

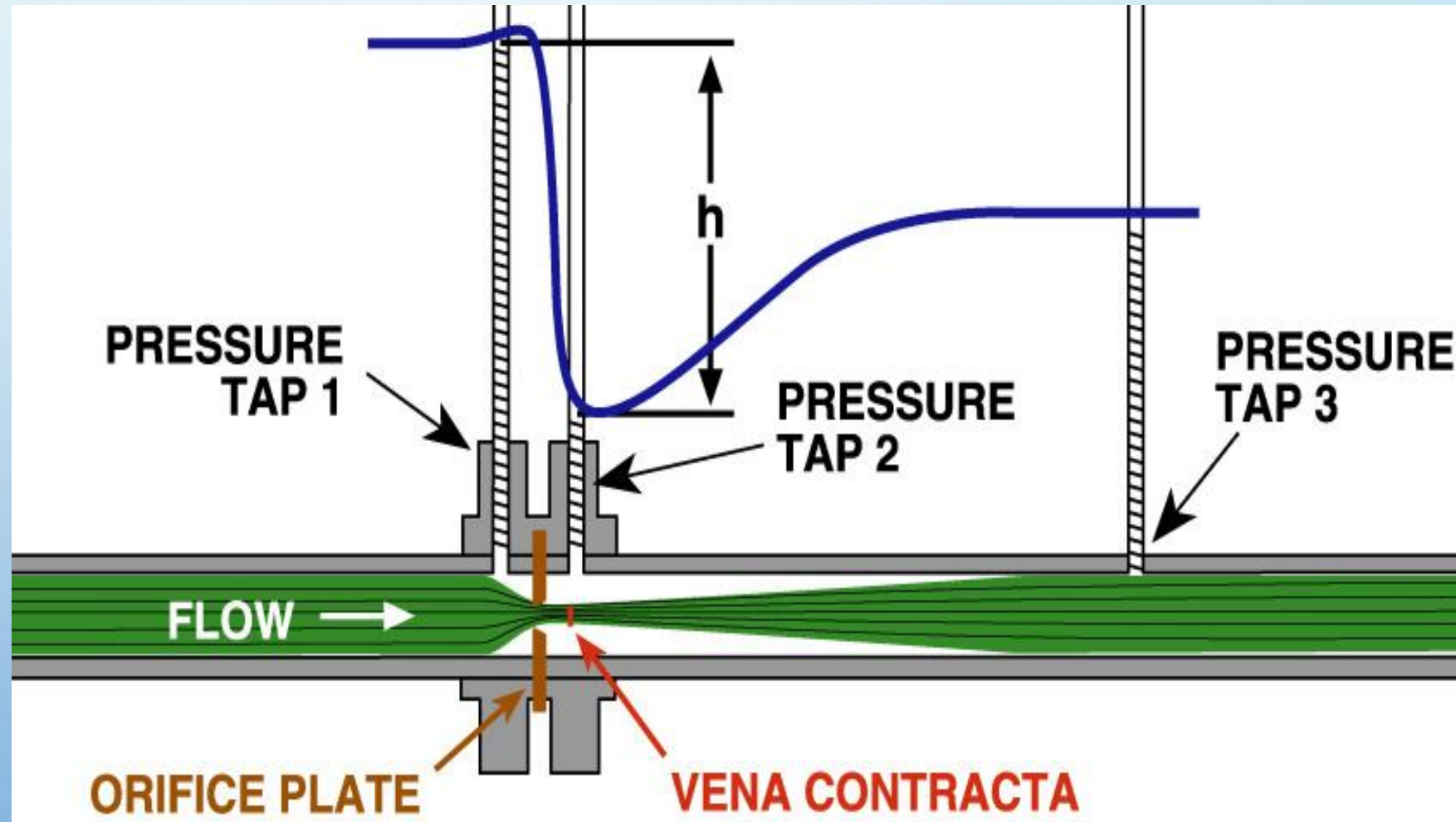
DESIGN CHANGES ADDRESSING MEASUREMENT LIMITATIONS OF ORIFICE FLOWMETERS

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ORIFICE METER LIMITATIONS

- Maximum Differential Pressure
- Reattachment Point
 - Effects on downstream pressure port
 - Closest Sample Collection Point – 5D
- Single Point Measurement
 - Fully Developed Flow Profile
 - Concentricity of Plate Bore
 - Flow Conditioner
 - Long Upstream/Downstream Meter Tubes
- Large variations in beta ratio
- Single Phase Fluid Flow
- Permanent Pressure Drop
- Stringent Mechanical Tolerances
 - Edge Sharpness
 - Pipe Roughness
 - Pipe Circularity
 - Upstream Steps and Gaps
 - Upstream/Downstream Tap Distance
 - Plate Roughness
 - Plate Bore Thickness
 - Plate Bevel and Plate Land Thickness



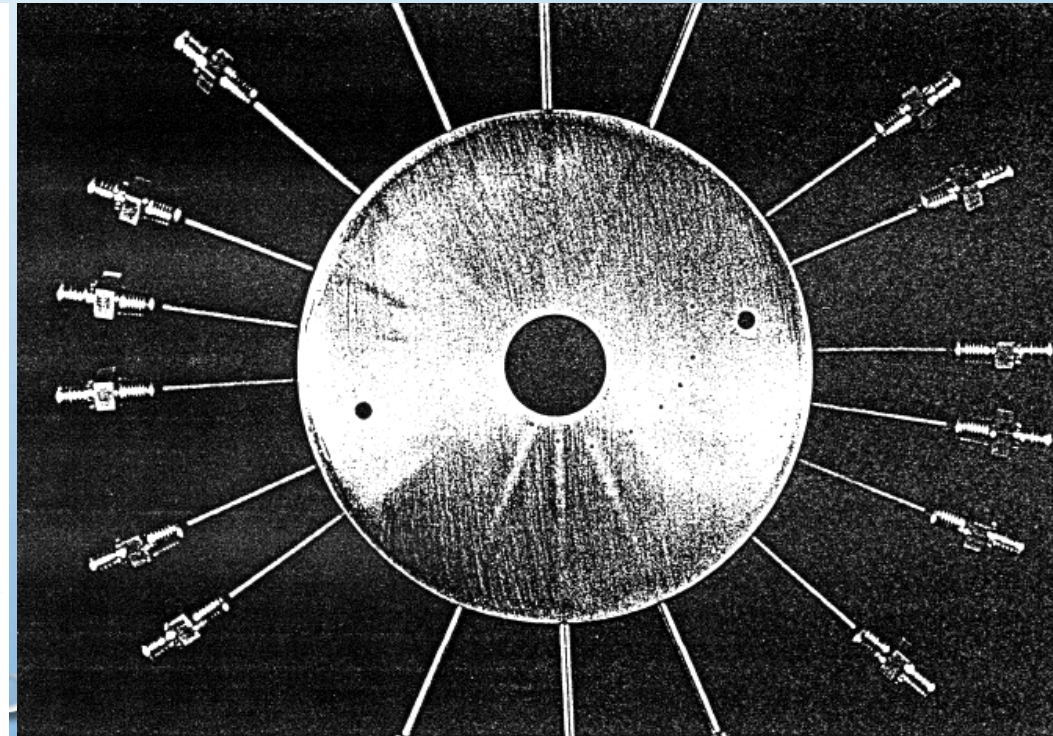
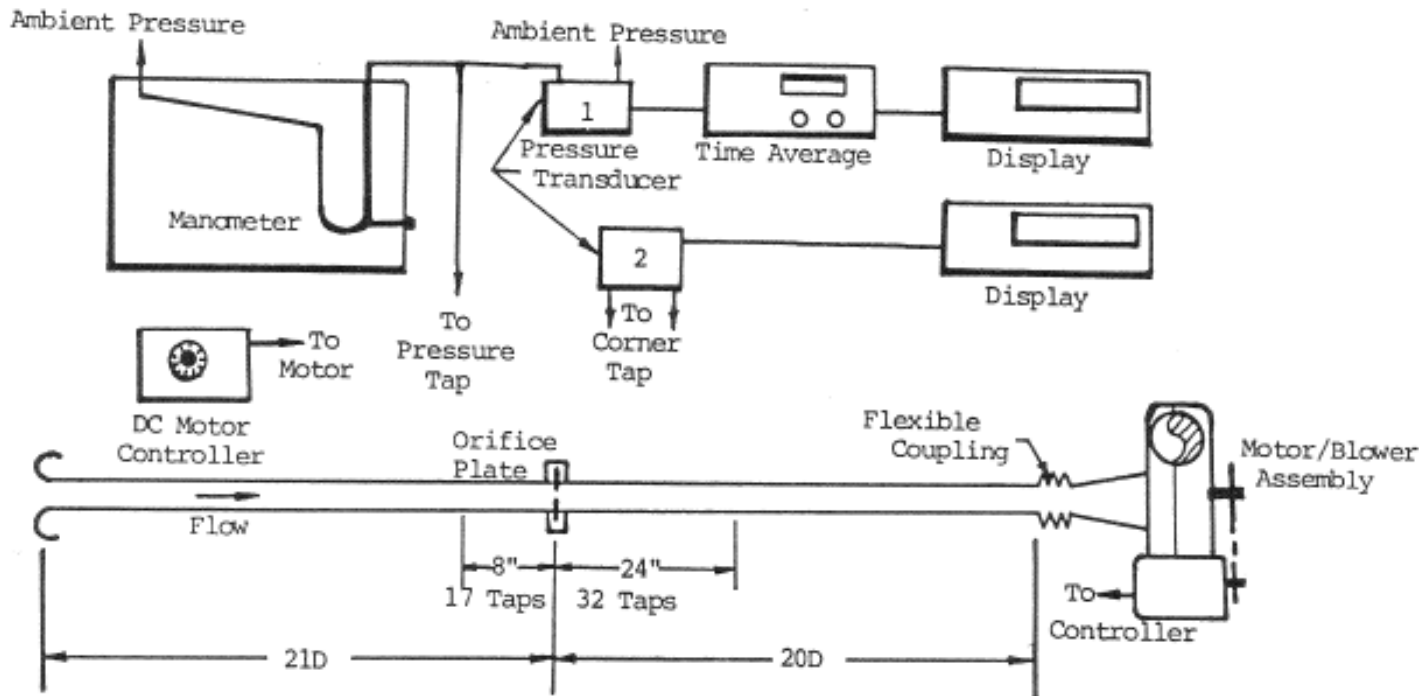
EXPERIMENTAL SETUP & RESULT

