FUSION TECHNOLOGY DESCRIPTION

EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

Predictive maintenance and sensor fusion in complex, mission-critical environments thanks to Bayesian probability theory

Ghent University's Nuclear Fusion Research unit has developed a Bayesian probability-based method for integrated data analysis (IDA) of fusion diagnostics. This approach combines heterogeneous diagnostics, enabling the extraction of validated physical results. The university's expertise in Bayesian probability enhances trustable sensor fusion and similarity measurement between probability distributions. These techniques find applications in predictive maintenance and sensor fusion across industries such as finance, heavy machinery, marine infrastructure, and space satellites.

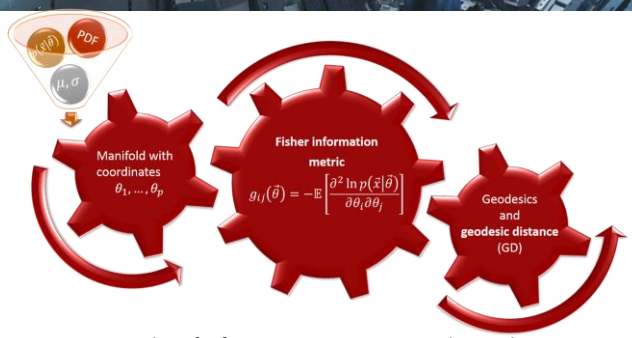
Description of the technology

The Nuclear Fusion Research unit at Ghent University (Ghent, Belgium) has developed a method based on Bayesian probability theory that enables all the information entering the diagnostic model to be systematically combined.

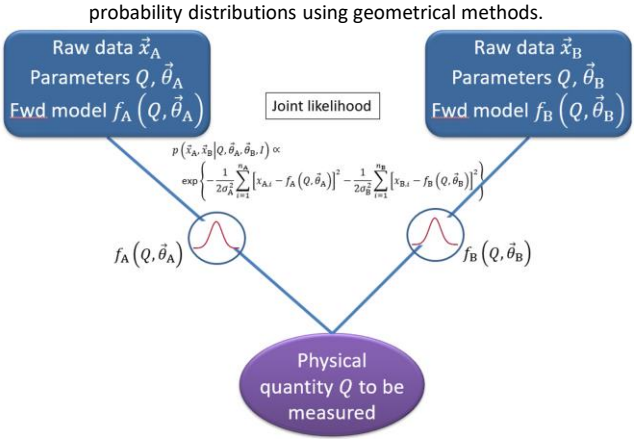
These elements ultimately enable integrated data analysis (IDA) of fusion diagnostics with the combination of heterogeneous diagnostics to obtain validated physical results.

These research activities have led to the development of advanced data analysis techniques (probability theory, machine learning, information geometry) and their application in fusion experiments that enable researchers to access quality data, carry out predictive maintenance and perform sensor fusion in complex and critical environments using Bayesian probabilities.

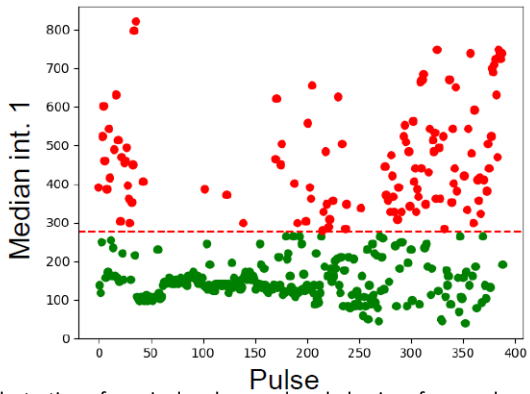
In addition to that, Ghent University can provide its expertise in the application of Bayesian probability for more trustable sensor fusion.



3 Principles of information geometry, an advanced mathematical approach for measuring similarity between probability distributions using geometrical methods.



2 Principles of sensor fusion using Bayesian methods, using two (or multiple) sensors (diagnostics) measuring raw data for estimation of a hidden system quantity Q.



4 Illustration of nominal and anomalous behavior of a complex circuit breaker at the JET fusion device.

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Innovation and advantages of the offer

The expertise in probabilistic modeling and advanced mathematical techniques allows to perform similarity measurement between probability distributions. This enables the quantification of complex stochastic phenomena and their dependence on experimental or environmental parameters, also in situations with rare but potentially catastrophic events.
Benefits from the integrated approach result from a systematic use of interdependencies; in that sense IDA optimizes the extraction of information from sets of different data.
In a nutshell, this type of techniques allow to "see" in advance (earlier than currently possible) endogenous or exogenous dynamics that could impair the functionality of a system.

Non-fusion Applications

Predictive maintenance and sensor fusion in industrial contexts; finance; heavy machinery operators, marine infrastructure developers, space satellite operators.

EUROfusion Heritage

The research unit Nuclear Fusion at the UGent department of Applied Physics has been involved in fusion research since over forty years. It has published numerous papers related to nuclear fusion, in particular in the field of data science, for projects related to JET and ITER.

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