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First detection of Kaons with scintillating fibers read by MPPC at the DAΦNE e^+/e^- collider

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Multi-Pixel Photon Counters (MPPC) consist of hundreds of micro silicon Avalanche PhotoDiodes (APD) in Geiger mode. The high gain, low noise and low voltage values needed for operating these relatively new devices, together with their good behaviour in magnetic field, make them ideal for the readout of scintillating fibers as front-end/trigger detectors in particle and nuclear physics experiments. A prototype setup consisting in 5 scintillating fibers read out by 10 MPPCs was mounted inside the DAΦNE collider at LNF-Frascati to measure the back-to-back K^+K^- in the Φ-decay processes. Such a system will be used as a trigger system in the AMADEUS experiment. Energy and time differences between Kaons and MIPs are a crucial features for the AMADEUS trigger. In this work, we present the first results on DAΦNE in wich energy and time spectra for scintillating fibers read out by MPPC are studied. The Kaon Monitor detector of the SIDDHARTA experiment is used as time reference Kaons' tagger.

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1. The experimental setup

The AMADEUS experiment [1] needs a trigger system on the back-to-back delivered Kaons (K^+K^-) in DAΦNE out of the ϕ-decay process, in magnetic field. Ideal for such a role are the Multi Pixel Photon Counter detectors (MPPC) [2][3][4][5], coupled to scintillating fibers. A prototype was built and tested. Preliminary indications of Kaons detected by such a prototype in the DAΦNE collider were presented during the XLVII Winter Meeting on Nuclear Physics in Bormio, in 2009 [6]. The prototype contains a mechanical support for 5 scintillating fibers (Bicron BCF-10,$\simeq$ 15 cm long), providing fibers' alignment and coupling with MPPCs. Both sides of the fibers are coupled to MPPCs from Hamamatsu (S10362-11-050U) and to the relative readout electronics. Dedicated modules were built in laboratory and used as power supply (high voltages with stability $\simeq 0.1mV$) and as preamplifier, with a variable gain between 20 and 100. The prototype was mounted on the collider in the interaction region of the SIDDHARTA experiment [7], below the lower scintillator of the SIDDHARTA Kaon Monitor (KM), which consists in two scintillators one above and one below the beam pipe, as shown in fig. 1

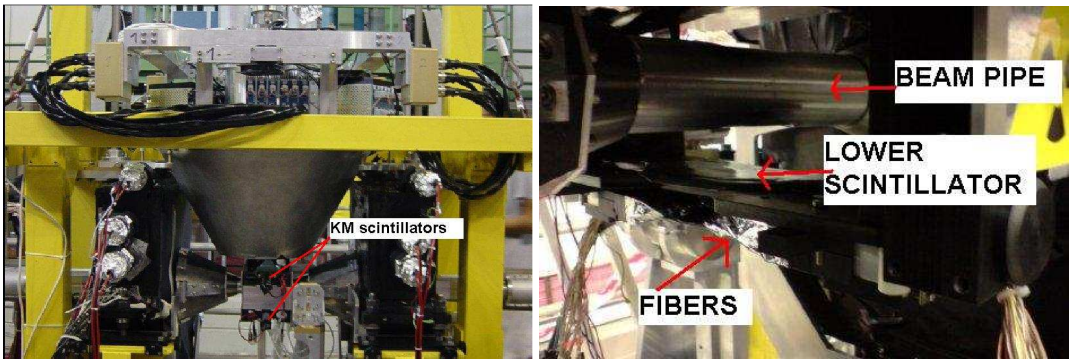

Figure 1: Picture of the setup mounted on the collider.

The SIDDHARTA Kaon Monitor represents a good tagger for Kaons and a good timing reference in order to test the real capability of Kaons' detection with scintillating fibers coupled to MPPCs.

2. Detection of Kaons in DAΦNE

Scintillating fibers plus MPPC setup was mounted on the e^+/e^- collider, including a chain with TDC signals coming from the Kaon Monitor of SIDDHARTA. The KM has a strong threshold and rejects events with low energy loss, which are mainly due to the MIPs passing through the scintillators, according to the picture shown in fig. 2

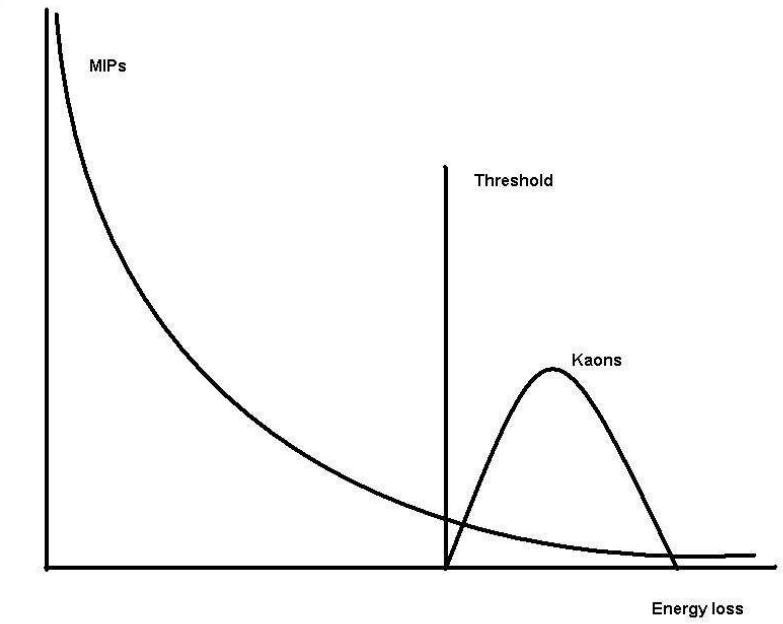

Figure 2: Energy loss by Kaons and MIPs in the KM scintillators.

