Investigation of Link Between Zebrafish Cataract Formation from Exposure to Galactic Cosmic Radiation and ^{137}Cs Gamma-Rays

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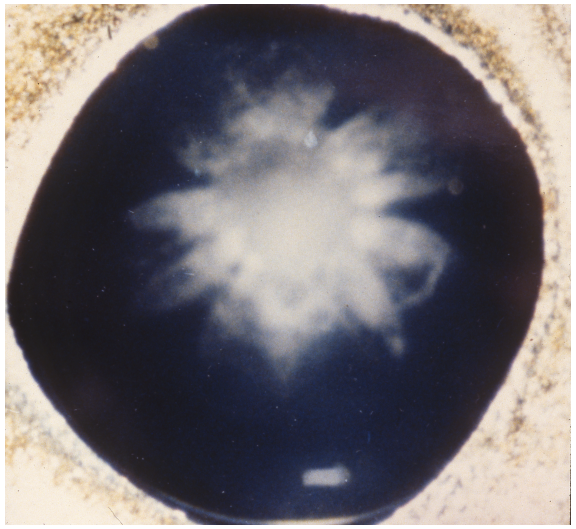
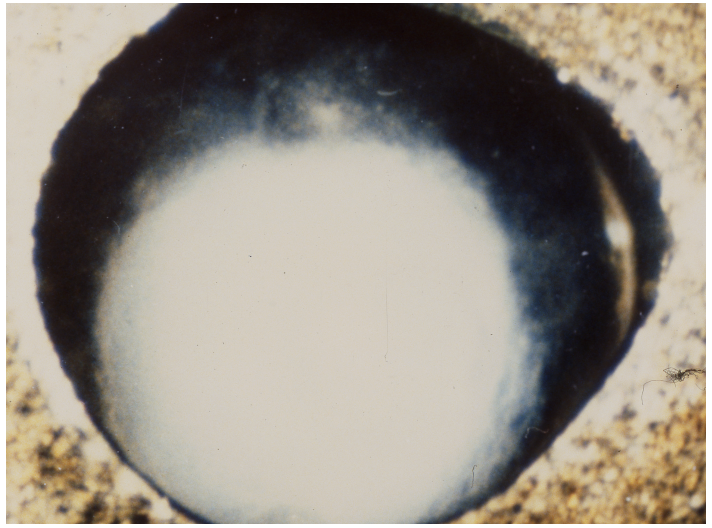
Background

Astronauts are more likely to have cataracts[1]

Exposure to GCR and amount of exposure also effects cataract occurrence[1,2]



Moderate nuclear cataract in rainbow trout[4]



Severe cataract in lens of rainbow trout[4]

What is a cataract?

