EUROfusion

On the technical aspects of the JET DT 99896 IMAS dataset

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JET

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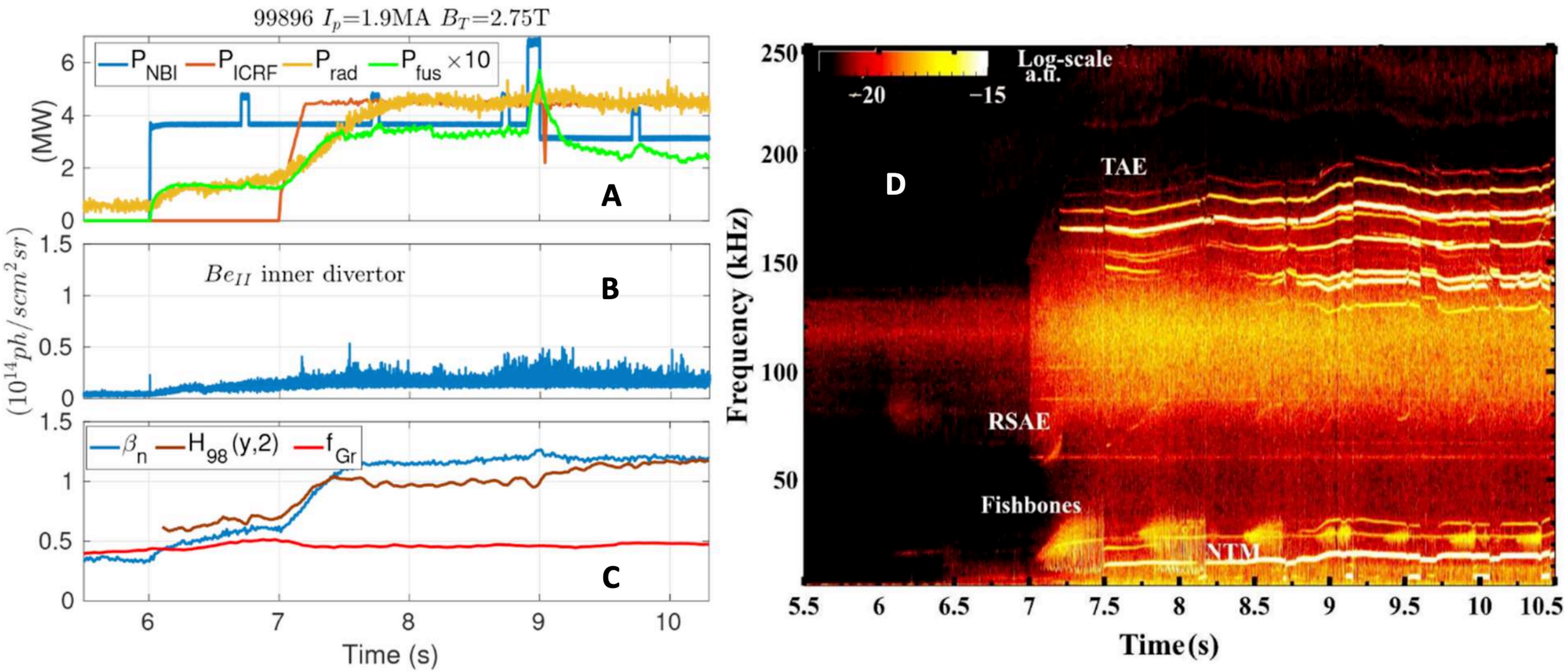
JET Stable Deuterium-Tritium burning plasmas with improved confinement



- described in https://arxiv.org/pdf/2309.11964.pdf
- 50/50 DT (actually ~58/42), BT = 2.75 T, Ip = 1.9 MA, q95 = 4.5
- mainly heated by ICRF = 4.5MW. PNBI ~ 3.5MW, D beams < 9 s and T > 9s. P_fusion ~ 0.5MW

