

Development and Testing of a New ISFET pH Sensor for use on Autonomous Platforms

Peter M. Walz, Kenneth S. Johnson, Yuichiro Takeshita, Luke Coletti,

Ben Davis, Jessica Metter and Gene Massion

Monterey Bay Aquarium Research Institute, Moss Landing, CA 95039 wape@mbari.org

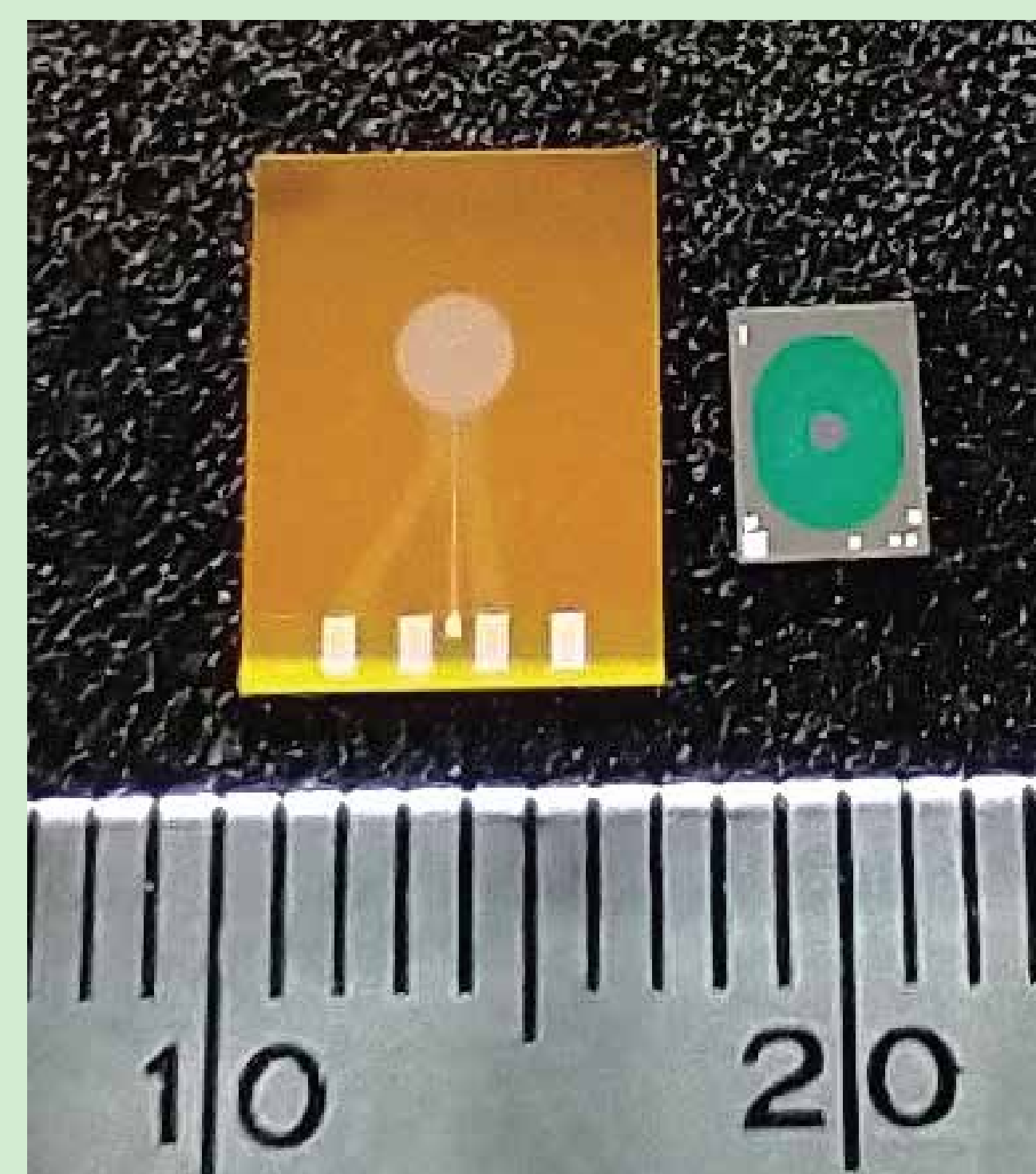
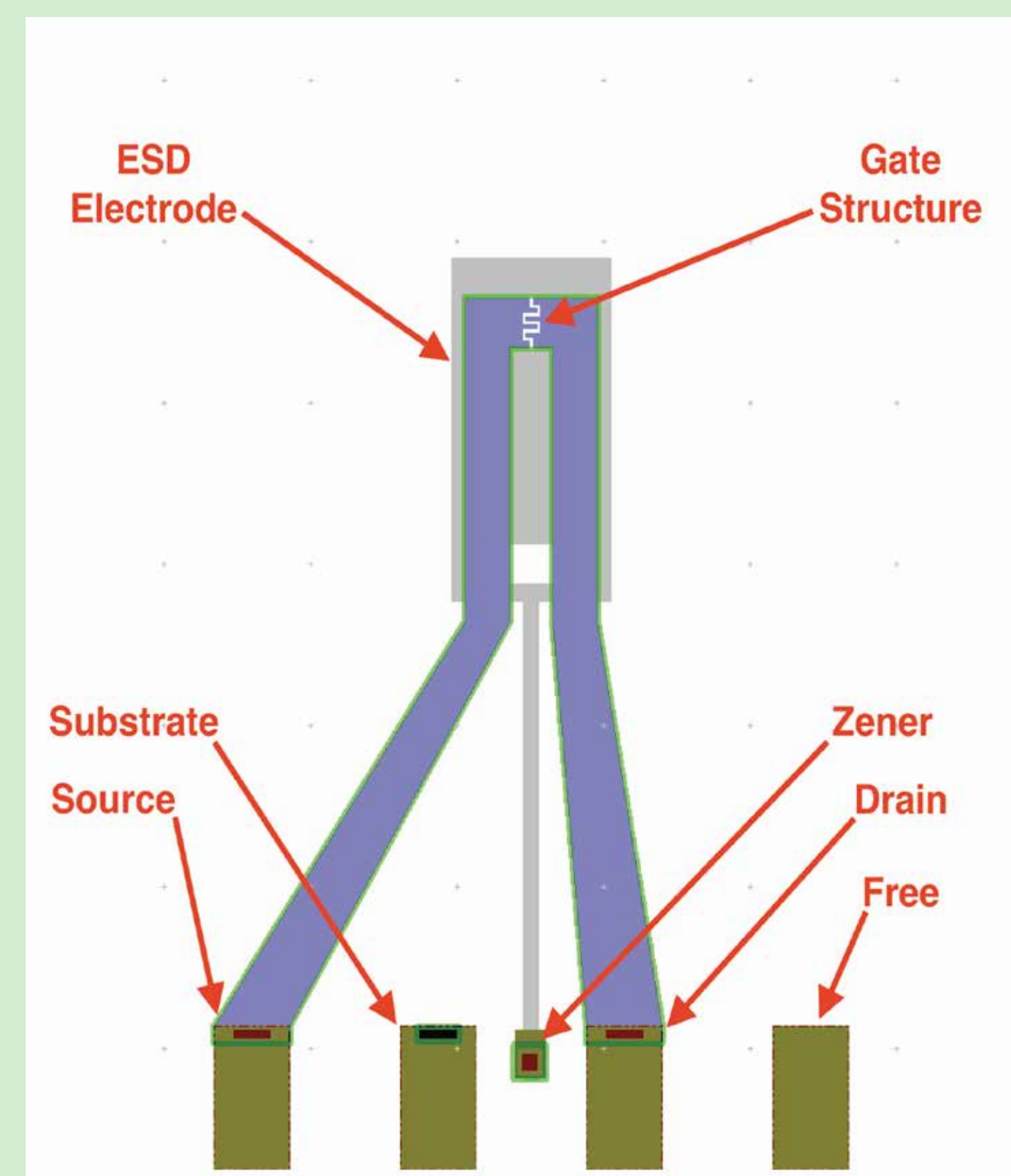
OT14B-1463

What?

