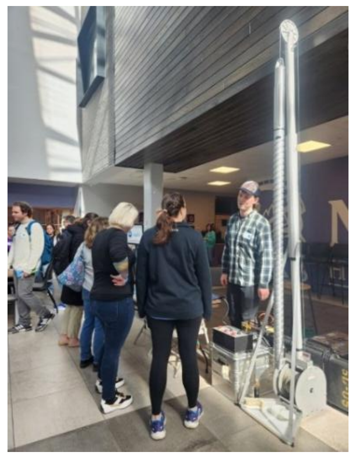
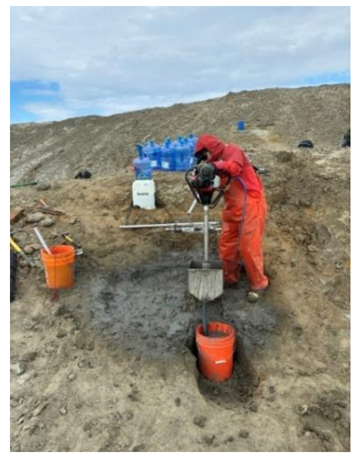
U.S. NSF Ice Drilling Program

LONG RANGE DRILLING TECHNOLOGY PLAN

June 30, 2026

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Contents

Cover photos: (top left) Layers of ice chips and sediment are seen on the Blue Ice Drill cutter head at Allan Hills, Antarctica (photo credit: Andrew Haala); (top center) IDP Engineer Elliot Moravec discusses ice drilling with workshop participants at the Climate of H.O.P.E in Downers Grove, IL (photo credit: Krissy Slawny); (top right) IDP Warehouse Manager/Driller Jim Koehler operates a PI-provided Shaw Drill on Seymour Island, Antarctica (photo credit: Tanner Kuhl); (bottom right) IDP Engineers test a new tower raising mechanism in Madison, WI (photo credit: Krissy Slawny); (bottom left) IDP Driller Elizabeth Morton and IDP Engineer/Driller Andrew Haala push a core out during shallow wet drilling proof-of-concept testing at Allan Hills, Antarctica (photo credit: Jay Johnson).

INTRODUCTION

The U.S. National Science Foundation (NSF) Ice Drilling Program (IDP) Long Range Science Plan lays out recommended directions for U.S. ice coring and drilling science. This companion Long Range Drilling Technology Plan addresses the IDP drills and technologies needed for implementation of parts of the Long Range Science Plan. Much of the equipment mentioned is already being developed or maintained by IDP as part of its inventory of NSF-owned equipment. This plan also describes the latest development projects at IDP and discusses potential technologies that could have positive impacts on NSF-funded science programs, if pursued. Finally, this plan briefly addresses the funding allocated for its implementation during the current Fiscal Year (FY).

Highlights/Changes for this 2026-2036 Update:

- Added a Borehole of Large Diameter (BOLD) Drill section.
- Added a Modular Hot Water Drill section.
- Added a Shallow Wet Drill section (Note: This is not a stand-alone drill system).
- Added a Clean, Deep Hot Water Drill section.
- Updated photos for several pieces of equipment.

The high priority tasks and investments identified by the IDP Science Advisory Board (SAB) and its working groups are shown below as listed in the U.S. NSF Ice Drilling Program Long Range Science Plan 2026-2036.

Recommended Technology Investments

Acquisition of major purchased items for the community results in the addition of drilling-related equipment to the IDP-WI inventory (e.g. winches) without major changes once purchased. *Development* projects result in additional drilling equipment that is novel or has required major changes from existing equipment. Each *Development* project has five phases: 1) development of the IDP Science Requirements, 2) the IDP-WI Conceptual Design, 3) the IDP-WI Detailed Design, 4) construction, and 5) integration and testing. IDP Science Requirements and IDP-WI Conceptual Designs are completed as per NSF-approval of the IDP Annual Program Plans, and each subsequent step may occur at the discretion of, and funding from NSF.

The following investments in drilling technologies are needed to accomplish science goals of the U.S. science community for the next decade. Many, but not all of the following could be achieved by IDP, subject to availability of funding and trained personnel. Investments that are prioritized by time (but are not prioritized within each Priority level) through consensus of members of the IDP Science Advisory Board and its working groups include:

Priority 1 (needed before August 2027):

- Maintain and upgrade agile equipment in inventory, including: Hand Augers, Sidewinders, the 700 Drill, the Foro 400 Drill, the Foro 1650 Drill, the 4" Electromechanical Drills, the 3" Electrothermal Drill, the 3.25" Eclipse Drills, the Stampfli Drill, Logging Winches, the Small Hot Water Drills (SHWD), the Blue Ice Drill, the Prairie Dog, the Agile Sub-Ice Geological Drill (ASIG), the Rapid Air Movement Drill (RAM) Drill, the Winkie Drill, the Chipmunk Drill, the existing 900 m Hot Water Drill, and the existing stand-alone components for use in shallow wet drilling.
- Investigate lighter weight sources of power and/or renewable energy technology to (partially) replace or offset generators for drilling systems and ease demand on logistics, with an emphasis on lightweight systems, and/or where practical.
- Develop detailed engineering design and cost estimate for the BOLD Drill.
- If COLDEX Phase II is funded, initiate fabrication of the drill NSF approved for COLDEX.
- As the next steps to building a hot water drill for clean subglacial access (for drilling up to 3,000 m depth) that minimizes its logistical footprint including fuel supply (e.g. replica of the BAS/NZ deep hot water drill), develop the Conceptual Design and Detailed Engineering Design for a clean hot water drilling system.

Priority 2 (needed before August 2029):

- Complete the Conceptual Design for Foro 1650/3000 replicate coring capability.
- Develop the Detailed Design for a clean hot water basal ice coring sonde for a hot water drill that has the ability to integrate with other hot water drills or deep ice coring drills.
- Develop a multi-optional Conceptual Design and cost estimate for a 4" stand-alone shallow wet drill (SWD). Options should include building a brand new SWD, complete the existing conceptual SWD configuration to a stand-alone drill, create a stand-alone fluid-capable version of the Foro 400 drill, and others as IDP sees fit.
- Identify procurement source and cost for potential purchase of a rapid hole qualifier (temperature and caliper) to meet the scientific need in borehole access applications.
- Complete the Detailed Design for replicate coring capability for the Foro 1650/3000 Drills.
- Finish adapting a commercial drill rig for retrieving rock core from beneath 200 m of ice (BASE Drill).
- Implement modifications needed for the 700 Drill to increase core quality, length, and production rate.
- Develop the Conceptual Design for collecting a small amount (chips to several cm) of sub-ice rock/mixed media/mud in a frozen regime using an intermediate or deep ice core drill in a fluid filled hole, for example with the Foro 3000 Drill.

- Establish Science Requirements for new drilling fluids for future ice and rock drilling projects, including clean ice core drilling (for biological and gas sampling) for future collaboration with international partners.

Priority 3 (needed before August 2031):

- Build a hot water drill for clean subglacial access drilling up to 3,000 m depth that minimizes its logistical footprint including fuel supply (e.g. replica of the BAS/NZ deep hot water drill).
- Establish the IDP Science Requirements for identification and planning of borehole maintenance and fluid maintenance over time, including removing (or lowering) drilling fluid from a borehole (for example for freezing in a sensor).
- Continue investigation and modifications of the RAM 2 Drill to achieve the 100 m depth goal reflected in the system Science Requirements.
- Establish the Science Requirements for retrieving sidewall ice samples at specific depths in an existing borehole without using an ice coring drill.
- Write a summary paper outlining the results from past attempts and the prognosis for future use of shallow drill fluid columns for ice coring.

IDP will address these priorities through the maintenance and modification of equipment already in its inventory, by developing or procuring new equipment, or through iterative discussion with the science community. The equipment involved in meeting these priorities is addressed in the following sections. Following that, the list of priorities is revisited with details of how IDP is addressing them.

ICE AND ROCK DRILLING SYSTEMS AND TECHNOLOGIES

Important technical aspects of ice and rock drilling equipment are its performance characteristics including its transportability (i.e. weight, size), its condition, and the availability of documentation such as component specifications, fabrication drawings, operations and maintenance manuals, etc. Major component inter-changeability and logistical agility are major design goals of all new and refurbished drills. IDP follows rigorous documentation procedures throughout the design, fabrication, testing and deployment of equipment. This allows IDP to better maintain the equipment, and allows IDP to undertake modifications that improve the equipment's performance and, hence, its usefulness to scientific investigators.

One of the guiding principles for development of drilling technology expressed in the U.S. NSF Ice Drilling Program Long Range Science Plan 2026-2036 prescribes that *"Major drilling systems (e.g. sondes, winches, controls and other major electronics systems) should be fungible to the maximum extent possible. Major component inter-changeability and logistical agility should be essential deliverables for all new drilling technology projects."* IDP has made strides in this area by developing the Foro Drill series.

Through the design of similar drill systems with varying depth capabilities and the implementation of interchangeable components, IDP is committed to pursuing the efficient deployment of systems, a reduction in the level of logistics required, and lower overall design and maintenance costs. Some of these systems, such as the Foro 400, will replace aging drills that are nearing the end of their useful life (e.g. 4-Inch Drill), while others like the Foro 3000 will dramatically decrease the amount of logistics required to collect cores to a certain depth. Finally, others fill a void where capability did not exist but is highly desired by the science community (e.g. 700 Drill).

The following sections provide a brief history of each piece of equipment in the IDP inventory, outline the current status of each system, note any technical issues with the equipment, and outline plans for the near future.

Chipmunk Drill

The Chipmunk Drill is a hand-held, motor driven drill that collects ice cores either 41 mm (1.6-inch) or 57 mm (2.2-inch) diameter in solid ice. Barrel sets are available in 15 cm, 25 cm, and 50 cm lengths. The drill was first used for a funded project (for which it was designed) at Pakitsoq, West Greenland, in 2003 and 2004. It has been used for exploratory work at the South Pole, to collect shallow cores in the Sierra Nevada range and Wyoming in the western U.S., and by an investigator at UW-Madison for testing highly strained ice created in a campus lab. The drill was recently used in west Antarctica during the 2024-2025 season to drill over 400 shallow core samples near Mt. Waesche and it is slated for use on ice patches in Alaska and Canada during the summer of 2026 and 2027.

Chipmunk Drill; photo credit Joe McConnell, DRI

Current Status

The drill is functional, and several improvements have been made and tested in recent years. In 2022, IDP shortened a damaged Stampfli Drill barrel for use with the Chipmunk Drill. IDP plans to fabricate additional barrels of this design. The Chipmunk Drill and Stampfli Drill will then use interchangeable heads and cutters designed by IDP, thereby standardizing parts inventory and reducing maintenance costs.

Technical Issues

The original two drill barrels (41 mm core) have different cutter attachment styles and limited cutter inventory for these barrels remain. The cutter heads are likely too small to accommodate the use of carbide cutter inserts, so shallow ice coring efforts in areas with dirty ice may be better served by using an IDDO Hand Auger with replaceable carbide inserts (see Hand Augers section).

Plans

1. Purchase/fabricate a second Stampfli-style barrel – FY 2027.
2. Fabricate cutter head assemblies for use with the Stampfli-style barrels – FY 2027.

Hand Augers

IDDO Hand Auger Kit

The hand auger is the most basic of the mechanical drills and is driven from the surface by extensions that are added as drilling proceeds into the ice. IDP deploys three types of hand augers: SIPRE (3-inch core), IDDO (3 and 4-inch cores), and Kovacs (3.54 and 5.5-inch cores). The SIPRE, Kovacs, and short IDDO systems collect half-meter cores, while the long IDDO systems collect one-meter cores. The maximum depth to which hand augers can be used without power assistance (see Sidewinder section) is approximately 20 m. Hand augers are typically operated by investigators without assistance from IDP drillers, although IDP offers instruction on use of the augers to investigators before they deploy into the field, printed instruction manuals are packed with each auger kit, and a helpful instructional video is available at: https://icedrill.org/equipment/hand-auger-iddo.

Current Status

Hand augers are individually packed and assigned to investigators, depending on project needs. Drills are shipped directly to the investigators or to the field sites. IDP maintains eight copies of the 3-inch IDDO hand auger, three copies of the 4-inch IDDO hand auger, and nine copies of the SIPRE hand auger. IDP maintains one Kovacs Mark V kit (14 cm/5.5 in core) and approximately four Kovacs Mark II kits (9 cm/3.5 in core). Carbide cutter inserts are available for the 3-inch IDDO and SIPRE hand augers and have been used with success in blue ice areas such as the Allan Hills region of Antarctica and other sites where the ice is entrained with grit.

Technical Issues

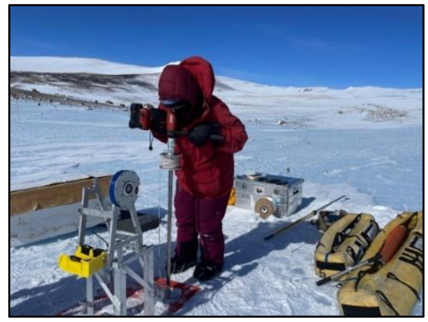
While ethanol can be used to free a stuck SIPRE or Kovacs hand auger, only glycol should be used with the IDDO hand augers, so as not to delaminate the flights. This is noted to users in the IDP Letters of Support, and noted in the Operations and Maintenance Manuals that accompany each drill into the field.

Plans

1. Maintain hand auger inventory – Ongoing.
2. Fabricate a core barrel to replace the one used with the new Prairie Dog – FY 2027.
3. Purchase new bags to replace aging inventory – FY 2027.
4. Fabricate additional carbide insert holders and inserts for the IDDO and SIPRE hand augers – FY 2027.

Sidewinder

Original Sidewinder



New Sidewinder

The Sidewinder is not a drill but is a drive/lifting system used in conjunction with the hand augers. It is driven by an electric motor (power hand drill) and a winching system to help in both lowering and retrieving the drill string. The power hand drill is also used to spin the hand auger barrel during drilling.

In 2024, IDP began deploying a new version of the Sidewinder known as the Sidewinder V2. The new Sidewinders use a Hilti battery-powered drill for operation, and are lighter weight and more user-friendly. The original Sidewinder units utilized a corded Milwaukee drill and required a generator and variac for operation. Those units are now being retired.

The Sidewinder extends the maximum practical depth of coring with a hand auger to about 30 m. The Sidewinders are typically operated by investigators without assistance from IDP equipment operators. Instruction on use of the Sidewinder is offered to investigators before they deploy to the field, an instruction manual is provided with the Sidewinder, and helpful instructional video can be found at: https://icedrill.org/equipment/sidewinder-power-drive.

