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

**Scope of Work**

**Michigan State University**

**Tyce DeYoung**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **5** (2 3 2)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 | Computing & Data Management | Triggering & Filtering | Data Quality, Reconstruction & Simulation Tools |
| KE | DeYOUNG, TYCE | Education & Outreach | Education & Outreach | Inst. In-Kind | 0.05 |  |  |  |  | **0.05** |
|  |  | Administration | Deputy Spokesperson | Inst. In-Kind | 0.25 |  |  |  |  | **0.25** |
|  | **DeYOUNG, TYCE Total** | |  |  | **0.30** |  |  |  |  | **0.30** |
|  | MAHN, KENDALL | Simulation Programs | Integration/development of GENIE for low energy systematics | Inst. In-Kind |  |  |  |  | 0.10 | **0.10** |
|  |  | Administration | ICB member |  | 0.05 |  |  |  |  | **0.05** |
|  | **MAHN, KENDALL Total** | |  |  | **0.05** |  |  |  | **0.10** | **0.15** |
| PO | HIGNIGHT, JOSHUA | Simulation Production | Simulation Production | Inst. In-Kind |  |  | 0.08 |  |  | **0.08** |  |
|  |  | Simulation Programs | Integration of GENIE for low energy systematics | Inst. In-Kind |  |  |  |  | 0.20 | **0.20** |
|  | Computing Resources | Simulation production site manager at MSU | NSF M&O Core |  |  | 0.25 |  |  | **0.25** |
|  |  | Offline Data Processing | Low energy L3 maintainer | Inst. In-Kind |  |  |  |  | 0.08 | **0.08** |
|  | **HIGNIGHT, JOSHUA Total** | |  |  |  |  | **0.33** |  | **0.28** | **0.61** |
|  | JOAO PEDRO DE ANDRÉ | Simulation Production | Simulation Production Reconstruction, IceSim vetting for LowEn | Inst. In-Kind |  |  | 0.08 |  |  | **0.08** |
|  | Reconstruction/ Analysis tools | Low energy reconstruction techniques for DeepCore | Inst. In-Kind |  |  |  |  | 0.20 | **0.20** |
|  | **DE ANDRÉ, JOAO PEDRO Total** | | | |  |  | **0.08** |  | **0.20** | **0.28** |
|  | LENNARZ, DIRK | Detector Monitoring | Monitoring Shifts | Inst. In-Kind |  | 0.03 |  |  |  | **0.03** |
|  | **LENNARZ, DIRK Total** | | | |  | **0.03** |  |  |  | **0.03** |
| GR | NEER, GARRETT | Reconstruction/ Analysis tools | Development of noise cleaning for vuvuzela noise. | Inst. In-Kind |  |  |  |  | 0.50 | **0.50** |
|  |  | Detector Monitoring | Monitoring Shifts | Inst. In-Kind |  | 0.03 |  |  |  | **0.03** |
|  | **NEER, GARRETT Total** | |  |  |  | **0.03** |  |  | **0.50** | **0.53** |
| GR | RYSEWYK, DEVYN | Reconstruction/ Analysis tools | Work on improved modeling of hadronic showers in reconstruction | Inst. In-Kind |  |  |  |  | 0.08 | **0.08** |
|  |  | Detector calibration | In-situ DOM sensitivity calibration/angular response from muon neutrinos | Inst. In-Kind |  | 0.42 |  |  |  | **0.42** |
|  | **RYSEWYK, DEVYN Total** | |  |  |  | **0.42** |  |  | **0.08** | **0.50** |
| **MSU Total** | |  |  |  | **0.35** | **0.48** | **0.41** | **0.00** | **1.16** | **2.40** |

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

**Faculty:**

Tyce DeYoung – Deputy Spokesperson, outreach, 95% IceCube (5% HAWC)

Kendall Mahn – low energy systematics/GENIE, ICB member, outreach, 15% IceCube (85% GENIE and T2K)

**Scientists and Post Docs:**

Joshua Hignight– simprod, distributed computing, DeepCore systematics studies, Low-En L3 maintainer, 75% IceCube (25% GENIE development)

Analysis topics: Improvements to muon neutrino disappearance analysis, joint analysis of muon disappearance and tau appearance

João Pedro A. M. de André –

Simprod, distributed computing, Low-En production reconstruction/filtering, Low-En reconstruction methods, 100% IceCube

*Reconstruction modules: MultiNest, DirectReco*

Analysis topics: Tau neutrino appearance

Dirk Lennarz Monitoring shift, 50% IceCube (50% HAWC)

Analysis topics: none

**Ph.D. Students:**

Garrett Neer Reco/analysis tools: Development of noise cleaning algorithms for vuvuzela noise.

Detector monitoring: shift

Thesis/Analysis topics: solar dark matter search (low energy)

Devyn Rysewyck Reco/analysis tools: improved modeling of hadronic showers in reconstruction, DOM calibration using neutrino-induced muons.

Thesis/Analysis topics: TBD

**Computing Resources:**

**MSU Pledged Computing Resources**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **2016** | | **2017** | |
|  | **CPU Cores** | **GPU Cards** | **CPU Cores** | **GPU Cards** |
| **IceCube** | 0 | 0 | 728 | 8 |
| **PINGU** |  |  |  |  |
| **Gen2** |  |  |  |  |

**Computing Resources Typically Available**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **2016** | | **2017** | |
|  | **CPU Cores** | **GPU Cards** | **CPU Cores** | **GPU Cards** |
| **IceCube** | 300 | 80 | 1000 (est.) | 100 (est.) |
| **PINGU** |  |  |  |  |
| **Gen2** |  |  |  |  |

NB: these totals include resources used for both simulation production and data analysis

The Michigan State IceCube group has access to several large computing clusters maintained and administered by the Michigan State High Performance Computing group and the Institute for Cyber-Enabled Research, comprising a total of approximately 8,000 computing cores, including 80 Tesla K20c GPU cards. A new cluster will be brought online in summer 2016, with 728 IceCube-dedicated cores and several IceCube-dedicated GPUs. Anticipated actual availability for IceCube is detailed separately.

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