KUBIK

Incubator inside the European Drawer Rack

KUBIK is a small controlled-temperature incubator or cooler with removable inserts designed for self-contained microgravity experiments.

View inside KUBIK showing centrifuge insert

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ERASMUS Centre - Directorate of Human Spaceflight and Operations

Facility Description

KUBIK

KUBIK consists of a small controlled temperature volume, which can function both as an incubator or cooler (+6°C to +38°C temperature range). It operates from 6 °C to 38 °C with a stability of 0.1 °C (except if the lid is open). Temperature accuracy, including spatial dispersion is as follows: ±2 °C between 6 °C and 15 °C, ±1 °C between 15 °C and 29 °C, ±0.5 °C between 29 °C and 38 °C.
KUBIK is a cubic box container measuring 37 cm by 37 cm by 37 cm composed of (from top to bottom) a thermal chamber of 26 cm by 26 cm by 13.3 cm.
Self-contained automatic experiments can be performed using power provided by the facility. Alternatively, it is possible to use manually operated experiment hardware, which the crew removes from the incubator for operations.
The thermal chamber can be equipped with removable inserts designed for maximal sample flexibility.
There are no data or command communication possibilities between the experiments and KUBIK; therefore, the experiment hardware design must include automatic operation.

KUBIK incubators can also be potentially operated powered in Soyuz providing a means of maintaining controlled temperature, providing 1g conditions & perform automatic experiments from a few hours prior to launch until docking.

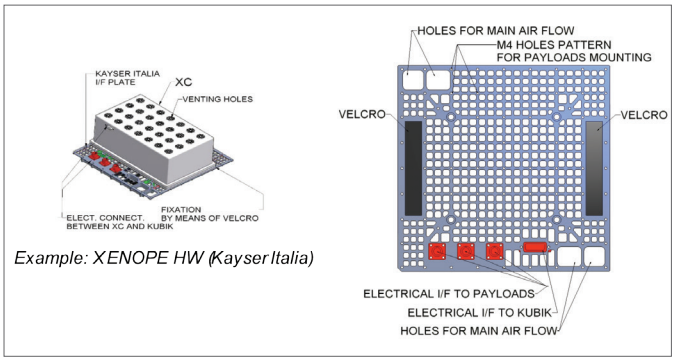
Settings (temperature, centrifuge acceleration) can easily be changed via push buttons. Internal and ambient temperatures, acceleration, events, and status can be download via the RS232 (data cable) and on-board laptop at the end of an experiment run.

INSERTS

Several removable inserts can be used depending on the experiment's requirements. The insert is a mechanical structure, placed in the thermal chamber which provides an interface to the experiment specific containers or equipment. Several inserts exist which can be used for different applications.
These inserts allow for an easy reconfiguration on orbit:

- Centrifuge insert (CI)
- Passive Insert (PI)
- Rack Insert (RI)
- KUBIK Interface Plate (KIP)
- KUBIK without insert

KUBIK Interface Plate (KIP) with XENOPUS Experiment as example



Example: XENOPE HW (Kayser Italia)

KUBIK without insert can accommodate a new insert as payload.	
Thermal chamber volume:	9.36l (260x260x133.2mm3)
Thermal chamber temperature:	6°C to 38°C settable by 0.1°C increments

Centrifuge insert (CI)

The centrifuge insert permits simultaneous 1 g or intermediate g-level control samples to be run in parallel with microgravity samples. Experiments interface with the centrifuge insert via small standardized containers; therefore experiments need to be designed to fit inside these containers. Alternatively, if an onboard centrifuge control is not need it is possible to interface larger, dedicated experiment hardware with KUBIK via an interface plate (see KUBIK Interface Plate (KIP) for more details).

The main capabilities of the centrifuge insert are:

- Settable acceleration between 0.2G to 2G in 0.1G increments;
- Accommodation of either 16 standard size containers in static positions or 8 standard size containers and 4 extended containers;
- Accommodation of 8 standard size or 8 extended containers on the centrifuge;
- 3 activation buses linking the containers by set of 8 (one bus on the centrifuge, two separate buses on the static rack).

Passive Insert (PI)

The passive insert is a static tray for ECs which provides a mechanical interface for standard & extended containers. A total of 32 standard (I/O or I/E type I) or 16 extended containers (IBEX type I) can be accommodated on the passive insert. No electrical power is provided to experiment containers by the passive insert.

Rack Insert (RI)

The rack insert (RI) is a static tray for vial cards with no electrical connection. It can accommodate 10 double side cards or 18 single side cards giving 100 (double side) or 80 (single side) vials at maximum. It permits controlled temperature of reagents or samples.

KUBIK Interface Plate (KIP)

The KUBIK Interface Plate (KIP) consists of a plate which attaches to the mechanical and electrical connections in the interior of the KUBIK incubator. Custom developed experiment hardware (as an alternative to the Type I/IBE/KIC mechanical and electrical I/F) that requires more volume or complexity than can be provided in the standard / extended experiment cassettes can then be attached to the KIP, which provides electrical power to the experiment if required.

