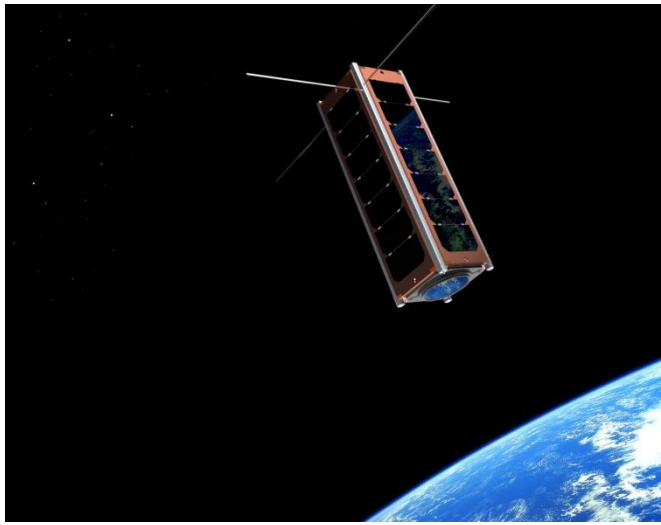
Analog Missions of the Austrian Space Forum

Gernot Groemer

Austrian Space Forum

Österreichisches Weltraum Forum

Research focus



- **Hardware development:**
  - Aouda.X spacesuit simulator
  - Mars analog rovers
  - Stratospheric balloons & Cubesats
- **Research focus**
  - Planetary surface operations
  - Planetary protection
  - Optimizing remote science support
- **Major field campaigns:** 11 so far
  - E.g. Rio Tinto 2011, Dachstein 2012 (NASA/JPL, Exomars-participation, Morocco 2013)

PolAres programme

- Passepartout stratospheric ballon
- Phileas rover
- Aouda spacesuit simulator

- **Goal:** preparing exploration strategies for a human-robotic Mars expedition with a focus on planetary protection.

- ***PolAres reference mission architecture***

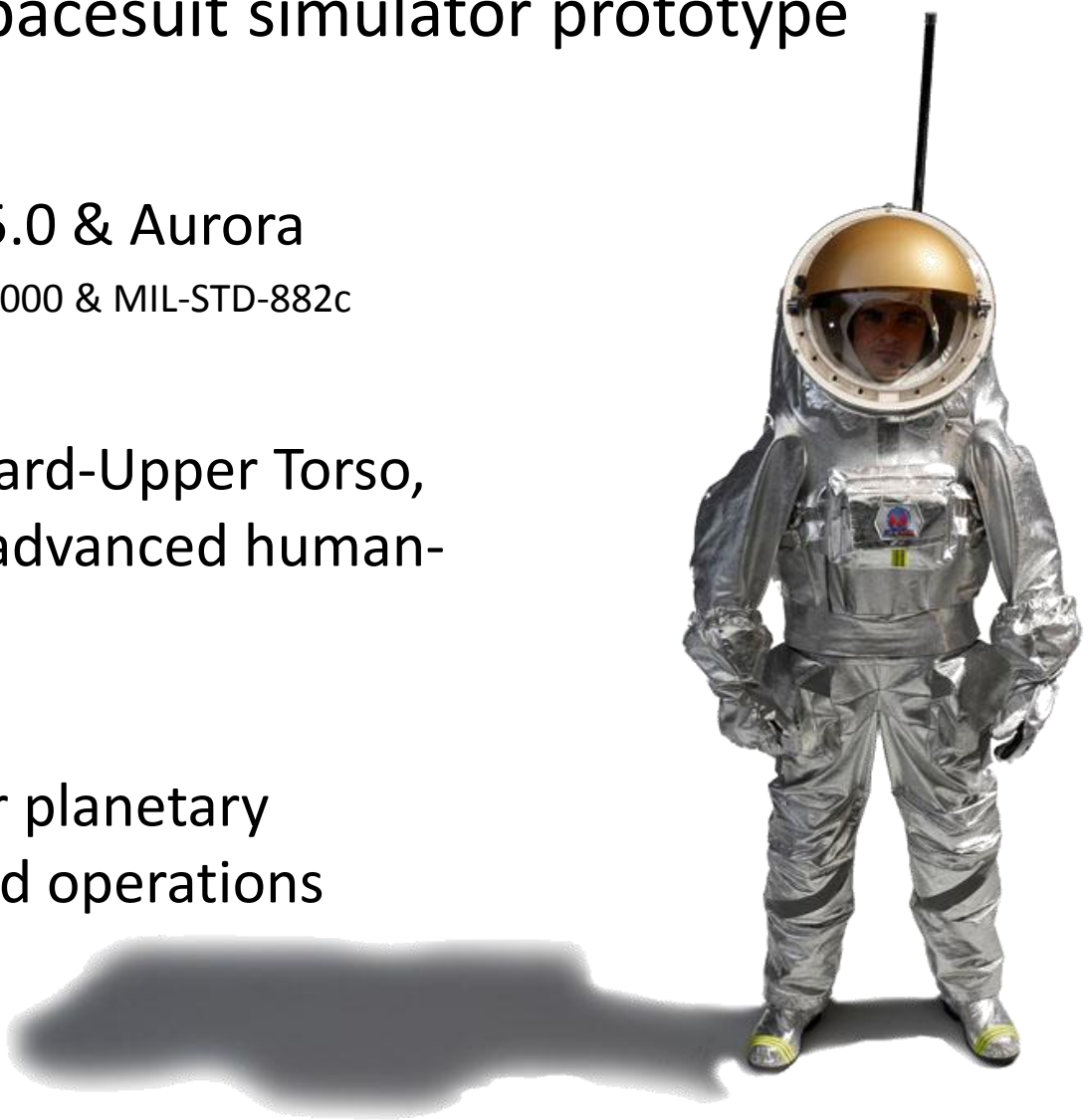
Aouda.X spacesuit simulator prototype

- Based upon NASA DRM 5.0 & Aurora
- NASA Human-System Standard STD-3000 & MIL-STD-882c

- <45 kg, unpressurized, Hard-Upper Torso, custom-built OBDH and advanced human-machine-interface

- Outer layer optimized for planetary protection, 4-6 hours field operations

- Broadband telemetry

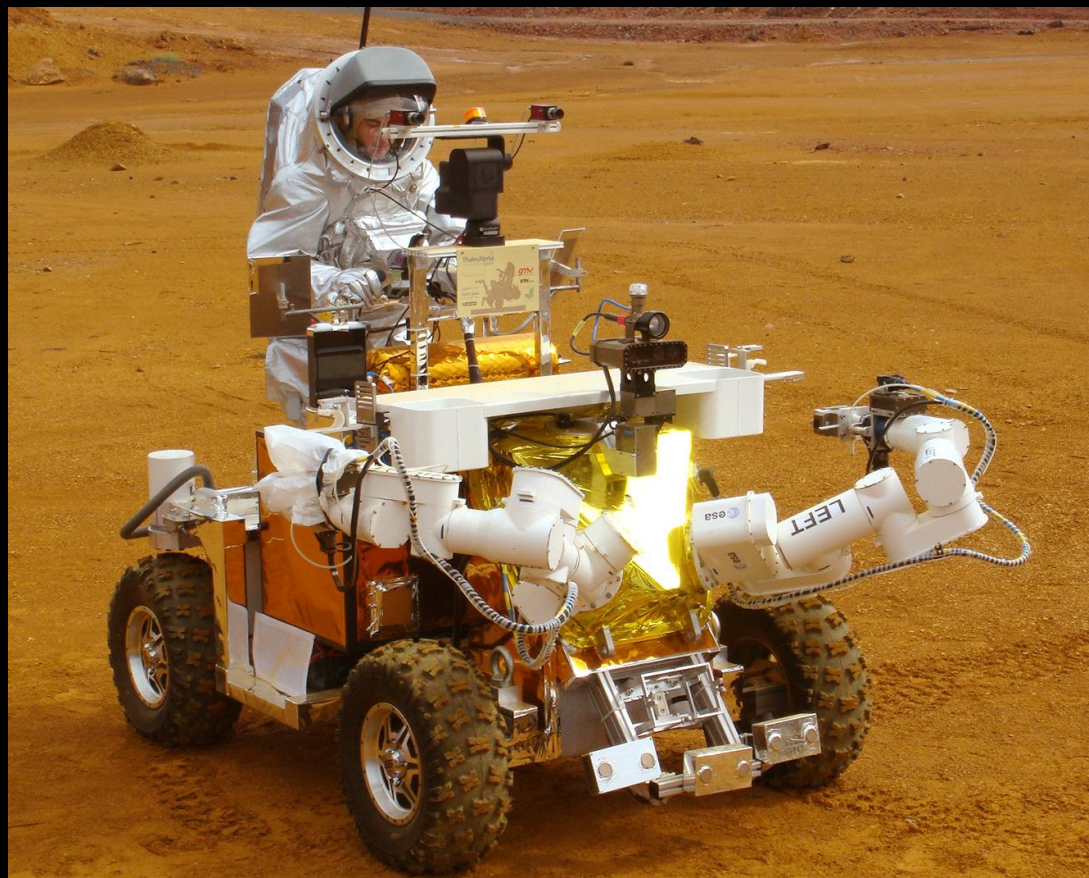


Groemer et al., 2012, *The Aouda.X space suit simulator and its applications Astrobiology. February 2012, 12(2): 125-134.*

