

The Venus SAGE Atmospheric Structure Investigation

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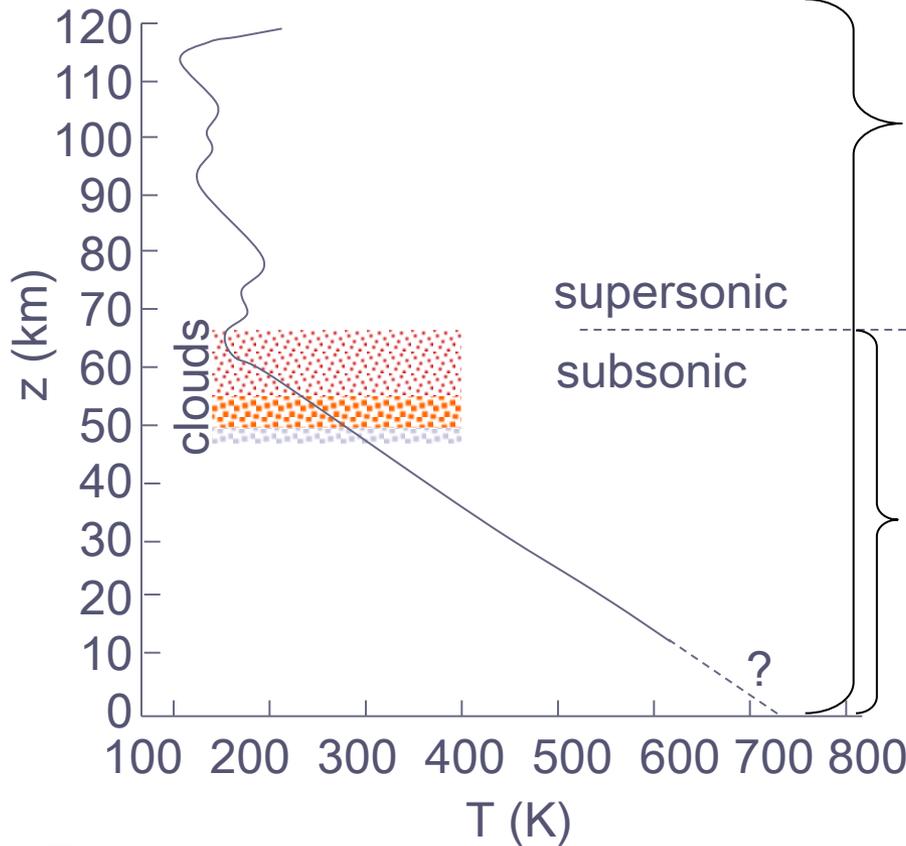
- *Experiment Goals and Objectives* -

- To accurately define the state properties as a function of altitude from below the 10^{-4} mb level (~150 km) to 92 bars (surface).
- To measure the stability of the atmosphere, and identify convective layers and stable layers, where they exist.
- To detect cloud levels from changes in the lapse rate at their boundaries.
- To provide state properties within the cloud levels, and thus provide supplementary information on cloud composition.
- To search for and characterize wave structure within the atmosphere.
- To search for and measure the intensity and scale of turbulence.
- To measure descent and surface wind speed and direction.
- To provide Lander altitude and attitude during decent for descent imaging analysis.
- To provide a back-up landing sensor.

Measurement

Performance

Example Venus Profile



Altitude

$dz \sim 250$ m (upper atm.)
 $dz \sim 20$ m (lower atm.)

