Memorandum of Understanding

for IceCube Maintenance and Operations

between

Board of Regents of the University of Wisconsin System (on behalf of the University of Wisconsin – Madison)

and the

Institutions of the IceCube Collaboration

May 2010

This Memorandum of Understanding ("MOU") effective April 1, 2010 ("Effective Date") is between the Institutions of the IceCube Collaboration ("Collaboration" or "Collaborating Institutions") and the Board of Regents of the University of Wisconsin System on behalf of the University of Wisconsin-Madison ("Host Institution") (collectively the "Parties"). The University of Wisconsin-Madison is both a collaborating institution and the Host Institution for the centrally managed M&O activities. The purpose of this MOU is to define the relationship of the Collaboration and the Host Institution for the Maintenance and Operations (M&O) phase of the IceCube detector and to establish the distribution of responsibilities between the Parties for the execution of M&O activities. The Parties will jointly maintain and operate the IceCube detector which is located at the South Pole Station operated by the National Science Foundation ("NSF"). The Parties share the common goal of enabling the full exploitation of the IceCube detector. Exhibit 1 provides a list of the Collaboration, Institutional Leads and number of Ph.D physicists at each institution.

The IceCube M&O program covers the period formally beginning on April 1, 2007, and shall remain in effect while the Host Institution continues to receive NSF funding for this project. Should the NSF Ice Cube Maintenance and Operations Cooperative Agreement to the Host Institution end, the Host Institution may assign its duties and responsibilities under this MOU to another Collaborating Institution. The M&O program includes:

1) maintenance and operation of the IceCube detector;
2) maintenance, upgrades, and documentation of the software and computing support required for data analysis;
3) the effort to ensure the integrity of the data;
4) research and development to optimize the existing detector and to manage the technical interfaces with potential expansions of the detector;
5) support for core central staff to ensure continuity of operations; and,
6) general coordination of education and outreach activities.

The M&O program comprises all of the actions needed to maintain and operate the individual components of the IceCube detector, along with the directly relevant infrastructure and facilities, in good working order.

This MOU does not constitute a legal or contractual obligation on the part of either Party; however, the Parties recognize that the success of the collaboration depends on adherence to its provisions. The Parties agree to negotiate changes to this Memorandum as needed to meet the evolving requirements of the IceCube detector.

1. Administration

To ensure the success of the Collaboration, the Host Institution will coordinate the overall IceCube detector M&O program. The Collaborating Institutions agree to provide relevant information on the status of M&O activities as necessary. The Host Institution agrees to make available to the Collaboration general status reports, including financial status and other major issues. The Host Institution agrees to establish and manage segregated accounts for the activities funded in common by the Collaboration ("Common Fund").

The IceCube International Oversight and Finance Group ("IOFG") is comprised of the major IceCube funding agencies and provides oversight for the IceCube M&O program. The IOFG member agencies are responsible for determining the annual funding for the M&O program, endorsing the arrangements for M&O cost sharing, monitoring and reviewing program implementation.

The Host Institution and the Collaboration management will report regularly to the IOFG on technical, managerial, financial and administrative matters, and on the composition of the Collaboration.

2. Roles and Responsibilities for Collaborating Institutions

Responsibility for M&O of the IceCube detector rests with the Collaboration as a whole and with the Host Institution. It is a fundamental principle of this agreement that each Institution within the Collaboration shall participate in maintenance and operation of the IceCube detector and contribute an equitable share to these activities. Institutions participating in construction are expected to continue to provide the scientific and technical personnel necessary to sustain the reliable operation of their original contributions. All Institutions are expected to obtain the support necessary from their funding agencies to keep the detector in good working order.

An Institution is considered "in good standing" if it has addressed its share for all previous years' responsibilities. If an Institution is unable to meet its obligations, the Director of Operations will bring this to the attention of the Collaboration Spokesperson, the IceCube Collaboration Board, and the IOFG.

