rnjer Tillen in Spee Radiation Risk Assessment in the search in the sear	Fiscal Year:	FY 2007	Task Last Updated:	FY 01/04/2008
NameHerman Researchropram/bicpline:IUMAN RESEARCH - Radiation healthropram/bicpline:IUMAN RESEARCH - Radiation healthrint Agency Nume:Tech Port:yesTech Port:unan Research Program Element(1) SRE Searce Radiationanima Research Program Element(1) SRE Searce Radiation Solar Particle Events (SPEE)anna Research Program Element(1) SRE Searce Radiation Solar Particle Events (SPEE)anna Research Program Element(1) SRE Searce Cognitive or Belavious Contributing to Adverse Ministon Performance and Health Document Radiation Exposure (2) Open Researce Radia or Radiation Solar Particle Events (SPEE)anna Research Program RikeNoseparce Biology Element:Noseparce Biology Special CattegoryNoseparce Biology Special CattegoryNoseparce Biology Special CattegoryNasetorrest of State Searce (Del Biology Cosse)First: PY10 Organization Nume:Nase10 Adversa :Nase10 Adversa :Nase11 Adversa :Nase12 Adversa :Nase13 Adversa :Nase14 Adversa :Nase	PI Name:	Cucinotta, Francis A Ph.D.		
Interaction         Interaction           regram/Discipline learent/Subdiscipline learen	Project Title:	Space Radiation Risk Assessment		
ProceedingsHUMAN RESEARCH-Radiation hashthItement/Subdissipline:IteAAPreyinid Agency Name:TechPort:Vagency Name:(1) SRS-pace Radiationunnan Research Program Element:(1) SRS-pace Radiationunnan Research Program Risk(1) SRS-pace Radiation Syndromes Date to Solar Paricle Fyents (SPE-) (2) Data Rel Bits of Adverses Cognitive of Habitroit Contolings and Psychiatric Bioorders (2) Cardio-content Risk of Advances Capitroite Pelawicel Contolings and Psychiatric Bioorders (2) Cardio-content Risk of Advances Capitro Pathwicel Contolings and Psychiatric Bioorders (2) Cardio-content Risk of Cardiovasalar Adpatations Contributing in Adverse Mission Performance and Health Outcomes Sociedary Specifial Stressorpace Biology Coss-Flement:Nonepace Biology Coss-Flement:Nonepace Biology Coss-Flement:Nonepace Biology Coss-Flement:Nonepace Biology Coss-Flement:Nonepace Biology Coss-Flement:Nonepace Biology Special Category:Nonepace Biology Special Category:None12 Fault:None Stressorpace Biology Special Category:None14 Address 1:Health Physics & Diagnostic Science / BIIS-34514 Address 1:Health Physics & Diagnostic Science / BIIS-34514 Address 1:Health Physics & Diagnostic Science / BIIS-34514 Address 1:La VegasState: NV16 Code:GroundSolartention / Funding State:17 OrderIsonoga State:No. of Physics & Diagnostic Science / BIIS-34518 Address 1:Isonoga State:No. of Physics	Division Name:	Human Research		
InteractSubdisciptine:         InterAction Control of Co	Program/Discipline:	HUMAN RESEARCH		
numan Research Program Electors       C) SRS Pace Radiation Syndroms Due to Solar Parifel Events (SPEs)         numan Research Program Risks       C) Subst Risks of Actume Continguine or Hadvarout Conditions and Psychiatric Disorders Massion Performance and Head         pare Biology Electors       None         pare Biology Electors       None         pare Biology Special Category       None Stepice Stepice Stepice Stepice Stepice Step	Program/Discipline Element/Subdiscipline:	HUMAN RESEARCHRadiation	health	
linnan Research Program Risis: (1) ARS, Risk of Acute Radiation Syndromes Due to Solar Particle Events (SPEs) (2) BWHet Risk of Advise Cognitive or Rehavioral Conditions and Psychiatric Disorders (3) Caracer, Risk of Radiation Caronicogenesis (4) Cardiovascular Adaptations Contributing to Adverse Masion Performance and Health Duccome (5) CRS, Risk of Acute (In-flight) and Late Central Nervous System Effects from Radiation Exposure (6) Degen Risk of Cardiovascular Adaptations Contributing to Adverse Masion Performance and Health Duccome (5) CRS, Risk of Acute (In-flight) and Late Central Nervous System Effects from Radiation Exposure (6) Degen Risk of Cardiovascular Adaptations Contributing to Adverse Masiation Exposure (6) Degen Risk of Cardiovascular Adaptations Contributing to Adverse Masiation Exposure (6) Degen Risk of Cardiovascular Adaptations Contributing to Adverse Masiation Exposure (6) Degen Risk of Cardiovascular Adaptations Contributing to Adverse Mission Performance and Health Dynane Biology Special Category: None Effonit: 10 Granization Type: None Effonit: 10 Granization Type: 10 Adverse 1: 11 Adverse 1: 11 Adverse 1: 12 Adverse 1: 12 Adverse 1: 12 Adverse 1: 13 Adverse 1: 14 Adverse 2: 14 Adverse 1: 14 Adverse 1: 14 Adverse 2: 14 Adverse 2: 14 Adverse 2: 14 Adverse 2: 15 Y 15 Adverse 1: 15 Adverse 2: 15 Y 15 Adverse 1: 15 Adverse 2: 15 Ad	Joint Agency Name:		TechPort:	Yes
