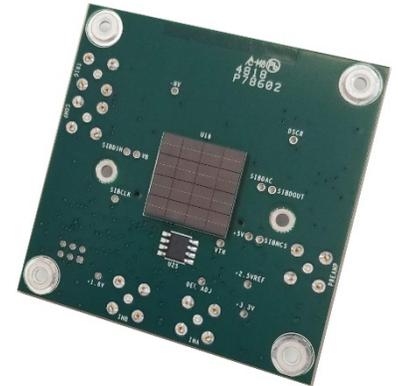


## Overview

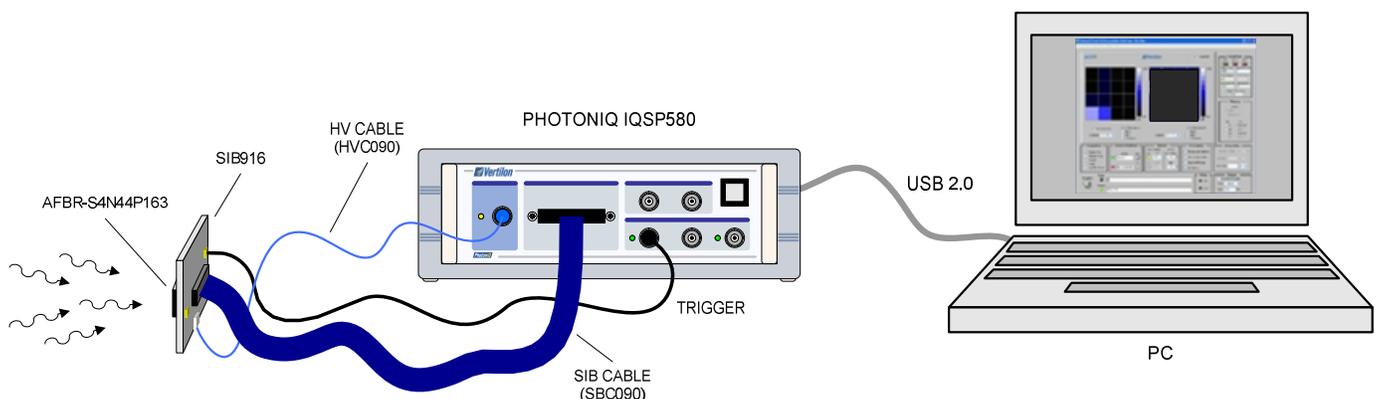
The Broadcom AFBR-S4N44P163 is an 4 by 4 element silicon photomultiplier array that is ideal for radiation sensing and positron emission tomography (PET) applications. Its compact size, UV sensitivity, and high photon detection efficiency make it well-suited for use in laboratory experiments that demonstrate SiPM devices in combination with scintillators and software signal processing algorithms.

In this application note we describe a simple, plug-and-play, real-world setup that utilizes a Broadcom AFBR-S4N44P163 SiPM array in combination with standard, off-the-shelf equipment from Vertilon. The equipment is configured to continuously capture and measure the scintillation light from a LYSO crystal attached to the SiPM array. The SiPM array is mounted to a Vertilon SIB916 sensor interface board that is in turn connected to a Vertilon PhotoniQ IQSP580 charge integrating, 32 channel data acquisition system (DAQ). A 10 mm cube of LYSO crystal is placed over several elements of the SiPM array with a cesium 137 check disk situated in close proximity. Light generated by the LYSO crystal is sensed by the AFBR-S4N44P163 array and measured by the SIB916 whose adjustable discriminator generates a trigger to the IQSP580 DAQ whenever the signal from the SiPM array exceeds a user-defined threshold. For each trigger, real-time data is displayed in the PhotoniQ's graphical user interface and logged on an attached computer.

