Proposed High-Voltage High-Current Solid State Tesla Coil Spark Gap Design

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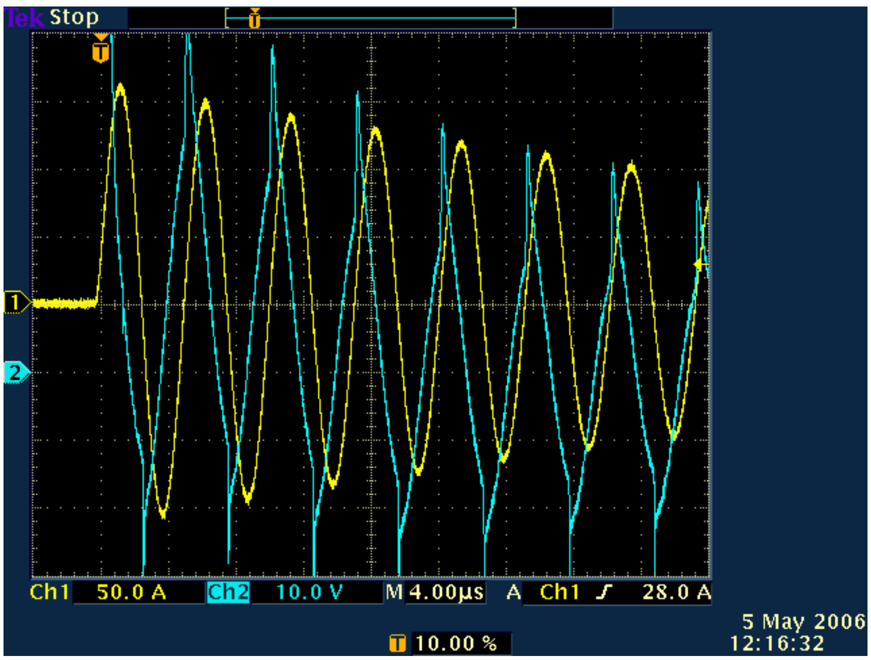
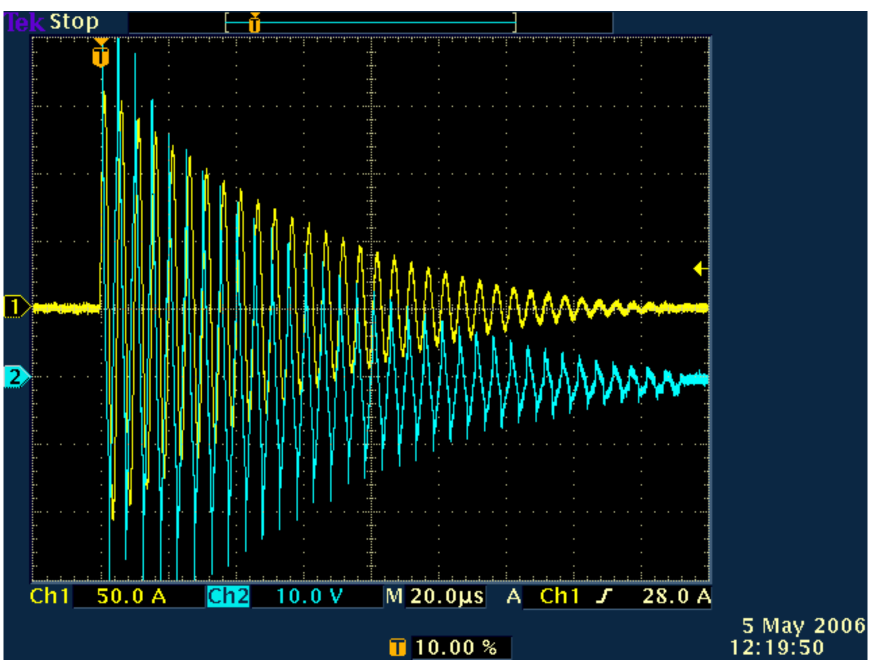
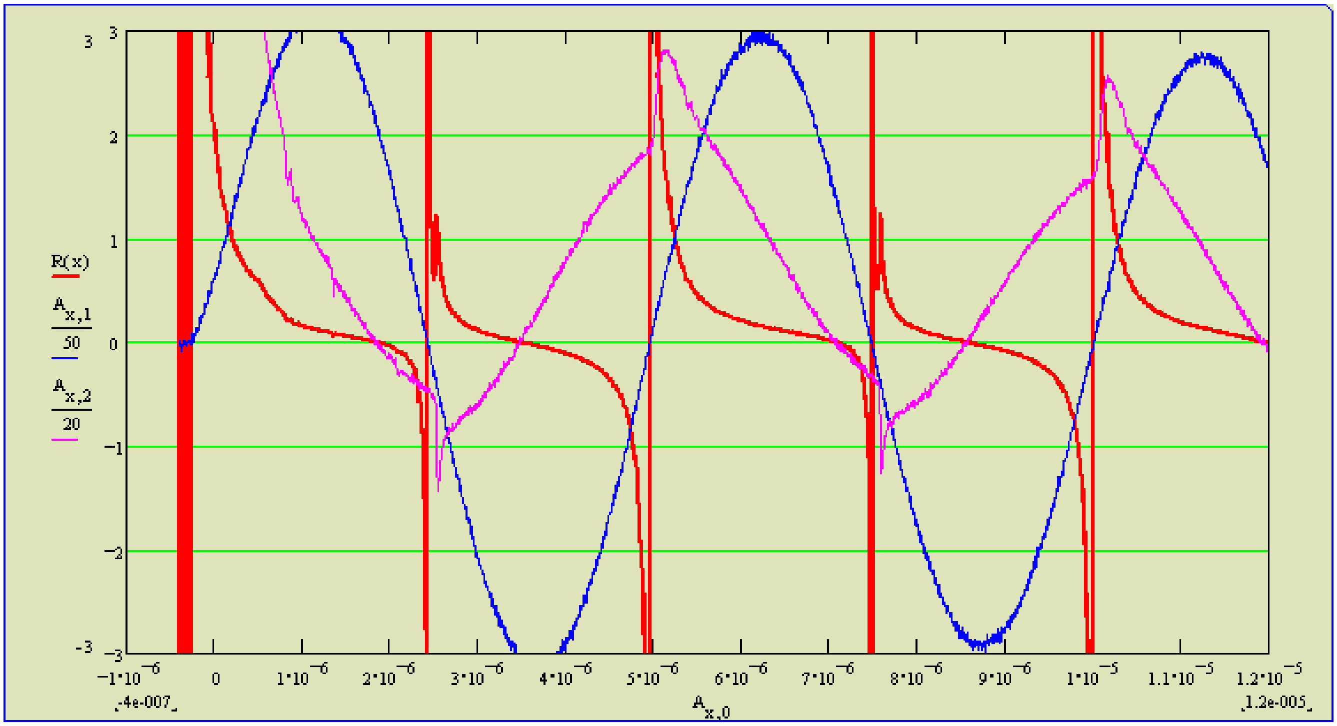
Power Measurements

