Development and operation of an aircraft-based through-ice CTD Rosette

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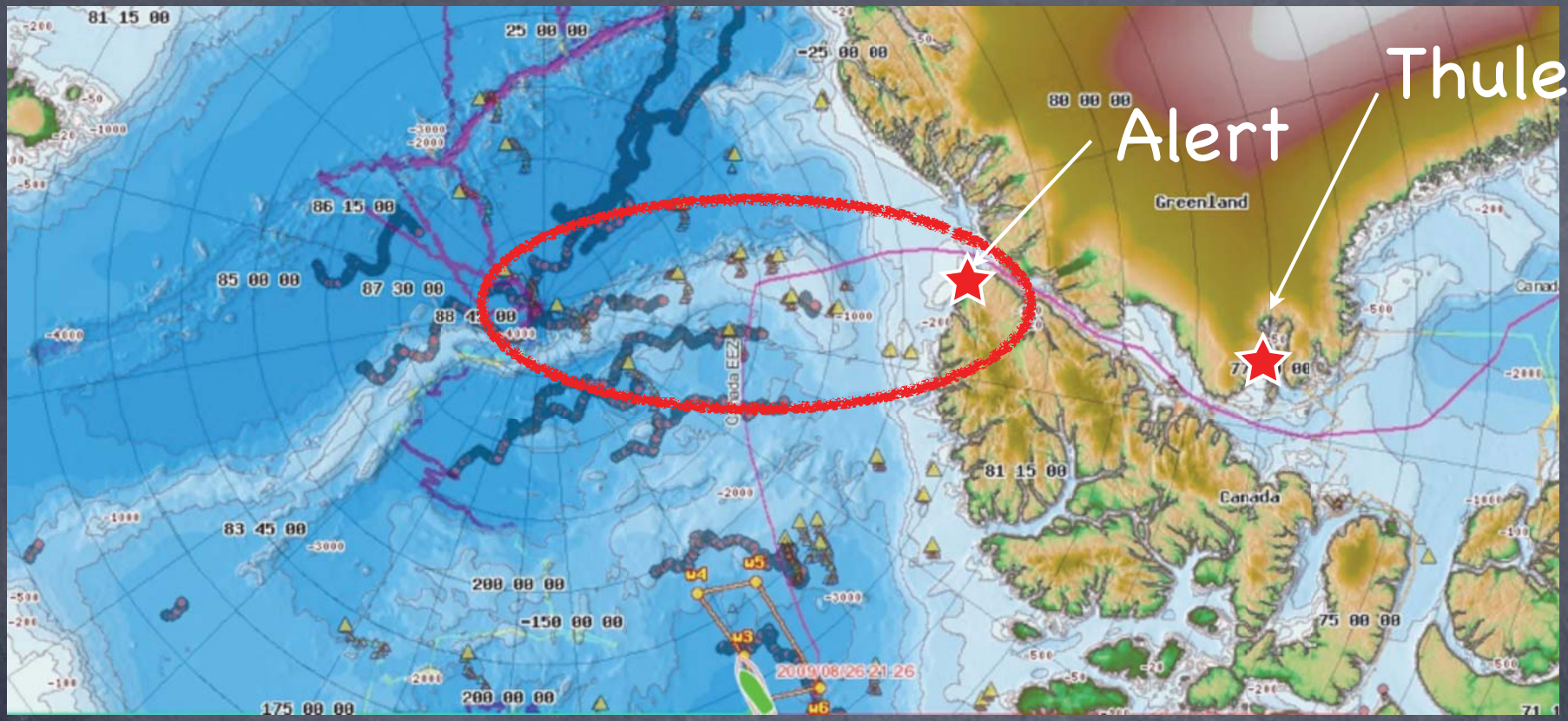
Science Objectives

- Real-time data from the CTD
- Precision located (depth) water samples
- Samples for chemical analysis to:
  - Track fresh water sources
  - Investigate temporal variability (composition and circulation)
  - Estimate "age" using trace gas techniques

Friday, March 25, 2011

Design ~~Requirement~~ Desires

- Transect from Alert to the Pole
- Trace gas tight (to the lab at 1ppb)
- 2 liter (useable) water samples
- 12 bottles per station
- 3 stations per day
- Depth: 600m minimum, 1km desirable
- Cheap, quick, with inexperienced operators...

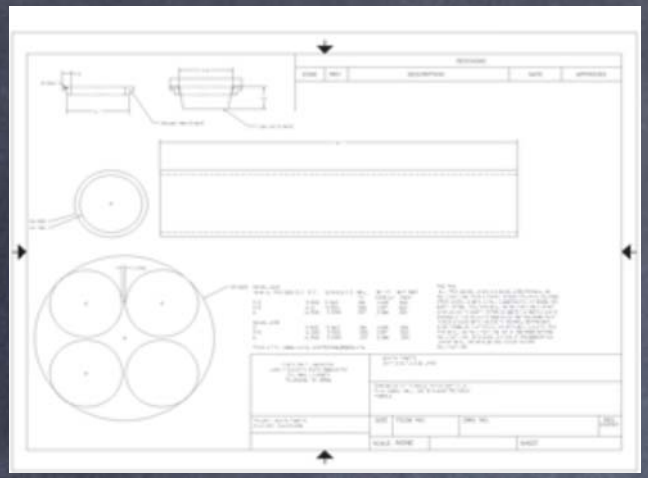


- Can't reliably get there w/ icebreakers (even nukes)
- Submarines aren't available (and can't sample deep)
- Hoover craft can't get the samples back fast enough
- So fly.....

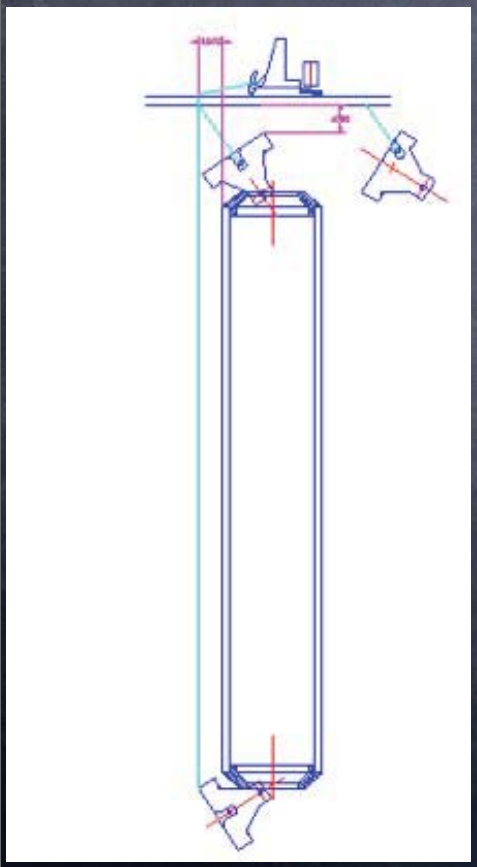
Concept #1

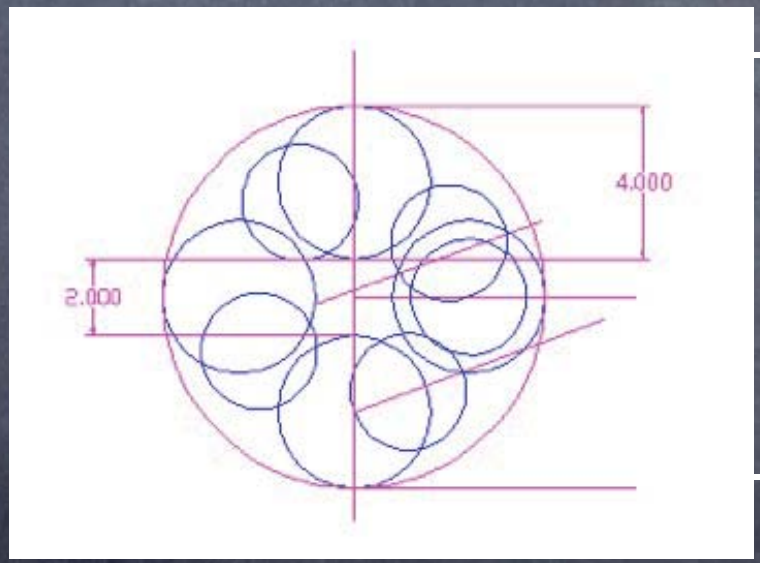
- It all fits in a suitable aircraft
- Stacking “modules”
- Drill w/ 10” ice auger
- Repurposed winch w/ 0.1” OD single conductor wire
- SeaBird 19plus CTD + decoder
- Standard SBE release, repackaged
- 4 liter bottles, four per module
- Standard SBE topside electronics (COTS)
- Transport in ice-chests

