horizontal bands. Of course, we do not yet know what the subsurface of Mars' north polar cap will look like up close, but this experiment helps demonstrate the wealth of information that could be obtained. The first scan covers just 10 in of stratigraphy, which could represent many thousands of years of Mars climate history. The actual MPP borescope could be programmed to automatically search for layers, or the science team back on Earth could control its motion interactively. The other type of sample we looked at was composed of "snow" and dust layers. We formed small "snow" grains by spraying water mist into liquid nitrogen, then sprinkled layers of this "snow" into a bucket followed by fine layers of dust. Each dust layer was cemented with a small spray of liquid water. The sample was then allowed to anneal for several hours at –3°C before cooling to –80°C for drilling. The second sequence of close-up borescope images in the video shows parts of a scan of a hole drilled in a snow/dust sample. The snow grains are bright spheroids 50–100 μm in diameter and some dark dust particles can be seen scattered among them, especially near the dust layers.

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HONEYWELL'S COMPACT, WIDE-ANGLE UV-VISIBLE IMAGING SENSOR. D. Pledger[1] and J. Billing-Ross[2], [1]Honeywell Systems and Research Center, Bloomington MN 55420, USA, [2]Honeywell Satellite Systems Operation, Glendale AZ 85308, USA.

Honeywell is currently developing the Earth Reference Attitude Determination System (ERADS). ERADS determines attitude by imaging the entire Earth's limb and a ring of the adjacent star field in the 2800°–3000 Å band of the ultraviolet. This is achieved through the use of a highly nonconventional optical system, an intensifier tube, and a mega-element CCD array. The optics image a 30° region in the center of the field, and an outer region typically from 128° to 148°, which can be adjusted up to 180°. Because of the design employed, the illumination at the outer edge of the field is only some 15% below that at the center, in contrast to the drastic roll-offs encountered in conventional wide-angle sensors. The outer diameter of the sensor is only 3 in; the volume and weight of the entire system, including processor, are 1000 cm³ and 6 kg respectively.

The basic ERADS configuration has many unusual features that could also be utilized for purposes other than attitude reference. The ability to image over a 360° azimuth with a small, strapdown sensor could find application wherever surveillance of the entire surrounding field is desired. Because field-of-view is brought into the optical system in seven isolated segments, it is possible to use different wavebands for different parts of the view field. In order to utilize a fiber-optic field flattener, the incoming ultraviolet is downconverted with high quantum efficiency to visible radiation. The same sensor, therefore, can be used for visible wavelengths with only a change in the input filter. The segmentation of the field also makes it possible to isolate the effects of bright sources, such as the Sun, and continue operation in other areas.

The phototube provides the necessary gating and eliminates the requirement for a mechanical chopper. In conjunction with the antiblooming CCD, it provides a very wide dynamic range. The ERADS processor is designed to provide a complete image readout at 2 Hz, and this frequency is dynamically variable. ERADS is a very smart sensor, and a high degree of processing capability is built into it to provide object recognition and analysis. CCDs of 4 and 16 megapixels are becoming available that will allow expansion of ERAD's resolution capabilities in the future.

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GAMMA RAY/NEUTRON SPECTROMETERS FOR PLANETARY ELEMENTAL MAPPING. R. C. Reedy[1], G. F. Auchampaugh[1], B. L. Barraclough[1], W. W. Burt[2], R. C. Byrd[1], D. M. Drake[1], B. C. Edwards[1], W. C. Feldman[1], R. A. Martin[1], C. E. Moss[1], and G. H. Nakano[3], [1]Los Alamos National Laboratory, Los Alamos NM 87545, USA, [2]TRW Space and Technology Group, Los Angeles CA 90278, USA, [3]Consultant, Los Altos CA 94022, USA.

Los Alamos has designed gamma ray and neutron spectrometers for Lunar Scout, two robotic missions to map the Moon from 100-km polar orbits. Knowledge of the elemental composition is desirable in identifying resources and for geochemical studies and can be obtained using gamma ray and neutron spectrometers. Measurements with gamma ray and neutron spectrometers complement each other in determining elemental abundances in a planet's surface.

Gamma rays with energies of ~0.2–10 MeV escaping from a planetary surface can map most elements using characteristic gamma rays [1]. NaI(Tl) gamma ray spectrometers on Apollo determined Th, Fe, Ti, K, and Mg over 20% of the Moon's surface [1], and a high-purity germanium gamma ray spectrometer (GRS) cooled by a passive radiator is on the Mars Observer, which will map Mars starting late in 1993 [2]. Our GRS is a high-purity n-type germanium (Ge) crystal surrounded by an CsI(Na) anticoincidence shield (ACS) and cooled by a split Stirling cycle cryocooler [3]. The ACS eliminates events in the Ge due to cosmic-ray particles, serves as a back-up gamma ray detector, and allows the GRS to be mounted close to the spacecraft. The cryocooler is the British Aerospace design marketed by TRW, and a pair of compressors and expanders are used to minimize vibration effects.

The fluxes of neutrons escaping from the Moon are very sensitive to hydrogen in the top meter of the surface and provide information on the abundance of elements that strongly absorb thermal neutrons [4]. The Mars Observer GRS will be the first instrument to measure neutrons from another planet using a special ACS designed to measure thermal and epithermal neutrons [2]. Our neutron spectrometer will measure fast and slow (epithermal and thermal) neutrons in the ranges of 0.5 MeV to 25 MeV and ~0.01–1000 eV respectively [5]. The fast neutron sensor consists of four boron-loaded plastic scintillator rods optically coupled to photomultiplier tubes. Thermal and epithermal neutrons will be measured with ^{3}He gas proportional counters. The epithermal counter will be wrapped with cadmium to remove thermal neutrons, and the "bare" counter measures both thermal and epithermal neutrons.

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