Progress Report Hyper-Spectral SPI Camera Febrero 2026

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The project to build an hyper-spectral Sediment Profile Image Camera (HySPI Camera) was divided in 3 parts:

1) Rebuild the the Profiler of penetrator into sediments to support 600bar or 950,000 psi. This is the Metal Structure Unit that penetrates de sediments.
2) Configured a camera and electronics made out of bullet proof acrylic to stand 600bar to keep a lower weight to the whole Camera. Bullet Proof top Chamber
3) Build an optical camera raw, to register VIS, UV and NIR.

Progress to date 18 February 2026

1) **Metal Structure Unit (MSU).** The structure made of 316 ANSI steel has been fitted with a new window made out of acrylic with a thickness of 3 cm (Figure 1)

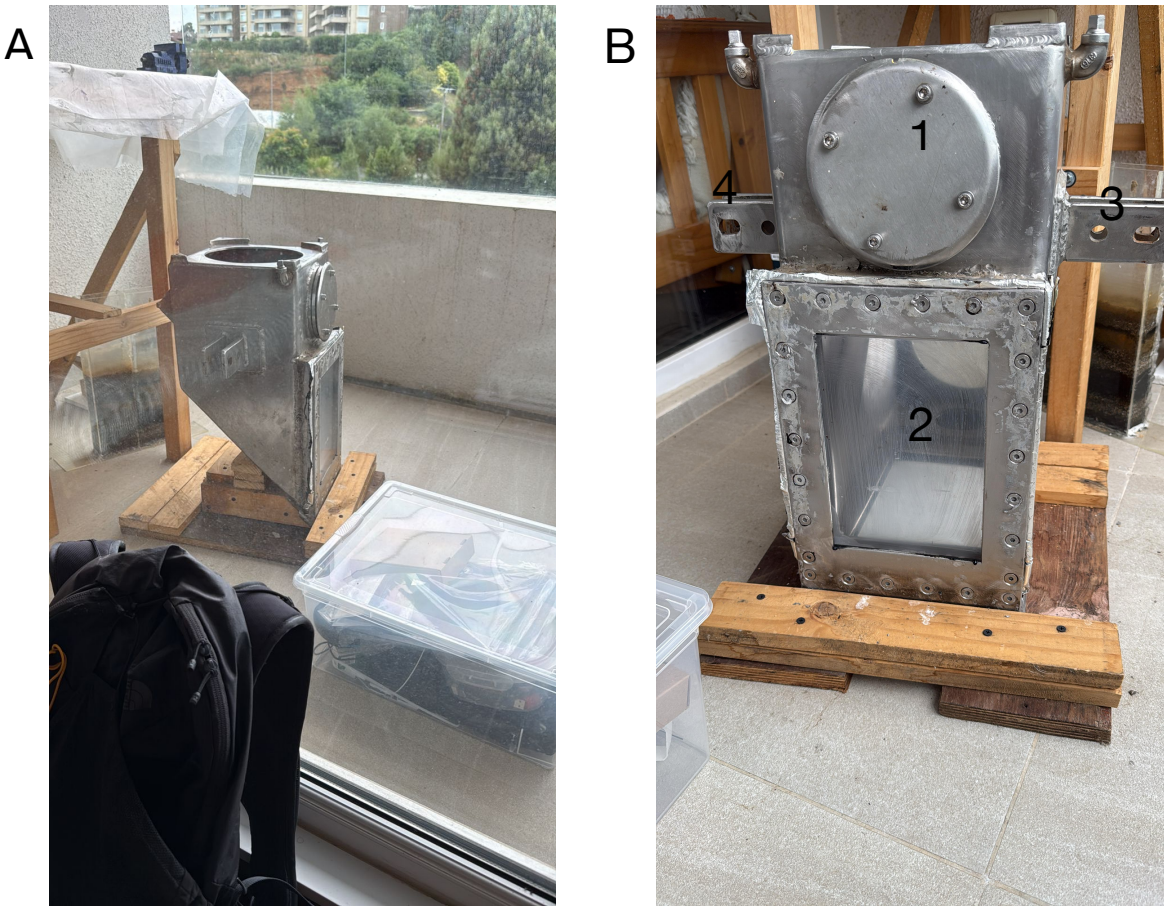

Figure 1. Metal structure of Hy-SPI (A) on wooden holder. In B, the front window (2) remade and fit to support 6000 m water depth. The whole structure will be filled with distilled filtered water to improved pressure resistance. In 1, a build into it a rubber that will act as a tympanic membrane. In 3 and 4, holders to keep the camera in position, a 3rd fix point is behind.

