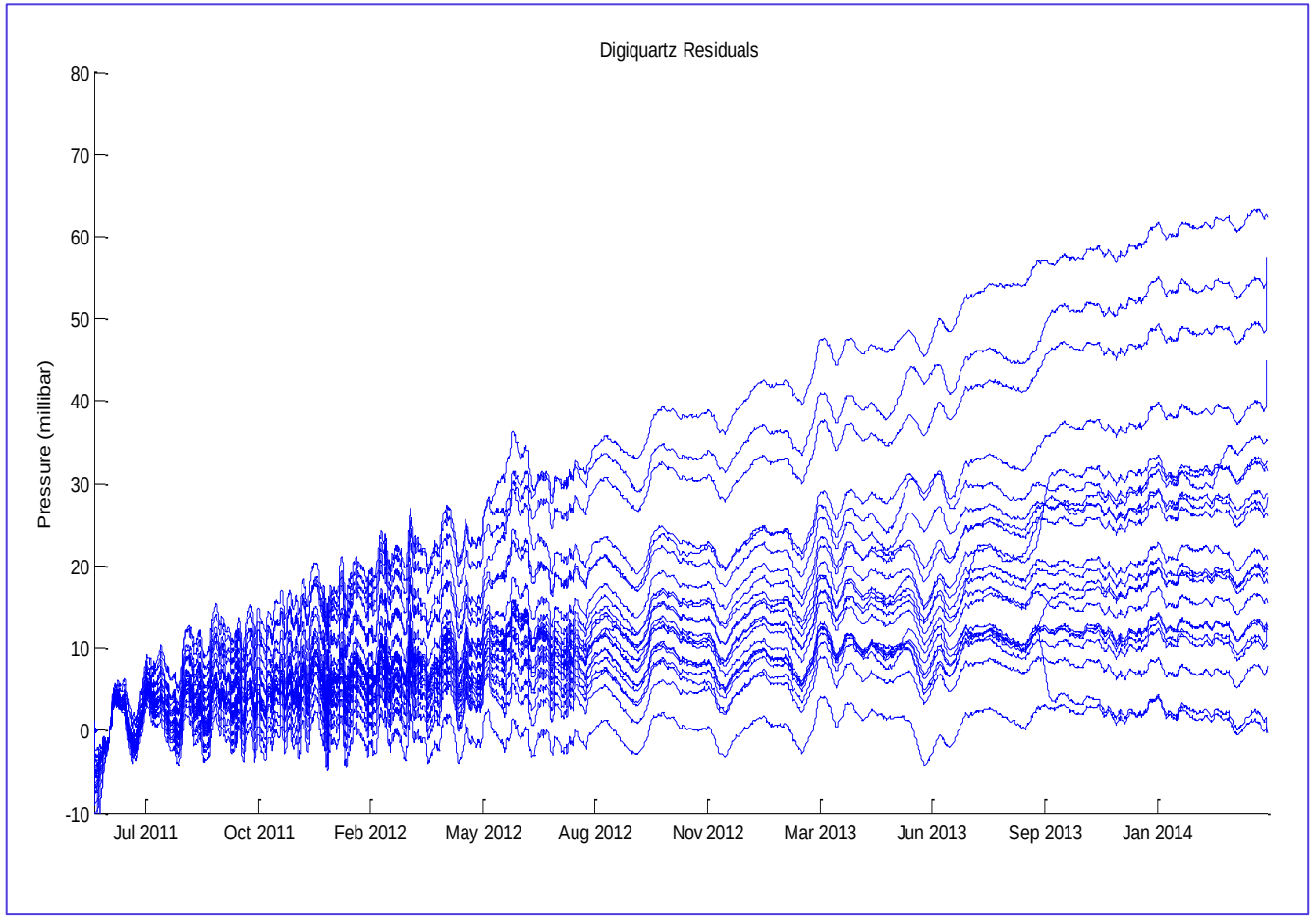
Introduction to the Fetch AZA (Ambient-Zero-Ambient) Transponder

7th Dec 2023

Fetch AZA – Pressure sensor drift removal

Pressure sensors drift over time

- Seabed data from > 30 sensors installed in an array ~ 10km across.
- Set a datum reference point ~ 50 days after installation to allow for settling in
- De-tide all nodes
- Resultant change is sensor drift or actual depth change



Pressure sensors drift over time

- Sensor manufacturers quote long-term drift as < 0.01% full-scale
- 300 bar full-scale, drift can be ±30 cm/year
- Assumed: not measured during manufacture
- Can be characterised in lab over 100+ days, but expensive to do

Pressure sensor characterisation

8 freezers in operation (30 sensors in each)

Common hydraulic pressure line

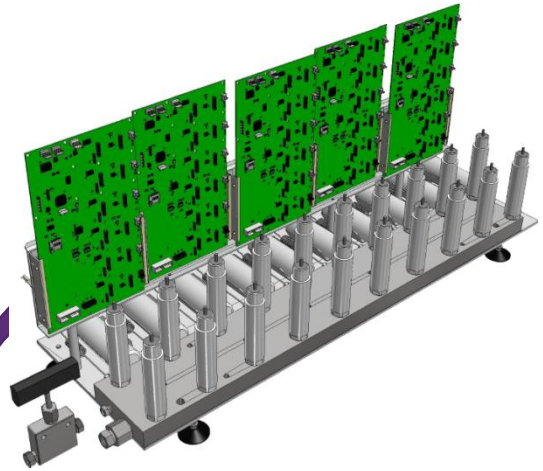
Very stable temperatures @ 5°C

10s sampling interval

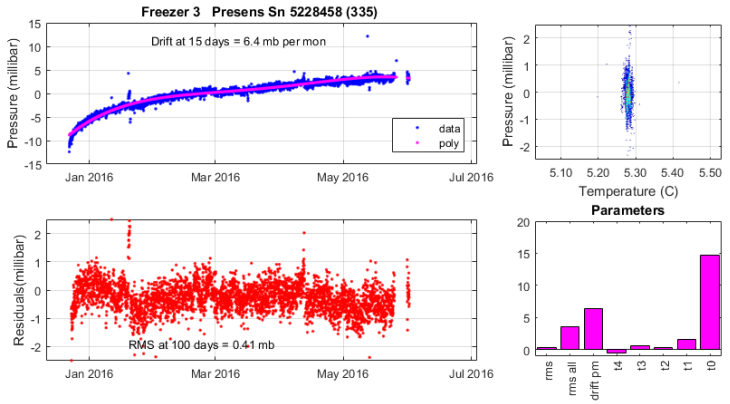
2M data points per day

8 - 16 week duration

Characterisation of pressure sensor start-up drift



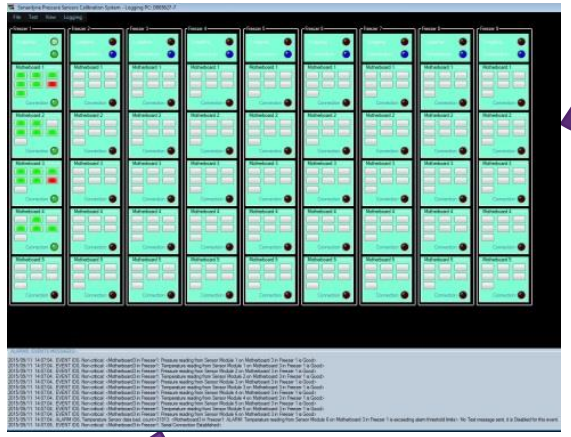
30 sensors
on manifold



Characterise individual sensor drift

Held at very stable temperature

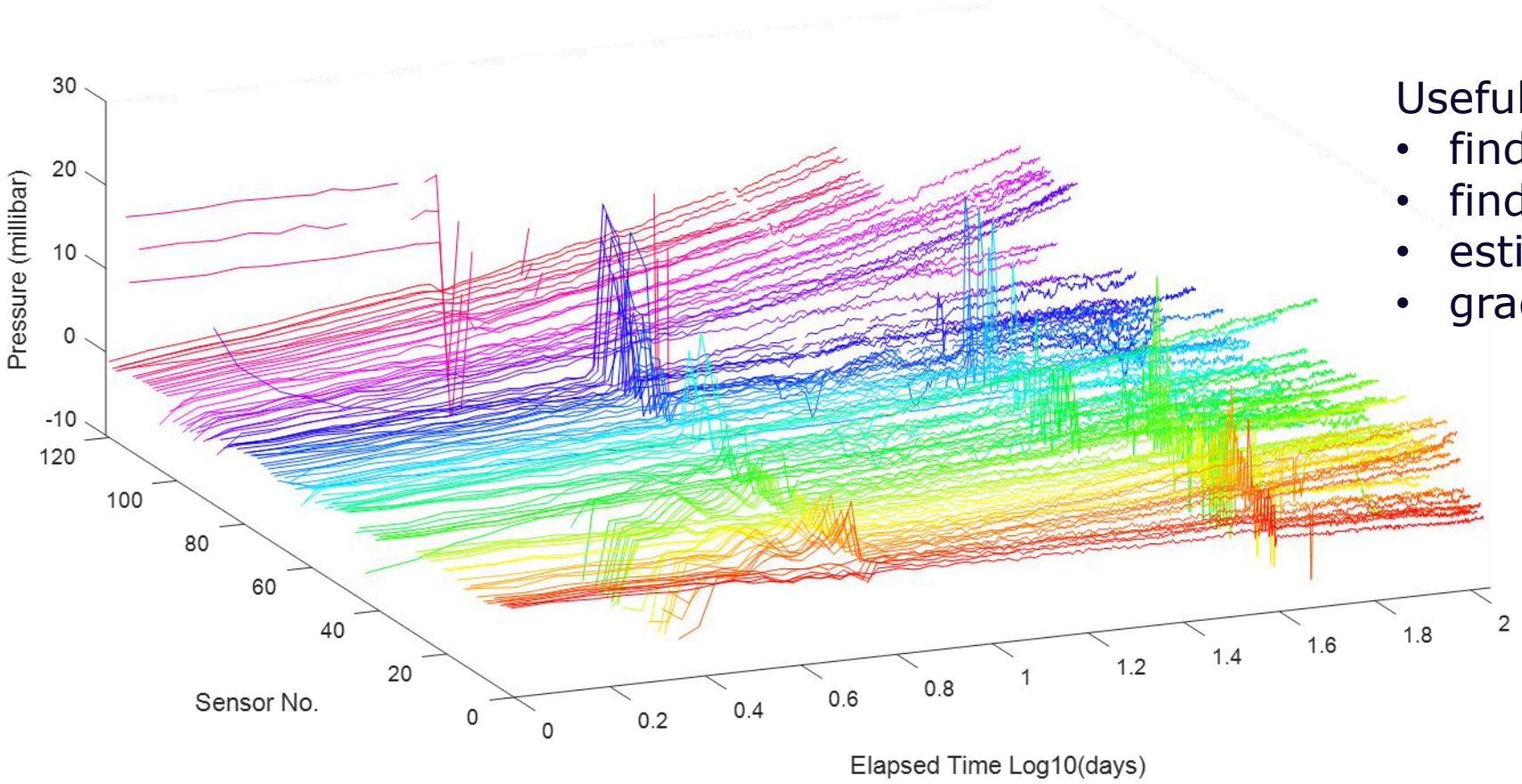
All sensors on common pressure line



Log data for 2-4 months

Fetch AZA – Pressure sensor drift removal

Pressure sensor characterisation



Useful method to:

- find outliers
- find batch issues
- estimate long-term drift rate
- grade sensors

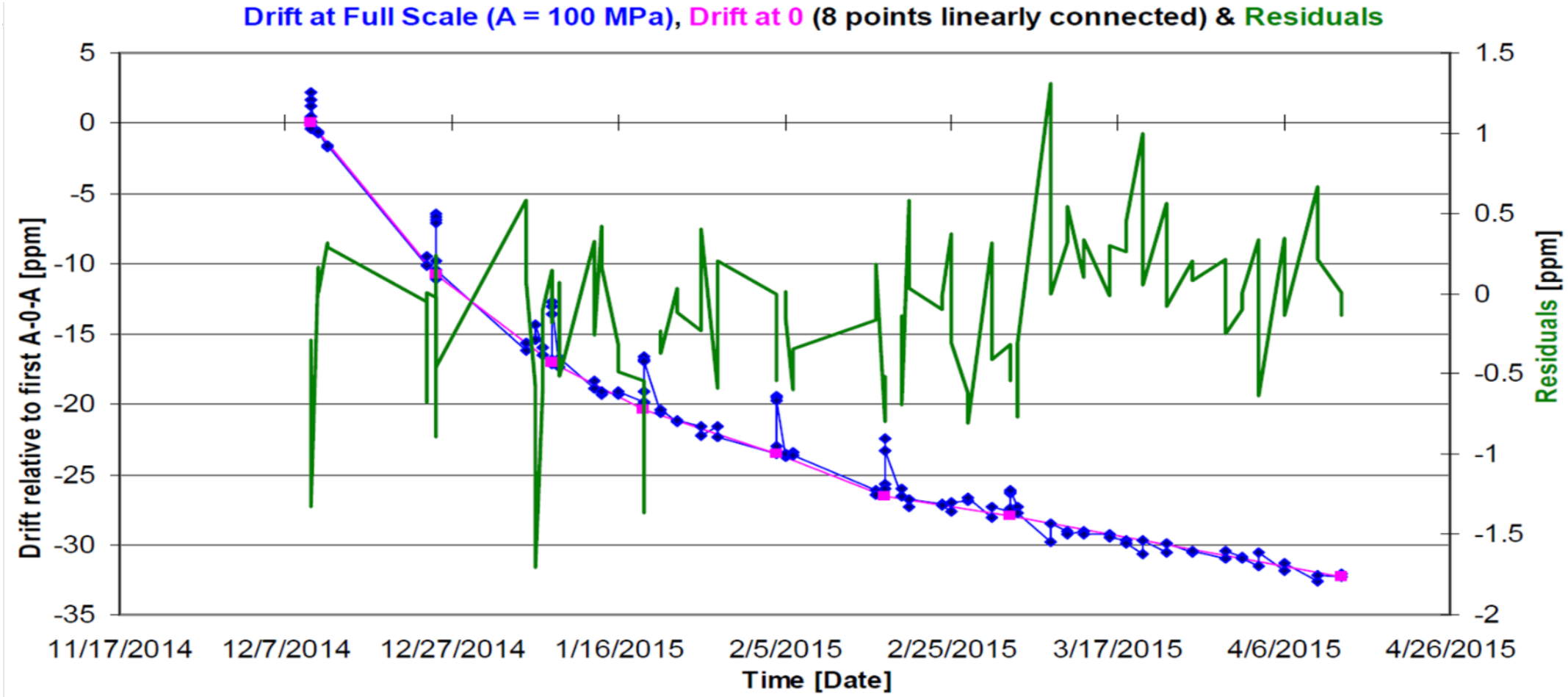
Fetch AZA – Pressure sensor drift removal

Serendipity: drift = bias

- National Metrology Institute of Japan (ASIT) regularly checked six 700 bar reference sensors
- They observed that the sensor drift only affected bias not span in Digiquartz pressure sensors
- Comparing a 700 bar sensor against a barometer at 1 bar allows drift error to be measured to very high accuracy
- Easy to measure in a lab, but not subsea

Fetch AZA – Pressure sensor drift removal

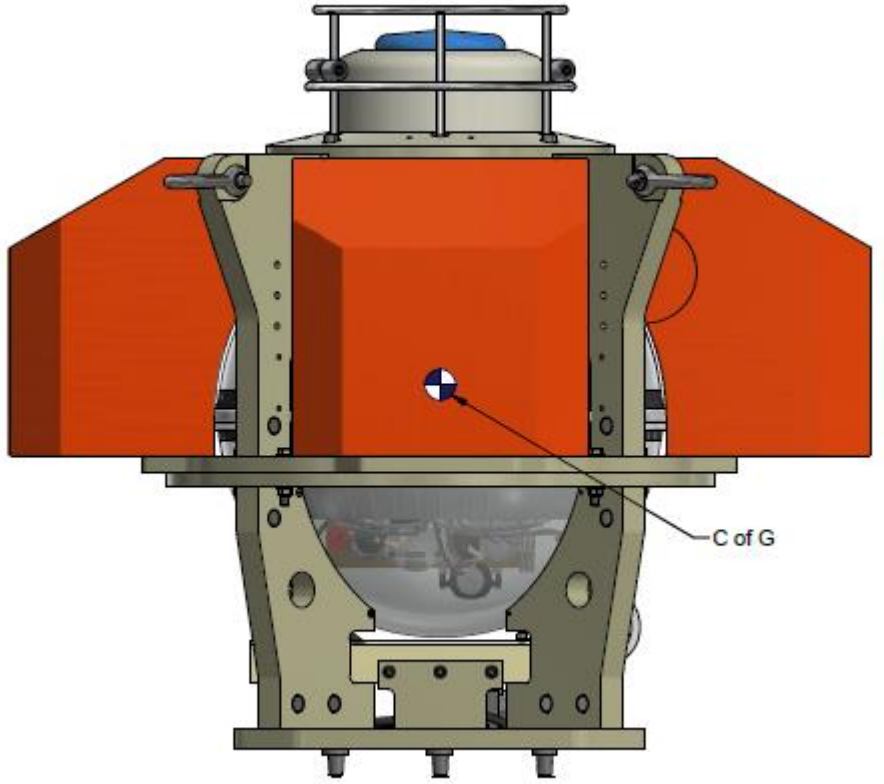
Calibration methods to eliminate Quartz sensor drift



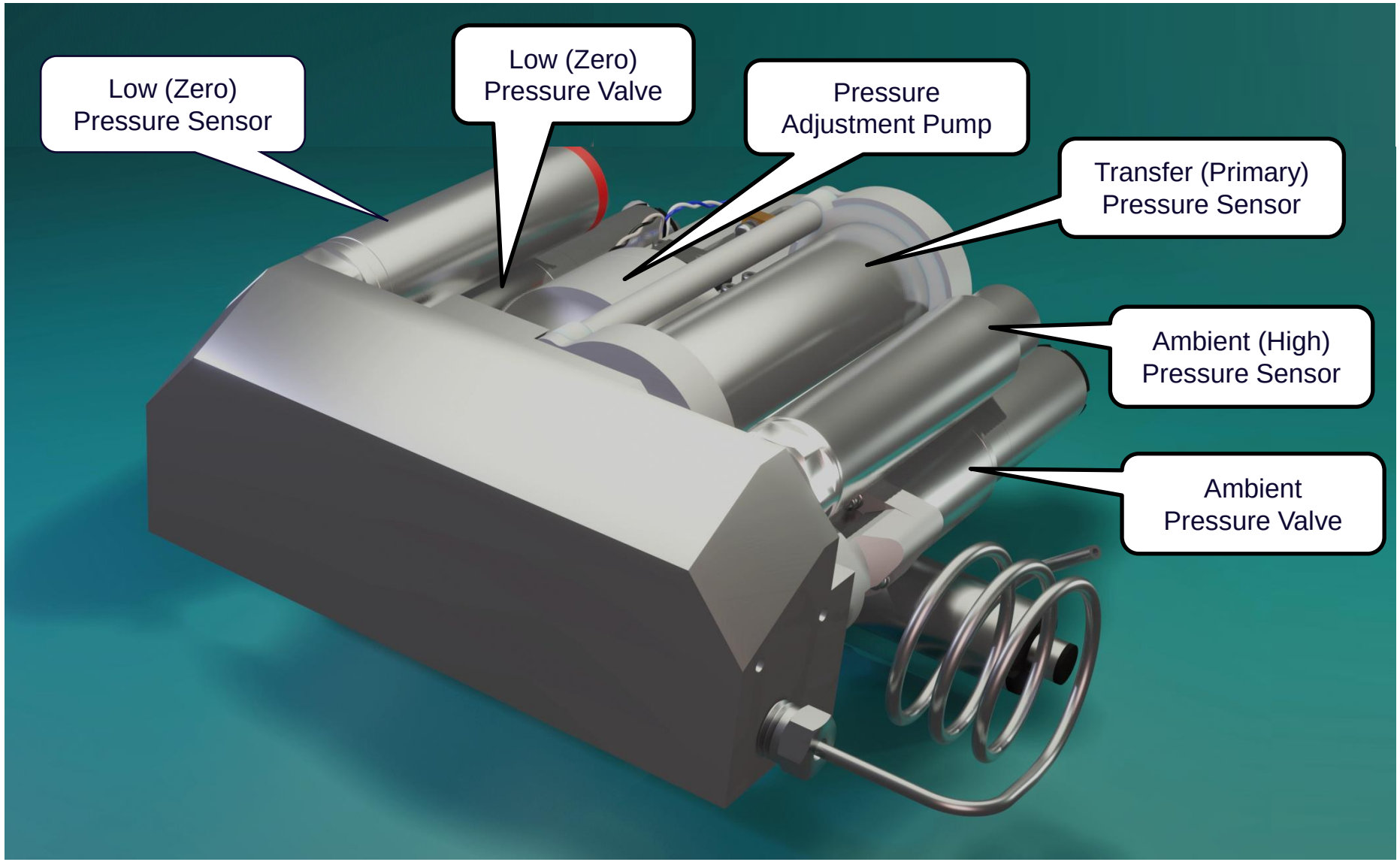
Jerome M. Paros &
Taro Kobayashi

AZA Principle of Operation

- Technique that allows long term senor drift in high range pressure sensor to be measured periodically in situ.
- Can be accommodated inside the Sonardyne Fetch which will power and operate the AZA for 5-10+ years depending on battery life.
- Data can be downloaded acoustically
- Post processing of the data can remove the drift from the logged seabed pressure.
- The ±0.2 mbar accuracy of the low-pressure sensor is transferred to the high pressure Digiquartz sensor

