the atmosphere to the target star, suggest that most of the atmospheric turbulence contributing to poor seeing is occurring within about 10 m of the ground. For the Table Mountain Ronchi telescope, signal-to-noise improvements will enable tracking of a visual magnitude 11 star. Demonstrations of this capability will occur this summer after hardware upgrades in the spring.

The above demonstrations will yield 10–50-nanoradian performance, but it has been shown that subnanoradian performance enables many mission enhancements. For example, subnanoradian angular tracking enables detection of Jupiter's spacecraft-relative position about 100 days before encounter. Subnanoradian tracking is largely prevented by atmospheric refractivity fluctuations for both the above mentioned devices. Methods of minimizing atmospheric effects using optimal stochastic estimation and direct calibration will be described.

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N93-28824

A TEAM APPROACH TO THE DEVELOPMENT OF GAMMA RAY AND X-RAY REMOTE SENSING AND *IN SITU* SPECTROSCOPY FOR PLANETARY EXPLORATION MISSIONS. J. I. Trombka[1] (Team leader), S. Floyd[1], A. Ruitberg[1], L. Evans[2], R. Starr[3], A. Metzger[4], R. Reedy[5], D. Drake[5], C. Moss[5], B. Edwards[5], L. Franks[6], T. Devore[6], W. Quam[6], P. Clark[7], W. Boynton[8], A. Rester[9], P. Albats[10], J. Groves[10], J. Schweitzer[11], and M. Mahdavi[11], [1]Goddard Space Flight Center, Greenbelt MD 20771, USA, [2]Computer Sciences Corporation, Calverton MD 20705, USA, [3]The Catholic University of America, Washington DC 20064, USA, [4]Jet Propulsion Laboratory, Pasadena CA 91109, USA, [5]Los Alamos Scientific Laboratory, Los Alamos NM 87545, USA, [6]EG & G Energy Measurements Santa Barbara, Goaleta CA 93117, USA, [7]Albright College, Reading PA 19612, USA, [8]University of Arizona, Tucson AZ 85721, USA, [9]University of Florida, Alachua FL 32615, USA, [10]Schlumberger-Doll Research, Ridgefield CT 06877, USA, [11]EMR Schlumberger, Princeton NJ 08542, USA.

An important part of the investigation of planetary origin and evolution is the determination of the surface composition of planets, comets, and asteroids. Measurements of discrete line X-ray and gamma ray emissions from condensed bodies in space can be used to obtain both qualitative and quantitative elemental composition information.

Remote sensing X-ray and gamma ray spectrometers aboard either orbital or flyby spacecraft can be used to measure line emissions in the energy region ~0.2 keV to ~10 MeV. These elemental characteristic excitations can be attributed to a number of processes such as natural radioactivity, solar X-ray fluorescence, and cosmic ray primary- and secondary-induced activity. Determination of composition for the following elements can be expected: O, Si, Fe, Mg, Ti, Ca, H, Cl, K, Th, and U. Global elemental composition maps can be obtained using such spectrometer systems.

More complete elemental composition can be obtained by landing packages that include X-ray and gamma ray spectrometer systems along with X-ray, charged particle, and neutron excitation sources on planetary surface. These *in situ* systems can be used on stationary, roving, and penetrator missions. Both the remote sensing and *in situ* spectrometer systems have been included aboard a number of U.S. and Russian planetary missions [1,2].

The Planetary Instrument Definition and Development Program (PIDDP) X-Ray/Gamma Ray Team has been established to develop X-ray and gamma ray remote sensing and *in situ* technologies for future planetary exploration missions. This team represents groups having active programs with NASA, the Department of Energy (DOE), the Department of Defense (DOD), and a number of universities and private companies. A number of working groups have been established as part of this research program. These include groups to study X-ray and gamma ray detectors, cryogenic cooling systems, X-ray and particle excitation sources, mission geochemical research requirements, detector space radiation damage problems, field simulation studies, theoretical calculations and X-ray and nuclear cross sections requirements, and preliminary design of flight systems. Major efforts in this program will be devoted to the development of X-ray/gamma ray remote sensing systems for the NEAR (Near Earth Asteroid Rendezvous) mission and for *in situ* X-ray and gamma ray/neutron systems for penetrators, soft landers, and rovers for MESUR missions.

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N93-28825

MINIATURE LONG-LIFE SPACE CRYOCOOLERS. E. Tward, TRW, One Space Park, Redondo Beach CA 90278, USA.

Cryogenic coolers for use in space on small satellites require low power and minimum weight. The need for exceptional reliability in a space cooler is made even more critical on small satellites since cooler redundancy is often not an option due to weight constraints. In this paper we report on two reliable, small, efficient low-power, vibrationally balanced coolers designed specifically for use on small satellites.

TRW has designed, built, and tested a miniature integral Stirling cooler and a miniature pulse tube cooler intended for long-life space application. Both efficient, low-vibration coolers were developed for cooling IR sensors to temperatures as low as 50 K on lightsats.

The vibrationally balanced nonwearing design Stirling cooler incorporates clearance seals maintained by flexure springs for both the compressor and the drive displacer. The design achieved its performance goal of 0.25 W at 65 K for an input power to the compressor of 12 W. The cooler recently passed launch vibration tests prior to its entry into an extended life test and its first scheduled flight in 1995.

The vibrationally balanced, miniature pulse tube cooler intended for a 10-year long-life space application incorporates a nonwearing flexure bearing compressor vibrationally balanced by a motor-controlled balancer and a completely passive pulse tube cold head. The maximum cooling power measured at 80 K is 800 mW for an input power to the compressor of 30 W. The cooler is suitable for cooling sensors and optics between 60 K and 200 K, with cooling powers up to 3.5 W at 200 K. Self-induced vibration measurements indicate that the cooler can be balanced to reduce vibration forces below 0.02 newtons from 0 to 500 Hz.