Precursor Field Tests

International Mars Simulation
In Rio Tinto/Spain 2011

Focus:
- Human robotic interaction
- Geoscience & Remote Science Support

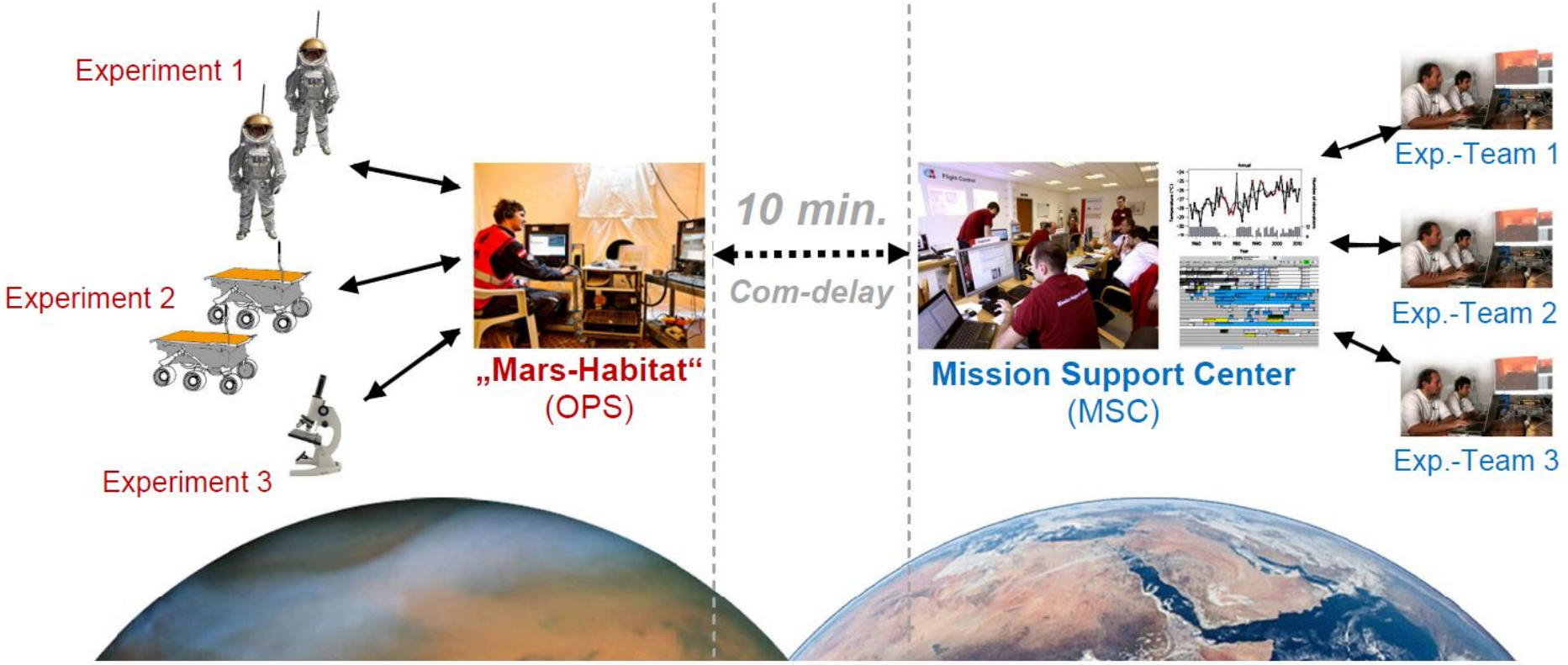


Orgel, C., et al. ***„SCIENTIFIC RESULTS AND LESSONS LEARNED FROM AN INTEGRATED CREWED MARS EXPLORATION SIMULATION AT THE RIO TINTO MARS ANALOGUE SITE****, Acta Astronautica 94/2 (2014)*

Dachstein Ice Caves

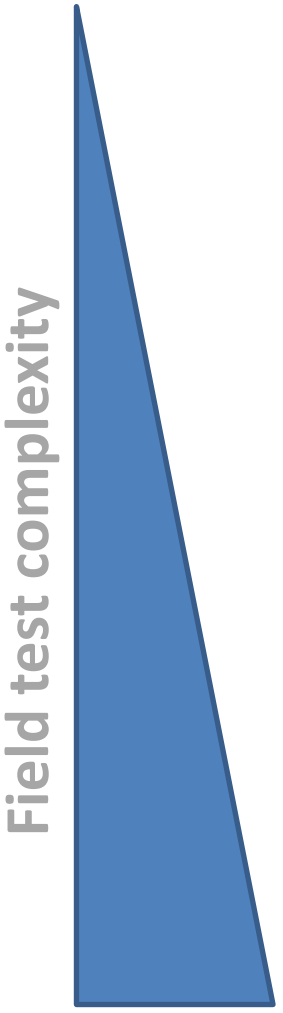
Subsurface field tests in Austria, 2012

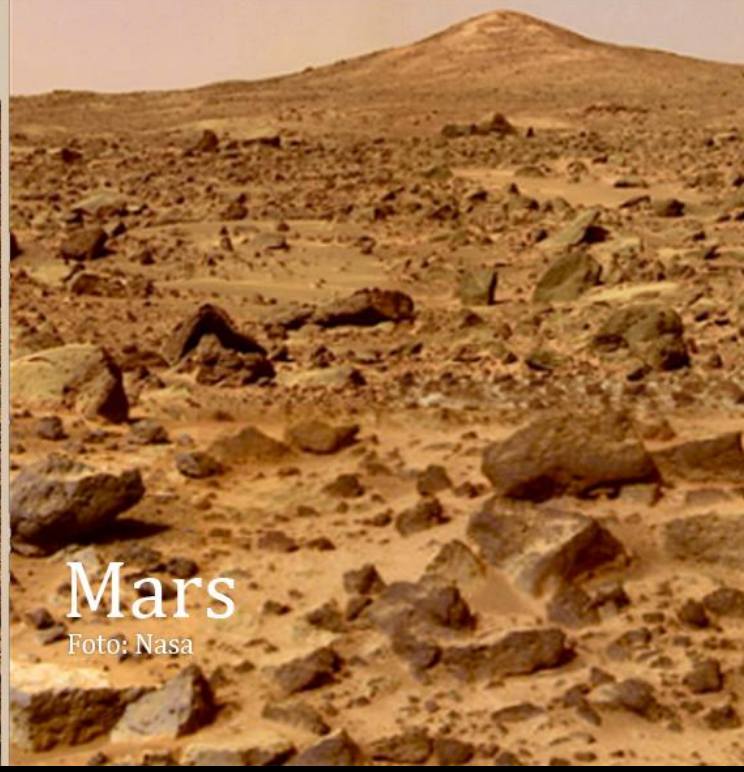
Remote Science Support
Terrain Trafficability tests & Robotics
Contamination vector analysis
Ground validation of EXOMARS instrument


Experiment 1
Experiment 2
Experiment 3
„Mars-Habitat“
(OPS)
10 min.
Com-delay
Mission Support Center
(MSC)
Exp.-Team 1
Exp.-Team 2
Exp.-Team 3

Previous system integration field tests

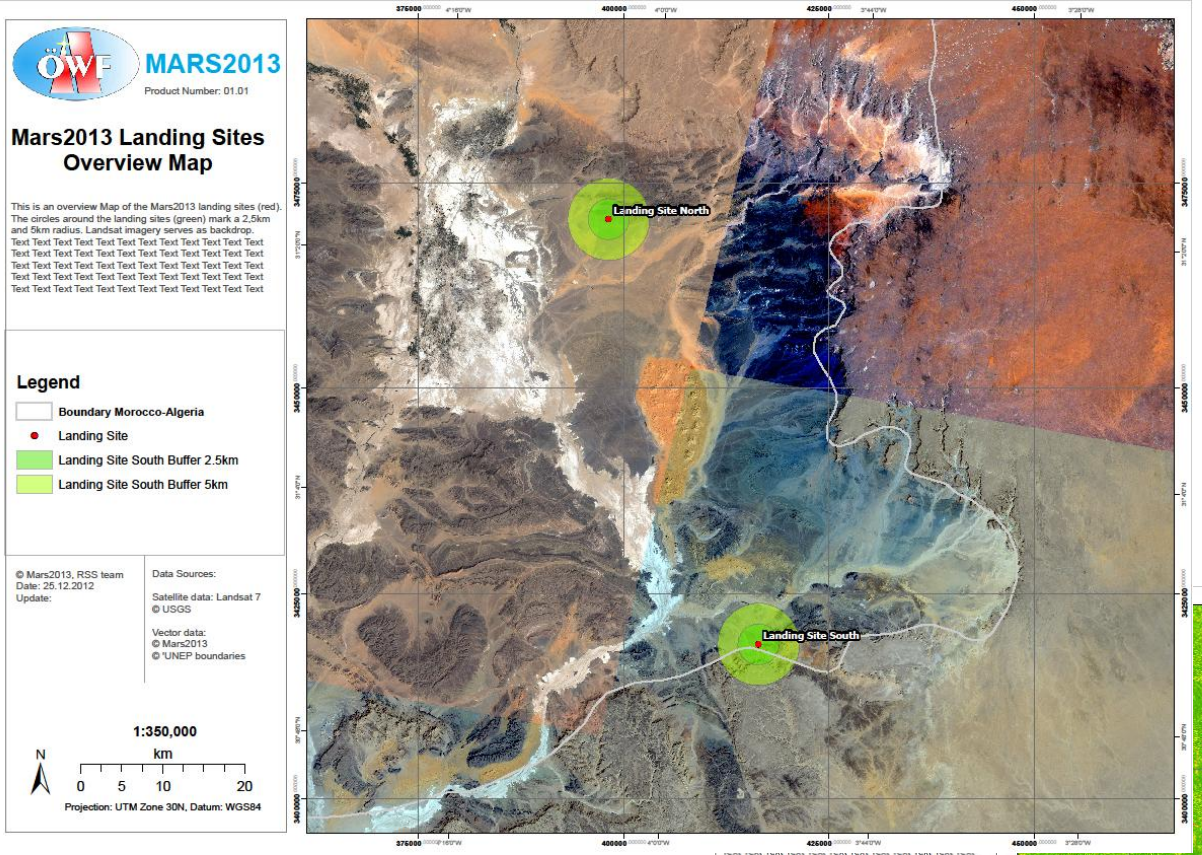
- Field-Test 1 – **Comissioning - July 2009**, Kramsach, Austria
- Field-Test 2 - **Pasterze-Glacier, August 2009**, Austria
- Field-Test 3 - **Cryo-Test, September 2009**, Seefeld, Austria
- Field-Test 4 – **Eifel-region, September 2009**, Germany
- Field-Test 5 – **Koppenbrueller-Cave, January 2010**, Austria
- Field-Test 6 - **Innsbruck**, **May 2010,** Austria
- Field-Test 7 – **Kaunertal Glacier**, **July 2010,** Austria
- Field-Test 8 – **Rio Tinto Integrated Sim, April 2011,** Spain
- Field-Test 9 – **Dachstein Ice Caves, May 2012**, Austria
- Field-Test 10 – **MARS2013, February 2013**, Morocco
- Field Test 11 – **AMADEE-15 Glacier, August 2015,** Austria





