Fiscal Year:	FY 2006	Task Last Undated	EV 05/20/2008
Fiscal Year: PI Name:		Task Last Updated:	F I 03/20/2008
	Brainard, George C. Ph.D.		
Project Title:	Blue Light for Enhancing Alertness in Space Missions		
Division Name:	Human Research		
Program/Discipline:	NSBRI Teams		
Program/Discipline Element/Subdiscipline:	NSBRI TeamsHuman Performance Factors, Sleep, and Chrono	biology Team	
Joint Agency Name:	Те	chPort:	Yes
Human Research Program Elements:	(1) <b>BHP</b> :Behavioral Health & Performance (archival in 2017)		
Human Research Program Risks:	(1) BMed:Risk of Adverse Cognitive or Behavioral Conditions a	and Psychiatric Disorders	
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
PI Email:	george.brainard@jefferson.edu	Fax:	FY 215-923-7588
PI Organization Type:	UNIVERSITY	Phone:	215-955-7644
Organization Name:	Thomas Jefferson University		
PI Address 1:	Light Research Program		
PI Address 2:	1025 Walnut St., Room 507		
PI Web Page:			
City:	Philadelphia	State:	PA
Zip Code:	19107-5083	Congressional District:	1
Comments:			
Project Type:	Ground	Solicitation / Funding Source:	Directed Research
Start Date:	09/01/2006	End Date:	08/31/2012
No. of Post Docs:		No. of PhD Degrees:	
No. of PhD Candidates:		No. of Master' Degrees:	
No. of Master's Candidates:	N	o. of Bachelor's Degrees:	
No. of Bachelor's Candidates:		Monitoring Center:	NSBRI
Contact Monitor:		<b>Contact Phone:</b>	
Contact Email:			
Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):			
Grant/Contract No.:	NCC 9-58-HPF00001		
Performance Goal No.:			
Performance Goal Text:			
	The overall goal of this project is to study the efficacy of blue enriched polychromatic solid-state light for acutely enhancing alertness and cognitive performance in healthy men and women. The purpose of this work is to develop an in-flight lighting countermeasure for enhancing alertness in astronauts as well as NASA ground crew. This is a new, directed research project. To initiate the work, we proposed the following seven aims:		
	1) Assemble a team of investigators who will create a set of stud		
	2) Establish either collaborative, consultant or subcontract agreen outside of Thomas Jefferson University (TJU).	ments for elements of the w	vork which are best done
	3) Write and secure Institutional Review Board (IRB) approval of	of the first study design.	

CFV and other space ciploration habitats for earthly enhancing astromant and ground crew alertness.           Travarda economication of the space ciploration habitats for earthly enhancing astromant and ground term were used to establish the team of invocinganous. Over the first year, a total of ciplin meetings were used to establish the team of invocinganous. Over the first year, a total of ciplin meetings were used to establish the team of invocinganous. Over the first year, a total of ciplin meetings were used to establish the team of invocing the NASA future first year, a total of ciplin meetings. See Center (SC). As a result of these meetings, key collaborators who have formula graved to participlice on this project. These includes Hauns Maido of SSC's Habitabitity and Human Factors Branch, Charles Browen, Ph.D. of Lackheed Human Factors Design team, David Davids, Ph.D. of State State and States, Ph.D. of State States and		
<ul> <li>e) Purchase and calibrate equipment for associng alertness and cognive performance in the study volunteers.</li> <li>f) Develop a multiyour plan for the development and testing of specific lighting technologies that can be installed in the CV and other space exploration halfs for and/explorations gathermant and possibility the sing of the protocol exploration halfs for and/exploration gatherman and subscriptions. The study volunteers.</li> <li>Toweds accompliability the time in the study volunteers.</li> <li>Towards accompliability the sing of the protocol explores of halfs for excering at TU in Philadelphic, one in League CV and other space. PhiLos et al. (1998), pp. 101-101, pp. 101-1</li></ul>		
7) Develop a multiyer plan for the development and testing of specific lighting testanologic that an to installed in the GN wards accomplishing the first two aims, written correspondence, plane calls and direct meetings were used to exhibit the testan of insertigence. Over the first year, a total of eight meetings or the first year as total of eight meetings or the set of t		5) Have an independent safety analysis completed on the solid-state lighting prototypes.
