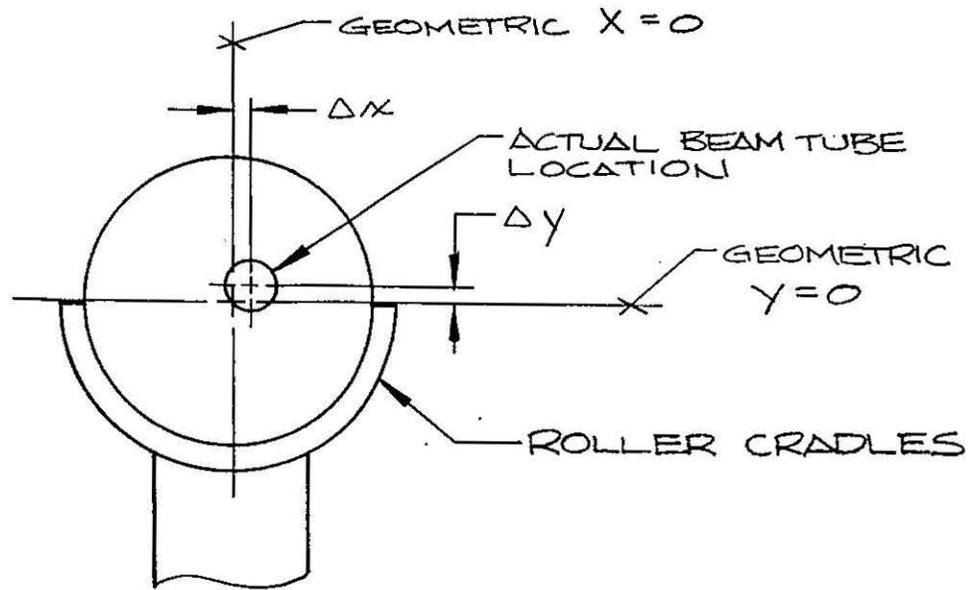
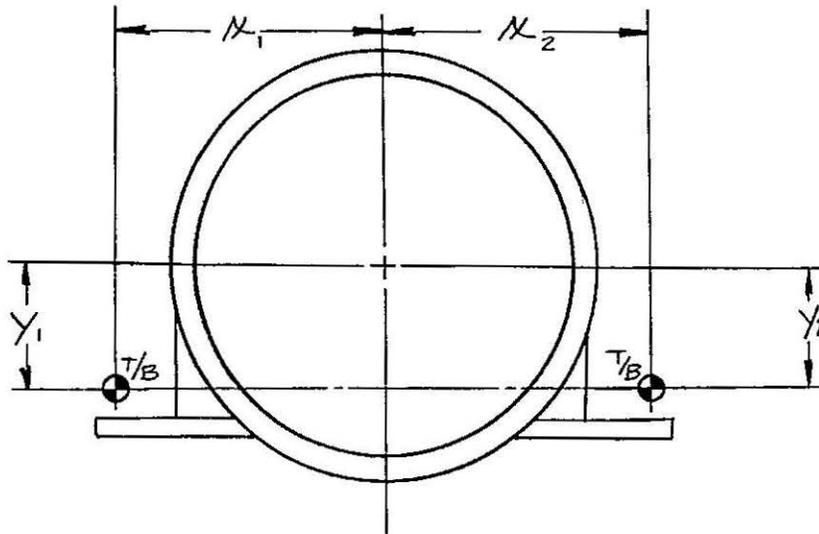


