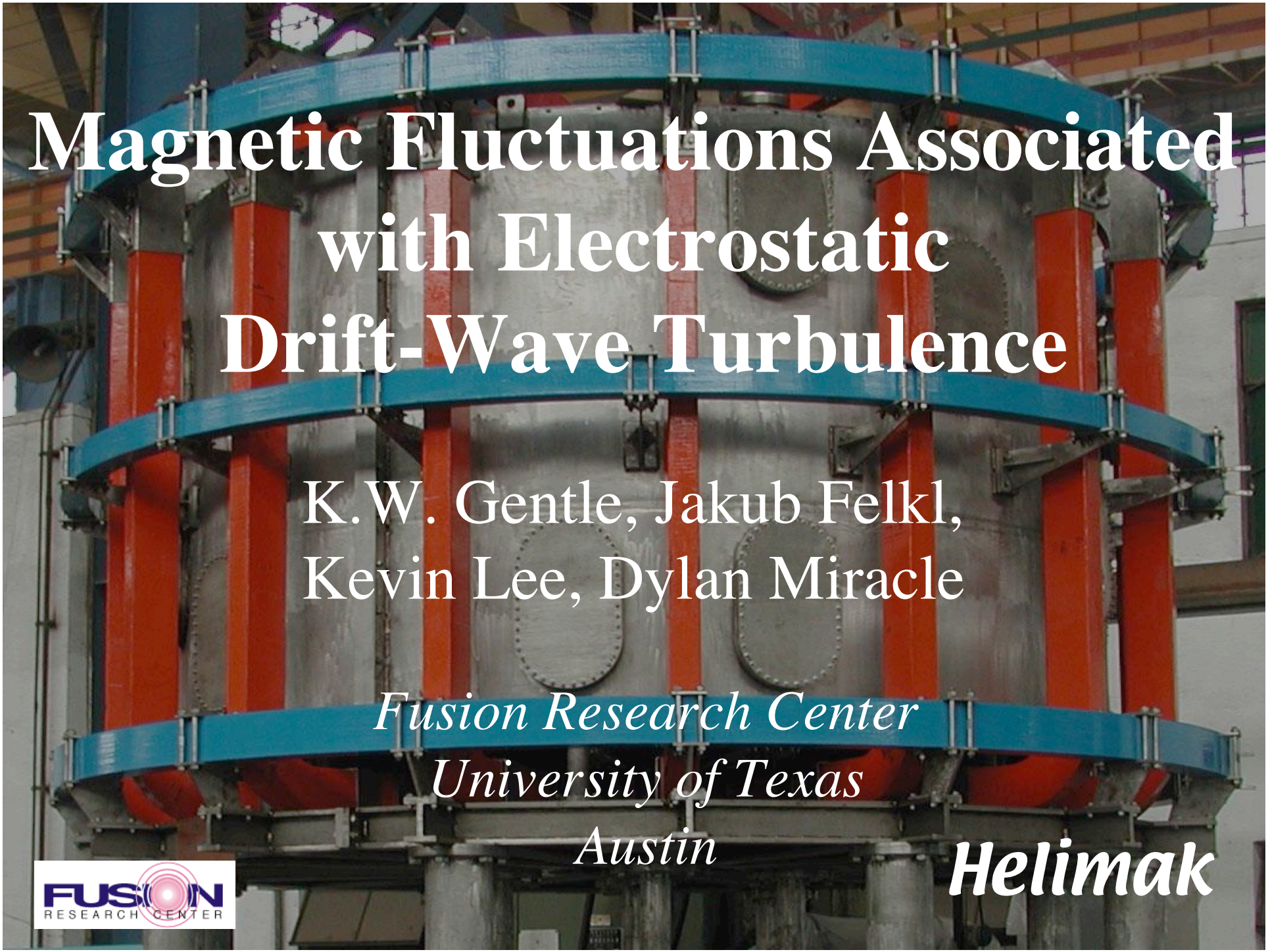

Magnetic Fluctuations Associated with Electrostatic Drift-Wave Turbulence

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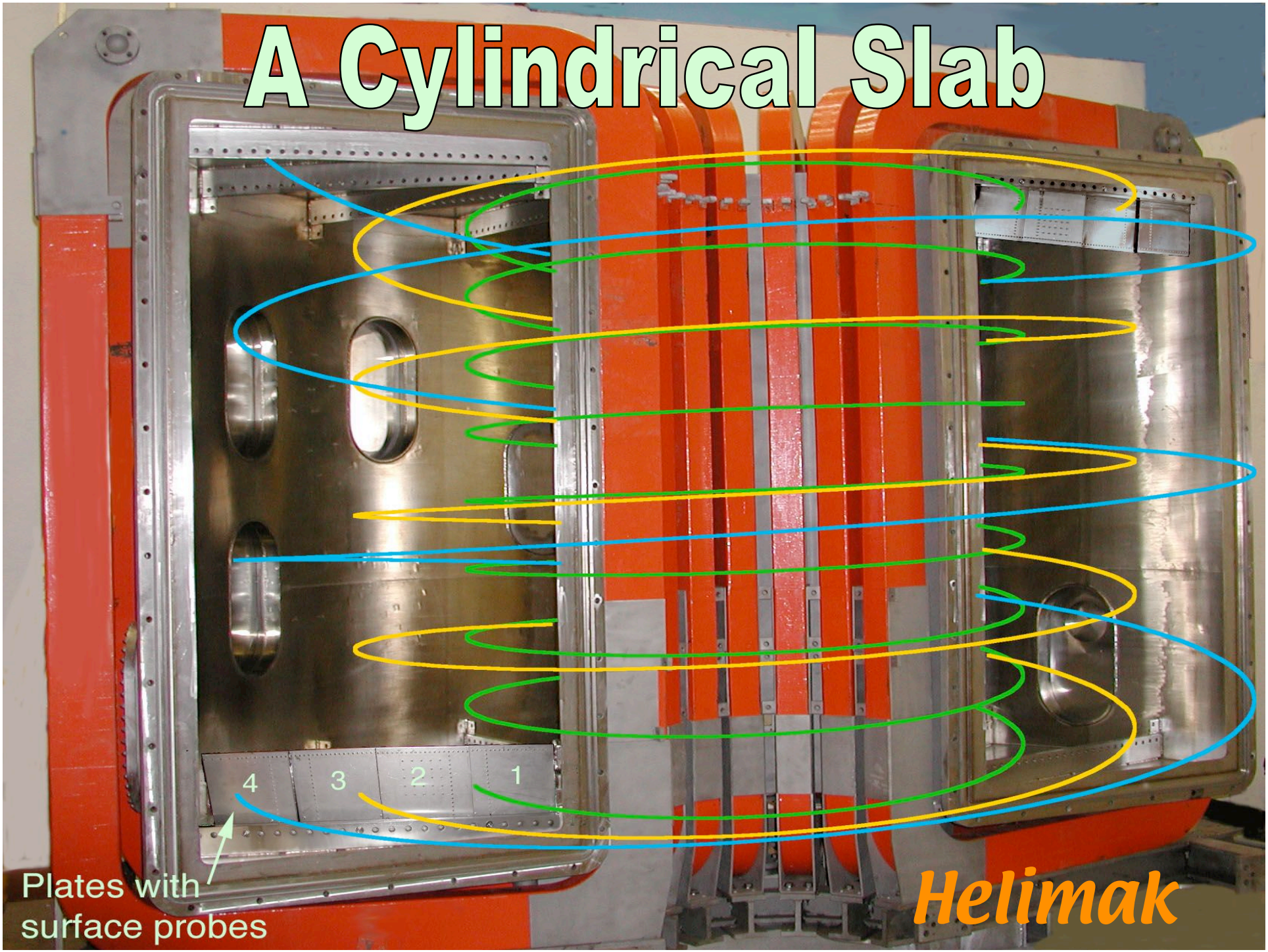
Outline

