Commissioning and First Results of the NA62 RICH

The NA62 experiment at CERN has been constructed to measure the ultra rare charged Kaon decay into a charged pion and two neutrinos with a 10% uncertainty. The main background is made by the charged kaon decay into a muon and a neutrino which is suppressed by kinematic tools using a magnetic spectrometer and by the different stopping power of muons and pions in the calorimeters. A RICH detector is needed to further suppress the μ contamination in the π sample by a factor of at least 100 between 15 and 35 GeV/c momentum, to measure the pion crossing time with a resolution of about 100 ps and to produce the trigger for a charged track. The detector consists of a 17 m long tank (vessel), filled with Neon gas at atmospheric pressure. Cherenkov light is reflected by a mosaic of 20 spherical mirrors with 17 m focal length, placed at the downstream end, and collected by 1952 photomultipliers (PMTs) placed at the upstream end.

The RICH detector installation was completed in the summer of 2014 and the detector was used for the first time during the pilot run at the end of 2014. The RICH was then operated during the NA62 Commissioning Run in 2015 and it is in use in the 2016 Physics Run.

In Figure 2 the time resolution of the RICH is shown. In the left picture the hits (i.e. fired photomultipliers) in a Cherenkov ring are split into two halves and the difference of the average times is plotted. In the right picture the difference between the average time of a Cherenkov ring and the KTAG time is shown. The measured RICH event time resolution is about 70 ps.

Figure 2. Left: intrinsic time resolution of the Cherenkov photons. The detected photons of one Cherenkov ring are divided into two groups and the time difference is plotted. The time resolution of the full ring is one-half of the sigma of the curve (∼70 ps). Right: time difference between the average time of a Cherenkov ring and the KTAG time (∼140 ps).
In order to illustrate the performance of the RICH detector samples of charged pions, muons and electrons were selected using calorimetric and spectrometer information. In Figure 3 (left) the number of hits per Cherenkov ring as a function of particle momentum (measured by the spectrometer) is shown for electrons, muons and charged pions. In Figure 3 (right) the Cherenkov ring radius as a function of momentum is shown without any selection on the type of particle: electrons, muons, charged pions and scattered charged kaons can be clearly seen.

![Figure 3](image1.png)

The squared particle mass can be reconstructed using the velocity estimated by the Cherenkov angle measured by the RICH and the momentum measured by the spectrometer. In Figure 4 the squared reconstructed particle mass is shown (left), selecting the fiducial momentum region between 15 and 35 GeV/c for samples of electrons, muons and charged pions identified using spectrometer and calorimetric information. Cutting on the reconstructed mass charged pions can be selected and muons can be rejected: the right picture indicates the efficiency for pion selection as a function of the muon suppression for different choices of the cut on the reconstructed mass; for a 86% pion efficiency a 1.3% muon survival probability is quoted. It must be noted that in 2014 and 2015 the RICH mirrors alignment was not optimal and the need of a better performance in the pion-muon separation was the main reason for the detector maintenance carried out in the 2015-2016 winter shutdown.

![Figure 4](image2.png)