Precursor site assessements

- Geological analysis, precursor sampling
- Safety/Security/Logistics analysis
- Erfoud/Morocco region exhibits similarities to Mars



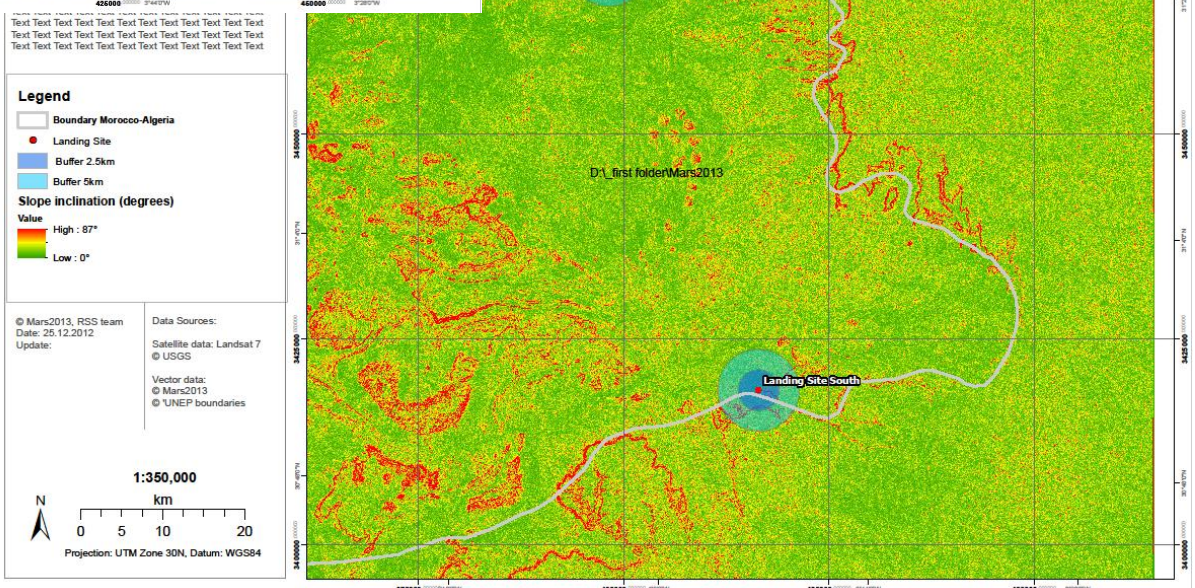
Context Maps:

Prepared before the mission utilizing Mars-analog data sets

„Blinding of science and flight planning team“

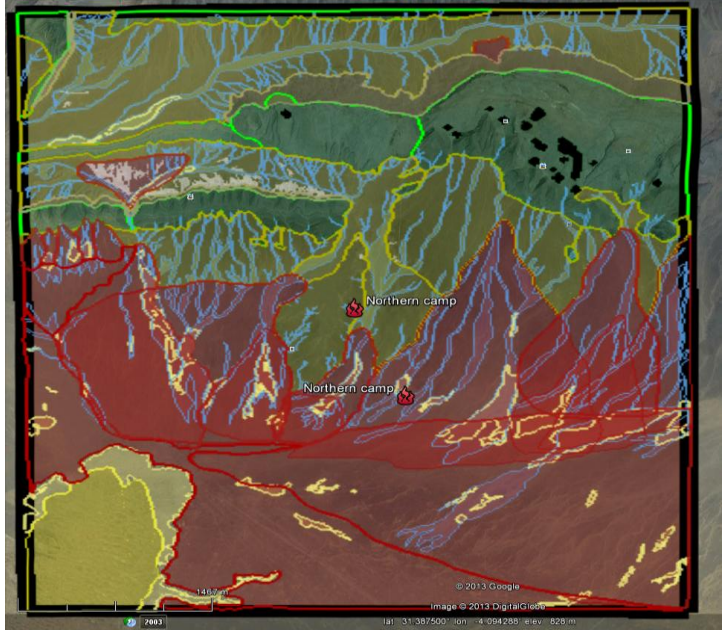
Satellite overview map
(Landsat 7, 30m resulution)

*Losiak, A et al. (2014) “**Design and utility optimization of maps for long duration planetary missions**“, Astrobiology 14:6*

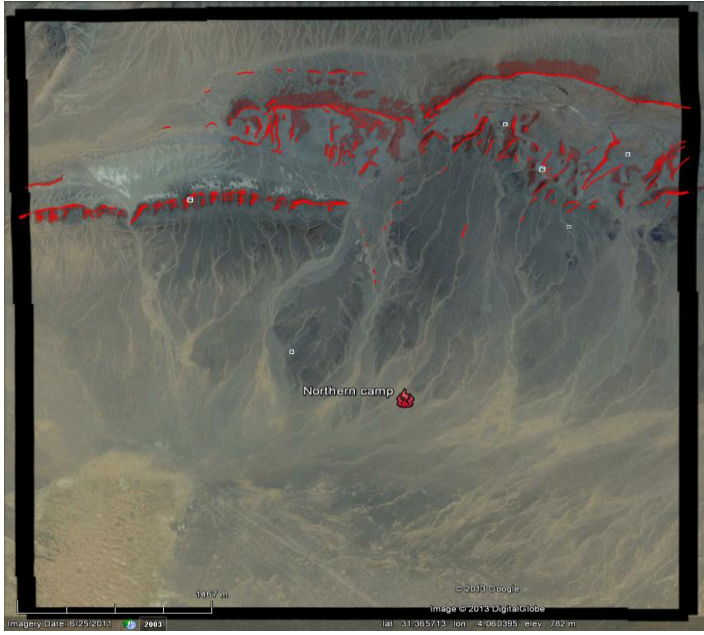


Slope inclination map
(ASTER GDEM, 30m resolution)

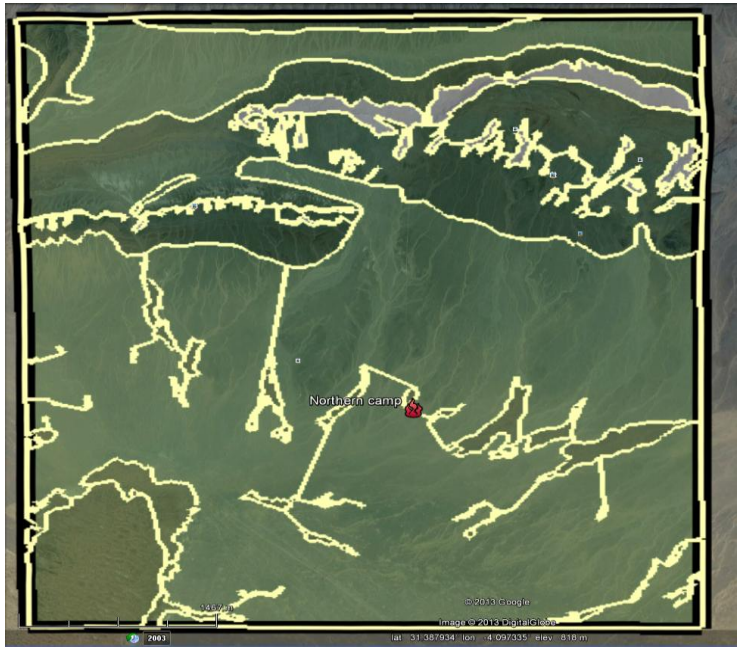
Basic Maps:
Prepared before the mission, regularly updated during the mission



