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# ATMOSPHERIC EMISSIONS PHOTOMETRIC IMAGING (AEPI) EXPERIMENT (N003)

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The basic scientific objective of the AEPI is the investigation of the upper atmosphere-ionosphere and the space shuttle environment. To this end, there are the following experiment areas of the AEPI: (1) the investigation of ionospheric transport processes by observing $Mg^+$ ions, (2) studies of optical properties of artificially induced electron beams, (3) measurement of electron cross sections for selected atmospheric species, (4) studies of natural airglow; and (5) studies of natural auroras.

Ionospheric transport processes are associated with global patterns of electric fields, neutral winds, and, on a smaller scale, plasma instabilities caused by field and density gradients. Observations show that there is an observable quantity of $Mg^+$ ions in the E and F regions and the direct imaging of resonance radiation of the $Mg^+$ ions enables us to study ionospheric transport processes using the natural $Mg^+$ as the ionospheric tracer. Examples of $Mg^+$ ion observations from Spacelab 1 are shown on Figure III-1.

Because of the offset of the geographic and geomagnetic poles, the 57 deg inclination orbit planned for ATLAS 1 will provide occasional auroral zone coverage. The nightside auroral zone extends to a magnetic (or invariant) latitude of 65 deg, which is within the ATLAS 1 orbit. Depending on the season during which the flight will be performed, locations in either the northern hemisphere (northern Canada) or the southern hemisphere (south of Australia) will be dark and, therefore, suitable for auroral studies. The high-resolution photometric imager flown on ATLAS 1 will be used to image auroral structures. The topside viewing permits the UV imaging of auroras and the limb viewing capability from orbit also gives a significant advantage over ground-based observations.

Another advantage of this ATLAS mission is the planned coordinated use of several different instruments in a given investigation. In the observation of natural auroras and airglow, the AEPI instrument will provide image data in coordination with the spectral data taken by the imaging spectrometer (experiment N001). Another joint endeavor is the study of induced emission from artificial particle injections using SEPAC (experiment N002). In such a joint investigation with SEPAC on ATLAS 1, an electron beam is directed downward or upward from the Orbiter. The electrons precipitate (either directly or after having mirrored at the opposite hemisphere) and cause artificial auroral emissions under the Orbiter. To satisfy the objectives of such an experiment, the generated optical aurora will be detected with a high signal-to-noise ratio by the AEPI instrument. The morphology of artificially induced auroras caused by mirroring electrons beamed upward (electron echo) and electrons beamed downward (artificial auroras) by the electron gun will be studied.

The objective of the induced equatorial auroral experiment is to measure the electron-impact cross sections of several atmospheric constituents. The experiment involves the ejection of an electron pulse on a magnetic equatorial crossing by the Orbiter, then viewing of the emission returning from the beam path with passive instruments from the Orbiter. The measurement results will include the effective excitation cross section for producing $O^+(^2P)$ and for producing other atomic metastables from their atmospheric ground states. Pulsed afterglows will also produce a measure of the collisional deactivation rate from some of the highly quenched metastable states. For $O^{+}(^{2}P)$, simultaneous sensing of emissions having different emission probabilities (i.e., $\lambda$ = 7319 Å and $\lambda$ = 2470 Å) will directly measure the total collisional deactivation at a given altitude.

On ATLAS 1, we will also continue our investigation of the optical emissions generated by the shuttle: the shuttle ram glow.

The experiment consists of the following major subsystems: (1) detector assembly and lens cover, (2) two-axis gimbal (MAST) with MAST electronics and load isolator, (3) pedestal support structure and launch locks, (4) video data encoder (VDE), (5) mount manual control (MMC), and (6) dedicated experiment processor (DEP). Items 1 through 3, depicted in Figure III-2, are located on the pallet and are exposed to the space environment.

The detector assembly, depicted in Figure III-2, consists of two principal parts: a dual-channel low-light-level television (LLLTV) system and a photon counting array (PCA). The system includes appropriate optical filters to provide spectral sensitivity and incorporates drive mechanisms and associated electronics to control filter wheels, to focus the TV lenses, and to change the TV field of view. The lens cover serves not only as a contamination cover and light baffle, but also houses shuttered light sources used to verify the sensitivity of the instrument in flight.

Another optical system was introduced into the AEPI package for the ATLAS 1 flight: a low-light-level unfiltered (spectral continuum) TV camera. This TV camera consists of an Augeniux 50 mm f/.95 lens which is focused at infinity. The image is formed on a single-stage microchannel plate intensified inverter tube. The intensifier is coupled to an uncooled CCD via a fiberoptic taper.

