Web Services for 3D MHD Equilibrium Data at Wendelstein 7-X

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Wendelstein 7-X (W7-X), the first fully-optimized stellarator experiment, started its operation in December 2015. W7-X research aims for good plasma confinement and the demonstration of steady-state operation. This could make the stellarator a serious option for a future fusion power plant. Magnetohydrodynamic (MHD) equilibrium data is needed at W7-X for data analysis and plasma operation (e.g. on-/off-axis heating scenarios). For axisymmetric tokamak configurations, equilibrium reconstruction in 2D can be done in nearly real-time. Due to the geometry of stellarators a three-dimensional MHD equilibrium model is needed. This leads to codes which are much more complex and time consuming. For example the VMEC code [1], a widely-used 3D code which assumes nested flux surfaces, takes minutes to hours for such computations. Therefore the VMEC equilibrium data for W7-X configurations has to be calculated in advance and stored in a database.

Web service technology is used to provide convenient access to equilibrium calculations by the whole W7-X team. The usage of standard web protocols allows the integration in client software written in almost any programming language. The VMEC web service provides access to equilibrium calculations via SOAP interface and REST API. The user can execute VMEC calculations and receive the results of completed runs. A website provides documentation for all functions as well as a listing of all stored configurations and previews of configuration parameters and interactive flux surface plots. The VMEC web service also provides access to the W7-X Reference Equilibria: a managed collection of VMEC configurations for W7-X experiments. This includes calculations for the standard magnetic configurations of Wendelstein 7-X and also the limiter configuration, which was used in the first operational phase of W7-X.

At Wendelstein 7-X a growing number of web services are implemented and in use. For example, the W7-X Archive Web API provides unified access to the data of all diagnostics and also machine operation data. Further examples are web services for Biot-Savart calculations, magnetic field line tracing, and function parameterization for W7-X configurations, as well as web service interfaces for a coil geometry database and a database for 3D meshes of machine parts and omponents. This allows service orchestration: results can be used directly as input for the VMEC web service and similarly the VMEC equilibrium data can be used as input for other web services. In this way the web service approach leads to a better interoperability of codes and increases the traceability of calculation results. Most of the services use generic data models and can therefore be used for calculations for other machines as well. This contribution presents the current state of the equilibrium web services at Wendelstein 7-X.

[1] Hirshman, S., van Rij, W. and Merkel, P. "Three-dimensional free boundary calculations using a spectral green's function method", Comput. Phys. Comm., 1986, 43, 143-155

Eligible for student paper award?

No

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