

Tokamak Research at University of São Paulo

I. C. Nascimento,¹ I. L. Caldas,¹ and R. M. O. Galvão¹

The main results obtained in the small tokamak TBR-1 of University of São Paulo (USP) are reviewed. The main effort has been concentrated on the characterization and external control of MHD activity, plasma edge phenomena and diagnostic development. The design of a small-aspect-ratio tokamak, TBR-E, and the research program to be carried out in TCA, to be transferred from Lausanne to São Paulo, are also briefly described.

KEY WORDS: Tokamak; plasma edge phenomena.

1. INTRODUCTION

Research in Plasma Physics is a relatively recent activity in Brazil. Although some sporadic work was carried out already in the fifties,⁽¹⁾ the first research groups were organized in the mid-seventies. The Plasma Physics Laboratory of USP was founded in 1977 by a group of experimental nuclear physicists interested in starting fusion research in Brazil. The strategy to initiate the group and attract graduate students was to design and construct a small research tokamak that could provide a good opportunity to get acquainted with the main experimental techniques relevant for fusion research. With the collaboration of a plasma physicist from the State University of Campinas and another from the University of Sydney, Australia, the group completed in 1978⁽²⁾ the design of a small tokamak, TBR-1, and obtained the first shots in the device in April 1980.⁽³⁾

The initial plan was to carry out experimental work in TBR-1 for 2–3 years, mainly to train graduate students and get experience on tokamak operation, and then design and construct a middle size tokamak in which a more scientifically ambitious research program could be pursued. Unfortunately, although the activities devel-

oped around TBR-1 were rather successful, with training of many graduate students and publication of some scientific papers in international journals, it was not possible to get financial support for the next device TBR-2. We have then decided to improve the performance of TBR-1 and establish a fusion-relevant research program that could be carried out in such a small tokamak. The main improvements in the device were to elongate the pulse, add a system of external helical windings, and develop a feedback system for the vertical equilibrium field and a PC-based data acquisition system. The research program concentrated mainly on the characterization and control of MHD activity and study of plasma edge phenomena.

A few years ago, the Plasma Physics Laboratory of USP received financial support to conduct the conceptual design of a middle-size tokamak, to be built in Brazil. After completing the design of a standard device, TBR-2⁽⁴⁾ with aspect ratio $R/a = 2.5$, major radius $R = 0.56$ m, the group decided to work on the design of a more ambitious device, in which the aspect ratio could be varied in the range $1.5 \leq R/a \leq 2.0$, to test the concept of the spherical tokamak put forward by Martin Peng.⁽⁵⁾ The conceptual and basic engineering design of the device, named TBR-E, was finished in 1991, in collaboration with the State University of Campinas and the National Institute for Space Research.⁽⁶⁾ Unfortunately,

¹Universidade de São Paulo, Caixa Postal 20516, CEP 01452-990, São Paulo, SP, Brasil.