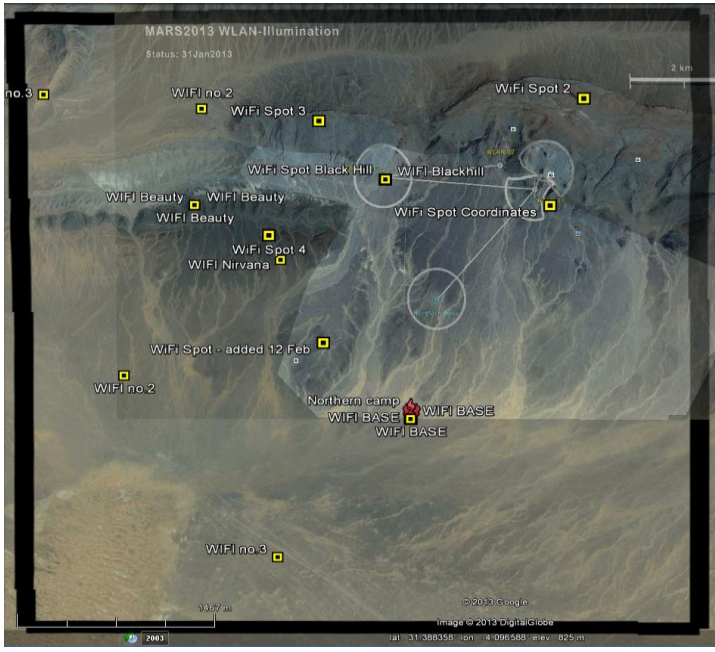
Geological Map



Terrain Risc Map



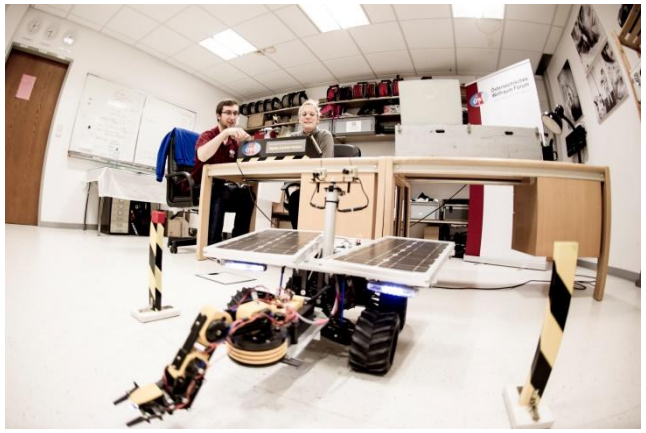
Suitability Map (example: SREC-Experiment)



Wifi Coverage Map

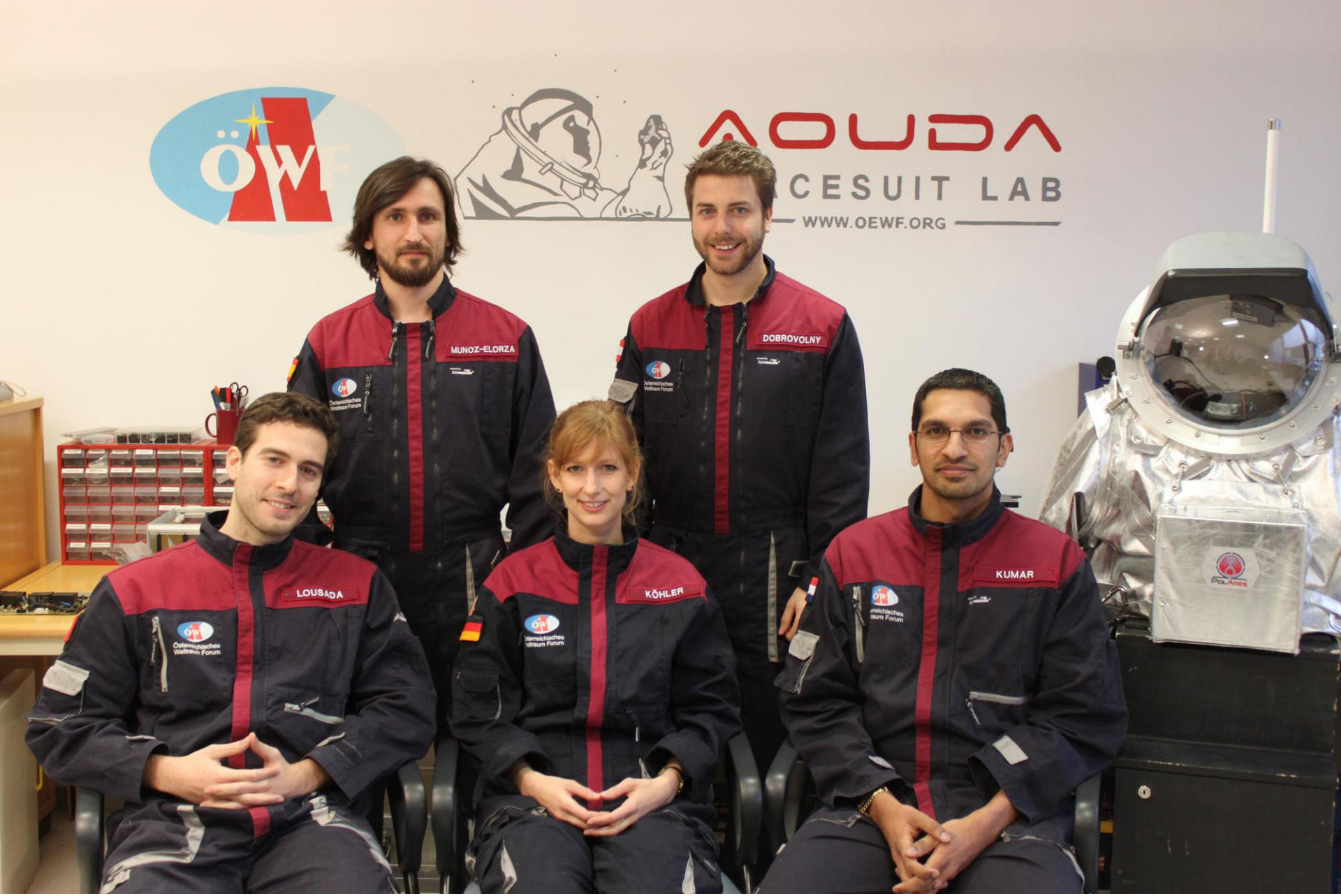
Analog Astronaut Selection 2015

- 100 applicants, 6 analog astronaut candidates
- 637 selection tests: psychological, physiological, team-fit, endurance, etc
- Only standing AA corps in Europe




SUIT TECH
TEAM

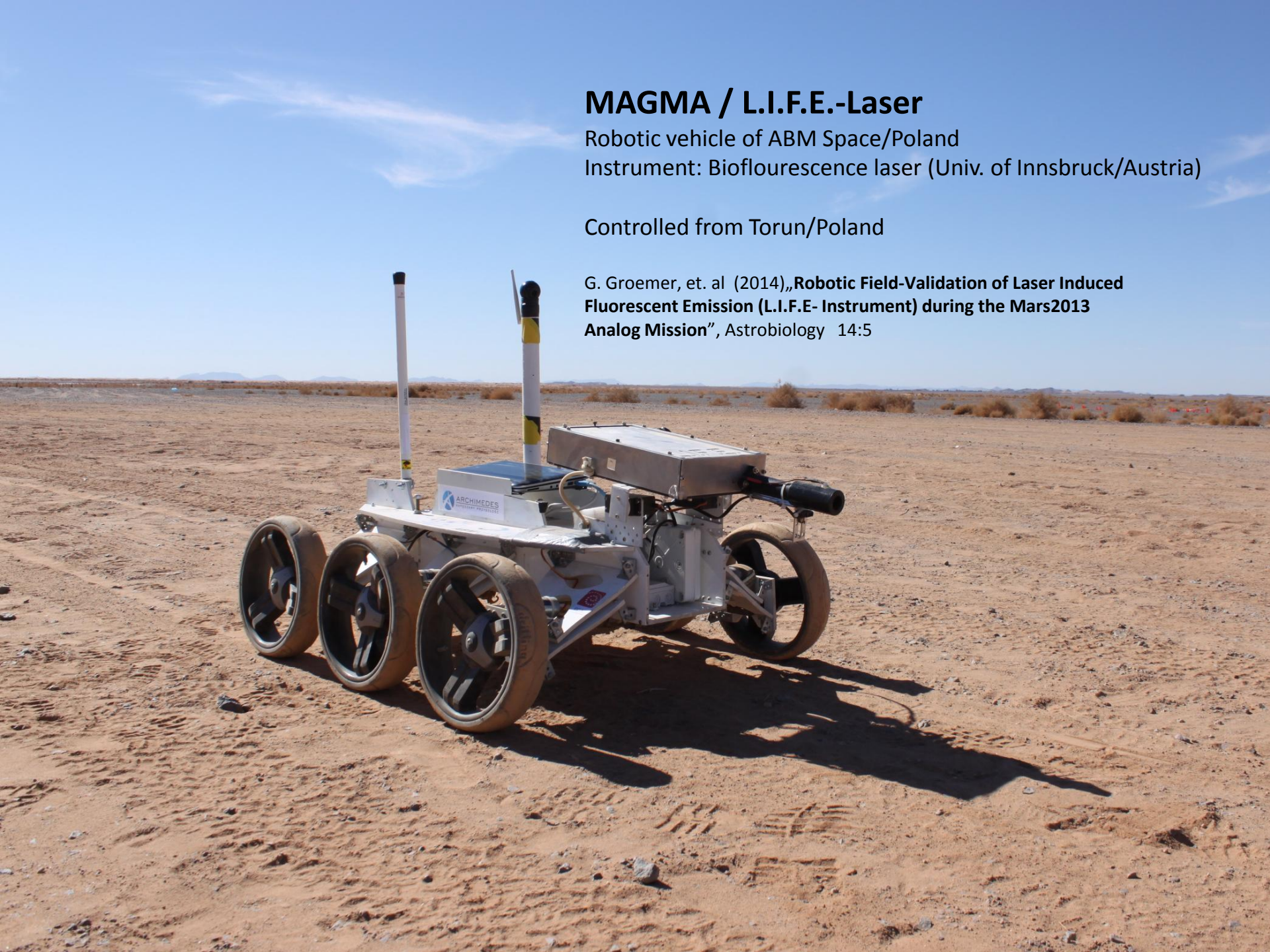

AKG
SUIT TECH



Analog astronaut class of 2015 (from 100 candidates, 5 month basic training)

Mission Experiment Examples


Österreichisches
Weltraum Forum



MAGMA / L.I.F.E.-Laser

Robotic vehicle of ABM Space/Poland
Instrument: Bioflourescence laser (Univ. of Innsbruck/Austria)

