NSF ICE DRILLING PROGRAM (IDP)
TECHNICAL ASSISTANCE BOARD (TAB) MEETING
Wednesday, March 5 - Thursday, March 6, 2025
Fluno Center - 601 University Ave, Madison, WI 53715
Room 201
University of Wisconsin - Madison

Meeting Notes

Attendees:

Technical Advisory Board Members

Jeff Cherwinka	Physical Sciences Lab University of Wisconsin – Madison
Chris Delahunty	Matrix Drilling Products
Steff Bo Hansen	Niels Bohr Institute, University of Copenhagen
Keith Makinson	British Antarctic Survey
Darcy Mandeno	Antarctic Research Centre, Victoria University of Wellington
Frank Wilhelms	Alfred Wegener Institute
Leo Stolov	Honeybee Robotics (attending on behalf of Kris Zacny)

Ice Drilling Program – WI

Barb Birrittella	NSF Ice Drilling Program, University of Wisconsin SSEC
Andrew Haala	NSF Ice Drilling Program, University of Wisconsin SSEC
Forest Harmon (online)	NSF Ice Drilling Program, University of Wisconsin SSEC
Jay Johnson	NSF Ice Drilling Program, University of Wisconsin SSEC
Jim Koehler	NSF Ice Drilling Program, University of Wisconsin SSEC
Tanner Kuhl	NSF Ice Drilling Program, University of Wisconsin SSEC
Elliot Moravec	NSF Ice Drilling Program, University of Wisconsin SSEC
Elizabeth Morton (online)	NSF Ice Drilling Program, University of Wisconsin SSEC
Chris Niendorf	NSF Ice Drilling Program, University of Wisconsin SSEC
Sam Porter	NSF Ice Drilling Program, University of Wisconsin SSEC
Krissy Slawny	NSF Ice Drilling Program, University of Wisconsin SSEC
Umberto Stefanini	NSF Ice Drilling Program, University of Wisconsin SSEC
Todd Turner	NSF Ice Drilling Program, University of Wisconsin SSEC

Ice Drilling Program – Dartmouth

Mary Albert	Dartmouth College

Ice Drilling Program – UNH

Joe Souney	University of New Hampshire

Other Guests

Terry Benson	Physical Sciences Lab, University of Wisconsin – Madison
Grant Boeckmann (online)	Niels Bohr Institute, University of Copenhagen

Dusty Brunner	Space Science & Engineering Ctr, University of Wisconsin-Madison
Chelsea Dahmen	Space Science & Engineering Ctr, University of Wisconsin-Madison
Mark Mulligan	Space Science & Engineering Ctr, University of Wisconsin-Madison
Brad Pierce	Space Science & Engineering Ctr, University of Wisconsin-Madison

Wednesday, March 5, 2025

Arrival & Coffee

Opening Remarks & Chair Comments

Update from IDP Leadership - Albert

Recent and Upcoming Fieldwork - Slawny

700 Drill Use in Greenland - Johnson

- Wilhelms: Do you use any cooling under the core tray?
    - Johnson: No, but there were issues with keeping things cool.
- Most cores have breaks 10-20 cm from the top.
    - Delahunty: Is this due to thermal expansion? Have you tried hanging the drill in the hole for a while before coring?
- Hansen: Did you try drilling shorter cores, and did you still see the breaks?
    - Johnson: Not deliberately. However, runs that yielded short cores often also had a break.
- Hansen: Does Isopar K have similar greasiness/lubrication as Estisol?
    - Johnson: The chip packing problem was observed during dry drilling.
- Johnson: The 700 Drill chips chamber is one length with the outer tube. In other drills, the chips chamber is a separate tube of slightly smaller diameter, so the chips come out easier when pulled through the larger diameter outer tube.
- Wilhelms: If the chips are sinking in the drill fluid, you could try to touch off bottom and then ascend quickly to stir up the chips before drilling.
- Hansen: Did you see the same core breaks and pull-out problems across different cutter configurations?
    - Johnson: The core breaks happened with both full-kerf and step cutters. Only full-kerf cutters were used for dry drilling, which is when the pull-out problems occurred.

GreenDrill Field Project Update - Kuhl

- Mandeno: What mud pump pressures were you running at the hydrofracture event and what circulation?
    - Kuhl: Have to look up the pressures, but we were using reverse circulation; thought we had to to keep chips moving, but that's not the case if you can avoid chip plugs.
- Delahunty: Do you wear through your PDC bits?
    - Kuhl: Yes, often after 5 m, but that's really all we need.
- Delahunty: Where do you get your bits from?

