Lessons from Science in μ-g

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Who am I?

- The Methodist Hospital Research Institute in Houston, TX
- Structure and Biochemistry of Nuclear Hormone Receptors

Goals of This Talk

- Overview of my micro-g projects
- What worked. What didn’t.
- Please ask questions. I’m still learning too.

GAS (Get Away Special) Project

- Shuttle payload bay
- Two sizes: 2.5 ft^3 or 5 ft^3
- Self contained. Only one switch option.
- Relatively cheap
  - $5k 2.5 ft^3
  - $10K 5 ft^3

GRaDEx

- Genotoxicology Radiation and Dosimetry Experiment
- Purpose: measure effect of cosmic radiation on *in vivo* and *in vitro* DNA.
- Flew on STS-91 Discovery June 1998. ~10 day exposure.

GRaDEx

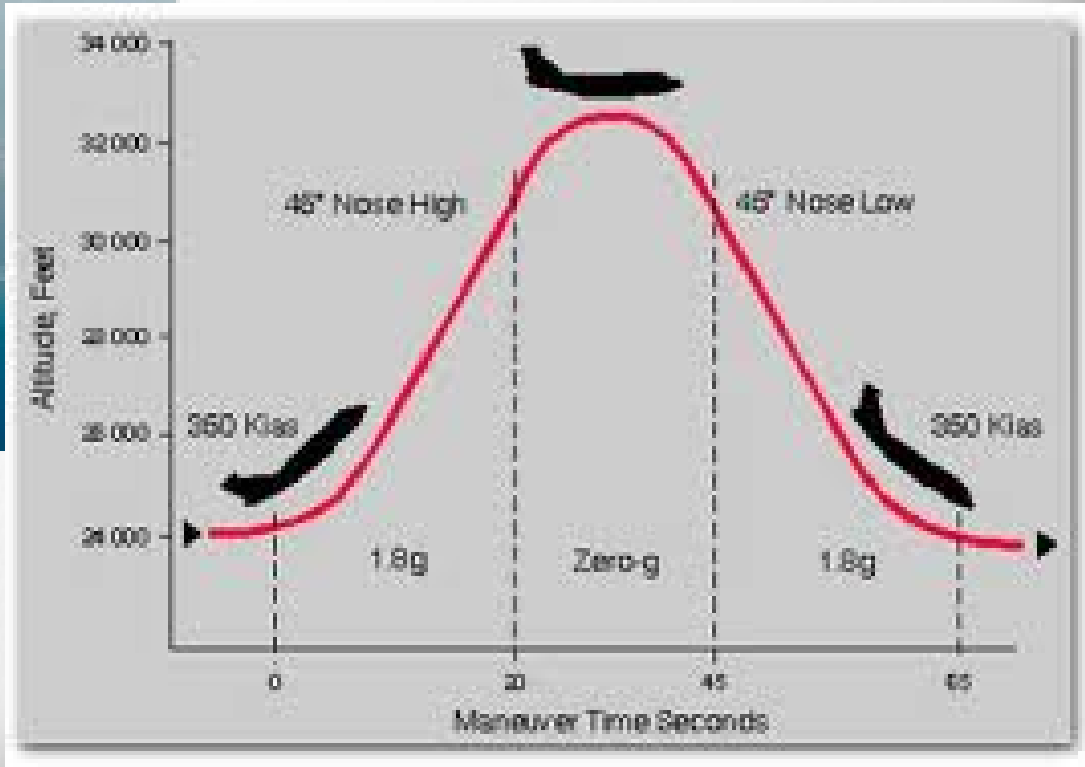
GRaDEx

- Assayed DNA for strand breakage and compared to ground control
- For seeds: Distributed to kids to grow and document any change in phenotype.

GRaDEx:Lessons

- There is a lot of paperwork!
- Passive is good.
- Importance of ground controls.

