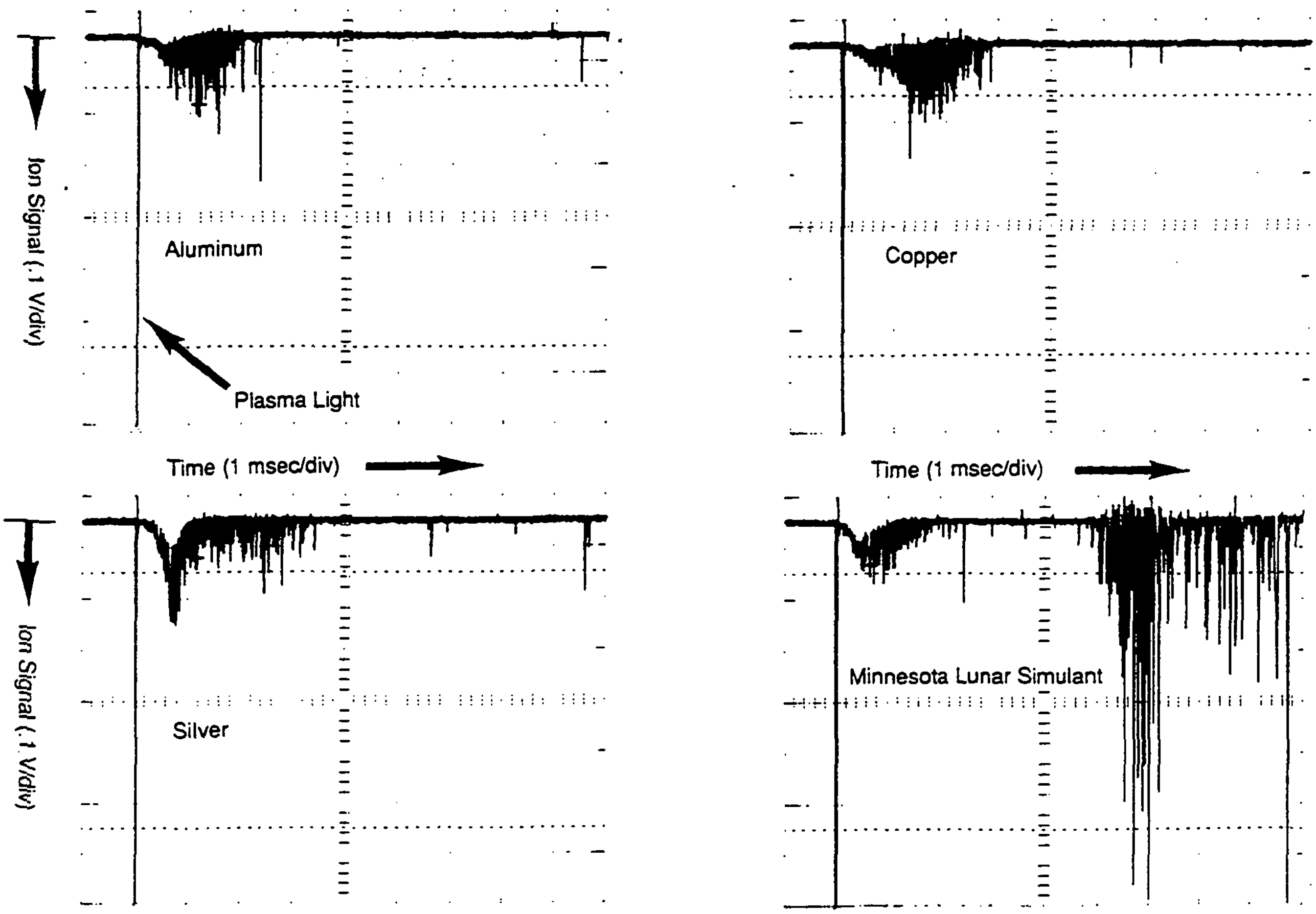

Fig. 2.

and lunar simulant detected at 18 m (bulk chemistry and mineralogy similar to Apollo 11 lunar mare basalts).

