

EPSC 2020 MITM12/TP

Future instruments and sustainable outposts for deep space, Moon and Mars



Convener: Prof. Bernard Foing
(ESA ESTEC, ILEWG EuroMoonMars & Leiden/VUA/EPFL)
Co-conveners: Brook Lakew, Mehdi Benna,
Lynn Carter, Tilak Hewagama,
Sabrina Kerber, Marc Heemskerk



Instruments (summary Brook Lakew and Mehdi Benna 6x 1min)

◆ 1EPSC2020-557 Bifocal Panoramic Stereoscopic Camera for Lunar Exploration

Claudio Pernechele, Gabriele Cremonese, Daniela Fantinel, Alice Lucchetti, Luigi Lessio, Matteo Massironi, Maurizio Pajola, Lorenzo Paoletti, Riccardo Pozzobon, Cristina Re, Bortolino Saggin, Diego Scaccabarozzi, Emanuele Simioni, Cristoforo Abbattista, Emilio Banfi, Luca Consolaro, Cesare Dionisio, Mark Kuijpers, Daniele Mura, and Stefano Piantone and the BIPS TEAM

◆ 2EPSC2020-60 The Lunar Environment Monitoring Station (LEMS)

Mehdi Benna, Nicholas Schmerr, Menelaos Sarantos, Hop Bailey, Daniel Gershman, Mihaly Horanyi, Xiaoli Sun, and Jamey Szalay

◆ 3EPSC2020-619 Candidate landing sites and possible traverses at the South Pole of the Moon for the LUVMI-X rover

Marine Joulaud, Jessica Flahaut, Diego Urbina, Hemanth H. Madakashira, Gen Ito, János Biswas, and Simon Sheridan

◆ 4EPSC2020-780 VOILA on LUVMI-X: Volatiles Detection in the Lunar Polar Region with Laser-Induced Breakdown Spectroscopy

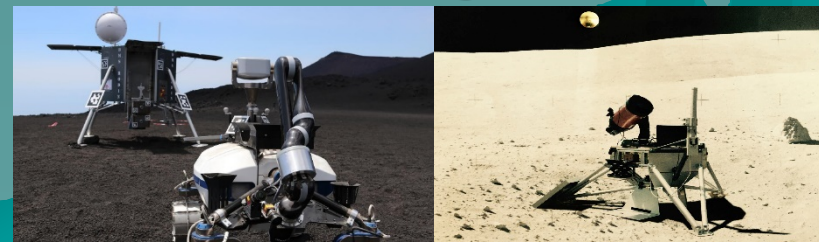
David Vogt, Susanne Schröder, Heinz-Wilhelm Hübers, Lutz Richter, Michael Deiml, Markus Glier, Peter Weßels, and Jörg Neumann

◆ 5EPSC2020-156 F, Cl and 'water' mineral-melt partitioning in a reduced, model lunar system: what does the 'volatile' content of lunar rocks tell us?