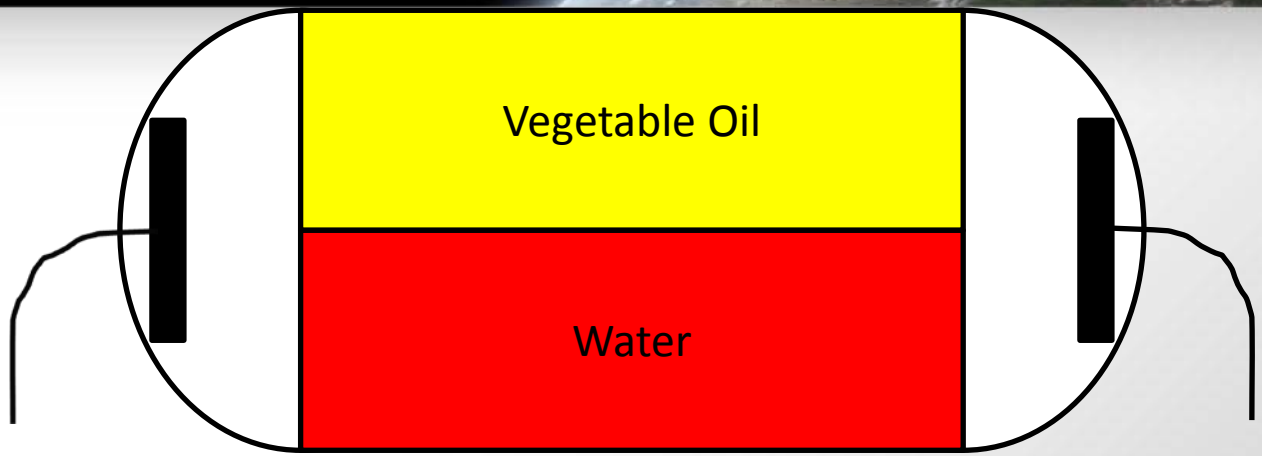
KC-135 Flights



KC-135 Flights

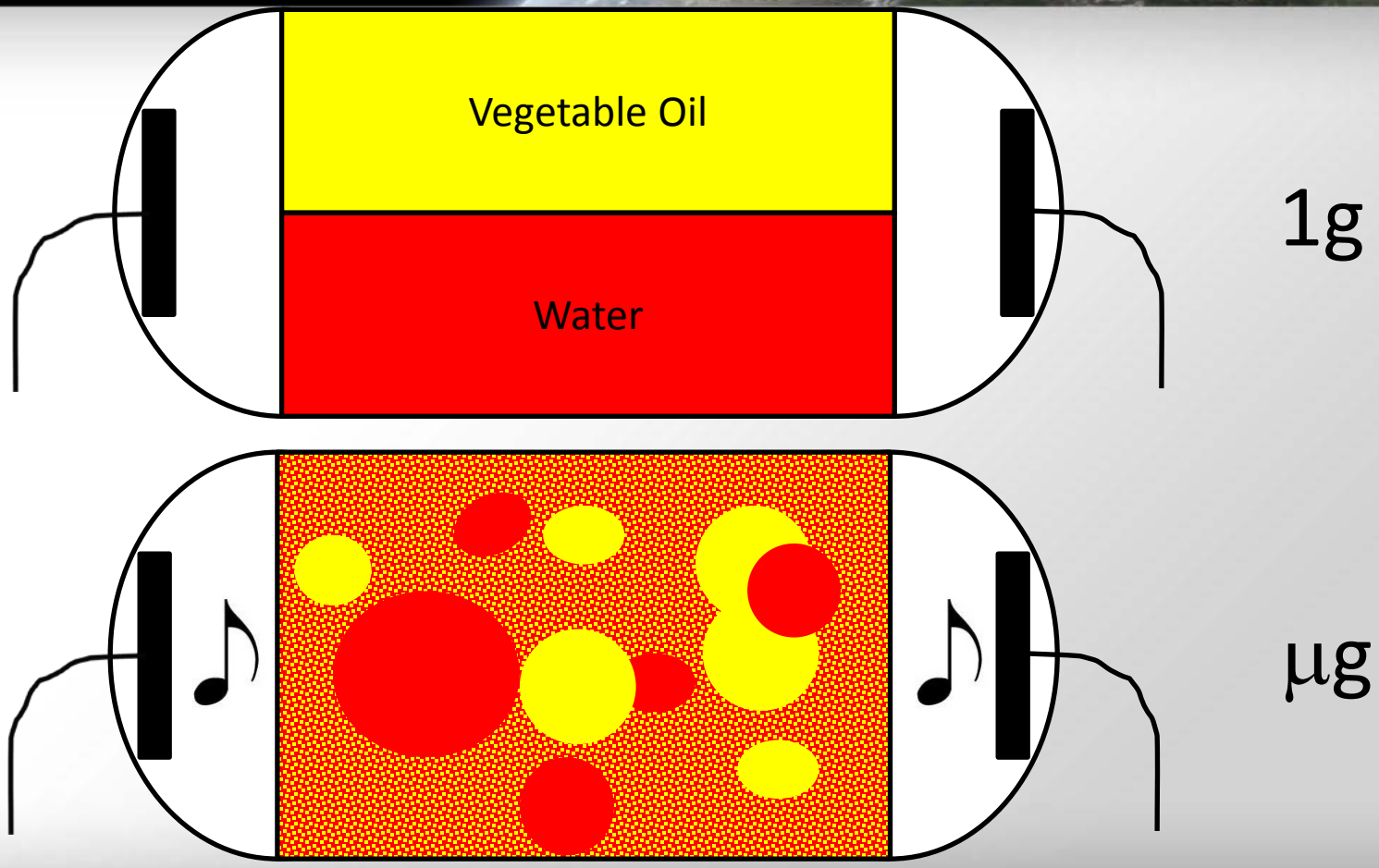
- Power restrictions
  - Dead switch, etc.
- Size limits
- Passenger Safety
  - i.e. fluid containment
  - Bumpers
- Time limit (~20s μg, 2min. 2g)
- Team member incapacitation concerns

