SNS DTL BPM pickup
Final Design Review

Los Alamos, September 19, 2001

by Michael Plum

Review Committee

- Mike Borden, LANL
- Andy Browman, LANL

Design Review Process

- **Evaluate design against design criteria and functional requirements**
- **Items to address**
  - Assumptions
  - Relevant calculations
  - Options considered
  - Interface requirements
  - Manufacturing/procurement plan
  - Actions taken from PDR to FDR
- **Consider committee's feedback**
- **Respond in writing to the committee's report**

Charge to committee

- **Review the design**
- **Categorize findings**
  - Critical (potential “show stoppers”)
  - Observations/recommendations
- **Consider key observations from audience participants**
- **Give us an outbrief**
- **Write a report**

Charge to committee (cont.)

- **Scope of the review**
  - Limited to DTL BPM pickup and how it is installed in the drift tube.
  - Also consider cabling inside the drift tube and the connectors used.
- **Portions covered by other reviews**
  - Cable plant from top of drift tube stem to electronics.
  - BPM pickups in other portions of the SNS facility.
  - BPM electronics and connections to the control system.
- **Key questions**
  - Are we at final design review status?
  - Have we adequately addressed issues and concerns from the PDR?
  - Are we ready to fabricate and install the DTL BPM pickups?

Agenda

- **Materials that will be presented**
  - Report from the preliminary design review.
  - Final set of drawings.
  - QA plan.
  - Cable and connector selection test results.

Results from the PDR

Committee Observation - DTL BPMs suffer the most mechanical constraints and demanding requirements. **Excellent progress** has been made since December and it appears that a **satisfactory design** has been achieved provided Kaman delivers parts as specified. The committee's concerns now center around **schedule** and **quality assurance** to guarantee delivery of BPMs that realize the performance promised by the design. Lifetime vacuum and electrical connection integrity are at risk.

Response: *Observation noted.*

Suggestion - Keep on top of **Kaman's progress** with the feedthroughs.

Response*: Contact with Kaman has been ongoing. The current status of our initial order is Kaman is awaiting piece parts from a supplier that are due 3/16/2001. If those parts arrive on time our scheduled delivery is 3/28/2001.*

Suggestion - Establish **fall-back plans** in case vacuum leaks develop in the feedthroughs either initially or after installation of BPMs in drift tubes.

Response: *The current fall-back plan is to remove the damaged drift tube assembly and cut out the leaking BPM and either replace it with a spare BPM or simply install a straight piece of tubing without the instrument. The drift tube is then replaced in the tank.*

Results from the PDR (cont.)

Committee Observation - DTL BPMs must go through numerous **brazing and welding steps** during fabrication and assembly into drift tube.

Response: *Observation noted.*

Suggestion - Establish a **written vacuum integrity quality assurance plan** to be followed during BPM fabrication. This could be as straightforward as a list of tests to be performed and qualifications to be met at appropriate stages of fabrication. It should include vacuum leak tests to assure that cable connection to the right angle feedthrough does not ruin the vacuum integrity of the feedthrough.

Response*: Specifications for cleaning, handling, shipping, inspecting, and leak checking have been incorporated into the Statements of Work for the machining, brazing, and welding operations the BPM's will go through.*

Committee Observation - DTL BPM feedthroughs and cables are **captured and inaccessible** for repair after drift tube assembly. It is crucial to assure **electrical integrity** during drift tube assembly, storage, installation into DTL tank, and for long term operation. There will be stages in the life of these BPMs that the electrical cables and connections will not be in the loving care of the diagnostics engineer. Design features and quality tests must be in place to guarantee electrical integrity.

Response: *Observation noted.*

Results from the PDR (cont.)

Suggestion - Incorporate **design features** to minimize vibration of the buried SMA connections and protect exposed cables and connectors during handling, storage, and operation.

