Planetary Regolith Delivery Systems for In Situ Resource Utilization

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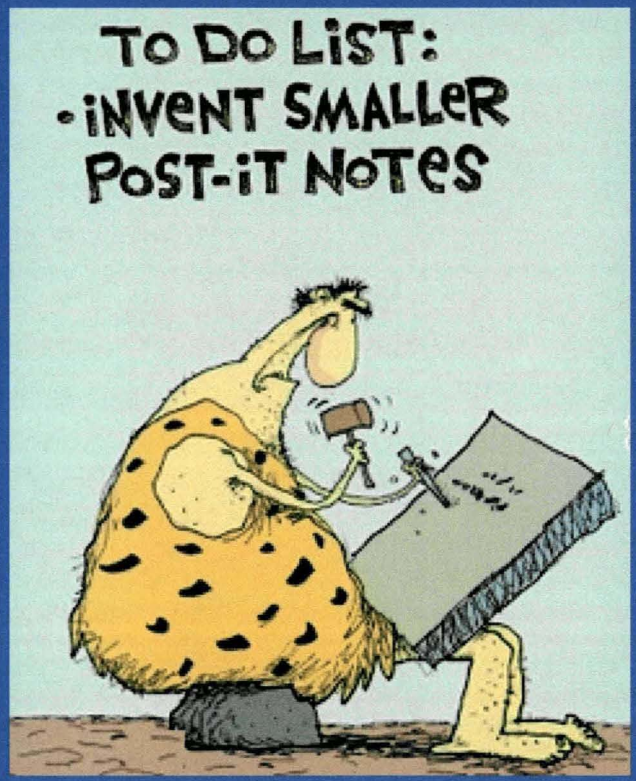
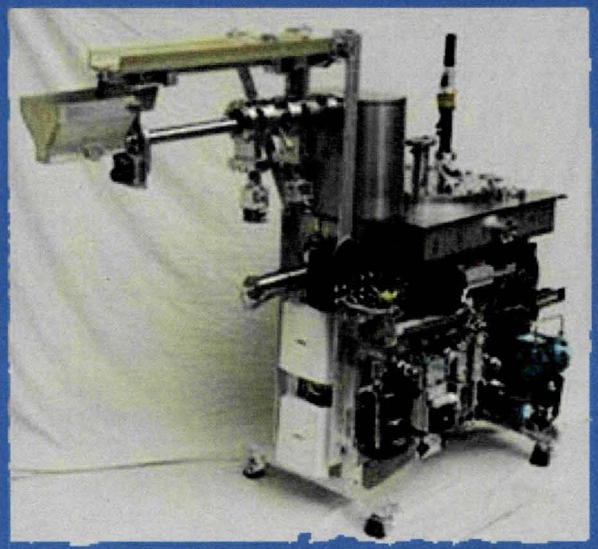
What is In Situ Resource Utilization?



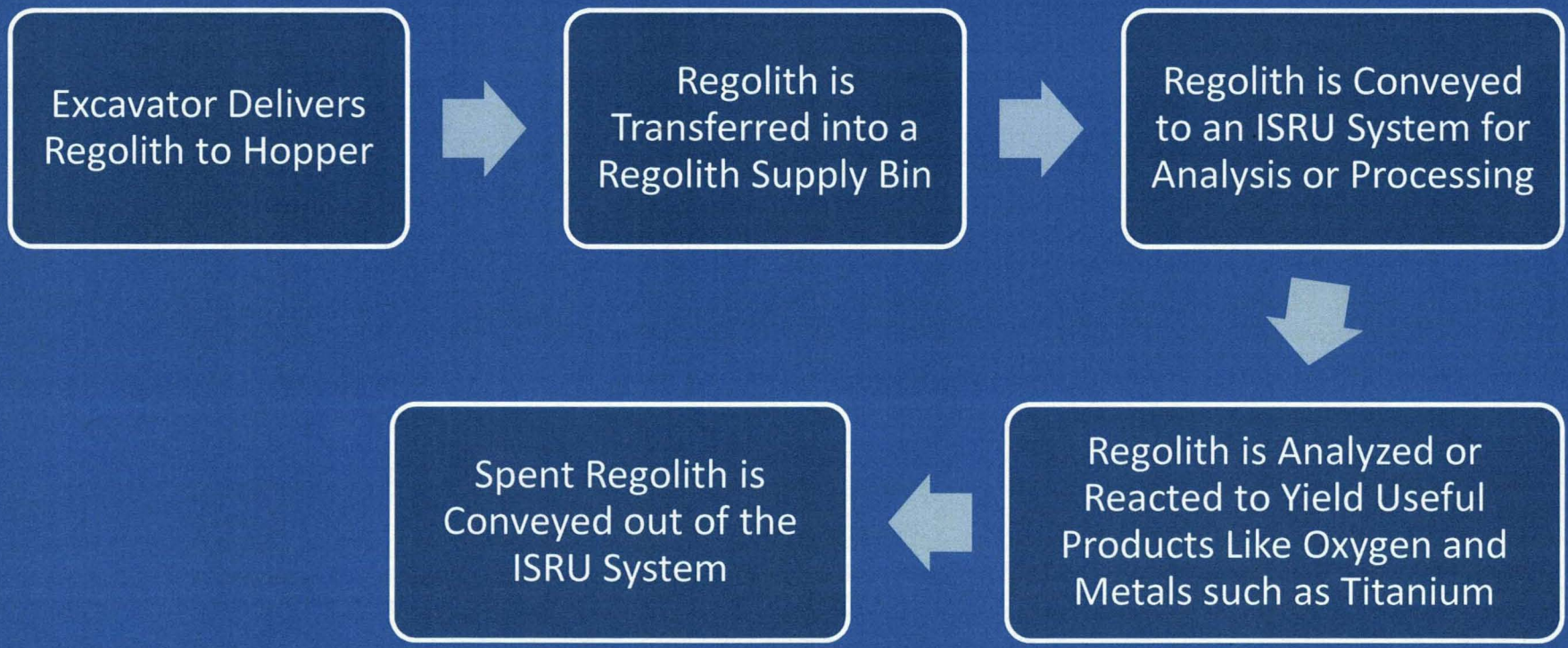
Example of In Situ Resource Utilization for Oxygen Productions



