**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, 100% 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; PISA maintenance; 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:**

Penn State computing resources and management have undergone significant changes over the past year or so, many of which have not been favorable to the high performance computing needs of IceCube. However, the situation is definitely improving, and after waiting quite a while for the dust to settle, we will be purchasing shares in a CPU-intensive cluster by early 2016 that will enable Penn State to once again contribute substantively to simulation production. Also, with D. Cowen recently appointed to a small university-wide “executive committee” (reporting directly to the Provost) charged with formulating university policy for research computing, the prospects for further improvements are good. This past year, Cowen was a co-PI on a computing-centric MRI proposal to NSF along with colleagues in astronomy, engineering and statistics. This MRI allocated considerable resources to IceCube computing. Although it reviewed well, it was not funded, but we have been encouraged to re-apply and are planning to do so.

Our overarching goal is to “punch above our weight” in simulation production, including simulation of low energy neutrinos with GENIE, PINGU simulations and reconstructions, and simprod jobs run collaboration-wide. Substantial amounts of reconstruction development work will also been conducted using these resources.

**Note:** The activities and staffing levels in this MoU are appropriate for the period beginning October 1, 2015.