Acceleration
& Attitude

$a \sim 3 \mu g$ (threshold)
 $a \sim 0.05 g$ (peak)
 $\Theta_v \sim 0.5$ mrad s^{-1}

Pressure

$dP \sim 0.1$ mb (100 mb)
 $dP \sim 25$ mb (92 bars)

Temperature

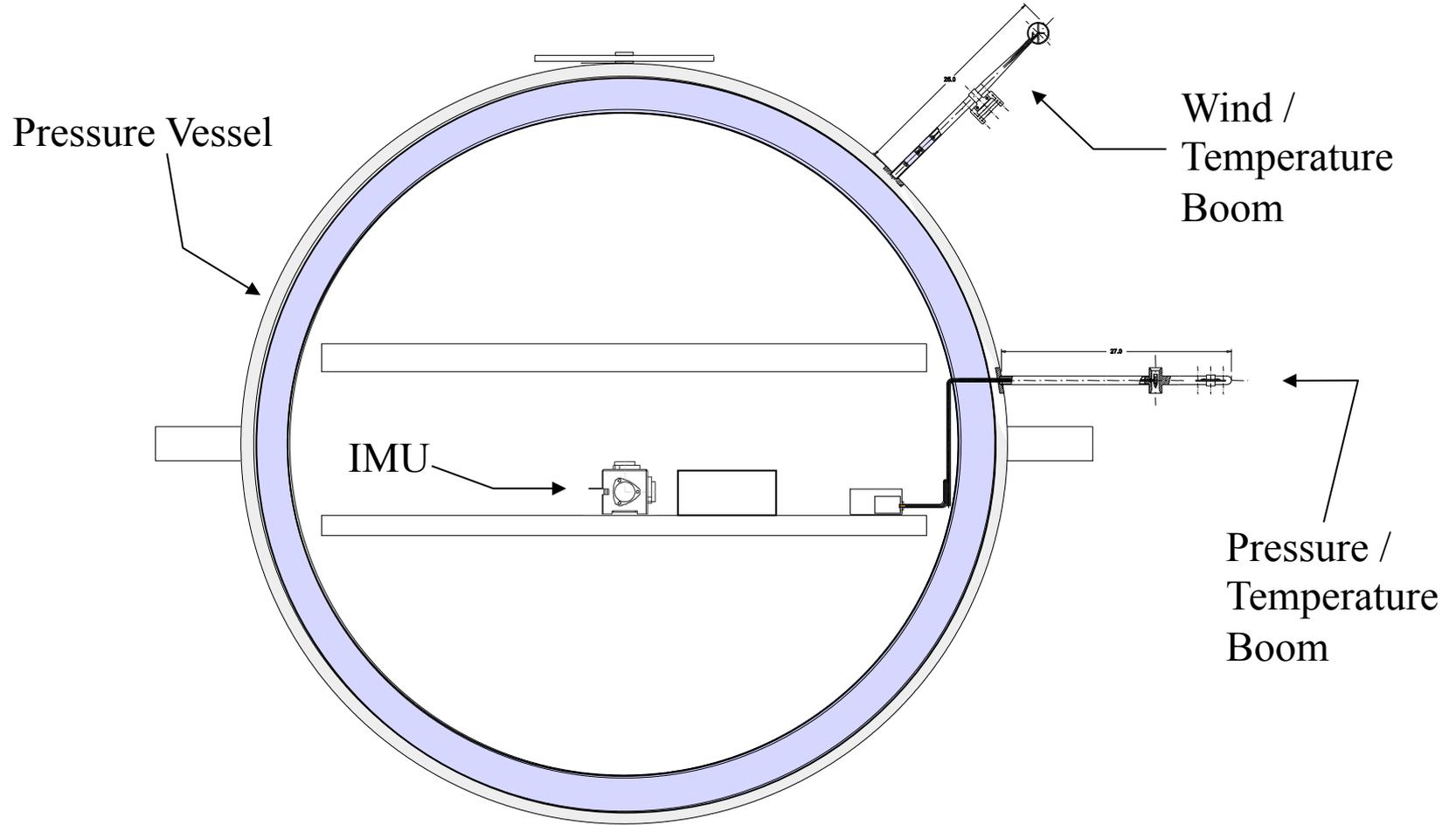
1 K

Surface Wind

$w < 0.05$ m/s



- Instrument Accommodation -



- ASI Inertial Measurement Unit (IMU) -

Measurement:

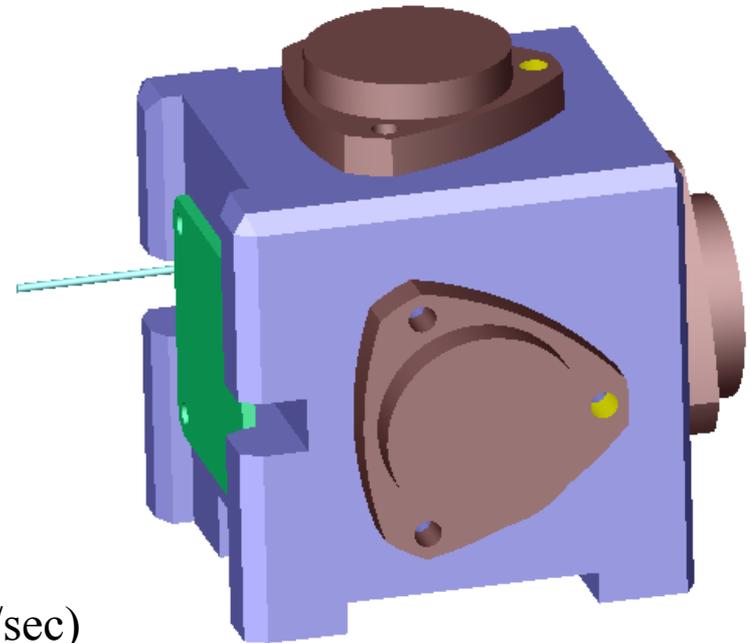
- Acceleration in 3 axis (x,y,z)
- Roll, pitch and yaw rates

Accelerometers:

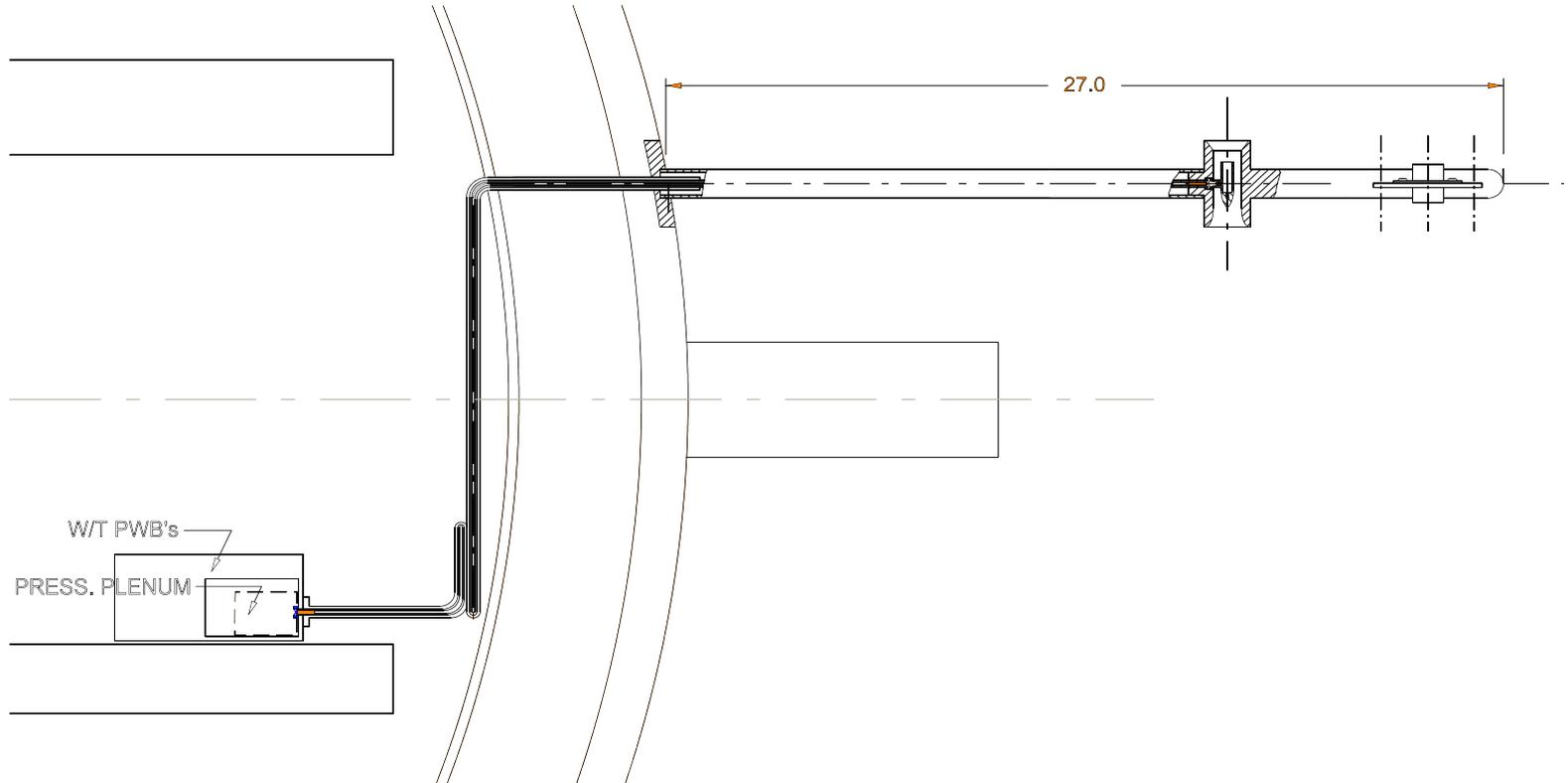
- x, y and z axis low impact sensors
- +/- 20 g range
- < 1 micro g accuracy
- z axis, high impact sensor
- +/- 1000 g range
- < 0.1 g accuracy

