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

**Scope of Work**

**Michigan State University**

**Tyce DeYoung**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **4** (2 2 2)

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 | 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 Software  | 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 Software  | Integration of GENIE for low energy systematics | Inst. In-Kind |  |  |  |  | 0.20 |  | **0.20** |
|  | Central Computing Resources | Simulation production site manager at MSU/Condor integration | NSF M&O Core |  |  | 0.25 |  |  |  | **0.25** |
|  |  | Offline Data Production | Low energy L3 scripts | Inst. In-Kind |  |  |  | 0.08 |  |  | **0.08** |
|   | **HIGNIGHT, JOSHUA Total** |  |  |  |  | **0.25** | **0.16** | **0.20** |  | **0.61** |
|  | JOAO PEDRO DE ANDRÉ | Simulation Production | LowEn Production Reconstruction, IceSim vetting for LowEn  | Inst. In-Kind |  |  |  | 0.12 |  |  | **0.12** |
|  | Reconstruction | Low energy reconstruction techniques for DeepCore | Inst. In-Kind |  |  |  |  | 0.08 |  | **0.08** |
|  |  | Administration | Member of ICC |  | 0.10 |  |  |  |  |  |  |
|  |  | Online Filter (Pnf) | LE/osc WG co-chair |  |  | 0.25 |  |  |  |  |  |
|  | **DE ANDRÉ, JOAO PEDRO Total**  | **0.10** | **0.25** |  | **0.12** | **0.08** |  | **0.55** |
| GR | NEER, GARRETT | Detector Monitoring | Monitoring Shifts | Inst. In-Kind |  | 0.03 |  |  |  |  | **0.03** |
|   | **NEER, GARRETT Total** |  |  |  | **0.03** |  |  |  |  | **0.03** |
| GR | RYSEWYK, DEVYN | Detector calibration | In-situ DOM sensitivity calibration/angular response from muon neutrinos | Inst. In-Kind |  |  |  |  |  | 0.50 | **0.50** |
|   | **RYSEWYK, DEVYN Total** |  |  |  |  |  |  |  | **0.50** | **0.50** |
| **MSU Total** |  |  |  | **0.45** | **0.28** | **0.25** | **0.28** | **0.38** | **0.50** | **2.14** |

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

**Faculty:**

Tyce DeYoung – Deputy Spokesperson, outreach, 100% IceCube

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, 60% IceCube (40% GENIE development)

 Analysis topics: atmospheric neutrino mixing parameters

João Pedro A. M. de André –

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

 *Reconstruction modules: MultiNest, DirectReco*

 Analysis topics: Tau neutrino appearance

**Ph.D. Students:**

Garrett Neer Detector monitoring: shift

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

Devyn Rysewyck Reco/analysis tools: 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**  | 500\* | 8\* | 500\* | 8\* |
| **PINGU** |  |  |  |  |
| **Gen2**  |  |  |  |  |

**\*as simprod by policy does not carry out low energy signal production, the primary computational task for low energy physics, these resources will be available for IceCube multi-institutional computing but not necessarily under simprod**

**Computing Resources Typically Available**

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

\*actual usage data are not available due to lack of jobs sent to MSU for processing

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 15,600 computing cores, including 80 Tesla K20c and 200 Tesla K80 GPU cards. Of these, 728 cores 8 K80 GPUs are dedicated to IceCube. Actual availability will be very substantially higher for jobs with durations less than 4 hours, but cannot be accurately estimated until simprod begins sending processing jobs to MSU.

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