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NSTX

Recent EBW Emission Results on NSTX

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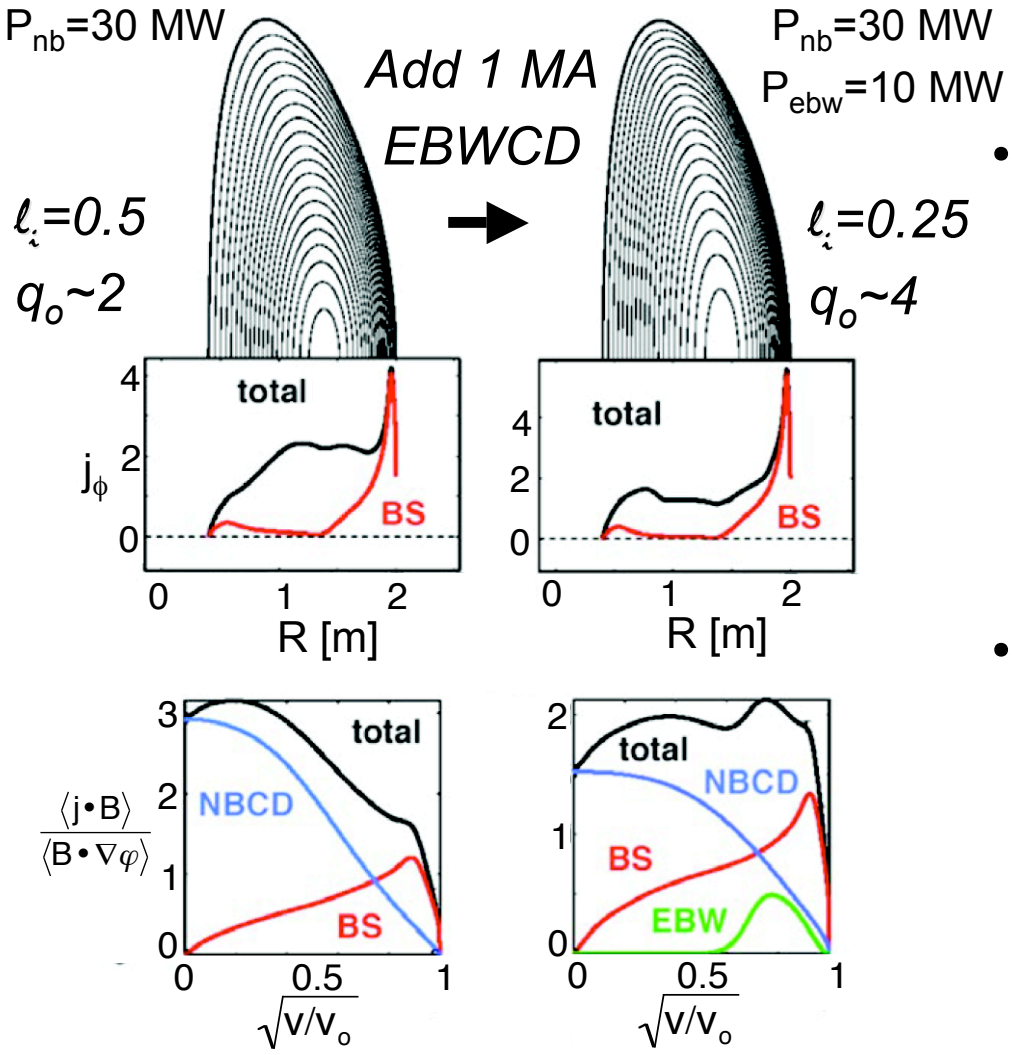
49th APS-DPP Meeting
Nov. 12-16, 2007
Orlando, Florida

EBW research objective to assess ability of EBWCD to generate off-axis stabilizing current in ST-CTF