1. BEAM TUBE ϕ VERSUS GEOMETRIC ϕ



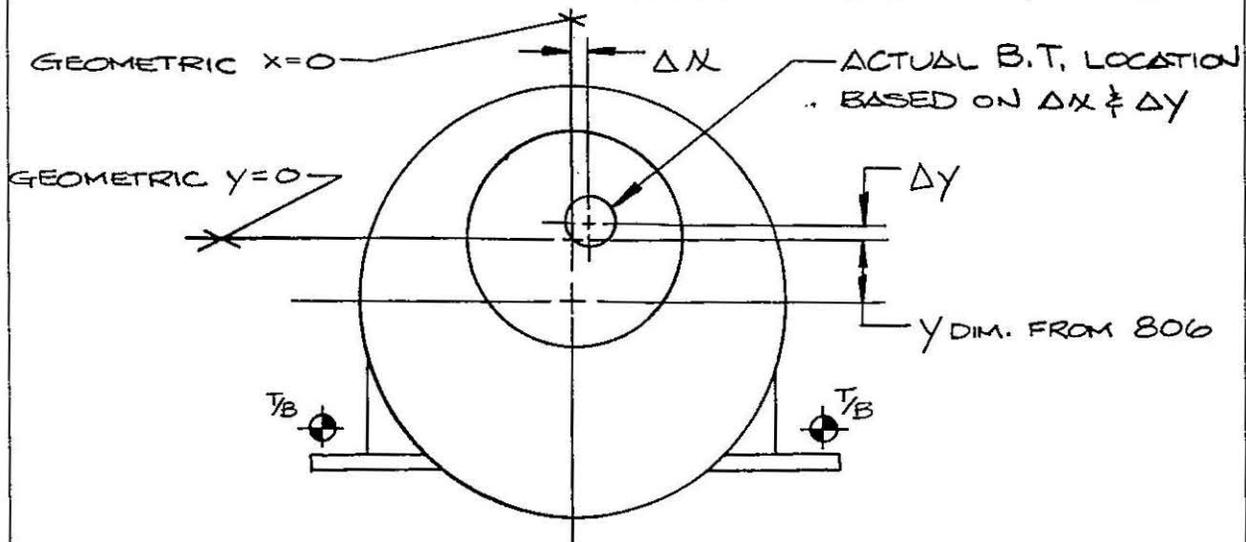
- THE ROLLER CRADLES ARE "SHOT" TO LOCATION SQUARE TO THEMSELVES AND THE WORLD WHEN ASSEMBLED.
 - (5) CRADLES @ MAGNET POST LOC'S.
- WHEN THE SURVEY CREW SHOOTS THE COLD MASS ASSEMBLY IN THE FINAL MEASURE PRIOR TO CRYOSTATING...
 - GEOMETRIC ϕ IS DETERMINED BY COLD MASS O.D. AS RELATED TO THE ROLLER CRADLE FIXTURING REFERENCE POINTS.
 - Δx & Δy ARE THE COORDINATES FOR THE ϕ OF THE BEAM TUBE REFERENCED FROM THE ESTABLISHED GEOMETRIC ϕ
 - THESE COORDINATES ARE THEN RECORDED FOR USE AT INSERTION AND POSITIONING IN THE VACUUM VESSEL

2. CURSORY CHECK OF VACUUM VESSEL PERIPHERALS



- THE VACUUM VESSEL IS OPTICALLY CHECKED WHEN RECEIVED FOR . . .
 - ROUNDNESS AT GUIDE RINGS
 - STRAIGHTNESS ALONG LENGTH
 - LOCATION OF ϕ FROM EXTERNAL FIDUCIALS
- TOOL BALLS ARE NOT LOCATED ON THE VACUUM VESSEL WITH ANY GREAT DEGREE OF ACCURACY.
 - THE X & Y DIMENSIONS FOR THE T/B'S TO THE ϕ OF THE VACUUM VESSEL WILL BE PECULIAR TO THAT INDIVIDUAL VACUUM VESSEL.
 - THESE NUMBERS MUST BE DOCUMENTED AND TRAVEL WITH THE VESSEL TO BE USED AT CRYOSTAT FINAL ASS'Y.
 - THESE NUMBERS WILL COORELATE THE POSITION OF THE GEOMETRIC ϕ OF THE COLD MASS & CRYOGENIC COMPONENTS TO THE EXTERNAL FIDUCIALS OF THE VACUUM VESSEL.

