. **Innovation[X] 2021-2022 Proposal Application**
The School of Innovation and Innovation Partners are calling for proposals for the next round of our Innovation[X] Program, which provides grants that allow multidisciplinary teams of faculty, undergraduates, graduate students, and postdocs to work together to address complex real-world challenges.

Faculty may apply for grants of up to **$20,000** to facilitate year-long projects. The number of grants to be awarded will depend on funding and application levels. Funding begins September 1, 2021.

Additionally, we have partnered with the Mays Innovation Research Center to fund a set of proposals to study the process of innovation itself. Successful proposals for this subset will pursue topics such as, barriers to or preconditions for innovation, the effects of law and policy on innovation, the behavior or psychological requirements for innovation, innovation and health, the social impacts of innovation, international comparisons of innovation, or novel measurements of innovation.

Proposals are due by 11:59 PM on our **newly extended** deadline of **February 22, 2021** and must be submitted using this online form.

NOTE - Only one team leader/faculty member needs to submit a proposal for a given project.

Reminder of Requirements:
- Teams must consist of an interdisciplinary set of faculty members, and must include two (2) faculty members from different colleges/schools.
- Teams must include a multidisciplinary team of 10-20 students, both undergraduate and graduate, from across the university.
- At least 8-10 of these students must be undergraduates.
- The team must include students from at least two (2) different colleges/schools.
- Students must participate in the project for both Fall 2021 and Spring 2022 semesters, with limited exceptions.
- Proposals should demonstrate a team-based approach to a complex problem and include meaningful deliverables.

Please contact Assistant Director Emily Finbow at innovationx@tamu.edu or 979-862-6071 with questions.

. For which tracks would you like your proposal to be considered?

- (●) Track A - Traditional Innovation[X] Project
- ( ) Track B - Special Track - "Process of Innovation" Innovation[X] Project
- ( ) Both Track A and Track B

. Project Title

A portable platform enables on-site rapid and sensitive detection of airborne bacteria and viruses in aerosol samples using droplet-based isothermal amplification

. *Please provide the following information for the Primary Point of Contact for the Project (Project Leader)*

. Prefix

Prof

. First Name

Arum

. Last Name

Han

. Email Address

arum.han@ece.tamu.edu

. Phone Number

979-458-8854

. Gender Identity

- ○ Man
- ○ Woman
- ○ Trans Man
- ○ Trans Woman
- ○ Genderqueer
- ○ Non-Binary/Gender non-conforming
- ○ Not listed above, please specify
- ◉ Prefer not to respond

.
Ethnic and Racial Identity

- ○ Hispanic/Latino/a/x
- ○ American Indian or Alaska Native
- ○ Asian/Pacific Islander/Desi-American
- ○ Black/African American

- ◯ White
- ◯ Bi-racial / Multi-Racial (please specify): [ ]
- ◯ Not listed (please specify): [ ]
- ◉ Prefer not to respond

. Project Information

. Please provide brief background/context for the issue this project seeks to address. (2,000 character maximum)

Airborne pathogen transmission has caused the outbreak of several severe pandemic diseases, including SARS (2003), H1N1 (2009), MERS-CoV (2015), and now COVID-19. The rapid development of the COVID-19 pandemic shows the high risk emerging pathogens pose on public health and economic loss. Significant amount of efforts have been devoted to developing rapid and accurate diagnostic methods, many with success. However, there is still a need for portable and sensitive airborne pathogen detection technologies that can be deployed for on-site monitoring, both for the current pandemic as well as in the future. Detection of airborne pathogens requires both aerosol sample collection and analysis. Current smapling methods include gravitational sampling, electrostatic sampling, centrifuge sampling, but they require long sampling time and complex steps. Therefore, a more simple and effective method is needed. Analysis of the collected pathogens can be conducted through two major techniques: nucleic acid-based method such as real-time reverse transcription-polymerase chain reaction (RT-PCR) that detects the viral genetic material, and protein based such as immunoassay (using antibody) that detects specific proteins that are generated in human body upon infection. RT-PCR is currently the gold standard for SARS-CoV-2 detection. This method also has relatively higher sensitivity than immunoassay. However, these assays are conducted in laboratory setting, taking 2-4 h to complete. Therefore, it is challenging to perform RT-PCR for rapid on-site testing. The integration of a microfluidic chip with PCR technique has the potential to address these limitaitons due to the advantages of microfluidis such as reduced reagent consumption, high-throughput multiplexed assay capability, shorter reaction time, easy to make it portable, and being low cost.