- The Helimak exhibits classic drift-wave turbulence in the region of density gradient with unfavorable magnetic curvature, $\beta < 10^{-4}$

- Despite electrostatic physics, magnetic fluctuations are associated with the drift-wave turbulence

- These (weak) fluctuations should be a good test of $j_{||}$ in the drift-wave model


A Cylindrical Slab
4
3
2
1
Plates with
surface probes
Helimak

Helimak Dimensions and Parameters

A Sheared Cylindrical Slab

$\langle R \rangle = 1.1$ m $\qquad \Delta R = 1$ m

$h = 2$ m

$B_T = 0.1$ T $\qquad B_v \leq 0.01$ T

Pulse ≤ 60 s

Plasma source and heating: 6 kW ECH @ 2.45 GHz

$n \leq 10^{11}$ cm^{-3} $\qquad T_e \sim 10$ eV $\qquad \beta \sim 3 \times 10^{-5}$

Helium, neon, argon, xenon

$c_s = 3 \times 10^4$ m/s (Argon) $\quad V_{drift} = 100$ m/s $\quad V_{diamagnetic} = 10^3$ m/s

$\nu_{drift\text{-}wave} \sim 1$ kHz

Connection length: $10 \text{ m} < L < 1000$ m $\quad \tau_p$ (parallel loss) > 1 ms

Probe arrays in end plates provide vertical and full radial profiles

Isolated end plates may apply radial electric fields: $V_p \leq \pm 100$ Volts

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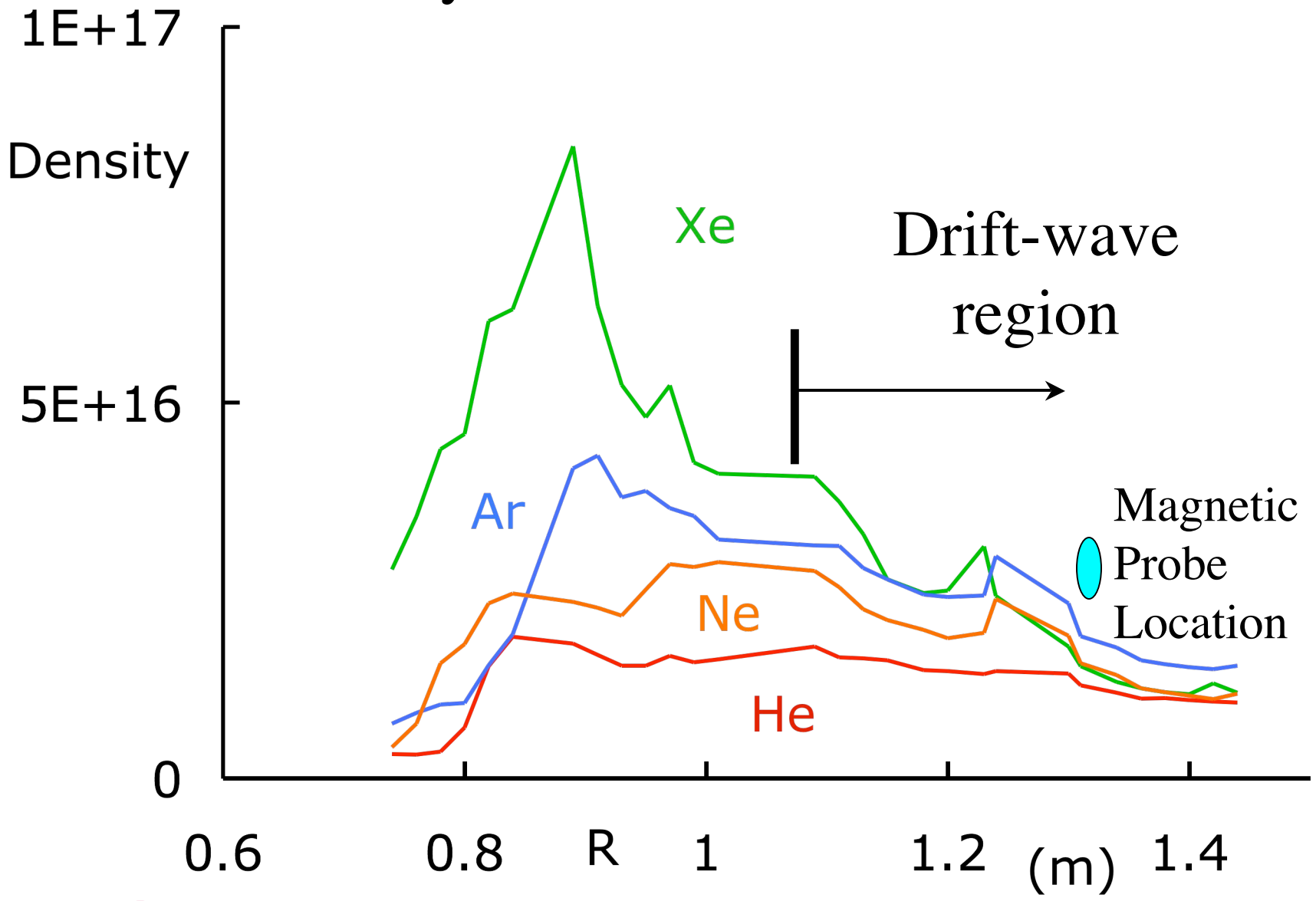
Density Profiles for various Gases



