

## IceCube Project Monthly Report March 2007

### Accomplishments

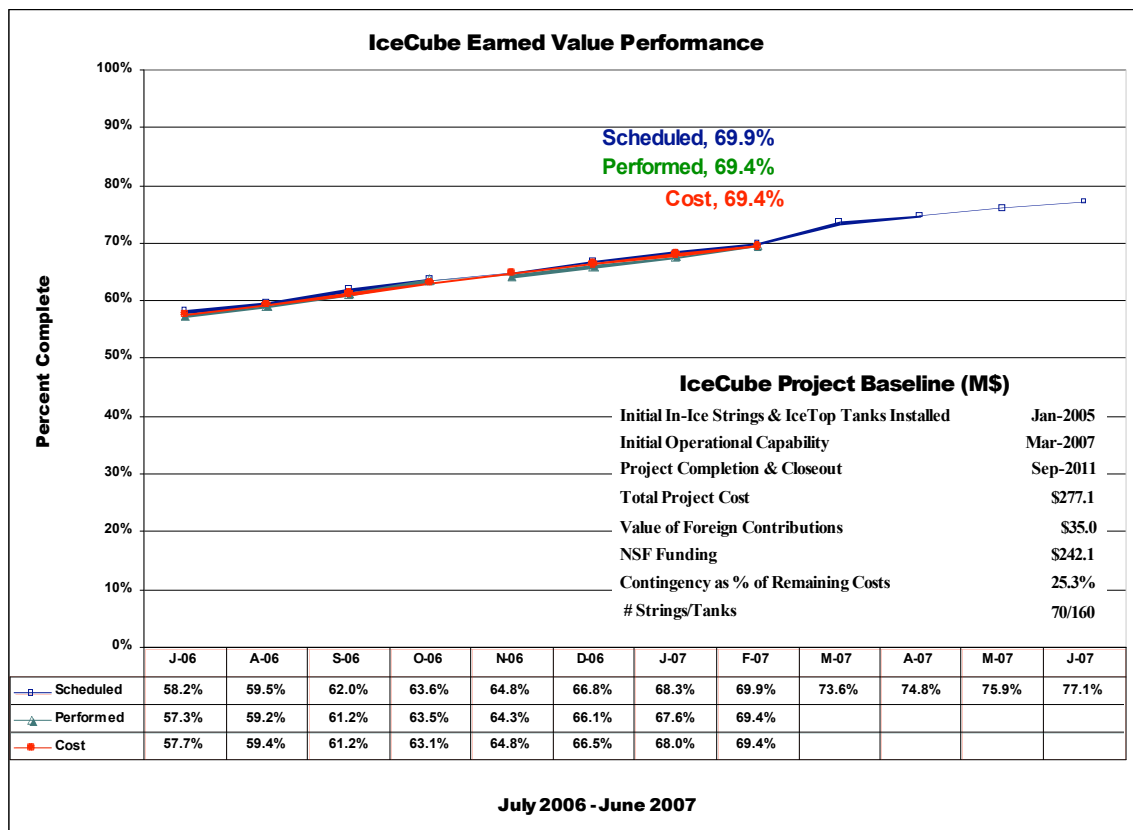
The data acquisition system reliability improved significantly this month after the resolution of a recurring instability issue. The DAQ is now very stable, running with very high uptime in excess of 95%. The in-ice coincidence trigger was relaxed and the trigger threshold was improved from a 20-fold multiplicity setting to 8-fold.

The IceCube Project Advisory Panel and Science Advisory Panel met together in early March to provide advice on the construction end game plan, the transition to operations, and plans for analysis. NSF program managers attended the meeting.

UW-Madison submitted a revised proposal for maintenance and operations covering the period from April 1, 2007 – March 31, 2010. NSF convened a panel to review the revised proposal on March 15-16, 2007. The revised proposal addressed recommendations from the original proposal review in August 2007 and more recent funding guidance from NSF.