Current Status

The new Sidewinder V2 was designed with the goal of mitigating safety risks posed by the original Sidewinder design, reducing transport weight, and optimizing operations. IDP currently has four units available and plans to fabricate additional kits as funds allow.

Technical Issues

Minor maintenance and upgrade tasks are being tracked and implemented for the new Sidewinder V2 units. Initial users of the new Sidewinders have noted some difficulty with installing the drill and spool into the tower. IDP plans to remake the 'telephone dial' portion of the tower with some helpful user feedback.

Plans

1. Maintain Sidewinder systems – Ongoing.
2. Purchase additional Hilti closeout cordless drills for future fabrication of additional Sidewinder kits – FY 2027.
3. Fabricate additional units of the new Sidewinder design – FY 2028 or as funds allow.

Prairie Dog

Prairie Dog system used with a Hand Auger

A modification of the hand auger, the Prairie Dog includes a stationary outer barrel that allows operation in solid ice as well as firn. The depth limit is approximately 30 m (with a Sidewinder). The system is commonly used in warm ice conditions where the two-barrel design aids in chip transport during coring. The system was used in both Wyoming and Montana in 2013 for ice patch coring and again near the Wyoming/Montana border in 2016 and 2018. The system is slated for use in Alaska and Wyoming in the summers for 2026 and 2027.

Current Status

The original system (Kyne and McConnell, 2007) utilizes a 4-Inch PICO Hand Auger. Many of the components are aging, but the drill system is complete and is ready for issue. In 2026, IDP is working to fabricate a newer version of the Prairie Dog that will utilize a simplified anti-torque design and a 3-Inch IDDO Hand Auger. This will allow the system to make use of the much newer inventory of IDDO Hand Auger cutter heads, cutters, core dogs, etc. Reducing the system from a 4-Inch to a 3-Inch model will also provide weight savings. The Prairie Dog is typically operated by one IDP equipment operator with assistance from the science team.

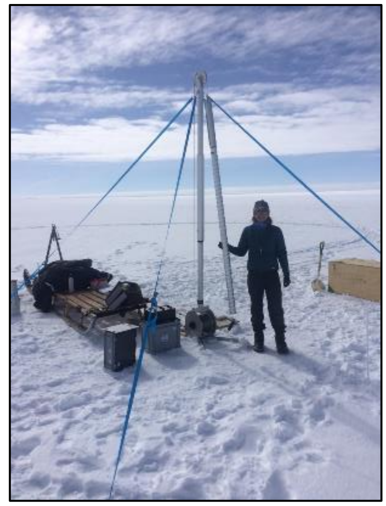
Technical Issues

None known, though parts of the system including the PICO Hand Auger equipment that is used with the original Prairie Dog are aging. IDP hopes to mitigate these issues with the new design.

Plans

1. General maintenance and modification – Ongoing as needed.
2. Complete fabrication of the Prairie Dog version 2 – FY 2026.

Stampfli Drill


Stampfli Drill

In 2015, community scientists identified the need for a lightweight coring drill, able to be transported by backpack. IDP researched commercially available systems and considered designing a new tool. In the end, a commercially available system called the Stampfli Drill was purchased from Icedrill.ch in Switzerland in 2016. IDP customized the order to include a winch with 100 m depth capability. To date, the deepest core retrieved with this drill is 58 m depth.

In 2017, IDP conducted preliminary field testing at Summit Station, Greenland. IDP subsequently completed minor maintenance, and procured spare parts and shipping cases for modularity and lightweight deployment. A lightweight Tentipi Safir tent was purchased for use with the system. IDP engineers designed and implemented steel cutter heads with removable cutters, as the manufacturer's design employed a one-piece aluminum head with cutters machined in. The system was deployed in 2018 in the Yukon Territory, Canada, where it was operated by the science team to collect one firn core to 10 m depth and another to 20 m depth. In 2019, a science team successfully collected a 50 m core from the summit plateau of Mt. Hunter in Denali National Park, Alaska. The drill can be operated with either solar panels or a gas engine. In 2021, IDP performed minor maintenance on the drill system, including replacement of a circuit board in the control box, re-termination of the cable, and procurement of field tools and spare brushes for the slip ring. In 2022, a new core barrel was procured to replace a warped barrel, the winch motor was tuned, and a cutter grinding fixture was designed.

In early 2026, NASA sent a surplus partial Stampfli Drill kit to IDP. One black pelican case with a basic Stampfli drill sonde was received, but this system does not have its own winch or tower included. The sonde design also differs slightly from the other Stampfli Drill originally purchased by IDP.

Current Status

The Stampfli Drill is ready for issue.

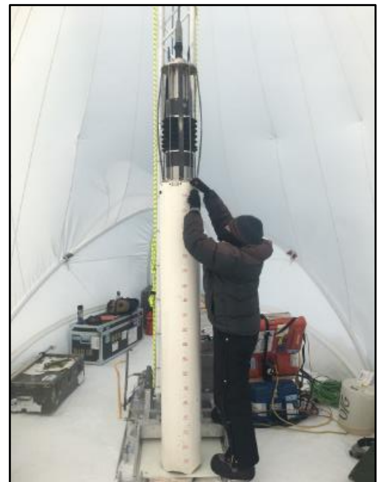
Technical Issues

In 2019, IDP sought to determine if the Stampfli Drill could be used to drill pilot holes in firn and ice, in advance of subglacial rock coring with the Winkie Drill. IDP tested Stampfli Drill operation in a prototype ice well near Madison, WI. Chip transport was found to be inefficient when drilling in solid ice. Future modifications to improve chip transport may include the addition of shoes with varying pitches and the addition of a ribbed outer barrel, though this would require wider kerf cutters and a taller tower.

Plans

1. General maintenance and modification – Ongoing as needed.

Blue Ice Drill (BID)



Blue Ice Drill

The Blue Ice Drill (BID) is an agile drill capable of retrieving cores of approximately 241 mm (9-1/2 inches) in diameter (Kuhl et al., 2014). The BID system was originally designed with a depth capability of 30 m, but was modified in 2014 in an attempt to collect cores to 200 m depth. A new cable winch and tower were implemented as well as new down-hole components. Depth capability is influenced by site/ice and firn depth characteristics.

Use of a MAST Tent (see Auxiliary Equipment section) has allowed operations to continue in poor weather conditions. Maintenance is conducted each year. In spring 2024, wiring in the winch control box was modified, greatly improving efficiency of operations in the field. Cutter holders and carbide inserts were designed, fabricated, and have been used with good success in the Allan Hills region of Antarctica. In FY 2024, IDP conducted a Blue Ice Core Quality Feasibility Study to evaluate long-term drilling approaches for retrieving high-quality ice cores in blue ice areas. IDP completed a report in January 2025 summarizing the findings of the study and worked with the community to formulate science requirements for a next-generation BOLD Drill (Borehole of Large Diameter).

Prior to the 2024-2025 Antarctic season, IDP added a load cell to the crown sheave to provide operators with more feedback and a penetration drive to allow for finer control. A steel core barrel was fabricated and tested but does not appear to improve core quality.

Current Status

The BID deploys regularly. Several components are aging beyond their useful life and are being replaced.

In FY 2026, IDP is working to complete the Conceptual Design of a new large-diameter ice coring drill. See the BOLD Drill section for more information.

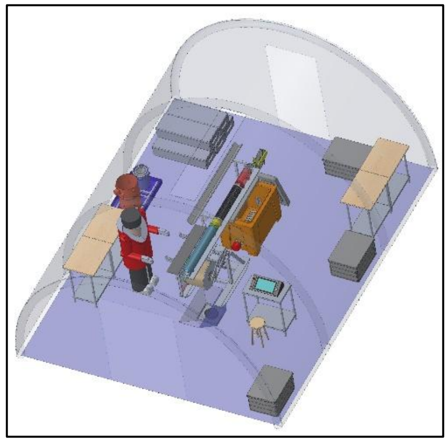
Technical Issues

Collecting good core quality at greater depths has proven to be an issue. The drill can easily drill through at least 80 m of firn, and deeper through another 70 m of solid ice. The drill has reached 187 m depth in Greenland, and 192 m in a firn-free area in Allan Hills, Antarctica. Site-specific ice properties such as firn depth, temperature, ice structure, contaminants in ice, as well as the large core diameter and/or mechanical aspects of the drill are all potential factors that may impact core quality.

Plans

1. Maintain the BID – Ongoing.
2. Rework/RFI spare components for the winch and sonde control boxes – FY 2027.

BOLD (Borehole of Large Diameter) Drill



Conceptual image of the BOLD Drill design

For over 15 years, IDP has regularly deployed the Blue Ice Drill (BID) for collecting large-diameter cores approximately 241 mm (9-1/2 inches) in diameter. The system has successfully collected large volumes of ice in both Greenland and Antarctica. For some projects, the large cores are melted onsite and only smaller canisters containing gas samples are returned to the U.S. for further study. If the cores are to be flown out, sizeable logistics are required as each ice core box can only hold one meter of BID core. Considering these logistics requirements, core quality degradation witnessed at certain sites/depths, and as components of the BID are aging after regular, prolonged use, IDP is working to address a recommendation in the U.S. NSF Ice Drilling Program Long Range Science Plan by undertaking the Conceptual Design of a next-generation large-diameter ice coring drill. IDP refers to the new design as the Borehole of Large Diameter (BOLD) Drill.

In 2025 and 2026, IDP worked with community scientists to iterate on and establish science requirements for a new drill. In contrast to the BID, the BOLD Drill could be used with drilling fluid to improve core quality. Discussion of core diameter has focused on reducing logistical needs such as quantity of core boxes and amount of drilling fluid required. Basic requirements include the following:

- 400 m wet capable, electromechanical cable-suspended drill
- 6-3/8” [162 mm] core diameter, 1 m core length
- Tent setup viable at 18 knots
- Replicate core drilled within the tent
- 6,000 lbs. or less drill system weight

Current Status

In FY 2026, IDP is working to complete the Conceptual Design of the BOLD Drill. IDP Engineers are working to conduct in-house testing of new approaches such as utilizing a stationary inner barrel with a rotating outer barrel and implementing a pump to improve chip transport issues for the wet drilling configuration. Logistics and efficiency improvements are also front and center in the design process.

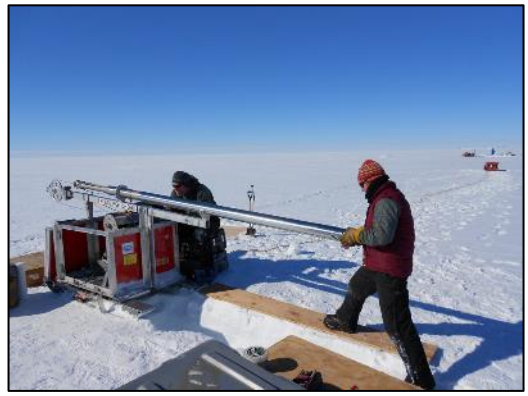
Technical Issues

Not applicable – System not yet developed.

Plans

1. Complete the BOLD Drill Conceptual Design – FY 2026.
2. Initiate and complete the BOLD Drill Detailed Design – FY 2027.
3. Build the BOLD Drill – Contingent upon NSF approval and provision of supplemental funding.

Eclipse Drill


Eclipse Drill

The IDP Eclipse Drills are modified Eclipse Drills originally manufactured by Icefield Instruments, Inc. The drill is an electromechanical system capable of collecting 81 mm (3.2-inch) diameter cores to depths of approximately 300 m. The drill system is transportable by small aircraft or helicopter. IDP has two Eclipse Drill systems that it regularly deploys.

In 2013, IDP designed and fabricated a solar and wind power system for use with the drill at a field site where use of a generator was not desirable/permitted. The solar/wind unit could benefit from updates and redesigned for lighter logistics. In 2017, IDP completed a redesign of the aging control boxes and readout boxes to provide simplified operation, weight reduction and new sealed cases. In 2018, new cover panels were implemented for the traversing system. New load pins and load pin amplifiers were implemented to make the load sense circuit more robust. In 2024, clearances were also opened up in the Gearhart-Owen cable bearing sections following some issues during the 2023-2024 field season. Beneficial updates have been made to the Operations and Maintenance Manual.

Current Status

Two Eclipse Drills are available for use. One is referred to as the 'standard' Eclipse Drill and the other as the 'traversing' Eclipse Drill, since it is sled mounted. IDP continues to research appropriate tents for use with the Eclipse Drills after experiencing stability issues during high winds with Mountain Hardwear Space Station tents and Axion inflatable tents (see Auxiliary Equipment section). New cover panels were again purchased for the traversing system in 2026, after they returned from Antarctica damaged, as well as fishing tools and cable grips. IDP also implemented new twist-style quick lock pins for the core barrel connection to ease surface operations. IDP is currently revisiting the readout box design and plans to re-anodize motor section components, mitigate GFCI issues and winch motor snow ingress issues, and purchase generators to avoid issues with the aging fleet of equipment in Antarctica.

Technical Issues

Following testing of a Gearhart-Owen (GOI) cable connection on one of the Eclipse Drills, and subsequent loss and recovery of the sonde downhole during a project at Summit Station, Greenland, in 2024, both Eclipse Drills have been returned to an Evergrip cable termination.

Plans

1. General maintenance and repairs – Ongoing.
2. Re-anodize motor sections – FY 2027.
3. Purchase generators – FY 2027.

4-Inch Drill

The 4-Inch Drill is an electromechanical ice coring drill that takes a 104 mm (4-inch) diameter core. Cores can be retrieved to depths of approximately 400 m. Winches with 100, 200, and 400 m cables are available. The drill is of a mature design and has been used successfully for decades. It is particularly useful on projects requiring a larger diameter core than that produced by the Eclipse or Foro 400 drills. The drill can be transported by light aircraft or helicopter.


4-Inch Drill; photo credit Alexander Ihle, University of Rochester

A chips bailer was designed, fabricated and is available for use with the 4-Inch Drill system for clearing cuttings from pilot holes drilled by ASIG Drill augers. In late 2020, new winch crates were implemented, and the readout and control boxes were re-calibrated.

The 4-Inch Drill was most recently used in northwest Greenland in 2023 with the GreenDrill project for drilling pilot holes and for bailing fluid from the ASIG Drill holes, as well as for ice coring at Dome Concordia in Antarctica during the 2024-2025 season.