Geoffrey D. Bromiley, Nicola J. Potts, and Richard A. Brooker

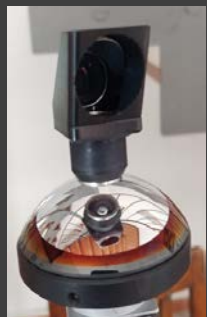
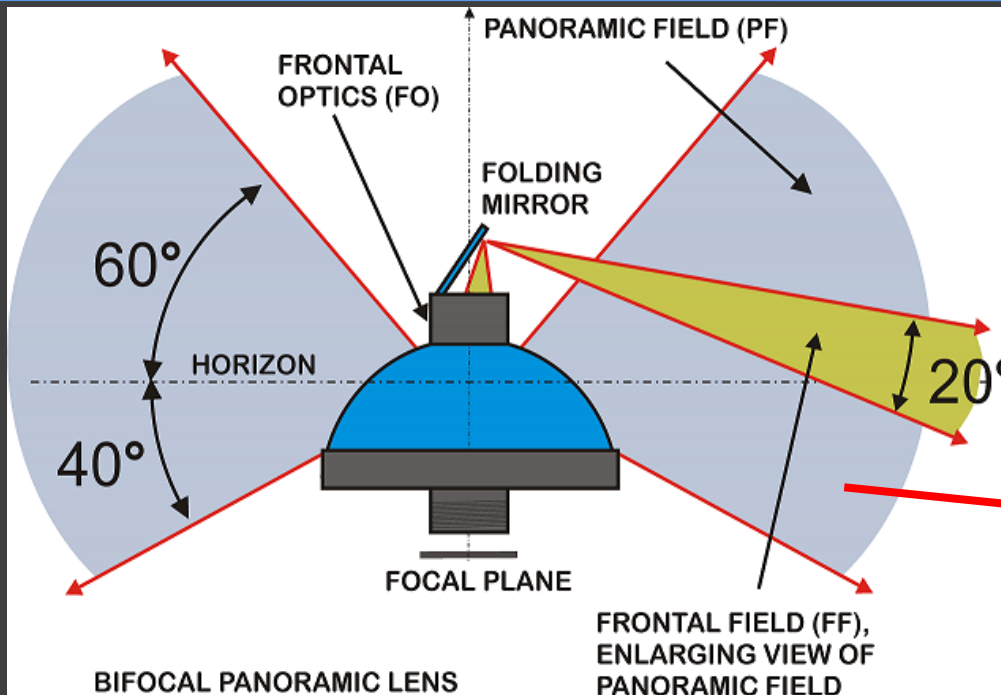
◆ 6EPSC2020-1124 Scientific Co-operative Rover with Artificial Intelligence for Futuristic Scientific Experiments on Moon

