

The Planetary Instrument for X-Ray Lithochemistry (PIXL) on the Mars 2020 Mission

Marc Foote
Abigail Allwood
Lawrence Wade
Jet Propulsion Laboratory

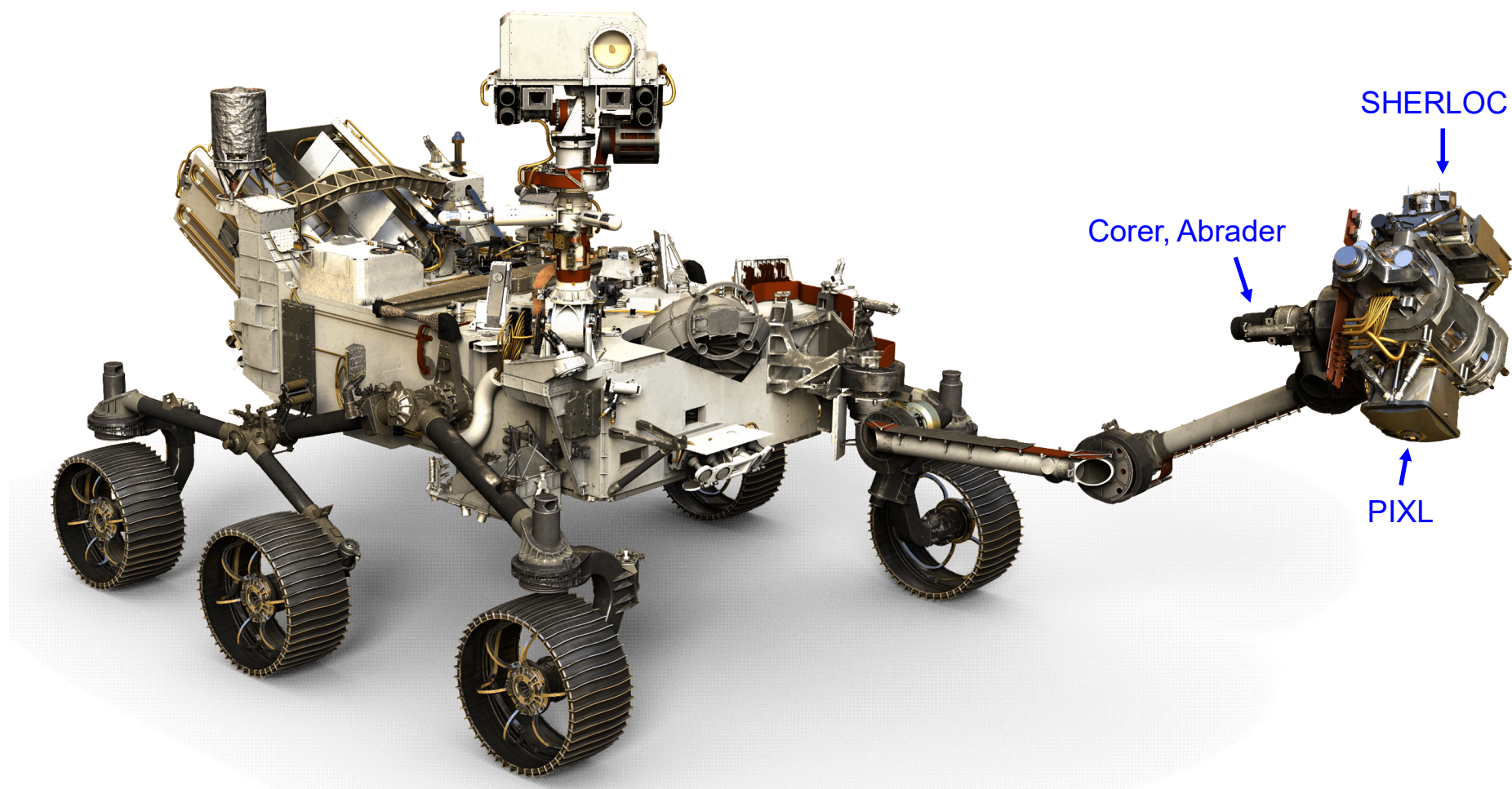


The technical data in this document are controlled under the U.S. Export Regulations. Release to foreign persons may require an export authorization

