Measurement of SOL widths in ELM-free H-mode plasmas

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Overview

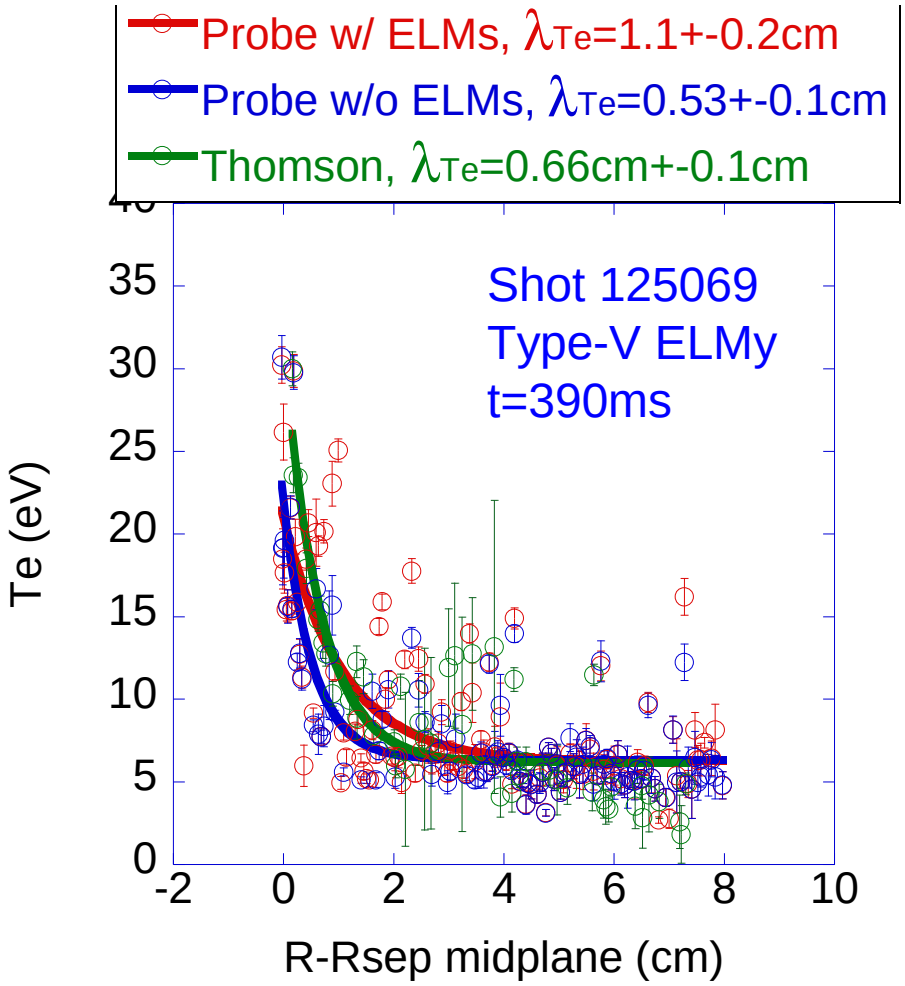
(1) To find the role of ELMs in determining SOL widths

- Present dataset suggests ELM filaments may increase the spread of the heat flux on the divertor (time-averaged) in the near SOL.
- Need to confirm this observation with profile data for 'ELM-free' discharges using LITER

