The Venus SAGE Atmospheric Structure Investigation

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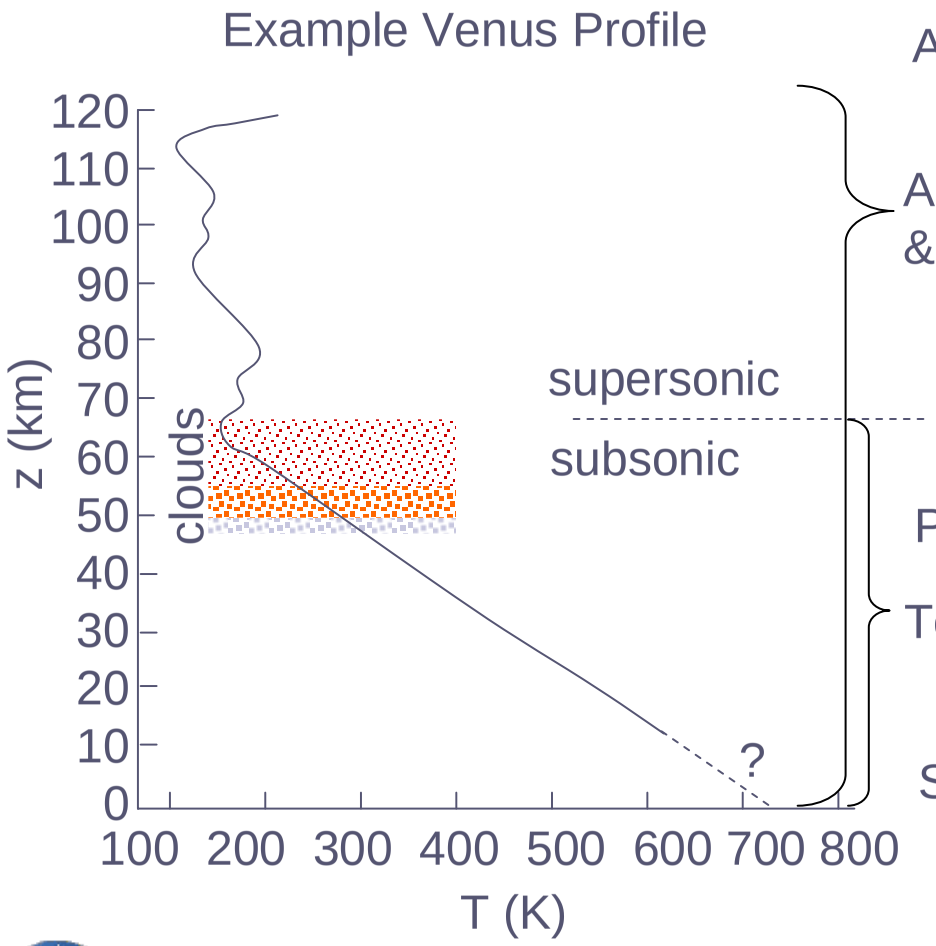
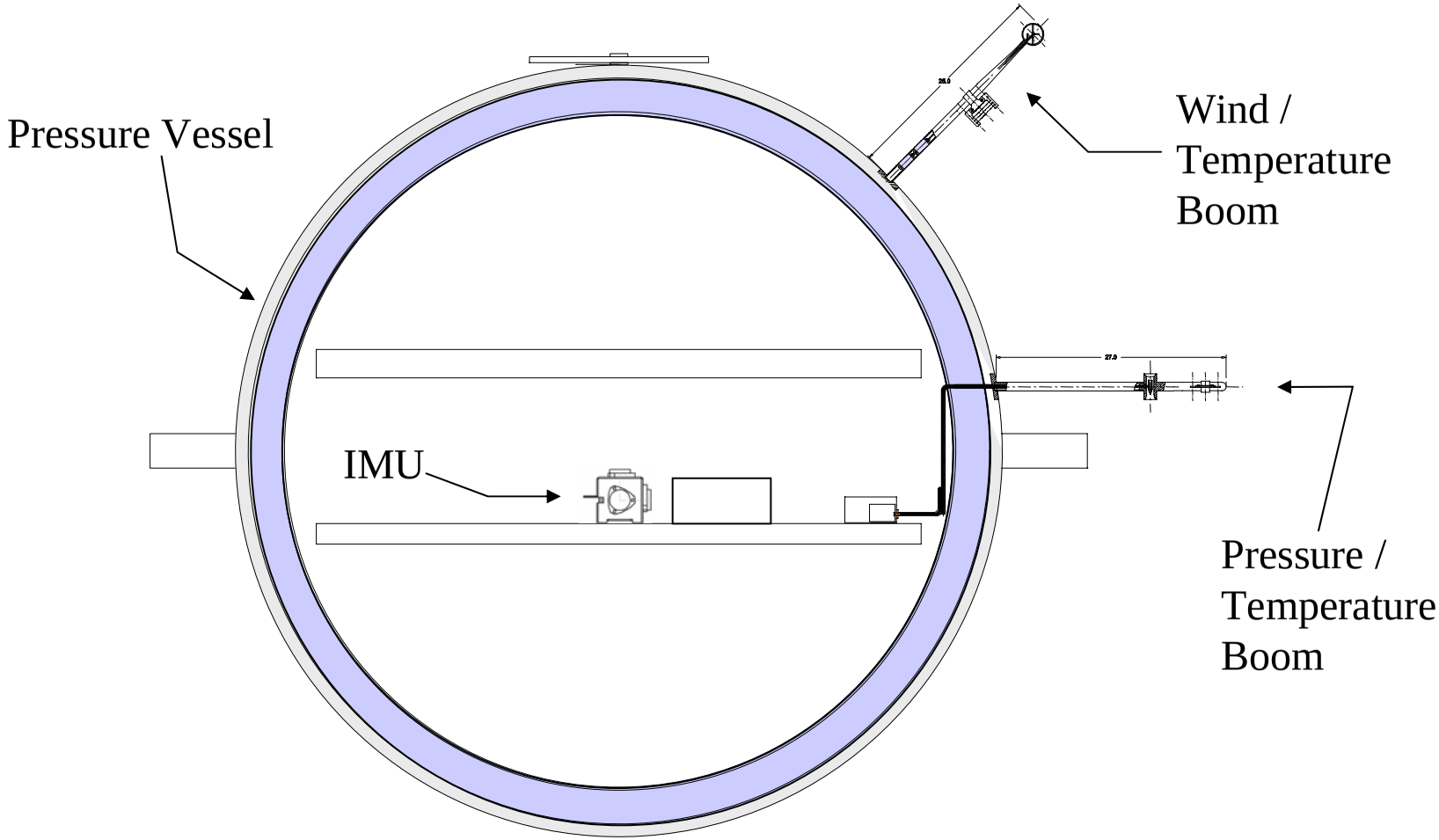
- *Experiment Goals and Objectives* -

