Mapping magnetic field and relativistic electrons along a solar flare current sheet

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In the standard model of solar flares, a large-scale reconnection current sheet (RCS) is postulated as the central engine for powering the flare energy release and accelerating particles. However, where and how the energy release and particle acceleration occur remain unclear due to the lack of measurements for the magnetic properties of the RCS. Here we report the first measurement of spatially-resolved magnetic field and flare-accelerated relativistic electrons along a large-scale RCS in a solar flare. The measured magnetic field profile shows a local maximum where the reconnecting field lines of opposite polarities closely approach each other, known as the reconnection X point. The measurements also reveal a local minimum near the bottom of the RCS above the flare loop-top, referred to as a "magnetic bottle". This spatial structure agrees with theoretical predictions and numerical modeling results. A strong reconnection electric field of over 4000 V/m is inferred near the X point. This location, however, shows a local depletion of microwave-emitting relativistic electrons. In contrast, the relativistic electrons concentrate at or near the magnetic bottle structure, where more than 99% of them reside at each instant. Our observations suggest crucial new input to the current picture of high energy electron acceleration.