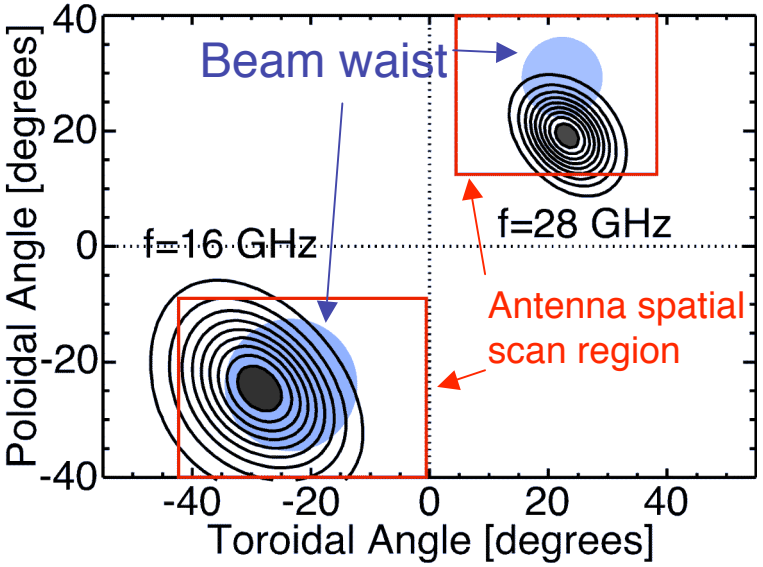


*Y-K. M. Peng, et al., PPCF, **47** B263 (2005)*

- Modeling shows adding 1 MA of off-axis EBWCD to ST-CTF plasma significantly increases stability:
  - β_n increases from 4.1 to 6.1
  - β_t increases from 19% to 45%
- Need efficient coupling of RF power to EBWs

→ Assess oblique O-X-B coupling by measuring B-X-O emission (EBE)

Remotely steered EBW antennas allow mapping of f_{ce} & 2 f_{ce} B-X-O emission window



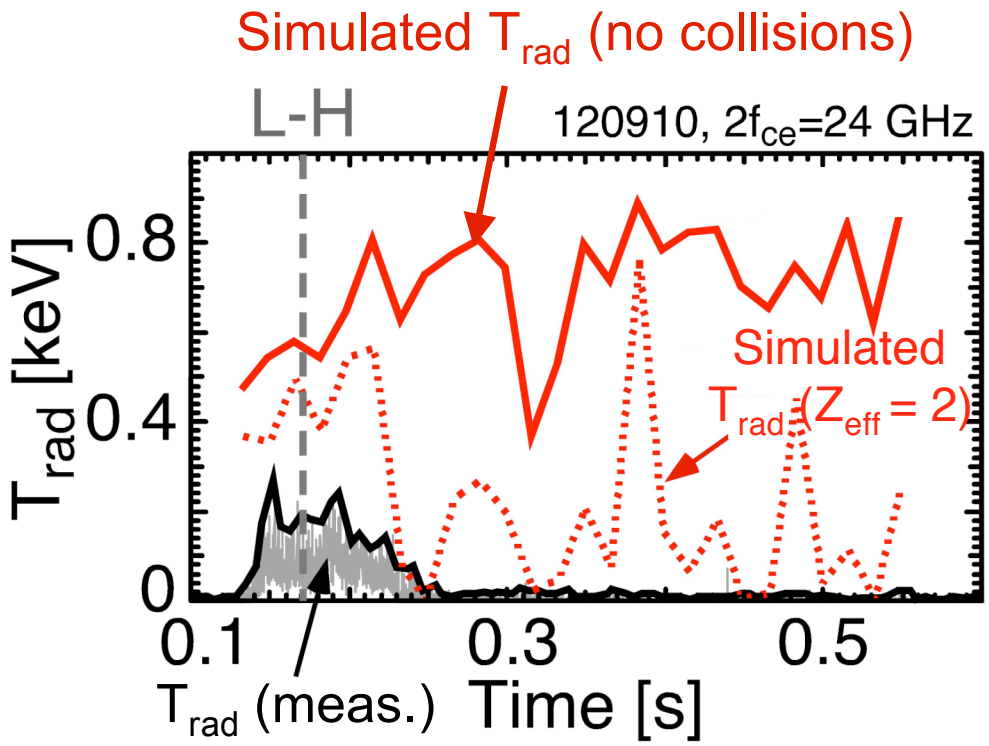
- ±10° scan in poloidal and toroidal directions possible between shots
- 30°-40° magnetic field pitch at edge determines window location
- Low density scale length, L_n, improves B-X-O coupling

