IceCube Maintenance & Operations
Financial Management and Common Fund

Presenter:
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Project Controls Manager, IceCube Gen-2 Phase 1

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IceCube Maintenance & Operations Mid-Term Review

Presenter's Background

- IceCube Maintenance and Operations Resource Coordinator
- Project Controls Manager, IceCube Gen-2 Phase 1
- 8+ years with IceCube Collaboration (2010-present)
- CMB PolarBear Project Control & Systems Manager (2015-2016)
- 12+ years of financial & project management experience in academia and private industry
- Master of Business Administration (MBA) degree (2008)
- Project Management Professional (PMP), license ID 1820230
- Member of Project Management Institute, PMI (2014–present)

Outline

- **IceCube M&O Sources of Funds**
- NSF M&O Core award financial status
- NSF M&O Subawards and monitoring process
- Memorandum of Understanding and Common Fund

IceCube M&O Sources of Funds

NSF M&O Core	This 5-year NSF award mostly covers Core M&O tasks, travel, M&S and service agreements for UW and eight U.S. sub-awardee institutions and contribution to the M&O Common Fund.
NSF Base Grants	NSF IceCube analysis grants support M&O activities done by U.S. graduate students and postdocs.
U.S. Institutional In-Kind	Institutional contribution mostly covers M&O activities done by faculty members, different fellowships and university funded activities.
Europe & Asia Pacific In-Kind	Institutional contribution from non-U.S. collaborators includes labor and travel and contribution to the M&O Common Fund.

IceCube M&O Sources of Funds (cont'd)

Definitions of M&O Task Categories: (2009 NSF Panel Summary Review)

1. Core M&O Tasks: Technical tasks required for the continuing efficient operation of the detector and its associated data acquisition, transmission, analysis and archiving systems.

Examples: South Pole overwinter personnel, computer system administration, software engineering to improve the performance of production code, running simulation production.

2. Collaboration Service: Additional tasks that are essential for the collaboration to achieve its scientific goals.

Examples: service on collaboration committees and subgroups, working on data reduction and filtering, shift-taking, and other tasks that benefit the collaboration as a whole.

NSF Core M&O funding is used for Category 1 tasks.

IceCube Maintenance & Operations Program

Money Flow Diagram

Revenue Sources

NSF IceCube M&O Awards

2007-10 Initial award	MSN106834/ANT-0639286
2010-15 5-year renewal	MSN126790/ANT-0937462
2016-21 5-year renewal	MSN 191507/PLR-1600823

Non-U.S. In-Kind

NSF IceCube Analysis Grants

U.S. Institutional In-Kind

UW Accounting System (WISDM)

UW Accounts	U.S. Core	U.S. Common Fund	Non U.S. Common Fund
Initial M&O	144-QC21	144-QS76	233-KJ11
5-Year Renewal	144-39XW	144-39XX	
2nd 5-Year Renewal	144-AAA9616	144-AAA9617	
		IceCube M&O Common Fund	

Reconciliation

IceCube Accounting System (Masterpiece)

Core activities of UW & eight U.S. sub-awardees:
- Program Management
- Detector Operations
- Computing & Data Mgmt.
- Core coordination roles
- Distributed computing

Agreed supported activities and infrastructure upgrades:
- WinterOver personnel
- Acquiring & filtering data
- Transmitting data north
- Archiving in data warehouse
- UW Data Center operations

Activities mostly done by Grads & Postdocs:
- Reconstruction software
- Simulations tools
- Filtering & Triggering
- Monitoring, Calibration
- Verification, Data quality

Activities mostly done by Faculty and Sr. Scientists:
- Committee chair/member
- Working Groups chairs
- Coordinators
- Overseeing group work
- Hosting meetings

Expenditures

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IceCube Maintenance & Operations Program

