NSTX

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Edge Impurity Transport Measurements with the New ME-SXR Diagnostic (XP1073)

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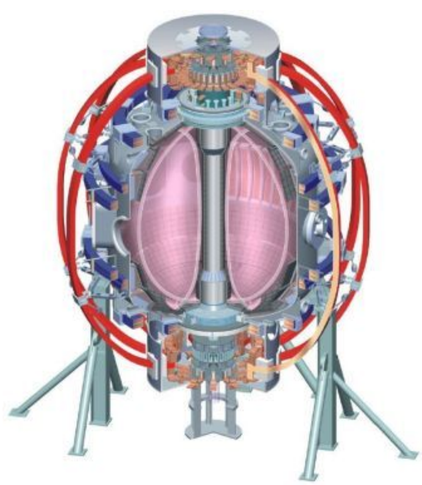
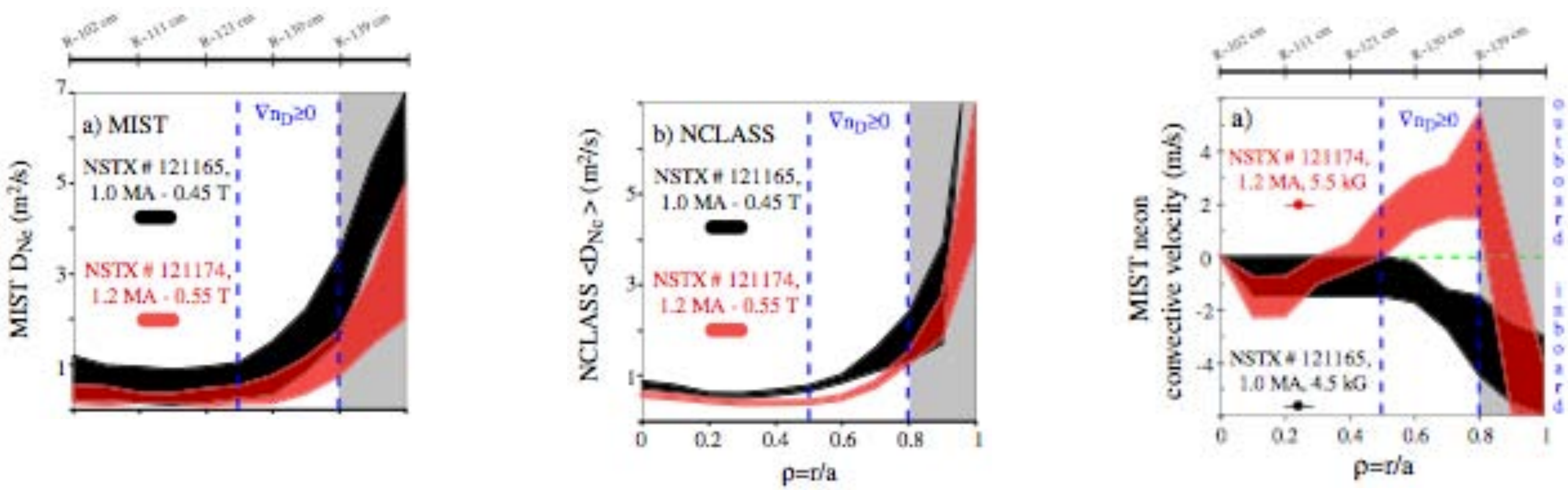


X-ray Emission from Plasma Impurities can be Utilized to Measure their Particle Transport

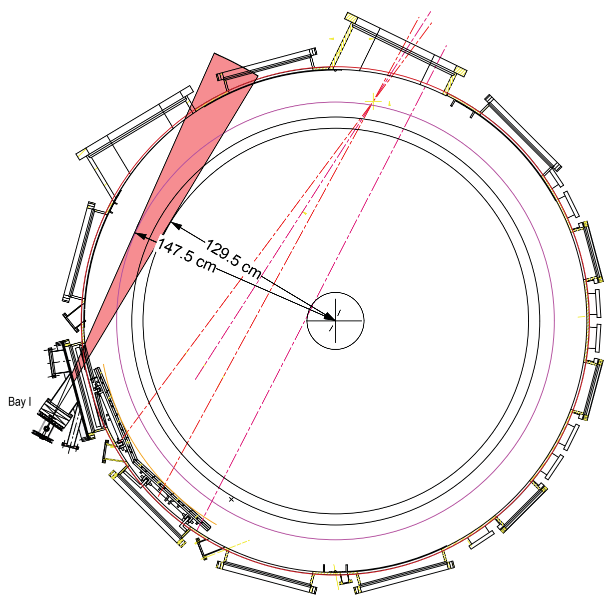
- Previous transport measurements of neon gas puffs using the optical SXR array had large uncertainty in the edge (~5 cm spatial resolution, weak signal in the plasma edge)
- Questions remain about transport in the edge
  - How does carbon build up in ELM-free discharges?
  - How does transport vary throughout the pedestal region?
  - Does the particle transport barrier broaden with lithium?