- Measuring efficient B-X-O transmission of EBE from H-mode plasmas supports future 28 GHz EBWH experiments on NSTX
- Recently added lithium conditioning capability provides tool to vary edge conditioning and its affect on B-X-O transmission efficiency

Previously measured H-mode B-X-O transmission efficiency < 30%

EBE simulations suggest low B-X-O emission from H-mode in 2006 due to EBW collisional damping

- Emission from f_{ce}, $2f_{ce}$ exhibited rapid decay after L-H transition
- Simulated B-X-O EBE $T_{rad} \sim 0.8$ keV for 24 GHz, measured $T_{rad} < 0.2$ keV:
  - EBE simulation uses EFIT magnetic equilibrium and measured T_e, n_e



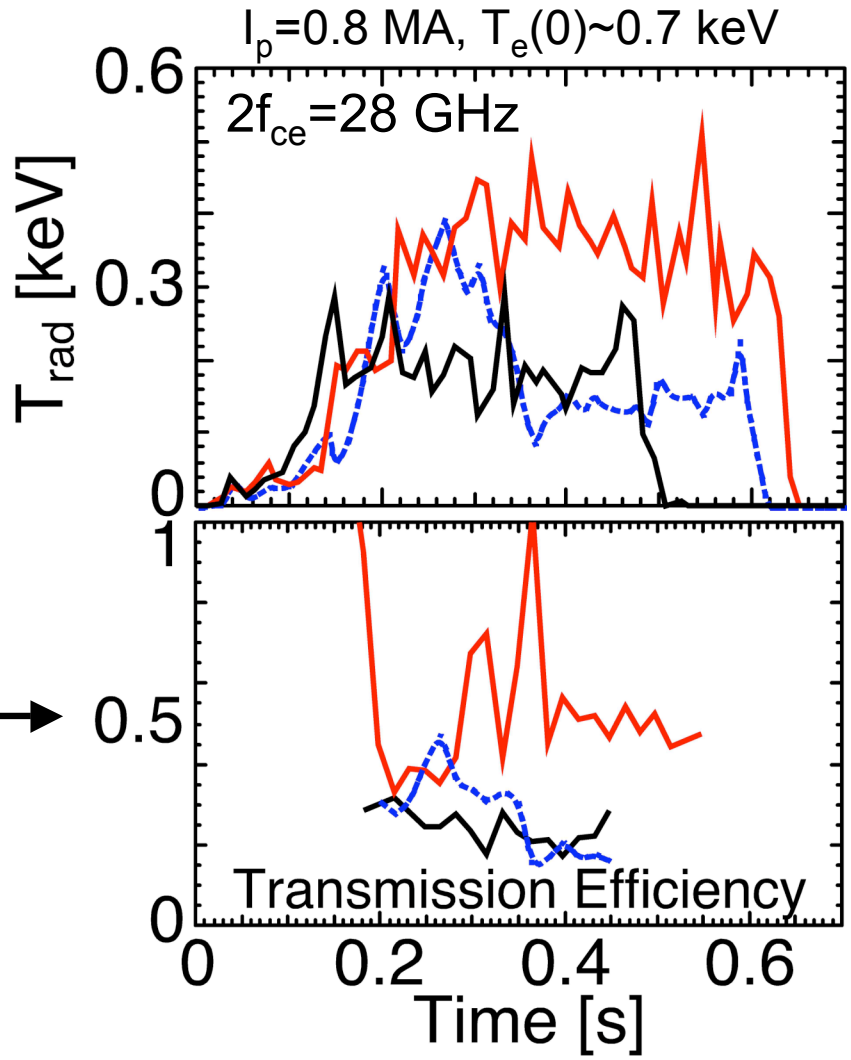
- Including collisional model (with Z_{eff}=2) results in closer agreement to measured T_{rad}

