

## IceCube Project Monthly Report May 2006

### Accomplishments

The NSF conducted the annual progress review of the IceCube Construction Project on May 23-25, 2006. The closeout briefing included a number of positive comments and recommendations.

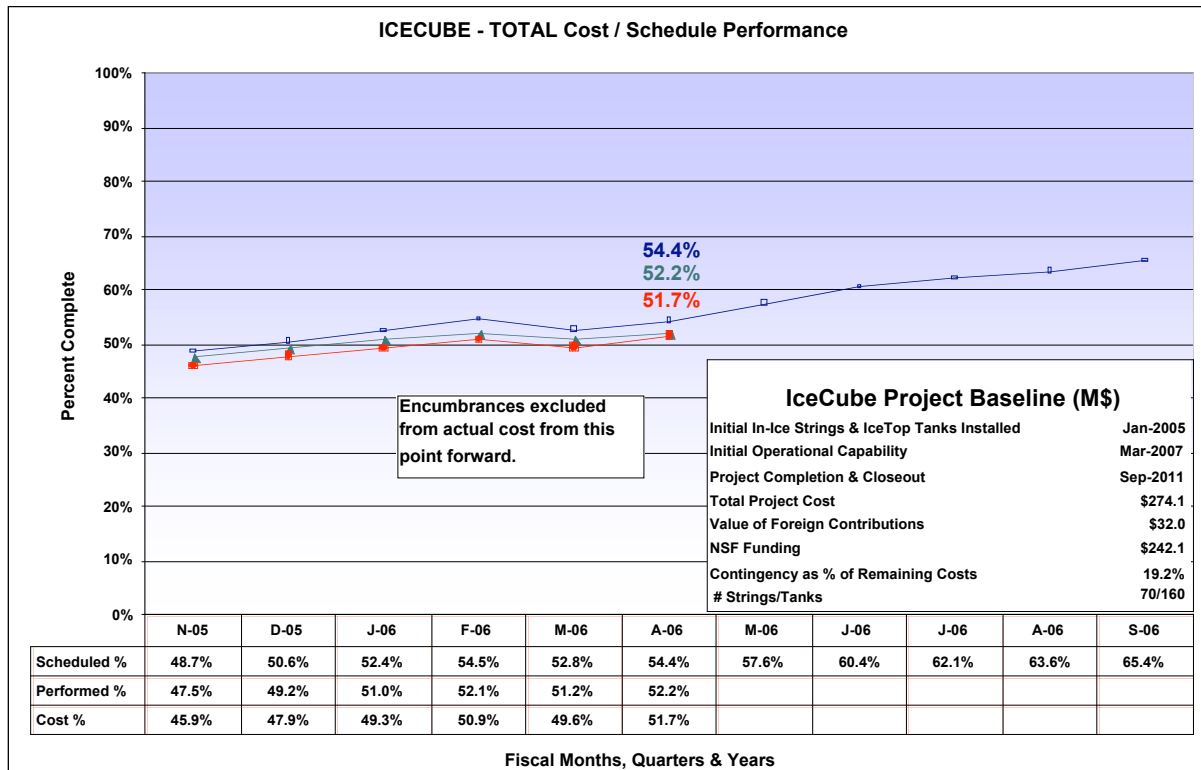
The on-line data filter for atmospheric muon neutrinos was implemented one month ahead of schedule and it is now possible to transmit this data over the satellite.

The verification group continues to collect data on detector performance. The data is stored on computers at the South Pole with summary information transmitted to Madison once per month.

During the month of May data acquisition ran on all 9 in-ice strings and 16 IceTop stations and collected 172 million events.

