

2016

Space Environment Effects of Ionizing Radiation on Seed Germination and Growth

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Souvall, Alexander; Dennison, JR; Sakai, Takayuki; Takahashi, Yuta; Morikawa, Midori; Okita, Shusuke; Nagata, Akihiro; Kameda, Toshihiro; and Wenger, Shaunda, "Space Environment Effects of Ionizing Radiation on Seed Germination and Growth" (2016). Four Corner Section Meeting of the American Physical Society. *Presentations*. Paper 153.

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Space Environment Effects of Ionizing Radiation on Seed Germination and Growth#*

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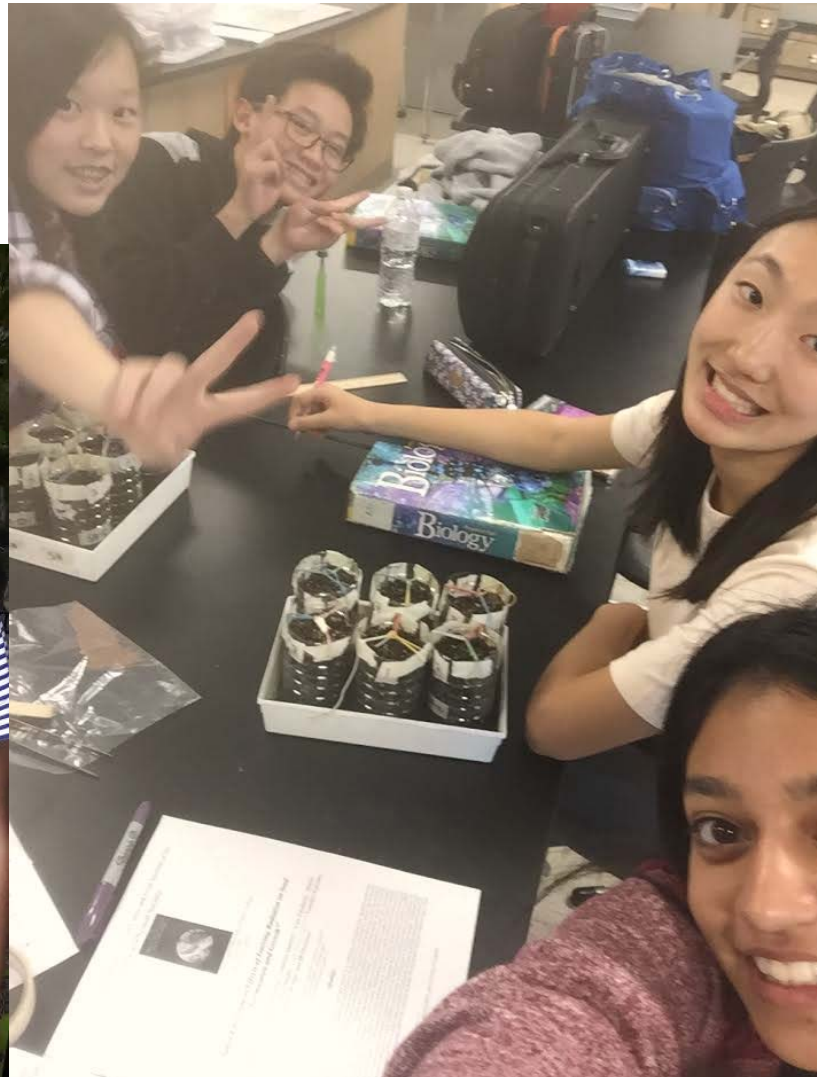
* Supported by USU STARS! GEAR UP partnership.

Partially funded by Japan Student Services Organization



Collaboration

- Russia
- Space Dynamics Lab
- High School Students
- University of Tsukuba, Japan
- Pros and Cons, but always fun.





Why

- Why study space seeds?



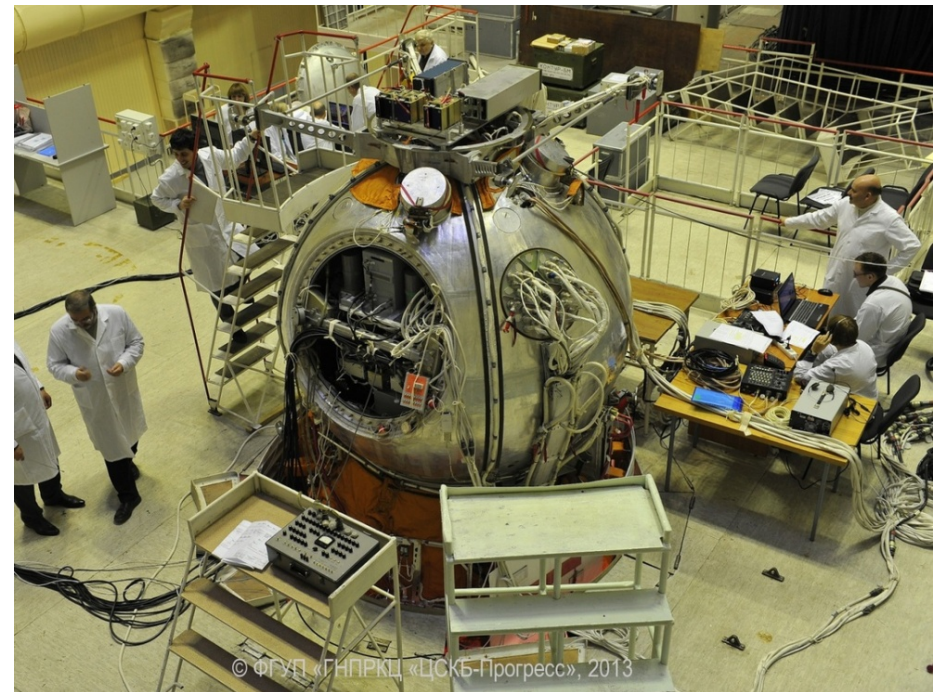
- “I'm excited to announce that we are working with our commercial partners to build new habitats that can sustain and transport astronauts on long-duration missions in deep space.” -President Obama



