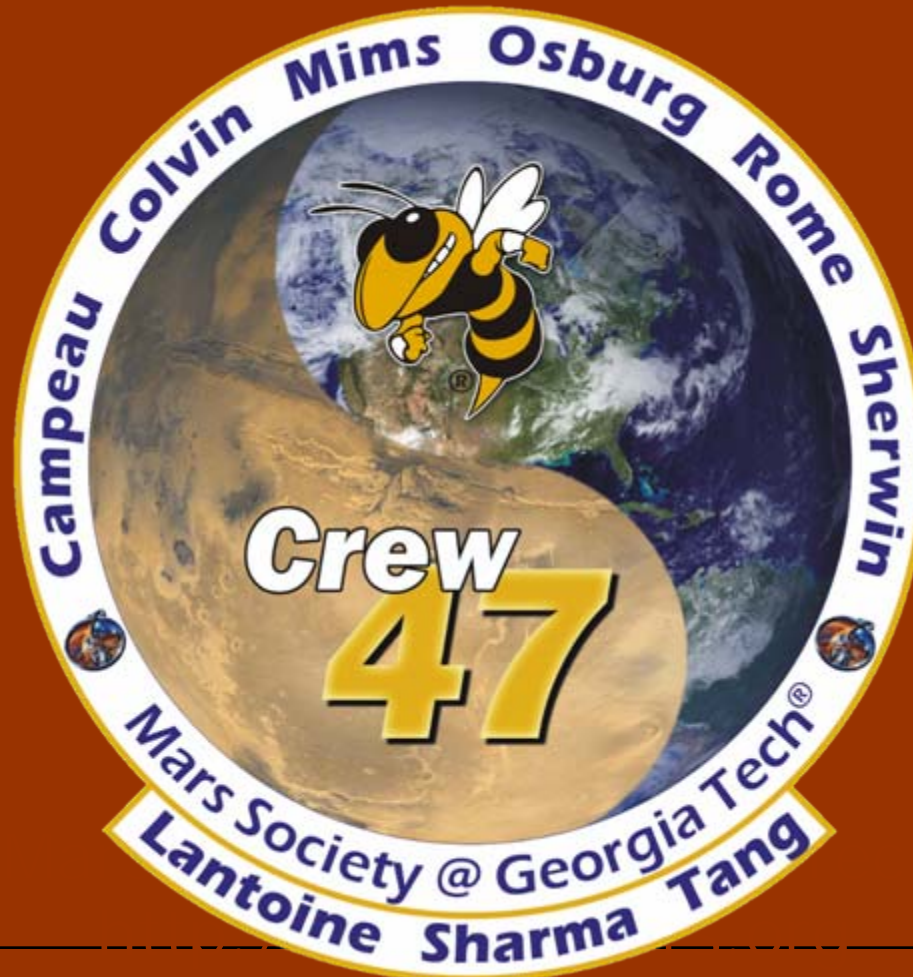


Simulating Mars on Earth: Georgia Tech's Crew 47 at the Mars Desert Research Station



Outline

→ On to Mars

- ✧ Why?
- ✧ How?
- ✧ The Mars Society's analog stations program

→ Crew 47 - The 2006 Georgia Tech Expedition to MDRS

- ✧ Meet the Crew
- ✧ Training
- ✧ Mission Timeline

→ Research

→ Engineering

→ Outreach

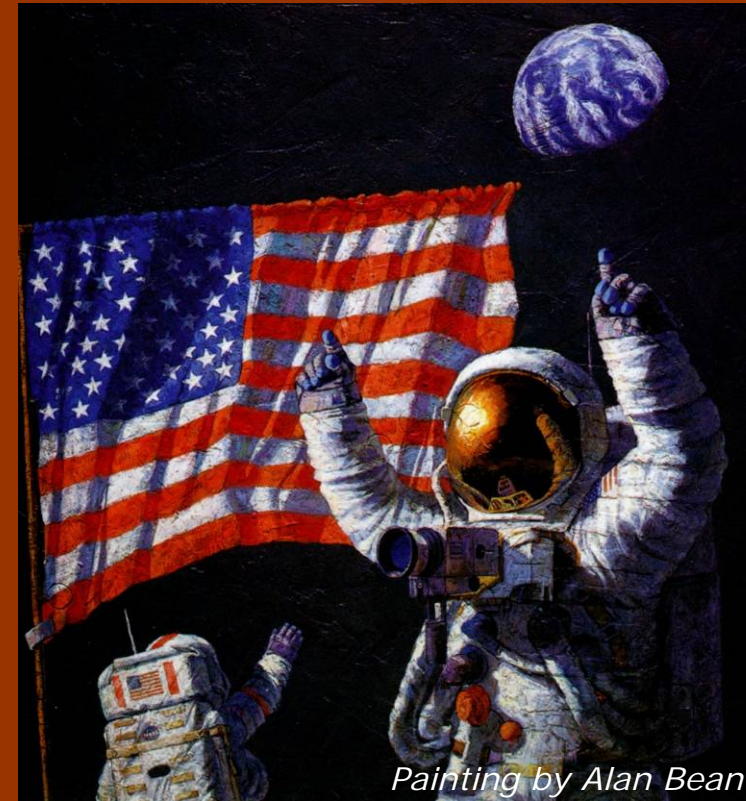


<http://www.solarviews.com/cap/mars/vmars3.htm>



Why Send Humans to Mars?

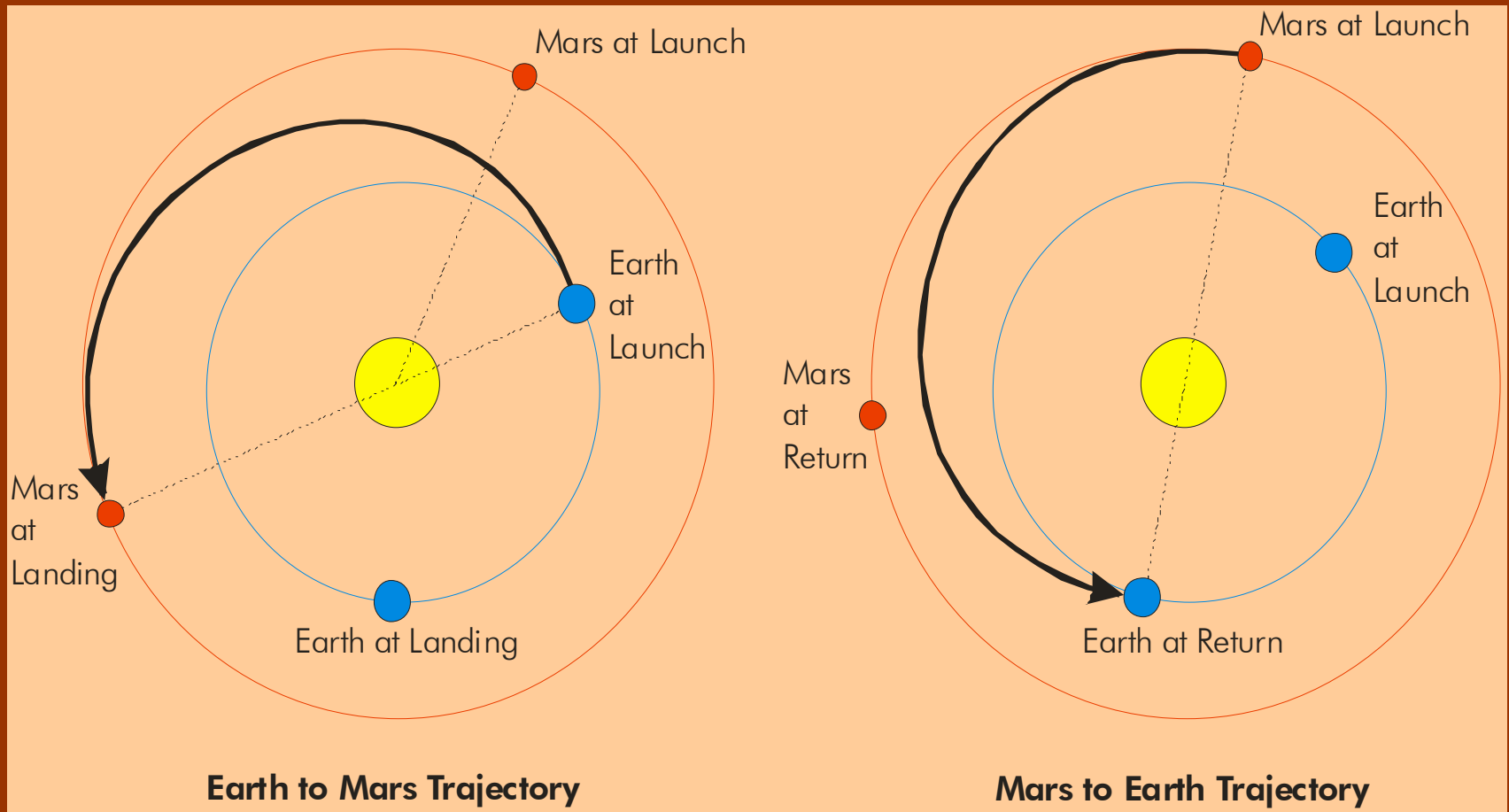
- ➔ To find out more about Mars, leading to a better understanding of
 - ✧ The origins of life
 - ✧ Earth's ecosystem and how to protect it
- ➔ To open up a "new frontier" for human civilization
 - ✧ Presenting opportunities and challenges
 - ✧ Providing a worthy objective for the best and brightest
 - ✧ Advancing culture and technology
 - ✧ Inspiring the human spirit
 - ✧ Following the Imperative of Life



