Project Description
Introduction:

Universidad Metropolitana (UMET) a member of the Ana G. Mendez University System (AGMUS) with a history of serving economically disadvantaged minority Hispanic students seeks to integrate pre-college, graduate and undergraduate student education with research in astronomy, atmospheric and space science by establishing a new **"Advanced Modular Incoherent Scatter Radar (AMISR)"** at the Arecibo geomagnetic conjugate point (AGCP), in Argentina, of the Arecibo Observatory, in Puerto Rico. AMISR is an ideal ISR complement to the Arecibo ISR for an AGCP facility. Together with the Arecibo ISR, it will enable simultaneous studies in the northern and southern hemisphere of a wide range of geophysical phenomena causally related to the vertical structure of the same geomagnetic field lines, north and south, and thus establish the first Global Scale Ionospheric Plasma Laboratory. A facility based on the installation of a face of AMISR near the town of La Plata in Argentina, hereafter referred as the Argentine Ionospheric Radar Experiment Station (AIRES), will offer innumerable educational, technological and scientific opportunities to Puerto Rican and Argentine academic and research institutions. It will directly promote international collaborations, enhance student participation and exchange, foster information technology development, and catapult the deployment of additional optical and radio remote sensing instrumentation that would provide complementary measurements of the atmosphere.

This effort is a partnership primarily between AGMUS through UMET, the lead institution, various interested parties in the Argentinean university and scientific communities, and SRI International, as the principal supplier, but presupposes the continued existence of the Arecibo Observatory, which is part of the National Astronomy and Ionosphere Center (NAIC) presently operated by Cornell University. It will also take advantage of the logistical coordination that is being carried out for the last five years by NorthWest Research Associates (NWRA) and Universidad Nacional de La Plata (UNLP) to build educational and scientific resources in Argentina to host such facility.

Under this project, UMET will procure, install, and operate a world-class, modern, phased array research radar at the AGCP, located in Argentina, for the prime benefit of the Puerto Rico and Argentinean student, academic and scientific communities, as well as the worldwide community. This unique facility would place UMET in a leadership position within the international atmospheric and space science community at a time when these measurements will be crucial to face the challenges of this century. These challenges range from fundamental ones such as climate change to the influence of space weather on satellite navigation and communication systems. UMET will also establish an appropriate student environment allowing local students to take advantage of the availability of the AIRES for studies and projects at all levels from undergraduate to post-doctoral.

UMET will place a purchase contract for the procurement, integration, and installation of the radar panels with SRI International. The site selection and preparation for the deployment of AMISR in Argentina will be coordinated by NWRA and UNLP who will work closely with both UMET and SRI. This will build on an on-going activity, which has already identified a potential candidate location. A site survey, aimed at assessing the feasibility of placing an AMISR face in Argentina, took place on September 28-30, 2009. The survey was conducted by personnel from SRI International, NWRA, and UNLP at the Argentine Institute of Radio Astronomy (IAR) campus in Villa Elisa near the city of La Plata. Overall, IAR's campus at Villa Elisa appears to be compatible with an AMISR installation and operation, the only major unresolved question concerns the availability of power at that location[1]. In addition SRI will provide data analysis and archiving facilities, and arrange student and staff training as appropriate during a subsequent operations and maintenance phase.

[1] Argentine Ionospheric Radar Experiment Station (AIRES) - Progress Report, D. Janches and C. Brunini eds., (http://www.cora.nwra.com/~diego/docs/AIRESReportFeb2010.pdf)

a. Instrument Location:

On May 27, 2009 Dr. Richard Behnke (Section Head - NSF Upper Atmospheric Research Section); Dr. Jessica H. Robin (Program Manager, NSF Office of International Science and Engineering - OISE) and Dr. Diego Janches (NWRA) traveled to Argentina to present the AIRES concept to the corresponding Argentinean authorities. The meeting was organized both to gauge interest and to plan a strategy that would guarantee the successful development of such a facility in Argentina. The other attendees of the meeting were

- Dr. Jose Lino Barañao (Minister, Ministry of Science and Technology - Mincyt , Argentina)
- Dr. Agueda Menvielle (Director of Foreign Relations, Mincyt, Argentina)
- Dr. Marta Rovira (President, Consejo Nacional de Investigaciones de Ciencia y Tecnica - CONICET, Argentina)
- Mr. James Perez (Science Counselor, US Embassy in Argentina)
- Dr. Hugo Levato (Director, Ciencias Astronmicas, de la Tierra y del Espacio - ICATE, Argentina)
- Prof. Raul Perdomo (Vice president, Universidad Nacional de La Plata - UNLP, Argentina)
- Prof. Pablo Cincotta (Department Head, UNLP, Argentina)
- Prof. Claudio Brunini (Professor, UNLP, Argentina)

