European Physiology Modules

The European Physiology Modules (EPM) are developed within the *Microgravity Facilities for Columbus (MFC) Programme*, the most important European contribution to the International Space Station's microgravity utilisation initiative. The MFC programme covers the development of five multi-user laboratories in the fields of Biology, Human Physiology, Materials and Fluid Science.

EPM is a modular, multi-user facility consisting of a *Carrier* supporting a set of *Science Modules*. Each Science Module uses a standardised container that allows easy on-orbit reconfiguration of the facility. This flexibility will allow accommodation of new Science Modules to be developed in response to new scientific requirements. The Carrier can support up to 8 Science Modules, and also includes storage volume for consumables and deployed items.

The EPM facility builds upon the previous European experience gained through experiments on such facilities as Sled, Anthrorack and Physiolab. *Human physiology experiments in microgravity* are aimed primarily at increasing our knowledge of how the human body reacts to long-term weightlessness. However, this area of research also contributes to an increased understanding of terrestrial problems such as the ageing process, osteoporosis, balance disorders, and muscle wastage. Typical research areas include: Neuroscience, Cardiovascular and Respiratory System, Bone and Muscle Physiology, and Endocrinology and Metabolism.

NASA has developed a complementary facility to the European Physiology Modules known as the *Human Research Facility* (HRF). It has collocated the Human Research Facility (2 racks) within the Columbus Laboratory with the European Physiology Modules facility in order to allow combined experiments using instruments from both facilities.

The **EPM Carrier** provides the infrastructure for the Science Modules and includes data handling, thermal control and mechanical accommodation. The Carrier interfaces directly to the Columbus Laboratory and provides support (thermal control, power, data handling) for both rack-mounted and external Science Modules. The Carrier can accommodate up to eight active Science Modules, allowing several Science Modules to perform experiments in parallel.

The Carrier contains two 8 PU passive containers used for on-board stowage.

In addition to Science Modules mounted in the Carrier, it is also possible for instruments deployed in the Columbus centre aisle, to interface to the Carrier via a Utility Distribution Panel. This panel provides the same interfaces as offered to the rack-mounted Science Modules.

Data handling

The Carrier is equipped with two separate computers for data handling. The facility Control Computer (FCC) handles all interfaces with the Columbus Laboratory and monitors the status of the Carrier.

The Science Module Control Computer (SMCC) handles all interfaces with the Science Modules. The SMCC collects data from all Science Modules and forwards this to the FCC for further downlink to ground.

The commanding of the Science Modules and housekeeping telemetry collection is performed by the SMCC via a redundant RS-485 serial line.

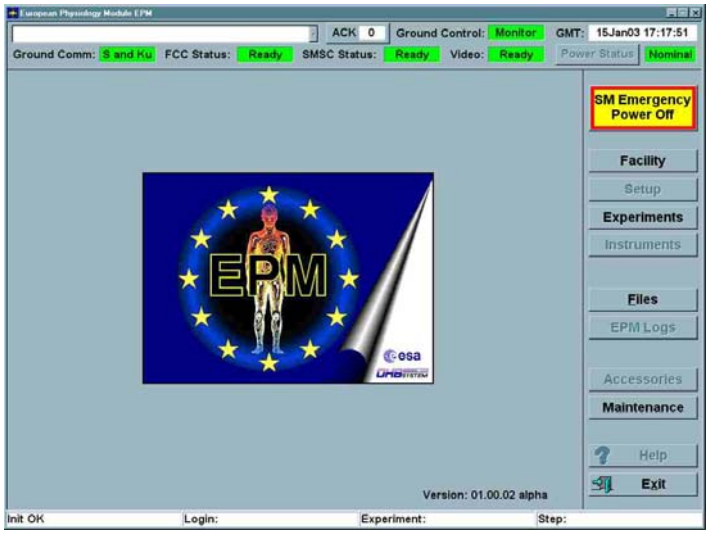
For science data transmission to the ground and facility laptop, a facility internal Ethernet Local Area Network (LAN) is available, using a TCP/IP protocol. In addition, the Carrier provides an easy to use TCP/IP interface to the Columbus high-rate downlink channel (this channel has a maximum capacity of 32 Mbps).

The Carrier Utility Distribution Panel also provides a standard Universal Serial Bus interface, which can be used by both deployed and internal Science Modules to interface to the Carrier.

Facility laptop

The Carrier includes a laptop computer that is used for all interactions with the crew, both for experiment execution and facility operations. The laptop display contains dedicated areas for facility monitoring and common experiment execution tasks. The remaining part of the display is available for Man-Machine Interface applications provided by Science Module developers, applications which are used to monitor and control the Science Modules themselves. The facility includes tools for experiment procedure execution, for both manual crew

procedures and automatic procedures. The Science Module developer can use the available procedure developer tool-kit to generate the necessary procedure inputs to be executed on the laptop during an experiment session. The provision of such procedure execution tools ensures a common "look-and-feel" for the crew across the different Science Modules.



-- Science Modules -- Overview

The **Science Modules** are the key items of the EPM Facility. They comprise scientific equipment, mounted in EPM Standard Active Containers (SACs) in the rack, or deployed instruments, used in front of the rack.

For the EPM-1 Launch configuration, three Modules have been selected by the Science Programme board and are funded by the European Space Agency. Also National Agencies are contributing to the EPM programme by developing additional SM's for EPM. Finally, ESA is also developing a SM for the NASA Human Research Facilities. An overview is given in the following table:

Acronym	Full Name	Developer	Destination
CDL	Cardiovascular Laboratory	CNES/DLR	EPM
MEEMM	Multi-Electrode Electroencephalogram Mapping Module	ESA	EPM
PFM/PAM	Pulmonary Function Module / Photo-acoustic Module	ESA	HRF2
SCK	Sample Collection Kit	ESA	EPM
	HRF Stowage Container (HGD/PFD)	NASA	EPM

Science Modules mounted in the EPM Carrier are using the ESA-provided Standard Active Container. This container provides all the mechanical, thermal and electrical interfaces to the Carrier, which reduces the effort of development for a Science Module developer.

The containers are available in two sizes, 4 Panel Unit and 8 Panel Unit (note that 1 PU = 44.25 mm). The containers are air-cooled, with the possibility for the Carrier to regulate the airflow for each container, depending on the requirements on the Science Module. The Carrier provides 28 Vdc (max. 10 A) to containers, and monitors the temperature inside the containers using two dedicated sensors in each container.

