

CURIOSITY

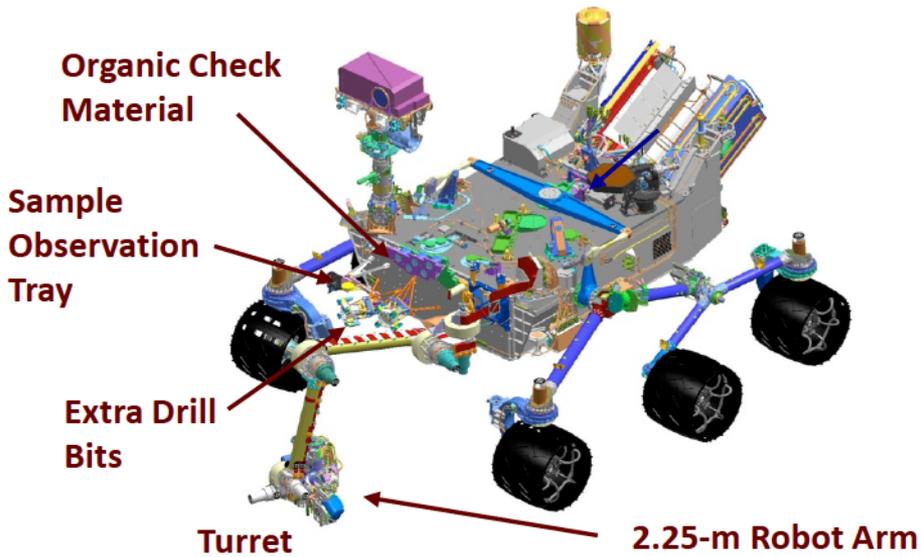


Drilling on Mars: Overcoming the Complexity

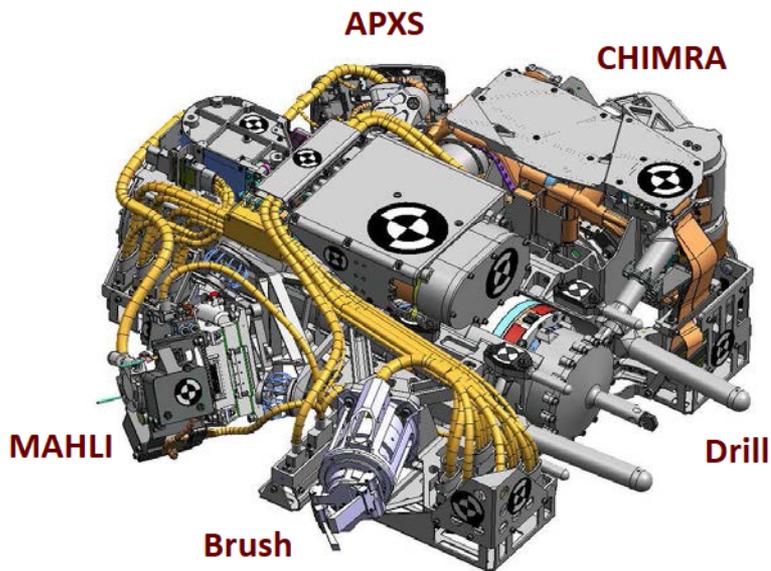


Jim Erickson - MSL
Jet Propulsion Laboratory, California
Institute of Technology

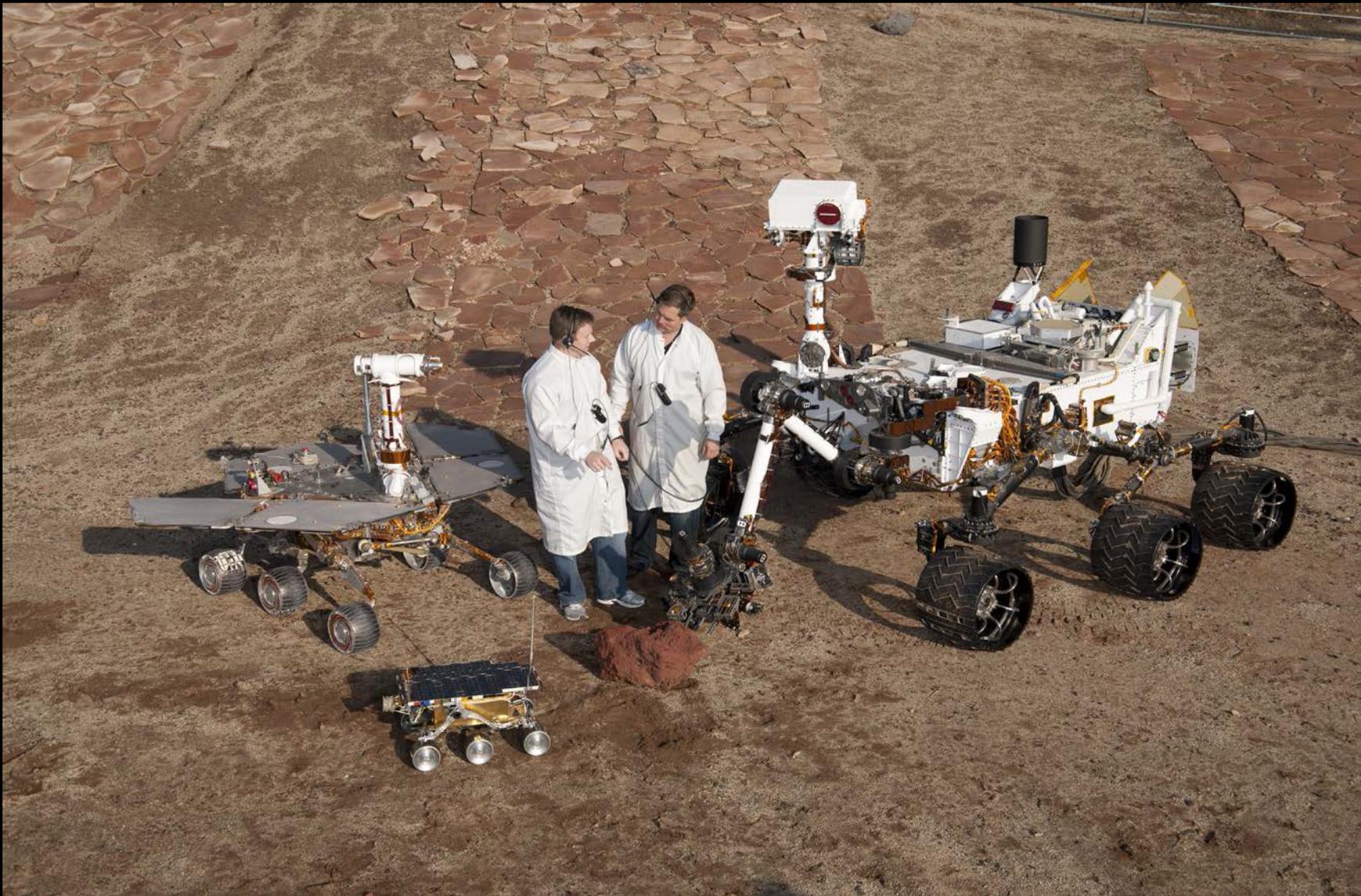
HARDWARE OVERVIEW



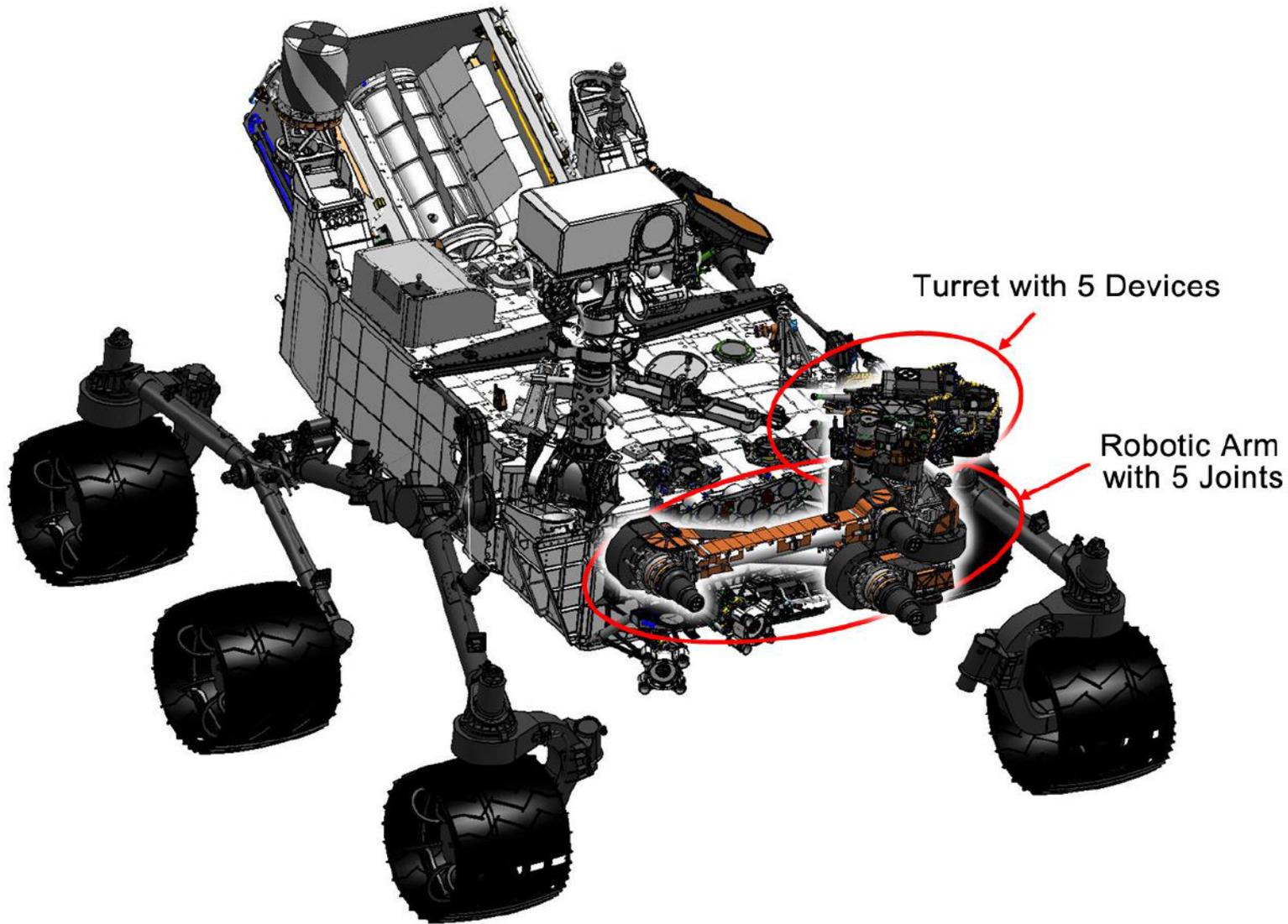
- Cleans rock surfaces with a brush
- Places and holds the APXS and MAHLI instruments