Mars 2020 Project

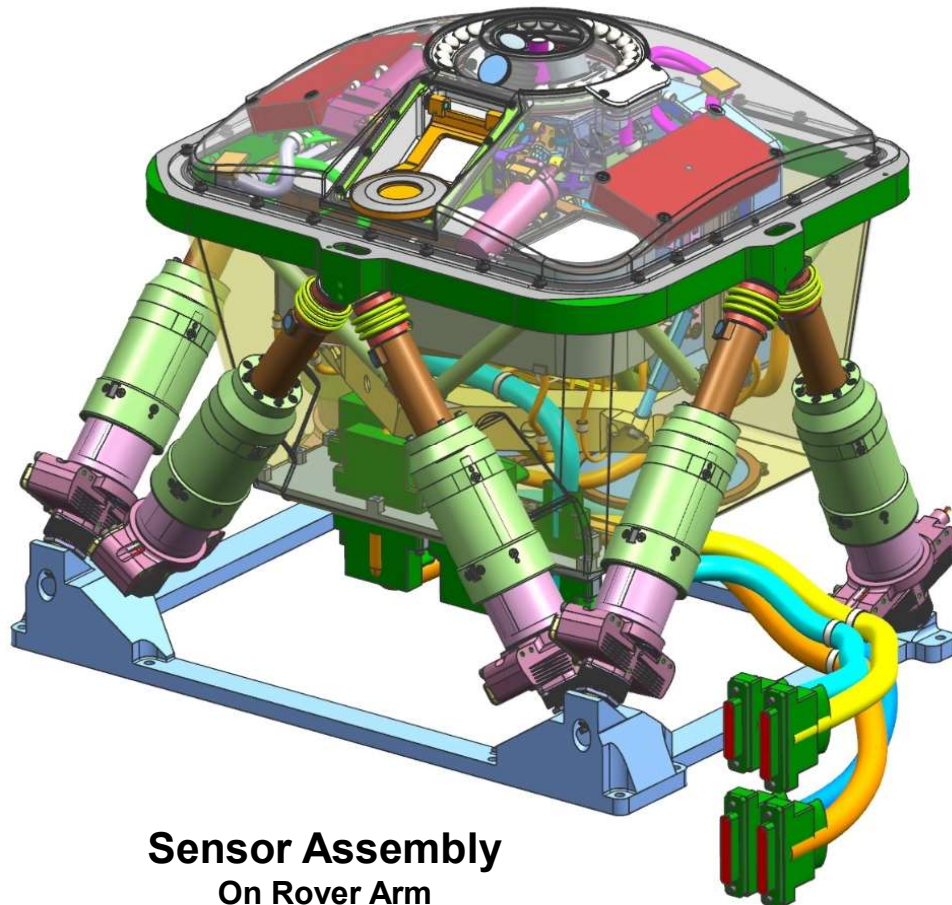
PIXL on the Mars 2020 Rover

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



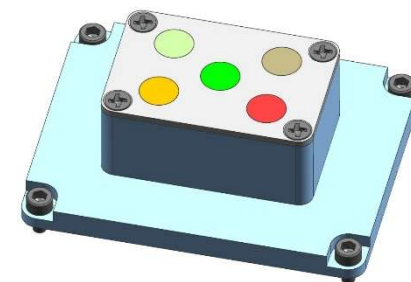
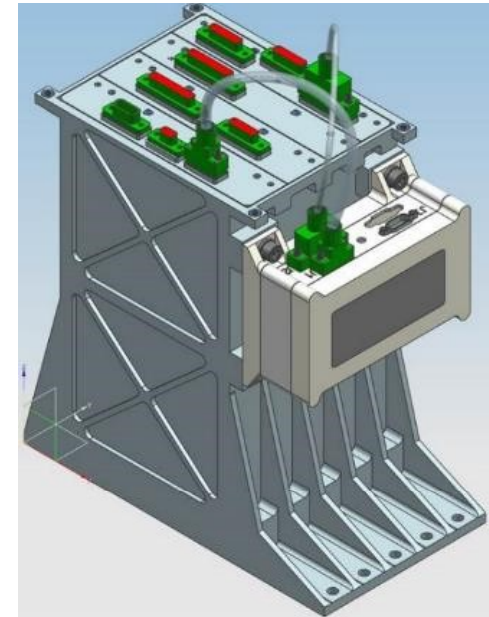
Major PIXL Assemblies

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



Sensor Assembly
On Rover Arm

Electronics
In Rover Body

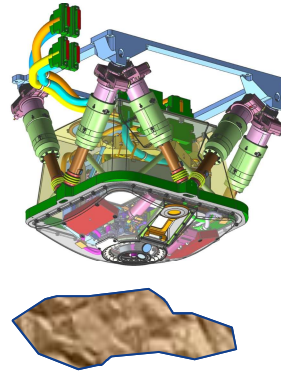


Calibration/Reference Target
On Rover-Arm Shoulder

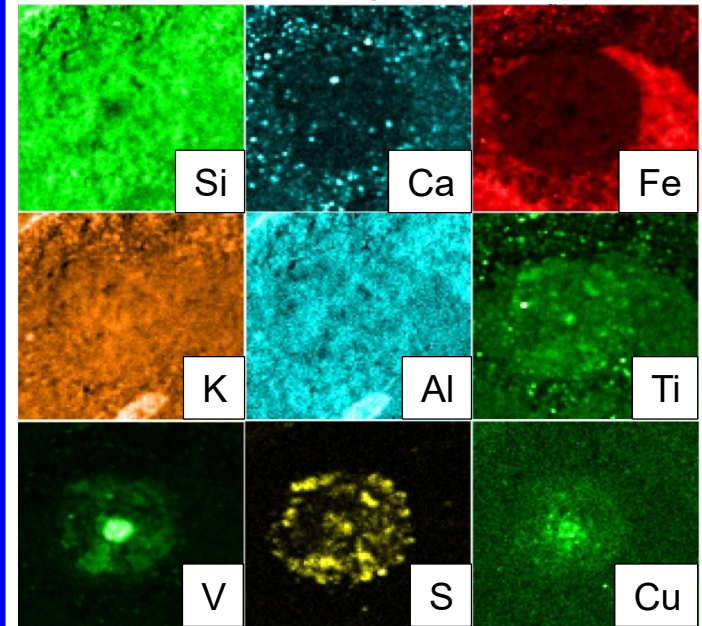
What Does PIXL Do?