The annual strategic planning meeting to review the previous field season and establish goals for the next season was held at UW-Madison in early March and a more detailed scheduling meeting was held at Raytheon Polar Services Company later in the month.

Digital Optical Module (DOM) production continues to progress smoothly and without any major issues.

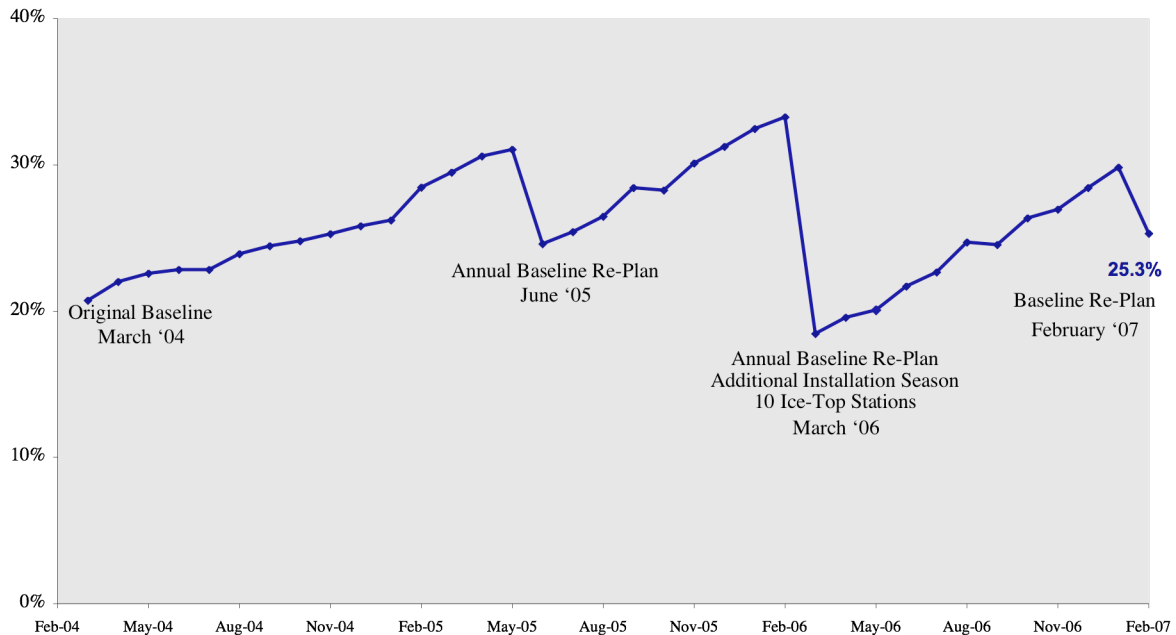


**Cost and Schedule Performance** – The project is 69.4% complete versus the plan of 69.9% complete, as measured using Earned Value techniques. The Earned Value measurement includes all tasks completed to-date including design, development, procured materials, as well as the construction of the infrastructure which supports the seasonal installation plan, e.g., the Enhanced Hot Water Drill (EHWD), cargo shipments, etc.

