Problems and lessons learned drilling into Subglacial Lake Whillans

Brief History Ice Drilling of Hot water drilling in the Polar regions

- Early drills were small units with limited output that did lost water drilling only.
- Once drills of larger capacity started being developed shoveling was no longer an option so return water pumps were used down the bore hole for makeup water


Using big power for making melt water on
500Kw drill

Small 37 KWH power washers adapted into drills


500 KWH total output

Up to a very large 5 MWH drill like the IceCube drill

WISSARD drill

- WISSARD drill was the first attempt by the USAP(United States Antarctic Program) to build a mid sized hot water drill that was able to meet clean access guide lines.
- The WISSARD drill falls into the mid-sized drill category with an output of 227 LPM with an average thermal output of 1 MWH
- Is towable to remote locations

WISSARD Drill being transported to Lake Whillians

WISSARD drill and LARS deck

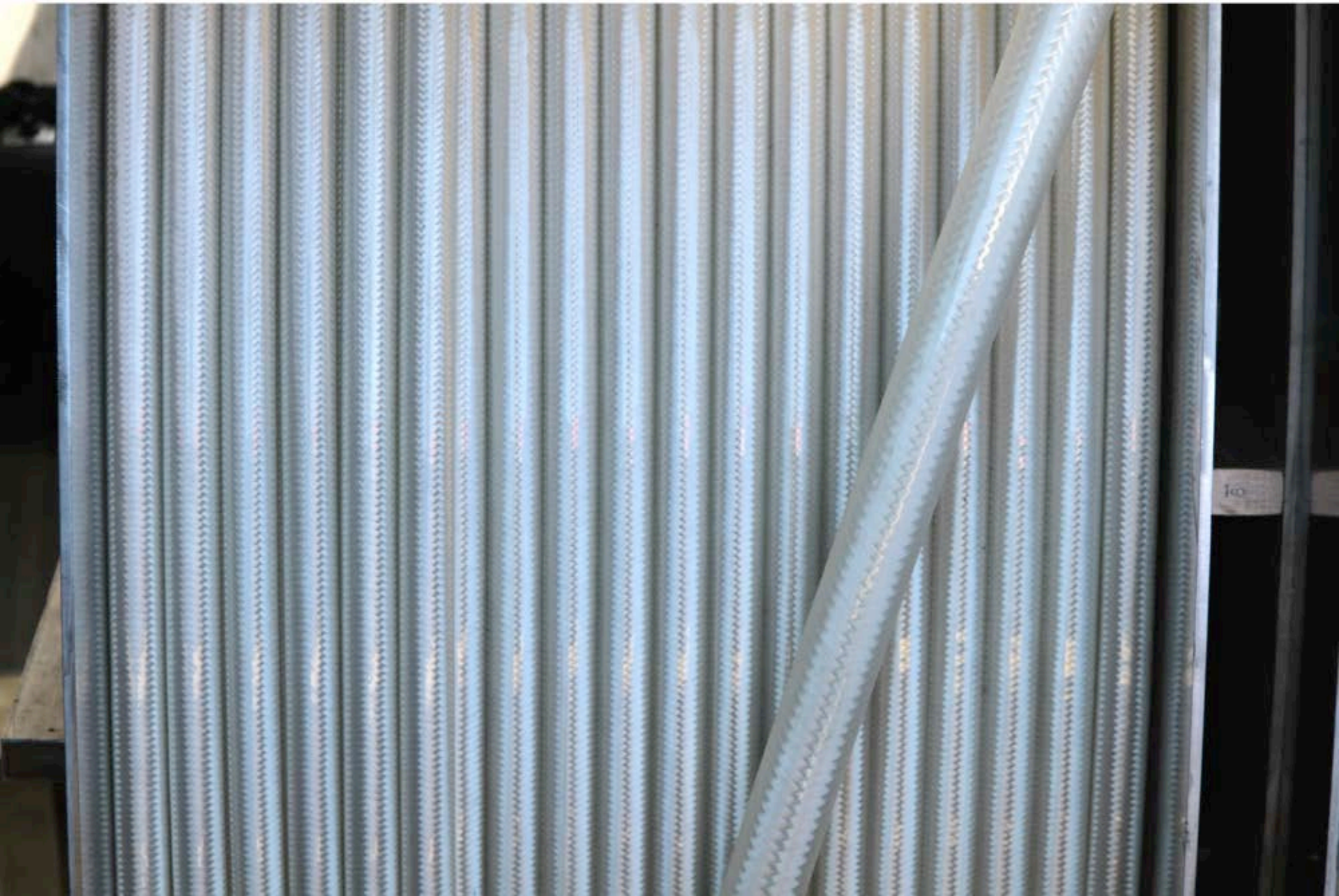
Problems of designing clean access drill

