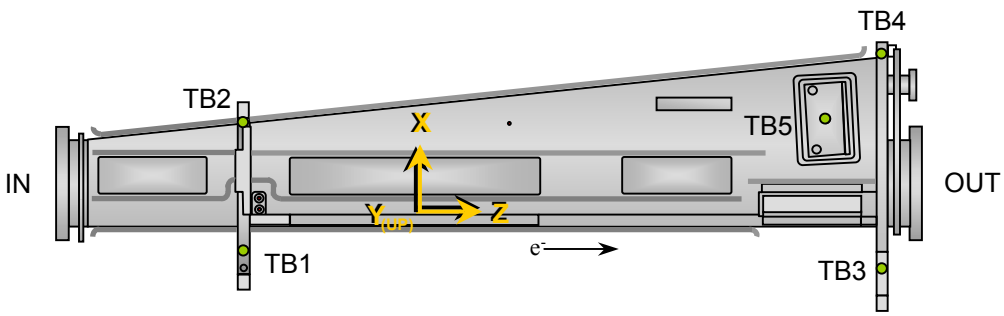
Vacuum Chamber Datum
QFC Case

Goal:

1. Find mid-plane of the chamber: 3 dof (pitch, roll, y)
2. Find axis of the chamber: 2 dof (yaw, x)
3. Find origin of the chamber: 1 dof (z)



In a perfect world

Get the inner top plane

Get the inner bottom plane

Average both planes -> this is the mid-plane

Get the inner right wall -> this will give the orientation of the chamber axis (yaw)

Move the chamber parallel to that axis -> this will set the z axis of the chamber

Place the chamber along this axis -> this will complete the datum (origin)

In reality

Inner top plane : **not possible anymore**

Inner bottom plane: **yes with correction**

Mid plane: **shift the bottom plane**

Inner right wall : **yes with 2 points**

Translation in x: **yes using nominal value**

Translation in z: **yes using nominal value**

Procedure for 1380 step

Take the twist of the chamber by using height gage on the bottom surface at both ends.

Use the mouse: calibrate – drag (measure every inch) – calibrate. Do it twice.

Measure 1 point US and 1 point DS of the inner right wall.

Scan the surface of the OUT flange.

Scan the external diameter of both DS flanges (OUT and small one).

Survey the 5 TBs and the 6 temporary points from 3 stations.

Datum computation part 1 of 3

Check the repeatability of the scans.

Best-fit a line to each of the 3 scans.

Best-fit a plane to scan A and scan B.

At this stage, we have an initial datum based on line B (z axis), normal of plane AB (y axis) with an origin as the average of the beginning of the 3 scans.

Datum computation part 2 of 3

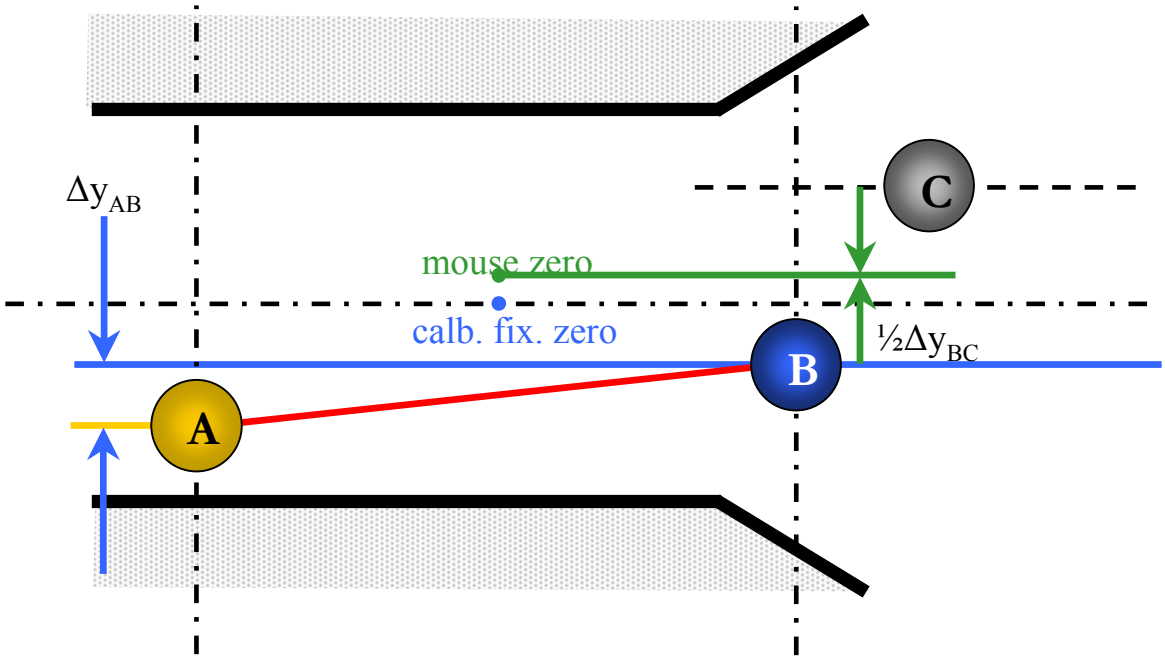
Use the calibration results to find the angle between the top plane of the calibration structure and the line made by points A and B.