Carbothermal Regolith Reduction Module (ORBITEC)

Solar Energy Collection and Delivery Module (PSI)

Regolith Transfer and ISRU Processing Steps



E.g., Carbothermal,
Hydrogen Reduction,
Molten Oxide Electrolysis

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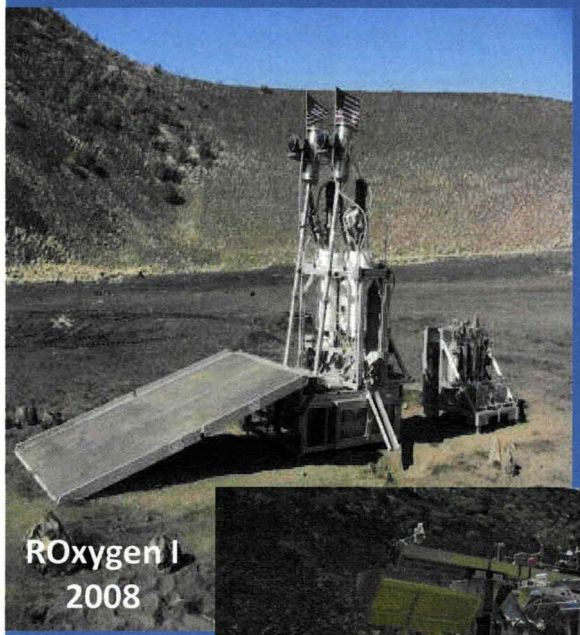
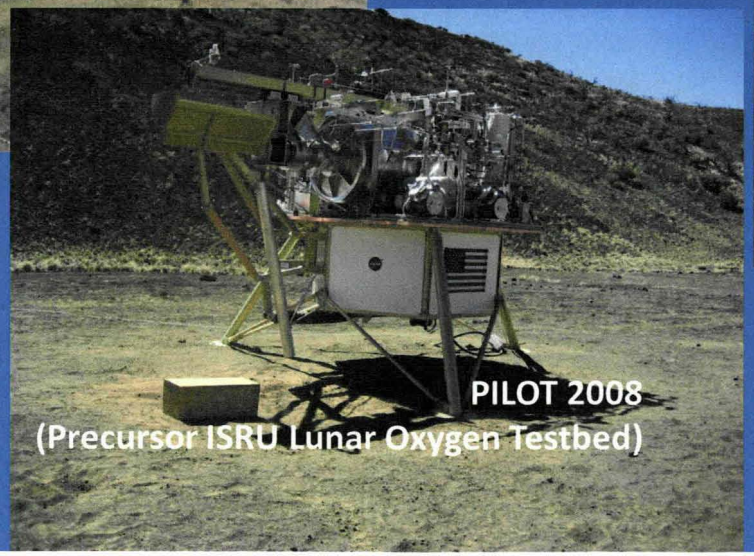
Regolith Feed Systems Field Tested for ISRU Reactors

Mechanical Systems (Inclined Auger)

