XP-952, Measurement of SOL widths in ELM-free H-mode plasmas

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Goal of experiment

(1) To find the role of ELMs in determining SOL widths
- Pobe measurement gives λ_{Te} longer than from TS, by a factor of ~2.
- Hypothesis: ELM filaments may broaden λ_{Te}, TS may not be able to catch them all due to its instantaneous time scale
  ELMs may increase the spread of the heat on the divertor in the near SOL.
- Need to confirm this hypothesis with profile data for ELM-free discharges using LITER

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

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

Important points for measurement and modeling

(1) Most important is the T_e measurement from the probe and TS and the comparison of λ_{Te} with each other

Deep enough reciprocating probe data necessary

Probe should be ready for operation for the remainder of run period. UCSD team is taking care of hardware & software issues

TS frequency of 60Hz necessary for averaging purpose

(2) Target heat flux profile will be measured by fast/slow IR cameras

(3) Lodestar group has agreed to target this plasmas for the SOLT modeling, which has an advantage in electrostatic blob modeling

(2) GPI data necessary to provide constraints on SOLT modeling

R. Maqueda has agreed to support the experiment

Important points for target plasmas

(1) Must have ELM-free H-mode in low NBI power (< 1MW)

(2) With help from LITER, we were able to achieve this year completely ELM-free, low powered H-mode plasmas

(3) Candidate group 1

132956 (P_{NBI}=1MW) and 132958 (P_{NBI}=0.6MW, modulated), Lithium rate 10mg/min, Ip=900kA

plasma boundary was very stable, rmidout=1.48m throughout

δ=0.65, κ=1.9, so outer divertor leg was on the inboard plates

(4) Candidate group 2

132713, 132721, P_{NBI}=1MW, Lithium 10mg/min, Ip=800kA

rmidout was moving by a few cm during ELM-free phase

δ=0.5, κ=2.0, so outer divertor leg was on the outboard plates

Other machine and diagnostic capabilities needed

NSTX

- HeGDC between shots to be adjusted according to need

- Boronization prior to experiment??

- Other desired diagnostics:
  - -- mid-plane D_β and divertor spectroscopy
    to determine regime of SOL plasma
  - -- USXR, reflectometry
    to characterize filament characteristics
  - -- Core and divertor Bolometry
    to determine accurate loss power

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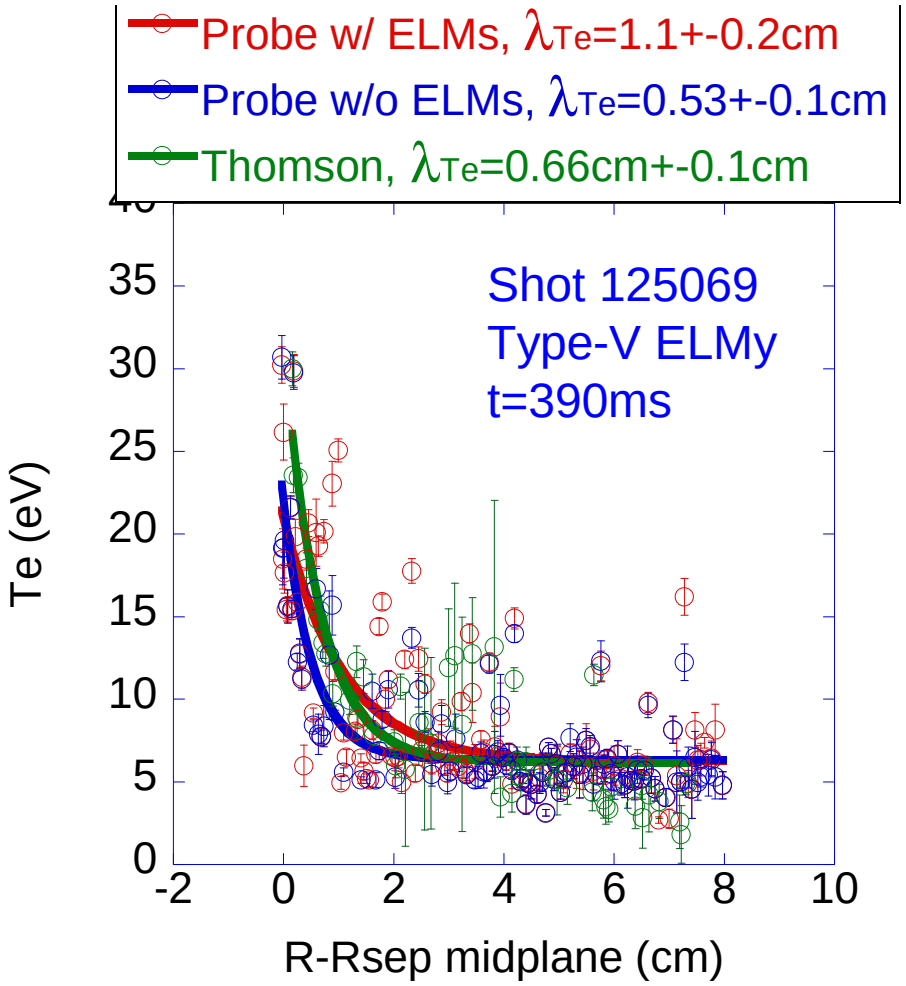
Experimental Plan

