Introducing the VSI LHCb Team

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The VSI LHCb Team

Antonio Pellegrino
Professor by special appointment
SciFi detector

Gerco Ondewater
Associate Professor
Director School of Science and Engineering

Kristof De Bruyn
Assistant Professor
VELO detector & Study of $B_c^+ \to \tau\nu$

Mick Mulder
Postdoc
Study of Λ_b decays

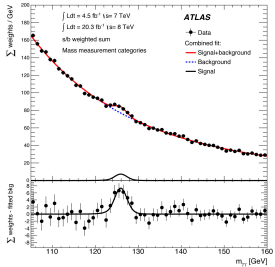
Jan de Boer
PhD
SciFi detector & Study of Λ_b decays

Maria Domenica Galati
PhD
VELO detector & Study of $B_c^+ \to \tau\nu$

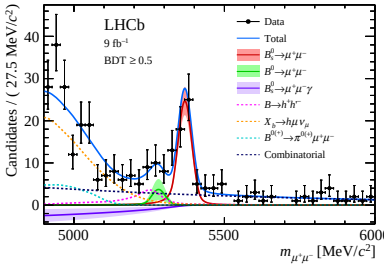
Andrej Sarnatskiy
MSc student
Production of B_c^+ at LHCb

The Large Hadron Collider

Two Complementary Strategies for the Large Hadron Collider



arxiv:1406.3827



LHCb-PAPER-2021-007

Direct Searches (High Energy Frontier*):

Search for new on-shell resonances

- *Bump*-hunting
  - Select x leptons + y jets (= observed decay products)
  - Require some missing energy (= undetected decay products)

Indirect Searches (Precision Frontier*):

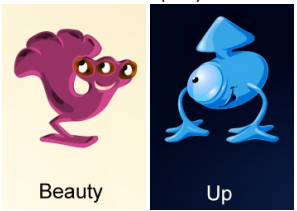
Search for differences with SM predictions

- Higgs Sector
- (Heavy) Flavour Sector
  - Asymmetries
  - Rare decays

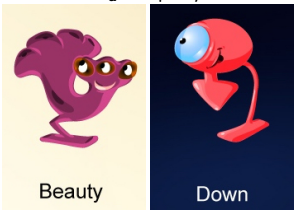
* Not to be confused with the VSI base units

The B Meson Family

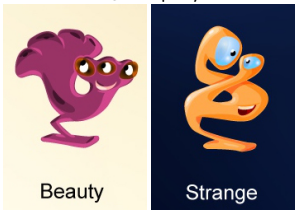
$B^+ = |\bar{b}u\rangle$



$B_d^0 = |\bar{b}d\rangle$



$B_s^0 = |\bar{b}s\rangle$



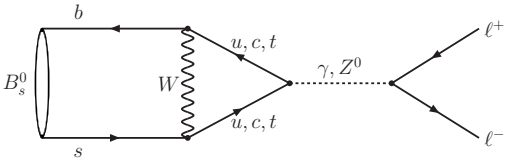
- Unstable particles (lifetime $\approx 1.5 \times 10^{-12}$ seconds)

→ Experimental advantage: can fly 1 to 2 cm away from production point before decaying

- More than 250 different decay paths
- Observables: branching fractions, asymmetries, angular correlations, ...
- Allows us to probe many SM parameters and perform high precision tests

