Near-Term Mars Colonization

- DevelopSpace Project -

April 20, 2008

Overview

- Project recap
- Some project “mechanics”
- Discussion of areas of work / assignment to team members
- Overview of some initial analysis

Project Motivation

- For manifold reasons, it is our destiny as humans to expand our presence:
  - Since the existence of our species, we have expanded our habitat over almost the entire Earth
  - This expansion was enabled by using technology (e.g. living in central Europe or northern Minnesota and surviving the winter)
- The next logical step is to go beyond Earth
  - Requires more significant reliance on technology
- In addition to expanding our presence, there may be numerous other benefits from this:
  - Rekindling of frontier spirit, societal invigoration
  - Generation of new technologies, now knowledge
  - Backup of our species and its achievements

There are people who want to make it happen

Project Goals

- To determine what would be involved in implementing a sustained human presence on Mars in the near future
  - By way of one-way colonization
  - For minimum closure and maximum closure levels
  - For constant or growing population size
- To investigate the cost of providing the colony with the capability for emergency evacuation back to Earth
- To gain an understanding of the financial needs and the time phasing of a near-term Mars colonization program
- To further develop the DevelopSpace infrastructure through identification of infrastructure needs

How to Colonize Mars

- Here are some initial ideas for our project:
  - Humans will be sent one way, possibly with an initial emergency Earth return capability
    - Return capability could be based on direct return
  - Re-supply will initially be provided from Earth, possible augmented with ISRU on Mars
    - Initially atmosphere-based ISRU
    - Possibly also greenhouses for growing food
  - The population of the colony will be assumed to grow over time
    - Maybe 4 crew initially, minimum of 2 additional every opportunity

Project Mechanics

- We now have a project website:
  - http://wiki.developspace.net/Minimalist_Human_Mars_Mission

- Action items:
  - Create project mailing list (Paul?)
  - Update your contact details / add yourself to the team
  - Project members need to identify task(s) they want to work on and put together an action plan for the task(s)
  - Review NASA Mars DRM 1.0, 3.0, Exploration Blueprint Data Book, and Mars Direct (see key references)

