Geodetic positioning on the deep sea floor using a one-way travel-time continuously operating reference station and an autonomous surface vessel

Harold T. “Bud” Vincent | Frederik J. Simons

Stefan Kildal-Brandt | Terance Schuh | Thalia Gueroult

Princeton University | DBV Technology | Ensta Bretagne

BEFORE WE BEGIN…

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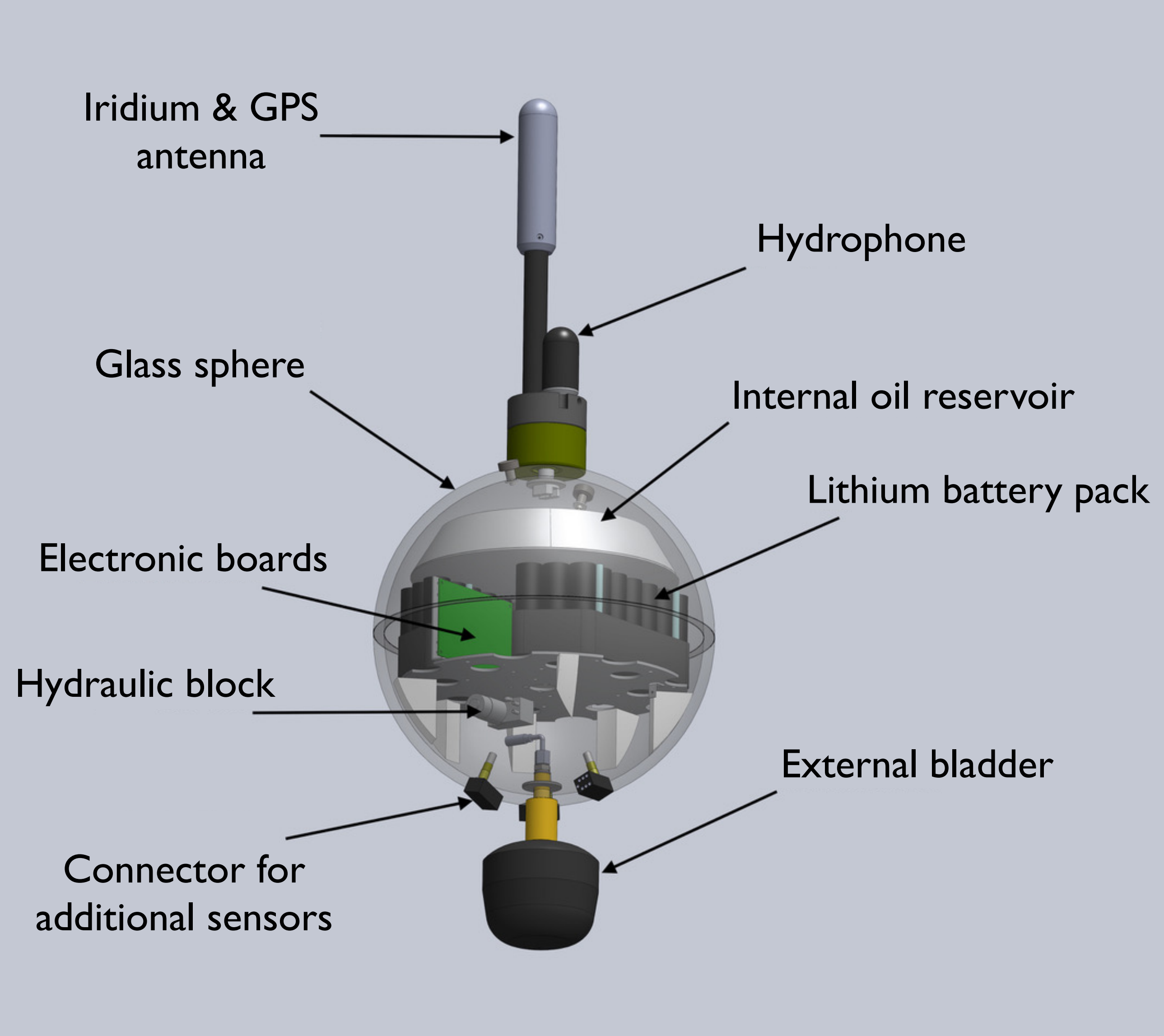

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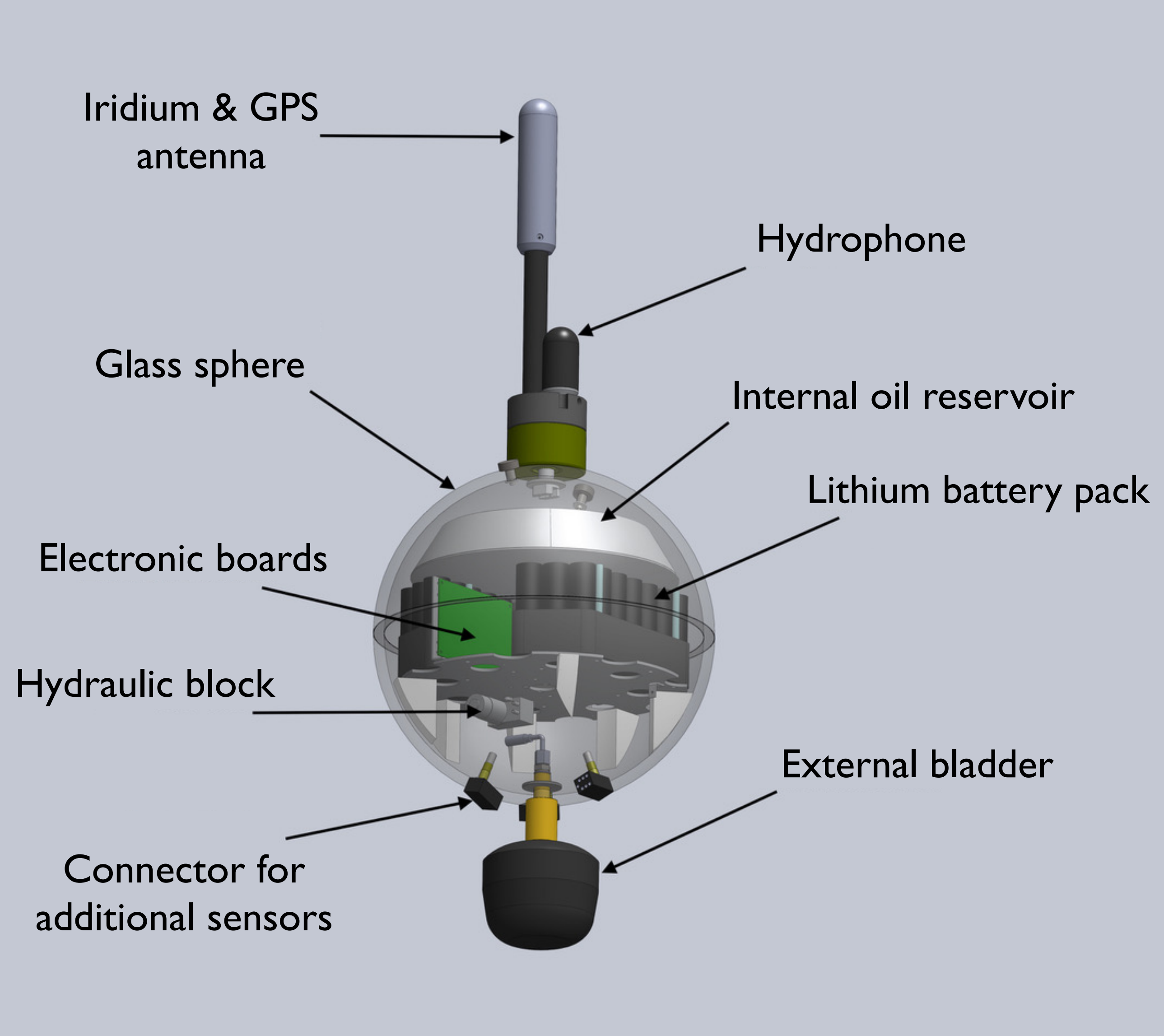

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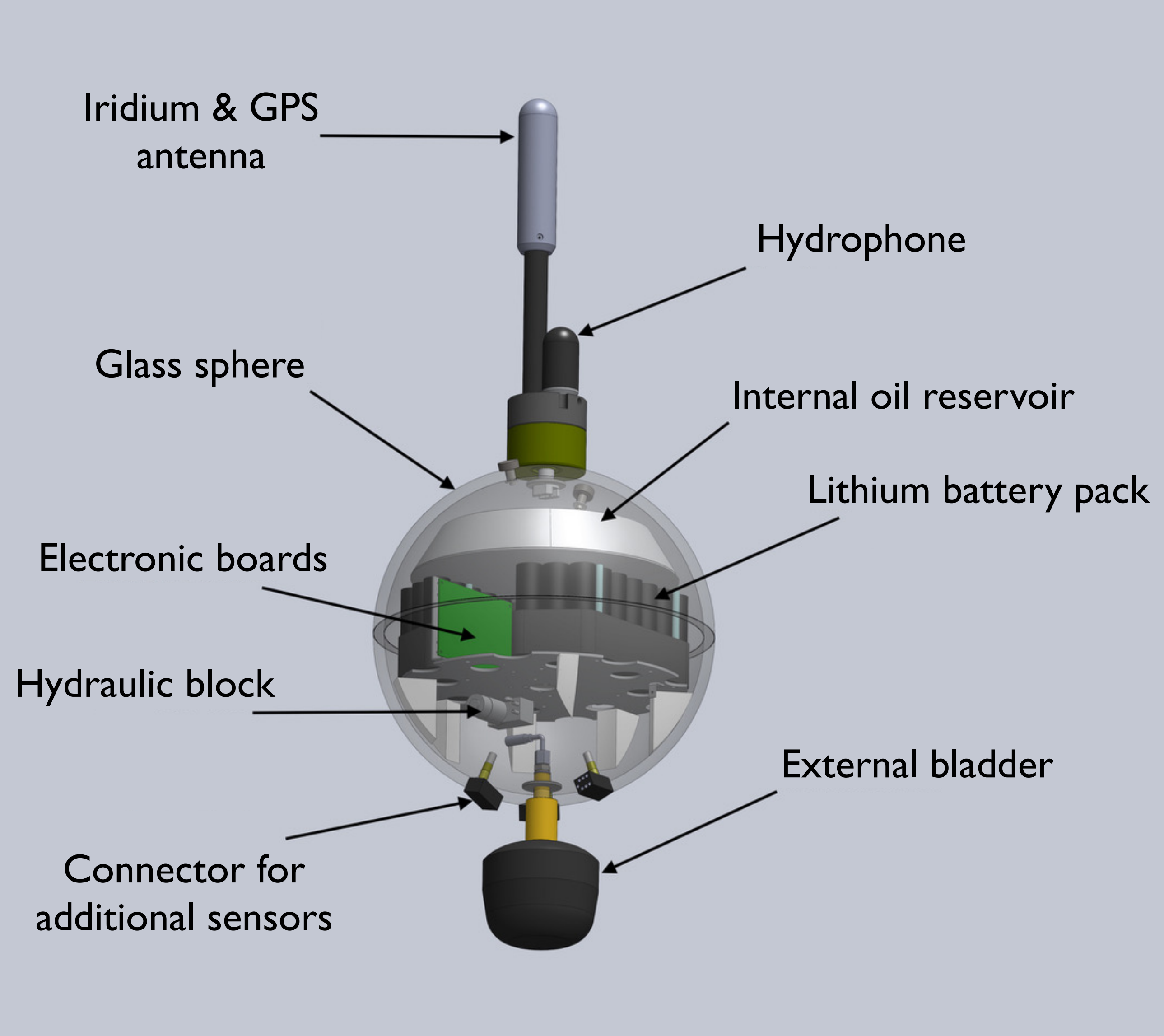

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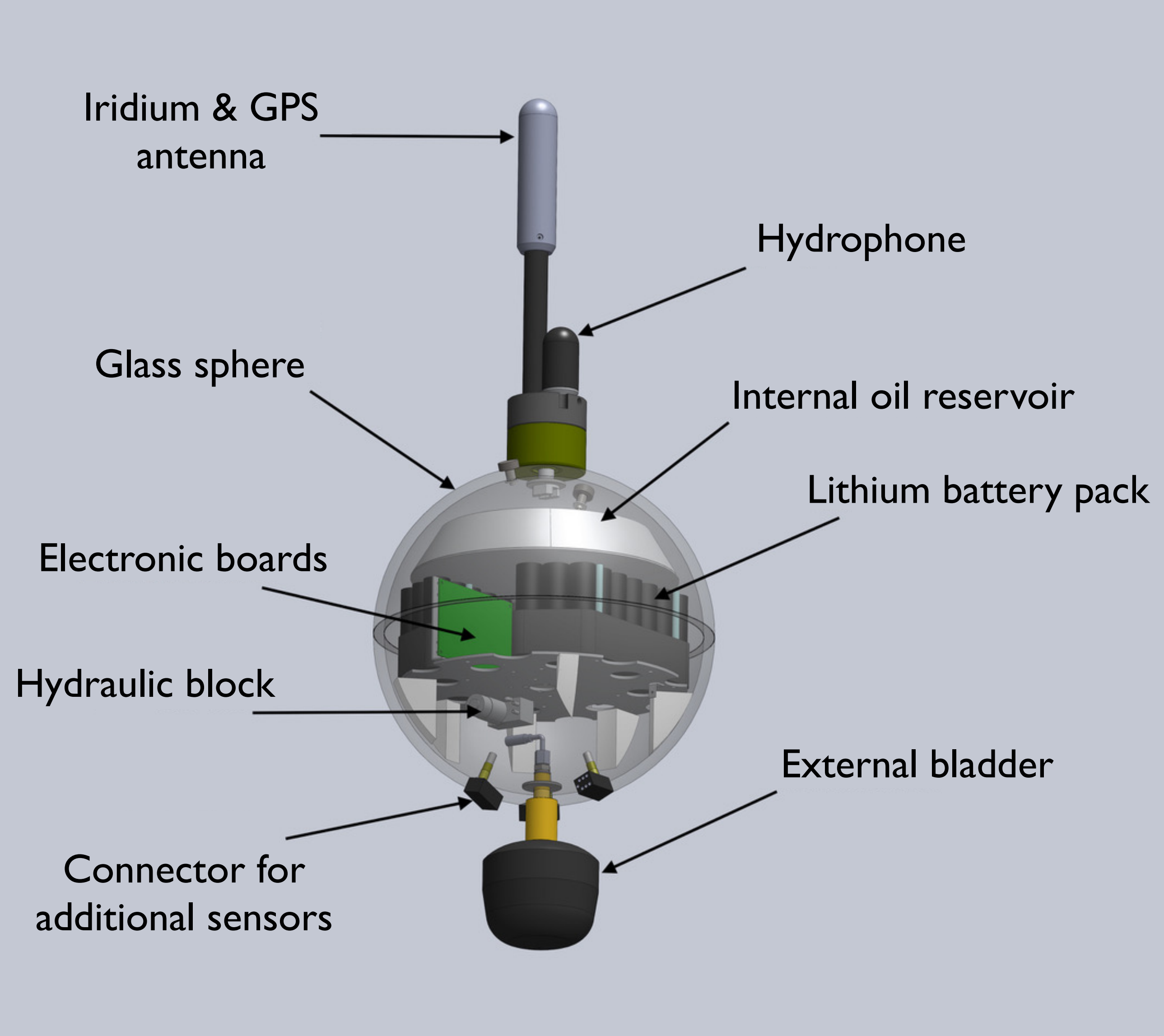

