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

**Scope Of Work**

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| **University of Alberta****Darren Grant****Ph.D Scientists** (Faculty Scientist/Post Doc Grads) : **6** (3 3 4) |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Labor Cat.** | **Names** | **WBS L3** | **Tasks** | **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 | GRANT, DARREN | Administration | Collaboration Spokesperson | 0.50 |  |  |  |  |  | 0.50 |
|  |  | Administration | ExecCom member | 0.20 |  |  |  |  |  | 0.20 |
|  | **GRANT, DARREN Total** |  | **0.70** |  |  |  |  |  | **0.70** |
|  | KOPPER, CLAUDIO | Reconstruction  | Icetray framework maintenance |  |  |  |  | 0.05 |  | 0.05 |
|  |  | Reconstruction | Maintenance of clsim direct photon propagation tool |  |  |  |  | 0.10 |  | 0.10 |
|  |  | Simulation Production | GPU computing resources |  |  |  | 0.10 |  |  | 0.10 |
|  |  | Online Filter (Pnf) | Diffuse WG co-chair |  | 0.25 |  |  |  |  | 0.25 |
|  |  | Offline Data Production | Offline Processing Support / pass2 |  |  |  | 0.10 |  |  | 0.10 |
|  | **KOPPER, CLAUDIO Total** |  |  | **0.25** |  | **0.20** | **0.15** |  | **0.60** |
|  | MOORE, ROGER | Detector Calibration | DOM efficiency with cosmic muons |  |  |  |  |  | 0.10 | 0.10 |
|  |  | Online Filter (Pnf) | TFT Board Member |  | 0.10 |  |  |  |  | 0.10 |
|  | **MOORE, ROGER Total** |  |  | **0.10** |  |  |  | **0.10** | **0.20** |
| PO | WEAVER, CHRIS | Simulation Production | High energy event generator (leptoninjector), PMT simulation, atmospheric flux library |  |  |  | 0.10 |  |  | 0.10 |
|  |  | Offline Data Production | Offline Processing Support / pass2 |  |  |  | 0.10 |  |  | 0.10 |
|  |  | Reconstruction  | “Shield” IceTop Veto module maintenance |  |  |  | 0.05 |  |  | 0.05 |
|  |  | Reconstruction  | Simulation and core software support |  |  |  |  | 0.15 |  | 0.15 |
|  | YANEZ, JUAN PABLO | Online Filter (Pnf) | LE WG co-chair |  | 0.25 |  |  |  |  | 0.25 |
|  | HIGNIGHT, JOSHUA | Simulation Production | Simulation production site manager at Compute Canada Resource Allocation |  |  | 0.25 |  |  |  | 0.25 |
|  |  | Offline Data Production | Level-3 processing maintainer the low-energy working group |  |  |  | 0.05 |  |  | 0.05 |
|  |  | Reconstruction | Genie-icetray maintainer |  |  |  |  | 0.05 |  | 0.05 |
|  | **ALBERTA, PO Total** |  |  | **0.25** | **0.25** | **0.30** | **0.20** |  | **1.00** |
| GR | Nowicki, Sarah | Reconstruction | Direct Reconstruction Tool Development |  |  |  | 0.75 |  |  | 0.75 |
|  | Sanchez Herrera, Sebastian | Detector Calibration | DOM efficiency with cosmic muons |  |  |  |  |  | 0.35 | 0.35 |
|  | Sarkar, Sourav (MSc) | Distributed Computing Resources | Grid Operations Team |  |  | 0.20 |  |  |  | 0.20 |
|  | Simulation Production | PYTHIA event generator implementation and maintenance |  |  |  | 0.15 |  |  | 0.15 |
|  | Wood, Tania | Reconstruction/ Analysis tools | Atmospheric Flux Systematics |  |  |  |  | 0.10 |  | 0.10 |
|  | **ALBERTA GR Total** |  |  |  | **0.20** | **0.90** | **0.10** | **0.35** | **1.55** |
| **ALBERTA Total** |  |  | **0.70** | **0.60** | **0.45** | **1.40** | **0.45** | **0.45** | **4.05** |