Response: *Current plans include providing strain relief for the cables as they exit the drift tube stem. Connections inside the drift tube will be made using some type of thread locking system (yet to be identified) to maintain electrical contact between the cable and feed through.*

Suggestion - Establish **written electrical integrity quality assurance plan** for DTL BPM cabling and feedthrough components. This plan should include electrical tests, inspections to be performed, and qualifications to be met at appropriate stages of fabrication and assembly. Cable assembly tests, before installation, might include electrical resistance measurements of center conductor and shield under vibration conditions at a moderate current levels (you're looking for milliohms!), a 'hipot' up to the voltage rating of the cable to assure no soft shorts at connectors, and a TDR or swept frequency network analyzer measurement. A sensitive cable resistance measurement setup is easily constructed that will permit monitoring cable voltage drop on an oscilloscope while cable is wiggled and vibrated. Sufficient test current turns milliohms into millivolts without an amplifier. Similar resistance measurements and TDR/swept frequency tests should be performed just before drift tube is welded closed and again just before drift tube installation into DTL tank.

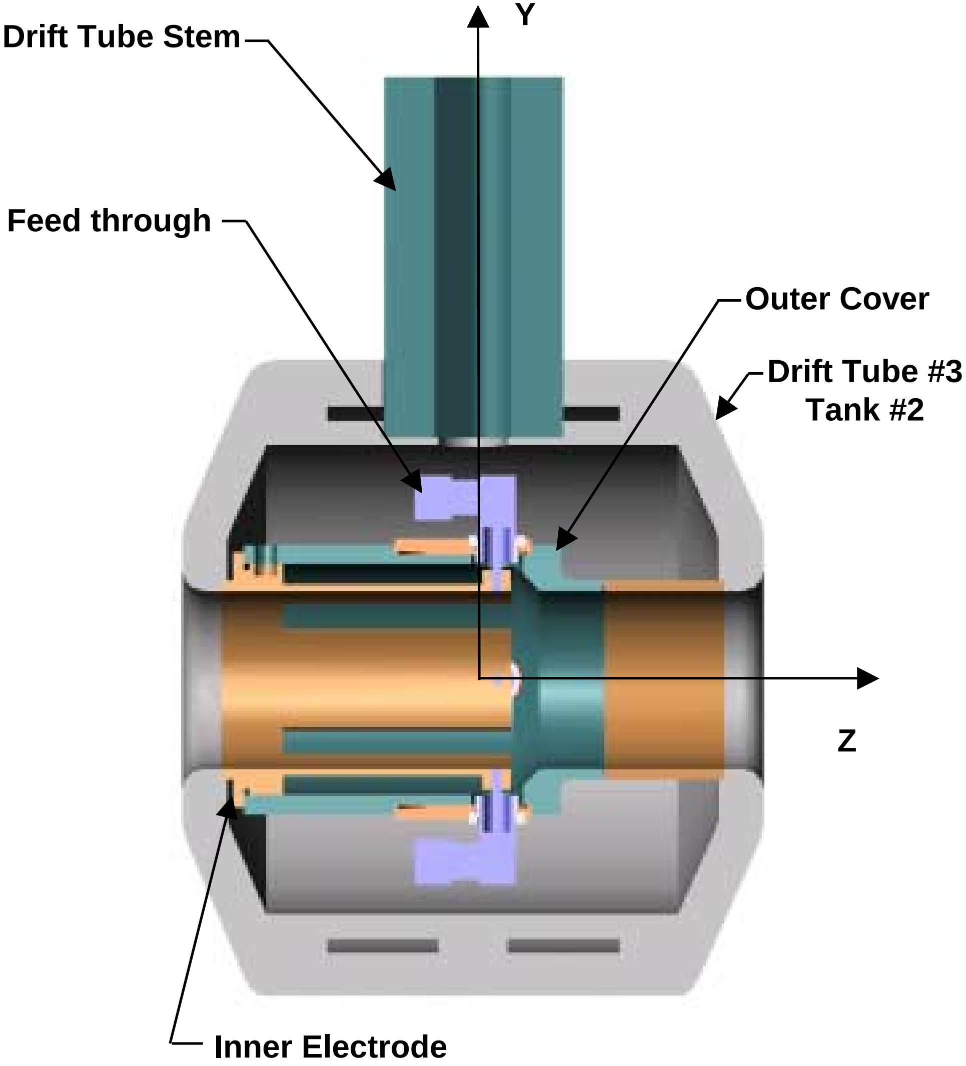
Response: *An electrical integrity quality assurance plan will be written*

Suggestion - In general, for all BPM pickups and before fabrication begins, prepare a set of **QC** steps to be taken throughout the fabrication process to assure required properties including vacuum integrity, electrical integrity, cleanliness, ability to withstand bake-out, etc. as appropriate for each fabrication.

