Transport and Confinement in JT-60SA

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Main objectives and confinement issues

- *JT-60SA is an Advanced Tokamak*: therefore one of the main objective is to study the mutual interaction amongst plasma pressure, rotation and current profiles *in high β, highly self-regulating, plasmas.*
- The other is to achieve *high confinement regimes at high-density, above the Greenwald density.*
  - This is another important issue, typical of AT and the way to it is through the control of the plasma profiles, plasma shape and particle fueling

High β-high confinement in self-regulating plasmas at high density.

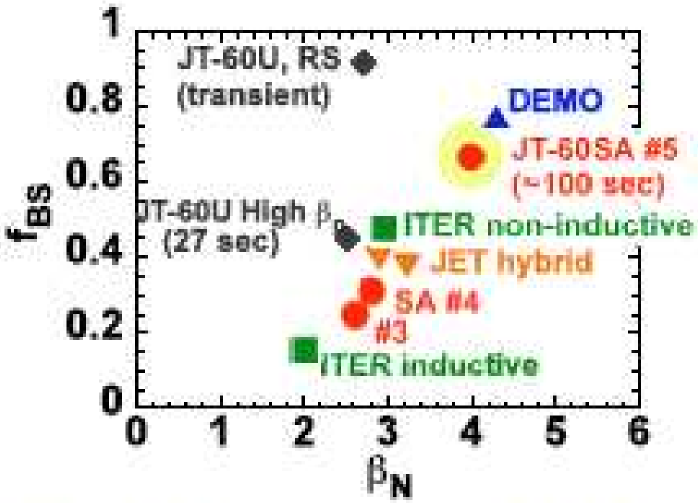


Fig.5-1 The bootstrap current fraction (f_{BS}) against the normalized beta (β_N). Linkage between plasma pressure, rotation and current profiles in highly self-organized plasmas is clarified taking advantage of high β_N and high f_{BS} (DEMO [1], JT-60U [2, 3], JET [5]).

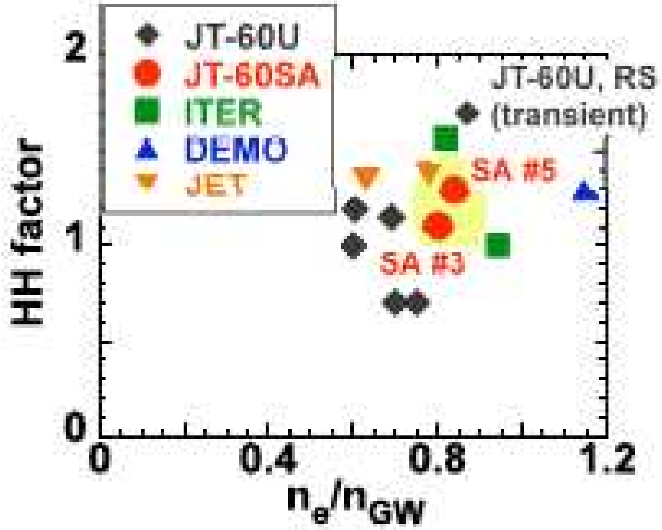


Fig. 5-2 Target regime in HH factor and the Greenwald Density fraction (n_e/n_{GW}). (DEMO [1], JT-60U [4], JET [5]).

Other T&C important issues

- Studies of the energy and particle and momentum confinement scaling,
  - both on hybrid and high β scenarios, at high plasma shaping
  - and in dominant electron heating condition
- Turbulence stabilization
  - stabilization of the ITG turbulence through alpha optimization in the presence of a large population of fast ions due to NBI [5]
  - JT6-60SA can operate at different Ti/Te ratios, thus contributing to investigate the role of the heating ratio, of Ti/Te and of collisionality on density peaking and TEM stabilization [4].

T_i/T_e variations

- **The ratio of the electron heating power to the total input power can be varied from ~20% to ~70% with low external fuelling and torque input by NNBI and ECRF**
- Transport dependence on Ti/Te ratio will be investigated by varying both the ratio of electron heating power and the electron density.