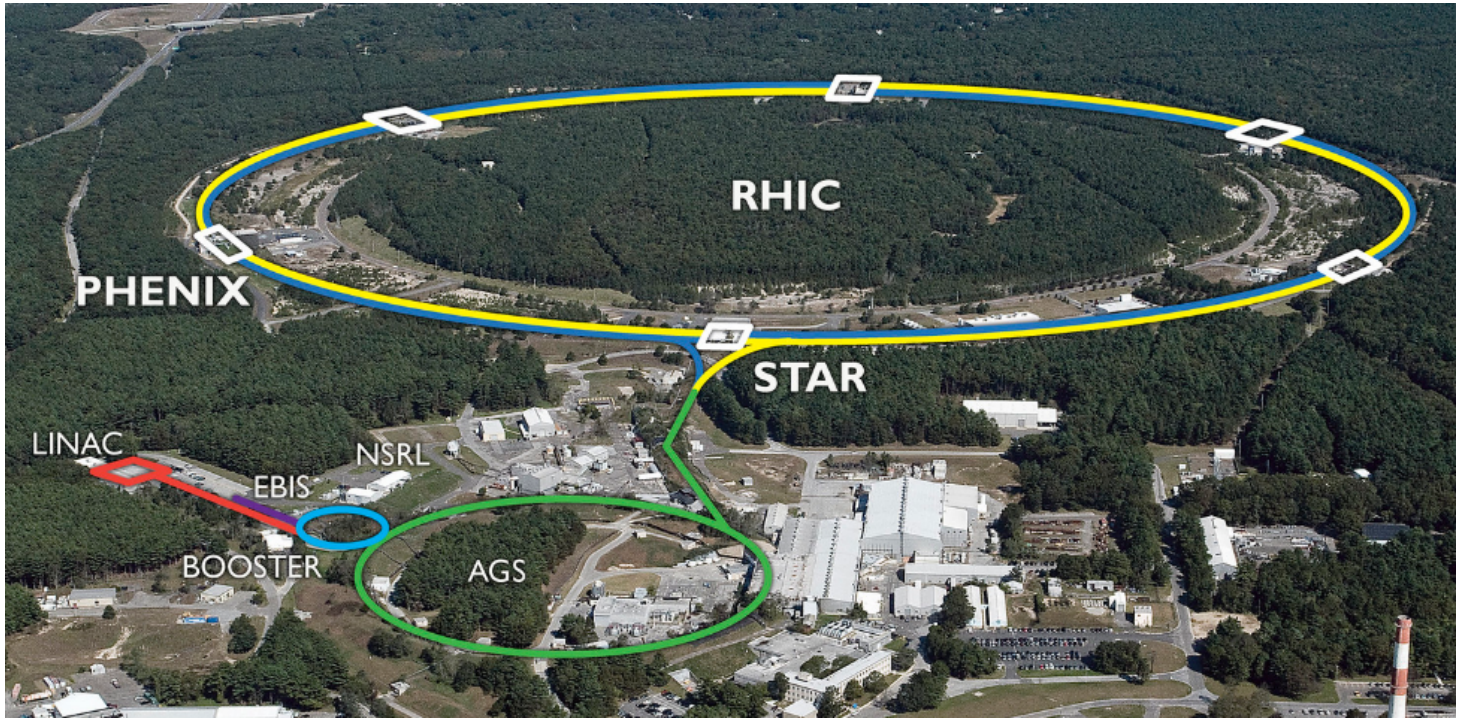
Clouding of the lens of the eye[3]

Tissues within the lens break down and clump together[3]

Why Zebrafish?

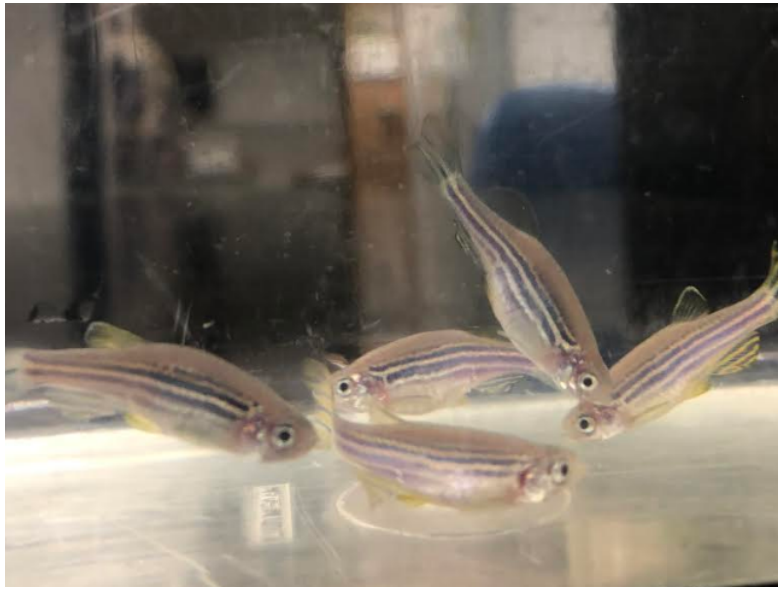
- More individuals
- Well understood vertebrate model
- More replicates
- Similar eye proteins to humans

