



Moon as a Stepping Stone for Mars : Centrifuge on the Moon !

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Also make use of a Moon base to prepare for Mars - generate Mars gravity levels which are not achievable on Earth

Human Missions Beyond Low-Earth Orbit

Explore Near-Earth Asteroid

Multiple Locations
in the Lunar Vicinity

Extended Duration Crew
Missions

Humans to
Lunar Surface

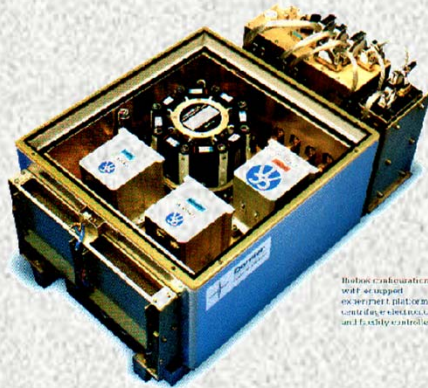
Missions to
Deep Space and
Mars System

Sustainable
Human Missions
to Mars Surface

Vrp h#Sdvw#) #Suhvhqw#Fhgwulixj hv



biorack



biobox



biopack



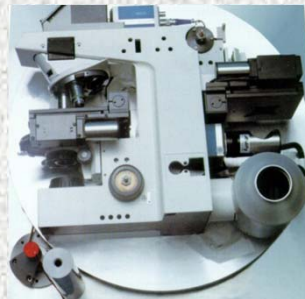
kubik



simbox



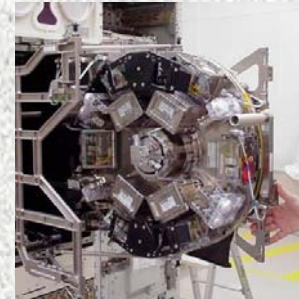
Cosmos



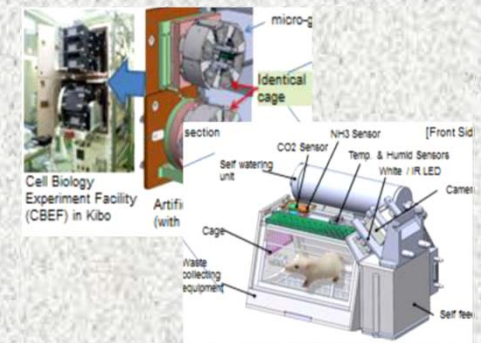
NIZEMI



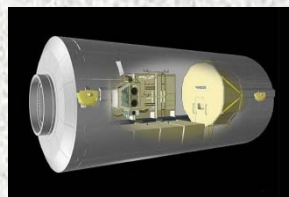
EMCS



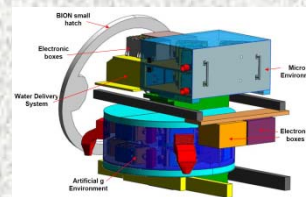
biolab



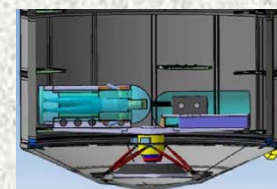
CBEF + mouse AG
(ISS-Kibo, 2016)



ISS CAM
(JAXA - NASA)

