Early physics with the LHCb detector

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LHCb is a dedicated experiment for the precision measurements of rare decays and CP-violation in the b-sector. It is currently being commissioned at the Large Hadron Collider at CERN. The experimental techniques applied allow for a highly efficient sampling of beauty events.

The Vertex Locator (VeLo) is a silicon strip detector 8 mm from the proton-proton beam. The 5 µm hit resolution allows 30 µm resolution of the impact parameter. The decay distance (time) measurement with an accuracy of 40 fs allows in particular the resolution of b, oscillations. Inclusion of the impact parameter measurement in the trigger system leads to early and powerful selection of b-decays.

The RICH2 covers the highest momentum range using 100 m Tm field radiators, with n=1.03, 0.5% precision. As the production of K stars is envisaged, the VeLo together with the Tracker Turicensis (Zurich Tracker) and the Silicon Inner and Straw drift tube Tracker after the magnet. The emission angle of the cone depends on the velocity of the charged particle tracks traverse the medium they radiate photons in a cone around their track direction. These photons make ring images around the track as measured in the RICH2.

The momentum and mass measurement is implemented with a dipole magnet and tracking stations before and after the magnet. The dipole magnet generates a 4 Tm field integral. The VeLo together with the Tracker Turicensis (Zurich Tracker) and the Silicon Inner and drift tube Tracker after the magnet are used to determine precisely the particle momentum with 8p/p = 0.3%-0.5%. This leads to good mass resolution of ϵ = 14 MeV to efficiently suppress background.

The particle identification for K-π separation is reached by two Ring Imaging Cherenkov counters. RICH1 has two different radiators, 5 cm aerogel with a refractive index n=1.03 4 m³ and gaseous C,F,N, with n=1.0014, to cover lower and middle momentum range. The RICH2 covers the highest momentum range using 100 m³ Tm field, with n=1.0005. As charged particle tracks traverse the medium they radiate photons in a cone around their track direction. These photons make ring images around the track as measured in the RICH2. The emission angle of the cone depends on the velocity of the particle. If the velocity from the RICH and the momentum from the trackers is known, the particle mass and therefore the identity is known as well.

The Kaon identification performance is 97.29 ± 0.00% for ϵ = 5.15 ± 0.02% Pions misidentified as Kaons. The physics program 2009 will be based on very interesting first results with first data taking starting in 2008. It combines good decay time resolution to resolve B_s oscillations, a mass resolution of ϵ=14 MeV to efficiently suppress background, and a working Muon system, main tracker and VeLo. After measurement of the J/Ψ → ψK*ν̄ν̄ production the fraction of the prompt and detached J/Ψ must be disentangled. From the non prompt J/Ψ yield the bb cross section will be derived, followed by the core program of new physics search in CP-violation and rare decays.

Physics reach vs. integrated luminosity

In the first days of data taking starting in 2008, a sample of 10^6 minimum bias events will be taken. Only four bunches will be filled leading to a luminosity of √s = 0.5-1 TeV. This initial data can be used to calibrate the detector and to study inclusive particle production.

In the following phase of running with increasing luminosity from 2 x 10^34 cm^-2 s^-1 to 2.4 x 10^34 cm^-2 s^-1, the beauty cross section will be determined amongst others. This requires a working Muon system, main tracker and VeLo. After measurement of the J/Ψ → ψK*ν̄ν̄ production the fraction of the prompt and detached J/Ψ must be disentangled. From the non prompt J/Ψ yield the bb cross section will be derived, followed by the core program of new physics search in CP-violation and rare decays.