- Adapting exiting drills was not an option as either most or all parts were not able to be adapted for clean access drilling.
- Large diameter high pressure, food grade drill hose, 1000 meters long did not exist, we had to convince hose manufactures to custom build one
- Finding components for that can take being towed for across Antarctica.

Components that had to be changed for making a clean access drill

- All plumbing components are stainless steel
- High pressure hydraulic hose that is food grade inner tube and non leaching outer cover
- Stainless steel, tanks and pumps
- Stainless Steel Filtration system housings
- Stainless Steel UV system

Main Drill Hose (1.25” ID) of WISSARD Hot Water Drill System (HWDS)



Stainless steel snow melt tank

Cleaning Drill Water

- Pre filter with a 2 micron cartridge
- Primary filter with a .2 micron cartridge
- Two, 6 bulb UV Sterilizing unit, one utilizing 185nm bulbs the other equipped with 254nm bulbs
- Filter and UV are capable of cleaning 265 lpm

Filtration and UV sterilization system

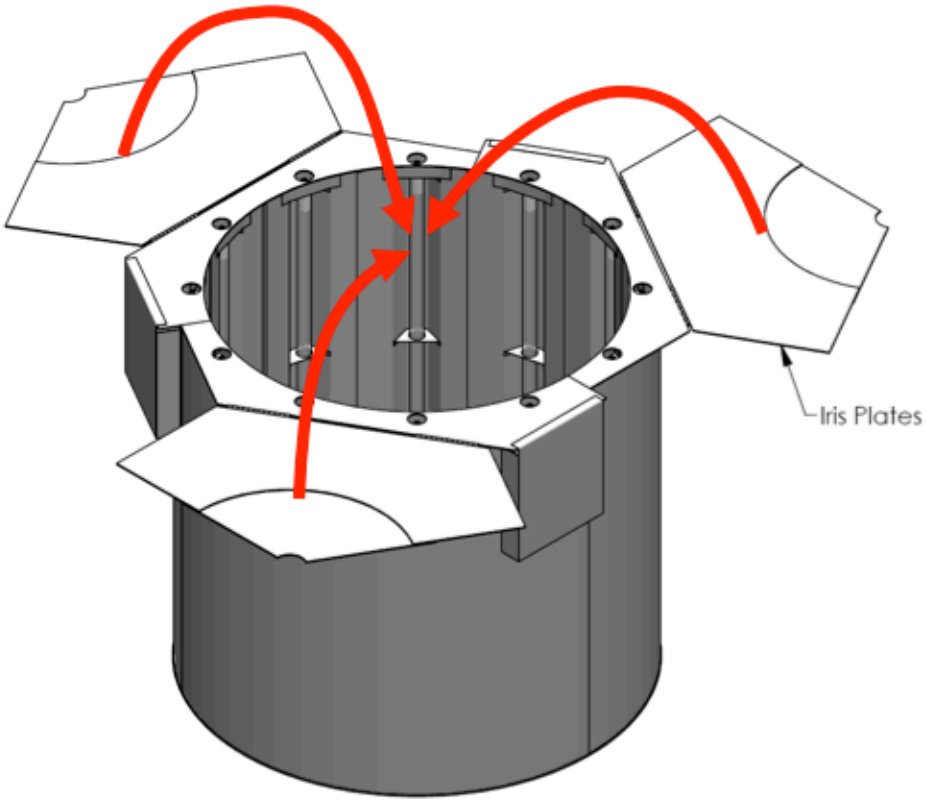
Heater-Pump Unit (HPU-1) of WISSARD Hot Water Drill System (HWDS)