- Acquires samples of rock or soil with a powdering drill or scoop
- Sieves the samples (to 150 μm or 1 mm) and delivers them to instruments or an observation tray
- Exchanges spare drill bits



Curiosity's Sampling System



Curiosity's & its cousins – human scale

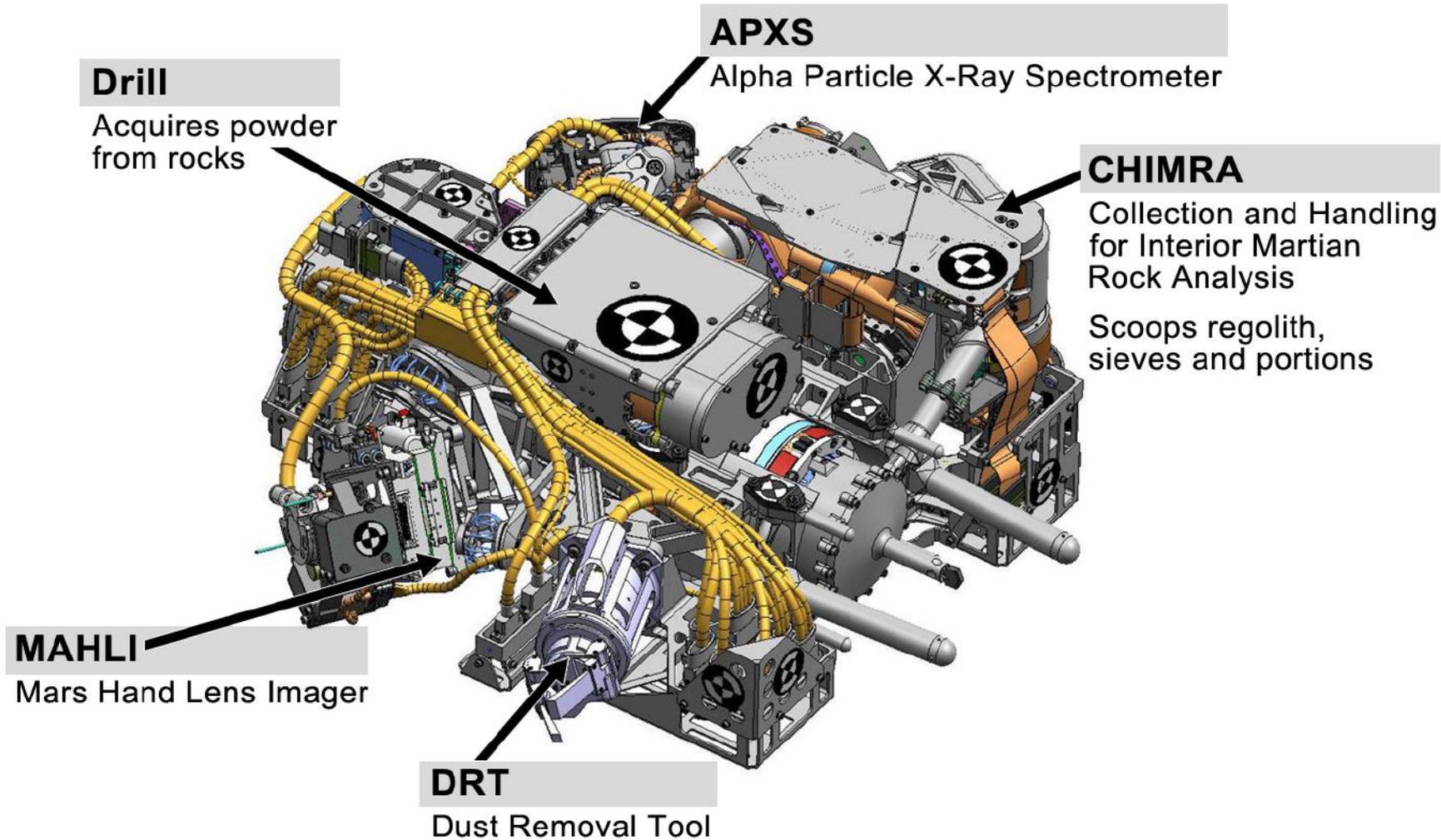


Turret with 5 Devices

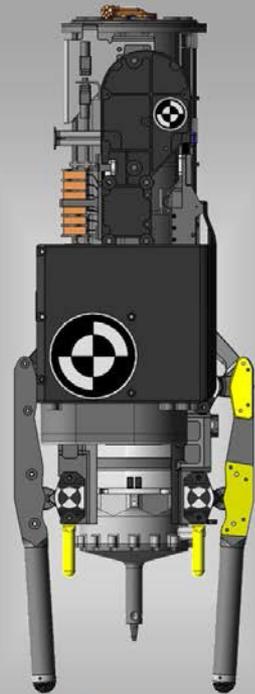
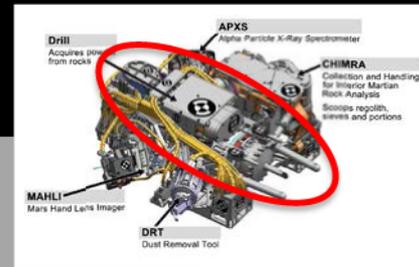
Robotic Arm
with 5 Joints