Painting by Alan Bean



How to Send Humans to Mars



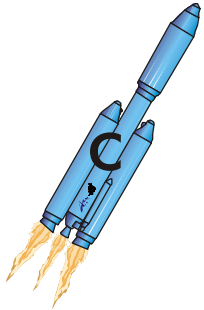
Earth to Mars Trajectory

Mars to Earth Trajectory



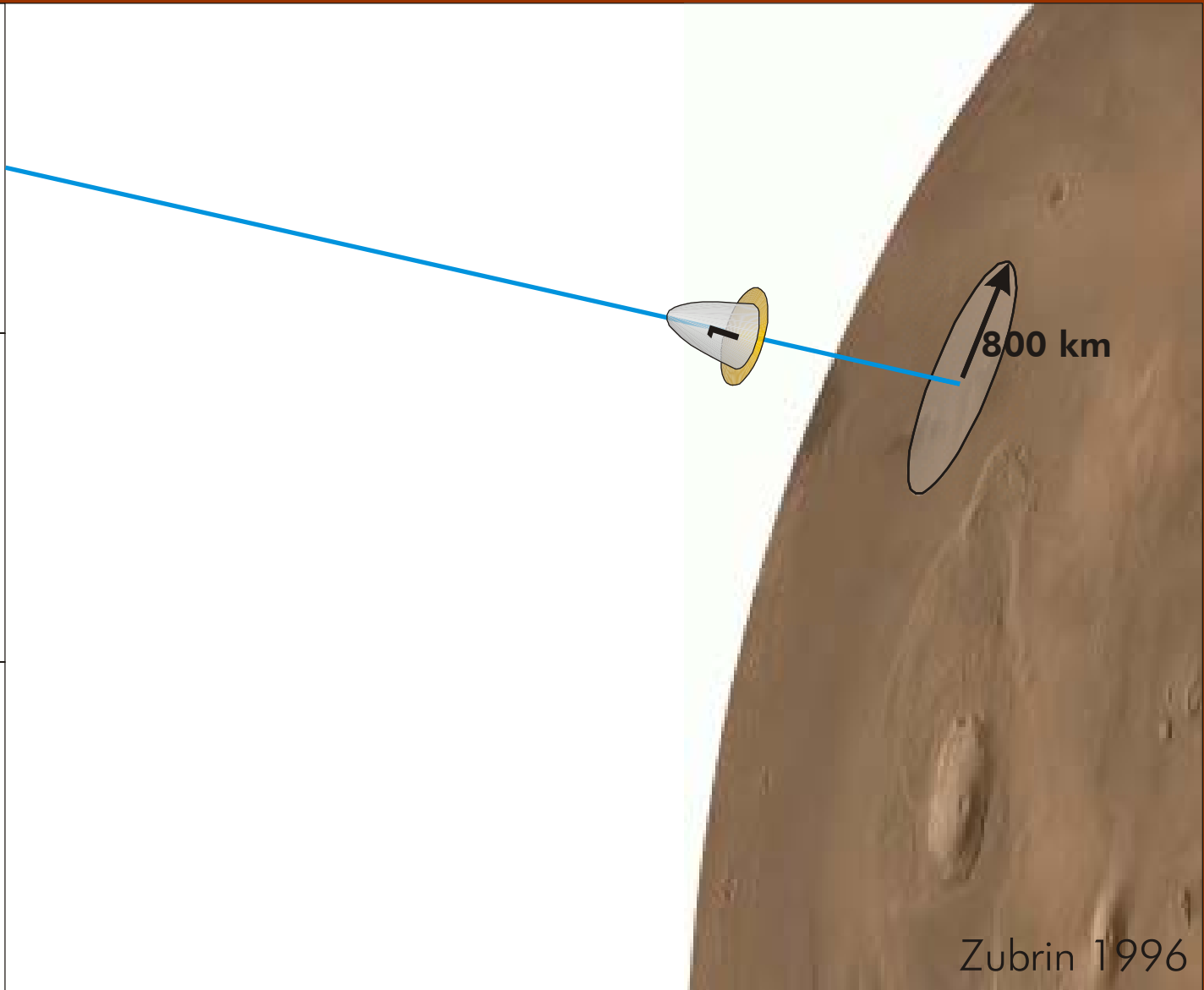
Mars Direct Mission Sequence 1

Year 1



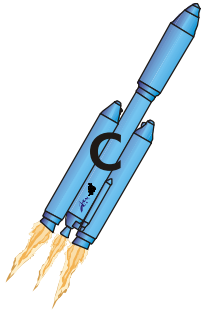
Year 3

Year 5

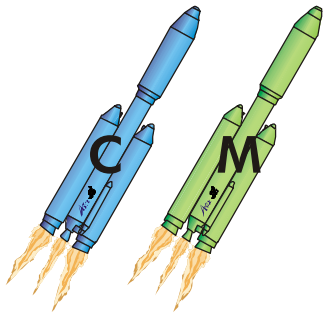


Mars Direct Mission Sequence 2

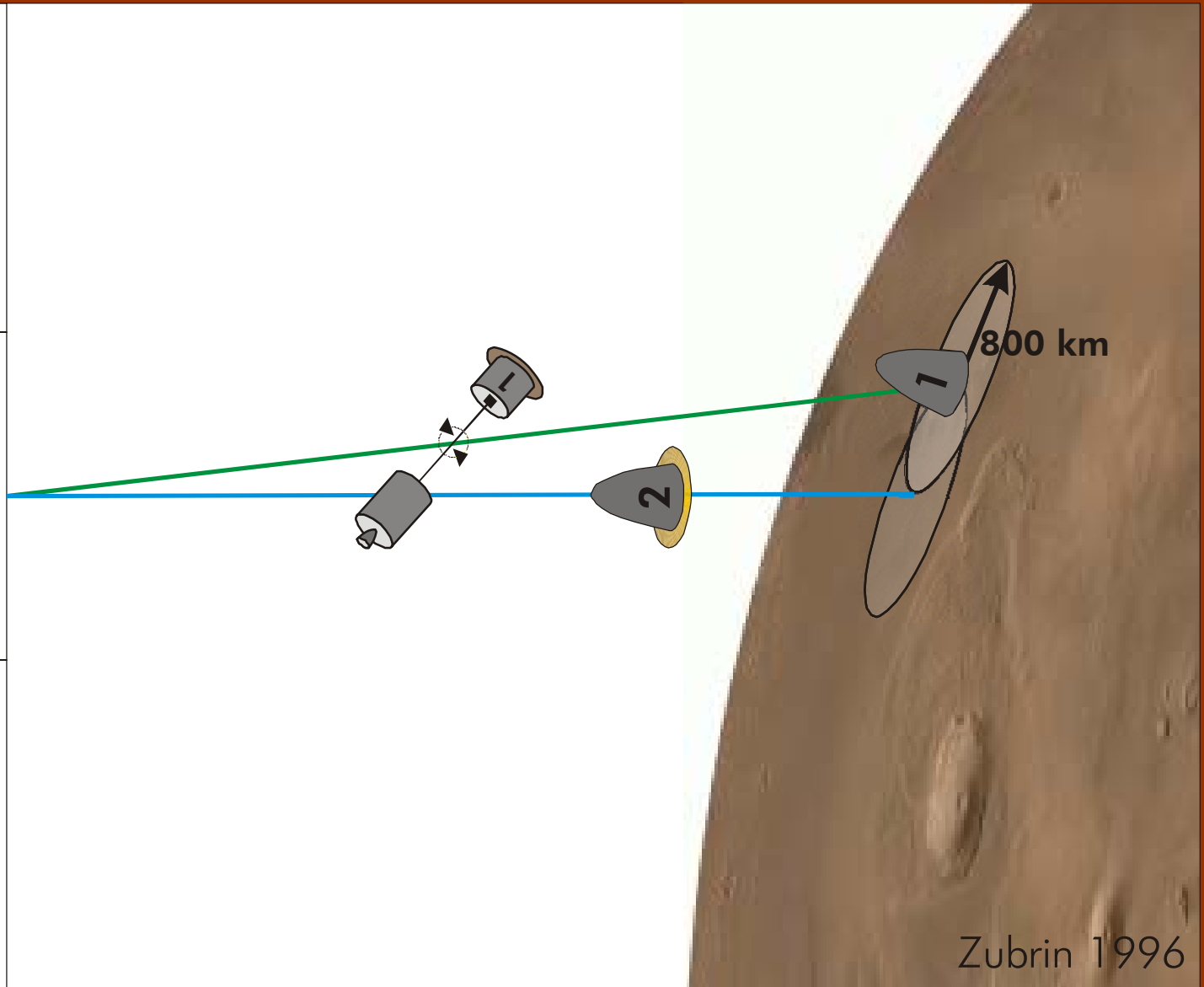
Year 1



Year 3



Year 5

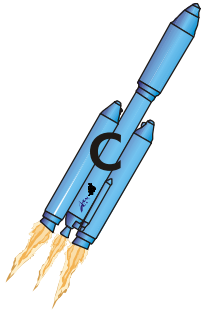


Zubrin 1996

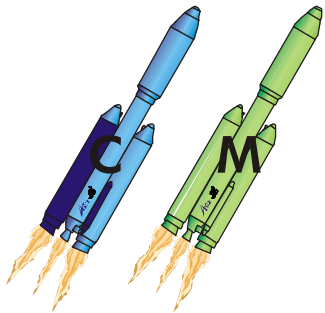


Mars Direct Mission Sequence 3

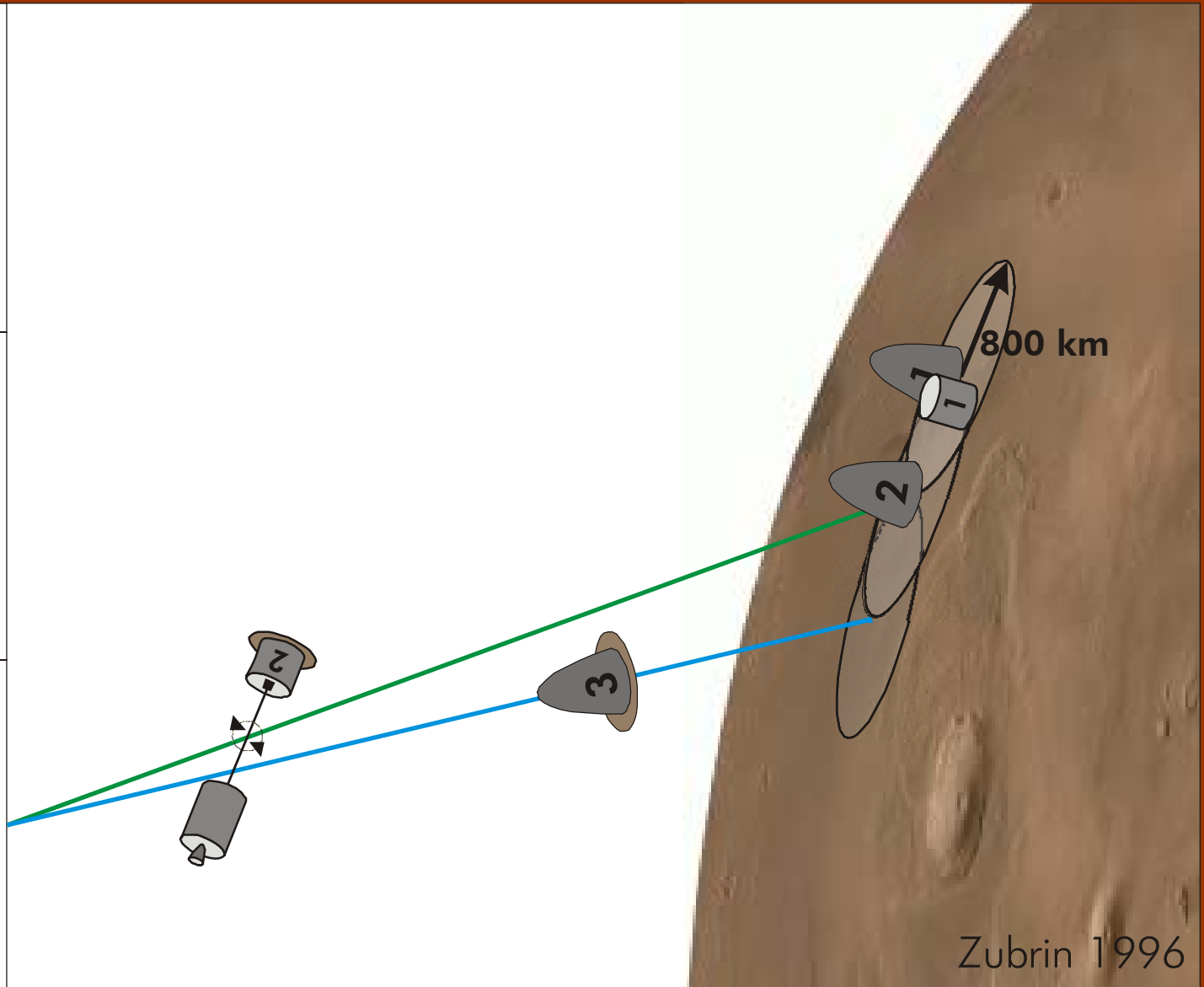
Year 1



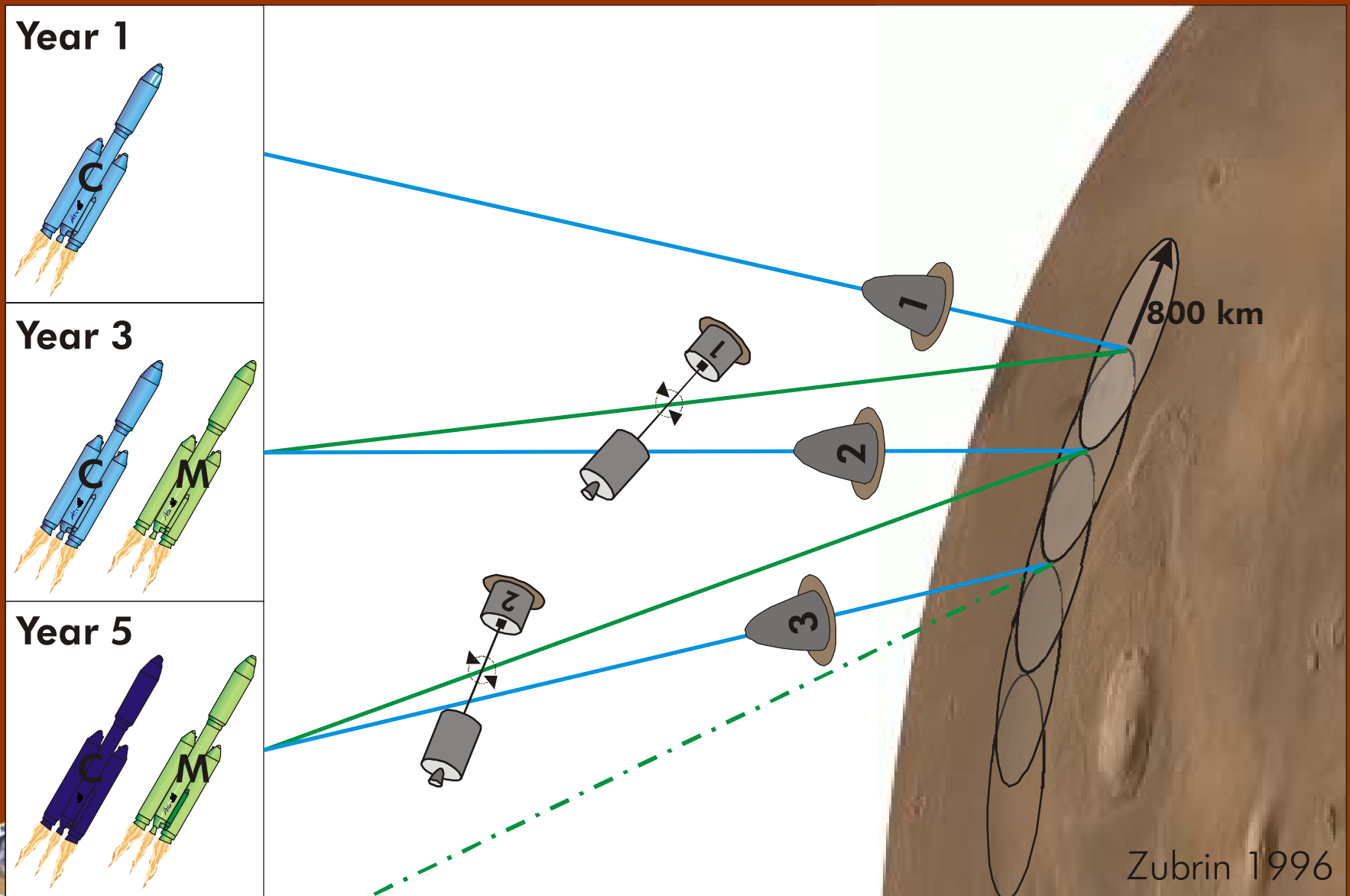
Year 3



Year 5



Mars Direct Mission Overview



First Human Base on Mars, 2025 (?)

Habitation Module

Earth Return Vehicle

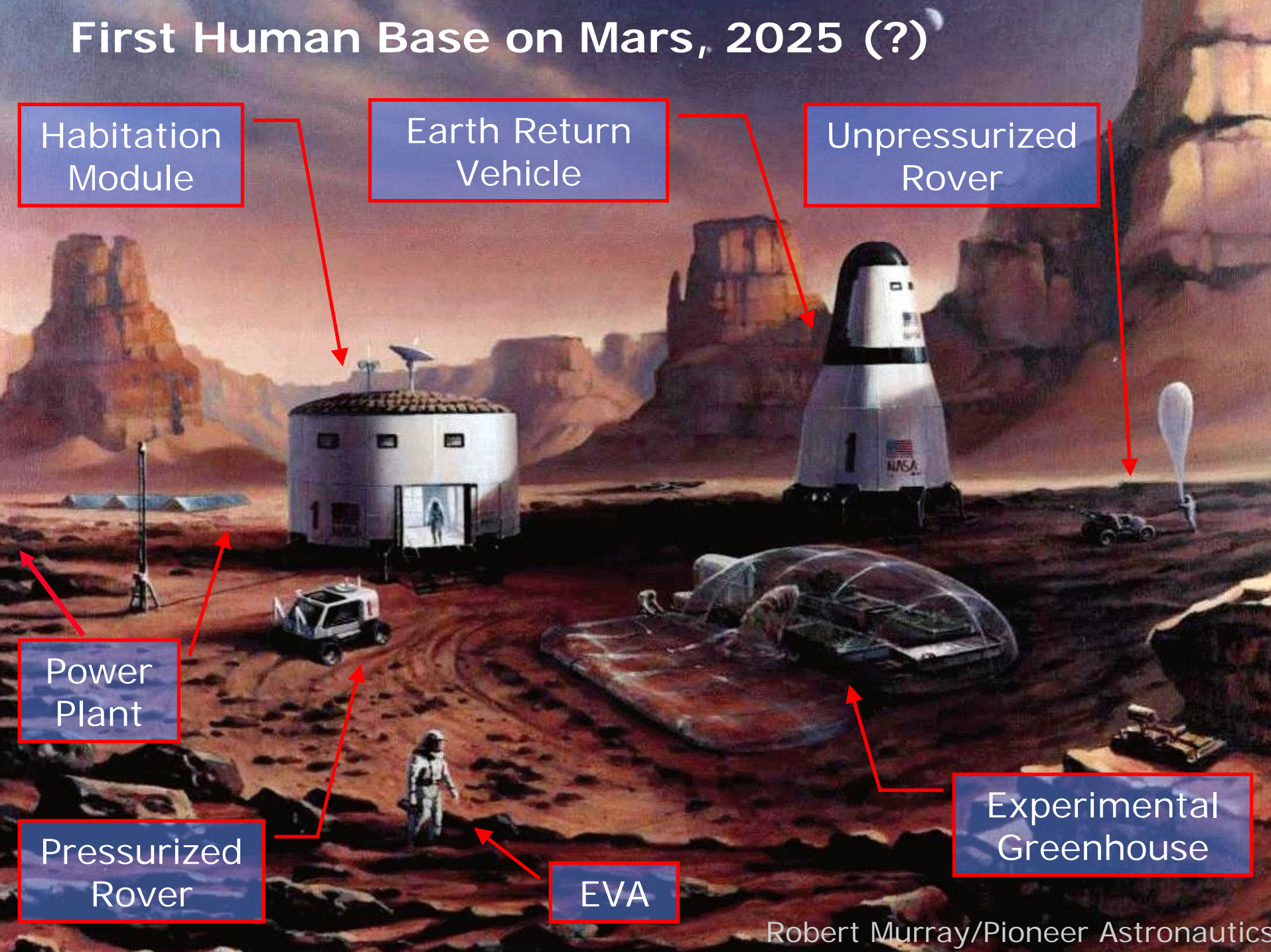
Unpressurized Rover

Power Plant

Pressurized Rover

EVA

Experimental Greenhouse



Mars Analog Stations Program Overview