Sandhya Rao and Sreemon Chowdhury



BIPS

Bifocal Panoramic Lens Concept

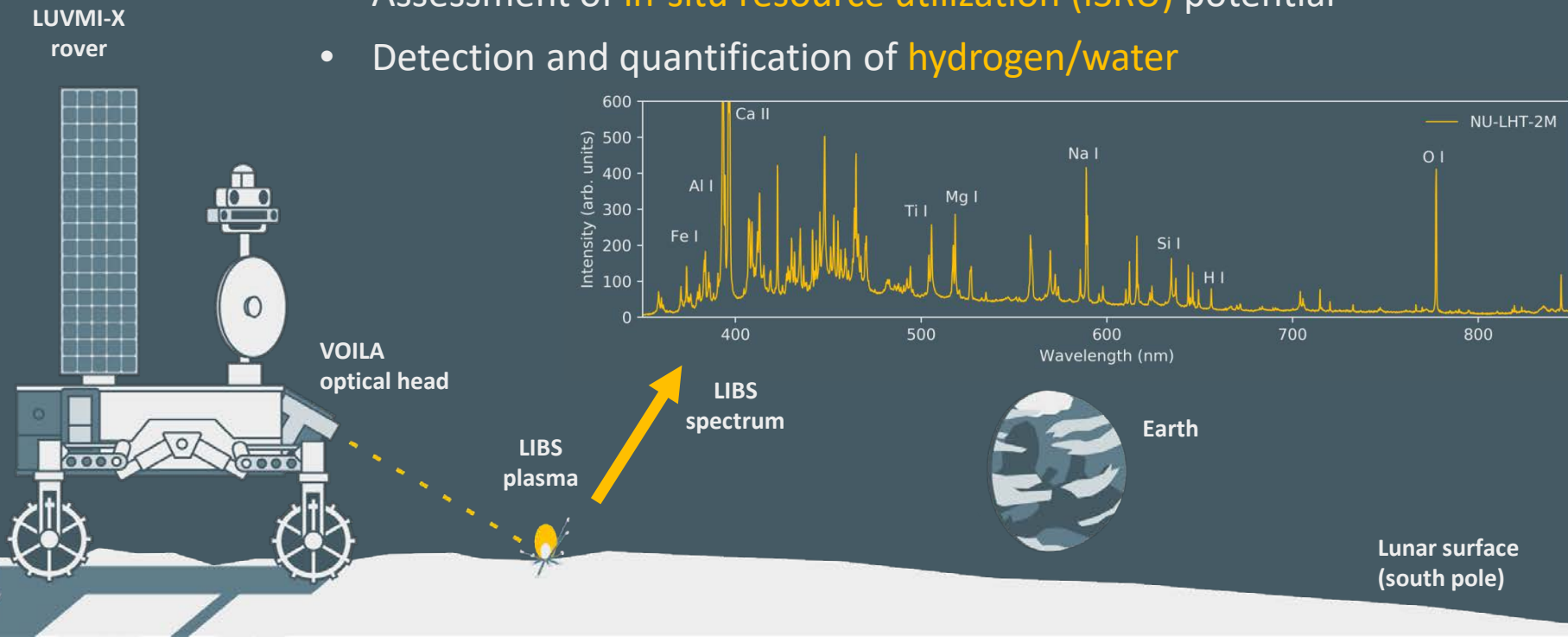


Optical Concept:

The lens is able to record a field of view of $360^\circ \times 100^\circ$ (panorama) plus an enlargement part of it, with a given magnification factor, using just one image sensor.

VOILA on LUVMI-X

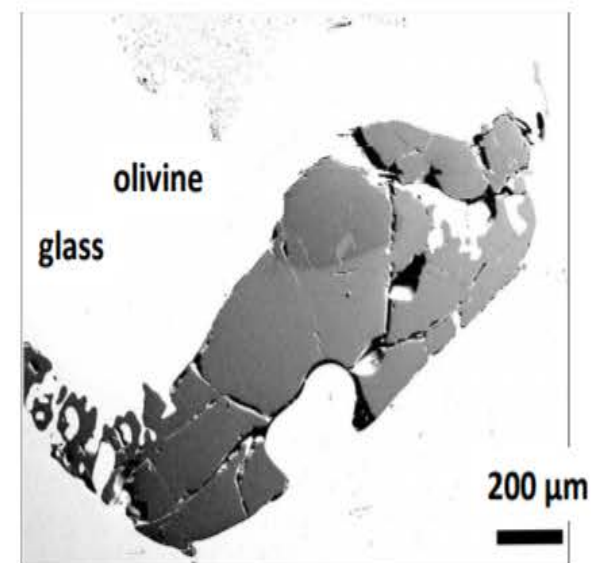
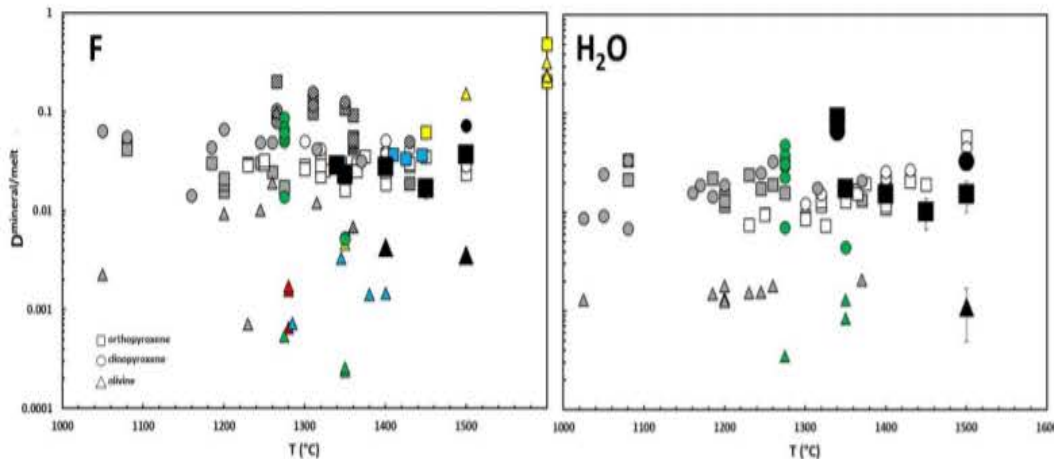
- LIBS instrument for **stand-off analysis** of lunar surface
- Assessment of **in-situ resource utilization (ISRU)** potential
- Detection and quantification of **hydrogen/water**



F, Cl and H₂O mineral-melt partitioning in a reduced, model lunar system: what does the 'volatile' content of lunar rocks tell us?