Curiosity's Sampling System



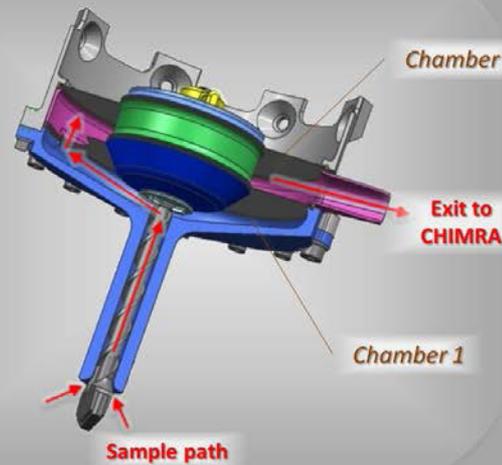


Turret Mounted Tools & Instruments



Contact Sensor / Stabilizer

Top View of Curiosity's Drill

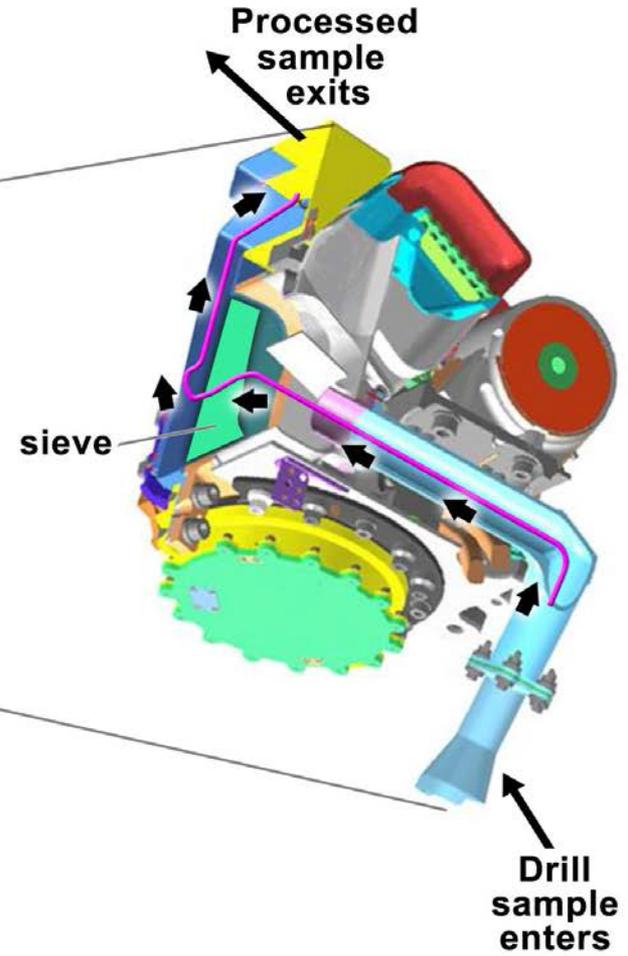
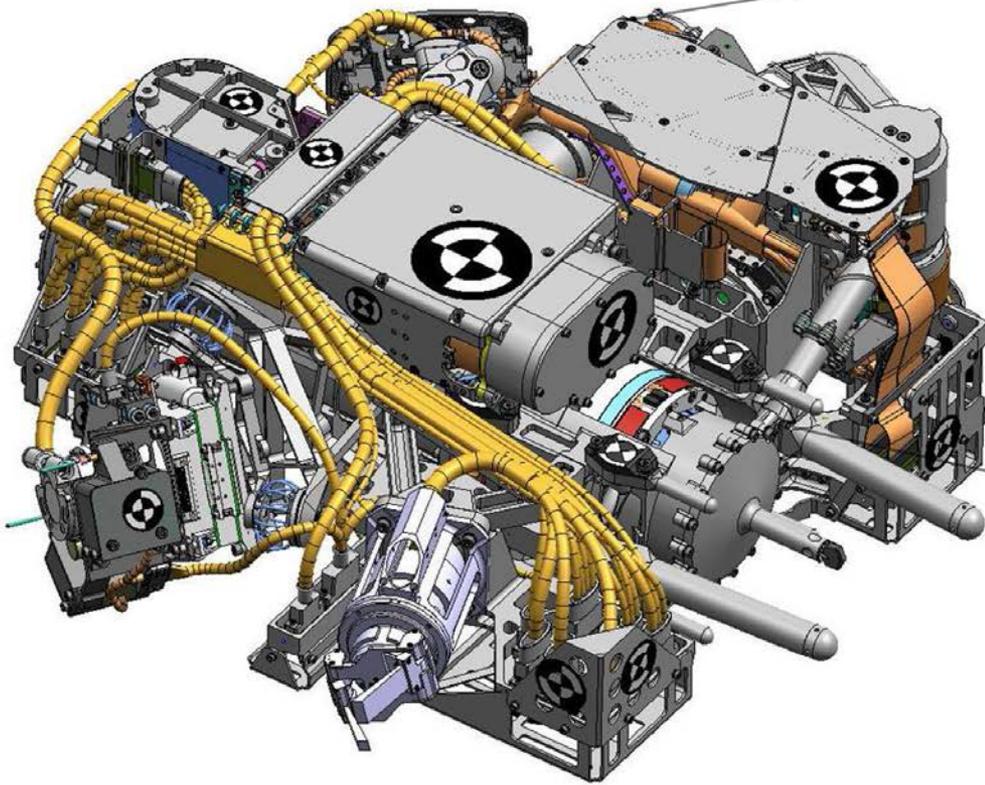


