THE UNIVERSITY OF MELBOURNE

High Efficiency Perovskite solar cells for space applications

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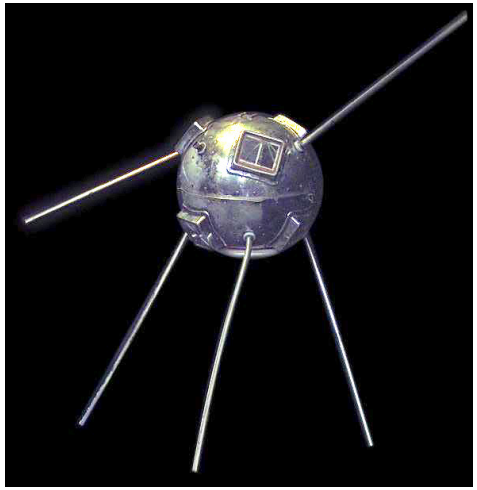
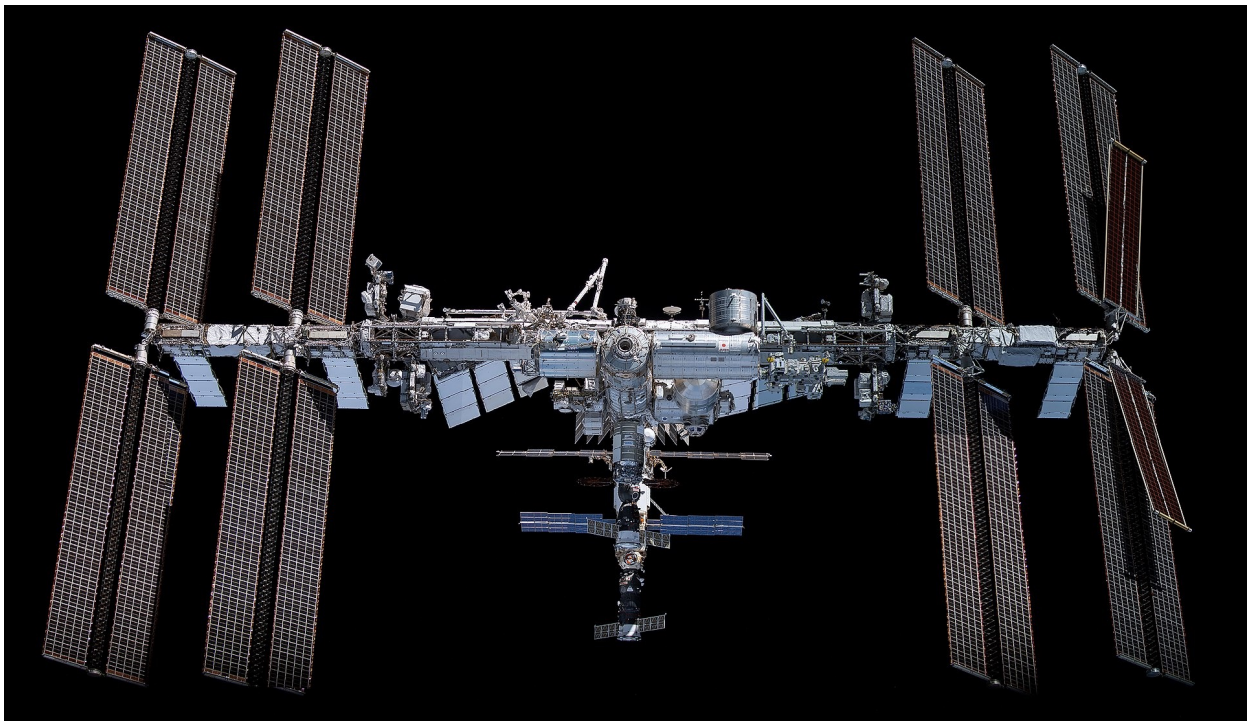
Australian Research Council Centre of Excellence in exciton science

