

# XFEL Data: Memory Cell Structure

This depends on both the X-ray beam structure (sometimes 1 or 2 pulses, sometimes 30 pulses) and the detector pattern used.

**The first two memory cells (memory cell index 0 and 1) are always excluded.**

If the name of the bunch structure pattern contains `_2mh*` or `_1mh*`, it was run **with VETO**. Bunch structure patterns without `_2mh*` or `_1mh*` in the name are without VETO.

## Without VETO:

Data taken in:	Data found in:
September - October	every 8th cell
November - December	every 4th cell

The first image should appear in memory cell:

Data taken in:	First image in memcell index:
September - October	4
November - December	2

## With VETO:

Data taken in:	Data found in:
September - October	every 4th cell
November - December	every 2nd cell

The first image should appear in memory cell:

Data taken in:	First image in memcell index:
September - October	4
November - December	2

## The History...

During first user operation only 7 pulses could be recorded. This had various reasons:

XFEL operates at 1.13MHz while the Firmware runs at 4.5MHz. Therefore, a XFEL pulse is saved only in every 4th memory cell.

This means that in order to catch 30 XFEL pulses, at least 120 memory cells are needed. Because each image consists of an amplitude frame and a frame in which the gain level is encoded, in total 240 images have to be read out. As the ADC sampling speed is currently artificially slowed down to 6.25MHz, 240 images can only be read out within 151.2ms. This exceeds the available read out time of 99.4ms between two trains.

## First beam time (p2012)

Therefore, a maximum of ~60 memory cells (120 frames) have been used during user operation. As only every 4th was filled with a pulse, one in principle ends up with 15 saved pulses. But since the first two memory cells are not used by default, one is left with 14 pulses. Due to a Firmware configuration issue, only half of the images could be saved properly. The other half of the images were corrupted and we end up with saving only 7 pulses per train.

For the second day of the beam time (p2012), we decided to use the modified bunch pattern file (with internal veto). It allowed us to veto some empty memory cells and re-use them. At this point we were able to have X-ray pulses in every 2nd memory cell and therefore in total 14 instead of 7 X-ray images.

## 2nd (p2042) and 3rd (p2017) beam times

During the 2nd (p2042) and 3rd (p2017) user experiments we decided to increase the number of memory cells to 64. By that we gained one additional X-ray pulse.

## 4th (p????) beam time to present

Between user runs three and four the aforementioned bug in the firmware was fixed, and the half of the dataset which was corrupt before is now usable. Currently, 64 memory cells are used, of which again the first two are not used at all and every 2nd catches an XFEL pulse. As a result all 30 pulses can be recorded.

## Future

Bunch structure patterns to veto all empty memory cells (to store all 30 pulses in consecutive memory cells) are available but are not tested yet. For this, dedicated commissioning beam time is needed.

Attached is a document written and distributed by Jola after the September user experiments. This document is only valid for the data collected before the firmware was updated (Nov. 1).