(2) To confirm the role of parallel heat transport in each case

(3) Comparison with SOLT modeling for SOL widths and blob characteristics

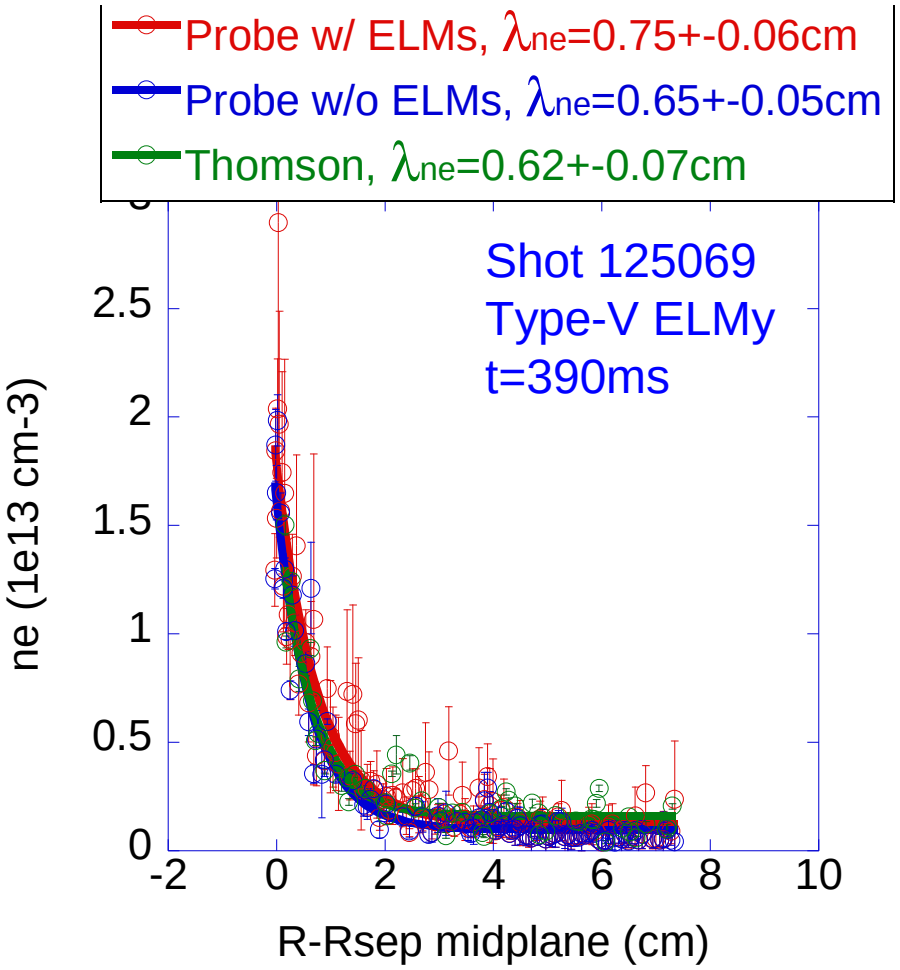
Justification 1 - λ_{Te} is strongly affected by ELMs



- Probe measurement is continuously affected by ELMs and blobs
  - measured Te shows high scatter
  - Te SOL width broadens
- Probe I-V data with ELM affected portions removed
  - re-process probe data
  - Te SOL width becomes narrower
- TS measurement is instantaneous
  - misses many ELM filaments in the near SOL
  - effectively represents inter-ELM profile with narrower λ_{Te}

λ_{Te} is highly affected by ELMs, measured by probe

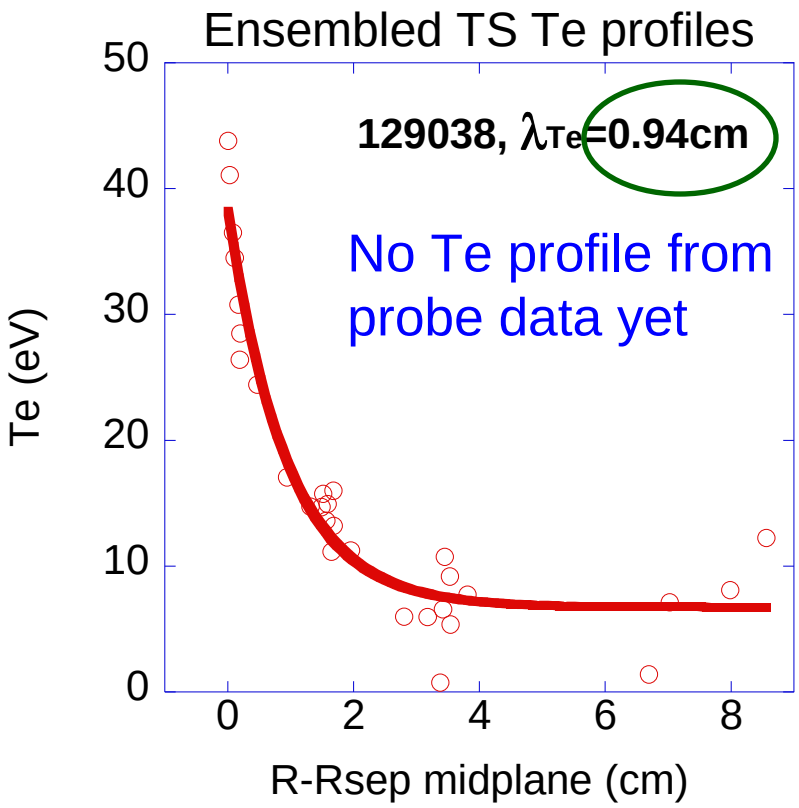
Justification 2 - λ_{ne} is little affected by ELMs