At the meeting, the IAR campus in Villa Elisa was proposed as the most likely candidate location for AMISR. IAR is a scientific institute, which belongs to CONICET, and has great expertise in radio engineering. Its scientific and engineering staff also teach at UNLP. The institute location and personnel skills are not only ideal, given the scientific goals of the AIRES concept, but also would guarantee that these objectives are met in an environment where academic, scientific and technical collaboration between Argentina and the US is fostered. The logistical activities that will prepare IAR to host AMISR will be conducted by Dr. Janches at NWRA and Prof. Brunini at UNLP, who will advise UMET and SRI in this regard. The precise location and the inclination of the radar support structure will be decided in the immediate post-award phase. Also in cooperation with NWRA and UNLP, UMET will coordinate the procurement of materials and components and erect a suitable structure to support the radar, procure and install major cabling and provide continued local technical support during the operational phase in Argentina.

Figure 1 shows the potential radar coverage of an AMISR located at La Plata, Argentina. The potential coverage is shown for a full size AMISR and integration times will be increased for a restricted-size array as envisaged in the present proposal. However, the main thrust of the initial deployment will be related to the study of phenomena generated by the new Arecibo Observatory ionospheric heater, which will be substantially easier to observe and measure than the quiescent ionosphere.

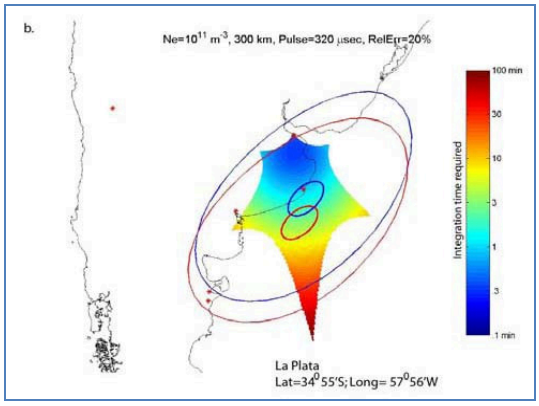

Figure 1: Potential coverage of AMISR located at La Plata (courtesy C. Heinselman)

Ionospheric modification experiments can produce substantial local perturbations in the ionosphere, which can be measured effectively by relatively small radar systems. Even at the magnetically conjugate point, simulation suggests that the heating effects will be easily visible as indicated in Figures 2 and 3. Initial measurement, prior to the deployment of AMISR to the AGCP, are already planned. Dr. Janches (NWRA) and Dr. Carlos Martinis from Boston University (BU) are currently planning the deployment of an All-Sky Imager (ASI) at the Estacion Astronomica Rio Grande (EARG). Dr. Martinis currently operates two similar imagers in Argentina, one at Complejo Astronomico El Leoncito (CASLEO) in San Juan and the second one at the Mercedes Astronomical Observatory, in the province of Buenos Aires. With the addition of the ASI at EARG we will be able to cover optically almost the entire ionosphere over the Argentine territory (Figure 4). This ASI chain will support measurements coincident with the Arecibo radar and its soon-to-be-operational ionospheric HF heater enabling the area of interest to be precisely located.

The effects will be most easily visible when solar activity and the background ionospheric density are low. Figures 5 shows the electron temperature and density behavior at 340 km in the nighttime conjugate ionosphere for two different values of F10.7 from which it can be seen that the electron temperature perturbation will be readily detectable.

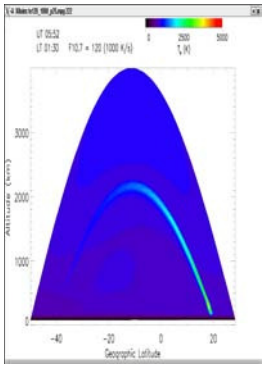

Figure 2: Electron temperature response to ionospheric heating at the Arecibo Observatory, simulation by J Huba (private communication, 2010)

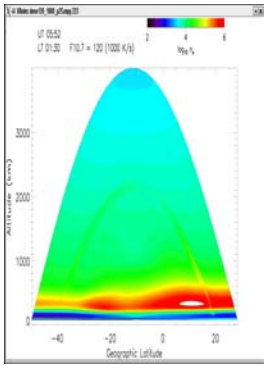

Figure 3: Electron density response to ionospheric heating at the Arecibo Observatory, simulation by J Huba (private communication, 2010)

