

FY2023 RISE Grant Final Report Form
Due March 15, 2024

*Please include the following information in your final report and return complete report to
internalgrants@gsu.edu*

GSU PI and co-PIs on project:

Xiaochun He (PI), Regents Professor, Physics & Astronomy
Ashwin Ashok (co-PI), Associate Professor, Computer Science
Anu Bourgeois (co-PI), Professor, Computer Science
Yang-Ting Chien (co-PI), Assistant Professor, Physics & Astronomy
Megan Connors (co-PI), Associate Professor, Physics & Astronomy
Petrus Martens (co-PI), Professor, Physics & Astronomy
Armin Mikler (co-PI), Professor and chair, Computer Science
Unil Perera (co-PI), Regents Professor, Physics & Astronomy
Viacheslav Sadykov (co-PI), Assistant Professor, Physics & Astronomy
Murad Sarsour (co-PI), Professor, Physics & Astronomy
Chetan Tiwari (co-PI), Associate Professor, Computer Science, Geosciences

Title of Research Project:

Catalyzing a Grassroots World-Wide Web of Cosmic Ray Detectors for Climate Studies

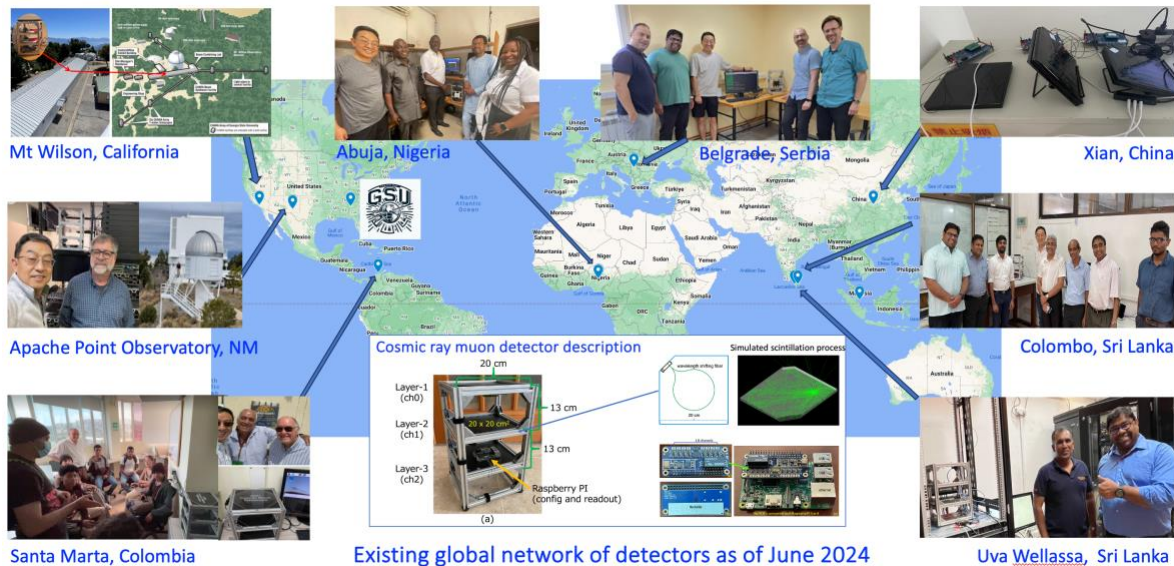
1. Please give a summary of the results of the project to date. Include a brief discussion of how the RISE project engaged in collaborative/inter- or transdisciplinary research activities that were “value added” for the institution, meaning that the project and results from the project were greater than what the individual investigators involved would have been able to do individually.

This project brings together an interdisciplinary team of GSU faculty to catalyze a climate science effort to develop GSU as a global Center of Cosmic Ray Climate Studies. The team took an integrated and shared-responsibility approach under the leadership of Xiaochun He (physics and astronomy) and Ashwin Ashok (computer science) with engaging weekly and bi-weekly meetings. For example, Xiaochun He led the detector assembling and testing with his graduate and undergraduate students, Ashwin Ashok led the effort on managing legal documentation with our international partner institutions, Ashwin Ashok and Chetan Tiwari took the lead on data infrastructure and website development, Viacheslav Sadykov was leading on data analysis meetings on Thursdays mostly with undergraduate students, Megan Connors, Anu Bourgeois and Chetan Tiwari led the STEM outreach. Each of these activities played a key role in building this unprecedented and innovative large-scale network of cosmic ray detectors worldwide for addressing the challenges and opportunities for climate-related studies.

