DTU Nutech
Center for Nuclear Technologies

User Manual

Photon Timer attachment for Risø TL/OSL reader

Risø, April 2013

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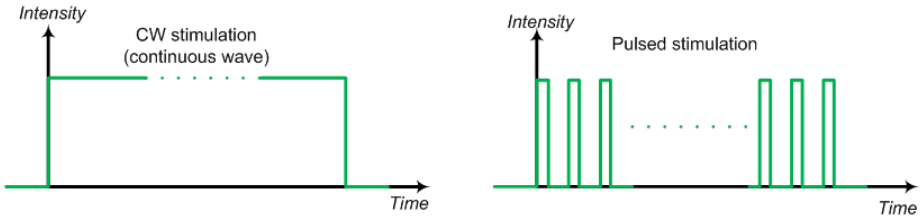
1. Introduction

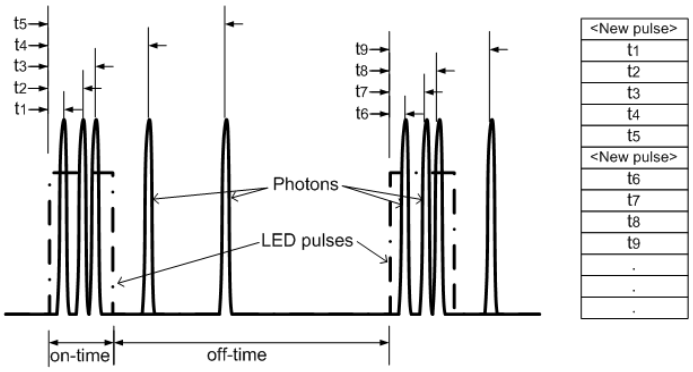
The standard Risø TL/OSL reader detects light emitted from a sample when stimulated thermally or optically. The emitted light intensity is detected as the number of photons in subsequent timeslots called channels. The minimum channel width is 2 ms.
The Photon Timer Attachment makes it possible to record when each individual photon is detected with very high time resolution (0.1/1 ns). This may be useful in connection with pulsed stimulation.

The standard Risø TL/OSL reader does Continuous Wave optical stimulation. With the Pulsed OSL attachment installed you may do pulsed stimulation as illustrated in the figure below



(cf. Guide to "The Risø Pulsed OSL attachment")
This attachment allows pulsed stimulation the LEDs in the stimulation head. It also provides the ability to gate the light detected, so only light in the off-period is detected.

The photon Timer is used in connection with the Pulsed OSL attachment. The Photon Timer records all photon events sequentially in a list file. For each stimulation pulse a marker is inserted in the list file, and each photon detected during the subsequent pulse period (pulse period = on-time + off-time) is recorded with its photon arrival time. This is illustrated in the figure below where the plot shows the arrival of photons relative to the stimulation pulses, and the list to the right in the figure illustrates the recorded list of photon events.



This method gives us full flexibility in the post processing, at the cost of increased file size.

The program *PTanalyse* allows you to present and analyse the Photon Timer data acquired. *PTanalyse* is included in the software package for the Risø TL/OSL Reader.

This User Manual describes how to install the attachment, how to acquire Photon Timer data and how to analyse the Photon Timer data.

The Pulsed OSL attachment and the Photon Timer attachment have been presented in :

Radiation Measurements 44 (2009) 571-575,
Development of pulsed stimulation and Photon Timer attachments to the Risø TL/OSL reader,
T. Lapp, M. Jain, C. Ankjærgaard, L. Pirtzel

2. Installation

The Photon Timer attachment consists of

- An extension of the Pulsed OSL attachment with extra control signals for the Photon Timer (ORTEC 9353 Time Digitizer or PicoQuant TimeHarp 260) board
- A Photon Timer board to be installed in a PC PCI-slot (ORTEC 9353 Time Digitizer) or PCI-Express-slot (PicoQuant TimeHarp 260), with software driver
- 3 connection cables for connecting the Photon Timer board to the Pulsed OSL attachment board
- A software license for the sequence editor extension and a program (PTanalyse) for analysis of Photon timer data

The Photon Timer (ORTEC 9353) board is installed as described in the *"Hardware and Software Users's Manual"* that comes with the board. Also the standard software for the ORTEC 9353 board is installed as described in the manual.

