SCIENCE CONNECT
EUROPEAN SCIENCE FOUNDATION
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ESSC

The European Space Sciences Committee

ESSC Membership

ESSC Chair: **Athena Coustenis, Paris Observatory and CNRS, France**	
Life and Physical Sciences in Space *Panel Chair:* **Dominique Langevin**, Université de Paris-Sud, France • Sarah Baatout, Belgian Nuclear Research Centre (SCK-CEN), Belgium • Alexander Chouker, Hospital of the Ludwig-Maximilian University, Germany • Berndt Feuerbacher, DLR, Germany • Helen Fraser, The Open University, United Kingdom • Marc Heppener, France • Anne Pavy Le Traon, University Hospital of Toulouse, France • Roberto Piazza, Milano Politecnico, Italy • Peter Preu, DLR, Germany • Hubertus Thomas, DLR, Germany	**Solar System Exploration** *Panel Chair:* **Hermann Opgenoorth**, Swedish Institute of Space Physics, Sweden • Mahesh Anand, The Open University, United Kingdom • Ester Antonucci, Torino Observatory of Astronomy, Italy • Luisa M. Lara, Instituto de Astrofisica de Andalucia -CSIC, Spain • Gerhard Paar, Joanneum Research, Austria • Petra Rettberg, DLR, Germany • Robert Wimmer-Schweingruber, University of Kiel, Germany
Earth Sciences *Panel Chair:* **Ian Brown**, Stockholm University, Sweden • Andreas Kääb, University of Oslo, Norway • Maarten Krol, University of Wageningen, Netherlands • Rosemary Morrow, LEGOS, France • Sindy Sterckx, VITO, Belgium • Pepijn Veefkind, Royal Netherlands Meteorological Institute, Netherlands	**Astronomy and Fundamental Physics** *Panel Chair :* **Stéphane Udry**, Université de Genève, Switzerland • Conny Aerts, Katholieke Universiteit Leuven, Belgium • Nabila Aghanim, IAS-CNRS, France • Michael Perryman, North University College, Ireland • Manolis Plionis, National Observatory of Athens, Greece • Alexander Tielens, Leiden Observatory, NL

ESSC and ESF

- **The European Space Science Committee is hosted by the European Science Foundation-Science Connect**
- ESF-SC is a not for profit, non governmental association of European Research Organisations
- ESF-SC provides valuable services on the European scientific landscape
  - Develop and manage projects of transnational nature (e.g. EC H2020 projects)
  - Provide independent peer-review services in the context of competitive research calls
  - Hosting expert boards and committees (NUPECC, CRAF, **ESSC**)

ESSC MISSION STATEMENT

“ The mission of the ESSC is to provide an independent European voice on European space research and policy. It is the ESF’s expert body on space research ”

ESSC FUNDING ORGANISATIONS

16 Funding Organisations from 13 countries (+ 1 European Organisation)

- FWO, Belgium
- FNRS, Belgium
- Academy of Finland, Finland
- CNES, France
- DLR, Germany
- FWF, Austria
- NoA, Greece
- ASI, Italy
- FNRS, Luxembourg
- NWO, Netherlands
- Research Council of Norway, Norway
- Norwegian Space Centre, Norway
- Swedish National Space Board, Sweden
- SNF, Switzerland
- UK Space Agency, UK
- ESA

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International Environment

European Union

- H2020 Space Advisory Group (individuals)
- Horizon 2020 stakeholder consultations
- Direct interactions with programme executives

National Space Agencies

- Annual meeting with ESSC Funding Organisations
- Representation in different national space agencies or advisory committees : CNES, UKSA, SAC, ..

