



IJSEP Experiment Guide: How to Use the FME Mini-Lab

1. What Is the FME Mini-Lab?

The **Fluids Mixing Enclosure (FME)** is a small silicone tube used to perform scientific experiments in microgravity aboard the International Space Station (ISS). It allows students to study how the absence of gravity affects biological, chemical, or physical systems.

Each FME Mini-Lab can contain one, two, or three compartments separated by clamps. Astronauts can open these clamps in orbit to mix different materials. Each FME holds around 8–10 mL of total sample volume.

Tube dimensions:

- Length: 6.7 inches (170 mm)
- Outer diameter: 0.5 inches (13 mm)
- Inner diameter: 0.37 inches (9.5 mm)

2. Why Conduct Experiments in Microgravity?

Microgravity is the condition where objects appear weightless. Astronauts float in the ISS because both they and the station are in constant free fall around Earth.

By comparing what happens in microgravity to what happens in normal gravity on Earth (the control experiment), we can learn how gravity influences different processes — from crystal growth and oxidation to cell behavior and seed germination.

Every space experiment must therefore have a control conducted on Earth at the same time.

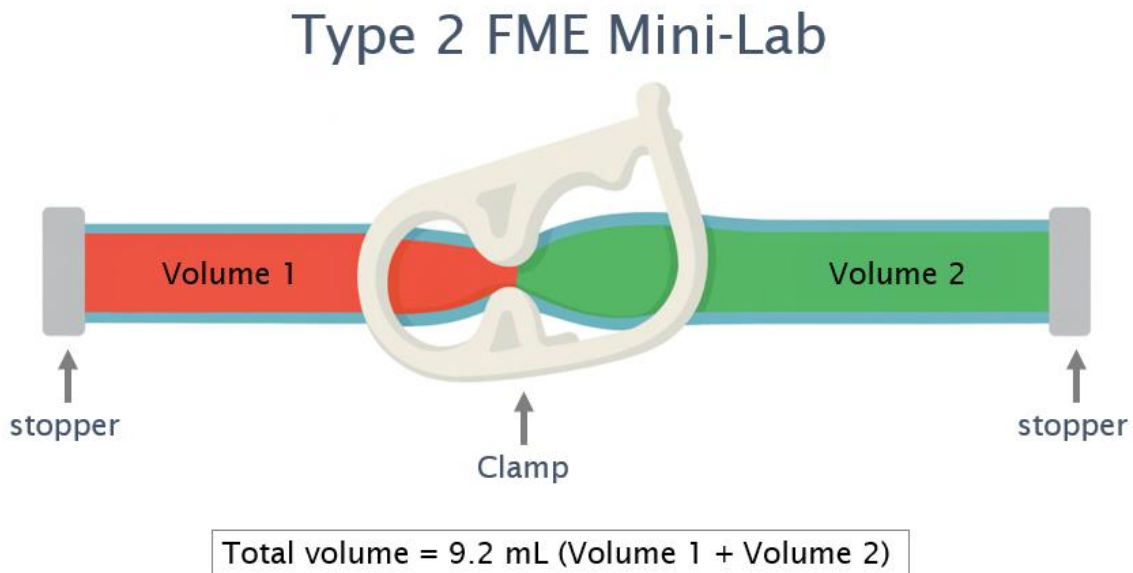


🔑 3. The Three Types of FME

Type 1 – One Chamber: contains a single sample and no clamps. Used when the experiment only needs exposure to microgravity, without mixing. Example: testing if synthetic blood degrades differently in space.



Type 2 – Two Chambers: contains two volumes, separated by one clamp. Astronauts open the clamp to mix the contents at a chosen time. Example: adding salt water to iron to study oxidation in space.

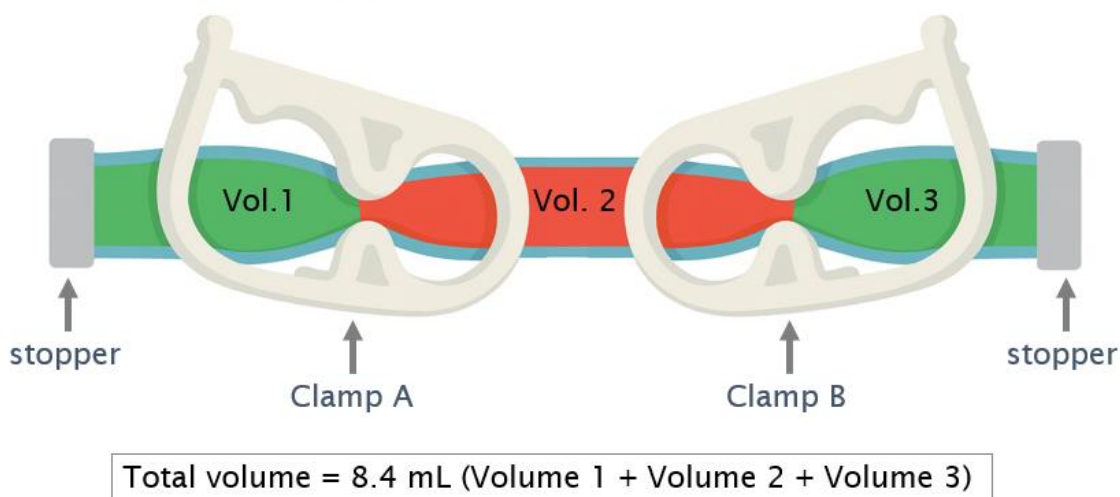


Note: Minimum volume for Volume 1 or Volume 2 (achieved when a clamp is placed as close to the end of the tube as possible) = 1.2 mL



Type 3 – Three Chambers: contains three volumes separated by two clamps. Allows two mixing steps: one to start the experiment and another to stop it. Example: growing seeds in space — first mix adds water for germination, second mix adds alcohol to stop growth and preserve the sample.