- ➔ The Mars Society is an international organization of engineers, scientists, artists and others interested in promoting the manned exploration and settlement of Mars
- ➔ It has started building and operating a number of Mars-analog stations in remote environments:
 - ✧ Flashline Mars Arctic Research Station, FMARS
 - ✧ **Mars Desert Research Station, MDRS**
 - ✧ European Mars Analog Research Station, EuroMARS
- ➔ Crews are volunteers with suitable professional and personal backgrounds

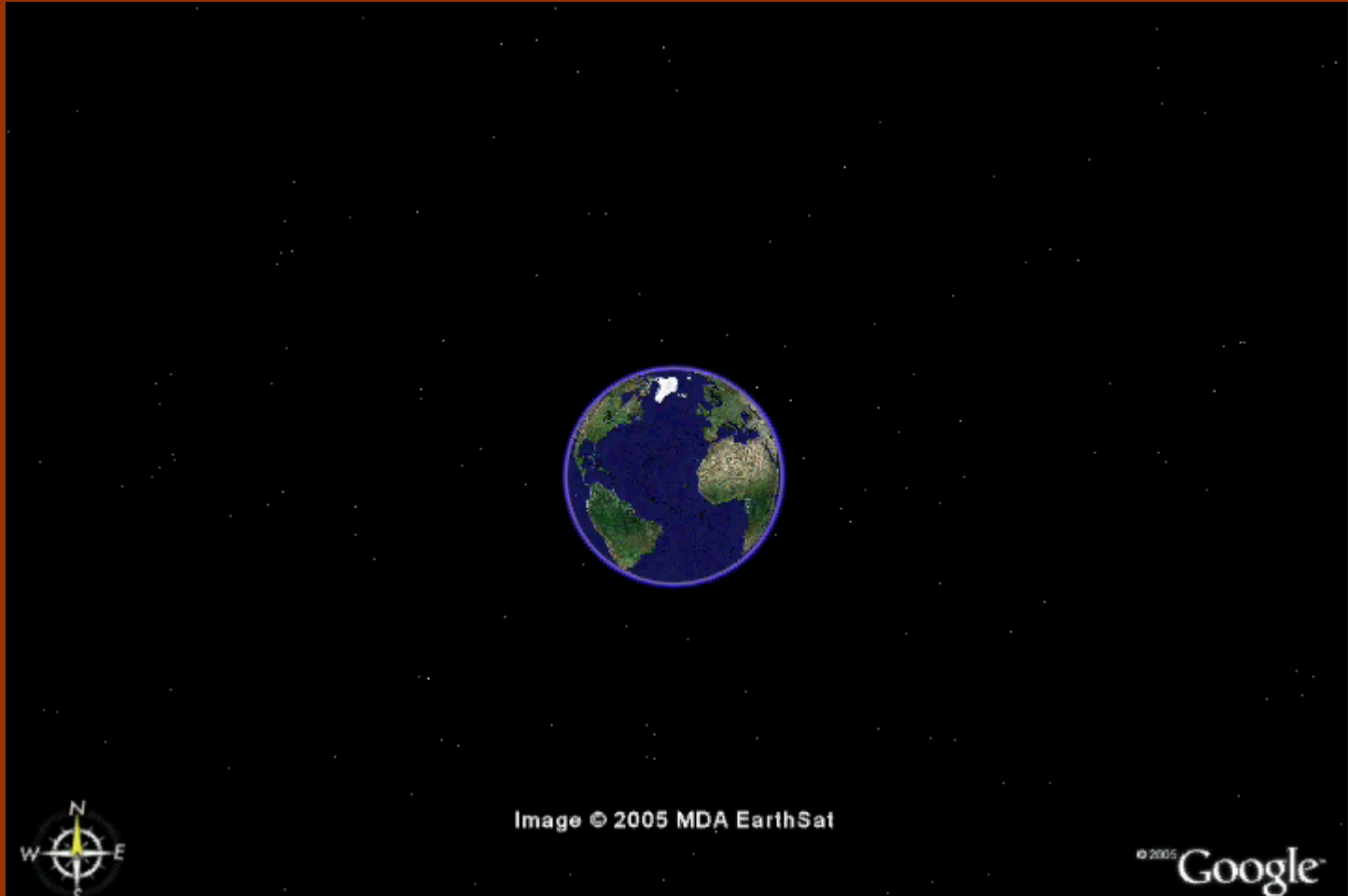


Mars Analog Stations Mission Objectives

- ➔ To develop requirements for the design of the first Mars surface bases:
 - ✧ Habitat layout
 - ✧ Life support systems
 - ✧ Communications technology
 - ✧ Mission support
 - ✧ Operational guidelines
- ➔ To engage in public outreach in support of manned space exploration
- ➔ To provide hands-on exploration experience to scientists, engineers and students