AIR FLOW FACILITY: 0.3, 0.5, AND 0.7 BETA RATIO PLATES

Reynolds Number Range 21,000 to 160,000

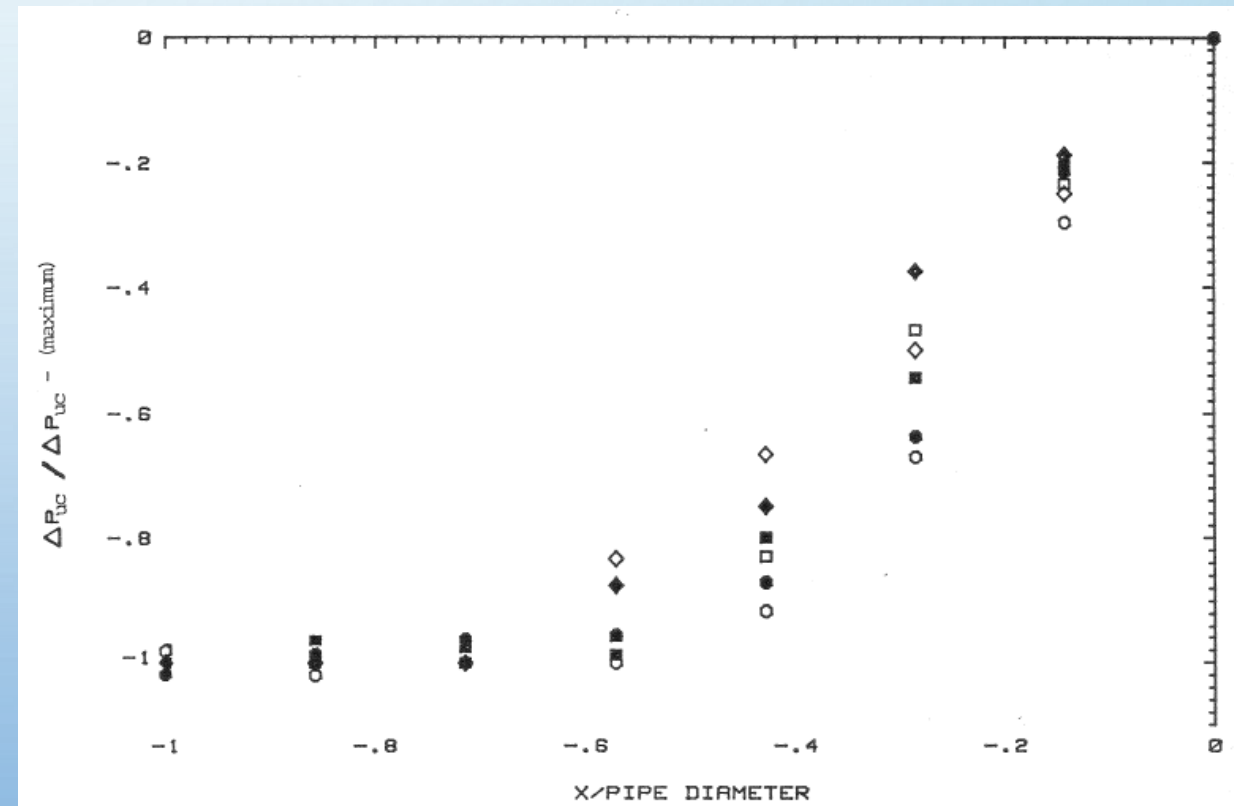
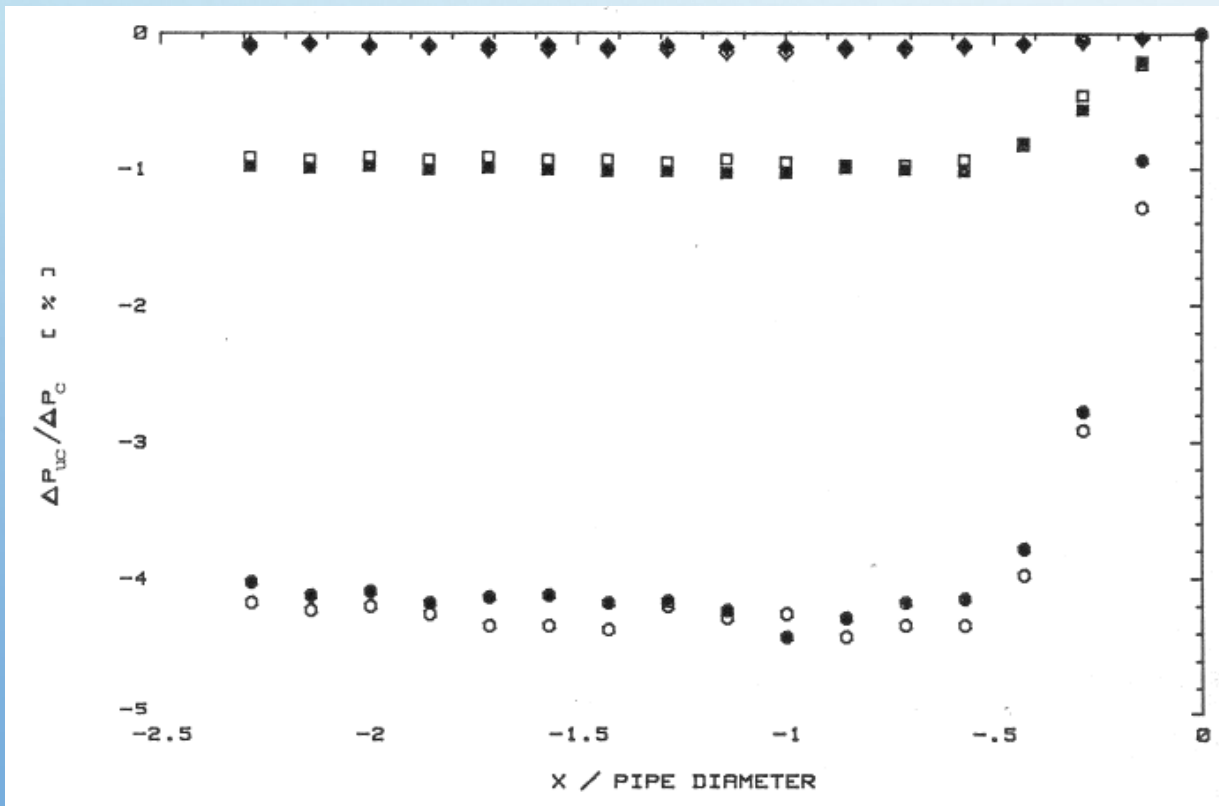
TOROIDAL SHAPE INLET PROFILE (Ower & Pankhurst, Measurement of Airflow, Pergamon Press, NY, 5th Edition, 1977)

This paper by Dr. Zaki Husain & Dr. Ray Teyssandier was presented at the 1985 ASME Winter Annual Meeting and later archived as GPA Technical Report 13. This paper is referenced in the ISO, API, AGA, GPA Orifice Meter standards, which is the basis for minimum piping length requirements for downstream disturbances and tolerances for upstream and downstream pressure tap locations.

