

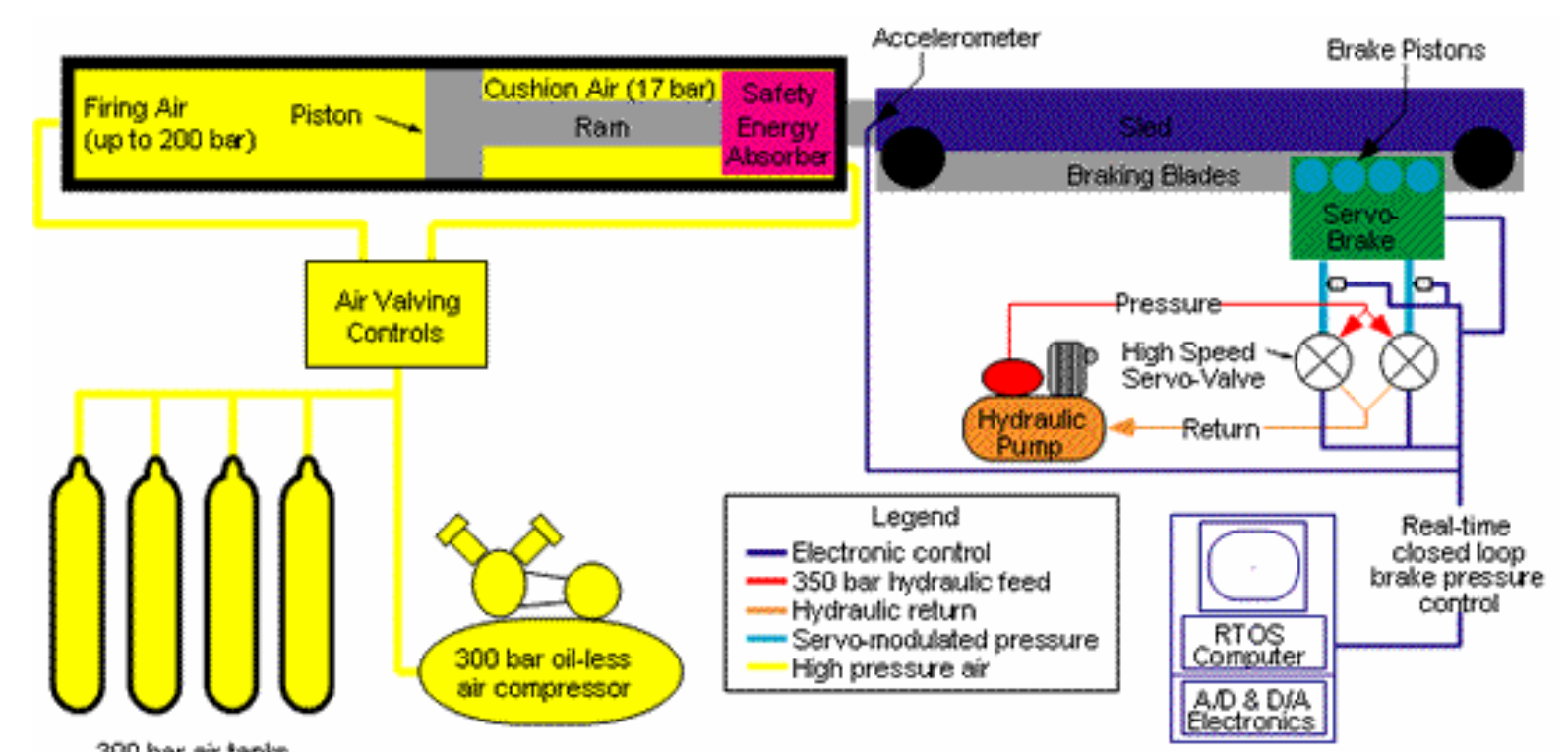
# Impact Laboratory and Crash Sled



The Virginia Tech – Wake Forest University Center for Injury Biomechanics (CIB) has gained a state-of-the-art impact laboratory and crash sled facility. This facility is the new VTTI (Virginia Tech Transportation Institute) CIB crash sled laboratory located in the VCOM II (Virginia College of Osteopathic Medicine) building in the CRC (Corporate Research Center) on the campus of Virginia Tech. The jewel in this showcase is a 1.4 MN ServoSled System (commonly known as a “crash sled”) manufactured by Seattle Safety. This sled is used primarily in the study of transportation-related trauma, with its chief applications found in the automotive environment. Although the sled is often used for basic research, more applied studies are conducted using reinforced vehicle structures, or “bucks”, fastened to the deck of the sled, which can accommodate up to a 2500-kg payload. The bucks are used to evaluate vehicle interior components and restraint systems. The sled starts from rest and is pneumatically driven (20 MPa maximum) to the desired speed while following a prescribed acceleration pulse. The pulse is shaped using a hydraulic braking system, and high-frequency (500 Hz), closed-loop control of acceleration and brake pressure. The acceleration pulse is selected to mimic the crash performance of a specific vehicle or other impact event, and the pulse is quickly and easily modified and programmed to suit. Unlike many other types of sled system, the ServoSled can provide large acceleration late in an event, and is capable of producing bipolar acceleration pulses. Frontal, rear, and side-impact car crashes can be simulated using human surrogates, including crash dummies. More than 200 transducer channels can be collected using onboard signal conditioning and data acquisition hardware. Multiple high-speed video cameras positioned both off and on the sled are used to capture event kinematics. The ServoSled System is capable of delivering 475,000 N-m, which translates to a maximum 90 kph and 93 g (20 g/ms) within a 2-m driving stroke. At full payload the sled can achieve 57 kph and 37 g. This system is designed to provide late-event and negative acceleration, both of which are typically unattainable by other systems. This crash sled is helping the CIB better understand the mechanisms of injury, and to develop better mitigation schemes and protection systems. One of the primary funding agencies to make use of the new sled is the National Highway Traffic Safety Administration.



**CIB researchers admire the new ServoSled System (left), and the principles of operation of the ServoSled (right)**



<http://www.seattlesafety.com/products/servo.html>

Adjacent to the crash sled is the high-speed, biplane (3D) x-ray suite. This 500-square foot installation is used in the study of impact event kinematics that cannot be imaged by conventional means. For example, this type of system is used to examine brain deformation, mediastinal motion and strain in the aorta, relative interactions of organ systems within the abdomen, and cervical spine kinematics in the cadaver. Skeletal structures can be imaged directly, but soft tissues are targeted using radiopaque neutral-density markers. A high-frequency, dual-axis x-ray generator provides the exposure energy (80 kW), up to 150 kV or 1,000 mA. State-of-the art, 40-cm diameter image intensifiers provide the largest possible field of view, and highest available frequency response (> 3 kHz). The output of these intensifiers is imaged using high-resolution monochrome CMOS video cameras, which are normally operated above 1000 fps. This system is accurate to within 0.1 mm in 3D space, typically.

The impact laboratory is outfitted with a collection of linear impactors, ballistic pendulums, and hydraulic loading machines. In addition to these are high-speed biaxial tissue testers. One such device is designed to test cruciate samples using strain rates up to 1000 s<sup>-1</sup>. This custom device is used to examine tissue response to rapid biaxial stretch, and to estimate strain energy density functions. High-speed, high resolution video cameras and lasers are used to measure strain and tissue thickness, respectively. Load is measured using miniature load cells attached to the clamps used to grasp the tissue. The tissue characteristics obtained from using this device have direct application to finite element models of the human body. One organization funding research examining high-speed tissue properties is the Global Human Body Models Consortium.