



Perspective means in Russian system of countermeasure

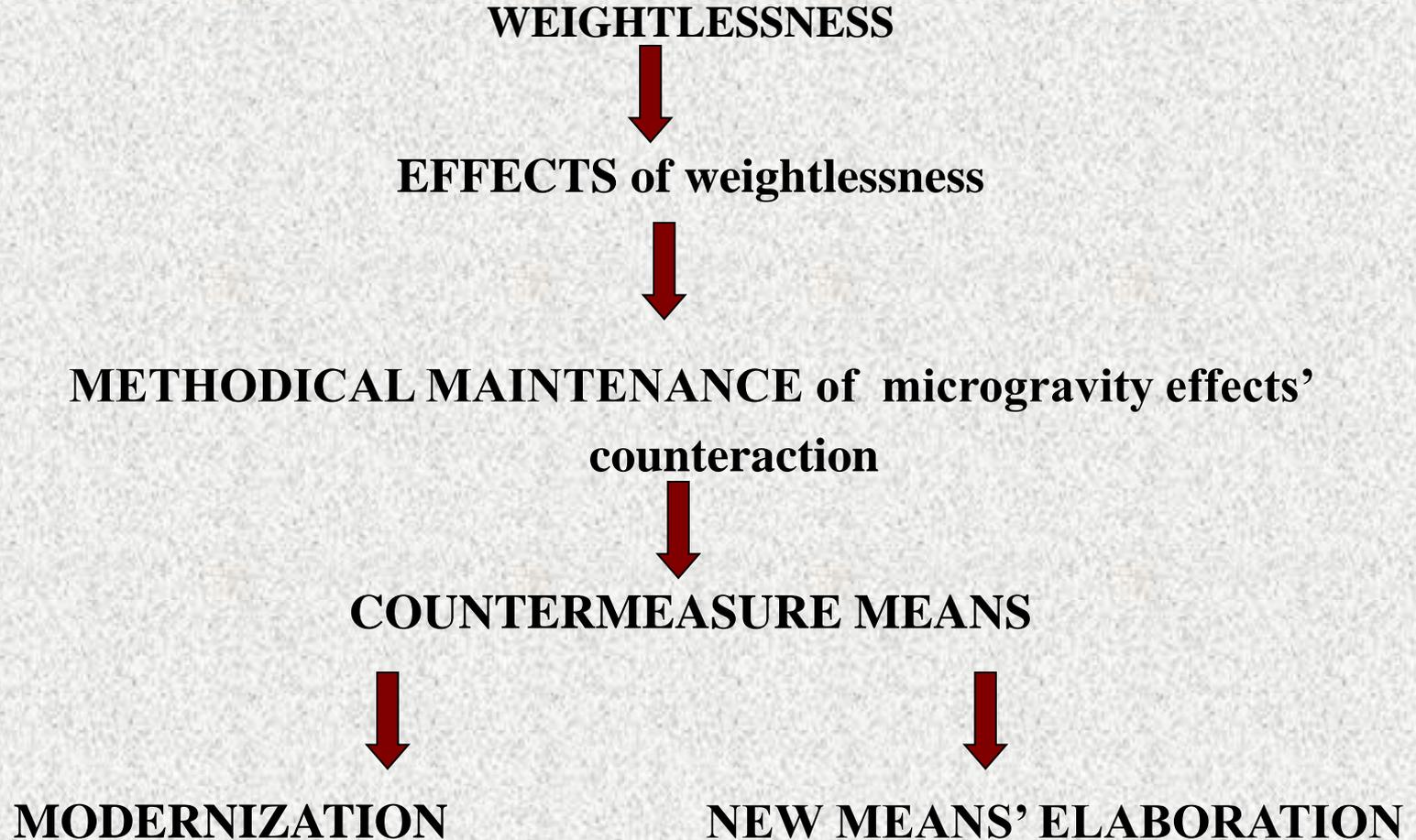
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Inesa B. Kozlovskaya