Section View of Curiosity's Drill Bit

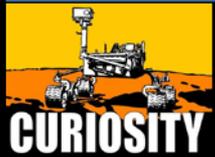
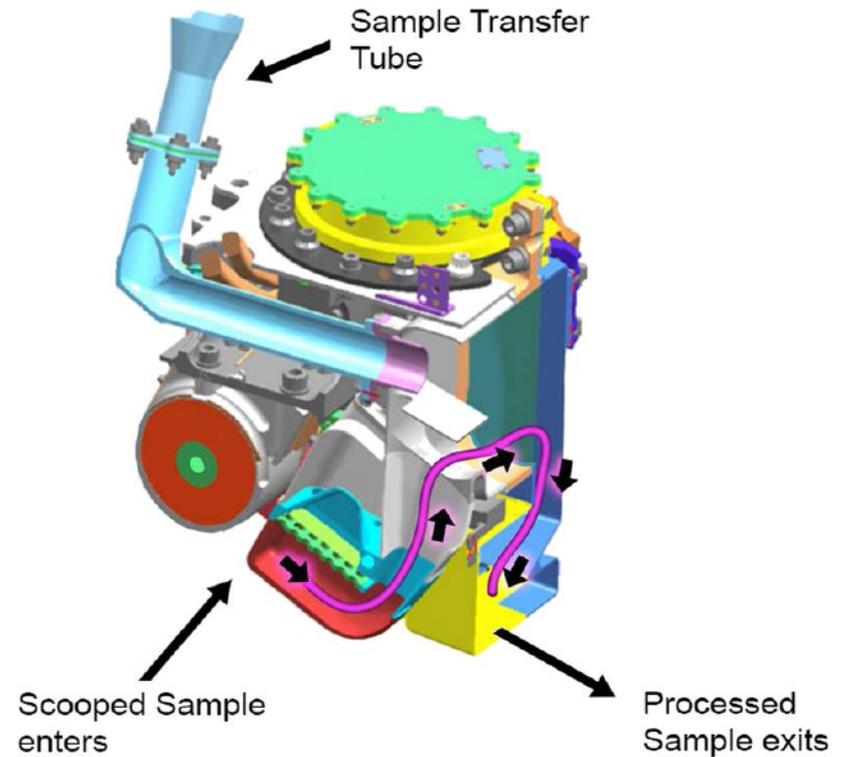
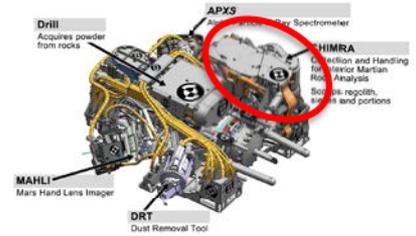
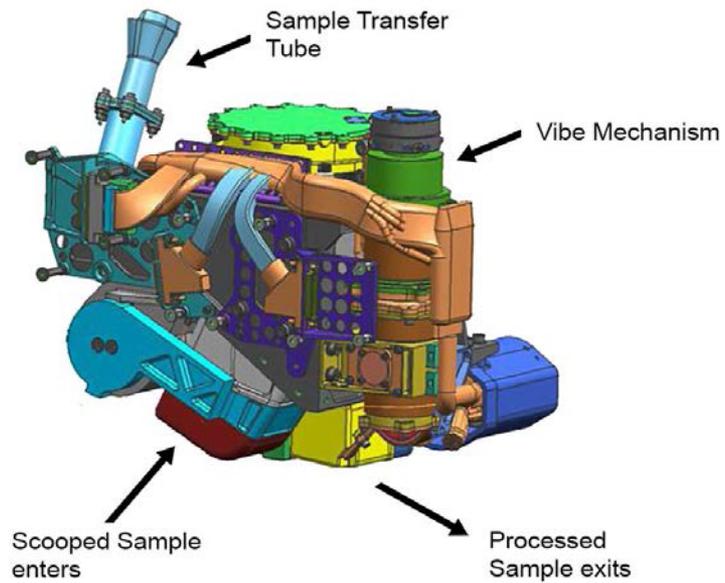
The Drill – Heart of the system



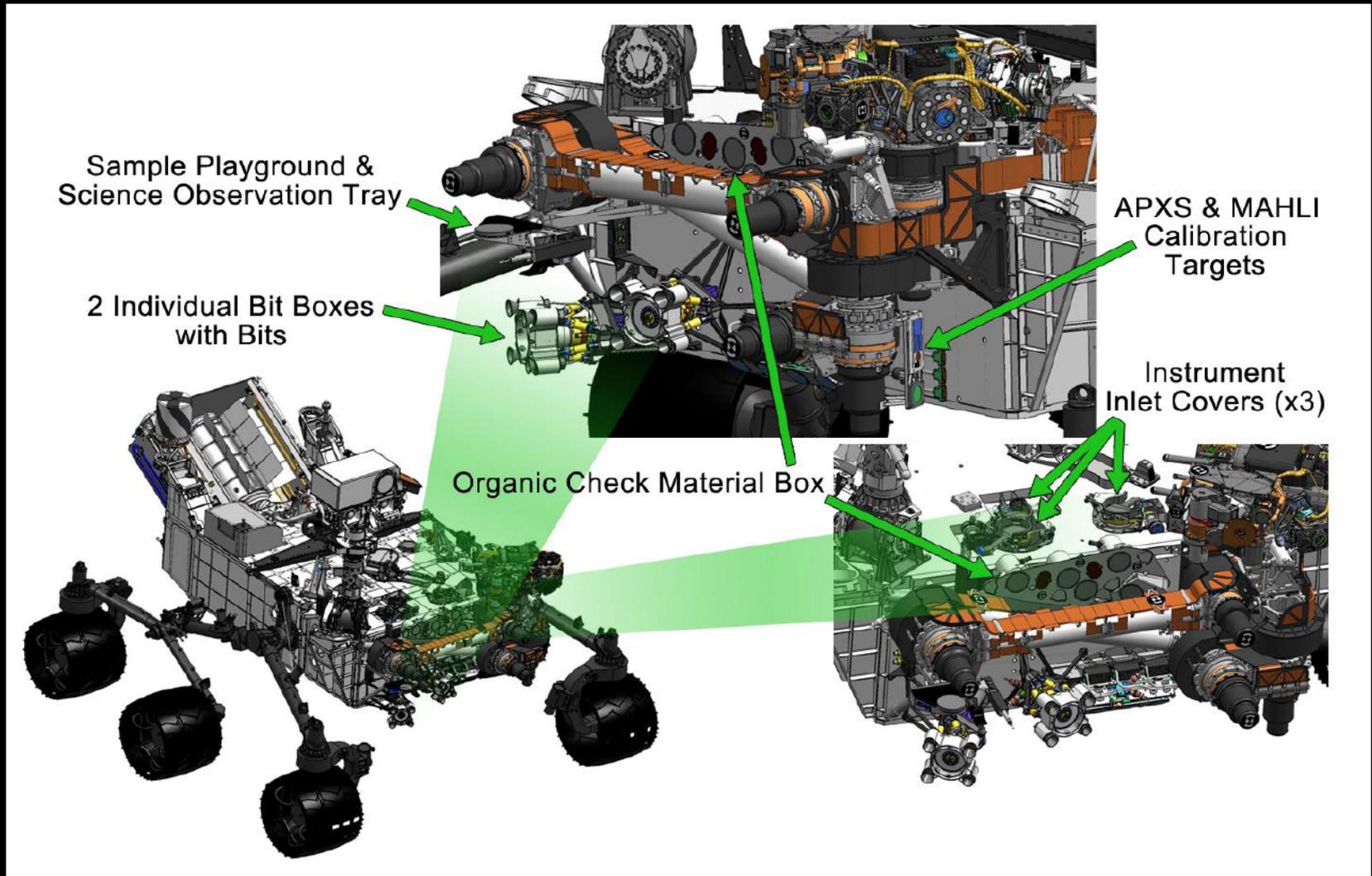
CHIMRA
Hardware location on turret
with sieve highlighted