The dedicated experiment processor (DEP) controls detector functions. The detector electronics perform such functions for the LLLTV as filter wheel positioning, camera focusing, prism movement (FOV), intensifier gain control (HV), and camera control. The appropriate function control for the PCA is filter wheel positioning. In addition, temperature is actively controlled (heater power) with internal temperature monitors to ensure that the narrowband optical filters remain centered on line emissions of interest. In the event that a very bright light source appears in the field of view of either the LLLTV or PCA, a sun sensor protectively disables both systems and commands the filter wheels to assume a mutually exclusve cross-filter position.

The AEPI instrument complement also includes a small hand-held image intensifier and its associated filters and manually operated spectrometer. These instruments are stowed in lockers for launch and landing in the Orbiter. The payload crew can use these devices to monitor a wide variety of phenomena ranging from the low-light-level environment of the shuttle to the Aurora Australis underneath the Orbiter. These low-light-level photographs are taken through the Orbiter windows with the equipment mounted in the window by means of appropriate mounting clamps and lens hoods to exclude Orbiter light contamination.

The experiment requires the ability to acquire track and stabilize on a given target, independent of shuttle attitude constraints. Initial pointing to the target area is automatic. Final alignment to the target is manual, based on a display of the TV image and is done by the Payload Specialist. Tracking commands must be generated based on shuttle and target data because there are no sensor-generated error signals.

A simple two-axis pointing system is used. It can perform those stability and control functions that go beyond the capability of the shuttle. This system is a modified star tracker mount (MAST). The MAST provides experiment pointing over an 80 x 160 deg range.

One of the primary functions of the video data encoder (VDE) is annotating the video with essential housekeeping and experiment parameters. These data are generated in the DEP and passed to the command and data distribution electronics in the VDE, where they are decoded and added to the video. For the ATLAS 1 mission, the DEP and VDE units are mounted on the pallet under the orthogrid structure. A special control panel is mounted in the Orbiter aft-flight deck. The Payload Specialist can interact with the DEP via the control panel and vary parameters in operational sequences which are pre-programmed for each functional objective.