Trieste, June 19, 2010



Requirements to countermeasure means' development





Direction of countermeasure means' effects in long term space flights

Microgravity Effects	Methodical maintenance of microgravity effects' counteraction
Fluid redistribution	-LBNP <i>-Providing of pressure in lower limbs with the aim of artificial blood deposit;</i> <i>-Preventing of liquid accumulation in lower limbs during descent and launch.</i>
Musculoskeletal and cardiovascular systems' unloading, changes of proprioceptive input and functionality of posture and locomotor controls systems	-physical exercises; -electromyostimulation of phasic and tonic muscles; -providing of long axis load of musculoskeletal system and basic muscle groups; -compensation of support unloading of the soles.
Inauspicious vestibular, metabolic and other reactions	Pharmacology



Countermeasure currently available on the ISS



- ▶ **Treadmill (TVIS)**
- ▶ **Veloergometer (VB-3)**
- ▶ **Force training device (NS-1)**
- ▶ **Expanders (Training)**
- ▶ **Electrostimulator (Tonus-3)**
- ▶ **Electrostimulator (Stimul-01 NCh)**
- ▶ **Axial loading suit PENGUIN**
- ▶ **Pneumatic vacuum suit CHIBIS (LBNP)**
- ▶ **Anti-G suit (CENTAURUS)**
- ▶ **Bracelet device (Bracelet-M)**
- ▶ **Water-salt supplements**

Veloergometer – VB-3



- Power on the pedal shaft - 100, 125, 150, 175, 200, 225, 250 Watts within the shaft speed range from 40 to 100 rpm
- XX mode– up to 50 watts

VB-3 is used for:

- Aerobic training
- Medical tests MO-1, MO-5, MO-6, MO-12.

Pedaling regimes:

- manual;
- foot.



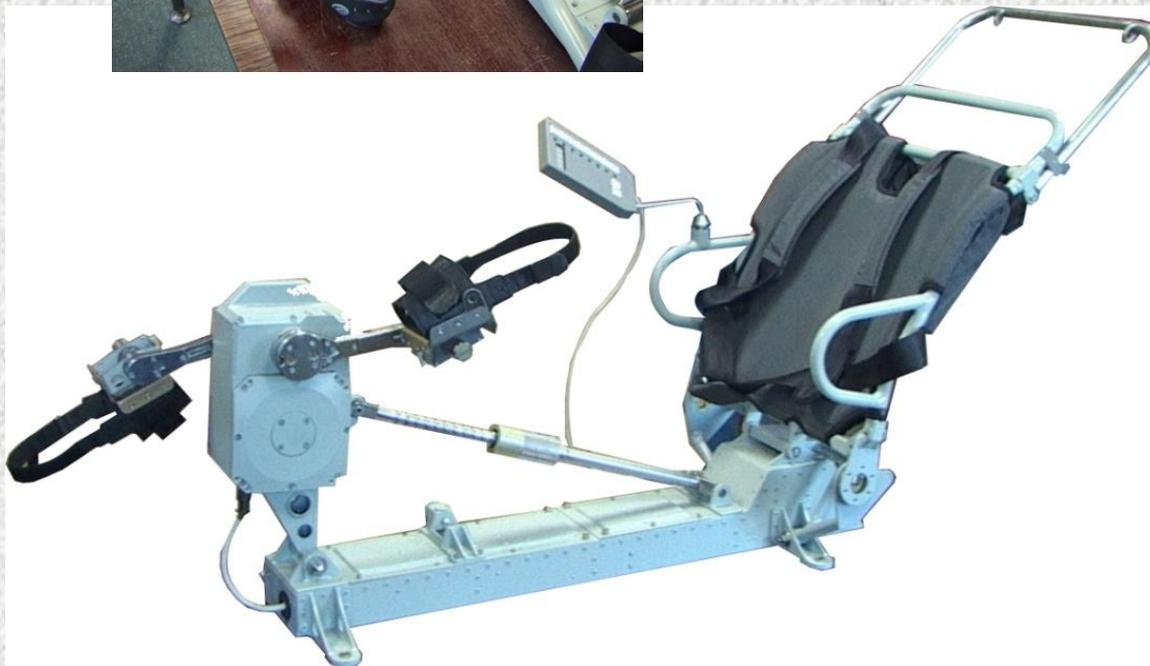


Veloergometer VB-3 M



Redesigned components:

- contact pedals;
- two fans mounted on the frame to cool off the load unit;
- lodgement lock mechanism;
- Indication of speed of pedal shaft.

