

Search for the rare decay

$$B_s^0 \rightarrow e^+ e^- \text{ at LHCb}$$

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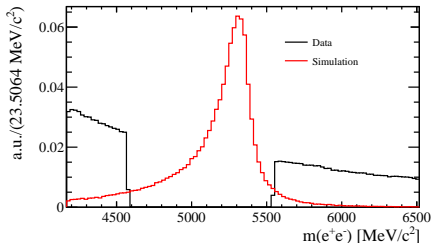
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Motivation

- $B_s^0 \rightarrow l^+ l^-$ decays interesting probes for new scalar physics
- $B_s^0 \rightarrow \mu^+ \mu^- = (3.0 \pm 0.6_{-0.2}^{+0.3}) \cdot 10^{-9}$ measured [arXiv:1703.05747], compatible with the SM
- assuming lepton-flavour non-universality $B_s^0 \rightarrow e^+ e^-$ and $B_s^0 \rightarrow \tau^+ \tau^-$ need to be studied separately
- since $B_s^0 \rightarrow e^+ e^-$ is predicted 4 orders of magnitude lower than $B_s^0 \rightarrow \mu^+ \mu^-$ small BSM effects might be visible
- some theories predict $\mathcal{B}(B_s^0 \rightarrow e^+ e^-) \mathcal{O}(10^{-8})$ [arXiv:1703.10160]
- current best limit $\mathcal{B}(B_s^0 \rightarrow e^+ e^-) < 2.8 \cdot 10^{-7}$ by CDF [PRD102 (2009)201801]
- question: can we reach an interesting sensitivity?
- analysis uses whole 5 fb^{-1} , talk focusses on Run 1

Analysis strategy

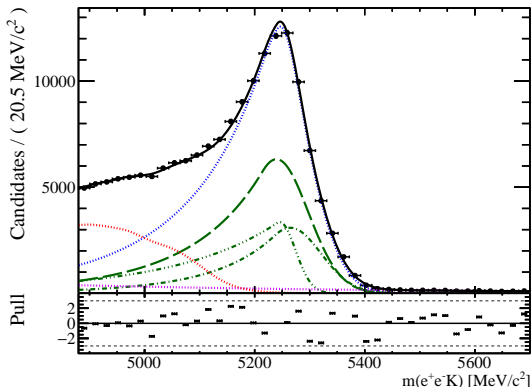
- Analysis is performed blind
- Analysis steps:
 - Preselection and Trigger requirement
 - Multivariate analysis
 - Particle identification (PID) requirements



- measurement relative to $B^+ \rightarrow K^+ J/\psi(\rightarrow e^+e^-)$
- Limit given as $\mathcal{B}(B_s^0 \rightarrow e^+e^-) < \alpha \cdot N_{obs}$

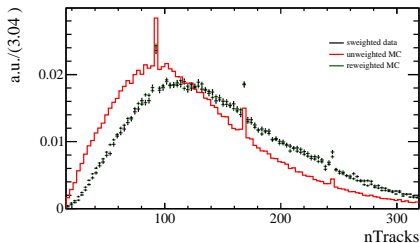
Control channel $B^+ \rightarrow K^+ J/\psi(\rightarrow e^+ e^-)$

- $B^+ \rightarrow K^+ J/\psi(\rightarrow e^+ e^-)$ used as control and normalisation channel
- background subtraction using sWeights
 - cross check efficiencies calculated on simulation
 - used in simulation reweighting



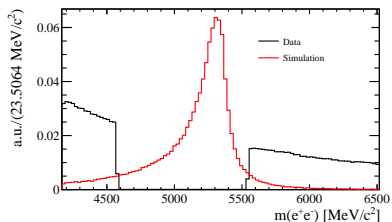
Data/Simulation differences

- some variables differ between data/simulation
- weights are calculated using a multivariate approach in
 - B_s^0 transverse momentum
 - track multiplicity
 - B_s^0 distance of closest approach
 - square root of the minimum impact parameter significance of the electrons

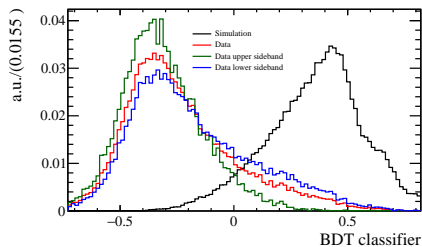


BDT

- BDT used to suppress combinatorial background
- Upper mass sideband used as background, simulation as signal

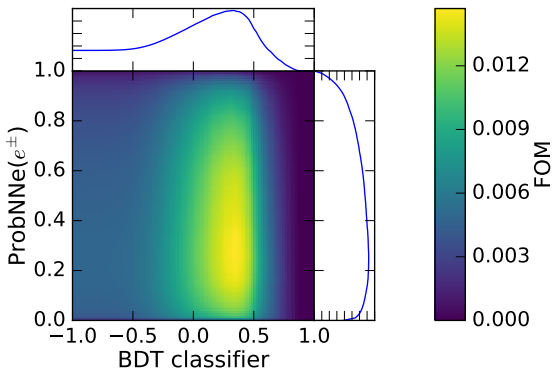


- Input variables are
 - isolation variables
 - topological variables
 - kinematic variables



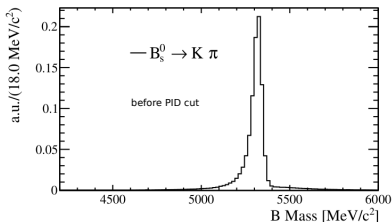
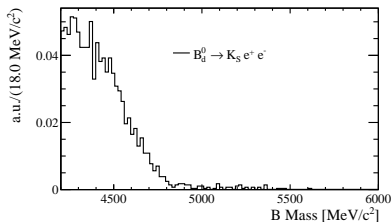
PID requirements

- PID variables are resampled using calibration data
- PID cut optimised together with BDT cut
- after PID cut the BDT is retrained

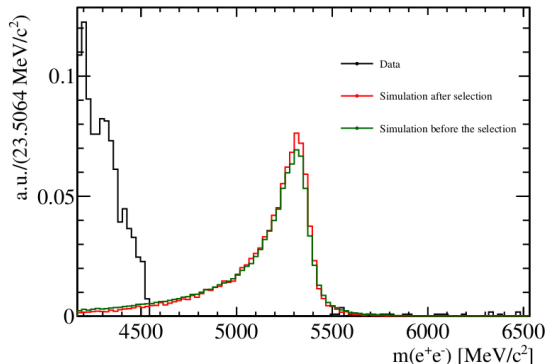


Backgrounds

- backgrounds are studied using simulation
- are reconstructed as $B_s^0 \rightarrow e^+ e^-$, have same selection applied
- backgrounds are split in three categories
 - $B \rightarrow hh'$ double mis-id
 - $B \rightarrow he^+ e^-$ partial reconstruction
 - partial reconstruction + mis-id (i.e. $\Lambda_b \rightarrow p e \nu$)
- no background dominating, use effective model
- expect about 46 background events in signal region



Results



- $\Rightarrow \mathcal{B}(B_s^0 \rightarrow e^+e^-) < 5.4 \cdot 10^{-9}$ @95 % CL expected
- $B_s^0 \rightarrow e^+e^-$ feasible at LHCb, close to (or even below) some BSM predictions
- Run 2 analysis ongoing, looks promising

Backup

BDT variablen

