Fiscal Year:	FY 2023	**Task Last Updated:**	FY 10/29/2023
PI Name:	Loucas, Bradford Ph.D.		
Project Title:	Protracted Exposure to NASA's GCR-Simulator: Cytogenetic Validation and Beam Time Optimization		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **SR**:Space Radiation		
Human Research Program Risks:	(1) **Cancer**:Risk of Radiation Carcinogenesis		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Galveston	**State:**	TX
Zip Code:	77555-5302	**Congressional District:**	14
Comments:			
Project Type:	GROUND	**Solicitation / Funding Source:**	2016-2017 HERO NNJ16ZSA001N-SRHHC. Appendix E: Space Radiobiology and Human Health Countermeasures Topics
Start Date:	05/20/2018	**End Date:**	05/18/2024
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	0
No. of Bachelor's Candidates:	0	**Monitoring Center:**	NASA LaRC
Contact Monitor:	Elgart, Robin	**Contact Phone:**	281-244-0596 (o)/832-221-4576 (m)
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Flight Program:			
Flight Assignment:	End date changed to 05/18/2024 per NSSC information (Ed., 10/29/23).		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Cornforth, Michael Ph.D. (University of Texas Medical Branch, Galveston)		
Grant/Contract No.:	80NSSC18K0864		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	Exposure to galactic cosmic rays (GCR) presents a health risk to astronauts on deep space missions. To study these risks, NASA is developing the GCR simulator that will be able to irradiate cell or animal samples with combinations of ions known to be present in GCR. This device will, by necessity, irradiate these samples at doses and dose rates considerably high than that found in space in order to produce statistically meaningful results. To produce the best simulations, dose rates and exposure sequences will need to be optimized. This proposal will endeavor to optimize these parameters by measuring the induction of chromosome aberrations. Most of these aberrations are exchanges of chromosomal segments that come about when radiation damage severs chromosomes. Normally, cells can repair these breaks, but on occasion, if two or more breaks are close to one another, a mistake can be made whereby the cell joins break ends to inappropriate partners causing an exchange of chromosomal segments. The damage forming these breaks is caused by ionizations along the paths (tracks) that ions take as they pass through a medium. While in some cases all the breaks necessary for an exchange to form occur along a single particle track, in other circumstances, breaks are formed along separate and independent tracks in a process referred to as track interaction. Track interaction events become important at higher doses when the number of tracks produce damage that is sufficiently close to interact increases. Track interactions are not likely to occur at the doses thought to be found in space but will certainly happen at the higher doses required for GCR simulations and potentially skew the results. One strategy to avoid track interactions is to lower the dose rate. By spacing out the time over which ions pass through a cell, breaks forming early in the time frame have an opportunity to be repaired before other breaks forming spatially close enough to interact with them arrive on the scene. This produces a reduction in the frequency of chromosome exchanges. As the dose rate decreases further a point is reached where virtually all the exchanges result from single track action. At this “limiting low dose rate” no additional reduction in chromosome exchange frequency is possible by further reduction in the dose rate. These results will be directly scalable to the low doses and dose rates present in space. Specific aim 1 of our proposal will endeavor to determine the limiting low dose rate for protons at the energy stated in the NRA (NASA Research Announcement). This will be accomplished by irradiating cells with a series of doses at dose rates we estimate will be close to the limiting low dose rate and looking for chromosome exchanges. When additional reduction in doses rate fails to produce any further decrease in exchanges as a function of dose we will be at the limiting low dose rate. The GCR simulator will be irradiating samples with a number of different ion beams in order to better simulate the nature of the mixed ion field found in space. The heavier ions in the GCR spectrum will behave differently from the lighter ions. The heavy ions produce more damage along their tracks--so much so that virtually all chromosome exchanges are formed via single track action. In this case we will need to determine the optimal time needed for repair to occur between irradiations with the subsequent ion beams to avoid track interaction. Specific aim 2 will address these concerns by varying the time between ion beams. Much like the dose rate experiments, as we extend the time between irradiations, the probability for track interaction should be reduced. Once we reach a level where no further chromosome exchange frequency reductions are observed, we will have reached the optimal point for irradiation delay. Sequence may also be important in that regard and additional experiment will search for the best sequence that minimizes track interaction.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Our project will endeavor to help optimize exposure protocols for NASA's GCR simulator by determining the limiting low dose rate for chromosome aberration induction. This will allow investigators to optimize their experimental protocols in ways that will better simulate the low doses and dose rates found in the space radiation environment. These results may impact how low dose and dose rate experiments are conducted in the future and might provide better risk estimates for low radiation doses both in space and here on Earth.
Task Progress:	Ed. Note: NASA Johnson Space Center indicates that this project has been on hold. A published peer-reviewed article has been added to the Cumulative Bibliography (Ed., 10/29/23).
Bibliography Type:	Description: (Last Updated: 10/29/2023)
Articles in Peer-reviewed Journals	Loucas BD, Shuryak I, Kunkel SR, Cornforth MN. "Dose-dependent transmissibility of chromosome aberrations at first mitosis after exposure to gamma rays. I. Modeling and implications related to risk assessment." Radiat Res. 2022 Apr 1;197(4):376-383. https://doi.org/10.1667/RADE-21-00180.1 ; PMID: 35030259; PMCID: PMC9109216 , Apr-2022