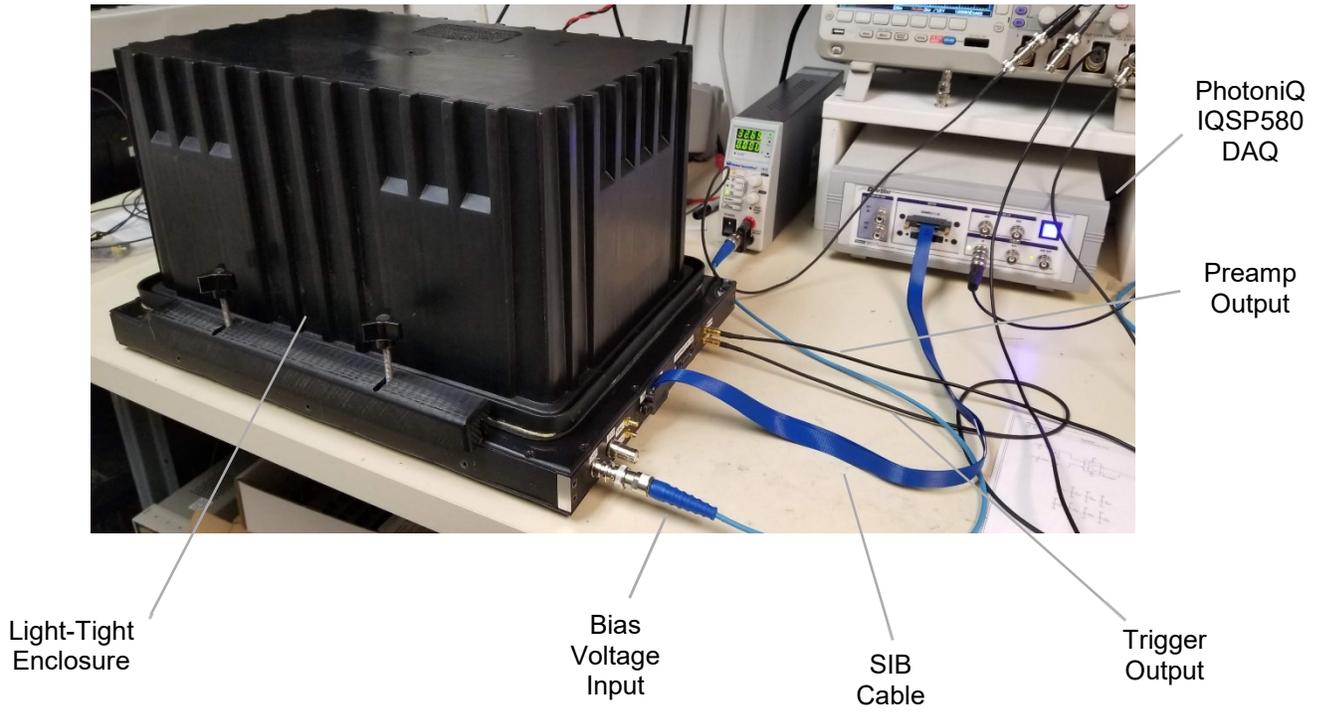


## Electronics Setup

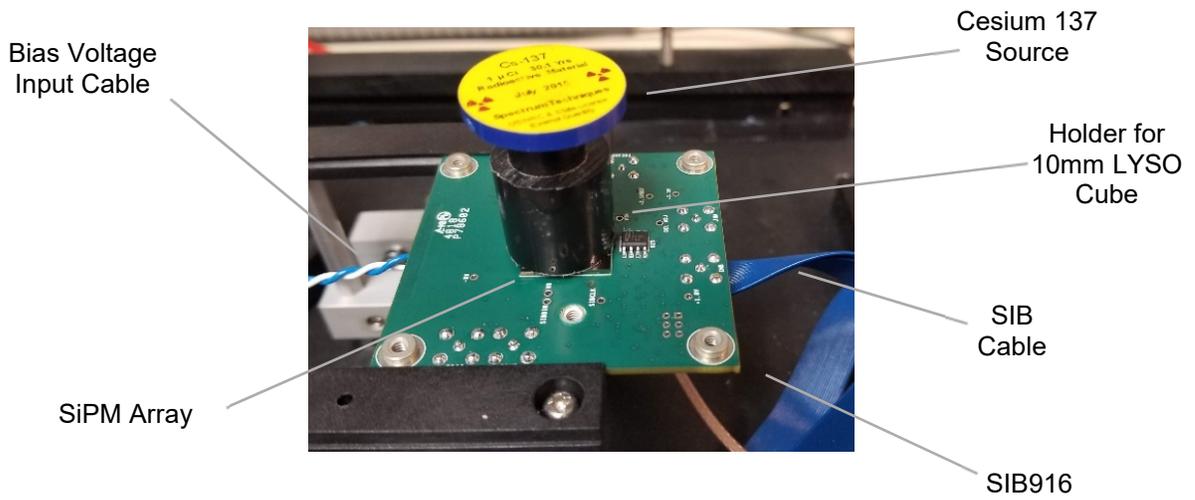
The Broadcom AFBR-S4N44P163 4 x 4 SiPM array is reflow soldered to the SIB916 which is positioned in a light tight enclosure. The cesium 137 source is also positioned inside the enclosure on top of the LYSO crystal which is mounted with optical grease to the SiPM detector array. The SIB cable from the SIB916 connects to a PhotoniQ IQSP580 multichannel data acquisition system. The discriminator signal from the SIB916 produces a trigger to the PhotoniQ whenever a radiation event is detected on the SiPM array. The energy level threshold for the radiation event is set by the user through the PhotoniQ graphical user interface. Charge signals from the 16 cathodes from the AFBR-S4N44P163 device are acquired by the PhotoniQ for each trigger produced by the SIB916. Digitized output data from the PhotoniQ is sent through a USB 2.0 connection to a PC for display, logging, or real time processing.