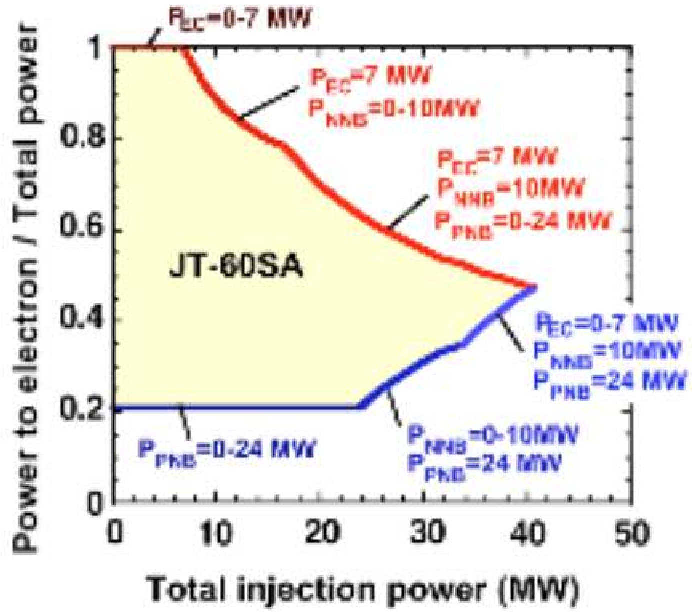
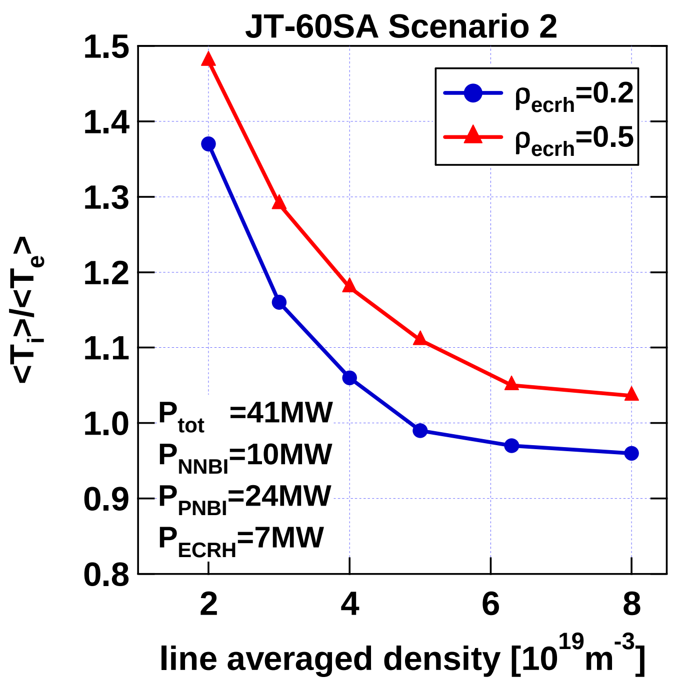
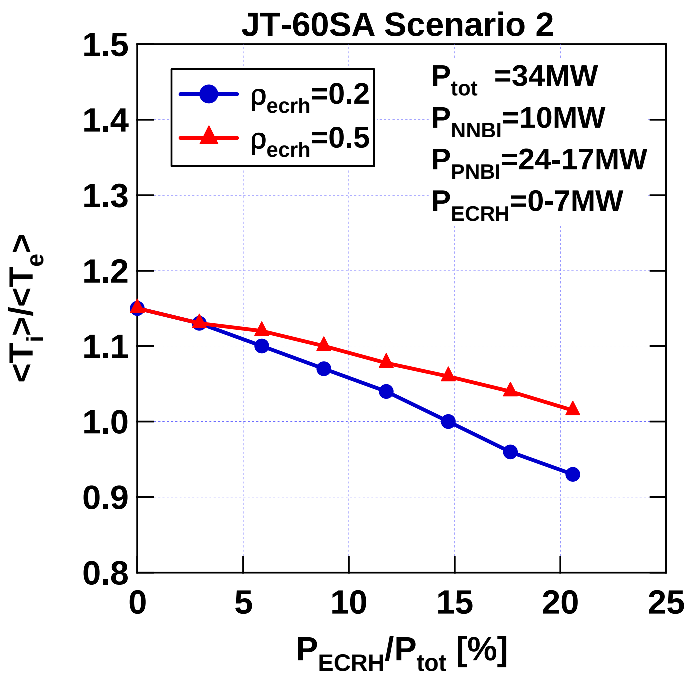