The Photon Timer -PicoQuant TimeHarp 260 board is described in the "TimeHarp 260" manual that comes with the board. This is how installation is done:

1. Install the Risø TL/OSL software package.
2. The TimeHarp260 board is installed in the PC in the PCI-Express slot, and the 4-pin power plug is connected to the internal PC-power supply. An extension power cable is also supplied, which may be needed on some PC models.
3. When The PC is turned on after installation of the board, the operating system automatically detects the new hardware. It will ask for the driver, and you browse to the driver directory that has been installed with the software *"<program directory>\TH260 Driver"* (<program directory> may be e.g. *c:\Program Files(x86)\Risoe*). You do not need to install the standard software that comes on a disc with the board, for operation with the TL/OSL reader.

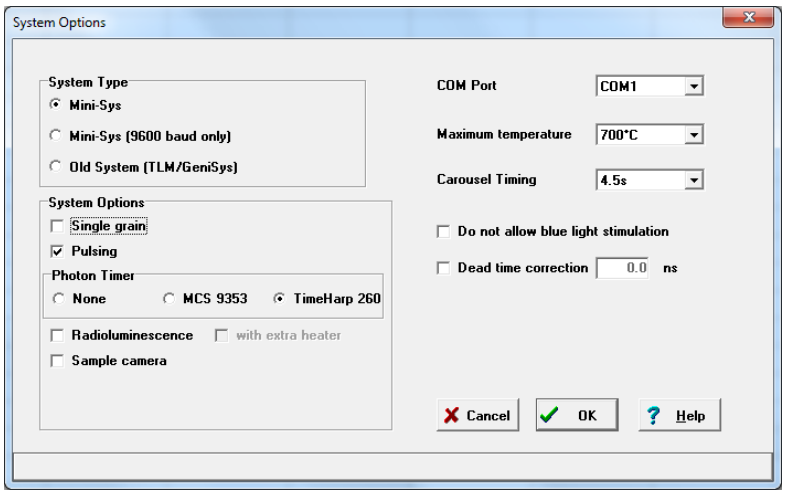
4. Connect START on Controller back to “S” on TimeHarp260. Connect STOP on Controller back to “1” on TimeHarp260. Connect ACK on Controller back to 15-pin sub-D connector on TimeHarp260.

The *Sequence Editor* and *PTanalyse* programs are installed from the “TL/OSL Software” disk that comes with the Risø TL/OSL system. The Sequence Editor must be V.3.32 or higher. For operation of the PicoQuant TimeHarp 260 board the Sequence Editor must be V.4.2 or higher.

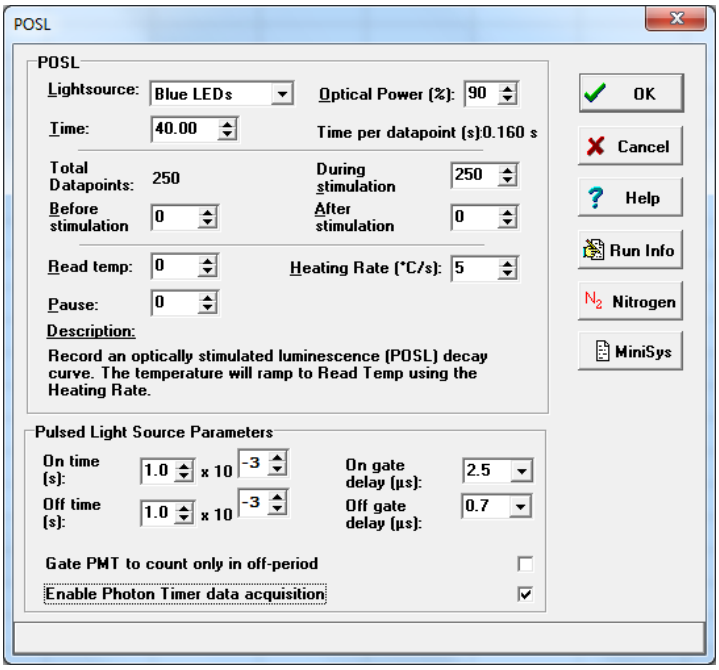
The license file (*license.ini*) for you particular Photon Timer board is copied to the directory where the *Sequence Editor* program is installed. The default directory for the *Sequence Editor* is *C:\Program Files\Risoe\TL*. If the license file is lost, a copy may be obtained by contacting Risø (osl@ntech.dtu.dk)