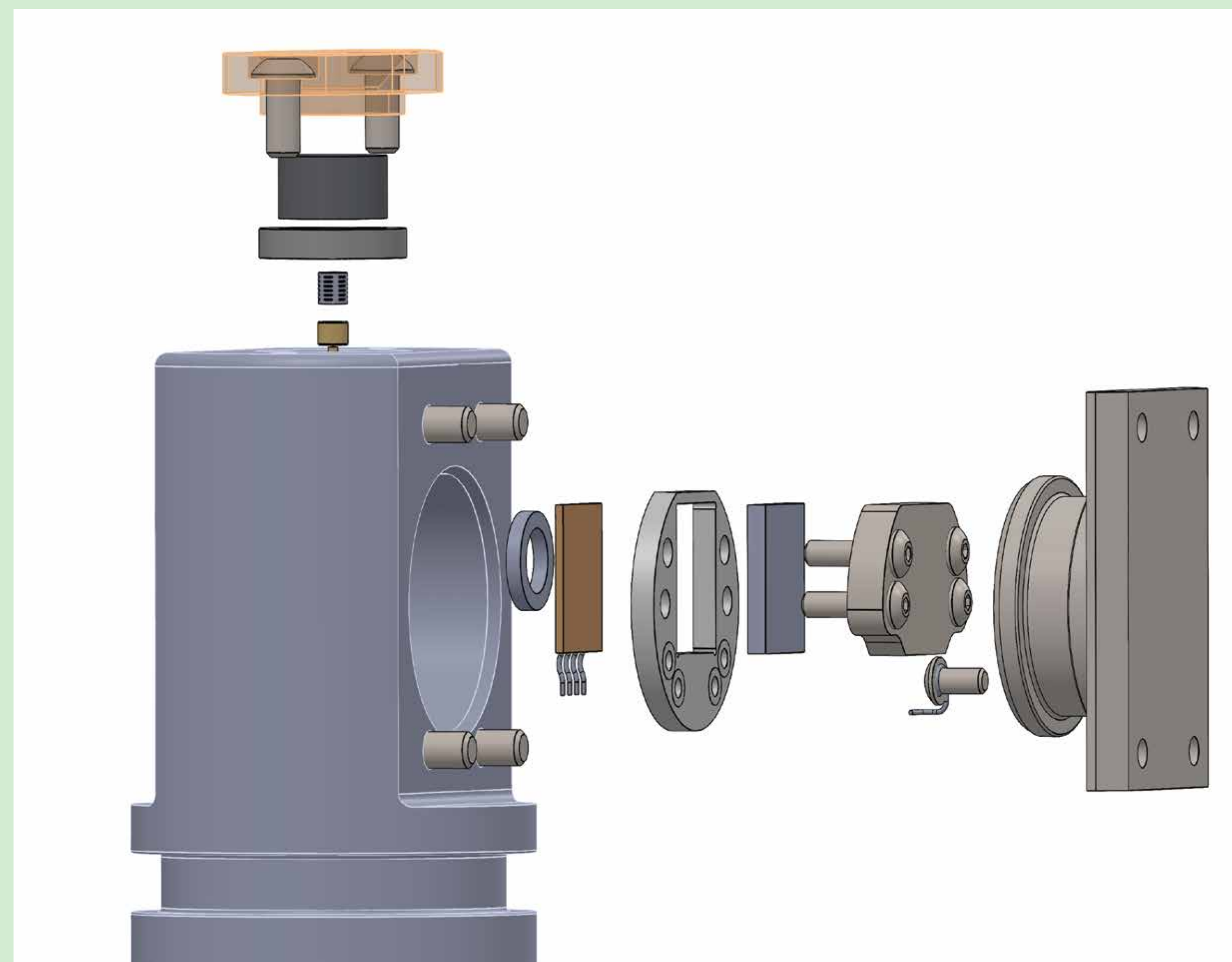
- Ion sensitive field effect transistors (ISFETs) have been used to measure pH in seawater, such as the Honeywell Deep-Sea Durafet.
- Here we report preliminary lab testing and field results of a new ISFET made by LioniX, to measure pH in deep waters up to 2000m depth.