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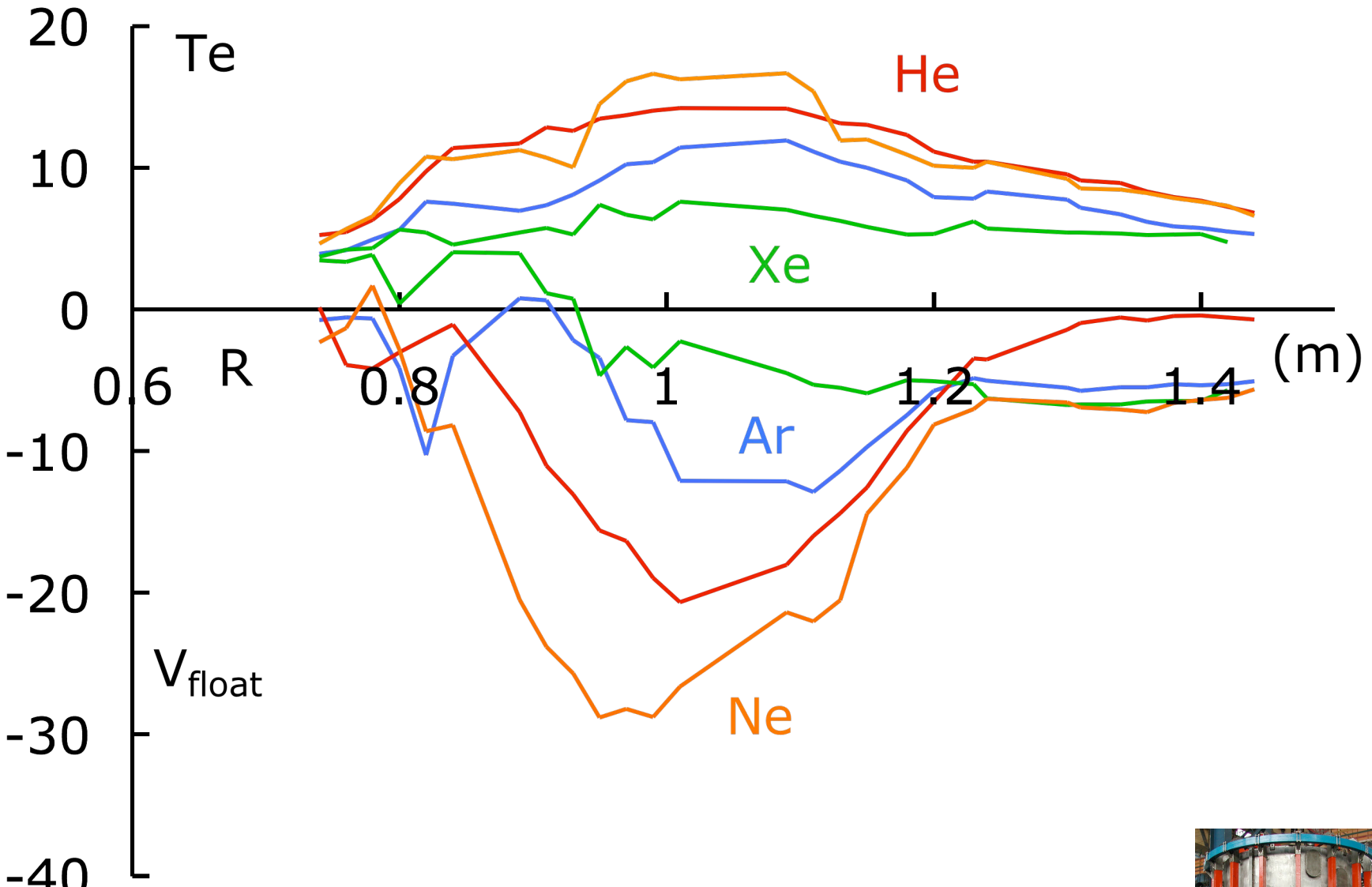
Typical Temperature and Floating Potential Profiles



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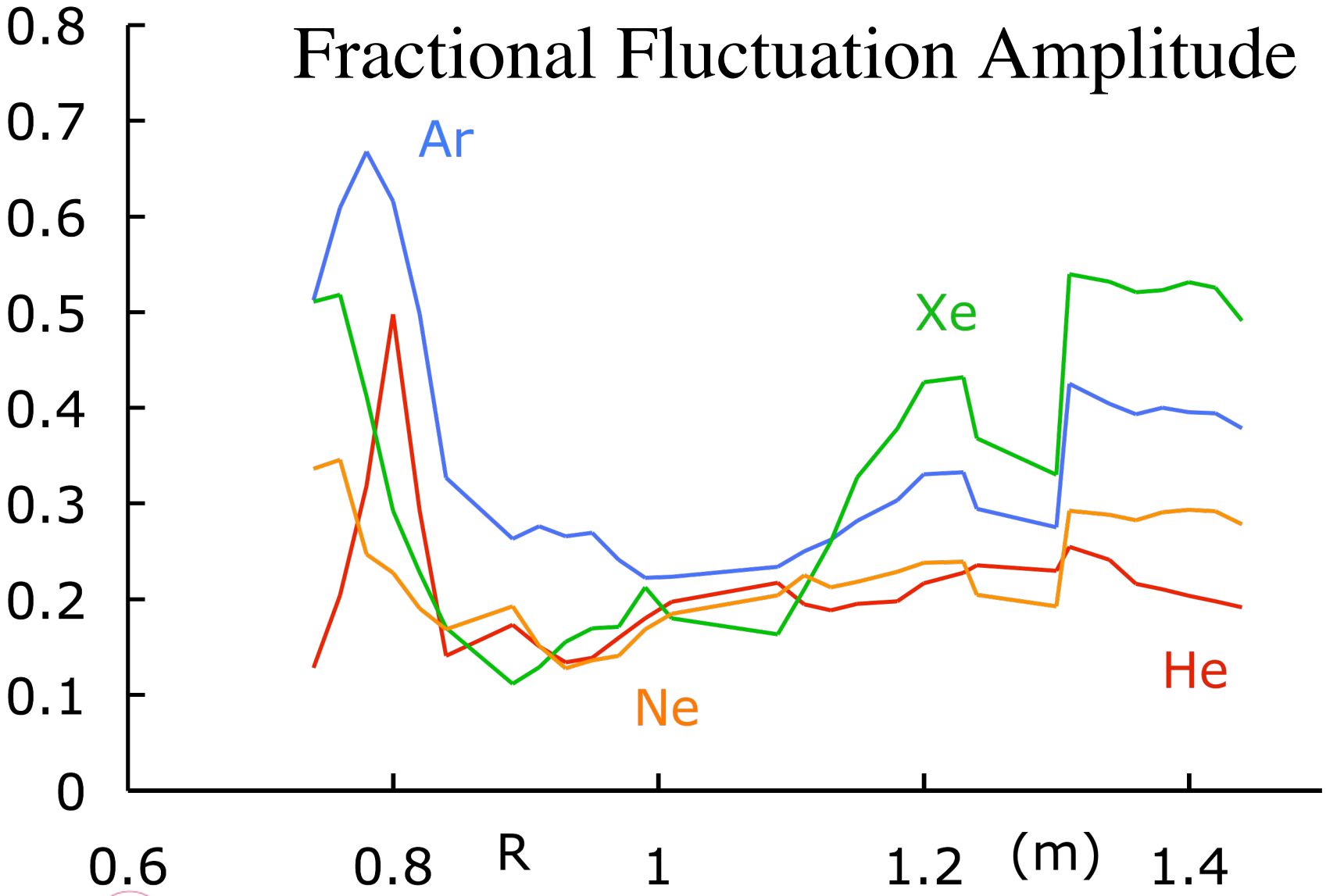
Radial Profiles of Fractional Fluctuation Amplitude



