

MEASUREMENTS OF IMPROVED CONFINEMENT DURING
MAGNETIC LEVITATION IN THE
LEVITATED DIPOLE EXPERIMENT (LDX)

Columbia University



A.C. BOXER, J.L. ELLSWORTH,
J. KESNER
MIT



D.T. GARNIER, M.E. MAUEL
COLUMBIA UNIVERSITY

Main Results

First 6 months of data with a levitating coil

Levitation triples the density

Levitation doubles the stored energy

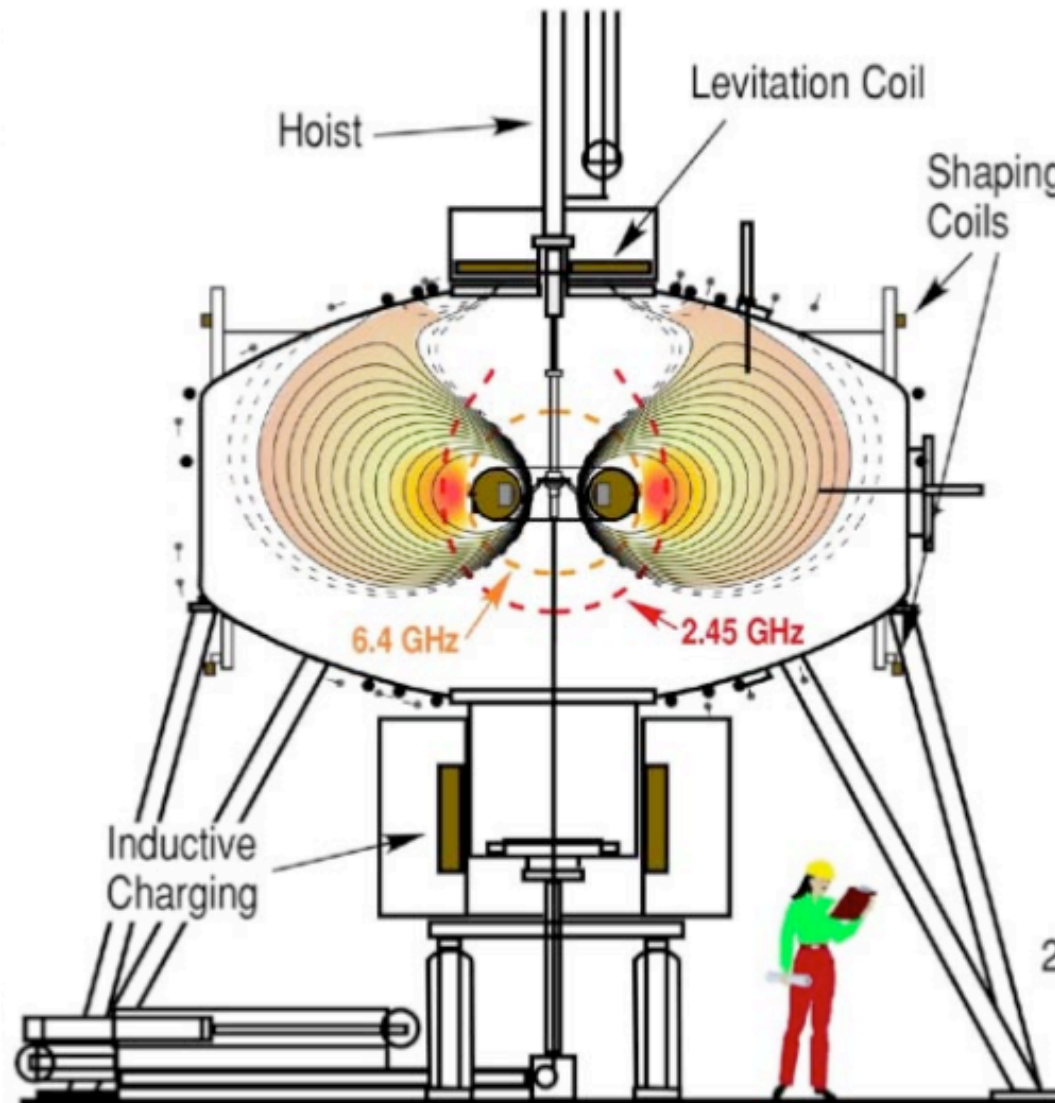
Observations of density self-organization

Observations of densities above cutoff

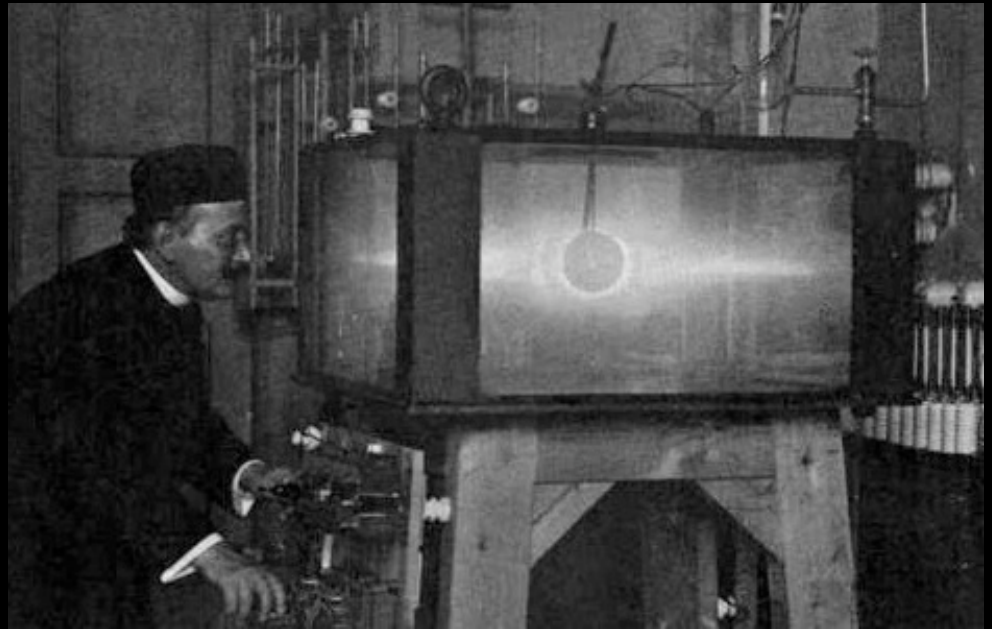
Plasma densities are power limited

THE LEVITATED DIPOLE EXPERIMENT

A NEW APPROACH TO NUCLEAR FUSION



LDX is part of a long tradition of dipole study.



Kristian Birkeland with his *terrella*, ca. 1910

Are there “natural” dipole profiles?

