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AN IMAGING SPECTROMETRIC OBSERVATORY (ISO)
(N001)

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The Imaging Spectrometric Observatory (ISO) has been designed for low light level spectroscopy of both the day and night side of the Earth. The instrument is composed of five spectrometers (Figs. I-10 and I-11), each of which covers part of the total wavelength range of 30 to 1300 nm spanned by the instrument. Wavelength resolution varies between 0.2 and 0.6 nm over the spectral range. The five spectrometers are each optimized for a portion of the spectrum by the choice of mirror reflective coatings and detector photocathode materials. The full spectral range for each spectrometer is covered in a total of 11 grating steps. Some relevant parameters are given in Table I-2.

The five spectrometers operate simultaneously, imaging the spectrum in one dimension and obtaining spatial information (for example, altitude) in the other. This is achieved by means of an intensified-solid state array detector developed especially for this instrument. Each spectrometer has a large dynamic range in signal intensity. Each spectrometer has a 0.65 x 0.01 deg field of view which can be directed at a selected region of the atmosphere either by maneuvering the Shuttle or by means of a scan mirror. Thus, it is possible to obtain spectral data distributed in latitude, longitude, slant path altitude and local time.

The spectrometer array is located on the instrument pallet and a dedicated experiment microcomputer is separately located on the instrument pallet. The microcomputer system controls the instrument observing sequences (scan mirrors, shutters, grating positions, gains), and handles the data compression. It also interacts with the Spacelab computer providing a link between the instrument and the scientists on the ground for direct commanding. In addition, the crew is able to operate the instrument from the Orbiter by using one of the two keyboards on the aft flight deck. Observational sequences can be run from predefined programs stored in the Spacelab system, or entered by the crew or by the scientist on the ground.

The Imaging Spectrometric Observatory was flown for the first time on the Spacelab 1 mission during which it acquired almost 40 hr of observations. This data base has provided the first nearly simultaneously acquired spectra of the thermospheric and mesospheric dayglow over the wide wavelength range of the instrument. These data have provided us with new insights into various atmospheric processes and with surveys of the atmospheric spectrum over a variety of conditions. The information gathered is relevant to the composition and energy budget of the thermosphere, mesosphere, and stratosphere; the solar EUV flux and its influence on the composition and the production of photoelectrons; cross sections for photon and electron ionization and excitation; precipitation of fast charged particles; and the production and loss of various species. An example of one of the novel measurements made by the ISO on the Sapcelab 1 mission is illustrated in Figure I-12. In this sequence, the vehicle was oriented so as to place the spectrometer entrance slit perpendicular to the limb with the center of the slit at 90 km. In this case, the 0.65 deg field of view spanned by the length of the slit subtends approximately 20 km and is resolved into eight adjacent 2.5-km altitude segments from 80 km to 100 km. Thus, in this configuration the entire altitude of the mesosphere is imaged simultaneously. The feature shown is the 1-0 band of the NO gamma system.

The Imaging Spectrometric Observatory investigation to be flown on the ATLAS 1 mission will draw on the experience gained from the data gathered on Spacelab 1. The detector system in each spectrometer has been upgraded to provide both higher sensitivity at low light levels and simultaneous imaging over larger spectral segments than was achieved on Spacelab 1. In addition, the instrument and the observing sequences have been modified to allow observation of the Sun in the extreme ultraviolet. During the solar pointing periods, the ISO will measure the solar spectrum from 30 nm to 125 nm. Rather than concentrating on spectral surveys as was the emphasis for the Spacelab 1 mission, the ATLAS 1 observation sequences have been developed to concentrate on specific scientific issues indicated in the earlier data set.

