Abstract

Part one of this thesis is concerned with the analysis of charmonium resonances based on events that have been collected with the BESIII detector at IHEP, Beijing. In the second half, developments and technical devices are presented for the prototype of the forward endcap of the electromagnetic calorimeter, a major component of the future PANDA experiment at FAIR in Darmstadt. In both experiments, charmonium spectroscopy is an issue of high interest.

Within the scope of the analysis of BESIII data, a search for intermediate resonances which decay into $\phi\phi$, is carried out. The radiative decay of $J/\psi \rightarrow \gamma\phi\phi \rightarrow \gamma K^+K^-K^+K^-$ is a gluon-rich process and therefore predestined for the search for exotic states. The analysis of the reaction is based upon a data sample of $10^9 J/\psi$ events. After event selection and detailed background studies, 16997 $\phi\phi$-events remain and serve as a basis for a partial wave analysis (PWA). In order to obtain precise results for intermediate resonances, first a mass-independent PWA has been performed, followed by a mass-dependent PWA. A predominant $0^{-+}$ wave is identified across the entire invariant $\phi\phi$ mass range, including a very clear $\eta_c$ signal. The mass and width of another contributing $2^{++}$-state is consistent with the values indicated for the $f_2(2340)$. This resonance is considered to be a glueball candidate. An additional weak contribution is observed near the $\phi\phi$ threshold. Due to the nearly identical quality of fit, one of the following two resonances may be taken into account: either a $2^{++}$-state which corresponds to the $f_2(2010)$ resonance and is supposed to be another glueball candidate, or a $0^{++}$-state corresponding to the $f_0(2020)$ resonance.

To achieve the energy resolution required for the electromagnetic calorimeter for PANDA, the operating temperature must be a stable $-25^\circ\text{C}$. Monitoring the crystal temperature is of utmost importance since the light yield of the PbWO$_4$ scintillator is strongly temperature-dependent. Very thin cables (90 $\mu$m) connected to sensors which measure the crystal temperature, are optimized and their production improved. New developments and improvements are carried out for a modular monitoring system (THM$P$) processing the signals of the temperature, humidity and pressure sensors inside the prototype. Resolution of temperature measurements by the THM$P$ is increased to 0.008 K. A calibration method and a new circuit-board to monitor the power supply of the preamplifiers of the photo detectors have been developed. In order to avoid condensation and formation of ice in the cooled prototype, an electrically controlled flushing system using dried air has been developed and installed. A relative humidity of $<70\%$ is thus maintained.