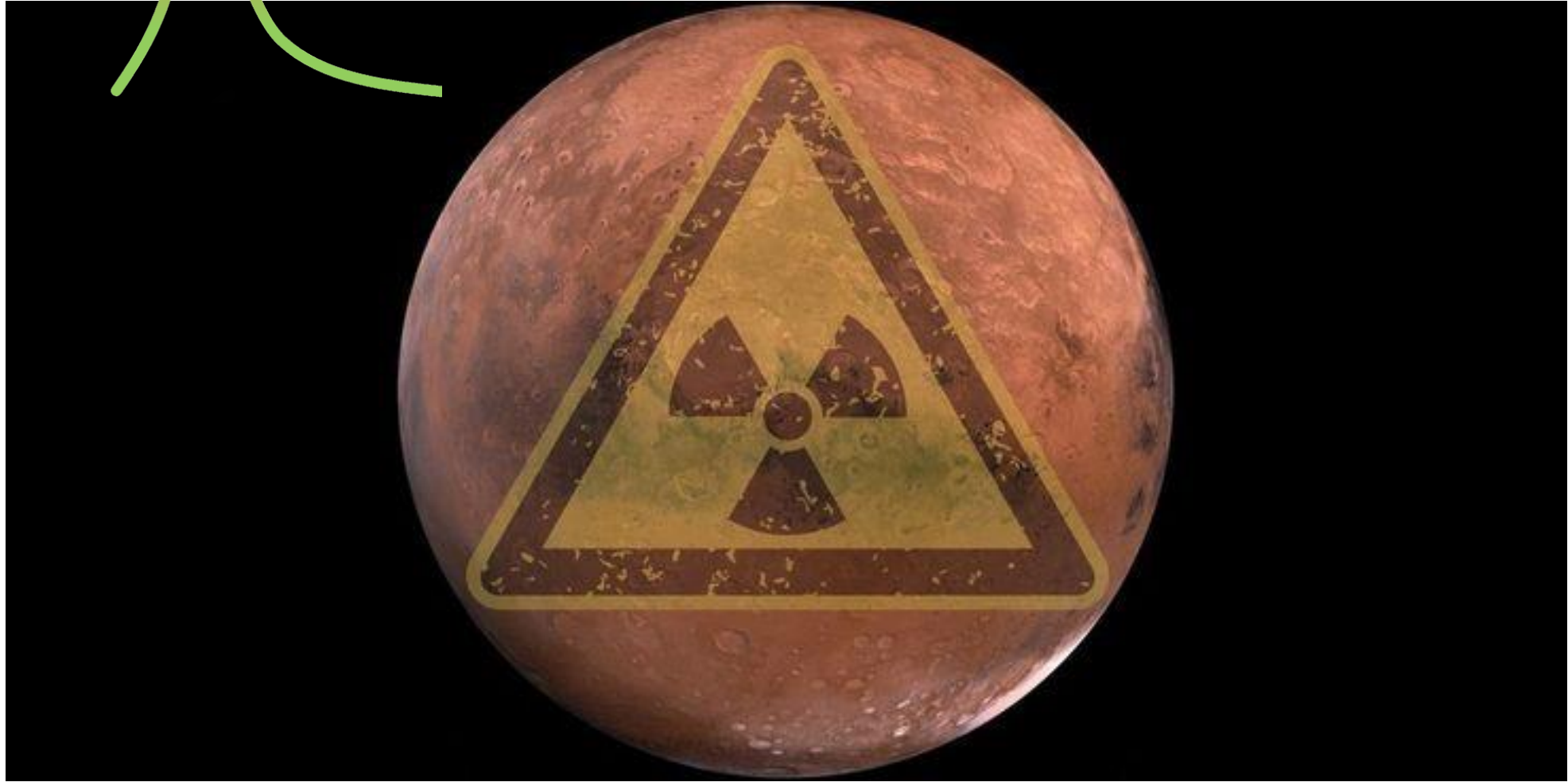
