BARD: B-Resonance Algorithm using Rare Decays

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The existence of new light particles could answer many open questions in the standard model of particle physics. Many different beyond the standard model theories exist that propose for example new light particles as a mediator between standard model and dark matter particles or aim to solve the standard model mass hierarchy problem. One possible way of searching for these new particles is by looking for a resonance decaying into a pair of b-quarks. These kind of resonances are difficult to find due to a very large background of QCD processes that result in the same final state. Another consequence of this is that the rate of di-bjet events is so high that it exceeds the disk rate available at the ATLAS experiment. Therefore, standard b-resonance searches often rely on a high energetic jet or photon to trigger the event to reduce the event rate to a manageable level. However, this requirement restricts the accessible masses to high regimes of order 1 TeV.

The BARD projects aims to change this pardigm by trading the high energetic object that is needed to trigger the event in the standard methods with a rare but clean b-hadron to J/ψ decay. The b-hadron to J/ψ decay has a branching fraction of order 10^{-3} which intrinsically brings down the event rate and enables one to circumvent the problem of exceeding the available disk rates. Moreover, the J/ψ can decay into a pair of muons or electrons which makes it easy to identify the event signature.

The BARD method enables one to search for light scalar resonances decaying to a pair of b-quarks in the difficult to access mass regime of $50 - 300$ GeV by using the b-hadron $\rightarrow J/\psi \rightarrow ee/\mu\mu$ decay channel to trigger the event and the presence of an additional conventionally-tagged b-jet. A sketch of the BARD methodology can be found in Figure 1. The talk will give an overview of the physics motivation of BARD and report on the ongoing developments of the analysis.

In particular a first proof-of-principle will be discussed that tries to demonstrate that the Z-boson, a known particle that can decay into a pair of b-quarks, can be identified using the BARD methodology. The particular signal process is depicted in Figure 2. Therefore, a summary of the trigger studies that have been performed to identify suitable triggers for the b-hadron $\rightarrow J/\psi \rightarrow ee/\mu\mu$ decay channel will be presented. Furthermore, methods to reconstruct the J/ψ and a framework to construct the bb-system will be discussed. Finally a preliminary sensitivity study will be shown as displayed in Figure 3.

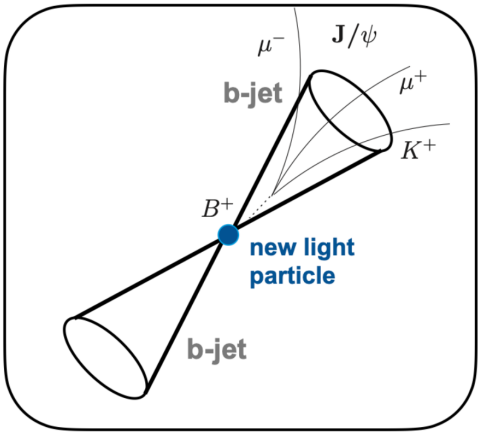

Abbildung 1: Methodology of the BARD project. It is a novel method to search for new particles decaying into a pair of b-quarks. The idea is to circumvent current limitations of di-bjet resonance searches by triggering the event using a rare but easy to tag b-hadron $\rightarrow J/\Psi \rightarrow ee/\mu\mu$ decay.

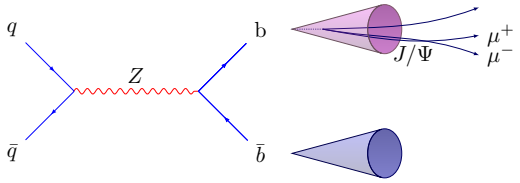

Abbildung 2: Signal process for the BARD proof-of-principle.

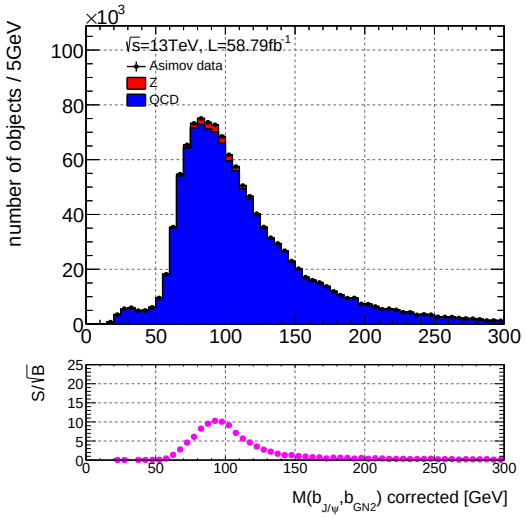

Abbildung 3: Mass spectrum of the bb-system in the BARD proof-of-principle.