    - Moravec: Good success with U.K. company Archway. We tried to have Hoffman Diamond Products build a full face PDC bit, but they were hard to work with.
- Hansen: What is the diameter of the core and what breaking strength do you need?
    - Moravec: 35.3 mm for Winkie; need a high lift jack to break the cores.
    - Kuhl: Should instrument this to collect data.

Break / Morning Refreshments

Mt. Waesche Field Project Update - Moravec

- Changed to custom TT46 coring assembly, allowing us to maintain the previous borehole diameter and use our existing casing and the Eclipse Drill for pilot holes, but it also allows for a larger Winkie core diameter.
- Wouldn't have been able to collect the dirty ice cores without the new carbide inserts on the Eclipse Drill.
- Delahunty: What grease were you using?
    - EM/TK: Sandvik pipe dope; washes off easily.
- Delahunty: Centrifuges take a lot of work; they're high speed, high energy, but they're a lot to handle. Not a simple solution. 480V, 30A, continuous to process 50 gpm.
    - Moravec: Would using a batch style centrifuge simplify this in any way?
        - Delahunty: Maybe a simple, gravity-style washing machine setup could be pursued?
- Delahunty: Noticed the plugging of one large hole and one small hole on the bit. Suggest some optimization could be made to the bit waterways.
- Moravec: Nothing touches the PDC inserts; they go through clean ice, dirty ice, etc.
- Stolov: How hard are you pushing down?
    - Moravec: We're pushing down with a couple hundred pounds in rock, but in ice, the operator holds back most of the string weight.
- Hansen: Remember the ISTUK drill had one pump for each channel in the bit.

COLDEX Field Project Update - Haala

- Average wind speed of 20 knots.
- Wilhelms: Do you think the old ice was originally say 1 km down and the clathrates have transitioned back to bubbles?
- Souney: What was the core quality like with the hand augers?
    - Haala: Depended on the site; the ones near the BID sites/nunatak were very fractured. One drilled next to the Eclipse site was much better quality.
- Wilhelms: Saw crystal interfaces becoming visible at EPICA Oldest Ice; polycrystalline ice is much tougher.
    - Haala: One scientist collecting hand auger samples took backlit photos and could see some crystal structure.
- Moravec: Used the Eclipse Drill with good success in the past. Have not run the Eclipse at the bad nunatak sites for comparison.
- Hansen: Have been trying out 3D printed cutters.
    - Haala: How much post-processing is required?
        - Hansen: A little hand stone work, but can often use them as received.

Dome C Field Project Update - Johnson

- Cherwinka: What was the altitude?
    - Johnson: 10,600 ft.
- Moravec: Which drill performed better, the IDP 4-Inch Drill or the French Drill?
    - Johnson: The French drill didn't go as deep, where many of the issues occurred, but probably had better core quality during the challenging depths.
- Wilhelms: Were round cutters used on the French drill?
    - Johnson: Round cutters were used for the first hole and step cutters for the second hole.
- Stefanini: Did core quality correlate with depth between the two drills?
    - Johnson: Hard to say, as the French team did not keep a core log.

Working Lunch

IceCube Upgrade: FY25 Update - Benson

- PSL is partners with WIPAC (Wisconsin IceCube Particle Astrophysics Center) and heads up drilling/installation for IceCube.
- Wilhelms: How do you improve the ice clarity/quality?
    - Benson: Going to try to degas the water; displace the melt water up and replace it with surface water.
    - Cherwinka: Melt water from the glacier has much more gas than the surface water.
- Predict ~53 hours per hole for the coming season.
- Wilhelms: Do you shut down the heaters over winter?
    - Benson: Shut down, drain, and winterize the system with water/glycol mix and blow it out.
- 22 sections of hose for 8,800 ft. total length.
- Clamshell O-ring radial seal and strain relief.
- New control system implemented.
- Have to heat the hose over the winter so the rubber won't sustain stress fractures.
- Plan to drill 7 holes in 25/26 with a full drill team of 28.
- Wilhelms: Does Starlink impact those willing to winter?
    - Benson: Not allowed to have Starlink near the Dark Sector, or radios, wifi, Bluetooth devices, etc.
- Benson: 50 people wintering at Pole, with two devoted to IceCube.
- Mandeno: How do you keep the reels synchronized?
- Benson: The cable becomes the master and the hose becomes the slave. PLC first and then mechanical coupling. Requires a lot of tuning.
- Stolov: Is the Rodwell in addition to the HWD (hot water drill)?
    - Benson: Always in a water deficiency with hot water drilling. Have a buffer reservoir where back up water can be made.
- Stolov: Do you gather Rodwell performance data?
    - Benson: We will.
- Makinson: How did you store the hose before it was uncrated?
    - Benson: It wintered in McMurdo and went up on the traverse this year.
    - Cherwinka: The original hose was discarded.
- Wilhelms: What is the strength member?
    - Cherwinka: Kevlar; Vectran cable.