- ELM-free H-mode discharges with assistance from LITER
  - Reference shot: 132956 (or 132721)
    δ=0.65 (0.5), κ=2, I_p=800 (900) kA, P_{NBI}=1MW
- 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

Backup slides

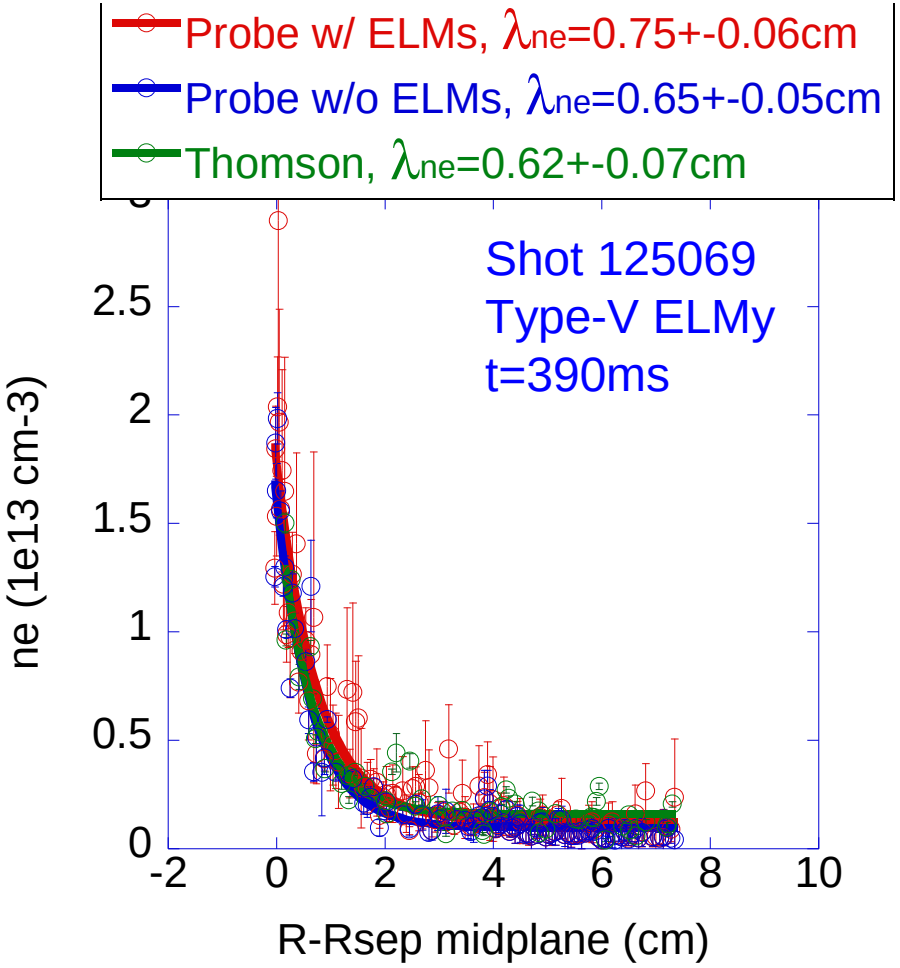
λ_{Te} is strongly affected by ELMs



- 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

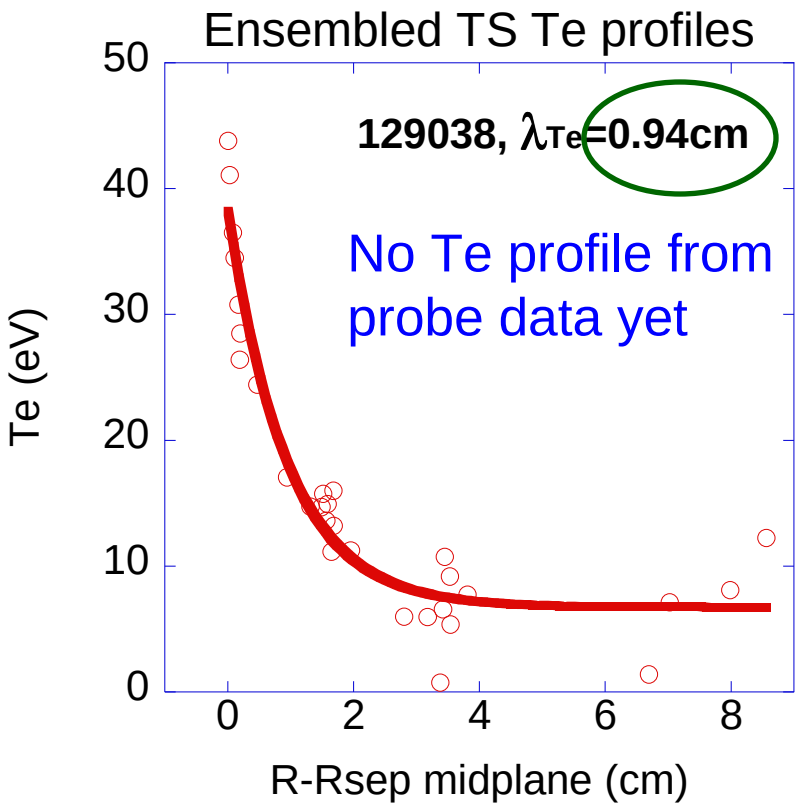