Cardiolab (CDL) is a facility for physiological research funded by CNES and DLR

Scientific objectives of Cardiolab:
- to get a better understanding of mechanisms underlying the changes in the human cardiovascular system induced by microgravity,
- to propose adapted prophylaxes to maintain the crew in a good health and well being during their stay on board,
- to prepare the astronauts to their return to Earth.

Cardiolab allows investigating of:
- The different systems (short term and long term loops) which are involved in the Arterial Blood Pressure and the Heart Rate regulations,
- The interference of basic mechanisms (at muscle level, vestibular or vascular ones) with these regulations,
- The arterial and venous haemodynamics.

Investigations will be performed either at rest or under physical or pharmacological stimuli.

Cardiolab consists of one main module, various modules and sub modules.

The Cardiolab Data Management Central Unit (DMCU) is foreseen as EPM rack mounted unit, accommodated in one 4 PU Standard Active Container.

All the other modules are stowage items.

Most of the scientific functions of Cardiolab are provided by rack-external sensor and stressor devices which are attached to the test subject. These instruments can be connected to the EPM rack via the DMCU front panel, by a direct interface (serial line) to the EPM Laptop or completely autonomous. A functional block diagram of the Cardiolab architecture is shown in Figure 1.

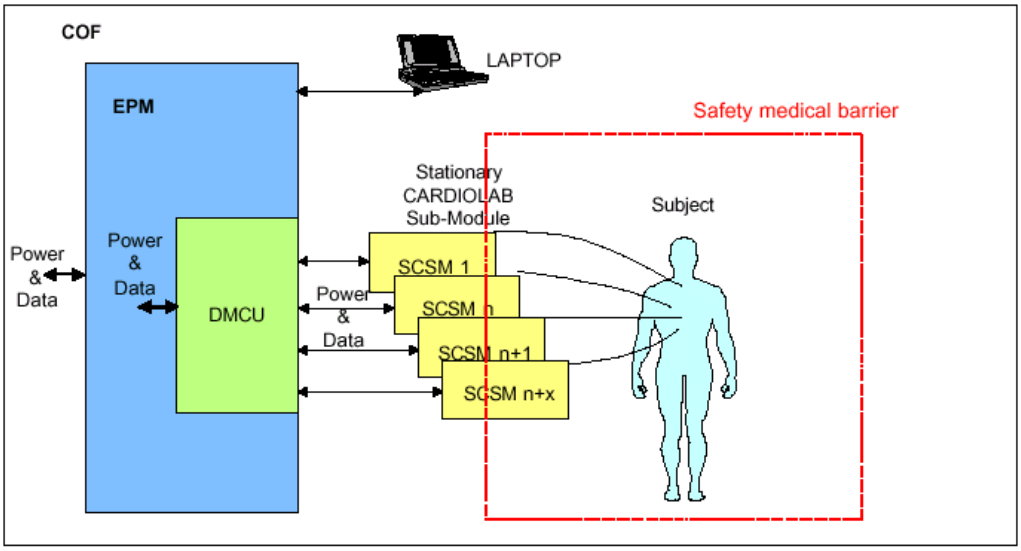


Fig. 1: Cardiolab functional block diagram

From a wide variety of possible Cardiolab sub-modules, a list of core elements has been defined, which are foreseen for the first complete configuration of Cardiolab. Additional elements are envisaged to be developed for a possible later use on the ISS.

Besides the rack mounted Data Management Central Unit (DMCU) and a set of standard interface cables, the list of Cardiolab core elements includes:

- **Cardiopres (CDPB):** Continuous blood pressure, ECG (1 to 7 leads), breathing thoracic and abdominal pattern measurements.
- **ECG Holter (HLTE):** 24 hours ECG recording
- **Arterial Blood Pressure Holter (HLTA):** Systolic, diastolic and mean blood pressure measurement
- **Cardiolab Multi Sensor Ambulatory System (CMAS):** Very versatile ambulatory device which can support various sensors recording
- **Portable Doppler (PDOP):** Main arteries blood velocities measurements
- **Air Plethysmograph (APLT):** Limb volume variation measurements
- **Limb Volume Measurement Device (LVMD):** Absolute limb volume measurements
- **Portable Blood Analyser Device (PBAD):** Main electrolyte parameter analysis depending on specific cartridge sets
- **Haemoglobinometer (HEMO):** Measurement of haemoglobin by azide methaemoglobin method, control of blood status
- **Haematocrit Centrifuge (HEMC):** Determination of the blood haematocrit by centrifugal separation of blood cells from plasma
- **Cold/Warm Pressure Glove (CWPG):** Application of temperature stress to hand
- **Leg/Arm Cuff System (LACS):** Arm/leg occlusions

In addition to the possibilities offered by Cardiolab alone, it is planned to perform combined experiments using Cardiolab sub-modules and external equipment together, In particular, there are a number of additional stressor devices provided by the US Human Research Facility (HRF), which will probably be applied during cardiovascular studies. One of those devices is e.g. the Lower Body Negative Pressure (LBNP) device.

-- Science Modules -- CARDIOLAB -- DMCU

Data Management Central Unit (DMCU)

General Description

CARDIOLAB consists of a Data Management System (DMS) which controls and manages the CARDIOLAB sub-modules (sensors / stressor devices) and which interfaces with EPM. CNES is responsible of the DMS and some sensors. EREMS and COFRAMI are co-contractors for the DMS contract. The DMS is in charge of the power supply and data acquisition of different scientific instruments.

The Data Management System includes:
- -a Data Management Central Unit (DMCU)
- -a set of software modules
- -a set of cables which interface with the sub-modules

The DMCU consists of a drawer including:
- - a computer (PC without monitor and keyboard)
- - data storage capability (HARD DISK)
- - a set of power supplies

Power: DMS power consumption is between 63.1 W (DMCU internal electronics only) and 280 W (DMCU internal electronics + maximum sub-module power supply)

Thermal: The DMCU is air cooled by the ACS. The heat load is between 63.1W (DMCU internal electronics only) and 91.9W (DMCU internal electronics + maximum sub-module power supply).