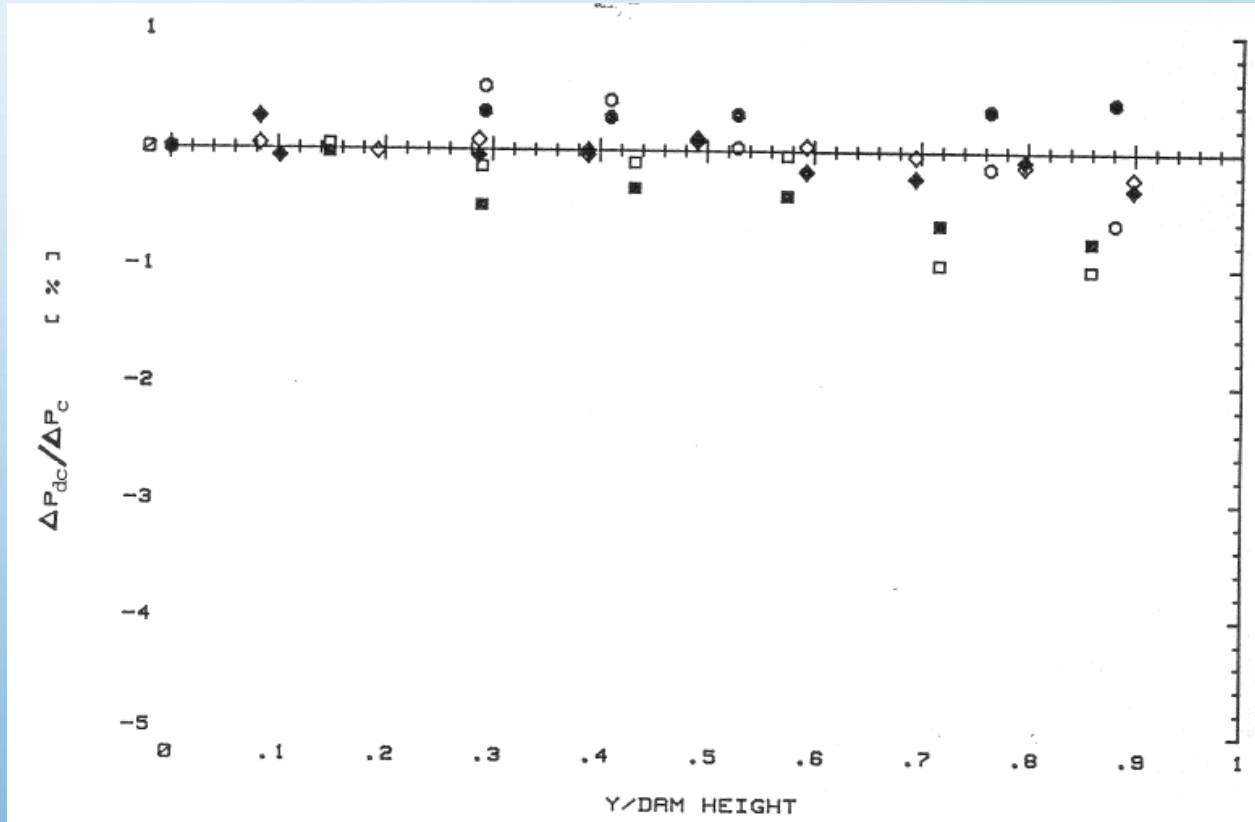
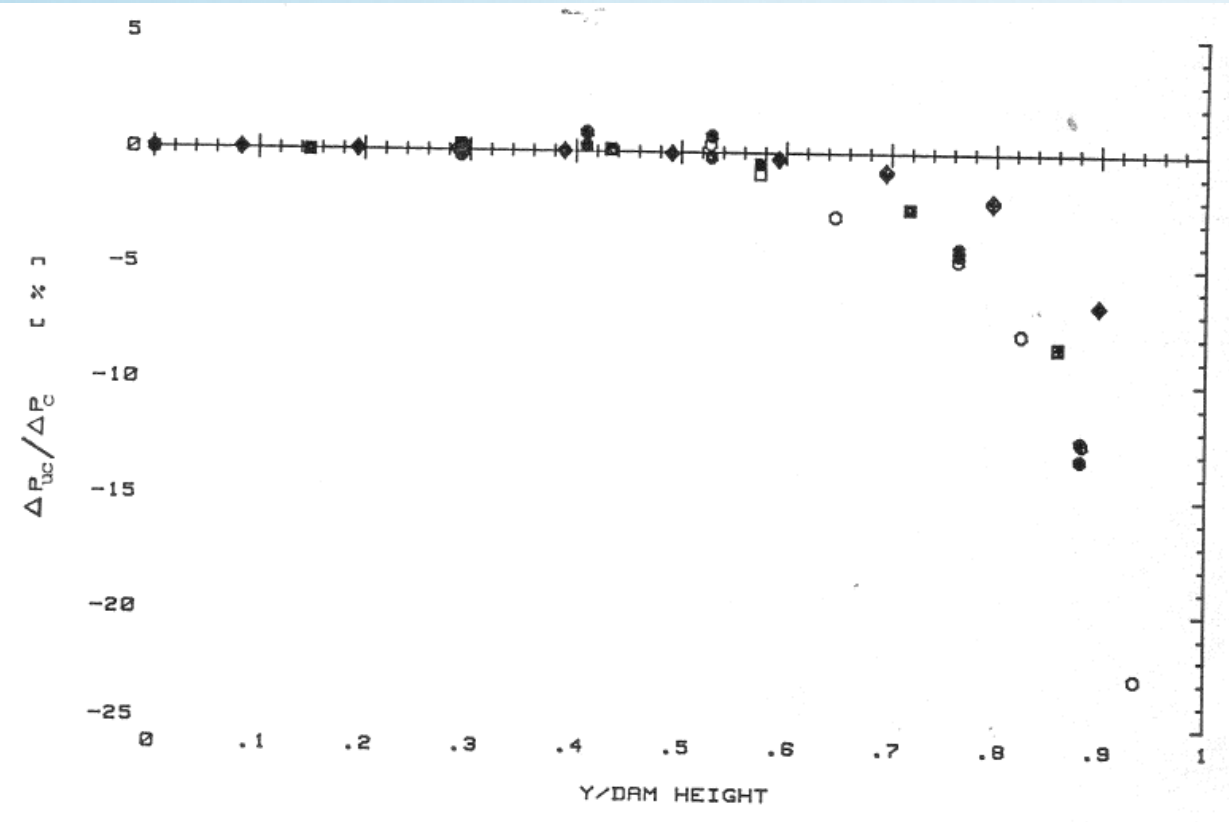


EFFECT OF CENTER TAP PRESSURE ON UPSTREAM PRESSURE DISTRIBUTION

Differential pressure referenced to Center Tap pressure, normalized by maximum differential pressure between upstream line pressure referenced to Center Tap pressure.

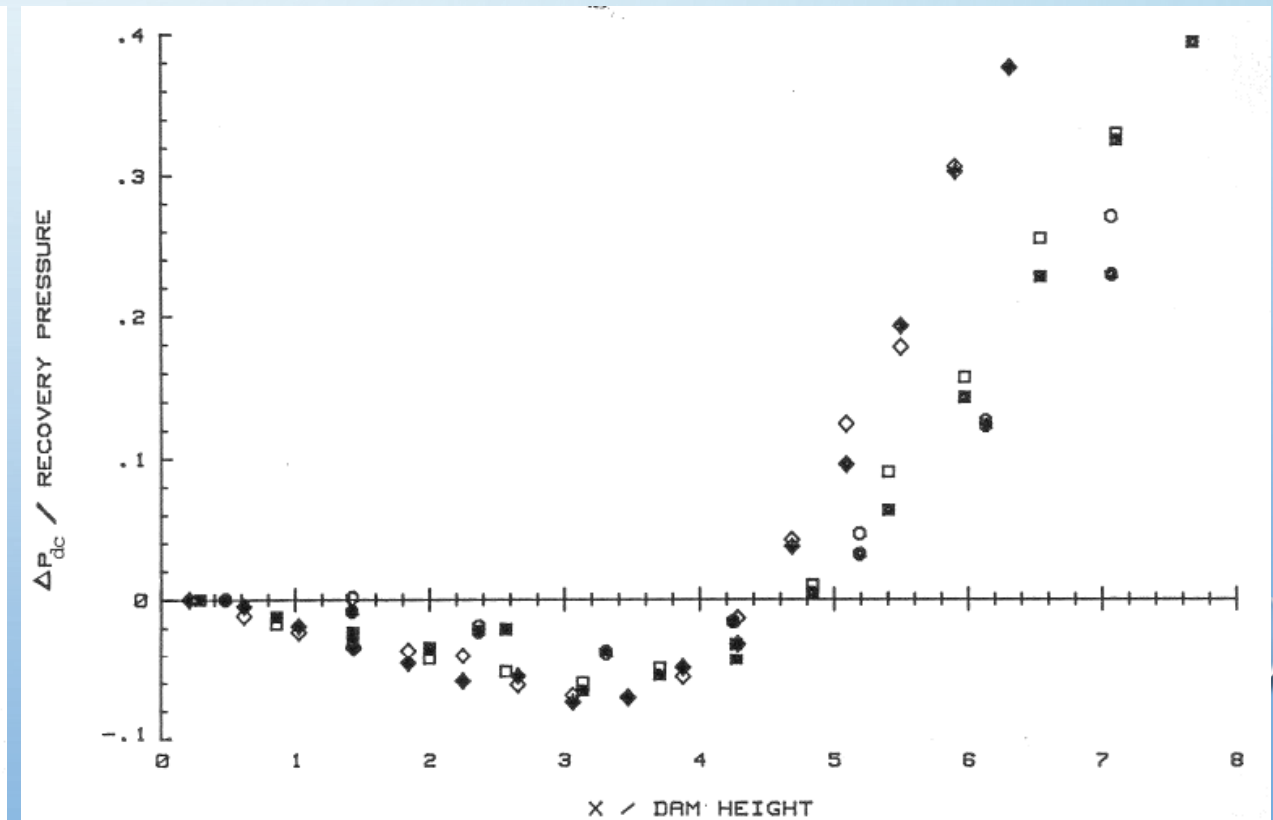
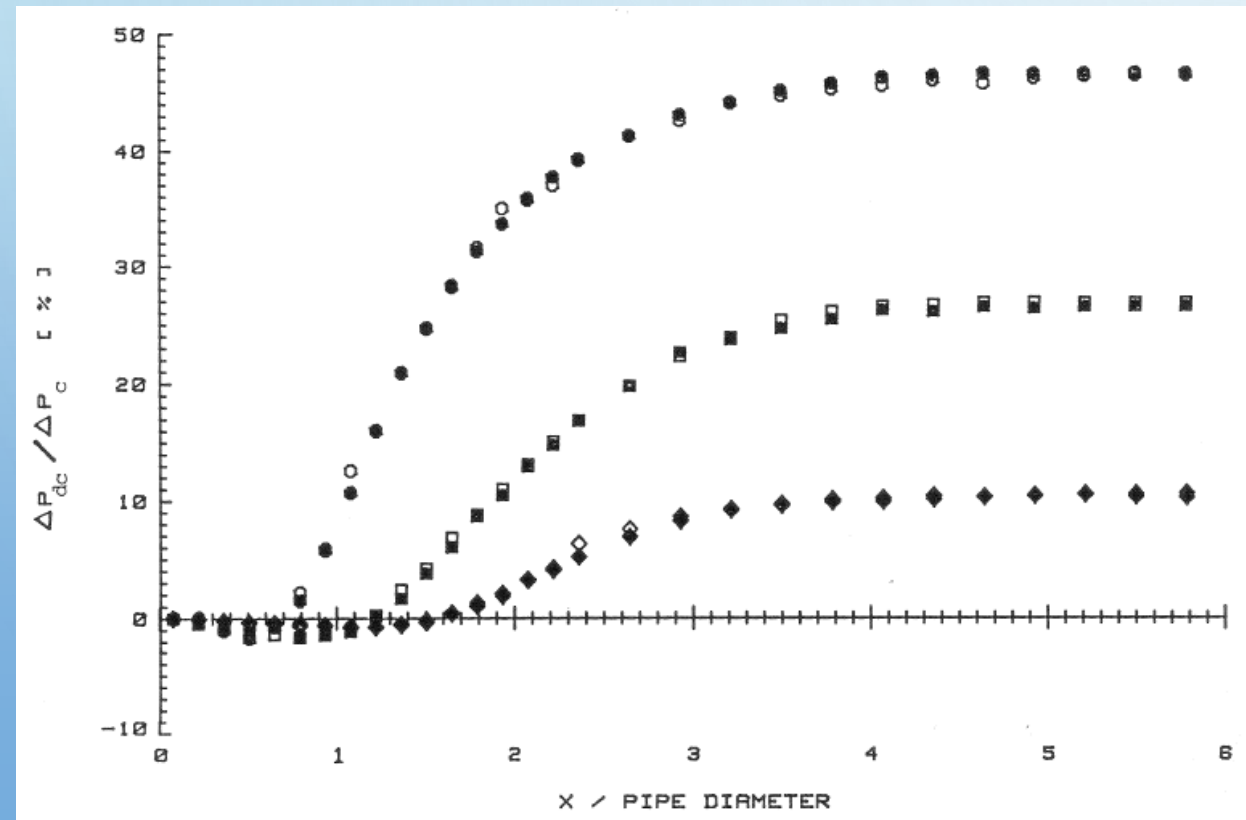


