LAr TPC Wire Experiments

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Short Wire Experiments

1.) Feasibility and Accuracy of Determining Tension Via Frequency.

2.) Tension verses Displacement Experiments.

3.) Liquid Nitrogen Cool Down Experiments.

Motivation

- To begin to understand the mechanical and technical challenges of tensioning and stringing 4 mil wires and their survivability during the cool down phase of the experiment.

1. Feasibility and Accuracy of Determining Tension Via Measuring Frequency.

- From Classical Mechanics,

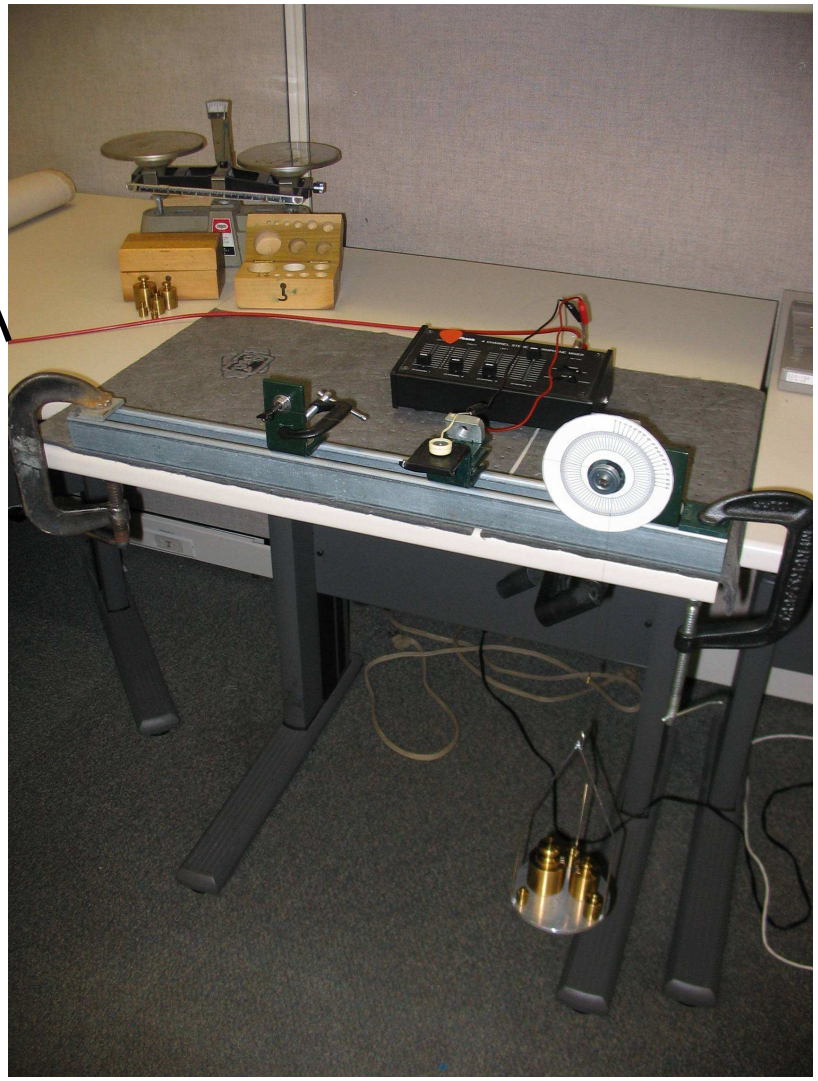
$$f_n = \frac{1}{d \cdot L}\sqrt{\frac{T}{\rho \cdot \pi}}$$

