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

**Scope of Work**

**University of Wisconsin - Madison**

**Albrecht Karle**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **20** (6 14 12)

| **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 | HALZEN, FRANCIS | Administration | Principle Investigator | NSF M&O Core | 0.38 |  |  |  |  | 0.38 |
|  |  |  | Inst. In-Kind | 0.12 |  |  |  |  | 0.12 |
|  | **HALZEN, FRANCIS Total** | | |  | **0.50** |  |  |  |  | **0.50** |
|  | KARLE, ALBRECHT | Administration | Associate Director for Science and Instrumentation | NSF M&O Core | 0.38 |  |  |  |  | 0.38 |
|  |  |  | ExecCom Member | Inst. In-Kind | 0.20 |  |  |  |  | 0.20 |
|  | **KARLE, ALBRECHT Total** | | |  | **0.58** |  |  |  |  | **0.58** |
|  | HANSON, KAEL | Administration | Director of IceCube Maintenance and Operations | NSF M&O Core | 0.47 |  |  |  |  | 0.47 |
|  |  |  |  | Inst. In-Kind | 0.08 |  |  |  |  | 0.08 |
|  | **HANSON, KAEL Total** | | |  | **0.55** |  |  |  |  | **0.55** |
|  | VANDENBROUCKE, JUSTIN | Administration | Pubcom member | Inst. In-Kind | 0.10 |  |  |  |  | 0.10 |
|  | **VANDENBROUCKE, JUSTIN Total** | | |  | **0.10** |  |  |  |  | **0.10** |
| SC | CHIRKIN, DMITRY | Detector Calibration | Direct photon tracking / ice- properties calibration | Base Grants |  | 0.35 |  |  |  | 0.35 |
|  |  | Reconstruction/ Analysis tools | Reconstruction software | NSF M&O Core |  |  |  |  | 0.25 | 0.25 |
|  |  | Simulation Programs | Maintain and Verify Simulation of Photon Propagation and update Ice Properties | NSF M&O Core |  |  |  |  | 0.40 | 0.40 |
|  | **CHIRKIN, DMITRY Total** | |  |  |  | **0.35** |  |  | **0.65** | **1.00** |
|  | DESIATI, PAOLO | Simulation Production | Simulation Production Manager | NSF M&O Core |  |  | 0.30 |  |  | 0.30 |
|  |  | Simulation Production | Simulation Production streamlining programs for the cloud, GPU | NSF M&O Core |  |  | 0.30 |  |  | 0.30 |
|  |  | Simulation Production | Simulation Production panel chair | Inst. In-Kind |  |  | 0.10 |  |  | 0.10 |
|  |  | Detector Ops. And Maintenance | IceCube Coordination Committee Chair | NSF M&O Core |  | 0.30 |  |  |  | 0.30 |
|  | **DESIATI, PAOLO Total** | |  |  |  | **0.30** | **0.70** |  |  | **1.00** |
|  | DUVERNOIS, MICHAEL | Engineering and R&D Support | Specialized simulations, designing new filters, unusual data selections, extracting specialized information | NSF M&O Core | 0.25 |  |  |  |  | 0.25 |
|  |  | Engineering and R&D Support | Ongoing EMI studies & mitigation, South Pole & Northern test site instrumentation, Summer South Pole field work | NSF M&O Core | 0.25 |  |  |  |  | 0.25 |
|  | **DUVERNOIS, MICHAEL Total** | | |  | **0.50** |  |  |  |  | **0.50** |
|  | HOSHINA, KOTOYO | Simulation Programs | NuGen maintenance | NSF M&O Core |  |  |  |  | 0.25 | 0.25 |
|  | **HOSHINA, KOTOYO Total** | | |  |  |  |  |  | **0.25** | **0.25** |
|  | KAUER, MATTHEW | Run Coordination | Run Coordinator | NSF M&O Core |  | 0.40 |  |  |  | 0.40 |
|  | Detector Monitoring | Training and coordinating monitoring shifters | NSF M&O Core |  | 0.10 |  |  |  | 0.10 |
|  |  | Detector Monitoring | Data Monitoring lead: coordinate test and feature development; design underlying analysis algorithms | NSF M&O Core |  | 0.20 |  |  |  | 0.20 |
|  |  | TFT Coordination | TFT Board member | Inst. In-Kind |  |  |  | 0.10 |  | 0.10 |
