Experiments on the physics of hot spots

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- Formation of hot spots on a first wall surface can result in a strong impurity and dust ejection into plasma and discharge termination (Tsitrone et al., 2008; Fenstermacher et al., 1997; Holmann et al., 2003; Takenaga et al., 2005; Fujita et al., 2006)

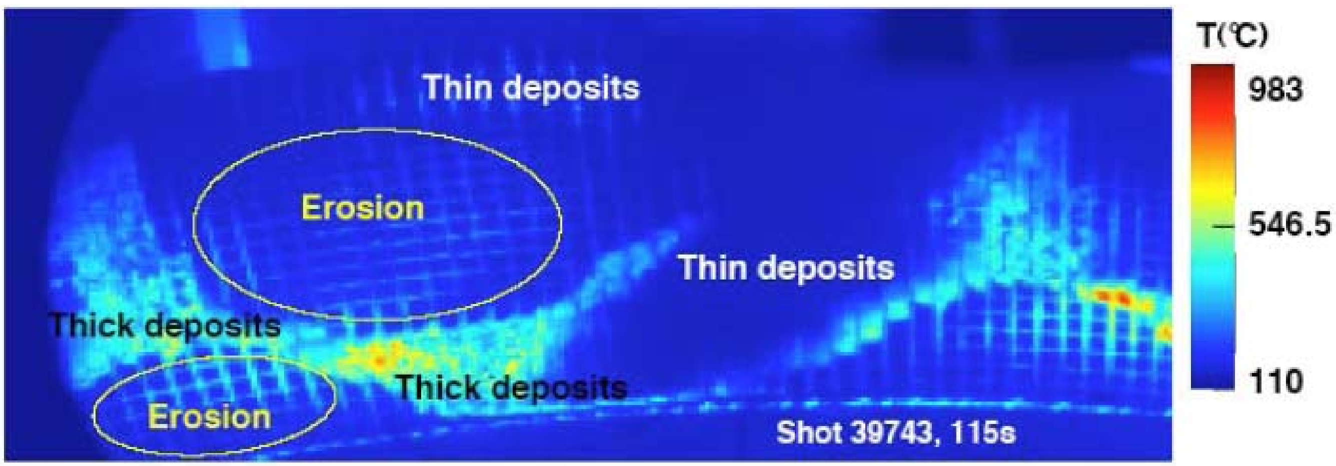
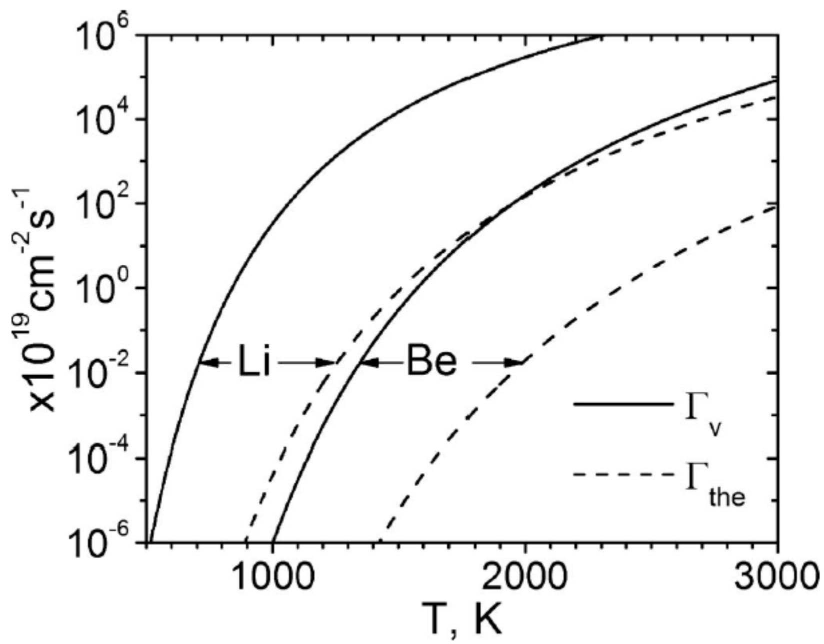


Fig 3b : IR imaging of the limiter sector during the DITS campaign. The different zones of interest are indicated