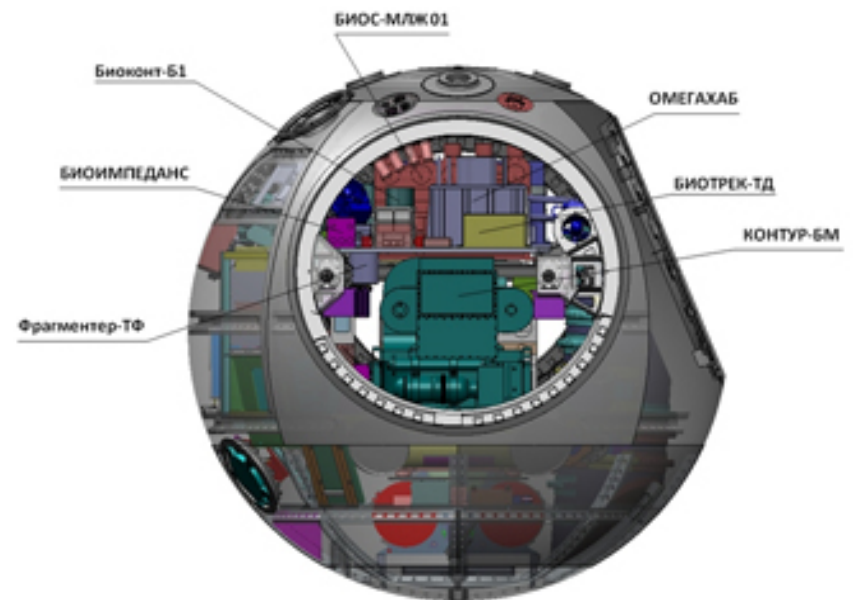
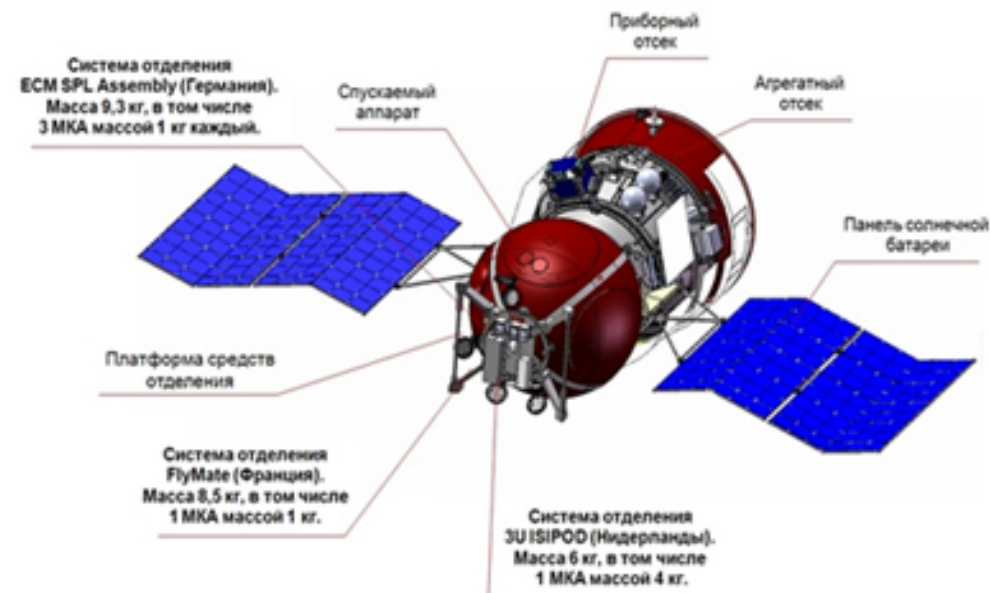


Bion-M1 Mission

- 30 Days in LEO/Polar Orbit
- Studies effects of space on organisms



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What: Space(Radish) Seeds!



Initial Experiments at 4 days after planting.

Space Based Seeds: 7/9 had sprouts

Ground Based seeds: 2/9 had sprouts



Expectations/Observations

So far the Space seeds have outdone the ground seeds every time.

