Position of MICE target #1 in ISIS beam pipe

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Scope:

The purpose of this note is to define the position of the MICE target inside the ISIS beam pipe and to define the relation between the target coordinate system and the distance of the tip of the target blade from the centre of the ISIS beam pipe.

This note refers to the first production MICE target (MICE target #1) installed on ISIS in January 2008. This note will have to be reissued each time the target is changed.

Position of target #1 with respect to centre of ISIS beam pipe:

A sketch of the location of the target blade relative to the centre of the ISIS beam pipe is shown in figure Figure 1. The sketch is made as a vertical cut through the target and beam pipe passing through the centre of the target shaft and perpendicular to the ISIS beam axis. The vertical distance from the horizontal centre line to the inner surface of the beam pipe is 67.1 mm. The length of the target blade is 35 mm, the thickness of the blade is 1 mm, and the width (parallel to the beam direction) is 10 mm.

When the target is resting on the bottom stop, i.e. at its lowest point, the vertical distance from the tip of the target to the inner surface of the top of the beam pipe is 42.6 mm. Therefore, in this position, the tip of the target blade lies at a point 24.5 mm above the centre of the ISIS beam pipe.

Two coordinate axes are also shown in Figure 1: the vertical coordinate, *t*, recorded by the target electronics; and the vertical coordinate, *y*, measured from the ISIS beam centre line. The origin of the target vertical coordinate (i.e. the point $t = 0$ mm) lies 2.4 mm below the tip of the target when the target shaft is resting on the bottom stop.

Relationship between target coordinate system and the position of the target in the ISIS beam pipe

When the target rests on the bottom stop (see Figure 1), i.e. when the target is at its lowest point, the position of the target blade is 2.4 mm in the target coordinate system. Therefore, if the '*y*' coordinate is defined as the vertical position measured from the horizontal centre line of the beam pipe and points with positive *y* are taken to lie above the centre line, the vertical position of the tip of the target blade is related to the position, *t*, of the target in the target coordinate system by:

$$y = t + 22.1; \qquad (1)$$

where both *y* and *t* are measured in mm. The offset, 22.1 mm, arises because the origin of the target coordinate system lies 2.4 mm below the position of the tip of the target blade when the target is resting on the bottom stop (i.e. $22.1 = (24.5 - 2.4)$ mm).

Relationship between target 'dip-depth' and the position of the target in the ISIS beam pipe

When the target is in its 'hold' position, the tip of the target is at a point $t = (51.75 \pm 0.3)$ mm. Using equation 1, this corresponds to $y = (73.85 \pm 0.3)$ mm. The target 'dip depth', *d*, is the maximum excursion

of the target, vertically downwards, from its 'hold' position. Therefore, the vertical position of the tip of the target during actuation is given by:

$$y = 73.85 - d\,; \qquad (1)$$

where, once again, *y* and *d* are given in mm. As an example, the target dip depths used in running on the 2nd June 2008 are shown in table 2 together with the vertical coordinate, *y*, to which they correspond.

Estimate of uncertainty in the conversion from the target coordinate system to the vertical coordinate measured from the ISIS beam centre line:

The uncertainties in the various dimensions that have been combined in equation 1 are summarised in table 1. Combining the uncertainties as a quadratic sum yields a total uncertainty of 1.1 mm, combining them linearly leads to an estimated uncertainty of 1.8 mm.

