Snowmass2021 Letter of Interest : Creating a Research Internship Program to Increase the Number of Minorities in Particle Physics

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Abstract: The NSF-sponsored Research Experience Program for Undergraduates (REU) is a fantastic opportunity for students to explore research and build professional networks. Yet it suffers from the same inequities surrounding structural racism that many government-sponsored programs face. We propose to design an ”augmented REU” that is targeted in nature, both with respect to the student population and the scientific project. Numerous examples exist which demonstrate that such a program can be successful if implemented properly. Such a program will not only serve to increase diversity within the field of particle physics but also increase the efficiency by which large-scale, technical projects can be executed.

1 Description

We propose to create a program that will facilitate increasing the number of under-represented minorities (URMs) in particle physics that is focused on short-term and well-defined technical projects. The primary goal is to create a platform by which students who would not normally have the ability to explore research in particle physics can do so. We would aim to do this in a way that provides an experience for students that is not as dependent on the particular host institution as existing internship programs (e.g. NSF-REU) by leveraging distributed mentoring, thereby making it more equitable for the participants. This will be achieved by focusing the program around technical projects related to the commissioning and/or of detectors, a sector of particle physics that perennially suffers from a lack of available person power.

2 Anecdotal Experiences/Inspiration

Numerous examples of success pertaining to the various aspects of this proposed program have demonstrated that if executed properly, it will be successful. Some come from established institutions and some come from individual experiences.

2.1 Inspiration from NSF-REU Programs

The NSF-funded Research Experience for Undergraduates[1] has been a successful program in which a number of the authors of this proposal have participated in during their university education. This was an important component of our research paths and provided both intellectual training as well as the ability to grow our professional network and develop soft skills that are essential in our field. In many ways, this proposal can be seen as an augmentation of the REU "research internship" model to more effectively achieve the goal of increasing the representation of minorities in particle physics. The reason we feel this is necessary include the following :

- (1) Admission to the REU program is not necessarily targeted in a particular way to benefit URMs, particularly those coming from institutions or countries that do not already have particle physics programs. Some REU abstracts mention a focused goal of supporting diversity (e.g. Alabama A&M University) but not all (e.g. Auburn University). Moreover, the initial NSF portal for students does not specify this and so it does not proactively encourage URMs to participate or help them find particularly supportive institutions. In this way, the current REU program broadly suffers from the existing structural inequalities that exist throughout academia.
- (2) The format of the program is highly dependent on the institution and mentor at that institution. This means that the experience of the student may simply be bad if they are paired with a mentor that was not committed. This may lead to otherwise capable students being discouraged from pursuing a particle physics career path. Additionally, projects created by individuals can imply substantial work and commitment on the mentor side. This itself can discourage otherwise fantastic mentors (e.g. early-career scientists) from signing up.
- (3) The REU program is largely focused on the student experience. While this is broadly a good goal, we feel that, if structured appropriately, a larger fraction of participants can contribute in a constructive way to a real ongoing project. In this sense, participation of the students will fill a hole in the current research model under which our field operates. We will not rely as heavily on graduate students who are meant to be pursuing original research but are often tasked with activities that are not

[1] https://www.nsf.gov/crssprgm/reu/

directly related to the innovative thesis project. Instead, we will leverage an orthogonal community who will be intellectually engaged while carrying out projects that would not normally constitute PhD-level research.

- (4) Although the current REU host institutes do not all specifically target URM students, they all benefit from the participation of these students in demographic reports within and external to the institutes. However from anecdotal experience of some of the authors, URM students that flourish in REUs, in particular students of color, are not accepted into the graduate programs of the host institutes despite their demonstrated success in research. We wish this program to specifically serve as a feeder of URM students that have been vetted through participation and good performance in the program into participating graduate programs.

2.2 A HEP Research Intern

In addition to reflections on the NSF-REU program, an example of success exists between two of the authors, Sam and Abdullah. Abdallah is a graduate of the African Institute for Mathematical Sciences spent four months hosted at CERN mentored by Sam, to contribute to the FASER experiment. He was involved with the commissioning of silicon strip tracking modules, a task which was intellectually challenging and engaging for Abdullah but for which there was a lack of individuals with ample free time to contribute to these activities. Abdullah contributed in the same way as any early-career graduate student but without the added responsibility of attending classes or carrying out a physics analysis in parallel. This was a successful initiative that furthered the goals of the detector commissioning and cost the collaboration approximately $1500/month. It should be noted that although this experience took place at CERN, this program is not intended to be CERN-centric and would apply to any institution participating in the technical project as described in the "Focused Projects" section.

2.3 An Existing UChicago Program

At the University of Chicago, a program exists whereby two recent graduates from the university spend one year working at CERN on the ATLAS experiment and specifically on technical tasks surrounding maintenance and operation of the hadronic tile calorimeter. These tasks are akin to those typically performed by a junior graduate student but by having bachelors-qualified students execute them, it frees up the time and energy of PhD students to perform innovative work and/or spend time working on their thesis project. Moreover, it creates a space whereby more junior students can learn about detectors and experimental methods in an active research environment away from the classroom. This program at University of Chicago can serve as a model for the appropriate knowledge base and selection process by which these students are "vetted" to ensure they can contribute effectively. The augmentation from this program would be to increase the applicant pool from which students are selected to as described in the section on Participant Targeting. It should be noted that although this experience took place at CERN, this program is not intended to be CERN-centric and would apply to any institution participating in the technical project as described in the "Focused Projects" section.