For example, without the presence of sunlight, oxygen exists in the atmosphere in the form of stable O_2 molecules. When illuminated with ultraviolet sunlight, the O_2 molecules are broken up into highly chemically active oxygen atoms which are capable of initiating and participating in a large number of chemical reactions. The recombination of atomic oxygen forms the protective ozone layer. Recombination of oxygen atoms also returns the original stable O_2 molecules from which the cycle is repeated. These O_2 molecules are returned via various so-called excited states of O_2 which can radiate characteristic emissions. Other chemically active species, such as hydroxyl(OH), are responsible for the removal of ozone molecules. Thus, by simultaneously monitoring the spectral signatures of atomic oxygen at 5577 Å, the various molecular oxygen systems such as the Herzberg and Chamberlain bands in the near UV, the atmospheric bands in the near IR, and the IR atmospheric bands at 1.27 μm, together with the excited OH* bands throughout the visible and near IR, we can obtain a considerable amount of information on this complex photochemistry chain in the mesosphere.

This is one of several such studies for which the ISO will gather the data on the ATLAS 1 mission.

TABLE I-2. SUMMARY OF ISO PARAMETERS FOR ATLAS 1

Spectrometer λ Range (nm)	Spectral Resolution (nm)	Instantaneous Δλ per Grating Step (nm)	Photocathode	Mirror Coatings
30-125	0.6	18.3	Windowless	Platinum
120-210	0.25	18.3	CsTe	MgF_2
200-410	0.4	24.4	Bi-alkali:S-11	MgF_2
400-800	0.4	49.0	Tri-alkali:S-20	Al/SiO
790-1300	0.6	55.2	S-1	Al/SiO