. What are the goals for this project? (5,000 character maximum)

The goal of this project is to offer a solution to tackle the challenge of on-site, rapid, and sensitive detection of airborne pathogens present in aerosol samples by integrating multidisciplinary effort from faculties, research staff, and STEM students from both engineering and life sciences. In this project, we aim to: 1) Develop a portable platform that is capable of on-site aerosol sampling, followed by rapid and sensitive detection of airborne pathogens using microfluidic droplet-based reverse transcription loop-mediated isothermal amplification detection. This aim includes three sub-aims: a) Development of an aerosol collection module to capture aerosol containing surrogates of airborne bacteria and viruses, and transform aerosol into liquid phase to collect pathogens. This is because most commonly used molecular analysis method requires the sample to be in liquid phase. To achieve this sub-aim, we will design an aerosol collection module by using membrane filters to trap aerosols inside an airflow. Then, the trapped aerosol will be buffered into the liquid phase to release pathogens into liquid phase and retained for downstream detection. The performance of the collection module will be evaluated using surrogates of airborne bacteria and viruses. b) Development of a portable platform that consists of a microfluidic droplet generation and collection module, integrated with a temperature controller module, to perform in-droplet isothermal amplification for pathogen detection. Isothermal amplification is a compelling alternative to PCR with advantages of reduced time-to-result (assay time less than 30 min), no need for temperature cycling or rapid heating and cooling, robustness against inhibitors, and high specificity. Two commonly used isothermal amplification methods for point-of-care diagnosis, loop-mediated isothermal amplification (LAMP) and recombinase polymerase amplification (RPA), will be evaluated and utilized in the proposed system. Microfluidic droplet-based assays have been demonstrated to improve the detection sensitivity by over 1,000 times compare to bulk assays. Therefore, performing isothermal amplification in droplet format enables rapid and sensitive detection of target pathogens. The pathogens released in liquid phase will be encapsulated and isolated into millions of picoliter volume droplets generated by a miniature microfluidic droplet generator module. Then, those droplets will be collected and positioned inside a microchamber for subsequent isothermal amplification and imaging. Isothermal amplification-based diagnosis requires only single-step heating and relatively low temperature (25˚C to up to 60 ˚C), so it has significant advantages for portable applications. Here, a portable temperature controller module will be designed to accommodate the droplet generation and collection modules to perform droplet-based isothermal amplification. This entire platform will be designed to be carried inside a suitcase. c) Development of a program and algorithm for platform control, image processing, and detection result reporting. A program will be coded to operate the portable temperature controller module. Algorithms will be developed to analyze acquired fluorescence images of droplets under a smartphone-based optical imaging module. A user interface will be developed to allow users to operate and view the detection results on a smartphone. 2) Foster STEM students' engagement in a multidisciplinary collaborative project to solve a real-world problem under a challenging circumstance. This aim includes the following three sub-aims: a) Design of tasks to enable interplay between remote and bench work personnel. For example, computational simulation personnel who can work remotely will have to work with module prototyping personnel. b) Design of a collaborative task for a small group setting. Generally, two undergraduate students will team up to work together on a single task. Depending on the task content, one graduate student may partner with one undergraduate student. c) Utilize technologies to enable a collaborative task for a large group setting. The final task of this proposed project will require the participation of the entire team (10 students). We will use available communication and management technologies, for example, Microsoft Teams, Zoom, Slack, etc., to facilitate the collaboration while minimizing in-person large group gathering.

