

# IceCube Project Monthly Report September 2007

## Accomplishments

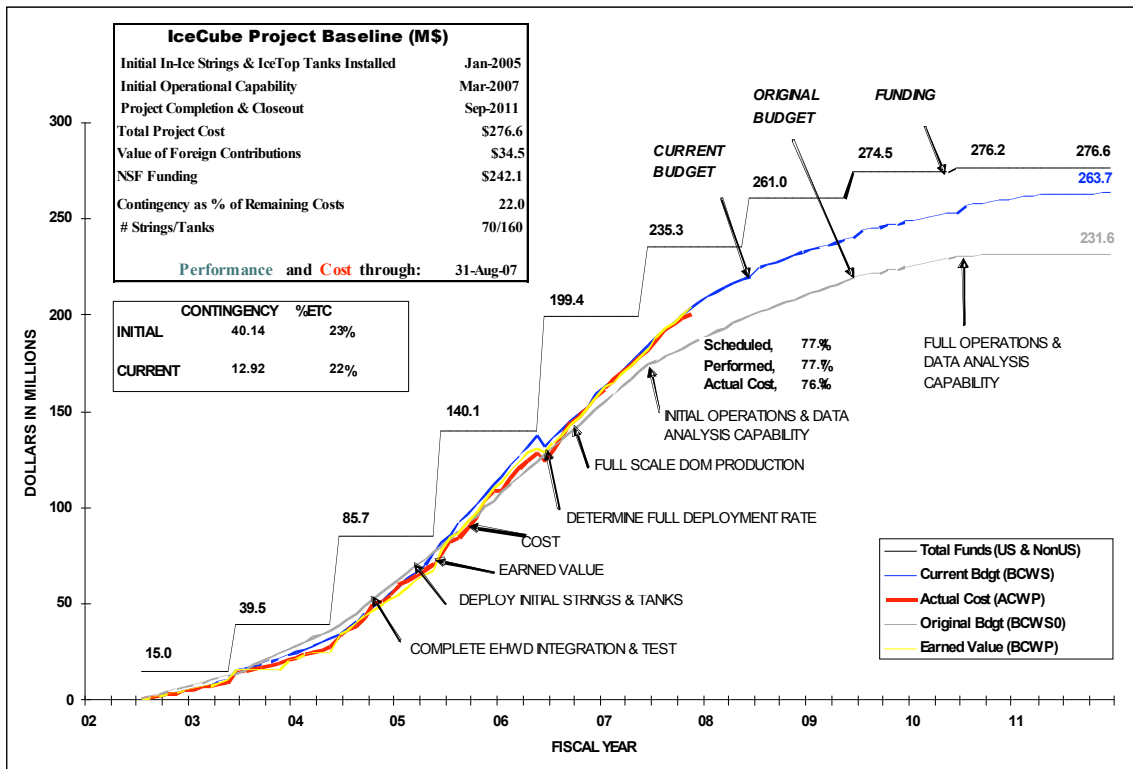
Replacement hose for the main drill arrived in Christchurch on September 22<sup>nd</sup>. A plan has been finalized for using insulation and heating to keep the main drill hose above its brittle transition temperature during winter storage.

A fabrication contract has been placed with Sanmina-SCI for the final production run of 570 DOM main boards. A total of 31 fully loaded DOMHubs were shipped from PSL to South Pole on September 20, six more than originally planned. The additional hubs will be are spares.

The new release of DAQ software, including over 100 new features, was deployed to South Pole on September 19<sup>th</sup>. The main new features include support for flasher calibration runs using the full IceCube DAQ and online filter machinery. Data taking during September 2007 was very successful and achieved an overall 96.5% uptime.

Two special long calibration runs were successfully completed this month, one to measure the amount of shear at the bottom of the long AMANDA string for glacial motion, and the other one using the IceCube Standard Candle that provides an absolute energy calibration for the detector. IceCube and AMANDA are now running with the full functionality of all the planned filters (as designed by the individual physics groups).