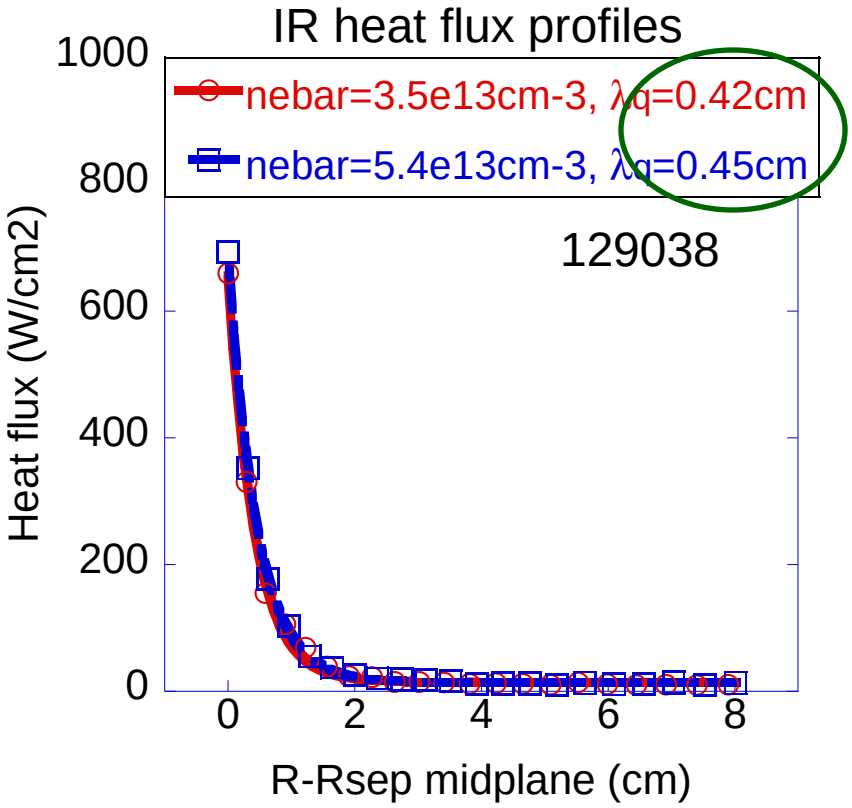


- λ_{ne} from probe is only a little broader than λ_{ne} from TS
- Probe data 'without ELMs' produces only a little narrower λ_{ne}, compared with λ_{ne} 'with ELMs'
- Change in Te affects density only to a limited extent because of stronger contribution of jsat ($n_e \propto I_{sat}^{+} / \sqrt{T_e}$)

λ_{ne} is not sensitive to ELMs, measured by probe

Justification 3 – Need probe data for ELM-free H-mode





- nebar continuously rises during the H-mode, by a factor of ~2, with $n_{e,sep}$ fixed
- λ_{Te} and λ_q stays constant at ~0.4cm and ~0.9cm, respectivey
  - λ_{Te}/λ_q ~2, close to prediction from simple parallel power balance model

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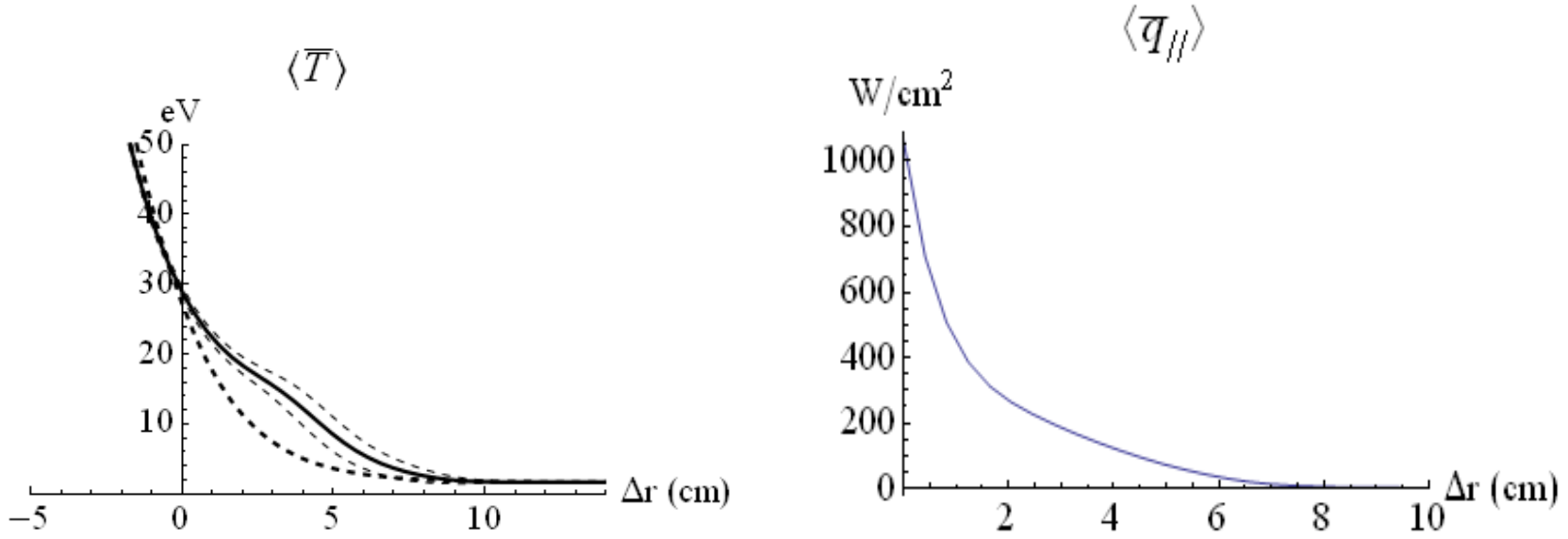
Justification 4 - ELM-free H-mode is good for SOLT modeling