Edge lithium conditioning may reducing edge collisionality

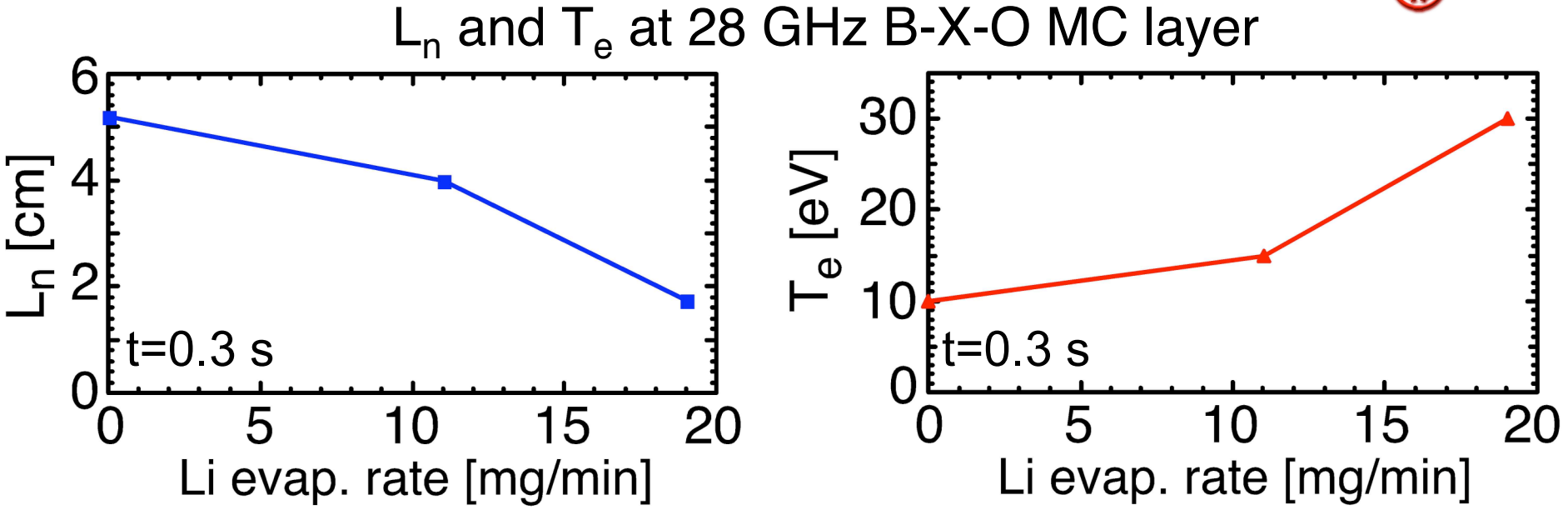
EBE transmission efficiency increased with lithium evaporation rate

0 mg/min (124284)
11 mg/min, total = 171 mg (124290)
19 mg/min, total = 286 mg (124309)

- Measured T_{rad} increased from 200 eV to ~ 400 eV →
- Transmission efficiency increased with Li conditioning: →
  - From 20% → 60% for f_{ce}=18 GHz
  - From 20% → 50% for $2f_{ce}$=28 GHz



Lithium conditioning increases T_e and reduces L_n near B-X-O mode conversion layer