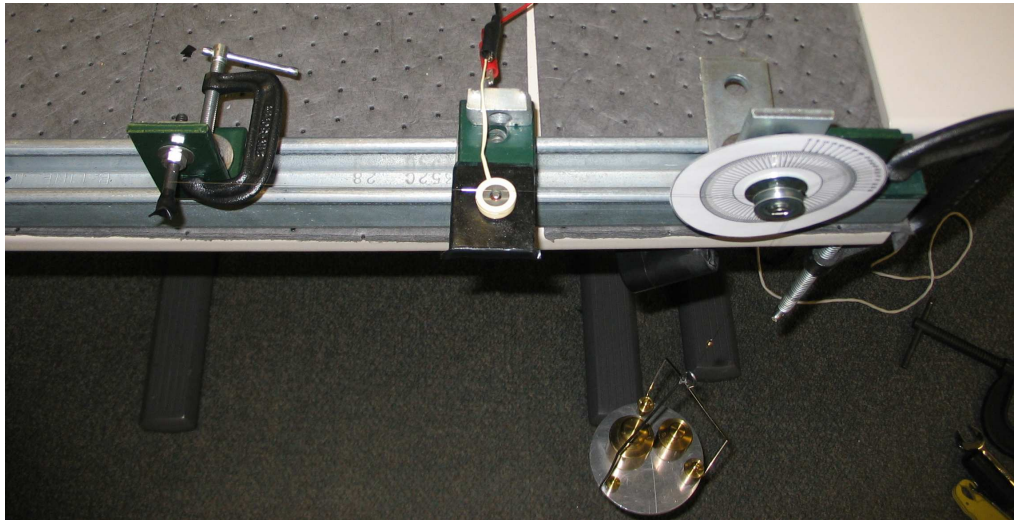
- Where the actual diameter of the wire was measured to be 3.85 mils.
- For increased accuracy Poissons ratio with theoretical displacement in length is used to find deflection in diameter.

$$\delta_l = \frac{PL}{AE}, \nu = \frac{\varepsilon_d}{\varepsilon_l} = 0.3$$

Test Setup

To Computer





Results

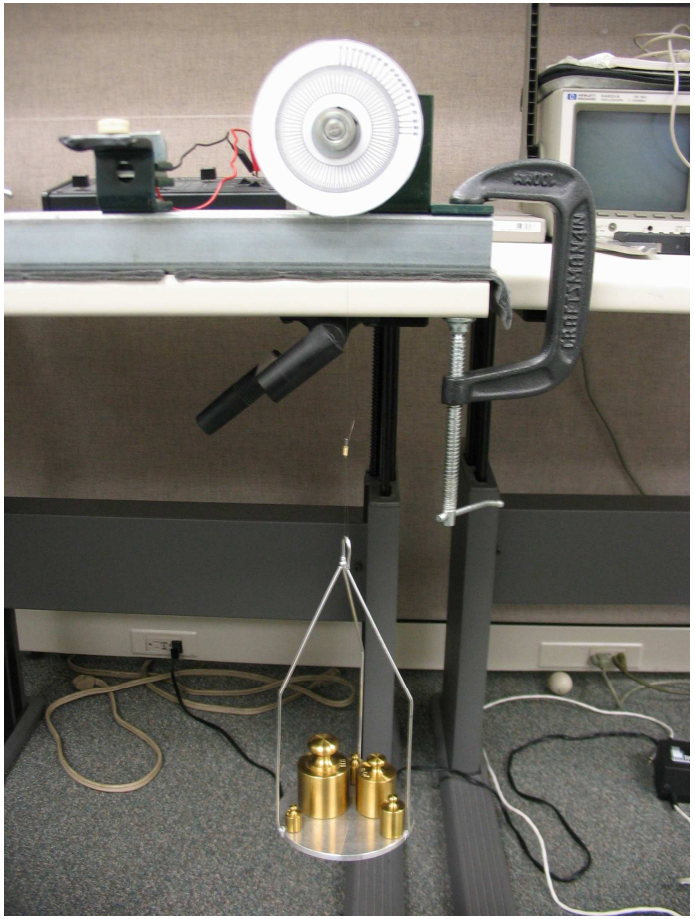
- Average Experimental Error: 0.13 %
- Experimental Error - elastic region: 0.12 %
- Experimental Error - inelastic region: 0.14%