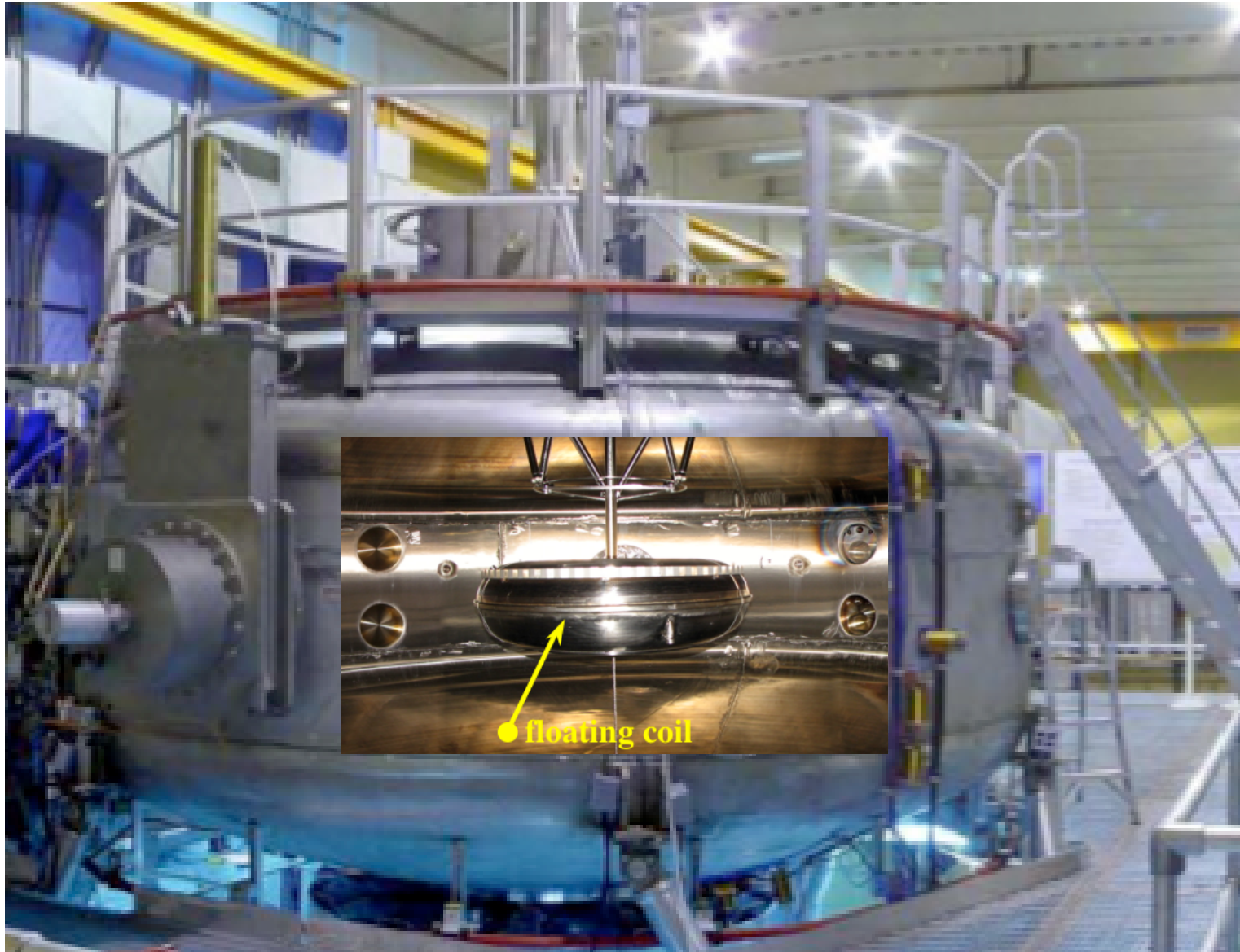
$$\delta(\mathbf{p}V^\gamma) = 0$$

$$\Rightarrow \mathbf{p} \sim r^{-20/3}$$

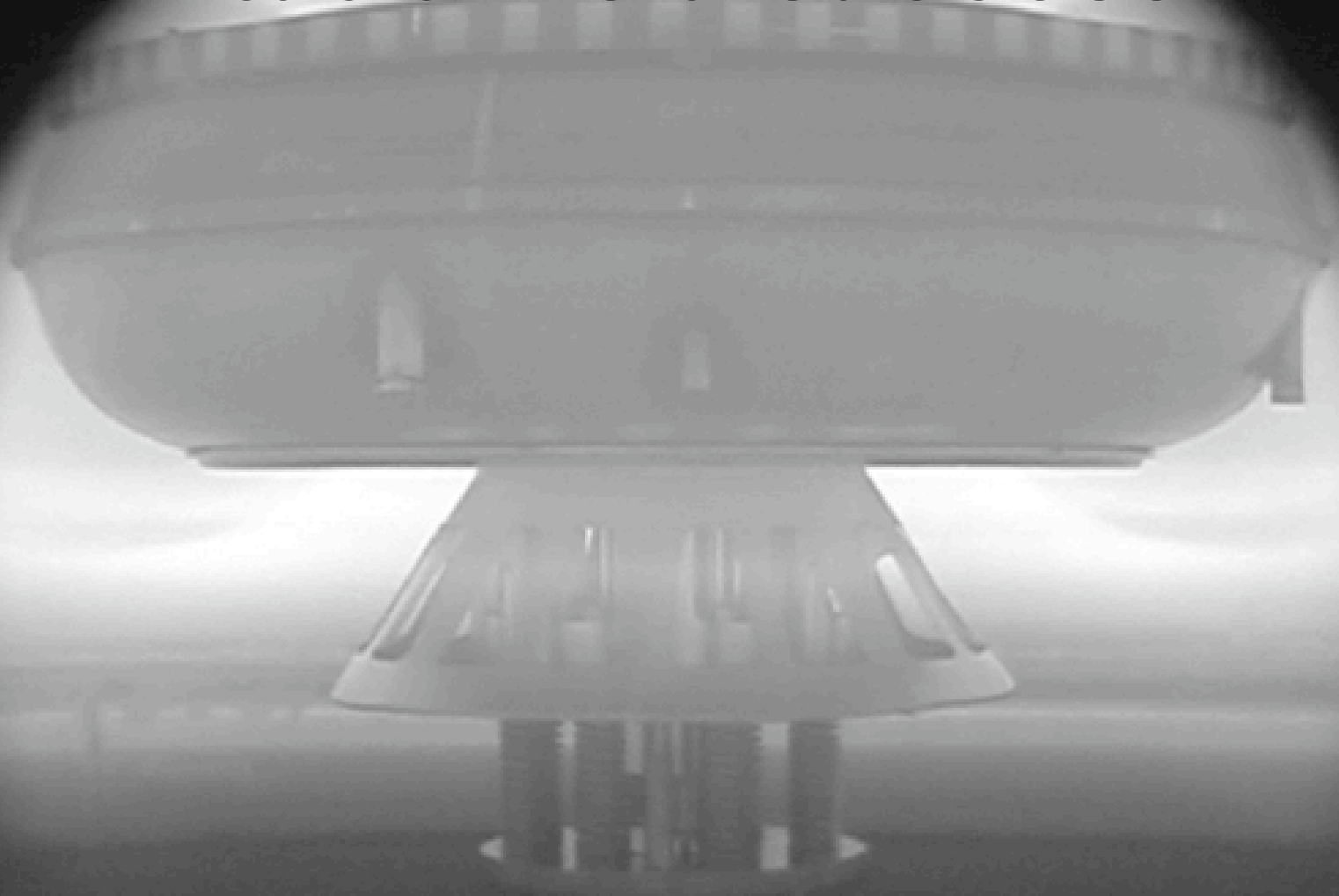
$$\delta(\mathbf{n}V) = 0$$

$$\Rightarrow \mathbf{n} \sim r^{-4}$$

THE LEVITATED DIPOLE EXPERIMENT



Levitation is a success!