Mars Desert Research Station



Mars Desert Research Station

Observatory

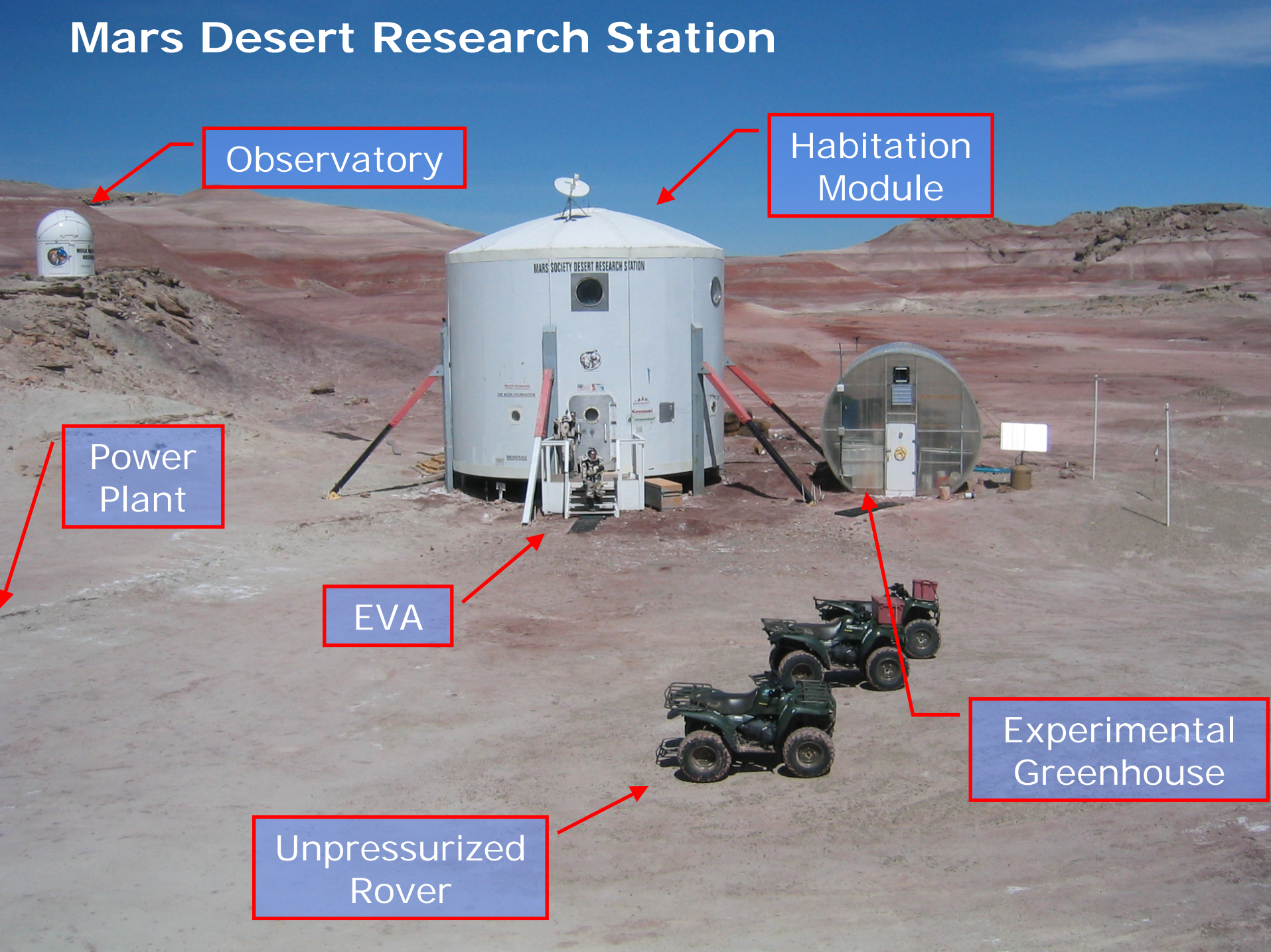
Habitation
Module

Power
Plant

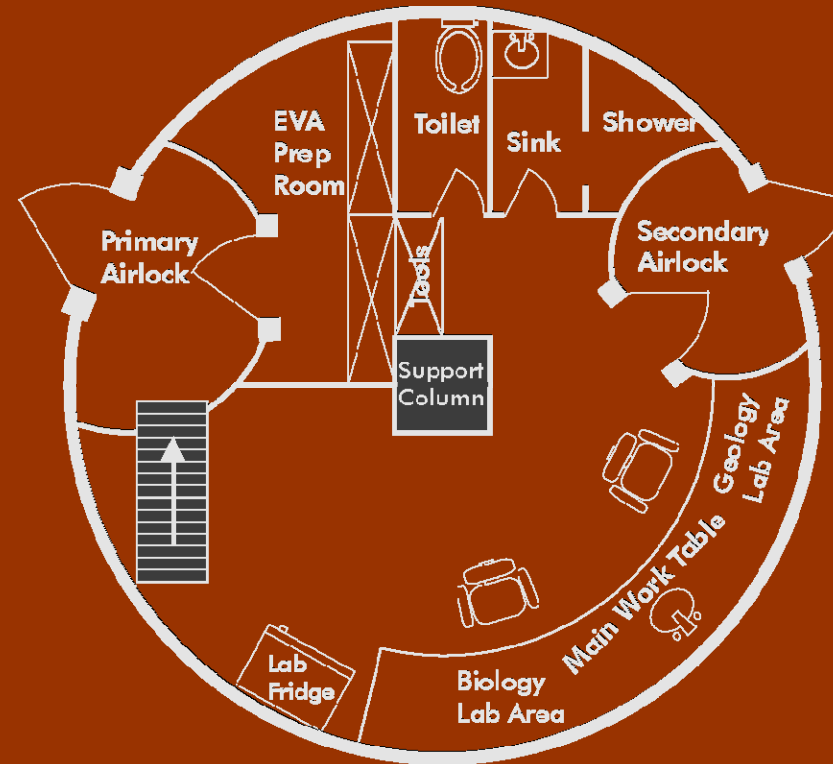
EVA

Unpressurized
Rover

Experimental
Greenhouse



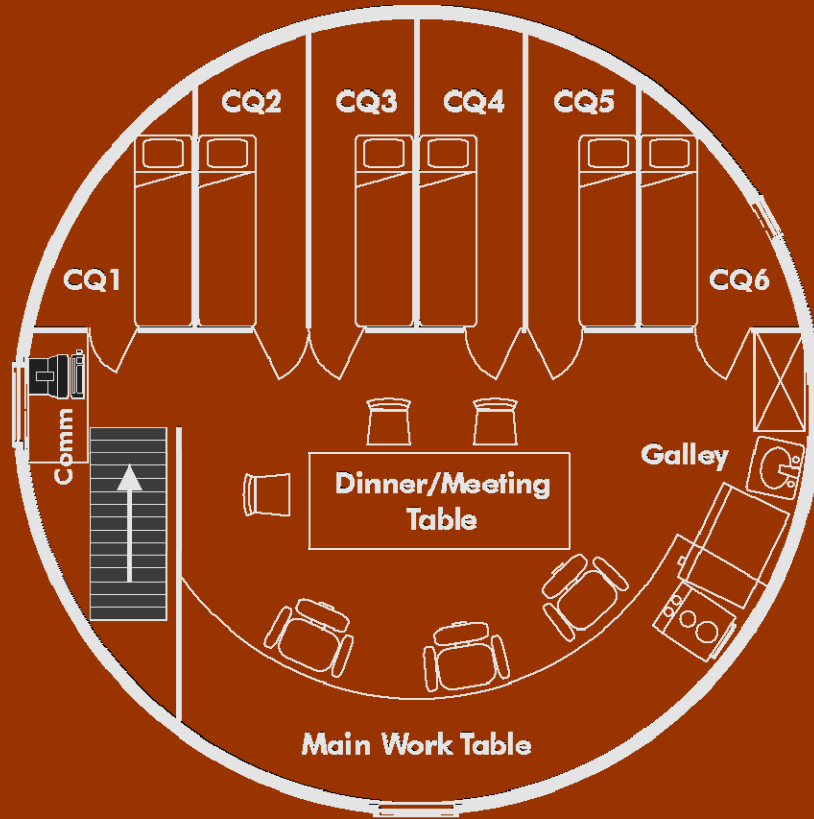
Floor Plan: Lower Deck



Scale (approximate)
0 1m 2m



Floor Plan: Upper Deck



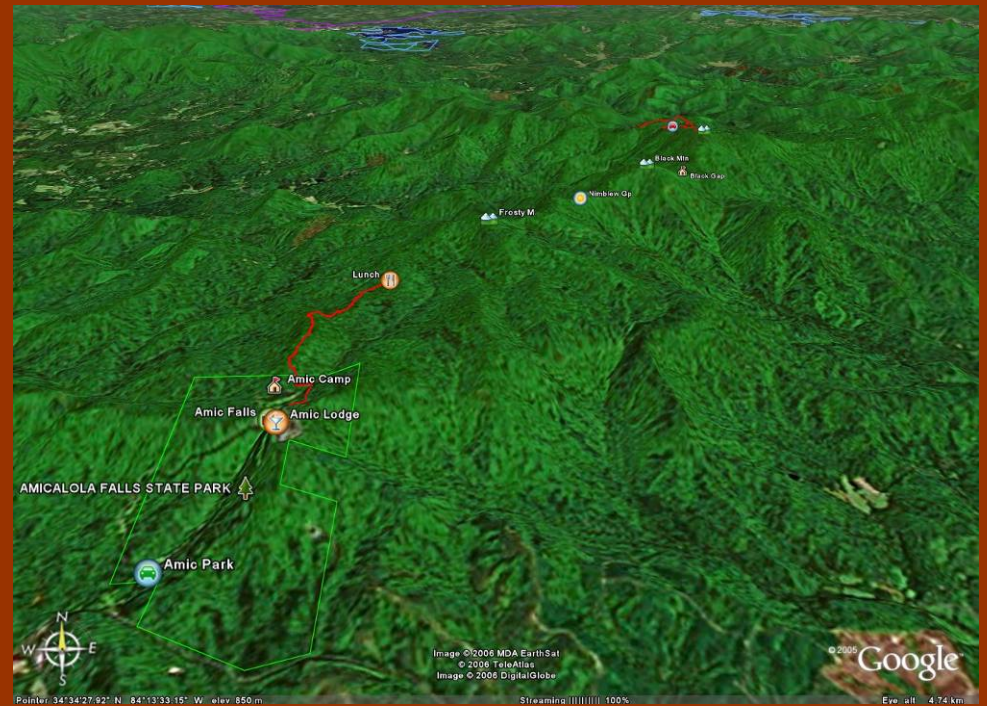
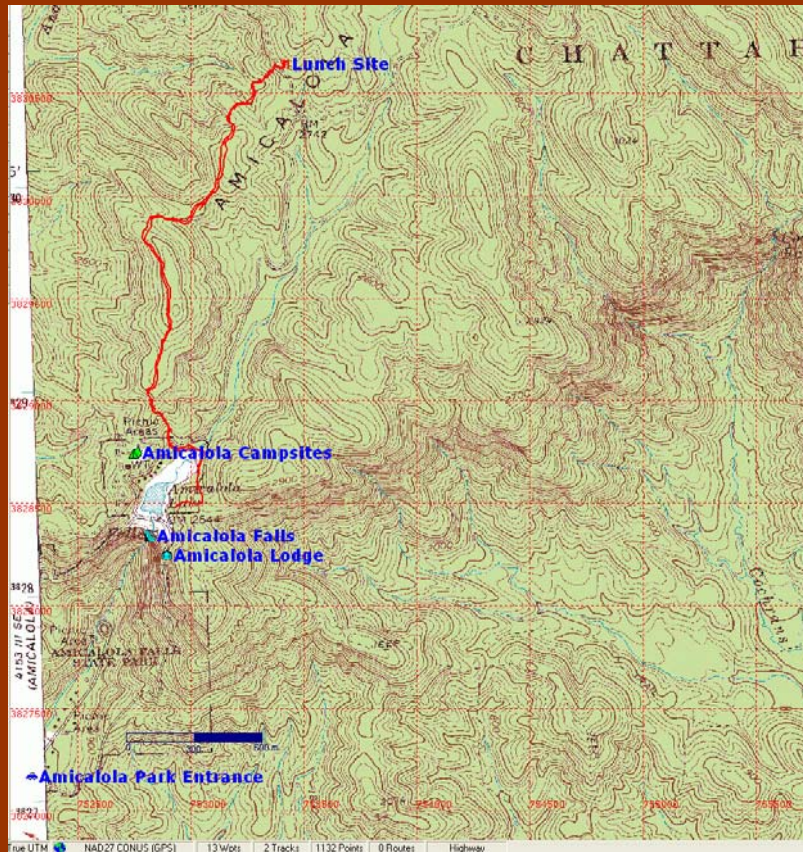
Meet Crew 47



- **Dr. Jan Osburg:** Commander, Radio, Navigation, Human Factors
- **Emily Colvin:** Executive Officer, IT Engineering
- **Anne Campeau:** Station Engineer, Materials and Tools Research
- **Meryl Mims:** Biology, Geology, Health and Safety Officer
- **Jennifer Rome:** Astronomy, Logistics
- **Jason Sherwin:** Radiation Research, Public Affairs Officer
- **Elizabeth Tang:** Mission Support Lead, Outreach
- **Gregory Lantoine:** Mission Support, Mars In-Situ Construction
- **Jonathan Sharma:** Mission Support



Training Hike, January 2006



Hiking Track Visualization in Google Earth

Hiking Track Visualization in GPS TrackMaker



Daily Life at MDRS

→ Typical daily schedule:

- ✧ 08:00h: wake/wash/breakfast
- ✧ 09:30h: start of IVA work
- ✧ 12:30h: lunch
- ✧ 14:00h: EVA (3 crew), continue IVA work (3 crew)
- ✧ 18:00h: report writing
- ✧ 19:00h: dinner
- ✧ 20:00h: continue reports, additional IVA work
- ✧ 22:00h: movie, homework, etc.
- ✧ 00:00h: sleep