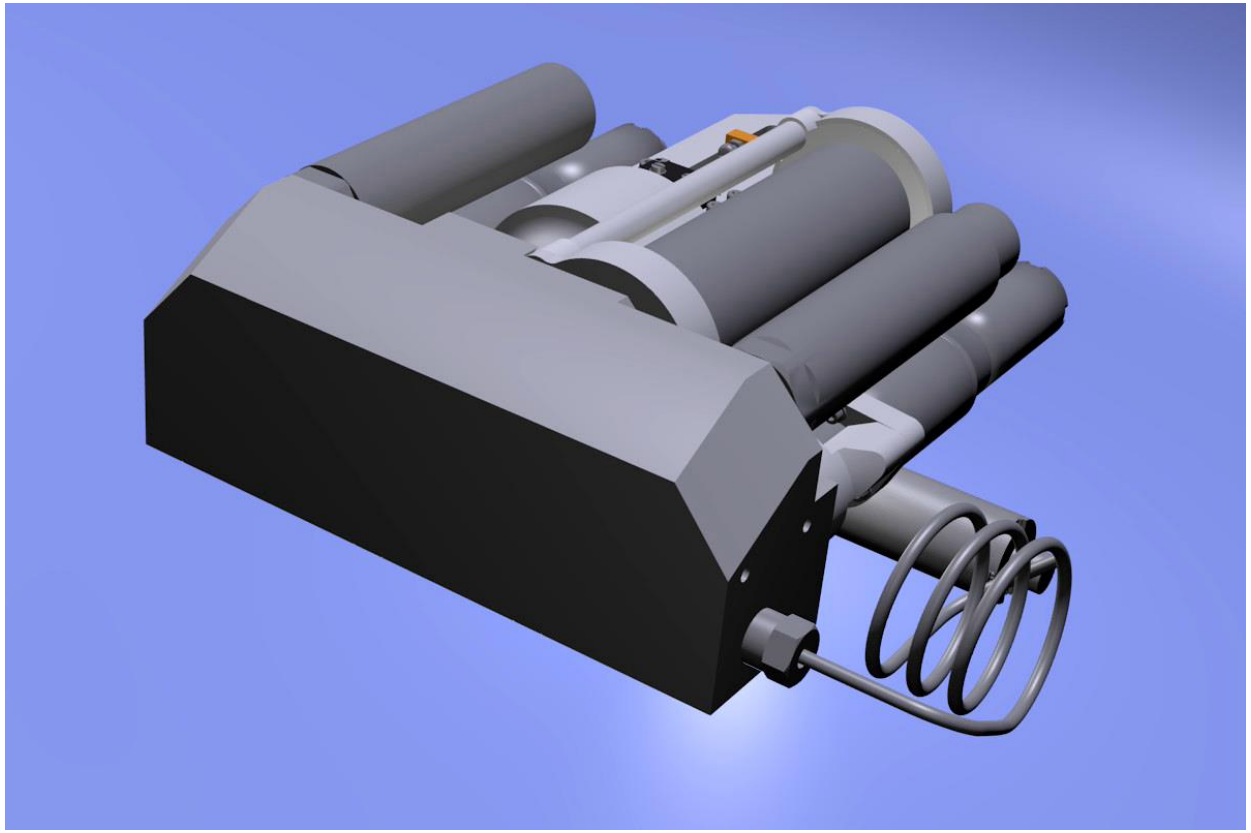


Fetch AZA Instrument - Overview

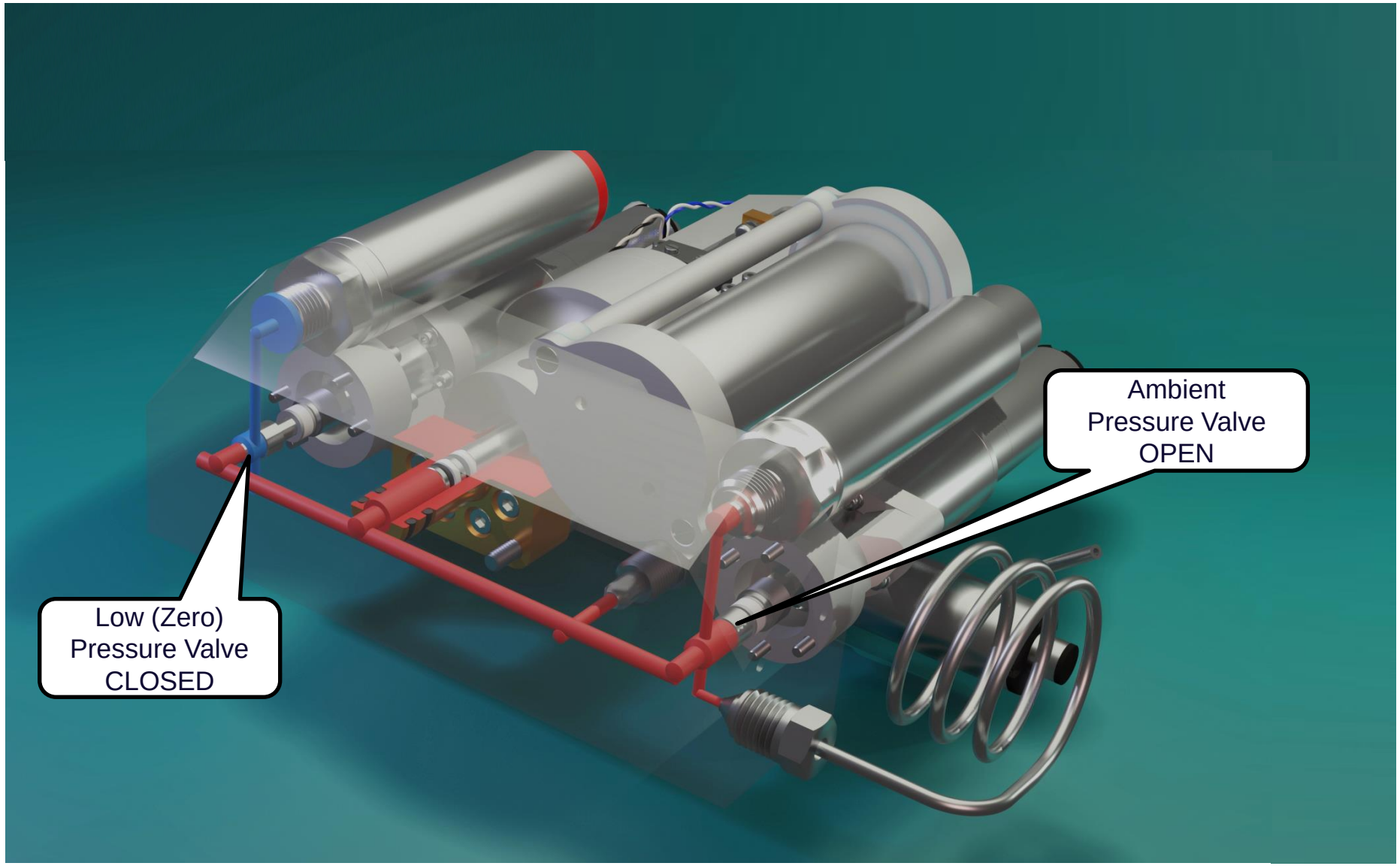


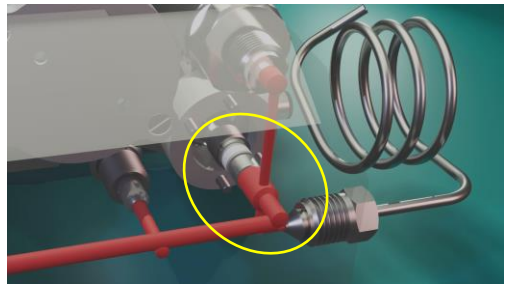
AZA Operation process

- Valve isolates the Quartz pressure sensor from ambient pressure and pressure reduced internally to one bar.
- Readings taken to compare the quartz sensor to the high accuracy internal low-pressure sensor
- Quartz pressure sensor is then returned to the ambient sea water pressure.

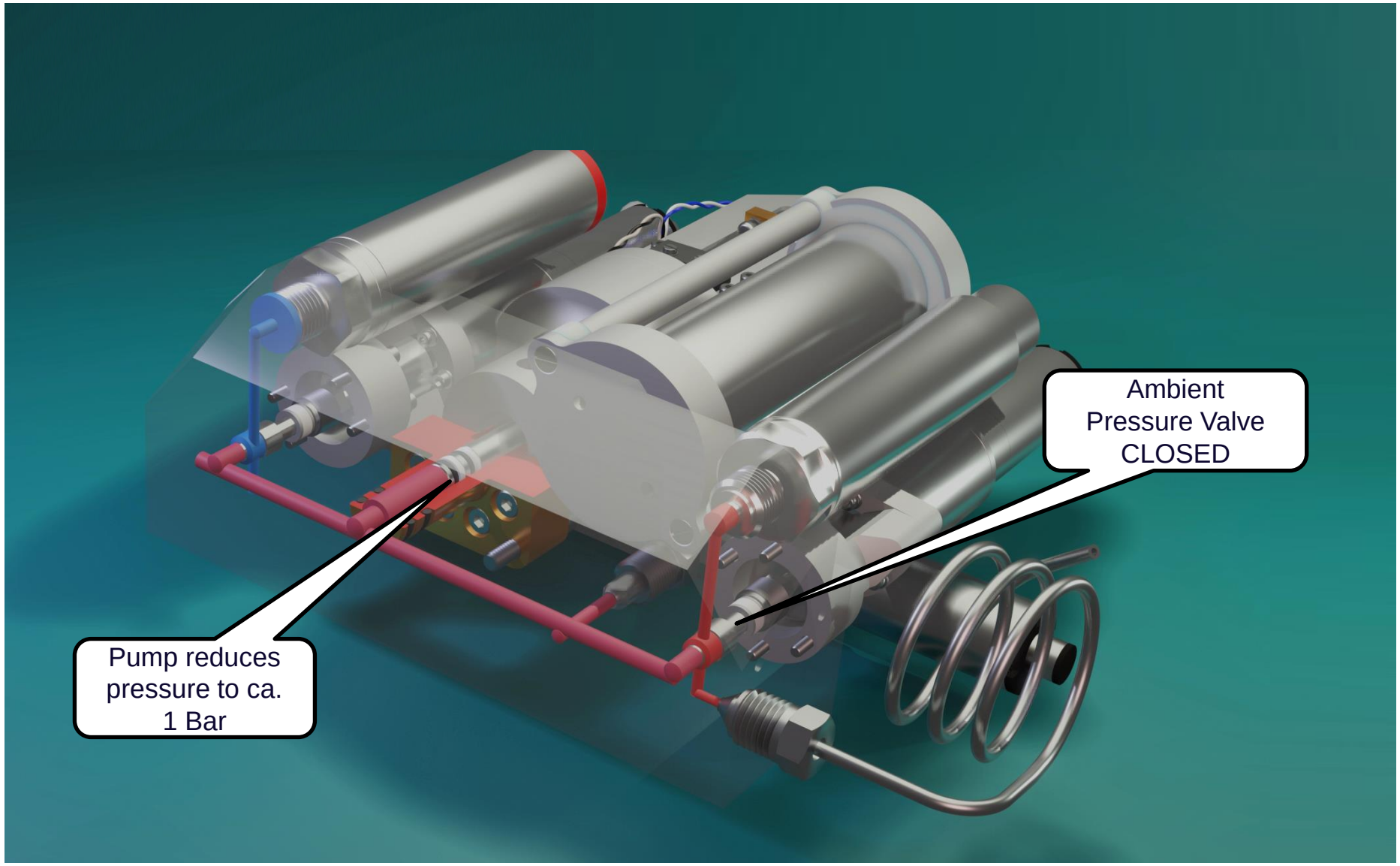


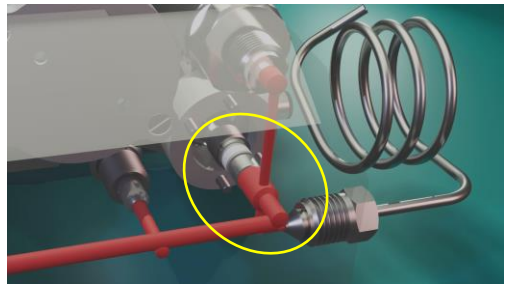
Fetch AZA Normal Operation – Ambient and Reference Open to Sea

