Small Body Sampling Techniques Being Developed at JHU/APL

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Agenda

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- JHU/APL objectives, requirements, goals
- Milestones
- Touch-and-Go sample acquisition
- Loose regolith passive samplers
  - "Sticky Pads"
  - Bulk samplers
  - Core samplers
- JHU/APL Sample Acquisition System

JHU/APL Objectives

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- Demonstrate ability to collect, transport, and store surface and subsurface samples that meet mission minimum requirements
- Provide enabling technology for sample return missions
- Become a sampling technology partner in sample return missions

Sample Acquisition Requirements & Goals

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- Mission science floor
  - 10g of loose regolith
- Mission science goals
  - Maintain particle orientation
  - Return ≥100g
  - Maintain stratigraphy

Milestones

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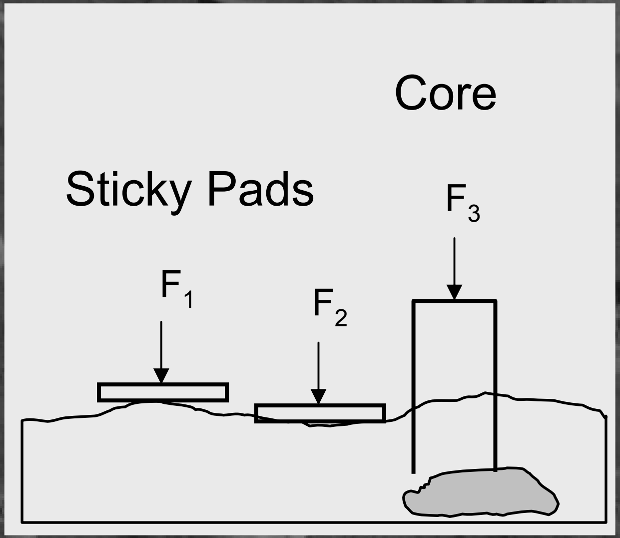
- Demonstrated validity of passive sampling techniques in loose regolith
- Demonstrated ability to preserve stratigraphy
- Demonstrated validity of electronically controlled force limited simultaneous sampling
- We have an active TAA with Marco Polo
  - Antonella Barucci
  - Marcello Fulchignoni
- Working to raise the TRL level

Touch-and-Go Simultaneous Sampling Concept

Touch-and-Go simultaneous sampling is complicated by factors that cannot be known beforehand

- Surface irregularities
- Local heterogeneities in the depth of regolith
- Obstructions below the surface



Sampling Mechanisms

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Mechanisms have been prototyped to be able to tailor the force applied to each individual sampler, absorb hard impacts below the surface, and drive the samplers into their individual storage receptacles

“Sticky-Pad” Surface Samplers

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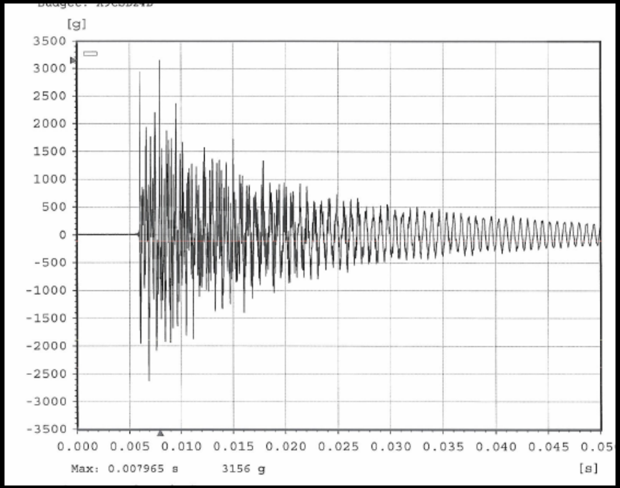
The objective of these sampling devices is to collect loose particles from the surface with a sticky material applied to the face of the sampler

Sticky Pad Shock Test

Before Shock
s/n 03003

After Shock
s/n 03003



- Shock tests were conducted on four "Sticky Pads"
  - 2697 g's
  - 63.4% retained (s/n 03003), 73.5% average
  - Material losses consisted of multi-layer dust with no loss of larger particles
- Particle orientation was preserved