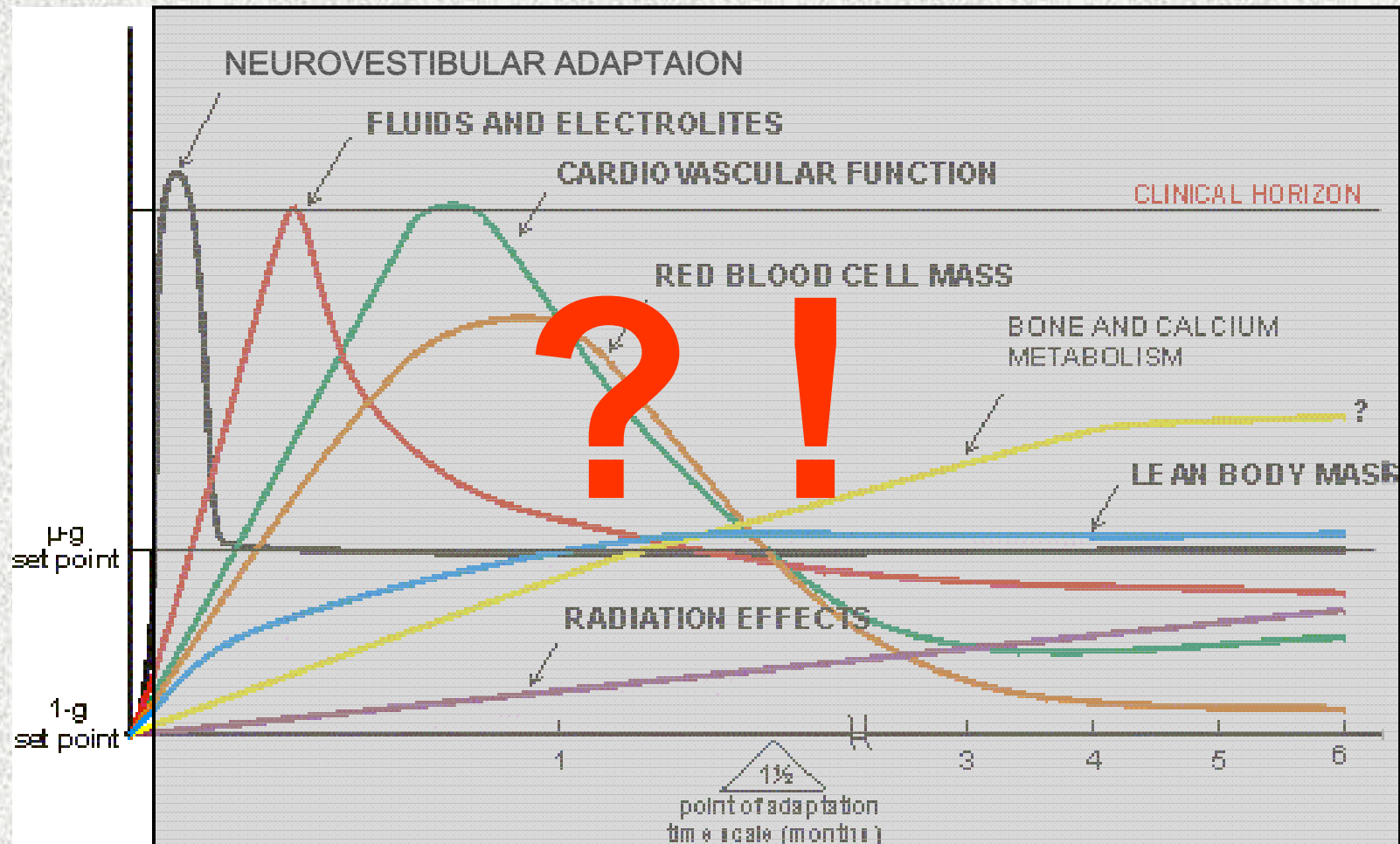


MISS: Bion-
Mouse Facility (ESA)



SAHC study in MPLM
(ESA)

K xp d q # \$ k | v l r α j | # d q g # J u d y l w |



Hyper – g ... ???????.....

Nicogossian A.E. In: Space Physiology and Medicine, Lea & Febiger, 1989

D u w l i f d o J u d y l w | # D J , # F r q f h s w

Permanent Multipurpose Module (PMM) Configuration

(5 September 9, 2010)

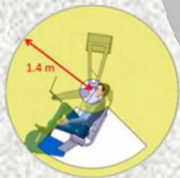
Even if the racks are removed, rack posts cannot be removed. Thus the maximum radius is about 1.5m.

Note: it hits the lamps

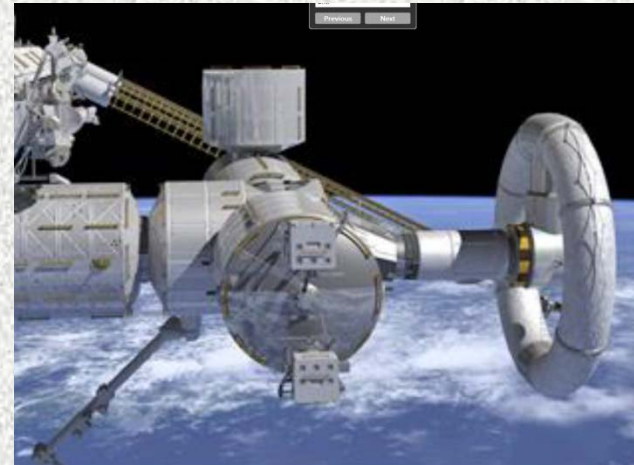
Proposed design:
φ2400mm
(R1200mm)

1034mm
To Rack face

Maximum Radius with racks placed (No interferences with racks in the current PMM configuration):
φ2508mm (R1254mm)