DMS budgets are in: CDL-RBR-1.0000-001-ERE
DMS ICD: CDL-CID-1.0000-001-ERE

For more information see the DMCU User Manual

-- Science Modules -- CARDIOLAB – CDP

Cardiopres

General Description

Cardiopres is a portable instrument to monitor and store continuously for up to 24 hours or longer under ambulatory conditions:
1. the continuous finger arterial blood pressure,
2. a full 12 derivations ECG, and
3. chest circumference changes using two respiratory belts.

In addition to this there are:
4. two Analog Inputs, and seven Analog Outputs.

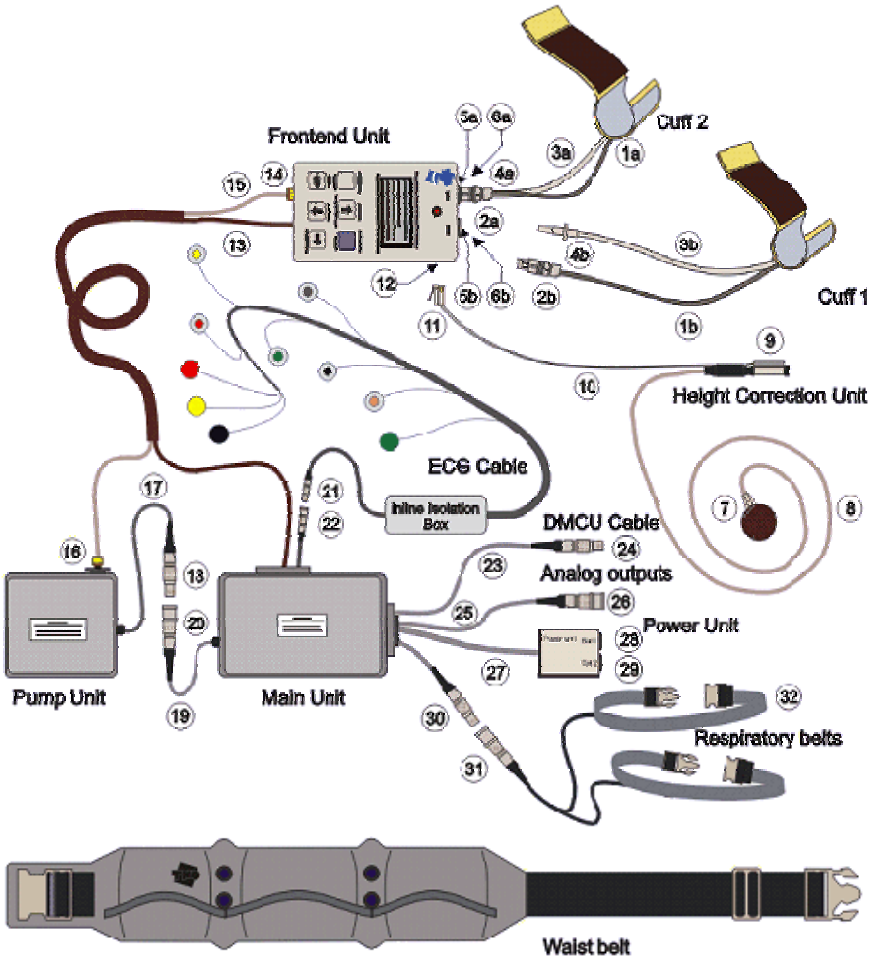
A measurement, once started becomes fully automatic and will continue without further operator intervention. Cardiopres stores the full, height corrected, finger pressure waveform, beat data detected in the pressure waveform, the height correction value, the ECG, the timing of the QRS complexes, respiratory signals, the timing of respiration, user defined analog input signals and run time status messages on its built-in memory.

Measurements can be transferred via a USB link with a PC running Windows 98 or Windows 2000. After transferring the data from the internal Flash memory card to a PC a comprehensive set of beat-to-beat parameters can be derived, using the TNO CardiView software, including systolic, diastolic and mean pressure, pulse rate, inter-beat-interval, and haemodynamic parameters such as stroke volume, cardiac output and total vascular resistance.

From the ECG derivations waveforms the R-peak timing and RR-interval, QRS and ST segment parameters can be derived.

Cardiopres comprises the following units:

Waist Belt: The Waist Belt comprises the Main Unit and Pump Unit.



Main Unit: Management of Cardiopres operation with digital and analog electronics, data input, output and storage on a built-in memory card. The main unit also comprises a card, the ECG-processor card of Mortara Instrument (Milwaukee, Wisconsin, USA). A number of so-called pig-tail cables allow connection of ECG cables, Respiratory belts, analog inputs/outputs, power, and DMCU communication.

Pump Unit: Air pressure generation for servo controlled cuff pressure.

Front-end Unit: The Front-end unit is worn on the lower arm and is connected to the main unit through the Front-end cable. The Front-end unit has connectors for two finger cuffs and a (optional) height correction unit. The Front-end unit has a LCD display and keyboard and serves as the primary user interface.

Height correction unit: Measurement of hydrostatic height with respect to the reference level (usually heart level). This height correction unit can easily be removed when not needed.

Finger cuffs: Used for the finger blood pressure measurement. A finger cuff contains a near-infrared plethysmograph, for the measurement of finger artery volume changes, and an inflatable airbladder. Three sizes of finger cufs are provided.

ECG cables: Four types of ECG cables are provided for measurement of 1 or 3 bipolar derivations (type E1 and E3) or 8 or 12 diagnostic derivations (type E8 and E12).

Respiratory belts: Recording of thoracic and abdominal chest circumference changes.

CardiWin: Software to monitor on-line, in real time, the functions of Cardiopres. CardiWin can also be used to download measurements from the built-in memory card to the PC (DMCU).

CardiView: Software to view the Cardiopres data files, to perform a comprehensive off-line beat-to-beat analysis (Model flow cardiac output method) on the pressure waveform, and to print and export data for further analysis.

For more information, see the Cardiopres User Manual

-- Science Modules -- CARDIOLAB -- HLTE

ECG Holter

General description

The ECG Holter is based on the PM350B ECG Monitor
manufactured by Medicomp Inc., USA.