Sub-Surface Samplers

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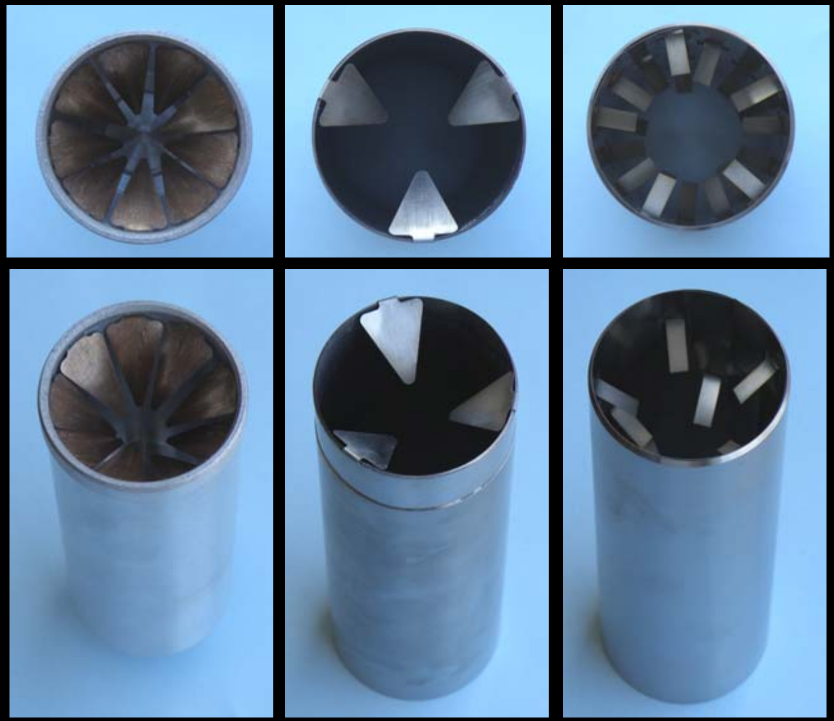
The objective of the Sub-Surface samplers is to penetrate the surface up to 100mm and reliably collect ≥100g of regolith while **not requiring** stratigraphy to be preserved



Phoebe, Saturn

Core Samplers

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- Core samples that maintain stratigraphy are a high priority for a sample return mission
- Core samples taken during the Apollo missions have provided the most valuable information about the lunar regolith evolution, textural, and structural complexities