MHD instabilities

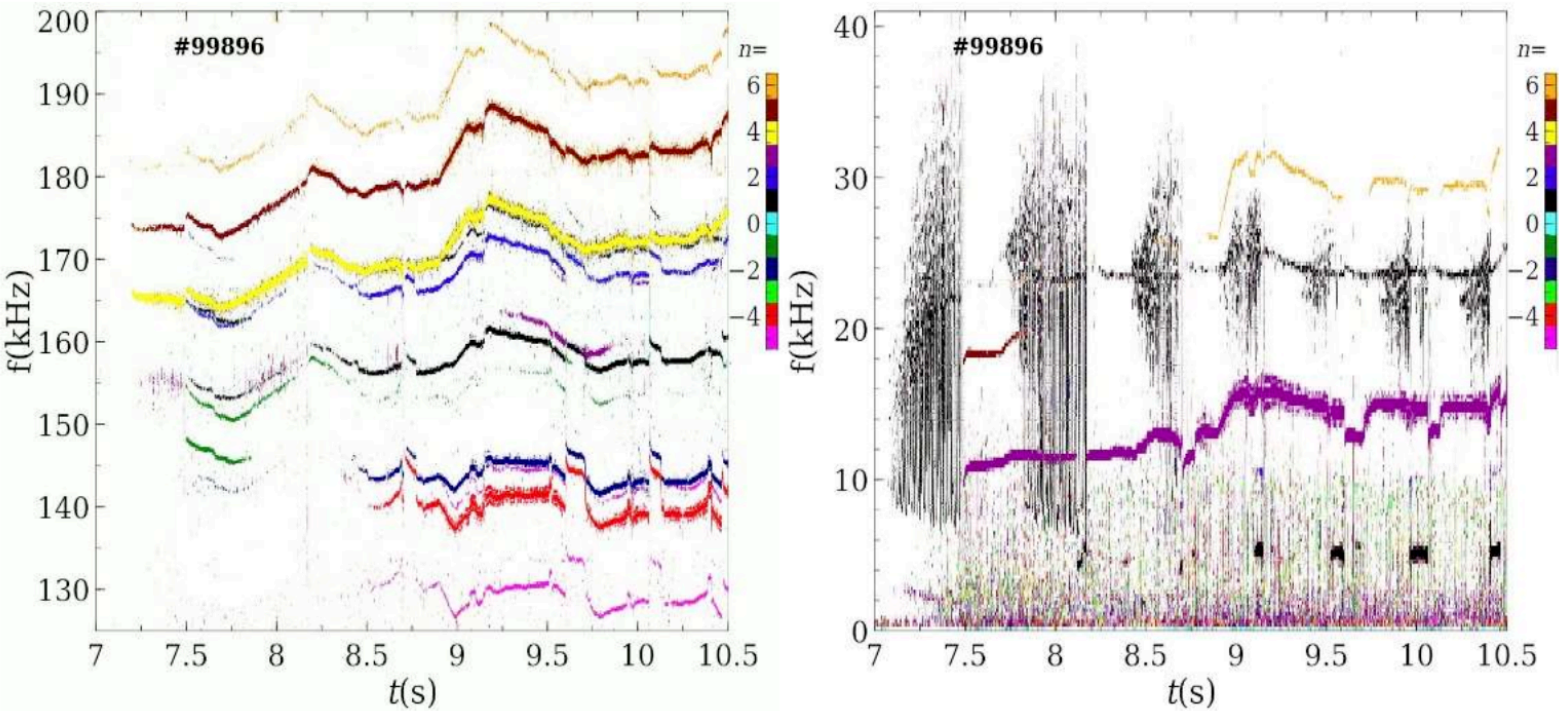


Fig. S1. High frequency spectrogram for the D-T discharge 99896 (left) Low frequency spectrogram for the D-T discharge 99896 (right).