ana Research Programskisk       Silverareska of Cardiovascular Adaptational Conditions and Bysichis Librer Mathine Cosponse Silverareska of Cardiovascular Adaptational Socies and University System Effective Exposure of Socies and Socies and Socie	Human Research Program Elements:	(1) SR:Space Radiation		
norm         None           pace Biology Special Category:         None           pace Biology Special Category:         None           pace Biology Special Category:         None           1 Email:         not available         Fax:           1 Grganization Type:         NASA CENTER         Phone:           1 Address 1:         Health Physics & Diagnostic Sciences / BIIS-345         Term           1 Address 2:         4505 Maryland Parkway         Term           1 Address 1:         Health Physics & Diagnostic Sciences / BIIS-345         Term           1 Address 2:         4505 Maryland Parkway         Term           1 Veb Page:         Termerly at NASA Johnson Space Center, unil summer 2013 (Ed, Oct 2013)         Termerly at NASA Johnson Space Center, unil summer 2013 (Ed, Oct 2014)           omments:         0 Formerly at NASA Johnson Space Center, unil summer 2013 (Ed, Oct 2013)         Termerly at NASA Johnson Space Center, unil summer 2013 (Ed, Oct 2013)           onf Post Docs:         0 for out 0         End Date:         6531/2011           o. of Post Docs:         0 for out 2006         End Date:         6531/2011           o. of Master's Candidates:         To out 2005         End Date:         Term           o. of Master's Candidates:         To out 2005         To out 2005         Term	Human Research Program Risks:	<ul> <li>(2) BMed:Risk of Adverse Cognit</li> <li>(3) Cancer:Risk of Radiation Carce</li> <li>(4) Cardiovascular:Risk of Cardio Outcomes</li> <li>(5) CNS:Risk of Acute (In-flight)</li> <li>(6) Degen:Risk of Cardiovascular</li> </ul>	ive or Behavioral Conditions and Psychiatric Disc inogenesis ovascular Adaptations Contributing to Adverse M and Late Central Nervous System Effects from Ra	ission Performance and Health idiation Exposure
Nume         Nume           pace Biology Special Category:         None           1 Email:         not available         Fax: FY           1 Organization Type:         NASA CENTER         Phone: (702) 895-4320           1 organization Name:         University of Nacoda, Las Vegas         Fax: FY           1 Address 1:         Health Physies & Diagnostic Sciences / BHS-345         Test           1 Address 1:         Health Physies & Diagnostic Sciences / BHS-345         Test           1 Web Page:         Test         Formerly and Parkway         Test           1 Web Page:         Ias Vegas         State: NV           1 web Page:         Test State: NV         Test State: NV           1 web Page:         Ias Vegas         State: NV         State: NV           1 gende:         Ias Vegas         State: NV         State: NV           1 organization Type:         Iorenerly at NASA Johnson Space Center, until summer 2013 (Ed, Oct 2013)         Torenerly at NASA Johnson Space Center, until summer 2013 (Ed, Oct 2013)         Toretel Research           1 of Pot Docs:         0 ofOul/2006         End Date: 05/31/2011         State: 05/31/2011           0 of Pot Docs:         No. of Master' Degrees:         No. of Master' Degrees:         No. of Master' Degrees:           0 of Bachelor's Candidates:         C	Space Biology Element:	None		