Conclusion

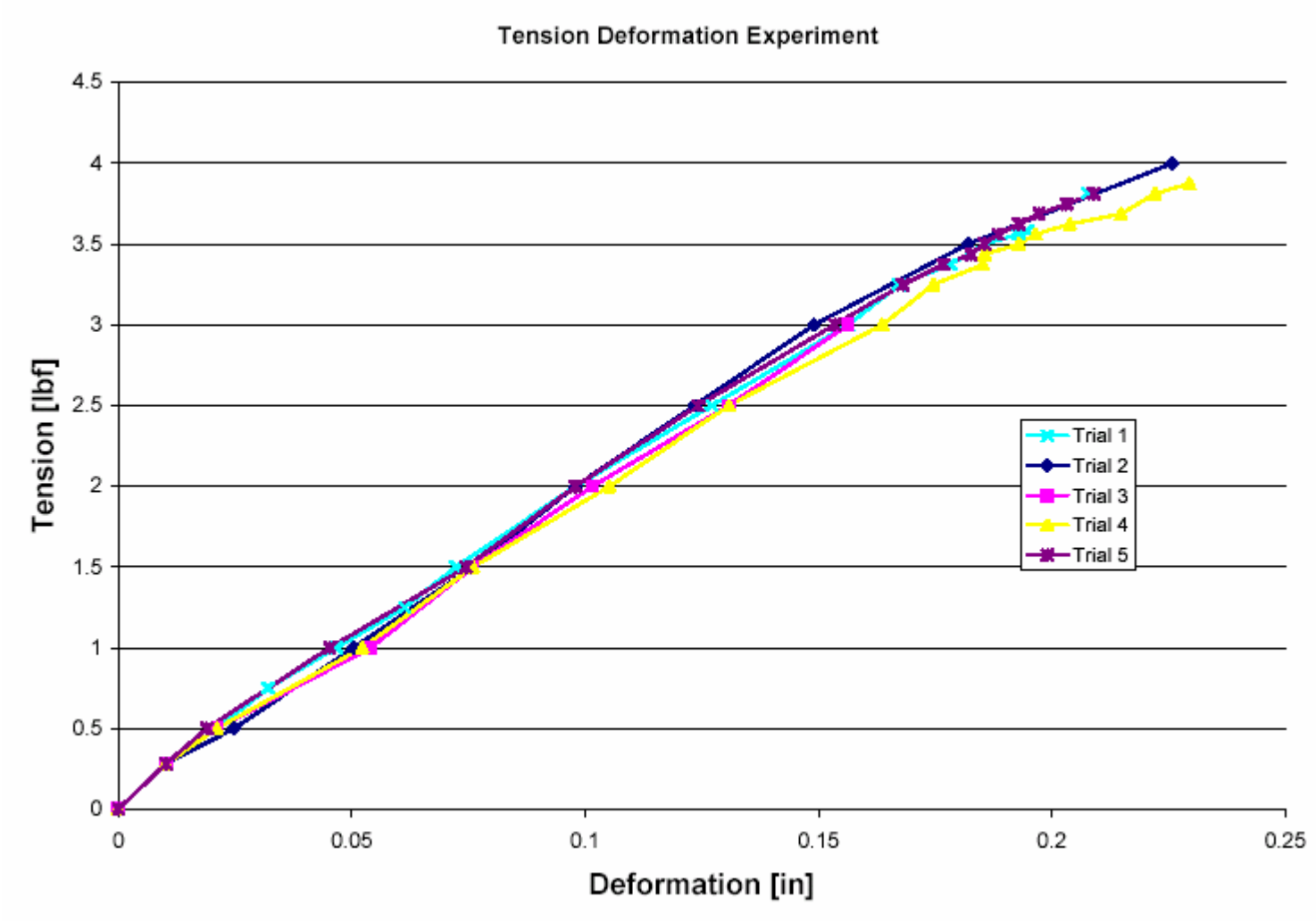
- Tension can be accurately predicted by measuring the frequency of vibration.
- Predictions in the inelastic region have little effect on accuracy since change in Young's modulus is small.

2. Tension versus Displacement Experiments

- To verify the specified yield point, T = 3.5 lbf.
- By measuring the amount the wheel rotates after each increment of mass.
- Angle of rotation is directly converted to deformation in wire.



