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ACCEDE | ESCCON

2025 Seville, Spain
25 - 27 March

SESSION:

RADIATION SHIELDING
MATERIALS AND OTHER
MATERIALS RELATED
TOPICS ON COTS



Talk:

**New radiation shielding materials
that allow COTS electronics
components to be used in Space**





Stephen Voller

Ancilia Shielding, Inc

New radiation shielding materials to allow COTS
components to be used

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- About Ancilia Shielding
- Why do we need radiation shielding in space ?
- Why existing materials are ineffective ?
- Test results from our new materials



Ancilia Shielding Inc, is a Florida based company focused on developing the next generation of space radiation materials to protect crewed and uncrewed missions in future space exploration

Richard Godwin and Paul Simpson
Space Technology Holdings, Inc

Stephen Voller C.Eng and Gayle Voller
CEO & Founder
B.Sc (hons) Human Biology

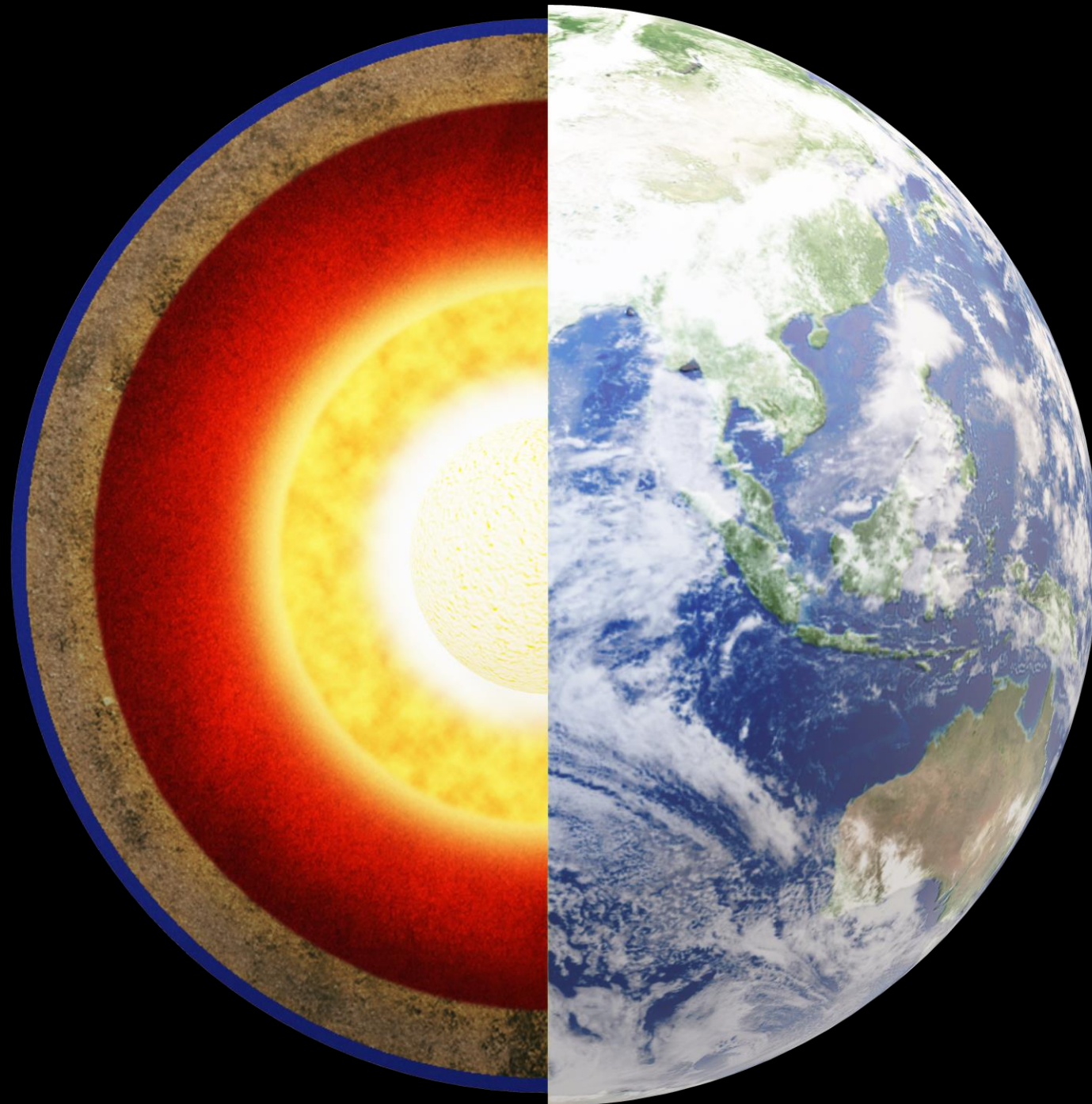


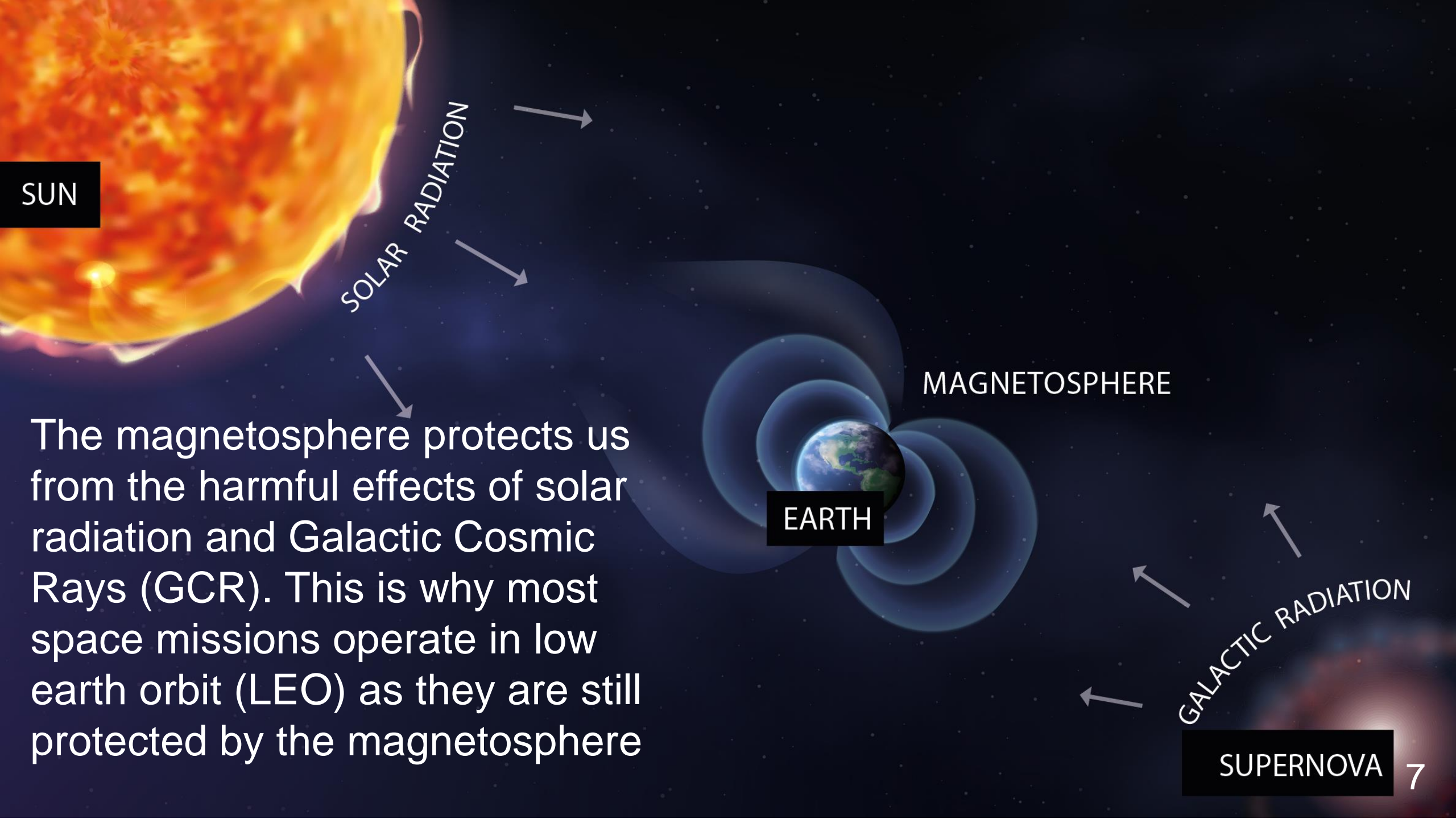
Why do we
need radiation
shielding in
space ?