- Theoretical study of the physics of spot formation show that it can be related to thermionic emission, hydrogen desorption, and wall material evaporation (Nedospasov et al., 1983; Tokar et al., 1992; Krasheninnikov et al., 2006; Smirnov et al., 2009)
- The onset of the hot spot formation (which in all these theories leads to the bifurcation of surface temperature) depends on wall material, plasma parameters and heat transport to the wall
- However, experimental data for fusion relevant plasma are very sparse and there are no dedicated experiments on tokamaks, which could provide information on the mechanisms of hot spot formation

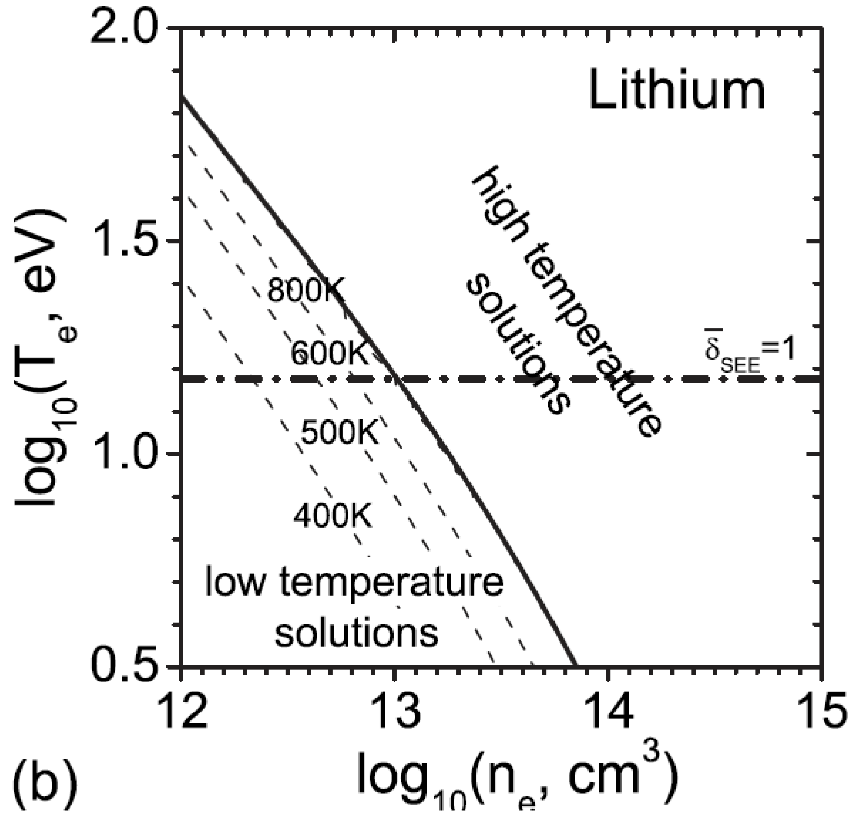
- Meanwhile Lithium (as well as Berillium) has a very interesting feature: Lithium evaporation rate by few orders of magnitude exceeds the rate of thermionic emission



- Therefore, the formation of hot spot on Lithium surface can only be triggered by wall evaporation mechanism

- Evaporation mechanism (Smirnov et al., 2009) is based on the fact that for tokamak conditions in recycling region there is a self-consistent electrostatic potential ϕ which reflects back to the surface about a half of ionized neutrals which acquire in this potential ϕ the energy ~ Te (Krasheninnikov and Chodura, 1994)
- As a result, heat flux to the surface increases
- Increasing heat flux increases surface temperature T, which increases evaporation rate and, correspondingly, ionization source, which leads to even higher plasma particle and heat fluxes to the wall and higher T

- As a result a bifurcation of T occurs



- 2D UEDGE modeling supports this idea and shows shrinking of heat profile to the plate at high T

- We suggest to study the formation of hot spot on Lithium surface in NSTX in the beginning of the LLD operation, with small amount of Lithium placed in a restricted location
- Monitoring of Li surface temperature T (or brightness) with IR camera can provide time history T(t) which can show bifurcation-like character
- Experimental results can be compared with available theoretical model developed at UCSD (Smirnov et al., 2009) and UEDGE modeling.