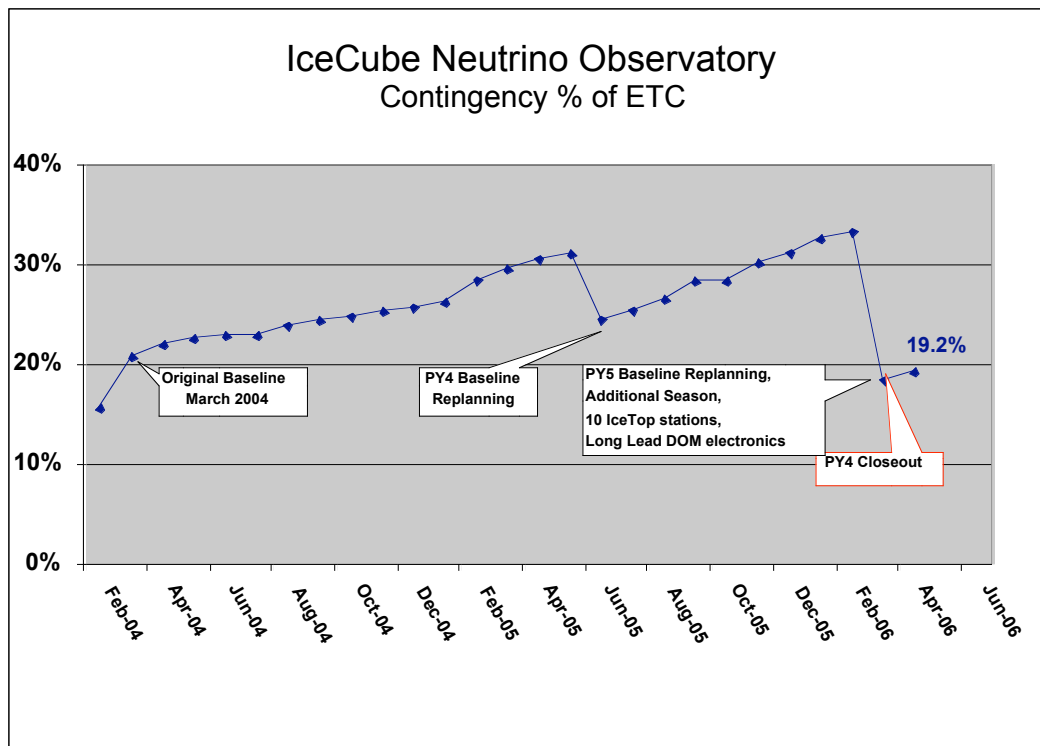
DOM main board production continues on schedule and well in advance of DOM production requirements.

Two modular dark freezer laboratories (MDFL) at the UW Physical Science Laboratory are now commissioned and the third will be fully commissioned in July.



**Cost and Schedule Performance** – The project is 52.2% complete versus the planned performance of 54.4% complete as measured using earned value techniques. The earned value measurement includes all tasks completed to date including design, development, procured materials, and the construction of the infrastructure that supports the seasonal installation plan, e.g., the hot water drill, cargo shipments, etc.

IceCube Neutrino Observatory Cost Schedule Status Report Reporting Period Ending: 4/30/2006 <sup>1</sup>											
OBS Structure L2	Cumulative To Date (AY K\$)					At Completion (AY K\$)			Complete (%)		
	Budgeted Cost <sup>2</sup>		Actual Cost of Work Performed	Variance		Budgeted AY \$s	Latest Revised Estimate	Variance	Scheduled	Performed	Actual
	Work Scheduled	Work Performed		Schedule	Cost						
PROJECT SUPPORT	17489.0	17494.3	17637.8	5.3	-143.5	30765.2	30908.7	-143.5	56.8%	56.9%	57.3%
IMPLEMENTATION	21551.1	21237.6	21376.4	-313.6	-138.8	37853.9	37992.8	-138.8	56.9%	56.1%	56.5%
INSTRUMENTATION	35856.3	35931.6	35706.6	75.3	224.9	68974.8	68749.9	224.9	52.0%	52.1%	51.8%
DATA ACQUISITION	21918.6	21759.7	22098.8	-159.0	-339.2	34072.6	34411.7	-339.2	64.3%	63.9%	64.9%
DATA SYSTEMS	13053.6	12298.0	12743.1	-755.6	-445.1	25368.9	25813.9	-445.1	51.5%	48.5%	50.2%
DETECTOR COMM. & VERIFICATION	9755.6	9455.7	9159.8	-299.9	295.9	20045.9	19750.0	295.9	48.7%	47.2%	45.7%
RPSC SUPPORT	16512.6	12459.7	10600.8	-4052.9	1858.9	32781.2	30922.4	1858.9	50.4%	38.0%	32.3%
NSF	567.3	567.1	567.1	-0.2	0.0	1263.0	1263.0	0.0	44.9%	44.9%	44.9%
Sub Total	136704.1	131203.6	129890.5	-5500.4	1313.2	251125.5	249812.4	1313.2	54.4%	52.2%	51.7%
Management Reserve											
Total Contingency						22,992.2	24,305.4	1,313.2			
Items Outside of Approved Baseline											
IceCube Neutrino Observatory <sup>2</sup>	136,704.1	131,203.6	129,890.5	-5,500.4	1,313.2	274,117.7	274,117.7	0.0	54.4%	52.2%	51.7%