3. How to acquire Photon timer Data

For acquisition of Photon Timer data you use the standard *Sequence Editor* program. To be able to acquire Photon Timer data, you need to mark the *Pulsing* and *Photon Timer* options in the *System Options* as shown in the figure below



To acquire Photon Timer Data from a Pulsed OSL stimulation you just mark *“Enable Photon Timer data acquisition”* as show in the POSL dialog in the figure below



For each POSL command with Photon Timer enabled, a Photon Timer data file is generated. The name of the file is derived from bin-file name, run no., set no. and sample no:

<bin-file name>_<run no><set no><sample no>.<PTdata extension>

<PTdata extension> = TRC for the ORTEC board and =PQ2 for the PicoQuant board.
E.g. *Q091026_010225.PQ2* is the file containing Photon Timer data from run=1, set=2, sample=25 of the data acquisition that produced bin-file *Q091026.bin*.

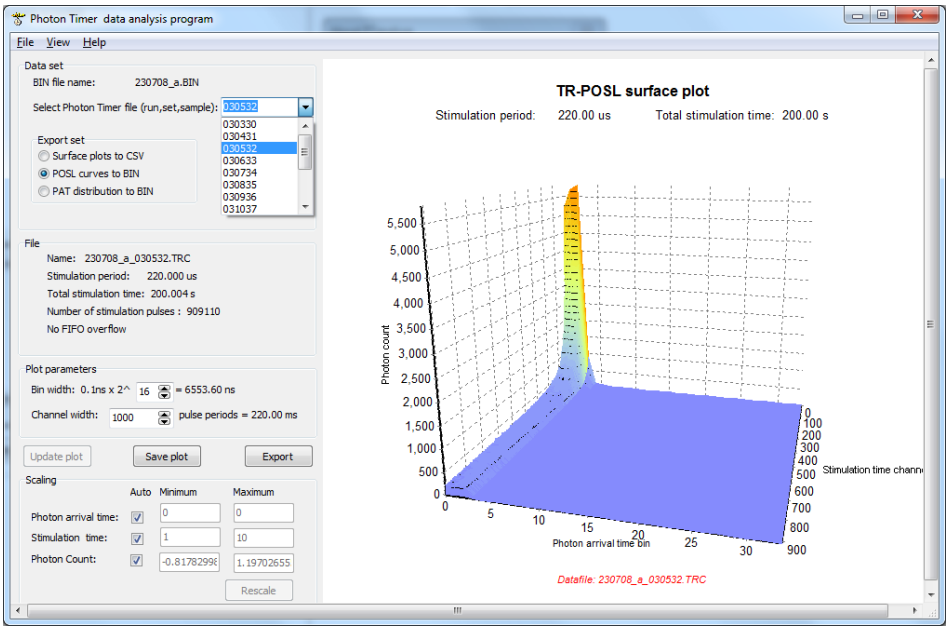
4. How to analyse Photon timer Data

4.1. Open file

For presentation and analysis the program *PTanalyse* is used.

