MS Instruments

# STANDARD STATISTICAL ANALYSES

In MS Instruments LTD software, a range of statistical functions are provided as standard and additional ones may be specified. The list below gives an explanation of the standard definitions. Enclosing Circle (sometimes known as Group Circle) is the diameter of the smallest circle that encloses all shots.
In the following explanations, the shot data is referred to in the equations as $X_i$, $Y_i$ where $X_i$ and $Y_i$ are the co-ordinates of shot number i. N is the total number of shots.

**MEAN POINT OF IMPACT (MPI): $X_m$ and $Y_m$**

This generates the mean value of all shots in the X and Y direction where:

$$X_m = \frac{1}{n}\sum_{i=1}^{n} X_i \qquad Y_m = \frac{1}{n}\sum_{i=1}^{n} Y_i$$

**GROUP RECTANGLE**

This gives the dimensions of the rectangle which encloses all shots. The sides of the rectangle are parallel to the X and Y axes. The sides are found by:

$$Side_x = \max\{X_i\} - \min\{X_i\} \qquad Side_Y = \max\{Y_i\} - \min\{Y_i\}$$

**STANDARD DEVIATION: $SD_X$ and $SD_Y$**

This produces the sample standard deviation for all X co-ordinates and all Y co-ordinates.

$$SD_x = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(X_i - X_m)^2} \qquad SD_y = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(Y_i - Y_m)^2}$$

**STANDARD DEVIATION in mils: $SD_X$ (m) and $SD_Y$ (m)**

The angular values of Standard Deviation (Distance from firing point to target = R)

$$SD_x(m) = 1018.59\,Tan^{-1}\left(\frac{SD_x}{R}\right) \qquad SD_y(m) = 1018.59\,Tan^{-1}\left(\frac{SD_y}{R}\right)$$

**EXTREME SPREAD (ES)**

This is the largest distance between any two shots.
Shot spacing between shots i and j is given by:

$$ES = \max\left\{\sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2}\right\}$$

**MEAN RADIUS (MR)**

This is the average distance of all shots from the mean point of impact, and is given by:

$$MR = \frac{1}{n}\sum_{i=1}^{n}\sqrt{(X_i - X_m)^2 + (Y_i - Y_m)^2}$$

**MEAN RADIUS in mils: MR(m)**

The angular value of MEAN RADIUS (Distance from firing point to target = R)

$$MR(m) = 1018.59\,Tan^{-1}\left(\frac{MR}{R}\right)$$

**GROUP S.D.: GSD**

This generates a single value from the standard deviation for X and Y, given by:

$$GSD = \sqrt{\frac{(SD_x)^2 + (SD_y)^2}{2}}$$

**GROUP S.D. in mils: GSD(m)**

The angular value of the GROUP S.D. (Distance from firing point to target = R)

$$GSD(m) = 1018.59\,Tan^{-1}\left(\frac{GSD}{R}\right)$$

N.B. 1018.59 is the conversion factor from Radians to mils:
6400 mils = 2π x 1000mRads = 360 degrees, or 1mRad = 1.01859 mils.

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