# Regularization extraction for real-time plasma tomography at JET

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Plasma tomography [1] consists in reconstructing the 2D radiation profile on a poloidal cross section of the fusion device. Such reconstruction is based on measurements of the line-integrated radiation along multiple lines of sight. However, since these lines are sparse, the problem is under-determined, and a solution must be found by employing regularization methods [2]. Typically, such regularization is implemented by enforcing smoothness along the magnetic flux surfaces [3] or by using prior knowledge from other diagnostics [4]. In addition, an iterative procedure is needed to find the optimal regularization parameters [5]. As a result, tomographic reconstructions are computationally expensive and have extensive knowledge embedded.

In this work, we describe an approach to extract the regularization from existing reconstructions. Based on a set of about 500 reconstructions that have been carefully curated at JET, we use a machine learning framework to extract a regularization matrix that can be used to generate new reconstructions directly from measurement data. Figure 1 shows one of the regularization patterns that can be found in such matrix, where a measurement taken along a line of sight contributes to pixels along a curvature that resembles a magnetic flux surface. Once the regularization matrix has been found, new reconstructions can be computed in a single matrix multiplication step, thus enabling the use of plasma tomography as a real-time diagnostic.

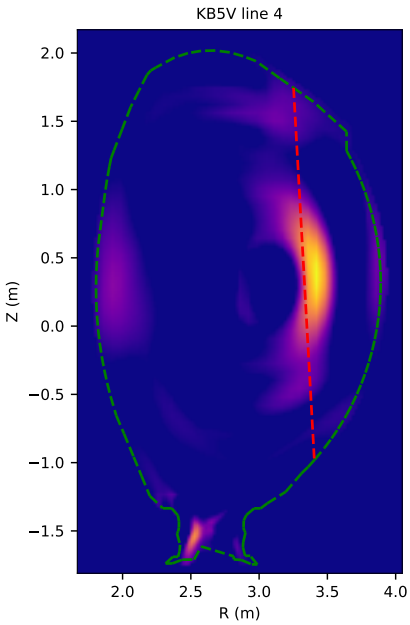


Figure 1: *Regularization pattern for line 4 of the vertical camera*

## References

[1] L. C. Ingesson et al., Fusion Sci. Technol. **53**, 2 (2008)

[2] J. Mlynar et al., Fusion Sci. Technol. **58**, 3 (2010)

[3] M. Odstrcil et al., Nucl. Instr. Meth. Phys. Res. A **686** (2012)

[4] J. Bielecki et al., Rev. Sci. Instrum. **86**, 9 (2015)

[5] V. Loffelmann et al., Fusion Sci. Technol. **69**, 2 (2016)

*See the author list of X. Litaudon et al., Nuclear Fusion **57**, 10 (2017)

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