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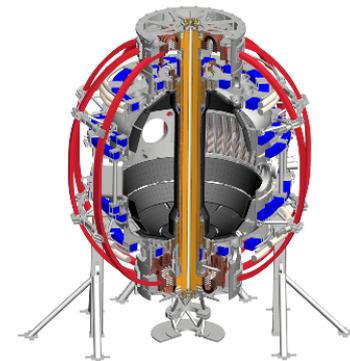
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Helium exhaust during RMP ELM control

O. Schmitz, E. Hinson, K. Flesch., H. Frerichs,
R. Maingi, I. Waters, and collaborators

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Motivation

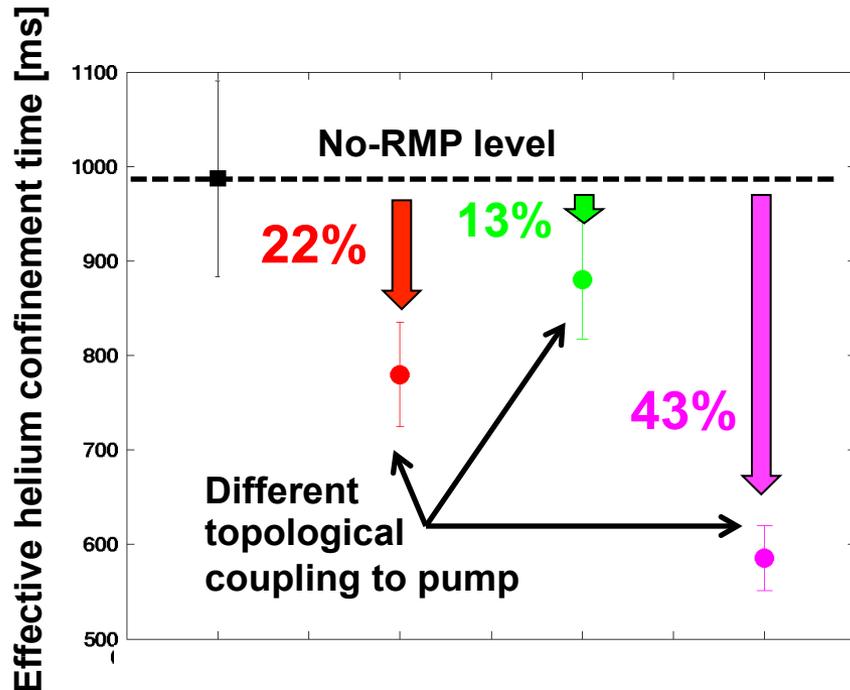
- RMP fields were demonstrated to enhance helium exhaust
 - Reduction of effective helium confinement time, decontamination of core and increase of helium neutral pressure in the periphery
- Finding offers attractive functionality of RMP fields to aid divertor efficiency in ITER and for future burning plasmas
 - Higher neutral pressure in the periphery enables better pumping
 - Reduced fueling efficiency yield retaining of helium in periphery
 - Overall significantly enhanced helium exhaust features expected
- Combination with ELM control needs to be shown including scaling to high recycling, possibly detachment
 - Mitigation vs. suppression -> can RMP make up for ELM flushing?
 - High recycling -> will selective decontamination survive?

Enhanced helium exhaust was demonstrated at TEXTOR and LHD

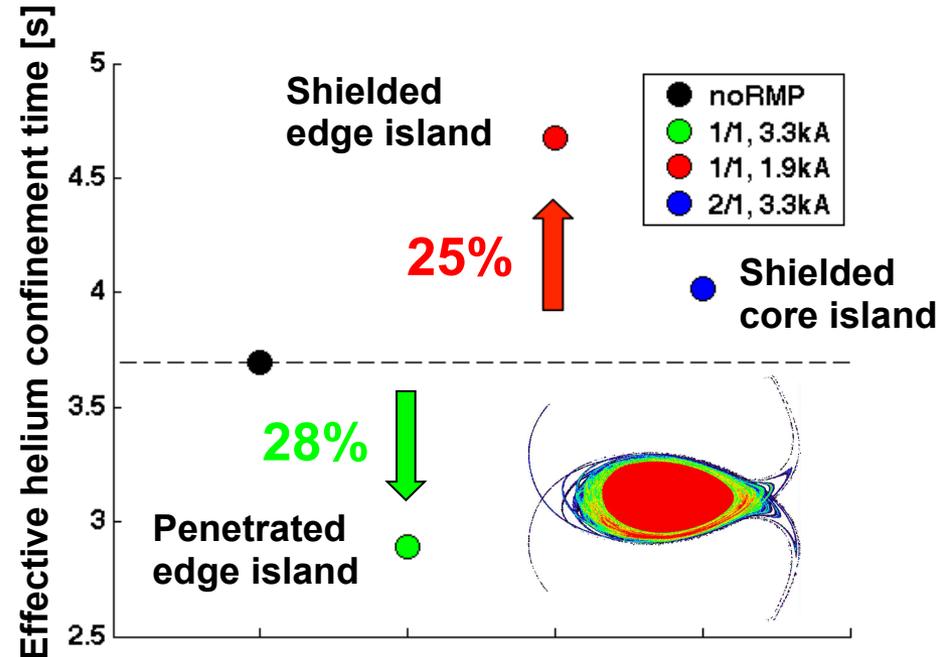
[Schmitz O. et al., IAEA 2016, EX/D-4], [O. Schmitz et al., NF 56 (2016) 106011]

25-50% reduction of effective helium confinement time $\tau_{p,He}^*$ by application of resonant magnetic perturbations was seen reliably in the experiment