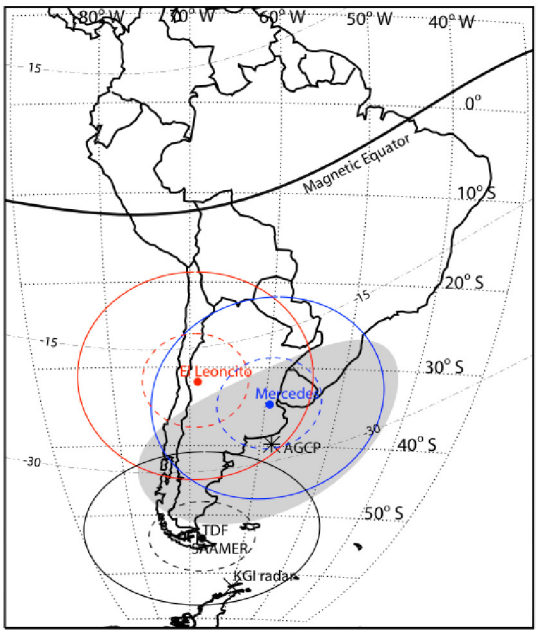

Figure 4 Proposed all sky imager. Solid (dashed) circles represent imager FOVs at 300 (90) km. Gray-shaded oval: mapped circular FOV of Arecibo's ASI.

The facility will provide a number of unique capabilities, which will substantially extend the observations possible in conjunction with the Arecibo ISR and Heater. In common with the existing AMISR installations, it is expected that the new system will eventually be run as part of the coordinated Upper Atmosphere Facilities (UAF) operated by a number of institutions on behalf of NSF. The AMISR system will be able to make multi-beam observations in the area of the magnetically conjugate point of the Arecibo Observatory ISR and Heater (see animation at www.cora.nwra.com/~diego/docs/LaplisrMovie.mov). By combining simultaneous observations by the AIRES and Arecibo, the joint system will provide a wholly new and unique capability to observe and measure both the natural and heated ionosphere at both ends of the magnetic field line. The ability of the

AMISR to make essentially simultaneous observations in many look directions allows the disturbed ionosphere and atmosphere to be studied in unprecedented detail. The superb performance of the AMISR system will allow unique observations of plasma line returns at both ends of the heated field line.

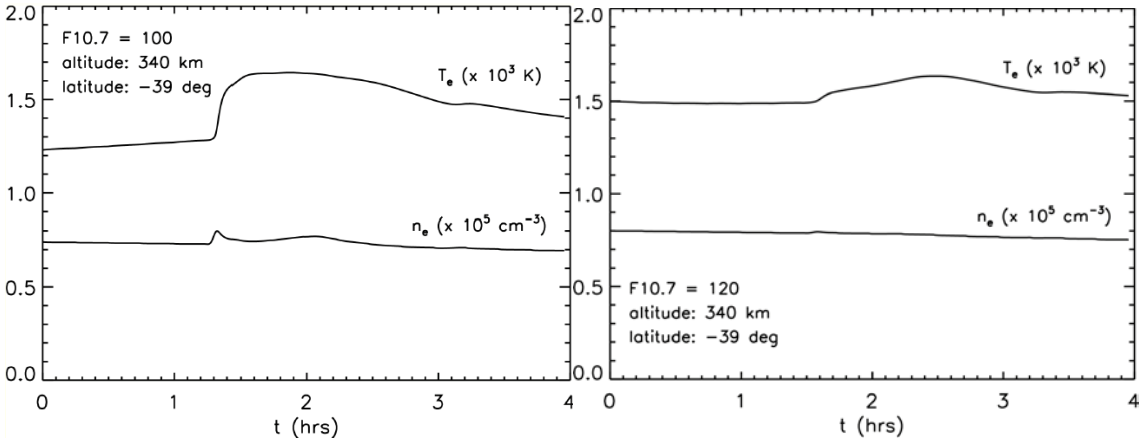

Figure 5: Conjugate electron density and temperature response to ionospheric heating at the Arecibo Observatory for two levels of solar activity, simulation by J Huba (private communication, 2010)

These capabilities provide excellent opportunities for student involvement at multiple levels, which can also be supported by locally deployed instrumentation. Student activities can be biased towards theoretical or observational goals depending on the motivation of the students, their supervisors, and their external collaborators or joint supervisors. The AMISR produces large volumes of high quality data, both raw and preprocessed, and provides a superb practical test bed for the development and exploitation of many software-based signal processing systems and regimes. Such projects, conducted within the Puerto Rico and Argentina science and student communities, can have wide ranging application elsewhere.

The AMISR provides for direct access by students; an integral and important part of this project is the creation and maintenance of local and international support for these activities and UMET will coordinate resources to ensure that students can benefit from the ready accessibility of the AMISR system. The process will build on and strengthen UMET's contacts and relationships as well as supporting and strengthening ties with Argentina through the existing NWRA and UNLP coordination.