Status to date: This task has been finished

2) **Bullet Proof top Chamber (BPC).** The BPC will be mounted on the Metal Structure Unit and will held inside the camera (CMOS -Raw - 12Mp), different light sources (LED- Vis-UV and NIR), the controlling unit (Raspberry Pi 5) and communication interface (ethernet).

To date I have designed the whole BPC to scale to order its construction. In Figure 2, all the components at scale 30% of the real size.

Figura 2. Model in 3D at scale of the components to held the electronics and optical elements of the HySPI. In white (1), The whole Chamber build in bullet proof acrylic and the cover with o-ring to provide a water tight environment. The cover will bear 2 connections points for tethering to surface the HySPI. In black, number 2, 3 and 4, are internal sections that will be held inside the chamber. Number 2, is a sub chamber that will held the controlling unit (raspberry Pi5 = small box) that will be inside the round box and covered. Bottom and cover wear connectors passages (round holes and square ones) to allow connection within the camber elements (LED and Camera CMOS). Number 3 is mock volume of the CMOS camera, lens and control; this camera will be held in position vertical in the central hole of number 4. This latter will held the LEDS that will be evenly distributed to achieve a fair illumination inside the MSU.

In Figure 3, a close up of the holder of the LED (A) and position of the camera for deployment in B. A total of 55 LEDs will be arranged in LED holder.

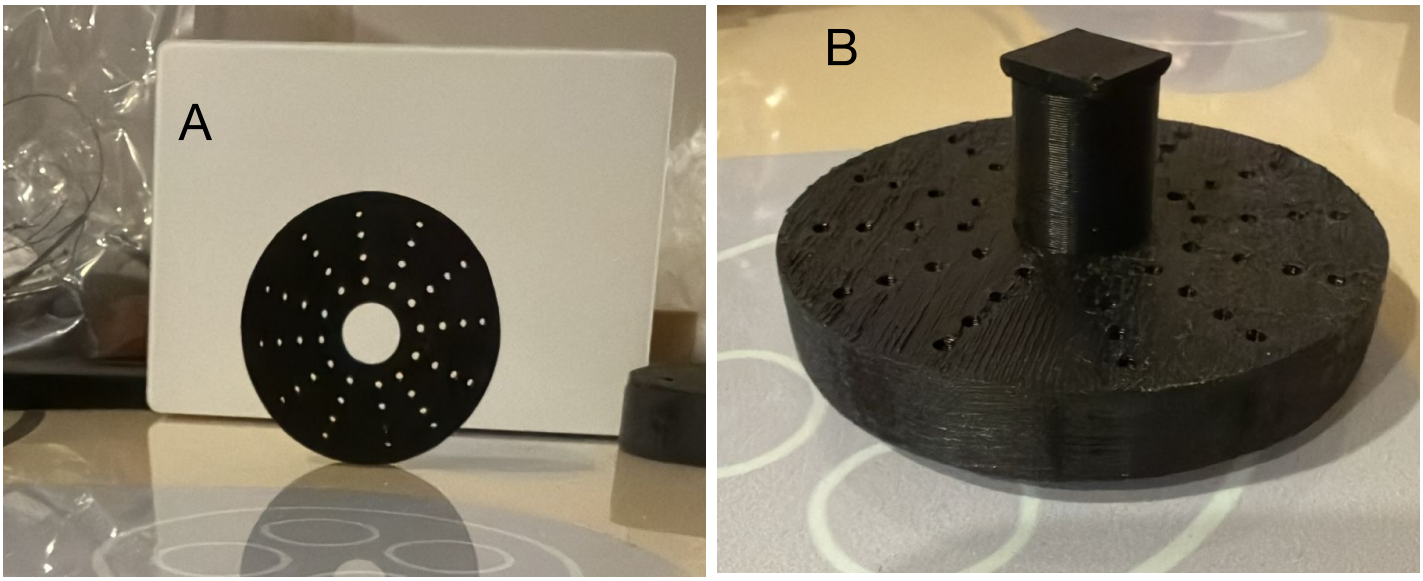

Figure 3 A and B. Best arranged design to deploy LED with different wave length after consultations with physics collaborators (holes will held in place individual LED. This unit will be build in dense polycarbonate. In. Figure 3B, the panel with LED arrays and a mock model of the camera SONY IMX477 CMOS (central cylindric shape).

The element shown in Figure 2, number 5, will be made in 316 Ansi steel (sleeve) and will be holding in place number 1 with all the elements inside: camera, LED arrangement, Control unit and communications to the metal structure shown in Figure 1.

