Development of the Lambda Disk Detector for the PANDA Experiment

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Introduction

The main physics motivation of PANDA future experiment is to study the low energy regime of Quantum Chromodynamics (QCD), theory of strong interaction. The PANDA detector will be installed at the High Energy Storage Ring (HESR) at the FAIR (**F**acility for **A**ntiproton and **I**on **R**esearch), which is currently under construction at Darmstadt, Germany. PANDA is a fixed target experiment which will use an intense, phase space cooled antiproton beam at FAIR in the beam momentum range of 1.5 to 15 GeV/c and incident on a hydrogen or heavy nuclear target. The experiment will focus on several physics programs, particularly on hadron spectroscopy, search for gluonic excitation, study of properties of hadrons inside nuclear matter, double-hypernuclei to study the hyperon-hyperon interaction and electromagnetic processes to investigate the various aspects of nucleon structure[1]. There is a possibility to extend the PANDA physics program including hyperon studies which require an additional detector called the "Lambda Disk" detector. Hyperons have a large decay length on the order of a few centimeters. Therefore they travel a large distance before decaying into other particles. This Lambda disk detector will increase the acceptance of these decay particles. In this paper, we will present the feasibility of putting a new subdetector-Lambda Disk to track the charge decay product of hyperons.

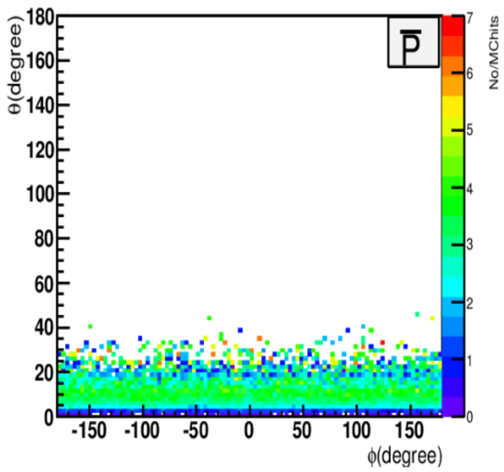

FIG. 1: Antiproton hits within MVD and Lambda Disks.

Detector Setup

The PANDA detector is designed as a nearly 4π acceptance detector with high momentum resolution, precise tracking and particle identification. It is divided into two parts, one is the target spectrometer and other is the forward spectrometer. The target spectrometer will surround the interaction point and consist of several subdetectors including tracking detectors named as the Micro Vertex Detector (MVD), Straw Tracker Tubes (STT), Gas Electron Multipliers (GEM), Scintillator Tile (SciTill), two Ring Imaging Cherenkov (RICH) detectors for particle identification, an Electromagnetic Calorimeter (EMC) for the energy measurement of neutral and charged particles. The forward spectrometer will consist of a set of multi-wire drift chambers (MDC) for tracking, a RICH detector for particle identification, a Time of Flight (TOF) detector for time of flight measurement, EMC detector and a muon detector as the most downstream component[2].

Micro Vertex Detector (MVD) and Lambda Disks

Lambda disks are the two additional disks. As a starting geometry of Lambda disks, these are fully made of double sided silicon strip

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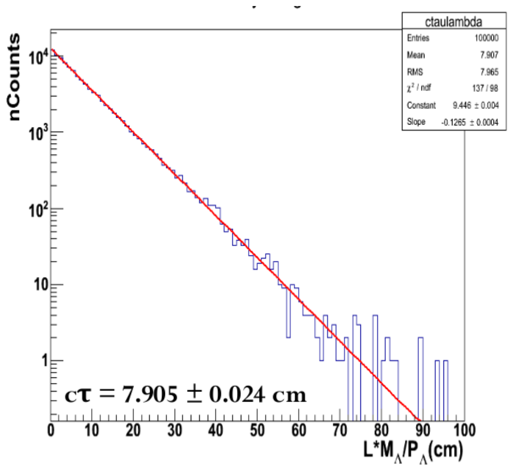

FIG. 2: Proper time distribution for the decay of the Λ particle.

sensor. In the basic design, the outer ring has been kept similar to the outermost layers of MVD forward disks and inner layer has been designed using silicon strip sensors. The MVD is an innermost tracking detector of PANDA detector setup[3]. It consists of four barrel layers and six forward disk layers. It is made of two types of silicon sensors, one is silicon hybrid pixels and another is double sided silicon strips. The last layer of the MVD forward disks is situated at 23 cm downstream from the interaction point and the first layer of GEM tracking station is located 110 cm downstream from the interaction point. Hence, there is a large region without any tracking detectors, and it is proposed to place the Lambda disks in this volume. One layer is at 40 cm and the other is at 60 cm downstream from the interaction point. The Lambda disk detector will improve the reconstruction probablity of hyperons having a longer decay length.

Analysis

At present, we are involved in simulation studies of the Lambda disks detector with $p\bar{p}{\rightarrow}\Lambda\bar{\Lambda}{\rightarrow}p\pi^-\bar{p}\pi^+$ to calculate the reconstruction efficiency of this channel. The present studies were performed by taking two different decay models having different physics at different momentum. The angular distribution for all final state particles have studied at 1.8 GeV/c for the low energy model[4] and 3 GeV/c for the high energy model[5]. In order to achieve the required tracking performance, a high spatial coverage with a sufficient number of hit points inside the detector is required. We will present the number of hits per track studies in this paper. The total number of hits in the MVD and Lambda disks from the antiproton as a decay product of antilambda is shown in FIG.1 as a function of the initial emission angles θ and ϕ. These data were calculated for $p_{beam} = 3$ GeV/c. We have studied the proper time distribution of Λ and $\bar{\Lambda}$ particles as shown in FIG.2. The slope of an exponantial fit to the data corresponds to the mean lifetime of the particle, and the results presented is in good agreement with the expectations based on the PDG[6]. We will report about the reconstruction efficiency of Λ and $\bar{\Lambda}$ with and without Lambda disks. Simulation studies like as material budget, radiation damage, and rate estimation which are essential for a development of the detector will be presented.

Acknowledgements

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