XP 951 Diffusive Lithium Injection

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PPPL

Motivation:

- Density and impurity control is goal of multi-year Li program on NSTX.

- Complete vessel coverage with a Li coating thicker than the sputtering depth should, *by definition*, eliminate non-Li influx from sputtering.

- Off-normal events complicate issues.

Plan:

- Increase Li coverage of NSTX vessel wall by using LiTER to inject Li into low pressure helium. Adjust mean free path of Li in He by varying the helium pressure to produce a diffusive coating of the upper vessel, midplane and regions not in line-of-sight to LiTER. Also use LLD or Dropper.

- Minimize impurity influx by, for example:
    - Increasing Ip from 0.93 - 1.1 MA
    - Type 5 ELMs ?
    - Vertical jogs ?

Mixed results XP951 in 2009

Promising initial results June 11 2009:

- 134279: 187 mg and
  134292: 183 mg Li evaporated.

- Fueling (gas+NB) 76 ↗ 88 torr-l

At 1.0 s:

- Same line electron density.

- Visible bremstrahlung Zeff ↘ 5%

- Rad power   ↘ 20%

- Carbon Zeff (chers)   ↘ 6%

- Zeff (metals)   ↘ 33%

Comparison complicated by difference in
    D-alpha (ELM) behavior.

Mixed results Aug 4th 2009

- Li 'in Mach' 154 mg ↗ 1,212 mg

- Fueling (gas+NB) 82 ↗ 134 torr-l

At 1.0 s:

- line electron density ↘ 12%

- Visible bremstrahlung Zeff ↗ 20%

- Rad power   ↗ 5%

- Carbon Zeff (chers)   ↘ 18%
  after event @ 0.76s

- Zeff (metals)   ↗ 37%

/p/nstxcam/miro/2009/Miro_135701.cin at 755.487 ms

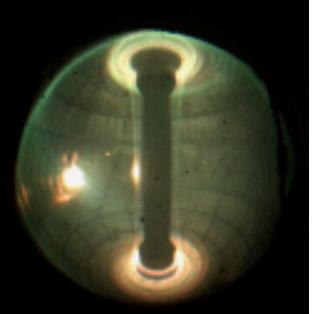Strong interaction with RF limiter @ 755 ms
increased Zeff metals, but decreased Zeff
carbon.

Could Li lowered edge density increase beam
ion loss and lead to more intense PMI that
defeated attempt to reduce impurities ?

Plans for FY10:

- Use same Li evaporation into He scheme as 2009
- Also evaporate from LLD upwards, or use Dropper.
- Reduce impurity influx with increased Ip (used 930 kA in FY09) and other strategies (jogs, I-mode, Type 5 ELMS…).
- Diagnose off-normal events with spectroscopy + fast cameras…
- Identify impurity sources and locations: metals, boron…; sputtering, ELMs...
- Identify cause of PMI events - ELMS or MHD or …. ? MIST modeling ?
- Mitigate cause…
- Possible synergy with other impurity control XPs e.g. successor to XP950 "Dependence of metallic impurity accumulation on I_p and the outer gap in the presence of lithium deposition"
- Potential joint experiment ...

- Milestones:
  - FY2011 Research Milestone R(11-3) "Understand and minimize the sources and accumulation of plasma impurities arising from lithium conditioning of the PFCs."
  - Relevant to ITER ELM control: "further exploration of increased Li coverage using He neutral gas or dropper."

- Run time requested: 1 - 2 d.