Stratified Crushed Granite

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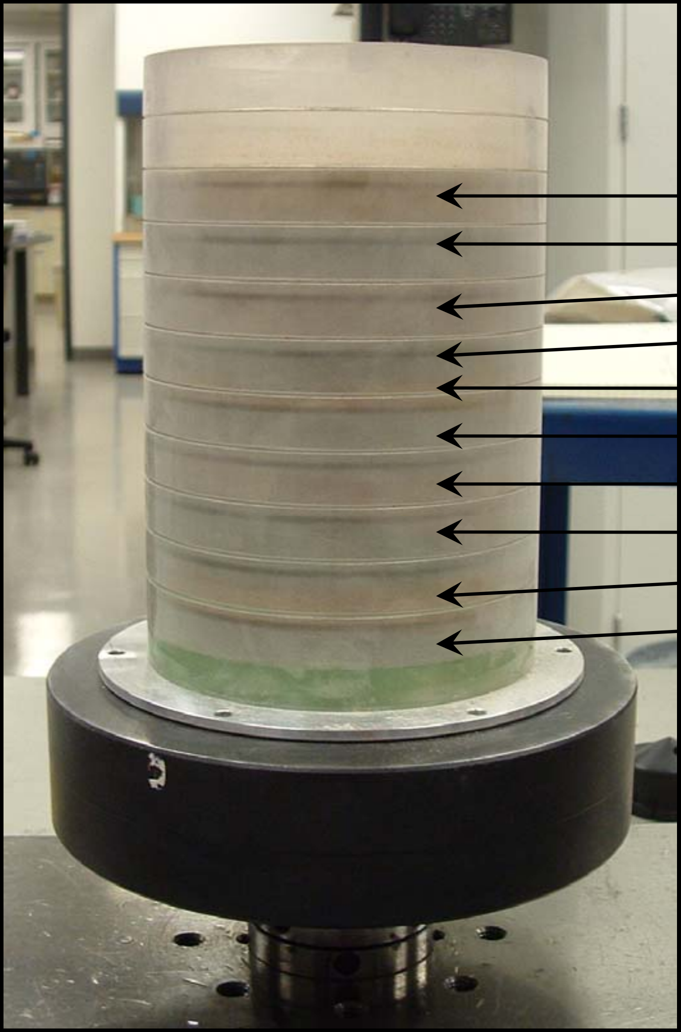
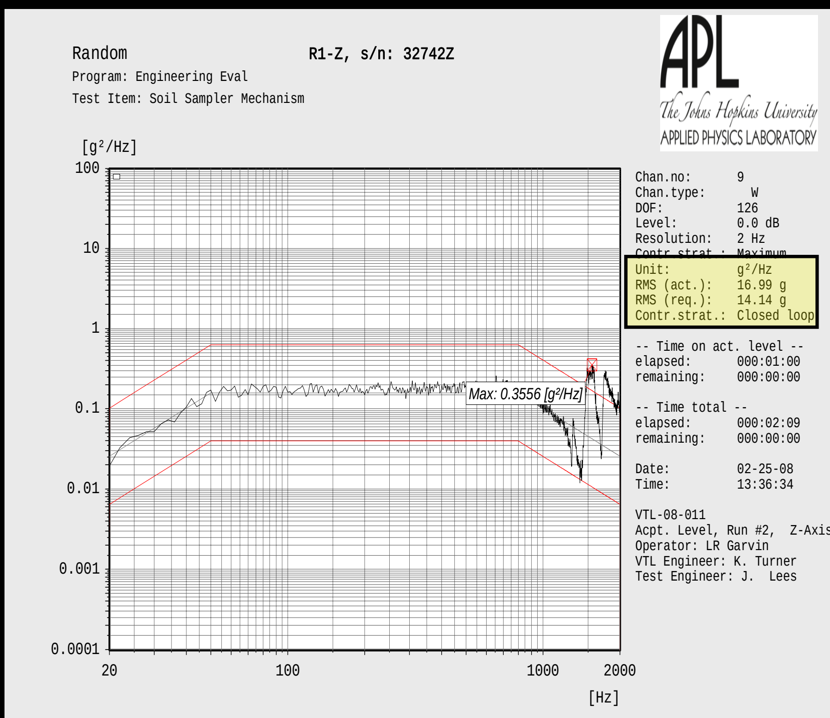
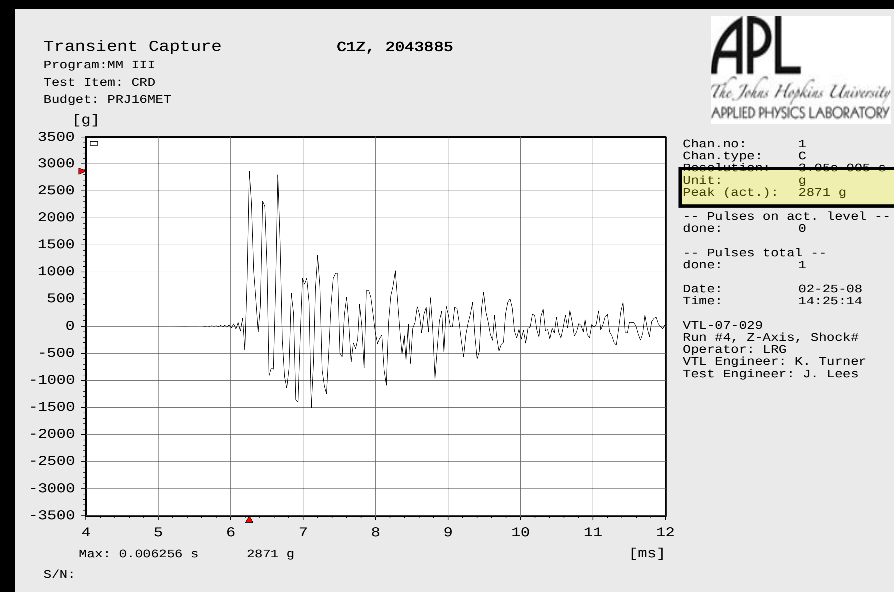
- 10 layers of colored crushed granite
- 114mm deep
- A full core was extracted