Results

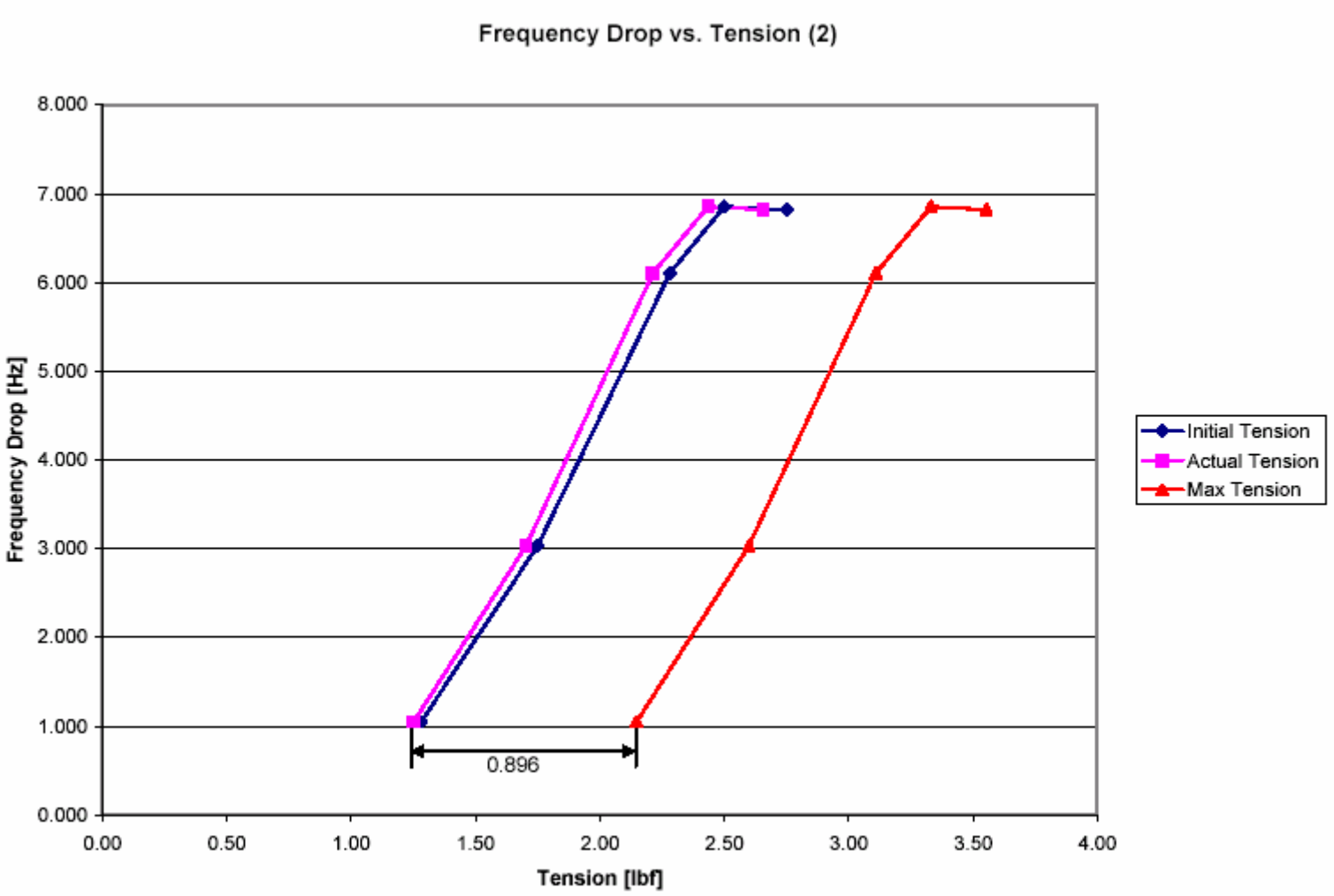


*A Small change in Young's Modulus visible at T = 3.5 lbf (yield point).

3. Liquid Nitrogen Cool-Down Experiments.

- The increase of tension in the wires due to thermally contracting faster then the support vessel may cause the wires to yield or break.
- Theoretical increase in tension during cool down: 0.896 lbf.
- Yield point, 3.5 lbf
- Break point, 4 lbf

Results


Frequency Drop vs. Tension (2)
Frequency Drop [Hz]
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.00
0.50
1.00
1.50
2.00
2.50
3.00
3.50
4.00
Tension [lbf]
0.896
Initial Tension
Actual Tension
Max Tension

Results cont.

- Wire snapped during cool down when initially tensioned at 2.86 lbf with a corresponding maximum tension of 3.756 lbf.

- Tension loss when fixing the ends,
  (6 – 20 Hz) or (0.03 – 0.14 lbf).

- Tension loss from cool down,
  (1 – 7 Hz) or (0.005 – 0.05 lbf).

Conclusion

- The change in slope may be due to going beyond the yield point - more data in this region should be taken.
- It is believed that the stress concentrations at the ends, is the main cause for the tension drop during cool down.
- A larger tension drop occurred from fixing ends then from cool down
- The same experiment should be conducted with other methods of fixing the wires.

