

Use of Aluminum Wire for the Liquid Argon TPC Wire Planes

Version 2 includes data on Cu98/ Be 2 wire, as supplied by Doug Jensen. Results are included in the spread sheet and summarized below. I have also increased the wire length to 40 m, which is appropriate for a 50 kTonne LArTPC, as suggested by Doug

In response to Dan Edmund's realization of the large noise contribution from the TPC wire resistance, I am looking here at using a high strength aluminum alloy for the wires.

Several advantages accrue by this choice of materials:

- the specific resistance of this materials is 10x lower than that of SS304
- The sagitta is reasonable due to the low density of the material
- The buoyancy in Lar reduces the sagitta another factor of two
- For the same wire tension, the lower density results in a larger diameter wire, hence lower resistance.

The attached Excel sheet makes a comparison with Aluminum alloy 7075 , SS304, which I tweaked by using the Sandvik yield stress data, and Be-Cu alloy.

To get specific comparisons I used the following data as input:

Wire length 40m

Wire angle 30 degrees from vertical

Wire force 5.35 N (1.2#)

Wire stress when warm 15% of yield stress

This is an active spread sheet, and users can change all inputs to explore other scenarios.

Results are:

Item	SS304	Al alloy 7075	Cu98/Be 2 Alloy
Wire diameter	0.176 mm	0.3 mm	0.225 mm
Wire resistance	1170 Ohm	29.4 Ohm	85.3 Ohm
Wire sagitta, warm	37.6 mm	38.1 mm	60.3 mm
Wire sagitta in Lar	9.0 mm	5.5 mm	14.3
Stress fraction cold	52%	50%	40 %

While aluminum looks like the best material under the assumptions made, it is also, of course, a more difficult material to work with than the other two. More R&D will be required to tame it.

The next step will be to measure CTE integral and resistivity on Al wire (I hope to get some from Karen) and to do a better web search for Al alloys and to get some “real” wire for further tests.

Items that need more work include how to make electrical and mechanical end connection and possible corrosion effects.