System Interconnections



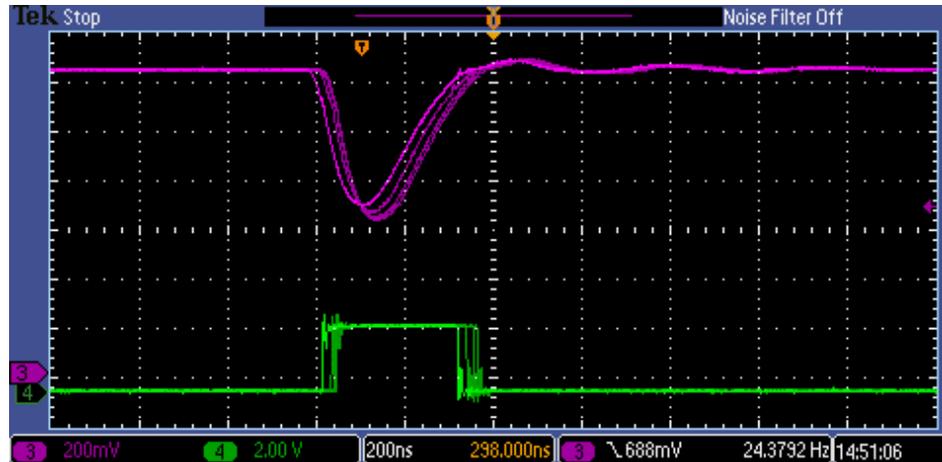
Light Tight Enclosure



Crystal and Source Location

## Operating Conditions

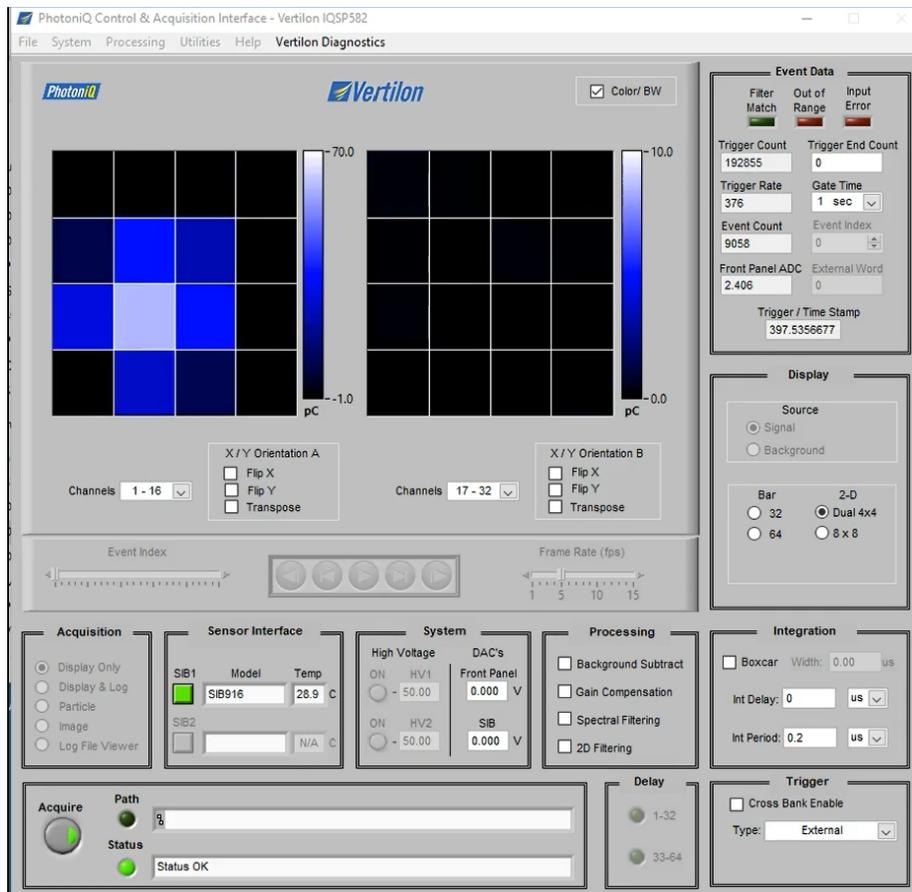
The operating parameters for the SiPM array and discriminator on the SIB916 sensor interface board are set through the PhotoniQ graphical user interface. The Broadcom AFBR-S4N44P163 is biased at negative 28.7 volts through the twisted blue and white cable connected to the SIB916 shown in the figure above. The SIB916 discriminator parameters are generally determined empirically. The preamp gain was set to low, the discriminator was enabled, and the discriminator threshold was set to 10%. In this demonstration, the preamp and trigger outputs from the SIB916 are connected to an oscilloscope that is set to trigger on the falling edge of the preamp signal. The figure below shows the SIB916 preamp (pink trace) and trigger (green trace) outputs for multiple overlapping decay events from the LYSO crystal.



Preamp and Discriminator Timing

## PhotoniQ Graphical User Interface Display

Data is displayed and logged to a file using the PhotoniQ graphical user interface. The figure below shows a screenshot of the GUI at a particular point in time. The display area consists of a 4 x 4 grid matching the SiPM array with the display intensity representing the total charge output per channel from a triggered event. The display area on the right side of the screenshot is normally used for dual sensor