Port 6 and Other Tests for PFC in ITER

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PFC Tests

Components

1. Divertor
2. rf antenna

Where Tests Can be Done

- Part of basic machine (e.g. replace one ITER divertor module with advanced concept)
- In Port 6
- Other test ports or ITER device location

Notes

- PFC Tests involve many nuclear issues (cooling, radiation effects, thermomechanics, etc.)
- This is a critical area which has not received attention in the past. Should we put some more serious effort into this?
- PFC Tests involve the special problem of interaction with the plasma.

Divertor Test Plan

Test Location

Radiation damage tests can be performed in Port 6

All other tests should be performed in the divertor region (including the toroidal limiter)

Test Module Types:

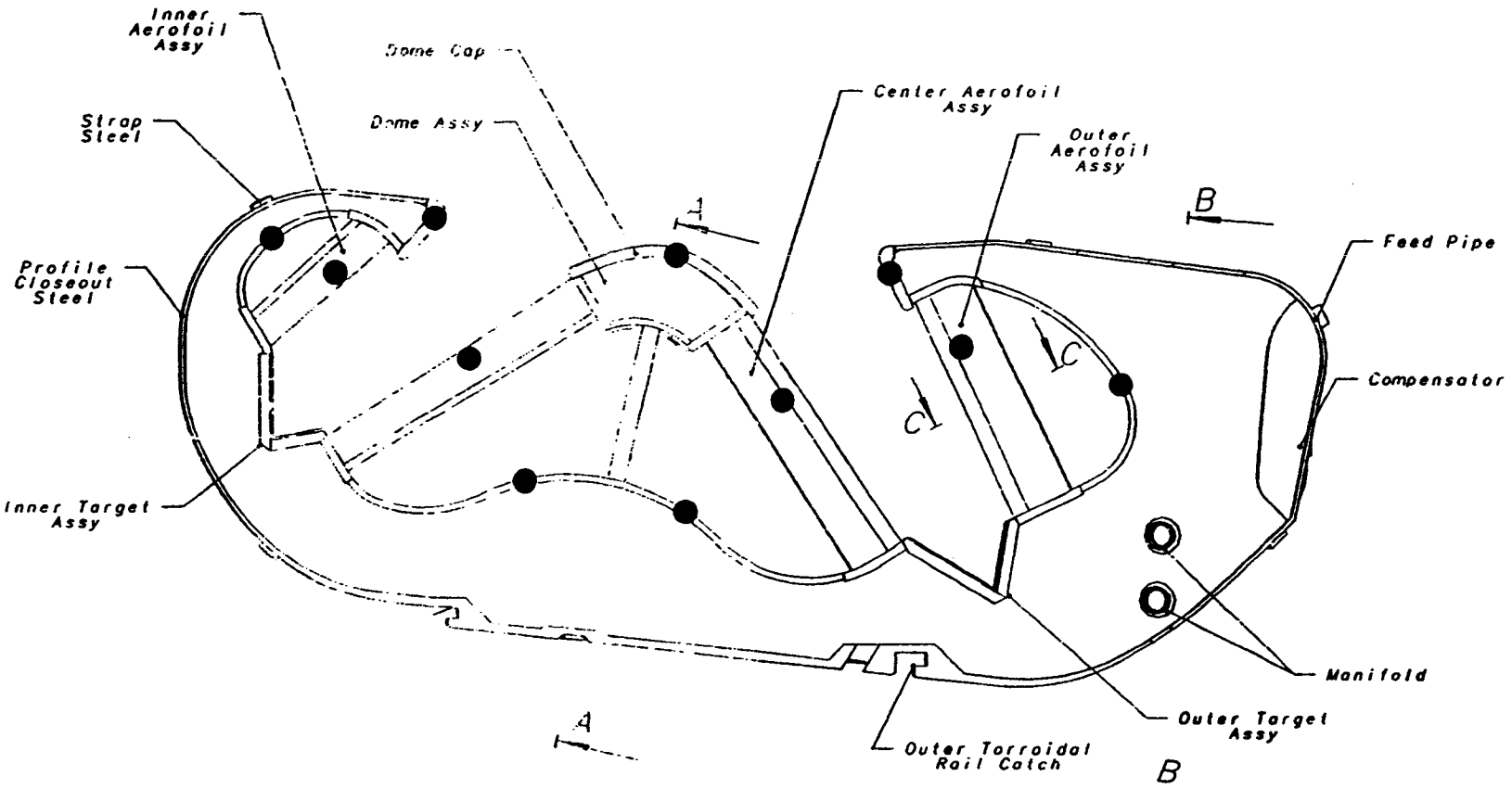
- Material characterization
- Evaluation of alternate pumping and impurity removal concepts
- Thermomechanical performance characterization and optimization in advanced and alternate concepts
- Design sensitivity studies
- Remote maintenance studies

