Fiscal Year:	FY 2020	**Task Last Updated:**	FY 12/17/2020
PI Name:	Zhang, Quan Ph.D.		
Project Title:	Characterizing the Baselines of Sleep Quality, Cognitive / Operational Performance, Immune Function, and Intracranial Fluids for Deep Space Expeditions		
Division Name:	Human Research		
Program/Discipline:			
Program/Discipline--Element/Subdiscipline:			
Joint Agency Name:		**TechPort:**	No
Human Research Program Elements:	(1) **HFBP**:Human Factors & Behavioral Performance (IRP Rev H)		
Human Research Program Risks:	(1) **BMed**:Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	02129-2020	**Congressional District:**	7
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	2017-2018 HERO 80JSC017N0001-BPBA Topics in Biological, Physiological, and Behavioral Adaptations to Spaceflight. Appendix C
Start Date:	04/22/2019	**End Date:**	05/31/2026
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 JSC
Contact Monitor:	Williams, Thomas	**Contact Phone:**	281-483-8773
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Flight Program:			
Flight Assignment:	NOTE: End date changed to 05/31/2026 per NSSC information (Ed., 2/3/2020) NOTE: End date changed to 9/30/2020 per NSSC information (Ed., 2/3/2020)		
Key Personnel Changes/Previous PI:	Dr. Gary Strangman was added to this project in year 1; he will help Dr. Zhang oversee the highly complex CIPHER project.		
COI Name (Institution):	Kimberly, William M.D., Ph.D. (Massachusetts General Hospital) Vujovic, Nina Ph.D. (Brigham And Women's Hospital, Inc.) Spielmann, Guillaume Ph.D. (Louisiana State University and A&M College) Strangman, Gary Ph.D. (Massachusetts General Hospital)		
Grant/Contract No.:	80NSSC19K0925		
Performance Goal No.:			

Performance Goal Text:	
Task Description:	Sleep is central physiological regulator of cognitive / behavioral, neurophysiological, and immune functions. The study of sleep quality and duration on orbit may thus yield important insights into etiology and mechanisms of adverse cognitive/behavioral, Spaceflight Associated Neuro-ocular Syndrome (SANS), and immunological responses during long duration deep space exploration missions. We propose to use an integrated approach combining assessments of (1) sleep quality and duration, (2) intracranial physiology, (3) cognitive performance, and (4) immunological response. We propose to collect data on crewmembers participating in integrated one-year mission project (CIPHER) aboard the International Space Station (ISS), and demographically matched control subjects in Human Exploration Research Analog (HERA) for missions of similar durations. Our specific aims are: (SA1) Characterize cognitive task performance changes during the integrated 1 Year Mission Project (1YMP) on the ISS; (SA2) Characterize brain and systemic physiology changes during 1YMP on the ISS; (SA3) Characterize the effects of sleep duration and quality on cerebral hemodynamics on ISS and in HERA; and (SA4) Quantify the effects of sleep duration and quality on immune response. The outcomes of the study will contribute to quantification of crew health and performance risks associated with human spaceflight, and aid in development of technologies for monitoring and mitigating crew health and performance.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Successful completion of this project will be a milestone in spaceflight behavioral, neurophysiological, and immune investigation. It will be the largest study of operational performance in space, and the first to conduct in-flight resting-state and task-related functional brain imaging. In addition, it will be the first study to probe the relationships and interactions between behavioral, neurophysiological, and immune functioning. The use of three different length missions will further enable us to extrapolate any effects towards longer missions. The findings will be important on Earth as well, by helping to better understand the complex inter-relationships between sleep, brain physiology, immune function, and cognitive performance.
Task Progress:	Since project initiation in April 2019, and in collaboration with NASA's research integration team (ROI) and our subcontracted collaborators at Louisiana State University (LSU) , we have worked on the Definition Phase statement of work. These activities have included the following: 1) NINscan device modifications: The majority of the Definition Phase work focused on making sure the NINscan devices would be suitable for flight. This work has included the following: * Battery management: we tested numerous batteries and configurations and found one that matches device needs with previously-approved or readily available batteries onboard the ISS. The main challenge is having sufficient battery power for the device to last the nominal overnight (sleep) recording periods (ideally >10 hrs continuous recording time, to provide some time-buffer). * Laser safety: the device lasers were confirmed to be safe (effective Class I). * Device Housing and EMI (electromagnetic interference): began coordinating with ISSMP [ISS Medical Project; as of May 2019, element is now Research Operations and Integration (ROI)--ed., Dec 2020] regarding the final housing of the NINscan devices to address in-flight concerns * Sterilization: benzalkonium chloride (BZK) confirmed to be fully compatible with our system. * Electrodes: we confirmed any wet-style stick-on (Ag/AgCl) electrodes will be suitable for our use. * Constraints document. We provided a detailed spreadsheet describing all study constraints. * Hardware modifications. Given device size is closely related to the upmass cost, flight certification user experience, we have been redesigning the device to reduce its form factor and improve its user interface. The new devices will have approximately 50% of the size and weight of the previous device, with numerous hardware enhancements to improve performance and reliability. * Flight requirements: Many device housing requirements, such as "no sharp edges; rounded corners preferred", are implemented in the new enclosure design with smaller form factor and more friendly user interface. We have built 4 enclosures and now testing the 5th version of the housing design; and will provide ISSMP with the final schematic for metal housing. In addition, other flight certification requirements include "no small loose pieces," as well as wiring changes. The current NINscan device has numerous manually soldered wires to connect the from the probe plug to the circuit boards, which can be unreliable during space flight. In order to improve and meet the flight need, we designed a new adaptor board structure to reduce the use of wires and manual assembly, which will significantly improve the systems reliability and signal quality. In summary, corresponding to the tasks of the SOW (statement of work), we completed our adaptation of the NINscan-SE next-generation (v3) design, based on ISSMP input/requests, and we have gone through two rounds of NINscan-SE V3 board design, fabrication, debugging and testing, including analog boards, digital boards, battery management, and device enclosure. The circuit design is 90% finalized and firmware design is 70% finalized. Fabrication and testing of all NINscan-SE components (i.e., analog boards, digital boards, probe "boards") * We have fabricated/re-fabricated two rounds and a total of 18 sets of analog, digital, and sensor adaptor boards, and prepared the lasers, connectors, and other key components for the four devices used for this project. Assembly and testing of 4 NINscan-SE v3 devices and probes, suitable for final NASA preflight testing * We expect to complete the assembly of two functional devices with probes by the end of May 2020. In addition to the above, we continued coordination with the Portfolio Manager, Flight Analogs Project (FAP), and ISSMP to develop clear, firm, and feasible baseline data collection (BDC), pre-, in-, and post-flight plans. These activities and achieved milestones included project presentations, timeline and scheduling coordination and modifications, blood and saliva sampling coordination with other 1YMP investigators, data share coordination, discussions regarding BDC support for the BHP (behavioral health & performance) and DST Laboratory (Cognition/ROBoT-r testing), IRB (Institutional Review Board) submissions with MGH, LSU, and NASA (awaiting

	confirmation on whether MGH or NASA (or neither) will be the IRB of record for this study)), and coordinating plans for sample-retrieval post-flight. In all, progress to date keeps us in line with other CIPHER studies to meet the projected flight timelines.
Bibliography Type:	Description: (Last Updated: 04/12/2022)