CEV and other spice criptonics habits for saturity enhancing astronautinal ground crox detronautinal productions.         Transfa scorentizing the first first work with correspondence, phone calls and direct macings were uted to establish the term of investigators. Over the first year, a total of eight meetings were hold; the meetings at TJU in first phate/philo, and in Legans CT Up which for hours phone Theorem intervisions. Which are reported to the term of the singlators who have for found to grace the term of the singlator of the singlator for the term of the singlator of the singlator term of the singlator the singlator of the singlator of the singla		6) Purchase and calibrate equipment for assessing alertness and cognitive performance in the study volunteers.
<ul> <li>establish the taxin of investigators. Over the first year, a final of eight meetings were hold; row meetings, etc. on its engage. City during the NASA Humme Research Program. Investigators Workshop, one at the Lixternal Advisory Committee meeting in ILosion, and one at Johnson Space Center (JSX), as result of Bees meetings, by Collaboraties with aver formally agreed to participate on the hyportex. This is a result of Bees meetings, by Collaboraties with aver formaly danged to the Culture strugged to the Star Mark and Tereme David Dings, PhD. and Numa Goed, PhD. from the University of Penapolyumic Stephan Lockby, PhD. or the ULX-array Lacet Polyumic Registration of the Star Mark and Work with a centralism and star of TOTUS tight. Research Polyman Lockby, PhD. or the ULX-array Lacet Polyumia Registration Program at Alexaders Porving Ground, and Mark Rollag, PhD. of the ULX-array Lacet Polyumia Registration Program at Alexaders Porving Ground, and Mark Rollag, PhD. of the ULX-array Lacet Polyumia Registration and the registration of the star particular behavior and the science of the sprojeet a per theraper star and work with a centralism and star of TOTUS tight. Research Porving ULX and the science of the project per set of the science of the sciencof the science of the science of the science of the science o</li></ul>		7) Develop a multiyear plan for the development and testing of specific lighting technologies that can be installed in the CEV and other space exploration habitats for acutely enhancing astronaut and ground crew alertness.
Task Description:       experiment will be initiated during this month (the end of the first funding year. The fast experiment is, beend-marking study to characterize the biological potency of the prototype solid-stute light source that is described below. A white subt will be withen and source relative to monochromatic and polychromatic light source previously studied in ou lab. In addition, it will guide the selection of the light intensity that will be toesend experiment and on the acting effects of Nue light, is still being method, which will feet on addition, at will guide the selection of the light intensity that will be tased in the second experiment and you have a second experiment and polychromatic light systems, Inc., an industrial partner of NSBRL Apollo bas donated engineering time and materiats to develop a large parel of marrowhad bulk ELBs. This light source will be the independent variable in the first two experiments and and and for the second experiment and the second experiment and materiats to evelop a large parel of marrowhad bulk ELBs. This light source will be the independent variable in the first two experiments and marce light intensities will no change to spectral output. Jeffessoris LEP staff has thoroughly characterized the prototype radiometry and photometry. This light unit is now completely eviceable for experimental use.         Concerning our fifth aim, David Sliney, Ph.D. of Aberdeen Proving Ground has made a series of madiometrie measurements of the prototype and has provided in and and the study will be distributed to review.         For our sixth aim, we have purchased and received polysonmography and psychamotor vigilance task equipment. Set testing, and calibration of the sequipment that been indicated prototype existed for rootype radiometry and photometry. This light unit after period for the first band, has described from the first with set to a second experiment will andicate pr		establish the team of investigators. Over the first year, a total of eight meetings were held: five meetings at TJU in Philadelphia, one in League City during the NASA Human Research Program Investigators Workshop, one at the External Advisory Committee meeting in Houston, and one at Johnson Space Center (JSC). As a result of these meetings, key collaborators who have formally agreed to participate on this project. These include James Maida of JSC's Habitability and Human Factors Branch; Charles Bowen, Ph.D. of Lockheed Martin's Human Factors Design team; David Dinges, Ph.D. and Namni Goel, Ph.D. from the University of Pennsylvania; Stephen Lockley, Ph.D. of Brigham and Womens Hospital and Harvard Medical School; David Sliney, Ph.D. of the U.S. Army Laser/Optical Radiation Program at Aberdeen Proving Ground; and Mark Rollag, Ph.D. Of the University of Virginia. These collaborators will work with scientists and staff of TJU's Light Research Program (LRP) towards accomplishing the
