IceCube-Gen 2

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DESY

IOFG meeting
September 28, 2020

- Science
- Scope
- Project status
- Cost and schedule
- Project development

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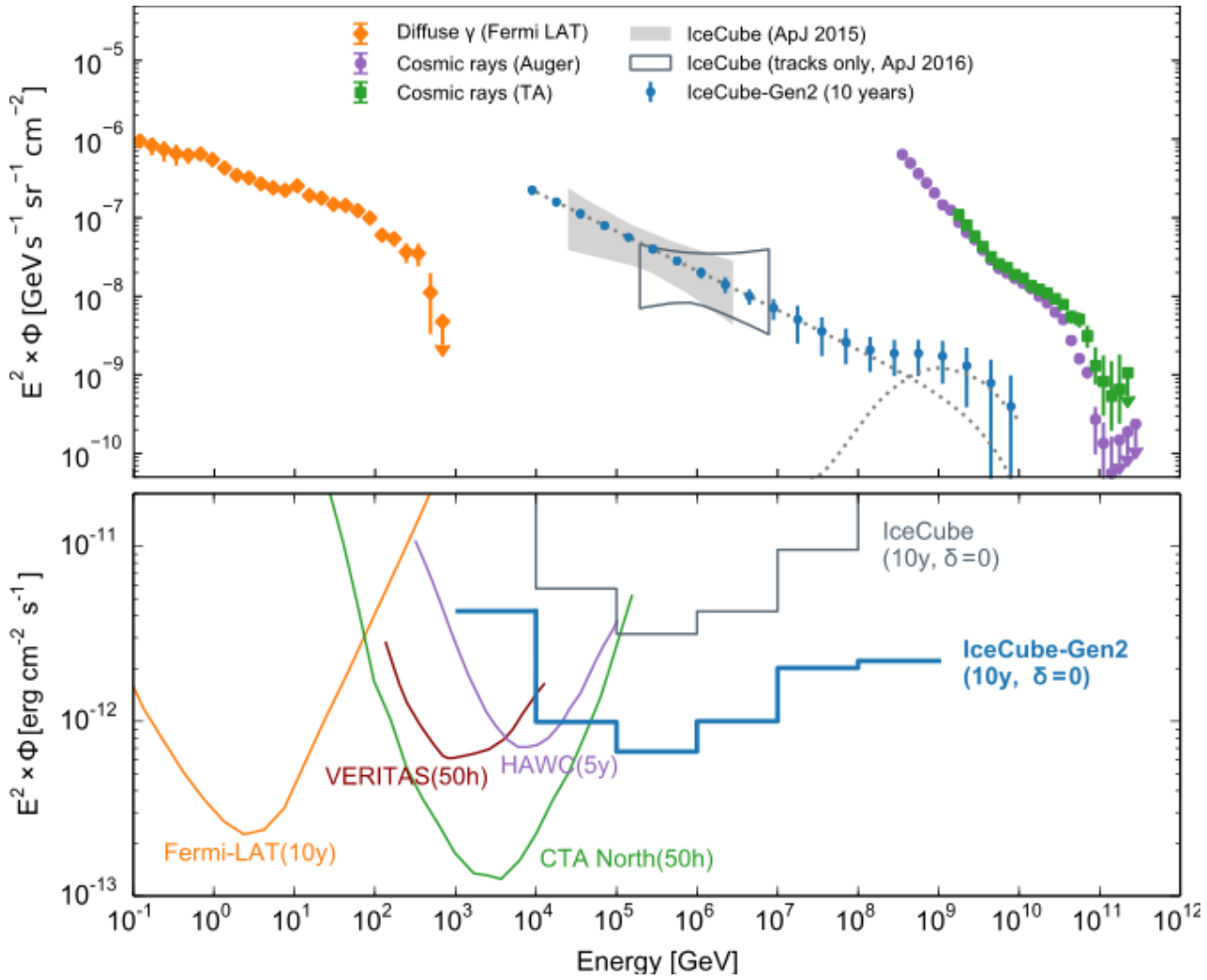
Science defines the requirements