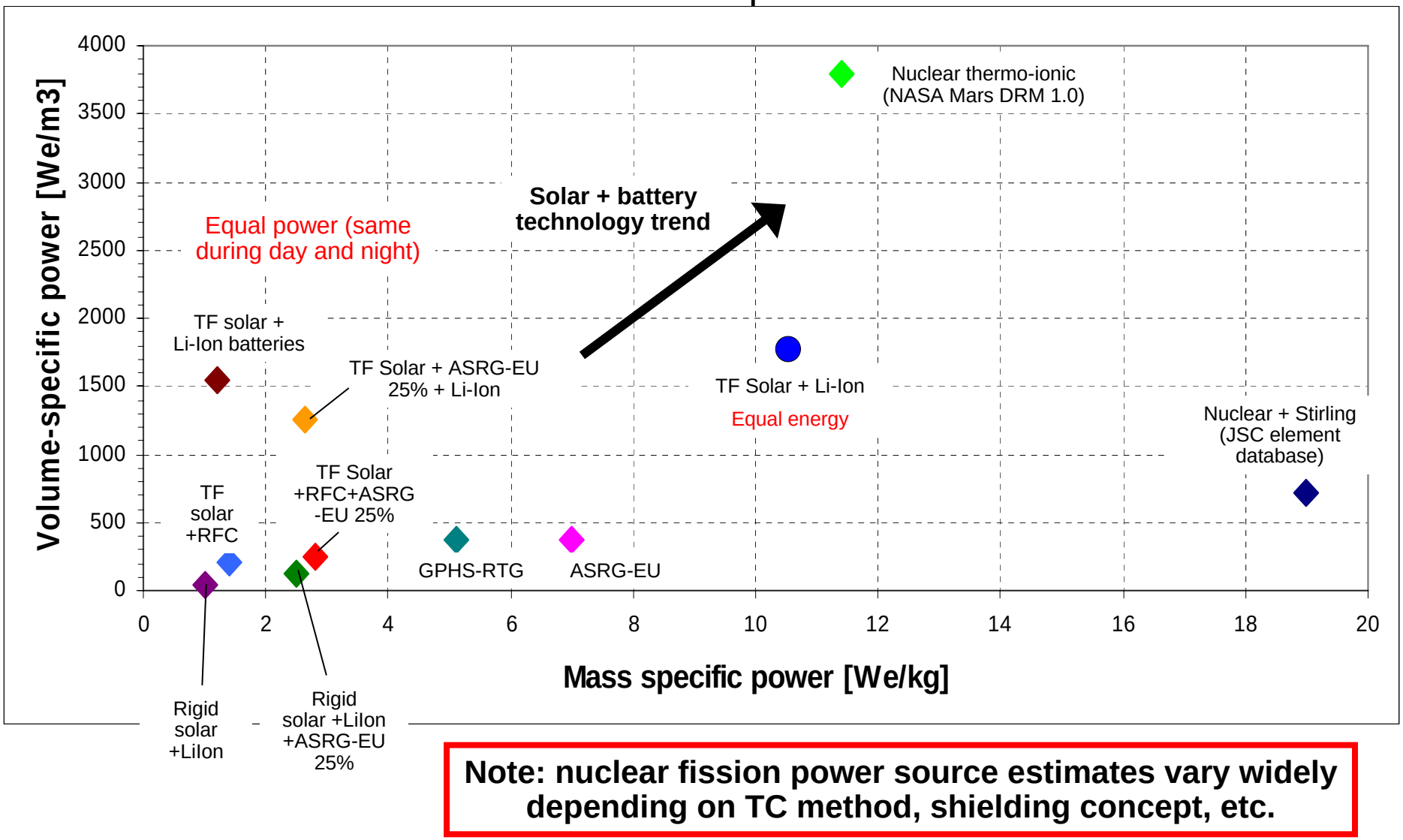
- Project timeline:
  - What about a review in early September 2008?

Possible Areas of Work for Project

• Surface power: solar vs. nuclear + different secondary power generation and energy storage technologies	**Chase**
• Surface infrastructure other than power: habitation, surface mobility / transportation / EVA, surface operations	**Arthur, Ryan**
• Logistics, life support, and ISRU: life support system closure, ISRU, re-supply from Earth	**Wilfried**
• Earth-Mars transportation, Mars EDL	**Arthur, Chase**
• Return to Earth in emergency	
• CAD modeling / visualization of concepts	**Ryan**
• Location, location, location! Where should the colony be located?	**All**
• Financial and management considerations: financing of project, operational management, program planning	**Paul (advising)**
• Integration of results into coherent strategy	**Wilfried**
• Other… (information system)	

Preliminary Surface Power System Assessment

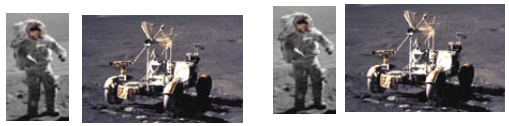
- Volume and Mass Specific Power -



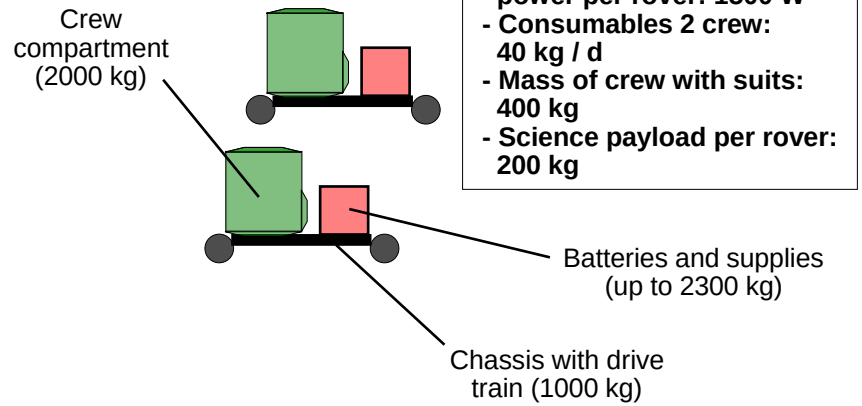
Note: nuclear fission power source estimates vary widely depending on TC method, shielding concept, etc.