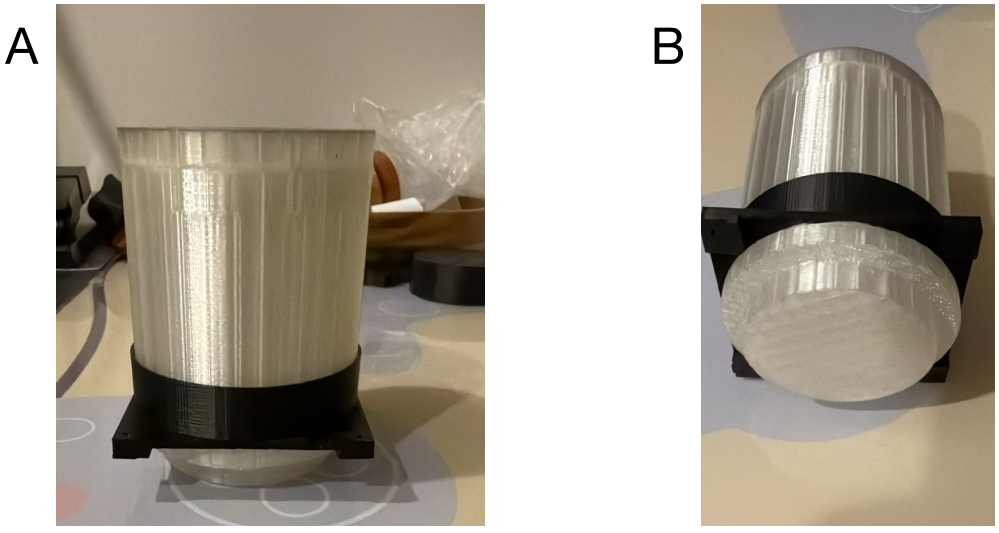

Figure 4. In A, the BPC closed (which will be completely transparent) with all elements inside and with black cylinder sleeve that will fix tight over BPC. The latter will be made out of 316 ANSI steel.

Status to date. This task is now in the process of building the units at a real scale and materials. All the specific scale model and technical drawings sent to provider for construction of the BPC. This has been ordered in one block. Similarly the specific drawings and technical details were sent to metal workshop to build the metal cylinder sleeve. Both units will be done and delivered on mid to end of March 2026. Units in polycarbonate (internal structures of BPC) will be done once received Bullet Proof Chamber, to make adjustments to accommodate elements inside. This latter process will be finished in 10 working days upon receiving BPC.

Camera, LEDs elements and communications network

3) CMOS camera and LED array buildings.

After a thorough review of several CMOS camera on the market compatible with Raspberry PI 5, I have settled for SONY IMX477 12.3 Mp. In Figure 5, a desk test of the Camera, driven by Raspberry PI5, using a special port for display. We also tried out a Filtered NIR camera with a prepared sediment column made out of natural sediments collected in Valdivia Estuary (Figure 6). Nonetheless the real optical test will be done when a complete Hyper-spectral SPI will be finally assembled.

