Charge Exchange Emission Spectroscopy
This diagnostic technique noninvasively provides information on:
- Atomic and molecular species
- Spatially resolved species energy
- Gas Temperature

Excited species in a plasma emit photons under a variety of processes. In a Hydrogen plasma the charge exchange predominately produces excited neutrals that can be spectroscopically measured.

Charge Exchange reactions dominant in spectroscopic measurement of Hydrogen:

\[
\begin{align*}
\text{H}^+ + \text{H}_2 &\rightarrow \text{H}^+ + \text{H}_2^+ \\
\text{H}_2^+ + \text{H}_2 &\rightarrow \text{H}^+ + \text{H} + \text{H}_2^+ \\
\text{H}_3^+ + \text{H}_2 &\rightarrow \text{H}^+ + \text{H}_2 + \text{H}_2^+ 
\end{align*}
\]

The observed wavelength of the photons emitted by excited atoms is Doppler shifted:

\[
\Delta \lambda = \frac{\nu \lambda}{c} \cos(\theta)
\]

Lighter species will reach a higher velocity than the heavier species, allowing a measurement of relative accelerated molecular population as well as energy distribution information in a variety of IEC conditions.

Initial spectroscopic measurements of the IEC have been taken in glow discharge mode. An inherent trade between resolution and signal intensity exists.

The intensity of the helicon plasma allows the measurement of molecular Hydrogen lines. Theoretically, these lines can be used to measure gas temperature.

Optics & focusing:
Primary ion path
Helicon
Possible field of view

Diagnosis of the IEC will proceed by examining the primary beam path produced when using the helicon source in the IEC. By focusing on points along the beam path a detailed ion energy spectrum can be spatially resolved.

A close-up of the H\(_\alpha\) (656.3 nm) line from the helicon shows a persistent Gaussian peak about at 657.0 nm. The source of this signal is not yet identified.

With acknowledgments to the Grainger Foundation