Mars2020 Sample Acquisition and Caching Technologies and Architectures

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HONEYBEE ROBOTICS
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ISO 9001 CERTIFIED AS9100 CERTIFIED

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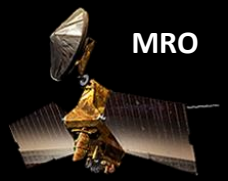
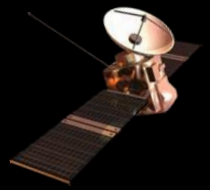
NASA's Mars Exploration Program

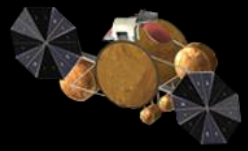
HONEYBEE ROBOTICS

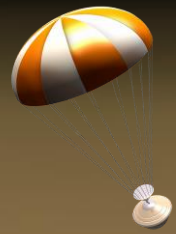
Launch Year

2000 to Present	2011	2013	2016	2018	2020 & Beyond
Odyssey, MRO, Mars Express (ESA)		MAVEN	TGO (ESA-NASA)		Mars Sample Return









MER

MER

Phoenix

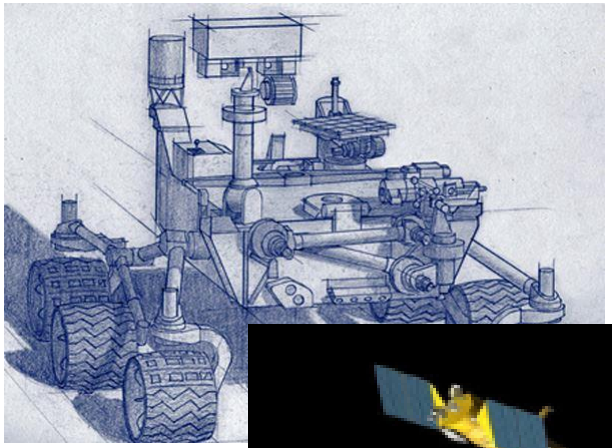
Mars Science Lab

ExoMars

MAX-C Rover

Source: NASA

Mars Sample Return - Background



2020

M2020 Rover

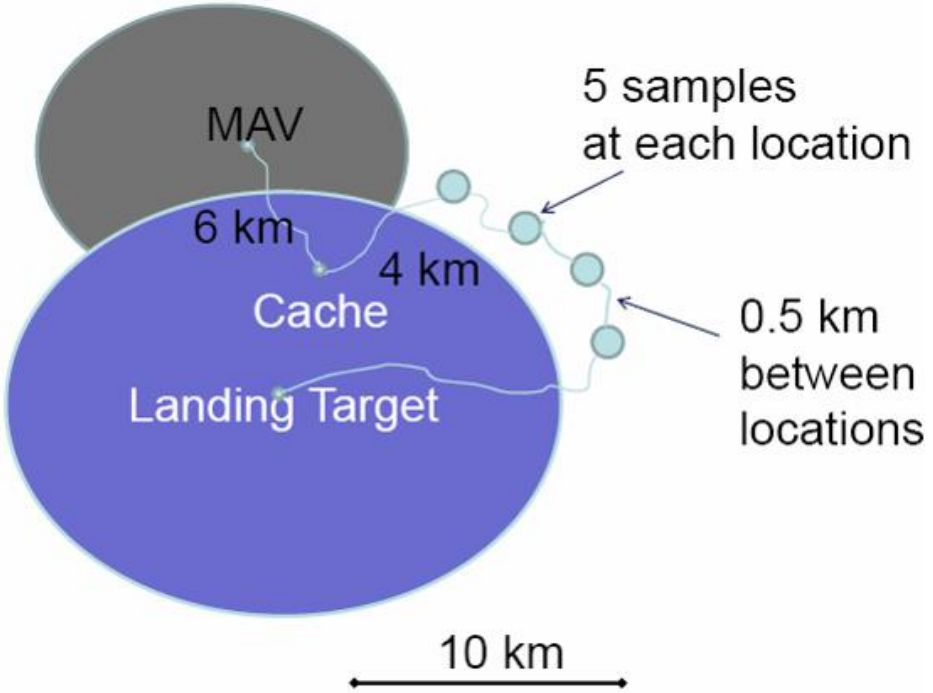
202X

202X +2

MEPAG, 2009

Goal:

Acquire ~37 cores (~8 cc each) of selected Mars rocks and bring them back to Earth.



