# Time Correlated Single Photon Counting at ALBA

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June 15, 2015
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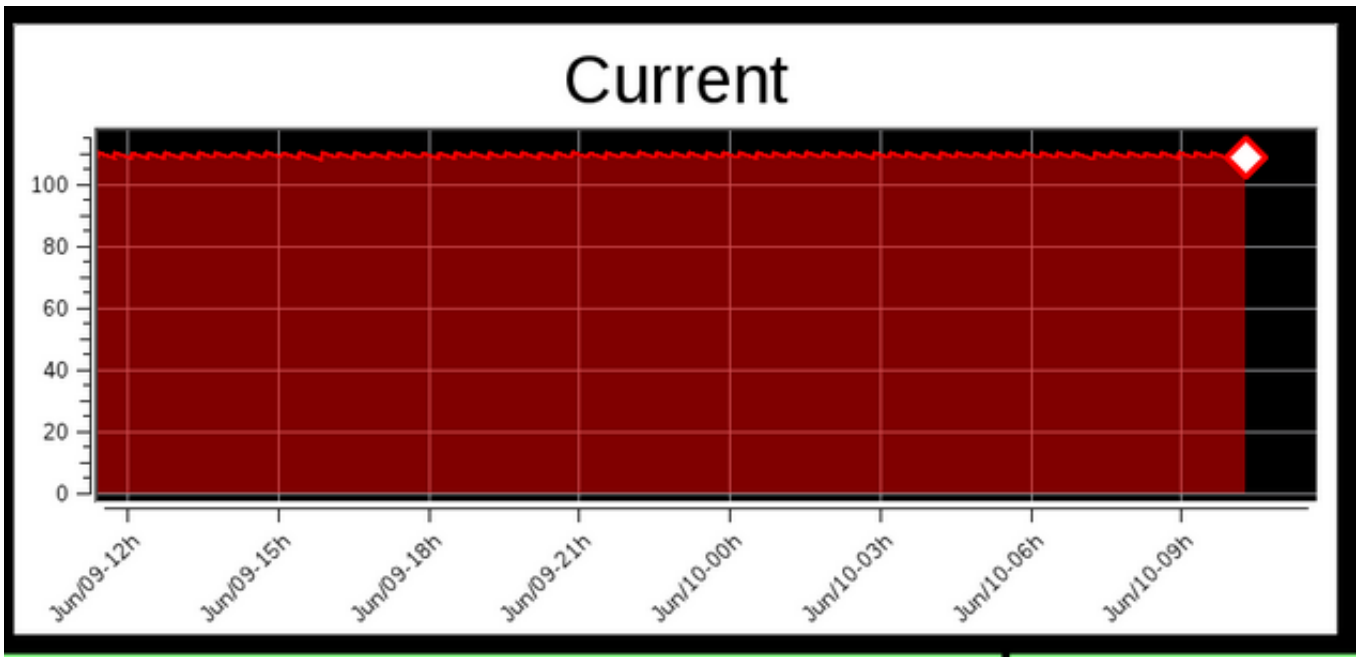
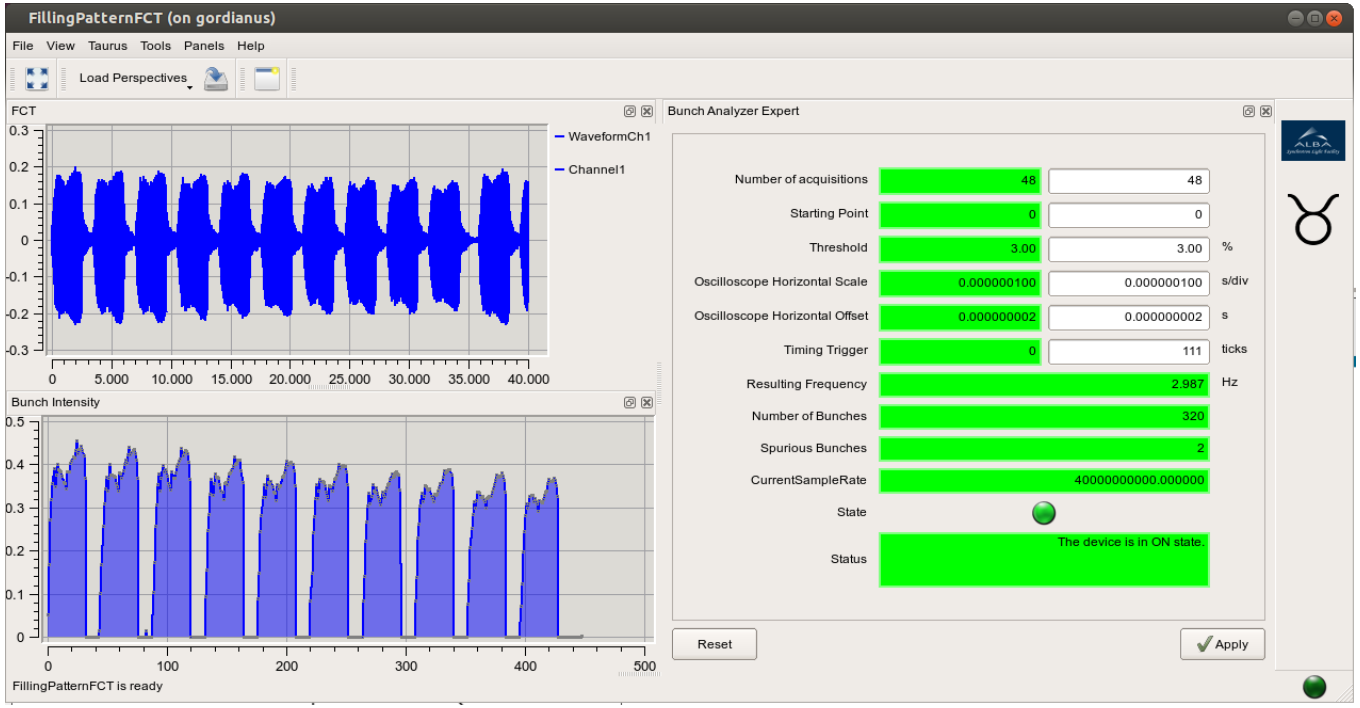
Diagnostic Expert of European Light Sources

# Motivations

Filling pattern measurements are needed for selective top-up operation.
*Future* bunch purity measurements will be needed for time resolved experiments.



# Fast Current Transformer



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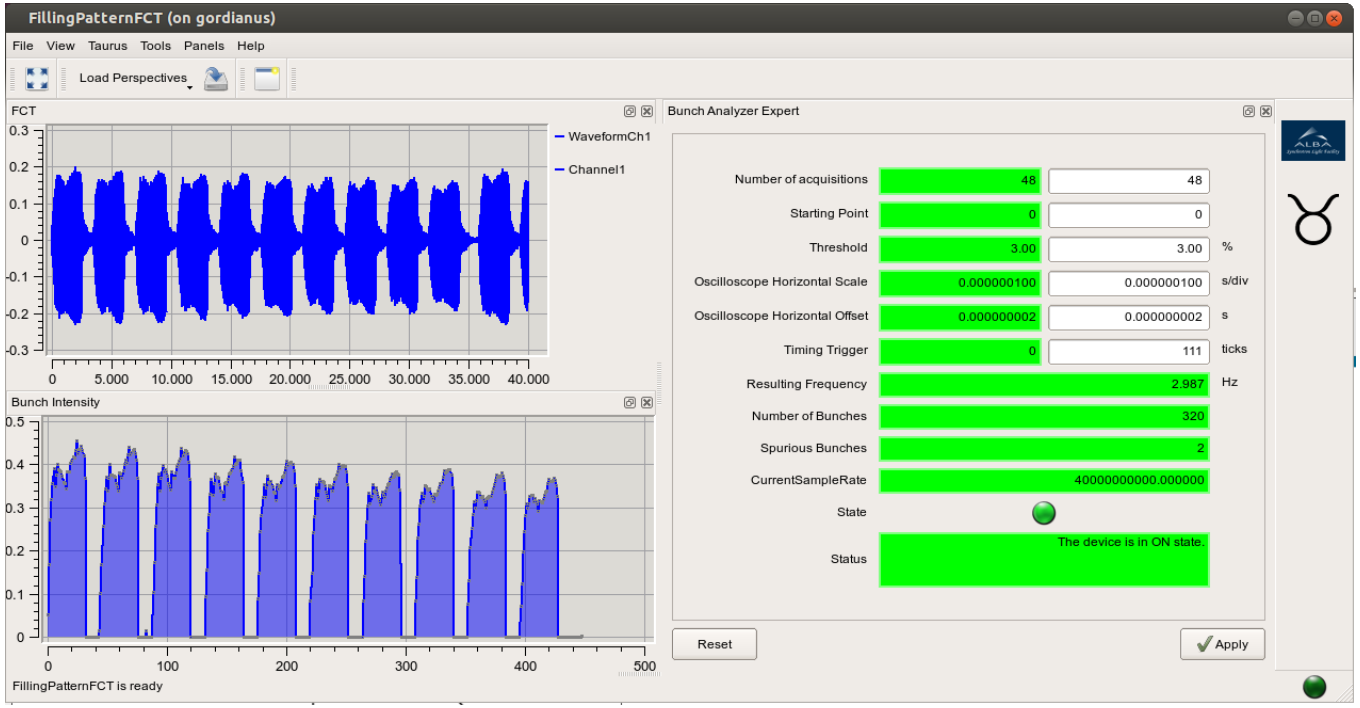


- Reliable
- Online
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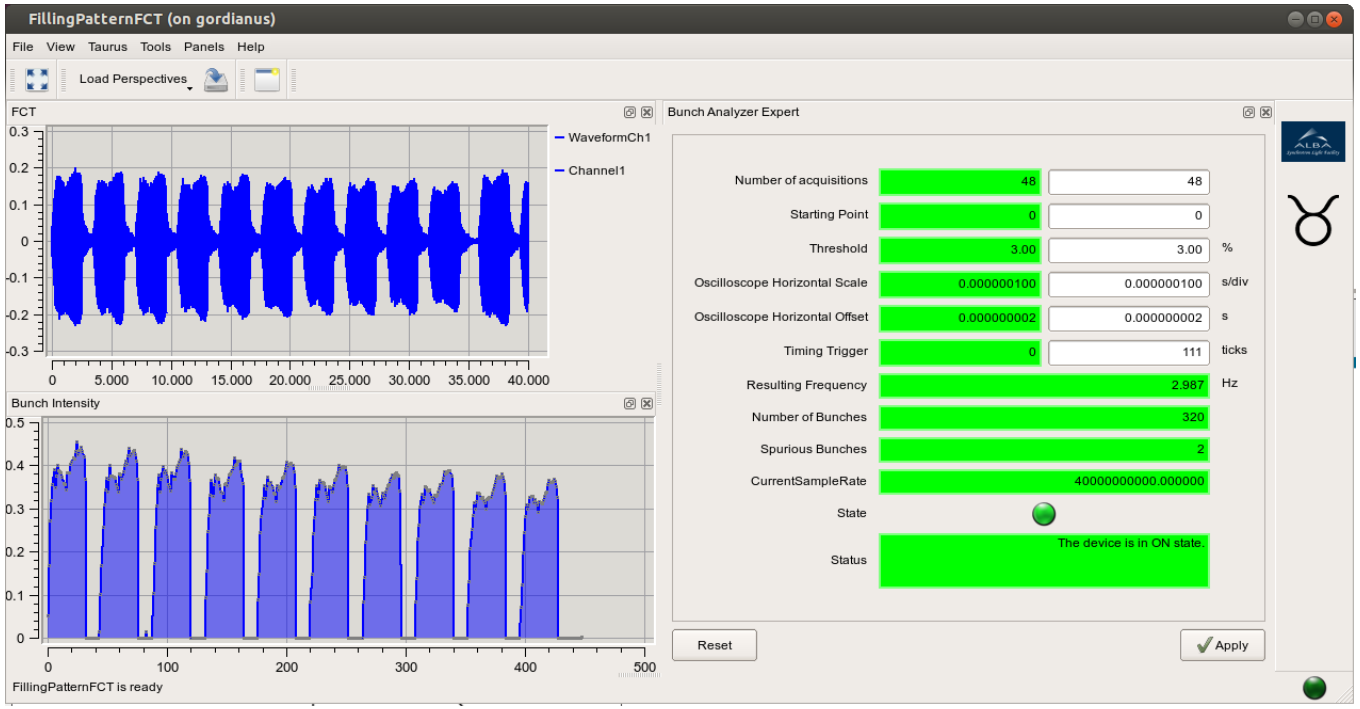


- Reliable
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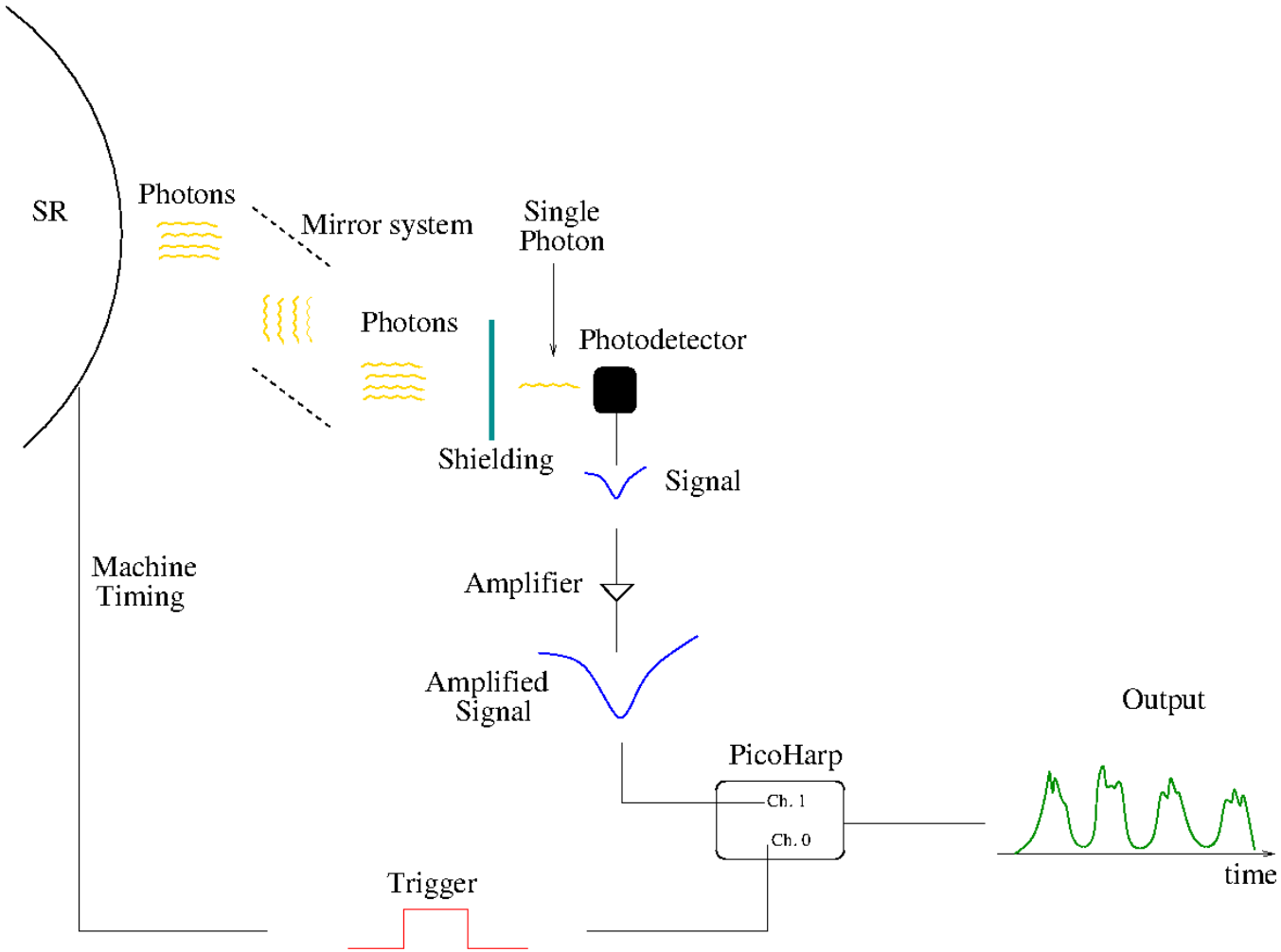
- Shared oscilloscope
- Dynamic range $< 10^2$
- Only way of measurement