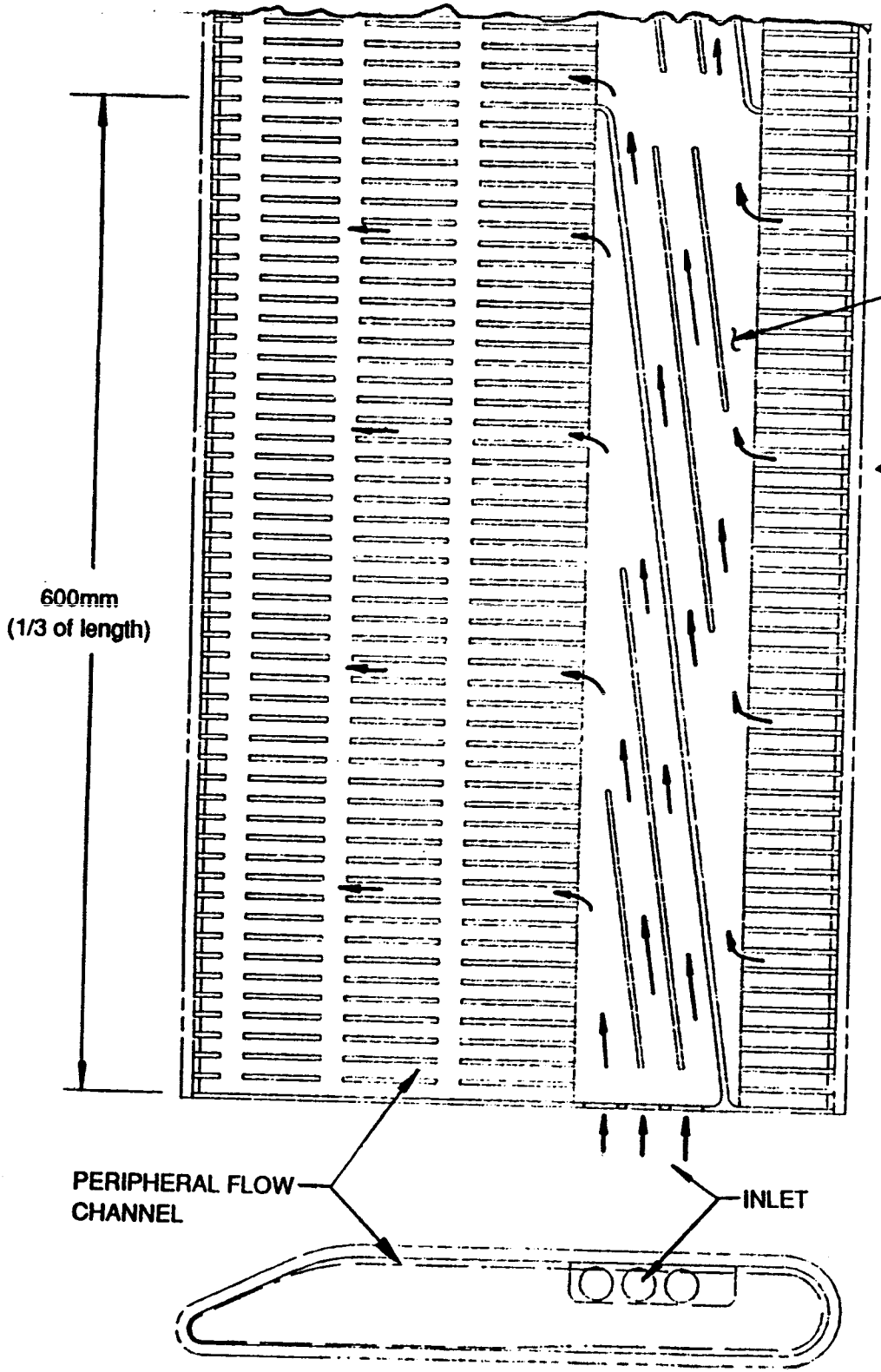
Examples:

- helium-cooled baffle/toroidal limiter concept
- alternate airfoil flow geometry (water coolant)
- tungsten-coated module tests
  (all surfaces except end-plates, which see direct plasma contact)

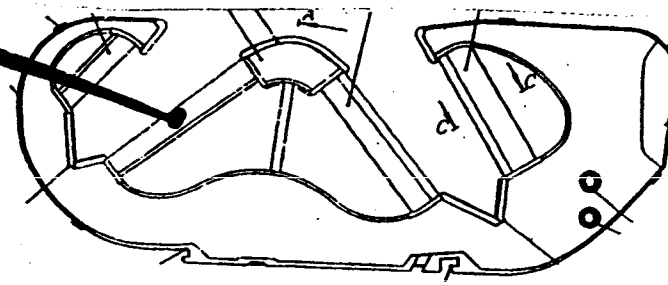
Alternate Armor Material Test Module

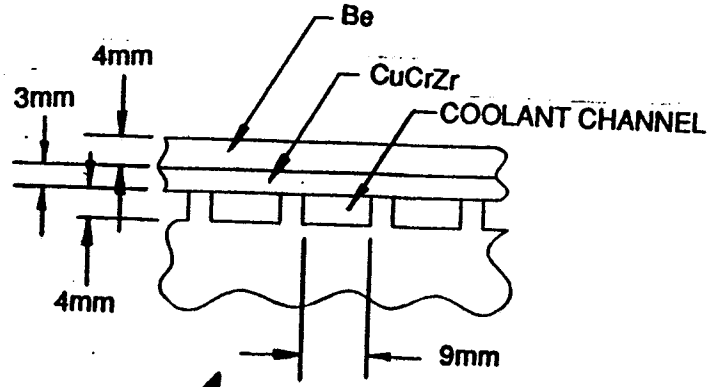
● Alternate Armor Locations

