XICS on NSTX-U

Provides passive measurements of ion temperature and toroidal rotation profiles

also impurity density profiles (for impurity transport studies) and electron temperature profiles

Comparison with CXRS

pros:
- much simpler interpretation of spectra
- no background subtraction
- faster time resolution
- can be used to measure intrinsic or purely RF driven rotation
- can be used for high z impurity transport studies

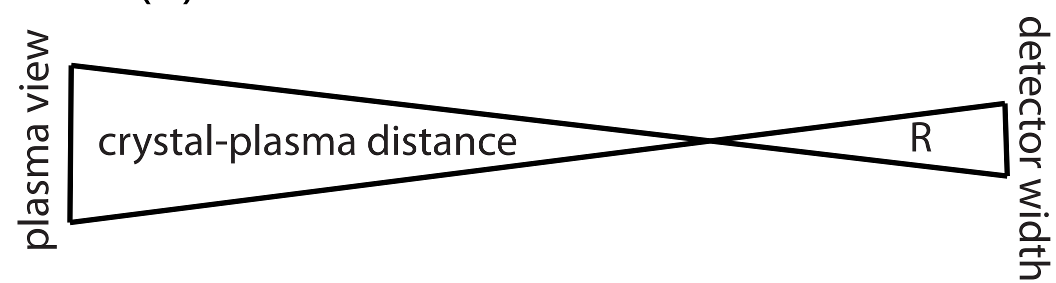
cons:
- requires impurity (argon) puffing
- lower signal near the plasma edge (unless population by radiative recombination)
- (argon can only work for electron temperatures below 4 keV)

Constraints/Tradeoffs

Case 1 He-like argon only: V_{Tor} and T_i (T_e and n_{Ar})
with tangential view, excellent V_{Tor}, even with low resolving power. edge T_i may require strong Ar puffing or low time resolution.

Variables:

magification: determined by detector size, plasma view, distance to plasma and length of exit arm/Rowland circle (R)



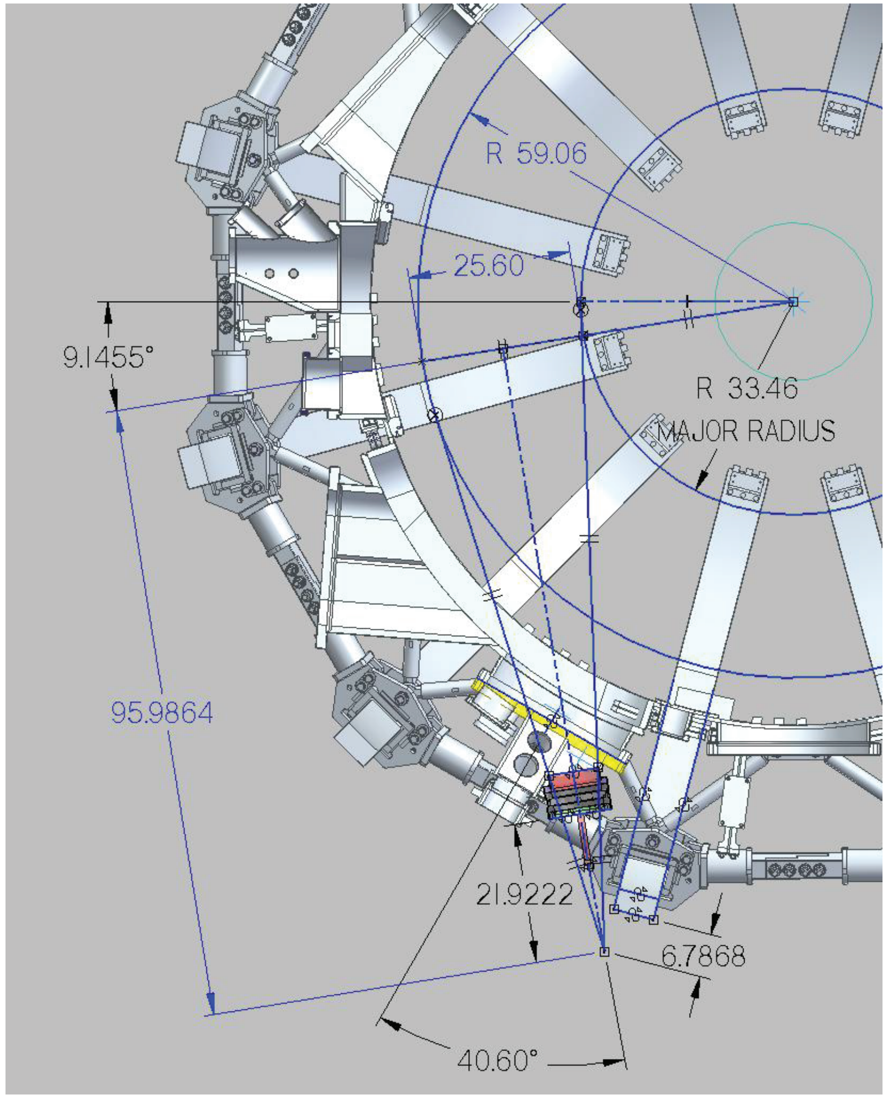
impurity species: crystal 2d, crystal cut (reflectivity), Bragg angle θ (> 45^o for imaging), also crystal size l