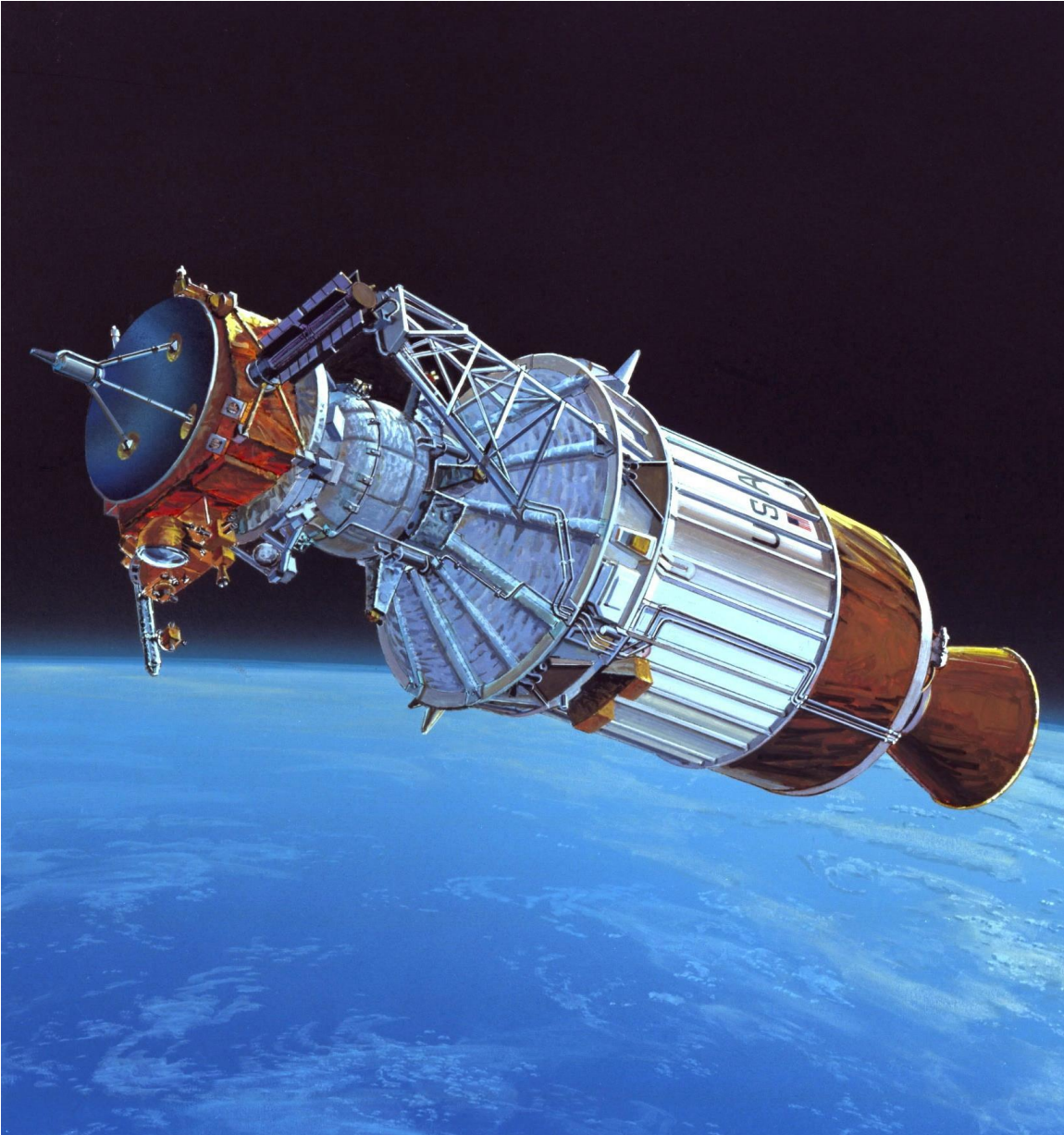