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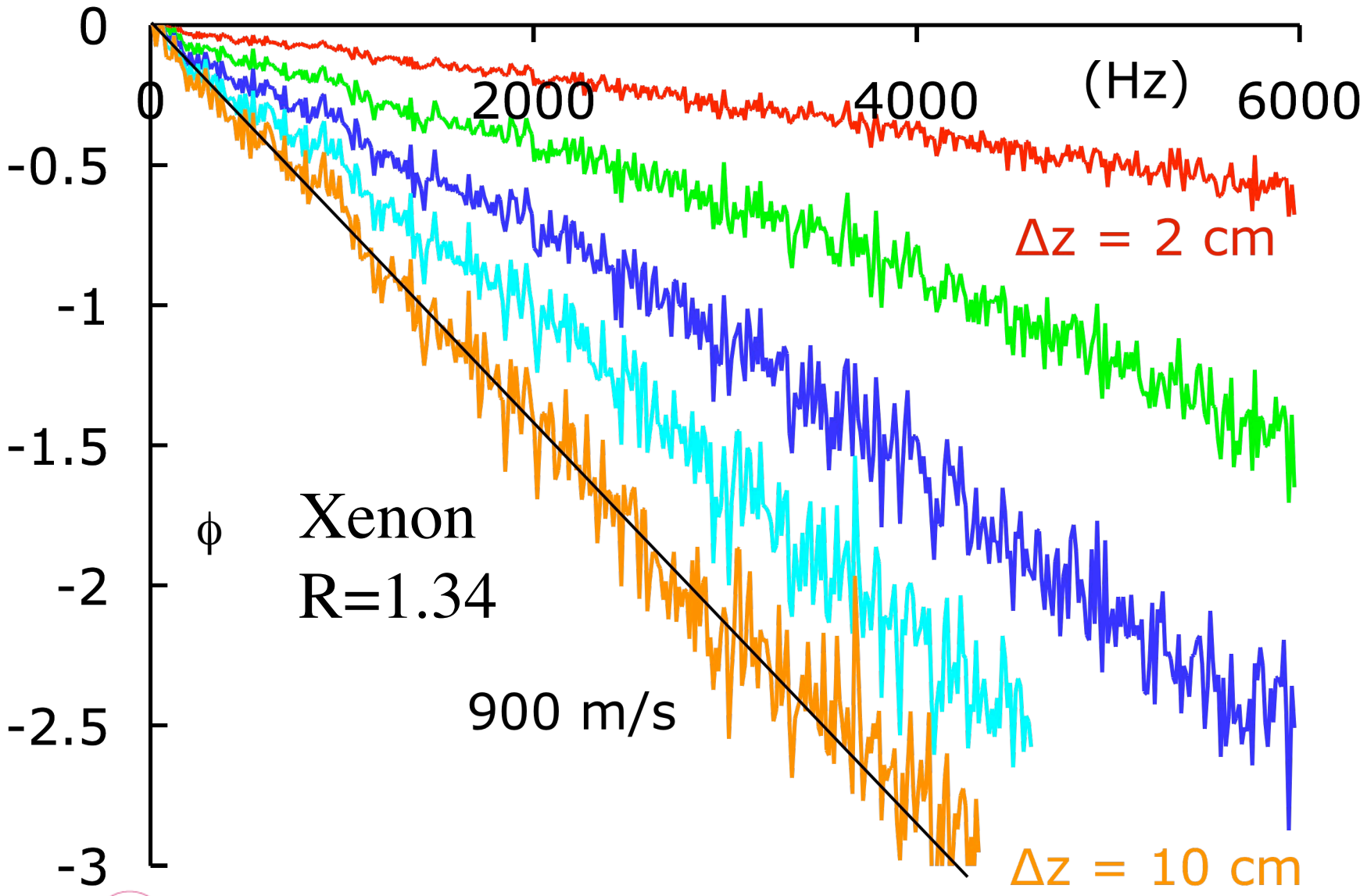
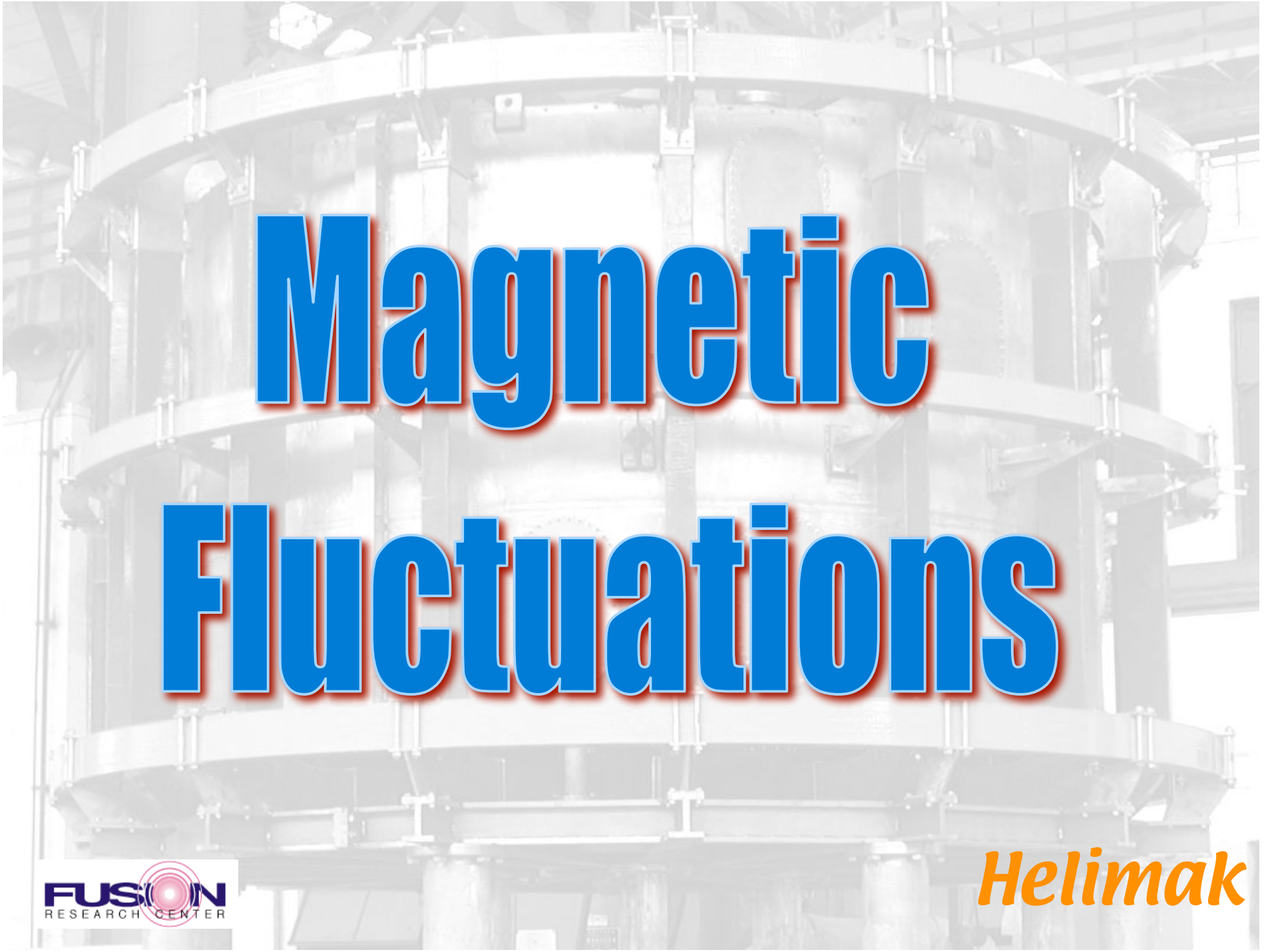
Cross-Phase between probes with various Δz



Consistent with drift-wave velocity


Magnetic
Fluctuations
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Magnetic Fluctuations

- Small: $\tilde{B} < 10\ \mu$T; $\tilde{B}/B < 10^{-4}$
- Highly non-Gaussian -- intermittent
- Correlated with drift wave $\tilde{n}$