NSF M&O Award: Baseline Budget by Cost Categories and Project Years

UW-Madison and U.S. Sub-Awards	YEAR1	YEAR2	YEAR3	YEAR4	YEAR5	TOTAL
	Apr '16 - Mar '17	Apr '17 - Mar '18	Apr '18 - Mar '19	Apr '19 - Mar '20	Apr '20 - Mar '21	Apr '16 - Mar '21
Labor	$6,214,583	$6,259,716	$6,230,959	$6,172,008	$6,163,558	**$31,040,824**
Capital Equipment	$80,950	$154,947	$220,579	$162,777	$243,431	**$862,684**
Materials & Supplies	$115,090	$115,159	$108,161	$153,582	$152,691	**$644,683**
Travel	$361,926	$364,268	$362,206	$360,977	$360,842	**$1,810,219**
Service Agreements	$147,951	$105,910	$78,095	$150,656	$79,479	**$562,090**
Subaward Setup Fee	$79,500	$0	$0	$0	$0	**$79,500**
NSF M&O Award Total	**$7,000,000**	**$7,000,000**	**$7,000,000**	**$7,000,000**	**$7,000,000**	**$35,000,000**

The NSF IceCube M&O award provides funds for M&O Core activities and for the U.S. portion of the M&O Common Fund.

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

(a)	(b)	(c)	(d)= a - b - c	(e)	(f) = d – e
YEARS 1-3 Budget (Apr.'16-Mar.'19)	**Actual Cost To Date** through Dec. 31, 2018	**Open Commitments** on Dec. 31, 2018	**Current Balance** on Dec. 31, 2018	**YEAR3 Remaining Projected Expenses** through March 2019	**End of YEAR 3 Forecast Balance** March 31, 2019
$21,360K	**$18,908K**	**$842K**	**$1,609K**	**$1,645K**	**-$36K**

This second five-year NSF M&O renewal award started in April 2016.

NSF award of **$7M** per year: **$35M total**

NSF Supplemental funding of **$292K** to develop a multimessenger INCLUDES program and **$68K** for SDSM&T

This negative balance will be addressed by increasing efficiency in the remaining two years of the program.

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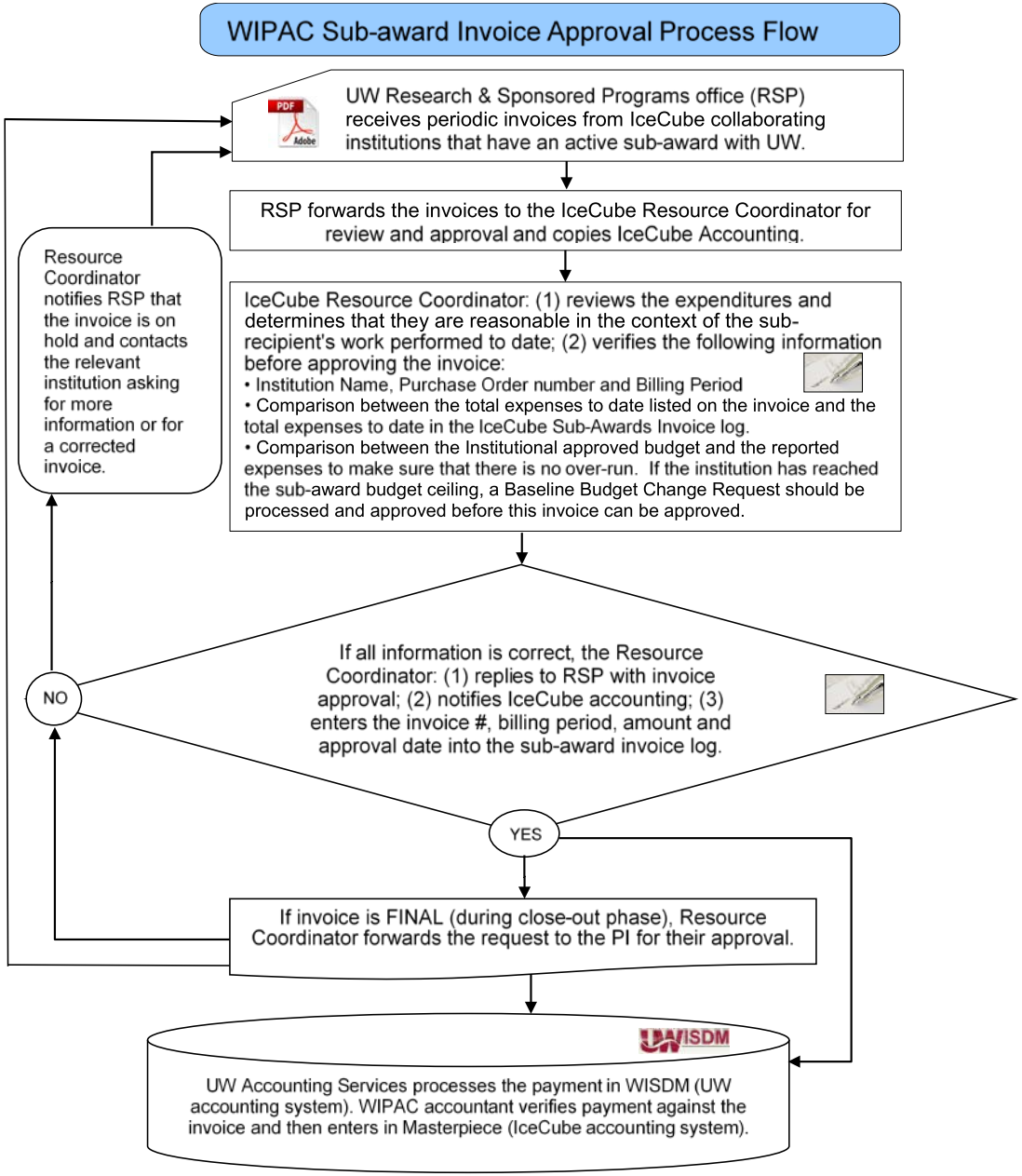
IceCube NSF M&O Sub-Awards
Major Responsibilities and Funds