I kmailnot availableFaxFYI Organization Type:NASA CENTERPhone: (702) 895-4320I Address 1:University of Nevada, Las VegasII Address 1:Health Physics & Diagnostic Sciences / BHS-345II Address 2:4505 Maryland ParkwayII Veb Page:III'ryLas VegasState: NVip Code:89154-3037Congressional District: 1omments:Formerly at NASA Johnson Space Center, until summer 2013 (Ed., Oct 2013)roject Type:GroundSolicitatior / Funding Source: Directed Researchact Option:06/01/2006End Date: 05/31/2011o. of Post Docs:On Of 002006No. of Matter' Degrees:o. of Post Docs:On Of No. of Matter' Degrees:o. of Bachelor's Candidates:Vonitoring Center: NASA JSContact Monitor:Contact Phone:ontact Monitor:Contact Phone:itght Assignment:Itey Personnel Changes/Previous PI:light Assignment:Itey Personnel Changes/Previous PI:ON Name (Institution):Corofroth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Domonary, Attem (USRA) Ming, Jancie (USRA) Ming, Marka (NASA Langley) Ouldes, Garry (NASA Langley) Oundes, Garry (NASA Langley)	Space Biology Cross-Element Discipline:	None		
Internation         Production           10 Organization Type:         NASA CENTER         Phone: (702) 895-4320           14 Organization Name:         Uversity of Nevada, Las Vegas         Image: Control of State: St	Space Biology Special Category:	None		
Internation Name: University of Nevada, Las Vegas I Address 1: Health Physics & Diagnostic Sciences / BHS-345 I Address 2: 4505 Maryland Parkway I Web Page: I Web	PI Email:	not available	Fax:	FY
I Address 1:       Health Physics & Diagnostic Sciences / BHS-345         I Address 2:       4505 Maryland Parkway         I Web Page:	PI Organization Type:	NASA CENTER	Phone:	(702) 895-4320
I Address 2: 4505 Maryland Parkway I Address 2: 4505 Maryland Parkway I Web Page: iity: Las Vegas State: NV ip Congressional District: 1 iomments: 69154-3037 Congressional District: 1 iomments: Formerly at NASA Johnson Space Center, until summer 2013 (Ed., Oct 2013) roject Type: Ground Solicitation / Funding Source: Directed Research tart Date: 06/01/2006 End Date: 05/31/2011 0. of Post Docs: 0. of PhD Degrees: 0. of Orb Condidates: No. of PhD Degrees: 0. of Dater's Candidates: No. of Bachelor's Degrees: 0. of Bachelor's Candidates: No. of Bachelor's Degrees: 0. of Bachelor's Candidates: No. of Master' Degrees: 0. of Bachelor's Candidates: No. of Master' Degrees: 1. of Ortart Monitor: Contact Phone: 1. Ortaret Email: 1. Strict	Organization Name:	University of Nevada, Las Vegas		
Instant of the second	PI Address 1:	Health Physics & Diagnostic Scien	nces / BHS-345	
ity: Las Vegas is the information of the informatio	PI Address 2:	4505 Maryland Parkway		
ip Code: 89154-3037 Congressional District: 1 oonments: Formerly at NASA Johnson Space Center, until summer 2013 (Ed., Oct 2013) roject Type: Ground Solicitation / Funding Source: Directed Research (art Date: 06/01/2006 End Date: 05/31/2011 0. of Post Docs: 3 No. of PhD Degrees: 0. of PhD Candidates: No. of Master' Degrees: 0. of Master's Candidates: No. of Master' Degrees: 0. of Master's Candidates: No. of Master' Degrees: 0. of Bachelor's Candidates: No. of Bachelor's Degrees: 0. of Bachelor's Candidates: No. of Master' Degrees: NASA JSC 001 att Monitor: Contact Phone: Contact Phone: 1. Ontact Email: 1. If the set of the se	PI Web Page:			
ProtectionFormerly at NASA Johnson Space Center, until summer 2013 (Ed., Oct 2013)roject Type:GroundSolicitation / Funding Source: Directed Researchtart Date:06/01/2006End Date:Directed Researcho. of Post Docs:3No. of PhD Degrees:o. of PhD Candidates:No. of Master' Degrees:Image: Solicitation / Solicitation	City:	Las Vegas	State:	NV
roject Type: Ground Solicitation / Funding Source: Directed Research tart Date: 06/01/2006 End Date: 05/31/2011 0. of Post Docs: 3 No. of PhD Degrees: 0. of PhD Candidates: No. of Master' Degrees: 0. of Master's Candidates: No. of Master' Degrees: 0. of Bachelor's Candidates: Monitoring Center: NASA JSC 0 ontact Monitor: Candidates: Monitoring Center: NASA JSC 0 ontact Email: light Assignment: etey Personnel Changes/Previous PI: Vol Name (Institution): Puth, Janice (LBNL) Cornforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs Ponomarev, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Oualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	Zip Code:	89154-3037	Congressional District:	1