Correct line A by rotating it around line B with the calibration angle. Get a new AB plane based on the corrected line A.

Get a line by averaging lines B and A corrected to get the x translation. Average this line with line C to get the y translation.

At this stage, we have a temporary datum close to the final one, except for a small shift in x and a shift in z.

Mouse in calibration structure



Δy_{AB} is used with the nominal distance AB to compute the angle and correct scanned line A.

Δy_{BC} is used in the QC procedure to check tolerance.

Datum computation part 3 of 3

Compute the line from the 2 measured points of the inner right wall. Find the angle of this line and the z axis in the z-x plane. Rotate the temporary datum around the y axis by that angle. Compare the new x value for the right inner wall with the nominal value of **–1.654 in,** this will give the translation in x.

Find the plane of the OUT flange and get the intersection with the z axis. Compare the z value of this intersection with the nominal value of **40.701 in** for the OUT flange, this will give the final translation in z, placing the origin at the center of the quad.

Procedure for the US flange check

Level the chamber.

Measure the TBs and best-fit their values to the 1380 step results.

Scan the surface of the IN flange as well as its external diameter.

Scan the visible part of the diameter of the OUT flange.

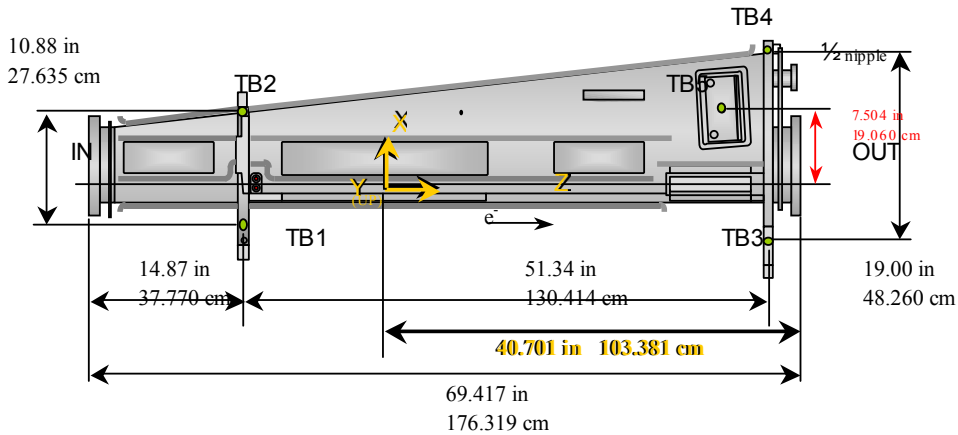
Fiducials for QFC Std. Vac. Chamber | *QFC007*

Date: 8/6/01

Chamber: QFC007

Operator(s): M.Gaydosh, F. Gaudreault

Notes:



Fiducial Coordinates for QFC Standard Vacuum Chamber: (inches)

Fiducial	Z	X	Y
TB1	-13.887	-3.351	4.415
TB2	-13.951	7.316	4.369
TB3	37.543	13.308	2.963
TB4	37.428	-5.519	4.411
TB5	33.442	7.595	2.076
Source	US Step		

$TB5_x$ Absorber Check	
Measured	7.595
Nominal	7.504
Difference	**0.091**

STATUS: WARNING

±0.004 in

Description:

Fiducial values based on internal chamber datum. Source = "US Step" indicates final data.

