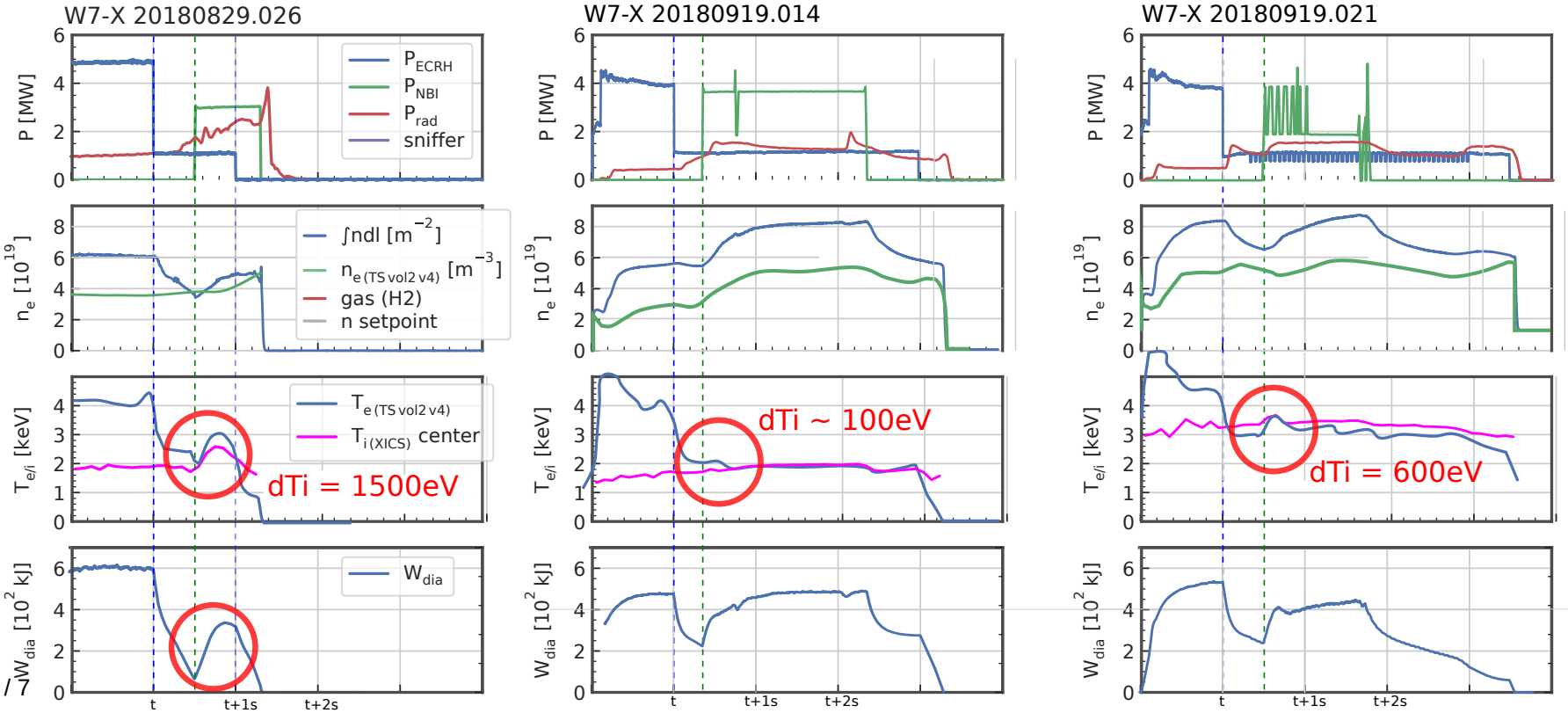
Session Identifier: ~~S46~~ S47 – ‚NBI heating/NC transport‘

Primary aims: **1) Characterise NBI heating/fuelling (> 1sec NBI)**
2) Explore Er changes and power to ions/electrons with NBI vs ECRH
3) Helium operation: Calibrate CXRS H/He, NBI into He, He/H Transport

Technical issues in S45 --> Include NBI pulse extension in parallel.
> 1.5s: Hot spots on AEF Immersion tube protection colars from fast ions. OK for n_e > 5e19.