Baseline Surface Mobility Capabilities

Proposed



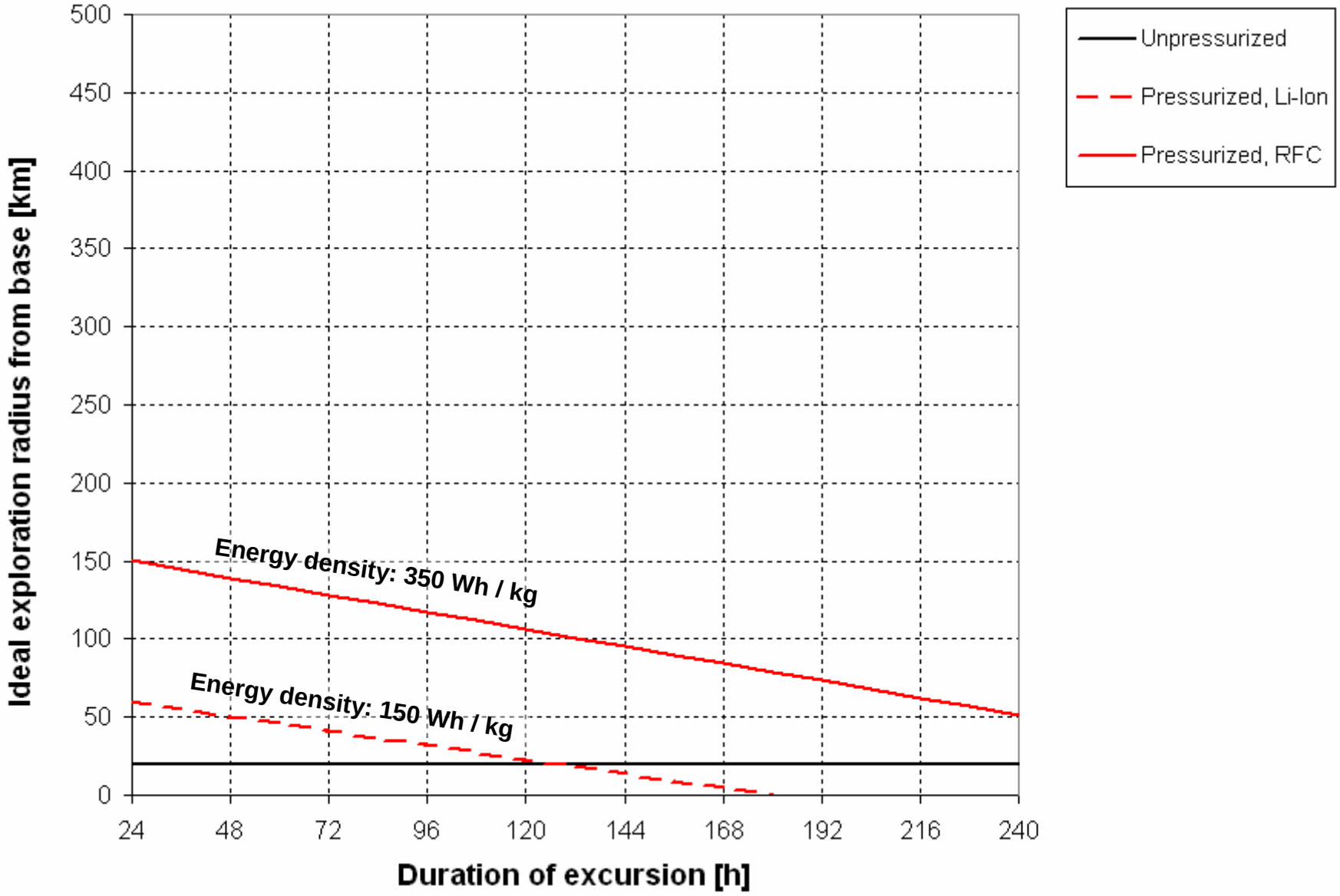
Apollo 15, 16, 17



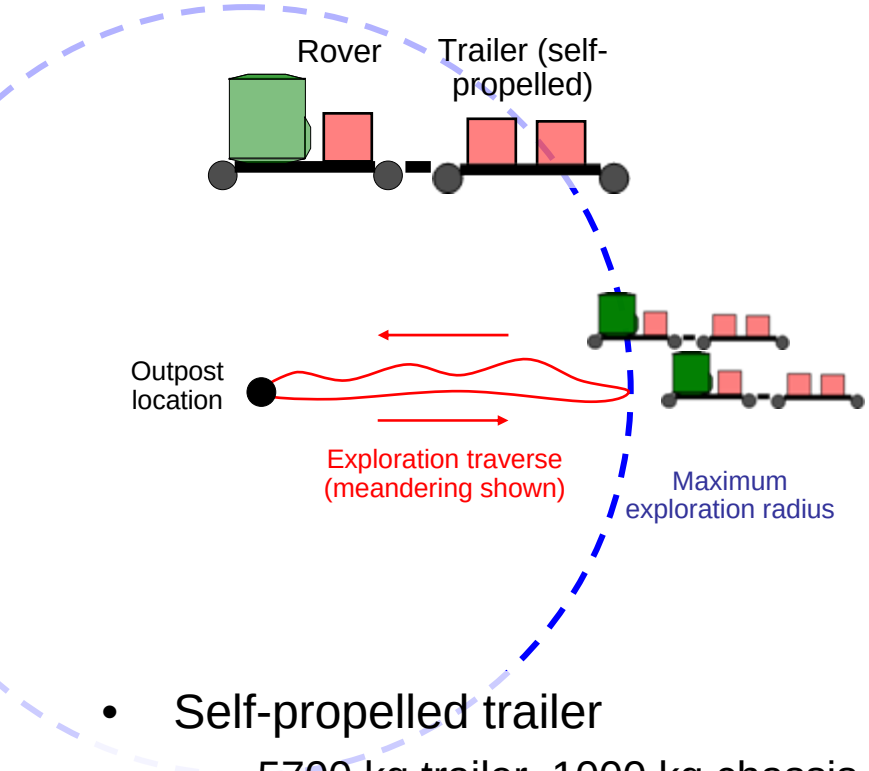
- Unpressurized
  - 2 independent unpressurized rovers on traverse, each can carry the entire crew back to base in contingency
  - Exploration radius is limited by contingency constraints and EVA time
  - Due to 2 independent vehicles on traverse drive-back constraint applies
  - This is different from the walk-back constraint for Apollo traverses which had only a single vehicle – the LRV
  - 20 – 25 km ideal exploration radius from base can be achieved for 6 – 8 hour excursion

- Pressurized
  - 2 independent pressurized vehicles on traverse, each can carry the entire crew back to base in contingency
  - Either the camper concept or a pressurized rover can be used (we think there are advantages to the camper concept)
  - Exploration radius is limited by consumables and energy storage mass rather than contingency constraints
  - For the analysis presented here we assumed 2 pressurized rovers with a total mass of 5700 kg (nominal 2 crew)