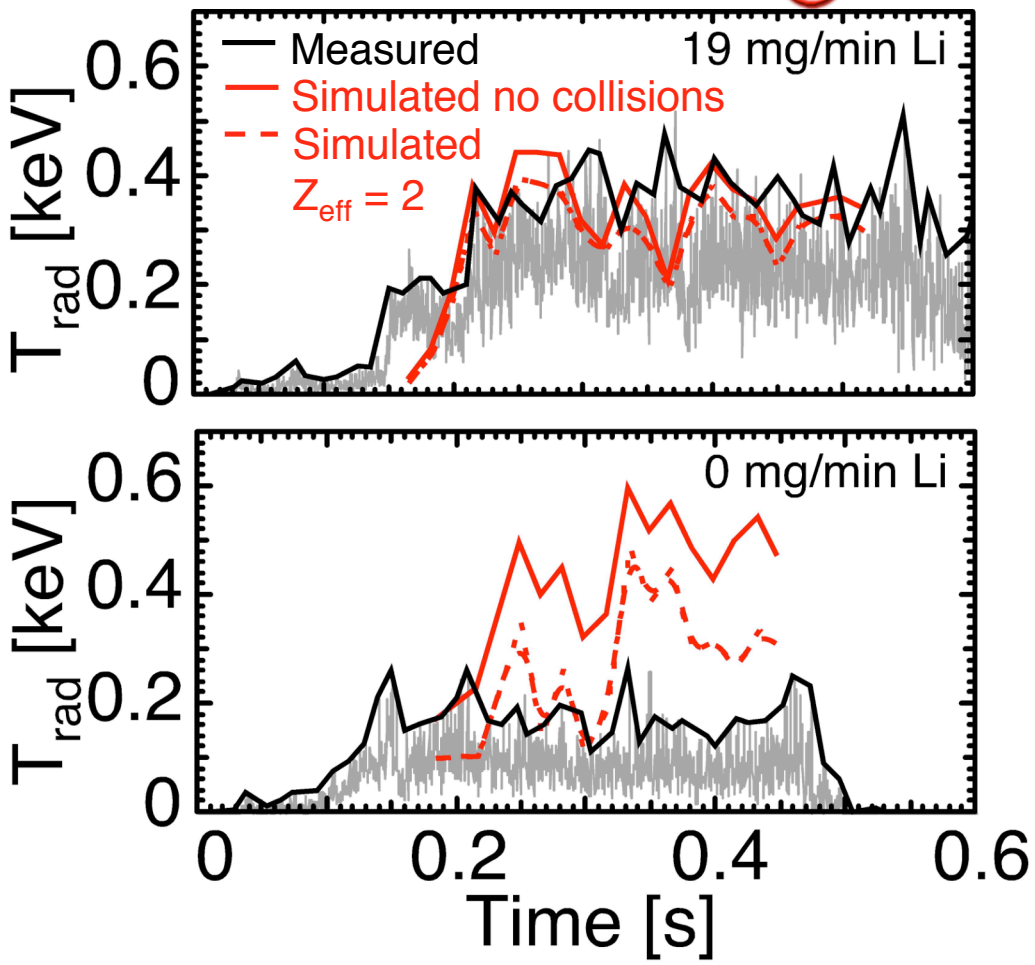


- 28 GHz mode conversion (MC) layer typically between R=144 cm and R=151 cm

- At t=0.3 s, T_e at B-X-O MC layer increased from 10 eV to 30 eV when Li evaporation rate increased from 0 to 19 mg/min
  - For $T_e < 20$ eV, EBW collisional damping becomes significant

Good T_{rad} agreement with EBE simulation in highest Li evaporation rate case for $2f_{ce}$=28 GHz

- For highest Li evaporation rate, 19 mg/min:
  - Measured and simulated T_{rad} agree
- For no Li:
  measured T_{rad} ~ 0.2 keV
  simulated T_{rad} ~ 0.4 - 0.6 keV



For 19 mg/min of Li conditioning, T_e near MC may be high enough to avoid EBW collisional damping before B-X-O conversion

