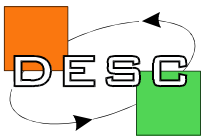
THE BIOPACK FACILITY



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INTRODUCTION

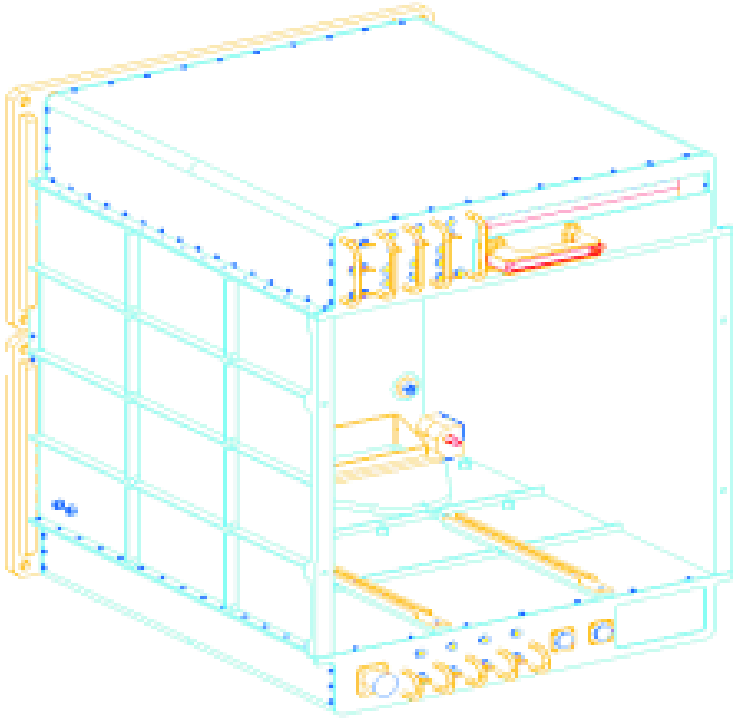
Space Shuttle Middeck Locker-based facilities payloads are one of the most suitable payloads for cell biological studies . The Biopack is a locker-based facility that builds on already existing experiment hardware and facility infrastructure such as the ESA Biorack.

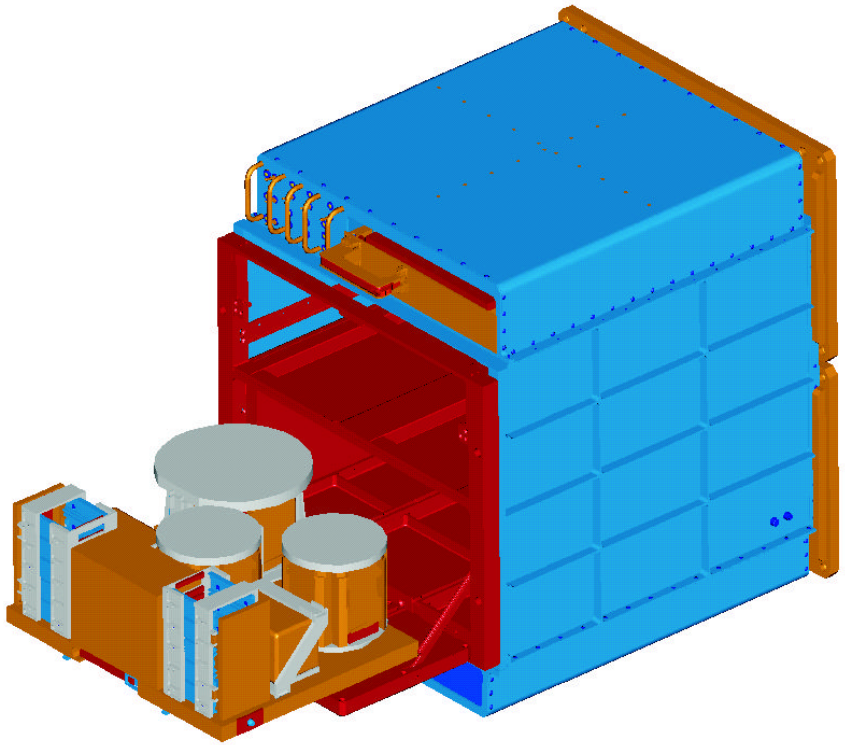
The facility is especially suitable to perform biological studies on cells, small animals or plants.