ESA

- Council at Ministerial level
- Scientific advisory committees at programme level : SSAC, HESAC and ACEO
- Meetings with DG, Directors and programme executives

- COSPAR Science Advisory Committee (ex-Officio)
- Observer status to UN COPUOS in progress
- Copernicus Academy member

- US National Academies Space Studies Board
- CAS/NSSC and CAST
- JAXA
- IKI

ESSC PLENARY MEETINGS 2017-2018

22-24 Nov 2017
DLR, Munich, Germany

21-23 May 2018
Univ. Geneva, Switzerland

26-28 Nov 2018
Royal Society, London

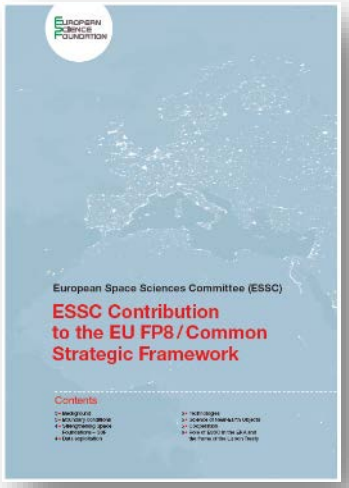
Attending : ESA HRE (human spaceflight and robotic exploration), SCI (science program) and EO (earth observation) directors

Representatives from EC and (spring plenary) JAXA, IKI, CAS

SSB director (Michael Moloney, Colleen Hartman)

Overarching Science Policy Advice

- High level policy recommendations to ESA council at ministerial level
- High level policy recommendation to EC on space sciences related matters
- Pro-Active specific communications and recommendations expressed to institutions
- Studies ExoOceans, Space Weather, CalVal Copernicus



Human Space flights and Robotic Exploration (HSRE)
European Exploration Envelope Program (E3P)

European Exploration Envelope Programme E3P

Programme approved at ESA's 2016 Council meeting at ministerial level

European Exploration Envelope Programme E3P

Strategic guidelines of E3P

- Balanced mix of human and robotic
  - ***Robots as Human precursors***
- Secure maximum benefit from existing investments
  - ***ISS and ExoMars***
- Progressively develop new technological and operational capabilities
- Prepare future steps for beyond LEO sustained human presence
  - ***Moon as most likely next destination***
- Seek new opportunities for international cooperation
  - ***Maintain NASA as core partner***

E3P main activity areas

ISS:
- Operations
- Sustainability, Evolution and Technology
- Obligations: MPCV-ESMs and complementary barter
- Astronaut missions

SciSpacE:
Science in the Space Environment:
1. Science Support and Applications
2. ISS Payload Development
3. Complementary non-ISS experiment platforms

ExoMars
- 2016 mission ops
- 2019 mission

European contribution to Lunar Resource Lander:
- PILOT
- PROSPECT
- SPECTRUM (Ground ops)