Colonial Red
Imperial Gray
Mauve
Midnight Blue
Colonial Red
Imperial Gray
Mauve
Midnight Blue
Colonial Red
Imperial Gray

Random Vibration & Shock



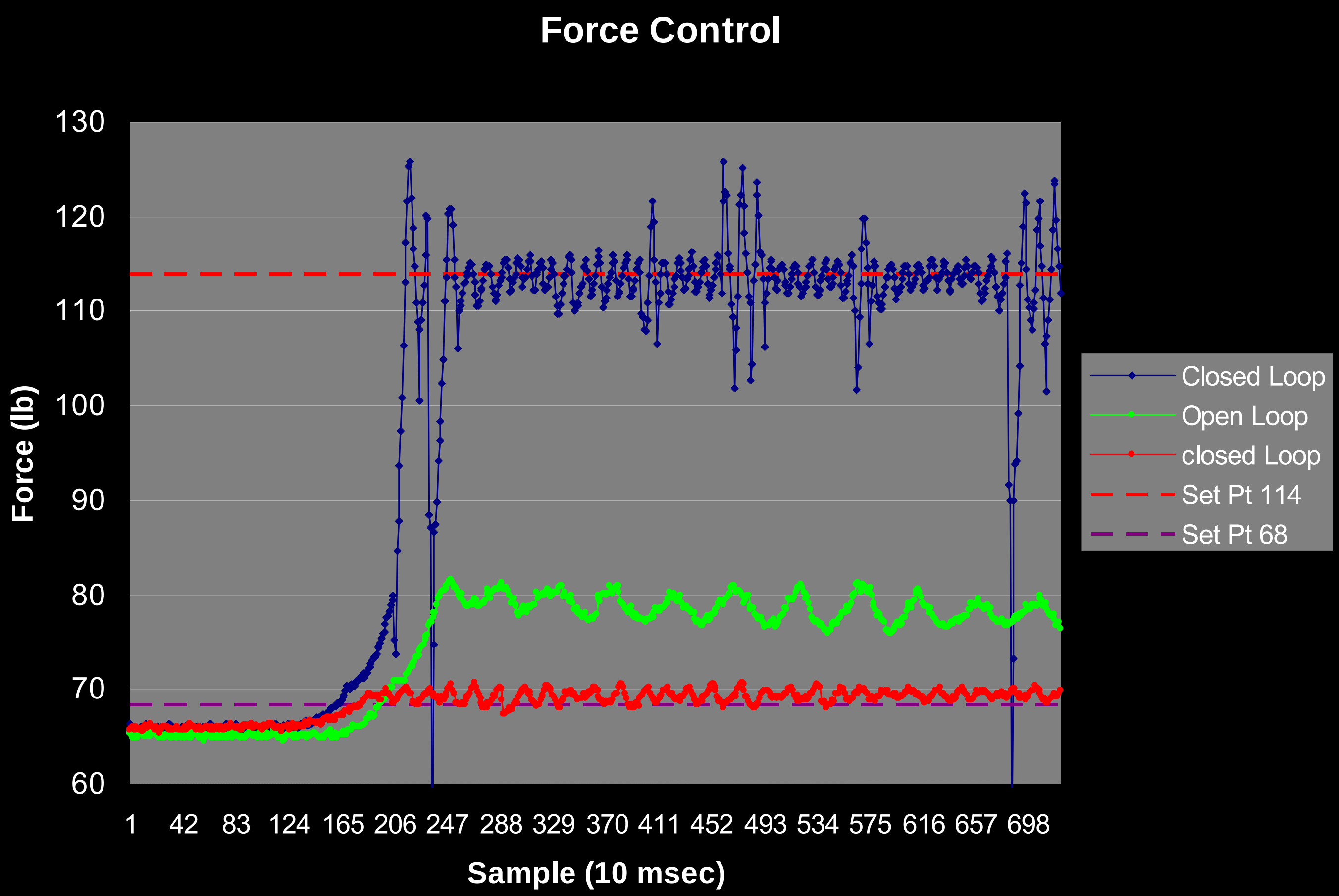


14.1grms

2871g

Cores Preserve Stratigraphy

Applied Force Control