Levitation is a success!

Coil floats for nearly 3 hours



A large, metallic, spherical object is levitating above a complex, multi-tiered base structure. The sphere is highly reflective and has a textured surface. The base consists of several concentric rings and vertical supports, suggesting a sophisticated magnetic or levitation system. The background is dark, making the metallic components stand out.

Levitation is a success!

Coil floats for nearly 3 hours

Vertical excursions are only a few mm



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Coil floats for nearly 3 hours

Vertical excursions are only a few mm

Over 200 levitated shots

DIAGNOSTICS SET

- **4-Channel Microwave Interferometer**

- **Moveable Probes**

- **Magnetics**

 - **Flux Loops**

 - **Mirnov Coils**

- **Visible Light Detectors**

 - **Photodiode Array**

 - **Fast Cameras**

 - **Spectrometer**

- **X-Rays**

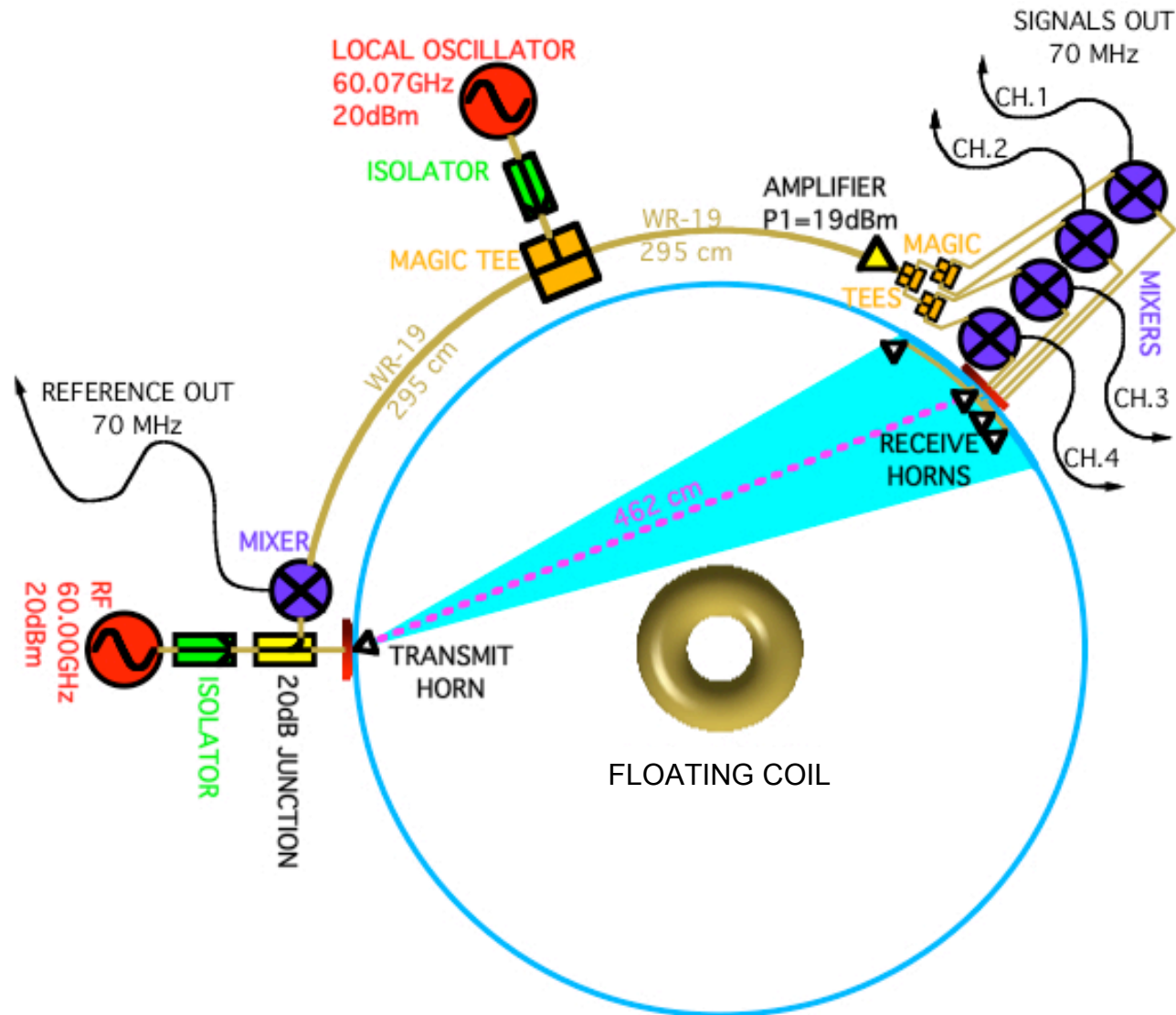
 - **X-Ray camera**

 - **Pulse Height Analyzer**

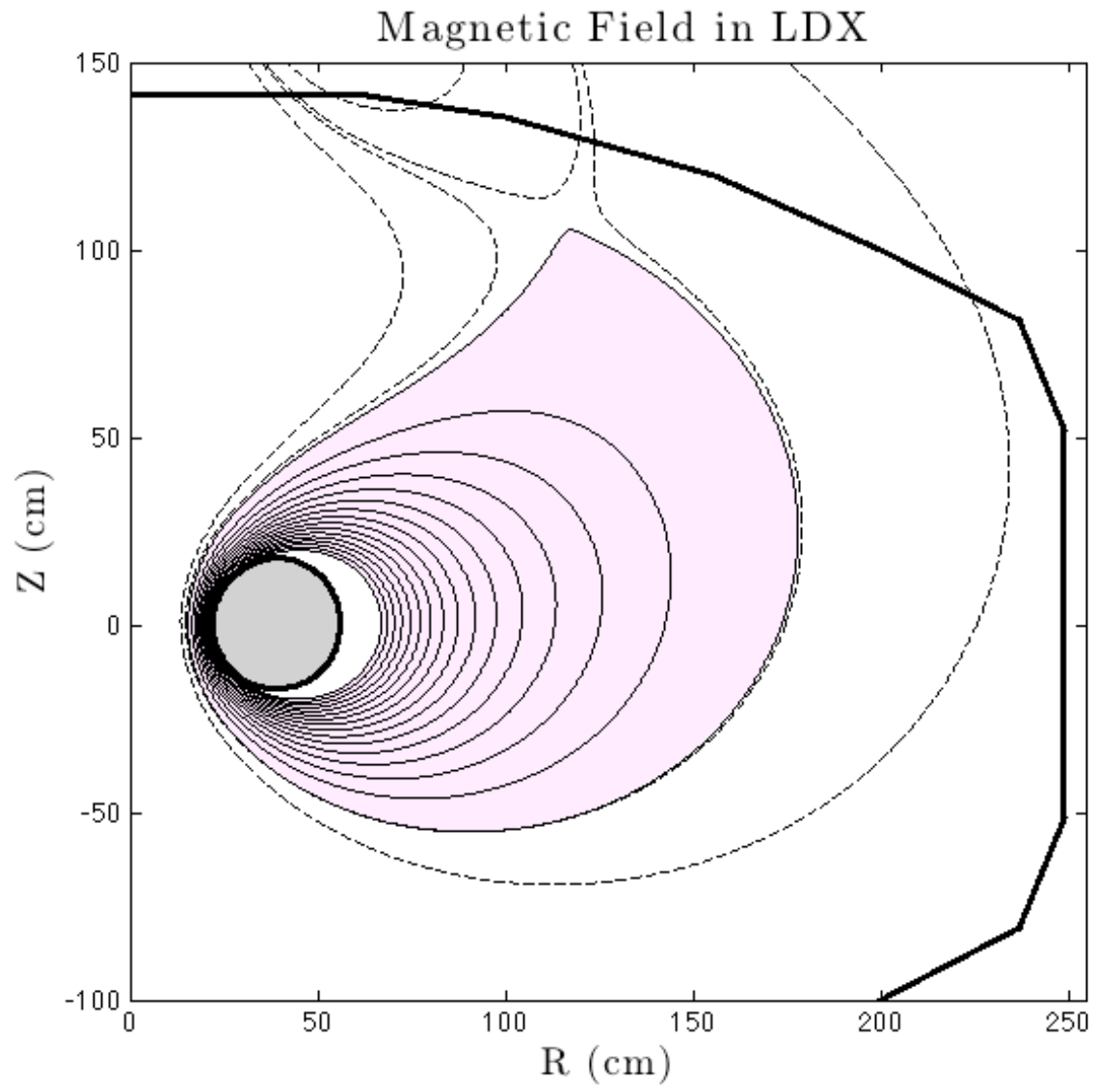
- **V-Band Radiometer**

- **Ion Gauge**

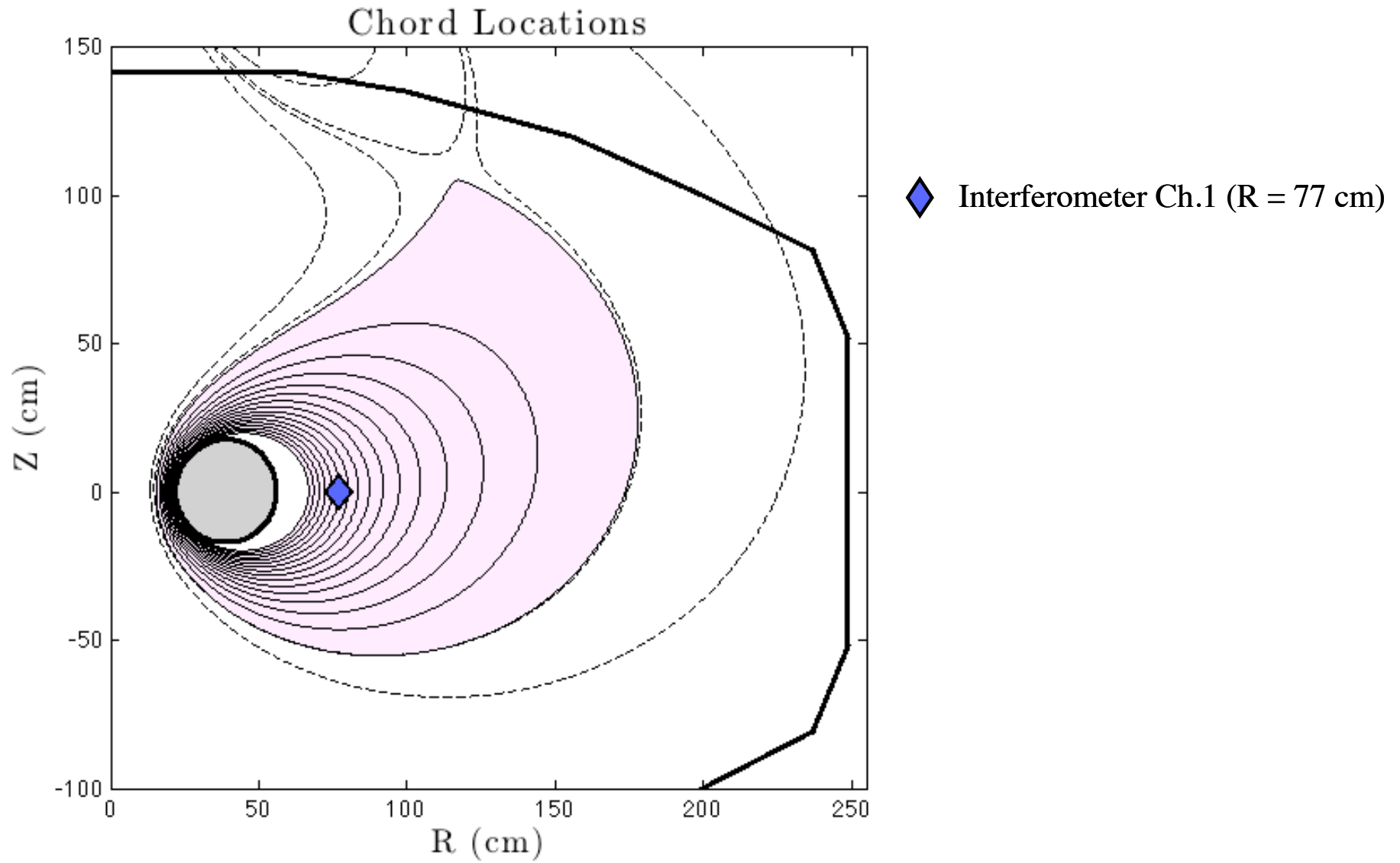
A 4-Channel Interferometer (60 GHz) Measures the Plasma Density Profiles