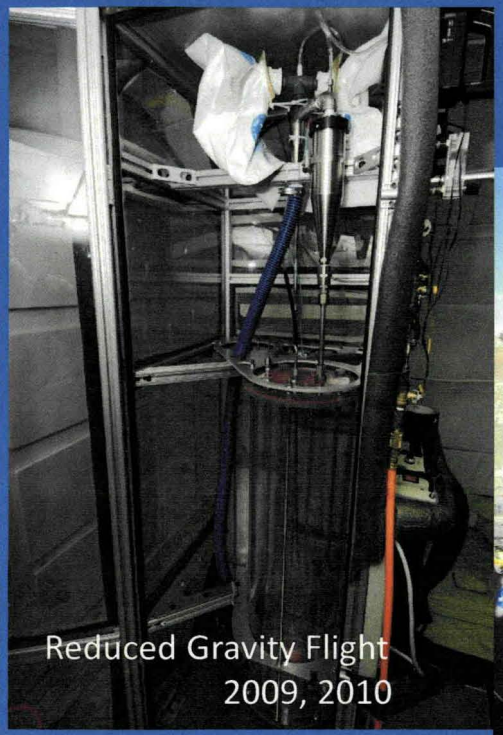


ROxygen I
2008

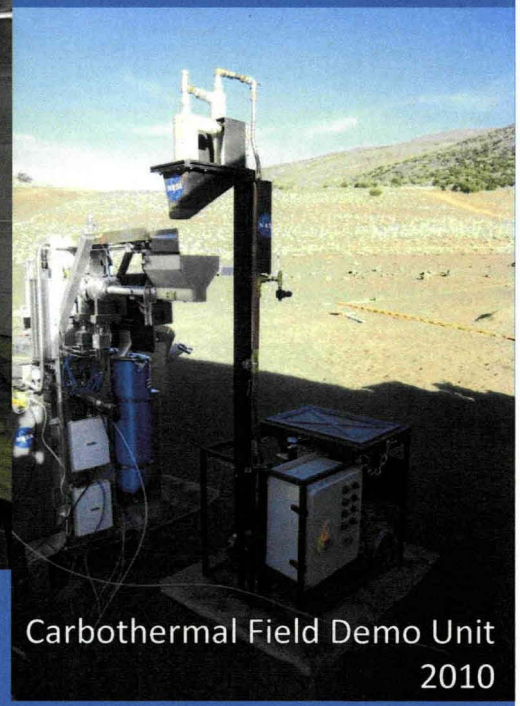


PILOT 2008
(Precursor ISRU Lunar Oxygen Testbed)

Non-Mechanical Systems (Pneumatic Conveyor)