- 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
Altitude	dz ~ 250 m (upper atm.) dz ~ 20 m (lower atm.)
Acceleration & Attitude	*a* ~ 3 μg (threshold) *a* ~ 0.05 g (peak) Θ_v ~ 0.5 mrad s^{-1}
Pressure	dP ~ 0.1 mb (100 mb) dP ~ 25 mb (92 bars)
Temperature	1 K
Surface Wind	*w* < 0.05 m/s

- *Instrument Accommodation* -



- ASI Inertial Measurement Unit (IMU) -

Measurement:

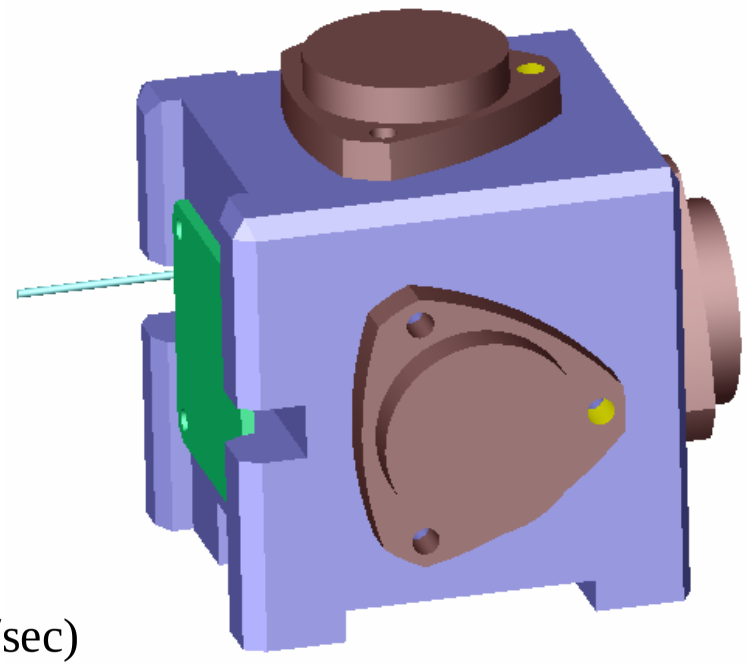
- Acceleration in 3 axis (x,y,z)
- Roll, pitch and yaw rates

