Amending the Performance Period of NSF/OPP Proposal #0944335

Since the authoring of our NSF/OPP proposal in June 2009, entitled "*High Elevation Antarctic Terahertz (HEAT) telescopes for Dome A and Ridge A*" (#0944335), new opportunities and changing international priorities have suggest an improved logistical course of action that focuses solely on the (undeveloped) Ridge A site. This emphasis: (1) increases the project's scientific merits and impact, (2) would cement an exciting joint venture between the U.S. and Australia for site testing and science on the high Antarctic Plateau, (3) increases the visibility of the U.S. involvement in (terahertz) astronomy on the Plateau, and (4) minimizes the very significant risk of ITAR-related export infringements with our Chinese colleagues.

Here, at the request of our NSF program officer, we recommend that the title of the proposal be adjusted accordingly: "*High Elevation Antarctic Terahertz (HEAT) telescopes for Ridge A*", and are requesting a no-cost extension to the science proposal's performance period, and accompanying deployment plan, to 4 years.

While increased international logistical support will be sought, RPSC has already developed a logistics plan that includes the 2010-11 and 2011-12 deployment seasons. However, with the deployment to Ridge A notionally taking place in January 2012, the current period of performance would expire before significant scientific results from Ridge A would be obtained. The scientific aims presented in the proposal would not be achieved without a renewal proposal, which would be difficult to defend with a scant 4 months of summer data. In order to accomodate a schedule with a significant science return and to mitigate the impact of possible delays in deployment, we are requesting a no-cost extension in advance, to a 4 year performance period starting July 1, 2010. An amended budget justification follows. The deployment plan would be summarized as follows, with the first two points already included in the current RPSC logistics workup.

1. A deployment of the first HEAT telescope to South Pole Station will be made in January 2011, for a full year of testing, accessing station power and network resources from the Dark Sector.
2. During calendar year 2011, a second HEAT telescope (HEAT #2) will be built and integrated with Plateau Observatory (PLATO) components from the University of New South Wales, for which (Australian) funding has been successfully acquired. This standalone HEAT+PLATO unit would be deployed via Twin Otter aircraft from South Pole to Ridge A in January 2012. The original HEAT telescope (HEAT #1) at South Pole would be retrograded to the U.S. for refurbishment and repair.
3. In January 2013, a second Twin Otter deployment to Ridge A will resupply fuel and allow the HEAT telescope (and specific PLATO components) to be swapped on-site.
4. A third deployment to Ridge A in January 2014 will be scheduled to retrograde the HEAT/PLATO facility.

Focusing on a single, ideal site with two interchangeable, field-swappable telescopes and instruments minimizes field deployment efforts and time spent on-site. Furthermore, the instruments can be fully tested at South Pole Station before the remote field deployment to Ridge A.

A heightened focus on Ridge A will dramatically increase the astronomical impact of our proposed efforts within the proposed performance period, and has a cleaner deployment plan that remains clear of potentially devastating ITAR entanglements. With the development of new HEAT telescopes and PLATO site testing platforms for the high Antarctic plateau, astronomy in Antarctica is poised to take a tremendous leap forward, rivaling airborne and space platforms for answering a variety of fundamental and timely questions in astronomy. I and my team at the University of Arizona look forward to working with the NSF, USAP, our international colleagues, and to the opportunities and challenges that these pioneering efforts will undoubtedly provide.

Dr. Craig A. Kulesa
Assistant Astronomer
Steward Observatory
The University of Arizona
25 May 2010

Budget Impact Statement

HEAT will be the world's first automated THz observatory. The overall design of the telescope and instrumentation has been completed as part of an OPP funded study in 2006. The design has been vetted through the construction, deployment, and successful operation of the prototype "Pre-HEAT" instrument in Antarctica in 2007-9. Wherever possible, we are making the fewest number of changes to the successful Pre-HEAT design. Here we request funds to build two HEAT observatories and remotely operate them at South Pole and Ridge A for a total of 3 years. The HEAT project is therefore budgeted for a 4 year period. The first HEAT telescope, "HEAT #1", will be constructed based on the current designs from July 2010 through December 2010. Environmental testing will take place on all components, followed by deployment to South Pole Station in January 2011. It will then operate autonomously at South Pole for 1 year. Following deployment, the second HEAT telescope will be constructed deployed to Ridge A on a Twin Otter fixed wing aircraft in January 2012. "HEAT #1" will return to the U.S. in spring 2012 and be refurbished for redeployment in relief of "HEAT #2" at Ridge A in January 2013. In turn, "HEAT #2" will subsequently return to the U.S. for minimal maintenance. Finally, "HEAT #1" will be retrograded from Ridge A in January 2014. This ultimately results in one year of science from the low-elevation South Pole site, and two full years of operations from the remote Ridge A site before retrograde operations ensue.