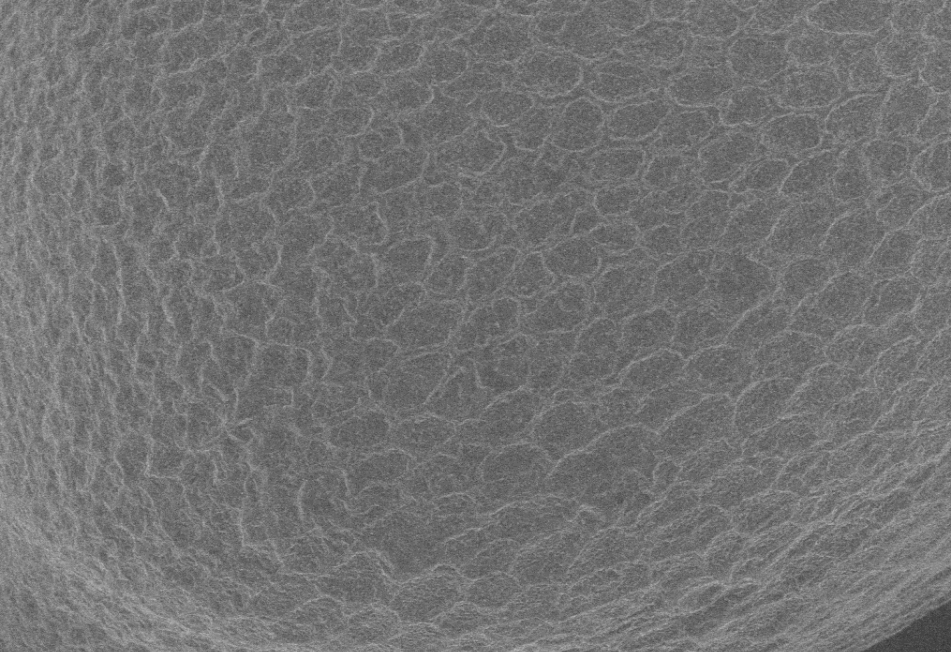
Hypothesized reasons?

Radiation or vibration creating micro fractures in the shell of the seed.

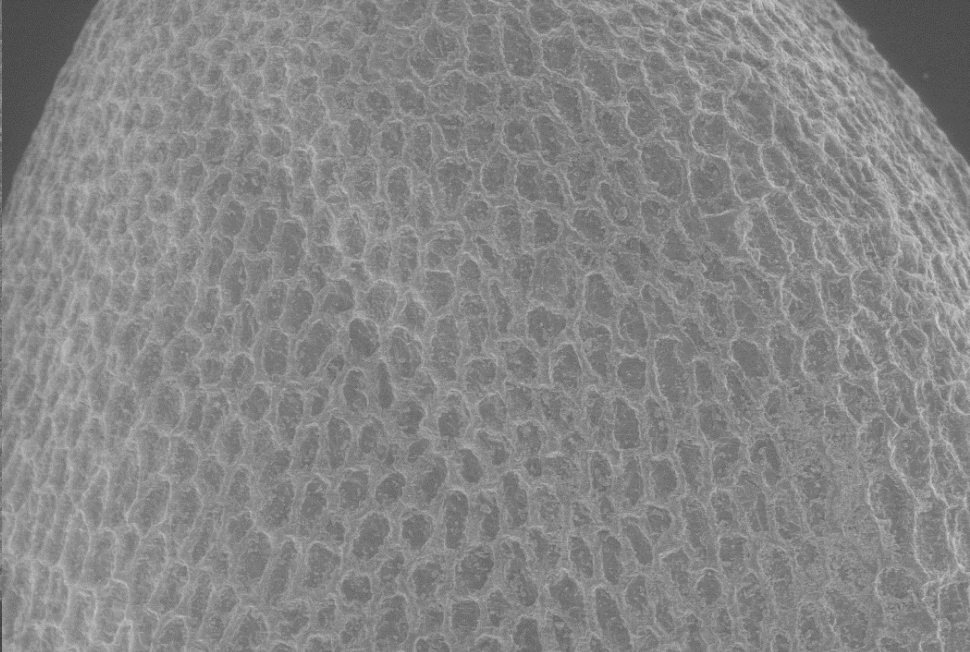


IMG_2153.MOV

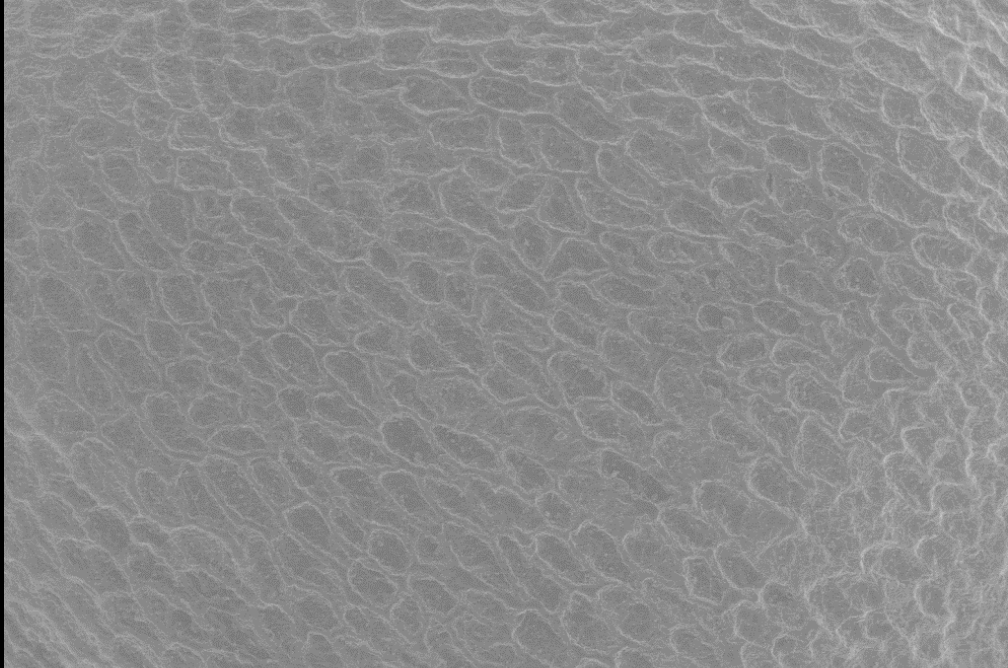
6-axis shaker table to simulate launch and reentry conditions will be provided by Tsukuba University (Japan)