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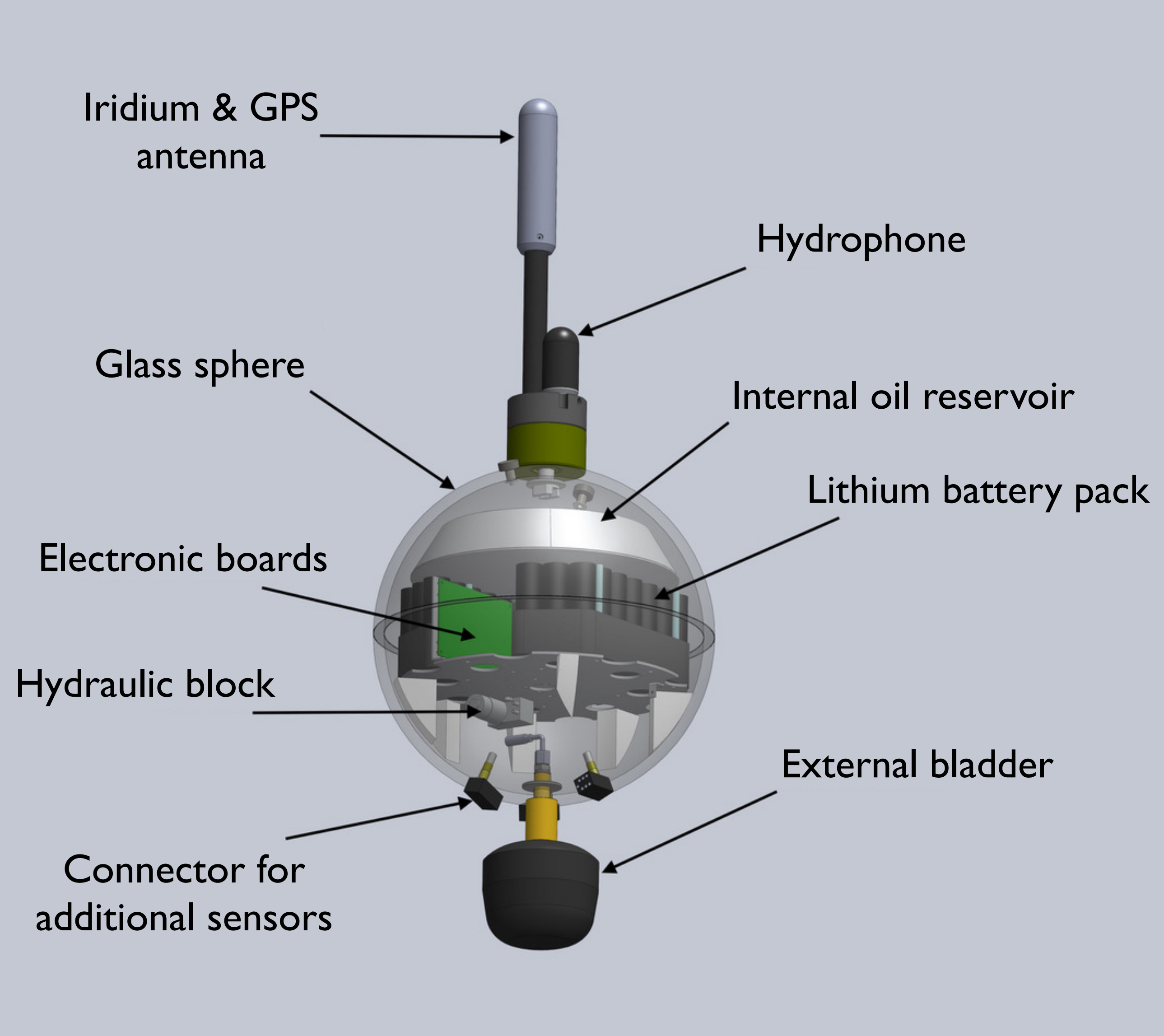

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END OF MERMAID PRELUDE

One-Way Underwater Geodetic Positioning

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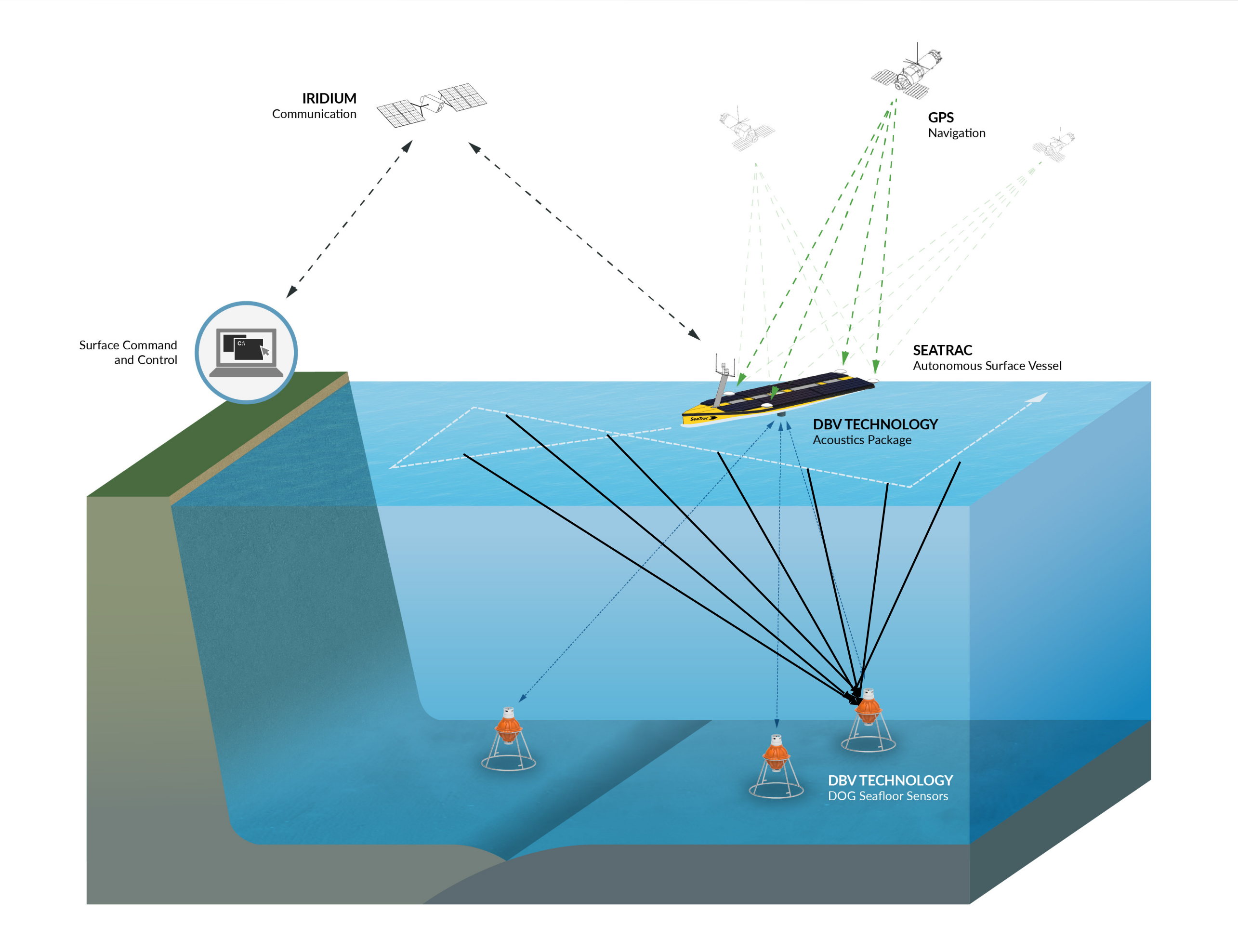

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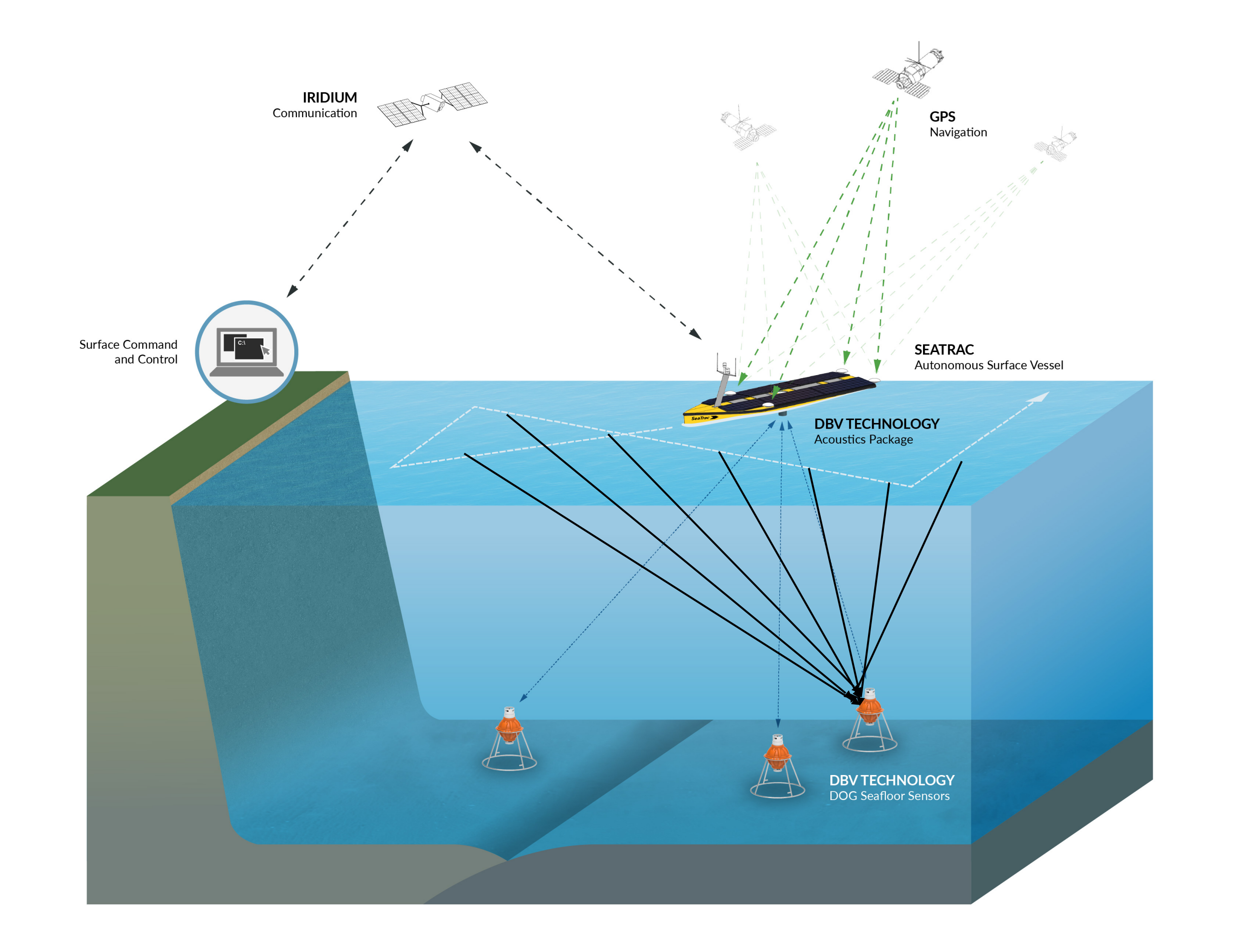

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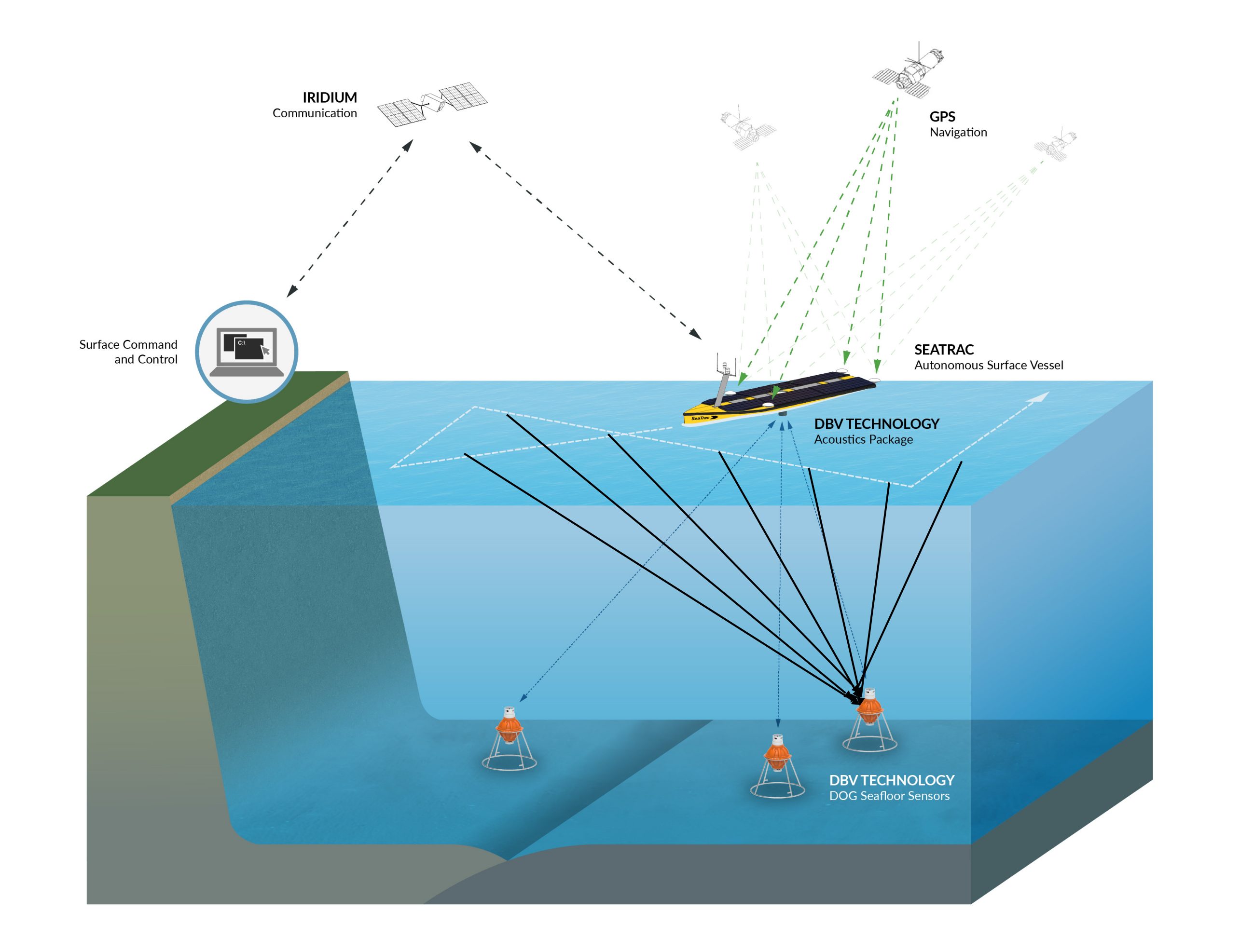

