NSTX

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Core x-ray imaging spectrometer (CXIS) for measurements of temperature ($T_{i,e}$) and velocity ($v_{\phi,\theta}$) profiles in NSTX-Upgrade

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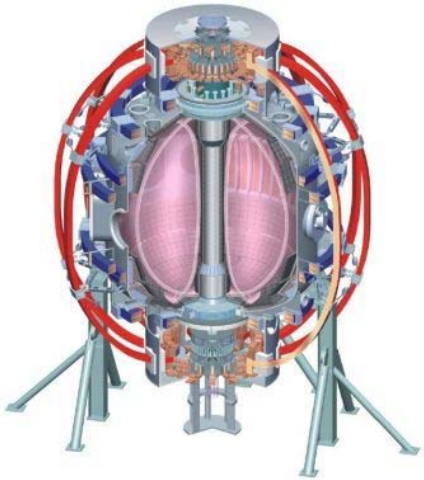

Motivation for using this diagnostic in NSTX-Upgrade

① Measurement of good profiles of $\mathbf{v_{\phi,\theta}}$ & $\mathbf{T_{i,e}}$ important for understanding and optimizing transport and confinement.

- ETG, ITG & TEM ($\propto\nabla T_{i,e}$, T_e/T_i) driven turbulence are leading candidates for explaining anomalous transport.
- Rotation velocity and velocity shear play important roles in the L→H-mode transition, ITB formation, evolution of NTMs and Locked-Modes as well as RWM stabilization.

① Study of **intrinsic** and/or **driven** rotation in the absence of a strong momentum input (e.g. comparison between Ohmic vs NBI vs RF driven discharges). *Important for ITER and future reactors!*

③ Help diagnose advanced scenarios envisioned with the 2nd NBI.

③ It will contribute to many TSGs: MHD, Transport (particle, heat and momentum), Waves, ITER urgent-needs and Li-research.

③ CXIS is a PRIMARY diagnostic for T_i and $v_{\phi,\theta}$ measurement on ITER – provides at home, hands on training for young physicists to work on ITER later.

XCIS enables $v_{\phi,\theta}$ & $T_{i,e}$ measurements via Doppler broadening, line shifts and line-ratios

Additional notes:

① **Will provide $v_{\phi,\theta}$ & $T_{i,e}$ measurements in RF heated plasmas.**

② **NBI not required.**

③ **CHERS will encounter background problems when the 2nd NBI is in use.**

④ Continuous operation for steady state long pulses.

⑤ Measurement of Mo, Ar, Fe density profiles.

⑥ Similar systems installed at C-Mod, EAST, KSTAR and LHD.

⑦ "Non-perturbative" passive spectroscopy.

Characteristics:

① $\Delta r \lesssim 1$ cm.

② $\Delta\lambda/\lambda \sim 10000$.

③ $\Delta t \gtrsim 5$ ms (unless EIGER becomes available).

Needs:

① Two access ports for poloidal and tangential imaging.

② Tentative locations are: **a)** Poloidal view @ Bay D and **b)** tangential view at Bays L or K.

NSTX-U CXIS provides also a local platform for the ITER CXIS R&D

Examples of ITER CXIS relevant R&D:

① Detailed ***comparisons of CXIS measurements with CXRS measurements*** for validation of both systems.
② Continued development and improvement of the analysis software for improved robustness, analysis speed for ***real-time T_i evaluation*** for machine safety, improvements in the inversion algorithms.
③ Dealing with neutron background noise; experience with shielding of a system exposed to 12 MW of NBI.
④ Training the engineers and draftsmen who will design the ITER CIXS.

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⑤ Developing the *λ-calibration capability* with x-ray line sources.
⑥ Testing advancements such as multiple crystals on the same substrate.
⑦ Crystal temperature control.
⑧ Evaluating new detectors as they become available.