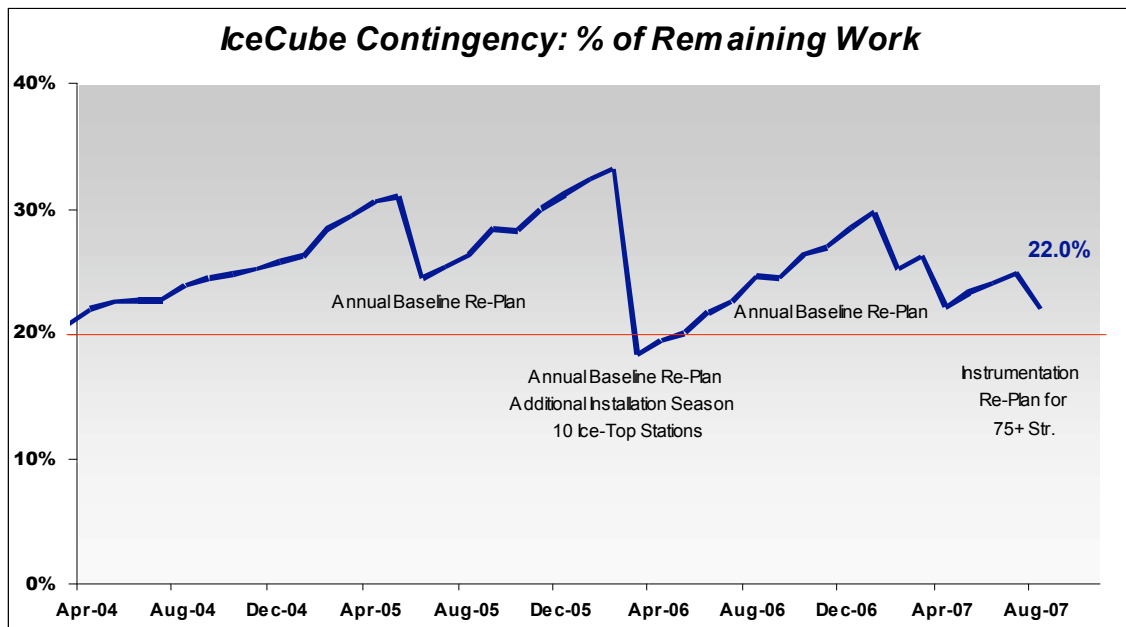
Two major shipments to Port Hueneme were made this month of drill and ICL equipment.



**Cost and Schedule Performance** – The project is 77.7% complete versus the plan of 77.4% 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: 8/31/2007 <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> Work		Actual Cost of Work	Variance		Contingency		Budgeted AY \$s	Latest Revised Estimate	Variance	Sched	Perf	Actl Cost
	Scheduled	Performed		Schedule	Cost	Assigned	% ETC						
Project Support	21,524.2	21,524.2	21,356.8	0.0	167.4	269.6	5.4%	27,312.0	26,365.9	946.1	78.8%	78.8%	78.2%
Implementation	30,939.8	30,888.8	30,779.8	-51.0	109.0	2,963.7	19.7%	44,447.1	45,850.1	-1,403.0	69.6%	69.5%	69.3%
Instrumentation	60,253.4	61,691.1	58,706.1	1,437.8	2,985.0	743.3	5.5%	72,267.8	72,267.8	0.0	83.4%	85.4%	81.2%
Data Acquisition	32,081.4	31,695.6	31,645.0	-385.8	50.7	222.0	10.3%	33,803.7	33,803.7	0.0	94.9%	93.8%	93.6%
Data Systems	21,062.2	20,889.1	21,013.4	-173.0	-124.2	158.4	2.8%	26,723.2	26,723.2	0.0	78.8%	78.2%	78.6%
Detector Comm. & Verification	16,293.4	16,332.7	16,634.8	39.3	-302.1	502.6	9.3%	22,017.3	22,017.3	0.0	74.0%	74.2%	75.6%
Pre Operations	193.6	193.6	95.8	0.0	97.8	0.0	0.0%	533.8	533.8	0.0	36.3%	36.3%	17.9%
Subtotal	182,348.0	183,215.2	180,231.6	867.2	2,983.6	4,859.6	10.3%	227,104.9	227,561.8	-456.9	80.3%	80.7%	79.4%
RPSC SUPPORT	21,009.1	21,062.3	20,579.5	53.2	482.8	1,609.2	10.8%	35,339.9	35,475.5	-135.6	59.4%	59.6%	58.2%
NSF	746.4	746.4	746.4	0.0	0.0	31.0	6.0%	1,263.0	1,263.0	0.0	59.1%	59.1%	59.1%
Total	204,103.5	205,024.0	201,557.6	920.5	3,466.4	6,499.8	10.4%	263,707.8	264,300.4	-592.5	77.4%	77.7%	76.4%
CONTINGENCY <sup>Notes 3,4</sup>								12,919.7	12,327.2	592.5			
IceCube Total <sup>Note 2</sup>	204,103.5	205,024.0	201,557.6	920.5	3,466.4	6,499.8	10.4%	276,627.5	276,627.5	0.0	77.4%	77.7%	76.4%