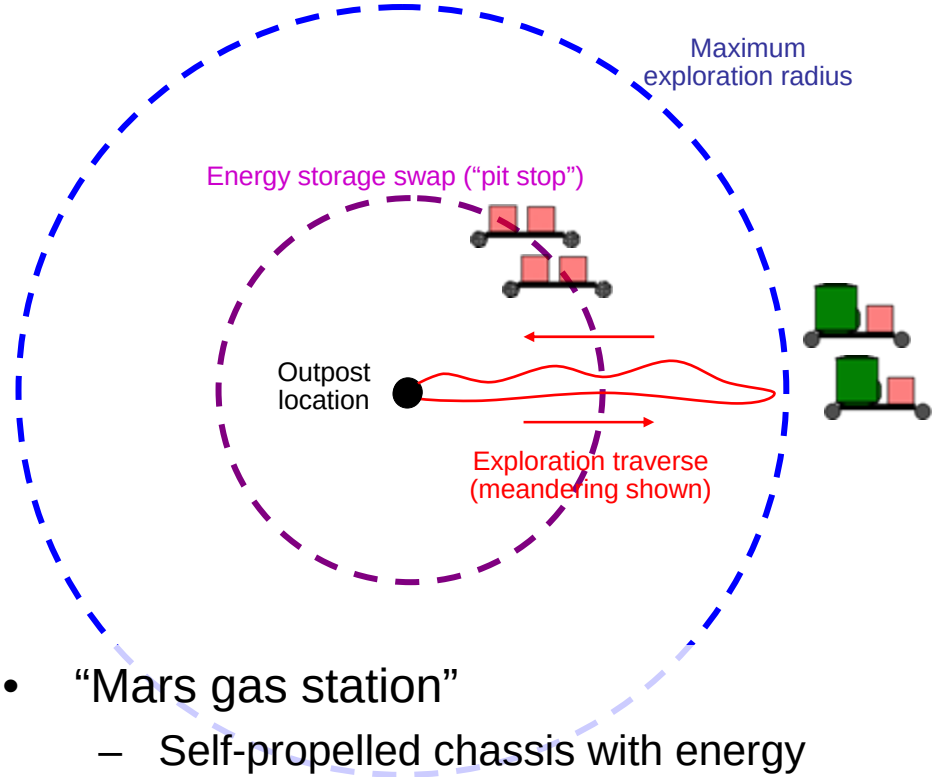
Baseline Surface Exploration Capabilities