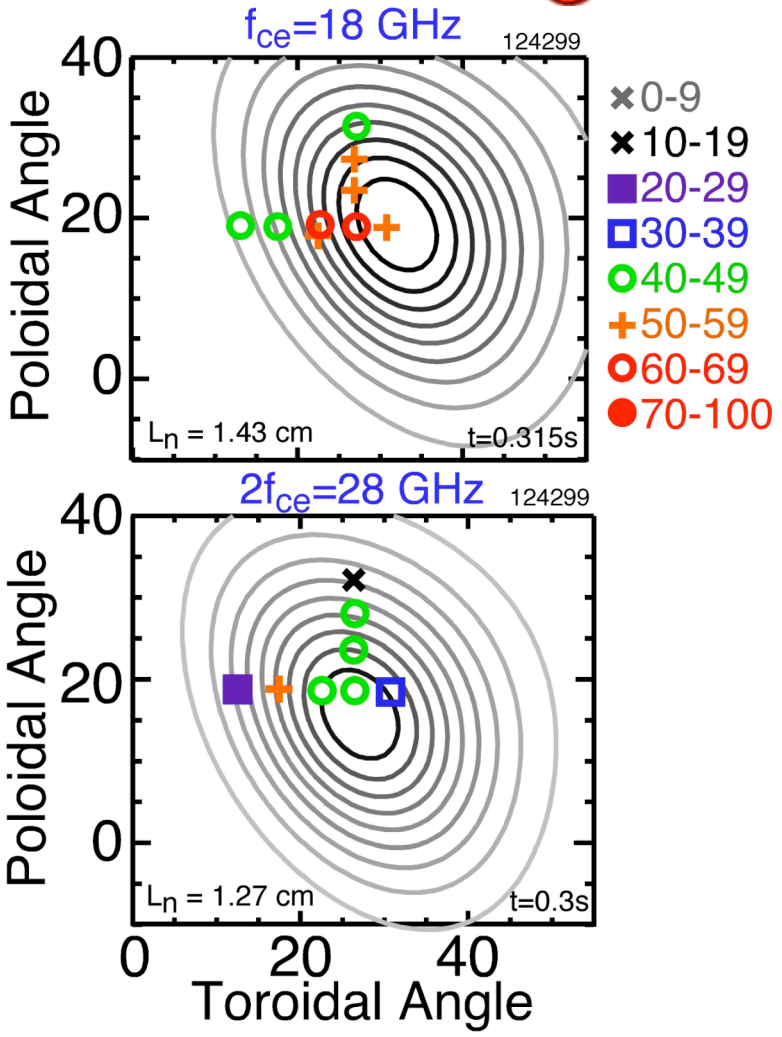
Angle of maximum B-X-O transmission consistent with theory

- Repeated target plasma, (I_p =0.9 MA, $T_e(0)$~1keV) with Li conditioning

- Experimental B-X-O transmission efficiency:

$$\text{Transmission}_{EBW} = \frac{T_{rad}(\text{measured})}{T_{e,\text{Thomson}}(R_{\text{emission}})}$$

- Maximum measured transmission efficiencies:
  - 62% for f_{ce}=18 GHz near axis emission
  - 49% for $2f_{ce}$=28 GHz near axis emission



Significant improvement in EBW transmission efficiency observed with Li edge conditioning

