# OVERVIEW OF THE TJ-II STELLARATOR RESEARCH PROGRAMME TOWARDS MODEL VALIDATION IN FUSION PLASMAS

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**ON BEHALF OF THE TJ-II TEAM AND COLLABORATORS**
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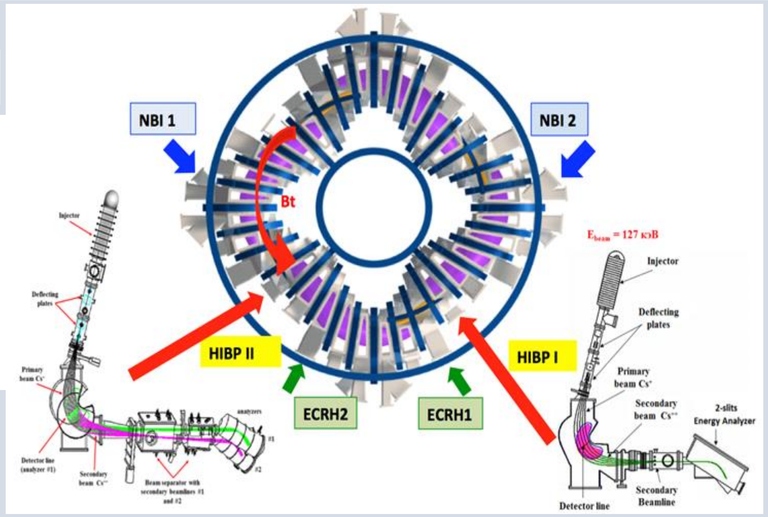
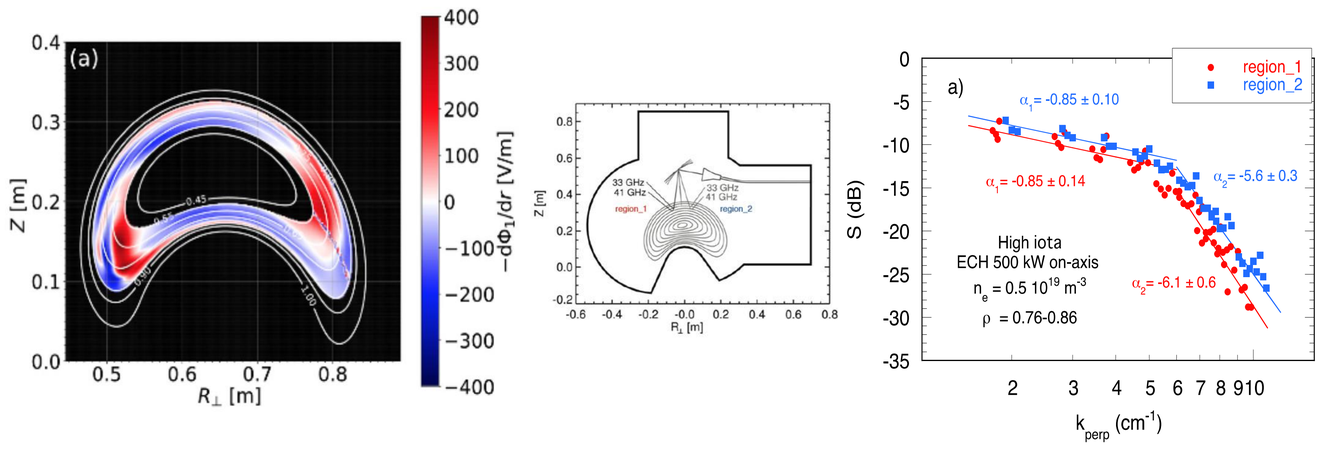
## TJ-II research areas

- Transport and asymmetries
- Physics of plasma fueling
- Fast particles: actuators and stability
- Turbulence control: Zonal Flows
- Edge – SOL coupling physics
- Power exhaust