The proposal also fits the goals and requirements of MRI funding available. The proposal procures a substantial research instrument, which could not otherwise have been considered and positions the new instrument to be exploited by a student community, which has not previously enjoyed access to such cutting-edge facilities. In doing this, the component procurement, fabrication, integration and deployments all involve important US labor and manufacturing resources which this project will help to sustain.

b. Research Activities to be Enabled

The scientific rationale for placing an incoherent scatter radar at the AGCP of the Arecibo Observatory has been extensively documented in a report[2] following a workshop held at the Arecibo Observatory April 17-19 2006. That report noted that, although the Argentinean ionospheric research community has been active for more than 50 years, the installation of an AMISR and other experimental facilities in Argentina would encourage a rebirth of interest in Aeronomy Research through a joint effort of national groups active in the field and the collaboration of external partners. This effort would be crystallized in a

[2] Janches, D. and R. Brown (Eds), 'Report on the Concept Development for an Upper Atmospheric Research Facility at the Arecibo Geomagnetic Conjugate Point in Argentina', NAIC Arecibo Observatory April 17-19, (2006).

"Programa Argentino de Investigaciones Aeronómicas" (PRARIA), under the sponsorship of national organizations with the participation of external partners. The research groups initially involved in PRARIA would include 1) Instituto de Ciencias Astronomica, de la Tierra y del Espacio (ICATE), Conicet, San Juan; 2) Department of Astronomy and Geosciences, Universidad Nacional de La Plata; 3) IAR, and 4) research groups at various Argentine universities (i.e. Universidad Regional de Tucuman and Unversidad de Buenos Aires). Together, this group has the potential to obtain institutional and financial support at the national level in Argentina sufficient to assure the sustainability of the partnership effort.

Since the aim of this MRI opportunity is to establish new instrumentation, the focus is on the broad outlines and leaves the specific science cases to be included in subsequent proposals for support to exploit the installed infrastructure. This proposal is constructed to support procurement, installation, and initial operation of a general purpose research infrastructure, in the vicinity of the AGCP, which is applicable to a wide variety of scientific investigations and whose user-base is potentially huge. It also builds on already NSF-funded projects that are exhaustively exploring the logistical feasibility of Argentina to host AMISR through various educational and scientific activities (NSF awards, OISE- 0824742 AGS-0944104, OISE-0921612).

The wide diversity of studies and investigations conducted at other NSF Upper Atmosphere Facilities (UAFs) demonstrate both the wide ranging utility of a modern ISR and talented, competent, and extensive actual and potential user base. A facility based on the installation of a face of AMISR at the AGCP will offer innumerable educational, technological and scientific opportunities to Puerto Rican, US, and Argentine academic and research institutions. It will directly promote international collaborations, enhance student participation and exchange, foster information technology development, and catapult the deployment of additional optical and radio remote sensing instrumentation that would provide complementary measurements of the atmosphere.

After more than four decades of successful, transformational, science done at Arecibo, many of the most fundamental questions of ionospheric physics still remain unanswered. It is now apparent that they can only be successfully addressed with global arrays of instrumentations such as the one proposed here. The proposal of such facility is a natural next step given the success shown by existing collaborative programs between Argentine and US researchers involving the deployment of smaller scale instrumentation across the Argentine territory. Since this is a facility procurement proposal, only some potential applications are identified by way of illustration and to illuminate further discussion. The unique configuration of two incoherent scatter radars at opposite ends of the magnetic field line will support a remarkable range of scientific studies as detailed in the workshop report (from which the following is abridged):

1. Three-dimensional structure of the atmosphere - ionosphere - magnetosphere (A-I-M) system, particularly for those phenomena tied to the geomagnetic field.
2. Very large density gradients have been observed at Arecibo, as well as all kinds of structures at "sub-grid" resolution in global models. The Arecibo ISR limited "coning" motion prevents the gradients to be monitored adequately but, with an AMISR suitably placed near the conjugate point having a much larger field of view, it will be possible to observe the ion velocity distributions over an extremely large region of sky and, in so doing, unravel the physical processes involved.
3. Experiments performed at Arecibo during evening periods give evidence for conjugate photoelectrons precipitating through the field lines and the reappearance of the plasma line after astronomical twilight at Arecibo could only be attributed to conjugate photoelectrons, indicating that the F-region gyro line gets enhanced in the presence of the same conjugate photoelectrons. These results lead to the conclusion that there is a definite wave-particle interaction process going on during the evening period that directs the conjugate photoelectrons into the local ionosphere. However, there is no information about the conjugate ionosphere parameters, such as electron density or temperature, needed to understand these phenomena quantitatively.
4. Whistler waves are electromagnetic plasma waves arising from the conversion of naturally occurring or man-made radio waves over a broad range of frequencies. Intense whistler waves can interact with the ionosphere and magnetosphere effectively, generating plasma modes and

density irregularities, accelerating charged particles, and triggering electron precipitation. Controlled experiments on whistler wave propagation and interactions with ionospheric plasmas and radiation belts can be simultaneously conducted at the Arecibo Observatory in Puerto Rico and at the AGCP in Argentina.

