Supporting Information for

Spatiotemporal properties of sub-Rayleigh and supershear ruptures inferred from full-field dynamic imaging of laboratory experiments

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Additional Supporting Information (Files uploaded separately)

Table S1
Captions for Movies S1 to S4
Table S1. Imaging and image analysis parameters for vision measurements

|                  |                                                |
|------------------|-------------------------------------------------|
| Camera           | HPV-X 400 x 250 pixel array                     |
| Lens             | Nikon AF Micro-Nikkor 200 mm                    |
| Light source     | Cordin 605                                      |
| Exposure         | 200 ns                                          |
| Aperture setting | F/8                                             |

**Small field of view**

| Field of view     | 19 x 12 mm²                                    |
| Subset size       | 41 x 41 to 51 x 51 pixels²                    |
| Step              | 1 pixel                                        |
| Filter type       | Center-weighted gaussian                       |
| Magnification     | 45.7 - 46.5 µm/pixel                          |
| Average speckle size | 279 µm                                      |

**Large field of view**

| Field of view     | 131 x 82 mm²                                  |
| Subset size       | 41 x 41 pixels²                               |
| Step              | 1 pixel                                       |
| Filter type       | Center-weighted gaussian                       |
| Magnification     | 327.9 µm/pixel                                |
| Average speckle size | 984 µm                                       |
**Movie 1.** Experimental measurements of a sub-Rayleigh rupture revealing the spatiotemporal evolution of the fault-parallel (left) and fault-normal (right) velocity components. Full-field velocity maps with contour lines (top) and plots of the particle velocities tracked along the fault (bottom). The particle velocities in m/s are obtained for the sub-Rayleigh case discussed in the text ($P = 12$ MPa, $\alpha = 24^\circ$). Time is in microseconds starting from rupture nucleation. The rupture arrival is anticipated by the dilatational field entering the imaging window at a time $t = 60.3\,\mu$s, signaled by the two lobes in the fault-parallel velocity field and the associated positive motion in the fault-normal direction. As the rupture enters the field of view at $t = 63.3\,\mu$s, the fault-parallel velocity discontinuity across the interface increases rapidly with the particle velocity reaching $+/-\,1.2$ m/s on each side of the fault. At the same time, the fault-normal velocity is characterized by a pronounced negative motion, localized around the rupture tip, with a peak of 2.4 m/s indicating the predominance of the fault-normal over the fault-parallel motion for sub-Rayleigh ruptures.

**Movie 2.** Experimental measurements of a supershear rupture revealing the spatiotemporal evolution of the fault-parallel (left) and fault-normal (right) velocity components. Full-field velocity maps with contour lines (top) and plots of the particle velocities tracked along the fault (bottom). The particle velocities in m/s are obtained for the supershear case discussed in the text ($P = 23$ MPa, $\alpha = 29^\circ$). Time is in microseconds starting from rupture nucleation. The rupture arrival is signaled by the sharp increase in the fault-parallel velocity up to 12 m/s. The fault-parallel motion is accompanied by a fault-normal motion in the positive $x_2$ direction with a peak of 1.5 m/s. The positive fault-normal motion is localized to a near-fault region and is followed by a negative motion of 1 m/s, indicating the prevalence of the fault-parallel over the fault-normal motion for supershear ruptures. The evolving maps also capture the formation of shear Mach fronts, a key feature of supershear ruptures.

**Movie 3.** Spatiotemporal surface of the fault-parallel velocity of a supershear rupture. The plot is produced for the supershear rupture discussed in the text with $P = 23$ MPa and $\alpha = 29^\circ$. At the beginning of the animation, the fault-parallel velocity time history is shown for a point on the interface ($x_2 = 0^\circ$) and at the center of the field of view ($x_2 = 8.9\,\text{mm}$), replicating the time history shown in Figure 9b (blue curve). The plot is then rotated to display the $x_2$ axis and the animation develops by incrementally adding time histories at increasing values of $x_2$, up to $x_2 = -5.2\,\text{mm}$, so that the last curve added corresponds to the time history shown in Figure 9d (blue curve). The three-dimensional plot is then spun around to show the spatiotemporal surface.

**Movie 4.** Spatiotemporal surface of the fault-normal velocity of a supershear rupture. The plot is produced for the supershear rupture discussed in the text with $P = 23$ MPa and $\alpha = 29^\circ$. At the beginning of the animation, the fault-parallel velocity time history is shown for a point on the interface ($x_2 = 0^\circ$) and at the center of the field of view ($x_2 = 8.9\,\text{mm}$), replicating the time history shown in Figure 9b (red curve). The plot is then rotated to display the $x_2$ axis and the animation continues by incrementally adding time histories at increasing values of $x_2$, up to $x_2 = -5.2\,\text{mm}$, so that the last curve added corresponds to the time history shown in Figure 9d (red curve). The three-dimensional plot is then spun around to show the spatiotemporal surface.