Experimental results will be presented that demonstrate the characteristics and ability of detecting laser-produced ions over very long distances.

THE APX SPECTROMETER FOR MARTIAN MISSIONS. T. Economou, Laboratory for Astrophysics and Space Research, University of Chicago, Chicago IL 60637, USA.

Obtaining the chemical composition of any planetary body should be a prime science objective of each planetary mission. The APX spectrometer has been designed to provide a detailed and complete chemical composition of all major (except H) and minor elements with high accuracy, *in situ* and remotely. From such complete analyses a first-order mineralogy of analyzed samples can be deduced. Laboratory studies in the past have shown that rock types (e.g., dunites, basalts, Philippinate 300 sample) were identified uniquely in blind test analyses. Such identification is more accurate than can be obtained from any other remote spectroscopic technique.

The APX technique is based on three modes of nuclear and atomic interactions of alpha particles with matter resulting in three different energy spectra containing the compositional information. The instrument uses 50 to 100 mCi of ^{242}Cm or ^{244}Cm transuranium radioisotopes to provide a monoenergetic beam of alpha particles (6.01 MeV and 5.80 MeV respectively) and solid-state detectors for acquiring the energy spectra.

The technique has been used for the first time on the Surveyor missions in 1967–1968 to obtain the first chemical composition of the Moon. Since then the instrument has been miniaturized and refined to improve its performance. The alpha and proton detectors were combined into a single telescope with a very thin Si front detector that acts like an alpha detector and at the same time as an absorber of alpha particles for the proton detector in the back. An X-ray mode was incorporated into the instrument that is by itself equivalent to an X-ray fluorescence instrument. A rather complicated logic determines if the particle is an alpha, proton, or an unwanted background event. This arrangement has improved the energy resolution of proton lines, eliminated the need for an additional guard detector system, and substantially reduced the size of the sensor head.

However, the big saving in size and power in the APX instrument comes from replacing the cryogenically cooled Si or HP Ge X-ray detectors in the X-ray mode with HgI_2 ambient-temperature X-ray detectors that do not require cryogenic cooling to operate and still achieve high-energy resolution. These detectors are being provided by Xsirius, Inc. in Marina del Ray.

The spectrometer as it is implemented for Mars '94 and Mars '96 Russian missions (the Mars '94 and Mars '96 APX experiment are a collaboration of IKI of Moscow, The University of Chicago, and Max Planck Institut für Chemie in Mainz) and for NASA's Pathfinder mission (the APX experiment for Pathfinder will be a collaboration of MPI Mainz and The University of Chicago) to Mars in 1996 has a combined weight of about 600 g and operates on 250 mW of power. It still can benefit from higher-quality alpha sources available from the Russians and more hybridized electronics.

N93-28777 160723 p. 1

INVESTIGATION OF MARS ROTATIONAL DYNAMICS USING EARTH-BASED RADIO TRACKING OF MARS LANDERS. C. D. Edwards Jr., W. M. Folkner, R. D. Kahn, and R. A. Preston, Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 91109, USA.

The development of space geodetic techniques over the past two decades has made it possible to measure the rotational dynamics of the Earth at the milliarcsecond level, improving our geophysical models of the Earth's interior and the interactions between the solid Earth and its atmosphere. We have found that the rotational dynamics of Mars can be determined to nearly the same level of accuracy by acquiring Earth-based two-way radio tracking observations of three or more landers globally distributed on the surface of Mars (Fig. 1). Our results indicate that the precession and long-term obliquity changes of the Mars pole direction can be determined to an angular accuracy corresponding to about 15 cm/yr at the planet's surface. In addition, periodic nutations of the pole and seasonal variations in the spin rate of the planet can be determined to 10 cm or less. Measuring the rotation of Mars at this accuracy would greatly improve the determination of the planet's moment of inertia and would resolve the size of a planetary fluid core, providing a valuable constraint on Mars interior models. Detecting seasonal variations in the spin rate of Mars would provide global constraints on atmospheric angular momentum changes due to sublimation of the Mars CO_2 polar ice caps. Finally, observation of quasisecular changes in Mars obliquity would have significant implications for understanding long-term climatic change.

