Planen: Bantacharjee, Subrah Ph.D. Project Title: Bioldoes Tane Driven Flame Spread Over Solid Fuels Project Title: Physical Sciences Program Divelyline: GondBUSTION SCIENCE-Combunion science: Program Divelyline: No Program Divelyline: No Bint Agency Nume: Tech Pert: No Human Research Program Rike: Nose	Fiscal Year:	FY 2021	Task Last Updated:	FY 02/12/2021
Project Title:Residence Time System Of Your Solid StatesProgram Discipline:VProgram Discipline:COMEUSTION SCIENCE-Combusion actenceInternativation Solid Splane:VInternativation Solid Splane:VSpace Biology Ford CategoNocSpace Biology Ford CategoNocSpace Biology Special CategoNocSplane: Biology Special CategoNocOrganization Name:Sol Splane: NocOrganization Name:Sol Splane: NocP1 Address 1:Sol Splane: NocP2 Address 1:Sol Splane: NocNoc Splane: Noc Splane:	PI Name:	Bhattacharjee, Subrata Ph.D.	x	
Program/Discipline: COMBUSTION SCIENCECombustion science Program/Discipline: No Joint Agency Name: TechPort: No Human Research Program Eleneie: None Image Science No Joint Agency Name: None Image Science None Space Biology Eleneit: None Image Science Image Science None Space Biology Eleneit: None Image Science	Project Title:			
Program/Discipline: COMBUSTION SCIENCECombustion science Program/Discipline: No Joint Agency Name: TechPort: No Human Research Program Eleneie: None Image Science No Joint Agency Name: None Image Science None Space Biology Eleneit: None Image Science Image Science None Space Biology Eleneit: None Image Science	XX · · · XY			
Program/Discipline- Licensity/abdiscip		Physical Sciences		
Ekement Synchrönigen Könno Skiller Commusion Science No John Ageney Name: TechPort: No John Ageney Name: None				
Human Research Program EleanNoneHuman Research Program RiskNoneSpace Biology ChementNoneSpace Biology ChementNoneSpace Biology ChementNoneSpace Biology ChementNonePlonalicmorbhattantreefgramal.comFax: FVPlonalicmorbhattantreefgramal.comFax: SVPlonalicmorbhattantreefgramal.comFax: SVPlonalicStatus UniversityPhone:PlonalicStatus UniversityPhone:PlonalicStatus UniversityFax: SVPlonalicStatus UniversityFax: SVPlonalicStatus UniversityStatusPlonalicStatus UniversityStatusPlonalicStatus UniversityStatusPlonalicStatus UniversityStatusPlonalicStatusCompressionPlonalicStatusStatusPlonalicStatusStatusStatusStatusStatusStatusOneStatusStatusOneStatusStatusOneStatusStatusStatusStatusStatusStatusStatusStatusStatusStatusStatusOneStatus<	Program/Discipline Element/Subdiscipline:	COMBUSTION SCIENCECombustion science		
Human Research Program Riske: None Space Biology Cleanent: None Space Biology Cross-Element biochimes: None Space Biology Special Category: None Space Biology Special Category: None PI Email: nor Chatter Special Category: None Companization Type: UNIVERSITY Organization Type: UNIVERSITY PI Address 1: 5500 Companis Drive, Mechanical Engineering Department PI Address 2: State: PI Medress 1: State: PI Medress 2: State: PI Medress 2: State: PI Medress 1: State: Clay: San Diego State University State Date: Quantization Type: Project Type: Figits State Date: Quantization State: State Date: Quantization Science State: No. of Paster Date: Quantization State: Project Type: Figits No. of Paster Date: No. of Paster Date: Quantization Science State: No. of Master's Candidates: Quantization Science State: No. of Master'S Candidates: Quantization Science State	Joint Agency Name:		TechPort:	No
Space Biology Cass-Element DirectionNoneSpace Biology Special CategoryNoneP1 Conspace Biology Special CategoryNoneP1 Conspanization Type:NoneOrganization Type:UNVERSITYP1 Organization Type:Sun Diego State UniversityP1 Address 1:Store Biology Optimize Drive, Mechanical Engineering DepartmentP1 Address 1:Store Diego State UniversityP1 Address 1:Store Diego State UniversityP1 Address 1:Store CassesP1 Address 1:Store CassesNo Af	Human Research Program Elements:	None		
