

Using Beta range to determine thickness of MICE production Al windows

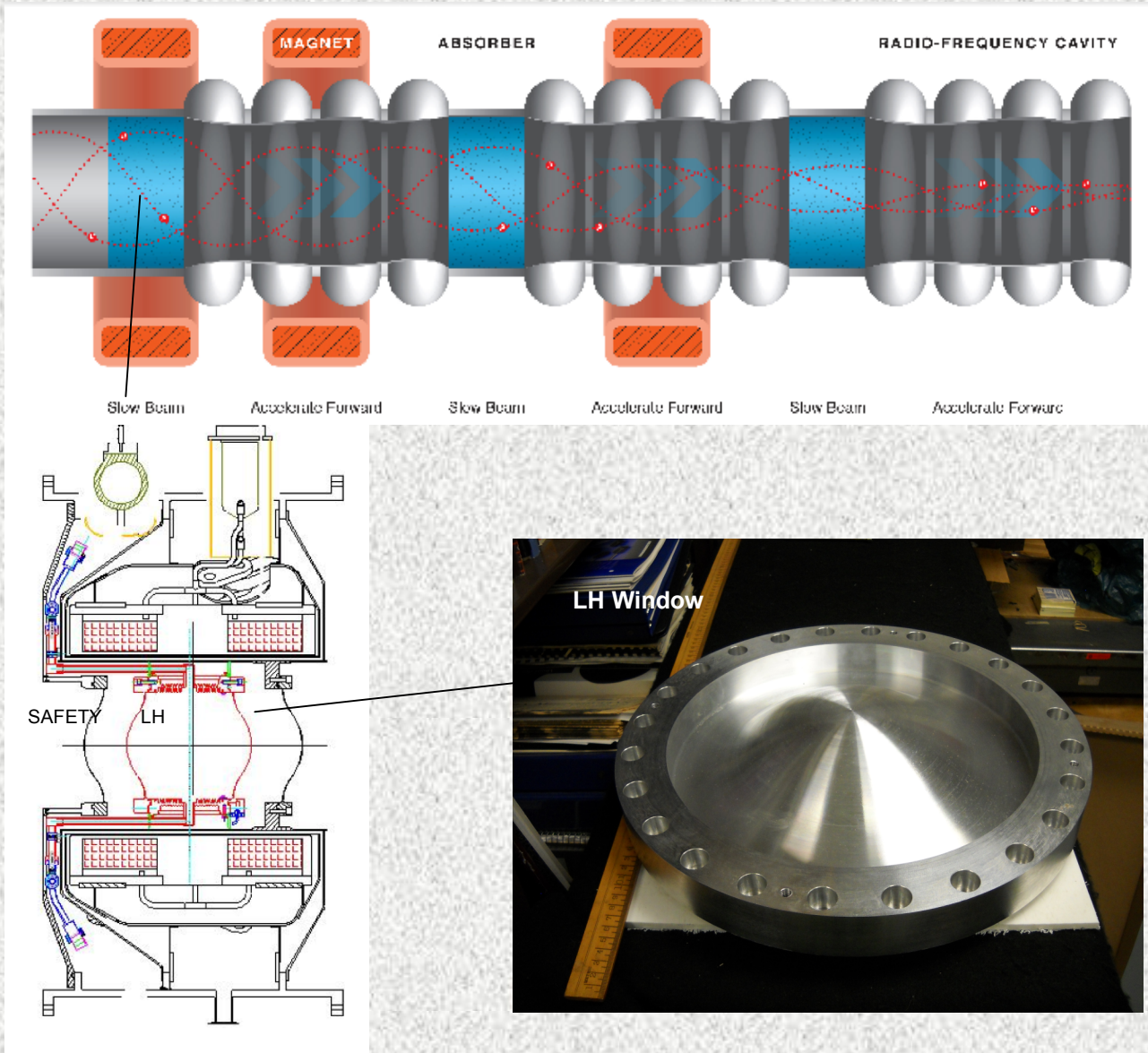
Neetish Pradhan*, Lucien Cremaldi, Don Summers, Tianhuan Luo, Terry Hart, David Sanders
University of Mississippi

Abstact

- Low energy betas range out in modest thicknesses of Al. We can use the fact to measure the nominal thickness of the LH2 & safety windows being produced for the MICE experiment.
- These thin 180 μm windows are used in the MICE hydrogen absorbers.
- This nondestructive measurement is used for QA before shipping windows to Berkeley for final QC.