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

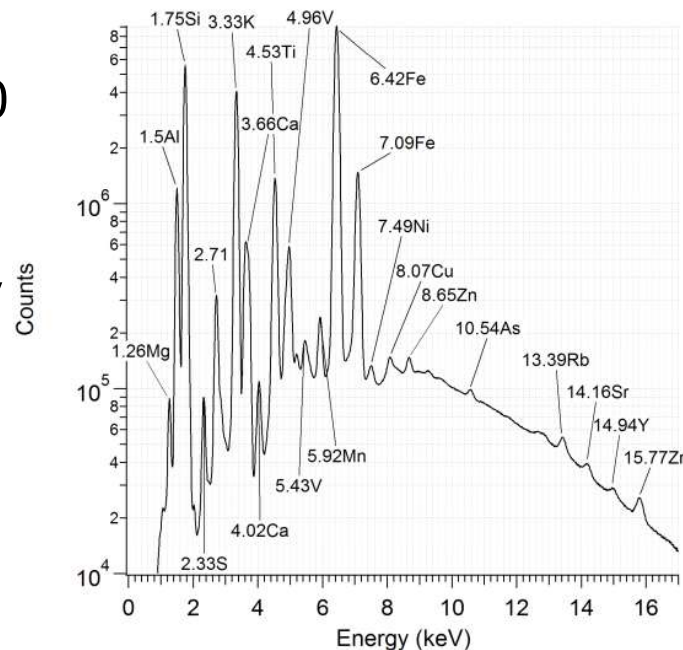
1. Rover Arm places PIXL about 25 mm from rock



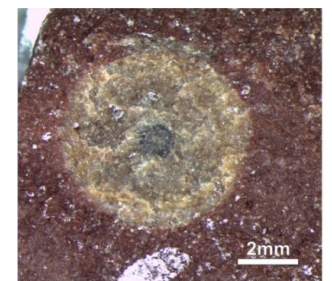
3. PIXL Sensor is scanned to produce map of elemental composition



2. Focused 150 μm X-ray spot on rock produces X-ray spectrum showing elemental composition



4. Images from cameras provide context



PIXL science objectives

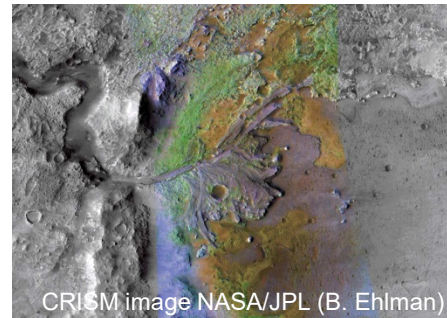
PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

PIXL *in situ* science objectives:

- 1 Interpret past environments, and their habitability and biosignature preservation potential
- 2 Detect potential chemical biosignatures
- 3 Characterize other kinds of potential biosignatures
- 4 Provide detailed geochemical basis for selection of compelling samples for future return to Earth

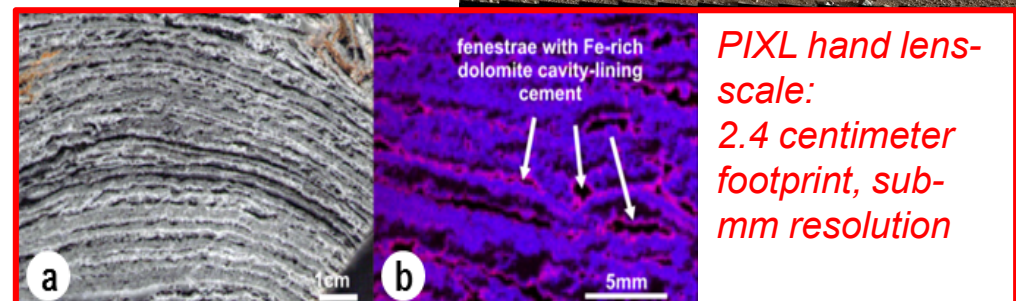
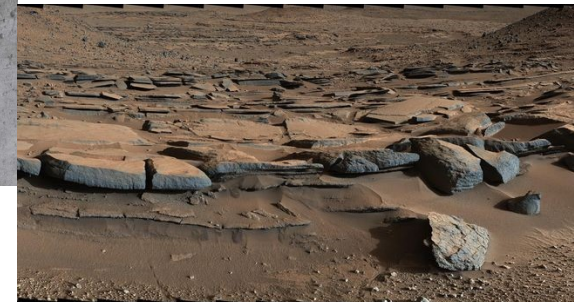
PIXL and Returned Sample Science

Context is key for sample data interpretation. PIXL bridges regional>outcrop>sample scales:

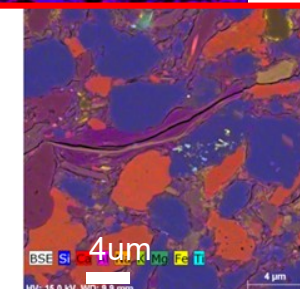


ORBIT: Regional scale

ROVER MAST: Outcrop-scale



RETURNED SAMPLES: Micron-scale



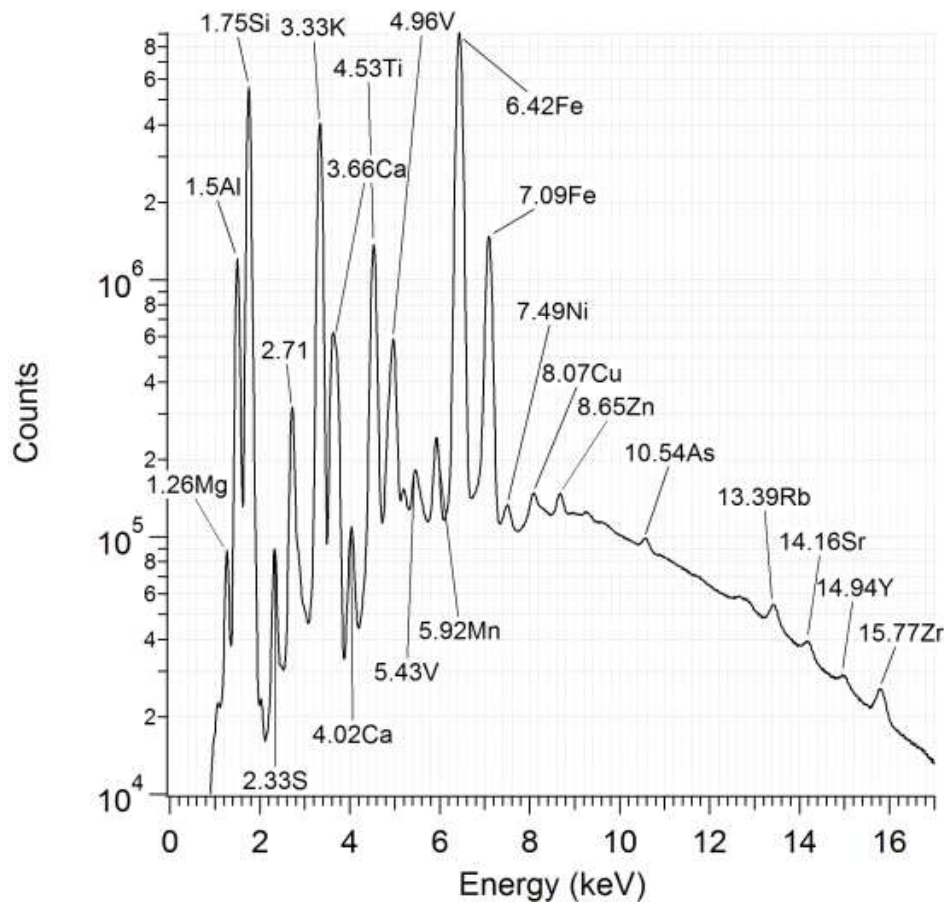
http://www.beg.utexas.edu/gcc/miocene/stratigraphic_contentainment.php

PIXL: A Geochemistry and Petrology Investigation

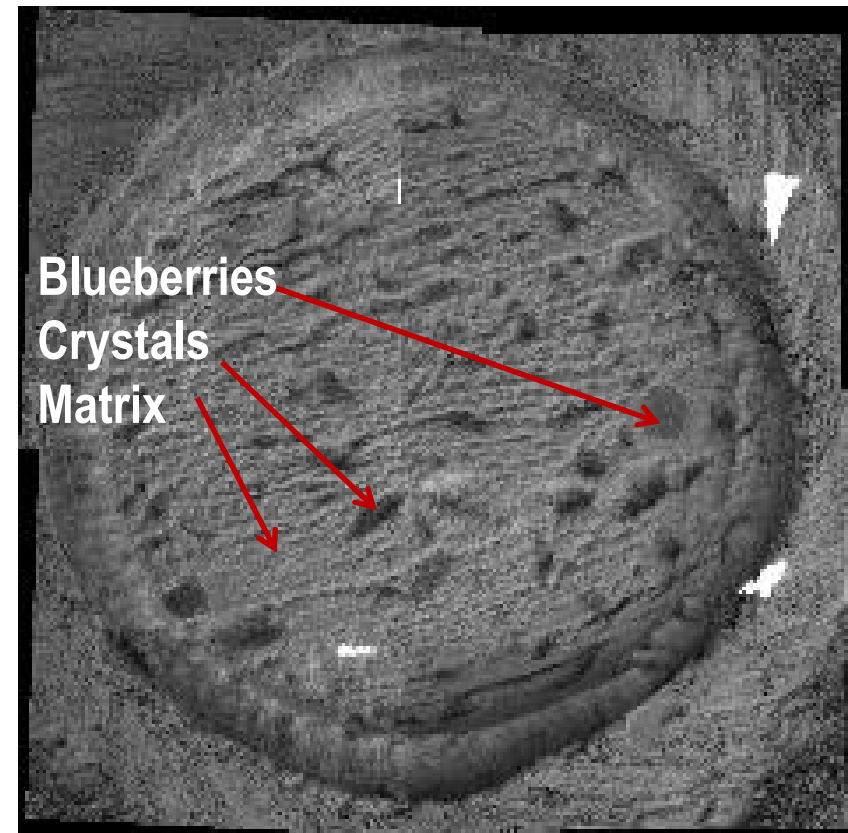
PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

Petrology: correlation of rock **chemistry** & **texture** to interpret geologic origin and history

