Comments on Pedestal Stability and ELMs

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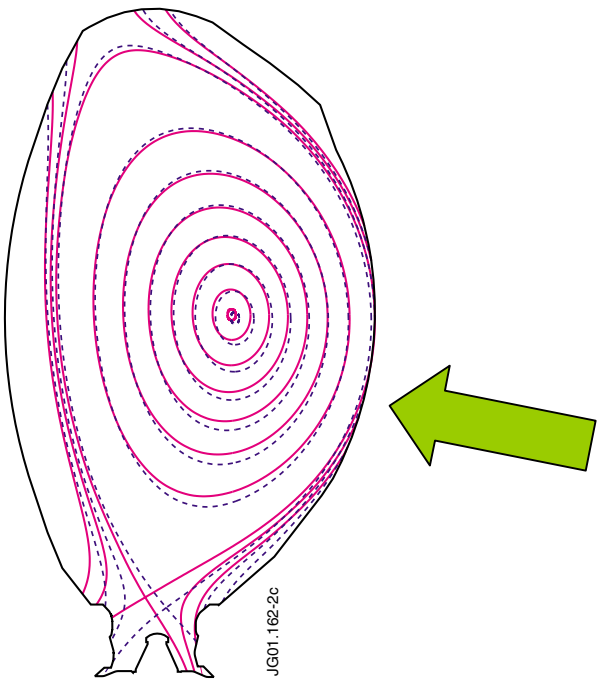
JET : Plasma Shape and Pedestal Plasma

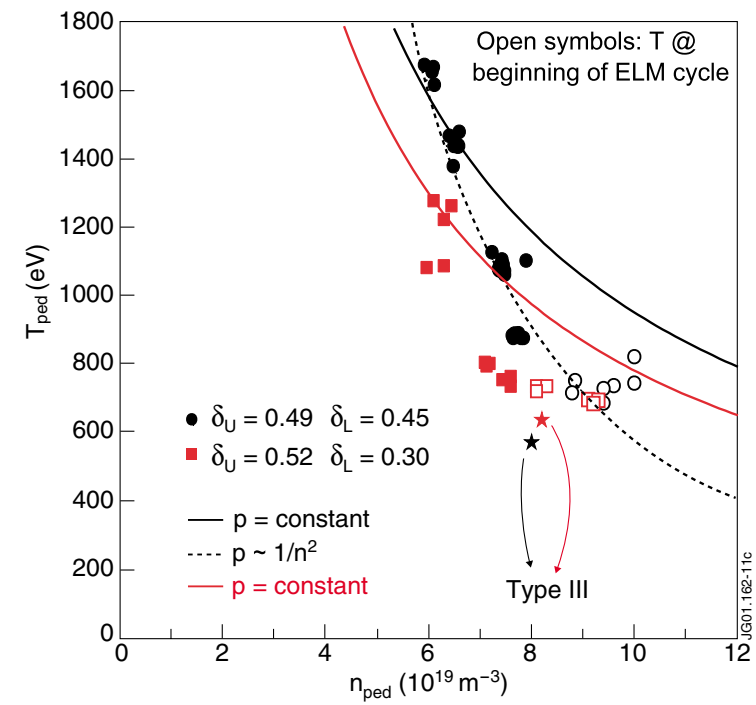
Details of Plasma Shape → Pedestal Plasma Parameters

High δ_L and low δ_L
EFIT reconstruction



- Comparison of gas scans for 2 configurations:
- Very similar δ_U but $\neq\delta_L$ (near the X-point)
- Same I_p, B_t and similar P_{in}. Increased squareness