✓ Extended to 3s at higher densities OK!

Task 1: Clean repeat of rapid Ti heating in #20180829.26:
Unsuccessful, but good comparisons for searching for mechanism: 2 with, 1 partial, 2 without.



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Primary aims: **1) Characterise NBI heating/fuelling (>**
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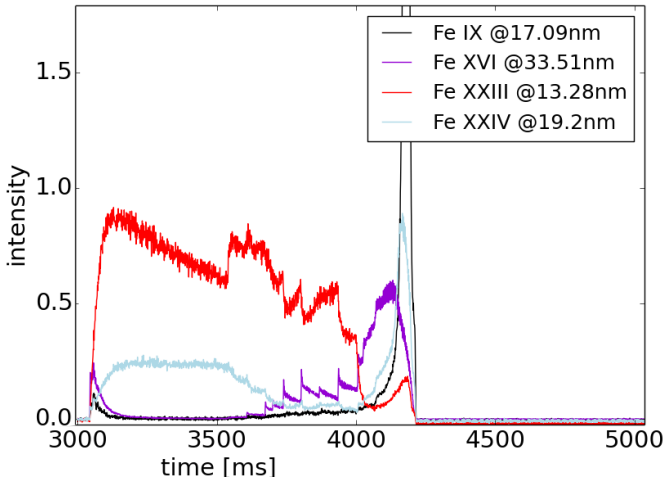
Technical issues in S45 --> Include NBI pulse extension in p
> 1.5s: Hot spots on AEF Immersion tube protection colars

✓ Extended to 3s at higher densities OK!

Impurity accumulation seen in these shots after NBI switch off.



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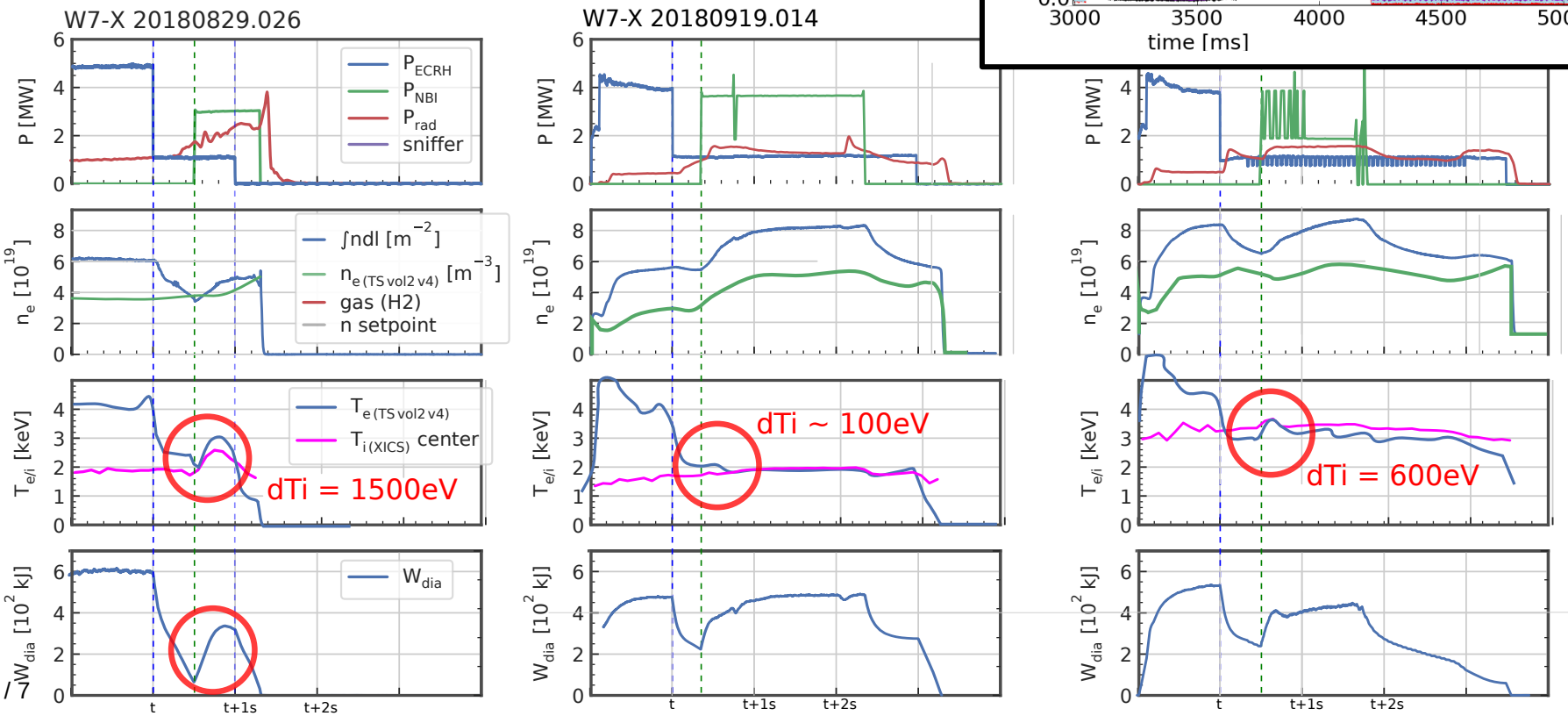