Understanding cosmic particle acceleration through multimessenger observation



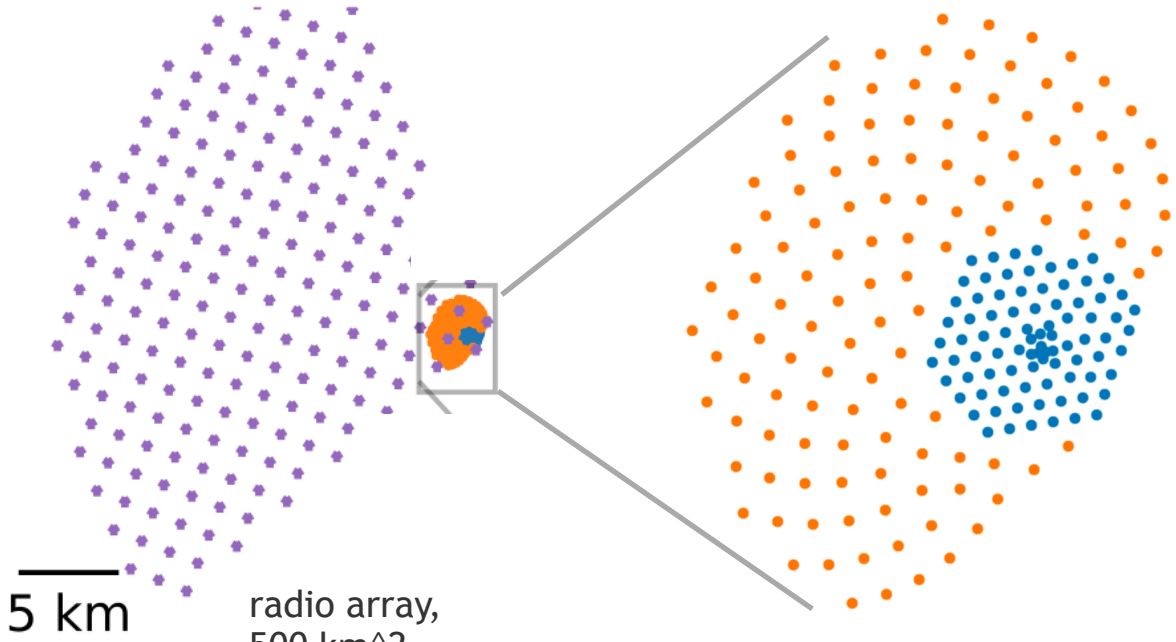
Completing the multi-wavelength view of the Universe

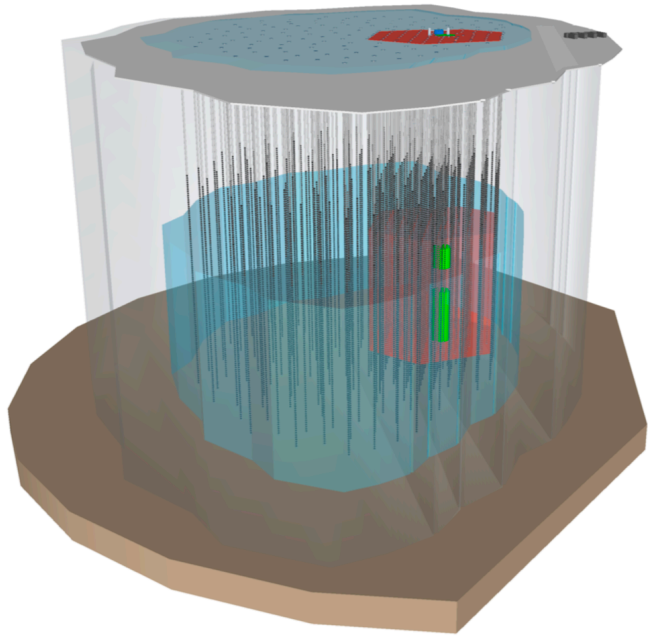
IceCube-Gen2: Scope

Optical Array of 120 strings with 100 sensors each
Surface array: for cosmic rays and veto
Radio Array: 500 km^2 for neutrino detection above 10 PeV

References:
Submission to Decadal Survey on Astronomy and Astrophysics 2020

White paper: IceCube-Gen2: The Window to the Extreme Universe. (arxiv.org/abs/2008.04323)

