# Prioritized Technology: Planetary Protection
# Backward Contamination Technology Demonstration

## Technical Goal

**To enable planetary protection capabilities to meet**

- **Forward Contamination**: $10^{-4}$ inadvertent contamination probability
- **Backward Contamination:** $10^{-6}$ probability of contamination from Break The Chain (BTC) and sample containment

**Near-Term: Forward Contamination Detection:** Bioinformatics development for low biomass environments, sample collection and processing developments, development of enhanced modeling for metagenomics response to sterilization and initial BTC breadboard.

**Mid-Term: BTC + Microbial Contaml Testing:** breadboard testing (TRL 1-3) with low biomass detection/evolution and fail safes

**Long-Term: Round-Trip BTC Testing:** Round Trip testing of BTC system including sterilization + relevant environments exposure demo with biomass passenger evolution, including microbes with known specific lethality constraints and fail-safes

## Technical Status

- Very limited development of bioinformatics and low biomass sampling
- BTC and sample containment efforts are Mars Sample Return-focused, with tests that are Mars / Earth environment centric and no round-trip TRL 6-level tests which include interior/exterior passengers.
- Sample return containment is at very low TRL (1-3) with highly limited experimental testing for seals (Mars relevant).
- Ocean Worlds Sample Return containment work has not yet been invested in

## Mission Applications

### What is enabled if we achieve the goal?

**Sample Return Mission Architectures and Hardware that is Compliant with a Robust Earth Safety Analysis:**

- Europa Lander, Enceladus Plume, Enceladus Lander, Mars Lander

**Backward Contamination Risk Reduction for:**

- Europa: Clipper, Lander, Sample Return
- Enceladus: Plume Sample Return, Lander Sample Return
- Ceres, Vesta, Mars, TItan: Landers, Rovers/Boats, Sample Return

**Reduced Uncertainty:** Passenger list assessment with roundtrip testing addresses current known limits in understanding of microbial lethality for space conditions

## Development Cost and Schedule