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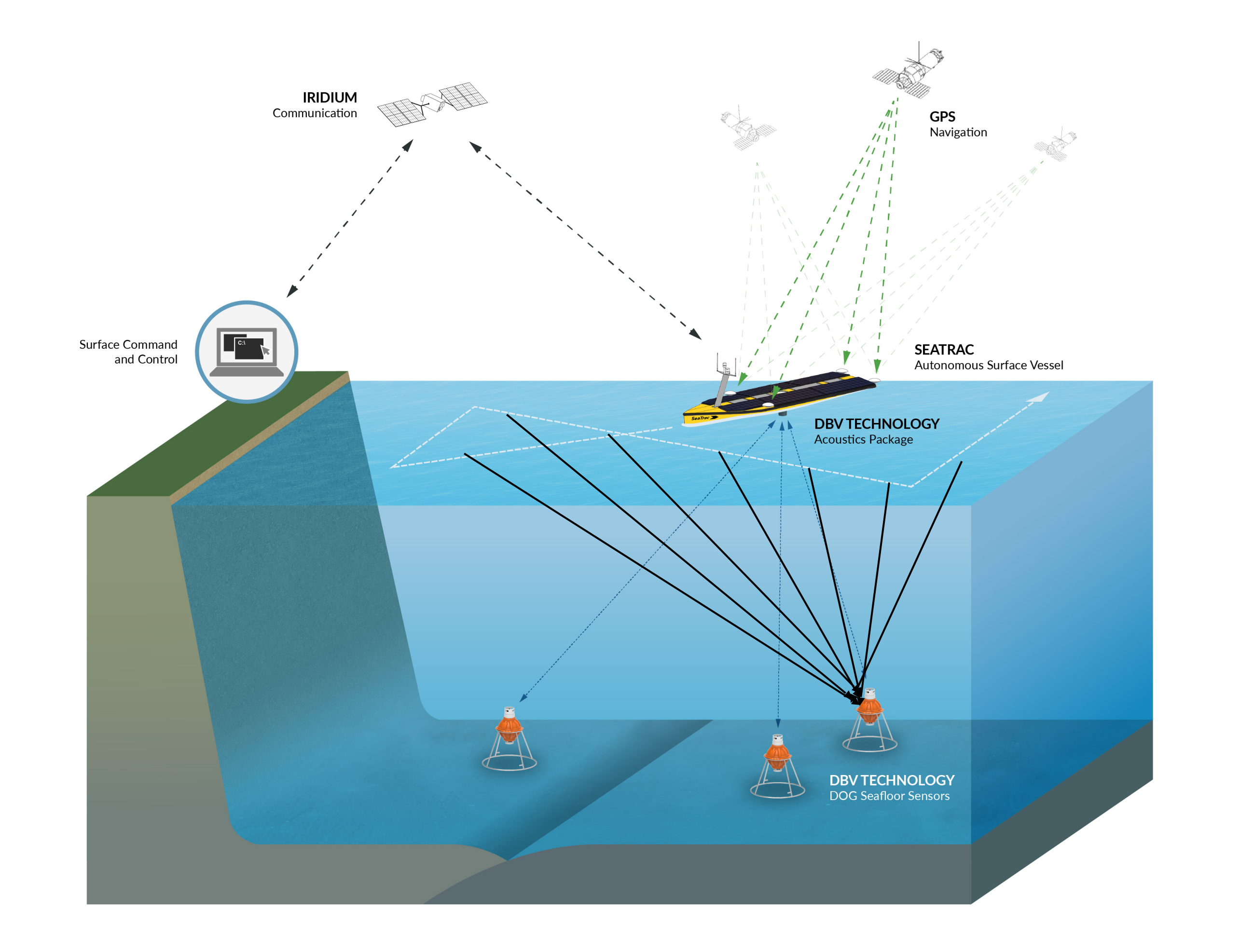

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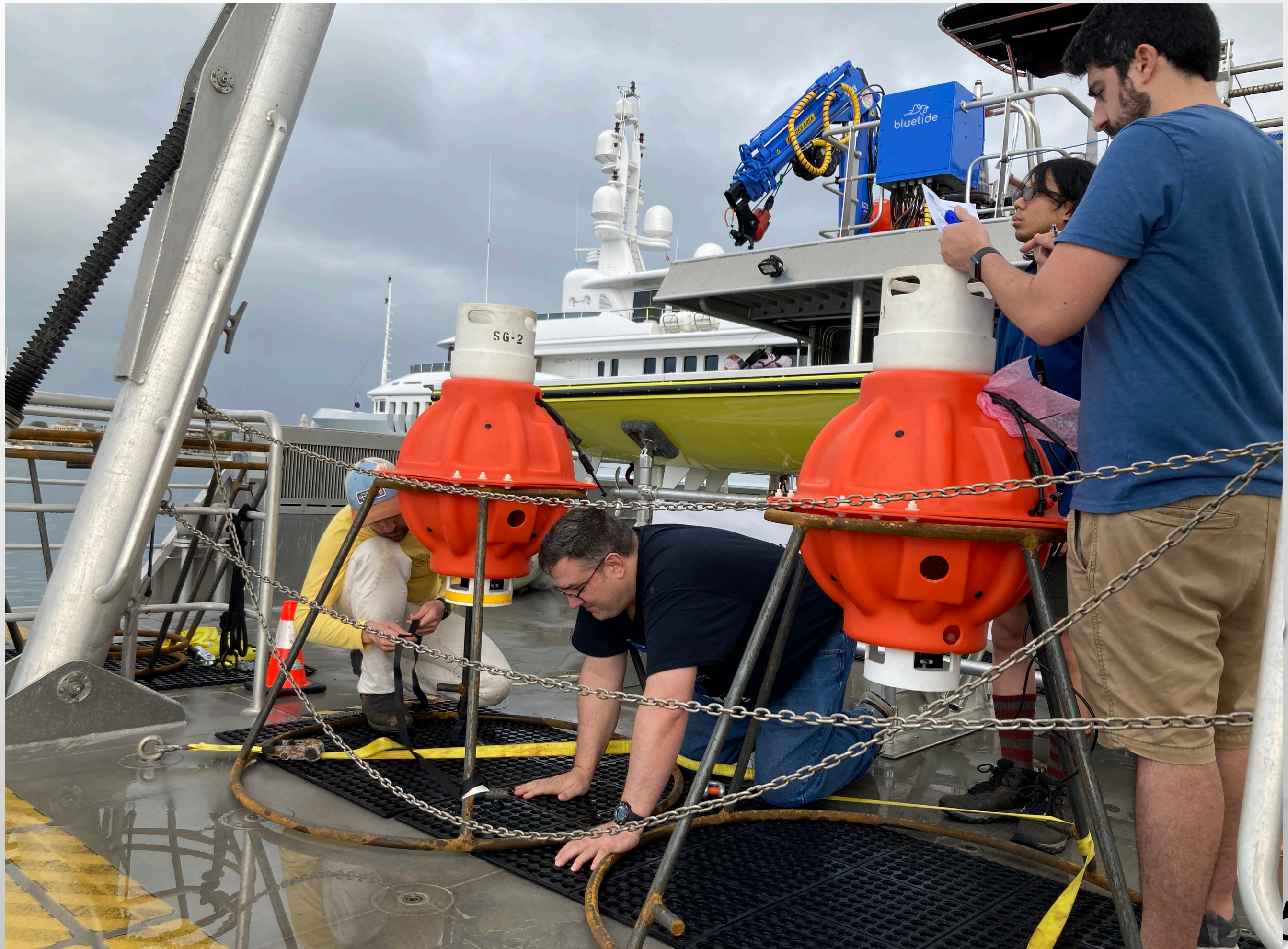

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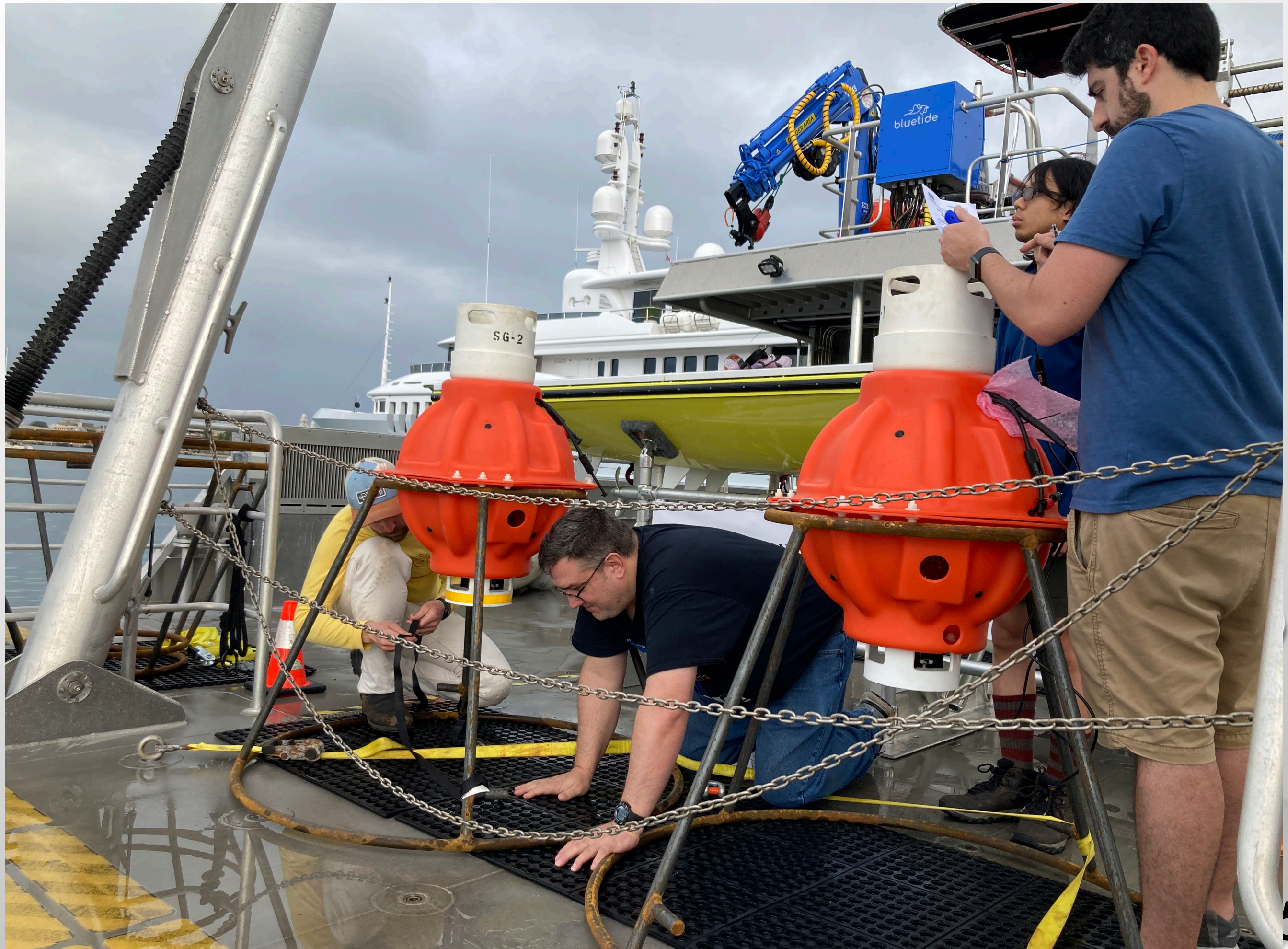

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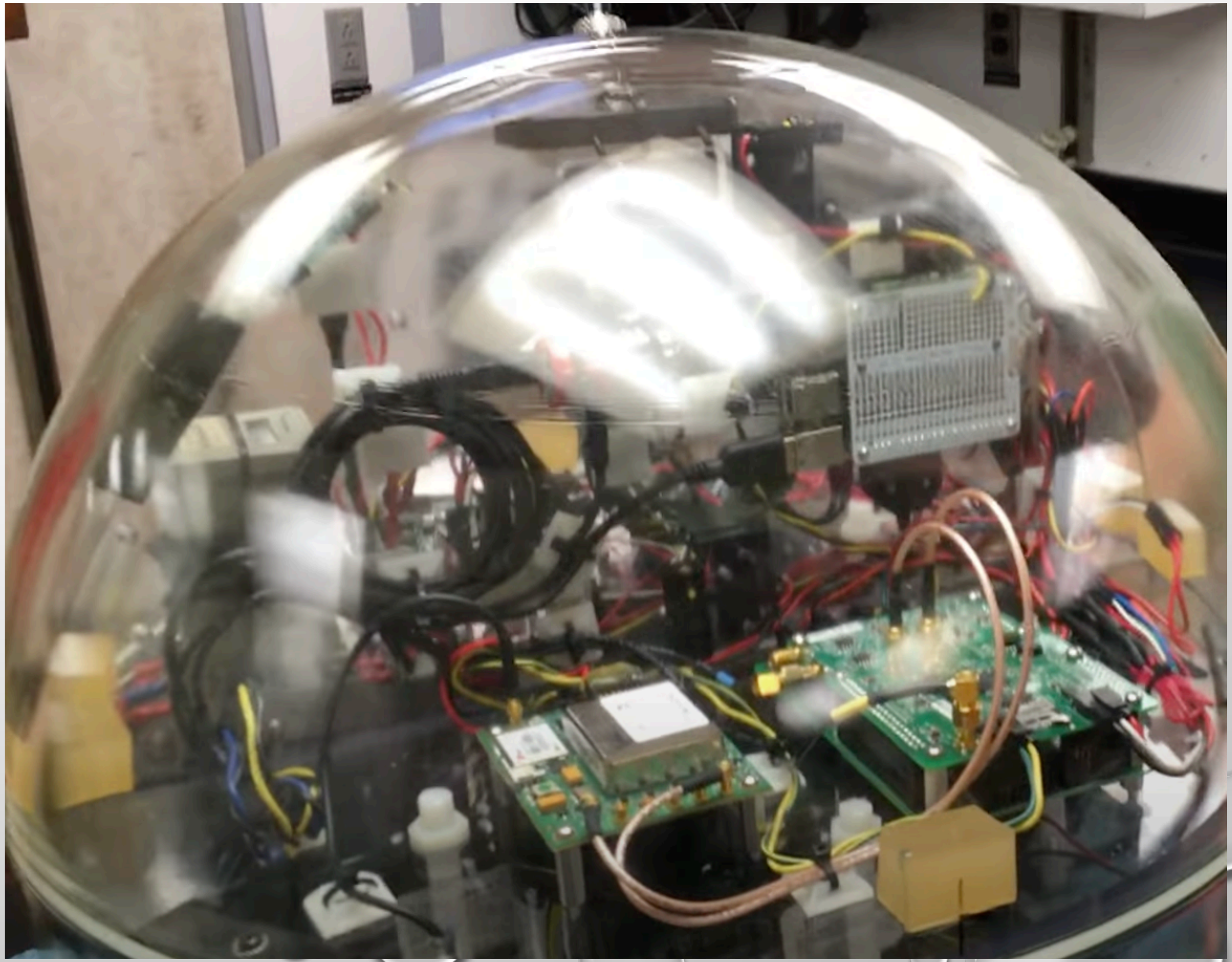

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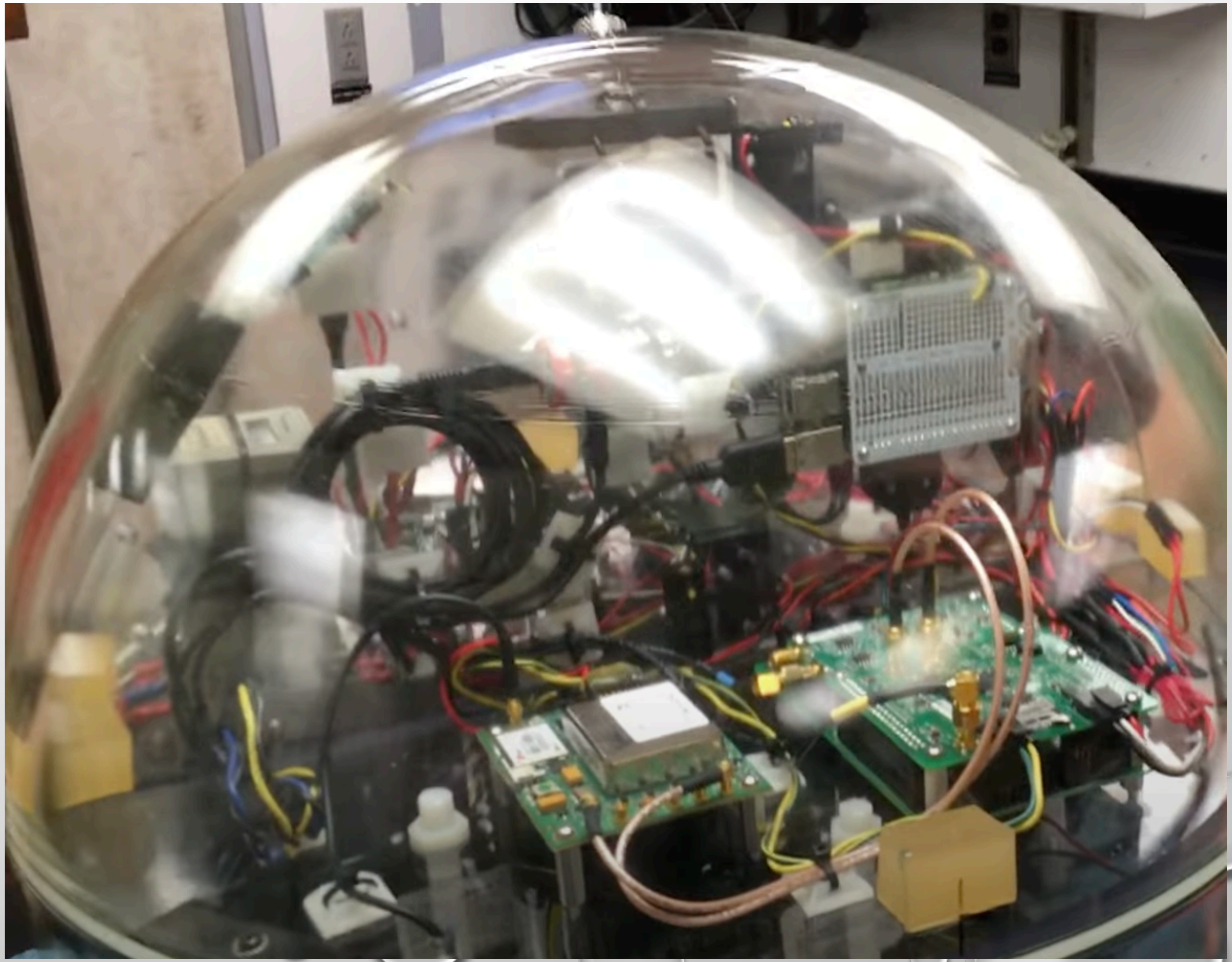