Goal of the M2020 Sampling System

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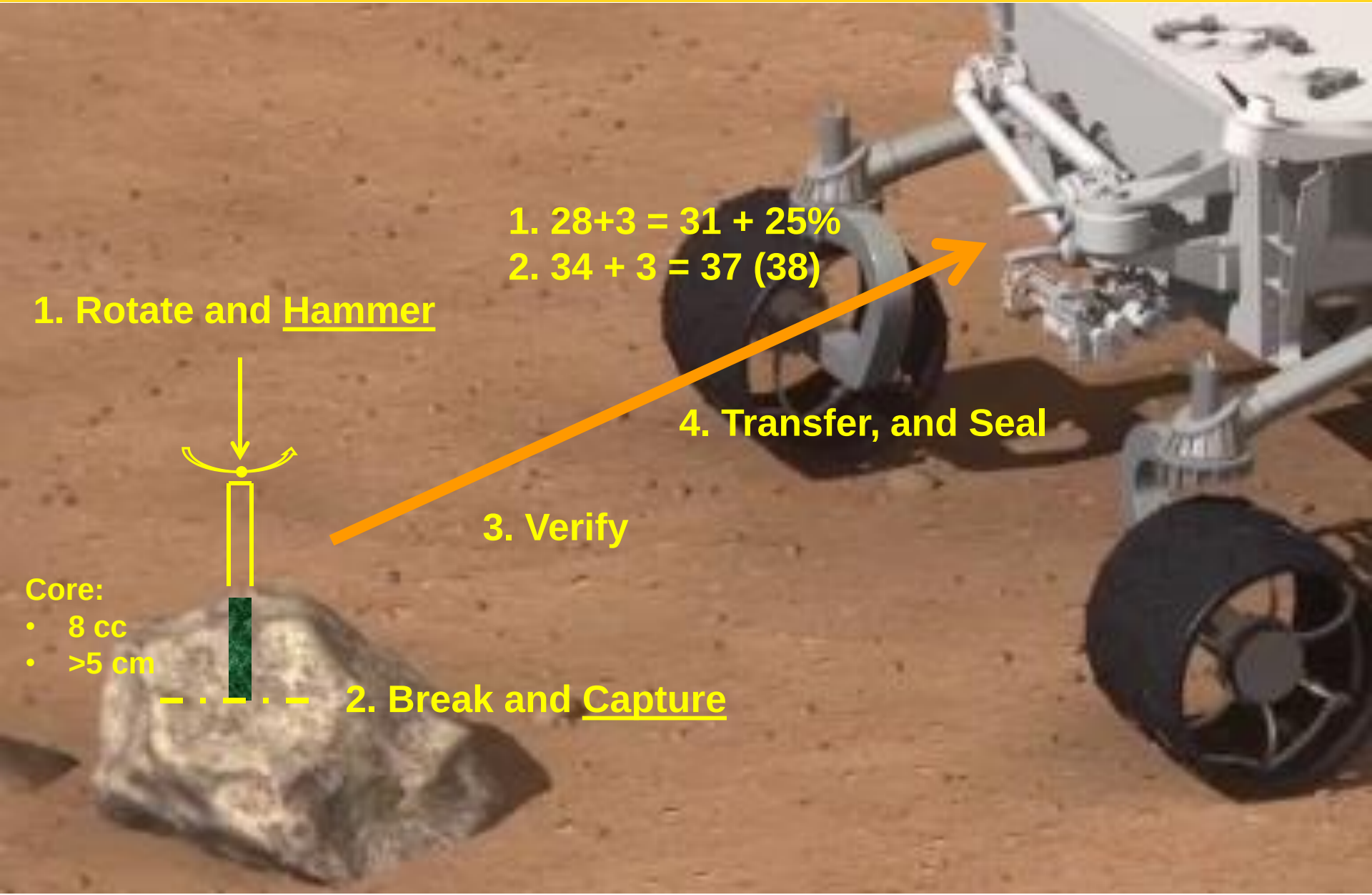
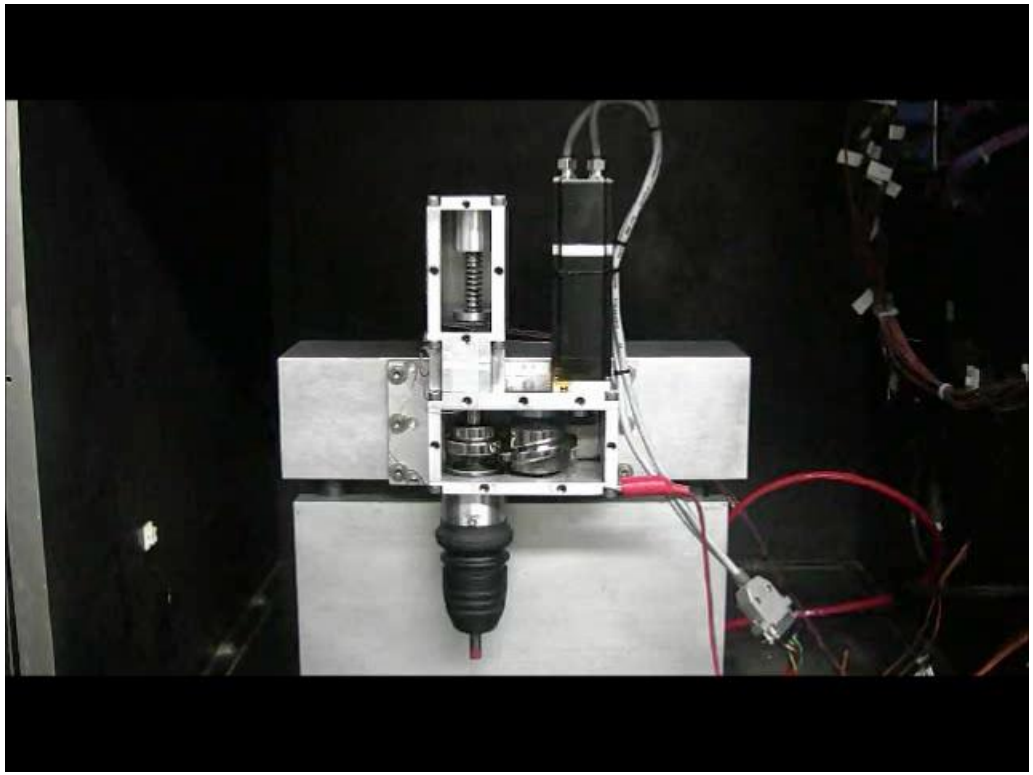


