The HiPSMI project: High Precision Supercooling Measurement Instrument for supercooling measurements under ice shelves

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Aim: To design and construct a new novel instrument; the High Precision Supercooling Measurement Instrument ("HiPSMI"). HiPSMI will be optimised for harsh Antarctic ocean conditions and installed into an innovative, modular underwater robot, Schmidt's (Georgia Tech) "Icefin"[1,2] .

Background:

- Beneath the Antarctic sea ice and ice shelves, sea water is often colder than its freezing point temperature, yet still liquid ("supercooled").
- Snap-freezing of supercooled sea water and small free-floating ice crystals known as "frazil" are fundamental obstacles to obtaining high-precision measurements of key ocean parameters.
- In the project we will overcome this obstacle by working to design and construct a new novel instrument; the High Precision Supercooling Measurement Instrument ("HiPSMI") to install into Icefin.

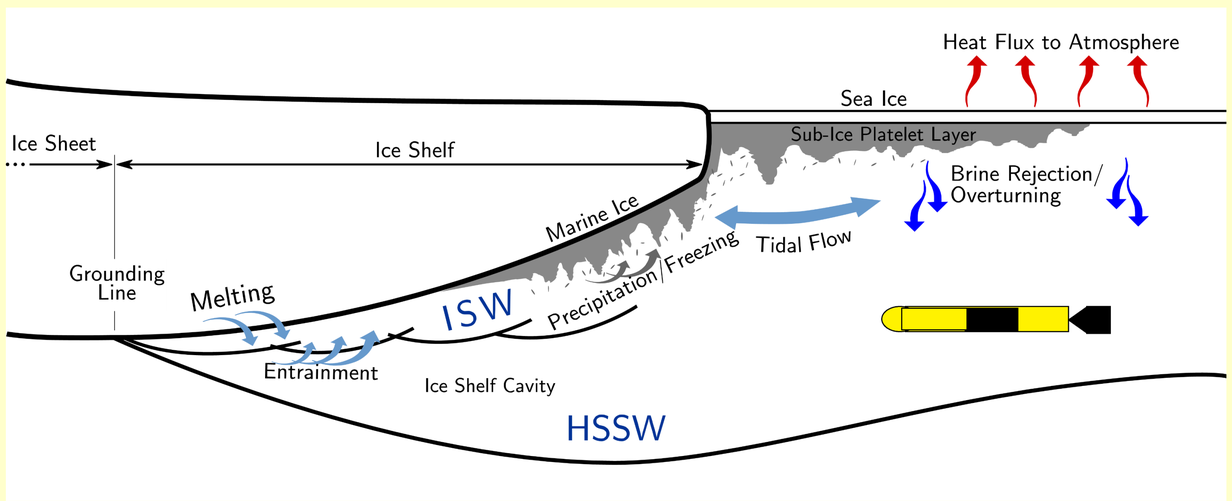

Figure 1: Schematic diagram of ice shelf cross-section, showing the connections between potentially supercooled ISW and ice. Small grey crystals in the water below marine ice and the sub-ice platelet layer are frazil crystals. Figure adapted from one by Ken Hughes published in Nelson et al. (2017)[3].

Proposed methods:

- HiPSMI will include high precision temperature and pressure sensors and a pumped electrical conductivity sensor, configured for supercooling measurements.
- In addition, Icefin will have on-board un-pumped electrical conductivity sensors, possibly including nanotechnology sensors, to allow comparisons with HiPSMI.
- **Key question:** What is the influence of frazil crystals on measurements of in situ supercooling?