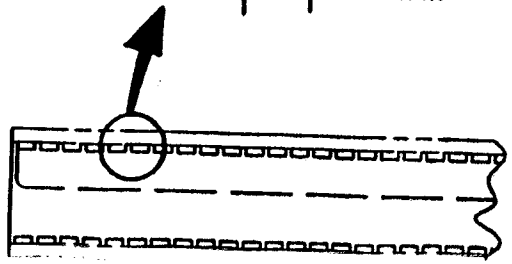




ıate Sidewall Airfoil
t Flow Configuration







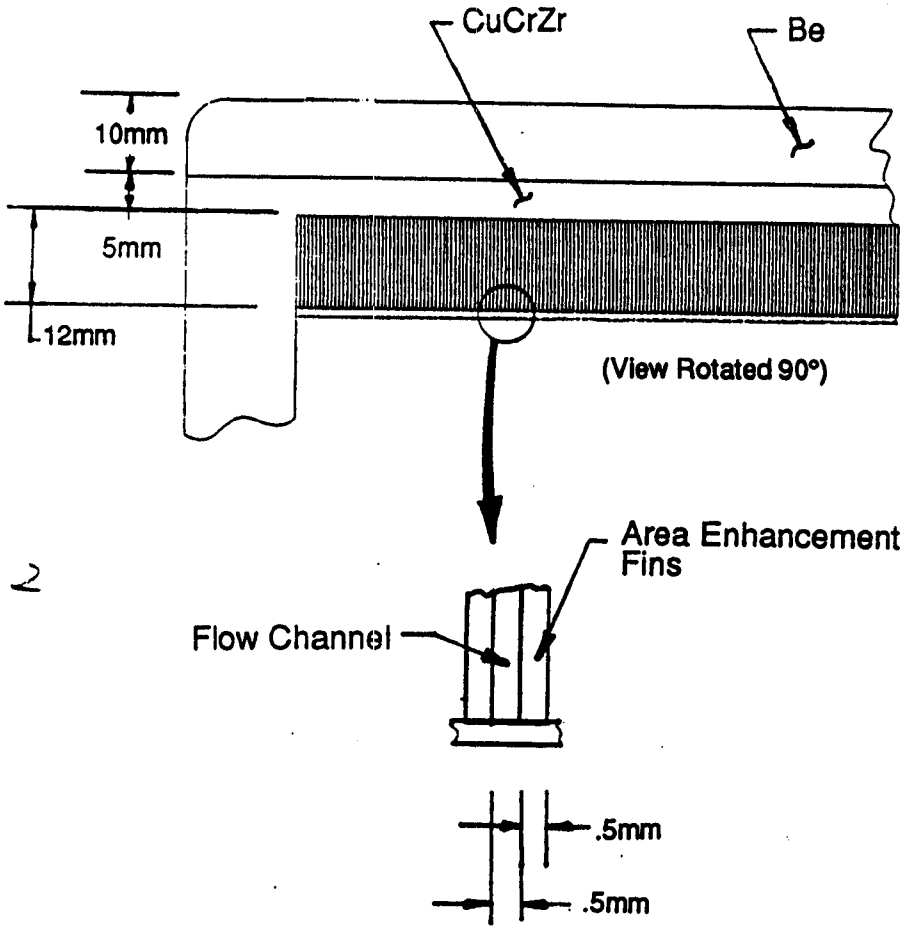
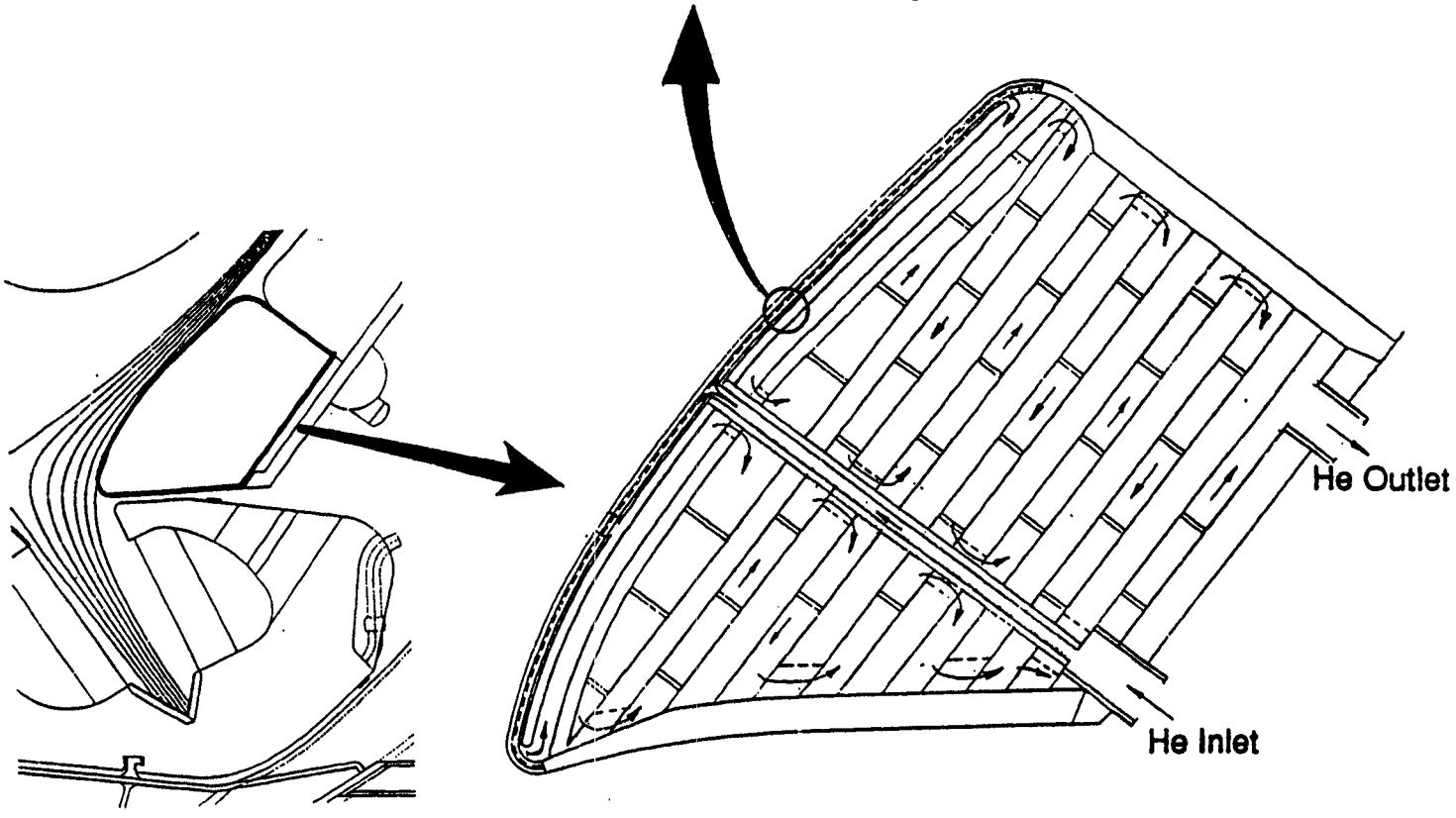


