We measure deposition profiles 1.5 to 3.5x wider than TORAY predictions in six DIII-D discharges

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Introduction

- ECH is responsible for many tasks where its narrow deposition width is crucial
- The standard for determining the deposition profile is beam/ray-tracing
- Several studies have shown discrepancies between beam/ray tracing and measured profiles [1,2]
- We aim to measure this discrepancy using new, advanced methods

Method

We obtain the results by:

- Analyzing temperature fluctuations (A) resulting from a modulated ECH source (B)
- Applying advanced filtering (C) and data processing techniques (D) [3,4]
- Using the well-know break-in-slope (BIS) method [5] to estimate the deposition profile
- Using three different state-of-the-art estimation methods (MLE, FDLS, FF) [6,7,8] to compare against BIS

Tab. 1: An overview of the different estimation methods applied in this work

Criterium	Method: BIS	MLE	FDLS	FF
Includes transport	✗	✓	✓	✓
Analysis domain	Time	Frequency	Frequency	Frequency
Perturbation shape	Square/ step	Any	Any	Any
Optimization type	-	Maximum likelihood	Ordinary LS	Nonlinear LS
Optimization method	-	Gradient-based	Direct evaluation	Gradient-based
$\int dx$(data)?	✗	✗	✗	✓
$\frac{d}{dx}$(data)?	✗	✗	✓	✓
$\frac{d}{dt}$(data)?	✓	✗	✗	✗
Imposes profile shape	✗	✗	✗/✓	✓
Contains error bounds	✗	✓	✓	✗
Type of error estimation	-	Fit residual	Fit residual	-

