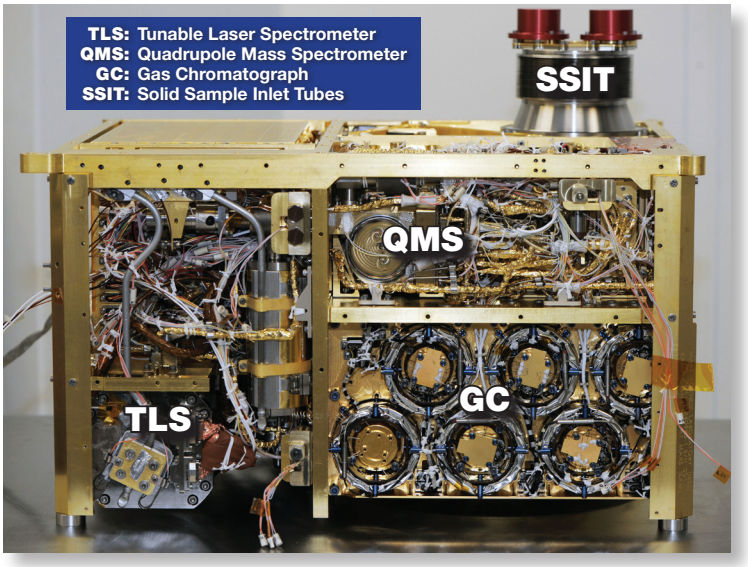
NASAfacts

SAM

Sample Analysis at Mars

A ROBOT DETECTIVE NAMED SAM IS SEARCHING MARS FOR CLUES ABOUT ITS HABITABILITY

The Sample Analysis at Mars (SAM) instrument suite is a complex chemistry lab that's been miniaturized to fit inside the Mars Science Laboratory Curiosity rover. It works with the other instruments aboard Curiosity to learn more about whether Mars could have supported life. SAM was launched toward Mars with Curiosity on Nov. 26, 2011. Curiosity touched down on the Martian surface on Aug. 6, 2012 at 1:32 am Eastern time and SAM analyzed its first sample in early Nov. 2012.



SAM is designed to analyze at least 74 solid samples over its core mission of two Earth years, which is one Mars year. In order to get the most information from each rock sample analyzed, SAM works closely with other instruments on Curiosity to select the most interesting rocks to analyze on our travels in Gale Crater. We will ultimately be traveling up the 5 km high mound, informally known as Mt. Sharp, in the middle of Gale Crater. In the meanwhile, we continue to sniff the atmosphere as we look for changes in ratios of atmospheric gases that might occur on a seasonal basis.

SAM's GADGETS AND INVESTIGATIVE PROCEDURE

Prepare the sample: Curiosity's drill powders rock samples and delivers small portions to SAM for detailed analysis of minerals and volatiles (things that vaporize easily, like water and other gases). SAM can also sample gases directly from the atmosphere by separate inlets.

The Sample Manipulation System (SMS) transports powder delivered from the drill to the SAM inlet and into one of 74 sample cups. The SMS then moves the sample to the SAM oven to release gases by heating it to about 1,000 degrees Celsius (1,800 degrees Fahrenheit). The oven is part of the Chemical Separation and Processing Lab, which enriches and processes gases of interest to investigators.

GAS CHROMATOGRAPH: *separate the molecules*

SAM consists of three instruments, which each specialize in specific types of analysis. Gas from the sample can travel to the Gas Chromatograph (GC) instrument. The purpose of this instrument is to sort out all the different molecules in the sample, and tell how much of each kind there is. It accomplishes this by using a stream of helium gas to push the sample down a long, narrow tube (which is wound into a coil to save space). Helium is used because it is inert, meaning it won't react with and change any of the sample molecules. The inside of the tube is coated with a thin film. As molecules travel through the tube, they stick for a bit

on the film, and the heavier the molecule, the longer it sticks. Thus, the lighter molecules emerge from the tube first, followed by the middleweight molecules, with the heaviest molecules bringing up the rear. Since molecules of different weights emerge from the tube at different times, the GC delivers groups of molecules sorted by weight into SAM's Quadropole Mass Spectrometer (QMS).

QUADRUPOLE MASS SPECTROMETER: *identify the molecules*

The Quadrupole Mass Spectrometer (QMS) instrument fires high-speed electrons at the molecules, breaking them up into fragments and giving the molecules and their fragments an electric charge. These molecules and their fragments with an electric charge can be moved by electric fields. The QMS uses both DC and AC fields to sort the electrically charged molecules and fragments based on their weight (mass). Molecules and fragments of different mass are counted by a detector at different times to generate a mass spectrum, which is a pattern that uniquely identifies the chemical elements and compounds in Martian materials.

TUNABLE LASER SPECTROMETER: *determine the isotopes*

Gas samples can be directed into the Tunable Laser Spectrometer (TLS), which analyzes specific gases like methane, water and carbon dioxide. The sample enters a chamber with precisely positioned mirrors at both ends. A laser is fired through a tiny hole in one of the mirrors. As the laser light bounces between the mirrors, it illuminates the sample. Different molecules will absorb certain colors (frequencies) of light, so the TLS identifies the molecules by which colors of the laser are blocked (since the laser is tunable, it can be adjusted to look for a specific range of colors). The TLS can also measure chemical isotopes the same way. Isotopes are versions of an element with different weights or masses. Isotope measurements can help us understand the processes that have affected the planet over time. It is thought that much of the Martian atmosphere has been lost to space since early in its history. This loss might have fundamentally changed the habitability of the planet. If it occurred, we would be able to see a record of the loss in the isotope measurements. Finally, since volatile molecules are found in the atmosphere as well as in soil and rock, samples of the Martian air can be sent directly to the TLS without going through SAM's other instruments.

WHO MADE YOU, SAM? THE SAM TEAM

Science team: Principal Investigator Paul Mahaffy/ NASA Goddard Space Flight Center with 43 Co-Investigators and Collaborators from 24 institutions.

Development team: Based at NASA's Goddard Space Flight Center, Greenbelt, Md., but with significant elements provided by industry, university, and NASA partners.

NASA GSFC: Quadrupole Mass Spectrometer, Chemical Separation and Processing Lab, software.

University of Paris/CNRS: Gas Chromatograph (Michel Cabane, Institutional Principal Investigator).

NASA Jet Propulsion Laboratory, Pasadena, Calif.: Tunable Laser Spectrometer (Chris Webster, Institutional Principal Investigator).

Honeybee Robotics, New York: Sample Manipulation System (Steve Gorevan Lead).

Other key partners: University of Michigan Space Physics Laboratory (digital electronics), Creare, Inc., Hanover, N. H., (Wide Range Pump), Battel Engineering, Scottsdale, Ariz., (power and analog electronics), BCI Technology Co., AMU Engineering, and many others. SAM and Curiosity are funded by NASA's Science Mission Directorate.

For more information, please visit our web site:
http://ssed.gsfc.nasa.gov/sam/

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