Fiscal Year:	FY 2021	**Task Last Updated:**	FY 03/27/2021
PI Name:	Hargens, Alan R. Ph.D.		
Project Title:	Self-Generated LBNP for Deep-Space Missions		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **HHC**:Human Health Countermeasures		
Human Research Program Risks:	(1) **SANS**:Risk of Spaceflight Associated Neuro-ocular Syndrome (SANS)		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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PI Organization Type:	UNIVERSITY	**Phone:**	858-534-7837
Organization Name:	University of California, San Diego		
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City:	La Jolla	**State:**	CA
Zip Code:	92037-0863	**Congressional District:**	52
Comments:			
Project Type:	Ground	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	01/31/2019	**End Date:**	01/30/2022
No. of Post Docs:	0	**No. of PhD Degrees:**	0
No. of PhD Candidates:	1	**No. of Master' Degrees:**	1
No. of Master's Candidates:	2	**No. of Bachelor's Degrees:**	2
No. of Bachelor's Candidates:	6	**Monitoring Center:**	NASA JSC
Contact Monitor:	Brocato, Becky	**Contact Phone:**	
Contact Email:	becky.brocato@nasa.gov		
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:	2021 report: James Friend, Linda Loerch, and Lonnie Petersen are no longer CoInvestigators on the project. 2020 report: Dr. Natalie Afshari is a new CoInvestigator for her ophthalmology expertise.		
COI Name (Institution):	Lee, Stuart Ph.D. (KBR/NASA Johnson Space Center) Macias, Brandon Ph.D. (NASA Johnson Space Center) Afshari, Natalie A. M.D. (University of California, San Diego)		
Grant/Contract No.:	80NSSC19K0409		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	This Ground-Based proposal will evaluate a novel, self-generated Lower Body Negative Pressure (LBNP) device as a countermeasure to prevent Spaceflight Associated Neuro-Ocular Syndrome (SANS). This device is ideal for off-normal conditions in space craft when power is low. The self-generated LBNP device was invented and published by our team almost 20 years ago and is presently on the Chinese Space Station Tiangong One. This concept is very timely now with NASA's need to provide a SANS countermeasure while at the same time, providing physiologically-integrated exercise hardware that is safe, low mass, low volume, low power, and simple for deployment on a small, confined deep-space vehicle. Previous ground-based tests of the self-generated LBNP device document that the maximum footward force at the peak of the exercise cycle is over 110 kg and pressure within the cylinder concomitantly decreases by over 25 mm Hg below ambient to help counteract SANS, maintain aerobic capacity and the musculoskeletal system. This proposal is a logical extension of our previous ground-based simulations validating the self-generated LBNP device to re-introduce daily gravitational pressures and footward reaction forces. Furthermore, it extends our ongoing International Space Station (ISS) project "Fluid Distribution Before, During and After Prolonged Space Flight," demonstrating short-term LBNP by the Russian Chibis Suit to reduce venous congestion in the neck. We will use state-of-the-art, non-invasive technologies and imaging to prove efficacy of our self-generated LBNP device by quantifying cerebral volumes, pressures, and compliance along with visual deficits and ocular remodeling in 16 healthy female and male volunteers during parabolic flight and ground simulations of microgravity. We will determine dose-response efficacy of self-generated LBNP and accompanying shoulder-vest and footward mechanical loads to re-introduce diurnal effects of gravitational stress. Our self-generated LBNP device is very timely now with NASA's need to provide an integrated countermeasure for SANS and musculoskeletal (MS) losses, while at the same time providing physiologically-integrated exercise hardware that is safe, low mass, low volume, no power, and simple for deployment in a confined deep-space vehicle. Taken together, we therefore propose low-level, almost daily application of self-generated LBNP as an integrated countermeasure to reintroduce diurnal cycles of gravitational fluid and pressure variability to preserve cerebral, ocular, cardiovascular, and musculoskeletal health, relevant to 2011 Decadal priorities AH6 ("Studies should be done to develop and test new prototype exercise devices, and to optimize physical activity paradigms/prescriptions targeting multi-system countermeasures"). A self-generated LBNP device will go from a Technology Readiness Level of 7 to 8.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	This Ground-Based proposal will evaluate a novel, self-generated Lower Body Negative Pressure (LBNP) device as a countermeasure to prevent Spaceflight-Associated Neuro-Ocular Syndrome (SANS). The change in position and forces from an exercising astronaut in the device expands the accordion device to create a suction pressure. This suction trans-locates blood from the upper body to the lower body while applying musculoskeletal loads to crewmembers' bodies without a separate electricity source, making it ideally suited to spaceflight conditions when power supply is limited. This concept is very timely with NASA's need to provide a SANS countermeasure while at the same time, providing physiologically-integrated exercise hardware that is safe, low mass, low volume, low power and simple for deployment in a small, confined deep-space vehicle. Additionally, the self-generated LBNP device presents less of an engineering challenge than a short-radius centrifuge or whole space vehicle rotation.
Task Progress:	The design was optimized this year and we will employ a supine SELF LBNP device for acute tests of cardiovascular and cerebral physiology. Problems involving chamber collapse and leakage during decompression in early prototypes were addressed, and a new SELF LBNP device is under construction. After human research is re-instated at University of California San Diego, acute posture studies of SELF LBNP will be compared with short-term exposures to conventional LBNP.
Bibliography Type:	Description: (Last Updated: 06/30/2025)
Articles in Peer-reviewed Journals	Khossravi EA, Hargens AR. "Visual disturbances during prolonged space missions." Curr Opin Ophthalmol. 2021 Jan;32(1):69-73. https://doi.org/10.1097/ICU.0000000000000724 ; PMID: 33196542 , Jan-2021
Articles in Peer-reviewed Journals	Ashari N, Hargens AR. "The mobile lower body negative pressure gravity suit for long-duration spaceflight." Front Physiol. 2020 Aug 5;11:977. https://doi.org/10.3389/fphys.2020.00977 ; PMID: 32848889; PMCID: PMC7419691 , Aug-2020