Budget Impact Statement

Supercam will be the world's largest heterodyne receiver array and the first array to have a fully integrated approach to the focal plane design and construction. The overall construction of the instrument was completed through an NSF MRI-funded program starting in 2005, and saw first light in a May 2012 engineering run at the HHT 10-meter telescope on Mt. Graham. The operation of the instrument has been vetted and will be ready to install again with an finalized, optimal focal plane in winter 2012-13. Here we request funds to operate Supercam at the HHT as it undertakes its first key project, a northern Galactic Plane survey in CO J=3-2 and HCO^+ J=4-3. The instrument will be operated at the HHT for two, month-long observing runs in *each* of years 1 and 2 of the project's performance period. The third year is specifically intended for data product assembly, dissemination, and scientific publications. The project is therefore budgeted for a 3 year period. By and large, the budget reflects support of graduate and undergraduate research and training, with necessary oversight by senior personnel to help operate the instrument and manage the torrent of data that will result from its operation.

The total 3 year project cost is $641,291, with annual distribution of 41%, 33%, and 26% among the three years.

Personnel

Senior Personnel include PI- Kulesa and Co-PI Walker, data processing software lead Bill Peters and operations manager Brian Duffy. PI-Kulesa will be responsible for the overall conduct of the project, for the systems integration, control system, observation planning and data management. Two months of funding is requested for him in each of years 1 & 2, plus one month in year 3, to lead the science operations and oversee the delivered data products and guarantee their general availability. Co-PI Walker requests 1 month summer salary for each year of the project. He will share responsibility for the science operations and take lead responsibility for student advising. Co-PI Yancy Shirley will provide guidance on the dense gas survey in HCO^+. Both Walker and Shirley's academic year salaries are provided by the University of Arizona. Bill Peters is taking the lead role on array receiver data processing. He has delivered the first generation data processing pipeline for Supercam, and will be using his two months of salary in each of years 1&2, and one month in year 3, to improve the portability and ease of use of the pipeline. Brian Duffy will help support the instrument installation and integration efforts, and lead the management of operations particularly during the preparation of each Supercam observing campaign. Two months of salary are reserved for Brian in years 1 and 2 to lead the operations effort.

Retired cryogenics engineer Jack Cochran is explicitly listed as an 'on call' staff member to support the annual servicing the Supercam's closed-cycle refrigerators. He has performed this service for Supercam in support of the 4K Sumitomo and 20K CTI-350 cold head maintenance, and we have baselined this continued maintenance in years 1 and 2 to ensure that Supercam will be able to support observing whenever it is granted.

In all aspects of this project, from instrumentation, to science operations and science publication, *graduate and undergraduate students play a central role*. Under the direction of the PI and Co-PI, the software lead and operations manager, two undergraduate students and one graduate student will be directly funded from this effort. These students will focus on instrument operations, science observing, and data processing and software development in the first two years, and will participate in publishing the survey data in the final year. As is typical in the team's laboratory, an equal number of students will work on Supercam while supported by other sources (e.g. departmental support, fellowships, etc.). Some undergraduate students work for academic credits (independent study, senior thesis, etc.).

Operations

Funds are requested to cover basic, annual operating costs of the project including communications, survey data storage hard drive replacement, and publication charges. In year 1, we will purchase new IF processor components including two local oscillators and new filters for two modules to allow simultaneous observation of CO J=3-2 and HCO^+ J=4-3. Annual refurbishment of the supercam closed-cycle refrigerators is a basic maintenance requirement and the costs listed are based on actual costs incurred over the last two years of Supercam testing in the laboratory. Basic travel to domestic science conferences such as the American Astronomical Society (winter) meeting is crucial

to the intellectual development of (esp. graduate) students, and additionally generates broader interest for submillimeter spectroscopy within the national astrophysics community.

Equipment Purchases

Only one capital equipment expense is budgeted in this science-operations-driven proposal. The array receiver local oscillator (LO), required for fundamental operation of Supercam, is currently being borrowed from another project. Even if the unit did not need to be returned, there is no spare and the lead time for a powerful LO (to drive 64 mixers at 350 GHz) is significant. To achieve operational independence and some degree of redundancy, we are budgeting for an identical local oscillator in this work effort.