The principal changes to the original NSF budget are as follows:

- The proposal now spans 4 years instead of 3. The new period of performance is therefore July 1, 2010 through June 30, 2014.
- No money for PLATO development is proposed. The Australian Division of Innovation, Industry, Science and Research (DIISR) is funding new PLATO development through a $1.3M AUD grant to the University of New South Wales (UNSW) via Astronomy Australia Ltd. (AAL).
- A more complete, simpler instrument design saves mechanical engineering effort. More of the machining will now be performed in-house.
- Three months of electrical engineering time is now included to finalize the electronics design and take it through to fabrication.
- Graduate student salary now includes funding for the academic year in year 4, for assistance with data analysis and publication. Funding now includes ancillary support for one undergraduate student.
- ERE rates at the University of Arizona are increasing effective 7/1/2010, as indicated in the detailed budget spreadsheet that follows.

The total 4 year project cost is now $1,481,311 owing to some cost savings in project scope, labor, travel and equipment. Thus, the extension of the program comes at no cost. Indeed, it results in a 2% savings from the original budget.

Personnel

Senior Personnel include PI- Kulesa and Co-PI Walker. PI-Kulesa will be responsible for the HEAT instrument control system, software development, system integration and data management. Six months of funding is requested for him during the proposal's performance period for construction and operation of the telescope and producing the basic data products. Co-PI Walker requests 1 month summer salary for each year of the project. He will be responsible for the HEAT receiver system and student advising. His academic year salary is provided by the University of Arizona.

Other personnel include engineers Ruben Dominguez, a mechanical and cryo engineer with extensive experience in instrument design and implementation. He will be responsible for overseeing the basic mechanical design of the HEAT telescopes. Three months of salary are allotted for him in year 1, two months in year 2, and one month in year 3. Similarly, three months of electrical engineer Robert Stickney is requested in year 1 to finalize the HEAT electronics design, packaging and fabrication. Three total months of an electronics technician is requested for miscellaneous wiring, assembly and fabrication of the electronics components needed for an autonomous instrument. Summer salary for one graduate student is provided for all four years of the project, with academic year salary included in the 4^{th} year. (S)he will focus on telescope and instrument development in the first two years, and will participate in gathering, analyzing and publishing the data obtained with the HEAT telescopes in the last two years. One undergraduate student will be funded to assist in HEAT instrumentation and science for all four years.

Operations

Funds are requested to cover basic, annual operating costs of the project including communications, computer & networking charges, and publication charges. To make a fully functional system, the HEAT telescopes and instruments will be integrated with the University of New South Wales PLATO subsystems in the Fall of 2011. The costs associated with this trip are reflected in the travel budget. Basic travel to international meetings crucial to the development of Antarctic astronomy and instrumentation, such as the SCAR, SPIE and IAU conferences, are included.

Equipment Purchases

All major expenditures are related to the creation of the observatory and its instrumentation. These expenditures and target vendors/sources are:

1) *Receivers:* vendors- Virginia Diodes Inc.: A world leader in millimeter-wave/THz Schottky based receivers/components. The budget includes $20,000 for receiver integration costs above the VDI quote. This includes a small vacuum vessel and telescope mounting hardware. Two receivers will be purchased in each of years 1 and 2.
2) *Spectrometer System:* vendor- Omnisys Inc. has successfully delivered spectrometers of the type being used for HEAT to the University of Arizona for the SuperCam project and the Pre-HEAT telescope prototype successfully deployed to Antarctica. One spectrometer system will be purchased in each of years 1 and 2.
3) *Telescope System:* vendor- Larson Engineering in Boulder, CO successfully delivered the Pre-HEAT tipper telescope in 2007; the costs associated with the HEAT telescopes are directly scaled from the machining costs incurred by Pre-HEAT. The telescope optics, mounts, and cryostat will be machined at Larson. Other machining will occur in-house at Steward Observatory. One telescope system will be purchased in each of years 1 and 2.
4) *-80ºC Laboratory Freezer:* In order to test electronics, telescope drive systems, and cryo systems in a realistic Antarctic environment, a cold laboratory-grade deep chest freezer will be purchased that is large enough to house the entire HEAT telescope. The quoted cost is a mean quoted cost including shipping. There are several vendors who will bid on this purchase order. This item will be purchased at the beginning of year 1.

