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

**Pennsylvania State University**

**Doug Cowen**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **4** (1 3 3)

**Scope of Work**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Labor Cat.** | **Names** | **WBS L3** | **Tasks** | **Funds Source** | **WBS 2.1** | **WBS 2.2** | **WBS 2.3** | **WBS 2.4** | **WBS 2.5** | **Grand Total** |
| Program Management | Detector Maintenance & Operations | Compuing & Data Management | Triggering & Filtering | Data Quality, Reconstruction & Simulation Tools |
| KE | COWEN, DOUG  | Education & Outreach | Education & Outreach | Inst. In-Kind | 0.05 |  |  |  |  | **0.05** |
|   | Engineering and R&D | PINGU Co-Lead | Inst. In-Kind | 0.35 |  |  |  |  | **0.35** |
|   | **COWEN, DOUG Total** |  |  | **0.40** |  |  |  |  | **0.40** |
| SC | ANDERSON, TYLER | Data Acquisition | DAQ Firmware Development | NSF M&O Core |  | 0.23 |  |  |  | **0.23** |
|  | **ANDERSON, TYLER Total** |  |  |  | **0.23** |  |  |  | **0.23** |
| PO | ARLEN, TIM | Simulation Production | Simulation Production | Base Grants |  |  | 0.08 |  |  | 0.08 |
|  | Reconstruction/ Analysis tools | Develop analysis tools for systematics study | Base Grants |  |  |  |  | 0.20 | 0.20 |
|  |  | Detector Monitoring | Monitoring Shifts | Base Grants |  | 0.03 |  |  |  | 0.03 |
|  |  | Computing Resources | Coordination and Support Grid distributed computing | NSF M&O Core |  |  | 0.25 |  |  | 0.25 |
|   | **ARLEN, TIM Total** |  |  |  | **0.03** | **0.33** |  | **0.20** | **0.56** |
|  | KEIVANI,AZADEH | Reconstruction/ Analysis tools | Integrate IceCube into AMON | Inst. In-Kind |  |  |  |  | 0.25 | 0.25 |
|  | **KEIVANI, AZADEH Total** |  |  |  |  |  |  | **0.25** | **0.25** |
| GR | HUANG,FEIFEI | TFT Coordination  | Study PINGU/HEX hardware requirements using IceCube data & simulation | Inst. In-Kind |  |  |  | 0.47 |  | 0.47 |
| Detector Monitoring | Monitoring Shifts | Base Grants |  | 0.03 |  |  |  | 0.03 |
|  | **HUANG, FEIFEI Total** |  |  |  |  **0.03** |  | **0.47** |  | **0.50** |
|  | LANFRANCHI, JUSTIN | Reconstruction/ Analysis tools | Low energy event reconstruction quality | Inst. In-Kind |  |  |  |  | 0.47 | 0.47 |
|  | Detector Monitoring | Monitoring Shifts | Inst. In-Kind |  | 0.03 |  |  |  | 0.03 |
|  | **LANFRANCHI, JUSTIN Total** |  |  | **0.03** |  |  | **0.47** | **0.50** |
|  | PANKOVA, DARIA | Data Acquisition | DAQ electronics hardware and firmware | Inst. In-Kind |  | 0.47 |  |  |  | 0.47 |
|  | Detector Monitoring | Monitoring Shifts | Inst. In-Kind |  | 0.03 |  |  |  | 0.03 |
|  | **PANKOVA, DARIA Total** |  |  |  | **0.50** |  |  |  | **0.50** |
| **PSU Total** |  |  | **0.40** | **0.82** | **0.33** | **0.47** | **0.92** | **2.94** |

**Summary:**

Penn State contributions to the maintenance and operations of IceCube include:

**Faculty:**

Doug Cowen (L,+) - PINGU co-lead, outreach, 90% IceCube

**Scientists and Post Docs:**

Tyler Anderson – firmware maintenance, electronics support, 23% IceCube

 Analysis topics: n/a

Tim Arlen – simprod, distributed computing, PINGU systematics studies, monitoring, 100% IceCube

 Analysis topics: Neutrino Mass Hierarchy, Neutrino Oscillations

Azadeh Keivani– Integrating IceCube into AMON, 50% IceCube (on internal PSU funds, not PSU base grant)

 Analysis topics: n/a

**Ph.D. Students:**

Feifei Huang - Gen-2 hardware requirements from IceCube data; Tau neutrino appearance with DeepCore; 100% IceCube

 Thesis/Analysis topics: tau neutrino appearance

Justin Lanfranchi – PINGU and low energy event reconstruction quality; parametrization of resolutions for NMH analysis; 100% IceCube

 Thesis/Analysis topics: n/a

Daria Pankova - Gen-2 DAQ electronics hardware and firmware; 100% IceCube

 Thesis/Analysis topics: n/a

**Computing Resources:**

The Penn State IceCube group has access to several large computing clusters maintained and administered by the Penn State High Performance Computing group, comprising a total of approximately 12,000 computing cores, including several GPUs. Since September 2014, the Penn State group has had priority access to about 200 cores, the purchased “share” of the cluster. However, our average utilization this past year has been in excess of 900 cores, with peak usage reaching over 3,000 cores. In total we used about 8 million CPU hours in the past year.

With these clusters Penn State has contributed substantially to simulation production, including the entire collaboration-wide simulation of low energy neutrinos with GENIE, PINGU simulations and reconstructions, and a significant fraction of simprod jobs run collaboration-wide. Substantial amounts of reconstruction development work have also been conducted using these resources.

**Note:** The activities and staffing levels in this MoU are appropriate for the period beginning October 1, 2014.