Simultaneous Sample Testing

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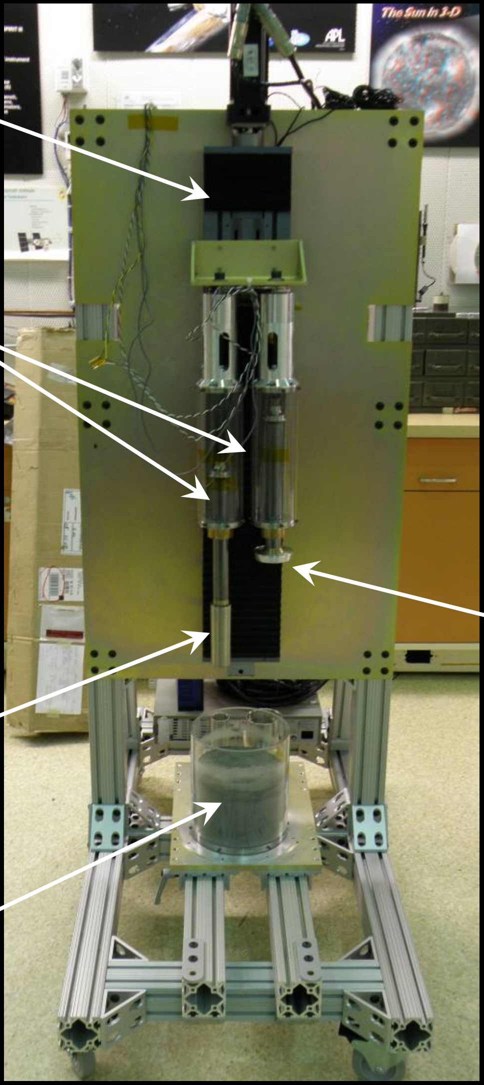

2 Chanel Control Electronics

100mm × 100mm

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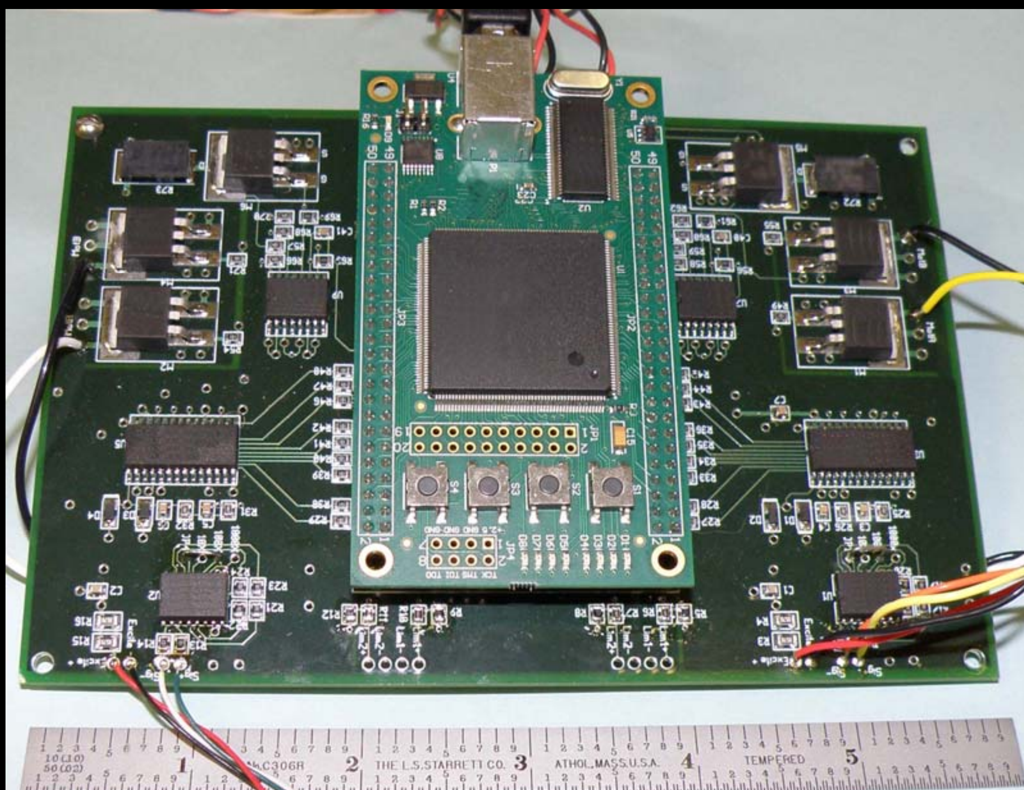
USB Interface