Current Status

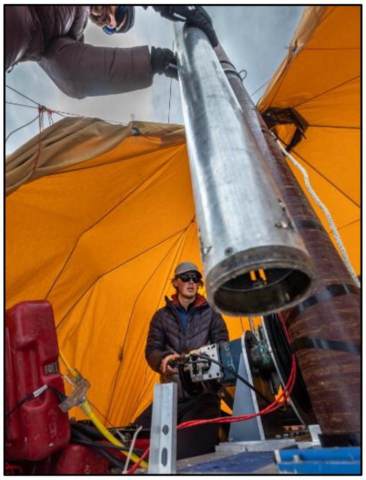
IDP currently has two 4-Inch Drill systems ready for issue. To meet continued demand for a drill of this type, IDP designed and fabricated a drill known as the Foro 400 Drill (see Foro 400 section). A 4-Inch Drill system will still be maintained. However, the Foro 400 Drill offers new capabilities and substantial weight savings, albeit with a slightly smaller (3.9-inch, 98 mm) diameter core.

Technical Issues

The current 4-Inch Drills are repaired as needed, however, the systems are aging. In some cases, replacement parts may no longer be available. The cable winch sleds are very heavy, making the drill not optimal for transport by small aircraft. Improvements to the instrumentation and control system for the drill have also been noted as desirable to improve reliability and to reduce weight. All of these considerations were taken into account with regard to the Foro 400 Drill design.

Plans

1. Perform general maintenance and repairs – Ongoing.
2. Maintain at least one each of the 100, 200, and 400-meter winches – Ongoing.


Electrothermal Drill

Electrothermal Drill

The Electrothermal Drill (aka Thermal Drill) melts an annulus around the ice cores it collects. It can be substituted for the 4-Inch Drill sonde, using the same winch system, for use in ice warmer than about minus 10°C. The drill collects an 86 mm (3.4 inch) core and has been used to drill to nearly 300 m. The sonde is particularly useful in ice close to the pressure melting point, where electromechanical drills are at risk of getting stuck. At the request of the science community, IDP pursued upgrades in 2018 to allow for coring to 300 m. New heat rings, a new 300 m water-shedding cable, a magnetic tool to aid in core removal, and an ethanol deployment system were implemented. In 2021, a new debris vacuum was implemented to remove debris from the borehole that might impede melting and forward progress. In 2022, a second aluminum sonde was fabricated to replace the heavier steel barrel. The Thermal Drill has performed well in Alaska, British Columbia, southeastern Greenland, and Peru. In 2019, the drill was tested to 300 m depth in Alaska in conjunction with the Juneau Icefield Research Program (JIRP). The drill was used in 2022 to drill 128 m to bedrock at a high-altitude site on the Quelccaya Ice Cap in Peru, and was used on Mt. Waddington in British Columbia in 2023 to 219 m depth.

Current Status

IDP has one Thermal Drill ready for issue.

Technical Issues

In 2025, a safety risk was identified with the heat rings. IDP engineers investigated options to mitigate this risk, including purchasing a new cable or dedicating a conductor in the current cable for ground, which would result in slightly slower penetration rates. The 4-Inch Drill winch sleds used with the Thermal Drill are very heavy, making the drill not optimal for transport by small aircraft. The Thermal Drill sonde should eventually be made compatible with the Foro 400 Drill or Eclipse Drills to allow for weight savings and better drill control and usability.

Plans

1. Perform maintenance and repairs – As needed.
2. Dedicate a conductor in the cable for ground – FY 2027.
3. Redesign and procure new core dogs – FY 2027.
4. Upgrade for weight reduction and compatibility with the Foro 400 Drill or Eclipse Drill systems – Contingent upon available budget and NSF approval; will be completed as community priorities dictate.

Foro 400 Drill

Foro 400 Drill

Design of the Foro 400 Drill was initiated in 2015 based on driller feedback with the aging 4-Inch Drill, and to utilize more recent and proven designs from other IDP drill systems. The design is largely based on the current 4-Inch Drill equipment but offers generous weight savings. The Foro Drill produces a 98 mm (3.9-inch) diameter core, the same as IDP's Foro 1650 Drill (Intermediate Depth Drill) and Foro 3000 Drill. In addition, the Foro 400 sonde design is submersible and watertight. However, the barrel assemblies are only suitable for dry drilling. Using a common sonde design across several drills spreads design costs over multiple projects, strengthens component availability, and reduces future maintenance costs. The system was deployed to Antarctica for its first field project during the 2019-2020 field season at Allan Hills, Antarctica. In 2023, IDP purchased new aluminum outer tubes to replace the fiberglass tubes, as it was surmised the fiberglass was creating heat, resulting in chip transport issues and poor core quality starting at depths as shallow as 150 m. The new barrels were tested at Summit Station in summer 2024. A new truss tower was also designed and implemented to make system assembly easier and safer by increasing the load capacity for use with the MAST Tent. In 2025, IDP implemented and successfully tested a safer, easier method of raising and lowering the truss tower.

The system was used on Tunu Glacier in Greenland in spring 2022, at Allan Hills during the 2022-2023 Antarctic field season, and on Canisteo Peninsula during the 2023-2024 field season. In 2024, IDP conducted beneficial hands-on training for several IDP team members at Summit Station in conjunction with a funded field project nearby.

Current Status

IDP has one Foro 400 Drill ready for issue.

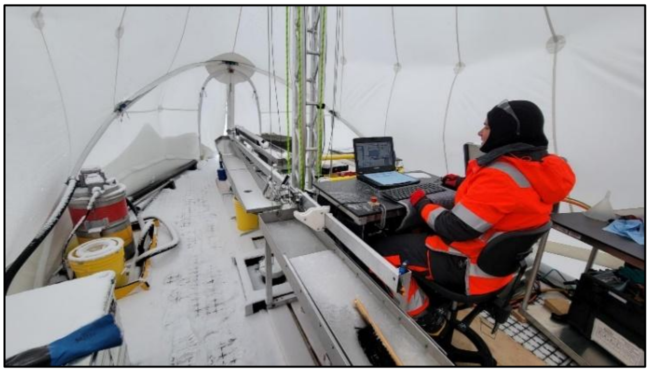
Technical Issues

Operators have noted several challenges with chip transport. IDP has tested different barrel materials, coatings, and configurations (e.g. fiberglass, aluminum, NANOMYTE® coating), though chip transport issues were still seen across all barrel and cutter combinations. Further research is needed. In FY 2027, IDP plans to adapt a 4-Inch Drill barrel set to fit the Foro 400 Drill motor section. This could provide for a larger core diameter option, and eventual field testing would determine if the 4-Inch Drill barrels transport chips better than the Foro 400 barrel geometry.

Plans

1. Perform maintenance and repairs – As needed.
2. Adapt a 4-Inch Drill barrel set to fit the Foro 400 Drill motor section. – FY 2027.

700 Drill



700 Drill

Per recommended technology investments in a previous version of the Long Range Science Plan, a mid-range drill (700 m) was desired for use in remote areas such as mountain glaciers in the Arctic. Science Requirements were completed in March 2018 for a drill originally referred to as the Foro 700 Drill, as the idea was to utilize the current sonde design of the Foro 400, 1650 and 3000 Drills. IDP subsequently completed a Conceptual Overview of the system, and a conceptual design review was held in August 2019 with members of the science community. IDP also completed an analysis of the quantity of drill fluid and ice core boxes needed. Following further consultation, the IDP Science Requirements were updated based on an even smaller-diameter core than that produced by the Foro Drills or the Eclipse Drills, in an effort to reduce the logistical burden related to the amounts of drilling fluid and core boxes required. The final IDP Science Requirements, finalized in January 2021, identified a core diameter of 70 mm, with the drill to be designed in a way that would allow for collection of 64 mm diameter core with only minor adaptation. IDP subsequently updated the Conceptual Overview for the drill, now referred to as the 700 Drill. Following further reviews by the science community and approval from NSF, IDP completed the Detailed Design and construction of the 700 Drill.

Current Status

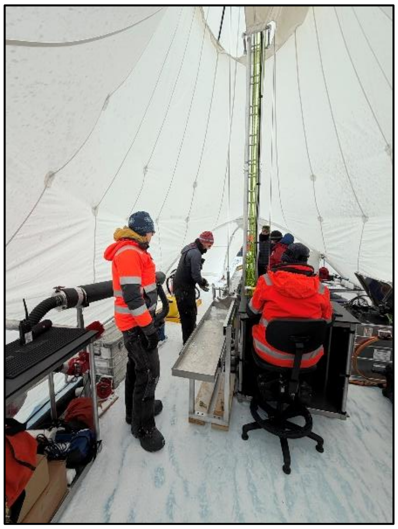
The 700 Drill was used for a funded science project at Summit Station in summer 2024. Portions of the system were used with components from other drills during the 2025-2026 Antarctic field season at Allan Hills as proof-of-concept testing for wet shallow drilling. Repairs, maintenance, and upgrades are being made following those two deployments. An Operations and Maintenance Manual was completed and released in 2025.

Technical Issues

As with any new drill system, several issues with the equipment and its performance were documented in the 2024 End-of-Season Report. Modifications and repairs were made to the console screen, the core processing tray, anti-torque blade adjustment, etc. Further modifications and repairs are planned for FY 2027 following the recent return of the drill from Antarctica, including building a new sonde clamp, implementation of an Evergrip termination, and work on the graphical user interface (GUI).

Plans

1. Complete necessary repairs, modifications, and upgrades – Ongoing.



Shallow Wet Drill components

Shallow Wet Drill

The Shallow Wet Drill is not a stand-alone drill system, but is a combination of equipment from existing drills as well as newly-designed components that were assembled for proof-of-concept testing to see if wet drilling could improve the quallity of core collected in the Allan Hills region of Antarctica. By largely using components from drills in inventory, IDP was able to expedite the fielding of shallow wet drilling capability and keep development costs low. The system utilized the winch, tower, control box, fluid handling components, tent, and generators from the 700 Drill. The motor sections, cutter heads, and chip bailer from the Foro 1650 Drill were used, along with an anti-torque section from the Foro 400 Drill. IDP designed and fabricated a 1-meter barrel set for wet coring and developed electronics for the sonde that are very similar in form and function to the new 700 Drill.

Current Status

Shallow wet drill testing at Allan Hills in 2025-2026 was completed successfully, with drill fluid dramatically improving core quality. All drilling equipment returned to IDP in spring 2026 and will be repaired, maintained, and modified. The equipment may again deploy to Allan Hills during the 2027-2028 Antarctic field season, however guaranteed shallow wet drilling beyond that time will require supplemental funding to IDP for fabrication of stand-alone Shallow Wet Drill system components.

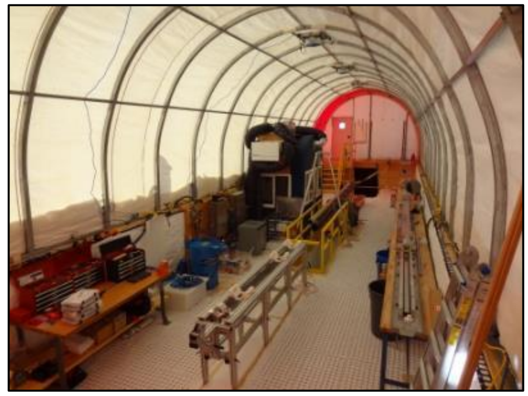
Technical Issues

A number of challenges were identified during the 2025-2026 testing and are outlined in the End-of-Season Report. Primary challenges that IDP is working to mitigate/resolve include, but are not limited to thermal issues on PCBs, graphical user interface (GUI) and control system issues, icing and galling of mechanical components, and chip melter capacity.

Plans

1. Complete necessary repairs, modifications, and upgrades to allow for potential use during the 2027-2028 Antarctic field season – Ongoing.
2. Fabricate stand-alone Shallow Wet Drill components – Contingent upon available budget and NSF approval; will be completed as community priorities and NSF approval dictate.

Foro 1650 Drill



Foro 1650 Drill

In 2014, IDP completed the design and fabrication of the Foro 1650 Drill, which retrieves 98 mm diameter ice cores (Johnson et al., 2014). With assistance from international colleagues, IDP modified the existing design of the Hans Tausen Drill and built a new system. The system was field-tested outside of Summit Station, Greenland, in spring 2014 and was used in the successful completion of the SPICEcore project near South Pole Station from 2014-2016, where a total of 1,751 m of core was collected (Johnson et al., 2021). The drill was originally designed to reach a depth of 1,500 m. Following a post-project analysis of the SPICEcore project, IDP set the cable limit for the winch drum at 1,700 m capacity, which allows for drilling to approximately 1,650 m depth. This maintains adequate safety margins for the drum flanges and mitigates the risk of damage should the level wind not spool the cable perfectly every time. While the system was originally called the Intermediate Depth Drill (IDD), the name was updated in 2019 to signify the shared sonde design of other IDP drill systems (e.g. Foro 400, Foro 3000). IDP also implemented new 4-conductor cables and beneficial sensors for temperature, pressure, and inclination.

Current Status

IDP is working to replace the console electronics for the Foro 1650 and Foro 3000 drill systems with a central controller to bring the systems more into line with the latest control system implemented in the 700 Drill. This will make the hardware of the Foro 3000 and Foro 1650 systems more interchangeable. It will also allow some reuse of 700 Drill control software, which is more stable than the current Foro 1650/3000 counterpart and will implement new features that improve operational efficiency. IDP is also working on powerline communications development for the Foro 1650/3000 drills. At the direction of NSF and the Antarctic Support Contractor, the Foro 1650 system was shipped to Port Hueneme, CA in November 2022 for transport to McMurdo Station on the resupply vessel. The majority of the drill, except for the control system and other do not freeze components, is currently stored in McMurdo and may be returned to IDP in 2027, as there are no longer any near-term plans to use it in Antarctica.

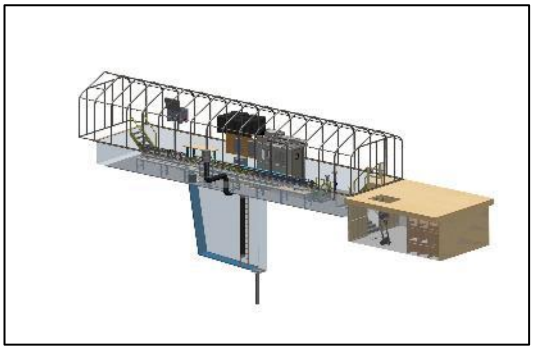
Technical Issues

Changes are being made to the electronics in 2026. In FY 2027, IDP plans to finish powerline communications development work and control system and console rework and testing.

Plans

1. Repair, maintain and upgrade the Foro 1650 Drill – Ongoing.
2. Complete electronics/powerline/control system/console development and upgrades – FY 2026 and FY 2027.