2.4 An Existing Collaboration Program: the Simons-NSBP Program

The Simons-NSBP program was developed by the National Society of Black Physicists (NSBP), Simons Observatory (SO), and the Flatiron Institute Center for Computational Astrophysics for undergraduate and masters degree students who are members of the NSBP. Each scholar works on a summer research project in Cosmology or Astrophysics with an SO mentor which culminates in a final research presentation at the end of the program. Two graduate students from NSBP serve as graduate fellows to support and inspire the students. These students further act as a liaison between the students and their professional mentors.

This year, the program was completely remote due to COVID-19. To kick-off the program, the scholars were given a crash course in cosmology that included an introduction to the field, python skills, and how their summer projects connected with the overall project. In addition to their research, scholars participated in weekly professional development workshops, speaker series, and social hours. The professional development workshops included how to apply to graduate school or industry jobs, preparing graduate school applications, and how to give scientific presentations. The speaker series included scientists both outside and within the collaboration sharing their work and experiences. The social hours offered an opportunity for the scholars to connect with each other and other SO scientists in an informal setting and highlight their talents and passions outside of research. Many of the scholars indicated at the conclusion of the program that they had a new interest in going to graduate school and were going to continue work with their mentors.

2.5 An Example Upgrade Project Budget Success

Beyond the qualitative reflections, a final consideration in forming this idea came in the form of the US-ATLAS experience in the context of the Phase I New Small Wheel muon upgrade project. This upgrade project was completed with greater than $1M in contingency according to the managers[2] indicating that for well-managed upgrade projects, the financial resources exist for a program such as this which can both contribute to its success while furthering social justice and diversity in our field.

3 Program Components

Described here are the key aspects of the proposed program.

3.1 Timing of Program

As opposed to conventional "summer student" programs, such as the NSF-REU program, this program will be open to any individual with the requisite qualifications and can be executed at any point during the calendar year. In this sense, it is more akin to the CERN Short Term Internship program[3]. The individual need not be enrolled in or returning to an academic program, thereby making it more inclusive to individuals with non-traditional career paths. The duration of the program would be determined at the time of the application and could range anywhere from one to six months.

3.2 Participant Targeting

The primary initial requirement is that the participant come from a URM. This will be made specific and can be supported by a list of qualified institutions within the USA that DPF needs to more fully include in the community including HBCUs. Furthermore, this program would be open to students from Latin America and the Caribbean as well as Africa to increase and promote international collaboration, similar in spirit to

[2] According to discussions in the USATLAS IB meeting on 18/09/19
[3] https://careers.cern/students

the Fermilab International Student Program[4]. The primary augmentation from this program would be to not require enrollment in an academic program at the time of participation in the program. Requiring enrollment or ongoing association with an institute disproportionately favors "connected individuals" and can place an artificial cap on determining when a program would benefit the career of the individual. Instead, all that would be required is that the individual have the "relevant credentials". For international students coming from regions that may not be as academically connected to the US-based system, organizations exist (e.g. AIMS) that can assist with the "vetting" of students to ensure that their academic credentials are viable and they will be able to contribute to the technical goals of the project. Initiatives to foster international scientific collaboration of this nature already exist within APS[5] and demonstrate precedence for the investment of research resources in increasing such international recruitment and collaboration. However, it should be noted that a mechanism will be put in place so that any individual will be empowered to include themselves in the community.

3.3 Focused Projects

The second key aspect of this program is the focus of the scientific project. In contrast to conventional "summer student" programs, the scope of the scientific content will be much more narrowly defined by the program, not the mentor. This will limit the number of institutions to those with ongoing research programs aligned with the scientific focus of the program but will make the individual effort required to participate by an individual mentor much lower, thereby increasing the number of individuals willing to mentor. This focusing will occur at the design of a specific instance of the program and be focused around a particular targeted goal of a construction program. This will also allow the DPF community to allocate resources in such a way as to support hardware and upgrade projects that are in particular need of capable students. A specific example is executing threshold and noise scans on silicon detectors when performing quality control. In this vein, in the next five years, the program will primarily focus on the silicon tracker upgrade projects being carried out by CMS and ATLAS for the HL-LHC. However, once this model of education-research is established, the scope can be expanded to encompass any hardware/upgrade project on further future projects such as DUNE or a future lepton collider. Occasionally, work such as this is referred to by some as "grunt work". We argue that this characterization is false and that for an individual just starting, there is an incredible amount of learning that must take place in parallel to achieving the research goal. As such, projects of this type are ideal for creating a pedagogical scaffold by which students can be introduced to research that is novel and challenging for them but "bread and butter" for the mentor. However, to protect against intellectual abuse and to combat the idea of "grunt work" appearing for an individual student, a distributed and parallel mentorship program will be implemented.

