**IceCube Institutional Memorandum Of Understanding (MOU)**

**Scope of Work**

**University of Delaware**

**David Seckel**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **9** (6 3 5)

|  |  |  |  |  |  |  |  |  |  |  |  |
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| **Maintenance and Operations** | | | | | | | | | | | |
| **Labor Cat.** | **Names** | **WBS L3** | **Tasks** | **Funds Source** | WBS 2.1 | WBS 2.2 | WBS 2.3 | WBS 2.4 | WBS 2.5 | WBS 2.6 | **Grand Total** |
| Program Coordination | Detector Maintenance & Operations | Computing & Data Management | Data Processing & Simulation | Software | Calibration |
| KE | Seckel, David | Administration | Institutional lead | Base Grant, Inst In-Kind | 0.10 |  |  |  |  |  | 0.10 |
|  |  |  | TFT Board | Inst In-Kind |  | 0.05 |  |  |  |  | 0.05 |
|  |  | InIce calibration | Ice models, DOM noise |  |  |  |  |  |  | 0.05 | 0.05 |
|  | **SECKEL, DAVID Total** | |  |  | **0.10** | **0.05** |  |  |  | **0.05** | **0.20** |
|  | Schroeder, Frank | Surface Detectors | Surface detector enhancements | Inst In-Kind |  | 0.15 |  |  |  |  | 0.15 |
|  | **SCHROEDER, FRANK Total** | |  |  |  | **0.15** |  |  |  |  | **0.15** |
|  | Stanev, Todor |  | Atmospheric leptons | Base Grant |  |  |  | 0.05 |  | 0.05 | 0.10 |
|  | **STANEV, TODOR Total** | |  |  |  |  |  | **0.05** |  | **0.05** | **0.10** |
|  | Holder, Jamie |  | Coordination with VERITAS/CTA | Inst In-Kind | 0.05 |  |  |  |  |  | 0.05 |
|  | **HOLDER, JAMIE Total** | |  |  | **0.05** |  |  |  |  |  | **0.05** |
|  | Evenson, Paul |  | Coordinating use of heliospheric dataset | Inst In-Kind | 0.05 |  |  |  |  |  | 0.05 |
|  | **EVENSON, PAUL Total** | |  |  | **0.05** |  |  |  |  |  | **0.05** |
|  | Gaisser, Tom |  | Atmospheric leptons | Emeritus, No cost |  |  |  | 0.05 |  | 0.05 | 0.10 |
|  | **GAISSER, TOM Total** | |  |  |  |  |  | **0.05** |  | **0.05** | **0.10** |
| SC | Tilav, Serap | Surface Detectors | Coordinate IceTop Operations | NSF M&O Core |  | 0.30 |  |  |  |  | 0.30 |
|  |  | Detector Monitoring | Data monitoring | NSF M&O Core |  | 0.20 |  |  |  | 0.10 | 0.30 |
|  |  | Administration | M&O management | NSF M&O  Core | 0.10 |  |  |  |  |  | 0.10 |
|  | **TILAV, SERAP Total** | |  |  | **0.10** | **0.50** |  |  |  | **0.10** | **0.70** |
| PO | Soldin, Dennis | Simulation Production | IceCube/IceTop  simulation production | NSF M&O Core |  |  |  | 0.15 |  |  | 0.15 |
|  |  | Software maintenance | IceTop reco, Corsika reader | Base Grant |  |  |  |  | 0.15 |  | 0.15 |
|  |  | Administration | ICC member | Base Grant | 0.05 |  |  |  |  |  | 0.05 |
|  |  | Administration | CR-WG co-lead | Base Grant | 0.20 |  |  |  |  |  | 0.20 |
|  |  | Online Filter (Pnf) | IceTop Filter | Base Grant |  | 0.05 |  |  |  |  | 0.05 |
|  | **SOLDIN, DENNIS Total** | |  |  | **0.25** | **0.05** |  | **0.15** | **0.15** |  | **0.60** |
|  | Coleman, Alan | Surface enhancements | Simulations | Inst In-Kind |  |  |  | 0.20 |  |  | 0.20 |
|  |  | Surface enhancements | Air shower reconstruction | Inst In-Kind |  |  |  |  | 0.10 |  | 0.10 |
|  | **COLEMAN, ALAN Total** | |  |  |  |  |  | **0.20** | **0.10** |  | **0.30** |
| GR | Rehman, Abdul | Software | Visualization software  (Steamshovel) | Base Grant |  |  |  |  | 0.15 |  | 0.15 |
|  |  | Simulation | Surface radio | Base Grant |  |  |  | 0.15 |  |  | 0.15 |
|  | Binta Amin, Moureen | Online Filter (Pnf) | Including IceTop in ROC consideration | Base Grant |  |  |  |  | 0.10 |  | 0.10 |
|  |  | IceTop simulation |  | Base Grant |  |  |  | 0.20 |  |  | 0.20 |
|  | Paudel, Ek Narayan | Monitoring |  | Inst In-Kind |  | 0.10 |  |  |  |  | 0.10 |
|  |  | Simulation | Surface radio | Inst In-Kind |  |  |  | 0.10 |  |  | 0.10 |
|  | Punsuebsay, Noppodal | Monitoring |  | Inst In-Kind |  | 0.10 |  |  |  |  | 0.10 |
| tbd | Pan, Yue | Radio operations | Operations, data management | Inst In-kind |  | 0.15 | 0.10 |  |  |  | 0.25 |
|  |  | Radio monitoring |  | Inst In-kind |  | 0.05 |  |  | 0.05 |  | 0.10 |
|  |  | Radio simulations |  | Inst In-kind |  |  |  | 0.15 |  |  | 0.15 |
|  | **UD GR Total** | |  |  |  | **0.40** | **0.10** | **0.60** | **0.30** |  | **1.40** |
| **UD Total** | |  |  |  | **0.55** | **1.15** | **0.10** | **1.05** | **0.55** | **0.25** | **3.65** |