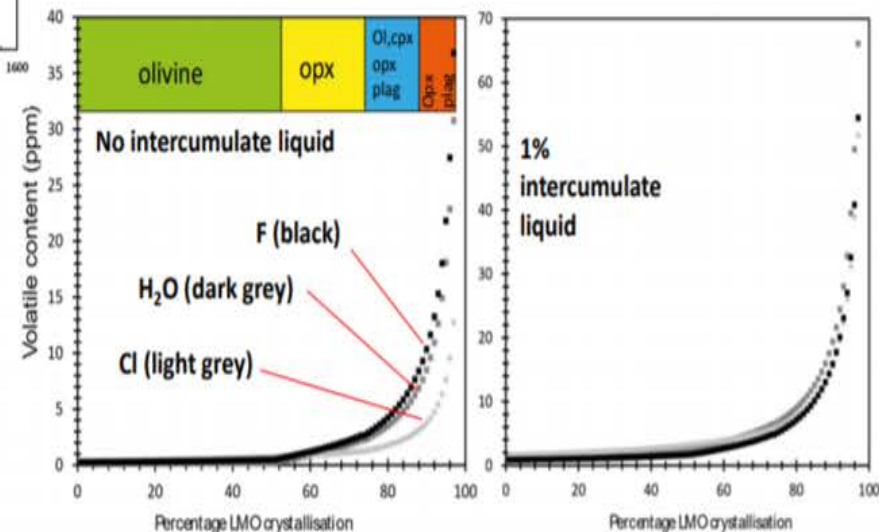
Geoff D. Bromiley, Nicci J. Potts (University of Edinburgh), Richard A. Brooker (University of Bristol)

- Experimental study: F, Cl and H₂O partitioning during partial melting/crystallisation.
- Data used to model redistribution of these 'volatiles' during magmatic processes.



- the lunar interior sourced by mare volcanism is 95% depleted in F and H₂O, and 98% depleted in Cl relative to Earth

- 'Volatile' content of lunar rocks is partly a reflection of lunar magma ocean solidification: strong depletion in Cl.



Sustainable MoonMars Outposts and Habitats

(summary by Sabrina Kerber & Marc Heemskerk 6 mn)

- ◆ 7EPSC2020-901 **CHILL-ICE: Construction of a Habitat Inside a Lunar-analogue Lava-tube: Iceland Campaign of EuroMoonMars**

Marc Heemskerk, Charlotte Pouwels, Sabrina Kerber, Eibhlin Downes, Robert Heemskerk, and Bernard Foing

- ◆ 8EPSC2020-1026 **How to Build Moon Bases**

Henk Rogers, Michaela Musilova, Rodrigo Romo, Vincent Paul Ponthieux, and Bernard Foing

- ◆ 9EPSC2020-1035 **International MoonBase Alliance missions at HISEAS**

Michaela Musilova, Henk Rogers, and Bernard Foing

- ◆ 10EPSC2020-1110 **EMMIHS-2 Analog Moonbase Viewpoint And Results – An Engineering Outlook at the Second Euro-MoonMars IMA HI-SEAS 2019 Campaign**

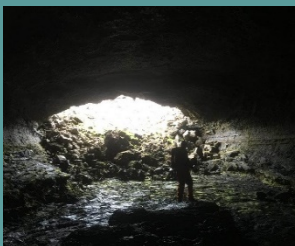
Ana Castro Nunes, Micaella Musilova, Sabrina Kerber, Charlotte Pouwels, Ariane Wanske, Josep D'Angelo, Bernard Foing, and Henk Rogers

- ◆ 11EPSC2020-971 **Inflatable Lunar Habitat**

Lyubov Dimova and Kamelia Encheva

- ◆ 12EPSC2020-1083 **California Research Analog for Deep Space and Lunar Exploration (CRADLE) 2020 Astronaut Simulations**

Hunter Singh



International MoonBase Alliance missions at HI-SEAS

Goals:

- Geology, astrobiology and in situ resource utilisation research
- Rover and other technology testing
- Human psychology, sociology and physiology studies for long duration space missions