Time spectra of KM and of Sci-Fi are shown in fig. 3

Since the acquisition chain is driven by the SIDDHARTA KM, only events in which a signal is collected in the scintillators are acquired. In the KM spectra a double structure of Kaons and MIPs peaks is clearly visible; the double structure is due to the fact that a signal of half radiofrequency of the collider is used as time reference. Time distance between Kaons and MIPs is around 1 ns while between the two structures there is an offset of $\simeq$ 3 ns (RF=340 MHz). In the Sci-Fi spectra, only two peaks are present; MIPs collected by KM scintillators are not passing through the fibers as expected (high angle) and peaks are only due to Kaons. The time resolution of Sci-Fi plus MPPC setup is $\simeq$ 400 ps.

In fig. 4, on the left, time spectra of MPPC are shown when Kaons or MIPs detected by KM scintillators are selected. On the right, time spectra of KM are shown when coincidence with Sci-Fi is requested or not. ADC information for MPPC are reported in fig. 5 showing all events (black), events in which a coincidence in the KM is selected (red) and events in which a coincidence with only Kaons (green) or MIPs (blue) is requested.

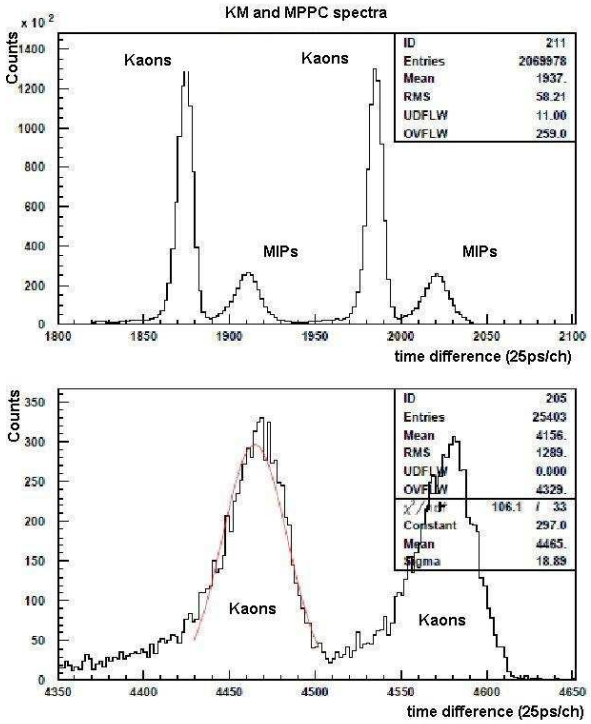

Figure 3: KM (upper) and Sci-Fi (lower) TDC spectra

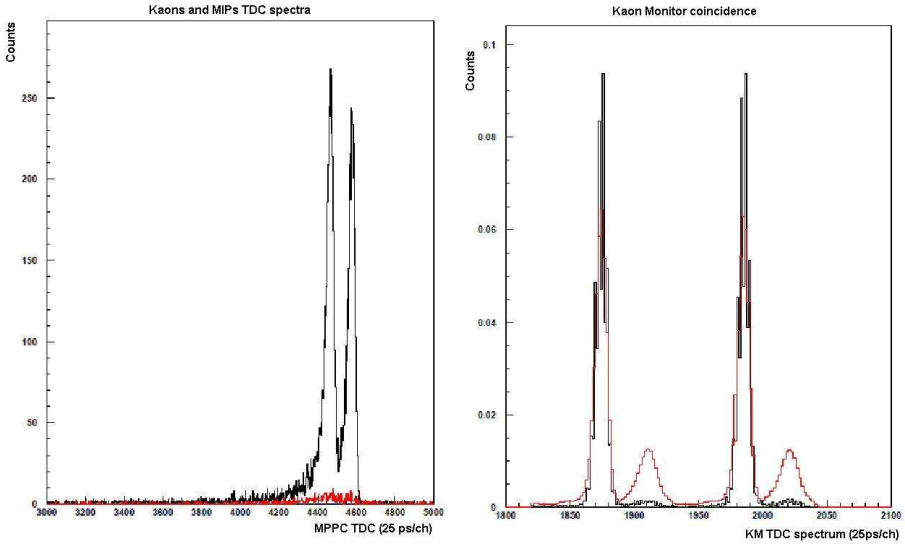

Figure 4: Left: MPPC time spectra when Kaons(black) or MIPs(red) are selected.

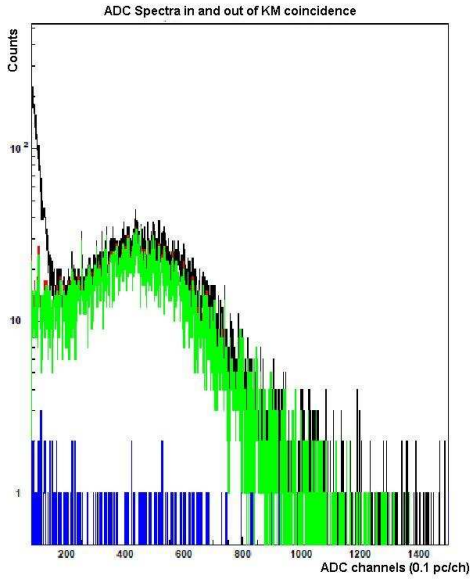

Figure 5: ADC spectra: total ADC (black), events in wich a coincidence in the KM is selected (red) and events in wich a coincidence with only Kaons (green) or MIPs (blue) is set

Concluding, a first detection of Kaons has been performed, confirming the good behaviour of MPPC devices in such an environment and confirming the possibility to use scintillating fibers coupled with MPPC as a trigger system in the future AMADEUS experiment.

Acknowledgments

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