PRESSURE DISTRIBUTION ON FACE OF THE ORIFICE PLATE



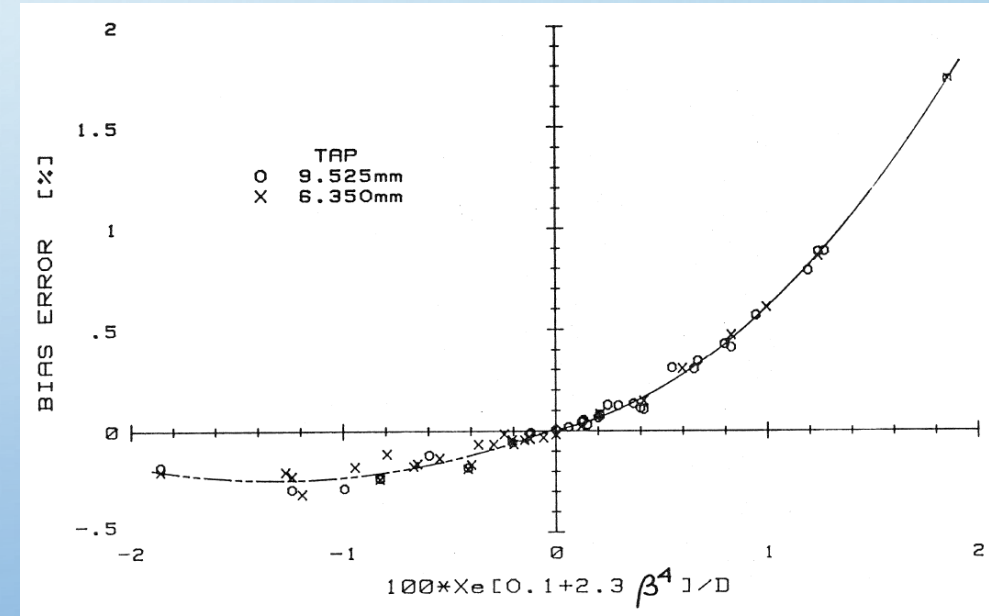
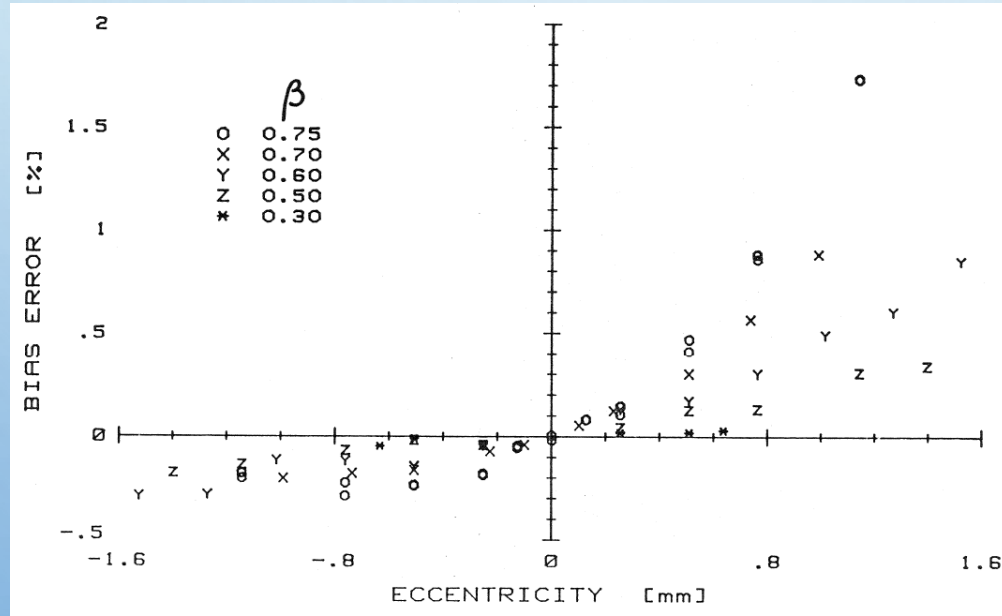
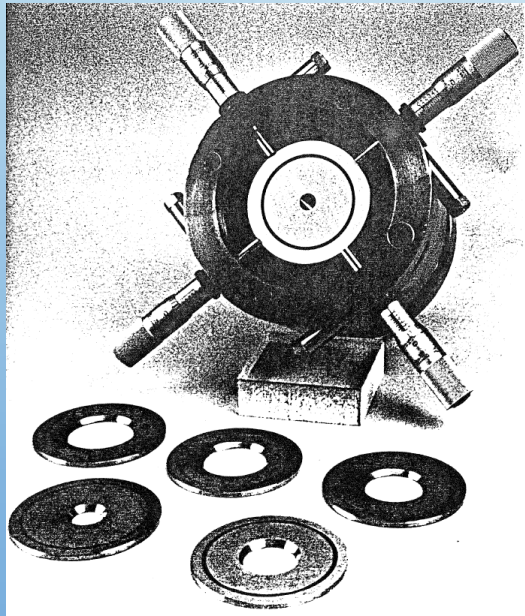
DOWNSTREAM PRESSURE DISTRIBUTION

Center Tap Pressure demonstrated minimal influence of flow profile disturbances. Differential pressure readings at any location of the orifice meter pipe and on plate surface, when normalized by the maximum differential pressure between upstream line pressure and Center Tap pressure influence of piping and plate geometry indicated minimal influence.

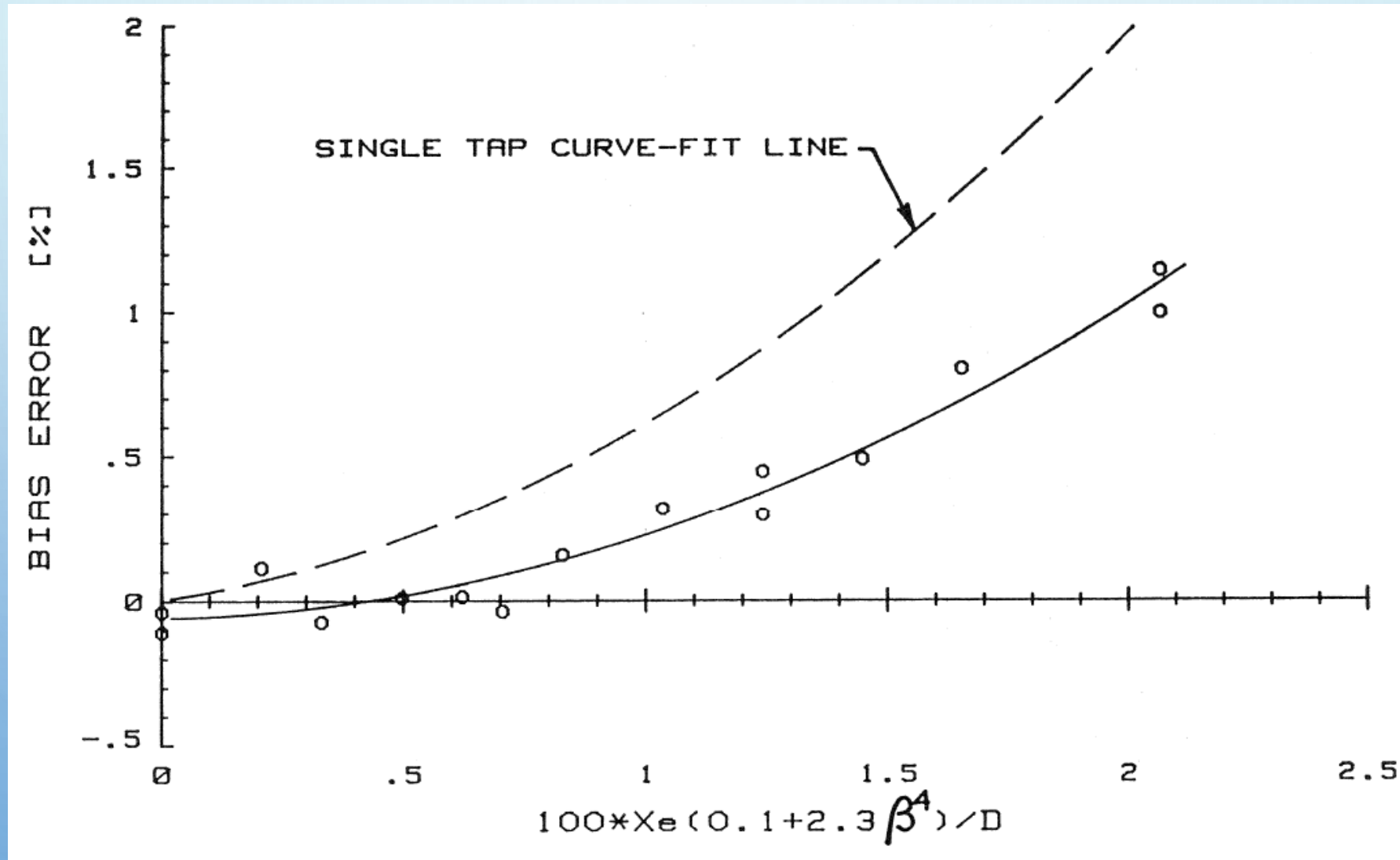


EFFECT OF ECCENTRICITY ON DIFFERENTIAL PRESSURE MEASUREMENT

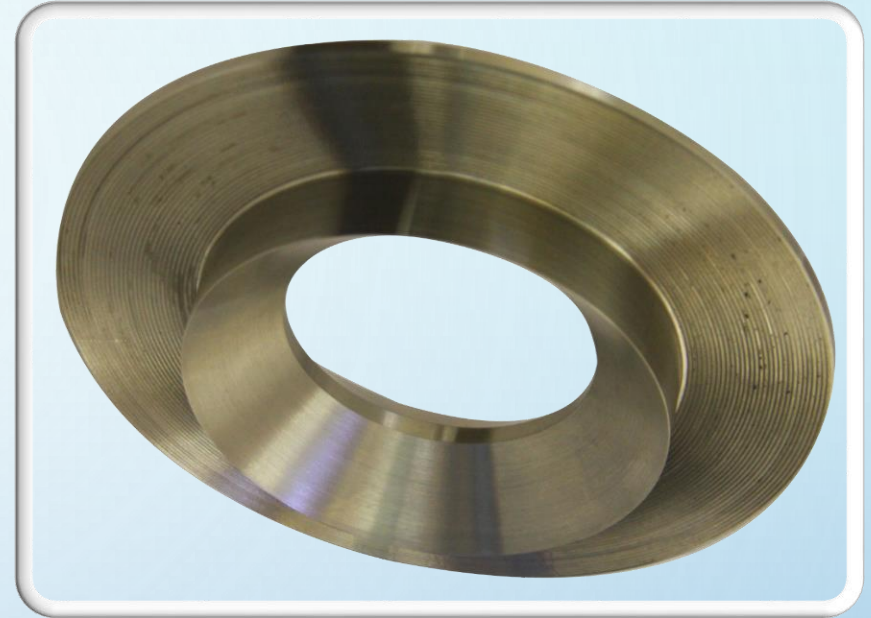
This paper on effect of orifice plate eccentricity by Dr. Zaki Husain and Dr. Ray Teysandier was presented at the 1983 British Instrument Society Conference and later archived as GPA Technical Publication 13 is also referenced in ISO, A{I, AGA, and GPA Orifice Meter Standards