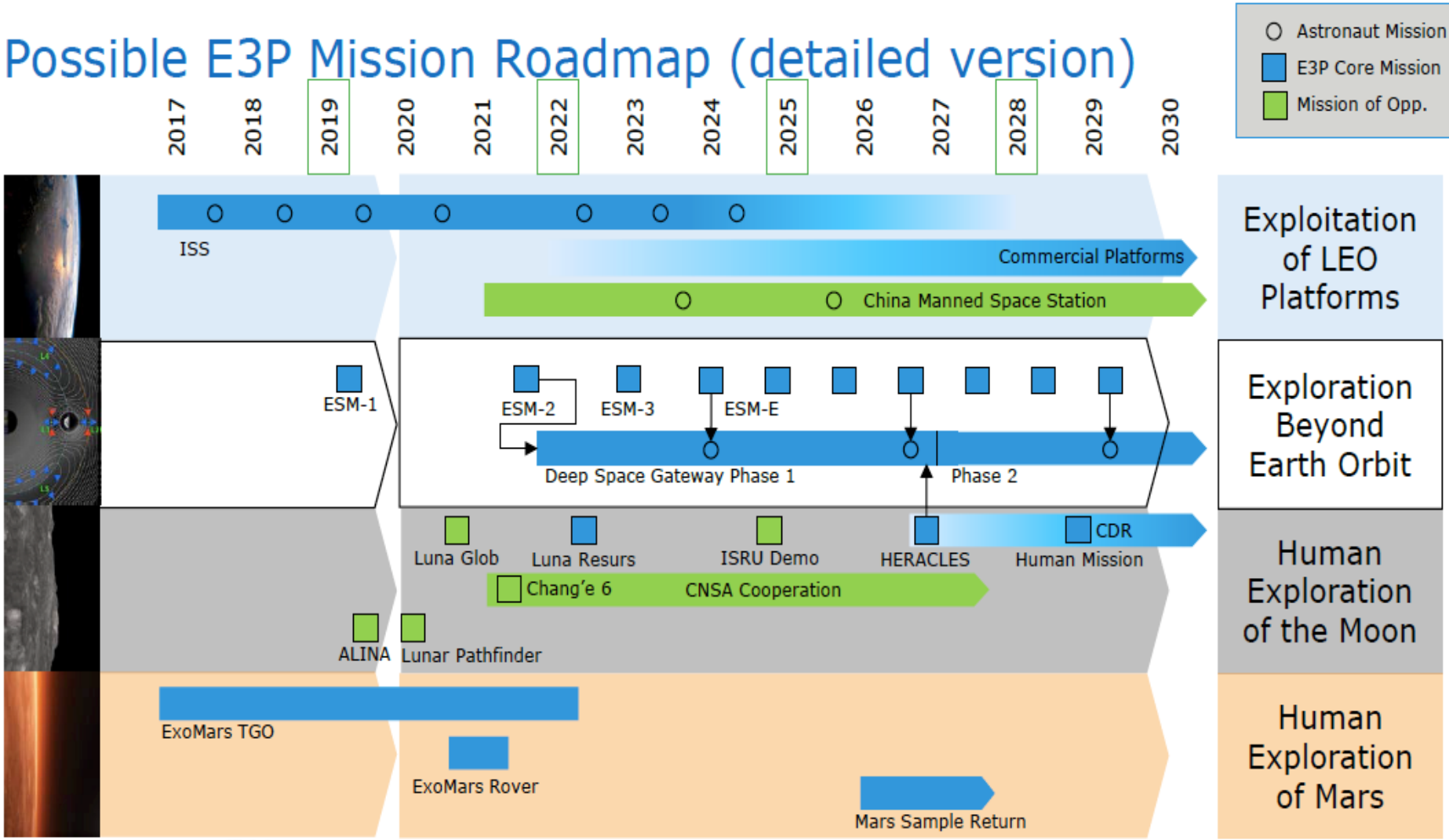
Human Exploration beyond LEO

Deep Space Habitat Phase A/B1

ExPeRT: Exploration Preparation, Research and Technology;
- System Studies
- Pre-development of new technologies
- International Collaborations
- Spaceship EAC/HRAF