. What are anticipated outcomes from this project? (e.g., publications, website, app, data collection for further research/grant) (2,000 characters maximum)

Prototype: The prototype of each component (including aerosol collection module, temperature controller module, droplet microfluidic module, optical module, and smartphone application) and integrated portable device will be manufactured and demonstrated for proof-of-concept validation. Publications: We expect to publish the work in a high impact journal such as the ACS sensors, Sensors and Actuators B: Chemical, or Biosensors and Bioelectronics. The combination of isothermal amplification with droplet microfluidics for portable airborne pathogen detection is novel and has never been done before, thus we expect that the completed work will lead to journal publication. Further grant application: The proposed detection method has broad utility. For example, the proposed system can be leveraged to fulfill different diagnosis needs, for example, other airborne pathogens such as influenza, tuberculosis (TB), Bird Flu (H5N1), and pathogenic fungus. The outcomes from this project can be a solid preliminary data in future funding applications to federal agencies such as the National Institute of Biomedical Imaging and Bioengineering (NIBIB). Patent application: The integrated system can be further developed into a portable point-of-care diagnosis system, since the fabrication of the platform is simple and can easily be standardized for mass production, which makes the system to have high commercial value and patentable. The integration of droplet microfluidics method with isothermal amplification could increase te detection sensitivity by several orders of magnitude, which has not been done by others yet. Airborne pathogen detection using such a portable system is rarely reported.

. Is this proposed project an extension of existing work or a new endeavor? (1,200 character maximum)

This is a new endeavor and not an extension of any existing work. Dr. Arum Han's group has strong expertise in the development of microfluidic droplet-based systems for cellular assay, however has not worked on any related work as proposed here. Dr. de Figueiredo and Dr. Criscitiello have extensive experiences in both cell biology and pathogenic assays, but have not worked on any diagnosis system development. This proposed project is a new collaboration between researchers having expertise in infectious disease and microsystem engineering to venture into a new area of molecular diagnosis using droplet-based systems.

. Is Institutional Review Board (IRB) approval required for this project?

Not required.

. *Team Participants*

. Please list all Team Leaders below (including yourself), including Prefix, Name, Title, and Department/School.

Arum Han, Professor, Presidential Impact Fellow, Department of Electrical and Computer Engineering, Texas A&M University Paul de Figueiredo, Associate Professor, Department of Microbial Pathogenesis and Immunology, College of Medicine, Texas A&M University Jing Dai, Assistant Research Scientist, Department of Electrical and Computer Engineering, Texas A&M University Han Zhang, Postdoctoral Researcher, Department of Electrical and Computer Engineering, Texas A&M University

. Do any of the team leaders listed above have plans for a sabbatical or other extended leave away from campus during the 2021-22 academic year? Note: Selecting “yes” will not automatically disqualify a team, but rather will indicate that we need to have a discussion with your team about the nature of the planned leave in relation to the project.

No.

. Please list all Team Contributors below, including Name, Title, and Department/School. *Please exclude anyone you already listed as a Team Leader.*

Michael Criscitiello, Professor, Department of Veterinary Pathobiology, College of Veterinary Medicine & Biomedical Sciences, Texas A&M University Felix Liu, Postdoc Research Associate, Department of Microbial Pathogenesis and Immunology, College of Medicine, Texas A&M University Jing Yang, Postdoc Research Associate, Department of Microbial Pathogenesis and Immunology, College of Medicine, Texas A&M University Kaitlyn Romoser, Ph.D. graduate student, Department of Veterinary Pathobiology, College of Veterinary Medicine & Biomedical Sciences, Texas A&M University

. Do you plan to assign someone other than a faculty leader as a “project manager” for your team (i.e., a graduate student, postdoc, staff person)?