The solar cell was invented for space applications

1954



1958



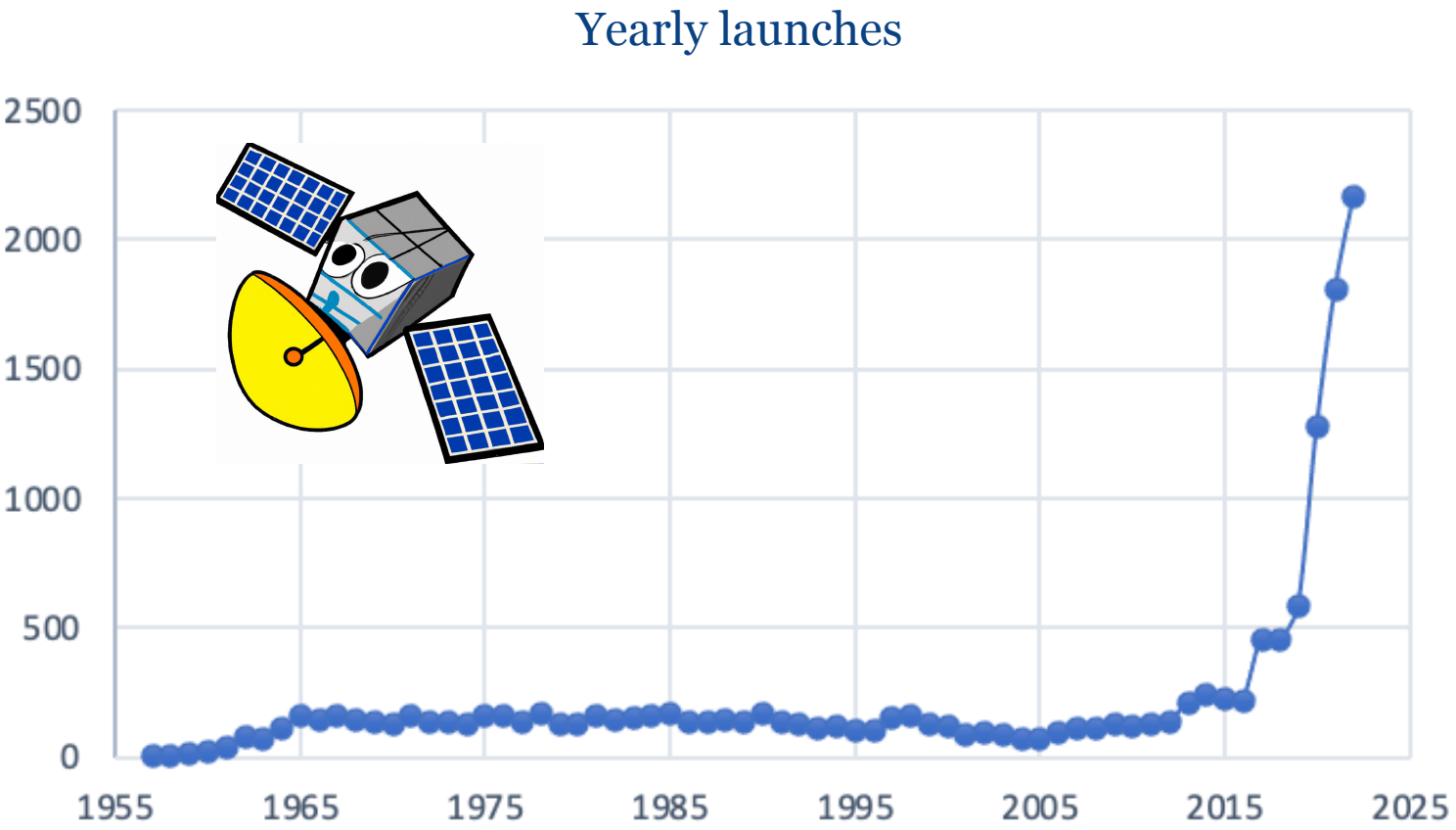
2021

2023

SpIRIT from Melbourne in orbit 1st Dec!

Demand for electrical energy in space is rocketing up!

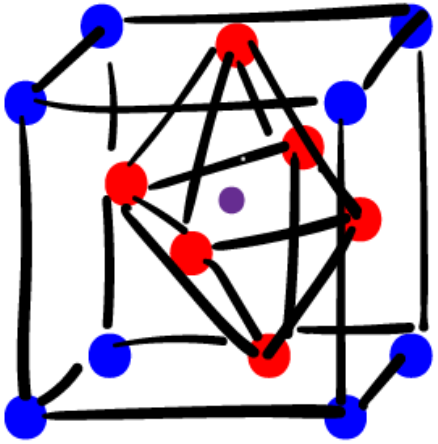
- > 2000 satellites launched in 2022
- All require electricity to operate