Life exists on
Earth because
on the surface
we are
protected from
space
radiation



Our planet has a molten core, and this creates a protective radiation shield called the magnetosphere





SUN

SOLAR RADIATION

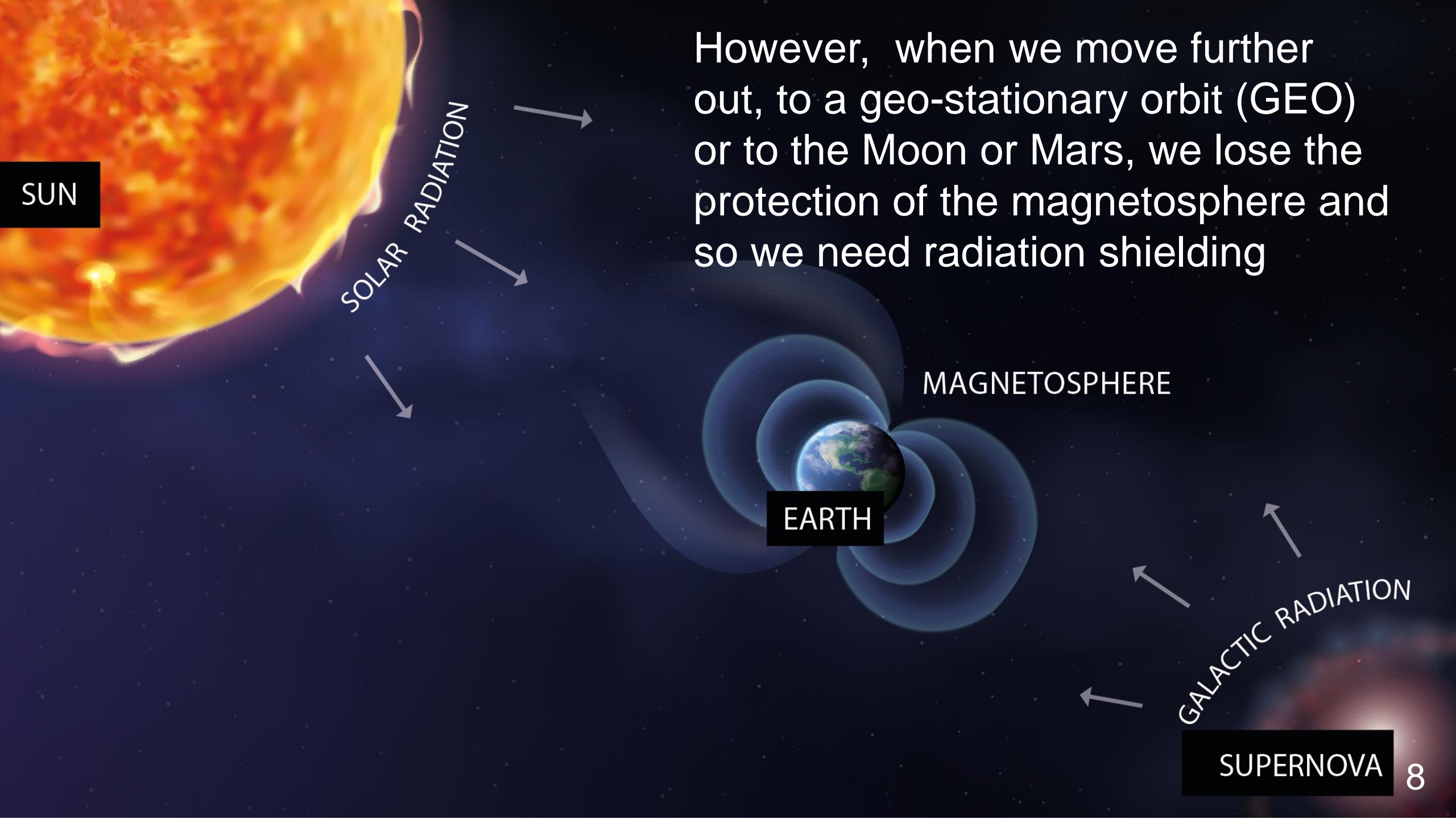
MAGNETOSPHERE

EARTH

GALACTIC RADIATION

SUPERNOVA

The magnetosphere protects us from the harmful effects of solar radiation and Galactic Cosmic Rays (GCR). This is why most space missions operate in low earth orbit (LEO) as they are still protected by the magnetosphere



SUN

SOLAR RADIATION

However, when we move further out, to a geo-stationary orbit (GEO) or to the Moon or Mars, we lose the protection of the magnetosphere and so we need radiation shielding

MAGNETOSPHERE

EARTH

GALACTIC RADIATION

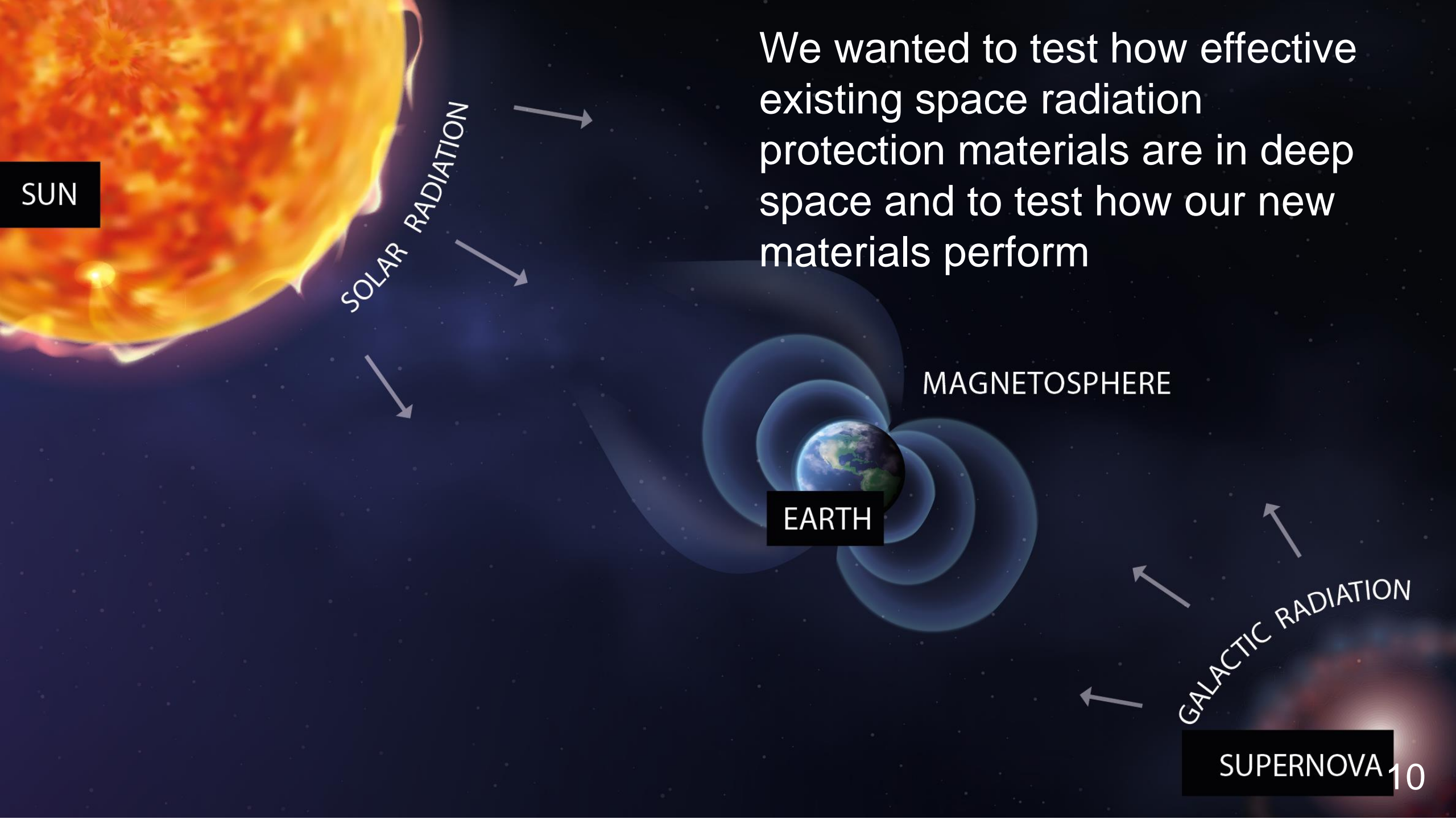
SUPERNOVA 8

- The US Department of Energy (DoE) publishes guidelines on the maximum safe radiation exposure.
- Crewed missions to deep space would exceed these safe limits.
- Electronic circuits must be protected by using radiation hardened (Rad-hard) components. Rad-hard components can be 10x to 20x more expensive than commercial off-the-shelf (COTS) components.