Fig 2

First Wall Coolant Channel Configuration



He Cooled Baffle Test Module

Internal Flow/Shield Configuration

RF Systems Test Plan

Existing Machine Systems (36 antennae, 4-m poloidal length)

Ion Cyclotron

Electron Cyclotron

Test Requirements

- Test location in Port 6 or in existing baseline rf location
- 6–12 months calandar time exposure
- Full power coupled to the plasma
- Power and particle loads expected in ITER are acceptable

Test Module Examples:

IC Systems

Test of advanced Faraday shield for IC launchers
e.g., tungsten-coating, SiC structure, design variants

High power density launcher tests (folded waveguide)

Advanced current drive structure designs

LH Systems

Standard launcher tests (ITER baseline has not LH systems)

Advanced launcher tests (e.g., designs with launcher farther from plasma)

EC Systems

Alternate launcher configurations

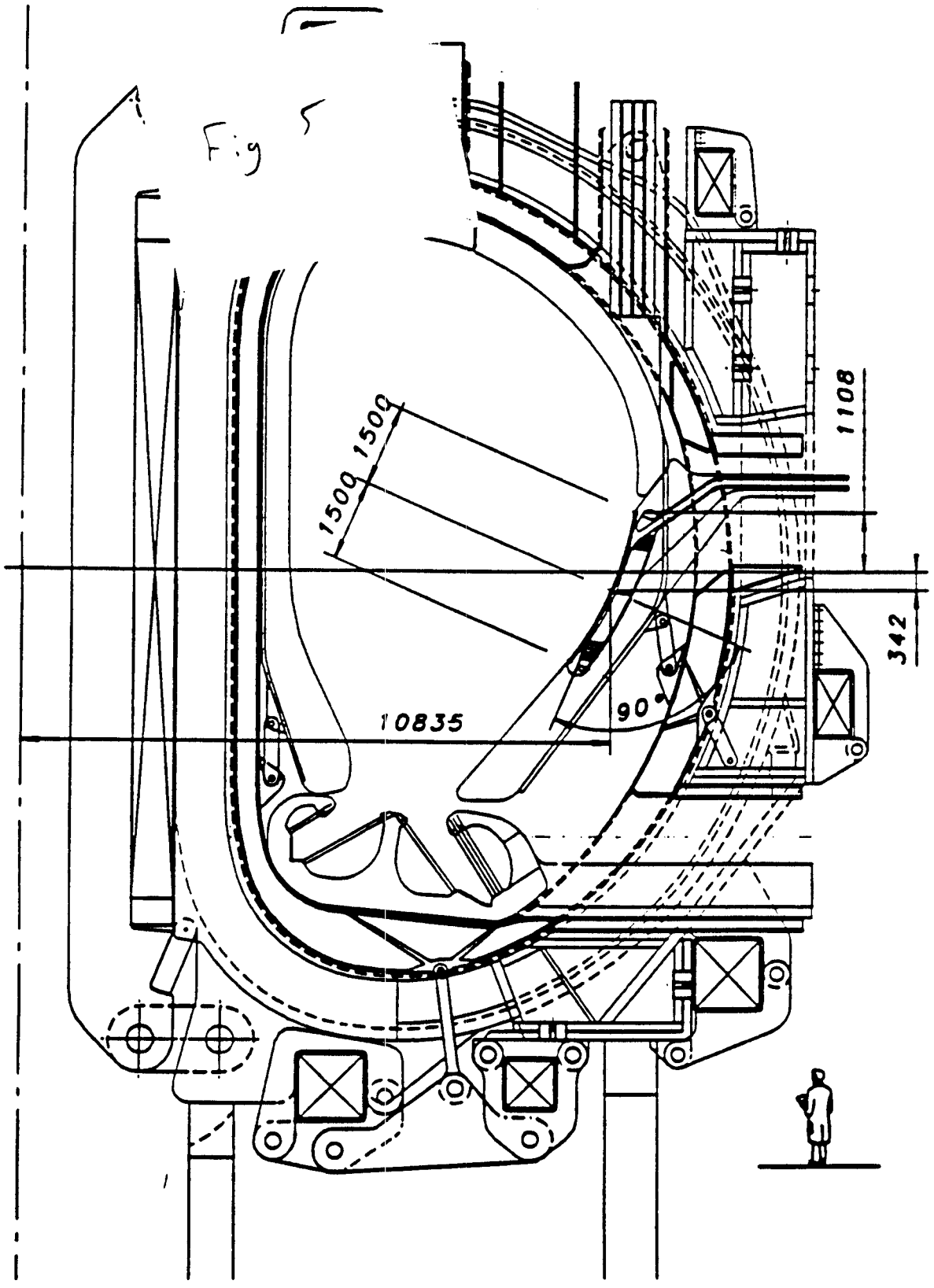


Fig. 5. Poloidal location of the ICRH/CD array

High power-density launchers

There are concepts for IC launchers that might provide significantly higher rf power to the plasma per unit area of launcher. The folded waveguide concept, shown in Figure 6, is one of these concepts. The advantage of higher power-density launchers would be a decreased need for first wall area.

