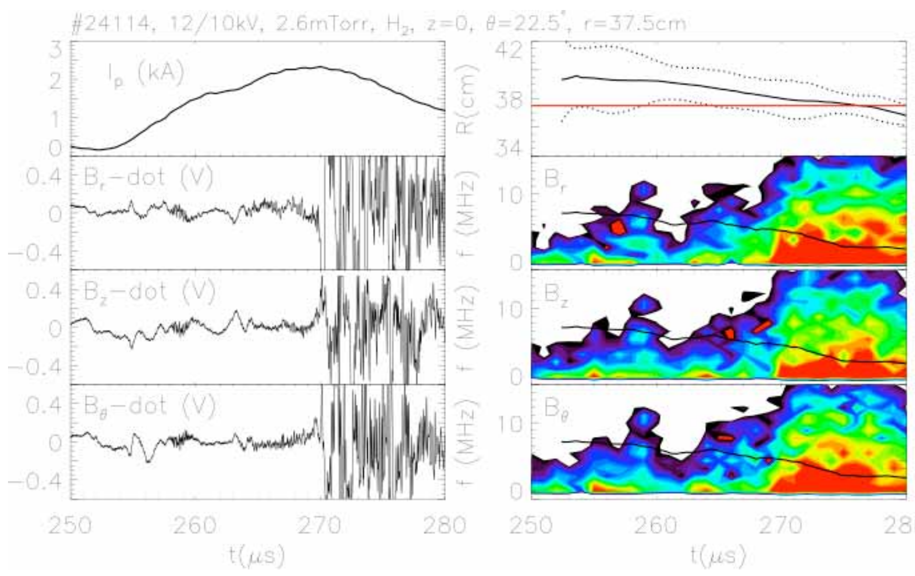
2. First Detection of Magnetic Turbulence during Fast Magnetic Reconnection

Magnetic reconnection has been an outstanding problem over more than a half century in plasma physics and astrophysics. It plays an important role in determining the evolution of magnetic topology and particle acceleration by dissipating magnetic energy. A central question concerns why the observed reconnection rates are much faster than predictions made by classical theories. A popular theoretical conjecture is that the fast reconnection is caused by an enhanced resistivity due to plasma turbulence. Despite its long history, a clear identification of such turbulence and its exact role in reconnection has never been established experimentally.

The first successful experimental detections of such candidate turbulence have been made in a laboratory experiment called Magnetic Reconnection Experiment (MRX), see picture attached below. While it is commonly believed that electrostatic turbulence speeds the reconnection rate, instead it was found that amplitude of magnetic turbulence correlates positively with fast reconnection. The turbulence has been identified as right-hand polarized whistler waves, propagating obliquely to the reconnecting field. This new finding provides a plausible way to explain the observed fast reconnection in many areas of astrophysical plasmas. These results will be summarized by Dr. M. Yamada (CI1.002) and by Dr. S. Terry (RO1.002), and will also be discussed in the mini-conference on "Laboratory Plasma Astrophysics" at the DPP meeting. Intensive theoretical and experimental efforts are under way for further understanding on the exact role by the magnetic turbulence on the fast reconnection.

References

H. Ji, S. Terry, M. Yamada et al., submitted to PRL(2003)



Measured magnetic turbulence during reconnection represented by plasma current (top left panel). Spectrograms are shown on the lower-right panels where fluctuation powers are color-coded in the time-frequency domain. The black lines indicate lower-hybrid frequency. The top right panel displays locations of the probe (red line) and the current sheet (center as black solid line and edges as dashed lines). When the current sheet center moves close to the probe, high-frequency magnetic fluctuations are detected.