3. M&O Funding

Any Institution that wishes to join the Collaboration during the period of validity of this MOU will be expected to make an appropriate contribution to the M&O program on an annual basis. Collaborating Institutions must contribute to the M&O program in two ways. The first is by contributing to the IceCube Common Fund by providing a combination of cash and/or payment of invoices for Common Fund Tasks. In addition, each institution is expected to contribute its fair share of "in-kind" by completing activities agreed upon by the Collaboration.

The Common Fund was established through dedicated accounts at the Host Institution, which are managed by the Host Institution and monitored by the Collaboration and the IOFG. Any and all monies contributed by the Host Institution, including the funds representing Common Fund payments from the U.S. Collaborating Institutions, shall comply with all terms and conditions associated with the NSF IceCube Maintenance and Operations Cooperative Support Agreement (CSA). This includes, but is not limited to, the NSF Cooperative Agreement Financial and Administrative Terms and Conditions (FATC) and the Cooperative Agreement Supplemental Financial and Administrative Terms and Conditions-Large Facilities (FATC-LG) as referenced in the CSA. In addition, contributions by Collaborating Institutions to the Common Fund are proportional to the number of Ph.D. physicists at the Collaborating Institution.

In November 2009, The NSF and the IOFG agreed to support an increase in the annual contribution rate to the IceCube M&O Common Fund. Effective April 1, 2010, the rate will increase from $9,100 to $13,650 per Ph.D. author. For example, two physicists would require a contribution of $27,300 US Dollars for the period of one year.
Exhibit 1 provides the census of IceCube institutional populations as of April 1, 2010. The Collaboration shall update this census twice a year at the Collaboration meetings and use it for calculating the Common Funds Contribution. The Common Fund annual calendar starts on October 1st and ends on September 30. When a new collaborating institution joins IceCube, the obligation to support the Common Fund is effective beginning with the next collaboration meeting. Authors of IceCube papers must be from Institutions in compliance with this MOU except as provided for in the governance document for joint publications with individuals who are not members of IceCube.

In-kind contributions, deliverables provided by Collaborating Institutions, Host Institution Deliverables, and Common Fund Tasks, are determined by the Collaboration twice a year at each collaboration meeting. The M&O activities identified as appropriate for support from the Common Fund are those core activities that are agreed to be of common necessity for reliable operation of the IceCube detector and computing infrastructure. The activities directly support the functions of winter over technical support at South Pole, hardware and software systems for acquiring and filtering data at the South Pole, hardware and software systems for transmitting data via satellite and tape to the UW data center, systems for archiving the data in the central data warehouse at UW and UW Data Center Operations as listed in the Cooperative Agreement with NSF. Proposed M&O tasks for the year starting on April 1st, 2010 are listed by institution in Exhibit 2.

4. General Considerations

Employees from Collaborating Institutions with responsibilities that include working at the South Pole Station or other Antarctic bases or sites agree to familiarize themselves with the NSF, Office of Polar Programs' safety and environmental policies and to adhere to these policies. All fabricated components must be designed, installed and operated in conformity with Collaborating Institution, NSF Office of Polar Programs and Host Institution safety and environmental policies and practices, engineering standards and the IceCube Quality Assurance Plan. The Host Institution will provide copies of the necessary standards and plans. All major components will undergo appropriate design, safety, and engineering reviews with oversight by the Host Institution.

The Collaborating Institution agrees to maintain, to the best of its ability, equipment provided for the IceCube detector so long as the Institution is a member of the Collaboration. All equipment, components, and software installed as a part of the IceCube detector and that are integral to the IceCube detector shall remain with the IceCube detector and under the auspices of the IceCube Collaboration Board unless otherwise specified.

5. Withdrawal or Termination

The Collaborating Institution may withdraw its support for this MOU by giving not less than a one year written notice to the Collaboration. In such an event, appropriate resolution of the Collaborating Institution's M&O responsibilities will be negotiated by the Host Institution and ratified by the Collaboration.

