

# Smart Rock - Low Cost Water Monitoring

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## Abstract

The Smart Rock is a submersible sensor suite that monitors temperature, pressure (water depth), turbidity, and electrical conductivity. The sensor suite can be deployed in streams for 3-6 months at a time taking data every 20 minutes. The frequency of data collection can be changed which will affect battery life. Smart Rock assembly has been streamlined to make assembly and programming as accessible as possible. We want water sensing to be affordable and accessible to water scientists around the world. Our goal with the Smart Rock remains to develop an affordable, user friendly, low cost, and accessible for our different users needs. For those familiar with previous versions of the Smart Rock let me cover what has changed with this latest revision. We have designed our own electrical conductivity sensor with increased control for the user to change the range and resolution of the sensor. The enclosure has shrunk with a new selection of batteries doubling the capacity of the previous version's battery. We worked on stabilizing the code and simplifying the operation. You can now control the unit's settings via a config file on the SD card. No more Arduino reprogramming to change settings.



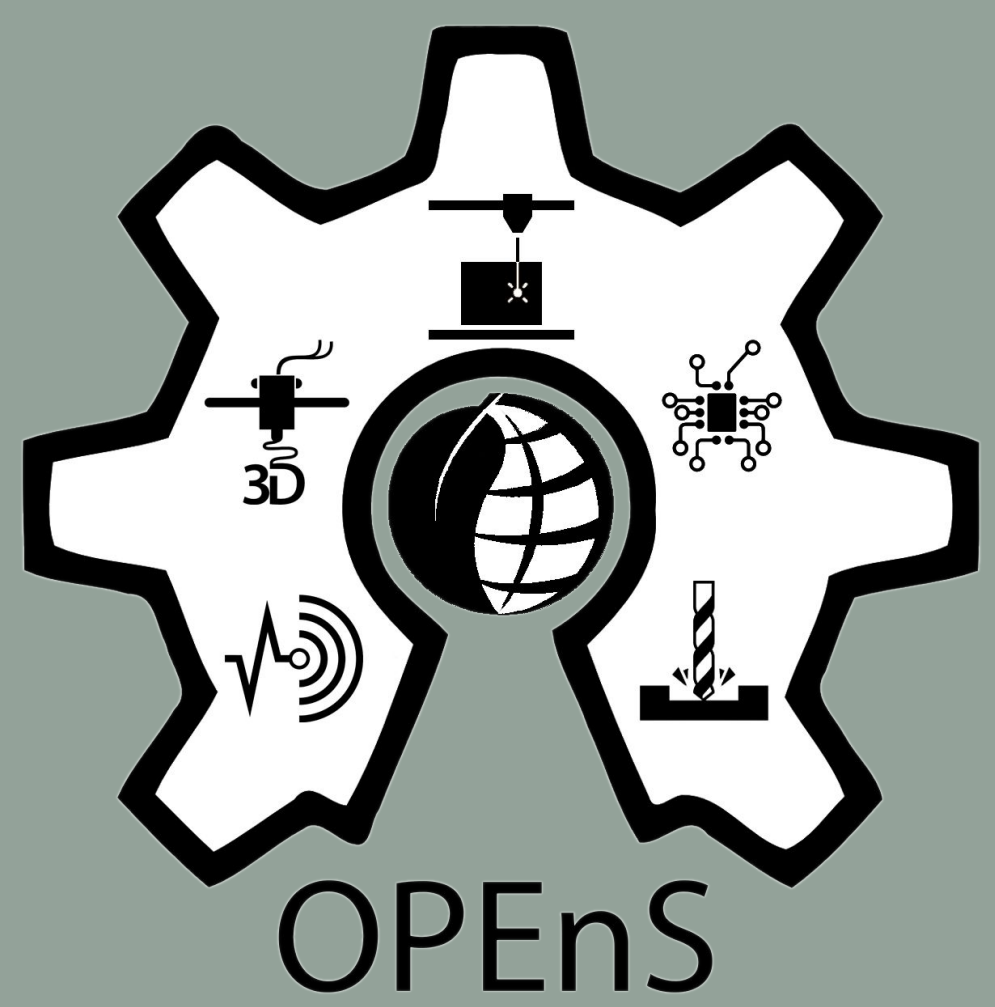


Oregon State  
University

# Smart Rock: Low-Cost User-Friendly Stream Monitoring

Colin Hale-Brown<sup>1</sup>, Brenda Fasse<sup>1</sup>, Annika Sundstorm<sup>1</sup>, Cara Walter<sup>1,2</sup>, Dr. Chet Udell<sup>1,2</sup>, Dr. John S Selker<sup>1,2</sup>

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## ABSTRACT

The Smart Rock is a submersible sensor suite that monitors temperature, pressure (water depth), turbidity, and electrical conductivity. The sensor suite can be deployed in streams for 3-6 months at a time taking data every 20 minutes. The frequency of data collection can be changed which will affect battery life. Smart Rock assembly has been streamlined to make assembly and programming as accessible as possible. We want water sensing to be affordable and accessible to water scientists around the world. Our goal with the Smart Rock remains to develop an affordable, user friendly, low cost, and accessible for our different users needs.