Notes: 1 Incorporates approved baseline changes.  
2 Total Budget at Completion includes non-US contributions 4,857 K over the amount in the post Hartill III baseline of: \$29,698 K  
3 Budgeted contingency is: 22.0% of the Budgeted cost of work remaining.  
4 Budgeted contingency is: 21.8% of the Estimated Cost to Complete (ETC)  
5 All latest revised estimates detailed planning for PY6-10  
6 Contingency is assigned to each L-2 element based on the ETC, a bottom-up risk assessment model, management judgement, and cost constraints.



## Risk Assessment & Potential Contingency Allocations

Item Description	Potential Contingency Allocation
1. Assign contingency to mitigate technical, cost and schedule risks associated with the defined scope of work. Risk model applied at WBS-Level 4 to assess appropriate contingency as a percent of the cost of work remaining.	\$6,500K
2. The cost to retro IceCube equipment/materials from the South Pole at the end of the project was not included in the baseline budget. This number represents a worst-case scenario if all drill equipment is returned after the 2010/11 drilling season. A more likely scenario is less than one half of this amount.	\$1,500K
3. The remaining budget for spare hose segments does not fully satisfy the likely demand. The increased hose service life gained by increasing the storage temperature is not yet quantified.	\$500K
4. Pre-Operations activities may be extended beyond the one-year currently budgeted. During the first three years of initial operations it may be necessary to conduct engineering runs concurrent with operations to debug software and ensure reliability of the installed equipment.	\$667K
5. Restore 80-string configuration. This is the current estimate of the cost to restore the array to the 80-string configuration described in the original IceCube proposal.	\$3,294K

8/31/2007

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

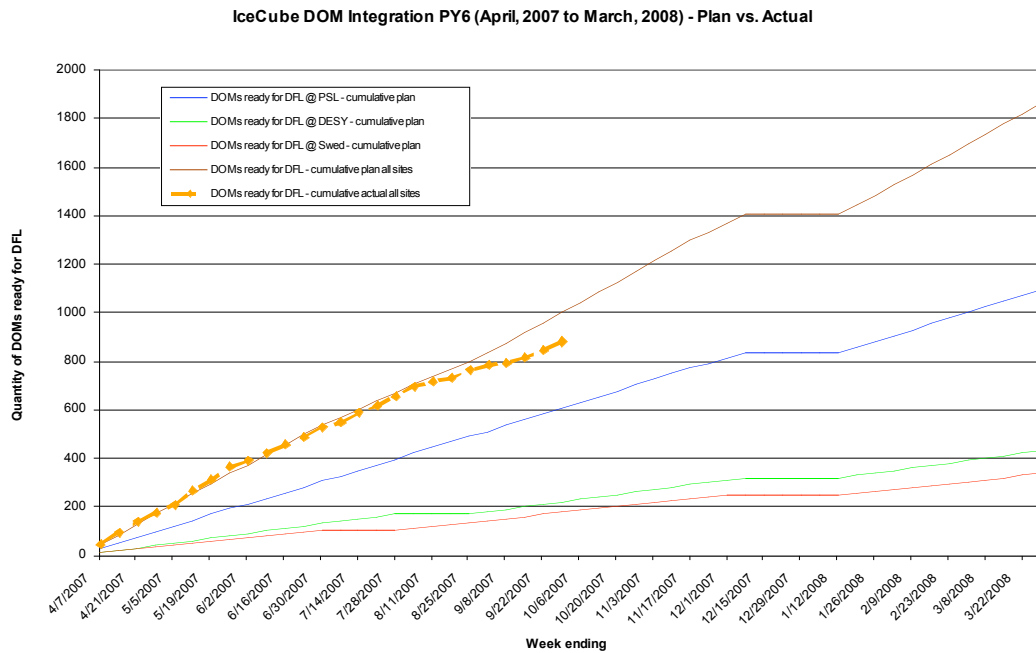
No.	Description	Date Approved	Total Baseline	Allocated Budget	Allocated Budget Change	Contingency Budget	Estimate To Complete (ETC)	Budgeted Cost of Work Remaining	Contingency % of Remaining Work
NA	Status as of July 2007		276,628	261,424	0	15,204	60,856	60,741	<b>25.0%</b>
CR104	CR 0104 DOM Components Assembly & Test for 75+ str.	08/29/07	276,628	263,708	2,284	12,920			
NA	Status as of August 2007		276,628	263,708	0	12,920	59,276	58,684	<b>22.0%</b>

**Drill Operation and String Installation** – The hole numbers and sequencing drill plan for the current seasons are established. Site plans for roads, paths, and equipment movement has been developed in conjunction with RPSC.