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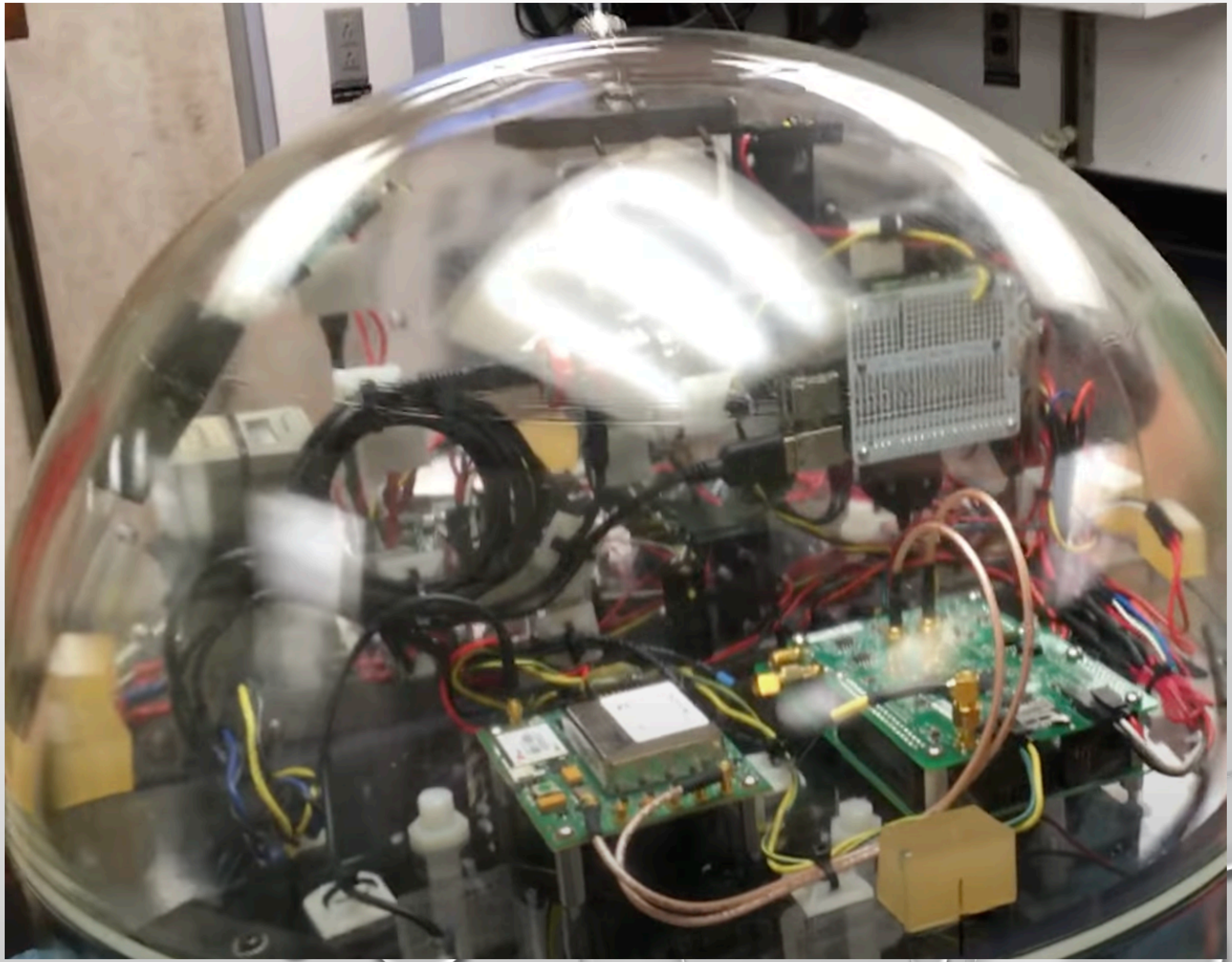

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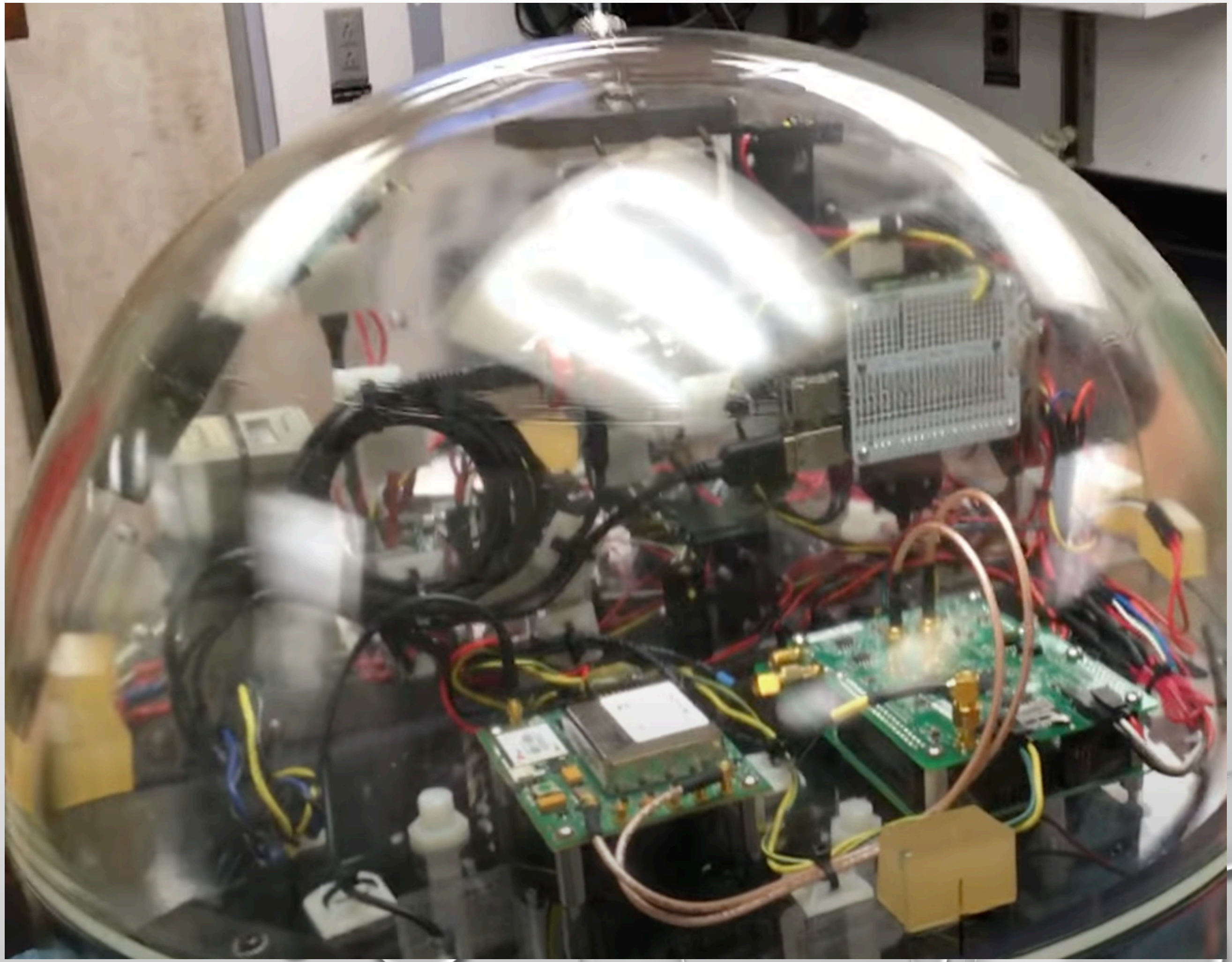

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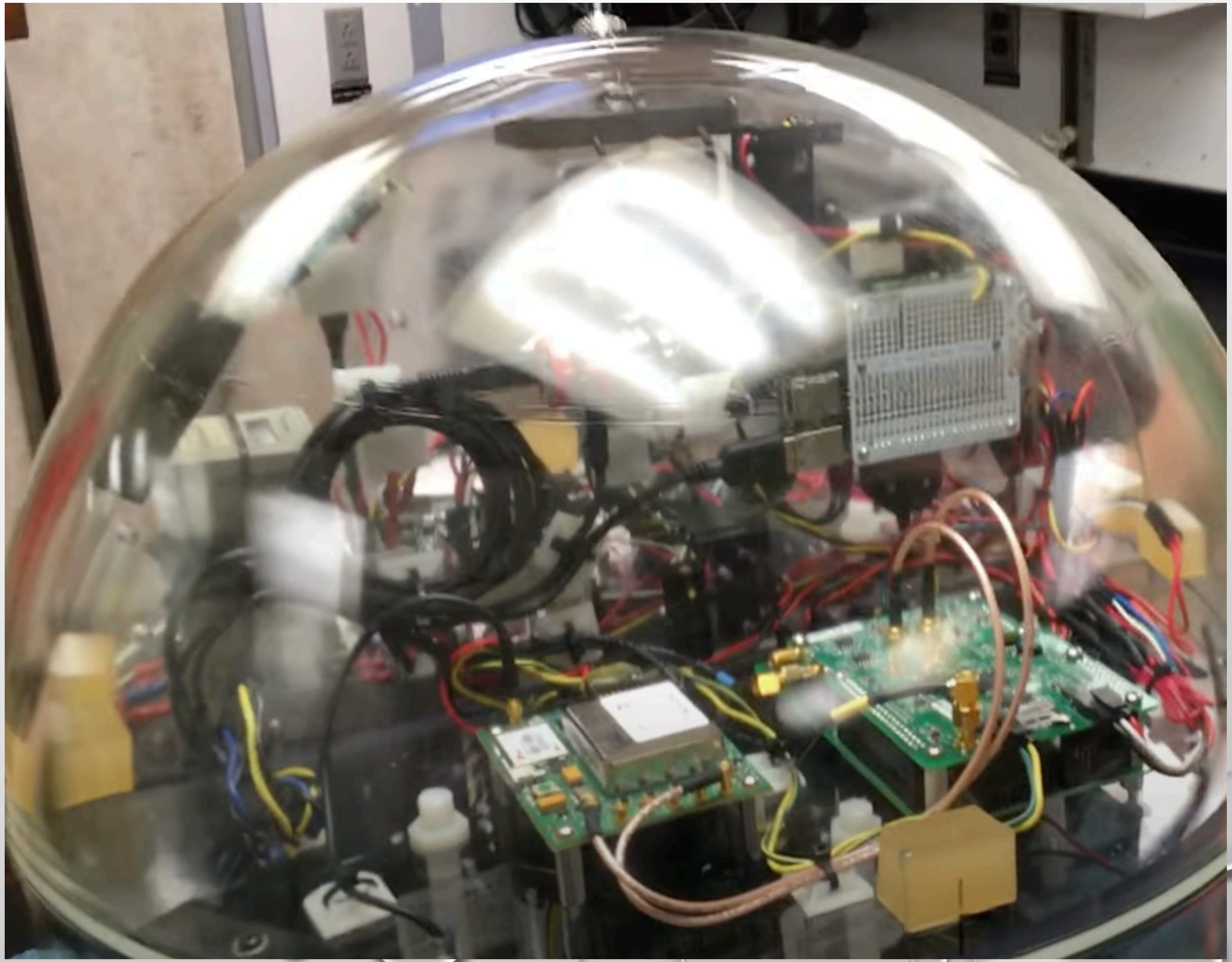

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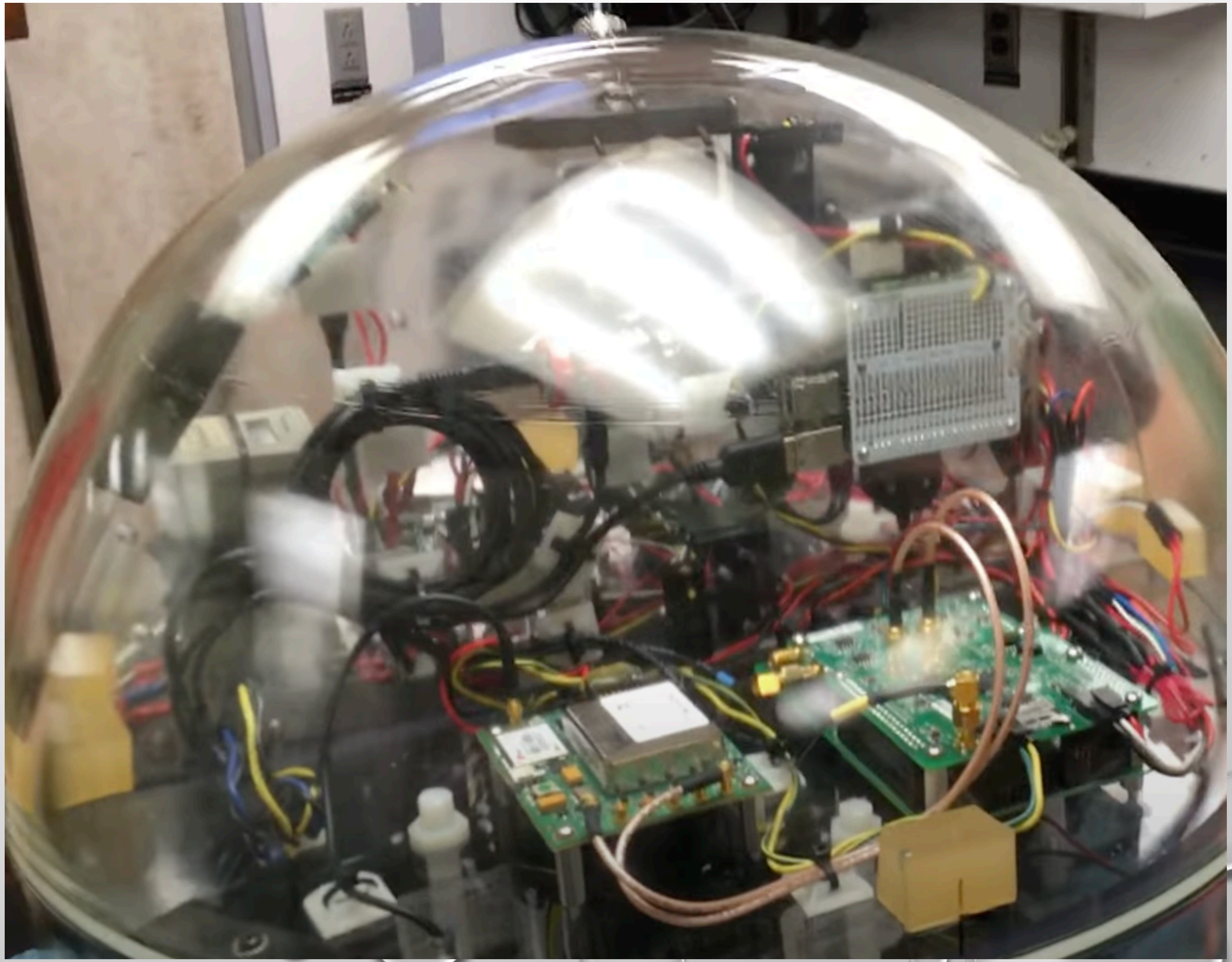
- C-DOG can be put to sleep to lengthen lifespan – decades