resolving power ~ $8 (R \tan\theta / l)^2$

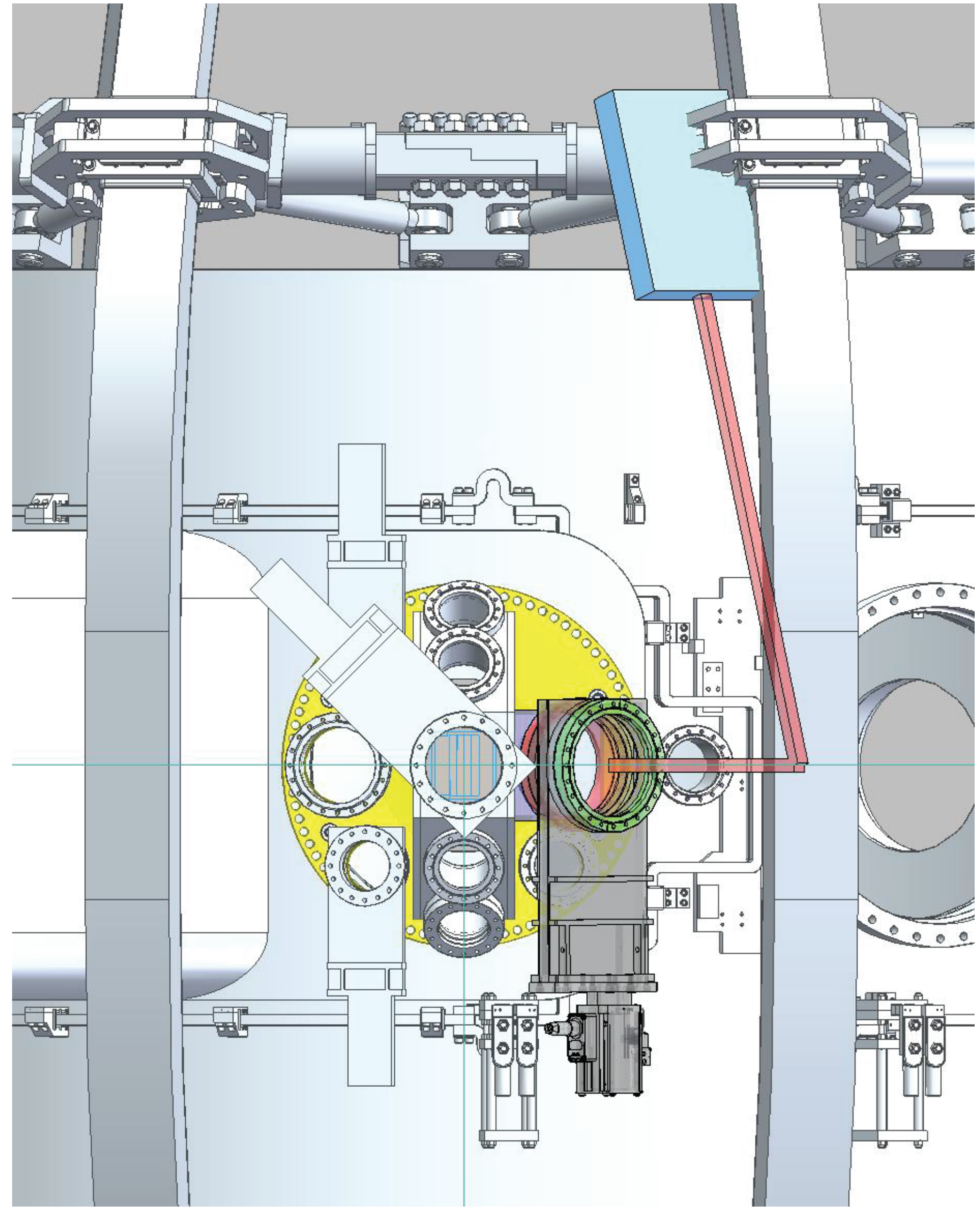
Case 2 also He-like calcium: for impurity transport requires variable Bragg angle and crystal change

other bells and whistles: variable aperture for crystal size allows changes in throughput and resolving power

