

# LOW COST SMALL EXPERIMENTAL FACILITIES FOR SPACE STATION AND THE POTENTIAL FOR TELEPRESENCE VIA THE INTERNET

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## ABSTRACT

Astrodeck and Astropack are two small experimental facilities in the early stages of design and development for Space Station and other flight opportunities. The former (in development) is a tray for small exposed payloads, the latter (still at the design stage) a drawer for small internal experiments. These facilities represent the flight hardware end of a complete low cost service, encompassing experiment design and development, integration, test, transport (including sample return) and operations, aimed mainly at second and third level educational institutions. The low cost approach is expected to also be of interest to users in industry, for certain applications.

The current status of the Astrodeck and Astropack facilities are summarised in Table 1 (attached at the end of this abstract). A design sketch of Astrodeck I (the passive version of the Astrodeck tray), with small experiments integrated, is shown in Figure 1. The accommodation of two Astrodeck I units on the roof of the Spacehab module is shown in Figure 2. The commercial focus here is in the provision of units of low cost experimental accommodation (prices start from approximately US\$15,000), primarily for second and third level educational institutions, in which they can design experiments exploring some of the basic properties of the space environment and fly samples which are subsequently returned to them.

The potential for the use of the Internet in the monitoring and control of the non-passive payload variants (Astropacks I & II, Astrodeck II) is of more interest to the ASTRA 2000 Workshop. Table 1 shows a clear evolution from the passive Astrodeck I, through the provision of power, data and video interfaces to enable experiment monitoring (Astropack I) and ultimately monitoring and control (Astrodeck II and Astropack II). The commercial focus shifts from not only sample return but also to the provision of a repeatable experimental programme that can be carried out by subscribers via the Internet. This programme of experiments is intended to demonstrate some of the basic properties of the microgravity environment - hence again the emphasis on second and third level education. Table 2 summarises some of the options currently foreseen for the realisation of the Internet interface.

Figure 3 shows a conceptual design for Astropack II, using a bean seedling experiment as an example. This experiment could also be carried out in Astropack I, without the control aspects. More ambitious experiments possible using Astropack II would include those in the area of fluid physics.

Figure 4 shows a conceptual design for the web-browser

interface. The salient features are as follows:-

- Housekeeping bar with Space Station data;
- Space area with window showing webcam output, data window and control panel;
- Ground control area similarly configured.

A mock-up based on this interface was on view at the ASTRA Workshop. The remainder of the Astrocourier exhibit consisted of panels focussing on the current activities to develop Astrodeck I. Although this is the passive tray and therefore of less intrinsic interest to the workshop, the point is that this is the basic commercial starting point from which the revenue will be derived to develop the variants that enable experiment monitoring and control.

The authors of this paper would be most interested to hear from any enterprise or institute interested in the investment, joint venture or subcontracting opportunities offered by Astrocourier's activities. They may be contacted at the following e-mail addresses:-

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*Figure 1. Astrodeck I; sketch of configuration with experiments.*

Attached at end of abstract.

*Figure 2. Two Astrodeck I trays on Spacehab module rooftop in orbit (simulation).*

Attached at end of abstract.

Figure 3. Astropack conceptual design.

