Enhancements to the Edge CXRS System on the Joint European Torus

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ABSTRACT

Enhancements have been made to 2 of the 4 instruments comprising the edge (r/a = 0.5 to ~1.0) charge-exchange recombination spectroscopy (CXRS) suite of diagnostics on the Joint European Torus (JET). Both enhanced instruments now consist of short focal length spectrometers coupled to fast framing CCD camera at "high dispersion." Between these two instruments the number of (predominantly poloidal) plasma viewing channels increases from 24 to 34 views. The time resolution is improved to 10 ms (signal permitting). The neutral-beam induced charge-exchange emission of C <\textsubscript>i} at 520 nm, of Ne I at 524.8 nm, and of Ar XVII at 522 nm is observed simultaneously, complementing the existing edge CXRS instruments, which can be tuned to observe any wavelength of interest. These enhancements enable the simultaneous observation of the temperature, rotation, and concentration of multiple plasma impurity ions at improved temporal and spatial resolution. An overview of the edge CXRS diagnostic system on JET will be presented. Preliminary data will be shown from the current JET campaign. In particular, the temporal and spatial improvements afforded by this instrument will provide additional data during the formation of ion internal transport barriers (ITBs) in JET, especially on the relative timing and location of emerging rational flux surfaces and poloidal flow spin up.

NEW EDGE CXRS HARDWARE (KS7C & KS7D) [4-8]

- New hardware installed and calibrated in 2009
  - Fixed wavelength, complements tunable system
  - Redistributes 24 JET Octant 4 & 8 views
- Spectrometer [4, 5]
  - Kaiser Optical Systems HoloSpec 018
  - 1 curved entrance slit/spectrometer
  - "High dispersion" gratings: ~125 mm<br>
- Center wavelength at 520 nm
- CXRS lines measured simultaneously
  - 52.9 nm C II, 687 nm
  - 52.4 nm Ar XVII, 521 nm
  - Bremsstrahlung background at 525.5 nm
- CCD Camera [6]
  - Princeton Instruments PhotonMax 512B
  - 512x512, 16x16 µm pixels, 16 bit depth
  - Thermoelectrically cooled to -70 °C
  - Binned to 17 "tracks"
- Rotary Chopper [7, 8]
  - Scklce Instruments 300 CCD
  - Prevents image "smearing" during CCD read-out
- 10 ms framing period
- Future Upgrades
  - 5 ms framing period with new chopper tabs
  - Sim calibration lamp data on every discharge

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Figure 1: Fig. 1 from Ref. [1] showing details of the JET core CXRS system, viewing Octant 4 neutral beams.
Figure 2: Line-of-sight coverage of the JET edge CXRS system (KS7C), viewing Octant 4 and Octant 8 neutral beams.

Figure 3: Photograph of the new KS7C and KS7D hardware as installed at JET.

Figure 4: Spectra from the KS7D diagnostic on JET pulse 72428 with and without neon puffing. A gaussian fit to the C II line is shown (in red) with the resulting line-of-sight velocity and temperature.

Figure 5: Time evolution of KS7D measured line-of-sight T<sub>c</sub> and v in JET pulse 72434, showing the effect of ion ITBs on poloidal dynamics and that individual ELMs are resolvable at this time resolution.

Figure 6: Contour plot of r<sub>i</sub>/r<sub>0</sub> in JET pulse 72434, showing the presence of an ion ITB. r<sub>i</sub>/r<sub>0</sub> = 0.320 is considered the threshold for a "sustained" ITB in JET.

SUMMARY

- New instruments are described, which enhance the coverage of the JET "edge" (i.e. poloidal dynamics) CXRS suite of diagnostics.
- Incorporation into the CXRS analysis package is underway.
- Upgrades to the edge CXRS system are planned to improve calibration confidence and achieve a 5 ms framing rate.

REPRINTS


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REFERENCES