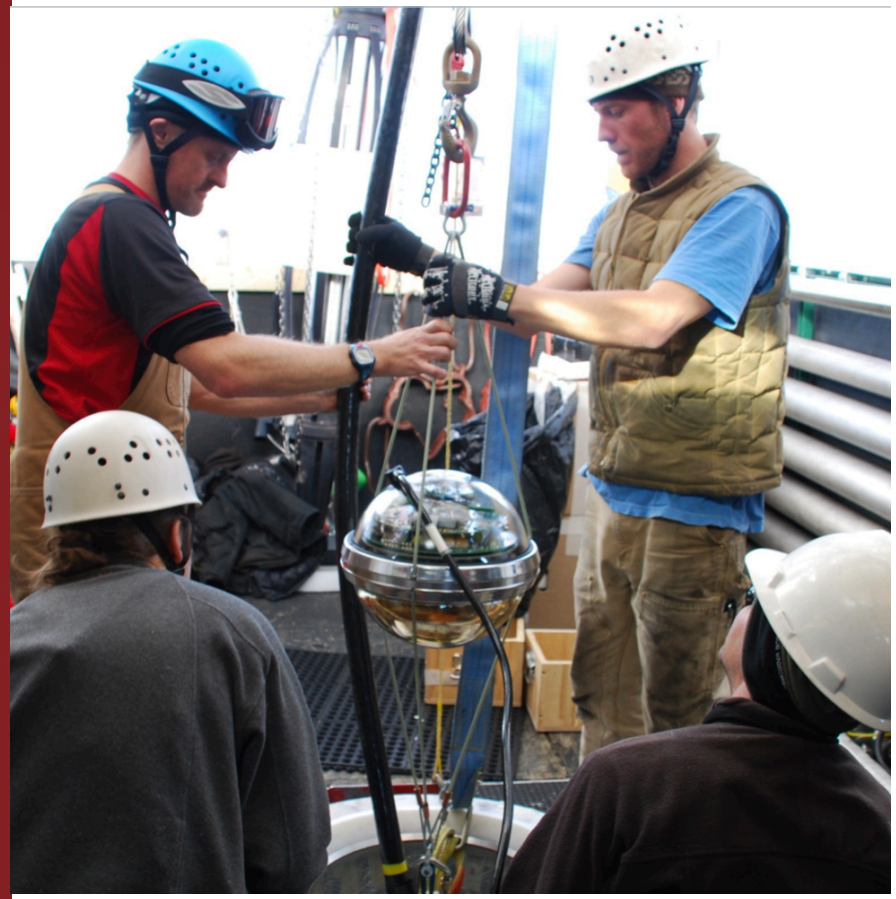




Artist's conception
120 strings at 240 m spacing

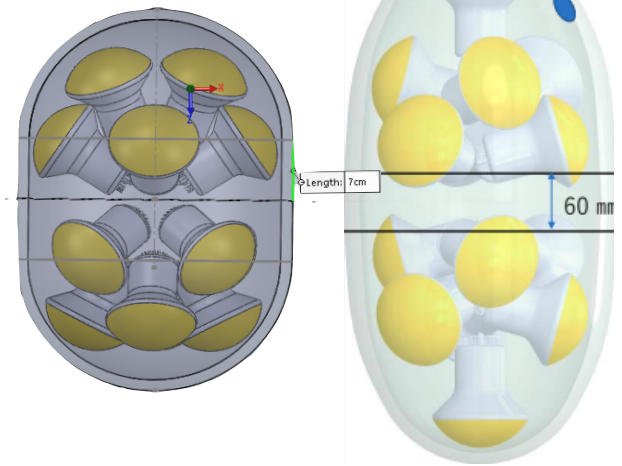
Advances in optical sensors

Building on understood technologies.



