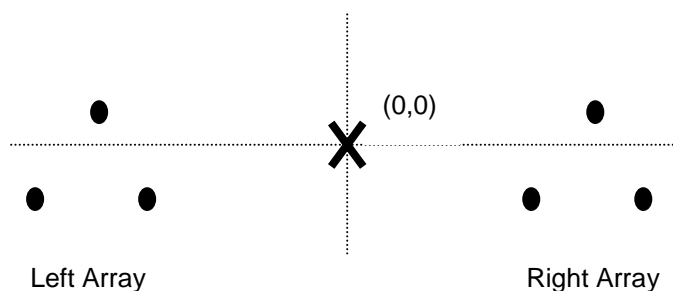


When using a virtual target system, it is often necessary to relate the “target” area of the virtual target to a physical witness for the purposes of calibration or verification. The computer software allows the user to calibrate the target in a variety of different ways

For acoustic targets, four calibration constants are usually calculated and programmed into the System. These may be easily checked and re-programmed if required.

Where four calibration constants are used, there are two for the “X” dimension and two for the “Y” dimension. The constants for each dimension comprise an offset term ( $C_x$  and  $C_y$ ) and a multiplication factor ( $M_x$  and  $M_y$ ).

If no calibration constants have been set, the centre of the virtual target (0,0), is the point mid-way between the two arrays in the x (horizontal) direction and a line that is drawn between the centre of the left and right arrays in the y (vertical) dimension. See Figure below.



So, if a shot is fired at point X, with no calibration constants set, then the virtual target will report a coordinate of (0,0). DO NOT DO THIS, however, as there is a serious risk of damage to the target if firing is done at this level.

If no constants are set, then shots will only appear in the top half of the target display in the software. For this reason,  $C_y$  will normally need to be set to a large negative number to make a correction.

If the target planes of the virtual target system and the physical witness are coplanar and perfectly aligned, the multiplication factor in X and Y will be 1.000 and the offset will be 0.0.

If the target planes are parallel in all dimensions but are offset in the X or Y dimension, the multiplication factors will be 1.000 and the offsets will be simply the distance that the physical witness target centre is offset from the virtual witness target centre.

For example, if the centre of the physical witness is 10mm to the right and 1000mm above the centre of the virtual target, the offset values will be set to  $X = -10\text{mm}$  and  $Y = -1000\text{mm}$ ; thus a shot fired at the centre of the witness target will be recorded on the physical witness at 0,0 and will now be shown on the target computer at 0,0.

If this is the only source of error, then these offsets can be manually entered into the “Surveyed Target Position” offset positions.

Do NOT use offset AND calibration constants at the same time, as this leads to confusion.

#### MS Instruments Ltd.

Unit 4, Ravensquay Business Centre, Cray Avenue  
Orpington, Kent, BR5 4BQ, United Kingdom  
Tel: +44 (0)1689 883 020  
Fax: +44 (0)1689 871 392  
contact@msinstruments.co.uk  
www.msinstruments.co.uk

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If the virtual target plane and the physical witness are not parallel and one leans away or towards the other, a simple offset is insufficient for correction. The multiplication factor is used to take account of this and operates on the original co-ordinate calculated by the target system as a multiple. For example, if the physical witness is perfectly upright and the virtual target is leaning towards it, a hole on the physical witness could be at a height of (say) 100mm above the centre and yet be recorded on the virtual target at 102mm; a Y dimension multiplication factor of 0.9804 when applied to the calculated virtual target value would correct to read 100mm. A similar factor can be used in the X dimension. If there is additionally a simple offset, this term would also be applied as above.

The four constant method does not correct for rotational effects. The accuracy will be affected if the virtual target or the physical witness is not level. Six or greater constants may be used if required, although they are not normally provided as such gross errors are usually a symptom of poor setup.

#### *Number of calibration constants*

In the BallisticsDB software, there is a calibration tab for the target. On this tab, there is a choice of 0, 2, 4 or 6 constants.

Select "0 Consts" to remove all multipliers and offsets. The target will record shots as noted in the diagram above.

Select "2 Consts" to calculate the simple offset in x and y. No multiplier terms are calculated.

Select "4 Consts" to calculate a combination of the best offset and best multipliers in x and y.

Select "6 Consts" to take account additionally of any rotational errors between the physical and virtual target.

#### ***Application of calibration constants***

**(In the following explanation, note that some versions of the software show RawX as X-row and RawY as Y-row)**

#### **The automatic target calculates the basic coordinates RawX, RawY.**

The relationship between X and RawX and between Y and RawY is shown on the calibration Tab, and is as follows:

$$X = (M_x \times \text{RawX}) + (M_{xy} \times \text{RawY}) + (C_x \times 1000)$$

$$Y = (M_{yx} \times \text{RawX}) + (M_y \times \text{RawY}) + (C_y \times 1000)$$

These are the equations when 6 calibration constants are used.

For a 4 constant calculation,  $M_{xy}$  and  $M_{yx}$  are both zero, which simplifies the equations to:

$$X = (M_x \times \text{RawX}) + (C_x \times 1000)$$

$$Y = (M_y \times \text{RawY}) + (C_y \times 1000)$$

If "0 Consts" is selected, then the X and Y coordinates shown on the Graphical display, and in the Shot list, will be the same as RawX, RawY.

#### *Method of Calibration*

Ensure that the shot grid is displaying, as a minimum, the following columns:

Shot No., RawX, RawY, X, Y, WitnessX, WitnessY, Calibration, XError, YError, RError.

