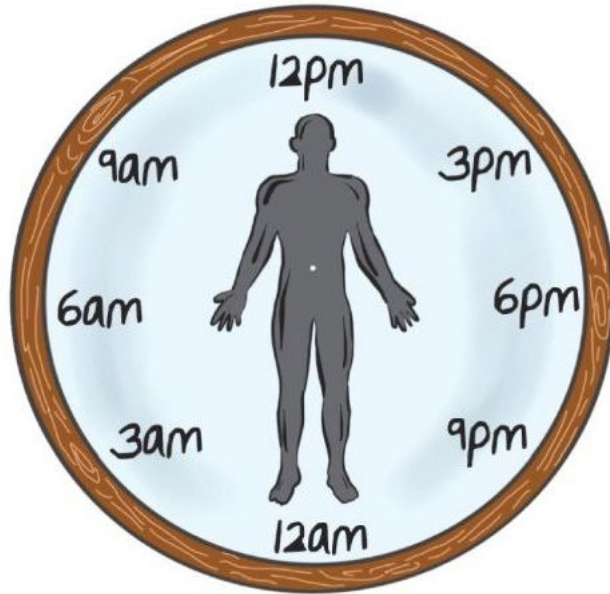


Body Clock

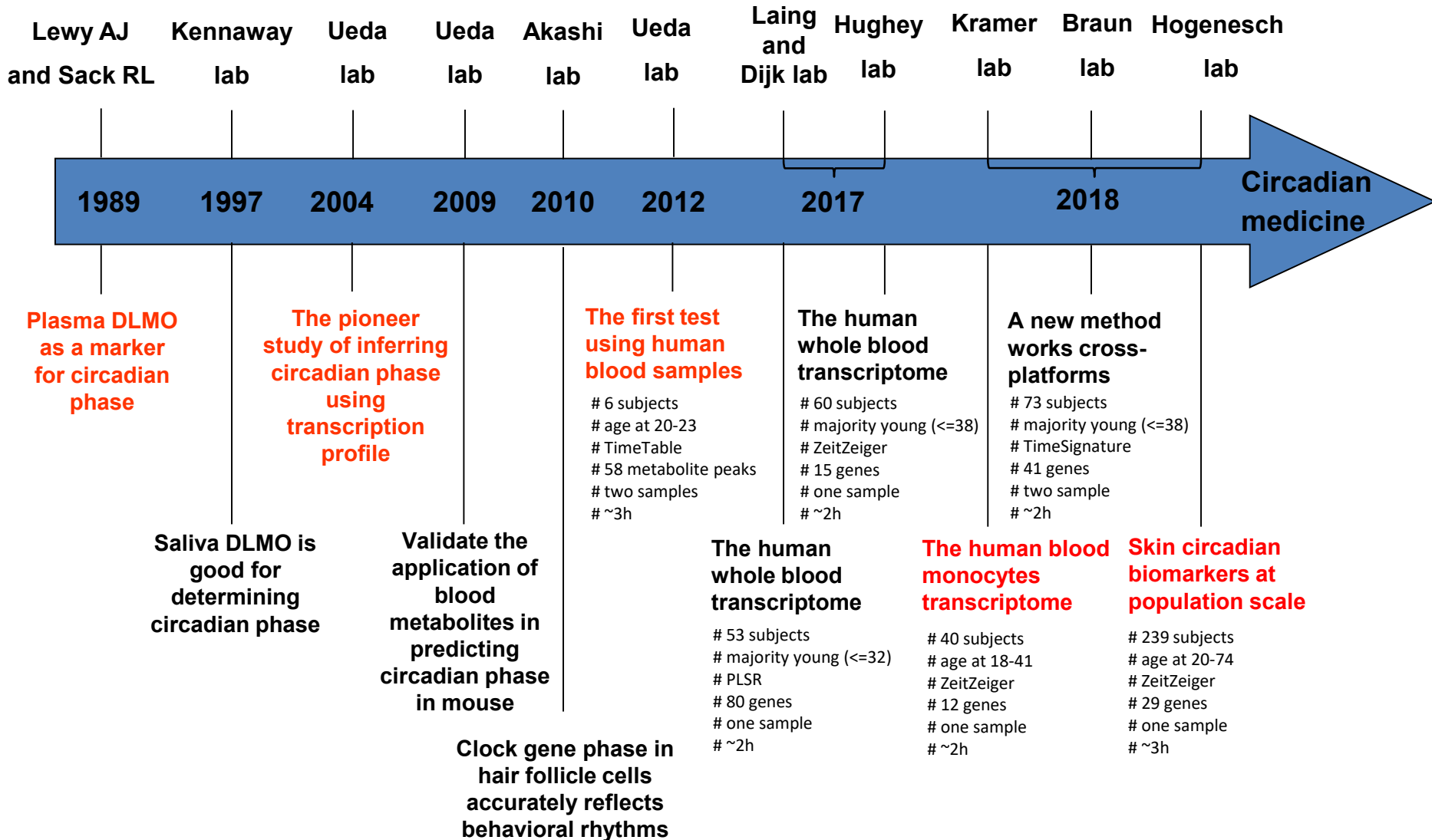


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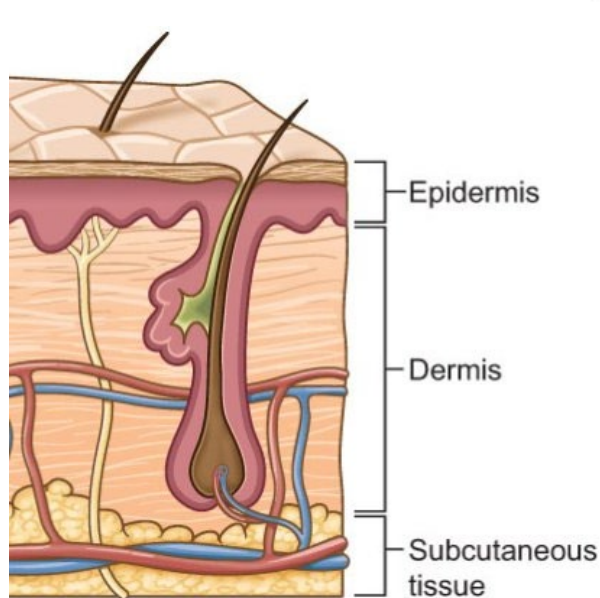
Wall Clock