Acoustical Separation of Immiscible Fluid (A.S.I.F)

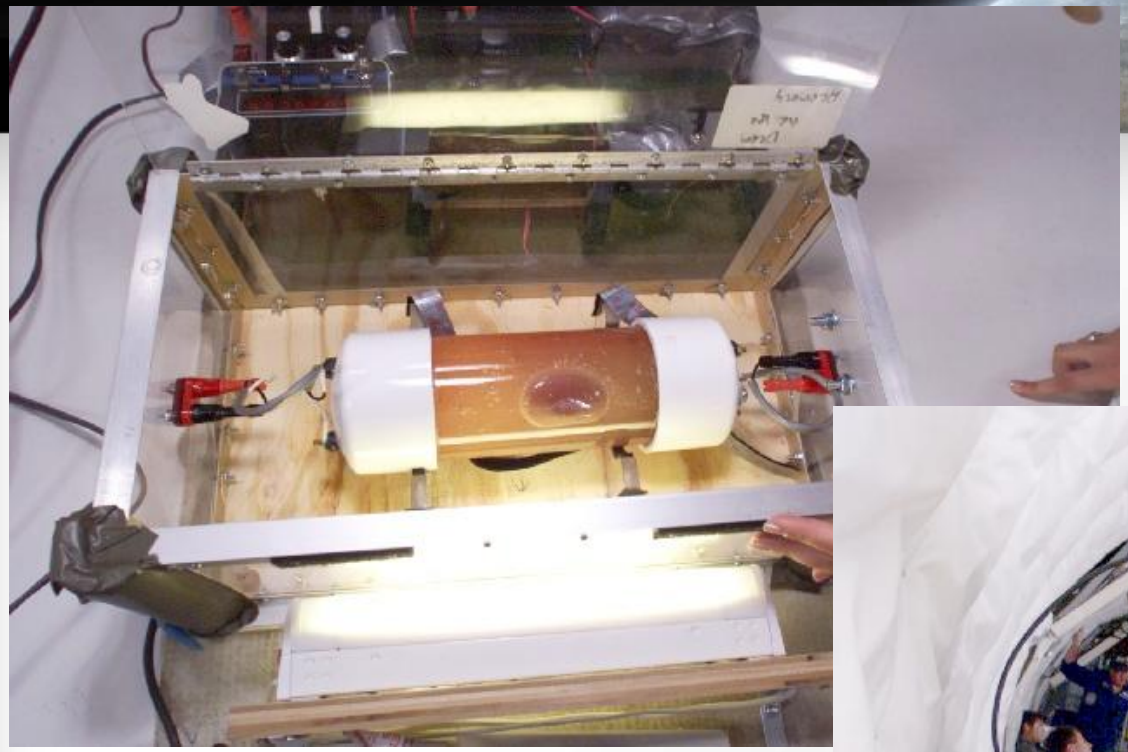


1g

Acoustical Separation of Immiscible Fluid (A.S.I.F)