TEXTOR with Dynamic Ergodic Divertor



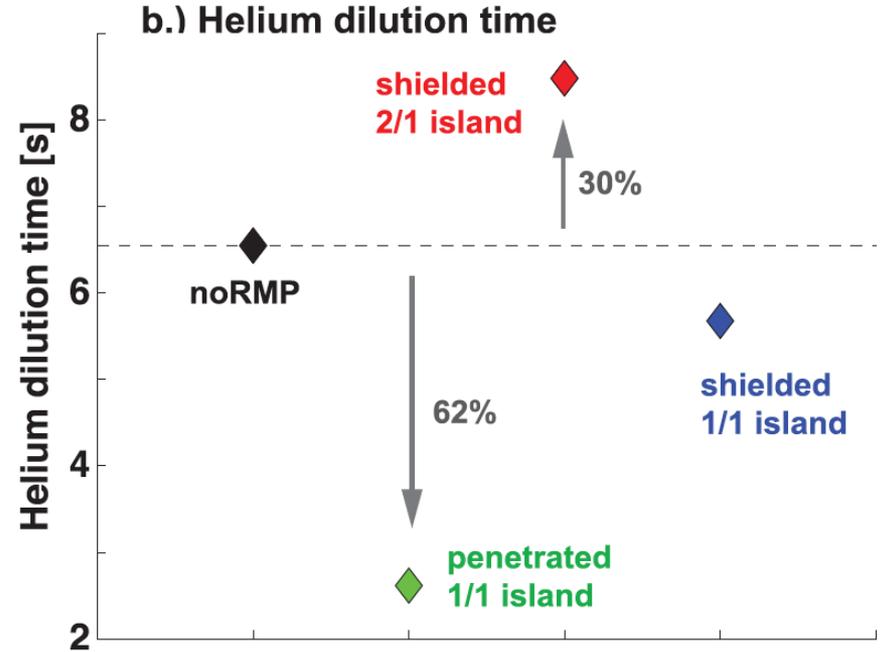
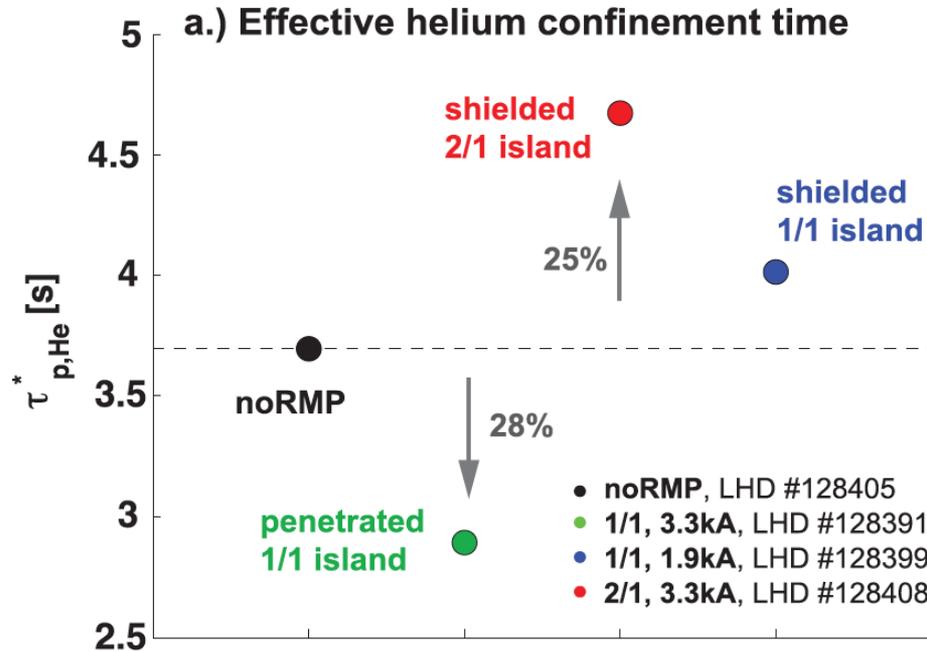
LHD with closed helical divertor



- RMP application is a fine tuning actuator for improvement of divertor functionality**

Preferential exhaust of helium was measured – impact of recycling conditions?

[Schmitz O. et al., IAEA 2016, EX/D-4], [O. Schmitz et al., NF 56 (2016) 106011]



- Preferential exhaust of helium – not just overall pump out
- Scaling with divertor recycling regime has to be investigated

Layout of experiment

- Physics principle to be tested
 - He transport and exhaust during RMP ELM suppression
- Technique & *output expected*
 - He puff pump studies to measure $\tau_{p,He}^*$ and τ_{dil}^* from He-I, He-II emissivity and CER, 0.5+0.5 days, Ar frost for 2nd half day
 - $\tau_{p, He}^* (n_{ped})$ and τ_{dil}^* **with and w/o RMP cpm. to $\tau_E (n_{ped})$**
- Analysis done / *planned*
 - EMC3-EIRENE ready and study at NSTX-U ongoing
 - *Decay times of He-I, He-II emission and of He/(He+H)*
- Why in national campaign? / *Why now?*
 - Reliable ELM suppression at DIII-D for ITER relevant low $v_{e, ped}^*$
 - New, promising results on He exhaust control with RMP at TEXTOR and LHD demand qualification program of RMP for He exhaust
 - **Later experiments at NSTX-U** will allow to understand helium exhaust in ST/low aspect ratio tokamak - > relevant for FNSF discussions (any benefit for one or the other concept?)
- Impact on path to fusion energy
 - He exhaust is a critical requirement for reactor divertors and compatibility of RMP ELM suppression with He exhaust requirements need to be verified
 - ST vs. standard tokamak comparisons informative for FNSF conceptualisation