* **Ethics Statement**

□Not applicable: This manuscript does not include human or animal research.

X If this manuscript involves research on animals or humans, it is imperative to disclose all approval details.

All procedures involving cow handling and image capturing were conducted in accordance with ethical guidelines and approved by the Virginia Tech Institutional Animal Care and Use Committee (IACUC #22-146). The cows studied were part of the dairy herd at the Virginia Tech Dairy Complex in Blacksburg, Virginia, USA, which comprises approximately ~80% Holstein and ~20% Jersey cows. For the 'External' setting, the study included 100% Holstein cows. The milking cows were housed in pens within a free-stall barn, featuring two rows of sand-bedded stalls, headlocks at the feed bunk, and two water troughs per pen. The stocking density was maintained at 100% (i.e., one cow per stall). Heat stress was managed using automatic 48-inch diameter fans positioned over the stalls and feeding alleys. Cows were milked twice daily at 1:00 am and 12:00 pm in a double-twelve parallel milking parlor. They were fed ad libitum (with less than 5% refusals) once daily at 8:00 am with a total mixed ration (TMR) consisting of approximately 42% corn silage, 8% grass hay, and 50% concentrate on a dry matter basis. Manure from the stalls was removed at each milking session by personnel driving the cows to milking. Manure from the walking alleys within the pen was cleared two or three times daily using an automatic flushing system with recycled water. Fresh or recycled sand was added on a weekly basis.