IceCube Upgrade

IceCube-Gen2



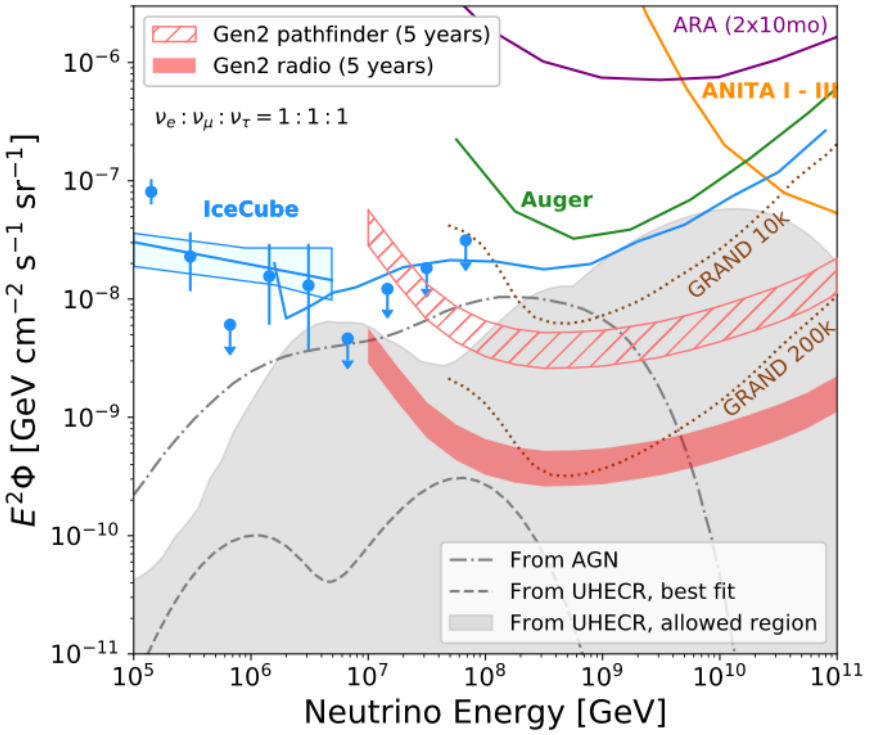
NSF IceCube GEN2

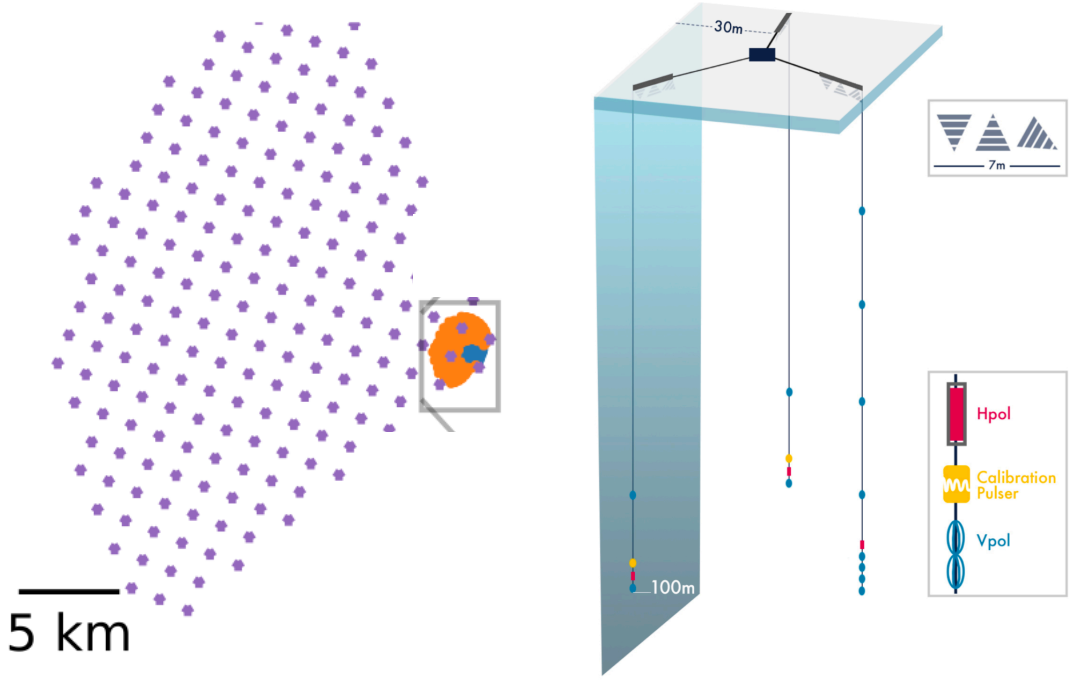
The Gen2 radio array

Reference design:
- 200 stations, similar to RNO design.
- Input from ARA, ARIANNA, RNO-G.

RNO-G preparing deployment of 10 stations in 2021 in Greenland.
Important for RNO-G to move forward (like Upgrade in the optical)
New drill from British Antarctic Survey secured.
Important test ground for Gen2 radio.

- Gen2-radio working group formed.
- Four “radio groups” now Associate members of Gen2.
- Assigned Task Force assigned to advance and detail the conceptual design.





IceCube infrastructure

Cost advantages of Gen2 compared to Gen1

IceCube exists and is running.

—> Experience with construction

—> Gen2 can be essentially integrated into Gen1.

—> Significant savings in design effort eg for DAQ and data systems.

—> Benefit of established IceCube Maintenance and Operations that will provide a host environment.

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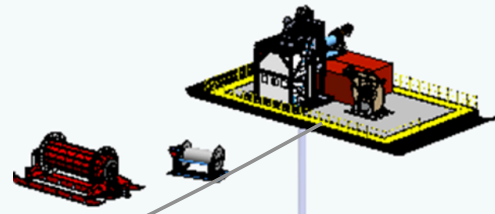
Hose reel
Mobile drill/deployment towers
EHWD heating plant: stationary
—> Gen2: mobile

Drilling

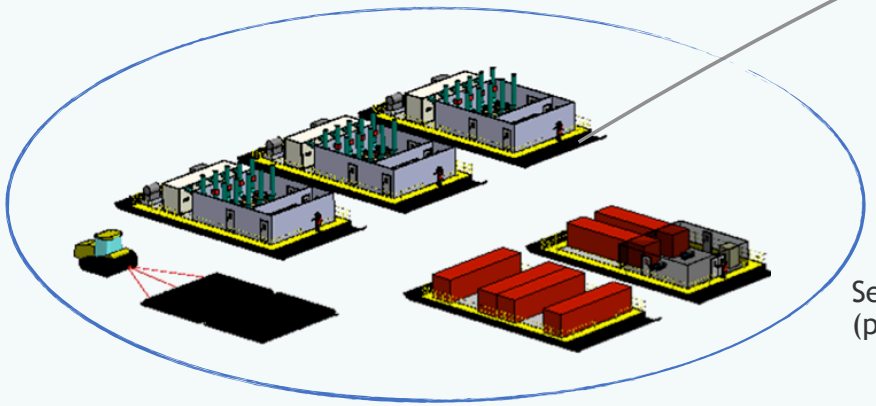
Gen2 hot water drill: significant recent advances.

- Evolution:
  - IceCube drill
  - —> Upgrade: refurbishments and modifications
  - —> Gen2 configuration
- Construction on large sleds:
  - Transport to Pole and mobility at Pole

Condensed Tower operations site
- deep drilling ops
- moves every hole



Hot water (low pressure) hose
Up to >500m,



Seasonal equipment site
(power, heaters, water storage,…)

Logistical Support

1. Logistical Support: IceCube Gen1 had 9.5 million lb of cargo + fuel delivered by plane, more than 300 LC 130 missions. Construction took place simultaneously with South Pole station completion and SPT construction.
2. In recent years logistical support has dropped compared to 10 years ago. However, funding for logistical support is provided by the project.
3. Strategies for logistical support exist and have been discussed with ASC.
    1. Population of 60 people: —> separate field camp.
    2. Cargo: Traverse is scalable and can take care of fuel (2/3) and possibly cargo but this is not current practice.
4. Successful support will require high level prioritization and strategic planning at NSF's Polar Program.

Cost

L2	Task	Total cost	In-Kind	NSF
1.1	Project Office	28.1	.0	28.1
1.2	Implementation	61.6	.0	61.6
1.3	Instrumentation - Deep	151.9	64.0	87.9
1.4	Instrumentation - Radio	25.9	5.0	20.9
1.5	Data Systems	13.1	.0	13.1
1.6	Commissioning and Calibration	12.2	.0	12.2
1.7	ASC Coordination / Polar Support	53.9	.0	53.9
Total w/o contingency		346.8	69.0	**277.8**
Contingency		61.1		61.1
Total with contingency		407.9	69.0	**338.9**

Cost as submitted to Astro 2020 review.