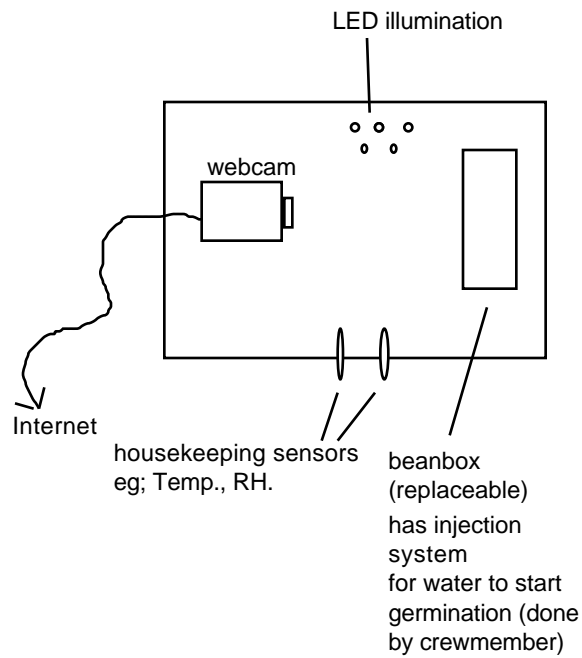


Figure 4. Astropack - preliminary mock up of user interface

Internet user interface concept - via web browser

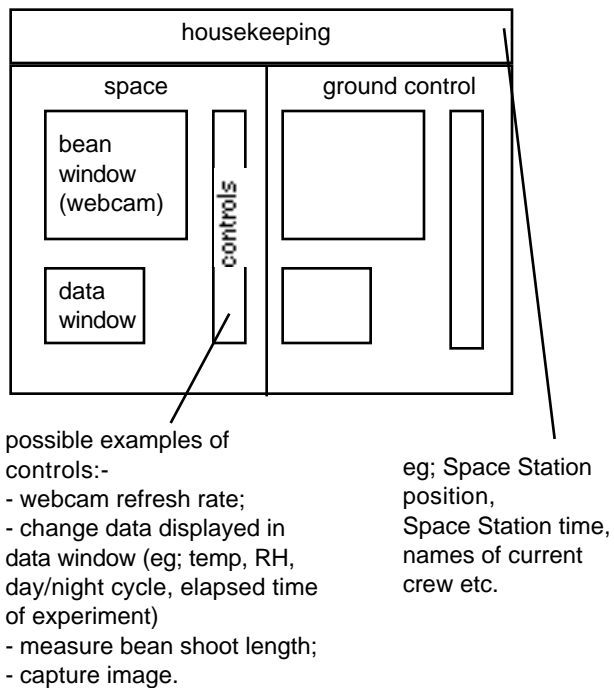


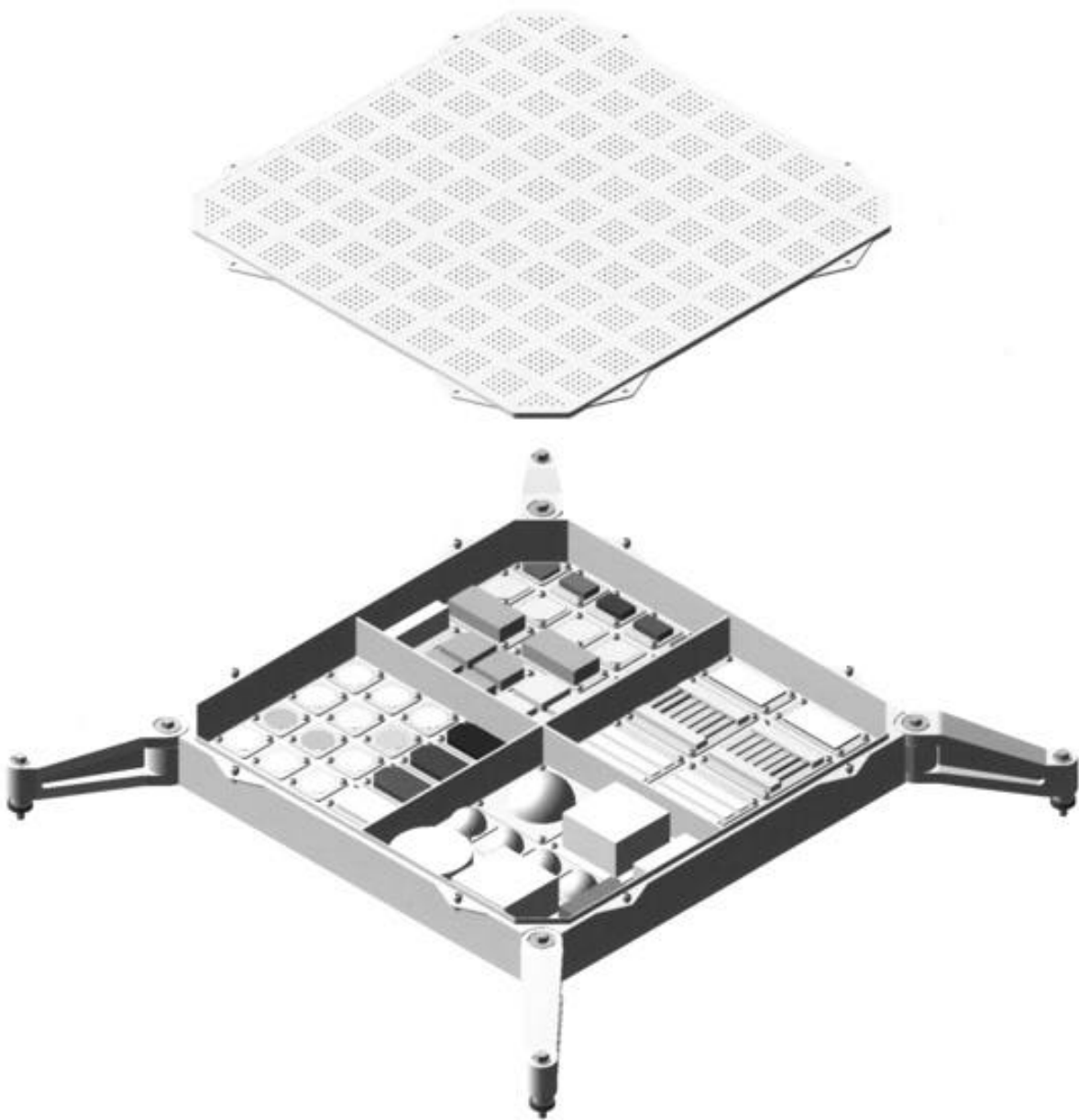
Table 1: Status of Astrodeck and Astropack variants.