In the event that one of the Parties commits any breach or default in any of the terms or conditions of this MOU, the Parties will make an effort to resolve the issue. If this fails, the Host Institution will send notice to the Collaboration. In such an event, appropriate resolution will be negotiated through the Collaboration, with consultation with the IOFG as appropriate.

6. Approvals

This Memorandum of Understanding will remain in force until the parties mutually agree to modify or terminate it.

The following persons are authorized by their respective Parties to approve the terms of this Memorandum of Understanding.

7. Counterparts and Facsimiles

This Memorandum of Understanding may be executed in any number of counterparts, each of which shall be deemed to be an original, but all together shall constitute but one instrument. This Memorandum of Understanding shall be considered accepted once it has been executed by all of the parties. A signature delivered by facsimile or electronic means will be considered binding for all parties.

IN WITNESS WHEREOF, the parties hereto have caused this Memorandum of Understanding to be executed by their duly authorized representatives as of the date first set forth above.

University of Wisconsin-Madison

James H. Yeck May 7, 2010
James H. Yeck Date
IceCube Director

Francis Halzen May 7, 2010
Francis Halzen Date
IceCube Principal Investigator

Thomas K Gaisser May 7, 2010
Thomas K. Gaisser Date
IceCube Spokesperson

The Board of Regents of the University Of Wisconsin System

Kim Moreland Date
Director Research & Sponsored Programs

Collaborating Institutions

George Japaridze Date
Clark Atlanta University

Marek Kowalski Date 7.5.2010
Universität Bonn

Shigeru Yoshida Date
University of Chiba

Christian Spiering Date
DESY-Zeuthen

Wolfgang Rhode Date
Universität Dortmund

Paul Evenson Date May 7, 2010
University of Delaware

Ignacio Taboada Date
Georgia Tech

Lutz Koepke Date May 7, 2010
Universität Mainz

Dirk Ryckbosch Date
Universiteit Gent

Hermann Kolanoski Date 7.5.10
Humboldt Universität

Klaus Helbing Date July 27, 2010
Universität Wuppertal

David Besson Date
University of Kansas

Spencer Klein Date 7/5/10
Lawrence Berkeley National Laboratory

Evelyne Daubie Date JULY 26, 2010
Université de Mons

Greg Sullivan Date 5/7/10
University of Maryland

Elisa Resconi Date
MPI Heidelberg

Daniel Bertrand Date
Université Libre de Bruxelles

Subir Sarkar Date 12 July 2010
University of Oxford

James Beatty Date
Ohio State University

Dawn Williams Date 5/7/10
University of Alabama

Suraj Seunarine Date 7th May 2010
University of the West Indies, Barbados

Doug Cowen Date
Pennsylvania State University

Katherine Rawlins Date
University of Alaska-Anchorage

Albrecht Karle Date 5/7/10
University of Wisconsin-Madison

Christopher Wiebusch Date 7.5.10
RWTH Aachen

Darren Grant Date
University of Alberta

James Madsen Date 5/7/10
University of Wisconsin-River Falls

Ali Fazely Date 5/7/10
Southern University

Buford Price Date 5/7/10
University of California-Berkeley

Olga Botner Date 31.6.2010
Uppsala University

Per Olof Hulth Date 7.5.10
Stockholm University

Steven Barwick Date
University of California-Irvine

Catherine De Clercq Date
Vrije Universiteit Brussel

Julia Becker Date
Universität Bochum

Jennifer Adams Date 7 May 2010
University of Canterbury

Mathieu Ribordy Date
Ecole Polytechnique Fédérale de Lausanne

Funding Authority

_____

Dr. Ir. Elisabeth Monard Date
Secretary General FWO for
Universiteit Gent and
Vrije Universiteit Brussel

_____

Dr. V. Halloin Date
Secrétaire Générale du F.R.S.-FNRS for
Université Libre de Bruxelles and
Université de Mons

_____

Manfred Nettekoven Date
Chancellor
RWTH Aachen

_____

Lars Borjesson Date
Swedish Research Council for
Stockholm University and
Uppsala University

