Supplementary Figure 1: Responses of VS cells and V2 to Translation and Rotation

(**A,B**) Mean responses of the 10 VS cells to the three translations (lift, sideslip, thrust) and the three rotations (yaw, pitch, roll) are shown. Before averaging, the responses of each cell were normalized to the maximum response. Each bar represents the mean response of one VS cell, with VS1 to VS10 from left to right. Data represent the mean of n=number of flies: VS1 (n=6), VS2 (n=2), VS3 (n=4), VS4 (n=6), VS5 (n=3), VS6 (n=5), VS7 (n = 7), VS8 (n = 5), VS9 (n = 2), VS10 (n = 1). (**C**) Example response of V2 to the three rotations. (**D**) Mean responses of n = 4 V2 cells to the same global motion stimuli used in **A** and **B**.

Supplementary Figure 2: Membrane potential distributions from neighboring VS cells

Average membrane potential distributions from a VS5 cell recorded in the dendrite (**A**) and in the axon (**B**), from a VS8 cell recorded in the dendrite (**C**) and from a VS9 cell recorded in the axon (**D**). Also in the VS cells next to VS6 and VS7, the variation of the membrane potential decreased from the dendrite to the axon.

Supplementary Figure 3: Robust representation of the roll and pitch axis

Mean Fano factors of DNOVS1, VS axon and VS dendrite (pooled data from VS6 and VS7) for clockwise (blue) and counterclockwise rotation (red) around the roll and the pitch axis. For the counterclockwise rotation, the Fano factors of DNOVS1 and VS axon / dendrite differ significantly to stimulation with the "artificial room" and the "natural room" whereas the "checkerboard room" elicited nearly no differences. Data are from n=number of cells indicated in the plot. First number represents the number of VS6 cells. Statistical tests were done between DNOVS1, VS axon and VS dendrite (*P < 0.05, Wilcoxon rank sum test).

Supplementary Movies

(Movie_A): Movie of the "checkerboard room" showing a rotation around a longitudinal body axis (roll). (Movie_B, Movie_C): Movie of the "artificial room" and "natural room" showing a rotation around the preferred axis of rotation of DNOVS1 (30° azimuth). All movies were compressed and are shown here 1.5 times slower than the stimulus movies.