

# BoraBora Documentation For Radio Neutrino Observatory - Greenland

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# Introduction

The purpose of this document is to provide sufficient information to perform the BoraBora time of flight (TOF), 9DOF (degrees of freedom) and Temperature sensors tests in Greenland for the session 2021. This experiment involves dropping the BoraBora down ice holes (filled with Isopar-K) and measuring their diameters. It will also measure temperature profile and magnetic moment of the ice as well as acceleration and angular velocity of the BoraBora while it drops deep down the hole.

# Testing TOF Distance Sensors

## Important Hardware Parts 1/2

- i Two 9/16 Combination Wrenches
- ii One 5/64 Hex Key
- iii Eight  $8/32 \times 1/2$  Low Head Socket Cap Screws
- iv Four 3/6 - 16 Jam Nuts
- v Four 3/8 - 16 Fin Hex Nuts
- vi Four 3/8 - 16 Sealing Nuts
- vii Two Lead-Acid Batteries with Male Connector (4 Volts)
- viii Feather M0 Board with SD Card, BoraBora I2C Breakout (Green Shield Board), Four Sparkfun VL6180 TOF Sensors
- ix Sensors on Frame and Boards inside Black Case: Battery Disconnected
- x Sensors on Frame and Boards inside Black Case: Battery Connected (see the Blue LED which blinks at a rate of 1 Hz)
- xi BoraBora Framework



# Hardware Images 1/2

Figure (i)



Figure (ii)

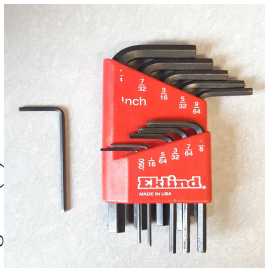


Figure (iii)



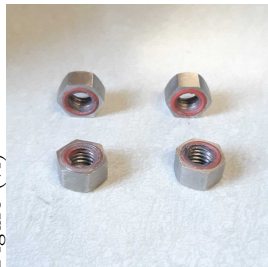
Figure (iv)



Figure (v)



Figure (vi)



# Hardware Images 2/2

Figure (vii)



Figure (viii)

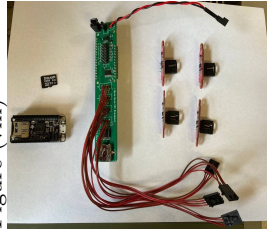


Figure (ix)

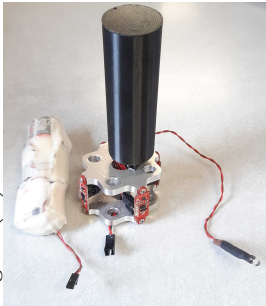


Figure (x)



# Testing The Sensors

## Compatible System

Before putting the sensors inside BoraBora framework or in case of any problems, check them using the KU AP1 Laptop with pre-installed Arduino IDE connecting USB cable.

## How to do it?

Connect feather M0 to laptop, open Arduino IDE, open bora\_distance\_1-2.ino code, click compile, upload and open serial monitor. If the port is not found, double click on the power button on the board while uploading the script. Feather board is already programmed and the script starts saving data to the SD card when voltage is applied. When the SD card is inside the slot, the external blue LED on will blink at 1 Hz. If the card is not inserted, the blue LED will remain off.

## Script & Output

Script which is uploaded on feather board:

[https://github.com/alisanozdrina/lightSensor/blob/main/Blink\\_feather.ino](https://github.com/alisanozdrina/lightSensor/blob/main/Blink_feather.ino)

Example of the output file:

[https://github.com/alisanozdrina/lightSensor/blob/main/SC\\_057.TXT](https://github.com/alisanozdrina/lightSensor/blob/main/SC_057.TXT)

## All You Need Are These!

Figure (xi)



# Step By Step Assembling: Test 1

- 1 Insert the sensor frame with boards and black case inside the upper half of Bora cylinder. Make sure that the sensors are outside. Fix the position with four  $3/6$  - 16 nuts as shown in the figure.
- 2 Put the battery pack in the gap and connect it with sensor frame. You will see the blue light starting to blink at 1 Hz rate.
- 3 Fit the semi-transparent plastic disk as shown in the figure. It should stay just above the sensors.
- 4 Put the lower half cylinder of Bora.
- 5 Tighten the sealing nuts on upper and lower cylinders with combination wrenches. Apply opposite twist for effective sealing.
- 6 Fit the lower strap holder and tighten it with four  $3/8$  - 16 fin hex nuts.
- 7 Connect the flexible metal straps on the upper and lower strap holder using eight  $8/32 \times 1/2$  low head socket cap screws with the help of  $5/64$  hex key. The upper strap holder is movable while the lower one is fixed.
- 8 BoraBora is ready take the ice hole diameter data.
- 9 Make sure to check the blue light still blinking!