The Power of Indirect Searches

Standard Model



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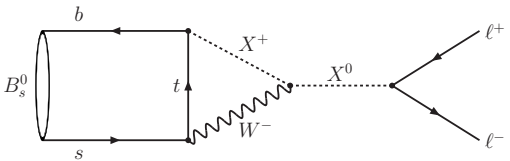
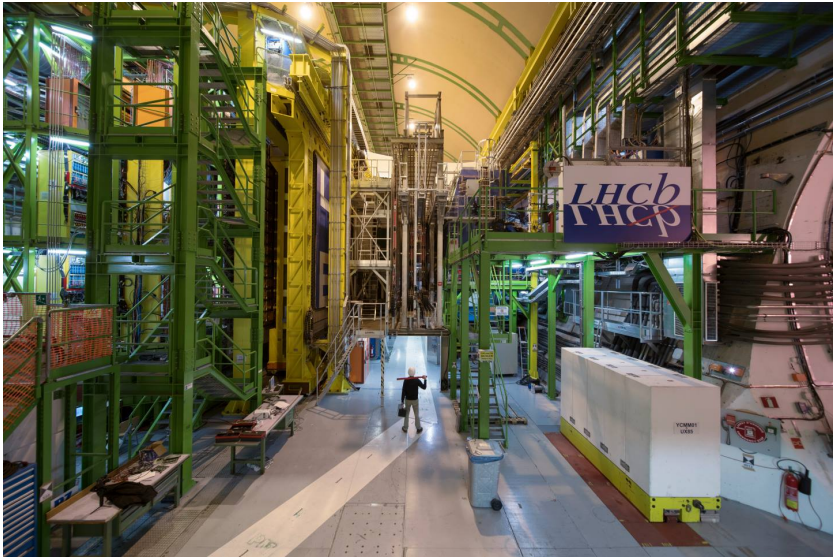
New Physics

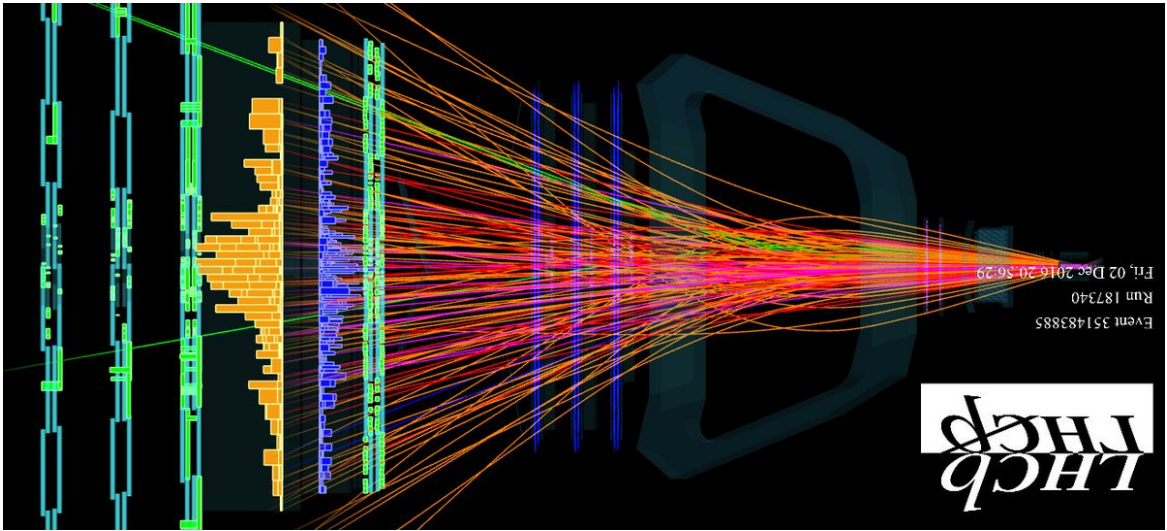


- Sensitive to new virtual contributions
  → Both at tree level and in loops
- Can probe energy scales much beyond LHC energy limit
- Many NP models predict new heavy particles that prefer coupling to third generation
- Matter-antimatter differences are largest in transitions involving third generation

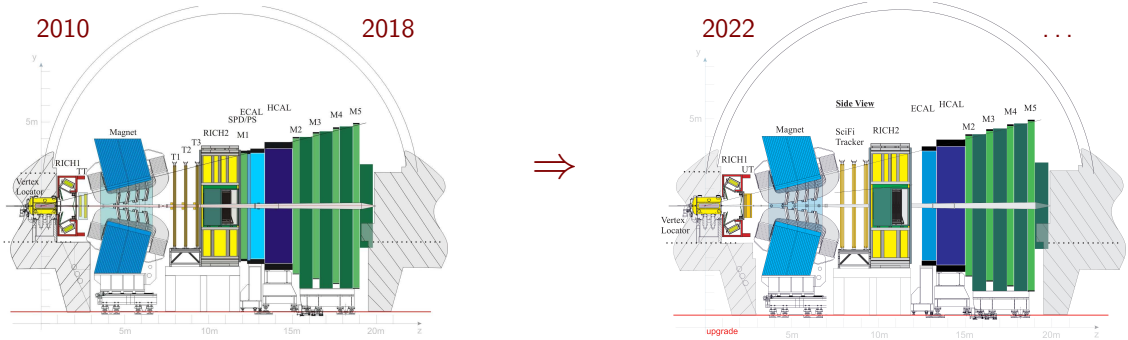
The Large Hadron Collider beauty Experiment