Concept 1 evaluation



Use a COTS release from SeaBird Electronics





- No chance in a 10” hole without radical redesign
  - No time for re-design
  - Concerns about mixing of water
- Very long release wires w/ a standard release mechanism

Concept #2

- Stacking “modules”
- 10” --> 12” drill
- Repurposed winch w/ 0.1” OD, single conductor armored wire
- SeaBird 19plus + custom telemetry decoder
- Custom release mechanism
- 4 liter bottles, four per module
- Standard SBE topside electronics
- Transport in “coolers” w/ ice and bottle clamps

Evaluate Concept #2

Project: Arctic Rosette
Subject: Water bottle sizes
Date: November 23, 2002
Eng: Dale Chayes

Station holes will be drilled with a 12" auger in a Jiffy Drill or perhaps with an electric drill powered from the same (diesel) generator used to run the winch. Some allowance for non-straight holes and for ice chips and junk in the hole will be allowed.

$Diameter_{max} := 10\ in$

$Bottle_{OD} := \frac{(Diameter_{max} - 0.25\ in) \cdot .9}{2}$

We have to allow some material around the outside of the bottle circumfrence for support. The exact amount depends on the design and the materials. The current estimate allows 1/8" for material and has a 10% tolerance.

$Bottle_{OD} = 0.111\ m$

$Bottle_{wall} := 0.3\ in$

$Bottle_{ID} := Bottle_{OD} - 2\ Bottle_{wall}$

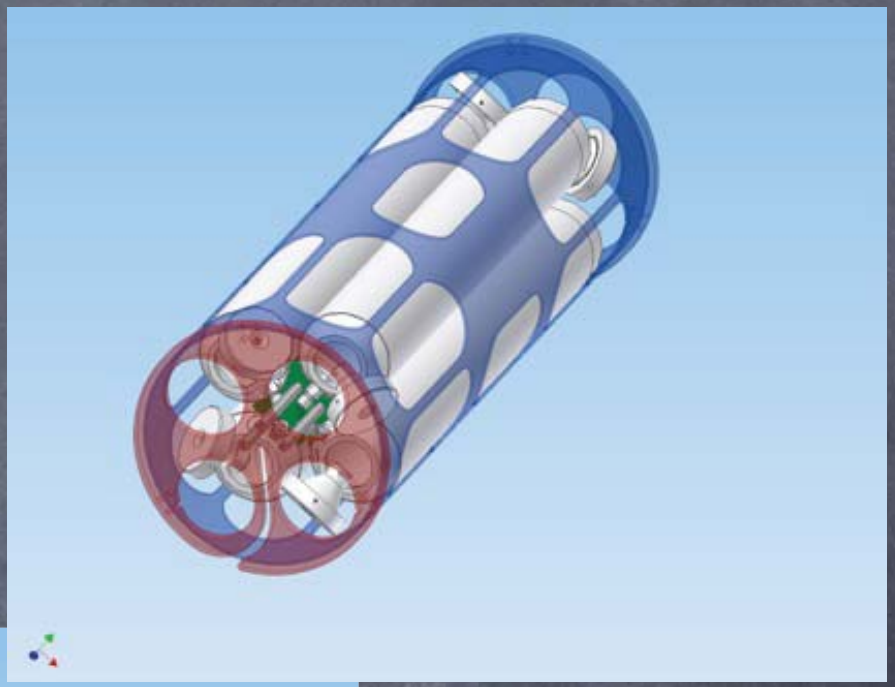
$Bottle_{ID} = 3.788\ in$

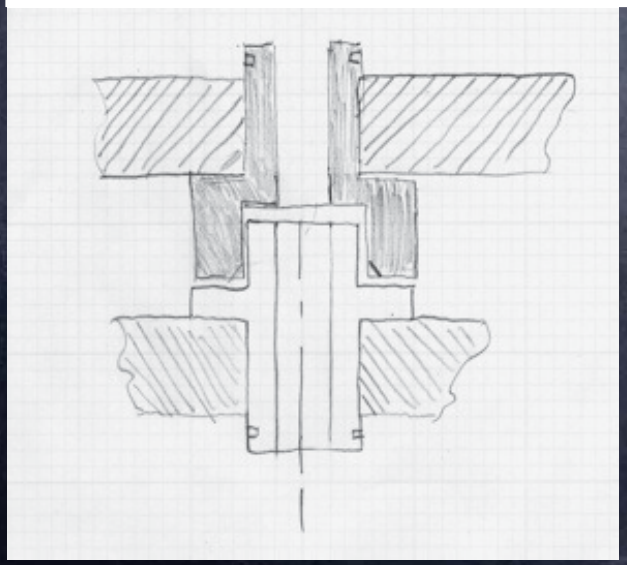
$Volume_{required} := 4\ L$

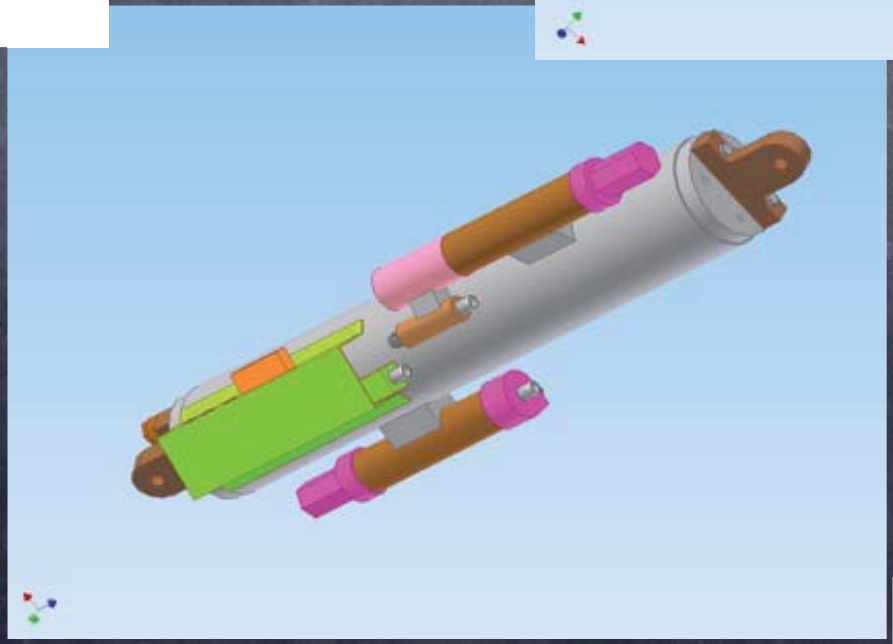
The mimimum acceptable sample volume seems to be three liters. The range goes up to four liters.

$$Bottle_{length} := \frac{Volume_{required}}{\pi \left(\frac{Bottle_{ID}}{2}\right)^2}$$

