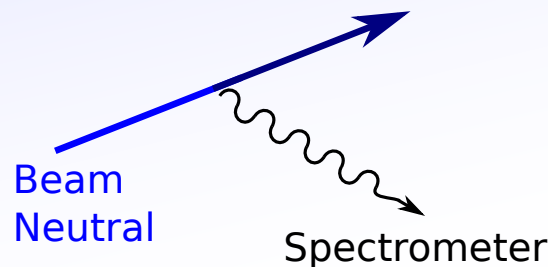


CXRS/BES on NBI

Charge Exchange Recombination Spectroscopy + Beam Emission Spectroscopy on the Neutral Beam Injection

Physics principles:

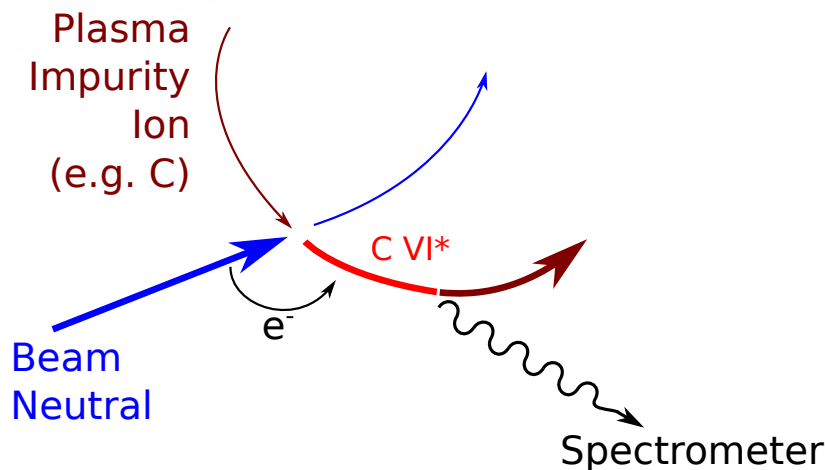
Beam Emission Spectroscopy:



Observe beam neutral H α emission.

--> Beam neutral density (n_b)
a.k.as 'beam attenuation' or 'beam fuelling'

Charge eXchange Recombination Spectroscopy:

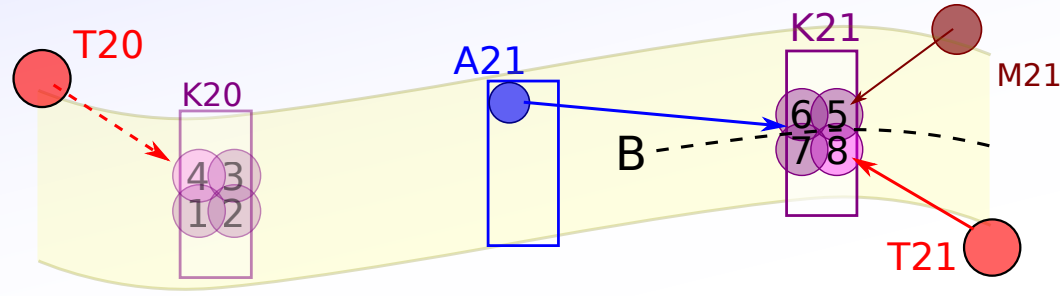
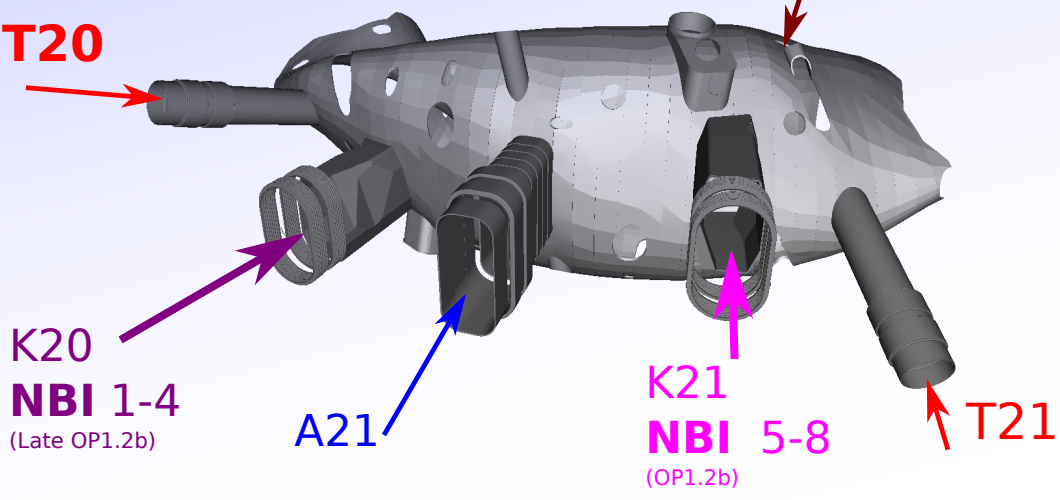
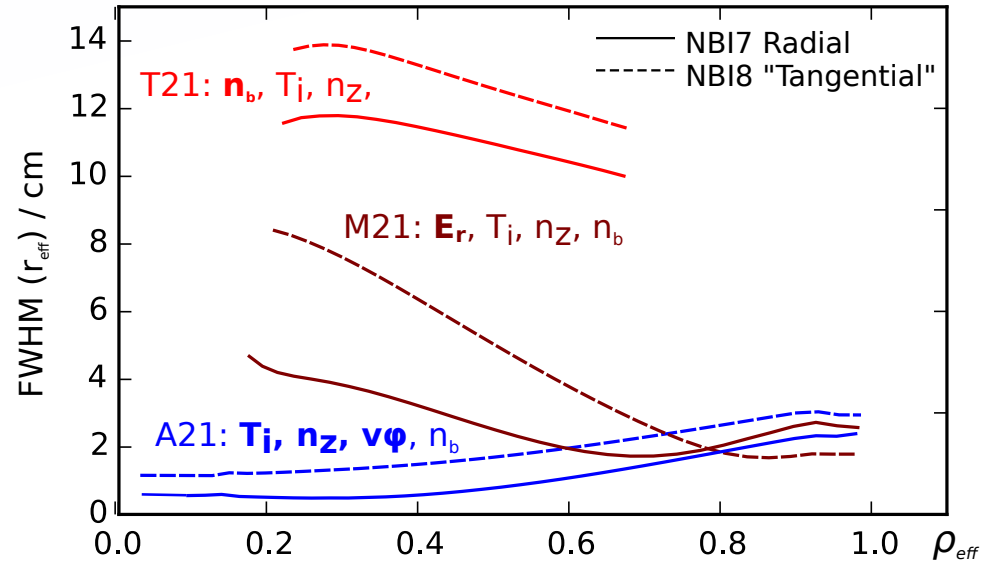
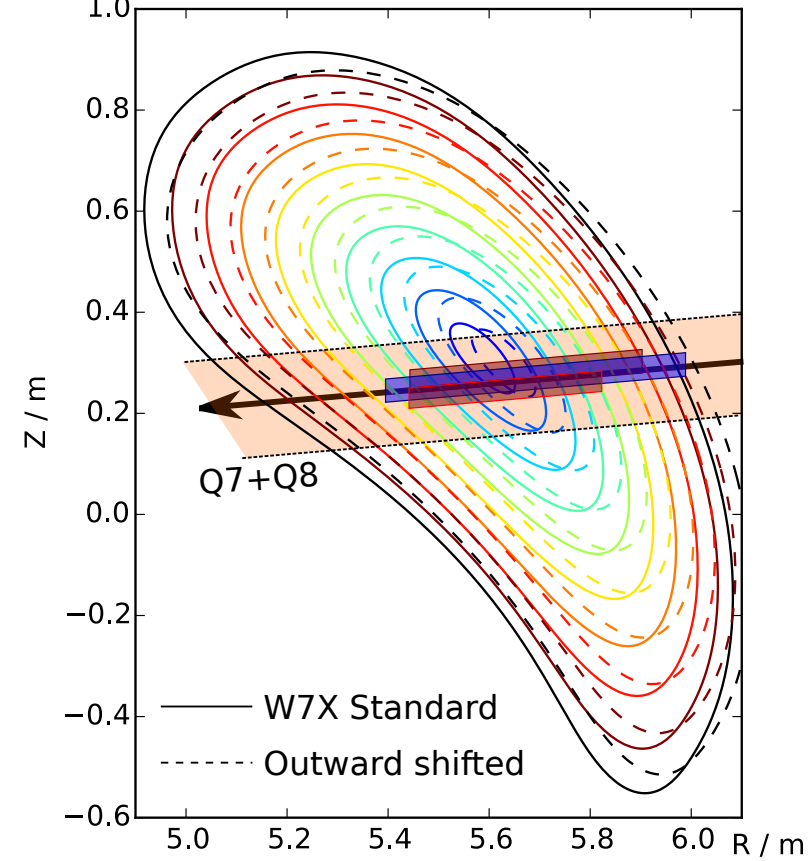


Observe excited impurity ions after charge exchange.

--> - Impurity Densities (n_z)
- Ion temperature (T_i)
- Radial Electric Field (E_r)
- Toroidal Rotation (ω_ϕ)

Availability: All plasmas with NBI (from OP1.2b)

CXRS Observation

Module 2:**Spatial resolution****Surfaces near NBI K21 beam**

- AEA21:** High resolution, toroidal view. (80 channels)
- AEM21:** 45° to toroidal. Primarily for E_r . (80 channels)
- AET20/21:** Low resolution -45° to toroidal. (8 channels per box)



Impurities / Emission Lines

All relevant impurity lines measured at other machines in relevant wavelength range (400 - 800nm):

297.6 O_VIII

298.2 B_V

343.0 F_IX

343.3 C_VI

344.9 Ar_XVIII

348.8 O_VIII

388.7 N_VII

434.1 O_VIII

436.5 Ar_XVI

452.45 S_XIV

468.58 HeII

479.3 Ar_XVII??

494.46 B_V

Ostensibly out of range, but will see what we can see.