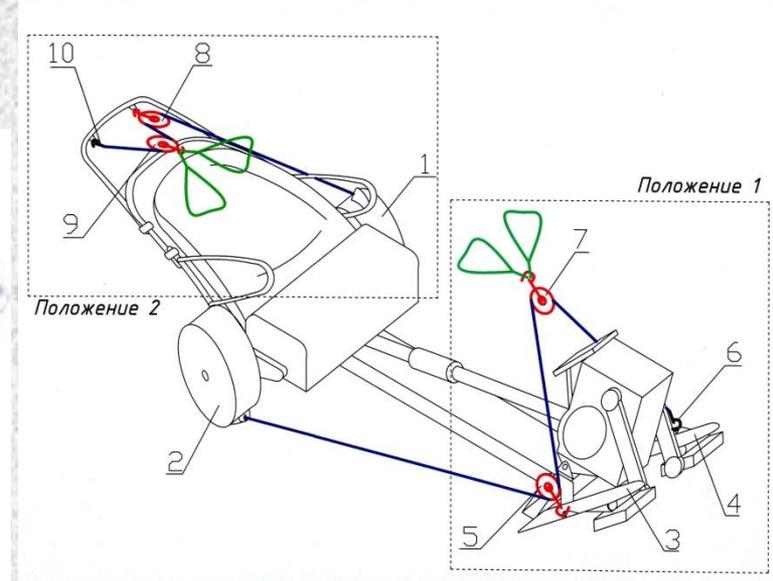


Status:

- Delivered on board of ISS.
- Substitution of veloergometer VB-3 for veloergometer VB-3M.



Force loading device NS-1



NS-1 is used to fulfill resistive exercises for arms, legs and the back.



Applies loading of 5 to 30 kg to each side. Loading with 60 kg is also possible.

Types of exercises:

- Body flexion/extension;
- Rowing imitation;
- Imitation of hammer-throwing;
- Simultaneous and alternate flexion/extension of forearms;
- Alternate arm flexion/extension рук (“sow”);

Interfaces the vehicle power-supply system.

The Bicycle ergometer plus NS-1 complex provide the opportunity to alternate the resistive exercises with pedaling.



Force loading device NS-1M



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Redesign:

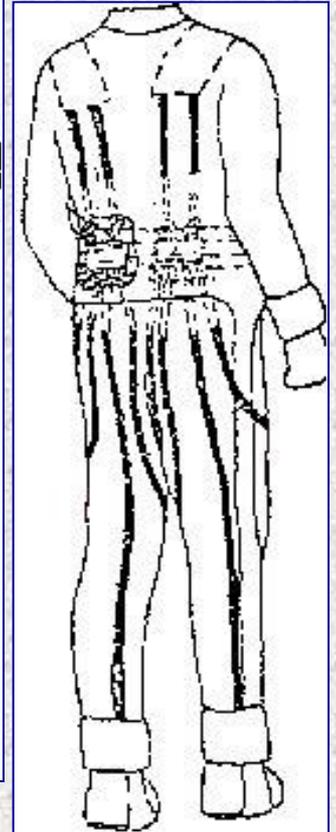
- **Downsizing of the control unit and panel;**
- **Enlargement of information shown on the screen;**
- **Elimination of loads asymmetry;**
- **Data filing for subsequent download.**



Axial loading suit “Penguin”



ISS006E45319



Tension of elastic elements of the suit produces the «compressive» loading along the longitudinal axis of up to 40 kg.

The axial loading suit compensates insufficient loading of the musculoskeletal system as well as lack of weight-bearing and proprioceptive afferentation in space environment.



“Penguin” Suit with the Load Measuring System (SIN PNK “Penguin”)



- The main advantage of the Penguin load measuring system is the existence of objective data about the loads to cosmonaut's body, that is provided by the suit.