_____

James Symons Date
Nuclear Science Division Director
Lawrence Berkeley National Laboratory

_____

Dr. Stephen Conway Date
Head of Research Services
Science Area
University of Oxford

_____

Prof. Jörg Winter Date
Research Department of Plasmas with
Complex Interactions
Ruhr-Universität Bochum

Exhibit 1: IceCube Collaborating Institutions and Funding Agencies

Last updated: 6 May 2010

Collaborating Institution	Institution Lead	PhD. Authors	Funding Agency
University of Alabama	D. Williams	2	NSF
University of Alaska-Anchorage	K. Rawlins	1	NSF
Clark Atlanta University	G. Japaridze	1	NSF
Georgia Tech	I. Taboada	2	NSF
Lawrence Berkeley National Laboratory	S. Klein	7	NSF
Ohio State University	J. Beatty	3	NSF
Pennsylvania State University	D. Cowen	6	NSF
Southern University	A. Fazely	4	NSF
University of California-Berkeley	B. Price	3	NSF
University of California-Irvine	S. Barwick	2	NSF
University of Delaware	T. Gaisser	8	NSF
University of Kansas	D. Besson	1	NSF
University of Maryland	G. Sullivan	7	NSF
University of Wisconsin-Madison	A. Karle	18	NSF
University of Wisconsin-River Falls	J. Madsen	3	NSF
DESY-Zeuthen	C. Spiering	8	DESY
RWTH Aachen	C. Wiebusch	3	BMBF
Ruhr-Universität Bochum	J. Becker	2	BMBF
Universitaet Dortmund	W. Rhode	1	BMBF
Humboldt Universitaet Berlin	H. Kolanoski	2	BMBF
Universitaet Mainz	L. Koepke	1	BMBF
Universitaet Wuppertal	K. Helbing	3	BMBF
MPI Heidelberg	E. Resconi	2	DFG
Universität Bonn	M. Kowalski	2	DFG
Stockholm University	P. Hulth	6	SRC
Uppsala University	O. Botner	4	SRC
Universite Libre de Bruxelles	D. Bertrand	4	F.R.S - FNRS
Universite de Mons	E. Daubie	1	F.R.S - FNRS
University of Gent	D. Ryckbosch	3	FWO
Vrije Universiteit Brussel	C. De Clercq	6	FWO
University of Alberta	D. Grant	2	NSERC
University of the West Indies, Barbados	S. Seunarine	1	
University of Canterbury	J. Adams	2	MARSDEN
University of Chiba	S. Yoshida	3	JSPS
Ecole Polytechnique Federale de Lausanne	M. Ribordy	2	SNSF
University of Oxford	S. Sarkar	1	Oxford U.

Exhibit 2: Deliverables by Institution and Institutional Responsibilities

This table lists the M&O and analysis responsibilities of each institution. For each institution, M&O activities are listed on the first line and analysis activities on the second line. All groups participate in detector operations by taking two-week shifts to monitor IceCube runs. Number of shifts is proportional to number of IceCube scientists at each institution. Administration of working groups (WG) and committees is shared by multiple institutions; only the institution of the chair of each group is indicated below. Listed activities refer specifically to the 12 months starting on April 1st, 2010. UW M&O numbers include winter-over personnel.