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## PURPOSE

Current hydrological monitoring is lacking many locations around the world as we see the effects of climate change and human influence. Stream monitoring is traditionally costly putting the responsibility on the governments or groups responsible for the pollution. Smart Rock aims to fill these gaps and to do so it offers:

- Low-cost kits/ units
- Open-source Arduino-programmable hardware and software
- Discrete deployment for high traffic areas
- Includes temperature, pressure (for water depth), turbidity, and electrical conductivity



## ACKNOWLEDGMENTS

The project is supported by the USDA NIFA Hatch Act (Regular Research Fund, ORE00218, ORE00218A) and the National Science Foundation award #1832170. We are thankful for all the support of the community in testing and working with us to improve the Smart Rock.

### Contact Information

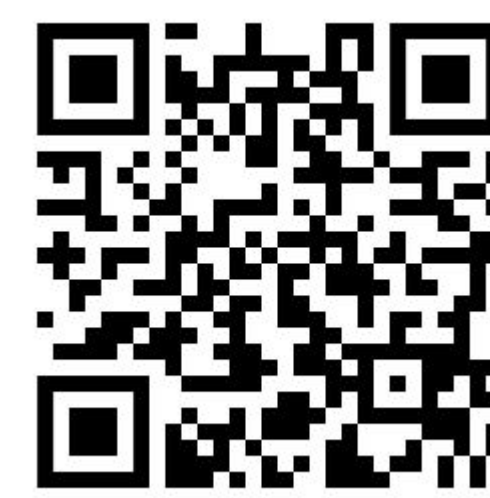
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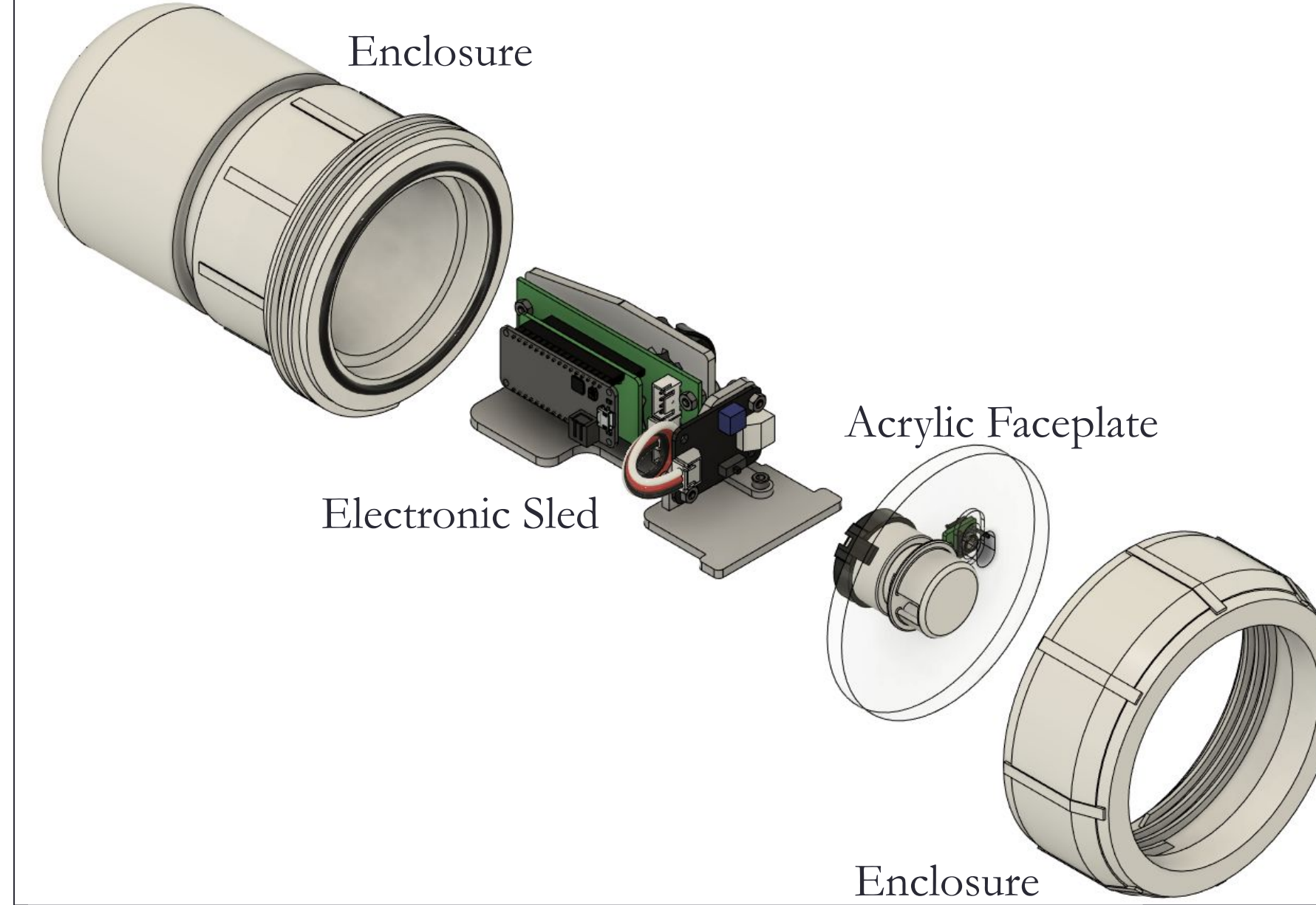
OPEnS Website