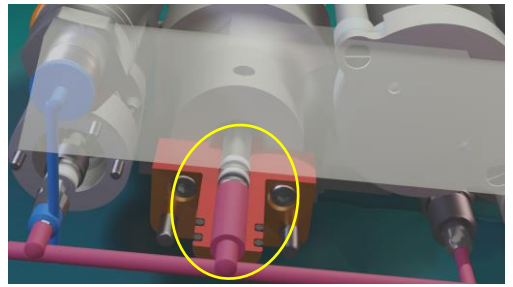




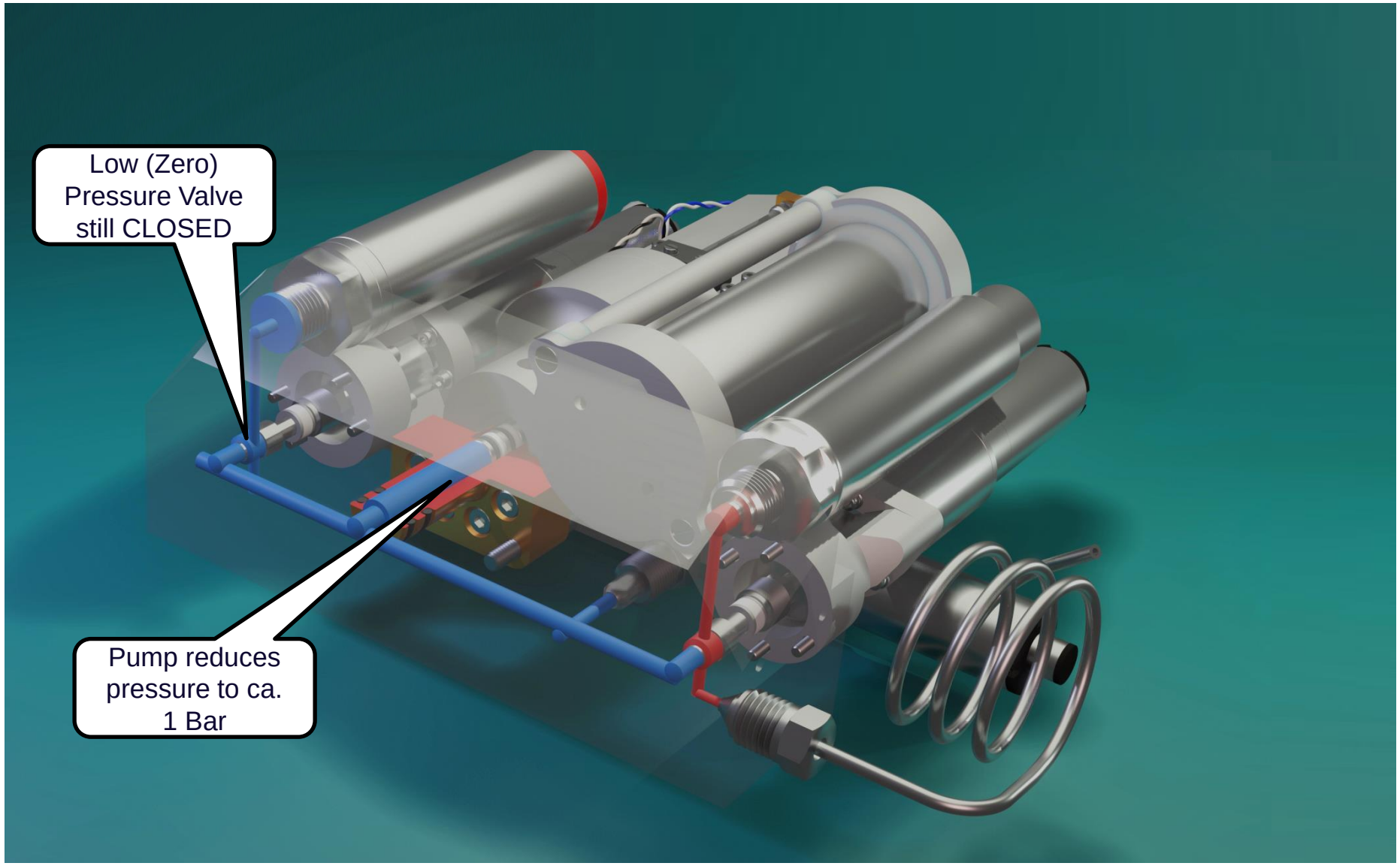
Fetch AZA Sequence Initiation

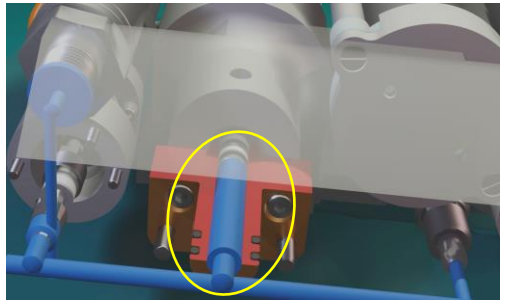


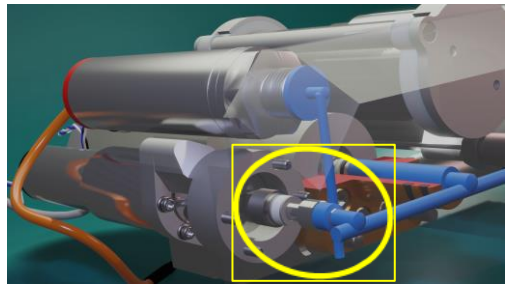




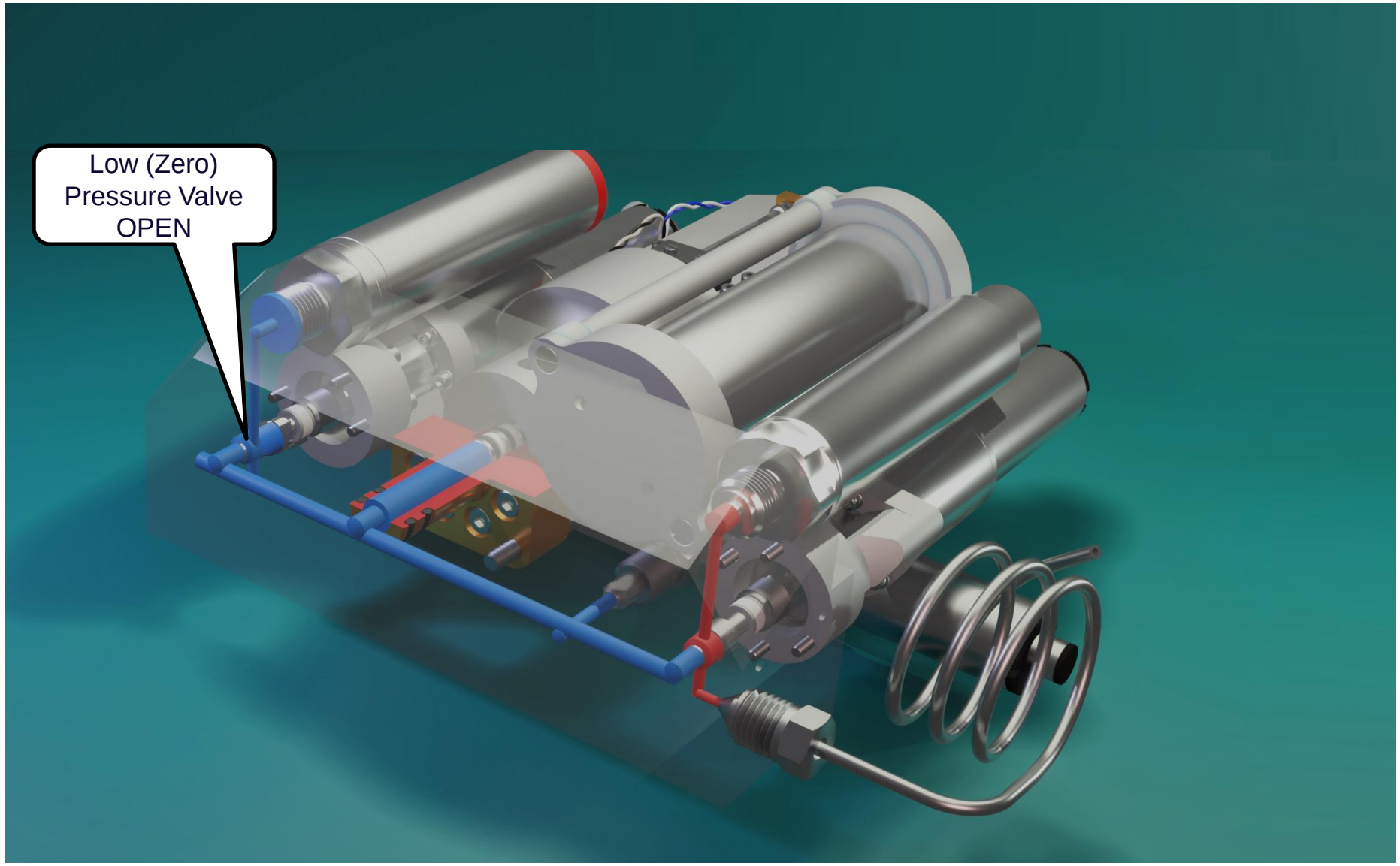
Fetch AZA Sequence – Reduce Instrument Pressure to 1 Bar