# TIME CORRELATED SINGLE PHOTON COUNTING

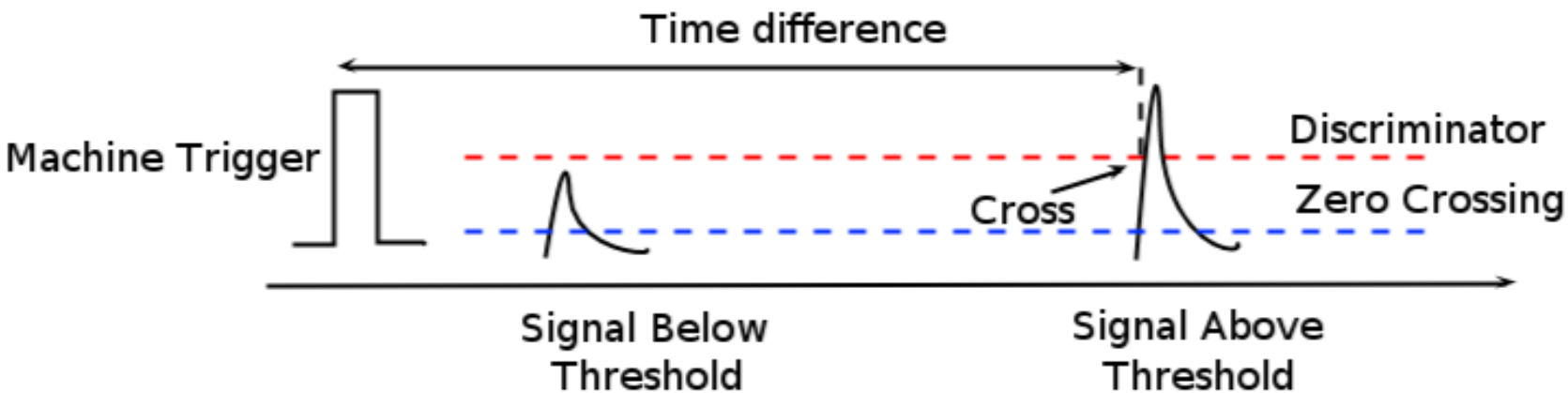


# Photon Detector

| PMT Hamamatsu H10721-210 | |
|---|---|
| Photocathode Material | Ultra Bialkali |
| Spectral Response | 230-700 nm |
| Input Voltage | 4.5-5.5 V |
| Max. Input Current | 2.7 mA |
| Max Output Signal Current | 100 $\mu$ A |
| Control Voltage Range | $0.5 - 1.1$ V |
| Gain (Control Voltage: 1 V) | $10^6$ |
| Dark Current | 10 nA |
| Rise Time | 0.57 ns |
| Ripple Noise (peak to peak) | 0.3 mV |

# Photon Counter


| PicoHarp300 | |
|---|---|
| Input voltage range | 0 to -800 mV |
| Bin width | 4-8...512 ps |
| Maximum sync rate | 84 MHz |
| Dead time | $< 95$ ns |



# Photon Detector Characterization

## Instrumental Response Function

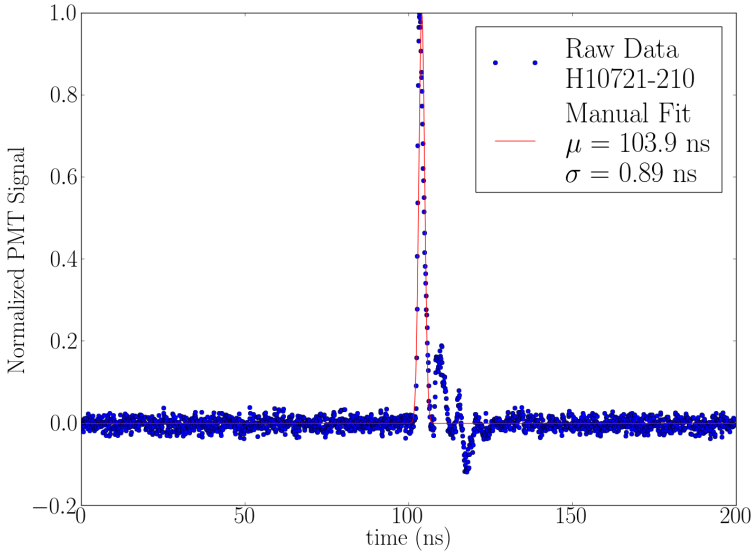



Image from the oscilloscope

$\sigma$ of the output signal of the device when detecting an isolated photon

0.89 ns

## Transit Time Spread

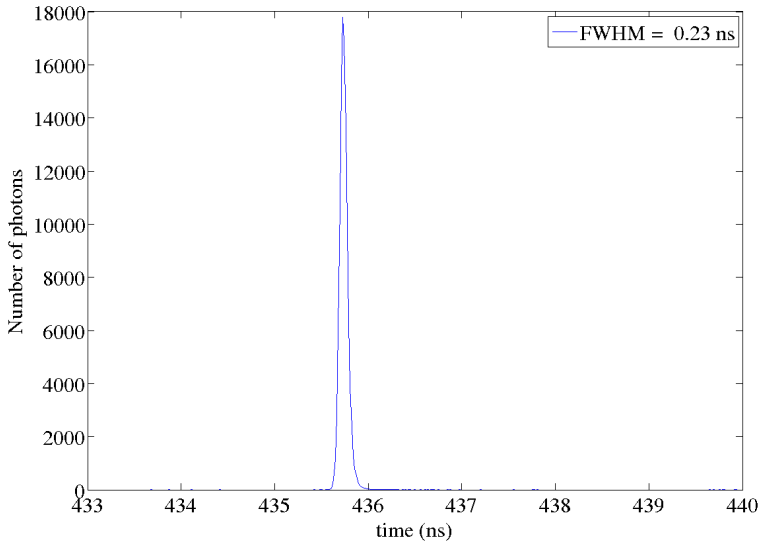



Image from the Picoharp

FWHM of electron transit time fluctuation between the photocathode and the signal

0.23 ns

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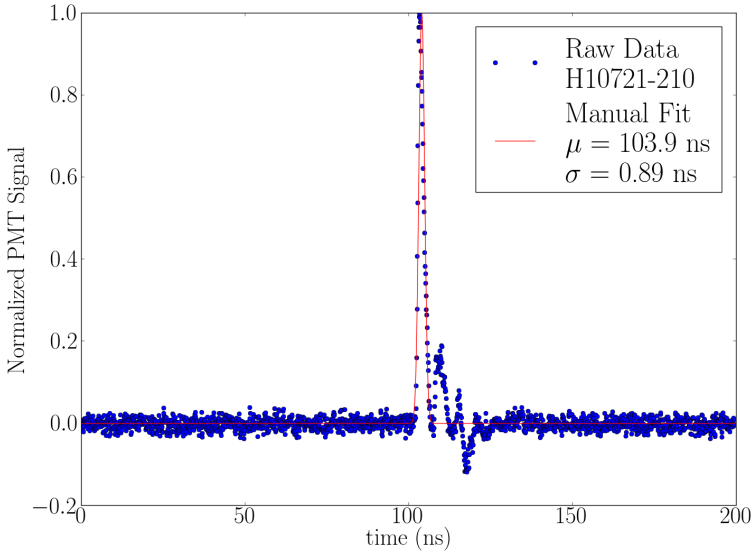


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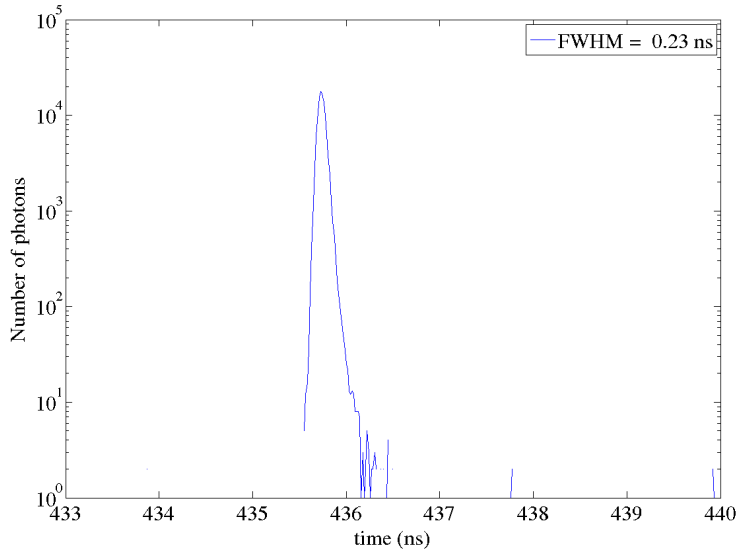


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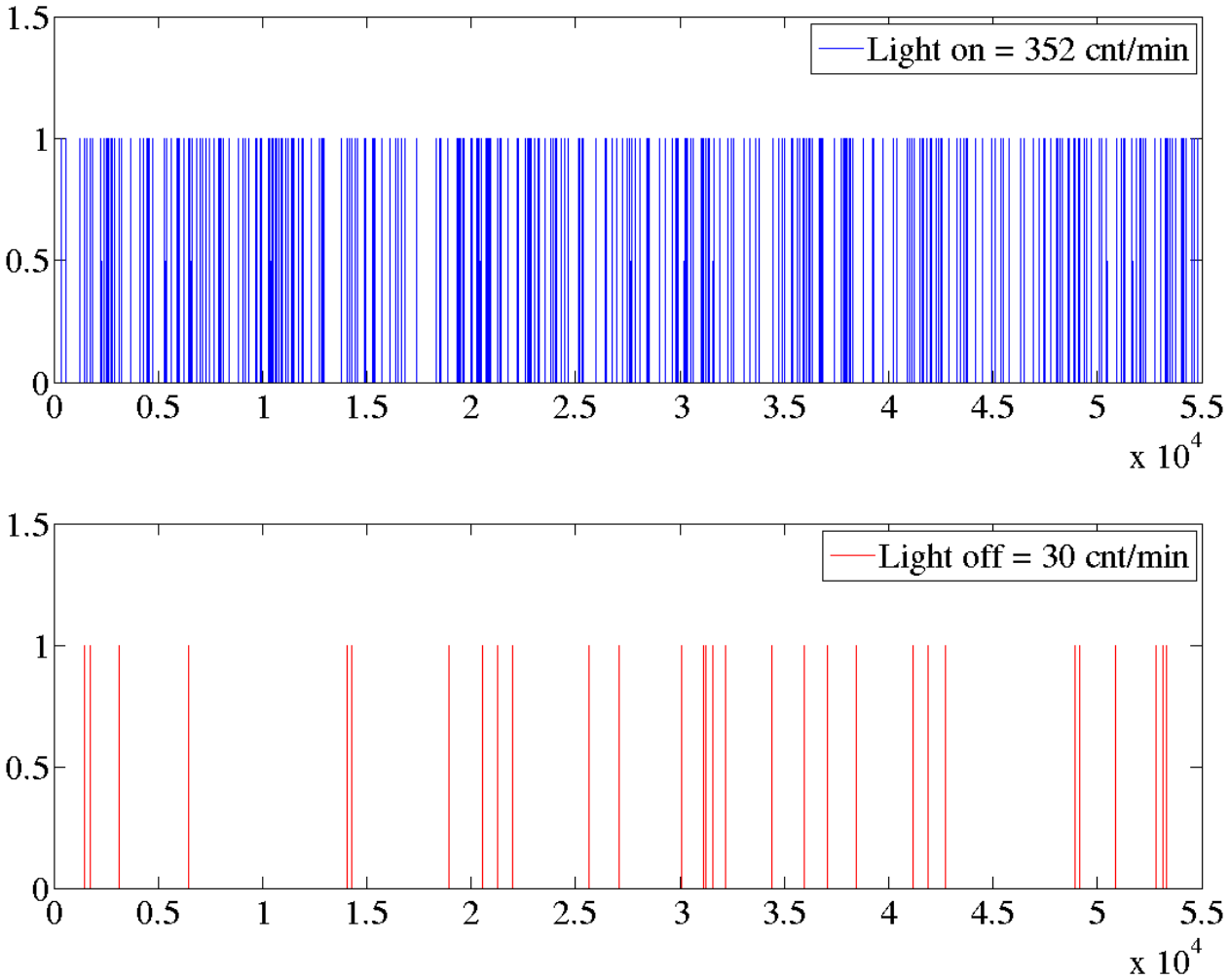
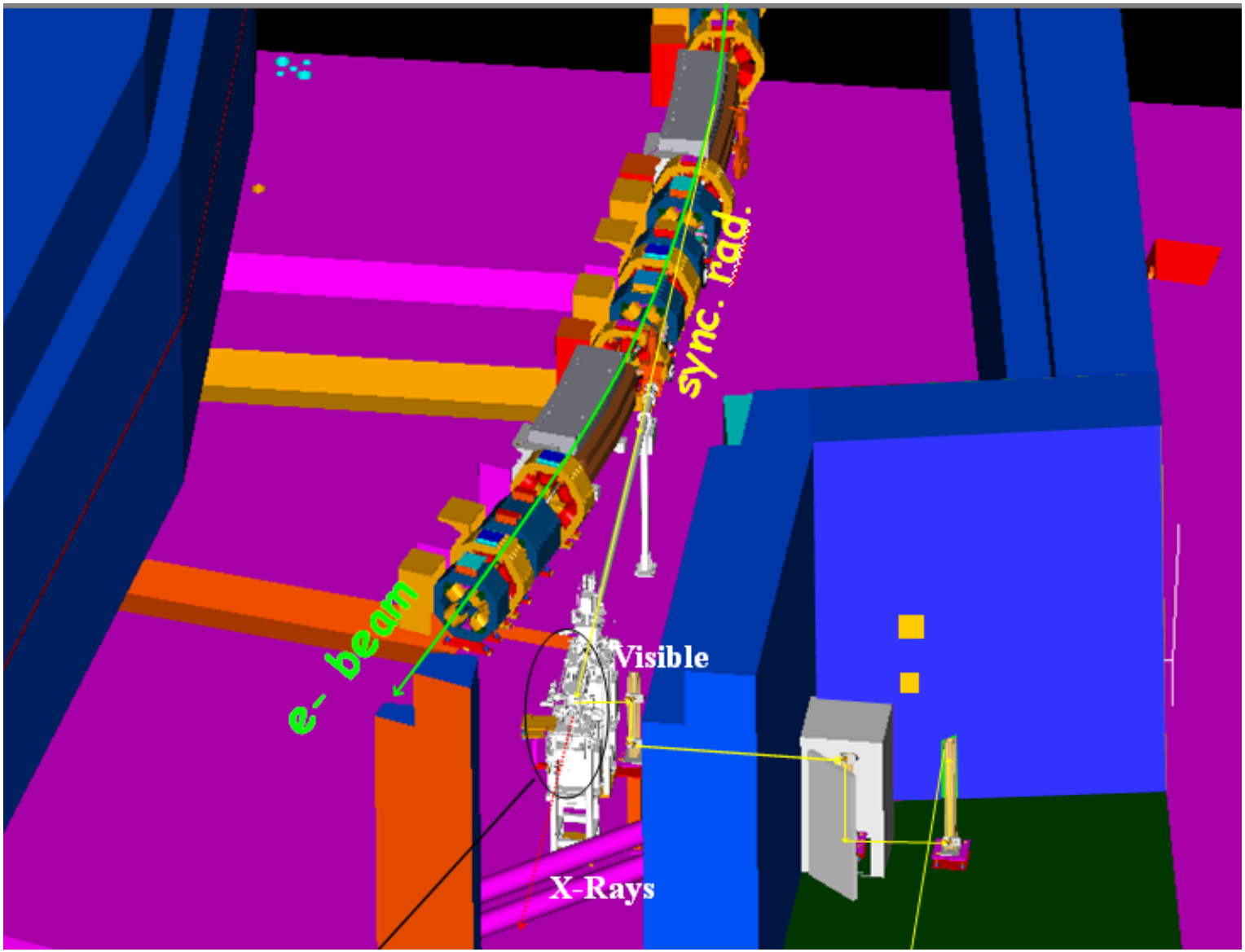
# PMT Dark Counts