I took two scope measurements of the voltage and current across the gap and pulled the scope date into files for analysis in MathCad.



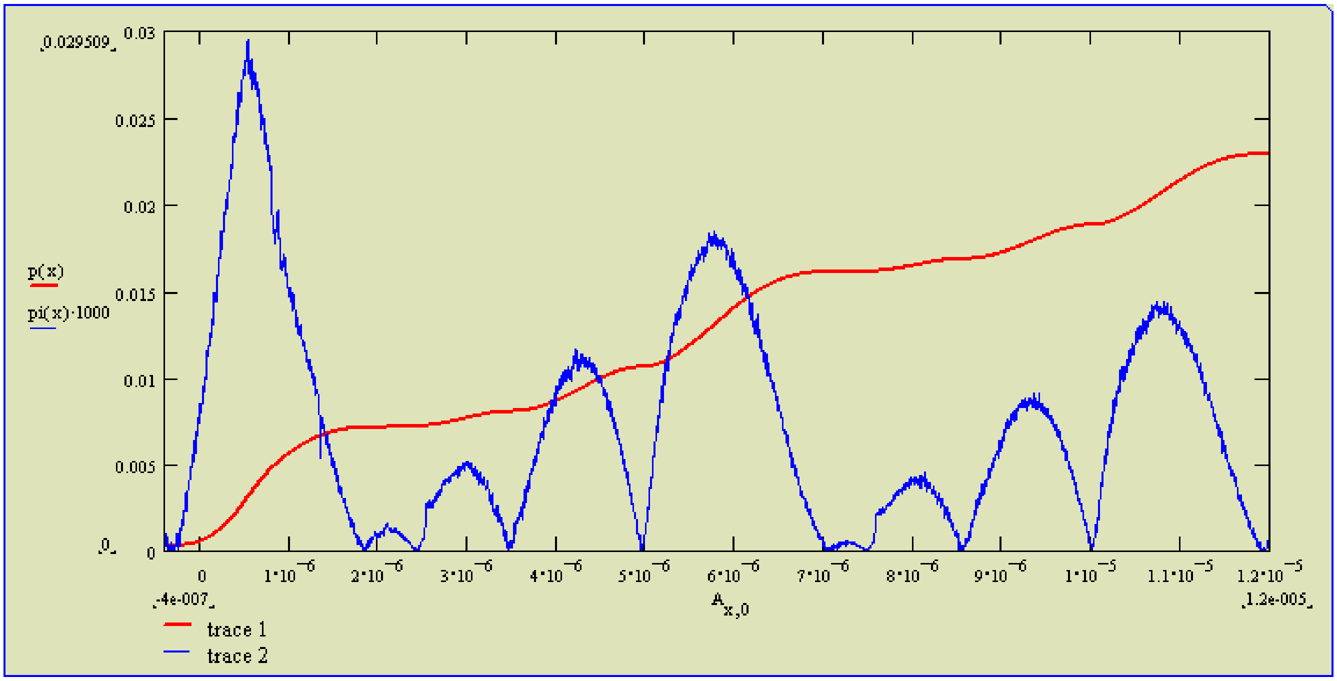


If we divide the voltage waveform but the current waveform, we can see the instantaneous resistance across the gap.



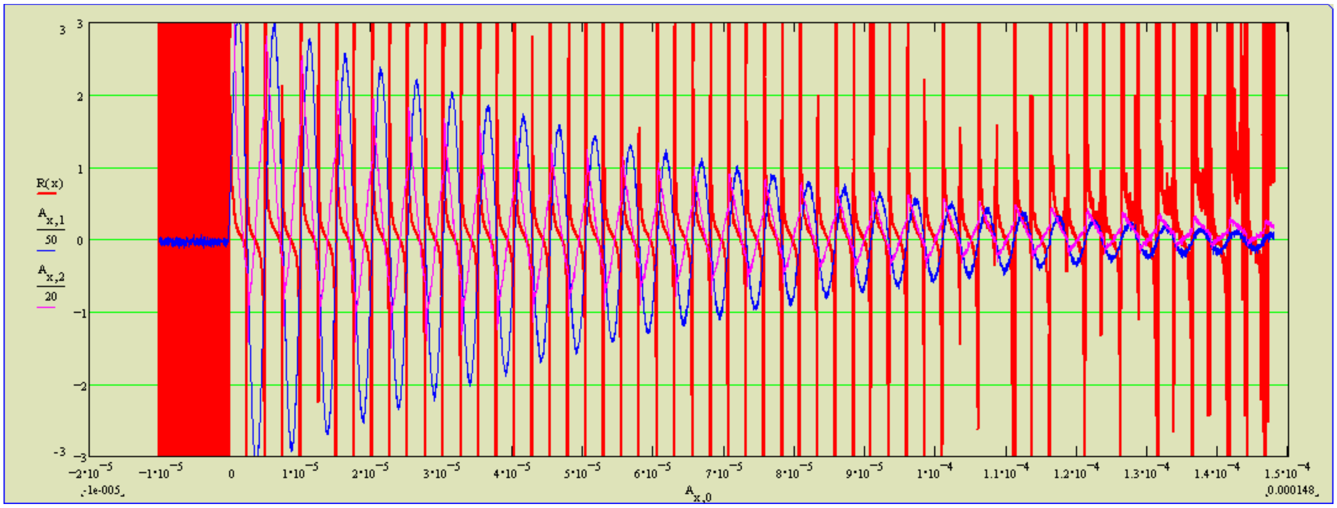
In the graph above, the voltage (purple) and current (blue) waveforms have been scaled to fit the graph for reference. The resistance (red) is to scale and shows the resistance during the first two cycles of the gap turn on. The resistance is in the order of ohms during the beginning of the first cycle. However, the resistance then stays in the <0.3 ohm range during the high current peaks. As the current reaches a maximum, the voltage across the gap goes to zero in a resonant circuit. Thus the resistance actually goes to zero. However that is due to the driving or "test" voltage dropping out rather than the resistance really going to zero. Basically, this perhaps confusing graph shows that the resistance of the gap at the 150 amp range is around 0.2 ohms. which is excellent!

