An Early Career Investigator Community Vision for the Future NSF Geophysical Facility: Instrumentation Services Needs

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1.0 Introduction

This white paper has been developed based on a compilation of input from ~45 Early Career Investigators (ECIs) from various institutions who participated in the "*Early Career Investigator Virtual Workshop on a Community Vision for the Future Geophysical Facility*" held April 23-24, 2020 and 59 respondents to a follow-up survey for ECIs distributed via IRIS and UNAVCO list-servs. Our aim is to identify the critical instrumentation services that need to be provided by the future NSF Geophysical Facility in order to best serve today's ECI scientific community.

2.0 Free-use Portable Instrument Pool with a Diverse Set of Geophysical Equipment

It is essential that the Future Geophysical Facility (FGF) provide a ***diverse, community input-driven, pool of geophysical equipment*** to scientists for geophysical fieldwork. It is imperative that this instrumentation be ***free at the point of use***, following the current model of PASSCAL, to ensure equity among institutions and investigators. The practice of prioritizing NSF-funded projects, but also supporting non-NSF projects given capacity, has an established record of success in enabling novel science. The support of non-NSF projects is particularly important for new faculty appointees who often pursue smaller, proof-of-concept deployments that lead to full-scale NSF proposals. We recommend that the FGF provides limited funding distributed through a competition model to support shipping costs for scientists without external grants or internal funds given equipment availability, thereby maximizing utilization. The specific geophysical equipment supported should, at a minimum, support data types (if not precise instrumentation) that IRIS and UNAVCO currently maintain. We would place ***recapitalization priority on modernizing*** the existing, aging instrument core to ensure that the community retains access to modern data collection capabilities through the lifetime of the FGF and beyond.

We advocate a ***balance of breadth and depth***. No other organization can provide the sheer number and variety of instruments required for modern emerging array-based (e.g., ***large***-N) science. The FGF instrument center should be able to support PI requests for large numbers of geophysical instruments and emerging big-data acquisition. We also request that the FGF continues to invest in emerging new technologies and instruments that facilitate cutting-edge research across the growing diversity of geophysical sub-specialities (see also Sections 5, 6, and 7), with prioritization of new capabilities based on community input.

3.0 Support for Permanent Global and Long-term Regional Networks

Current support for the Global Geodetic Network and Global Seismographic Network is highly valued in the ECI community, with nearly every workshop and survey participant having used either GGN or GSN data in their research. Both global and regional networks are crucial for advancing our understanding of broad-scale geophysical processes, and they provide an ***essential framework for targeted PI-driven studies*** using complementary instrumentation to investigate more localized processes. We recommend that the continuation of existing permanent global and long-term regional networks be a priority of the FGF. We also recognize that some

advances in our understanding of fundamental Earth processes are only possible through *community-level* experiments involving regional-to-continental multi-scale and dense geophysical arrays. We advocate that the FGF actively support experiments at scales beyond single-PI capacity (e.g. USArray, NOTA, SZ4D, Alaska Aleutians CSE).

The ECI community envisions future expansion of multidisciplinary, division-crossing investigations that include ***simultaneous collection of multiple complementary data types***. ECIs view experiments that ***bridge on-shore and off-shore*** regions, as well as, those encompassing the cryosphere and solid Earth as transformational for Earth Sciences in the next 5-10 years. The FGF is well-suited to take a leading role in facilitating such experiments by coordinating the use of equipment from multiple smaller NSF-funded facilities, e.g., Polar science instruments, OBSIC, the Seismic Source Facility, the new NSF-funded sea-floor geodetic facility. In parallel, building out regional and/or global networks with more co-located geophysical instruments that share common infrastructure will reduce overhead and foster collaboration amongst researchers from multiple disciplines. In particular, shoreline-crossing data acquisition is logistically daunting for individual PIs and can act as a barrier for ECIs entering the field. We would like to see the FGF develop mechanisms for coordinating multi-modal experiments.

