Pellet Injection

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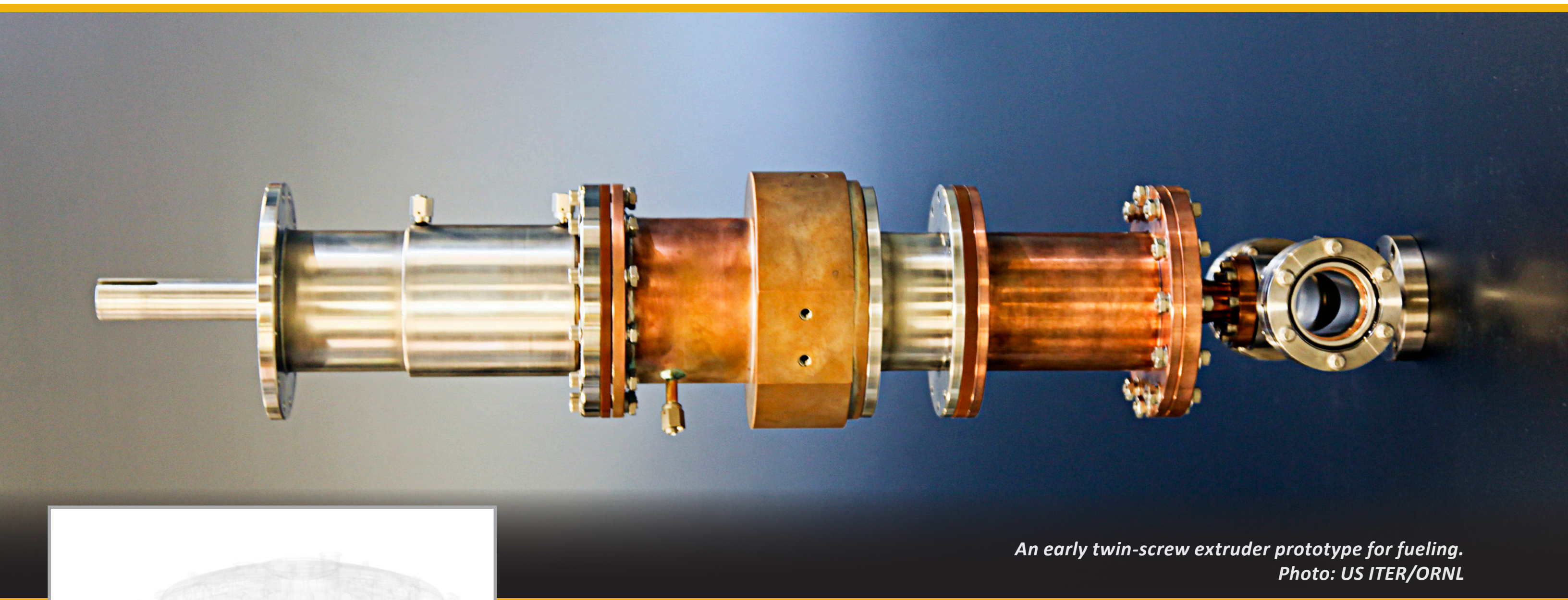
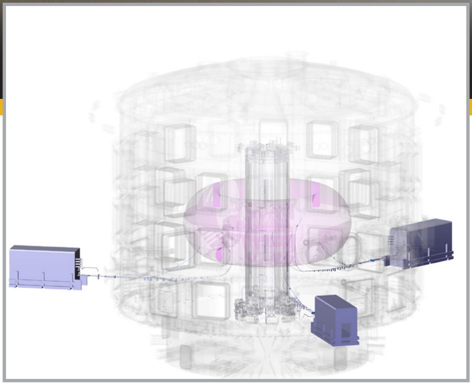


An early twin-screw extruder prototype for fueling.
Photo: US ITER/ORNL



Pellet injection design. Image US ITER

A dual-nozzle prototype was developed for fueling and ELM mitigation. Photo: US ITER/ORNL

US Contribution

The US is responsible for the R&D, design and fabrication of the pellet injection system.

Overview

The pellet injection system has three functions: providing a steady state supply of deuterium and tritium fuel; mitigating the impact of edge localized modes on the plasma-facing components; and providing impurity pellets for physics studies.

ITER will require significant fueling capability to operate at high density for long durations. Pellet injection, from the inner wall location, provides efficient core and edge fueling. The fueling injector will deliver hydrogen, deuterium, or a deuterium/tritium mixture, at up to 16 times per second, as required by plasma operations. The injector can also provide pellets to the outer edge of the plasma. Delivering small pellets to the plasma edge increases the frequency and reduces the intensity of edge localized mode instabilities, thus mitigating their impact on plasma-facing components.

1st Plasma Scope

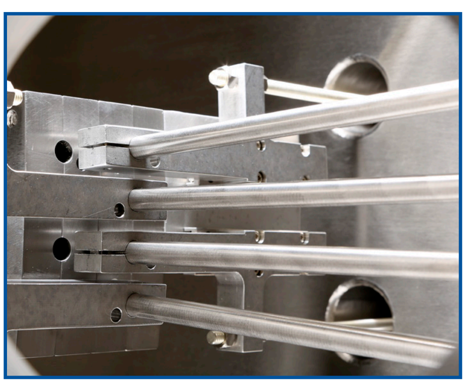
Perform R&D and design for the full system, and provide nine guide tubes that carry the pellets of frozen hydrogen, deuterium and tritium to the plasma for fueling and edge localized mode (ELM) mitigation, and impurity pellets of nitrogen, argon or neon for physics studies.

Status

Completed Preliminary Design Review of the flight tubes and cask. Final design of the pellet flight tube sections inside the plasma vacuum vessel is underway. Prototypes of the subsystems used to form, accelerate and guide the fueling and ELM mitigation pellets are being tested. Preliminary design of the cask enclosure that houses those pellet injection subsystems has been initiated.

Close-up view of the twin-screw extruder. Photo: US ITER/ORNL

Testing is performed at the ORNL pellet lab. Photo: US ITER



Internal view of a pellet guide tube selector test unit. Photo: US ITER/ORNL

Key Vendors

- Teledyne Brown Engineering (Huntsville, AL)

Technical Description

- **Number of injectors:** 2 at start-up, upgradeable to 6
- **Fueling configuration:** high field side pellet injection
- **ELM control configuration:** low field side and high field side pellet injection
- **Fueling pellets:** Deuterium (D), Deuterium/Tritium (DT) or Hydrogen (H)
- **ELM control pellets:** D, DT or H
- **Impurity pellets:** Nitrogen (N_2), Argon (Ar) or Neon (Ne)
- **Typical pellet volume for fueling:** 50 mm^3-92 mm^3
- **Typical pellet volume for ELM control:** 17 mm^3-33 mm^3
- **Typical pellet volume for Impurity pellets:** 50 mm^3
- **Maximum number of impurity pellets per pulse:** 5
- **Flow rate for fuelling:** 111 Pa m^3/s for DT (equivalent to 100 Pa m^3/s of pure Tritium) or 120 Pa m^3/ for H and D
- **Nominal pellet speed:** 300 m/s
- **Nominal pellet frequency for fuelling:** 4 Hz
- **Maximum pellet frequency for fuelling:** 16 Hz
- **Nominal pellet frequency for ELM control:** 45 Hz (upgraded configuration)
- **Maximum pellet frequency for ELM control:** 60 Hz (upgraded configuration)
- **Maximum injection duration:** 3000s

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