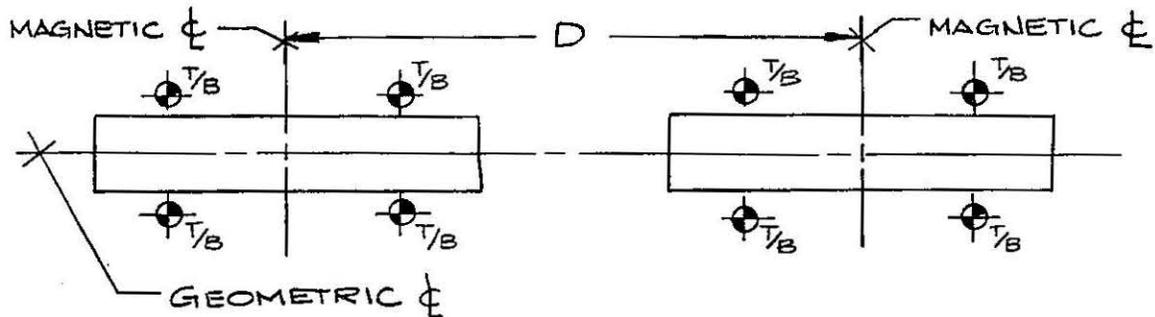
3. POSITIONING OF MAGNET IN VACUUM VESSEL



- AFTER THE INSERTION INTO THE VACUUM VESSEL THE COLD MASS & CRYOGENIC LINES ARE ADJUSTED AS A UNIT TO POSITION THE GEOMETRIC ϕ OF THE MAGNET PROPERLY, PER 806, INSIDE THE VACUUM VESSEL...
 - TO FACILITATE THIS A REFERENCE SYSTEM BASED UPON THE RELATIONSHIP OF THE T/B'S TO THE VACUUM VESSEL FROM THE CURSORY CHECK OF THE VACUUM VESSEL (ITEM 2) IS ESTABLISHED.
 - THIS TELLS THE SURVEY CREW WHERE THE ϕ OF THE VACUUM VESSEL IS WITHIN THE ESTABLISHED REFERENCE SYSTEM.
 - THE MAGNET, AND CRYOGENIC COMPONENTS, IS THEN ADJUSTED UTILIZING THE INFORMATION TAKEN IN ITEM 1.
 - SINCE THE EXTERNAL FIDUCIALS OF THE COLD MASS ARE NOW INACCESSIBLE, THE O.D. OF THE BEAM TUBE FLANGE BECOMES THE FIDUCIALS.
 - THE SURVEY CREW WILL POSITION THE GEOMETRIC ϕ OF THE MAGNET BY:
 - X POSITION = GEOMETRIC ϕ + ΔX
 - Y POSITION = Y DIM. FROM 806 + ΔY
 - BY POSITIONING THE B.T. FLANGE AT THESE COORDINATES, THE GEOMETRIC ϕ OF THE MAGNET BECOMES PROPERLY LOCATED WITHIN THE VACUUM VESSEL AND ACCESSIBLE BY THE EXTERNAL FIDUCIALS ON THE VACUUM VESSEL.
 - THIS ENABLES PROPER LOCATION, UTILIZING THESE T/B'S, OF THE MAGNET IN THE TUNNEL AT INSTALLATION.

4. POSITIONING OF ASS'Y WITHIN THE TUNNEL

* BASED UPON PRIVATE CONVERSATION WITH J. CARSON ON FERMI MAGNET INSTALLATION EXPERIENCE.



- FINAL MEASURE ILLUSTRATES:
 - THE POSITION OF THE MAGNETIC C IN RELATIONSHIP TO THE EXTERNAL FIDUCIALS. THIS ENABLES THE PROPER POSITION, D , OF ONE MAGNET C TO ANOTHER BETWEEN MAGNETS WITHIN THE TUNNEL.
 - THE POSITION OF THE GEOMETRIC C IN RELATIONSHIP TO THE EXTERNAL FIDUCIALS. THIS ENABLES THE PROPER ALIGNMENT OF THE GEOMETRIC C TO ANOTHER WITHIN THE TUNNEL IN THE X & Y DIRECTIONS.