5. Another fundamental question concerns the neutral oxygen density and temperature dilemma. Although knowledge of [O] density and temperature, Tn, in the upper thermosphere is essential for solving many fundamental problems in terrestrial-space physics, existing ground-based remote sensing techniques used to infer these neutral parameters suffer from long-standing experimental uncertainties and theoretical ambiguities. Observations using an AMISR array panel at the AGCP would remove the historical difficulties of theoretical inversion approaches in particular, and they have the potential to provide a routine and reliable means for thermospheric parameter estimation.
6. The new HF heating facility within the Arecibo dish will be the lowest latitude HF facility in the world, and the only one with a conjugate magnetic point near land. Conjugate HF experiments between Arecibo and the AIRES facility will provide unique data on the aeronomy of the ionosphere. One science objective for a conjugate HF experiment, for example, is mapping of the exact conjugate point to Arecibo. This would provide validation of the IGRF geomagnetic field descriptions. This would be done by using artificial aurora for conjugate mapping; supra-thermal electron transport processes can be studied. A second objective is to test the theory of thermal pulse generation. The conjugate experiments would be done using a pulsed heater to generate both artificial aurora and a field-aligned thermal pulse.
7. Processes associated with equatorial and low latitude aeronomy are usually considered to be important inside the region bounded by ± ~10-20º geomagnetic latitude, the location of the crests of the Equatorial Ionization Anomaly (EIA). Within this region, evidence of the latitudinal extent of thermosphere-ionosphere processes can be found in the phenomena of Equatorial Spread-F (ESF), and the Midnight Temperature Maximum (MTM). Inter-hemispheric comparisons can help researchers to understand these processes with much greater precision. Although the proposed UAF is based on the installation of one or more AMISR phases at the AGCP, it will be crucial to combine it with the installation of additional state-of-the art optical and radio instrumentation (e.g., imagers, spectrographs, Fabry-Perot interferometers, ionosondes, etc). The current installation and operation of these instruments represents the first phase of the overall effort (See ASI chain in Figure 4).
8. Another process is related to MSTIDs observed on 630.0 nm airglow images. These are bands moving southwestward (northwestward) in the northern (southern) hemisphere. There is no conclusive evidence, however, if these MSTIDs have always their counterpart at their conjugate locations. These types of optical structures offer the opportunity to investigate coupling, both in altitude and latitude, of aeronomic processes at low to mid latitudes in an under-sampled longitude sector in the Southern Hemisphere.
9. A second type of structure has been observed in the tropical ionosphere over Arecibo during heightened geomagnetic activity. This is usually referred to as “intense midlatitude spread-F”. These events create depletions, not only in the nightglow, but also in the TEC. Such structures almost certainly will have detrimental effects on navigation systems such as the Global Positioning Satellite system. Studying these phenomena from conjugate sites with complimentary sets of optical and radio instruments, including conjugate incoherent scatter radar facilities, may be the only way to come to a complete understanding of these disturbances.
10. The AGCP would be located inside one of the most dynamically active neutral atmosphere regions on the planet. Because of the critical role of GW momentum fluxes in controlling the mesospheric circulation, thermal structure, and variability, and in anticipated (but unproven) influences on tidal and PW structures, its quantification at a wide range of latitudes is perhaps the most pressing need in understanding and accounting for these dynamics in large-scale models of the MLT. The region extending from La Plata, Argentina, over the Antarctic peninsula may be among the most active, interesting, and important regions at which to quantify GW influences of any site on the planet

c. **Description of the Research Instrumentation and Needs**

The instrument, an Advanced Modular Incoherent Scatter Radar (AMISR), will have unprecedented scientific capabilities through a combination of size, power, and processing resources. Because the AMISR is designed in a modular fashion, it can easily be set up/extended in many configurations over its operating lifetime. The following list contains the technical specifications for the envisaged reduced-size AMISR face to be constructed within the announced MRI budget:

One face	30 (expandable to 128) panels, 960 AEUs
Peak power	0.48 MW
Max duty cycle	10%
Pulse length	4–2000 μs
Transmit frequency	43–450 MHz
Receive frequency	418–464 MHz
Polarization	Circular
Beam steering	± 25º grating-lobe-free pulse-to-pulse
Antenna beamwidth	1º
Antenna size	30 (expandable to 128) x (1.5 x 3.5 m)
System temperature	120 K
Antenna type	Crossed dipole phased array
Feed system	Distributed amplifiers

Full sized AMISR faces have already been deployed at Poker Flat, Alaska (1 face), and Resolute Bay, Canada (2 faces), while smaller instruments are deployed in conjunction with the HAARP project at Gakona, Alaska, and the Jicamarca ISR, in Lima, Peru. The systems are extensively documented through the project web site at isr.sri.com/iono/AMISR/. The central component of the AMISR is the antenna element unit (AEU), which consists of a 500-watt transmitter, a receiver, control circuitry, and a crossed dipole antenna. Figure 5 shows a photograph of a single AEU. The AEU design has been engineered to maximize ease of manufacturing, assembly, and testing, as determined by the contract manufacturer, Sanmina-SCI.