$Bottle_{length} = 21.665\ in$







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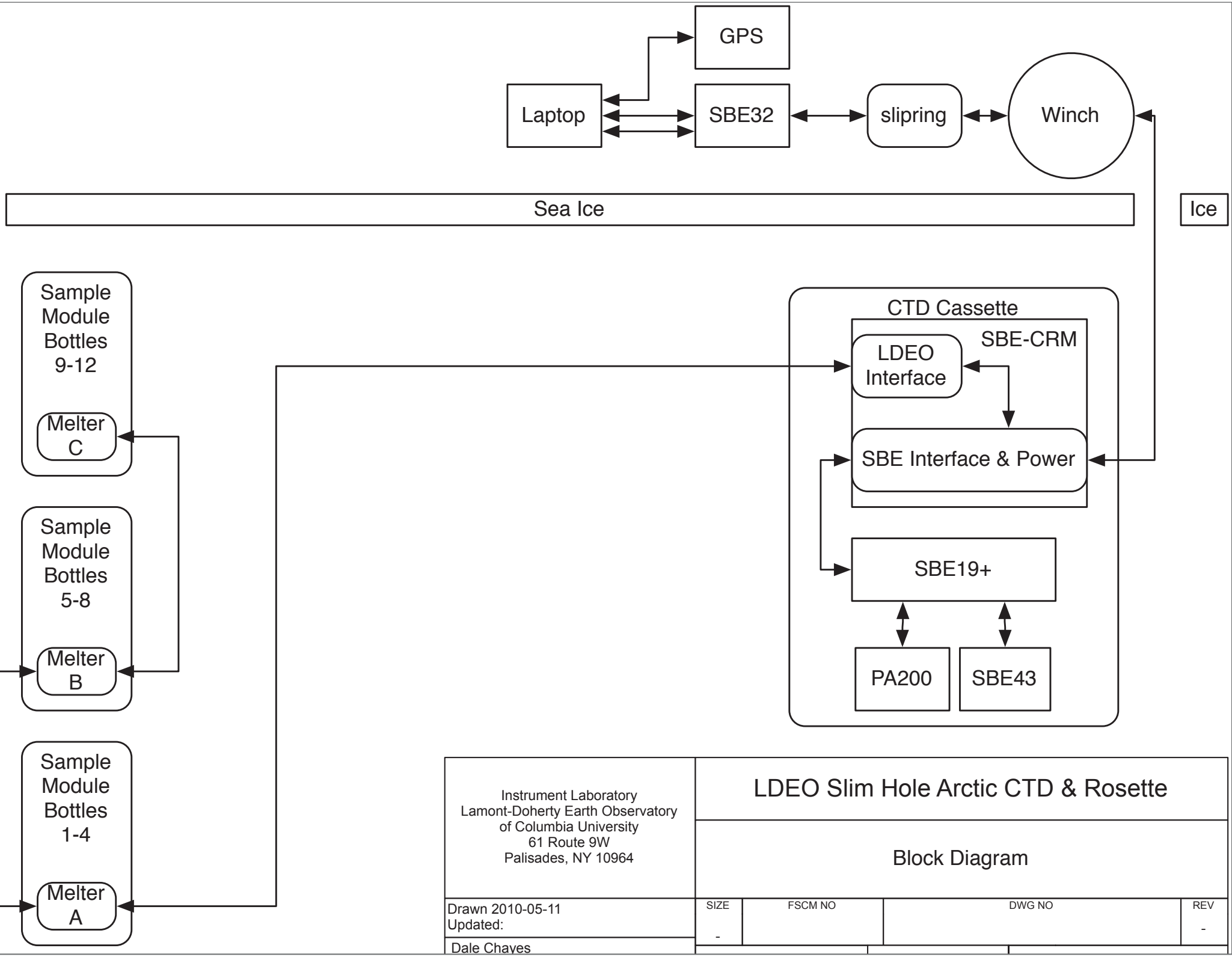
CYCLONE
2
STA-KON TERMINALS



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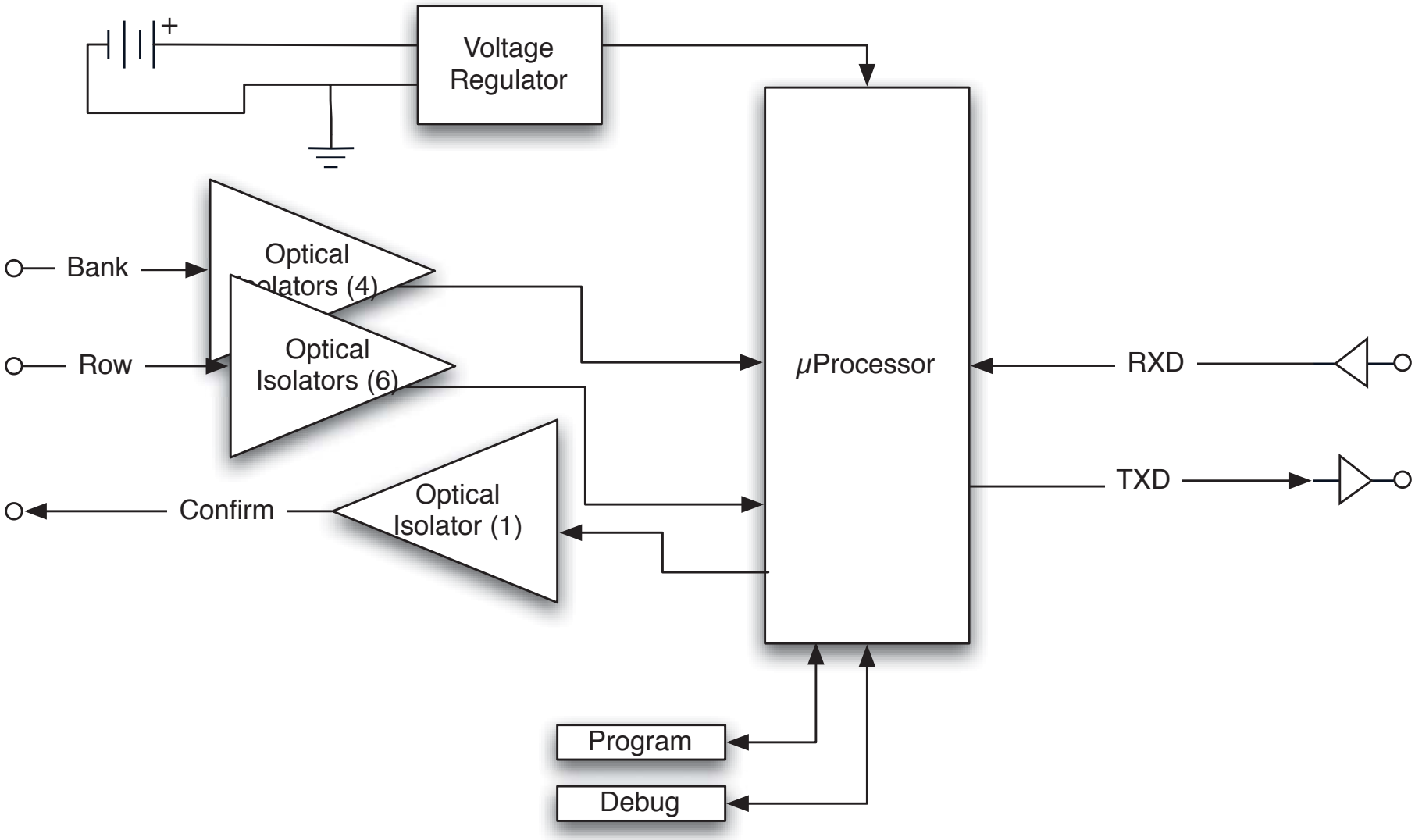
LDEO Slim Hole Arctic CTD & Rosette