| IceCube Neutrino Observatory<br>Cost Schedule Status Report<br>Reporting Period Ending: 2/28/2007 <sup>Note 1</sup> |                             |                |                               |          |          |             |  |                 |                         |              |       |       |           |
|---|-----------------------------|----------------|-------------------------------|----------|----------|-------------|--|-----------------|-------------------------|--------------|-------|-------|-----------|
| OBS Structure L2  | Cumulative To Date (AY K\$) |                |                               |          |          |             | At Completion (AY K\$) <sup>Note 5</sup> |                 |                         | Complete (%) |       |       |           |
|   | Budgeted Cost <sup>2</sup>  |                | Actual Cost of Work Performed | Variance |          | Contingency |  | Budgeted AY \$s | Latest Revised Estimate | Variance     | Sched | Perf  | Actl Cost |
|   | Work Scheduled              | Work Performed |                               | Schedule | Cost     | Assigned    | % ETC                                    |                 |                         |              |       |       |           |
| Project Support   | 20,624.6                    | 20,573.0       | 20,037.6                      | -51.5    | 535.5    | 360.3       | 4.8%                                     | 28,743.4        | 27,535.2                | 1,208.3      | 71.8% | 71.6% | 69.7%     |
| Implementation  | 27,044.7                    | 27,109.6       | 28,222.6                      | 64.9     | -1,113.0 | 3,617.3     | 22.3%                                    | 42,965.0        | 44,413.4                | -1,448.4     | 62.9% | 63.1% | 65.7%     |
| Instrumentation   | 52,551.1                    | 52,189.3       | 51,242.5                      | -361.7   | 946.8    | 7,019.0     | 36.6%                                    | 70,144.4        | 70,428.7                | -284.4       | 74.9% | 74.4% | 73.1%     |
| Data Acquisition  | 28,630.4                    | 28,544.8       | 28,289.2                      | -85.6    | 255.6    | 229.5       | 4.9%                                     | 33,181.7        | 32,954.5                | 227.2        | 86.3% | 86.0% | 85.3%     |
| Data Systems  | 18,721.9                    | 18,128.1       | 19,359.5                      | -593.8   | -1,231.4 | 1,006.4     | 14.0%                                    | 25,844.4        | 26,557.0                | -712.6       | 72.4% | 70.1% | 74.9%     |
| Detector Comm. & Verification   | 14,411.8                    | 14,179.1       | 14,285.2                      | -232.7   | -106.1   | 2,602.4     | 32.8%                                    | 22,228.4        | 22,228.4                | 0.0          | 64.8% | 63.8% | 64.3%     |
| Subtotal  | 161,984.4                   | 160,724.0      | 161,436.6                     | -1,260.5 | -712.6   | 14,834.8    | 23.7%                                    | 223,107.4       | 224,117.3               | -1,010.0     | 72.6% | 72.0% | 72.4%     |
| RPSC SUPPORT  | 17,146.7                    | 17,114.5       | 16,470.1                      | -32.3    | 644.3    | 5,042.3     | 26.1%                                    | 32,817.5        | 35,817.5                | -3,000.0     | 52.2% | 52.2% | 50.2%     |
| NSF   | 678.2                       | 678.2          | 678.2                         | 0.0      | 0.0      | 35.1        | 6.0%                                     | 1,263.0         | 1,263.0                 | 0.0          | 53.7% | 53.7% | 53.7%     |
| Total   | 179,809.4                   | 178,516.6      | 178,584.9                     | -1,292.8 | -68.3    | 19,912.2    | 24.1%                                    | 257,187.8       | 261,197.8               | -4,010.0     | 69.9% | 69.4% | 69.4%     |
| CONTINGENCY <sup>Notes 3,4</sup>  |                             |                |                               |          |          |             |  | 19,912.2        | 15,902.3                | 4,010.0      |       |       |           |
| IceCube Total <sup>Note 2</sup>   | 179,809.4                   | 178,516.6      | 178,584.9                     | -1,292.8 | -68.3    | 19,912.2    | 24.1%                                    | 277,100.1       | 277,100.1               | 0.0          | 69.9% | 69.4% | 69.4%     |

Notes: 1 Incorporates approved baseline changes.  
2 Total Budget at Completion includes non-US contributions 5,329 K over the amount in the post Hartill III baseline of: \$29,698 K  
3 Budgeted contingency is: 25.3% of the Budgeted cost of work remaining.  
4 Budgeted contingency is: 24.1% of the Estimated Cost to Complete (ETC)  
5 All latest revised estimates equal the proposed revised baselines resulting from PY6-10 detailed planning.