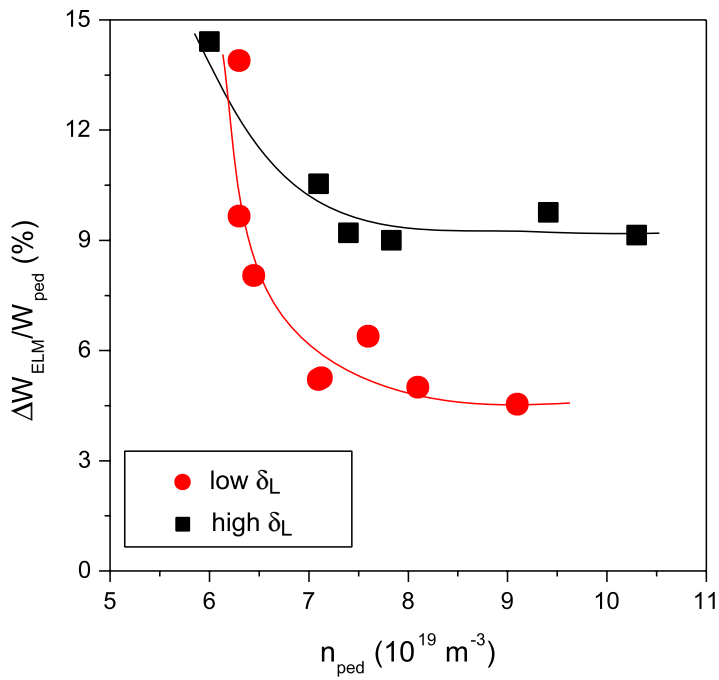
$<\delta>=0.47$
$<\delta>=0.41$

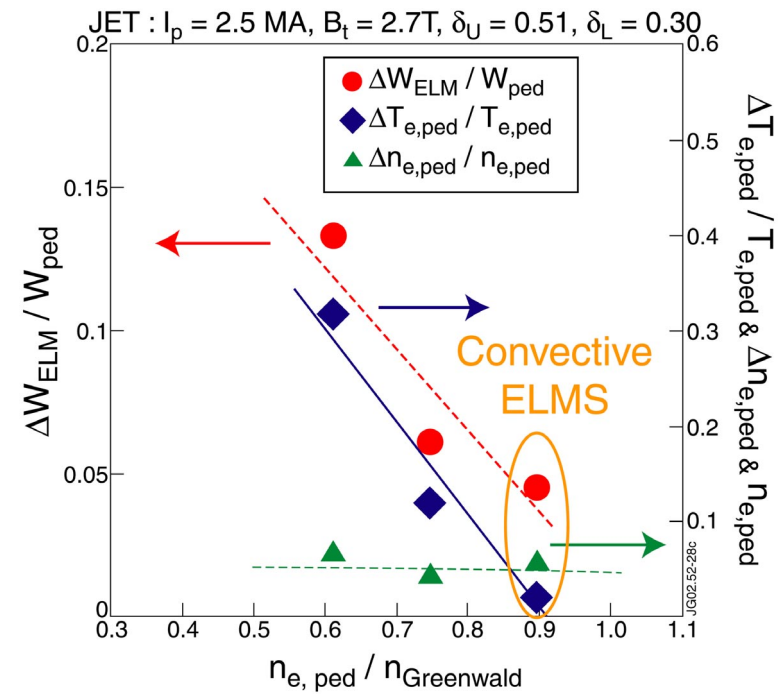


- Lower T_{ped} for a given n_{ped}
- Transition from Type I to Type III ELMs at lower n_{ped}
- Lower $W_{th,norm}$ consistent with the reduced p_{ped}

JET : ELM Energy Losses (I)

Details of Plasma Shape → ELMs but also ($n_{e,ped}$, $T_{e,ped}$)





Size and Nature of ELM Energy Loss (convective-conductive) ← $n_{e,ped}$ & $T_{e,ped}$ (ν^*_{ped})

