IPD SCIENCE ADVISORY BOARD

BOREHOLE LOGGING (ACCESS?) WORKING GROUP

OVERARCHING GOALS FOR BLWG

- Provide input to IDPO long term planning.
- Provide annual input to the Long Range Science Plan
- Establish logging protocols and norms for determination of field readiness for new borehole logging instruments
- Contribute/communicate community needs and scientific basis for borehole preservation to NSF and IDP
- Review status of and make suggestions for available community logging tools and winches (whether owned by IDP or by PIs) and make sure the community is aware of what is available.
- Engage in discussion with members of other working groups to propagate information, to learn about activities of other groups, and to foster coordination between the working groups.
- The BLWG members are from the broad range of scientists who deploy borehole logging instruments in glaciers and ice sheets for scientific investigations.

WHO'S INVOLVED?

Chair: Erin Pettit, Oregon State
Sridhar Anandakrishnan, PSU
Ryan Bay, Berkeley
Gary Clow, UC Boulder
Paolo Gabrielli, Ohio State
Jason Gulley, USF
Bob Hawley, Dartmouth
Lora Koenig, NSIDC

Jeff Severinghaus, SIO
Joey Talghader, U Minnesota
Don Voigt, PSU (retired)
Ed Waddington, UW
Trevor Williams, LDEO

Potential new members:
Michael McCarthy, UW
Jordan Beckler, FAU
Merlin Mah, U Minnesota

WHAT CAN BOREHOLE LOGGING/ACCESS PROVIDE:

Recent activities

SPICEcore/RAID logging in Jan 2020

Ice Cube Meeting in Jan 2021

Upcoming drilling/discussions

RAID, Here Dome, COLDEX

Targets? Hand-me-downs

Temperature

Deformation

Ice properties

- Crystal fabric,
- Dust,
- Chemistry
- Optical and acoustic properties

Deformation

Borehole shape

Access for deploying sensors to freeze in (fiber for DAS)
or for broader ice studies (e.g. borehole seismometers)

Note: different tools have different borehole size/type requirements

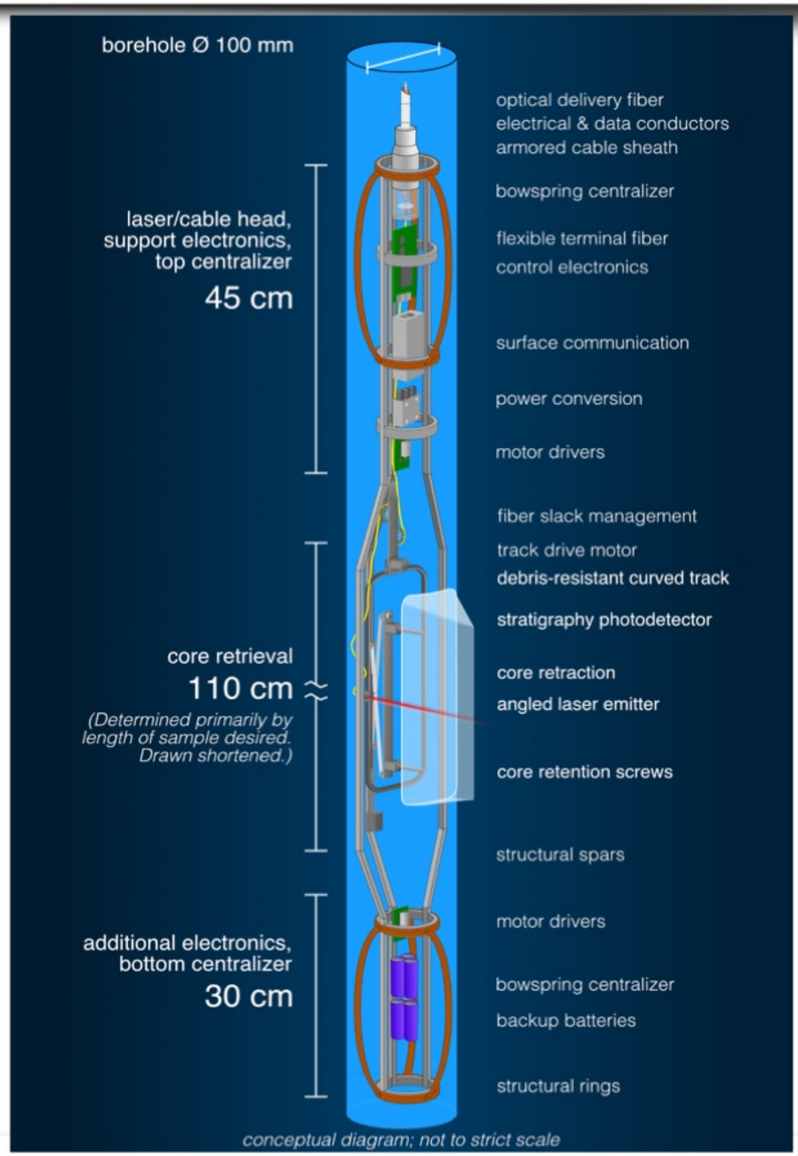
RELIC: Robotics-Enhanced Laser Ice Collection