None None Space Biology Special Category: None Space Biology Special Category: None PI Organization Type: UNIVERSITY Phone: 619-594-6080 Organization Type: UNIVERSITY Phone: 619-594-6080 Organization Name: San Diego State University Phone: 619-594-6080 Organization Name: San Diego State University FV FV PI Address 1: 5500 Companile Drive, Mechanical Engineering Department FV FV PI Address 2: FV FV FV FV PU Woh Page: San Diego State: CA City: San Diego State: CA Sign Diego State: Salo Companie Drive, Mechanical Engineering Department CA FV San Diego State University Salo Companie Drive, Mechanical Engineering Department CA San Diego State University San Diego State University Salo Companie Drive, Mechanical Engineering Department	Human Research Program Risks:	None		
Discipline: Note Space Biology Special Category: None PI Email: prof Dubatacharice@minil.com Fax: FV PI Organization Type: UNIVERSITY Phone: 619-594-6080 Organization Name: Smo Diego State University Filme: 500 Camponile Drive, Mechanical Engineering Department Image: State Category: PI Address 1: S500 Camponile Drive, Mechanical Engineering Department Image: State Category: Image: State Category: PI Address 2: Image: State Category: State Category: State Category: Image: State Category:	Space Biology Element:	None		
PI Rmail: prof.blattic.bin/ies/genail.com Fax: FV PI Organization Type: UNIVERSITY Pio e: 619-594-6080 Organization Type: Son Diego State University Pio e: 619-594-6080 PI Address 1: 5500 Campanile Drive, Mechanical Engineering Department F PI Address 2: F F F PI Web Page: San Diego State CA City: San Diego State CA Comments: F F 9406/2015 End Date: 9930/2021 No. of Pab Degresci 0 No. of Maxter' Degresci 0 <	Space Biology Cross-Element Discipline:	None		
Internation Internation PI Organization Type: UNVERSITY Phone: 6/9-594-6080 Organization Type: S500 Campanile Drive, Mechanical Engineering Department Image: Companize C	Space Biology Special Category:	None		
The construction of the	PI Email:	prof.bhattacharjee@gmail.com	Fax:	FY
P1 Address 1: 5500 Campanile Drive, Mechanical Engineering Department P1 Address 2: P1 Web Page: City: San Diego San Diego State: CA Zip Code: 92182-0001 Comments: Source: Project Type: Flight Solo Comments: Solo Composition Science Source: Project Type: O No. of Phot Degrees: 0 No. of Phot Degrees: 0 No. of Post Docs: 0 No. of Master' Degrees: No. of Master's Candidates: 3 No. of Master' Degrees: No. of Bachelor's Candidates: 3 Monitoring Cente: No. of Bachelor's Candidates: Sandra Contact Phone: 216-433-2859 Contact Monitor: Sustar Oleoničanasa gou State: Flight Assignment: ISS ISS ISS NoTE: End date changed to 4/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 19/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 19/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 19/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 19/2020)	PI Organization Type:	UNIVERSITY	Phone:	619-594-6080
Bit Products (Bit Products	Organization Name:	San Diego State University		
Piebe Page: City: San Diego Stat: CA Zip Code: 92182-0001 Congressional Distric: 53 Comments: Solicitation / Funding Solicitation / Suurce: Solor Compussion Science Project Type: light Solicitation / Funding Solor Compussion Science Start Date: 0406/2015 End Date: 09/30/2021 No. of Post Docs: 0 No. of Master's Degres: 0 No. of Master's Candidates: 3 No. of Master's Degres: 0 No. of Bachelor's Candidates: 3 Solor Solor Contact Phone 216-433-2859 No. of Bachelor's Candidates: Sandra Contact Phone 216-433-2859 Contact Monitor: Contact Contact Phone 216-433-2859 Flight Program: ISS Solor Solor Gando Contact Phone 216-433-2859 Solor Solor Solor Solor Solor Gando Distric End date changed to 9/30/2021 per NSSC information (Ed., 4/21/21), NOTE: End date changed to 9/30/2022 per Soloso/GRC (Ed., 1/9/2020), NOTE: End date changed to 4/30/2022 per Soloso/GRC (Ed., 1/9/2020), NOTE: End date changed to 4/30/2022 per Soloso/GRC (Ed., 1/9/2020), NOTE: End date changed to 4/30/2022 per Soloso/GRC (Ed., 1/9/2020), NOTE: End date changed to 4/30/2022 per Soloso/GRC (Ed., 1/9/2020), NOTE: End date changed to 4/30/2022 per Soloso/GRC (Ed., 1/9/	PI Address 1:	5500 Campanile Drive, Mechanical Engineering Depart	ment	
