IceCube winterovers gave a special tour of the IceCube Lab to the South Pole Traverse Team in December, 2021. Aman Chokshi, SPT/NSF

IceCube Neutrino Observatory

Management & Operations Annual Report

PY1 (April 1, 2021 - March 31, 2022)

IceCube Neutrino Observatory
Management & Operations
PY1 Annual Report

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Foreword

This FY2021-2022 (PY1) Annual Report is submitted as required by the NSF Cooperative Agreement OPP-2042807. This report covers the 11-month period beginning April 1, 2021 and ending February 28, 2022. The status information provided in the report covers actual common fund contributions received through February 28, 2022 and the full 86-string IceCube detector (IC86) performance through February 28, 2022.

1 Financial/Administrative Performance

The University of Wisconsin–Madison has established two separate accounts with supporting charge numbers for collecting IceCube M&O funding and reporting related costs: 1) NSF M&O Core account, 2) U.S. Common Fund account.

The NSF has released all PY1 funds to UW-Madison to cover the costs of management and operations for PY1: $1,201,200 was directed to the U.S. Common Fund account based on the number of U.S. Ph.D authors in the last version of the institutional MoUs, and the remaining $5,909,039 was directed to the IceCube M&O Core account (Table 1).

PY1: FY2021/FY2022	**Funds Awarded to UW (Apr 1, 2021–Mar 31, 2022)**
IceCube M&O Core account	$5,909,039
U.S. Common Fund account	$1,201,200
TOTAL NSF Funds	**$7,110,249**

Table 1: NSF IceCube M&O funds – PY1 (FY2021/FY2022).

Of the IceCube M&O PY1 Core funds, $1,029,889 were committed to the U.S. subawardee institutions based on their statement of work and budget plan. The institutions submit invoices to receive reimbursement against their actual IceCube M&O costs. Table 2 summarizes M&O responsibilities and total PY1 funds for the subawardee institutions.

Institution	**Major Responsibilities**	**Budget**	**Actual**
Lawrence Berkeley National Lab	DAQ; computing	$82,689	$82,688
Penn State University	Computing and data mgmt; sim production; DAQ	$23,098	$23,098
University of Delaware	IceTop calibration, monitoring and maintenance	$174,104	$174,104
University of Maryland	Software frameworks, online filter, simulation	$635,360	$635,366
University of Alabama	Detector calibration, reco & analysis tools	$30,101	$30,101
Michigan State University	Simulation software & production	$84,537	$89,792
Total		**$1,029,889**	**$1,035,149**

Table 2: IceCube M&O subawardee institutions, major responsibilities and funding – PY1 (FY2021/FY2022).

IceCube NSF M&O Award Budget, Actual Cost, and Forecast

The current IceCube NSF M&O 5-year award was established in the middle of Federal Fiscal Year 2021, on April 1, 2021. The following table presents the financial status and estimated balance at the end of PY1 of the 5-year award.

Total awarded funds to UW–Madison (UW) for supporting IceCube M&O from the beginning of PY1 through March 2022 are $7,110,249. Total actual cost as of September 30, 2021 is $5,488,027 and open commitments against purchase orders and subaward agreements total $620,950. The current balance as of February 28, 2022 is $1,001,271. With a projection of $747,525 for the remaining expenses during the final month of PY1, the estimated balance at the end of PY1 is $253,746, which is 3.6% of the PY1 budget (Table 3). COVID-19 furloughs and restrictions on travel have resulted in lower actual costs. This carryover balance will help to offset higher than expected inflation in the remaining project years.

(a)	(b)	(c)	(d)= a-b-c	(e)	(f=d-e)
Year 1 Budget	**Actual Cost to Date**	**Open Commitments**	**Current Balance**	**Remaining Projected Expenses**	**End of PY1 Forecast Balance**
Apr 2021-Mar 2022	through Feb 28, 2022	on Feb 28, 2022	on Feb 28, 2022	through Mar 31, 2022	on Mar 31, 2022
$7,110K	**$5,488K**	**$629K**	**$1,001K**	**$746K**	**$254K**

Table 3: IceCube NSF M&O award budget, actual cost, and forecast.

IceCube M&O Common Fund Contributions

The IceCube M&O Common Fund was established to enable collaborating institutions to contribute to the costs of maintaining the computing hardware and software required to manage experimental data prior to processing for analysis.

Each institution contributes to the Common Fund, based on the total number of the institution's Ph.D. authors, at the established rate of $13,650 per Ph.D. author. The Collaboration updates the Ph.D. author count twice a year before each collaboration meeting in conjunction with the update to the IceCube Memorandum of Understanding for M&O.

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 and are listed in the Management & Operations Plan. These activities directly support the functions of winterover technical support at the 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 disk 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 IceCube M&O Cooperative Agreement.

Table 4 summarizes the planned and actual Common Fund contributions for the period of April 1, 2021–March 31, 2022, based on v30.0 of the IceCube Institutional Memorandum of Understanding, from September 2021. The remaining contributions from non-U.S. collaborators are still underway, and it is anticipated that the planned contributions will be fulfilled.

	Ph.D. Authors	**Planned Contribution**	**Actual Received**
U.S.	88	$1,201,200	$900,900
Non-U.S.	73	$1,010,100	$360,846
Totals	**161**	**$2,211,300**	**$1,261,746**

Table 4: Planned and actual Common Fund contributions for the period of April 1, 2021–March 31, 2022.

2 Management and Operations Status and Performance

WBS 2.1: Program Coordination

Education and Outreach

The E&O team has continued to seek new opportunities and develop new partnerships to best use available resources and personnel.

Our PY1 focus areas are:

1. *Reaching high school students and teachers* through IceCube Masterclasses, an after school program, summer research activities, and South Pole webcasts targeting K-12 classrooms and the public.

2. *Increasing STEM awareness* through undergraduate research experiences, and integrating educators who have deployed to the South Pole with IceCube into the UWRF Upward Bound (UB) program.

3. *Engaging the public* with in-person events and new multilingual polar virtual reality resources for rural libraries.

There were multiple opportunities for high school students to learn about IceCube. Many IceCube institutions will hold their masterclasses, one-day events held at IceCube Collaboration campuses that give high school students and accompanying teachers a chance to experience real research using IceCube data, in March and April, 2022. Web materials have been updated with a significant effort to produce content in Japanese. WIPAC is planning on holding an in-person masterclass with about 20 high school students in April, 2022. WIPAC hosted a weekly research meeting for ten weeks for high school students working on self-contained muon detectors known as CosmicWatches. We are currently running a 10 week after school program whose weekly two-hour meetings include technical talks with career information and tutorials on computer programming.

In the reporting period, we held five South Pole webcasts. The first was in April, 2021 in conjunction with IceCube masterclasses. The second and third were both in June, 2021 one for a joint meeting of the Castro Valley Science and Rotary clubs, the other for a public lecture series hosted by Oxford University. All three had strong attendance. Webcasts for the Stockton Astronomical Society and German Physical Society are scheduled for March, 2022.

Deployments to the South Pole continue to be constrained by the COVID pandemic. We remain in contact with the educator we had selected in conjunction with the PolarTREC program to deploy to the South Pole, and look forward to having her on the team in a future season when that is possible.

High school students in the 2021 summer UWRF Upward Bound program led by longtime IceCube educators Eric Muhs and Steve Stevenoski learned about communicating science using stop action videos. WIPAC hosted a summer virtual research program for five high school students. The UWRF summer REU program was held virtually with a diverse group of eight students from across the country, exceeding the goal to have at least 50% of students from groups underrepresented in physics. They participated in the virtual IceCube boot camp and worked on neutrinos oscillations, data analysis and simulations, and sensor fabrication troubleshooting.

As part of IceCube's 10th anniversary celebrations this year, IceCube E&O helped host two public events. In a virtual event hosted by the University of Oxford Department of Physics, IceCube

Figure 1: Students, scientists and staff spent a cold day on the ice describing the IceCube project and what it is like to live and work at the South Pole to those who visited the IceCube tent at the Frozen Assets Festival.

collaborators spoke about IceCube and its achievements, and IceCube winterovers called in from the South Pole to talk about life at the bottom of the world. The other event, hosted by UW–Madison, was held in person and presented online; three UW–Madison IceCube collaborators talked about IceCube's past, present, and future in front of an audience of over 50 live attendees and over 100 virtual connections.

WIPAC participated in its first two in-person events in the last two years, both held outside. Science on the Square, held in the evening on October 22, 2022, attracted a diverse group to the IceCube booth to try their hand at ice drilling and hear more about IceCube Science. Over 400 people stopped at the IceCube tent (see Fig. 1) on Lake Mendota during the Frozen Assets Festival on February 5, 2022.

Work has begun with the UW team (WIPAC, Field Day, and the Wisconsin Institutes of Discovery) that developed the IceCube virtual reality experience (VRE) on a five-year polar education project. *EHR-Polar DCL: Expedition VRctica: Utilizing Public Library Systems To Engage Rural and Latinx Communities in Polar Research* will redo the IceCube VRE and produce four new Polar VREs.

Communications

Producing captivating web and print resources, graphic designs, and displays is a core mission for IceCube Communications. With 2021 marking the 10th year of IceCube operation as a fully instrumented detector, IceCube Communications produced a campaign to celebrate the first decade. The products from the celebration, available on the IceCube turns ten web page, include:

1. *IceCube 10-year logos and graphics* for our social media profiles.
2. *IceCards*, an album of real postcards mailed by collaborators around the globe containing favorite memories and lessons from their time in IceCube.

Figure 2: The IceCube 10-year logo, mosaic, and cake.

3. *A timeline of IceCube's history*, including the events in neutrino physics that made our experiment possible.

4. *IceCube: 10 Years of Neutrino Research from the South Pole*, a five-minute video reviewing IceCube's first decade of discovery featuring IceCube collaborators from around the world, ranging from graduate students to full professors.

5. *The IceCube Mosaic*, a composite picture celebrating 10 years, composed of photos of collaboration members and other memorable images.

6. *The IceCube Cake*, an elaborate two-tier IceCube-themed "birthday" cake made by a UW–Madison graduate student. A gallery of photos and videos about the cake can be found on the IceCube turns ten web page.

The Multimessenger Diversity Network (MDN) continues to grow under the leadership of WIPAC's Ellen Bechtol, the MDN community manager. She organized posts for the International Day of Women and Girls in Science that invited submissions that described what scientific accomplishment each contributor was most proud or excited about. An example post and the response on Twitter, Instagram and Facebook are shown in Fig. 3.

WBS 2.2: Detector Operations and Maintenance

During the period from April 1, 2021 to February 28, 2022, the detector uptime, defined as the fraction of the total time that some portion of IceCube was taking data, was 99.9%, exceeding our target of 99% and close to the maximum possible, given our current data acquisition system. The clean uptime for this period, indicating full-detector analysis-ready data, was 98.5%, exceeding our target of 95%. Other key performance metrics are listed in Table 5; in all cases performance metrics were met.

Figure 4 shows a breakdown of the detector time usage over the reporting period. The partial-detector good uptime was 0.96% of the total and includes analysis-ready data with fewer than all 86 strings. The excluded uptime of 0.4% includes maintenance, commissioning, and verification data. The unexpected detector downtime was limited to 0.14%.

The total number of active DOMs in the data stream is currently 5405 (98.5% of deployed DOMs), plus three DOM-mainboard-based scintillator panels. While no new DOMs failed during this reporting period, one previously-failed DOM stopped working again in December of 2021. After

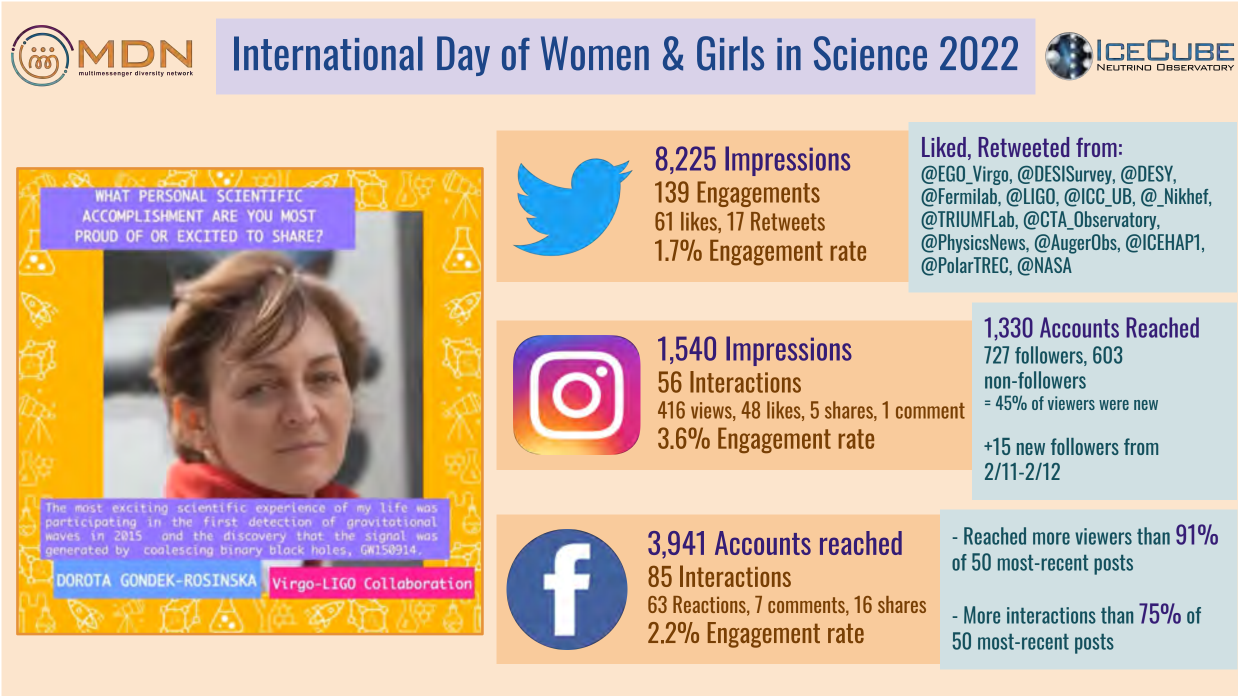

Figure 3: An example post, one of more than two dozen from the multimessenger community, that celebrated the 2022 International Day of Woman and Girls in Science, along with a few statistics on the audience it reached.

originally failing in 2006, this particular DOM had started working again in 2018 and was included in the data stream while active.