✂ IT IS IMPORTANT TO NOTE THAT:

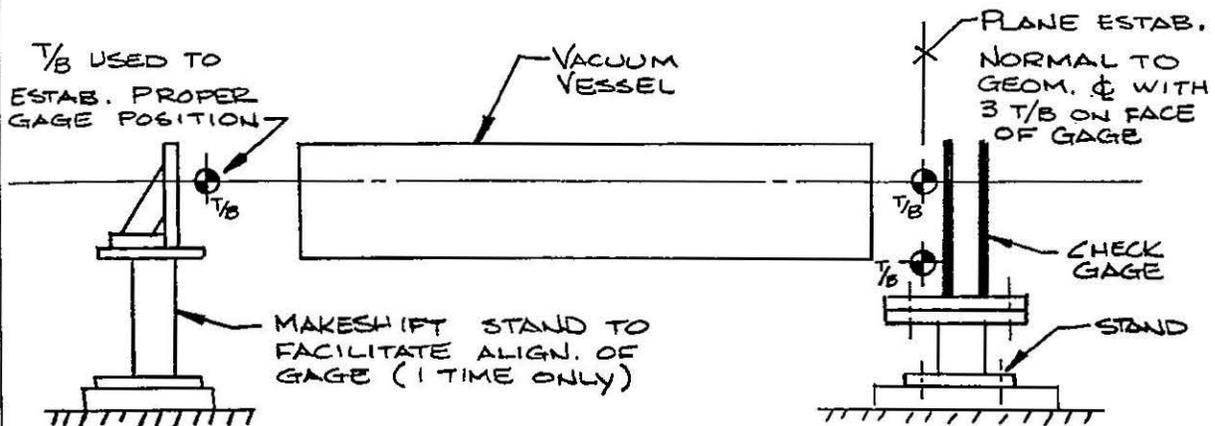
- THE RELATIONSHIPS FOR THE REFERENCE SYSTEM ALWAYS REFER TO THE GEOMETRIC C AND NOT THE ACTUAL BEAM TUBE LOCATION.
- WHEN MAGNETS ARE ALIGNED WITHIN THE TUNNEL IN THE X & Y DIRECTION, THEY ARE ALIGNED BY THE GEOMETRIC C NOT BY THE BEAM TUBE LOCATION.
- THE GEOMETRIC C AND BEAM TUBE C ARE THEORETICALLY BUT NOT NECESSARILY IN REALITY THE SAME C .
- TO DEFINE THE C OF THE BEAM TUBE THE SHOT IS TAKEN TO THE O.D. OF THE FLANGE. THE FLANGE IS THEN MIC'D. AND C IS MATHEMATICALLY DERIVED.

5. PROPOSED MODIFICATION IN THE USAGE OF THE INTERFACE CHECK GAGE.

- THESE MODIFICATIONS CHECK PIPING ALIGNMENT IN RELATIONSHIP TO THE GEOMETRIC ϕ , IN X & Y, IN THE SAME MANNER IN WHICH THE MAGNETS WILL BE ALIGNED WITHIN THE TUNNEL AND TO THE PARAMETERS DEFINED BY THE 806 I.C.D.

A. REMOVE THE BOTTOM PLATE AND LEVELLING BOLTS FROM THE FIXTURE.

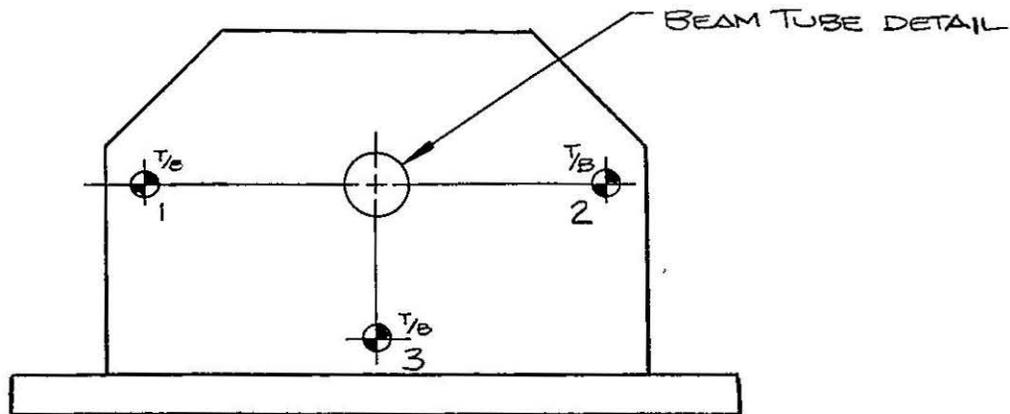
B. LOCATE FIXTURE TO A TABLE IN THE FOLLOWING MANNER:



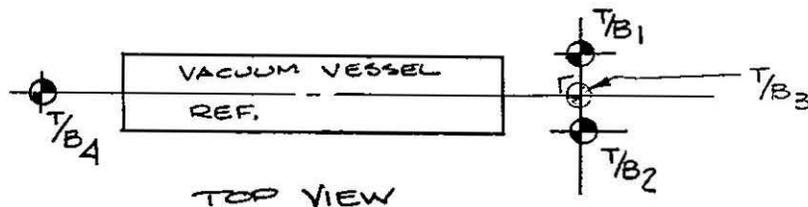
1. ATTACH, LEVEL, & GROUT A PLATE TO THE FLOOR.
2. FABRICATE A STAND TO ALLOW LOCATION OF GAGE.
3. LOCATE STAND ON PLATE AND DRILL BULLET NOSE DOWEL AND BUSHING LOC'S COMMON TO STAND AND PLATE. THIS ALLOWS FOR QUICK, ACCURATE, REPEATABLE LOCATION OF THE STAND TO THE PLATE.
4. PLATE AND STAND TO BE SHOT IN SQUARE TO THE WORLD AT INSTALLATION. THIS IS A ONE TIME TASK.
5. SET UP A MAKE SHIFT STAND ON A SIMILAR PLATE GROUTED IN AT THE OPPOSITE END OF WHERE THE MAGNET WILL BE.
6. ON THIS STAND SET UP AN ANGLE PLATE WITH T/B ON THE SURFACE TO FACILITATE THE ESTABLISHING

6. (CONT'D)

- OF THE THEORETICAL GEOMETRIC ϕ
OF THE MAGNET TO LOCATE THE GAGE.
7. LOCATE (3) T/B'S ON THE FACE OF THE
GAGE AS SUCH:



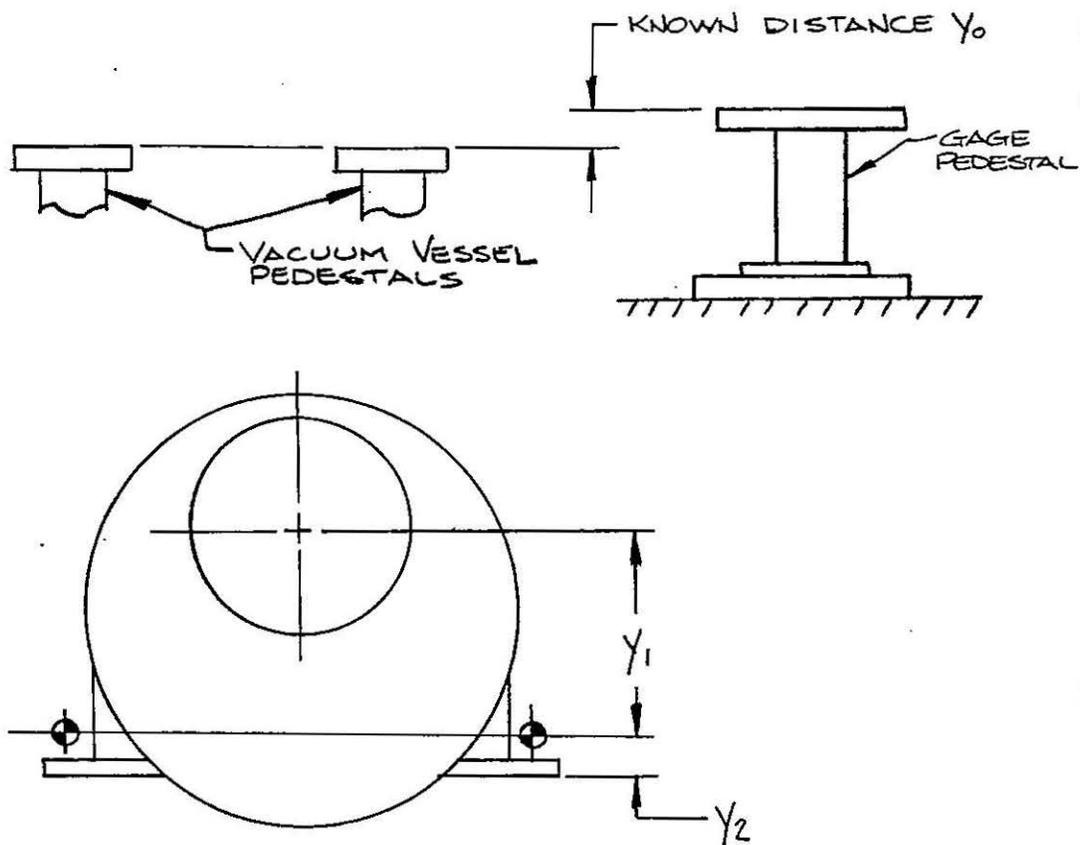
- THESE T/B'S ALLOW THE GAGE FACE TO BE ESTABLISHED AS A PLANE NORMAL TO THE GEOMETRIC ϕ
- T/B'S 1 & 2 ARE SHOT TO ADJUST THE GAGE NORMAL TO THE GEOMETRIC ϕ AS VIEWED FROM THE TOP.



