Application note
HIDEX 300 SL™

TDCR quench correction with the HIDEX 300 SL

This application note provides an introduction to Quench correction with the Hidex 300 SL.This note focuses on Triple to Double Coincidence Ratio method or TDCR. A few special cases are noted where TDCR needs to be corrected for effect of Background radiation or High luminescence.

Quench correction with the TDCR method

The Hidex 300 SL is the first commercial liquid scintillation analyser to facilitate the triple to double coincidence ratio counting.

In TDCR triple and double coincidences are measured and the ratio of these coincidences is calculated. Triple coincidences are more affected by quench (chemical and color) than double coincidences (or the total of all coincidences).

For pure beta-emitting radionuclides the ratio of triple to double (all) approximates the overall efficiency generally (+/- 15 %). This can be proved by experimental results and mathematics. Hence, in TDCR the quench level is (as different from systems with 2 PM`s at 180° facing the sample) automatically included in the ratio of the triple to double coincidences.

Measuring TDCR enables the determination of activities for pure beta-emitting radionuclides with high accuracy. The level of quench is directly taken care of by TDCR.

TDCR does not require an external source and does not require a vial of known activity – therefore it is an "absolute" measurement.

TDCR is automatically deployed in the Hidex 300 SL. DPM is available as part of the data selection. In this situation it is CPM divided by the TDCR factor.

The TDCR value is also available from the data selection and can be used as an indicator of quench in standards. A standard curve of quench set can be stored with the curve fit option and this can be employed to gain a more accurate DPM value.

Quench correction with standard quench set

Standard quench sets can be purchased from your local Hidex representative. As an example we can consider the H-3 quench set. Open the Hidex 300 SL H-3 parameter file using the stored quench curve.par This parameter file has stored information on the quench curve of the standards and automatically fits the TDCR value to the standard curve to determine the real efficiency of the counter.

Click on the Quench curve view to see if an appropriate .fit file is selected.

**Application note**

HIDEX 300 SL™
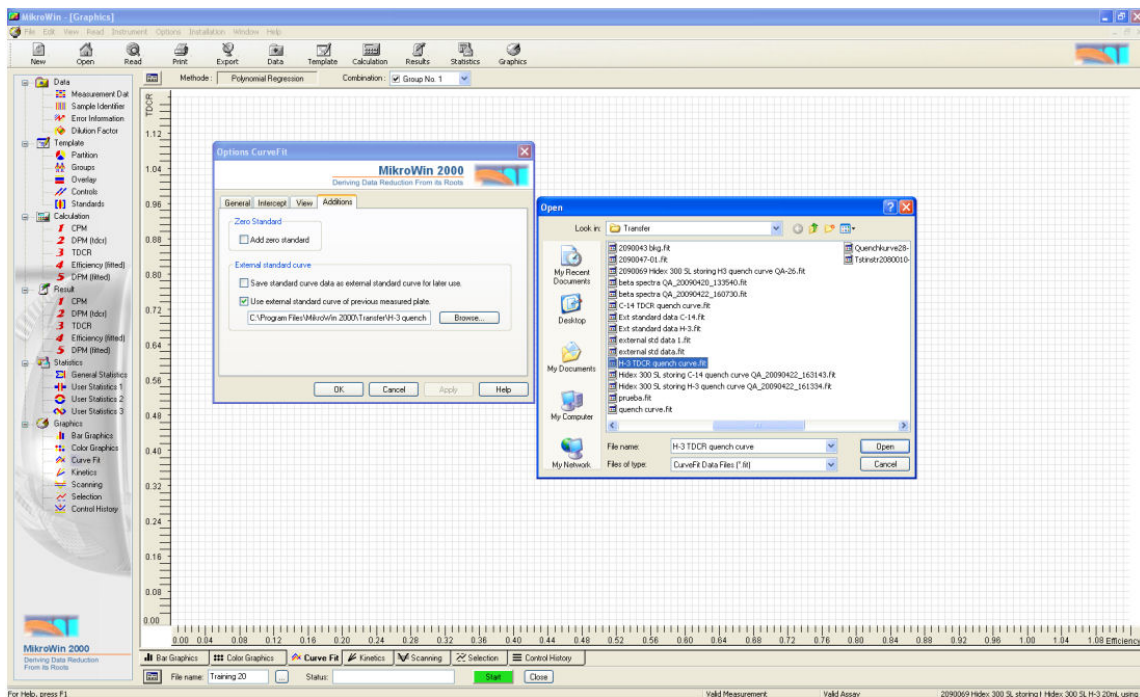
If you would like to change either the .fit file or the curve fitting method click on **Options** and **Curve Fit**. A variety of fitting functions are available.