Detector operations milestones for PY1 are shown in Table 6. A major milestone in this reporting period is the IC86-2021 physics run start (**WBS 2.2.1 Run Coordination**), which began on schedule on May 27, 2021. The physics run start included the standard detector recalibration and tuning but no major trigger or filter changes.

Because of the ongoing impact of COVID-19, the 2021–22 South Pole season has been scaled back, impacting several upcoming milestones. Operationally critical cargo (e.g. storage disks and UPS batteries) was delivered, and important maintenance was carried out by the winterovers and one additional summer deployer (winterover manager R. Auer). The usual planned field season readiness review, however, was cancelled since all non-critical activities have been delayed, such as surface array deployments. The **South Pole System (SPS; WBS 2.2.9)** computer operating system upgrade, delayed from 2019—20 due to COVID-19, was successfully completed this austral summer season, with the exception of a few infrastructure servers. All servers involved in data taking, including the DOMHubs, were successfully upgraded with minor impact on detector uptime; this accounts for approximately 90% of the machines at SPS. This operating system upgrade, from Scientific Linux 6 to Alma Linux 8, ensures compatibility with current and future IceCube data processing software and enables long-term security support. The SPS configuration management system, Puppet, was upgraded at the same time. The remaining infrastructure servers will either be upgraded remotely during 2022, or in a few cases, during the 2022–23 season.

Two new winterovers, Moreno Baricevic and Wenceslas Marie-Sainte, were trained at the UW Physical Sciences Laboratory (PSL) starting in July 2021 and at WIPAC in August 2021, and

Performance Metric	Objective	Achieved	Description
Total Detector Uptime	>99%	99.9%	Detector taking data in some configuration
Clean Detector Uptime	>95%	98.5%	Full-detector data usable by all analyses
IceCube Live Uptime	>99.9%	99.95%	Control/monitoring functioning
Supernova System Uptime	>99%	99.8%	Supernova DAQ online taking data
L1 Processing Latency	<60 s	27 s	90% quantile of time from event in ice to processed event on disk

Table 5: Detector operations and maintenance key performance parameters for this reporting period.

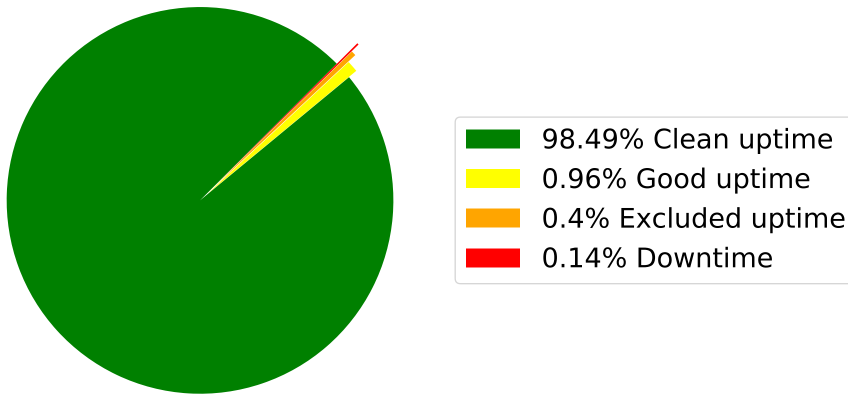

Figure 4: Detector uptime for the period from April 1, 2021 to January 31, 2022.

deployed to South Pole in November 2021 on schedule. Winterover training involves in-depth, hands-on exercises on all online computing and detector subsystems using the IceCube South Pole Test System (SPTS). Training began one month early this year at PSL with the IceCube Upgrade drill team so that the winterovers could support a few on-site investigations, given that all Upgrade summer deployments were canceled for 2021–22. These investigative activities involving the drill buildings in storage at pole were completed in January of 2022.

Planning and definition of interfaces to integrate the IceCube Upgrade into the existing **data acquisition software (DAQ, WBS 2.2.2)** have begun. Minor release "Akupara2" was installed on July 12, 2021 to fix some minor bugs associated with the Python3 upgrade. Minor release "Akupara3" was installed on November 17, 2021 in order to add support for the operating system upgrade. As part of this release and the DOMHub OS upgrade, the hitspool lookback cache on the DOMHubs was extended from 6.25 days to 12.5 days; this allows all (pre-trigger) detector hits to be archived in the case of an external multimessenger alert within this lookback period.

Uptime metrics for the DAQ, supernova DAQ, and IceCube Live all exceeded targets despite these major system software upgrades. This was achieved by developing detailed operational plans for each system upgrade on the test system (SPTS) and by using spare systems to keep data-taking active while critical servers were upgraded. The clean uptime, while above our target, was slightly impacted by a few intermittent crashes of the DOMHubs after the upgrade; we believe this has been addressed by a subsequent upgrade of the Linux kernel, but we continue to monitor the situation.

The online data **processing and filtering system (PnF, WBS 2.2.3)** was updated for the IC86-2021 run start. While most event filtering was unchanged, new IceTop hit information was

WBS L3	Planned	Actual	Milestone
2.2.1	05/31/21	05/27/21	IC86-2021 run start
2.2.1	08/02/21	07/01/21	21/22 WinterOvers begin training
2.2.1	11/15/21	11/04/21	21/22 WinterOvers deploy, replace outgoing WO crew
2.2.3	10/15/21	n/a	Field season readiness review completed
2.2.9	01/28/22	12/09/21	Operating system upgrade of SPS servers completed (90%; see text)

Table 6: WBS 2.2 Detector operations and maintenance PY1 milestones.

added to the **realtime event stream (WBS 2.2.8)** in order to facilitate faster veto detection.

A new major release of the IceCube Live **experiment control and monitoring software (WBS 2.2.4 & 2.2.5)** was installed on June 29, 2021, I3Live v4.4.0 ”Enterprise”. This version, in addition to bug fixes, supported the upgrade of SPS to Python3. Support ended for the previous version of Python on January 1, 2020. The ”Enterprise2” and ”Enterprise3” minor releases were installed in September and October 2021, with changes to support the operating system upgrade. The next major release, I3Live v4.5 ”Falcon”, will upgrade many of the underlying JavaScript libraries and add several quality-of-life improvements for the winterovers.

IceTop and the surface array (WBS 2.2.6) have been functioning smoothly. The elevated scintillator panels, antennas, and FieldHub of the prototype surface station took data through another winter with minimal apparent snow drifting. While new planned station deployments for 2019–20 and 2020–21 were postponed due to logistics constraints, a DAQ electronics swap was performed by the winterovers in January 2022 that fixes some issues with radio signal acquisition. Additionally, the winterovers fixed several minor light leaks in the panels, and elevated one panel that was close to the snow surface (Fig. 5).

Figure 5: One elevated scintillator panel, close to the snow surface, was raised by the winterovers in early 2022 (photo is prior to raising).

A new release of the **supernova data acquisition system (SNDAQ, WBS 2.2.7)**, BT20, was installed on SPS on November 24, 2021, in conjunction with the operating system upgrade. This release upgraded the major version of the ROOT analysis framework used by SNDAQ. Since maintenance of the software is complicated by a legacy C++ codebase and this reliance on ROOT, development of a new version of SNDAQ based on Python (PySNDAQ) is in progress. The core online analysis functionality has largely been completed, with the exception of the background muon significance correction, and development is now focused on performance improvements and the control subsystem.

Detector Operations Labor Assessment

A detailed list of M&O supported labor is included in the Appendix *Staffing Matrix by WBS L3*. Planned and actual labor are very close with the exception of two personnel departures during this reporting period. Senior DAQ software developer Dave Glowacki retired in July 2021, and IceCube Live developer Colin Burreson left for industry in late September 2021. Developer Tim Bendfelt has taken over as lead DAQ developer, and physicist Jim Braun has transitioned into a scientist and DAQ management role.

Detector operations (WBS 2.2) has historically been adequately staffed for IceCube M&O, reflected in high detector uptime and hardware/software stability. The departures of two long-time developers as well as the additional resource needs of the integrating the new systems for the IceCube Upgrade (see next paragraph) present a risk: the 2021–2026 M&O budget did not allow replacement of Glowacki. However, a new search for a DAQ developer to replace Burreson will be launched in the 1st half of PY2.

The online software plan for expansions like the Upgrade relies on tight integration into the current IceCube DAQ and filtering systems rather than a new design, saving significant time and labor. This is possible because the IceCube operations software has been well-maintained and modernized over the course of previous M&O periods. However, significant effort is still needed across all L3 areas in order to expand the system to incorporate new sensors, calibration instruments, and their data products. Specifically, one additional FTE for 2.2.2 Data Acquisition (as originally requested in the proposal) will ensure that data acquisition systems are ready at the time of IceCube Upgrade deployment. An additional 0.5–1.0 FTE DevOps engineer in 2.2.9 South Pole Systems would also allow modernization of the configuration management and monitoring systems of the computing cluster at South Pole.

WBS 2.3: Computing and Data Management Services

During the period from April 1, 2021 to February 28, 2022, the core infrastructure Uptime, defined as the fraction of the total time that the core infrastructure located at UW-Madison was accessible to the collaboration, was 97-99% depending on the service. This exceeds our target of an average uptime of 95%.

Similarly, the non-core infrastructure was also working at 95-99%. Major outages of non core infrastructure were caused by interruptions in the UW-Madison campus chilled water (used for cooling the equipment), which are out of our control. The workflow management software (IceProd) has been up 97% of the time. Filtered data from the South Pole is currently transferred to Madison on average within less than 24 hours. The replication of our processed data is currently a number of weeks behind the current data. We are catching up and will be up-to-date within a week or two.

We stayed constant at 13 users. We continue to recruit new users and improve the system user-friendliness to recruit new users.

Performance Metric	Objective	Description
Core Infrastructure Uptime	95%	Data warehouse, virtualization infrastructure, data retrieval infrastructure, detector operations infrastructure
Non-core Infrastructure Uptime	90%	Data analysis infrastructure, websites, etc.
Data Transfer Delay	2 days	Time from data taking to arrival in data warehouse, assuming no satellite interruptions
Latency in replication of processed data	7 days	Replication of verified and processed data to archive at DESY
Latency in replication of raw data	90 days	Moving data that arrives via retro-cargo from South Pole to NERSC for archival
IceProd Uptime	90%	Workflow management system
Non-production IceProd users	20	Number of users that use the centralized workflow management system outside of the core simulation production

Table 7: Computing and data management (WBS 2.3) performance parameters.

Computing and Data Management milestones for PY1 are shown in Table 8. We have completed the experimental data ingest to NERSC ahead of schedule. It took us less than 90 days from data arrival from the South Pole via retro-cargo in Madison until the data was archived at NERSC. The archive at NERSC now includes over 10 years of unfiltered IceCube data.

We finished the Single sign-on implementation. Unfortunately, supply chain issues, in particular shortages of computing hardware, have caused a delay in acquiring new hardware needed for the planned VM infrastructure upgrade. Our preferred vendor cannot give us an estimate when the hardware may be available. Other computing acquisition projects have seen lead times of up to 300 days for certain components. We are exploring alternatives, including different vendors and combining our VM infrastructure with that hosted by central campus IT. We are still waiting for a cost model from central campus IT to see whether moving our VM infrastructure is feasible.

We purchased replacement hardware for two of our file systems–`/data/user` hosting user intermediary analysis data and `/data/ana` hosting final analysis results. The hardware is currently being commissioned and should go into production within the next month. The still reliable hardware from the old filesystem will be re-purposed as temporary storage space for users.

WBS L3	Planned	Actual	Milestone
2.3.1	12/31/21	06/30/21	CY 2020 experimental data ingested into NERSC LTA
2.3.2	09/15/2021	10/15/2021	Single sign-on (Keycloak) implemented
2.3.3	10/08/2021	TBD	VM infrastructure upgrade complete

Table 8: WBS 2.3 Computing and data management PY1 milestones.

Computing and Data Management Labor Assessment

The computing group has witnessed a decline in staffing. The computing operations team (WBS 2.3.1-3) has shrunk by 30% over the course of the last decade: 1 storage engineer, 1 help desk person, 1 sysadmin, and 1 network engineer. WIPAC mitigated the loss of the network engineer by transitioning to a model where UW-Madison campus IT manages the IceCube networks. At the same time, the overall responsibilities for the operations have increased, e.g. size of filesystems, number of users, and notably an increasing reliance on heterogeneous hardware systems. While operations continues to meet the key performance metrics, infrastructure improvement has slowed significantly and the risk of losing critical institutional knowledge has increased dramatically. Ultimately, modernizing systems to make use of contemporary computing technology (cloud, containers) is very slow given the competing demands on a shrinking team. We are adding back support personnel to improve the ability of the M&O program to respond to the changing technology landscape. Another DevOps position will be posted in Q2 2022.

There are currently no human effort and physical resources allocated within WBS 2.3 for the Upgrade. At the current estimate of a 10% data rate increase, we expect that data transfer software will have no issue handling the increased load. Yet, the data warehouse, data processing resources, and simulation workflow will be impacted. We expect that there will also be an increase in the resource requirements for simulation and data processing.