Principles and advantages of this new pH sensor:

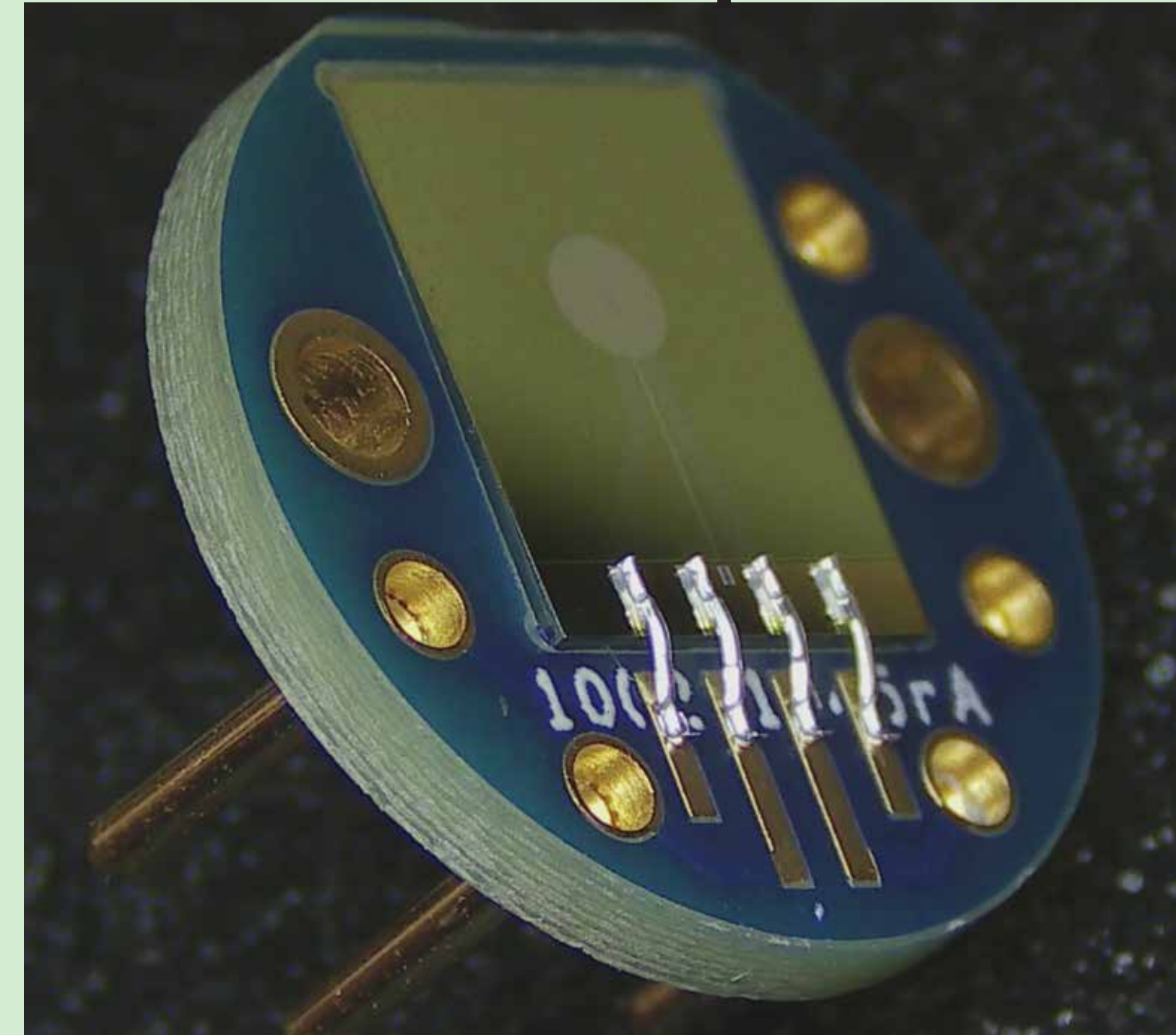
- Both ISFETs are based on ion implantation and a tantalum oxide gate dielectric, and both exhibit a Nernstian response and minimal drift.
- The surface area of the LioniX chip is 4x larger than the Honeywell chip, making it more suitable for packaging and use on profiling floats, gliders, or other long-term observation platforms.
- Beneficial to have multiple ISFET vendors for novel oceanic pH sensors.



LioniX (left) and Honeywell (right). Ruler scale is in mm.