1) *Local Oscillator:* vendors- Virginia Diodes Inc.: A world leader in millimeter-wave/THz Schottky based receivers/components. The budget includes ~$3,000 for LO integration costs above the VDI quote, performed at the University of Arizona. This includes optical translation stages and mounting hardware to interface it to the Supercam dewar. This LO unit will be purchased in Year 1.

We have provided the above vendor with detailed specifications and they in turn have provided the costing information used in the budget. Once project funding commences, purchase orders will be issued to suppliers as appropriate.

Supplies, Publications, Other costs

The breakdown of operational supplies, publications, travel, and other costs are broken down in the detailed budget spreadsheet that follows.

Title A Submillimeter-Wave Spectroscopic Galactic Plane Survey using Supercam at the HHT
Organization *The University of Arizona*
PI *Craig A. Kulesa*
Sponsor/Program *NSF Astronomy & Astrophysics Research Grants (AAG), solicitation 12-589*
Performance Period *9/1/2013 - 8/31/2016*

	YEAR 1			YEAR 2			YEAR 3			3 YEAR TOTALS
	Year 1 Rate	Labor Hrs.	TOTAL YEAR 1	Year 2 Rate	Labor Hrs.	TOTAL YEAR 2	Year 3 Rate	Labor Hrs.	TOTAL YEAR 3	
PERSONNEL										
Appointed Personnel										
Kulesa, Craig PI	$ 27.56	320	$ 8,819	$ 28.47	320	$ 9,110	$ 29.41	160	$ 4,706	$ 22,635
Walker, Christopher - Co-I	$ 65.35	160	$ 10,456	$ 67.51	160	$ 10,802	$ 69.74	160	$ 11,158	$ 32,416
Peters, William	$ 35.69	320	$ 11,421	$ 36.87	320	$ 11,798	$ 38.09	160	$ 6,094	$ 29,313
Duffy, Brian	$ 31.58	320	$ 10,106	$ 32.62	320	$ 10,438	$ 33.70	-	$ -	$ 20,544
Appointed Personnel Subtotal		*1,120*	*$ 40,802*		*1,120*	*$ 42,148*		*480*	*$ 21,958*	*$ 104,908*
On Call Staff Subtotal										
Jack Cochran	$ 45.00	60	$ 2,700	$ 46.49	60	$ 2,789	$ 48.02	-	$ -	$ 5,489
Con Call Staff Subtotal		*60*	*$ 2,700*		*60*	*$ 2,789*		-	*$ -*	*$ 5,489*
Undergraduate Student										
Undergrad #1 (academic year)	$ 12.00	800	$ 9,600	$ 12.40	800	$ 9,920	$ 12.81	800	$ 10,248	$ 29,768
Undergrad #2 summer salary)	$ 12.00	464	$ 5,568	$ 12.40	464	$ 5,754	$ 12.81	464	$ 5,944	$ 17,266
Undergraduate Student Subtotal		*1,264*	*$ 15,168*		*1,264*	*$ 15,674*		*1,264*	*$ 16,192*	*$ 47,034*
Graduate Students										
Graduate Research Assistant - AY (9-months) @ 50% FTE	$ 22.61	800	$ 18,088	$ 23.36	800	$ 18,688	$ 24.13	800	$ 19,304	$ 56,080
Graduate Research Assistant - summer (3-months) @ full-time	$ 26.05	464	$ 12,087	$ 26.91	464	$ 12,486	$ 27.80	464	$ 12,899	$ 37,472
Graduate Students Subtotal		*1,264*	*$ 30,175*		*1,264*	*$ 31,174*		*1,264*	*$ 32,203*	*$ 93,552*
Labor Subtotal		**3,708**	**$ 88,845**		**3,708**	**$ 91,785**		**3,008**	**$ 70,353**	**$ 250,983**
FRINGE BENEFITS - Rates effective 7/1/12 and beyond										
Faculty and Appointed Personnel @ 31.2%	$ 40,802		$ 12,730	$ 42,148		$ 13,150	$ 21,958		$ 6,851	$ 32,731
On Call Staff @ 9.9%	$ 2,700		$ 267	$ 2,789		$ 276	$ -		$ -	$ 543