An expected change within IceCube and the Upgrade is the transition to more machine learning based data analysis. This will require rethinking the data analysis CI currently deployed. The current dedicated CI is at least 5 years old and was purchased with a focus on mass data processing and simulation production. We are expecting (and already experiencing in some cases) an increasing demand for accelerated hardware (GPU and FPGAs) to accommodate ML model training and inference. The M&O 5 plan includes a dedicated hire in PY2 to support these needs. We are accelerating the schedule for hiring and will have begun this search in the early parts of the 2nd half of PY1.

WBS 2.4: Data Processing and Simulation Services

WBS L3	Date	Milestone
2.4.1	01/14/22	Offline filter requirements captured - IC86-2022 run
2.4.2	11/01/21	Datasets SnowStorm / ESTES completed

Table 9: WBS 2.4 Data processing and simulation PY1 milestones.

Key performance parameters for Computing and Data Management are tabulated in Table 10.

Performance Metric	Objective	Achieved	Description
L2 processing latency	2 weeks	8.4 days	80% quantile time from event in ice to L2 processed file in the data warehouse
Simulation Production Efficiency	90%	85%	Total useful time (completed jobs) divided by total computing time
Simulation Requests	60 days	110 days	90% quantile request to production

Table 10: Data processing and simulation (WBS 2.4) performance parameters.

Data Processing

Current offline data processing is running on the IceProd2 framework on opportunistic grid computing resources, distributed across the globe. The move required some coordination with the distributed infrastructure team to implement additional features needed to support this task.

The detector run for the IC86-2021 season began on May 27, 2021. Filtering and processing scripts where validated by technical leads from each physics working group with data recorded during the 24-hour test run using the new DAQ configuration and updated software stack. Observed differences with respect to the previous season are consistent with statistic fluctuations.

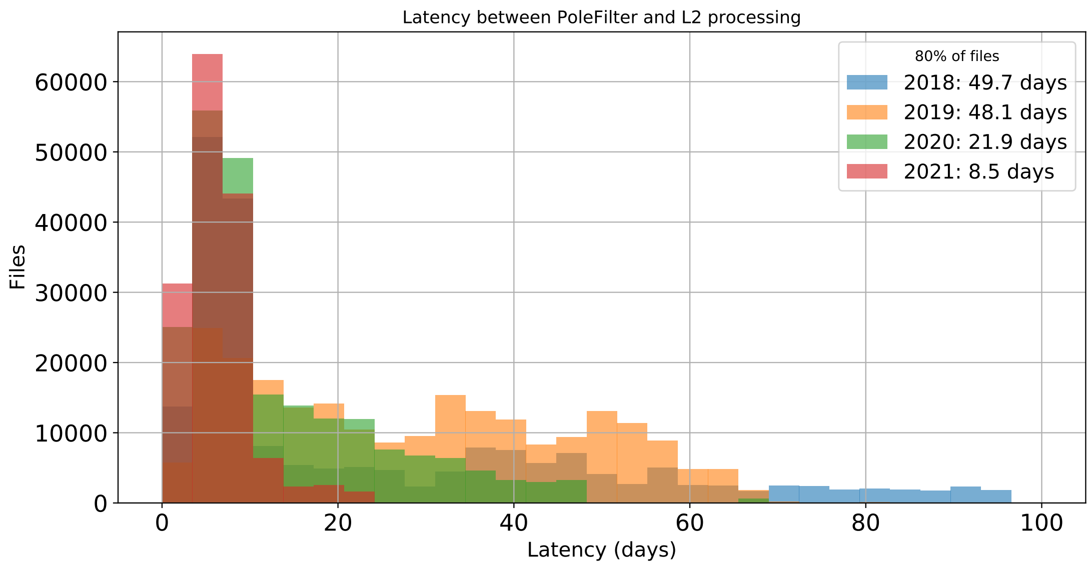

Figure 6: L2-processing latency distribution for the last four years. Minimum latency is determined by the weekly data validation process in the North.

During previous years, an effort was done to clean up filters reconstructions and libraries no longer needed in offline reconstruction resulting in a 36% reduction of CPU utilization and a comparable reduction in memory requirements. Resources consumed for the offline production resulted in approximate 480,000 CPU hours of processing time and consistent with prior estimates. We are currently reviewing existing filters and reconstructions with the aim of streamlining offline processing at Level 2 and Level 3.

Additional data reprocessing campaigns will be needed as further improvements in calibration and feature extraction are developed. The current refinements do not yield sufficient improvements to warrant the expense of roughly $1,000,000 in compute time and person-hours. We anticipate that future improvements in calibration resulting from the IceCube Upgrade will require additional reprocessing campaigns.

We recently established a new performance metric for Level-2 processing. We set an an objective to reduced the time from triggered events in ice to processed L2 file in the data warehouse for 80% of the files. A result of our new focus on this metric was that the latency of data at L2 was reduced from almost 50 days in 2018 to only 8.5 days in 2021 (see Figure 6).

Monte Carlo Simulation Production

The production of Monte Carlo simulations is based on the IC86-2020 detector configuration. This configuration is representative of past previous trigger and filter configurations included in pass2. As with previous productions, direct generation of Level 2 background simulation data is used to reduce storage space requirements. The transition to the 2020 configuration was done in conjunction with a switch to a new combined simulation-reconstruction software suite.

New features in the simulation software include individually calibrated PMT waveforms, optimized event re-sampling for low-energy background simulation, and improved models of the optical properties of the ice. Direct photon propagation is currently done on dedicated GPU hardware at several IceCube Collaboration sites and through opportunistic grid computing. The number of such resources continues to grow along with further software optimizations for GPU utilization.

The simulation production team organizes periodic workshops to explore better and more efficient ways of meeting the simulation needs of the analyzers. This includes both software improvements as well as new strategies and providing the tools to generate targeted simulations optimized for individual analyses instead of a one-size-fits-all approach. New strategies have been developed for dynamically simulating of systematic uncertainties in our understanding of ice properties, hole-ice and DOM sensitivity and determining their impact on physics analyses.

Throughput has continually increased due to incorporation of an increasing number of dedicated and opportunistic resources and a number of code optimizations. New monitoring tools are currently being developed in order to keep track of efficiency and further optimizations. New procedures have been implemented for coordinating allocating resources and priorities for simulations produced by working groups as well as individuals. These efforts include performance metrics to reduce the time between a request by a group or individual and the completion of such request. We are currently far from reaching our objectives but are making progress in this regard.

Computing Resource Needs

	CORSIKA	MuonGun	Diffuse	OscNext	IceTop	Total
CPU (years)	30000	23	58	2112	1157	33350
GPU (years)	2400	95	680	184	0	3359
Storage (TB)	3330	10	10	60	200	3610

Table 11: Estimated resource requirements for the main Monte Carlo data sets needed for physics analyses. `CORSIKA` simulation assumes DOM-oversizing factor of 5.

Simulation production requirements are primarily dominated by background simulations with `CORSIKA` given that there is roughly a factor of 10^6 cosmic-ray induced muons triggering the detector for each neutrino event. Background simulations for the in-ice array require roughly 30k years of CPU time and about 2.4k years of GPU time to produce and filter. This is in addition to IceTop surface array simulations and signal simulation (including systematics). As an alternative to this amount of background simulation, we can also simulate final-state muons that can be weighted according to a parametrized flux calculated from `CORSIKA` simulations using the same approach of MUPAGE which was developed by the ANTARES Collaboration . These `MuonGun` simulations are significantly more efficient to produce, requiring about 6M CPU-hours and comparable GPU time to simulate in order to meet our goals. These simulations have to be validated against `CORSIKA`, but this requires a significantly smaller data set.

Key achievements include:

- improvements in hardware simulation including individually calibrated PMT waveforms, and improved models of the optical properties of the ice;
- addition of support for future detector hardware;
- optimization to improve efficiency and utilization of resources;
- new catalog of Monte Carlo datasets and simulation requests;
- improved monitoring of data processing and simulation production;

Data Processing and Simulation Services Labor Assessment

There are currently 2.4 FTEs assigned to WBS 2.4. There are no current plans to increase the number of FTEs working on Data Processing and Simulation Service though we anticipate an increase demand of labor from the extensions to the IceCube detector. Mitigation of risk of labor shortages due to this additional scope is being handled through promulgation of the simulation mass production middleware (IceProd) to permit individual users to profit from the scheduling and data provenance services provided by this software.

WBS 2.4.0 and 2.4.2 DIAZ-VELEZ, JUAN CARLOS (Lead) : Coordination of Offline Processing and Simulation Production efforts with analysis working groups. Oversees Offline Data Production. Evaluates shared resource needs for large-scale simulations and data processing for IceCube collaboration and coordinates with Physics Working Group Technical Leads and Computing and Data Management tea to evaluate computing needs and priorities for Monte Carlo production datasets. Maintains and optimizes workflow scripts, and provides support for Physics Working Groups to manage production datasets.

WBS 2.4.1 SNIHUR, ROBERT : Experimental data processing and reduction. Interface with collaboration working groups to deliver analysis-ready data. Manages day to day operations for data processing at North and coordinates with Working Group Technical Leads to validate data and processing scripts. Coordinates with Detector Operations team to validate detector runs.

WBS 2.4.1 and 2.4.2 EVANS, ERIC : Software development of automated data validation tools to detect potential problems involving software and/or human errors in data processing and simulations.

WBS 2.4.2 SOLDIN, DENNIS : Maintains and optimizes workflow scripts for simulations of the IceTop surface array and manages dataset submission and monitoring.

WBS 2.5: Software

Key milestones and performance parameters for Software are tabulated in Table 12 and Table 13, respectively.

The plan for the first year period was to generate four releases, however only 2 releases are expected to be generated. In November 2020 the CD system was offline due to third-party feature

WBS L3	Date	Milestone
2.5.1	06/30/2021	Summer 2021 software release
2.5.1	09/30/2021	Fall 2021 software release
2.5.1	12/17/2021	Winter 2021 software release
2.5.1	03/11/2022	Spring 2022 software release

Table 12: WBS 2.5 Software PY1 milestones.

Performance Metric	Objective	Description
Releases per year	4	Quarterly releases meeting minimal quality standards
Test coverage, minimum	66%	Fraction of lines of code executed in the test suite
CI min uptime	90%	Fraction of days all tests pass on all supported platforms
CD min uptime	50%	Fraction of days full-chain tests pass on single platform
Critical ticket max lifetime	1 month	At least 90% of critical tickets resolved within this timescale

Table 13: Physics software (WBS 2.5) performance metrics.

deprecations, which broke the reporting system. Shortly after this, the software group initiated the transition, in planning for several years and a significant undertaking, from our self-hosted subversion repository to GitHub, which further delayed the reactivation of the CD system. The repository transition, which took longer than anticipated, delayed the transition of subversion-based CI system as well.

The transition to GitHub is now complete, with all of our contributed development effort now being coordinated through GitHub issues, as well as larger release planning and coordination via dedicated ZenHub (www.zenhub.com) road maps and Kanban boards. Additionally, all CI/CD systems are available after the transition to GitHub. These are implemented with a collection of self-hosted GitHub Action runners (CI) and custom "full stack" software tests that check physics level output (CD). Several issues that impacted physics-level data distributions had appeared in our software during the volatile transition period from Subversion to Github. Over the past several months, these have been addressed and after several release candidates the Winter 2021 release arrived in February 2022. With these new tools in place, the Spring 2022 release is expected to follow in short order, encapsulating many delayed maintenance and tool/library upgrades that are ready for inclusion in releases.

The winter release is now in use for production of updated simulation samples. There were no critical tickets whose lifetime extended beyond one month. The test coverage remains at ≃50%, below our stated goal of 66%. The CD system remains available, but is currently run manually as needed near release checkpoints. However, work is underway to automate the CD process. The CI uptime for this year-long time period is estimated to be around 50%, below the goal of 90%, but since the completion of the move to GitHub, has had had solid uptime values in excess of 90%.

Software Labor Assessment

M&O harvests a significant amount of labor under 2.5 from resources, mostly graduate students and postdocs, contributed in-kind by IceCube collaborating institutions. These are coordinated through the semi-annual statements of work collected as part of the IceCube resource coordination process. This includes work to maintain core software infrastructure, development of new reconstruction and analysis software frameworks, and support for simulation and analysis of the upcoming Upgrade extension.

Despite the large pool of contributed effort, maintenance of the IceCube software systems does require the daily attention of a dedicated, professional team of software engineers to handle the manifold aspects of rigorous software maintenance and maintenance of the development and build environments. The M&O revised budget and current 5-year plan includes support for an additional simulation programmer in the 3rd year of the program. Plans for this hire was accelerated. A search identified an internal candidate who began work on simulation program modernization in January 2022, with initial focus on updates to photon simulations to allow more detailed simulation of multi-PMT optical modules that will be include in the IceCube detector as part of the Upgrade.

WBS 2.6: Calibration

We continue to refine measurements of the optical properties of the South Pole ice that comprises the majority of our detector, as well as the IceCube DOM response to photons. Precise modelling of both is fundamental to converting detector observables into physical measurements such as neutrino direction, energy, and absolute flux.

Ice characterization

After the release of a new bulk ice model, called SpiceBFRv2[1], in March 2021 the focus has shifted towards improving tilt modeling. Tilt describes the undulation of layers of constant optical properties over the face of the detector and is e.g. required for precise cascade energy reconstruction. To date, tilt modeling has been based solely on stratigraphy measurements performed by the dust logger during the deployment of the array. We have now been able to show that it can independently be deduced from LED calibration data. In addition to confirming the magnitude of tilt along its primary direction orthogonal to the flow, we were able to discover a tilt component along the flow. This result was cross-checked with data from ground penetrating radar (GPR) in particular from the PolarGap campaign. The feasibility of sled-drawn GPR measurements is currently being investigated with the aim to extend the knowledge of tilt to regions slightly outside the array, as relevant for through-going muons and partially contained cascades.