Summary of DOE Radiation Dose Limits

Limits	
Whole body	5,000 mrem/year
Extremities	50,000 mrem/year
Skin	50,000 mrem/year
Internal organs	50,000 mrem/year
Lens of the eye	15,000 mrem/year
Declared pregnant worker	500 mrem/gestation
Untrained person	100 mrem/year





SUN

SOLAR RADIATION

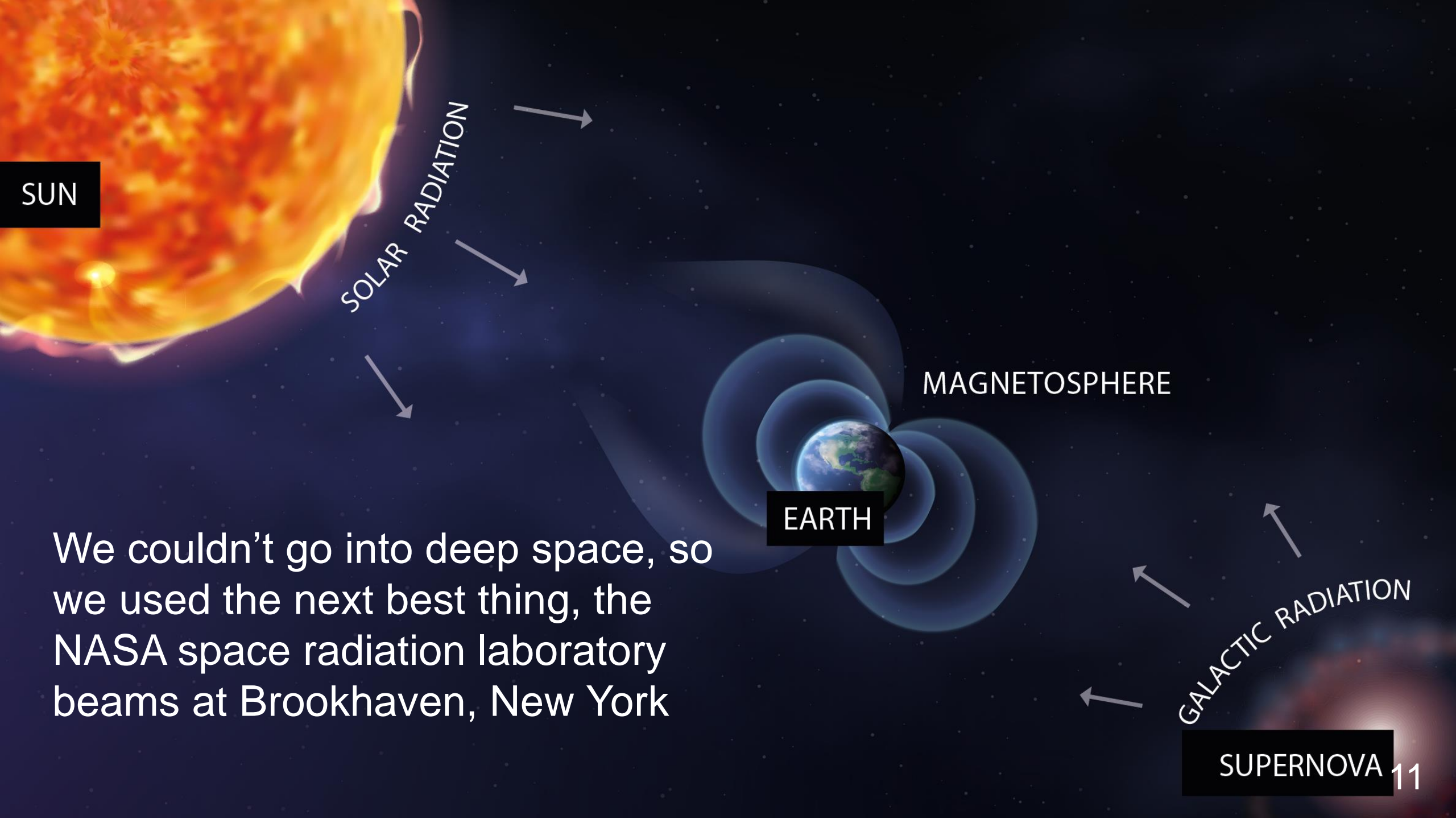
We wanted to test how effective existing space radiation protection materials are in deep space and to test how our new materials perform

