StreakCam measurement – How to

Do first
- Optimize laser
- Optimize photonic fiber (if used)
- Calibrate monochromator (needed every time the monochromator is switched on)

Terms

MCP : multi channel plate : an electron amplifier inside the streak camera. The gain sets the amplification.

The monochromator slit is vertically and determines the spectral resolution (e.g. 10 um)
The StreakCam slit is horizontal and determines the temporal resolution (e.g. 20 um).

Streakcam entrance slit and shutter

The streak camera is a very sensitive instrument and can be damaged when too much light falls on it. To prevent light from entering it, there is an entrance **slit** (knob with red arrow: pointing to the left it's closed) and an internal **shutter**, which is operated by the software.
Whenever the streakcam is not measuring, it's best to **always** keep the streakcam slit in the closed position (red arrow to the left).
The entrance slit starts to open at the 12:00 position (pointing up). It has a scale (in micron) to show how far it is opened.

Streak camera : "Synchroscan" vs "Slow speed" mode

The streak camera can do 2 types of measurements. Fast & slow.
Both methods have their own physical hardware module (time module), which should be inserted in the streak camera.

- **Synchroscan** (Fast : 4 timebases: 165, 800, 1450 & 2200 ps).
This uses the 76 MHz output of the laser.
  2 coax cables :
  Trigger diode -> Delay Unit [C1097-04] : "IN/50 ohm"
  Delay Unit [C1097-04] : "Out 50/ohm" -> SynchroScan [M5675] : "Sync IN/50 ohm"
Inverted image : Since the Synchroscan time unit used a sort of triangular-shaped time-sweep profile, it's also possible to see a signal where the time decreases from top to bottom.
In this case, change the delay, until you find an image where the time increases from top to bottom.

- **Slow speed** (Slow : 5 ns - 5 us), also called "Single sweep".
This uses the 0.2 – 1.9 MHz output of the pulse picker (+maybe doubler/tripler) after the pulse picker.
  3 coax cables :
  Cavity dumper : "Rep Rate Sync Out" -> Trigger Unit [C4792] : "External Trigger In"
  Trigger diode -> Trigger Unit [C4792] : "Modelock Clock In"
  Trigger Unit [C4792] : "Streak Out" -> Slow Speed Sweep Unit [M5677] : "Trig in"

In “Slow speed” we have (each time) to specify in the C4792-01 menu : **Trig Mode = Dump Mode**
If we don't do this, the green trigger light on the streak camera blinks only one per second.

Measurement software

A link to the streakcam measurement program can be found on the desktop and is called: “HPDTA”. After starting it, you should choose the ‘hardware profile’, which corresponds to the inserted time module (Synchroscan or Single Sweep).

Excitation sources

The most used excitation sources are :
- **76 MHz** laser radiation using the photonic fiber (> 520 nm ?), using a band pass filter after the fiber
- the doubled laser radiation at **1.9 MHz** (about 380-450 nm)
[It’s also possible to use the doubled 76 MHz, or the 1.9 MHz with the fiber]

Optimizing the signal

The actual, to be measured, signal might be very weak, so it’s easier to align the optics and sample placement with a **cuvette with very fluorescent laser dye**, e.g. Rhodamine 6G.
If your actual sample is a thin film on a cover slide, it’s also possible to align everything using a cover slide with laser dye in PMMA.

- Use as excitation light e.g. 530 nm from the fiber (530 band pass filter after fiber), or the light from the doubles (~400 nm).
- Put a 570 nm long pass filter in front of the monochromator. This should block any excitation light.
- Close the streakcam entrance slit (red arrow to the left)
- Insert the cuvette laser dye in the cuvette holder. The cuvette should have an angle of slightly less then 45 degrees with respect to the excitation light.
- make sure the reflected excitation light does not hit the monochromator slit. It should fall left of the first lens.

- In the HPDTA software :
C5680+M5675
  Time range : does not matter
  Mode : focus (means: no time sweep). All the light is on a single (middle) horizontal line.
  Gate mode : normal
  MCP gain : 10-20
  Shutter button : closed (this is the shutter inside the streak camera. Not the one with the red arrow)
  Gate time : 0
  Delay : 0
  FocusTimeOver : 5
Chromex (monochromator)
  Wavelength : 500 or so

Grating : 40.7 g/mm
Slit width : 10 micron (this is the smallest value)

Make sure the streakcam slit is still closed (arrow to the left)

Menu : Acquisition, Live
press : Action Live
Popup question “Use auto streak shutter & MCP gain ?” :
No = you want to do this manually. Yes = open internal shutter and use previous MCP gain.
“Acquisition live” continuously acquires the image and simply measures the light (as is) which falls on the camera. Only useful for optimization.

Press the “*” in the bottom right area of the “LUT Control” window.
LUT = “Lookup table”. It translates a camera pixel value to a color.
Pressing the “*” automatically sets the minimum and maximum value, based on the current measured values.
Doing it without having any light in the streakcam (slit & shutter still closed) always starts you up with default (and very conservative) min & max values. Any light will now immediately show up as black areas on the screen. This makes it easy not to overflow the streak camera with light.

Using the “2 vertical lines” button (top), select the region (with the signal) in the middle of the display (by dragging over the center line at the position of the signal).
Right click on the image display and select “Quick profile”. This now shows the integral value between the selected signal region on the right side of the image (in the middle).

If still closed, set “Shutter” option to “open”.

While keeping an eye on the screen, slowly open the streak camera slit.
It just opens when the red arrow is in the 12:00 position.

If only a very little light is seen on the image display, open it until 14:00 position (20 micron).