Response: *Since the fabrication of the BPMs will be done by vendors, the statements of work will detail the quality assurance steps required for dimensional inspection, cleanliness, handling, and vacuum integrity. LANL personnel will be conducting the electrical integrity testing according to the plan to be developed (discussed above).*

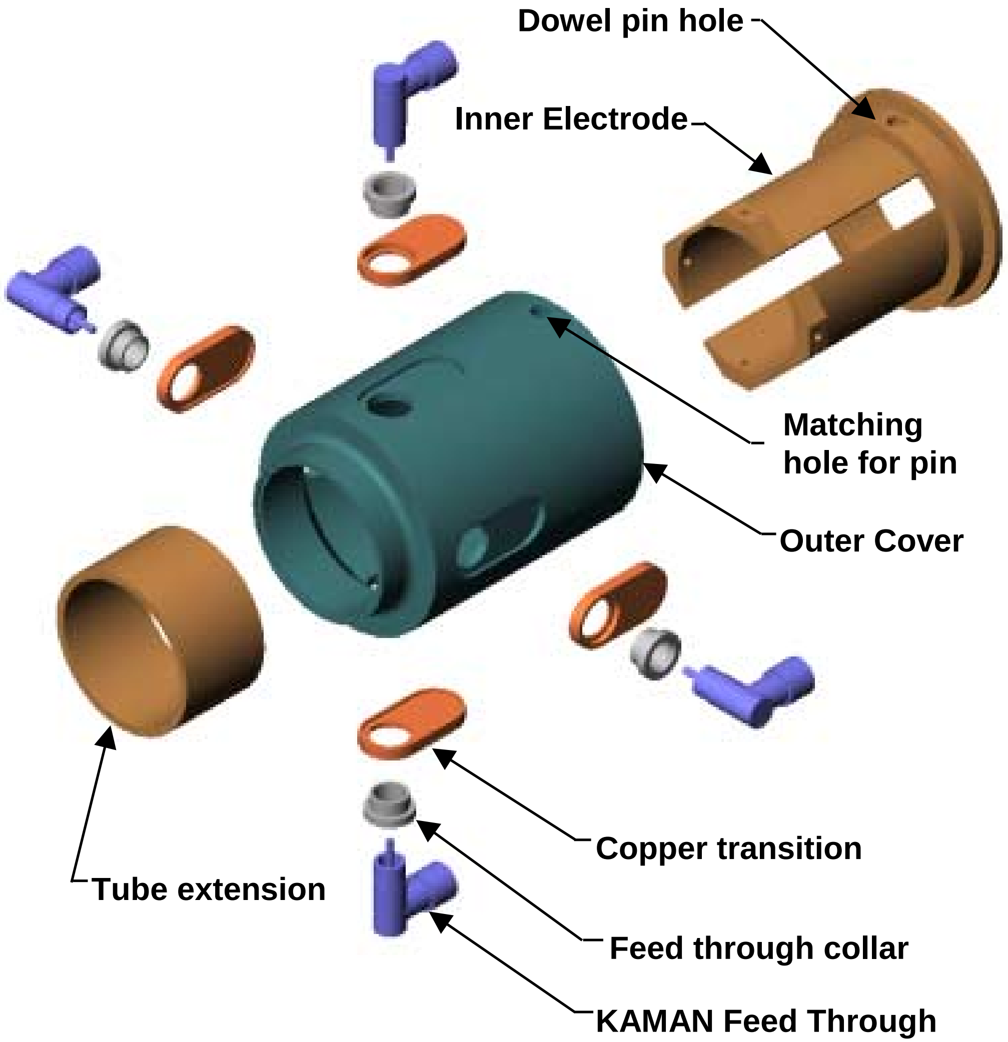
DTL Beam Position Monitor

- **Beam line instrument consists of outer cover and inner electrode parts.**
- **Inner part has four, 60° included angle, strip-line electrodes, shorted at one end.**
- **Electrodes flush with drift tube ID.**
- **Geometry is optimized to form 50-Ω impedance transmission line.**
- **Signals from electrodes are taken through the outer cover via the feed through.**
- **Coaxial cable threads onto the feed through and is fed out through the center of the drift tube stem.**
- **SMA vacuum feed through is used to provide vacuum seal (Al_2O_3 strengthened boro-silicate seal).**