tart Date: 06/01/2006 End Date: 05/31/2011 o. of Post Docs: 3 No. of PhD Degrees: o. of PhD Candidates: No. of Master' Degrees: o. of Master's Candidates: No. of Master' Degrees: o. of Bachelor's Candidates: Monitoring Center: NASA JSC on fach Monitor: Contact Phone: ontact Email: light Program: light Assignment: sey Personnel Changes/Previous PI: Pluth, Janice (LBNL) Comforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Phonomarcy, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Qualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	Comments:	Formerly at NASA Johnson Space	Center, until summer 2013 (Ed., Oct 2013)	
o. of Post Docs:3No. of PhD Degrees:o. of PhD Candidates:No. of Master' Degrees:o. of Master's Candidates:No. of Bachelor's Degrees:o. of Bachelor's Candidates:Monitoring Center: NASA JSCo. of Bachelor's Candidates:Contact Phone:ontact Email:Contact Phone:light Program:Image: Contact Phone:light Assignment:Image: Contact Phone:tey Personnel Changes/Previous PI:Image: Contact Phone:on No. of Name (Institution):Pluth, Janice (LBNL) Cornforth, Michael (UTX Medical Branch) Cogrege, Kerry (Wyle Labs) Ponomarey, Artem (USRA) Huff, Janice (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Qualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	Project Type:	Ground	Solicitation / Funding Source:	Directed Research
io. of PhD Candidates: No. of Master' Degrees: o. of Master's Candidates: No. of Bachelor's Degrees: o. of Bachelor's Candidates: Monitoring Center: NASA JSC Contact Monitor: Contact Phone: ontact Email: light Program: light Assignment: light Ass	Start Date:	06/01/2006	End Date:	05/31/2011
io. of Master's Candidates: No. of Bachelor's Degrees: o. of Bachelor's Candidates: Monitoring Center: NASA JSC Contact Monitor: Contact Phone: Contact Email: light Program: light Assignment: cey Personnel Changes/Previous PI: Cornforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Ponomarev, Artem (USRA) Nikijoo, Hooshang (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Kim, Myung-H	No. of Post Docs:	3	No. of PhD Degrees:	
io. of Bachelor's Candidates: Monitoring Center: NASA JSC Contact Monitor: Contact Phone: Contact Email: light Program: light Assignment: light Assignment: fey Personnel Changes/Previous PI: Pluth, Janice (LBNL) Cornforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Ponomarev, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Qualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	No. of PhD Candidates:		No. of Master' Degrees:	
Contact Monitor:       Contact Phone:         Contact Email:       Contact Phone:         light Program:       Iight Assignment:         Cey Personnel Changes/Previous PI:       Pluth, Janice (LBNL)         Pol Name (Institution):       Pluth, Janice (LBNL)         VOI Name (Institution):       Nikjoo, Hooshang (USRA)         Huff, Janice (USRA)       Kim, Myung-Hee (USRA)         Kim, Myung-Hee (USRA)       Convolute, Garry (NASA Langley)         Clowdsley, Martha (NASA Langley)       Clowdsley, Martha (NASA Langley)	No. of Master's Candidates:		No. of Bachelor's Degrees:	
Sontact Email:         light Program:         light Assignment:         tey Personnel Changes/Previous PI:         OI Name (Institution):         Pluth, Janice (LBNL) Cornforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Ponomarev, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Kim, Myung-Hee (USRA) Qualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	No. of Bachelor's Candidates:		Monitoring Center:	NASA JSC
light Program: light Assignment: light Assignment	Contact Monitor:		Contact Phone:	
light Assignment: Teey Personnel Changes/Previous PI: Pluth, Janice (LBNL) Cornforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Ponomarev, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Qualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	Contact Email:			