Redesigned components:

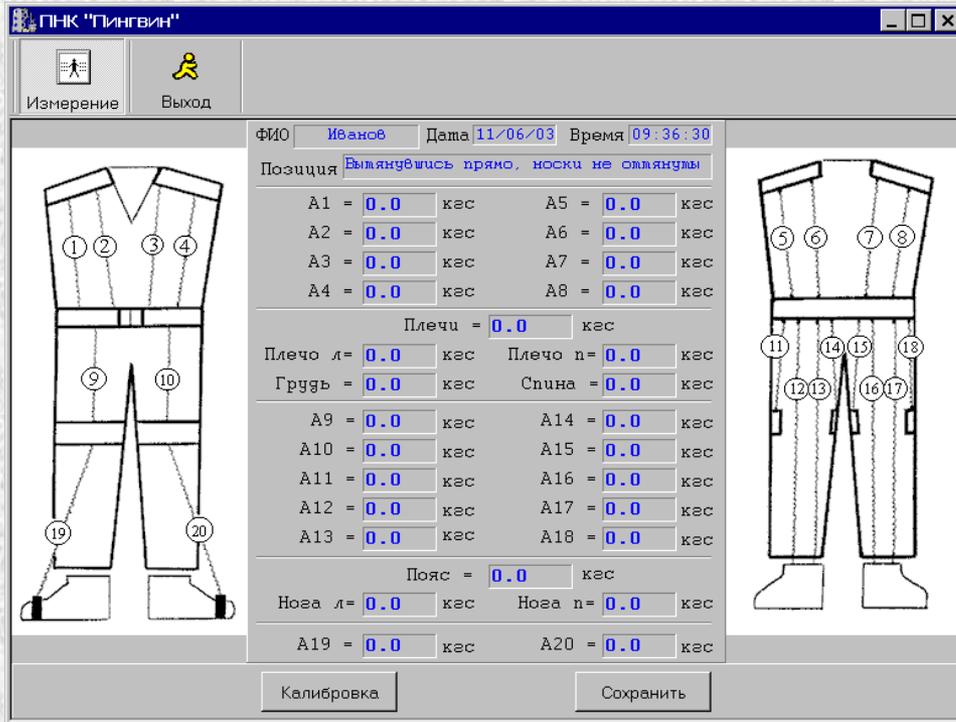
- Penguin-M is outfitted with an automatic system for measuring tension of suit bungees. The system has an interface with onboard PC.

Status:

- The system passed the in-flight testing onboard the ISS and will be delivered on board of ISS starting from mission 26/27.

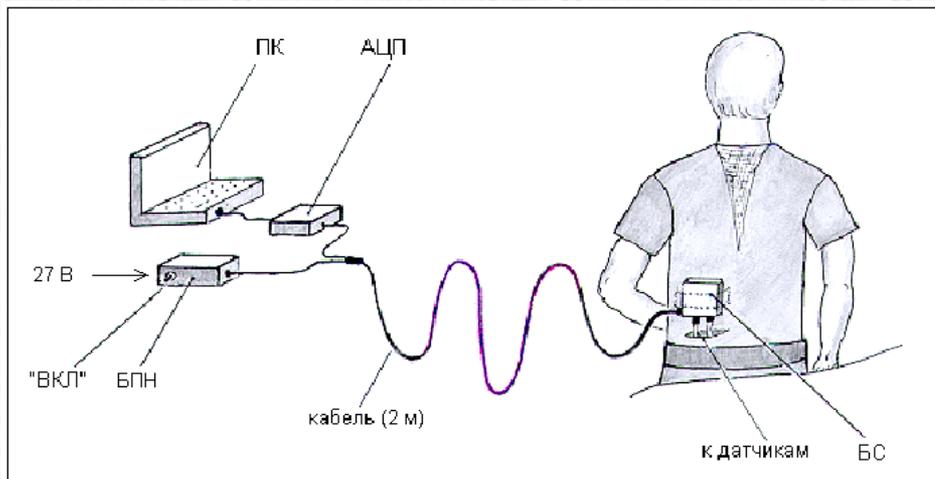


“Penguin” Suit with the Load Measuring System



Computer-based LMS provides:

- Data sampling at a preset frequency (10 - 50 Hz);
- Display of tabulated actual loads to individual bungees and the total load value produced by the groups of bungees;
- Possibility to enter brief comments;
- Data retention.