Institution	Activity Type	Activity	FTE
University of Alabama	M&O	Flasher runs calibration, geometry , Simulation verification, Data Quality coordination	1.1
	Analysis	Composite-tau and Low energy. Also cascades.	
University of Alaska-Anchorage	M&O	SPASE / IceTop simulation; flat n-tuple	0.4
	Analysis	Coincident event analysis for composition of cosmic rays	
Clark Atlanta University	M&O	Detector Monitoring	
	Analysis	GRB neutrino search using time profile stacking	
Georgia Tech	M&O	Standard Candle Vertex and Energy Calibration, Chair of speakers' committee, Simulation Production	0.7
	Analysis	High energy neutrinos from Supernovae and GRBs including low-energy;	
Lawrence Berkeley National Laboratory	M&O	DAQ S/W and H/W maintenance; Detector Calibration; Publication Com., DOM Simulator & calibrator, Simulation programs	2.3
	Analysis	Diffuse cascades, high-Pt muons in cosmic rays; parallel upward tracks; Cascade WG co-lead; Diffuse WG co-lead, photon astronomy	
Ohio State University	M&O	Vertical events filter, Data Quality, maintain good run list	0.5
	Analysis	neutrinos from Dark Matter, muon neutrino disappearance effects in the vertical up-going events sample, WIMPs, correlated neutrino emission from gamma ray bursts (GRBs), EHE	
Pennsylvania State University	M&O	high level monitoring; trigger; calibration, Software coordinator, Deep Core filters, tau simulation, reconstruction	2.8
	Analysis	Low-energy neutrinos; atmospheric electron neutrinos; Tau neutrinos; point-sources; cascades; Hybrid/ Tau WG lead; Low-E co-lead	
Southern University	M&O	Simulation programs, LONI Grid computing, GEANT Simulations, Reconstruction	0.9
	Analysis	Supernovae; oscillations; WIMPs	

Institution	Activity Type	Activity	FTE
University of California-Berkeley	M&O	Calibration coordination; monitoring coordination, simulation of photon propagation and update ice properties	1.7
	Analysis	GRBs; gamma-ray astronomy with IceCube; Exotic particle searches; acoustic R&D; Diffuse/atmospheric WG co-lead	
University of California-Irvine	M&O	EHE event simulation	
	Analysis	EHE neutrinos	
University of Delaware	M&O	Monitor IceTop data and detector performance and recalibrate; IceTop maintenance, IceTop Simulation, Ice properties simulation	3.0
	Analysis	Cosmic-ray coincident event analysis; muon-WG co-lead; GZK neutrinos; Monitor solar activity; Radio R&D	
University of Kansas	M&O	EMI – Radio R&D	0.1
	Analysis	R&D Radio Analysis	
University of Maryland	M&O	Support IceTray software framework; on-line filter; simulation production; TFT board , Core Software support, simulation programs coordination, reconstruction	6.8
	Analysis	Analysis of neutrino-induced muons and downward muons; GRBs; WIMPs; beyond-standard model physics; atmospheric neutrinos; GRB-working group lead; Exotic WG Lead	
University of Wisconsin-River Falls	M&O	Outreach; IceTop monitoring and simulation, Reconstruction	0.6
	Analysis	Cosmic ray shower simulations	
University of Wisconsin-Madison	M&O	ICC Coordination; Simulation production coordination; DAQ maintenance; Manage SPS, SPTS, winter-over personnel, data warehouse, outreach; administer M&O grant; provide core computing infrastructure; coordinate distributed CPU resources; support R&D, offline processing, moon shadow, Supernova WG, Filters: muon, cascade online, DC online , GRB	31.1
	Analysis	Atmospheric neutrinos; atmospheric muons; point sources; diffuse flux; EHE-GZK search; gamma ray bursts; supernova; WIMP search; cosmic-ray physics, SN-WG lead	
RWTH Aachen	M&O	support simulation production; moon filter; D-grid-computing, Photonics production	2.9
	Analysis	Low-energy neutrinos; diffuse & atmospheric neutrinos, point sources Acoustic R&D; exotic particles; muon WG co-lead	
Universitaet Bochum	M&O	Simulation programs: MMC from Java to C++, neutrino generator	0.8
	Analysis	Energy Spectrum of Atmospheric Neutrinos, GRBs; point sources	
Universitaet Bonn	M&O	Run Coordinator, alert system for follow-up, IC-40 L3 processing, Reconstruction	1.6
	Analysis	Cascades, GRBs and supernovae; optical follow-up of IceCube events; Cascade WG co-lead	