Construction       Pluth, Janice (LBNL)         Cornforth, Michael (UTX Medical Branch)       George, Kerry (Wyle Labs)         Ponomarev, Artem (USRA)       Ponomarev, Artem (USRA)         VOI Name (Institution):       Nikjoo, Hooshang (USRA)         Huff, Janice (USRA)       Kim, Myung-Hee (USRA)         Qualles, Garry (NASA Langley)       Clowdsley, Martha (NASA Langley)	Flight Program:			
Pluth, Janice (LBNL)         Cornforth, Michael (UTX Medical Branch)         George, Kerry (Wyle Labs)         Ponomarev, Artem (USRA)         Nikjoo, Hooshang (USRA)         Huff, Janice (USRA)         Kim, Myung-Hee (USRA)         Qualles, Garry (NASA Langley)         Clowdsley, Martha (NASA Langley)	Flight Assignment:			
Cornforth, Michael (UTX Medical Branch) George, Kerry (Wyle Labs) Ponomarev, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Qualles, Garry (NASA Langley) Clowdsley, Martha (NASA Langley)	Key Personnel Changes/Previous PI:			
	COI Name (Institution):	Cornforth, Michael (U TX Medi George, Kerry (Wyle Labs) Ponomarev, Artem (USRA) Nikjoo, Hooshang (USRA) Huff, Janice (USRA) Kim, Myung-Hee (USRA) Qualles, Garry (NASA Langley	)	
	Grant/Contract No.:	Clowdolcy, Martila (INASA Lälly	5	

Performance Goal No.:		
Performance Goal Text:		
Task Description:	The Risk Assessment Project at Johnson Space Center is responsible for the integration of results from NASA space radiobiology research into computational models used for astronaut radiation risk assessments. The purpose of the Project is fourfold: (1) evaluate the extent to which ongoing research leads to reduction in the uncertainty of risk assessments and provide, as a metric of program progress, the number of days in space during which the radiation exposure of astronauts remains below NASA limits within a 95% confidence interval ("safe days in space"); (2) perform mission planning studies to predict the number of safe days for any mission; (3) assess the radiation risk to astronauts for ongoing missions in real time; and, (4) provide recommendations for research directions most likely to reduce risk or improve the accuracy of risk predictions. The four categories of risks from radiation in space are defined by the NASA Bioastronautics Roadmap (BR). They are: 1) Carcinogenesis, 2) Acute and late effects to the Central Nervous System (CNS), 3) Degenerative Tissue Effects such as heart disease and cataracts, and 4) Acute Radiation risks. The number of safe days currently predicted for an astronaut's career is less than required by mission planning, due to the large uncertainties in risk prediction. In particular, a projection uncertainty below + or - 50% is the goal for the 1000-day Mars mission because the high level of risk will require high precision risk evaluations. The current approach used to project risk is based on epidemiology and genetics are the only viable ones for achieve risk prediction from them. This approach cannot lead to improvements in the accuracy of risk prediction beyond a factor of approximately 2. New approaches using molecular biology ang genetics are the only viable ones for achieving the level of accuracy required by space exploration and a robust program to obtain the required data is supported by the Space Radiation Program. However, how to incorporate these data into risk predi	
Rationale for HRP Directed Research:		
Research Impact/Earth Benefits:	Radiobiology research provides many important qualitative descriptions of biological effects of radiation on biomolecules, cells, and tissues. The Space Radiation Risk Assessment Project provides an important link that integrates qualitative experimental observations into detailed quantitative biophysical models of radiations risks. This research benefits all humans that will be exposed to ionizing radiation. Models of cancer, acute and other risks developed by the Space Radiation Risk Assessment Project provide NASA with the ability to project risks and develop cost-effective mitigation approaches for future exploration missions.	