Accelerometers:

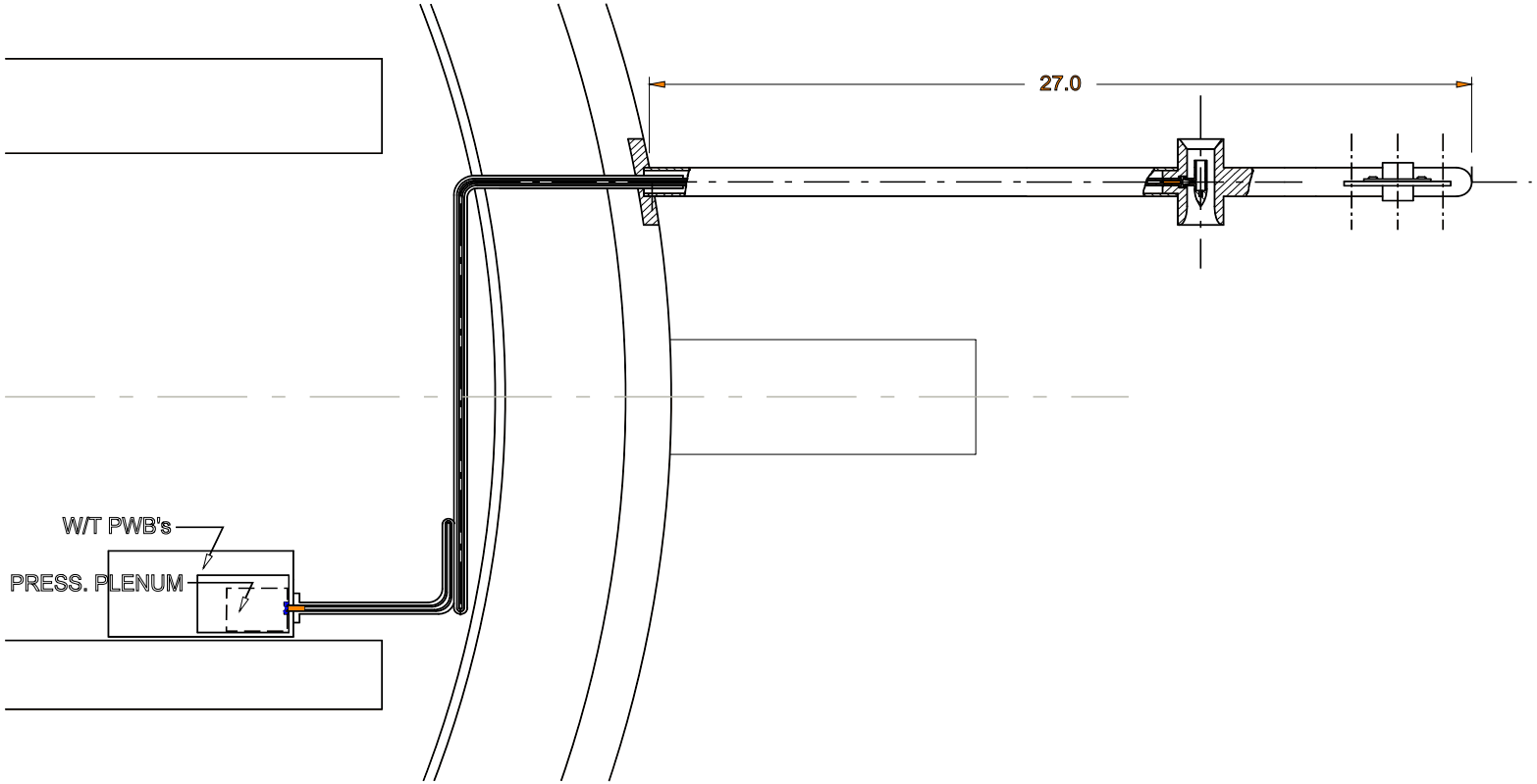
- x, y and z axis low impact sensors
- +/- 20 g range
- < 1 micro g accuracy
- z axis, high impact sensor
- +/- 1000 g range
- < 0.1 g accuracy