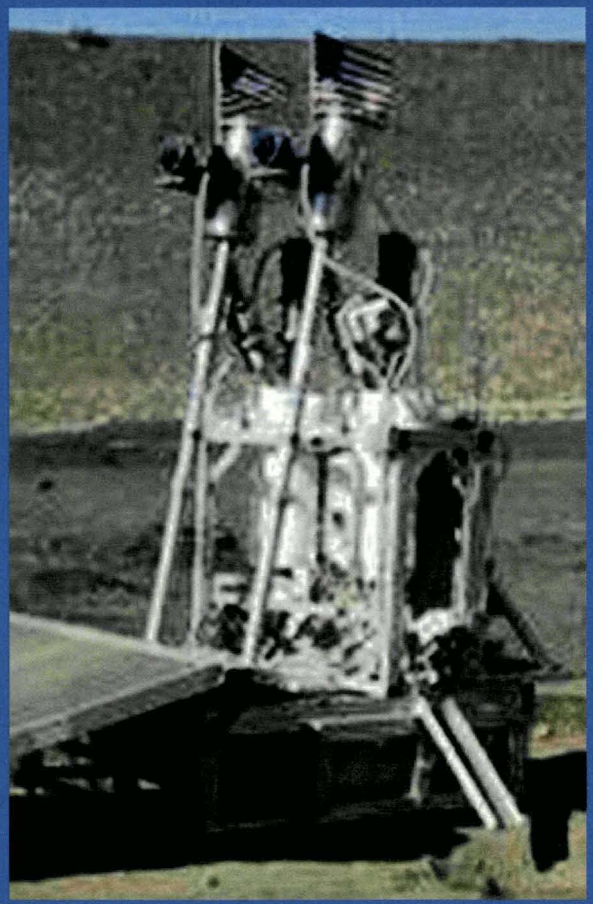


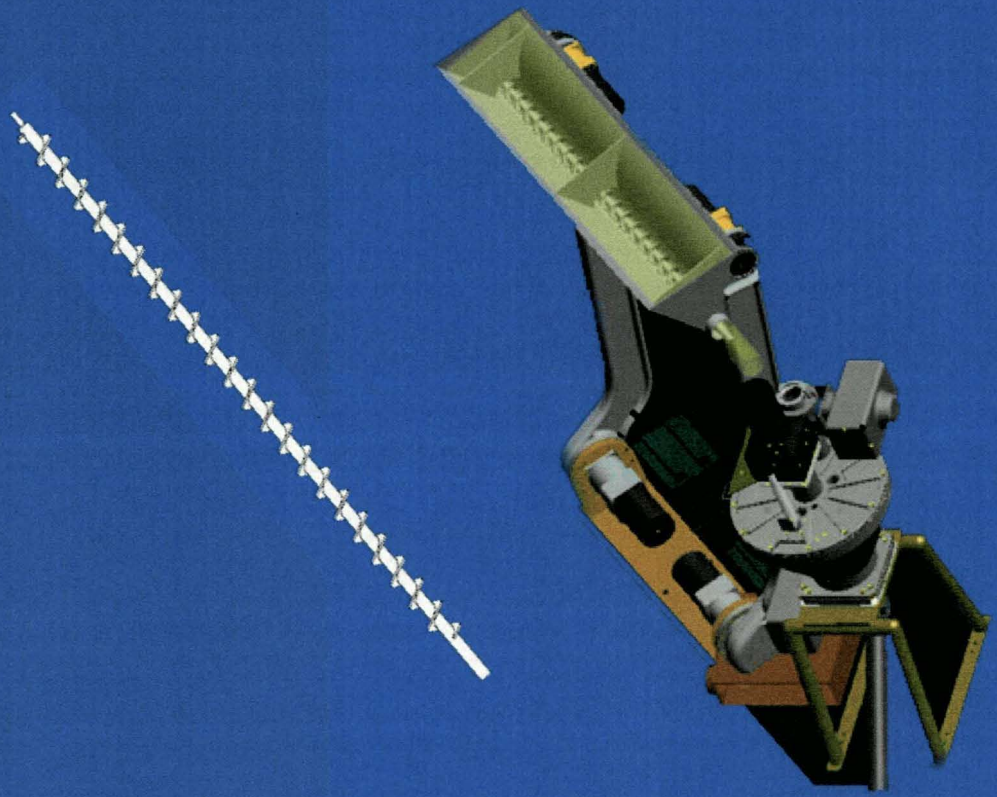
Reduced Gravity Flight
2009, 2010



Carbothermal Field Demo Unit
2010

Using a Mechanical Auger for Regolith Delivery to an ISRU Reactor





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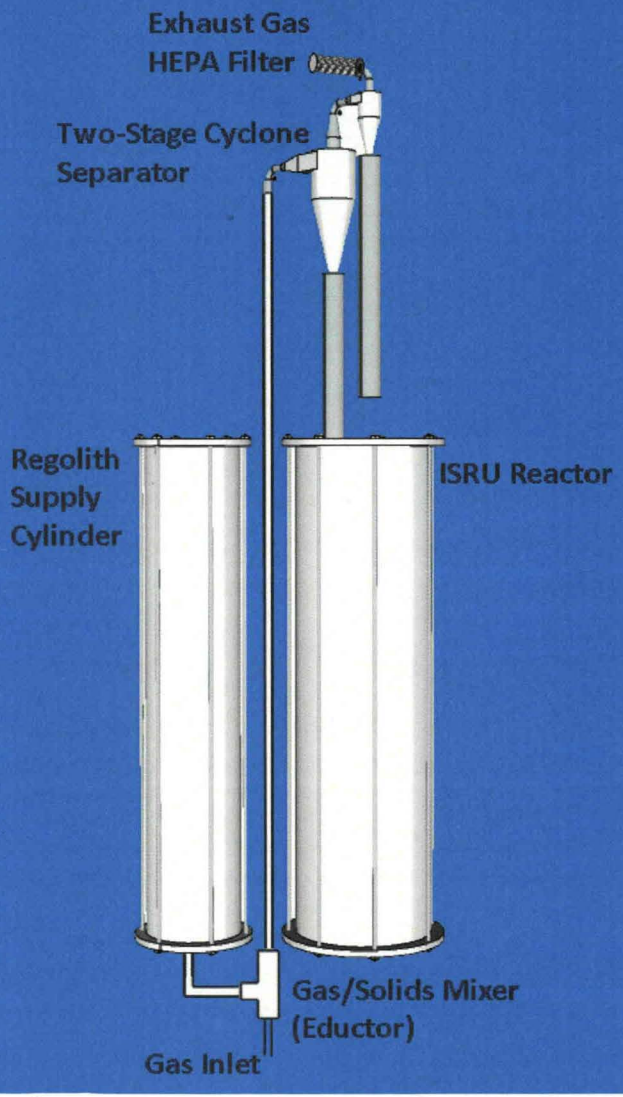
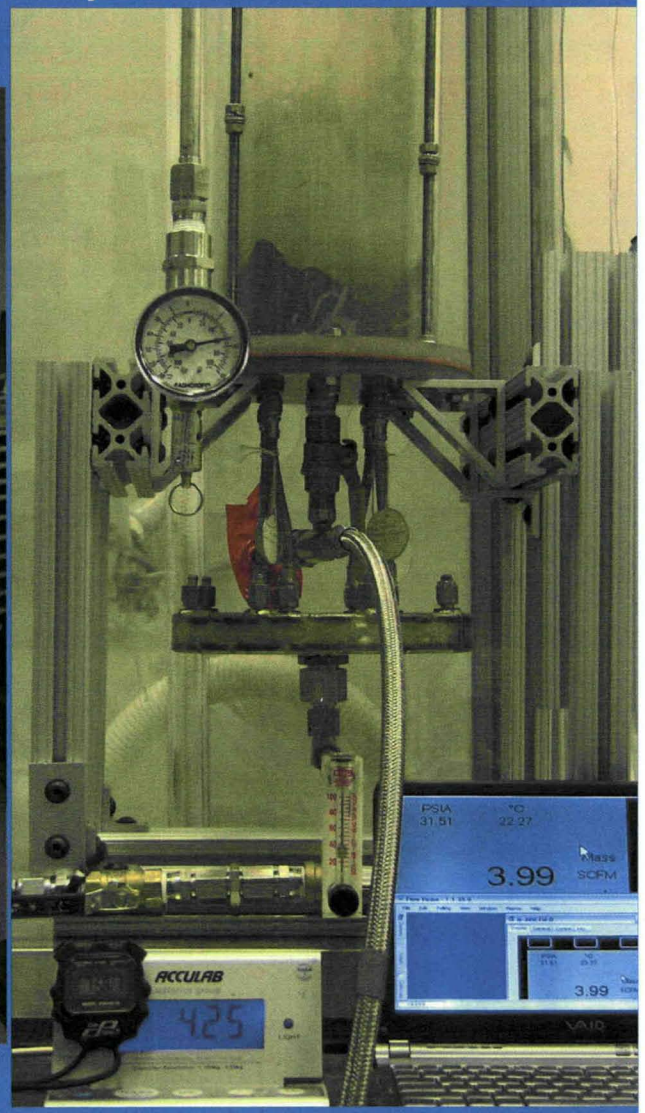
Pneumatic Regolith Delivery System