Type 3 FME Mini-Lab



Notes: (a) Minimum volume for Volume 1 or Volume 3 (achieved when a clamp is placed as close to the end of the tube as possible) = 1.2 mL / (b) Minimum for Volume 2 (achieved when both clamps placed as close to one another as possible) = 1.9 mL

4. How the FME Works in Orbit

Astronauts operate the FME following the student team's instructions. They can:

- **Open or Close Clamp A or B**
- **Shake** the tube gently, moderately, or vigorously (for up to 120 seconds total per day)
- **Wait** for a certain time between actions
- **Expose** the tube to ambient light (max 120 seconds)

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Table 1: Allowed Crew Interactions and Modifiers

The table below lists all the actions astronauts can perform with the FME Mini-Lab during Crew Interaction Days, along with the possible modifiers that define how each action should be executed. These parameters ensure consistent and safe operation of the experiment aboard the International Space Station (ISS).

Allowed Crew Interactions	Allowed Modifiers
Open Clamp	none
Close Clamp	none
Shake	Must specify: • <i>Intensity</i>: gently, moderately, or vigorously • <i>Duration (15–120 seconds)</i>: 15 s, 30 s, 45 s, 60 s, 75 s, 90 s, 105 s, or 120 s
Wait	Must specify: • <i>Duration (15–120 seconds)</i>: 15 s, 30 s, 45 s, 60 s, 75 s, 90 s, 105 s, or 120 s • May include “expose to ambient light” modifier

Note: The maximum total time per FME on any one Crew Interaction Day is 120 seconds.

Table 2: Crew Interaction Schedule

The table below shows the five Crew Interaction Days, when astronauts can perform the allowed actions during the mission.

Crew Interaction Day	When	Descriptor
1	On arrival at ISS	A=0
2	2 days after arrival	A+2
3	2 weeks before return	U-14
4	5 days before return	U-5
5	2 days before return	U-2

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For the five Crew Interaction Days in the table above, an experiment can run for **2 days, 3 days, 9 days, or 12 days**.

The total time from **Arrival (A=0)** to **Departure (Undock, U)** is typically **4 to 6 weeks**. By choosing specific Crew Interaction Days, an experiment can:

- Run for the **entire duration** aboard the ISS ($A=0$ to $U-2$), or
- Run for about **1–2 weeks less** than the full stay ($A=0$ to $U-14$).

It is essential to consider the **temperature conditions on the ISS**, which may significantly affect the experiment design (see Section 8).

Researchers have the flexibility to define how long the experiment remains active in microgravity before de-orbiting and returning to Earth. Only the Crew Interaction Days listed above can be selected.

For example:

- To run for **2 days**, select Crew Interaction Days **A=0** and **A+2**.
- To run for **about 2 weeks**, select Crew Interaction Days **U-14** and **U-2**.

Each FME experiment operates **independently** of others aboard the ISS, allowing teams to define unique schedules and interactions tailored to their scientific objectives.

5. From Earth to Space and Back

After being sealed, your FME travels a long journey:

**Shipment to USA → Launch Preparation → Flight to ISS →
→ Time on ISS → Return to Earth → Return to Team**

Total mission time: about 7–8 weeks.

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6. Sample Rules and Safety Requirements

- **Prohibited materials:** radioactive materials, hydrofluoric acid, acetone, toxic metals, magnets, perfumes, electronics, technologic devices (batteries, lighting, others).
 - **Hazardous materials:** avoid samples that generate heat, pressure, or gases. Only [Biosafety Level](#) 1 or lower and [Toxicity Hazard Level \(THL\)](#) 0–1 materials are allowed.
 - **Problematic samples** that may compromise the integrity of the minilab require compatibility tests lasting 6–8 weeks.
 - **Biological samples:** Human samples must be certified virus-free. No vertebrate animals or cephalopods allowed.
 - **Documentation:** each team must provide Safety Data Sheets (SDS) and Certificates of Conformity (CoC) of the materials.
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7. Preparing Your Experiment

Each IJSEP community receives demo FMEs (for training) and flight-certified FMEs (for real use). The selected team uses:

- Up to 2 kits for testing and optimization
- 2 kits for the actual flight
- Up to 2 kits for ground controls

Teams assemble, load, and seal the FMEs following the IJSEP team's instructions. They are double-sealed in polyethylene bags before launch.

8. Environmental Conditions During the Mission

Temperature ranges:

- Shipment: Cold packs optional (to keep temperature in the 2–8°C range)
- Storage before launch: Refrigeration optional (2–4°C)
- On ISS: 21–24°C (room temperature)
- Return: no refrigeration available

Note: There is no refrigeration or incubator aboard the ISS.



9. Light and Power Conditions

FMEs are stored in opaque boxes, so they stay in the dark. The only light exposure is up to 120 seconds during crew interaction. FMEs have no power or data recording systems.

10. Sterilization

FMEs and samples can be sterilized by heat, gas, radiation, or chemicals. Heat limits: below 200°F (~95°C) for clamps and 390°F (~200°C) for the silicone tube. Biological materials must be sterilized or purchased sterile to avoid contamination.

11. Important Design Tips

- Keep total volume under 10 mL.
 - Use dormant or freeze-dried biologicals.
 - Activate the experiment after arrival, and deactivate before return.
 - Always prepare a ground control experiment.
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12. Summary Checklist

- ✓ Understand microgravity and your experiment goals.
 - ✓ Choose the correct FME type.
 - ✓ Ensure materials are safe and approved.
 - ✓ Provide SDS and CoC documents.
 - ✓ Prepare a ground control experiment.
 - ✓ Define astronaut instructions clearly.
 - ✓ Keep your design simple and safe!
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