Block Diagram

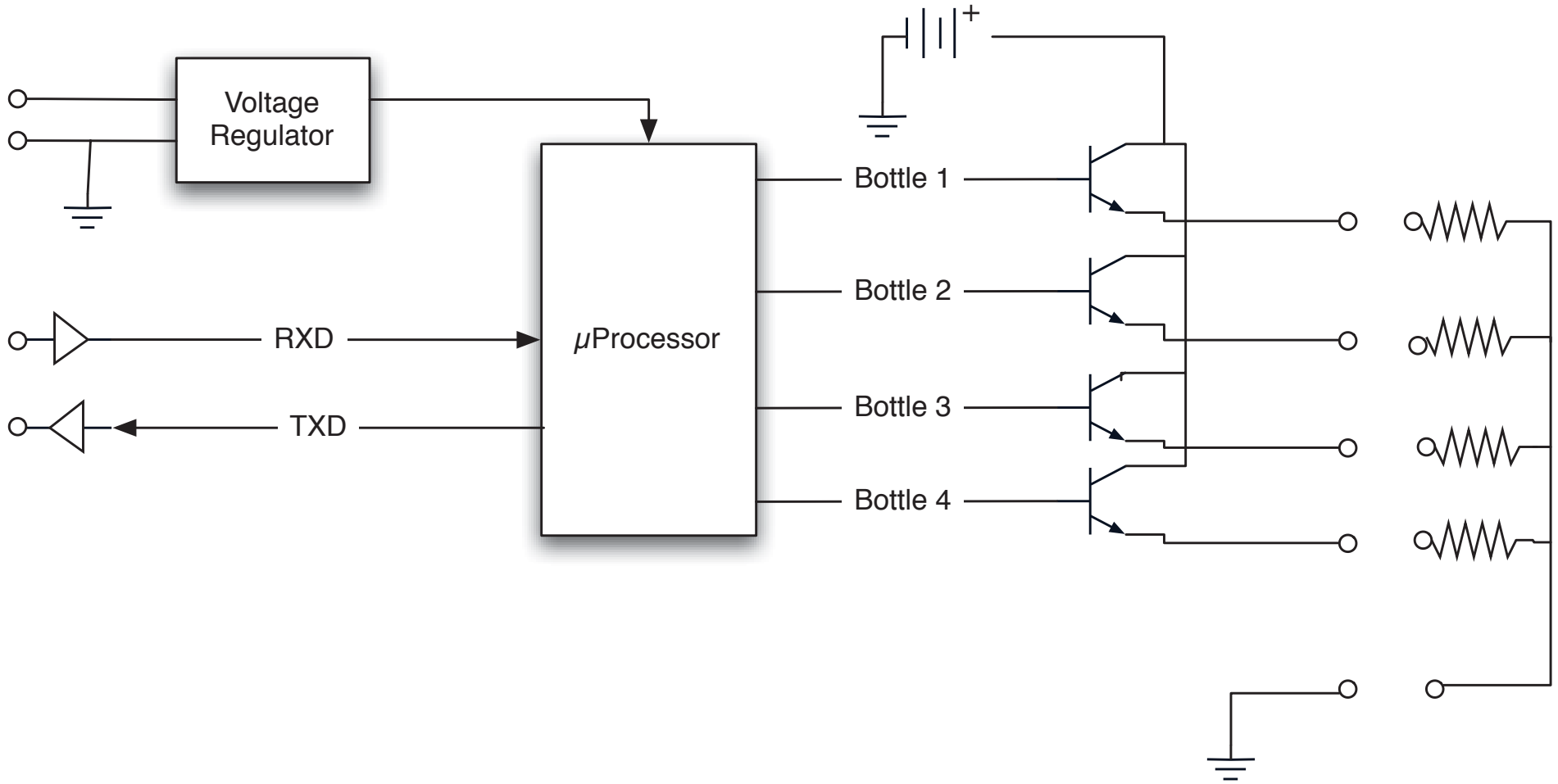
Drawn 2010-05-11
Updated:

Dale Chayes

SIZE	FSCM NO	DWG NO	REV
-			-



Instrument Laboratory Lamont-Doherty Earth Observatory of Columbia University 61 Route 9W Palisades, NY 10964	LDEO Slim Hole Arctic CTD & Rosette			
	Interface Block Diagram			
Drawn 2010-05-11 Updated:	SIZE -	FSCM NO	DWG NO	REV -
Dale Chayes dale@ldeo.columbia.edu	SCALE None		SHEET 3OF 3	



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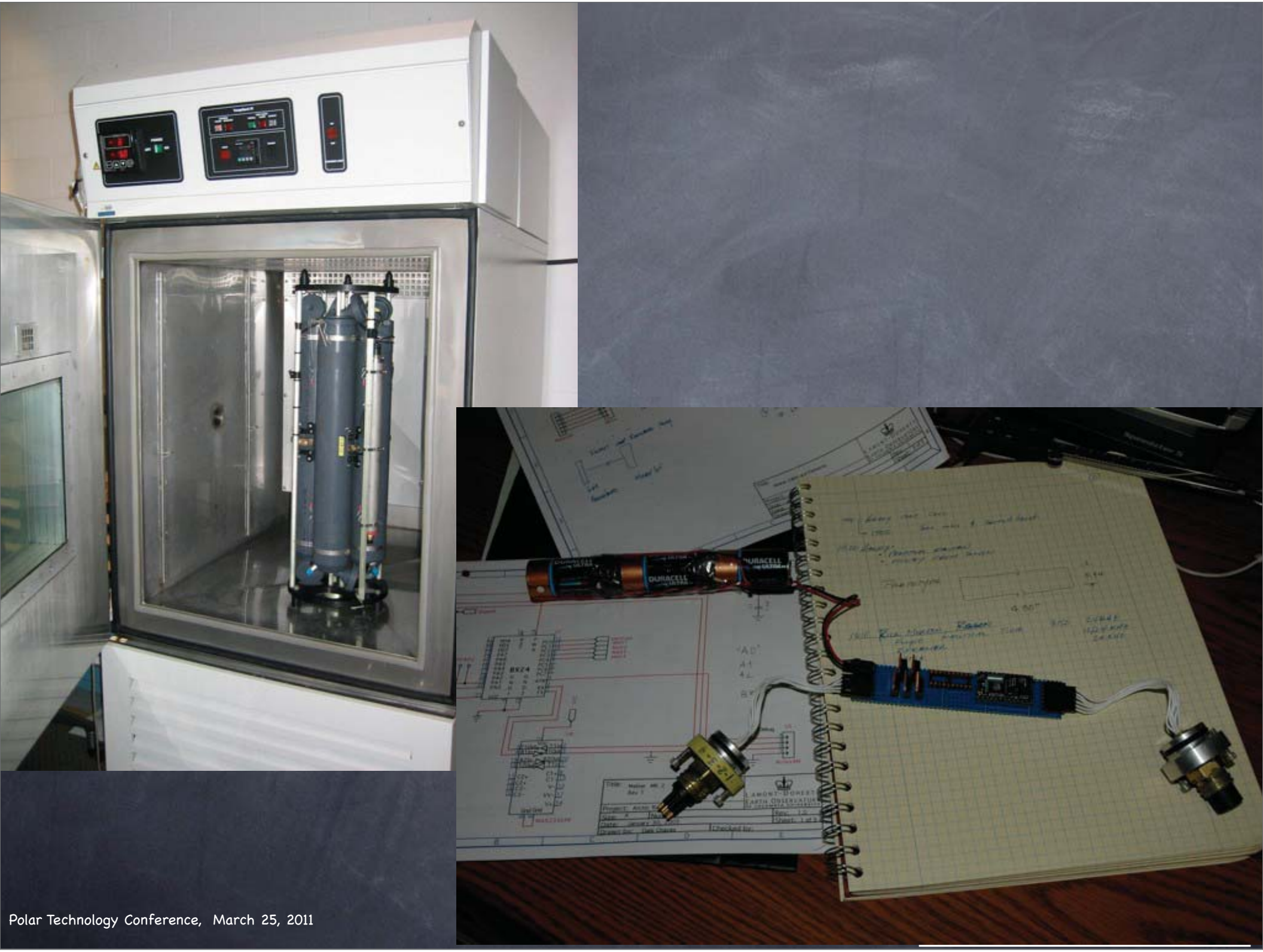
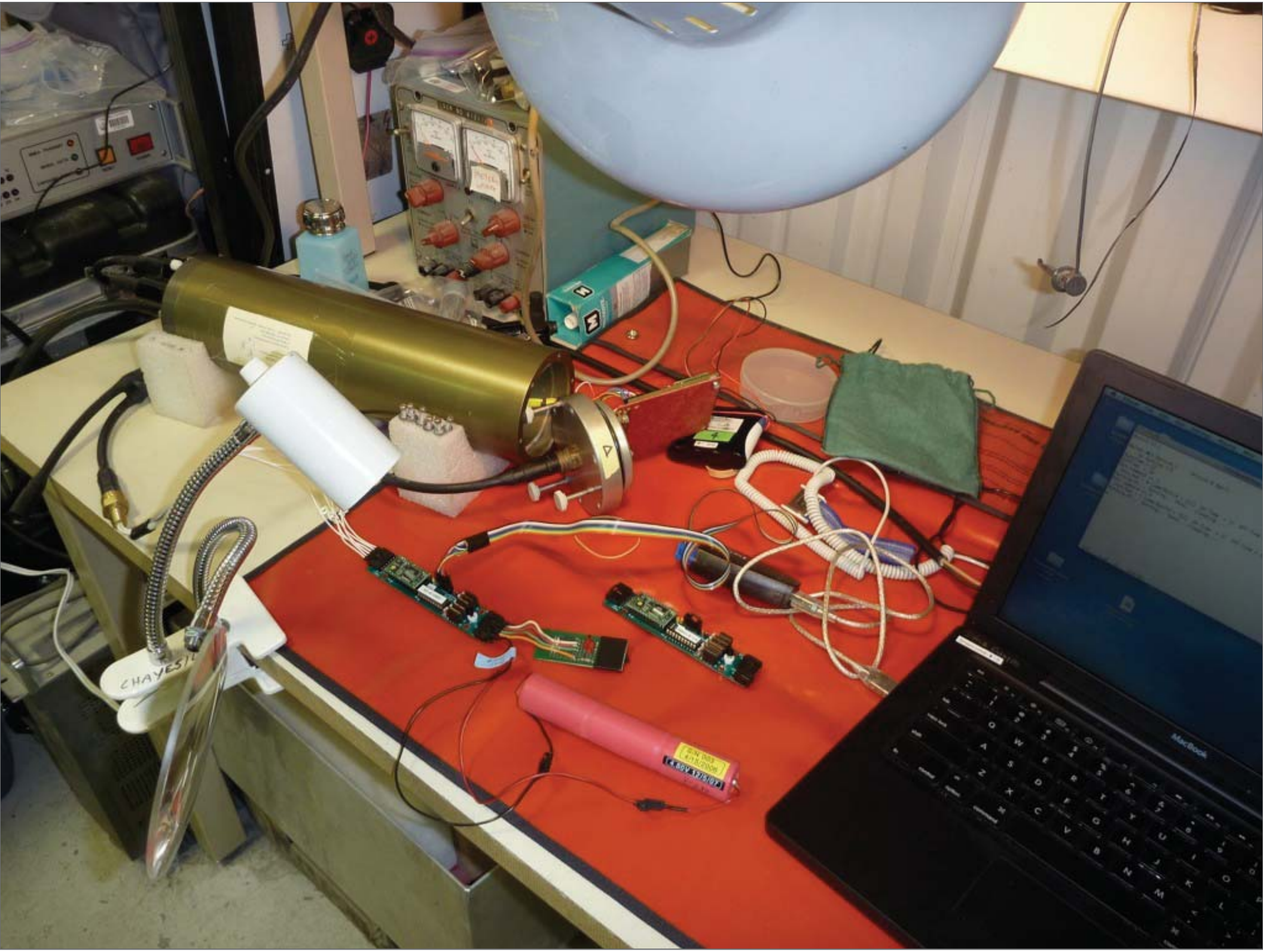
LDEO Slim Hole Arctic CTD & Rosette