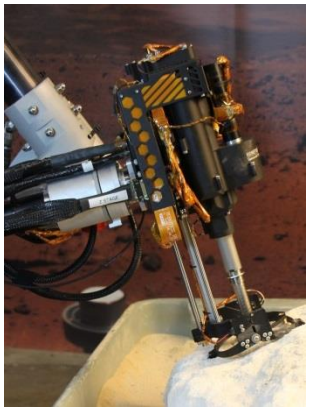
1. Hammer Mechanism

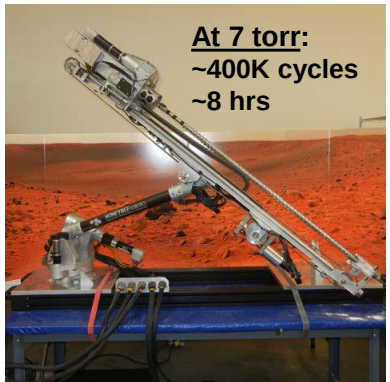
- Investigated various percussive approaches
- Selected cam-spring
  - Apollo “heritage”
  - Mechanically simple
  - Frequency and Energy can be adjusted
  - High blow energy per mechanism mass
- Incorporated into 8 drills systems



At 7 torr:

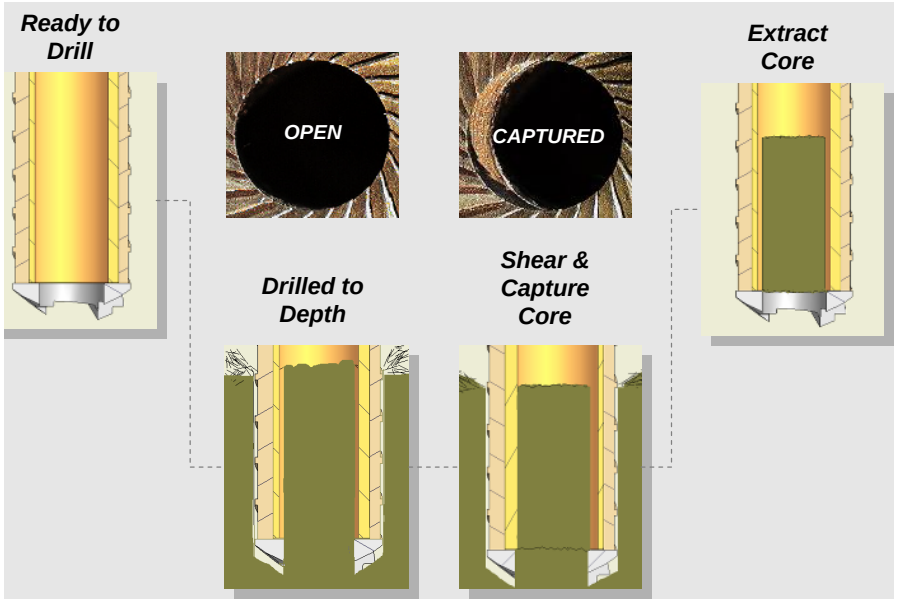
- **~2M cycles**
- **~19 hrs**





2. Core Breakoff and Retention

- **Shears <u>AND</u> Captures the core**
- **Narrow Kerf:**
  - **Low Weight on Bit**
    - Smaller and Lighter Arm
  - **Lower Power and Faster Drill Time**
    - Lower Energy
    - Smaller Actuators
- **Light and Small Drill Bit**
  - Potential for returning cores in bits