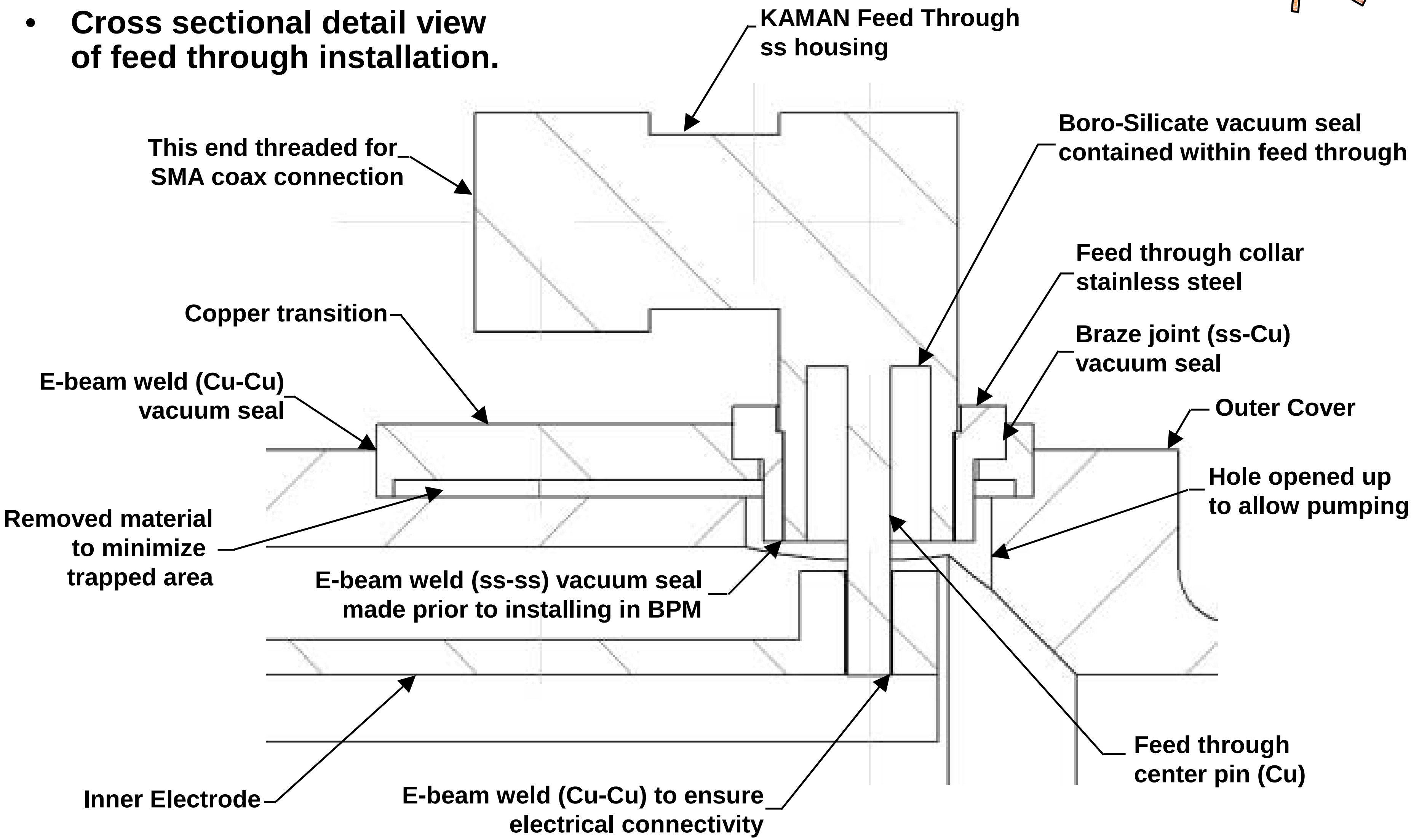
DTL BPM Fabrication and Assembly

- BPM outer cover and inner electrode parts are brazed together.Dowel pins are used to correctly clock the two parts.
- The feed through cannot withstand brazing temperatures, limit is 300 C.
- Stainless collars are brazed to copper transition pieces.
- Feed through is e-beam welded to that combined ss collar and Cu transition.
