MSc Interim Report Oral Exam: Summary

**Introduction**

* Introduce self, supervisor, and project title.

**Chapter 1: Background and Motivation**

* ALPs are motivated in a similar fashion to axions, which are postulated to resolve the Strong CP problem, relating to the absence of CP violation in the strong force due to the presence of the “theta” term. Resolution of the Strong CP problem => promoting theta to a field and adding to it the PQ symmetry. Spontaneous breaking of this symmetry mandates the introduction of a pseudoscalar Nambu-Goldstone boson known as the QCD axion
* Search strategies for the same have been outlined (LSW, Haloscope, Helioscope, etc.). All exploit (inverse) Primakoff effect whereby axions convert into photons and vice versa.
* ALPs => spontaneous breaking of other symmetries (not PQ). These couple to pairs of **photons** and other gauge bosons. Limits imposed by search strategies (collider and otherwise) for ALPs are summarised.
* Promising decay channel to look for these at LHCb = B to Kst a0, a0-> gamma gamma. Model is described in detail in report as well as Ref [26].

**Chapter 3: Summary of Preliminary Analysis**

* Performed L0 electromagnetic trigger study to explore how the trigger efficiency varies as a function of the ALP mass. Results indicate that there is a greater proportion of final state photons with transverse energy greater than L0 trigger threshold with an increase in ALP mass **(consistent with conservation of four momentum).**
* Sought to explore the range of possible exclusion limits that we can set on the mass coupling parameter space through this search strategy (see fig 5b). This required us to set a 90% confidence level upper limit on the branching fraction of the decay mode of interest.
* From generator level simulations and comparison to a topologically similar decay, we deduced an upper limit at the 90% confidence level of O(10^-7). Using this value, we can deduce the type of limits we can set on the mass-coupling to W+- of the ALP (**which is assumed to be equal to that of the coupling to photons).**
* Branching fraction of that order extends into a region of parameter space that has not been probed by previous searches => analysis is viable and worth performing, as there is potential of setting new exclusion limits within the parameter space.
* Will proceed to event selection stage where we will develop selection algorithms on full-detector MC simulated data.