Application of MVA methods to the analysis of inclusive $J/\psi$ in Pb-Pb collisions with ALICE at the LHC

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**Physics Motivation**

The suppression of charmonium production induced by color screening of quarks was proposed as a probe of the formation of the QGP [1]. At LHC collision energies new production mechanisms are expected to lead to a charmonium enhancement in most central collisions [2, 3]. The inclusive $J/\psi$ nuclear modification factor $R_{AA}$ measured by ALICE [4, 5] at $\sqrt{s_{NN}} = 2.76$ TeV and at $\sqrt{s_{NN}} = 5.02$ TeV in the dielectron channel, shows a striking enhancement in central collisions compared to the measurements at lower energies [6, 7], supporting models including (re)generation. The measurement is limited by the low signal to background at lower energies [6, 7], supporting models including (re)generation.

**The ALICE detector**

The ALICE experiment [8] is designed to examine strongly interacting matter under extreme energy densities.

**Analysis with Machine Learning**

- Classical: high quality electron selection with rectangular cuts on PID and tracking variables
- MVA: combine PID variables and tracking variables in one classifier to select $J/\psi$ candidates

**Classifier training**

- Three different variable combinations are evaluated based on the particle identification of the TPC and TOF, the impact parameter (DCA), and the transverse momentum $p_T$
- Use MC simulated events as signal and real data as background
- Used algorithm: Extreme Gradient Boost XGBoost [9]
- Training in $p_T$ bin 3-5 GeV/c

**Signal extraction + efficiency**

Signal extraction

- Invariant mass spectrum from combination of unlike-sign tracks
- Background description with the mixed event technique
- Cut on the MVA classifier to select signal-like $e^+e^-$ pairs
- Signal extraction after background subtraction by bin counting in the $p_T$ bin 3-5 GeV/c and 20-40% centrality class

**Stability of the efficiency corrections**

- Signal, efficiency and significance ($S/\sqrt{S+B}$) are extracted as a function of the MVA cut
- Ratio of signal and efficiency is stable $\rightarrow$ MVA cut well described in simulation

**Comparison to classical approach**

For both, the classical (rectangular cuts), and the MVA approach a variation of all cuts is performed to investigate the distribution of the signal divided by efficiency and the significance ($S/\sqrt{S+B}$).

**Results**

- Agreement between classical and MVA approach
- Better statistical significance

**Outlook**

- Improvement of data-MC agreement
- Preparation to apply MVA methods in the standard analysis

**References**