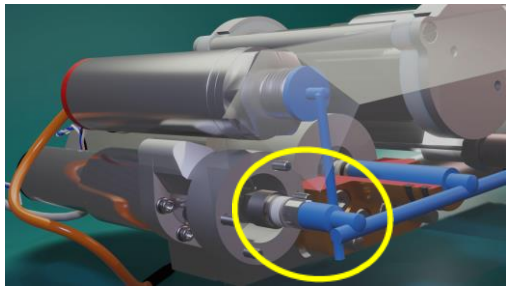




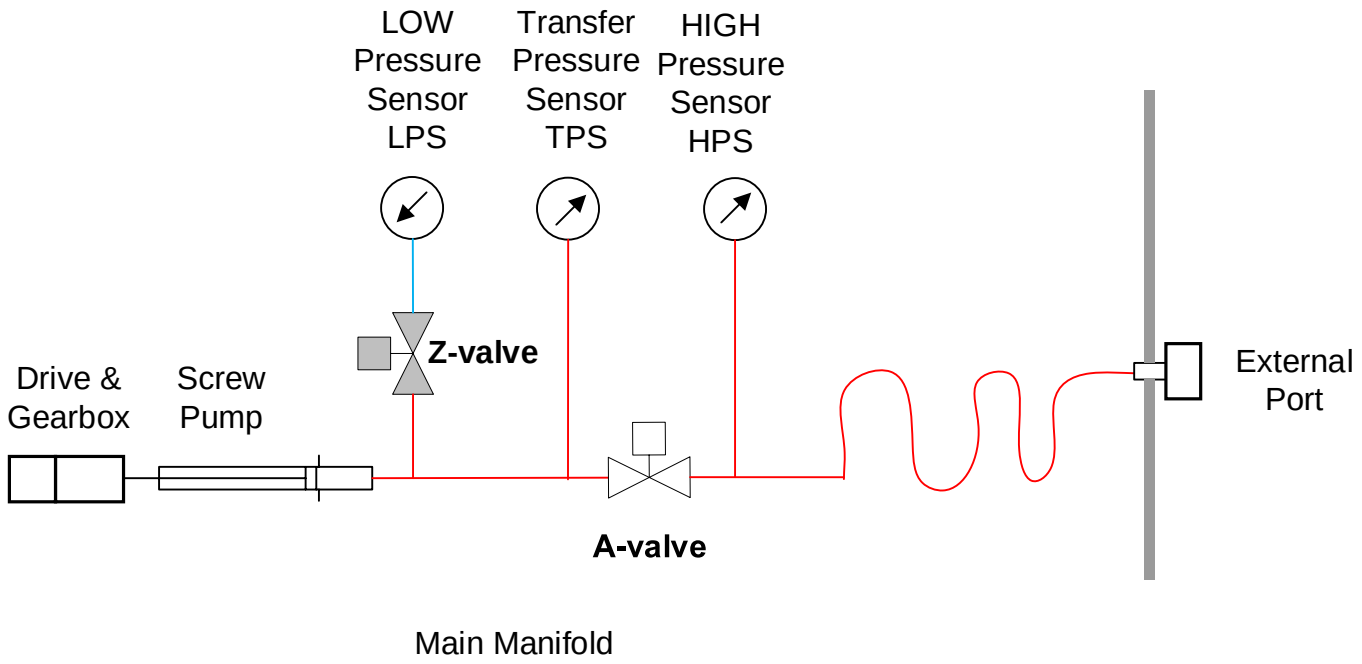


Fetch AZA Sequence – Reference Measurement

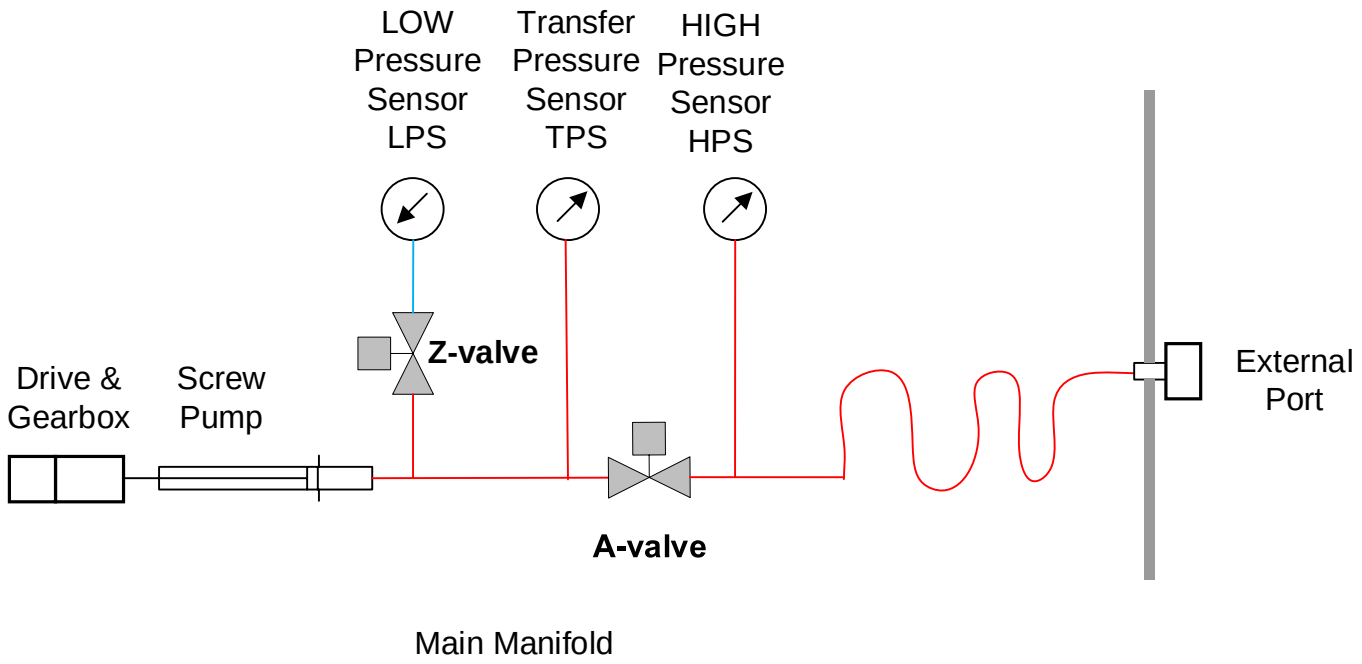




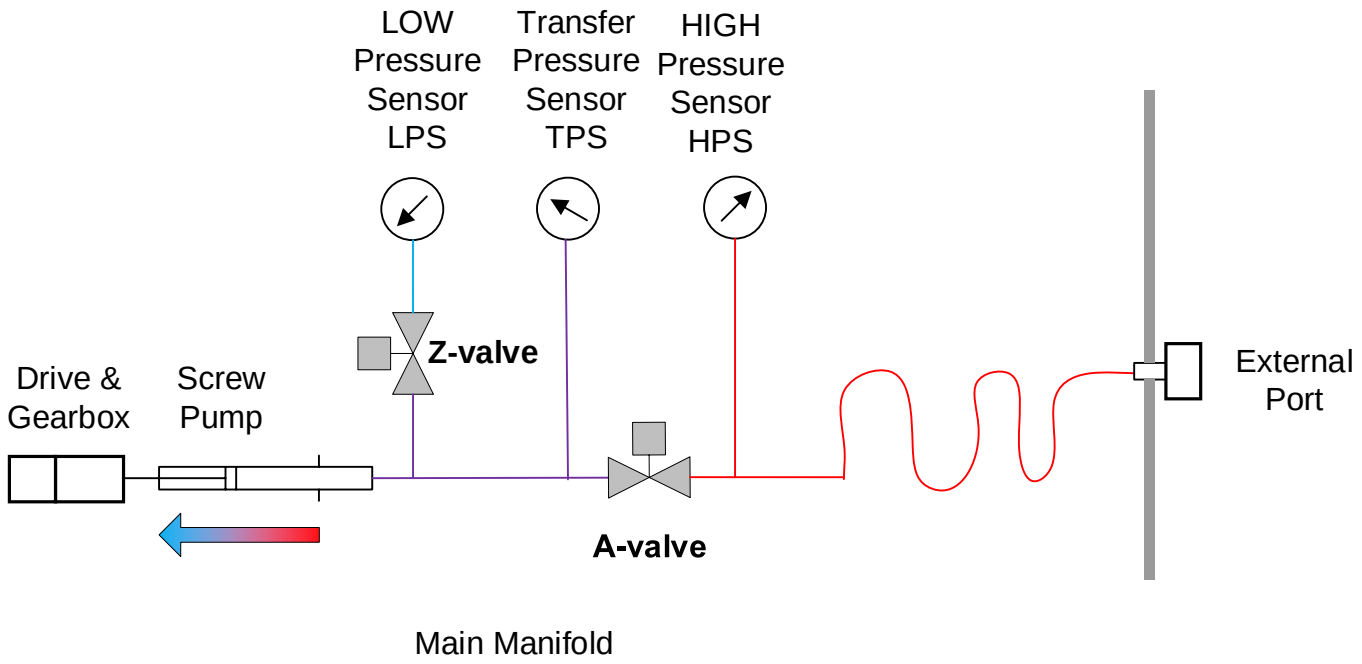
AZA Sequence – stage 0



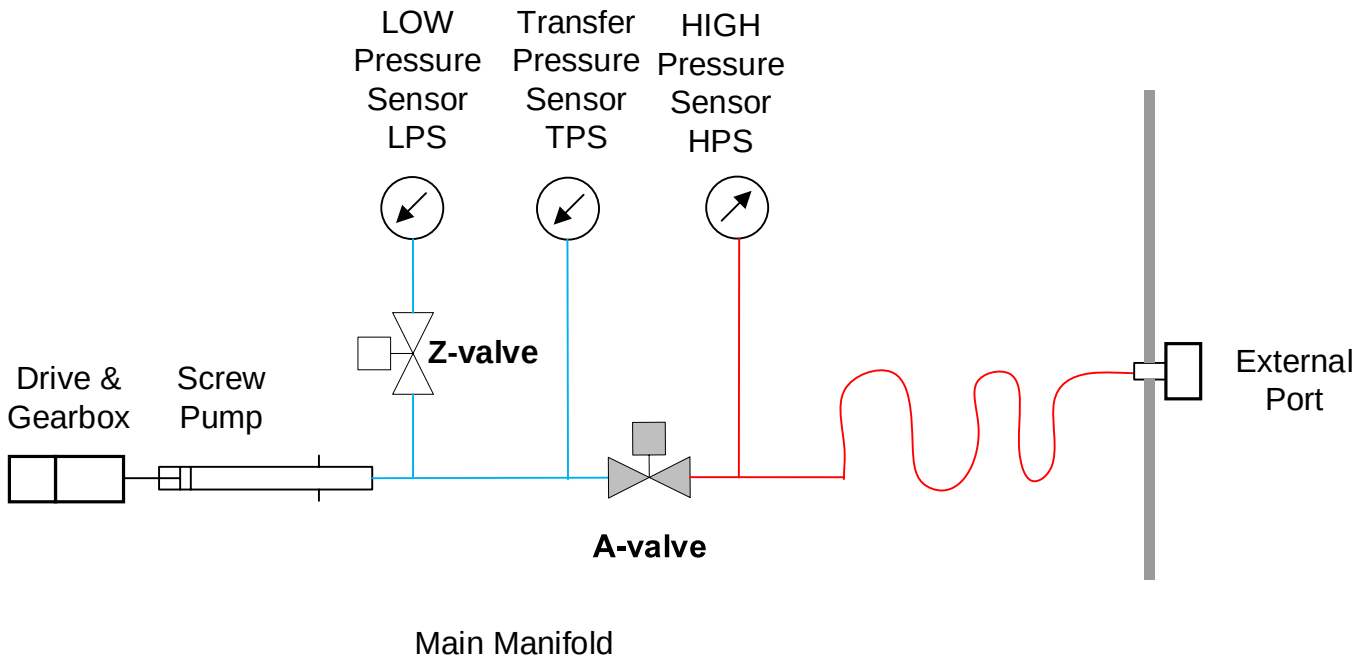
AZA Sequence – stage 1



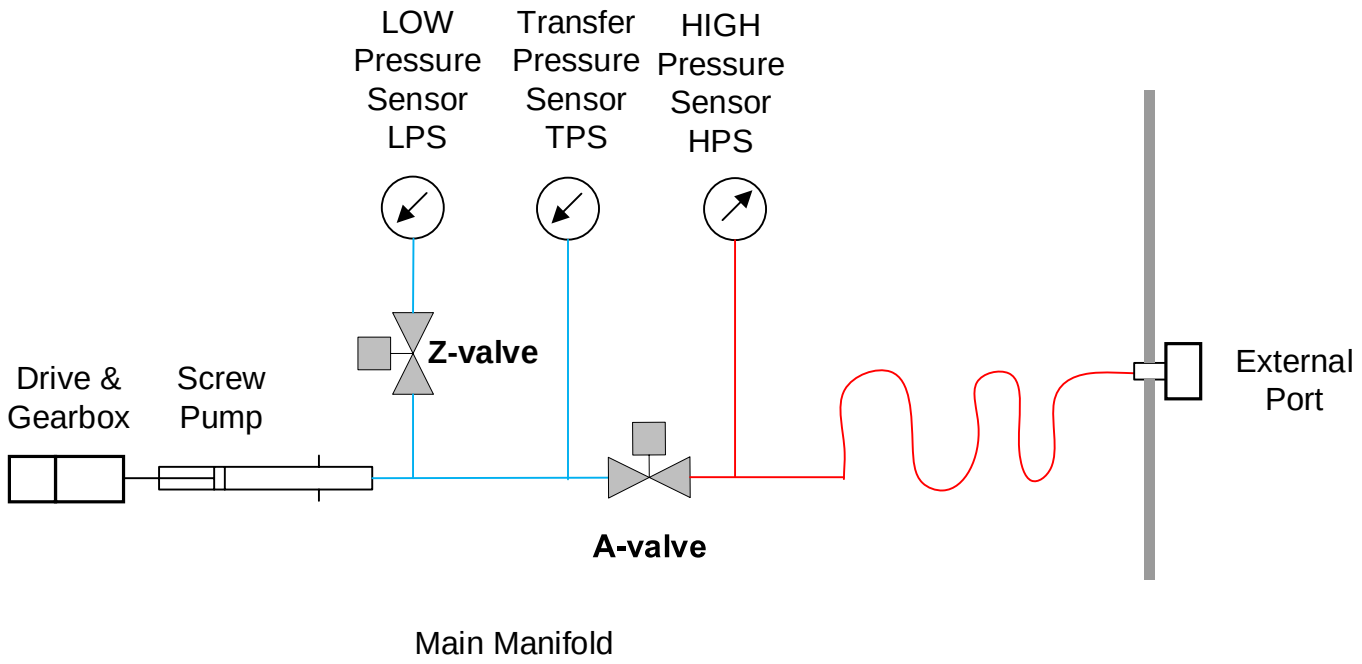
AZA Sequence – stage 2



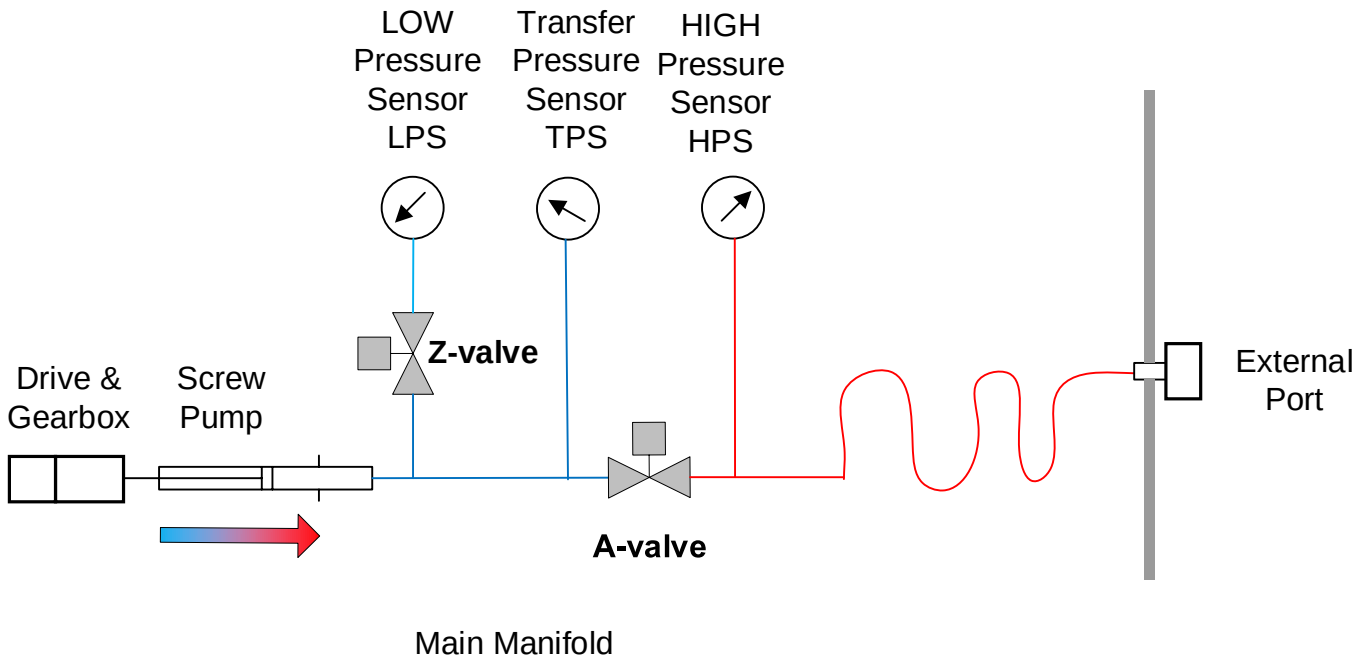
AZA Sequence – stage 3



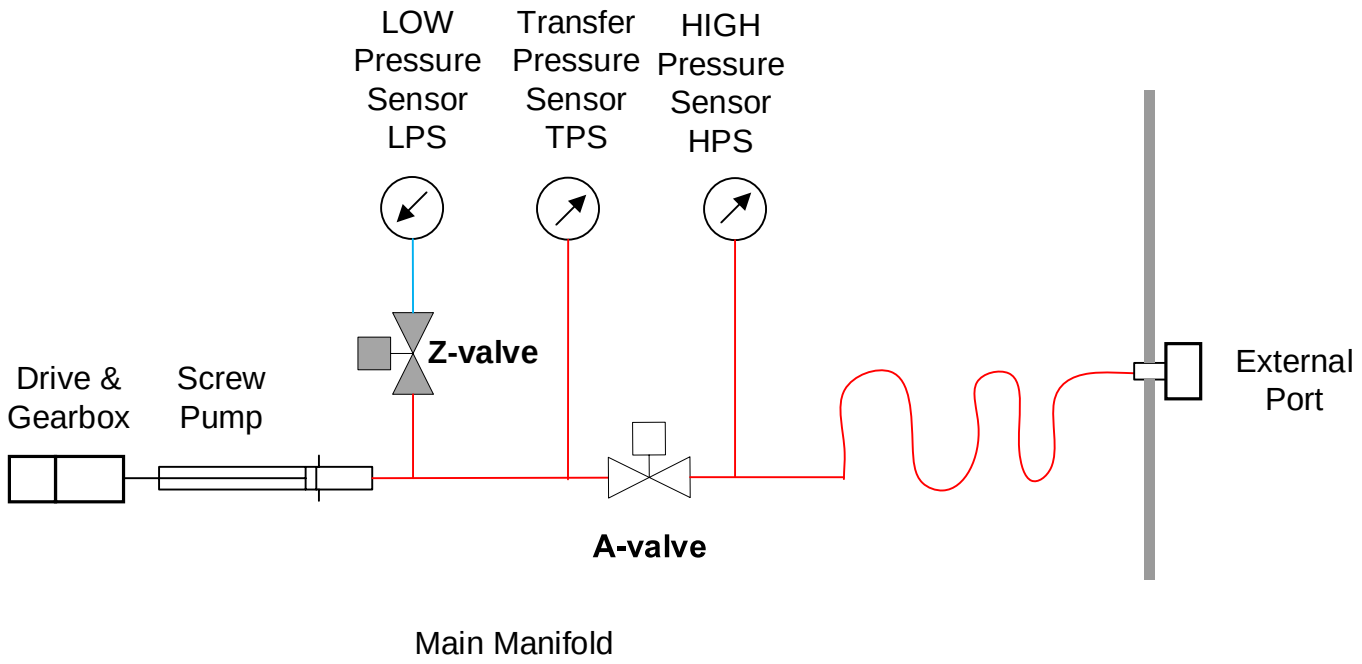
AZA Sequence – stage 4



AZA Sequence – stage 5

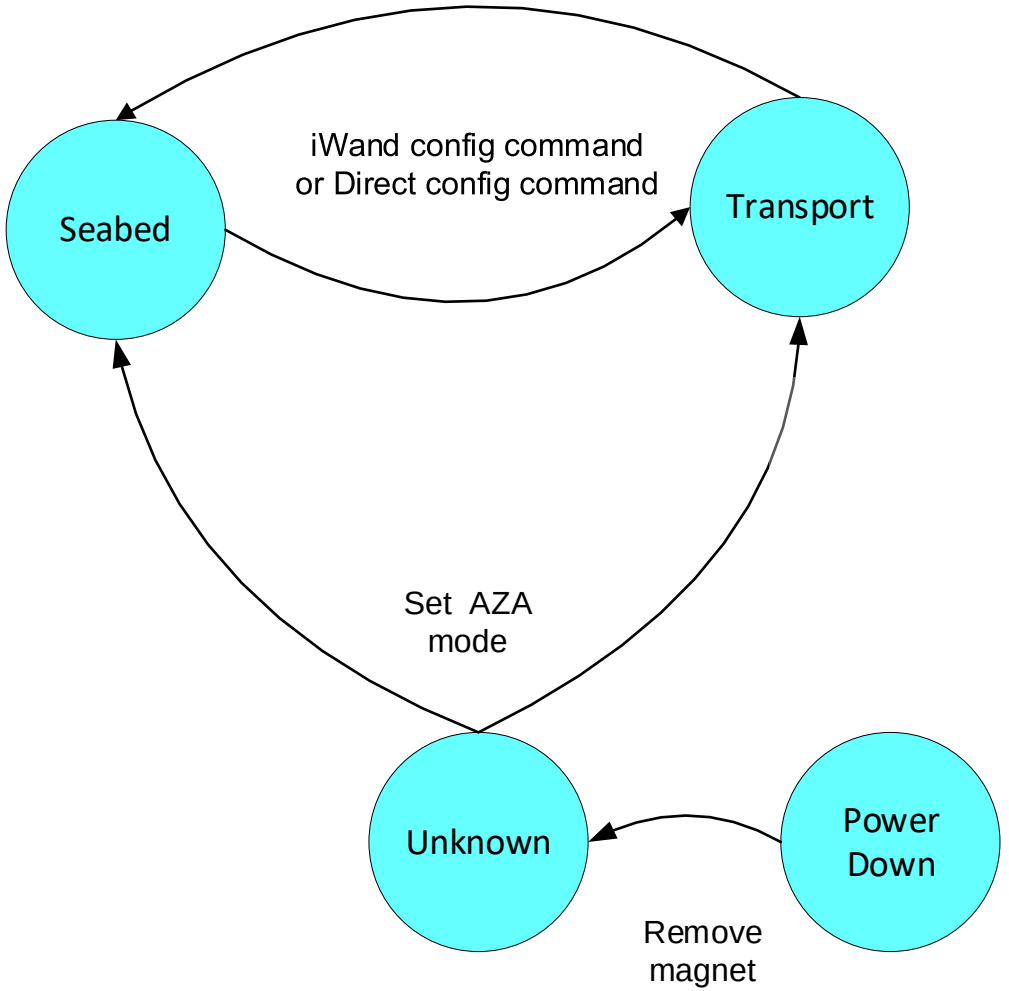


AZA Sequence – stage 6



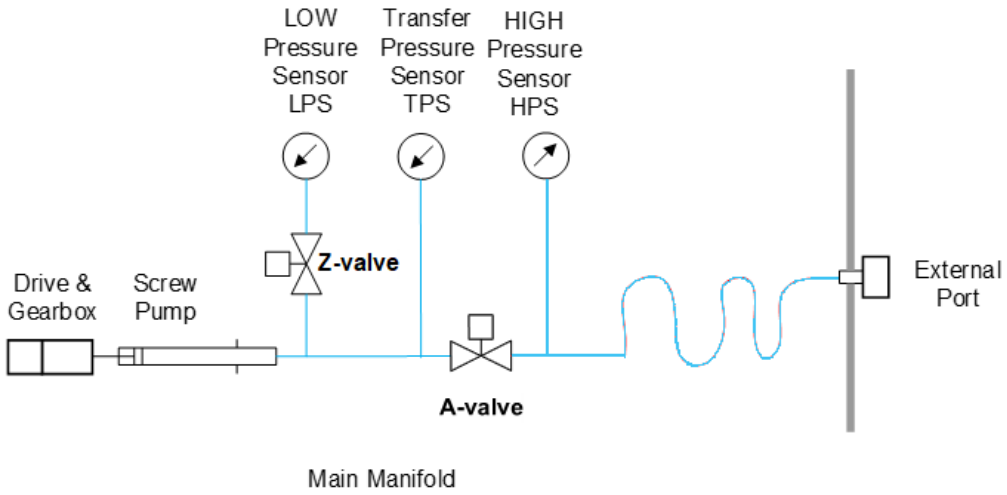
AZA Operational States

- The AZA must be configured into the correct state for the current operational phase