KIP accommodation volume	260 x 260 x 108 mm3
KIP power supply	3 independent power busses

Examples of experiment specific containers (ECs) for CI and PI

Individual experiments interface with the KUBIK facility via experiment specific containers (EC's). For the Centrifuge (CI) and Passive insert (PI) these include a family of "standard sized containers (Type-I/O, IBE and KIC-SL containers), providing approximately 20 x 40 x 80mm internal space and extended sized containers (IBEX, KIC-SL-E) with approximately 30 x 40 x 80mm internal space. The EC's can contain either manually operated hardware (without electrical connections to KUBIK) or automatically operated hardware. Power can be provided to the experiment containers via a 17pin connector which in the case of the Centrifuge Insert (CI) interfaces with the centrifuge insert electrical buses.

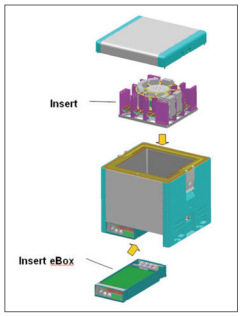
Experiment Specific Hardware

Experiment specific hardware, the so called Experiment Unit (EU) is usually developed by ESA according to the requirements of the experiment. Once the experiment requirements have been finalised new hardware development typically takes 12-18 months. For some experiments it may also be possible to use an already existing hardware design.

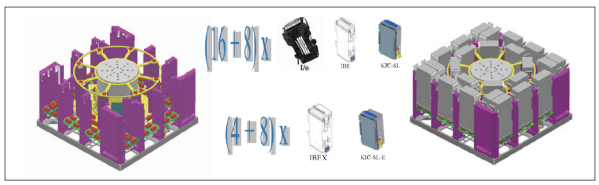
Specifications

The container is a cubic box (366x366x366mm) composed of:	
The thermal chamber:	260x260x133mm (internal dimensions)
The thermal structure:	Peltiers, fans and exchangers
The electronic boxes:	used to control incubator and inserts
The main capabilities are:	
Settable temperature:	+6°C and +38°C in 0.1°C increments (KUBIK FM3 is limited to 48h below +18°C)
Removable inserts	

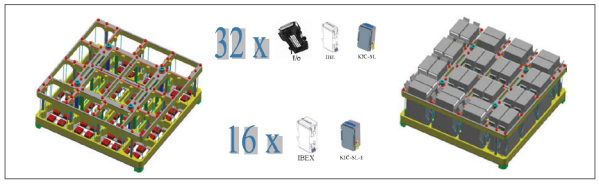
NASA astronaut Doug Wheelock working with KUBIK in the Columbus laboratory



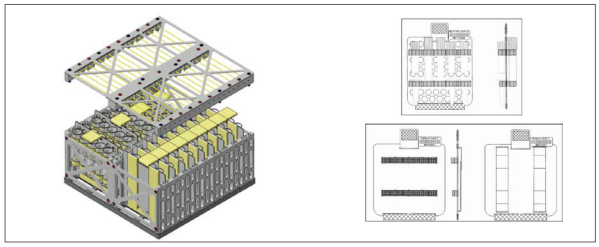
Configuration of KUBIK with Centrifuge Insert



Configuration of KUBIK Centrifuge Insert (CI) with experiment containers



Configuration of KUBIK Passive Insert (PI) with experiment containers



Configuration of Rack Insert (RI) with sample vials

Operations and Utilisation

ACCOMMODATION & TRANSPORT

In the past KUBIK was operated as a stand alone facility in the Russian segment of the ISS. Nowadays however it is operated in Columbus. Currently there are 2 KUBIK on orbit; one in the KUBIK Interface Drawer (KID) in the European Drawer Rack (EDR), the other stowed and deployed in front of EDR as stand-alone centre-aisle payload when needed.

Depending on the requirements of the experiment, the experiments samples can either be prepared and loaded into the experiment containers in the investigators laboratory and shipped to the launch site, or be prepared at the launch site. For Soyuz and Progress launches the experiment can be integrated up to 14 hours prior to launch.

Generally experiments are launched in passive stowage, without electrical power at ambient temperature. If a specific temperature range needs to be maintained, then phase change materials can be used. Once the experiment arrives at the ISS it will be installed in the KUBIK incubator. A typical experiment consists of up to 8 experiment containers. Previously, some experiments were launched onboard Soyuz in a powered KUBIK to provide temperature control & power from approximately 8h prior to lift off until transfer to ISS. However, it is foreseen that future experiments will be performed by launching experiment cassettes in passive stowage.