CitySan DiegoStateC AZip Code:2182-001Congressional Distric:53Comments:Solicitation / Funding2009 Combustion Science Source:Project Type:FlightSolicitation / Funding2009 Combustion Science Source:Start Date:04/06/2015End Date:0/30/2021No. of Post Docs:0No. of PhD Degrees:0No. of Post Docs:0No. of Master' Degrees:0No. of Master's Candidates:3Monitoring Cente:NASA GRCContact Monitor:Olson, SandraContact Phone:16-433-2859Contact Email:Sandra Olson/Ginasa.gov16-433-2859Flight Program:ISSSolicitation / End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21)NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 4/23/21)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Kry Personnel Changes/Previous PFSan Diego State University) Paolini, Christopher Ph.D. (San Diego State University) Notice: Sin Diego State University) Notice: Sin Diego State University) Notice: Sin Diego State University) 	PI Address 2:			
Zip Code:92182-001Congressional District:53Comments:FightSolicitation / Funding Source:009 Combustion Science Source:Project Type:https://www.science.com/source:009 Combustion Science Source:Start Date:0406/2015End Date:09/30/201No. of Post Docs:0No. of PhD Degrees:0No. of PhD Candidates:0No. of Master' Degrees:0No. of Master's Candidates:3Monitoring Cente:No. of Bachelor's Degrees:No. of Bachelor's Candidates:Sondra Otomi/Ginasa acovNo. of Isater Phone:No. StartaContact Email:Sondra Otomi/Ginasa acov16433-2859Flight Program:ISSSondra Otomi/Ginasa acovStarta Science CellFlight Assignment:ISSNOTE: End date changed to 9/30/2021 per NSSC information (Ed., \$1/2/2020) NOTE: End date changed to 4/3/2022 per S. Olson/GRC (Ed., 1/9/2020)Start Science CellKry Personnel Changes/Previous PFSuller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (Sin Diego State University), JapanStart Science CellGrant/Contract No:NN15AG11GNN15AG11GStart Science CellPerformance Coult No:NN15AG11GStart Science Cell	PI Web Page:			
Comments: Comments: Project Type: Flight Solicitation / Funding 2009 Combustion Science Source NNH09ZTT001N Start Date: 04/06/2015 End Date: 09/30/2021 No. of Post Does: 0 0 No. of PhD Degrees: 0 No. of PhD Candidates: 0 0 No. of Master' Degrees: 0 No. of Master's Candidates: 3 0 No. of Master' Degrees: 0 No. of Bachelor's Candidates: 3 No. of Master' Degrees: 0 No. of Bachelor's Candidates: 3 No. of Master' Degrees: 0 No. of Bachelor's Candidates: 3 No. of Sachelor's Candidates: 3 No. of Master' Contact Phone: 216-433-2859 Contact Email: S NoTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed.,	City:	San Diego	State:	CA
Project Type:FightSolicitation / Funding SourceSOOP Combustion Science SourceProject Type:FightSolicitation / Funding SourceSolicitation / Funding Solicitation / Funding Solicitation / SourceSolicitation / Funding	Zip Code:	92182-0001	Congressional District:	53
Project Type:PightSource:NNH09ZTT001NStart Date:04/06/2015End Date:09/30/2021No. of Pot Docs:0No. of PhD Degrees:0No. of PhD Candidates:0No. of Master' Degrees:0No. of Master's Candidates:3No. of Bachelor's Degrees:0No. of Bachelor's Candidates:3Monitoring Center:NASA GRCContact Monitor:Olson, SandraContact Phone:216-433-2859Contact Email:Sandra.Olson/@inasa.gov	Comments:			
No. of Post Docs:0No. of PhD Degrees:0No. of PhD Candidates:0No. of Master' Degrees:0No. of Master's Candidates:3No. of Bachelor's Degrees:0No. of Bachelor's Candidates:3Monitoring Center:NASA GRCContact Monitor:Olson, SandraContact Phone:216-433-2859Contact Email:Sandra Olson@inasa.gov216-433-2859Flight Program:ISSISS NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 5/12/2020) NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:Vietter Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)Grant/Contract No.:NX15AG11G	Project Type:	Flight		