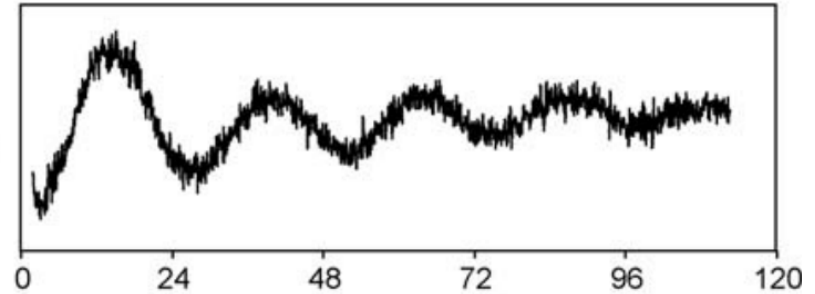
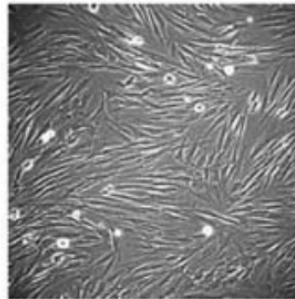
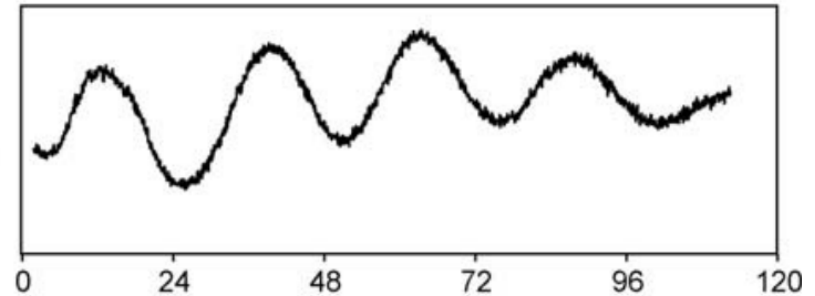
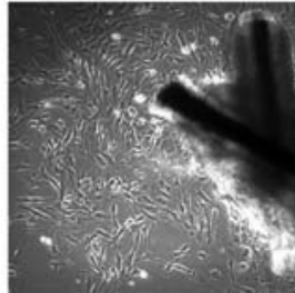
A brief history of circadian biomarkers



Skin has robust circadian clocks



Epidermal
keratinocyte



Dermal
fibroblast

PLoS Biol. 2005, 3(10):e338.

