

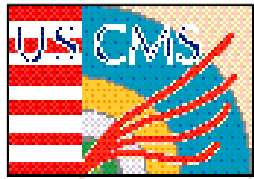
MIRROR-FINISH? STAINLESS STEEL TUBES FOR GAS CHERENKOV CALORIMETRY

Virgil Barnes

Purdue University

With Alvin Laasanen and Matthew Barrett

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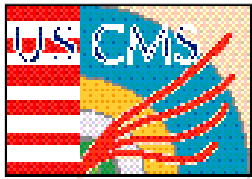


REFLECTIVE TUBES FOR GAS CHERENKOV



OUTLINE

- Overview
- Description of the tubes
- Preliminary measurements of light transmission
- Prospects for improvement

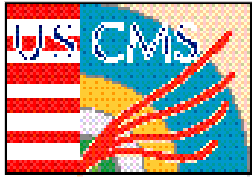


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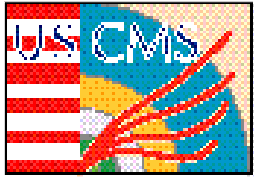
OVERVIEW

- We seek totally Rad Hard (therefore metal) tubes with sufficient internal reflectivity to guide gas Cherenkov light from one end of a 1m- to 2m-long Very Forward Calorimeter to a photodetector some distance from the other end of the calorimeter, with acceptable attenuation.
- Assume that the tubes will be straight when inside the matrix, but will be significantly curved between the matrix and the photodetectors.
- We want the tube interiors to be resistant to surface contamination from radiation-induced polymerization of organic gasses; or at least be fairly easily cleanable in situ.



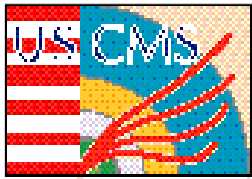
DESCRIPTION OF THE TUBES

- Smooth interior stainless steel hypodermic tubing, needle grade, fully hardened. Two passes of “plug drawing” smooth the interior [the usual customers do chromatography, or handle blood and want a non-stick and low-drag surface.]
- There is said to be a very thin residue of TFE lubricant on the interior surfaces.
- The present samples are NOT bright or mirror finish, but are said to be as smooth as possible from this tube mill.
- Presently available smooth interior samples (5' lengths only):
 - 13 ga, 0.095” OD, 0.073” ID
 - 14 ga, 0.083” OD, 0.064” ID



Measurements of Light Transmission

- A bright red narrow-angle LED is securely mounted to a 5" collimating section of the 14 ga tubing. A photodiode is securely mounted to a short section of the 13 ga tubing and its output voltage is read using a hand-held Fluke DVM.
- We have two pieces of each size of the tubing, about 5' long. They are coupled to the emitter and detector using short sleeves of 11ga or 12 ga tubing for alignment.
- It was discovered early that there is significant extra light loss at a coupling point if the ends of the tubes are not cut exactly squarely.

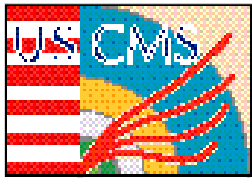


Measurements of Light Transmission

(Some care was taken to keep tubes straight.)

No tube (emitter tube coupled to detector tube)		135 mV
14ga tube A	10.4 mV	7.7%
14ga tube B	27.8 mV	20%
13ga tube C	59.8 mV	44%
13ga tube D	58.8 mV	44%
A + B	3.4 mV	2.5%
Repeat	3.2 mV	2.4%
B + A	3.7 mV	2.7%
C + D	22.7 mV	17%
D + C	28.8 mV	21%

The thinner tubes act somewhat inconsistently, and are surprisingly worse than the thicker tubes. The thicker tubes seem to attenuate the light in an orderly multiplicative fashion. $0.44^2 = 0.19$



Measurements of Light Transmission

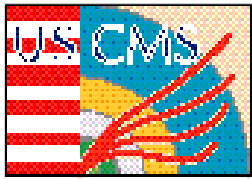
Force the tubes into roughly circular arcs. Estimate bending radius as $R \approx L^2/2d$ where d is the deviation of one end from a line tangent to the other end of the tube.

One 13ga tube. This is a typical set of results:

R	Response (mV)	Total attenuation (%)
∞	57.4	42.5
1000"	48.2	36
500"	35.3	26
250"	25.1	18.6
132"	12.5	9.3
100"	8.6	6.4
80"	4.8	3.6
66"	2.9	2.1

Comment: These are not very tight bends, and yet the attenuation is both excessive and also varies rather sharply with bend radius.

It is not clear to me how closely the LED light mimics the angular distribution expected for the Cherenkov light, and how much this matters.

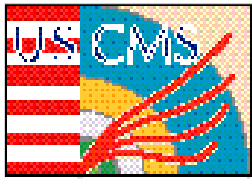


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WHAT'S NEXT?

- These tubes are about as bright as the mill can make. The good news is that they or their clients often use a nearby polishing company.
- I am initiating an order for K-tube Co. to send another sample batch (two smooth 13ga and two smooth 14 ga tubes) to L. A. Micro Polishing Co. to have the interiors chemically polished. The teflon residue is said to be easily removable chemically before polishing. L. A. Micro will polish these samples for free.
- We hope to measure the attenuations of these tubes in January.
- L. A. Micro offers an alternative polishing method, “extrusion honing”, where a diamond-grit-loaded putty is repeatedly forced back and forth through the tubes. Alvin Laasanen will explore having L. A. Micro extrusion-hone a sample batch of four larger tubes --- 11ga and 12ga (which are only available in interior rough mill-finish, unless I request a plug-draw special run, with an expensive minimum order of at least 500 feet at \$1.70 or \$1.76 per foot.)



WHAT'S NEXT? (contd.)

- We hope to be able to test the larger polished tubes also in January.
- The claim is that K-tube's smooth interior is "RA 28 to 30 finish" while the chemical polishing gives "RA 10 to 12" (not sure what was said about the extrusion honing). I was told that the notation refers to the "reflection attenuation" in percent (of light removed, on one bounce. Not clear if that's only for normal incidence or applies also to grazing reflection.) This may mean that we can hope for attenuation lengths ~ 2.6 times longer. Remains to be seen.
- Stay tuned for direct measurements on actual tubes, as before.