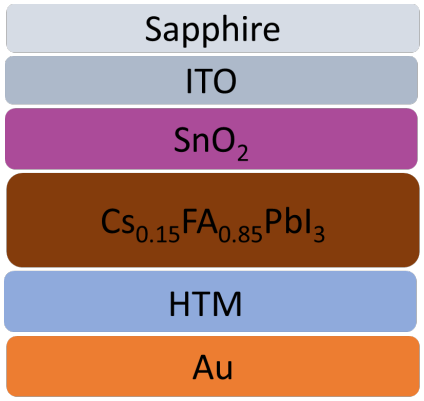


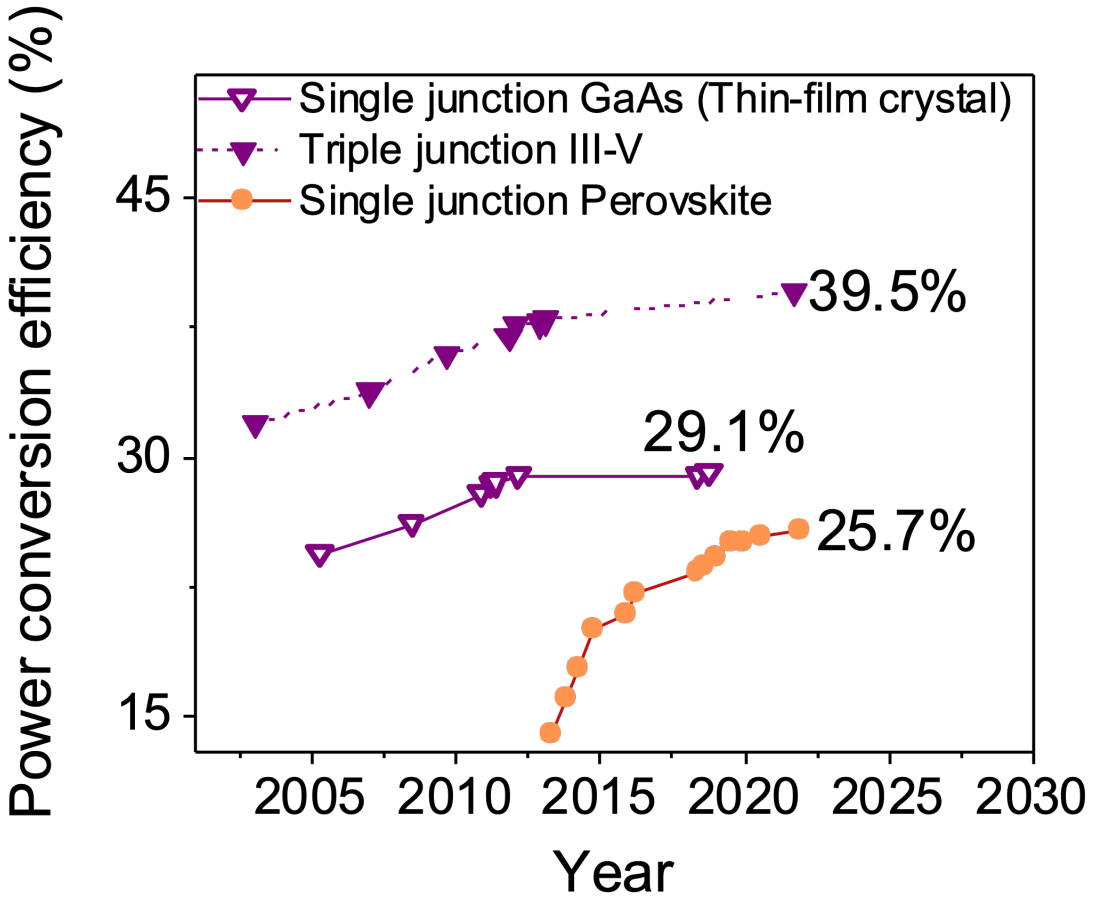
Data adapted from: www.ourworldindata.org

Perovskite solar cells

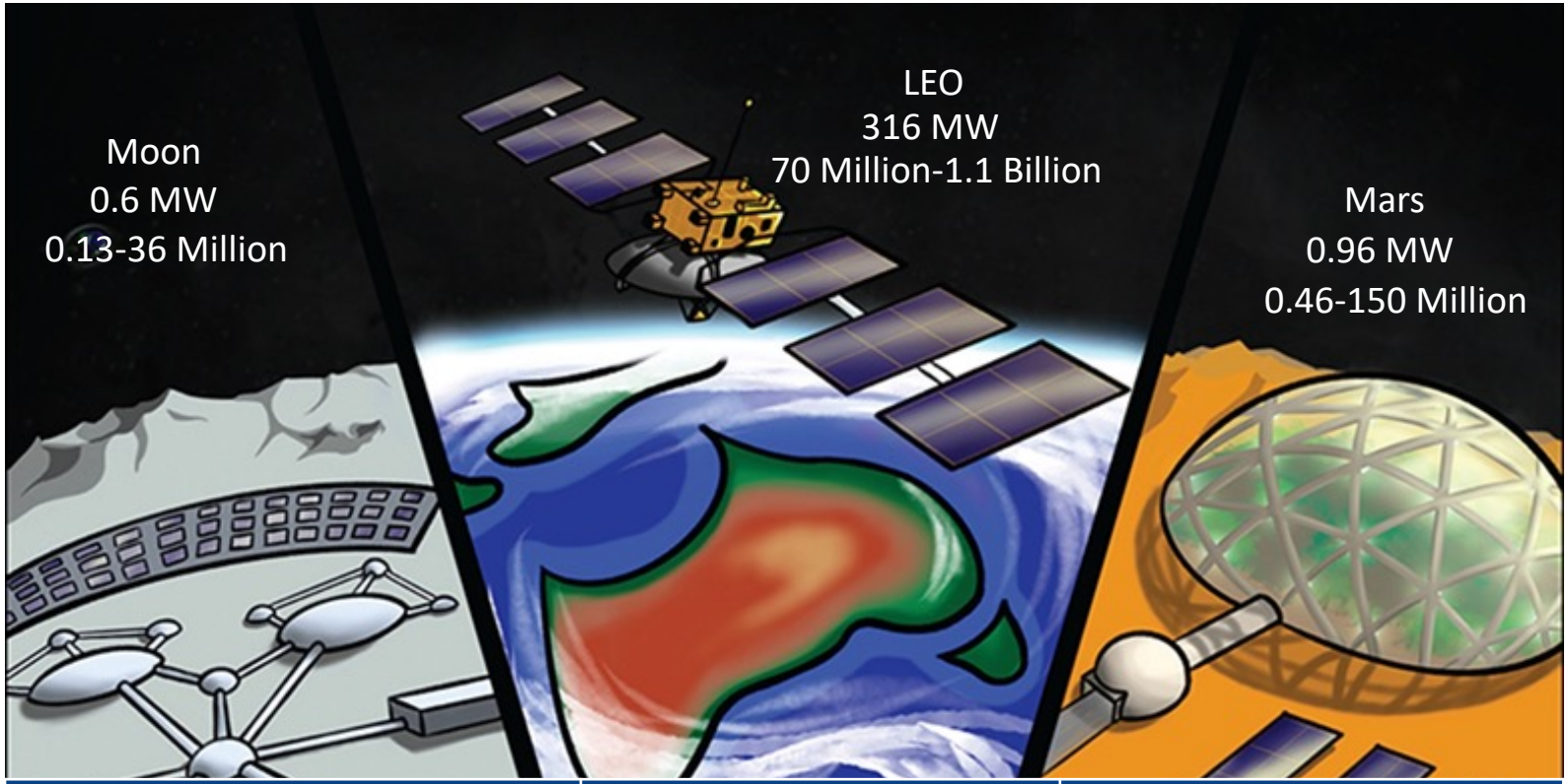
- Inorganic-organic hybrid material with crystal structure
- Low cost, thin, lightweight, flexible, and increasingly efficient