## Ch1 Threshold = 30 mV, bin = 16 ps



# Diagnostic Beamline



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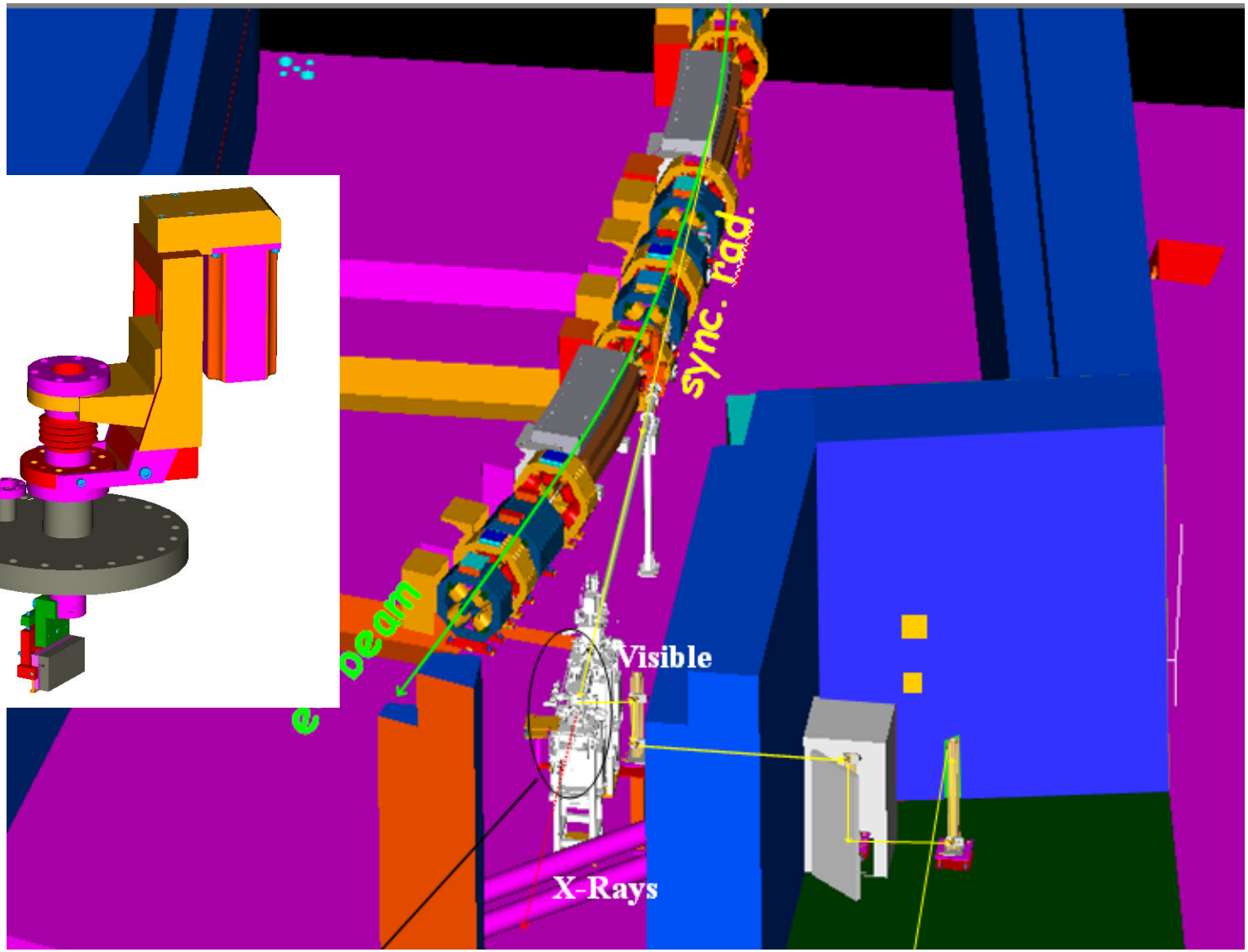

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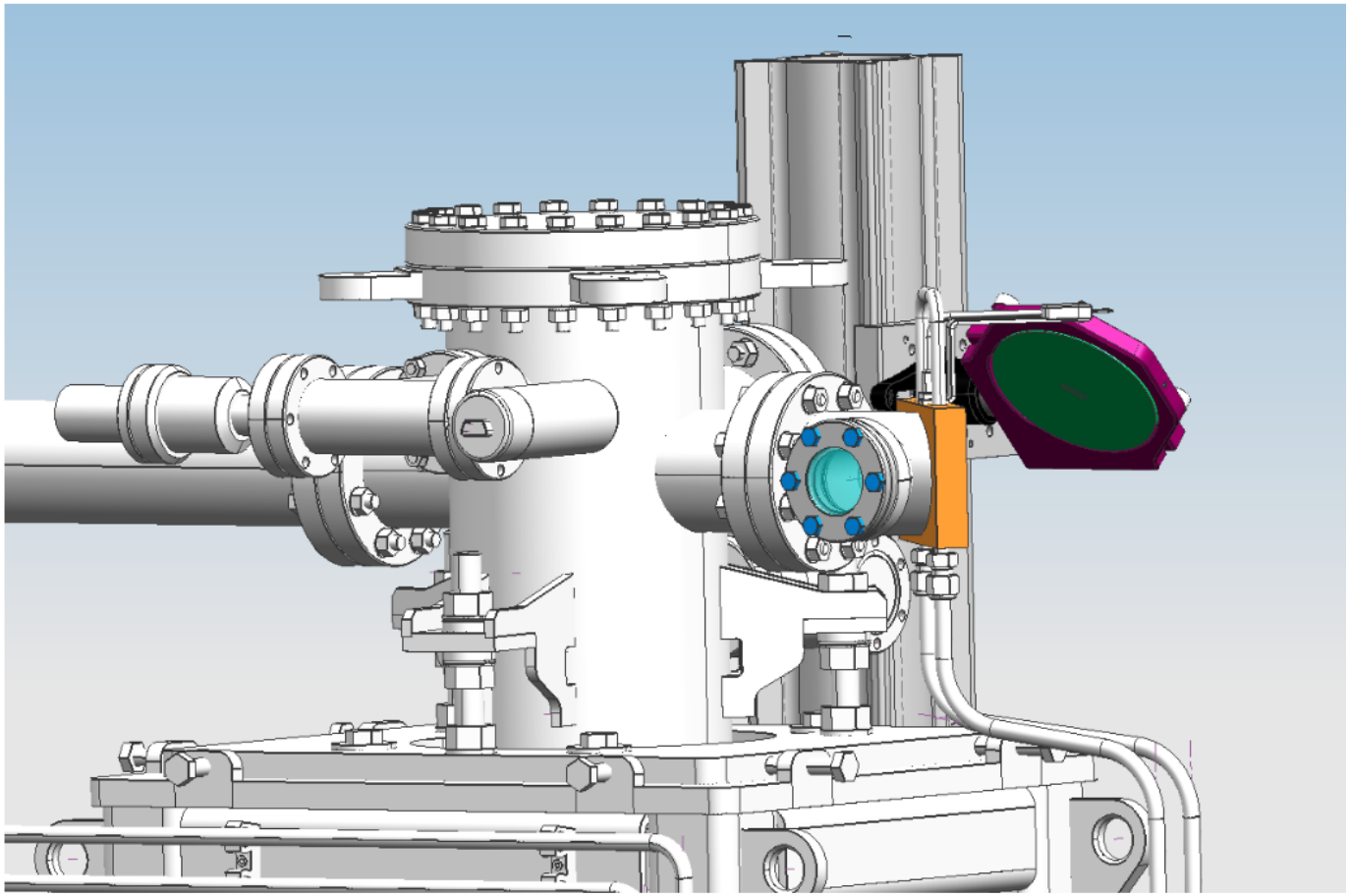

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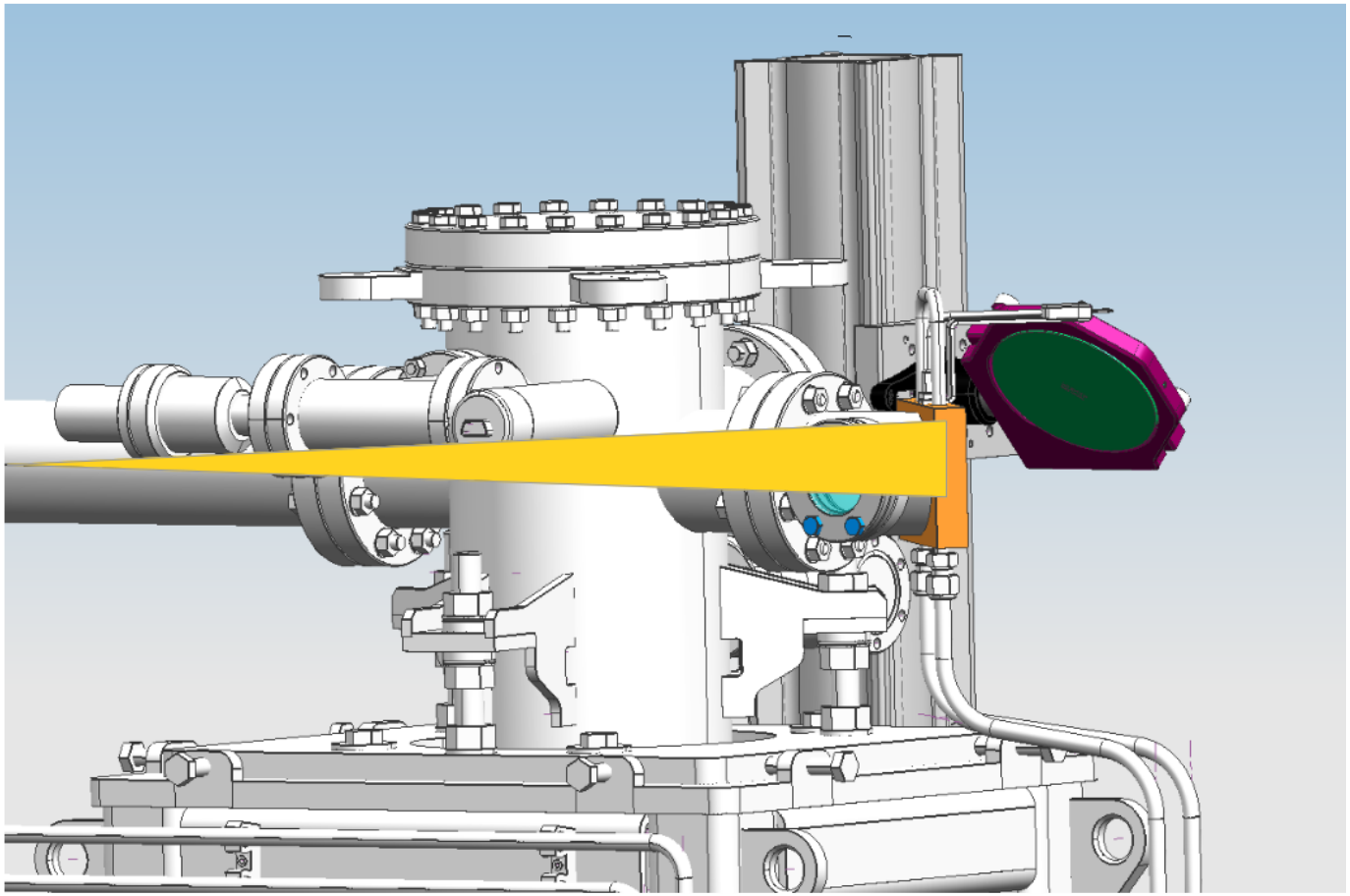

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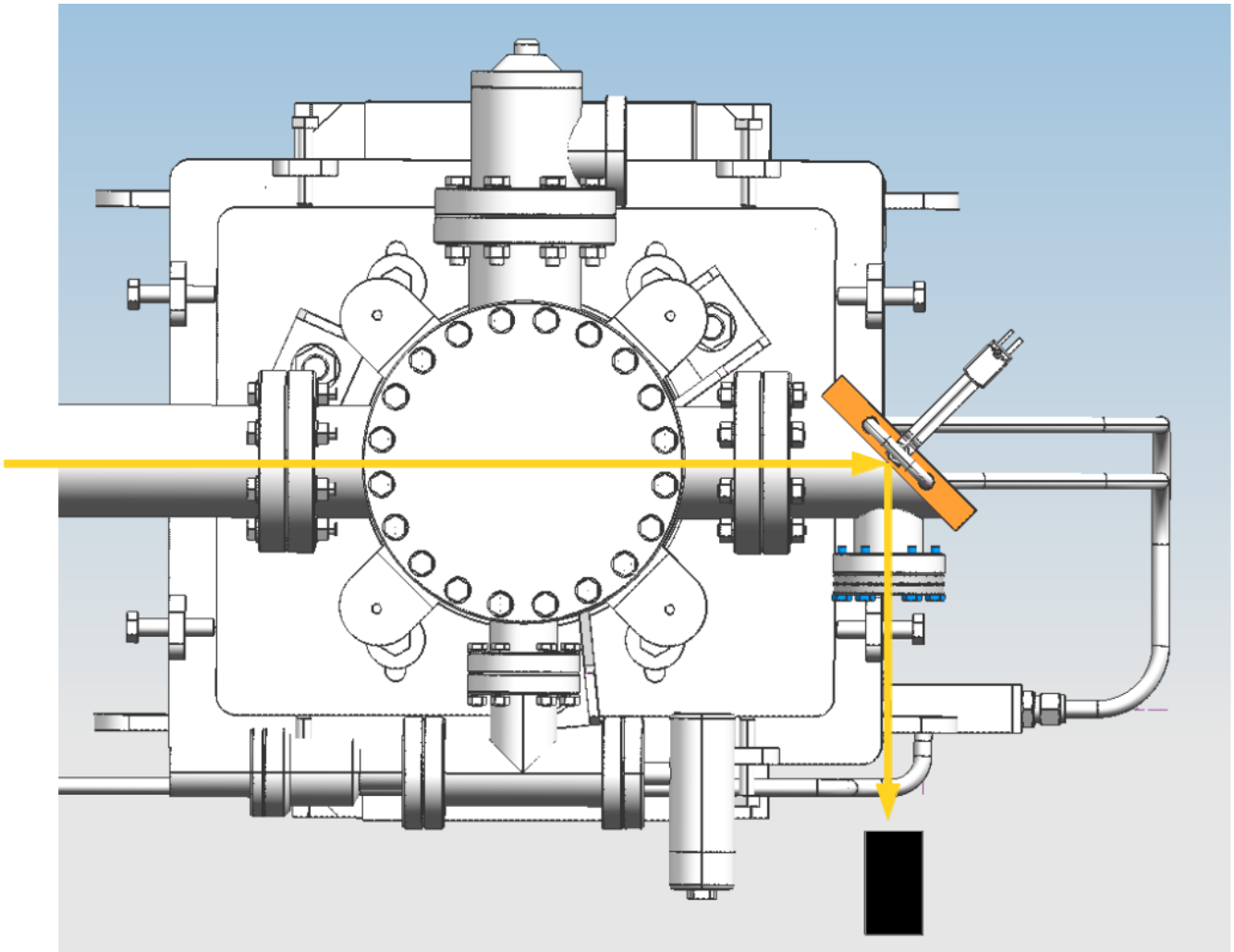

# Real Frontend

## Problems

- Support
- Remote control
- Single Photon
- Radiation
- Light always on

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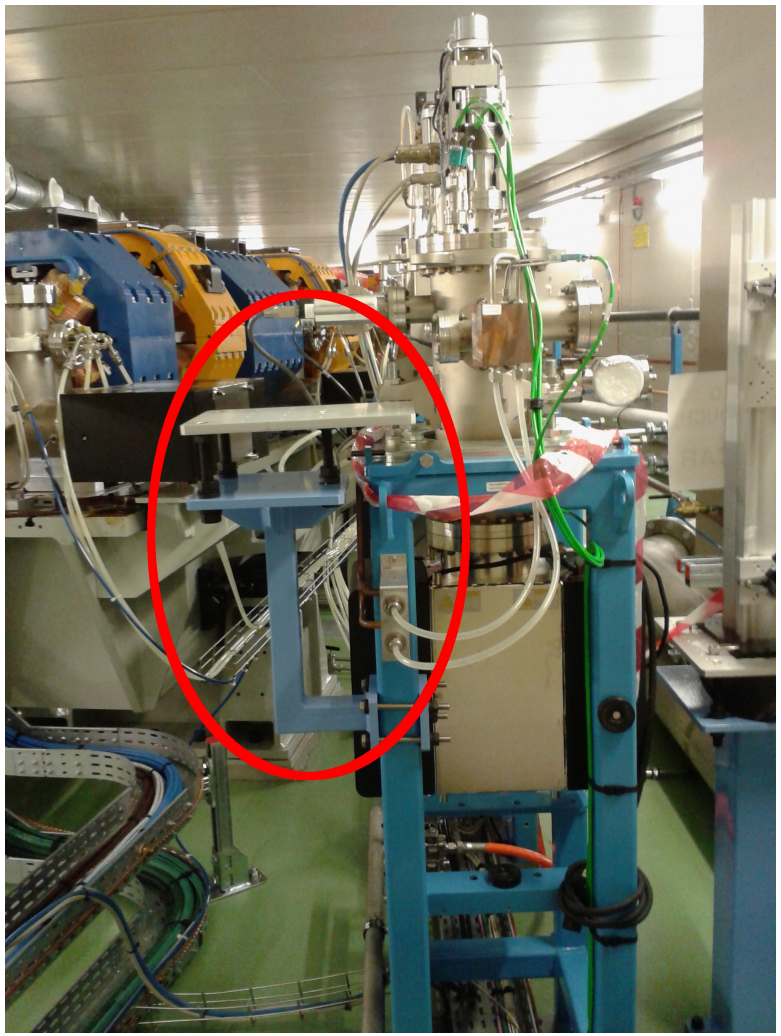