	HV	8.00 kV	mag		det	LFD	WD	10.9 mm	pressure	3.81e-1 Torr	dwell	15 μ s	spot	2.0	humidity	---	500 μ m	
																	Ground Seeds	




	HV	8.00 kV	mag		det	LFD	WD	11.0 mm	pressure	3.76e-1 Torr	dwell	15 μ s	spot	2.0	humidity	---	500 μ m	
																	Shaker Seeds	

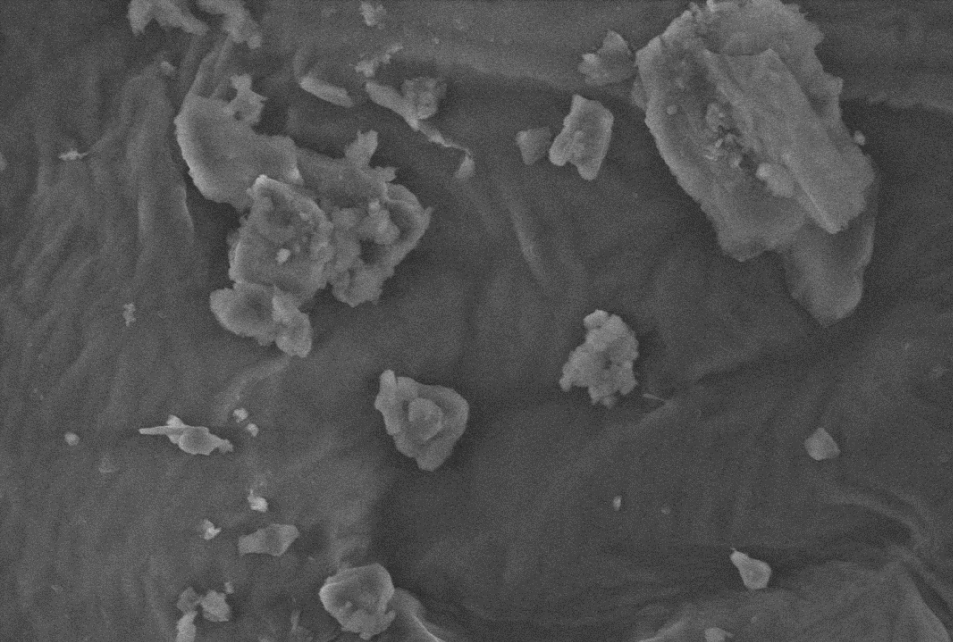



	HV	8.00 kV	mag		det	LFD	WD	11.2 mm	pressure	3.73e-1 Torr	dwell	15 μ s	spot	2.0	humidity	---	500 μ m	
																	Space Seeds	

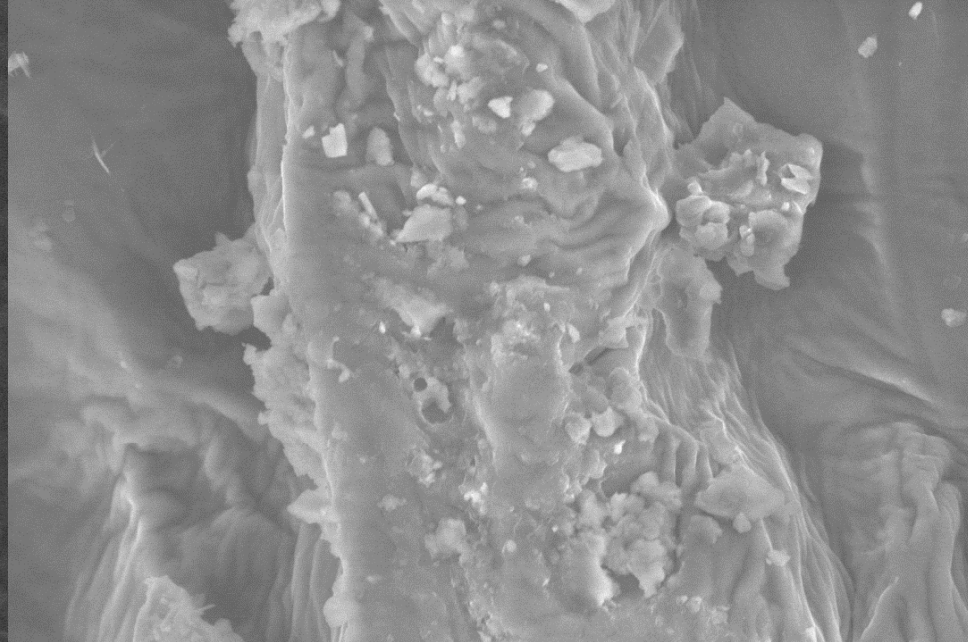
	HV	mag 	det	WD	pressure	dwell	spot	humidity	
	8.00 kV	1 000 x	LFD	10.5 mm	3.73e-1 Torr	15 µs	2.0	---	Ground Seeds


