5. SAS experimental validation.

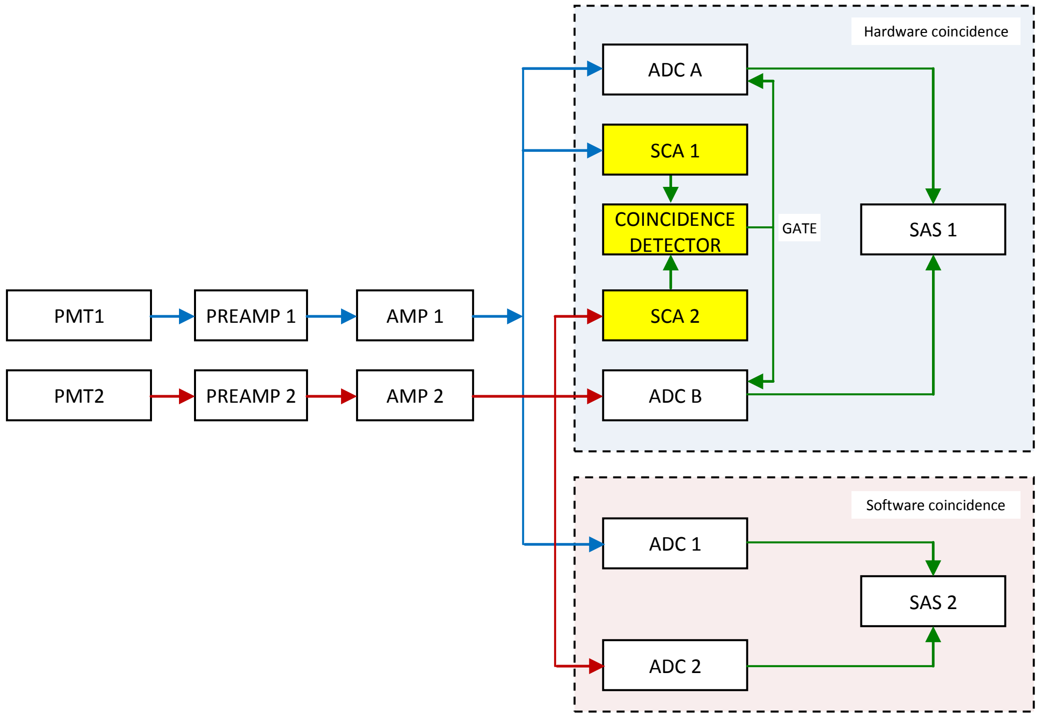
To validate the SAS reliability and proper functioning, several data acquisition experiments with the muon telescope MD1 (see Sect. 2.1) were performed. Both, hardware and software coincidence configurations were simultaneously tested and their results were compared.

Figure 11 shows the experimental setup operating in hardware (blue background block) and software (red background block) coincidence simultaneously. In hardware coincidence, the SAS is used to store data, so it does not work as a coincidence detector module and that is the reason why its software has been slightly simplified; it waits for the activation of both DR signals to read and store data, and then resets the ADCs.

The software coincidence block shows how, this configuration, is significantly simpler than the one based on hardware coincidence, saving three modules: two SCAs and one coincidence detector module (yellow modules in Fig. 11). Moreover, the SAS has the capability of storing and transferring data to a PC, avoiding the use of an interface module. From an economical point of view, the total cost of those four NIM modules is well above 6000 € (only one SCA module costs more than 1600 €) and the SAS implementation components have cost less than 150 €. So, we can say that the SAS, working in software coincidence, reduces the value of the laboratory equipment replaced by a factor of 40.

To make comparisons between both types of coincidence detection systems, we acquired data during one day with the experimental setup shown in Fig. 11. Obviously, the data registered by both software and hardware coincidence chains should be identical. Figure 12 shows the corresponding histograms produced, which are nearly identical, showing only a minor difference in the total amount of data acquired by both systems (0.05 %).

Although this difference can be considered negligible, further tests were performed in order to find out the origin of this discrepancy. Sometimes, the ADC conversion process produces errors and conversion is aborted (see Sect. 2.4). In these cases, DR signal is not generated and INV signal activated, which causes data is not registered. Ad-hoc code has been written to register INV signal and several samples has been taken and analyzed. As it can be seen in Fig. 13, an error causes the INV activation in hardware coincidence chain. However the software coincidence prototype stores the correct value because its ADCs have not produced conversion errors. In normal operation, this hardware coincidence data would not be registered and, as a result, the total amount of hardware coincidence data would be lower than the one registered with software coincidence. That is the origin of the small difference between the histograms corresponding to hardware and software coincidence shown in Fig. 12. Therefore, seeing how the rest of data are similar in time and amplitude values, we conclude that under the experimental conditions used in this work, both kinds of coincidence detection systems (hardware and software) produce equivalent result.



PREAMP: Preamplifier. AMP: Amplifier. SCA: Single Channel Analyzer. PMT: Photomultiplier.

Figure 11. Schematic setup for hardware coincidence and software coincidence results comparison. The same analogue signals detected by PMT1 and PMT2 are introduced into both hardware coincidence and software coincidence chains. Working in hardware coincidence, SAS 1 only stores data from both chains. Working in software coincidence, SAS 2 detects coincidence and stores data. We can see in yellow colour the unnecessary modules when SAS is working in software coincidence.