Session II: Special Diagnostics

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Progress in Profile Diagnostics

- Ultrasoft X-Ray Arrays (Stutman)
  - ST challenges
    - High time resolution to observe MHD
    - Strong edge gradients require "two-color" measurements for mode structure
  - Future plans
    - Miniature re-entrant array with 200 kHz time resolution
    - Tangential array with 100 kHz, 1300 pixels (proposed)

- Multichord Reflectometry (Kubota)
  - High time resolution profiles
    - Clear L to H transition in profiles every 1.2 ms
    - Very fast density changes correlated with 100-150 kHz magnetic oscillations
  - Future plans
    - Fast FMCW, 3-channel quadrature, and radial correlation reflectometers
    - Higher frequencies (65 GHz) and 100 kHz sweep rates planned

Progress in Profile Diagnostics (cont.'d)

- D-alpha Measurements of Density Gradients (Tournianski)
  - Edge electron density profiles important for H-mode studies
    - D-alpha data give profiles with good temporal and spatial resolution
    - EBW emission correlates well with D-alpha density gradients

- Far Infrared Interferometry and Polarimetry (Lee)
  - Good progress with two-channel system
    - Vibrations eliminated and data compare well with Thomson scattering
    - "Ear" structure observed and measured across H-mode transition
  - Future plans
    - Faraday rotation measurements
    - Increase number of channels (2->4) and laser power (50 -> 90 W)

New Diagnostic Techniques

- Electron Bernstein Wave Emission Diagnostics (Shiraiwa)
  - Electron Bernstein wave (EBW) system working on TST-2
    - Consists of heterodyne detection radiometer and AM reflectometer
    - Permits monitoring of mode conversion efficiency by correlating changes in T_{rad} with variations in density

- X-Ray Spectroscopy (Bitter)
  - Spherical crystals permit X-ray imaging instrument
    - No need for neutral beam injection for ion temperature measurements
    - 1 cm spatial resolution and 10 ms time resolution demonstrated with RF-heated plasma
  - Future plans are for two-dimensional detector
    - Multiwire proportional counters (BNL and K-Star) for 500 kHz range
    - GEM detector with delay line readout being developed to get into MHz range

Progress in Imaging Diagnostics

- Fast X-Ray Imaging (Pacella)
  - Time-resolved X-ray images obtained
    - Based on gas electron multiplier (GEM) detector
      - Proportional counter means in 128 "low resolution" spectrometers
    - Rotating mode structure seen in 80 cm x 80 cm field of view
  - Future plans
    - "Zoom" feature for improved spatial resolution
    - Increase energy range from 3-8 keV to 0.2 - 10 keV

- GEM system one of three 2-D tangential soft X-ray imaging systems on NSTX
  - Soft X-Ray Pinhole Camera
    - Standard CCD camera used to image window coated with phosphor scintillator
  - Fast X-Ray Pinhole Camera
    - Uses fast-framing CCD camera with on-chip memory storage for high speed

Current Profile Diagnostics

- Motional Stark Effect Measurements on NSTX (Levinton)
  - Collisionally-Induced Fluorescence (CIF)
    - Throughput maximized with large number of fibers
    - 10 channels at start and 19 channels at end of FY03 run
  - Laser-Induced Fluorescence (LIF)
    - RF source for beam under development at Berkeley
    - Availability expected for 2006

Summary and Recommendations

- Summary
  - Data show need for improved temporal and spatial resolution
  - All upgrades seek to add channels and increase time response
  - Efforts complement development of fluctuation diagnostics

- Recommendation
  - Data for internal equilibrium constraints will be major focus in FY03 run
    - Motional Stark effect polarimetry
    - Microwave reflectometry and interferometry
    - Far infrared interferometry
    - GEM and pinhole camera soft X-ray imaging
      - Successfully demonstrated for ST by constraining q(0) on Pegasus
  - Each constrains q(0) but "cross checking" important in new class of devices like ST's
    - Precedent set in current profile diagnostic development on PBX-M
      - Simultaneous exploration of Motional Stark effect polarimetry, X-ray pinhole camera, and fast ion orbit shift diagnostics built confidence in measurements