The ECG Holter:

- Provides long term (up to24 h) ambulatory recording of the ECG
- Records two channels in parallel
- Has online analysis capabilities during data collection
- Classifies the patient's ECG into:
  supraventricular, ventricular, bradycardic, and ST activity
- Uses the Diogenes algorithm to identify 40 types of arrhythmia

For more information on the use of the device, see the User Manual

Specifications

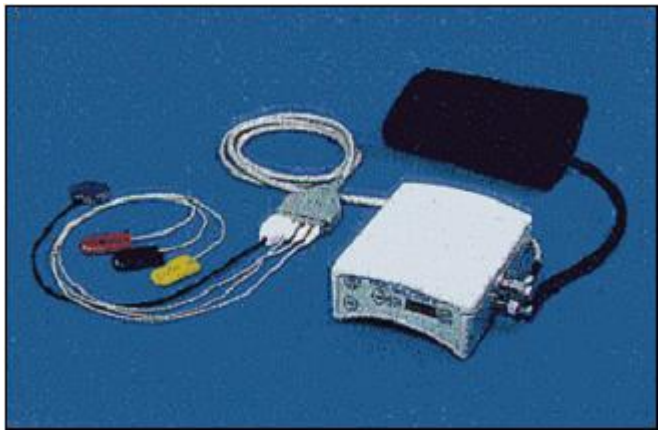
Height: 2 inches (5.1 cm)
Length: 3.2 inches (8.1 cm)
Weight: 3.7 oz, with battery (105 g)

Operating Temperatures: -0° C (32° F) to 45° C (113° F)
Humidity: 10% to 95% relative, non-condensing

-- Science Modules -- CARDIOLAB -- HLTA

Arterial Blood Pressure Holter (HLTA)

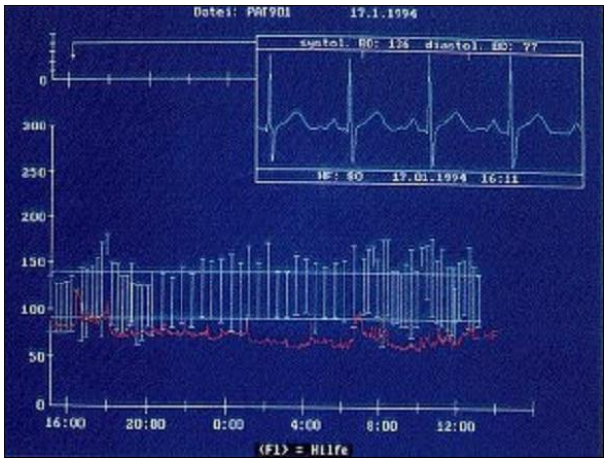
General description



TONOPORT IV/IVa is a small-size, patient-borne blood-pressure recorder. For periods of up to 30 hours it takes the patient's blood pressure at selectable intervals and saves the results. After the procedure, the stored data can be viewed on a PC monitor or they can be documented via a printer.

The holter measures Arterial Blood Pressure values either using the **oscillometric** or **auscultatory** method with optional ECG stripes recordings.

For the oscillometric method, instead of the KOROTOV sounds, the criteria for this method are the pressure pulsations superimposed with every systole on the air pressure in the cuff.



For the auscultatory method a microphone is employed. Furthermore, this model saves the heart rate and ECG strips in addition to the blood pressure readings. The recorder acquires the audio and the ECG signals via the same patient cable. With special adhesive tabs, the microphone is fixed on the arm underneath the cuff. The ECG signal is acquired via 3 electrodes.

Frequency measurement can vary from 1 measurement per 2 minutes to 1 measurement per 2 hours. A maximum of 200 measurements can be stored in the 32 kB memory. The measuring range for systolic pressure is from 70 to 300 mmHg and for diastolic pressure from 50 to 230 mmHg.

Height 128 mm
Width 105 mm
Depth 48 mm
Weight 390 g, including the battery

For more information on the use of the device, see the User Manual

-- Science Modules -- CARDIOLAB -- CMAS

Continuous Measurement Ambulatory System (CMAS)

General Description

CMAS is based on the VitaPort 2 / ADAS 2 instrument manufactured by TEMEC Instruments B.V., the Netherlands.

CMAS consists of two modules: an 18 channel PSG module and a module with 8 universal bipolar channels.
The PSG module provides you with 18 polysomnography channels. All the channels are connected to the multi-connector. To this multi-connector you can either connect a PSG patch panel or a specific especially tailored cable. This is the ideal module for full polysomnographic or cardio-respiratory recordings. This module offers all functionality required for differential diagnosis of apnea and sleep.

The second module provides you with 8 universal bipolar channels with selectable excitation voltage output. This is the ideal module if you require more bipolar channels for a specific application.

CMAS collects data in a temporary RAM buffer of 1 Mbytes. If this buffer is written for more than 50%, the content is flushed to the PCMCIA card or hard disk for permanent storage. It is preferable to use non-disk PCMCIA devices as they are energetically favourable and therefore provide much longer lifetime for the batteries.

For more information on the use of the device, see the User Manual

-- Science Modules -- CARDIOLAB -- PDOP

Portable Doppler

General Description

The Portable Doppler module permits the blood flow measurements in three arteries in parallel (to ensure a larger measurement combination range, two probes can be located on each way).

The arteries selected are:

- Cerebral artery
- Internal Carotid artery
- Aorta
- Femoral artery
- Superficial arteries: Radial, Tibial

The PDOP consists of the following elements:
1. The main unit
2. The electronic accessories:
   Probes (2, 4 & 8MHz PW)
   Two earphones
3. The Harness
4. The Nomex flight container
5. The ground container
6. The GSE (Ground Support Equipment)
7. Consumables kit: gel, wipes....

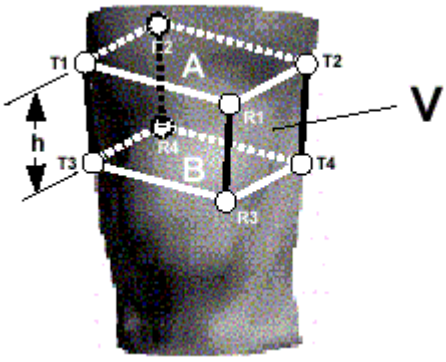
More information on the probes:
2MHz PW probe for Transcranial application
2MHz PW probe for Aorta application
2MHz PW probe for Carotid application
4MHz PW probe for Femoral application
8MHz PW probe for Peripheral application

For more information on the use of the device, see the User Manual

-- Science Modules -- CARDIOLAB -- LVMD

Limb Volume Measurement Device (LVMD)

General Description



The LVMD includes two separate measurement principles, both based on the same H/W components using ultrasound technique. In one case LVMD provides **limb volume measurements** based on distance measurements between U/S sensor heads, which are applied to the skin of the upper and lower segments of arms and legs of the test subject. The other function supports a continuous recording of the spine geometry over a 48 h period also named as **body position function**.

