

ECE Radiometer

Absolute T_e profiles measured and reconstructed in real time on a system-on-chip backend.

NEXT STEP FUSION

WHAT IT IS

Electron cyclotron emission (ECE) radiometry is the workhorse electron temperature diagnostic of MCF devices: electrons emit at harmonics of the cyclotron frequency, so each received frequency maps to a known radius. A calibrated radiometer delivers localized, absolute temperature profiles in real time, ready for plasma control: non-perturbative, with no in-vessel calibration targets, and reliable in high magnetic field and neutron environments. Our backend is a millimeter-wave system-on-chip developed by UC Davis and proven on DIII-D.

WHAT YOU GET

- Absolute T_e profiles at 100 μ s resolution, stand-alone calibration
- On-chip backend: over 30 dB gain, 0.1 nW detectable, 120 channels in one rack
- Chip family from 50 to 220 GHz for devices up to 6 T; radiation-hard GaN tested
- Physics-informed reconstruction of the full profile where field and density block ECE
- Standalone, or in one Modular Diagnostics Platform port plug with our reflectometer

HOW IT WORKS

We derive the frequency plan, channels, 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.

PROOF

The on-chip backend by UC Davis runs the ECE imaging system on DIII-D, maintenance-free for seven years. We are developing a prototype ECE radiometer and profile reflectometer in one port-plug unit, to be tested on TCV in early 2027 and on DIII-D in spring 2027, including Versatile Integrated Data Acquisition software and physics-informed neural networks for real-time T_e and n_e profile reconstruction. The prototype passed its DIII-D physics validation review in 2026, and the concept was presented at the International Reflectometry Workshop and the International Conference on Frontiers in Diagnostic Technologies.

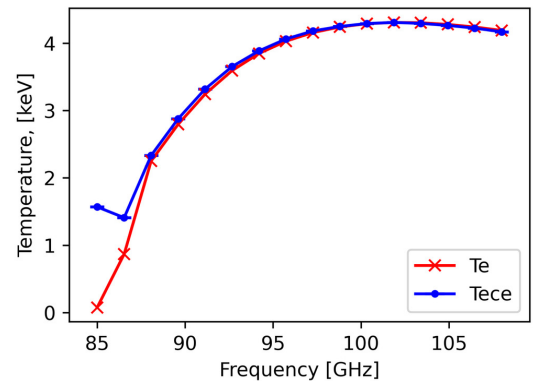


Fig. 1. Synthetic ECE validation for a DIII-D reference discharge (TRAVIS ray tracing): the simulated radiometer measurement (blue) reproduces the model electron temperature profile (red) over 85–108 GHz. Below: W-band on-chip receiver module with horn antenna, developed by UC Davis.

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.



Next Step Fusion S.à r.l. · 33 Rue du Puits Romain, L-8070 Bertrange, Luxembourg
info@nextfusion.org · nextfusion.org