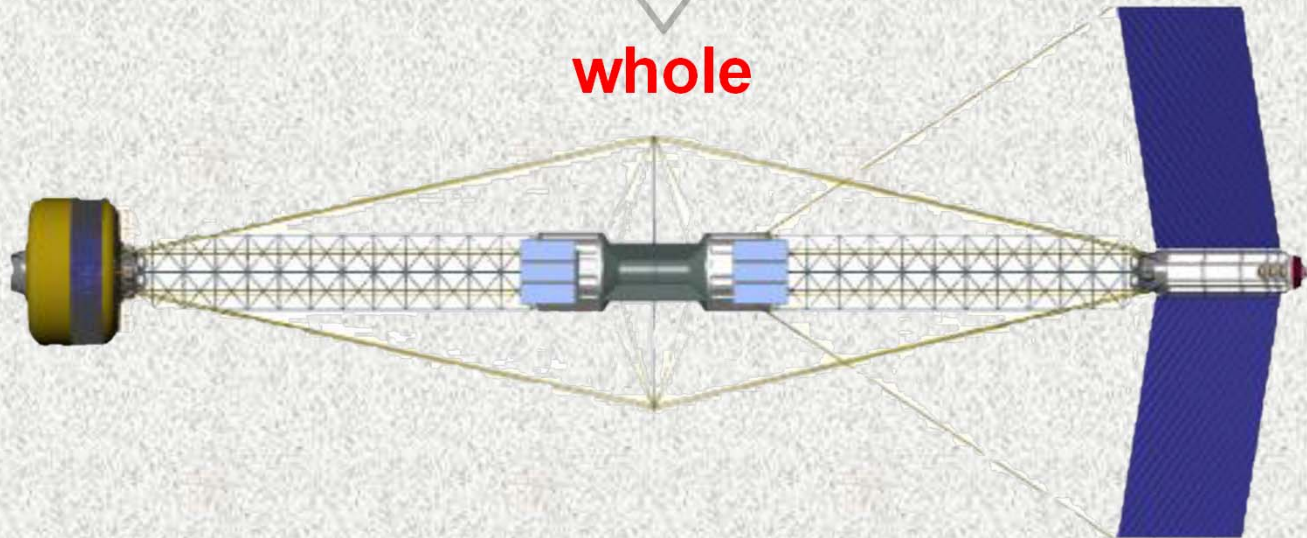


AGREE-concept for ISS



Nautilus X-concept

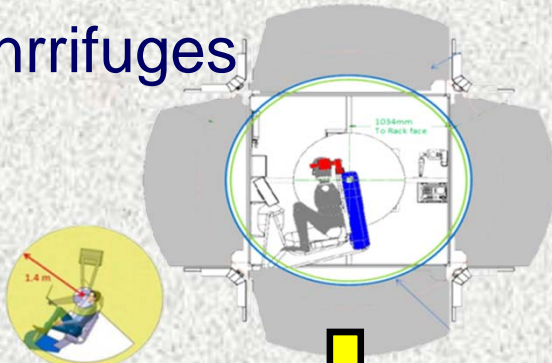
in
part
whole



Fire Baton concept

DJ #Frq fhs w#Û J urxqg #Uhvhdufk

internal
cenrrifuges



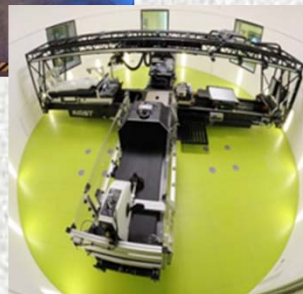
Toulouse /
Cologne
(EU)



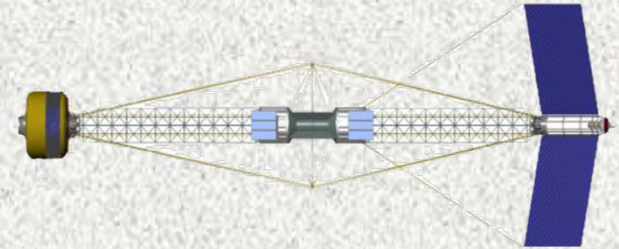
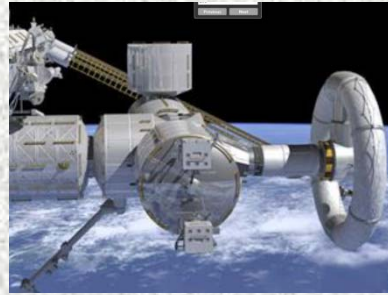
Nagoya,
JP



