Assessment of the PCI diagnostics measurement by synthetic diagnostics

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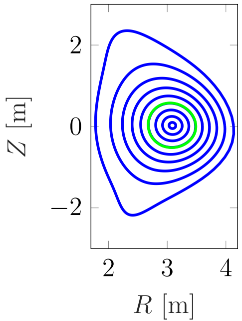
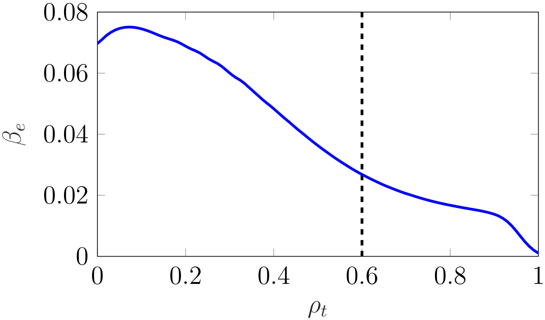
The scenario

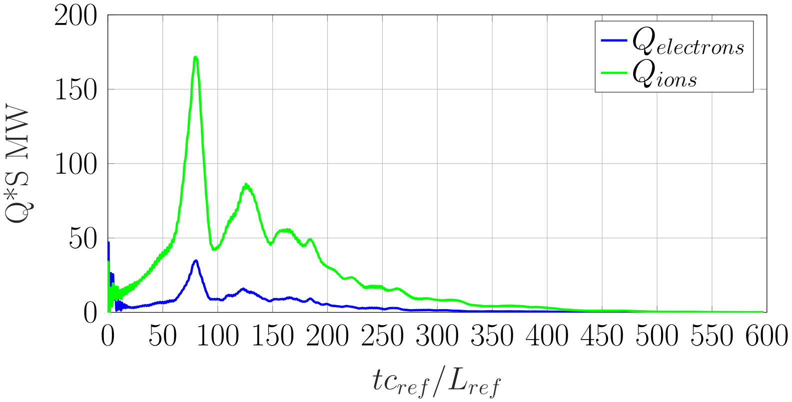
1. Predicted JT-60SA discharge.
2. Double-Null with 41 (34 NBH + 7 ECH) MW heating $\Longrightarrow$ fast ions (Maxwellian at larger T).





Simulations at nominal parameters $\Longrightarrow$ too low heat flux

Turbulent heat flux should match injected power of 41 MW...



Total heat flux $< 1\mathrm{MW}$

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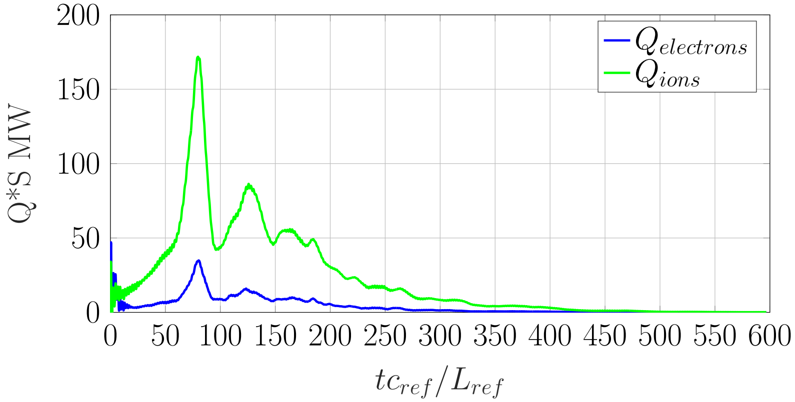
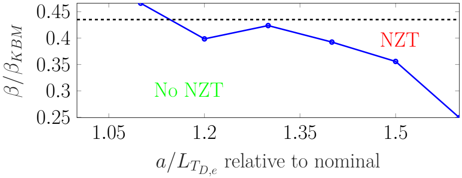


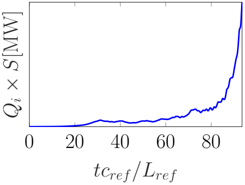
Total heat flux $< 1\text{MW}$ $\implies$ need to increase gradients.