The facility consists of three major units: the Biopack Interface Frame (BIF), the Biopack Experiment Insert (BEI) and the Biopack Incubator Tray (BIT)
The BIT is the hart of the facility and accommodates experiment containers on static and centrifuge posit ions. Various centrifuges provide the possibility to expose samples to gravity profiles ranging from 0.1×g to 2.0×g.

Possible drawbacks for Space Station payloads regarding late access for biological samples are reduced to the maximum within the Biopack set-up.
Biopack could fly in the Space Shuttle middeck, in Spacehab, and at the long-term in the European Drawer Rack (EDR) in COF, the Columbus Orbiting Facility or any other Middeck locker based interface.

BIOPACK INTERFACE FRAME (BIF)



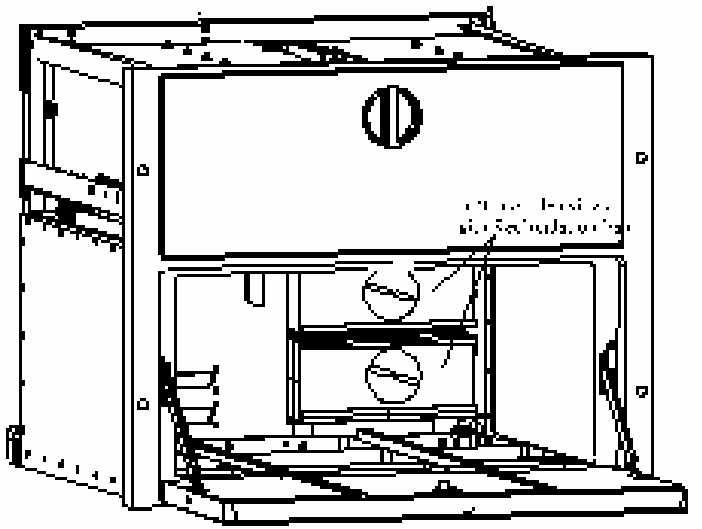


Picture courtesy from MECON, Doetinchem (NL)

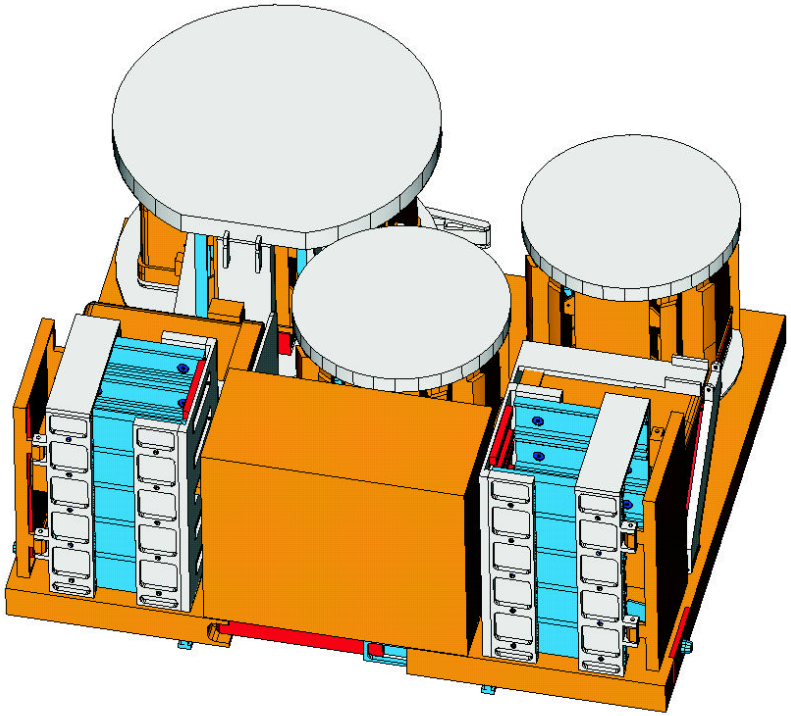
The Biopack Interface Frame (BIF) occupies the volume of two Space Shuttle Middeck lockers. It is the primary interface to the spacecraft, mechanically, thermally (air-cooling), and electrically (28 VDC power and telemetry / tele-command data), and to the crew.
All Biopack functions can be controlled and monitored by the astronauts from the Control and Monitoring Panel (CMP). On the CMP, controls for main power, for stopping and starting each individual centrifuge and for setting the incubator temperature are located. Indicators are available for major Biopack status information. In addition, a palmtop computer which forms part of the CMP, will be used for controlling Biopack's operations and displaying housekeeping and experiment data.