Commercial Exploration Partnerships

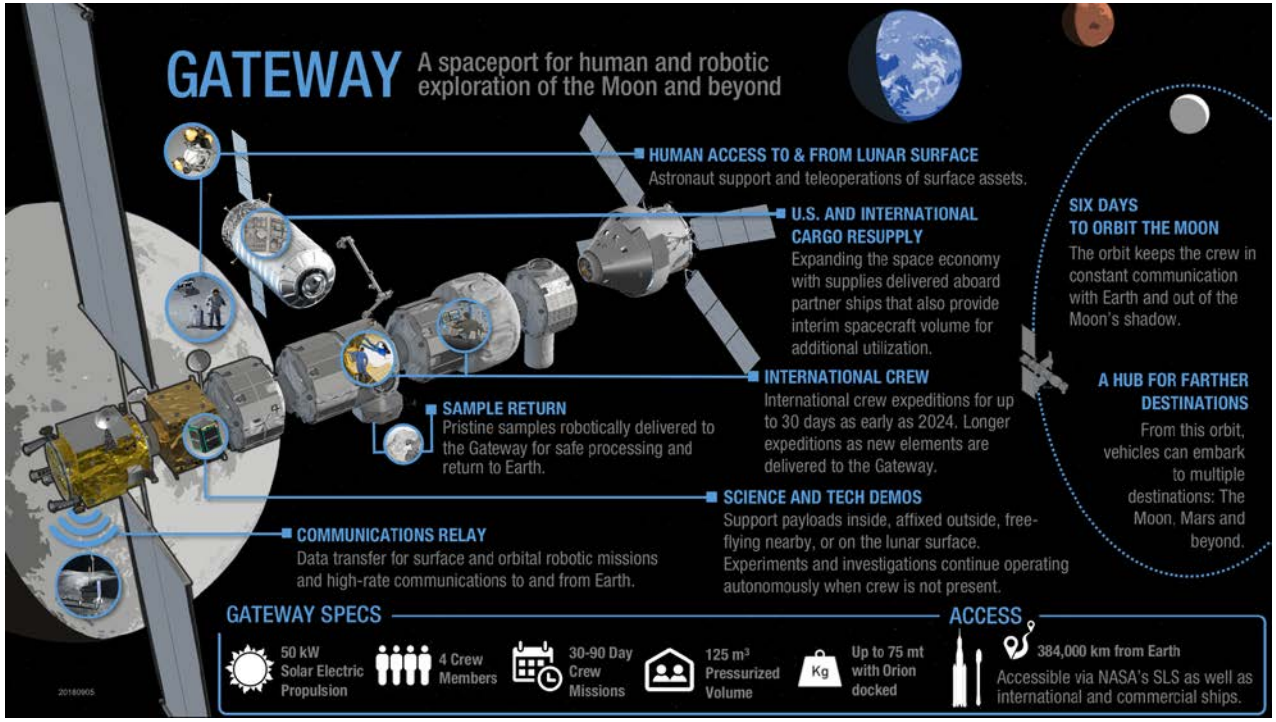
Possible E3P Mission Roadmap (detailed version)



Cooperation with China (CMSA-CSU)

Joint Call for Proposals April-Nov. 2017

- invitation to projects pre-selected on both sides for their common objectives planned on ISS and CSS
- to seek synergies and a cooperative approach to maximising the outcome of both flight opportunities within an integrated project.
- teams are free to decide not to cooperate, with no penalty to their already selected project



- International elements, including proposed ESA provided infrastructure
- Some infrastructure and capabilities to support research during both crewed and uncrewed phases
- Resources and capabilities significantly more constrained than ISS, but Gateway provides access to unique environment.

Moon Village

Human Research

The Human body under space conditions: adaptations and countermeasures

- *Understanding human physiological processes.*
- *Exploration –related health risks and their prevention.*
- *Health and ageing issues on Earth.*

Psychological and neurosensory adaptations to reduced gravity, isolation and confinement

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Biology

Astrobiology

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Physical Sciences

Ultra-precise cold atom sensors, quantum information and high energy particles

- *Boundaries of relativity and quantum physics.*
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Soft or Complex matter

- *Interactions and self-organisation in foams, emulsions, granular matter, atmospheric dust and colloids.*
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Boiling, evaporation and heat transfer

- *Multi-scale modelling of fluid physics including phase change.*
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Advanced material processing

- *Microstructure formation and materials properties.*
- *Casting, automotive and aerospace industry.*

Cosmic radiation risks for Human Exploration of the Solar System

Excellent curiosity-driven research

Energy storage, fire safety, cardiovascular fluid physics, hibernation and torpor

SciSpacE – Research Community in Physical Sciences - in 2018:

- **48** projects in research "pool"
- **568** scientists (718 non-unique)
- **35** different countries !
- **~40** multi-user instruments, inserts or modules under development for the ISS, sounding rockets and parabolic flights
- **59** industry partners to **18** projects qualifying for "MAP" co-funding by ESA
- **23** "Topical Teams"