You may open the individual *.TRC* or .PQ2 files either directly via *File→Open file...* or from a set of *.TRC* /.PQ2 files associated with a *.BIN/.binx* file via *File→Open data set...*

If you chose to open via a data set, you are prompted for a name of the *.BIN* file that was generated from the run. When the *.BIN* file has been selected you may chose the individual *.TRC* files via the list box as shown below



After opening the file, a 3D surface plot of the data is shown.

All data are time-stamped with a resolution of 100 ps. The *stimulation period = on-time + off-time* is divided into a number of *Photon arrival time bins*, and the total stimulation time is divided into a number of *Stimulation time channels*. The 3D surface plot shows the *Photon counts* accumulated in *Photon arrival time bins* and *Stimulation time channels*.

4.2. TR-POSL surface plot

4.2.1. Changing bin width

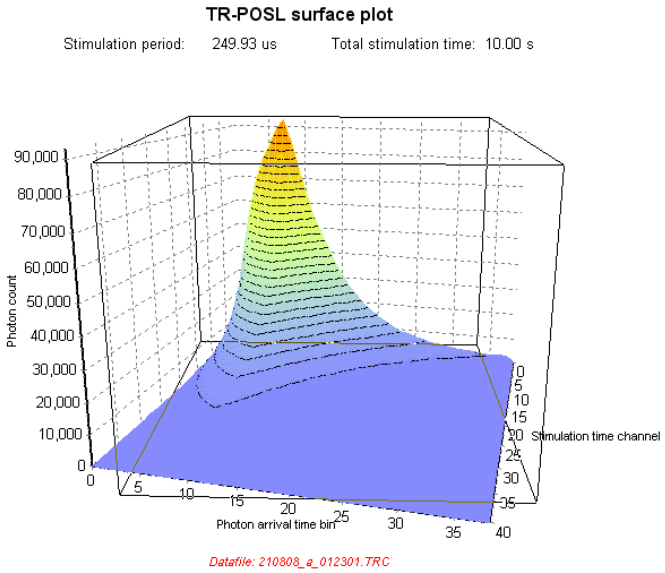
The *Photon arrival time bins* are time intervals for the photon arrival time relative to the start of the stimulation pulse. The minimum bin-width (or time stamping resolution) is 0.1 or 1.0 ns depending on your Photon Timer board (Ortec: 0.1 ns, TimeHarp: 1.0) and may be changed in steps of a factor of 2. I.e. the bin width can be changed to 2^n × minimum bin-width, where n = 1,2,3,..... When you have changed the bin width, the *Update plot*-button is enabled, and the plot may be updated with the new bin width by pressing this button.

4.2.2. Changing channel width

The *Stimulation time channels* are acquisition time intervals relative to the start of the acquisition. You may choose a channel width as an integer number of pulse periods. When you have changed the channel width, the *Update plot*-button is enabled, and the plot may be updated with the new channel width by pressing this button.

4.2.3. Rotation of the 3D surface

If you press the left mouse button on the surface plot, the outline of the 3D plot is show by vertexes of a box.



Keeping the mouse button down and moving the mouse at the same time allow you to change the angle from which you see the surface. When you release the mouse button the surface plot is redrawn with the new angle of view.

4.2.4. Scaling of the 3D surface

By default the axis are scaled automatically, but you may manually define the minimum and maximum of each axis. You do this by

- removing the check mark in the *Auto*-column
- entering valid minimum and maximum parameters
- pressing the *Rescale*-button

If you mark the *Auto*-checkbox the plot is automatically rescaled

4.2.5. Save plot

If you press the *Save Plot*-button you are prompted for a bitmap (.bmp) file name. The current surface plot will then be stored as a bitmap file that may be printed out directly or used in e.g. Word documents.

