Sixth IAEA Technical Meeting on Fusion Data Processing, Validation and Analysis

Tuesday 9 September 2025 - Friday 12 September 2025

TBD

Topics

This technical meeting endeavours to holistically address the data processing, validation, and analysis needs of the fusion community to facilitate the successful transition of fusion energy from pure research to a deployed energy source. In this effort nine topics have been created covering topics such as, but not limited to, data retrieval, machine learning, and uncertainty propagation.

The committee encourages all relevant abstract submissions even if the subject is not explicitly mentioned in the topic list!

Next Fusion Device Concepts: Data Challenges and Design Optimization

This topic is devoted to the concept description of new fusion devices, possibly in preparation, focusing on the data challenges and design optimization, e.g. making use of digital twins. Description of the mathematical techniques for optimizing the device, validating the approaches is expected.

Information Retrieval and Visualisation

All data analysis relies on access to the underlying recorded and computed values. Data selection is done through a combination of metadata exploration, automated retrieval and interactive visualization. This session will present advances in all these areas.

Sensor Fusion and Integrated Data Analysis

This topic concerns integration of data from multiple sources, uncertainty propagation, as well as development of forward models and synthetic diagnostics. Both methods (Bayesian probability, machine learning, …) and applications are of interest, either for off-line analysis or for plasma control.

Inverse Problems and Image Processing

In physics, an inverse problem is defined in full generality as the task of calculating from a set of observations the factors that generated them. Many data-centric problems in fusion are 'inverse' in nature. The main examples are: the measurements to obtain the magnetic topology, tomographies, videos and gamma and neutron detectors. In general, the interpretation of these measurements needs solving mathematically ill-posed inversions and therefore present issues such as: estimating the confidence intervals in the results, dealing with the consequences of noise, minimizing bias effects etc. Any innovative approach to address these or related issues, posed by advanced inversion tasks in fusion, are welcome.

Keywords: Inverse problems, tomography, unfolding, equilibrium reconstruction, image processing.

Signal Processing and Anomaly Detection

Even if the understanding of the tokamak configuration has progressed significantly in the last years, improved signal processing techniques are very useful to investigate many advanced phenomena such as: instabilities, non-linear coupling of modes and intermittent fluctuations. Given the importance of guaranteeing continuous operation of next generation devices particular emphasis should be accorded to anomaly detection, disruption avoidance and predictive maintenance.

Keywords: signal processing, event detection, disruptions, predictive maintenance.

Physics-Based Machine Learning

This topic focuses on integrating established physical principles directly into machine learning methods used in fusion, simulation, and theory. Researchers contributing to this area leverage domain knowledge—such as plasma physics laws or reactor constraints—to guide data-driven models. Work towards merging of theory with data-driven techniques, ultimately improving the reliability and usefulness of ML solutions in fusion research.

Pattern Recognition

This topic concerns the discovery and quantification of patterns in data, by means of classification, clustering, regression and dimensionality reduction. Applications to the analysis and interpretation of fusion data are of interest, as well as new developments using the methods of statistics, probabilistic inference, information theory, machine learning and artificial intelligence.

Data Analysis for Feedback Control

Sophisticated real-time control methods are becoming more common in the planning and operation of new magnetic fusion devices. In particular, the advent of machine learning for simulation, control, and off-normal event prediction is a growing area of research. This session will include presentations on real-time control with a focus on the underlying data analysis.

Uncertainty Propagation, Verification and Validation

This topic deals with quantifying confidence in inferred quantities which rely upon the propagation of uncertainties from multiple inputs. Verifying the correctness of implemented algorithms and validating them against real-world observations is essentially to establishing confidence in data processing and analysis tools.