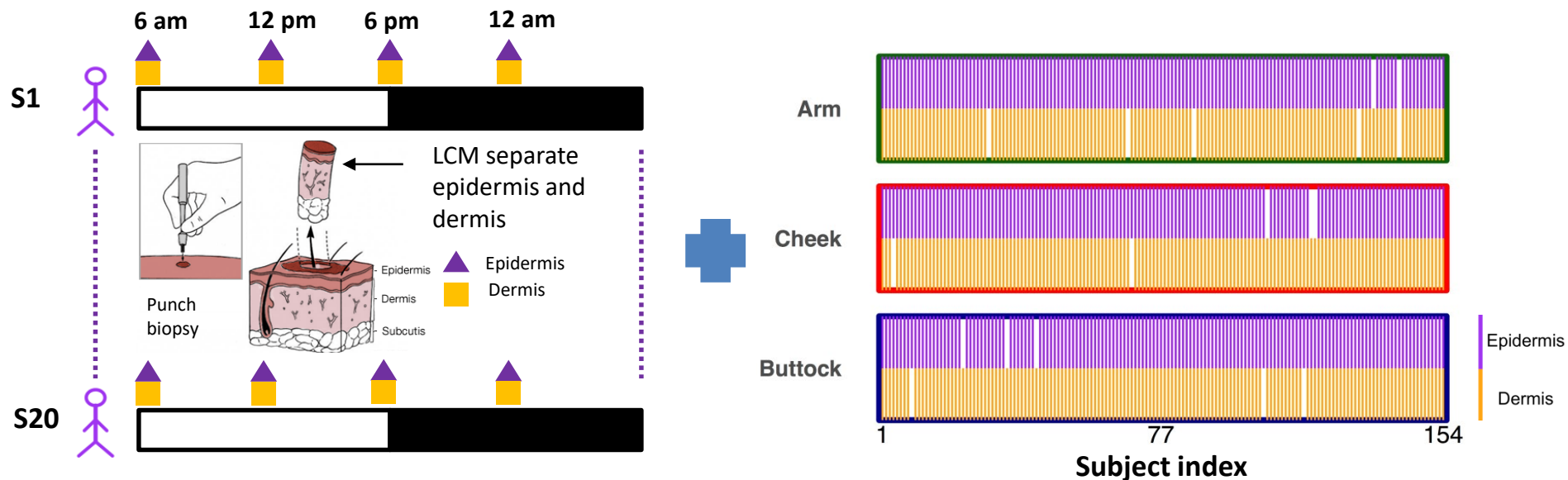
A hybrid experimental design



Procter&Gamble

Longitudinal

Population based

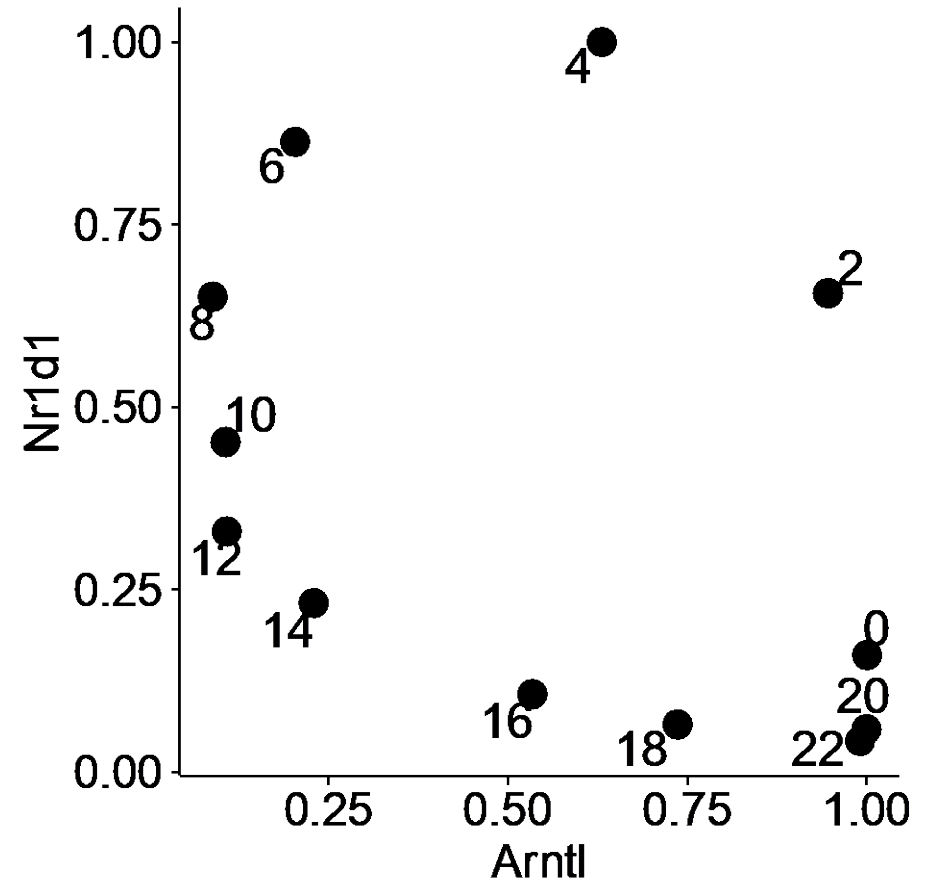
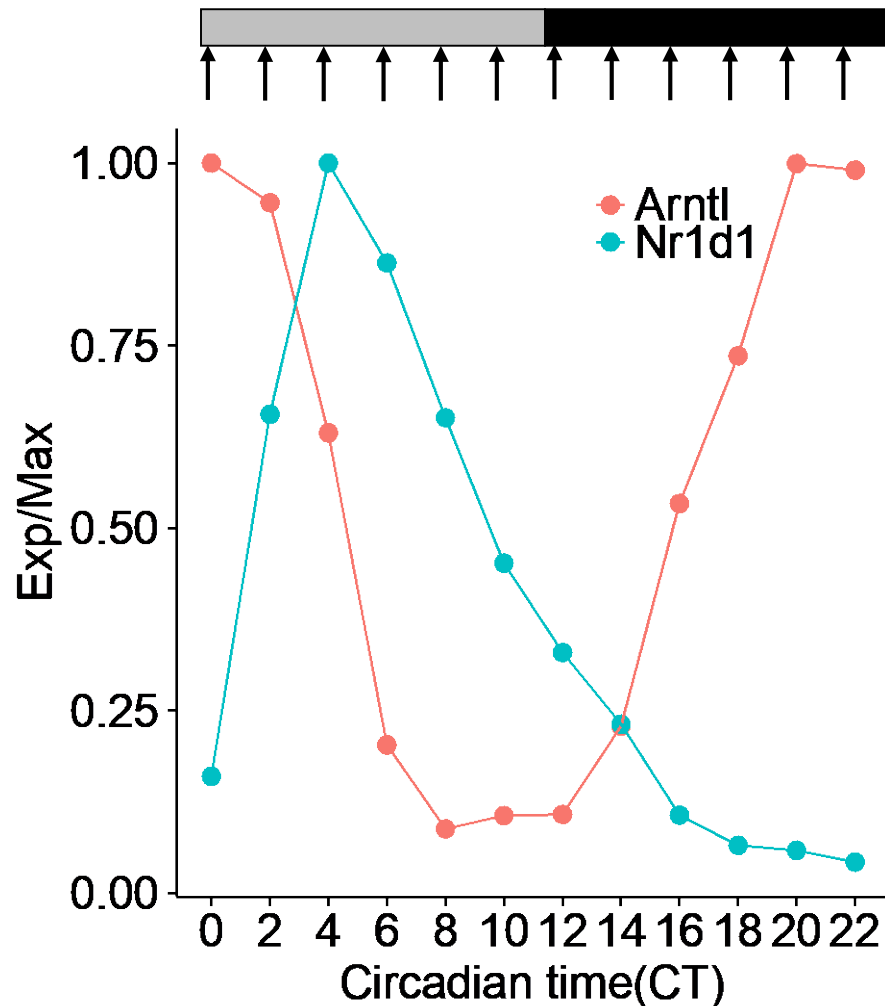