Reduced gravity setup to pneumatically convey 17 kg of planetary regolith 1.5 meter vertically using compressed dry air and helium gases.

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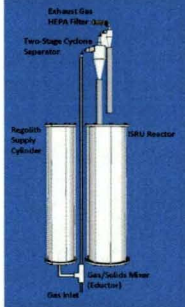
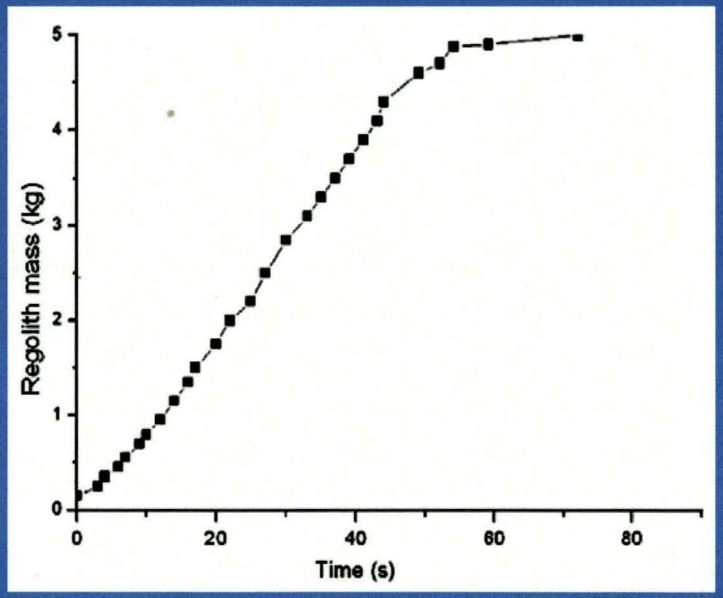
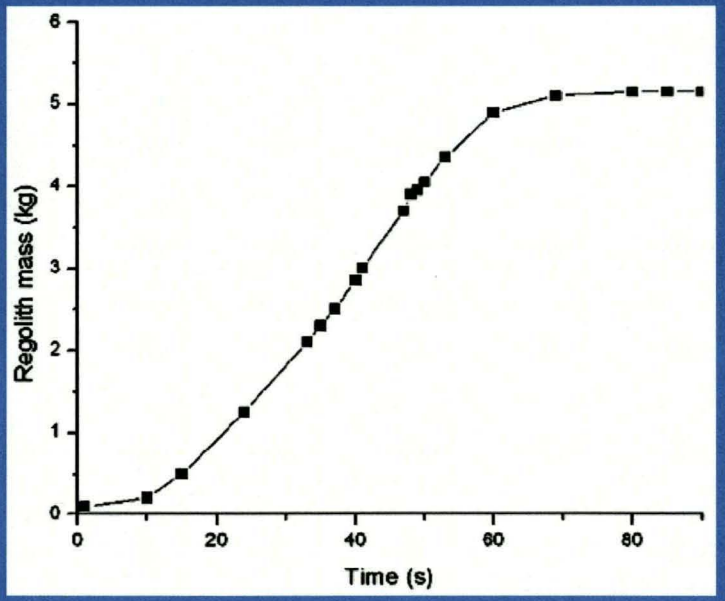


Pneumatic Regolith Transfer

Amount of regolith mass (JSC-1A) conveyed as a function of time for given gas pressures applied to a supply cylinder for fluidizing 17 kg of regolith, and to the eductor gas inlet for conveying the regolith.



