Wendelstein 7-X: Proposal for Operational Phase 2
"He exhaust at Wendelstein 7-X (from the island divertor and sub-divertor volume perspective)"

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Objectives

1. Obtain needed experimental data
2. Questions:

He removal	
How can we increase the divertor neutral pressure?	
○ Strike line/ I_{cc} scan	
○ Configuration scan	
○ Density scan	
What are our effective pumping speeds for He?	Dieter for neutral conductunces
How can we increase the pumping efficiency of He?	
How can we increase the He neutral source in the divertor?	
What will Ar frosted cryo-pumps change?	I can combine with CP if we do He/NBI

He enrichment – Route to decouple He and H exhaust	
Can we de-couple He from H (T) exhaust?	
What affects one but not the other?	
Is τ_{α} following τ_H or $\tau_{Impurities}$	
Differences in pumping efficiency between H and He?	Dieter for neutral conductunces
Can we increase He enrichment of pump gap vs divertor plasma $\eta_{gap/div}$	
Do we see changes in impurity source, with He enrichment?	
○ Higher physical sputtering and higher C source?	

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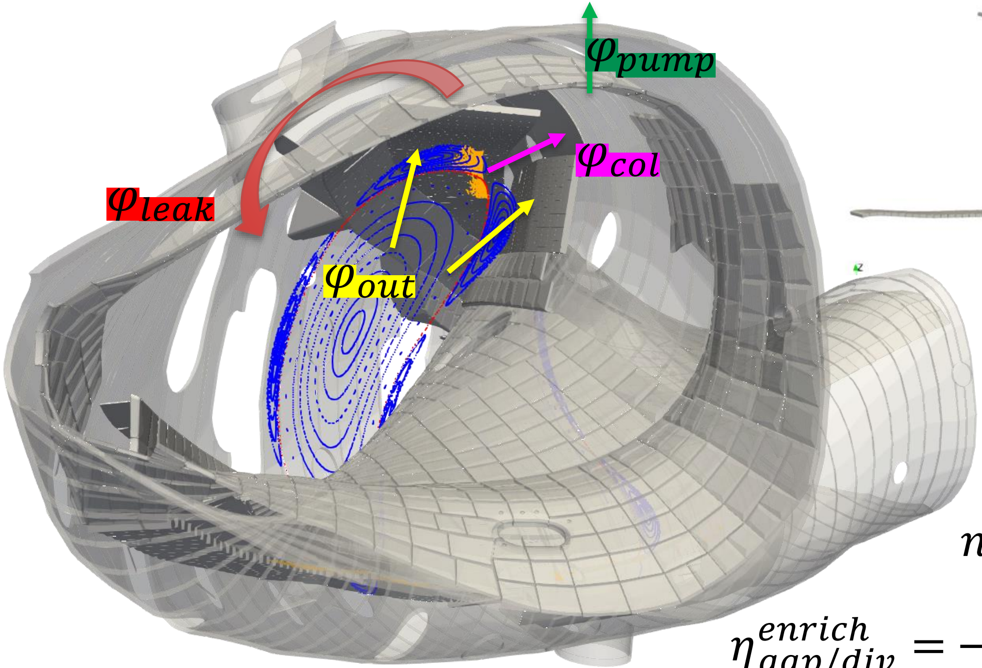
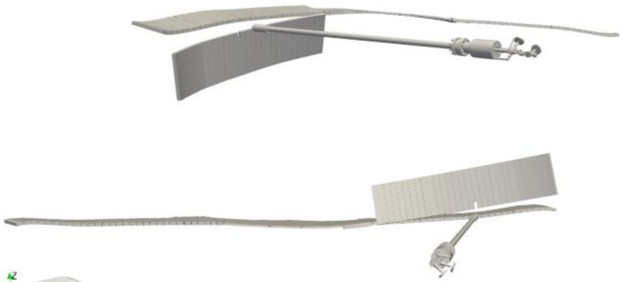
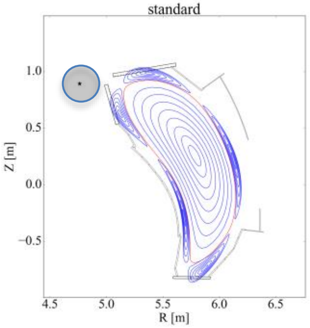
Characteristic parameters







$$\tau^*_{He,p}$$

Edge spectroscopy

$$\eta^{enrich}_{gap/div} = \frac{n^{gap}_{He} / 2n^{gap}_{H_2}}{n^{div}_{He} / n^{div}_{H}} \; ? \; \frac{p^{gap}_{He} / 2p^{gap}_{H_2}}{n^{div}_{He} / n^{div}_{H}}$$