Open the **Additions** tab and click the **Browse** button. Go to your MikroWin transfer folder to open the appropriate .fit file. If you have followed our suggested example, described under *Storing a quench curve of a standard quench set*, below, you can open H3 TDCR quench curve.fit.

In general the Cubic Spline method is found to be the best fitting method for quench curves. Click **OK**, and your curve fit view should be of the TDCR quench curve.
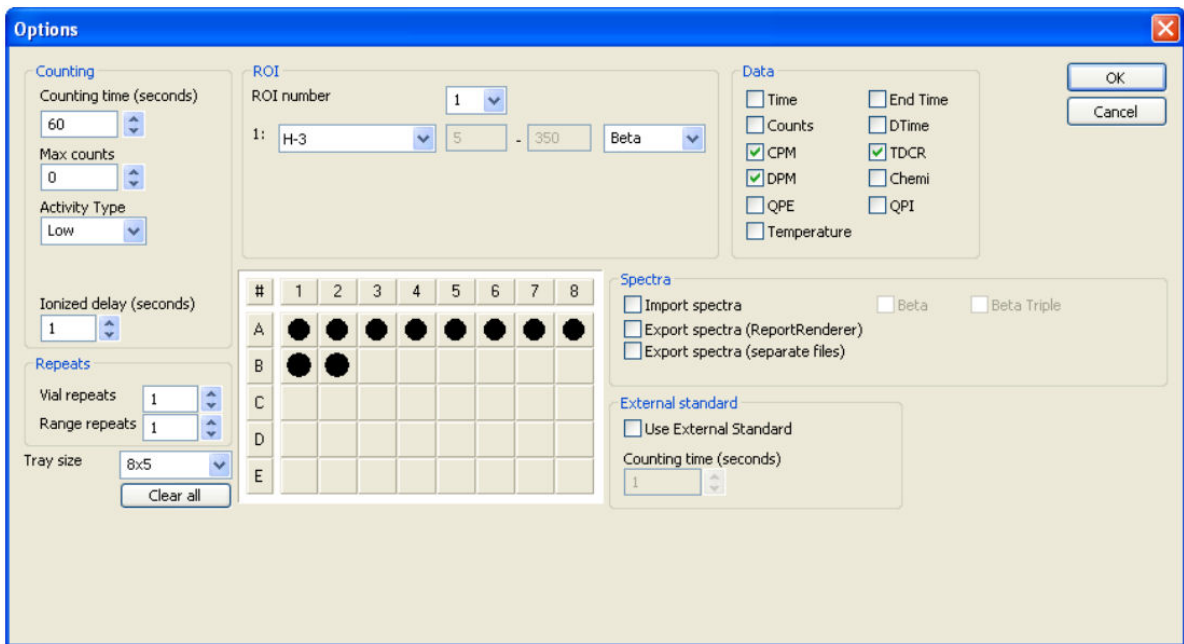
Application note