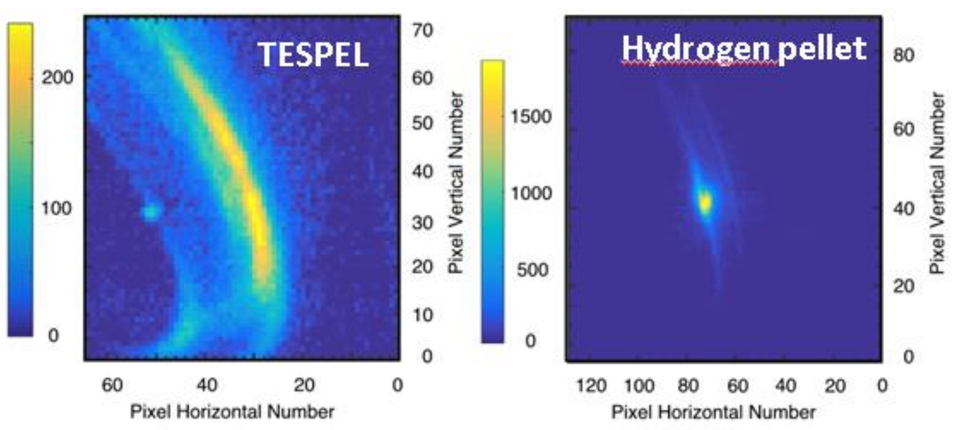

## 1. TRANSPORT AND ASYMMETRIES




Predicted poloidal asymmetries in radial electric field (Er) are comparable to those found in the experiments [Doppler reflectometry].
T. Estrada et al., NF-2019; E. Sanchez et al., NF-2019

Different intensity in the density fluctuation spectra can be related to the poloidal locatlization of instabilities found in GK simulations.
T. Estada et al., NF-2019; E. Sánchez et al., NF-2019 / IAEA-2021

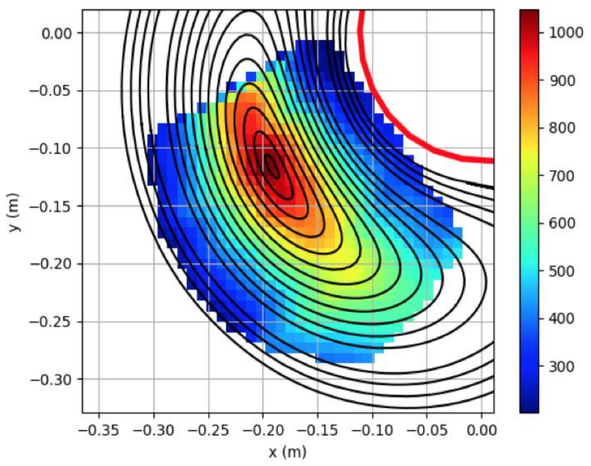
## 2. PLASMA FUELING

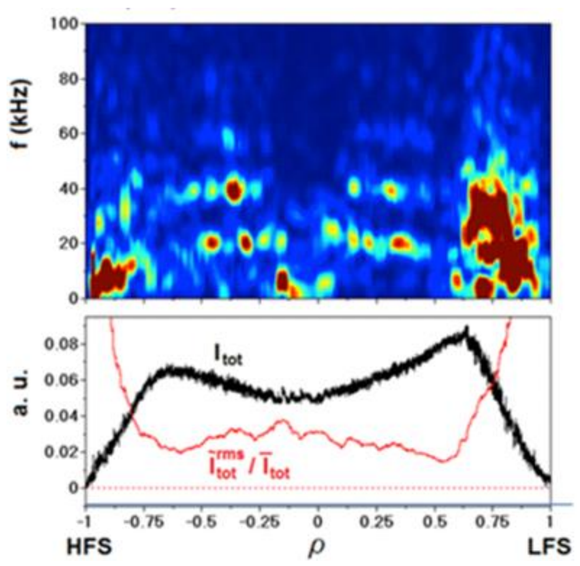



Zonal Flows arise/interact from/with turbulence self-organization and could act asPost-injection particle radial distributions can be understood qualitatively from neoclassical predictions. BUT pellets can also impact strongly MHD plasma stability and plasma turbulence [N. Panadero et al., NF-2018 / K. McCarthy et al., IAEA-2021].