Austria	13
Australia	3
Belgium	36
Brazil	1
Canada	22
Switzerland	12
China	12
Czech Republic	2
Germany	106
Denmark	1
Spain	24
Finland	1
France	96
Greece	3
Croatia	1
Hungary	10
Ireland	6
India	3
Italy	47
Japan	31
Kazakhstan	1
Korea	2
Netherlands	5
Norway	4
Poland	3
Portugal	0
Romania	2
Serbia	1
Russia	31
Sweden	6
Slovakia	3
Slovenia	1
Turkey	2
United Kingdom	32
USA	57

Working Internationally in Physics in Space

				US	RU	JP	CA	Others
FUNDAMENTAL PHYSICS	ACES	2017	Atomic Clock Ensemble in Space	X		X		AU
	SOC	?	Space Optical Clock	X				
	Q-WEP	?	Quantum test of the Weak Equivalence Principle	X				
	PK4	2014-2019	Plasma-Kristall-4	X	X	X		HU
	PLASMALAB	?	Complex Plasma laboratory	X	X	X		HU
ASTRO- & ATMOSPHERIC PHYSICS	ASIM	2017	Atmosphere-Space Interactions Monitor	X	X	X		
	JEM-EUSO	?	Extreme Universe Space Observatory	X	X	X		PL, SK, ME, KR
SOFT MATTER PHYSICS	VIPGRAN, PF then ISS	2019	Vibrational Phenomena in Granular Matter	X	X			CN
	SOFT MATTER DYNAMICS	2017	Foam-Coarsening, Emulsion, Granular	X	X	X		
	COLLOIDAL SOLIDS	2019	Colloid Physics / Colloid Light Scattering	X			X	
MATERIALS SCIENCES	MSL cartridges B#3a and B#3b **XRMON in MSL**	2009-2020	Materials Sciences Laboratory - sample cartridges	X				HU
	EML batch 1,2,3 & 4	2014-19	Electromagnetic Levitator -1rst batch of samples	X	X	X		HU, PL, CN, IN, KR
	Transparent Alloys	2017	Solidification studies in transparent model materials	X				TU
FLUID PHYSICS & COMBUSTION	DCMIX	2012-13-16-17	Diffusion Coefficients in Ternary Mixtures		X	X		
	VIPIL/FARADAY	?	Vibrational Physics in Interdiffusing Fluids	X	X	X		
	JAXA-FPEF JEREMI	2017	Japano-European Research on Marangoni Instabilities	X		X	X	
	SAFFIRE	2014	Solid fuel Flammability Test in Cygnus	X	X	X		
	NEUF-DIX and ELECTRO-DENDRITES		Giant fluctuations	X		X		CN
HEAT TRANSFER	MULTI-SCALE BOILING	2017	Reference Multi-Scale Boiling Investigations	X	X	X		CN
	Thermal Platform	2019	Multi-User platform for Heat Transfer Studies	X	X	X	X	CN

ISS SCIENCE

SCIENCE

- **MATERIALS RESEARCH**:
  - EML:
    - Batch 2.2 successfully concluded. Next batch already started.
  - MSL furnace swap paves way for future research
- **SOFT MATTER RESEARCH**:
  - Soft Matter Dynamics:
    - Commissioning performed. 1st experiment runs started
  - PK-4: Research successfully restarted
- **TECHNOLOGY RESEARCH**:
  - Continuation of Vessel ID
  - SUPVIS-JUSTIN
- **COMMERCIAL RESEARCH ACTIVITIES**:
  - ICE Cubes Facility installed and commissioning on-going

Images: Hardware asssociated with Soft Matter Dynamics (top),
ICE Cubes being installed by Alexander Gerst(bottom)

Industrial involvment (physical sciences)