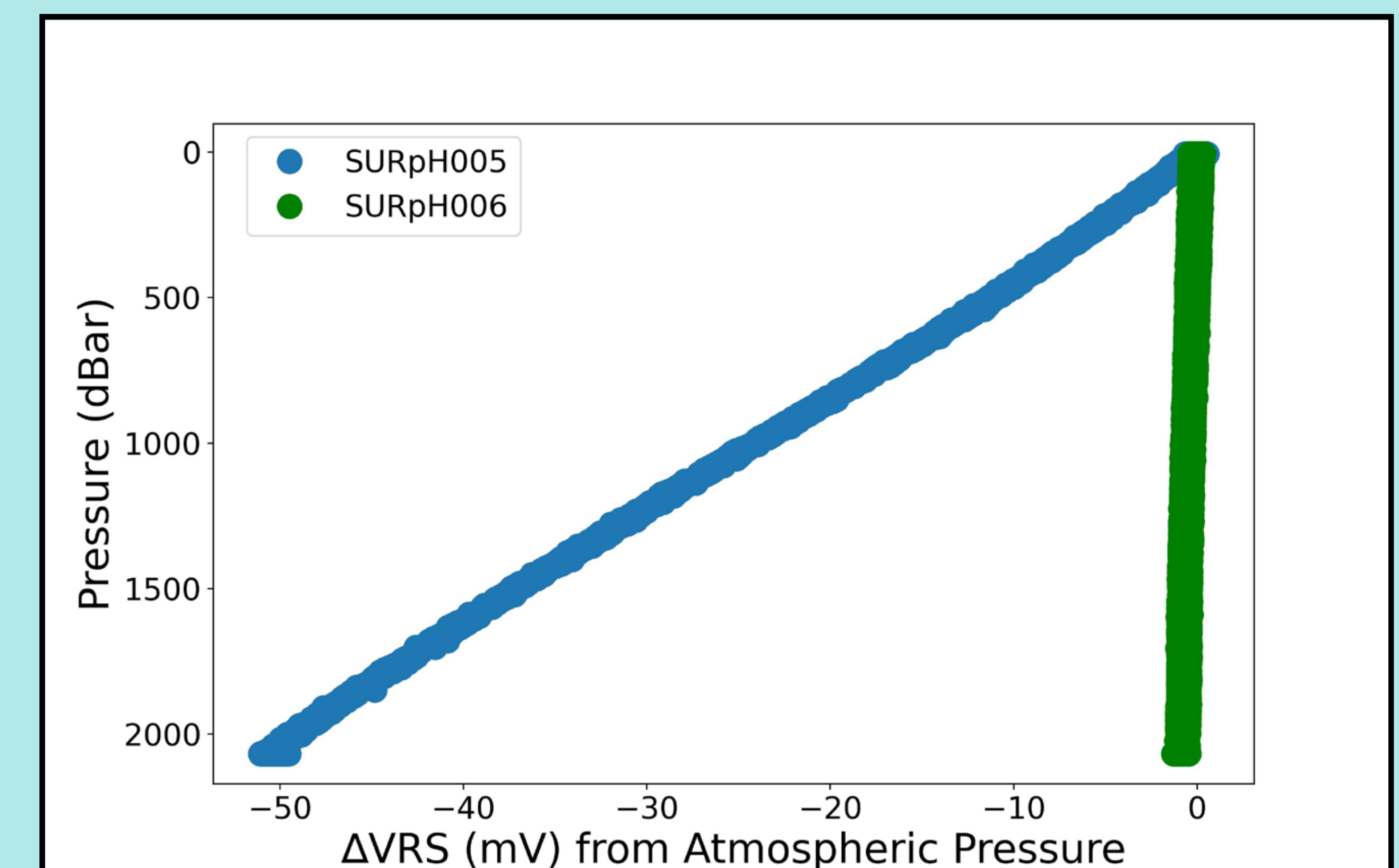


SURpH: Semiconductor Underwater pH sensor



Pressure Balanced Design

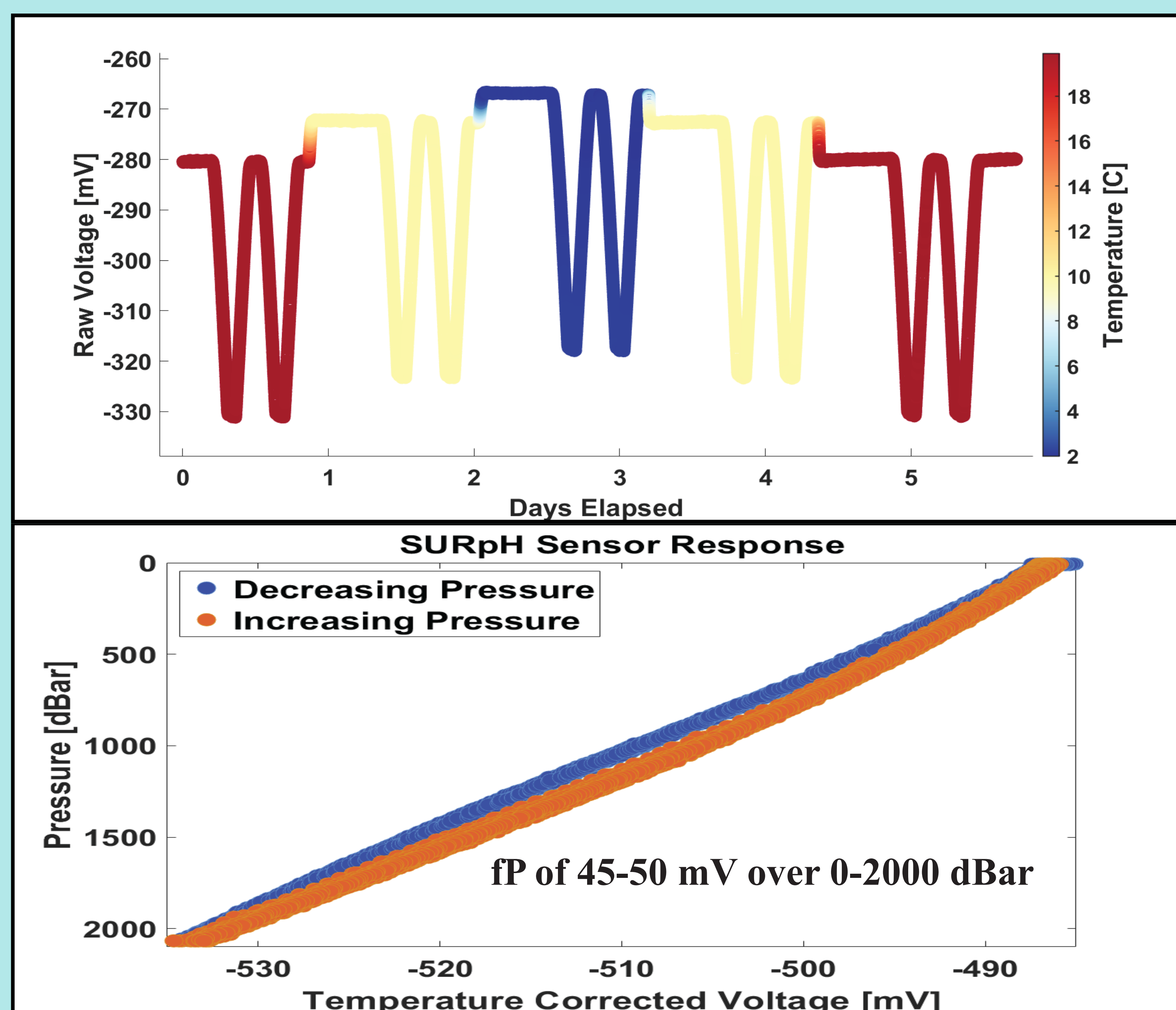
The larger surface area of the LioniX isfet results in a much larger pressure coefficient compared to the Honeywell. Pressure compensating the sensor by filling the inner volume with silicone oil has both reduced the pressure coefficient and resulted in a linear fP. fP decreased from 45-50mV (blue line) to 3-4 mV (green line).