configurations and is therefore not active in this example. Activity from the LYSO crystal is clearly shown in the center section where the 10 mm LYSO cube overlaps several SiPM elements. Since this setup provides a real-time display of event data, the true capability of this system is better illustrated by video. This video link (<https://youtu.be/ISWrg5uEmjc>) shows approximately ten seconds of data captured and displayed using the described system where the varying signal intensity can be observed. Additionally, the event counters in the upper right section of the GUI provide the real time count of the number of triggered events. Other information is also available in the GUI including the current trigger rate, event time stamps, and the SIB916 temperature. Event data can also be viewed in the GUI on a linear display rather than a 2D grid. This is sometimes useful for applications in which the 4 x 4 arrangement of the SiPM is transformed into other spatial mapping by the use of optical fibers or other techniques.



PhotoniQ GUI Screenshots

## Related Documents

SIB916 Product Sheet:

<https://vertilon.com/pdf/PS2746.pdf>

SIB916 User Guide:

<https://vertilon.com/pdf/UG2874.pdf>

IQSP580 Product Sheet:

<https://vertilon.com/pdf/PS2708.pdf>

PhotoniQ Data Acquisition Systems User Manual:

<https://vertilon.com/pdf/UM6177.pdf>

Broadcom AFBR-S4N44P163 Data Sheet:

<https://docs.broadcom.com/docs/AFBR-S4N44P163-DS>



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