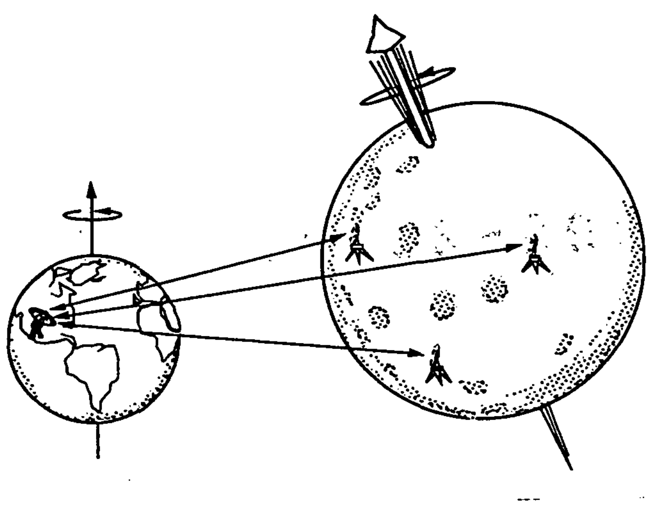

Fig. 1. Simultaneous two-way tracking of multiple Mars landers from Earth.

The key to achieving these accuracies is a globally distributed network of Mars landers with stable, phase-coherent radio transponders. By simultaneously acquiring coherent two-way carrier phase observations between a single Earth tracking station and multiple Mars landers, Earth media errors are essentially eliminated, providing an extremely sensitive measure of changes in the differential path lengths between the Earth tracking station and the Mars landers due to Mars rotation. Time variability of the instrumental phase delay through the radio transponder may represent the limiting error source for this technique. Calibration of the transponder stability to about 0.1 ns or less, over a single tracking arc of up to 12 hr, is sufficient to provide the decimeter-level determination of Mars orientation parameters quoted above.

We will provide a detailed description of the multilander tracking technique and the requirements it imposes on both the lander radio system and the Earth-based ground-tracking system. This concept is currently part of the strawman science plan for the Mars Environmental Survey (MESUR) mission and complements many of the other MESUR science goals.

N93-28778 160724 p-2

CLEMENTINE SENSOR PROCESSING SYSTEM. A. A. Feldstein, Innovative Concepts, Inc., 8200 Greensboro Drive, Suite 801, McLean VA 22102, USA.

The design of the DSPSE Satellite Controller (DSC) is baselined as a single-string satellite controller (no redundancy). The DSC performs two main functions: health and maintenance of the spacecraft, and image capture, storage, and playback. The DSC contains two processors, a radiation-hardened Mil-Std-1750, and a commercial R3000. The Mil-Std-1750 processor performs all housekeeping operations, while the R3000 is mainly used to perform the image processing functions associated with the navigation functions, as well as performing various experiments. The DSC also contains a data handling unit (DHU) used to interface to various spacecraft imaging sensors and to capture, compress, and store selected images onto the solid-state data recorder.

The development of the DSC evolved from several key requirements: The DSPSE satellite was to (1) have a radiation-hardened spacecraft control and be immune to single-event upsets (SEUs); (2) use an R3000-based processor to run the star tracker software that was developed by SDIO (due to schedule and cost constraints, there was no time to port the software to a radiation-hardened processor); and (3) fly a commercial processor to verify its suitability for use in a space environment.

In order to enhance the DSC reliability, the system was designed