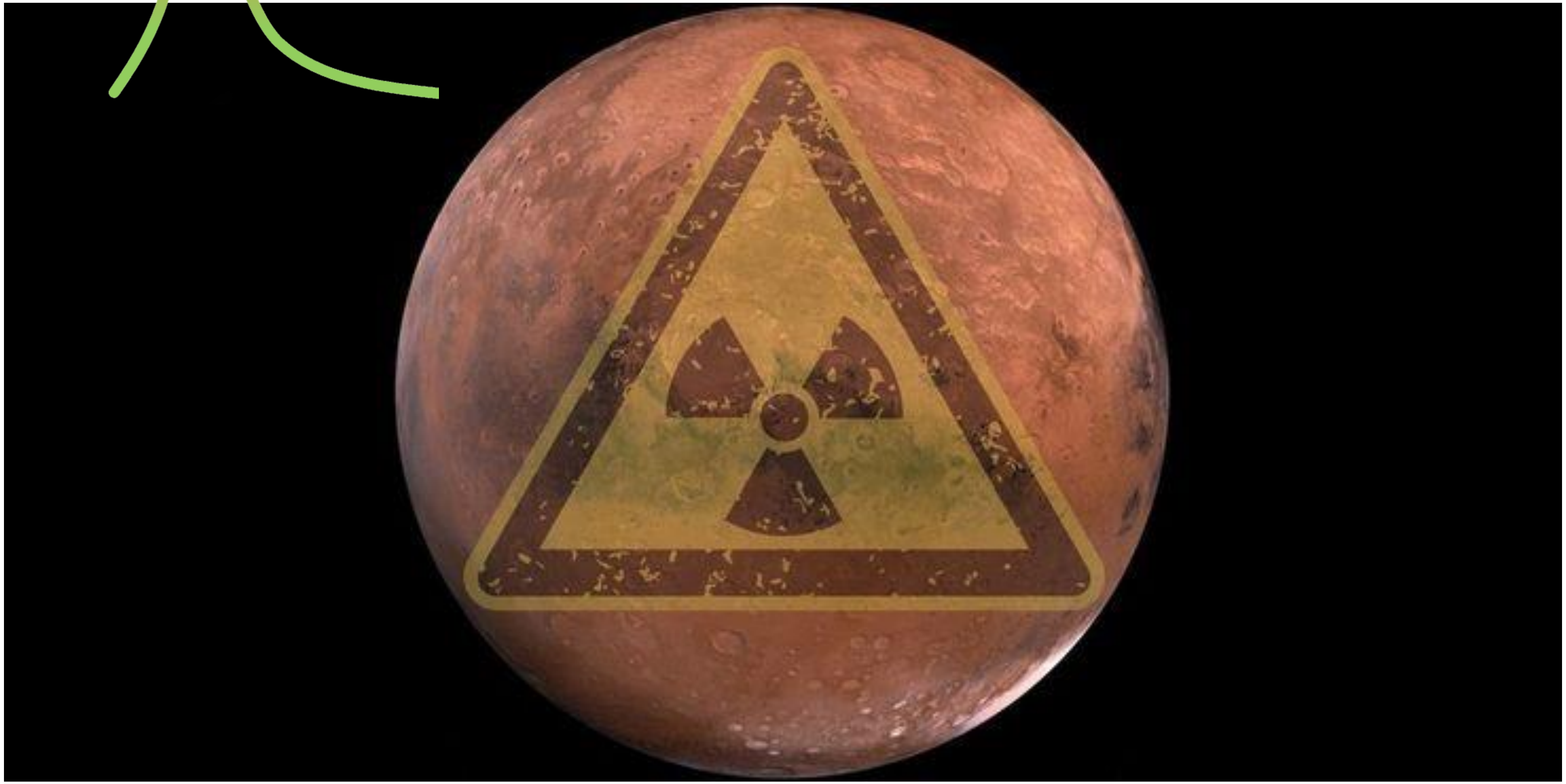
MODE DATA CHALLENGE



INTRODUCTION

Overview

- A scenario for an initial manned mission to Mars involves a 400-day cruise phase to and from the planet.
- The cruise phase poses a significant problem due to the cumulative effects of exposure to cosmic and solar radiation.
- This challenge remains unresolved.