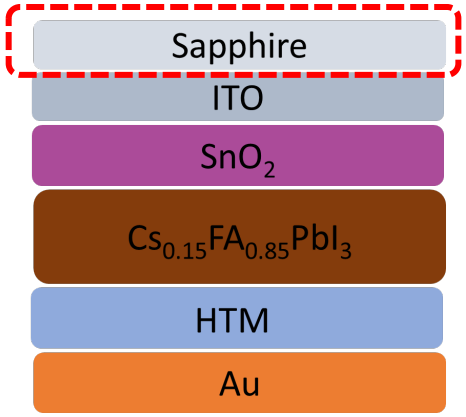
High potential for solar cells in low earth orbits (LEOs)



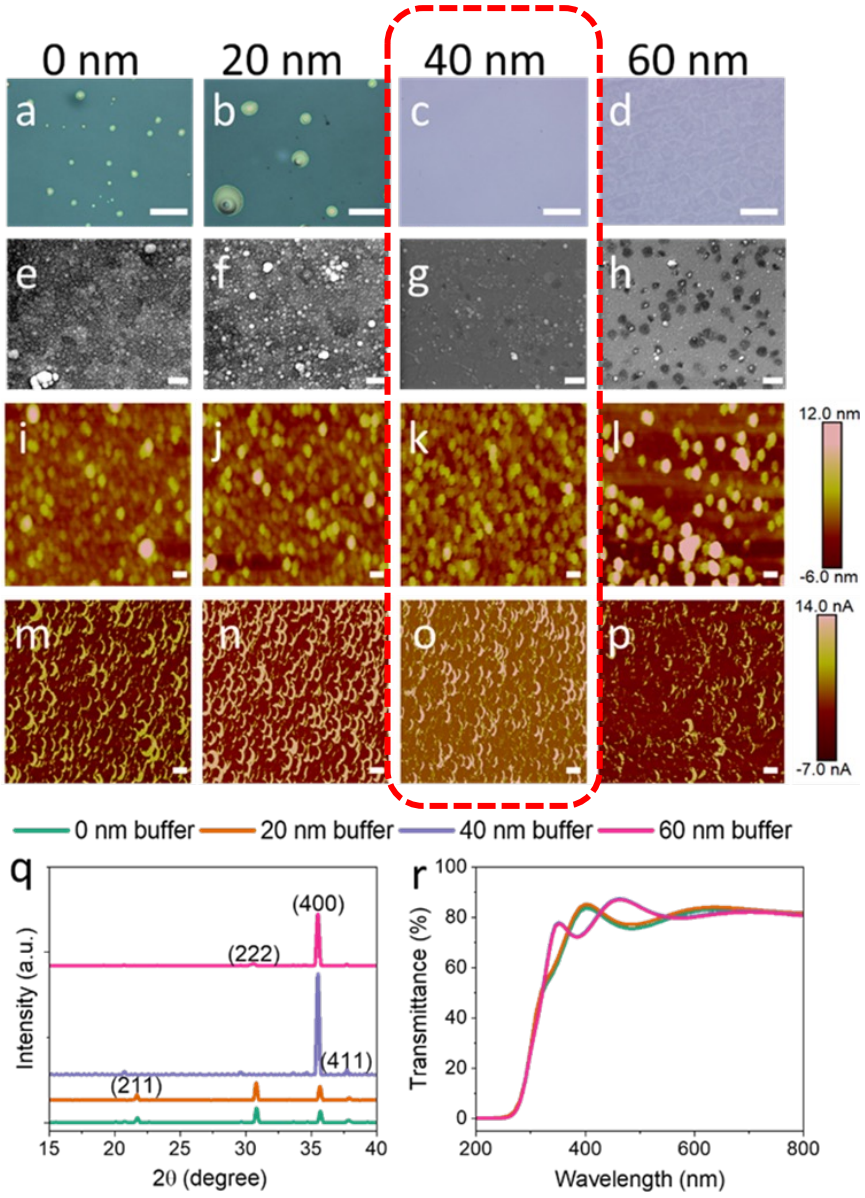
Metrics	Perovskite	III-V
Power to weight ratio [W g^{-1}]	79-83	3
Manufacturing cost [USD m^{-2}]	90-600	13200-33000
Radiation hardness	√√	√

Ho-Baillie, Anita WY, et al. "Deployment opportunities for space photovoltaics and the prospects for perovskite solar cells." Advanced Materials Technologies 7.3 (2022): 2101059.