OPERATIONAL CONCEPT

Experiments can be run in automatic or manual mode, depending of the scientific requirements and associated hardware. For automatic experiments there is currently no capability to command the experiment from the KUBIK facility, therefore the operation of the experiment must be controlled directly from within the experiment. Manual experiments are performed by the crew using simple experiment specific tools. Experiment manipulations may be performed in the experiment cabin or in a glovebox depending on the toxicity of the experiment samples.

UTILISATION SCENARIO

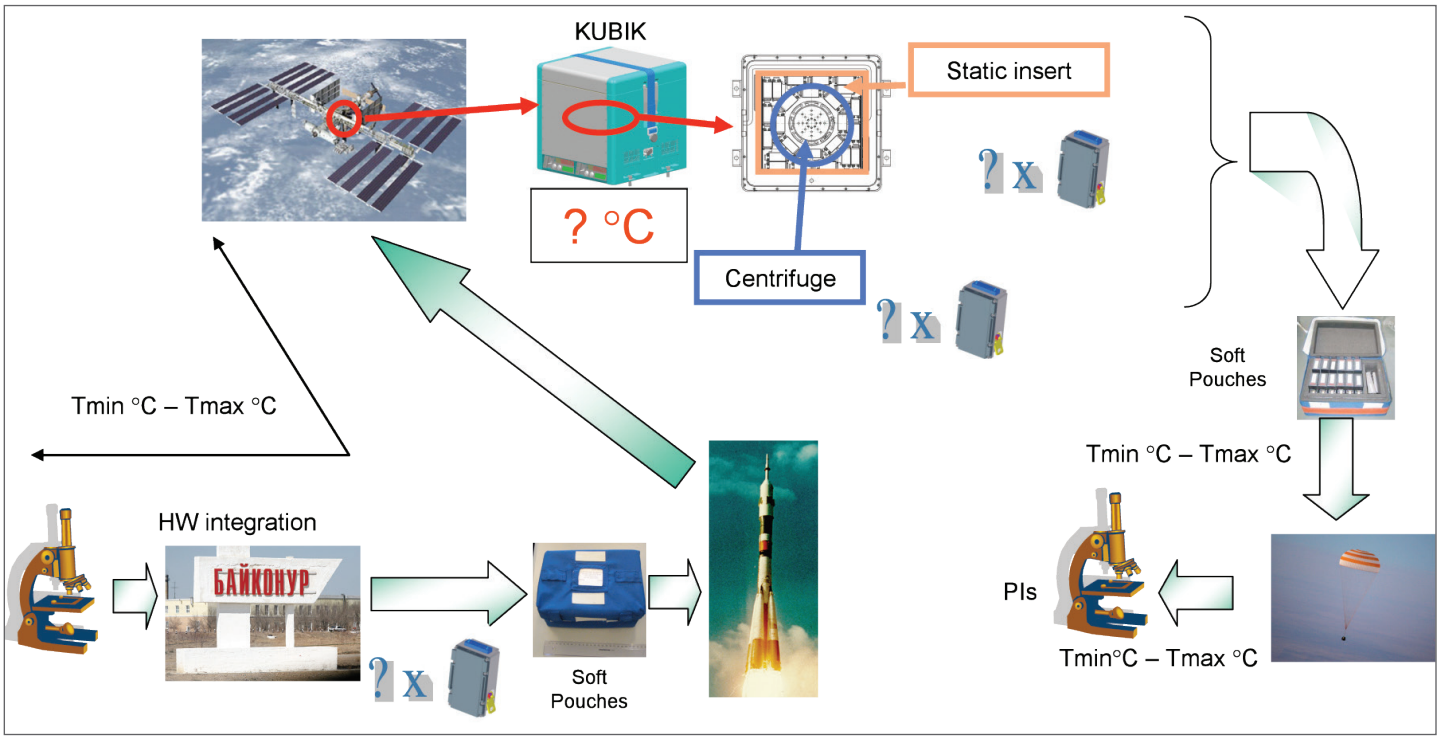
Automatic experiments are inserted into KUBIK & run according to an automated timeline until completed. The containers are removed from KUBIK by the crew following completion of the experiment operation & transferred to onboard stowage (ambient, refrigerated or frozen) until return to earth. Typically, the minimum time between upload & download of experiment samples for current ISS operations is a minimum of 2-4 month, therefore experiment samples must be able to withstand at least this period of stowage.

A typical return with Soyuz is ambient. Experiment cassettes are typically exposed to ambient temperature for 1-2 days before they can be transferred to conditioned temperature stowage on ground. Handover to the experiment team generally takes place 2 days after landing. Due to the limited facilities available at the landing site, manipulation of experiment samples at the landing site by the investigator can only be performed in exceptional circumstances.

SCHEDULE

Two KUBIK are currently on orbit. KUBIK 3 was launched on 10 October 2007 on Soyuz 15S and is used as stand-alone centre-aisle payload. KUBIK 6 was launched on HTV-1 in September 2009 and is used in KID in EDR.

Experiment uploaded via soft pouches: KUBIKs already on orbit



Illustrations: ESA/D. Ducros