Together, the team has developed a framework and will continue developing cutting-edge research and scholarship that transforms lives and communities in our global society. An international workshop on cosmic ray measurements and the associated applications was organized by the team from March 11 to 14, 2024. During the workshop, a formal

international collaboration was formed and called “gLOWCOST”. There are five Memorandum of Corporations (MoC) which have been established with the support from the International Students & Scholar Services and the Legal Office at Georgia State University.

As of June 17, 2024, there are two detectors installed in Sri Lanka, one in Singapore, one in Colombia, one in Nigeria and two in Serbia. In US, we installed one detector in California (at GSU’s CHARA facility on Mt Wilson, California) and one at Apache Point Observatory, New Mexico, as shown below:



In June of 2023, Xiaochun He and Ashwin Ashok flew to the NASA’s Ames Research Laboratory in California and worked with the scientists and engineers at NASA for miniaturizing the GSU’s cosmic ray detector for future CubeSat launching to monitor the real-time space weather activities. This is also an MS thesis project of Ashwin’s student, Tori Padgett, who recently graduated from GSU. A field test of the detector operation was carried out in a balloon flight at Middlebury, VT, in April 2024, led by Ashwin Ashok.

In addition, the team was able to take the cosmic ray CubeSat detector on several international flights (and long flights in US) measuring the radiation dose from cosmic rays at flight altitude when faculty and students were attending international conferences and work-related trips. This is a part of the scientific objectives of the RISE project for “imaging” the radiation level in atmosphere. These trips included travels to Sri Lanka, India, Singapore, Colombia, Nigeria, Serbia, Switzerland, Australia, Japan, etc. The team is working on a manuscript for publishing these measurements led by Viacheslav Sadykov.

2. Were you approved to purchase any capital equipment with your RISE award? If so, please list the capital equipment purchased and where is it currently located (whose individual lab, which shared facility, etc.)?

We didn’t purchase any capital equipment. Instead, we built cosmic ray detectors in the Nuclear Physics Lab at GSU, which have been installed internationally in Sri Lanka, Singapore, Colombia, Nigeria, and Serbia. In US, one detector was installed in California (at

the GSU CHARA Observatory) and one at Apache Point Observatory, New Mexico besides the detectors recording data on GSU downtown campus.

3. Please provide specific information for outcomes listed below from your RISE award that would not have been possible without the RISE award and the collaboration it supported.

Proposals Submitted and Grants Awarded (title, sponsor, total award amount – direct and indirect together, note whether declined, pending a decision, or funded, and if funded provide full award period)

Award received:

- 1) *Grant "Data Discoverability and Machine Learning Readiness for Understanding Space Radiation in Earth Environment" (PI Viacheslav Sadykov, NASA HITS program). Award amount: \$200,489. Performance period: 09/01/2022-09/01/2024.*
- 2) *Grant "Operational and Exploration Requirements and Research Capabilities for SEP Environment Monitoring and Forecasting" (PI Viacheslav Sadykov, NASA TWSC program, workshop organization award). Award amount: \$44,328.00. Approximate performance period: 01/01/2024-12/31/2024.*

Proposals submitted (not funded or pending):

- 1) *NSF proposal "A World-Wide Web of Cosmic Ray Detectors for Climate Research and Awareness", May 2022, \$1,499,796.*
- 2) *NSF proposal "Global Centers Track 2: Center for Cosmic Ray Science based Climate Research and Awareness", May 2023, \$249,588.*
- 3) *NSF proposal "GEO OSE Track 1: Development of a Computational Framework for Automating Environmental Data Collection and Integration Workflows to Support Open Science Research in Geosciences", March 2023, \$399,492.*
- 4) *NSF proposal "REU Site: Summer Undergraduate Research on Agricultural IoT", September 2023, \$589,247.*
- 5) *NSF proposal "Elements: Modeling Space Weather and Building Climate Research Awareness through a Global Network Deployment of Cosmic Ray Muon Detectors", December 2023, \$597,627.*
- 6) *NSF proposal "Mid-scale RI-1 (M1:IP): Modeling Terrestrial and Space Weather and Building Climate Research Awareness through a Global Deployment of Cosmic Ray Muon Detector Network", January 2023, \$7,080,844.*
- 7) *NSF proposal "RET Site: Interdisciplinary Summer Research Experience at the Intersection of Environmental Science, Sensing and Computing", January 2024, \$595,818, pending.*