Undergraduate Student @ 12%	$ 15,168		$ 1,820	$ 15,674		$ 1,881	$ 16,192		$ 1,943	$ 5,644
Graduate Students @ 65% (58.3% IDC exempt)	$ 30,175		$ 19,614	$ 31,174		$ 20,263	$ 32,203		$ 20,932	$ 60,809
Fringe Benefits Subtotal			**$ 34,431**			**$ 35,570**			**$ 29,726**	**$ 99,727**
Personnel Labor + ERE Totals			**$ 123,276**			**$ 127,355**			**$ 100,079**	**$ 350,710**
OTHER DIRECT COSTS										
OPERATIONS			**$ 22,250**			**$ 18,266**			**$ 8,800**	**$ 49,316**
Replacement disk storage for survey products			$ 250			$ 250			$ 250	
New IF processor LO units for dual-line mode (2 x $1000)			$ 2,000			-			-	
Replacement IF processor filters for dual-line mode (16 x $150)			$ 2,400			-			-	
Minor annual repairs, materials and supplies (obj code 5290)			$ 2,900			$ 2,996			$ 1,400	
Communications (postage/Fedex, phone/fax, copying/printing) (obj code 5560)			$ 250			$ 258			$ 267	
Conference Registration (2 people per year)			$ 450			$ 465			$ 480	
Publication costs charges (3 papers x 8 pages in each of Y1 and Y2; 6 papers in Y3)			$ 3,000			$ 3,099			$ 6,403	
Annual Refurbishment, Sumitomo cold head			$ 5,000			$ 5,165			$ -	
Annual Refurbishment Parts, CTI-350 cold head			$ 1,000			$ 1,033			$ -	
Instrument transport to MGIO, 2 obs runs/year (est'd $2500 ea)			$ 5,000			$ 5,000			$ -	
TRAVEL			**$ 2,840**			**$ 2,934**			**$ 3,031**	**$ 8,805**
1 domestic conference (AAS) for 2 people in each year	Domestic	Intern'l		Domestic	Intern'l		Domestic	Intern'l		
Airfare ($450 x 2)	$ 900	$ -		$ 930	$ -		$ 961	$ -		
Lodging ($100/night x 2 x 5 nights)	$ 1,000	$ -		$ 1,033	$ -		$ 1,067	$ -		
Per diem ($59/day x 2 ppl x 5 days)	$ 590	$ -		$ 609	$ -		$ 629	$ -		
Parking ($10/day)	$ 50	$ -		$ 52	$ -		$ 54	$ -		
Rental car (5 days, $60/day)	$ 300	$ -		$ 310	$ -		$ 320	$ -		
Total per trip	$ 2,840	$ -		$ 2,934	$ -		$ 3,031	$ -		
CAPITAL EQUIPMENT			**$ 50,000**			**$ -**			**$ -**	**$ 50,000**
broad band Local Oscillator unit from VDI			$ 50,000							
SUBCONTRACTS			**$ -**			**$ -**			**$ -**	**$ -**
			$ -			$ -			$ -	
Total Other Direct Costs			**$ 75,090**			**$ 21,200**			**$ 11,831**	**$ 108,121**
TOTAL DIRECT COSTS			**$ 198,366**			**$ 148,555**			**$ 111,910**	**$ 458,831**
INDIRECT COSTS - 51.5%, effective 7/1/10										
MTDC BASE = Total Direct Costs (TDC) less capital equipment, less Tuition Remission (58.3% of Graduate Student fringe), and on first $25K of **EACH** subcontract										
	MTDC Base	**IDC**		**MTDC Base**	**IDC**		**MTDC Base**	**IDC**		
Base (on salaries, operations, travel)	$ 130,774	$ 67,349		$ 130,381	$ 67,146		$ 93,136	$ 47,965		
Base (on first $25K of **EACH** subcontract)	$ -	$ -		$ -	$ -		$ -	$ -		
Total Indirect Costs		**$ 67,349**			**$ 67,146**			**$ 47,965**		**$ 182,460**
TOTAL PROJECT COSTS		**$ 265,715**			**$ 215,701**			**$ 159,875**		**$ 641,291**

3.3% inflationary rate applied to all eligible costs in Years 2 and 3.