CANADIAN SCIENCE INSTRUMENTS FOR PLANETARY EXPLORATION

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Introduction

In recent years, MDA, in collaboration with other Canadian companies, has been building a series of science instruments for planetary exploration. These range from sensors for navigation and workspace characterization, to chemical and elemental analysis of the surface, to subsurface and atmospheric investigations – thus complementing each other for maximum science return.

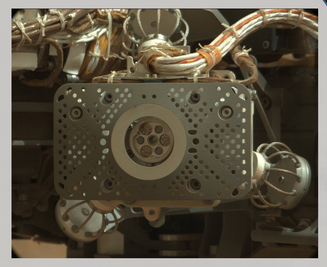
For each sensor described herein, a critical part of the development process was the early involvement of the science community, typically led by a principal investigator (PI). Such involvement leverages the technical knowledge of the various investigators, and thus maximizes the scientific returns.

These instruments are currently at various levels of maturity, ranging from flight heritage (APXS, Phoenix) to prototype (TEMMI, CFSL) to detailed design (RSIC, LGPR).

Alpha Particle X-ray Spectrometer

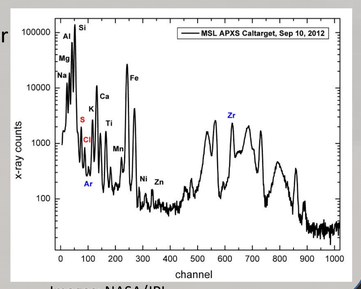
Highlights:

- Payload contribution to the Mars Science Laboratory (MSL) mission 2011
- Third generation after Sojourner (1997) and MER rovers (2003)
- Intended for elemental analysis
- Improved sensitivity (factor 3 – 6)
- PIXE and XRF modes using ^{244}Cm sources
- Improved temperature range (up to -5°) allowing daytime operation due to Peltier cooler



Main capabilities:

Elemental range	Na through Sr
Energy range	0.7 – 25 keV
Data acquisition	3 hours typ.
Power	8 W
Total mass	1.64 kg



See also abstract for talk by Dickinson et al.

Images: NASA/JPL

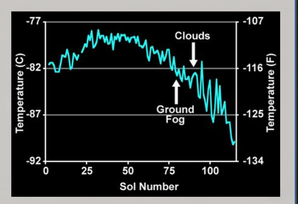
Phoenix METeorological Station

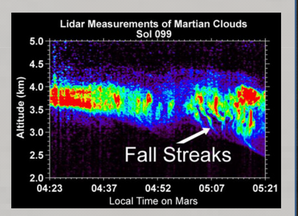
Highlights:

- Payload contribution to the Mars Phoenix Lander Mission 2007
- Intended for meteorological observations (temperature, pressure, atmosphere) on Mars
- Lidar observed dust, clouds, ground fogs and snow falling to surface of Mars

Main capabilities:

Lidar range	50 m – 20 km
Pressure range	5 – 12 hPa with 20 Pa accuracy
Temperature range	-140° - +60° C
Maximum power	30 W lidar, 3W pressure&temp.
Total mass	6 kg



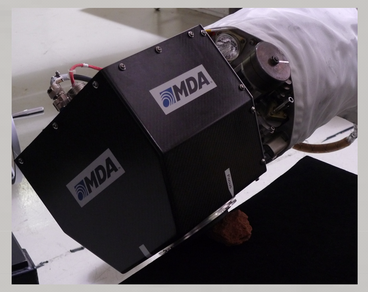


Images: NASA/JPL-Caltech/University of Arizona/Canadian Space Agency

Three-dimensional Exploration Multi-spectral Microscopic Imager

TEMMI is:

- a terrestrial prototype
- of a high-resolution colour microscope
- with 3D and multispectral capabilities
- intended for space exploration (Mars, Moon)
- for geological investigations
- mounted at end of a robotic arm on a rover platform



Main capabilities:

Optical resolution	≤ 5 µm (10 µm)
3D resolution	5 µm (x,y) × 2 µm (z)
Working distance	25 mm
Illumination	8 wavelengths from 455 nm to 850 nm
Focusing	Manual and autofocus with 25 mm travel
Modes	Colour, 3D, fluorescence (365 nm), reflectance (at 8 bands)

For more details and data products see poster by Coulter et al.