Smart Rock Github

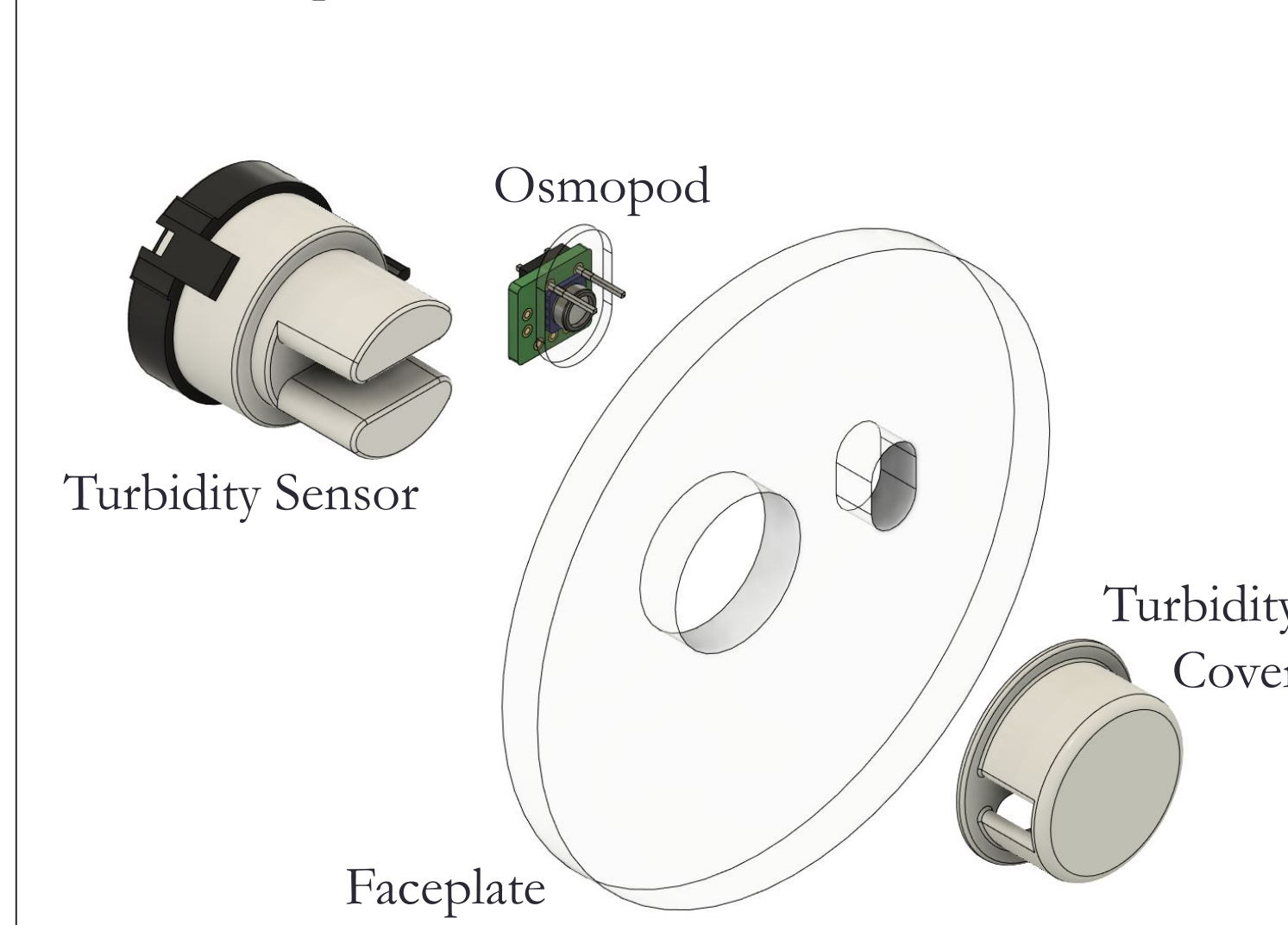
## COMPONENT BREAKDOWN

### Smart Rock Overview

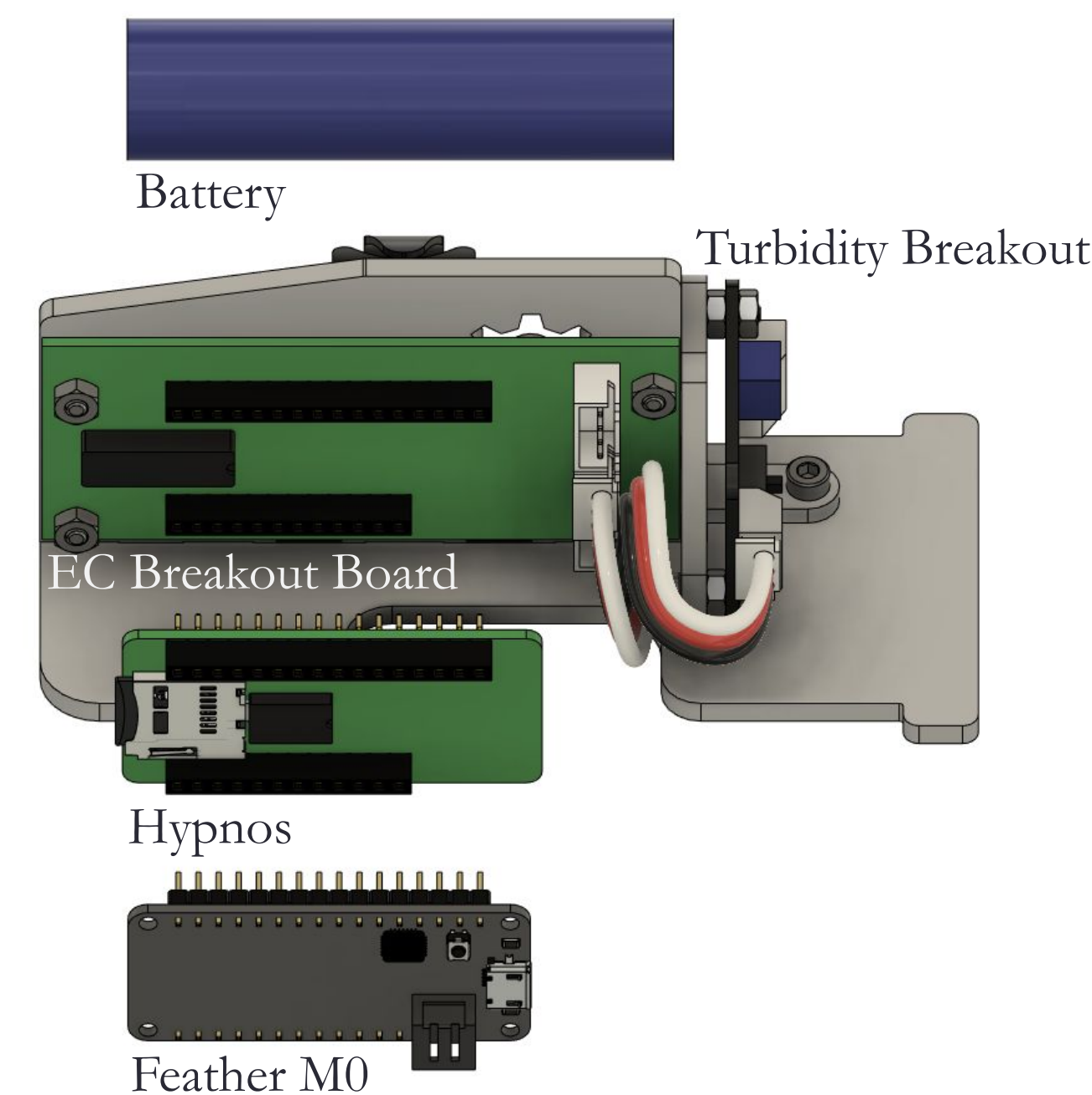


- Powered by a 2200mAh (3-5 months) or 4400mAh (5-7 months) battery.
- Electronics Sled holds the circuit board and battery for the unit.
- Acrylic faceplate safely exposes the sensors to the stream while keeping water out of the unit.
- Osmopod contains the MS5803-02 pressure and temperature sensor along with the 2 electrical conductivity probes.
- Enclosure is made of welded schedule 40 PVC.