Challenge towards efficient space solar cells--substrate



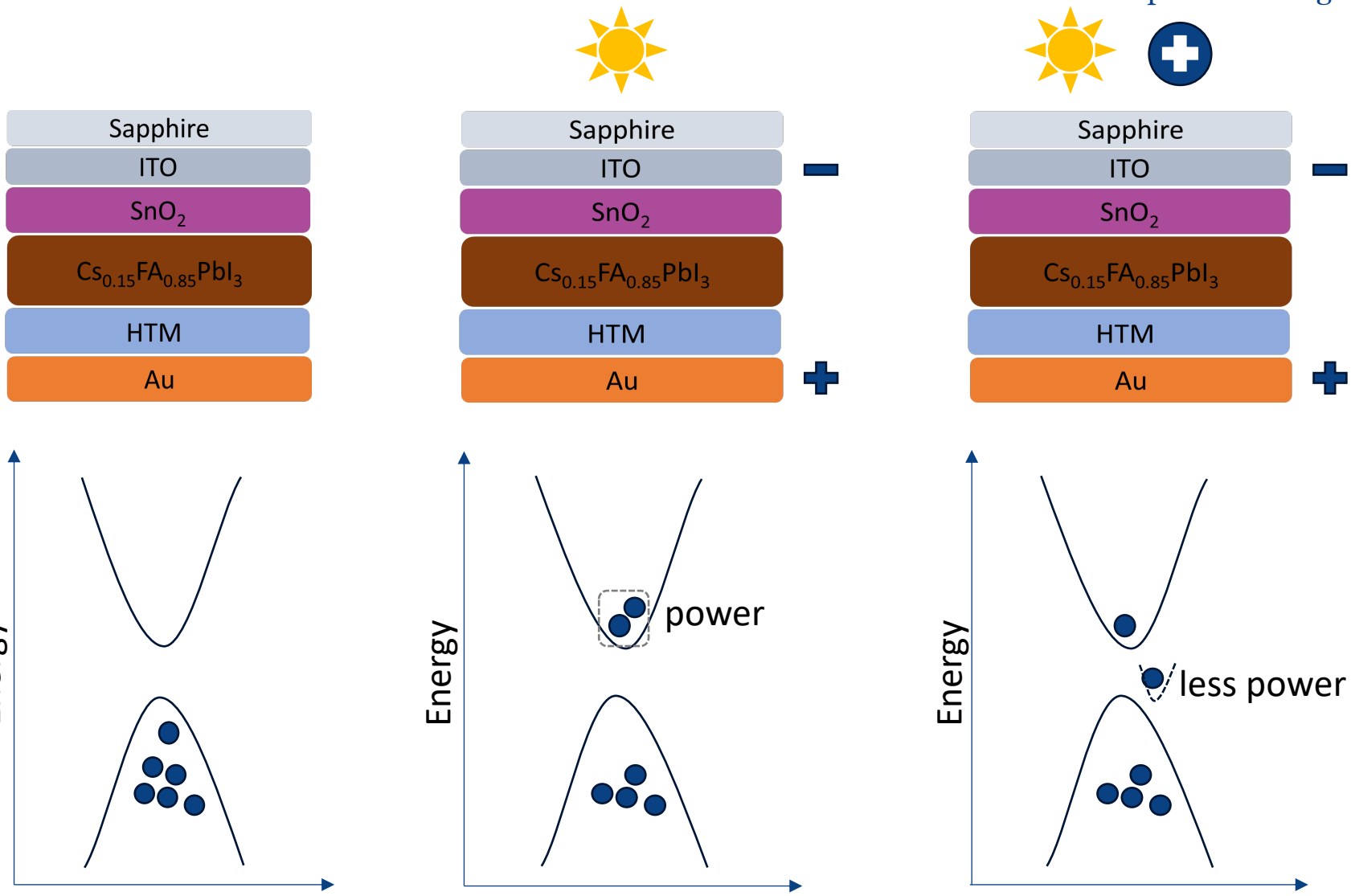
ITO coating is difficult on Sapphire, due to mechanical stress.