Manuscripts Submitted and Publications (full bibliography for books, book chapters, journal articles, literature reviews and note whether pending a decision, accepted for publication, or fully published)

One paper is published: <http://dx.doi.org/10.1029/2023JA031943>

Media Spots (name of media outlet, date of occurrence, brief description of type of feature such as interview, feature story on research, etc.)

Here are two news articles about our work in Nigeria:

- 1) <https://central.nasrda.gov.ng/?p=2933>
- 2) <https://greentvafrica.com/nasrda-nigeria-becomes-first-african-country-to-acquire-cosmic-rays-detector/>
- 3) <https://www.thecable.ng/nigeria-acquires-cosmic-ray-muon-detector-to-aid-climate-prediction/>
- 4) <https://pmnewsnigeria.com/2024/05/03/nigeria-becomes-first-country-to-acquire-cosmic-rays-detector-in-africa-nasrda/>
- 5) <https://promptnewsonline.com/nasrda-us-varsity-partner-to-deepen-climate-change-research/>

News article in Sri Lanka: <https://island.lk/sl-joins-american-georgia-state-universitys-global-cosmic-ray-muon-detector-network/>

News article at GSU: <https://news.gsu.edu/research-magazine/cosmic-rays-space-weather-and-larger-questions-about-the-universe>

Exhibits and Productions (full bibliography for books, book chapters, journal articles, literature reviews and note whether pending a decision, accepted for publication, or fully published)

Other Outcomes (anything not clearly under categories above such as musical recording, patent filing, etc.)

Hosted two workshops:

- 1) *Hosted one STEM workshop in October of 2022. The focus was to discuss the challenges and opportunities with middle school teachers and to organize future activities.*



- 2) *Hosted one international workshop from March 11 to 14, 2024 at GSU. The official website is here: <https://sites.google.com/view/wacr24/home>. More than half of the participants were international and joined online mainly because of visa issues.*



Presentations given by faculty and students

- 1) *University Uva Wellessa, Sri Lanks (Xiaochun He, Ashwin Ashok & Unil Perera)*
- 2) *University of Colombo, Colombo, Sri Lanka (Xiaochun He, Ashwin Ashok & Unil Perera)*
- 3) *Northwestern Polytechnical University, Xian, China (Xiaochun He)*
- 4) *University of Madlenna, Santa Marta, Colombia (Xiaochun He)*
- 5) *Talk in Singapore (Ashwin Ashok)*
- 6) *Talk in India (Ashwin Ashok)*
- 7) *Abuja, Nigeria (Xiaochun He)*
- 8) *Ashwin's talk at GSU workshop*
- 9) *Xiaochun's talk at GSU workshop*
- 10) *Slava's talk at GSU workshop*
- 11) *Piet's talk at GSU workshop*
- 12) *Ernesto's talk at GSU workshop*
- 13) *Will's talk at GSU workshop*
- 14) *Enosh's talk at GSU workshop*
- 15) *Tharindu's talk at GSU workshop*
- 16) *Megan's talk at GSU workshop*
- 17) *Arfa's talk: 3 talks*

18) Arfa's 3 posters

Honors and Awards (Please include only those that are regional, national or international in scope for your profession; title of award/honor, sponsor, date of award/honor)

4. List any next steps that you expect to result from this project (e.g. external grant proposals to be submitted, publication manuscripts to be prepared and submitted, other plans for project outcomes) List any grants or publications in preparation including the agency or publisher where they will be submitted and expected date of submission; list or describe any other outcome you expect resulting from this project and provide dates and agencies involved as possible.