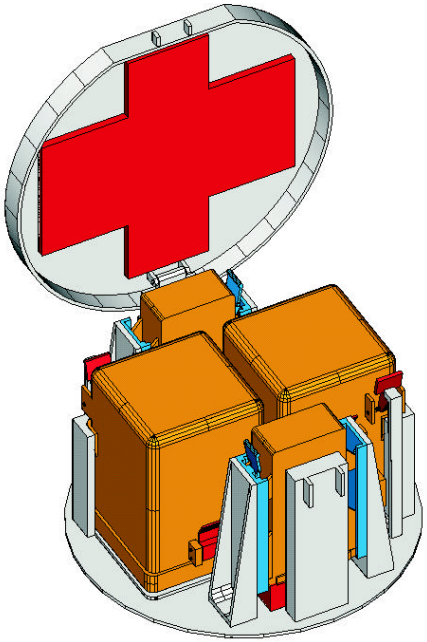
BIOPACK EXPERIMENT INSERT (BEI)

The BEI consists of an incubator which is temperature controlled between 20º and 37 °C which accommodates both Type I/E and Type-II/E containers.
To store samples two temperature controlled areas are available. Ten Type I/E containers can be stored in the +4 °C cooler, while the same number of containers can also be kept frozen in a -15 °C freezer.
To speed up the freeze/cool down time for an EC, special freeze/cool locations are provided in the cooler and the freezer. These locations, two for each compartment, are equipped with stronger cooling elements (peltier). The cool down time, for 37 °C down to 15 °C / 4 °C, will be about 60 min. The EC freeze / cool down locations are thermally decoupled from the other eight ECs storage locations, in order to minimize cross talk between the "hot" and "cold" ECs.
All static as well as the centrifuge positions of the ECs in the incubator have electrical connectors that interface with the Type-I/E and Type-II/E containers. Activation signals can be issued to experiment units either automatically via pre-programmed time lines. Experiment (sensor) data can be displayed, down-linked and / or stored locally in the palmtop memory.

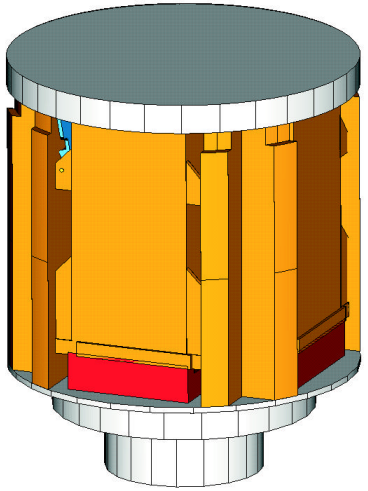


BIOPACK INCUBATOR TRAY (BIT)





Type-II/I centrifuge



Type-I centrifuge

Pictures courtesy from MECON, Doetinchem (NL)

The Biopack Incubator Tray can accommodate twenty standard Type I/E and four Type-II/E containers, ten Type I/E and two Type II/E containers in static positions and another ten Type I/E and two Type II/E on three centrifuges. Each of the centrifuges is software controlled and can be programmed individually to provide any acceleration value between microgravity, 0.1×g and 2×g in steps of 0.1×g, with a response time for µg to 2×g in about 10 seconds. Static as well as dynamic gravity profiles can be generated providing the experimenter with an unlimited range of experiment scenarios.
All centrifuges are software controlled offering numerous experiment acceleration profiles as depicted elsewhere in this poster.