NSBR1. Apollo has donated engineering time and materials to develop a large panel of narrowband blue LEDs. This light source will be tindependent variable in the first two experiments discussed above. Working closely with an engineer from Apollo, we have modified the original prototype as oit can provide a broad range of light intensities will on change to spectral output. Jeffrostor LRP stifth as thoroughly characterized the prototype radiometry and photometry. This light unit is now completely serviceable for experimental use.         Concerning our fifth aim. David Sliney, Ph.D. of Aberdeen Proving Ground has made a series of radiometric measurements of the prototype and has provided an independent safety analysis based on criteria from the American College of Government and Industrial Hygiene (ACCIII) and the blue solid-state prototype contasts' at all wavelengths and emission levels that are far below limits that are recognized as maximal safe exposure values." Once finalized, the report will be distributed to James Maida at JSC and Charles Bowen, Ph.D. of Lockheed Martin for review.         For our sixth aim, we have purchased and received polysonmography and psychomotor vigilance task equipment. Set testing, and calibration of this equipment has been initiated and will be completed prior to the start of our second experiment. This equipment will not be needed for the first bench-marking experiment.         Rationale for HRP Directed Research:       The knowledge we hope to gain from this research, though focused on spaceflight, will also benefit people here on Earth. The sleep deficit experiments, econitive on yos of the signify and psychomotor performance (Dijk, et al., 2005). The resulting physiological and behavioral changes caused by sign an directadian disruption, over 45% of all medications also will be significant benefits to civilians living on emissite. Conceress of rypositions,	Task Description:	experiment will be initiated during this month (the end of the first funding year) and the study will be completed in the second funding year. The second experiment will be initiated and run during the second year. The first experiment is a bench-marking study to characterize the biological potency of the prototype solid-state light source that is described below. A within-subjects, acute light-induced melatonin suppression study will be done with eight healthy men and women. This study will have two important outcomes. First, it will help characterize the biological efficacy of the prototype solid-state light source relative to monochromatic and polychromatic light sources previously studied in our lab. In addition, it will guide the selection of the light intensity that will be tested in the second study, which will focus on alertness. The IRB for the first study has been approved by TJU. The protocol for the second experiment, a two-day study on the alerting effects of blue light, is still being refined. Once the experimental design is completed, a separate
measurements       measuremeasurements       measurements		NSBRI. Apollo has donated engineering time and materials to develop a large panel of narrowband blue LEDs. This light source will be the independent variable in the first two experiments discussed above. Working closely with an engineer from Apollo, we have modified the original prototype so it can provide a broad range of light intensities with no change to spectral output. Jefferson's LRP staff has thoroughly characterized the prototype radiometry and
testing, and calibration of this equipment has been initiated and will be completed prior to the start of our second experiment. This equipment will not be needed for the first bench-marking experiment.Finally, for the seventh aim, extensive discussions have been held between TJU's LRP and the extramural collaborato concerning a multiyear plan for the development and testing of specific lighting technologies that can be installed in t CEV and other space exploration habitats for acutely enhancing astronaut and ground erew alertness. The specific experiments, experiment sequence, and technology development will be determined once data is available from the fi two studies.Rationale for HRP Directed Research:The knowledge we hope to gain from this research, though focused on spaceflight, will also benefit people here on Earth. The sleep deficits experienced by astronauts during space flight can be considered a threat to the success of spa missions (Longnecker and Molins, 2005). The resulting physiological and behavioral changes caused by sleep and circadian disruption can lead to diminished