USING PLANETARY SCIENCES FOR EARLY ENGAGEMENT AND DEVELOPMENT OF THE NEXT GENERATION OF STEM PROFESSIONALS. D. Schaefer[1], M. Kroll[2], D. Gobler[3], L. Hemmick[4], J. Nelson[5], P. Northrup[6], and A. Perez[7] [1]Shoreham-Wading River HS, Shoreham, NY (dschaefer@swr.k12.ny.us), [2]West Islip HS, (m.kroll@wi.k12.ny.us), [3]Westhampton Beach HS, (goblerd@whbschools.org), [4]Longwood HS, Middle Island, NY (lucinda.hemmick@longwoodcsd.org), [5]Newfield HS, Selden, (jnelson@mccsd.net), [6]Stony Brook University, NY (paul.northrup@stonybrook.edu), [7]Brookhaven National Laboratory, Upton, NY (pereza@bnl.gov).

Introduction: An ongoing challenge for science educators is finding a way to create real life connections for students to the curriculum, and no field of science could present more of a challenge for that than astrophysics. Students are introduced at a young age to aspects of space science, through television and online sources such as NASA and noteworthy missions such as the Mars Rover. These events raise interest and enthusiasm for astrophysics, but the reality of those opportunities is rare and would not be possible for many years to come for these students. Developing a passion for science leads to greater investment in long term careers in science, and therefore more opportunity for scientific discovery.

The SPARK program (Student Partnerships for Advanced Research and Knowledge) is an opportunity for high school students to be exposed to those rare opportunities in authentic science research that would typically be far out of their reach. SPARK is a collaborative effort between Brookhaven National Laboratory (BNL) and higher education institutions such as Stony Brook University, and is sponsored by the Department of Energy, in an effort to increase exposure of high school students to these areas of science that would have otherwise been confined to textbook learning in the classroom setting.

This program's overarching aim is for high school students to collaborate in tandem with teachers and scientists to further expand their scientific knowledge and skills in preparation for college and career.

Project Development: A pioneer project for the SPARK collaboration was the *Characterization of Potential Micrometeorites by Synchrotron Analysis* [1]. Specifically, the work focused on students designing methodology to collect, isolate, and analyze microparticles from school roof tops in the search for micrometeorites. Students wrote a scientific proposal that was subject to the same review process as researchers around the world seeking to use the advanced research tools at BNL's National Synchrotron Light Source II (NSLS-II). Students learned how to operate a synchrotron beamline and use x-ray microspectroscopy to determine the elemental composition of microparticles in order to distinguish them as terrestrial versus extra-terrestrial.

Student Engagement: Central to introducing students to authentic science is immersion in the academic scientific community. Collaboration of students and educators from the students' home school and other participating schools, with professional researchers at the NSLS-II, offers opportunities to share ideas, troubleshoot problems, and discuss new findings and discoveries. Students are expected to take ownership of their work through presentation of their project development and data analysis at joint monthly meetings.

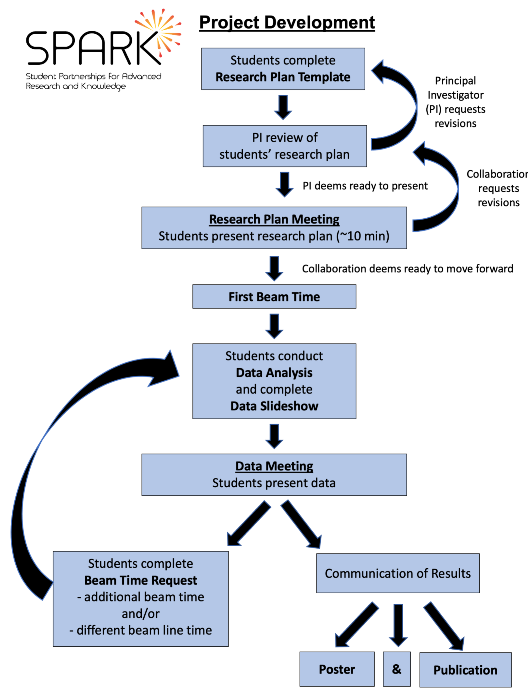

Figure 1: Stages of project development take the students from conception through data collection and communication of results. Figure created by M. Kroll.

Students were ultimately able to use the advanced beamline tools at the NSLS-II to identify particles they collected as being terrestrial and some potential micrometeorites. Students published their findings as a peer-reviewed paper in *Geosciences*, 2020 [1].