Fig. 5-5 Ratio of electron heating power to total input power versus total injection power.

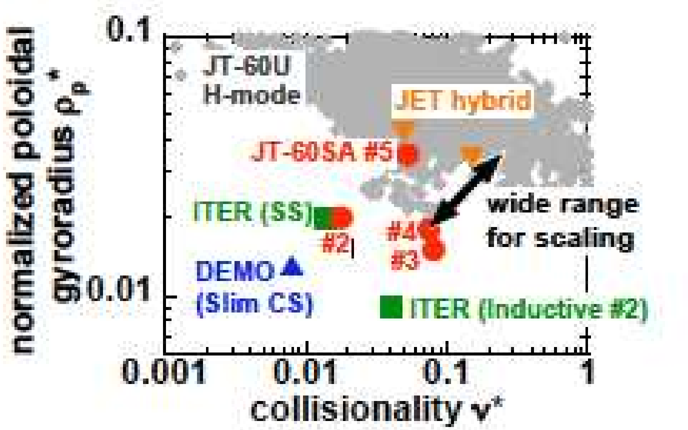
Predicted T_i/T_e variations (METIS[3])

- Ti/Te variations as they result from a density scan at fixed power and from an ECRH power scan at a fixed density.

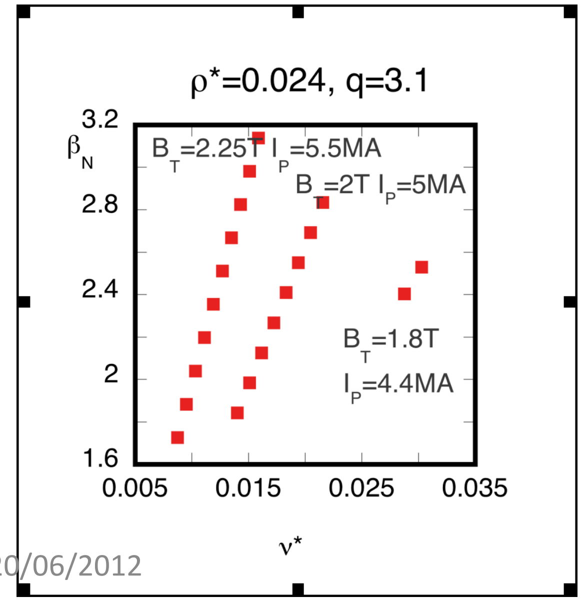


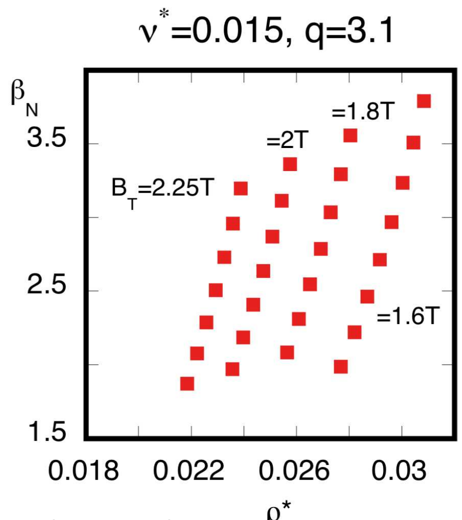


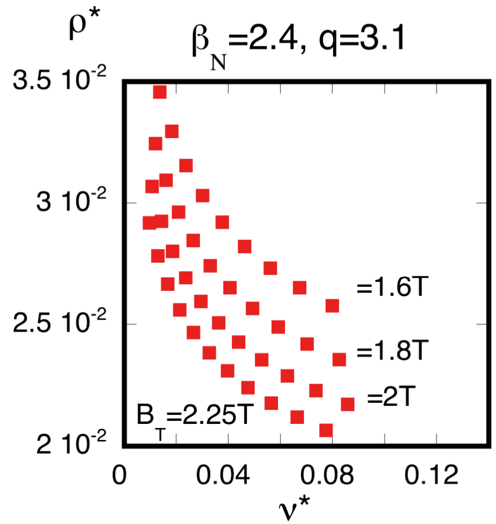
A large region of dimensionless parameters space.



By virtue of its auxiliary heating systems JT-60SA allows to carry out transport experiments covering a wide region of the dimensionless plasma parameters space and will access, although not