

# FootSTEPS

(Product ID: FS3F-1)

The FootSTEPS platform, combined with a force plate, provides the “best of both gait analysis worlds” ... high resolution **pressure** and **shear** data under the entire foot and ground reaction force measurements that gait researchers know and trust.



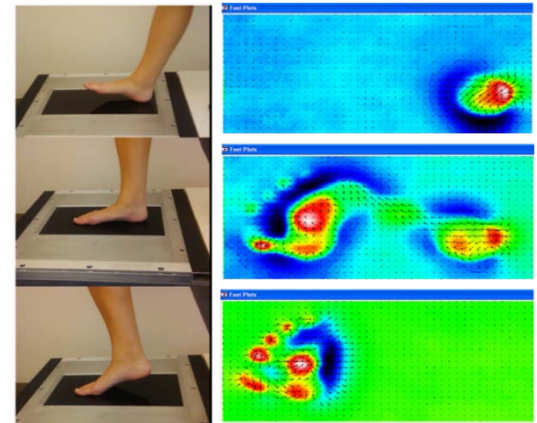
## PRINCIPLE OF OPERATION

A high-resolution camera images ISSI’s Surface Stress Sensitive Film (S3F) layer, polymerized on a glass window, as participants walk across the FootSTEPS platform.

The S3F layer contains a probe material that enables changes in film thickness, produced primarily by pressure, to be visualized as changes in illumination level. The mathematical ratio of loaded and unloaded images quantifies the vertical displacement of the film.

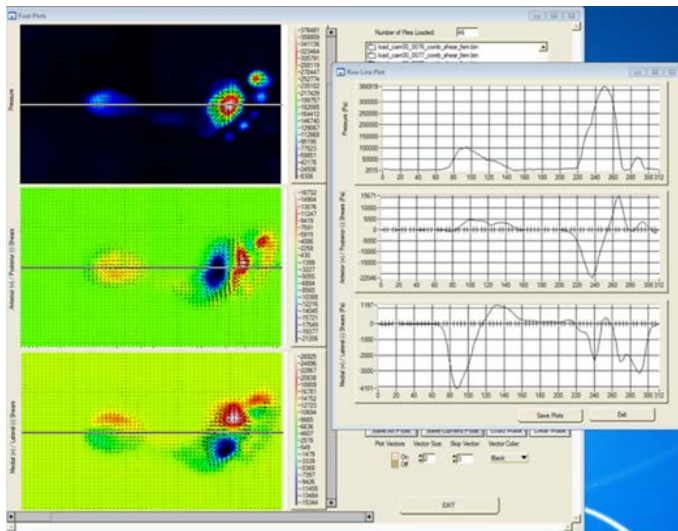
A series of markers are applied to the film below the opaque upper layer. These markers are displaced laterally during foot contact, primarily by shear forces. Cross-correlation analysis quantifies the displacements produced by shear.

The force plate, mounted underneath the FootSTEPS platform, simultaneously measures three forces and three moments about the x, y, and z axes. Synchronized data collection is initiated by a trigger pulse from the force plate on initial foot contact.

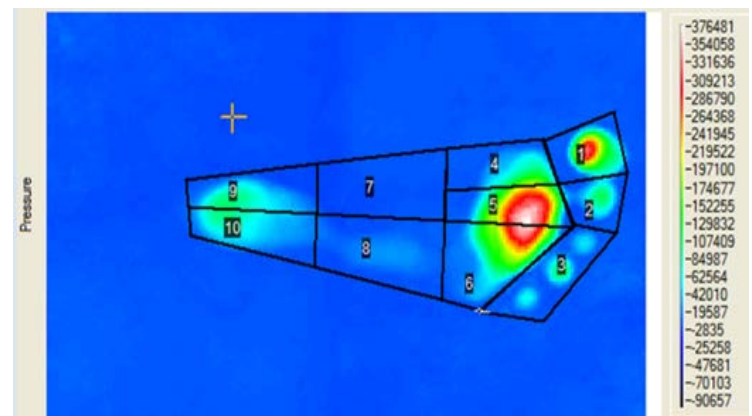


3-D displacement maps provide rapid visualization of the pressure and shear patterns produced by foot contact. Reconstruction of the pressure and shear force values is provided by offline analysis using a finite element model of the S3F with the measured displacements as inputs.

## EXAMPLE DATA



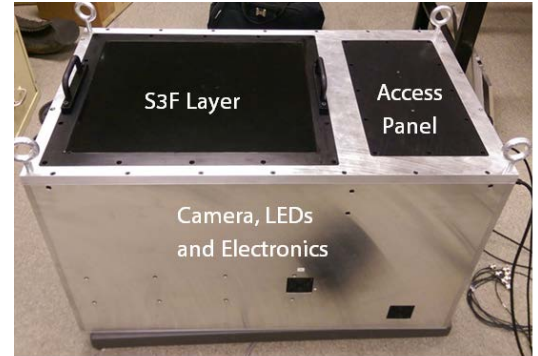
Pressure and shear forces along a user-selected line.



Mask-based pressure and shear analysis

**SPECIFICATIONS**

<b>Power</b>	110-120 VAC, 50-60 Hz
<b>Interface</b>	Dedicated USB 3.0 for camera. USB 2.0 for others.
<b>Linear Pressure Range</b>	15 to 700 kPa. Unsaturated response to over 2000 kPa.
<b>Linear Shear Range</b>	3 to $\pm 100$ kPa. Also not the saturation point.
<b>Accuracy</b>	$\pm 5\%$ of full scale for both pressure and shear.
<b>Data Capture Rate</b>	50 frames per second.
<b>Spatial Resolution for Reconstructed Forces</b>	2 mm
<b>Crosstalk</b>	Less than 3% between pressure and shear.
<b>Active Measurement Area</b>	32 by 43 cm (12.6 by 17 inches).
<b>S3F and Force Plate Data Streams</b>	Synchronized using force plate SYNC signal.
<b>Size</b>	91.4 cm (L) by 53.3 cm (W) by 54.9 cm (H) (36 by 21 by 21.6 inches) not including force plate.
<b>ECCN</b>	EAR99



Ready for installation in user's walkway using removable eye bolts and handles.



FootSTEPS installed in elevated walkway at Univ. of North Texas Health Science Center (courtesy of Dr. Metin Yavuz).

**Software**

Acquires images and force plate data.
Computes normal and tangential film displacements.
Provides immediate post-run display of the pressure and shear displacements to ensure that good data were collected.
Reconstructs the pressure and shear forces using freeFEM++ and offline batch processing.
Displays pressure and shear maps, plots pressure and shear values temporally and spatially, and conducts mask-based analysis.
Additional software for force plate data analyses can be downloaded from manufacturer's website.

**REFERENCES**

Stucke S, McFarland D, Goss L, Fonov S, McMillan GR, Tucker A, Berme N, Guler HC, Bigelow C and Davis BL 2012 Spatial relationships between shearing stresses and pressure on the plantar skin surface during gait *J. Biomech.* 45 619–622

Berke V, Boswell MA, Ciltea D, Guseila LM, Goss L, Barnes S, Berme N, McMillan GR and Davis BL 2015 Expanded butterfly plots: A new method to analyze simultaneous pressure and shear on the plantar skin surface during gait *J. Biomech.* 48 2214–2216