HIDEX 300 SL™
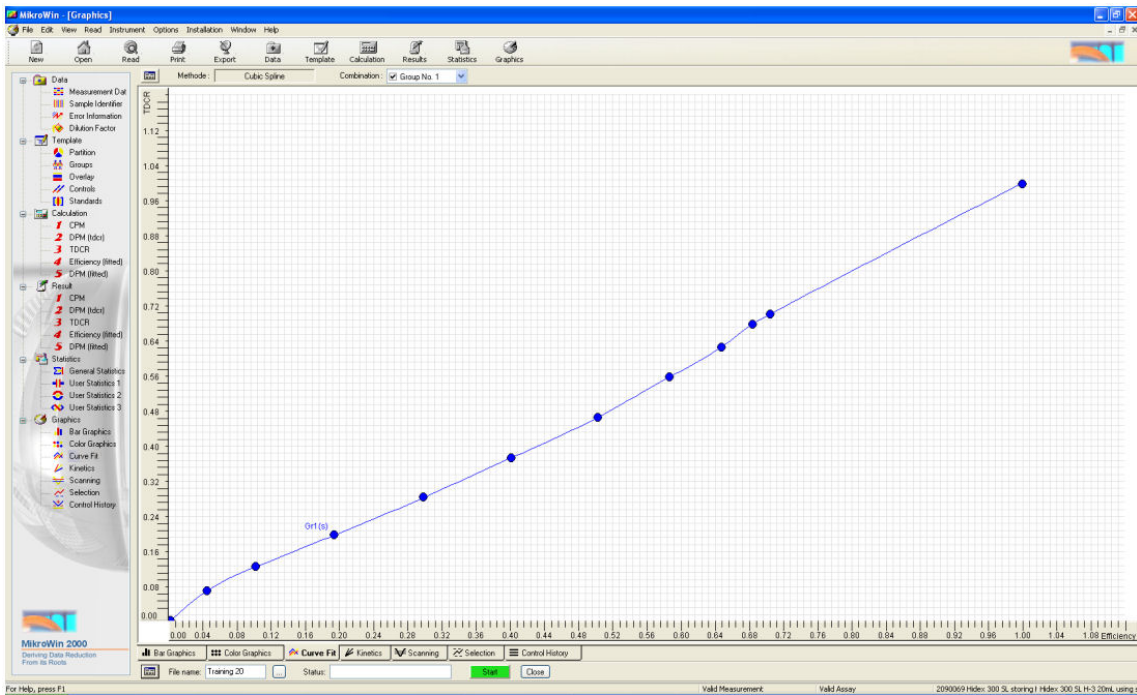
Enter a data file name and start counting. The DPM matrix will then show the quench curve corrected activities of your unknown samples.

Storing a quench curve of a standard quench set

To create your own standard curve you may either obtain a ready made quench set from Hidex or prepare one yourself. As an example we can consider the creation of a standard curve using a ready made H-3 quenched standards set. Open the parameter file, Hidex 300 SL H-3 20mL save TDCR quench curve. Make sure your sample trays include the correct standard set. Place the standards in the positions from A1 to B2. Make sure your reader settings are set as shown below.