Melter Block Diagram

Drawn 2010-05-11 Updated:	SIZE -	FSCM NO	DWG NO	REV -
Dale Chayes dale@ldeo.columbia.edu	SCALE None		SHEET 2OF 3	

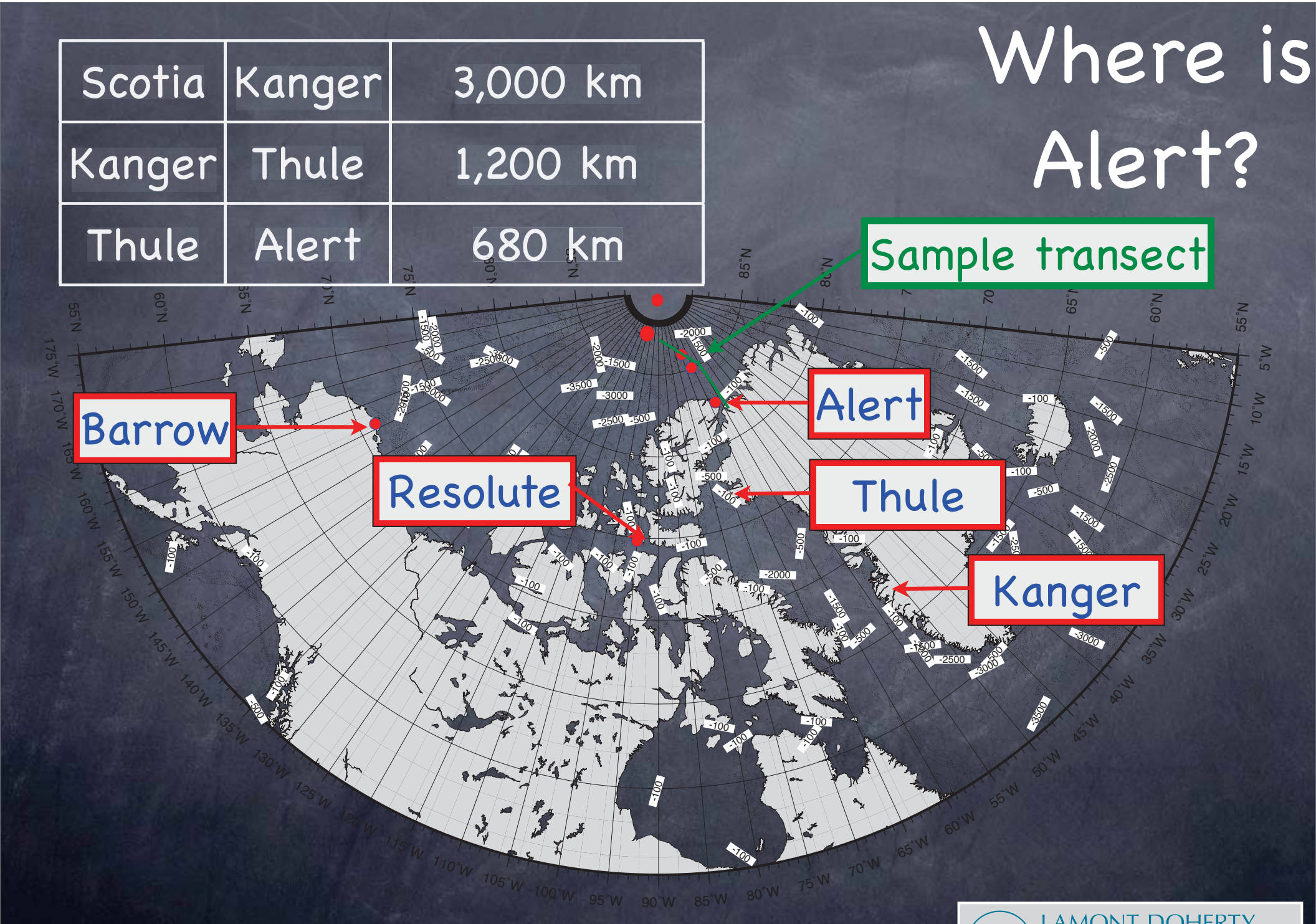


Polar Technology Conference, March 25, 2011



Where is Alert?

