APPLICATION NOTE

The IPA option for the QuantaSmart software in Tri-Carb LSC´s, documentation of the instrument performance.

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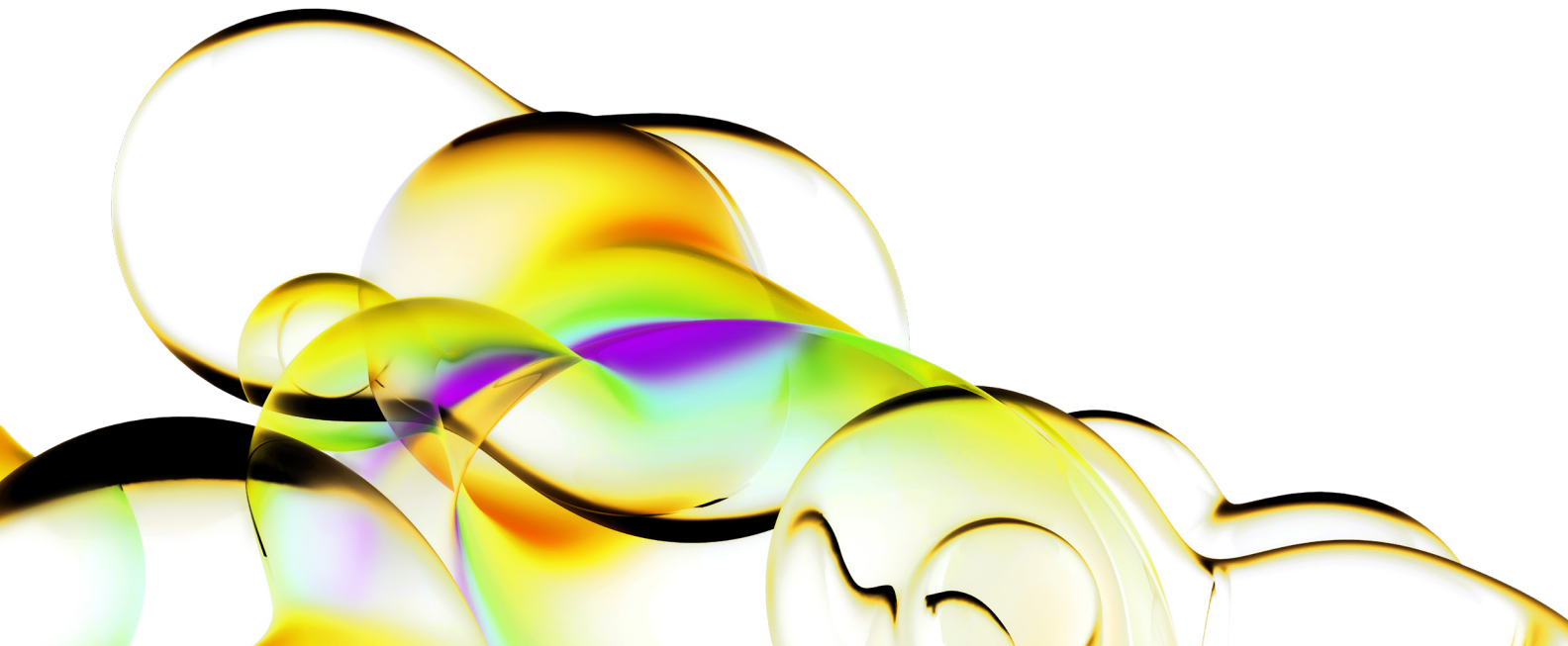
Introduction

In many areas in which liquid scintillation counters are used, reliable and meaningful documentation of all kinds of events are necessary. GLP/GMP regulations in research and production or regulations in agreement with 21 CFR part 11[1)] are meanwhile used by many researchers. In many cases the documentation does not only include the method development, instrument settings and the data evaluation but also the documentation of the instrument performance. For this reason, many of the liquid scintillation counters from Revvity can not only be equipped with the Enhanced Security Software (which follows 21 CFR part 11) but also with the IPA Option (Instrument Performance Assessment). This application note will focus on the description of the IPA option. If you would like to have further information about the QuantaSmart Software or other available options, please also read the application notes mentioned in the literature section.[1-7)] The IPA option comes standard with all Tri-Carb™ scintillation counters of the 3110TR and 3180TR/SL models but models from the 2810 and 2910 series can be upgraded at any time. The IPA option includes additional software with a database for instrument performance data and a set of standards. Three glass vials with an unquenched ^{3}H, an unquenched ^{14}C, and a background standard make this option complete. All these standards which you can get from Revvity are NIST (National Institute of Standards and Technology) traceable standards.