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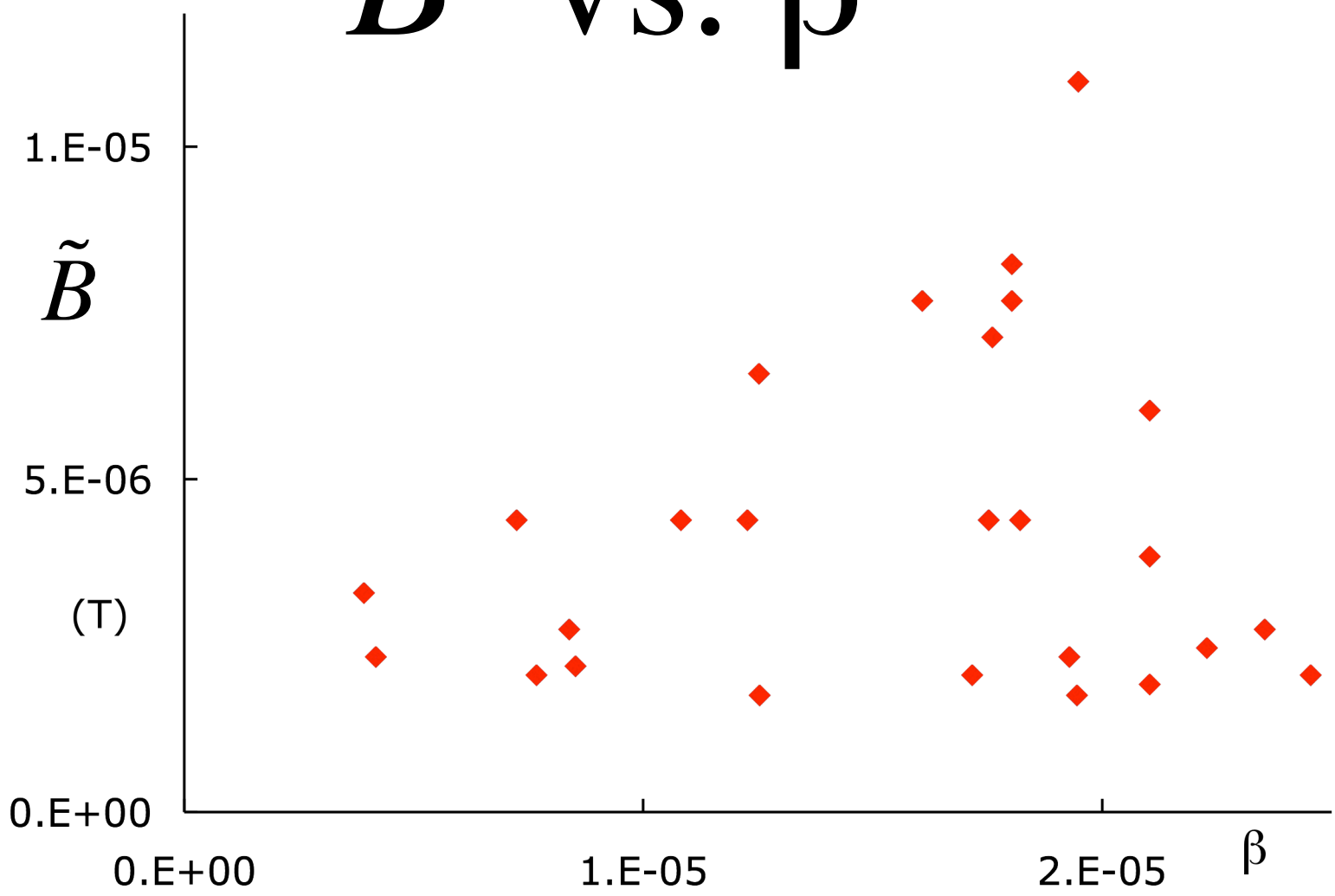
$\tilde{B}$ vs. β



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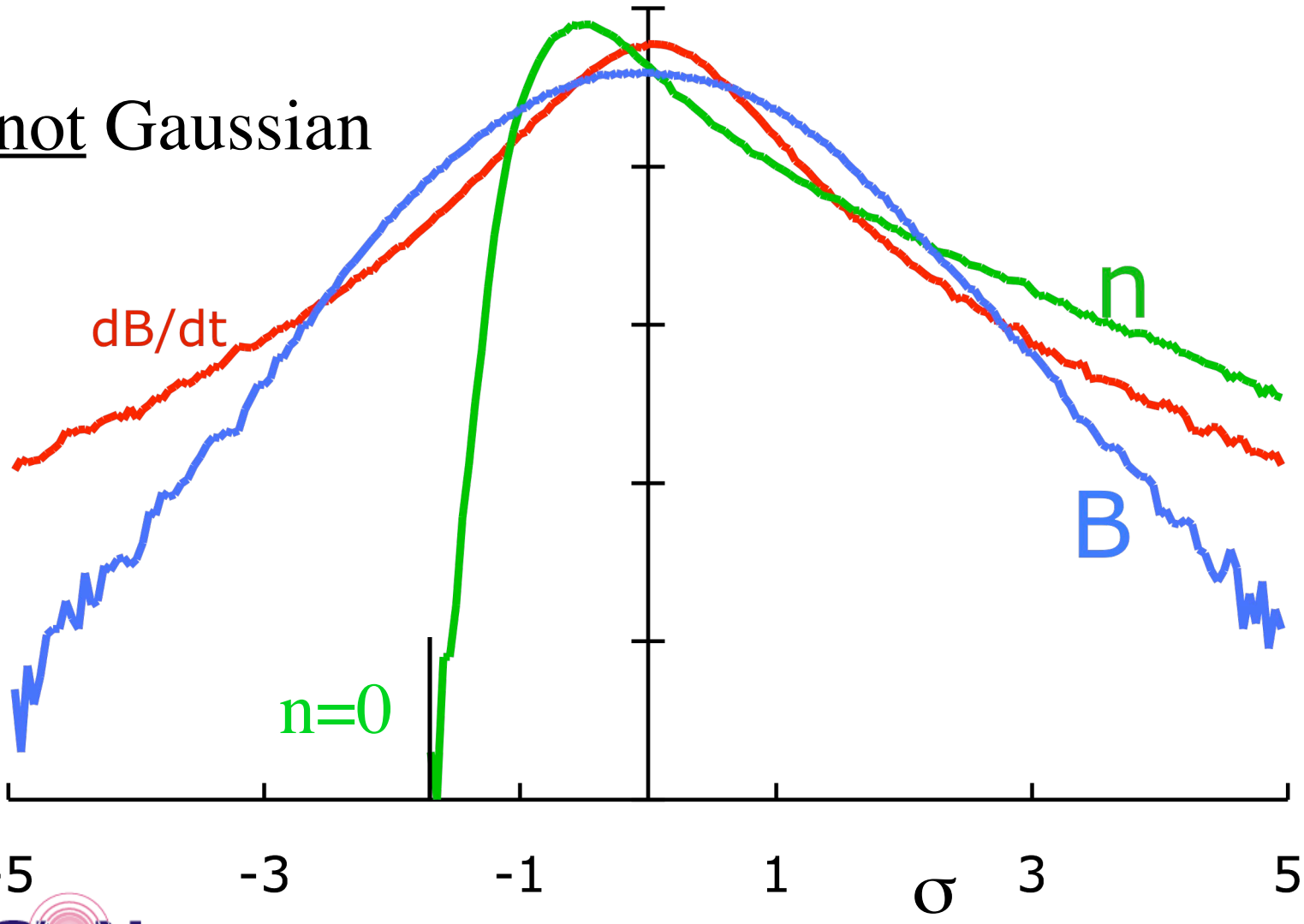
PDF (log)