No. of PhD Candidates:0No. of Master's Candidates:0No. of Master's Candidates:3No. of Bachelor's Degrees:0No. of Bachelor's Candidates:3Monitoring Center:NASA GRCContact Monitor:Olson, SandraContact Phone:216-433-2859Contact Email:Sandra.Olson@masa.gov216-433-2859Flight Program:ISSISSFlight Assignment:ISSISSNOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21)NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:Vorte: End date changed to 1/30/2022 per S. Olson/GRC (Ed., 1/9/2020)COI Name (Institution):Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)	Start Date:	04/06/2015	End Date:	09/30/2021
No. of Master's Candidates:3No. of Bachelor's Degrees:0No. of Bachelor's Candidates:3Monitoring Center:NASA GRCContact Monitor:Olson, SandraContact Phone:216-433-2859Contact Email:Sandra.Olson@nasa.govISFlight Program:ISSISS NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)ISS State Information (Ed., 5/12/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:Image: State University Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)Image: State University Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)Grant/Contract No.:NNX15AG11G	No. of Post Docs:	0	No. of PhD Degrees:	0
No. of Bachelor's Candidates:3Monitoring Center:NASA GRCContact Monitor:Olson, SandraContact Phone:216-433-2859Contact Email:Sandra.Olson@nasa.govImage: Image: Image	No. of PhD Candidates:	0	No. of Master' Degrees:	0
Contact Monitor:Olson, SandraContact Phone: 216-433-2859Contact Email:Sandra.Olson@nasa.govFlight Program:ISSSS NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:Col Name (Institution):Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)Grant/Contract No:NNX15AG11G	No. of Master's Candidates:	3	No. of Bachelor's Degrees:	0
Contact Email:Sandra.Olson@nasa.govFlight Program:ISS NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21)Flight Assignment:NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (San Diego State University) 	No. of Bachelor's Candidates:	3	Monitoring Center:	NASA GRC
Flight Program:ISSFlight Assignment:ISS NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:COI Name (Institution):Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)Grant/Contract No.:NNX15AG11G	Contact Monitor:	Olson, Sandra	Contact Phone:	216-433-2859
Flight Assignment: ISS NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21) NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020) NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) Key Personnel Changes/Previous PI: COI Name (Institution): Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan) Grant/Contract No.: NNX15AG11G	Contact Email:	Sandra.Olson@nasa.gov		
Flight Assignment:NOTE: End date changed to 9/30/2021 per NSSC information (Ed., 4/23/21)NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020)NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)Key Personnel Changes/Previous PI:COI Name (Institution):Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai, Kazunori Ph.D. (Gifu University, Japan)Grant/Contract No::NNX15AG11GPerformance Goal No::	Flight Program:	ISS		
Ingit Assignificit. NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) Key Personnel Changes/Previous PI: Miller, Fletcher Ph.D. (San Diego State University) COI Name (Institution): Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (Gifu University, Japan) Grant/Contract No.: NNX15AG11G Performance Goal No.: NNX15AG11G				
NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020) Key Personnel Changes/Previous PI: COI Name (Institution): Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan) Grant/Contract No.: NNX15AG11G Performance Goal No.: NNX15AG11G	Flight Assignment:	NOTE: End date changed to 4/5/2021 per NSSC information (Ed., 5/12/2020)		
COI Name (Institution):Miller, Fletcher Ph.D. (San Diego State University) Paolini, Christopher Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan)Grant/Contract No.:NNX15AG11GPerformance Goal No.:		NOTE: End date changed to 4/30/2022 per S. Olson/GRC (Ed., 1/9/2020)		
COI Name (Institution): Paolini, Christopher Ph.D. (San Diego State University) Takahashi, Shuhei Ph.D. (Gifu University, Japan) Wakai , Kazunori Ph.D. (Gifu University, Japan) Grant/Contract No.: NNX15AG11G Performance Goal No.: Value	Key Personnel Changes/Previous PI:			