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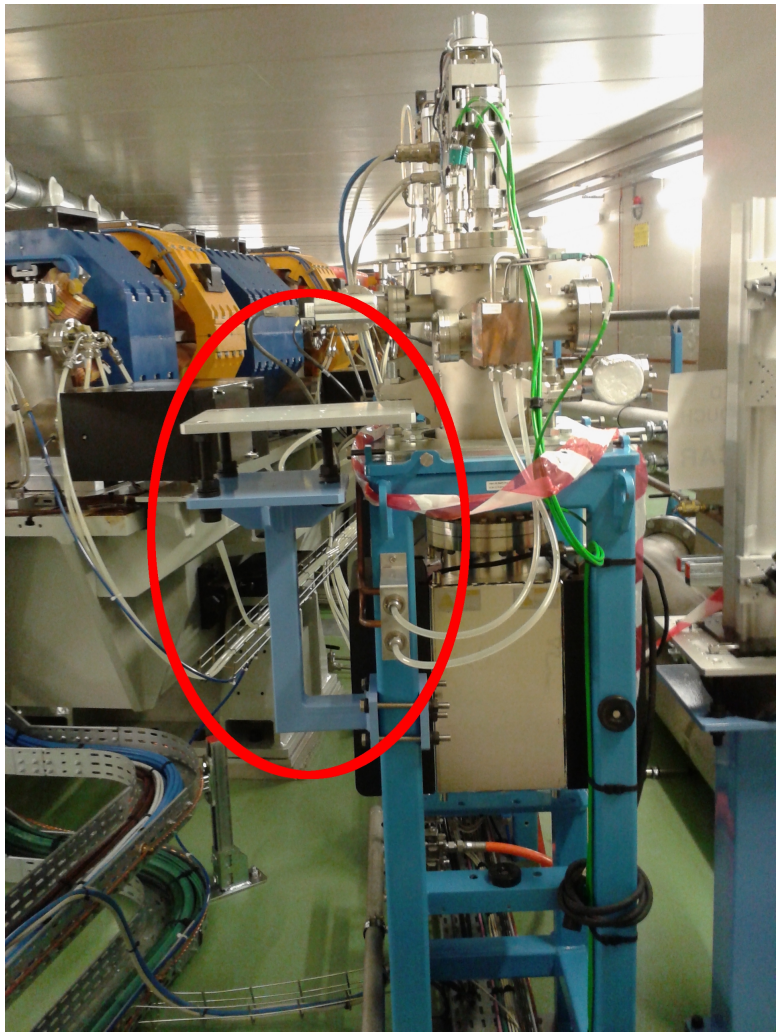

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Cabling everything outside the tunnel

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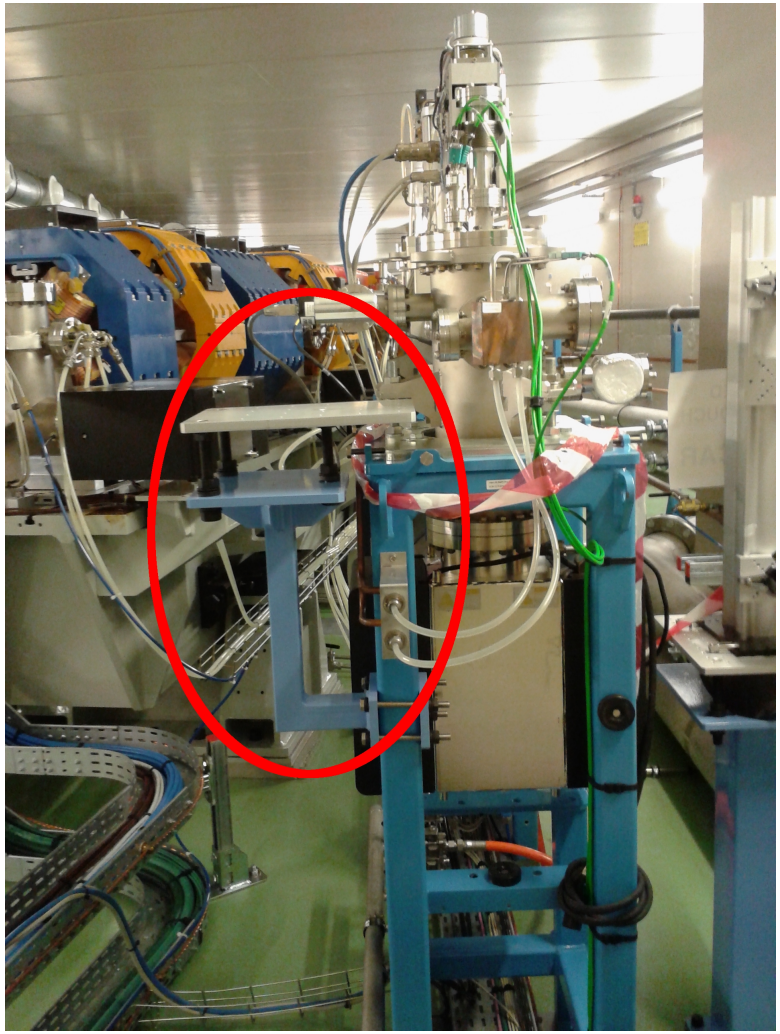

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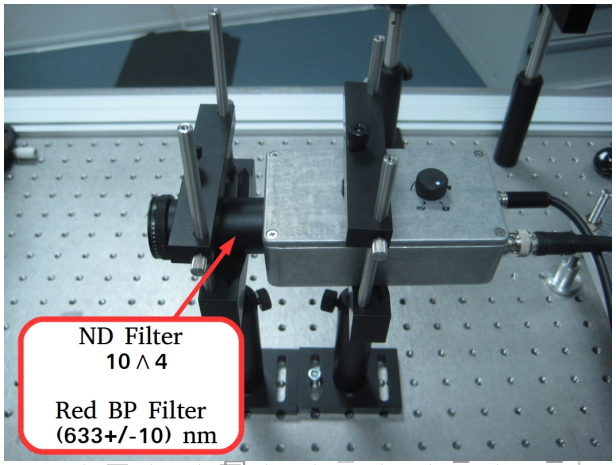

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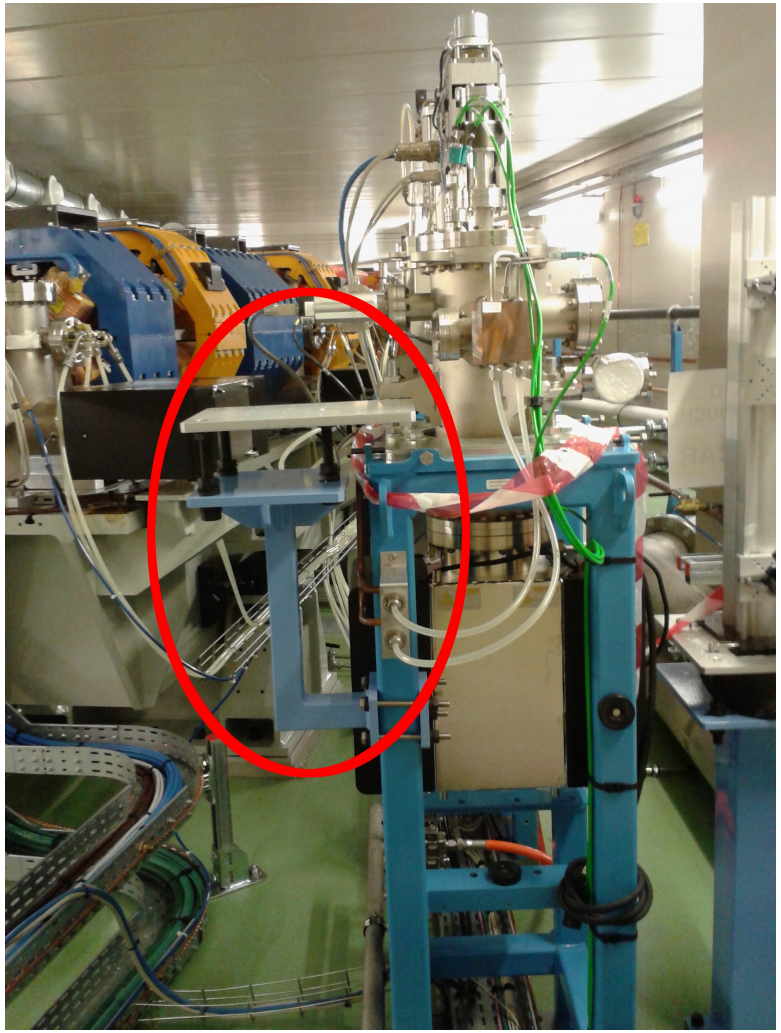

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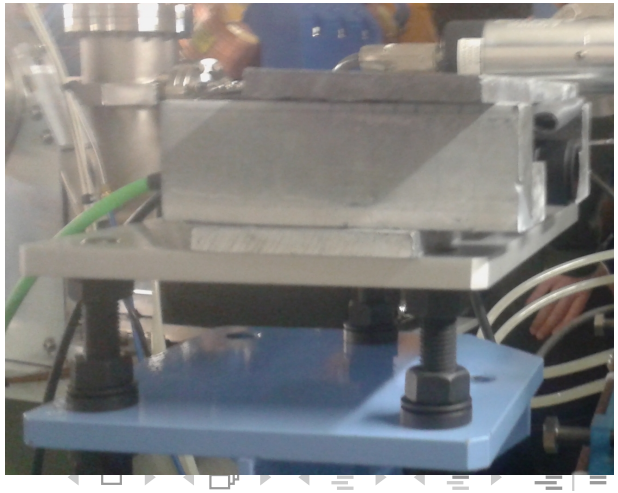

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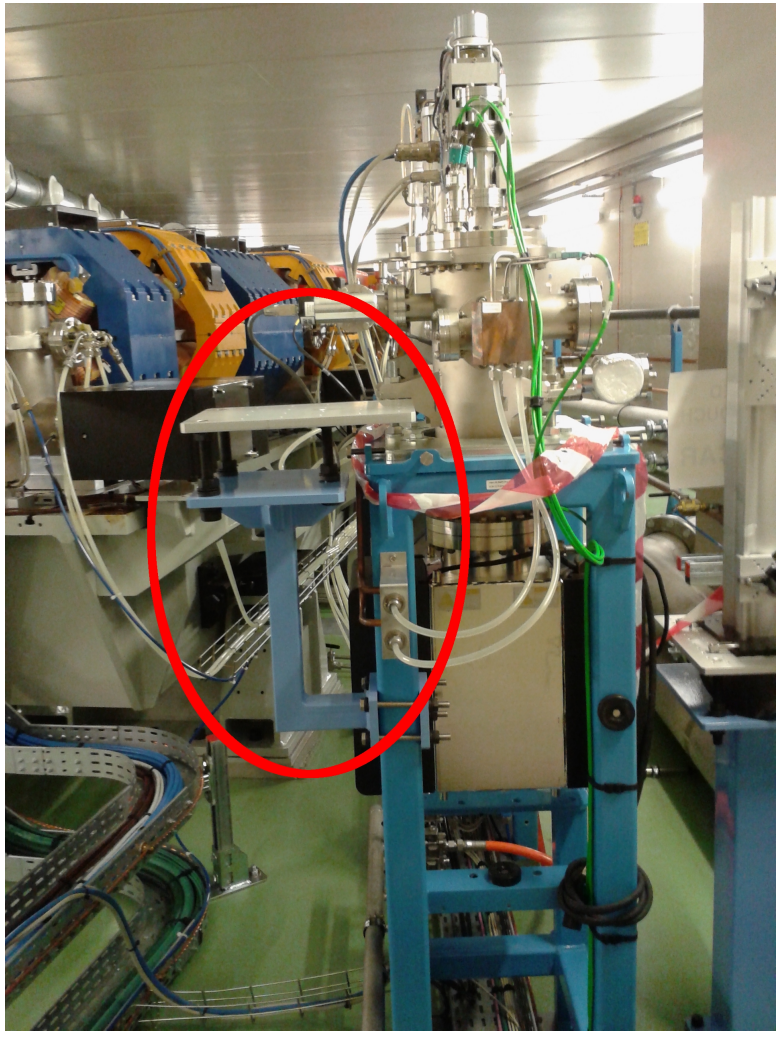

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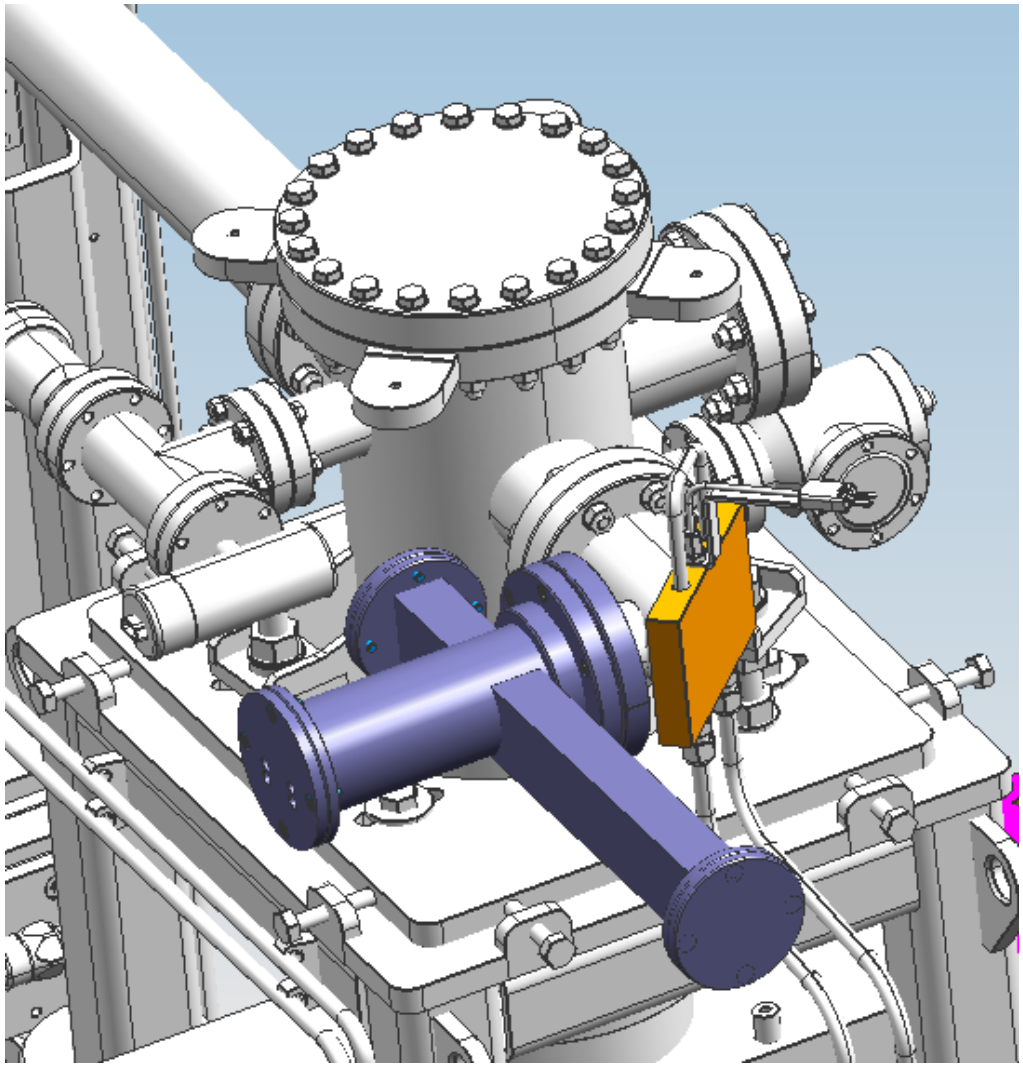
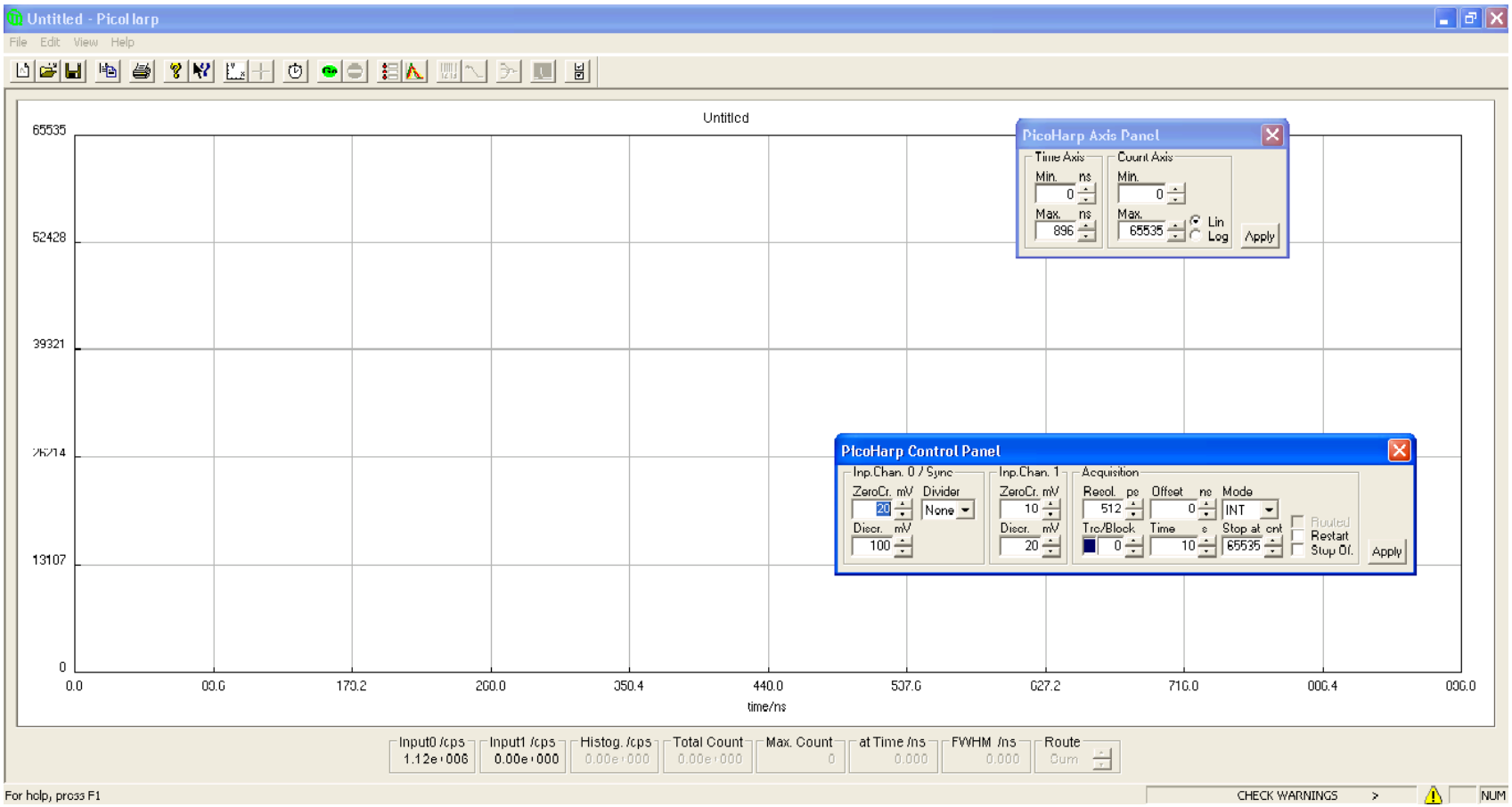
# FUTURE



