Performance of the ESR kicker magnet during E082 *

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In October 2014 the second run of experiment E082 *"Single-Ion Spectroscopy of Two-Body β-Decays"*[1] took place. After a shortage of time during the 2012 beamtime, this time 12 days were allocated to performing high precision lifetime measurements of ^{142}Pm. The measurements were performed by injecting ions and observing them until they decayed. The data was analyzed online and offline, and the parameter of interest was the exact timing of each decay. In order to get reliable data, one has to assure that injected ions are removed from the *ESR* between injections.

In the first experiment we used the injection kick, considering it powerful enough, to also remove the ions from the ESR stored from a preceding injection. However it was noticed that the *kicker magnet*, that is used to perform injections, had several documented failures and possibly more that went unnoticed. This time the experiment was improved in two ways: there was a dedicated extraction kick at the end of each cycle, and all kicker magnet pulses were monitored and saved using a digital oscilloscope.

The dedicated extraction kick enabled a visual confirmation in the *time resolved Schottky spectra* that all ions had been extracted. Thanks to the monitoring of kicks, it was possible to determine exactly what the failure rate of the kicker magnet is during controlled and repeatable operation for over 10000 accelerator cycles, and get quanititative numbers describing its performance.

Setup

The accelerator was operated using a 70 second cycle. Each cycle began with an injection kick which marked the beginning of data-taking (data acquisition systems were triggered on injection). Injected ions were observed over a 60 second window. After this time an extraction kick was performed, which was followed by a 10 second safety period to finish data acquisition and saving.

The kicker magnet is powered by three power modules. Each module supplies a voltage of up to 80 kV to the magnet and a single module typically suffices to perform a successful extraction of the beam. For the experiment all three modules were used during both extraction and injection phases. The length of the injection kick was set to 500 nanoseconds, and the extraction kicks lasted 1500 nanoseconds. The assumption was that at a revolution frequency of 2 MHz, an extraction pulse lasting 3 full revolutions of the ions would be more than enough to remove all of them with absolute certainty.

* Work supported by Helmholtz-CAS Joint Research Group HGJRG-108, FP7 Marie Curie ITN "oPAC", HGF ARD Program

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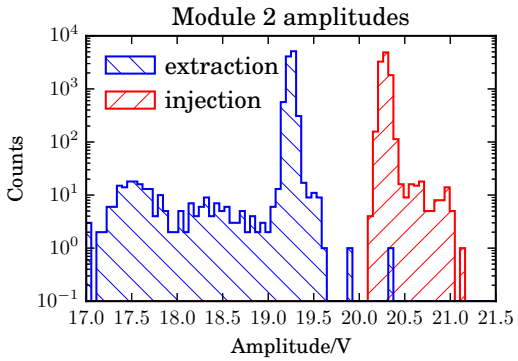

Figure 1: Logarithmic amplitude histogram for module 2. The curves show the extraction (left) and injection (right) amplitudes.

Results

Each power module has a monitoring unit through which a lower-voltage form of the pulse can be observed. We acquired 10359 injection and extraction kicks. We observed that modules 1 and 3 performed reliably throughout the entire experiment. Both delivered a signal with an amplitude of 20 V for injection and 19 V for extraction kicks, both of which are the required values for the monitoring signal. The FWHM of the kicks was around 300 mV. We noticed a single case were the kick was missed by all modules, however as this was a single incident we nonetheless consider the performance to have been extremely stable.

The behaviour of module 2 differed from that of the other modules. A histogram of the amplitudes for module 2 is presented in figure 1. For extraction kicks we counted 242 cases where kicks were weaker than the average amplitude by as much as 2 V. The curves for injections and extractions are visibly different for this one module.

Summary

For the first time in the operation of the *ESR*, the performance of the kicker magnet, crucial to the success of every experiment, has thoroughly been investigated. It was found that 2 out of 3 modules powering the magnet performed without failures in over 10000 accelerator cycles. For module number 2 it was found that the failure rate lies at 0.02%. A value of this magnitude was also confirmed by the Primary Beams High Voltage Pulsed Power group.

Acknowledgments We thank the GSI technical and accelerator groups for invaluable help during the preparation and conduction of the experiment.

References

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