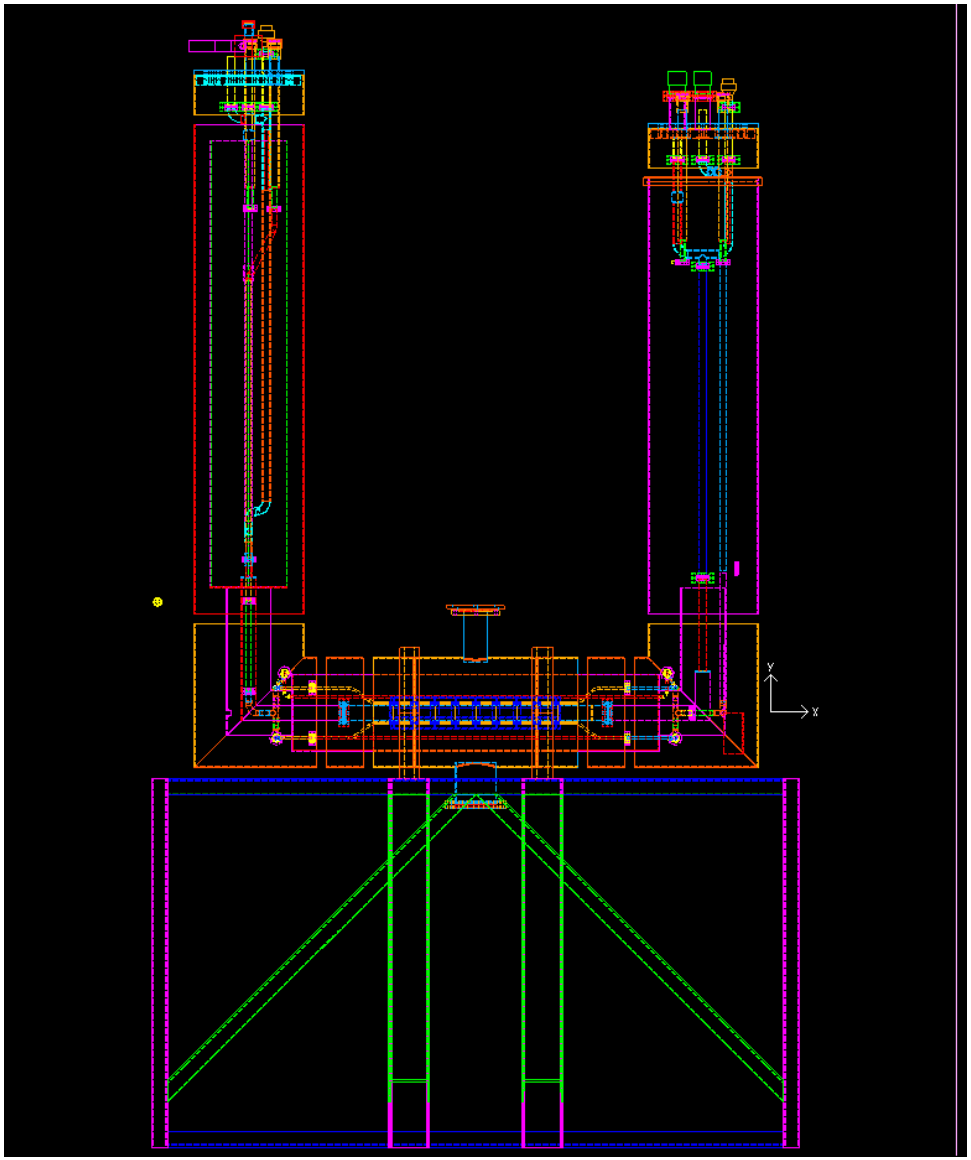
Cryostat for Long Wire Tests

- Requirements
- Conceptual Design
- Future Work

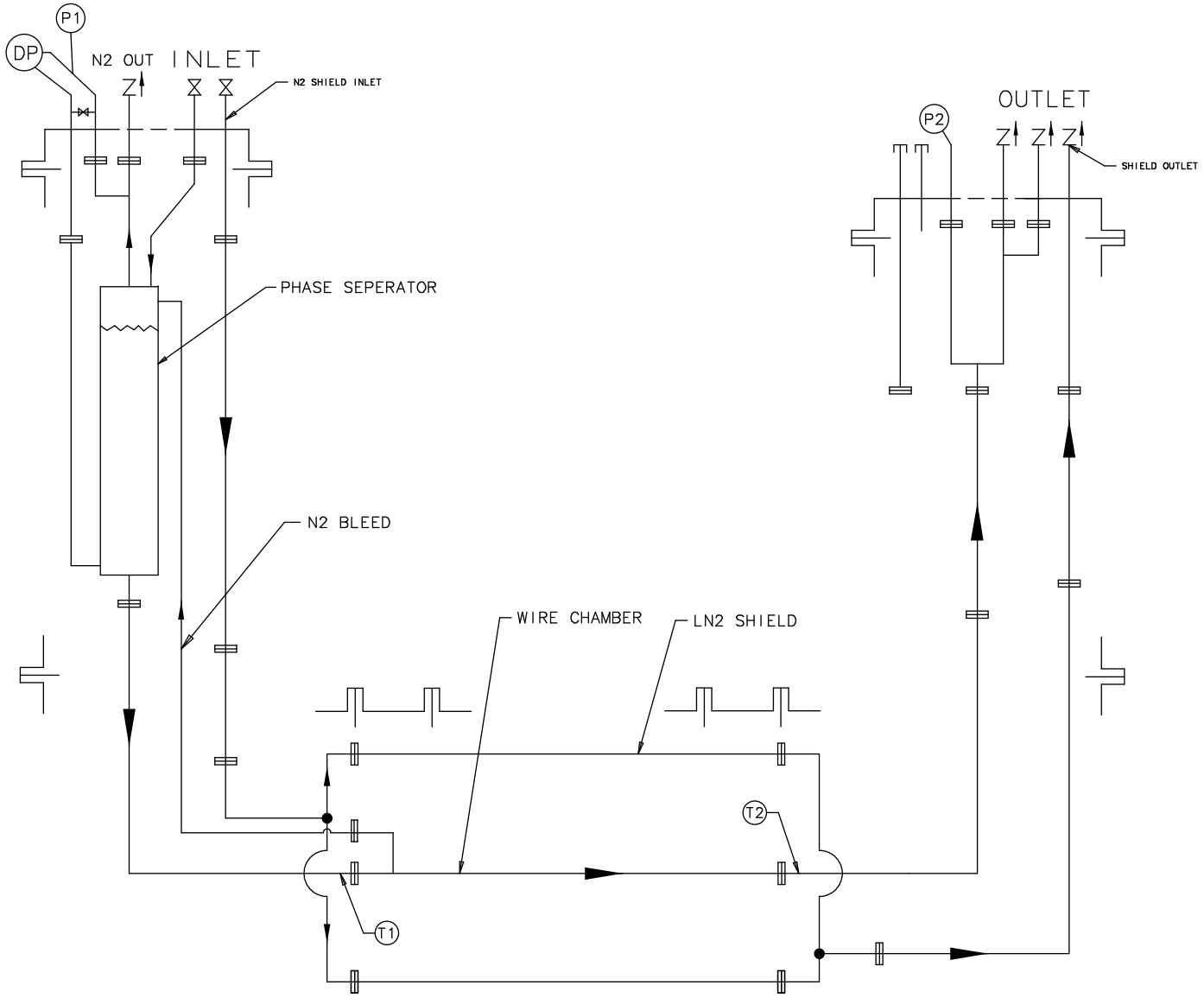
Requirements Goals

- Provide a near perfect liquid cryogenic environment for a matrix of 50 wires starting at 10 ft in length.
- Modifiable to accommodate wire lengths approaching 100 ft.
- Wire chamber easily accessible for repairs and adjustments.
- The option to create a less stable cryogenic environment.
- Use existing material and parts wherever possible.

