B Physics Results at LHCb

Featuring Template Capabilities

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Outline

B Decay Modes

Key decay channels studied in Run 2:

- $B^0 \to J/\psi(\to \mu^+\mu^-)K^0$
- $B^0 \to D^+(\to K^+\pi^-\pi^-)\mu^-\nu_\mu$
- $B_s^0 \to \psi(2S)(\to \mu^+\mu^-)\phi$

Resonant structure:

$$\Upsilon(1S) \to \mu^+\mu^- \quad (98\%)$$

$$\Upsilon(2S) \to \pi^+\pi^-\Upsilon(1S) \quad (2\%)$$

Selection Requirements

Event selection criteria:

- Track quality: $\chi^2/\text{d.o.f.} < 3$
- Momentum cuts: $p_{\text{T}} > 500$ MeV
- Isolation: $\Delta R > 0.4$

Total integrated luminosity:

$$\mathcal{L}_{\text{int}} = 9 \text{ fb}^{-1} \quad \text{at} \quad \sqrt{s} = 13 \text{ TeV}$$

Cross Section Results

Measurement of B^0 production:

$$\sigma(B^0) = (23.5 \pm 0.2_{\text{stat}} \pm 1.4_{\text{syst}} \pm 0.9_{\text{lumi}})\ \mu\text{b}$$

Kinematic regions:

$$p_{\text{T}} \in [0.5, 40]\ \text{GeV}$$
$$\eta \in [2.0, 5.0]$$

Selection Code

Python implementation of the selection:

```
1 def select_B_candidates(events):
2     """Apply B meson selection criteria."""
3     mask = (events.track_chi2dof < 3.0) & \
4            (events.pt > 0.5) & \
5            (events.eta > 2.0) & \
6            (events.eta < 5.0)
7     return events[mask]
8
```

Systematic Uncertainties

Breakdown of systematic uncertainties:

- Tracking efficiency: 2.1%
- PID calibration: 1.5%
- Fit model: 1.2%
- $\mathcal{L}_{\text{int}}$ determination: 2.0%