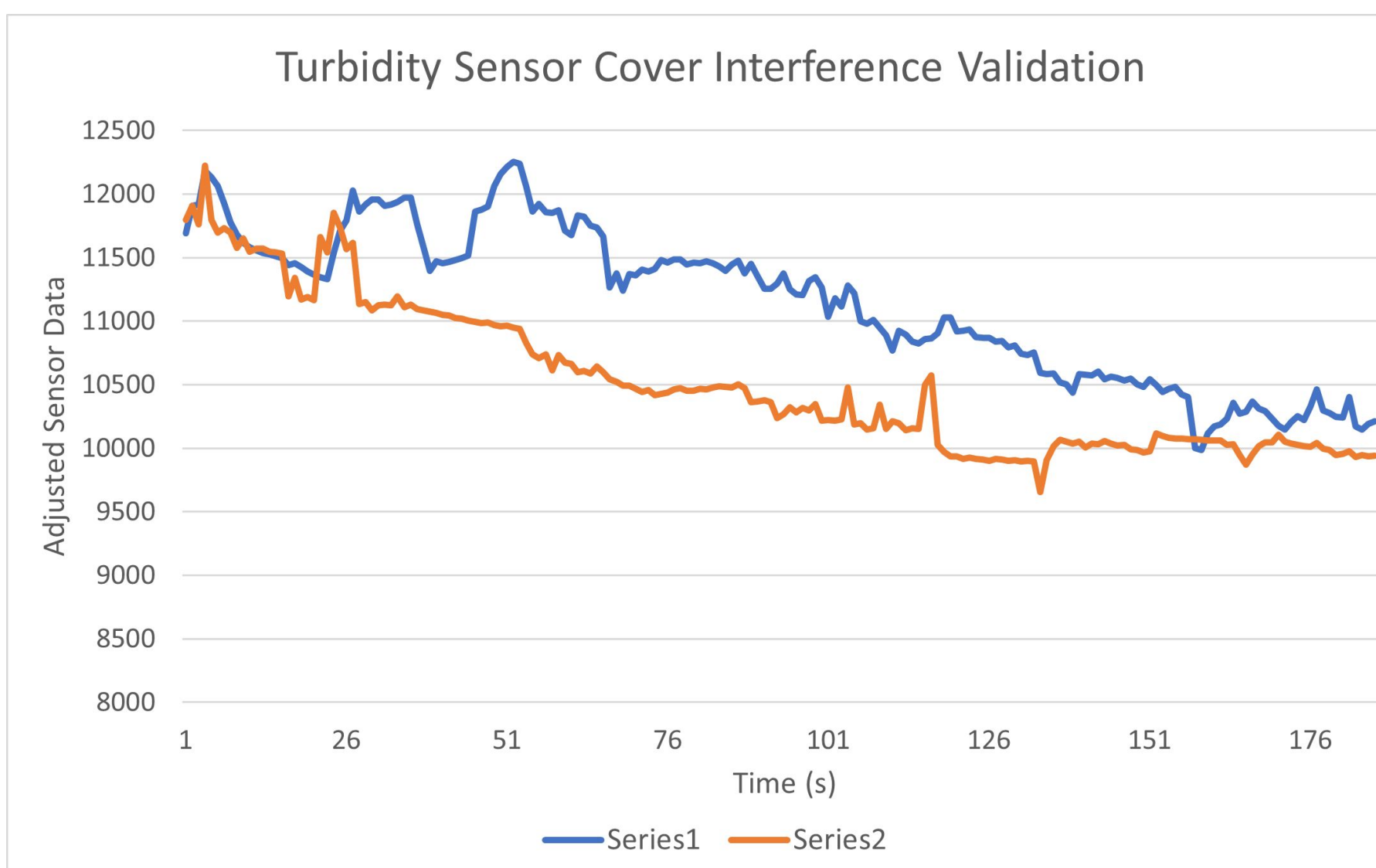
### Acrylic Faceplate Overview