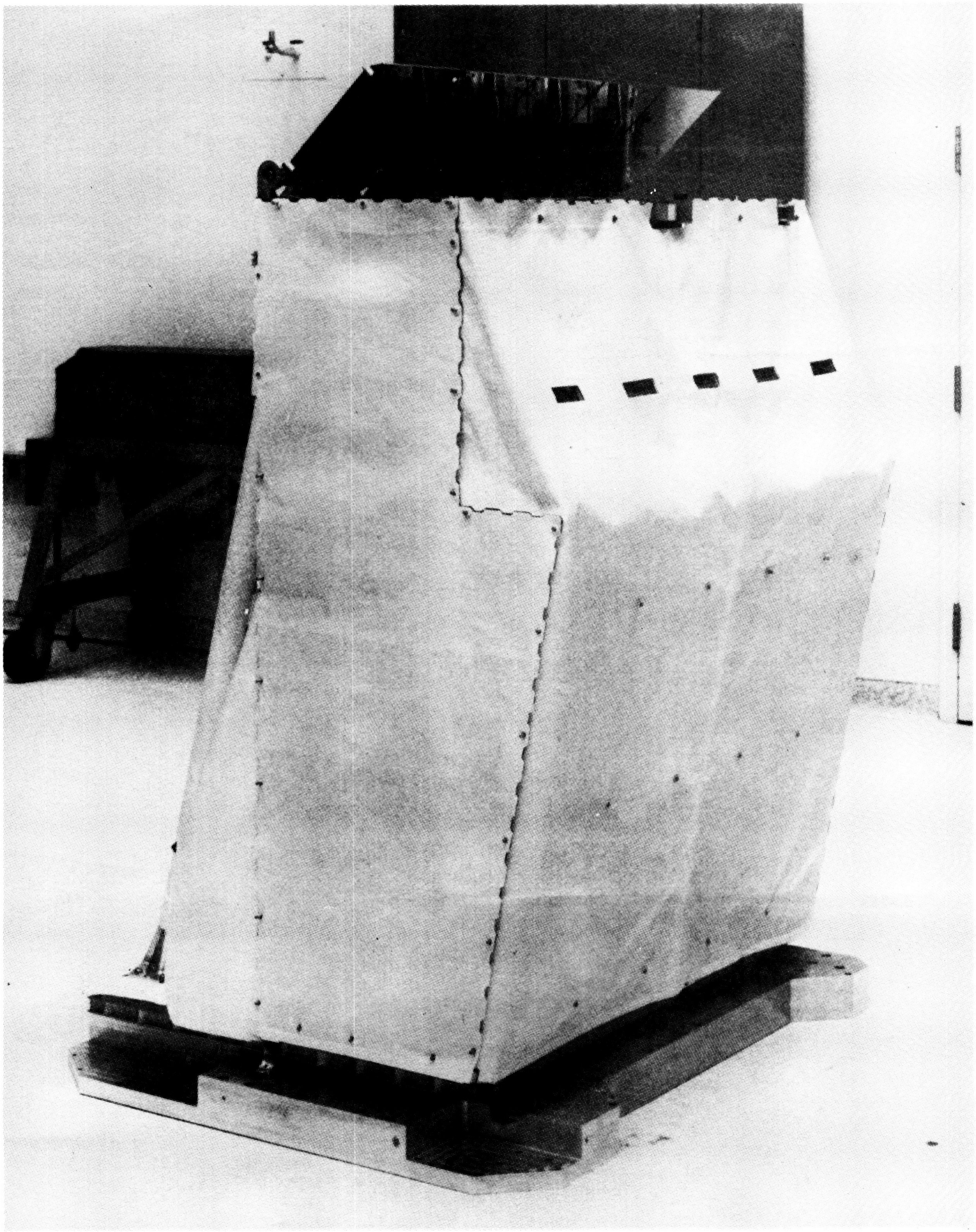
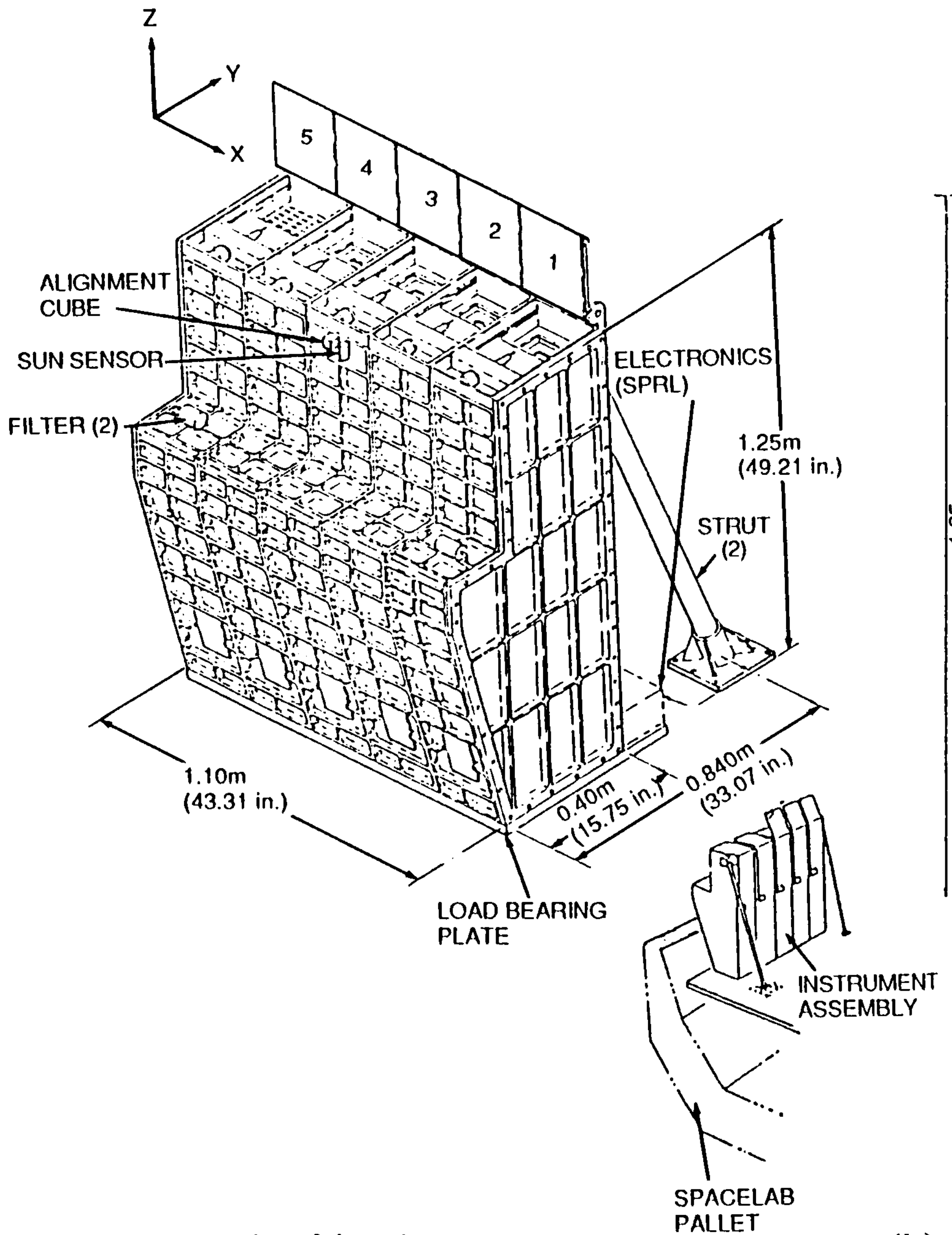
