Search for New Physics in $B^0_{(s)} \rightarrow \mu^+\mu^-$ decays, Development of Particle Detection Technology, and Assessment of Radiation Damage in the ATLAS Pixel Detector

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The $B^0_{(s)} \rightarrow \mu^+\mu^-$ decay is a flavor-changing neutral current process that is highly suppressed in the Standard Model. Comparison of the measurement of this branching ratio to contemporary predictions can indicate the presence of new physics. I will discuss the analysis technique that is used to minimize uncertainties on observation of this rare decay in ATLAS Run 2 data.

The High Luminosity upgrade of the LHC will increase the number of interactions per bunch crossing which will improve the statistics of data sets needed for branching ratio measurements. But pile-up derived from the increased luminosity will increase the challenge of separating the desired events from background. I will describe a new detector technology, AC-LGAD, which applies highly precise timing measurements to improve the event recognition capabilities, to combat the expected extreme number of nearly simultaneous interactions per bunch crossing.

Increased luminosity on the other hand damages the detectors, and this damage has implications for data-taking operations, charged-particle track reconstruction, detector simulations, and physics analysis. Simulations and measurements of the radiation damage-induced leakage current in the ATLAS pixel detector as a function of position in the detector and of time, using data collected in Run 1 (2010-2012), Run 2 (2015-2018) and early Run 3 of the Large Hadron Collider, are presented.