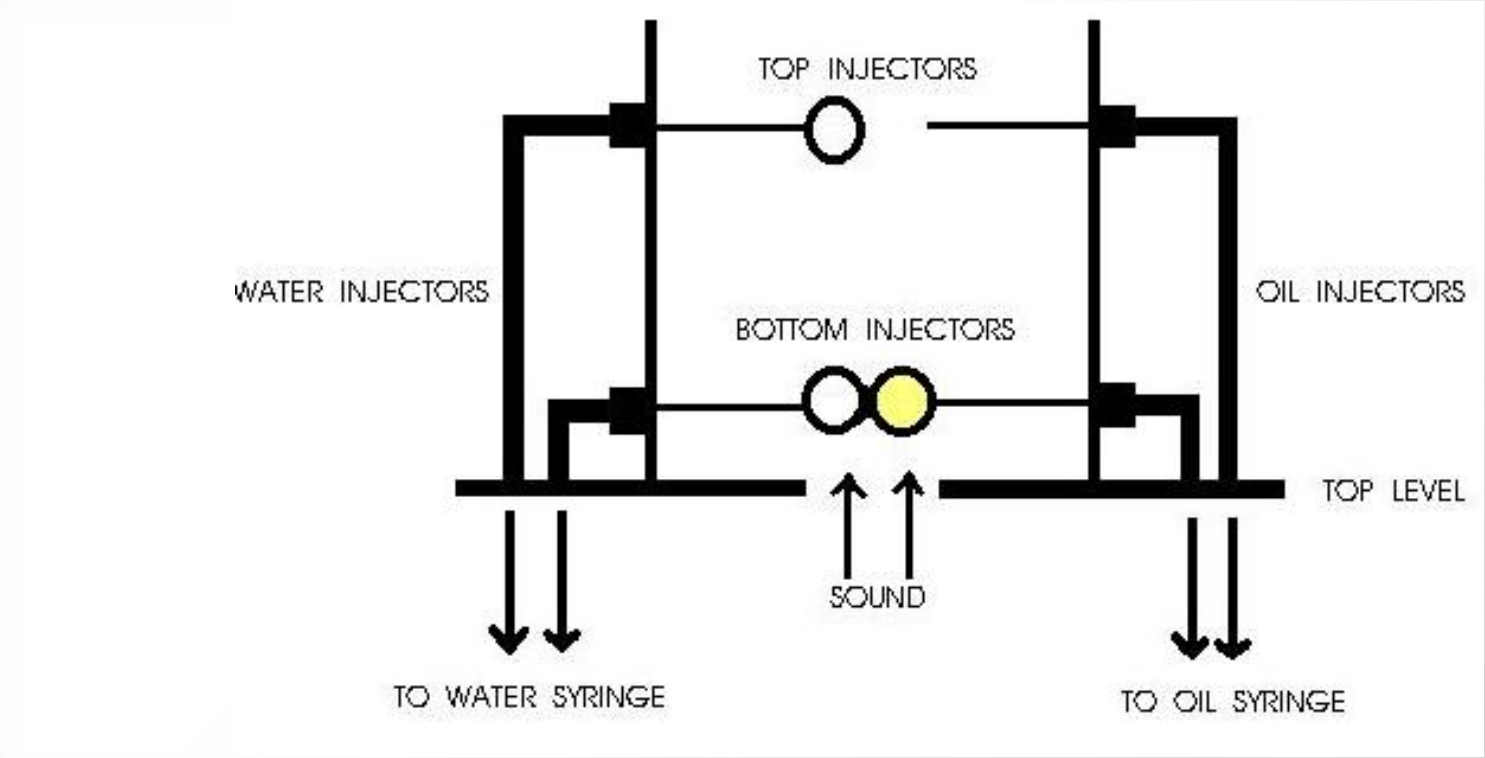
A.S.I.F. I



A.S.I.F. I: Lessons

- Shaking something in μg was not easy.
- Writing notes was challenging.
- Leaning over experiment was not comfortable.
- Volume of fluid was too large/power source too small.
- More automation = more fun.

A.S.I.F II


TOP INJECTORS
WATER INJECTORS
OIL INJECTORS
BOTTOM INJECTORS
TOP LEVEL
SOUND
TO WATER SYRINGE
TO OIL SYRINGE

A.S.I.F II

A.S.I.F II: Lessons

- Better ergonomics = better experience.
- Fluids behave very differently in μg.
- Semi-automated process allowed for more consistent data.