4.0 Engineering and Logistical Support

Excellent data relies on resilient instrumentation and robust field procedures. Several components of engineering and logistical support are integral to achieving ECI scientific objectives. IRIS and UNAVCO engineers currently provide ***training*** at the instrument centers and in the field. This training is critical for acquiring high quality data, ensuring responsible (and sustainable) instrument handling and consistency of results particularly for practitioners with limited experience. Both IRIS and UNAVCO currently assist with ***field experiment planning***. As experimental designs become more complex, involving combinations of data and instrument types, multi-scale arrays, and deployments in increasingly challenging environments, the insights from experienced technicians and engineers will maximize the success of instrument deployments. ECIs, in particular, benefit from the experience of IRIS and UNAVCO engineers in experiment design and in engineering equipment for novel, challenging environments. We consider retaining and recruiting expert facility engineers a fundamental component of the FGF. To help facilitate international geophysical investigations and deployments, we suggest that the FGF fosters relationships with skilled technicians that maintain the global networks. Global partnerships bring numerous benefits, including skill- and network-building within international communities, local expertise and resource access, broad involvement of local communities, and support for installation and maintenance of equipment. We suggest the FGF proactively support global science, for example by providing a detailed global contact list of trusted engineers for PIs to seek in-country technical support.

ECIs also rely heavily on the existing ***logistical support*** provided by IRIS and UNAVCO when shipping instruments both domestically and internationally (including polar regions). In addition to maintaining the role of shipping equipment that IRIS and UNAVCO already support, we recommend that the FGF take a more prominent and active role in shipping logistics by providing more information about best practices for shipping procedures (e.g., approved shipping vendors, customs requirements, insurance). New logistical considerations have emerged in recent years that would benefit from centralized administration of the FGF, such as shipping restrictions on items with internal lithium batteries and solar panels requiring certification for some countries. Following our recommendations in Section 3, we also emphasize the importance of logistical assistance with combined onshore and offshore geophysical experiments, which are often complex and time-sensitive.

In-field support has been critical to the success of numerous ECI-led field experiments. IRIS and UNAVCO engineering experience in areas that ECIs often lack (e.g., telemetry systems, power station design, and equipment weatherization) is vital to deploying and maintaining

complex networks that may contain real-time data transmission or co-located multi-instrument stations, particularly in extreme environments. The current model that requires the PI to provide only travel support for field engineers is highly valued, and the availability of remote field support through phone, email, or two-way satellite messaging has also proven crucial.

5.0 Facilitating Instrumentation Purchases, Testing, and Repair

ECIs already benefit from ***centrally negotiated vendor rates*** on GNSS/GPS instruments, and from IRIS and UNAVCO-supported testing of novel equipment that comes to market. We advocate expanding this model of central negotiation to the entirety of FGF equipment. Competitive pricing and detailed instrument quality reports are particularly important to ECIs seeking to maximize the impact of their startup funds. Researchers want to take advantage of new technological advancements as they emerge but often do not have the expertise or capital to evaluate instrument quality and resiliency. ***Instrument vetting and testing*** is a vital service provided by existing facilities, and one that needs to be incorporated into the FGF. In addition, ***repair services*** sustain existing equipment pools well beyond their marketed longevity, enhancing return on investment and supporting user specialization. We also advocate for continuation of limited repair services for PI-owned equipment, which substantially mitigates replacement costs that ECIs often cannot bear.

6.0 Community Governance:

It is essential that the FGF be responsive to the changing instrument services needs of its users. We support a ***community governance model*** that pairs facility guidance with community input via an oversight-empowered standing committee made of community member stake-holders, including ECIs. This system ensures detailed, two-way feedback between the FGF and the community, assists the FGF in responding more nimbly to changes or expansions in community science emphases, and enhances community investment in (and usage of) FGF services.

7.0 Preparing for Future Science

The ideal FGF will facilitate collaborations across the subdisciplines of geophysics in pursuit of new scientific discoveries. To ensure this future, we recommend the FGF demonstrate flexibility in its support of new directions in science and technology. For example, as technological advances continue to shape ECI-led research, it is important to maintain robust support for existing infrastructure while simultaneously accommodating future community needs. Access to free-use instruments (Section 2) and related technical support (Section 4) will remain vital. Maintaining state-of-the-art instrumentation and investing in new technologies (e.g., distributed acoustic sensing, sea-floor monitoring instruments) will ensure the impact and quality of future geophysical studies and the sustained growth of geoscience as a discipline. We expect that community-driven, multidisciplinary projects will become more prevalent, leveraging multi-scale and multi-instrument arrays that expand upon existing network infrastructure. Supporting interdisciplinary and innovative community experiments through the FGF is essential to NSF's core values.