

# **EFFECTS AND RESPONSES TO SPACEFLIGHT IN THE MOUSE RETINA**

Susana B. Zanello<sup>1,2</sup>, Corey Theriot<sup>2</sup>, Christian  
Westby<sup>1,2</sup> and Richard Boyle<sup>3</sup>

*<sup>1</sup>Universities Space Research Association,  
<sup>2</sup>NASA-Johnson Space Center, <sup>3</sup>NASA-Ames  
Research Center*

# Does spaceflight represent a hazard to the eye?

- Space radiation promotes cataract development (Cuccinota et al, Rad Res 2001)
- Vision alterations associated with globe flattening, choroidal folds and papilledema shown in some crew members returning from long duration missions (Mader et al 2011)
- Scarce evidence from animal flight experiments showing cell loss in retina of rat neonates aboard STS-72 (Tombran-Tink & Barnstable, Gravit Space Biol Bull 2005) and cell disruption in retina of rats aboard Cosmos 782 and 936 (Philpott et al, ASEM 1978, ASEM 1980)

# Objective

- To better understand the ocular health risks associated with spaceflight, this study investigates the impact of spaceflight on the biology of the mouse retina



BALB albino mice



**Retinal  
Pigment  
Epithelium**

**CHOROID**

**OPTIC NERVE**

**myelinated**

**Outer  
Nuclear  
Layer**

**Inner  
Nuclear  
Layer**

**Retinal Ganglion Cells**

**VITREOUS BODY**

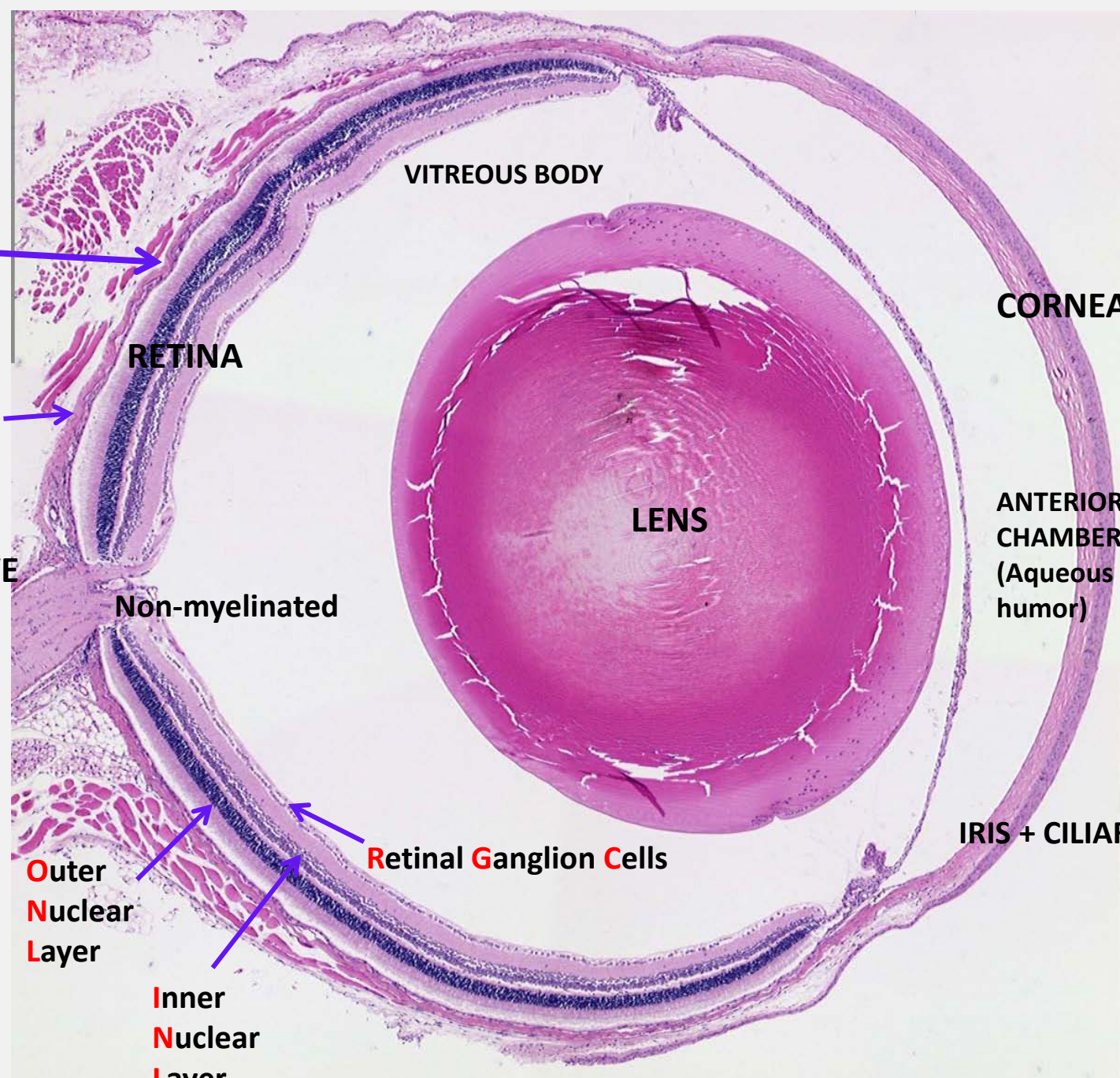
**RETINA**

**LENS**

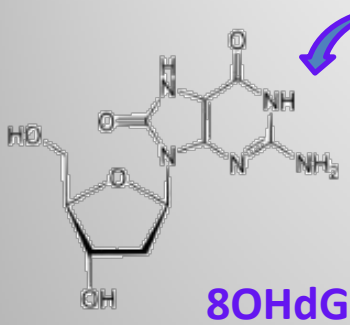
**CORNEA**

**ANTERIOR  
CHAMBER  
(Aqueous  
humor)**

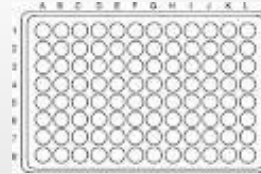
**IRIS + CILIARY BODY**



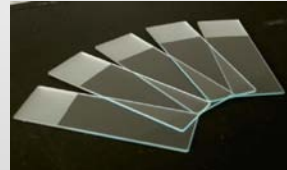
# Oxidative stress-DNA damage



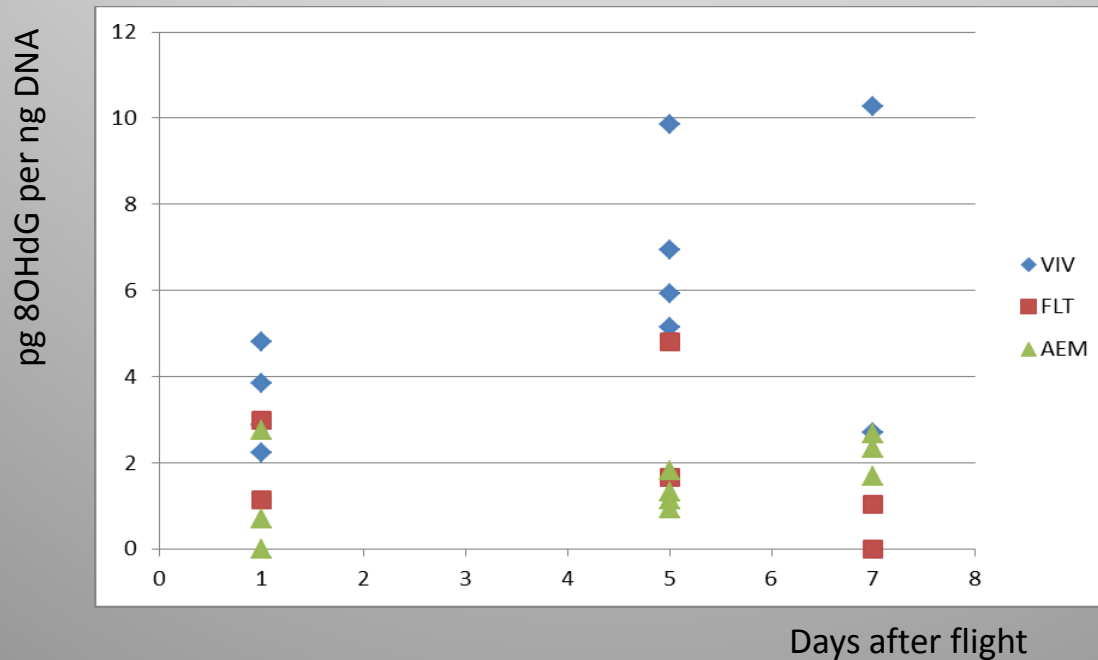
HO



ELISA (enzyme immunoanalysis)

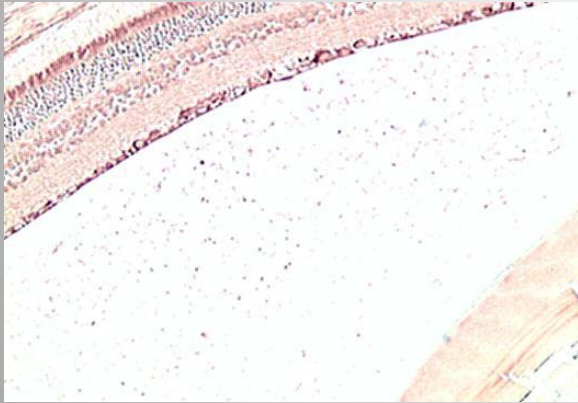


IH (immunohistochemistry)



