Solution of the MULTICHANNEL BOLOMETRY problem ON the t–11M TOKAMAK [[1]](#footnote-1)\*)

DOI: 10.34854/ICPAF.2021.48.1.173

Scopintsev D., Hovansky A.

SRC RF TRINITI, Moscow, Troitsk, Russia, [scopintsev.d.a@triniti.ru](mailto:scopintsev.d.a@triniti.ru), [hovansky@triniti.ru](mailto:hovansky@triniti.ru).

The paper investigates the possibility restoring by multichannel bolometry on tokamak T-11M. From mathematical point of view this problem is equivalent to solution of the integral equation of the first kind that is ill posed problem. So we apply K-method [1 – 3] to solve this inverse Radon problem [4] for automatically processing of model data.

K-method enables to process real data in real time on the flow with spatial resolution N × N (N = 13, 31, 41, Nvp = 17, 657, 1245 – pixel variables into inspection domain E) and Ne = 64 = 2 \* 32 detectors (equations) in 2-VOS (View of Sight) SS (Scheme of Scanning).

The problem is reduced to SLAE (System of Linear Algebraic Equations) with Radon matrix Ra(Ne, Nvp) (Ne < < Nvp) with noised right part (Ne detector values) and therefore it is ill posed and requires the regularization.

The regularization is achieved by wavelet (local-nonlinear) solution approximation on Lipchitz compact and by wavelet symmetrization (that enlarge the rang at the passing from Radon to wavelet matrix) and also the application of LSM (Least Square Method) that guarantees the uniqueness of solution due to non degeneracy of wavelet matrix (Gram matrix) constructed by almost orthogonal wavelet basis in the space (C2∩L2∩O)(E).

C2 – Banach space of twice continuously differentiable functions;

L2 – Hilbert space of functions integrable with its power 2;

O – Class of functions with effectively bounded Fourier spectrum;

Е – circle inspection domain.

By wavelet basis construction the a priori information about tokamak magnetic field is taking into account.

Stability coefficient Cs (the relation of error solution to detector error) in norms C and L2 is equal to Cs(C) = 2 – 3, Cs(L2) = 1 – 2 at Gauss background SigGb = 5% and Poisson noise SigPn = 5%.

Implementation algorithm was checked on scenarios №1 (Brownian movement of circle Gaussian center and random fluctuations of amplitude and width into inspection domain, Nt = 1000 variants by time)

References

1. Хованский А.В., Скопинцев Д.А., Стародубцева Л.Н.,Применение метода подбора и К–метода для решения задач нейтронной томографии ИТЭР.ГНЦ, РФ, ТРИНИТИ,Отделение физики токамаков–реакторов. Теоретические и экспериментальные исследования, выполненные в 2007 году. Троицк, 2008, с. 20–28.
2. Хованский А.В., Быстрый вариант K–метода с универсальной настраиваемой схемой сканирования для задач малоракурсной томографии на токамаках. М., Мат. Моделирование, 2012, T 25, № 6, с. 65–80.
3. A.V. Khovanskiy, A Fast Variant of the K–Method with the Universal Adjustable Scheme of Scanning for Few View of Sight Computed Tomography on Tokamaks. *Troitsk Institute for Innovation and Fusion Research (TRINITI), Troitsk, Russia,* Received April 23, 2012. *ISSN 2070\_0482, Mathematical Models and Computer Simulations, 2014, Vol. 6, No. 1, pp. 80–91.*
4. Наттерер Ф., Математические аспекты компьютерной томографии. М., Мир, 1990.

1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/XLVIII/E/ru/HO-Scopintsev.docx) [↑](#footnote-ref-1)