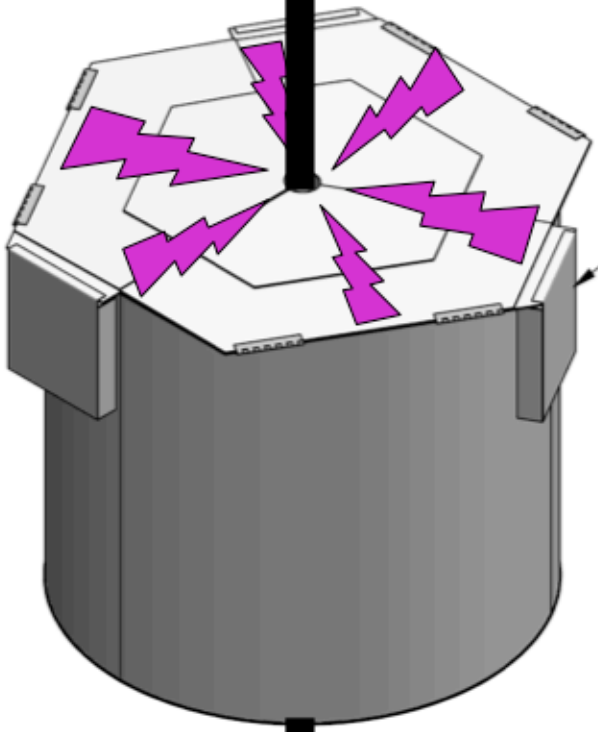
The Borehole UV collar

- ~2” (~5 cm) cable/hose
- Maximum drop rate of 100 cm s^{-1}
- Germicidal UV dosage of >40,000 μW s^{-1} cm^{-2}

Dosage rate sufficient for a 2 log (99%) reduction of most bacterial endospores and up to a 6 log reduction of most bacteria.

UV glasses, goggles, or face shields must be used by personnel when this system is operating below deck. The lights are turned off whenever the cover is opened.