Enhanced pellet ablation due to fast-electron impacts can lead to higher fuelling efficiencies (<40%) [K. McCarthy et al., PPCF-2019 / IAEA-2021]

Comparisons with HPI2 simulations have revealed that interactions between outward drifting pellet material and a resonant surface can lead to the abrupt deceleration and hence reduced pellet material loss [K. McCarthy et al., NF-2021 / IAEA-2021].

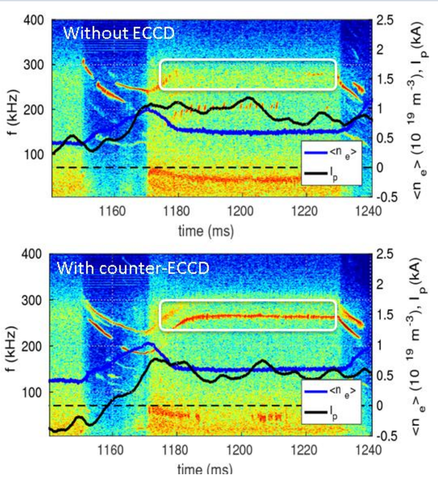


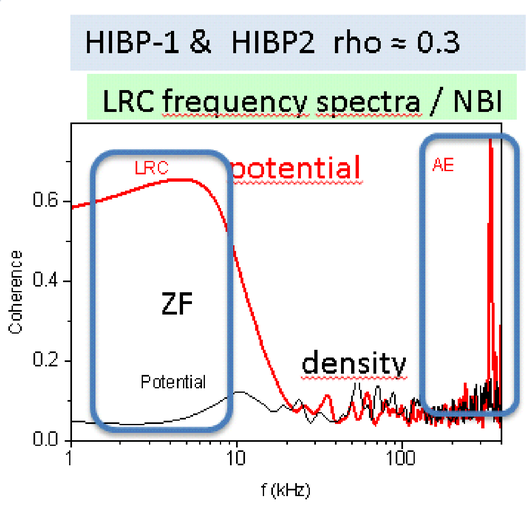




2-D mapping of plasma potential and density paves the way for model validation under positive and negative density gradient scenarios and asymmetries [Melnikov et al., EPS-2021].

Density fluctuations appear both at the positive and negative density gradient regions being stronger in the negative gradient region in agreement with TEM GK simulations [Sharma et al., PoP-2020].

## 3. FAST PARTICLES

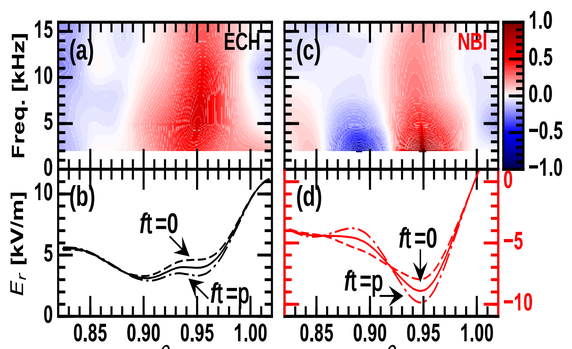


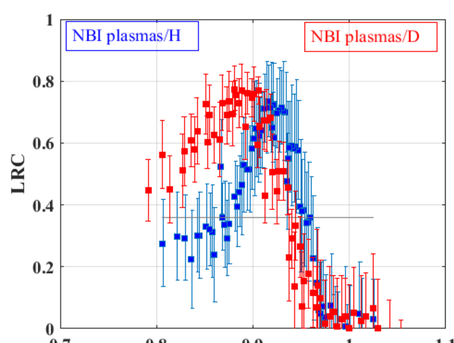




The impact of ECRH and ECCD has been investigated demonstrating a clear effect of ECCD on the observed AE mode spectrum [A. Cappa et al., IAEA-2021].