Compact Fast Scanning Lidar

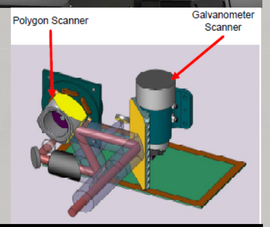
Highlights:

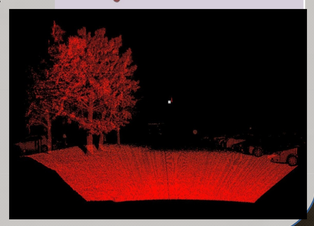
- A prototype of a compact, low-cost active sensor
- Based on a lidar scanner using a polygon/galvo scanner
- Dual use as navigation sensor for small/medium rovers and science instrument for workspace mapping and investigation

Main capabilities:

Maximum Range	> 120 m(*)
Field of View	60˚ x 54.5˚
Lateral Resolution	2-50 mrad (programmable)
Range accuracy	2 cm (1 σ)
Angular accuracy	1.3 mrad RMS
Frame Update Rate	up to 6 Hz (programmable)
Point rate	100k / 400k per s (programmable)
Size	140 x 175 x 210 mm (prototype)

(*) Range and scan performance can be enhanced if eye-safety requirements are relaxed.





Test results:

- Frame rate 1 Hz @ 60°x40° FOV with 2 mrad angular resolution at 120 m

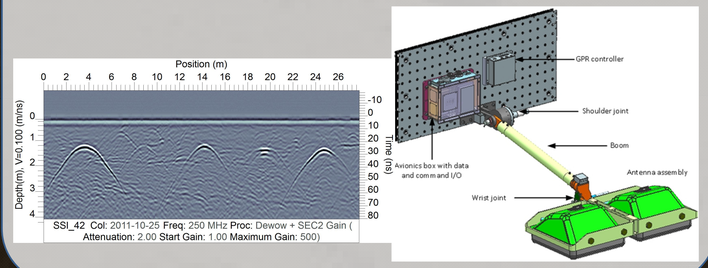
Lunar Ground Penetrating Radar

Highlights:

- Intended for characterization of near-subsurface for geology, resource prospecting and support for future infrastructure
- Based on rugged commercial GPR units
- Two-joint arm for deployment and stowing
- Different modes of operation
- Operation while rover is driving or stopping
- Mounted on the back of a rover for lunar or Martian exploration
- Current status: detailed design of a terrestrial prototype

Main capabilities:

Measurement depth	up to 20 m (soil dependent)
Spatial resolution	< 0.2 m
GPR frequency	250 MHz
Modes of operation	close-coupled to surface elevated at 50 cm above ground elevated at 100 cm above ground
Polarization	Variable antenna orientation



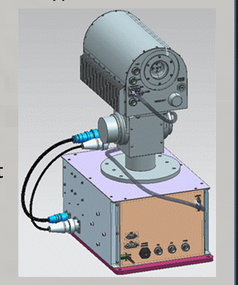
Raman Sensor for the Identification of Carbon

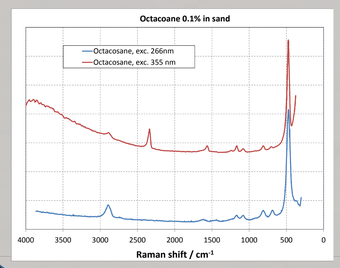
Highlights:

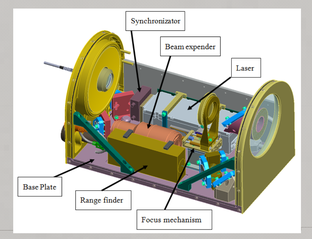
- Intended for detection and characterization of organic (and inorganic) compounds at stand-off distances
- Uses Raman spectroscopy for chemical analysis, in particular organic compounds
- Laser at 266 nm to improve sensitivity
- Gated intensified camera and compact spectrometer
- Mounted on a rover platform for Martian exploration
- Current status: detailed design of a terrestrial prototype

Main capabilities:

Measurement range	2 – 10 m
Sensitivity for carbon	10 ppm (TBC)
Spectral resolution	≤ 0.3 nm
SNR	> 600
Pan-tilt unit	180° panning and 80° tilt 0.1 mrad resolution







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1 MDA 2 McGill 3 Sensors & Software 4 INO 5 York University 6 University of Guelph 7 Western 8 Optech