	HV	mag 	det	WD	pressure	dwell	spot	humidity	50 μ m
	8.00 kV	1 000 x	LFD	11.0 mm	3.76e-1 Torr	15 μ s	2.0	---	Shaker Seeds

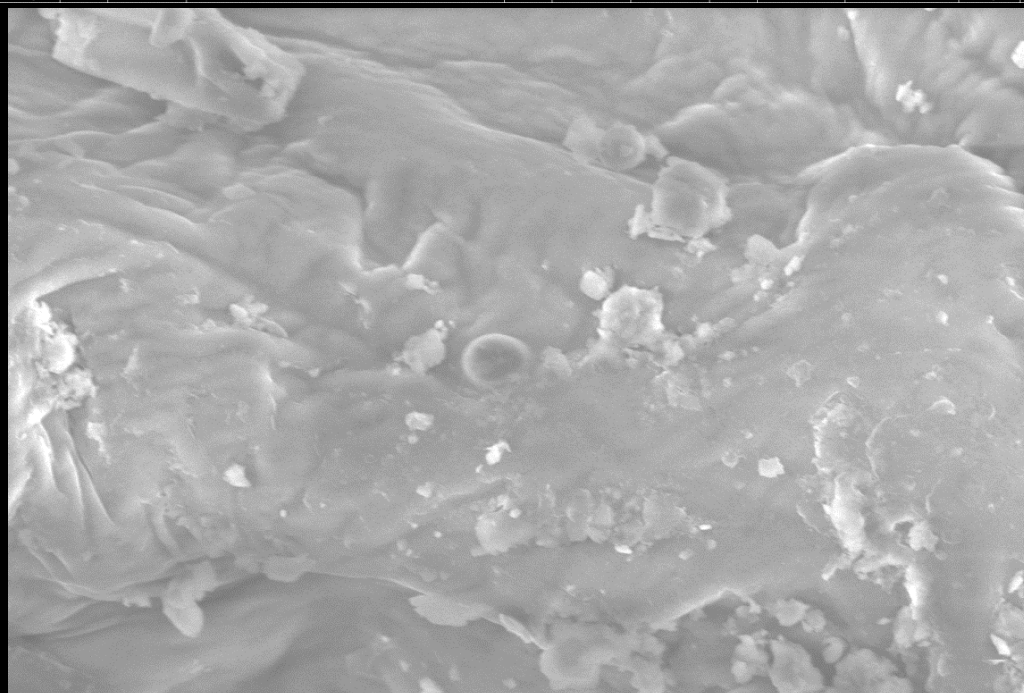
	HV	mag 	det	WD	pressure	dwell	spot	humidity	50 μ m
	8.00 kV	1 000 x	LFD	11.2 mm	3.76e-1 Torr	15 μ s	2.0	---	Space Seeds



	HV	mag	det	WD	pressure	dwell	spot	humidity	10 µm	
	8.00 kV	5 000 x	LFD	10.5 mm	3.78e-1 Torr	15 µs	2.0	---	Ground Seeds	



	HV	mag	det	WD	pressure	dwell	spot	humidity	10 µm	
	8.00 kV	5 000 x	LFD	11.0 mm	3.76e-1 Torr	15 µs	2.0	---	Shaker Seeds	

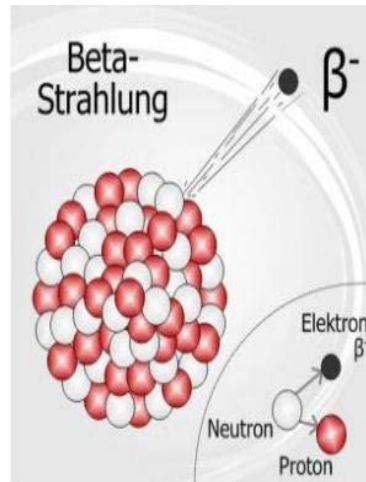


	HV	mag	det	WD	pressure	dwell	spot	humidity	10 µm	
	8.00 kV	5 000 x	LFD	11.2 mm	3.76e-1 Torr	15 µs	2.0	---	Space Seeds	

Radiation Effects



+



= **Die out?**
or
Grow up?