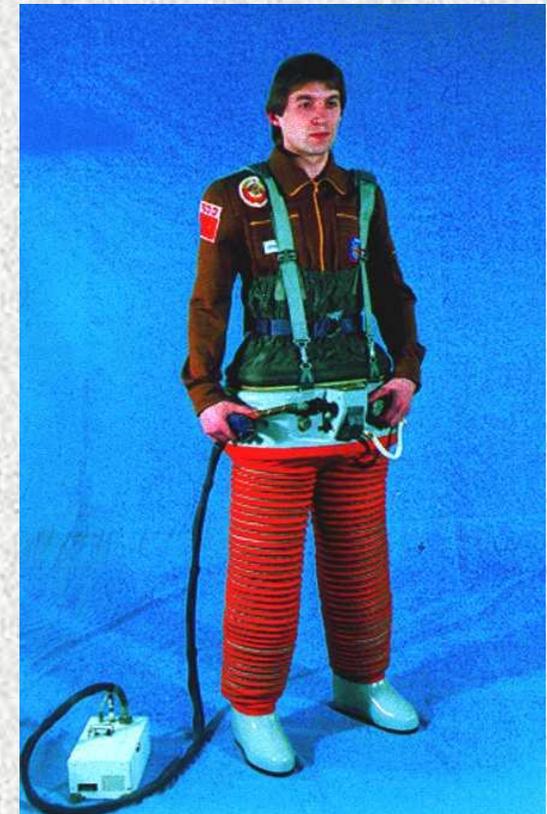
Suit «Chibis»



Lower Body Negative Pressure (LBNP) generated by vacuum suit CHIBIS is used to counteract the deconditioning effects of microgravity on the mechanisms of orthostatic tolerance.

Maximal rarefaction inside the suit is 60 ± 5 mm Hg.

Interface to board: by telemetry and by board feeding.





Suit «Chibis-M»

Redesigned components:

- Elimination of air hose and PVK-D unit;
- better sealing and a wider range of anthropometric dimensions (waist circle – 550 to 1020 mm);
- Computerized pressure setting with the help of either standard (stiff) or “on-the-fly” (flexible) timetable.

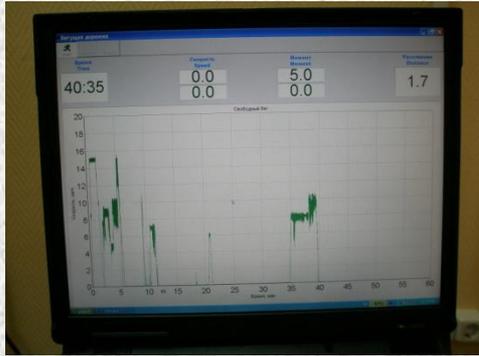


Status:

Completed development. According to the RSC-E contract, manufacturing and delivery are scheduled within 2010.