N93-28826

ENVIRONMENTAL MONITORS IN THE MIDCOURSE SPACE EXPERIMENTS (MSX). O. M. Uy, Applied Physics Laboratory, The Johns Hopkins University, Laurel MD 20723, USA.

The Midcourse Space Experiment(MSX) is an SDIO-sponsored spacebased sensor experiment with a full complement of optical sensors. Because of the possible deleterious effect of both molecular and particulate contamination on these sensors, a suite of environmental monitoring instruments are also being flown with the spacecraft. These instruments are the Total Pressure Sensor based on the cold-cathode gauge, a quadrupole mass spectrometer, a Bennett-type ion mass spectrometer, a cryogenic quartz crystal microbalance (QCM), four temperature-controlled QCMs, and a Xenon and Krypton Flash Lamp Experiment. These instruments have been fully space-qualified, are compact and low cost, and are possible candidate sensors for near-term planetary and atmospheric monitoring. The philosophy of adopted during design and fabrication, calibration and ground testing, and modeling will be discussed.

N93-28827

ULTRAVIOLET IMAGING SPECTROMETER. T. J. Wdowiak, Department of Physics, University of Alabama at Birmingham, CH 310, 1300 University Blvd., Birmingham AL 35294-1170, USA.

Wide-field imaging systems equipped with objective prisms or gratings have had a long history of utility in groundbased observations of meteors [1] and comets [2]. Deployment of similar instruments from low Earth orbit would allow the first UV observations of meteors. This instrument can be used for comets and Lyman alpha coronae of Earth-orbit-crossing asteroids. A CaF_2 prism imaging spectrograph designed for stellar observations was used aboard Skylab to observe Comet Kohoutek (1973f), but its 1300-Å cut-off precluded Lyman alpha images and it was not used for observation of meteors [3]. Because the observation of the UV spectrum of a meteor has never been attempted, researchers are denied the opportunity to obtain composition information from spectra at those wavelengths. We propose construction of a flight instrument functioning in the 1100–3200-Å spectral range that is suitable for a dedicated satellite ("QuickStar") or as a space-station-attached payload. It can also be an autonomous package in the space shuttle cargo bay.

The instrument structure is of graphite fiber epoxy composite, and has an objective diffraction grating, low expansion optics, multichannel plate electro-optics, and event discrimination capability through processing of video data. It would either have a field-of-view (fov) of 12° and f number of 0.75 or a wider fov of 20°–25° and f number of 1. The instrument has a heritage from the UV auroral imager of the Swedish Viking spacecraft [4].

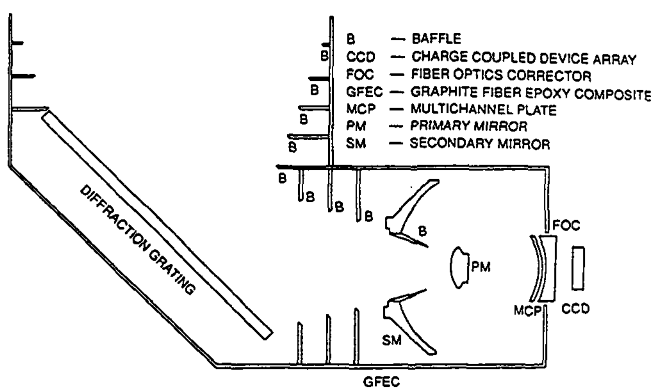

Fig. 1.

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N93-28828

DEVELOPMENT OF MINIATURIZED OPTIMIZED SMART SENSORS (MOSS) FOR SPACE PLASMAS. D. T. Young, Southwest Research Institute, Instrumentation and Space Research Division, San Antonio TX 78228-0510, USA.

The cost of space plasma sensors is high for several reasons: (1) Most are one-of-a-kind and state-of-the-art, (2) the cost of launch to orbit is high, (3) ruggedness and reliability requirements lead to costly development and test programs, and (4) overhead is added by overly elaborate or generalized spacecraft interface requirements. Possible approaches to reducing costs include development of small "sensors" (defined as including all necessary optics, detectors, and related electronics) that will ultimately lead to cheaper missions by reducing (2), improving (3), and, through work with spacecraft designers, reducing (4). Despite this logical approach, there is no guarantee that smaller sensors are necessarily either better or cheaper. We have previously [1] advocated applying analytical "quality factors" to plasma sensors (and spacecraft) and have begun to develop miniaturized particle optical systems by applying quantitative optimization criteria. We are currently designing a Miniaturized Optimized Smart Sensor (MOSS) in which miniaturized electronics (e.g., employing new power supply topology and extensive use of gate arrays and hybrid circuits) are fully integrated with newly developed particle optics to give significant savings in volume and mass. The goal of the SwRI MOSS program is development of a fully self-contained and functional plasma sensor weighing ~1 lb and requiring ~1 W. MOSS will require only a typical spacecraft DC power source (e.g., 30 V) and command/data interfaces in order to be fully functional, and will provide measurement capabilities comparable in most ways to current sensors.

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N93-28829

X-RAY, FAR, AND EXTREME ULTRAVIOLET COATINGS FOR SPACE APPLICATIONS. M. Zukic and D. G. Torr, Physics Department, University of Alabama in Huntsville, Huntsville AL 35899, USA.

The improved FUV filters that we have designed and fabricated