The cumulative schedule variance at the end of April is negative \$5.5 million, predominantly due to delays completing the IceCube Laboratory (counting house) and earned value reporting by RPSC. The baseline for work managed by UW was revised to incorporate the Project Year 5 (PY5), April 1, 2006 – March 31, 2007, detailed planning and closeout of PY4. The favorable cost variance of \$1.3M is also dominated by the RPSC reporting. The positive variance was reduced by approximately \$2.3M since the previous month to correct a long-standing RPSC accounting error. The cost commitment for Air National Guard (ANG) air transport support during the 2004/2005 was removed without transferring the associated costs to actual expenditures.

The project contingency is now relatively tight given that the project is just over one-half complete. A detailed contingency analysis was presented to the NSF review panel in May. The analysis included a risk based assessment of the contingency required at a detailed level of the Work Breakdown Structure and an adjusted value to address a more global assessment of the cost and schedule exposure, e.g., the pending increase to the RPSC budget, an additional year of installation beyond the current plan, the scope addition of a fire suppression system in the IceCube Laboratory, etc. The information is presented at a summary level in the following table:

30-April-06		Risk Model		Adjusted	
Budget Category	Estimated to Complete	Contingency Percent (%)	Contingency Amount (K\$)	Contingency Amount (K\$)	Contingency Percent (%)
Project Support	\$13,417,457	8.41%	\$1,128K	\$1,128K	8.41%
Implementation	\$16,124,079	21.09%	\$3,401K	\$10,100K	62.64%
Instrumentation	\$33,628,880	7.44%	\$2,503K	\$2,503K	6.11%
Data Acquisition	\$11,156,470	10.50%	\$1,172K	\$1,172K	9.60%
Data Systems	\$12,633,224	18.68%	\$2,359K	\$2,359K	18.68%
Commissioning & Verification	\$9,312,645	15.68%	\$1,460K	\$1,460K	15.68%
Polar Support Services	20,017,080	20.30%	\$4,064K	\$7,142K	35.68%
National Science Foundation	\$694,767	6.00%	\$42K	\$160K	23.03%
IceCube Total	\$116,984,602	13.79%	\$16,128K	\$25,475K	21.78%

Actual Contingency Percent of ETC ~ 20%

The NSF panel concluded that:

“IceCube estimates that they need 25.5 M\$ of contingency to complete the 70 string installation. They currently have 23 M\$. Based on their historical use of contingency they need 22 M\$. Based on this, the Panel believes that they can deliver 70 strings provided that they continue to manage contingency allocation carefully.”

The project is planning to aggressively manage the remaining contingency to ensure the successful installation of 70 strings and the possibility of some additional strings.