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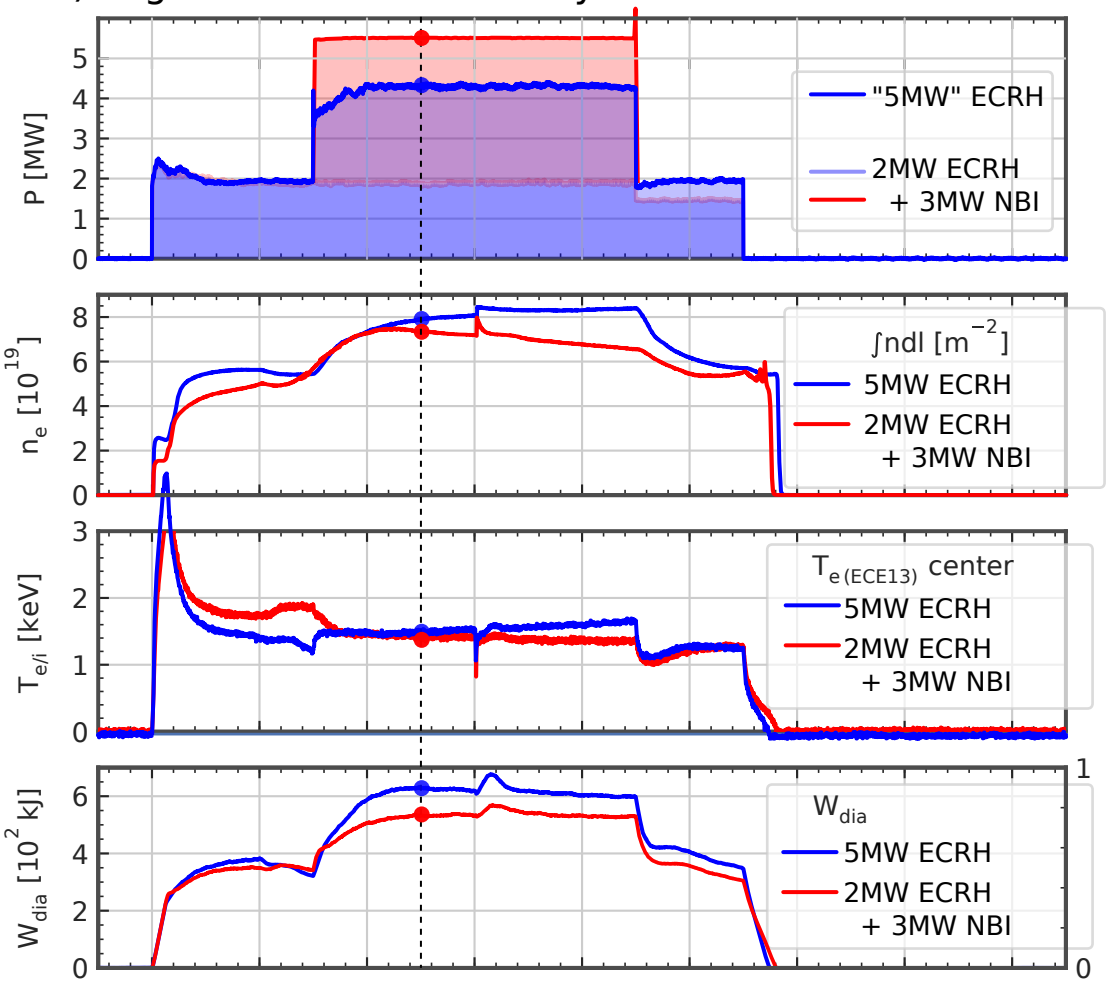
Primary aims: **1) Characterise NBI heating/fuelling (> 1sec NBI)**