→ Chores/housekeeping were rotated:

- ✧ Generator team, 2 crew (daily)
- ✧ Galley operations, 2 crew (daily)
- ✧ General housekeeping, 1 crew (daily)



Crew 47 Mission Objectives

- ➔ Navigation, communication and data transmission research
- ➔ Testing polymer fiber materials and tools
- ➔ Developing construction techniques based on in-situ resources utilization
- ➔ Making astronomical observations
- ➔ Testing celestial navigation procedures
- ➔ Characterization of the radiation field around the station
- ➔ Human Factors research
- ➔ Biological research
- ➔ Monitoring the station's power consumption
- ➔ Providing general engineering upgrades
- ➔ Outreach activities
 - ✧ High school involvement
 - ✧ Newspaper, TV and web reports



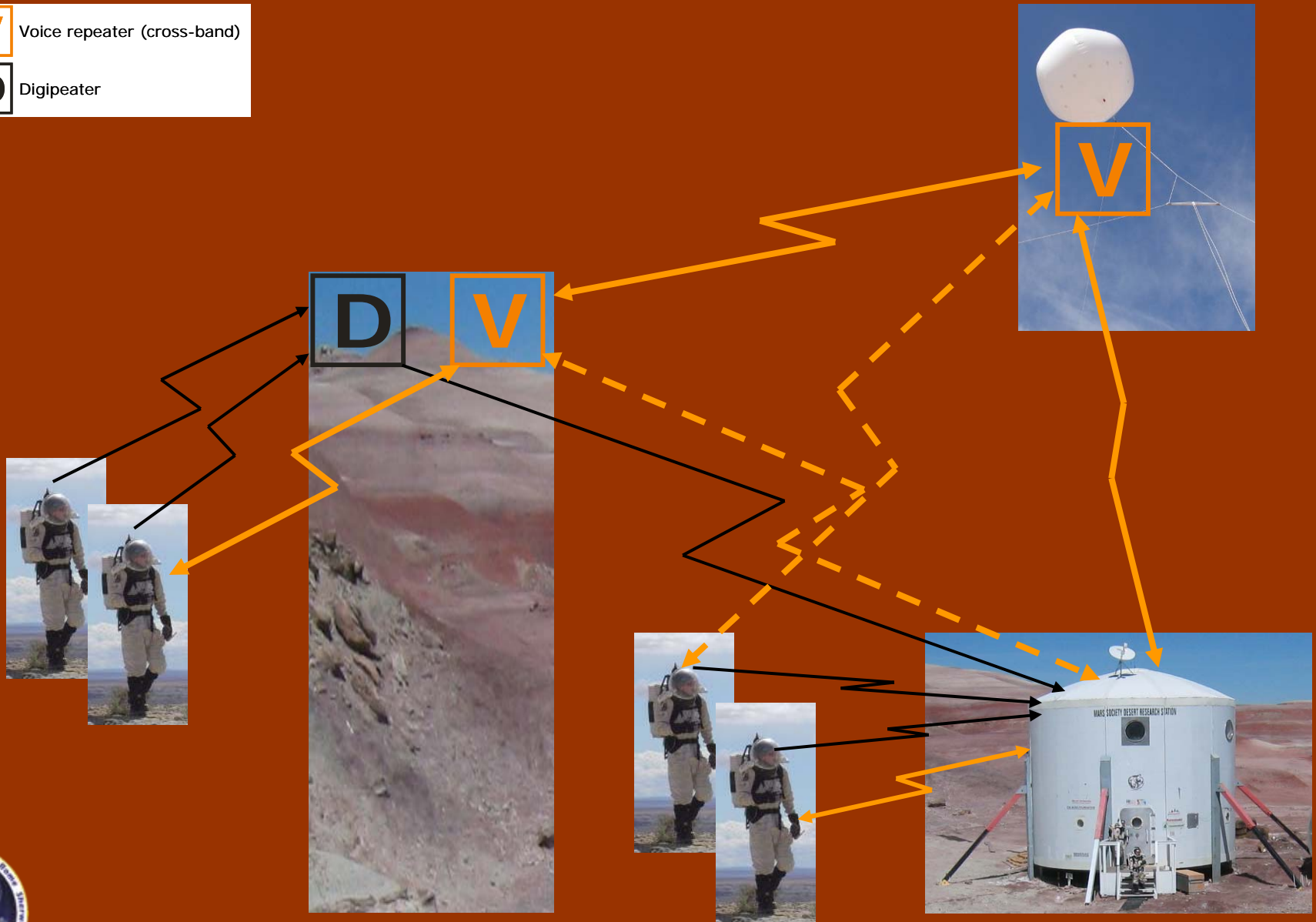
Crew 47 Navigation/Communication Experiments

- ➔ Based on off-the-shelf amateur radio equipment
- ➔ Features:
 - ✧ Each EVA suit has its own GPS receiver and amateur radio beacon ("Automatic Position Reporting System", APRS)
 - ✧ Voice and APRS repeaters (ground- and balloon-based) expand coverage
 - ✧ Near-real-time position tracking and display of EVA positions on web site
- ➔ Scope:
 - ✧ Evaluate practicality and determine fielding issues
 - ✧ Standardize/document to encourage adaptation by other crews
 - ✧ Characterize RF coverage, determine good repeater locations
 - ✧ Gather additional data for MDRS waypoint/track database

