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

**Scope of Work**

**University of Wisconsin - Madison**

**Albrecht Karle**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **18** (6 12 14)

| **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 | 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 | Ice Properties  | Direct photon tracking / ice- properties calibration , Individual DOM hole ice calibration | Base Grants |   |   |   |   |  | 0.55 | 0.55 |
|  |  | Reconstruction  | Reconstruction software | NSF M&O Core |   |   |   |   | 0.15 |  | 0.15 |
|   |   | Simulation Software | Maintain and Verify Simulation of Photon Propagation and update Ice Properties | NSF M&O Core |   |   |   |   | 0.30 |  | 0.30 |
|   | **CHIRKIN, DMITRY Total** |  |  |  |  |  |  | **0.45** | **0.55** | **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 calibrations, SPICE core project coordination, 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 Software | 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 |
|   |  | Online Filter (PnF) | TFT Board member | Inst. In-Kind |  | 0.10 |  |  |  |  | 0.10 |
|  |  | Surface Detector Operations | Design and build experimental apparatus for restoring IceTop detector efficiency | NSF M&O Core |  | 0.20 |  |  |  |  | 0.20 |
|   | **KAUER, MATTHEW Total** |  |  |  | **1.00** |  |  |  |  | **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 |   |  |   |   |   | 0.15 | 0.15 |
|  | Surface Detector Operations | Test and commission experimental apparatus for restoring IceTop detector efficiency | NSF M&O Core |  | 0.50 |  |  |  |  | 0.50 |
|   | **TOSI, DELIA Total** |  |  | **0.50** |  |  |  | **0.15** | **0.65** |
|   | 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, Absolute DOM sensitivity, microDAQ (scintillator) | NSF M&O Core |   |  |   |   |   | 0.40 | 0.40 |
|   | **WENDT, CHRISTOPHER Total** |  |  |  |  |  |  | **0.80** | **0.80** |
| PO | XU, DONGLIAN | Detector Calibration | Calibration, waveforms, cascade systematics | Base Grants |  |   |  |  |  | 0.30  | 0.30 |
|   | XU, DONGLIAN **Total** |  |  |  |  |  |  |  | **0.30** | **0.30** |
|  | WANDKOWSKY, NANCY | Data Storage & Transfer | Analysis disk storage curator, 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** |
|  | YUAN, TIANLU | Reconstruction | Impact of DOM response on reconstruction, cascade reconstruction at high energies | Base Grants |  |  |  | 0.40 |  |  | 0.40 |
|   | **YUAN, TIANLU Total** |  |  |  |  |  | **0.40** |  |  | **0.40** |
|   | UW PO | Detector Monitoring | Monitoring shifts | Base Grants |   | 0.08 |   |   |   |  | 0.08 |
|   | **UW PO Total** |  |  |  | **0.08** |  |  |  |  | **0.08** |
| GR | JERO, KYLE | Reconstruction | Event reconstruction, angular resolution | Base Grants |   |  |   |   | 0.10 |  | 0.10 |
|   |  | Simulation Software | Veto simulation, Corsika development | Base Grants |   |  |   |   | 0.10 |  | 0.10 |
|  | GHORBANI, KEVIN  | Ice Properties  | Muon time residuals/hole ice | Base Grants |  |  |  |  |  | 0.25 | 0.25 |
|  | FAHEY, SAM | Online Filter (PnF) | Trigger simulations, grbllh | Base Grants |  | 0.20 |  |  |  |  | 0.20 |
|  | MANCINA, SARAH | Real Time | filter development (ESTES), DOM sensitivity | Base Grants |  |  |  |  |  | 0.20 | 0.20 |
|  | Schneider, Austin | Reconstruction | Event reconstruction, software development | Base Grants |  |  |  |  |  | 0.15 | 0.15 |
|  | Luszczak, William | Detector Calibration | Calibration, 2D-DOM response, anisotropy with muons | Base Grants |  |  |  |  |  | 0.40 | 0.40 |
|  | GRIFFITH, ZACHARY | Reconstruction | Photon/hadron separation | Base Grants |  |  |  |  | 0.20 |  | 0.20 |
|  | Simulation | Gamma simulation production | Base Grants |  |  |  | 0.30 |  |  | 0.30 |
|  | Ty, Bunheng | Detector Calibration | DOM glass noise, PMT negative HV studies | Inst. In-kind |  |  |  |  |  | 0.20 | 0.20 |
|  | Safa, Ibrahim | Detector Calibration | IceTop maintenance, Scintillator project | Inst. In-kind |  |  |  |  |  | 0.20 | 0.20 |
|   | UW GR | Detector Monitoring | Monitoring shifts | Base Grants |   | 0.12 |   |   |   |  | 0.12 |
|   | **GR Total** |  |  |  | **0.32** |  | **0.30** | **0.40** | **1.40** | **2.42** |
| **UW – Madison Total** |  |  | **2.23** | **3.10** | **0.10** | **1.60** | **1.10** | **3.20** | **11.33** |

**Faculty:**

Halzen, Francis Principal Investigator

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

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:**

Chirkin, Dmitry Service: Direct photon tracking with GPUs, ice properties calibration; DOM level 2 D calibration, event reconstruction software, Simulation Programs

 Analysis: energy reconstruction of high energy events

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

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

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, micrDAQ (scintillator project).

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

Wandkowsky, Nancy (AK) Service: Analysis disk storage curator, data filters

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

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

 Analysis: Search for neutrino flux in coincidence with fast radio transients. Investigation double pulse tau events

Wood, Joshua (SW) Service:

 Analysis: search for IceCube neutrinos from Galactic sources (point-like and extended) from the HAWC catalog, mass composition cosmic rays

Tianlu, Yuan (KH) Service: DOM response impact on reconstruction, bright DOMs use in high energy events.

 Analysis: Physics with high energy cascade events.

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

Schneider, Austin (AK) Service: Energy reconstruction of events with contained vertex, monopod upgrade

 Analysis: HESE and MESE diffuse analysis

Luszczak, William (AK) Service: DOM sensitivity (azimuth and zenith), anisotropy of ice

 Analysis: TBD, astrophysics with muon neutrinos

Bourbeau, James (SW) Service: DST level processing

 Analysis: CR anisotropy, energy and composition and other

Fahey, Sam (JV) Service: Trigger simulations

 Analysis: Analysis of transients

Ghorbani, Kevin (FH) Service: -

 Thesis /Analysis topics: Sterile neutrino search

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

 Service: Gamma simulation production

Jero, Kyle (AK) Service: muon event reconstruction, veto techniques

 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: ESTES analysis

Ty, Bunheng (KH) Service: DOM noise studies, PMT with negative HV

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

Qinrui Lu (FH) Service: TBD

 Analysis: TBD

Kayla Leonard (FH) Service: TBD

 Atmospheric neutrino studies as background to astrophysical

Hussain, Ramis (SW) Service: TBD

 Analysis: IceCube – HAWC correlations

\* Funded by Fellowship.

\*\* Supported other than NSF.

**UW-Madison Computing Resources**

|  |  |  |
| --- | --- | --- |
|  | **2017** | **2018** |
|  | **CPU Cores**  | **GPU Cards** | **CPU Cores** | **GPU Cards** |
| **IceCube**  | 7000 | 408 | 7000 | 408 |
| **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 408 GPU cards in 2017 are in the IceCube cluster at WIPAC (including GZK). The GPU types are: 36 Nvidia GTX 690, 36 AMD 7970 and 256 Nvidia GTX 980 and 56 Nvidia GTX 1080.