Separate fuelling and heating: Compare 3MW additional ECRH vs NBI with matched density.

Partial:

1) Gyrotrons failures in 5MW ECRH case
2) Slight mismatch in density.



Shot	#19.22	#19.16
P_{ECRH}	4.3 MW	2 MW
P_{NBI}	-	3.5 MW
P_{tot}	4.3 MW	5.5 MW
n_e dl	7.9 m^{-2}	7.4 m^{-2}
$Te_{(ECE)}$	1.5 keV	1.4 keV
$Ti_{(XICS)}$	2.0 keV	2.0 keV
W_{dia}	630 kJ	530 kJ
dW_{dia} /P_{tot}	125 kJ/W	50 kJ/W

Consistent with general observation of NBI+ECRH vs ECRH heating efficiency.

In 0 or low ECRH plasmas, dW_{dia}/P_{NBI} increases to similar level to ECRH
--> Significantly different transport regime.

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Primary aims: **1) Characterise NBI heating/fuelling (> 1sec NBI)**

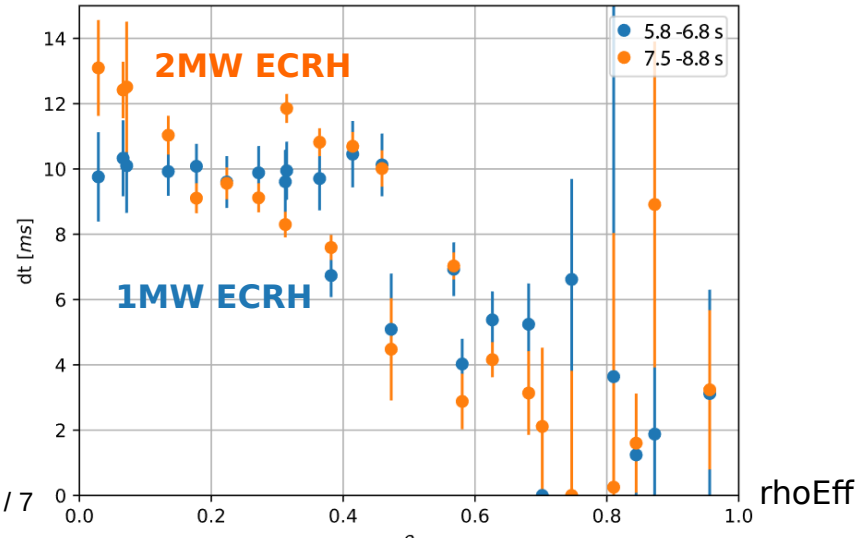
Fuelling: Attempt NBI into peaked ne profile from pellets.
Failed: Too few pellets / too high initial density --> Not peaked profile.
✓ but later Success: BES data acquired in pure NBI shot **#19.33** with very peaked core ne.