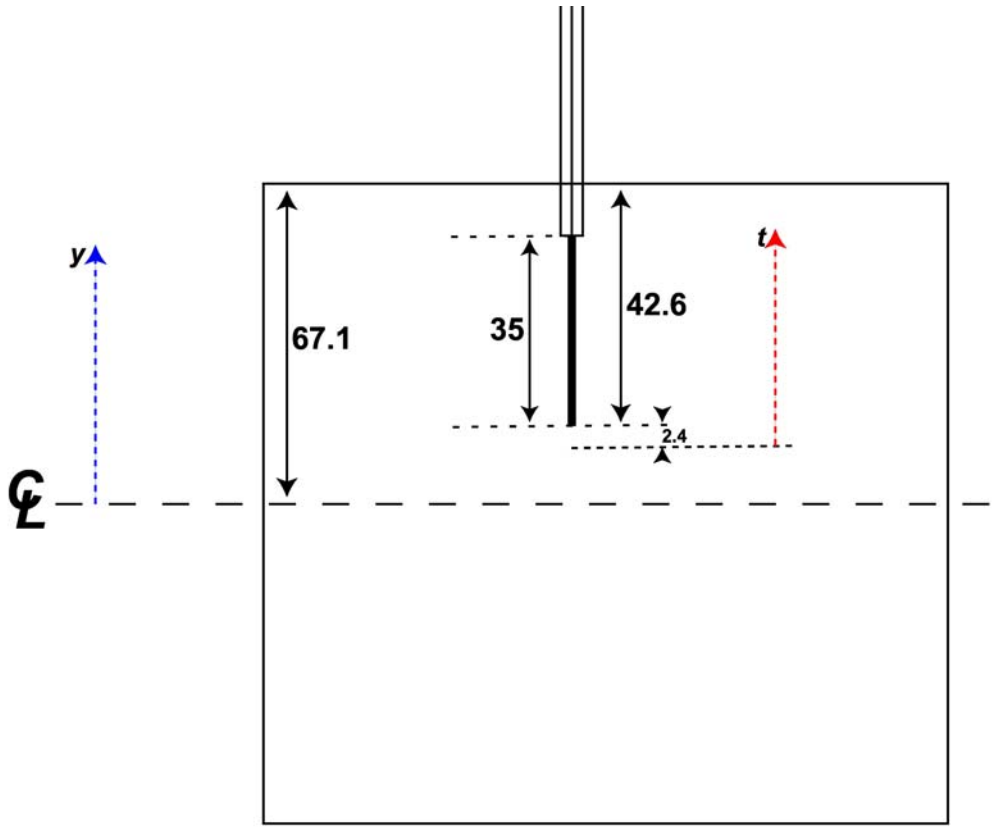

Figure 1: Sketch of location of target blade relative to the centre of the ISIS beam pipe. The dimensions refer to the first production target; MIEC target #1. The view is a cut through the beam pipe at the centre of the target blade. The dimensions (in mm) shown correspond to the target resting on the bottom end stop. In the target coordinate system this corresponds to a target position of 2.4 mm. The vertical coordinate measured from the ISIS beam centre line, y, *is shown (blue dotted line to left of figure). The target coordinate system (blue dotted line shown inside the ISIS beam pipe), as recorded by the target-control electronics, is also shown. The origin of the target vertical coordinate, t, lies 2.4 mm below the ISIS beam centre line.*

Table 1: Summary of uncertainties contributing to the uncertainty on the offset of 22.1 mm in equation 1.

Dimension/or setting	**Value (mm)**	**Uncertainty (mm)**
Vertical half-height of beam pipe	67.1	1
Protrusion of target inside beam pipe	42.6	0.25
Setting of vessel inside synchrotron		0.25
Position of hold position in target coordinates	51.75	0.3
Total uncertainty (quadratic sum)		***1.1***
Total uncertainty (linear sum)		**1.8**

*Table 2: Example of relationship between target dip depth (*d*) and vertical position with respect to the centre of the beam pipe (y). The target dip depths listed are those used in running on the 2nd June 2008.*

Dip depth (mm)	**Vertical position (mm)**
39.6	34.3
40.2	33.7
40.9	33.0
41.6	32.3
41.7	32.2
42.1	31.8
42.2	31.7
42.6	31.3
42.7	31.2
42.8	31.1
43.1	30.8
43.7	30.2
43.8	30.1
44.5	29.4
44.6	29.3
45.2	28.7
45.3	28.6
45.7	28.2
45.8	28.1
46.4	27.5
47.0	26.9
47.8	26.1
48.2	25.7