

FootSTEPS

(Product ID: FS3F-1)

The FootSTEPS platform, combined with a force plate, provides the “best of both gait kinetic analysis worlds” ... high-resolution **pressure, shear** and **ground reaction force** measurements under the entire foot combined with integrated force and moment measurements from a user-selected plate system.



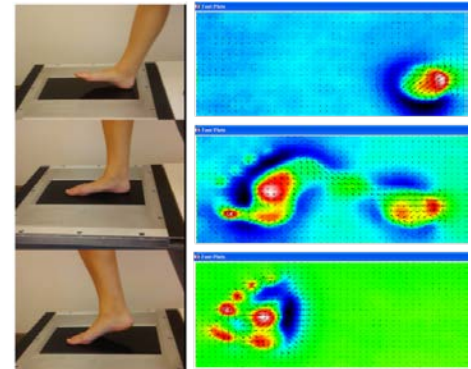
PRINCIPLE OF OPERATION

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.

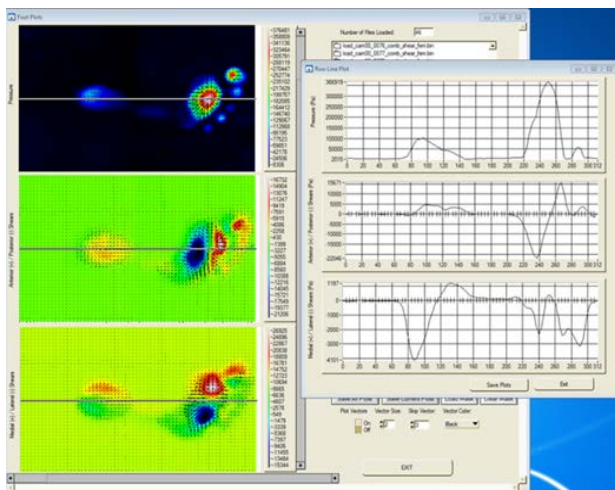
A series of markers are applied to the film below the opaque upper layer. These markers are displaced laterally during foot contact, primarily by shear forces. Cross-correlation analysis quantifies the displacements produced by shear.

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.

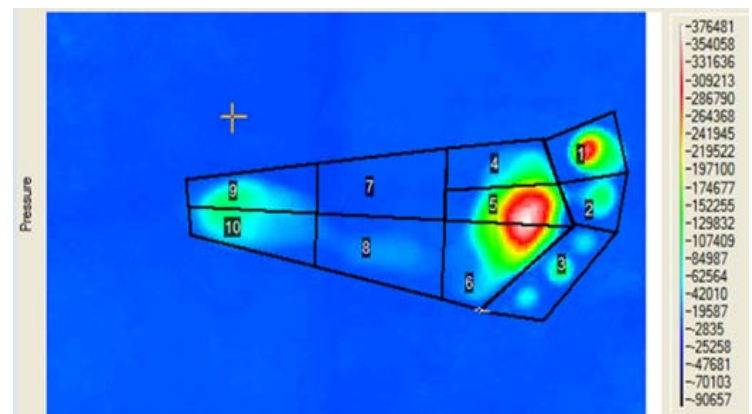


3-D displacement maps provide rapid visualization of the pressure and shear patterns produced by foot contact. Reconstruction of the pressure and shear force values is provided by offline analysis using a finite element model of the S3F with the measured displacements as inputs.

EXAMPLE DATA



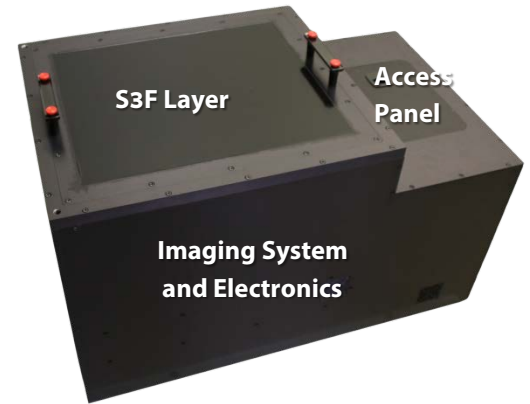
Pressure and shear forces along a user-selected



Mask-based pressure and shear analysis

SPECIFICATIONS

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



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
- Berki 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
- Davis B, Crow M, Berki V, Ciltea D 2017 Shear and pressure under the first ray in neuropathic diabetic patients: Implications for support of the longitudinal arch. *J Biomech.* 52 176-178