# MODE DATA CHALLENGE



## INTRODUCTION

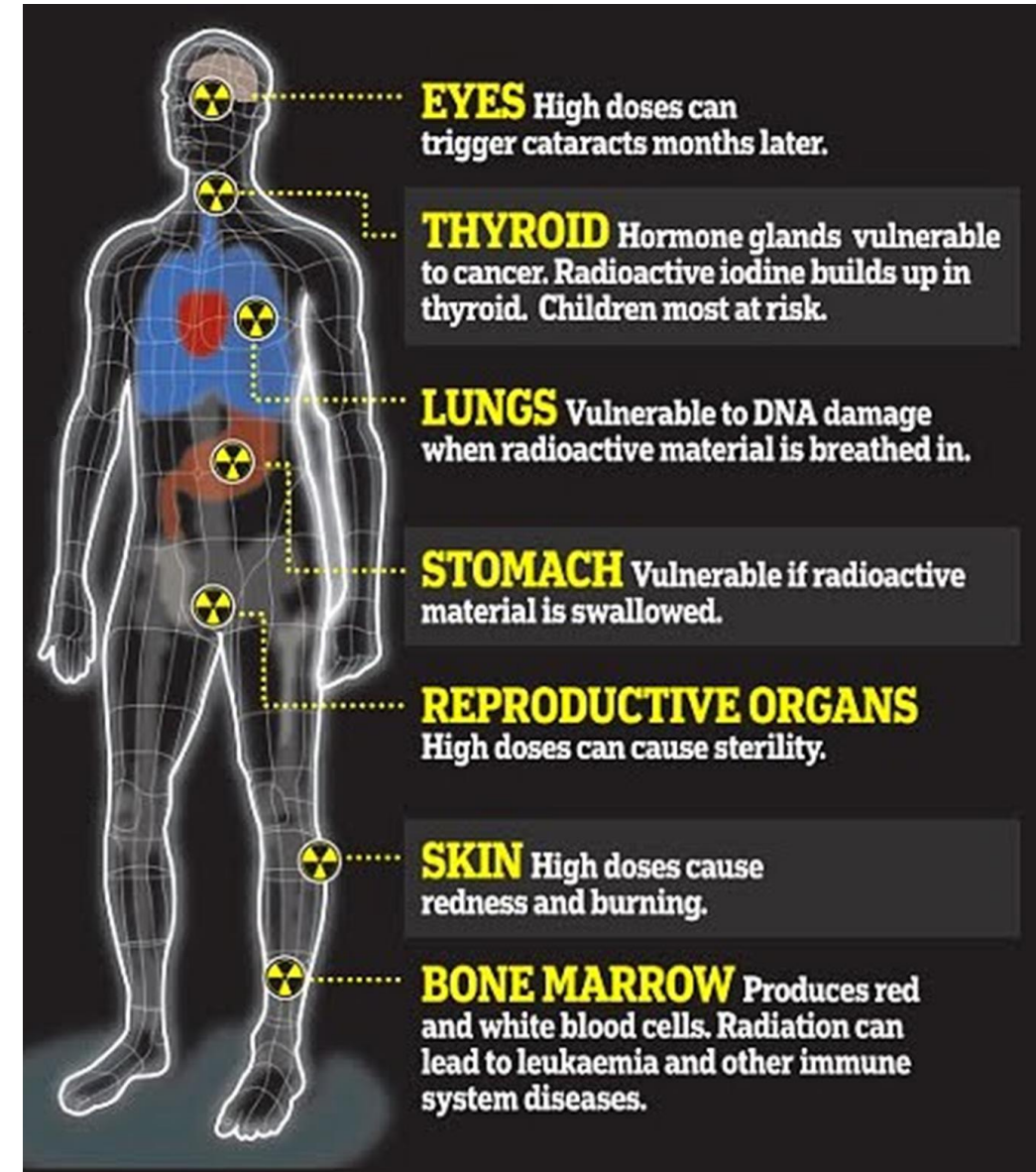
# Overview



- 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

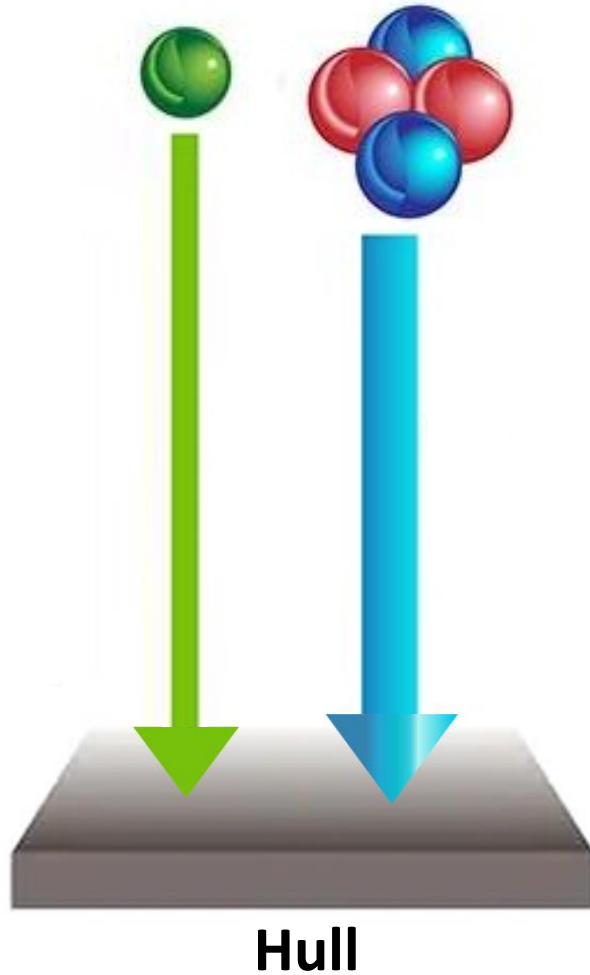
- Without the protection of earth's magnetosphere, the astronauts aboard future missions to Mars will be shielded only by the spacecraft itself.
- A dose of **100 milliSieverts** per year is known to increase cancer risk and other illnesses. Radiation workers on earth are limited to 50 mSv per year. Six months aboard the ISS exposes a crewmember to 72mSv, 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.