Gyroscopes:

- +/- 300 degree/sec range
- < 0.03 degree/sec accuracy (< 0.5 mrad/sec)

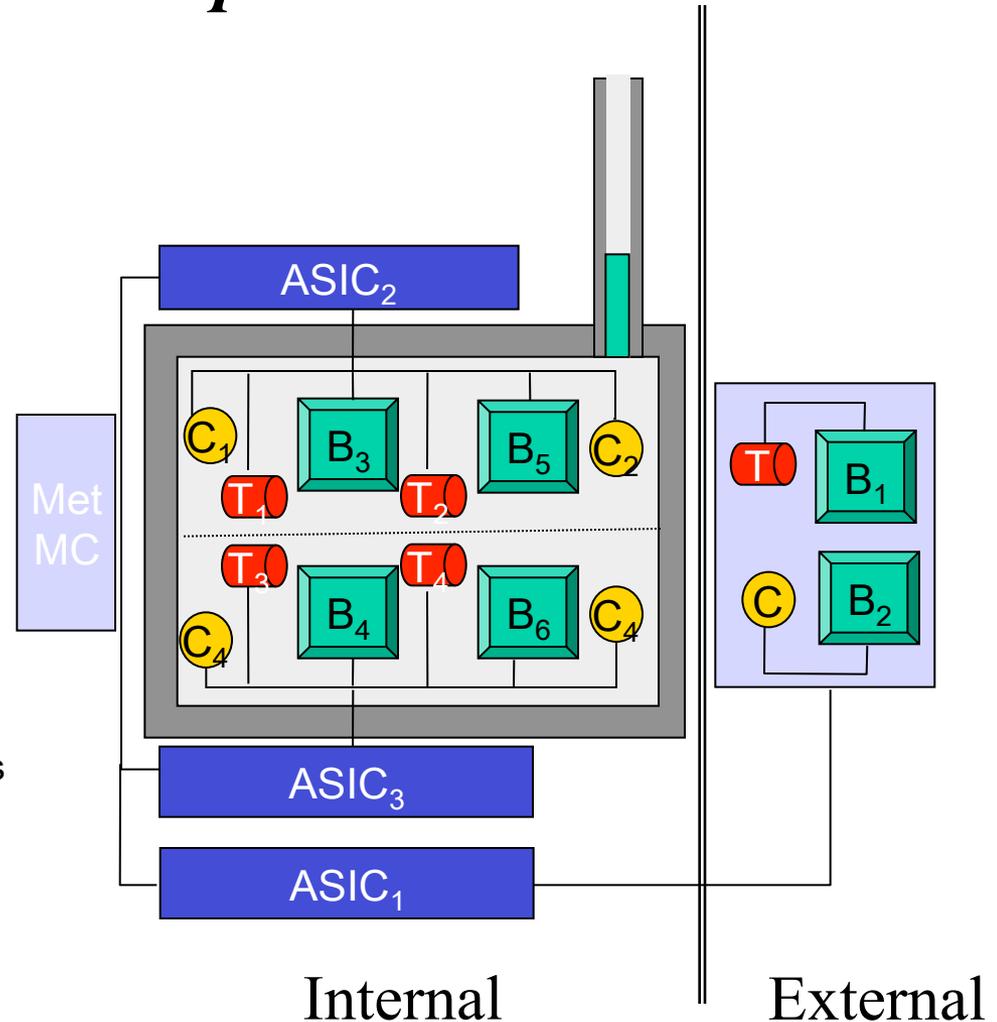


- Pressure / Temperature Boom -



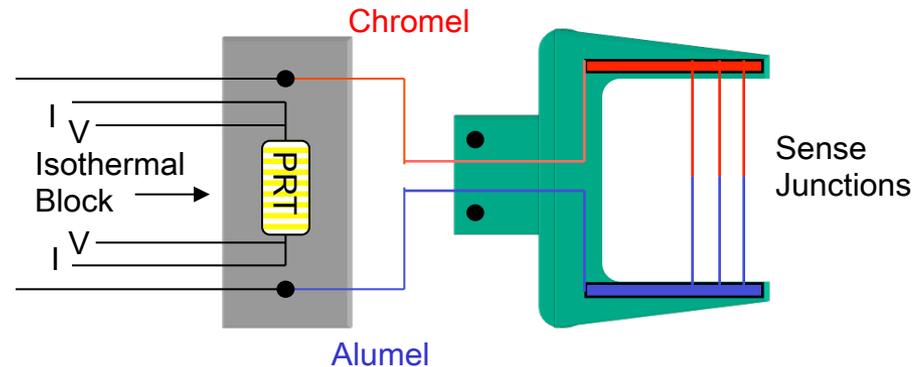
- Pressure Sensor Implementation -

- Pressure manifold holds pressure transducers with three ranges cover pressure range
 - 0.01 to 1 bar
 - 0.1 to 10 bar
 - 1 to 100 bar
- Fully redundant system
 - Provides method to measure pressure offset and gain drifts
- Micromachined capacitive aneroid barometers used
 - MVACS/HASI heritage
 - No new technology, but modifications needed for high temperature operation