simultaneously, the ITER and DEMO relevant values of ν^*, ρ_p^* and β_N with ITER- and DEMO-like plasma shapes.





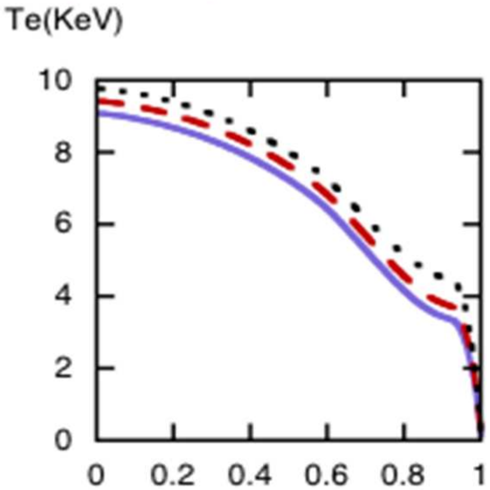


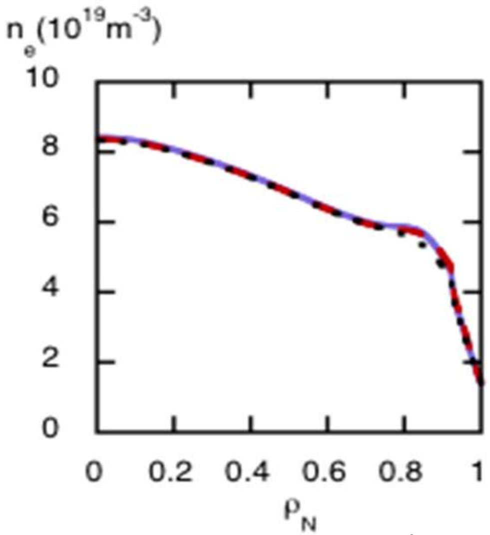
First predictive (100s) transport simulations of scenario 2 (H-mode)by Bgb empirical models [7,8,9]

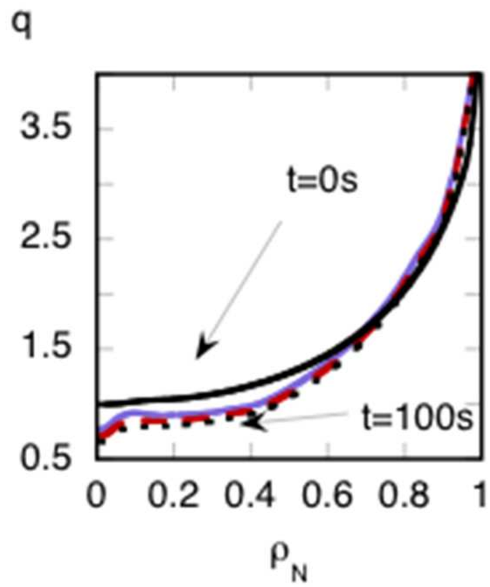
- By JINTRAC: *three field simulations (n_e, T_e and T_i) with pellets source to control plasma density*
  - Pellets are injected from the LFS at a velocity of 300 m/sec
  - A feedback mechanism on pellet injection controls the volume-average density $\langle n_e \rangle$.
- By ASTRA: *two field simulations (T_e and T_i) (100ms)*