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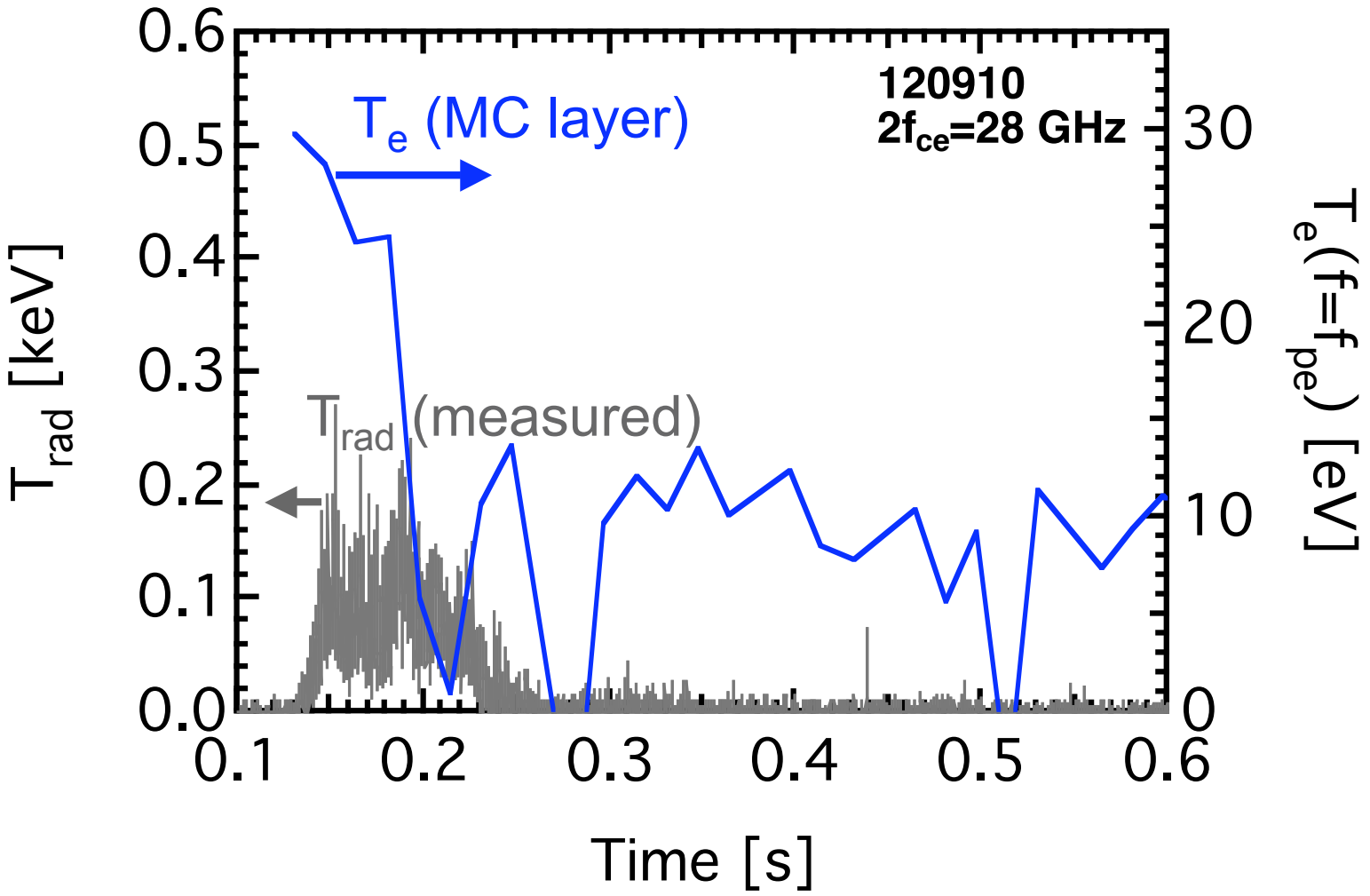
- EBE simulations support previously measured low B-X-O emission due to EBW collisional damping in plasma edge
- Li conditioning significantly increased measured EBE transmission efficiency
- Highest measured EBW transmission efficiency for H-mode plasmas now 50-60% with Li edge conditioning
- EBW emission measurements support the design of planned NSTX 28 GHz EBW heating system
- EBW heating experiments may have decreased collisional damping
  - Parasitic heating effects may increase edge T_e

