**Application of velocimetry in assessing the current delivered to targets on the Z generator.**

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The Z generator at Sandia National Laboratories routinely delivers >20MA of current with a rise time of ~100ns to a wide variety of high energy density physics experiments. In this electrical system the generator and target are tightly coupled with the current that can be delivered by the generator dictated by the dynamics of the target. Transmission line inefficiencies can also result in some loss of current that is target dependent. Understanding our experiments therefore requires accurate measurements of the current at the target location which can be a very challenging measurement environment. Successful current measurements are enabled by a velocimetry technique where the magnetic field from the applied current accelerates thin metal plates placed close to the target. The resulting velocity time history is measured and compared to magneto-hydrodynamic simulations of these metal plates in an iterative process that constrains a trial current by matching the resulting plate velocity. Measurements are performed both at single points, and with a new line-imaging velocity interferometer (Z Line VISAR (ZLV)) whose optical performance overcomes the measurement challenges presented by the steep velocity gradients encountered in measurements made at small radius. To explore and discuss the advantages, limitations, and uncertainties in this measurement technique we report on a series of power flow scaling experiments conducted on Z. For these experiments the radius and gap of a potential transmission line on a future generator delivering >50 MA, was scaled down to reproduce the magnetic field, electric field, current density, and ohmic heating rate at the smaller peak currents accessible on Z. To further constrain the current delivered these velocimetry measurements are combined with circuit analysis, target simulations and electrical current and voltage measurements to build a consistent picture of current delivery. This approach, and the precision enabled by velocimetry based current measurement techniques, have demonstrated confidence that future, higher current generators can successfully deliver high current to targets.

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