EFFECT OF PHYSICAL AVERAGING OF TAPS

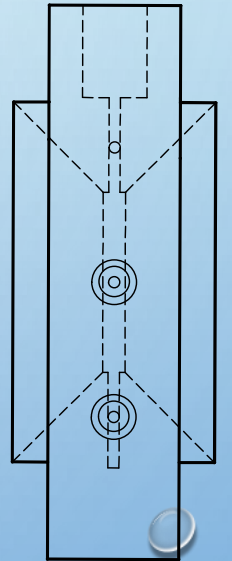
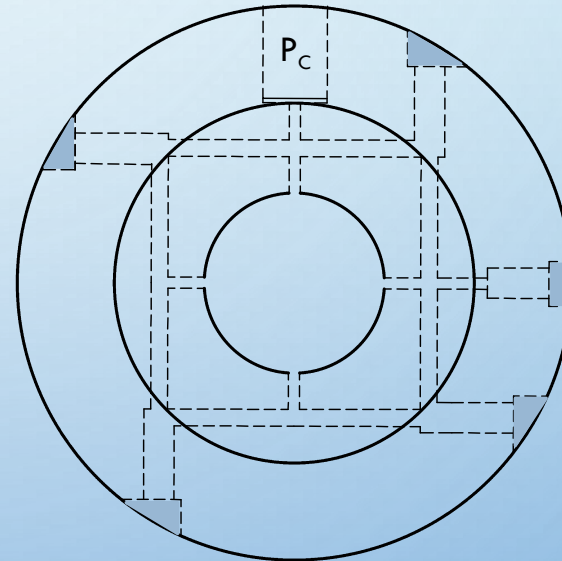
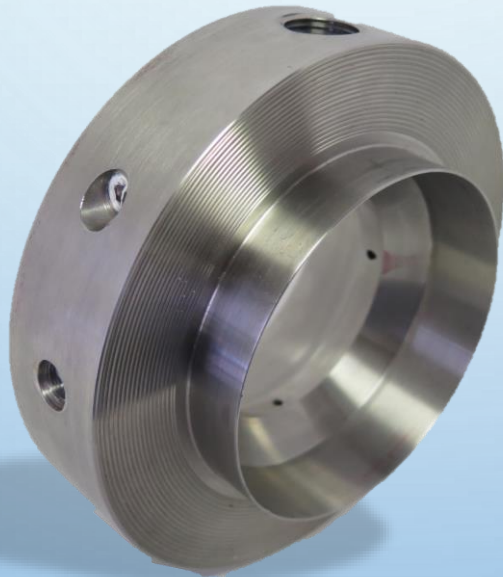


**WITHSTAND HIGH
DIFFERENTIAL
PRESSURES**

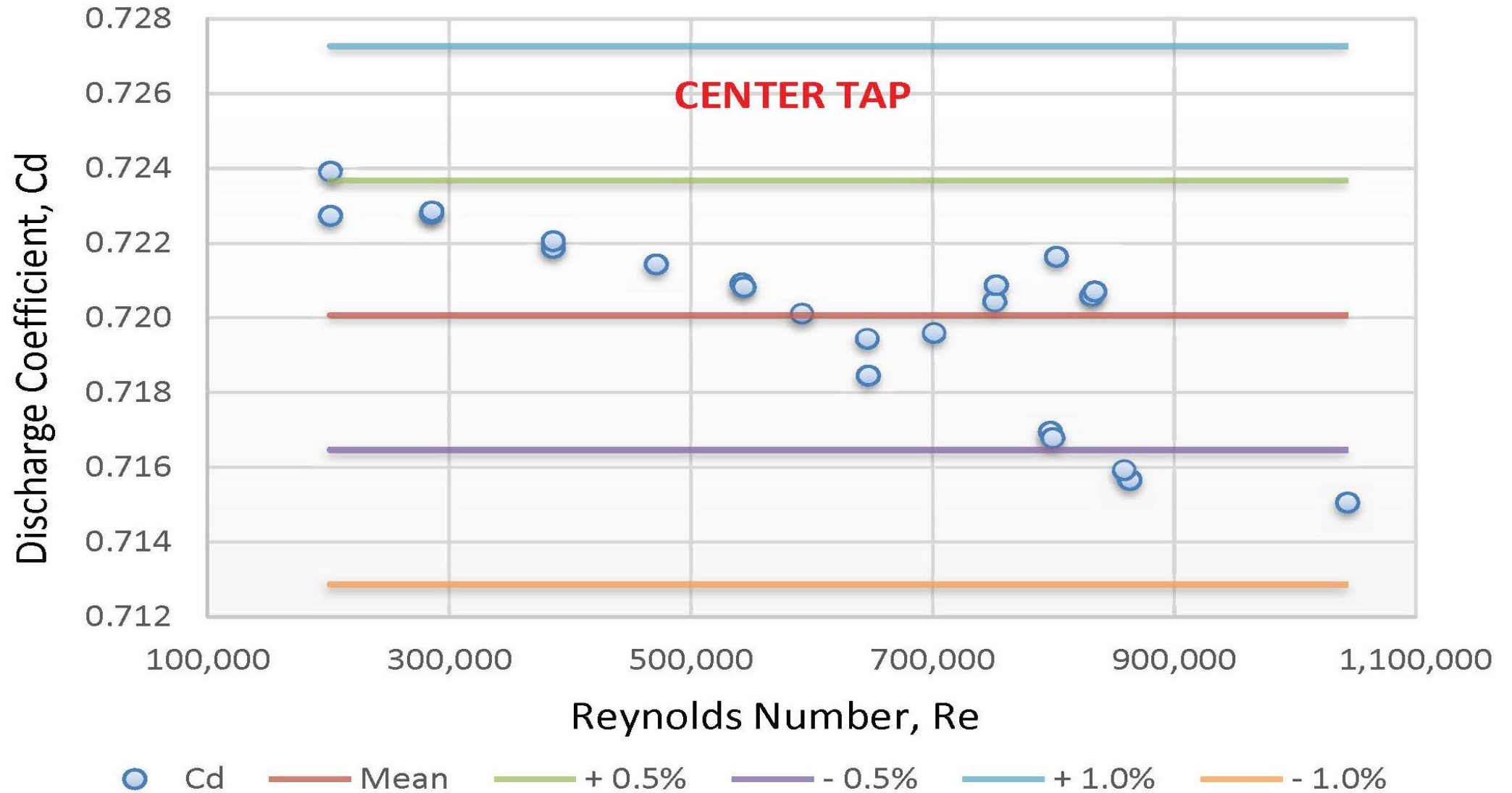


ELIMINATE INFLUENCE OF DOWNSTREAM DISTURBANCES & SINGLE POINT PRESSURE MEASUREMENT ISSUES

- Averaging Pressure Port
- Higher Differential
- Measured at High Velocity Point
- Minimize Effects of Downstream Flow Disturbances
- Independent of Downstream Reattachment point
- Bidirectional Flow Measurement Capability

