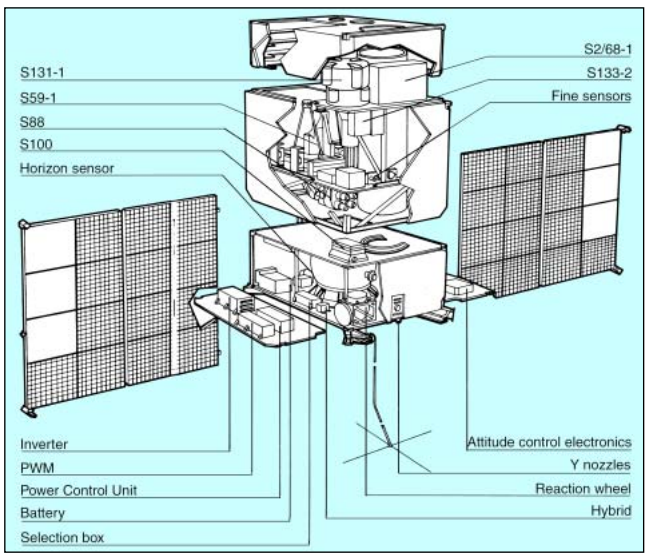
TD-1

Achievements: ESRO's first astronomy satellite; important advances in UV astronomy
Launch date: 12 March 1972
Mission end: 4 May 1974 (design life 6 months; reentered 9 January 1980)
Launch vehicle/site: Thor Delta (hence name of satellite) from Western Test Range, California
Launch mass: 473 kg (scientific payload 120 kg)
Orbit: 531x539 km, 95.3° (Sun-synchronous)
Principal contractors: Engins Matra (prime), ERNO (structure, thermal control, housekeeping subsystems), Saab (communications), HSD (power supply, gyros)

TD-1 was ESRO's most ambitious satellite project of that era, carrying a large and complex scientific payload to survey the whole sky in ultraviolet, X-rays and gamma-rays, monitor heavy cosmic ray nuclei and measure X/gamma-rays from the Sun.

It was the organisation's first satellite to carry astronomical telescopes, with heavy emphasis on UV observations of stars. One telescope used a wide aperture for scanning the whole sky in this little-studied section of the spectrum, while another made high-resolution measurements of UV spectral lines from individual stars. The resolution of 1.8 Å was a major advance over anything flown previously.



The mission was seriously jeopardised soon after launch, when both onboard tape recorders failed after only 2 months. A dramatic rescue operation by ESRO set up 40 ground stations around the world in collaboration with other space agencies to capture most of the realtime data.

As a result of the rescue, 95% of the celestial sphere was scanned, and spectral measurements on more than 30 000 stars were catalogued and published. The measurement of UV spectral line shapes and positions revealed, for example, that some stars are rapidly shedding their atmospheres. Significant advances were also made in identifying interstellar dust and plotting its distribution throughout the Galaxy.

The mission had been planned to end in October 1972 when the orbit had shifted such that the Earth began eclipsing the attitude system's Sun sensors. In view of the data lost from the recorder failures and TD-1's otherwise good health, it was decided to try a manoeuvre for which the satellite had not been designed. As the eclipses began, TD-1 was spun faster around its Sun-pointing axis for stability and placed in hibernation. The reverse operation was successful in February 1973, to the delight of its controllers and scientists. 70% data coverage was

TD-1 in the integration hall at ESTEC, July 1971. The attitude control system held this side square on to the Sun.

achieved in the second scan period of March-October 1973, the most productive phase of the mission. One tape recorder even began working again, in October 1973.

Hibernation was successful again October 1973-March 1974. All of the instruments were still working in May 1974 when attitude control was lost following exhaustion of the onboard gas supply, and the mission ended. By that time, TD-1 had achieved 2.5 celestial scans and the mission was declared a total success.

Satellite configuration: box-shaped bus, 0.9x1 m, 2.2 m high. Experiments housed in upper box; subsystems in lower box.

Attitude/orbit control: X-axis (solar array face) Sun-pointing with 1 arcmin accuracy, while TD rotated at 1 rev/orbit about X-axis for the four instruments pointing along the +Z-axis (anti-Earth) to scan the whole sky in 6 months. Sun/Earth sensors, momentum wheels and cold-gas jets (11 kg gas supply).

Power system: two deployed solar wings continuously faced Sun (Sun-synchronous orbit) to provide power from 9360 2x2 cm Si cells; supported by nickel cadmium battery.

Communications: 1700 bit/s realtime on 0.3 W transmitter, with simultaneous recording on tape recorders for playback at 30.6 kbit/s on 3 W transmitter. Both recorders failed by 23 May 1972, but one resumed working in October 1973.

This internal view of TD-1 highlights the complexity. Compare it with the photographs of its ESRO contemporaries on other pages.

TD-1 Scientific Instruments	
S2/68	Telescope/spectrometer: whole-sky scan at 1350-3000 Å. Inst d'Astrophysique, Liège (B)/Royal Obs Edinburgh (UK)
S59	Telescope/spectrometer gimballed for star-tracking: UV stellar spectroscopy 2000-3000 Å (1.8 Å resolution). Space Research Lab, Utrecht (NL)
S67	Two solid-state detectors/Cerenkov detector: spectrometry of primary charged particles. Centre d'Etudes Nucléaires, Saclay (F)
S77	Proportional counter: spectrometry of 2-30 keV celestial X-rays. Centre d'Etudes Nucleaires de Saclay (F)
S88	Solar gamma-rays (50-500 MeV). Univ of Milan (I)
S100	CsI scintillation crystal: solar X-rays (20-700 keV). Space Research Lab, Utrecht (NL)
S133	Spark chamber, vidicon camera, particle counters and Cerenkov counter: celestial gamma-rays (70-300 MeV). CENS/Univ of Milan/MPI Garching (F/I/D)