MICE Ionization Cooling Channel w RF (grey) LH2 absorbers (blue)



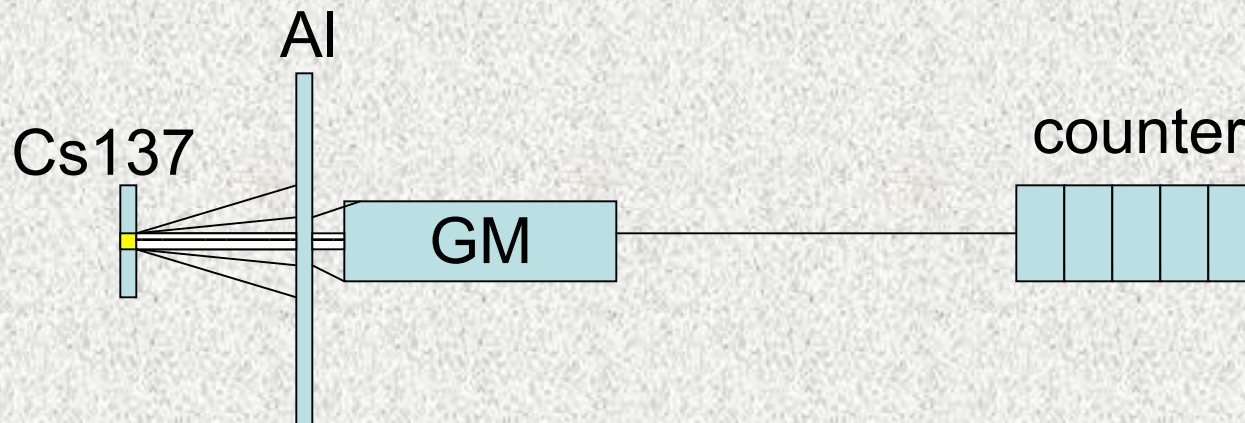


We can approximate the rate of betas attenuated in a thin absorber of thickness x with an exponential absorption formula

$$I = I_0 \exp(-\mu x)$$

The windows are 6061 Al and have a central thickness of approximately $180\mu\text{m}$ increasing to $360\mu\text{m}$ near the window edge. We choose a beta source Cs-137 with a half-thickness in Al of about $150\mu\text{m}$. (half attenuated.)

A simple geiger tube counted the rate. Due to electron scattering the result can be sensitive to apparatus geometry and a careful calibration needs to be performed.



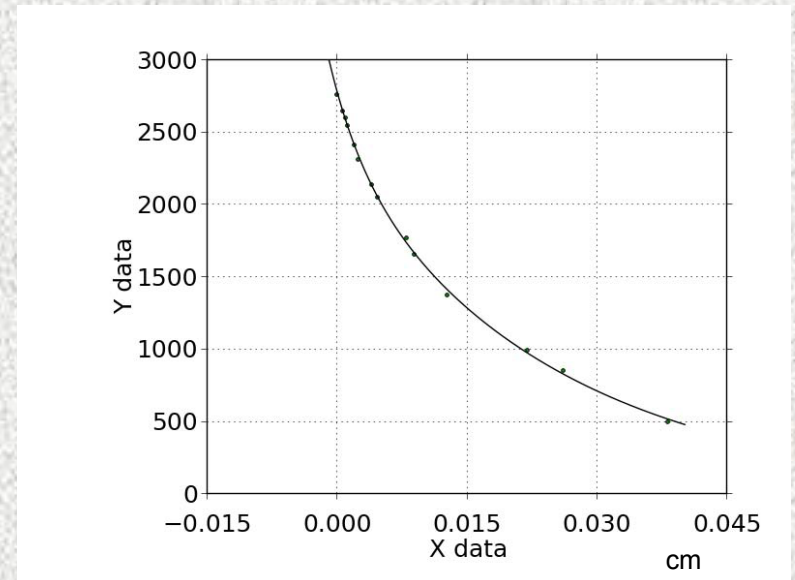


A Calibration was performed with Al absorbers to determine the attenuation coefficients μ_1, μ_2 . We used a dbl-exp fit.