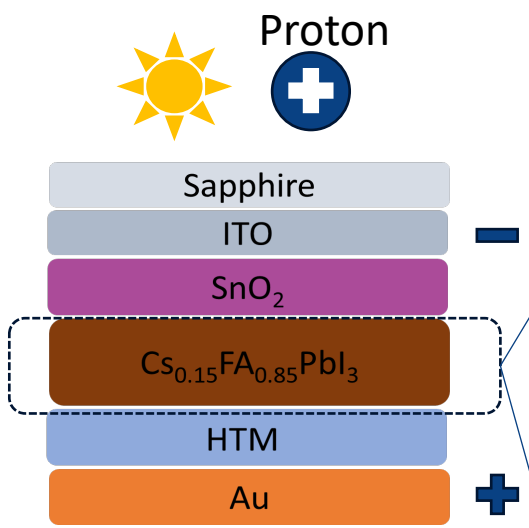
(a-d) Optical, (e-h) top view SEM; (i-l) AFM and (m-p) conductive-AFM images of ITO on 175-µm sapphire superstrate with varying underlying Al_2O_3 buffer layer thickness: (a, e, i, m) 0 nm; (b, f, g, n) 20 nm; (c, g, k, o) 40 nm and (d, h, l, p) 60 nm. Scale bars are 100 µm for optical images in (a) to (d) and 300 nm for other images (e) to (p).

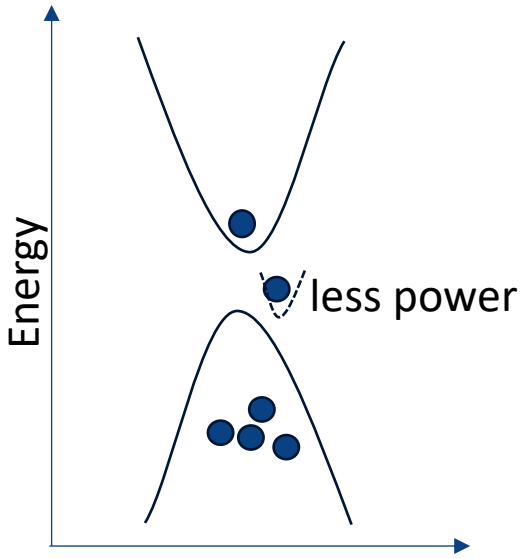
Radiation in space is a challenge for solar cells

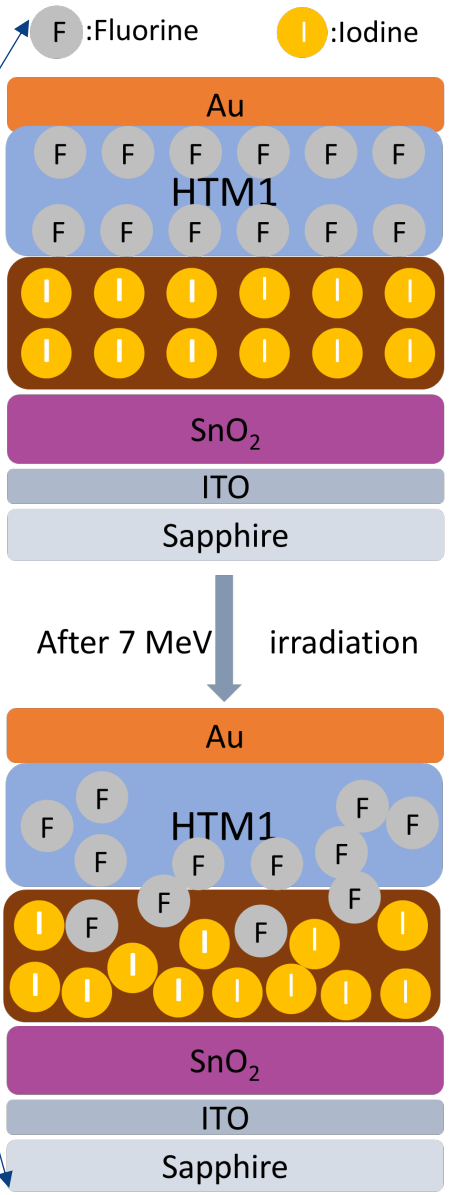
Proton: subatomic particle with a positive charge