Extension of Pressurized Mobility Radius

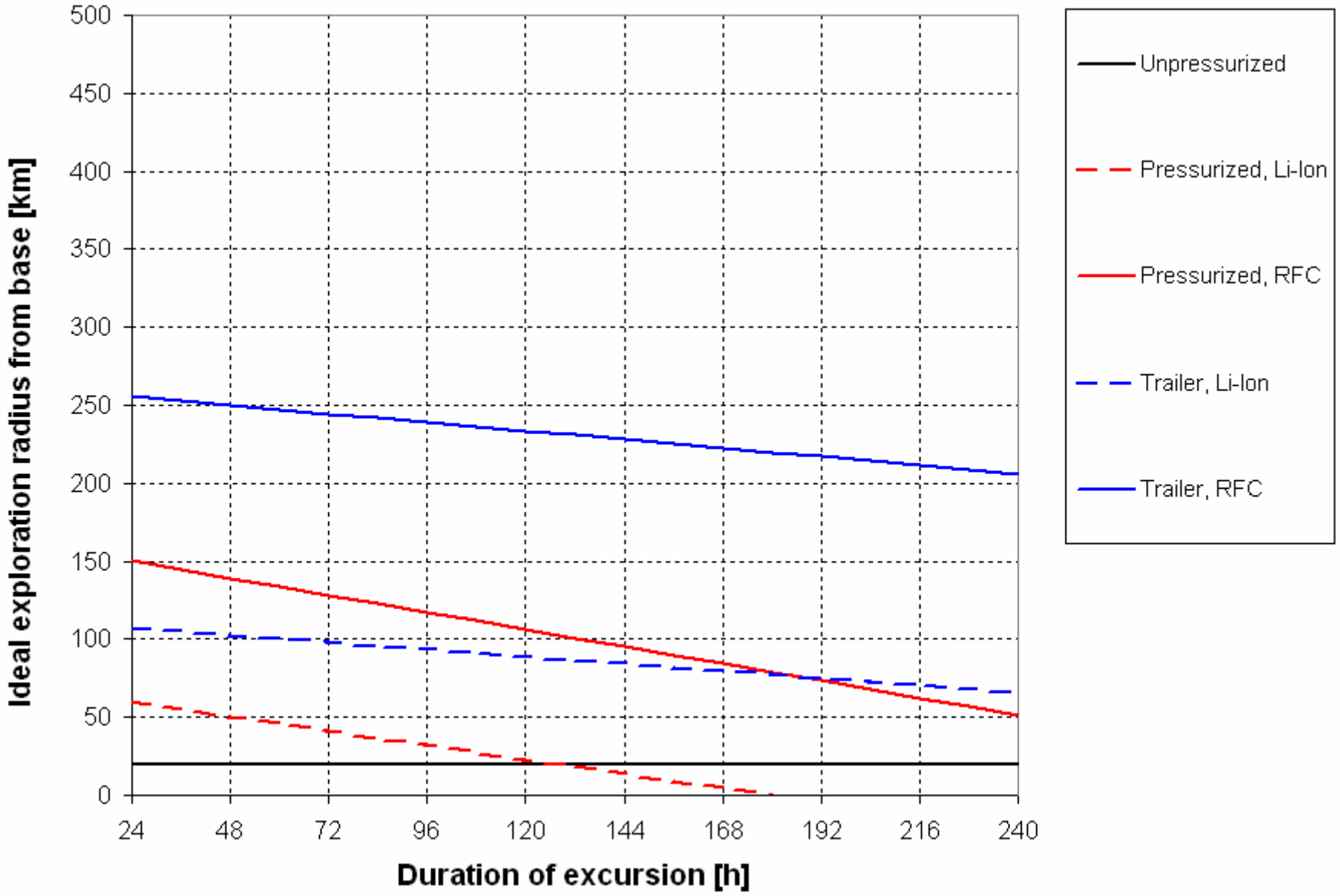


- Self-propelled trailer
  - 5700 kg trailer, 1000 kg chassis + drive train and 4700 kg energy storage mass
  - Trailer is self-propelled
    - Analysis shows parasitic drag results in higher mass than propelled trailer
  - Trailer is delivered to base as with logistics excess capability