B not Gaussian



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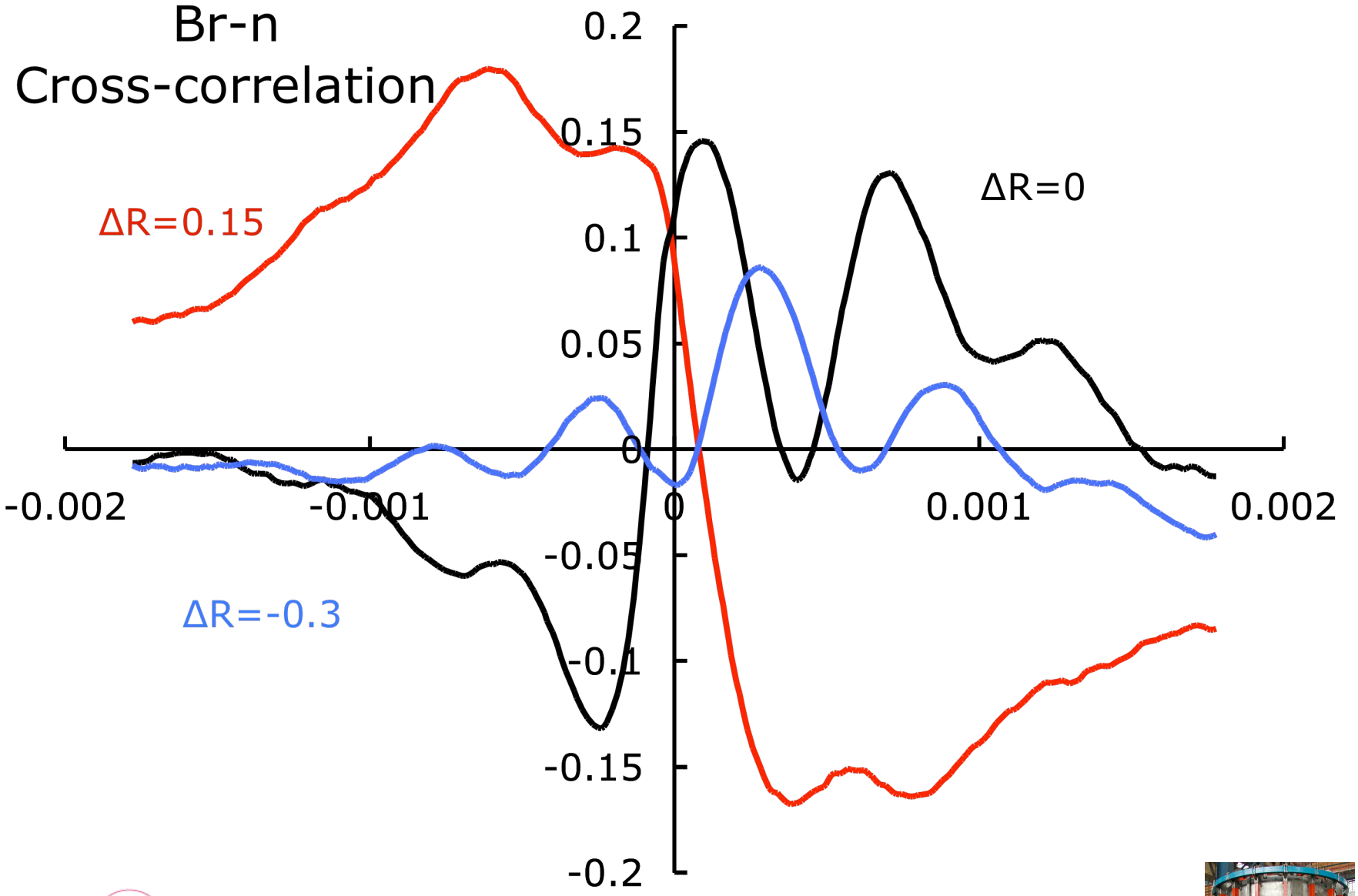

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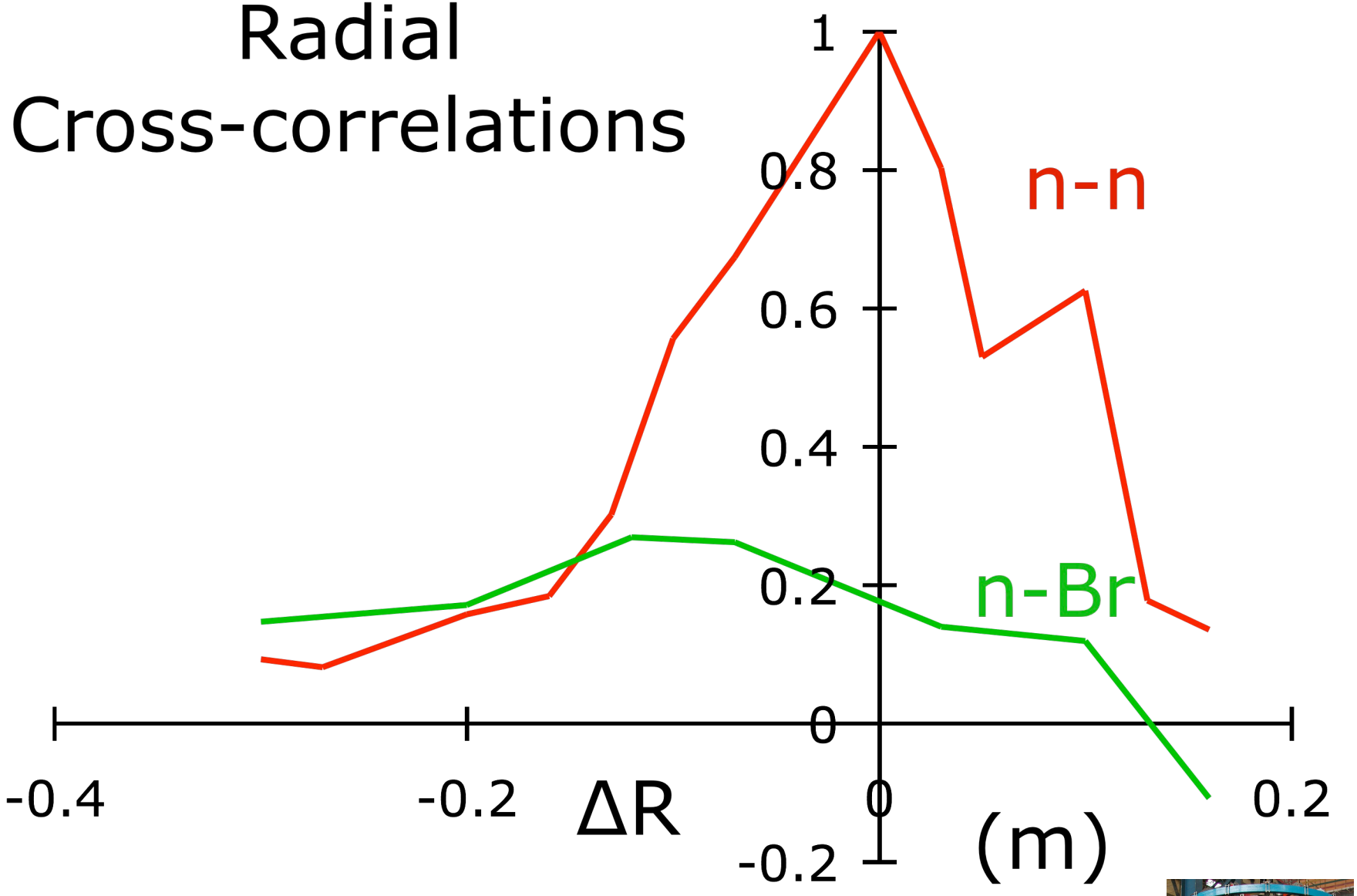
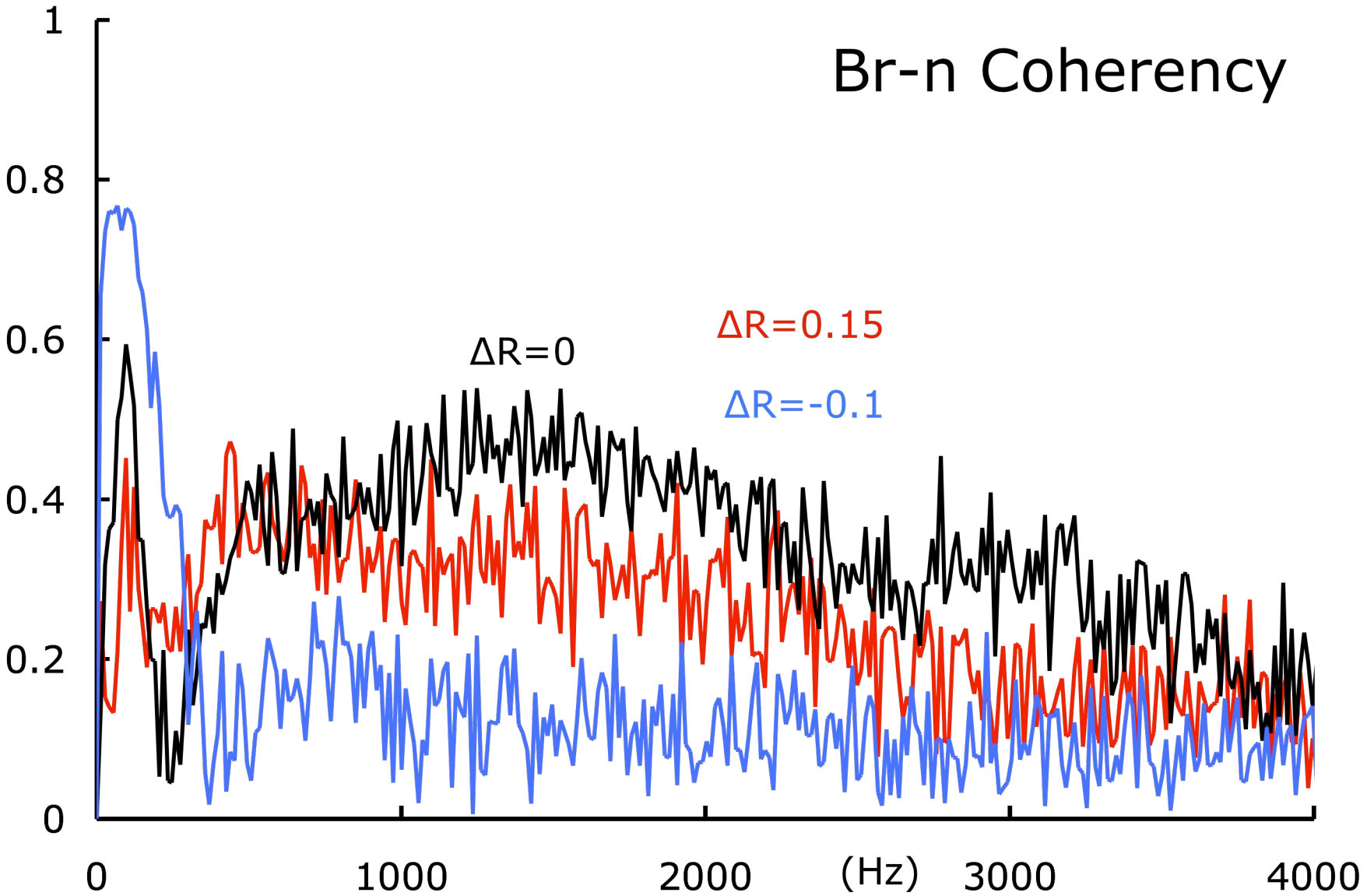
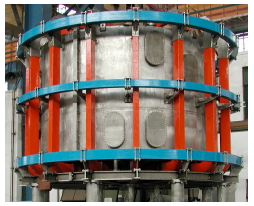
Radial Cross-correlations