Foro 3000 Drill



Foro 3000 Drill

In 2016, IDP worked with Antarctic Support Contract (ASC) personnel to conduct an analysis of using the DISC Drill for the next U.S. deep ice coring project versus using an adaptation of the Foro 1650 for retrieval of 98 mm diameter ice core. In 2017, IDP completed a Conceptual Overview document for the Foro 3000 outlining necessary changes to the Foro 1650 to enable drilling to 3000 m. A Concept Review was held with community scientists and IDP also researched the adaptation of whipstock technology to allow for replicate coring on the downhill side of the borehole with the Foro 1650 or similar drills. IDP and ASC subsequently completed a DISC Drill vs. Foro 3000 Drill Analysis report in late 2017, which outlined the size and weight of each system, transport options for moving each system to a deep drill site, quantity of fuel and drilling fluid needed for each system, the number of IDP personnel and ASC camp staff required, and other logistical concerns. The Foro 3000 design offers a dramatic reduction in system weight when compared to the DISC Drill (120,000 lbs. versus 52,000 lbs.). The report helped inform NSF's and the science community's decision to move forward with fabrication of the Foro 3000 Drill. In 2024, IDP conducted an inventory of all tools contained within the MECC (Mobile Expandable Container Configuration) machine shop, a 20-foot shipping container with expandable wings that was used with the DISC Drill and will be used with the Foro 3000.

Current Status

IDP is working to replace the console electronics for the Foro 1650 and Foro 3000 drill systems with a central controller to bring the systems more into line with the latest control system implemented in the 700 Drill. This will make the hardware more interchangeable. It will also allow some reuse of 700 Drill control software, which is more stable than the current Foro 1650/3000 counterpart. In FY 2027, IDP plans to build up two motor sections and fabricate the chip bailer as well as a chip bailer head for the core barrel, as has been used with success with the Beyond EPICA project. The drill system is nearly ready for issue and is slated for use on the next U.S. deep drilling project at Hercules Dome, Antarctica.

Technical Issues

The Foro 3000 Drill is a relatively straightforward expansion of the Foro 1650 (currently in IDP inventory). The Foro 3000 Drill makes use of a majority of the Foro 1650 component designs.

Plans

1. Complete system fabrication and ready system for issue – FY 2027.
2. Complete the Conceptual Design for replicate coring with the Foro 1650/3000 – FY 2027.
3. Deploy the drill to Antarctica – Tentatively anticipated for fall 2027.

Agile Sub-Ice Geological (ASIG) Drill


Agile Sub-Ice Geological Drill

The Agile Sub-Ice Geological (ASIG) Drill is based on a commercially available minerals exploration rig, which IDP adapted for drilling through ice and for ice coring. The system is designed to drill access holes through ice less than 700 m thick and subsequently collect bedrock cores from beneath glaciers (Kuhl et al., 2021). A minerals exploration rig was purchased from Multi-Power Products Ltd., and IDP designed auxiliary systems for fluid handling. The drill system was deployed to Pirrit Hills, Antarctica for the 2016-2017 field season where it was successfully used to drill through approximately 150 m of ice and collect 8 m of 39 mm (1.5-inch) diameter excellent quality rock core. Nearly 5 m of ice core was also collected near the ice-bedrock transition, but the core quality was poor. System maintenance was subsequently conducted, and an electronic pressure relief valve and a shaker table for separating ice chips and drill fluid were implemented. The system was most recently used in northwest Greenland in 2023 for the GreenDrill project, collecting 7.14 m of subglacial material, including 4.5 m of bedrock core from a 516 m deep borehole. IDP conducted post-season maintenance and upgrades, including the design and purchase of new full-face PDC bits, purchase of Kubota engine and rig spares, purchase of a manual level winder, and improvements to the shaker filtration table. To reduce downtime during inclement weather, the engines will be placed in a ventilated Arctic Oven tent, and an Eskimo tent was procured to keep drill rod and threads free of blowing snow.

Current Status

During return of the drill from Greenland in 2024, several components were inadvertently discarded by the NSF's Arctic logistics provider. IDP worked to replace the lost components and only the purchase of a replacement drill tent remains. The system is available for use on NSF-funded field projects.

Technical Issues

Despite implementation of an electronic pressure relief valve and no indication of an over-pressure occurrence, a hydro fracture occurred near the packer in May 2023 when drilling had reached approximately 400 m depth. Following the hydrofracture event, switching from reverse to normal circulation proved to work well for access hole drilling in ice with a full face PDC bit and will be the standard operating procedure going forward.

Plans

1. Replace the drill tent lost during return from Greenland – FY 2027.
2. Perform maintenance and repairs – As needed.

BASE (Basal Access and Subglacial Exploration) Drill

Basal Access and Subglacial Exploration (BASE) Drill

Through iterative discussion between IDP and science community members, it was determined that the subglacial rock coring drills in IDP inventory (see Winkie Drill and ASIG Drill sections) are not optimal logistically for retrieving cores from under 200 m of ice, which is an important depth for understanding the first two feet of estimated sea level rise from current melting of the Greenland Ice Sheet. The IDP Long Range Science Plan 2022-2032 prioritized acquisition of a drill rig with increased agility and safety for retrieving rock core from beneath 200 m of ice. IDP worked with community scientists and IDP engineers to develop the IDP Science Requirements for the BASE (Basal Access and Subglacial Exploration) Drill. With community enthusiasm and NSF support from both the Arctic and Antarctic sections, IDP was given approval in February 2022 to pursue the purchase of a 200 m rock coring rig. IDP worked closely with vendor Multi-Power Products Ltd. (MPP) as they modified one of their commercial rigs to meet IDP operational, polar and logistics requirements. In February 2024, two IDP engineers visited MPP in Kelowna, BC, Canada, to ensure all requirements and specifications had been met and received some operational training on the rig. The rig was subsequently shipped to IDP in March 2024. In FY 2025, IDP procured all downhole tooling.

Current Status

IDP is working to design and fabricate auxiliary systems and components for drilling through ice, similar to equipment used with the ASIG Drill, such as an electronic pressure relief valve and equipment for processing ice chips and drilling fluid. The system is expected to be ready for issue in late 2027.

Technical Issues

During initial assembly of the system in summer 2024, the two Danfoss hydraulic pumps were damaged from not having the case drain hoses connected properly. An assessment was made to determine the extent of the brass contamination in the hydraulic system. One of the pumps was repaired for use as a spare, and two new pumps were purchased. Further equipment malfunction/damage may develop from brass pieces distributed through other areas of the hydraulic system. IDP hopes to test the BASE Drill system in a local quarry prior to shipment for any field projects in the polar regions.

Plans

1. Complete system procurements (e.g. footing, fluid handling, specialty tooling, etc.) – FY 2027.
2. Specify and procure a drill tent – FY 2027.
3. Conduct drill system operational testing in a local quarry – FY 2027.
4. Continue system documentation (e.g. drawings, drafting of Operations Manual) – Ongoing.

Winkie Drill

Winkie Drill; photo credit Allie Balter-Kennedy, Columbia University

The Winkie Drill is a commercially-available rock coring system originally purchased by IDP in 2015. IDP has implemented upgrades to add ice augering and ice coring capabilities (Boeckmann et al., 2021). The system has a depth capability of approximately 120 m and creates ice and rock cores 33.4 mm (1.3-inch) in diameter. Modifications were subsequently made to accommodate a request for larger core diameter (71.7 mm) as well as replacement of the gas engine with an electric motor, for improved reliability and to allow for operation inside a tent. In 2018, IDP engineers incorporated modifications for use of the drill in areas where surface firn covers the ice and bedrock below. In 2020 and 2021, IDP built up a second Winkie Drill, referred to as Winkie 2, to meet funded field project demands. A new fluid chiller was designed and fabricated to mitigate warm temperatures and drilling challenges, and a slip-style foot clamp assembly was implemented to improve safety when tripping drill rod and casing into and out of the borehole. In 2023, an electronic pressure relief valve (PRV) was implemented to reduce the potential for a hydro fracture event while drilling through ice, and new core barrels and bits with greater clearances were implemented to help with cuttings and fluid transport in mixed media and clay.

Current Status

In FY 2027, IDP plans to conduct deferred maintenance on the Winkie Drill systems and procure additional downhole tooling and packers to standardize the two systems and ensure they are ready for issue. Both Winkie Drills are deployed regularly to the Arctic and Antarctic. An Eclipse Drill is currently sent with each system to drill pilot holes through firn.

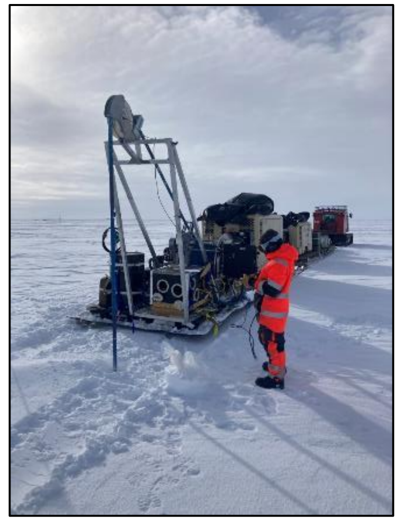
Technical Issues

Issues with drilling through thick layers of clay and unconsolidated debris have been experienced in both Greenland and Antarctica. This issue was discussed during biennial meetings of the IDP Technical Assistance Board and drag bits and tumbler media were procured in an attempt to drill through clay. A new core barrel and bits were purchased in 2024 to help clear and transport clay. The new components worked well, but their effectiveness may not prove the same at all locations/in all media. Drill performance details from various sites are contained in the End-of-Season Reports.

Plans

1. Repair, maintain and upgrade the Winkie Drill system(s) – Ongoing.
2. Procure a duplicate set of TT46 downhole tooling for Winkie 1 – FY 2027.
3. Purchase four new packers – FY 2027.

Rapid Air Movement (RAM) Drill



RAM 2 Drill

The Rapid Air Movement (RAM) Drill was developed for creating shot holes for seismic geophysical exploration. The system uses high-velocity air to drive rotating cutters and blow ice chips from the hole. The cutting drill motor hangs on a hose that carries the air from the surface and is reeled out as the hole deepens. The original RAM Drill was used three times in West Antarctica, where it routinely achieved depths of 90 m. The Askaryan Radio Array (ARA) project used the drill in 2010-2011 to test methods of producing holes for radio antennae at South Pole but could not get deeper than 63 m at that location.

In 2017, substantial modifications were made to reduce the system's logistical requirements, resulting in the RAM 2 system (Gibson et al., 2021). The modifications reduced the system weight and allowed for easier assembly and operations in remote areas. A field test was conducted near Raven Camp in Greenland in July 2018 and the drill was shipped to Antarctica in September 2018. The system was tested by two IDP personnel at WAIS Divide during the 2019-2020 field season where the drill routinely achieved between 50-55 m depth. Smaller RAM 2 compressors may eventually be optimized to provide the necessary airflow for deeper holes. During an abbreviated 2022-2023 Antarctic season, the RAM 2 Drill was used to drill 27 holes and operational data for the system was collected. The system was used again during the 2023-2024 season to drill 13 holes to a max depth of 45 m near WAIS Divide Camp. The system was to be used on Thwaites Glacier, but the PistenBully 100 provided by the logistics provider proved to be inadequate for towing the drill, and the Small Hot Water Drill was used in place of the RAM Drill.

Current Status

The RAM Drill returned to IDP in spring 2025 after extended seven-year storage and periodic use in Antarctica. System maintenance, particularly on the compressors, would be required prior to the drill's use on another field project.

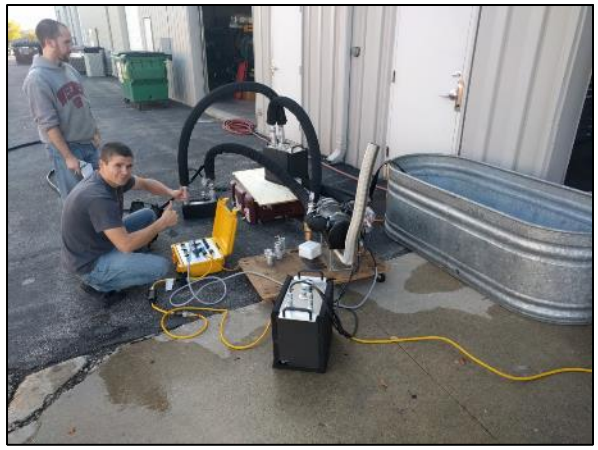
Technical Issues

Optimization of the compressors (small or large) and the hose and sonde are required to meet the revised science requirements for RAM 2. Even with the large compressors, the drill system is not reaching the 90 m depth range of the original RAM Drill. Further investigation is needed.

Plans

1. Continue work to address the need for more compressed air with modular units to meet the RAM 2 science requirements – Contingent upon available budget and NSF approval; will be completed as community priorities dictate.

Sediment Laden Lake Ice Drill (SLLID)


Sediment Laden Lake Ice Drill

Per recommended technology investments in a previous version of the Long Range Science Plan, IDP worked with representatives of the science community to finalize science requirements for a small, portable hot water drill system. The requirements were completed in 2015, and in 2016, IDP initiated the Conceptual Design of the system. In early 2017, the Detailed Design was completed and reviewed by community scientists as well as external technical personnel from the polar ice drilling community. Following a successful review in April 2017, IDP made minor adjustments to the design and iniated fabrication of the system. Basic requirements include a drilling speed of less than 30 minutes for a 5-inch hole through a 6 m ice cover. Drill components are small, lightweight and are able to be lifted by a maximum of two people. The drill has stand-alone capability for operation at remote sites with no heavy equipment and is intended to be operated by science teams. Components that allow for clean access drilling were also incorporated in the design. Fabrication, final assembly and in-house testing of the drill were completed in 2017. The system was deployed in the Dry Valleys of Antarctica during the 2018-2019 field season.

Current Status

Following use of the new system in 2018-2019, IDP solicited feedback from the science team who had operated the drill. The team noted several advantages of the SLLID system over the typical Hotsy/Jiffy Drill setup, including safer operation when starting holes to free cables and a substantially improved glycol heater. The team also provided beneficial recommendations needed to make the drill more agile, including less cumbersome fittings and hoses, new module support bracketry, a pump to accommodate pressure loss through smaller hoses and fittings and an IDP functional test on ice.

Technical Issues

A comprehensive account of the drill's performance is contained in PI feedback collected by IDP, teleconference notes, and in a project/task tracking list maintained by IDP.

Plans

1. Implement modifications to optimize performance and ease of use – Contingent upon available budget and NSF approval; will be completed as community priorities dictate.
2. Develop operating procedures and other procedural documents – Will be completed prior to shipment if the drill is slated for use.