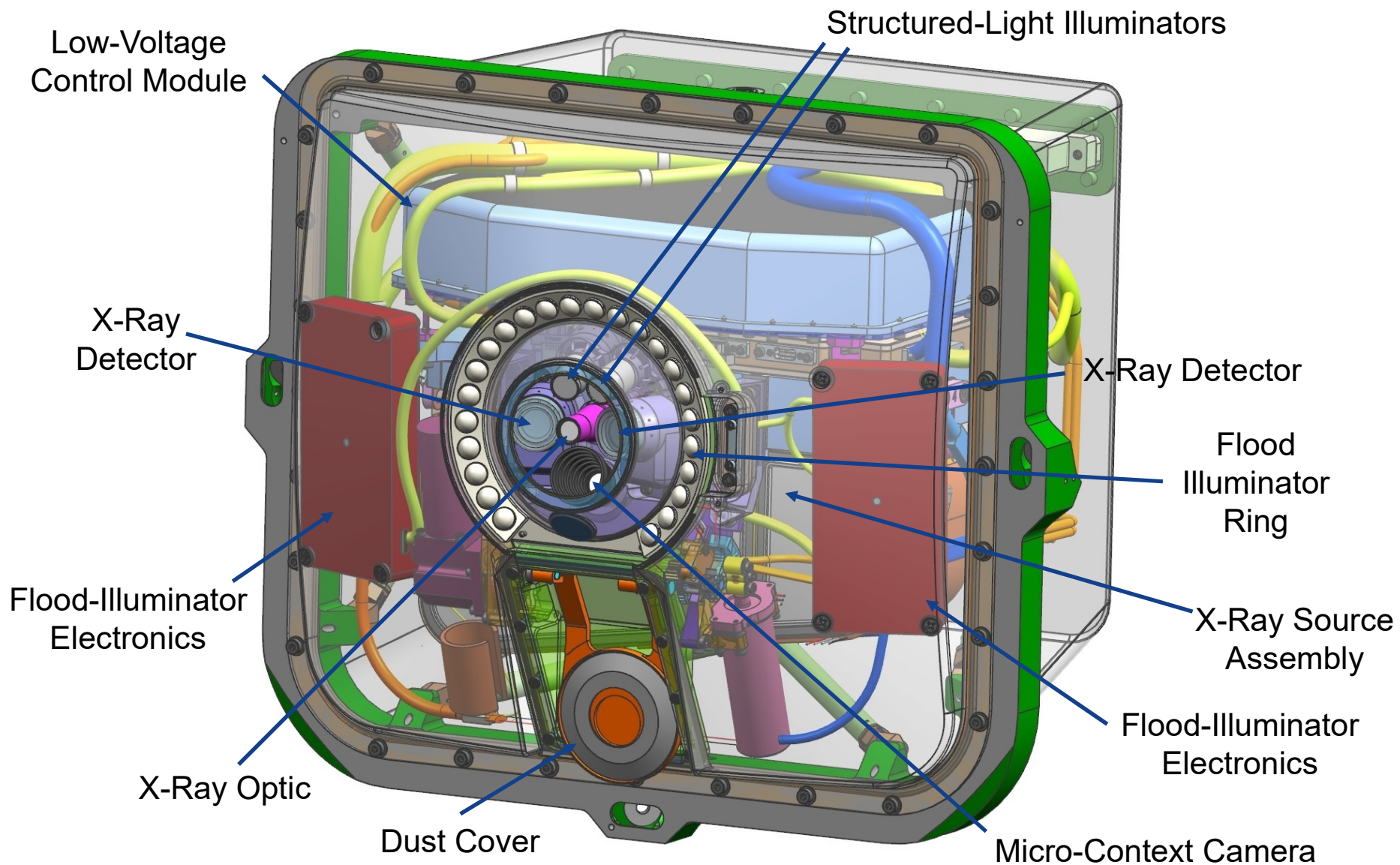
CHEMISTRY



TEXTURE



The PIXL Sensor Head



PIXL Engineering Model – Complete and Under Test

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



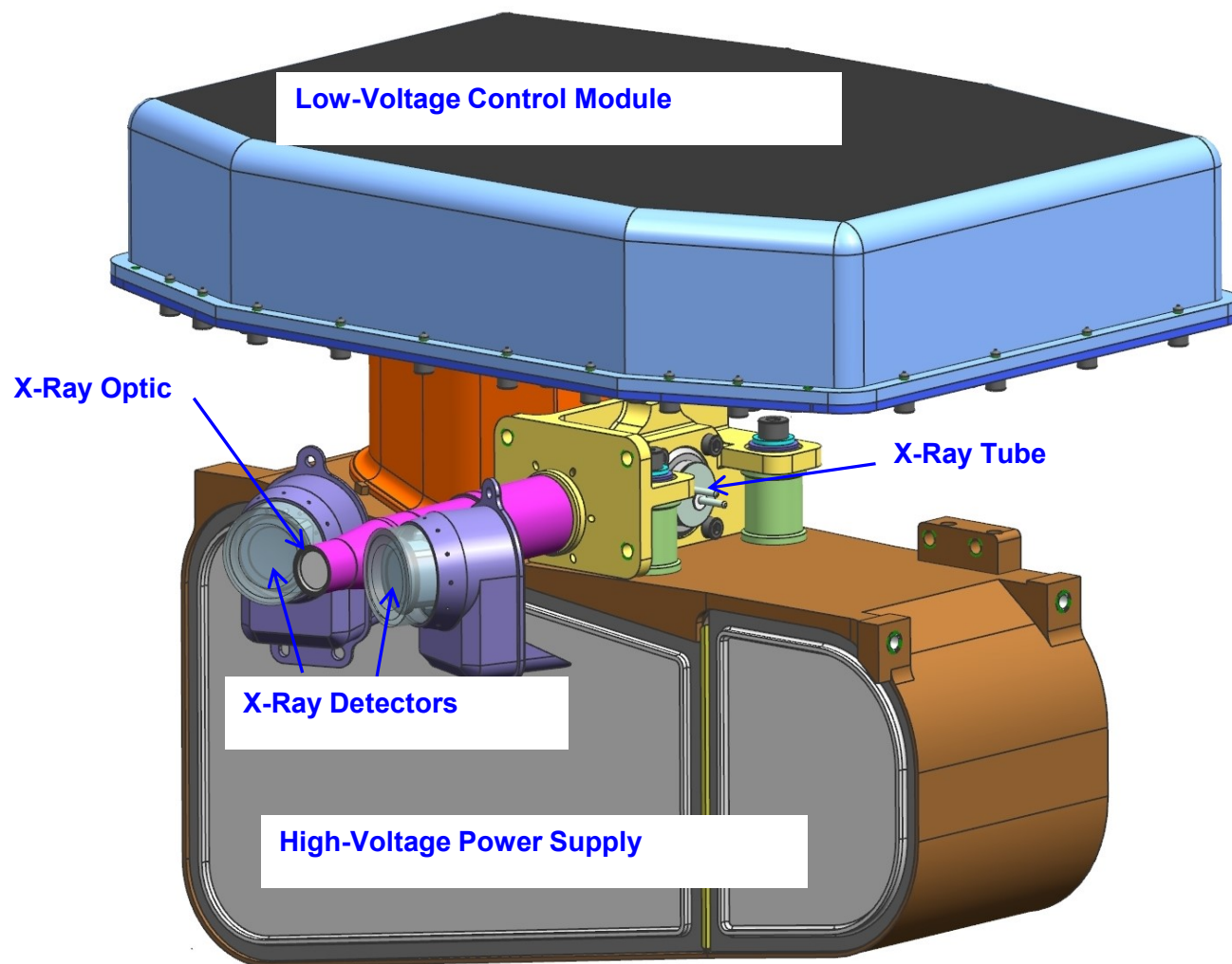
01/06/2018

Planetary Instrument for X-Ray Lithochemistry