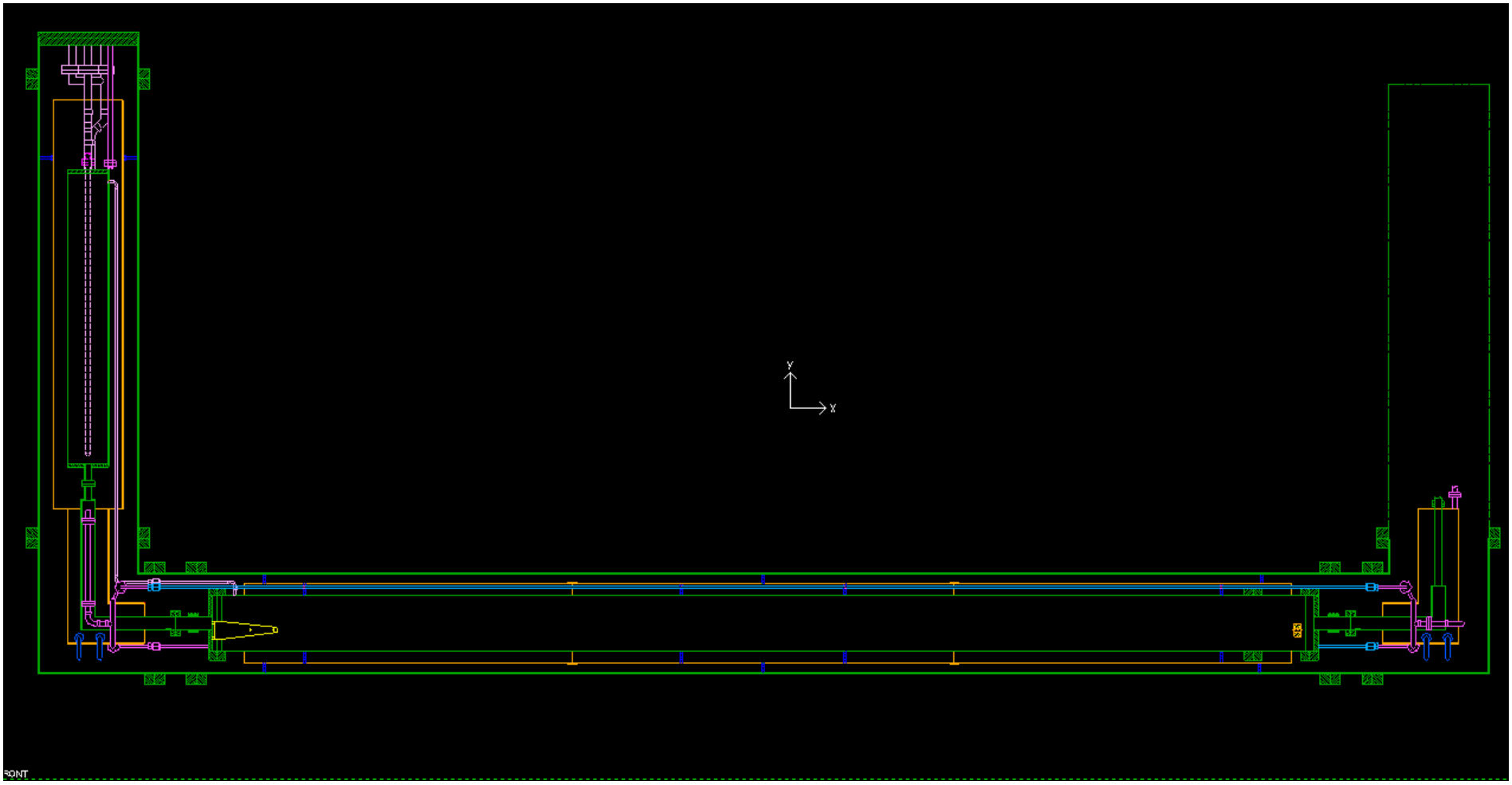
Original Assembly



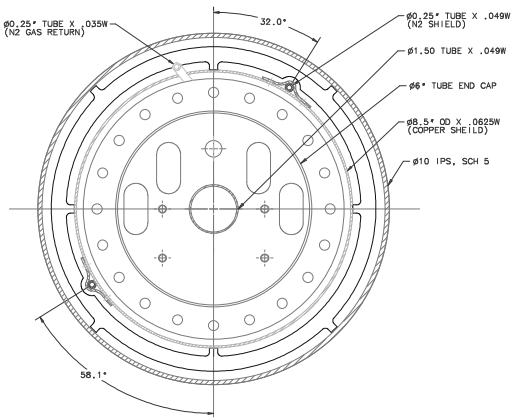
Flow Schematic



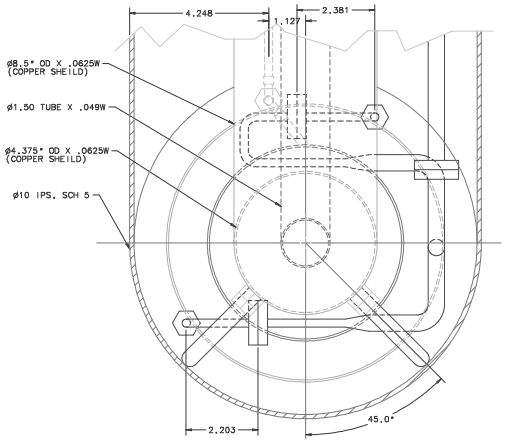
Cryostat Assembly



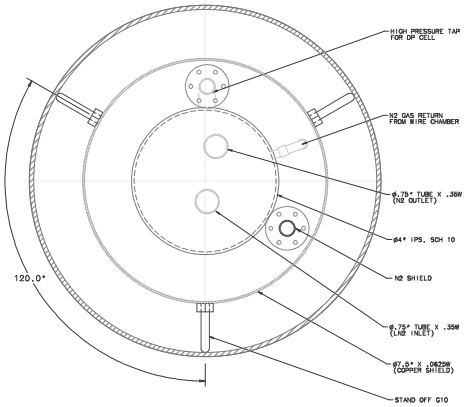
REV	DESCRIPTION	DRAWN / DATE APPROVED / DATE



