**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** | **WBS 2.6** | **Grand Total** |
| Program Coordination | Detector Maintenance & Operations | Computing & Data Management | Data Processing & Simulation | Software | Calibration |
| KE | COWEN, DOUG | Education & Outreach | Education & Outreach | Inst. In-Kind | 0.05 |  |  |  |  |  | **0.05** |
|  | Engineering and R&D | PINGU Co-Lead, Publication Committee | Inst. In-Kind | 0.45 |  |  |  |  |  | **0.45** |
|  | **COWEN, DOUG Total** | |  |  | **0.40** |  |  |  |  |  | **0.50** |
| SC | ANDERSON, TYLER | Data Acquisition | DAQ Firmware Development | NSF M&O Core |  | 0.23 |  |  |  |  | **0.23** |
|  | **ANDERSON, TYLER Total** | |  |  |  | **0.23** |  |  |  |  | **0.23** |
| PO | ELLER, PHILIPP | Simulation Production | Simulation Production | Base Grants |  |  |  | 0.08 |  |  | 0.08 |
|  | Reconstruction | Develop analysis tools for systematics study; PISA development | Base Grants |  |  |  |  | 0.20 |  | 0.20 |
|  |  | Detector Monitoring | Monitoring Shifts | Base Grants |  | 0.03 |  |  |  |  | 0.03 |
|  |  | Central Computing Resources | Coordination and Support Grid distributed computing | NSF M&O Core |  |  | 0.25 |  |  |  | 0.25 |
|  | **ELLER, PHILIPP Total** | |  |  |  | **0.03** | **0.25** | **0.08** | **0.20** |  | **0.56** |
|  | KEIVANI,  AZADEH | Reconstruction | Maintain IceCube integration with AMON; HESE reco | Inst. In-Kind |  |  |  |  | 0.25 |  | 0.25 |
|  | **KEIVANI, AZADEH Total** | |  |  |  |  |  |  | **0.25** |  | **0.25** |
|  | TESIC, GORDANA | Reconstruction | Maintain IceCube integration with AMON; HESE reco | Inst. In-Kind |  |  |  |  | 0.25 |  | 0.25 |
|  | **TESIC, GORDANA Total** | |  |  |  |  |  |  | **0.25** |  | **0.25** |
| GR | HUANG,  FEIFEI | Reconstruction | Develop analysis tools for systematics study; PISA development | Inst. In-Kind |  |  |  |  | 0.20 |  | 0.20 |
| Detector Monitoring | Monitoring Shifts | Base Grants |  | 0.03 |  |  |  |  | 0.03 |
|  | **HUANG, FEIFEI Total** | |  |  |  | **0.03** |  |  | **0.20** |  | **0.23** |
|  | LANFRANCHI, JUSTIN | Reconstruction | Low energy event reconstruction quality; PISA development; Software Strike Team member | 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; background studies | 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** | **0.25** | **0.08** | **1.37** |  | **2.92** |

**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

Philipp Eller – simprod, distributed computing, PINGU systematics studies, monitoring, PISA development and maintenance, 100% IceCube

Analysis topics: Tau neutrino appearance, Neutrino Oscillations

Azadeh Keivani– Maintain IceCube integration with AMON, 25% IceCube (on internal PSU funds, not PSU base grant)

Analysis topic: Realtime analysis, Point sources of high energy neutrinos

Gordana Tesic– Maintain IceCube integration with AMON, 25% IceCube (on internal PSU funds, not PSU base grant)

Analysis topic: Realtime analysis, Primordial Black Holes

**Ph.D. Students:**

Feifei Huang - Gen-2 hardware requirements from IceCube data; Tau neutrino appearance with DeepCore, PISA development and maintenance; 100% IceCube

Thesis/Analysis topics: tau neutrino appearance

Justin Lanfranchi – PINGU and low energy event reconstruction quality; PISA development and maintenance; Software Strike Team member; 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:**

Cowen is a co-PI on a successful $1M GPU-centric MRI proposal (“CyberLAMP”) to NSF along with colleagues in astronomy, materials science, and computer science. This MRI will provide considerable resources to IceCube computing. In anticipation grant approval, the handful of GPUs we purchased in April 2016 have enabled us to benchmark IceCube code on single- and double-precision GPUs (Titan X, K40 and K80) and will allow us to optimize the GPU purchase for the MRI accordingly. Cowen has also applied for and received additional local CPU resources in support of IceCube and PINGU related work. (As of September 2016, the quantity has not been specified, but it will be less than the requested 500 core-months.)

We will use these resources to contribute to 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 be conducted using these resources. It is not yet possible to specify the exact amounts of the contribution due to uncertainties in the final configuration of CyberLAMP and the unknown quantity of additional local resources we will be awarded.

**Note:** The activities and staffing levels in this MoU are appropriate for the period beginning October 1, 2016.

The numbers in the table below in parentheses are optimistic numbers that will obtain if applications for new computational resources are approved. The smaller number is the guaranteed average number of CPUs or GPUs, the second number after the dash is the possible burst level that we could obtain. The first number in parentheses is for the local resource application, the second for the NSF MRI (see text above for details). While the main emphasis will be on PINGU, GPU-centric IceCube jobs would certainly be welcome on the MRI cluster, if it is approved.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | 2016 | | 2017 | |
|  | CPU Cores | GPU Cores | CPU Cores | GPU Cores |
| IceCube |  |  | ? | ? |
| PINGU | 50-800  (40; 400) | 1-6 K80, 1 TitanX  (0; 50) | ? | ? |
| High E Array |  |  |  |  |