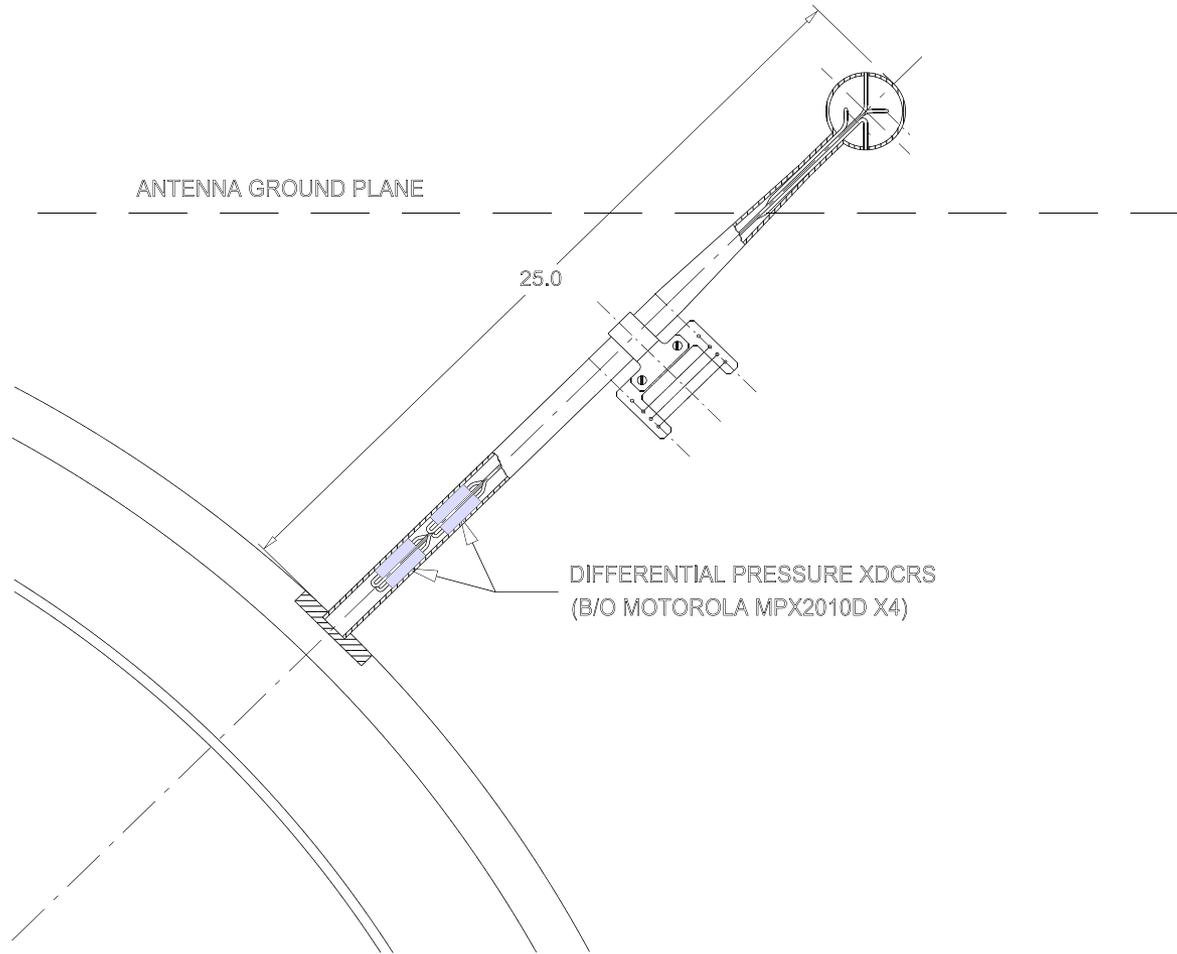
- Temperature Sensor Implementation -

Schematic of an atmospheric temperature TC sense junction and reference junction on the isothermal block



