

**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**

**April 2007**

This Memorandum of Understanding (“MOU”) effective April 1, 2007 (“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 will be 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. Initially, the contribution per scientist is \$9,100 USD which is approximately equivalent to 6460 Euros at the exchange rate of 0.7098 effective on Sept. 24, 2007. For example, three physicists would require a contribution of \$27,300 US Dollars for the period of one year. The Host Institution will indicate the exchange rate and Euro equivalent in effect on the date of each invoice sent to collaborating institutions. Exhibit 1 provides the census of IceCube institutional populations as of April 1, 2007. The Collaboration shall update this census annually, by March 31. 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 on an annual basis. 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. 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 and systems for archiving the data in the central data warehouse at UW. Proposed M&O tasks for PY06-08 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**

**The Board of Regents of the  
University Of Wisconsin System**

\_\_\_\_\_  
James H. Yeck            Date  
IceCube Director

\_\_\_\_\_  
Diane Barrett            Date  
Research & Sponsored Programs

\_\_\_\_\_  
Francis Halzen            Date  
IceCube Principal Investigator

\_\_\_\_\_  
Thomas K. Gaisser        Date  
IceCube Spokesperson

## Collaborating Institution

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George Japaridze      Date  
Clark Atlanta University

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Christian Spiering      Date  
DESY-Zeuthen

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Marek Kowalski      Date  
Humboldt Universität

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Azriel Goldschmidt      Date  
Lawrence Berkeley National  
Laboratory

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Elisa Resconi      Date  
MPI Heidelberg

---

Doug Cowen      Date  
Pennsylvania Sate University

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Christopher Wiebusch      Date  
RWTH Aachen

---

Ali Fazely      Date  
Southern University

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Per Olof Hulth      Date  
Stockholm University

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Wolfgang Rhode      Date  
Universität Dortmund

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Lutz Koepke      Date  
Universität Mainz

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Klaus Helbing      Date  
Universität Wuppertal

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Philippe Herquet      Date  
Université de Mons-Hainaut

---

Daniel Bertrand      Date  
Université Libre de Bruxelles

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Katherine Rawlins      Date  
University of Alaska-Anchorage

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Buford Price      Date  
University of California-Berkeley

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Steven Barwick      Date  
University of California-Irvine

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Jennifer Adams      Date  
University of Canterbury

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Shigeru Yoshida      Date  
University of Chiba

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Paul Evenson      Date  
University of Delaware

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Dirk Ryckbosch      Date  
Universiteit Gent

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David Besson      Date  
University of Kansas

---

Greg Sullivan      Date  
University of Maryland

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Subir Sarkar      Date  
University of Oxford

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Albrecht Karle      Date  
UW-Madison

---

James Madsen      Date  
UW-River Falls

---

Olga Botner      Date  
Uppsala University

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Nick van Eijndhoven      Date  
Utrecht University

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Catherine De Clercq      Date  
Vrije Universiteit Brussel

## Funding Authority

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

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Mrs. M-J Simoen              Date  
Secrétaire Générale du FNRS for  
Université Libre de Bruxelles and  
Université de Mons-Hainaut

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Dr. Achim Stahl              Date  
Chair Physikalisches Institut for  
RWTH Aachen

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

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James Symons              Date  
Nuclear Science Division Director  
Lawrence Berkeley National  
Laboratory