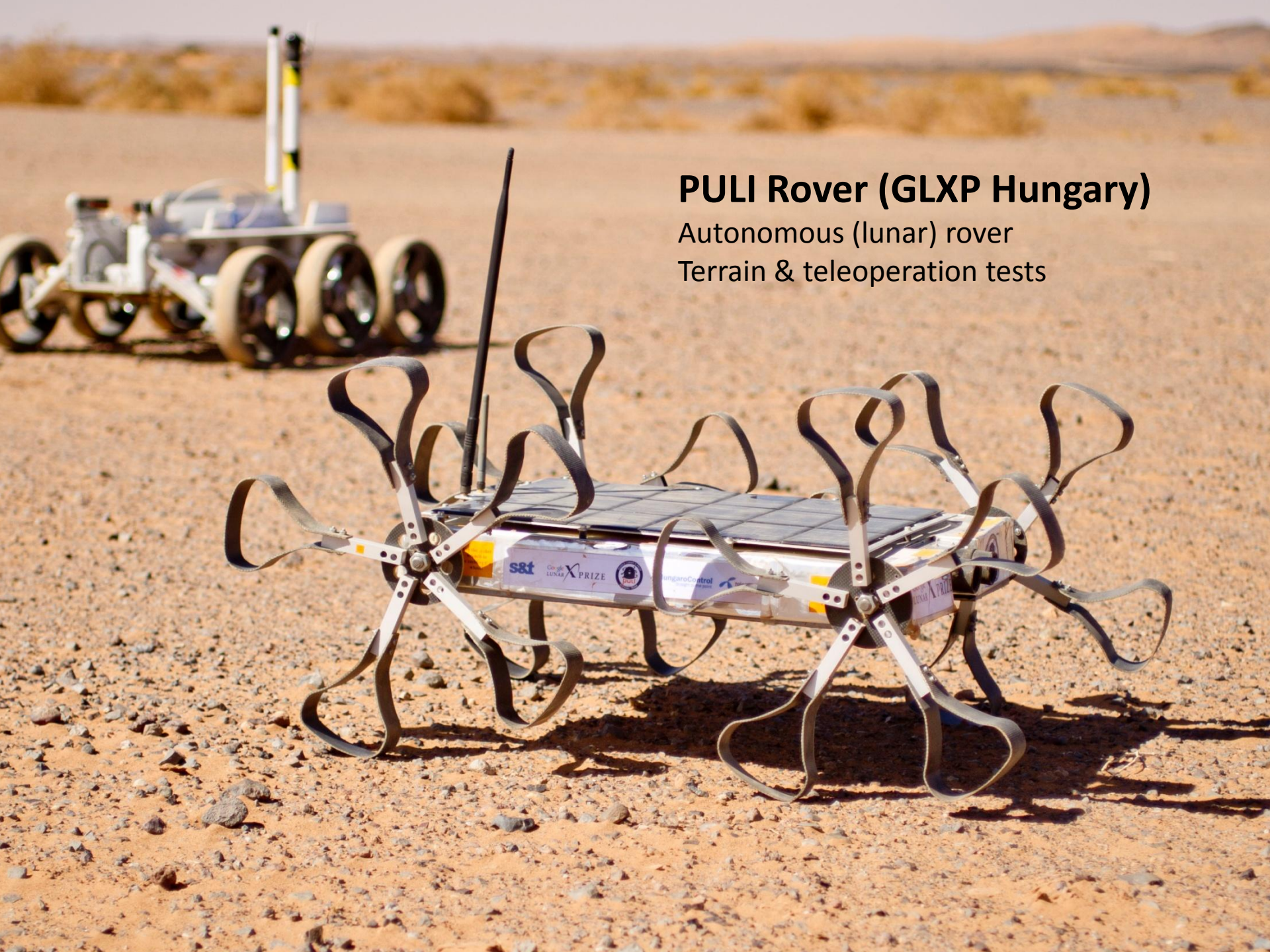
Controlled from Torun/Poland

G. Groemer, et. al (2014)„**Robotic Field-Validation of Laser Induced Fluorescent Emission (L.I.F.E- Instrument) during the Mars2013 Analog Mission**", Astrobiology 14:5

Cliff Recon Vehicle

(Association Planete Mars, France)

Human-operated vehicle for steep terrain
High-resolution imagery


PULI Rover (GLXP Hungary)
Autonomous (lunar) rover
Terrain & teleoperation tests

Deployable Shelter (TU Vienna / OeWF)

Inflatable/pressurizable shelter
Proof-of-concept study

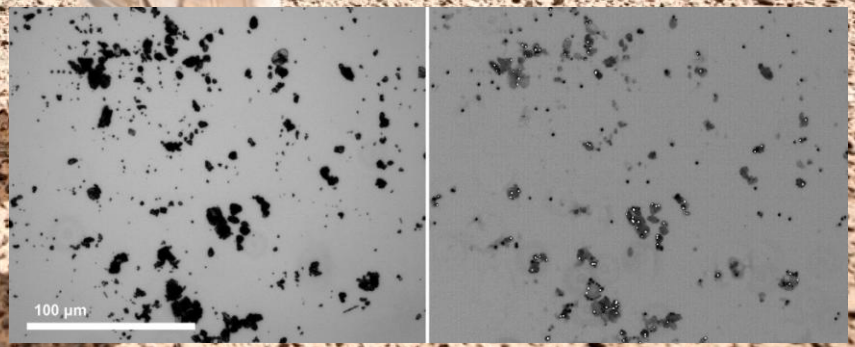
*Haeuplik, S., et al. (2014) MASH – **Deployable and potable emergency shelter for Mars**, 19th IAA Humans in Space Symposium, Cologne, Germany*

microEVA

(NASA/JPL-OeWF)

Quantifying contamination vectors for planetary protection

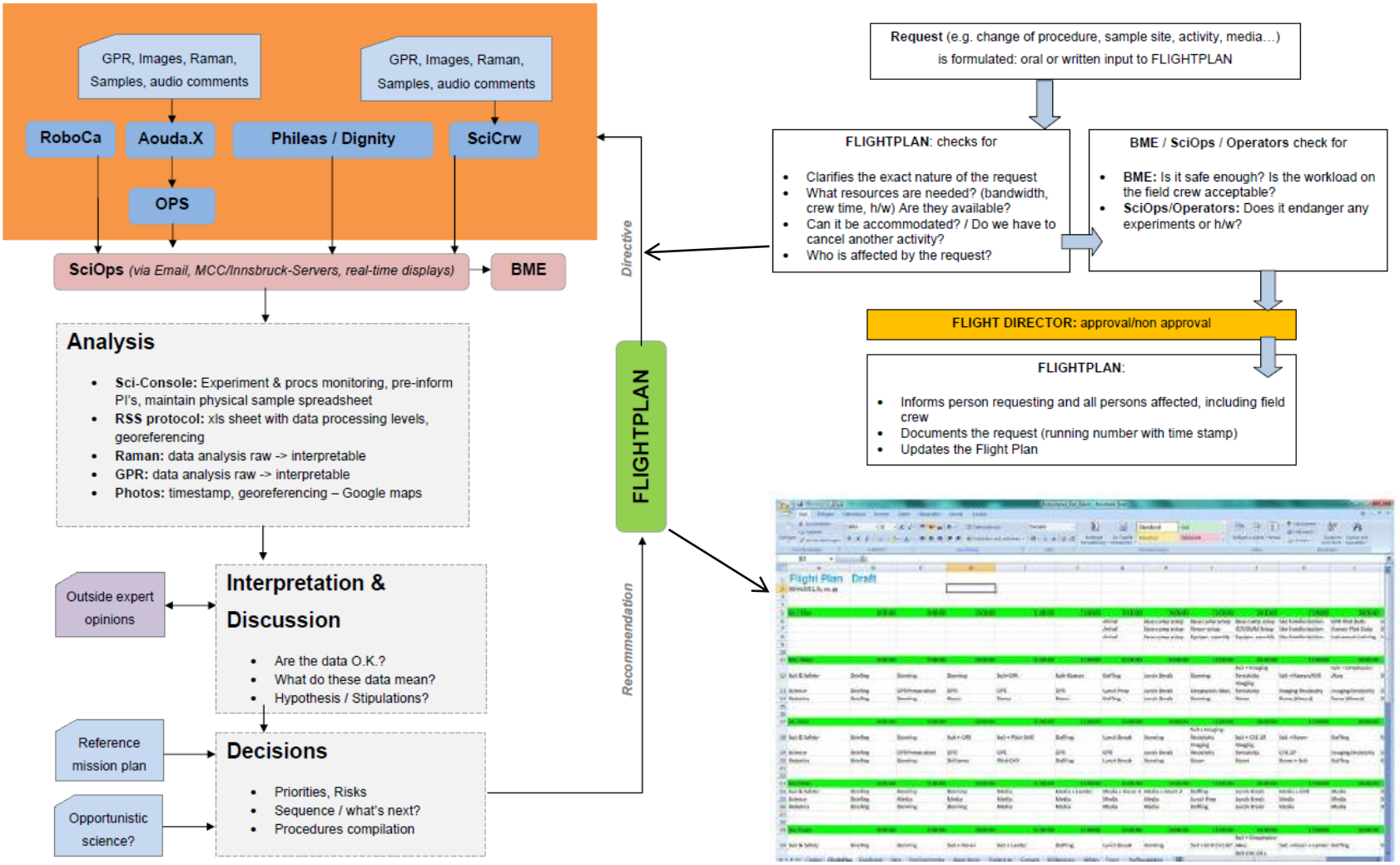
*G. Groemer, et al. (2012) "**The Aoud**
Suit Simulator and Its Applications t
Astrobiology", ASTROBIOLOGY, 12:2*