- Failure to set the correct state could result in damage to the unit causing faulty operation
- 2 different operational states for the AZA:
  - **Transport**
  - **Seabed**



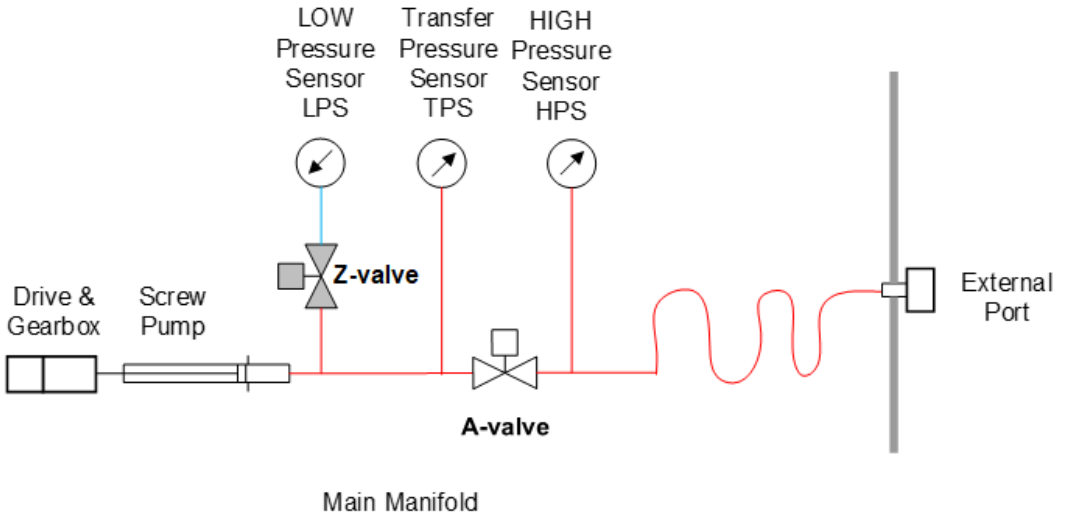
Transport state

- Mode that the AZA will be in when received.
- In transport state both valves are open with both the internal low-pressure sensor and quartz sensor open to the external (atmospheric) pressure
- AZA should be left in transport state when left in a non-temperature-controlled environment e.g. if left on deck in warm environment.



Seabed state

- Seabed state **MUST** be set prior to deployment.
- Low-pressure sensor is left at 1 bar at the end of the state change.