Results

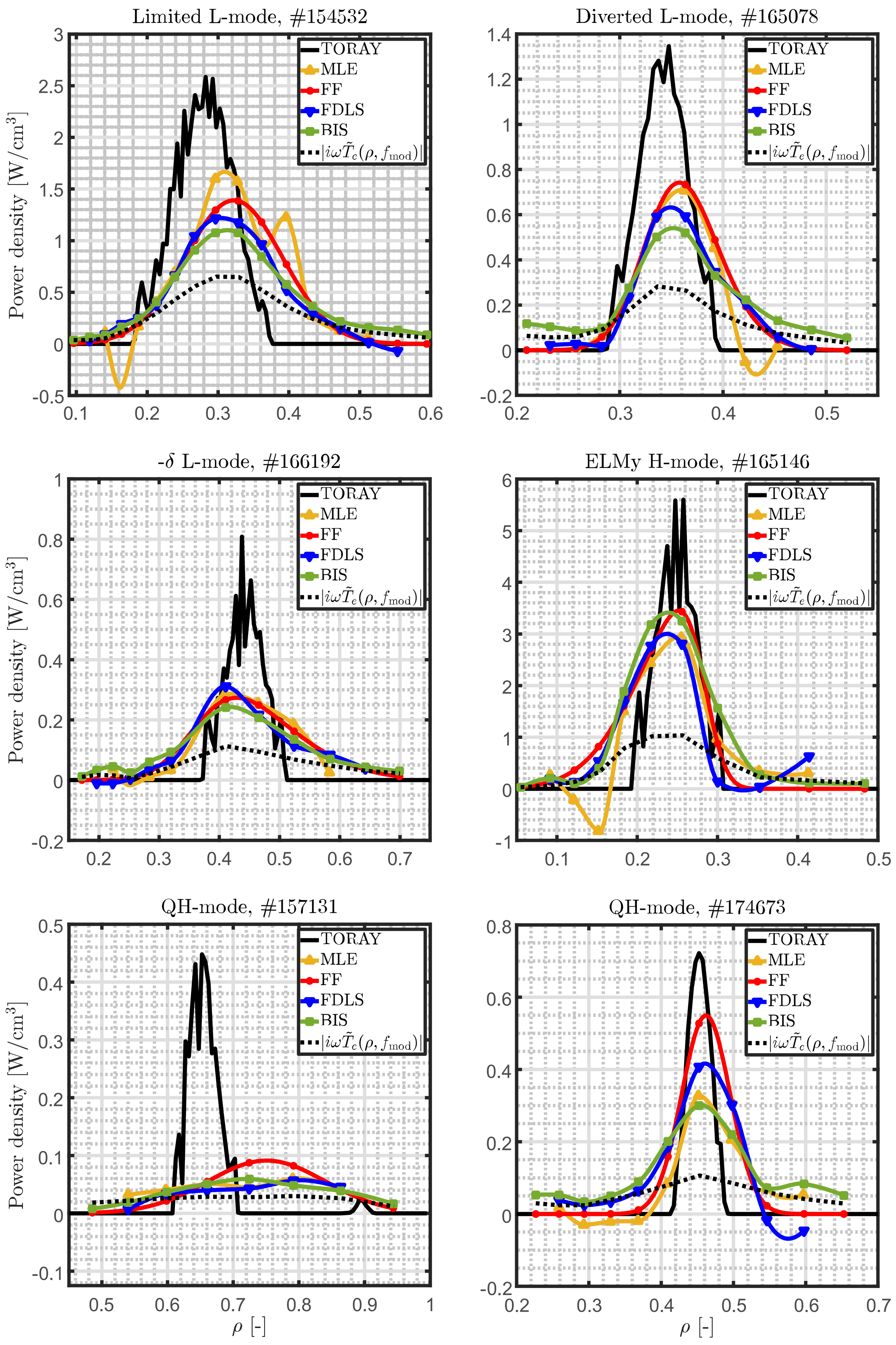
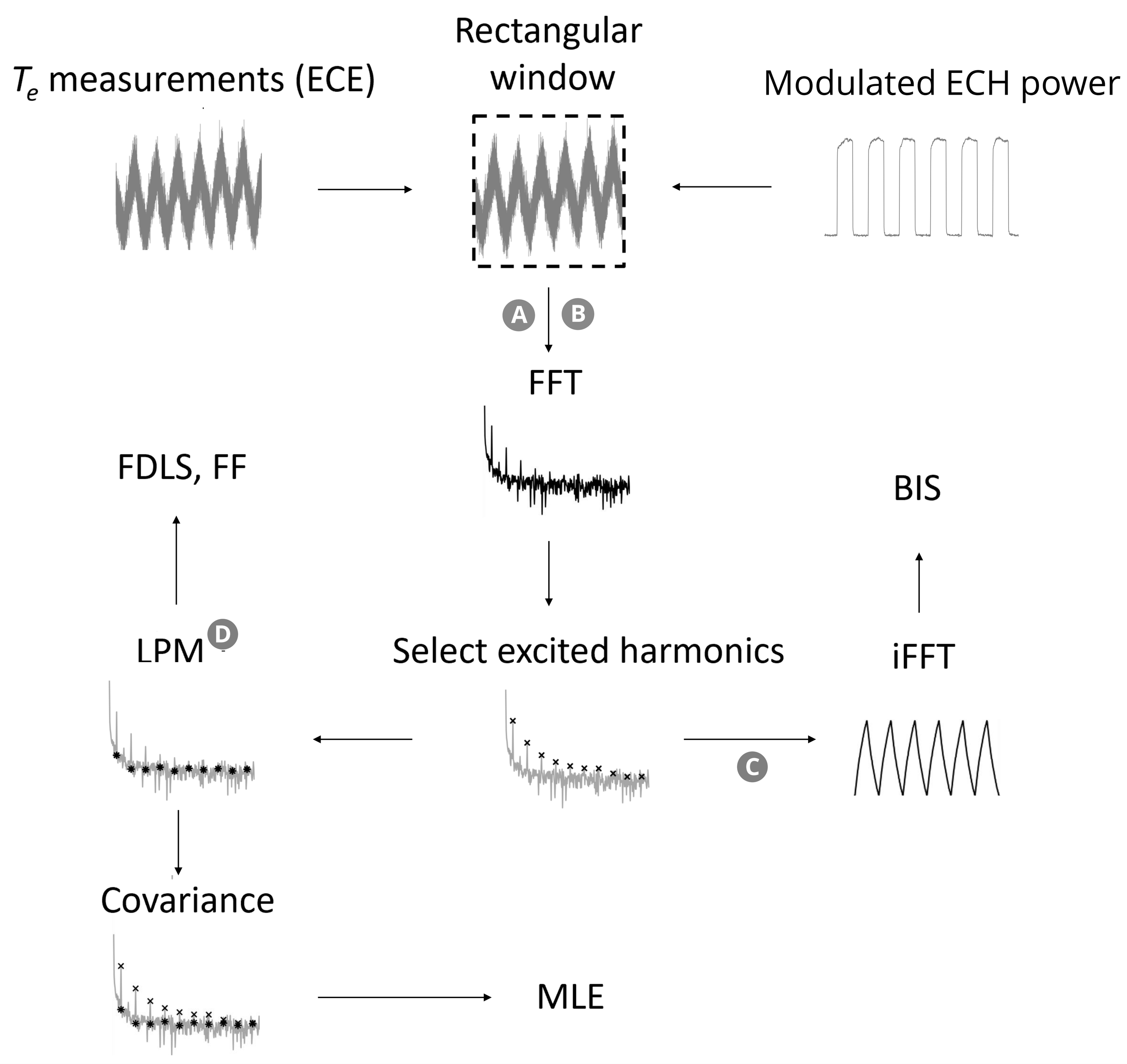
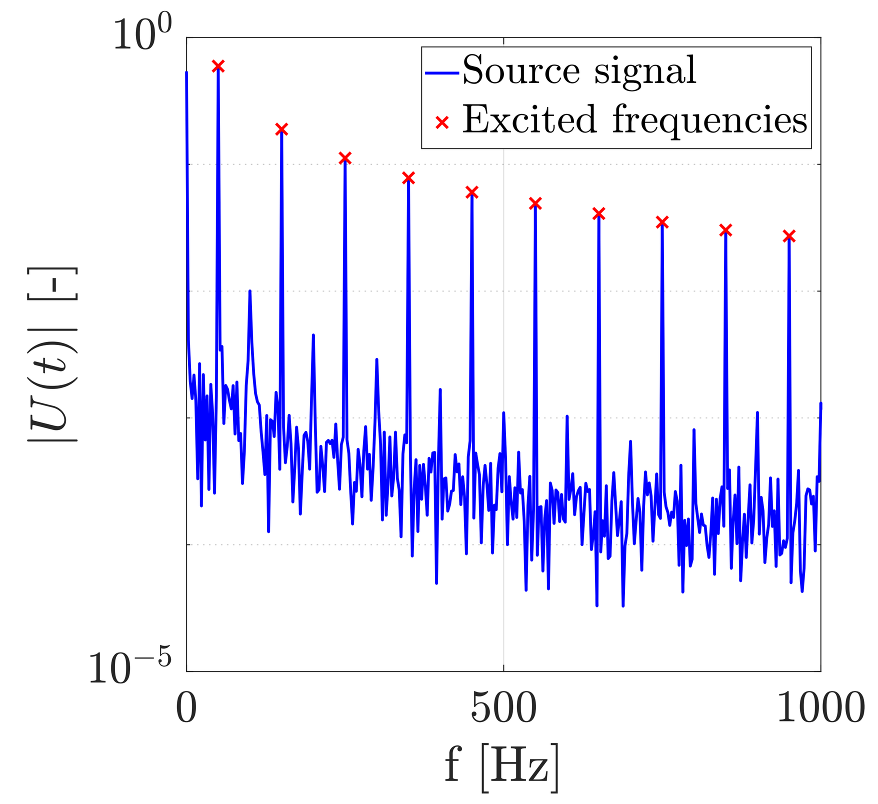