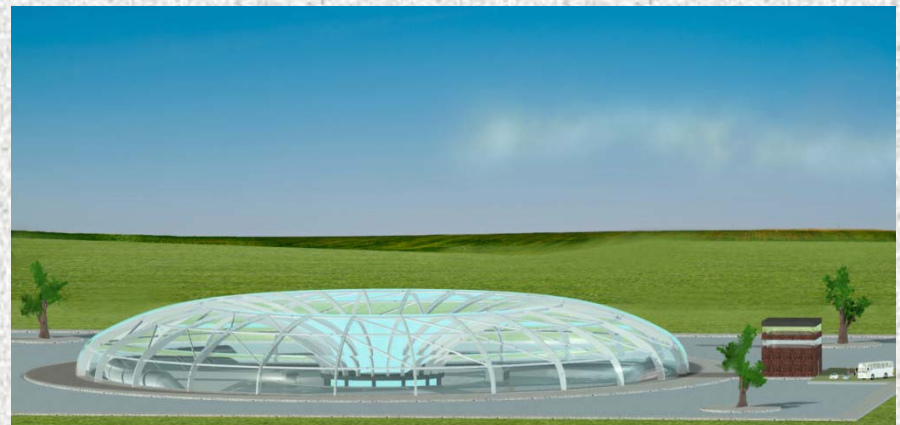
Boston,
US



Cologne, DE



no present solution



Human Hypergravity Habitat, H³

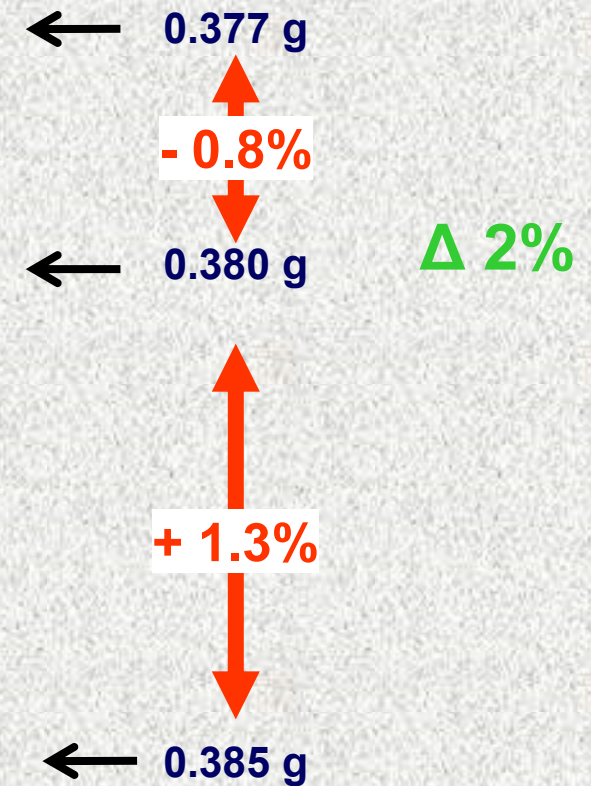
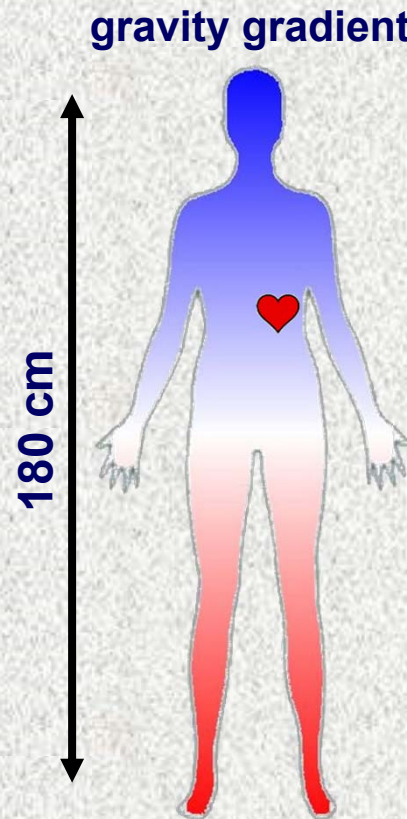
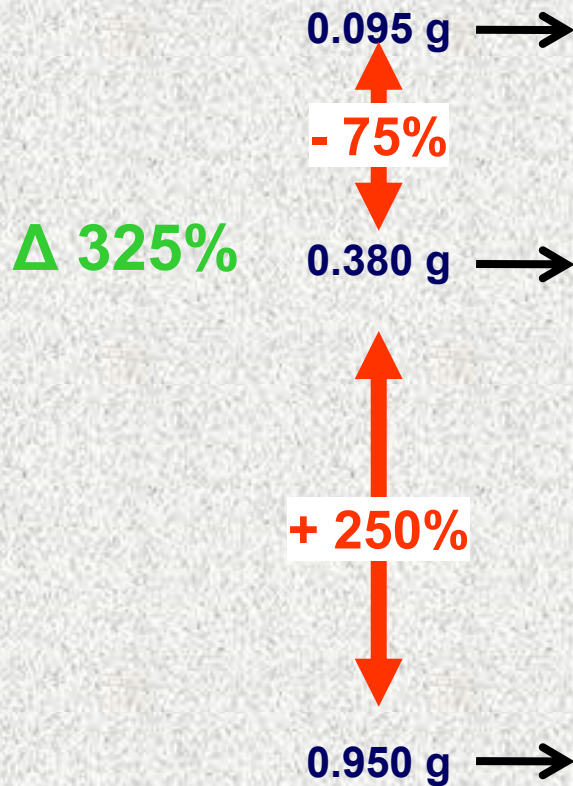
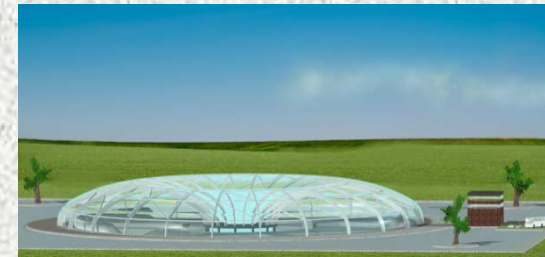
P d u v # j = # V k r u w # y v l # O r q j # N u p U # F h q w u l i x j h



