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

**Scope of Work**

**Lawrence Berkeley National Laboratory**

**Spencer Klein**

**Ph.D Scientists** (Faculty Scientist/Post Doc Grads): **6** (4 2 3)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 | KLEIN, SPENCER | Administration | Supervise LBNL effort | NSF M&O Core | 0.05 |  |  |  |  | **0.05** |
|  |  | Administration | PubComm Member | Institutional In-Kind | 0.10 |  |  |  |  | **0.10** |
|  |  | ~~Physics Filters~~ | ~~co-chair of Diffuse WG~~ | ~~Institutional In-Kind~~ |  |  |  | ~~0.25~~ |  | **~~0.25~~** |
|  | **KLEIN, SPENCER Total** | | |  | **0.15** |  |  |  |  | **0.15** |
|  | NYGREN, DAVID R | Detector Maintenance & Operations | Track Engine Trigger | Institutional In-Kind |  | 0.10 |  |  |  | **0.10** |
|  | **NYGREN,DAVID R Total** | | |  |  | **0.10** |  |  |  | **0.10** |
| PO | CHANG, HYON HA | Detector Monitoring | Monitoring shifts | Base Grant |  | 0.09 |  |  |  | **0.09** |
|  |  | Simulation Production | Simulation Production on PDSF | Base Grant |  |  | 0.20 |  |  | **0.20** |
|  |  | Physics Filters | L2 processing for IC86, studying cascade energy resolution | Base Grant |  |  |  | 0.25 |  | **0.25** |
|  |  | Simulation Programs | Simulation Programs: cmc | Base Grant |  |  |  |  | 0.10 | **010** |
|  |  | Simulation Programs | DOM simulator & calibrator | Base Grant |  |  |  |  | 0.10 | **0.10** |
|  | **CHANG, HYON HA Total** | | |  |  | **0.09** | **0.20** | **0.25** | **0.20** | **0.74** |
| EN | STEZELBERGER, THORSTEN | Data Acquisition | Maintain DAQ Hardware | NSF M&O Core |  | 0.15 |  |  |  | **0.15** |
|  | **STEZELBERGER, THORSTEN Total** | | |  |  | **0.15** |  |  |  | **0.15** |
| GR | SANDRA, MIARECKI | Reconstruction/ Analysis tools | Algorithm for measuring muon energy | Base Grant |  |  |  |  | 0.25 | **0.25** |
|  | **SANDRA, MIARECKI Total** | | |  |  |  |  |  | **0.25** | **0.25** |
| BINDER, GARY | Reconstruction/ Analysis tools | PMT saturation corrections for analysis | Base Grant |  |  |  |  | 0.50 | **0.50** |
|  | **BINDER, GARY Total** | | |  |  |  |  |  | **0.50** | **0.50** |
| **LBNL Total** | |  |  |  | **0.15** | **0.34** | **0.20** | **0.25** | **0.95** | **1.89** |

LBNL built the DOM main boards, and many of our service tasks are related to that; we are responsible for DOMsimulator and DOMcalibrator (Chang Hyon Ha), and work on flasher calibrations, where the original goal was to measure the electronics performance. This includes work on the calibration of saturated PMT pulses, to expand the usable dynamic range of the DOMs (G. Binder). Our other service activities include member of the Publication Committee (S. Klein), co-chairing the atmospheric/diffuse PWG (S. Klein), work on verification and monitoring,, Simulation Programs: cmc (Chang Hyon Ha) and work on reconstruction algorithms (G. Binder, S. Miarecki), and work on the track engine trigger (D. Nygren). L. Gerhardt, has developed and is maintaining reconstruction algorithms for two parallel tracks, as are found in air showers with high transverse momentum muons, and pairs of upgoing particles that are predicted in some models of supersymmetry. G. Binder has developed a new simple cascade reconstruction as an alternative ‘first guess’ method. S. Miarecki has developed, implemented and is maintaining a new method for measuring muon energy which has significantly better resolution than the previous approaches.

Our analysis efforts are focused in several areas. The first is a search for extraterrestrial neutrinos, especially cascades, where we have multiple efforts covering different energy ranges. The second is a search for atypical cosmic-ray showers; events with high transverse momentum muons in showers and photon-initiated showers with a very low muon content. Finally, Miarecki is working on a measurement of the neutrino-nucleon cross-section by measuring atmospheric neutrino absorption in the Earth; statistics permitting, this will be her PhD dissertation.

We use the National Energy Research Supercomputer Center (NERSC) PDSF (Parallel Distributed Systems Facility) to produce Monte Carlo event samples; this has mostly been cascade signal events. C. Ha maintains the PDSF software installation and coordinates this production. The hardware is maintained by NERSC.

**Faculty:**

R. Stokstad – timing calibrations

D.R. Nygren – Executive committee, “Track Engine” trigger

S.R. Klein – ~~diffuse wg co-lead,~~ Pubcomm member

Azriel Goldschmidt

**Scientists and Post Docs:**

Lisa Gerhardt – double muon reconstruction

Analysis topics: studies of high transverse momentum muons, studies of contained cascades

Chang Hyon Ha – DOM simulator & DOM calibrator, L2 processing for IC86, simulation production, maintenance of cmc

Analysis topics: studying cascade energy resolution, atmospheric neutrino studies

**Graduate Students:**

Sandy Miarecki – Algorithm for measuring muon energy

Thesis/Analysis topics: muon energy measurement, atmospheric muon neutrinos, and the neutrino-nucleon cross-section

Gary Binder – PMT saturation corrections for analysis

Thesis/Analysis topics: contained cascades

Trine Poulsen – Project TBD

**Undergraduate Students:**

Mario Gonzales – studies of muon tracking, using a new method to measure our muon track resolution (institutional in-kind support).