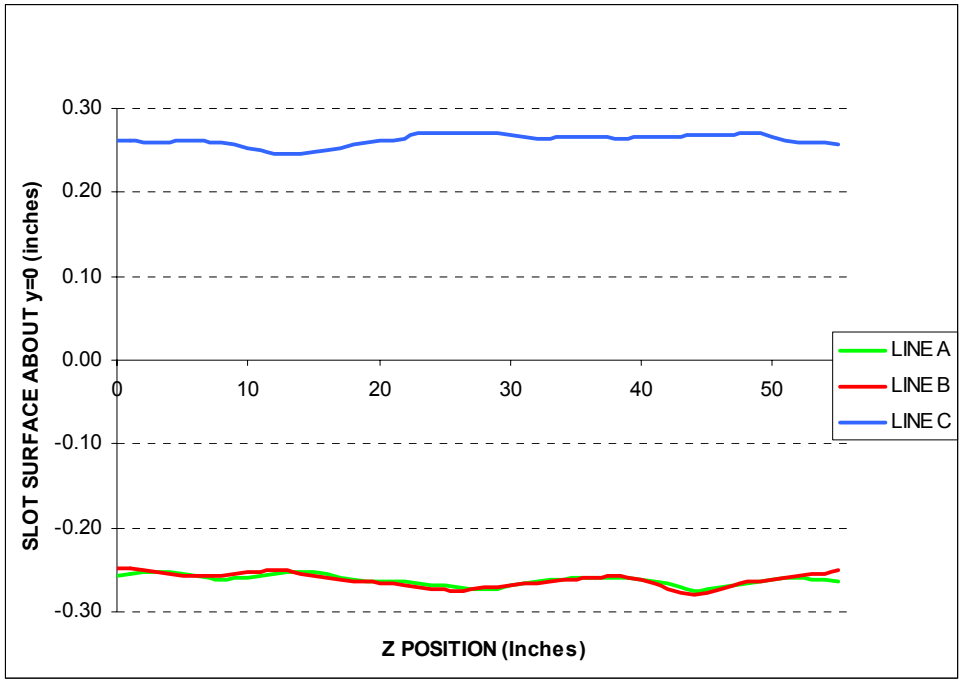
Flange Positions: (inches)

Flange	Z	X	Y	
IN	-28.631	1.821	-0.007	US
OUT	40.701	1.833	0.020	DS
NIP	N/A	10.521	-0.011	DS

Description:

Flange values based on scans of flange surfaces and referenced to internal chamber datum.

Fiducialization Step: (Traveler Step # 1380)



QFC007

Step 1: *Fiducial and Flange Coordinates for QFC Std. Vac. Chamber*

Fiducial	Z	X	Y
TB1	-13.887	-3.351	4.415
TB2	-13.951	7.316	4.369
TB3	37.543	13.308	2.963
TB4	37.428	-5.519	4.411
TB5	33.442	7.595	2.076
	inches	inches	inches

Downstream Flanges

	OUT	NIP	
Z	41.451	N/A	in
X	1.833	10.521	in
Y	**0.020**	-0.011	in

Nominals:	Xout	Yout
	1.836	0.000

Description:

Fiducial values based on internal chamber datum. Flange OUT X and Y values checked ±0.006 in.

Step 2: *Downstream Flange Check*

Flange	Yaw	Pitch	Diameter Meas.	Diameter Actual
OUT	-8.373	-2.264	11.467	9.967
NIP	N/A	N/A	4.229	2.729
	mrad	mrad	inches	

Status	Nominal Diameter	
	9.970	OK
	2.750	DIAM? ??
		±0.015 in

Description:

Problems in measuring the flange can show in the yaw, pitch or diameter.

Final "Upstream Flange" Step:

QFC007 Status

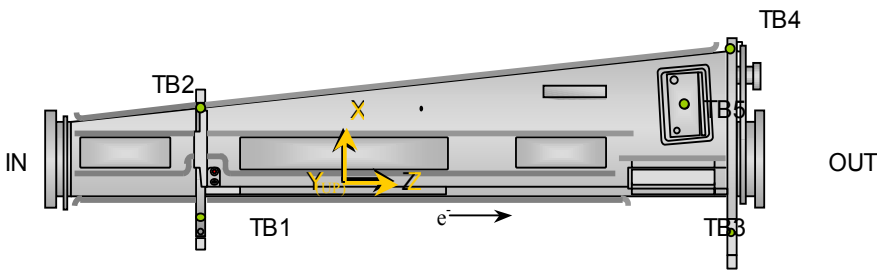
Step 1: *Change in Fiducial Values Check*

Fiducial	Delta Z	Delta X	Delta Y	
TB1	-0.001	-0.001	0.000	OK
TB2	-0.002	0.000	0.001	OK
TB3	0.000	0.000	0.001	OK
TB4	0.001	0.000	0.000	OK
TB5	0.002	0.000	-0.001	OK
	inches	inches	inches	±0.006 in

Description:

Difference between current and previous fiducial values.