Galactic-Cosmic Radiation



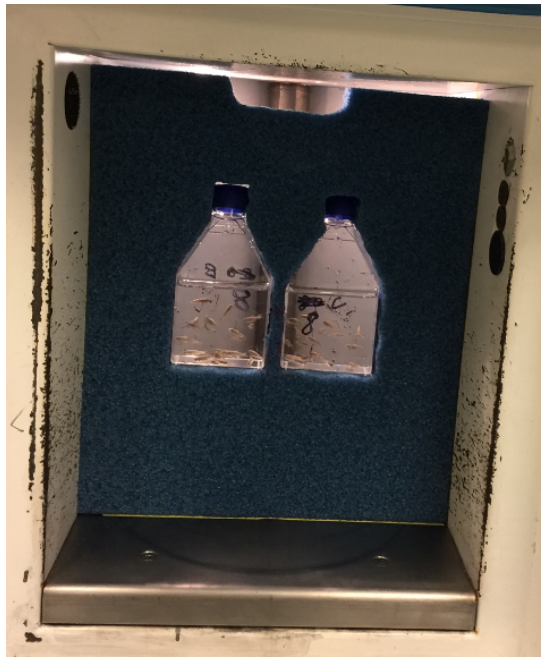
The RHIC complex at Brookhaven National Laboratory. [6]

- Nuclei of atoms, no electrons[5]
- High ionizing[5]
- Pass through spacecraft and astronauts easily[5]



Methods

- AB wild-type and albino zebrafish
- 2-5 months of age
- Shipped to Brookhaven National Lab and back for radiation treatments
- Monitored and kept at the Aquatic Animal Health Lab



Brookhaven National Laboratory (BNL)

- August 2018 (Gamma), November 2018 (Gamma), April 2019 (Gamma + GCR)

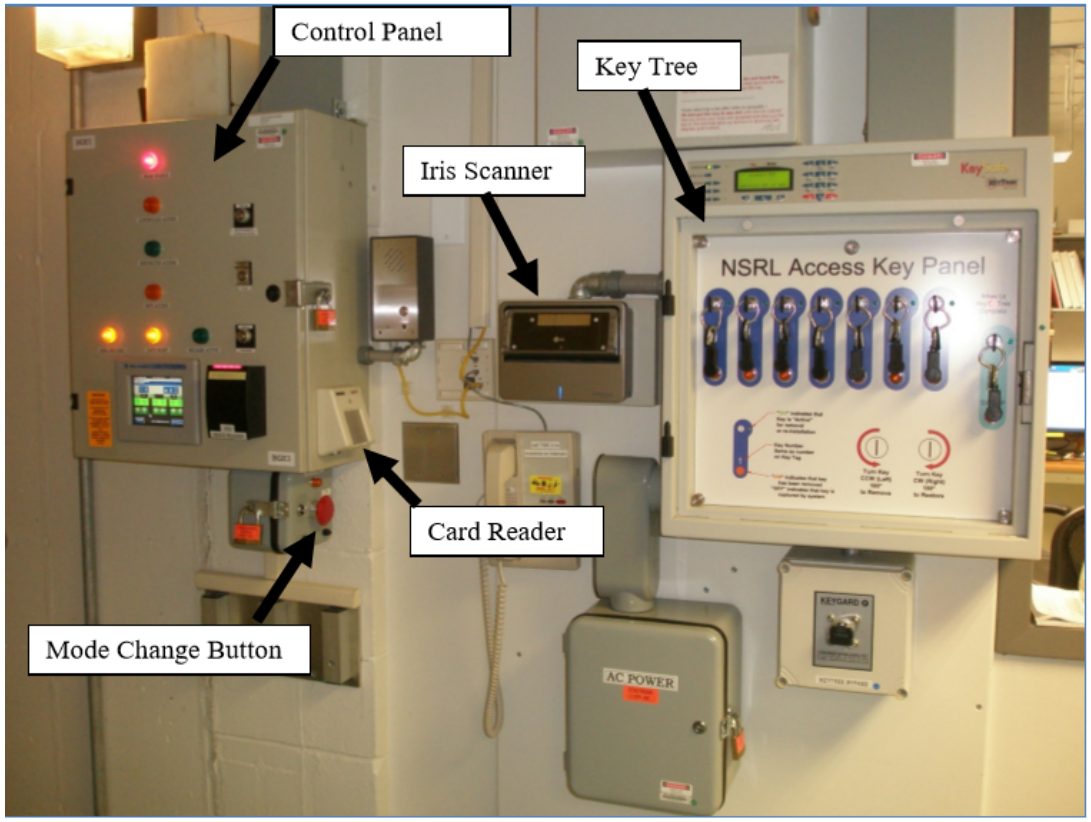
Gamma Treatment Groups:

- 8 Gy gamma
- 10 Gy gamma
- 20 Gy gamma
- No radiation

Galactic Cosmic Ray exposure

NASA Space Radiation Laboratory

Researchers here are working to understand and reduce the risks astronauts will face on future long-term space missions to Mars and beyond. The National Aeronautic and Space Administration (NASA) and the DOE Office of Science partnered to build this unique facility.



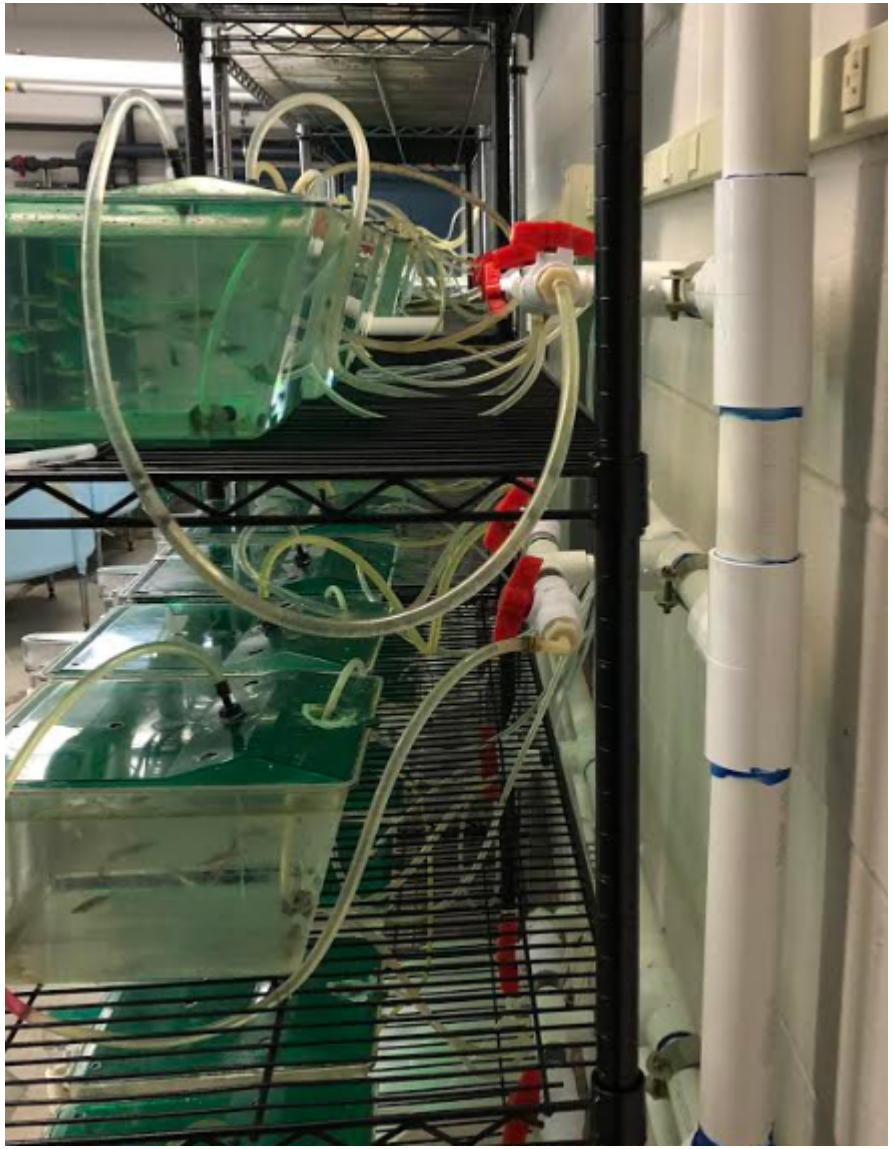
Treatment Groups:

- 0.75 Gy GCR
- 0.75 Gy GCR + 10 Gy Gamma
- 0.75 Gy GCR + 20 Gy Gamma
- No radiation

GCR-Galactic Cosmic Radiation

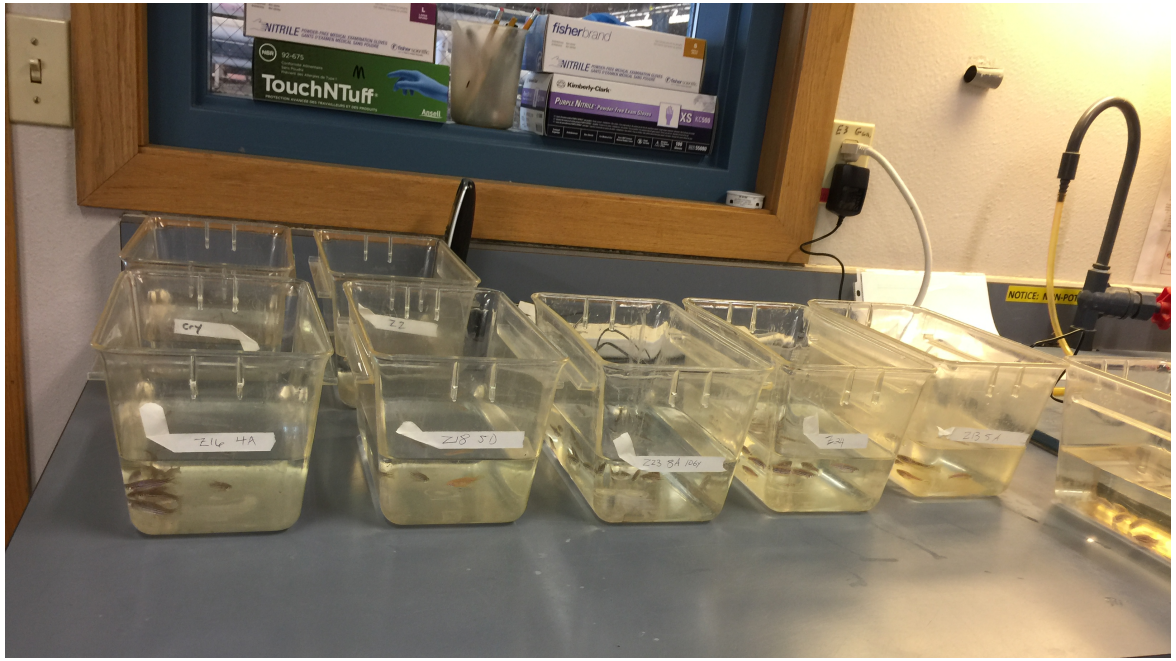
Ion Species	Dose (cGy)
p1000	26.25
si600	0.7500
he250	13.50
o350	4.50
fe600	0.7500
p250	29.25