Treadmill BD-2



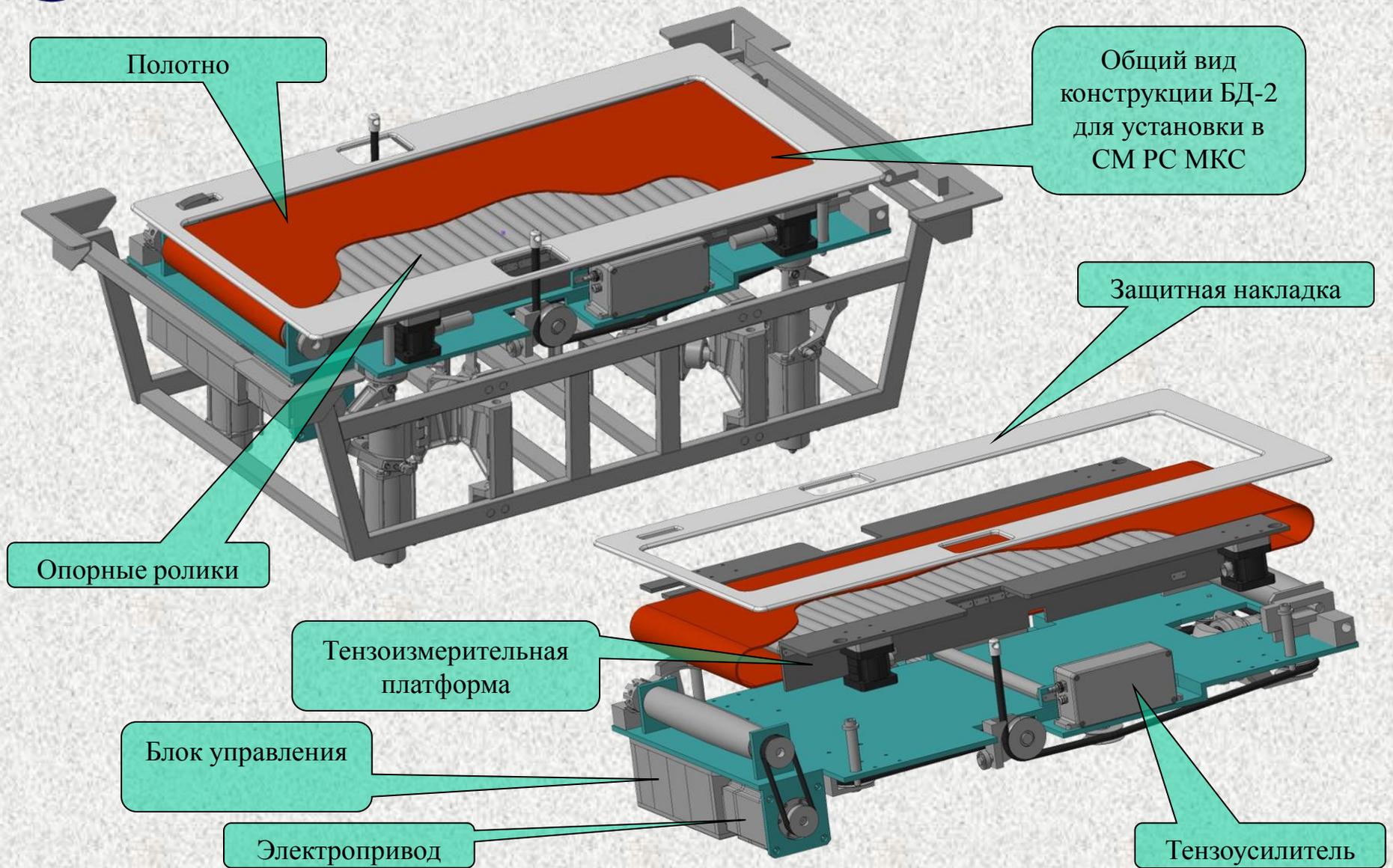
The treadmill allows human to walk and run :

- in motorized and non-motorized modes;
- With a speed from 2.4 to 20 km/hr;
- Having axial loading ranging from 40 to 70 kg;
- Using the vibroisolation system that provides the mechanic isolation from the station.