**Faculty:**

**Full:** Darren Grant, Claudio Kopper, Roger Moore

**Associate (Gen2):** Carsten Krauss, James Pinfold

**Scientists and Post Docs:**

Chris Weaver: high-energy event generator development (the “LeptonInjector” project); PMT simulation and development of an atmospheric flux library (“NewNuFlux”); Offline-processing/pass2 support and implementation; IceTop veto module maintenance (“Shield”); Software and core framework support (“IceTray”)

Juan Pablo Yanez: Convener low-energy working group

Joshua Hignight: Simulation production site manager at Compute Canada Resource Allocation

**Ph.D. Students:**

Tania Wood (PhD) [graduating fall 2017]: (Analysis focus – low-energy atmospheric neutrino flux)

Sarah Nowicki (PhD): Direct Reconstruction tool development (Analysis focus – neutrino oscillations with DeepCore)

Sebastian Sanchez Herrera (PhD): DOM efficiency with cosmic muons (Analysis focus: BSM studies)

Sourav Sarkar (PhD): Grid Operations Team (Analysis focus: neutron capture from high-energy hadronic showers)

**Diploma/Master Students:**

Nicholas Kulacz (MSc): service work TBD, started Sept. 2017

**Undergraduates:** 4 students.

**Explanation:**

A Canadian Natural Science and Engineering Research Council (NSERC) Discovery Subatomic Projects grant was just renewed for a 2-year period to support IceCube and IceCube-Gen2 activities at the University of Alberta and SNOLAB.  The level of support is for 4 full-participant faculty (Clark, Grant, Kopper, Moore) and 2 associate faculty (Krauss, Pinfold). Also supported are Juan Pablo, Chris and Joshua with plans for 2 additional PDFs, up to 4 PhD students (in this time) and 4 undergraduate students at the University of Alberta.

**Description of service work and planned analysis:**

The Alberta group is focused on analyses involving data from DeepCore, the development of the PINGU and high-energy IceCube-Gen2 project and precision studies of astrophysical flux properties such as the flavour composition. Tania’s PhD thesis is the measurement of the atmospheric neutrino flux at energies to ~10 GeV with DeepCore. Sarah is currently working on a “direct reconstruction” tool development running photon propagation on the fly to build a reconstruction hypothesis and will complete her PhD thesis on a test of maximal theta\_atm mixing with the 5-year DeepCore dataset. Sebastian will conclude his absolute DOM efficiency with cosmic muons and will then move to his PhD topic of beyond-the-standard-model searches. Sourav is working as part of the Grid Operations Team instructed by the Madison grid group and is working on creating simulation tools allowing the detailed study of very high-energy showers in IceCube simulated with Geant4 well above its original energy limit. He will then move to his PhD topic of identification of hadronic cascades using a delayed signal from neutron capture and applications in neutrino flavor fits. The undergraduates this summer have worked on topics like trigger efficiency studies of PINGU and a direct fitter with simulation.

**Computing Resources**

Compute-Canada resources have been established as a primary simulation production resource for the IceCube collaboration. In 2017, a resource allocation of nearly 1700 CPU-years and 40 GPU-years from Compute-Canada was awarded to support IceCube activities. Claudio is in the process of constructing a high-performance GPU computing cluster based on TITAN X(p) GPUs with the first 96 GPUs online at this time and a total of 144 GPUs total online by late October 2017. Our service activities are centred on the simulation production and reconstruction developments with these resources, and calibration efforts.

GPU types:
\* 14 GPU-years on Tesla K20m [Compute Canada]
\* 22 GPU-years on Tesla M2070 [Compute Canada]
\* 144 GPU-years on TITAN X(p) [Claudio Kopper]