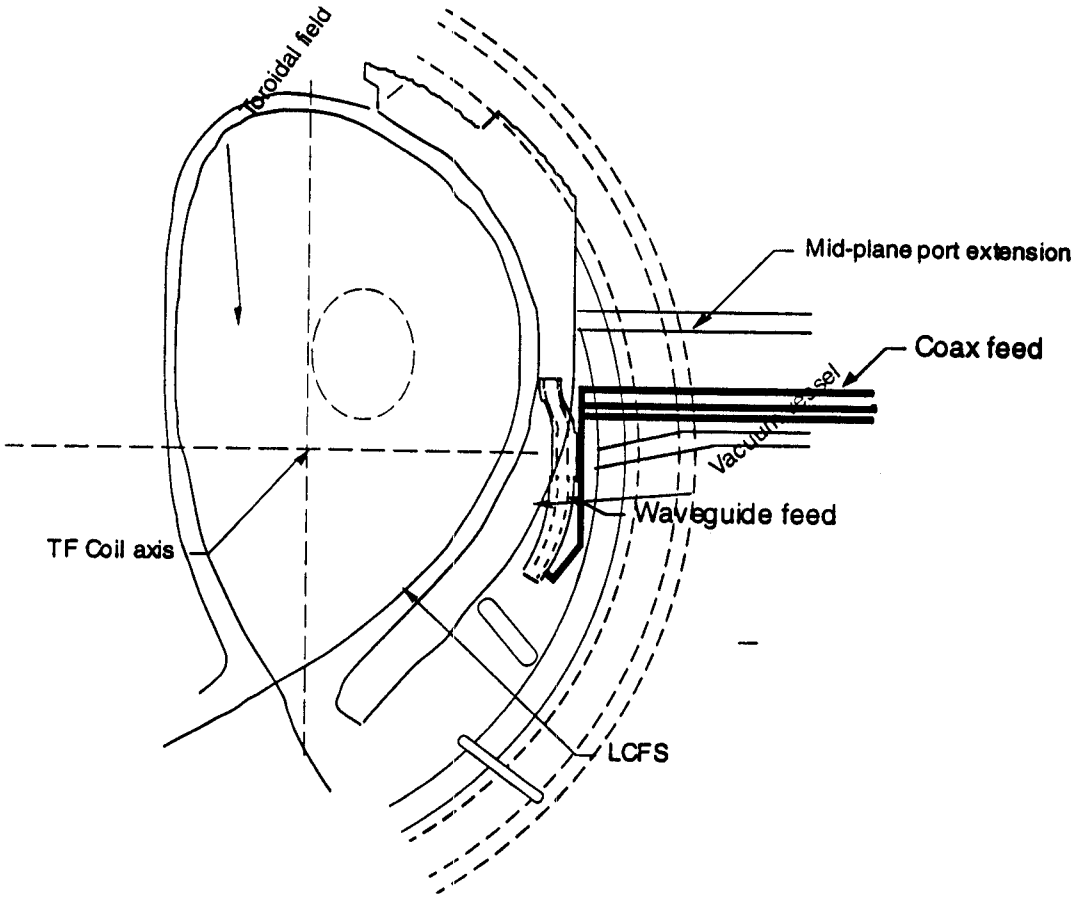


Figure 6. Folded waveguide launcher installed as ITER test item

The folded waveguide launcher could be used with some of the higher frequencies being planned for ITER (e.g., ≥ 80 MHz). Operation at significantly higher frequencies (100 – 200 MHz) could also be used for heating; this would require new rf power sources.

Advanced current-drive structures

Utilization of IC for steady-state current drive can be done with the present design of a separate set of independent launchers. However, a more efficient system might consist of a launcher system that would be specifically designed for current drive, such as the combline system. It might be