Br-n Coherency





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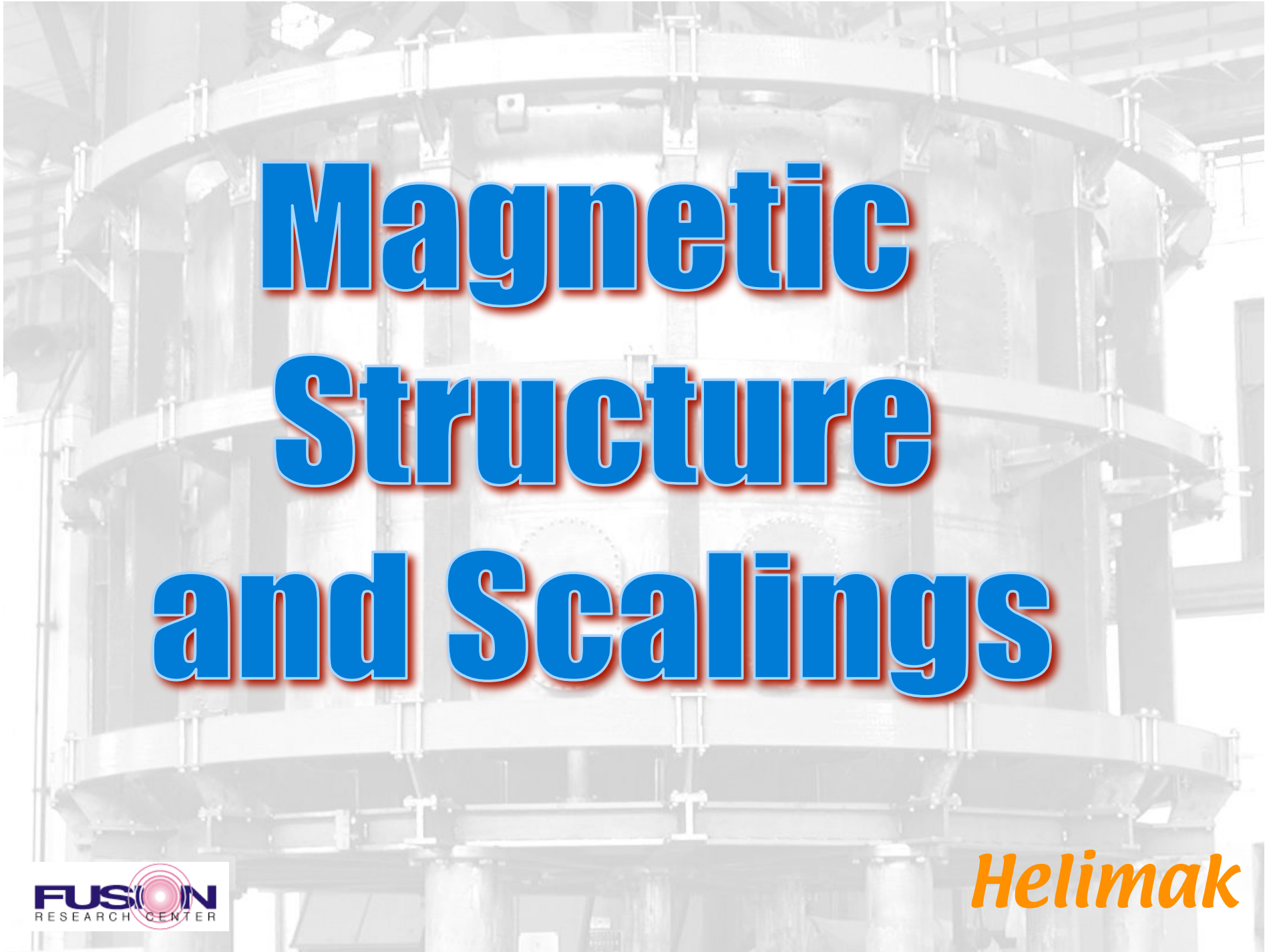
Magnetic Structure and Scalings