3.4 Parallel Training/Mentorship

A uniform and "parallel" training program will be implemented to ensure that the program is a success and rewarding experience for the particpant independent of the specific host institution. This will be uniform in the sense that it will be developed in a central way and pertain to all of the trainer/trainee pairs, independent of the institution at which the program is carried out. It will be "parallel" in the sense that in contrast to conventional internships, not only will the trainees be given instruction, but there will be a separate educational track for the trainers.

[4]https://internships.fnal.gov/international-student-programs/
[5]https://www.aps.org/programs/international/programs/

3.4.1 For the Trainees

The students participating in a given project will be guided through a well-defined series of pedagogical "events" (e.g. paper readings, lectures) that will complement the specific technical project on which they are working. These can, but need not, include discussions on conceptual aspects of particle physics but the essential aspect is that there will be intellectual engagement that complements the technical work which itself occupies a majority of the trainees time. These events will be provided virtually (e.g. 2020 SLAC b-tagging lectures) such that if there is a cohort of students working on common projects, they can build a community and network more broadly than their host institute. In addition to this trainer-driven aspect of the mentorship, a critical aspect of the program will be a "student only" space where discussions can happen that allows participants to compare and contrast their own experiences. At least one individual who themselves is not a trainer, but is a senior facilitator, will partake in the discussion and create an atmosphere to ensure that any issue which is negatively impacting the participant (e.g. trainee-neglect) is identified and dealt with. The goal of this aspect of the program is in the vein of "group recruitment" such that their can be community support among URMs and the program can broadly serve as a "feeder" program for students who are interested to enter into graduate education with the support of their mentor and the network of mentors and institutions engaged in the program.

3.4.2 For the Trainers

A requisite for participation as a trainer will be participation in a series of training events focused around educating and changing the culture in particle physics that can rely on existing communities (e.g. APS community of mentors) and also be unique to this program. Aspects of this can be shared among the current cohort of trainers and can include bias training or reflective "assignments" to compare and contrast their institutional commitments to diversity. This will emphasize accountability between institutes and mentors in a way similar to the IDEA initiative[6]. Others can be individual engagements such as writing a statements on diversity and inclusion, something that itself is becoming more and more common in job applications throughout academia thereby benefitting the professional development of the trainers. As additional incentive, upon completion of a successful mentorship, one could imagine that the trainer receives an official certification of some sort from APS or DPF that can be put on their CV to demonstrate a commitment to DEI.

3.5 Starting a Pipeline

One of the services that can be provided by the program is facilitated networking for the participants. Several REU programs provide some sort of professional development (resume writing workshops, GRE preparation classes, seminar series, etc), but the success of these approaches are not universal. In the mindset of creating a feeder program, we propose that the participating institutes commit to providing extensive networking on behalf of successful participants, matching them with graduate schools with open positions in their programs/labs to ease the disproportionate effort that URM students have to invest when applying to Masters and PhD programs. In addition, this practice can be further facilitated by hosting seminar speakers with open positions who are actively recruiting URM students; faculty who are in this position tend to know of similar open positions to expand the network on behalf of the participants.

[6] https://www.aps.org/programs/innovation/fund/idea.cfm

4 Foreseen Challenges

The goal throughout snowmass will be to flesh out the details of this project, or something related, and include it as a "Recommendation to Funding Agencies" to create such a program within DPF.

4.1 Funding

As highlighted with the anecdotal example of the budgetary success of the ATLAS New Small Wheel upgrade project, there appears to be ample funding for technical upgrade projects. However, the details of how this can be allocated are unclear to the authors. One could imagine a system of "institutional recognition" whereby institutions themselves contribute to common funds used to support this program from whatever means they have. In turn receive validated recognition that demonstrates their commitment to diversity and inclusion which could help them attract students in the future including those who have been trained in this program. With increasing sizes of experimental collaborations that would profit from the technical work carried out in this program, this method of motivating financial contributions ensures that it is not a "sink" of funding for that institution, but a reallocation to the same project.

4.2 Initial Recruitment

Though it sounds positive to target and recruit URMs from institutions and countries where particle physics is not currently represented, the reality is that precisely because it is not represented there poses a challenge for how to begin this recruitment as those students are not plugged into the particle physics network.

4.3 Foreign Students

One body of students that is not typically targeted by existing APS programs are foreign students. There are a limited number of programs that exist[7] but these pertain to more senior level individuals or are very limited in their reach for whatever reason. The authors are not clear about what limitations in funding exist to support bachelors graduates or masters level students not holding US citizenship or a visa and this will need to be explored.

4.4 Undocumented Students

In addition to recruiting students within the US from the community of URMs, one challenge that the authors foresee is the challenges or limitations to supporting undocumented immigrants. Other students with strict migrant status (DACA, TPS, etc) may also be affected by travel. To the authors it is important to provide an avenue for these students to participate in this program while being sensitive to their particular legal limitations.

[7] https://www.aps.org/programs/international/programs/