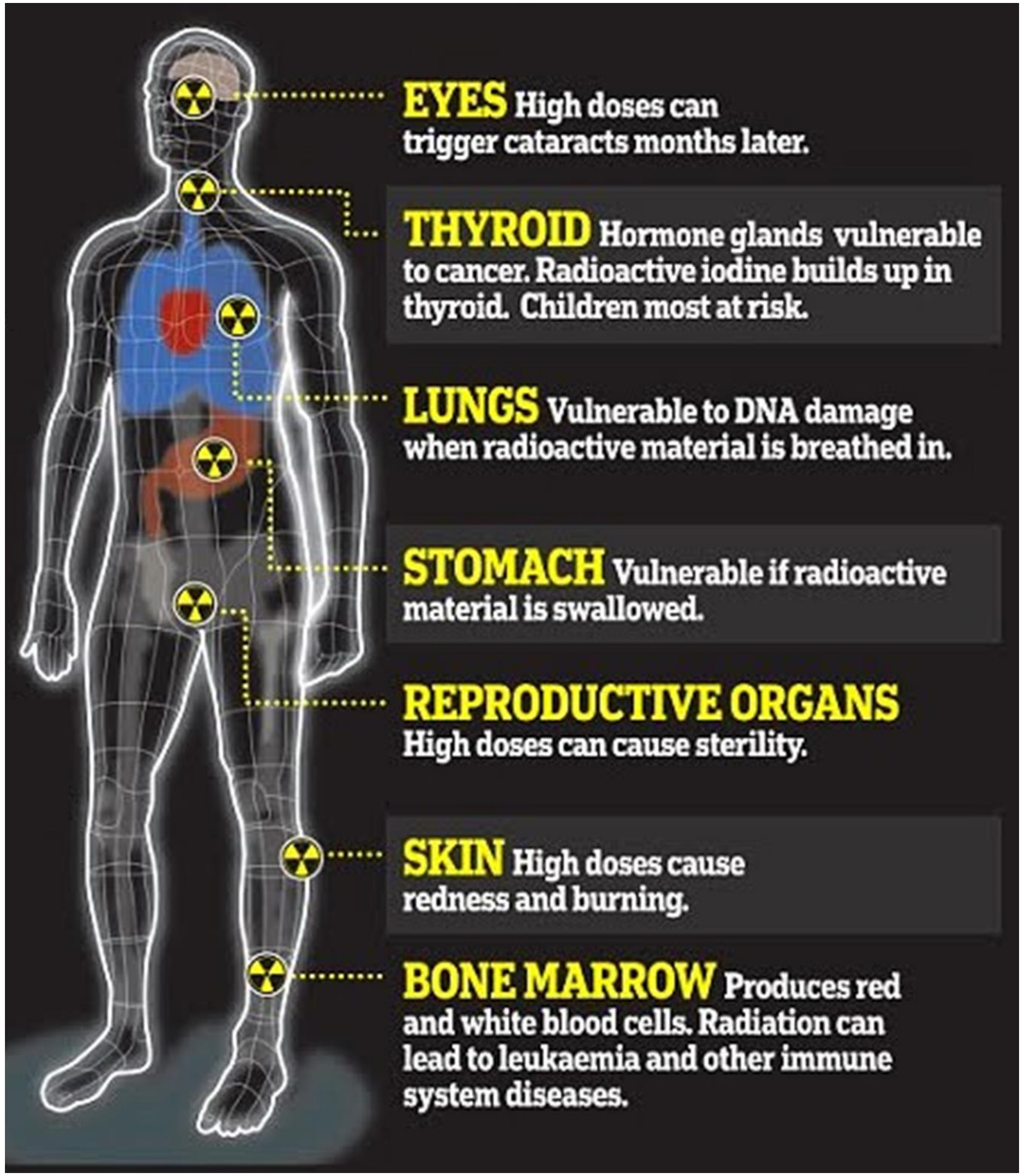
The Physics

- Without the protection of earth's magnetosphere, the astronauts aboard future missions to Mars will be shielded only by the spacecraft itself.