Replacement hose for the main drill hose arrived in Christchurch, New Zealand, on September 22<sup>nd</sup>. A delivery plan to the South Pole has been completed and is matched to the start of drilling and on an as needed basis. Winter storage of the hose using insulation and heating was developed and supplies have been ordered.

Two major shipments to Port Hueneme from PSL were made this month of EHWD replacement, spares, and ICL equipment.

**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. The actual status of DOM integration is provided in the following chart. Note that although the cumulative actual DOMs ready for the DFL is about 100 less than planned, the needs at Pole will be exceeded by a wide margin (> 700 DOMs). The plan for this year has considerable built-in flexibility that allows each site to modify short-term production goals to minimize cost.



**Detector Commissioning and Verification** - Numerous high-level verification plots were incorporated into the standard monitoring pages and are being used during monitoring shifts. These plots allow a better understanding of how the detector is performing with a typical feedback time of less than 24 hours. The current system for generating the verification plots is still being run separately from the PnF. The software coordinator suggested a new way to incorporate the verification suite into PnF that will satisfy the requirement that all the data is in the same form as seen by the filters (i.e., fully calibrated, etc.) and that the code base for distributing data to the verification processes is the same as that used for the filters. The first

draft “good run” list was shown at the Ghent Collaboration Meeting and will undergo continuous revision as more experience with the data is gained. The system uses a series of tests to verify the quality of the data. Roughly 99% of the data taken so far appears on the list. The runs that do not typically appear are ones taken during calibration activities that put light into the detector. In the future, even these runs will be considered “good” because it will be straightforward to extract the flasher events from the run based on simple trigger bit information.

The final set of hole-ice data with the fully frozen strings was taken, and analysis of this data is underway. Work continues on the calibration of the PMT/saturation curves and on the third stage of the geometry calibration using muon tomography. The monitoring web pages and accompanying processing software are completely transferred from computers at the University of California-Berkeley to UW.

***Data Acquisition System Hardware*** - The remaining primary deliverables for the DAQ hardware group at LBNL for the remainder of the project year are DOM Main Board Assemblies.

LBNL has received funding for the final production run of 570 DOM Main Boards and a fabrication contract is now in place with Sanmina-SCI. The DOM Main Board manufacturing process began at the end of September and deliveries to LBNL are expected to resume in late October. On delivery of fully qualified DOM Main Boards, LBNL plans to deliver a minimum of 200 DOM Main Boards per month to the DOM Integration sites until the final delivery goal is met or exceeded.

Repair and test of DOM Main Boards from previous production runs continues to progress well with a current yield of approximately 20 to 30 units repaired and qualified for deployment per month.

Thirty one fully loaded DOMHubs shipped from PSL to South Pole on September 20, six more than planned. The additional hubs will be kept at Pole as cold spares.

***Data Acquisition Software*** - DOM mainboard release 429 supports new DOM monitoring records and locks the timing paths which control the DOM digitizer readouts. The latter will fix the digitizer pedestals to a stable value.

The Croyden release and test was a milestone software release which included over 100 new features and bug fixes. Its main new feature is the support for flasher calibration runs using the full IceCube DAQ and online filter machinery. It was deployed to South Pole on September 19<sup>th</sup>. The Devon release was issued quickly to patch a problem with a small number of dropped data channels at the beginning of each run that showed up in the Croyden release. An attempt to deploy it on October 4<sup>th</sup> failed to produce a more stable system (indeed, less stable operation was observed) so it was aborted and the code rolled back to the Icelandic release.

Work continues to improve trigger performance in preparation for the 40-string planned upgrade to the array next year. Many minor speedups appear to have resulted in a system which reliably can handle simulated loads of 40 strings on the SPTS testing system. In addition, we have

procured CPU upgrade kits which will increase the clock speeds from 1.8 GHz to 2.6 GHz on the trigger computing host.