Application note

HIDEX 300 SL™

You can increase counting time to increase the precision of the results.
Choose the Calculation Matrix with DPM of Standards and enter the half-life corrected activity as DPM into positions A1 to B2.
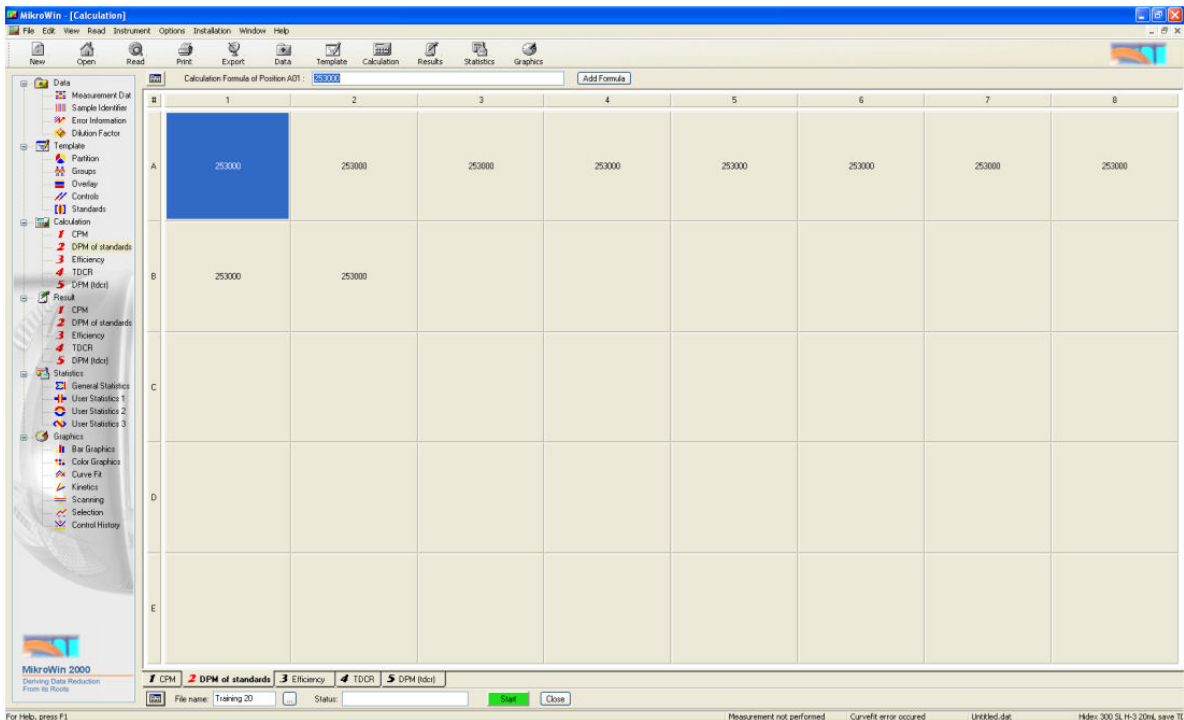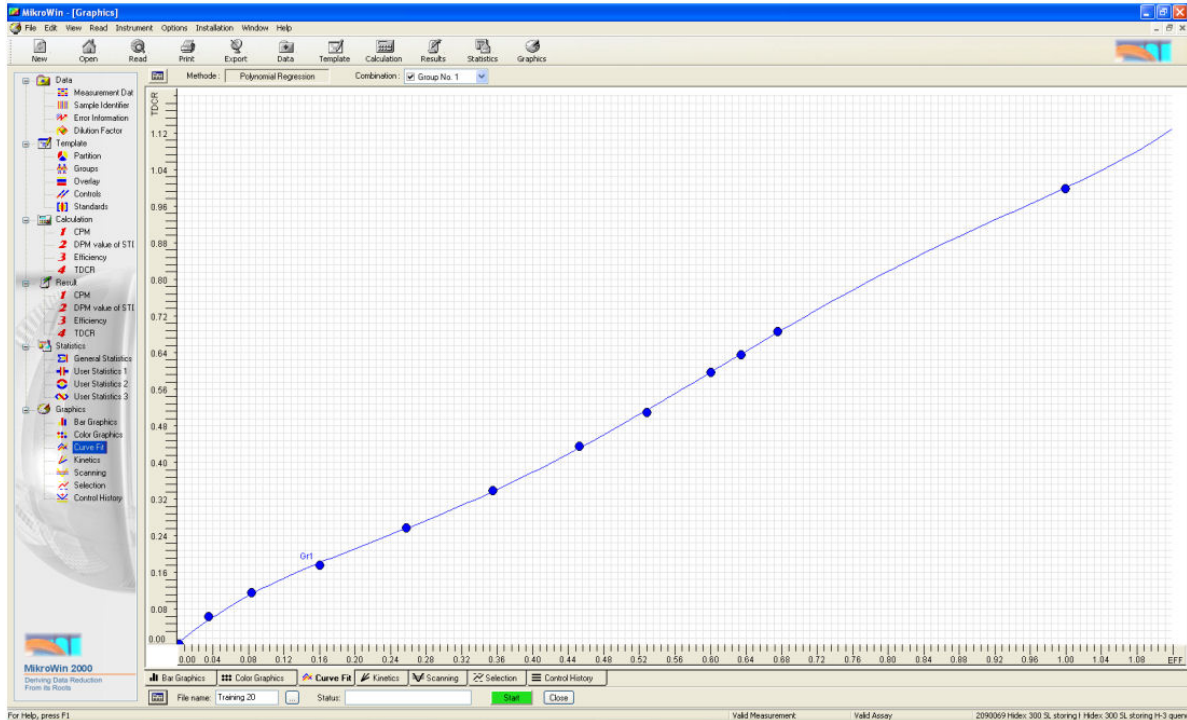
Application note