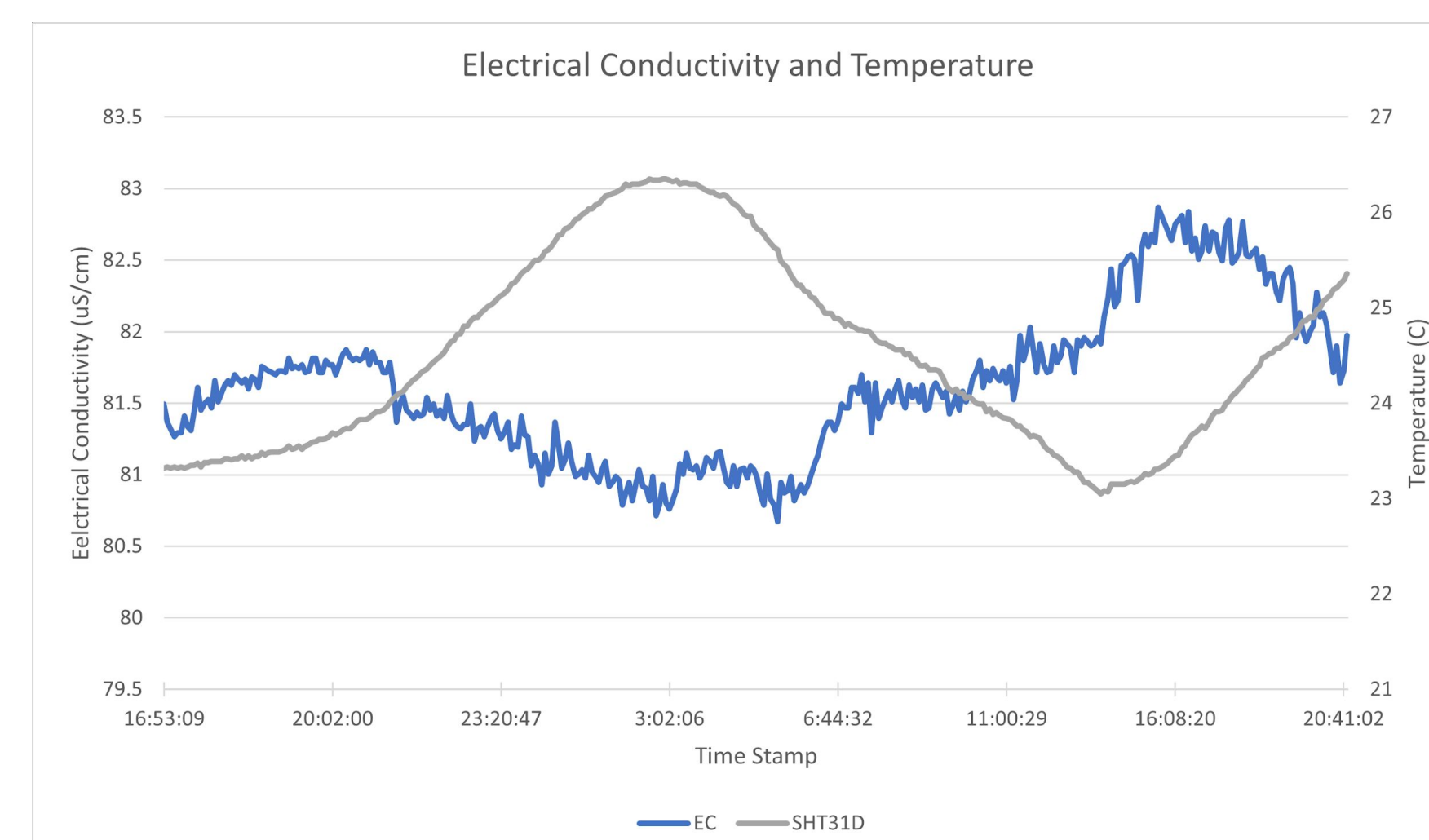
### Electronics Sled Overview



## TESTING