Institution	Major Responsibilities	Effort and coverage	Total PY1-5
Lawrence Berkeley National Laboratory	Data Acquisition maintenance, computing infrastructure	*Institutional PI 5%, Engineer 15%*	**$445,626**
Pennsylvania State University	Data acquisition firmware support, simulation production	*Postdoctoral Researcher 25% Scientist 25%*	**$354,313**
University of Delaware, Bartol Institute	IceTop calibration, monitoring & maintenance, On-Ice field work	*Scientist 70%-80%, Engineer 17%*	**$773,285**
University of Maryland at College Park	Overall IceCube software coordination, IceTray software framework, simulation software, maintain and test PnF software and online filters	*Institutional PI 2%, Scientist 75%, Computer Science 90%, Software Engineer 75%, Admin Support 4%, Capital Equip. for sim. prod. & maintenance of PnF software*	**$3,017,448**
University of Alabama at Tuscaloosa	Detector calibration, reconstruction and analysis tools	*Institutional PI 8%,*	**$122,990**
Michigan State University	Simulation software, simulation production	*Postdoctoral Researcher 25%*	**$142,481**
South Dakota School of Mines and Technology (added in July 2017)	Simulation production and reconstruction	*Graduate Student for 12 months fulltime*	**$54,749**
Total			**$4,910,892**

M&O Sub-Award Monitoring Process



M&O Sub-Award Monitoring Process
Sub-Award Invoice Log Rev 2019.0215

Maryland			
Award 677K390	**NEW M&O**	**Sub Ceiling**	
Initial, June 22 '16	293,789	$293,789.00	PY1 1st
mod 1 Nov 4 '16	293,789	$587,578.00	PY1 2nd
mod 2 June 5 '17	595,413	$1,182,991.00	PY2
mod 3 May 31 '18	603,369	$1,786,360.00	PY3
mod 4		$1,786,360.00	
mod 5		$1,786,360.00	
Total Budget to date		**$1,786,360.00**	

Penn State			
Award 673K444	**NEW M&O**	**Sub Ceiling**	
Initial, Nov 7 '16	$ 34,386	$34,386.00	PY1 1st
mod 1, Dec 5 '16	$ 34,386	$68,772.00	PY1 2nd
mod 2, Sept 8 '17	$ 69,800	$138,572.00	PY2
mod 3, July 31 '18	$ -	$138,572.00	PY3
mod 4		$138,572.00	
mod 5		$138,572.00	
Total Budget to date		**$138,572.00**	

