Fiscal Year:	FY 2016	**Task Last Updated:**	FY 11/20/2015
PI Name:	Czeisler, Charles A. M.D., Ph.D.		
Project Title:	Sleep-Wake Actigraphy and Light Exposure During Spaceflight		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Behavior and performance		
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 (2) **Sleep**:Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Boston	**State:**	MA
Zip Code:	02115-5804	**Congressional District:**	8
Comments:			
Project Type:	Flight	**Solicitation / Funding Source:**	98-HEDS-02
Start Date:	01/24/2001	**End Date:**	06/30/2017
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:	Leveton, Lauren	**Contact Phone:**	
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Flight Program:	Shuttle/ISS		
Flight Assignment:	ISS-12 (added 12/5/13 per PI/CoI information) STS-133, STS-134, STS-135 (addt'l flight info per PI report 11/2011) STS 129, 130, 131, 132 ; ISS increments 22-24 (addt'l flight info per PI 11/2009) STS 126, STS 127, STS 128 ; ISS Increments 18-21 (addt'l flight info per PI office, 11/2008) STS 122, STS 123, STS 124, STS 125; ISS Increment 17 (add'l flight info per PI office, 1/2008) STS 116, STS 118, STS 120; ISS Increments 14, 15, 16 (add'l flight info provided 11/06) STS 121, STS 115; ISS Increments 13-14 STS 104, STS 109, STS 111, STS 112, STS 113, STS 114 NOTE: New end date is 6/30/2017 per K. Ohnesorge/JSC (Ed., 10/31/16) NOTE: New end date is 3/31/2017 per CoI L. Barger (Ed., 12/5/13) NOTE: Expected to be extended to 4/30/2017 per CoI L. Barger (Ed., 8/31/13) NOTE: End date changed to 4/30/2013 per CoPI Barger (Ed., 9/10/2012)		

	NOTE: End date is not firm per CoI/PI (Ed., 11/18/2011) NOTE: End date is 7/31/2012 per PI/CoI (Ed., 10/27/11) NOTE--end date should be around 4/30/2012 per JSC (11/08)
Key Personnel Changes/Previous PI:	Laura K. Barger, Ph.D. is assigned as Co-Principal Investigator (1/2008 report).
COI Name (Institution):	Barger, Laura Ph.D. (Co-PI: Harvard Medical School) Wright, Kenneth Ph.D. (University of Colorado) Ronda, Joseph M.S. (Harvard Medical School) Evans, Erin Ph.D. (NASA Ames Research Center)
Grant/Contract No.:	NCC9-119
Performance Goal No.:	
Performance Goal Text:	
Task Description:	BACKGROUND An inadequate quantity or quality of sleep may impair an astronaut's ability to maintain a high level of cognitive performance and vigilance while operating and monitoring sophisticated instrumentation during spaceflight. In order to understand sleep in space more completely, we conducted a large scale study of astronauts across multiple Space Shuttle (STS) and International Space Station (ISS) missions. Since 2000, crewmembers assigned to shuttle flights were briefed about the opportunity to participate in this experiment. ISS crews were briefed beginning in 2006. Participants wore a small light-weight ambulatory recording device [Actiwatch-L; manufactured by MiniMitter, then Respironics, then Philips, Bend, OR] for assessment of sleep-wakefulness activity via wrist actigraphy and light-exposure levels via wrist photometry during three Earth-based data-collection intervals and the spaceflight mission. Additionally, crewmembers were instructed to complete a sleep log within 15 minutes of awakening to record medication use (every day on STS and for approximately one-third of ISS mission days). Sleep was estimated using Actiware Software [Version 3.4] and circadian timing was estimated using Circadian Performance Simulation Software (CPSS). We studied 21 ISS crewmembers (3,201 ISS inflight days) from 2006-2011 during missions lasting, on average, 155 ± 39 days. Preliminary results indicate that the mean (+ SD) nightly sleep duration, as estimated from actigraphy, was 6.1 + 0.7 hours on ISS missions, which was significantly shorter than during Earth-based collections 90 days prior to the mission and one-week postflight ($p<0.01$) [1]. To obtain even this limited amount of sleep, 75% of ISS crewmembers reported taking sleep-promoting medications inflight. Circadian misalignment occurred during 20% of mission days and was significantly associated with increased use of sleep medication, decreased sleep quality and shorter sleep durations [2]. One US astronaut and one Russian cosmonaut plan to take part in a one-year ISS mission. Given that the duration of this mission will be essentially twice as long as the nominal ISS missions, it is unknown how the mind and body, including sleep and the circadian system, will respond or adapt to that much time in space. We plan to estimate sleep and circadian alignment throughout the mission via the previously employed protocol. Findings from this long duration mission are crucial to inform future exploration class missions. METHODOLOGY: Crewmembers wear a small light-weight ambulatory recording device [Spectrum; Philips, Bend, OR] for assessment of sleep-wakefulness