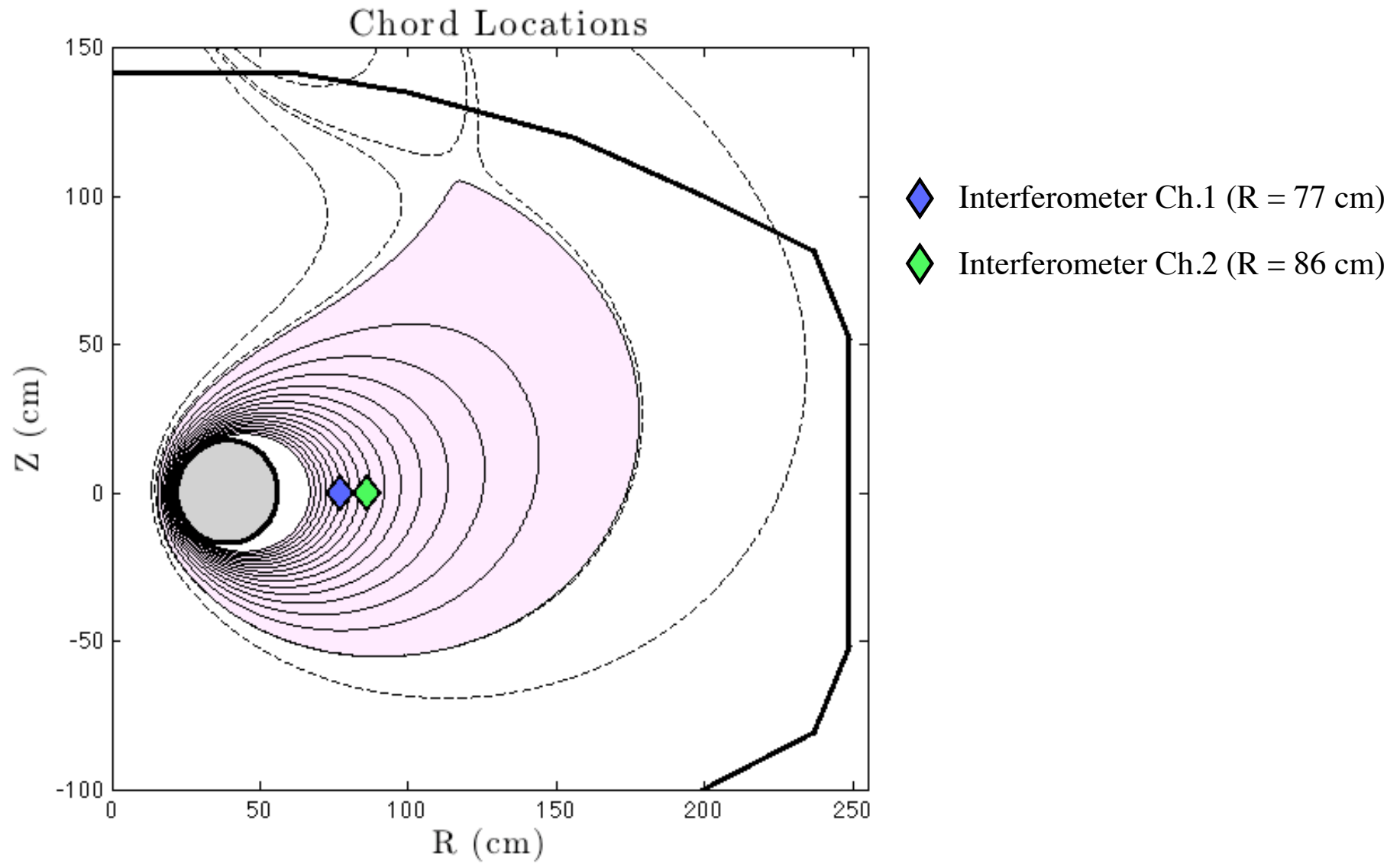
Chord Measurement Locations



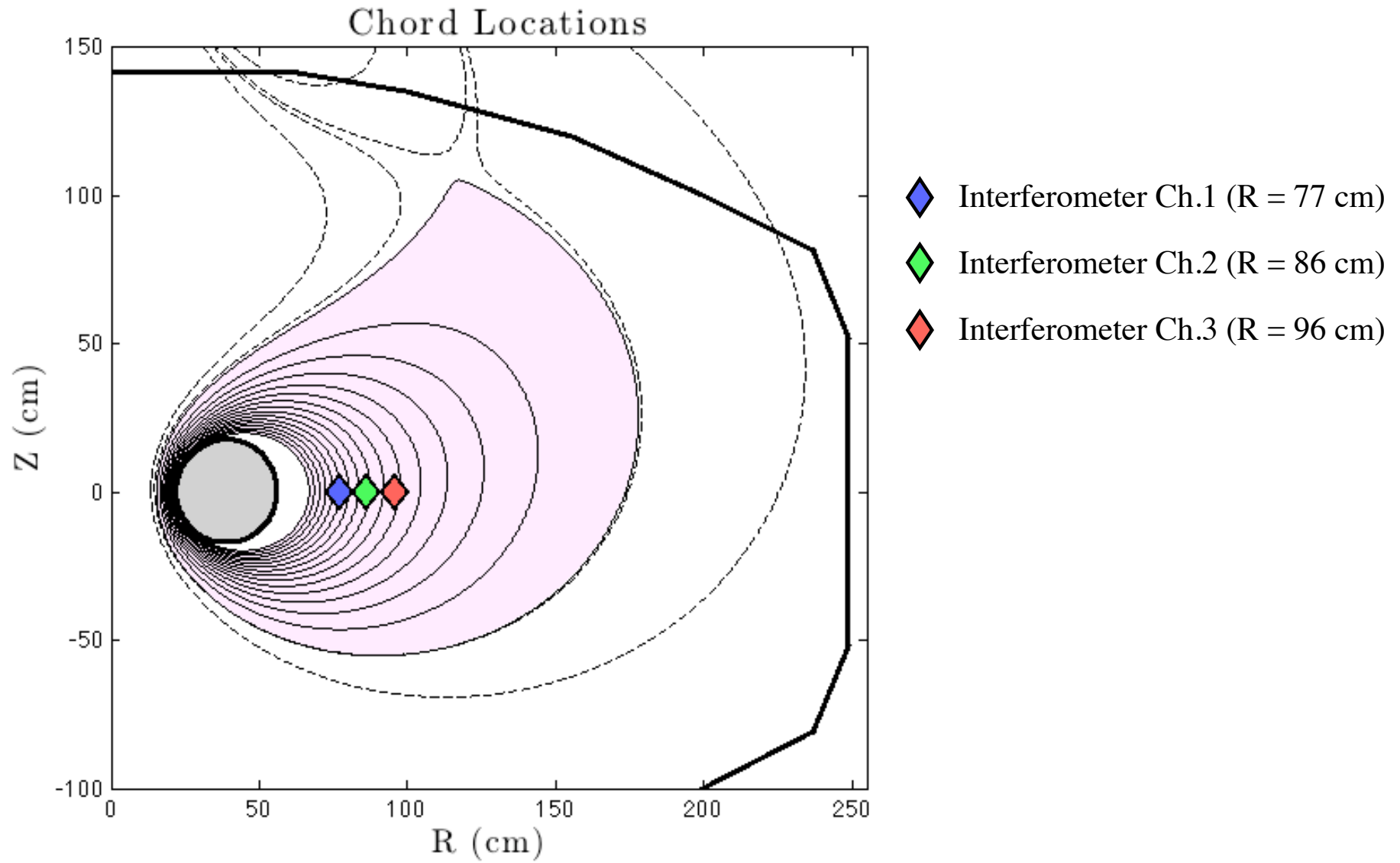
Chord Measurement Locations