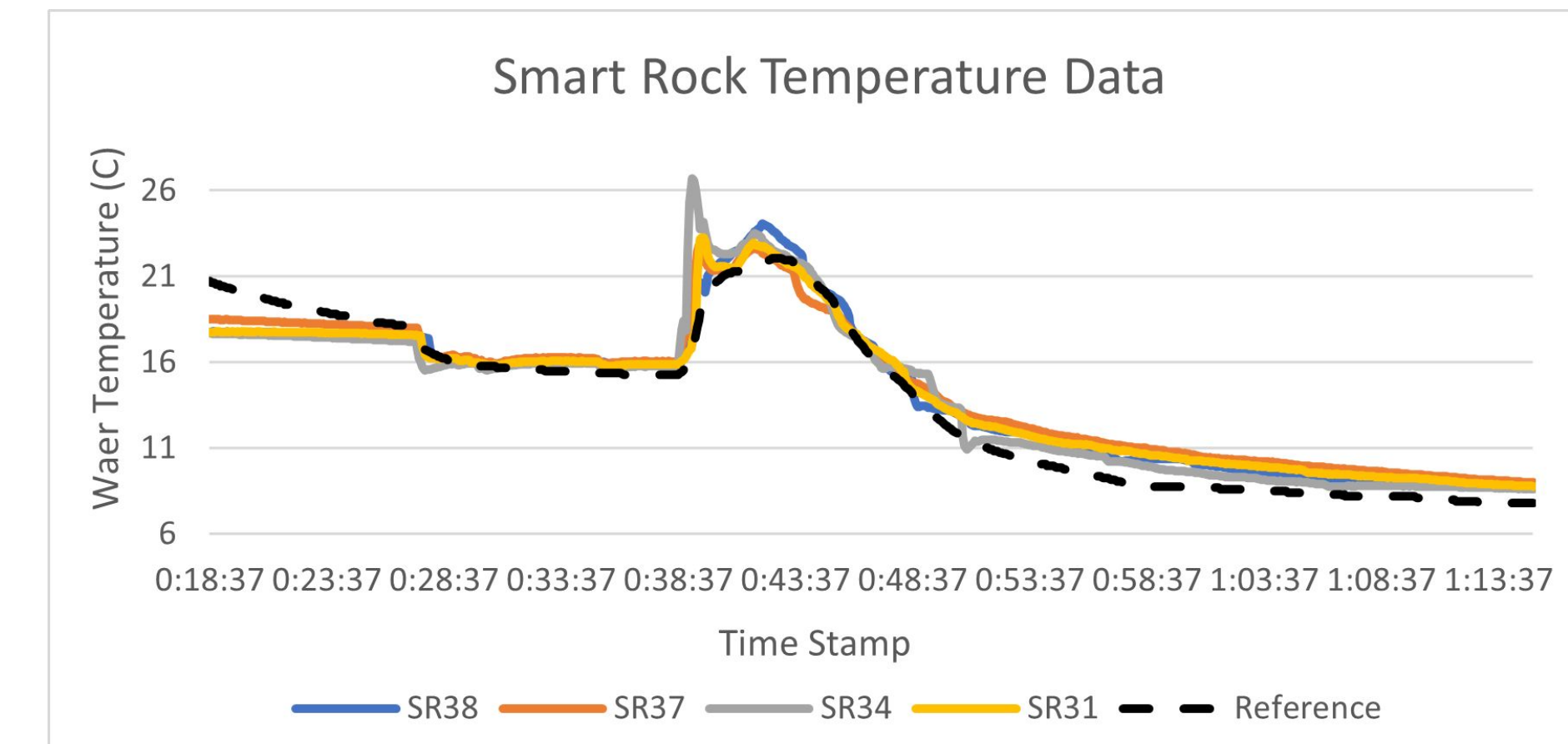
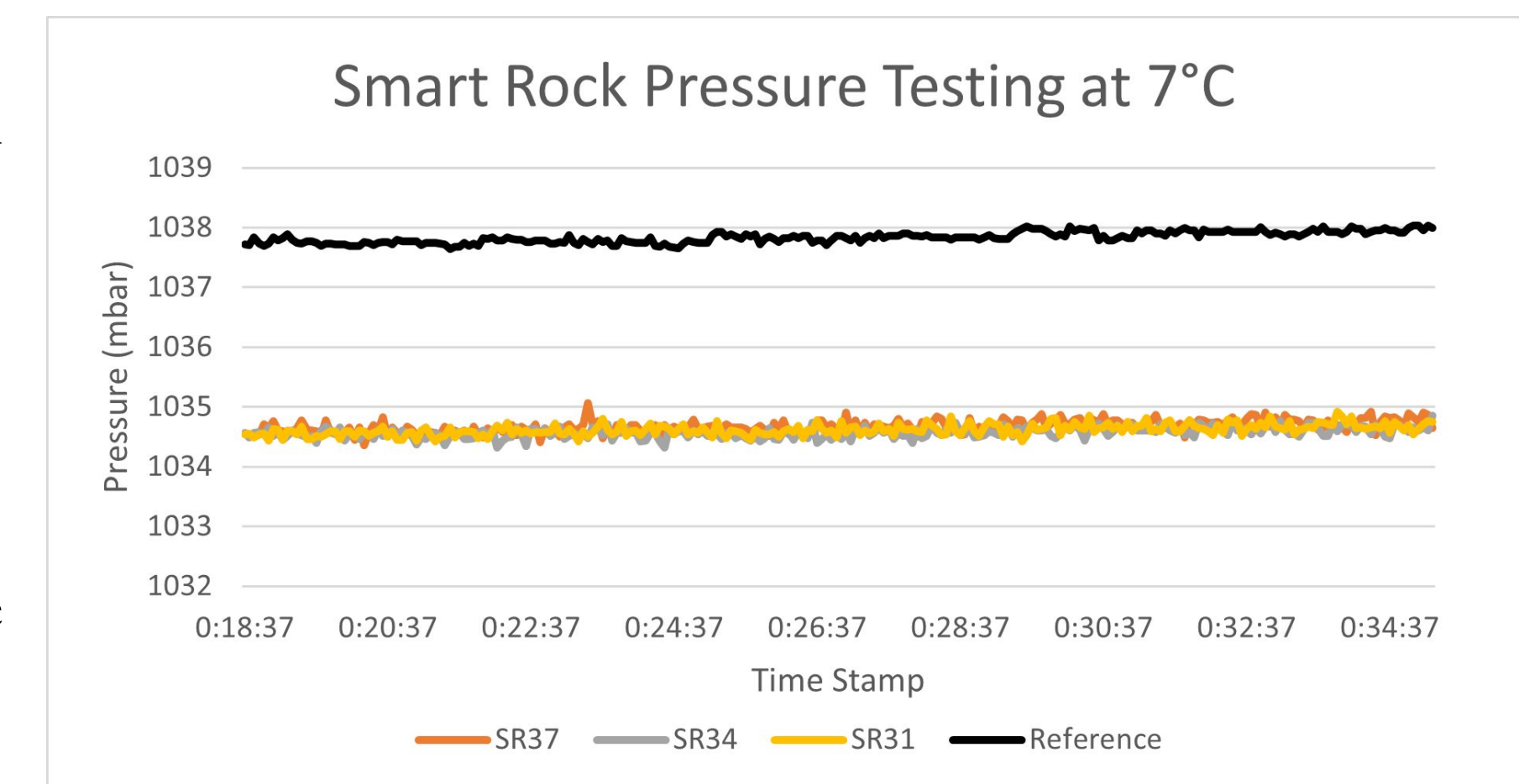


