**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) : **5** (3 2 3) |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |  | Collaboration Spokesperson | x.xx |  |  |  |  |  | x.xx |
|  | **GRANT, DARREN Total** |  | **x.xx** |  |  |  |  |  | **x.xx** |
|  | KOPPER, CLAUDIO | Administration | Member of ICC | 0.05 |  |  |  |  |  | 0.05 |
|  |  | 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 |
|  |  | Engineering and R&D support  | Lead in-ice high-energy extension  | 0.15 |  |  |  |  |  | 0.15 |
|  |  | Offline Data Production | Offline Processing Support / pass2 |  |  |  | 0.10 |  |  | 0.10 |
|  | **KOPPER, CLAUDIO Total** |  | **0.20** | **0.25** |  | **0.20** | **0.15** |  | **0.80** |
|  | MOORE, ROGER | Detector Calibration | DOM efficiency with cosmic muons |  |  |  |  |  | 0.10 | 0.10 |
|  | **MOORE, ROGER Total** |  |  |  |  |  |  | **0.10** | **0.10** |
| PO | WEAVE, 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 |
|  | **ALBERTA, PO Total** |  |  | **0.25** |  | **0.25** | **0.15** |  | **0.65** |
| GR | Nowicki, Sarah | Reconstruction | Direct Reconstruction Tool Development |  |  |  | 0.50 |  |  | 0.50 |
|  | Sanchez Herrera, Sebastian | Detector Calibration | DOM efficiency with cosmic muons |  |  |  |  |  | 0.35 | 0.35 |
|  |  | Distributed Computing Resources | Grid Operations Team |  |  | 0.20 |  |  |  | 0.20 |
|  | Reconstruction (?) | PYTHIA event generator implementation and maintenance |  |  |  |  | 0.15 |  | 0.15 |
|  | **ALBERTA GR Total** |  |  |  |  | **0.50** |  | **0.35** | **0.85** |
| **ALBERTA Total** |  |  | **0.20** | **0.50** |  | **0.95** | **0.30** | **0.45** | **2.40** |

**Master Students M&O Contribution:**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |
| Master | Sarkar, Sourav **(MSc)** | Distributed Computing Resources | Grid Operations Team |  |  | 0.20 |  |  |  | 0.20 |
|  | Reconstruction (?) | PYTHIA event generator implementation and maintenance |  |  |  |  | 0.15 |  | 0.15 |
|  | **Master Students Total** |  |  |  | **0.20** |  | **0.15** |  | **0.35** |

**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 (PhD): Convener low-energy working group

**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)

**Diploma/Master Students: 1 new MSc student started September 2017.**

**Undergraduates:** 4 summer 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 and Chris with plans for 3 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 studies absolute DOM efficiency with cosmic muons and will then move to his PhD topic of beyond-the-standard-model searches. 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 48 GPUs online at this time and a total of 144 GPUs total online by June 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]