

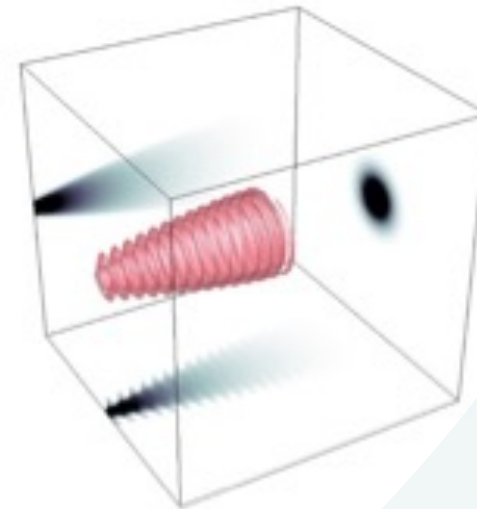
A hosing mitigation experiment

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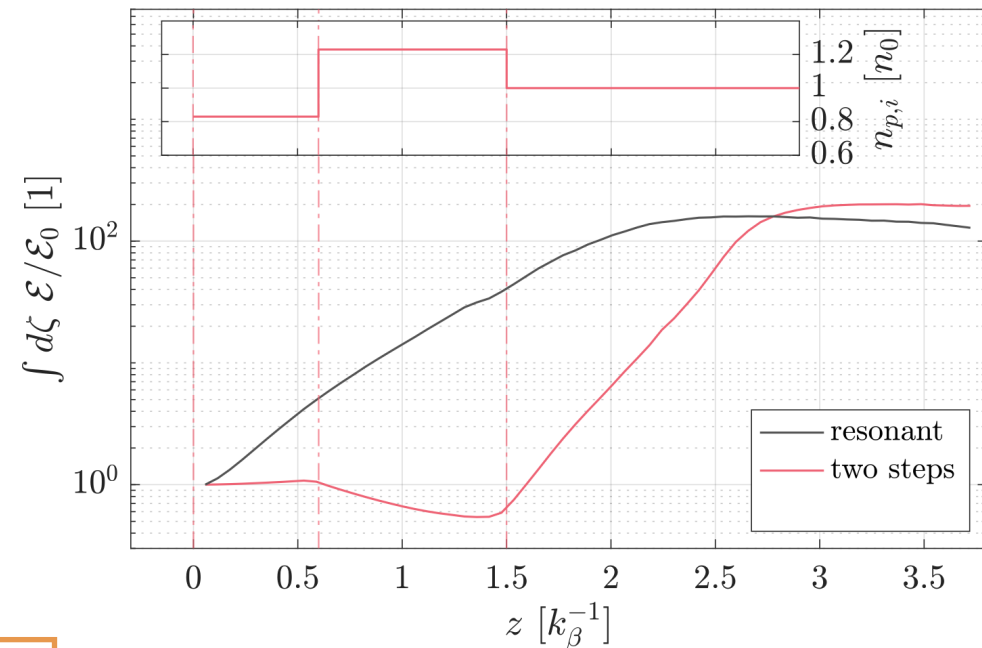
A hosing mitigation mechanism has been proposed

Key characteristics

- sequence of up and down density steps
- delay rather than suppress
- “backlash” after some betatron periods

$$k_{\beta}^{-1} = c/\omega_{\beta} = c\sqrt{2\gamma\frac{\epsilon_0 M_b}{q_b^2 n_{b0}}}$$

Transverse centroid energy along propagation



OSIRIS 3D simulations with a transversely flat-top bunch in a window spanning $\sim 22 \lambda_p$

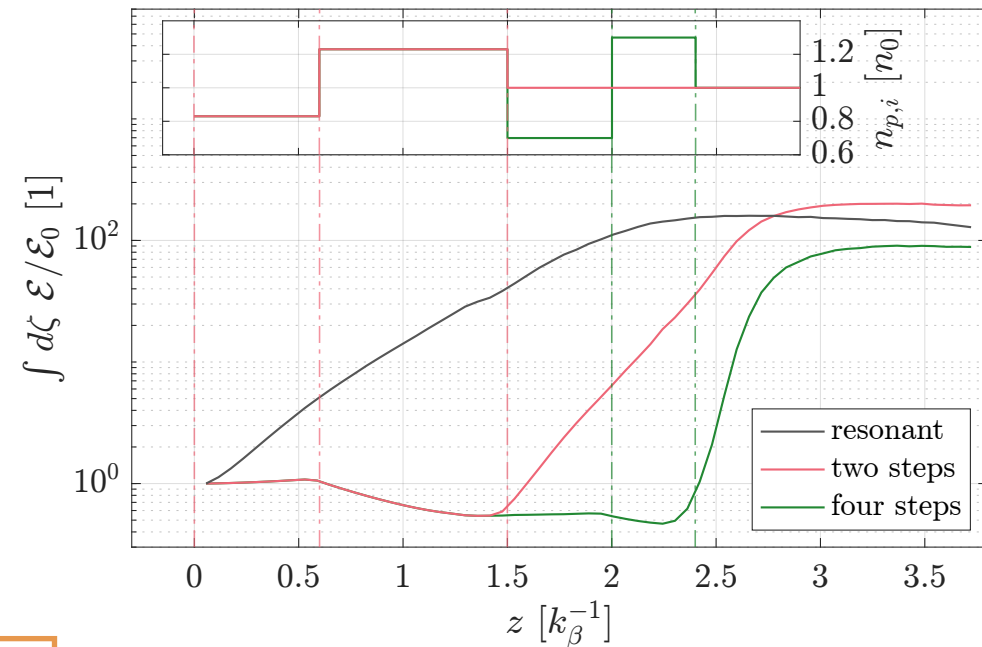
A hosing mitigation mechanism has been proposed