RELIC
Robotics-Enhanced Laser Ice Collection
and Other BLWG-related Interests

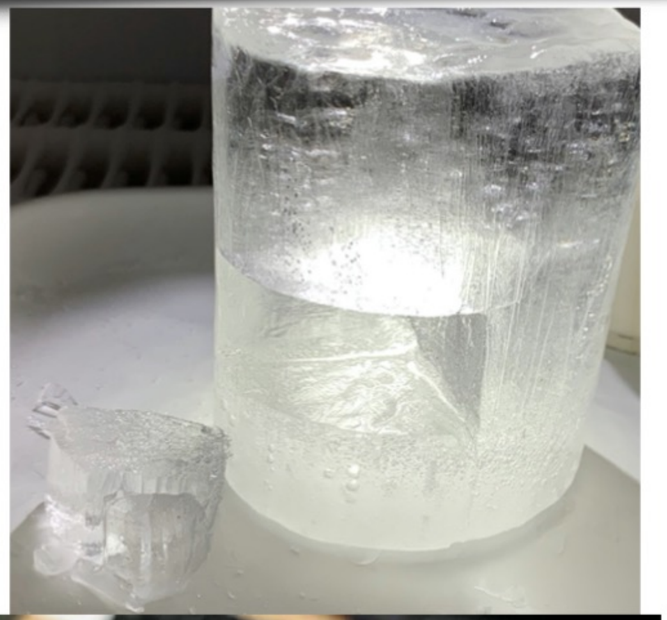
Joseph Talghader
Merlin Mah
Andrei Kurbatov

University of Minnesota · OMEMS · Climate Change Institute · NSF

- Logging instrument, using optical fiber to convey 1kW-class laser light, cuts a meter-scale section of ice from any desired depth of a borehole and returns it to the surface
- Laser and all high power electronics remain at surface
- Can collect samples from non-coring drill holes or existing older boreholes



Demonstrations and Applications



- Targets of Opportunity: Discoveries of objects or features where a large drilling program is impractical, e.g. two impact craters recently found in Northwestern Greenland

- Replicate sections from critical, missing, or damaged sections of previous drilling, e.g. Siple Dome 673m, idea courtesy J. Severinghaus).