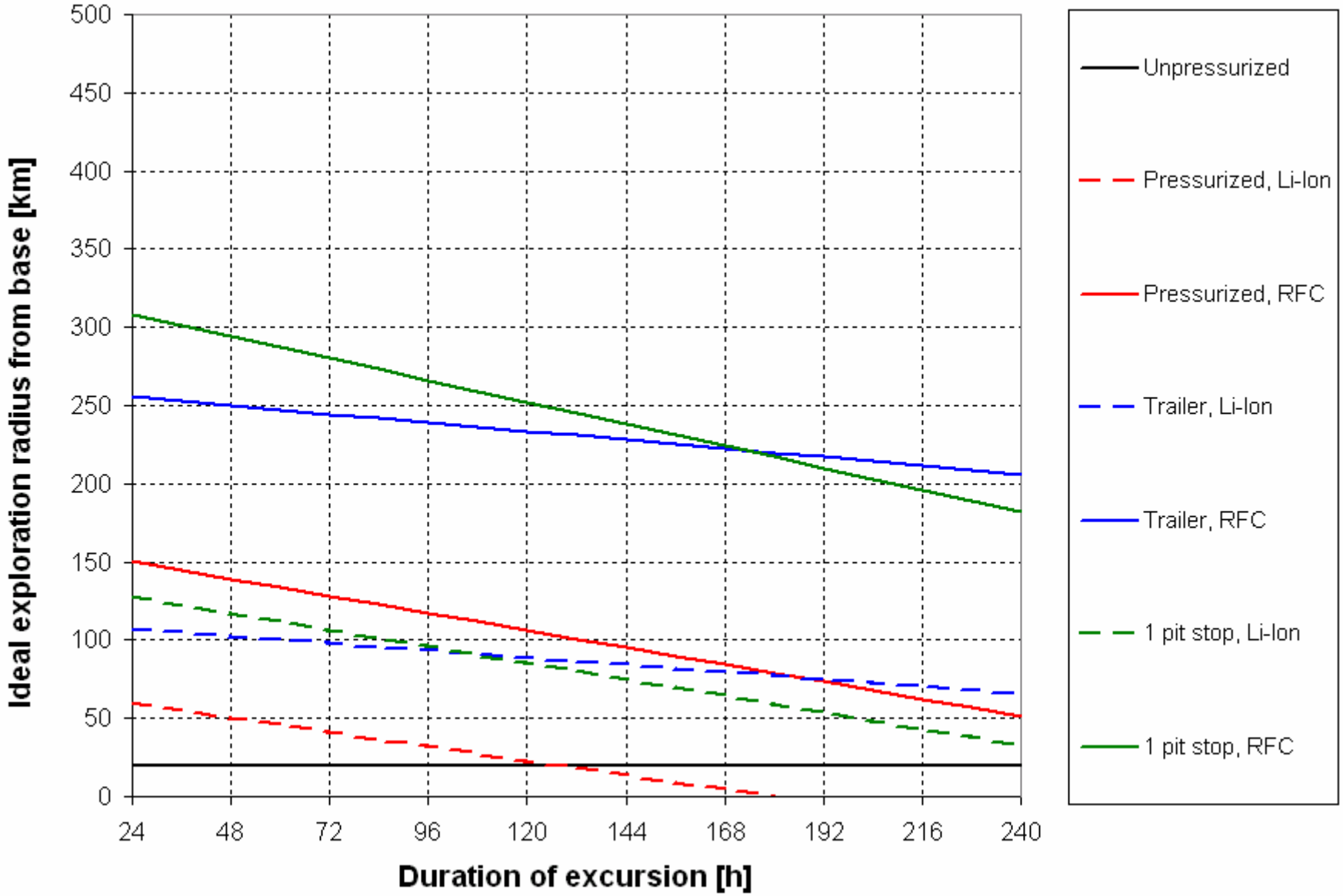


- “Mars gas station”
  - Self-propelled chassis with energy storage and solar power generation is pre-positioned
  - Crew visits station with pressurized rovers and swaps energy storage (“pit stop”)
  - Can theoretically be extended indefinitely