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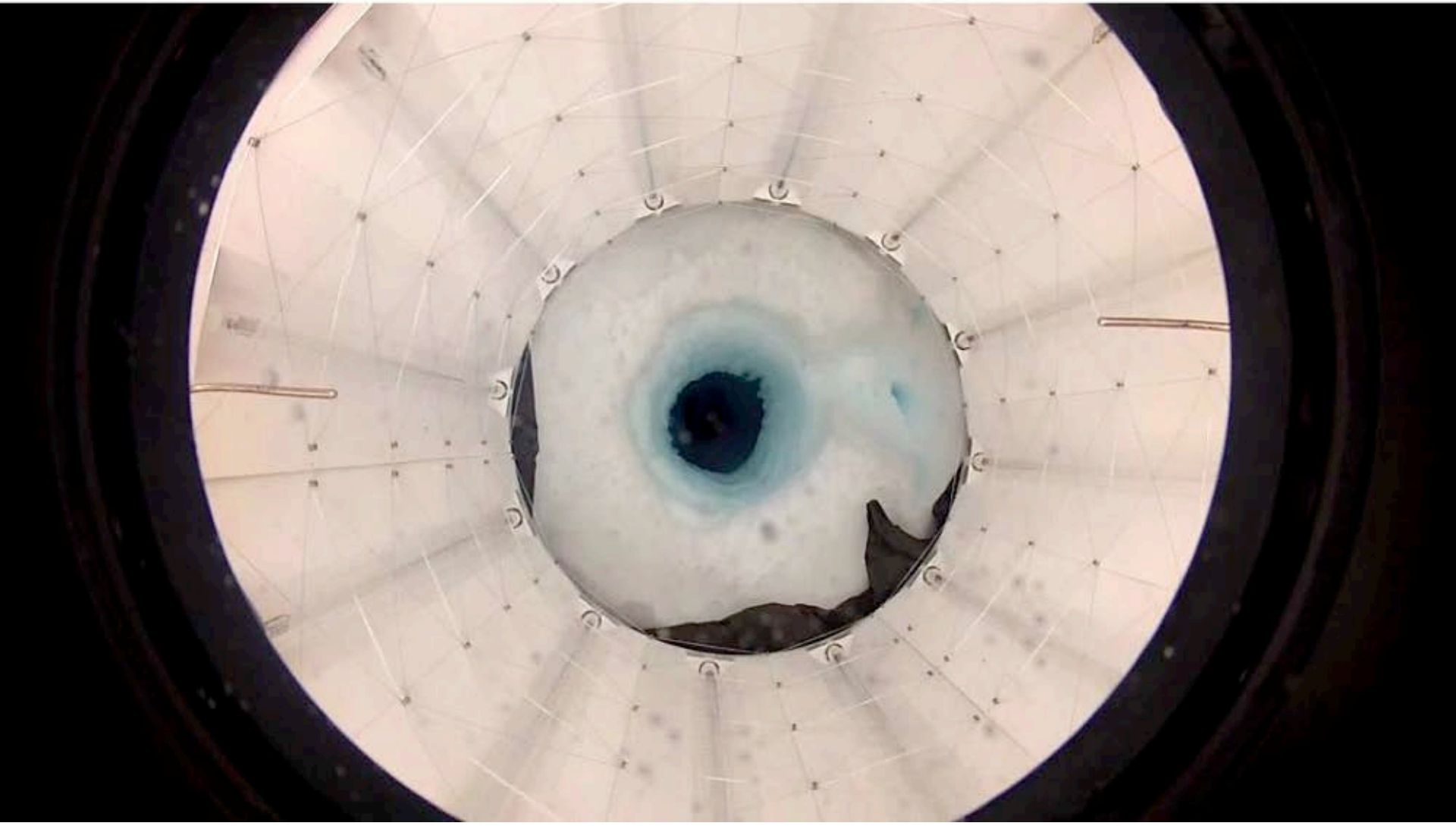
UV-C Collar (Ring of 12 Lights) for Decontamination of Hoses and Cables

Looking Down into the WISSARD Borehole through the UV-C Collar used for Decontamination of Hoses and Cables [12 Germicidal UV-C Mercury Amalgam Lights]



Drilling Techniques for Clean access to Sub-Glacial Lakes

Main bore access drilling

- Drilling techniques are similar to non clean access until you do the break through.
- Important to develop a Rodwell at the top of the bore hole to allow a cleaner source of make up water.

Techniques for breaking through into Sub-Glacial Lakes

- Pump the bore hole out of equilibrium so the water from Lake Whillians will rise up the bore hole containing the drill above the lake.
- Make your diameter the size you need when you achieve penetration into the lake other wise the dilution of lake water with drill water makes it hard to ream the hole and is putting drill water into the lake.

Good Sensors are the key to make sub-glacial drilling more successful

The Main sensors where

- Drill tower sensor, without this there is no way to know if the drill head had bottomed out and started drilling at an angle

Pressure Sensor on Return Water Pump

- The return water pump pressure sensor is the main sensor for alerting the drill operator to when the drill breaks through to the lake and lake water floods up the bore hole.

Drill hose encoder

- The drill hose encoder, plus marks on the hose are the only way to know the drills depth with any accuracy

What is Needed on the Next Generation Clean access drill?