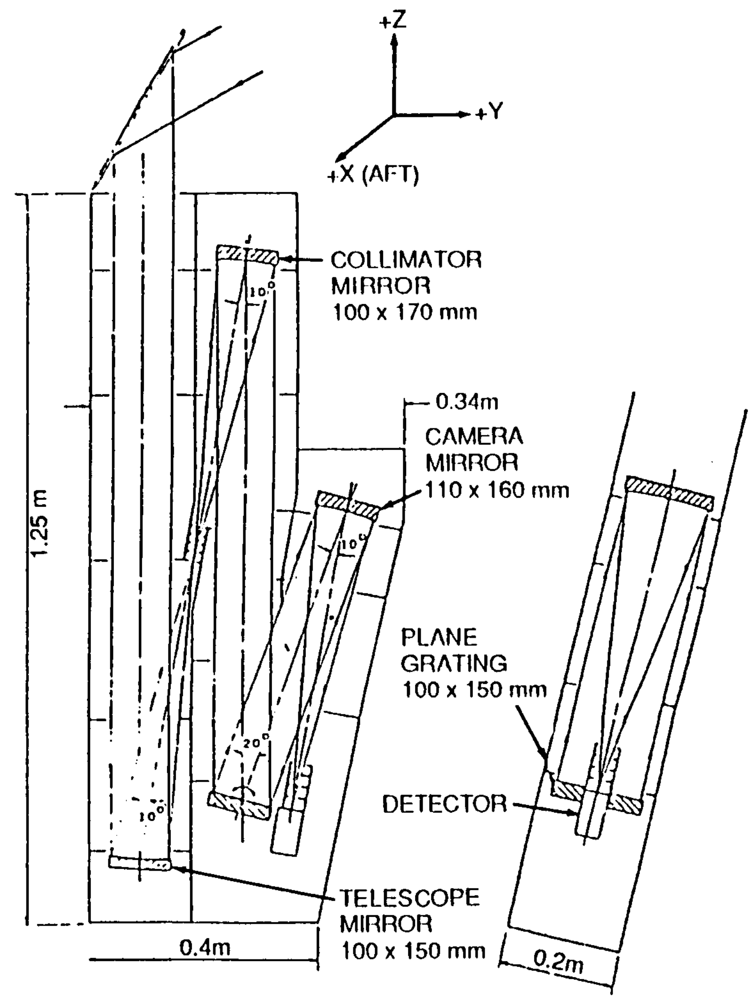