Drill System Electronics - Stefanini

- Wilhelms: What type of motor is it?
    - Stefanini: Maxon brushless DC motor.
- Wilhelms: Used the same cable for shallow drills. Had 250 m on the drum for a 100 m hole. Voltage drop on outer armor.
    - Stefanini: RS485 is isolated on both ends and we have not had issues with that problem.
- Stefanini: Have people implemented powerline communications?
- Stolov: IDP could talk to Dale Winebrenner who sends 2kV through smaller gauge cable in deep holes.
    - Stefanini: But there's no load on his cable.
- Stolov: Tested 600V, 24-gauge wire with success. Do you need to keep things cool? Ratings are often developed at room temp.
    - Delahunty/Makinson: Will be impacted by the -25° temps as opposed to 25° on the data sheets.
- Hansen: Had a battery section in the sonde in the past.
- Wilhelms: Power line modems with connection over coax cable.
- Birrittella: How much does the torque requirement change?
    - Wilhelms: Working on a new motor for deep drills; tested it; it was limited in torque.
- Brunner: Has anyone ever tried two separate cables for power and for pulling?

Shallow Wet Drill Development - Birrittella

- IDP will no longer hard coat anodize barrels, as it leaves the surface finish 2-3x rougher, which can't be helping with chip transport.
- Single piece vs. two-piece outer barrel/chip chamber.
- Wilhelms: Have you checked the hollow shaft for icing? Best to use heated and cleaned downhole assemblies.
    - Birrittella: Won't have the time to dry hollow shaft screens during shallow drilling at Allan Hills. Looking to have 10-15 screens to swap them out between runs.
- The Danes have done the most research regarding fluid column height. 240-300 m fluid column recommended for a 400 m hole. IDP plans to bring enough to fill the hole in 2025-2026.
- Delahunty: How much weight does the clamp have to hold?
    - Birrittella: The sonde is 100-150 lbs.
- Delahunty: What are the pads made of? 90 A durometer?
- Delahunty: Used tire rubber/a pneumatic tire in a home-grown clamp.
- Haala: One hitch is that our clamp allows our drill to travel horizontally. Needs to auto release if the controls go errant.
- Birrittella: Could we put tread on the gripping pads?
    - Cherwinka: Grooves would allow fluid to flow off.
    - Delahunty: Sipe them.
- Wilhelms: Is the holding force only down?
- Mandeno: Is the linear track active with motor control?
    - Birrittella: It's passive.