e.g. ESA SAHC



H3



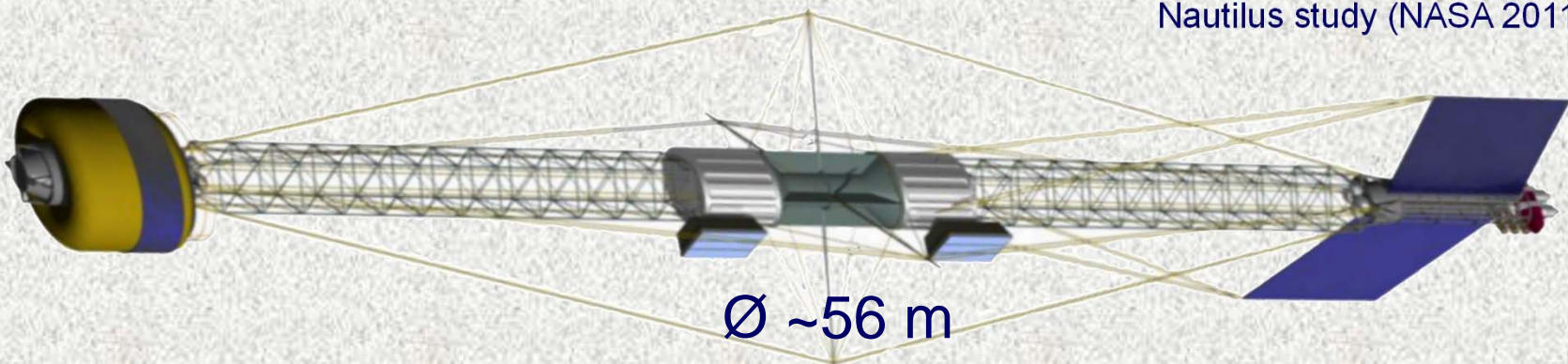
J u d y l w | # d q g # D q j x o d u # Y h a r f l w |



Ø ~12 m



Nautilus study (NASA 2011)

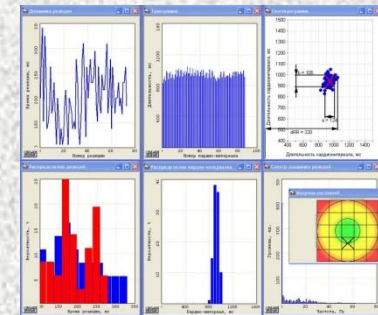


Ø ~56 m

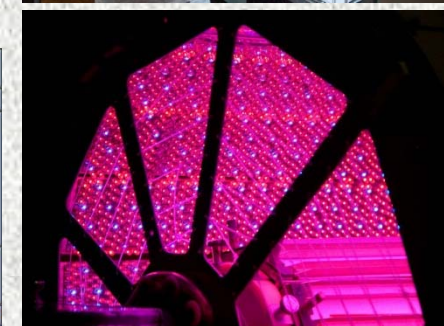
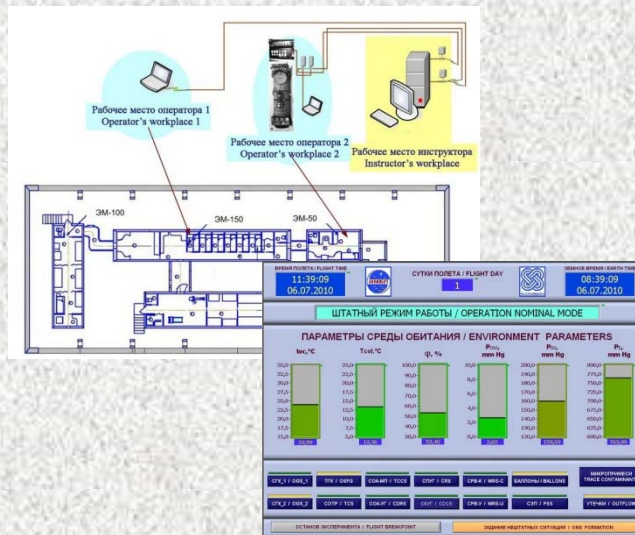
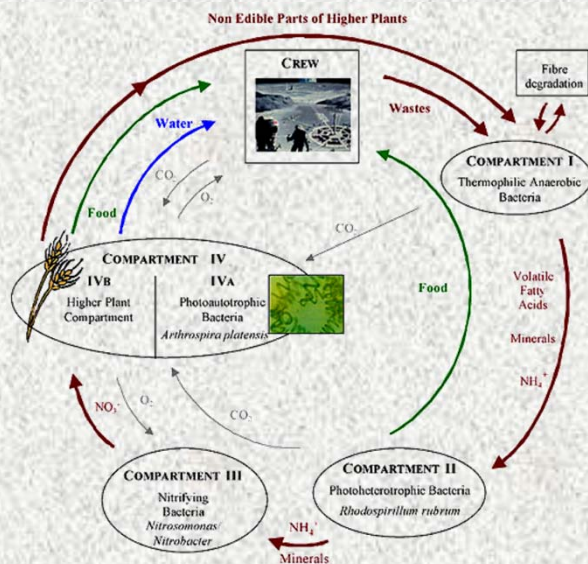
H³ in preparation for large in-flight rotating systems