Small Hot Water Drill

Small Hot Water Drill

The IDP Small Hot Water Drills (SHWD) use hot water to create shallow holes in ice. They are non-coring and are typically used to produce holes nominally 10 cm in diameter down to a maximum practical depth of 60 m. Primary use is for shot holes for seismic work, but they have also been used for access holes through a thin ice shelf. These drills are transportable by light aircraft and helicopter. Substantial modifications to the drills were made between 2014 and 2016, including refurbishment of the heaters and specification and procurement of new nozzle kits. Additional modifications and upgrades were made to the drills in 2017, and IDP built up a fully operational second unit. One of the two systems has a 30 m depth capability, and the second system has a depth capability to 60 m. Lightweight Siglin sleds and system covers for protection from the elements were implemented. Following upgrades to the system and upon review of user feedback, IDP now recommends that trained IDP operators deploy with each system. The system was tested in West Antarctica by two IDP personnel during the 2022-2023 field season and was subsequently used in support of a science project on Thwaites Glacier during the 2023-2024 field season where it was used to drill 32 holes to a depth of 50 m each.

Current Status

IDP has two small hot water drills in inventory, one with 30 m and one with 60 m depth capability. In 2024, IDP performed testing of one system in Madison, worked to troubleshoot issues with the heaters/thermostats, and documented the performance of heaters and other equipment. Burner controller mounting was made more secure and burner nozzles and pressure gauges were replaced. The Operations and Maintenance Manual was also updated. The second system returned to Madison in April 2025 after lengthy storage and use in Antarctica. Maintenance is conducted between field seasons as needed.

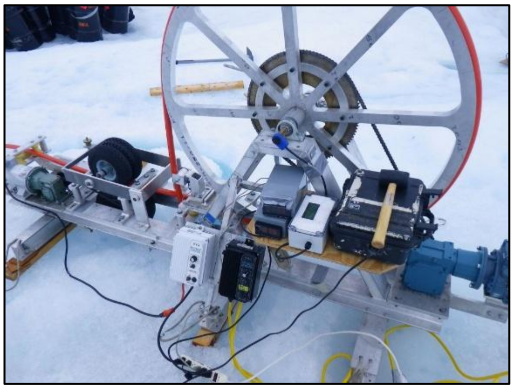
Technical Issues

Site specific ice and firn properties may affect depth capability. Issues with the burner controller were witnessed during system testing and characterization in 2024, but have largely been resolved.

Plans

1. Update documentation and operating procedures – As needed.
2. Perform maintenance and repairs – As needed.

Modular Hot Water Drill



900 m Modular Hot Water Drill sled and sheave

In 2025, PIs Neil Humphrey (University of Wyoming) and Joel Harper (University of Montana) shipped a hot water drilling system to IDP. Humphrey and Harper built the drill for use in Greenland and successfully operated the system for many years. The system is very modular with 1,000 m depth capability, but with hose sections in 100 m increments. Operation does not require a hose reel, though one could be designed and implemented. The equipment includes a capstan-drive drilling tower, two pumps, four heaters, a generator, two kilometers of ¾-inch Synflex hose, several hundreds of meters of ½ Synflex for shallower holes, and extensive supporting items such as manifolds, water tubs, sump pumps, etc. The drill has been used to drill 35 boreholes to the bed of the Greenland ice sheet, reaching depths as deep as 850 m in approximately 10 hours. Holes are nominally 10 cm in diameter. The drill was designed to be lightweight and hand-transportable by a small crew, and the system has been hand-carried up to 1 km over rough ice with six people. The drill is also configurable, with a stripped-down version used to drill 100+ m boreholes in firn.

Current Status

IDP received the drill in summer 2025. In fall 2025, Humphrey and Harper visited IDP in Madison to walk IDP engineers through assembly and discussion of the system. IDP is working with the PIs and with NSF to officially transfer the drill from the University of Wyoming to the inventory of Federally Owned Property (FOP) that IDP maintains on behalf of the NSF. In FY 2027, IDP engineers plan to assemble the system and determine which components need to be replaced prior to any future deployment of the system. A proposal has been submitted that would require use of the drill during the 2027-2028 Antarctic season.

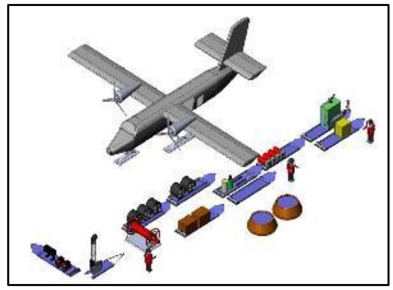
Technical Issues

With limited expertise in hot water drilling, IDP will rely on correspondence with Humphrey and Harper to navigate the maintenance, repair, and operation of this drill.

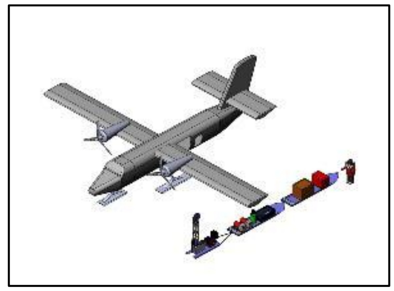
Plans

1. Assemble and assess the drill system – FY 2027.
2. Perform maintenance and repairs – FY 2027 or beyond.
3. Develop system documentation – As needed.

Scalable Hot Water Drill (ScHWD)



Scalable Hot Water Drill setup for 1000 m deployment



Scalable Hot Water Drill setup for shallow deployment

When an ice core is not needed, a hot water drill can provide fairly rapid access to the base of an ice sheet. Such a drill is particularly useful for drilling through an ice shelf, to enter the ocean beneath, or for creating holes for the installation of scientific instruments within the ice, and for seismic studies. IDP does not at present maintain a deep hot water access drill. Based on science requirements established in 2014, IDP developed a conceptual design for a modular hot water drill with flexibility to create holes of various sizes to depths between 50 and 1,000 m. This design is known as the Scalable Hot Water Drill (ScHWD).

In 2016, a joint proposal was submitted to the NSF by the University of Tennessee-Knoxville, Dartmouth College and the University of Wisconsin-Madison to fabricate the ScHWD system. That proposal was declined.

In May 2017, IDP initiated a conceptual design for a sanitation unit for use with the ScHWD, in accordance with the IDP Science Requirements developed in collaboration with science community representatives. Such a unit would allow for operation at field sites where environmental impact is of special concern. In September 2017, IDP engineers drafted a *Preliminary Evaluation of Hot Water Sanitation Unit for Application to Scalable Hot Water Drill (ScHWD)* report.

Current Status

Proposals to build a scalable hot water drill have been submitted to the NSF for consideration but have been declined. Design and fabrication of such a drill remains a high priority of the IDP Science Advisory Board, its Englacial-Subglacial Working Group, and community members.

Technical Issues

Not applicable; the system is not yet built.

Plans

1. Design and build a scalable hot water drill, possibly based on proven designs from the British Antarctic Survey and New Zealand programs – Will be pursued when NSF and community priorities converge; contingent upon NSF approval and supplemental funding to IDP.

Clean, Deep Hot Water Drilling Capability

At present, IDP does not maintain hot water drilling capability for clean drilling access, large-diameter holes, or for depths beyond approximately 1,000 m. The IDP Science Advisory Board and its Englacial-Subglacial Working Group have expressed interest for some time in developing a hot water drill for clean, intermediate or deep hot water drilling capability. Such hot water drilling systems have traditionally required substantial logistics.

Current Status

IDP is working to address recommendations in the U.S. NSF Ice Drilling Program Long Range Science Plan by undertaking a Hot Water Drill Analysis and Cost Estimate in FY 2026. IDP engineers have corresponded with international colleagues from the British Antarctic Survey (BAS) and in New Zealand, and have obtained and reviewed existing hot water drill designs developed and maintained by those groups. IDP is working on a cost estimate to determine what it might cost to build a replica of the BAS clean, deep hot water drill, as that drill was built several years ago and supplier availability and costs may differ in the U.S. By the end of July 2026, IDP plans to complete a brief summary report on this work. In FY 2027, IDP will expand on the costing exercise to include a basic conceptual design of the addition of an instrumented drill head. Further drill development may or may not be completed by IDP, depending on NSF funding and prioritization. IDP is making documentation available on our website for use by universities or other organizations who may acquire funding and wish to pursue detailed engineering design and construction.

Technical Issues

Not applicable; a system is not yet built.

Plans

1. Complete an analysis and updated cost estimate of the BAS Drill – FY 2026.
2. Conduct the Conceptual Design of an instrumented drill held for adaptation to the BAS Drill – FY 2027.

Rapid Access Ice Drill (RAID)

Rapid Access Ice Drill (RAID); photo credit RAID project UMD

The Rapid Access Ice Drill (RAID) is a University of Minnesota-Duluth (UMD) and University of California-San Diego (UCSD) project funded by the National Science Foundation. Design, fabrication, and initial test activities were completed by DOSECC Exploration Services, LLC (DES) in Utah. Subsequent test activities were managed directly by UMD and were carried out by Timberline Drilling Inc. IDP did not directly participate in the design or fabrication of the RAID, however, throughout the process of designing, building, and fielding the RAID, ASIG, and Winkie Drills, the RAID PIs, the DES and Timberline teams, and the IDP engineering and management teams developed a synergistic relationship of benefit to all. While the drill systems differ in scope, size and capability, they share many common characteristics. In March 2015, two IDP engineers and the IDP Program Manager participated and provided advice in the RAID North American Test (NAT) in Utah. Additionally, IDP and DES personnel jointly supported the RAID Auger & Packer Test conducted outside of McMurdo Station in February 2016. During the brief test, IDP and DES engineers worked collaboratively to successfully test both the RAID and ASIG Drill packer devices.

This collaborative relationship continued through deployment of the systems to Antarctica during the 2016-2017 field season, with each organization providing troubleshooting support to the other via phone. The RAID system completed its first Antarctic Field Trial (AFT-1) at Minna Bluff during the 2016-2017 field season. The system was successfully traversed to the Minna Bluff site, set up and operated. However, the firn-ice transition at the site proved to be over twice as deep as expected. This resulted in an insufficient length of augers onsite, and the team was unable to successfully set and seal the packer device. During the following 2017-2018 field season (AFT-2), an IDP engineer was onsite for related coring and logging projects nearby and was invited to view the RAID operations and testing. The RAID team made important progress in sealing the firn-ice transition but was ultimately unable to complete their objective to drill through 700 m of ice at the site and to collect bedrock core below, stemming from the creation of a larger amount of firn cuttings than anticipated, which overwhelmed the fluid circulation system. In early January 2019, an IDP engineer deployed to McMurdo Station to lead planned RAID maintenance efforts. The team of five set up the drill rig and completed modifications and test objectives including repair and testing of the hydraulic system, testing of the Fluid Recirculation System, documentation of operation and winterization procedures, installation and testing of new components, and deployment of a new conductor casing. In addition, the team developed procedural efficiencies to reduce rig set up and take down time.

The RAID system completed its third Antarctic Field Trial (AFT-3) at Minna Bluff during the 2019-2020 field season. UMD contracted with Timberline Drilling Inc. for primary operation of the drill system. The

IDP engineer who deployed for the previous maintenance season was again onsite to provide ice drilling expertise and general consultation. Three holes were drilled. The first and third holes were abandoned following hydro-fracture events (the second of which was planned in order to measure pressure at hydro fracture). Bedrock was reached successfully in the second hole, resulting in the first rock core collection using the RAID system. While several challenges were encountered during the season, 1 m of near-basal material was retrieved as well as 3 m of bedrock core from just below the ice-bedrock interface. A summary report of AFT-3 activities and results is provided by Goodge et al. (2021, *Annals of Glaciology*).

Current Status

Following the AFT-3, the RAID project obtained supplemental funding from the NSF to carry out further upgrades and maintain system readiness for future deployment. A subset of the drilling equipment, including the Fluid Recirculation System (FRS), was returned to the U.S. for maintenance and modification. Much of this work was conducted by Matrix Drilling Products in Lewisburg, TN. Upgrades and modifications to the FRS and related equipment include: (a) design and fabrication of a new fluid swivel and diverter; (b) design and installation of a new automation system; (c) refinement of the shaker; (d) upgrade to the glycol loop in the melting tank; (e) re-routing of hose lines and installation of sight glasses; (f) addition of a centrifugal pump for reverse-circulation drilling; (g) installation of a new door and partition between cold and warm rooms; (h) installation of new ventilation; (i) design and fabrication of improved ice-coring and rock-coring bits; and (j) acquisition of new firn augers. Matrix has completed a functional system test of the FRS and has designed a new drill sensor and driller's control interface. The refurbished FRS is currently stored at the Matrix facility in Tennessee awaiting approval for shipment to Antarctica. Through IDP's Continuing Award and with NSF approval, an IDP engineer familiar with the RAID system provides periodic advice, feedback and evaluation of engineering proposals. The IDP engineer also periodically travels to either Matrix Drilling Products or the University of Minnesota-Duluth to provide feedback on the modifications being made. Ultimately, the RAID team envisions drilling on the polar plateau in search of the oldest ice and bedrock samples. A second RAID Science Planning Workshop was held in Herndon, VA, on September 25-27, 2024. Principal outcomes of this science planning workshop are provided and future white papers will be available at the RAID project website: https://www.rapidaccessicedrill.org/2nd-raid-science-planning-workshop/.

Logging Winches

Intermediate Depth Logging Winch (IDLW)

Deep Logging Winch (DLW)

Following a SAB recommendation articulated in the U.S. NSF Ice Drilling Program Long Range Science Plan, IDP purchased and modified two logging winches and made them available for use by the science community. The first, the Intermediate Depth Logging Winch (IDLW), is very portable and is used for logging shallow and intermediate depth holes to 1,750 m. The IDLW has been used several times for logging the SPICEcore borehole at South Pole, and IDP engineers have implemented several user-recommended upgrades since those deployments. In 2023, a spare motor for the IDLW was purchased, received and wired. In 2026, IDP added an anchor point to the logging tripod used with the IDLW and tightened loose brake assembly components and reassembled them.

The second logging winch, the IDP Deep Logging Winch (DLW), is capable of logging to 4,000 m. The DLW was first deployed to WAIS Divide during the 2016-2017 Antarctic season for logging of the WDC06A borehole and later to Minna Bluff in support of RAID during the 2017-2018 field season. Repairs and upgrades for the DLW were implemented, including adjustment of the tension reading (calibration, noise, and oscillation), addition of a cable grip, and creation of a reference guide for operation of the LCI-90i display (tension settings, depth zeroing, field calibration). The winch, however, experienced communication issues because of electromagnetic interference (EMI). After several years of periodic investigation, two filters were installed and wired, slip ring contacts were cleaned, and the system was successfully tested with a portion of a dust logger originally used with the winch in Antarctica. The EMI issues were resolved and the winch is ready for issue.