(Refer to manual for instructions on how to switch columns on and off).

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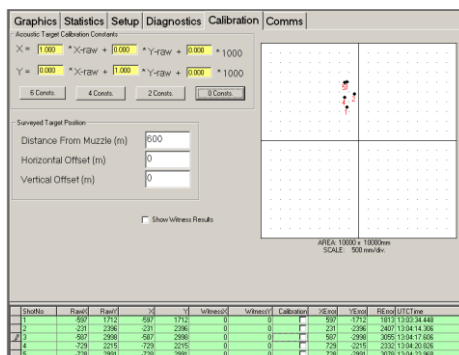


- 1) Place a witness target of the required dimensions in a convenient position behind the virtual target, taking care to ensure that the targets are parallel and level and that there is a minimal possibility of the two targets interfering. The physical target should normally be placed around 2m behind the virtual target.
- 2) Set up the controlling computer so that it is ready for live firing (check operators manual for details). The calibration constants should be set to their base values i.e. 1.000 for the multiplication factors and 0.0 for the offsets and any additional constants.  
This is done in BallisticsDB by selecting "0 Consts".
- 3) For best results, the shots should be scattered about the target area with a minimum of one shot in the centre and one in each of the four corners. Please note that at least 5 shots must be fired for the "4 or 6 Consts" calculation to be made, although it is advised that one or two extra shots are fired in case of corruption or shots registering off target.
- 4) When firing has finished, measure the witnessed results taking great care to ensure that the axes drawn on the witness target are orthogonal.
- 5) Type these values into the "WitnessX" and "WitnessY" locations on the shot grid, taking care to ensure that the witnessed results relate to their relevant virtual target results.
- 6) Tick the "Calibration" box for each shot being used for the calculation.
- 7) Select "2, 4 or 6 Consts" as appropriate. The calibration constants are then calculated by the program and displayed on the screen. If the targets are accurately aligned, you should see multiplication factors of approximately 0.90 to 1.1 and small offsets in X and Y relating to the actual offsets of the target centres. If the results are very different, or the calibration is rejected (this is done automatically if the multiplication factors are less than 0.8 or greater than 1.2) check that the witness results have been correctly measured and re-enter the values.
- 8) Take a printout of the results and calculated calibration constants for future reference.

If the constants are already known, these may be entered manually. This method can be used to effect an approximate calibration without the trouble of a live firing, by accurately measuring the differences between the two target centres and entering these manually as offsets and setting the multiplication factors to 1.000.

A worked example is given below:

- a) Set "0 Consts" and fire 5 shots. RawX, RawY and X, Y should be the same.



- b) Enter witness results, tick calibration boxes and select the appropriate number of Consts.



**“2 Consts”**

ShotNo	RawX	RawY	X	Y	WitnessX	WitnessY	Calibration	XError	YError	RError
1	-597	1712	-597	1712	-595	1710	<input checked="" type="checkbox"/>	2	-2	3
2	-231	2396	-231	2396	-233	2399	<input checked="" type="checkbox"/>	-2	-3	4
3	-587	2998	-587	2998	-585	2996	<input checked="" type="checkbox"/>	2	-2	3
4	-729	2215	-729	2215	-730	2219	<input checked="" type="checkbox"/>	-1	4	4
5	-728	2991	-728	2991	-730	2988	<input checked="" type="checkbox"/>	-2	-3	4

**“4 Consts”**

ShotNo	RawX	RawY	X	Y	WitnessX	WitnessY	Calibration	XError	YError	RError
1	-597	1712	-597	1713	-595	1710	<input checked="" type="checkbox"/>	2	-3	4
2	-231	2396	-232	2396	-233	2399	<input checked="" type="checkbox"/>	-1	3	3
3	-587	2998	-587	2997	-585	2996	<input checked="" type="checkbox"/>	2	-1	3
4	-729	2215	-729	2216	-730	2219	<input checked="" type="checkbox"/>	-1	3	4
5	-728	2991	-728	2990	-730	2988	<input checked="" type="checkbox"/>	-2	-2	3

**“6 Consts”**

ShotNo	RawX	RawY	X	Y	WitnessX	WitnessY	Calibration	XError	YError	RError
1	-597	1712	-597	1713	-595	1710	<input checked="" type="checkbox"/>	2	-3	3
2	-231	2396	-232	2396	-233	2399	<input checked="" type="checkbox"/>	-1	1	2
3	-587	2998	-588	2997	-585	2996	<input checked="" type="checkbox"/>	3	-1	3
4	-729	2215	-728	2215	-730	2219	<input checked="" type="checkbox"/>	-2	4	4
5	-728	2991	-728	2989	-730	2988	<input checked="" type="checkbox"/>	-2	-1	2

XError, YError shows the difference between the shot positions on the physical and virtual targets. RError is the radial distance between (X, Y) and (WitnessX, WitnessY)

Note that for this particular shot pattern, there is little difference in accuracy between the 3 methods. This shows that the target was set up accurately and simple offsets only are required.

As the virtual target is always installed in front of the physical target, there will always be a parallax error. When firing at long distances, this is fairly small, however at shorter distances, the 4 or 6 const calibration methods are used to correct for this factor.

The calculation may be repeated at any time and as the constants operate on the Raw values, the calibration may even be done after firing.

Once the appropriate number of constants has been selected, the constants will be calculated and shown on the calibration tab. These constants will be used for all subsequent firings.