Numerical analyses of baseline JT-60SA design concepts with the COREDIV code

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- JT-60SA reference design scenarios have been analyzed with the help of the self-consistent **COREDIV code**
- Simulations results for **C PFCs** and the **full W** have been compared in terms of the influence of impurities, both intrinsic (C, W) and seeded (N, Ar, Ne, Kr) on the radiation losses and plasma parameters.

Main assumptions:

•Carbon:

✓physical and chemical sputtering at the targets

✓neoclassical and anomalous transport

•Tungsten:

✓physical sputtering at the targets

✓anomalous transport

•The same transport assumptions in all simulations

✓Different scenarios: **high density #3:** (n_e=9x10^{19} m^{-3}, P_{aux}=30 MW) and **low density: #2** (n_e=5.6x10^{19} m^{-3}, P_{aux}=41 MW)

•Diffrent seeding: N, Ne, Ar, Kr

•Reference parameters

✓n_e^{sep} =0.4 $\langle n_e \rangle_{VOL}$

✓D_{SOL}=0.5m^2/s

CONCLUSIONS

Tungsten PFCs

- Seeding is indispensable to control the power to divertor plates.
- **#3:** with Ne seeding a wide operating window has been found: for $C_{ne} \geq 0.7\%$ P^{plate} < 10 MW and P^{SOL} > $P_{L\text{-}H.}$
- Energy losses are dominated by Ne and deuterium radiation and for maximum applied seeding up to 83% of the input power can be radiated and semi-detached divertor operation is observed.
- **#2**: seeding by noble gasses (Ne, Ar, Kr) leads to efficient plasma cooling and tolerable heat loads to the target plates (<10 MW) at reasonable contamination level (Z_{eff}~3).
- Argon seems to be optimal choice for #2, showing wider operating window.
- Ne leads to high plasma dilution at high seeding levels preventing the achievement of semi-detached conditions in the divertor.
- Using krypton as a seeding gas has an advantage that it replaces tungsten in the central plasma and limits its concentration.

Carbon PFCs:

•For the high density **scenario #3** the regime of detachment on divertor plates can be achieved with N and Ne seeding.

•For high auxiliary power and low density **scenario #2**, the carbon and seeding impurity radiation does not effectively reduce power to plate and consequently, results with very high Z_{eff} (about 6-8) impurity concentrations ($\geq$ 9%) are found.

•In case of low density scenarios (#2), slight increase of neither average density or edge density together with Kr seeding might lead to the development of very favorable conditions in the discharge with strong radiation losses and semi-detached conditions in the divertor.