This device is designed for easy **stationary** and full independent **ambulatory** measurements. Data recording is performed either online, via continuous connection to the DMCU, or internally (by 48 hours-flash memory at 0.5 Hz sampling rate). LVMD operates on batteries. The light-weight electronic unit can be strapped on the test subject. The device can be handled by a single crew member with minimum interaction and tools need. U/S sensors can be fix placed on the skin with a minimum effort during the experiment session runs. The sensor placement on the skin is automatically checked and any failure is announced to the user via acoustic and optical signals.

LVMD contains eight U/S sensors, operating as four pairs of transmitters and receivers. Each sensor pair is placed either on the back for body position measurements, or two pairs are placed around one circumference of the selected limb segment for limb volume measurements.

For more information on the use of the device, see the User Manual

-- Science Modules -- CARDIOLAB -- APLT

Air Plethysmographs (APLT)

General Description

The APLT = Air Plethysmographs are pneumatic plethysmographs designed for measuring absolute volume changes in the lower extremities.

A special sensing cuff is applied to the patient's calf which extends from the ankle to just below the knee. An air pump inflates the cuff to a selectable pressure referred to as "bias pressure" (6 mmHg is standard) which is just enough pressure to stabilize the cuff on the patient. A pressure sensor reads the pressure in the cuff displays the data on the bar graph on the front panel and sends the volume calibrated signal to a computer.

The pressure in the cuff is calibrated to changes in leg volume by infusing 100 ml of air into the leg cuff from a calibration syringe.

For more information on the use of the device, see the User Manual

HemoCue B-Hemoglobin measuring device (HEMO)

General Description

Hemoglobin indicates changes in the volume of the blood plasma and the overall status of the blood.

The HEMO system is used for quantitative determination of hemoglobin in blood using a specially designed photometer and specially designed microcuvettes. The method is based on Vanzetti, G., J. Lab & Clin Med 67:1, 116 (1966). The absorbance is measured at two wavelengths (570 and 880 nm) in order to compensate for turbidity in the sample.

The measurement range is 0-256 g/L, 0-15.9 mmol/L. Accuracy is ± 1.5%. Linearity is < 2% (range 5-180 g/L) and < 4% (range 18-25 g/dL).

The disposable microcuvettes (which are for in vitro diagnostic use only) contain reagent in dry form and are used as reaction vessels and for measuring the samples. No dilution is required. Reading of hemoglobin takes place in the photometer, which follows the reaction and presents the results only when the reaction has stopped. The photometer is calibrated at the factory against the hemoblogincyanide-(HiCN) method, which is the international reference method.

The HemoCue Analyzer records all measurements in its internal memory. Each record contains Operator, Date and Time, Type of Record, Identity (Patient), and Result. The data stored in the memory can never be changed or modified. The memory can be uploaded to a PC.

The function of the photometer should be checked on a daily basis by measuring a control/calibration cuvette.

The photometer is powered by batteries.

For more information on the use of the device, see the User Manual

Hematocrite Centrifuge (HEMC)

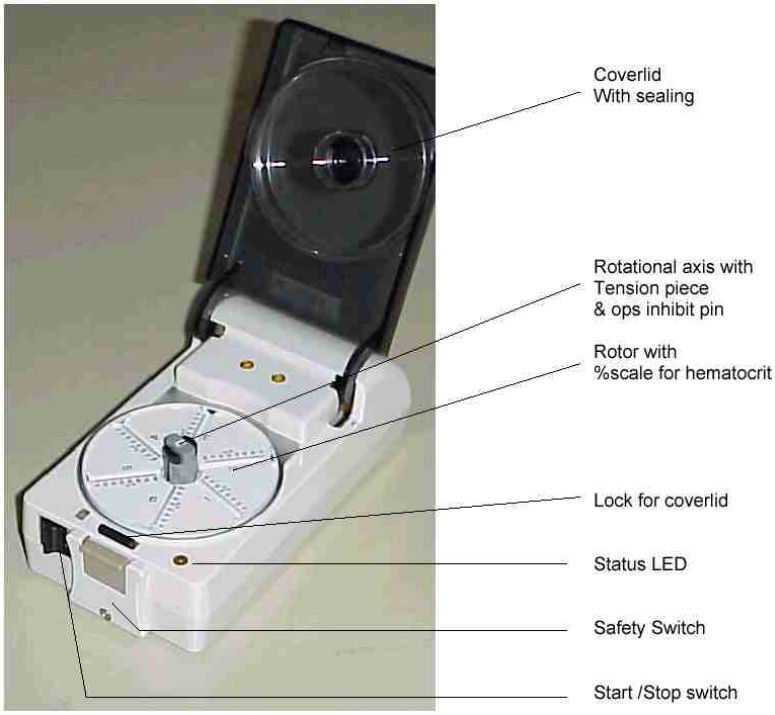
General Description

Whole blood hematocrit (range of 10-80%, accuracy of ± 1%),

HEMC processes up to 6 capillaries simultaneously (9 µl of blood per capillary),

The centrifuge runs with a rotational speed of 11,500 rpm producing a centrifugal force of 5396 g.

For more information on the use of the device, see the User Manual



Portable Blood Analysis Device (PBAD)

General Description

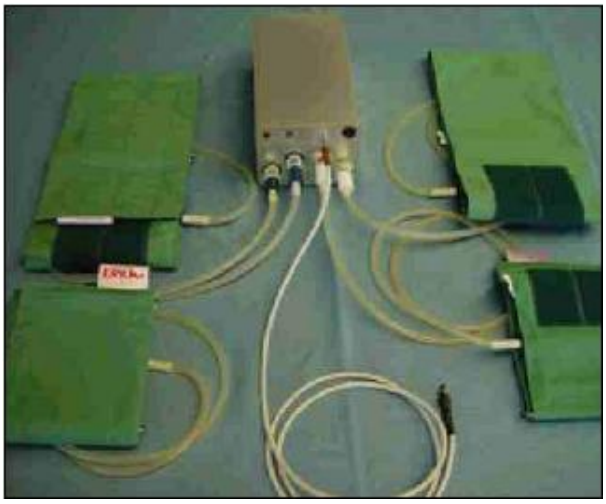
The PBAD device is based on the commercial i-STAT instrument.