Key characteristics

- sequence of up and down density steps
- delay rather than suppress
- “backlash” after some betatron periods
- effect can be prolonged with an extra pair of steps

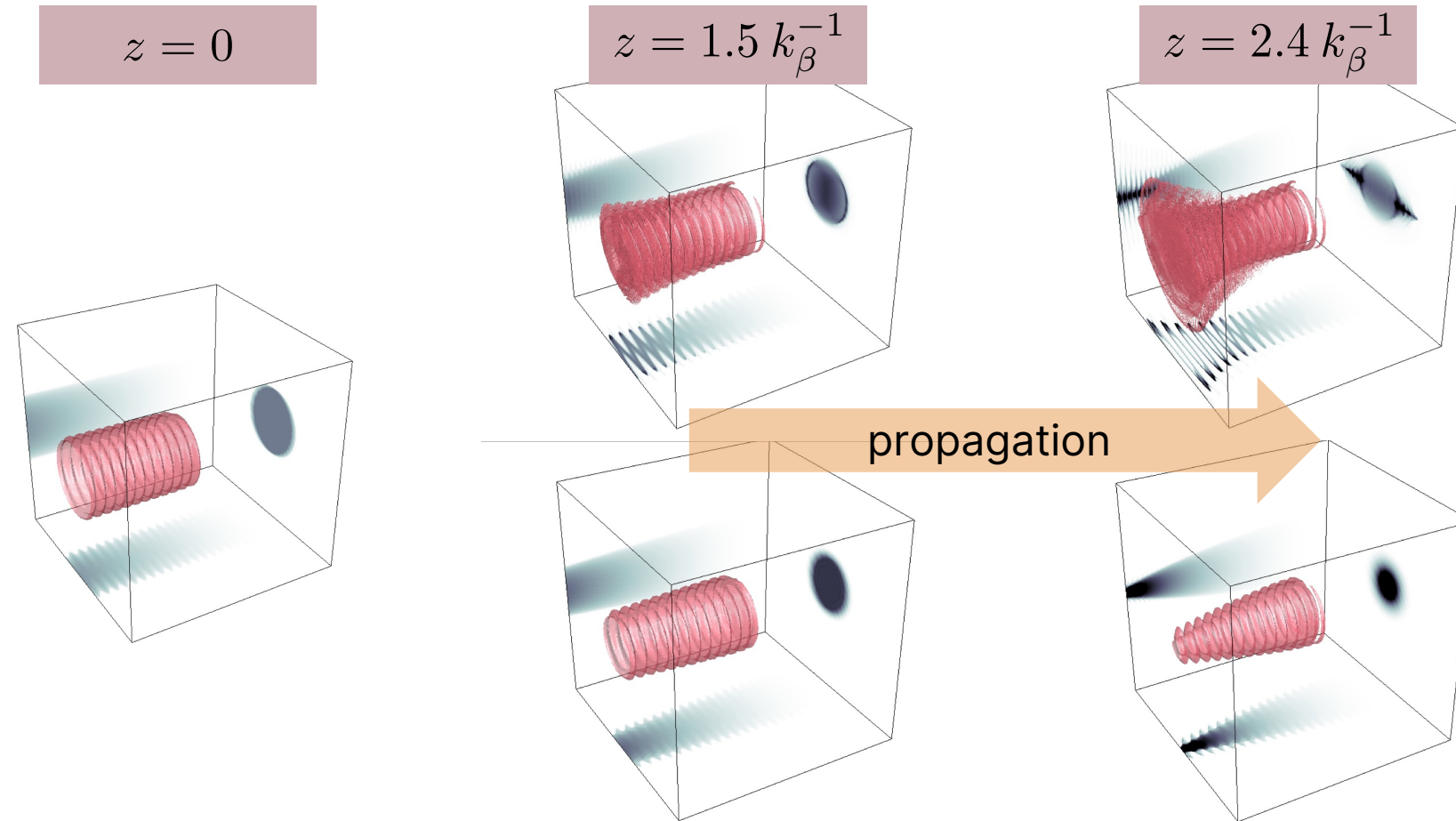
$$k_{\beta}^{-1} = c/\omega_{\beta} = c\sqrt{2\gamma\frac{\epsilon_0 M_b}{q_b^2 n_{b0}}}$$