CHIMRA: Drill Sample Path



CHIMRA: Scooping and Processing

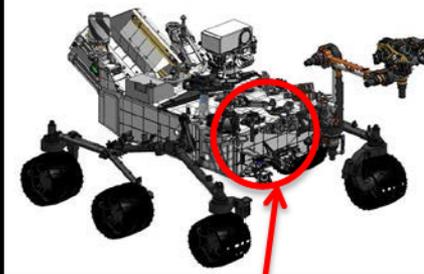
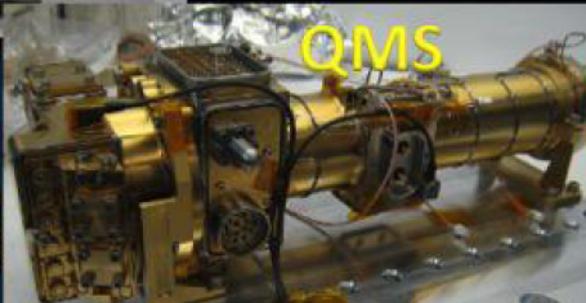
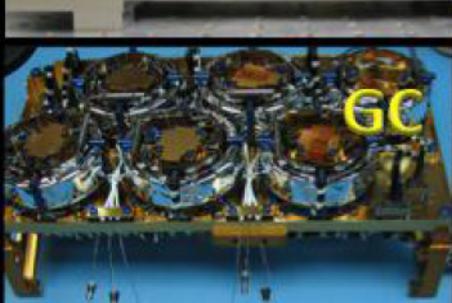
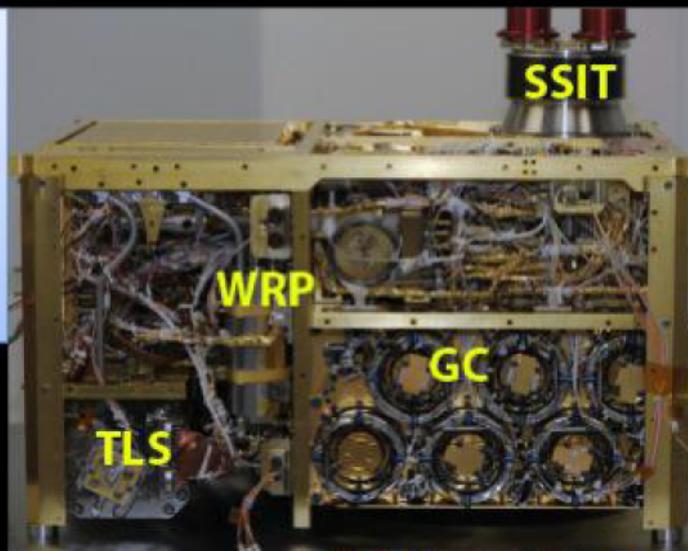


Rover Body Mounted Sampling System Hardware

The SAM suite

SAM suite instruments and major subsystems

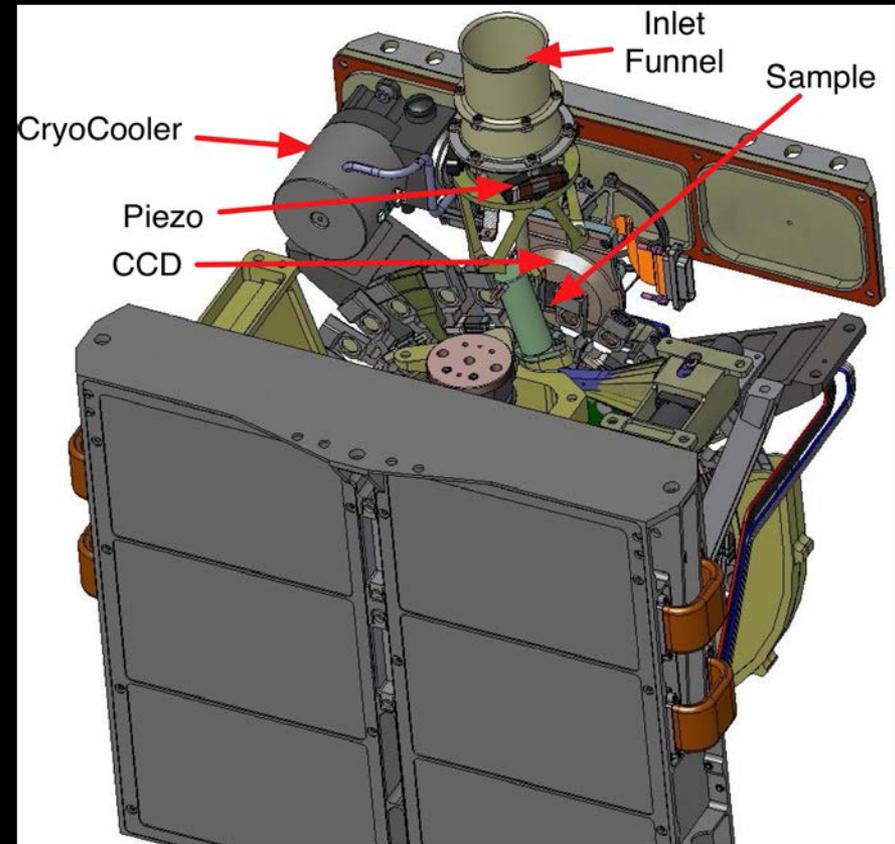
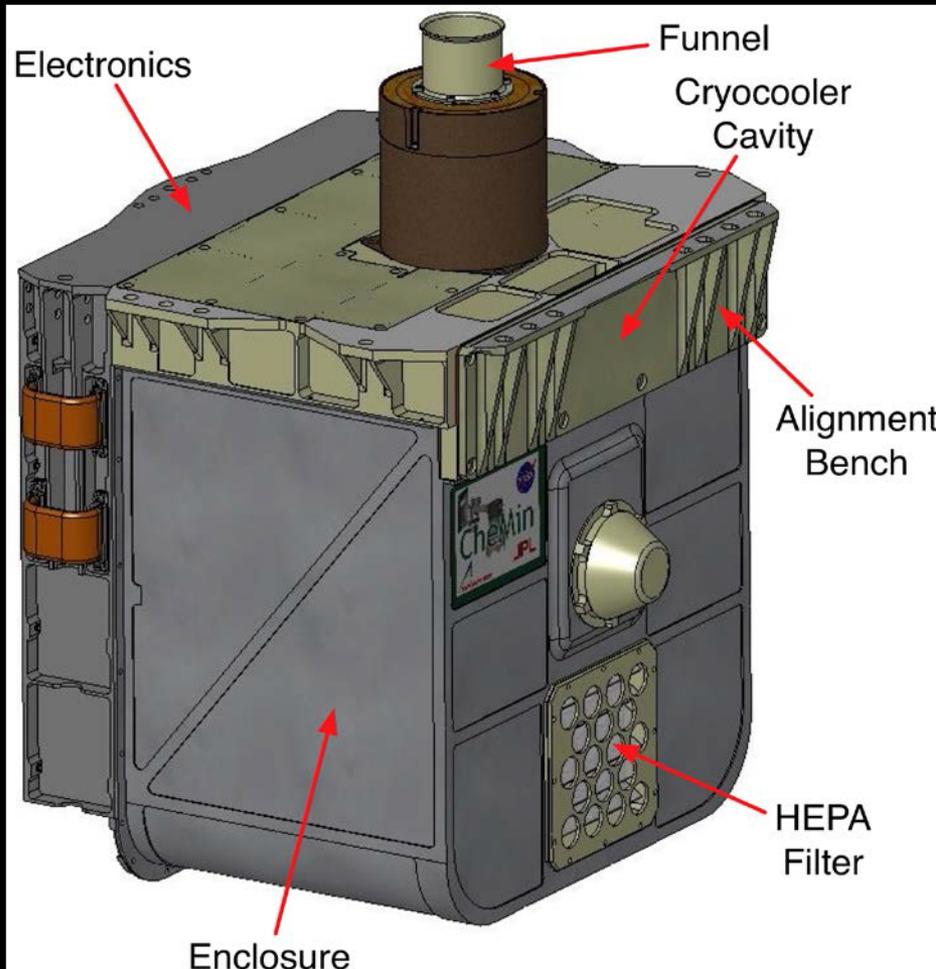
- Quadrupole Mass Spectrometer (QMS)
- 6-column Gas Chromatograph (GC)
- 2-channel Tunable Laser Spectrometer (TLS)
- Sample Manipulation System (SMS)
- Gas Processing System