- Low pressure valve is closed.
- The high-pressure valve is open, and the quartz sensor is open to ambient pressure
- The unit is ready to start making seabed measurements, this is controlled by the logging status configuration.

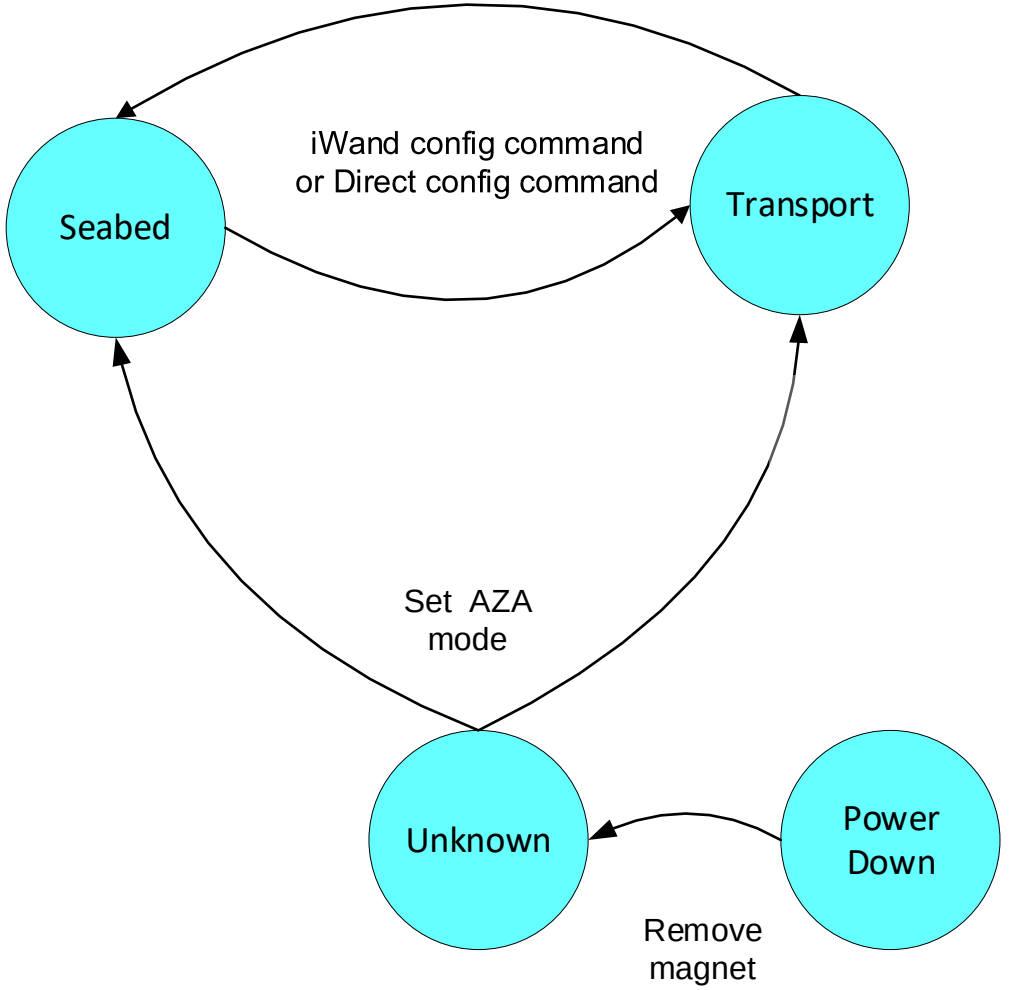


AZA Power Cycling

- Internal battery in the AZA can be disconnected by fitting the magnetic fob on the outside of the instrument.
- When power is cycled the AZA valves are left in the current state.
- When power is re-applied the AZA valve positions will remain as they were when power was removed.
- Memory of the valve position and operational state does not persist after power cycle and the mode should be set again before operating.