Transverse centroid energy along propagation



OSIRIS 3D simulations with a transversely flat-top bunch in a window spanning $\sim 22 \lambda_p$

There is a visible effect on the bunch centroid

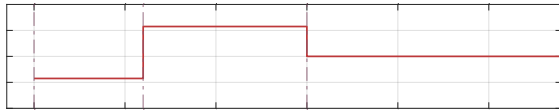


resonant
plasma

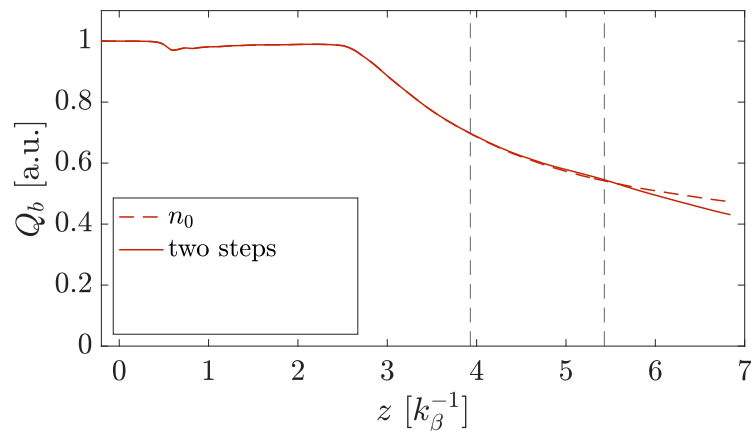
density
steps

Does the mitigation set-up destroy a self-modulated bunch?

- 2D cylindrical OSIRIS simulations
- submit fully self-modulated bunch to the two-step density profile