from Jeronimo Garcia supplementary material

MHD instabilities

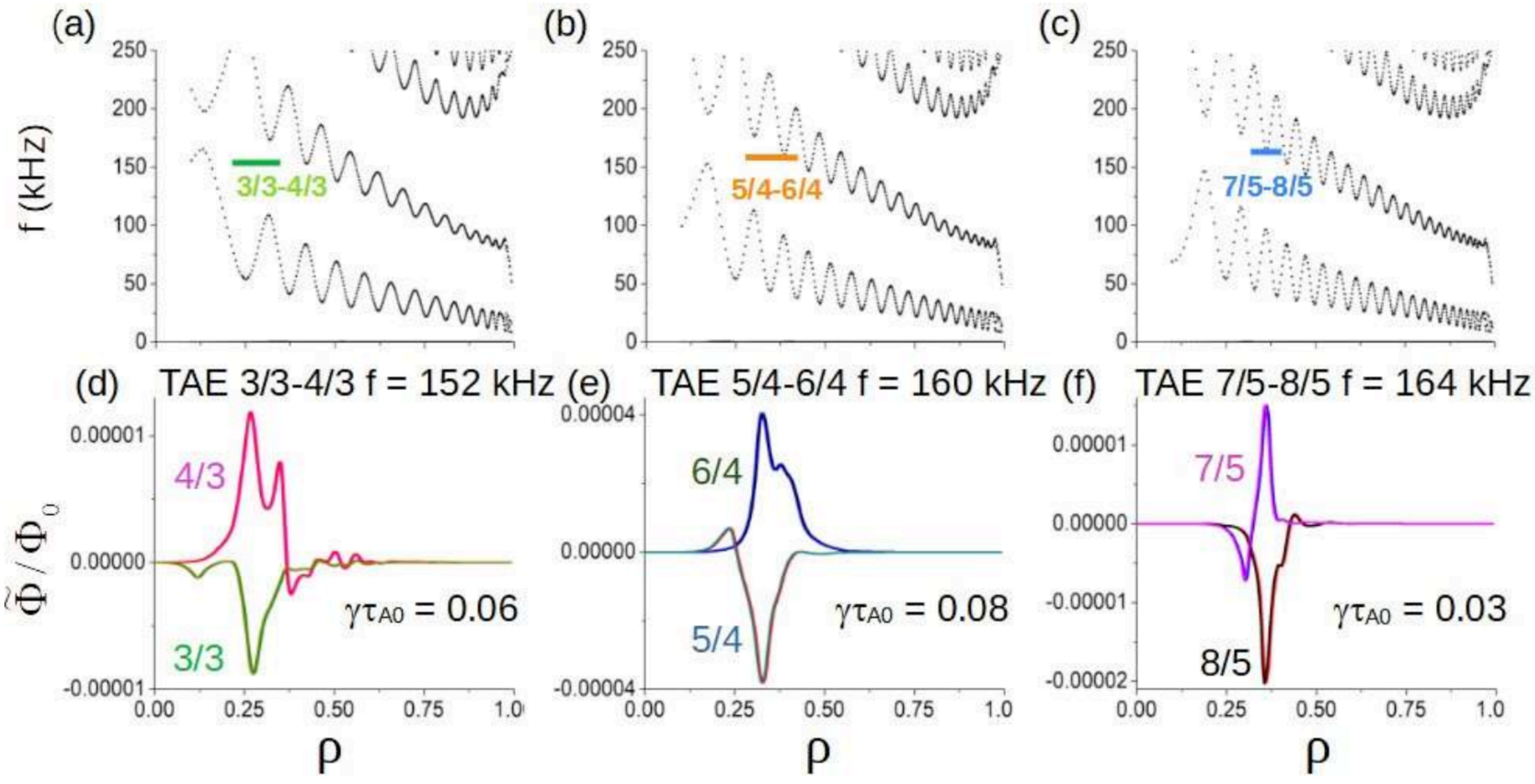


Fig. S3. Eigenfunctions of the electrostatic potential fluctuations, Φ, obtained from linear FAR3D simulations and comparison with the gap in the Alfven continuum. The toroidal modes n=3,4,5 with different poloidal mode numbers are obtained. γ is the mode growth rate, τ_{A0} is the Alfvén time and $\Phi_0 = a^2 B_T/\tau_{A0}$ with a the plasma minor radius.