Performance Goal No.:	COI Name (Institution):	Paolini, Christopher Ph.D. (San Diego State University Takahashi, Shuhei Ph.D. (Gifu University, Japan)	7)	
	Grant/Contract No.:	NNX15AG11G		
Performance Goal Text:	Performance Goal No.:			
	Performance Goal Text:			

	NOTE: Continuation of "Residence Time Driven Flame Spread Over Solid Fuels," grant # NNX10AE03G, with the same Principal Investigator Subrata Bhattacharjee, PhD. Flame spread over solid fuels in an opposed-flow environment has been investigated for over four decades for understanding the fundamental nature of hazardous fire spread. The appeal for this configuration stems from the fact that flame spread rate remains steady, even if the flame itself may grow in size. For practical fire safety issues, however, wind-assisted flame spread is more relevant.
	However, these two regimes have always been studied in isolation without much effort to establish a connection, even though the underlying mechanism of flame spread is the same in all regimes. Sitting between the two regimes are high-residence time flames, as found in a low-velocity or quiescent microgravity environment. Residence time is the time spent by an oxidizer in the combustion zone. Such flames, which are of interest on their own merit due to fire safety issues in spacecraft, offer some unique characteristics because of the high residence time. Radiation becomes dominant and, based on previous space experiments and analysis, we contend that a vigorously spreading flame on Earth becomes self-extinguishing in a microgravity environment under certain conditions such as the fuel thickness being greater than a critical value.
	The goal of the RTDFS (Residence Time Driven Flame Spread) experiments as part of the SoFIE (Solid Fuel Ignition and Extinction) program is to experimentally test the hypothesis that radiative quenching of a flame in a low gravity environment is caused by the asymmetry between how the species field and temperature field evolve. While the radiation loss, enhanced due to higher residence time, restricts the size of the reaction zone, the combustion products field keeps expanding around the flame, displacing the oxidizer, in effect choking the flame.
Task Description:	Using results from BASS-II (Burning and Suppression of Solids) experiments, part of our hypothesis that under a critical flow velocity flames will extinguish in a microgravity environment has already been tested successfully, resulting in a number of publications. The RTDFS experiments will provide us with much more comprehensive measurements on the species and temperature distribution around the flame, leading to a better understanding of the mechanism of flame quenching. Moreover, flame spread experiments over samples covering a range of thicknesses will help us experimentally establish the critical fuel thickness above which flames become self extinguishing, a phenomenon predicted by theoretical and computational analysis.
	One of the significant works we have carried out this year is to explore the similarities between flame spread in a microgravity environment with that in a low-pressure terrestrial environment. We have identified the non-dimensional numbers that capture the radiative and chemical kinetics effects, which are both affected by gravity and pressure. The work, published in the 38th Proceedings of the Combustion Institute, shows that while the a reduction in pressure or gravity affects the radiation number in a similar manner, their effect on the kinetics number (Damkohler number) is just the opposite. Therefore, a low-pressure experiment cannot be a substitute for a low-gravity experiment.
	Another key work involved a comprehensive comparison of different radiation sub-models to evaluate the importance of (i) surface radiation loss, (ii) gas radiation loss; and (iii) radiation feedback on flame spread rate and flame structure in different regimes of opposed-flow flame spread.