Fluidization Pressure: 24.7 PSIA
Eductor Pressure: **20.1 PSIA**



Fluidization Pressure: 24.7 PSIA
Eductor Pressure: **16 PSIA**

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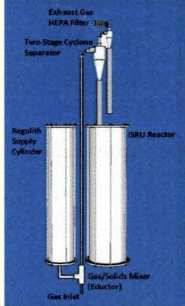
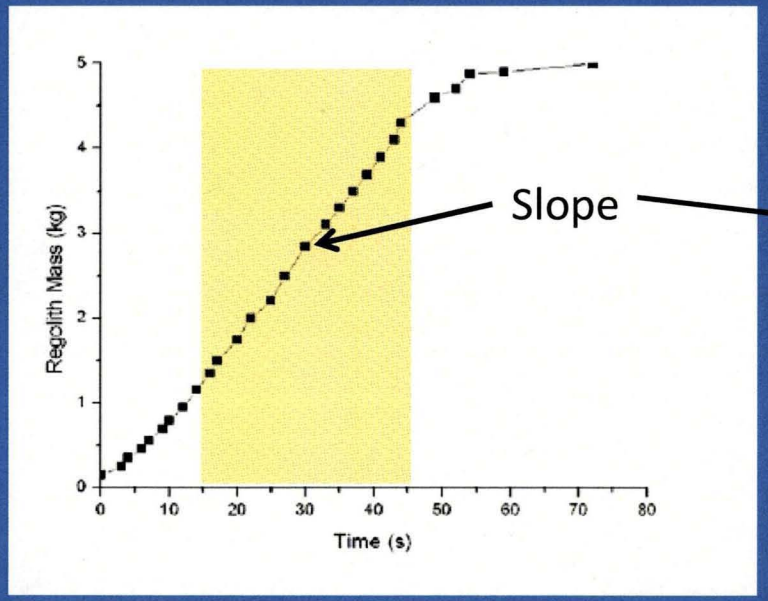
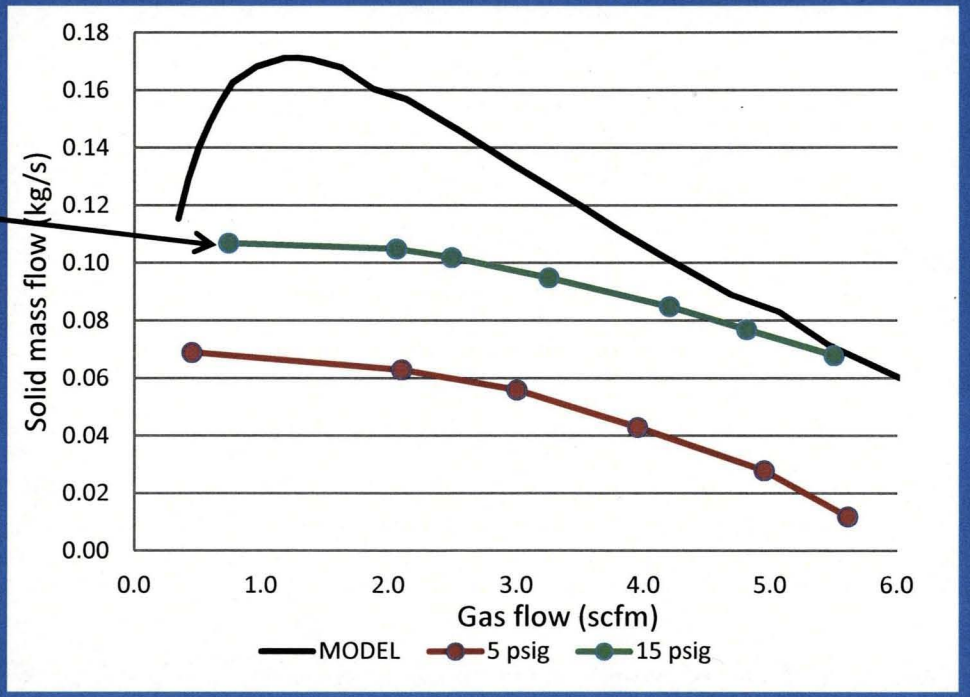


