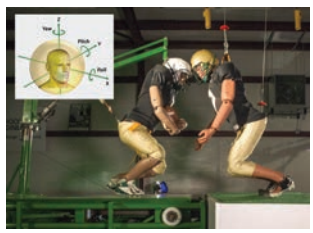
Head injury prediction

Available as a bare flexible PCBA, the DDR can be encapsulated in a custom mouthguard that couples directly to the top jaw and skull

Miniature measurement solutions are becoming indispensable in injury biomechanics testing around the world, and will help advance research into traumatic brain injuries

An estimated 69 million individuals worldwide sustain a traumatic brain injury (TBI) each year. So it's no surprise that identifying sensor technologies able to detect and quantify blunt head impact exposure has become a top priority for safety experts. Although the battlefield and sports field are commonly associated with head injuries, according to the Centers for Disease Control & Prevention (CDC) the second leading cause of TBIs in the USA is motor vehicle-related incidents. Based on hospitalization records, the CDC identifies falls as a leading cause of TBIs (35%), followed by road-traffic accidents (17%), and collectively workplace and sports-related injuries are a close third (16.5%).

While today's high-tech anthropomorphic test devices are designed for biofidelity and repeatability, researchers recognize that sometimes there's no substitute for measuring real humans in risky environments. Over the past eight years, dozens of commercial transient shock recorders have been marketed and some fielded for use in military and sports, including American football and hockey. Most measure linear and angular motion using commercially available MEMS (micro-electro-mechanical system) sensors. Based on independent evaluations, all the units were deemed inaccurate in some way due to a combination of poor head coupling, insufficient sensor range/sampling/bandwidth, data collection logistics (inability to correlate event and real-time data), or they were too large and cumbersome for practical use.



Researchers are continually trying to recreate head injury scenarios in the lab for sports, military and vehicle-related incidents, but also recognize that sometimes there is no substitute for human subjects

In 2017, California-based Diversified Technical Systems (DTS) was contracted to develop a new dosimeter and sensing technology for head injury prediction. DTS confirmed that sensors available at the time did not offer the right sampling rates and bandwidth frequencies to accurately measure concussive events at a professional sports level. Sensor power draw also proved to be another issue.

"DTS knew that existing MEMS sensors were primarily designed for the 'wearables' market and didn't have adequate performance or low power features," says Steve Pruitt, DTS CEO and co-founder. "It was clear that a new, innovative sensing technology was needed."

In addition to finding the right sensors, the other part of the challenge was to create a 6DOF dosimeter that occupied less than 50% of the size and mass of any existing technology. The new DTS DDR (dynamic data recorder) was able to meet the challenge with triaxial MEMS linear and angular accelerometers that are ultra-small and low power, and offer improved range, accuracy and bandwidth. The unit also runs on a hearing aid battery – minimizing size and mass.

Previous DTS sensors have been embedded in helmets, bite-blocks, ear pieces and even skin patches. In contrast, the new DDR was designed to be embedded by customers in a mouthguard, providing that missing component of good coupling to the skull.

"Many sports don't officially require players to wear a mouthguard, so our DDR had to be small enough for our customers to be able to embed it, comfortable enough to get player buy-in, and durable enough to last," Pruitt explains.

Using the same core technology, DTS is also working on a 6DOF sensor for measuring head motion in US Air Force pilot ejection events and NASA crew motion during the launch and re-entry phases. ❮

The DTS DDR is a miniature 6DOF dosimeter featuring triaxial linear and angular accelerometers