Figure 5. AEU, production model.

Figure 6: The AMISR at Poker Flat, Alaska has operated quasi-continuously since March 2007.

The AMISR represents a mature instrument development with well proven and documented capabilities demonstrated by the first years of continuous operation at Poker Flat (Janches et al 2009), the construction and commissioning of a further AMISR at Resolute Bay, northern Canada, the current construction of a second AMISR face at Resolute Bay, and extensive plans for further installations in Antarctica and elsewhere. An AMISR in Argentina will allow those proven capabilities to be exploited by

the local and extended scientific community in conjunction with the Arecibo ISR and heater and would significantly extend the current NSF ISR chain to cover a range of latitudes from the North Pole to southern latitudes, bridging the gap to the proposed Antarctic facilities..

The combination of an AMISR and the Arecibo ISR and Heater allows observations of both the heated and undisturbed ionosphere and atmosphere, which are impossible from a single site, such as Arecibo itself. This dramatically expands the information which can be gathered, including information which is invisible to one system alone, allowing transformational improvements in the expected scientific insights arising from, for example, ionospheric modification operations at Arecibo.

The information, which can be obtained using an AMISR in Argentina cannot be obtained in any other way, even with combinations of other instrumentation.

While not specifically covered in this proposal, the AMISR has well proven capabilities for continuous observations at low overall power levels and could dramatically improve the availability of low latitude, long time series data required by atmospheric modelers. Such data sets cannot be obtained using the Arecibo ISR since the available time for active radar operations is constrained by allocations of telescope time for other incompatible programs such as radio astronomy and planetary radar.

Impact on Research and Training Infrastructure AMISR will impact high school students, undergraduates, graduates, as well as teachers, professors, and the scientific community in Astronomy, Atmospheric Science, and Space Science. It will impact and broaden the participation in science and engineering research by women, underrepresented minorities, and persons with disabilities who will be provided with the opportunity to learn radar technology and conduct state-of-the-art research. UMET has a number of students who conduct research at the pre-college level as well as the undergraduate level. For research projects, during the academic year and the summer, students will work on small aspects of the project. Some of these could be monitor and control software for the new radar system. For example, students could build LabVIEW applications that monitor the radar safety and other interlock systems that would shut down the radar if it is required. This is needed for aircraft safety primarily, but it can also be based on radar performance issues.

The focus will be on students with interest in going on to graduate degrees and use these opportunities to both excite them to continue and give them valuable experience that potential advisors will appreciate.

Local scientists could get involved in many projects (including many already possible) with the AMISR that may include atmospheric, marine and space science. This project will provide the opportunity for local teachers and professors teaching students about communication and radar technology to visit the new radar system to give demos of state-of-the-art radar systems. We will use also the proposed activity to promote atmospheric and space science in Argentina with the goal to develop a graduate curriculum at UNLP. This would represent the first such program in an Argentine university. This international collaborative structure will provide UMET, and Puerto Rican and American students in general, with international collaborative research training and a unique environment for personal networking on which to build their own future international collaborations.

Management Plan

Facility Management: UMET, in cooperation with INWRA and UNLP, and with advice from SRI as the AMISR vendor, will locate and provide a suitable site, arrange all necessary permits, operating licenses, power and communications, source and fabricate the support structure and erect same on site. SRI will provide the AMISR panels, the utility distribution unit (UDU) hardware, cabling (RF, fiber-optics, power and other cables), and operation and control center (OCC) hardware, as well as arranging packaging and transport to Argentina. SRI will also oversee the integration of the panels and cabling on the support structure, installation and testing of the UDU and OCC; and initial testing and calibration of the entire system.

The technical development of the project will be overseen by a Technical Advisory Committee (TAC), which will include representatives of UMET, the Arecibo Observatory, NWRA, UNLP, IAR, and the AMISR vendor, as well as co-opted members from the wider technical and administrative community as required.

Future operations (beyond initial testing and calibration) are not covered within the MRI model and will be the subject of further proposals once the construction is under way; such operation is expected to be conducted according to the model used at the other existing UAF AMISRs.

Ownership of the facility will be vested in UMET who plan that it should be operated as far as possible as an integral part of the UAF. UMET expect to maintain the system at the AGCP for at least five years following a successful award.