The turbidity cover of the Smart Rock aims to reduce the outside interference of reflecting light from the sun. This is a worst-case scenario one taken with and one without the cover. This demonstrates how the cover reduces noise and improves the quality of the sensor.



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All these sensors were tested at the same time in the same bin. The reference was sitting on the bottom of the bin 1.2in( 3.05cm) below the Smart Rock's sensor. This explains the shift we see in the reference. sensor.



All these sensors were tested at the same time in the same bin, some of the variation is due to placement and distance to the ice that was added. The Reference probe was below all the Smart Rocks being tested.

## RESULTS

Smart Rock V3 Specs.	Metric	Range (min)	Range (max)	Value/Accuracy
Battery Life 2200mAh @ 20 min freq.	Months	-	4	+/- 1
Battery Life 4400mAh @ 20 min freq.	Months	-	6	+/- 1
MS5803-02 Pressure (Data Sheet)	mbar	10	1300	+/- 2.5
MS5803-02 Temperature (Data Sheet)	°C	-40	85	+/- 0.8
Turbidity (Data Sheet)	ntu	0	4000	+/- 10%
Electrical Conductivity	µS	0	200	+/- 2
MS5803-02 Pressure (Experimental)	mbar	10	1300	+/- 2.6
MS5803-02 Temperature (Experimental)	°C	-40	85	+/- 0.94
Turbidity (Experimental)	Qualitative Zones	3	7	

We originally intended the EC sensor to have a much larger maximum range, closer to ~2000µS. This modification has been inconsistent across the Smart Rocks making the sensor unreliable above 200µS. We have also seen biofilm eat away the film of the MS5803 in one deployment. It is unlikely however possible.

## Future Directions

The Smart Rock team plans to work toward improving the quality and range of the EC sensor. A 4-pin sensor will be used which reduces the effects of biofouling and increases reliability. We also plan to make the Smart Rock capable of fitting down a 2" pipe so it can more easily be used in pipes/ wells. If possible, we would like to also increase the capacity of the onboard battery.

Long term we hope to add some form of wireless communication to the Smart Rock for remote data retrieval.