Pneumatic Regolith Transfer





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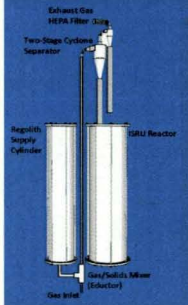
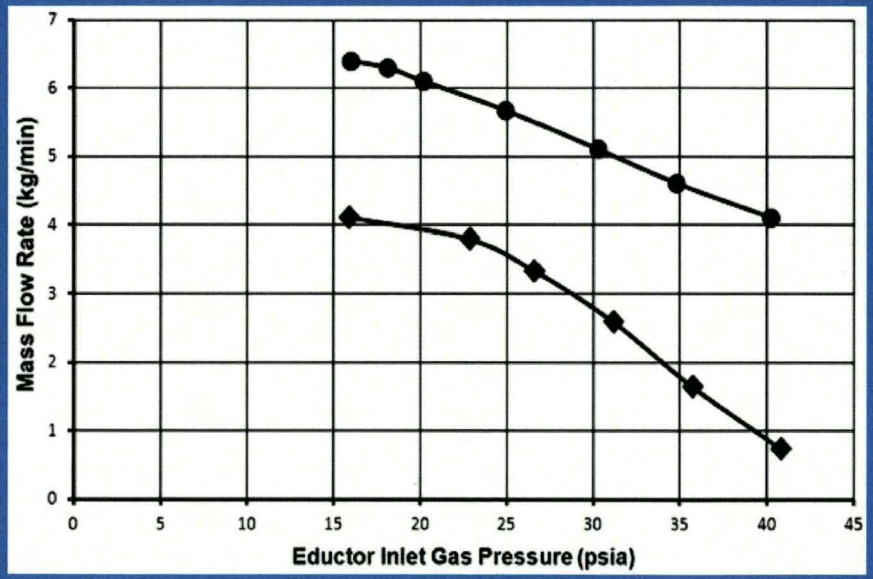
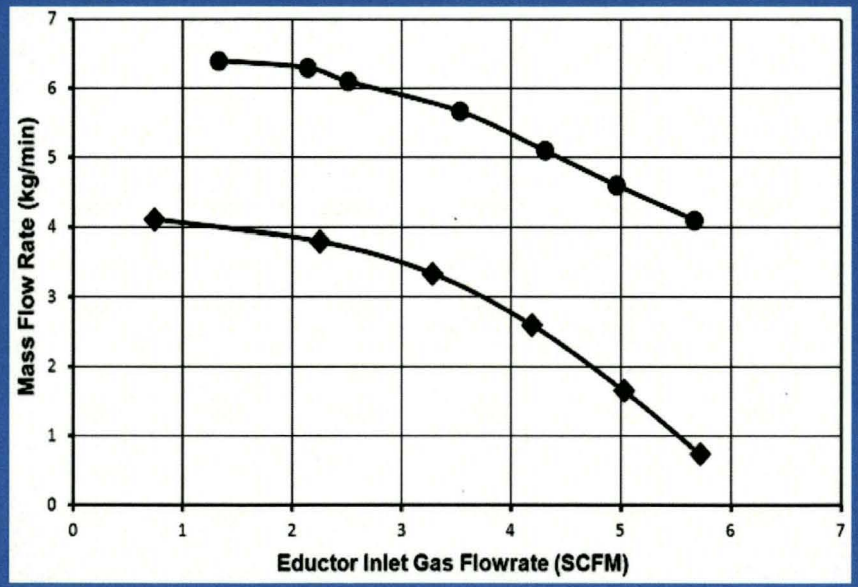


Pneumatic Regolith Transfer



Mass flow rate versus eductor inlet gas pressure



Mass flow rate versus eductor inlet gas flow rate

Pneumatic conveying of JSC-1A into ambient air under 1-g using compressed dry air as the convey gas. Upper curves (solid circles) are for the supply cylinder fluidized at a pressure of 24.7 psia, while the lower curves (solid diamonds) are for a fluidization pressure of 19.7 psia.