MAGNETOSPHERE

EARTH

GALACTIC RADIATION

SUPERNOVA 10



SUN

SOLAR RADIATION

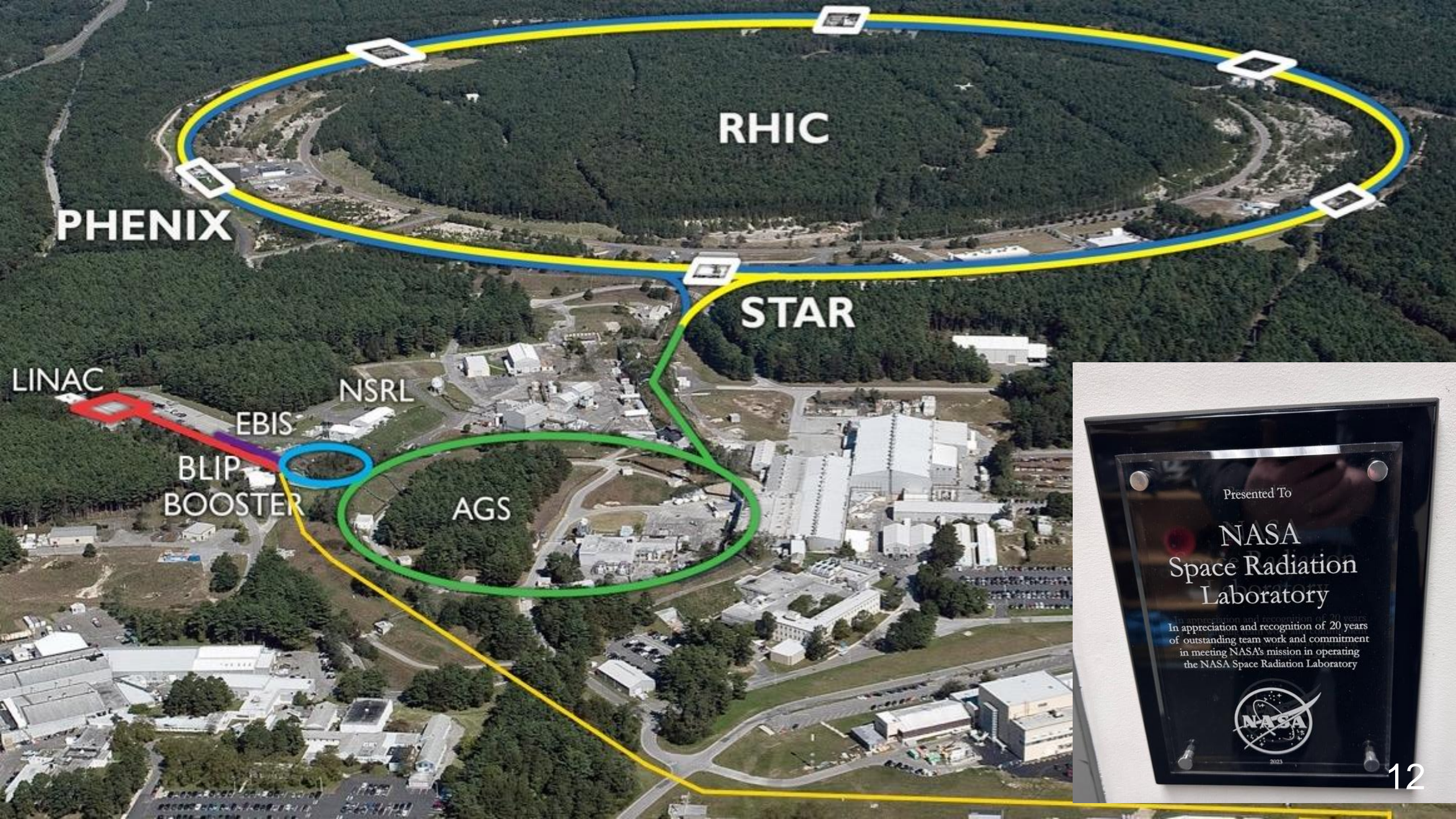
MAGNETOSPHERE

EARTH

GALACTIC RADIATION

SUPERNOVA 11

We couldn't go into deep space, so we used the next best thing, the NASA space radiation laboratory beams at Brookhaven, New York



PHENIX

RHIC

STAR

LINAC

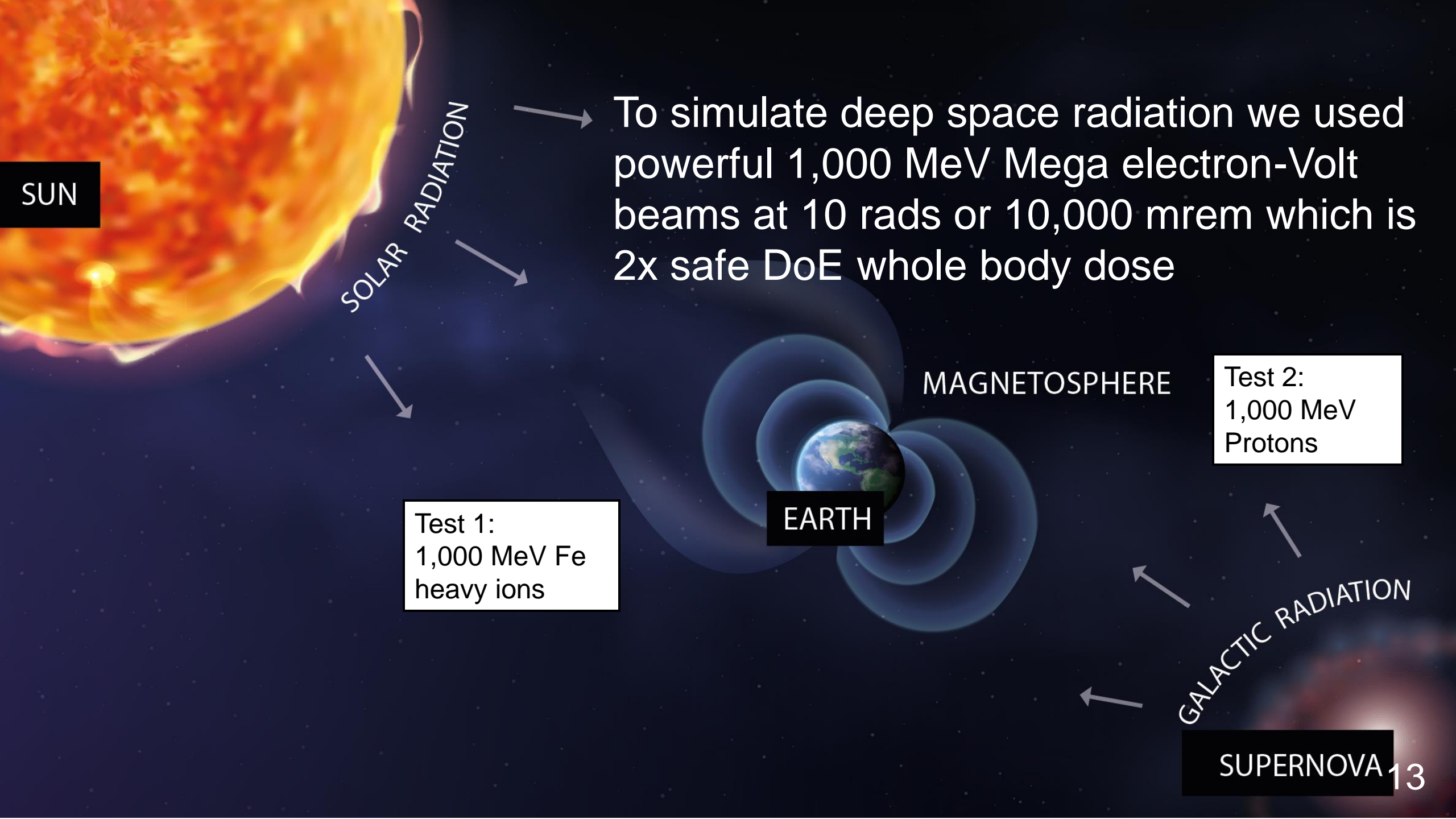
NSRL

EBIS

BLIP
BOOSTER

AGS





SUN

SOLAR RADIATION

To simulate deep space radiation we used powerful 1,000 MeV Mega electron-Volt beams at 10 rads or 10,000 mrem which is 2x safe DoE whole body dose