Traditionally ice fits require computationally intensive simulations for each tested parameter combination. A recently concluded study explored the possibility to use machine learning techniques to train a neural network to predict the outcome of arbitrary parameter combinations based on a sparse set of input simulations. Independently and within the context of the aforementioned tilt study, a method is currently being developed. A small set of simulations perturbing several thousand parameters at once in conjunction with a custom matrix solver which requires positive-definite solutions is employed to predict solutions close to the global minimum. Such techniques may in the

[1] describing the ice anisotropy effect through the cumulative light deflection caused by the birefringent microstructure of the glacial ice and yielding near perfect data-MC agreement for previously hard to match variables

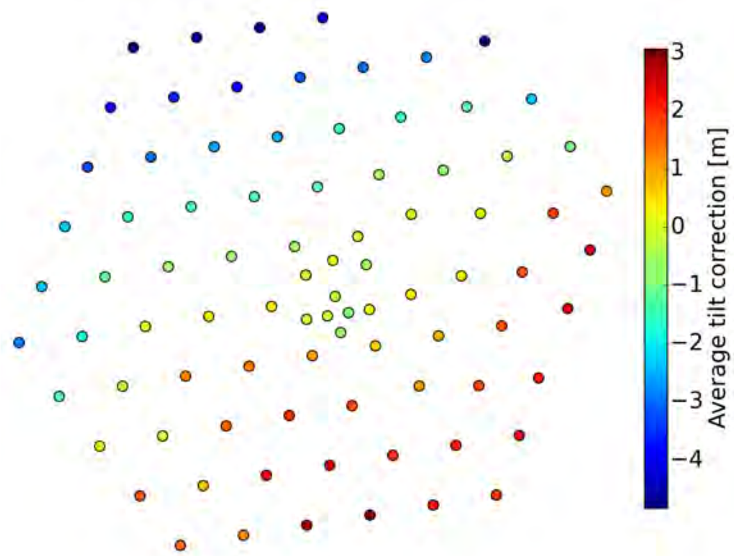

Figure 7: Per-string average corrections to the default tilt model as fitted to flasher data. A near constant slope in the direction of flow is observed.

future result in significant speed-ups in determining ice properties while at the same time yielding additional information such as the correlation between the fitted parameters, which is usually hard to access.

DOM characterization

The uncertainty on the absolute detection efficiency of our DOMs is a systematic considered in most analyses. A new iteration of an established study employing minimum ionizing muons as standard sources of known light emission is currently being finalized. It will update the recommendation to a new ice model and reduce the uncertainty range that has to be considered.

Closely related to the DOM efficiency is the correct simulation of the distribution of amplifications resulting from single photons incident on the PMTs, implemented as so called SPE charge distributions. While these were already calibrated in great detail during a study which concluded in 2020, we recently identified an inconsistency in their application between the simulation and reconstruction software. This for some reconstructions results in a percent level energy bias. Work in collaboration with the software and reconstruction working groups is currently underway to resolve this issue and document the changes made.

Knowledge of the DOM positions in the ice is important for the event reconstruction. The baseline assumption is that their horizontal coordinates are the same as those of the drilled hole at the surface. It is though known that the hole deviates from the straight vertical line by up to a few meters laterally. A new attempt to determine individual DOM positions using a large sample of muon tracks is being made and is showing promising first results. A continued effort is needed to include a larger number of DOMs and to validate the results.

Upgrade related activities

The IceCube Upgrade will further boost our ice understanding and also pose unique challenges as currently subdominant effects, such as the precise shape of the scattering function, become relevant. In preparation for the IceCube Upgrade we are facilitating discussion of and simulation for the calibration devices (i.e. Pencil Beam, POCAM, camera systems, LED flashers, dust-logger). The past months saw a number of discussions on photomultiplier properties and the utility of camera systems as well as a simulation study identifying observables to distinguish different ice anisotropy scenarios based on Pencil Beam data.

Appendix A: M&O Staffing Matrix

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.1 Program Coordination	2.1.0 Program Coordination	UTA	KE	JONES, BENJAMIN	OSCILLATIONS WORKING GROUP LEADERSHIP	US In-Kind	0.15
2.1 Program Coordination	2.1.1 Administration	BOCHUM	KE	Franckowiak, Anna	Analysis Coordinator	Non-US In-Kind	0.4
2.1 Program Coordination	2.1.1 Administration	BOCHUM	KE	TJUS, JULIA	Institutional lead	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	CHIBA	KE	ISHIHARA, AYA	Member of Speaker Comm	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	CHIBA	PO	Meier, Maximilian	Diffuse WG Techinical Coordinator	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.1 Administration	DESY	KE	ACKERMANN, MARKUS	ExecCom member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	DESY	KE	FRANCKOWIAK, ANNA	ExecCom member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	DESY	KE	FRANCKOWIAK, ANNA	ICC member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	DESY	KE	FRANCKOWIAK, ANNA	Analysis coordinator	Non-US In-Kind	0.25
2.1 Program Coordination	2.1.1 Administration	DESY	KE	KOWALSKI, MAREK	ExecCom member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	DESY	KE	KOWALSKI, MAREK	IceCube extensions coordination	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	DESY	KE	VAN SANTEN, JAKOB	ICC Member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	DPNC	KE	MONTARULI, TERESA	ICB Member, UHECR-neutrino coordinator	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.1 Administration	ERLANGEN	KE	KATZ, ULI	Institutional lead	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	KIT	KE	ENGEL, RALPH	Coordination	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	KIT	KE	HAUNGS, ANDREAS	Coordination	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	MAINZ	PO	Rongen, Martin	Calibration WG convener	Non-US In-Kind	0.25
2.1 Program Coordination	2.1.1 Administration	MÜNSTER	KE	KAPPES, ALEXANDER	Institutional lead	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	MÜNSTER	KE	KAPPES, ALEXANDER	Chair IceCube Impact Award committee	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	RWTH	KE	Wiebusch, Christopher	PubCom Member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	SU	KE	FINLEY, CHAD	ICB Member	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	SU	KE	FINLEY, CHAD	Pubcomm member	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	SU	KE	HULTQVIST, KLAS	ICB Member	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	SU	KE	WALCK, CHRISTIAN	Publications Bookkeeping	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	UC	KE	ADAMS, JENNI	ICB Member	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	ULB	KE	AGUILAR SANCHEZ, JUAN ANTONIO	Institutional Lead	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	ULB	KE	AGUILAR SANCHEZ, JUAN ANTONIO	Member of PubCom	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	ULB	KE	AGUILAR SANCHEZ, JUAN ANTONIO	Beyond Standard Model WG co-Chair	Non-US In-Kind	0.25
2.1 Program Coordination	2.1.1 Administration	ULB	KE	TOSCANO, SIMONA	Member of PubCom	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	UNIPD	KE	Bernardini, Elisa	ICB member, Gamma-ray Follow-up (GFU) coordination	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	UOX	KE	SARKAR, SUBIR	ICB Member	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	UU	KE	BOTNER, OLGA	ExecCom Member	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	UU	KE	DE LOS HEROS, CARLOS	BSM working group co-lead	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.1 Administration	UU	KE	DE LOS HEROS, CARLOS	Publications Committee member	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.1 Administration	VUB	KE	DE VRIES, KRIJN	Institutional Co-Lead	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	VUB	KE	VAN EIJNDHOVEN, NICK	Institutional Lead	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	DREXEL	KE	NEILSON, NAOKO	ICB member	US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	GTECH	KE	TABOADA, IGNACIO	Spokesperson	US In-Kind	0.35
2.1 Program Coordination	2.1.1 Administration	HARVARD	KE	ARGUELLES, CARLOS	Beyond Standard Model working group technical leader and ICB membe	US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	LBNL	KE	KLEIN,SPENCER	Supervise LBNL effort	NSF M&O Core	0.05
2.1 Program Coordination	2.1.1 Administration	LOYOLA	KE	Abbasi, Rasha	Institutional Lead	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	MARQUETTE	KE	ANDEEN, KAREN	Program Administration	NSF Base Grants	0.2
2.1 Program Coordination	2.1.1 Administration	MERCER	KE	MCNALLY, FRANK	Program administration	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	MIT	KE	CONRAD, JANET	ICB member	US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	MSU	KE	GRANT, DARREN	ExecCom member	NSF Base Grants	0.1
2.1 Program Coordination	2.1.1 Administration	MSU	KE	KOPPER, CLAUDIO	Analysis coordinator	NSF Base Grants	0.25
2.1 Program Coordination	2.1.1 Administration	MSU	KE	KOPPER, CLAUDIO	ICC member ex officio	NSF Base Grants	0.1
2.1 Program Coordination	2.1.1 Administration	MSU	KE	KOPPER, CLAUDIO	ExecCom member ex officio	NSF Base Grants	0.1
2.1 Program Coordination	2.1.1 Administration	ROCHESTER	KE	BENZVI, SEGEV	Supernova Working Group Co-convener	US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	ROCHESTER	KE	BENZVI, SEGEV	ICB member	US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	ROCHESTER	KE	BENZVI, SEGEV	PubComm Chair	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	SBU	KE	KIRYLUK, JOANNA	Member of ICB Speakers committee chair	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	SDSMT	KE	XINHUA, BAI	SDSMT Institutional Lead	NSF Base Grants	0.53
2.1 Program Coordination	2.1.1 Administration	UA	KE	SANTANDER, MARCOS	Realtime Oversight Committee Chair	US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	UA	KE	WILLIAMS, DAWN	Alabama Institutional Lead	US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	UA	KE	WILLIAMS, DAWN	Publications Committee member	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	UD	KE	SCHROEDER, FRANK	ICC member	US In-Kind	0.05
2.1 Program Coordination	2.1.1 Administration	UD	KE	SECKEL, DAVID	Institutional Lead	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	UD	PO	SOLDIN, DENNIS	ICC member	NSF Base Grants	0.05
2.1 Program Coordination	2.1.1 Administration	UD	PO	SOLDIN, DENNIS	CR-WG co-lead	NSF Base Grants	0.2
2.1 Program Coordination	2.1.1 Administration	UD	SC	TILAV, SERAP	ICC member	NSF M&O Core	0.05
2.1 Program Coordination	2.1.1 Administration	UD	SC	TILAV, SERAP	M&O management	NSF M&O Core	0.05
2.1 Program Coordination	2.1.1 Administration	UMD	KE	SULLIVAN, GREG	ExecCom member	US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	UMD	KE	SULLIVAN, GREG	M&O planning	US In-Kind	0.3
2.1 Program Coordination	2.1.1 Administration	UMD	PO	OLIVAS, ALEX	ICC member	NSF Base Grants	0.05
2.1 Program Coordination	2.1.1 Administration	UMD	SC	BLAUFUSS, ERIK	ICC member	NSF Base Grants	0.05
2.1 Program Coordination	2.1.1 Administration	UTAH	KE	Rott, Carsten	publication committee member	US In-Kind	0.1