Payload Type	Characteristic	Location	Status
Astrodeck I	Passive	Initially within Kistler K-1 aeroshell or on rooftop of Spacehab module or Spacehab Integrated Cargo Carrier. Ultimately on external Space Station locations eg; Enterprise or Russian modules or truss location.	Development activities have commenced. Preliminary negotiations with Kistler have commenced for first flight (proof of concept - dummy payload) in mid-2001. Preliminary negotiations with Spacehab have commenced for first flight in late 2003.
Astropack I	Active - monitoring only via Internet.	Within Space Station modules - initial options are Enterprise module (only available through Space Media Inc.), commercialised NASA module or possibly European Drawer Rack in Columbus module.	Design stage. First flight planned for 2004 - carrier tbd.
Astrodeck II	Active - monitoring & control via Internet.	On roof of Spacehab module or on external Space Station locations eg; Enterprise or Russian modules or truss location.	First flight planned for 2005 - carrier tbd.
Astropack II	Active - monitoring & control via Internet.	Within Space Station modules - initial options are Enterprise module (only available through Space Media Inc.), commercialised NASA module or possibly European Drawer Rack in Columbus module.	First flight planned for 2006 - carrier tbd.

Table 2: Internet connectivity options.

Initiative	Originator	Technical Basis	Status	Astrocourier contact
WebACT	Origin, Skytek, ESA/Estec	Development of ACT that, <i>inter alia</i> , allows a ground-based PI to take control of experiments on-orbit via the Internet. Baseline is experiments in Columbus module EDR.	Current development phase due for completion February 2001.	Preliminary discussions held with Skytek but stalled due to unavailability of WebACT information.
Internet access to images, streaming video, educational content, streaming video etc.	Space Media Inc.	Orbital broadcast studio in development as part of Spacehab/RSC Energia's commercial Enterprise module for ISS.	Launch in 2002	Preliminary discussions held with Space Media inc.
First web-server in space	Skycorp, Apple	Slightly modified Apple G4 web server to be flown, initially for the remote monitoring of satellite housekeeping data, using a modified version of the Airport wireless protocol.	tbd	No contact yet.

*Figure 1. Astrodeck 1; sketch of configuration with experiments.*



*Figure 2. Two Astrodeck 1 trays on Spacehab module rooftop in orbit (simulation).*