Institution	Activity Type	Activity	FTE
DESY-Zeuthen	M&O	European data center; DAQ maintenance ; simulation production; Flasher calibration, Reconstruction framework, online filter for alerts.	4.3
	Analysis	Multi-messenger astronomy; monopoles; Cosmic ray, Point source, Acoustic R&D; cascades	
Universitaet Dortmund	M&O	Support simulation and verification, GRID Computing coordination, simulation programs: noise-generator	0.9
	Analysis	Point source search; diffuse & atmospheric neutrinos; CR muons	
Humboldt Universitaet Berlin	M&O	IceTop Operations, CR-WG Filter, Reconstruction Coordination	0.8
	Analysis	cosmic-ray physics with IceTop; CR-WG lead	
Universitaet Mainz	M&O	Supernova system operation and monitoring , monitoring live integration, simulation production, Reconstruction	1.8
	Analysis	Supernovae;	
MPI Heidelberg	M&O	Data Quality and Deep Core	1.2
	Analysis	Analysis Coordinator , Point source; multi-messenger astronomy ; low energy	
Universitaet Wuppertal	M&O	Simulation production; DAQ maintenance, R&D Lead, EMI Monitoring, SUSY filter reconstruction and simulation.	2.1
	Analysis	Air shower analysis techniques; direct SUSY detection; multi-track EHE; radio, acoustic R&D	
University of Gent	M&O	Simulation, reconstruction and calibration for IceTop, R&D support	0.6
	Analysis	Shower front shape and fluctuations; horizontal air showers	
Universite Libre de Bruxelles	M&O	GRID computing, simulation, EMI/R&D, DAQ, Simulation programs	1.2
	Analysis	WIMPs; point source searches	
Universite de Mons	M&O	Data base maintenance; simulation	0.3
	Analysis	Exotic particle searches with IceCube	
Vrije Universiteit Brussel	M&O	Muon track reconstruction, waveform feature extractor – verification Deep Core data quality, filter for Southern sky muons, simulation of ice properties	2.5
	Analysis	WIMP searches. GRBs, GRB/AGN; low energy	
Stockholm University	M&O	Nordic Grid simulation production, develop and verify filters, UHE trigger, WIMP trigger, photonics/simulation work	2.7
	Analysis	WIMP search; low-energy neutrinos; point sources; composite-tau; Point Source WG Lead; Low-E co-lead	

Institution	Activity Type	Activity	FTE
Uppsala University	M&O	GRID computing, simulation , acoustic R&D, online filter development, simulation programs: photonics	1.5
	Analysis	WIMP search; GRB; WIMP WG lead	
University of Alberta	M&O	WestGrid computing, photonics interface maintenance	0.5
	Analysis	DeepCore data analysis, Solar WIMP searches and a precision measurement of θ_{23} using atmospheric neutrinos. potential neutrino hierarchy measurement	
University of the West Indies, Barbados	M&O	Cascade filter, flasher runs calibration, standard candle runs	0.3
	Analysis	Analysis of flasher runs for in-ice calibration of saturation, and flasher and Standard Candle runs for absolute energy calibration for cascades.	
University of Canterbury	M&O	Data Quality, Reco. & Sim. Tools Coordinator ("Low-level" Analysis Coordinator), flasher runs	0.6
	Analysis	WIMPs; cascades; radio R& D	
Chiba University	M&O	maintain simulation tools; MC data production , EHE filters, Romeo, EHE simulations, reconstruction projects	1.0
	Analysis	EHE WG lead; GZK neutrinos; large events; large events in coincidence with IceTop	
University of Oxford	M&O	Yellow book	0.1
	Analysis	GZK neutrinos; Exotic particle searches	
Ecole Polytechnique Fédérale de Lausanne	M&O	IceTop Calibration; support acoustic R&D, SLF, Low Energy, Energy reconstruction (development)	0.4
	Analysis	EHE neutrinos; Atm. neutrinos, multi-messenger point sources	