- (●) Yes
- ( ) No
- ( ) Not sure yet

. What would be the ideal composition of team members for this project? What majors, disciplines, skills, backgrounds, or perspectives would you like to have on the team? (2,000 characters maximum)

There are four key technological components that are needed to accomplish the project. These are cell biology, lab-on-chip techniques, electronics & automation, and programming & simulation. Thus, we will be recruiting undergraduate students and graduate students (most likely MS/ME students) having background and skills, included but not limited to below: Major in Biology/Life science/Pathology. We expect students have at least one of the following skills and experience: 1. Basic knowledge of microbiology, cell biology, and molecular biology. 2. Hands-on experience in a life science lab. Experience in bacteria/cell culture and molecular biology is preferred. Major in Engineering/Physics. We expect students have at least one of the following skills and experience: 1. Programing: Python, MATLAB, LabVIEW, JavaScript. Experience in image analysis and/or smartphone user interface design is preferred. 2. Computational simulation and modeling: COMSOL Multiphysics and/orANSYS, AutoCAD and/or Solidworks. Experience in fluidic dynamics and/or thermal simulation is preferred. 3. Microelectronics and electrical engineering: Hands-on experience in photolithography, electronic circuit design is preferred.

. Will your team also include any external organizations or individuals as either partners, clients, study subjects, beneficiaries of the work, etc.?

No

. *Travel*

. Does your proposal include travel for students beyond Bryan/College Station?

- ( ) Yes
- (●) No
- ( ) Not sure yet

. Where would the team travel?

N/A

. When do you anticipate that this travel would take place? (e.g., Fall 2021, Spring 2022, some other academic break, TBD)

N/A

. Do you expect that all students selected for the team would be able to travel, or just a select number?

N/A

. *Collaboration with Students*

. Ideally, how many undergraduate students would you select to participate on this team? (Numeric responses only, please)

8

. Ideally, how many graduate students would you select to participate on this team?

2

. Ideally, how many professional or doctoral students would you select to participate on this team?

0

. How will you facilitate collaborative inquiry on the team? How often and in what format will the team meet? How will you divide tasks? How you will ensure effective management of the project (e.g., appoint a student as a project manager, assign that role to a faculty leader, etc.)? (2,500 character maximum)

To facilitate collaborative inquiry on the team, we propose the following endeavors: 1) This project will be divided into 6 tasks so that each team member will be teamed up to take a task. Tasks will be either assigned or picked by members with suitable background and knowledge to accomplish the designated tasks. 2) Team members have to establish plans, develop strategies/methods, and tackle problems. They will have to adjust the plan or method based upon their progress. The timeline of each task is planned to guide progress, and team/project management software such as Microsoft Teams will be utilized. 3) Team leaders will supervise progress and provide guidance through regular group meetings (entire group and small group). The meeting frequency will be: An entire team meeting will be held every two weeks to update progress of each task through presentation and brainstorm to tackle problems. Small-scale group meetings will occur on an as-needed basis. To effectively carry out this project and maximize the engagement of team members, the project is divided into following six tasks: 1) Five small group tasks (Two students work collaboratively per task). Team members in each task will not be separated from other tasks. Rather, they will have to work together to ensure their accomplishment in their own task can be seamlessly transitioned to other tasks. 2) One large group task (entire team works collaboratively). To effectively manage this project, we will: 1) Assign members from team leaders to actively manage and act as project managers and be responsible for day-to-day operation and management of the project. 2) Set goals and timelines for each task. Team members and leaders will review the progress together.

. What might students gain from their participation (e.g., conducting research directly with subjects, contributing to publications, using language skills)? What unique and differentiated learning opportunities would be available for graduate students? (2,500 character maximum)

8 undergraduate and 2 graduate students will be involved in this project. Students will learn how to collaborate with persons having different background and knowledge to complete a task in a small group setting and/or a project in a big group setting. We expect to recruit team members from STEM background, create a natural multidisciplinary environment. Both undergraduate and graduate students will improve their skills in research design and method under the mentorship of faculty and research staff. Specifically, in the project, students will gain experience from hands-on experiments such as the use of biosafety cabinets for virus and bacteria cell culture and the use of nebulizers and gelatin filters for aerosol sample generation and collection as well as microfluidic device fabrication (photolithography and replication molding). Besides, students also learn important professional skills in engineering design such as microfluidic device design and microcontroller design, software control such as LabVIEW or Arduino automation, simulation & programming (COMSOL heat transfer simulation, fluidic dynamic simulation and JavaScript for Android smartphone application development), and integration technique that to combine the separated compartments to an entire device. Besides, they will learn how to collect and analyze data and evaluate the outcomes, for example, signal processing, calibration technique and calculate the target concentration based on the fluorescent image result acquired by the camera. For graduates, in addition to the above-mentioned benefits, they will learn how to organize and lead a group task/project and supervise undergraduate research. Students will also have the opportunity to co-author publications with the faculty and team leaders. During the manuscript preparation, students will practice their academic data presentation and writing skills and learn how to construct a high-quality academic journal article.