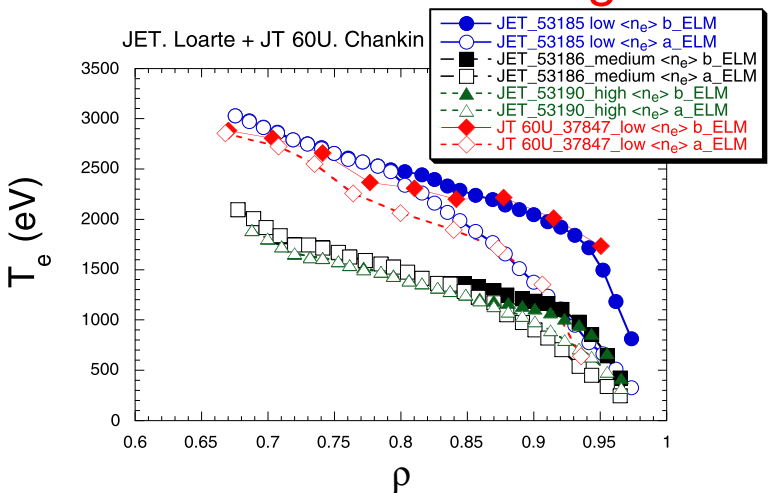
$\Delta W_{ELM}/W_{ped}$ decreases with increasing $n_{e,ped}$ because of $\Delta T_{e,ped}/T_{e,ped}$ ↘

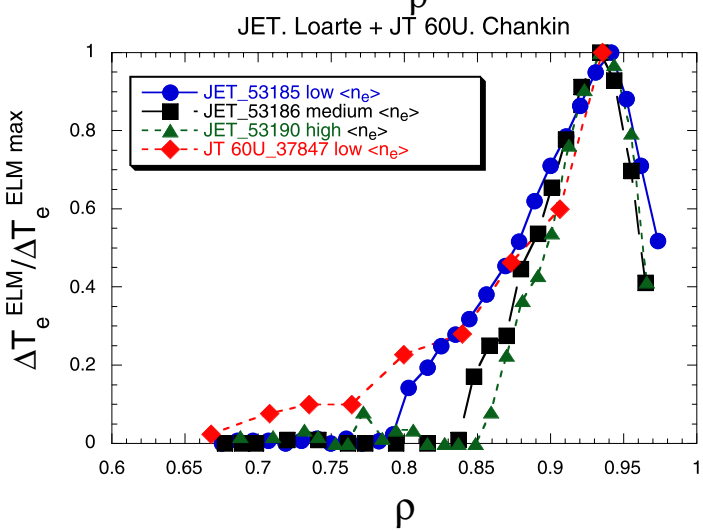
$\Delta W_{ELM}^{Convective}/W_{ped}$ ~ constant (independent of n_{ped} & T_{ped})

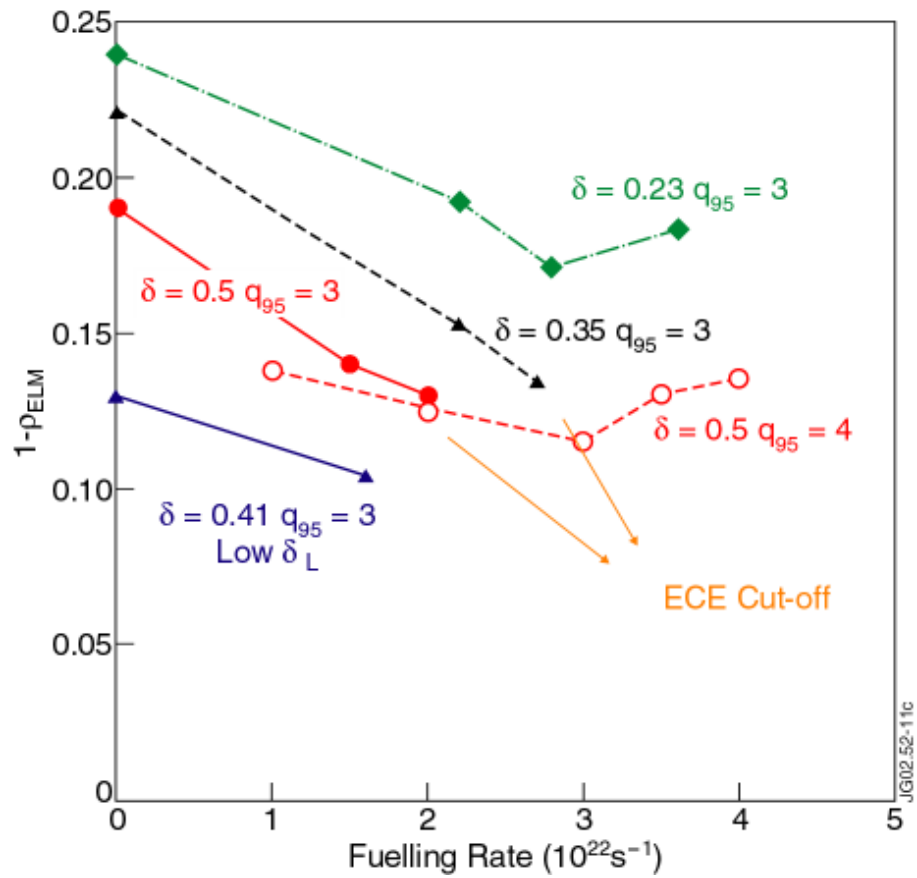
JET : ELM affected Area (I)