**533 epidermis samples across body sites
profiled with Affymetrix array**

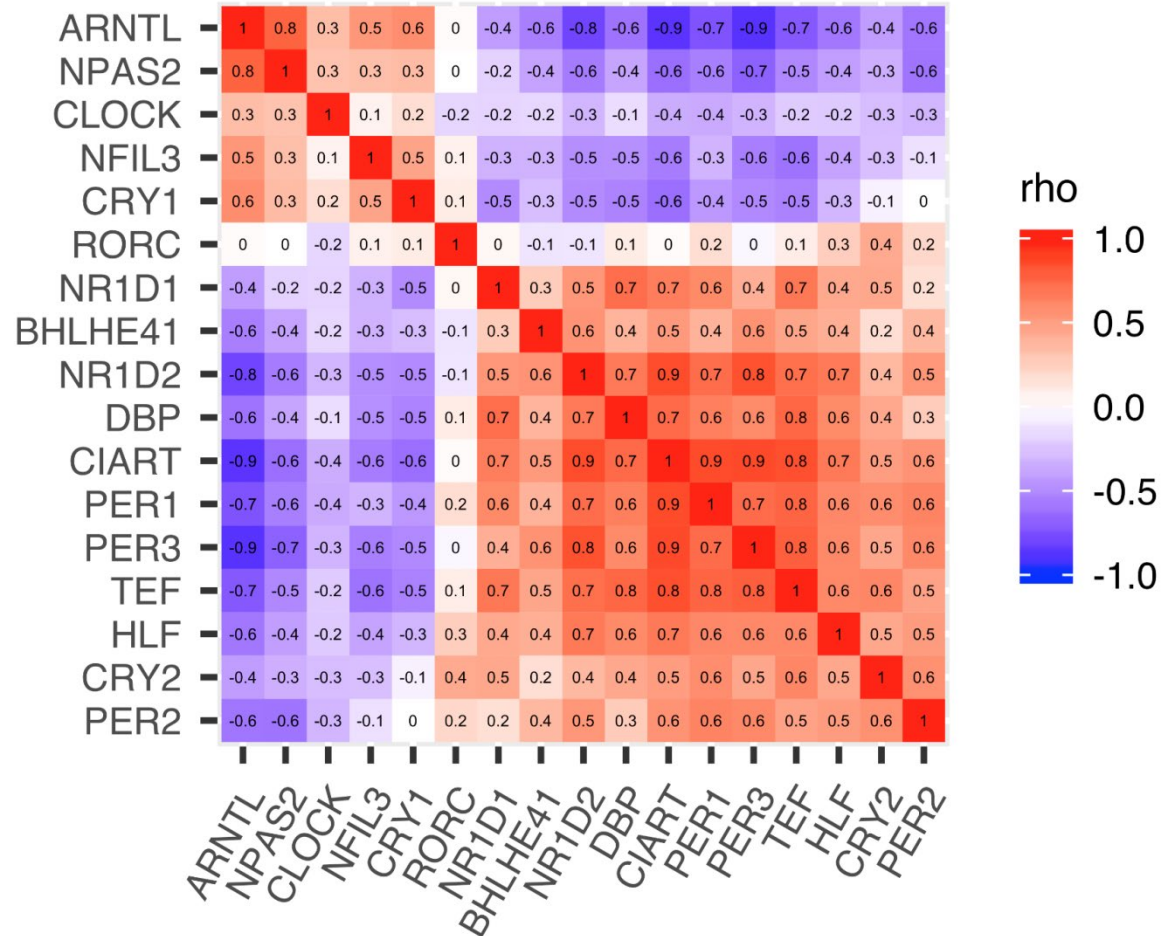
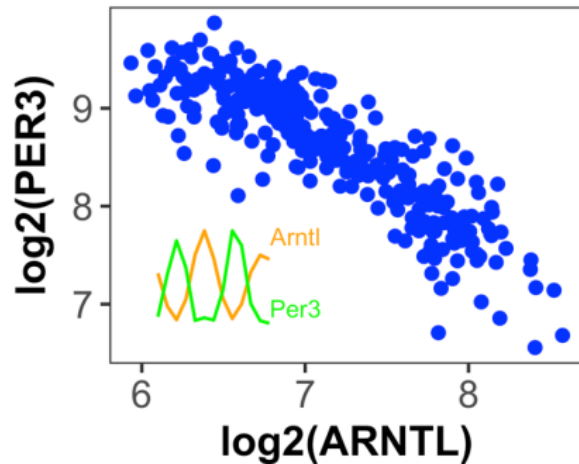
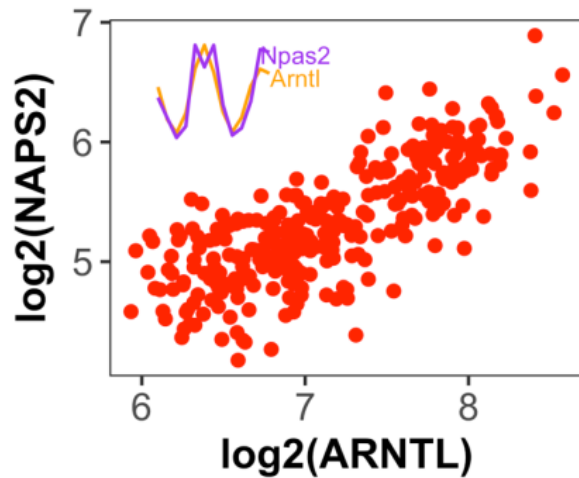
**531 dermis samples across body sites
profiled with Affymetrix array**