	The NASA cancer risk projection model was updated with new excess relative risks and excess additive risk coefficients recommended by the BEIR VII report and in recent publications from the RERF in Hiroshima. The age at exposure dependence of cancer risks is a critical factor in these newer models, and displays a much slower change with age than the models described in NCRP Report No. 132. A cancer incidence data base was developed and a publication is in preparation. Uncertainty analysis for the new Dose and dose-rate reduction effectiveness factors (DDREF) and age dependence of cancer risks are being updated for the NASA model. Progress was made in developing systems biology models of the double strand break repair (DSB). In mammalian cells there are two mechanisms of DNA double strand break repair: Non-homologous end-joining (NHEJ) and homologous recombination (HR). The error-prone NHEJ is the main mechanism in resting cells and the GI phase of the cell cycle. A systems biology model (Cucinotta et al., in press) of the NHEJ pathway was developed and used to make quantitative descriptions of the gamma-H2AX foci and DSB rejoining experiments. The model includes a kinetics description of several DNA-repair proteins including the Ku70/80 hetero-dimer, the catalytic sub-unit of the DNA-PK repair complex denoted DNA-PK cs, and the Ligase-IV/XRCC4 complex. The regulation of DNA-PK cs by autophosphorylation for simple and complex DSB was described. The model is being extended to consider the radiation quality dependence of the relative fraction of simple and complex DSB, rejoining and associated repair defects, and the kinetics of various radiation induced foci (RIF). In further work, the addition of ATM and the MRN complex to the model was achieved and the role of processing of damaged ends by the Artemis and WRN proteins are being modeled	
Task Progress:	For biophysical understanding of sub-tissue structures a description of cell size and shape, and geometry of multiple cell lineages is needed. A "tissue box" model (Ponomarev and Cucinotta, 2006) was developed to represent heterogeneous tissue architecture and to score HZE tracks and nuclear reactions in 2D and 3D tissues. Accurate segmentation of imaging data from 2D or 3D from a variety of imaging methodologies is possible. The tissue box model will be applied to represent experimental models used by SRP funded investigators. Nuclear reactions were shown to be rare in a small tissue sample (<100 cubic-micron), however the possibility of a large imparted dose at such sites is a continuing concern. A random walk polymer model of whole chromosomes was extended to include description of all human chromosomes within a typical cellular volume and to predict the role of DNA loops and attachment points on the spatial distributions of DSB (Ponomarev and Cucinotta, 2006) To overcome the background DSB inherent in experimental methodologies a subtraction technique was formulated and applied to several data sets in collaboration with the Tufts U. NSCOR (PI. L. Hlatky) (Ponomarev et al., 2007). Also these models were used in an imaging approach to study DNA repair foci (Costee et al., 2007) in collaboration with the LBNL NSCOR (PI. M. Barcellos-Hoff). A more detailed model of DNA damage	
	and mutation using Monte-Carlo scoring of energy deposition in atomistic models of DNA and chromosomes is also under development (Nikjoo et al. 2007). Work on the transmission of specific chromosomal aberrations in subsequent cell cycles was initiated using basic	

	cytogenetic theories. A modeling project to predict the initial yield of terminal and interstitial deletions was begun. Differences between normal cells and specific DNA repair defects are also under study and the role of longer times for open breaks in ATM and MRN deficient cells will be studied to consider the increases in overall and specific types of aberrations and the potential impacts on transmission frequencies. New statistical models of the probability of SPE frequency and size were developed using our data base of historical SPE and solar cycles (Kim et al., 2006, 2007). The model was extended back to the 15th century for the >30 MeV proton fluences using ice-core data on nitrate concentrations normalized to modern events as reported by McCracken and collaborators. The time dependence of dose-rate for the 30 largest SPE's was also evaluated. These studies indicate that acute radiation risks will only occur with a realistic probability under EVA conditions, and therefore the focus of acute risk models should be on the so-called prodromal risks (nausea, vomiting, fatigue, etc.) that may occur during EVA in deep-space or on the lunar surface. The DoD based, RIPD model was adapted for a description of risks from SPE. A computer code of the model was developed ab-initio at JSC. This model uses a logistic scale to assign performance degradation probabilities and time-courses for the acute risks. Using the BRYNTRN code and initial estimates of RBEs from the scientific literature, application of the model to the 1972 SPE for EVA conditions was made. (Hu et al., 2007 and in preparation). Work in collaboration with Dr. Smirnova of Moscow State U. was begun to study the probabilities of mortality from one or more, large SPE's, including the role of an adaptive response due to simulation of granulocytes by a first SPE, leading to protection against a second SPE within the ensuing next few months.