Gyroscopes:

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

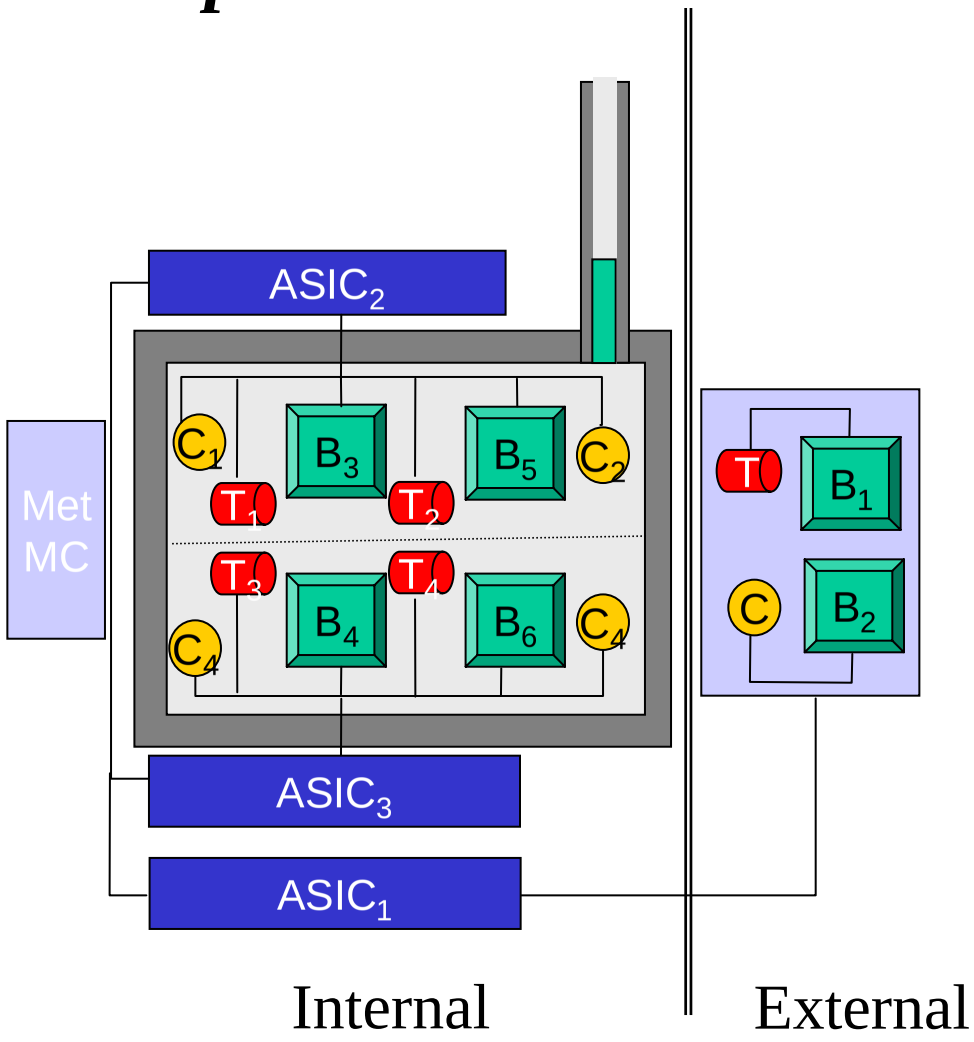


- Pressure / Temperature Boom -



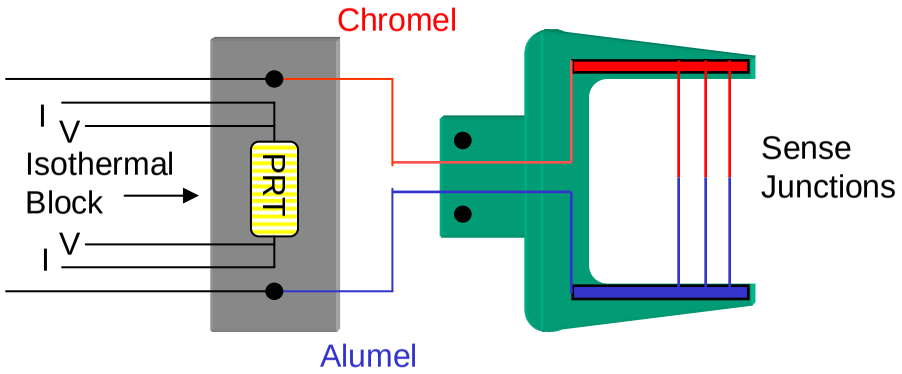
- *Pressure Sensor Implementation* -