MAGNETOSPHERE

EARTH

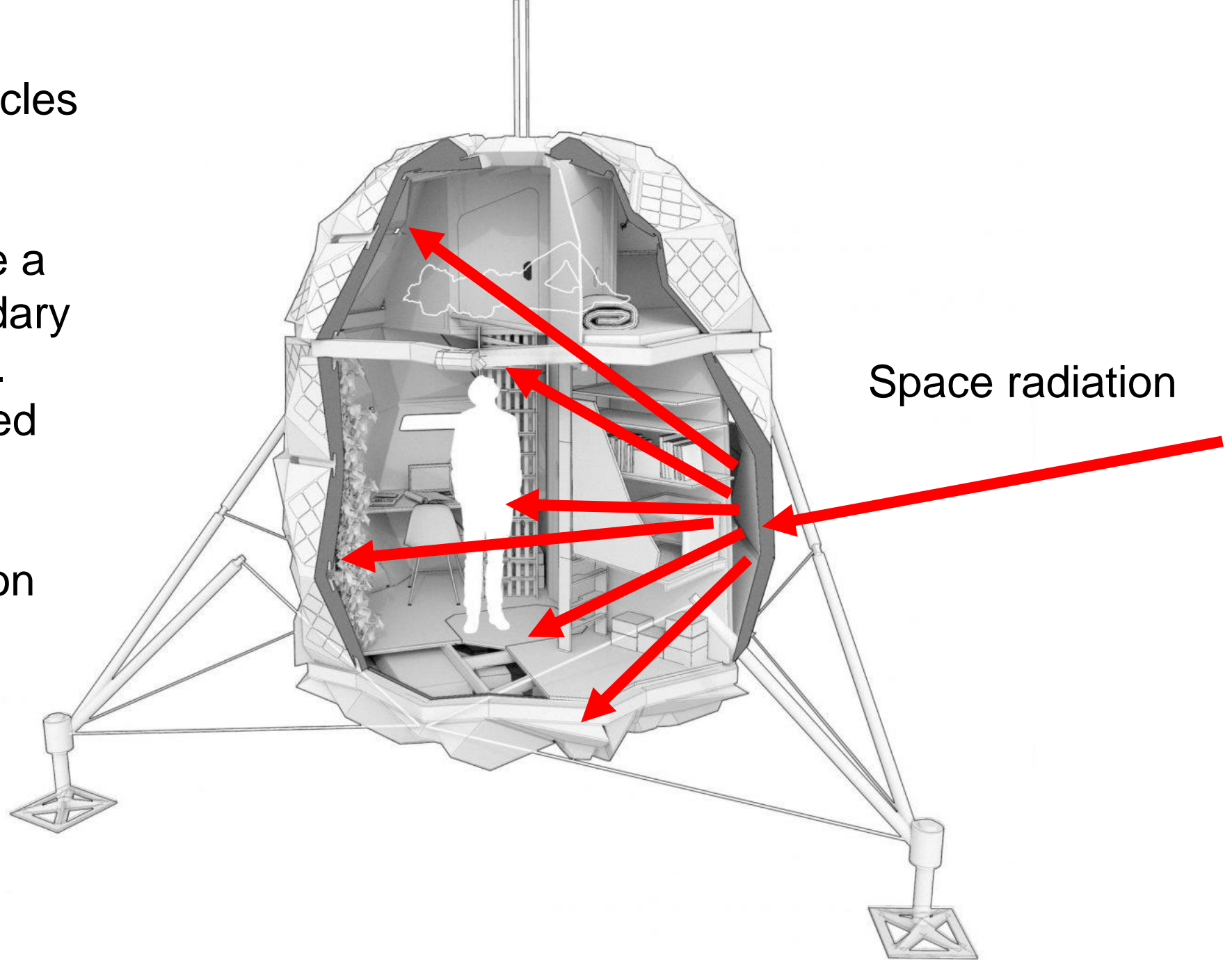
Test 1:
1,000 MeV Fe
heavy ions

Test 2:
1,000 MeV
Protons

GALACTIC RADIATION

SUPERNOVA 13

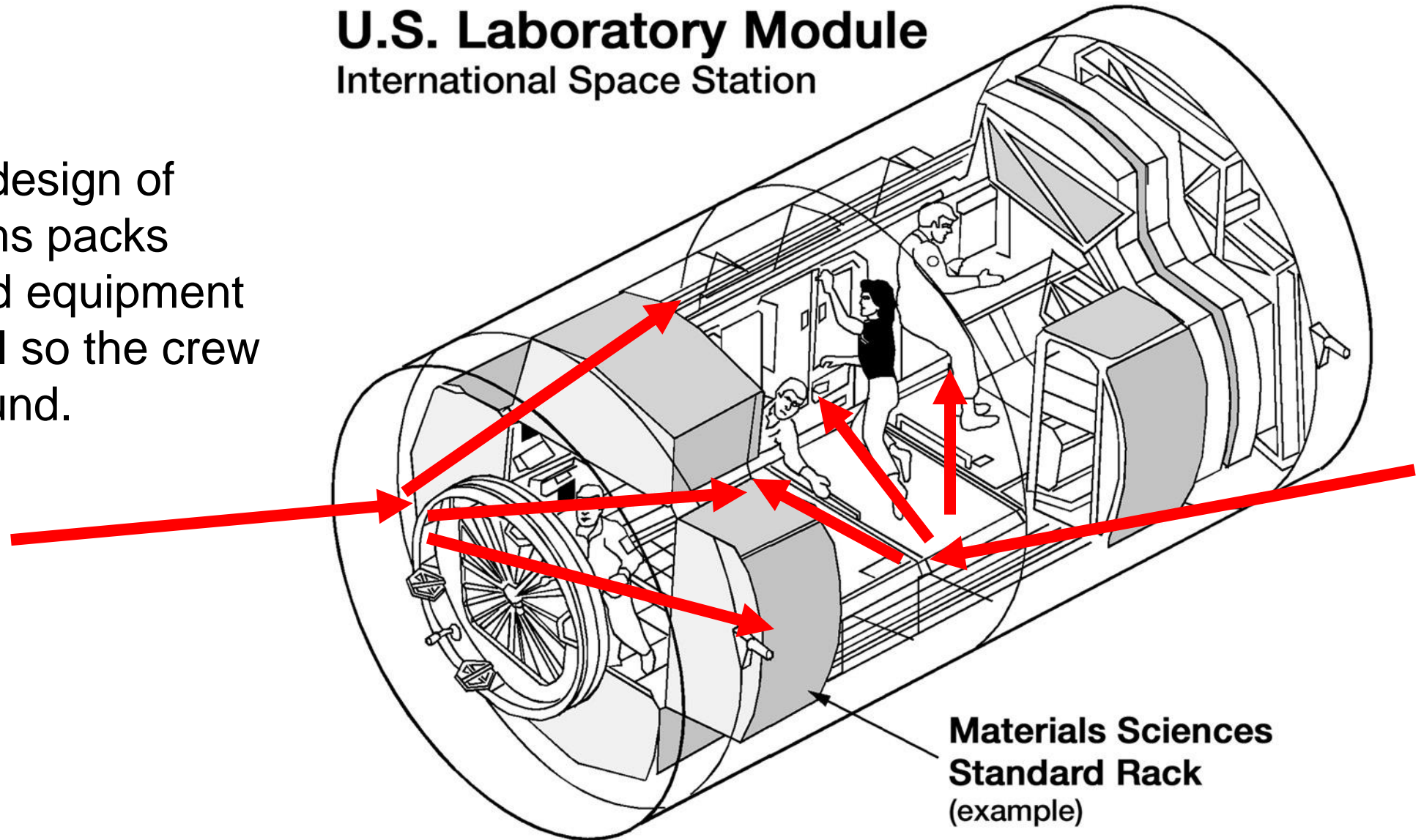
High energy particles colliding with the metal hull of a spacecraft, cause a shower of secondary ionizing radiation. This effect is called sintering and increases the radiation effects on electronics and human tissue



