

BUDGET JUSTIFICATION

A. SENIOR PERSONNEL

4.0 calendar months of salary is requested for PI Craig Kulesa in Year 1, and 6.0 months per year in Years 2 and 3. His base salary is \$58,131 per 12-month fiscal year.

0.5 summer months of salary is requested for Co-PI Christopher Walker in Year 1 and 1.0 summer months per year in Years 2 and 3. His base salary is \$92,582 per 9-month academic year.

4.0, 6.0, and 2.0 calendar months of salary in years 1, 2 and 3 respectively is requested for Systems Engineering Lead, Abram Young. His base salary is \$72,800 per 12-month fiscal year.

B. OTHER PERSONNEL

Partial funding for 3 years is requested for one graduate student (base salary \$36,177) engaged in Ph.D. thesis research under this project. One semester of academic year support, plus 50% (1.5 months) summer salary is requested.

During the Year 2 development of the new cryogenic receiver systems, one month of an electrical engineer and one month of a mechanical engineer is requested. The costing is based on the average salary of a departmental electrical and mechanical engineer (\$60,000 and 70,000 per 12-month fiscal year, respectively).

200 hours of undergraduate student research support is requested each year (base rate \$12/hour).

C. FRINGE BENEFITS

The following university-approved fringe benefit rates were applied to each labor category:

- Faculty/Appointed Personnel: 28.6%
- Classified Staff: 47.8%
- Graduate Students: 63.3% composed of:
 - 13.3% for health/dental/life insurance
 - 50.0% for tuition remission (exempt from indirect cost charges)
- Undergraduate Students: 2.1%

D. CAPITAL EQUIPMENT

Based on the successful design and construction of the 50-Kelvin HEAT cryostat, Universal Cryogenics will be consigned to construct the two next-generation 4K instrument cryostats. Their quotation for a dual-cryocooler cryostat is \$45,000 per system, commensurate with the \$26,000 for the current single-stage version. One system will be delivered in year 1, with a second identical system in year 2. They will recycle the Sunpower CT cryocoolers from the prototypes.

A 1.5 THz Local Oscillator source will be purchased in year 2 from Virginia Diodes Inc. to operate the Hot Electron Bolometer mixer receivers. They are the only commercial supplier of such THz systems. Their quotation for a single unit is \$80,000.

SRON will provide two quasioptical Hot Electron Bolometer mixers to the HEAT project for a total of 25,000 EUR, or 31671 USD at the current exchange rate.

A ROACH2-based spectrometer system, identical to one purchased in the prototype system, will be purchased from Digicom in year 1. Their quote is for \$7,500 for the ROACH2 FPGA board,

ADC boards, and 10 Gbit ethernet boards. Digicom is the only commercial supplier of the ROACH2 systems.

We will purchase replacement engine modules for PLATO-R from the University of New South Wales (UNSW), the designer and manufacturer of PLATO-R. The total cost for two complete engine modules ready to be installed into PLATO-R is \$30,000 and is based on a breakdown of the current actual costs for the individual components. We will purchase one replacement set of 2 engines in each of years 1 and 2.

Finally, only one of the two HEAT telescopes has precision-machined diamond-turned aluminum mirrors. We will task NiPro Optics, the manufacturer of the first precision set for the currently- deployed telescope, to construct a duplicate mirror set for the second telescope. The quoted cost for diamond turning and lightweighting all three mirrors is \$34,000.

E. TRAVEL

Domestic

Funds are requested for one domestic conference (typically AAS, SPIE, or SCAR) for two personnel (typ. one graduate student and one mentor) for five days each year. Travel funds requested include roundtrip airfare (@ \$400/trip), lodging (@ \$100/night), and per diem (@ \$50/day). Conference registration fees are detailed under 'Other Direct Costs' in accordance with University of Arizona cost classification practices.

International

To support the annual servicing mission to Antarctica, travel funding support for per diem (@\$50 USD/day) and lodging (@\$100 USD/day) is requested for 2 personnel for 5 days in Christchurch, New Zealand.

F. OTHER DIRECT COSTS

Funds are requested in each year for research supplies and work-flow/data capture and telecommunications expenses required for the conduction of this investigation. These operational items represent the material costs of creating, replicating, archiving, distributing and presenting all project related data, documentation, reporting, and analysis that are directly related to this project. Such material costs include, but are not limited to, disk drives, poster printer costs, and design and analysis software.

Funds are requested for operational repairs to the HEAT telescope and its cryogenic, receiver, electronics, and optomechanical systems. Costing is based on the replacement costs of repairs during the first two years of operating HEAT at Ridge A, including replacement of instrument control computers, solid state storage, and power supplies.

Funds are requested in years 1 and 2 for augmenting the HEAT electronics control boards used to operate the more advanced receiver system proposed here. The costs listed are based on the actual costs incurred during the previous design and prototyping efforts.

Funds are requested for two domestic conference registrations per year, typically one student and one mentor.

Funds are requested for publication of findings in professional journals each year; estimated at 3 papers of 8 pages per year @ \$110/page (Astrophysical Journal).

Shipping charges for equipment to/from Antarctica (commercial surface shipping to Port Hueneme, CA or air freight to Christchurch, New Zealand) is estimated at \$3,000 USD annually, based directly on the average shipping cost incurred during the last two years of operation. Shipping costs in year 3 are estimated at \$1,500 for the return of the experiment.

G. INDIRECT COSTS

The university-mandated indirect cost rate (IDC) was applied to all costs except capital equipment and 50.0% of the graduate student fringe benefit rate, which is tuition remission and exempt from IDC. This rate is 53.0% effective 7/1/2015, and 53.5% effective 7/1/2016. A flat spending profile puts 75% of Year 1 expenditures (10/2015 through 6/2016) in UA FY2016 (53.0%), and 25% in FY2017 (7/2016 through 9/2016, 53.5%). The calculated IDC for year 1 follows this profile. Years 2 and 3 follow the fixed 53.5% IDC rate.

*A cost inflation rate of 3.3% per year is applied to all eligible costs for years 2 and 3.