# BoraBora Assembling Images 1/3

Figure 1



Figure 2

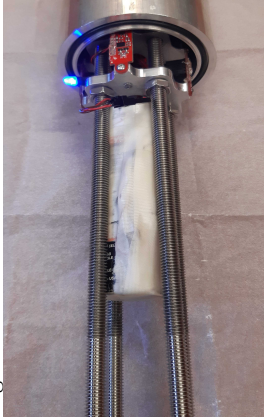


Figure 3



## BoraBora Assembling Images 2/3

Figure 4



Figure 5



Figure 6



# BoraBora Assembling Images 3/3

Figure 7



Figure 8



Figure 9





# Testing 9DOF & Temperature Sensors

## Important Hardware Parts 2/2

- i One 1/16 Hex Key & Lower Half of the TOF Sensor Holder Framework
- ii One  $4/40 \times 1/4$  Button Socket Caps
- iii Temp & Attitude R3 Board with Blue LED light
- iv One 9 DOF (Degrees of Freedom) Sensor
- v Three Temperature Sensors
- vi Two Lead-Acid Batteries with Male Connector (4 Volts)
- vii Another Black Case
- viii BoraBora Framework

# More Hardware Images

Figure (i)

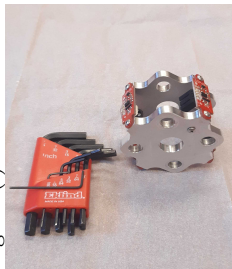


Figure (ii)



Figure (iii)

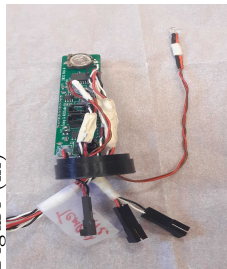


Figure (iv)

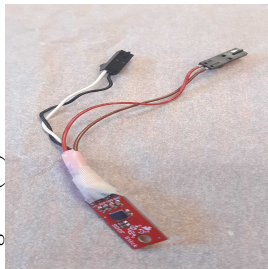
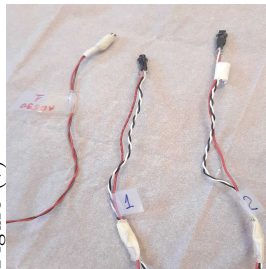


Figure (v)



# Step By Step Assembling: Test 2

- ➊ Using 1/16 hex key, separate the half of the TOF Sensor Holder Framework which has a small button socket hole.
- ➋ Connect the battery with Temp and Attitude R3 board before putting it inside the black case. Make sure that the SD card is inserted by seeing the blue LED blink at 2Hz rate.
- ➌ The 9DOF sensor stick has two male molex connectors; one with red and brown wires and the other with black and white wires. Connect the respective terminals with the Temp and Attitude R3 board. Then fix the 9DOF stick with TOF Sensor Holder Framework with a  $4/40 \times 1/4$  button socket cap using 1/16 hex key.
- ➍ This is how the second test setup would look like before connecting the 9DOF stick with TOF Sensor Holder Framework.
- ➎ Put this setup inside the upper half of BoraBora cylinder. Make sure that the temperature sensors and LED bulb are tapped to the inner wall of the cylinder.
- ➏ The blue LED will keep blinking like this figure.
- ➐ The rest of the assembling is similar as Test 1.

# 9DOF & Temperature Sensors Assembling 1/2

Figure 2

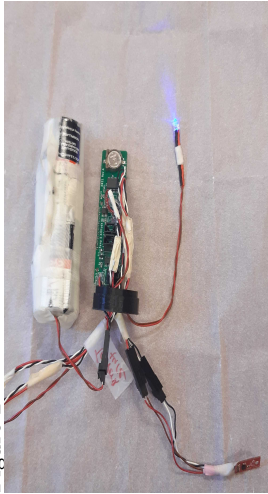


Figure 3

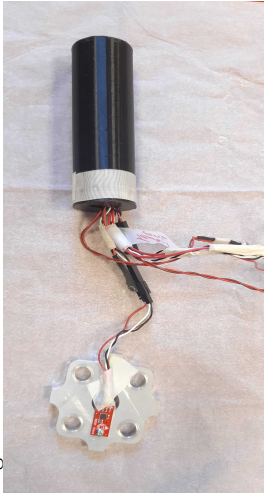
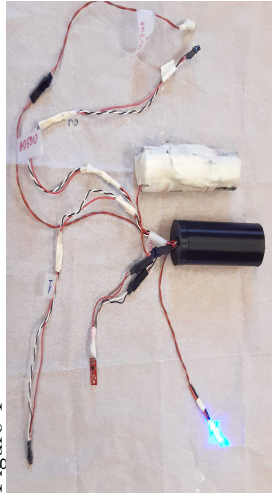


Figure 4

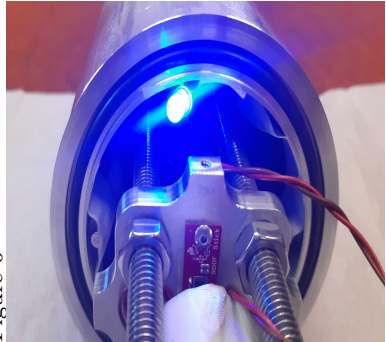


# 9DOF & Temperature Sensors Assembling 2/2

Figure 5



Figure 6



# Some Important Points

- **Battery Charging:** For 4V battery packs, we need to charge them keeping the power supply in between 4.9 - 5.0V.
- **RTC Battery Replacement:** Before every run (for both distance sensors and temperature/orientation), the RTC battery should be replaced. The time should be synchronized after that using `stYYYYMMDDhhmmss` (e.g. `st20210715181332` - July 15th 2021 18:13:32) command in Arduino terminal (Serial Monitor). It takes 2 seconds to adjust the time; therefore, enter it before 2 seconds (current time + 2 seconds).
- **9DOF Sensor Adjustment:** Put a mark outside BoraBora in the direction where the 9DOF sensor is oriented before dropping it into the hole.

# References



<https://www.overleaf.com/project/604684552e36606fe95e44fd>  
SPUNK Team (2021).



[https://docs.google.com/document/d/18iihYhMwv-BkEfiYlycbMeOur2mAeJ48yg8xhKoF\\_Ro/edit](https://docs.google.com/document/d/18iihYhMwv-BkEfiYlycbMeOur2mAeJ48yg8xhKoF_Ro/edit)

Nozdrina, Alisa (2021).