USGS Logging Winch

In 2025, IDP engineers trained a number of UW Physical Sciences Lab and IceCube personnel on DLW operation. Instruction on how to clean the contacts in the slip ring was also provided. The DLW was deployed to South Pole Station during the 2025-2026 season, but was ultimately not used after IceCube drilling operations were cut short by equipment issues. The DLW was returned to IDP in spring 2026.

In 2026, IDP purchased lifting straps and cable grip terminations for the IDLW and DLW systems and wrote a procedure for using the provided cable grips to recover from a damaged cable. A procedure for replacing the encoder was also developed and added to the IDLW operations manual.

In 2014, the United States Geological Survey (USGS) gifted its 4,000 m logging winch (Clow, 2008) to the University of Wisconsin-Madison for continued use by the polar logging community. The winch was used extensively for logging boreholes in both Greenland and Antarctica and was last deployed during the 2014-2015 Antarctic season for logging at WAIS Divide.

Through consultation with the borehole logging community, IDP plans to require at least one IDP operator deploy with the systems, as equipment damage has been witnessed when a dedicated IDP operator did not deploy. When slow speed, multi-shift logging is required, IDP will work to train a member of the science team to assist with winch operation. Exceptions may be made if a non-IDP operator with good engineering credentials or experience operating similar equipment in the polar regions is identified, and is approved and trained by IDP.

Current Status

IDP periodically works with PIs to test communications and compatibility of their logging tools with the winches at the IDP facility in Madison, WI. Depending on the availability of funds and labor, IDP also plans to investigate the design or purchase of a rapid hole qualifier for borehole logging applications.

Technical Issues

The DLW experienced electromagnetic interference issues with several science team-provided logging tools when deployed to Antarctica. In late 2023 and early 2024, IDP engineers worked to set up a series of modems to recreate the issues seen in the field with the dust logger borehole tool operated by PI Ryan Bay. It was determined that the DLW slip ring was failing because the contacts were having issues. The contacts were cleaned, an output filter was added to the winch drive, and a line reactor was installed. Subsequent testing performed at IDP with both the modem test setup and with a portion of the actual dust logger confirmed the EMI issues have been resolved. IDP engineers also worked with scientists and engineers at UW-Madison, who have been involved in use of the dust logger at South Pole, to ensure the dust logger's LabVIEW program can communicate with the DLW's LCI-90i instrument display. During 2025 pre-shipment preparation, the DLW spare winch drive failed catastrophically during maintenance of the electrolytic capacitors. This component is now obsolete and is no longer available. Future deployments of this winch will incorporate a new drive and spare.

Comprehensive lists of technical issues and general recommendations for the IDLW and the DLW are contained in the End of Season Reports. IDP has not deployed the USGS winch since it was transferred to IDP. It would require maintenance prior to any future deployments.

Plans

1. Maintain the IDLW, the DLW and the USGS logging winch systems – Ongoing.
2. Identify a new DLW winch drive and spare – FY 2027.
3. Purchase and implement a new DLW winch drive – FY 2028 or when needed.
4. Investigate and design or purchase a rapid hole qualifier unit – FY 2027 or beyond.

AUXILIARY EQUIPMENT

Mast Anchored Suspended and Tensioned (MAST) Tent

Mast Anchored, Suspended & Tensioned (MAST) Tents

In 2018, IDP worked with Fabricon LLC in Missoula, MT, to design and fabricate a tent for use with IDP's Blue Ice Drill (BID). The tent was first deployed to Law Dome during the 2018-2019 Antarctic season and improves IDP's ability to continue operations during inclement weather. In 2019, PI John Higgins from Princeton University purchased a second tent of this design for use with IDP's Foro 400 Drill at Allan Hills, Antarctica. The tent was subsequently added to IDP's equipment inventory for use on future projects. A third tent was procured for use with the new 700 Drill. IDP refers to the tents as the MAST (Mast Anchored, Suspended & Tensioned) Tents. The MAST Tents can currently be used with the BID and Foro 400 systems, the 700 Drill, and was used during shallow wet drilling operations at Allan Hills in 2025-2026. Minor modifications to the 4-Inch Drill would make it compatible as well.

Axion Inflatable Tent

Following issues with the use of Mountain Hardwear Space Station tents in high winds, IDP researched alternative tent options and purchased a 6 x 6 m Axion low-pressure inflatable tent in 2023 from Zepelin USA. The manufacturer has tested the tent in winds up to 100 kph (62 mph or 53 knots). A 7 x 7 m tent was subsequently purchased to allow for more headroom for Winkie Drill operations. The tents are comprised of inflatable air beams, removeable sides, and red coloring along the beams for visibility in poor weather conditions and easy identification by aircraft. The 6 x 6 m tent functioned well in northeast Greenland in 2023 with the Winkie Drill and Eclipse Drills, but experienced issues when used at Allan Hills, Antarctica. Average wind speed and gust data will determine where the Axion tents will be most useful.

6 x 6 m Axion inflatable tent

NIXUS Inflatable Tents

IDP is currently working with representatives from manufacturer NIXUS to explore design and implementation of custom high-pressure inflatable tents for use with several drill systems (e.g. ASIG Drill, BASE Drill, BOLD Drill). IDP's drilling colleagues in Denmark and Canada deployed a NIXUS tent in northern Canada in 2025 with good success.

Sheerspeed windscreen

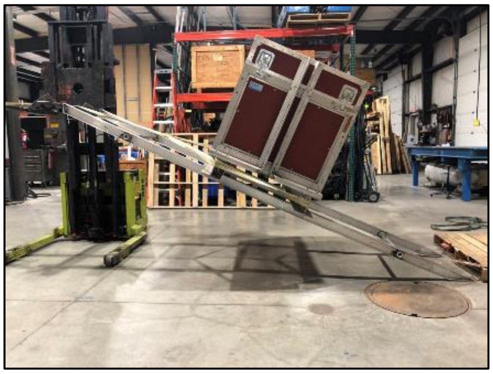
Windscreens

For projects where weather or project duration do not necessitate use of a drill tent, windscreens can help to shield operators and equipment from the wind. In 2023, IDP purchased four three-panel windscreens from Sheerspeed Shelters Ltd. in the UK. IDP is currently working to fabricate more durable shipping bags to replace those provided by the manufacturer.

Cargo Ramps

In 2020, IDP worked to design a ramp for safer and easier loading and unloading of cargo at polar field sites. IDP consulted with Kenn Borek Air Ltd. to ensure the design would meet flight crew requirements and be easily adapted to Twin Otter and Basler aircraft. The ramp was assembled in early 2021 in Madison and preliminary load testing was conducted. The ramp was first deployed to the field for testing with the Tunu project in NE Greenland in spring 2022 and was used at Allan Hills during the 2022-2023 Antarctic season. Minor delamination (seen in photo at right) was repaired, and the ramp was used in Greenland with the GreenDrill project in spring 2023 and again at Allan Hills during the 2023-2024 and 2024-2025 field seasons.


Aircraft cargo ramp designed by IDP


New lightweight cargo ramp based on BAS design

In 2024, IDP designed and fabricated a simpler, lighter weight ramp based on the design of an aircraft ramp used by the British Antarctic Survey (BAS). The new ramp assembly is made of two long sections of aluminum I-beam with cross members. The ramp was tested in northeast Greenland in spring 2024 with the GreenDrill project and was used in Antarctica during the 2024-2025 and 2025-2026 field seasons.

SYSTEM DECOMMISSIONING

In instances where substantial operational or technical issues are identified with equipment or in cases where components have aged beyond their useful life or have been replaced by newer technology in the IDP inventory, IDP seeks NSF approval to decommission and retire the equipment. Equipment is either cannibalized and useful components kept for future testing and development efforts, or the systems are disposed of per the proper channels. IDP does, however, retain certain smaller components that might be of interest for Education and Outreach work.

Items Recently Decommissioned

Though not officially listed in the NSF-owned inventory of equipment maintained by IDP, the original Sidewinder kits are being disposed of in 2026. Many components in these kits have aged beyond their useful life, and this design has been replaced by the new Sidewinder V2 model, of which four kits are available. The Sidewinder V2 weighs less, is more user friendly, and utilizes battery-powered drills instead of relying on corded drills and a generator.

Items Slated for Decommissioning

IDP is working to pursue decommissioning of the DISC Drill system and its associated Replicate Coring components.

Deep Ice Sheet Coring (DISC) Drill

DISC Drill

The Deep Ice Sheet Coring (DISC) Drill is a tilting-tower electromechanical drill designed to take 122 mm (4.8-inch) diameter ice cores to a depth of 4,000 m (Shturmakov et al., 2014; Slawny et al., 2014). The drill recovers cores up to 3.5 m long per run. The drill was utilized for six production seasons at WAIS Divide, Antarctica, from 2007-2013 and completed the deepest U.S. ice core ever drilled at 3405 m depth. Replicate coring operations were also successfully completed onsite (see Replicate Coring section).

Current Status

In spring 2020, all remaining DISC Drill components were returned from Antarctica to Madison. In 2017, IDP worked with science community representatives to complete a DISC Drill vs. Foro 3000 (see Foro 3000 section) analysis, to help determine which system should be used for the next deep U.S. ice drilling project to tentatively occur at Hercules Dome, Antarctica. The community consensus was that IDP should pursue development of the Foro 3000 Drill, to decrease the logistical requirement of future deep drilling projects. As much of the functionality of this drill is being replaced by the new Foro 3000 Drill, IDP initiated a discussion with the science community in spring 2021 regarding decommissioning of the DISC Drill. A survey was also distributed to the science community in August 2021 to gauge interest in future use of the drill. Following these efforts and with the approval of the NSF, IDP will soon decommission the DISC Drill and remove it from inventory. The MECC (Mobile Expandable Container Configuration) machine shop would not be decommissioned as it is planned for use with the Foro 3000 Drill.

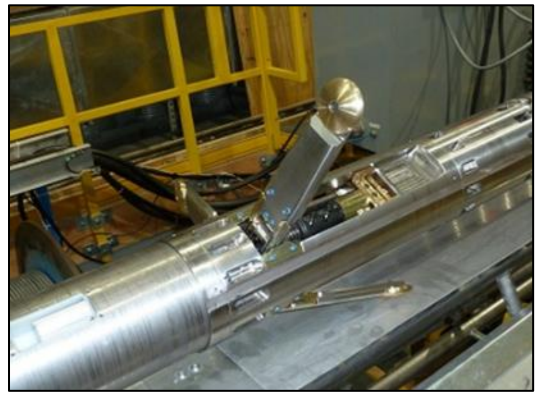
Technical Issues

The obsolescence and the resulting inability to source replacement components, particularly electronics, was an ongoing challenge throughout operation of the drill at WAIS Divide, though the project was successfully completed. Significant reductions in logistical requirements have been gained through transition to the Foro 3000 Drill for drilling deep ice cores.

Plans

1. Pursue decommissioning and removal of the DISC Drill from inventory – FY 2026 and FY 2027.

Replicate Coring



DISC Drill Replicate Coring components

Collecting a single deep ice core from a region makes verification of the validity and spatial representativeness of key results difficult. Furthermore, scientific demand for ice samples is unevenly distributed versus depth and the inventory of existing cores is being depleted in depth intervals of high scientific interest. The ability to obtain additional volumes of samples at selected intervals, termed replicate coring, addresses these concerns and adds value to the scientific return from ice coring.

The IDP replicate coring system for the DISC Drill (Gibson et al., 2014; Mortensen et al., 2014; Shturmakov et al., 2014) functions by tilting and forcing the sonde against the drill hole wall with 'actuators' that push against the wall upon command from the surface. This gradually deviates the drill out of the main borehole into the side wall and eventually into the new replicate hole. The replicate coring system was constructed in 2011. The system was tested at WAIS Divide, Antarctica, during the 2011-2012 field season (Johnson et al., 2014). No core was obtained, but using insight from that test, IDP engineers made modifications to the sonde and carried out further testing in Madison. During the 2012-2013 field season at WAIS Divide, the system produced five azimuth and depth-controlled deviations at four target depths. A total of 285 m of excellent quality replicate ice core was recovered.

At the urging of the science community, IDP engineers undertook evaluation of a less complex replicate coring method that might be applied with the Foro 1650 and Foro 3000 Drills. A *Replicate Coring System for 98mm Electromechanical Drill – Whipstock Conceptual Documentation* report was completed, describing a more passive replicate coring approach through implementation of a whipstock device like those used in the oil and gas industry. IDP believes this concept shows promise for successful implementation with future intermediate depth and deep drilling projects.

Current Status

The replicate coring-specific equipment of the DISC Drill system was returned to IDP in 2013. IDP is working to decommission the DISC Drill and Replicate Coring components and remove them from inventory.

Technical Issues

See DISC Drill section.

Plans

1. Pursue decommissioning and removal of the DISC Drill replicate coring components from inventory – FY 2026 and FY 2027.

Items Previously Decommissioned

The following equipment previously maintained by IDP on behalf of the NSF has been decommissioned and scrapped or cannibalized:

5.2-Inch Drill - In 2018, IDP received approval from the NSF to decommission the winch used with the 5.2-Inch Drill system. The winch was sold in an online auction in September 2020 by UW SWAP (Surplus With A Purpose). In March 2021, IDP received approval from the NSF to scrap/cannibalize the remaining components of the 5.2-Inch Drill. In June 2021, the remaining components were sold in a UW SWAP online auction.

2-Inch Drill - The 2-Inch Drill system was developed and manufactured by Glacier Data in Fairbanks, AK for rapid, near-surface core collection on the U.S. ITASE project. The maximum depth the drill reached is 42 m. A number of performance issues were noted with the drill. The system was last used in 2003. The system would have required extensive repair and/or redesign to be made into a useful tool. IDP decommissioned this system, as its function has now been replaced by the 2-inch Stampfli Drill system (see Stampfli Drill section).

Koci Drill - The Koci Drill, named after the late drill engineer Bruce Koci, was an electromechanical, single-barrel coring drill that was designed to operate in ice containing limited amounts of sand, silt and very small sedimentary rocks (Green et al., 2007). The drill sustained significant damage during its last deployment in 2009-2010. Community enthusiasm is now focused on sub-glacial rock coring. To that end, IDP purchased two shallow off-the-shelf rock coring drills (see Winkie Drill section) and has modified them to drill and core clean ice, mixed media and bedrock. The Koci Drill system has been retired as its function has now been replaced by the Winkie Drills.

Miscellaneous Equipment - A number of other stand-alone components, various tooling and support equipment have also been decommissioned.