HIDEX 300 SL™

Enter a name for your data, for example, H3 TDCR quench curve; it is advisable to choose a name clearly indicating that the data represents a TDCR quench curve.
Start counting.
When all the positions in the rack are counted a quench curve is generated. You can view the curve under Curve Fit view.

The curve plots TDCR number as a function of efficiency for the known standards. Two artificial points TDCR 0 and Efficiency 0 and TDCR 1 and Efficiency 1 are added, because triple to double coincidence theory states that they must be included.
In your MikroWin Transfer folder (if you followed the example above) you now have a file called H3 TDCR quench curve.fit. This file holds the information of the particular quench set you have used in the specific instrument that you have been working with. In practice TDCR quench curves are quite generic and do not need to be redone several times. All Hidex instruments are calibrated in the factory for H3 and C14 TDCR quench curves. Please contact your local distributor to obtain the curves retained by the manufacturer for your instrument.
Store the data file name with an appropriate name as that will be the name of the quench curve .fit file in your preset transfer folder. The fit file can now be used by selecting it as your curve fit master plate in your parameter files.
You can create a quench curve for any isotope. It is important to note that the MCA ROI window must be set to accommodate the energy of the isotope in question.
Also either the QPE (if your instrument has an optional external standard) or QPI can be used as quench indicator in all the above cases. TDCR is found to be the most reliable quench correction method as it is not dependant on the spectral position.

Application note

HIDEX 300 SL™

TDCR and Background

TDCR is affected by background because background TDCR can be different from isotope TDCR. This should be taken into account with low activities.

TDCR obeys linear mathematics. In the following, C(A), C(B) and C(Tot) are CPM or counts of isotope, bkg and total (= isotope + bkg), respectively. TDCR(A), TDCR(B) and TDCR(Tot) are their TDCRs. C(A), C(B) and C(Tot) mean the accepted coincidences (3-coincidences + 2-coincidences).

(1) C(Tot)*TDCR(Tot) = C(A)*TDCR(A) + C(B)*TDCR(B).

From which one can solve, noting that C(A) = C(Tot) - C(B):

(2) TDCR(A) = (C(Tot)*TDCR(Tot) - C(B)*TDCR(B)) / (C(Tot) - C(B)).

With common pure beta emitters TDCR approximates counting efficiency. If this principle is used for DPM counting, one gets:

(3) DPM(A) = C(A) / TDCR(A) = (C(Tot) - C(B)) / TDCR(A).

By inserting TDCR(A) from (2), this can be written as

(4) DPM(A) = (C(Tot) - C(B))^2 / (C(Tot)*TDCR(Tot) - C(B)*TDCR(B)).

It is required that bkg values C(B) and TDCR(B) are carefully measured. Note that TDCR(A) needs not be known beforehand.

In a special case that TDCR(A) is known beforehand, one can simply use eq (3) for DPM. TDCR(B) needs not be known then.

TDCR and luminescence
Luminescence can affect TDCR because it can produce random 2-coincidences although random 3-coincidence (triple) rate is negligible. Below is shown how to correct TDCR for luminescence.

As known,

TDCR = T/D

T = triple count rate.
D = logic sum of all coincidences.

Because luminescence does not markedly produce triples, the luminescence corrected TDCR, or TDCRcorr is:

TDCRcorr = T/(D – chemiCPM).

Where chemiCPM is the reported random coincidence rate. From (1) one gets T = D * TDCR. Inserting this into (2) one obtains

TDCRcorr = TDCR * D/(D-chemiCPM).

If triple count rate T can be printed out, one can calculate TDCRcorr directly from (2).