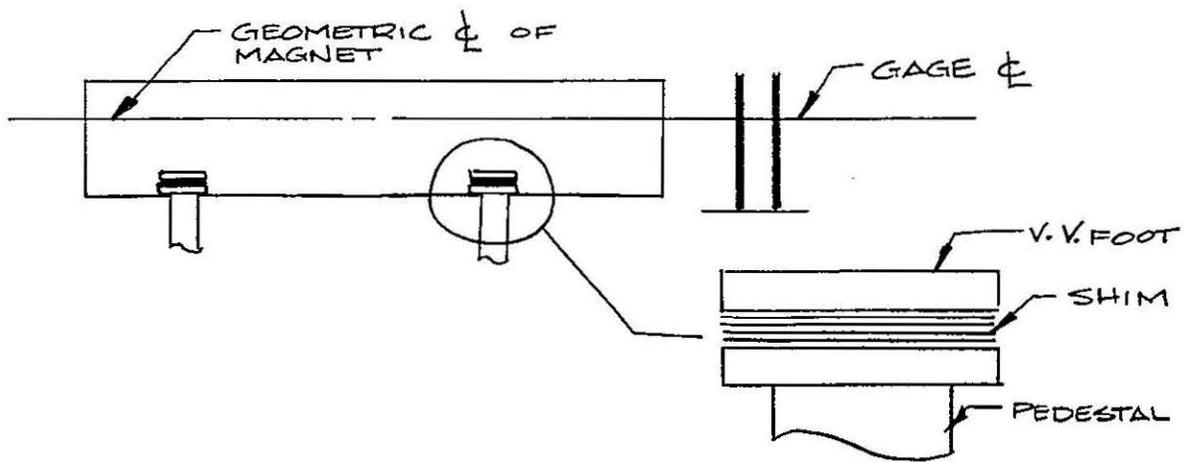
- THEN, BY LINING UP T/B'S 1 & 2 AS VIEWED FROM THE SIDE, A THEORETICAL GEOMETRIC ϕ CAN BE ESTABLISHED USING T/B 4. BY SETTING T/B'S 1 & 2 AS A SINGLE POINT ALONG FACE OF THE GAGE AND ESTABLISHING A LINE BETWEEN THEM AND T/B 4 THE GAGE CAN NOW BE SET TO THE STAND.
- TO SET THE GAGE TO THE STAND, DRILL BULLET NOSE DOWEL AND BUSHING HOLES THROUGH THE GAGE BASE AND STAND AT THE SAME TIME
- REPEAT GAGE LOCATION AT THE OPPOSITE END OF THE MAGNET AND TRANSFER THE HOLE LOC'S FROM THE STAND TO THE FLOOR PLATE BY BACK DRILLING.