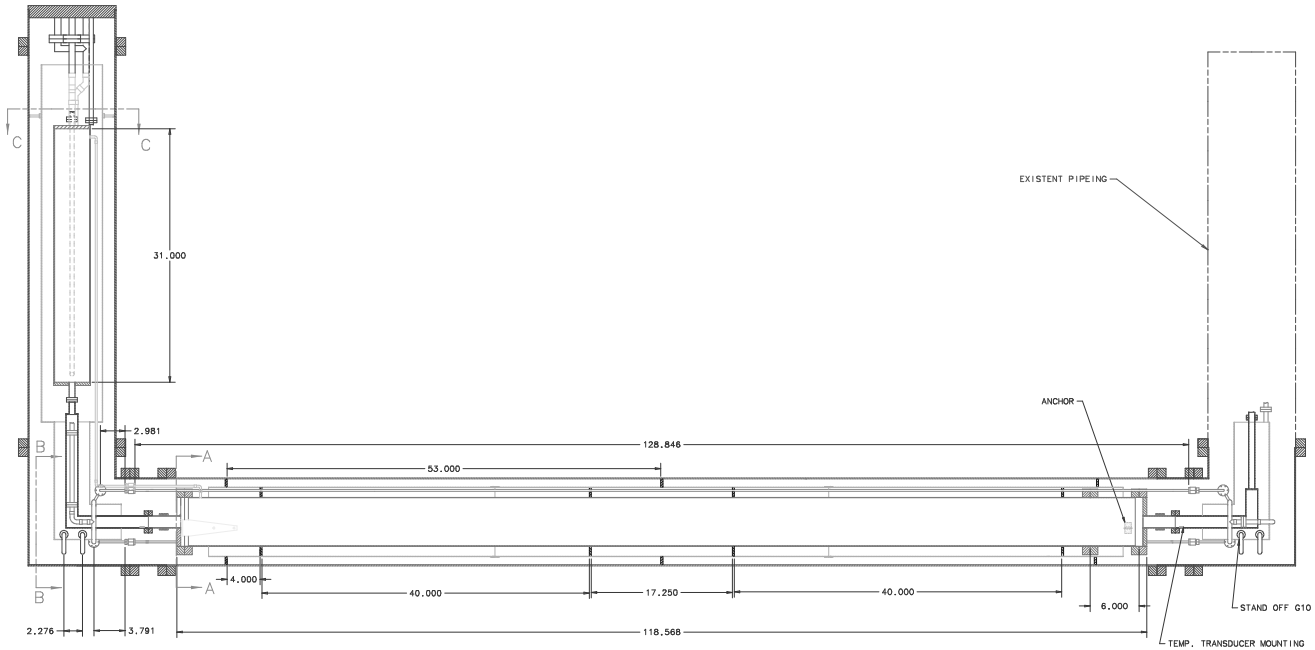
SECTION A-A



SECTION B-B



SECTION C-C



ITEM	PART NO.	DESCRIPTION OR SIZE	QTY

BILL OF MATERIAL

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	?	00/00/01
.XX	.XXX	ANGLES	DRAWN	?	00/00/01
± .02	± .005	± .5°	CHECKED		
			APPROVED		

1. BREAK ALL SHARP EDGES 1/64 MAX.
2. DO NOT SCALE DRAWING.
3. DIMENSIONS BASED UPON ANSI Y14.5M-1994
4. MAX ALL MACH SURFACES 125

USED ON: 1650-M- ITEM

MATERIAL: SEE BILL OF MATERIAL

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

BEAMS CRYOGENIC SYSTEMS
FLARE WIRE CHAMBER ASSEMBLY

SCALE	FILMED	DRAWING NUMBER	REV
FULL		1650-ME-XXXXXX	

CREATED WITH I-DEAS 8m2

Cryostat Characteristics

- Utilizes a phase separator and nitrogen shielding to insure that the wires are always fully emerged in a stable cryogenic environment.
- The nitrogen shield can be turned off to test the effect of a noisier cryogenic environment.
- Rotatable Flanges allow to test various wire orientations.
- Flange positions allow for easy access to wire chamber.
- Modifiable to accommodate longer wire lengths.
- All piping diameters are less then or equal to 6".
- Made mostly of existing parts and available materials thereby minimizing cost.

Future Work

- Heat Leak and Relief Calculations
- Parts List and Detailed Drawings
- Data Acquisition, Transducers and Electrical Setup
- Fabrication

Thank You