Invoice	Period	Payment	Comment
Actual Payments to Date		**$1,606,862.27**	
Budget to date		**$1,786,360.00**	
Balance to date		**$179,497.73**	
314471-1	Apr-2016	$113,937.55	Approved 7/18/16
	May-2016		
	Jun-2016		
314471-2	Jul-2016	$37,876.62	Approved 9/28/16
314471-3	Aug-2016	$39,766.72	Approved 9/28/16
314471-4	Sep-2016	$42,130.06	Approved 10/26/16
314471-5	Oct-2016	$44,217.70	Approved 11/11/16
	Jan-2021		
	Feb-2021		
	Mar-2021		

Invoice	Period	Payment	Comment
Actual Payments to Date		**$48,505.69**	
Budget to date		**$138,572.00**	
Balance to date		**$90,066.31**	
2DY80-1	Apr-2016	$12,172.84	Approved 12/15/2016
	May-2016		
	Jun-2016		
	Jul-2016		
	Aug-2016		
	Sep-2016		
2DY80-2	Oct-2016	$1,573.31	Approved 12/20/2016
	Jan-2021		
	Feb-2021		
	Mar-2021		

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Memorandum of Understanding (MoU) and Common Fund (CF) Contribution

The IceCube M&O Common Fund was created in April 2007, the start of formal operations:

- 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 as indicated in the Institutional MoU.
- The Collaboration updates the Scope of Work and M&O Responsibilities in the MoUs twice a year at the collaboration meetings.
- As of April 1st 2010, the annual established rate per Ph.D. author is $13,650.

IceCube M&O Common Fund	
U.S. Common Fund	Non U.S. Common Fund

Memorandum of Understanding (MoU) and Common Fund (CF) Contribution

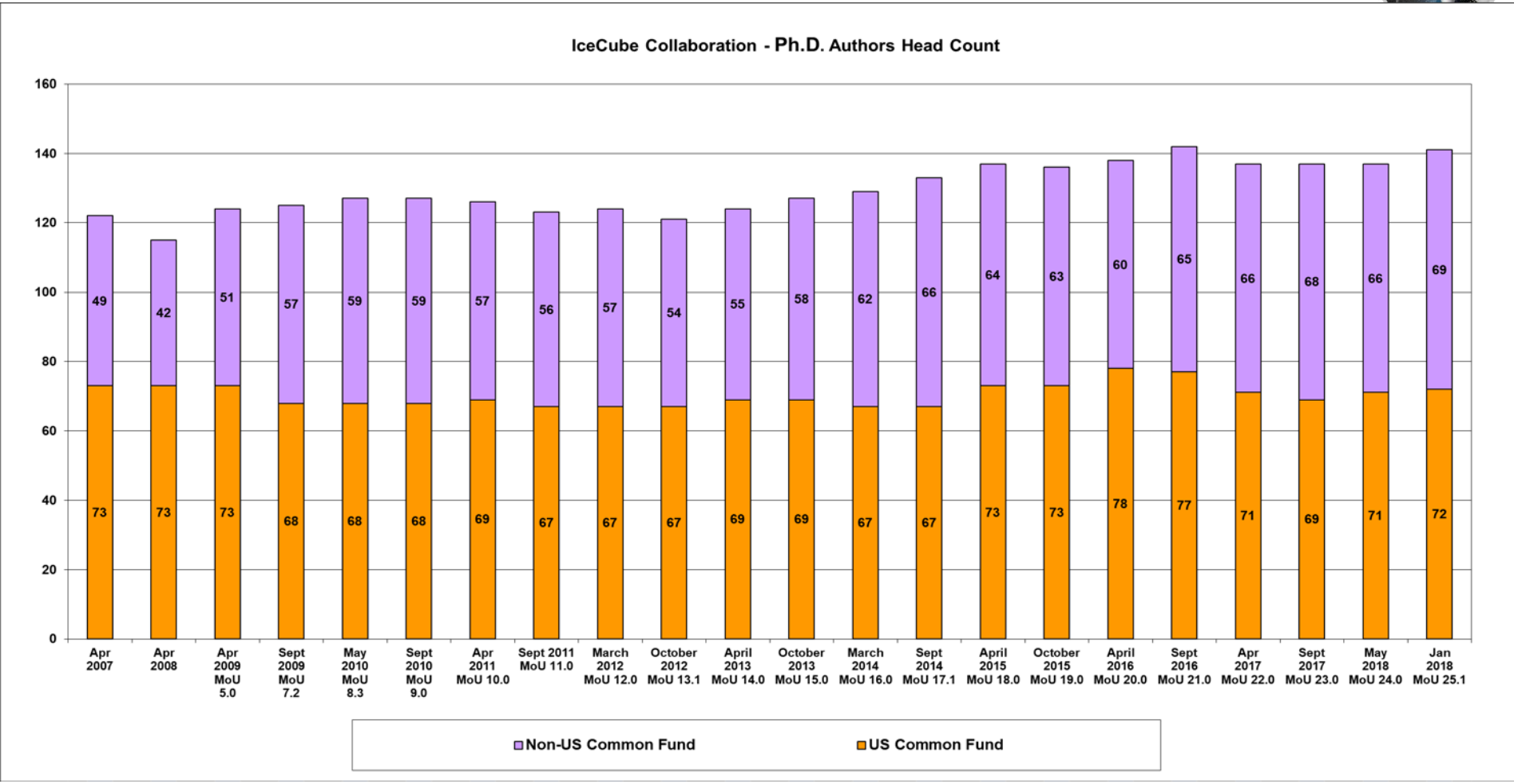
The M&O activities identified as appropriate for support from the Common Fund are those core activities that are agreed to be of common necessity for reliable operation of the IceCube detector and computing infrastructure. The activities directly support the functions of:

- 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 disks 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 Cooperative Agreement

IceCube M&O MoU's are posted on:

Docushare: https://docushare.icecube.wisc.edu/dsweb/View/Collection-6627

Memorandum of Understanding



The total number of Ph.D. authors has increased from 122 in April 2007 to 141 in January 2019. Several institutions are in the process of hiring new postdoctoral fellows.

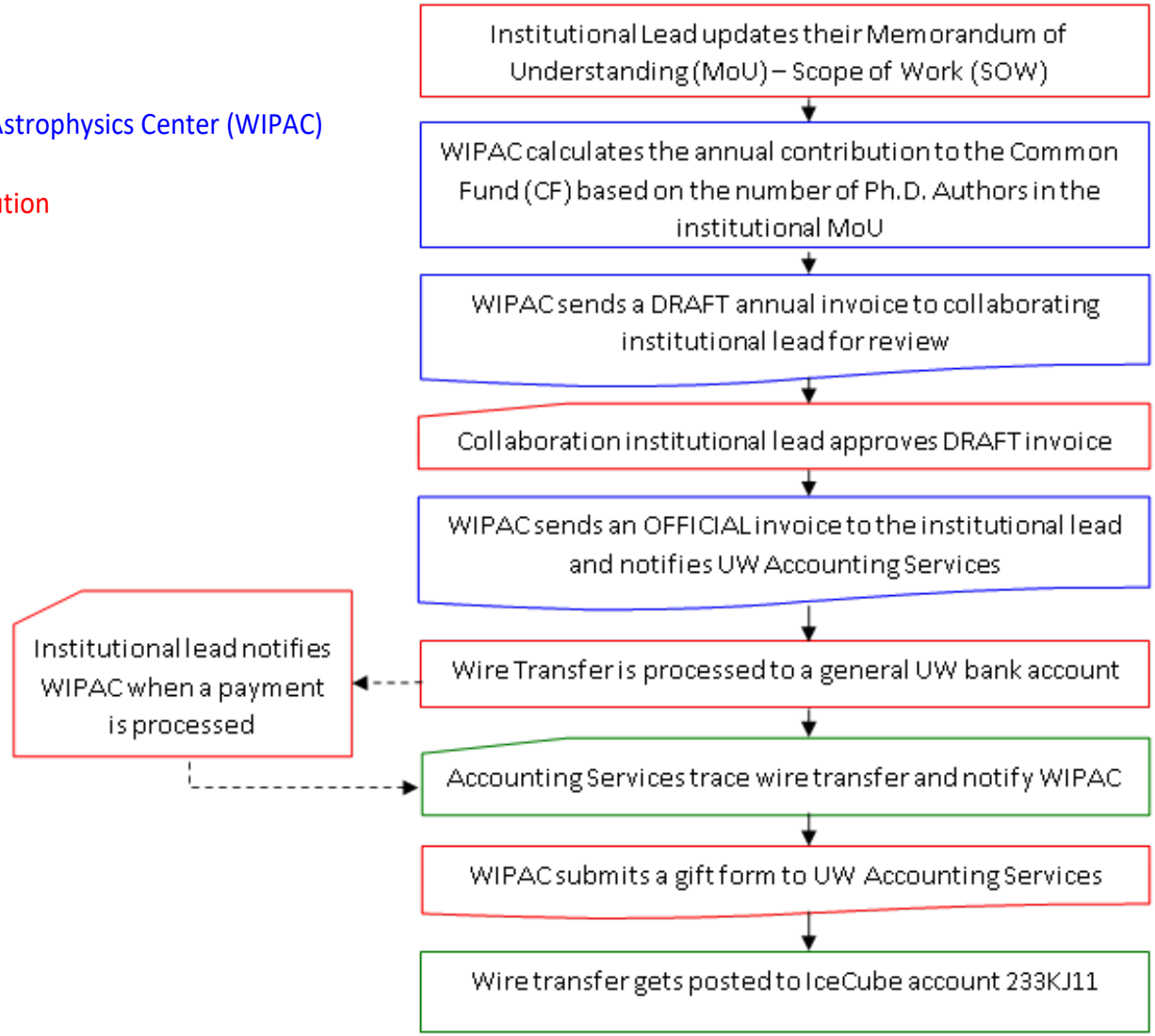
Common Fund Contribution

Wire Transfer from Non-U.S. Institutions

Wisconsin IceCube Particle Astrophysics Center (WIPAC)

IceCube Collaborative Institution

UW Accounting Services



M&O Common Fund Contributions in 2014-2017

Planned and Actual (US dollars in thousands)

	2014		2015		2016		2017	
	PhD. authors	**Planned**	**PhD. authors**	**Planned**	**PhD. authors**	**Planned**	**PhD. authors**	**Planned**
Total CF Planned	**129**	**$1,777**	**137**	**$1,870**	**138**	**$1,904**	**137**	**$1,843**
U.S. Contribution	67	$915	73	$996	78	$1,065	71	$969
Non-U.S. Contribution	62	$862	64	$873	60	$839	66	$874
		Actual						
Total CF Contributions		**$1,767**		**$1,848**		**$1,931**		**$1,839**
U.S. Cash Transfer		$915		$996		$1,065		$969
Non-U.S. Cash Transfer		$713		$715		$786		$692
Non-U.S. In-Kind		$139		$137		$80		$177
Difference (Actual-Planned)		**-$10**		**$-22**		**+$27**		**$-4**

Actual Common Fund contributions were 10k lower than planned in 2014 and 22k lower in 2015, $27k higher than planned in 2016, and $4k lower than planned in 2017. It is anticipated that most of the planned contributions for 2017 will be fulfilled.

IceCube M&O Computing Infrastructure Upgrade - 2017/2018, funded by Common Fund

System Upgrade	Computing Infrastructure	Detector Infrastructure	Labor	Total
South Pole System		$148K	$386K	**$534K**
South Pole Test System		$7K		**$7K**
Data Warehouse	$680K			**$680K**
UW Data Center	$160K			**$160K**
Total	**$840K**	**$155K**	**$386K**	**$1,381K**

This summary includes the major purchases for the 2017/2018 upgrades of the South Pole System (SPS), South Pole Test System (SPTS), UW Data Center, UW Data Warehouse and networking equipment that are funded by IceCube M&O Common Fund.