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.1 Program Coordination	2.1.1 Administration	UW	AD	VAKHNINA, CATHERINE	IceCube Resource Coordinator	NSF M&O Core	0.75
2.1 Program Coordination	2.1.1 Administration	UW	KE	HALZEN, FRANCIS	Principle Investigator	NSF M&O Core	0.38
2.1 Program Coordination	2.1.1 Administration	UW	KE	HALZEN, FRANCIS	Principle Investigator	US In-Kind	0.12
2.1 Program Coordination	2.1.1 Administration	UW	KE	HANSON, KAEL	Director of IceCube Maintenance and Operations	NSF M&O Core	0.47
2.1 Program Coordination	2.1.1 Administration	UW	KE	HANSON, KAEL	Director of IceCube Maintenance and Operations	US In-Kind	0.08
2.1 Program Coordination	2.1.1 Administration	UW	KE	KARLE, ALBRECHT	Associate Director for Science	NSF M&O Core	0.38
2.1 Program Coordination	2.1.1 Administration	UW	KE	KARLE, ALBRECHT	ExecCom member	US In-Kind	0.2
2.1 Program Coordination	2.1.1 Administration	UW	KE	VANDENBROUCKE, JUSTIN	Pubcom member, TFT member	US In-Kind	0.1
2.1 Program Coordination	2.1.1 Administration	UW	MA	MADSEN, JIM	Associate Director for Education & Outreach	NSF M&O Core	0.5
2.1 Program Coordination	2.1.2 Engineering and R&D Support	GENT	SC	UGENT SC	Acoustic R&D Support	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.2 Engineering and R&D Support	RWTH	EN	BOCK, ERIC	IceAct Telescope electronic construction	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.2 Engineering and R&D Support	RWTH	EN	JAHN, DIETER	IceAct Telescope mechanical construction	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.2 Engineering and R&D Support	RWTH	GR	SCHAUFEL, MERLIN	IceAct Hardware Development	Non-US In-Kind	0.25
2.1 Program Coordination	2.1.2 Engineering and R&D Support	ULB	KE	MARIS, IOANA	SiPM characterization	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.2 Engineering and R&D Support	ULB	KE	TOSCANO, SIMONA	Hybrid detection Radio/In-Ice	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.2 Engineering and R&D Support	PSU	KE	COWEN, DOUG	Upgrade Co-PI	US In-Kind	0.2
2.1 Program Coordination	2.1.2 Engineering and R&D Support	UMD	GR	FREIDMAN, LIZ	Detector R&D	NSF Base Grants	0.25
2.1 Program Coordination	2.1.2 Engineering and R&D Support	UMD	KE	HOFFMAN, KARA	Detector R&D	US In-Kind	0.2
2.1 Program Coordination	2.1.2 Engineering and R&D Support	UW	EN	SANDSTROM, PERRY	Engineering support: IceCube Lab Summer operations, fieldwork manag	NSF M&O Core	0.2
2.1 Program Coordination	2.1.2 Engineering and R&D Support	UW	MA	HAUGEN, JAMES	Engineering Support: logistics, northern hemisphere testing, & vendor m	NSF M&O Core	0.15
2.1 Program Coordination	2.1.2 Engineering and R&D Support	UW	SC	DUVERNOIS, MICHAEL	Specialized calibrations, SPICE core project coordination, extracting spe	NSF M&O Core	0.25
2.1 Program Coordination	2.1.2 Engineering and R&D Support	UW	SC	DUVERNOIS, MICHAEL	Ongoing EMI studies & mitigation, South Pole & Northern test site instru	NSF M&O Core	0.25
2.1 Program Coordination	2.1.3 USAP Support & Safety	DREXEL	KE	NEILSON, NAOKO	South Pole Population planning committee	US In-Kind	0.05
2.1 Program Coordination	2.1.3 USAP Support & Safety	UW	MA	HAUGEN, JAMES	USAP Support: yearly sip, coordination with contractor (ASC)	NSF M&O Core	0.2
2.1 Program Coordination	2.1.3 USAP Support & Safety	UW	MA	ZERNICK, MICHAEL	Safety manager	NSF M&O Core	0.25
2.1 Program Coordination	2.1.4 Education & Outreach	DESY	GR	BROSTEAN-KAISER, JANNES	Organization of IceCube master classes at DESY	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	DPNC	GR	LUCARELLI, FRANCESCO	Masterclass IceCube et Nuit de La Science 2022	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	DPNC	KE	MONTARULI, TERESA	Responsible of Analysis Output of the group, Advising of students, Maste	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.4 Education & Outreach	KIT	PO	Link, Katrin	training education outreach	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.4 Education & Outreach	MAINZ	GR	UM GR	I3 virtual reality	Non-US In-Kind	0.25
2.1 Program Coordination	2.1.4 Education & Outreach	MÜNSTER	GR	BUSSE, RAFFAELA	Public outreach	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	MÜNSTER	PO	CLASSEN, LEW	Public outreach	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	NBI	KE	KOSKINEN, JASON	Speaking engagements (high school classes, open houses, etc.)	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	RWTH	GR	HALVE, LASSE	Netzwerk Teilchenwelt/Masterclasses	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	RWTH	GR	HALVE, LASSE	AIS3	Non-US In-Kind	0.01
2.1 Program Coordination	2.1.4 Education & Outreach	RWTH	KE	WIEBUSCH, CHRISTOPHER	AIS3	Non-US In-Kind	0.01
2.1 Program Coordination	2.1.4 Education & Outreach	SU	KE	FINLEY, CHAD	Masterclasses, model, etc	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	SU	KE	HULTQVIST, KLAS	Masterclasses, model, etc	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	ULB	KE	AGUILAR SANCHEZ, JUAN ANTONIO	Masterclass	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	ULB	KE	TOSCANO, SIMONA	Masterclass	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UNIPD	GR	Caterina Boscolo Meneguolo	Presenting IceCube at secondary schools and at the European Researcl	Non-US In-Kind	0.02
2.1 Program Coordination	2.1.4 Education & Outreach	UNIPD	KE	Bernardini, Elisa	Presenting IceCube science at secondary schools and at the European F	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UNIPD	KE	Bernardini, Elisa	Responsible of analysis output of the group, advising students	Non-US In-Kind	0.3
2.1 Program Coordination	2.1.4 Education & Outreach	UOX	KE	SARKAR, SUBIR	Education & Outreach	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UU	KE	BOTNER, OLGA	Education & Outreach	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UU	KE	DE LOS HEROS, CARLOS	Outreach	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UU	KE	HALLGREN, ALLAN	Outreach	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UU	KE	O´SULLIVAN, ERIN	Outreach	Non-US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	VUB	GR	CORREA, PABLO	Education & Outreach	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.4 Education & Outreach	VUB	GR	DE KOCKERE, SIMON	Education & Outreach	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	VUB	GR	MERCKX, YARNO	Education & Outreach	Non-US In-Kind	0.15
2.1 Program Coordination	2.1.4 Education & Outreach	VUB	KE	DE CLERCQ, CATHERINE	Education and Outreach	Non-US In-Kind	0.2
2.1 Program Coordination	2.1.4 Education & Outreach	VUB	KE	DE VRIES, KRIJN	Education & Outreach	Non-US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	DREXEL	KE	NEILSON, NAOKO	Being the collaboration Ombudsperson	US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	HARVARD	KE	ARGUELLES, CARLOS	Outreach activities in the Boston area	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	MERCER	KE	MCNALLY, FRANK	IceCube MasterClass	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	MIT	KE	CONRAD, JANET	CosmicWatch	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	MSU	GR	MICALLEF, JESSIE	MSU Science Festival exhibit	NSF Base Grants	0.02
2.1 Program Coordination	2.1.4 Education & Outreach	MSU	KE	GRANT, DARREN	Education & Outreach	NSF Base Grants	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	MSU	KE	WHITEHORN, NATHAN	Educaton & Outreach	US In-Kind	0.04
2.1 Program Coordination	2.1.4 Education & Outreach	MSU	PO	CLARK, BRIAN	Education & Outreach	US In-Kind	0.04
2.1 Program Coordination	2.1.4 Education & Outreach	MSU	PO	HALLIDAY, ROBERT	Education & Outreach	NSF Base Grants	0.02
2.1 Program Coordination	2.1.4 Education & Outreach	PSU	KE	COWEN, DOUG	Education & Outreach	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	PSU	KE	FOX, DEREK	Education & Outreach	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	ROCHESTER	KE	BENZVI, SEGEV	IceCube MasterClass	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	SBU	KE	KIRYLUK, JOANNA	Masterclasses, IceCube outreach activities in NY area	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	SDSMT	GR	LEON SILVERIO, DIANA	Education & Outreach for neutrino astronomy and IceCube	NSF Base Grants	0.05

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.1 Program Coordination	2.1.4 Education & Outreach	SDSMT	KE	XINHUA, BAI	Education & Outreach for neutrino astronomy and IceCube	NSF Base Grants	0.15
2.1 Program Coordination	2.1.4 Education & Outreach	UA	KE	SANTANDER, MARCOS	IceCube Outreach	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UA	KE	SANTANDER, MARCOS	IceCube Diversity Task Force Member	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UA	KE	WILLIAMS, DAWN	IceCube Outreach	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UCB	KE	PRICE, BUFORD	Institutional lead	US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	UMD	KE	UMD KE	Education & Outreach	US In-Kind	0.1
2.1 Program Coordination	2.1.4 Education & Outreach	UTA	KE	JONES, BENJAMIN	UTA astroparticle physics summer school for high school students	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UTAH	KE	Rott, Carsten	outreach	US In-Kind	0.05
2.1 Program Coordination	2.1.4 Education & Outreach	UW	AD	CHILDRESS-BECHTOL, ELLEN	Evaluation support: framework design and implementation for Broader In	NSF M&O Core	0.5
2.1 Program Coordination	2.1.4 Education & Outreach	UW	AD	DEMERIT, JEAN	Editor / science writer, E&O support	NSF M&O Core	0.25
2.1 Program Coordination	2.1.4 Education & Outreach	UW	AD	STEFFES, LINDSEY	E&O events and collaboration meetings mgmt. Website & social network	NSF M&O Core	0.75
2.1 Program Coordination	2.1.5 Communications	UW	AD	O'KEEFE, MADELEINE	Communication plan manager, science writer. Masterclass and commun	NSF M&O Core	0.75
2.2 Detector Operations & Maintenance (Online)	2.2.0 Detector Operations & Maintenance	UMD	PO	OLIVAS, ALEX	SW Coordinator – Detector M&O	NSF M&O Core	0.35
2.2 Detector Operations & Maintenance (Online)	2.2.0 Detector Operations & Maintenance	UW	MA	HAUGEN, JAMES	Logistics Manager	NSF M&O Core	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.0 Detector Operations & Maintenance	UW	SC	DESIATI, PAOLO	IceCube Coordination Committee chair	NSF M&O Core	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.0 Detector Operations & Maintenance	UW	SC	KELLEY, JOHN	Detector Maintenance and Operations Manager	NSF M&O Core	0.65
2.2 Detector Operations & Maintenance (Online)	2.2.1 Run Coordination	UW	IT	AUER, RALF	Winterovers coordinator, hiring and training of winterovers	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.1 Run Coordination	UW	SC	KAUER, MATTHEW	Run Coordinator	NSF M&O Core	0.4
2.2 Detector Operations & Maintenance (Online)	2.2.1 Run Coordination	UW	WO	UW WINTER OVERS	Operate Detector (Winter-Overs)	NSF M&O Core	3
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	LBNL	EN	STEZELBERGER,THORSTEN	Maintain DAQ Hardware	NSF M&O Core	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	PSU	SC	ANDERSON, TYLER	DAQ Firmware Development	NSF M&O Core	0.23
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	UW	CS	BENDFELT, TIMOTHY	IceCube DAQ: StringHub and domapp; Upgrade integration	NSF M&O Core	0.75
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	UW	CS	GLOWACKI, DAVID	IceCube DAQ: trigger and event builder	NSF M&O Core	0.5
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	UW	CS	GLOWACKI, DAVID	IceCube DAQ: command-and-control server, testing infrastructure	NSF M&O Core	0.5
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	UW	GR	TY, BUNHENG	DOR Firmware	NSF M&O Core	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	UW	SC	KELLEY, JOHN	DOM software: DOR device driver, DOMHub scripts, DOMCal	NSF M&O Core	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.2 Data Acquisition	UW	SC	KELLEY, JOHN	Track DOM issues, generate detector run configurations	NSF M&O Core	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	ALBERTA	KE	MOORE, ROGER	TFT Board Member	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	BOCHUM	GR	Wulff, Johan	responsible for Moon Filter	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	CHIBA	KE	ISHIHARA, AYA	EHE Filters	Non-US In-Kind	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DESY	KE	VAN SANTEN, JAKOB	Reco/Syst WG co-chair	Non-US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DTMND	GR	Gutjahr, Pascal	Reconstruction	Non-US In-Kind	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DTMND	GR	HÜNNEFELD, MIRKO	Reconstruction	Non-US In-Kind	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DTMND	GR	Kardum, Leonora	Physics filters	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DTMND	SC	RUHE, TIM	Physics filters	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	NBI	PO	STUTTARD, TOM	Oscillation WG co-convenor	Non-US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	RWTH	GR	BOETTCHER, JAKOB	SLOP Filter + Trigger	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	RWTH	GR	FÜRST, PHILIPP	Final level diffuse tests	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	RWTH	GR	PHILIPPEN, SASKIA	Moon filter verification	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	ULB	GR	RENZI, GIOVANNI	Vertical event filter, WIMP L2	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UU	KE	DE LOS HEROS, CARLOS	TFT Board member	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	WUPPERTAL	GR	LAUBER, FREDERIK	Detection of Magnetic Monopoles through radio luminescence	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	WUPPERTAL	KE	HELBING, KLAUS	BSM WG chair	Non-US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	WUPPERTAL	KE	HELBING, KLAUS	BSM WG chair	Non-US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	WUPPERTAL	PO	POLLMANN, ANNA	SLOP filter, Monopole filte	Non-US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DREXEL	KE	NEILSON, NAOKO	TFT Board Co-Chair	US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	DREXEL	KE	NEILSON, NAOKO	Splitting – Q/P frame and coincidence	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	MSU	KE	WHITEHORN, NATHAN	Diffuse WG co-chair	US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	SBU	GR	ZHANG, ZELONG	Cascade filter / L3	NSF Base Grants	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UAA	KE	RAWLINS, KATHERINE	Cosmic Ray WG co-convener	US In-Kind	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UD	GR	BINTA AMIN, MOUREEN	Including IceTop in ROC consideration	NSF Base Grants	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UD	PO	SOLDIN, DENNIS	IceTop Filter	NSF Base Grants	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UMD	CS	SCHMIDT, TORSTEN	Maintain and develop PnF software, support operations to respond to an	NSF M&O Core	0.5
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UMD	GR	EVANS, JOHN	Near Real time alerts/GRB	NSF Base Grants	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UMD	GR	FREIDMAN, LIZ	Real-time & near real time alerts	NSF Base Grants	0.35
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UMD	PO	LARSON, MICHAEL	Near Real time alerts/GRB	NSF Base Grants	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UMD	SC	BLAUFUSS, ERIK	Maintain PnF S/W and Online Filters	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UMD	SC	BLAUFUSS, ERIK	Filter requests, bandwidth, TFT Board Member. IceTray	NSF M&O Core	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.3 Online Filter (PnF)	UW	SC	KAUER, MATTHEW	TFT Board member	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	DESY	GR	DESY GR	Detector Monitoring	Non-US In-Kind	0.12
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	DESY	SC	DESY SC	Detector Monitoring	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	DPNC	GR	LUCARELLI FRANCESCO	Detector Monitoring	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	DTMND	GR	DTMD GR	Detector Monitoring	Non-US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	GENT	GR	VERPOEST, STEF	Detector Monitoring	Non-US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	HUMBOLDT	GR	Feigl, Nora	Optical detector calibration	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	MAINZ	GR	FRITZ, ALEXANDER	SuperNova Operations	Non-US In-Kind	0.4
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	MAINZ	GR	UM GR	Detector Monitoring	Non-US In-Kind	0.05