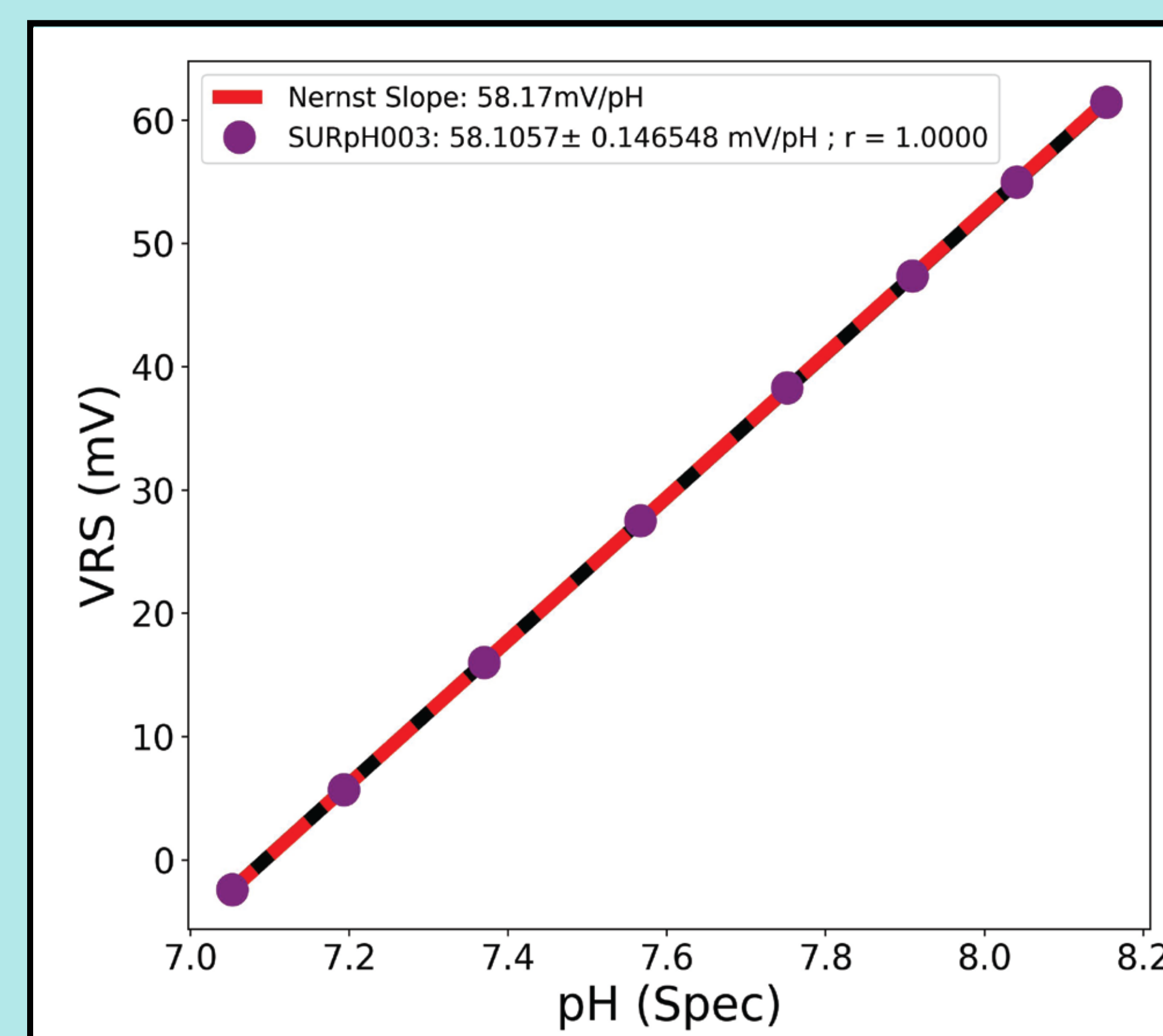
Pressure response of two LioniX sensors: SURpH 005 and 006. SURpH 006 has been pressure compensated and now has a very small pressure coefficient. We plan to use future Spray Glider deployments in Monterey Bay to test this pressure balanced design.

Pressure and temperature calibration in the lab

Any ISFET responds to changes in pressure and temperature so we characterize each sensor in a known calibration solution (0.01 N HCl). Plots below illustrate the typical LioniX ISFET voltage changes in Vrs over 0-2000 dbar pressure cycles run at 20, 10, and 2 C.



Nernst Titrations



- Sensor was titrated with CO₂ over the oceanic pH range in seawater and showed Nernstian behavior
- Purple dots are discrete pH samples (measured using spectrophotometry)

December 2023 Spray Glider deployment Monterey Bay, CA

We performed three days of profiles to 1000 dbar. Overall performance was good and compares well to CANYONB neural network pH data. CANYONB surface discrepancies are expected in the coastal zone.