JINTRAC density and temperature profiles at different α_c

- **At t =100 s.**
  - **α_c=1.3**
  - **α_c=1.5**
  - **α_c=1.7**

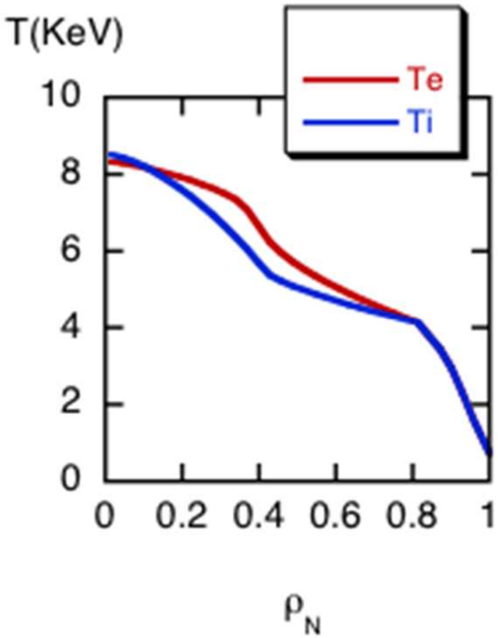


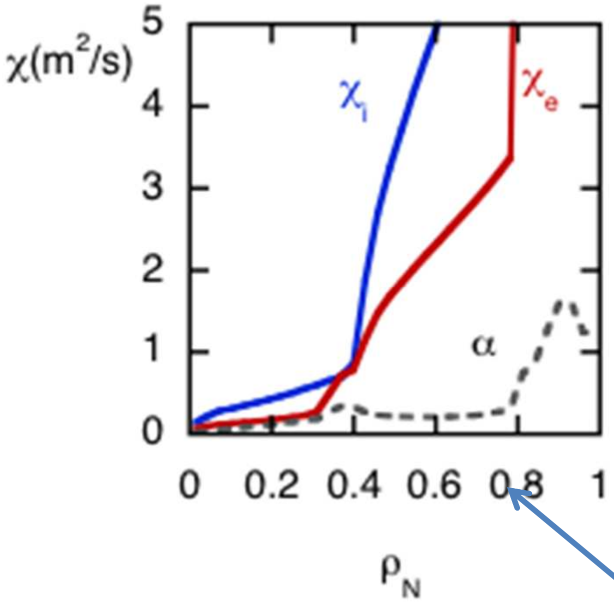




q-profile evolution similar for the three cases.

ASTRA results by BgB shear dependent model (and different pedestal width and height)





- **H=1.1** **$\langle T_i \rangle$=4.7 KeV**
- **I_{BS}=1.2** **$\langle T_e \rangle$=5.1 KeV**

The pressure gradient $\alpha < 2$ in the pedestal region.

1.5D calculations : summary & conclusions

	ASTRA(1&2)	JINTRAC (α_c=1.3)	JINTRAC (α_c =1.5)	JINTRAC (α_c =1.7)
F_{pellet}(Hz)		16.7	16.3	15.3
$n_e(10^{20}\ m^{-3})$	0.62			
$<T_e>$(KeV)	5.1	5.8	6.3	6.6
$<T_i>$(KeV)	4.7	5.8	6.2	6.5
F_{BS}	0.22			
H	1.1	1.15	1.25	1.30
W(MJ)	19	22.5	24.0	25.5

- **Full predictive (100s) transport calculations have been performed for JT-60SA scenario 2 by JINTRAC and ASTRA.**
- **Density control by pellet injection has been shown with a resulting injection frequency between 15-17 Hz**
- **An H factor of 1.3 is obtained when the pressure ballooning limit is set at ac=1.7**
- **In all cases an H factor larger then 1 is obtained**