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	NBI	GR	KOZYNETS, TANIA	Detector monitoring shifts	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	RWTH	GR	HALVE, LASSE	Detector monitoring shifts contact from Aachen	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	RWTH	GR	PHILIPPEN, SASKIA	Integration of Moonshadow into detector monitoring	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	RWTH	GR	RWTH GR	Detector monitoring shifts	Non-US In-Kind	0.12
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	SKKU	PO	Rodan, Steven	Detector Monitoring	Non-US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	SU	GR	DEOSKAR, KUNAL	Detector Monitoring	Non-US In-Kind	0.06
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	TUM	GR	MPI GR	Detector Monitoring	Non-US In-Kind	0.045
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UC	GR	THOMAS, HAMISH	Detector Monitoring	Non-US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UC	KE	ADAMS, JENNI	Detector Monitoring	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	ULB	GR	IOVINE, NADÉGE	IceTop Snow Monitor	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	ULB	GR	ULB GR	Detector Monitoring	Non-US In-Kind	0.12
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	ULB	KE	MARIS, IOANA	Detector Monitoring	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UU	GR	VALTONEN-MATTILA, NORA	Detector monitoring shifts	Non-US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	VUB	GR	VUB GR	Detector monitoring shifts	Non-US In-Kind	0.06
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	WUPPERTAL	GR	WUPPERTAL GR	Monitoring shifts	Non-US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	CAU	KE	JAPARIDZE, GEORGE	Detector monitoring shifts	US In-Kind	0.015
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	DREXEL	GR	Kang, Luna (Xinyue)	Detector monitoring shifts	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	GTECH	GR	PRANAV, DAVE	Detector monitoring shifts	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	LBNL	PO	ROBERTSON, SALLY	Detector monitoring shifts	NSF Base Grants	0.09
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	LOYOLA	KE	Abbasi, Rasha	Detector monitoring shift	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	MSU	GR	KRUPCZAK, EMMETT	Detector monitoring shifts	NSF Base Grants	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	MSU	GR	MICALLEF, JESSIE	Detector monitoring shifts	US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	MSU	GR	TWAGIRAYEZU, JEAN PIERRE	Detector monitoring shifts	NSF Base Grants	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	MSU	PO	NIEDERHAUSEN, HANS	Detector monitoring shifts	US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	PSU	GR	Li, Yijia	Detector monitoring shifts	US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	PSU	PO	GREGOIRE, TIMOTHEE	Maintain IceCube integration with AMON; HESE cascades	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	ROCHESTER	GR	GRISWOLD, SPENCER	Detector monitoring shifts	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	SBU	GR	ZHANG, ZELONG	Detector Monitoring	NSF Base Grants	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	SDSMT	GR	LEON SILVERIO, DIANA	IceCube operation monitoring	NSF Base Grants	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	SDSMT	KE	XINHUA, BAI	IceCube operation monitoring	NSF Base Grants	0.02
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UA	GR	GHADIMI, AVA	Monitoring shifts	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UA	GR	GOSWAMI, SREETAMA	Monitoring shifts	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UCI	GR	HANSON, JORDAN	Detector monitoring shifts	US In-Kind	0.01
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UCI	KE	BARWICK, STEVE	Detector monitoring shifts	US In-Kind	0.01
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UD	GR	PAUDEL, EK NARAYAN	Data monitoring	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UD	GR	PUNSUEBSAY, NOPPODAL	Data monitoring	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UD	SC	TILAV, SERAP	Data monitoring	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UMD	GR	UMD GR	Detector monitoring shifts	NSF Base Grants	0.06
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UTAH	PO	Chowdhury, Nafis	monitoring shift	US In-Kind	0.03
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	CS	BRAUN, JAMES	I3MS Iridium messaging system software	NSF M&O Core	0.5
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	CS	BURRESON, COLIN	IceCube Live monitoring system: web interface, databases	NSF M&O Core	0.9
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	CS	BURRESON, COLIN	Supernova alert interface, DAQ monitoring, and visualization in IceCube	NSF M&O Core	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	CS	FRERE, MICHAEL	IceCube Live lead developer	NSF M&O Core	0.75
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	GR	SAFA, IBRAHIM	Detector monitoring shifts	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	GR	UW GR	Detector monitoring shifts	NSF Base Grants	0.12
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	PO	UW PO	Detector monitoring shifts	NSF Base Grants	0.08
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	SC	KAUER, MATTHEW	Data Monitoring lead: coordinate test and feature development; design u	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.4 Detector Monitoring	UW	SC	KAUER, MATTHEW	Training and coordinating monitoring shifters	NSF M&O Core	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.5 Experiment Control	UW	CS	BRAUN, JAMES	IceCube LiveControl experiment control software: alerts and component	NSF M&O Core	0.5
2.2 Detector Operations & Maintenance (Online)	2.2.5 Experiment Control	UW	CS	FRERE, MICHAEL	IceCube LiveControl experiment control software: operator interface	NSF M&O Core	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	GR	Bontempo, Federico	Radio operation	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	GR	KOUNDAL, PARAS	Scintillator operation	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	GR	OEHLER, MARIE	Scintillator operation	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	GR	Shefali, Shefali	Scintillator operation	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	GR	TURCOTTE, ROXANNE	Radio operation	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	KE	HAUNGS, ANDREAS	Co-task leader scintillators	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	PO	DUJMOVIC, HRVOJE	Radio operation	Non-US In-Kind	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	PO	HUBER, THOMAS	Scintillator operation	Non-US In-Kind	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	SC	SCHIELER, HARALD	Construction (scintillator)	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	KIT	SC	WEINDL, ANDREAS	DAQ surface	Non-US In-Kind	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	RWTH	GR	SCHAUFEL, MERLIN	IceAct Monitoring	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	ULB	PO	MOCKLER, DANIELA	Validation between SLC signals and MC	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	WUPPERTAL	GR	BINDIG, DANIEL	Laterally separated muons in IceTop	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	MARQUETTE	GR	PAUL, LARISSA	Surface detector R&D	NSF Base Grants	0.6
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	MARQUETTE	KE	ANDEEN, KAREN	Surface detector R&D	NSF Base Grants	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UD	GR	BINTA AMIN, MOUREEN	IceTop simulation	NSF Base Grants	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UD	GR	PAN, YUE	Radio operations, data management	US In-Kind	0.25

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UD	GR	PAN, YUE	Radio monitoring	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UD	GR	PAN, YUE	Radio simulations	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UD	KE	SCHROEDER, FRANK	Surface detector enhancements	US In-Kind	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UD	SC	TILAV, SERAP	Coordinate IceTop Operations	NSF M&O Core	0.3
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UW	EN	SANDSTROM, PERRY	Design, build and test experimental apparatus for restoring IceTop detec	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UW	SC	KAUER, MATTHEW	Design and build experimental apparatus for restoring IceTop detector el	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.6 Surface Detectors	UW	SC	TOSI, DELIA	Test and commission experimental apparatus for restoring IceTop detect	NSF M&O Core	0.5
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	MAINZ	GR	Kappesser, David	Supernova Simulation	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	UU	GR	VALTONEN-MATTILA, NORA	Responsibility for the hitspool data	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	UU	KE	O´SULLIVAN, ERIN	Supernova WG co-chair	Non-US In-Kind	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	ROCHESTER	GR	GRISWOLD, SPENCER	Supernova DAQ	US In-Kind	0.15
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	ROCHESTER	KE	BENZVI, SEGEV	Supernova DAQ	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	SUBR	KE	TER-ANTONYAN, SAMVEL	Supernova Data Analysis	US In-Kind	0.015
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	UW	CS	BENDFELT, TIMOTHY	IceCube DAQ: supernova interface, hitspooling	NSF M&O Core	0.25
2.2 Detector Operations & Maintenance (Online)	2.2.7 Supernova System	YALE	KE	MARUYAMA, REINA	Supernova DAQ	US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	BOCHUM	PO	Lincetto, Massimiliano	Realtime Shifter	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	DESY	GR	LAGUNAS GUALDA, CHRISTINA	Online data stream maintenance	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	DESY	GR	STEIN, ROBERT	Online data stream maintenance	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	DESY	KE	FRANCKOWIAK, ANNA	Realtime oversight committee member	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	SU	KE	FINLEY, CHAD	Realtime Oversight Committee	Non-US In-Kind	0.05
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	UNIPD	GR	Caterina Boscolo Meneguolo	Comparison of alerts p-value online/offline	Non-US In-Kind	0.45
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	UNIPD	KE	Bernardini, Elisa	Coordination with Imaging Air Cherenkov Telescopes (IACTs)	Non-US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	UU	PO	SHARMA, ANKUR	Development and automatization of alternative angular uncertainty meas	Non-US In-Kind	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	GTECH	GR	CHEN, CHUJIE	Design of Alert DB and webpage	NSF Base Grants	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	PSU	PO	AYALA, HUGO	Maintain IceCube integration with AMON; HESE cascades	US In-Kind	0.1
2.2 Detector Operations & Maintenance (Online)	2.2.8 Real-Time Alerts	UW	GR	MANCINA, SARAH	Estres filter, Starting track veto	NSF Base Grants	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.9 SPS/SPTS	UW	EN	SANDSTROM, PERRY	Maintain South Pole System H/W Infrastructure	NSF M&O Core	0.2
2.2 Detector Operations & Maintenance (Online)	2.2.9 SPS/SPTS	UW	IT	AUER, RALF	Maintain South Pole computing H/W infrastructure and operating system	NSF M&O Core	0.23
2.2 Detector Operations & Maintenance (Online)	2.2.9 SPS/SPTS	UW	IT	AUER, RALF	Maintain South Pole Test System computing H/W Infrastructure and ope	NSF M&O Core	0.1
2.3 Computing & Data Management Services	2.3.0 Computing & Data Management Services	LBNL	KE	KLEIN,SPENCER	Oversee raw data storage at LBNL	US In-Kind	0.08
2.3 Computing & Data Management Services	2.3.0 Computing & Data Management Services	UW	IT	Nutting, Karl	End-user support for common collaboration services	NSF M&O Core	0.6
2.3 Computing & Data Management Services	2.3.0 Computing & Data Management Services	UW	MA	RIEDEL, BENEDIKT	Computing Infrastructure Manager	NSF M&O Core	0.9
2.3 Computing & Data Management Services	2.3.1 Data Storage & Transfer	UW	CS	MEADE, PATRICK	Operate data handling services	NSF M&O Core	0.25
2.3 Computing & Data Management Services	2.3.1 Data Storage & Transfer	UW	CS	MEADE, PATRICK	Maintain data handling software (JADE): Archive at the S. Pole, transfer,	NSF M&O Core	0.25
2.3 Computing & Data Management Services	2.3.1 Data Storage & Transfer	UW	CS	MEADE, PATRICK	Operate Data transfer from S. Pole to UW Data Warehouse and archive	NSF M&O Core	0.5
2.3 Computing & Data Management Services	2.3.1 Data Storage & Transfer	UW	IT	BARNET, STEVE	Maintain and Operate Data Storage Infrastructure	NSF M&O Core	0.3
2.3 Computing & Data Management Services	2.3.1 Data Storage & Transfer	UW	IT	BELLINGER, JIM	Long term preservation and archive services, data curation	NSF M&O Core	1
2.3 Computing & Data Management Services	2.3.1 Data Storage & Transfer	UW	IT	BRIK, VLADIMIR	Maintain storage system needed for simulation production	NSF M&O Core	0.2
2.3 Computing & Data Management Services	2.3.2 Core Data Center Infrastructure	UW	IT	BARNET, STEVE	CI Operations and cybersecurity manager	NSF M&O Core	0.7
2.3 Computing & Data Management Services	2.3.2 Core Data Center Infrastructure	UW	IT	BRIK, VLADIMIR	Maintain Core Data Center Infrastructure Systems	NSF M&O Core	0.1
2.3 Computing & Data Management Services	2.3.2 Core Data Center Infrastructure	UW	IT	MAYER, DAVID	IceCube Web Development	NSF M&O Core	0.5
2.3 Computing & Data Management Services	2.3.2 Core Data Center Infrastructure	UW	IT	SHEPERD, ALEC	Maintain and operate Virtual Machines deployment infrastrucutre	NSF M&O Core	0.5
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	DESY	IT	DESY IT	European Data Center - Distributed Computing and Labor	Non-US In-Kind	1
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	DESY	KE	ACKERMANN, MARKUS	DESY TIER-1 coordination	Non-US In-Kind	0.1
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	DESY	KE	VAN SANTEN, JAKOB	TIER-1 coordination / Simulation Production	Non-US In-Kind	0.25
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	LBNL	IT	LBNL, all	NERSC Data Archiving, Distributed Computing and Labor	US In-Kind	1
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	UMD	IT	UMD IT	Coordination and Support for Grid and distributed computing	NSF M&O Core	0
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	UW	IT	BRIK, VLADIMIR	Maintain High Performance Computing services.	NSF M&O Core	0.1
2.3 Computing & Data Management Services	2.3.3 Central Computing Resources	UW	IT	SHEPERD, ALEC	Maintain Central Computing Infrastructure Systems	NSF M&O Core	0.5
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	ALBERTA	KE	YANEZ, JUAN PABLO	Management of ComputeCanada allocation	Non-US In-Kind	0.1
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	KIT	SC	KANG, DONGHWA	Middleware Setup	Non-US In-Kind	0.15
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	RWTH	GR	Ganster, Erik	OSG Site RWTH/Pyglidein	Non-US In-Kind	0.05
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	MSU	KE	KOPPER, CLAUDIO	GPU computing resourses	NSF Base Grants	0.05
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	MSU	PO	CLARK, BRIAN	IceProd site manager at MSU HPCC	US In-Kind	0.1
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	MSU	PO	HALLIDAY, ROBERT	IceProd site manager at MSU HPCC	NSF M&O Core	0.25
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	UW	CS	EVANS, ERIC	Core software maintenance	NSF M&O Core	0.5
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	UW	IT	BRIK, VLADIMIR	Maintain distributed high-throughput cluster	NSF M&O Core	0.6
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	UW	IT	SCHULTZ, DAVID	Core distributed software maintenance	NSF M&O Core	0.5
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	UW	IT	SCHULTZ, DAVID	Maintain workflow management system	NSF M&O Core	0.4
2.3 Computing & Data Management Services	2.3.4 Distributed Computing Resources	UW	IT	SCHULTZ, DAVID	Manage Production Software Team	NSF M&O Core	0.1
2.4 Data Processing & Simulation Services	2.4.0 Data Processing & Simulation Services	DPNC	GR	LUCARELLI FRANCESCO	Time dependent flare search	Non-US In-Kind	0.7
2.4 Data Processing & Simulation Services	2.4.0 Data Processing & Simulation Services	SDSMT	GR	LEON SILVERIO, DIANA	Data/processing consistency justification; Additional parameters from ne	NSF Base Grants	0.2
2.4 Data Processing & Simulation Services	2.4.0 Data Processing & Simulation Services	UW	DS	DIAZ-VELEZ, JUAN CARLOS	Coordination of Offline Processing and Simulation Production efforts witl	NSF M&O Core	0.25
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	GENT	GR	VERPOEST, STEF	Cosmic Ray L3 scripts	Non-US In-Kind	0.5
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	GENT	GR	VERPOEST, STEF	Pass2 verification	Non-US In-Kind	0.05
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	NBI	PO	STUTTARD, TOM	OscNext Event Selection	Non-US In-Kind	0.4
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	RWTH	GR	FÜRST, PHILIPP	Diffuse sample production	Non-US In-Kind	0.1