from Jeronimo Garcia supplementary material

Data validation and mapping - TRANSPP simulation

Typical workflow to get a good set of representative plasma states

- As usual in JET, after data validation, good equilibria reconstruction is found by doing a loop between the EFIT code and the TRANSP code. The main goal of this procedure is to take into account the fast pressure calculated with NUBEAM/TRANSP into the Grad-Shafranov equilibrium.

- Data is mapped from the laboratory frame into these magnetic coordinates. Typically, HRTS for thermal electrons (density + temperature), CXRS for thermal ions (temperature and rotation), Zeff to model impurities (important for the assessment of ion dilution)

- TRANSP is run “interpretatively” to get sources and transport coefficients from balance equations.

JPN 99896 IMAS dataset based on TRANSP simulation 99896M05

TRANSP simulation highlights

- Simulation window: 6.123 s -> 11.976s with around 300 timeslices.

- current diffusion + GS equations are solved throughout the simulation to get a consistent equilibrium with the interpretative thermal state + the simulated fast content (ICRH + NBI)

- Impurities, here Beryllium and Nickel, are assumed to be fully stripped and matched against the measured averaged Zeff

- TRANSP is run “interpretatively” to get sources and transport coefficients from balance equations.

- NBI is modelled with NUBEAM, a Monte Carlo code, and includes synergy with ICRH (kick-operator). See how it is used in JET here: https://pubs.aip.org/aip/acp/article/2254/1/030011/795419/Synergistic-ICRH-and-NBI-heating-for-fast-ion

- H-minority ICRH is modelled with TORIC

Data translation into IMAS (IDS)

Workflow used for the data translation from TRANSP -> IMAS

- WPCD are used to convert **TRANSP output** data into the **ITM CPOs** data structures, and then into IDS using a **CPO2IDS** translation tool. (A direct TRANSP to IMAS translation tool is currently in development, and we should use it when ready)

- Several IDSs are produced and these can be found @ the JET DATA CLUSTER here:

/common/ETS/users/jmsfer/public/imasdb/JET/3/0/ids_99896000*.*

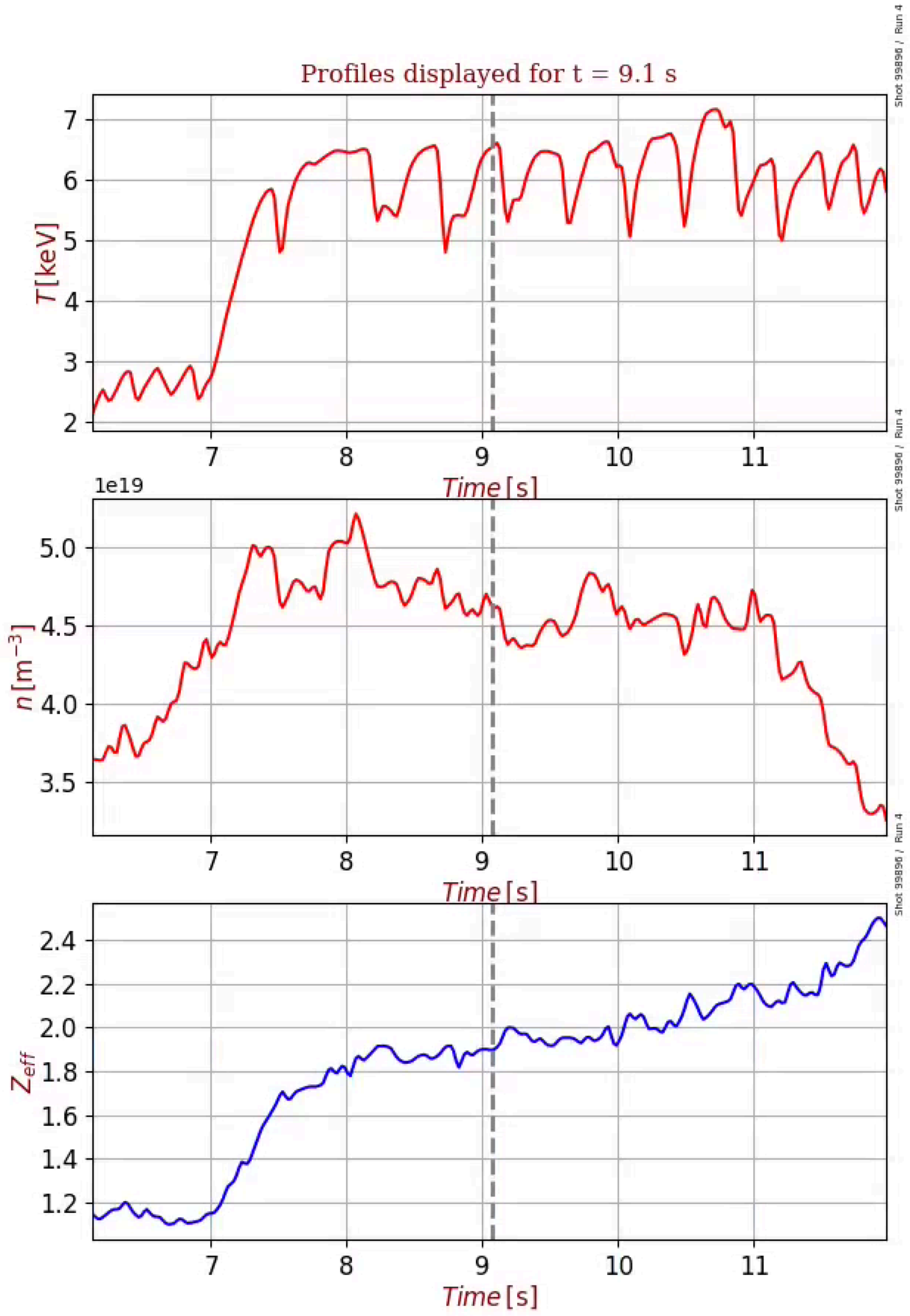
(Use the highest run number, currently run #4)