### Contingency (% of remaining work)



## Change Log - IceCube Total Project Budget Baseline (\$K)

| No.  | Description                                     | Date Approved | Total Baseline | Allocated Budget | Allocated Budget Change | Contingency Budget | Estimate To Complete (ETC) | Budgeted Cost of Work Remaining | Contingency % of Remaining Work |
|------|---|---------------|----------------|------------------|-------------------------|--------------------|----------------------------|---------------------------------|---------------------------------|
| NA   | Status as of Jan 2007                           |               | 274,686        | 251,503          | 0                       | 23,182             | 82,514                     | 77,749                          | 29.8%                           |
| CR82 | CR 0082 Project Support PY6-10 Rebaseline       | 02/14/07      | 274,686        | 249,986          | -1,517                  | 24,699             |                            |                                 |                                 |
| CR84 | CR 0084 Implementation PY6-10 Rebaseline        | 02/21/08      | 274,463        | 253,651          | 3,664                   | 20,812             |                            |                                 |                                 |
| CR83 | CR 0083 Instrumentation PY6-10 Rebaseline       | 02/28/07      | 276,281        | 255,377          | 1,726                   | 20,904             |                            |                                 |                                 |
| CR85 | CR 0085 Data Acquisition PY6-10 Rebaseline      | 02/28/07      | 276,073        | 254,429          | -948                    | 21,644             |                            |                                 |                                 |
| CR86 | CR 0086 Detector Verification PY6-10 Rebaseline | 02/28/07      | 277,373        | 256,725          | 2,296                   | 20,648             |                            |                                 |                                 |
| CR87 | CR 0087 Data Systems PY6-10 Rebaseline          | 02/28/07      | 277,100        | 257,188          | 463                     | 19,912             | 82,681                     | 78,671                          | 25.3%                           |

| Item  | Item Description  | Potential Contingency Adjustments |
|---|---|-----------------------------------|
| Assign contingency to mitigate technical, cost and schedule risks associated with the currently defined scope of work | Risk model applied at WBS-Level 4 to assess appropriate contingency as a percent of the cost of work remaining. | \$8,300K                          |
| Current PY5 U.S. cost variance will not be recovered  | Capital expenditures were made this year to increase storage at the pole and upgrade CPU cluster performance.   | \$713K                            |
| PY6-10 Non-U.S. contributions to DOM production may be less than budgeted   | Funding for German universities is less than originally anticipated and available in later years.               | \$318K                            |
| Estimated 1.6 Baseline Change from PY6-10 Planning  | Increase work scope and higher fuel prices will increase the RPSC out-year budget baseline.                     | \$2,500K                          |
| Restore 80-string configuration   | Potential funding needed to increase configuration to 80-strings.   | \$6,000K                          |
| Pre-Operations Costs  | Engineering runs and other construction work required to enable operations.                                     | \$1,500k                          |

***Drill Operation and String Installation*** – A meeting was conducted to review the recent field season and identify necessary off-ice improvement efforts. Tasks were captured in a resource-loaded schedule that includes durations; material and personnel costs; and weight, cube, and ROS information. The Season Review and Strategic Planning Meetings were held in Madison with Raytheon Polar Services Company participation. A first-draft schedule for the next on-ice