Cost Drivers:

—> Instrumentation: 12,000 Optical modules for the array of 120 deep strings

—> Construction: Implementation (Drilling + installation) and Antarctic Support.

Contingency:

- DOMs provide options for scope contingency.

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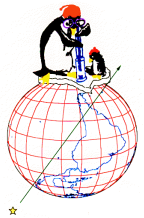
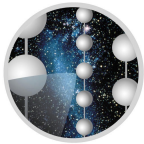
International collaboration





Building on history:

- IceCube-Gen2 builds on 30 years of collaboration from AMANDA to IceCube. Early 1990ies Sweden and then Germany joined forces with US groups to develop AMANDA and 10 years later IceCube.
- Today evenly split between US and -Non-US.
- Strong traditions and well established relations.

Large contributions:

IceCube GEN2

- For Gen2, the hardware contributions almost 1/2 of instrumentation.
- Assumed contributions expressed monetarily: $69M (In US accounting this would be well above $100M*)
- Contributions in other areas, including logistics and field work being explored.

Coordination at all levels important,

- in project development and funding process

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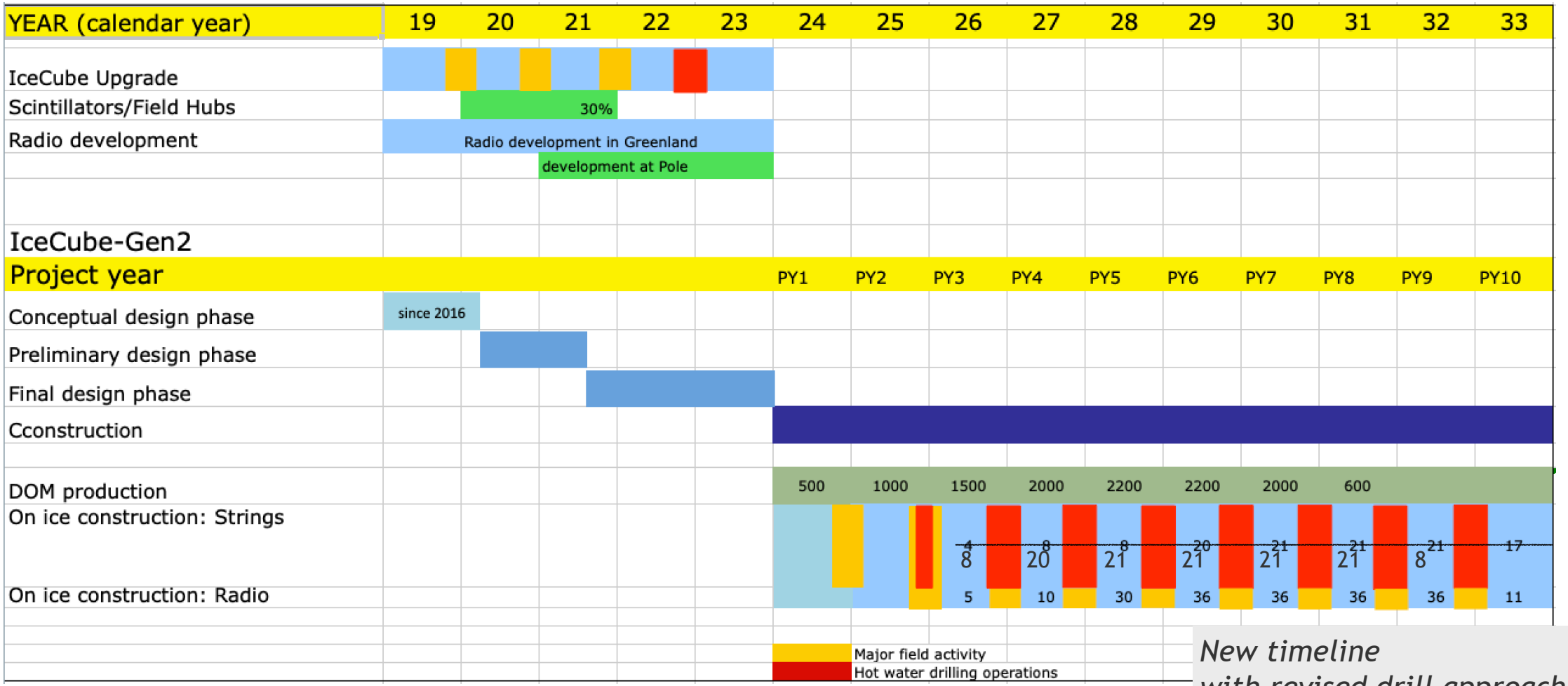
Footnote:

* The construction of the budget will usually under-represent in-kind contributions for two reasons:

- contributions are formulated primarily as hardware and other products.
- —> contingency is largely owned by the country that commits hardware.
- Labor does not even appear as contribution and is supported off project.

