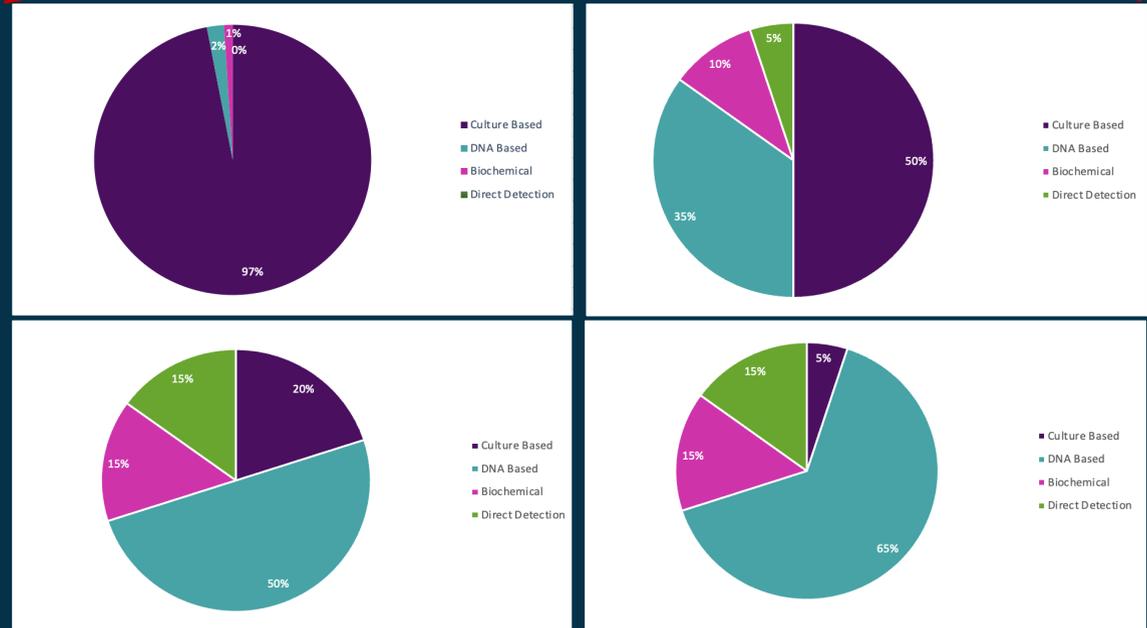
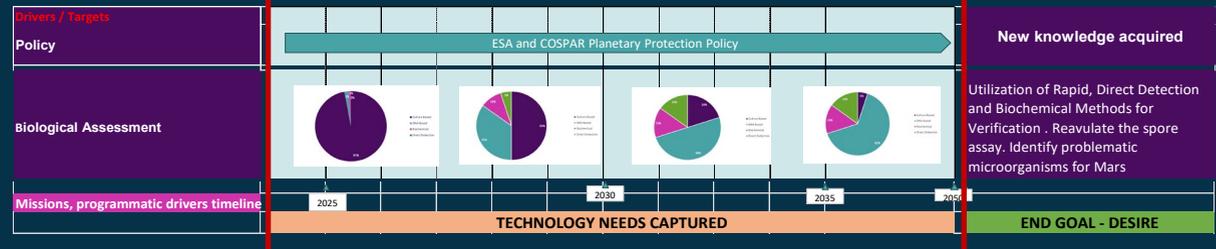


Why metagenomics at ESA



In line with the Planetary Protection vision in TECHNOLOGY 2040 and international roadmaps

- Switch from culture-based assay to culture independent/DNA based
- Currently it is estimated that 97% of methods used rely on culturing
- Future activities should consider investing in molecular biology and dropping culture based down to 50% by 2030 and 5% to 2050.



Why metagenomics at ESA



Information about the function, i.e. not only the “who”, but the “what” and the “how”



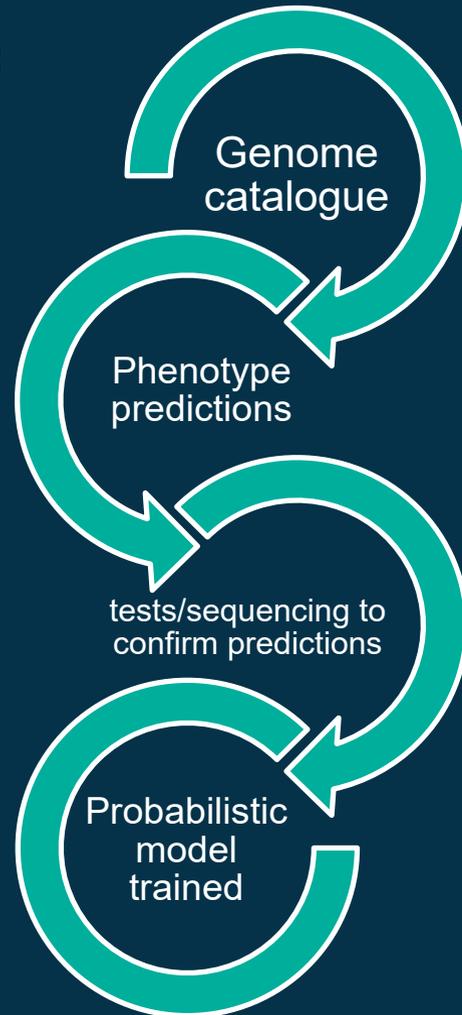
Potential powerful tool(s) to help:

1. assessing harmful contamination even beyond pre-launch
2. Influence system design and operations of a spacecrafts
3. Re-thinking of PP approaches, so far until “pre-launch”



Metagenomic strategy

Ideal step-by-step approach:



Note: Based on models that were trained

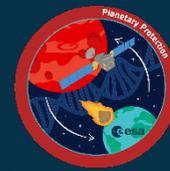
Note: This includes validation through experiments in the lab

Genome catalogue is paramount to make the initial step, however we do not have it yet.

What do we do then? We need to start somewhere and improve step by step

We won't start with the perfect solution

Ongoing activities at ESA



Systematic metagenomic campaigns on all ESA PP related missions

Study leads:



Cleanroom, ground support equipment and (potentially) flight hardware

- 1 Spore assay
- 2 Cultivation of oligotrophic, alkaliphilic, vegetative, anaerobic microorganisms and fungi
- 3 16S rRNA gene (taxa)
- 4 Metagenomics (function)

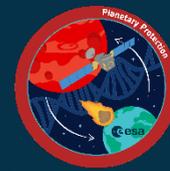
Extending the scope of ESA databases

ESA Strain Collection

Morphology			
[Ref. #125438]	Gram stain	negative	Confidence in % 100
Culture and growth conditions			
[Ref. #16984]	Culture medium	CASO AGAR (MERCK 105458) (DSMZ Medium 220)	
[Ref. #16984]	Culture medium growth	✓	
[Ref. #16984]	Culture medium link	Medium recipe at MediaDive	
[Ref. #16984]	Culture medium composition	expand / minimize	
[Ref. #16984]	Temperatures	Kind of temperature ↓	Temperature ↓
[Ref. #16984]		growth	28 °C
Physiology and metabolism			
[Ref. #125438]	Ability of spore formation	no	Confidence in % 94.441



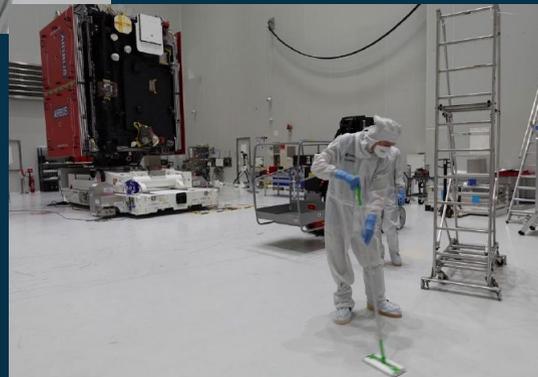
Ongoing activities at ESA



Metagenomic campaigns

Independent safety office study (started 2025):

- JUICE, ExoMars (both Prime contractors UK and IT)
- European Spaceport – Korou
- Another European contractor (FR)
- ESA ESTEC ISO 1 cleanroom



The screenshot shows the ENA website interface. At the top, there is a navigation bar with the ENA logo and the text "European Nucleotide Archive". To the right of the logo is a search bar with the placeholder text "Enter text search terms" and a search icon. Below the search bar, there are two example search terms: "Example: histone, BN000065" and "Enter accession" with a "View" icon. Below the search bar, there are four menu items: "Home", "Submit", "Search", "About", and "Support". Below the navigation bar, there is a blue banner with the text "We recommend that you subscribe to the ENA-announce mailing list for updates on ENA services." Below the banner, there is a section titled "European Nucleotide Archive" with a paragraph of text: "The European Nucleotide Archive (ENA) provides a comprehensive record of the world's nucleotide sequencing information, covering raw sequencing data, sequence assembly information and functional annotation. [More about ENA.](#)" Below the text, there is a paragraph: "Access to ENA data is provided through the browser, through search tools, through large scale file download and through the API." Below the text, there are three buttons: "Submit", "Search", and "Support". At the bottom of the page, there are two logos: the ELIXIR logo and the Global Core Biodata Resource logo. Below the ELIXIR logo, there is text: "The European Nucleotide Archive (ENA) is part of the ELIXIR infrastructure. The ENA is an ELIXIR Core Data Resource. [Learn more >](#)" Below the Global Core Biodata Resource logo, there is text: "The European Nucleotide Archive (ENA) is a Global Core Biodata Resource. The ENA is a GBC Global Core Biodata Resource. [Learn more >](#)"