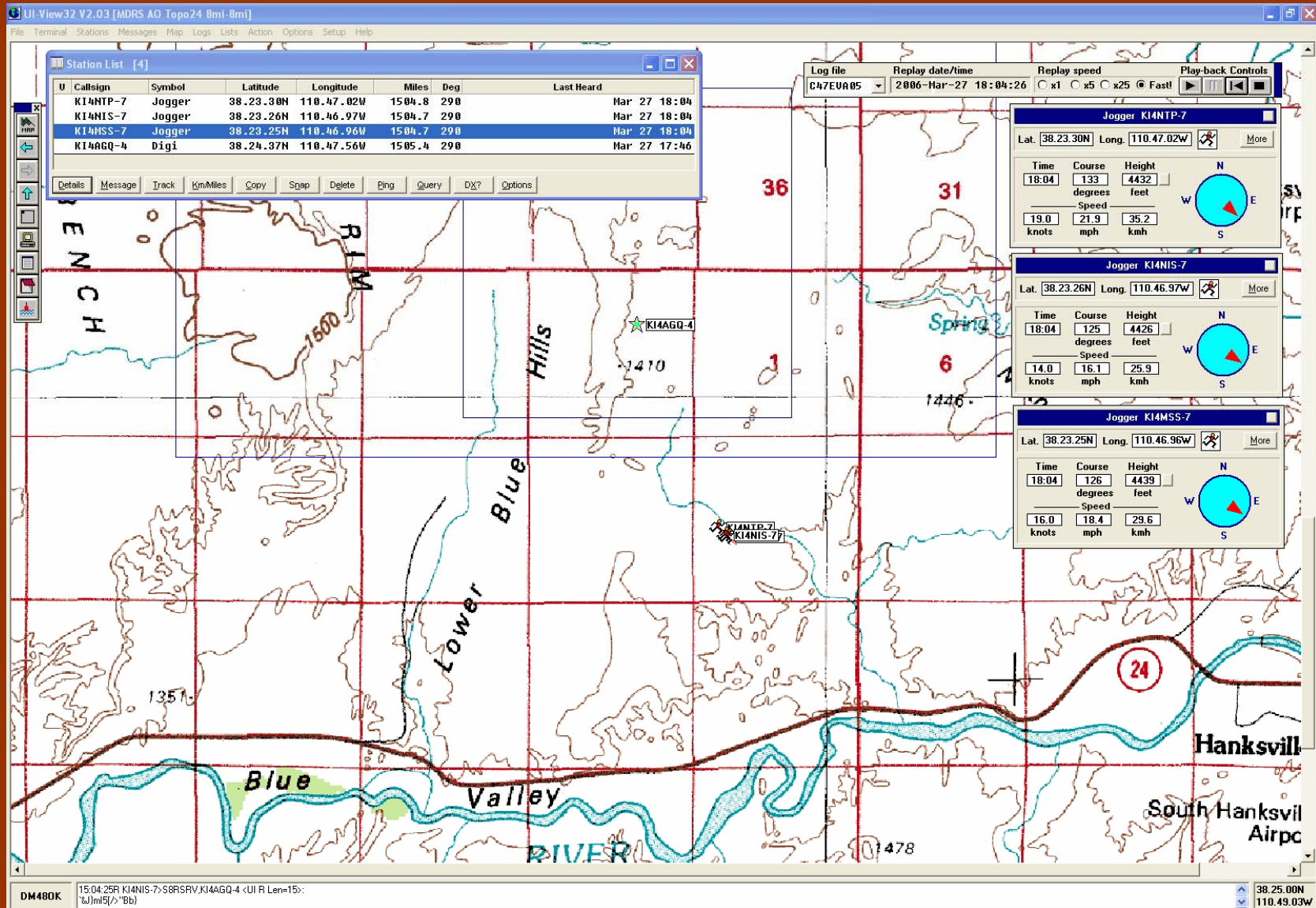


Radio System Overview

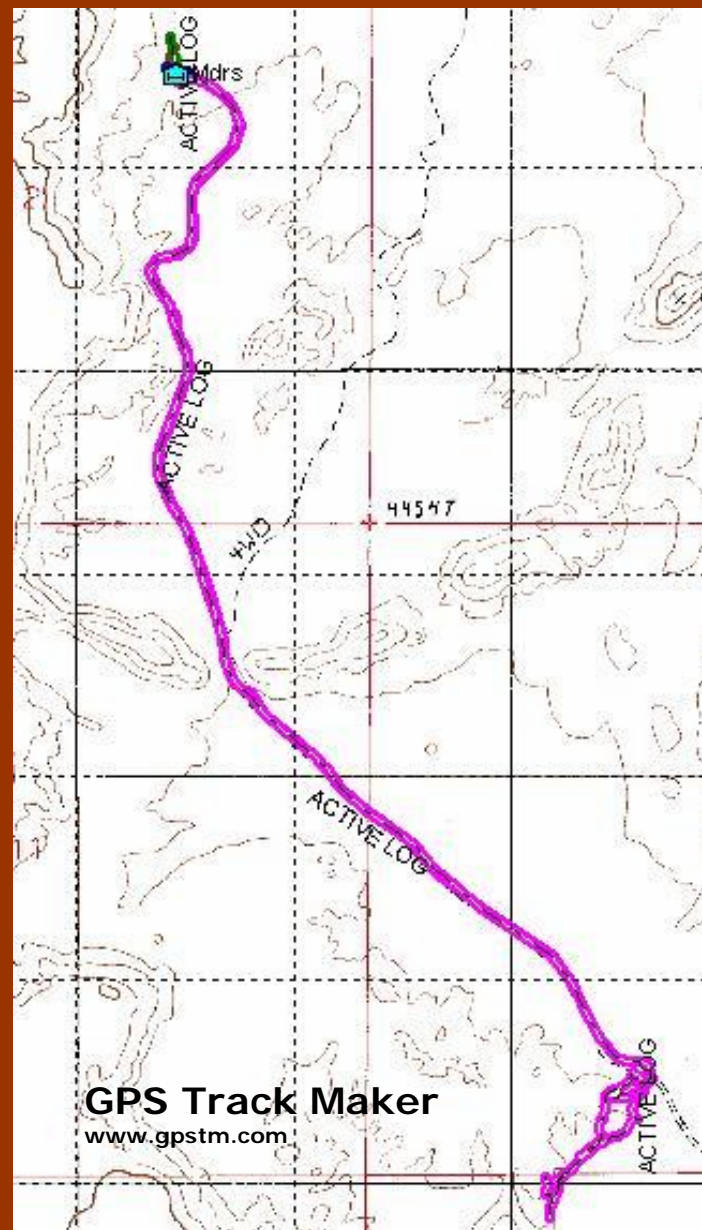
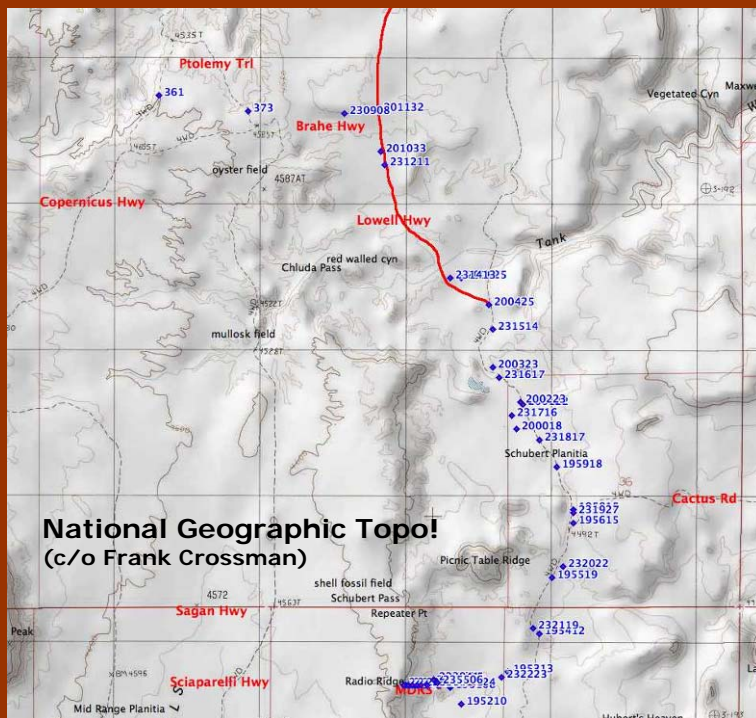
V Voice repeater (cross-band)
D Digipeater



Real-Time EVA Position Tracking with Amateur Radio



EVA Track Visualization and Live Data on the Web



Navigation Database Updates and GPS Route Survey

GPS TrackMaker - C:\users\janosburg\Mars Society\WDRS2006\navigation\WDRS_skyline_rim_topo_waypoints_roads_2006_03_30_gtm

File Edit View Tools Maps Interface Help



1:300 m [No Map] Waypoint Names Zone-Easting Northing

Microsoft Excel - MDRS_waypoints_2006-03-30.xls

File Edit View Insert Format Tools Data Window Help Adobe PDF

Arial 10 [Navigation icons]

E334 Serenity Valley Updated 29 March 2006

1 MDRS Main Waypoint Database

2 Anyone entering/adding information, please provide details on the "Notes" sheet

3 green background: navigational waypoints (ATV routes and intersections)

4 blue background: Project MAST image locations

5 orange background: unnamed waypoints

6 yellow background: TBO issues

7

8

9 If you have doubts about the accuracy of a GPS measurement, or if it was generated from a Map, mark the entry RED.

10

11 SET GPS DATUM TO NAD27 CONUS (NOT WGS84)

12 SET GPS COORDINATES TO UTM

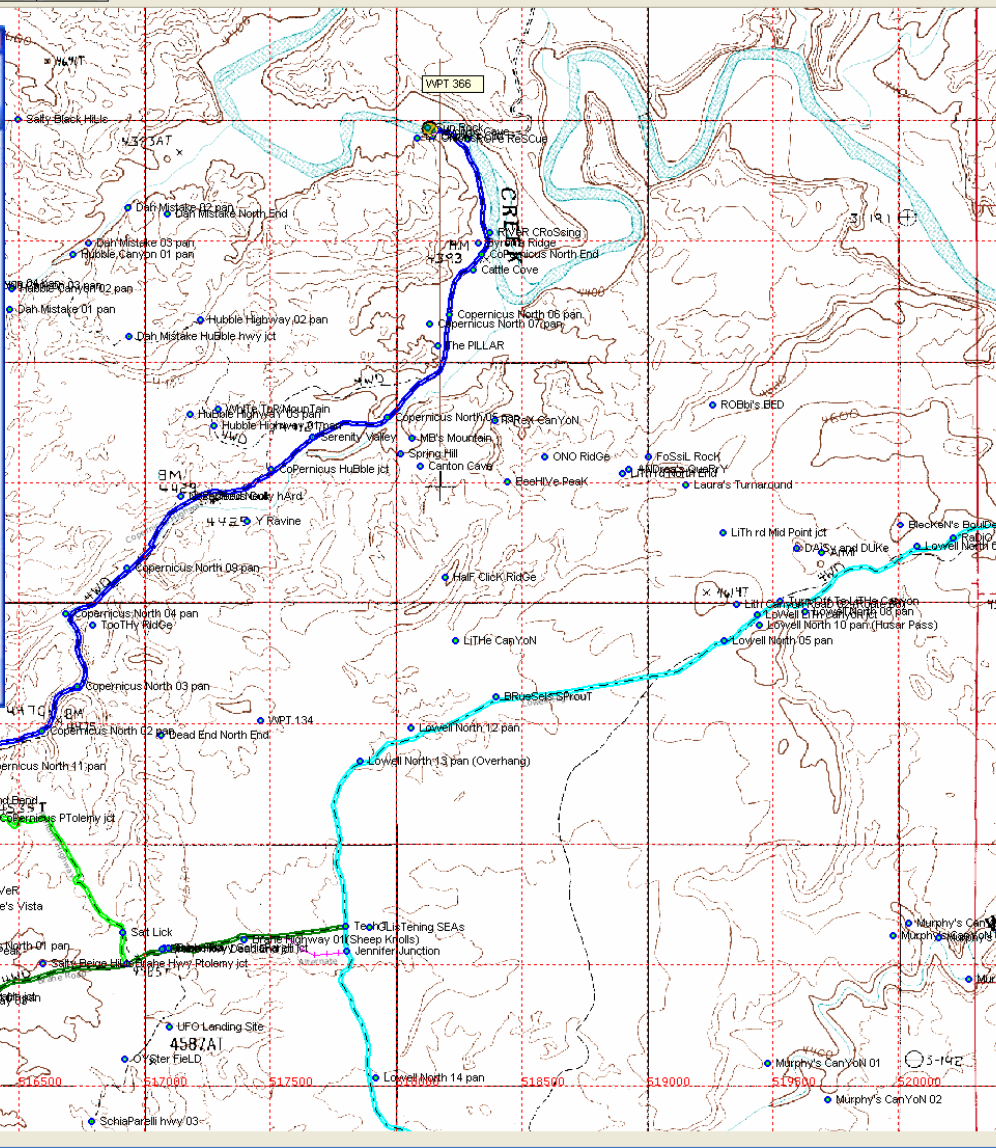
13 SET ELEVATION UNITS TO METERS!