MARS 500



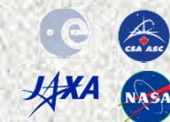
Operator's psycho-physiological parameters.



Salad Machine

Artificial Gravity

H³ \rightarrow {w r s l f d o, W h d p # P h p e h u v}



Science - oriented

Bone	Daniel Belavy	Berlin	Germany
Bone	Nathalie Bravenboer	Amsterdam	The Netherlands
Bone	Marelise Eekhoff	Amsterdam	The Netherlands
Bone	Dieter Felsenberg	Berlin	Germany
Bone	Laurence Vico	St. Etienne	France
Cardiovascular	Marc-Antoine Custaud	Anger	France
Cardiovascular	John Karemaker	Amsterdam	The Netherlands
Cardiovascular	Peter Norsk	Copenhagen	Denmark
Cardiovascular	Marcel Rutten	Eindhoven	The Netherlands
Environm. Physiol.	Ola Eiken	Stockholm	Sweden
Environm. Physiol.	Igor Mekjavic	Ljubljana	Slovenia
Ethics/Safety	Patrick Cras	Antwerp	Belgium
Ethics/Safety	Christian Lüthen	Rotterdam	The Netherlands
Ethics/Safety	Paul van de Heyning	Antwerp	Belgium
Immunology	Alexander Chouker	Munich	Germany
Immunology	Patrick de Boever	Mol	Belgium
Immunology	Millie Hughes-Fulford	San Francisco	USA
Immunology	Oliver Ullrich	Zurich	Switzerland
Integr. Physiology	Pierre Denise	Caen	France
Integr. Physiology	Chuck Fuller	Davis	United States
Integr. Physiology	Nandu Goswami	Graz	Austria
Integr. Physiology	Helmut Hinghofer-Szalko	Graz	Austria
Muscle	Satoshi Iwase	Aichi	Japan
Muscle	Marco Narici	Nottingham	United Kingdom
Muscle	Dick Stegeman	Manchester	United Kingdom
Muscle / Exercise	Edwin Mulder	Cologne	Germany
Nutrition	Stéphane Blanc	Strasbourg	France
Nutrition	Martina Heer	Neuss	Germany
Operations	Laurent Braak	Toulouse	France
Operations/Edu/Outreach	Rob van den Berg	Noordwijk	The Netherlands
Physiol./Ageing	Felice Strollo	Rome	Italy
Planten	Peter Suedfeld	Vancouver	Canada
Psychology	Emilia Barakova	Eindhoven	The Netherlands
Psychology	Emily Cross	Nijmegen	The Netherlands
Psychology	Mark Moss	NewCastle	United Kingdom
Psychology	Matthias Rauterberg	Eindhoven	The Netherlands
Pulmonary	Kim Prisk	San Diego	United States
Pulmonary	Dag Linnarsson	Stockholm	Sweden
Training/Sport/Rehab.	Marco De Angelis	L'Aquila	Italy
Training/Sport/Rehab.	Kevin Fong	London	United Kingdom
Training/Sport/Rehab.	Norman Heglund	Leuven	Belgium
Training/Sport/Rehab.	Per Tesch	Stockholm	Sweden

Vestibular	Jelte Bos	Soesterberg	The Netherlands
Vestibular	Richard Boyle	Moffott Field	United States
Vestibular	Gilles Clement	Strasbourg	France
Vestibular	Eric Groen	Soesterberg	The Netherlands
Vestibular	Bill Paloski	Houston	United States
Vestibular	Floris Wuyts	Antwerp	Belgium
Vestibular	Larry Young	Boston	United States