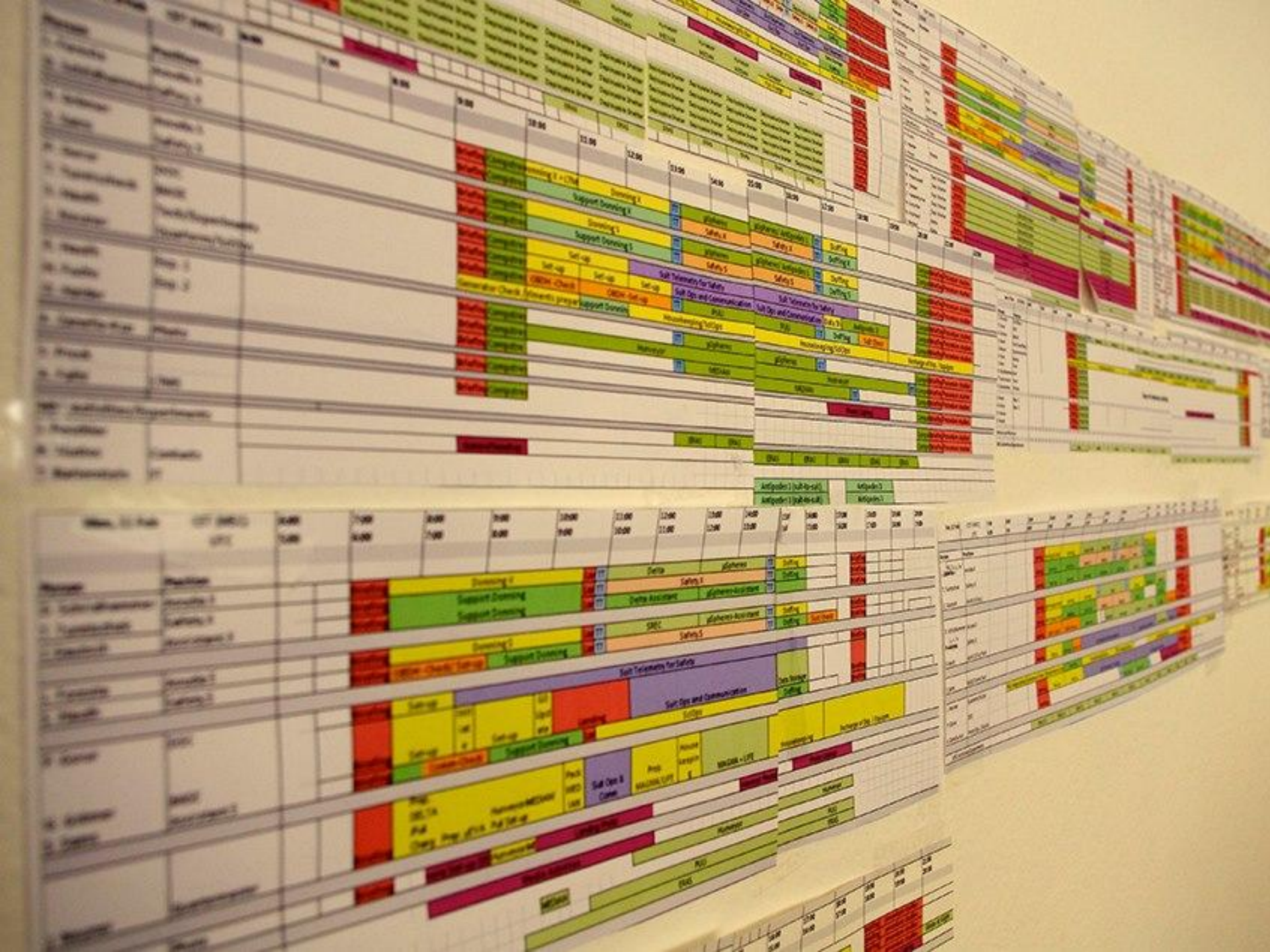


Epiflourescence pattern with contaminated surface under excitation.


Aus Liebe zum Menschen.
ÖSTERREICHISCHES ROTES KREUZ
AQUAX
Österreichisches
Weltraum Forum
www.oewf.org

Mission Support

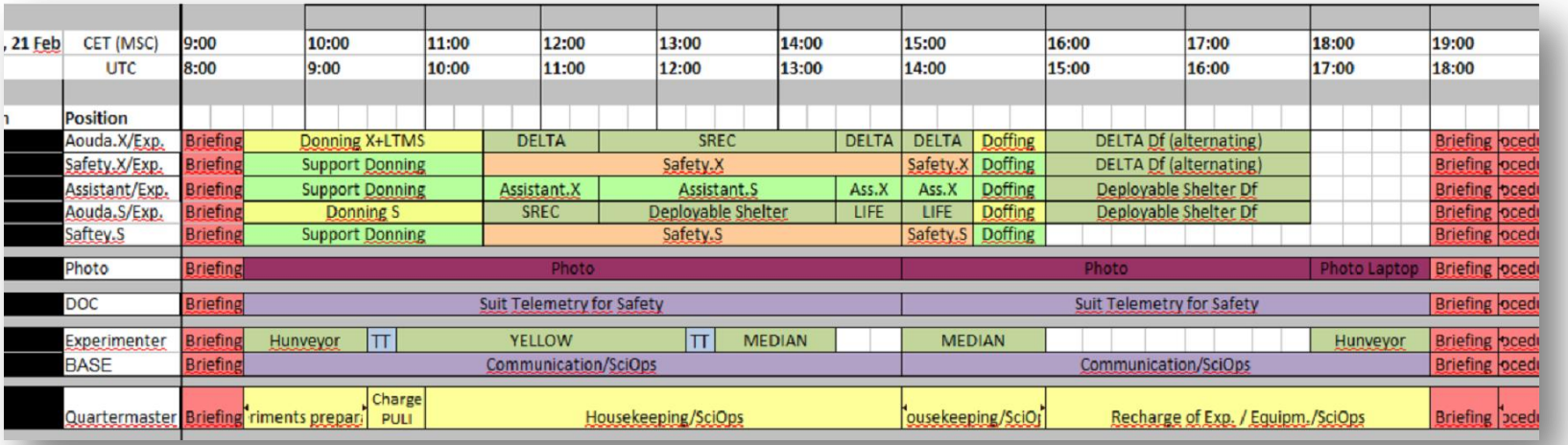





EARTHCOM
FD-A
PROCEDURES


Flight Control
Science
CapCom
Flight Director
MARS2013
Mission Support Center


Flightplan



, 21 Feb	CET (MSC)	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00
	UTC	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00
n	Position											
	Aouda.X/Exp.	Briefing	Donning X+LTMS		DELTA	SREC	DELTA	DELTA	Doffing	DELTA Df (alternating)		Briefing ocedu
	Safety.X/Exp.	Briefing	Support Donning		Safety.X			Safety.X	Doffing	DELTA Df (alternating)		Briefing ocedu
	Assistant/Exp.	Briefing	Support Donning		Assistant.X	Assistant.S	Ass.X	Ass.X	Doffing	Deployable Shelter Df		Briefing ocedu
	Aouda.S/Exp.	Briefing	Donning S		SREC	Deployable Shelter	LIFE	LIFE	Doffing	Deployable Shelter Df		Briefing ocedu
	Saftey.S	Briefing	Support Donning		Safety.S			Safety.S	Doffing			Briefing ocedu
	Photo	Briefing	Photo					Photo			Photo Laptop	Briefing ocedu
	DOC	Briefing	Suit Telemetry for Safety					Suit Telemetry for Safety				Briefing ocedu
	Experimenter	Briefing	Hunveyor	TT	YELLOW	TT	MEDIAN	MEDIAN			Hunveyor	Briefing ocedu
	BASE	Briefing	Communication/SciOps					Communication/SciOps				Briefing ocedu
	Quartermaster	Briefing	riments prepar	Charge PULI	Housekeeping/SciOps			ousekeeping/SciO	Recharge of Exp. / Equipm./SciOps			Briefing ocedu

Daily Activity Package for DAY "12" (12/08/2015)

Daily Activity Package (DAP) for

12 Aug 2015

Developed by:	Date of Development:
Nina Sejkora	11 Aug 2015
Silvio de Carvalho	VERSION
Claudia Rieger	
Peter Hartman	#4
Helgel Tuschy	
Marcello Valdatta	
Approved by:	**Date of Approval:**

The DAP provides a "best-fit" suggestion for field activities and traverses based on most recent data. The DAP does not constitute a command order nor claims to be irreproachable. Therefore use your autonomy and decide ad-hoc on changes or delays.

If you take decisions other than suggested in the DAP, please report these back to MSC for information. Consider transporting non-suited experiments when on the way to suit activities.

Hettrich, S. et al. (2013), "Efficiency Analysis of the MARS2013 Planning Strategy", Astrobiology 14:5

Sans Fuentes, S.A. (2012) "Human-robotic Mars science operations: target selection optimization via traverse and science planning". MSc thesis, University of Innsbruck, Innsbruck, Austria.