Probably weak, will attempt.

Standard.

Request.

524.9 NeX

Probably weak, will attempt.

529.06 C_VI

Standard. Primary.

541.152 HeII

566.94 N_VII

Request.

570.2 S_XIV

606.8 O_VIII

Possible with enough O content. (Unlikely after Boronisation)

608.5 N_VII

656.01 HeII

656.28 HI

Standard (Beam density + FIDA)

706.8 S_XIV

771.7 C_VI

792.7 N_VII

Fixed spectrometer (Available for all NBI shots):

- **Carbon, Helium** and beam emission --> T_i E_r ω_ϕ n_b n_C n_{He}

Variable spectrometer (on Request):

- **Boron** and **Nitrogen**: Reasonable quality expected.
- Oxygen, Argon, Neon: Viability/quality unknown.

Expected accuracy:

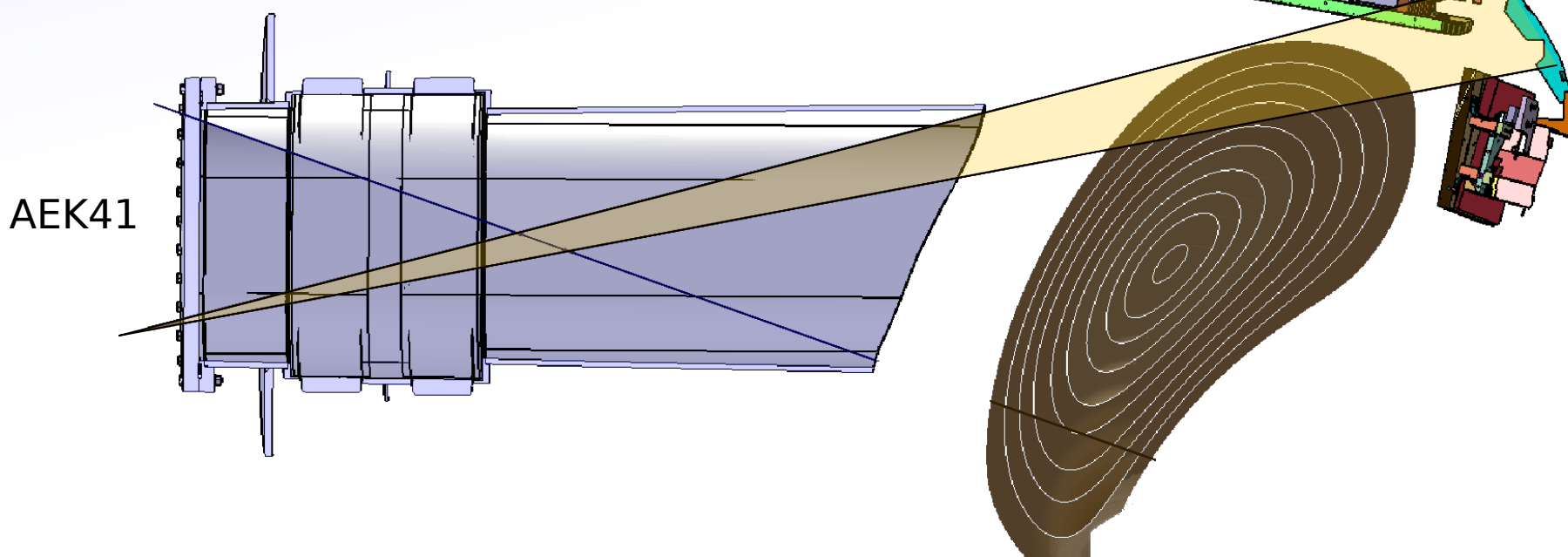
(Tentative, based on AUG experience for $\Delta t \sim 20$ ms)

	Core	Edge
Ti:	± 100 eV	± 30 eV
n_C, n_B :	$\pm < 0.2\%$	
v_ϕ :	± 5 km/s	± 0.5 km/s
Er:	± 10 kV/m	± 1 kV/m

Time resolution: Δt min 10ms

"Passive CXRS"

- Extension of the CXRS systems for T_i and E_r in the cold edge region ($T_e \leq 300\text{eV}$).
- Measure electron-impact excited Boron IV (282nm) or Carbon V (227nm) (so not really charge-exchange!)
- Successfully used in W7-AS (J. Baldzuhn) to extend active CXRS to edge.
- Line integrated measurements - will need careful modelling.
- 5 lines of sights for OP1.2a.
(Possible to upgrade for OP1.2b if successful with fairly low effort)



Data:

- All raw spectroscopy data will be written directly to ArchiveDB in common form.
- Active and passive CXRS will be modelled in Minerva.
- Evaluated n_C , T_i , E_r , ω_ϕ , n_b profiles will be written for all NBI plasmas.
- Other impurities analysed on request during OP1.2b.