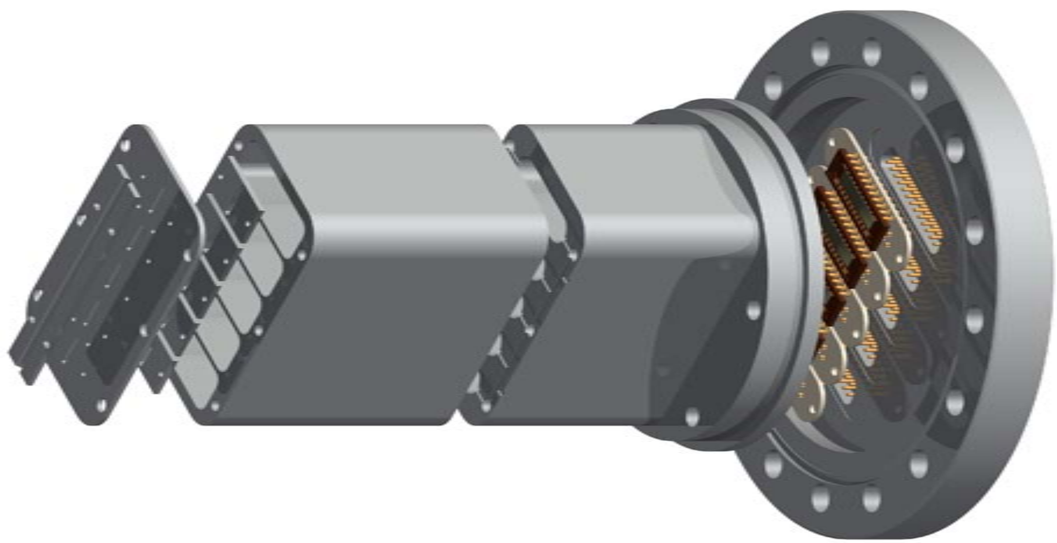


L. Delgado-Aparicio et. al., Nucl. Fusion (2009)

A New Multi-Energy Soft-X-Ray Diagnostic (JHU) Measures Emission from the NSTX Plasma Edge

- 5 photodiode arrays, each with a different filter (0.3 μm Ti, 5, 15, and 50 μm Be, and one without a filter for bolometry)
- 20 spatial channels provide ~1 cm resolution of plasma edge (R=127-147 cm) with a time resolution >10 kHz
- Digitally-controlled variable gain amplifiers provide excellent signal-to-noise for low intensities measured in the edge