NBI heating/fast ion studies with NBI modulation:

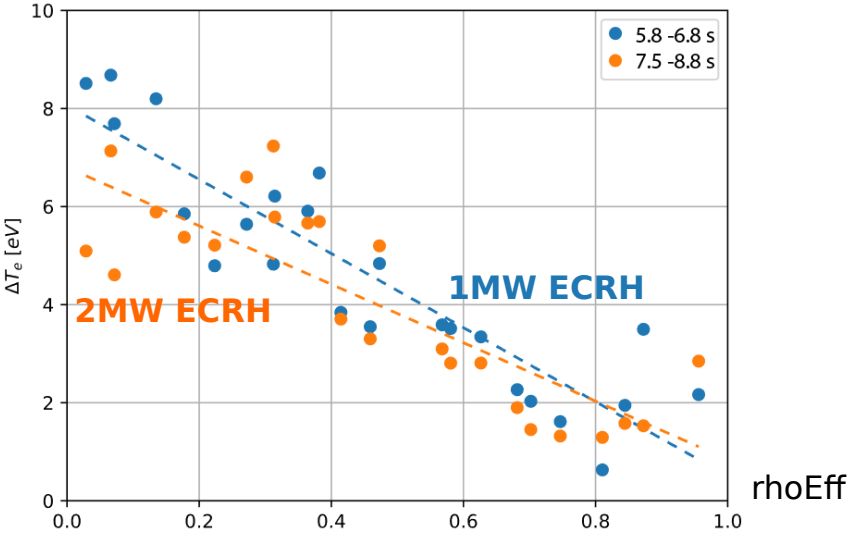
Partial: Only 1/3 shots possible due to time and 1/2 program due to NBI limit at low n_e.
- No on/off axis comparison possible.
- No source comparison possible.

Some measurements also made in S48:
- dT_e modulation with NBI clearly seen. Slightly higher for lower ECRH power.
- Time delay supports hypothesis of differences in heat transport profile at reduced ECRH power:

Time delay of observed heating from NBI pulse



Amplitude of observed heating after NBI pulse



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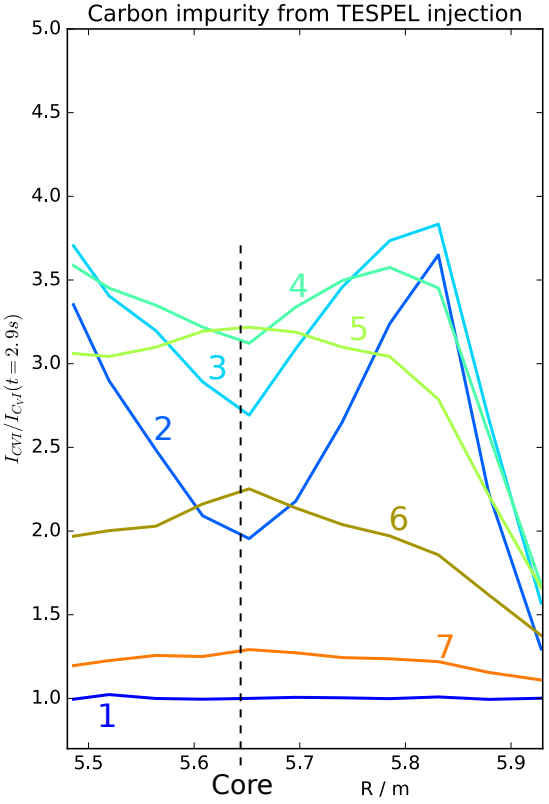
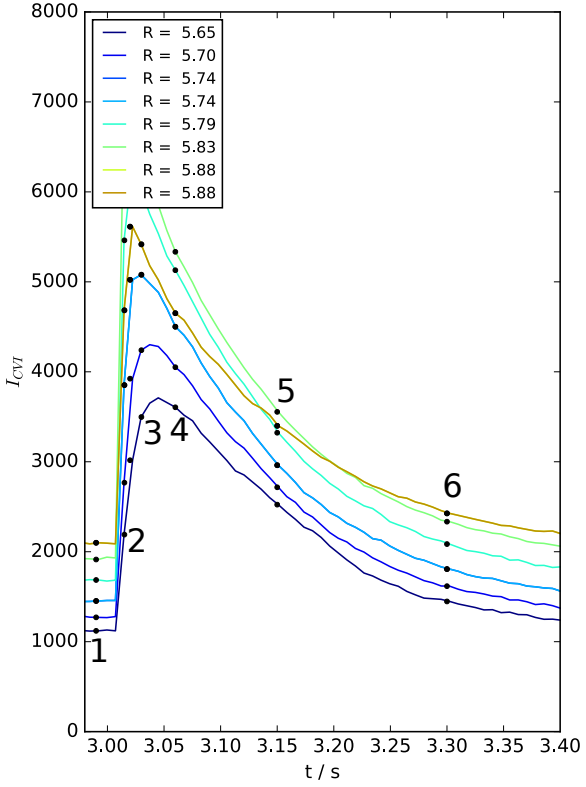
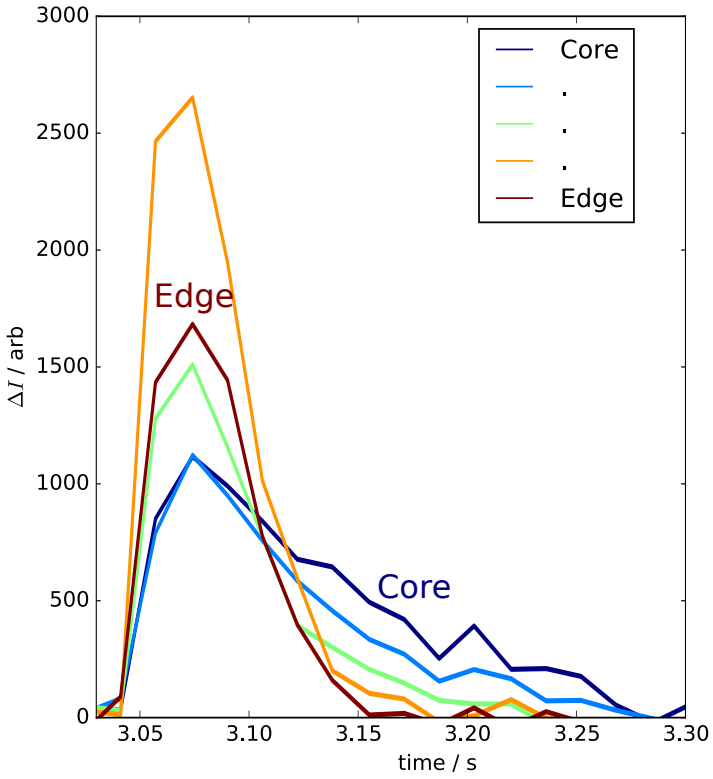
liva_001: Low-Z impurity injection during NBI.
Successful.

Lots of good high time resolution data recorded with Tespel (Carbon) and LBO (Boron Carbide) injections:







+ Indications of change in impurity accumulation behaviour in low/no ECRH shots.
(see N. Pablant S48)

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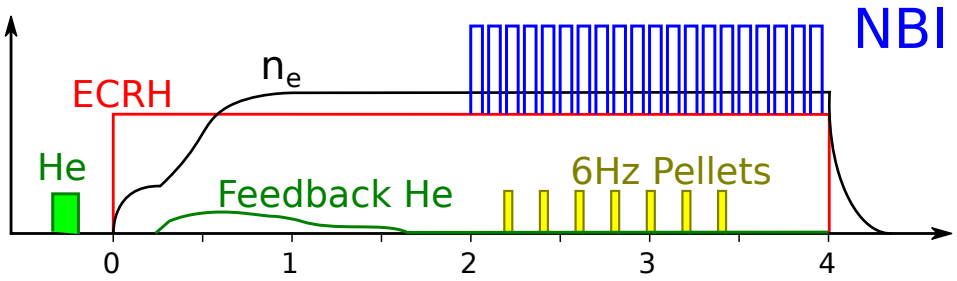
Primary aims: 3) Helium operation: Calibrate CXRS H/He, NBI into He, He/H Transport.