# INTEGRATE SOFTWARE FOR TANGO

Software available for Windows and Epics



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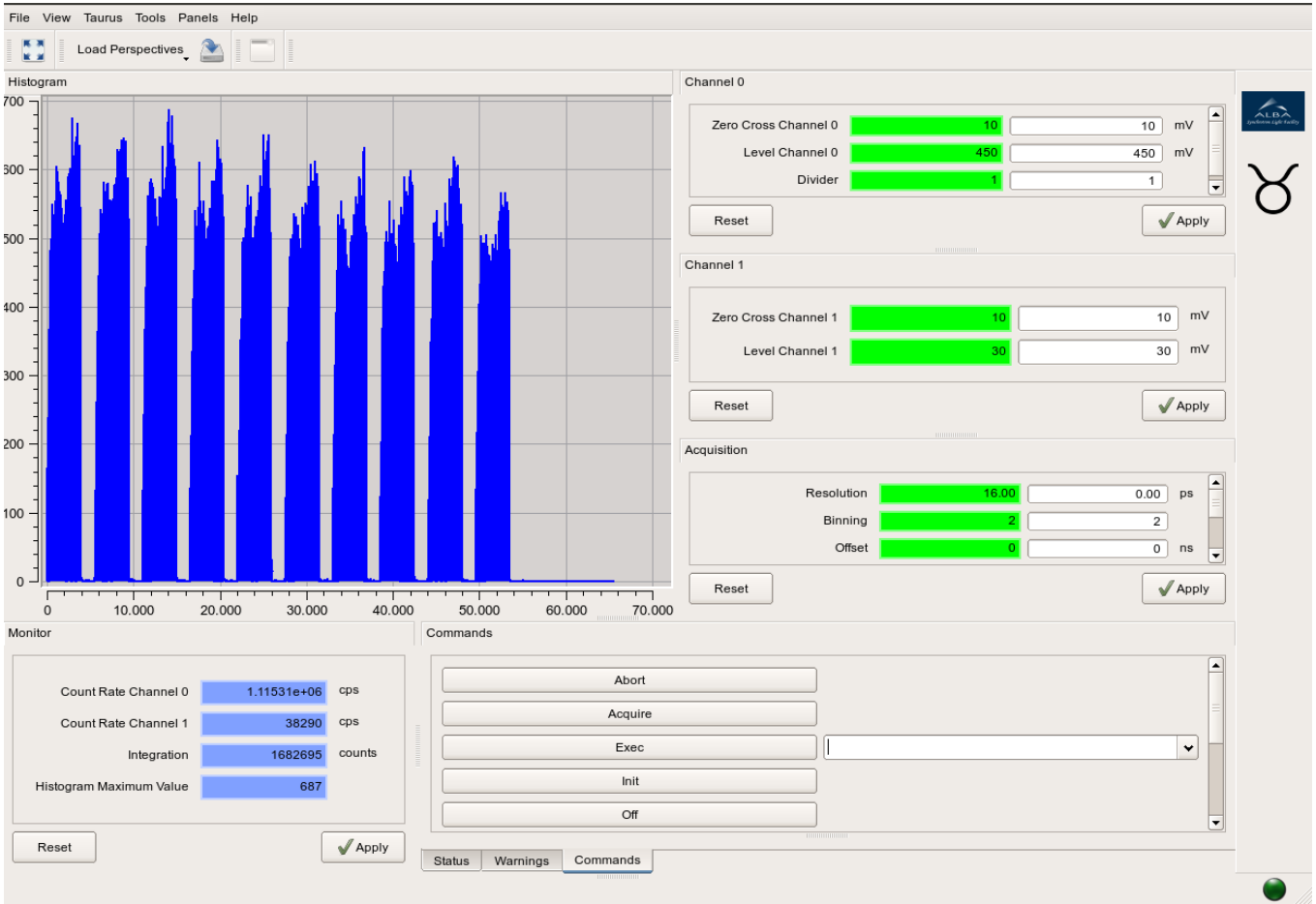
Development of a new Tango+Taurus version




Still to be optimized...

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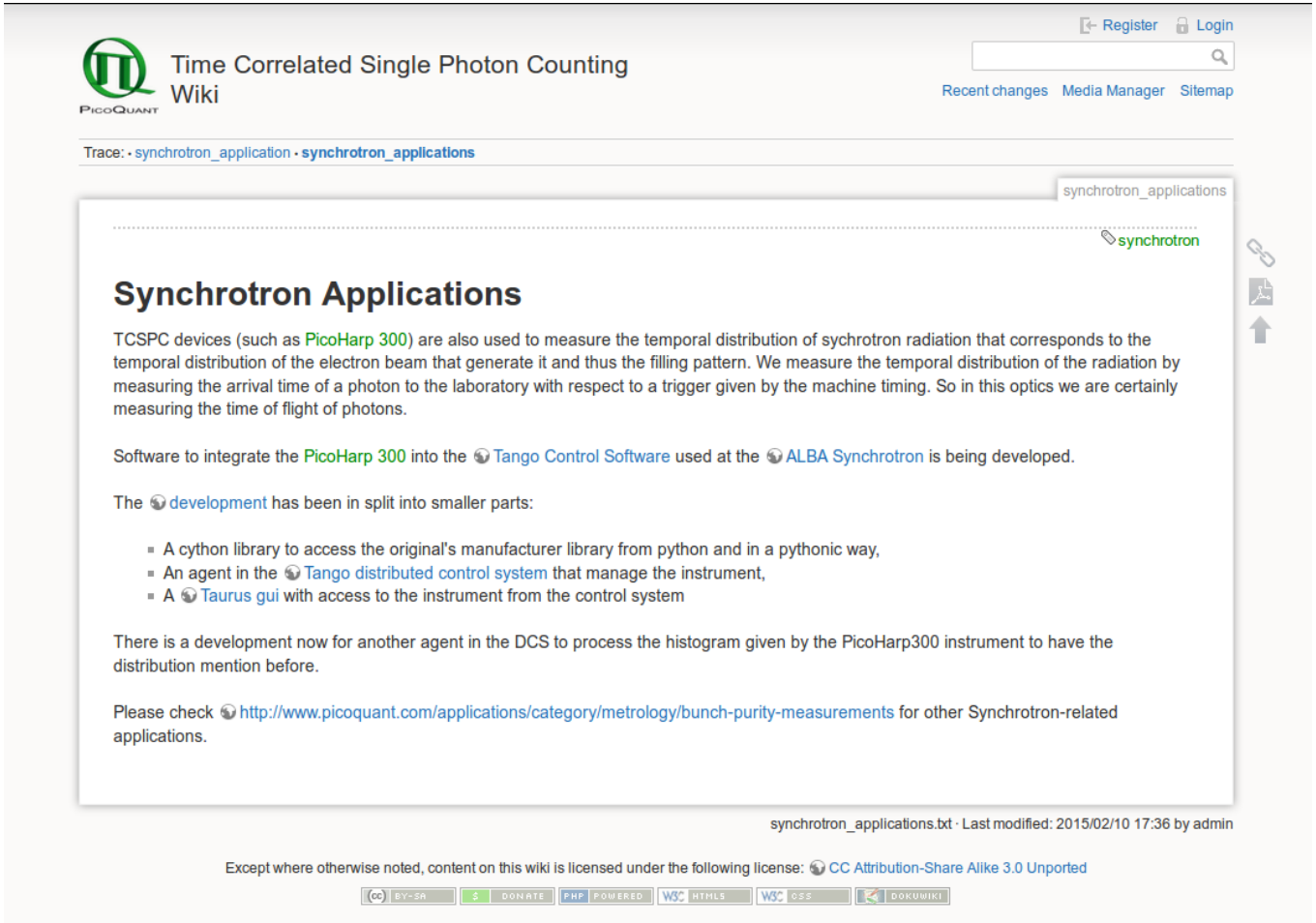

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## Synchrotron Applications

TCSPC devices (such as PicoHarp 300) are also used to measure the temporal distribution of sychrotron radiation that corresponds to the temporal distribution of the electron beam that generate it and thus the filling pattern. We measure the temporal distribution of the radiation by measuring the arrival time of a photon to the laboratory with respect to a trigger given by the machine timing. So in this optics we are certainly measuring the time of flight of photons.

Software to integrate the PicoHarp 300 into the Tango Control Software used at the ALBA Synchrotron is being developed.

The development has been in split into smaller parts:

- A cython library to access the original's manufacturer library from python and in a pythonic way,
- An agent in the Tango distributed control system that manage the instrument,
- A Taurus gui with access to the instrument from the control system

There is a development now for another agent in the DCS to process the histogram given by the PicoHarp300 instrument to have the distribution mention before.

Please check http://www.picoquant.com/applications/category/metrology/bunch-purity-measurements for other Synchrotron-related applications.

synchrotron_applications.txt · Last modified: 2015/02/10 17:36 by admin

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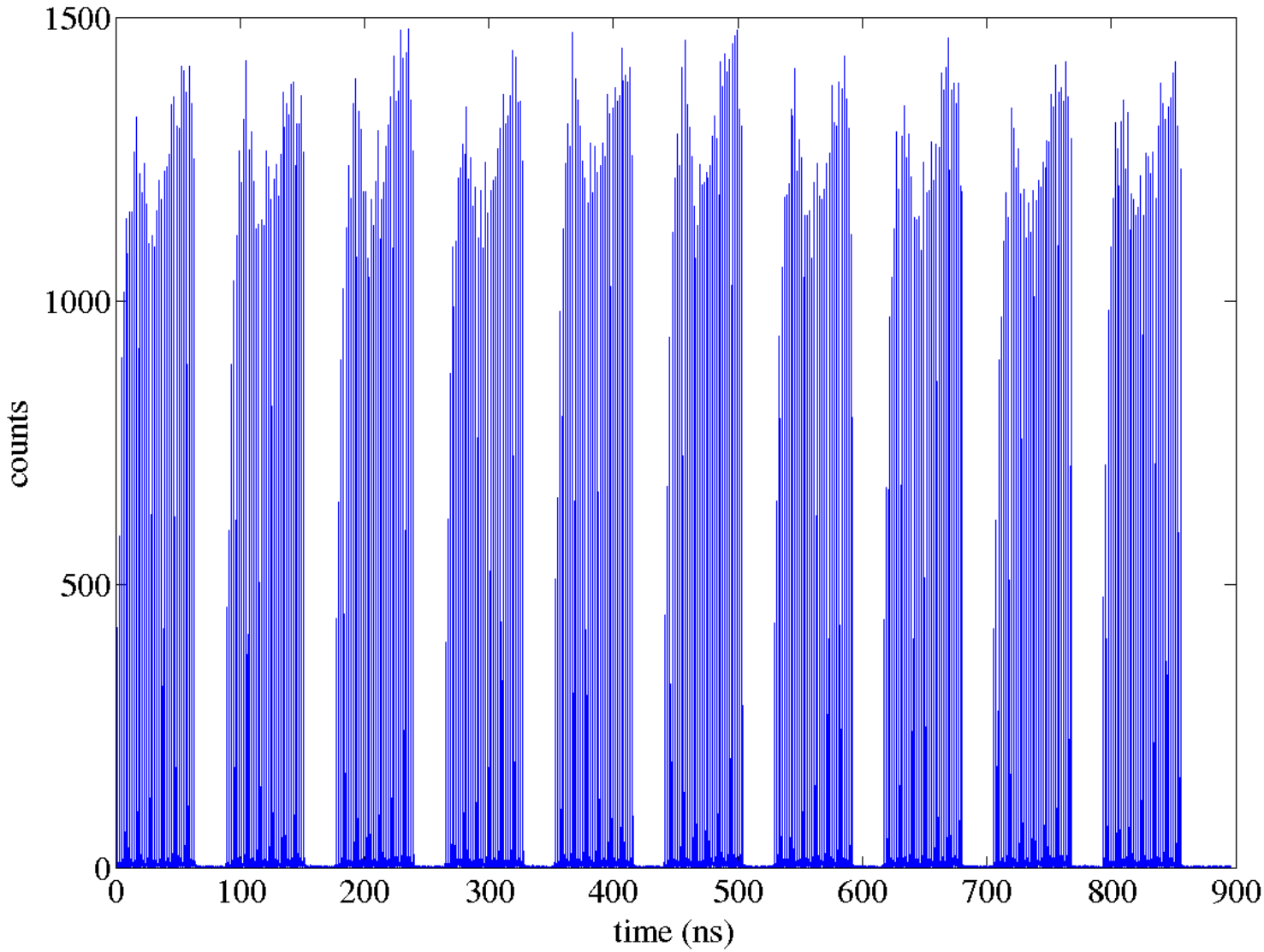
# TANGO DEVICE SERVER

More technical info :

- `http://sourceforge.net/p/tango-ds/code/HEAD/tree/DeviceClasses/MeasureInstruments/PicoHarp300/trunk/`
- `https://github.com/srgblnch/PicoHarp300`
- Ask Sergi (`sblanch@cells.es`)