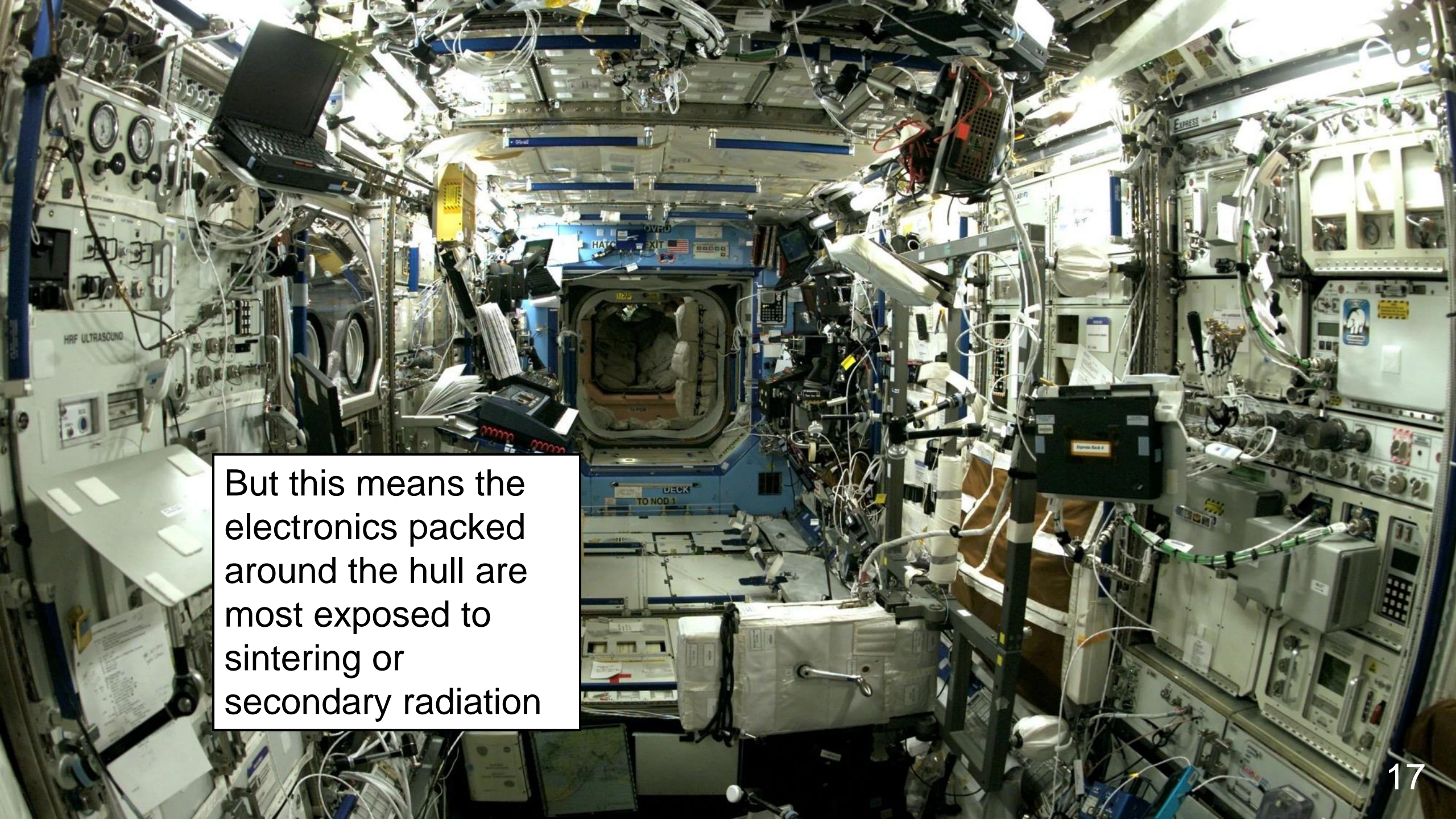
U.S. Laboratory Module

International Space Station

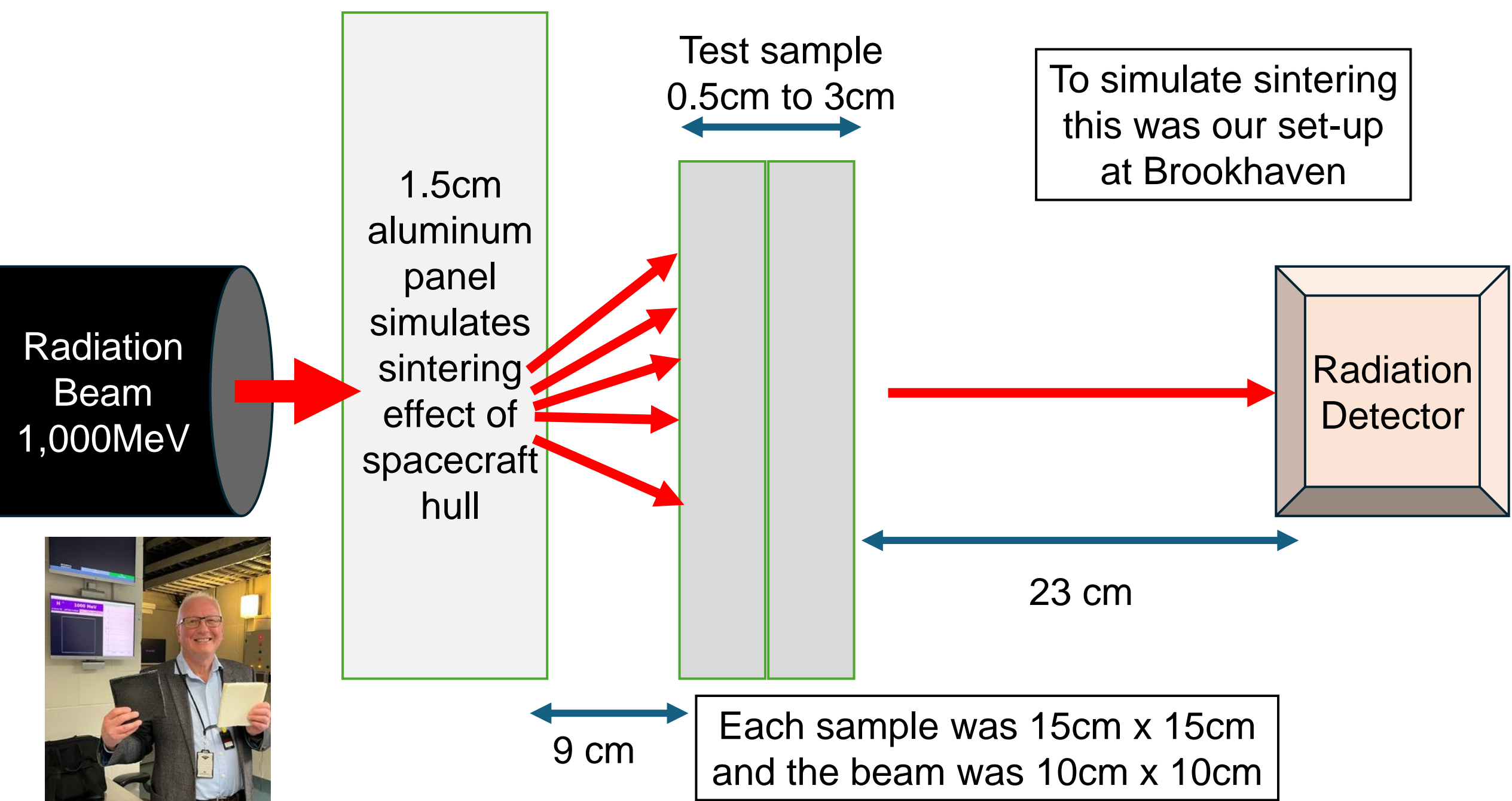
Conventional design of crewed systems packs electronics and equipment around the hull so the crew can move around.