- Feed though sub-assembly is welded into BPM cover.
- Electrical contact is ensured by e-beam welding feed through center pin to electrode (Cu-Cu).
- Tube extension is welded last, this allows access for e-beam of feed through center pin.



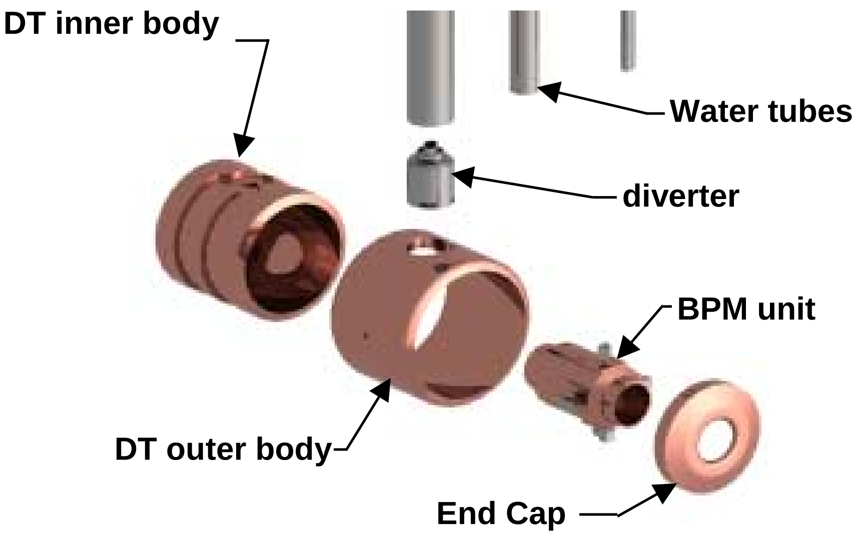
DTL BPM Feed Through Installation

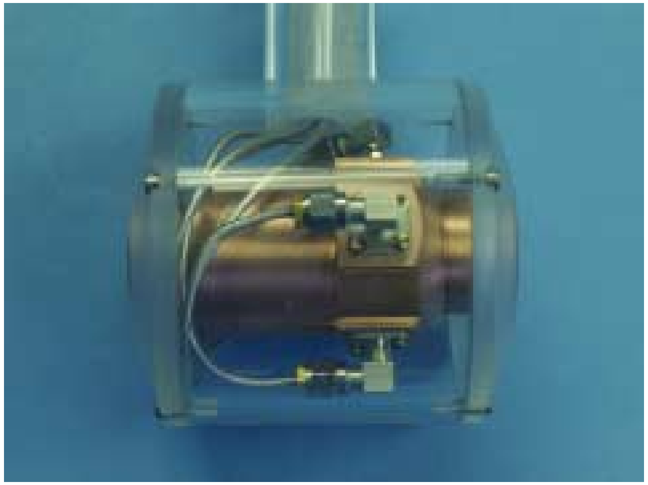
- Cross sectional detail view of feed through installation.