Dr. Michaela Musilova, Henk
Rogers & Prof. Bernard Foing

musilova@moonbasealliance.com



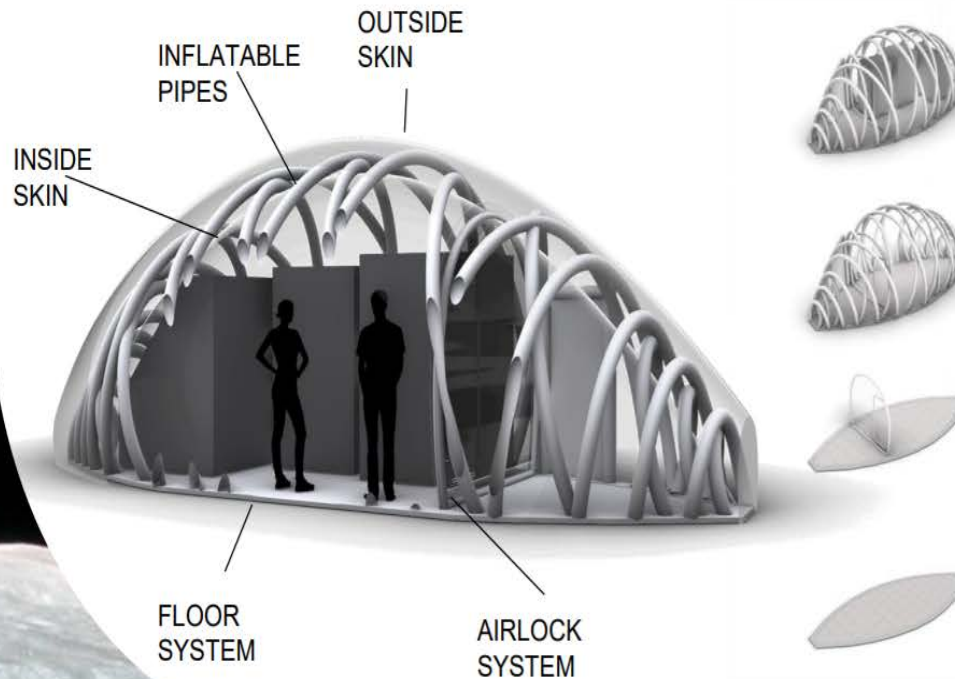


Inflatable Lunar Habitat

Presented by Lyubov Dimova and Kamelia Encheva

In order to be able for humanity to study the space, we need the right protection.

In this sense building a place that provides safe and comfortable living and working conditions is one of the most important steps that must be taken in building strategy for exploring the world outside our planet.



The Inflatable Habitat module could be tested in-extreme environment on Earth.

After improving the prototype for working on Earth and adjusting it to the conditions on the Moon, can be use to build a small village in the lava tubes on the Moon.



Image Credit: NASA

MoonMars Communities, Economy and Societies (summary by Bernard Foing 5 mn)

- ◆ 13EPSC2020-1040 **Moon Village Association (MVA) Global Collaboration Framework for Lunar Missions**

Elissavet Koumi and Pavithra Manghaipathy

- ◆ 14EPSC2020-108 **New Economy in space: Cis-lunar economic circle and analogue simulations in China to the 2061 Horizon**

guo linli, blanc michel, huang tieqiu, huang jiangze, yuan jianping, and guo yufei

- ◆ 15EPSC2020-871 **Numerical Modeling of the Special Features in the Dynamics of Near-Moon Objects**

Nikita Popandopulo, Tatyana Bordovitsyna, Anna Aleksandrova, Victor Avdyushev, and Irina Tomilova

- ◆ 16EPSC2020-1107 **Towards a rules-based order for the emergence of a space resources-based economy leading to a lunar renaissance**