### *IceCube Detector Maintenance & Operations*

Detector Up Time (Goal of 95%)	96.5%
IceCube & AMANDA Combined Mode	93.1%
IceCube Only Mode	2.3%
Unscheduled Downtime	1.3%
Events from DAQ	1.6 billion

Data taking during September 2007 was very smooth and achieved an overall 96.5% uptime. The unscheduled downtime was 1.3% and was mostly due to two incidents: one in which the computer process that produces the monitoring data was not running and it caused a disk full condition in one of the data collecting computers, therefore stopping the DAQ and the second incident was due to a problem in the interaction between the experiment control system and the DAQ systems which is still not well understood or characterized.

The detector ran most of the time (93.1%) in its default mode combining data from the IceCube and AMANDA-TWR DAQs. The fraction of time reported as IceCube-only mode (2.3%) was due largely to a power outage that affected TWR operation and to an experiment control problem that processed data from a combined-mode run as an IceCube only run (for this case the combination can be done offline once the data comes North on tapes).

A new version of the IceCube DAQ software was installed that has support for data-taking using the LED flashers that are part of all DOMs. This will make it easier to take calibration data with light sources around the detector without interrupting or adversely affecting normal physics data-taking. This new functionality requires upgrades of the experiment control software that are underway. In addition, the new version of DAQ enabled a new trigger (Physics Minimum Bias trigger) to evaluate detector performance. The new trigger captures mostly very small events adding about 50 Hz (but small data volume) to the overall trigger rate of 680 Hz.

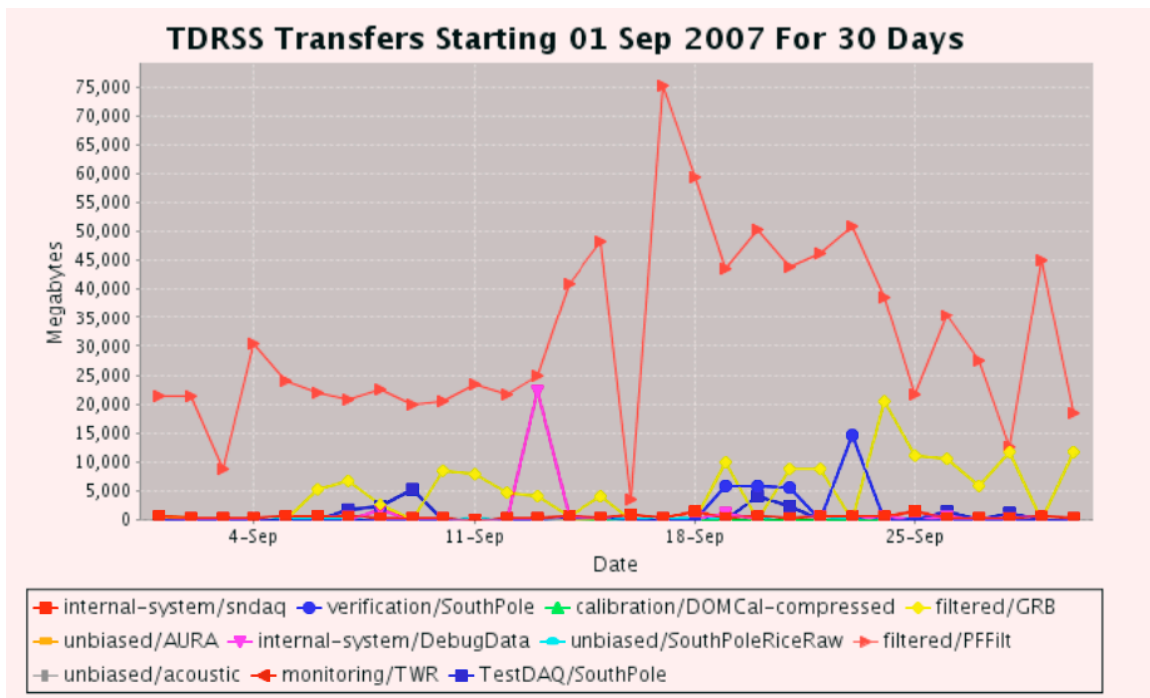
A new version of the DOM main board software/firmware was installed that provides more monitoring information and that fixes (“freezes”) the analog calibration of the baselines of digitized waveforms. A down side of the two upgrades (DAQ software and DOM software/firmware) is that about one DOM per day is dropping out from the data runs (a dropped out DOM is recovered by power cycling the corresponding power wire). The problem is being analyzed and a new version of the DAQ software will likely address the issue.