- A 1000-gallon tank used at WAIS Divide with the DISC Drill system for drill fluid storage and transport was re-purposed in 2019 for fuel transport at a McMurdo Station airfield.
- Original RAM Drill hose reel and related components
- P05 cable spooler – Title transferred to the NSF-sponsored IceCube program at the University of Wisconsin-Madison, NSF Award #1719277
- Blue A-frame double girder gantry crane
- Qty. 3 Dell desktop computers
- DISC Drill control room (destroyed by a storm in McMurdo Station)
- Pengo cable tensioner

DRILLING FLUID


Drill fluid drums and a sled mounted storage tank used at WAIS Divide

With the phase-out and banning of the production of ozone-depleting substances such as chlorofluorocarbons, a good substitute for the two-part Isopar K and HCFC 141b drilling fluid used at WAIS Divide and on several European drilling projects was a necessity for the continuation of intermediate and deep coring projects. A few possible substitutes were identified: n-butyl acetate, dimethyl siloxane (silicone) oil, and an ESTISOL-COASOL mixture. Butyl acetate has been used by both the U.S. and the Japanese programs in the past, and is still used by the Chinese program, but because of the health risks associated with the chemical, IDP and the U.S. science community have decided not to use this fluid. ESTISOL-COASOL is routinely used by Danish drill projects in Greenland. The mixture has a disadvantage in that ESTISOL 240, a coconut extract, could compromise biological experiments because it is a nutrient. Silicone oils have been suggested as a possible ice drilling fluid but have not been used by the U.S. community, as the oils are difficult to remove from surfaces, are expensive, and may not be available in the required quantity. Both the silicone oils and the ESTISOL-COASOL mixture also have the major disadvantage of being significantly more viscous at low temperatures than fluids successfully used in the past. In 2013 and 2014, a drilling fluid emerged called ESTISOL 140, made by a company in Denmark. ESTISOL 140 is dense enough to balance the borehole without a densifier and also has only a modest increase in viscosity at temperatures as low as -55°C. ESTISOL 140 was used for testing of the Foro 1650 (IDD) in Greenland as well as for the SPICEcore drilling project completed at the South Pole Station. It was also used for shallow wet drilling at Allan Hills during the 2025-2026 field season and is slated to be used for planned drilling at Hercules Dome. ESTISOL 140 is also used with the RAID system. IDP uses Isopar K, without the addition of a densifier, for ASIG Drill and Winkie Drill deployments, as there has been no requirement that the holes need to remain open (i.e. hydrostatically balanced).

After IDP equipment operators experienced mild headaches, minor lung and throat irritation, skin irritation and other side effects when working with the ESTISOL 140 in Greenland, IDP and SSEC Quality Assurance & Safety personnel initiated an investigation into the fluid’s composition. IDP/SSEC worked with the manufacturer of the fluid, Esti Chem A/S in Denmark, on acquiring the latest Safety Data Sheet (SDS). The main ingredient in ESTISOL 140 is 2-ethylhexyl acetate, and evidence based on review of the Safety Data Sheet (SDS) suggests that this fluid has low toxicity. In addition, available literature on the fluid was reviewed by a UW Safety Chemical Hygiene Officer (CHO) and a University Health Services Industrial Hygienist (UHS IH). Additional improvements to Personal Protective Equipment (PPE) were recommended and implemented through the purchase of protective eyewear and new gloves and aprons to be worn over the drilling suits. These efforts primarily focused on reducing the amount of fluid that ends up on the equipment operators' work suits. Following the Greenland field test in 2014, IDP also made substantial modifications to the Foro 1650 ventilation system, including the addition of active ventilation components for the driller control room to ensure continuous air flow and to induce an air flow pattern that pulls room air down and away from the occupants' breathing area and workspace. The system uses an energy recovery ventilator (ERV) and two inline duct heaters to circulate enough air to replace the volume of air inside the control room every 67 seconds (53 times/hour). An Ion Science PhoCheck Tiger air monitoring sensor that had been shown to work down to -40°C was identified and procured for use with the ESTISOL 140.

Following improvements to the drill structure's ventilation system and to the available PPE, side effects from use of the fluid abated a bit but were still present during operations at the South Pole. IDP continued its discussions with UW Health & Safety personnel, the fluid manufacturer, and the equipment operators, but all sources indicate that while the fluid is an irritant, it is not toxic. A good replacement has not yet been identified, however, IDP continues to discuss this issue with its U.S. and international colleagues.

With deep (i.e. >1,000 m) drilling in very cold regions in East Antarctica likely in the future, IDP will continue to work with U.S. and international colleagues on cold temperature drilling fluids.

Current Status

While there are currently available drilling fluids, none are ideal for drilling at very cold sites. Several papers have been published about potential fluids and can be found on IDP's Icedrill.org website at: https://icedrill.org/library/drilling-fluids. While use of ESTISOL 140 is advantageous for maintaining the borehole, the fluid's strong odor and tendency to readily vaporize in warmer areas, such as the drilling control room and facilities used to dry driller clothing, prompts the continued search for alternative fluids. IDP remains in discussion with its working groups and international colleagues on this matter. In 2022, a representative from Battelle who is familiar with polar drilling operations, extended an offer to research potential drilling fluids. IDP engineers provided Battelle with information on desired specifications and previous fluids used to aid in Battelle's research. Research on new drilling fluids also continues in China, and scientists at the Colorado School of Mines are considering research in this area.

Technical Issues

Drilling fluids should, among other things, be non-hazardous, have low viscosity at very low temperatures, and not inhibit or complicate biological studies.

Plans

1. Continue correspondence with U.S. and international colleagues to investigate alternative drilling fluids – Ongoing.
2. Provide proper Personal Protective Equipment (PPE) for drill system deployments and operator safety – Ongoing.

RESPONSES TO TECHNOLOGY PRIORITIES FROM THE LONG RANGE SCIENCE PLAN 2026-2036

IDP notes the following guiding principles for development of drilling technology expressed in the NSF Ice Drilling Program Long Range Science Plan 2026-2036:

- Drill designs require that the supporting logistical needs are available and do not impede the planned execution of the field science. Current limitations with Antarctic logistics reinforce the desirability of having modular equipment that can be transported by small aircraft and that require few operators on site.
- While developing the science requirements, logistical issues such as weight, size, costs, and time for development, must be clearly defined and transparent at the initial stage of planning. Scientists and engineers working together through IDP must assess the impact of changes as they arise during the engineering design and fabrication process.
- Drills, major drilling subsystems, and accompanying technology must be developed with consideration of potential use in future projects. The drills and technology must be versatile and well documented so that they can be used, maintained, and repaired by other engineers.
- Major drilling systems (e.g. sondes, winches, control and other major electronics systems) should be fungible to the maximum extent possible. Major component interchangeability and logistical agility should be essential deliverables for all new drilling technology projects.
- Engineering design teams must include individuals with field experience using appropriate ice drilling technology and/or other relevant field experience.
- Heavy traversing capability is urgently needed to improve access to many scientifically important regions of the Antarctic and Greenland Ice Sheets, including heavy traverse capability that will enable larger drilling systems in both rotary and hot-water formats, heavy tractor capacity, and berthing facilities for personnel.

These principles have been and are being adhered to during IDP's development and maintenance/upgrade projects – most recently in the design and fabrication of Shallow Wet Drill components, the BASE Drill, the design of the BOLD Drill – and in iterations between IDP and community scientists in establishing new or updated Science Requirements for a variety of systems. IDP also works closely with both the Arctic and Antarctic logistics providers to ensure that ease in transport of IDP equipment and logistical support of IDP projects is achievable. Through IDP’s collaboration with the science community and IDP’s Science Advisory Board, IDP ensures that the drilling systems and technologies it develops will directly support the priorities outlined by the NSF and by the community. IDP has on staff project managers, engineers and field support personnel with extensive field experience. This allows for the pursuit of practical and polar-ready designs and equipment.

Recommended technology investments in the U.S. NSF Ice Drilling Program Long Range Science Plan 2026-2036

The IDP Science Advisory Board, the IDP working groups, and the broader polar science community have identified high-priority investments in drilling technology that are needed to achieve the science goals planned for the next decade (see pages 5-6). IDP works to plan its investments in technology within the time frames listed in the Long Range Science Plan. However, NSF ultimately determines the timelines for such investments. IDP's annual scope of work and schedule are influenced by several factors, including:

- Timing of funded and planned proposals
- Definition of science requirements
- State of the technology to meet the requirements
- Availability of personnel
- Availability of funding

The following are the recommended technology investments, as listed in the U.S. NSF Ice Drilling Program Long Range Science Plan 2026-2036, together with the corresponding IDP action taken or to be taken.

Priority 1 (needed this year):

1. *Maintain and upgrade agile equipment in inventory, including: Hand Augers, Sidewinders, the 700 Drill, the Foro 400 Drill, the FORO 1650 Drill, the 4" Electromechanical Drills, the 3" Electrothermal Drill, the 3.25" Eclipse Drills, the Stampfli Drill, Logging Winches, the Small Hot Water Drills (SHWD), the Blue Ice Drill, the Prairie Dog, the Agile Sub-Ice Geological Drill (ASIG), the Rapid Air Movement Drill (RAM) Drill, the Winkie Drill, the Chipmunk Drill, the existing 900 m Hot Water Drill, and the existing stand-alone components for use in shallow wet drilling.*

   IDP action: These systems will be maintained and upgraded as a high priority. This is a major focus of this Plan – see related content for each drill system in section 2.0 above as well as in other points of this section below.

2. *Investigate lighter weight sources of power and/or renewable energy technology to (partially) replace or offset generators for drilling systems and ease demand on logistics, with an emphasis on lightweight systems, and/or where practical.*

   IDP action: Two of the drills in IDP inventory, the Eclipse Drills and Stampfli Drill, currently have solar operation capability. It is possible those components could be adapted to run other equipment in the IDP inventory, though advancements in solar technology have come a long way since those components were designed in 2012. More recently, IDP conducted a brief analysis of lighter weight power sources and generator alternatives as part of the 700 Drill development. That analysis, conducted in 2021, found there was little decrease in power system weight with hybrid components (i.e. generator plus battery support) due to the low power density of cold-rated batteries and the need for inverters, charge controllers, etc. In FY 2027, IDP engineers will conduct additional research to see if any emerging technologies might be applicable for polar drilling applications. A summary report will be compiled and made available.

3. *Develop detailed engineering design and cost estimate for the BOLD Drill.*

   IDP action: In FY 2026, IDP is working to complete the Conceptual Design of the BOLD Drill. The preliminary design was reviewed by community scientists and external drilling experts in April 2026. With NSF approval of the IDP FY 2027 Program Plan, IDP plans to conduct the Detailed Design in FY 2027 (begins August 1, 2026). The Detailed Design would also be externally reviewed. Should NSF further approve fabrication of the BOLD Drill, long-lead components (e.g. cutter heads) may be ordered in FY 2027.

4. *If COLDEX Phase II is funded, initiate fabrication of the drill NSF approved for COLDEX.*

   IDP action: See number 3 above. Pending NSF approval and the provision of supplemental funding, IDP would either initiate fabrication of the BOLD Drill or equipment to make the shallow wet drill system a stand-alone drill.

5. *As the next steps to building a hot water drill for clean subglacial access (for drilling up to 3,000 m depth) that minimizes its logistical footprint including fuel supply (e.g. replica of the BAS/NZ deep hot water drill), develop the Conceptual Design and Detailed Engineering Design for a clean hot water drilling system.*

   IDP action: The current size of the IDP engineering team and the number of systems IDP is currently maintaining and/or developing likely preclude IDP from completing the Detailed Engineering Design or building of a deep hot water drilling system. In FY 2027, IDP plans to build on cost estimating work conducted in FY 2026, and round out a Conceptual Design document based largely on the existing BAS drill design but with the addition of an instrumented drill head. Building a hot water drill for such depths may require an MRI-level investment by NSF, which would involve a solicitation where proposers could compete for an award to build the drill. IDP would make Conceptual Design documentation available for another group to use in pursuit of a Detailed Design, but such efforts are currently not planned within IDP.

Priority 2 (needed in the next 3 years):

6. *Complete the Conceptual Design for Foro 1650/3000 replicate coring capability.*

   IDP action: In 2018, IDP completed an initial analysis of replicate coring methods suitable for an electromechanical drill. Summary of the research and a description of use of a whipstock device were outlined in a report titled Replicate Coring System for 98mm Electromechanical Drill –

Whipstock Conceptual Documentation. In FY 2027, IDP plans to revisit that paper and flesh out details for how to implement these concepts with the Foro 1650 and Foro 3000 Drills. The Detailed Design would be reviewed by science community members and external engineering experts.

7. *Develop the Detailed Design for a clean hot water basal ice coring sonde for a hot water drill that has the ability to integrate with other hot water drills or deep ice coring drills.*

   IDP action: In 2020, the University of Nebraska-Lincoln (UNL), under a subaward from IDP-Dartmouth, developed the Conceptual Design for such a hot water coring sonde. The Conceptual Design was reviewed, and several improvements were identified. Future fabrication will depend on NSF approval, supplemental funding, and may or may not be conducted by IDP.

8. *Develop a multi-optional Conceptual Design and cost estimate for a 4" stand-alone shallow wet drill (SWD). Options should include building a brand new SWD, complete the existing conceptual SWD configuration to a stand-alone drill, create a stand-alone fluid-capable version of the Foro 400 m drill, and others as IDP sees fit.*

   IDP action: IDP has reviewed the costs associated with building the 700 Drill and certain sonde components of the Foro series drills and has compiled a preliminary cost estimate to build a stand-alone Shallow Wet Drill. Such a system would essentially look the same as the equipment used during proof-of-concept shallow wet drilling at Allan Hills during the 2025-2026 season. That would likely be the most efficient approach versus designing a different (brand new) SWD. The existing Foro 400 Drill is a dry drill. The motor sections are water tight, but are not pressure rated and would require swapping in a rotary seal package like that used on the Foro 1650/3000 Drills, but it could be made into a wet drill with additional adaptations.

9. *Identify procurement source and cost for potential purchase of a rapid hole qualifier (temperature and caliper) to meet the scientific need in borehole access applications.*

   IDP action: IDP does not currently maintain any borehole logging tools within its inventory. In FY 2027, IDP plans to iterate with the community on science requirements for a rapid hole qualifier. Using those requirements, IDP will research commercially-available products as well as obtain and review hole qualifier designs from international colleagues, if possible. Estimated purchase and/or fabrication costs would be included in a summary report. Future purchase or fabrication will depend on NSF approval and may require supplemental funding.

10. *Complete the Detailed Design for replicate coring capability for the Foro 1650/3000 Drills.*

    IDP action: Following completion of the Conceptual Design (see number 6 above) and pending approval from the NSF, IDP engineers would complete the Detailed Design for replicate coring capability. IDP would then hold a design review with reviewers including community scientists and external engineering experts.