Break / Afternoon Refreshments

Open Discussion

Pumps/Chip Transport/Fluids

- Hansen: Designed the pump with Sigfus; doesn't destroy itself even if it gets packed; might recommend just a booster for shallow wet drilling at Allan Hills. Prefer a 3-blade booster, as it seems to hold the chips up better.
- Wilhelms: The Japanese have implemented an impellor.
- Moravec: Does the booster or pump perform better with fine cuttings?
    - Hansen: The pump would likely be better with fine chips. Could use both a pump and a booster. Drilled 700 m at Renland with just a booster. A little bottleneck from the outer barrel to the chips chamber can create chip movement problems.
- Wilhelms: If you just use a booster, use a flapper valve.
    - Birrittella: We do have one to prevent the chips from falling out.
- Birrittella: Using Isopar allows the chips to sink. Do we need more fluid flow than just the booster would provide?
    - Wilhelms: The Hans Tausen Drill was the first dry/wet drill. Tried a full length auger in the hollow shaft. Worked 4 out of 5 times for drilling 80 cm cores. The booster should work for a 1 m drill. In a dry drill, you have to lift the chips. In fluid, they're buoyant.
        - Stefanini: This is the opposite of our experience at Summit, but we attribute this to using Isopar.
- Mandeno: Used only boosters for a 760 m hole. Had one at the bottom and had a moveable booster up above. Had a 3.5 m chips chamber with 10,000 holes (1.3 mm holes) drilled into it for a 2 m core barrel.
    - Wilhelms: Used 0.8 mm holes and they didn't work.
    - Hansen: Used 18,000 holes at NEEM, but feel like it introduces toothpaste-like fines in the hole. Have moved away from this.
- Birrittella: What size mesh do you use?
    - Hansen: Had a few choices; stepped away from the very fine one.
- Wilhelms: Suggest making grooves in the shaft and applying a commercial braid over the shaft.
- Hansen: Make sure the slope of your cutter and your barrel scallop are a little different.
    - Kuhl: Tested some different configurations at CRREL with the Blue Ice Drill. Need something, but not sure it can be optimized. The 4-Inch Drill has high scallops, which may expose the barrels to damage.
- Haala: Has anyone tried a low-profile cutter head, where it is recessed up into the barrel to start capturing chips?
    - Wilhelms: The kerf area needed for the dogs in the limiting factor.
    - Hansen: Recommend staying with the current profile. Seldomly have packing around the drill head. Avoid enlarging your drill head, as you'll get packing around the head.
- Wilhelms: Will show a design/tooth profile tomorrow where the sleeve and pump can mount into a grooved tube.
- Hansen: Have used stainless steel barrels that don't require coating, but prefer anodizing.
- Delahunty: Did some electroless plating of the mild steel U.S. RAID augers; did this to combat a rust/dirty hole problem. They now feel shiny, smooth, and the plating filled in any pits.

    - Mandeno: Low coefficient of friction; have seen this done in industry.
- Brunner: What surface prep was done before the anodizing on the IDP tubes? Some surface prep can result in a smooth, anodized finish.
- Haala: Has anyone tried a spiraled outer barrel?
    - Hansen: Good idea, but hasn't been easy to manufacturer.
    - Mandeno: Like rifling in a gun barrel.
- NANOMYTE SuperAi Anti-Ice Coating was produced to apply to the propellors of aircraft.
- Cherwinka: PTFE on stainless steel is a problem; the coefficient of thermal expansion will make the coating separate off. With the big temperature ranges, the Teflon doesn't like to stick.
- Cherwinka: Can you dip the hollow shaft screen in ethanol?
- Wilhelms: Make a box with warm drill fluid.
    - Birrittella: Not feasible to have multiple full screen section assemblies, but are exploring having spare mesh screens.
        - Hansen: Too much handling time to change the mesh screens. Bring two assemblies and put one in a hot box for melting.
- Moravec: What about an internal air blade that you can insert in the tube and use compressed air to blow the screen out?
    - Hansen: Stay away from compressed air; you create aerosols and its very unhealthy. Just make a heated box.
    - Delahunty: Could port the exhaust from your generator to make a hot box.
- Birrittella: Difficult to do anything outside at Allan Hills.
- Wilhelms: Why don't you like Estisol 140?
    - Birrittella/Slawny: Smell, headaches, temporary loss of smell and taste.
    - Slawny: For SPICEcore, were the issues experienced in the drill tent or mainly in the driller's cabin?
        - Johnson: Mainly in the driller's cabin.
- Delahunty: Pour point of Estisol 240 is -30°. Estisol 140 is -90°.
- Wilhelms: What is the annual mean temp at Allan Hills?
    - Haala/Kuhl: -30° to -25°.
- Delahunty: Estisol 240 is vegetable based vs. synthetic, which is giving off the VOCs.
- Slawny: Would other Isopar grades work?
    - Wilhelms: Seems Mike Gerasimoff did a study and paper on the various grades of Isopars and the chain links.
- Delahunty: Estisol 135 has a pour point of -65° and is vegetable based.
- Delahunty: Lots of Estisol 140 totes in MCM from RAID, but its dirty fluid per Jay.

Drill Tents

- Hansen: Bought an inflatable tent from Slovakia (Nixus Tent), but haven't tested it yet.
    - Moravec: How are you inflating this higher-pressure tent?
        - Hansen: Bought a special compressor from the manufacturer.

Driller Staffing Issues

- Delahunty: Had to start a for-profit side of the business to attract/retain people.
- Wilhelms: Trained up some people who dislike their other jobs.