Science Management: Science management will be overseen by a Scientific Steering Committee (SCC). The scientific management will cater to the particular requirements of students and student minorities in Puerto Rico and Argentina, coordinate carefully with operations and developments at Arecibo, and liaise with the UAF science committee through the already-proposed Integrated Facilities Office (INFO). The SCC will consider, as needed, the development of time allocation policies, the determination of goals and priorities for the ISR science efforts based on the solicitation and incorporation of community input, and software and experiment management.

Plans for attracting and supporting new users include providing information to be posted on the UMET, Argentinean, INFO, and SRI web pages for the scientific community and pre-college, undergraduates and graduate students on possible projects, ongoing projects and conferences and workshops available to them and to the community in Puerto Rico, Argentina, and elsewhere in the US mainland and internationally. Usage and performance information will be included on these web sites.

Administrative Structure and Governance: The project headquarters will be at UMET. Dr. Juan F. Arratia, Executive Director of the Student Research Development Center, an AGMUS student-based organization, will be the PI and will manage the project. The Co-PI for the procurement phase will be Professor Sixto González, who will cover scientific issues. Dr. Arratia is a senior administrator and mentor with experience implementing Cooperative Agreements at UMET. Dr. Arratia will report to the Chancellor of UMET for the period of the grant in matters related to the project. Dr. Arratia was awarded the 2007 US Presidential Award of Excellence in Science, Engineering, and Mathematics Mentoring. The PI, Co-PI and the staff at UMET will coordinate all the activities of the project agenda. The PI and Co-PI will coordinate all communication with the local government, municipalities, the universities, the high schools, industry and commerce, professional organizations and non-profit institutions. The PI and Co-PI' responsibilities include day-to-day operation of the project, planning, and implementation of all project activities, subcontracting, reporting, and direct interactions with the funding agency, and external funding development, as well as the implementation of the administrative and research activities with scientists.

The **Implementation Team** will be comprised of the PI, Co-PI, the Administrative Director, the Evaluator, and representatives of the AMISR vendor as required. They will be active participants in all major activities. The Team will meet every month and implement daily project activities, carry out tasks and activities outlined in the proposal, and coordinate project work. In particular the Project Management Team will be include Dr. Diego Janches from NWRA and Prof. Claudio Brunini from UNLP, whose participation is already funded through other awards and whose main goal will be the coordination between UMET, SRI and the Argentine institutions in the deployment of AMISR. They will also organize the scientific and educational activities in Argentina.

The **Administrative Director** will report to the PI and will assist him in the proper financial administration of all activities. In addition, the Director and the staff will support the students in their visits and research which will be also coordinated by the PI and Co-PI, and will assist him in the proper implementation of project activities including supervision of contractors, follow-up with the assembly, testing and operation of the scatter radar. **The Project Evaluator** will be in charge of the formal evaluation of all project activities.

Dates	Activity
October 2010	Selection of project personnel
November 2010	Design project web page
Jan 2011	Issue purchase orders and subcontracts
Jan-April 2011	Final survey of Argentine site
March 2011	Selection of student team for project
March-Dec 2013	Student engineering and research activities
Nov 2011	AMISR panels and support equipment ready for delivery
Jan 2011 – Dec 2011	Evaluation of project activities
August 2010- Dec 2010	Student attending conferences
Dec 2010	Annual report to NSF
Nov 2011	Ship to Argentina
Jan 2011 – Dec 2011	Evaluation of project activities
Aug 2011 – Dec 2011	Students attending conferences
Dec 2011	Annual report to NSF
Dec 2011 – June 2012	Erect support structure and install panels and Cable assemblies & UDUs
July 2012 – Sept 2012	Test and calibrate radar
Jan 2012 – Dec 2012	Evaluation of project activities
Aug 2012 – Dec 2012	Students attending conferences
Dec 2012	**Final Report to NSF**

Potential timetable for Implementation of Activities

Performance Assessment/Evaluation The evaluation will be carried out by Systemic Research, Inc., led by experienced evaluators Dr. Jason Kim and Mrs. Linda Crasco. Systemic Research will design and develop a master evaluation plan, and will conduct project assessment/evaluation for the three years project period.

With assistance and feedback from the project leadership, Systemic Research will develop a project logic diagram, and evaluation framework based on the overarching goals and specific objectives. The evaluation framework will identify key evaluation questions, relevant metrics and indicators, and data sources for each objective/goal. The framework will guide the master evaluation plan over the project period. Based on the master plan, Systemic Research will design and develop both quantitative and qualitative key indicator data collection instruments. Key indicators will be measured throughout project implementation to assure the overall project goals and objectives are reached. Constant communication between the PI, Co-PI and the evaluators will assure on-time feedback and appropriate actions by the administration. A master activity database will be designed to record pre-college and undergraduate performance and follow-up, and progress in project activities.

