Editor’s Introduction

The reversed-field pinch (RFP) is a magnetic confinement concept with a forty-year history of experimentation. Work begun in the 1950s culminated in the mid-1960s with the ZETA experiment at the Culham Laboratory in the UK. Experimentation slowed after that until the major result by J.B. Taylor in 1974 regarding magnetic helicity and stable, relaxed states of the RFP configuration. From the mid-1970s to the end of the 1980s, experimentation on RFPs was vigorous, and the world’s largest RFP experiment is now operating in Padua, Italy.

From a reactor viewpoint, the RFP has several distinctions. First, the plasma current density is sufficient to reach plasma ignition in deuterium and tritium if the confinement of energy is adequate. Second, the RFP is naturally a high density device. This permits small, compact, and rather high power-density systems to be feasible. Third, the RFP appears to operate at its beta limit without disruption, and to be capable of operating with reasonable transport confinement even when a large percentage (60%–80%) of the plasma input power is radiated from its core. This has major advantages when it comes to managing the surface heat loadings in such a system. On the other hand, the RFP is highly turbulent, the absolute value of energy confinement is modest compared to that in tokamaks of similar physical dimensions, the prospects of sustaining the plasma current continuously are not bright, and the system does not readily permit a magnetic divertor.

Nonetheless, the unique characteristics of the RFP warranted a major study of its prospects as a reactor. This was the objective of the TITAN research program, whose technical results are summarized in the papers of this Topical Issue. The research team comprised groups from the U.S. and abroad and was led by the reactor study team at UCLA under the direction of Farrokh Najabadi and myself. The TITAN research has clearly established both the prospects and the critical technical and engineering issues of an RFP as a power reactor. If results from on-going physics experimentation again make the RFP a leading fusion-reactor candidate, the results of the TITAN research effort will provide the basis for the technical program needed to proceed towards a practical RFP fusion power system.

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