3. Core Observation/Verification

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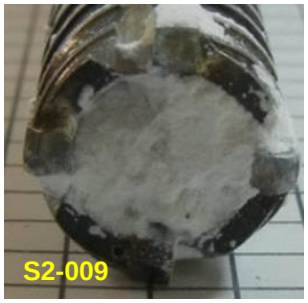
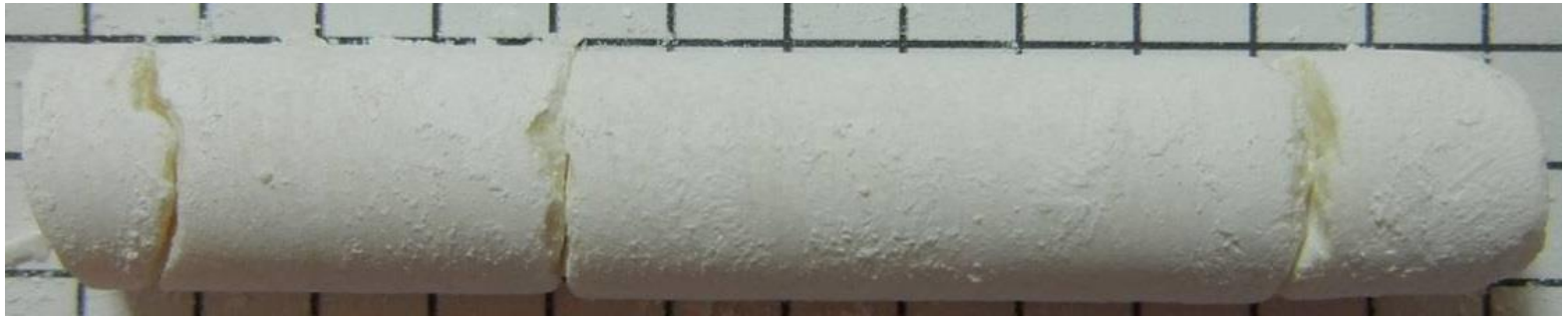
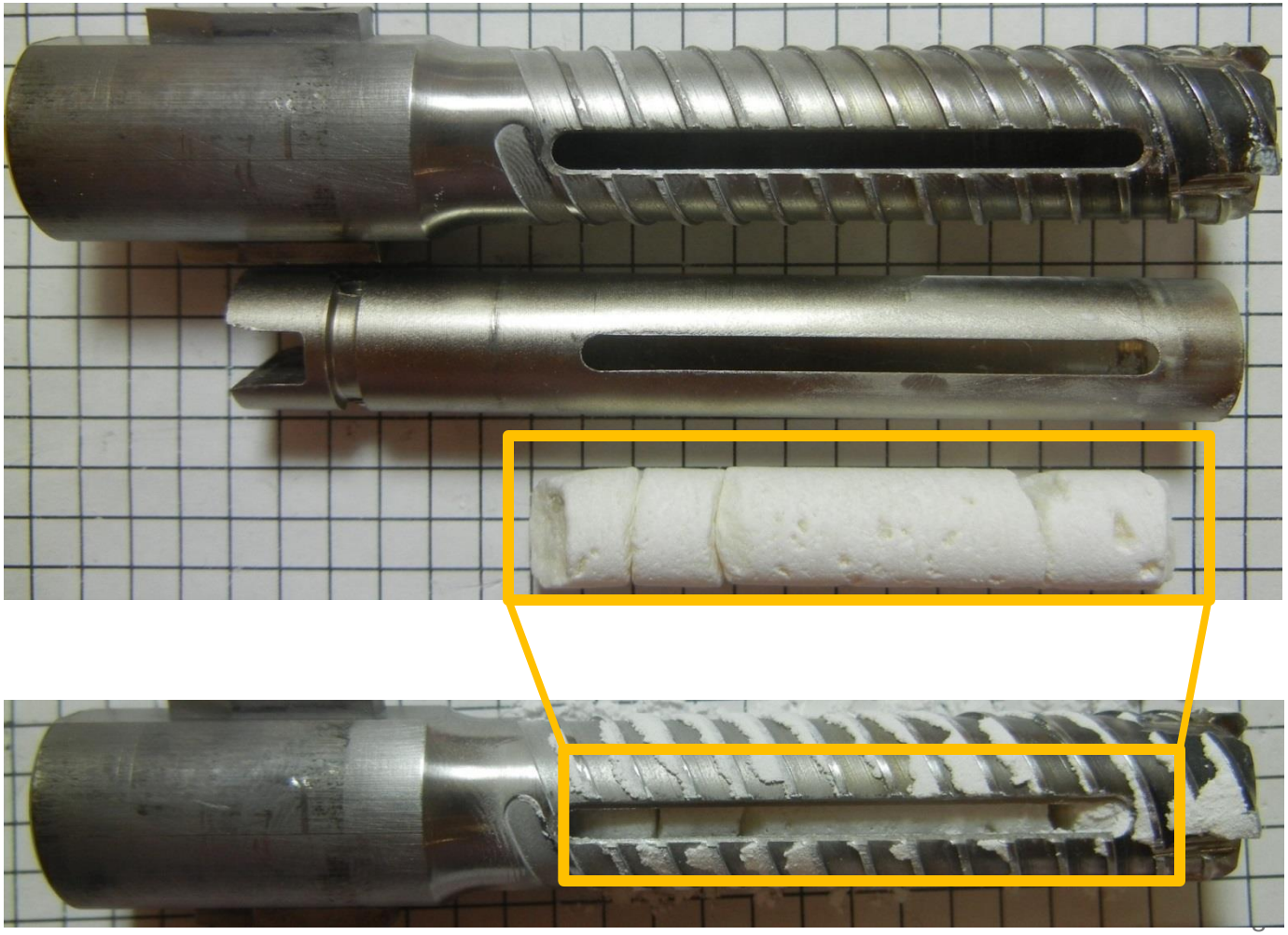