# Operation Filling Pattern



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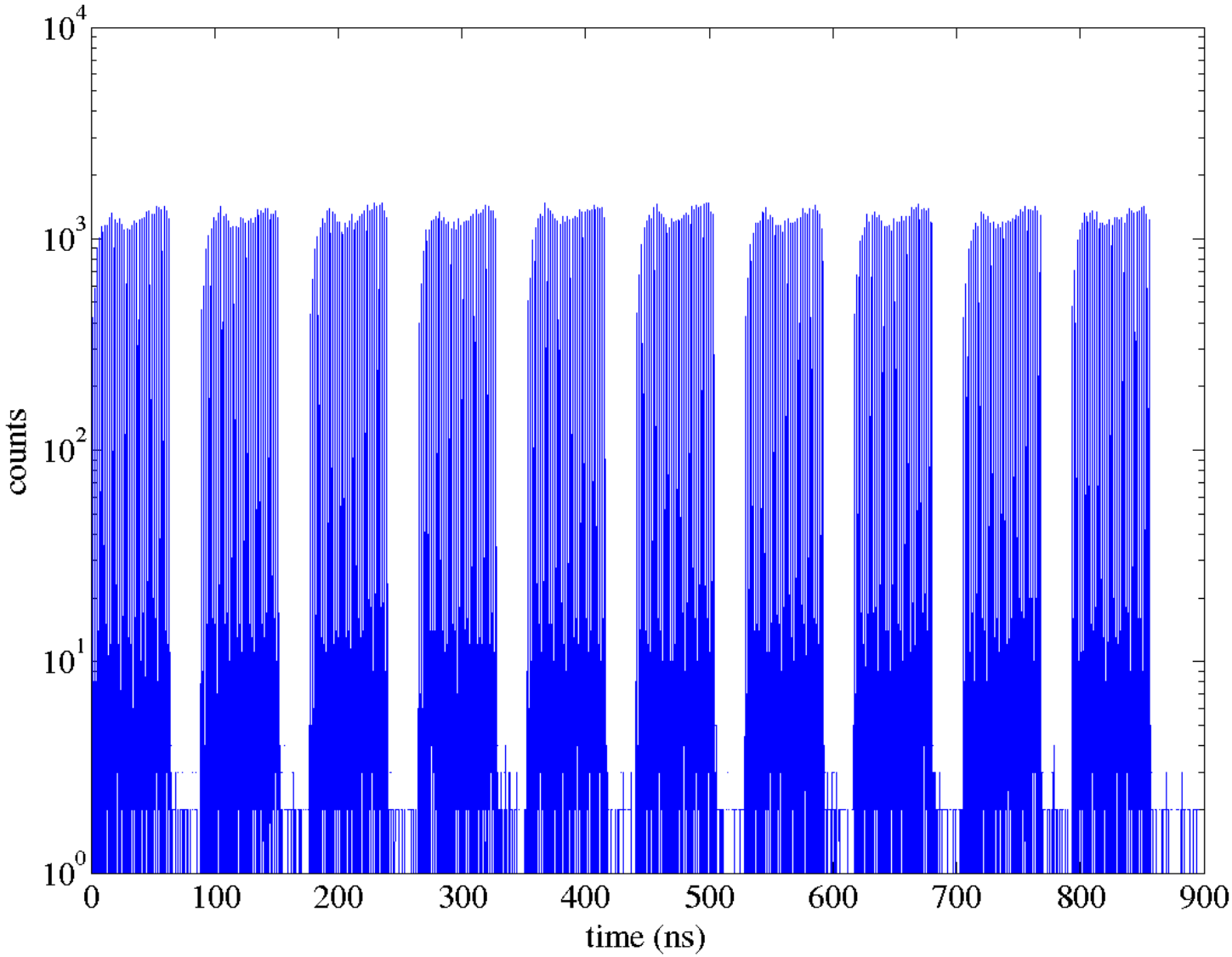

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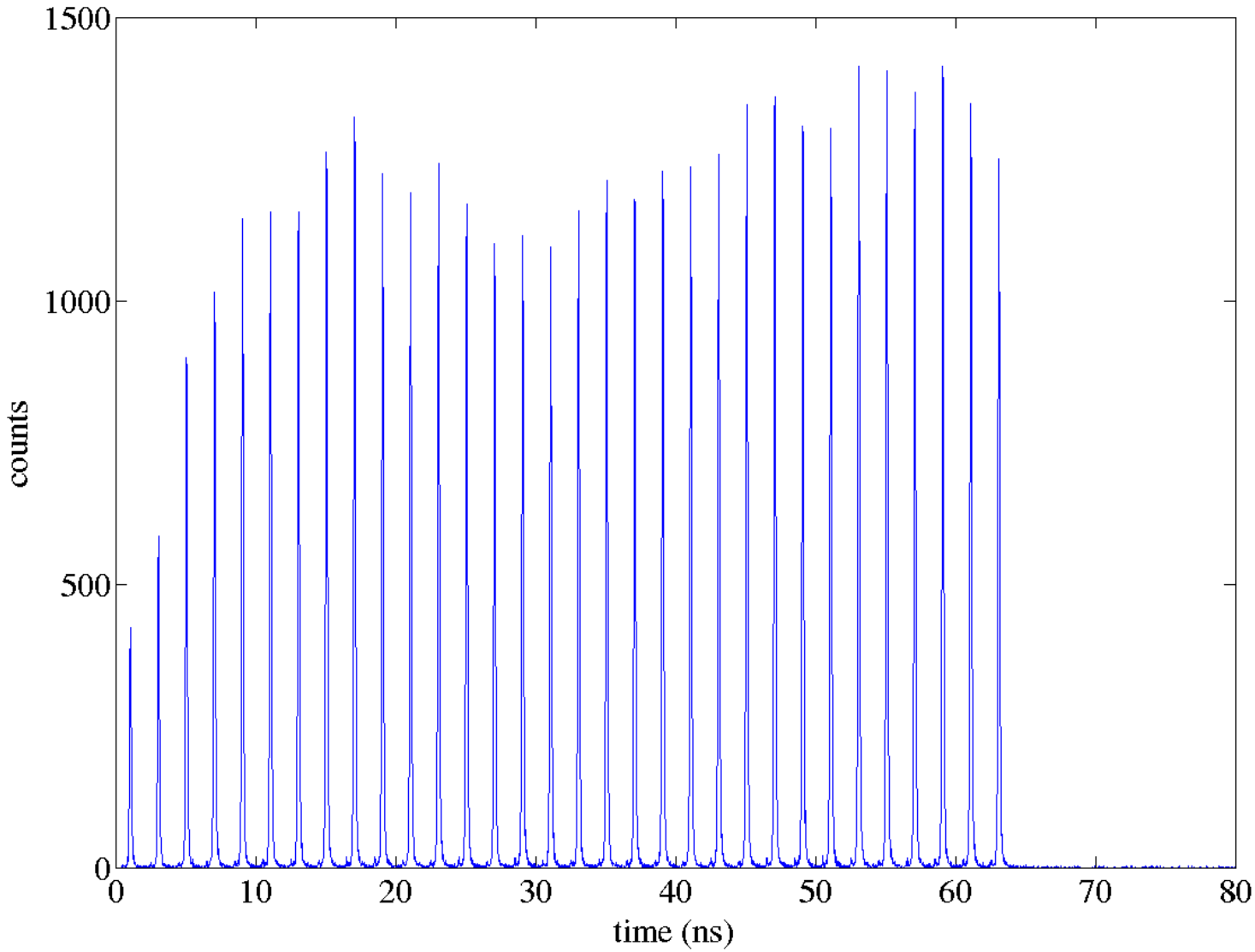
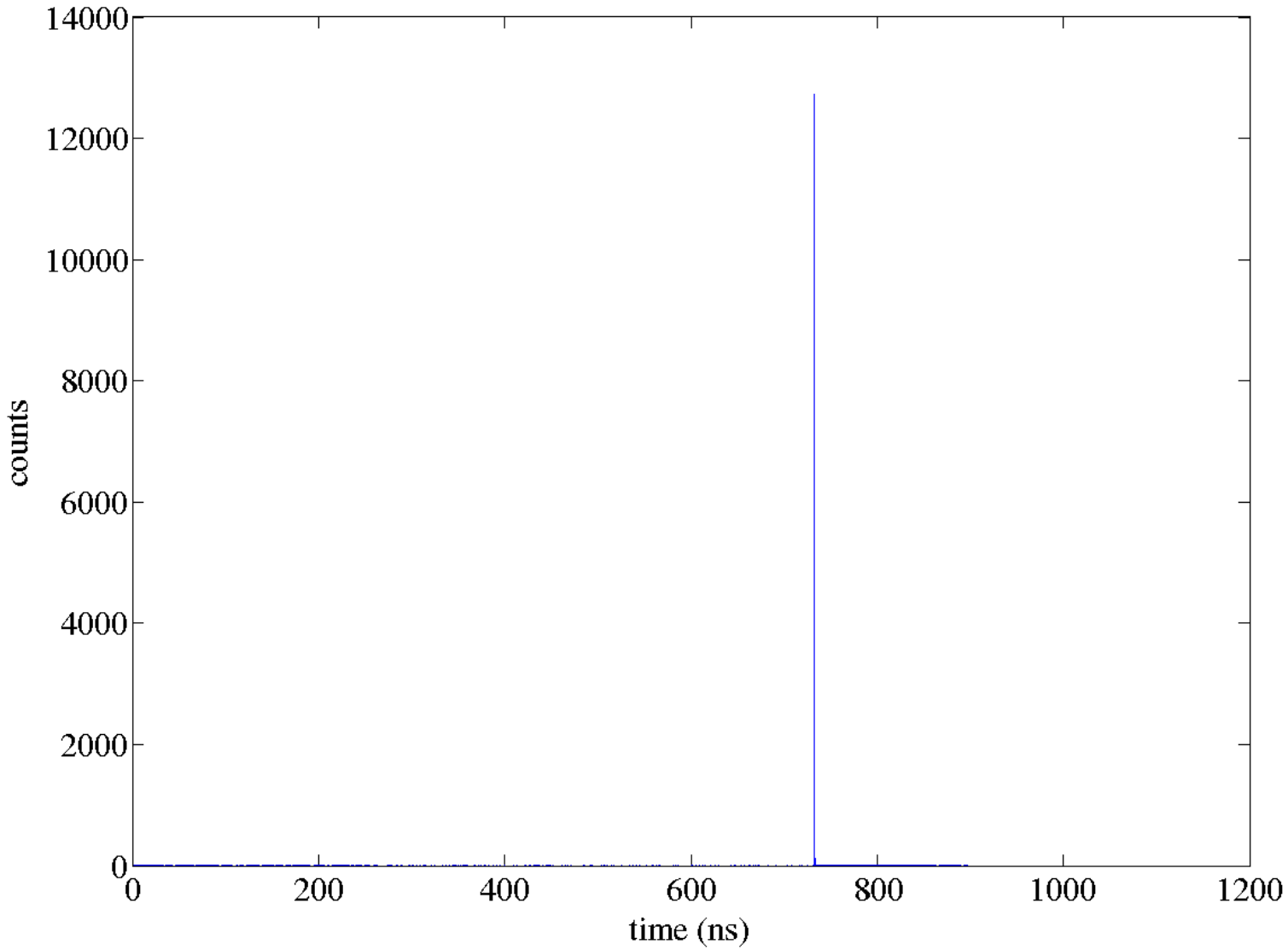


# Single Bunch



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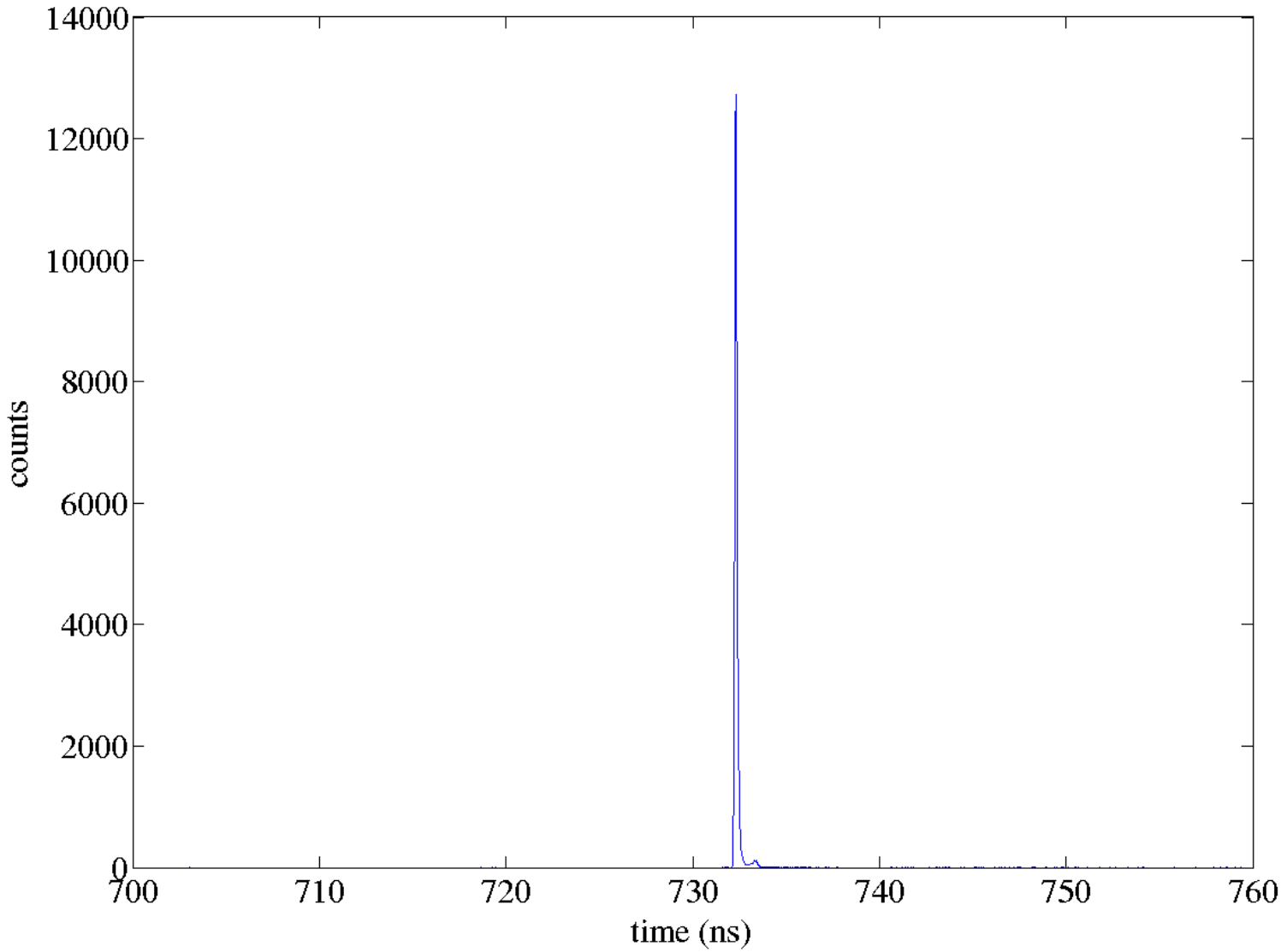