Figure I-10. ISO flight instrument.



(a) Schematic of imaging spectrometer.



(b) Optical layout of imaging spectrometer.

Figure I-11. Spectrometer housing and optical layout of all modules except one for EUV measurements.

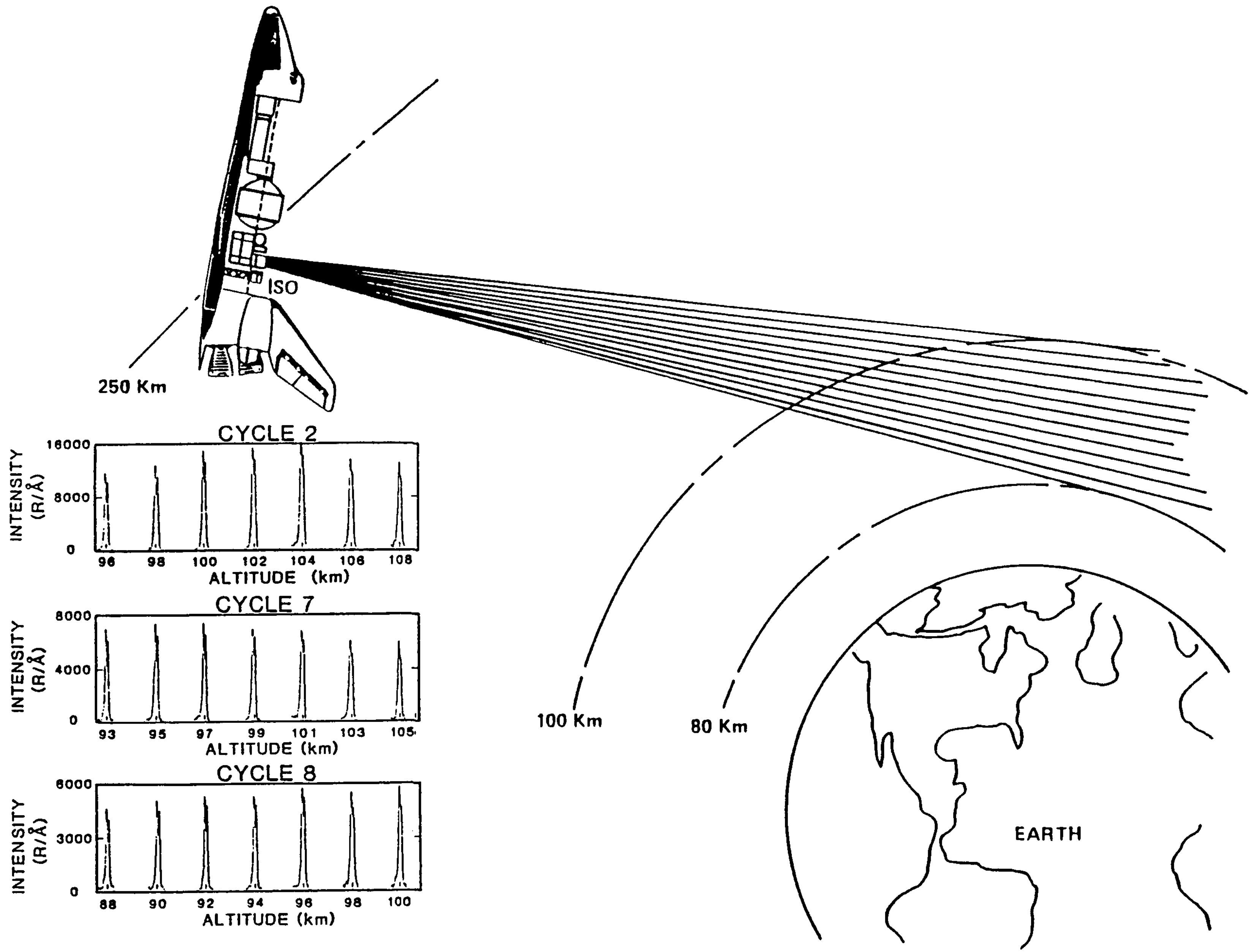


Figure I-12. Illustration of atmospheric measurements made by ISO.