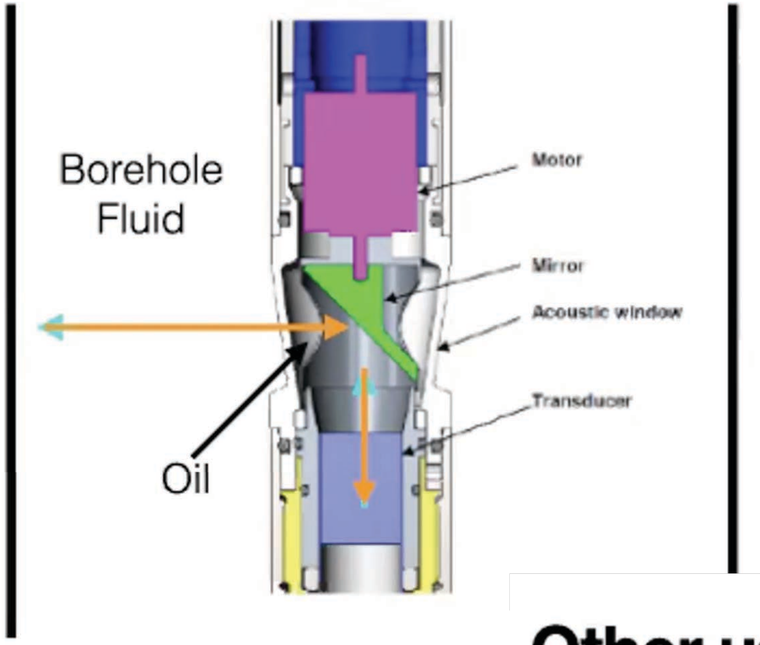
- Projects where one or more non-continuous sections at different depths are needed, e.g. Metagenomics across glacial transitions or ice core archeology of specific historical periods. Also applies to projects requiring samples of a single age from multiple sites

Projects Where we/RELIC might contribute:

- Hercules Dome
- RAID
- Brittle ice (we are using RELIC to test if laser cutting beats mechanical for brittle ice)
- General optical borehole logging when Ryan is not available
- We have a portable C-axis analyzer (would need to be "ruggedized" for field use)

Acoustic Televiewer

- Sonic borehole logging tool
- Collects:
  - Travel time and amplitude of returned signal (up to 288 pts/ revolution)
  - Borehole inclination and azimuth
  - Temperature, Roll, etc.
- At SP: 1 up/down, 1 up/down with velocity ring



High Resolution Caliper Shape

Ice Cube team logged SPICE

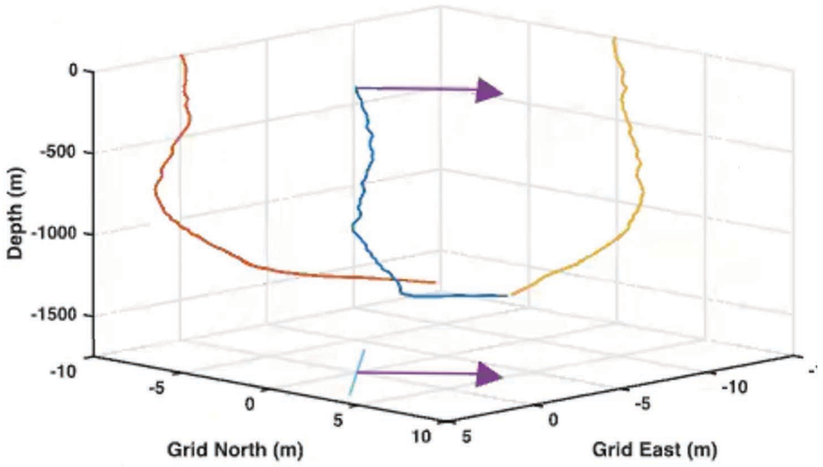
At OSU, available to others

Cold tolerant

Tested to ~3000m

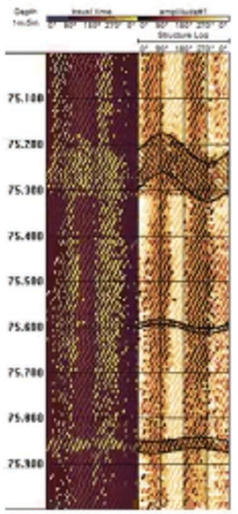
Borehole Trajectory

- Bottom of the borehole is ~16m at 112 degrees W (of grid N) of surface hole
- Shearing of the borehole is unlikely since it does not go near bed