Increasing gradients $\implies$ non-saturation

Nominal β + large gradients $\implies$
heat fluxes do not saturate due to the **NZT**



Example of runaway in the heat flux



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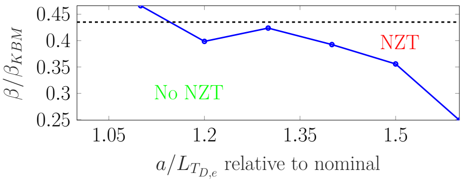

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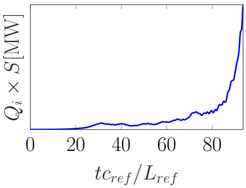
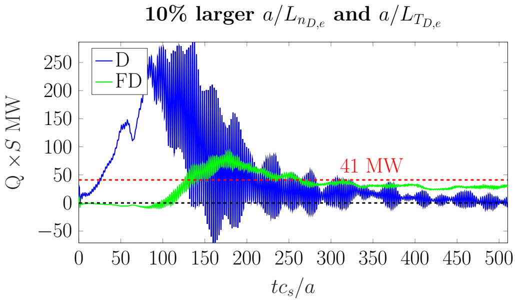
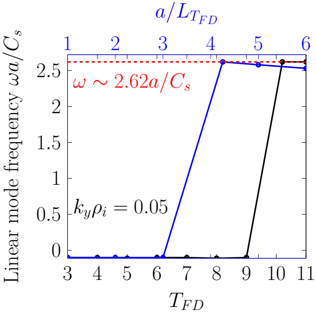


So far only 2 species (D,e) $\implies$ include impurities and fast ions.

Fast frequency mode is driven by fast ions

Including fast ions $\implies$ heat flux is dominated by a high-frequency oscillation.





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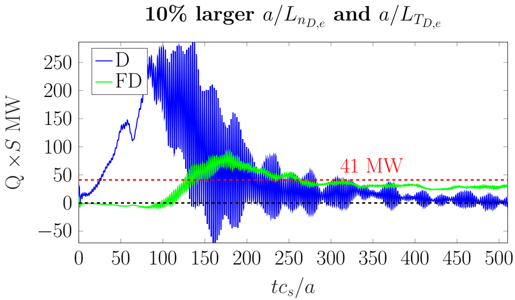
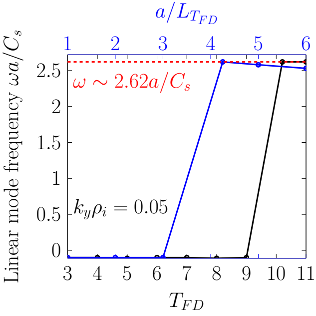
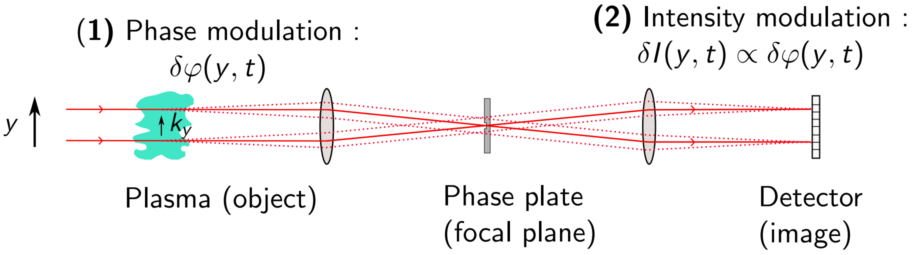




Next : Use results from the gyrokinetic simulations to predict PCI signals at JT-60SA

The PCI diagnostic



In the **Phase contrast imaging (PCI)** set-up :

- A laser beam is sent through the plasma.
- Part of the beam is phase shifted by $\delta\varphi$.
- $\delta\varphi \propto \int_L \delta n_e \, \mathrm{d}z$.