WISP gauges

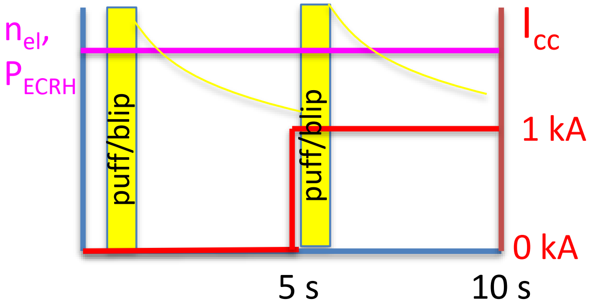
S/XB + spectroscopy

Characteristic parameters

1. He removal and enrichment (maximization) - Questions to answer:
    1. $\tau\alpha^*/\tau E < 10$?
    2. How can we decrease $\tau\alpha^*$, study it properly?
    3. How can we increase the pumping gap neutral pressure (and later also further to the pumps)?
    4. Can we de-couple He from H (T) exhaust – He enrichment?
    5. Is He retention good enough for the IRC vs ERC regimes?
2. Knobs
    1. Strike-line location (I_{cc} = [0..2] kA)
    2. Island size (correct its position) (-> optimum λ_0 for He -> EMC3-EIRENE)
    3. Magnetic configuration: standard vs high/low-i – islands connection
    4. Density scan
    5. Power scan
    6. Different puffing locations
3. Metrics
    1. Puff/pump studies
    2. He-NBI/pump studies
    3. $\eta_{gap/div}^{enrich}$
    4. $P_{He}(t)$, $P_{H2}(t)$
    5. τ_{He}, τ_{H2}
    6. HeI, H balmer lines
    7. He, H densities
4. Attachment -> Detachment: pressure stays constant (should drop) – done for H. But what about He?
5. Non-resonant configuration (Geiger + Schmitz + Garcia)
6. Influence of He on neutral conductance by Dieter
7. Cryo pumps will increase H_2 pumping => He enrichment? + Possibly Ar frosting.

1. He exhaust studies at W7-X

1. Standard configuration
    1. Attached plasma
    2. n_{el} = [3, 6, 10] x10^{19} m-3 — 3 shots (N = 3 shots)
    3. P_{ECRH} = [6, 10] MW — x2 (N = 6)
    4. I_{cc} = [0, 1, 1.5, 2] kA — x2 (N = 12)
    5. 2 He-puffs from the divertor nozzles during a discharge (which nozzle(s)?) — +1 (N = 13)
2. High-mirror
    1. 1 shot from 1 — +1 (N = 14)
3. High-i
    1. 1 shot from 1 — +1 (N = 15)
4. Low-I
    1. 1 shot from 1 — +1 (N = 16)
5. Repeat [1 - 5] in OP2.2 with He-NBI blips
   (if discharges are longer, then we can combine)



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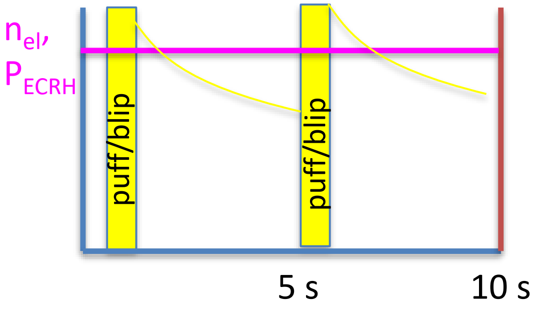
2. He exhaust during detachment at W7-X + 3. CVP + 4. NRD



2. He exhaust during detachment

- 2 shots as in 1.1, but higher density and power 2 (N = 2)

3. Influence of cross-field talk on He exhaust

- 1st, 3rd, 5th He nozzles at the divertor 2 (N = 2)
- Change island size and compensate shift by PC +2 (N = 4)

4. Influence of CVP He enrichment (combine with CP)

- 2 shots as in 1.1, but with CVP 2 (N = 2)

5. Influence of non-resonant configuration on He exhaust (needs to be clarified)

- 2 shots as in 1.1 2 (N = 2)

Repeat in OP2.2 with He-NBI blips (if discharges are longer, then we can combine)

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Characterization of neutral conductances in He discharges

Objective:

- Examine influence of He exhaust on neutral conductances

Approach:

- No plasma and plasma experiments, known gas injection
  - → Pressure measurement at different locations
  - → Define conductances between pressure gauges (compare with modeling)
- Repeat for different levels of He/H mixture
- Overlap with other proposals in H-exhaust subgroup (can probably be merged)

Requirements:

- Pressure gauges to measure neutral pressures
- Known gas injection

Q&A