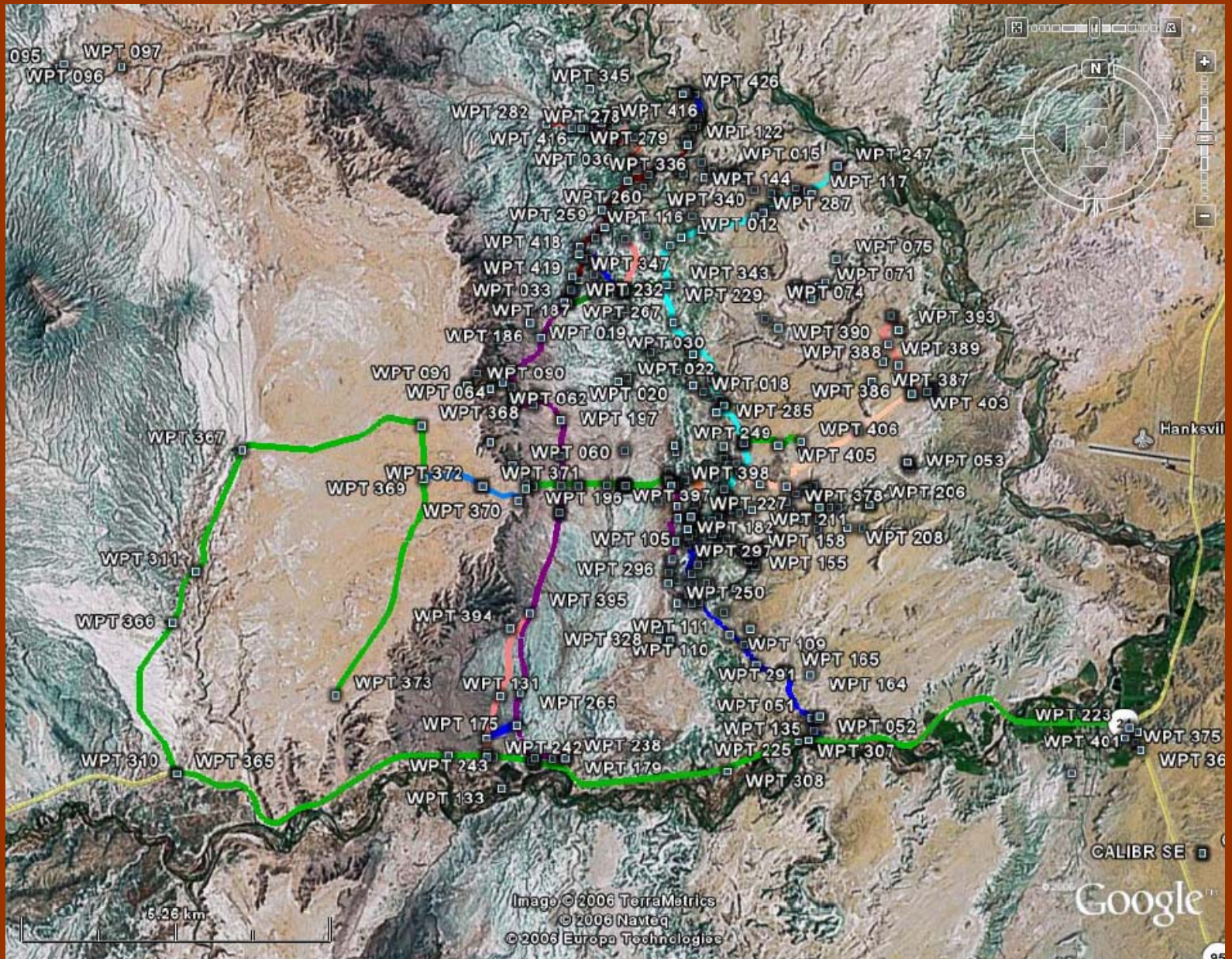
14

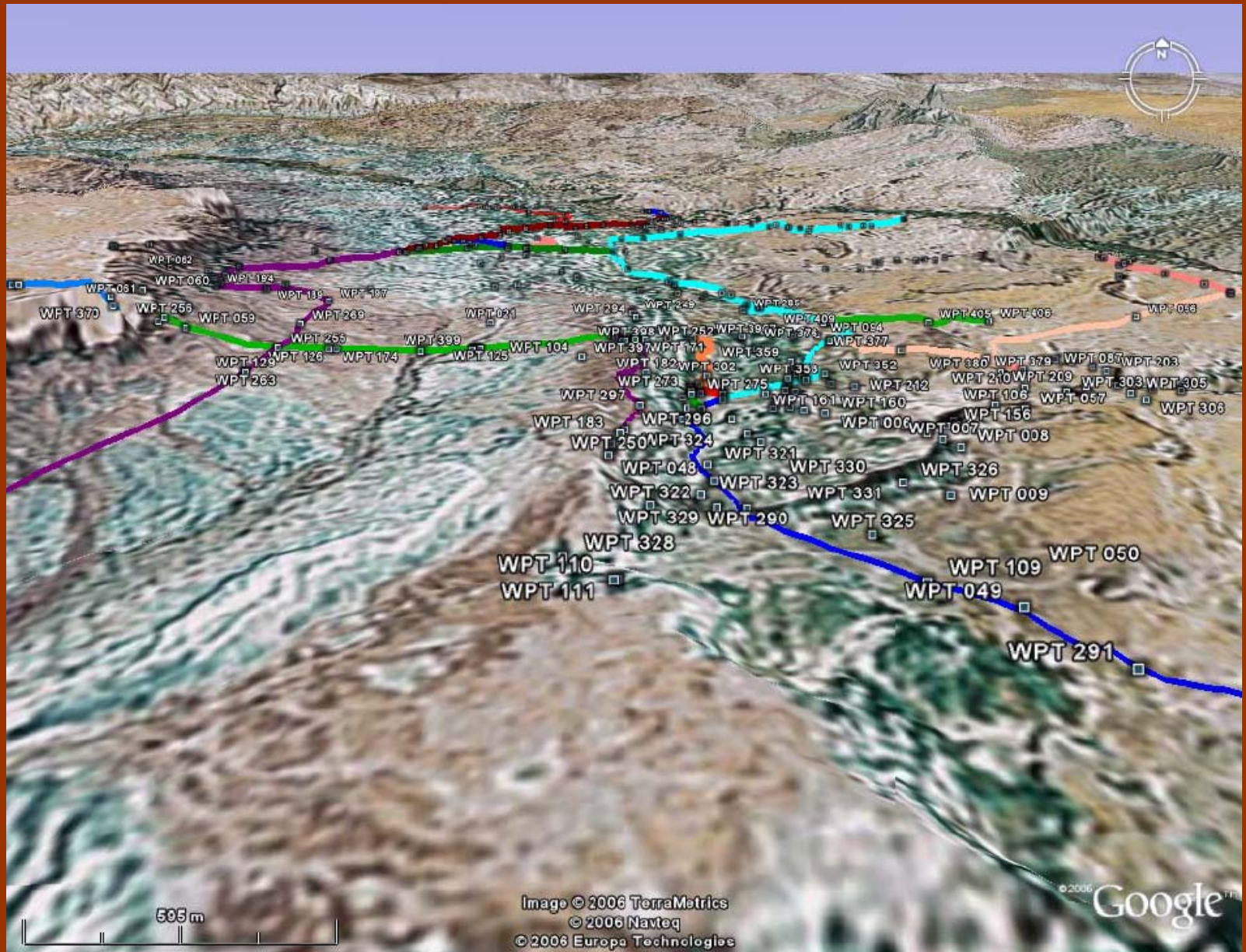
| | | UTM Zone 12S | | | | | | | | |
|-----|----|--------------|----------------------------|-----------------------------|--------------------|------------------|---------|------|-------------|----|
| | | Outnum | UTM Easting (all 6 digits) | UTM Northing (all 7 digits) | Elevation (Meters) | Date Established | Est. | | | |
| 321 | 47 | 3 | BRNCSO | 390 | Branal Bend | NAD27 516313 | 4265176 | 1371 | 2006-Mar-24 | 17 |
| 322 | 47 | 6 | ZECVJS | 391 | Zecie's Vista | NAD27 516310 | 4264736 | 1496 | 2006-Mar-26 | 13 |
| 323 | 47 | 6 | NOSENV | 392 | Notheast Neck | | | 1350 | 2006-Mar-26 | 13 |
| 324 | 47 | 6 | SERENV | 393 | Serenity Valley | | | 1343 | 2006-Mar-26 | 13 |
| 325 | 47 | 6 | CATTVC | 394 | Cattle Cove | | | 1327 | 2006-Mar-26 | 14 |
| 326 | 47 | 6 | BYVRD | 395 | Byron's Ridge | | | 1345 | 2006-Mar-26 | 14 |
| 327 | 47 | 6 | SUNRCK | 396 | Sun Rock | | | 1326 | 2006-Mar-26 | 14 |
| 328 | 47 | 6 | JUCVCV | 397 | Jupiter's Cave | NAD27 518162 | 4267945 | 1332 | 2006-Mar-26 | 14 |
| 329 | 47 | 6 | CAROLC | 398 | Carole's CRT | NAD27 518154 | 4267928 | 1361 | 2006-Mar-26 | 14 |
| 340 | 47 | 6 | 47ONAS | 399 | 47 Onions | NAD27 518091 | 4267923 | 1364 | 2006-Mar-26 | 14 |
| 341 | 47 | 6 | SPRHLL | 370 | Spring Hill | NAD27 518023 | 4266614 | 1339 | 2006-Mar-26 | 15 |
| 342 | 47 | 6 | MBMTH | 371 | MD's Mountain | NAD27 518070 | 4266660 | 1346 | 2006-Mar-26 | 15 |
| 343 | 47 | 6 | CANTVC | 372 | Carbon Cove | NAD27 518102 | 4266665 | 1329 | 2006-Mar-26 | 15 |
| 344 | 47 | 6 | SALTRV | 373 | Salt Lick | NAD27 518109 | 4266676 | 1366 | 2006-Mar-26 | 14 |

Waypoints / Area Features / WptNames / EXPORT / EXPORT_description / EXPORT

Cell E334 converted by Jan Osburg







Polymer Fiber Materials and Tools Research

- Design and build a shovel out of carbon fiber
- Compare strength and weight against regular metal shovel
- Investigate compatibility with EVA suits
- Support other research (ISRU, radiation)



In-Situ Construction Techniques

→ Use of in-situ construction materials on Mars reduces launch mass:

- ✧ Radiation shielding
- ✧ Pressurized structures

→ Objective:

- ✧ Use sandbags as building blocks for small structures
- ✧ Examine compatibility of sandbag filling and placement with EVA suits
- ✧ Evaluate the effectiveness of a radiation shield made of filled sand bags