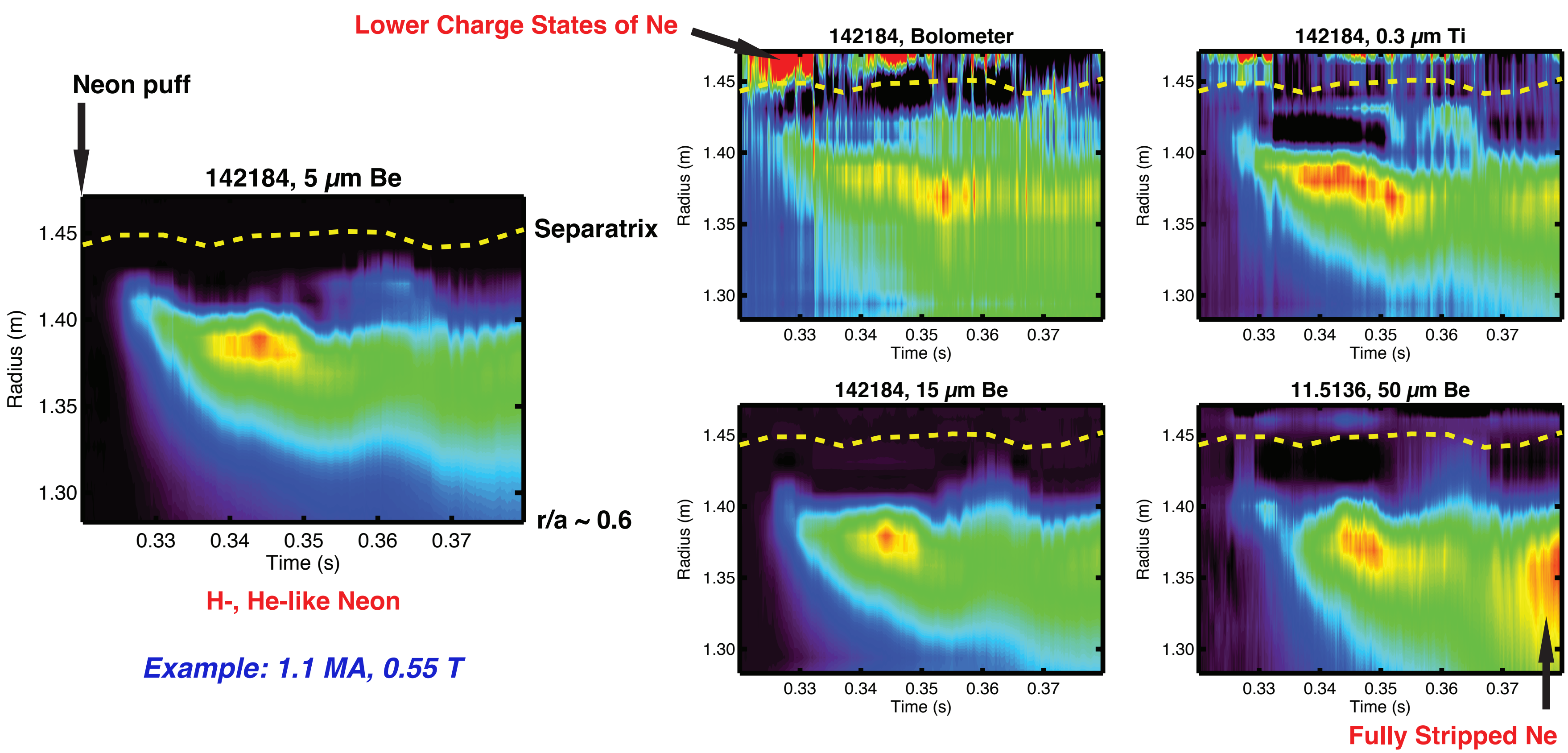


XP1073: ½ Run Day Used to Test ME-SXR, Optimize Ne Puff, and Collect Initial Data for a Variety of Plasma Conditions