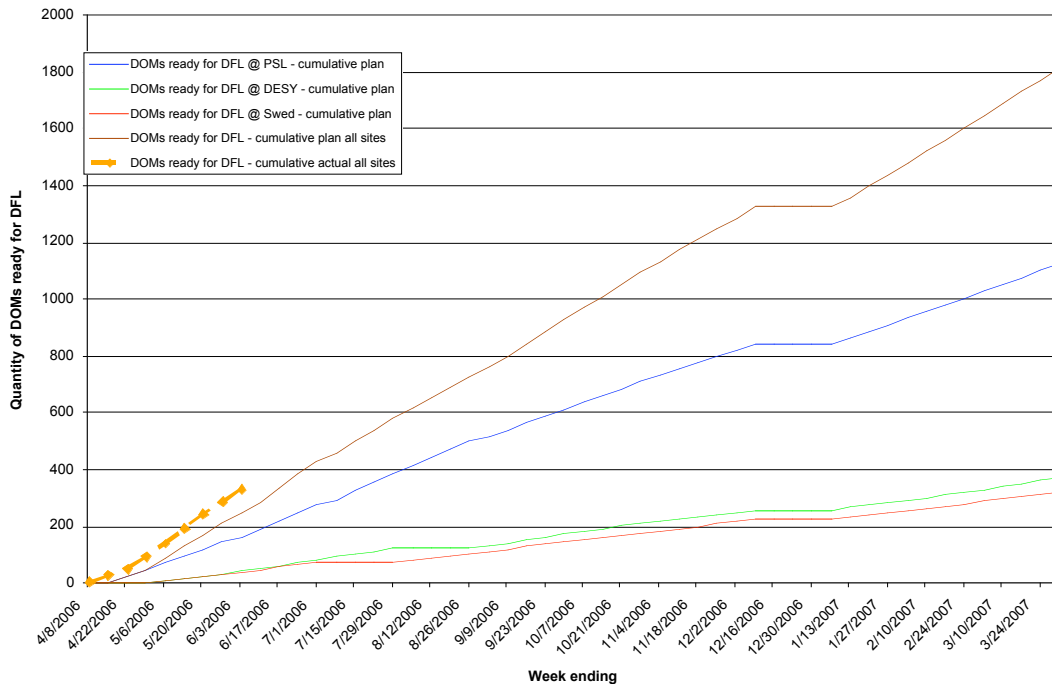
**Drill Operation and String Installation** – Most of the drill equipment upgrades planned for this summer are far enough along that parts are now being ordered and fabrication is underway. A crew of seasonal drillers and students was assembled in Madison and started work. Tom Hutchings joined the UW team as Drilling and Installation Manager. Schedules for the summer work and for the equipment upgrade work on the ice are being developed. The main drill hose and camp surface hose order for this year was placed. A conceptual design for the firm drill was

selected that uses electric heaters at the surface (supplied by the drill generating plant) to heat propylene glycol that will be circulated through a firm drill head. A plan was adopted for the testing and training area at PSL and construction is underway. We determined that a single power cable and a single signal cable is the best solution for connecting the Tower Operations Site to the Seasonal Equipment Site. The failure of the drill head communications on two holes last season was tracked to a water leak in an auxiliary instrumentation cable. The damaged cable will be replaced with an improved cable. Work on fabrication of a third drill head is proceeding in parallel.