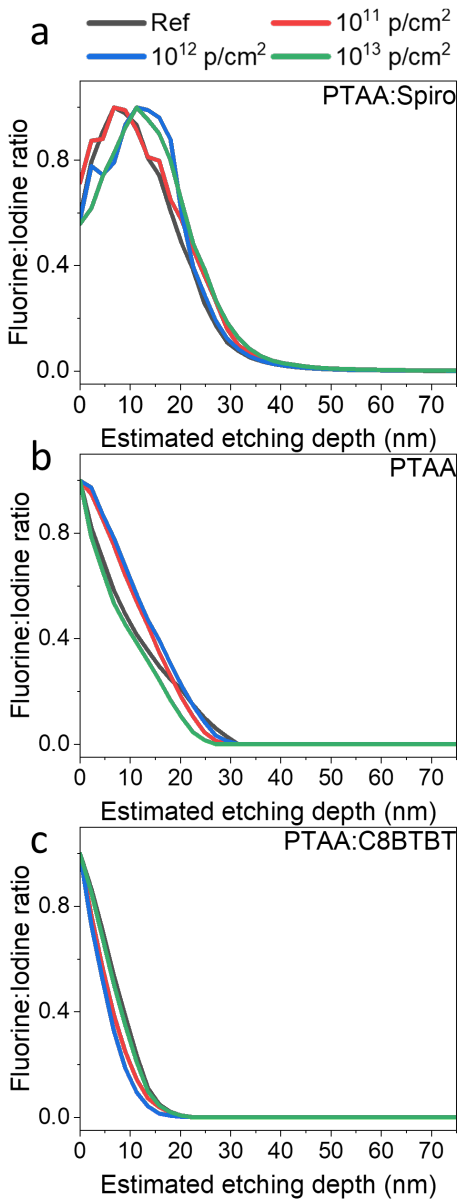


How protons reduce solar cell efficiency

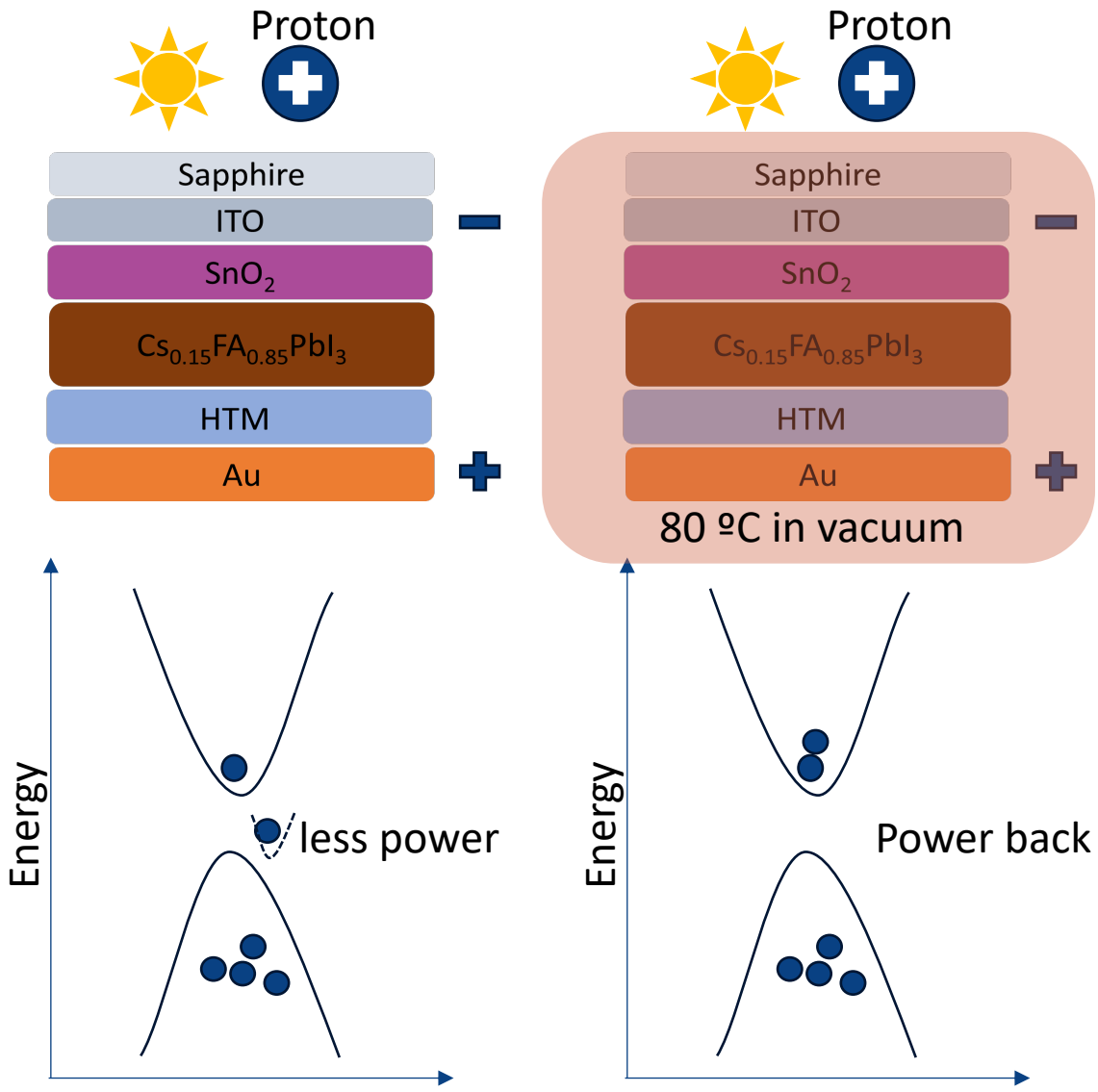


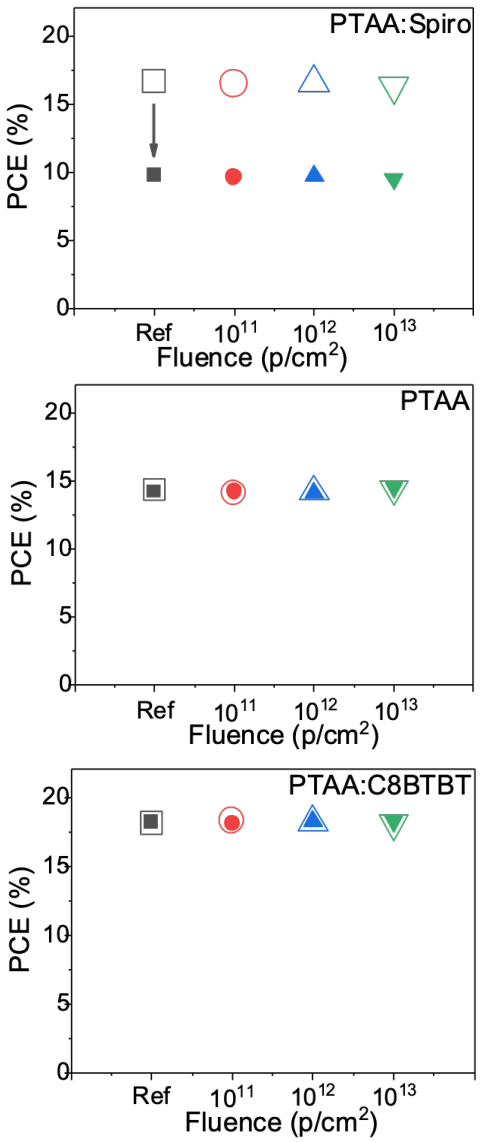






How can we restore solar cell efficiency in space?





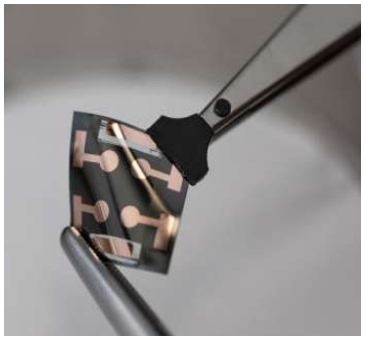
Path to market

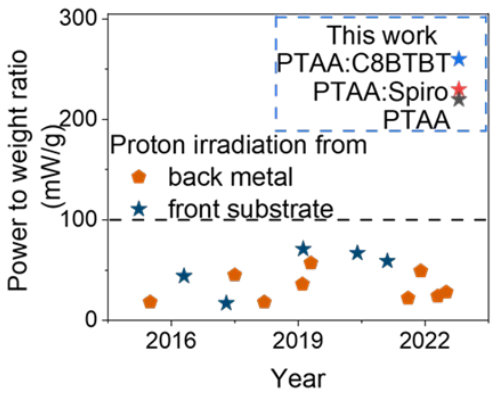
Concept

Patents (3)

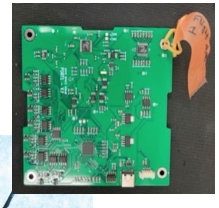