- Mandeno: All drilling industries are struggling with this. Generational shift where people no longer want to go on 6-week or longer drill stints. COVID reset people's family perspective. It might work if we could afford to pay people all year round, but we can't.
- Delahunty: The NSA has taken pilots out of planes and allowed them to operate drones from anywhere. Able to operate cleanup bulldozers remotely and keep people out of harm's way. Strategies like this are a 10-year problem.
- Cherwinka: Could you get remote access for folks to view drilling operations from afar?
- Benson: Relied on daily Zoom calls and sat phone calls to get through the season, as we were short on some critical expertise. Had harnesses to hold your phone on your chest or forehead to show someone up north what's broken.
- Cherwinka: IceCube has a northern hemisphere support group with an email list.
    - Makinson: Have a similar driller WhatsApp group.
- Albert: You're not suggesting we send inexperienced drillers and just have a Starlink helpline connecting them to the north?
- Brunner: Utilized 3D video/GoPro in the railway industry. Recorded the equipment and operations for later viewing/training.
    - Makinson: Did something similar for the ship.
- Hansen: Train up the scientists to help.
- Delahunty: Do your E&O funds work to seek out operators?
    - Albert: The funds are used to inform teachers and students.
- Mandeno: If you can, find academics who are willing to support the operations; need to find people who 'have the bug'. It's a built-in crowd, as they want to be there.
- Wilhelms: We train a lot of students, but they don't stay.
- Delahunty: It takes a special person to want to leave for 3 months.
- Hansen: Counted 100 drillers who had come through EastGRIP! But they don't stick around for future projects. Work to integrate the scientists into the operations teams. The Danes integrate science, drilling and logistics teams.
- Slawny: How to get a handle on who is out there, what experience they have, and are they available?
    - Souney: Keith had a database idea in the past about an inventory of drill equipment/manufacturers, but could create one for international driller human capital.
- Makinson What can you sustain? One year on, one year off, before you burn people out?
- Delahunty: Hard to share between countries because all of the countries had teams in Antarctica last season.
- Makinson: IceCube requires the most drillers. How does this work?
    - Benson: Some IceCube drillers have UW jobs (e.g. PSL) during the off-season. Careful recruitment of seasonal hires, where their regular job is ok with them leaving for 3 months at a time; get a commitment to return. Pull drillers from 4 groups: 1) Core group at PSL, 2) contractors, 3) targeted seasonal hires, 4) international collaborators/contributed drillers.
    - Cherwinka: Contractors can be more expensive than a PSL engineer.
        - Delahunty: But they're not on the budget the entire year.
    - Cherwinka: Have a two-week summer training session at PSL.
- Brunner: Insurance is a major selling point.
    - Cherwinka: IceCube is able to offer insurance if people are on the payroll once every 6 months (training and then deploying).

- Delahunty: When does the IceCube need for drillers end?
    - Benson: After the 2025-2026 season.
    - Slawny: Should send the targeted seasonal drillers to IDP after 2025-2026.

Adjourn

Group Dinner and Continued Discussion
The Great Dane, 123 E. Doty Street, Madison, WI 53703

Thursday, March 6, 2025

Arrival & Coffee

TAB Membership & Next TAB Meeting - Slawny

- Delahunty: Is IDP getting out of this what they want?
- Kuhl/Johnson/Slawny: Yes.

BAS ice drilling: Recent fieldwork and future plans - Makinson

- Excellent meeting in fall 2024 in Madison with IDP help to consult on BigRAID.
- Korean owned HWD owned and operated by BAS.
- New funding for drilling on Petermann Glacier in 2026.
- Returning to Ronne Ice Shelf in 2026-2027.
- Looking to build up a Winkie Drill similar to those developed by IDP.
- Delahunty: Is the percussive bit actuated at the bit or from the surface?
    - Makinson: Hammers at the bit.
- Birrittella: How many drills does BAS maintain?
- Makinson: 4 large HWDs, 2 small HWDs, 3 ice coring systems in inventory. Many more drills than we have drillers for.
- Hansen: What is your ratio between length of the chips chamber and the length of the core barrel? How much do you pack your chips?
    - Makinson: Will get back to you.
- Haala: Fully rounded bottom profile on an EM drill.
- Makinson: Copy of an AWI drill in the 1990's. Fine for shallow work, but likely a disadvantage for deeper work.
- Wilhelms: Has IDP rounded some cutters?
    - Haala: Just small fillets at the edges.
- Wilhelms: Much prefer the HT type cutters for core quality.
    - Hansen: Intuitively you'd like to add rounding, but they do create fine chips, and we don't like fine chips.
    - Johnson: French drill had rounded cutters and no shoes. They had trouble with fine chips. Did one hole with rounded and one with regular cutters and shoes, right next to each other, and the core quality was the same.