- 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



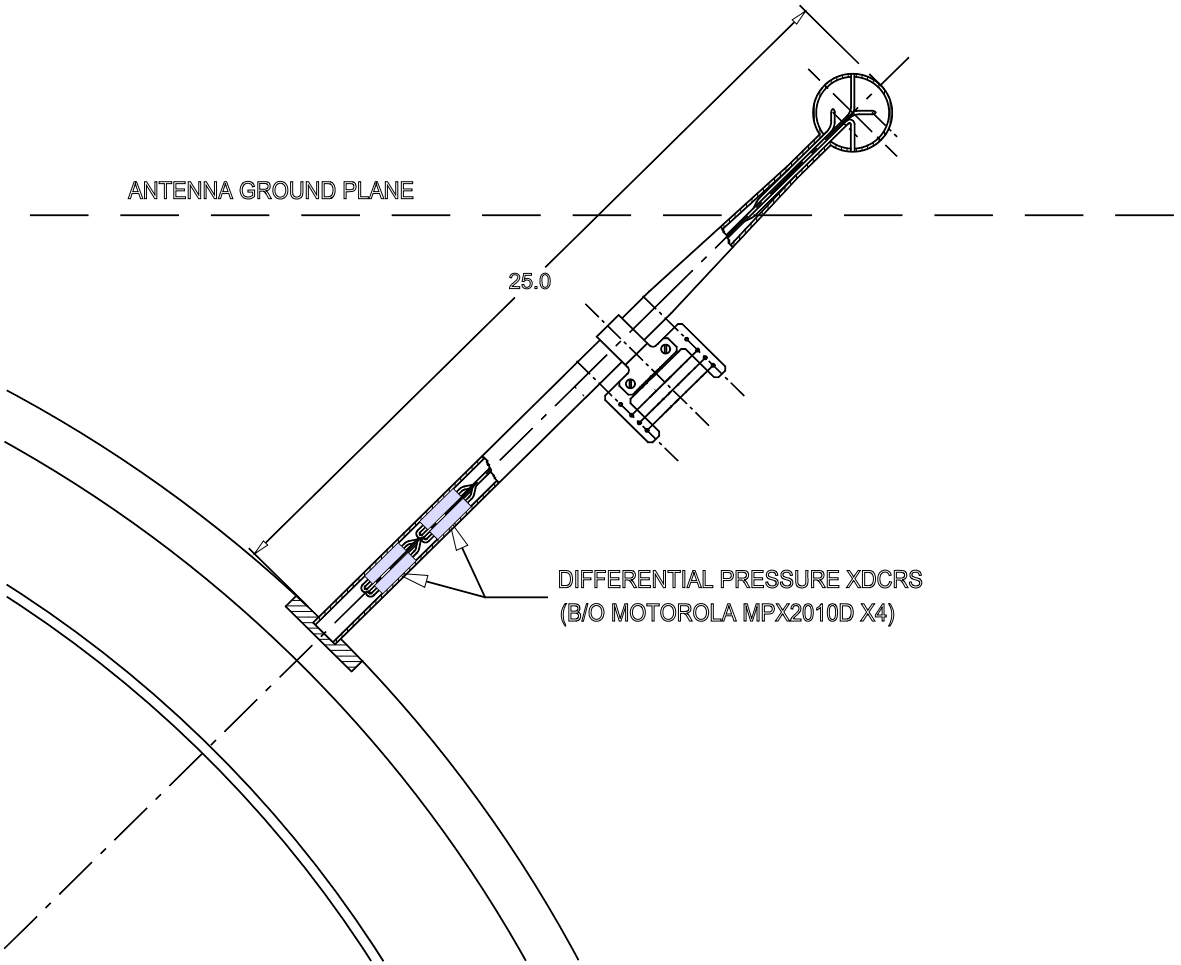
- *Temperature Sensor Implementation* -

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: ±1 ^{o}C, 150 $\leq$T$\leq$750 ^{o}C Precision: ~0.01 ^{o}C (14-bit)