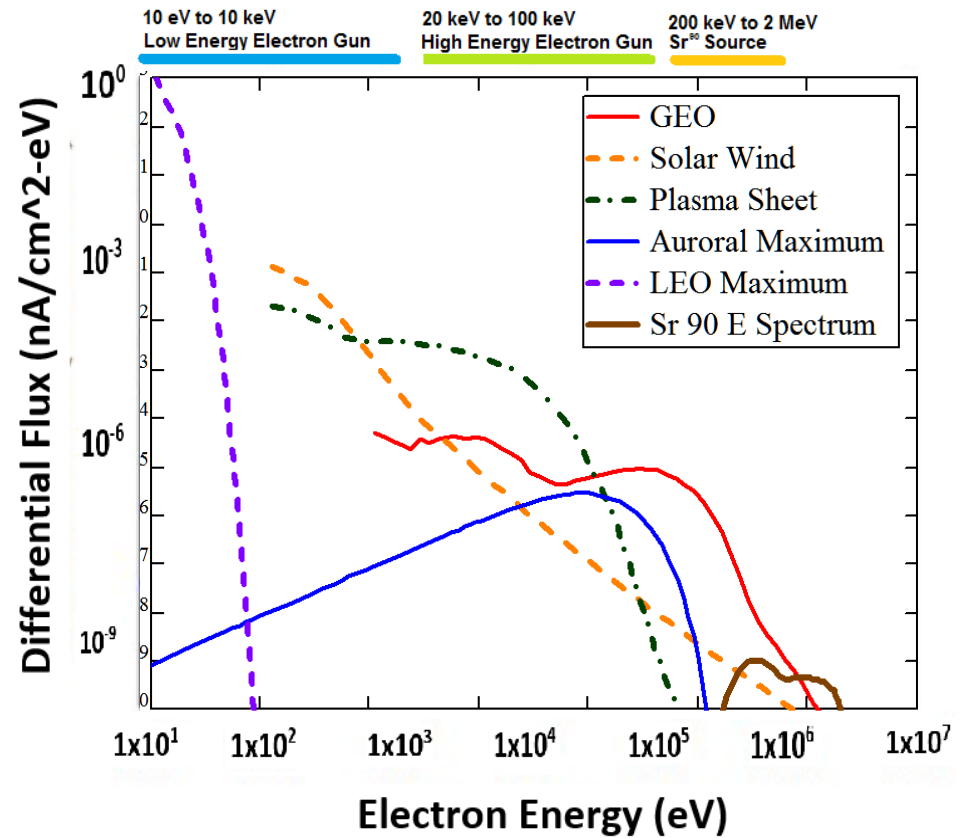
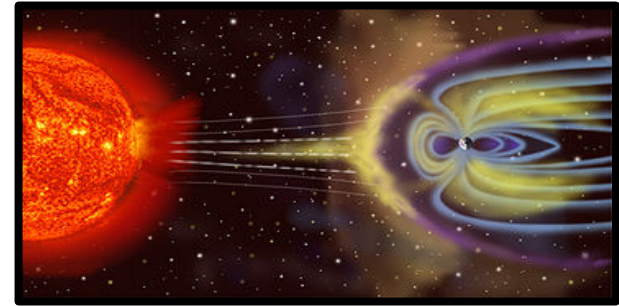
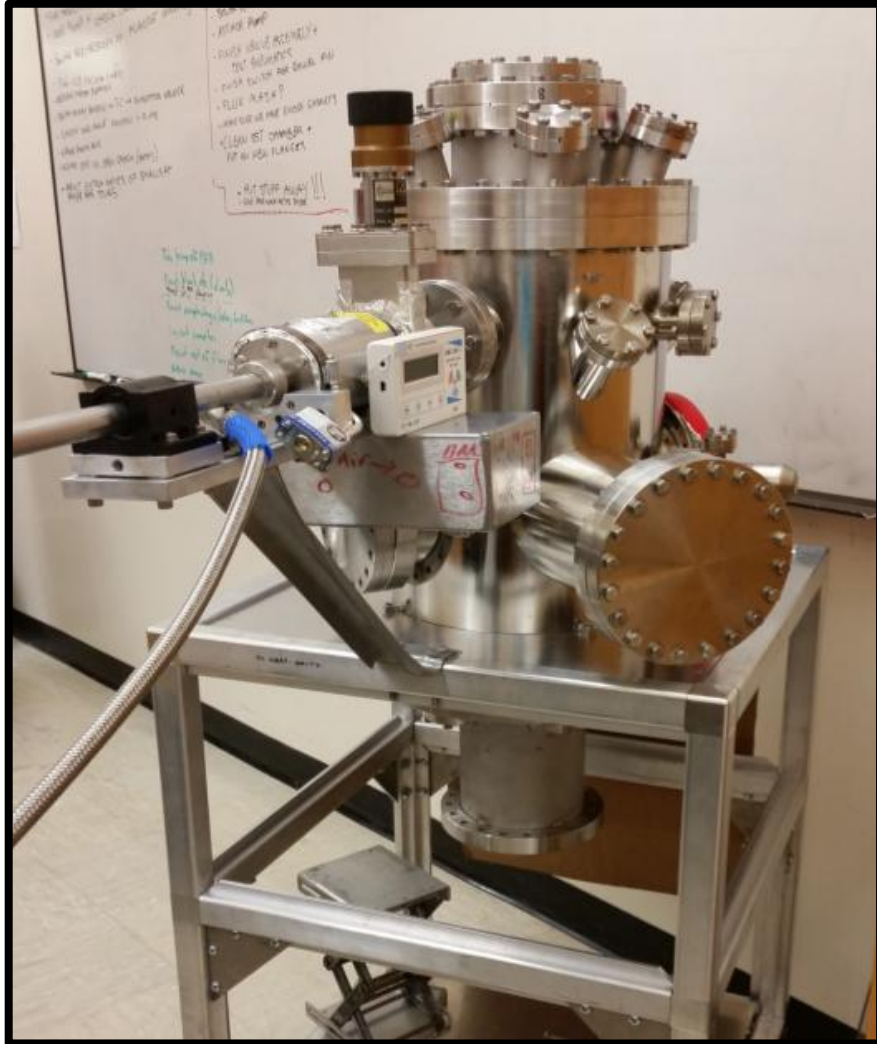