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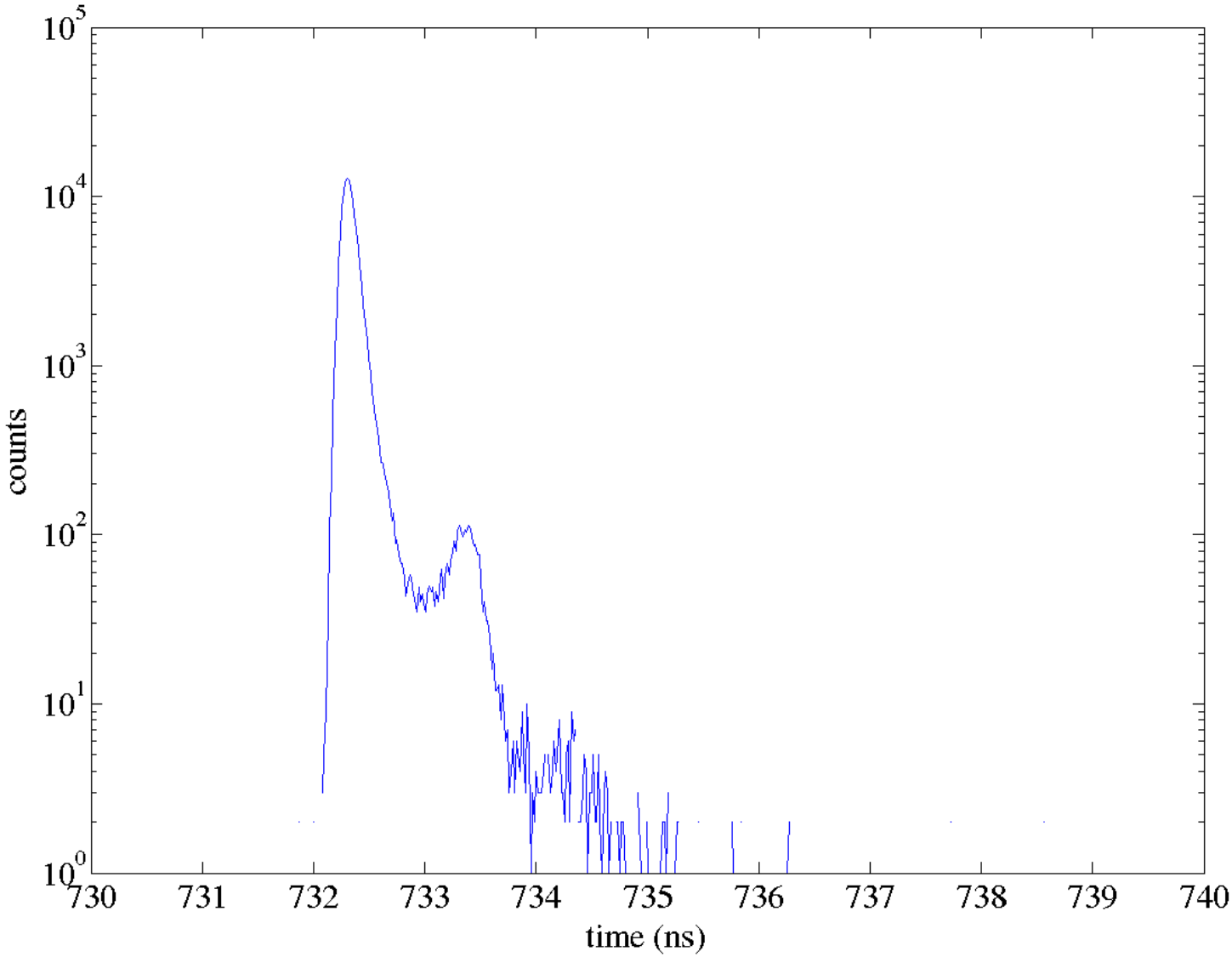
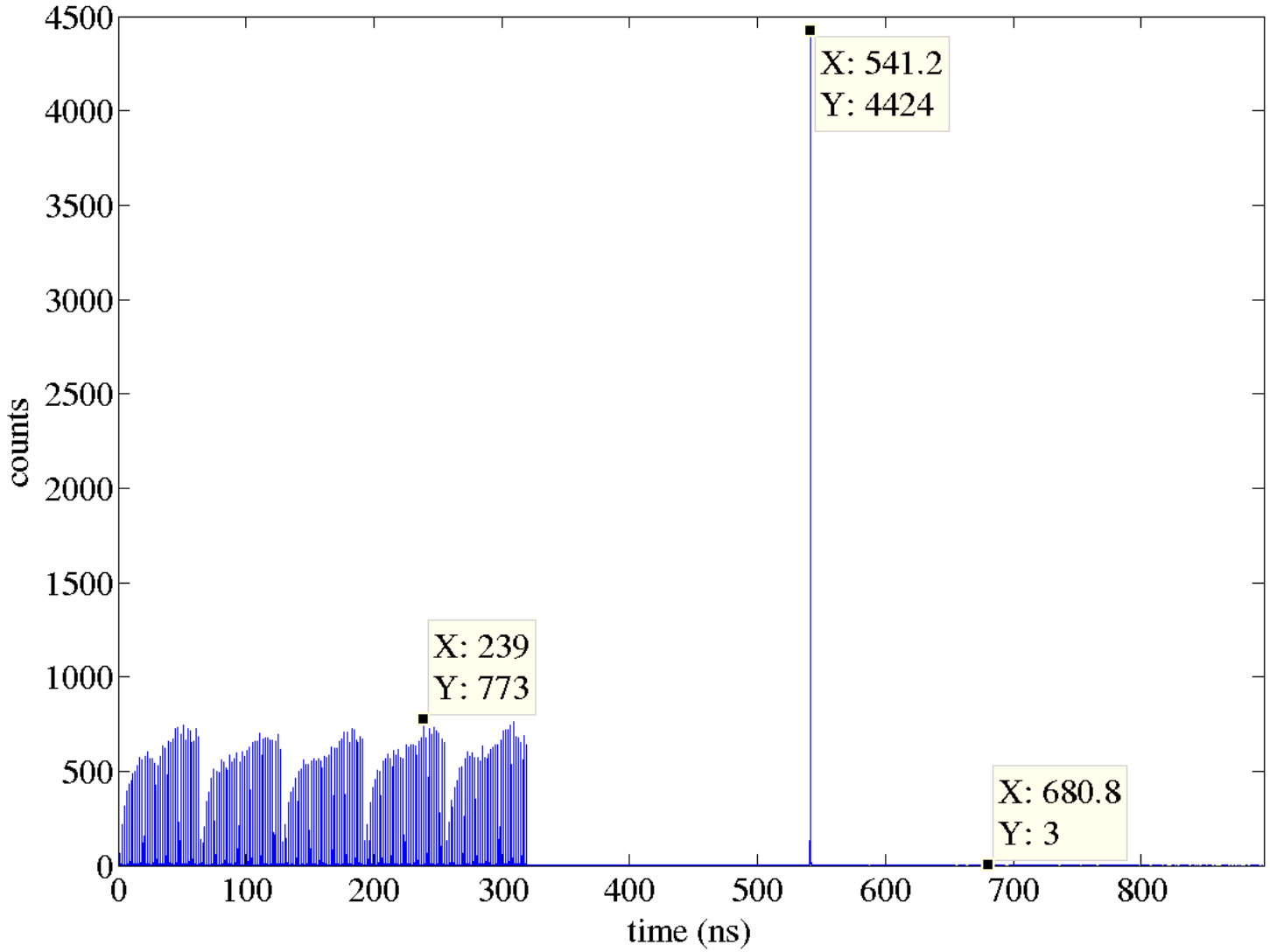


# Hybrid Filling Pattern



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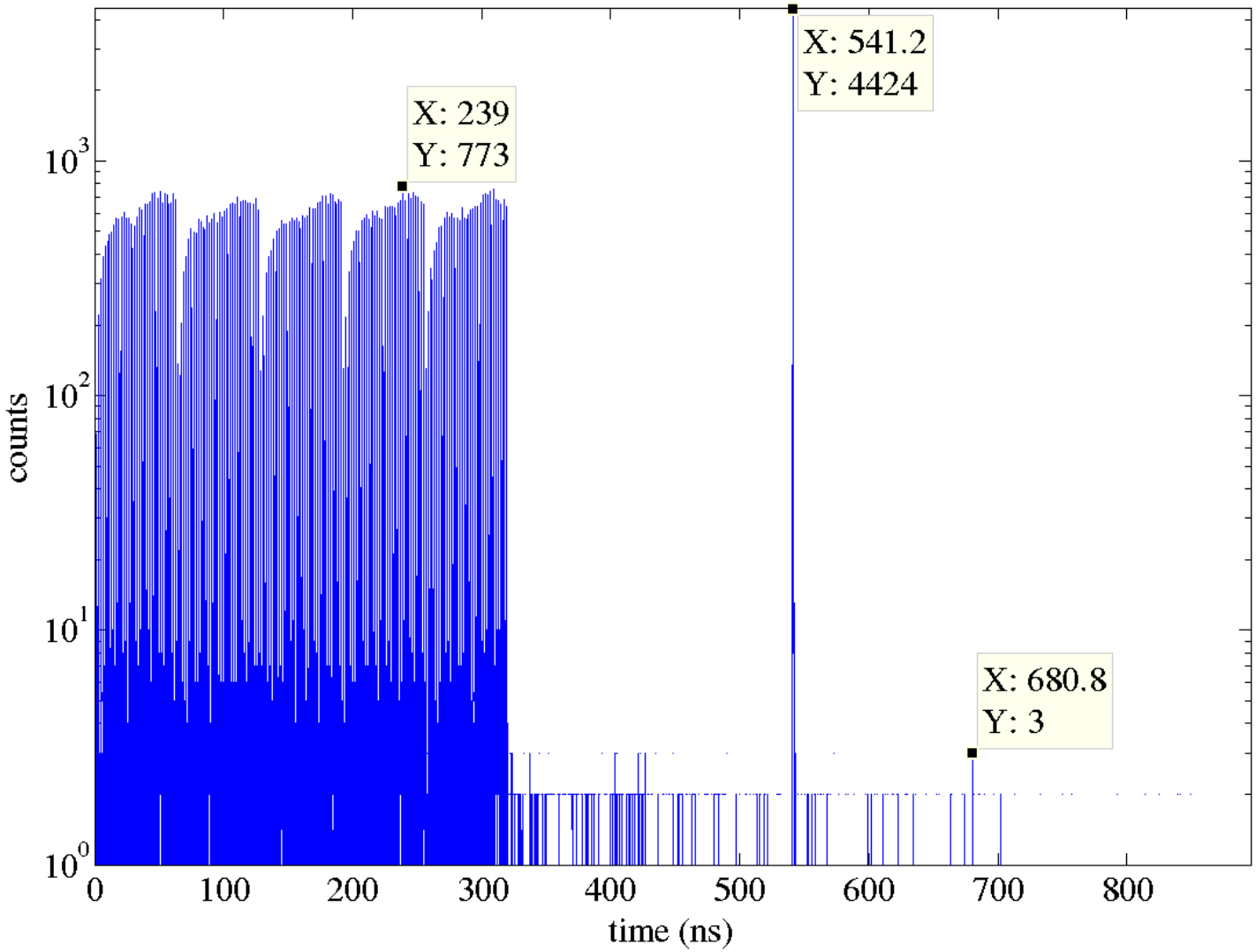
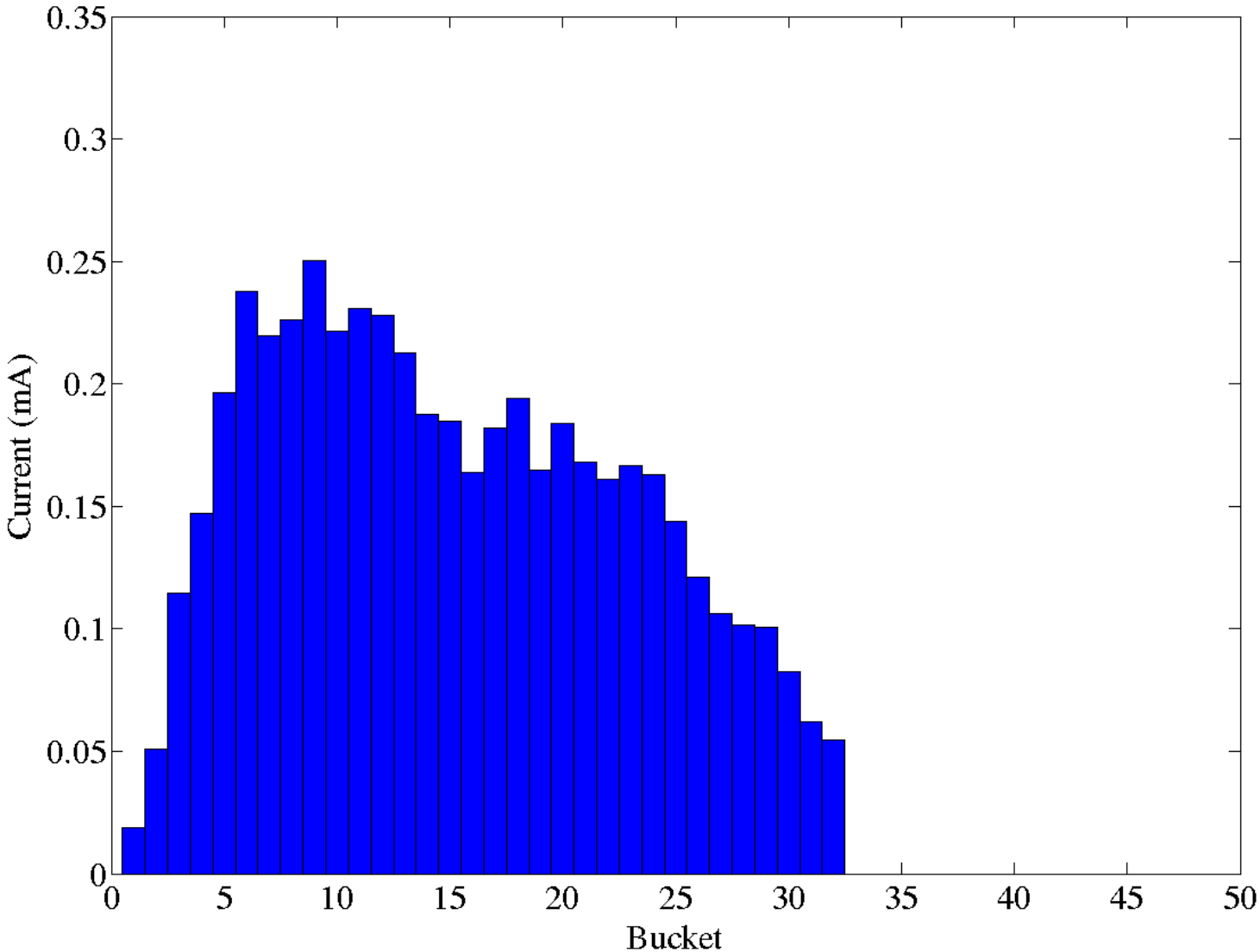


# Application: Top-Up selective refilling



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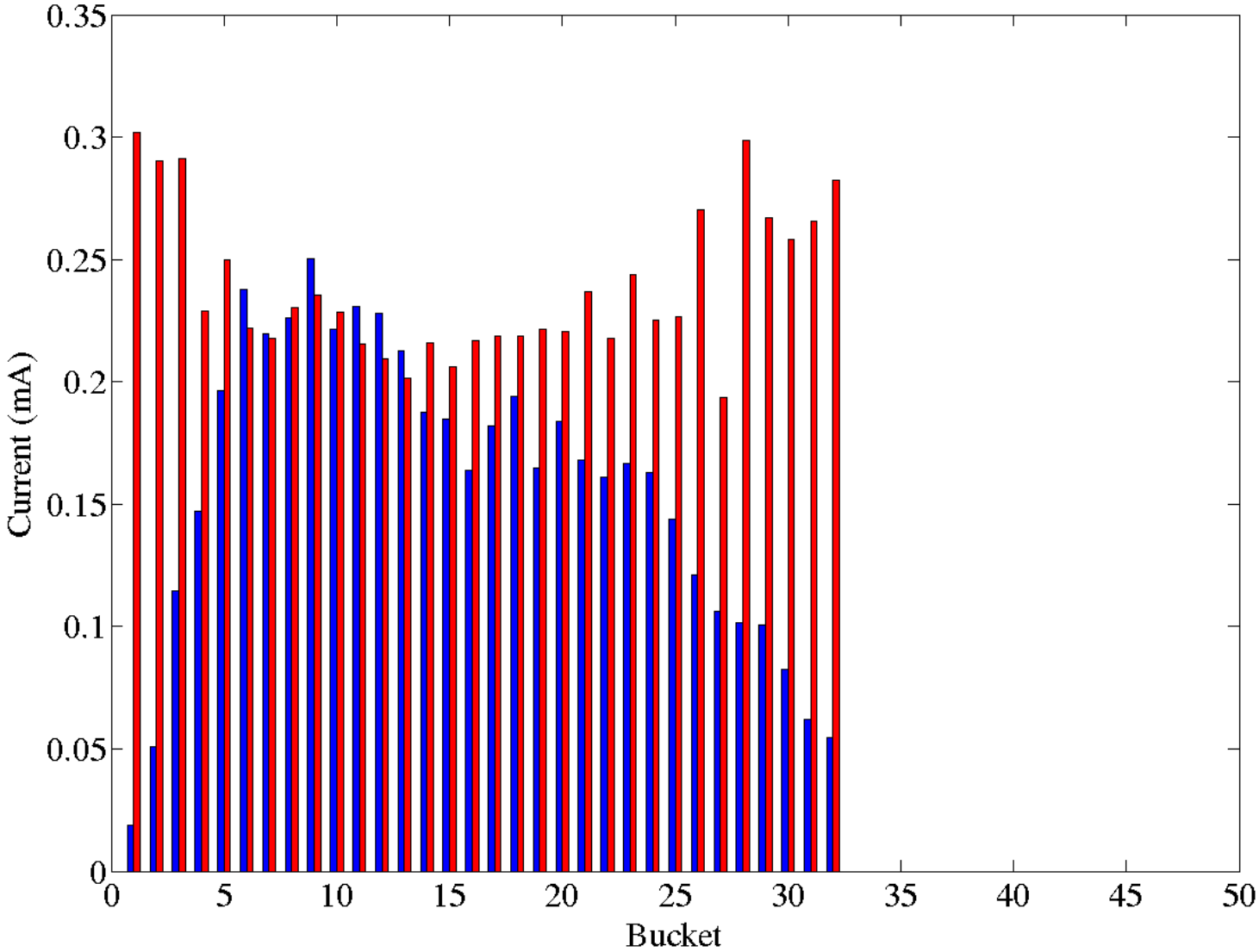