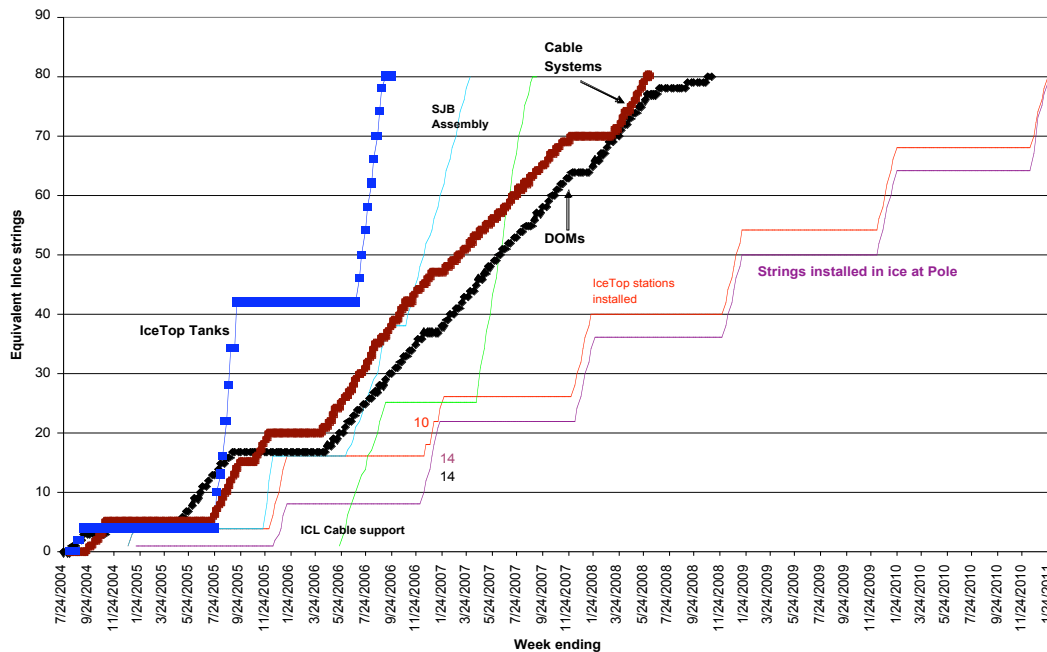
**Logistics** – IceCube is currently in the process of improving the weights and cubes estimates for submission to RPSC. An inventory system is being researched to keep better track of the EHWD and its components. At the present time storage options for instrumentation equipment is being assessed.

**Digital Optical Module and Cable Production Status and Plans** - The plan for DOM production for 2006 is provided in the chart below along with the plan for DOM, cable, and tank production plan for 2004 – 2008. There are no major issues with instrumentation production. The plans provide instrumentation well in advance of the installation dates and support the use of the least expensive shipping methods.

**IceCube DOM Integration PY5 (April, 2006 to March, 2007) - Plan vs. Actual**



Instrumentation Production CY2004 - CY2008 for 80 strings installed



**DOM Testing at UW-Madison** – The two of the three modular dark freezer laboratories (MDFL) are fully commissioning. The third MDFL is scheduled to be commissioned in July. Until recently, all DOM production in the U.S. was carried out using a single dark freezer laboratory. IceCube is in need of expanded DOM testing capability due to the large number of DOMs that will be needed in the next and subsequent seasons.

The first FAT in MDFL-1 was completed in late May. Of the 60 DOMs that were tested 12 DOMs failed. The main failure modes were high rates and flasher board failures.

**Detector Commissioning and Verification** – The verification effort has produced a comprehensive set of plots demonstrating the high quality performance of the newly deployed strings. These plots will be used by the collaboration in summer conferences. The verification group continues to collect data from Pole and has set up a complete system for analyzing the data on the computers at the pole, and then shipping only summary information to the north. This enables us to work with extremely large datasets that are too large to fit over the satellite bandwidth. Without this system, we would otherwise have to wait until November 2007 to look at this data.

The calibration effort has begun Stage 3 geometry calibration using downward-going muons. The first gain calibration has been partially completed and compares favorably to the existing laboratory measurements.

The monitoring system is being used regularly by collaborators. An automated procedure for creating monitoring plots of high level quantities, such as the downward-going muon angular

distribution, has been implemented and is under test. Initially these plots will be loosely coupled to the existing monitoring page and in a few months more tightly coupled.

Data from the AMANDA TWR system has been read into the IceCube software framework and analyzed. Minor bugs have been found and fixed, and we anticipate full reconstruction of AMANDA-only events and, eventually, joint AMANDA-TWR/IceCube events in the near future. Work on the IceSim-based TWR simulation is progressing well.