In-orbit test (early 2024)

Startup

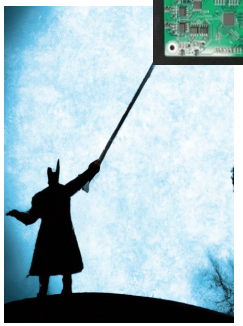




Expecto



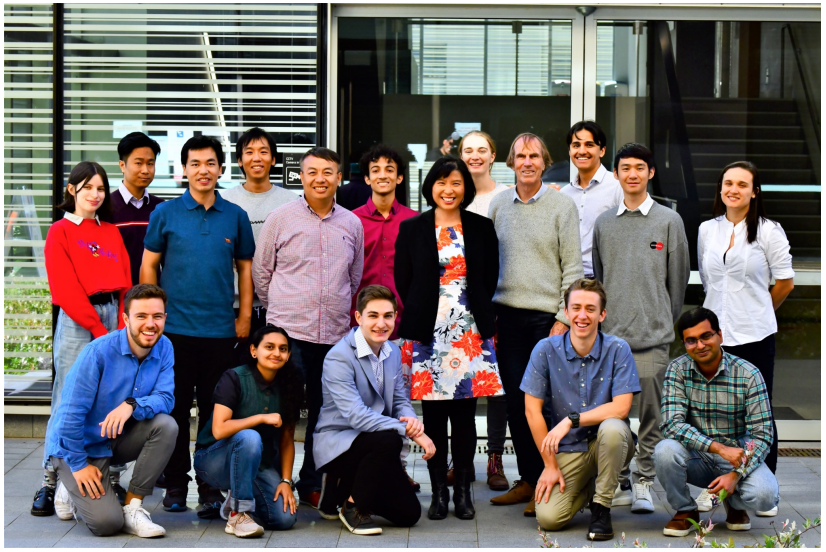
Patronum



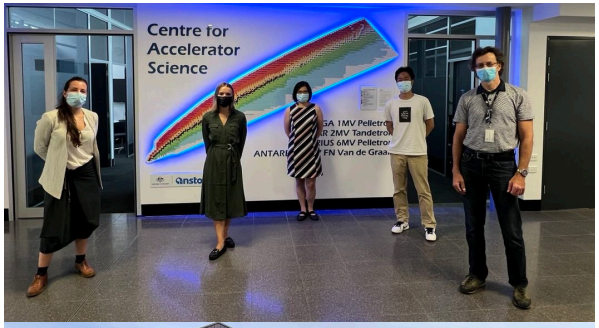
EurokaPower

https://www.eurokapower.com

Acknowledgements



Solar Research Group



Collaborators at ANSTO

- The John Hooke Chair of Nanoscience Postgraduate Research Scholarship
- CSIRO postgraduate research top-up scholarship