Designed of a pulsed negative ions source

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The Middleton sputter source is the most versatile source for production of beams of atomic negative ions [1]. In this source Cs+ ions are created and accelerated towards a cathode holding a sample containing the element to be produced. Atoms and small molecules are sputtered from the sample with a substantial fraction being in the negative charge states. Cathodes of refractory metals last for many hours producing stable negative ion beams. Non-conducting elements or metals with low melting points are more difficult to produce. The lifetime of some cathodes are only a few hours, and the reproducibility of the cathodes are low. This hampers experimental investigations of such elements. However, in many experiments the negative ions are investigated with pulsed laser where only a small fraction of the duty cycle is used. We have therefore investigated the possibility to pulse the ion source in order to extend the lifetime of the cathode.

We have designed a system where we are able to pulse the ions source in order synchronize it with a 10 Hz, 6 ns Nd:YAG laser. This was achieved by pulsing the high voltage between the ionizer, where the Cs+ are produced, and the cathode. We choose to produce 500 μs long ion pulses.

Figure 1 (red rectangles) shows the number of neutral atoms produce from the beam of negative ions. We observe an increased in the ion production over the first 150 μs, where after the production is essentially constant. A laser pulse was intersecting the ion beam at $t = 170\ \mu s$. The resulting photodetachment signal is shown as the blue rectangle. This data clearly shows that we can produce a pulsed ion beam which can be synchronized with the laser pulse.

As a final test, two identical aluminum cathodes were operated for 24 hours. One was continuously operated whereas the other was run in pulsed mode with a 1% duty cycle. A deep hole was created in the cathode run in the continuous mode, whereas the cathode operated in the pulsed mode looked essentially unused. This was confirmed by their measured mass losses of $\Delta m_1 = (9.0 \pm 0.2)\ mg$, $\Delta m_2 = (0.2 \pm 0.2)\ mg$, respectively. This means that a single cathode operated in pulsed mode will last for many hundreds of hours of operation.

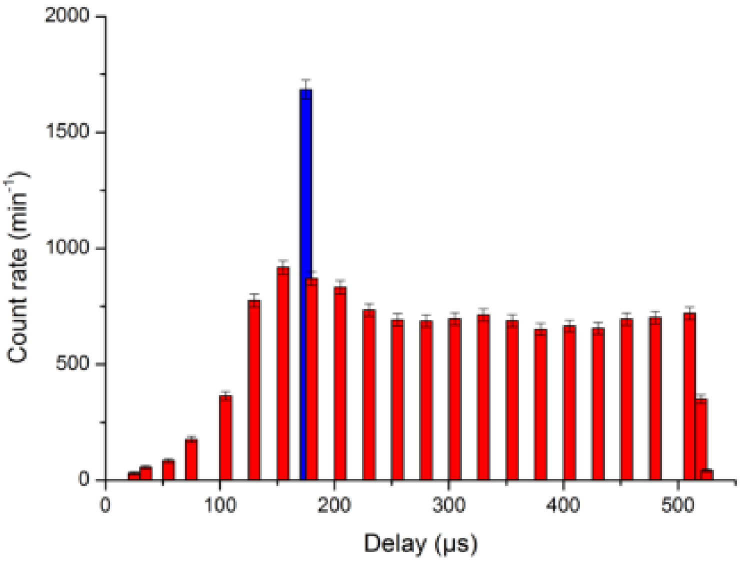

Figure 1: *Collisional detached negative ions (red), and photodetached negative ions (blue).*

References

[1] A negative ion cookbook `http://www.pelletron.com/cookbook.pdf`