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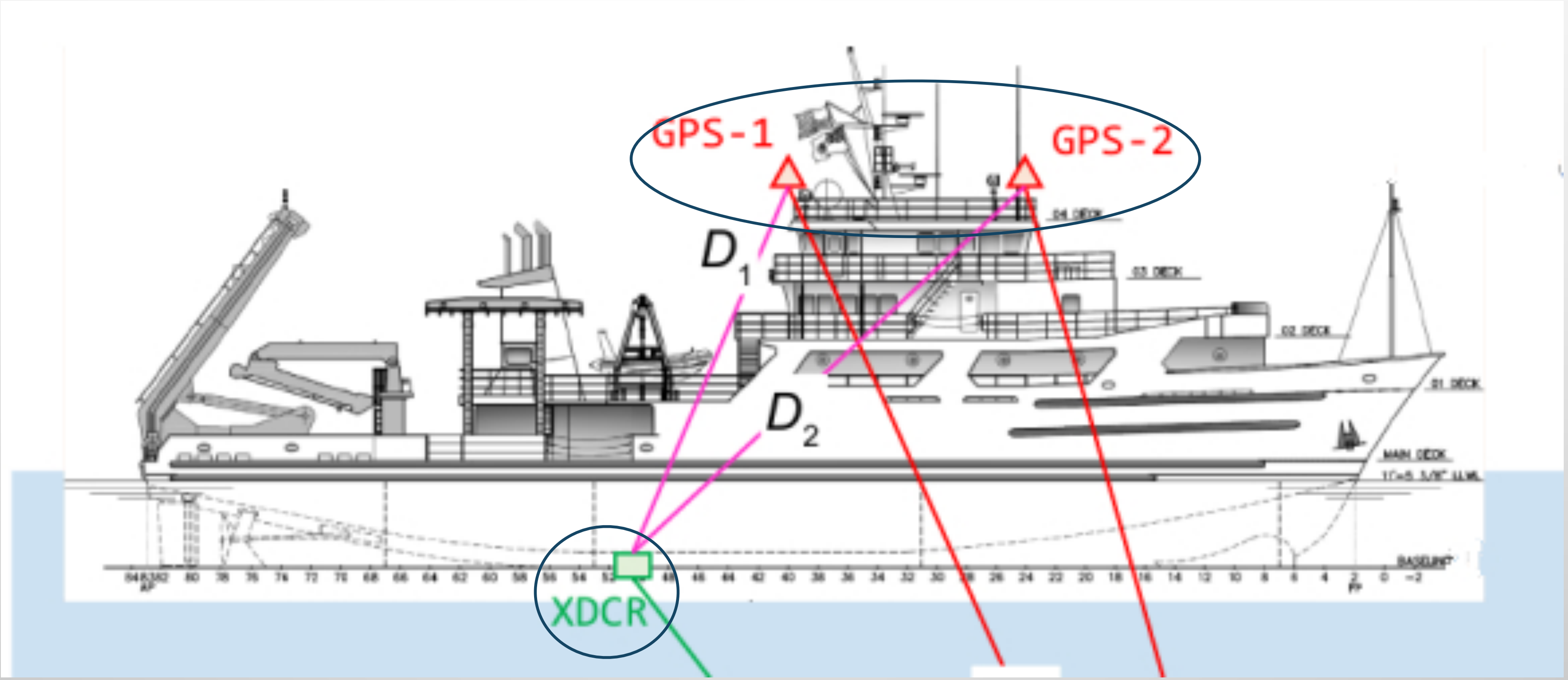
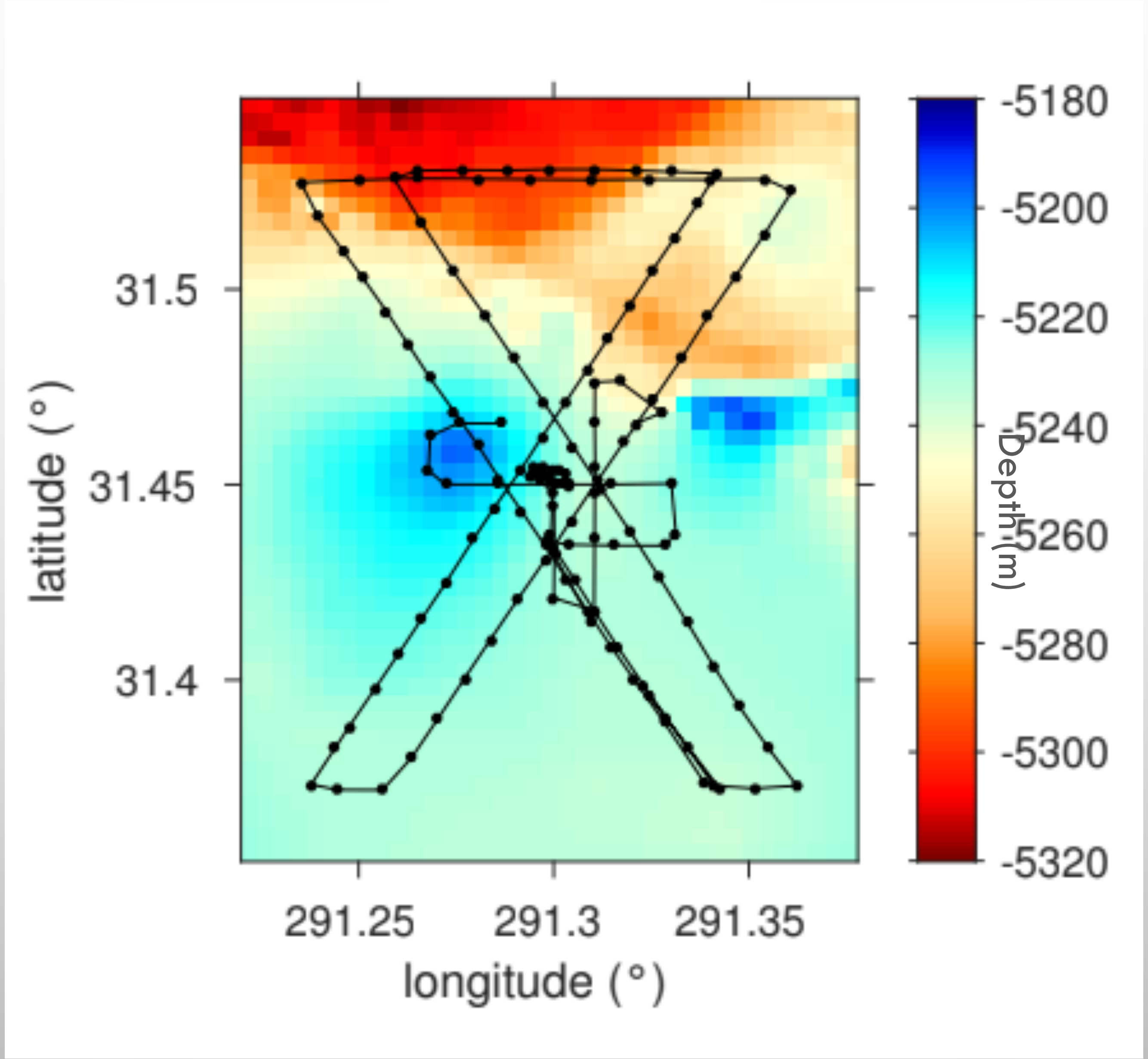


An experiment in 5000 m water



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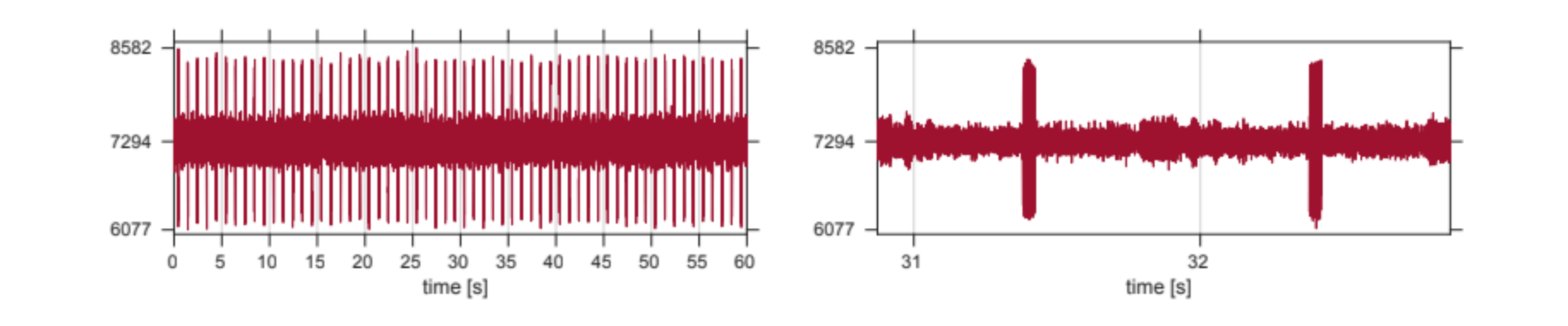

- Experiment performed in **5000 m** water
- Time series of acoustic data observed by hydrophone on C-DOG
- On-board correlator time-stamps arrivals against the CSAC atomic clock
- Timing uncertainty of ~20 μs

Terance Schuh, 2023 Master's Thesis, Princeton University

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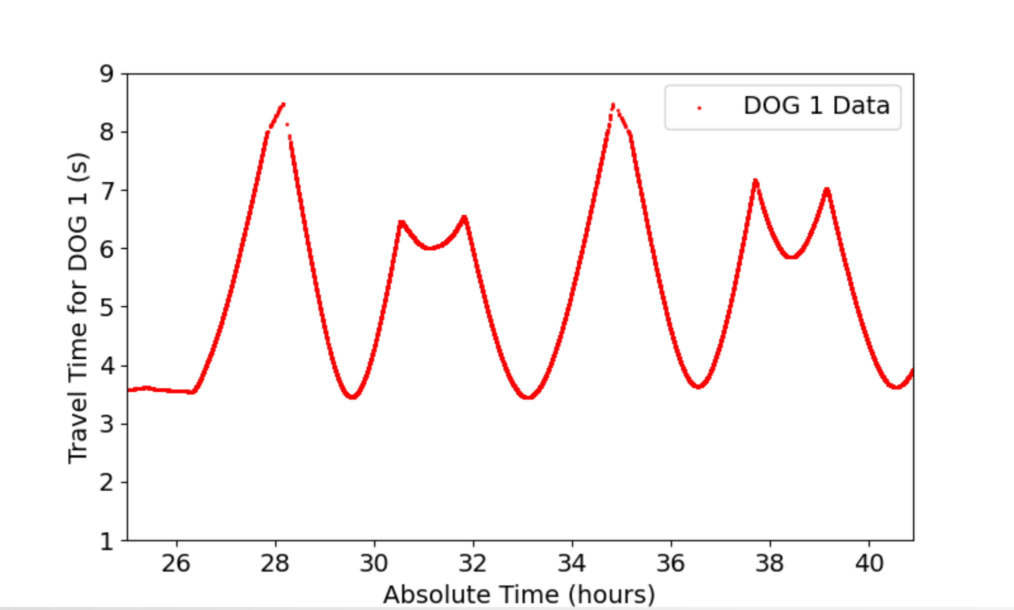

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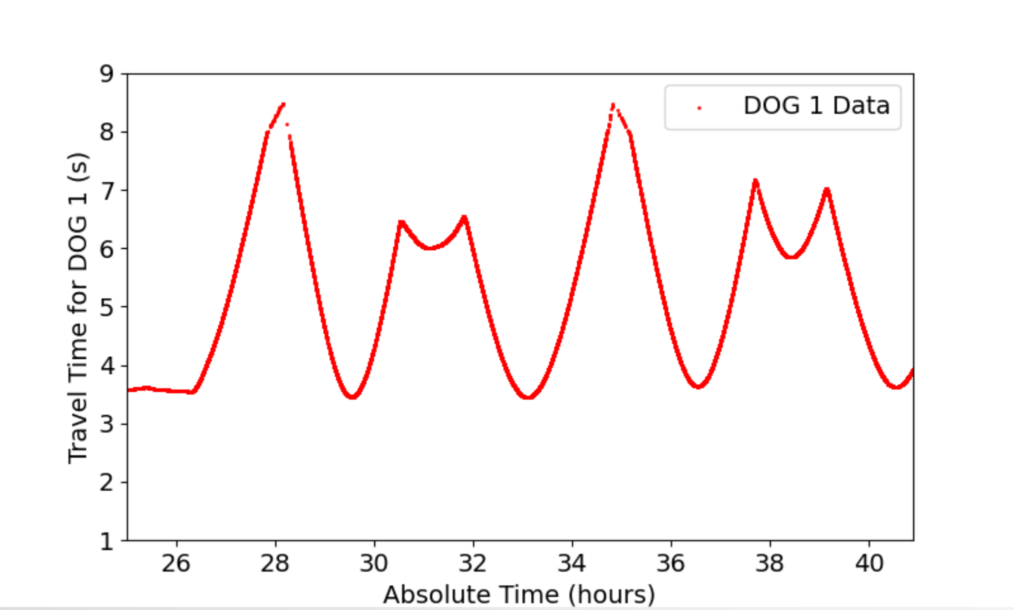

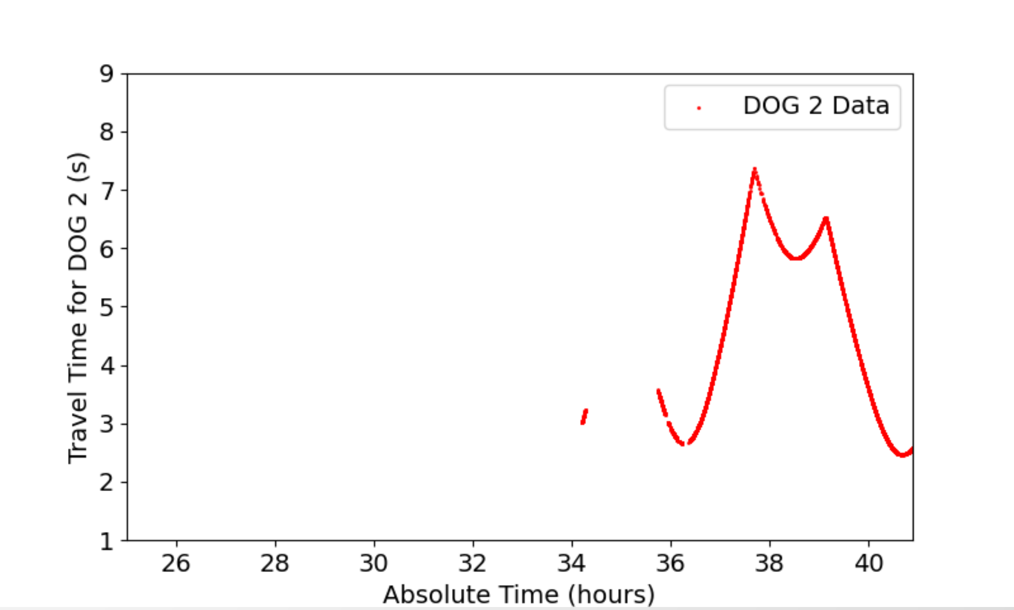

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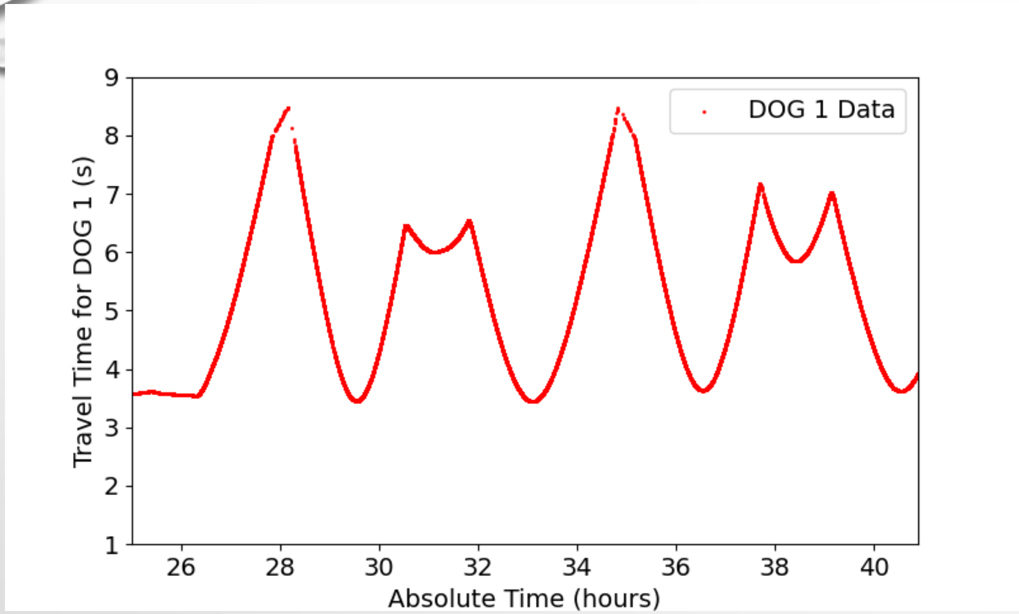