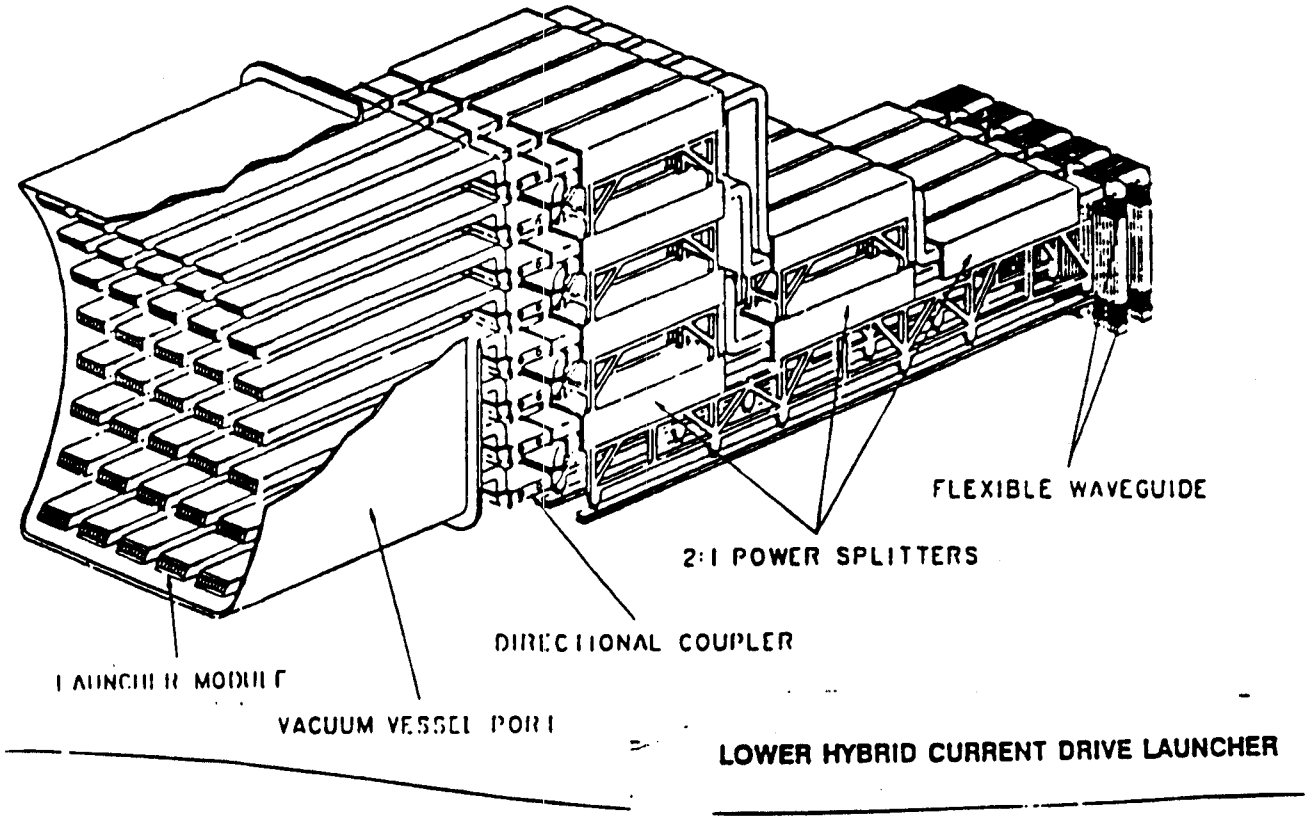


Figure 7. Conventional LH launcher for testing in ITER

Advanced LH launcher

One of the major disadvantages of present-day LH launcher designs (generally consisting of an array of waveguides near to the plasma) is the complicated structure and the need to have the launcher in the scrapeoff region of the plasma, and adjustable in location to maintain good coupling to the plasma. Several designs for launchers that can be more remote from the plasma have been proposed, although they have not been tested on actual tokamaks yet. If preliminary tests on other tokamaks prove their utility, these systems could be installed on ITER for further testing in a fusion device environment.

Electron cyclotron system

The electron cyclotron heating system has a simple launcher configuration. The present launcher design for ITER is fairly simple, but has a moving mirror in vacuum to switch between heating and current-drive launch. Possible other configurations could be tested, although the interface between the EC system and the tokamak/plasma is much simpler than those of the IC or LH systems.