Dummy Subtraction for Cryo Target

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1 Dummy and Target Cell Geometry

The target cell geometry for the loop 2 and loop 3 cryo cells are shown respectively in the Fig:1 and Fig:2 [1].

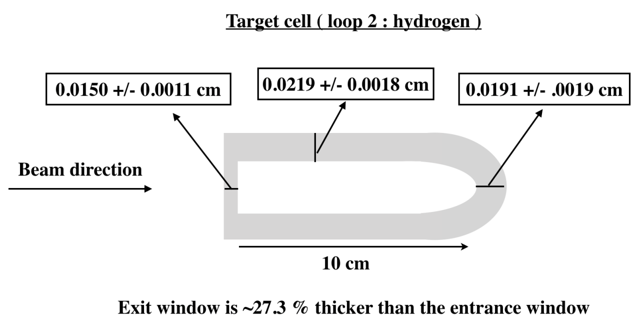

Figure 1: Loop 2 target cell geometry : Exit window is 27.3% thicker than the entrance one (figure is not drawn to scale)

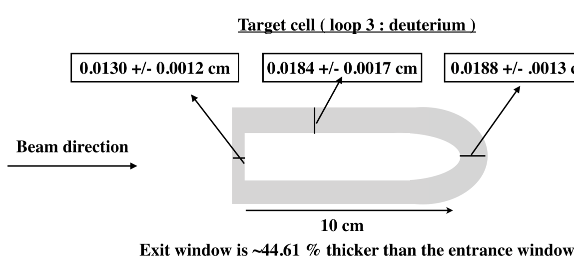

Figure 2: Loop 3 target cell geometry : Exit window is 44.61% thicker than the entrance one (figure is not drawn to scale)

In the context of the study of this section the main thing to notice is the entrance and exit window length are different for both the cells. The geometry of the dummy target is shown in Fig: 3 [1].

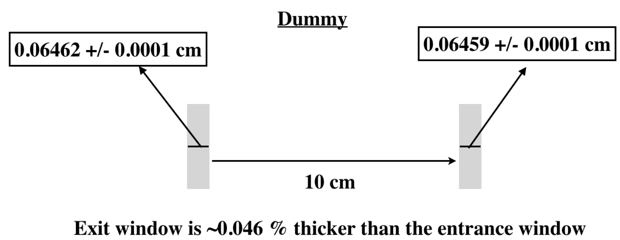

Figure 3: Dummy Target geometry : Exit window is 0.046% thicker than the entrance one (figure is not drawn to scale)

2 Dummy Subtraction Method

During data taking cryogenic targets (Liquid hydrogen and deuterium) were kept in a 10 cm long cylindrical aluminum (Al 7075) cell. So some of the beam electrons will be scattered from the entrance and the exit cap of the target cell. In the detector stack they are indistinguishable from the electron scattered from the target. So the target cell contribution to the total yield need to be determined and subtracted.

To estimate the target cell contribution, data were taken with the Dummy target exactly at the same kinematics as the target. Dummy target is consist of two aluminum plates (10 cm apart from each other) placed at the positions of entrance and the exit caps of the target cell.

In general the Luminosity, efficiency, prescale, rc factor etc. will be different for the dummy and cryo runs. So after the PID cuts dummy run need to be scaled to cryo run event by event. The scale factor is defined as -

$$scale\ factor = \frac{raw\ counts_{\ cryo\ cell\ window}}{raw\ counts_{\ dummy}} \tag{1}$$

$$Yield = raw\ counts \times \frac{prescale}{total\ \ eff} \tag{2}$$

$$Yield = Luminosity \times \frac{\sigma}{rc} \tag{3}$$

plugging the equations (2) and (3) into equation (1) -

$$scale\ factor = \frac{Luminosity_{\ cell\ window}(\sigma_{al}/rc_{\ cell\ window})}{Luminosity_{\ dummy}(\sigma_{al}/rc_{\ dummy})} \tag{4}$$

Now

$$Luminosity = \frac{Q}{e^-}\frac{N_A \rho t}{A} \tag{5}$$

Q = total charge
e^- = electronic charge
N_A = Avogadro's Number
ρ = target density
A = mass number
t = target length

Using equation (5) to (4) -

$$scale\ factor = \frac{(Q.\ eff/ps)_{\ cryo\ window}}{(Q.\ eff/ps)_{\ dummy}}\frac{t_{cryo\ window}}{t_{dummy}}\frac{rc^{ext}_{dummy}}{rc^{ext}_{cryowindow}} \tag{6}$$

in equation (6) rc (radiative correction factor) is replaced by rc^{ext} (external radiative correction). Both the dummy and cryo cell are made up of same material and only difference is in target length (t); hence rc^{ext} (bremsstrahlung process) is the most important part of rc factor .

In equation(6) the the factor $\frac{rc^{ext}_{dummy}}{rc^{ext}_{dummy}}$ is in general a very small factor and ignoring it for now. Apart from that the factor $\frac{t_{cryo\ window}}{t_{dummy}}$ is important due to target cell and dummy target geometry. This target length ratio is different at the beam entrance window point from the exit window point. In the table 1 we summarize the target length ratio for both the entrance and exit window positions .

Table 1: target length ratio for beam entrance & exit

	entrance ratio	exit ratio
loop 2	0.23212627669	0.29571141043
loop 3	0.20117610646	0.29106672859

The target geometry is divided into three parts based on the Y-Target quantity [Fig : 4]. For the region Y-Target $\leq$ -0.5 cm, target length ratio will be considered equal to entrance ratio where as for the region Y-Target $\geq$ 0.5 cm , the target length ratio will be equal to exit ratio. This method will ensure the consideration of the target length difference for the entrance and exit windows. Now for the region -0.5 cm > Y-Target < 0.5 cm we will use linear interpolation to get the target length ratio.

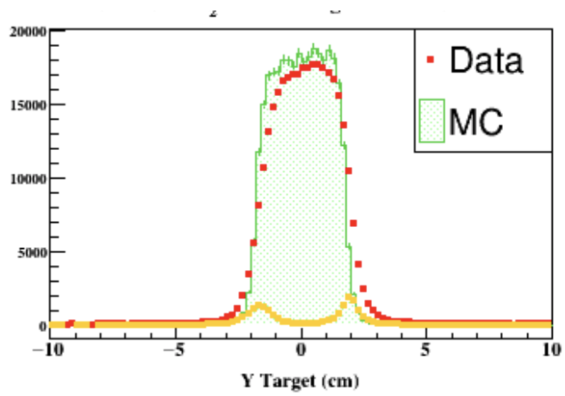

Figure 4: Y-Target Distribution

A Appendix

A.1 Linear Interpolation

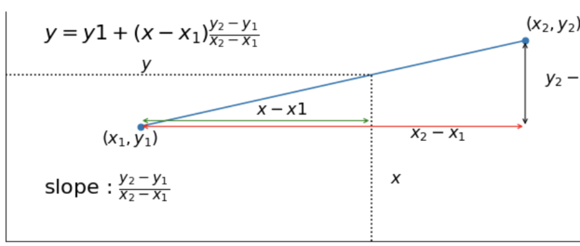

Figure 5: Interpolation Formula (Figure from Google)

$$y = y1 + \frac{(y2 - y1)}{(x2 - x1)} \times (x - x1) \tag{7}$$

References

[1] Dave Meekins. *Hall C Target Configuration.* ,8-9-2017.