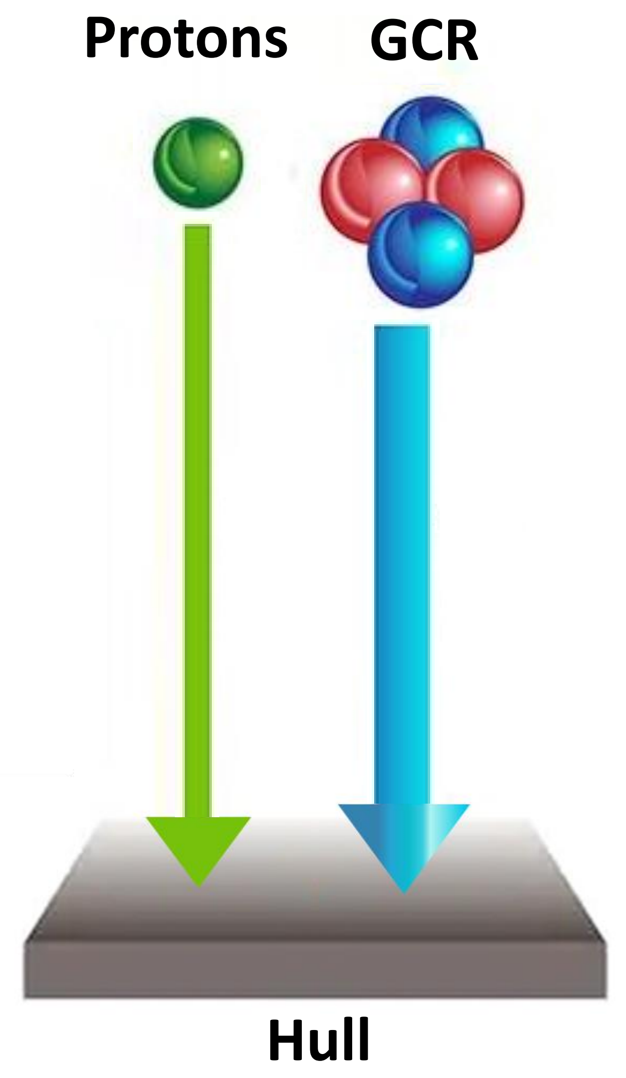
- A dose of **100 milliSieverts** per year is known to increase cancer risk and other illnesses. Radiation workers on earth are limited to 50 mSv per year. Six months aboard the ISS exposes a crewmember to 72 mSv, dangerously close to the limit.

- The aluminum walls of the ISS provide some protection. However, thin aluminum shielding causes a net increase in the interplanetary environment due to absorption and emission of secondary radiation. Thicker shielding would be needed to block secondary radiation.

- The radiation hazard comes from two sources:
  1. **Galactic cosmic rays**, which are isotropic.
  2. **Solar protons**, which emanate radially from the sun.