λ_{ne} is little affected by ELMs

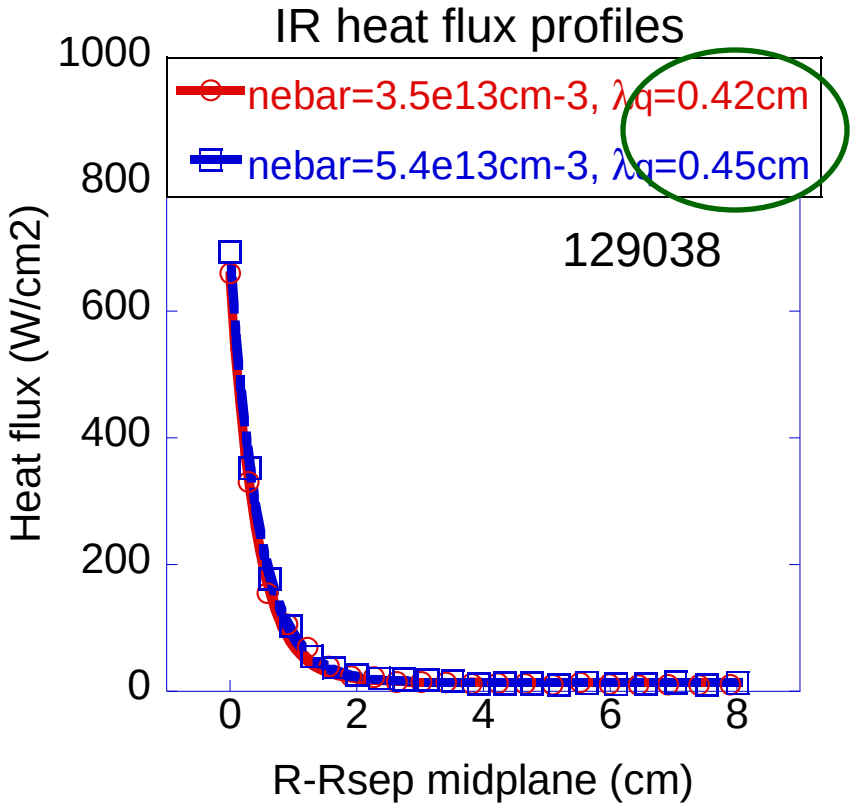


- λ_{ne} from probe is only a little broader than λ_{ne} from TS
- Probe data 'without ELMs' produces only a little narrower λ_{ne}, compared with λ_{ne} 'with ELMs'
- Change in Te affects density only to a limited extent because of stronger contribution of jsat ($n_e \propto I_{sat}^{+} / \sqrt{T_e}$)