- IN DOING THIS ONLY THE INITIAL OPTICAL SET UP IS REQ'D. AND A MEANS TO LOCATE THE GAGE THAT IS QUICK, ACCURATE, AND REPEATABLE IS ESTABLISHED WITHOUT HAVING TO USE OPTICS FOR THE GAGE CHECK AGAIN.

6. POSITIONING OF THE MAGNET TO FACILITATE USAGE OF THE AFOREMENTIONED GAGE SET UP



- By KNOWING THE DISTANCES $Y_1 \neq Y_2 \neq Y_0$ THE VACUUM VESSEL CAN BE SHIMMED ON THE PEDESTALS TO BRING THE GEOMETRIC ϕ OF THE MAGNET IN LINE WITH THE ϕ ESTABLISHED BY THE GAGE IN THE Y DIRECTION.



- TO ESTABLISH THE AMOUNT OF SHIM:

$$Y_0 - (Y_1 + Y_2) = \text{AMOUNT OF SHIM}$$

- THE Y LOCATION OF THE ASS'Y IS ESTABLISHED CONCURRENTLY WITH THE OPTICAL OPERATIONS DESCRIBED IN ITEM 3 "POSITIONING OF..."
- ONCE THE Y LOCATION IS ESTABLISHED THE ASS'Y IS ADJUSTED "SIDE TO SIDE" (LOOKING FROM THE TOP) TO ALIGN THE GEOMETRIC ϕ OF THE ASS'Y TO THE ϕ OF THE GAGE.
- AFTER THIS IS ACCOMPLISHED NO FURTHER OPTICAL REQ'S EXISTS.
- THE GAGE IS UNBOXED, DROPPED ONTO LOCATION ON THE STAND AND THE REQ'D. MEASUREMENTS ARE TAKEN.
- ONCE THE ASS'Y IS TAKEN TO 1B4 AFTER MTF AND THE FILLER TUBES ARE REMOVED AND FLANGES PREP'D. THE ASS'Y CAN BE ADJUSTED MANUALLY, KNOWING Y_1 & Y_2 & Y_0 , TO POSITION THE ASS'Y RELATIVE TO THE GAGE SET-UP (WHICH IS THE SAME AS IN 1CB) AND NON-OPTICAL CHECKS WITH THE GAGE CAN BE MADE.

CONCLUSIONS:

- GAGE MUST BE MODIFIED TO CHECK LOCATIONS RELATIVE TO GEOMETRIC ϕ ; NOT TO ACTUAL BEAM TUBE FLANGE.
- GEOMETRIC ϕ AND BEAM TUBE ϕ ARE NOT NECESSARILY THE SAME.
- CHECKING ALIGNMENT OF CRYO PIPING & SHIELDS TO ACTUAL B.T. FLANGE O.D. DOES NOT REFLECT ACTUAL TUBE LOCATIONS
- REVISE 806 DWG. TO REFLECT THE GEOMETRIC ϕ OF THE MAGNET AND APPLY A POSITIONAL TOLERANCE TO THE B.T. ALSO.
- GAGE SUPPLIES ONLY A "GO-NOGO" RESPONSE AND DOES NOT SUPPLY THE AMOUNT THAT THE PIPE IS OUT-OF-TOLERANCE IN A NOGO SITUATION.
- OPTICAL SHOTS FOR ITEMS 1, 2, & 3 CANNOT BE ELIMINATED OR REVISED AT THIS POINT WITHOUT SERIOUSLY AFFECTING SCHEDULE.
- THE INITIAL GAGE SET UP WILL, HOWEVER, PROVIDE ACCURATE, REPEATABLE RESULTS ELIMINATING THE USE OF OPTICS IN FINAL MEASURE.
- BY FOLLOWING THIS PROCEDURE THE GAGE WILL BE USED IN A MANNER CONSISTENT WITH THOSE PARAMETERS USED IN TUNNEL INSTALLATION

* NOTE: THIS IS A BRIEF OVERVIEW AND SOME DETAILS MAY NEED TO BE ELABORATED ON TO PROPERLY DESCRIBE THE SCENARIO.

FOR MORE INFO, CONTACT

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