Beyond EPICA – Drilling to Bedrock - Wilhelms

- 2019-2020 site selection, radar, camp and drill site construction, RADIX drilling.
- Game changers: Starlink, Picarro, 3D printer was running all the time (this requires engineers on site), EasyLog data loggers.
- -8° or -9° at bedrock, nice and cold.
- Sent the ice chips home for radiocarbon dating.
- Had prepared a heat box, but put the hollow shaft into a section of casing and used a heater to dry it; took a few hours overnight.
- Had issues with steel cutter chipping.
- In warm dirty ice, used one grooved cutter and the other two acted as shoes.
- Cores stored in -55° balloon caves at Dome C.
- Started with Danish electronics and switched to German electronics after an issue with the harmonic drive.
- Stefanini: What is the output torque of the motor and gearbox?
    - Wilhelms: 60 rpm, 500W?
- Basal ice was sampled under red light.
- Moravec: Did you lose any fluid when reaching the bed?
    - Wilhelms: No, it was frozen as expected.
- Wilhelms: Final depth was 2799.83; see debris on the bottom; was also an easy core break; showed an image where the core dog came from below and didn't break and enter inward.
- Original idea was to drill rock in 2025-2026; were ahead of schedule in 2024-2025, so built dead weights to attempt rock drilling.
- Drill length determined by what you could put in a 20-foot shipping container; core barrel was 4.5 m; chips chamber was optimized to diagonally fit in a 20-foot shipping container.
- Core quality strongly depended on the temperature in the drill trench; core quality was better at night.
- Ended with an inclination of ~6 degrees; tried to correct it, but then stopped to allow for deviation drilling.
- Lost rock drill components down hole but recovered them.
- Planning rock drilling for 2025-2026, maybe for two weeks, and deviation drilling.
- Moravec: How much does the sonde weigh in fluid during the rock drilling?
    - Wilhelms: 150 kg in air + 100 kg of dead weights; marginal if this is enough weight.
- Moravec: Have you considered bringing a smaller bit to reduce kerf area?
    - Wilhelms: Yes, but some in the group are mistakenly talking about wanting bigger core.
- Hansen: Exact copy of the rock drill used at Summit; realized the drill is outside of the advised parameters. Utilizing a superbanger concept.
- Kuhl: Do you have a variety of bits (diamond impreg, impreg, Geoset)?
    - Wilhelms: Only have PDC bits, but want a variety.
- Moravec: Don't think the rpm is an issue; the Winkie is hundreds vs. thousands.
- Kuhl: Mixed media drilling of ice and rock is a problem; toothed PDC bit has been a game changer for us; they don't glaze and work well for low rpm and low WOB.

HWD and core drilling at Kamb Ice Stream, challenges, and lessons - Mandeno

- 5000 L fuel bladders.
- MP1000 drill from Multipower Products Ltd.; bigger chuck to handle larger casing than IDP; has a tower extension to enable 6 m tubular operations.
- Rockwell automation PLC/SCADA.
- Cherwinka: Enough flow capacity when changing the materials?
    - Mandeno: Marginal, but yes; the sea riser was installed this year.
- Moravec Uneven wear on jaws suggests the risers were not round?
    - Mandeno: The GRE (glass reinforced epoxy) pipe was very out of round, with variable diameter.
    - Delahunty: There's a bunch of HRQ casing and N-size drill rod sitting in McMurdo for RAID.
        - Mandeno: Could be a backup for next season; also have a B-string backup.
- Delahunty: Specific gravity of GRE pipe; was it floating?
    - Mandeno: Had 800 kg of weight on the GRE; slightly heavier than water.