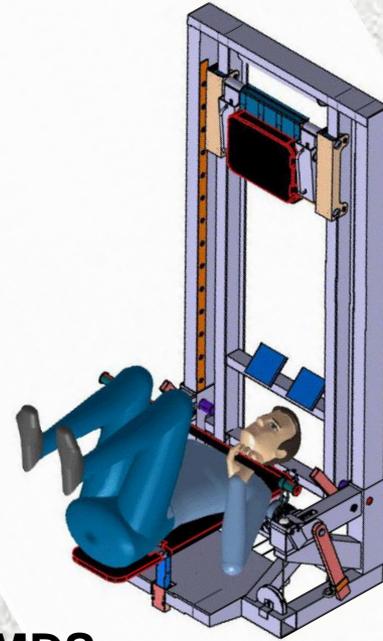


Тренажёр «Treadmill BD-2» БД-2

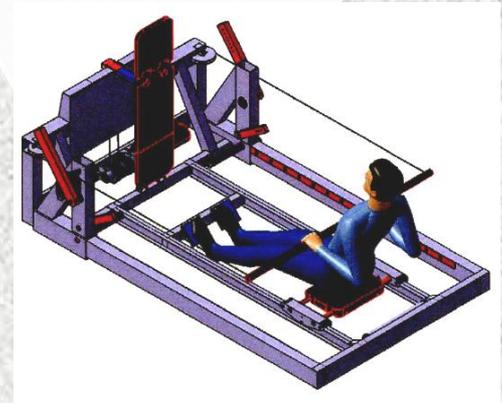




Multifunctional strength exercise device MDS



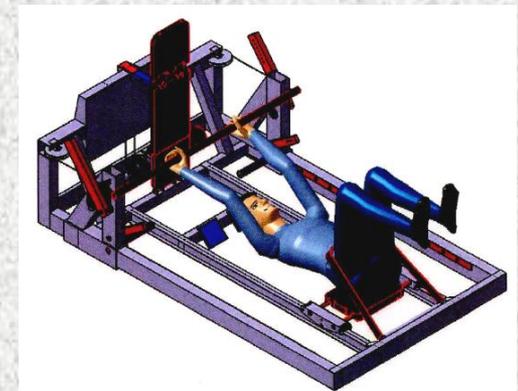
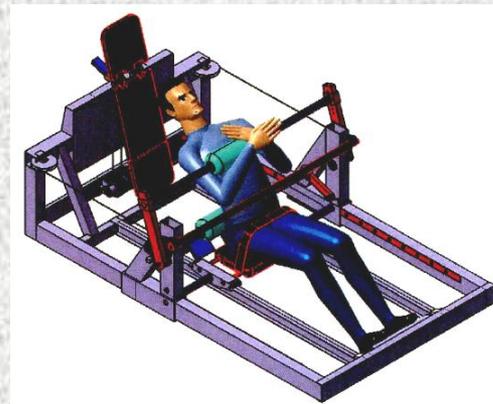
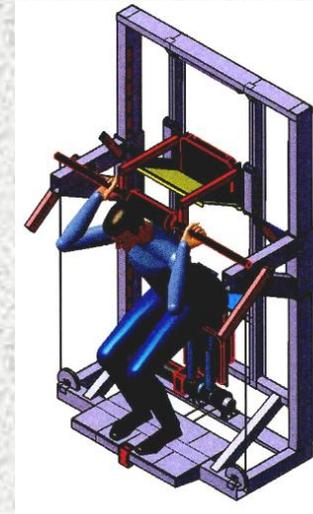
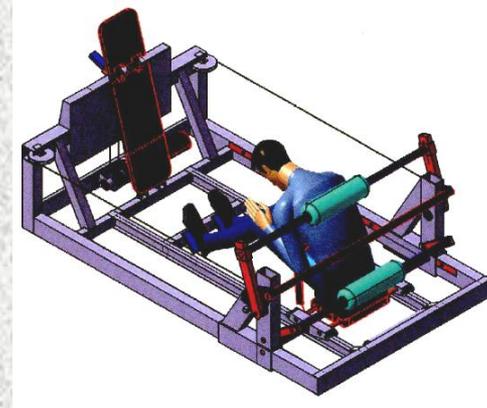
- Technological model of resistive training device MDS is developed;
- The range of loads provided is from 5 to 250 kgs;
- Isometric, concentric and eccentric regimens;
- Possibility to control by velocity means - 0,15; 0,3 and 0,6 m/s;
- Control panel – flatbed computer;
- Download abilities.



Eccentric, concentric and isometric exercises for arms, legs and the back..

Types of exercise:

- Rowing
- Body flexion
- Body extension
- Forearm flexion/extension
- Leg press
- Bench press;
- Seated press;
- chin-up simulation.