CYCLOPS reveals human transcriptional rhythms in health and disease

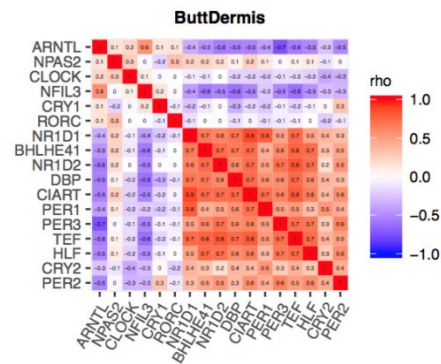
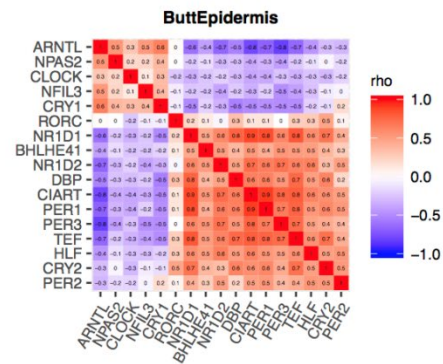
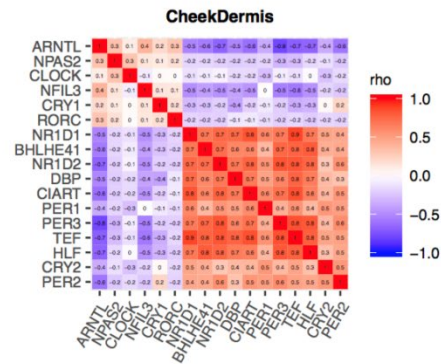
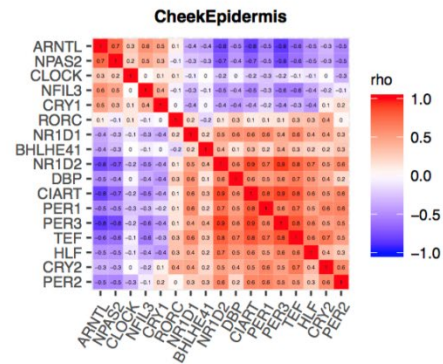
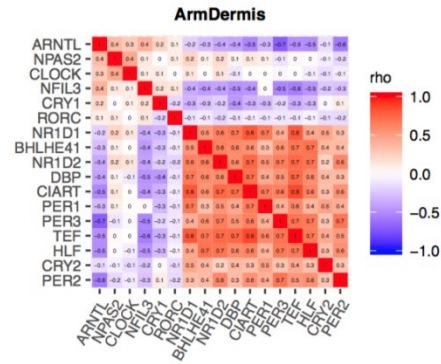
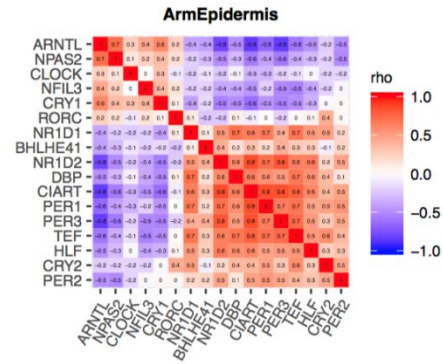
Ron C. Anafi^{a,b,c,1}, Lauren J. Francey^{d,e,f}, John B. Hogenesch^{d,e,f}, and Junhyong Kim^{g,h}



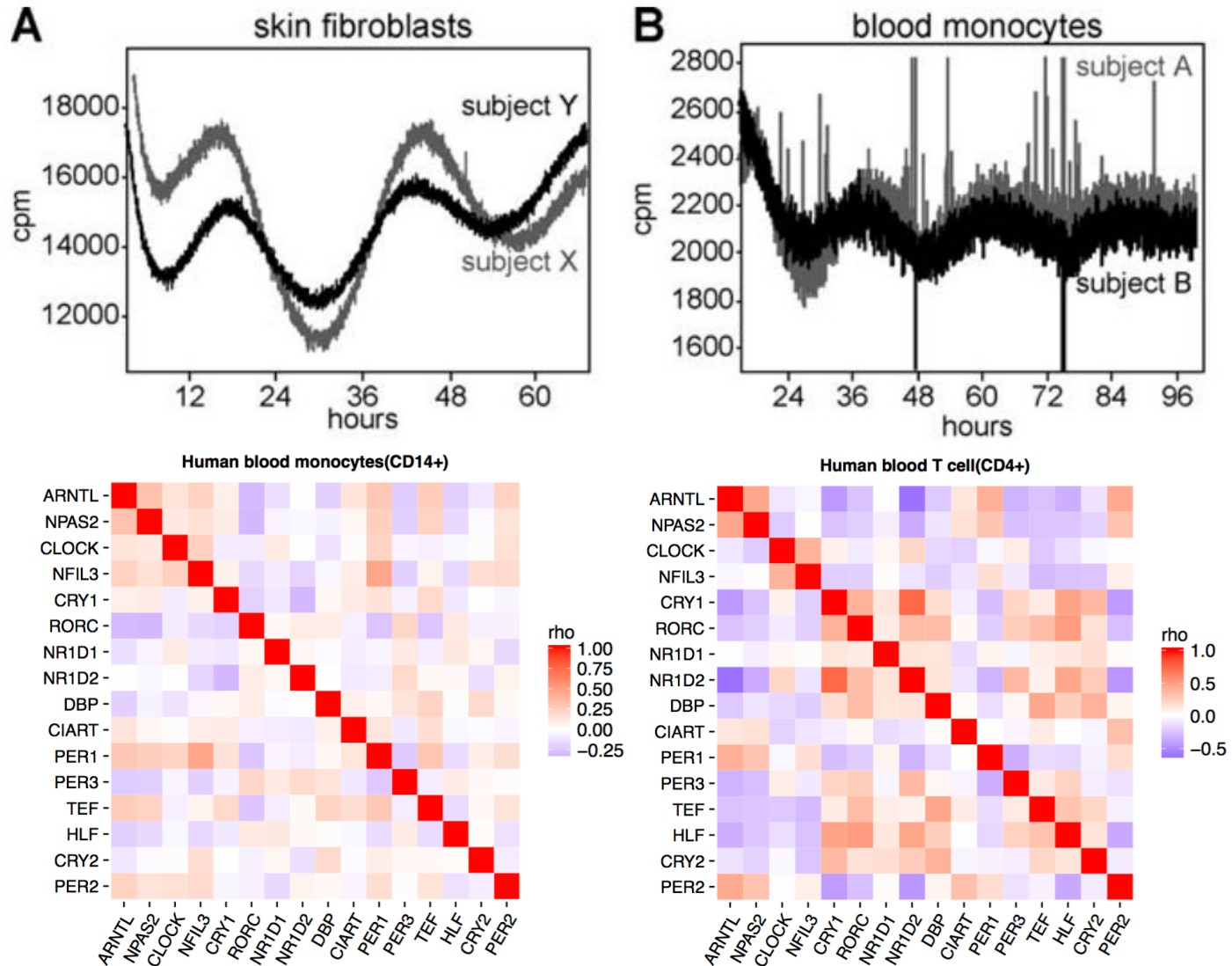
Strong clock signals in human skin at the population level