RSS mandate

Supporting the development of hardware and procedures

Analog astronaut science training

(Orgel, C. et al. (2013) Geological trainings for analogue astronauts: Lessons learned from the MARS2013 expedition, Morocco, EPSC conf proc)

Near-real time data analysis

Post-mission data analysis

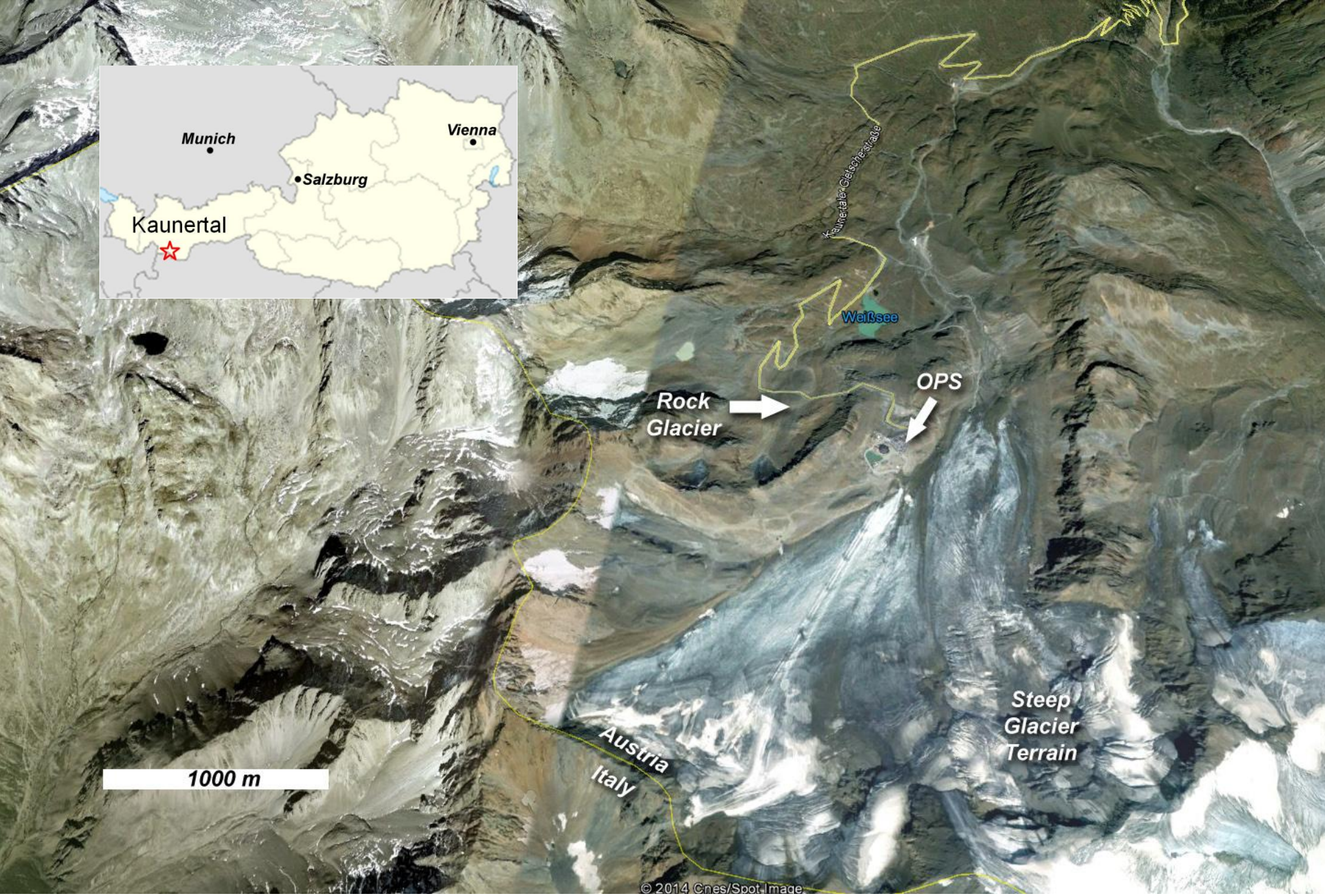
Multi-mission science roadmaps

Mission rational

- Mission operations on planetary surfaces is different from e.g. ISS operations and needs new concepts (time-delay, long duration autonomy,…)
- OeWF and its partners have identified “doable niches”, where a significant contribution can be made → (almost) open-source body-of-knowledge on human Mars mission operations

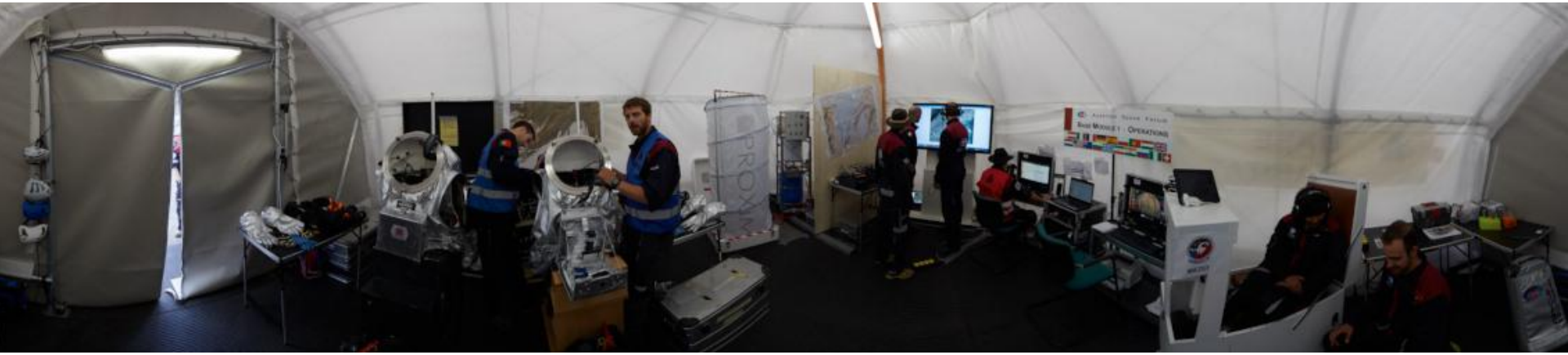
Mission objectives

- **Investigate** the limitations and opportunities of studying a Martian (rock) glacier
- **Test** mission support strategies, decision making workflows and near-real time data analysis for flight planning.
- **Serve** as a high-visibility showcasing of analog field research



Base station coordinates: N 46.86320, E 10.71401


BASE
HABITAT 1

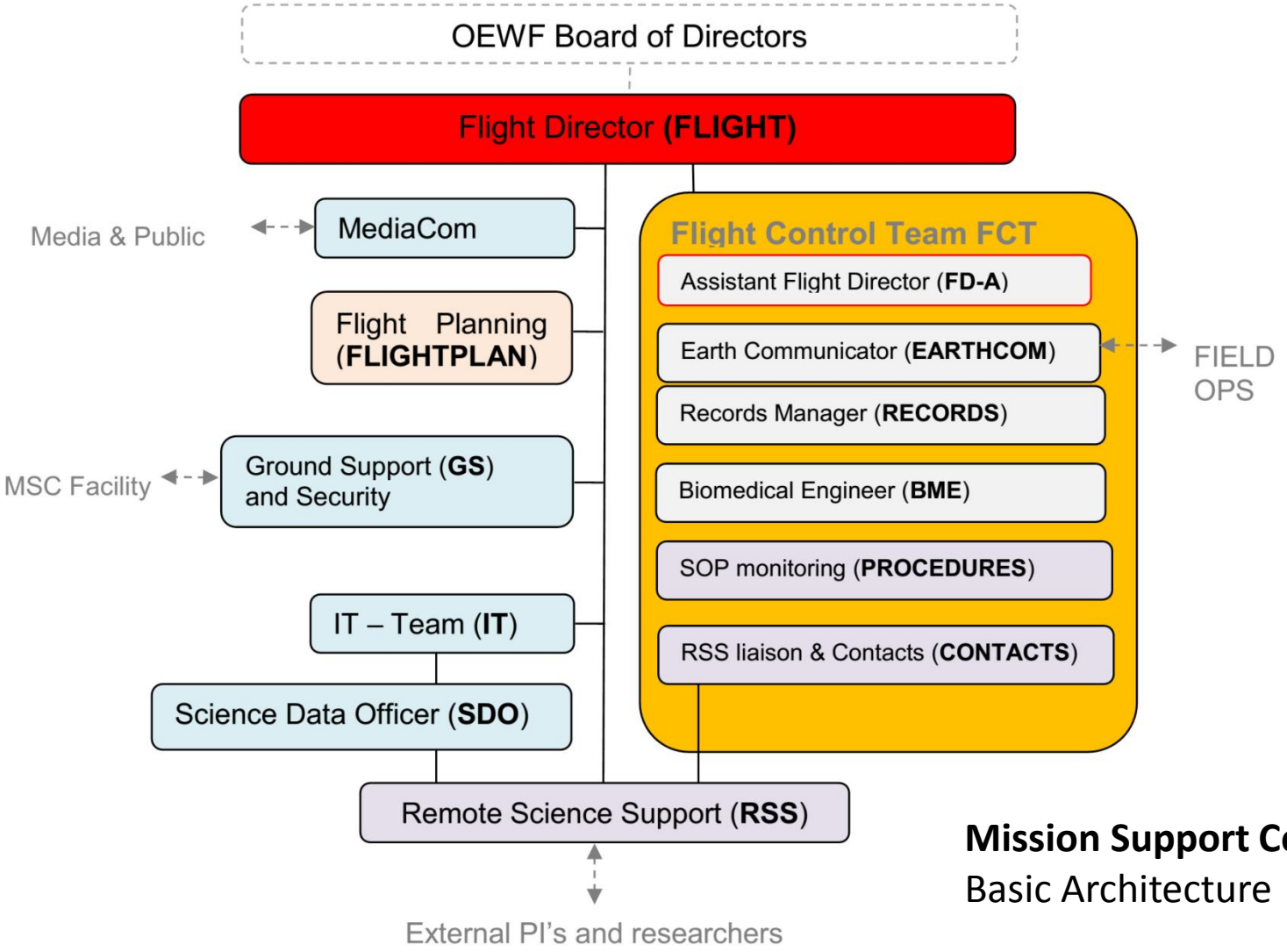



GSSI
GSSI

Mission Support Center Innsbruck/Austria

+ Support Rooms (Flight Planning, Ground Support, IT/Science Archive, Rem. Sci. Support)