Mapping Radiation Levels

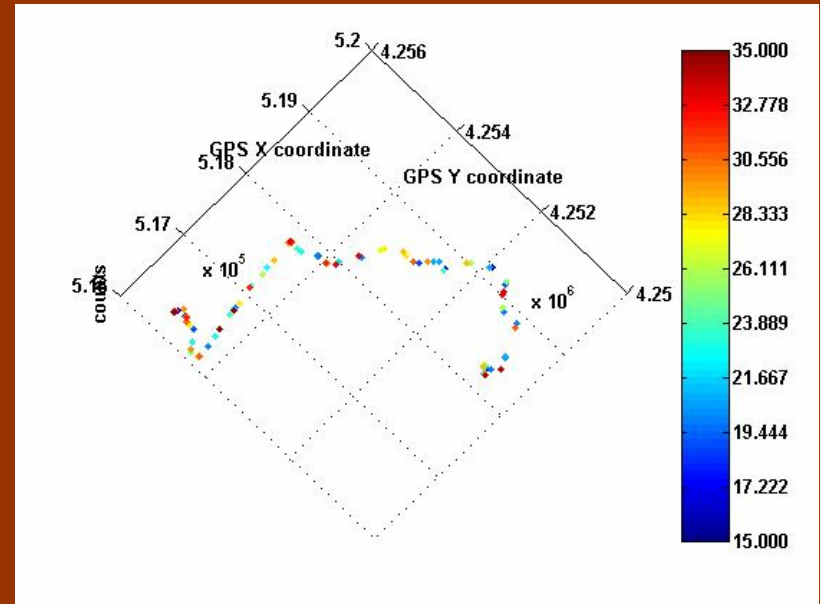
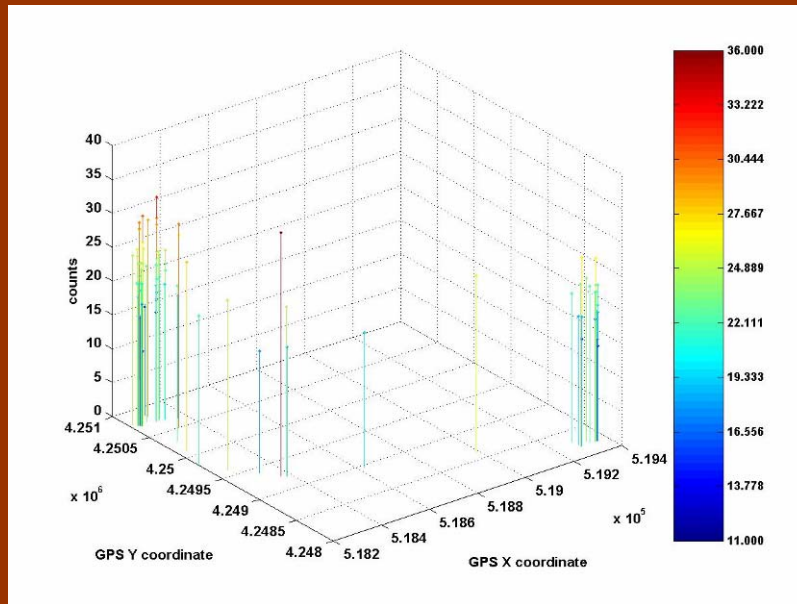


→ Equipment:

- ✧ Handheld GammaScout radiation meter
- ✧ Global Positioning System (GPS) receivers

→ Approach:

- ✧ Match timestamps of radiation and position data
- ✧ Plot radiation data (counts per minute) on map



Celestial Navigation Experiment

→ Background

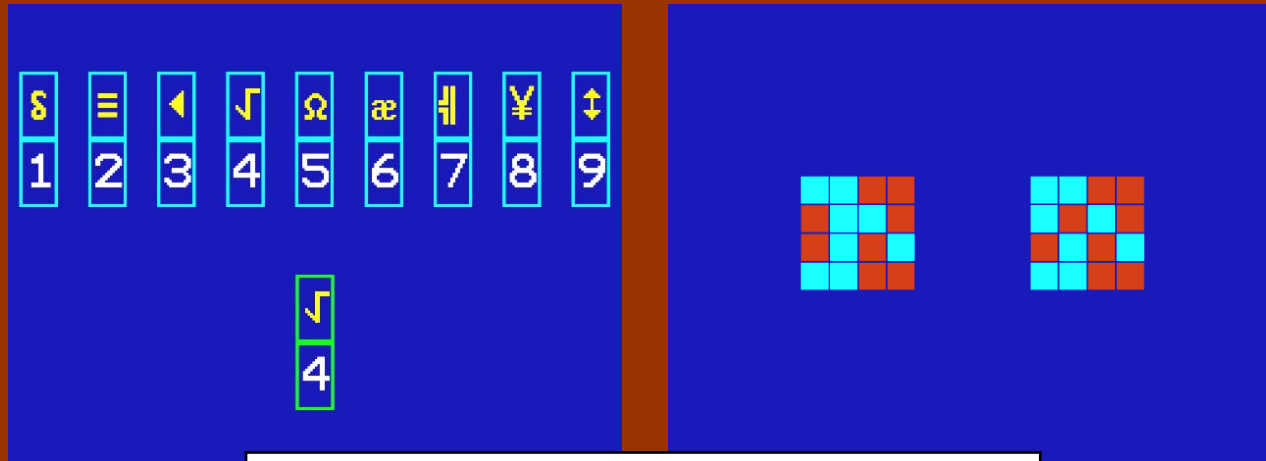
- ✧ Backup navigation in case of electronic positioning system failure
- ✧ Celestial navigation is time-honored method

→ Objective: evaluate the feasibility of celestial navigation as a contingency navigation technique on Mars

- ✧ Is the equipment reasonably portable?
- ✧ Can the equipment be used in a spacesuit?
- ✧ Is the technique accurate?
- ✧ Can the techniques that work on Earth be applied to the Martian sky?



Human Factors Research



MASCOT cognitive performance test

Microsoft Excel - MDRS_Crew47_PHADES_Survey_adfh45afdhfg.xls

Environment/Architecture

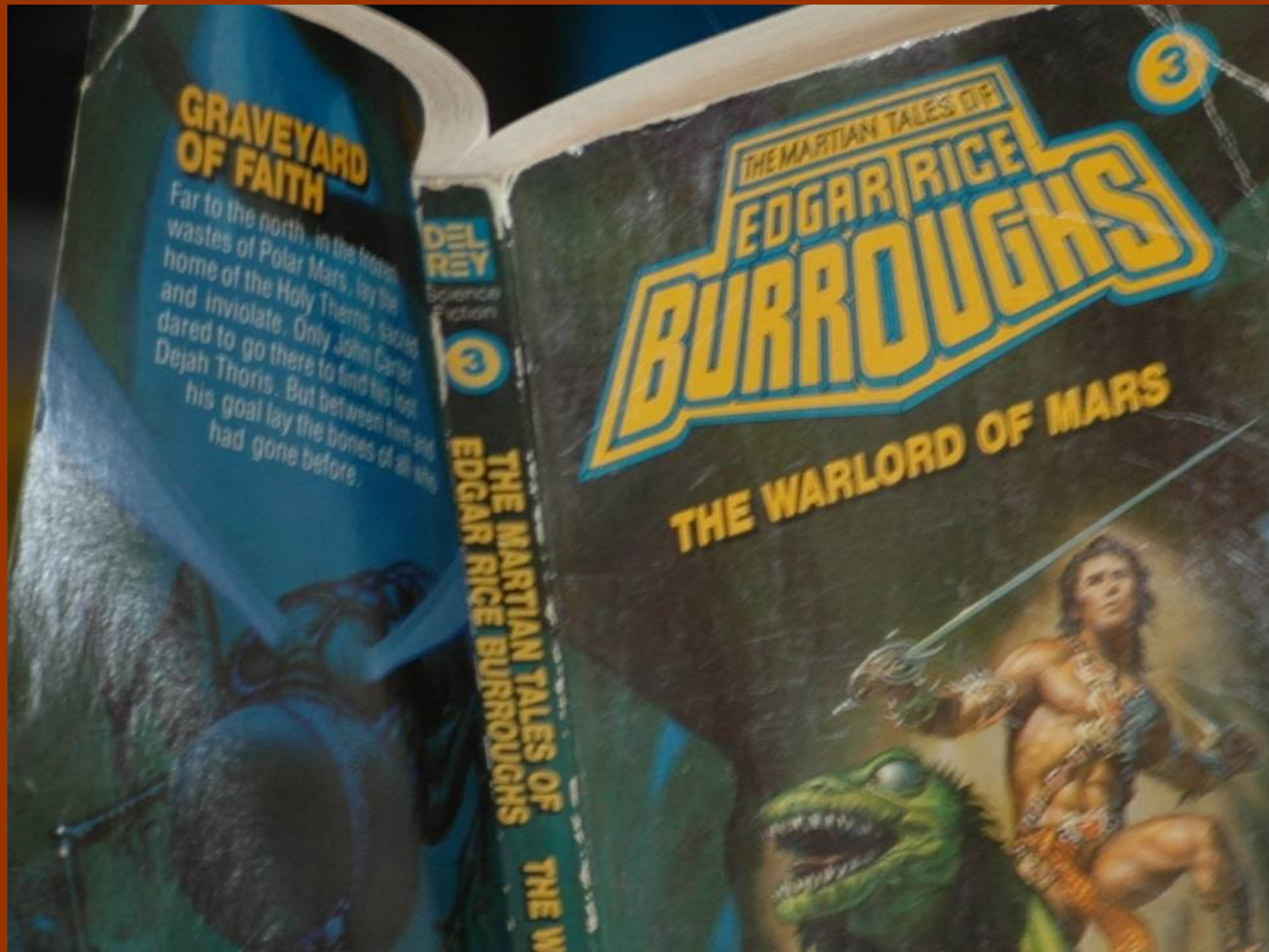
For each of the statements below, please indicate the extent of your agreement or disagreement by placing a tick in the appropriate column.

| | | | | | F | G | H | I | J | K | L | |
|----|--------------|--------------------------|-----------|--|--|----------|-----------|-------|------------------|----------------|----------------------------|--|
| | | | | | Completely Disagree | Disagree | Undecided | Agree | Completely Agree | Not Applicable | COMMENT | |
| 7 | | | | | | | | | | | | |
| 9 | Architecture | Environment/Architecture | Lighting | level | The lighting is not bright enough | | | X | | | in some of the rooms, espe | |
| 10 | | | | location | The lights are located accurately | | | | X | | | |
| 11 | | | | general acceptability | Lighting is good | | | | | X | | |
| 12 | | | | Aesthetics | Lighting is pleasant | | | | | X | | |
| 13 | | | | color | The color of the illumination is poor | | X | | | | | |
| 14 | | | | control | The level of illumination can be easily changed. | | X | | | | | |
| 15 | | | | quantity | There are enough lights | | | X | | | | |
| 16 | | | Acoustics | level generally | The noise is too loud | | X | | | | | |
| 17 | | | | general acceptability | The acoustics are acceptable | | | | X | | | |
| 18 | | | | Aesthetics | The noise level is pleasant | | | | X | | | |
| 19 | | | | privacy | Sound is contained well | | X | | | | | |
| 20 | | | | sleep | Noise does not impact sleep and rest | | | | X | | | |
| 21 | | work | | Noise does not impact work | | | | X | | | | |
| 22 | | | control | Noise level can be easily controlled or mediated | | | | X | | | | |

PHADES Habitability Survey



Mars Literature as a Cabin Fever Countermeasure



The Backup Crew



Photos: [imdb.com](http://www.imdb.com)

Engineering and Emergencies



- ENGINEERING TASKS**
- Find Paul's Scope meter charger
 - Add hanging bar
 - Remove latent A/B faucet
 - Foam around heater vent & flip it
 - Fix hole in the skidwin hob
 - Install water fill switch
 - GSM - (constalled but doesn't work yet)
 - Power Meter Sensors
 - Run DC wire to MUSK
 - connect DC power to MUSK
 - Solder toilet pump **PRIORITY**
 - Xantrex load converter
 - Shower patching & caulking
 - Clean Engineering Bench



Exploration



Media Response (Crew 37 and Crew 47)



- Additional Crew 47 coverage:
- ❖ The Chicago Tribune
 - ❖ The Washington Times
 - ❖ The Forward
 - ❖ VIEW Magazine



On to Mars!



Thanks to our sponsors!



Mars in our lifetime?
Make it happen!
Join* the Mars Society
www.marsociety.org

*Service Guarantees Martian Citizenship ;-)



[Original: NASA]