We have provided the above vendors/sources with detailed specifications of each item and they in turn have provided the costing information used in the budget. Once project funding commences and vendor selection has been completed, purchase orders will be issued to suppliers as appropriate.

Project Title: High Elevation Antarctic Terahertz (HEAT) telescopes for Ridge A (Craig Kulesa – PI)	YEAR 1 (7/1/10-6/30/11)			YEAR 2 (7/1/11-6/30/12)			YEAR 3 (7/1/12-6/30/13)			YEAR 4 (7/1/13-6/30/14)			4 YEAR TOTALS
	YEAR 1 Rate	'/1/10 - 12/31/10 Labor	7/1/10 – 6/30/11 Subtotal	YEAR 2 Rate	Labor Hrs.	TOTAL YEAR 2	YEAR 3 Rate	Labor Hrs.	TOTAL YEAR 3	YEAR 3 Rate	Labor Hrs.	TOTAL YEAR 4	
PERSONNEL													
Senior Personnel													
C. Kulesa, PI – 6 cal months in Y1-Y4	$27.56	1,044.00	$28,773	$28.47	1,044.00	$29,723	$29.41	1,044.00	$30,704	$30.38	1,044.00	$31,717	$120,917
C. Walker, Co-PI – 1 month summer salary in Y1-Y4	$65.35	154.67	$10,108	$67.51	154.67	$10,442	$69.74	154.67	$10,787	$72.04	154.67	$11,142	$42,479
Senior Personnel Subtotal		*1,198.67*	*$38,881*		*1,198.67*	*$40,165*		*1,198.67*	*$41,491*		*1,198.67*	*$42,859*	$163,396
Appointed Personnel													
Mechanical Engineer, 3 months in Y1, 2 months Y2, 1 mo Y3	$38.31	522.00	$19,998	$39.57	348.00	$13,770	$40.88	174.00	$7,113	$42.23	-	$-	$40,881
Electrical Engineer, 3 months in Y1	$28.74	522.00	$15,002	$-			$-	-	$-	$-	-	$-	$15,002
Appointed Personnel Subtotal		*1,044.00*	*$35,000*		*348.00*	*$13,770*		*174.00*	*$7,113*		-	$-	$55,883
Classified Staff													
Electronics Technician, 1 month Y1-Y3	$26.34	174.00	$4,583	$27.21	174.00	$4,735	$28.11	174.00	$4,891	$29.04	-	$-	$14,209
Classified Staff Subtotal		*174.00*	*$4,583*		*174.00*	*$4,735*		*174.00*	*$4,891*		-	$-	$14,209
Graduate Students													
Graduate Research Assist.-AY (9-months) @ 50% FTE	$21.53	-	$-	$22.24	-	$-	$22.97	-	$-	$23.73	800.00	$18,984	$18,984
Graduate Research Assist. - summer @ FTE	$24.81	301.60	$7,483	$25.63	464.00	$11,892	$26.48	464.00	$12,287	$27.35	464.00	$12,690	$44,352
Graduate Students Subtotal		*301.60*	*$7,483*		*464.00*	*$11,892*		*464.00*	*$12,287*		*1,264.00*	*$31,674*	$63,336
Undergraduate Students													
Undergraduate Researchers (10 hrs/wk) academic year	*$12.00*	*500.00*	$6,000	*$12.40*	*500.00*	$6,200	*$12.81*	*500.00*	$6,405	*$13.23*	*500.00*	$6,615	$25,220
Undregraduate Students Subtotal		*500.00*	*$6,000*		*500.00*	*$6,200*		*500.00*	*$6,405*		*500.00*	*$6,615*	$25,220
Labor Subtotal		**3,218.27**	**91,947**		**2,684.67**	**$76,762**		**2,510.67**	**$72,187**		**2,962.67**	**$81,148**	**$322,044**
FRINGE BENEFITS - Rates effective 7/1/10 and beyond		**Base**	**Fringe**		**Base**	**Fringe**		**Base**	**Fringe**		**Base**	**Fringe**	**4 year total**
Faculty and Appointed Personnel @ 28.4%		$73,881	$20,982		$53,935	$15,318		$48,604	$13,804		$42,859	$12,172	$62,276
Classified Staff @ 44.9%		$4,583	$2,058		$4,735	$2,126		$4,891	$2,196		$-	$-	$6,380
Graduate Students @ 42.6% (30.7% IDC exempt)		$7,483	$3,188		$11,892	$5,066		$12,287	$5,234		$31,674	$13,493	$26,981
Undergraduate Students @ 3.4%		$6,000	$204		$6,200	$211		$6,405	$218		$6,615	$225	$858
