Signal Decomposition for GRETINA

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GRETINA is a new type of gamma-ray detector, based on the revolutionary concept of gamma-ray tracking. Gamma-ray tracking detectors will be much more efficient and sensitive than ordinary detectors, and could have important imaging applications in nuclear medicine and homeland security. GRETINA depends on sophisticated digital signal processing ("decomposition") for the information it needs to track gamma rays, and therefore requires new decomposition programs ("algorithms") which are both accurate and run very fast on existing computers.

We have succeeded in developing software which runs almost a thousand times faster than previously, yet is also able to reproduce the input signals much more accurately. Furthermore, the new algorithm is able to process any valid signal from the detector; previous versions could only handle signals where no more than one or two parts of the detector were hit by gamma rays.

Shown below are signals from three different events in a prototype GRETINA detector, showing how accurately the measured signals (in red) are reproduced by the algorithm (in blue). Most lines appear purple in the plot due to the excellent overlap of measured and simulated signal.

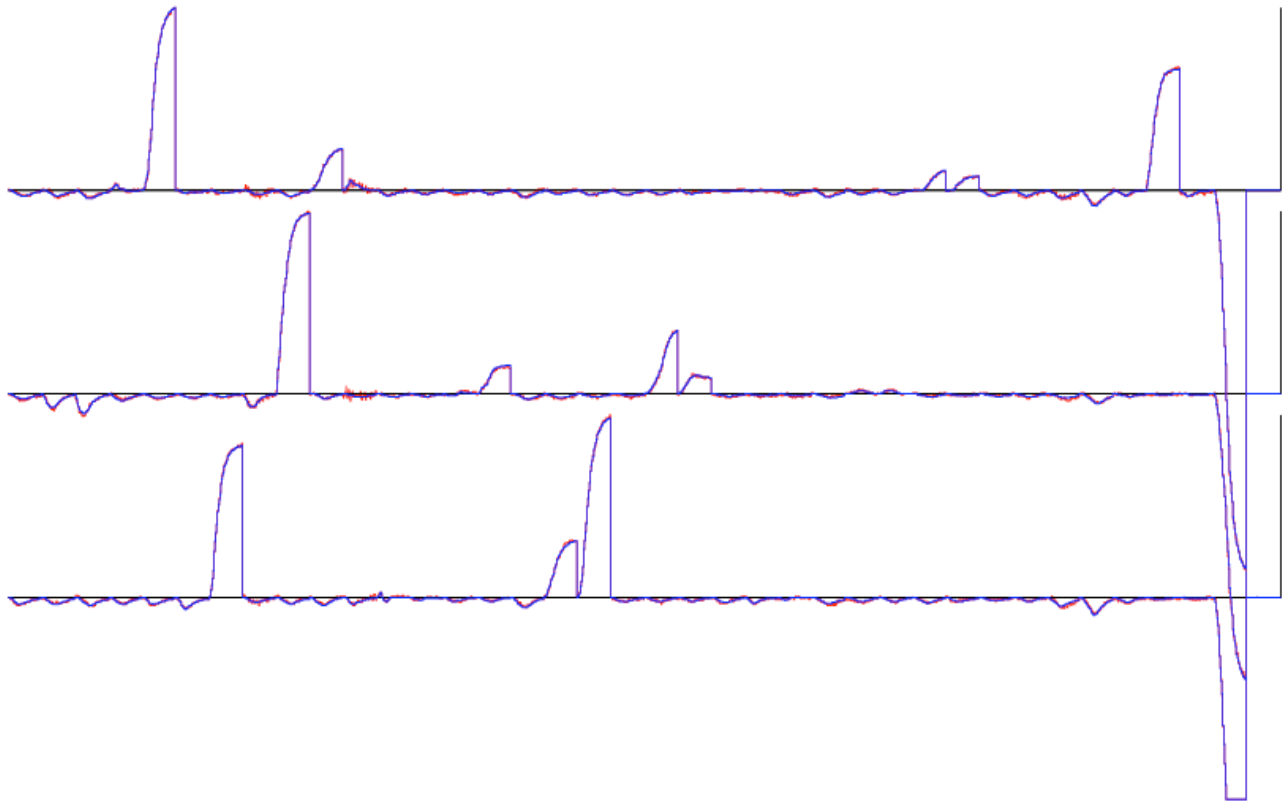

Figure: Signals from three different events in a prototype GRETINA detector. Each event has the measured signals shown in red, and the reproduced (fitted) signals overlaid in blue. In the lowest event three parts of the detector were hit by a gamma ray; in the top event, five parts were hit.