7-2 Detailed Measurement of Boiling Flow –Monitoring 3D Change of Vapor / Water Distribution by Neutron Beam–

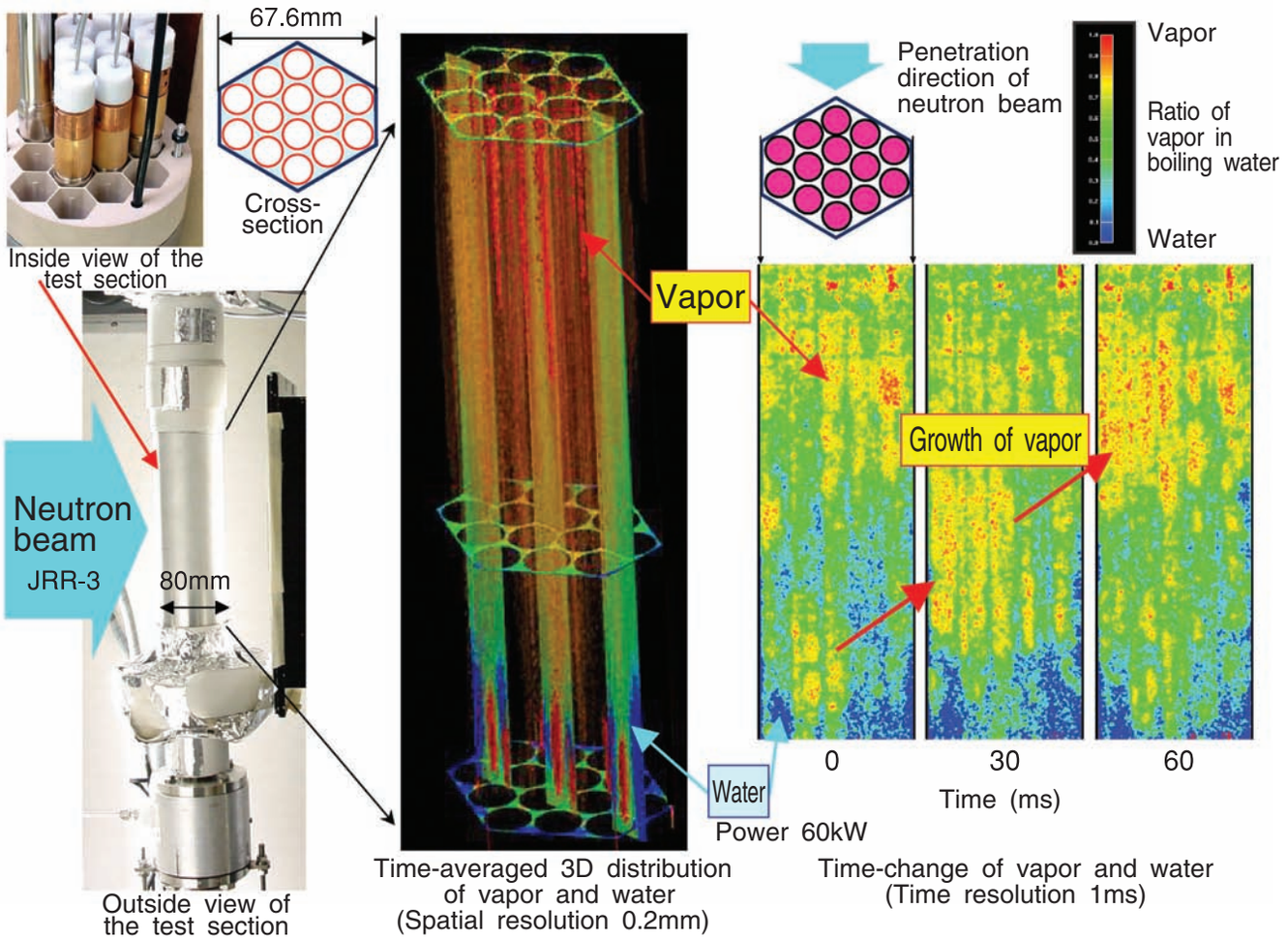

Fig.7-5 Measuring 3D changes of vapor/water distribution in the heated rod-bundle by neutron beam
Changes in spatial distribution of boiling flow in the fuel assembly of a water-cooled breeder reactor affect the cooling performance of the nuclear reactor. In this study, we developed a technique by which we can measure the changes in spatial distribution of vapor and water, using a neutron beam.

One of the important considerations in the design of the water-cooled breeder reactor is the estimation of cooling limit of a fuel assembly. Since the cooling performance depends on the distribution of water and vapor, we need high definition data in order to understand the flow behavior between rods and thereby estimate the cooling limit. However, it is difficult by traditional measurement techniques to measure the flow distribution in a heated bundle. Thus, we developed a new technique which can measure in detail the distribution of boiling flow, using a neutron beam which has a high sensitivity to water. We carried out tight-lattice 14-rod bundle experiments using "JRR-3" as the neutron source (Fig.7-5). The aim of the experiments was to measure the changes in spatial distribution of vapor and water in the heated rod bundle. This is a new technique combining neutron radiography and computed tomography. We can understand the high definition 3D distribution of vapor in boiling flow. We also measured the flow behavior. It was found from the visualization with the time resolution of 1ms that the vapor accumulation point which was observed in 3D data was washed away by cooling water periodically. These results were of use not only for advancing our understanding of various phenomena but also for the verification of advanced thermal hydraulic codes.

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Reference

Kureta, M., Experimental Study of Three-Dimensional Void Fraction Distribution in Heated Tight-Lattice Rod Bundles Using Three-Dimensional Neutron Tomography, Journal of Power and Energy Systems, vol.1, no.3, 2007, p.225-238.