|  |  | IceTop Operations | Design and build experimental apparatus for restoring IceTop detector efficiency | NSF M&O Core |  | 0.20 |  |  |  | 0.20 |
|  | **KAUER, MATTHEW Total** | |  |  |  | **0.90** |  | **0.10** |  | **1.00** |
|  | KELLEY, JOHN | Detector Maintenance & Ops | Detector Maintenance and Operations Manager | NSF M&O Core |  | 0.65 |  |  |  | 0.65 |
|  |  | Data Acquisition | DOM software: DOR device driver, DOMHub scripts, DOMCal | NSF M&O Core |  | 0.15 |  |  |  | 0.15 |
|  |  | Data Acquisition | Track DOM issues, generate detector run configurations | NSF M&O Core |  | 0.10 |  |  |  | 0.10 |
|  | **KELLEY, JOHN Total** | | |  |  | **0.90** |  |  |  | **0.90** |
|  | TOSI, DELIA | Detector Calibration | Absolute DOM sensitivity calibration (laboratory measurements) | NSF M&O Core |  | 0.30 |  |  |  | 0.30 |
|  | IceTop Operations | Test and commission experimental apparatus for restoring IceTop detector efficiency | NSF M&O Core |  | 0.60 |  |  |  | 0.60 |
|  | **TOSI, DELIA Total** | | |  |  | **0.90** |  |  |  | **0.90** |
|  | WENDT, CHRISTOPHER | Detector Calibration | Flasher output, flasher calibration | NSF M&O Core |  | 0.40 |  |  |  | 0.40 |
|  |  | Detector Calibration | DOM charge response, linearity, DOM cal support | NSF M&O Core |  | 0.40 |  |  |  | 0.40 |
|  | **WENDT, CHRISTOPHER Total** | | |  |  | **0.80** |  |  |  | **0.80** |
| PO | Xu, Donglian | Detector Calibration | TBD | Base Grants |  |  | 0.30 |  |  | 0.30 |
|  | XU, DONGLIAN **Total** | |  |  |  |  | **0.30** |  |  | **0.30** |
| PO | DAY, MELANIE | Simulations Production | Low energy simulation production | Base Grants |  |  | 0.30 |  |  | 0.30 |
|  | DAY, MELANIE **Total** | |  |  |  |  | **0.30** |  |  | **0.30** |
|  | WANDKOWSKY, NANCY | Data Storage & Transfer | Analysis disk Data storage review, data filters | Base Grants |  |  | 0.10 |  |  | 0.10 |
|  | WANDKOWSKY, NANCY | Offline Data Processing | Level 2 offline processing – co-coordinator | Base Grants |  |  |  |  | 0.20 | 0.20 |
|  | **WANDKOWSKY, NANCY Total** | |  |  |  |  | **0.10** |  | **0.20** | **0.30** |
|  | UW PO | Detector Monitoring | Monitoring shifts | Base Grants |  | 0.08 |  |  |  | 0.08 |
|  | **UW PO Total** | |  |  |  | **0.08** |  |  |  | **0.08** |
| GR | JERO, KYLE | Reconstruction/ Analysis Tools | Event reconstruction, angular resolution | Base Grants |  |  |  |  | 0.20 | 0.20 |
|  |  | Simulation programs | Veto simulation, Corsika development | Base Grants |  |  |  |  | 0.20 | 0.20 |
|  | TOBIN, MORIAH | Reconstruction/ Analysis Tools | Low energy event reconstruction (BiPed), spline service | Base Grants |  |  |  |  | 0.30 | 0.30 |
|  | GHORBANI, KEVIN | Detector Calibration | Muon time residuals/hole ice | Base Grants |  | 0.25 |  |  |  | 0.25 |
|  | FAHEY, SAM | Physics Filters | Trigger simulations | Base Grants |  |  |  | 0.20 |  | 0.20 |
|  | MANCINA, SARAH | Detector Calibration | muon neutrinos, DOM sensitivity | Inst. In-kind |  | 0.20 |  |  |  | 0.20 |
|  | Ty, Bunheng | Detector Calibration | DOM glass noise | Inst. In-kind |  | 0.20 |  |  |  | 0.20 |
|  | UW GR | Detector Monitoring | Monitoring shifts | Base Grants |  | 0.12 |  |  |  | 0.12 |
|  | **GR Total** | |  |  |  | **0.77** |  | **0.20** | **0.70** | **1.67** |
| **UW – Madison Total** | | |  |  | **2.23** | **5.00** | **1.40** | **0.30** | **1.80** | **10.73** |