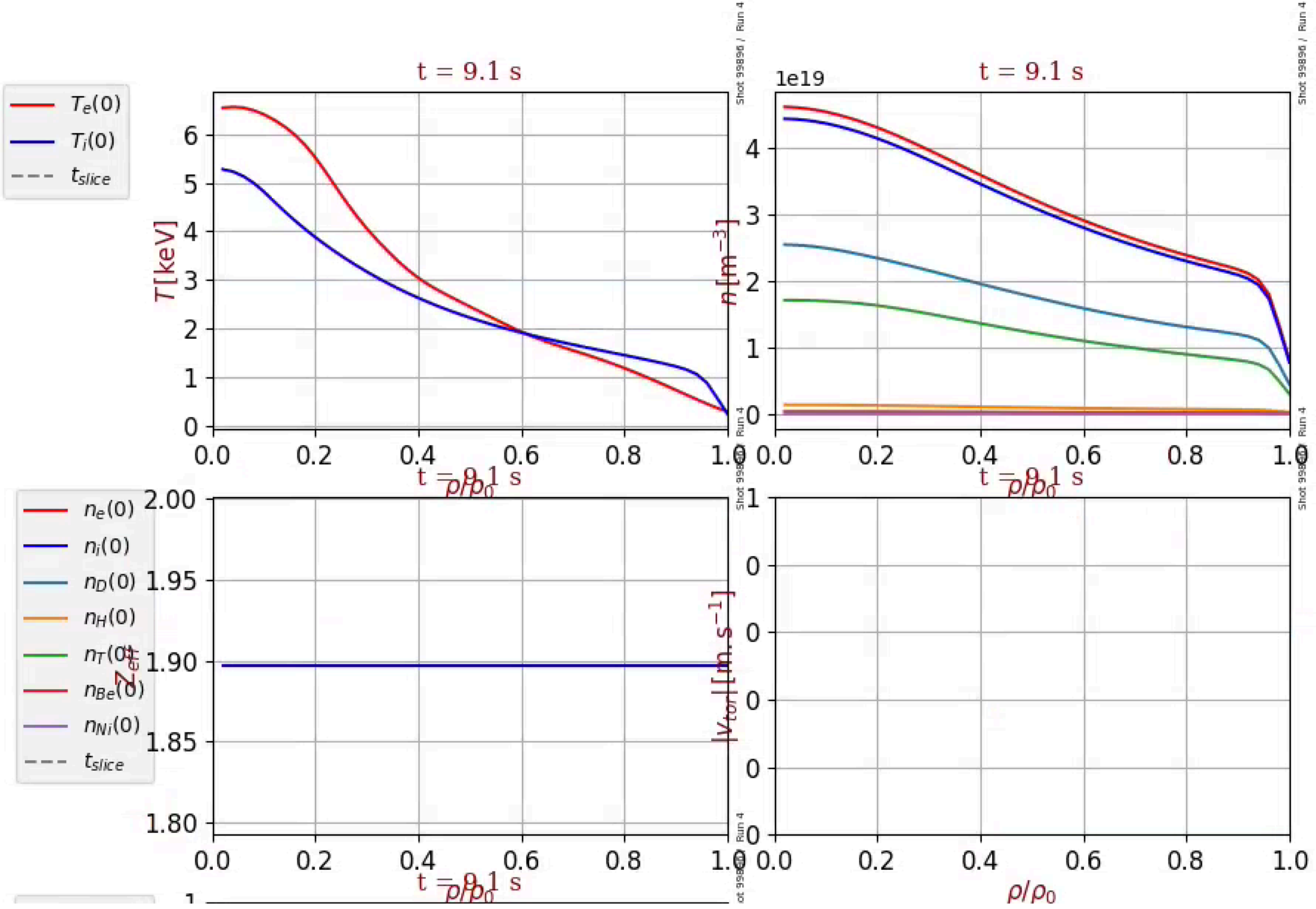
- The most important IDSs for MHD and gyrokinetics are the **equilibrium** and **core_profiles**, which store plasma states for hundreds of time slices. They should contain all the data needed for MHD or gyrokinetic modelling.

- Other IDSs such as **core_sources**, **core_transp**, **ec_launchers**, **nbi** and **wall**, are partially fielded with the minimum data needed by the IMAS transport codes such as ETS or JINTRAC/HPFS for transport modelling. Any potential user should contact me before using them.