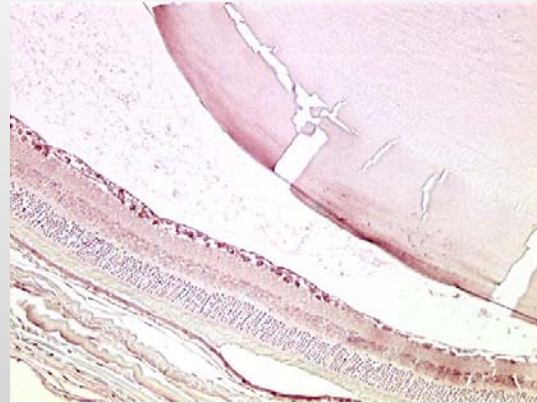


# Oxidative stress-DNA damage



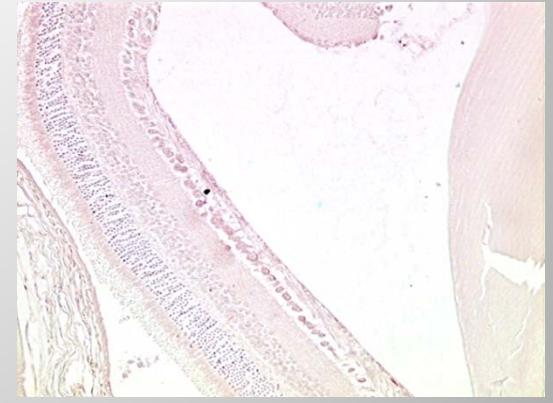
**FLT R+1 (#13)**

1.14 pg 8OHdG/ng DNA



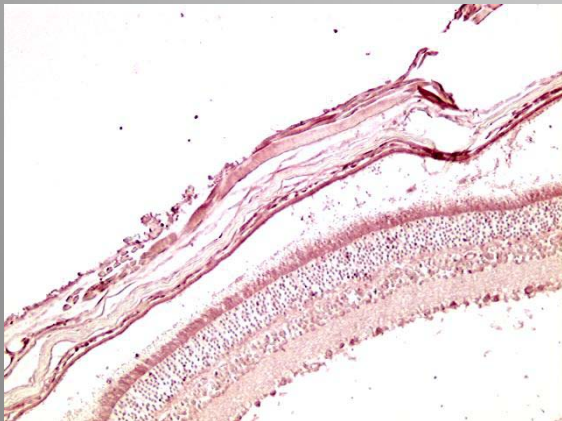
**FLT R+5 (#35)**

4.81 pg 8OHdG/ngDNA



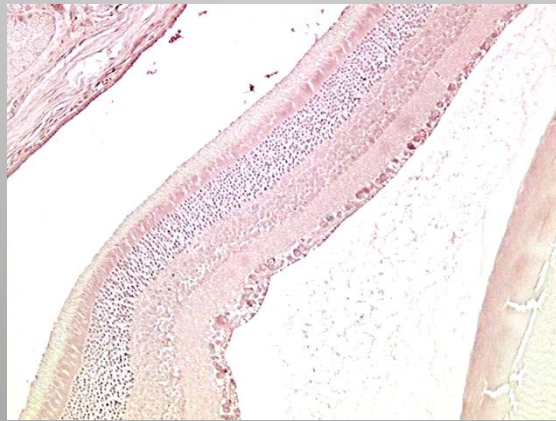
**FLT R+7 (#52)**

1.02 pg 8OHdG/ng DNA



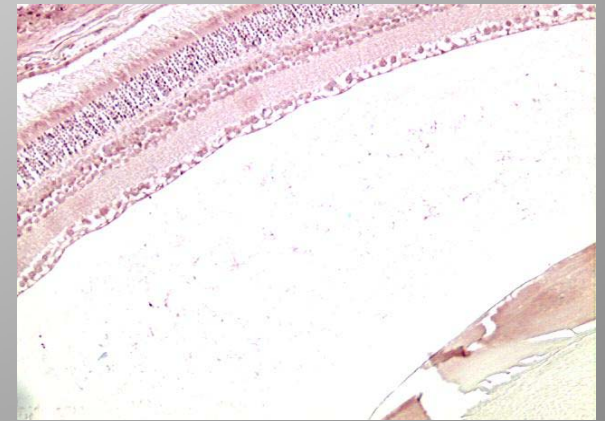
**VIV R+5 (#19)**

5.14 pg 8OHdG/ng DNA



**FLT R+5 (#34)**

1.65 pg 8OHdG/ng DNA

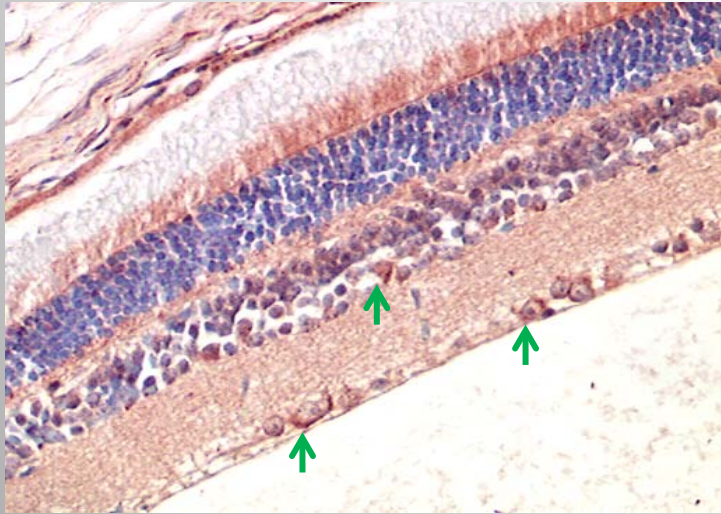


**AEM R+5 (#2)**

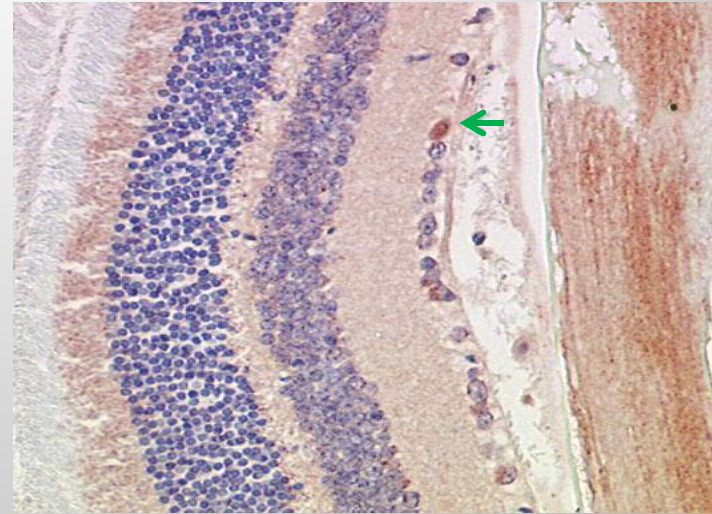
1.14 pg8OHdG/ng DNA