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

### Exhibit 1: IceCube Collaborating Institutions, Institutional Leads, and Funding Agencies

<b>Collaborating Institution</b>	<b>Institutional Lead</b>	<b>Scientists</b>	<b>Funding Agency</b>
University of Alaska-Anchorage	K. Rawlins	1	NSF
Clark Atlanta University	G. Japaridze	2	NSF
Lawrence Berkeley National Laboratory (UCB)	R. Stokstad	7	NSF
Pennsylvania State University	D. Cowen	9	NSF
Southern University	A. Fazely	4	NSF
University of California-Berkeley	B. Price	7	NSF
University of California-Irvine	S. Barwick	2	NSF
University of Delaware	T. Gaisser	11	NSF
University of Kansas	D. Besson	2	NSF
University of Maryland	G. Sullivan	8	NSF
University of Wisconsin-River Falls	J. Madsen	2	NSF
University of Wisconsin-Madison	F. Halzen	18	NSF
RWTH Aachen	C. Wiebusch	1	BMBF
DESY-Zeuthen	C. Spiering	10	DESY
Stockholm University	P. Hulth	5	SRC
Universitaet Dortmund	W. Rhode	2	BMBF
Universitaet Mainz	L. Koepke	2	BMBF
Universitaet Wuppertal	K. Helbing	3	BMBF
Universite Libre de Bruxelles	D. Bertrand	3	FNRS
MPI Heidelberg	E. Resconi	2	DFG
Humboldt Universitaet Berlin	M. Kowalski	1	DFG
Universite de Mons-Hainaut	P. Herquet	1	FNRS
University of Canterbury	J. Adams	2	NSF
University of Chiba	S. Yoshida	4	JSPS
University of Gent	D. Ryckbosch	2	FWO
Utrecht University	N. van Eijndhoven	4	NWO
Uppsala University	O. Botner	3	SRC
Vrije Universiteit Brussel	C. De Clercq	2	FWO
University of Oxford	S. Sarkar	2	STFC



## 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 PY06; they are expected to evolve with time. UW M&O numbers include winter-over personnel. Numbers in [square brackets] under M&O specify the service component of operations associated with supplements to base grants.

Institution	Funds	Activity	FTE and Equipment		
			PY06 total	PY07 total [service]	PY08 total [service]
University of Alaska-Anchorage	M&O	Maintenance of IceTray/icerec software for coincident events	0.1	0.1	0.1
	Analysis	Coincident event analysis for composition	0.12	0.12	0.12
Clark Atlanta University	M&O	Geometry verification and hit cleaning; simulation production	0.3	1.5	1.5
	Analysis	GRB neutrino search using time profile stacking	0.3	0.25	0.25
Lawrence Berkeley National Laboratory (via UCB)	M&O	DAQ maintenance; Run coordination; Detector Calibration;	1.25	2.12 [0.7]	1.21 [0.66]
	Analysis	Diffuse cascades, point sources with muon neutrinos; high-Pt muons in cosmic rays; parallel upward tracks; Cascade WG; Diffuse WG	1.5	2.5	2.5
Pennsylvania State University	M&O	Verification, high level monitoring and calibration; TWR maintenance	2.01	1.73 [1.07]	0.82 [0.82]
	Analysis	Low-energy neutrinos, including AMANDA in IceCube; atmospheric electron neutrinos; Tau neutrinos; Hybrid and tau channel WG	2.54	2.59	3.0
Southern University	M&O	Simulation production	0.4	0.4	0.4
	Analysis	Supernovae; oscillations; WIMPs	1.4	1.4	1.4
University of California-Berkeley	M&O	Calibration; monitoring	1.01	1.29 [0.83]	0.91 [0.91]
	Analysis	Ice Properties; standard candle analysis; GRBs; gamma-ray astronomy with IceCube; Exotic particle searches; acoustic R&D; Exotic events WG; GRB WG	1.50	1.71	1.57

Institution	Funds	Activity	FTE and Equipment		
			PY06 total	PY07 total [service]	PY08 total [service]
University of California-Irvine	M&O	EHE event simulation	0.16	0.16	0.16
	Analysis	GRBs; EHE neutrinos	1.2	1.2	1.2
University of Delaware	M&O	Monitor IceTop data and detector performance and recalibrate; Operate test station; IceTop maintenance	1.47	2.36 [0.95]	1.91 [1.42]
	Analysis	Cosmic-ray WG; coincident event analysis; atmospheric neutrinos; GZK neutrinos; Monitor solar activity; Radio R&D	2.52	2.89	4.86
University of Kansas	M&O	Support development of new technology	0.1	0.1	0.1
	Analysis	TBD			
University of Maryland	M&O	Support IceTray software framework; on-line filter; simulation production; Tier 2 support; TFT board	2.00	2.00 [0.75]	2.51 [1.01]
	Analysis	Analysis of neutrino-induced muons and downward muons; GRBs; WIMPs; beyond-standard model physics; atmospheric neutrinos; muon channel WG	2.73	2.54	2.69
University of Wisconsin-River Falls	M&O	Outreach; support IceTop re-survey	0.2	0.2	0.2
	Analysis	TBD			