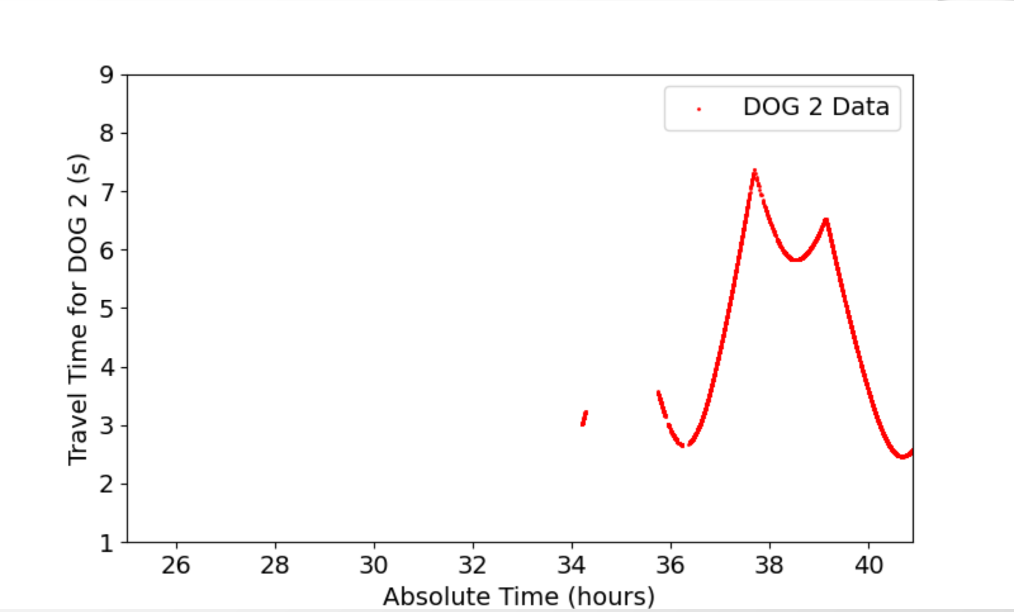

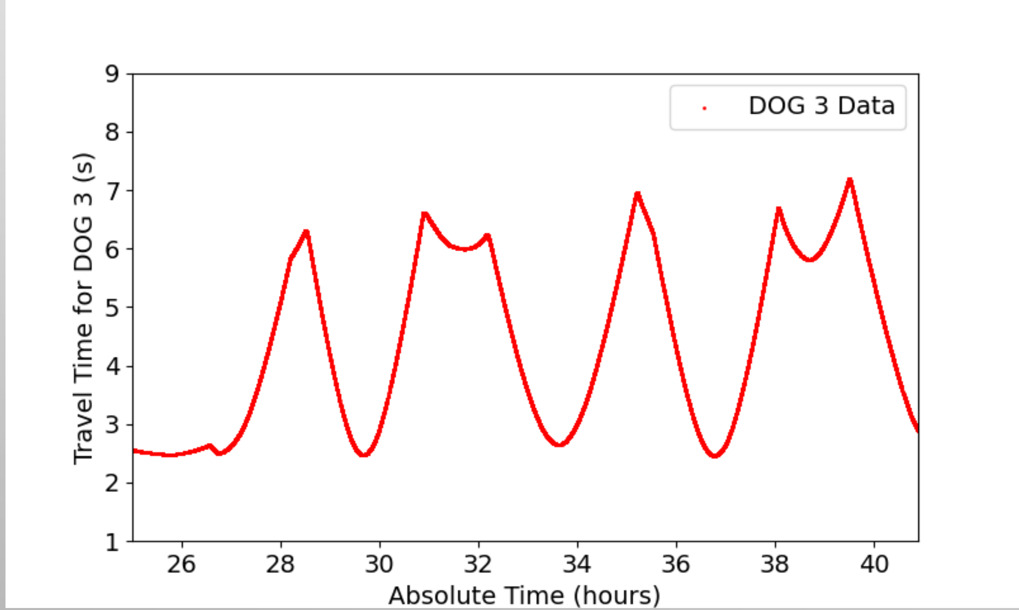

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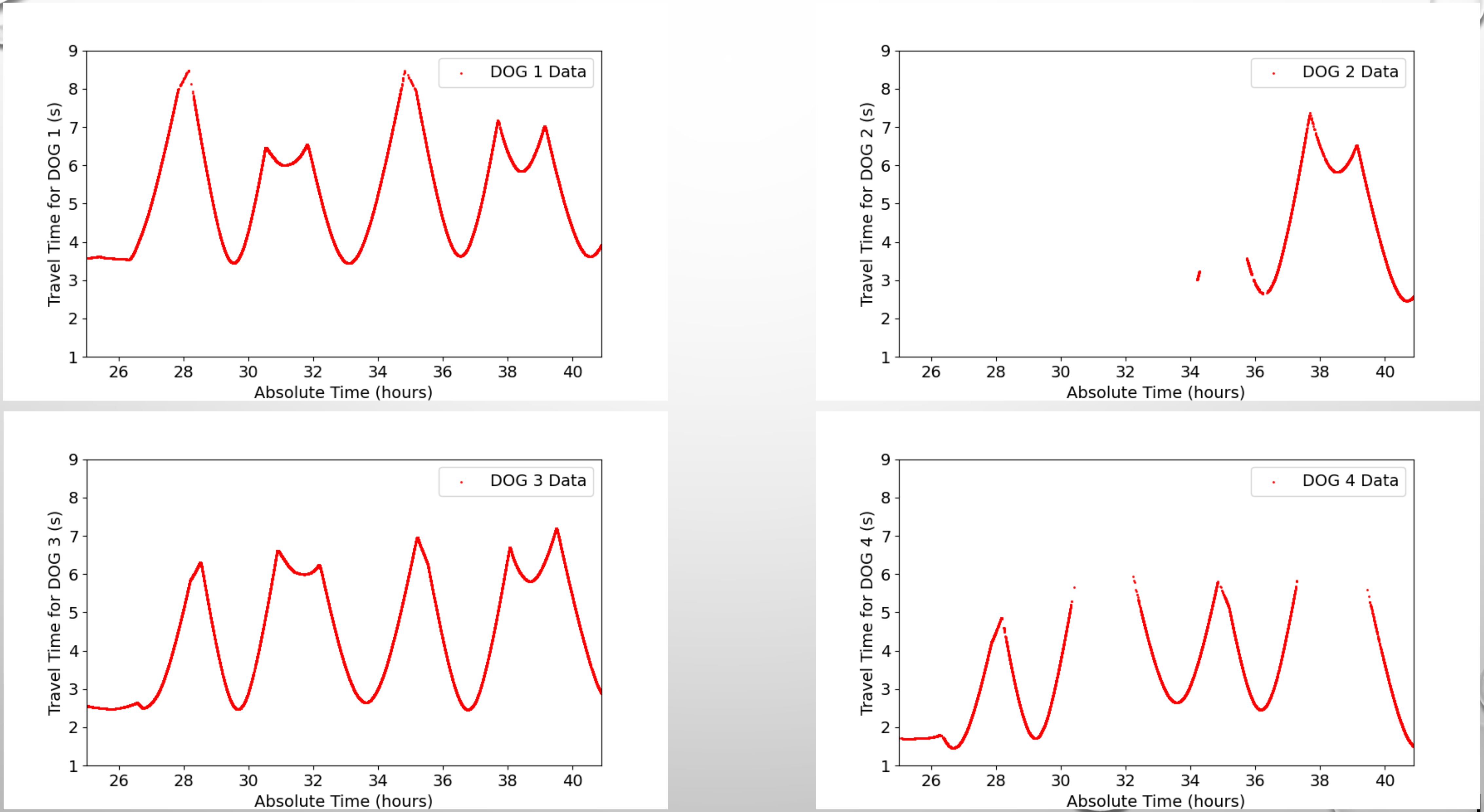

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- Current workflow solves for three parameters: spatial offset, timing offset, and C-DOG position

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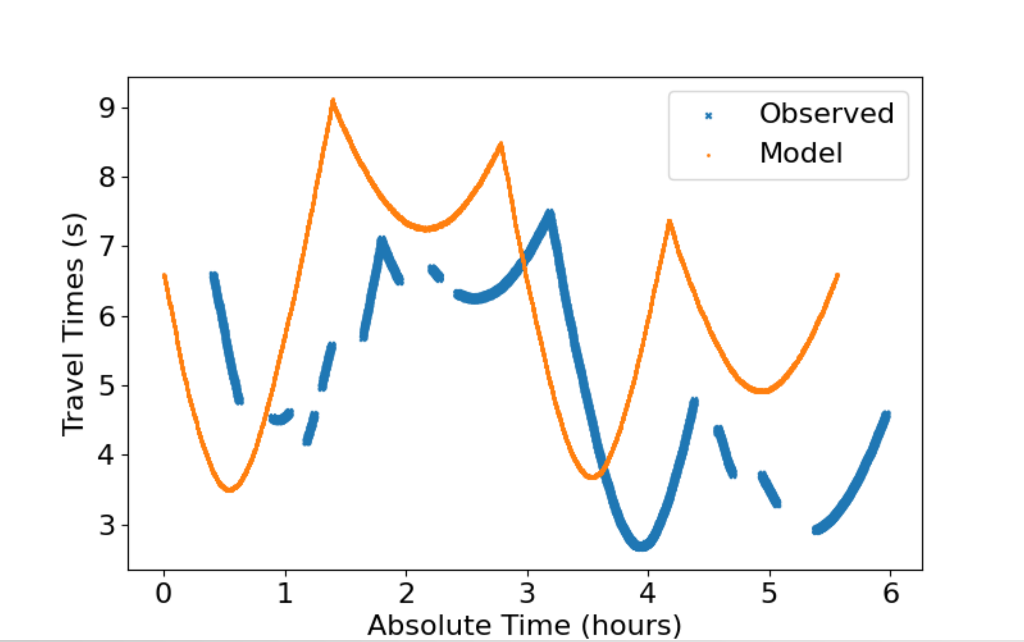

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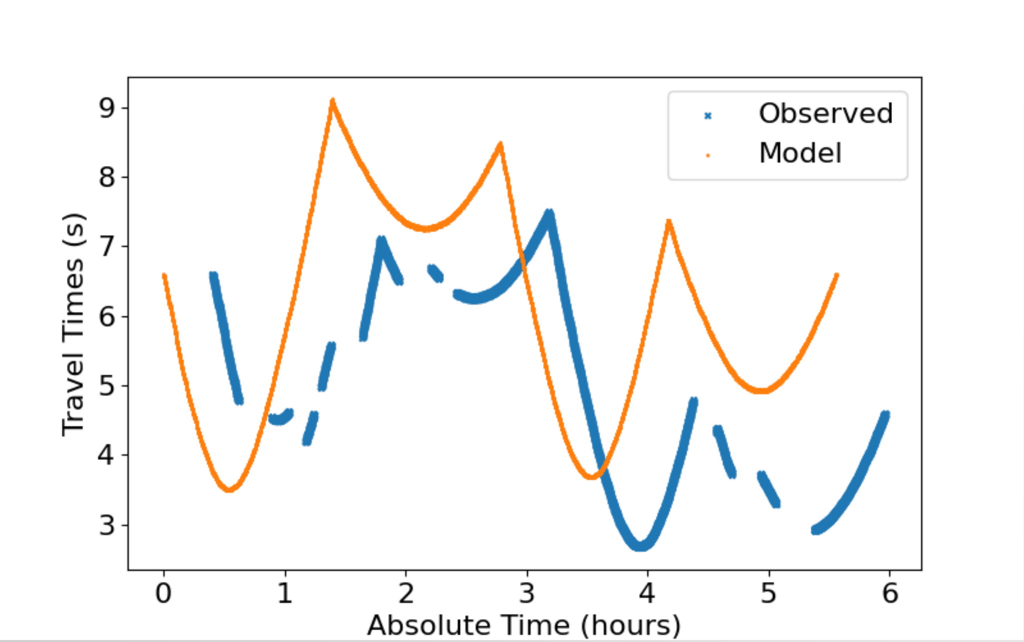