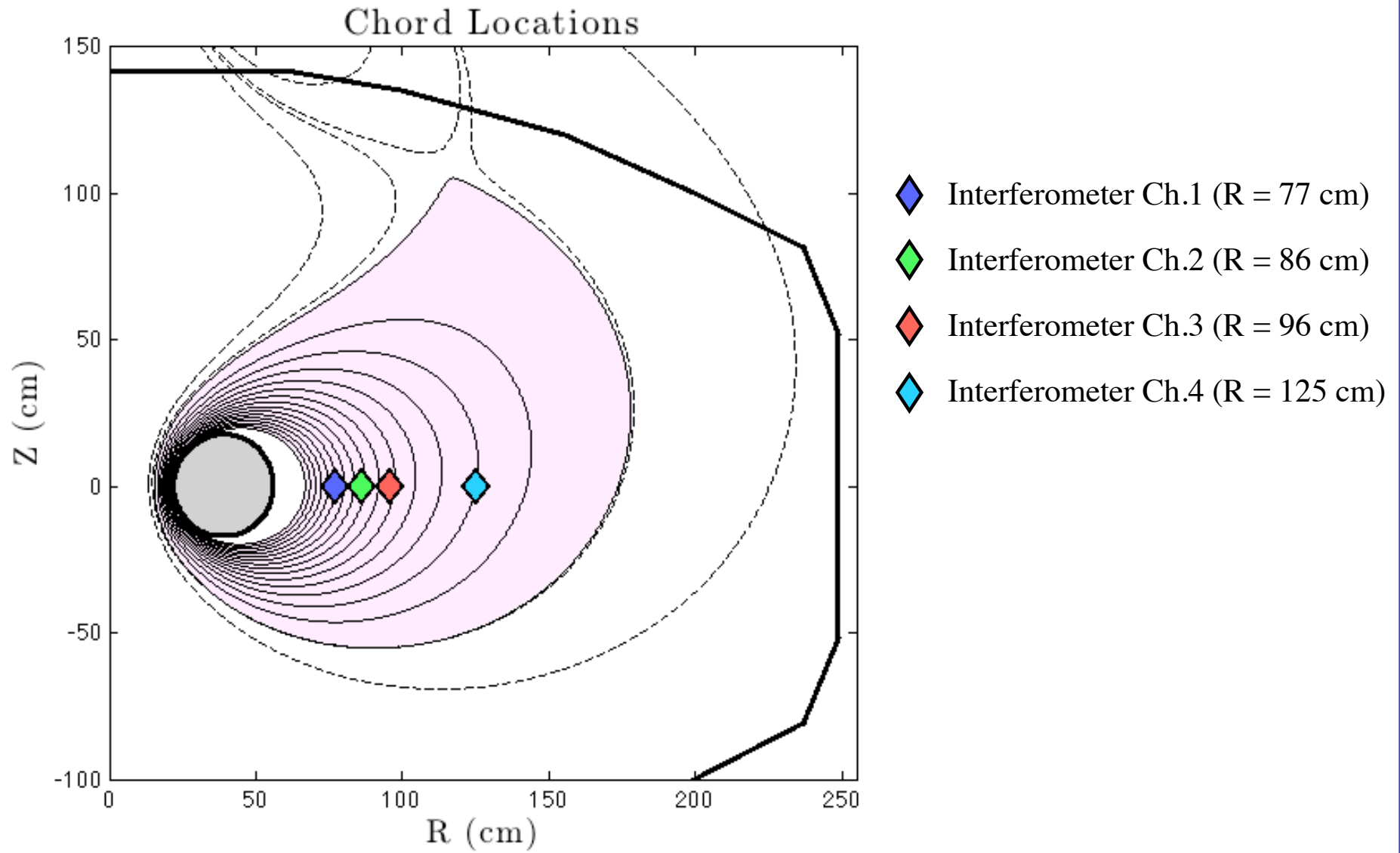
Chord Measurement Locations



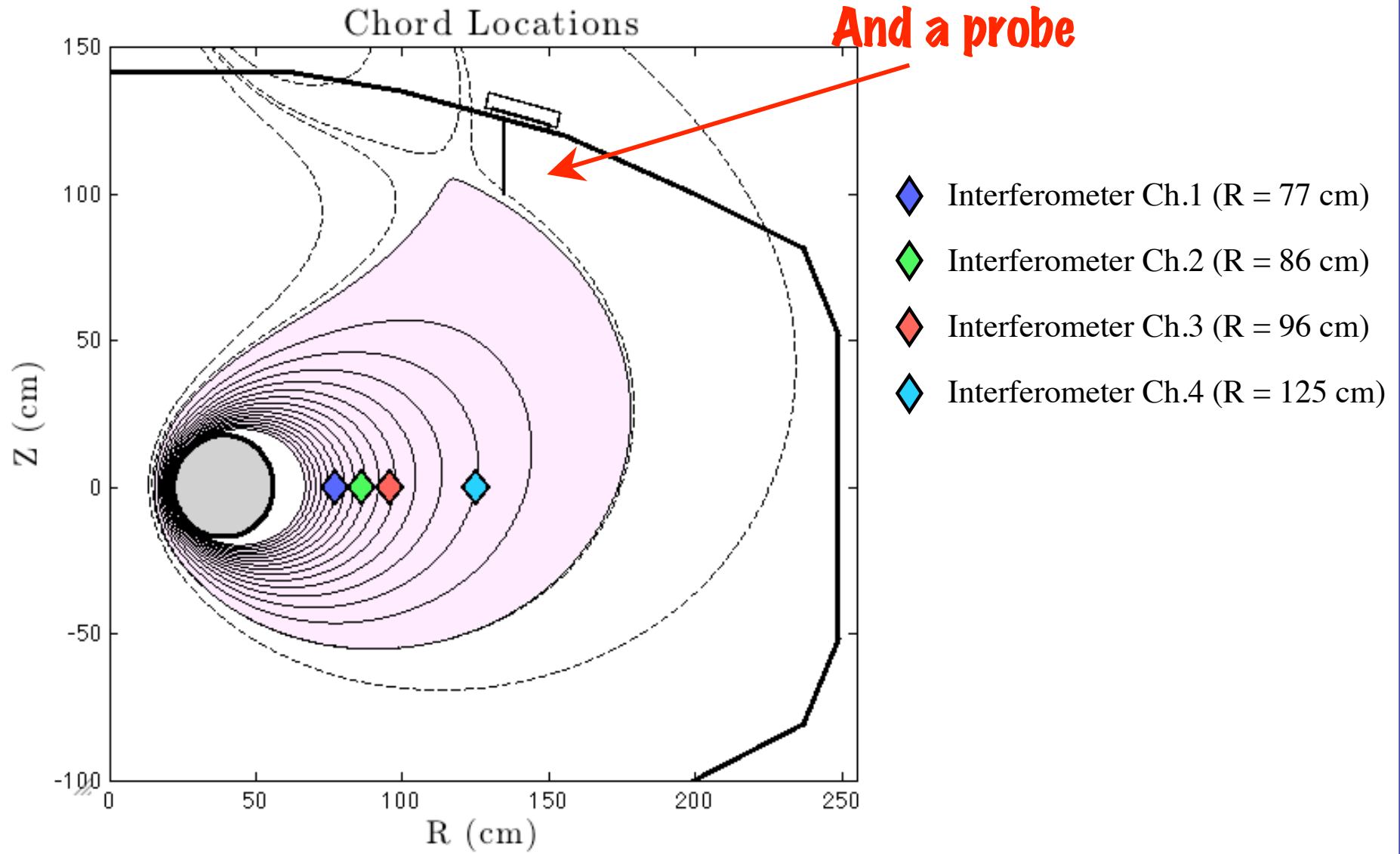
Chord Measurement Locations