Institution	Funds	Activity	FTE and Equipment		
			PY06 total	PY07 total [service]	PY08 total [service]
University of Wisconsin-Madison	M&O	Simulation production; analysis coordination; DAQ maintenance; Manage SPS, SPTS, winter-over personnel, data warehouse, web page, and outreach; administer M&O grant; coordinate simulation production; provide core computing infrastructure and DAQ maintenance; coordinate distributed CPU resources; support R&D	13.51	17.67 [2.42]	20.40 [3.34]
	Analysis	Atmospheric neutrino WG; point source WG; diffuse WG; atmospheric neutrinos; atmospheric muons; point sources; diffuse flux; EHE-GZK search; gamma ray bursts; supernova; WIMP search; cosmic-ray physics, downward muons	12.17	10.54	11.29
RWTH Aachen	M&O	Support AMANDA TWR DAQ; support simulation	0.8	0.8	1.0
	Analysis	Low-energy neutrinos; Acoustic R&D	1.4	1.4	1.4
DESY-Zeuthen	M&O	European data center; DAQ maintenance (DOR card); simulation production	4.5	4.7	4.8
	Analysis	point source WG; multi-messenger astronomy; monopoles; Energy spectrum with IceTop-16; Acoustic R&D; atmospheric neutrinos; cascades	6.4	7	7
Stockholm University	M&O	Nordic Grid simulation	2.9	2.8	2.8
	Analysis	WIMP WG; WIMP search; UHE events; low-energy neutrinos	2.3	2.3	2.3
Universitaet Dortmund	M&O	Support simulation and verification	0.4	0.5	0.5
	Analysis	Point source search; diffuse & atmospheric neutrinos	2.2	2.2	2.2

Institution	Funds	Activity	FTE and Equipment		
			PY06 total	PY07 total [service]	PY08 total [service]
Universitaet Mainz	M&O	Supernova system operation and monitoring.	0.4	0.4	0.4
	Analysis	Publication committee; Supernovae; SN WG	2.8	2.8	2.8
Universitaet Wuppertal	M&O	Simulation production; support TWR DAQ; DAQ maintenance (DOR card)	1.4	1.2	1.2
	Analysis	Air shower analysis techniques; GRBs; multi-track EHE; radio, acoustic R&D	3.0	3.2	3.2
Universite Libre de Bruxelles	M&O	GRID computing, simulation	0.75	0.75	0.75
	Analysis	WIMPs; point source searches	2.0	2.0	2.0
MPI Heidelberg	M&O	Support verification	0.2	0.2	0.2
	Analysis	:Point source; multi-messenger astronomy	1.6	1.6	1.6
Humboldt Universitaet Berlin	M&O	Support simulation; optical follow-up of IceCube events (PY08)	0.2	0.2	0.8
	Analysis	Neutrinos from GRB, SNe; cascades; R&D for optical follow-up of IceCube events	1.4	1.4	1.4
Universite de Mons-Hainaut	M&O	Data base maintenance; simulation	0.3	0.5	0.7
	Analysis	Amanda TWR	1.1	1.1	1.1
University of Canterbury	M&O	Simulation;	0.5	0.6	0.7
	Analysis	WIMPs; cascades; radio R& D	2.3	2.3	2.3
University of Chiba	M&O	PMT calibration; maintain simulation tools	0.8	0.9	1.0
	Analysis	EHE WG; GZK neutrinos; large events; large events in coincidence with IceTop	2	2	2
University of Gent	M&O	Simulation for IceTop	0.3	0.3	0.4
	Analysis	Shower front shape and fluctuations; horizontal air showers	1.7	1.7	1.7
Utrecht University	M&O	Support verification	0.2	0.2	0.2
	Analysis	GRB analysis	2.4	2.4	2.4
Uppsala University	M&O	GRID computing, simulation	0.4	0.4	0.4
	Analysis	WIMP search; GRB; Speakers' Committee	1.9	1.9	1.9

Institution	Funds	Activity	FTE and Equipment		
			PY06 total	PY07 total [service]	PY08 total [service]
Vrije Universiteit Brussel	M&O	GRID computing, simulation	0.75	0.75	0.75
	Analysis	WIMP search; point source searches	2.0	2.0	2.0
University of Oxford	M&O	Yellow book	0.5	0.5	0.5
	Analysis	GZK neutrinos; Exotic particle searches	0.5	0.5	0.5