Scotia	Kanger	3,000 km
Kanger	Thule	1,200 km
Thule	Alert	680 km



GMT 2004 Jun 18 22:46:19

Switzerland 2004 Lambert Conformal Conic Projection with GSHHS Coastline and GEBCO IBCAO Bathymetry

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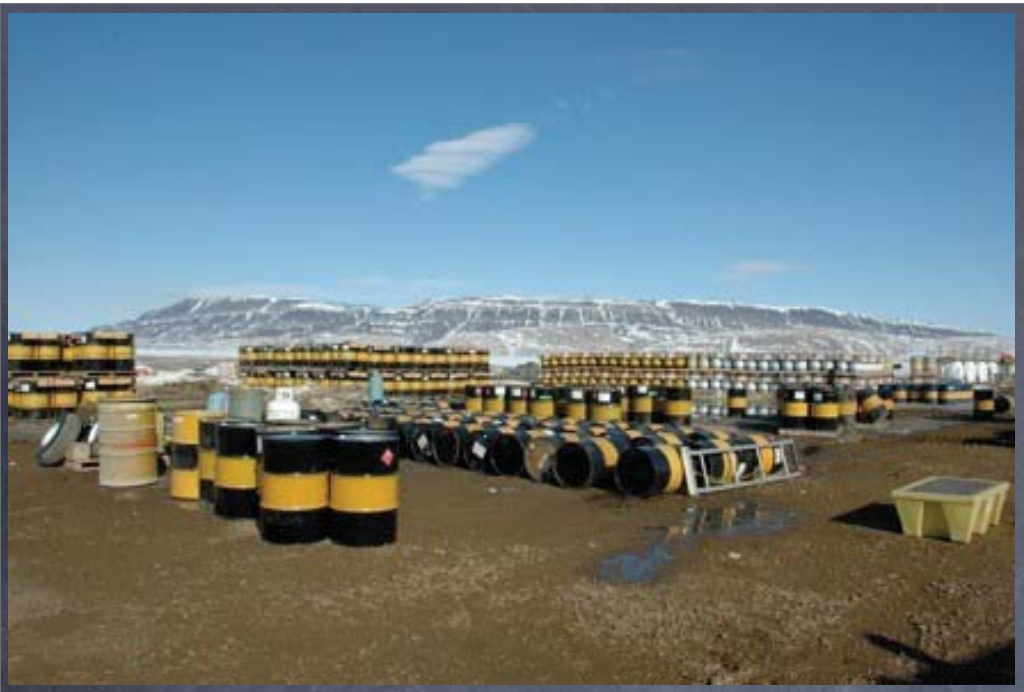

How do you get there (and back)?

- Comair + Charter:
  - New York->Ottawa->Iqaluit->Resolute
  - Then charter to Alert (via Eureka)
- US Air National Guard (109th)
  - Scotia NY -> Kangerlussuaq -> Thule -> Alert

Chartered Hawker 748
Resolute -> Alert


Switchyard
2003 Team
BRADLEY AIR
FIRST AIR

US Air National Guard C130


Switchyard 2008
Team
U.S. AIR FORCE
0486

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A
Alert
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DRDC 1
JUSTRITE
FLAMMABLE
KEEP FIRE AWAY
INFLAMABLE
MANTENGA ALEJADO DEL FUEGO
INFLAMMABLE
PRODUITS INFLAMMABLES

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A two-station flight:
7 coolers (CTD +3)
Ice drill & flights
Tripod & tent
Heater
Electronics
Winch & wire
Generator
Fuel, tools, emergency gear
Four souls:
Pilot, copilot, Richard and Dale

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TWIN OTTER
1863

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C-GCKB
Borek Air Ltd.