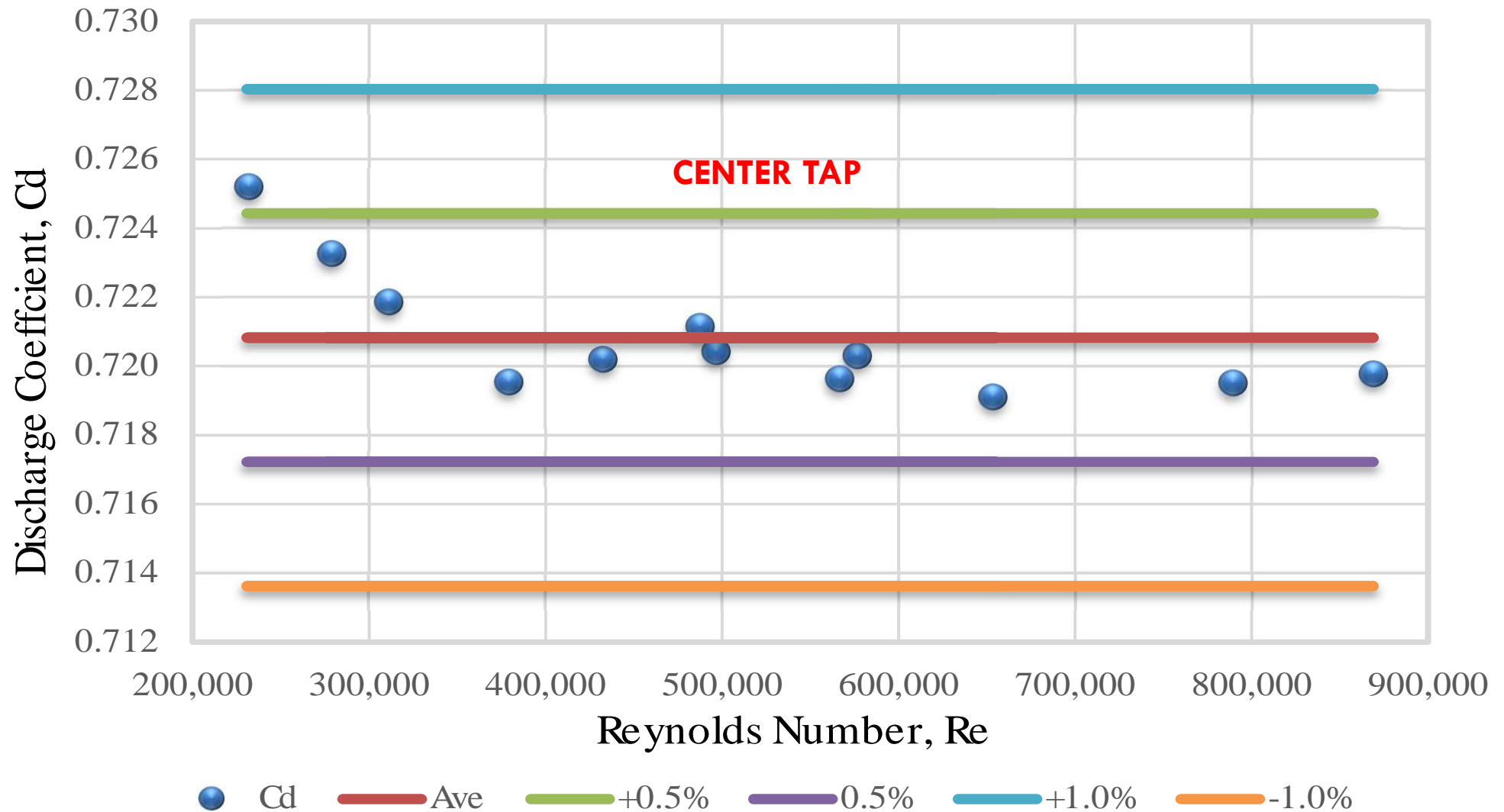


4" METER 0.3 BETA RATIO CEESI AIR CALIBRATION



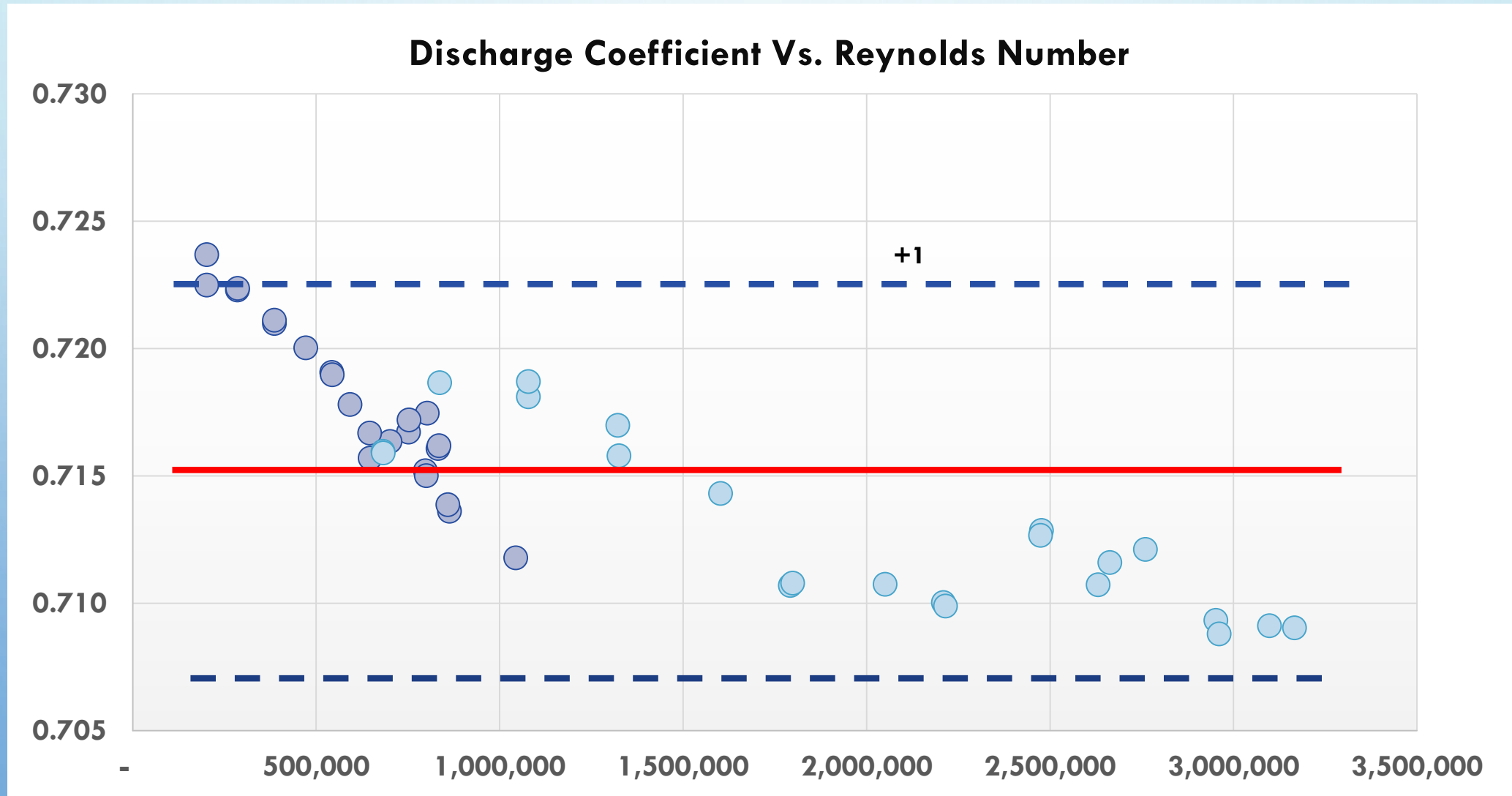
6" METER 0.54 BETA RATIO

CEESI WATER CALIBRATION



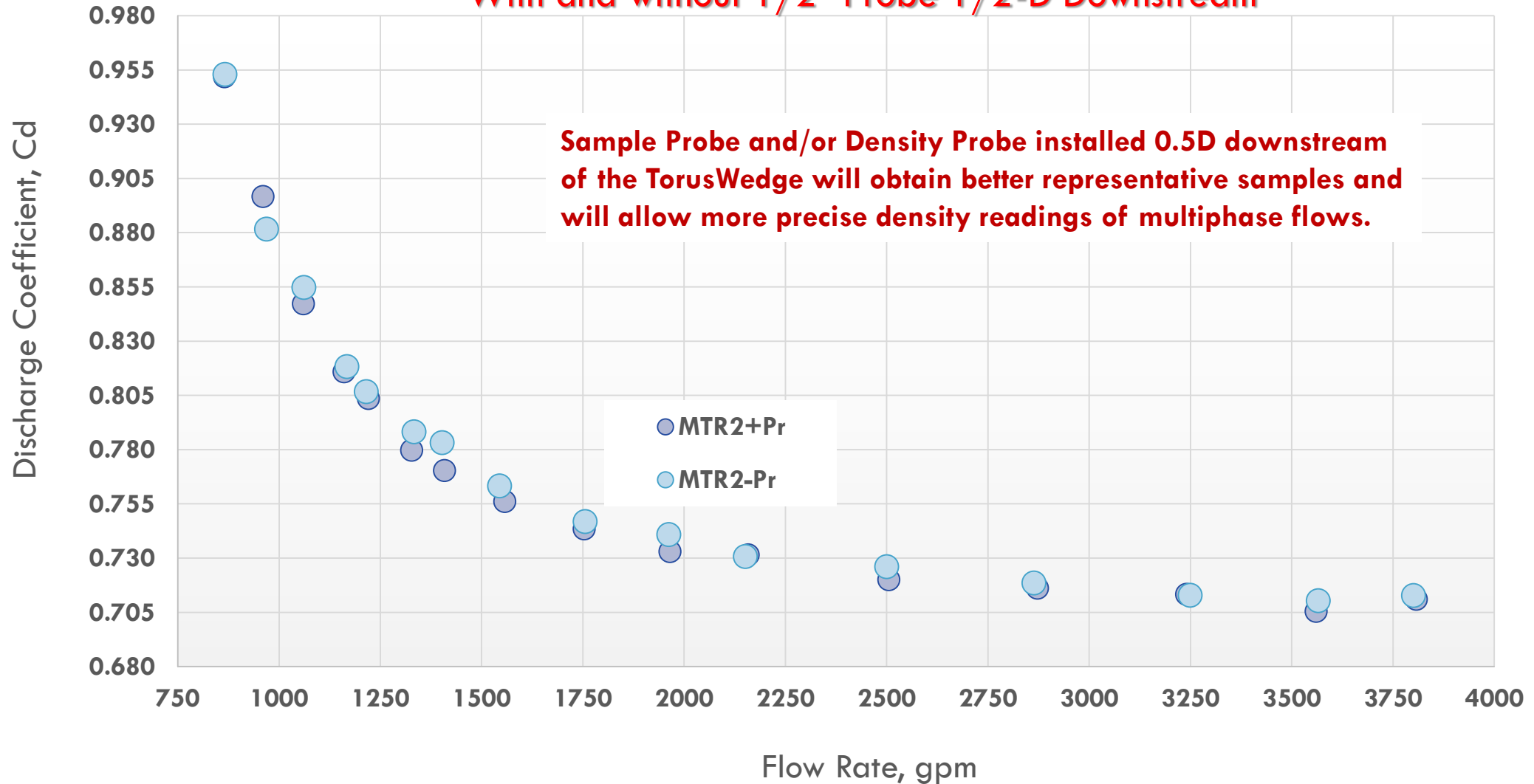
6" Water & 4" Air Calibration @ CEESI Calibration Facility

Influence on discharge coefficient due to line size and bore size is minimized by referring to the Center Tap pressure