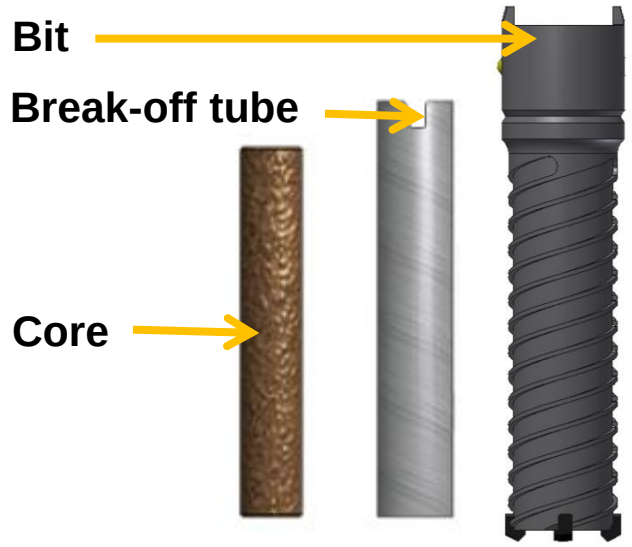


3. SLOT Bit



4. Caching

Bit Assembly

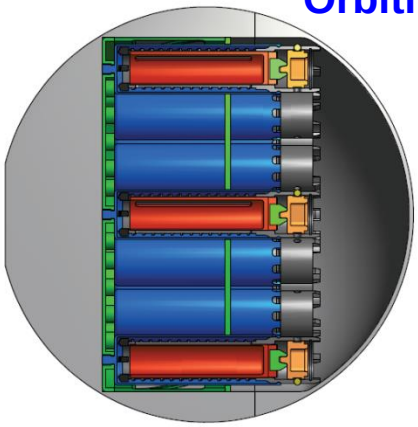


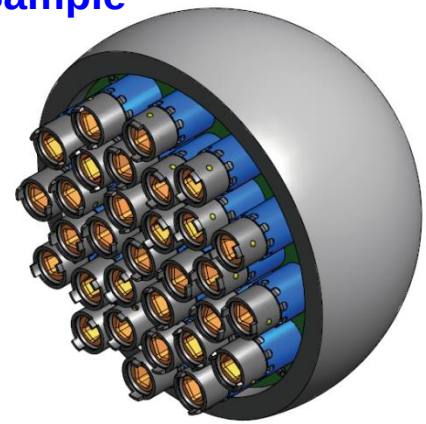
Each core stored in individual bits
[spare bits available]