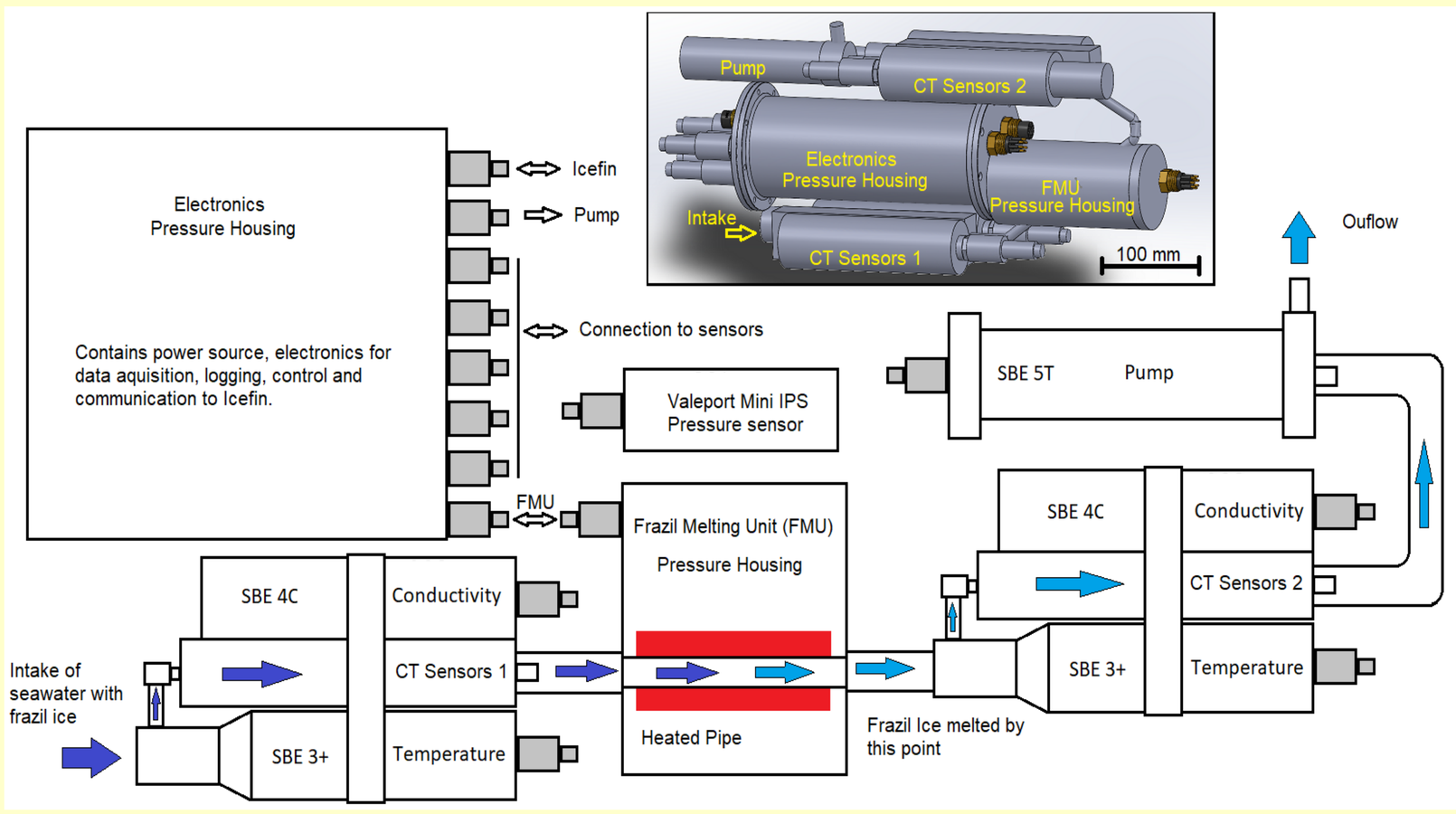

Figure 2: Concept daigram of HiPSMI. Water is pumped through system and CT measurements are made before and after melting of frazil ice crystals. The insert is a prototype design of HiPSMI.

References:
[1] Spears, A., West, M.E., Meister, M.R., Walker, C.C., Buffo, J.J., Collins, T., Howard, A., and Schmidt, B.E. 2016. The Icefin Under-Ice Unmanned Underwater Vehicle: Development And Deployment In Antarctica. IEEE Robotics and Automation Magazine, 23:30-41.

[2] Meister, M., Dichek, D., Spears, A., Hurwitz, B., Ramey, C., Lawrence, J., ... & Schmidt, B. E. (2018, October). Icefin: Redesign and 2017 Antarctic Field Deployment. In OCEANS 2018 MTS/IEEE Charleston (pp. 1-5). IEEE

[3] Nelson, M.J.S., Queste, B.Y., Smith, I.J., Leonard, G.H., Webber, B.G.M., Hughes, K.G. 2017. Measurements of Ice Shelf Water beneath the front of the Ross Ice Shelf using gliders. Annals of Glaciology, 58(74):41-50, doi: 10.1017/aog.2017.34.

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