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	RWTH	GR	PHILIPPEN, SASKIA	Moon Processing MC& Experimental data	Non-US In-Kind	0.05
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	RWTH	GR	SCHAUFEL, MERLIN	IceAct Standard Processing development	Non-US In-Kind	0.1
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	TUM	GR	GLAUCH, THEO	Pass-2	Non-US In-Kind	0.2
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	TUM	GR	HUBER, MATTHIAS	Muon L3 Scripts	Non-US In-Kind	0.2
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	TUM	PO	ELLER, PHILLIPP	Data curator Low Energy WG	Non-US In-Kind	0
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	TUM	PO	HAACK, CHRISTIAN	Muon L3 Scripts	Non-US In-Kind	0
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	DREXEL	GR	SCLAFANI, STEVE	Neutrino Sources Tech Lead	US In-Kind	0.25
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	SBU	GR	ZHANG, ZELONG	Pass2/3 verification	NSF Base Grants	0.1
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	UW	CS	EVANS, ERIC	Data validation tool development	NSF M&O Core	0.1
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	UW	DS	SNIHUR, ROBERT	Experimental data processing and reduction. Interface with collaboratior	NSF M&O Core	1
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	UW	GR	LEONARD, KAYLA	Developing for MuonGun for low energies	US In-Kind	0.3
2.4 Data Processing & Simulation Services	2.4.1 Offline Data Production	UW	GR	LUSZCZAK, WILLIAM	maintenance of C-Sky, other	NSF Base Grants	0.2
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	ALBERTA	GR	LIUBARSKA, MARIIA	New GENIE interface developer / maintainer	Non-US In-Kind	0.3
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	ALBERTA	GR	SARKAR, SOURAV	PYTHIA event generator implementation and maintenance	Non-US In-Kind	0.15
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	CHIBA	PO	MEIER, MAXIMILIAN	High energy Corsika simulation production with Sibyll 3.2 and EPOS	Non-US In-Kind	0.2
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	DTMND	GR	Hymon, Karolin	Simulation production site manager at Dortmund	Non-US In-Kind	0.3
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	KIT	PO	LESZCZYNSKA, AGNIESZKA	Validation and Monitoring data sets	Non-US In-Kind	0.2
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	KIT	SC	KANG, DONGHWA	Surface simulations	Non-US In-Kind	0.15
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	RWTH	GR	Boettcher, Jakob	Monopole Background simulation production	Non-US In-Kind	0.1
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	RWTH	GR	GANSTER, ERIK	MC Production for global diffuse fit	Non-US In-Kind	0.15
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	TUM	GR	MEIGHEN-BERGER, STEPHAN	Development of MCEq	Non-US In-Kind	0.3
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	MIT	GR	WEIGEL, PHILIP	Development of ML algorithms for the MEOWS dataset	US In-Kind	0.1
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UD	GR	REHMAN, ABDUL	Surface radio	US In-Kind	0.15
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UD	PO	SOLDIN, DENNIS	IceCube/IceTopsimulation production	NSF M&O Core	0.15
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UMD	PO	LARSON, MICHAEL	Low Energy tools	NSF Base Grants	0.05
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UMD	SC	BLAUFUSS, ERIK	Simulation production site manager	NSF Base Grants	0.1
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UW	CS	EVANS, ERIC	Simulation production monitoring and validation	NSF M&O Core	0.4
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UW	DS	DIAZ-VELEZ, JUAN CARLOS	Manage Centralized Simulation Production. Maintain, test and update ph	NSF M&O Core	0.4
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UW	GR	Leonard, Kayla	developing for MuonGun for low energies, simulations Oscnext	NSF Base Grants	0.3
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UW	SC	DESIATI, PAOLO	Simulation Production Manager	NSF M&O Core	0.3
2.4 Data Processing & Simulation Services	2.4.2 Simulation Production	UW	SC	DESIATI, PAOLO	Simulation Production panel chair	US In-Kind	0.1
2.4 Data Processing & Simulation Services	2.4.3 Public Data Products	KIT	GR	Tista Mukherjee		Non-US In-Kind	0.2
2.4 Data Processing & Simulation Services	2.4.3 Public Data Products	VUB	KE	VAN EIJNDHOVEN, NICK	Public data release	Non-US In-Kind	0.1
2.4 Data Processing & Simulation Services	2.4.3 Public Data Products	MIT	GR	DIAZ, ALEJANDRO	Organize and maintain BSM public data release page	US In-Kind	0.1
2.4 Data Processing & Simulation Services	2.4.3 Public Data Products	MSU	SC	WEAVER, CHRIS	Real-time alert software framework development	US In-Kind	0.2
2.5 Software	2.5.1 Core Software	SU	GR	JANSSON, MATTI	Software strike team	Non-US In-Kind	0.2
2.5 Software	2.5.1 Core Software	TUM	GR	KARL, MARTINA	Software strike team	Non-US In-Kind	0.2
2.5 Software	2.5.1 Core Software	MSU	KE	WHITEHORN, NATHAN	Icetray framework maintenance	US In-Kind	0.05
2.5 Software	2.5.1 Core Software	UD	GR	REHMAN, ABDUL	Visualization software (Steamshovel)	NSF Base Grants	0.15
2.5 Software	2.5.1 Core Software	UD	PO	COLEMAN, ALAN	Software strike team	US In-Kind	0.1
2.5 Software	2.5.1 Core Software	UMD	CS	UMD CS	Maintain Core Software Repository	NSF M&O Core	0
2.5 Software	2.5.1 Core Software	UMD	PO	OLIVAS, ALEX	SW Coordinator – Core Software	NSF M&O Core	0.2
2.5 Software	2.5.1 Core Software	UMD	PO	OLIVAS, ALEX	Support Core Software	US In-Kind	0.05
2.5 Software	2.5.1 Core Software	UMD	SC	BLAUFUSS, ERIK	Support Core Software	NSF M&O Core	0.1
2.5 Software	2.5.2 Simulation Software	BOCHUM	KE	TJUS, JULIA	Development PROPOSAL simulation software	Non-US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	CHIBA	KE	YOSHIDA, SHIGERU	Maintain EHE related simulation projects (JULIeT and Weighting Module	Non-US In-Kind	0.2
2.5 Software	2.5.2 Simulation Software	CHIBA	PO	Hill, Colton	Photonics long range spline table production	Non-US In-Kind	0.2
2.5 Software	2.5.2 Simulation Software	DESY	KE	VAN SANTEN, JAKOB	Software package maintenance	Non-US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	DTMND	GR	ALAMEDDINE, JEAN-MARCO	PROPOSAL-IceProdIntegration and optimization	Non-US In-Kind	0.5
2.5 Software	2.5.2 Simulation Software	ERLANGEN	GR	FIEDLSCHUSTER, SEBASTIAN	software development	Non-US In-Kind	0.2
2.5 Software	2.5.2 Simulation Software	ERLANGEN	GR	WREDE, GERRIT	Novel reconstruction algorithms	Non-US In-Kind	0.2
2.5 Software	2.5.2 Simulation Software	ERLANGEN	PO	GLÜSENKAMP, THORSTEN	Track/Cascade reconstruction and simulation / reconstruction WG lead	Non-US In-Kind	0.3
2.5 Software	2.5.2 Simulation Software	GENT	GR	VERPOEST, STEF	Investigations of thinning in simulation	Non-US In-Kind	0.05
2.5 Software	2.5.2 Simulation Software	KIT	PO	Alves Junior, Antonio Augusto	CORSIKA8 Simualtions	Non-US In-Kind	0.3
2.5 Software	2.5.2 Simulation Software	KIT	SC	WEINDL	Software surface	Non-US In-Kind	0.15
2.5 Software	2.5.2 Simulation Software	QUEEN'S	KE	CLARK, KENNETH	Low Energy Simulation Software updates	Non-US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	RWTH	GR	BOETTCHER, JAKOB	Monopole Noise Simulation Tool	Non-US In-Kind	0.05
2.5 Software	2.5.2 Simulation Software	RWTH	GR	GANSTER, ERIK	Snowstorm MC	Non-US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	RWTH	GR	SCHAUFEL, MERLIN	IceAct/IceCube/IceTop MonteCarlo	Non-US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	MIT	GR	DIAZ, ALEJANDRO	Development of GolemFit	US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	MIT	PO	Hardin, John	Development of GolemFit	US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	MIT	PO	Hardin, John	Development of algorithms looking for starting events	US In-Kind	0.3
2.5 Software	2.5.2 Simulation Software	MSU	KE	KOPPER, CLAUDIO	Maintenance of clsim direct photon propagation tool	US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	ROCHESTER	GR	GRISWOLD, SPENCER	Supernova and transient simulations	US In-Kind	0.1
2.5 Software	2.5.2 Simulation Software	SUBR	KE	FAZELY, ALI	GEANT Simulation, Supernova Data Analysis	US In-Kind	0.15
2.5 Software	2.5.2 Simulation Software	SUBR	SC	XIANWU, XU	Simulation Programs	US In-Kind	0.15
2.5 Software	2.5.2 Simulation Software	UD	GR	PAUDEL, EK NARAYAN	Surface radio	US In-Kind	0.1