A Typical Collision Event at LHCb in 2016

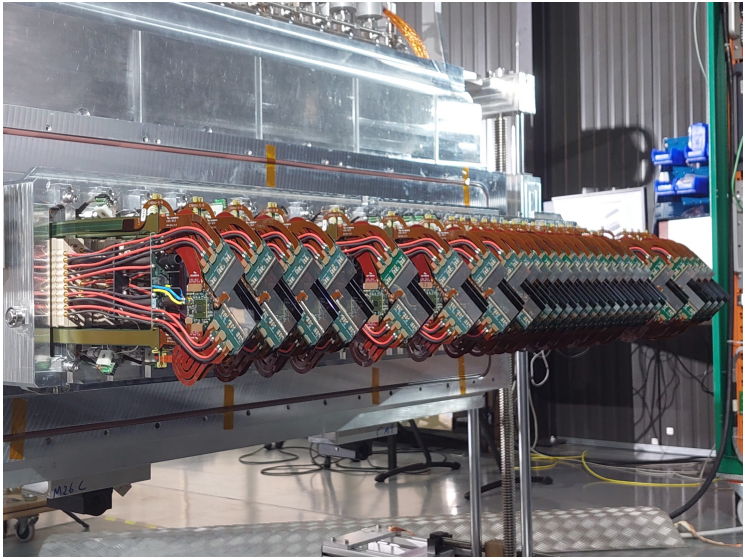


Upgrading the LHCb Detector



- Aim:
  1. Significantly reduce the statistical uncertainty on the measurements ($\sqrt{n}$)
  2. A more flexible trigger to select interesting events and reject uninteresting ones
- To achieve this:
  - → Increase the number of interactions per proton bunch crossing from 1.1 to 5
  - → Upgrade complete detector to triggerless read-out at 40MHz
- Requires a complete redesign of the data acquisition (Hardware + Software)

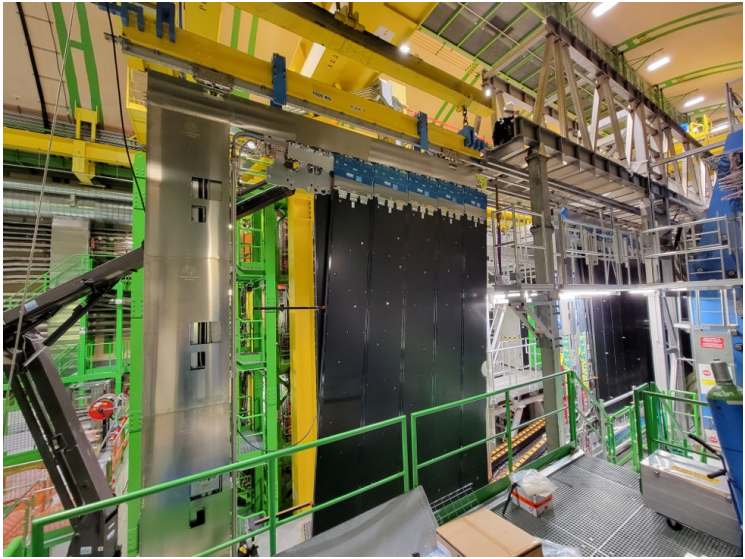
The Vertex Locator



The Team:

- Construction
- Commissioning

The Scintilating-Fibre (SciFi) Detector



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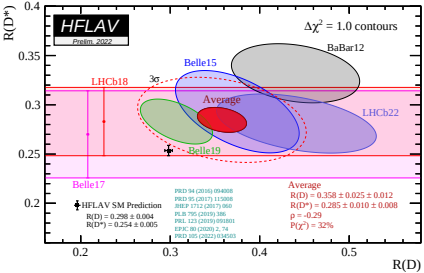
Testing Lepton Flavour Universality



- Do electrons, muons and tau leptons behave the same?

The Team:

$B_c^+ \to \tau\nu$ Λ_b Decays