Expanded Capability of the Edge CXRS System on the Joint European Torus

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ABSTRACT

A new instrument has been added to the Joint European Torus (JET) edge charge-exchange recombination spectroscopy (CXRS) suite of diagnostics. This instrument consists of a short focal length spectrometer coupled to a fast framing CCD camera. With the addition of this instrument, the number of (predominantly poloidal) sightlines is increased by 20 to a total of 58 views. The radial range of the edge CXRS system extends from \( r/a = 0.5 \) to 1.0. The time resolution of this instrument is improved to 10 ms (signal permitting.) This diagnostic observes simultaneously the neutral-beam induced charge-exchange emission of C \textsuperscript{+} vi at 529.1 nm and of Ne x at 524.8 nm, complementing the existing edge CXRS instruments, which can be tuned to observe any wavelength of interest. The entire edge CXRS diagnostic suite has been absolutely calibrated and provides measurements of impurity ion temperatures, as well as the toroidal and poloidal components of impurity ion rotation. An overview of the edge CXRS diagnostic system on JET will be presented. Additionally, 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 \( q \) surfaces and poloidal flow spin up. Moreover, the ability to simultaneously measure the poloidal dynamics of multiple ion species (particularly Ne in addition to C) will facilitate “puffed” impurity transport studies.

CXRS SYSTEMS ON JET [1,2,3]

- JET core Charge Exchange Recombination Spectroscopy (CXRS) [1,2] consists of:
  - Two horizontally mounted periscopes (Octants 1 and 7) viewing the heating neutral beams (Octant 8, primarily PINI's 5 and 7)
  - Three vertical views of NBI PINI's and background plasma
  - 44 spatial views/periscope covering from outboard mid-plane to beyond the magnetic axis
  - 7 instruments providing coverage of spectral range from 430 to 750 nm

- JET edge Charge Exchange Recombination Spectroscopy (aCXRS) [3] consists of:
  - Three vertically mounted periscopes viewing the heating NBI PINI's
  - 40 paired views on Octant 4 (20 radial locations)
  - 18 Octant 8 views extending into core region
  - Slight toroidal offset from the NBI's allows for toroidal and poloidal rotation measurements
  - 4 instruments providing coverage of spectral range from 430 to 750 nm

NEW EDGE CXRS HARDWARE (KSTD) [4,8]

- New hardware installed and calibrated in 2007:
  - Fixed wavelength, complements tuneable system
  - Utilizes “unused” JET views
- Spectrometer [4,5]
  - Kaiser Optical Systems Holostopc F1.8
  - 2 curved entrance slits
  - ‘low dispersion’ grating: -400 nm/mm
  - Center wavelength at 529.1 nm
  - 10 nm BP filter
- CXRS lines measured simultaneously
  - $\lambda = 524.8 \text{ nm } (\text{ Ne x, } n=11-10)$
  - $\lambda = 529.1 \text{ nm } (\text{ C vi, } n=8-7)$
  - $\lambda = 528.4 \text{ nm } (\text{ Ne x, } n=11-10)$
- CCD Camera [6]
  - Roper PhotonMax 512
  - 512x512, 18x18 \( \mu m \) pixels, 16 bit depth
  - Thermoelectric cooled to -70 °C
  - Binned to 10 “tracks” = 20 views
- Rotary Chopper [7,8]
- Sctlic Instruments 300CD
- Prevents image “smearing” during CCD read-out
  - 10 ms framing period
- Future Upgrades
  - 5 ms framing period with new chopper tabs
  - “high dispersion” grating: -125 nm/mm

MEASUREMENTS [9,10,11]

- Caveat: Work is ongoing to incorporate this new edge CXRS instrument and the other edge CXRS instruments into the analysis package CXSFit[9], which will facilitate direct comparisons between the “edge” and “core” CXRS measurements on JET.
  - In this paper, line-of-sight rotation velocities and apparent temperatures will be shown for the new edge CXRS instrument.
  - Toroidal effects need to be removed from line-of-sight measurements to yield poloidal dynamics.
  - Preliminary result indicate good signal levels at 10 ms framing period.
  - CX light from both C vi and Ne x ions are observed simultaneously.

Figure 6: Contour plot of $\nu_i/\rho$ in JET pulse 77243, showing the presence of an ion ITB.

REFERENCES