

**Supporting information includes:**

**Movies 1,2, and 3**

**Movie 1. Severing and fusion of small actin complex bundles.** Two examples of severing-transport-fusion events. In both examples, small actin fragment (see arrows) are severed from their original bundle, then move across the system and eventually fuse with distant bundles.

**Movie 2. Bidirectional motion of bundles.** Many bundles can be seen changing their directions every few frames, moving back and forth with similar, relatively low, velocities ( $\sim 1\mu\text{m}/\text{min}$ ). Few fusion events can be observed as well. Myosin II concentration  $0.6\ \mu\text{M}$ . Bar =  $5\mu\text{m}$ .

**Movie 3. Directional motion.** Many bundles are seen moving unidirectionally at high velocities ( $\sim 10\mu\text{m}/\text{min}$ ). Note that the motion takes place both along pre-existing actin tracks (immobile faint blue tracks) as well as along the BSA bed, both covered with the active myosin II mini-filaments. The motion between these two areas is continuous, showing that the whole surface is covered uniformly with motors. Myosin II concentration  $0.3\ \mu\text{M}$ . Bar =  $5\mu\text{m}$ .

**Supplementary Figure 1.** (A) Fluctuations in position of a bundle around the origin after depletion of ATP. The fluctuations in position are typical of the order of 200 nm (dashed line). (B) The distribution of the position of the bundle presented in A. The distribution is Gaussian (solid black line) with a STD of  $\sim 0.2\ \mu\text{m}$ .

**Fig. S1.**