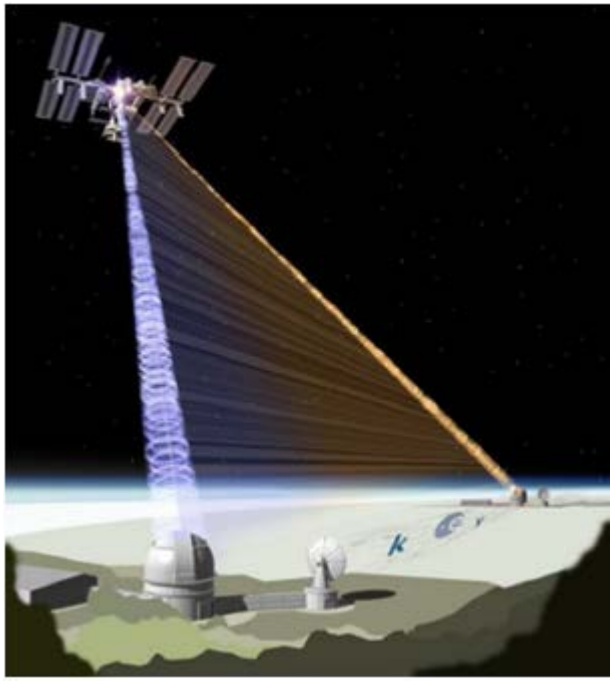
ACES
Cold Atom clock (Pharao)

ESA JP US, launch in 2020

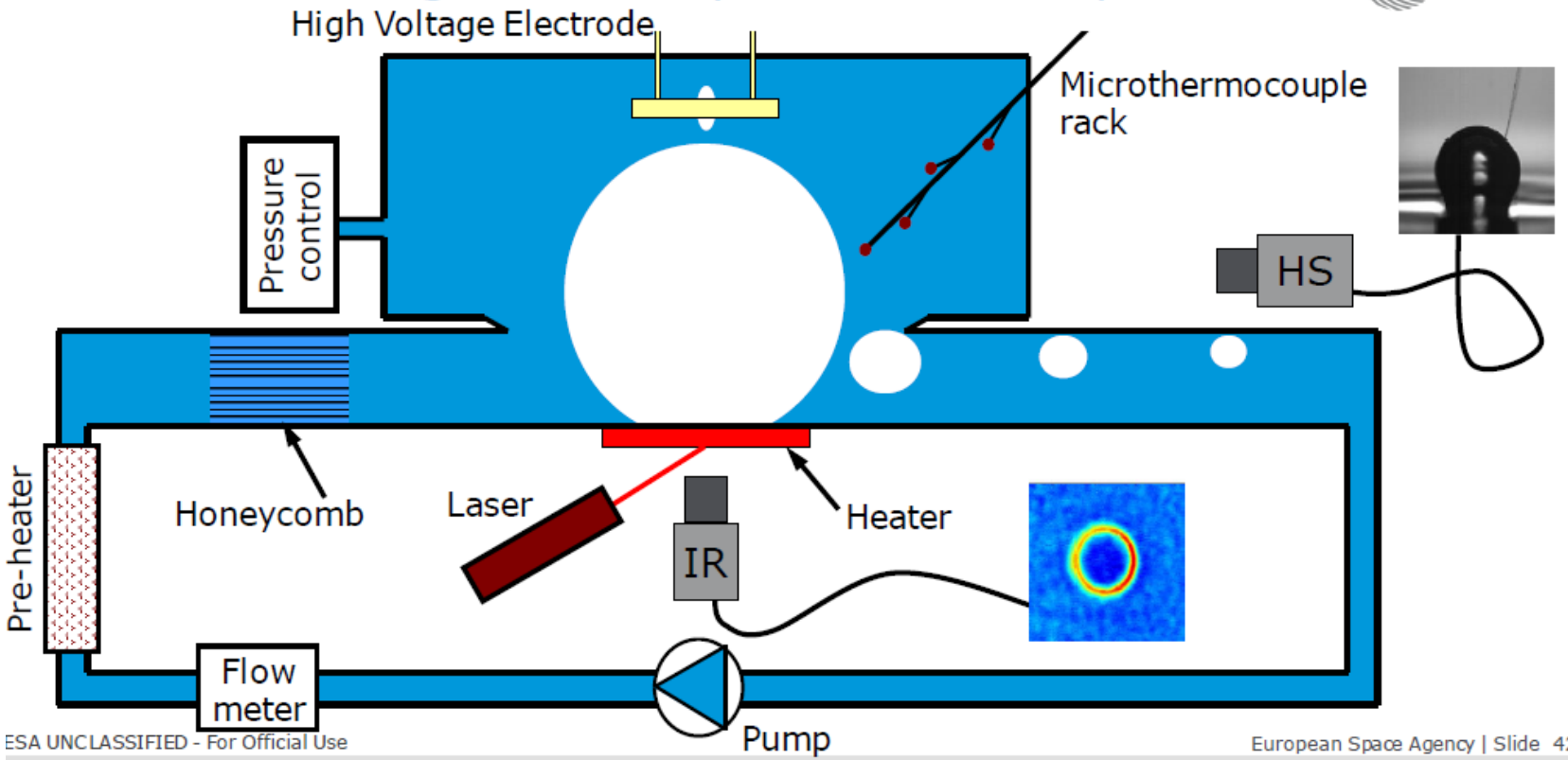
Space QUEST
Experiments with quantum Entanglements