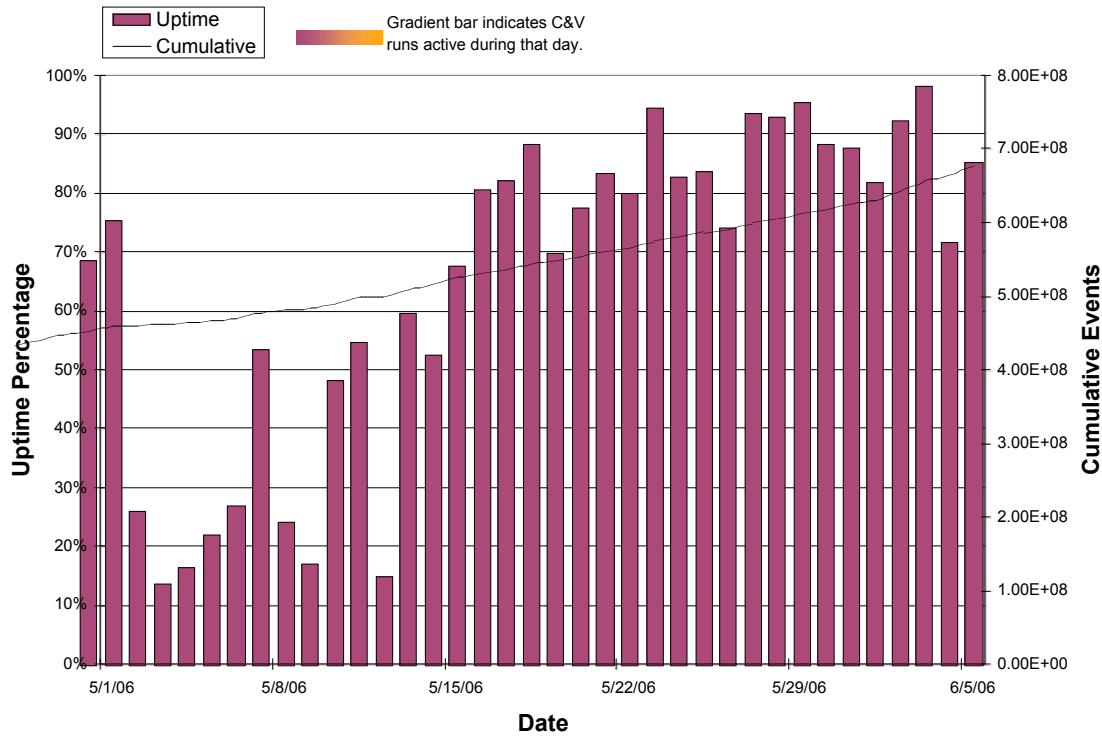
***Data Acquisition System Hardware*** - The primary deliverables for the DAQ hardware group are 1250 DOM Main Board Assemblies, one GPS/Master Clock Distribution system and 35 DOMHub Industrial Computers.

DOM Main Board production continues to progress smoothly. To date, Sanmina-SCI, the Mainboard manufacturer, has delivered 1050 of the DOM Main Board subassemblies to LBNL for final board level testing. 890 of the DOM Main Board assemblies have been delivered to DOM assembly sites in Wisconsin, Germany, and Sweden. Deliveries are well ahead of schedule. The current delivery plan is to complete all European shipments before July 1<sup>st</sup> and US shipments by August 1<sup>st</sup>.

The final version of the GPS/Master Clock Distribution system, which is used to distribute time codes and system clocks to all of the DOM/Hubs in the IceCube array, is in the last stages of fabrication. The first article units have been built and tested, the production revision of the PC board is being fabricated, and all parts are in hand. A first article unit will be delivered to the South Pole Build System (SPBS) at UW Madison in the middle of June, and all of the final tested production units required for the full distribution system will be delivered by the middle of July.

The production of the complete quantity of DOM/Hub computers may be late to arrive at the SPBS this year due to an industry wide shortage of the low power microprocessor used on the specified Single Board Computer. The SBC manufacturer has been able to procure 17 of the microprocessors and hopes to receive the remainder by the middle of July. All of the other parts that are required for DOM/Hub production are in hand at the integration house. While 17 of the 35 DOM/Hubs will be delivered on schedule to the SPBS, mitigation planning has been initiated to resolve the microprocessor shortage before there is a real impact on the South Pole delivery schedule for the DOMHubs.