$$I = I_0 \exp(-\mu_1 x) + I_1 \exp(-\mu_2 x)$$

Table 1: Calibration Data with standard absorber data for Cs-137 and TI-204

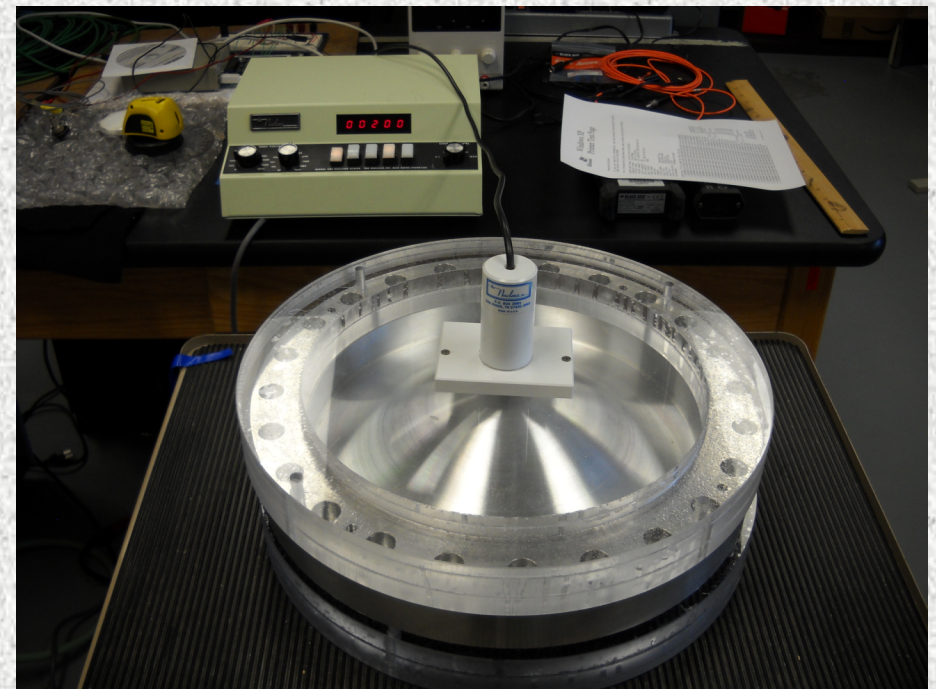
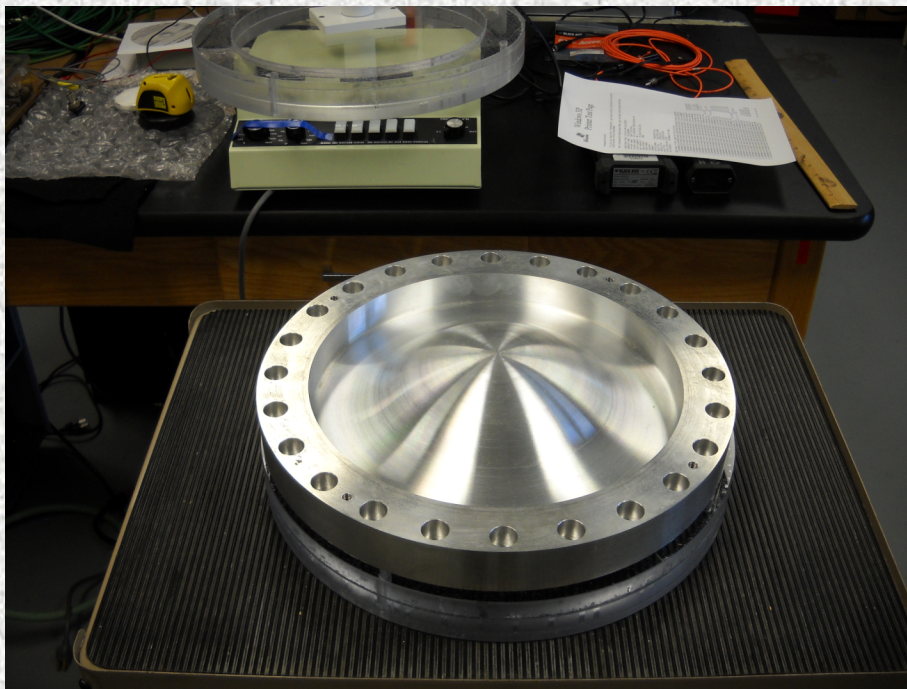
Absorber	Thickness (cm)	Cs-137 #/min #	TI-204 /min
0	0.00000	2762	313
1	0.00059	2648	288
2	0.00093	2600	285
3	0.00122	2548	277
4	0.00200	2414	253
5	0.00241	2308	241
6	0.00393	2134	221
7	0.00467	2052	210
8	0.00796	1770	175
9	0.00893	1658	162
10	0.01270	1373	135
11	0.02200	991	77
12	0.02615	852	57
13	0.03819	494	29





A 180 μ m window and 220 μ m standard foil are mounted between the source below and GM tube. Counts are recorded and compared to the calibration curve for thickness determination. Cs-137 and TI-204 were used.

$x = 174.2 \pm 4.3 \mu\text{m}$	window w Cs-137
$x = 180.8 \pm 3.2 \mu\text{m}$	window w TI-204
$x = 218.9 \pm 2.5 \mu\text{m}$	220 μm standard foil w Cs-137





Measurements taken with the thickness gauge. Window 4 was machined to 200 μm thickness and measured 203 μm .

Overall precision seems to be about 5 μm when care is taken and $N > 10000$ counts (1% statistical error).