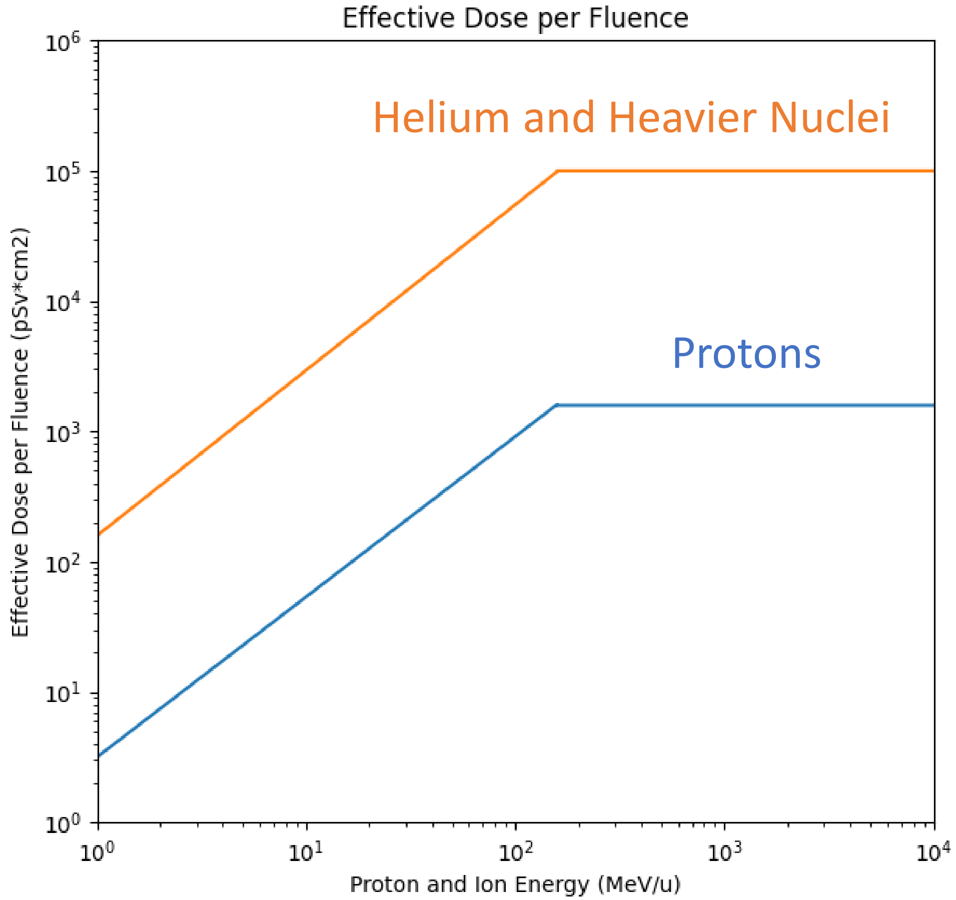
The Task



- **Your task is to develop the lightest spacecraft possible while keeping the total 400-day astronaut exposure to under 100 mSv.**

- The internal spacecraft volume must be $100m^3$. The hull material(s), thickness, and shape are up to you.

- Beyond the 100mSv and $100m^3$ limits, you are free to design the spacecraft as you choose.
    - You can use a cylinder, sphere, or other shape.
    - You can use a single material or layers of different materials.
    - Considerations for creativity will be given in the scoring.



The Rules

1. **Total exposure for the 400-day mission must not exceed 100mSv.**

2. **The internal volume of the spacecraft must be 100m³.**

3. **The effective doses for various energetic particles are shown below. Datasets for particle fluences are available at https://github.com/Mode2025/Data-Challenge/ .**

$$\text{Effective Dose for Protons } (pSv \cdot cm^2) = \begin{cases} 3.16 \cdot (\text{energy})^{1.23} & E < 10^{2.2} \\ 10^{3.2} & E \geq 10^{2.2} \end{cases}$$

$$\text{Effective Dose for Other Elements } (pSv \cdot cm^2) = \begin{cases} 158 \cdot (\text{energy/atomic mass})^{1.27} & E/u < 10^{2.2} \\ 10^{5} & E/u \geq 10^{2.2} \end{cases}$$

Scoring

- **Points will be awarded for three criteria:**

1. **Technical score – 10 points.** This is determined by the mass of your solution. Lighter spacecraft will be awarded more points.

2. **Creativity and execution – 10 points.**

3. **People's choice – 10 points.** A ballot box for voting will be open to workshop participants throughout the day after the presentation session.

Submissions

- Participants must send an email to the workshop organizers at mode-workshop-organizers@cern.ch
    - They will then send you an invitation to the discord server.
- Submissions must be uploaded to the discord server, either publicly or by private message.
    - There is no specific file format. Submissions must include your name, spacecraft mass, a description of your design, and an optional ID number.
    - In case of multiple submissions, the one with the highest ID number will be used.
- Submissions can be made any time before the deadline, and multiple submissions are ok.
    - Final results will be based on the latest submission.
- Teams are allowed, but we can only offer one prize to each team.
- Results will be announced every Friday.
- The final results will be announced at the workshop awards session.
- The deadline is 23:59:59 CET on 8 June, 2025.