Decrease of ΔW_{ELM} with $<n_e>$ due to $\Delta T_{e,ped}/T_{e,ped}$ decrease

not to large reduction of ELM affected volume



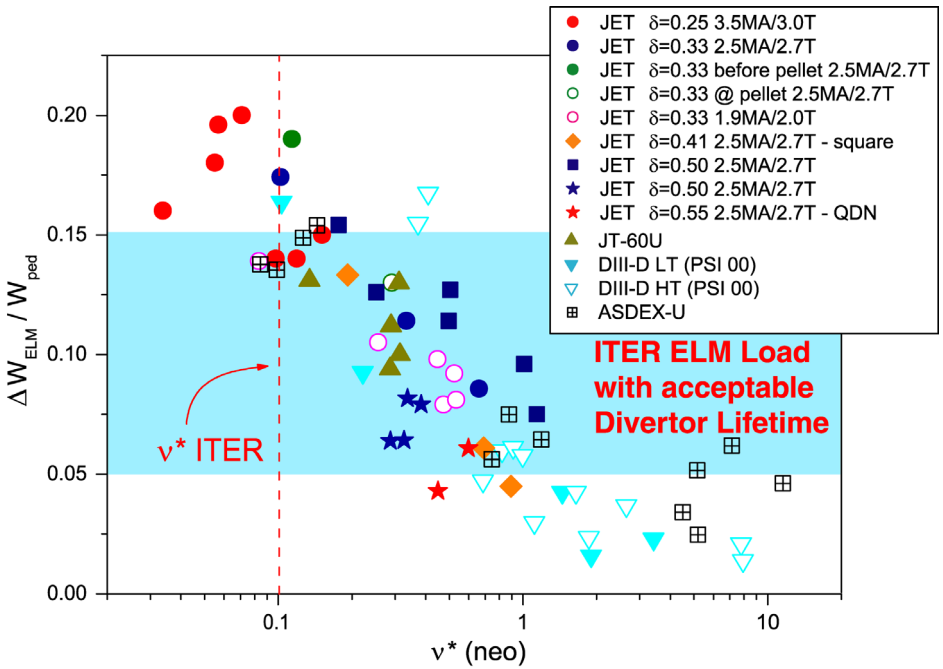


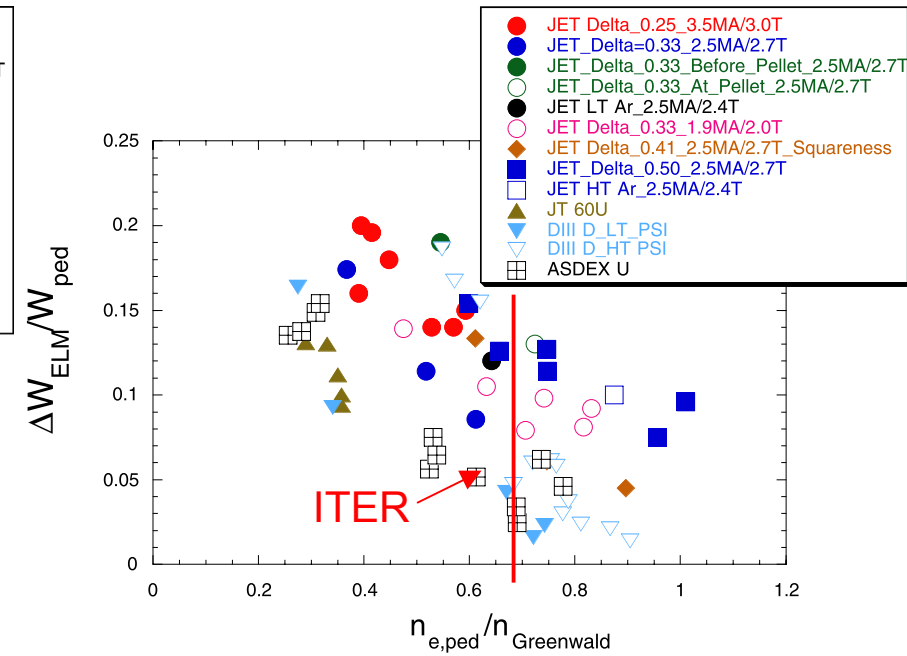


ELM affected Volume depends on Plasma Shape !!

Multi-Machine ELM Energy Losses (I)

Multi-machine Evaluation of ΔW_{ELM} indicates that ν^*_{ped} is an ordering Parameter for ELM Energy Losses





Not a ΔW_{ELM} Scaling ←→ Development of ELM Energy Loss Physics Model :

1) ν^*_{ped} → MHD Trigger of ELM (Bootstrap Current)
2) ν^*_{ped} → ⊥ B Energy/Particle Transport during ELM
3) ν^*_{ped} → II B SOL Energy/Particle Transport during ELM