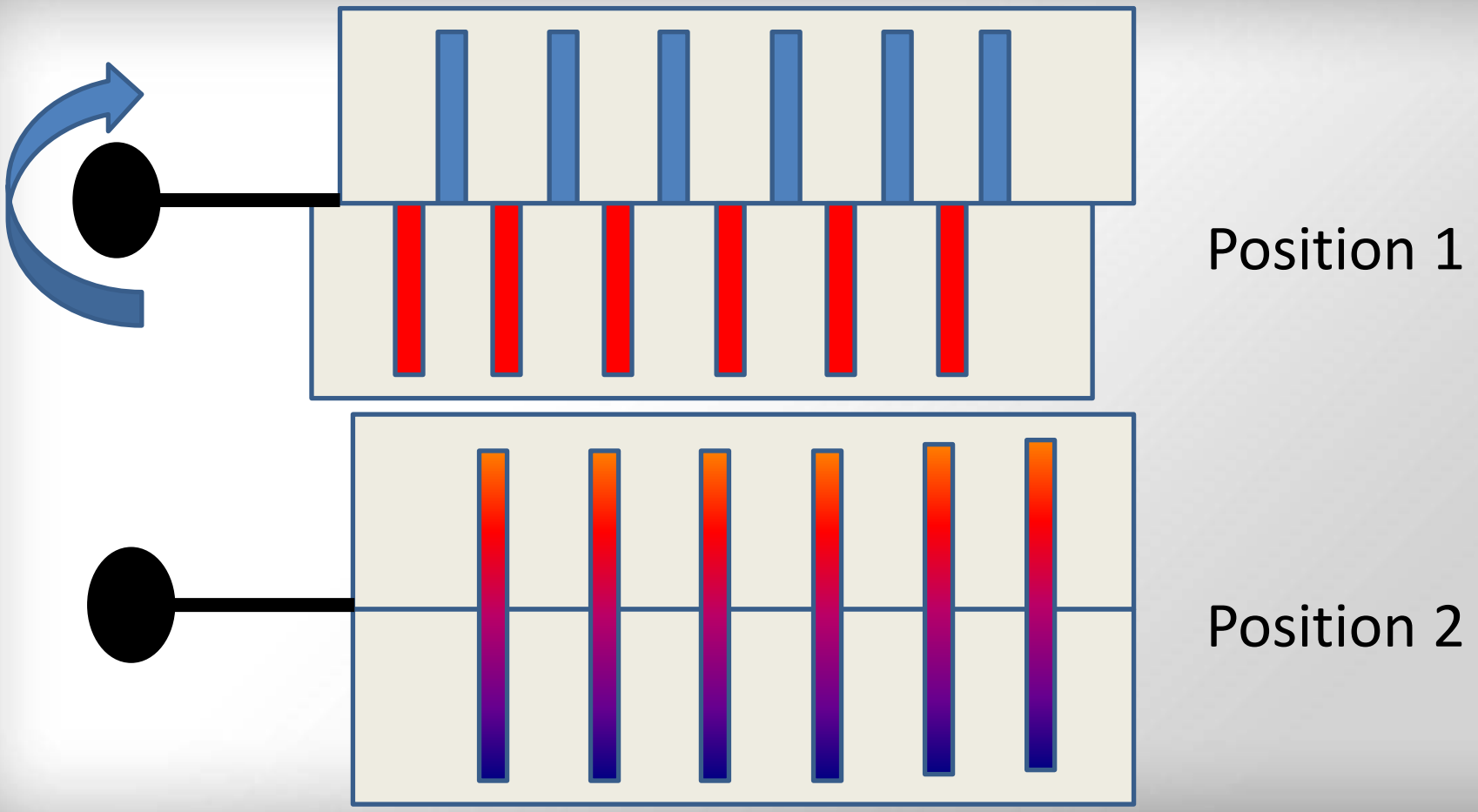
Protein Crystal Growth in μg

- Flew on STS-134 and 135
  - 16 & 13 days
- Used Materials Dispersion Apparatus (MDA) by ITA, leased by NanoRacks

Protein Crystal Growth in μg

- Same process as making rock candy
- Protein forms lowest energy state when water removed
- Need crystals to determine 3-D structure of protein

Materials Dispersion Apparatus (MDA)