Here is a list of expected plans of actions (in five years) our team will perform:

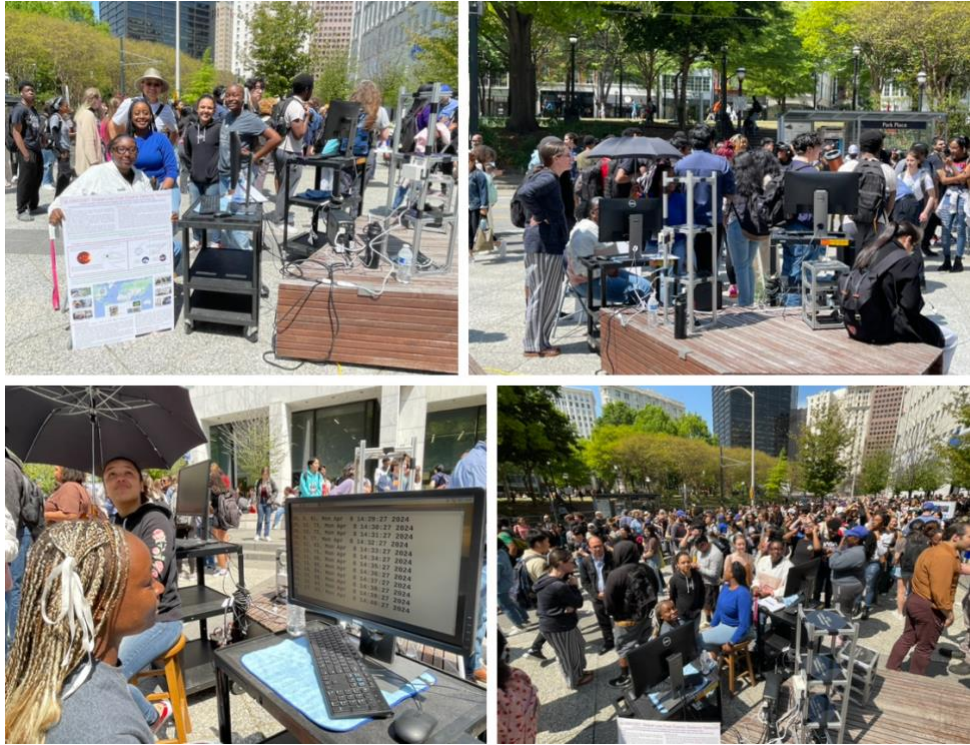
- 1) Seek external funding sources to build more cosmic ray detectors and scale-up the gLOWCOST detector network, including NSF, NASA and various foundations.**
- 2) Continue analyzing the data and quantify the sensitivity of the network for monitoring the changes in space and terrestrial weather.**
- 3) Take a data-driven approach and strategically select the sites of new installation.**
- 4) Use the network of detectors as a tool for training new generations of young scientists internationally overcoming the barriers of culture difference and economic limitations.**
- 5) Organize a workshop (the third) in Belgrade, Serbia in 2025 and one in Xian, China in 2026.**

5. Please share any other information that you would like to share with us regarding your project.

STEM effort – local, regional and international:

- 1) Our faculty in this RISE team actively engaged training graduate and undergraduate (in physics & astronomy, computer science, and geoscience) for building cosmic ray detectors, analyzing data, and developing software tools for the managing the data from the networked cosmic ray muon detectors worldwide.**
- 2) Our faculty in this RISE team provided research opportunities for local high school students in summer period.**
- 3) Our faculty and students in this RISE team participated in public events for reaching out broader communities and advocating the importance of measuring cosmic radiation and the associated practical applications in public health and climate awareness studies. The photos below were taken in front of the 25 Park Place Building on April 8, 2024 during the solar eclipse. Our undergraduate students took the lead and demonstrated the cosmic ray measurement during the eclipse and the importance of understanding the changes in the atmosphere for climate studies.**

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Also, Megan Connors led the effort of displaying our work at the 2024 Atlanta Science Festival at the Piedmont Park and reaching to the public (young and old) about the importance of better understanding the radiation, including the solar radiation which supports the life on our planet.



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- 4) Our faculty in this RISE team are working with our international collaborators and identifying the opportunities for promoting collaborative effort in STEM using the tools (both in hardware and in software) developed in this RISE project.**
- 5) With significant help from Andrea Rohlfing, Director of Development, Corporate & Foundation Relations, College of Arts and Sciences, we submitted our “big ideas” to the Audacious Project (<https://www.audaciousproject.org/>) for a potential large funding.**

This information is for URSA records only. Please contact us if you have concerns about the reporting requirements (internalgrants@gsu.edu).