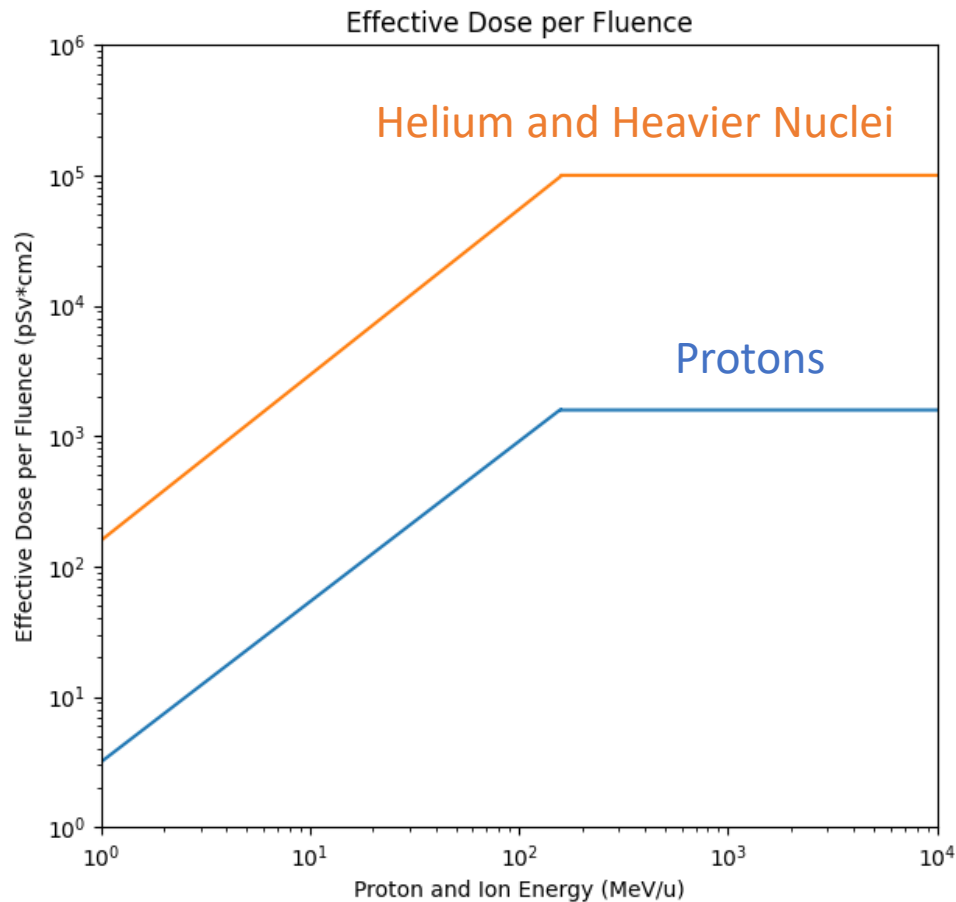


# The Task

Protons      GCR



- 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  $100\text{m}^3$ . The hull material(s), thickness, and shape are up to you.
- Beyond the 100mSv and  $100\text{m}^3$  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 100m<sup>3</sup>.
3. The effective doses for various energetic particles are shown below. Datasets for particle fluences are available at <https://github.com/Mode2025/Data-Challenge/>.

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

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

# Scoring

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- **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

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- Participants must send an email to the workshop organizers at [mode-workshop-organizers@cern.ch](mailto: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.**