IAGG-ER: European Region Internat. Assoc. Gerontology and Geriatrics	J.P. Baeyens	Knokke	EU Societies
ECSS: European College of Sport Science	Thomas Delavaux	Cologne	EU Societies
FENS: Federation of European Neurosciences Societies	Sten Grillner	Stockholm	EU Societies
ESMAC: European Soc. Movement Analysis in Adults and Children	Jaap Harlaar	Amsterdam	EU Societies
ECTS: European Calcified Tissue Society	Bente Langdahl	Aarhus	EU Societies
ELGRA: European Low Gravity Research Association	Monica Monici	Florence	EU Societies
ESPEN: Muscle European Society for Clinical Nutrition and Metabolism	Pierre Singer	Tel Aviv	EU Societies
ESMR: European Society for Muscle Research	Ger Stienen	Amsterdam	EU Societies
EASO: European Association for the Study of Obesity	Euan Woodward	Hampton Hill, UK	EU Societies

Engineering - oriented

Engineering	Oliver de Haas	Dresden	Germany
Engineering	Josef Joachimbauer	Ranshofen	Austria
Engineering	Michael Mayrhofer	Ranshofen	Austria
Engineering:	Johan Berte	Brussels	Belgium
Engineering:	Krijn Bok	Hardinxveld Giessendam	The Netherlands
Engineering:	Arnd Stephan	Dresden	Germany
Scale model	Rene Delfos	Delft	The Netherlands
Scale model	Christian Poelma	Delft	The Netherlands
Life Support	Joan Albiol	Barcelona	Spain
Life Support	Cesare Lobascio	Turin	Italy
Life Support	Gary Stutte	Limerick	Ireland
Data Management	Luigi Carotenuto	Gerona	Italy
Fluid Mechanics	Joel Sommeria	Grenoble	France
Fluid Mechanics	GertJan van Heijst	Eindhoven	The Netherlands

Coordination	Jack van Loon	Amsterdam	The Netherlands
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science / applications