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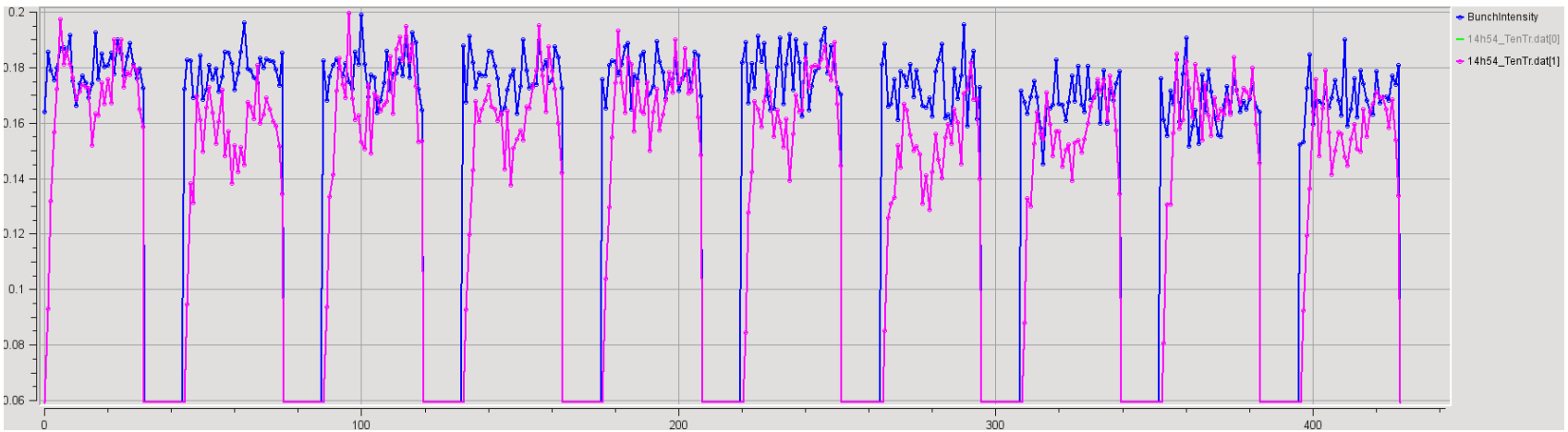
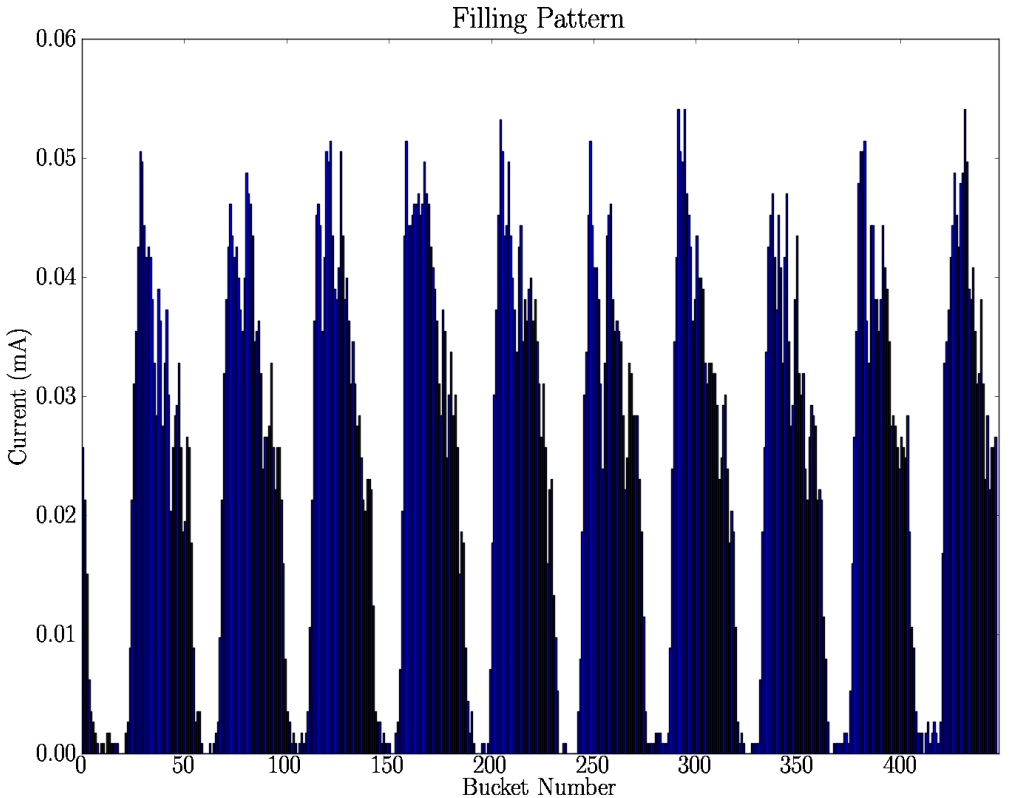
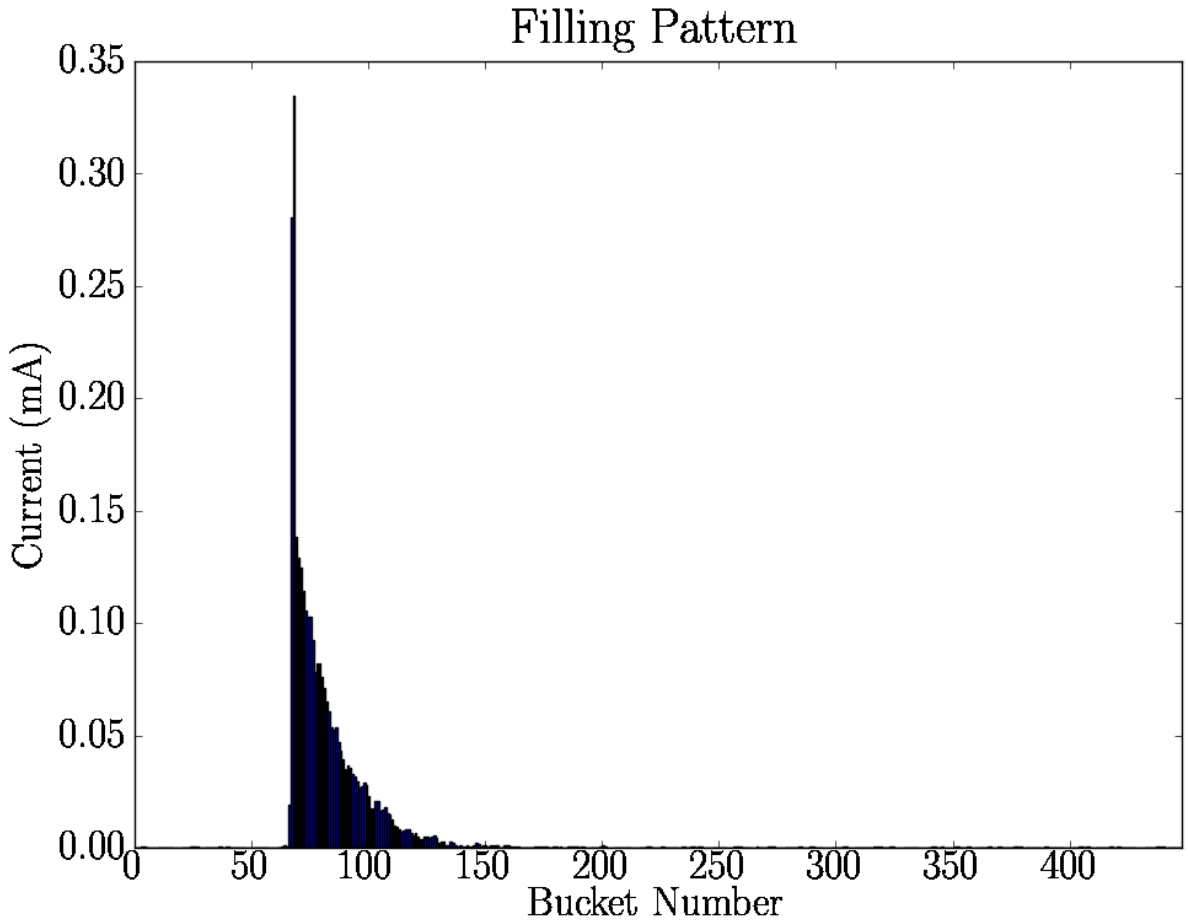


# HOMEMADE BLM



# HOMEMADE BLM 2

## Adding a Scintillator (Prelude)



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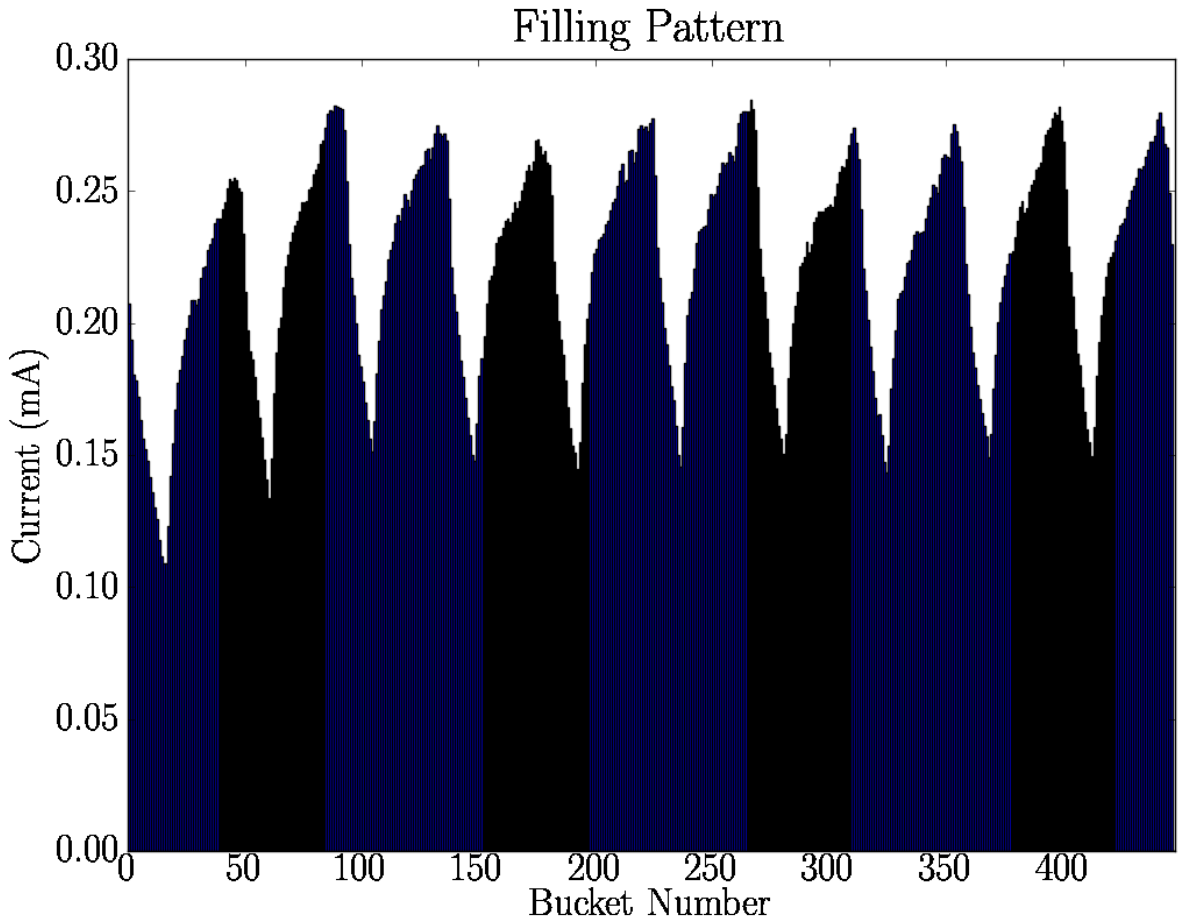

# To Improve

- The set-up is still not definitive, the design of the final set-up is ready, waiting for the actual implementation
- The Software still is in the debugging phase, we are the only ones using it, several issues were found and solved but there might be others
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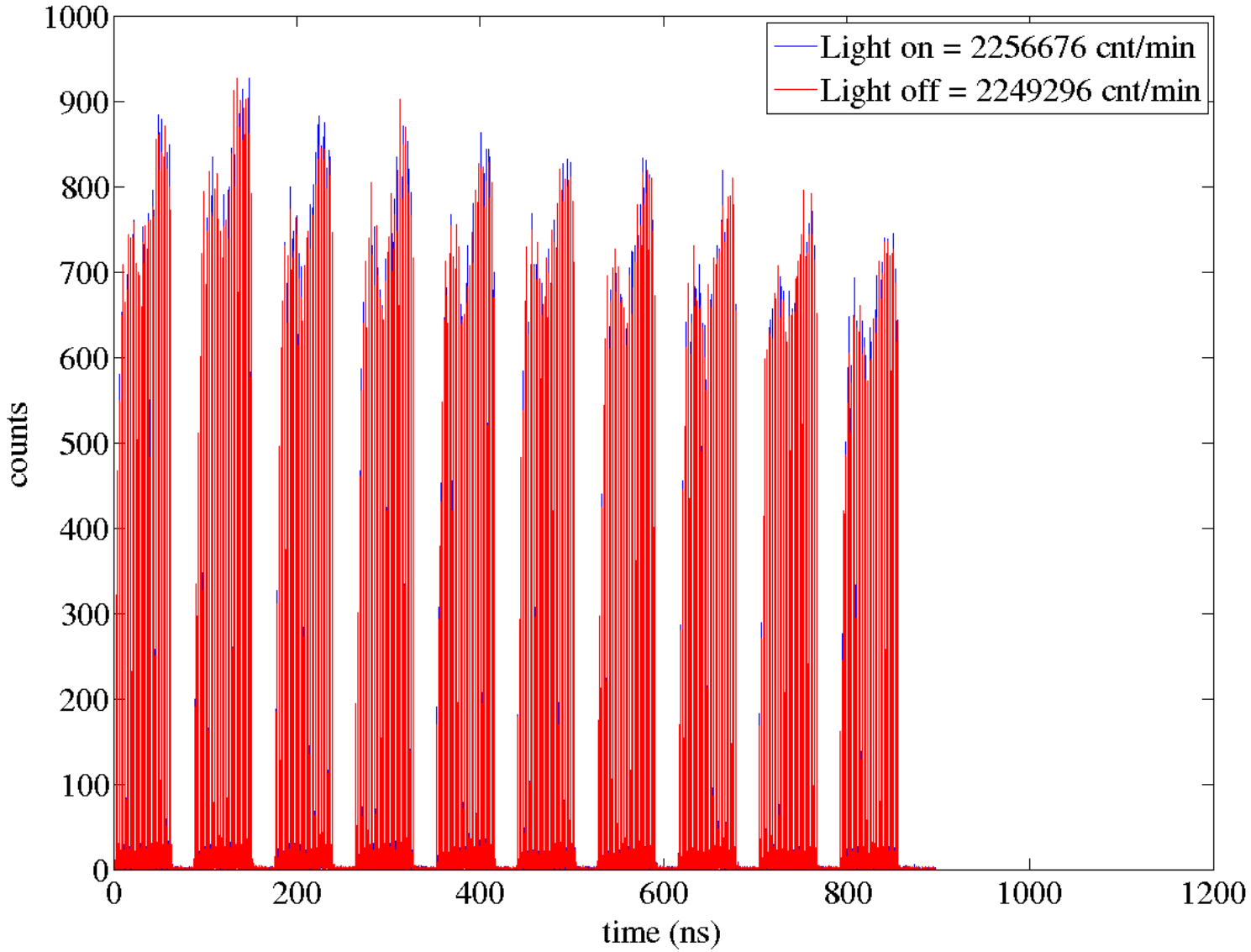
Many thanks to Dr. U. Iriso, S. Blanch, A. Camps and the ALBA staff for the patience and the help!

# BACKUP SLIDES

# Filling Pattern Light On/Off



# Filling Pattern Different Thresholds