

Using VR Head-mounted Displays (HMD) with fNIRS and B-Alert Sensors

Head-mounted displays (HMD) are often used in virtual reality VR protocols. Physiological measurement such as functional near-infrared spectroscopy (fNIRS), EEG, and Cognitive State are particularly useful when studying participant response within virtual environments. When used in combination, sensors for such measurements must be placed on the participant's head along with the HMD. Maintaining **participant comfort** as well as **field of view** is critical for such studies to provide meaningful results. We have thoroughly tested such combinations to affirm that these devices can be used together without sacrificing significant functionality or participant comfort.



fNIRS (top, left) and B-Alert X-Series EEG (bottom, left) sensors were tested for comfort and functionality when used in combination with three popular VR HMDs: (left to right) Oculus Quest 2, Vive Pro, and HP Reverb.

TESTING

The comfort and fit of a range of HMDs were tested with fNIRS and B-Alert sensors. It was determined that the very thin and flexible design of these sensors allowed them to fit comfortably under most HMDs, as shown in the following video: [HMD with fNIRS](#)



HMDs

Popular HMDs include HP G2, Oculus Quest 1 and 2, Oculus Rift S, Varjo, and Vive. The following three were selected for this test, with similar results expected for other models:

- HP Reverb
- Oculus Quest 2
- Vive Pro

Sensor(s) tested

- [fNIRS Sensors](#) 18-optode sensor; 6-optode sensor
- [B-Alert X-Series EEG](#)

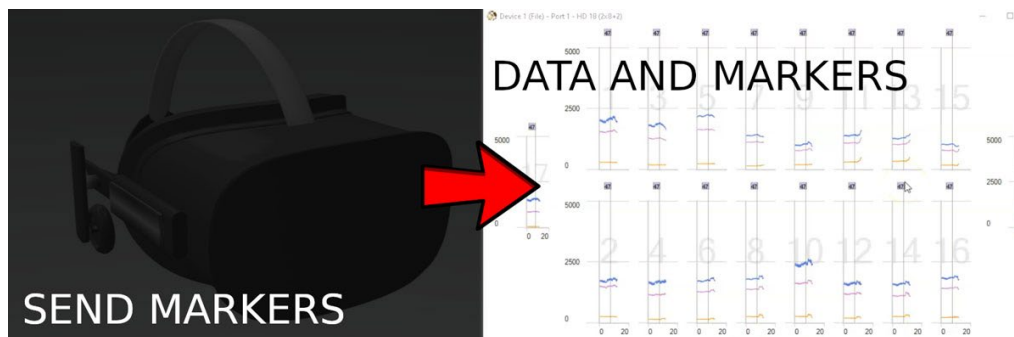
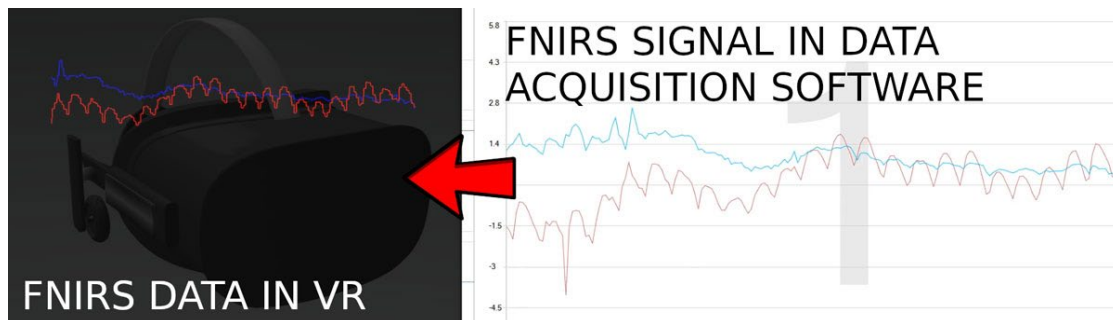
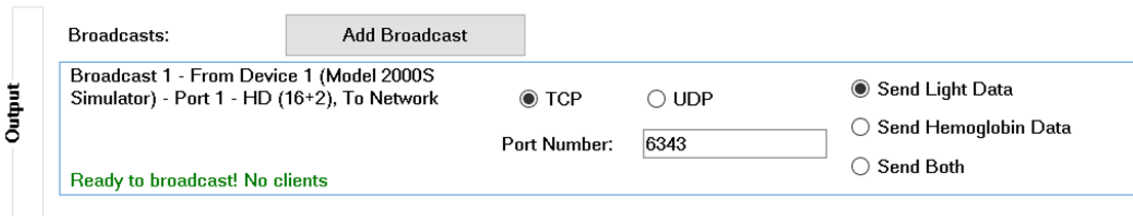
Test Results

Our testing found that fNIRS and B-Alert sensors did not block the field of view of an individual wearing either device with a VR headset. Both fit relatively comfortably under all three headsets. Individual results follow:

- **HP Reverb** was considered the most comfortable in this test (and in general) due to its padded, adjustable headband and relatively lightweight form factor
- **Vive Pro** produced similar results but was heavier and thus rated slightly less comfortable
- **Quest 2** felt the least secure when both EEG and fNIRS were used, and was rated slightly less comfortable due to only having elastic straps to hold the headset in place—this could be alleviated with tighter the head straps

Additional Benefits Integrating Sensors into VR Experience

Benefits of using our fNIRS and other sensor solutions in VR include real-time streaming of oxygenation and raw data to the virtual environment, enabling neurofeedback as well as the ability to send markers from VR to the fNIRS software over the network.



Additional resources for integrating VR in physiology studies:

- [Virtual Reality Resources](#)
- [Projection VR, Training, Physiological Evaluation, & Biofeedback](#)
- [Integrating VR, Eye Tracking, and Biofeedback in Your Research](#)
- [Biofeedback + VR + Physiological Technical Showcase](#)
- [How to Create a Stimulus Presentation Paradigm in VR](#)