Fig. 2: Measured ECH deposition profiles for six DIII-D discharges using 4 different techniques, compared against TORAY estimates

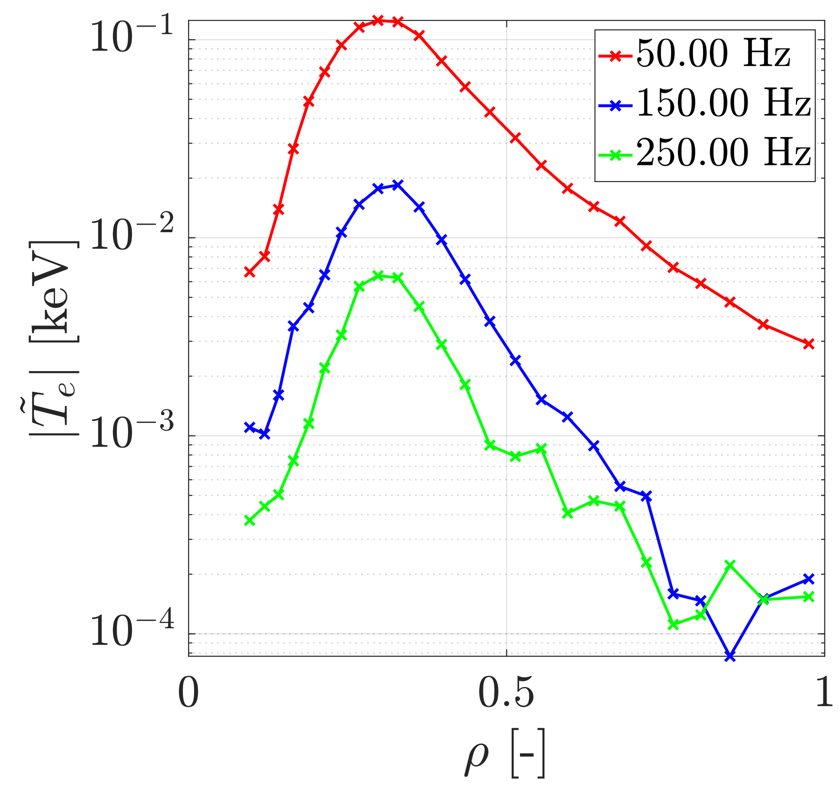
Fig. 1: Data processing



Data



(A) **Fig. 3:** The Fourier spectrum of the perturbing source signal *U(t)*, approximately a square wave



(B) **Fig. 4:** The Fourier spectrum of the perturbed electron temperature

Conclusions

- We can measure the deposition profile
- We measure broadening between 1.0 – 3.5 times over TORAY predictions
- This may have implications for ITER in e.g. NTM control
- We have not investigated what causes the broadening

Quantifying electron cyclotron power deposition broadening in DIII-D

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