Two special long calibration runs were successfully taken, one to measure the amount of shear at the bottom of the long AMANDA string from glacial motion, and the other one using the IceCube Standard Candle that provides an absolute energy calibration for the detector.

During September a few deployments of new versions of the filtering code that selects events for transmission via satellite were made. As a result, IceCube and AMANDA are now running with the full functionality of all the planned filters (as designed by the individual physics groups).

Last, an unexpected fast increase of the detector trigger rate by about 5% was observed around Sept 20 lasting a few days. This rise in rate was eventually understood to be due to a seasonal effect caused by the fast warming of the upper atmosphere at pole which may have some unusual features this year.

**Data Systems** - South Pole systems in the ICL continue normal operation. Data rates on the satellite during normal TDRSS operations are on the order of 20-30 GB/day. During this period IceCube had a request to send more data to the satellite for system and throughput testing. The peak data transfer was in excess of 75 GB/day during this time. The Figure below shows the satellite usage for the month of September.



Continued operation, maintenance and upgrades to the UW data center and data warehouse to keep pace with incoming engineering data from IC-22 are on-going. Purchasing and installation of the tape archiving upgrade continues on schedule. An effort was begun to make a detailed re-plan for the storage and CPU costs using the latest information and experience from IC-22 data rates and post satellite transmission production processing plans. The re-planning will go through an iterative process to make a plan that maximizes our ability to exploit the data within the resources that are planned for.

The Joint-Event Builder and Processing and Filter server (JEB/PnF) merging of IceCube-22 and Amanda TWR data streams continues at South Pole sending filtered data sets of approximately 20-30 GB/day over the satellite. This month saw the successful implementation of joint Amanda (TWR) and IceCube event filtering in addition to the previous IceCube only event filtering. We are now transmitting event candidates over the satellite for Icecube only, Amanda Only and joint Icecube-Amanda events. The JEB/PnF system went through a detailed one day review on September 28<sup>th</sup> to assess the system status and to identify critical issues for the system as it

grows to work the final 80 string configuration. The review went well and concluded that the system design will be able to meet or exceed the original requirements on data rates and overall capability. The review also produced constructive feedback on some detailed system issues, which were then recommended as deliverables for the final system.

Mass simulation production continues with IceSim Version 2 to produce large background and signal Monte Carlo datasets for the physics working groups to prepare for IC-22 physics analysis. The first datasets were available to prepare for the October Collaboration Meeting. There was also continued work on the software and procedures for the production system to enable distributed production across the collaboration competing resources. In particular, this month saw the DESY computing facility start to come online with sizeable production testing and processing.

The experiment control (EC) system is running at Pole and coordinating all subsystem configuration start/stop and status information for all IceCube subsystems (i.e. p-daq, JEB/PnF/Spade/TWR-daq). Work on the final feature set and improved ease of use for operators is continuing. Final planning of requirements and implementation details towards integrating the calibration flasher runs into the experiment control infrastructure using the new pDAQ system in place of the old testDAQ system was done. The work for flasher runs under EC was scheduled to be completed this month, but has slipped about two weeks into October.

***Quality Assurance and Safety*** – No significant issues to report.

**Meetings and Events**

NSF Business Systems Review at UW-Madison	November 26 – 30, 2007
Collaboration Meeting at UW-Madison	April 29 – May 3, 2008
International Oversight and Finance Group at UW-Madison	TBD (Spring 2008)

***GPRR Reporting through FY07 (September 30, 2007) \****

The GPRR report below pertains to that portion of the project funded to date, i.e. through FY07. IceCube funding through FY07 totals: \$208,012K. These funds are intended to cover IceCube construction costs through the end of PY6 (March 31, 2008). 86.45% of the available funding has been allocated to budgets through the end of FY07, resulting in a planned value at the end of the fiscal year of \$179,828K. The remaining 13.5% of available funding has been allocated to budgets for the second half of PY6 and management reserve.

The final GPRR report for FY07 follows:

• Planned Value through FY07	\$179,828K
• Actual Cost through FY07	\$178,431K
• Percent Complete through FY07	86.34%
• Earned Value through FY07	\$179,597K
• Cost Variance as a percent of Project Plan	0.65%
• Schedule Variance as a percent of Project Plan	-0.13%

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\* The Actual Cost and Earned Value was calculated based on actual cost and measured performance through August 2007 and a projection for the month of September 2007 based on current schedule and cost variance analysis.