Typical data available in the IMAS IDSs

Thermal plasma state



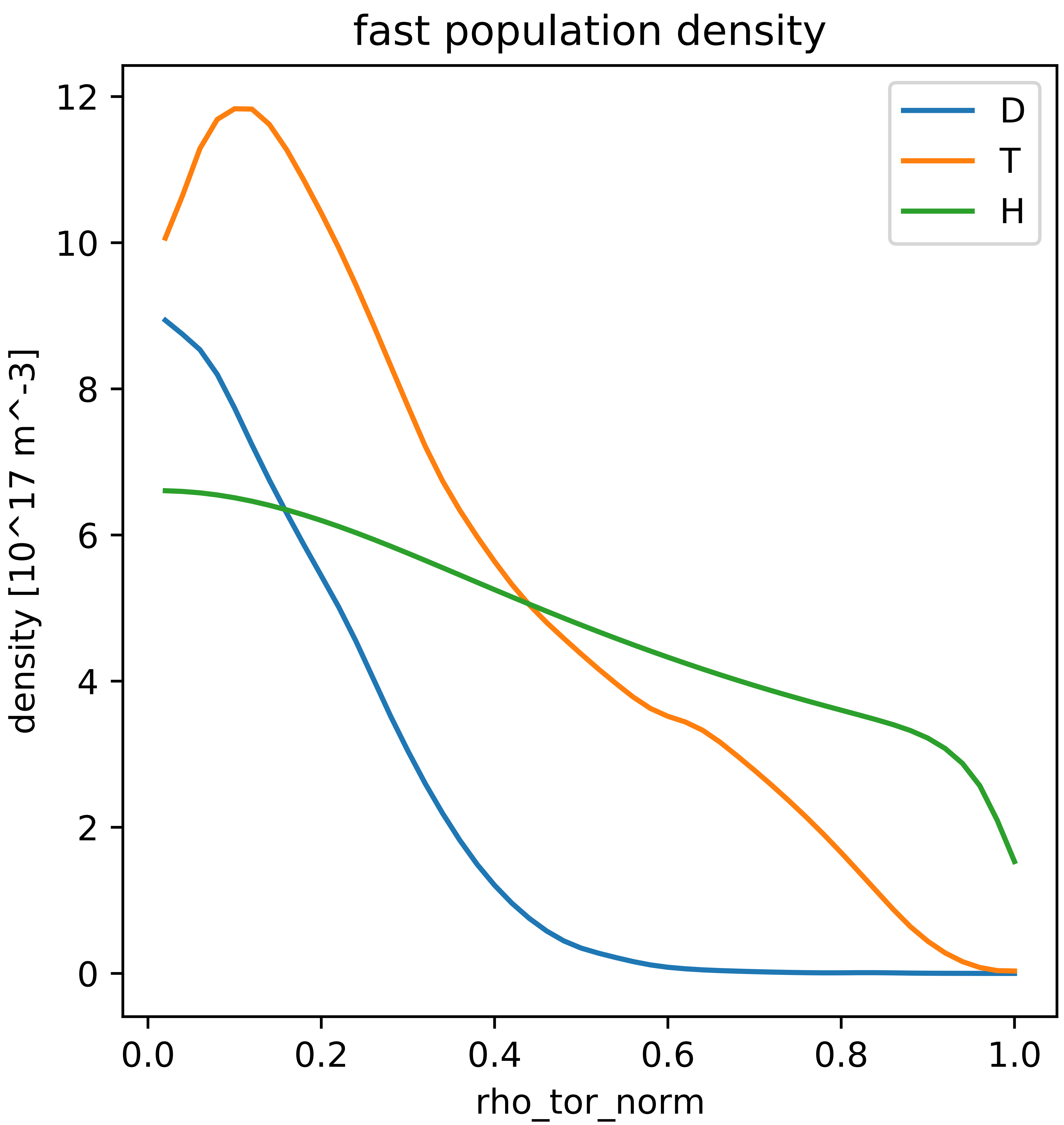


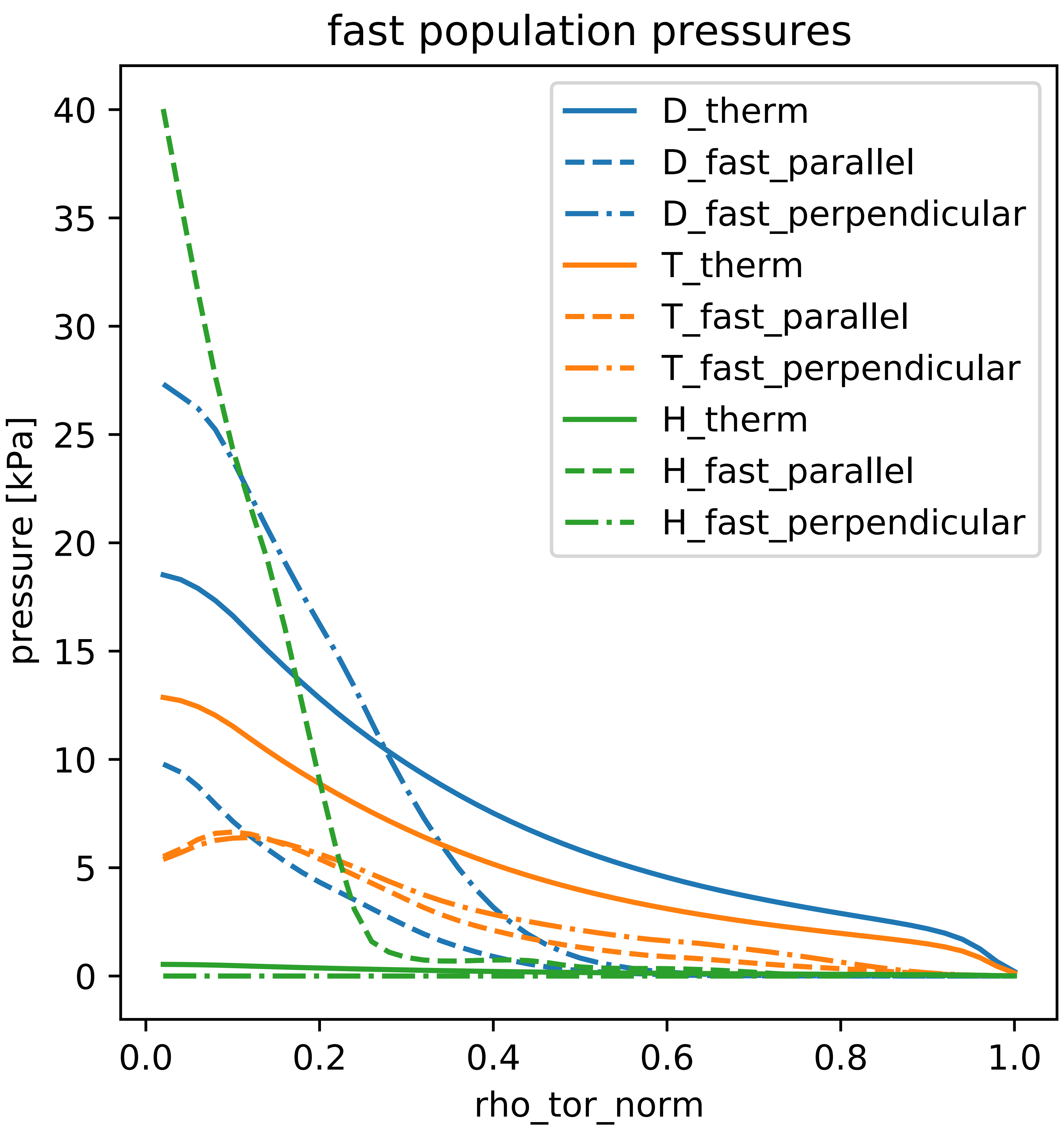
generated with IMAS kinplot tool

Typical data available in the IMAS IDSs

No-thermal plasma state - (1D profiles)

Time = 9.1s





Future enhancements to the JPN 99896 dataset

- Fix H-minority fast pressures (in particular issues with perpendicular component)
- Agree on how TSVV-10 IMAS codes will read NBI 4D distributions and push these distributions using (R,Z, vpar, vper) or COMs coordinates into the distribution IDS
- Add operational data such as injected NBI beam power and energy, and ICRF power and wave frequency

Thank you