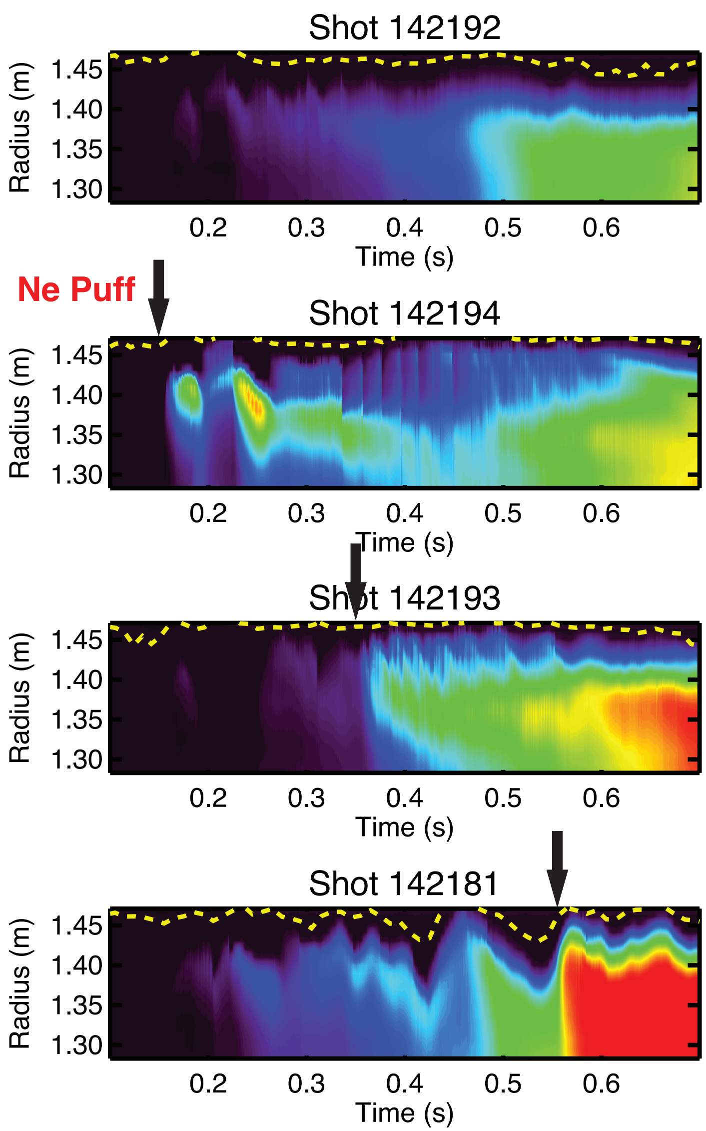
- 8 shots used to optimize neon gas puff and amplifier gains
  - Neon puff large enough to produce a strong x-ray signal without perturbing the plasma: 5 ms puff with flow rate of 10 torr L/s
- B_t scan (constant q) and q scan (constant B_t) performed
  - The time of the neon puff injection varied, and reference shots without puffs were taken at each step
  - **0.9 MA, 0.45 T**: 0.15, 0.35, 0.55 s + 2 reference shots
  - **0.8 MA, 0.40 T**: 0.45 s + reference shot
  - **1.1 MA, 0.55 T**: 0.32, 0.45 s + reference shot
  - **1.1 MA, 0.45 T**: 0.15, 0.50 s + reference shot
- MHD-quiescent, ELM-free H-mode plasmas were desired
  - LITER shutters malfunctioning, Li evaporation only before the run
  - ELMs were present in some discharges
  - More discharges for each condition are required for systematic study

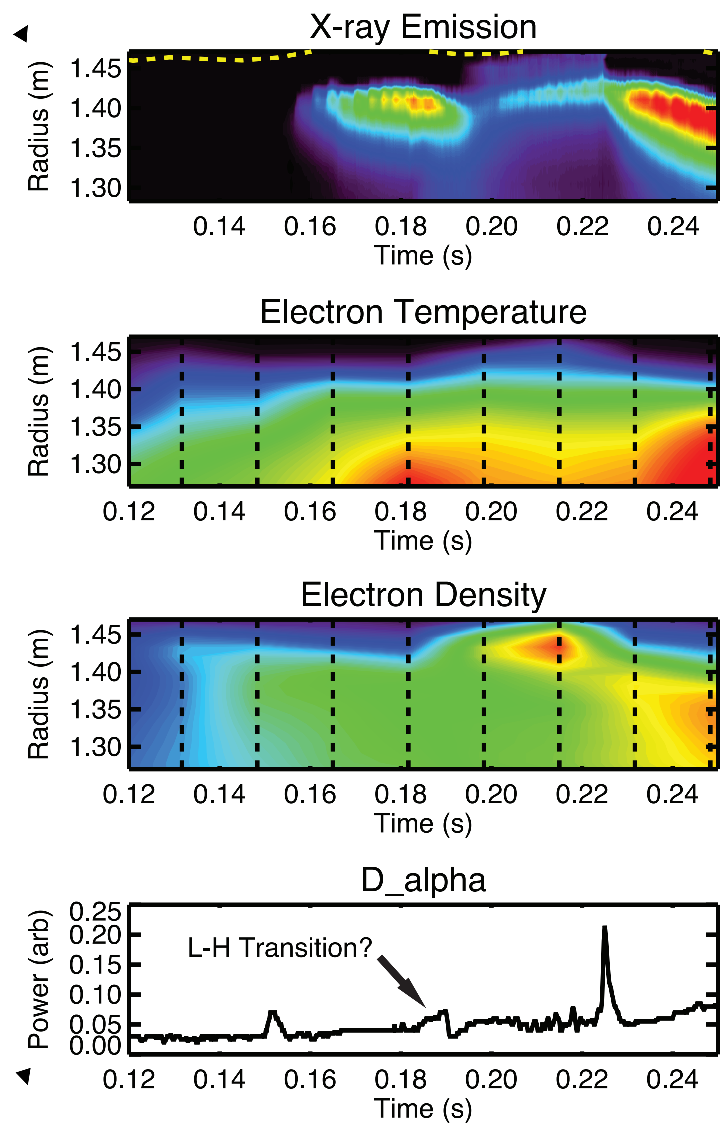
Inverted Data from Five Arrays Provide X-Ray Emissivity Profiles with 1 cm Resolution