Inside the rover chassis

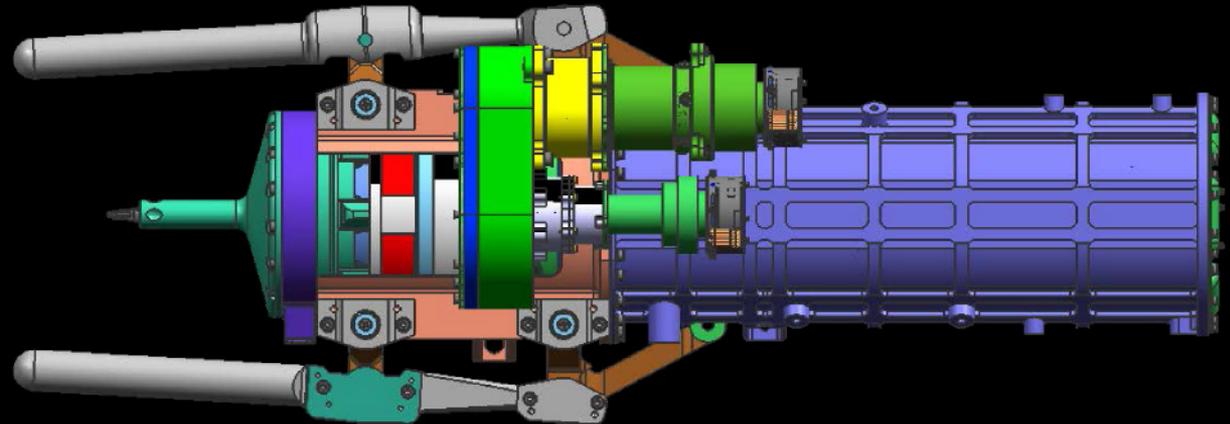
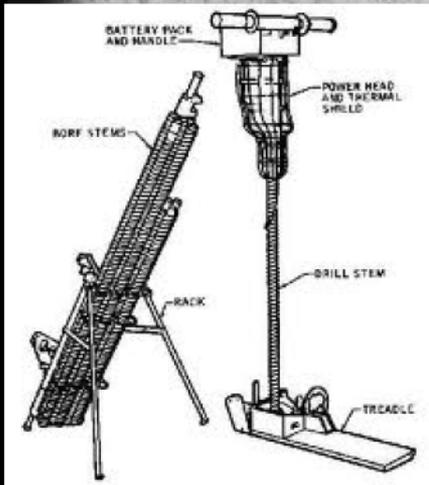
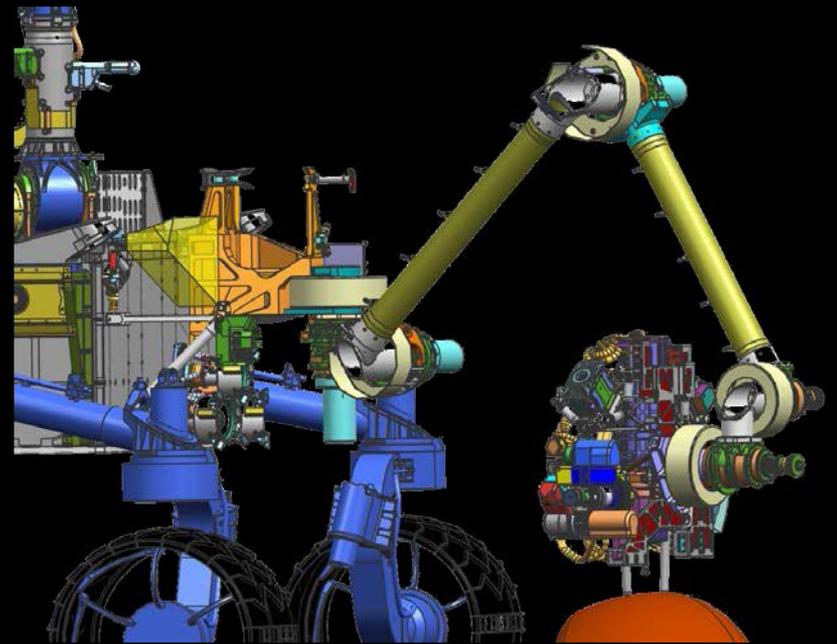


Sample Analysis at Mars (SAM)



Chemistry and Mineralogy (CheMin) – 1st planetary in-situ X-ray diffraction

DEVELOPMENT & TESTING



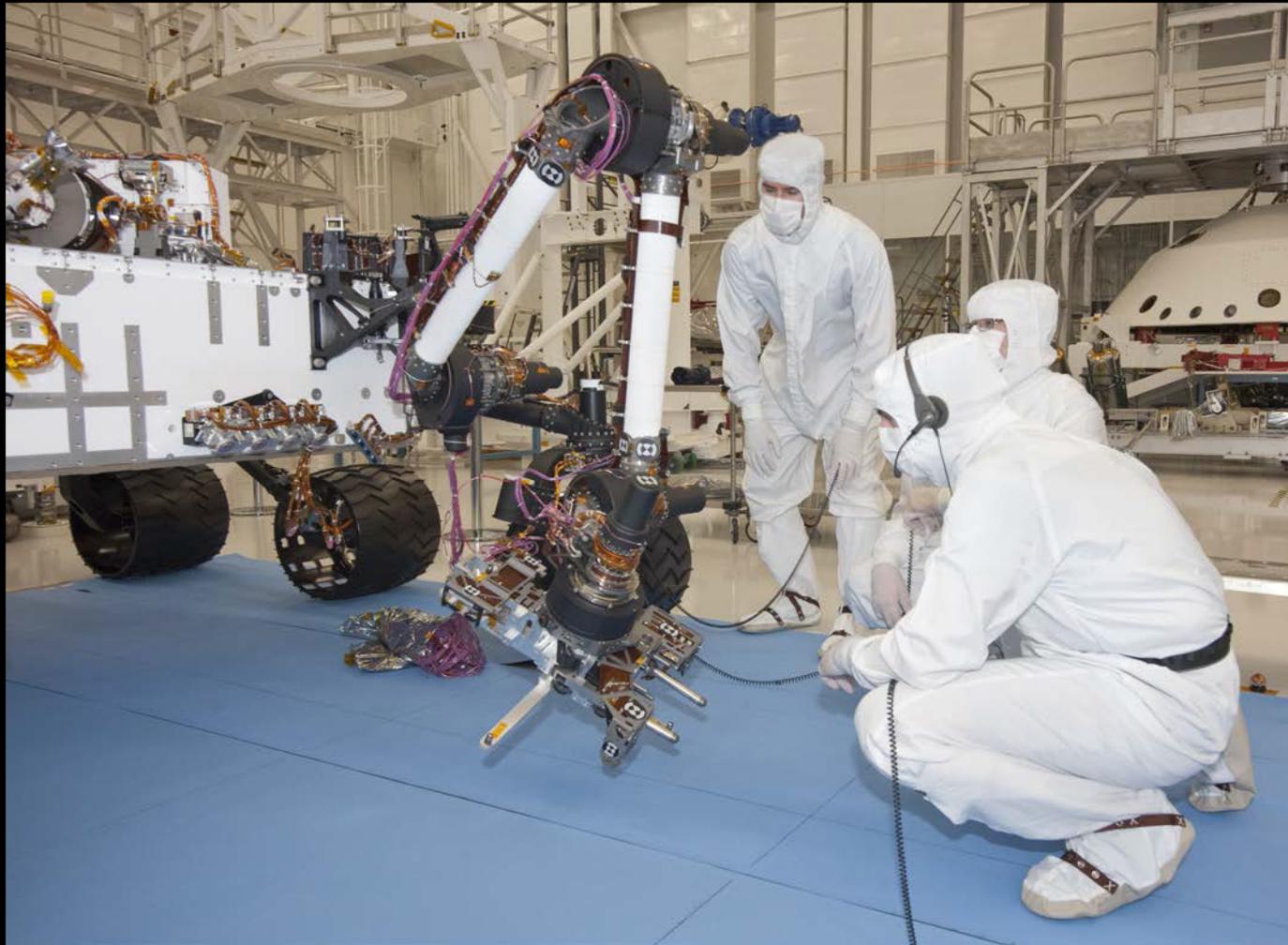
The Last Time the US Drilled Off Earth...