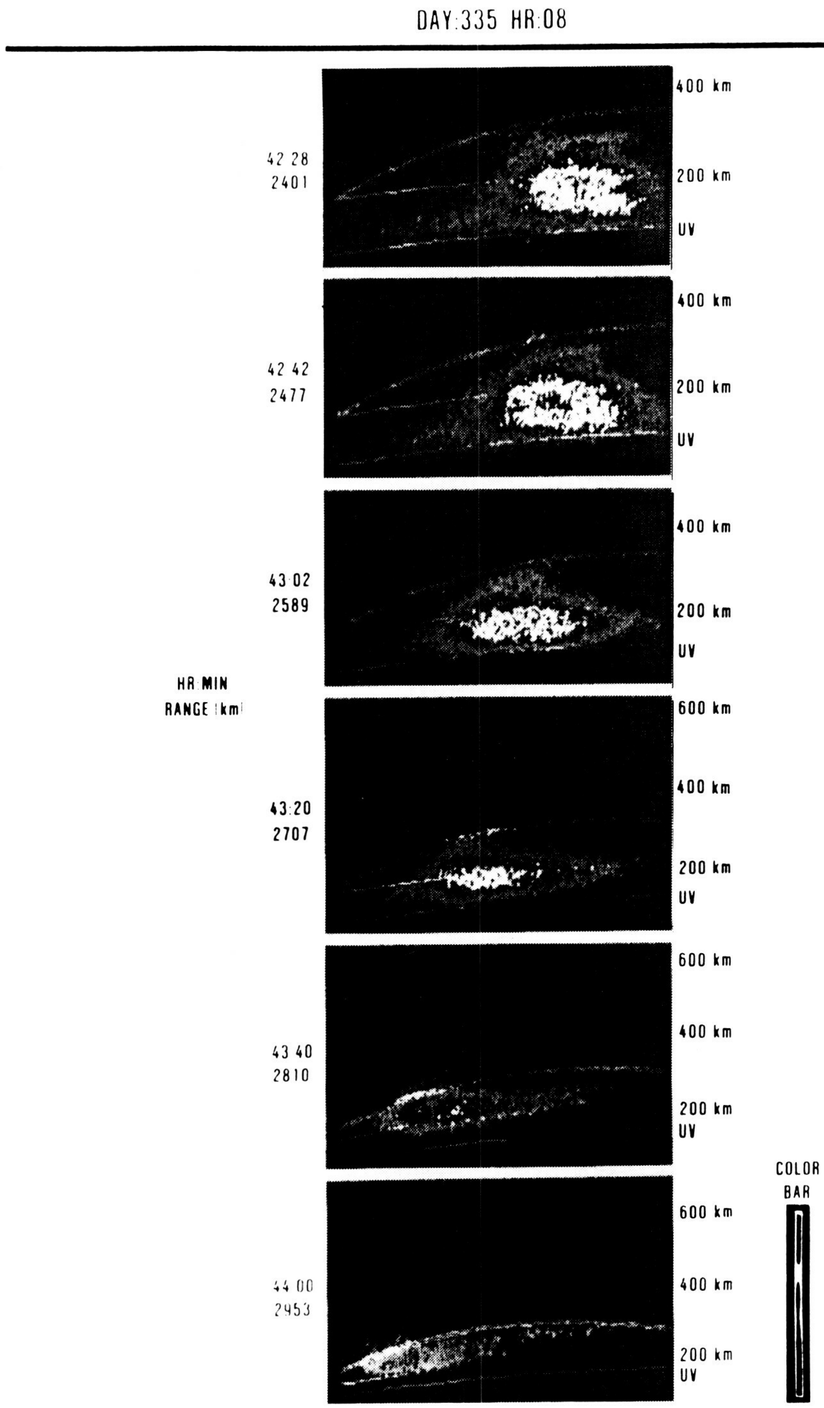



Figure III-1. Examples of $Mg^+$ data taken with the AEPI instrument on Spacelab 1.