Cartridges are available to measure: Sodium (Na), Potassium (K), Chlorid (Cl), Harnstoff-Stickstoff/Harnstoff (Ammonium), Glucose (Glu), Hematocrit, Ionized Calcium (iCa), pH, pCO2, pO2, and Creatinine.

Calculation of following parameters is possible: Haemoglobin, TCO2, HCO3, BEecf, SO2, and Anion Gap (AGP).

For more information on the use of the device, see the User Manual

Leg/Arm Cuff System (LACS)



General description

LACS consists of a Main Unit and a set of occlusion cuffs for legs and arms. The pressure can be applied and released in a controllable manner in a range from 0 to 300 mmHg.

For more information on the use of the device, see the User Manual

Science Modules -- CARDIOLAB -- CWPG

Cold/Warm Pressure Glove (CWPG)

General description

The CWPG is a local stressor on the cardiovascular system. The experiment is comparable to a water immersion experiment on ground.

The principle: the CWPG is a conditioned glove to a certain temperature (0-5°C for cold and 43-44°C for warm) for a defined period by the means of phase change material with a delta T of less than 1°C for 10 min.

For more information on the use of the device, see the User Manual.

Multi Electrodes Encephalogram Measurement Module (MEEMM)

General description

MEEMM is a Science Module installed in the European Physiology Modules (EPM) Facility. It is dedicated to the study of **brain activity** by measuring both EEG and Evoked Potentials in both stationary and ambulatory mode.

The Multi-Electrode Electro-encephalogram Mapping Module (MEEMM) will be used for non-invasive brain function investigations by recording electro-encephalograms (EEG) and evoked potentials (EP). It will also allow the measurement of electro-myogram (EMG) channels, reflecting the electrical activity of the muscles. Studies of the brain reaction on external (e.g. visual or acoustic) stimuli will be a major application of the MEEMM. Besides the equipment for stationary experiments near the EPM rack, the MEEMM also includes a small, portable unit for ambulatory and sleep studies.

MEEMM records electrophysiological signals generated by brain or muscle activity. The signals are acquired by specific electrodes fixed to the test subject, electrodes for brain investigations being integrated in a flexible cap. For the cap measurements, the injection of gel into the electrodes is necessary to ensure a good contact to the skin. A commercial gel cap was chosen as baseline because it provides a reliable and sufficient scientific performance.

The MEEMM Science Module is composed of the following units:

- Main Unit included in a 4 PU Standard Active Container
- Stowable items including:
- Sensors
- Head boxes in charge of pre-conditioning the signal
- Harnesses to link the sensors, the head boxes and the main unit for the different operational configurations
- A portable unit referred as PORTEEM dedicated to ambulatory and sleep studies
- A digital camera
- Consumables: spare sensors/electrodes, gel application and cleaning equipment, spare flash disks and batteries

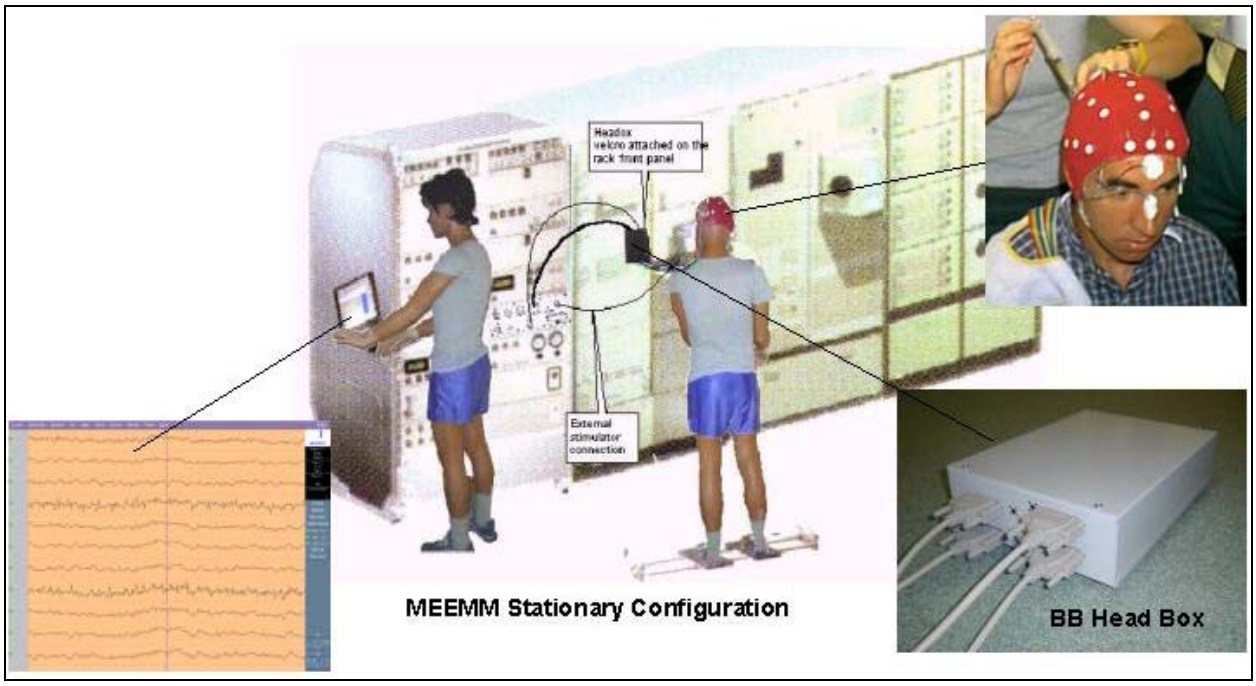


Fig. 1: MEEMM SM Overview

The first amplification steps for the small signals are performed in a head box attached to the test subject. From the head box, the signals are transferred to the rack mounted main unit for further amplification, processing, and storage.

Various measurement types are possible, based on the selection of different sensors and head boxes. The selection of acquisition path will be made by SW and harness choice between EEG/EP cap, EMG electrodes and head boxes.

The positions of the electrodes once mounted on the subject are determined using a dedicated, commercial digital camera. The position calculation shall be performed on ground using appropriate software.