Break / Morning Refreshments

EastGRIP: Termination and innovations - Hansen

- Largely use step cutters for all operations, even in the brittle zone.
- Balloon trenches really crept during three years offsite due to COVID.
- Encountered unusually high core breaks (25 kN) in 2022; had to stop drilling for the season due to limited winch pulling power.
- Used the rock drill to drill 7 m of mixed media at NEEM.
- Surprised to find that the glacier was moving as one big block all the way to the bottom.
- Knowing drill orientation allows you to control borehole orientation (reduce inclination or steer down the ice flow direction).
    - Haala: How do you orient the drill at the bottom?
    - Hansen: We passively orient the drill by raising and lowering it a number of times. No active rotational control.
    - Cherwinka: Do you get positioning from magnetic fields?
        - Hansen: Other sensors.
- 3D printed new geometry 3-blade boosters.
- Sonic device and receiver on top of borehole to monitor liquid level when contacting the bed, in case water infiltrated the hole from the bed.
- Use a vacuum to suck chips slurry into the PIG melting tank.
- Working to add a mechanical fuse to the broaching edge, in case comms is lost with the motor.
- Mandeno: Wiper seal on the wiper/cable cleaner?
    - Hansen: Some rubber seals with close tolerance.
- Moving from EastGRIP to GRIP in summer 2025.
- Estisol 222 may be an option; half the viscosity of Estisol 240, but requires further investigation.
- Stefanini: Cable wiper speed?
    - Hansen: Usually at 1m/s, but could try to optimize the weight.
- Helpful Zoom meetings between Denmark and IDP, etc. throughout the year.

Matrix Drilling and Engineering Updates - Delahunty

- Lot of modeling, dry fitting, 3D printing, in-house destructive testing.
- Developing sonic wireline drilling.
- Started 3D printing O-ring seals, some urethane up to 18-inch diameter; helps where there are minimum quantity requirements from vendors; 90 durometer flexible urethane TPU95HF.
- Started running liner plastic casings.
- Working on laser stamping, sonic swivel, carbide grippers, spiral dual-tube stabilizers.
- Upcoming drilling off of Martha's Vineyard in Nantucket for Integrated Ocean Drilling Program (IODP); PIs at Colorado School of Mines and University of Massachusetts.
- Moravec: Do you always choose the shallowest hole first?
    - Delahunty: No, the highest science priority hole. Looking for fresh water; installing transponders that will collect data long term.
- Started a new company called BoreLogic; developing autonomous pipe rig; working with an eye toward the future (e.g. ability to remove the geothermal loops in 75 years without redrilling, thereby protecting the environment.)
- Matrix sold their first drill rig; 8 more on order for this year; 30 on order for next year. Intent is to install geothermal ground loops. Have small rigs that you can take into parking decks below buildings or home basements to drill geothermal loops.
- Turner: For residential loops, are you replacing natural gas loops or to clear roadways, etc.
    - Delahunty: Intended to replace direct carbon burn. Utility companies are looking to fund/develop this as the next utility network, not house by house. Removes the need for individual homes to maintain pumps.

Honeybee's Ice Probe Testing for Icy Worlds - Stolov

- Honeybee now owned by Blue Origin.
- Landing attempt today on the moon! May be the first company to drill at the south pole of the moon.
- One-way trip of the probe; the slush moves up the drill and refreezes above the probe.
- Cherwinka: How does the fiber optic distributed temperature sensing (DTS) work?
    - Stolov: Sends out a pulse and measures the return time. This DTS was only a couple thousand dollars. More expensive ones are $10K.
        - Cherwinka: Would be great to have one alongside the nozzle of the HWD.
- Stolov: Fiberoptics work well with good coatings.
- Moravec: Melt probes often struggle in firn.
    - Stolov: Did run into this issue; the hybrid tether contains a lot of heat, that isn't well dissipated in the firn; were afraid of melting the fiberoptics, so were limited in the amount of power they sent to the melt head.
- Moravec: IDP Thermal Drill has trouble burning out resistive heads in the firn.
- Haala: Water sublimation; does this also happen with the percussive design? How deep are you before the ice closes behind you?
    - Stolov: ~1.5x the length of the probe.
- Moravec: How do you make the clear ice blocks for testing?
    - Stolov: Purchase ice blocks that are used for making ice sculptures. Stack them with a liquid layer in between to cement them. Clean them up with a hot plate. Tall 5 m walk in freezer at -20°.
- Makinson: BAS rents out commercial warehouses (frozen) with head room.

Drilling to subglacial environment: Latest developments of Polar Research Center at Jilin University - Talalay (recorded)

Working Lunch

9th International Workshop on Ice Drilling Technology - Wilhelms

Open Discussion

Tour IDP Facility at 1 Marsh Court, Madison, WI 53718

Adjourn