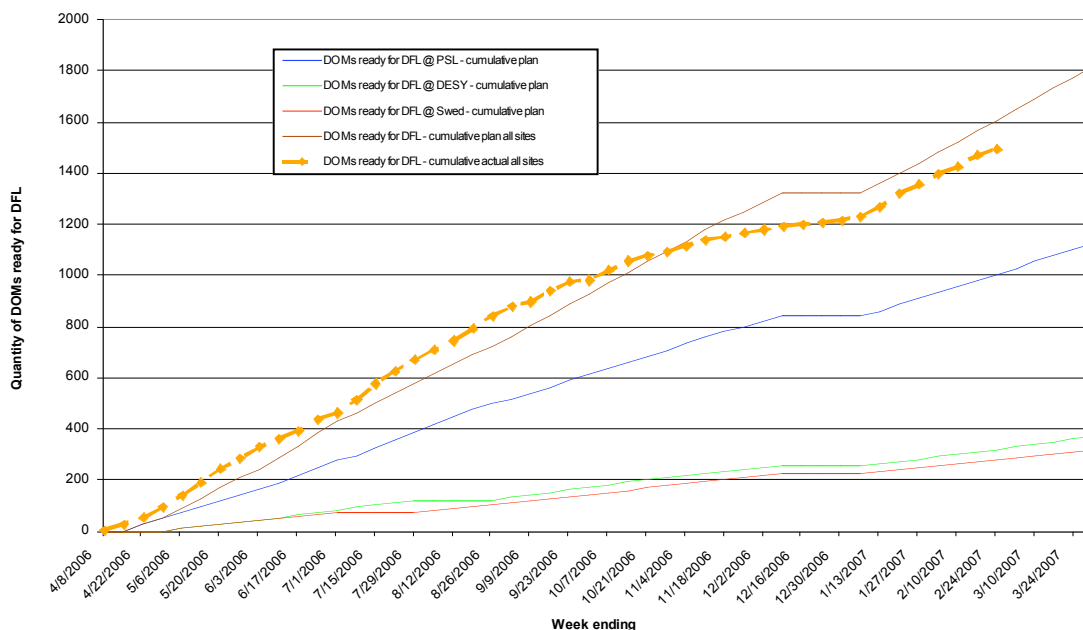
season was developed and a follow-up on-ice detailed planning meeting was scheduled for April. On-ice driller recruiting interviews were completed and a staffing plan for the next field season was drafted. An off-ice staffing plan was also finalized. A drilling hose review meeting was held to discuss problems that occurred during the past season. Visual evidence of failures was reviewed and possible root causes discussed. Root cause analysis and test plans were reviewed and include additional testing at UW and IVG. These tests include a cold test to simulate over-winter storage conditions and a hot pressurized tensile test of sample sections of hose used at Pole. At least two possible causes are at work and being discussed and evaluated: possible brittle transition of hose material over-winter and stress concentration at end fittings.

A drill software workshop was conducted to gather information and discuss results from the recent drilling season. Plans to address problems and improve overall system reliability were presented and priorities for improvements were discussed.

Plans for minor modifications to the Independent Firm Drill are being developed, and parts are being procured. The firm drill is scheduled as a separate, yet integral part of next season's drilling and deployment plan and as a result firm drilling is decoupled from deep-ice drilling tasks.

**Digital Optical Module and Cable Production Status and Plans** - 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**



**Detector Commissioning and Verification** – The detector verification team has performed initial timing and geometry checks that indicate that all but 11 of the 780 new DOMs installed in-ice are functioning as expected. It is anticipated that muon data will verify that most, or possibly all, of the remaining 11 DOMs conform to performance expectations. Geometry measurements are

consistent with expectations, and the team was able to quantify and correct a 10m z-coordinate discrepancy for a string suspected of having deployment depth readings of limited accuracy.

Solid progress has been made to incorporate high-level verification test output into the monitoring system so that collaborators can view this data when performing monitoring shifts. Progress is being made in the use of muons to calibrate relative DOM efficiencies and to study detector geometry as a function of time. Additionally, hole ice data has undergone preliminary analysis and initial results look very encouraging.

A series of power outages at the South Pole has done some damage to the AMANDA instrumentation. Most of the detector was brought back on line but the AMANDA “string trigger” may not be repairable and is currently not being used.

***Data Acquisition System Hardware*** - The remaining primary deliverables for the DAQ hardware group for the project year are DOM Main Board Assemblies and final design documentation for the DOM Hub Industrial Computers. DOM Main Board production continues to progress smoothly and without any major issues. The vendor has been able to meet all of its quality and shipping commitments to-date. The assembly and test vendor has delivered 1413 tested DOM Main Boards and will deliver a minimum of 240 Main Boards per month from now until the purchase order quantity is reached. LBNL has delivered 1272 fully tested and inspected MBs, on schedule, to the DOM integration sites: 828 to UW-Madison, 252 to DESY Zeuthen, and 192 to Stockholm.