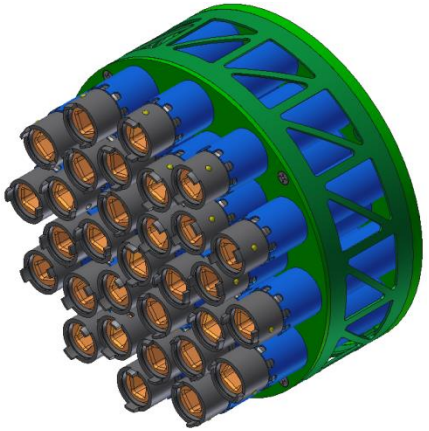
Bit Sleeve Assembly

Each bit placed inside a sleeve within the cache and sealed

Orbiting Sample



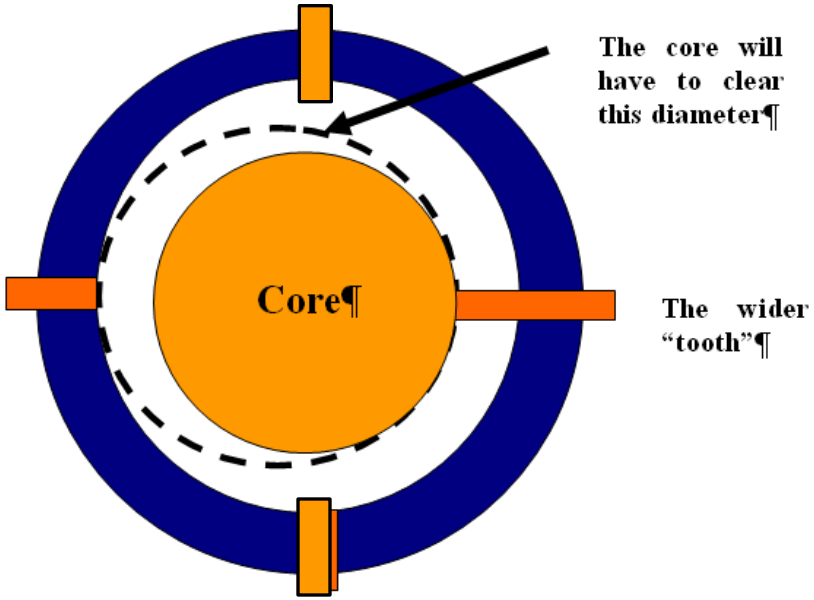


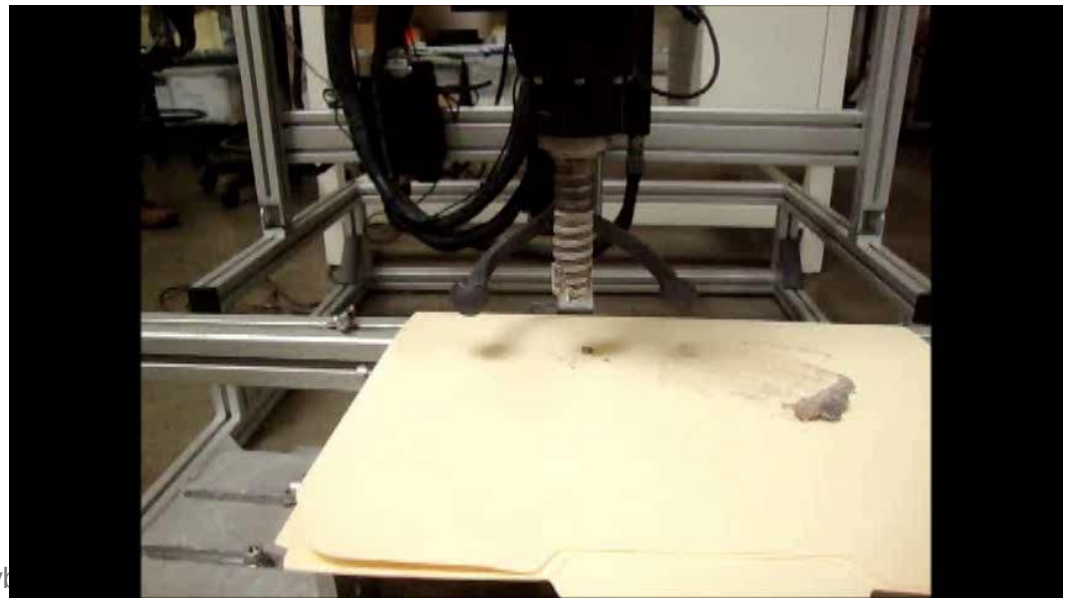


5. Ejecting a Core: BigTooth Bit

BigTooth Bit→ Reusable bits

- One tooth wider than remaining teeth
- Core Diameter < Bit ID
  - Allows Easy Ejection of Cores → Re-use of the Same Bit