activity and light-exposure during four Earth-based data-collection intervals and the spaceflight mission. Crewmembers also complete a sleep log within 15 minutes of awakening every day during ground collection intervals and for approximately one-third of ISS mission days. We plan to estimate sleep and circadian alignment via the analysis methodology previously used on the ISS. RESULTS: Two weeks of baseline data were collected at approximately 9 months and 4.5 months prior to launch. Inflight, we have recorded 281 days of actigraphy and collected 117 sleep logs. CONCLUSION: This research project will inform Behavioral Health and Performance risk-related questions such as "Does sleep loss continue on long duration spaceflight or is there adaptation?" and "What is the nature of circadian desynchronization over long duration missions?" The findings from this long duration mission are crucial to inform future long-duration exploration class missions. REFERENCES [1] Barger LK, Flynn-Evans EE, Kubey A, Walsh L, Ronda JM, Wang W, Wright KP Jr, Czeisler CA. "Prevalence of sleep deficiency and use of hypnotic drugs in astronauts before, during, and after spaceflight: an observational study." Lancet Neurol. 2014 Sep;13(9):904-12. http://dx.doi.org/ [2] Barger LK, Sullivan JP, Ronda JM, Czeisler CA. "Sleep-wake actigraphy and light exposure on a one-year International Space Station mission." 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. See also http://www.nasa.gov/
Rationale for HRP Directed Research:	

Research Impact/Earth Benefits:	An inadequate quantity or quality of sleep may impair an astronaut's ability to maintain a high level of cognitive performance and vigilance while operating and monitoring sophisticated instrumentation during spaceflight. In order to understand sleep in space more completely, we conducted a large scale study of astronauts across multiple Space Shuttle (STS) and International Space Station (ISS) missions. Since 2000, crewmembers assigned to shuttle flights were briefed about the opportunity to participate in this experiment. ISS crews were briefed beginning in 2006. Participants wore a small light-weight ambulatory recording device [Actiwatch-L; manufactured by MiniMitter, then Respironics, then Philips, Bend, OR] for assessment of sleep-wakefulness activity via wrist actigraphy and light-exposure levels via wrist photometry during three Earth-based data-collection intervals and the spaceflight mission. Additionally, crewmembers were instructed to complete a sleep log within 15 minutes of awakening to record medication use (every day on STS and for approximately one-third of ISS mission days). Sleep was estimated using Actiware Software [Version 3.4]. We studied 21 ISS crewmembers (3,201 ISS inflight days) from 2006-2011 during missions lasting, on average, 155 ± 39 days. Preliminary results indicate that the mean (+ SD) nightly sleep duration, as estimated from actigraphy, was 6.1 + 0.7 hours on ISS missions, which was significantly shorter than during Earth-based collections 90 days prior to the mission and one-week postflight ($p<0.01$). To obtain even this limited amount of sleep, 75% of ISS crewmembers reported taking sleep-promoting medications inflight. Circadian misalignment, as measured by Circadian Performance Simulation Software (CPSS), occurred during 20% of mission days and was significantly associated with increased use of sleep medication, decreased sleep quality, and shorter sleep durations. One US astronaut and one Russian cosmonaut plan to take part in a one-year ISS mission. Given that the duration of this mission will be essentially twice as long as the nominal ISS missions, it is unknown how the mind and body, including sleep and the circadian system, will respond or adapt to that much time in space. We plan to estimate sleep and circadian alignment throughout the mission via the previously employed protocol. Findings from this long duration mission are crucial to inform future exploration class missions.
Task Progress:	Two pre-flight data collection intervals have been completed for two ISS12 crewmembers. Inflight actigraphy and sleep log data collection are ongoing.
Bibliography Type:	Description: (Last Updated: 12/13/2023)
Abstracts for Journals and Proceedings	Barger LK, Sullivan JP, Ronda JM, Czeisler CA. "Sleep-wake actigraphy and light exposure on a one-year International Space Station mission." 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. 2015 NASA Human Research Program Investigators' Workshop, Galveston, TX, January 13-15, 2015. , Jan-2015
Articles in Peer-reviewed Journals	Flynn-Evans EE, Barger LK, Kubey AA, Sullivan JP, Czeisler CA. "Circadian misalignment affects sleep and medication use before and during spaceflight." npj Microgravity. 2016 Jan 7;2:15019. https://doi.org/10.1038/npjmgrav.2015.19 , Jan-2016