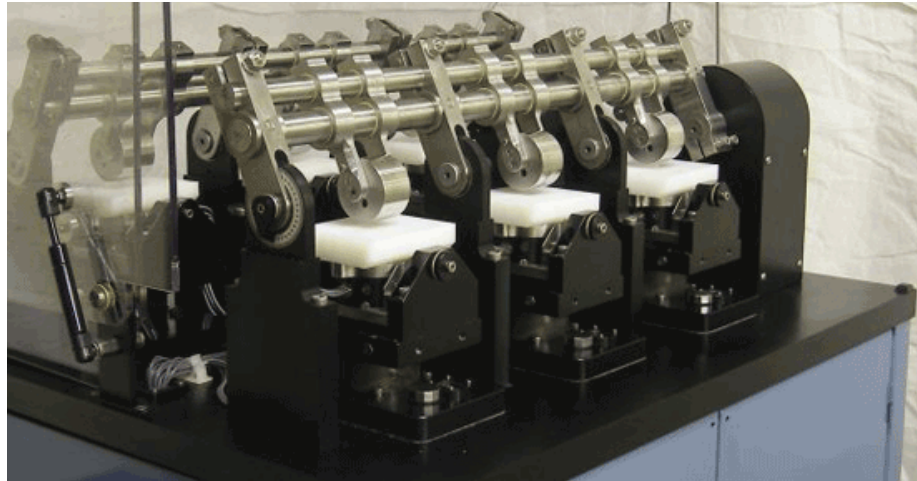


Knee Wear Simulator



The Shore Western Knee simulator was developed through direction from medical device manufacturers and orthopaedic professionals to simulate the complex kinematics and kinetics of the human knee in a physiological environment. Running in accordance with ISO 14243 under displacement or load control an array of knee complexities can be studied allowing researchers and designers to extensively analyze their prosthetic-knee design optimizing components and materials tribological performance.

Typical knee simulator has six stations orientated in two series of three. Each station has the capacity of independent control giving the capability of running individual conditions per station. Each station has four controlled degrees of freedom; axial load, anterior-posterior translation, internal-external rotation (axial torsion) and flexion-extension. Axial loads can be configured up to 5kN (1.1 kip) on each station, femoral motion can rotate in the horizontal plane up to a maximum of 140° in flexion ($\pm 70^\circ$ of flexion-extension). Tibial translation (anterior-posterior) has a total of $\pm 25\text{mm}$ ($\pm 1\text{ in.}$) relative to the femoral component programmable up to 735N (165 lbs) combined with internal-external rotation totaling $\pm 10^\circ$ programmable up to 36N.m (320 in.lbs) about the vertical axis. The medial-lateral and Varus-Valgus are both passive planes of motion with $\pm 5\text{mm}$ ($\pm 0.2\text{ in.}$) of translation and $\pm 10^\circ$ of tibial rotation respectively. The medial-lateral pivot point is adjustable with $\pm 10\text{mm}$ ($\pm 0.4\text{ in.}$) of translation.

Each knee joint is immersed within an individual test chamber (implementing water, saline or bovine/alpha calf serum) making collection

of spent serum for wear debris analysis straightforward without risk of cross-contamination between test chambers. Available individual peristaltic pump for each station with level and temperature interlocks in each serum storage reservoir; lubricant temperature can be set and is maintained via heater/chiller unit. The test chambers are enclosed within polycarbonate swivel doors maintaining a clean test environment and user safety. Available loaded-soak stations (loaded-soak stations do not translate knee kinematics) can accept three daisy-chained specimens on each load channel for a total of six specimens. Each station includes independent control with load feedback.



SPECIFICATIONS

Six station knee simulator, orientated in 2 series of 3 stations.

- **Four Axes** - Four separate actuator axes for each station, Flexion/Extension is not coupled between both series giving a total of 24 servohydraulic control valves.
- **Axial load** - Axial load (Fz) up to 5000N (1100lbs) per station, each station of six under separate control - ALL stations can be independently adjusted to match command.
- **Axial torque** - Axial torque up to 36N.m (32in.lbs) at each station, with $\pm 10^\circ$ of rotation each station of six under separate control.
- **Flexion** - Flexion of $\pm 70^\circ$ total ROM with 51N.m of torque per station.
- **Translation** - ± 25 mm (± 1 in.) of Anterior/Posterior translation, with up to 735N (165lbs) per station, each station of six under separate control.
- **Individual load cells** - Individual multi-axis load cells on each station monitor Fx, Fy, Fz and Mx.
- **Passive Planes** - Medial-lateral and Varus-Valgus have ± 5 mm (± 0.2 in.) of translation and $\pm 10^\circ$ of tibial rotation respectively.
- **Medial Pivot Point Off-set** – Adjustable translation ± 10 mm (± 0.4 in.).
- **Speed** - Up to 2Hz cycle speed, computer adjusted.
- **Access** - Separate ergonomic swivel doors cover each series from external environment.
- **Independent Control** - Each actuator on each series can be independently controlled under manual mode outside its normal automatic operation.

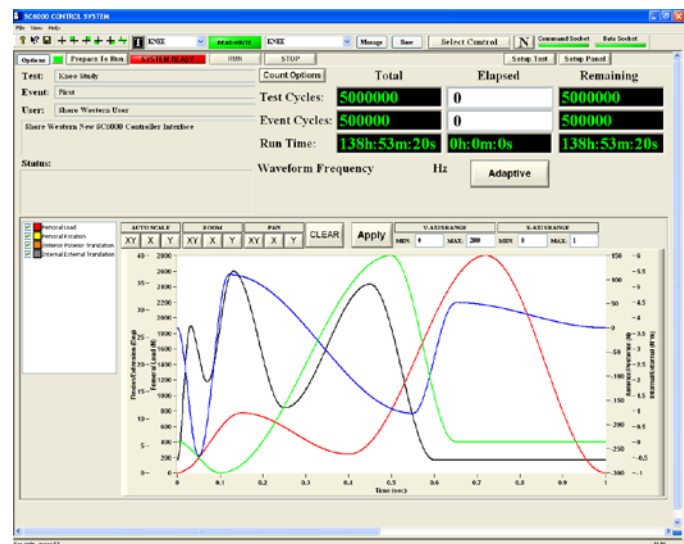
CONTROL SYSTEM

The Knee Wear Simulator controller system is based on Shore Western's new SC6000 platform running under a Windows XP environment. Depending on the ISO specification simulated the controller functions both in displacement and load control using Shore Western's Mixed Input-Real Time Adaptive Control (MI-RTAC) algorithm. The MI-RTAC algorithm compensates for cumbersome servo-hydraulic tuning while monitoring and correcting via a point-by-point basis amplitude and phase of the control waveform(s). The load control MI-RTAC takes advantage of load limited displacement control which enables dynamic

load scenarios to run under the safe and stable control of a displacement environment while maintaining the control waveform levels. The controller monitors user definable peak and valley error detects combined with gait synchronization across all channels to the control waveform.

OPTIONS

- **Individual peristaltic pump** for each station with level and temperature interlock in each serum storage reservoir - lubricant temperature can be set and is maintained via heater/chiller unit.
- **Load-Soak Stations** (Load-Soak Stations do not translate knee kinematics). Each series accepts three daisy-chained specimens on each load channel for a total of six specimens. Each series includes independent control with load feedback.
- **5th degree of freedom** for Medial/Lateral control.
- **Calibration fixtures** to calibrate the multi-axis load cell. A single axis calibration cell is used to calibrate the Fz load to full scale.



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