. *Timeline and Budget*

. Identify the timeline for the project, including start, completion and major project milestones.

NOTE - You may use the text box or upload a table or file in the next question.

See attached timeline

. Timeline Upload (if needed)

InnovationX timeline-final.xlsx
100.6KB
application/vnd.openxmlformats-officedocument.spreadsheetml.sheet

. Total Budget Request (numeric response only, please). As a reminder, the maximum amount that can be requested is **$20,000.**

$20,000

. You may upload a budget table here encompassing the categories below, or you may complete the fields below through this form as applicable.

For each item listed below or on your budget table upload, please enter both dollar amount and any relevant notes/justification.

InnovationX budget-final.xlsx
13.9KB
application/vnd.openxmlformats-officedocument.spreadsheetml.sheet

. GRADUATE OR RESEARCH ASSISTANTSHIP (PHD) *(Suggested range: $15-18/hour; note: RAships for students in graduate school should include costs for tuition remission and fees)*

$15/hour for students who already RAs or TAs

. RESEARCH ASSISTANTSHIP *(Suggested range: $12-15/hour)*

N/A

. INSTRUCTION (Teaching) - PHD STUDENT

N/A

. POST-DOCTORAL OR STAFF EFFORT

N/A

. UNDERGRADUATE STUDENT STIPEND OR WORK STUDY *(Suggested range: $11-14/hour)*

$11/hour

. INSTRUCTIONAL, RESEARCH OR OFFICE SUPPLIES

see attached budget sheet

. COMPUTERS AND MINOR EQUIPMENT

N/A

. TRAVEL - DOMESTIC

N/A

. TRAVEL - INTERNATIONAL

N/A

. CONTRACT WORK

N/A

. MEETINGS - BUSINESS

N/A

. OTHER - MISC.

N/A

. Please briefly note below any other sources of project funds. *(Projects that match or leverage additional funds are strongly encouraged. Please note any such funds, awarded or proposed, here so that we understand the comprehensive outlay for the project.)*

Dr. Han will make all facility and equipment in his NanoBio Systems Laboratory available for this project, where project team can utilize the facility free of charge. The laboratory consists of a 2,200 sq. ft. facility in the Frederick E. Giesecke Engineering Research Building (GERB). The laboratory is fully equipped to microfabricate polymer, glass, and silicon microdevices as well as test diverse ranges of microfluidic lab-on-a-chip and organ-on-a-chip systems. The laboratory is also fully equipped to conduct mammalian and microbial cell culture and is designated as biosafety level 2 (BSL2) under an Institutional Biosafety Committee (IBC) permit. This facility is being used for designing, fabricating, and testing various micro and nano scale fluidic devices and lab-on-a-chip/organ-on-a-chip systems for biological applications. The facilty has extensively list of equipment for microfluidics and biological testing, including 5 fluorescent microscopes, more than 30 syringe pumps, 2 biosafety cabinets, multiple 3D printers and rapid prototyping tools, to name just a few. In addition, the project requires microfabrication, which occurs inside the AggieFab Nanofabrication Facility (https://aggiefab.tamu.edu), a campus-wide user facility that has a equipment usage fee associated with it. Dr. Han will cover the user fee by the project personnel, estimated to be $3000 – $5000, from his strategic research account. This will supplement the small amount of microfabrication budget included in the budget proposal, as that is not sufficient to cover the microfabrication cost.