8

X-Ray Subsystem: Overview

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

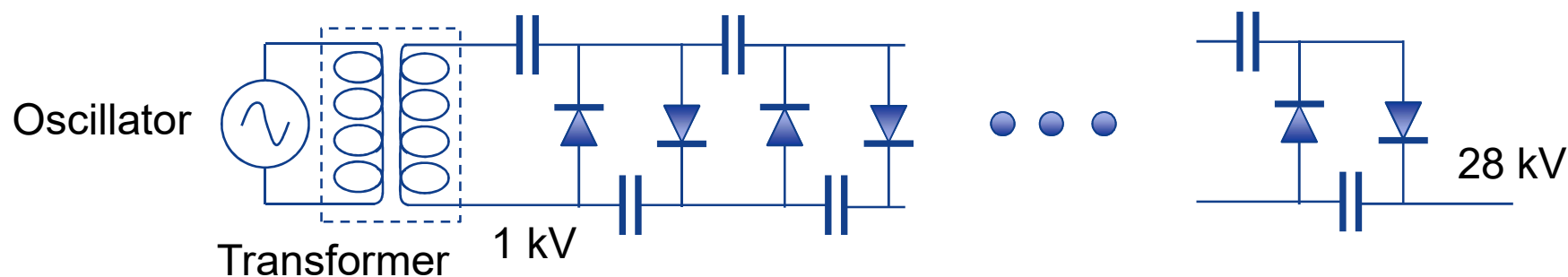


X-Ray Subsystem: Producing High Voltage on Mars



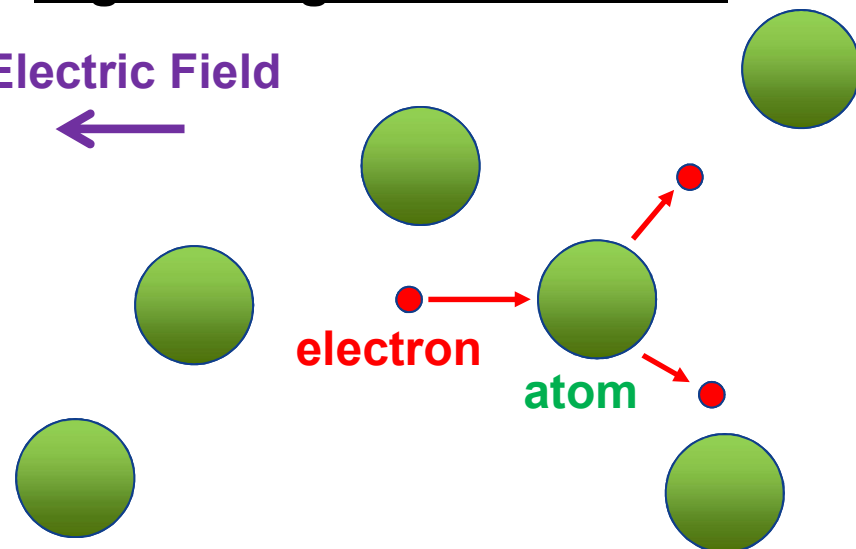
PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