4.2.6. Export

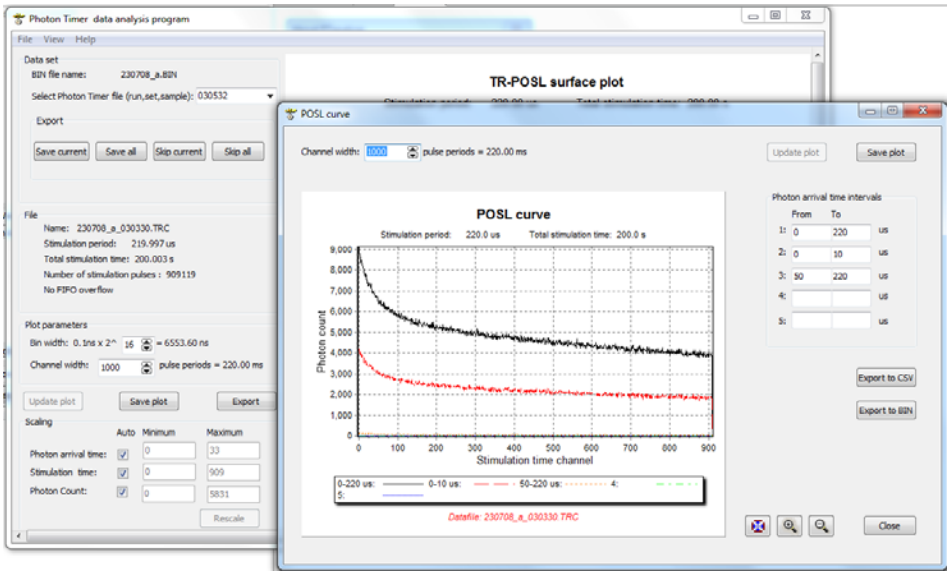
If you press the *Export*-button you are prompted for a name of a Comma Separated Values text (.csv) file. All the data of the current surface plot including acquisition and plotting parameters are stored. The file format may directly be read by e.g. spreadsheet programs. In the figure below is shown a part of a file, read by Excel:

	A	B	C	D	E	F	G	H	I
1	File name:	C:\RisoeTL\Bin\cank\210808_a_012301.TRC							
2	Stimulation period [us]:			249.93		Bin width [ns]:		6553.6	
3	Total Stimulation Time [s]:			10		Channel width [ms]:		249.93	
4									
5	Bin\Chan	0	1	2	3	4	5	6	
6	0	15440	13190	11167	9368	7813	6436	5554	46
7	1	38849	32622	27204	23059	19029	15868	13667	114
8	2	54975	46533	38985	32925	27750	23194	19567	166
9	3	67236	57108	48110	40704	34342	29375	24422	205
10	4	76440	65483	55181	47017	39753	33759	28703	245
11	5	83444	71591	60750	52259	44102	37390	32005	271

4.2.1. Export Set

This button is in the “Data set” group. This button is used for exporting all processed data from the entire photon timer data set. You may chose to export either Surface plots to CSV text files, Pulsed OSL curves to BIN files or Photon arrival time distributions to BIN files by pressing the appropriate radio button.

When the “Export set” button is pressed, the first processed data (Surface plot, POSL curve or PAT distribution) is shown. You may change the parameters for the data processing (cf. 4.2 TR-POSL surface plot, 4.3 POSL curve, or 4.4 Photon Arrival Time distribution) before saving. If you change parameters, remember to press “Update plot” before saving:

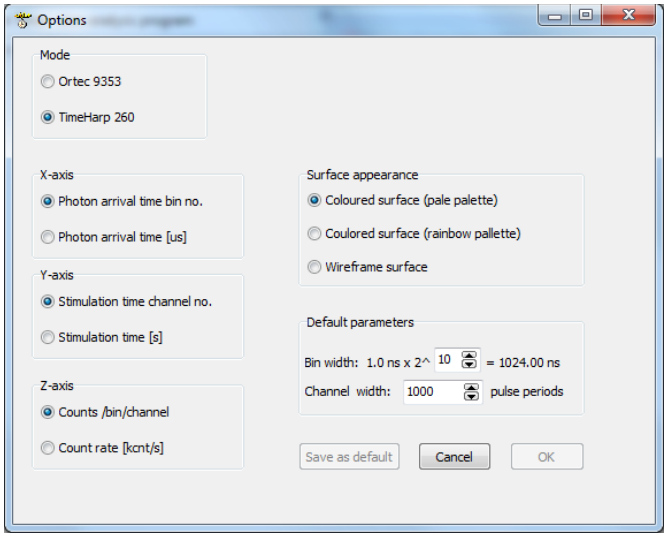


You may then choose between

- Save current (exports the currently shown processed data)
- Save all (exports the currently shown and all remaining processed data)
- Skip current (skips the currently shown processed data)
- Skip all (skips the currently shown and all remaining processed data)

4.2.2. Options

In the *File→Options* dialog you may change axis units and other plotting parameters. You may furthermore store the settings as default settings that are applied when you open the program again.



In the *Mode* box you select the board that your Photon Timer attachment is equipped with.

The photon arrival time may be given in either bin no. or as time in µs.
If you select bin no. as the unit, the stimulation period is written on the plot.
If you select time in µs as the unit, the bin width is written on the plot.

The stimulation time may be given in either channel no. or as time in s.
If you select channel no. as the unit, the total stimulation time is written on the plot.
If you select time in s as the unit, the channel width is written on the plot.

The photon counts may be given in ether counts/bin/channel or as count rate in kcnt/s (kilo counts per second)

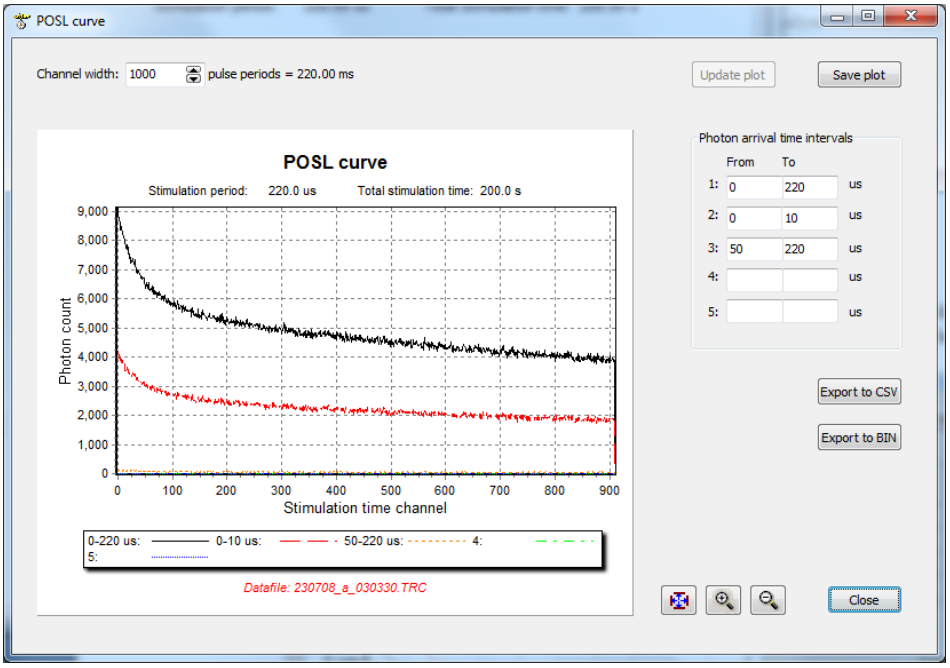
You may select between 3 different appearances of the surface and choose the default setting of the bin width and the channel width.

If you press the *Save as default*-button, the setting is stored in the file *PTanalyse.cfg* which is read when the program is started.