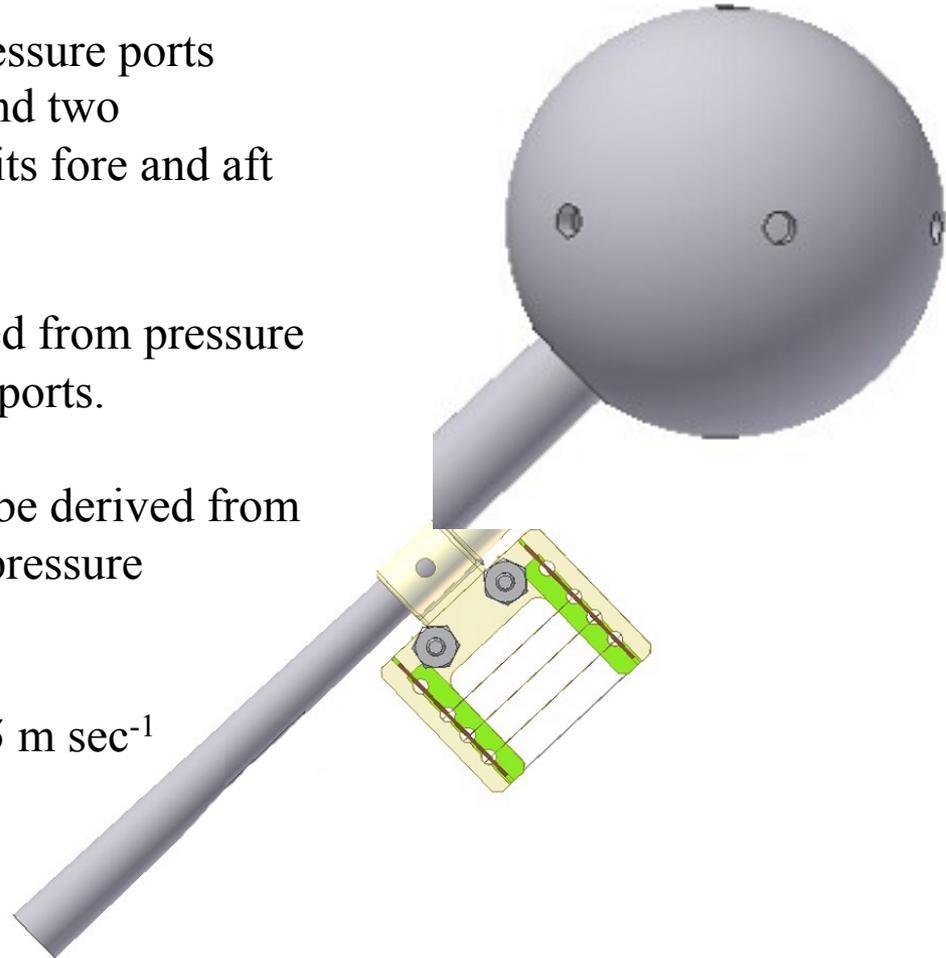
- Thin-wire thermocouple (TC) assemblies deployed on 2 fixed booms
- Reference junctions are located on an isothermal block inside probe body
 - temperature monitored by a precision platinum resistance thermometer (PRT)
- Accuracy: $\pm 1\text{ }^{\circ}\text{C}$, $150 \leq T \leq 750\text{ }^{\circ}\text{C}$ Precision: $\sim 0.01\text{ }^{\circ}\text{C}$ (14-bit)
- Time Constant: $< 1\text{ sec}$