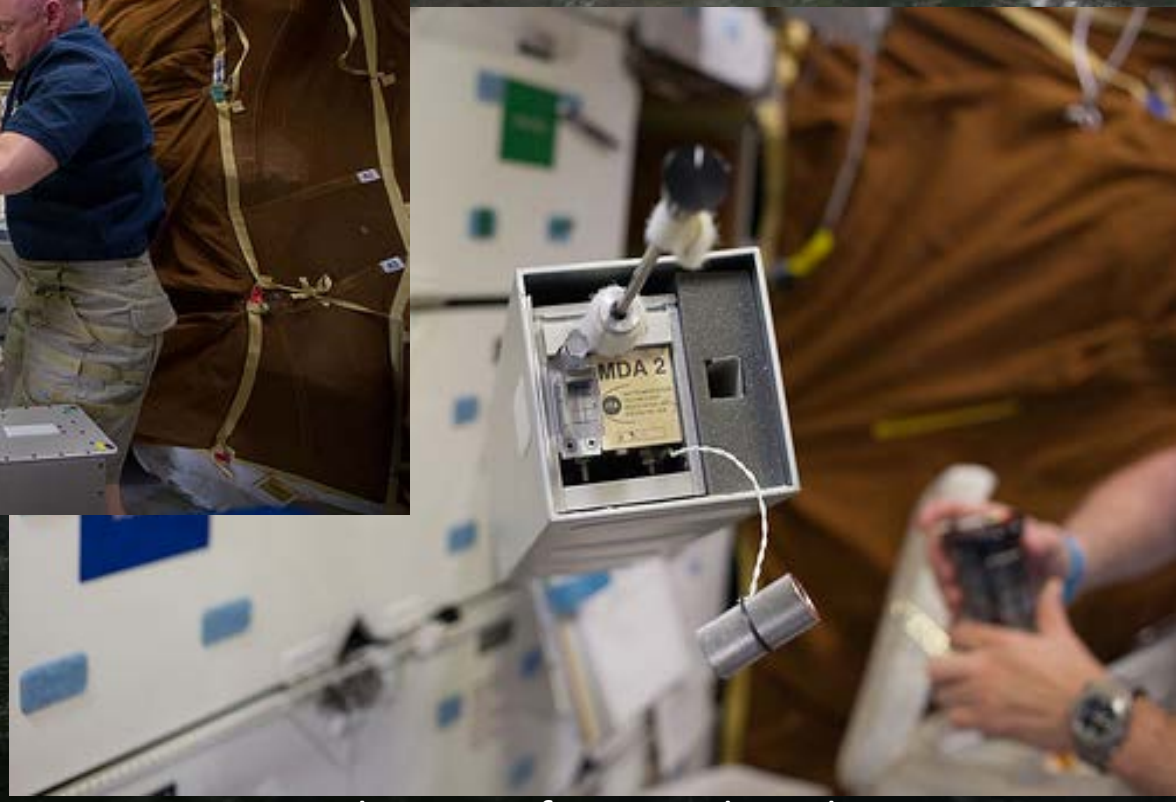


Protein Crystal Growth in μg

- Large volume
  - Much larger than those used in 1g crystal labs
- Treated like all other experiments in MDA
- Ambient temps
- Possible launch delays
  - Multiple backup samples
  - Ground control synch

Protein Crystal Growth in μg

MDA being handled by STS-134 crew



Close-up of MDA onboard STS-134

Photos Courtesy of NanoRacks

Protein Crystal Growth in μg

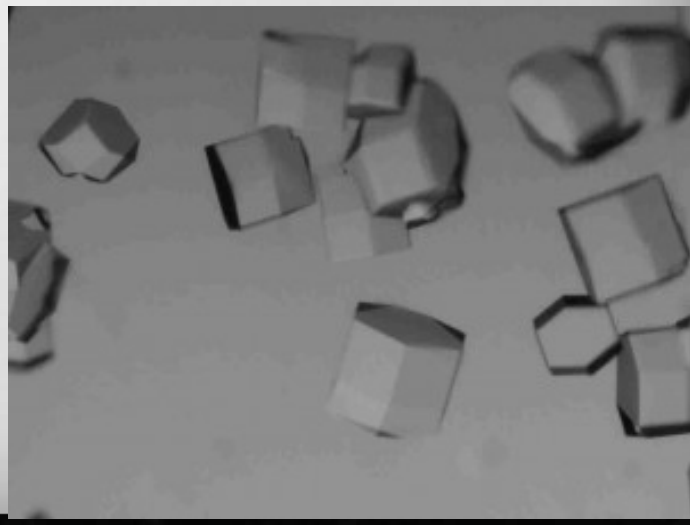
- STS-134 returned no crystals.
- On STS-135, flew different standards (controls), still no crystals. :O(
- Determined that apparatus was not functioning or temperature fluctuations melted crystals

Final Words

- Ground and internal controls *very* important.
- Sometimes experiments won’t work. Not your fault.
- Still important

to figure out why

it didn’t work.



Final Words

- Test, test, and test again!
- Have back-up plan, be prepared for experiments to fail.
- More (reliable) automation is better.
- Simplify.

- Have Fun!