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| **Upgrade** | | | | | | | | | | | |
| **Labor Cat.** | **Names** | **WBS L3** | **Tasks** | **Funds Source** | **WBS 1.1** | **WBS 1.2** | **WBS 1.3** | **WBS 1.4** | **WBS 1.5** | **WBS 1.6** | **Grand Total** |
| Project Management | Drilling | Sensors | Comms, Power, Timing | Calibration | Data Systems |
| KE | Seckel, David | Administration | Institutional lead | Inst In-Kind | 0.05 |  |  |  |  |  | 0.05 |
|  | **SECKEL, DAVID Total** | |  |  | **0.05** |  |  |  |  |  | **0.05** |
| EN | Roth, James | Field Season | Equipment survey | NSF |  | 0.20 |  |  |  |  | 0.20 |
|  | **ROTH, JAMES Total** | |  |  |  | **0.20** |  |  |  |  | **0.20** |
| GR | Punsuebsay, Noppodal | Noise reduction |  | Inst In-Kind |  |  | 0.20 |  |  |  | 0.20 |
|  | **UD GR Total** | |  |  |  |  | **0.20** |  |  |  | **0.20** |
| **UD Total** | |  |  |  | **0.05** | **0.20** | **0.20** |  |  |  | **0.45** |

**Faculty:**

David Seckel – Institutional lead

Gen-2 R&D Radio, Calibration (80% :: 20% ANITA)

Frank Schroeder – Development of new surface instrumentation

(75% :: 25% Auger)

Todor Stanev – Atmospheric leptons (background calibration) (50%)

Jamie Holder – Coord. with VERITAS (5% :: 95% CTA/VERITAS)

Paul Evenson – Solar and heliospheric coordination w/IceTop (20%)

Tom Gaisser – Atmospheric leptons (background calibration) (Emeritus)

**Scientist:**

Serap Tilav - IceTop data quality, operations; scintillators (100%)

**Post-docs:**

Dennis Soldin – Air shower reconstruction and simulation code. Coordination of IceTop simulations. IceTop filter maintenance. CR-WG co-lead. (100%)

Alan Coleman – Simulation, surface layout optimization, reconstruction with radio and scintillator surface enhancements (100%)

**Ph.D. Students:**

Abdul Rehman – Surface radio simulations, visualization

Moureen Binte Amin – IceTop simulation, IceTop real time data

Ek Narayan Paudel – Data monitoring shift; surface radio simulations

Noppodal Punsuebsay – Data monitoring shift; TBD

Yue Pan - In-Ice Radio: operations, data management, simulation

**Computing resources:**

The Bartol Research Institute maintains a modest cluster (272 cores, 800 GB RAM, 90TB storage) for particle astrophysics, which is used primarily for simulation (CORSIKA) production of air showers and development of simulations for the enhanced surface instrumentation (scintillators, radio). This year, the UD IceCube group is investing in three nodes in the UD central computing cluster, with 20 cores and 192 GB per node.