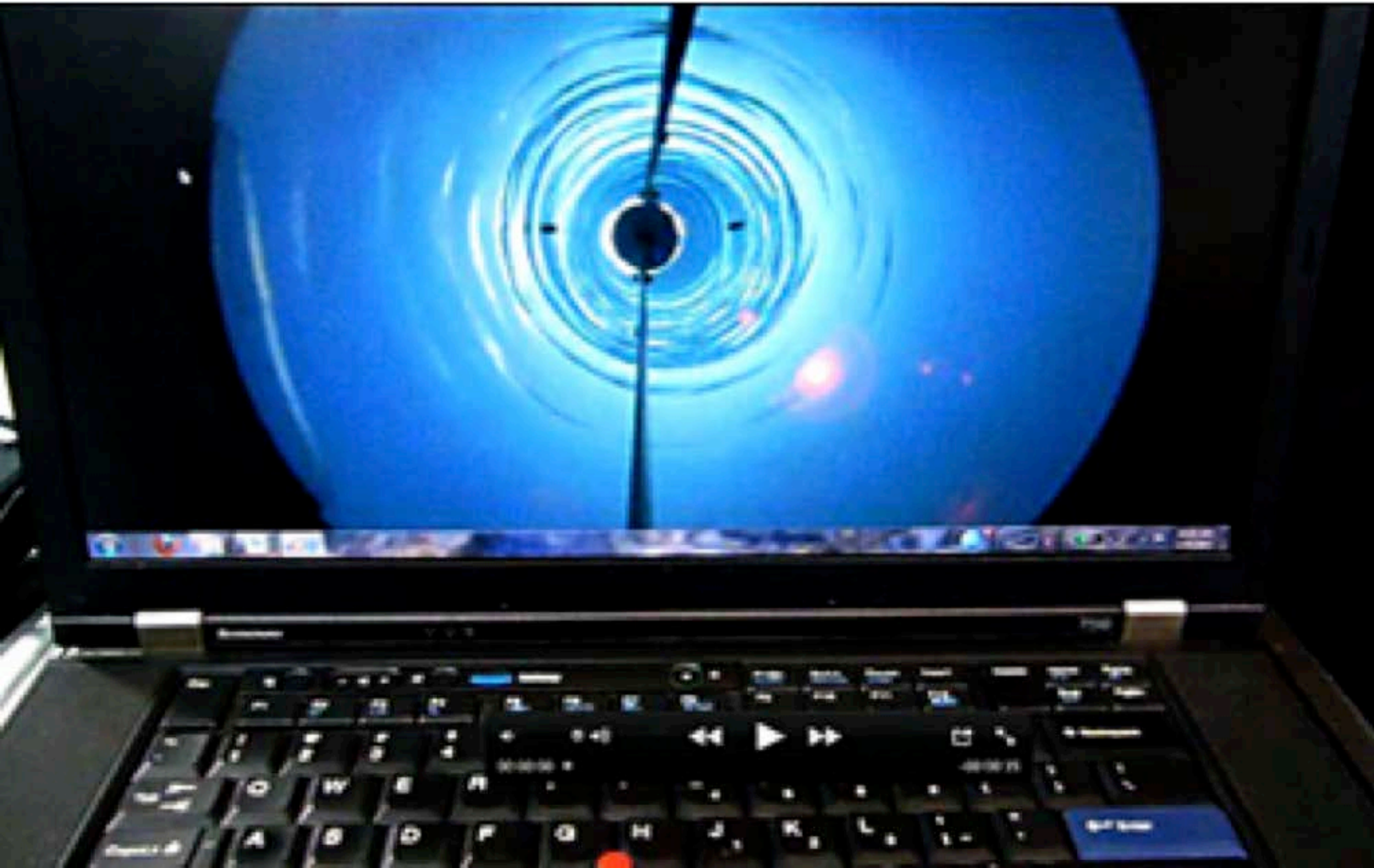
- Drill head instrumentation to more accurately know depth and hole diameter
- Top hole instrumentation to allow better monitoring of the drill water and return water
- Above all, a good drill team.

WISSARD Drill Team from the University of Nebraska-Lincoln

Jeff Lemery, Daren Blythe, Dar Gibson, Dennis Duling, Chad Carpenter, Graham Roberts and Justin Burnett

[Not Shown: Drs. Frank Rack & Steve Fischbein, and Adam Melby]

Image of WISSARD Borehole – Confirming Entry into Subglacial Lake Whillans



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Thanks
Any Questions?