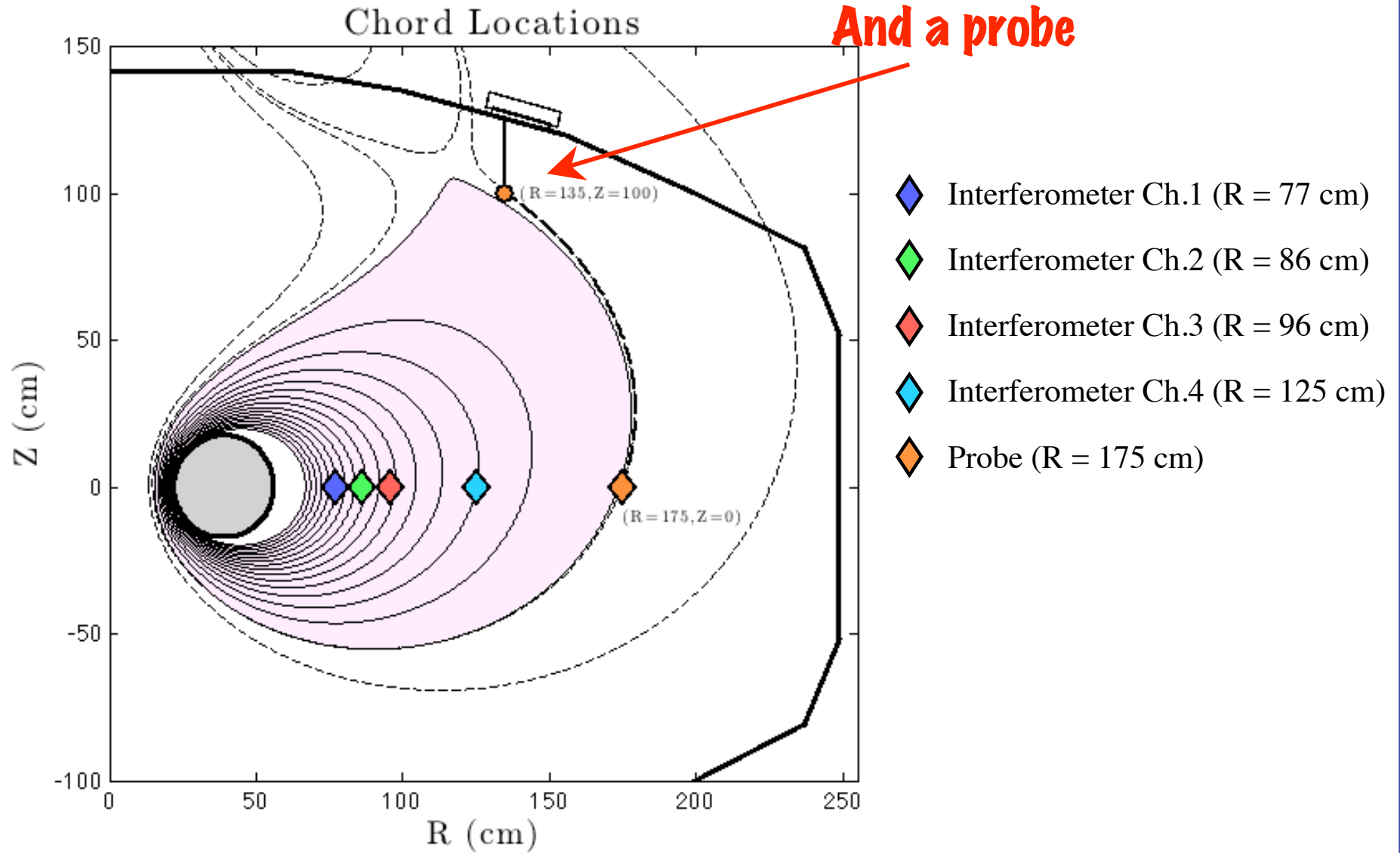
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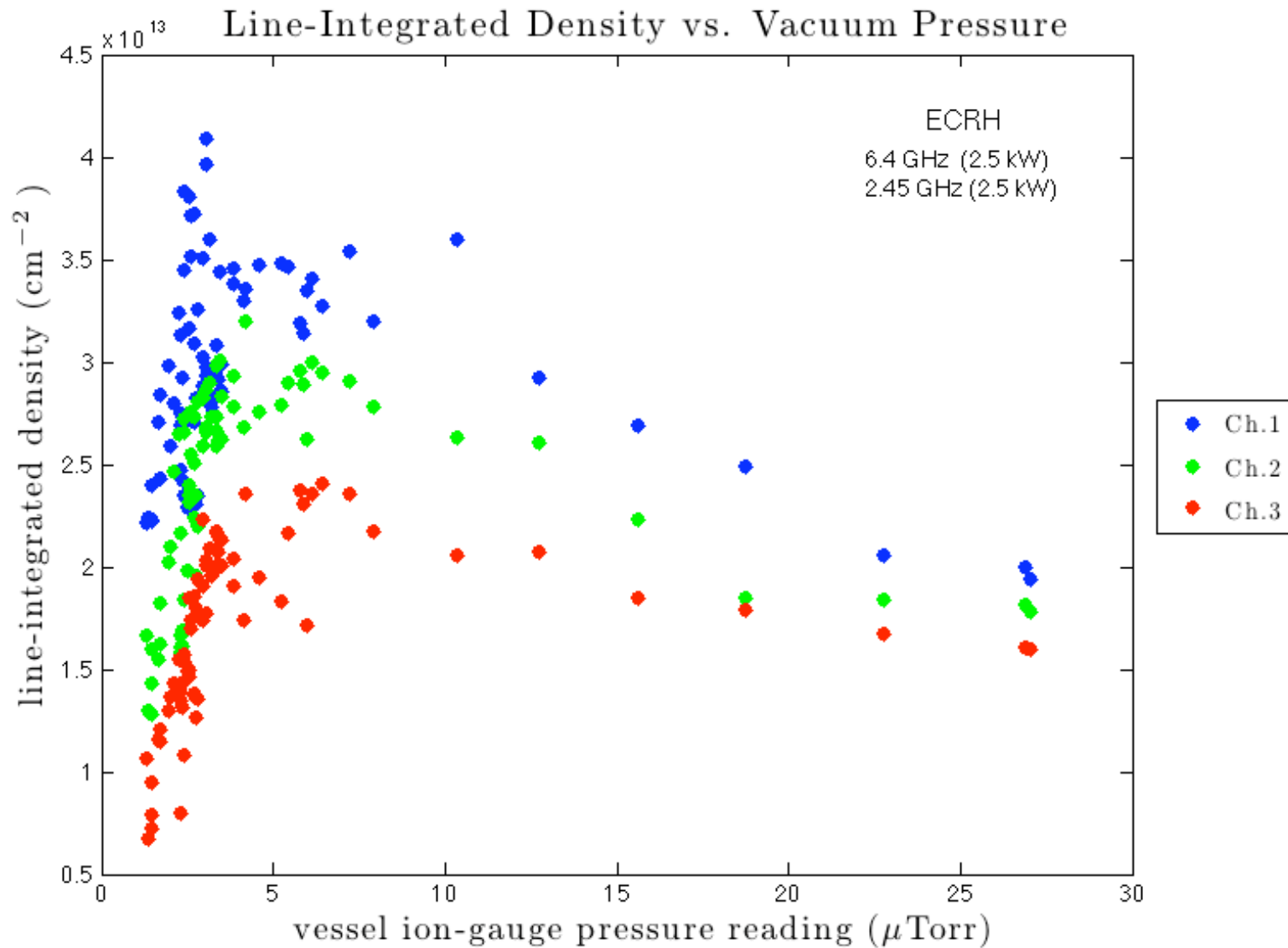
Levitation doubles the stored energy