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

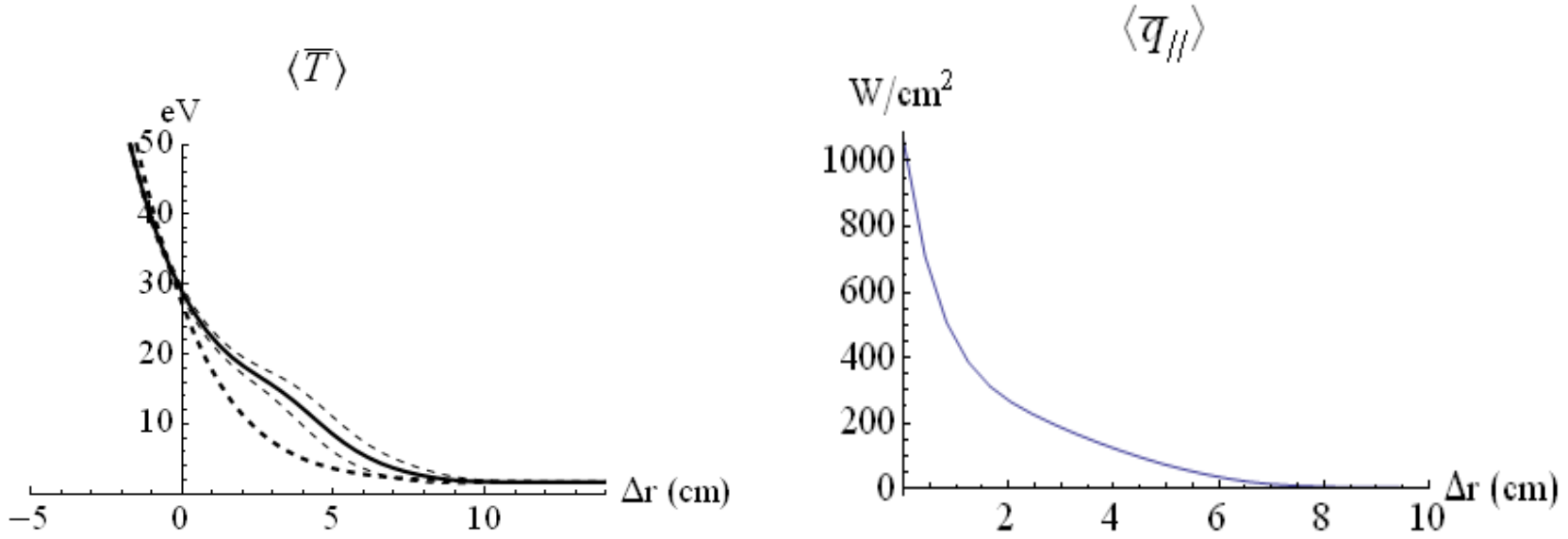
Need probe data for ELM-free H-mode





- 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

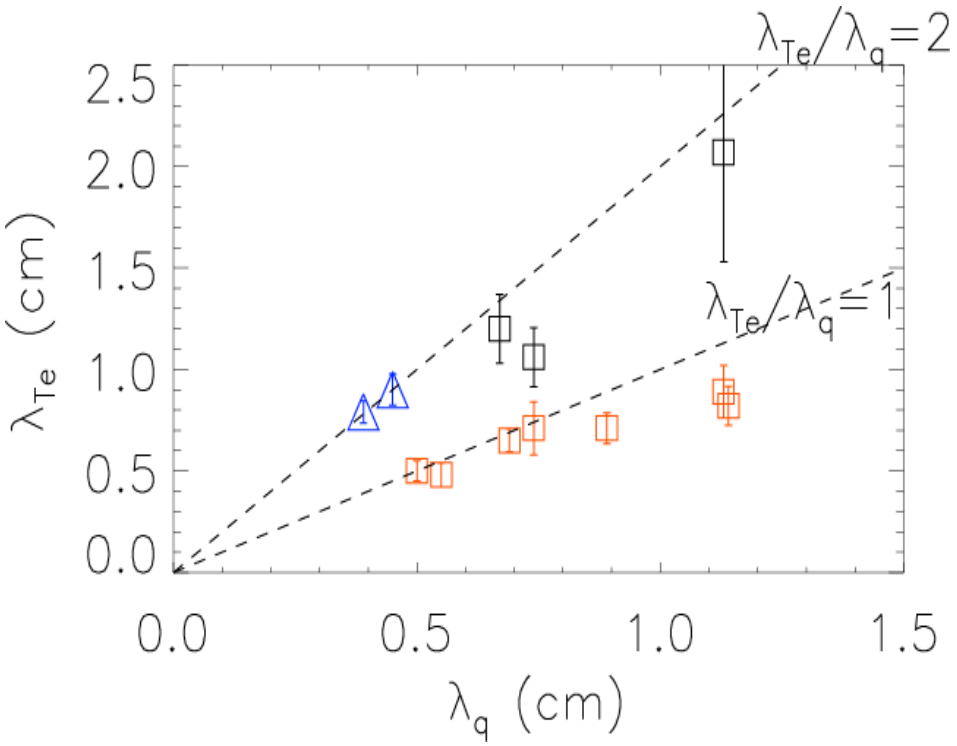
ELM-free H-mode is good for SOLT modeling



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

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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