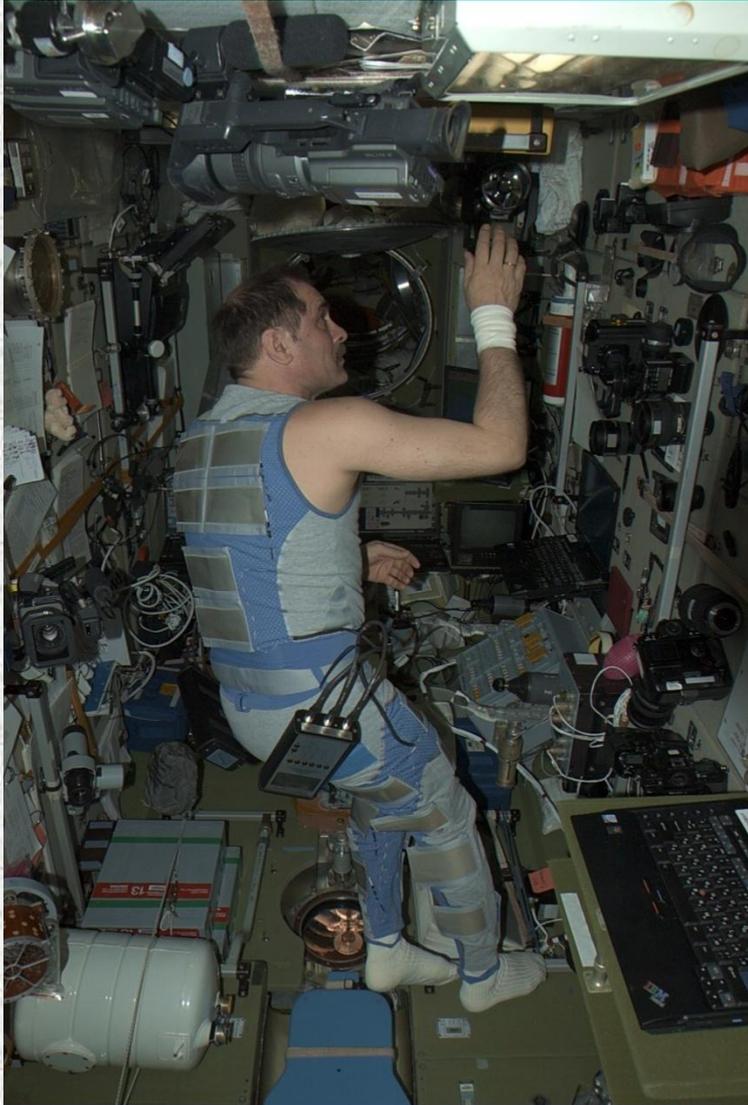


Status:

Successfully tested in the 105-d experiment, now is used in Mars-500 isolation experiment.



Set “Stimul-01 NCh”



Electrical myostimulator (wearable) is intended for separate low-frequency, low-amplitude stimulation of leg and back muscles.

- Stimuli amplitude doesn't exceed 45V;
- Cyclic work regimen: $1 \pm 0,1$ sec of stimulation, then - $2 \pm 0,1$ sec pause;
- Kind of stimulation – bipolar symmetrical rectangular electrical impulse;
- Autonomous power supply;
- Maximal duration of electromyostimulation – 6 hours;
- Data transfer to board computer for further delivery on Earth;
- The number of stimulation channels – 6 per stimulator.





Compensator of support unloading KOR-01N

1. Two modes of mechanic stimulation:
 - a. walk-1 –75 steps/min;
 - b. walk-2 –120 steps/min.
2. Pressure in air bladders – 0.15-0.4 kgf/cm²
3. “Rigid” and “flexible” operating mode.
4. Time of stimulation up to 100 min.



Consisted of:

- shoes;
- pneumatic insoles;
- compressor and control unit;
- connective hoses.





Countermeasure means modernization



From Penguin-3
to SIN PNK Penguin-3



From NS-1
To NS-1M



From Chibis
to Chibis-M



From VB-3
to VB-3M





Redeveloping countermeasure means



From TVIS



Stimul-01 NCh



KOR-01N

To BD-2



MDS