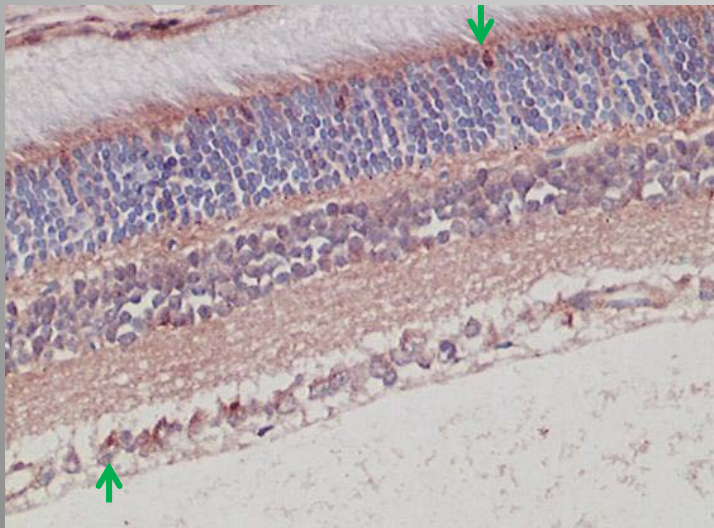
# Apoptosis



**FLT R+1 (#13)**



**AEM R+1 (#8)**

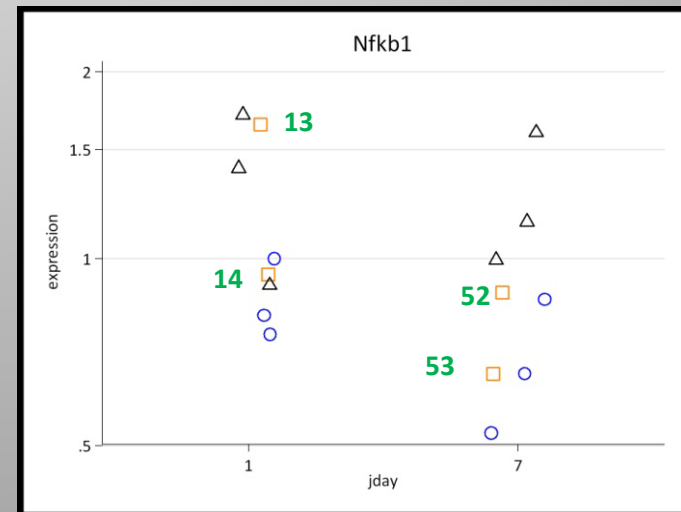
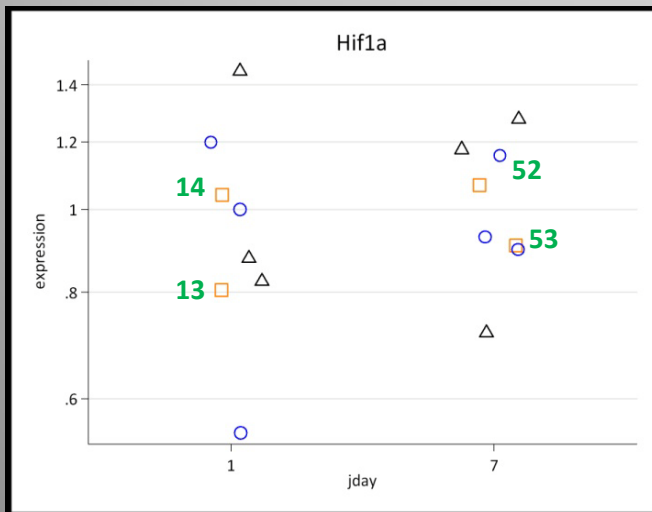
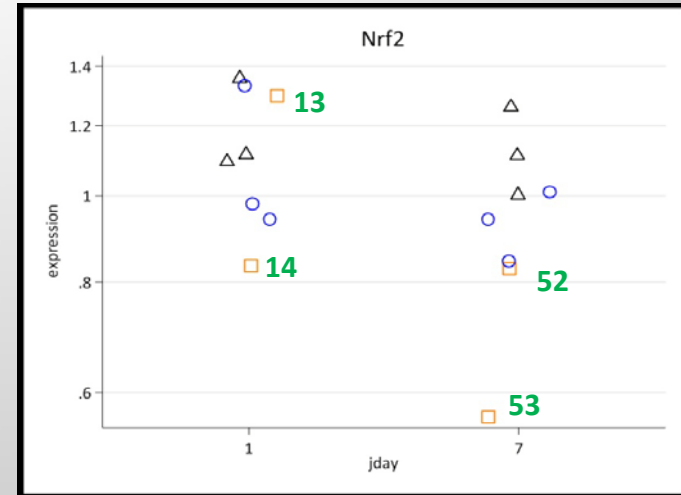
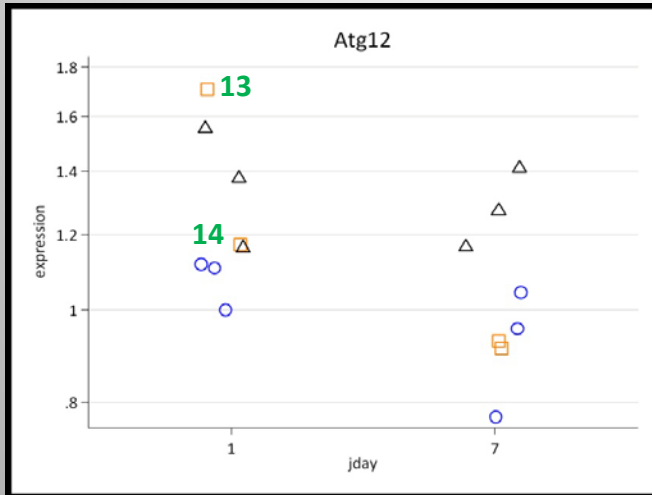


**VIV R+1 (#2)**

*Activated caspase-3 immunoreactivity (red-brown, green arrows) in retina sections of mice aboard STS133 and ground controls, on R+1.*



# Gene Expression



FLT AEM VIV

# Summary of results and conclusions

- Spaceflight induces DNA damage in the retina which is partially repaired after return to Earth.
- Oxidative stress induced-DNA damage in flight retina is tends to localize to RGC (vivarium samples localize oxidative stress to ONL)
- Cell death prevails in the INL and RGC in flight, and in ONL in vivarium samples
- Oxidative stress response gene expression tends to correlate with the oxidative stress damage observed by immunostaining
- Damage (oxidative and inflammatory) and cellular stress response seem to be correlated, elevated in flight but reversible after return to Earth.
- These results represent pilot data. No statistical analysis was possible due to small sample size.
- Further research is needed to investigate whether these pilot data indicate that stress induced by spaceflight in the retina may be of clinical significance.

# Acknowledgements

- Rich Boyle and the experimental team at KSC
- Corey Theriot
- Chris Westby
- James Fiedler
- Biomedical Research Core Lab, Radiation Lab
- Paula Pierce (Excalibur Pathology)
- HRP
- *Tissue collection*
- *RNA isolation*
- *8OHdG ELISA*
- *Gene expression plots*
- *Confocal microscope, real time qPCR instrument*
- *Immunohistochemistry*
- *Funding*