	In preparation to the RTDFS experiments we will focus our work on: (i) Comprehensive numerical modeling of the entire experimental matrix; (ii) Improving the pyrolysis kinetics model; (iii) Investigating effect of solid conductivity on radiative quenching of flames; (iv) Predicting of flame length; (v) Expanding our work to cylindrical geometry.
Rationale for HRP Directed Research	1:
Research Impact/Earth Benefits:	Our research has four components. (a) We have built three experimental setups at San Diego State University (SDSU) : Flame Tower where a test sample can be traversed up or down at any desired velocity; Flame Stabilizer where the motion of the flame can be arrested by moving the sample exactly at the speed of the flame spread in the opposite direction; and a rotating Flame Tunnel where a combustion tunnel can be oriented at any desired angle to study the interaction of buoyancy and forced flow; (b) Theoretical and computational work that explores the similarity and differences between the mechanisms flame spread in a zero gravity space environment and on Earth; (c) Support the space based experiment (in the SoFIE project) to establish extinction mechanism of flames; (d) Develop software tools for data analysis and share those with the research community. The data that we are acquiring in the experiments provide the research community with a comprehensive set of results for testing different theories of flame spread in a normal gravity environment. Moreover, by controlling the residence time, various regimes of flame spread, including the microgravity regime, can be explored in the Flame Tower. Our theoretical work predicts a fuel thickness beyond which steady flame spread is unsustainable in a gravity free environment. If we are successful in establishing a critical thickness, this will have a powerful impact on making fire resistant environment for humans in space.
	As part of this project, we are developing thermodynamic calculators for combustion and equilibrium calculations, which has a significant educational component. These are available to the community through http://www.thermofluids.net . We have also developed a MATLAB based image processing tool named FIAT (Flame Image Analysis Tool), which is now available to the community from http://flame.sdsu.edu .
Task Progress:	One of the significant works we have carried out this year is to explore the similarities between flame spread in a microgravity environment with that in a low-pressure terrestrial environment. We have identified the non-dimensional numbers that capture the radiative and chemical kinetics effects, which are both affected by gravity and pressure. The work, published in the 38th Proceedings of the Combustion Institute, shows that while the a reduction in pressure or gravity affects the radiation number in a similar manner, their effect on the kinetics number (Damkohler number) is just the opposite. Therefore, a low-pressure experiment cannot be a substitute for a low-gravity experiment. Another key work involved a comprehensive comparison of different radiation sub-models to evaluate the importance of (i) surface radiation loss, (ii) gas radiation loss, and (iii) radiation feedback on flame spread rate and flame structure in different regimes of opposed-flow flame spread.
	In preparation to the RTDFS experiments we will focus our work on: (i) Comprehensive numerical modeling of the entire experimental matrix; (ii) Improving the pyrolysis kinetics model; (iii) Investigating effect of solid conductivity on radiative quenching of flames; (iv) Predicting flame length; (v) Expanding our work to cylindrical geometry.

Bibliography Type:	Description: (Last Updated: 06/13/2025)
Articles in Peer-reviewed Journals	Bhattacharjee S, Carmignani L. "Radiation-kinetics interactions: A comparison of opposed-flow flame spread in a low-velocity microgravity and low-pressure downward environments." Proceedings of the Combustion Institute. 2021;38(3):4795-803. Available online 11 July 2020. <u>https://doi.org/10.1016/j.proci.2020.05.014</u> , Jan-2021
Articles in Peer-reviewed Journals	Bhattacharjee S, Carmignani L. "Prediction of flame length in opposed-flow flame spread: Global similarity analysis and experiments." Comb. Sci. Technol. 2021 Feb 28. <u>https://doi.org/10.1080/00102202.2021.1885030</u> , Feb-2021
Papers from Meeting Proceedings	 Bhattacharjee S, Carmignani L. "Comparison of Flame Length in Downward Spread over Flat and Cylindrical Samples." 36th Annual Meeting of the American Society for Gravitational and Space Research, Virtual Meeting, November 5-6, 2020. 36th Annual Meeting of the American Society for Gravitational and Space Research, Virtual Meeting, November 5-6, 2020. 36th Annual Meeting of the American Society for Gravitational and Space Research, Virtual Meeting, November 5-6, 2020.