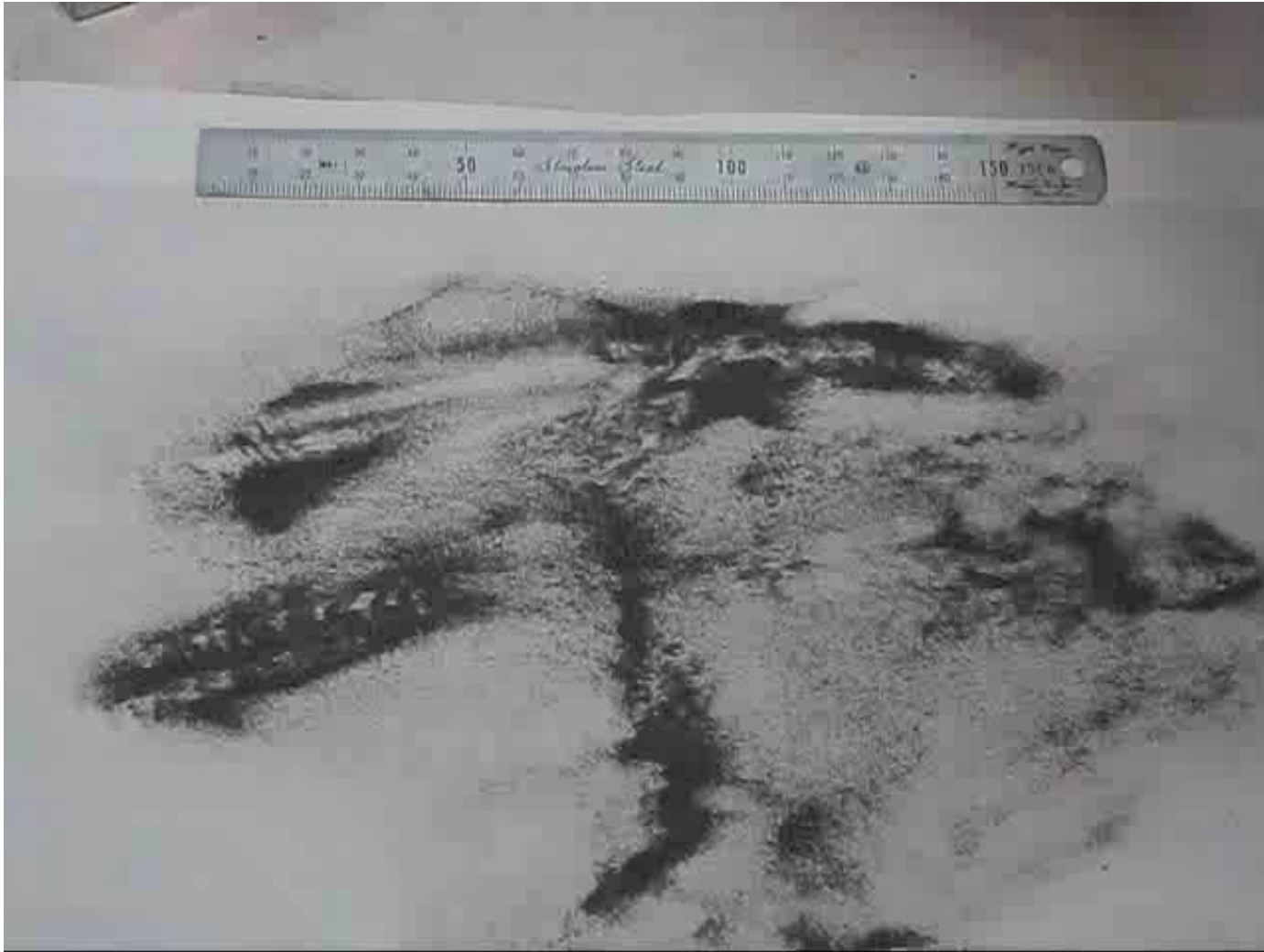
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Electrostatic Cleaner of Lunar Dust Adhered to Spacesuits



We need your support !!

We need **textile of spacesuits** for the demonstration of our cleaner.

Please provide for us.

We will report the results of our investigation.