A PROPOSED MULTIFUNCTIONAL MULTICHANNEL RECEIVER FOR SGSLR, J.J. Degnan[1] and R. L. Machan[2], Sigma Space Corporation, 4600 Forbes Blvd., Lanham, MD, 20760 USA,
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In the present paper, we describe a device proposed for possible use in SGSLR which, when combined with a segmented anode photomultiplier or other detector array, performs multiple functions as: (1) a multichannel Event Timer (ET) with extremely low deadtime (<2 nsec) per channel; (2) an automated pointing error correction system which monitors and reports the angular offset between the receiver optical axis and the target satellite; and (3) an "Electronic Spatial Filter" which eliminates the vast majority of noise counts which do not emanate from the immediate angular vicinity of the satellite. The device design draws heavily from Sigma's multibeam 3D imaging lidar experience and is relatively indifferent to sensitivity or gain non-uniformities in the array detector which complicated an earlier approach based on balancing the outputs of a quadrant detector [1].

A block diagram of our approach is illustrated in Figure 1. Solar and satellite returns collected by the telescope pass through the spatial filter (assumed to be a circular iris so it can be easily varied for day vs night operations). A telephoto lens reimages the spatial filter/iris onto the photocathode of a NxN ($N \leq 10$) Segmented Anode MCP/PMT. For the purposes of this discussion, we will assume N = 10 since this is our standard lidar configuration and provides good angular resolution. Each of the pixels within the iris FOV generates an electrical pulse for each detected photon (signal or noise). The electrical pulses from each pixel are then amplified to ensure that a single photon return will generate a voltage in excess of the required comparator threshold. This compensates for any gain nonuniformity in the MCP/PMT which might result in different pixel count rates in response to the same stimulus.

The Time-of-Flight (TOF) boards time-tag each photon event with a precision of $\pm$ 40 picoseconds and a pixel recovery time of less than 2 nanoseconds between photon events. Automated calibration provides real-time updates of timer delays as affected by voltage and temperature. Relative to the contributions of the PMT and satellite impulse responses, the $\pm$40 psec timing quantization effects on single pulse RMS are inconsequential.

On average, solar noise counts will be distributed uniformly among the 88 pixels, within the iris FOV, while satellite returns will be concentrated on a small number of pixels determined by the image size at the MCP/PMT. Thus, the pixel with the most counts (dark green pixel in Figure 2) determines the angular position of the satellite relative to the receiver axis centered on the array detector. In the event that the satellite image spills over into adjacent pixels, inclusion of the 8 nearest pixels in a centroid computation may be useful in better defining the satellite angular position. This information would then be gathered and sent to the SGSLR interface to drive the telescope/tracking gimbal mount and correct for the pointing error.

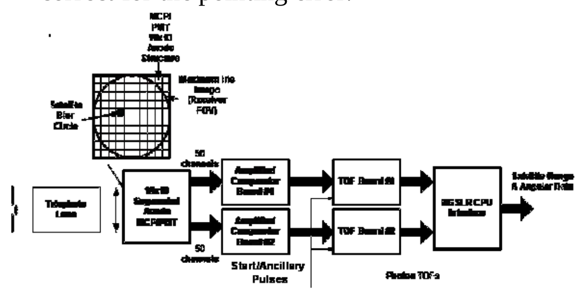

Figure 1: Block diagram of the proposed pointing correction system.

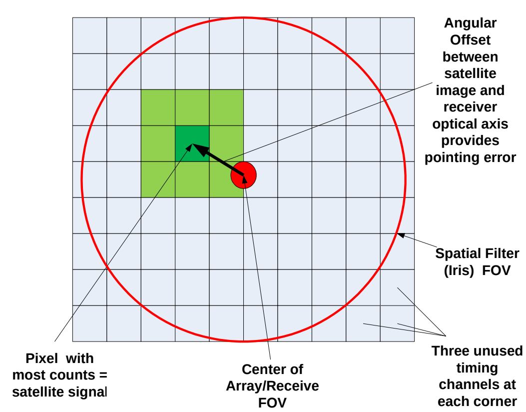

Figure 2: Closeup view of a 10x10 anode array.

Since noise counts are, on average, uniformly distributed over the pixels contained within the receive spatial filter FOV (indicated by the red circle in Figures 1 and 2), the events in the grey pixels can be discounted as noise by the SGSLR Processor.

References: [1] Degnan, J.J. and McGarry, J. F., (1997), SPIE 3218, 63-77. [2] Degnan J. J. and Field, C. T., (2014) SPIE 9114-16.