- Wind / Temperature Boom -

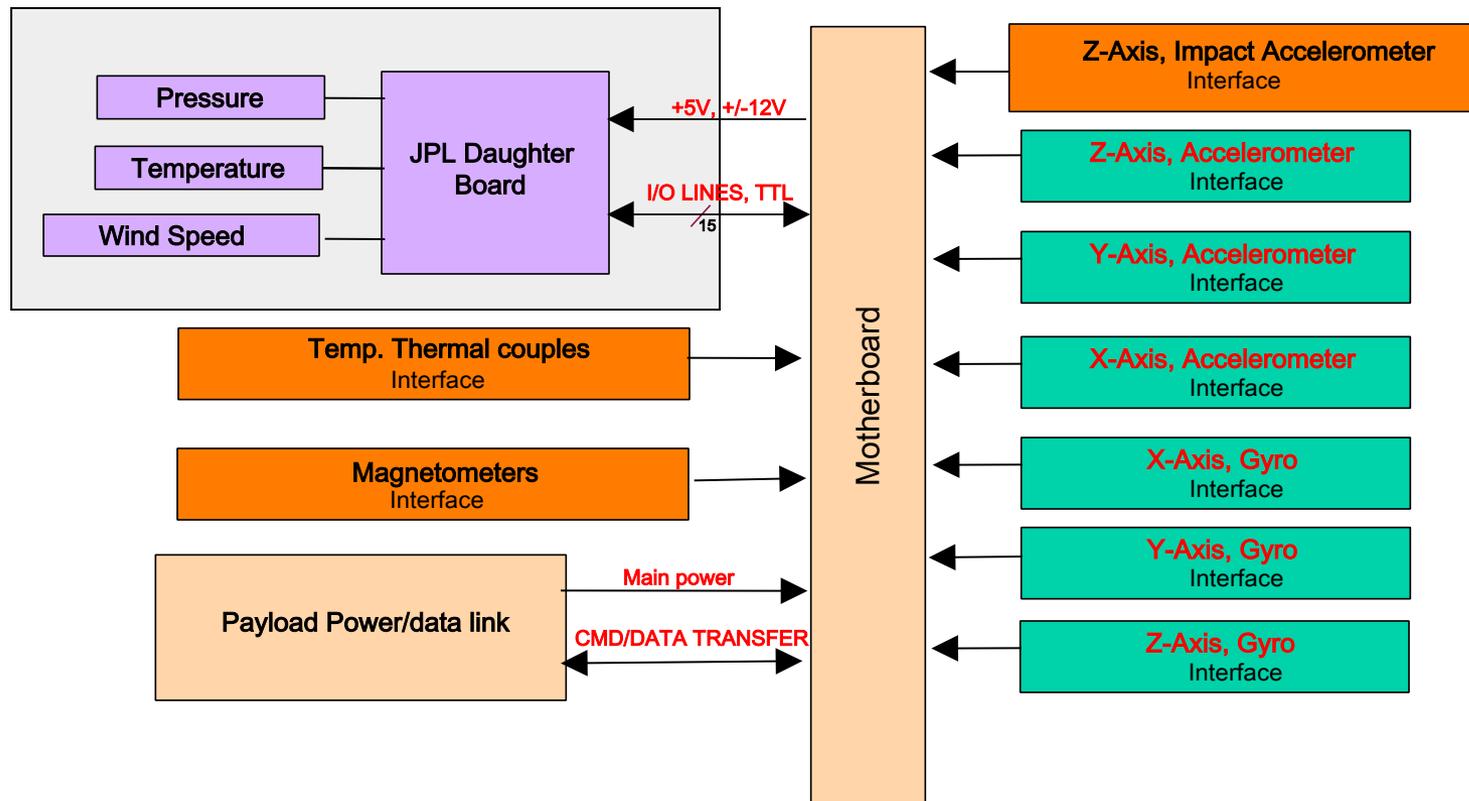


- Directional Pitostatic Anemometer -

- 1-cm diameter sphere with six pressure ports equally spaced around its equator and two additional pressure ports located at its fore and aft poles.
- Speed and direction can be derived from pressure differences measured at these eight ports.
- During decent the fall speed will be derived from the wind sensor and used to adjust pressure measurements for dynamic effects
- Surface winds measured to $< 0.05 \text{ m sec}^{-1}$



- SYSTEM ARCHITECTURE -



- Future ASI Development -

High Pressure and Temperature, Miniaturized Sensors

- AlGaN/GaN-based microsensors (Kyung-ah Son, JPL)
 - Small: $\sim 1\text{cm}^3$
 - Low mass: $<5\text{g}$
 - Low power: $< 10\text{ mW}$
- Broad Operational range
 - Temperature: 4 K-1000 K (0.1 °C)
 - Pressure: 0-10 kbar ($<5\%$)

Highly Integrated Systems

- Integrated power, com., C&DH, and structure