4.3. POSL curve

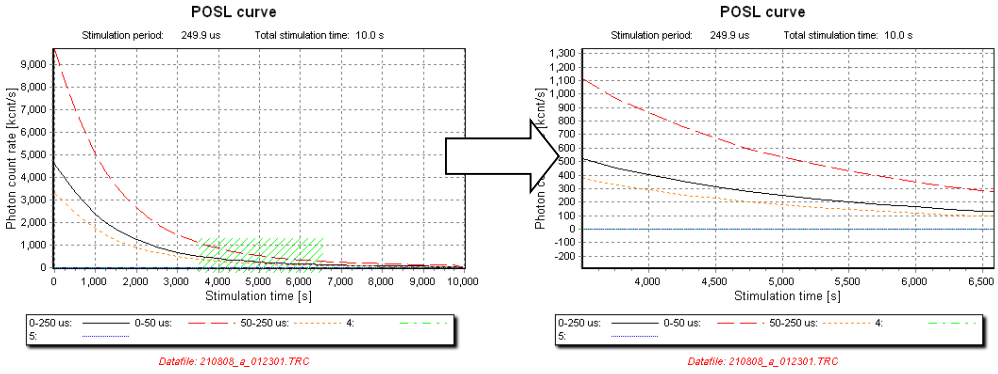
You may want to see the decay of the signal obtained in a certain photon arrival time interval. This corresponds to gating the signal in the POSL command with the Pulsed OSL attachment. However, with the *Photon* Timer you do the gating after the acquisition and several gating intervals may be defined without any limitations.

For this you select *View→POSL curve.* The plot starts out with one gating period or *Photon arrival time interval* covering all the stimulation period. You may freely define up to 5 different *Photon arrival time interval*s. When the *Update plot*-button is pressed the corresponding POSL curves are plotted as shown in the figure below



4.3.1. Scaling

With the  and  buttons you may scale the plot. You may also use the mouse to zoom into a particular part of the plot: Press the left mouse button on the upper left corner of the region you want to expand, and draw the mouse to the lower right corner of the region you want to expand. The region is marked with a green line pattern as shown in the figure below, and when you release the button, the plot is expanded to show the marked region.



To rescale the plot automatically you may press the  button

4.3.2. Save plot

If you press the *Save Plot*-button you are prompted for a bitmap (.bmp) file name. The current POSL curve plot will then be stored as a bitmap file that may be printed out directly or used in e.g. word processor documents.

4.3.3. Export to CSV

If you press the *Export to CSV*-button you are prompted for a name of a Comma Separated Values text (.csv) file. All the data of the current POSL curve plot including acquisition and plotting parameters are stored. The file format may directly be read by e.g. spreadsheet programs. In the figure below is shown a part of a file, read by Excel:

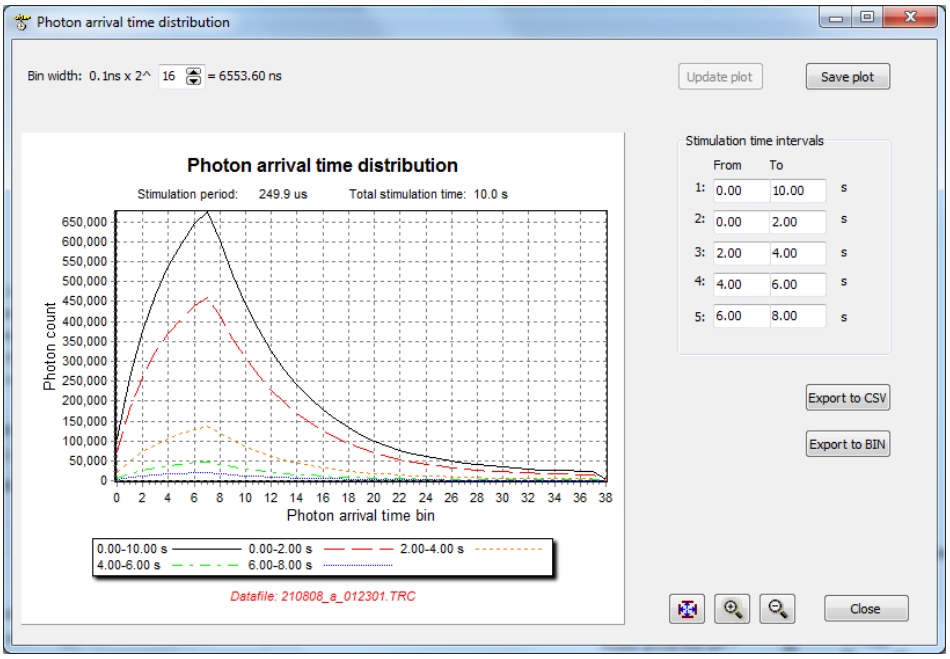
	A	B	C	D	E	F
1	File name:	210808_a_012301.TRC				
2	Total Stimulation Time [s]:		10	Channel width [ms]:		249.93
3						
4	From [us]:	0	0	50	0	0
5	To[us]:	250	50	250	0	0
6	Channel\Interval:	1	2	3	4	5
7	0	1147548	484397	663151	0	0
8	1	990415	413577	576838	0	0
9	2	838012	349823	488189	0	0
10	3	709427	298031	411396	0	0
11	4	598450	251848	346602	0	0
12	5	506098	213896	292202	0	0
13	6	427802	181565	246237	0	0
14	7	364835	154959	209876	0	0

4.3.4. Export to BIN

If you press the *Export to BIN*-button you are prompted for a name of a BIN file (The default name is the name of the TRC/PQ2 file). If you have more than one "Photon arrival time interval" a section for each interval is stored in the BIN file. The "Photon arrival time interval" parameters are stored in the comment field so you will be able to distinguish the data (because they will all have the same run, set and sample ID). They will also be given a different Curve No., which is a header parameters that is shown with Version 4 or later of the Viewer program.

4.4. Photon Arrival Time distribution

The *Photon arrival time distribution* within the *stimulation period* may change during the total stimulation time. You may plot the *Photon arrival time distribution* in specified time intervals by selecting *View→Photon arrival time distribution.* The plot starts out with one *Stimulation time interval* covering all the total stimulation time. You may freely define up to 5 different *Stimulation time interval*s. When the *Update plot*-button is pressed the corresponding photon arrival time distribution curves are plotted as shown in the figure below



4.4.1. Scaling

Scaling is done with mouse and buttons as described in 4.3.1

4.4.2. Save plot

The *Save Plot*-button works just as the button on the *TR-POSL surface plot* window (4.2.5) and the *POSL curve* window (4.3.2).

4.4.3. Export to CSV

If you press the *Export to CSV*-button you are prompted for a name of a Comma Separated Values text (.csv) file. All the data of the Photon Arrival time Distribution plot including acquisition and plotting parameters are stored. The file format may directly be read by e.g. spreadsheet programs. In the figure below is shown a part of a file, read by Excel:

	A	B	C	D	E	F
1	File name:	210808_a_012301.TRC				
2	Stimulation period [us]:		249.93	Bin width [ns]:		6553.6
3						
4	From [s]:	0	0	2	4	6
5	To [s]:	10	2	4	6	8
6	Bin\Interval:	1	2	3	4	5
7	0	105892	73670	20077	7192	3207
8	1	259364	181724	48698	17178	7548
9	2	374292	260581	71699	25188	10882
10	3	466484	322324	91136	31717	13894
11	4	538945	370958	105862	36937	16468

4.4.1. Export to BIN

If you press the *Export to BIN*-button you are prompted for a name of a BIN file (The default name is the name of the TRC/PQ2 file). If you have more than one "Photon arrival time interval" a section for each interval is stored in the BIN file. The "Photon arrival time interval" parameters are stored in the comment field so you will be able to distinguish the data (because they will all have the same run, set and sample ID)