The annual formative evaluations will focus on the process and will collect continuous feedback from participants in the program in order to revise the program as needed. This will be done through observations made by the evaluators, informal talks with participants, and group discussions with focus groups to gain feedback. The final summative assessment will measure the overall impact of the project, and outline improvements made under the award period. The evaluation will document the implementation strategies, lessons learned, and best practices to achieve the program goals and objectives. Systemic Research will deliver annual evaluation reports to project leadership. A summative evaluation report will be delivered at the end of the project period. The evaluation reports will demonstrate and disseminate project program performance to the PI, Co-PI, NSF, and other stakeholders.

Results from prior NSF support for Dr. Juan F. Arratia, who is the PI of this proposal

The Model Institutions for Excellence Project (NSF-sponsored) had a remarkable impact on the Ana G. Méndez University System during the 13 years of its existence, especially in the area of undergraduate research under the leadership of Dr. Juan F. Arratia, Director and Principal Investigator. This Project (Cooperative Agreement DMS-9988401 and Grant HRD 0348742) provided AGMUS and Universidad Metropolitana in particular with over $25 million with the following impact: **Pre-college**: 2256 high school students participated since 1997 through the two MIE pre-college programs: the Saturday Academy and the Summer Adventure Research Training (SART). All of the students conducted research with an undergraduate mentor and a faculty mentor. At the end of each session (3/year), each student group presented its results. 100% of these students graduated from high school and entered college; 85% chose STEM majors. **Scholarships**: 525 students received at least one semester of MIE scholarship, most including full tuition and a monthly stipend.. Additionally, the grants AGMUS Institute of Mathematics (DMS-0822404) provides the opportunity to fund 20 students per year until the spring semester of 2013 and the Caribbean Computing Center for Excellence [CCCE], (CNS-0940522) are being implemented at present. **Internships**: All MIE Fellows conducted research during the semester with STEM faculty. It has provided research opportunities in summer internships to 500 students at US institutions and abroad. The Project established a network of over 100 STEM mentors at leading universities in the US and abroad. **UMET Symposia**: Three pre-college and two undergraduate research symposia were held each year. 1,250 pre-college students made presentations at pre-college symposia and 550 undergraduates made presentations at undergraduate symposia at Universidad Metropolitana. Participation in research at the undergraduate level reached HBCU and universities in the US mainland. Student Presentations and Publications: 300 student research outcomes were presented at national and international conferences such as SACNAS, NCUR, IEEE, and ACS. **Transfer to graduate school**: Over 100 students from AGMUS have been transferred to graduate school during the last 14 years. Five have completed PhD degrees in Mathematics (3), Pharmacy (2) and ten are candidates for PhD degrees in Psychology, Cellular Molecular Biology, Geology, Chemistry, Mathematics, Biology and Astronomy.

Dissemination Plan

Dissemination of the project outcomes and agenda of is an important and critical component for the project. Reaching the community, partners, collaborators and all stakeholders will be a priority. Different means of communication will be used, such as personal contact, bulletin boards, flyers, TV, the Internet, and conferences to keep a constant flow of information to persons who might be interested. A web page for the international program will be designed at http://srdc.suagm.edu to document all major activities of the project. Research outcomes will include peer-reviewed publications that will be disseminated in proceedings and journals.

As part of the dissemination activities, the students who conduct research at the Arecibo Observatory will present their research results at the annual Undergraduate Research Symposium held at AGMUS in September of every year. Scientists and researchers from the STEM fields, as well as STEM researchers and summer mentors, will be invited to attend the symposium. STEM majors from universities in Puerto Rico will benefit from student presentations and the opportunity to network with scientists and researchers in a scientific environment. Students will also disseminate their research outcomes at national conferences like SACNAS, NCUR and STEM professional meetings. The PI and research consultants will disseminate the project experiences at national and international meetings.

Description of Lead Institution

Universidad Metropolitana (UMET) is part of the Ana G. Méndez University (AGMUS) system, which has three main campuses, Universidad del Turabo (UT), Universidad del Este (UNE), and UMET with a total enrollment of close to 40,000 students, UMET campus in Cupey, San Juan, Puerto Rico, and three smaller campuses have an enrollment of 8,317 undergraduate students and 1,811 graduate students (Office of the Vice Presidency of Planning and Research, 2008). UMET offers degrees in four major schools: Science and Technology, Business Administration, Health Sciences, and Education, which offers a degree at the PhD level. The School of Science and Technology currently enrolls 725 students and offers bachelor's degrees in Chemistry, Computer Science, Biology, Cellular Molecular Biology, Environmental Science, and Applied Mathematics. It also includes a School of Environmental Affairs that offers an MS degree in Environmental Affairs. Since 1995, when UMET was awarded the Model Institutions for Excellence (MIE), it established a program for undergraduates in partnership with major research institutions in the United States and abroad. After fourteen years, UMET is a leading undergraduate research organization in Puerto Rico.

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