→ For more details, see TP8.00103 & TP8.00104 Thursday AM

Supporting Slides

T_e decrease in 2006 H-mode observed to coincide with T_{rad} decrease



EBE transmission efficiency increased with Li evaporation rate for f_{ce}=18 GHz

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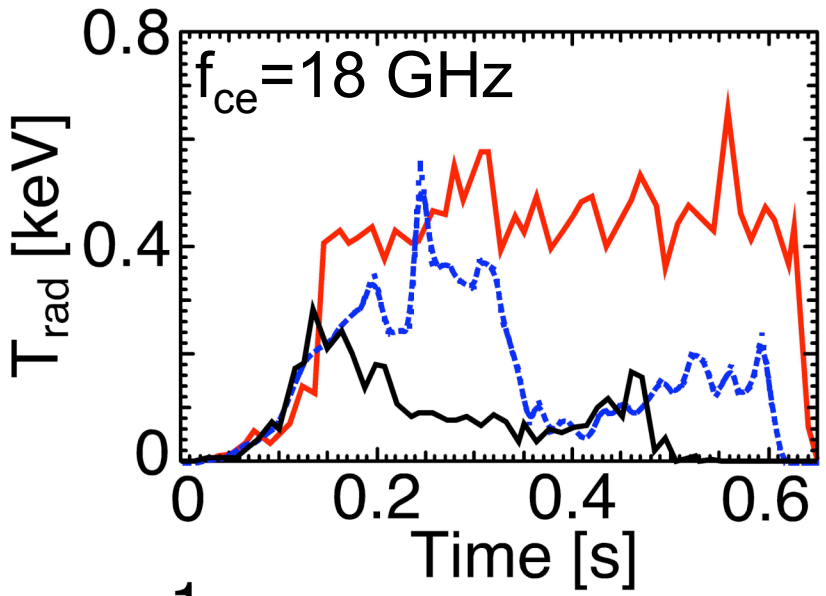
0 mg/min of Li (124284)

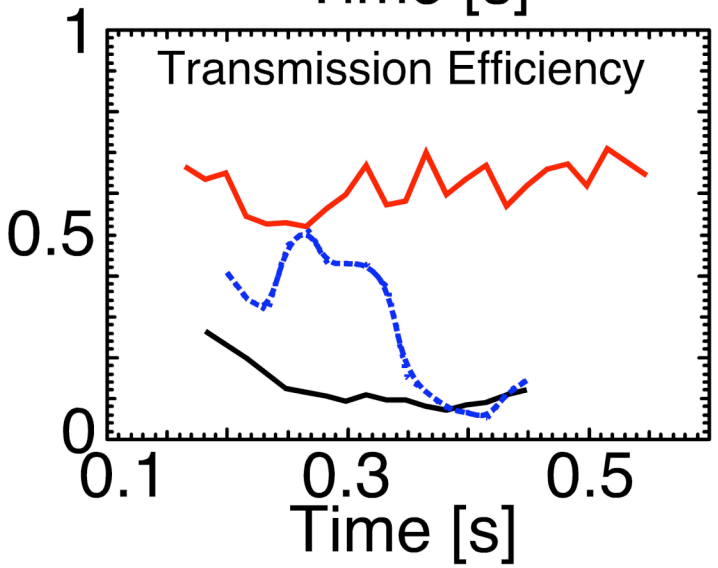
11 mg/min of Li (124290)

19 mg/min of Li (124309)

- Measured T_{rad} increased from 200 eV to ~ 400 eV
- Transmission efficiency increased
  - From 20% → 60% for f_{ce}=18 GHz
  - From 20% → 50% for $2f_{ce}$=28 GHz

Li conditioning ↑ T_e & ↓ L_n near mode conversion layer





Better T_{rad} agreement with EBE simulation in highest Li evaporation rate case for f_{ce} = 18 GHz

- For highest Li evaporation rate, 19 mg/min
  - Measured T_{rad}~0.4 keV, simulated T_{rad}~0.6 keV
- For 0 mg/min
  - Measured T_{rad}~0.1 keV, simulated Trad ~0.4 kev