Fringe Benefits Subtotal			**$26,432**			**$22,721**			**$21,452**			**$25,890**	**$96,495**
Personnel Labor + ERE Totals			**$118,379**			**$99,483**			**$93,639**			**$107,038**	**$418,539**
OTHER DIRECT COSTS													
OPERATIONS			**$10,700**			**$26,700**			**$22,700**			**$7,700**	**$67,800**
Computer network support & Licenses			$1,200			$1,200			$1,200			$1,200	
Communications			$1,000			$1,000			$1,000			$1,000	
Materials and Supplies			$500			$500			$500			$500	
Miscellaneous Electronic Components (connectors, cables, etc.)			$5,000			$5,000			$-			$-	
Instrument/Facility maintenance & repairs			$-			$15,000			$15,000			$-	
Shipping			$3,000			$3,000			$3,000			$3,000	
Publication costs			$-			$1,000			$2,000			$2,000	
TRAVEL			**$5,050**			**$9,105**			**$5,320**			**$3,320**	**$22,795**
Y1: SCAR 2010Q3, NPX deployment 2011Q1, Sydney mtg to finalize PLATO-R design 2011Q2													
Y2: Sydney AU for PLATO I&T, AAS mtg, NPX deployment 2012Q1													
Y3: SCAR mtg in US, IAU mtg, NPX deployment in 2013Q1													
Y4: AAS mtg, NPX deployment in 2014Q1													
		Domestic	Intern'l		Domestic	Intern'l		Domestic	Intern'l		Domestic	Intern'l	
Airfare @ $350 (domestic); Sydney AU ($1800/RT); Other Intnl ($1500/RT)		$-	$3,300		$700	$3,600		$700	$1,500		$700	$-	
Lodging @ $100/night		$-	$1,000		$700	$2,100		$700	$1,000		$700	$800	
Per diem: $45/day		$-	$450		$360	$945		$360	$360		$360	$360	
Conference registration, avg $300 PI's, $100 students		$-	$300		$400	$300		$400	$300		$400	$-	
Totals		$-	$5,050		$2,160	$6,945		$2,160	$3,160		$2,160	$1,160	
FABRICATED EQUIPMENT			**$45,000**			**$35,000**			**$2,500**			**$-**	**$82,500**
Instrument Control System			$5,000			$5,000			$-			$-	
RF electronics (synthesizers, freq. refs, IF amps, etc.)			$10,000			$10,000							
Machining for construction & integration of components			$30,000			$20,000			$2,500			$-	
CAPITAL EQUIPMENT			**$345,000**			**$250,000**			**$-**			**$-**	**$595,000**
-80C Laboratory Freezer for environmental testing			$15,000			$-			$-			$-	
2x Telescope System, enclosure, mount (Larson Engineering)			$80,000			$40,000			$-			$-	
2 x Spectrometer System - 2 GHz (Omnisys Inc.)			$40,000			$40,000			$-			$-	
Schottky Mixers – Y1: 0.8+1.9 THz, Y2: 0.8+1.4 THz (Virginia Diodes, Inc.)			$210,000			$170,000			$-			$-	
Total Other Direct Costs			**$405,750**			**$320,805**			**$30,520**			**$11,020**	**$768,095**
TOTAL DIRECT COSTS			**$524,129**			**$420,288**			**$124,159**			**$118,058**	**$1,186,634**
INDIRECT COSTS – 51.5% effective 7/1/10													
MTDC BASE = Total Direct Costs (TDC) less capital equipment, less Tuition Remission (30.7% of Graduate Student fringe), and on first $25K of each subcontract													
		Base	**IDC**		**Base**	**IDC**		**Base**	**IDC**		**Base**	**IDC**	
Base @ 51.5%		$176,832	$91,068		$166,637	$85,818		$120,387	$61,999		$108,334	$55,792	
Total Indirect Costs			**$91,068**			**$85,818**			**$61,999**			**$55,792**	**$294,677**
TOTAL PROJECT COSTS			**$615,197**			**$506,106**			**$186,158**			**$173,850**	**$1,481,311**