3 attempts at Helium discharge with NBI + Pellets:



#19.23: 20% Helium, 8x10^{19} m^{-2}. Mostly hydrogen due to high recycling

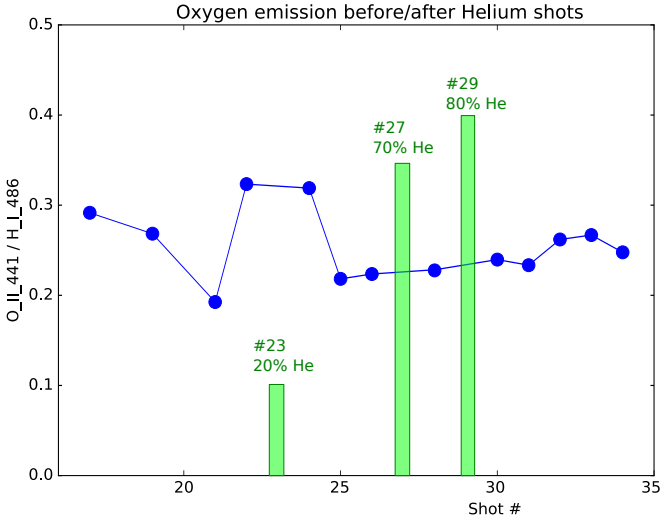
- (3x Std. Ref. 0% He, 6.5, 5.5, 5.0 x10^{19} m^{-2})

#19.27: ~70% Helium, 8x10^{19} m^{-2}. OK. No Pellets.

- (1x Std. Ref. <3% He, 4.0 x10^{19} m^{-2})

#19.29: ~80% Helium, 8x10^{19} m^{-2}. OK. No Pellets.

- (1x Std. Ref. <5% He, 3.5 x10^{19} m^{-2})



Passive Spectroscopy / Filterscope:
No significant rise in O_II lines seen.

He operation, impurity monitoring: **Complete.**
H/He scan: **Partial** - 70%, 80% points.
Full NBI into Helium: **Not performed** due to insufficient time.
CXRS H/He Calibration: **Complete.** Low S/N, but OK. Will retry piggy-back this week.
H/He transport study (K. Ida): **Failed (no pellets)**

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Proposals status:

priority-I proposals			
proposal-ID	**short title**	**status**	**open aspects (in case proposal is not finished)**
Dih_004, dih_006	NI21 commissioning	*partially conducted*	Missing full 4MW NBI into Helium and pulse extension.
dih_008	NBI heating characterisation	*fully conducted*	Data now collected in full range of ne, PECRH/PNBI (incl S25-30, S46, S48).
olfo_010	NBI fuelling characterisation	*fully conducted*	
olfo_016	Parallel ion flow measurements	*fully conducted*	
liva_001	Core low-Z impurities + transport	*fully conducted*	
bgeiger_004	Fast-ion transport using NBI modulation	*partially conducted*	Only 1/3 shots completed. Anything measured??
npablant_014	Core energy and impurity Transport with NBI	*partially conducted*	Some additional data provided in support of S48. Density steps in pure NBI still missing.
tere_002	Zonal flows	Not yet determined,	
rjose_001	Phi_1 effects on impurity transport	Not yet determined,	
ajvv_001	Passive FIDA measurements At W7-X	not attempted - (technical conflict)	Not measured in this session as spectrometer used for LBO.
olfo_013 (K. Ida)	CXRS H/He ratio: Calibration	*fully conducted*	Poor S/N, but approximate calibration successful. Should be repeated at lower density.
olfo_015 (K. Ida)	CXRS H/He ratio: H pellets into He	*not conducted*	No pellets injected. Requires 6Hz pellets+NBI into Helium.

Priority 2:

olfo_011	XICS vs CXRS	*fully conducted*	Data now collected in full range of ne, PECRH/PNBI (incl S25-30, S46, S48).
fwa_006	Config effect on heat transport (KJM)	*not conducted*	KJM not used due to baffle heat loads.
thomsen_005	MHD stability survey	Not yet determined,	
cbra_007	Asymmetries in 2D impurity emission	Not yet determined,	

Additional (interlaced non-NBI shots):

boz_011	Optimize the high energy discharge.	*partially conducted*	Some additional data collected.
boz_012	Config change of high energy discharge.		
baldzuhn_010	Pellets into high energy discharge.		