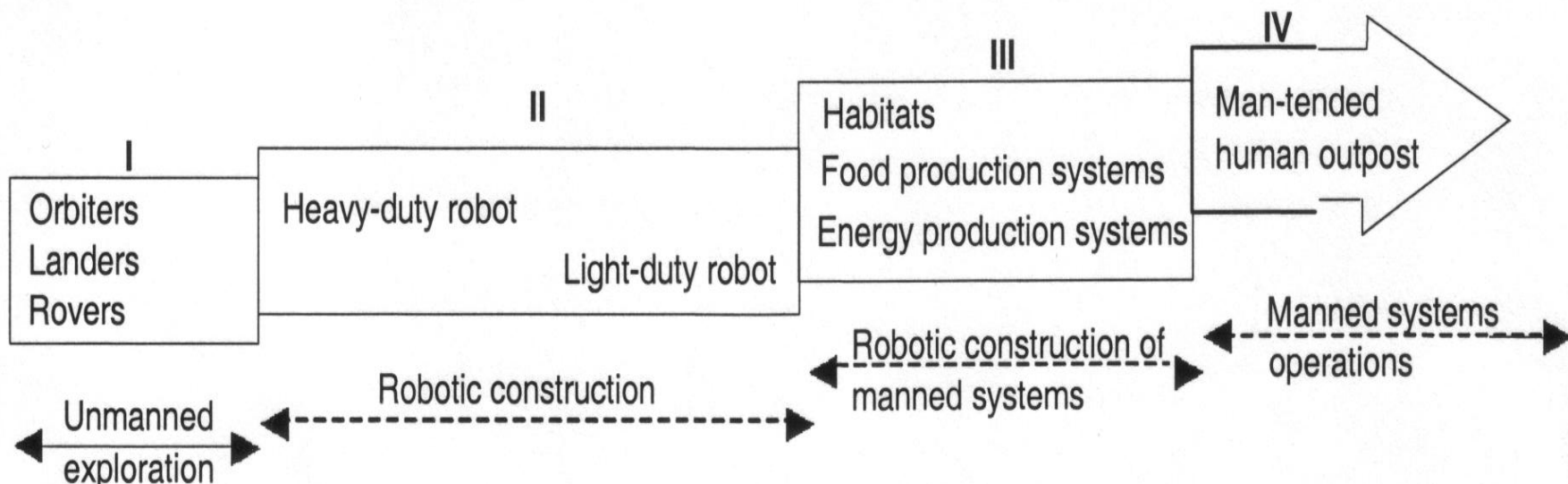
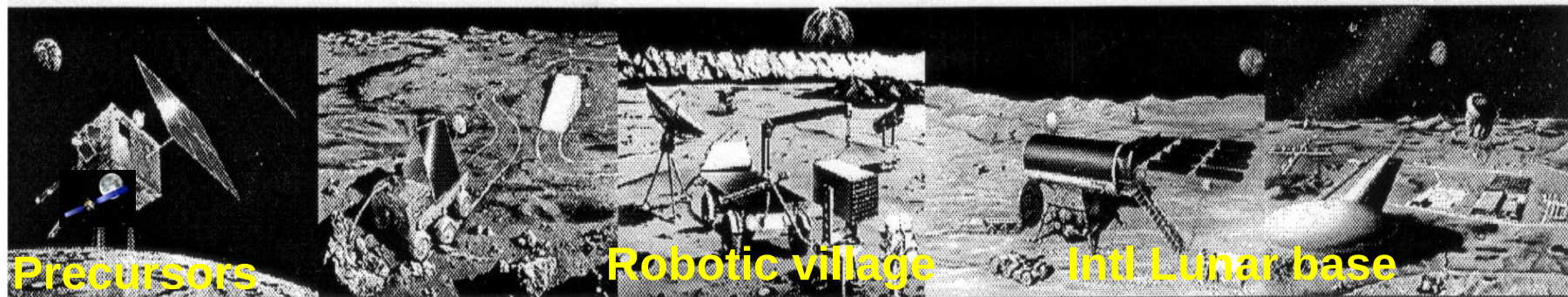
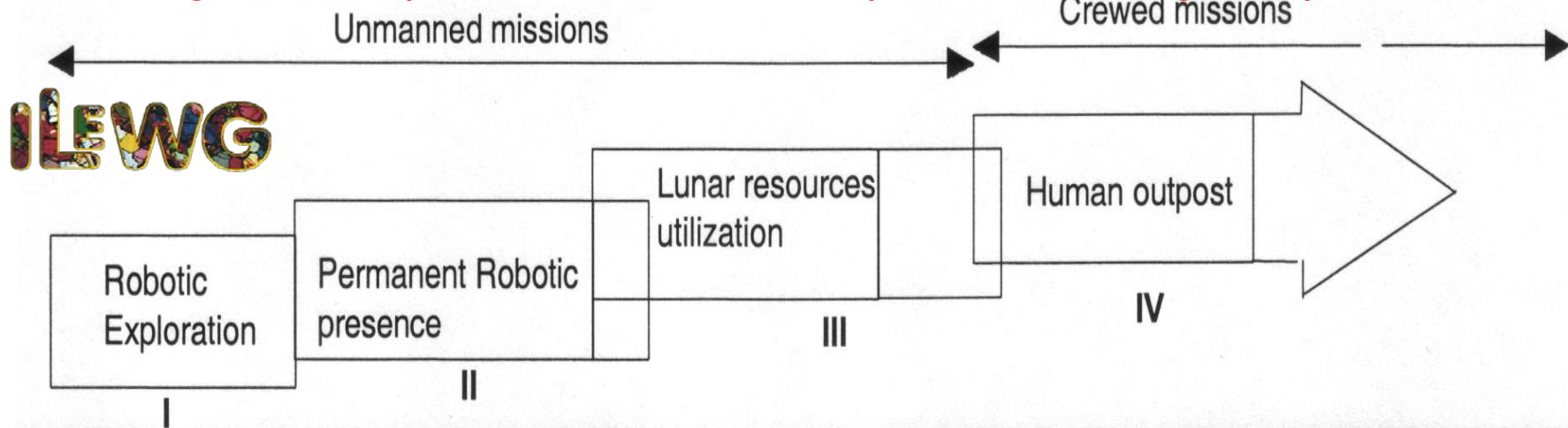
Vidvuds Beldavs, Bernard Foing, Jim Crisafulli, and Dennis O'Brien