GRAVITY PROFILES

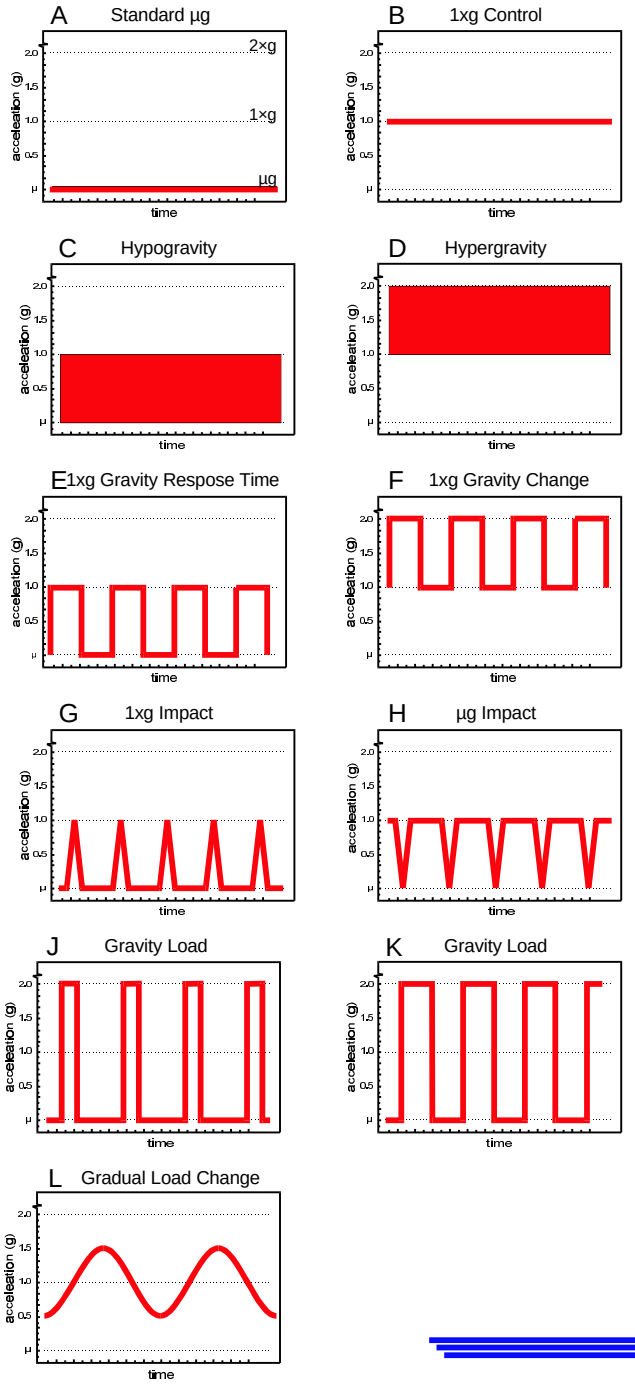
Experiments located in the static microgravity position in the incubator in combination with 1×g samples on the centrifuges, provide the ‘classic’ set-up for spaceflight experiments as have been applied in facilities such as Biorack, Biobox or CIS (Figure A and B).

Experiments can be conducted in the hypogravity area between microgravity (µg) and 1×g (Figure C). In such a scenario, threshold values for the various responses can be explored. Accelerations beyond the Earth's 1×g can be applied to evaluate whether the changes found in the hypogravity area continue in the hypergravity domain (Figure D).

To overcome a possible effect of microgravity (countermeasure), exposure for shorter or longer times to 1×g can be evaluated (Figure E). In addition, profiles could be applied sequentially to verify whether the exposure to 1×g, as such, is responsible for a response, or whether the transition and change in acceleration levels is capable of producing similar effects (Figure E versus F).

If a microgravity response has already been demonstrated, peak pulses of gravity or microgravity at preset intervals could be applied to define any gravity-sensitive windows within the samples under investigation (Figure G and H).

To investigate whether systems are sensitive to various accelerations, the impact of the total sum of loads given by the gravity level multiplied with exposure time could be analyzed. Although the total loads are similar, it could be interesting to investigate how biological samples will respond to different acceleration profiles (Figure I and J) and compare these data to an average of 1×g as per Figure K. Studies involving 'perception times can be done even more sophisticated. Gravity perception could be different when systems are exposed to sudden changes (previous figures), as compared to more gradual changes (Figure L).



STATUS

The Biopack facility is currently (May 1999) in its detailed study and breadboarding phase (Phase-B). Phase C/D is anticipated to start in early 2nd half of 1999.
Industrial team: Bradford Engineering (NL) prime contractor, HTS (CH) and Fokker Space (NL) as sub-contractors.
Its maiden flight shall be on board the STS-107 Shuttle flight, currently scheduled for January 2001.

ACKNOWLEDGEMENTS

This work is funded by the Netherlands Organization for Scientific Research (NWO) through the Space Research Organization of the Netherlands (SRON) and the Netherlands Agency for Aerospace Programs (NIVR) combined grant # MG-051 (DESC), the NIVR / SRON (Bradford Engineering and Fokker Space) and ESA / Prodex (HTS). Pictures courtesy from MECON, Doetinchem (NL)