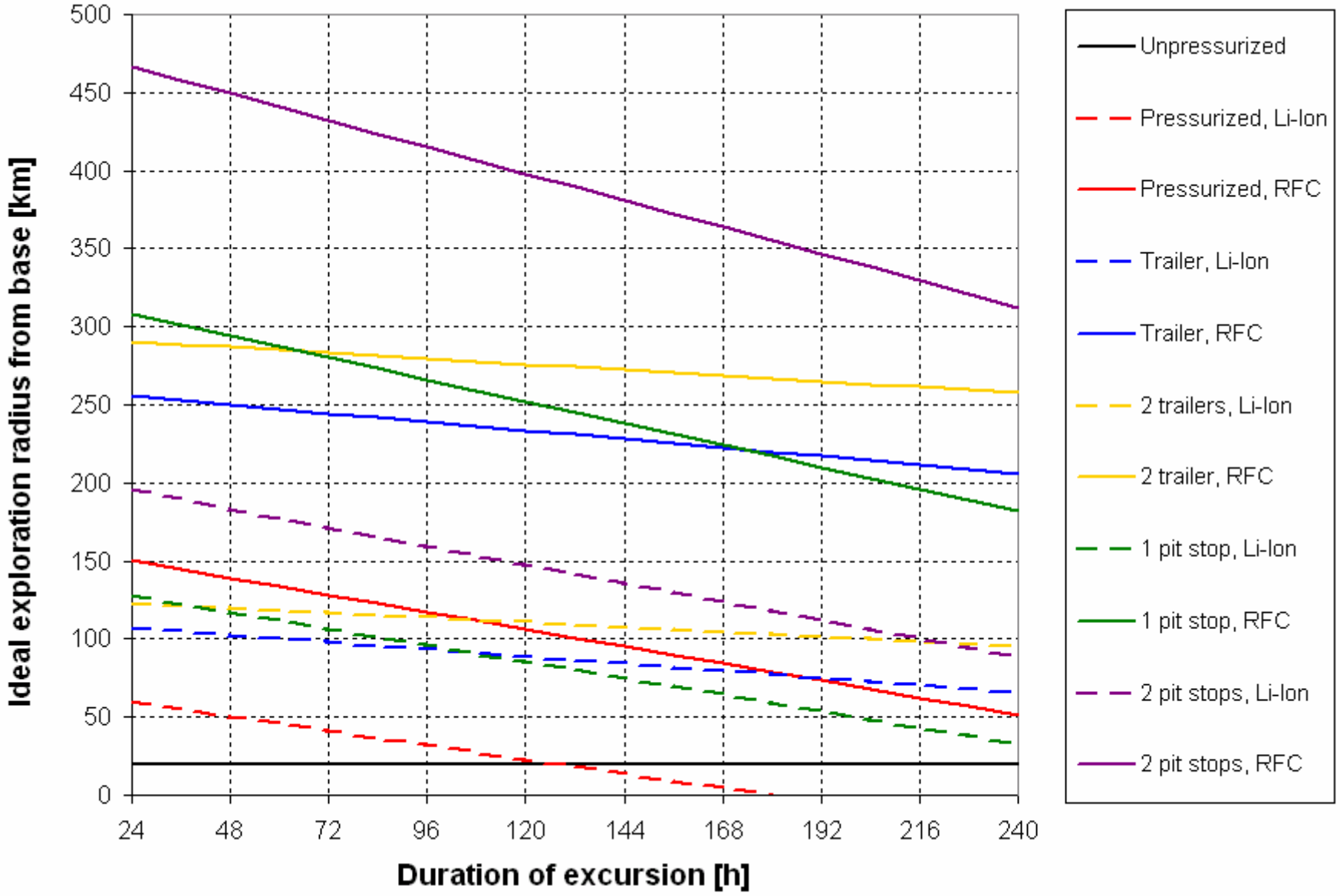
Extended Surface Exploration Capabilities (1)



Extended Surface Exploration Capabilities (2)



Extended Surface Exploration Capabilities (3)



Backup Slides

Why Mars?

- Why would we want to expand to Mars, instead of other destinations such as the Moon?
- Of all the bodies of the inner solar system eligible for near-term colonization, Mars is the most suitable
  - Mars has an atmosphere, specifically a CO_2 atmosphere (GCR / SPR protection, feedstock for ISRU)
  - All the other elements necessary for sustained human existence are present in one for or another on the Martian surface
    - Nitrogen, hydrogen, oxygen, carbon, iron, aluminum, etc.
  - From a mass / energy perspective, the Martian surface is about as hard to reach as the lunar surface
  - Higher gravity level than on the Moon
- Major challenges of Mars are that it takes longer to get there and aeroentry / aerocpature is required

Actions

- Everyone
  - Select the areas that you would like to work on, and formulate an initial set of tasks for yourselves
  - Think about tools we need for this project on DevelopSpace
  - Start the work!
- Wilfried
  - Set up project site on DevelopSpace
  - Prepare kick-off next weekend