alertness, cognitive ability and psychomotor performance (Dijk, et al., 200 As a measure to counteract sleep disruptions, over 45% of all medications taken in space are sleep aids (Putcha, et al. 1999). Although the studies being considered in this project are focused on developing a non-pharmacological lighting countermeasure for space exploration, it is anticipated that there also will be significant benefits to eivillans living on past everal years. In the United States, 20 million Americans do shift work which interferes with a biologically healt nocturnal sleep cycle (U.S. Congress OTA, 1991). This group has been shown to be more likely to suffer from a vida variety of aliments, including cardiovascular disease, gastrointestinal distress, cognitive ad litor of the significant problems. Furthermore, r		measurements of the prototype and has provided an independent safety analysis based on criteria from the American College of Government and Industrial Hygiene (ACGIH) and the International Commission on Non-Ionizing Radiation Protection (ICNIRP). His draft report confirms that the blue solid-state prototype operates "at all wavelengths and emission levels that are far below limits that are recognized as maximal safe exposure values." Once finalized, the
concerning a multiyear plan for the development and testing of specific lighting technologies that can be installed in t CEV and other space exploration habitats for acutely enhancing astronaut and ground crew alertness. The specific experiments, experiment sequence, and technology development will be determined once data is available from the fi two studies.Rationale for HRP Directed Research:Research Impact/Earth Benefits:The knowledge we hope to gain from this research, though focused on spaceflight, will also benefit people here on Earth. The sleep deficits experienced by astronauts during space flight can be considered a threat to the success of spe missions (Longnecker and Molins, 2005). The resulting physiological and behavioral changes caused by sleep and circadian disruption can lead to diminished alertness, cognitive ability and psychomotor performance (Dijk, et al., 200 As a measure to counterract sleep disruptions, over 45% of all medications taken in space are sleep aids (Putcha, et al. 1999). Although the studies being considered in this project are focused on developing a non-pharmacological lighting countermeasure for space exploration, it is anticipated that there also will be significant benefits to civilians living on Earth. A significant portion of the global population suffers from chronic sleep loss and/or circadian-related disorders Evidence for disease or illness occurring due to a disruption of circadian homeostasis has mounted significantly in the past several years. In the United States, 20 million Americans do shift work which interferes with a biologically healt nocturnal sleep cycle (U.S. Congress OTA, 1991). This group has been shown to be more likely to suffer from a wide variety of ailments, including eardiovascular disease, gastrointestinal distress, cognitive and emotional problems. Furthermore, recent epidemiological studies of female night-shift nurses		
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New project for FY2006.	Research Impact/Earth Benefits:	<ul> <li>Earth. The sleep deficits experienced by astronauts during space flight can be considered a threat to the success of space missions (Longnecker and Molins, 2005). The resulting physiological and behavioral changes caused by sleep and circadian disruption can lead to diminished alertness, cognitive ability and psychomotor performance (Dijk, et al., 2001) As a measure to counteract sleep disruptions, over 45% of all medications taken in space are sleep aids (Putcha, et al., 1999).</li> <li>Although the studies being considered in this project are focused on developing a non-pharmacological lighting countermeasure for space exploration, it is anticipated that there also will be significant benefits to civilians living on Earth. A significant portion of the global population suffers from chronic sleep loss and/or circadian-related disorders. Evidence for disease or illness occurring due to a disruption of circadian homeostasis has mounted significantly in the past several years. In the United States, 20 million Americans do shift work which interferes with a biologically healthy nocturnal sleep cycle (U.S. Congress OTA, 1991). This group has been shown to be more likely to suffer from a wide variety of ailments, including cardiovascular disease, gastrointestinal distress, cognitive and emotional problems. Furthermore, recent epidemiological studies of female night-shift nurses have shown that they are statistically more likely to suffer from breast cancer and colon cancer compared to day shift workers. Our laboratory is involved in testing</li> </ul>
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**Bibliography Type:**