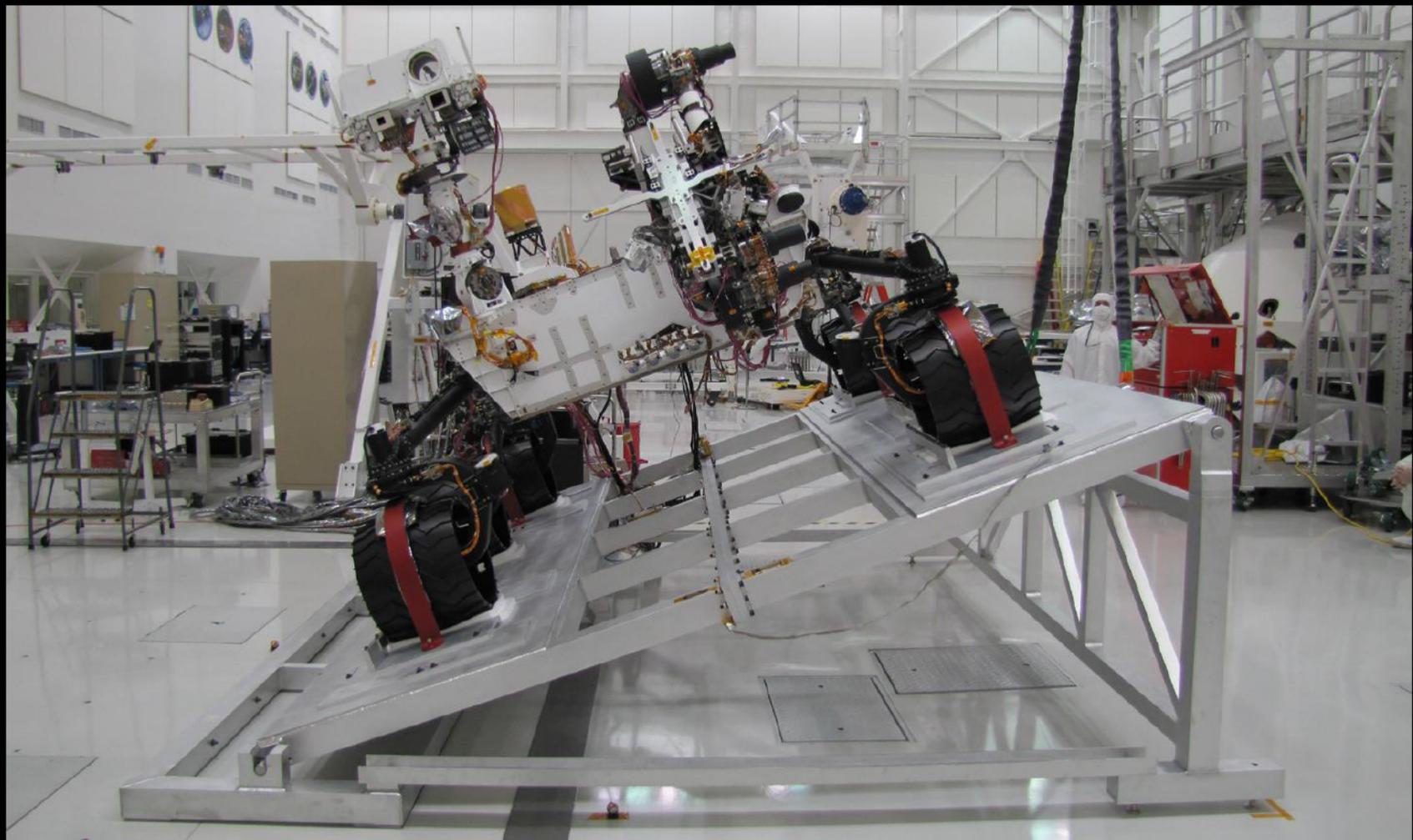
Extensive Drill Development Testing



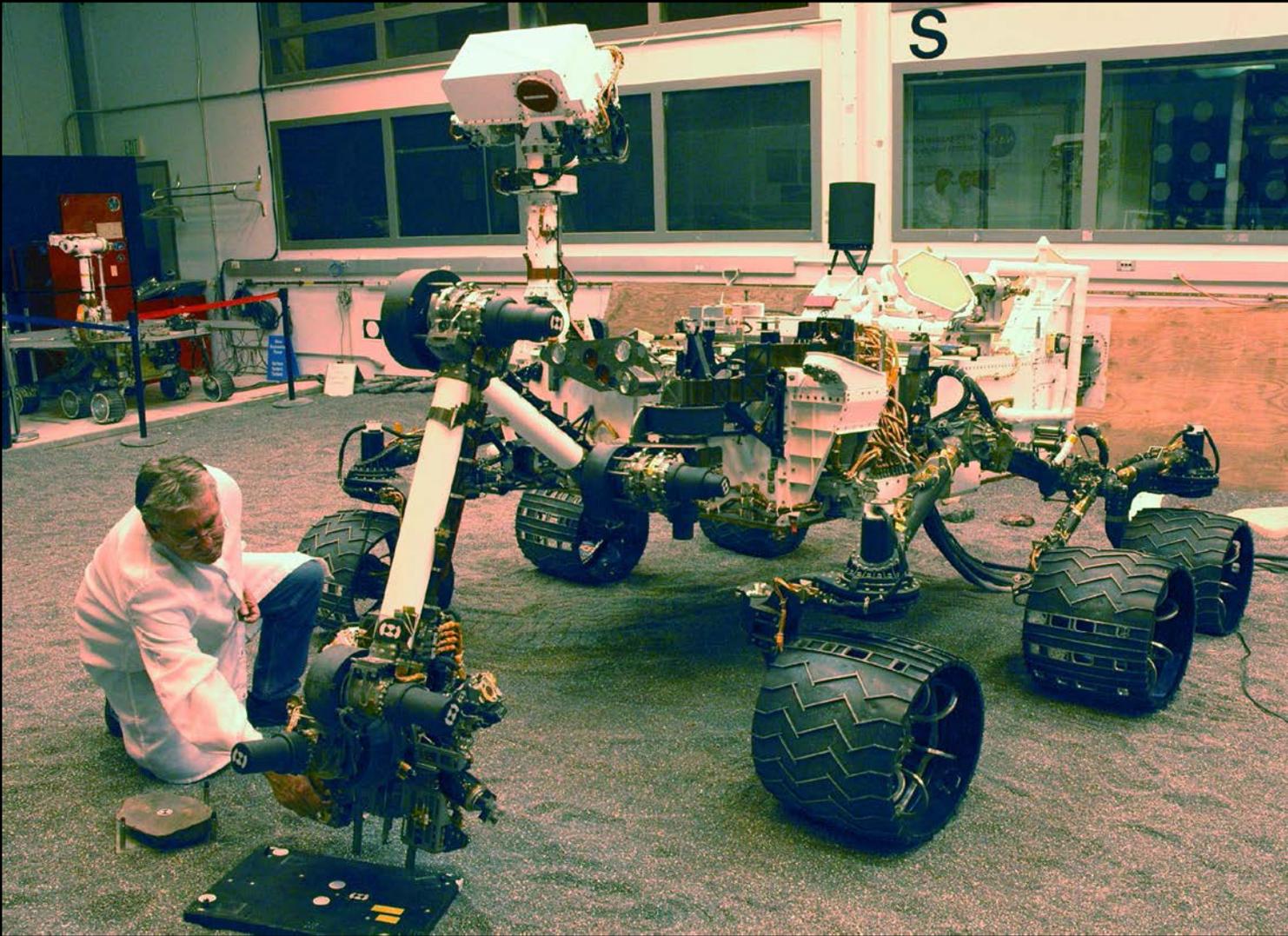
Flight Rover Testing



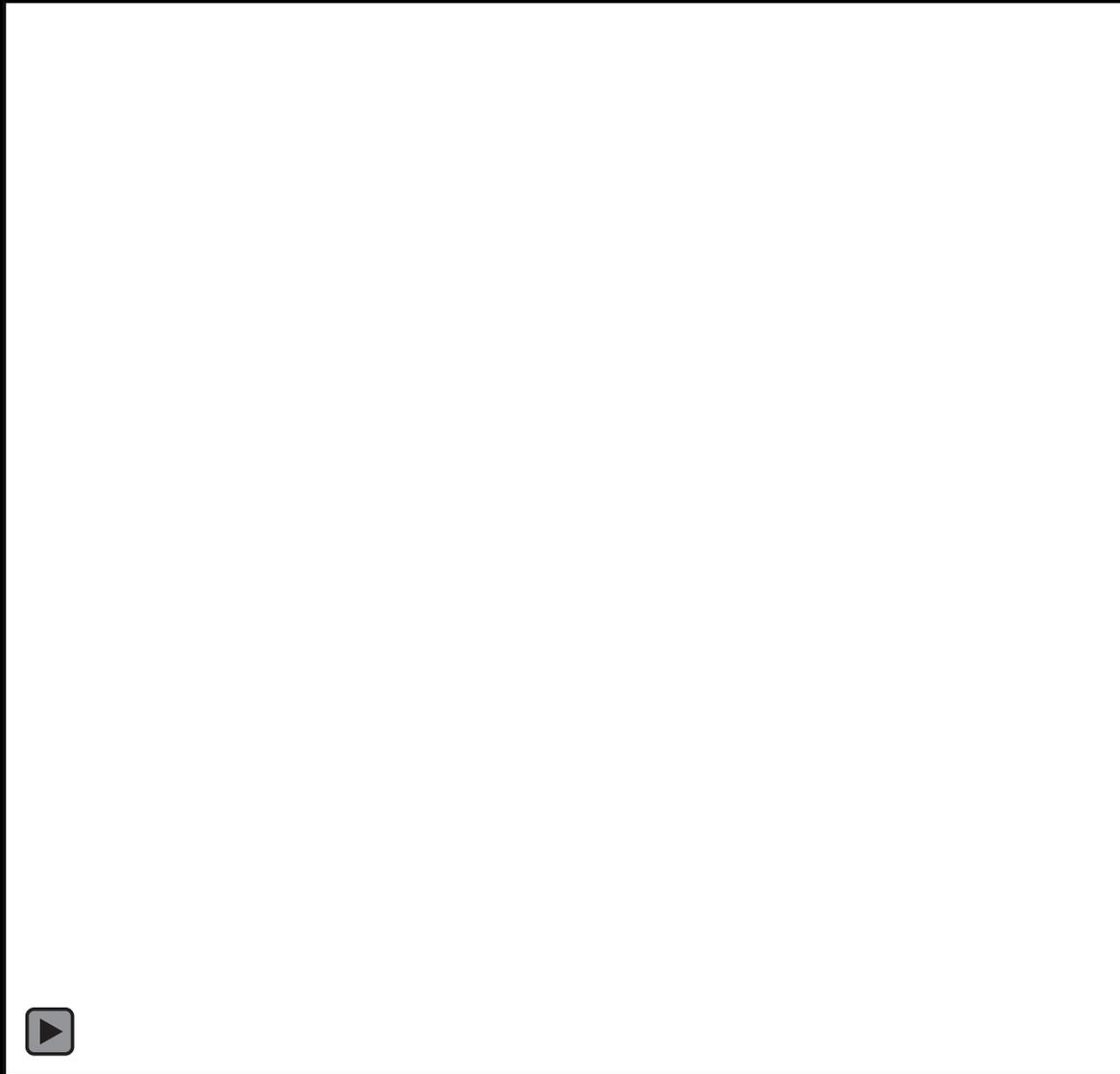
Flight Rover Testing – Arm Calibration While Level



Flight Rover Testing – Arm Calibration at Tilt



Engineering Model Rover Arm Calibration



First Drill Test Using Integrated Arm/Drill

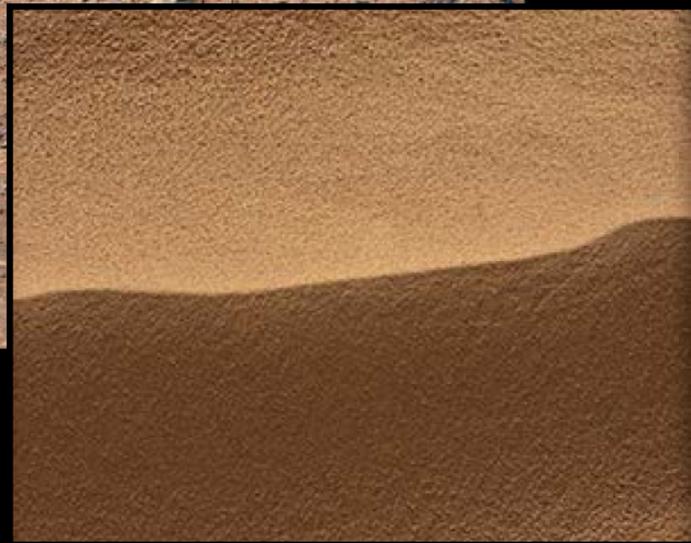


Scooping Test

OPS HIGHLIGHTS



First Drill Hole on Mars! By Anyone!



NASA/JPL-Caltech/MSSS



Windblown “sand shadow” at the Rocknest site

**Wheel scuff
to confirm
depth of
sand, for
safe
scooping**





NASA/JPL-Caltech/MSSS



MAHLI view of coarse (0.5 to 1.5 mm) sand from the ripple's surface, and fine (< 0.25 mm) sand on wall and floor of trench

Curiosity self-portrait at Rocknest

Assembled from 55
MAHLI images

Shows four scoop
trenches and wheel
scuff





NASA/JPL-
Caltech/LANL/CNES/IRAP/IAS/LPGN



NASA/JPL-Caltech/MSSS

NASA/JPL-Caltech/MSSS



Curiosity's 1.6-cm drill bit, drill and test holes, and scoop full of acquired sample

CREDITS

Daniel Limonadi – for his valuable assistance in testing and presentations.