Sampling Strategy

Example M2020 Architecture

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Core Drill

Drill Bits

Cache

YouTube videos

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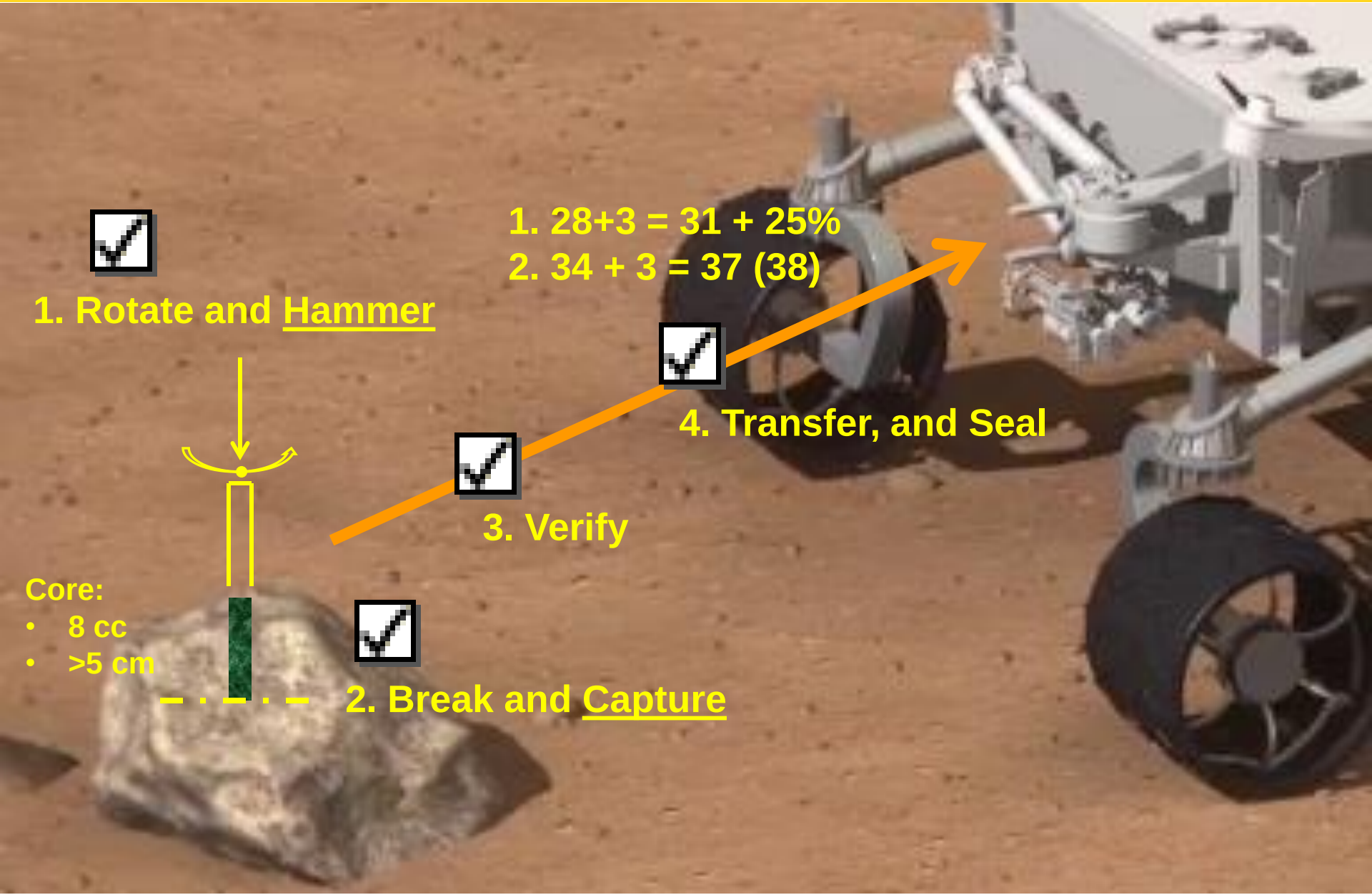
https://www.youtube.com/watch?v=VhfL3htrtZ8

https://www.youtube.com/watch?v=cf47bvULtEQ

https://www.youtube.com/watch?v=NphWPvi9cy4

Conclusions



Acknowledgements

- NASA's Mars Program
- NASA SBIR
- NASA PIDDP

Thank you!

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Engineering the Future