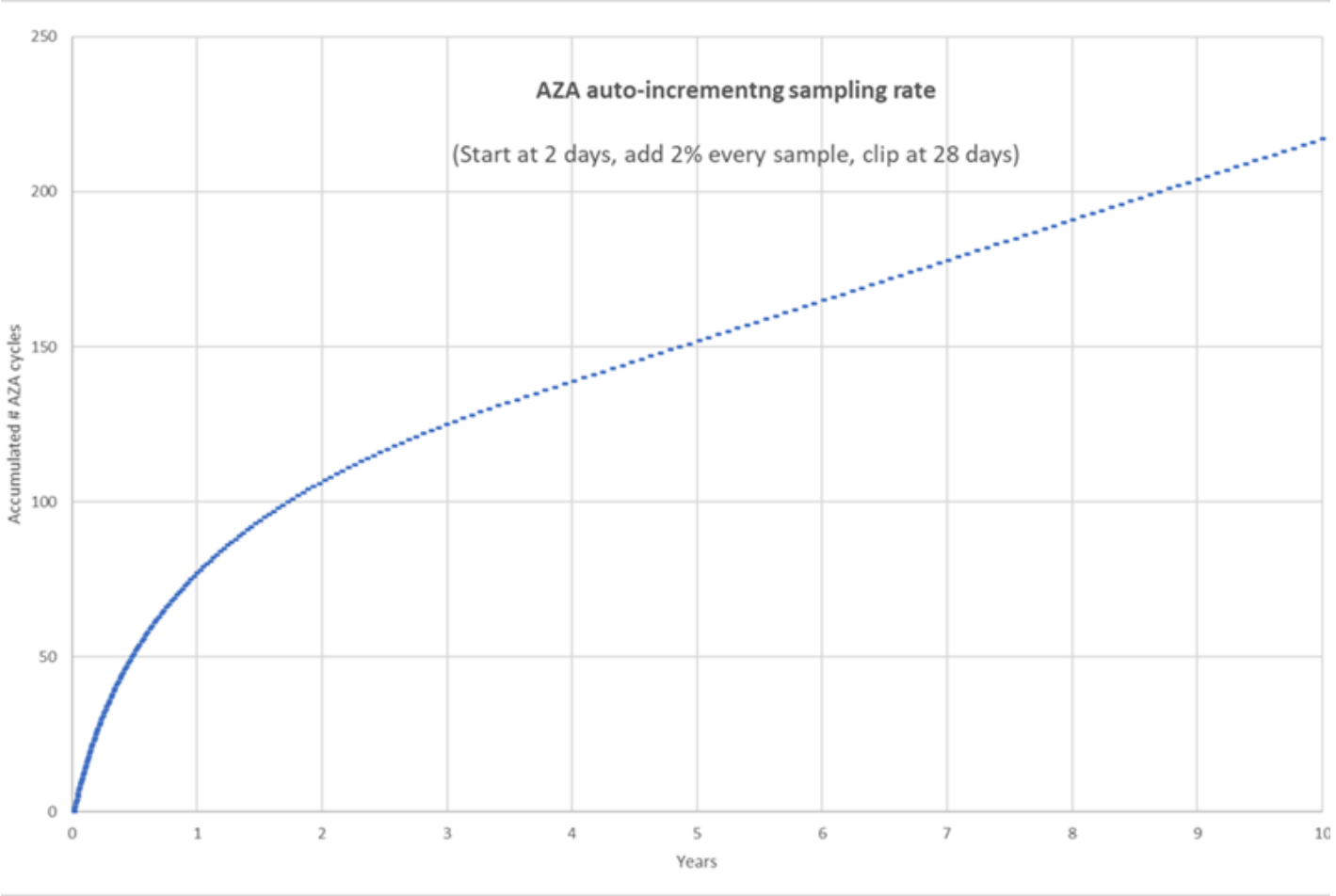
AZA power-up sequence

- Remove the magnet to power up the Fetch AZA.
- From power-up the AZA state is “Unknown”
  - and RTC uninitialized
- Send a **Seabed** or **Transport** command to set the required operating state.
- Send **Get AZA Status** to read the pressure from each sensor and confirm state.



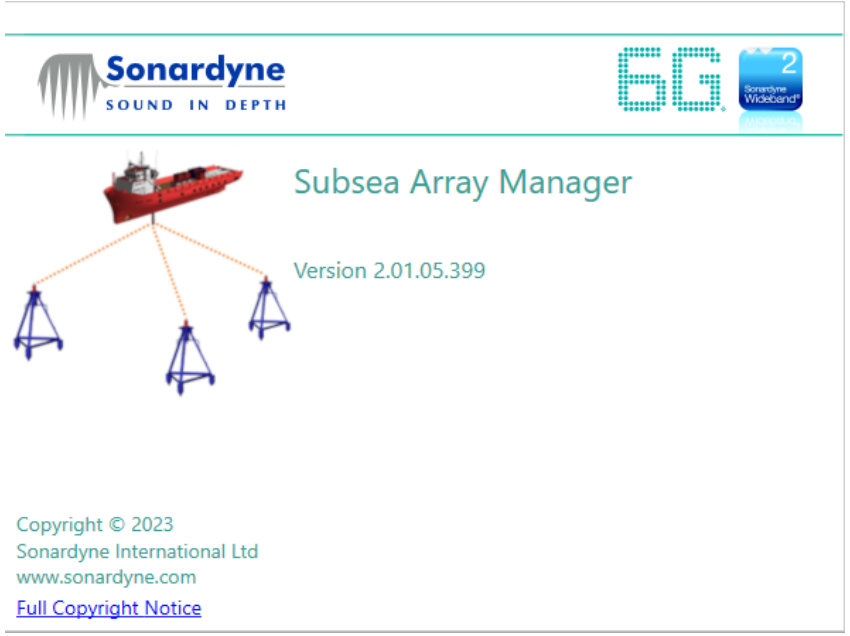
Recommended AZA Logging Scheme

- Experience tells us that the drift of the pressure sensors is more significant early in the deployment and settles over time to a long-term drift rate.
- Ideal is to have more frequent AZA operations early in the deployment and automatically increase the interval slowly over several years.
- Recommended log interval begins at 2 days with a 2% progressive increment clipping at a maximum of 28 days between AZA cycles.
- Total number of AZA cycles over a 10-year deployment would be around 250.



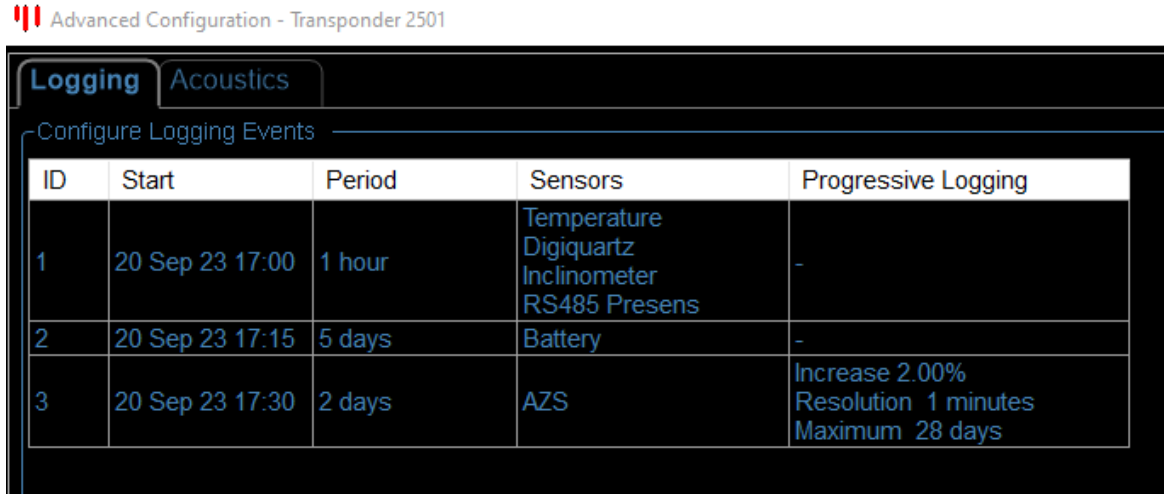
AZA Configuration

- The AZA is configured using the bespoke Sonardyne application '**Subsea Array Manager'** this software is based on the Monitor Software used for AMTs.
- On deck configuration of Fetch can be done via:
  - an iWand
  - an RS232 cable (if release option fitted)
  - Bluetooth to Fetch
  - Acoustic link via transceiver
- Pre-deployment checks and test report should be retrieved using the iWand 6G Configurator or 6G Terminal Lite (using Bluetooth connection – covered later).
- Subsea Array Manager must be used to set the correct AZA operating mode on deck



Example Logging Configuration

- Typical logging scheme is hourly logging of sensors: Pressure(s), Temperature, Inclination & PIES
- Battery reading every 5 days.
- Progressive logging for AZA starting at 2 days incrementing by 2% to maximum 28 days.
- Avoid overlapping AZA and sensor readings
- For a 180Ahr single battery, the battery life with this logging scheme would be around 5 years.



ID	Start	Period	Sensors	Progressive Logging
1	20 Sep 23 17:00	1 hour	Temperature Digiquartz Inclinometer RS485 Presens	-
2	20 Sep 23 17:15	5 days	Battery	-
3	20 Sep 23 17:30	2 days	AZS	Increase 2.00% Resolution 1 minutes Maximum 28 days

Logged Data - Sensors

- Exported data from the software is an ASCII CSV file.
- File contains a header with the record formats for each sensor type
- Each sensor logged will create a new record on a separate line with its own identifier.
  e.g., TMP for Temperature
- Each record will contain an individual timestamp, serial number and the data fields.
- 8318 file specification provides details regarding the data formatting along with timestamp format, units and decimal place information.

```
PAG,Record Time,Retrieval Time,Node Ref,UID,Page Number
BAT,Record Time,Retrieval Time,Node Ref,UID,UsedPercentage %,Volts V
INC,Record Time,Retrieval Time,Node Ref,UID,Index,Pitch (deg),Roll (deg),Serial Number
TIM,Record Time,Retrieval Time,Node Ref,UID
TMP,Record Time,Retrieval Time,Node Ref,UID,Index,Temperature Deg C,Serial Number
DQZ,Record Time,Retrieval Time,Node Ref,UID,Index,Pressure (kPa),Temperature (Deg C),Serial Number
KLR,Record Time,Retrieval Time,Node Ref,UID,Index,Pressure (kPa),Temperature (Deg C),Serial Number
# Data
PAG,2021/08/27 10:30:00,2021/12/14 14:54:19,,0064E4,630
KLR,2021/08/27 10:30:00,2021/12/14 14:54:19,,0064E4,5,127.17340,21.720,59891
TIM,2021/08/27 11:30:00,2021/12/14 14:54:19,,0064E4
BAT,2021/08/27 11:30:00,2021/12/14 14:54:19,,0064E4,2,14.2
TMP,2021/08/27 11:30:00,2021/12/14 14:54:19,,0064E4,4,-246.8610,0
INC,2021/08/27 11:30:00,2021/12/14 14:54:19,,0064E4,1,-3.9438,4.4688,0
DQZ,2021/08/27 11:30:00,2021/12/14 14:54:19,,0064E4,3,138.89453,22.05,136594
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```

AZA Data Format

- Each AZA cycle will typically contain 5 logged records: 2x AZS records and 3x AZA records.
- AZS - status record, occurs at the start and end of the AZA cycle, single point readings,

  - used to indicate if there are any issues before/after the AZA cycle.
- AZA readings are averaged pressure readings and occur during each stage of the AZA cycle.
- 3 AZA records per event:
  - first with the quartz pressure sensor at high (ambient) pressure
  - second after the quartz sensor is at the low pressure
  - third when the quartz sensor is back at ambient pressure.

```
AZS,2021/05/11 01:30:20,2021/12/03 21:12:15,MS166,00530C,1,0.0,4000,8039,9059.30273,5.298,136405,9060.35156,5.322,5232045,98.12901,-9999.000,10116141
AZA,2021/05/11 01:30:20,2021/12/03 21:12:15,MS166,00530C,1,31.4,4023,8039,9059.13477,5.307,136405,9060.42676,5.338,5232045,98.13000,-9999.000,10116141,0.00004,-0.006
AZA,2021/05/11 01:30:20,2021/12/03 21:12:15,MS166,00530C,1,310.4,4053,8036,94.48977,5.350,136405,9060.62891,5.527,5232045,94.82000,-9999.000,10116141,0.00000,0.002
AZA,2021/05/11 01:30:20,2021/12/03 21:12:15,MS166,00530C,1,1105.4,4083,8039,9058.65820,5.480,136405,9060.73340,5.812,5232045,98.40800,-9999.000,10116141,0.00005,0.000
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Thank you for your time today

Any questions?

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