

## Background/Goal:

- Proton bunches are accelerated and collided with each other – bunch crossing
- Each bunch crossing produces hundreds of particles – called as an “event”
- Uninteresting events are discarded – background
- Still majority of events are known events – also called as background
- Goal: find region in the feature space in which there is a significant excess of events – signal
- Once region is found a significance test is applied
- If prob. that excess is produced by background falls below a limit -> new particle discovered
- finding a “pure” signal region corresponds roughly to separating background and signal events
- The classifier is trained on simulated background and signal events. Simulators produce **weights for each event** to correct for the mismatch between the natural (prior) probability of the event and the instrumental probability applied by the simulator (an importance-sampling flavor). The weights are **normalized** such that in any region the sum of the weights of events falling in the region gives an **unbiased estimate** of the expected number of events found there for a fixed integrated luminosity, which corresponds to a fixed data taking time for a given beam intensity. In our case this corresponds to the data collected by the ATLAS Experiment in 2012. Since the probability of a signal event is usually several orders of magnitudes lower than the probability of a background event, the signal and background samples are usually **re-normalized** to produce a balanced classification problem. A **real-valued discriminant function** is then trained on this reweighted sample to minimize the weighted classification error. The signal region is then defined by cutting the discriminant value at a certain threshold, which is optimized on a held-out set to maximize the sensitivity of the statistical test.
- **The goal of the Challenge is to improve the procedure that produces the selection region.** We provide a training set with signal/background labels and with weights, a test set (without labels and weights), and a formal objective representing an approximation of the median significance (AMS) of the counting test. The objective is a **function of the weights of selected events**. We expect that significant improvements are possible by **re-visiting some of the ad hoc choices** in the standard procedure, or **by incorporating the objective function or a surrogate into the classifier design**