Bibliography Type:	Description: (Last Updated: 02/11/2021)
Articles in Peer-reviewed Journals	Cucinotta FA, Durante M. "Cancer risk from exposure to galactic cosmic rays: implications for space exploration by human beings." Lancet Oncol. 2006 May;7(5):431-5. <u>PMID: 16648048</u> , May-2006
Articles in Peer-reviewed Journals	Ponomarev AL, Cucinotta FA. "Chromatin loops are responsible for higher counts of small DNA fragments induced by high-LET radiation, while chromosomal domains do not affect the fragment sizes." Int J Radiat Biol. 2006 Apr;82(4):293-305. <u>PMID: 16690597</u> , Apr-2006
Articles in Peer-reviewed Journals	Kim M-HY, George KA, Cucinotta FA. "Evaluation of skin cancer risks from lunar and Mars missions. " Advances in Space Research 2006;37(9):1798-803. <u>http://dx.doi.org/10.1016/j.asr.2006.03.032</u> , Aug-2006
Articles in Peer-reviewed Journals	Cucinotta FA, Kim M-HY, Ren L. "Evaluating shielding effectiveness for reducing space radiation cancer risks." Radiation Measurements 2006 Oct-Nov;41(9-10):1173-85. <u>http://dx.doi.org/10.1016/j.radmeas.2006.03.011</u> , Nov-2006
Articles in Peer-reviewed Journals	Cucinotta FA, Wilson JW, Saganti P, Hu X, Kim M-HY, Cleghorn T, Zeitlin C, Tripathi RK. "Isotopic dependence of GCR fluence behind shielding." Radiation Measurements 2006 Oct-Nov;41(9-10):1235-49. http://dx.doi.org/10.1016/j.radmeas.2006.03.012, Nov-2006
Articles in Peer-reviewed Journals	Ponomarev AL, Belli M, Hahnfeldt PJ, Hlatky L, Sachs RK, Cucinotta FA. "A robust procedure for removing background damage in assays of radiation-induced DNA fragment distributions." Radiat Res. 2006 Dec;166(6):908-16. <u>PMID: 17149980</u> , Dec-2006
Articles in Peer-reviewed Journals	Cucinotta FA, Kim MH, Schneider SI, Hassler DM. "Description of light ion production cross sections and fluxes on the Mars surface using the QMSFRG model." Radiat Environ Biophys. 2007 Jun;46(2):101-6. <u>PMID: 17342547</u> , Jun-2007
Articles in Peer-reviewed Journals	George K, Cucinotta FA. "The influence of shielding on the biological effectiveness of accelerated particles for the induction of chromosome damage." Advances in Space Research, 2007;39(6):1076-81. http://dx.doi.org/10.1016/j.asr.2007.01.004, Aug-2007
Articles in Peer-reviewed Journals	Costes SV, Ponomarev A, Chen JL, Nguyen D, Cucinotta FA, Barcellos-Hoff MH. "Image-based modeling reveals dynamic redistribution of DNA damage into nuclear sub-domains." PLoS Comput Biol. 2007 Aug;3(8):e155. <u>PMID:</u> <u>17676951</u> , Aug-2007
Articles in Peer-reviewed Journals	Kim MH, Cucinotta FA, Wilson JW. "A temporal forecast of radiation environments for future space exploration missions." Radiat Environ Biophys. 2007 Jun;46(2):95-100. <u>PMID: 17165049</u> , Jun-2007
Articles in Peer-reviewed Journals	Kim M-HY, Cucinotta FA, Wilson JW. "Mean occurrence frequency and temporal risk analysis of solar particle events." Radiation Measurements 2006 Oct-Nov;41(9-10):1115-22. <u>http://dx.doi.org/10.1016/j.radmeas.2005.11.006</u> , Nov-2006
Articles in Peer-reviewed Journals	Ponomarev AL, Cucinotta FA. "Nuclear fragmentation and the number of particle tracks in tissue." Radiat Prot Dosimetry. 2006;122(1-4):354-61. <u>PMID: 17261538</u> , Jul-2006
Articles in Peer-reviewed Journals	Nikjoo H, Uehara S, Emfietzoglou D, Cucinotta FA. "Track-structure codes in radiation research. A review." Radiation Measurements 2006 Oct-Nov;41(9-10):1052-74. <u>http://dx.doi.org/10.1016/j.radmeas.2006.02.001</u> , Nov-2006