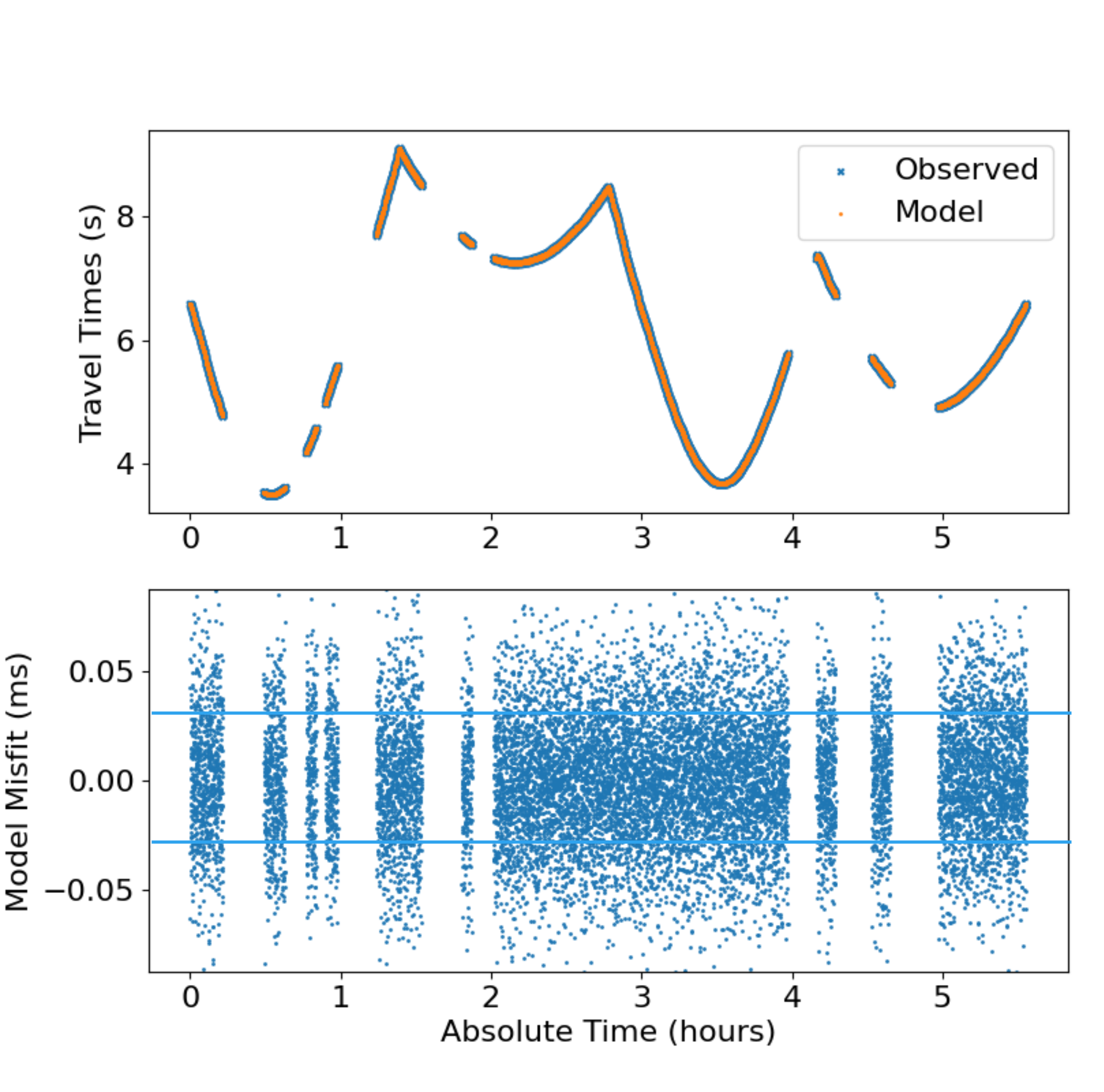

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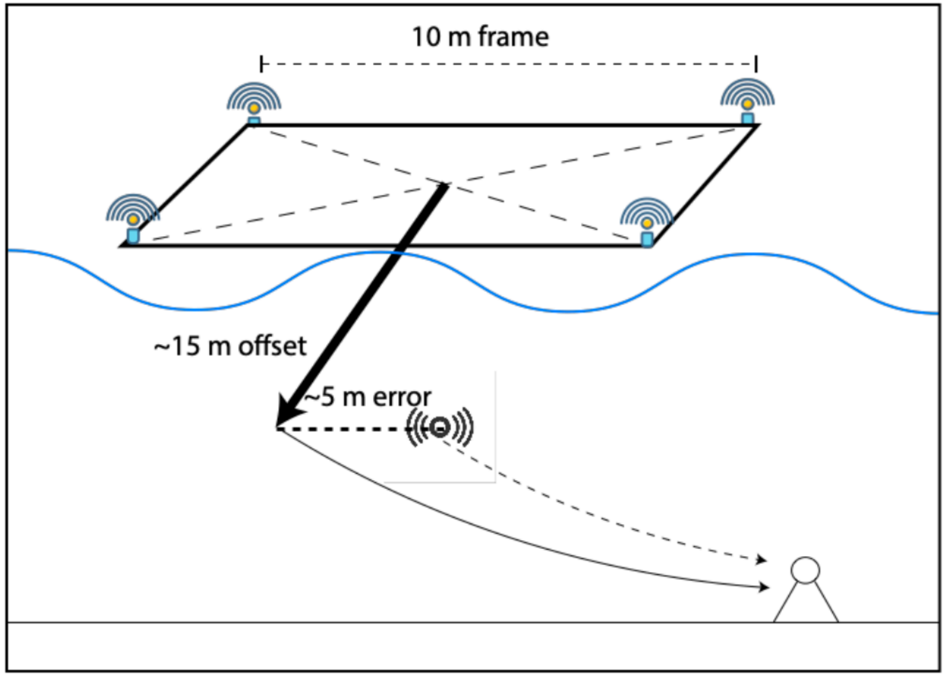

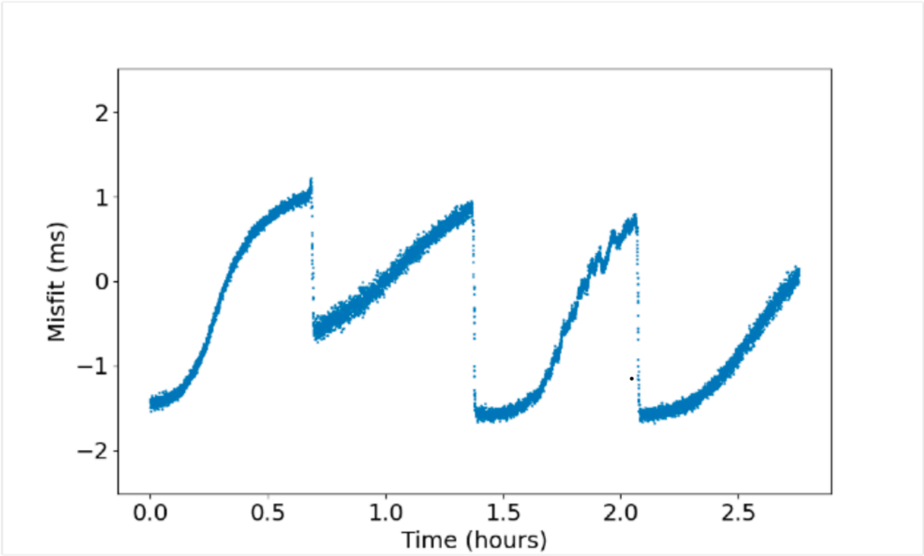

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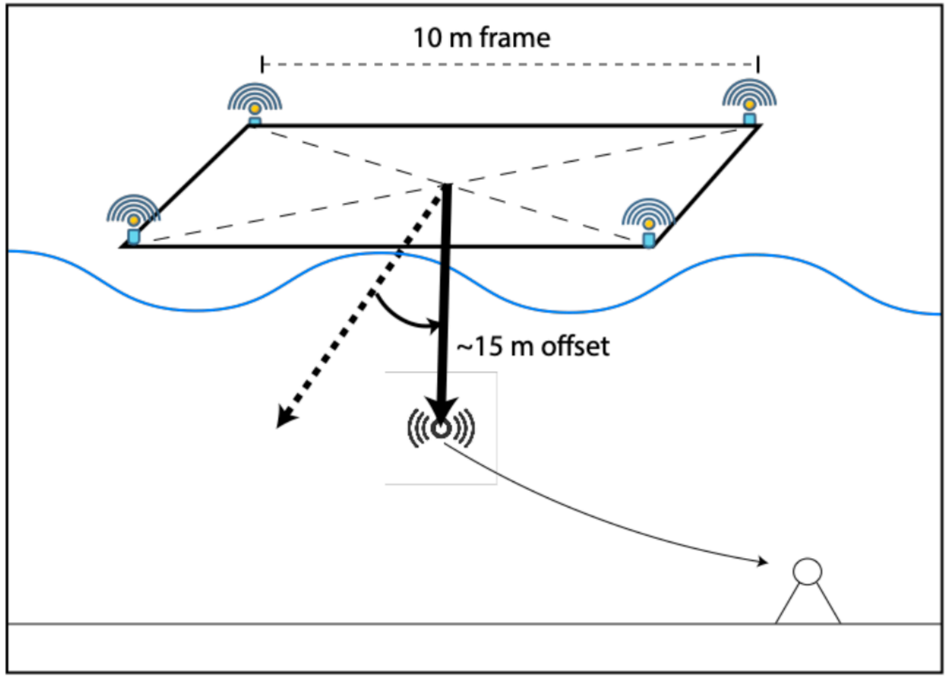
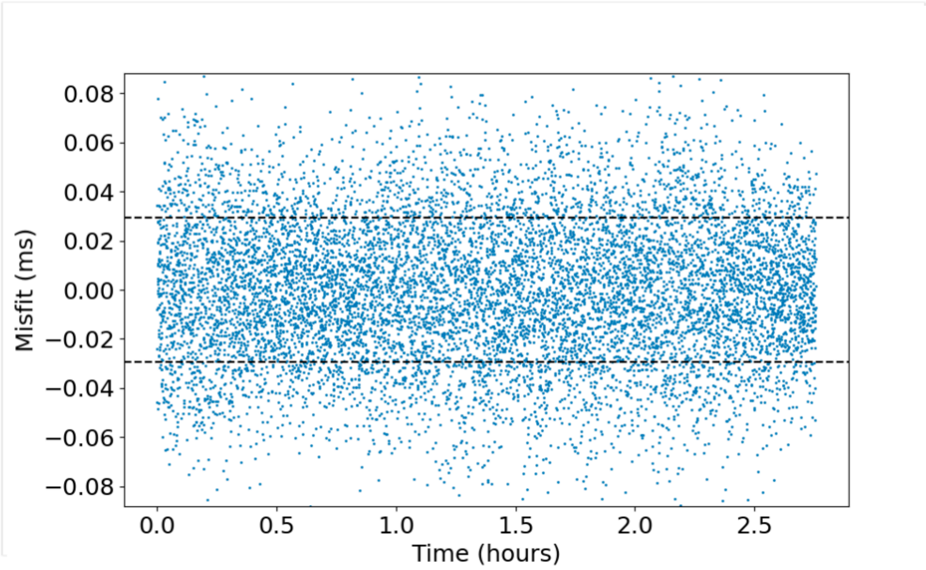
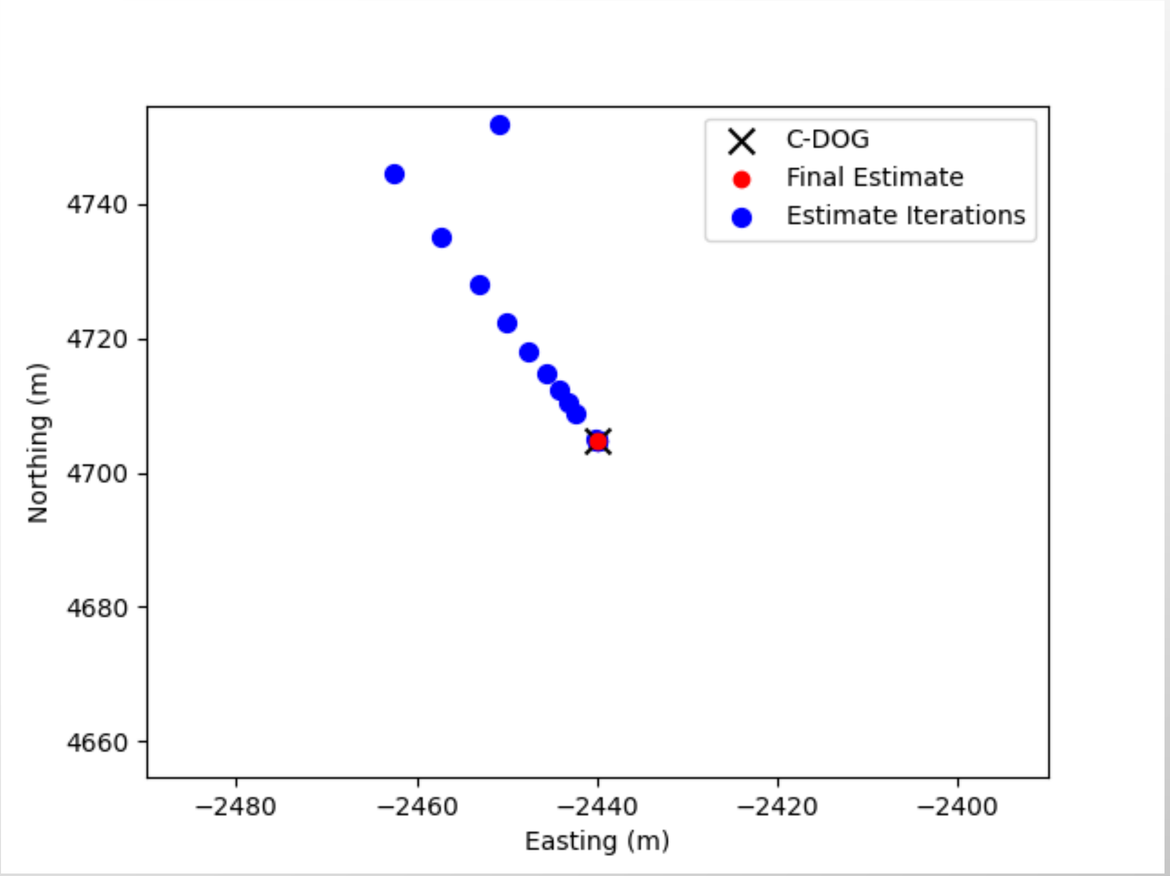




(III) Gauss-Newton Inversion

- An iterative Gauss-Newton method hones in on the seafloor C-DOG
  - Works in conjunction with the alignment and simulated annealing algorithms
  - Requires reasonable initial guesses for transponder offset, alignment timing offset, and C-DOG position (otherwise it diverges)



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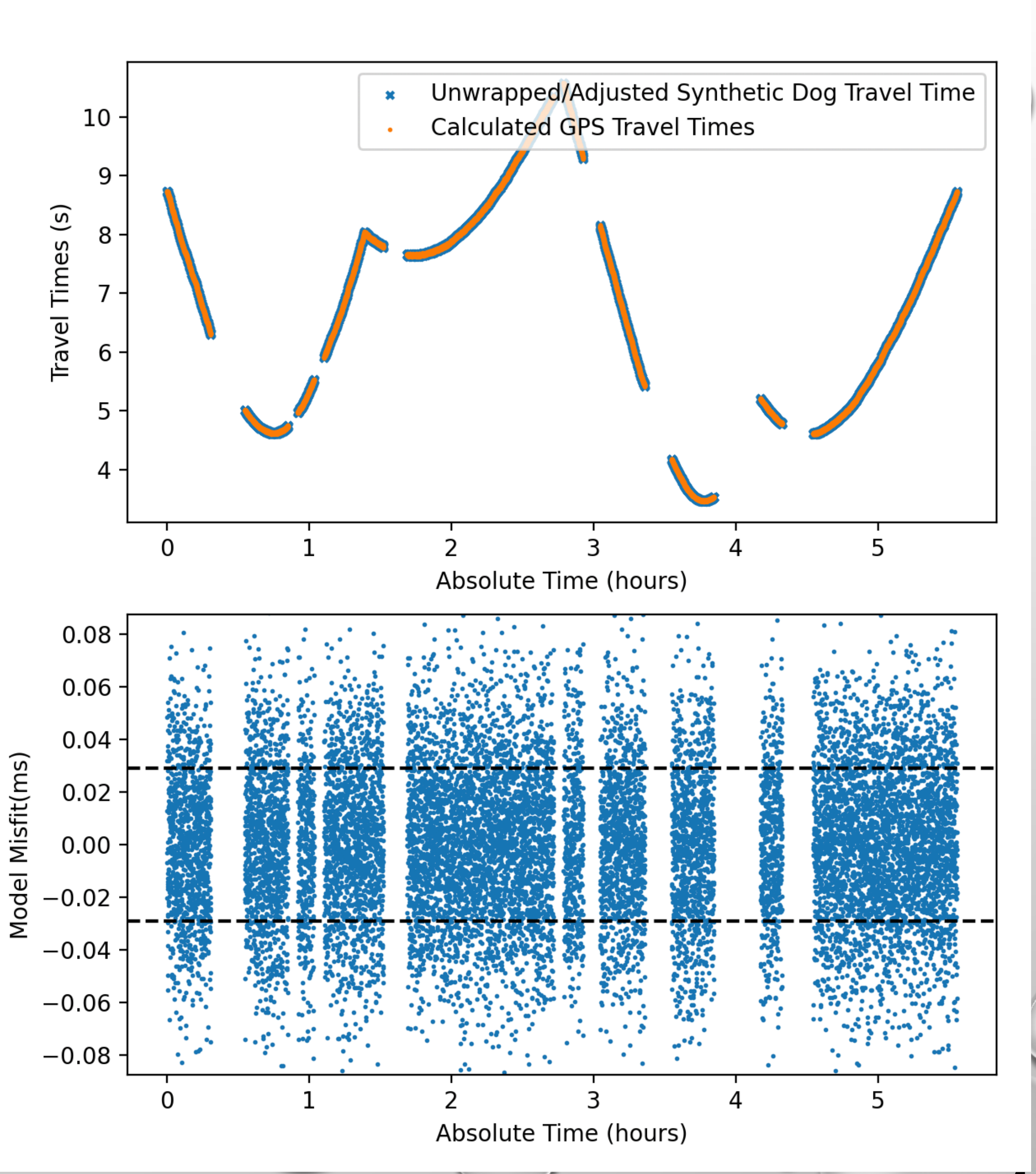