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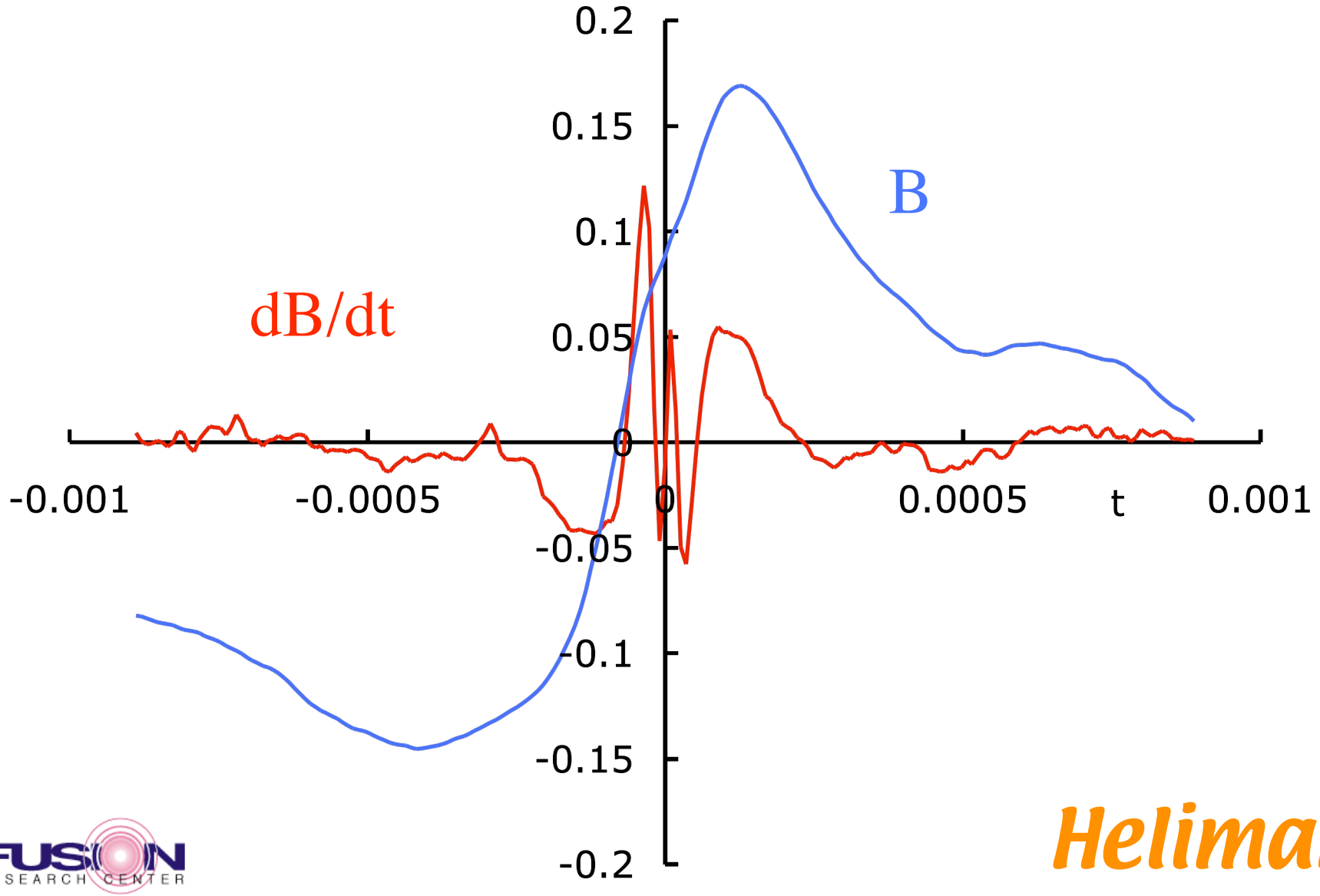
B_r-B_z Cross-Correlation



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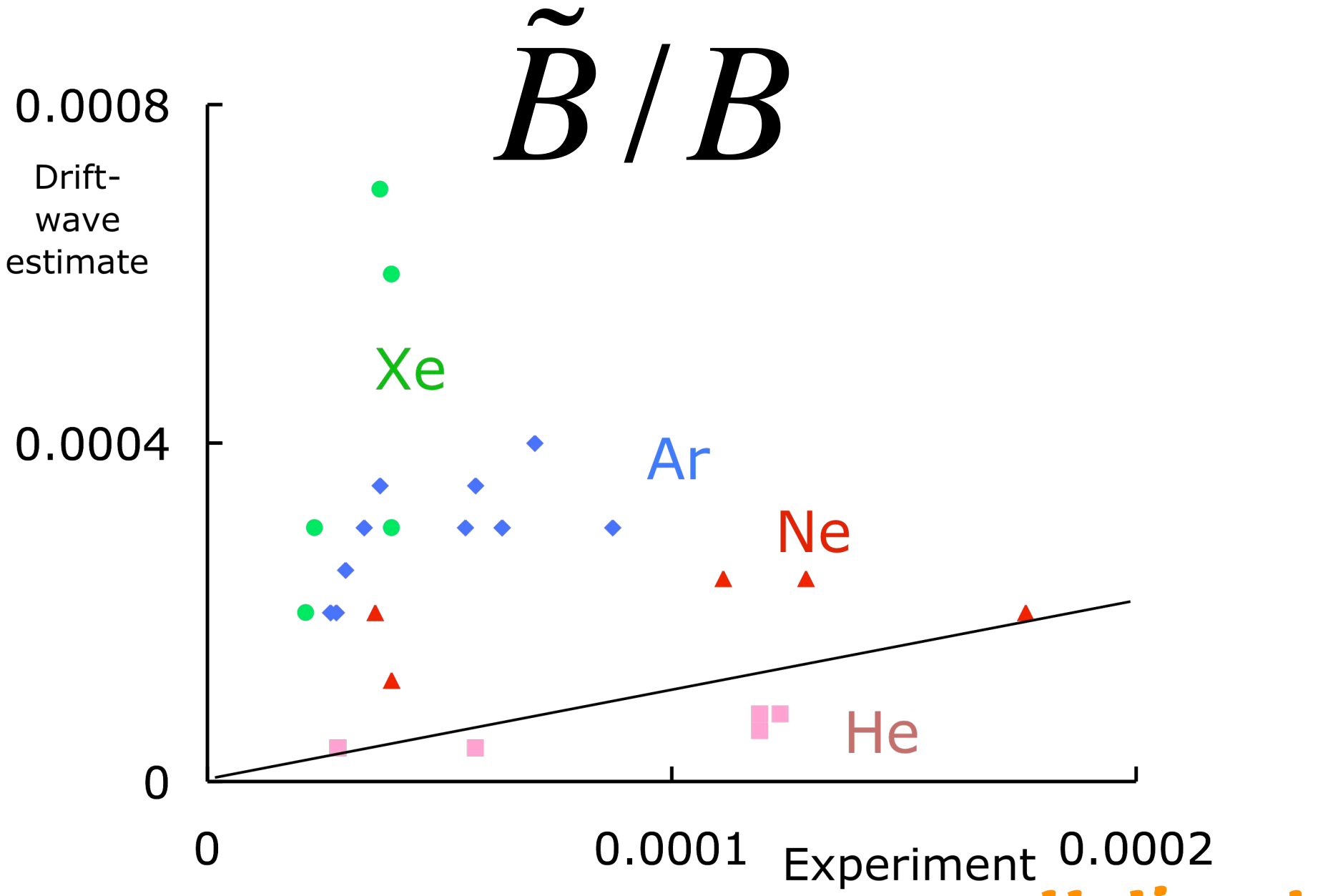

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Callen, PRL 39, 1540

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Conclusions

- Drift waves have associated magnetic fluctuations
- The $j_{||}$ seems "more turbulent" than n
- Magnetic fluctuations open a new "window" on drift-wave dynamics

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