“Plants derived from seeds exposed to higher doses (0.5, 0.7, and 1 kGy) did not survive”



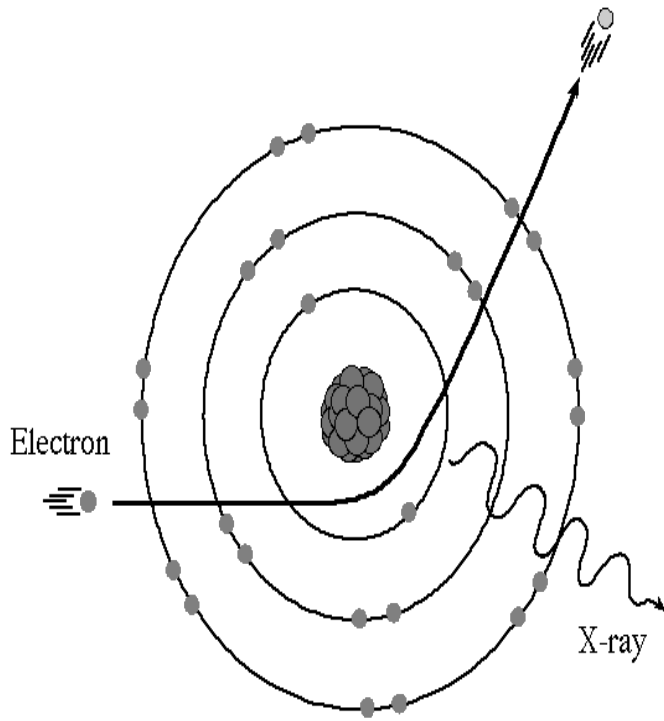
Radiation Testing

- Space Survivability Chamber



Chamber Material

Bremsstrahlung Radiation



	I		II		III		IV		V		VI		VII		O
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	
1	1 H														2 He
2	3 Li		4 Be		5 B		6 C		7 N		8 O		9 F		10 Ne
3	11 Na		12 Mg		13 Al		14 Si		15 P		16 S		17 Cl		18 Ar