Timeline



New timeline with revised drill approach

Notes:
Drilling possibly 1.5 seasons shorter, also cost savings
No formal linkage between Upgrade and Gen2
No formal linkage between RNO-G (or Arianna) and Gen2

NSF

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Developing Project

Next big milestone: ‘Preliminary Design’ by fall 2021

(PD is as much about project plans, cost, risk schedule, as it is about technical matters. Eg. PD total cost will be seen as final)

- Optical sensor design progress.
- Project support starting to come into place
- Working towards a organizational structure
  - Project team, Project office, Level 2, Level 3 coordinators
  - Advisory committees

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Developing Project

Next big milestone: ‘Preliminary Design’, currently targeted for fall 2021

The preliminary Design is a very important step. It forms the basis for starting the funding process.

(Perhaps similar to getting on the “roadmap” in Europe.)

- Ramping up vigorous efforts to develop project, build a project team.
  - started serious engineering effort on drilling
  - Recruiting personnel, including project manager


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Latest Jobs

IceCube Gen-2 Project Manager

The Wisconsin IceCube Particle Astrophysics Center is looking to recruit a Project Manager to lead the development of IceCube-Gen

Closing date: 07 Oct 2020

United States | **Wisconsin IceCube Particle Astrophysics Center (WIPAC)**

Date posted: 07 Sep 2020 **Job type:** Research facilities

Near term:

Internal reviews in January/February.

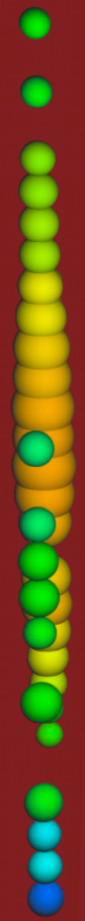
Possible workshop later in spring 21, perhaps May, immediately after Astro2020 decadal review report released.

Challenges:

A lot of work in the next 12 months.

Bridging from Gen2 development phase and Upgrade to Gen2 construction

Backup slides



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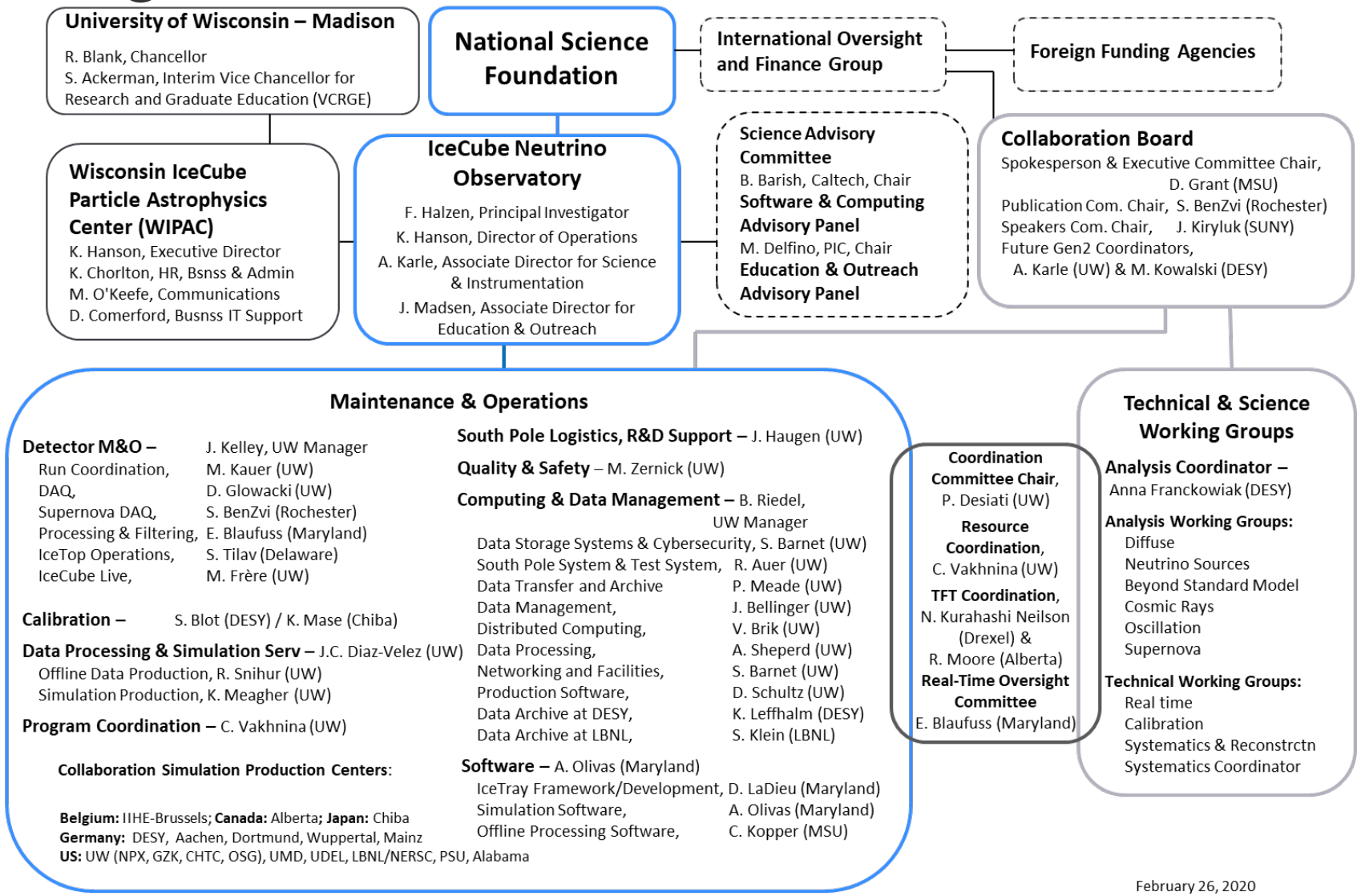
IceCube Organization Structure



