Bayesian Gaussian process tomography for a soft X-ray diagnostic on the Tore Supra tokamak

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A typical SXR tomography (GPT [1]) has been developed and tested on simulated emissivity (phantoms) and Tore Supra data. The Bayesian Gaussian process tomography method has a high potential for real-time application. The Bayesian Gaussian process tomography method is demanded for a better regularization. A mixed adaptive covariance approach is intended across the spatial domain, enabling an adequate trade-off between scarce diagnostic information and prior knowledge [3].

Key points
- A soft X-ray tomographic reconstruction technique based on Bayesian Gaussian process tomography (GPT [1]) has been developed and tested on simulated emissivity (phantoms) and Tore Supra data.
- The Bayesian Gaussian process tomography method has a high potential for real-time application. Non-stationary regularization is applied across the spatial domain, enabling an adequate trade-off between scarce diagnostic information and prior knowledge [3].

TOKAMAK & Tore Supra

A tokamak is a device that uses a powerful magnetic field to confine plasma in the shape of a torus. Achieving a stable plasma equilibrium requires magnetic field lines that move around the torus in a helical shape.

Tore Supra is a French tokamak belonging to CEA, the Institute for Magnetic Fusion Research (IRFM). Its name comes from the words torus and superconductor, as Tore Supra was for a long time biggest tokamak with superconducting toroidal magnets, allowing the creation of a strong permanent toroidal magnetic field.

Experimental data tomography

In tomography, information from the spatial boundary region is typically scarce. To solve this problem, the Gaussian process approach the covariance acts as a regularizer. A stationary covariance gives a more symmetric result in the plasma center, while the spatially-dependent non-stationary covariance has a good performance at the boundary.

Conclusion
- Bayesian Gaussian process tomography performs well in a real-time application with a view to plasma control in fusion devices.
- A mixed adaptive covariance approach is demanded for a better regularization.
- Using information from additional diagnostics may provide further prior knowledge to improve the tomographic reconstruction.

References