Channel-1 **Channel-2**



Each Channel

- Motor driver
- Force feedback
- Position feedback
  - Not currently active
- Limit switches
  - Not currently active

Assessing the Preservation of Scientific Integrity of Meteorite Samples Collected Via Sticky Pads

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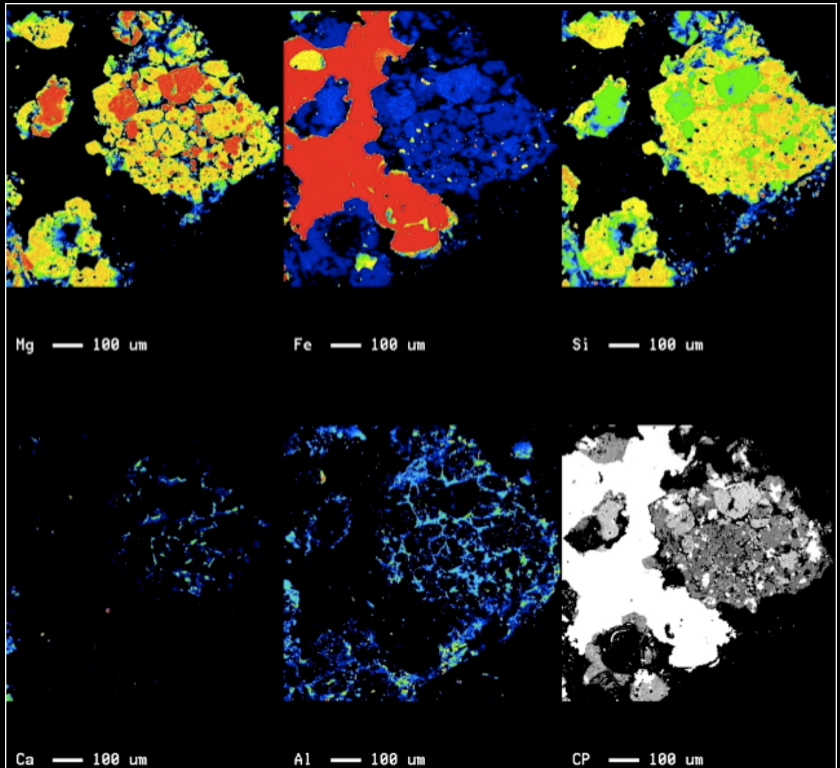
APPROACH

- Create “mini sticky pads” using candidate sticky materials
- Use primitive meteorites, which are appropriate analogs for primitive asteroid composition
- Meteorites used include Allende (CV chondrite) and Allegan (H chondrite), both of which are fresh meteorite falls (not meteorite finds)
- Analyze the meteorites before sampling and after sampling via the “mini sticky pad.” Revisit the analysis over time. Analyses currently include reflectance and major chemical and mineralogy measurements.

CHEMICAL RESULTS

- Right image shows elemental maps of Allegan meteorite **after** sampling via sticky pad
- The meteorite material was coated with sticky material
- But major element chemistry and mineralogy determined after sampling via the sticky pad were the same as measured using the Allegan meteorite before sampling



Reference: Chabot & Lees (2008) Asteroids, Comets, Meteors Conference. LPI Contribution No. 1405, paper id. 8093.

JHU/APL SAS Summary

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- The JHU/APL SAS is very close to being verified to a NASA TRL 6
  - "Sticky Pads"
    - Meet mission science floor (10g)
    - Maintain particle orientation
  - Bulk samplers
    - Meet mission science goals (>100g)
  - Core samplers
    - Maintain stratigraphy
  - Mechanisms
    - Verified controlled force simultaneous sampling

JHU/APL SAS Summary

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- Minimal system complexity
  - Simple 2 DOF system
    - 1 linear motion
    - 1 rotary motion
  - Autonomous
    - Sample acquisition
    - Sample transport
    - Sample storage
- Fully programmable force control
- Fully deployable at asteroid
- Can accommodate active and passive samplers

The End

Questions?

Backup Material