Production of High Voltage



High-Voltage Arcs in Gases

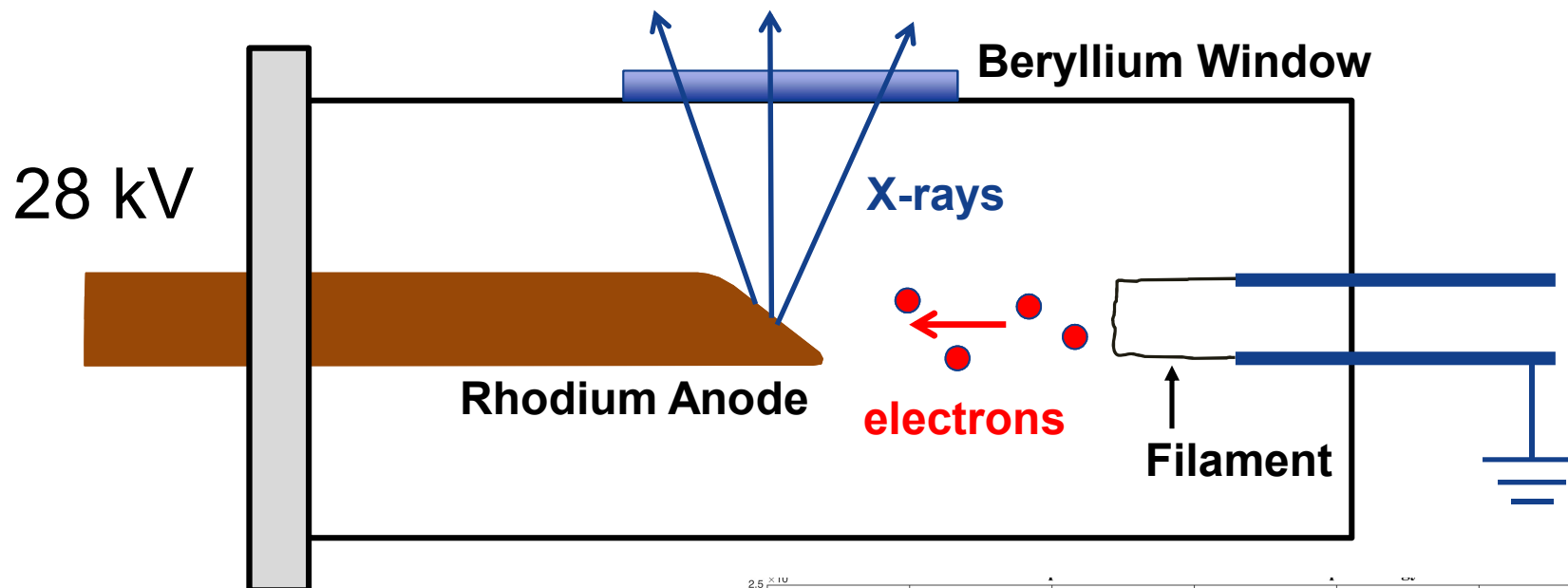
Electric Field



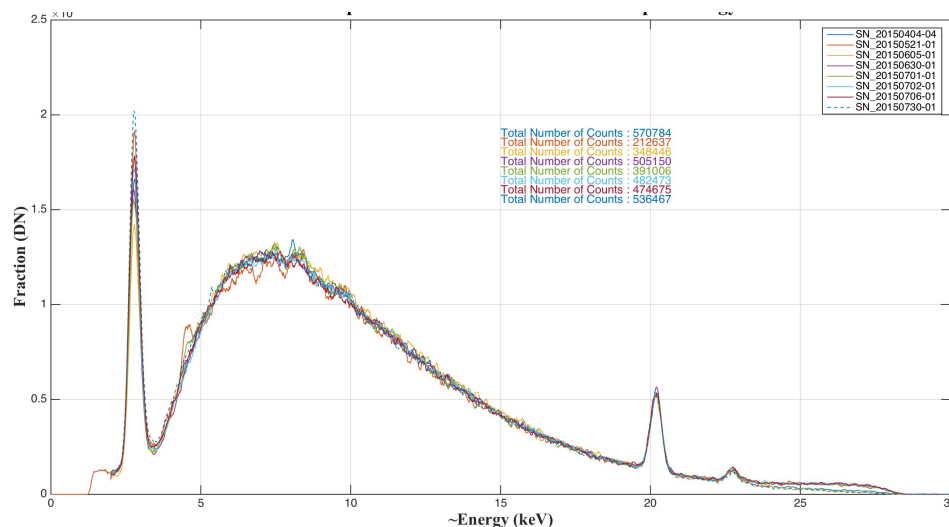
Mars atmosphere, at 4-8 Torr, provides a perfect environment for high-voltage arcs. All high-voltage elements are potted in polyurethane to prevent arcing.