MEEMM can simultaneously sample 128 channels at a sampling frequency of 2,2 kHz or 32 channels with a sampling frequency as high as 40 kHz. Each channel has a CMRR higher than 100 dB. The full range of performance capabilities are specified in the table below:

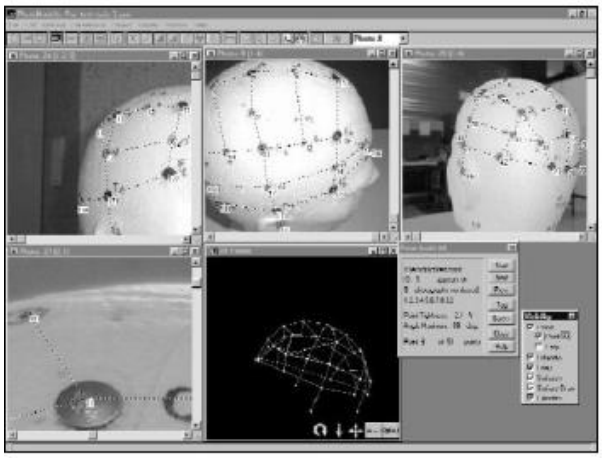
Mode	Channels	Bipolar Interfaces	Maximum Bandwidth	Max. Sampling Freq.	Signal Envelope
Fast Stationary	Up to 32	Up to 32	1Hz - 10 kHz	40 kHz	25 mVpp
Slow Stationary	Up to 128	At least to 32	0.01Hz - 570 Hz	2.2 kHz	25 mVpp

EMG acquisitions only include conventional surface EMC acquisition (without electrical stimulations). The MEEMM acquisition channels allow acquiring low impedance signals.

MEEMM acquires and stores the raw scientific data channels (continuous acquisition) as well as 3 other external analogue inputs on a removable 40 Gbyte hard disk in a synchronised process.

MEEMM acquires external triggering digital signals using an 8-bit digital interface:
- with the sample relative accuracy for sampling frequencies up to 10 kHz
- with 0.1 ms for higher sampling frequencies

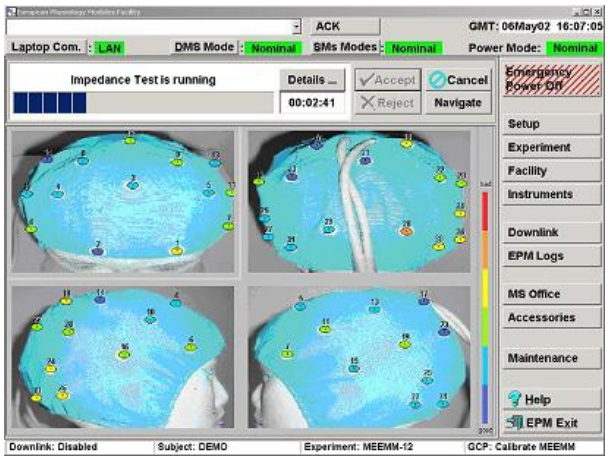
Position of the electrodes
MEEMM determines the position of the electrodes once mounted on the subject, using an onboard digital camera. The position calculation will be performed on ground using appropriate software (see the screen capture in picture).



Impedance tester function and MEEMM Software.
MEEMM LTU software includes an impedance tester function prior to the start of recording of the EEG signals.

For monitoring purposes MEEMM displays the following results using the EPM Laptop interface:

- Impedance test results
- Required FFT spectra
- EEG/EMG data
- EP processed data



Data transfer
Data can be down-linked near real time for tumescence purposes which means that MEEMM transmits to the EPM carrier the same experiment data as those displayed on the laptop. For complete raw experiment data transfer to the EPM carrier the MEEMM internal hard disk will be used in played back mode. Based on a maximum MEEMM/EPM transfer rate of 1Mbit/s:

- For a 128 electrode session at 2.2 kHz sampling frequency, the transfer to the EPM requires at least 4.5 hours for a 1 hour acquisition session;
- For a 32 electrode session at 20 kHz sampling frequency, the transfer to the EPM requires at least 3 hours for a 20 minute acquisition session.

For the global down linking duration from MEEMM to ground, the EPM to ground link has to be taken into account. At the moment, it appears that the capabilities of this EPM to ground link are quite similar to those of the MEEMM to EPM link, resulting in a similar required duration.

For more information on the use of the device, see the User Manual.

-- Science Modules -- PORTEEM

PORTEEM General Description
The PORTEEM device, based on the VitaPort 2 / ADAS 2 instrument manufactured by TEMEC Instruments B.V. (the Netherlands), has been modified and qualified for flight by EREMS (Toulouse, France).

The VitaPort 2 consists of a PCMCIA type 3 based digital recorder including software processing and analysis. It is applied along with up to 8 modular analogue boards for signal conditioning bringing the maximum number of channels to 64. There are several types of analogue boards targeted for established clinical tests (as for instance sleep and respiration recording or EEG epilepsy monitoring) or for physiological research.

The configuration used for PORTEEM consists of the following two modules:
- The data acquisition module including the display interface
- The analogue amplification module referred as EEG16

PORTEEM acquires and stores the raw scientific data channels on a 256 MB compact flash disk.

In summary, PORTEEM provides a 16 channel EEG / Polysomnography acquisition system which complies with various types of sensors required for the sleep and ambulatory studies:
- 12 EEG electrodes cap
- ECG electrodes
- Strain-gauge respiration channel
- EMG surface electrodes

To download the PORTEEM brochure, click here : PORTEEM BROCHURE.

For more information on the use of the device, see the User Manual.

-- Science Modules -- SCK

Sample Collection Kit

General Description

Most of the planned investigations using the EPM facility, will require the sampling of blood, saliva and/or urine for later analysis. This SM provides kits for blood, urine, and saliva sample collection. Special containers for used medical/biohazard objects and for metallic and sharp objects are also part of the SCK, as well as some dedicated volume for intermediate stowage of the collected samples.

The Sample Collection Kit is a very flexible set of standard equipment items, which can be extended or reduced during the lifetime of the EPM facility, according to the scientific needs and the available resources. The components (stowage bags) of the Sample Collection Kit will be accommodated in the stowage volume available in the EPM rack, or in the stowage area allocated to EPM within the European Columbus laboratory.