**Faculty:**

Halzen, Francis Principal Investigator

Karle, Albrecht Institutional Lead, ExecCom member, Point and diffuse astrophysical neutrinos, DeepCore

Hanson, Kael Director of IceCube Maintenance & Operations

Vandenbroucke, Justin Low energy physics, IceCube analysis, selected point source searches, multimessenger with radio bursts

Westerhoff, Stefan Cosmic Rays with IceCube and IceTop.

Gallagher, John Selection of candidate point sources of neutrinos, catalogues for stacking searches and multi-wavelength observations.

**Scientists:**

Ahlers, Marcus (John Bahcall Fellowship).

Analysis: Cosmic Ray anisotropy analysis, neutrino sources

Chirkin, Dmitry Service: Direct photon tracking with GPUs, ice properties calibration; event reconstruction software, Simulation Programs

Analysis: energy reconstruction of high energy events, ice properties.

Desiati, Paolo Service: Simulation Production Coordinator, Sim. Prod. Panel Chair

Analysis: Atmospheric neutrinos, time and weather dependence of neutrino flux, charm

DuVernois, Michael (50%) Service: Engineering Support and R&D Science Support

Hoshina, Kotoyo (75% appointment with University of Tokyo, based in Madison)

Service: Simulation Programs - nugen maintenance

Analysis: Earth Core neutrino absorption (Tokyo)

Kauer, Matthew Service: Run Coordinator, TFT Board Member, IceCube Monitoring Lead, Cosmic Ray Surface Array Development

Kelley, John (90%) Service: Detector Maintenance and Operations Manager, DOM Cal Maintenance, DOM issues technical analysis

Tosi Delia Service: Absolute DOM sensitivity calibration, Scintillation detectors (IceTop maintenance)

Analysis: IceTop veto for astrophysical neutrino search

Wendt, Christopher (80%) Service: Flasher output, Flasher Calibrations; DOM sensitivity, Supporting DOM charge response (lab, flashers), DOM Cal support

**Post Docs** (supervisor)**:**

Bechtol, Keith (JV) Service: TBD

Analysis: Correlations between neutrino flux and gamma ray observations

Day, Melanie (AK) Service: Low energy simulation production

Analysis: Neutrino oscillations with Deep Core, Non Standard Interactions

Wandkowsky, Nancy (AK) Service: Analysis disk Data storage review, filter development

Analysis: All flavor all sky contained vertex neutrino analysis at high energies

Donglian Xu (AK) Service: Calibration, waveforms, cascade systematics

Analysis: Search for neutrino flux in coincidence with fast radio transients. Investigation of non-contained high energy cascade events in IceCube

Huelst, Tova (AK) Analysis: Search for neutrino fluxes from galactic sources, Cygnus region

**Grad Students** (supervisor)**:**

Schneider, Austin (AK) Service: Energy reconstruction of muons with contained vertex

Analysis: Energy loss of muons

Bourbeau, James (SW) Service: TBD

Analysis: TBD

Fahey, Sam (JV) Service: Trigger simulations

Analysis: Analysis of transients

Fasig, Ben (KH) Analysis: thermalizing neutrons

Ghorbani, Kevin (FH) Service: Muon time residuals/hole ice

Thesis /Analysis topics: Sterile neutrino search

Griffith, Zachary (SW) Thesis /Analysis topics: search for gamma-ray sources in IceTop with IceCube muon veto

Service: TBD

Jero, Kyle (AK) Service: DOM linearity, sensitivity; muon event reconstruction

Analysis: point sources, atmospheric neutrino veto

Kheirandish, Ali (FH) Service: Supernova system rate studies

Analysis: Supernova, GRB, Point sources

Mancina\*, Sarah (AK) Service: Calibration studies (DOM sensitivity) with muon neutrinos

Analysis: TBD Physics with muon neutrinos (possibly point sources)

Tobin, Moriah (AK) Service: low energy event reconstruction (BiPed), spline service

Analysis: Atmospheric neutrino studies using IceCube's DeepCore.

Ty, Bunheng (KH) Service: DOM noise studies

Wille, Logan (FH) Analysis: Charm contribution to the atmospheric neutrino flux

\* Funded by Fellowship.

**UW-Madison Computing Resources**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **2016** | | **2017** | |
|  | **CPU Cores** | **GPU Cards** | **CPU Cores** | **GPU Cards** |
| **IceCube** | 7000 | 376 | 8000 | 376 |
| **PINGU** |  |  |  |  |
| **Gen2** |  |  |  |  |

The dedicated 7000 CPU cores in 2016 are in the IceCube cluster at WIPAC (NPX cluster). The processor types are: Intel X5670, E5-2680, E5-2680v2 and E5-2680v3.

UW-Madison also provides access to opportunistic CPU resources at UW and OSG shared clusters. The number of cores accessible this way is higher than 10.000

The dedicated 376 GPU cards in 2016 are in the IceCube cluster at WIPAC (including GZK). The GPU types are: 48 Nvidia M2070, 36 Nvidia GTX 690, 36 AMD 7970 and 256 Nvidia GTX 980.