View of Outer Half of Plasma Cross Section



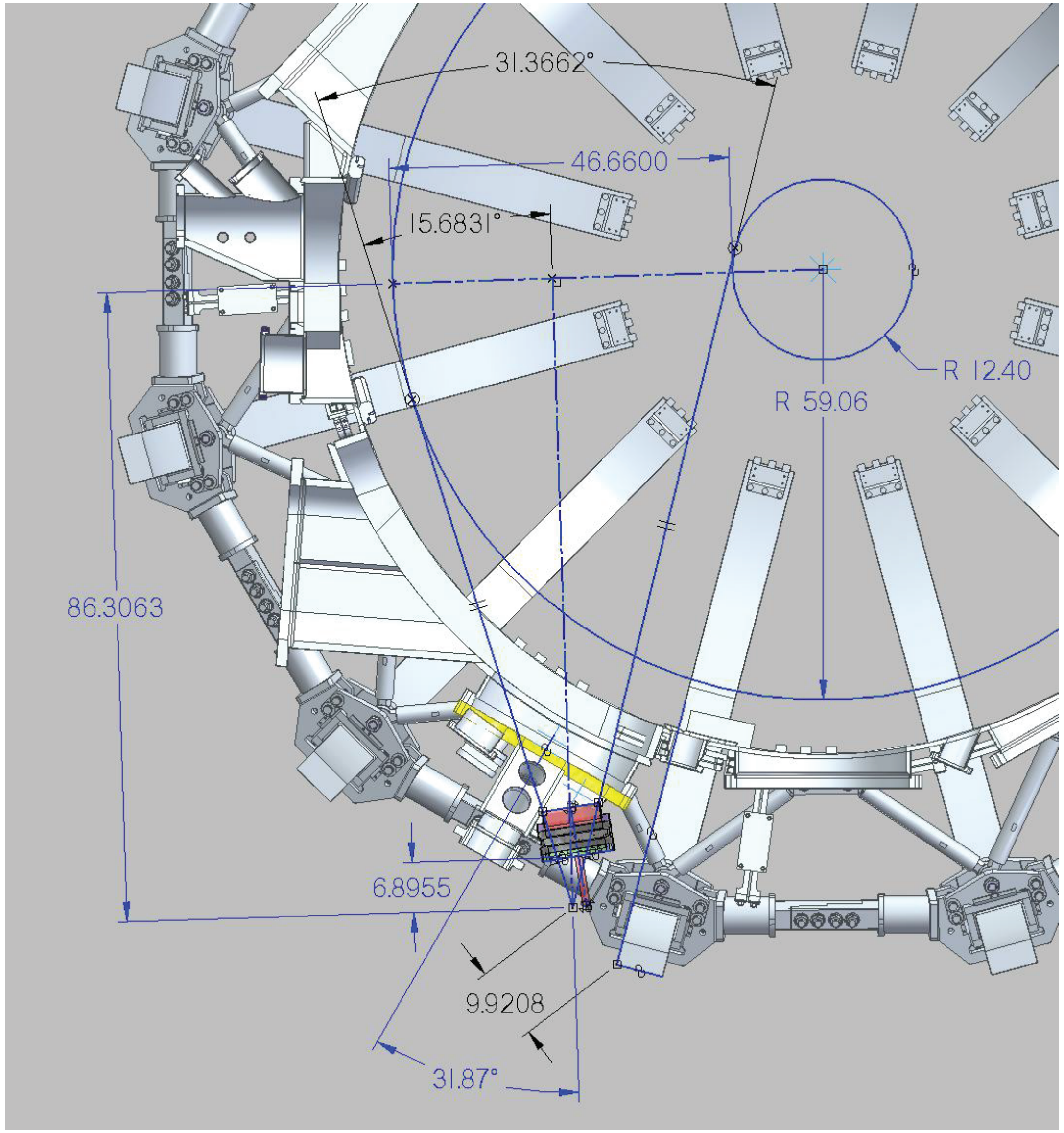
with a Bragg angle of 54 degrees,
interference of detector arm



active width of detector ~ 25 cm gives ~ 3.8 to 1 magnification which leads to an exit arm length ~ 94 cm or a crystal curvature radius of 1.9 m.

resolving power ~ 8 $(R \tan\theta / l)^2$ ~ 5400 with R ~ 94 cm, l ~ 5 cm

View of Full Plasma Cross Section



active width of detector ~ 25 cm
gives ~ 2 to 1 magnification which
leads to an exit arm length ~ 46 cm
or a crystal curvature radius of 92 cm.
too low resolving power? ~1300

with a Bragg angle of 54 degrees,
no interference of detector arm