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

**Scope of Work**

**University of Wisconsin - Madison**

**Albrecht Karle**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **16** (5 11 16)

| **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, TFT 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 | KHEIRANDISH, ALI  | Detector Monitoring | Detector monitoring shifts, fast Response monitoring shifts | Base Grants |  | 0.20 |  |  |  |  | 0.20 |
|   | **KHEIRANDISH, ALI Total** |  |  |  | **0.20** |  |  |  |  | **0.20** |
|  | WOOD, JOSH | Reconstruction | Skylab maintenance | Base Grants |  |  |  |  | 0.2 |  | 0.20 |
|   | **WOOD, JOSH Total** |  |  |  |  |  |  | **0.2** |  | **0.20** |
|  | 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 | BOURBEAU, JAMES | Simulation Production | Gamma showers | Base Grants |   |  |   | 0.10 |  |  | 0.10 |
|  | GHORBANI, KEVIN  | Ice Properties  | Residual and deltaT analyses for IC86  | Base Grants |  |  |  |  |  | 0.20 | 0.20 |
|  | FAHEY, SAM | Online Filter (PnF) | Trigger simulations, grbllh development and maintenance, fast response shifts | 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 |
|  | LEONARD, KAYLA | Offline Data Production | Developing for MuonGun for low energies | Inst. In-kind |  |  |  | 0.50 |  |  | 0.50 |
|  | SILVA, MANUEL | Simulation (PA 1 sem) | Muongun maintenance, upgrade | NSF M&O Core |  |  |  |  |  | 0.25 | 0.25 |
|  | Luszczak, William | Detector Calibration | Calibration, 2D-DOM response, anisotropy with muons | Base Grants |  |  |  |  |  | 0.30 | 0.30 |
|  | GRIFFITH, ZACHARY | Reconstruction | Photon/hadron separation | Base Grants |  |  |  |  | 0.20 |  | 0.20 |
|  | Simulation Production | Gamma simulation production | Base Grants |  |  |  | 0.30 |  |  | 0.30 |
|  | Ty, Bunheng | Detector Calibration | PMT negative HV studies | Inst. In-kind |  |  |  |  |  | 0.05 | 0.05 |
|  | TY, BUNHENG | Data Acquisition | DOR Firmware | NSF M&O Core |  | 0.25 |  |  |  |  | 0.25 |
|  | Safa, Ibrahim | Detector Calibration | IceTop maintenance, Scintillator project | Inst. In-kind |  |  |  |  |  | 0.20 | 0.20 |
|  | Safa, Ibrahim | Detector Monitoring | Monitoring shifts | Inst. In-kind |  | 0.10 |  |  |  |  | 0.10 |
|  | WILLE, LOGAN | Simulation Production | Simulation production for muon decay Glashow resonance events | Inst. In-kind |  |  |  | 0.30 |  |  | 0.30 |
|  | Pizzuto, Alex | Real Time, Reconstruction | Fast response analysis maintenance, SkyLab transients | Inst. In-kind |  |  |  |  | 0.20 |  | 0.20 |
|   | UW GR | Detector Monitoring | Monitoring shifts | Base Grants |   | 0.12 |   |   |   |  | 0.12 |
|   | **GR Total** |  |  |  | **0.67** |  | **1.10** | **0.40** | **1.35** | **3.62** |
| **UW – Madison Total** |  |  | **2.23** | **3.65** | **0.0** | **2.30** | **1.30** | **2.85** | **12.33** |

**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 Pub comm, TFT board, transients and multi-messenger analysis (fast radio bursts, ANITA followup, novae)

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), scintillator array lead.

 Analysis: IceTop veto for astrophysical neutrino search

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

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

Wood, Joshua (SW) Service: neutrino source group technical lead, Science Support Tools L3

 Analysis: search for IceCube neutrinos from Galactic sources (point-like and extended) TXS Blazar analysis, 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.

Kheirandish, Ali (FH) Service: detector monitoring shifts, fast response monitoring shifts

 Analysis: Supernova, GRB, Point sources

**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, muon reconstruction studies

 Analysis: Stacked flaring sources search, blazar catalogues, other

Silva, Manuel (AK) Service: Muongun maintenance and upgrade. Report.

 Analysis: None.

Bourbeau, James (SW) Service: DST level processing

 Analysis: CR anisotropy, energy and composition and other

Fahey, Sam (JV) Service: Trigger simulations, GRBLLH maintenance, fast response analysis

 Analysis: Analysis of transients including FRBs, novae and ANITA followup

Ghorbani, Kevin (FH) Service: residual and deltaT analyses for IC86 to compare experimental data with multiple ice models for the calibration working group

 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

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, DOR firmware

Wille, Logan (FH) Service: simulation production for muon decay Glashow resonance events, estimated the effect of adding Glashow resonance channel to a through going NuMu analysis, and worked on muon bundle muongun simulation

 Analysis: Charm contribution to the atmospheric neutrino flux

Qinrui Lu (FH) Service: TBD

 Analysis: TBD

Kayla Leonard (FH) Service: developing for MuonGun for low energies

 Atmospheric neutrino studies as background to astrophysical

Hussain, Ramis (SW) Service: TBD

 Analysis: IceCube – HAWC correlations

Ibrahim, Safa\*\* (FH) Service: June monitoring shifts

 Analysis: TBD

Alex Pizzuto (JV) Service: maintenance of fast response analysis, implementing transient functionality in SkyLab

 Analysis: Galactic novae, ANITA followup, fast response analyses

Lazar, Jeffrey (FH/KH) Service: DOM Waveform Templates

 Analysis: TBD

\* Funded by Fellowship.

\*\* Supported other than NSF.

**UW-Madison Computing Resources**

|  |  |  |
| --- | --- | --- |
|  | 2018 | 2019 |
|  | CPU cores | GPU Cards | CPU cores | GPU Cards |
| pledged resources in the IceCube common cluster | 7000 | 410 | 7000 | 440 |

The dedicated 7000 CPU cores in 2016 are in the IceCube cluster at WIPAC (NPX and GZK clusters). 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

From June 2018, the IceCube GPU cluster at WIPAC (NPX and GZK) has 440 GPU cards. The GPU types are: 184 Nvidia GTX 1080 and 256 Nvidia GTX 980.