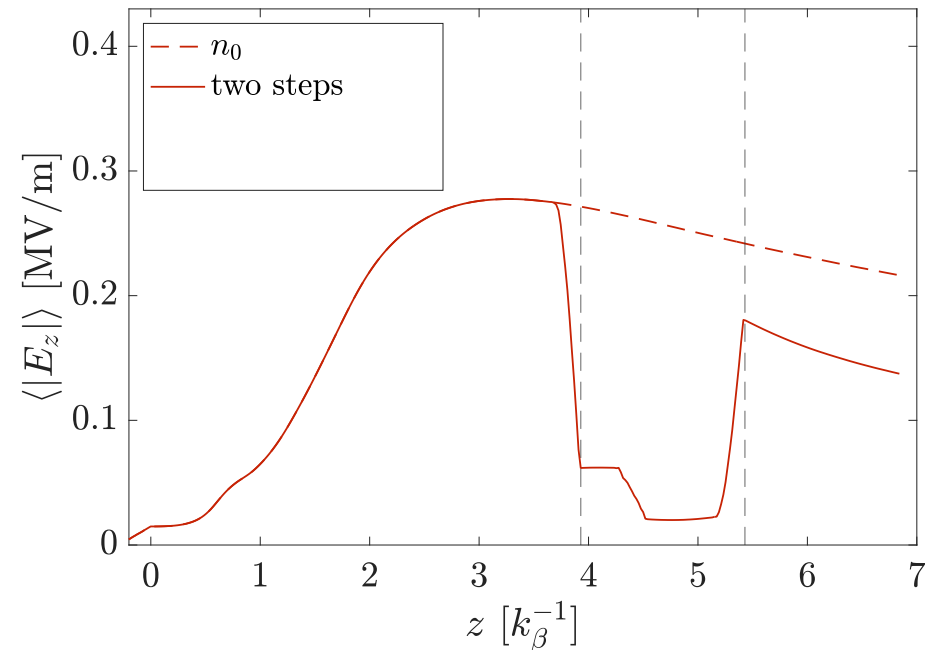


Virtually no effect on bunch charge



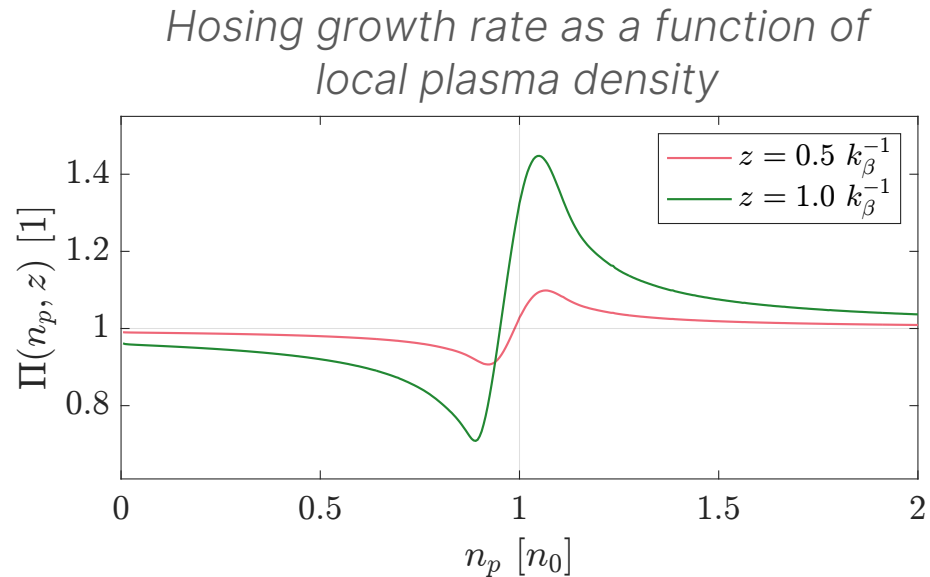
Accelerating field is lowered

- preliminary study indicates a large drop in the wakefield amplitude ($\sim -40\%$)



What lies behind the proposed mitigation mechanism?

Accessing different growth regimes



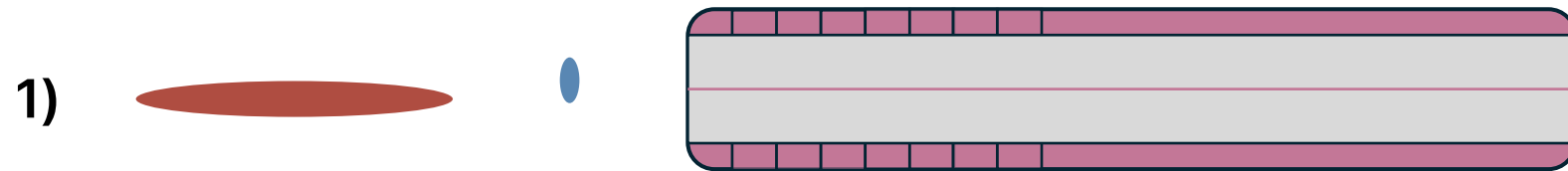
- by tuning the plasma density early in the instability's development

Assumptions and approximations

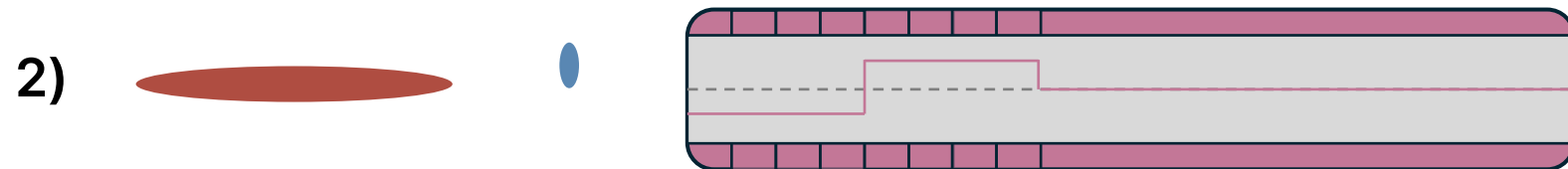
- electron bunch (assume everything scales with the betatron period)
- cold / zero emittance
- hosing is seeded along one plane
- probably lower SMI seed than in reality
- “early” = $z \lesssim k_\beta^{-1}$

M. Moreira, P. Muggli, and J. Vieira, Phys. Rev. Lett. **130**, 115001 (2023)

A potential experimental setup using electron seeding



→ observe hosing consistently*



→ observe:

- less hosing
- self-modulation
- no difference

→ SPS proton bunch: $k_{\beta}^{-1} \approx [1.8, 3.1]$ m

* T. Nechaeva *et al.* (AWAKE Collaboration), *Phys. Rev. Lett.* **132**, 075001 (2024)

Conclusion

- it may be possible to use the current AWAKE setup to try to demonstrate a theoretically predicted **hosing mitigation scheme**
- although no fundamental show-stoppers yet, **3D simulations with nominal parameters** still have to be conducted

Betatron skin depth	3.1 m	1.8 m
RMS bunch length	220 ps / 6.6 cm	
RMS bunch radius	200 μm	
Proton energy	400 GeV	
Bunch charge	15 nC	46.5 nC
Bunch population	0.9×10^{11}	2.9×10^{11}

Thank you!

Questions?