(Decoherence induced by gravity
Entangled photons produced on Earth and detected on ground and ISS)

ESA JP, phase A



Multiscale Boiling "RUBI" experiment concept



Launch : spring 2019

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Human immune system dysregulation & countermeasures in space

Nutrition, microbiome, exercise, bones

Muscle tone loss during bedrest & in space
Long-term daylight deprivation
Structural changes in the brain Pre- & post-flight MRI scans

Myotones project

monitors the tone, stiffness and elasticity of astronaut's muscles.

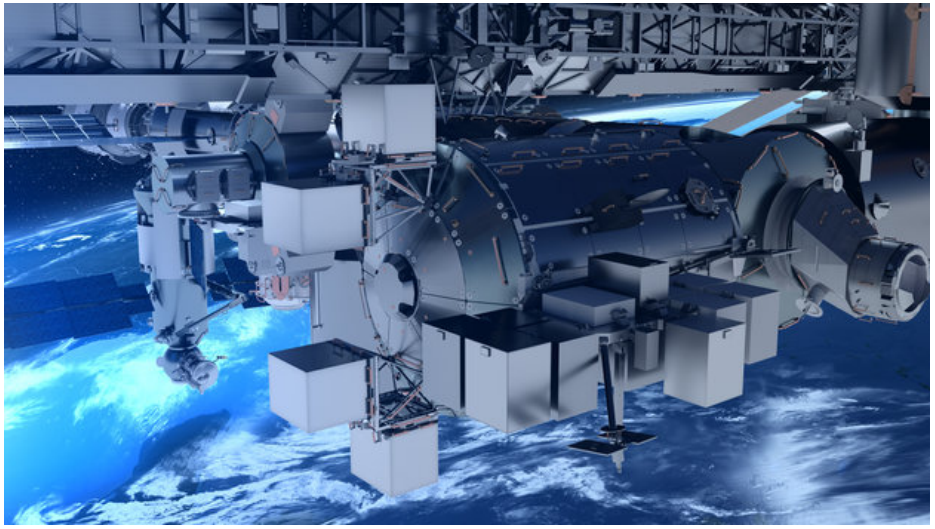
non-invasive, portable device which emits a painless pressure pulse and records how the tissue responds.

MyotonPro device being used in the ISS on the foot of Alexander Gerst

Exobiology

resistance to radiation
and other harsh conditions,
survival mechanisms

External ISS facility



Rotifer B DNA repair on flight

BIOROCK how gravity affects the interaction between microbes and rock in a liquid medium

Biofilms

Conclusions

-the current (many) microgravity research projects need a prolongation of the ISS. Some of the hardware has only be installed recently (ex: CAL)

-the exploration programs also require ISS access, which is the most suitable instrument (presence of astronauts, long time missions possible)

-other options : chinese space station, new tools in space vehicles, satellites, lunar gateway…

-international cooperation needed, even for industry

-positive output : PFs offer variable g conditions