DTL BPM Fabrication and Assembly

- BPM unit will be delivered to Drift Tube fabricator for installation in DT.
- Signal cables will be threaded through the center of the Drift Tube stem and connected to feed throughs.
- It will be necessary to leave one end of the cable un-terminated so that it will fit through the stem.
- Cable will be labeled and checked by LANL personnel prior to final welding on of the end caps.
- Once the cable is in place it's end will be terminated.
- Thread lock will be used on the SMA connections.
- Cables will need to be secured while drift tube undergoes final machining of the faces.

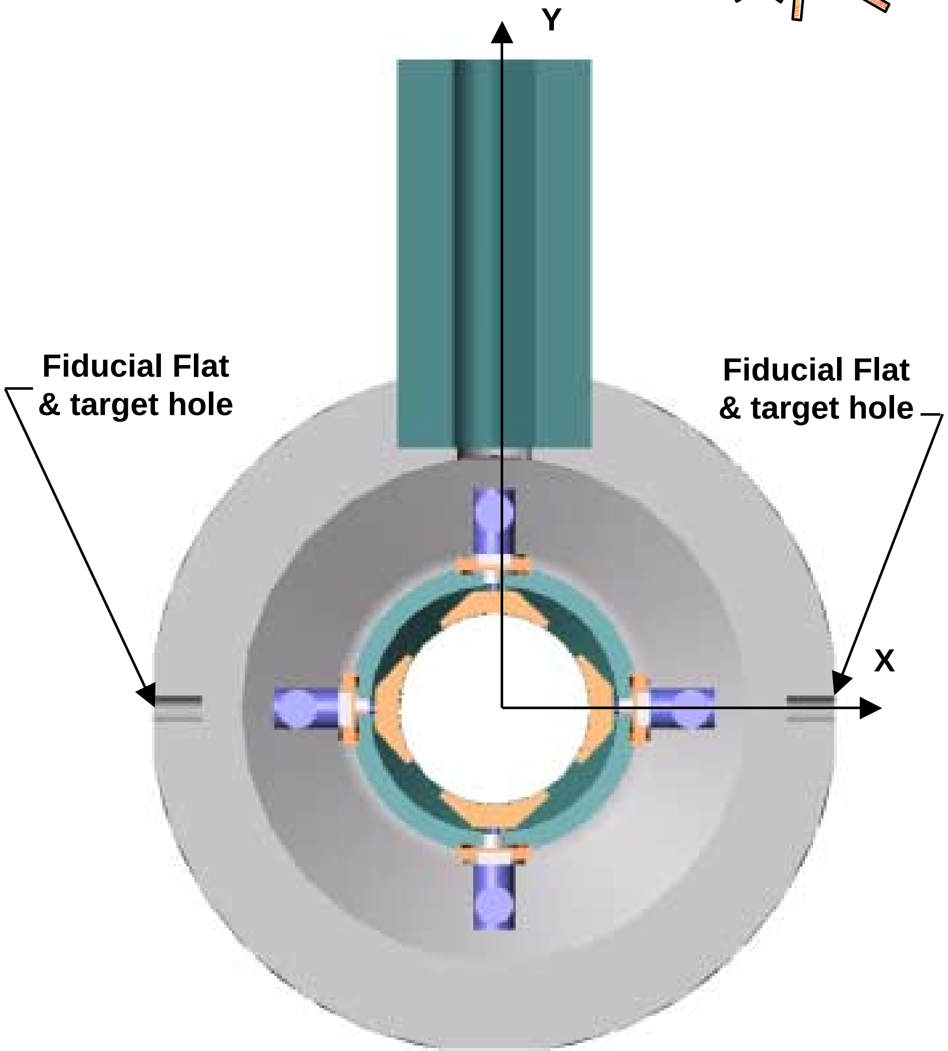




Coax cables inside mock-up drift tube

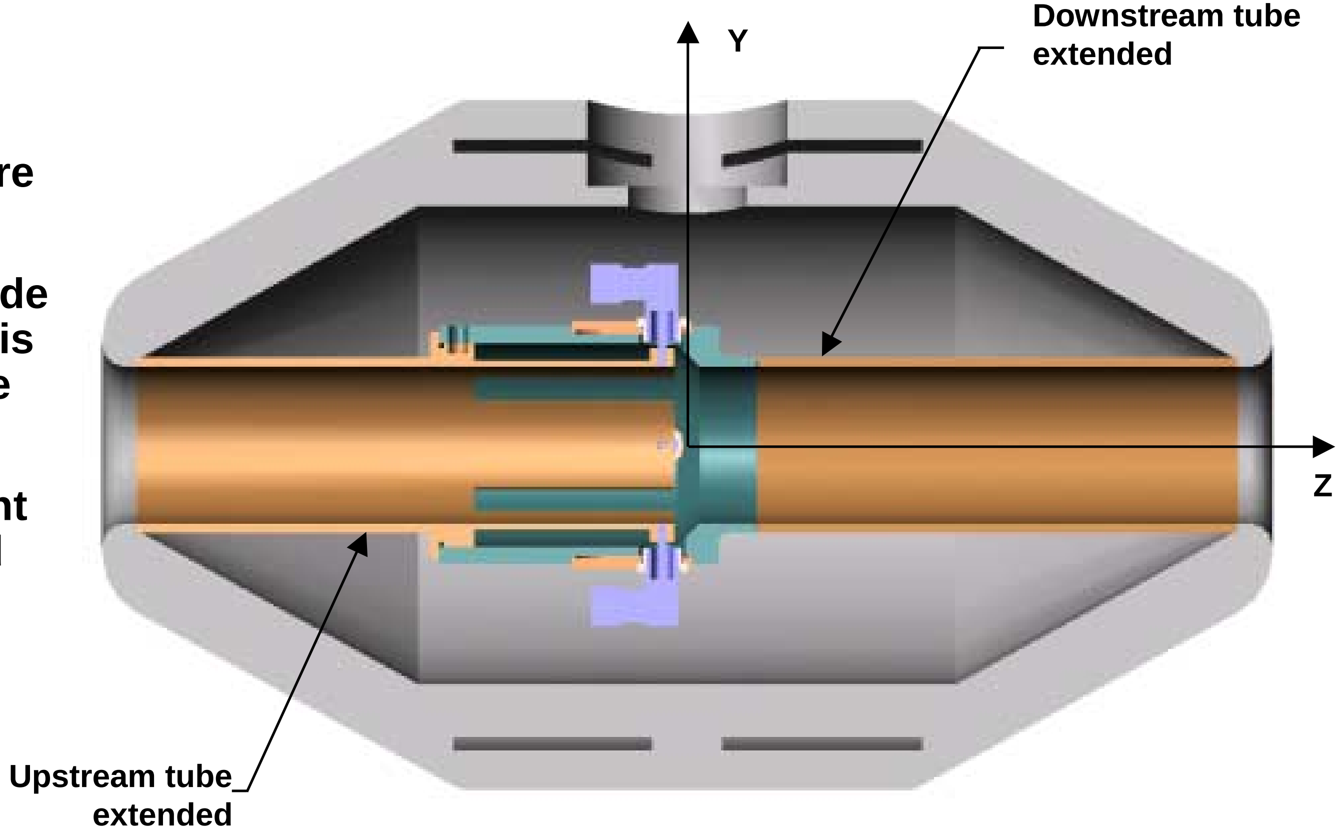
DTL BPM Alignment

- The drift tube/BPM assembly will be mapped (taut wire measurement) with reference to the fiducial features in the laboratory.
- Alignment of the drift tube/BPM assembly will be accomplished by using the two fiducial holes in the side of the drift tube.
- It will be necessary to insure the BPM is clocked in the drift tube so that the fiducial holes line up with the horizontal electrodes.
- There will be a pin in the drift tube end cap and a groove in the BPM body, so that as the two parts go together roll will be controlled.



DTL BPM In Larger Drift Tubes

- The functional dimensions of the BPM will not change as it is used in larger drift tubes.
- The upstream and downstream tubes are just extended.
- Gap between electrode end and cover taper is centered in Drift tube (except in tank #2).
- Minimizes the amount of signal contributed from RF fields.



BPM Shown in tank #6, Drift tube #9
Largest configuration