The Rev3 DOM Hub design documentation is 100% complete and all documents have been released to UW-Madison. The engineers at UW are making modifications to the existing documentation for the benefit of the chosen contract manufacturer. The Single Board Computers for the DOM Hubs are under contract with the selected manufacturing vendor.

***Data Acquisition System Software*** - Development progress for the DAQ software made a major leap this past month with the resolution of the standing issue of poor stability. On March 17<sup>th</sup> a version of the DAQ software with a totally rewritten memory management kernel, was deployed at the South Pole. As a result, the DAQ has been running with very high uptime, well in excess of 95%, and appears to be very stable. The problem was discovered during simulation stress tests made on the Northern Hemisphere Test Facility (SPTS64). It was recognized that the previous version of this core DAQ component was limiting overall performance, due to inefficiencies in object creation and destruction. Because of this breakthrough in performance it has been possible to (a) loosen the in-ice coincidence trigger and (b) lower the array trigger threshold from a 20-fold multiplicity setting to an 8-fold multiplicity setting. This combination has increased the trigger rate almost by a factor of 10, going from 60Hz to 600Hz and has not compromised DAQ’s stability. We are working to resolve several lingering issues in preparation for the start of pre-operations running May 1<sup>st</sup>. These include (1) run start/stop issues and (2) implementation of data compression.

The S-CUBE string simulator device was delivered at the end of March and in the last week was fully installed into the SPTS64 system. This device uses 64 NFD (not-for-deployment) Main Boards connected to a DOM Hub into which are injected PMT-like pulses from an FPGA board.

The test operator is able to control several parameters of the 64 stimuli such as rate, relative timing offset to ~10ns precision, and can even run the stimuli in 'random noise' mode. This facility will allow precision tests to be run on a complete simulated string of DOMs and will be incorporated into the testing procedure for new Main Board releases.

**Data Systems** - South Pole systems in the IceCube Laboratory ran smoothly in March. Satellite transmission of engineering data and pre-scaled minbias data for DAQ and PnF filter studies continued in preparation for planned physics data taking to start in May. Data rates on the satellite are in excess of 20 GB/day. Raw data tapes for IceCube IC9 2006 (the nine-string IceCube detector) were spooled to disk in Madison for commissioning and verification studies.

First versions of the JEB/PnF are running at the South Pole on both AMANDA TWR-DAQ and IceCube production DAQ systems to pre-scale engineering data for satellite transmission. The final version is in testing at the UW-Madison South Pole Test System (SPTS) and is scheduled to be deployed at the South Pole in April. The schedule calls for physics data-taking and filtering to begin in May. Interfaces and system integration with the production DAQ, TWR-DAQ, Experiment Control and SPADE at the South Pole continues moving towards this milestone. New releases of the IceTray analysis framework continue. A preliminary build of the online filter reconstruction IceTray code is in testing on engineering data and Monte Carlo to set final cut parameters in an effort to meet satellite bandwidth requirements.

Simulation is developing well with the release of production version V01-09-07. This upgraded version is being used for large production runs with the official production processing system coordinated from UW. Simulation is moving towards a release of IceSim version 2.0, which will include a full-feature set and improved storage of detailed Monte Carlo information in the IceTray dataclass framework. Version 2.0 will be released in early May, about one-month behind the current schedule.

The Experiment Control system is running at the South Pole and is coordinating all subsystem configuration start/stop and status information for all IceCube subsystems (i.e. P-DAQ, JEB/PnF, SPADE, and TWR-DAQ). Development of the final feature set and improved ease-of-use for operators is continuing.

**Quality Assurance and Safety** – No significant issues to report. An incident report is in preparation to address the recent overheating condition in the ICL.

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

### **Meetings and Events**

|   |                   |
|---|-------------------|
| Drill Advisory Committee, Madison, Wisconsin          | April 18, 2007    |
| IceCube Collaboration Meeting, Lake Geneva, Wisconsin | April 24-28, 2007 |
| NSF Annual Review of the IceCube Project              | May 30-31, 2007   |