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Early-data measurement of J/$\psi \to \mu^+\mu^-$ decays with the ATLAS detector at LHC

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Summary. — The approach for the observation of the first J/$\psi \to \mu^+\mu^-$ production using the ATLAS detector at the Large Hadron Collider will be presented. Given the large quarkonia cross sections, large sample of muons can be obtained with few pb^{-1}. These clear muon samples can be used to study the Muon Spectrometer in all his aspects, like detector alignment, trigger calibration and trigger efficiency. Events of interest can be triggered by requiring one or two isolated muons; offline selection can then be applied, consisting maily of muon pseudorapidity cuts and lepton transverse-momentum threshold.

PACS `13.85.Ni` – Inclusive production with identified hadrons.
PACS `13.20.Gd` – Decays of J/ψ, Y, and other quarkonia.
PACS `07.05.Hd` – Data acquisition: hardware and software.
PACS `07.75.+h` – Mass spectrometers.

1. – Introduction

The foreseen rate of J/ψ resonance production on the basis of Standard Model predictions will be very high at the Large Hadron Collider [1]. In particular, ATLAS detector [2] is expected to collect about 6000 J/ψ per pb^{-1} at $\sqrt{s} = 7$ TeV. Muons coming from the subsequent decays are naturally candidates in commissioning the ATLAS detector [2], in particular the Muon System [3], and in evaluating the Level-1 Trigger [4] efficiency. All the relevant information concerning trigger and muon reconstruction have been retrieved using a tool developed in the ATLAS software framework contest in order to perform these studies. J/$\psi \to \mu^+\mu^-$ decays have been observed [5] very recently by the ATLAS Collaboration in $\sqrt{s} = 7$ TeV collision data.

2. – Muon System and Trigger

Final states containing high-transverse-momentum muons are the principal signatures in most of the research goals of LHC physics programme, so the ATLAS Muon Spectrometer [3] has been set-up in order to provide an independent trigger system and to perform standalone measurements in terms of muon transverse momentum (p_T), pseudorapidity

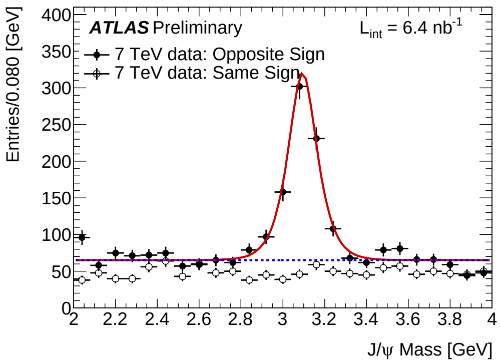

Fig. 1. – Invariant-mass distribution of reconstructed $J/\psi \to \mu^+\mu^-$ candidates. The full circles represent opposite-sign combinations while the open circle the same-sign ones. The solid line is the result of a maximum-likelihood unbinned fit in the mass window $(2, 4)$ GeV. The overall value for the invariant mass obtained, 3.099 ± 0.007 GeV, is in agreement with the PDG value.

(η) and azimutal angle (ϕ). The three main detector technologies composing this system are the TGCs, the RPCs, and the MDTs. TGCs and RPCs are mainly used for ATLAS Trigger [4], that is divided into three levels of event selection and has been designed to reduce the LHC interaction rate of 1 GHz to 200 Hz. In particular the Level 1 must lower the initial rate to 75 kHz with a latency of 2.5 μs, and the detectors involved are distributed over three stations placed at different distances with respect to the interaction point. MDTs provide precise coordinate measurement in the bending plane. The Muon System is capable of identifying and reconstructing muons in the $|\eta| < 2.7$ range having a p_T that varies in a large spectrum (1–1000 GeV).

3. – $J/\psi \to \mu^+\mu^-$ observation in ATLAS

The large quarkonia production cross section allows resonances to be observed with a few pb^{-1}. At the time of writing the contribution to these proceedings the decay of J/ψ into dimuons has been observed in ATLAS data with a clear peak [5]. Data used correspond to an integrated luminosity of $6.4 \pm 1.3\,nb^{-1}$. Events were selected by requiring Level-1 Minimum Bias Trigger [4] and collision events; moreover, some quality criteria on the number of ID hits on track has been required. The fit of the peak in the mass window $(2, 4)$ GeV using an unbinned maximum-likelihood method is shown in fig. 1, solid line; points with error bars are data. Full circles representing opposite-sign combination are superimposed to same-sign (open circles) ones.

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