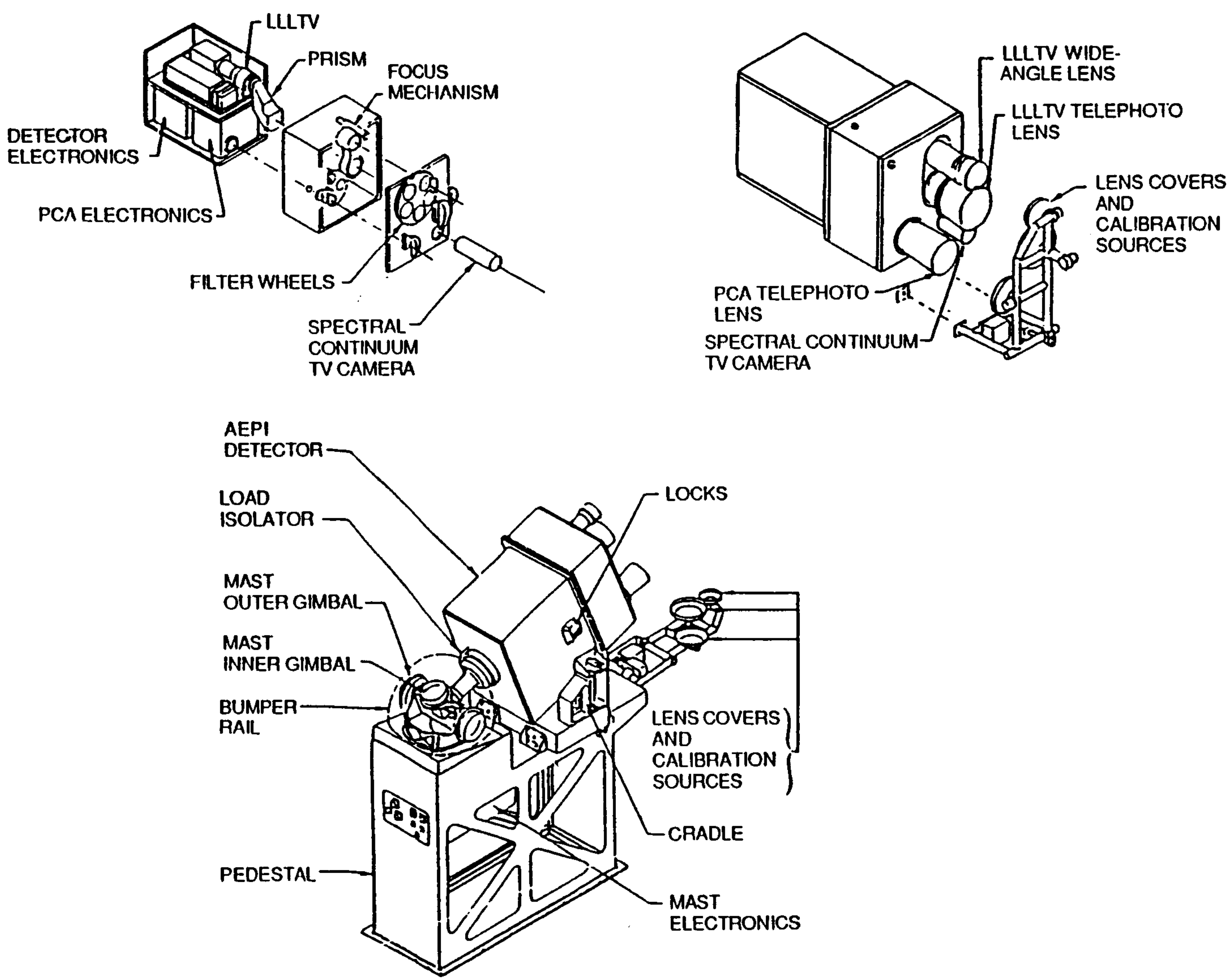
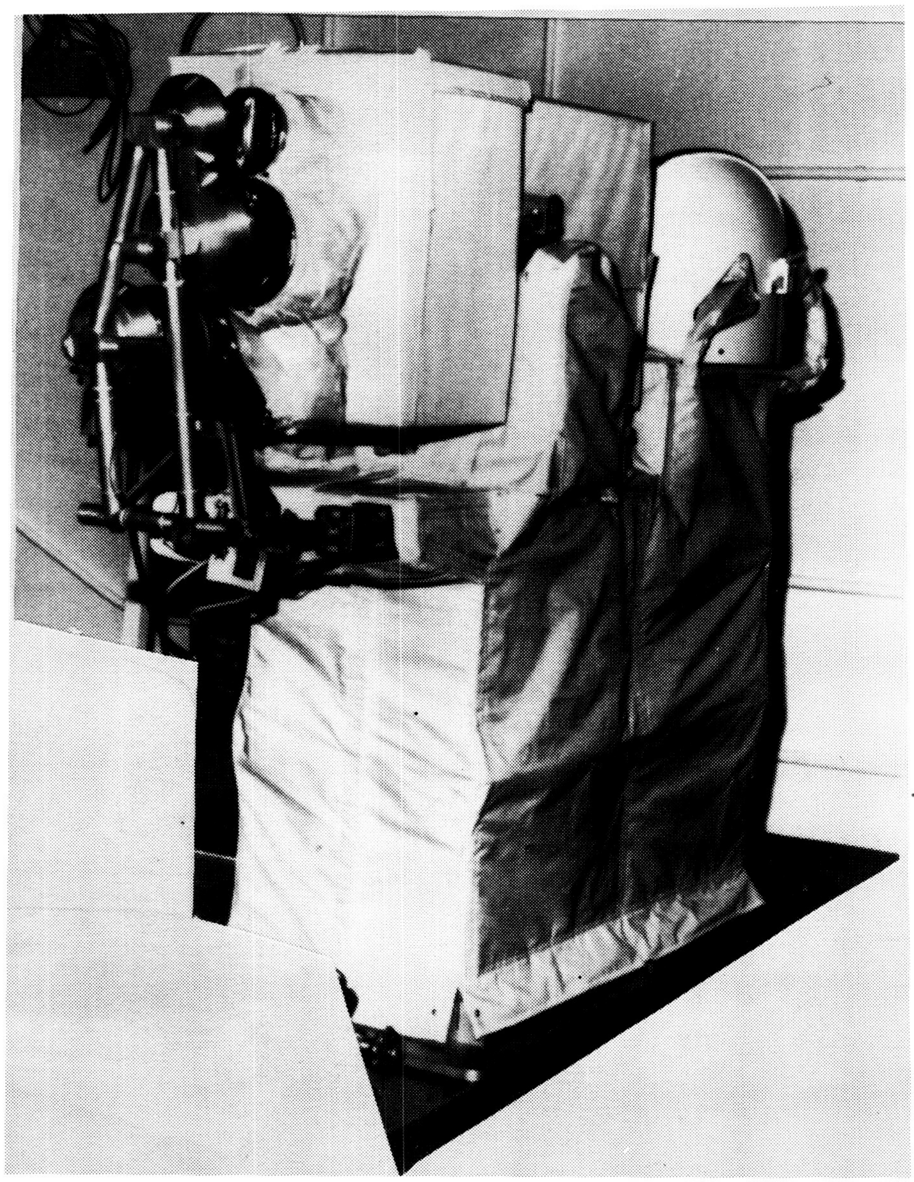



Figure III-2. (a) Elevated isometric illustration of the AEPI pallet-mounted equipment, including pointing mount, detector, pedestal, load isolator, and launch locks.



(b)

Figure III-2. (b) AEPI pallet-mounted equipment shown with thermal blankets prior to integration at Kennedy Space Center.