How to perform an IPA run

If you want to start an IPA run, you need all three standards and a special sample rack with a special protocol flag. The flag is named SNC (self normalization and calibration) and the rack shows you which sample positions in the rack have to be used for the background, ^{3}H standard or ^{14}C standard respectively. If you place this rack into the scintillation counter and start the run you will always start a new IPA run in the 2810TR, 2910TR and 3110TR models if the last IPA run has been done more than 23 hours before. If the instrument detects this rack and the last IPA run has been done less than 23 hours ago, the instrument will ignore this rack. Revvity recommends using these daily normalizations and calibrations making sure that the instrument is always in best working condition. One exception is the 3180TR/SL model with BGO-detector which does not have a 23-hour timer. In this model you will always start an IPA run if you place the rack inside the instrument and start counting. Instruments equipped with the IPA option will have the IPA menu in the main menu including two submenu options.

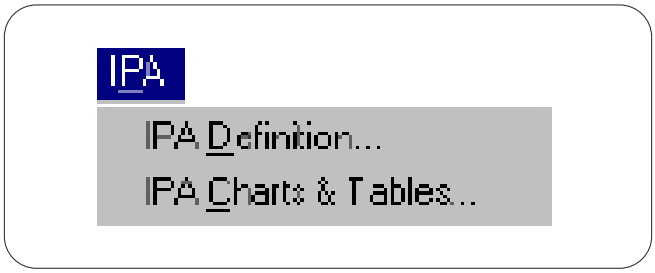


Figure 1: The IPA menu.

As soon as you push the IPA main menu you have access to the “IPA Definition...“ and “IPA Charts & Tables...“ sub menu. Before you can start the actual IPA run you have to define a few settings in the “IPA Definition...“ menu.

The IPA definition

The first thing you have to do (see figure 2) is to enter the activities of the ^{3}H and ^{14}C standards in DPM into the corresponding fields. For the ^{3}H standard you also must enter a reference date to correct for the short half life of Tritium which is not necessary for ^{14}C because the half life is much longer. Standards delivered from Revvity will have a printed value of the activity on the caps of the standards. To allow the determination of the background and sensitivity (E^2/B) of the instrument you must do background measurements. On this page you can enter the necessary counting time. Due to the low amount of decay events resulting in bad counting statistics we do not recommend measurement times below 60 minutes. A measurement time of 60 minutes is the default value within the software. The sensitivity (also called FOM or Figure Of Merit) of an LSC will be calculated using the squared efficiency divided by the background.

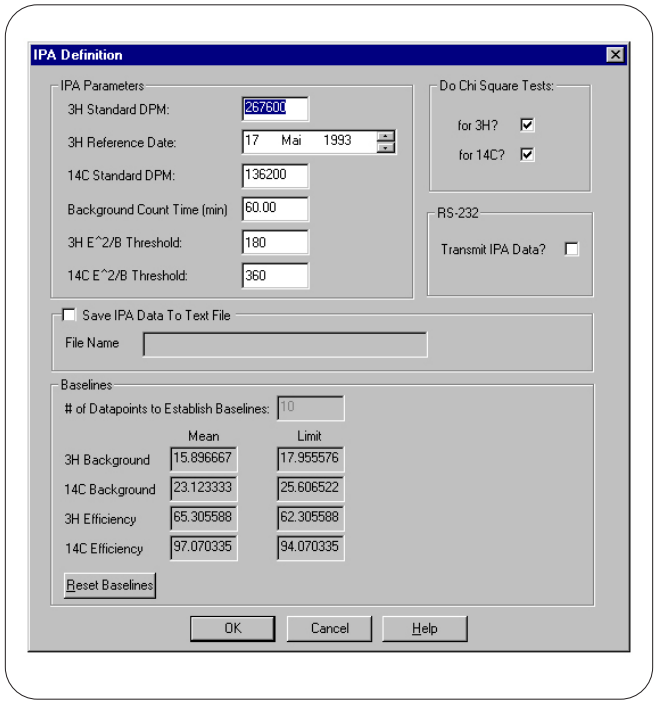


Figure 2: The IPA-Definition dialog box.

For both, the ^{3}H- and the ^{14}C-sensitivity you can enter threshold values into the software. In case the sensitivity of the instrument will fall below this threshold a warning will appear in the report. The default value for the sensitivity is 180 for ^{3}H and 360 for ^{14}C. Revvity does guarantee these values for all instruments working with the NCM (Normal Count Mode). Instruments using count modes with higher sensitivity will also reach higher values for the figure of merit, but the SNC run is always using the NCM even if the instrument is equipped with higher sensitivity. Table 1 gives an overview of the possible count modes and expected FOM values. If you run an IPA assay you will automatically get the E^2/B-value determined in the energy windows mentioned in Table 1.

The measured IPA data can be saved in a text file upon activation of the corresponding IPA box. It is also possible to print out the IPA block data information. This can be done in the report definition tab and allows printout of IPA data including graphics.[7)]

Table 1: Performance of the different measurement modes.