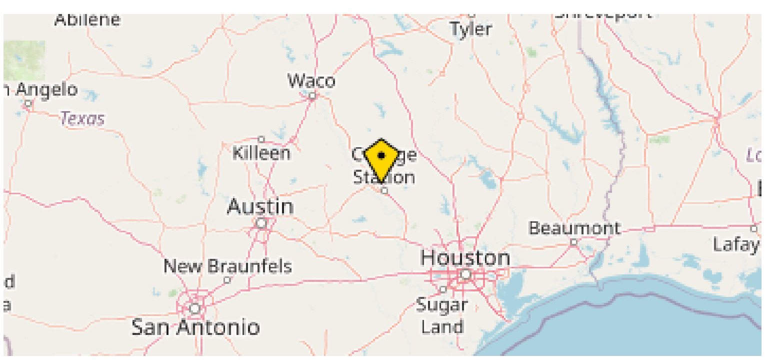
. Please name a Unit/Business Manager who could administer funds for project, if requested. Include their name, email address, and phone number:

Yolanda Veals, Senior Business Administrator I, Department of Electrical and Computer Engineering, yveals@tamu.edu, 979-845-7409

Location Data

Location: (30.662292480469, -96.334899902344)

Source: GeoIP Estimation



Proposal Title	A portable platform enables on-site rapid and sensitive detection of airborne bacteria and viruses in aerosol samples using droplet-based isothermal amplification												
	2021				2022								
Tasks	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**
TA1 Aerosol Sample preparation (2 undergrad)	■	■	■	■	■	■							
TA1.1 Biological sample preparation	■	■	■	■									
TA1.2 Aerosol sample preparation	■	■	■	■									
TA1.3 Biological validation					■	■							
TA2 Aerosol collection and microfludic droplet generation module design & fabrication (1 grad & 1 undergrad)	■	■	■	■	■	■	■	■	■				
TA2.1 Design	■	■	■										
TA2.2 Fabrication				■	■	■							
TA2.3 System validation							■	■	■				
TA3 Temperature controller and optical module design & fabrication (1 grad & 1 undergrad)	■	■	■	■	■	■	■	■	■	■			
TA3.1 Design	■	■	■	■									
TA3.2 Fabrication					■	■	■	■					
TA3.3 Controller validation									■	■			
TA4 Simulation & programming (2 undergrad)	■	■	■	■	■	■	■	■	■	■			
TA4.1 Thermal simulation (COMSOL multiphysics etc)	■	■	■	■									
TA4.2 Thermal control program (labview, matlab etc)	■	■	■	■	■	■	■	■	■	■			
TA5 Data acquisition & analysis (2 undergrad)								■	■	■	■	■	■
TA6 Integration & system validation (all team)									■	■	■	■	■

Item Name	Rate/Unit Cost	Qty	Total
Device fabrication			
Silicon wafer	$10/piece	10	$100
Photoresistor	$625/bottle	1	$625
PDMS	$110/kit	2	$220
Aggifab cleanroom usage fee	$350/month/studen	1	$350
Film mask printing charge	$100/order	2	$200
Pathogen culture and biological reagent			
Culture media	$100/bottle	2	$200
Isothermal amplification reagent	$625/kit	1	$625
Primer	$3,364	1	$3,364
Lysis buffer	$200/bottle	1	$200
Miscellaneous culture supply (tubes,flasks, etc)	$380	1	$380
Droplet generation supply			
Oil and surfactant	$300.00	1	$300.00
Miscellaneous supply (tubing, needle, etc)	$150.00	1	$150.00
Aersol collection &Temperature controller & Optical modules			
Aerosol trapping filter	$200/pkg	1	$200
Heater unit	$50.00	2	$100.00
Blue LED	$2.00	8	$16.00
Bandpass filters	$126/ea	5	$630.00
Lens	20/ea	2	$40.00
Rapid 3D prototyping	$25/h	8	$200.00
Miscellaneous electronical and mechanic supply (PMMA plates, battery, PCB, etc)	$300.00	1	$300.00
Labor cost			
Graduate student	15$/h	200	$3,000.00
Undergraduate student	11$/h	800	$8,800.00
Total			$20,000