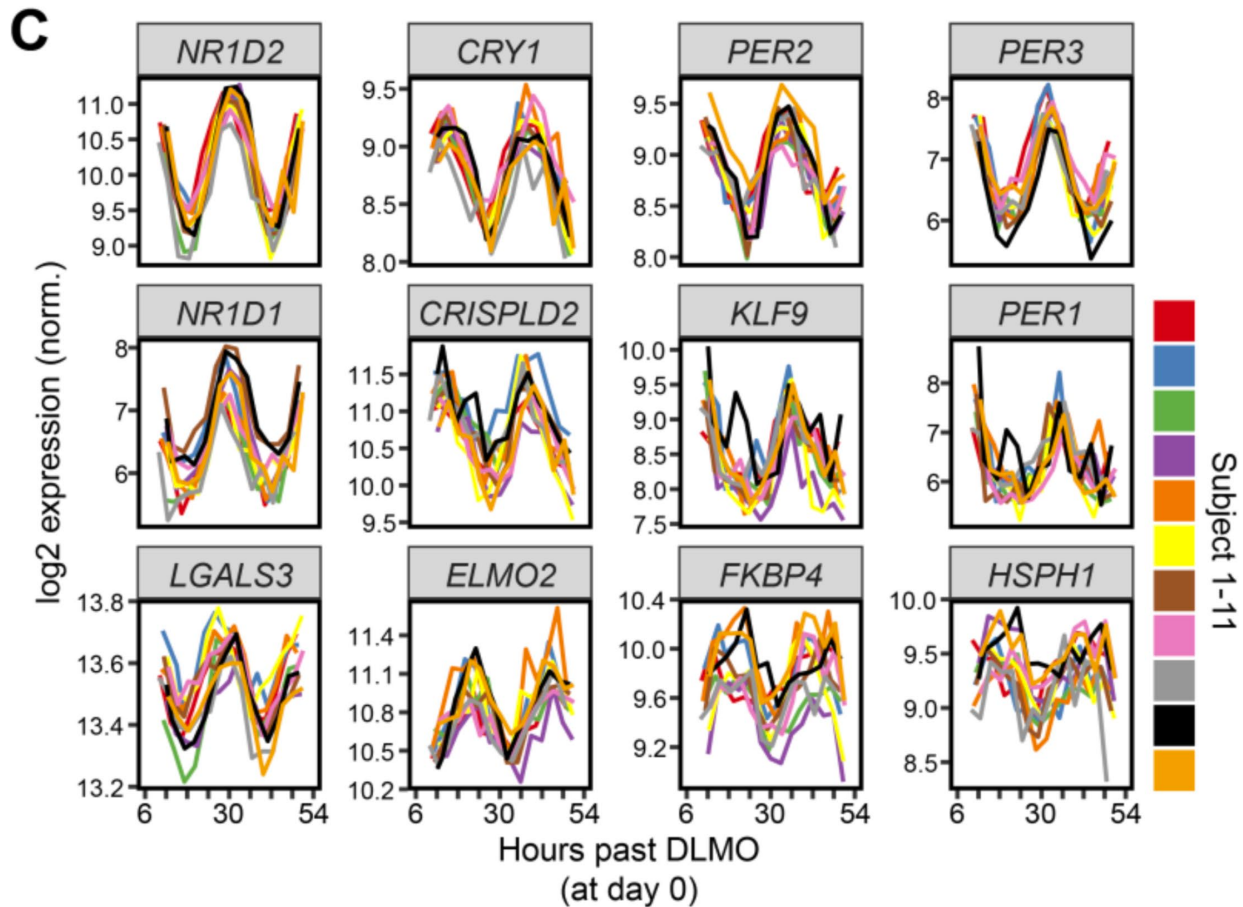
Epidermis has a stronger clock than dermis across body sites



The clock is weaker in the immune system



Or is it?