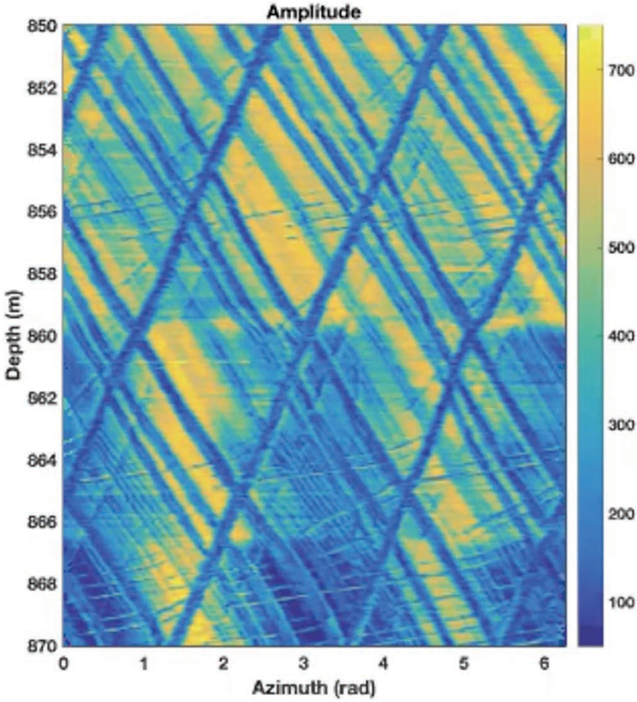


Other uses

- See Drill Artifacts
- Good for aligning depths of different runs
- Can be used to reorient core where tilted layers are present



Obbard et al., 2011



CONNECTION BETWEEN IDP AND SCIENTISTS

IPO

- Maintain winches
- Drills for more dedicated boreholes
    - (RAID, ASIG? Winkie? How water?)
- Mechanical
- Electrical (bandwidth)
- Provide guidance and testing opportunities
- Manuals and advice
- Pre-deployment testing (make winches available)
- Provide field support when needed

BLWG and Scientists

- Scientists provide
    - Idea – Proposals
    - Sensors that are well tested
- BLWG - Provide guidance on
    - Which holes to maintain for how long?
    - Feedback on winches and drilling
    - Primers for scientists.

.

Destructive versus Non-Destructive Access?

PRE-FIELD TESTING

Pressure Vessel Specifications

- Internal Diameter: 10 inches
- Internal Length: 120 inches
- Cylinder tested to 5000 psi per JARP J-102 specification
- Vessel can only be operated and pressurized by an IDDO engineer and with an IDDO approved fluid.
- Hydrostatic testing is the only preferred method of pressure testing at IDDO.
- Gearhart-Owen pigtail terminated through bulkhead connector to the external terminal block.

WINCHES

IDDO Deep Logging Winch

Capabilities

- Max Depth: 4000 meters
- Standard four-conductor logging cable
- The cable is headed with a standard 1-inch outer-diameter Gearhart-Owen variant
- Broadband slip-ring connector
- Can transmit both analog and high speed digital signals from DC to ~10 MHz.

Intermediate Depth Logging Winch

Capabilities

- Max Depth: 1500 meters
- Standard four-conductor logging cable
- The cable is headed with a standard 1-inch outer-diameter Gearhart-Owen variant
- Broadband slip-ring connector
- Can transmit both analog and high speed digital signals from DC to ~10 MHz.

USGS Logging Winch

Capabilities

- Max Depth: 4000 meters
- Standard four-conductor logging cable
- The cable is headed with a standard 1-inch outer-diameter Gearhart-Owen variant
- Broadband slip-ring connector
- Can transmit both analog and high speed digital signals from DC to 250 MHz.

CHALLENGES FOR BOREHOLE LOGGING IN GENERAL AND CURRENT COMMUNITY CONCERNS

- Bench Testing
- Cold tolerant sensors
- Adapting off the shelf sensors for ice
- Access to boreholes after camp is gone
- Borehole maintenance
- Winch noise reduction
- Being in touch with Ice Core community for access to lesser known drilling projects
- Hand-me-down versus dedicated boreholes (RAID, hot water)
- Destructive versus Non-Destructive Access?