If we look at the instant power and accumulated energy loss, We can estimate the total power in the gap.

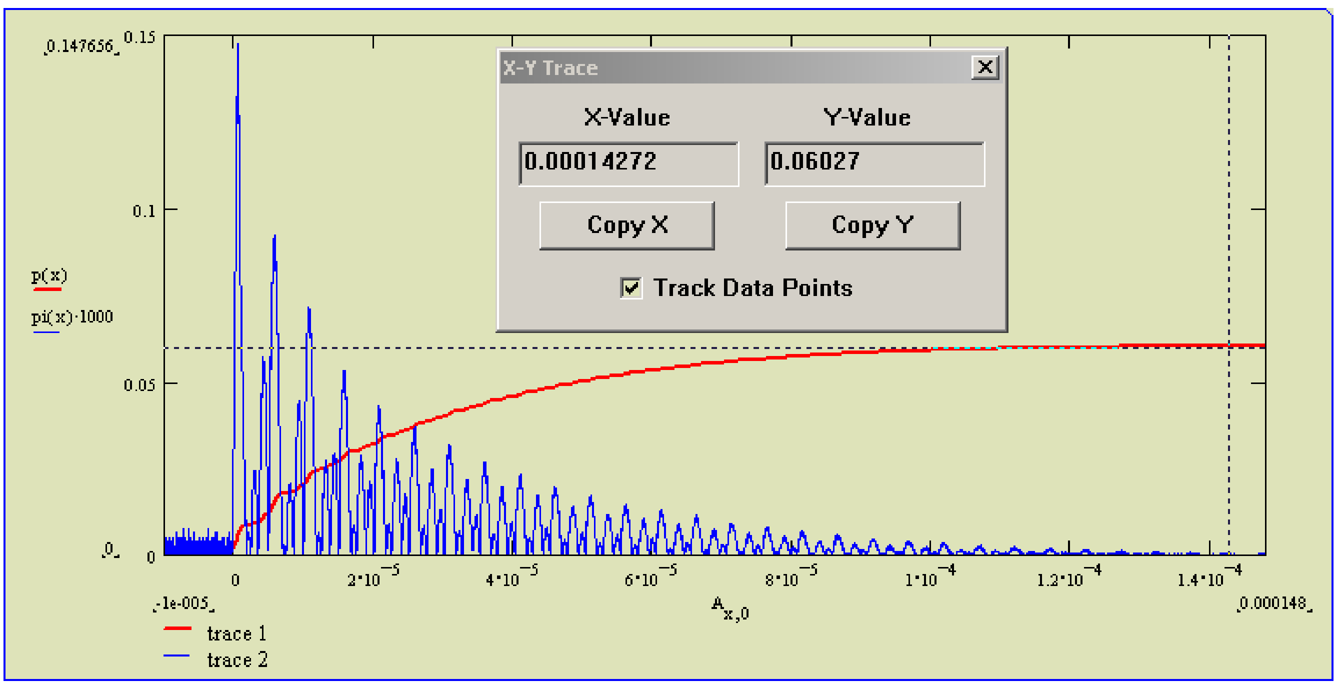


The instant power (blue) is the power expended every 4nS in milliwatts. The red line is the energy lost in Joules. The time scale is identical tot he first graph. In this case, one may simply note that the energy loss during the gap's initial turn on is reasonably close to the normal full on operation of the gap.

If we look at the same two types of graphs over the entire firing cycle, we can see the entire gap's operation.



As the current falls, the gap starts to loose conduction in the 20 and certainly 10 amp peak current range.



The power and energy graph shows that the total energy expended is 60.3mJ. The original capacitor energy was 63.3mJ. The primary capacitor's ESR is rated at 0.005 ohms and the coil's ESR is measured at 0.0217 ohms with a less than trusted meter. If we calculate the equivalent resistance of the gap, it is 0.54 ohms. Typical spark gaps are usually in the 3 ohm range so the gap seem to be very efficient.