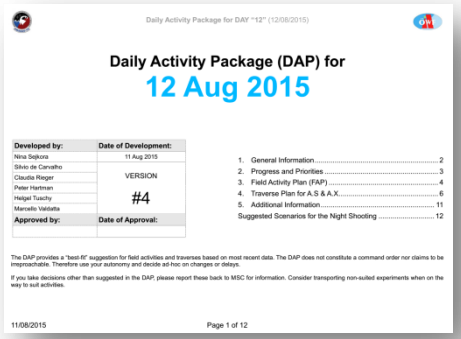
+ ext. Rover control room(Budapest/Hungary)



Mission Support Center
Basic Architecture

→ Virtual & MSC site training
→ Dress rehearsal
→ Certification & Recertification

Procedural Hierarchy



Daily Activity Package for DAY "12" (12/08/2015)

Daily Activity Package (DAP) for
12 Aug 2015

Developed by:	Date of Development:
Nina Sejkora	11 Aug 2015
Silvio de Carvalho	
Claudia Rieger	VERSION
Peter Hartman	#4
Helgal Tuschy	
Marcello Valdatta	
Approved by:	**Date of Approval:**

1. General Information 2
2. Progress and Priorities 3
3. Field Activity Plan (FAP) 4
4. Traverse Plan for A.S & A.X 6
5. Additional Information 11

Suggested Scenarios for the Night Shooting 12

The DAP provides a "best-fit" suggestion for field activities and traverses based on most recent data. The DAP does not constitute a command order nor claims to be irreproachable. Therefore use your autonomy and decide ad-hoc on changes or delays.

If you take decisions other than suggested in the DAP, please report these back to MSC for information. Consider transporting non-suited experiments when on the way to suit activities.

11/08/2015 Page 1 of 12

What to do when

Austrian Space Forum

MARS MISSION SIMULATION ANALOGUE GEARED AMADEE-15

Standard Operating Procedures

CONFIDENTIAL

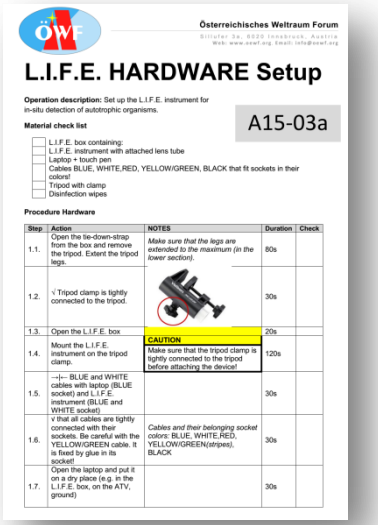
Not to be distributed or used without permission.

Mission	AMADEE-15
Tracking Number	P10_013B, **RELEASE 1**
Version / Date	V2.1 / 2nd of August 2015
Book captain	Clemens Plank

Strictly for project internal usage only.
Not for Media, not for public distribution.

1

Who is responsible



Österreichisches Weltraum Forum

L.I.F.E. HARDWARE Setup

A15-03a

Operation description: Set up the L.I.F.E. instrument for in-situ detection of autotrophic organisms.

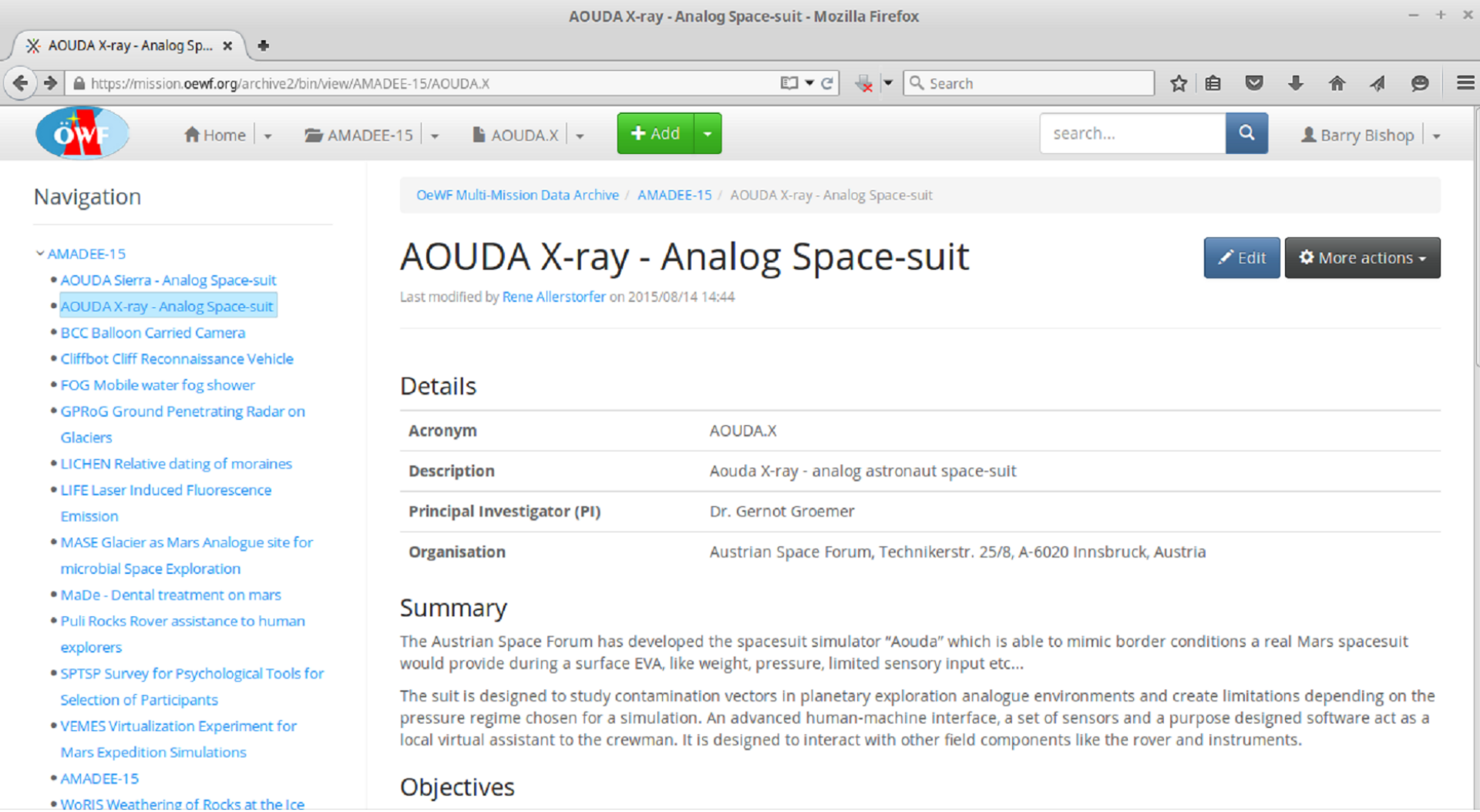
Material check list

- L.I.F.E. box containing:
- L.I.F.E. instrument with attached lens tube
- Laptop + touch pen
- Cables BLUE, WHITE,RED, YELLOW/GREEN, BLACK that fit sockets in their colors!
- Tripod with clamp
- Disinfection wipes

Procedure Hardware

Step	Action	NOTES	Duration	Check
1.1.	Open the tie-down-strap from the box and remove the tripod. Extent the tripod legs.	*Make sure that the legs are extended to the maximum (in the lower section).*	80s	
1.2.	√ Tripod clamp is tightly connected to the tripod.		30s	
1.3.	Open the L.I.F.E. box		20s	
1.4.	Mount the L.I.F.E. instrument on the tripod clamp.	**CAUTION** Make sure that the tripod clamp is tightly connected to the tripod before attaching the device!	120s	
1.5.	→|← BLUE and WHITE cables with laptop (BLUE socket) and L.I.F.E. instrument (BLUE and WHITE socket)		30s	
1.6.	√ that all cables are tightly connected with their sockets. Be careful with the YELLOW/GREEN cable. It is fixed by glue in its socket!	*Cables and their belonging socket colors:* BLUE, WHITE,RED, YELLOW/GREEN(stripes), BLACK	30s	
1.7.	Open the laptop and put it on a dry place (e.g. in the L.I.F.E. box, on the ATV, ground)		30s	

How to do it



Aouda.X page from the multi-mission data archive

https://mission.oewf.org/archive

Experiments

- **Surveillance / Recon**
  - Cliffbot / Aerostat
  - PULI ROCKS: GLXP rover terrain tests
  - Ground Penetrating Radar

- **Astrobiology**
  - L.I.F.E.: Biomarker fluourescence instrument
  - Glacier-MASE: glacial extremophile inventory
  - WORIS: Lichenometry
  - Morraine Dating

- **Human Factors & Operations**
  - VEMES Pilot-A: Virtual & Blended reality tests
  - FOG: aerosol shower for low water usage
  - Aouda Suit monitoring
  - Dental procedures: 3d manufacturing


XPRIZE

VERAS/VEMES PILOT-A Study


Aldebran
Virtual Space Systems


PROXIM


PROXIM

glacierMASE - extremophile inventory (EU/FP7 project)

Next Challenges…

- Suit development
- flight controller certifications for MSC & more standardized workflows
- Analog missions in 2016/2017

What we are looking for…

- Geoscientists with field experience
- Georadar / Sounding instruments
- Guest researchers & Interns & Students

Austrian Space Forum
Gernot Groemer
gernot.groemer@oewf.org