System



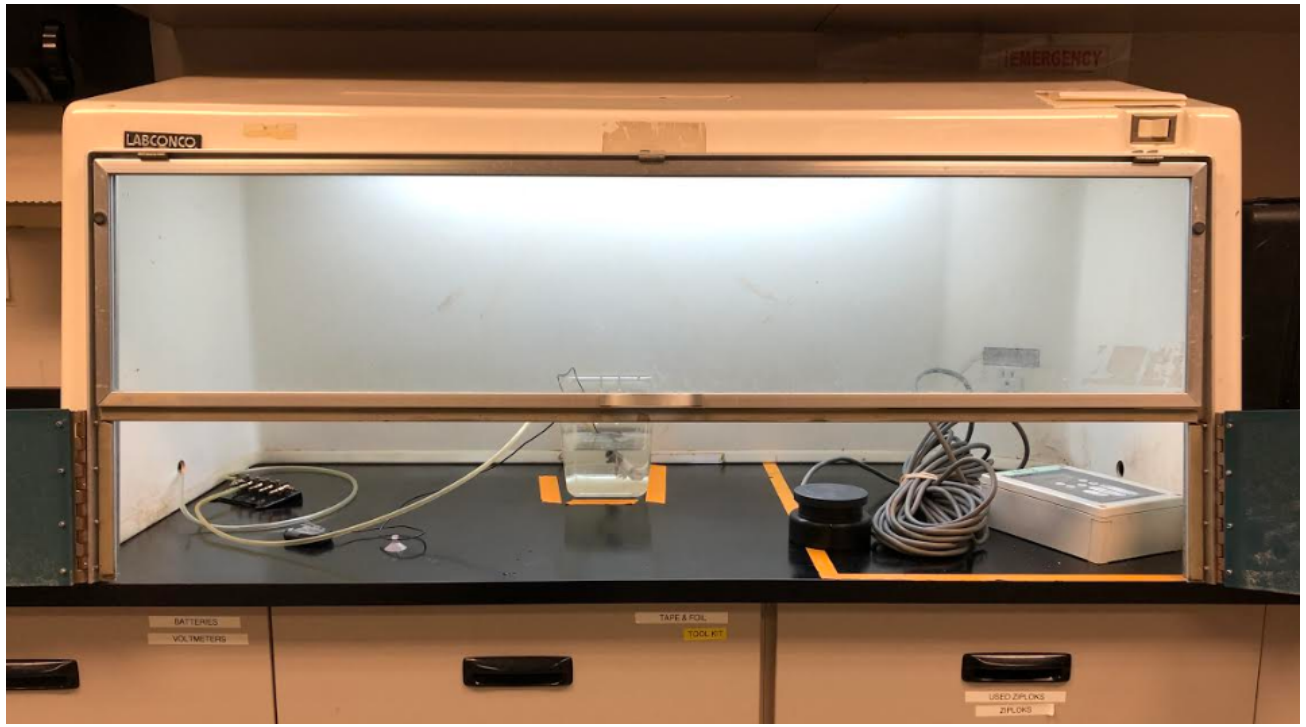
Eye exams


LP GAS
NO SMOKING
DANGER
PROPANE
WAKE UP
200
150


NITRILE
TouchNTuff
fisherbrand
NITRILE
Kimberly-Clark
XS

Preliminary Results

- 6-9 months post Gamma
- 6.5 months post Gamma +GCR
  - Only small cortical and central cataracts
  - None visible to naked eye
  - In both control and irradiated fish



UV Exposure

- 5 ABwt zebrafish
- 4.5 J/cm^2 UVA
- 3.7 J/cm^2 UVB
- No cataracts

Zebrafish are highly regenerative

Stem cell research potential in lens regeneration

Implications

Works cited

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4. Cullen, A. P. and C. A. Monteith-McMaster (1993). "Damage to the rainbow trout (*Oncorhynchus mykiss*) lens following an acute dose of UVB." Curr Eye Res **12**(2): 97-106.
5. “Why Space Radiation Matters.” NASA. https://www.nasa.gov/analogs/nsrl/why-space-radiation-matters
6. RHIC. https://www.bnl.gov/rhic/physics.asp