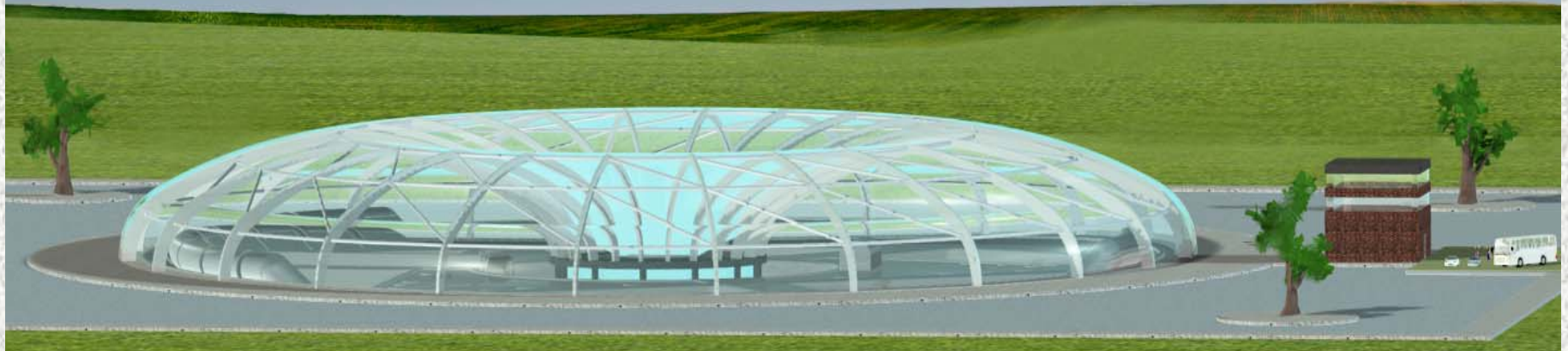
safety/ethics

engineering / daya

coriolis

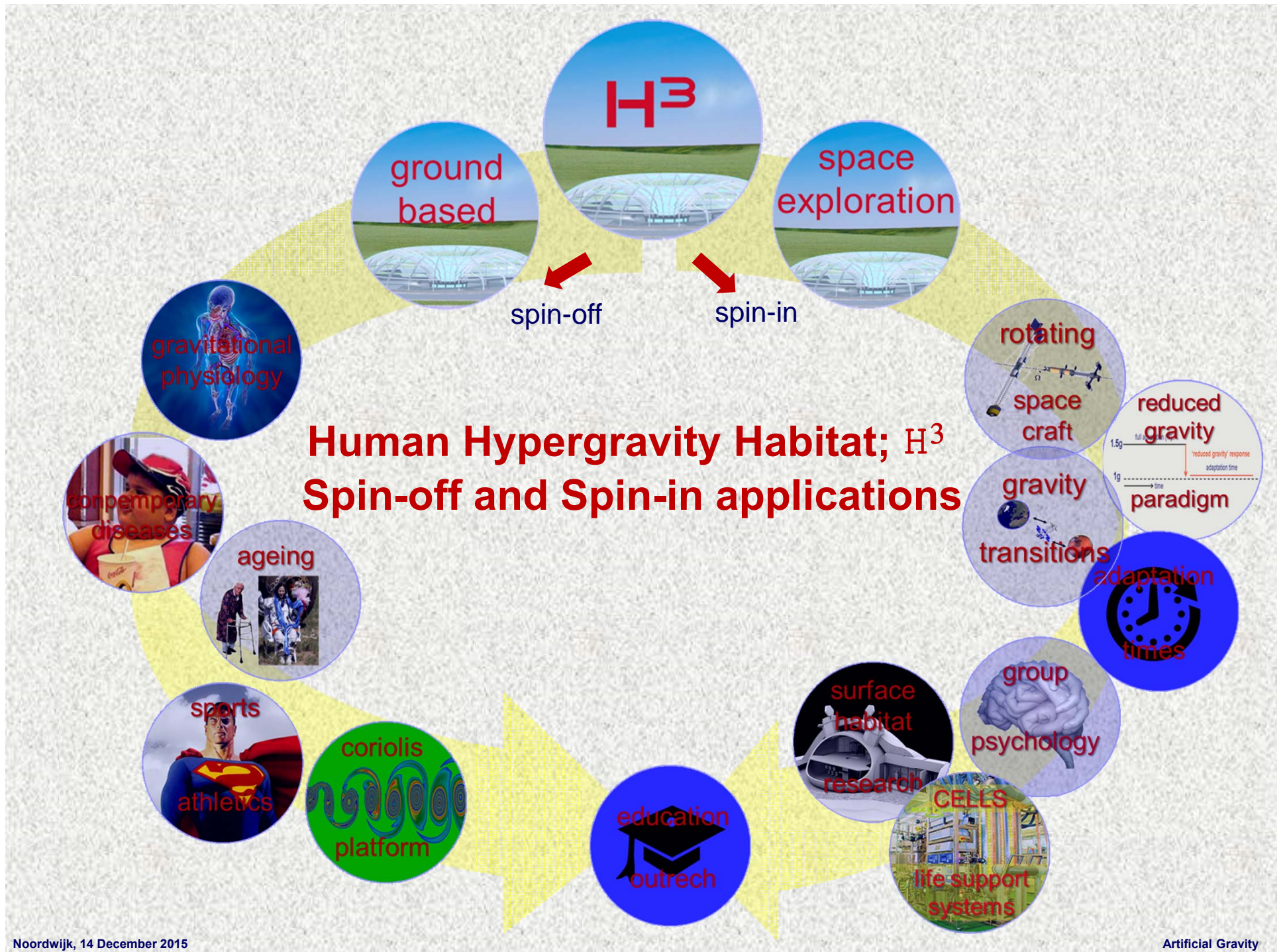
operation / outreach

The Human Hypergravity Habitat, H³



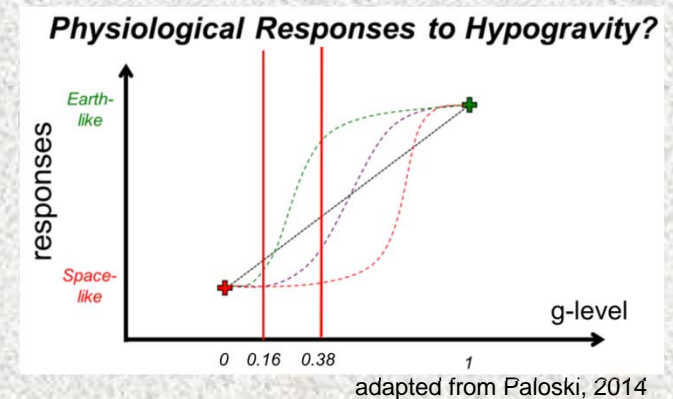
~ 175 m

- ✓BERTE bvba
- ✓BETAQUA
- ✓QinetiQ
- ✓IFB GmbH



Z k | #Fhqwulixj hv#rq#P rrrq#B

- Explore Moon+ gravity levels in:
 - cells / small systems
 - plants / animals
 - technology: e.g. life support
 - humans
- Basic understanding of the impact of gravity (and radiation) on above life forms from single cells to complete systems
- Identify threshold levels for operations of crew and other systems (like life support)
- Explore and develop protocols for long duration missions beyond Moon – *i.e.* Mars and others.





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