Global: OK



QFC007 Status

Step 2: *Change in Downstream Flange Check*

Flange OUT	X	Y	Diameter	
New:	1.837	0.015	11.469	in
Delta:	0.004	-0.005	0.002	in

Diameter: 9.969

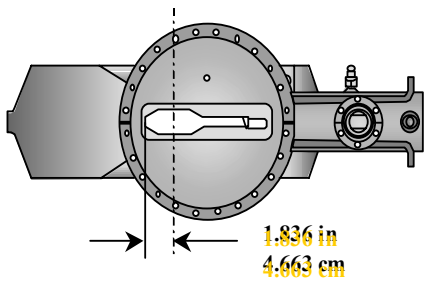
OK

X and Y: ±0.015 in

Diameter: ±0.015 in

Description:

Difference between current and previous fiducial values and diameter.



Final "Upstream Flange" Step (continued):

QFC007 Status

Step 3: *Upstream Flange Values*

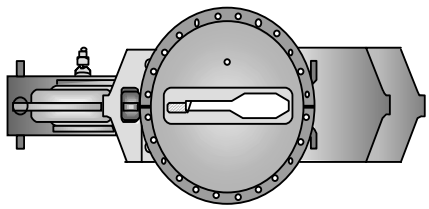
Flange IN		Flange IN		
-29.381	Z	6.807	-2.989	mrad
1.821	X	Yaw	Pitch	
-0.007	Y			
inches		Meas.	Actual	
	Diameter	11.467	9.967	in

Nominal Diameter: 9.970 — OK — ±0.015 in

Description:

Location and orientation of Flange IN (upstream) plus its measured diameter.

Flange IN X and Y values are also checked ±0.006 in.



QFC007 Status

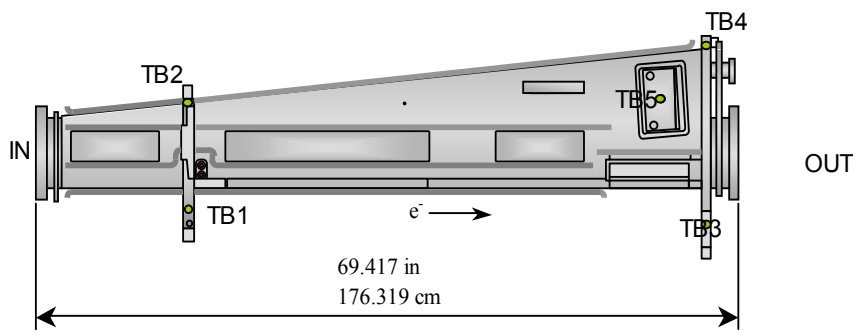
Step 4: *QFC Chamber Length*

Length **with SMR**		Length	
70.832	inches	69.332	inches

Nominal Length: 69.417 — OK — ±0.100 in

Description:

Length check of the chamber.



First Results in mil and mrad

QFC	001	005	006	007	008
TB5 x	53	74	43	91	57
Length		-79	-68	-85	-81
OUT x	16	6	4	-3	4
OUT y	31	26	11	20	-2
OUT ∅	-255	-1	-3	-3	-1
OUT yaw	-7.5	-11.6	-6.7	-8.4	-9.1
OUT pitch	5.7	-6.7	-0.9	-2.3	-1.9
best fit		4	-52	2	2
IN x		-18	1	-15	4
IN y		21	-7	-7	-2
IN ∅		3	0	-3	2
IN yaw		7.7	5.5	6.8	7.4
IN pitch		-0.3	-0.3	-3.0	-3.3

Questions

Size & position of small DS (NIP) flange

All the tolerances

- absorber check: 4 mil
- all position checks: 6 mil
- all diameter checks: 15 mil
- length check: 100 mil

Potential final datum adjustment

- in x if absorber check failed
- in z if chamber length failed

Conclusion

Quality of the QFC datum:

- **roll**: weakest but no fix possible

- **yaw** and **x** based on 2 single shots (with nominal checks) -> may want to add a verification

- **z** based on plane-scan of OUT flange possibly updated by the measured length of the chamber -> may want to get the 2 plane-scans of the flanges IN and OUT from the same survey.

- **pitch** and **y**: OK