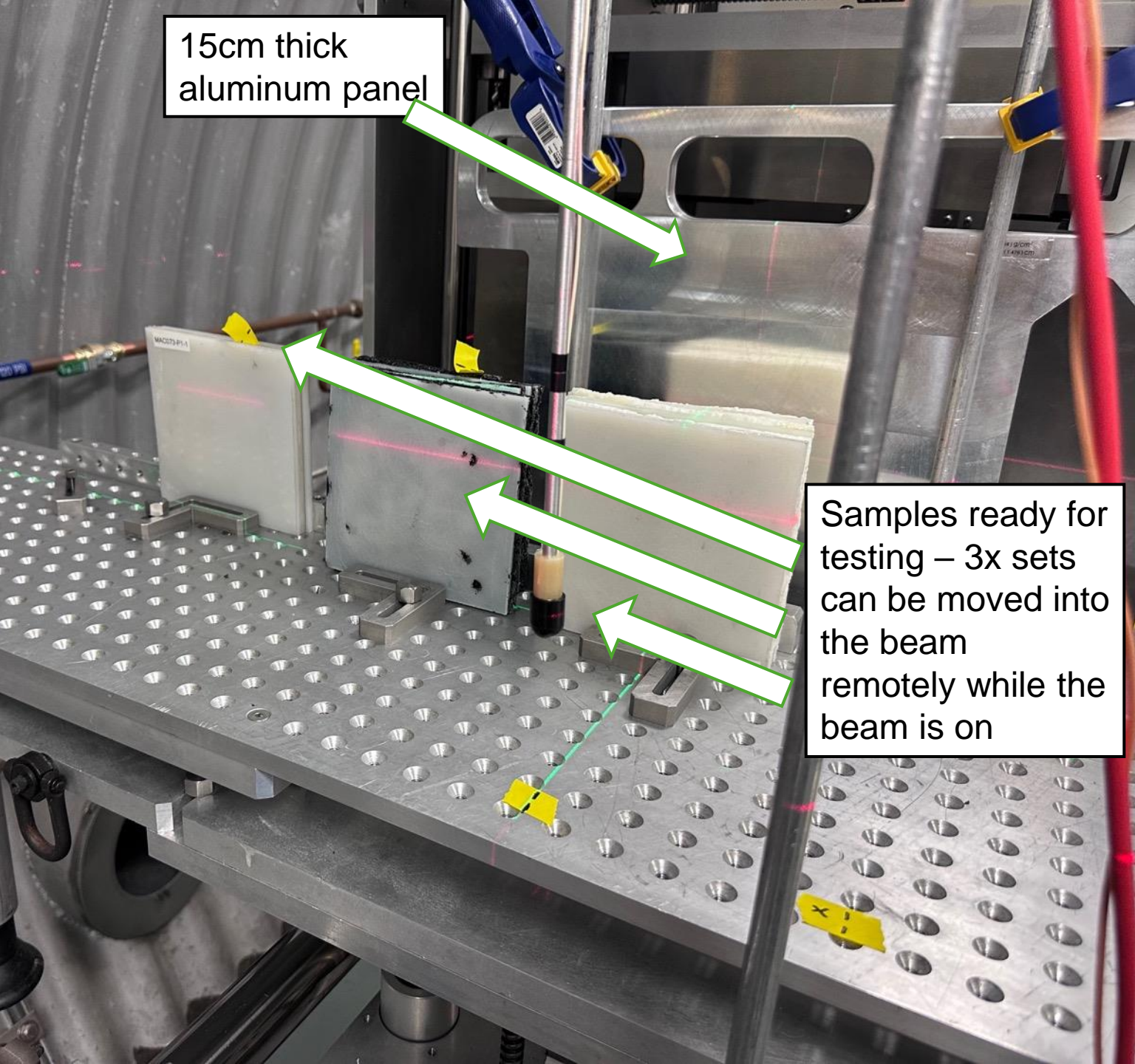




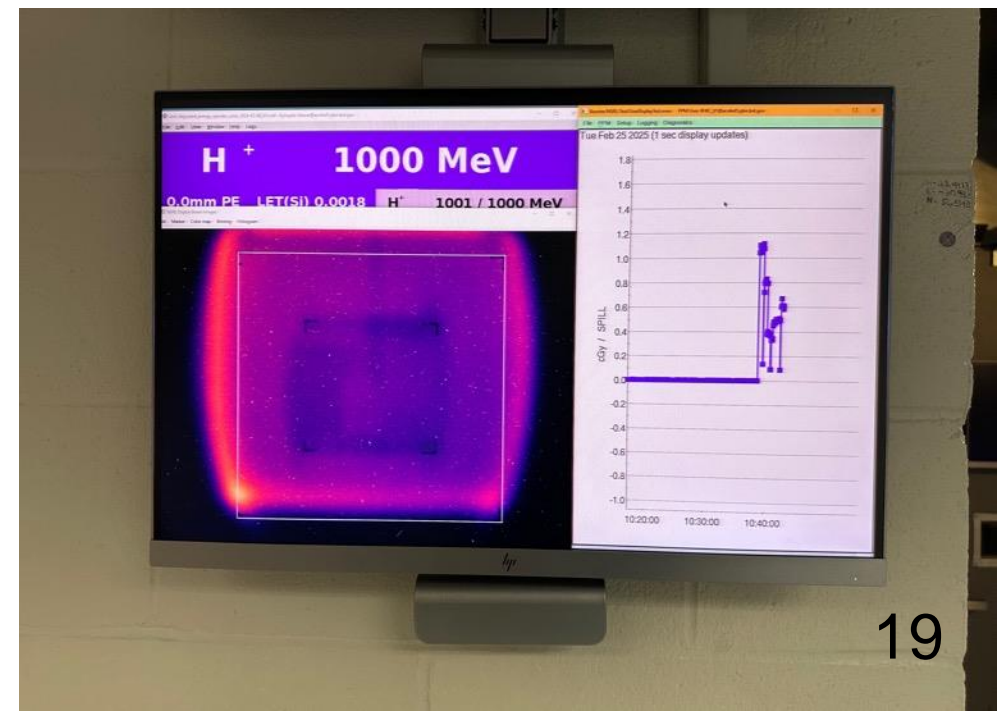
But this means the electronics packed around the hull are most exposed to sintering or secondary radiation



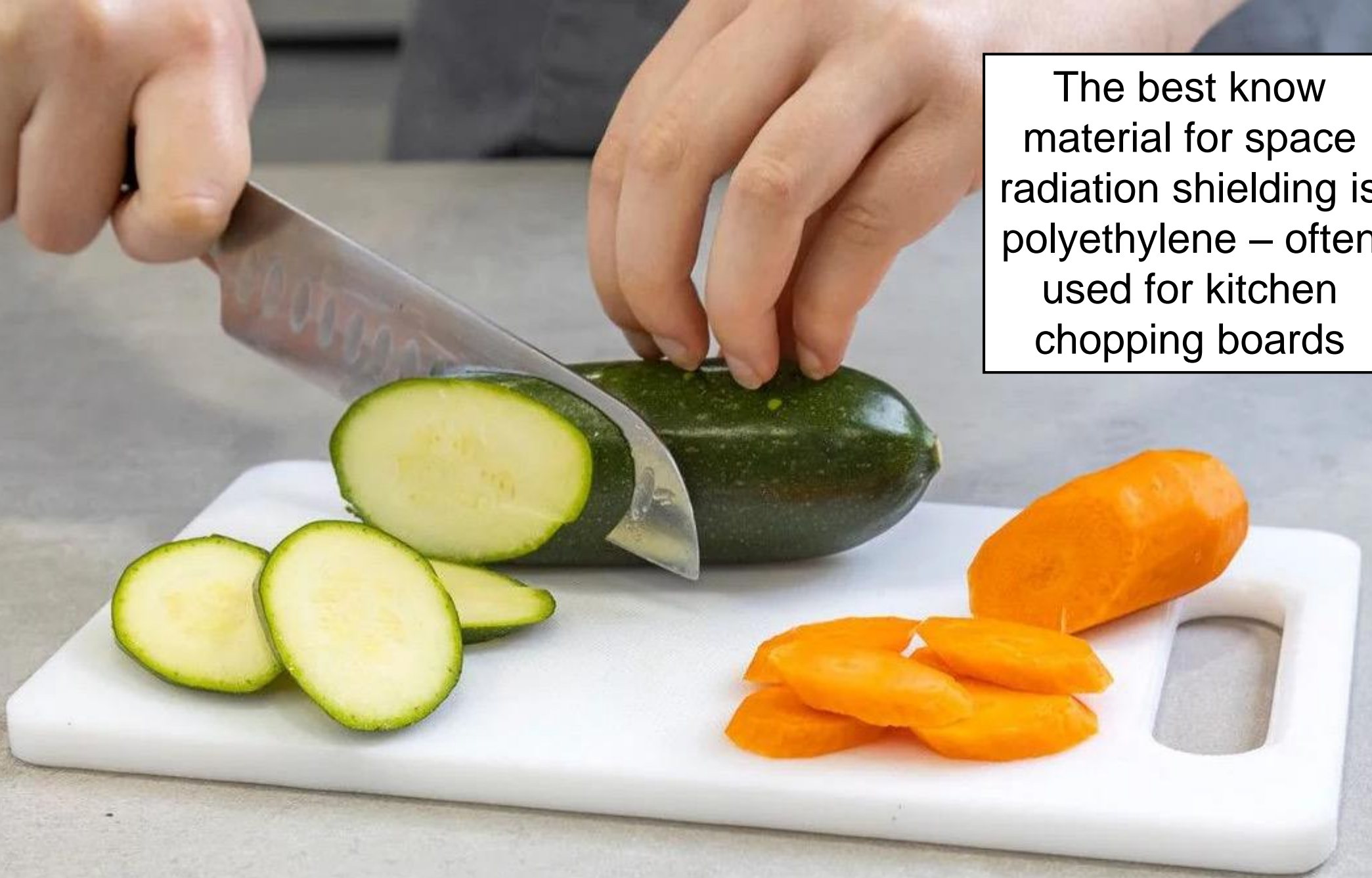
15cm thick aluminum panel



Samples ready for testing – 3x sets can be moved into the beam remotely while the beam is on