The design of the major elements of the Sample Collection Kit is based on a sampling type specific stowage concept as realised in HRF. The EPM Sample Collection Kit comprises sampling type specific sub-kits for blood, saliva, and urine sample collection, respectively.

The sub-kit design concept will closely follow the HRF concept. That means all items will be packed in Nomex bags, comparable to those used in HRF (see image below). It is intended to purchase complete bags from NASA.

If the selected EPM kit configuration and stowage locations do not fit to the available bag sizes, suitable Nomex bags based on the HRF concept will be manufactured. Additional equipment such as trash bags and sharps containers will also be procured from NASA. The proposed concept provides high flexibility to react on changing scientific and accommodation needs while requiring a minimum development and qualification effort.

Commonalties with HRF in the Sampling Kit design will simplify the crew operations and training for physiological experiments.

The EPM Sample Collection Kit comprises the following elements:

- Blood collection kit: Butterfly needles, Vacuettes, Alcohol swabs, Dry wipes, Plaster
- Urine collection kit: Urine bags with clip, Condoms, Female adaptor rings (TBC), Monovettes
- Saliva tubes
- Tourniquet
- Scaling device
- Staging plates and/or belts
- Surgical tape
- Pens
- Trash bags for used medical items
- Urine containment bags
- Sharps container

-- Science Modules -- HRF stowage container

HRF stowage container

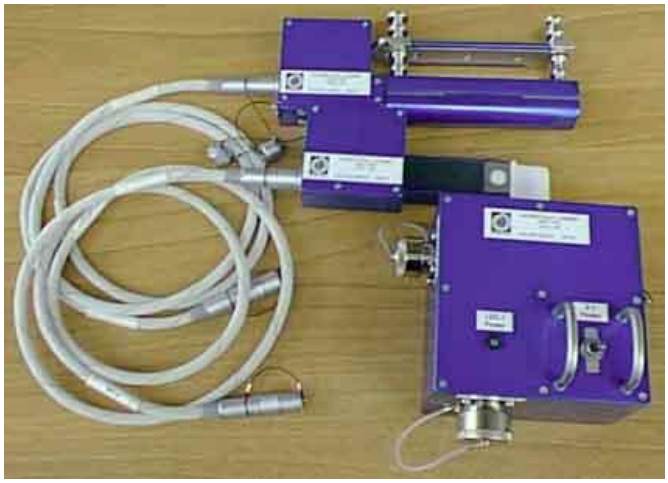
To optimise the scientific benefits from the utilisation of the European Physiology Module Facility (EPM) and the American Human Research Facility (HRF), both facilities for life sciences will comprise as much as possible complementary sets of instruments that will be made available to all international partners for scientific research. Moreover, after its respective launches, EPM, HRF-1 and HRF-2 will be collocated in the European Columbus laboratory, allowing for combined experiments.

In order to enhance the co-operation between ESA and NASA an exchange of hardware has been initiated. ESA will provide the PFM/PAM Science Module to NASA.

In return for this contribution, NASA will provide instruments to EPM. For the initial launch configuration (EPM-1), the allocated space in EPM for NASA will be used to stow some HRF equipment in the so-called "HRF stowage container".

Among the instruments selected to be launched in the HRF stowage container is the ESA developed Handgrip Dynamometer and Pinch Force Dynamometer (HGD/PFD).

General Description:



- **The Handgrip Dynamometer** (HGD) is a stowable hand held device capable of measuring instantaneous hand strength as a function of time. The principle components of the HGD are a handgrip, instrumentation amplifier, and associated cables. Dynamic voltage representing instantaneous hand strength is taken from the output of the instrumentation amplifier and sent to a laptop computer or to a data acquisition system for data manipulation, display, correlation with other data sources, and/or storage.

- **The Pinch Force Dynamometer** (PFD) is a stowable hand held device capable of measuring instantaneous strength of the thumb and opposing finger or groupings of fingers as a function of time. The principle components of the PFD are a pinch force transducer, instrumentation amplifier, and associated cables. Dynamic voltage representing instantaneous finger(s) pinch strength as a function of time is taken from the output of the instrumentation amplifier and sent to a laptop computer or to a data acquisition system for data manipulation, display, correlation with other data sources, and/or storage.

Functional requirements:

The Handgrip Dynamometer is capable of:

- Providing a hand-held device for measurement of isometric force and sustained static exercise stimulation.
- Accommodating the 5th percentile Asian female to the 95th percentile American male - the distance between the parallel beams is adjustable and handgrips widths and lengths are adequate for this population.
- Providing comfortable hand grips.
- Providing an analog output signal with a bandwidth of 0-20 Hz.
- Providing a means to check the calibration.

The Pinch Force Dynamometer is capable of:

- Providing a hand-held device for measurement of isometric force and sustained static exercise stimulation of the thumb and opposing finger(s) and groupings of fingers on each hand (not including opposing hand activity).
- Providing an analog output signal with a bandwidth of 0-20 Hz.
  Provide two parallel surfaces joined by the equivalent of a strain gauge such that when the thumb and opposing fingers of one hand pinch the device, the force of the pinch is determined.
- Accommodating the 5th percentile Asian female to the 95th percentile American male - the surface widths and lengths are adequate for this population.
- Assessing fatigue over serial contractions.
- Providing a means to check the calibration.
- Providing comfortable thumb and finger contacts.
- Operating by means of a bonded strain gauge bending beam system.

Technical specifications:

The Handgrip Dynamometer provides:

- Operation by means of bonded strain gauge bending beam system.
- A range of force measurement from 40 to 1000 Newton.
- An accuracy of 0.75% of the full range.
- 0 to 5 VDC output from the instrumentation amplifier with 2 mV resolution.
- Provisions for time synchronization with other data collection systems, such as Ambulatory Data
- Acquisition System (EMG) or video system.

  Mass: 1000 g
  Length: 240 mm
  Width: 34 mm
  Height: 100 mm

The Pinch Force Dynamometer provides:

- Operation by means of bonded strain gauge bending beam system.
- A range of force measurement is from 0 to 270 Newton.

- An accuracy of 0.75% of the full range.
- 0 to 5 VDC output from the instrumentation amplifier with 2 mV resolution.
- Provisions for time synchronization within 1 msec.

Mass: 600 g
Length: 180 mm
Width: 70 mm
Height: 55 mm

Total System Mass: 3300 g

Standby Power: 5 W
Open Power: 5 W
Peak Power: 5 W