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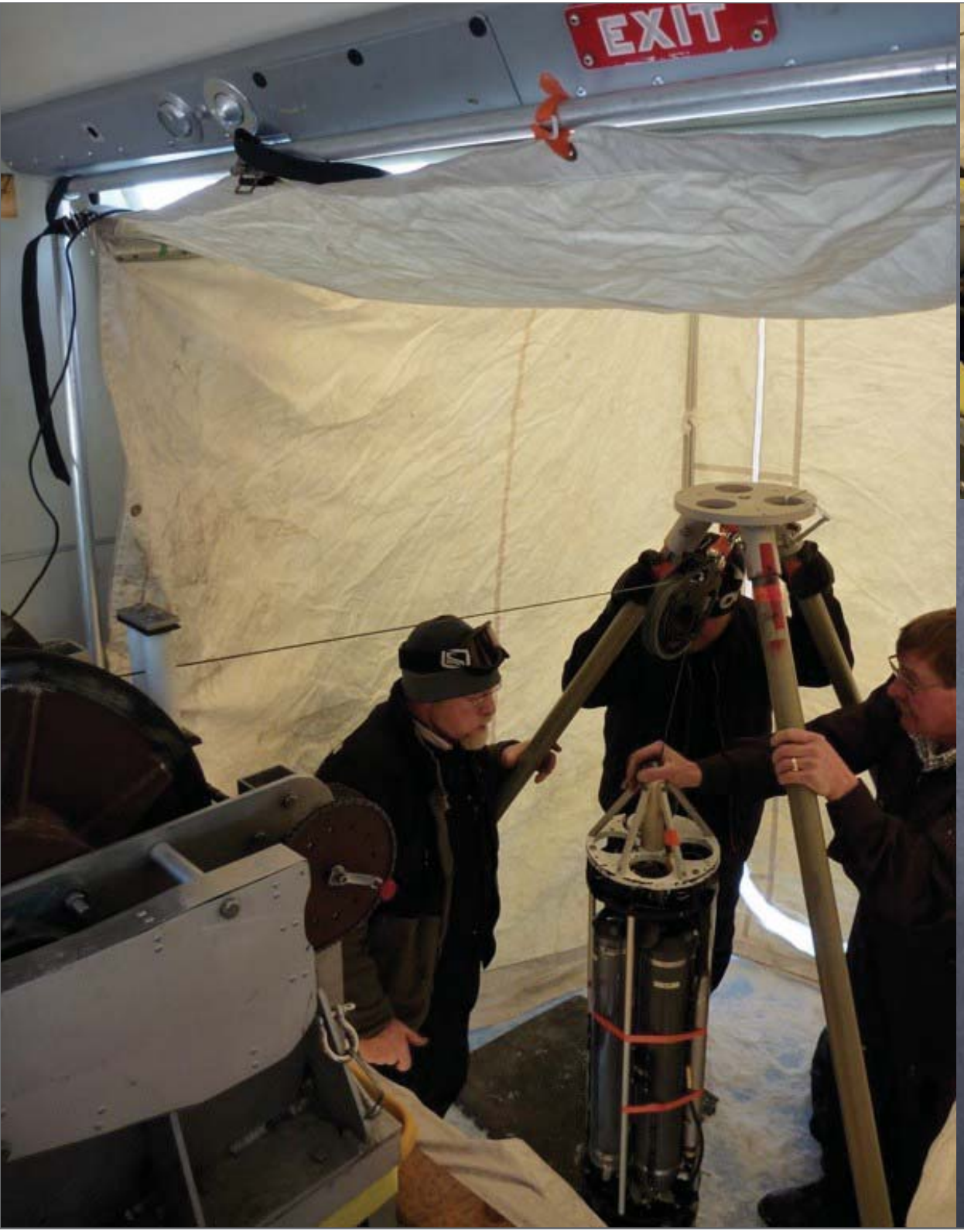
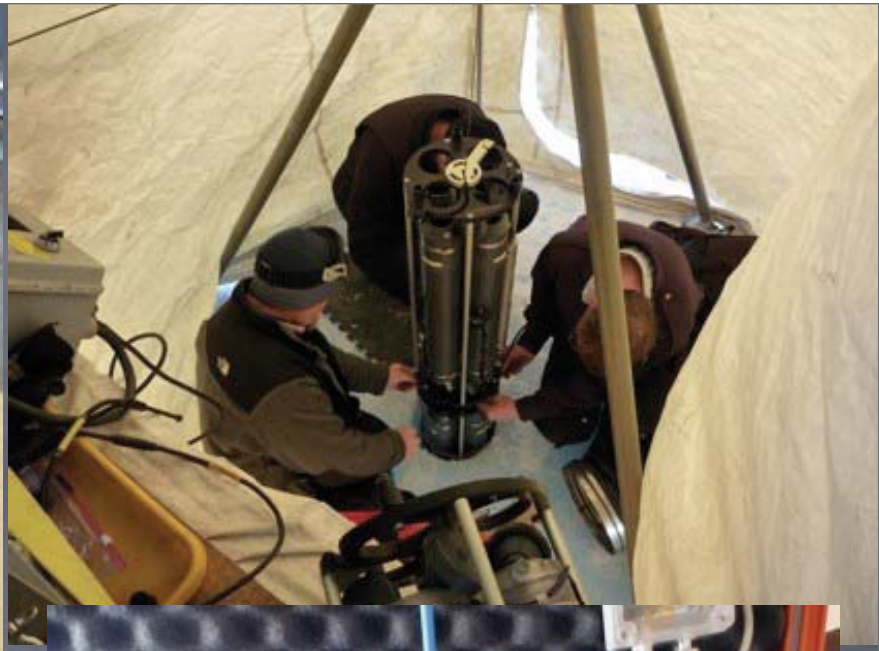
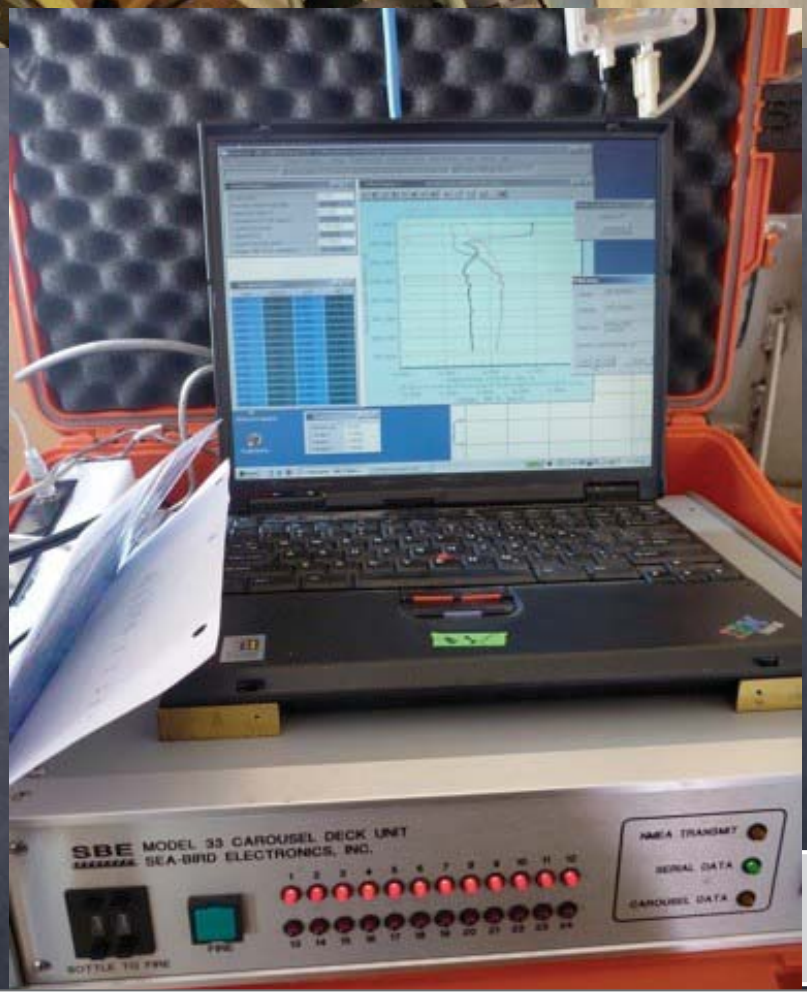
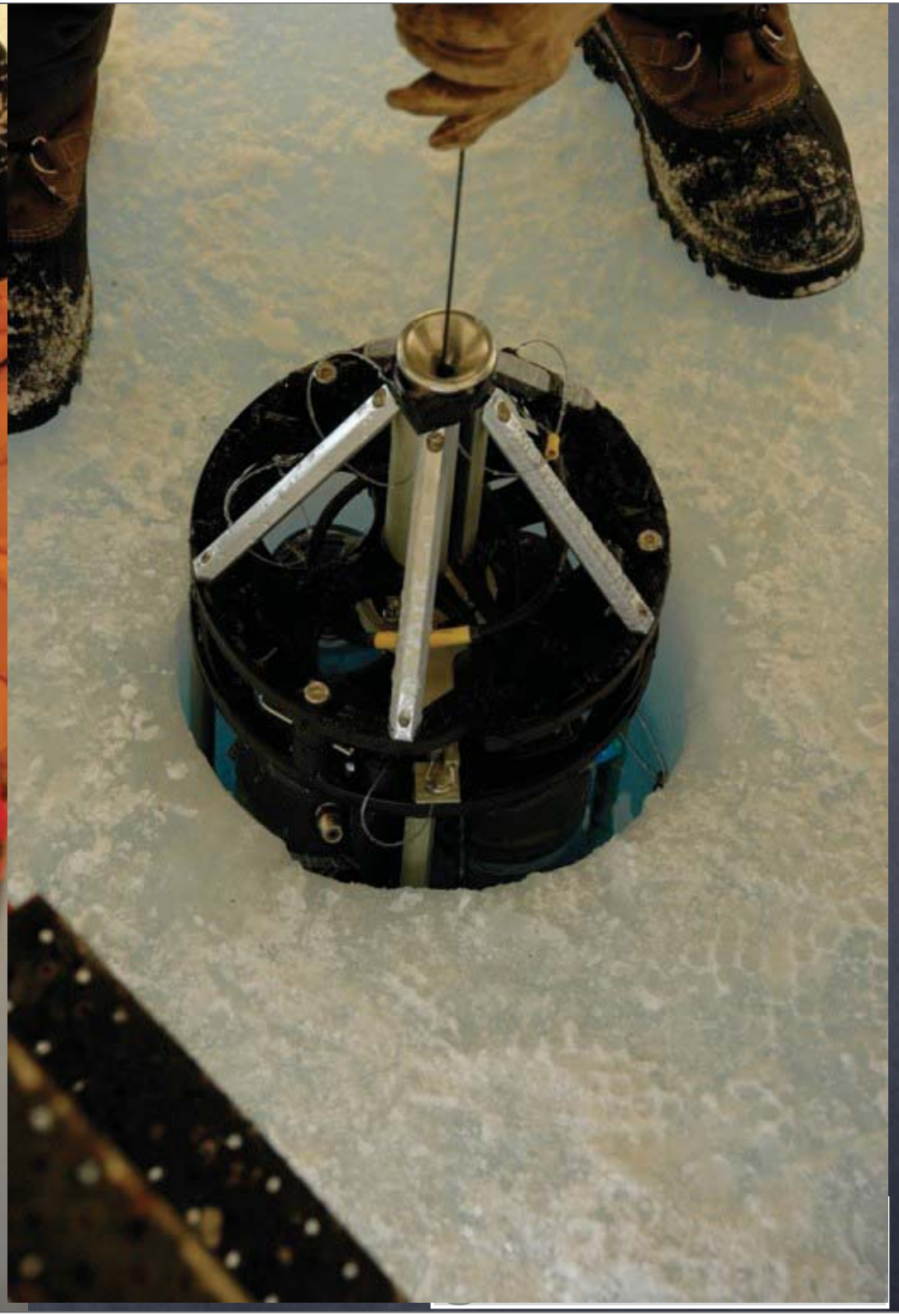
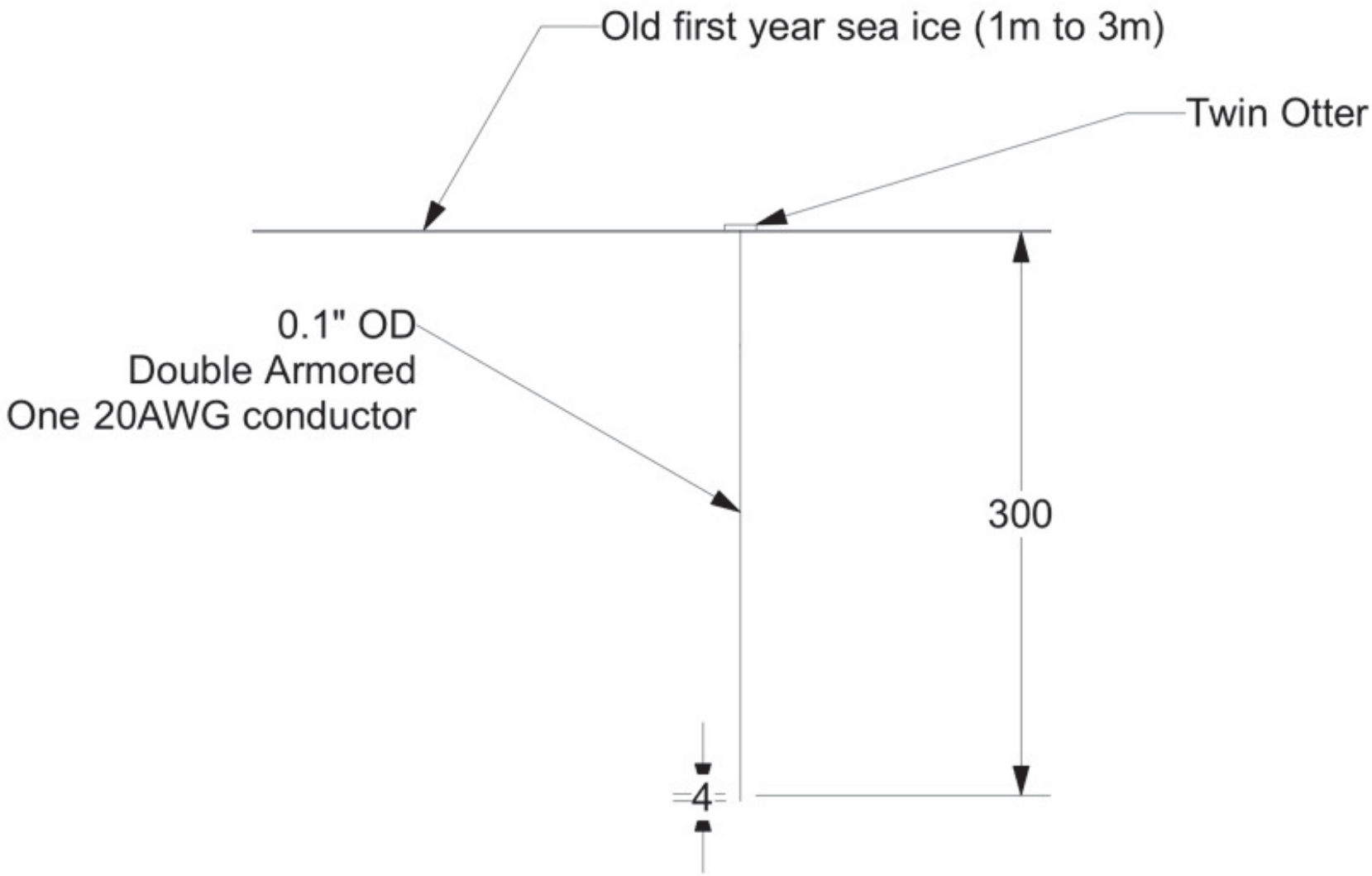
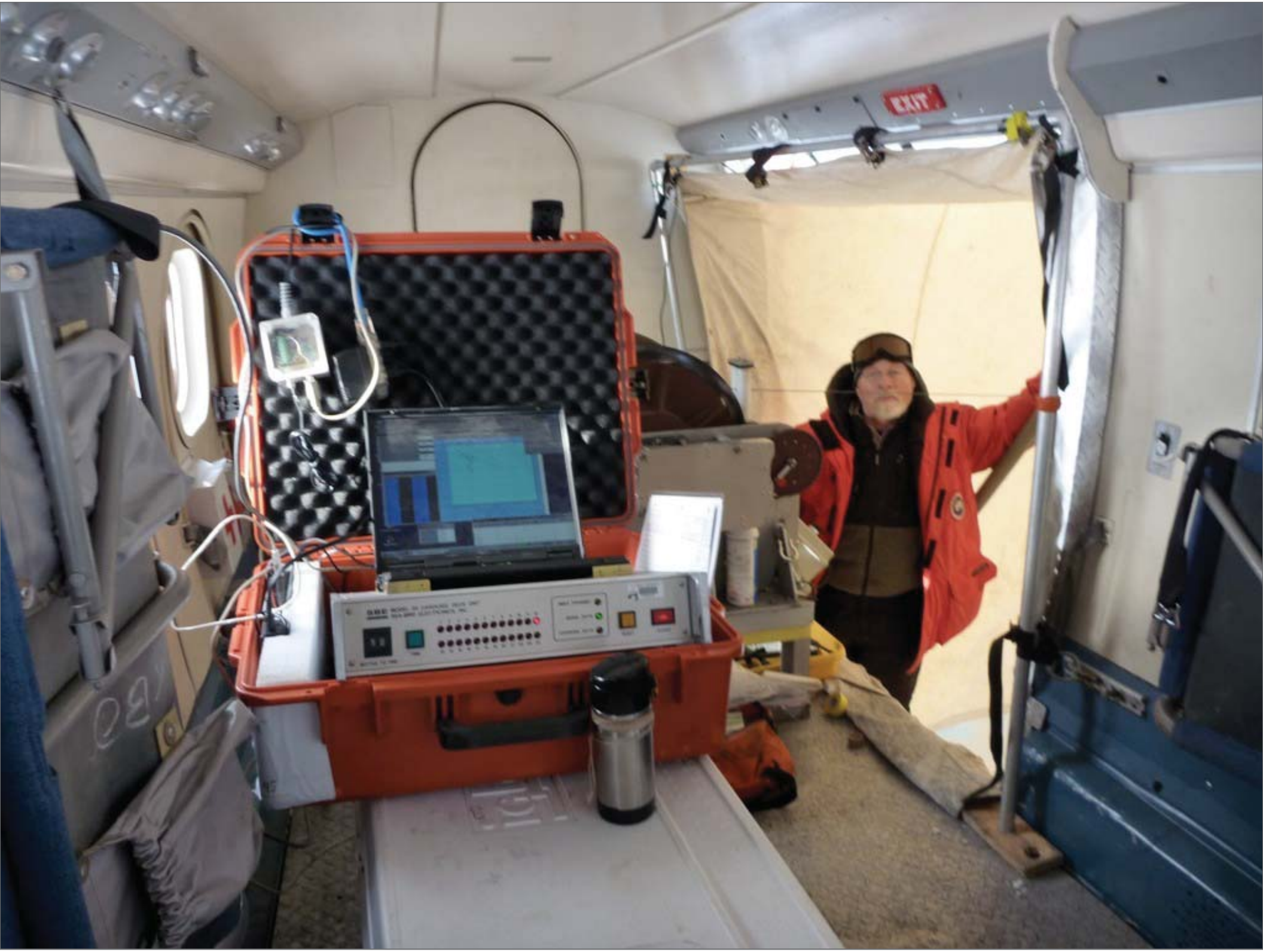

EXIT




SBE MODEL 33 CAROUSEL DECK UNIT
SEA-BIRD ELECTRONICS, INC.
NMEA TRANSMIT
SERIAL DATA
CAROUSEL DATA




Old first year sea ice (1m to 3m)
Twin Otter
0.1" OD
Double Armored
One 20AWG conductor
300
4



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Year	Stations	Duration (Days)	Weather & Aircraft Days
2004	3	8	~3
2005	4	6	~2
2006	3	6	~3
2007	5	11	~4
2008	5	11	~3
2009	9	17	6
2010	4	12	7
2011	?	~18	?

Data

This project is apart of the NSF-funded Arctic Observing Network (AON) so the data is at CADIS

http://aoncadis.ucar.edu/home.htm

This talk represents to the work of many individuals including engineers, technicians, and scientists at LDEO, pilots and flight crew from Ken Borek Air Ltd, Canadian Forces & Environment Canada personnel at Alert and elsewhere, the NY Air National Guard and our collaborators at UW/APL and SIO.

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US National Science Foundation