S. Coda, Ph.D. Thesis, Massachusetts Institute of Technology (1997).

Prediction of PCI signals at JT-60SA

1. Take δn from GENE.
2. Define diagnostic volumes.
3. Integrate δn_e over the volumes $\implies \delta\varphi$
4. Apply experimental transfer function.
5. Analyse like experimental data.

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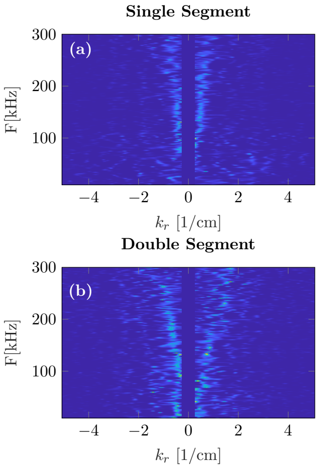

Proposed work for 2022

- **Finalise resolution study of larger gradient case.**
- **Improve prediction of the PCI signals**
  - Simulations at different ρ.
- Prepare a publication.

Summary

- Gyrokinetic GENE simulations to estimate turbulent transport in a JT-60SA scenario.
- Nominal parameters $\implies$ too low heat flux.
- NZT and fast ion driven high frequency mode.
- First PCI predictions.
- Future plan : improve PCI predictions and finalise results into a publication.

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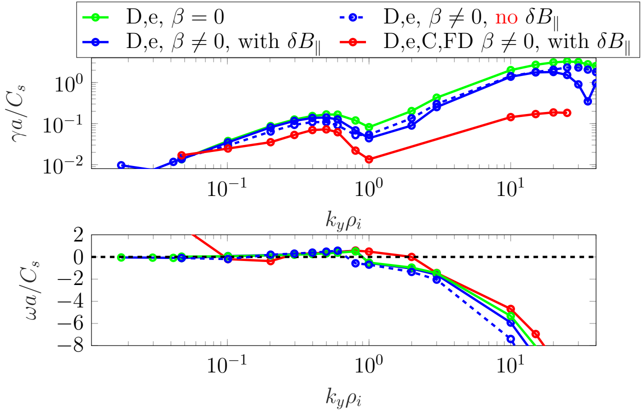
Thank you for your attention !

Linear simulations of the most unstable mode



- ITG($\omega > 0$), TEM ($\omega < 0$) and ETG ($\omega < 0$).
- Stabilising : fast ions + impurities and β_e.
- Destabilising/Stabilising : $\delta B_\parallel$.

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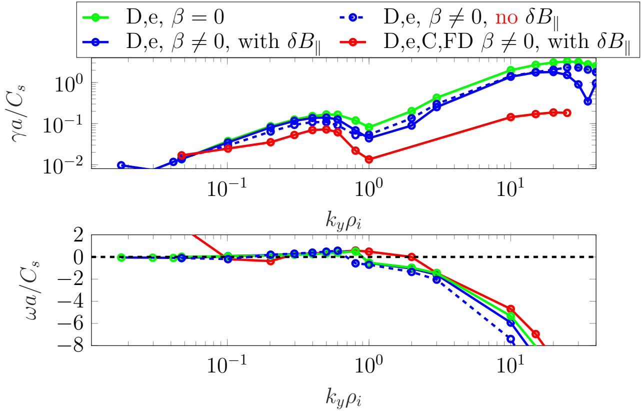

- ITG($\omega > 0$), TEM ($\omega < 0$) and ETG ($\omega < 0$).
- Stabilising : fast ions + impurities and β_e.
- Destabilising/Stabilising : $\delta B_\parallel$.
- $\frac{\gamma}{k_y}\big|_{\text{ion}} \ll \frac{\gamma}{k_y}\big|_{\text{electron}} \implies$ limited multi-scale interactions.

Electromagnetic modes at $k_y \leq 0.2$

Signature of microtearing like electromagnetic modes @ $k_y \leq 2$