Diagnostic Issues workshop summary

Short diagnostic capability presentations of the two main FRC experiments were made by Guo (TCS) and Inomoto (FIX). Wurden presented an overview of diagnostic needs and problems pertaining to CTs. Audience discussion agreed with the basic importance of diagnostics to our entire physics programs. Discussion of the commonality of many diagnostics with other confinement concept needs, and that diagnostic issues should play a major role at the upcoming Snowmass meeting in July 2002. It was recognized that "a" diagnostic is often the piece of an experiment that Ph.D. students are trained with and which they are able to "own."

Diagnostic issues for CTs. In order of needs: money; physical access; ideas.

Money. Money is clearly over-constrained; more is needed both to implement good diagnostic sets on existing CT machines, and to have the ability to fund "exotic" or "advanced" diagnostics for special CT issues. For all CT experiments, there is rarely a person who only works on "one" diagnostic. The manpower is over-committed. (As an aside, in most of the one-person cases, that person is a student!)

Special access constraints. For spheromaks: the need to diagnose the helicity injector (i.e. gun) region for spheromaks; experiments often have a tight fitting flux conserver, limiting spatial views in the main plasma. For FRCs: end-on access is equivalent to looking through the divertor region (axial flow); side-on access ports are difficult, due to conventional quartz tube and tight-fitting theta or guide coils and in some cases HV insulation.

Common problems. CT's are still diagnosed with 70's era techniques, and often with recycled 70's era equipment. There is a need for multi-point spatial and temporal resolution obtainable in one shot, in all diagnostic categories. Internal current/B-field profile measurements, without resorting to probes are still developmental at best. Ability to measure flows without resorting to probes is also problematic. Due to high power systems (HV, RMF), noise issues are usually even more difficult than in tokamaks and stellarators. Multi-Megawatt noise sources are an everyday issue in CT's.

Probes. We love them and we hate them. Single probes, multi-probes, dense-pack arrays, all are used, especially for colder basic science plasmas. Swept probes often don't work well in our plasmas due to the short plasma lifetime, forcing many shots to make a "scan." However, the perturbative effects of probes are an evil we live with. There is a need for "nano-probes" … ones that are much smaller than standard, and yet still able to survive, while measuring more than just B-dot, such as local current densities, local flows, energy analyzers, etc.

Support issues. Support for machine subsystem controls. Support for data acquisition: many machines using MDS+ from MIT/LANL; most without dedicated computer staff. Support for analysis and modeling of experimental data is a point that could be greatly strengthened. Community network is strong, through cross-collaborations and sharing of ideas, problems, and solutions.

Ideas. We have no shortage of ideas on how to better diagnose our plasmas, some of which we are implementing, but many of which we are not, due to resource limitations.

– Transient pellets … TIP
–FLIRT …. Zap a pellet with a laser, and look at fast electron transport via observation of soft-x-rays.
– Thomson scattering (SSPX, FIX, HIT-II, FRXL, TCS)
– Intense pulsed neutral beam for spectroscopy
– Time-of-flight Faraday rotation of a laser pulse
– Hypervelocity dust for a neutral source across the plasma
– Better polarimetry (more chords, better S/N)
– Time-resolved high-speed imaging, in both the visible and soft-x-ray ranges.
– Better power balance measurements in both the bulk and divertor regions of the plasma.