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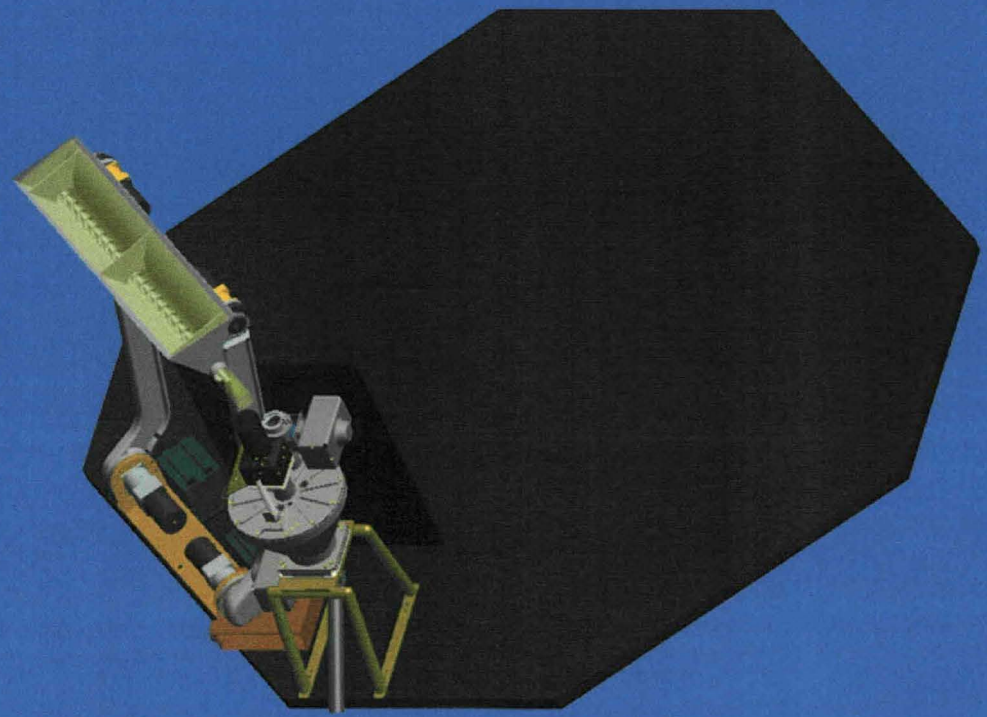
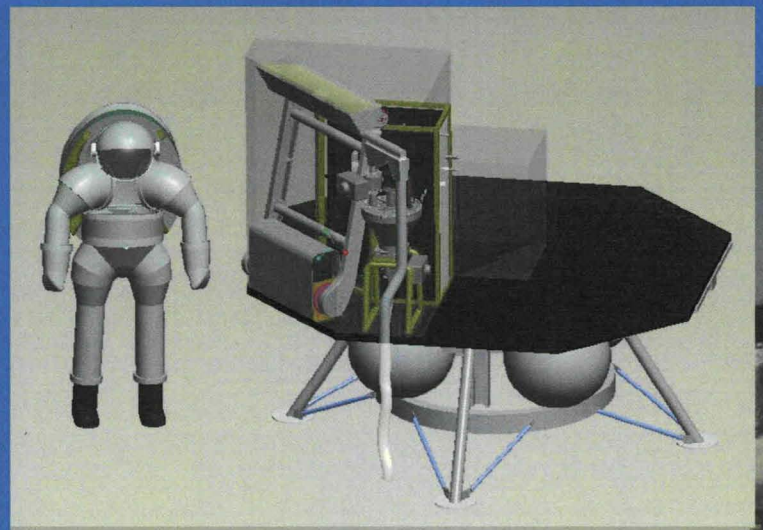
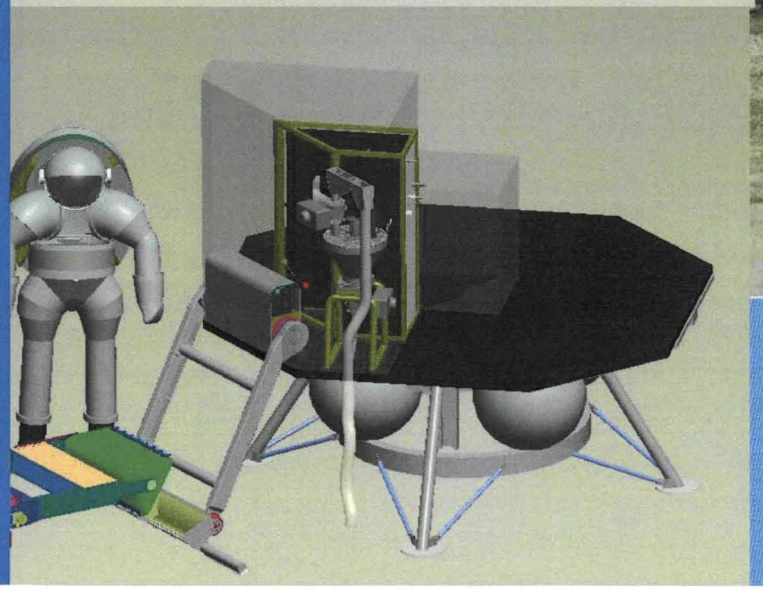
Hybrid Regolith Delivery System Using Hopper Lift and Auger Mechanisms



Regolith Delivery System designed for an ISRU 2012 Field Test to be conducted at NASA JSC

ISRU 2012 Field Test at JSC will use a Mockup Lander





JSC Morpheus Lander

Regolith Hopper Lift.mpg

Conclusions ISRU 2012 Field Test at JSC Using a Mockup Lander

- Pneumatic delivery systems convey are compact and versatile in deployment, have been demonstrated in reduced gravity and can convey regolith at significant mass flow rates, but they require a source of compressed gas.
- Standalone mechanical auger systems convey regolith in a simple, reliable and well understood way, but contain moving parts that are susceptible to wear and jamming from contact with regolith and can be bulky for transferring regolith over large distances.
- A hybrid mechanical system that combines a hopper lift with an auger makes the system more versatile and compact than a standalone auger system, but still contains moving parts that are susceptible to wear and jamming by contact with regolith particles.