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.5 Software	2.5.2 Simulation Software	UD	PO	COLEMAN, ALAN	Simulation of surface enhancements	US In-Kind	0.2
2.5 Software	2.5.2 Simulation Software	UTA	GR	PARKER, GRANT	Development, testing and maintenance of GolemFit code	NSF Base Grants	0.1
2.5 Software	2.5.2 Simulation Software	UTA	GR	SMITHERS, BENJAMIN	LeptonInjector and SnowSuite development and maintenance	NSF Base Grants	0.25
2.5 Software	2.5.2 Simulation Software	UW	DS	DIAZ-VELEZ, JUAN CARLOS	Simulation software programs coordinator	NSF M&O Core	0.25
2.5 Software	2.5.2 Simulation Software	UW	DS	MEAGHER, KEVIN	Triggered CORSIKA maintenance and development	NSF M&O Core	0.75
2.5 Software	2.5.2 Simulation Software	UW	GR	SILVA, MANUEL	Muongun maintenance, upgrade	NSF M&O Core	0.25
2.5 Software	2.5.2 Simulation Software	UW	SC	CHIRKIN, DMITRY	Maintain and Verify Simulation of Photon Propagation and update Ice Pr	NSF M&O Core	0.3
2.5 Software	2.5.2 Simulation Software	UW	SC	HOSHINA, KOTOYO	nugen maintenance	NSF M&O Core	0.25
2.5 Software	2.5.3 Reconstruction	ADELAIDE	KE	HILL, GARY	Event energy and direction reconstruction, millipede	Non-US In-Kind	0.4
2.5 Software	2.5.3 Reconstruction	CHIBA	KE	ISHIHARA, AYA	Maintain Portia and the SC data filtering	Non-US In-Kind	0.15
2.5 Software	2.5.3 Reconstruction	CHIBA	KE	YOSHIDA, SHIGERU	EHE online pipeline for follow-up observations	Non-US In-Kind	0.15
2.5 Software	2.5.3 Reconstruction	CHIBA	PO	Meier, Maximilian	Maintain Combo for EHE simulations	Non-US In-Kind	0.2
2.5 Software	2.5.3 Reconstruction	DESY	GR	LAGUNAS GUALDA, CHRISTINA	Millipede systematic uncertainties	Non-US In-Kind	0.1
2.5 Software	2.5.3 Reconstruction	ERLANGEN	GR	SCHINDLER, SEBASTIAN	reconstruction tests	Non-US In-Kind	0.2
2.5 Software	2.5.3 Reconstruction	MAINZ	GR	WELDERT, JAN	freeDOM reconstruction	Non-US In-Kind	0.2
2.5 Software	2.5.3 Reconstruction	RWTH	GR	FÜRST, PHILIPP	New energy estimator for Muon reconstruction	Non-US In-Kind	0.05
2.5 Software	2.5.3 Reconstruction	RWTH	GR	PHILIPPEN, SASKIA	Moon analysis tool for reconstruction software	Non-US In-Kind	0.05
2.5 Software	2.5.3 Reconstruction	SU	GR	DEOSKAR, KUNAL	Event reconstruction, angular resolution	Non-US In-Kind	0.2
2.5 Software	2.5.3 Reconstruction	VUB	GR	COPPIN, PAUL	Maintenance of GRBWEB	Non-US In-Kind	0.1
2.5 Software	2.5.3 Reconstruction	VUB	KE	VAN EIJNDHOVEN, NICK	IcePack analysis software tools	Non-US In-Kind	0.25
2.5 Software	2.5.3 Reconstruction	GTECH	GR	CHEN, CHUJIE	Maintainer of Cramer-Rao	NSF Base Grants	0.1
2.5 Software	2.5.3 Reconstruction	LBNL	GR	LYU,YANG	Stochasticity and IceTop veto software, including for Real time alerts, sta	NSF Base Grants	0.1
2.5 Software	2.5.3 Reconstruction	MERCER	KE	MCNALLY, FRANK	IceTop energy reconstruction with CNNs, Processing Cosmic Ray Aniso	US In-Kind	0.1
2.5 Software	2.5.3 Reconstruction	MSU	GR	HARNISCH, ALEXANDER	Machine learning-based semi-supervised all-sky background rejection	NSF Base Grants	0.1
2.5 Software	2.5.3 Reconstruction	MSU	GR	MICALLEF, JESSIE	Low-energy machine learning reconstruction development	US In-Kind	0.4
2.5 Software	2.5.3 Reconstruction	MSU	GR	NOWICKI, SARAH	DirectReco software support	NSF Base Grants	0.1
2.5 Software	2.5.3 Reconstruction	MSU	PO	YU, SHIQI	Low-energy machine learning reconstruction development	US In-Kind	0.1
2.5 Software	2.5.3 Reconstruction	PSU	PO	FIENBERG, AARON	PISA Maintenance	NSF Base Grants	0.1
2.5 Software	2.5.3 Reconstruction	SBU	GR	ZHANG, ZELONG	Reconstruction tau, cascades	NSF Base Grants	0.1
2.5 Software	2.5.3 Reconstruction	SDSMT	GR	LEON SILVERIO, DIANA	Update the IceTop-InIce combined (3-D) reconstruction in the new Rockl	NSF Base Grants	0.7
2.5 Software	2.5.3 Reconstruction	SDSMT	KE	XINHUA, BAI	New reconstruction method; Study of high energy cosmic rays, high ene	NSF Base Grants	0.3
2.5 Software	2.5.3 Reconstruction	SUBR	KE	FAZELY, ALI	Reconstruction/ Analysis tools, data analysis, Cloud Computation; High E	US In-Kind	0.15
2.5 Software	2.5.3 Reconstruction	SUBR	SC	XIANWU, XU	Reconstruction/ Analysis tools	US In-Kind	0.15
2.5 Software	2.5.3 Reconstruction	UAA	KE	RAWLINS, KATHERINE	Snow correction for IceTop	US In-Kind	0.2
2.5 Software	2.5.3 Reconstruction	UD	PO	SOLDIN, DENNIS	IceTop reco, Corsika reader	NSF Base Grants	0.15
2.5 Software	2.5.3 Reconstruction	UMD	PO	LARSON, MICHAEL	Neutrinos source WG technical lead software/likelihood	NSF Base Grants	0.2
2.5 Software	2.5.3 Reconstruction	UMD	PO	OLIVAS, ALEX	SW Coordinator – Data Quality, Reconstruction and Sim. Programs	NSF M&O Core	0.25
2.5 Software	2.5.3 Reconstruction	UW	DS	MEAGHER, KEVIN	Reconstruction software programs coordinator	NSF M&O Core	0.25
2.5 Software	2.5.3 Reconstruction	UW	GR	Lazar, Jeffrey	reconsructions Upfilter	NSF Base Grants	0.3
2.5 Software	2.5.3 Reconstruction	UW	GR	Liu, Qinrui	csky and skylab software, extensions of Firesong	NSF Base Grants	0.3
2.5 Software	2.5.3 Reconstruction	UW	GR	PIZZUTO, ALEX	Fast response analysis maintenance, SkyLab transients	US In-Kind	0.2
2.5 Software	2.5.3 Reconstruction	UW	SC	CHIRKIN, DMITRY	Reconstruction software	NSF M&O Core	0.15
2.5 Software	2.5.3 Reconstruction	UW	SC	YUAN, TIANLU	Impact of DOM response on reconstruction, cascade reconstruction at hi	NSF Base Grants	0.3
2.5 Software	2.5.3 Reconstruction	UWRF	KE	SEUNARINE, SURUJ	Low-Energy Extensions of IceTop	US In-Kind	0.1
2.5 Software	2.5.3 Reconstruction	YALE	KE	MARUYAMA, REINA	Coincident events between IceCube and DM-Ice, low energy reconstruct	US In-Kind	0.05
2.5 Software	2.5.4 Science Support Tools	RWTH	GR	GANSTER, ERIK	NNMFIT tool for diffuse profile likelihood fits	Non-US In-Kind	0.2
2.5 Software	2.5.4 Science Support Tools	RWTH	GR	SCHUMACHER, LISA	NNMFIT tool for diffuse profile likelihood fits	Non-US In-Kind	0.05
2.5 Software	2.5.4 Science Support Tools	TUM	PO	NIEDERHAUSEN, HANS	Maintenance SkyLab, Development SkyLLH	Non-US In-Kind	0.2
2.5 Software	2.5.4 Science Support Tools	HARVARD	GR	SKRZYPEK, BARBARA	Maintenance and development of LeptonInjector	US In-Kind	0.1
2.5 Software	2.5.4 Science Support Tools	HARVARD	GR	SKRZYPEK, BARBARA	GolemFit framework development	US In-Kind	0.1
2.5 Software	2.5.4 Science Support Tools	HARVARD	KE	ARGUELLES, CARLOS	GolemFit framework development coordination	US In-Kind	0.1
2.5 Software	2.5.4 Science Support Tools	UA	KE	SANTANDER, MARCOS	Public alerts summary web page	US In-Kind	0.1
2.5 Software	2.5.4 Science Support Tools	UW	GR	Safa, Ibrahim	SkyLLH and PStracks	NSF Base Grants	0.3
2.5 Software	2.5.5 Software Development Infrastructure	UMD	CS	LADIEU, DON	Maintenance of DevOps systems, e.g. build, test coverage, CI/CD, VCS,	NSF M&O Core	0.75
2.6 Calibration	2.6.1 Detector Calibration	ALBERTA	KE	MOORE, ROGER	DOM efficiency with cosmic muons	Non-US In-Kind	0.1
2.6 Calibration	2.6.1 Detector Calibration	ALBERTA	KE	YANEZ, JUAN PABLO	New DOM efficiency study with muons	Non-US In-Kind	0.25
2.6 Calibration	2.6.1 Detector Calibration	ALBERTA	PO	MCELROY, THOMAS	DOM efficiency with cosmic muons	Non-US In-Kind	0.5
2.6 Calibration	2.6.1 Detector Calibration	NBI	PO	MEAD, JAMES	Relative Individual DOM Efficiency	Non-US In-Kind	0.1
2.6 Calibration	2.6.1 Detector Calibration	RWTH	GR	PHILIPPEN, SASKIA	Geometry Calibration	Non-US In-Kind	0.2
2.6 Calibration	2.6.1 Detector Calibration	RWTH	GR	SCHAUFEL, MERLIN	IceTop & IceCube Calibration with IceAct	Non-US In-Kind	0.1
2.6 Calibration	2.6.1 Detector Calibration	SKKU	GR	JEONG, MINJIN	Online filter devel-opment & testing (Full Sky Starting Filter)	Non-US In-Kind	0.2
2.6 Calibration	2.6.1 Detector Calibration	SKKU	GR	JEONG, MINJIN	Dark Matter Flux Module - Add and maintain Dark Matter Decay	Non-US In-Kind	0.1
2.6 Calibration	2.6.1 Detector Calibration	SU	GR	JANSSON, MATTI	Geometry studies	Non-US In-Kind	0.4
2.6 Calibration	2.6.1 Detector Calibration	UU	KE	HALLGREN, ALLAN	Calibration WG co-chair	Non-US In-Kind	0.15
2.6 Calibration	2.6.1 Detector Calibration	KU	GR	MADISON, BRENDON	Development of four radio-frequency pulsers for IceCube upgrade	US In-Kind	0.15
2.6 Calibration	2.6.1 Detector Calibration	KU	GR	MAGNUSON, MITCH	Development of four radio-frequency pulsers for IceCube upgrade	US In-Kind	0.15
2.6 Calibration	2.6.1 Detector Calibration	KU	KE	BESSON, DAVE	Development of four radio-frequency pulsers for IceCube upgrade	US In-Kind	0.3

WBS L2	WBS L3	Institution	Labor Cat.	Name	Task Description	Source of Funds (U.S. Only)	FTE
2.6 Calibration	2.6.1 Detector Calibration	MSU	GR	SANCHEZ HERRERA, SEBASTIAN	Afterpulse characterization	NSF Base Grants	0.2
2.6 Calibration	2.6.1 Detector Calibration	UA	GR	Matthew Marsee	SPE Pass 3 processing	US In-Kind	0.1
2.6 Calibration	2.6.1 Detector Calibration	UA	KE	WILLIAMS, DAWN	Baseline and charge harvesting and DOMCal	NSF M&O Core	0.1
2.6 Calibration	2.6.1 Detector Calibration	UA	KE	Williams, Dawn	SPE template harvesting	NSF M&O Core	0.1
2.6 Calibration	2.6.1 Detector Calibration	UW	GR	SAFA, IBRAHIM	IceTop maintenance, Scintillator project	US In-Kind	0.2
2.6 Calibration	2.6.1 Detector Calibration	UW	GR	TY, BUNHENG	PMT negative HV studies	US In-Kind	0.05
2.6 Calibration	2.6.1 Detector Calibration	UW	SC	TOSI, DELIA	Absolute DOM sensitivity calibration (laboratory measurements)	NSF M&O Core	0.15
2.6 Calibration	2.6.1 Detector Calibration	UW	SC	WENDT, CHRISTOPHER	Flasher output, flasher calibration	NSF M&O Core	0.4
2.6 Calibration	2.6.1 Detector Calibration	UW	SC	WENDT, CHRISTOPHER	DOM charge response, linearity, DOM calibration support	NSF M&O Core	0.4
2.6 Calibration	2.6.1 Detector Calibration	UWRF	KE	SEUNARINE, SURUJ	Calibration-Flasher Studies	US In-Kind	0.1
2.6 Calibration	2.6.2 Ice Properties	SKKU	GR	KANG, WOOSIK	Photon tracking / ice-properties calibration	Non-US In-Kind	0.2
2.6 Calibration	2.6.2 Ice Properties	SKKU	PO	TOENNIS, CHRISTOPH	Anisotropy Measurement with Spice hole camera	Non-US In-Kind	0.2
2.6 Calibration	2.6.2 Ice Properties	SKKU	PO	TOENNIS, CHRISTOPH	Dark Matter Flux Module - Add and maintain secluded DM	Non-US In-Kind	0.1
2.6 Calibration	2.6.2 Ice Properties	SU	KE	FINLEY, CHAD	Sweden Camera development	Non-US In-Kind	0.2
2.6 Calibration	2.6.2 Ice Properties	SU	KE	HULTQVIST, KLAS	Sweden Camera development	Non-US In-Kind	0.2
2.6 Calibration	2.6.2 Ice Properties	TUM	GR	HENNINGSEN, FELIX	Simulation / Calibration	Non-US In-Kind	0.1
2.6 Calibration	2.6.2 Ice Properties	TUM	GR	HOLZAPFEL, KILIAN	Simulation / Calibration/ IceCube Upgrade	Non-US In-Kind	0.1
2.6 Calibration	2.6.2 Ice Properties	WUPPERTAL	GR	HOFFMANN, RUTH	Acoustic and radio ice properties	Non-US In-Kind	0.2
2.6 Calibration	2.6.2 Ice Properties	UA	KE	WILLIAMS, DAWN	Supporting flasher runs and flasher analysis	US In-Kind	0.05
2.6 Calibration	2.6.2 Ice Properties	UD	KE	SECKEL, DAVID	Ice model, DOM noise	US In-Kind	0.05
2.6 Calibration	2.6.2 Ice Properties	UTA	GR	PARKER, GRANT	Continuing improvements to SnowStorm MC uncertainty	NSF Base Grants	0.5
2.6 Calibration	2.6.2 Ice Properties	UTA	GR	SMITHERS, BENJAMIN	SnowStorm extension to systematics including hole ice, anisotropy, etc.	NSF Base Grants	0.25
2.6 Calibration	2.6.2 Ice Properties	UTA	KE	JONES, BENJAMIN	Ice model uncertainty estimation using multisim MC method	US In-Kind	0.1
2.6 Calibration	2.6.2 Ice Properties	UW	EN	NUCKLES, JACK	Pencil beam, LED flasher support	NSF M&O Core	1
2.6 Calibration	2.6.2 Ice Properties	UW	SC	CHIRKIN, DMITRY	Direct photon tracking / ice- properties calibration , Individual DOM hole i	NSF Base Grants	0.55
2.6 Calibration	2.6.2 Ice Properties	UWRF	KE	SEUNARINE, SURUJ	Calibration-Flasher Studies	US In-Kind	0.1
Grand Total							**94.71**