

Profile Reflectometer

n_e profiles and plasma position from small antennas: no large ports, no lasers.

NEXT STEP FUSION

WHAT IT IS

A profile reflectometer launches a frequency-swept microwave beam into the plasma. Each frequency reflects at the cutoff layer set by the local electron density and magnetic field, and the round-trip delay locates that layer, so sweeping the band yields the electron density profile. Non-perturbative, with no in-vessel calibration targets, no large ports, and no lasers: a robust, real-time density diagnostic for next-gen MCF devices and future FPPs. On-chip modules developed by UC Davis are the path to radiation-tolerant units.

WHAT YOU GET

- O-mode K/Ka (18–40 GHz) and X-mode Q/V (33–75 GHz) in one compact front end
- Full-band sweep in $\sim 20 \mu\text{s}$, faster than turbulent density fluctuations
- $\sim 0.5 \text{ cm}$ spatial resolution; transients such as ELM crashes and pellets resolved
- Phase-locked oscillators and hardware IQ detection: robust at low signal-to-noise
- Physics-informed reconstruction of the full profile where field and density block reflectometry

HOW IT WORKS

We derive the frequency plan, polarizations, antennas, and port geometry from your field, density, and access constraints with our synthetic diagnostics and design tools (SynthDia, TRAVIS ray tracing). Where high fields and densities in next-gen MCF devices and future FPPs leave part of the profile unmeasurable, we are developing physics-informed neural networks to reconstruct the full profile in real time.

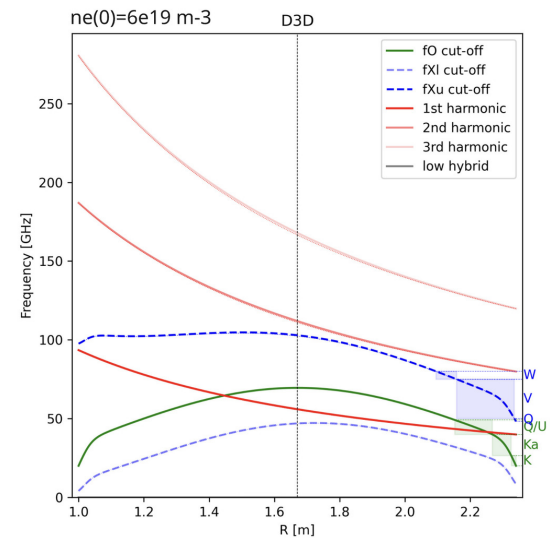


Fig. 1. Frequency band selection for the DIII-D prototype at a central density of $6 \times 10^{19} \text{ m}^{-3}$: O-mode and X-mode cutoff profiles with the K, Ka, Q, and V probing bands placed clear of the electron cyclotron harmonics.

PROOF

The prototype passed its DIII-D physics validation review in 2026 as part of a joint ECE and reflectometer port-plug unit for TCV and DIII-D, and restores a profile reflectometry capability at DIII-D. Plasma tests are planned on TCV in early 2027 and on DIII-D in spring 2027. Our team brings multi-band reflectometry experience from JET, EAST, DIII-D, ASDEX Upgrade, and ITER. Confinement-state classification with a profile reflectometer for FPPs is published in Nuclear Fusion with UC San Diego and UCLA.

Our mission is to accelerate fusion companies by bridging world-class science with deployable, industry-ready solutions.

Next Step Fusion is a specialized fusion supply chain company, founded in 2023, with its HQ in Luxembourg, a UK office, and a distributed team across Europe.



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