A **B** **C**

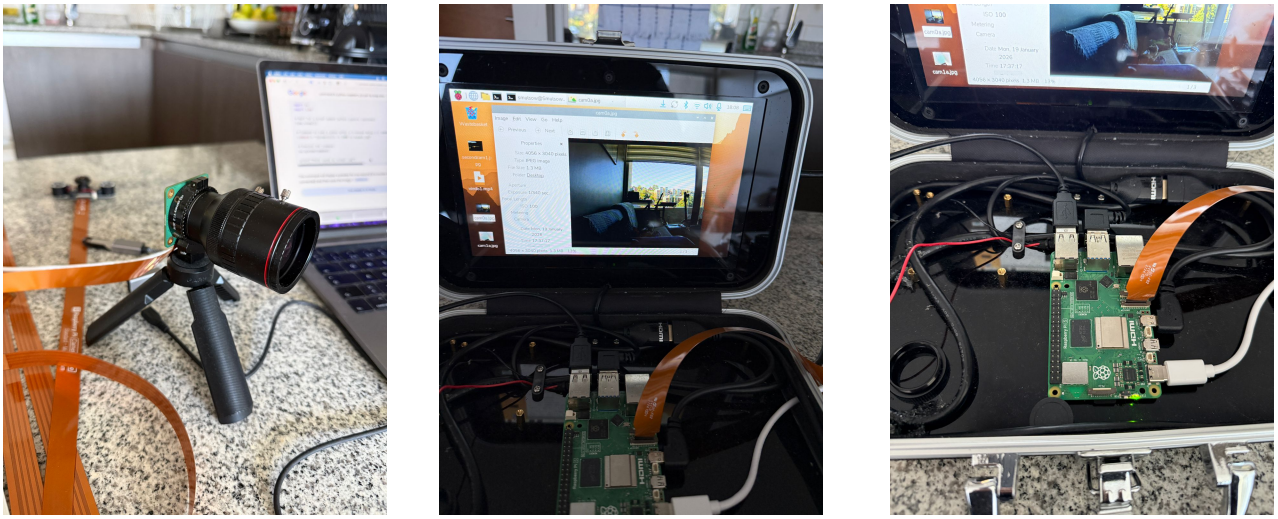

FIGURE 5. Optical camera chosen (A) in small tripod on desk test. In B a picture taken on desk, controlled by Raspberry Pi5, using python algorithms. In C a close up of the capabilities of Raspberry Pi5, showing several (4) USB ports, video displays (two ports), one HDMI and ethernet connector.

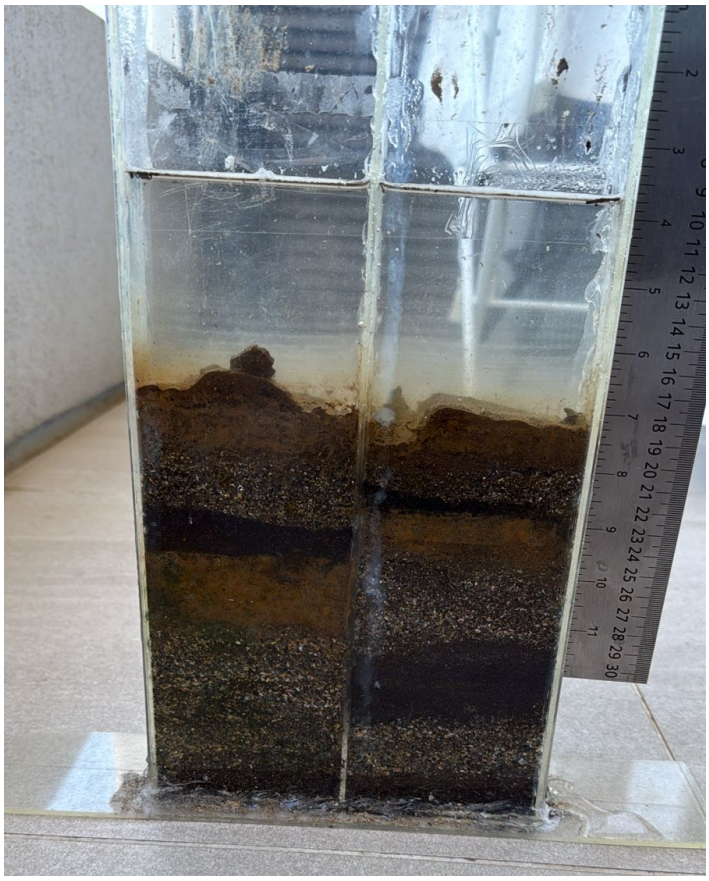

Figure 6, artificially made sediment columns with natural sediments collected in Valdivia Estuary. Light colors sediment particles rich in carbonates, dark sediments rich in magnetic volcanic derived sediments and brown fine sediments are richer in organic matter. All sediments collected at subtidal coastal embayments (less than 2 meters water depth)

Next Steps for this proposal to finish.

1) Assemble the whole unit. Metal and bullet proof chamber fully functional (optical, power and communication). Expected date, mid June 2026

2) Bench dry testing and communications. Using artificial sediment column in total darkness. Mid July 2026

3) HySPI will be mounted on a 316 ANSI frame. Probably tested at 400 meters water depth in Patagonian fjords under heavy contamination by salmon farming. Early August 2026.

4) Full shallow water testing in Chile, will depend on funding. It is needed a midsize boat with 4000 m, and 8 to 10 mm wire and a hydraulic winch. Mid to late September 2026

5) Testing of full Hyper-spectral SPI at 6000 m. This is a major undertaken that includes a research vessel or similar, with a winch big enough to hold 6500 m 10 mm steel wire, sonar and bow trust. Not estimated date yet. Collaboration is needed.

NEXT PHASE of Hyper-spectral camera

1) Cloud data collection and AI hub for analysis of images - some talks with partners. Not financing yet.
2) Scale up of Hyper-spectral SPI to lower construction costs and weights. Not financing yet.
3) International sampling experiment world wide, at least 1 or 2 from all the oceans sea-floors, in particular from the CCZ (deep-sea mining license actives).