# THE NEIL SQUIRE FOUNDATION BRAIN-COMPUTER INTERFACE LABORATORY

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**Abstract:**
The focus of our research is the development of BCI technologies for intermittent control applications, that is, technology that will work when the User intends control, but also remains neutral when there is no intent to control.

Our BCI laboratory is located in the G.F. Strong Rehabilitation Centre in Vancouver, Canada. This lab is equipped with a computer network running a Matlab/Simulink development environment. Our team of three researchers, an RA and several graduate students conduct a range of studies across the following four streams of research:

**Stream I: BCI Technology Development**

In this stream of research, our efforts are focused on developing better signal processing methods to convert EEG into reliable control signals. To date, our research team has developed a single-position, switch that responds to specific spatiotemporal patterns in EEG data related to imagined movement. This switch, which we refer to as the Low-Frequency Asynchronous Switch Design (LF-ASD) or more casually, the "brain switch", has demonstrated on-line asynchronous detection accuracies greater than 96% with able-bodied subjects and subjects with high-level quadriplegia (see Stream 2).

Currently our team is working on various statistical signal processing methods to improve the design of our brain switch. For example, we recently added a custom energy normalization transform to the LF-ASD. An off-line study of this new addition has indicated that True Positive or hit rates can be increased by 13-24% for False Positive rates near 1.0%.

In the last year, we began a collaborative project with Dr. Moore and her team at Georgia State University, Atlanta, USA to conduct a comparative evaluation of selected BCI technologies.

In the future we plan to investigate alternative electrode designs, electrode placement (external vs subcutaneous), and the ability to extend our brain switch to recognize multiple brain states.

**Stream II: BCI Technology Evaluation and Usability Evaluations**

A significant portion of our research is dedicated to on-line studies of the BCI technologies we have developed. These studies are used to determine switch performance and reliability and to determine how well people can adapt to a particular interface technology. For example, we are completing a study involving five able-bodied subject and five subjects with high-level quadriplegia as they dynamically control a simple video game. Preliminary results from seven subjects indicate that the brain switch can be operated at True Positive (TP) rates in the range of 40%-75%, with corresponding False Positive (FP) rates less than 1.0%. This corresponds to an overall switch accuracy greater than 96%. These results verify previous results from an on-line evaluation on a smaller test population.

**Stream III: Theoretical Modeling**