- ◆ 17EPSC2020-1108 **Operation of future lunar society in 2040**

Shigeru Imai



MoonVillage Roadmap: International Lunar Exploration Working Group



Preparing MoonMars Village on Earth

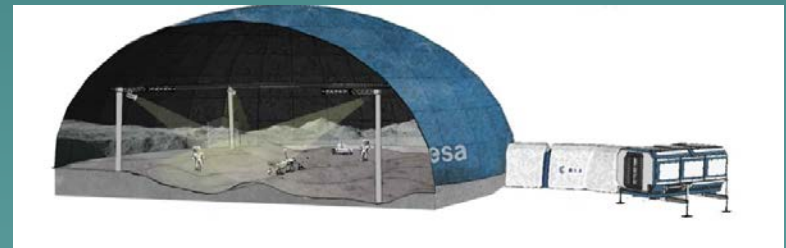
Robotic Village

- ◆ Landers and rovers , telerobotics
- ◆ Instruments, ISRU & life sciences
- ◆ Field tests in MoonMars analogues
- ◆ Dusty Vacuum facilities



Human Bases

- ◆ Habitats & pressurised vehicles
- ◆ Laboratories (geo, astro, bio)
- ◆ Infrastructures (transport, power, ISRU)
- ◆ Human facilities
 - ESTEC ExoHab/EXoLab , EAC Luna
 - LunAres isolation studies
 - ESA Lab & Ice Habitat (CH)
- ◆ MoonMars analogue bases MDRS, HiSeas, Intl MoonBase Alliance



Society, Commerce & ArtMoonMars

MoonGallery, workshops, events, Lunar Social Telescope



A rules-based order for the emerging space resources-based economy

Vidvuds Beldavs, Jim Crisafulli, Dennis O'Brien, Bernard Foing

- Goal: Global Space Renaissance (GSR) benefitting all countries.
- Challenge to address – creation of a framework for international cooperation within which all countries can cooperate to advance GSR and their interests thru outer space development.
 - No framework exists for cooperation among major spacefaring countries
 - China and the U.S. are emerging as strategic competitors in space
- Recommendation – UN Space Summit in 2021 involving heads of state to develop the framework for international cooperation in outer space development.