Detailed expenditures information by cost category, vendor, quantity and line item description can be found in the annual Common Fund Status reports on Docushare:

https://docushare.icecube.wisc.edu/dsweb/View/Collection-8986

IceCube Maintenance & Operations: Opportunities & Challenges

- Tracking of in-kind labor pledges from multiple institutions
- Complex program funding profile
- Communication management: different needs of various stakeholders worldwide
- Deadlines hard to meet in the environment of academic bureaucracy
- Cultural differences (holidays, languages)
- High-visibility program => financial audits

- Despite many challenges associated with running the business aspect of the program, it has been running smoothly
- Part of a large collaboration => more diversity and resources (human, computing, financial) => better scientific results

Summary

- The 5-year NSF M&O award started in April 2016 and renewed the previous 5-year program.
- The Collaboration updates the Scope of Work and M&O Responsibilities in the MoU's twice a year.
- The total number of Ph.D. authors has increased from 122 in April 2007 to 141 in January 2019. Several institutions are in the process of hiring new Postdoctoral fellows.
- Actual Common Fund contributions have been either exactly as planned or balanced out across years, with any negative balances offset by positive balances.
- Current negative balance will be addressed by increasing efficiency in the remaining two years of the program.

Thank You

IceCube Maintenance & Operations Program

NSF M&O Award: Baseline Budget by WBS and Project Years

WBS	YEAR1 $	YEAR2 $	YEAR3 $	YEAR4 $	YEAR5 $	TOTAL	%
2.1.1 Management & Administration	$825k	$758k	$769k	$781k	$793k	**$3,927k**	**11.2%**
2.1.2 Engineering Support	$255k	$259k	$205k	$196k	$187k	**$1,102k**	**3.1%**
2.1.3 Usap Support	$65k	$53k	$54k	$54k	$55k	**$282k**	**0.8%**
2.1.4 Education & Outreach	$262k	$266k	$270k	$251k	$255k	**$1,303k**	**3.7%**
2.2 Detector Operations & Maintenance	$2,608k	$2,591k	$2,666k	$2,611k	$2,569k	**$13,046k**	**37.3%**
2.3 Computing And Data Management	$2,615k	$2,699k	$2,657k	$2,721k	$2,751k	**$13,444k**	**38.4%**
2.4 Triggering And Filtering	$81k	$82k	$84k	$85k	$86k	**$418k**	**1.2%**
2.5 Data Quality, Reco. & Sim. Tools	$287k	$291k	$296k	$300k	$305k	**$1,479k**	**4.2%**
NSF IceCube M&O Proposal Total	**$7,000k**	**$7,000k**	**$7,000k**	**$7,000k**	**$7,000k**	**$35,000k**	**100%**

The two major WBS areas supported by NSF M&O program are WBS 2.2 Detector Operations and Maintenance (37.3%), and WBS 2.3 Computing and Data Management (38.4%).

M&O Common Fund Contributions in 2010-2013 Planned and Actual ($000)

	2010		2011		2012		2013	
	PhD. authors	**Planned**	**PhD. authors**	**Planned**	**PhD. authors**	**Planned**	**PhD. authors**	**Planned**
Total CF Planned	**127**	**$1,734**	**126**	**$1,720**	**124**	**$1,693**	**124**	**$1,693**
U.S. Contribution	68	$928	69	$942	67	$915	69	$942
Non-U.S. Contribution	59	$805	57	$778	57	$778	55	$751
		Actual		**Actual**		**Actual**		**Actual**
Total CF Contributions		**$1,726**		**$1,720**		**$1,709**		**$1,671**
U.S. Cash Transfer		$928		$942		$915		$942
Non-U.S. Cash Transfer		$744		$730		$719		$671
Non-U.S. In-Kind		$54		$47		$75		$58
Difference (Actual-Planned)		**$0**		**$0**		**+$16**		**-$21**

Actual Common Fund contributions were exactly as planned in 2010 and 2011, $16k higher than planned in 2012, and $21k lower than planned in 2013.

M&O Responsibilities

Head Count / FTE

MoU v.25.1 January 2019	U.S. Head Count	U.S. FTE	Non-U.S. Head Count	Non-U.S. FTE
Key Personnel	34	9.95	33	9.10
Scientists	29	8.38	17	1.75
Post Docs		5.55		4.05
Grad Students	40	11.18	62	19.86
Other Professionals *	28	24.65	1	1.00

*** Other professionals include engineers, data science, software engineers, winterovers, program mngt**