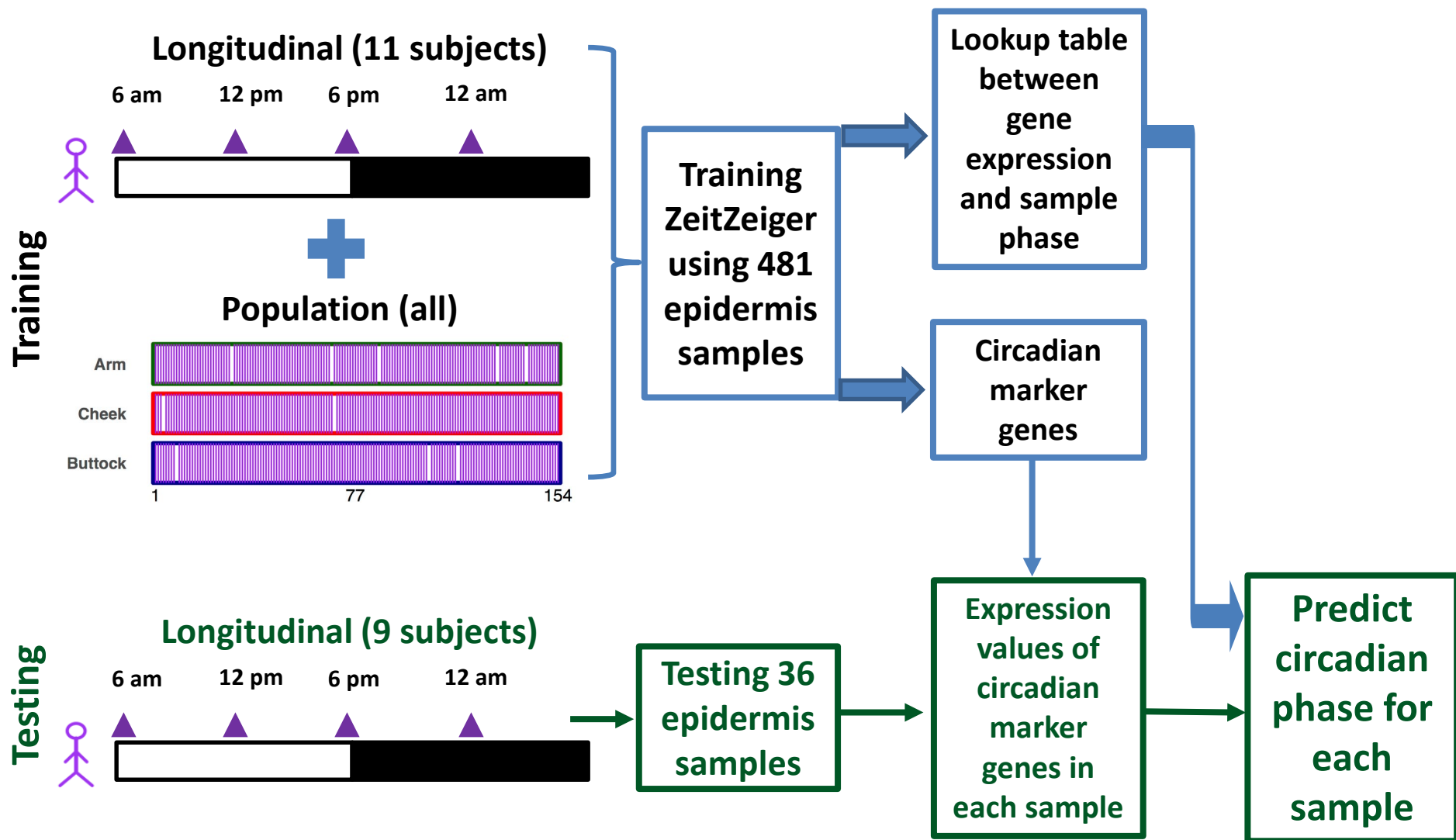


Caveats: 11 young subjects in a constant routine protocol

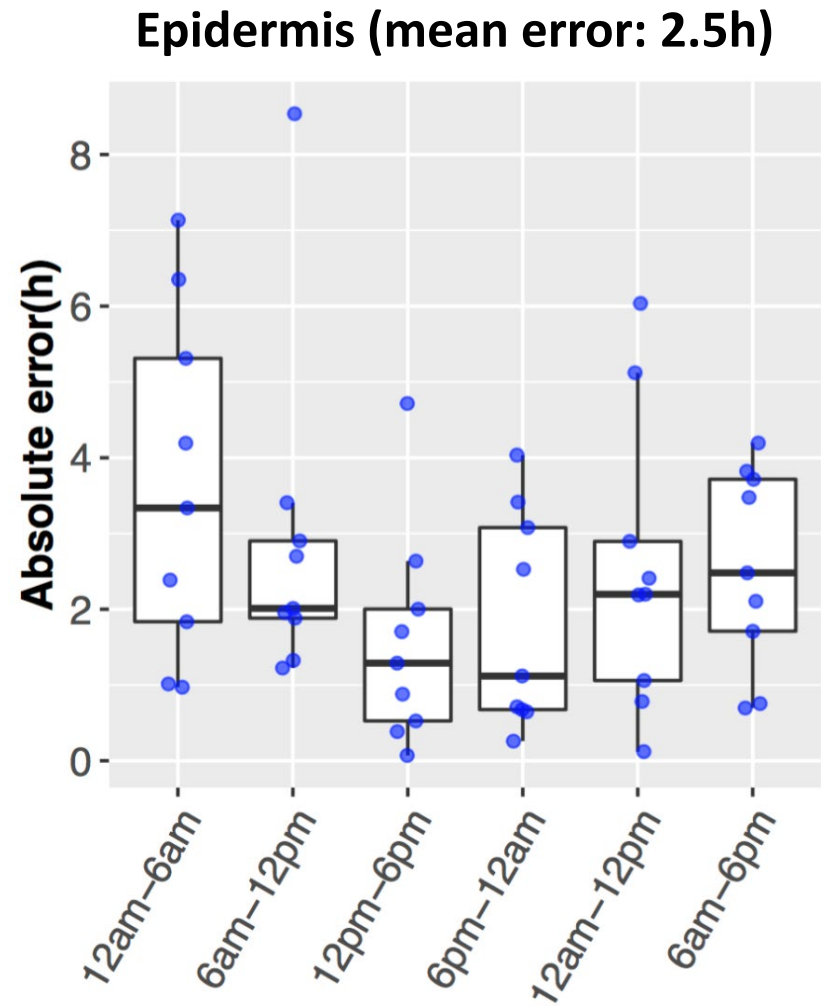
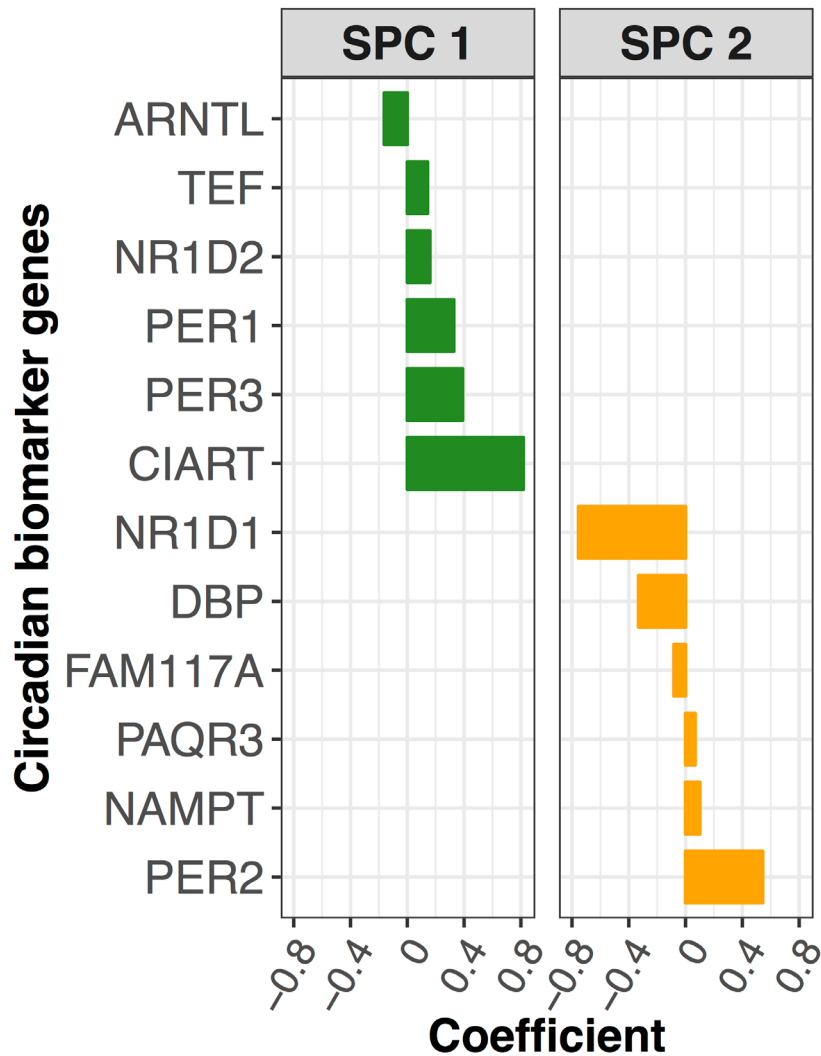
Wittenbrink et al., JCI, 2018