11. *Finish adapting a commercial drill rig for retrieving rock core from beneath 200 m of ice (BASE Drill).*

    IDP action: IDP is working to design and purchase and/or fabricate auxiliary systems and components such as a dampener for the water pump, the footing, fluid handling equipment, specialty tooling, and a drill tent. IDP also hopes to conduct an operational test of the BASE Drill system in FY 2027 in a local quarry in Wisconsin.

12. *Implement modifications needed for the 700 Drill to increase core quality, length, and production rate.*

    IDP action: Maintenance and modification tasks remain following the first use of the system in Greenland in 2024, and portions of the system were used with components from other drills to conduct proof-of-concept shallow wet drilling at Allan Hills during the 2025-2026 Antarctic field season. In FY 2027, IDP plans to build a new sonde clamp, continue development of the graphical user interface (GUI), complete deferred maintenance and upgrades to the sonde barrel and cutter head assembly, and implement an Evergrip cable termination update. The sonde items in particular are planned to attempt to consistently recover 1 m long cores per run while wet drilling.

13. *Develop the Conceptual Design for collecting a small amount (chips to several cm) of sub-ice rock/mixed media/mud in a frozen regime using an intermediate or deep ice core drill in a fluid filled hole, for example with the Foro 3000 Drill.*

    IDP action: IDP plans to iterate with community scientists on formulation of applicable Science Requirements. If approved by NSF in an IDP Annual Plan, IDP would then use that information to develop a Conceptual Design document for review by members of the science community, drilling engineers external to IDP, and the NSF.

14. *Establish Science Requirements for new drilling fluids for future ice and rock drilling projects, including clean ice core drilling (for biological and gas sampling) for future collaboration with international partners.*

    IDP action: Discussion on drilling fluid research and use is regularly included at the IDP Technical Assistance Board (TAB) Meetings and at other drilling community meetings. Consideration of fluid cost, availability, conductivity, viscosity, etc. remains part of the ongoing conversation. Related research papers are available at https://icedrill.org/library/drilling-fluids.

Priority 3 (needed in 3 to 5 years):

15. *Build a hot water drill for clean subglacial access drilling up to 3,000 m depth that minimizes its logistical footprint including fuel supply (e.g. replica of the BAS/NZ deep hot water drill).*

    IDP action: The current size of the IDP engineering team and the number of systems IDP is currently maintaining and/or developing likely preclude IDP from building a deep hot water drilling system. Building a hot water drill for such depths may require an MRI-level investment by NSF, which would involve a solicitation where proposers could compete for an award to build the drill. IDP would make Conceptual Design documentation available for another group to use in pursuit of a Detailed Design, but such efforts are currently not planned within IDP.

16. *Establish the IDP Science Requirements for identification and planning of borehole maintenance and fluid maintenance over time, including removing (or lowering) drilling fluid from a borehole (for example for freezing in a sensor).*

    IDP action: IDP will iterate with community scientists on formulation of the applicable Science Requirements.

17. *Continue investigation and modifications of the RAM 2 Drill to achieve the 100 m depth goal reflected in the system Science Requirements.*

    IDP action: Following IDP testing of the RAM 2 Drill components at Raven Camp, Greenland in summer 2018 and at WAIS Divide during the 2019-2020 field season, several component modifications were made. During abbreviated 2022-2023 and 2023-2024 Antarctic seasons, the RAM 2 sonde, winch, and tower were used with the larger compressors from the original RAM Drill for drilling near WAIS Divide Camp. Even with the large compressors, the drill was unable to reach the 80-90 m depth range achieved by the original RAM Drill. IDP intends to review a range of additional options, pending interest by the community in using the drill, approval from NSF to make additional modifications, and pending staff availability and funding.

18. *Establish the Science Requirements for retrieving sidewall ice samples at specific depths in an existing borehole without using an ice coring drill.*

    IDP action: IDP will iterate with community scientists on formulation of the applicable Science Requirements.

19. *Write a summary paper outlining the results from past attempts and the prognosis for future use of shallow drill fluid columns for ice coring.*

    IDP action: IDP discussed the practice of drilling with shallow drill fluid columns during the 8th International Ice Drill Symposium as well as at biennial Technical Assistance Board Meetings since that time. IDP's international colleagues have noted limited success in practice and have provided IDP with field data. There are limits to benefits of engineering analysis given the wide range of variables and unknowns with ice conditions. IDP conducted limited testing during the first use of the 700 Drill in Greenland in 2024, and additional testing during shallow wet drilling for the COLDEX project during the 2025-2026 season. At that Allan Hills site, IDP found that if the average fluid column height dropped below approximately 41% of the borehole depth, microcracking on the core surface started to exceed 2-3 mm depth. This may be a helpful benchmark for that location, but fluid column height requirements may vary and may be site dependent due to variations in glacial ice fabric and structure.

FIELD SUPPORT OF SCIENCE PROJECTS

IDP provides researchers with Letter of Support/Scope of Work (LOS/SOW) documents for inclusion in their proposals to the NSF. IDP field support generally consists of assisting PIs with planning field activities, providing equipment for the projects, and providing a field crew for the operation of the equipment.

Field projects are typically one to three seasons long and are usually defined only a year or two prior to their execution. Typically, during a fiscal year, IDP might have 8-12 projects being actively supported with half of them in the field and the other half in the planning/preparation phase of the project. A summary of planned and potential equipment assignments can be found in Appendix 1.

EXPENDITURES

The U.S. National Science Foundation Ice Drilling Program currently operates under a 5-year Continuing Grant with the NSF. The prime award is to Dartmouth College, with subawards to the University of New Hampshire and the University of Wisconsin. Annual budgets are estimated based on the proposal budgets tentatively approved by the NSF but are subject to annual negotiation. Funds are included in the Continuing Grant for sustaining a base level of engineering support, for specific existing NSF field projects where IDP was funded by NSF at the time the IDP award was made in August 2024, and for minimal maintenance, upgrade, and equipment development work. Appendix 2 outlines current development and maintenance and upgrade expenditures for FY 2026 (August 1, 2025 – July 31, 2026). Any newly proposed field projects requesting IDP support or equipment currently require approval and contribution of supplemental funds to IDP from the NSF Program Manager funding the field project. Such costs are generally transferred internally within NSF and IDP as supplemental funding and are not included in PI awards.

Annual expenditures for operations supporting field projects vary depending on the science projects funded by the NSF. Preparation and shipping of equipment for very simple projects typically only require IDP expenditures of $500-$5,000. Large or multi-year projects require substantially higher expenditures.

CUTTING EDGE TECHNOLOGY NEEDS

IDP is committed to continuous improvement and the streamlining of operations in the design of new equipment, the maintenance and upgrade of existing equipment, and the operation of drilling and logging equipment in the field. IDP routinely works to consider and evaluate cutting edge technologies that could minimize downtime and reduce component and system weights and footprints, fuel consumption and logistical requirements. The following are potential technology needs (in no priority order) that could have a positive impact on NSF-funded science programs if pursued.

1. Ice Well – A shallow, prototype ice well was established by IDP engineers near Madison, WI. A larger, deeper and easily accessible ice well would prove extremely valuable during the design and testing of equipment. This would help ensure designs are vetted and field deployments are successful.
2. Cold Room – Similar to an ice well, a cold room or freezer lab would prove invaluable for component testing. IDP conducts component testing in a chest freezer or process chiller, and occasionally rents a small, portable freezer unit when necessary. IDP plans to pursue the purchase of a walk-in freezer in FY 2027 to facilitate additional testing. In addition, the use of clear ice blocks combined with a high-speed camera would allow IDP to clearly evaluate cutter head geometry as well as any flexion in the drill barrels and heads. The addition of strain gauges and/or accelerometers with data acquisition would provide for even more comprehensive testing.
3. Composites – Further investigation and testing of the feasibility of using composites for chips chambers, core barrels, or structural components could expand design options and reduce drill system weight and cost.
4. Battery Power – With the new Sidewinder V2 design, battery-powered drills reduce the need for corded drills, generators, and fuel. Research into the application of onboard battery power for downhole equipment could reduce system complexity, cable diameter and weight of associated surface infrastructure. Battery powered augers could also be explored.
5. Wireless – Research into the feasibility of wireless communication between the surface and drill sondes could reduce system complexity.
6. Thermal Regulation – Research into the latest technology for implementation of thermal regulation for the IDP Thermal Drill could reduce burnout of heat rings and could also reduce the need for IDP operators to deploy with the system, thereby reducing field project logistics.
7. Rapid Access – Research into lightweight, mechanical rapid access drilling leveraging the latest technology developed by the British Antarctic Survey could prove beneficial for the U.S. science community.
8. Lasers – The use of lasers for extracting ice samples from borehole walls is being explored by the community. This technology could be implemented for coring, replicate coring, directional drilling, etc. in the future.

ACRONYMS

AFT	Antarctic Field Trial
ARA	Askaryan Radio Array
ASC	Antarctic Support Contract (Antarctic logistics provider)
ASIG	Agile Sub-Ice Geological (Drill)
BID	Blue Ice Drill
CHO	Chemical Hygiene Officer
DES	DOSECC Exploration Services, LLC
DISC	Deep Ice Sheet Coring (Drill)
DLW	Deep Logging Winch
EMI	Electromagnetic Interference
ERV	Energy Recovery Ventilator
FOP	Federally Owned Property
HCFC	Hydrochlorofluorocarbon
IDDO	Ice Drilling Design and Operations (now IDP-WI)
IDLW	Intermediate Depth Logging Winch
IDP-WI	Ice Drilling Program at the University of Wisconsin-Madison (formerly IDDO)
IH	Industrial Hygienist
IDD	Intermediate Depth Drill
ITASE	International Trans-Antarctic Scientific Expedition
MECC	Mobile Expandable Container Configuration
NSF	National Science Foundation
PI	Principal Investigator
PICO	Polar Ice Coring Office
PPE	Personal Protective Equipment
PRV	Pressure Relief Valve
RAID	Rapid Access Ice Drill
RAM	Rapid Air Movement (Drill)
SAB	Science Advisory Board
ScHWD	Scalable Hot Water Drill
SDS	Safety Data Sheet
SHWD	Small Hot Water Drill
SIPRE	Snow, Ice and Permafrost Research Establishment
SLLID	Sediment Laden Lake Ice Drill
SPICEcore	South Pole Ice Coring Project
SSEC	Space Science and Engineering Center at the University of Wisconsin-Madison
SWAP	UW Surplus With A Purpose (program)
TAB	Technical Assistance Board
UCSD	University of California-San Diego
UMD	University of Minnesota-Duluth
USGS	United States Geological Survey

WAIS West Antarctic Ice Sheet

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Appendix 1 – Long Range Project Schedule

View this table at: https://icedrill.org/equipment/availability

Legend:

Planned Field Project	
Proposed Field Project	
System In Development	
Planned Maintenance/Upgrade (Equipment Not Available)	
System Available	
System Not Available	

	FY 2027		FY 2028		FY 2029		FY 2030		FY 2031	
Equipment	**2026-2027 Antarctic**	**2027 Arctic**	**2027-2028 Antarctic**	**2028 Arctic**	**2028-2029 Antarctic**	**2029 Arctic**	**2029-2030 Antarctic**	**2030 Arctic**	**2030-2031 Antarctic**	**2031 Arctic**
700 m Drill										
900 m Hot Water Drill										
4-Inch Drill 1										
4-Inch Drill 2										
Agile Sub-Ice Geologic Drill										
BASE Drill										
Blue Ice Drill										
Chipmunk Drill										
Drill Fluid Development										
Eclipse 1 - Standard [1]			2 proposed							
Eclipse 2 - Traversing [1]										
Foro Drill - 400 m										
Foro 1650 Drill (Intermediate Depth Drill)										
Foro Drill - 3000 m										
Hot Water Corer	TBD									
Logging Tower										
Logging Winch - IDP Intermediate Depth										
Logging Winch - IDP Deep										
Logging Winch - USGS										
Prairie Dog										
Pressure Vessel										
Rapid Hole Qualifier	TBD									
RAM (Rapid Air Movement) 2 Drill										
Scalable Hot Water Drill	TBD									
Sediment Laden Lake Ice Drill										
Small Hot Water Drill - 1 (Red)										
Small Hot Water Drill - 2 (Blue)										
Shallow Wet Drill (shares components w/ other drills)										
Stampfli 2-Inch Drill [1]										
Thermal Drill 1										
Thermal Drill 2										
Winkie Drill 1										
Winkie Drill 2										
Original Sidewinder (5 available)										
New Sidewinder (4 available)		1funded, 1proposed	2 proposed	2 proposed	2 proposed	1proposed	1proposed		1proposed	
Hand Auger, 3" IDDO (8 in inventory)			2 proposed	1proposed	1funded, 2 proposed		1proposed		1proposed	
Hand Auger, 4" IDDO (3 in inventory)		1proposed		1proposed		1proposed				
Hand Auger, SIPRE (6 in inventory)		1funded								
Hand Auger, 9 cm Kovacs Mark II (2 in inventory)										
Hand Auger, 14 cm Kovacs Mark V (1 in inventory)										

[1] Solar/wind power capabilities available.

Appendix 2 – FY 2026 Budgets for Development and Maintenance & Upgrade Work

Development or Maintenance & Upgrade Project	FY 2026 [3]
700 m Drill	$ 106,000
4-Inch Drill	$ 10,000
ASIG Drill	$ -
Badger-Eclipse Drill	$ 132,000
BASE Drill (Basal Access and Subglacial Exploration) [1]	$ 31,000
Blue Ice Drill	$ 84,000
BOLD (Borehole of Large Diameter) Drill Conceptual Design	$ 106,000
Foro 400 Drill	$ 34,000
Foro 1650 Drill	$ 105,000
Foro 3000 Drill	$ 95,000
Hand Augers	$ 139,000
Hot Water Drill Analysis & Cost Estimate	$ 80,000
Logging Winches	$ 16,000
RAM Drill	$ -
Shallow Wet Drill	$ 160,000
Small Hot Water Drills	$ -
Stampfli Drill	$ -
Thermal Drill	$ 18,000
Winkie Drill	$ 42,000
TOTAL COSTS	**1,158,000**

[1] Commercial rig purchased and received in March 2024; IDP is designing and fabricating auxiliary subsystems for drilling in the polar regions.

[2] IDP does not have a stand-alone Shallow Wet Drill. Proof-of-concept drilling during the 2025-2026 field season required components from the 700 Drill and the Foro series drills in IDP inventory for operation.

[3] Budgets reflect baseline FY 2026 project budgets set in August 2025.

Equipment Development	(blue)
Maintenance & Upgrade	(green)