Simulated Te and $q_{||}$ profiles by SOLT (J. Myra, ECC 2009)

- SOLT is strongest without presence of ELMs with electrostatic terms only included at the moment
- Modeling has been focused on L-mode (eg, 112825) so far
- ELM-free H-mode will still have blobs and should be fine for modeling

Experimental Plan

- ELM-free H-mode discharges with assistance from LITER
  - Reference shot: 132601
    (δ=0.5, κ=1.8, I_p=800kA, P_{NBI}=2MW)
- Measure λ_{Te} simultaneously with TS and probe up to LCFS
- Measure λ_q with fast and slow IR cameras
- Repeat to complete measurements at 3 density points at t=300ms, 500ms, 700ms (5 shots for each)

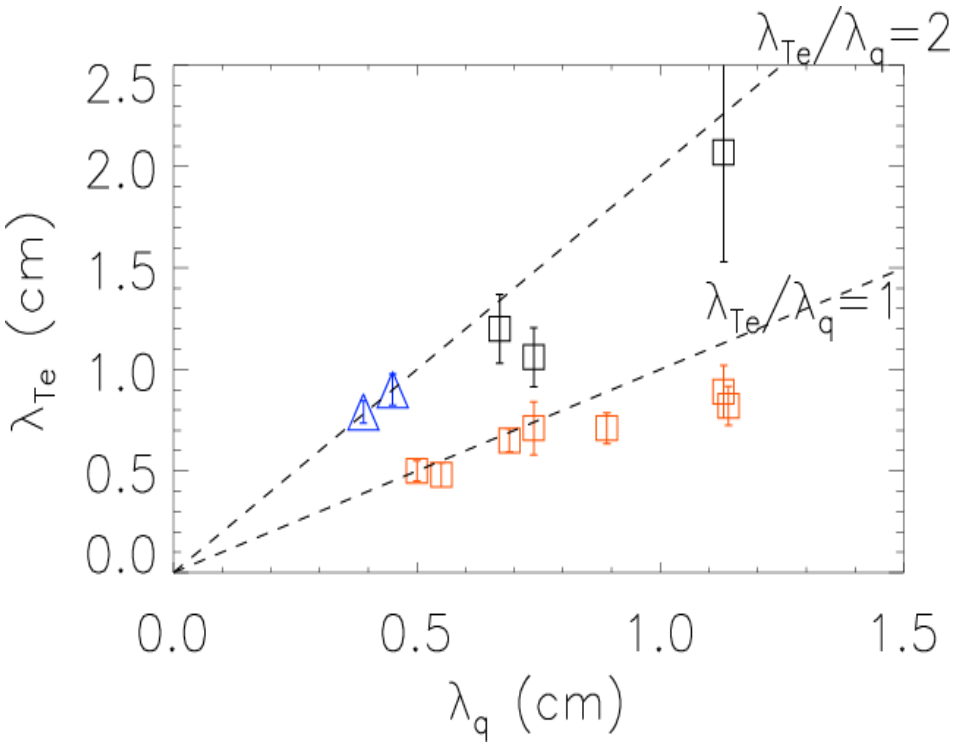
Requested run time: 1/2 day

Required machine and diagnostic capabilities

- LITER needed for access to ELM-free H-mode
- At least one NBI source will be necessary
- HeGDC between shots to be adjusted according to need
- GPI necessary for SOLT modeling
- Other desired diagnostics:
  mid-plane D_β, reflectometry, divertor spectroscopy, target probe array

Backup slides

Missing data is λ_{Te} measured by probe for ELM-free plasmas



1. $\lambda_{Te}/\lambda_q = \frac{7}{2}\left(\frac{T_e - T_{e1}}{T_e - Cq_1 T_e^{-5/2}}\right)$
2. Experimental results so far:
   - ELMy H-mode: λ_{Te}/λ_q ~ 1 (TS *vs* IR)
   - ELMy H-mode: λ_{Te}/λ_q ~ 2 (Probe *vs* IR)
   - ELM-free H-mode: λ_{Te}/λ_q ~ 2 (TS *vs* IR)
   - ELM-free H-mode: λ_{Te}/λ_q =??? (Probe *vs* IR)

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