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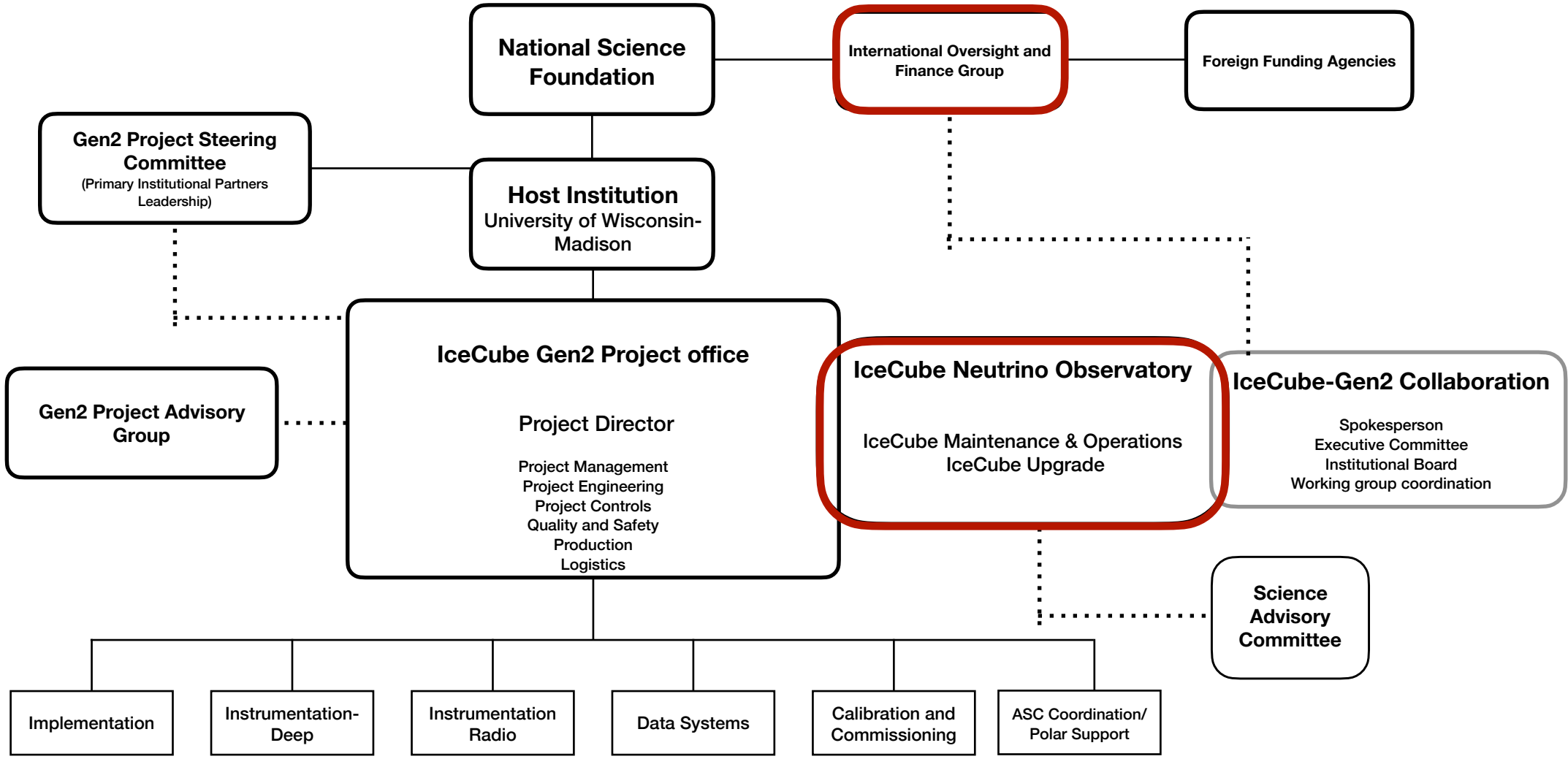
IceCube-Gen2 Organization Structure



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Cost

Cost Profile - US [Real Year, M$)																
		Development				Project Year										
L2	Task	2020	2021	2022	2023	PY01	PY02	PY03	PY04	PY05	PY06	PY07	PY08	PY09	PY10	TOTAL
1.1	Project Office	.26	.72	.74	.80	2.83	2.89	2.95	3.01	3.08	2.73	2.66	2.72	2.77	2.45	**28.08**
1.2	Implementation	1.73	.91	1.15	1.98	21.68	5.09	4.25	4.34	4.57	4.61	4.27	4.35	4.44	4.06	**61.64**
1.3	Instrumentation - Deep	.11	.22	.22	.23	6.28	6.84	9.38	14.70	16.45	16.59	12.35	5.32			**87.91**
1.4	Instrumentation - Radio	.21	.44	.45	.46	1.51	1.93	2.67	2.69	3.11	2.73	2.83	2.14	.66	.68	**20.92**
1.5	Data Systems					1.27	1.03	1.06	1.37	1.44	1.28	1.35	1.36	1.43	1.51	**13.10**
1.6	Commissioning and Calibration					1.13	1.15	1.18	1.20	.99	1.26	1.28	1.31	1.34	1.37	**12.22**
1.7	ASC Coordination / Polar Support					.91	7.98	10.70	8.33	7.70	7.55	3.82	3.31	2.74	.91	**53.94**
	Total development	**2.32**	**2.30**	**2.56**	**3.47**											
	Total US w/o contingency					**35.59**	**26.90**	**32.19**	**35.64**	**37.32**	**36.74**	**28.57**	**20.50**	**13.38**	**10.98**	**277.81**
	Contingency (22%)															**61.12**