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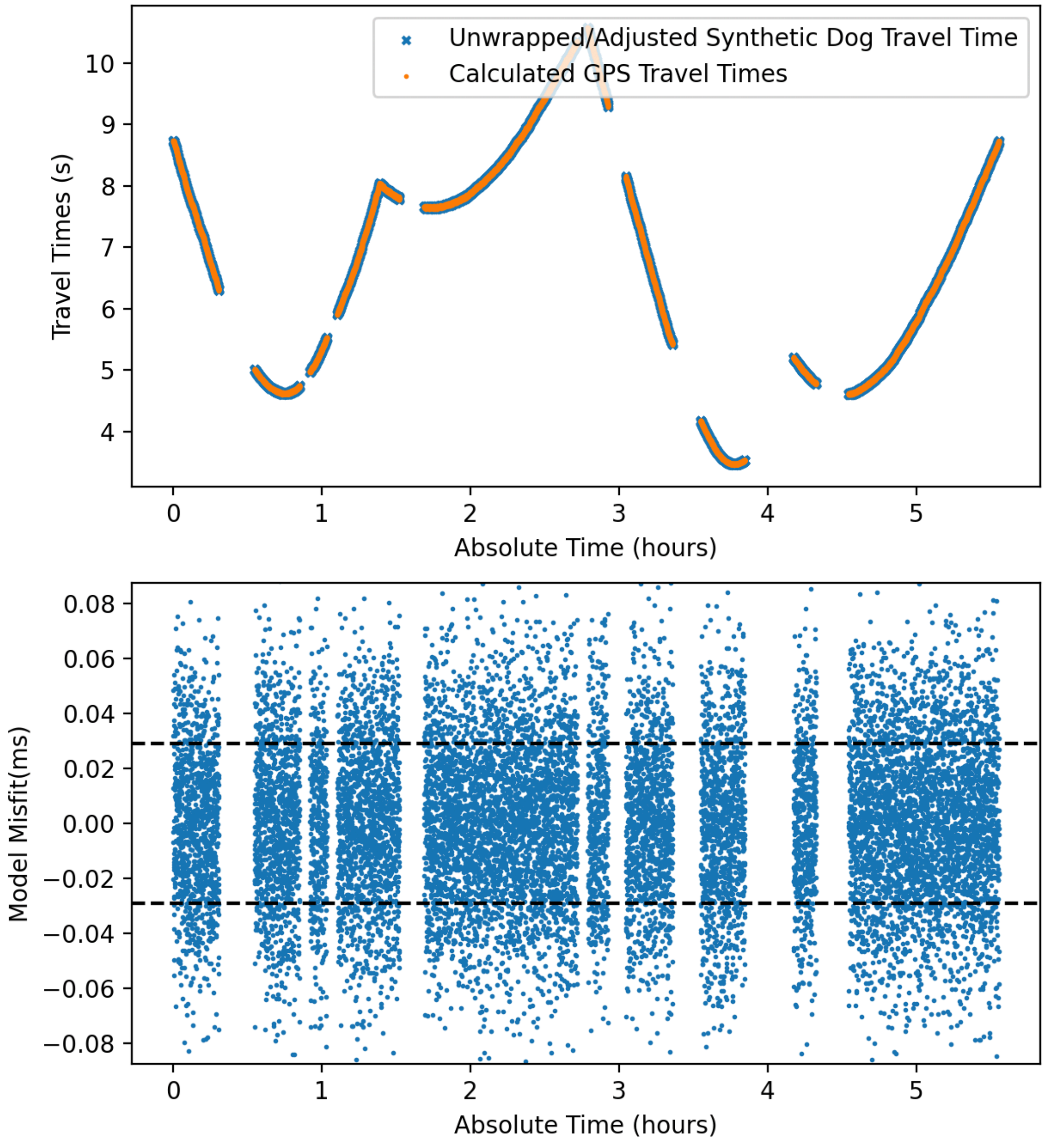

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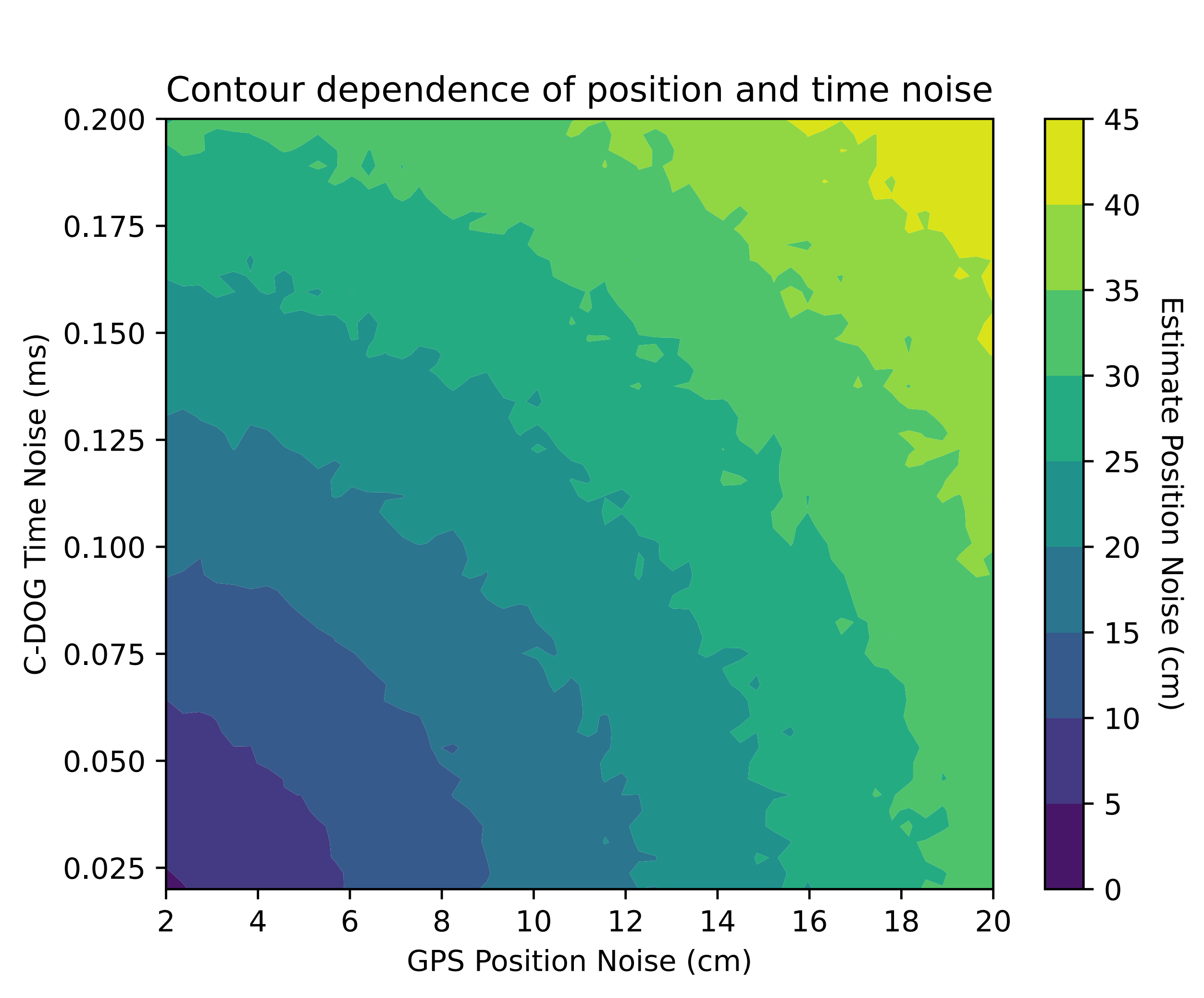

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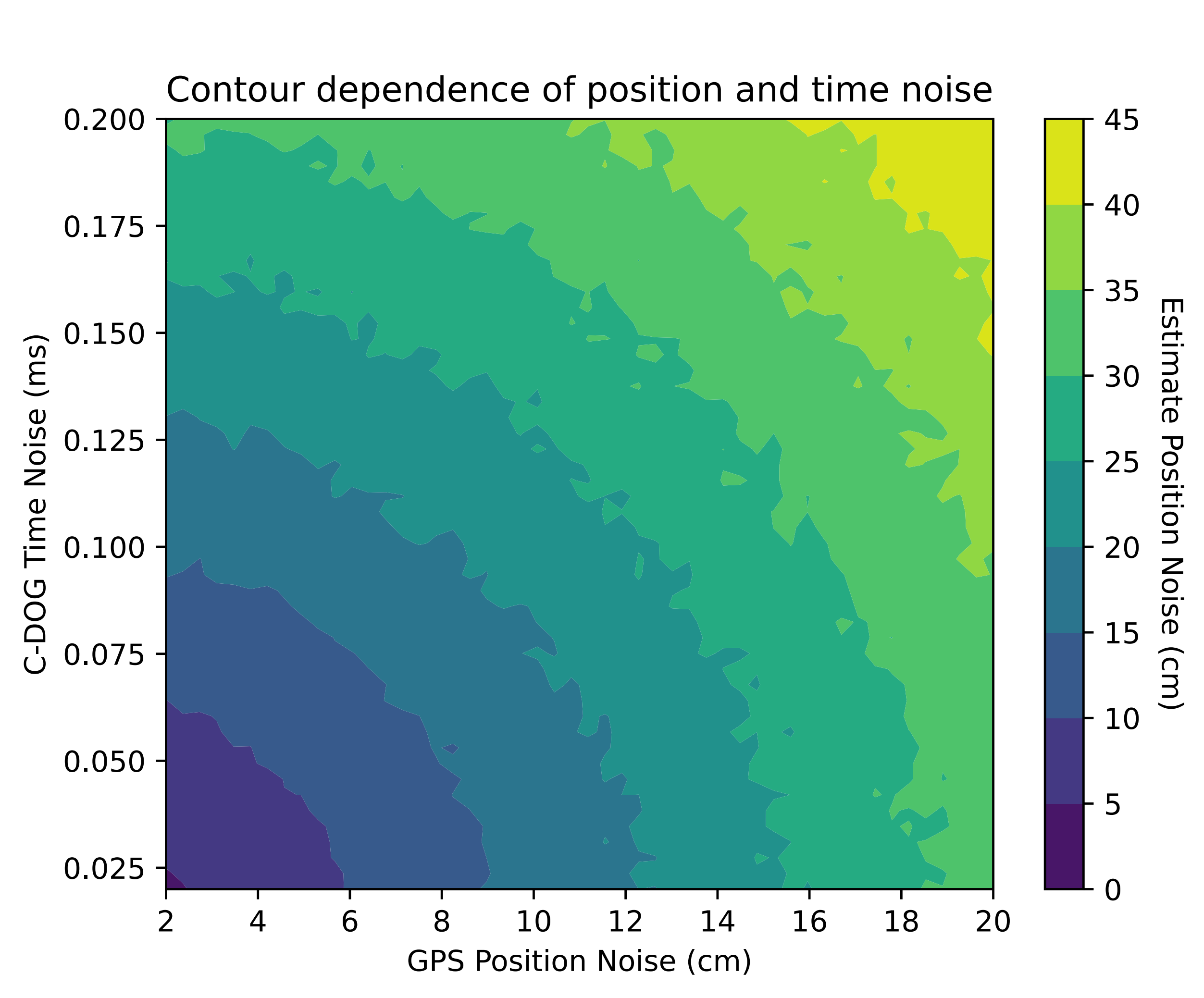

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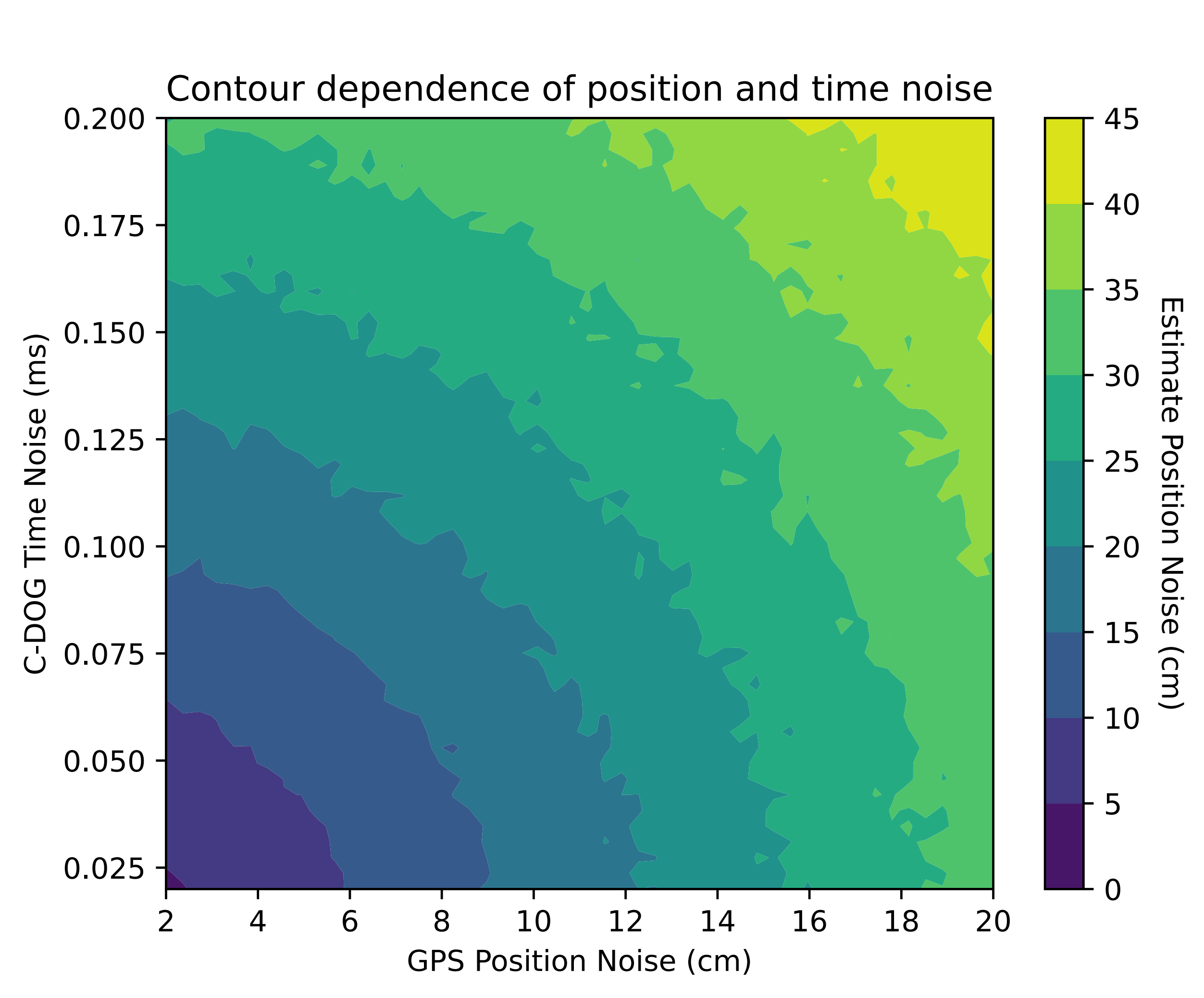
  - 2 cm surface GPS position error
  - 20 μs time-tagging error
  - Random timing offset and data drops
- The model estimates the C-DOG to a position **~0.2 cm** from the actual location
- Next: Varying ocean sound speed in the synthetic
- Next: Real data analysis



THE END