Bringing electronics into vacuum: smarter targets for positron physics

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Electrostatic positron beams use an accelerating potential to propel positrons towards their intended target. This requires either the source [1] or the target [2] to be kept at an electric potential with respect to ground that typically exceeds several kilovolts. As a consequence, any instrumentation attached to the positron source (in the former case) or to the target (in the latter) needs electrical connections that are galvanically decoupled from the ground of the rest of the instrument control system.

As positron beams require high vacuum to be transported, the selection of materials that can be employed inside of the experimental chamber is limited by their degassing characteristics. This makes most of the commercially-available electronic instrumentation incompatible with installation in vacuum. As a consequence, any signal processing and conversion from active targets needs to be performed on the outside of vacuum chambers, requiring the routing of every connection through highly insulated cables outside of the chamber for processing. The number of these connections cannot be reduced by means of multiplexing and their length is a source of noise for high impedance analog signals e.g. those generated by Faraday cups.

We have recently challenged these limitations by developing dedicated electronics specifically designed to be brought inside of the vacuum chambers of positron experiments. We present here the custom instrumentation that we have built, the design principles that allowed us to achieve high vacuum compatibility, the results of our testing of these new systems and the benefits that this new approach can bring to the design of future positron physics experiments.

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[2] Gigl T., Beddrich L., Dickmann M., Rienäcker B., Thalmayr M., Vohburger S. and Hugenschmidt C. Defect imaging and detection of precipitates usinga new scanning positron microbeam *New J. Phys.* **19** 123007 (2017)