LRC are observed in potential fluctuations but not in density fluctuations [i.e. ZF-like structures]. It is an open question whether those ZFs can be directly driven by fast particle effects.

## 4. ZONAL FLOWS

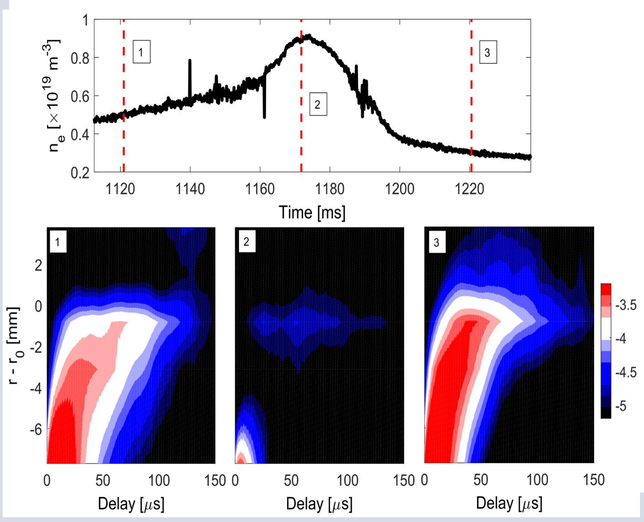



The radial width of LRC is strongly affected by plasma heating and isotope mass [Losada et al., PPCF- 2021 / IAEA-2021]

Amplification of ZFs in the vicinity of the density limit [D. Fernández-Ruiz et al., NF-2021]

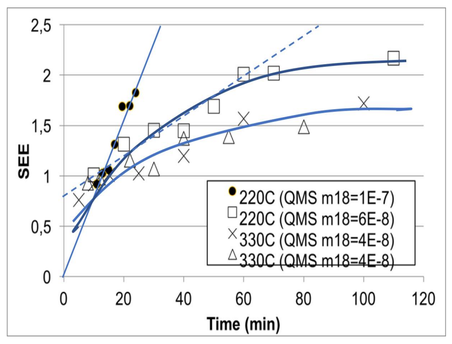
## 5. EDGE – SOL COUPLING

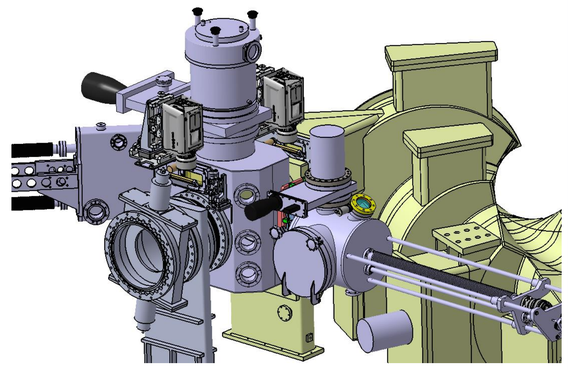



Turbulence radial spreading controlled by edge radial electric fields has been experimentally identified during the electron-ion root transition and edge biasing [Grenfell NF-2019 / NF-2020].

The radial electric field was also found to have a profound impact on turbulence intermittence [B. van Milligen et al., NF-2020]

## 6. POWER EXHAUST



**Secondary electron emission in Liquid surfaces**

- ✓Oxidation of Li leads to an increase in the SEE yield. Annealing of the Li sample at 500 $^0$C was enough to revert the values to those corresponding to clean surfaces.
- ✓These results have a direct impact on the development of LM-based divertor targets in fusion [E. Oyarzabal et al., Nucl. Mater. and Energy 2021].

**D retention**

- ✓ It was concluded that an exponentially decaying retention as the First Wall temperature is increased takes place, with negligible D/Li ratios at T>350ºC [A. de Castro et al., NF-2018 / E. Oyarzabal et al., NF-2021].

The **OLMAT facility**, aimed at testing prototypes under DEMO-relevant heat loads was constructed and installed.