Experimental study of RMP induced fast-ion transport using FIDA spectroscopy at the ASDEX Upgrade tokamak

A. Jansen van Vuuren

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  - Change in the fast-ion content

Outline

1. Overview of experiments performed

2. Analyses and modelling of experimental results

3. Conclusion and outlook
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FIDA spectroscopy measures Doppler shifted emission from fast particles

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- Background neutrals lead to source of passive emission particularly along edge lines of sight

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- FIDASIM [3] is used to calculate synthetic spectra from theoretical fast-ion distributions

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- Rotating RMP with n=2 periodicity were applied in two 2s phases with differing $\Delta\Phi$
RMPs cause a reduction in the edge FIDA emission

- Drop in the edge FIDA emission when RMP’s switch on

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![Graph showing FIDA and BES radiances](image)

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\[ \Delta \Phi_{ul} = 50^\circ \]
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- But, normalising the FIDA profile with the BES does not change the picture.
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- TRANSP modelling is able to match the RMP off phase measurements.
- The RMP induced reduction in stored energy is largely due to loss of thermal plasma.
- The remaining discrepancy can be accounted for by considering anomalous fast-ion diffusion.

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![Graph showing fast-ion density profile with and without edge FI diffusion](image)
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  - $\sim 2\%$ of the total fast-ion content
Anomalous diffusion also needed to match FIDA profiles

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- FIDASIM forward modelling produces good match with core FIDA/BES profiles
- Modelling of the edge FIDA/BES profile matches during RMP off phase
- However, the edge emission profiles overestimated during RMP on times
- Including anomalous fast-ion diffusion results in better match with the measured profile
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RMP perturbation field included in ASCOT
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- RMP vacuum fields have been added to the axisymmetric equilibrium used in TRANSP
- The non axisymmetric modelling shows a reduction in the fast-ion density in line with TRANSP
- However, fast-ion reduction underestimates change in the FIDA emission.
- Need to consider plasma response [1]

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- RMP fields cause a reduction in edge FIDA emission on AUG

- Neoclassical modelling overestimates the experimental stored energy and FIDA emission during RMP on times

- Including anomalous fast-ion diffusion in neoclassical modelling shows a good match with experimental measurements can be achieved

- Indeed, 3D modelling of the vacuum perturbation fields show a reduction in the edge fast-ion density, but underestimates the absolute change in the FIDA profile
Outlook

- ASCOT modelling using V-MEC calculated equilibria with ideal MHD plasma response [1] included is being performed

- Comparison with JOREK modelling of the RMP plasma response [2] is on the horizon

Core FIDA profiles well matched

#39414

- $t$: 1.8 to 2.0 [s] RMPs off
- $t$: 2.1 to 2.3 [s] RMPs on

$\lambda$: 659.22 - 660.32 nm

FIDA/BES

$\rho_{pol}$