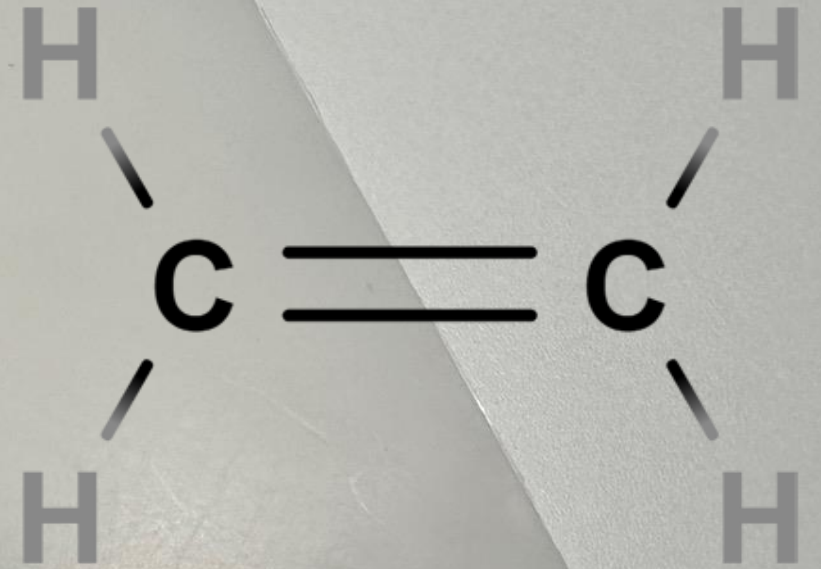
The best know material for space radiation shielding is polyethylene – often used for kitchen chopping boards



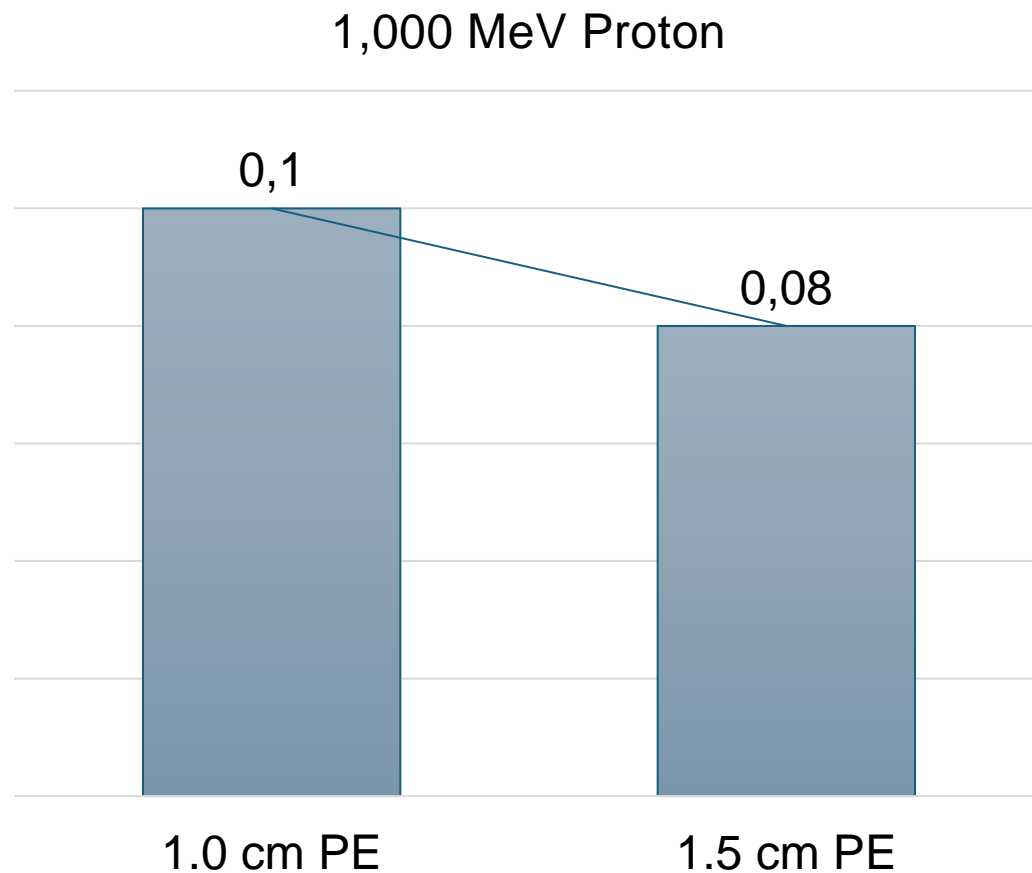
This is because
Ultra High Molecular Weight Polyethylene UHMWPE
has a high hydrogen content

Polyethylene

C_2H_4 14% Hydrogen by weight

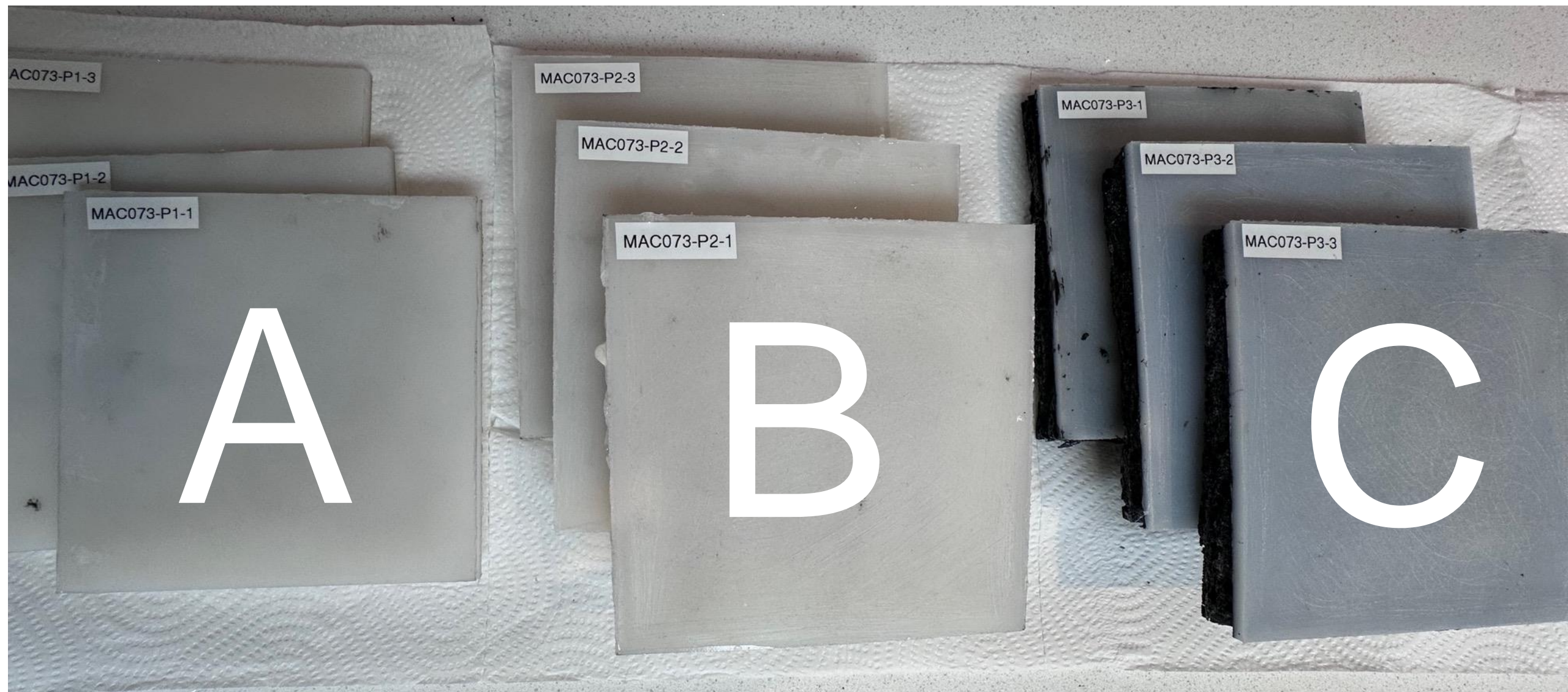


But the performance of polyethylene is not good



Increasing the thickness of UHMWPE ultra high molecular weight polyethylene (PE) in a proton beam, reduces the radiation shielding properties because of the secondary or sintering effects of the material itself.

Data shown is % of radiation shield effectiveness per cm of material



A samples are UHMWPE
or polyethylene (PE)

B samples are Ancilia
Shield new material mix 1

C samples are Ancilia
Shield new material mix 2



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1,000MeV test – % shielding effect