- Five arrays are used to distinguish different charge states of impurities and provide fast temperature modeling
- Bolometer, 0.3 μm Ti have large noise from neutral pickup



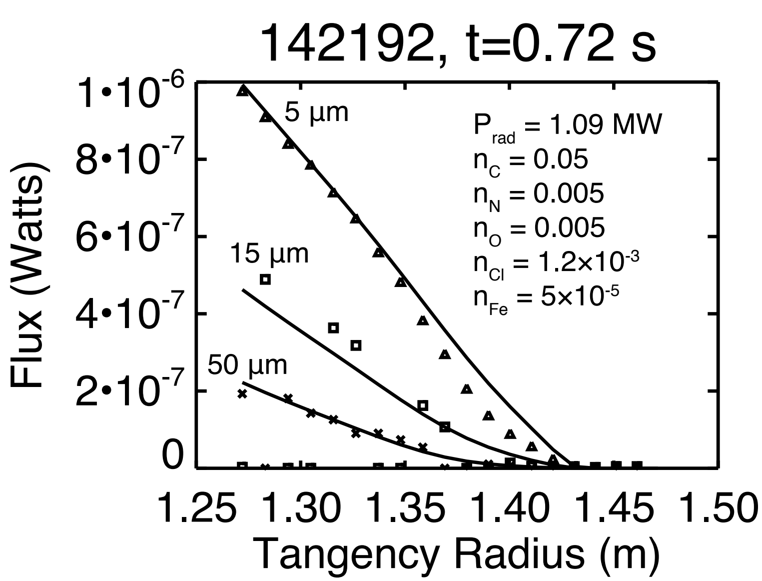
Neon Transport Appears to Change During a Discharge (Plots from 5 μm Be Array, Show H-, He-like Neon)

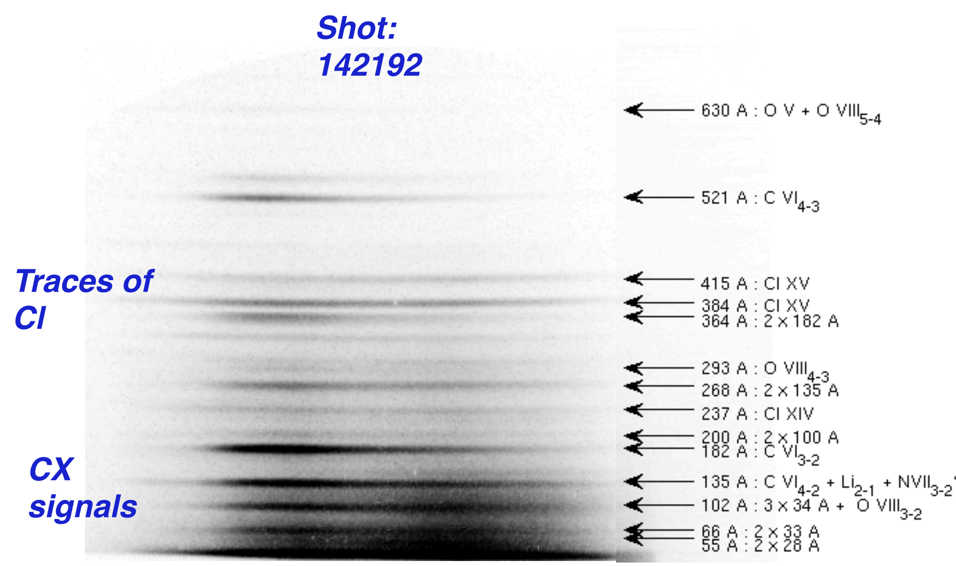




Initial Impurity Emission Modeling is Consistent with Data, Transport Modeling to Follow

- Expected x-ray emissivity calculated with Chianti atomic database code, using T_e, n_e from Thomson, n_C from CHERS, other impurity fractions from TGIS and other spectrometers
- All impurity density profiles assumed to be carbon-like
- Missing data points due to a digitizer failure
- Detector calibrations still ongoing





Neon Concentration is Small Compared to Carbon Density

- Neon density of 0.75% (of total electron density) at edge, linearly dropping to 0% in core gives decent fit to data
- Neon puff doubles 5 μm Be array signal, has smaller effect on 50 μm Be signals