A current project with students involves the characterization of elements found within the CM2 meteorite Northwest Africa 12748. The goal is to identify potential elements that may have been brought to Earth, leading to the creation of prebiotic organic molecules that laid the foundation for living organisms.

This project in particular is an example of creating a tangible link to a highly abstract concept that would

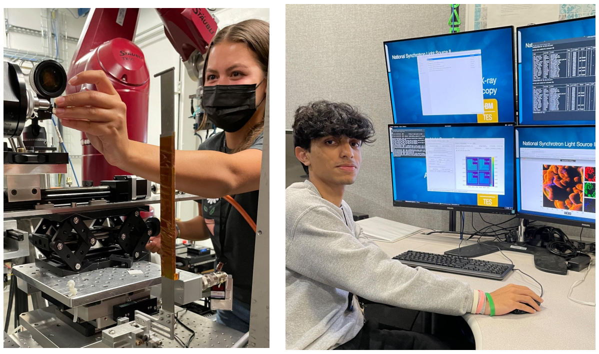

Figure 2: Student mounts a sample for analysis at the X-Ray Powder Diffraction (XPD) beamline (left). Student driving the beamline to collect and analyze data using Tender Energy X-Ray micro-Spectroscopy (TES) (right). Photos courtesy of M. Kroll.

prove difficult to teach in a meaningful way in the classroom, and one that engages students in an ongoing active search for answers that are not only new to them, but to the larger community of scientists.

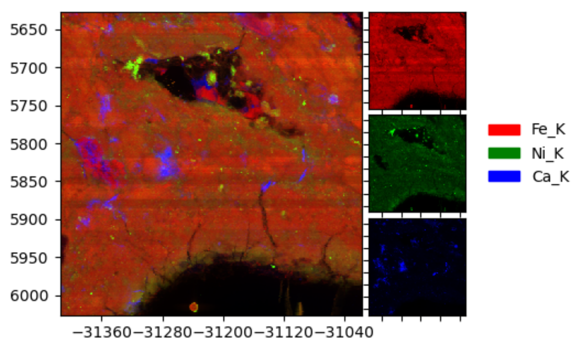

Figure 3: Elemental mapping of Northwest Africa 12748. Figure created by student using Submicron Resolution X-Ray Spectroscopy (SRX) beamline.

Communication: All students are required to share their findings as a culminating activity for participation in the SPARK program. This has been done through peer-reviewed publications, regional and national science competitions, and at the annual Users' Meeting for the NSLS-II facility. Teachers have also shared the impact of the SPARK program in a journal of the National Science Teaching Association [2].

Early Exposure and Outreach Drives Passion: Throughout the SPARK projects, students regularly employ a multitude of 21st Century Skills. Students are also engaged in curricular content that aligns with the Next Generation Science Standards (NGSS) [3]. The SPARK program at BNL is at the intersection of implementing the NGSS and 21st Century Skills with high school students. SPARK does this by exposing high school students to cutting-edge scientific equipment and partnering students with teachers and scientist collaborators in order to prepare them for STEM careers. As the global workplace and technology rapidly evolve, so does the need for education to change to properly prepare our students and the next generation of STEM professionals. Academic and professional institutions have defined skills that are necessary for student success in life and academia as 21st-century skills and have advocated for their inclusion into the secondary curriculum [4]. Science classes have been suggested as integral content areas to include the fostering of these skills [4]. It is imperative that as a scientific community, we begin student engagement in authentic research opportunities at an earlier age, opening doors to new opportunities.

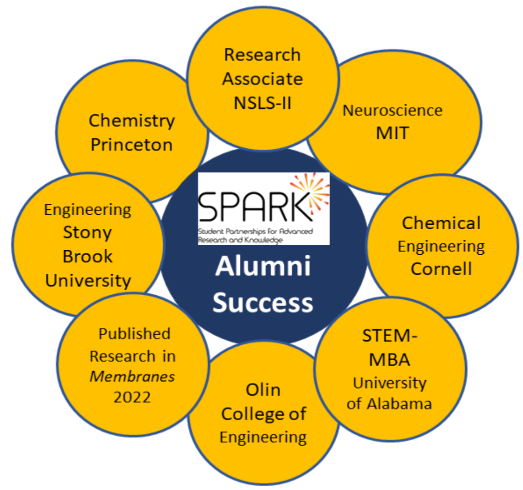

Figure 4: Many alumni of the SPARK program have moved on to study or work in a STEM field with much success. Figure created by M. Kroll.

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