- Time Constant: <1 sec

- Wind / Temperature Boom -



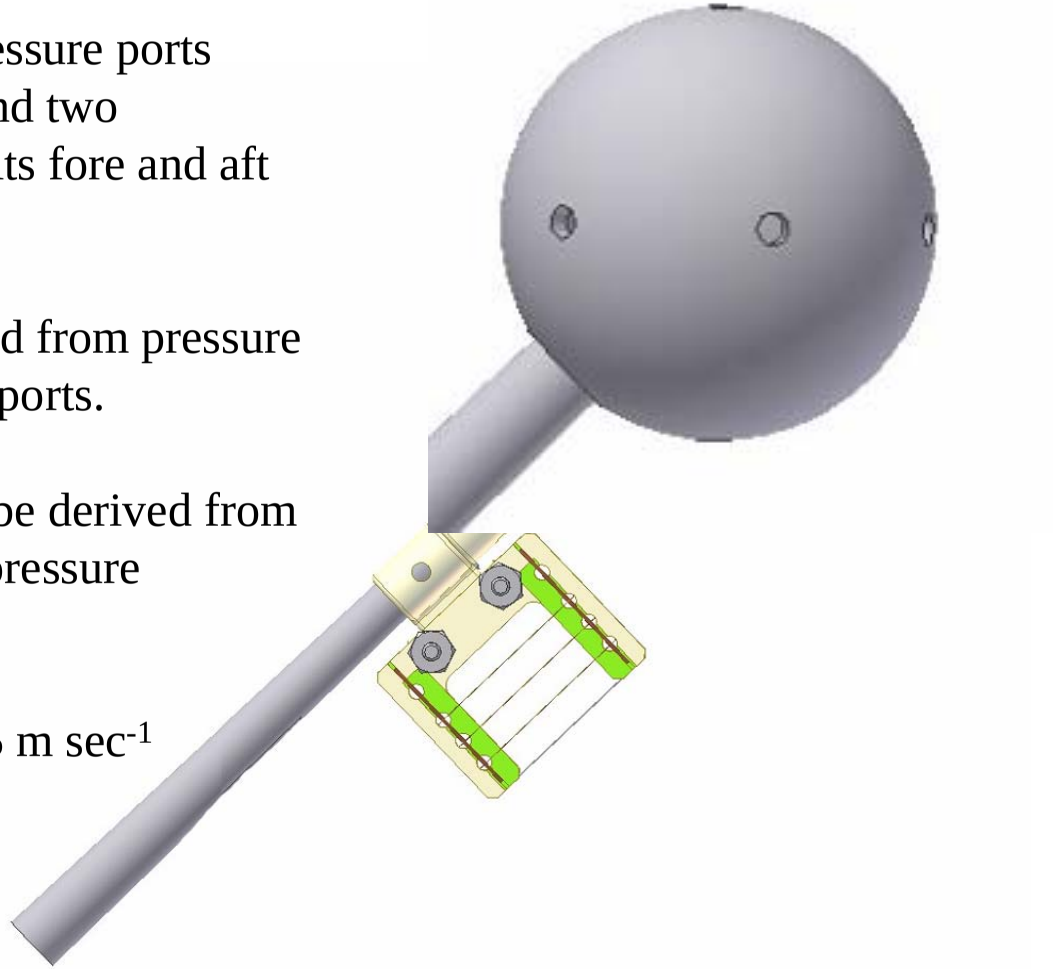
- Directional Pitostatic Anemometer -

- 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.