ZeitZeiger: supervised learning for high-dimensional data from an oscillatory system

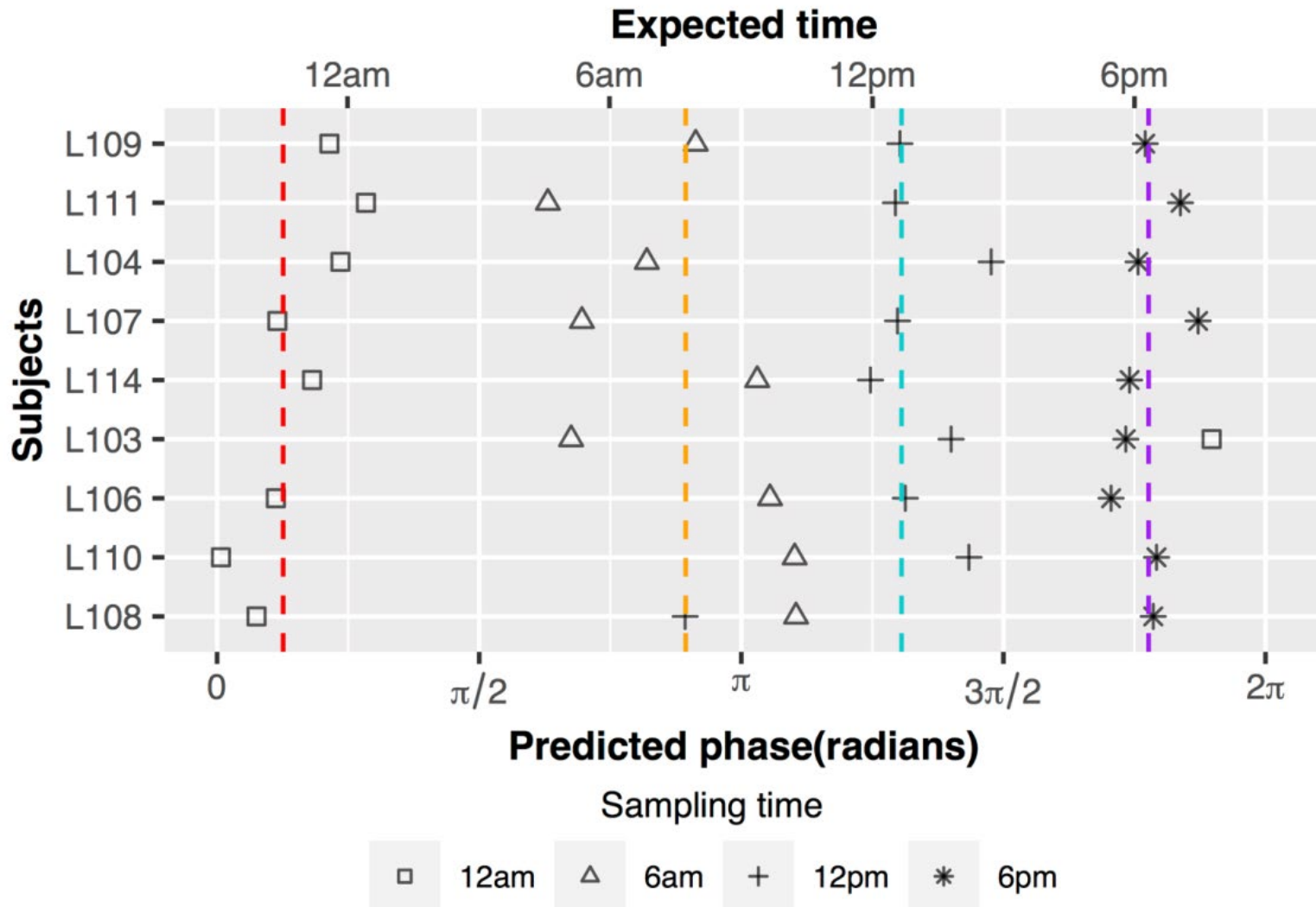
Jacob J. Hughey^{1,*}, Trevor Hastie² and Atul J. Butte¹



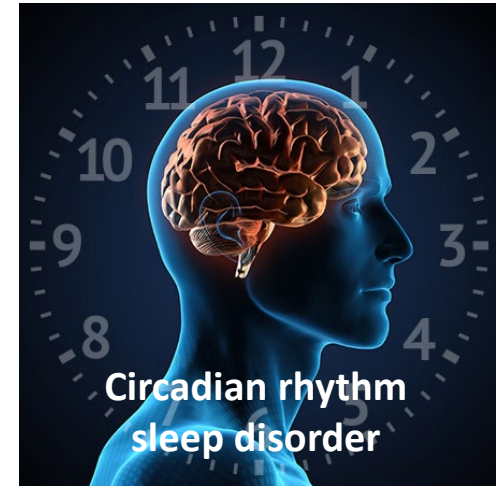
Good prediction with just 12 genes



Temporal sample order recovered from test subjects



Future clinical application of circadian biomarkers



Making medicine more precise.