X-Ray Subsystem: The X-Ray Tube

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY



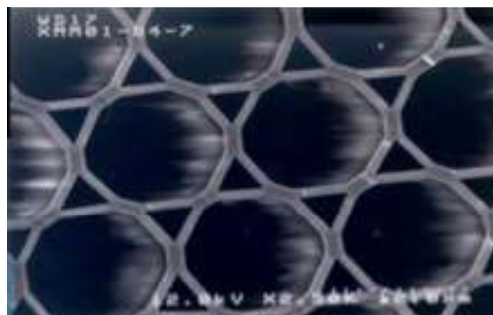
Moxtek X-Ray Tube



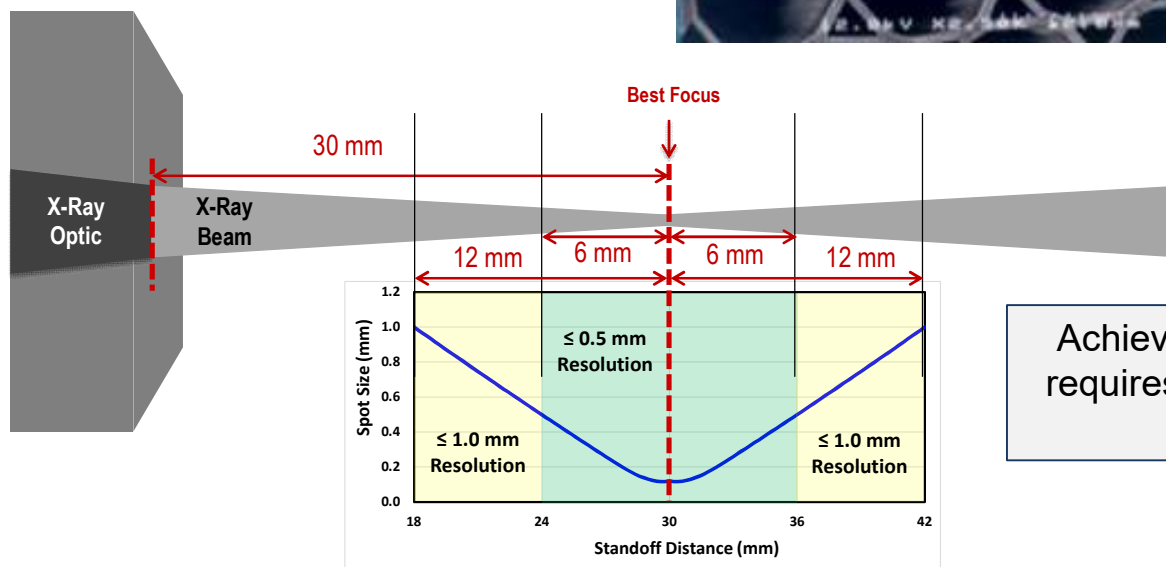
X-Ray Subsystem: X-Ray Optic

PLANETARY INSTRUMENT FOR X-RAY LITHOCHEMISTRY

X-ray microcapillary optic contains thousands of microscopic glass tubes. X-rays follow tubes by grazing-incidence reflection.



XOS Inc X-Ray Optic

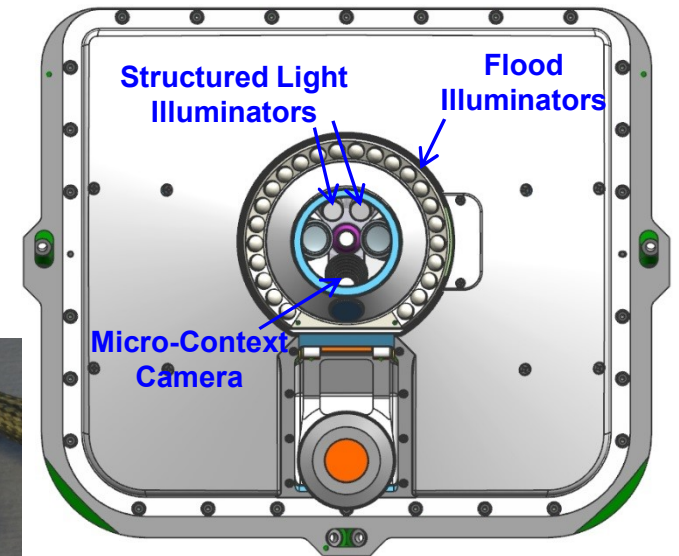


Achieving <200 μm spatial resolution requires maintaining focus (instrument standoff) within 2 mm

Optical Fiducial Subsystem: Tying Texture to Chemistry

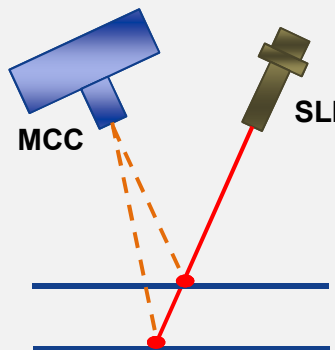
- Provides images to
 - Characterize surface texture and topography
 - Allow image-recognition software to find area of interest
 - Allow image-recognition software to correct for Rover-arm thermal drift
- Provides distance measurements to target for
 - Achieving and maintaining focus
 - Locating X-ray spot
 - Safety (avoiding crashes into rocks)

Micro-Context Camera (MCC)
(Danish Technical University)



Measuring Distance to Target and Target Topography

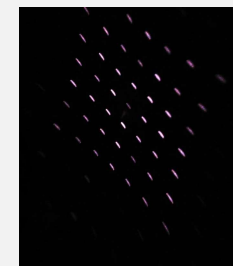
- Structured Light Illuminators (SLIs) project arrays of laser spots
- Micro-Context Camera (MCC) images spots
- Location of spots on MCC focal plane indicates distance to target at spot location
- Software algorithm calculates distances
- Careful clocking of SLIs removes ambiguities in laser spot identification



Structured Light Illuminators

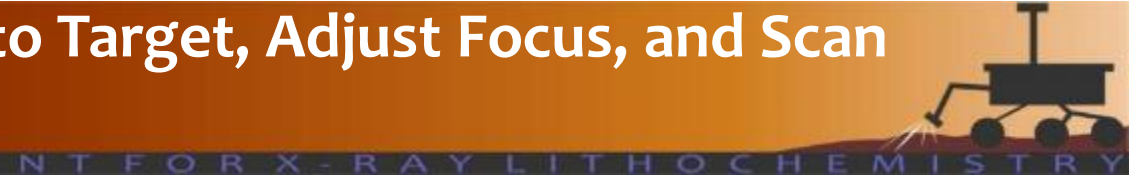


Diffraction Grating



SLI Dot Pattern

Active Hexapod Role: Point to Target, Adjust Focus, and Scan



- 6 actuated struts with integral vibration isolators
- Range 50 mm in XY and 38 mm in Z
- Three Roles:
 - Pointing to target - FSW recognizes features in PIXL camera images and directs hexapod to desired location
 - Adjust Focus - Optical Fiducial Subsystem measures distance to target, hexapod is adjusted for optimal X-ray spot focus
 - Scan – Many small hexapod movements create scan pattern, software monitors thermal drift of arm and directs appropriate corrections

