Simulation focus: mid-radius

- Internal-reference, laser-based interferometer: images line-integrated density fluctuations in plane perpendicular to beam
- Both $k$ and $k_\theta$ wave vectors at the edge, mainly $k$ in the center
- Served for detection of complex spatial structures such as zonal flows
- Comparisons with gyrokinetic modelling mediated by a synthetic diagnostic

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A phase-contrast-imaging core fluctuation diagnostic and first-principles turbulence modeling for JT-60SA

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Sensitivity

- Improves with laser power
- Depending on integration length, densities as low as $10^{15}$ m$^{-3}$ can be measured

Gyrokinetic modelling

- GENE code [6]
- Scenario 1: DND 41-MW full current
- Linear analysis shows importance of retaining full physics, esp. impurities, e.m. effects
- ETGs could be important but nonlinear ETG/ITG interaction appears minor

Unfinished (non-steady-state) nonlinear e.m. flux-tube simulation

Conclusions

- Tangential PCI system planned for JT-60SA, would likely provide first deep insight into turbulence in reactor environment and usher in the next level of model validation
- Measures full profile in all plasma conditions
- 1 MHz bandwidth, 0.33<k<20 cm$^{-1}$, $\int$dn dl>10$^{14}$ m$^{-2}$
- $\Delta \rho<0.1$ (axis + edge), 0.4-0.1 at mid-radius ($k=2-10$ cm$^{-1}$)

Design criteria

- CO2 laser wavelength 10.6 $\mu$m
- Tangential port assemblies P1 and P8 can fit 18-cm beam
- Chosen path resolves just inside LCFS and near magnetic axis

Spatial localization

- Measurement location vs k direction is partially double-valued: no localization loss in our geometry as two locations have same $\rho$
- k-dependent but well-known transfer function
- Good aggregate localization, improving with $k$

Mainly $k_\rho$ in center, $k_\rho$ and $k_\theta$ at edge

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Experimental technique

- Internal-reference, laser-based interferometer: images line-integrated density fluctuations in plane perpendicular to beam
- Localization is achieved by selecting $k$ direction, which must be locally oriented along $B$ [x $k_0$]
- Good localization near tangency point because $B$ x $k_0$ varies rapidly, and $d\rho/dl=0$ enhances effect (HFS edge in our geometry)
- $d\rho/dl=0$ also on the magnetic axis, so localization there is good too

Hardware layout

- Beam-generation and detection equipment above vessel
- Simple with no optics on the vessel

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