***Data Acquisition System Software*** - During the month of May, 2006, the IceCube Data Acquisition running on 9 in-ice strings and 16 IceTop stations collected 172 million events. At the outset the system suffered from poor reliability as the average rate of hits from all array modules entering the trigger and event processors was increased from 3 kHz to 5 kHz following the increase of the DOM local coincidence (LC) trigger windows from 125 ns to 1000 ns on all DOMs. After several unsuccessful attempts to diagnose and correct the problem on the South Pole System (SPS) it was decided to return the LC windows to 125 ns and attempt diagnosis on the South Pole Test System (SPTS). The graph of uptime versus day of month is shown in the following figure:



Much of May was spent increasing the instrumentation density in the DAQ components so that the problem could be understood. On 6/1/2006 the trigger window was returned to 1000 ns for the deep ice modules following the discovery that reduction of the periodic hit strobes, colloquially called beacons, from 5 Hz to 1 Hz was sufficient to bring the DAQ back into stable operation. These strobes are used for debugging and to force periodic flushes of the caches and it is believed that 1 Hz is sufficient for these purposes.

As the stability issues wane attention now turns to completion of the first major DAQ release since start of DAQ operations on February 13<sup>th</sup>, a release which supports readout of the supernova system and which will enable sensitivity to gravitation collapse events in our galaxy. We expect SPTS testing of this release to occur mid-June and deployment to occur before the close of June.

**Data Systems** - Work is continuing on the South Pole Build System (SPBS) at UW for planned shipment to Pole in October. The SPBS is the computing system to be installed at the IceCube Counting House (ICL) this season at pole, and consists of approximately 17 racks with associated computer systems, networking infrastructure, cabling and power distribution. The build, shipment and installation of the SPBS this season in the ICL is major project milestone. We remain on schedule with the SPBS.

Installation of the first major computing equipment for the Northern hemisphere Tier 1 Data Center at UW was started. Northern Hemisphere UW Tier 1 Data warehouse is functioning well and ingesting IceCube 9-string data into the warehouse as it is received over the satellite at an average rate of ~6.5 GB/day.

During the previous month a major milestone for Filtering was accomplished one month ahead of schedule with the implementation of online filtering to select (i.e. filter) events as possible atmospheric muon neutrinos for transmission over the satellite. This represents a significant level of systems integration between, DAQ, Online, Experiment Control, Database, Offline Software and Reconstruction efforts. Significant enhancements to the online and offline database tools for IceTray were also delivered this last month.

**Quality Assurance & Safety** – Approximately 420 non-conforming material (NCM) reports have been written regarding failures or issues with verification of DOM's, test equipment, DOM components and production articles. Roughly 378 of the NCMs have been closed. Additional work on the NCM process is currently being addressed. This will help to speed up analyses and increase the closure rate over the coming months. Corrective/preventive Action planes have been implemented to reduce and/or eliminate the potential for recurrence.

The Safety Manual is in the process of being reviewed to incorporate any lessons learned from the past South Pole Season, including the new Safety Hierarchy at the Pole. The coming season will see additional focus on the creation of an improved safety culture on site.

A variety of training has been set up for the summer for those that intend on traveling to the South Pole. Everyone will be able to participate in computer based snowmobile training and first-aid/CPR training. Forklift training is being planned also. During Drilling and Deployment training those attending will learn about generic OSHA standards and specific standards customized for the unique environment at the drill site.

Hazard analyses will take place later this summer for the IceCube Laboratory, once the preliminary design documents are finished. All hazard analyses will be reviewed and revised based upon the design/process changes and from input from the recent South Pole Season.

The monthly reports are posted at [IceCube Monthly Reports](#).

### **Meetings and Events**

Summer Analysis Meeting – Penn State	June 21-25, 2006
Simulation Meeting – Penn State	June 26-29, 2006
DuPont Safety Training – Wisconsin	June 28-30, 2006
Drilling and Deployment Training – Madison	July 24-August 4, 2006
NSF Review of IceCube Operations Plans – Madison	August 1-3, 2006
International Oversight and Finance Group Meeting - DESY	September 11, 2005
Season Confirmation Meeting – RPSC	September 12, 2006
Safety Table-Top Meeting – RPSC	September 13, 2006
IceCube Collaboration Meeting – DESY	October 6-10, 2006