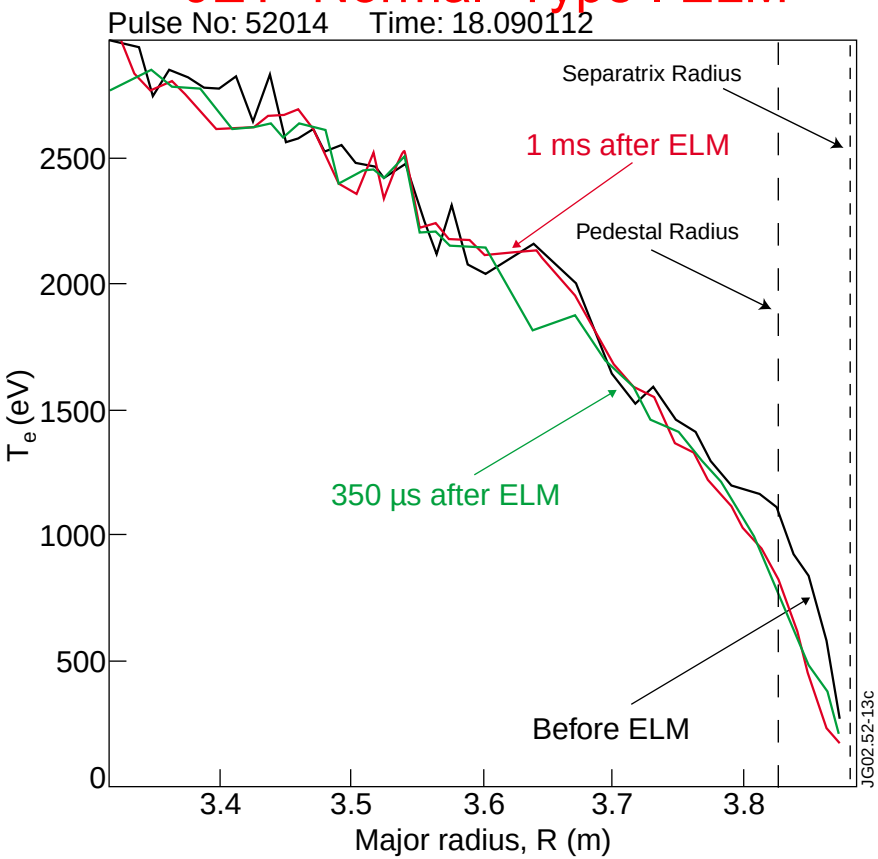
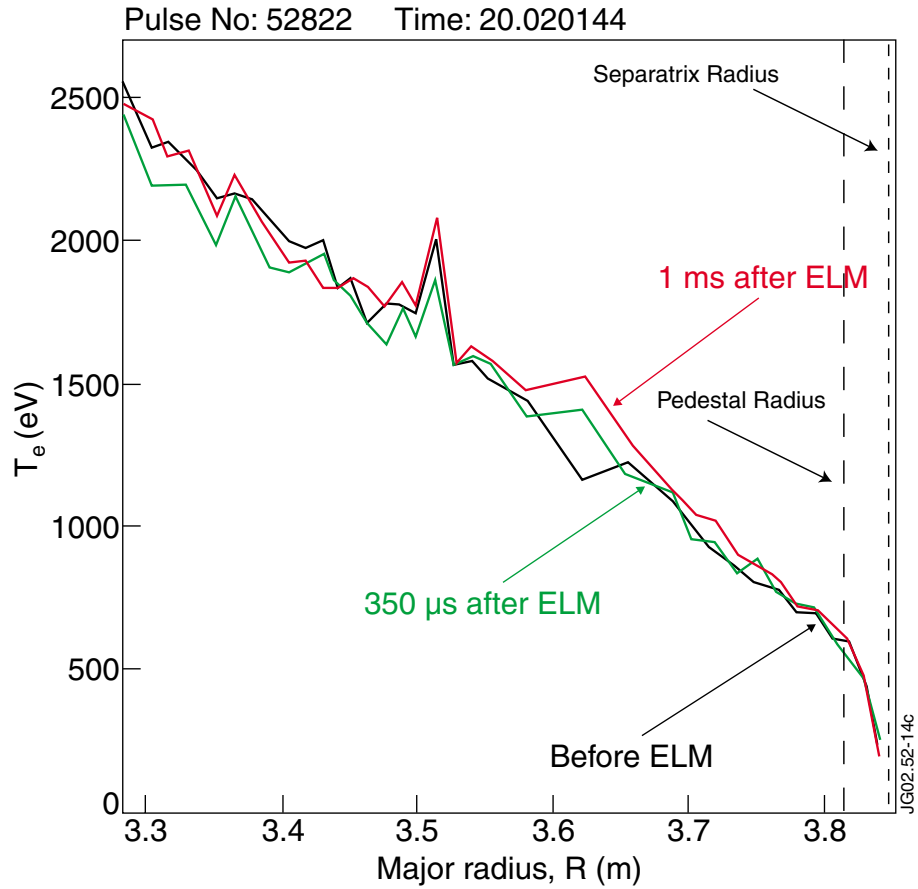
Conclusions

- Pedestal Plasma Parameters are determined by I_p, B_t, Shape & Input Power
- Type I ELMs Divertor Energy Loads are of Concern for the Lifetime of the ITER Divertor. Physics based Extrapolation is still uncertain (MHD & Transport) but the Situation is not hopeless!!
- Type I ELM Energy Losses determined by (I_p, B_t, $n_{e,ped}$ & $T_{e,ped}$)
- Bulk Plasma ELM conductive Energy Losses decrease with ν^*_{ped} ELM convective Energy Losses independent of ν^*_{ped}
  - Physical Process that leads to ν^*_{ped} Dependence ?
  - Extrapolation of pure convective Type I ELMs?
  - Physics behind ELM Particle Losses (MHD?)
- In parallel to Type I ELM Studies, Regimes with small (Type II ELMs) with high & low ν^*_{ped} must be developed and their operation space widened

JET :ELM Energy Losses (IIa)

“Minimum” Type I ELMs (purely convective) can occur at high density

JET “Normal” Type I ELM



JET “Minimum” Type I ELM