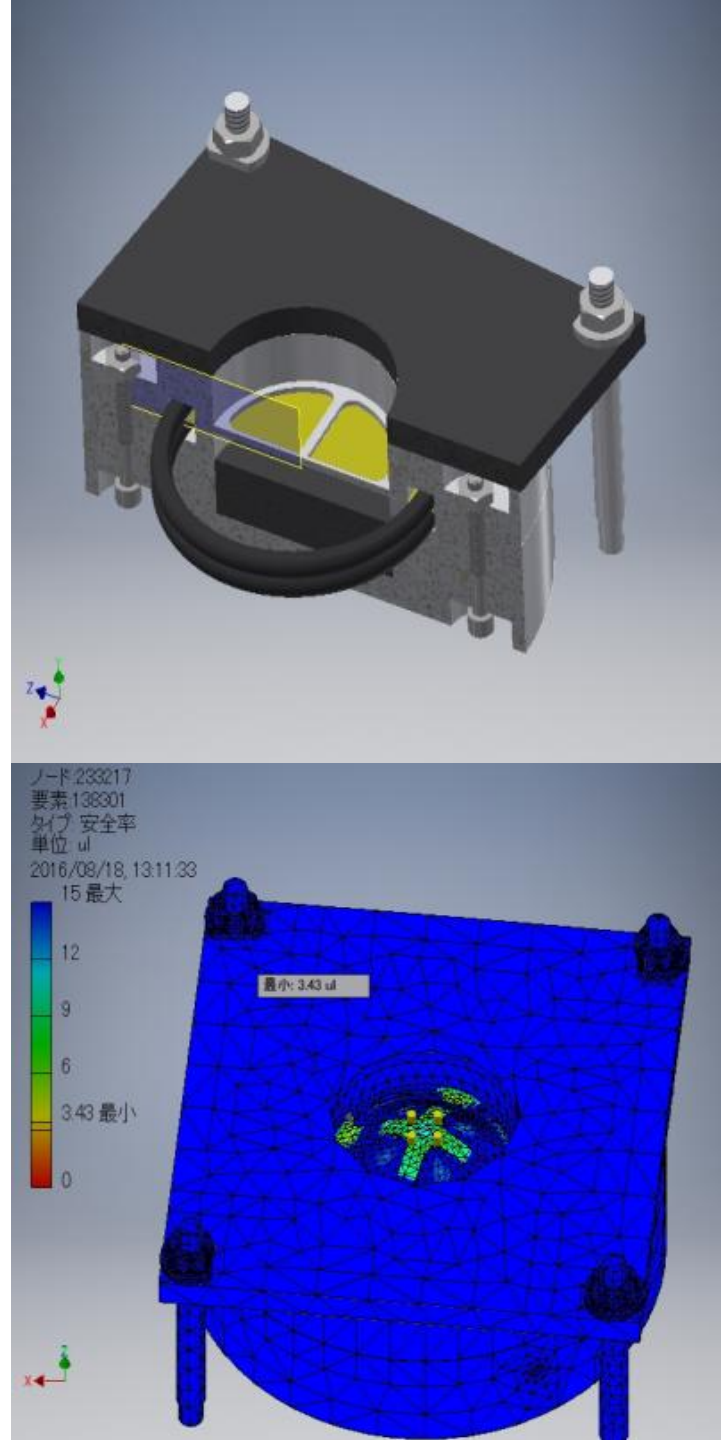
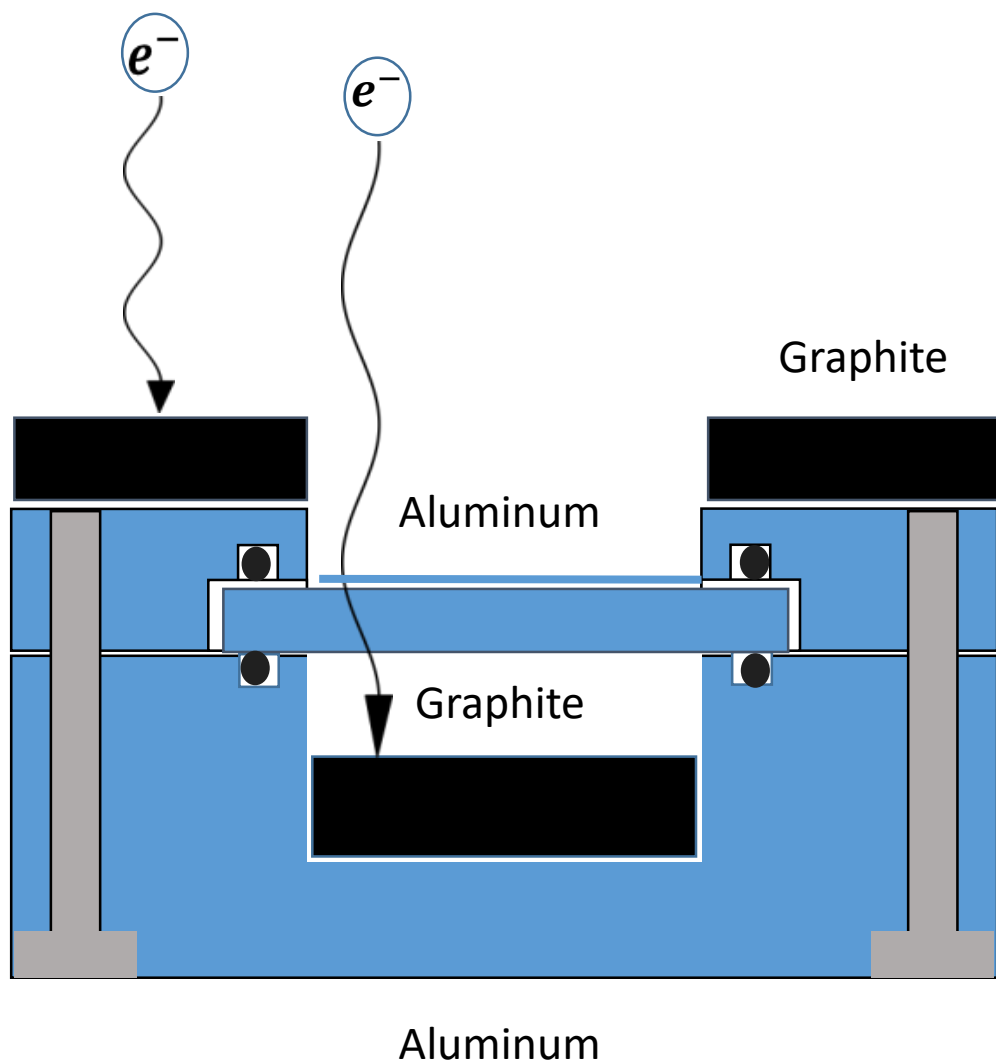
Be → Too expensive

C → Fragile

Al → Suitable, but generate X-rays



Reverse Chamber



Future Work

- Materials Physics Group

Space Environment Testing, SEM Imaging, Test Other Seed Types

- University of Tsukuba

Simulation of Launch Conditions

- Logan High School

Develop procedures to distribute to other High Schools

- Russia

More flights



References / Thanks

- Seeds were donated by the USU Space Dynamics Lab, where tests were initiated.
- Special Thanks to Gayle Bowen for organizing these experiments with Russia, and to all the Logan High students who contributed.
- Blau, Patrick. "Bion-M1 Mission Updates". *Spaceflight101*. N.p., 2013. Web. 19 Oct. 2016.
- Disher, Brandon et al. "CT Physics". *Web2.uwindsor.ca*. N.p., 2006. Web. 19 Oct. 2016.
- Gamma radiation effects on seed germination, growth and pigment content, and ESR study of induced free radicals in maize (*Zea mays*), 2013, pp.9

Questions?