Count Mode	Isotope	Energy window	E2/B
NCM*	^{3}H	1-18.6	180
	^{14}C	4-156	380
HSCM†	^{3}H	1-12.5	300
	^{14}C	14.5-97.5	950
ULLCM‡	^{3}H	1-12.5	500
	^{14}C	14.5-97.5	1400
SLLCM§	^{3}H	1-12.5	880
	^{14}C	14.5-97.5	6000

* NCM = Normal Count Mode, IPA-Läufe werden nur im NCM durchgeführt.
† HSCM = High Sensitivity Count Mode
‡ ULLCM = Ultra Low-Level Count Mode
§ SLLCM = Super Low-Level Count Mode

Besides the "figure of merit" you can also use the **χ^2-value** (Chi^2-value)[8, 9] as one performance parameter. With this parameter you get some information abou the stability of the instrument. This parameter calculates the theoretical standard deviation and compares this value with several short-term measurements done with the instrument.
The **χ^2-value** will be calculated using the following formula:

$$\chi^2 = \sum_{i=1}^{m} \frac{\left(x - \bar{x}\right)^2}{\bar{x}}$$

$\bar{x}$ = Arithmetic average
i = Number of measurements
x = Value of each individual measurement

In case the Chi^2-value for 20 short term measurements for a ^{3}H or ^{14}C standard is within an acceptable range, the variation of counts of individual samples are a result of the counting statistics only but not a result of an instrument problem. You can use check boxes to activate this test for one or both isotopes. If desired, you can transfer all the IPA data via RS-232 interface. This rather old interface is not used by many customers anymore because many liquid scintillation counters are using networks nowadays which are more convenient and faster.

A further very important point is the definition of the baseline for background and counting efficiency for ^{3}H and ^{14}C. At least 5 IPA measurements have to be done before you can determine the baseline. However, if you like you can use more measurements to define the baseline.

A graphical display of the acquired data is only possible if the number of measurements entered in "# of Datapoints to establish Baseline" has been acquired. Based on these measurements the software will determine a baseline and all future deviations will be determined using this baseline.

The columns "Mean" and "Limit" will show the average of the baseline runs and the limit. The limit will be calculated as 4 SE (statistical error based on counts) above baseline. If this limit will be reached an error message will appear in the main window on the screen.

IPA charts and tables

The second option in the IPA menu is the "Charts & Tables" option. When you click this option, you will get the window shown in figure 3. In the pull down menu "Current IPA Chart", you can choose the parameter you want to see on this page. The following parameters can be chosen from the list:

1. ^{3}H Efficiency
2. ^{14}C Efficiency
3. ^{3}H Background
4. ^{14}C Background
5. E^2/B for ^{3}H
6. E^2/B for ^{14}C
7. χ^2-value for ^{3}H
8. χ^2-valuer for ^{14}C

For each parameter you choose from the list you will see a table on the right listing all of the measured values with date and validity (checkbox). Invalid values can be deactivated if you choose by accident a wrong sample as the IPA standard. In such a case you can use the checkbox to prevent the software from using this data point for calculations, but the value will stay in the library. The data point will not be used anymore for the calculation of the average or the standard deviation. Because the data in the IPA library will be saved for the total lifetime of the instrument very long tables can result. To allow viewing of details in the graphical display it is possible to choose an interesting range for your data. By activating the "Date Range" checkbox, you can enter a Start- and End- Date. If you are interested in the IPA option, you can contact our service department or your responsible account manager from Revvity. All Tri-Carb systems using the QuantaSmart software can be upgraded with the IPA-option in the field. The part number for this software option is 7001661.

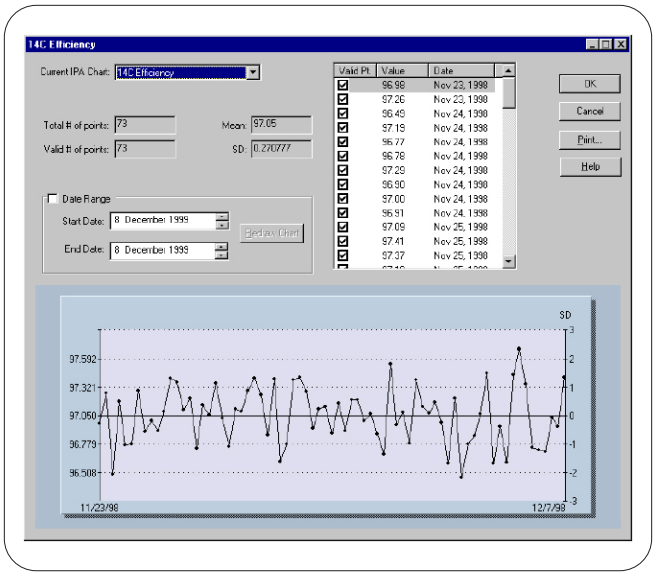


Figure 3: Charts & tables page.

Literature

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