Assumed in-kind contributions: $76.2 M (90% in instrumentation)

Note:
Instrumentation budgets do not include in-kind contributions.
This is not a total project cost.
Also, L2 radio is not a standalone project budget (does not include deployment, project office, data, etc.).

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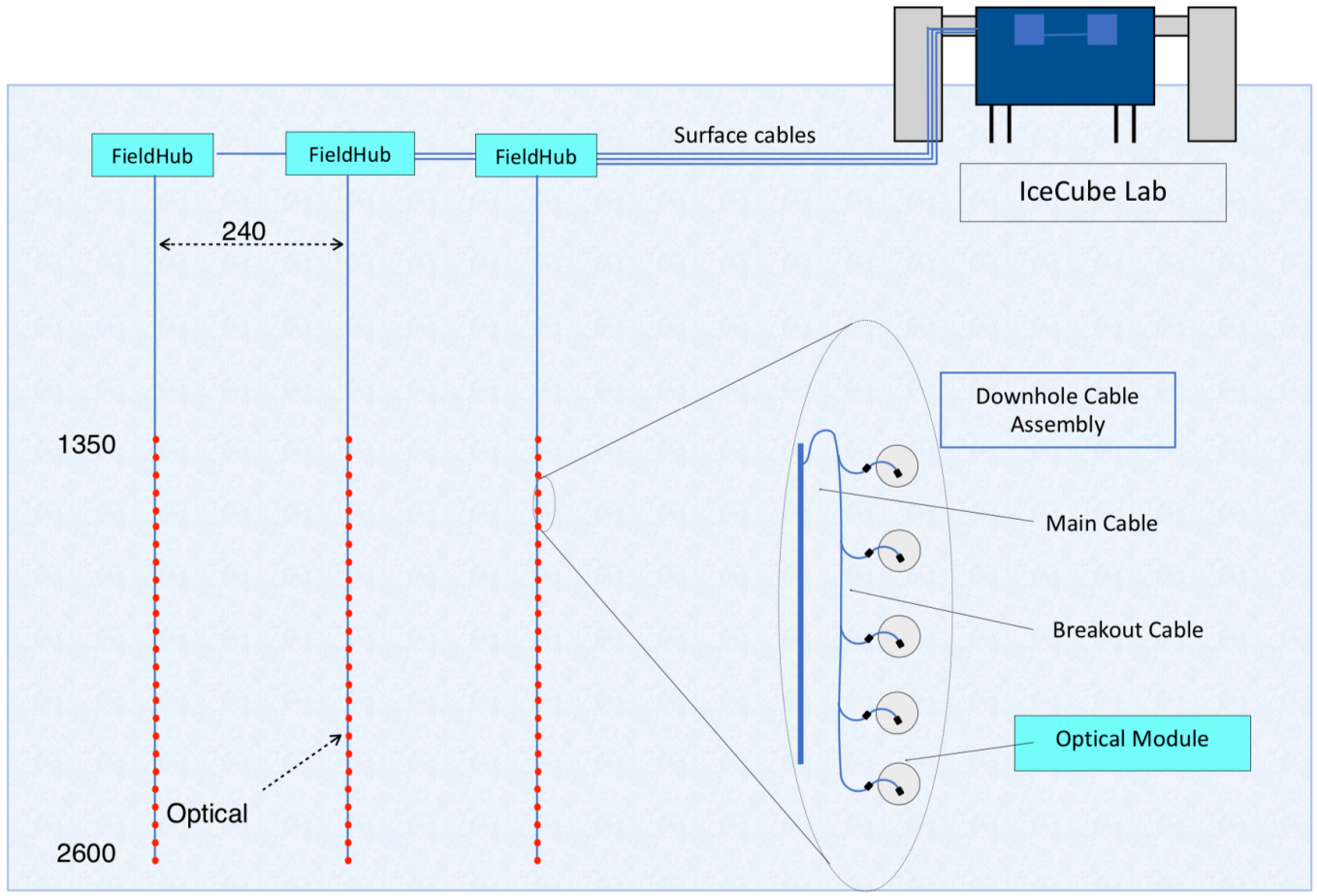
Power and communications architecture

A safe strategy with room for optimizations and cost savings.

- Reference design
  - Adiabatically evolved from IceCube: copper for power and comms, use field hub to switch comms from copper to fiber.
  - Less copper needed (~1/2)
- R&D for alternate approach:
  - Optical fiber all the way to deep ice. Locally switch to comms on copper.



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