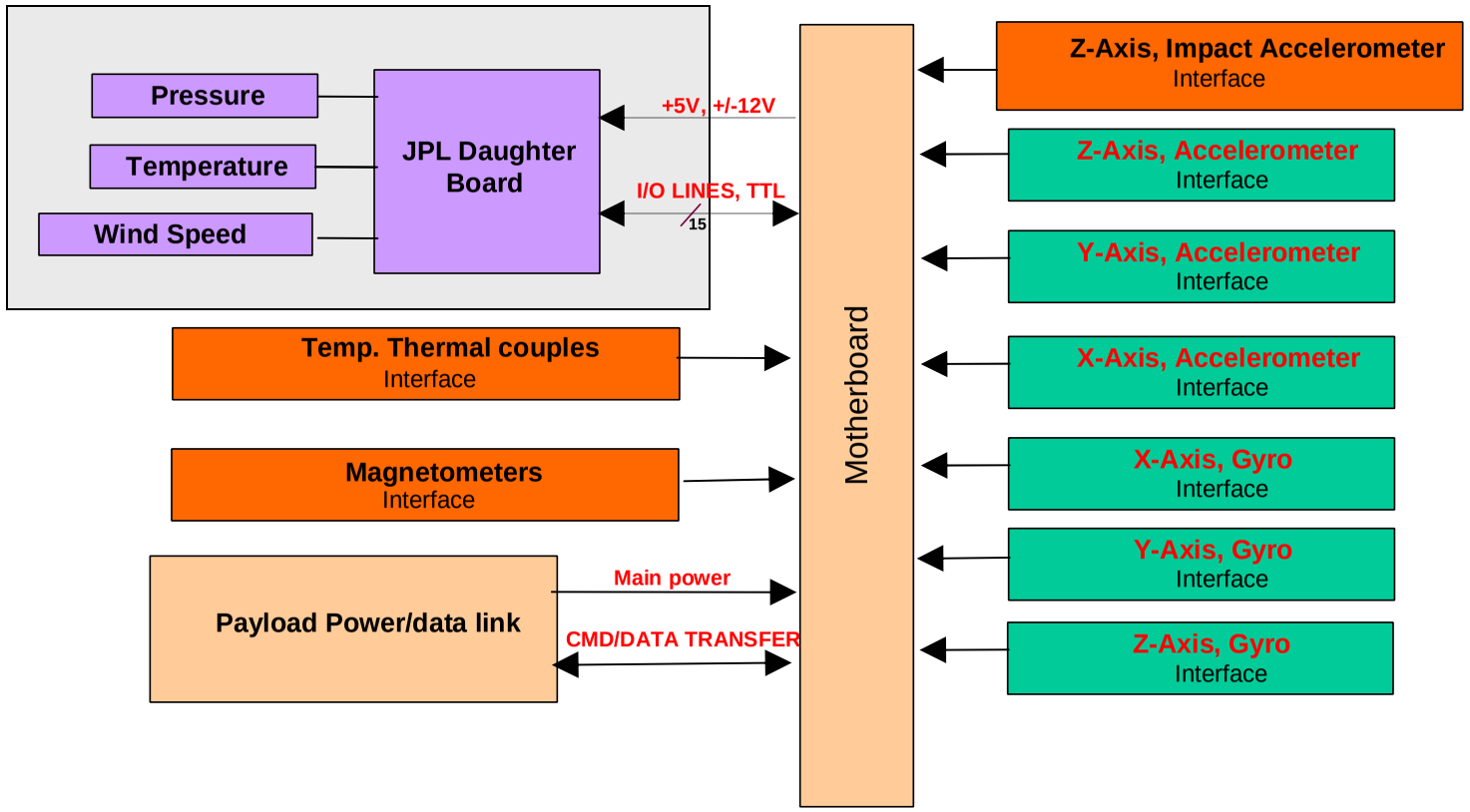
- Speed and direction can be derived from pressure differences measured at these eight ports.

- 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 m sec^{-1}



- SYSTEM ARCHITECTURE -



- Future ASI Development -

High Pressure and Temperature, Miniaturized Sensors

- AlGaN/GaN-based microsensors (Kyung-ah Son, JPL)
  - Small: ~ 1cm^3
  - Low mass: <5g
  - Low power: < 10 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