Any signal should now be in the (vertical) center of the screen, since in Focus mode the time scan is not used. The integral of the selected signal (between the 2 vertical lines) should show up in the right quick profile.

If no signal is seen in the right profile, you can
!! FIRST CLOSE THE STREAKCAM SLIT AGAIN (red arrow to the left) !!
- increase the slit width of the monochromator (horizontal error)
- increase the slit width of the streak camera (turn it further then 14:00) (vertical error)
- increase the MCP gain
- increase the amount of laser light on the cuvette

Then slowly open the streakcam slit again, while keeping an eye on the screen.

If you see some signal, optimize it, using (first) the position of the cuvette along the incoming laser light. Since it’s at 45 degrees, this sort of scans (horizontally) the light over the monochromator slit. Continue to optimize it, using all 6 controls of the 2 lenses before the streakcam. Maybe do it circulate over all 6 controls.

If the signal becomes to large, close the monochromator slit (down to minimum 10 micron), the

streak cam slit (minimum 20) or the MCT gain (minimum 10).
If it's still too large, decrease the amount of laser light on the cuvette.

Keep optimizing everything, until the signal is at it's maximum.

After 5 minutes in FOCUS mode, the shutter inside the streakcam will automatically close (for safety reasons). You then have to stop and restart the live measurement.

When done with optimizing, close the streak cam slit (arrow left) and stop the live acquisition.

The real measurement

The 'real' measurement is done in **photon counting mode**. This means that the MCP gain is set so high, that single photons cause a signal on the camera image.
The light on the camera is integrated for a single "Exposure time" (e.g. 56 ms).
This image is then transferred to the computer
Any signal (a single pixel value) below the threshold is considered to be noise and is ignored.
Any signal (a single pixel value) **above** the threshold is considered to be **one** single photon.
[This greatly reduces the electronic noise]
These photons are then summed to a buffer.
It also means that the amount of light on the streak camera should not be too high : it can not discriminate between 1 or more photons on a single camera pixel (anything above the threshold is considered to be 1 photon).

Replace the cuvette with laser dye with the cuvette with your sample. The alignment should be ok, but it is possible to redo the "Optimizing signal part", if fluorescence clearly can be seen.
Probably, only a lateral movement of the cuvette holder is needed.

Make sure the streakcam slit is still closed (red arrow to the left)

- In the software :
C5680+M5675
  Set mode : Operate (this means that it will use the time sweep)
  Time range : e.g. 4
  MCP gain : 63
  Shutter : closed

Acquisition control :
  Choose : Photon counting
  Exposure : 56 ms is ok
  # of exposures : e.g. 10000 (= 9.5 minutes)
  Clear on start : checked

  The threshold (the pixel signal above which it is considered to be a photon) : 43
  [this can be re-measured with the button : "Setup", but normally not needed]

To start the measurement : press "Count"
(Popup question : "Use auto streak shutter & MCP gain ?" : No = you want to do this manually. Yes = open internal shutter and use previous MCP gain.)

Once it started measuring, press the star on the LUT window. The range should now be 0-4
C5680+M5675
MCP gain : 63
Shutter : open
Slowly open the streakcam slit (red arrow) to the position used during optimization, e.g. 20 micron

The signal should now become visible from top to bottom.
The Time=0 position can be shifted vertically with the delays of the delay unit.

On the most intense part of the signal, drag a small rectangle, using the 'square' ROI button on top. In the acquisition control panel (at the bottom) it now shows ("Above thresh [%]") the percentage of pixels in this square (during 1 exposure (e.g.56 ms)) which contain a photon. This number should be less then 5%, to reduce the possibility that 2 photons end up on the same pixel.

During the measurement, you can press the '*' on the LUT window again, to rescale the maximums of the graphs. (don't forget to also click on it at the start of the measurement, to put it back to 0-4).

Time delay settings

Synchroscan (C1097-01)

76 MHz & photonic fiber

Time base	Delay time [ps]	Range [ps]	
1	?	160	
2	700 (old 1280)	800	
3	1050 (old 1650)	1500	
4	1340 (old 2120)	2200	

Doubled light, second mirror after doubler, diagonal over table

Time base	Delay time [ps]
1	?
2	8560
3	8840
4	9340

Slow speed (C4792)

Delays for UV from doubler, to 2nd mirror, diagonal to 2 mirrors & cuvet :
[Pulse picker divider = 20. For higher dividers, T(0) shifts to higher times]

Time base	TD1 [ps]	TD2 [ps]	T(0) [ps] @
5 ns	379000	6500	647
10 ns	360000	9700	667
20 ns	350000	3400	2370
50 ns	288000	9000	10000
100 ns	208000	0	

NB:
- Every extra 3 cm of light path is an extra 100 ps delay
- The delay also depends on the height of the laser beam above the transducer of the pulse picker.
- The delay _might_ also depend on the amount of light on the trigger photodiode.
- TD1 (slow mode) refers to the 13.1 ns time difference of the modelocking. So it's quit coarse & jumpy.

Miscellaneous

Vertical stripes in the spectrum are caused by dust particles on the streakcam entrance slit.

Best practice to remove these dust particles : open entrance slit to 180 degrees, then back to wanted position.

The lens system between the monochromator and the streak camera is made of quartz. For different wavelength it might be necessary the change the focus of this system a bit (big ribbeled ring), since it is not completely achromatic. And if focus is not good, so is the time resolution. There is also a lense between the streak-camera and the ccd-camera : loosen the screw, and turn the ring between the streak and ccd camera, for best focusing.

Little meter shows the amount of bounced signal due to impedance mismatch. This can cause the streakcamera to stop. Minimize : there is a little hole to the left of the front, which gives access to a variable capacitor.