10" meter 0.7 Beta Water Calibration

With and without 1/2" Probe 1/2-D Downstream



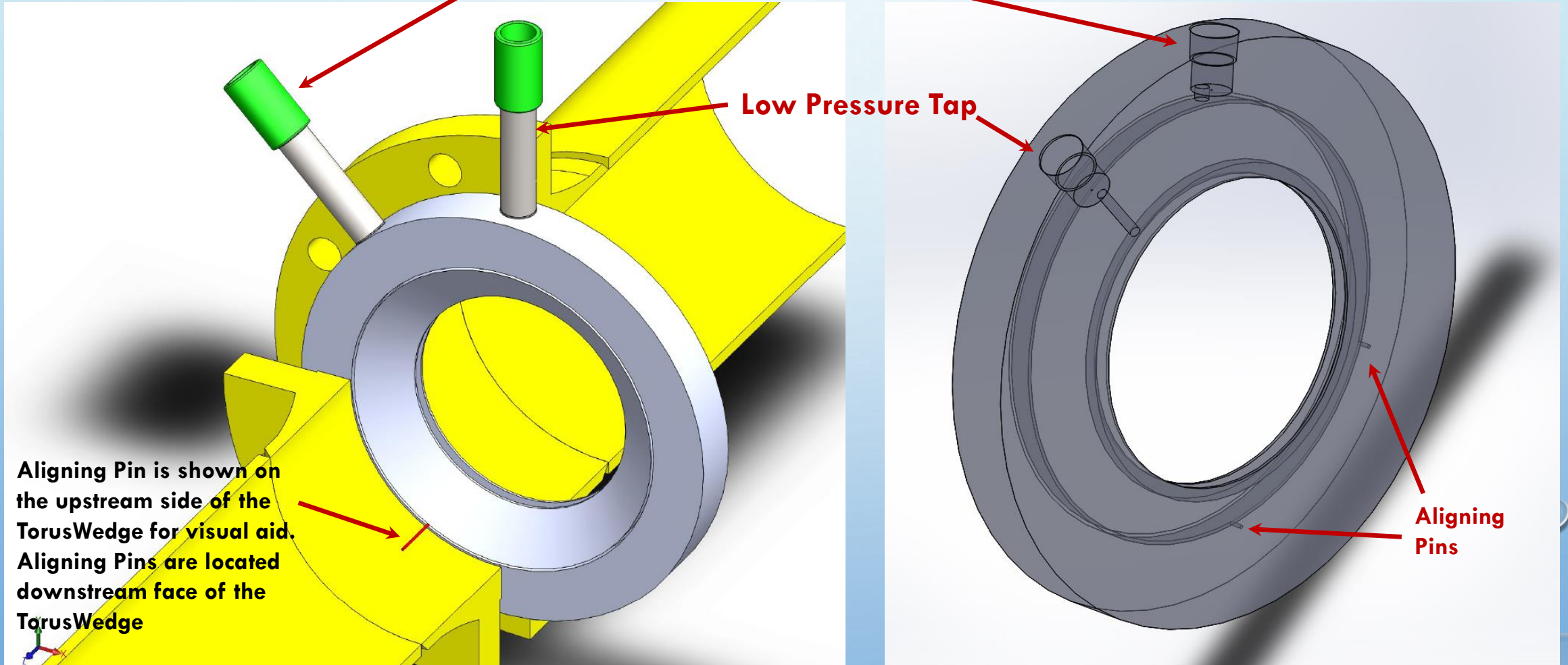
MODIFIED DESIGN

High Pressure Tap

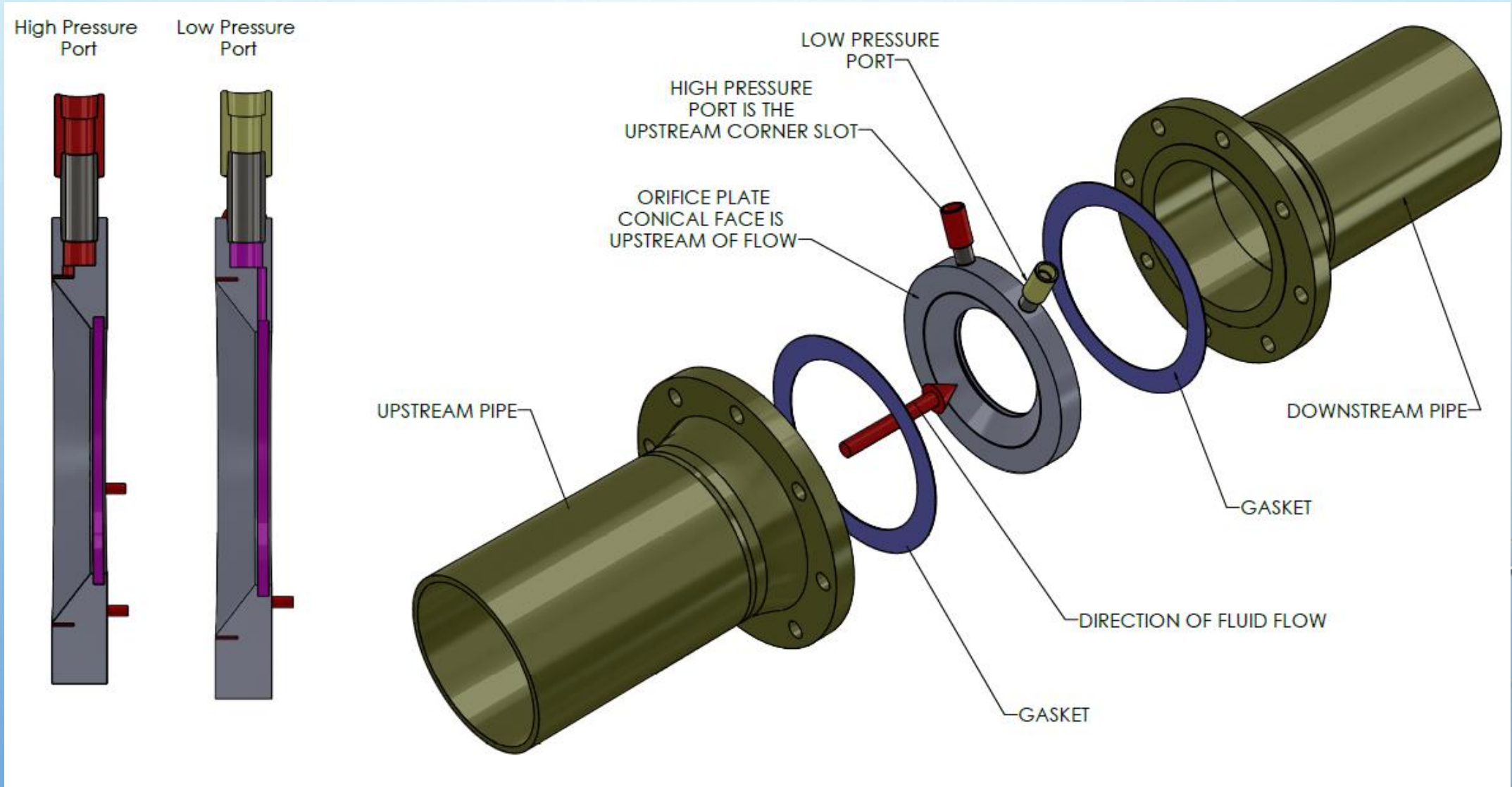
Low Pressure Tap

Aligning Pins

Aligning Pin is shown on the upstream side of the TorusWedge for visual aid. Aligning Pins are located downstream face of the TorusWedge

