# Interactive Exploration of Plasmas in Magnetic Confinement Fusion

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Interactive exploration of data from simulations is an important part of understanding physical phenomena whether it be part of the validation or verification process. In this talk, we highlight tools for interactively exploring plasmas primarily found in the simulation of magnetic confinement fusion. One of our focuses has been on detecting features in the magnetic fields used to confine the plasma, namely magnetic islands. Magnetic islands are responsible for instabilities in the field and can lead to a loss in plasma confinement. As such, understanding their formation and growth is an important need for magnetic confinement fusion to be successful.

Our approach for indentifying magnetic islands has been to understand their quasi-periodic nature when compared to stable flux surfaces. We have found that magnetic fieldlines when laying on an island chain will have a toroidal and poloidal resonant period that is directly related to its safety-factor. Such resonant periods are absent in stable flux surfaces. In addition, when a fieldline is lays on an island chain, the resonant periods will be in a form that allows us to indentify the island as being part either primary or secondary chain. Further, we have found that the higher order harmonics of these resonant periods provide additional information about the islands. In that the harmonics are directly related to number points needed to fully describe the cross section of the island in a Poincaré section

Our second focus has been on understanding ways to identify the signatures of multivariate particle data. In fusion simulations as well other plasma simulations such as laser wakefield particle accelerators utilize millions to billions of particles as part of the simulation process. For fusion scientists, they are interested in understanding particles that are part of the transport phenomena. To assist, we have developed query based visualization tools that allow scientists to interactively ask what if questions of large multivariate data sets. By combining parallel coordinates, which allows one to identify trends within multivariate data with accelerated index searches we can quickly perform range based queries on a large number of multivariate entries, thus allowing scientists to ask “what if” questions.

We will discuss both of these focus areas and how plasma scientists can use them for not only for post processing but also in-situ as well as for achieving data reduction.

*Work done as part of the DOE SciDAC VACET (Visualization and Analytics) and in collaboration with the DOE SciDAC SDM (Scientific Data Management).