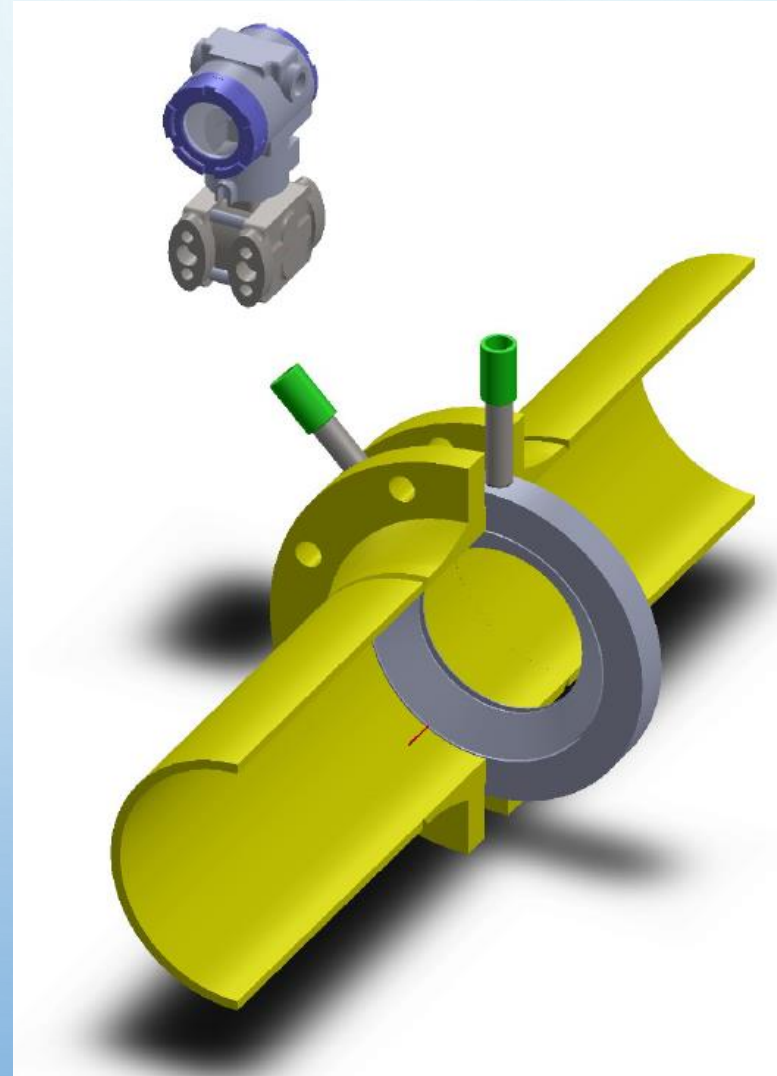


INSTALLATION OF TORUSWEDGE

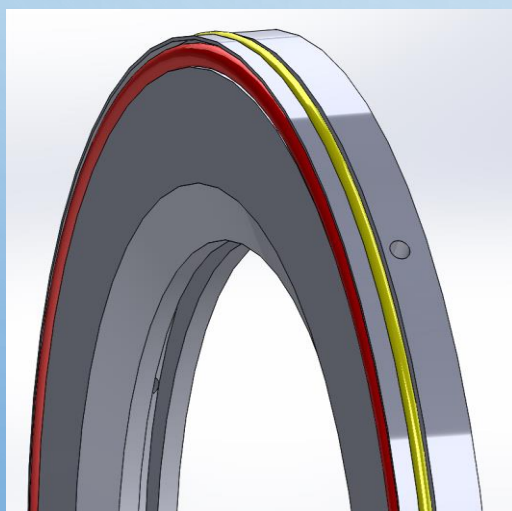
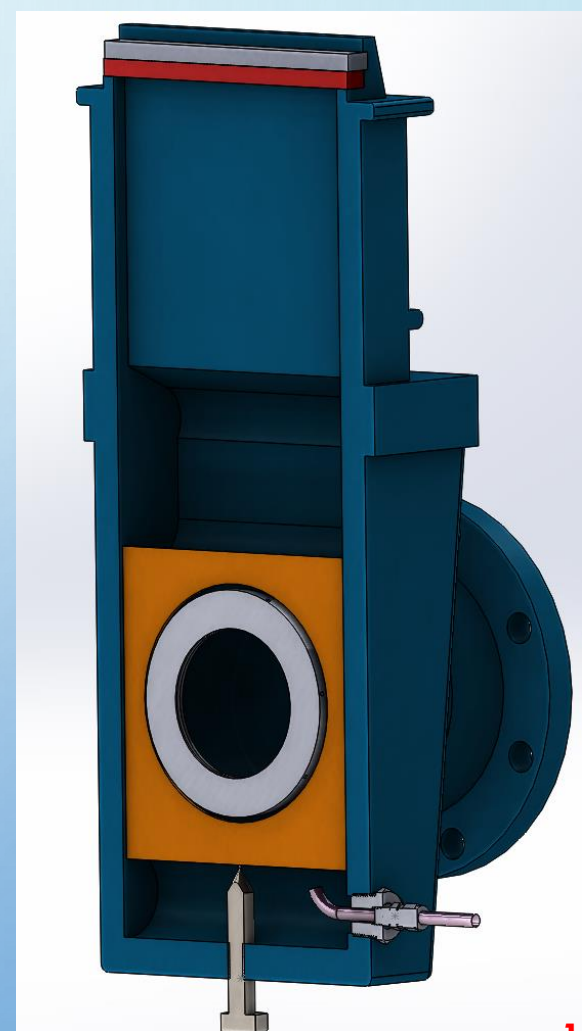
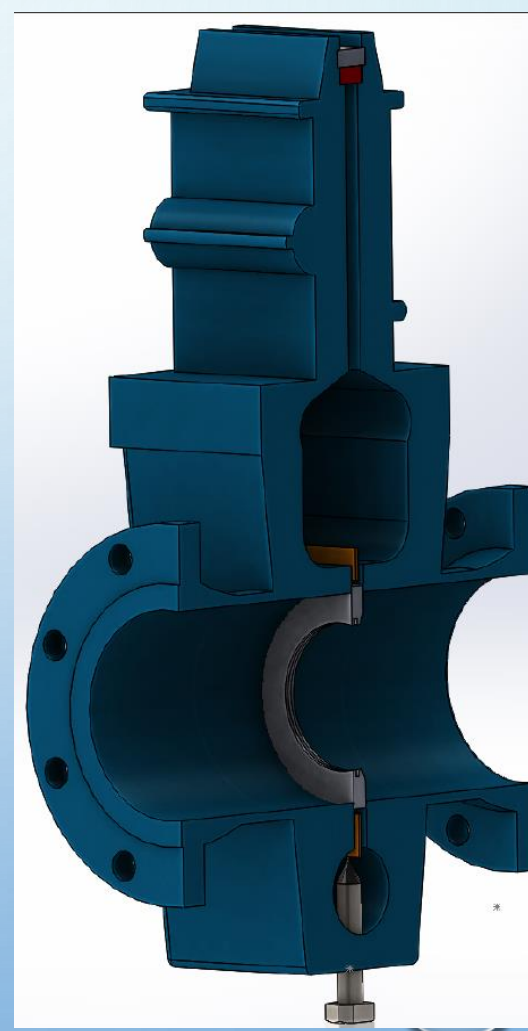
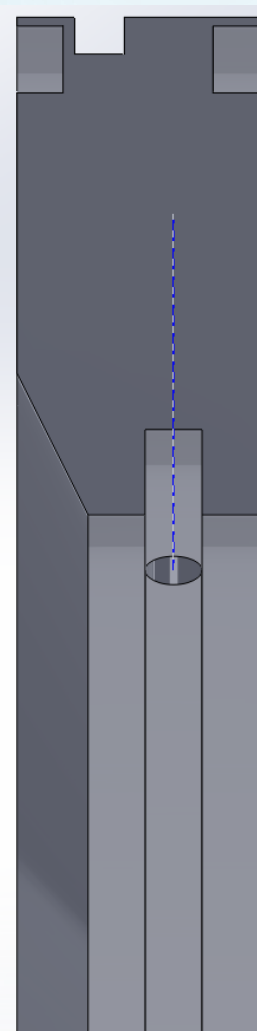
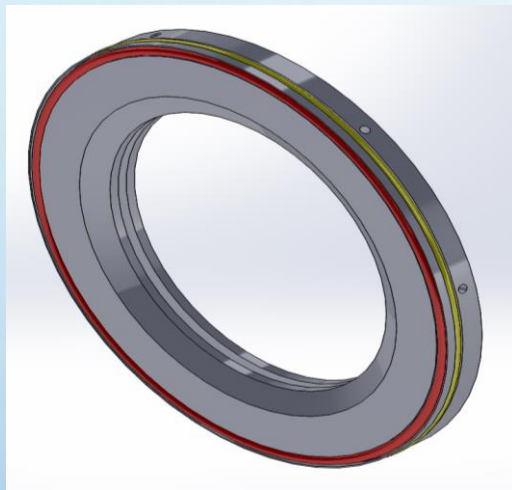


SELF ALIGNING CENTER PORT

Differential Pressure Taps can be offered as parallel ports, to allow direct mounting of the Differential Pressure Transmitter.



DUAL CHAMBER CENTER TAP CONFIGURATION

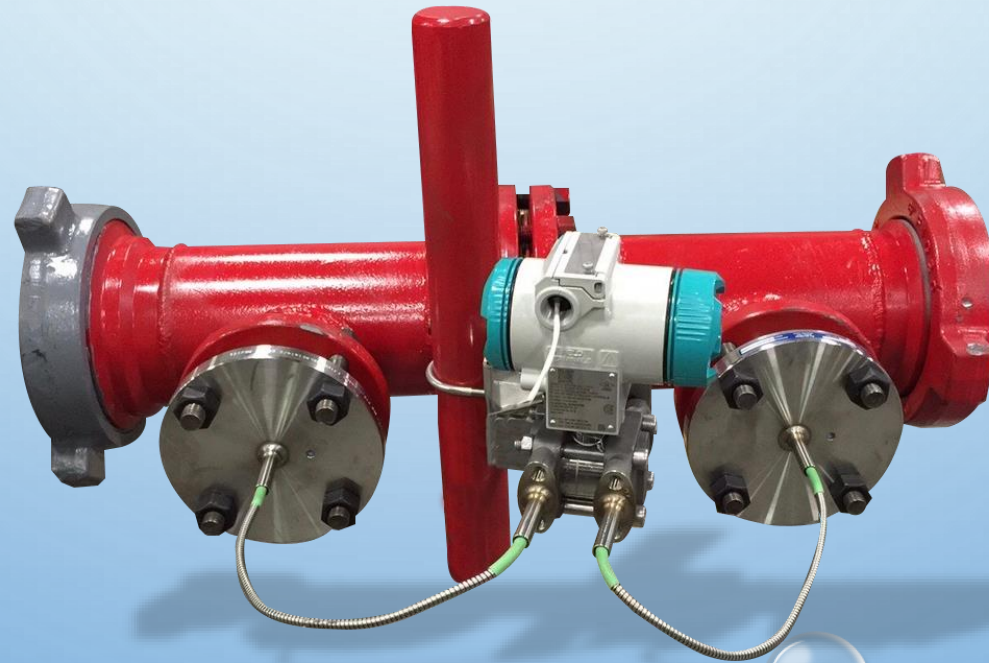
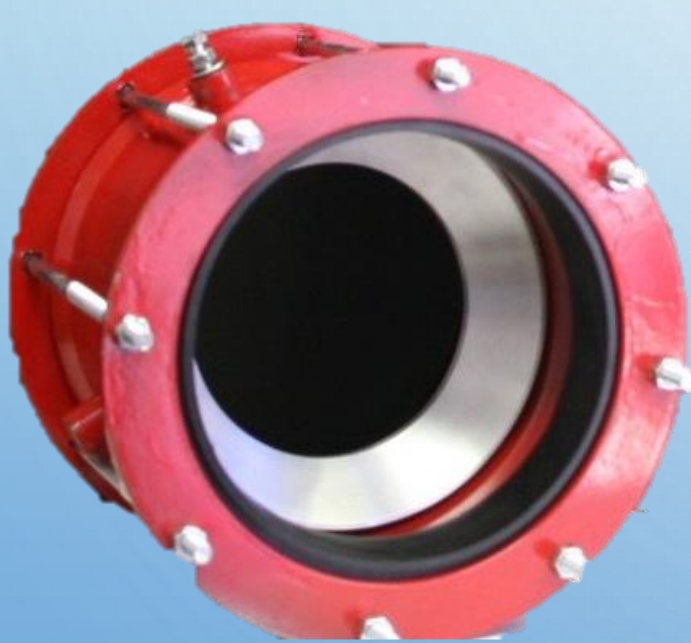


OPTIONAL DIAGNOSTIC CAPABILITY

- ADD SECOND DP TO STANDARD FLANGE TAPS.
- COMPARE THE HISTORICAL PRESSURE RATIO OF DP MEASURED BETWEEN UPSTREAM PRESSURE TAP AND CENTER TAP TO DP MEASURED BETWEEN STANDARD FLANGE TAPS.
- AT A GIVEN FLOW RATE, THAT PRESSURE RATIO IS CONSTANT AND BE MORE THAN 1.
- DEVIATION OF PRESSURE RATIO FROM THE HISTORICAL VALUE BY MORE THAN 5% IS INDICATION OF POSSIBLE LEAKAGE AROUND THE PLATE SEALS, DAMAGE TO , OR DEPOSIT ON THE TORUSWEDGE.

OTHER FLOW RATE MEASUREMENT CAPABILITY

REMOTE SEAL DP TRANSMITTER FOR FLOWS WITH SUSPENDED SOLIDS OF LIQUID DROPLETS



MODIFIED DESIGN MONITORING CENTER TAP PRESSURE BY REMOTE SEAL DP TRANSMITTER IS AVAILABLE.

QUESTIONS