Observations of density self-organization

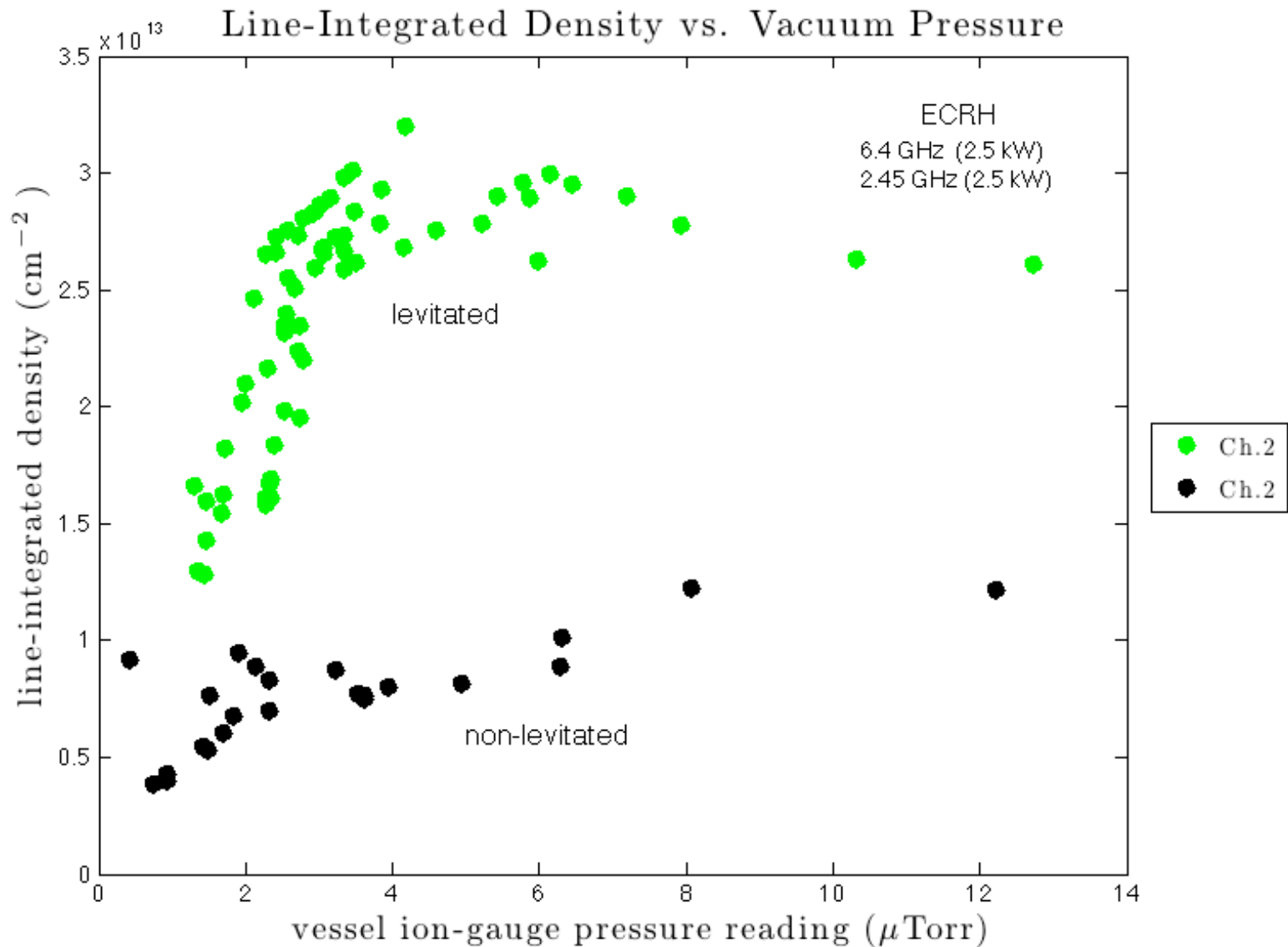
Observations of densities above cutoff

Plasma densities are power limited

Plasma Parameters are Strongly Affected by the Neutral Pressure in the Vacuum Chamber



Levitation Triples the Density



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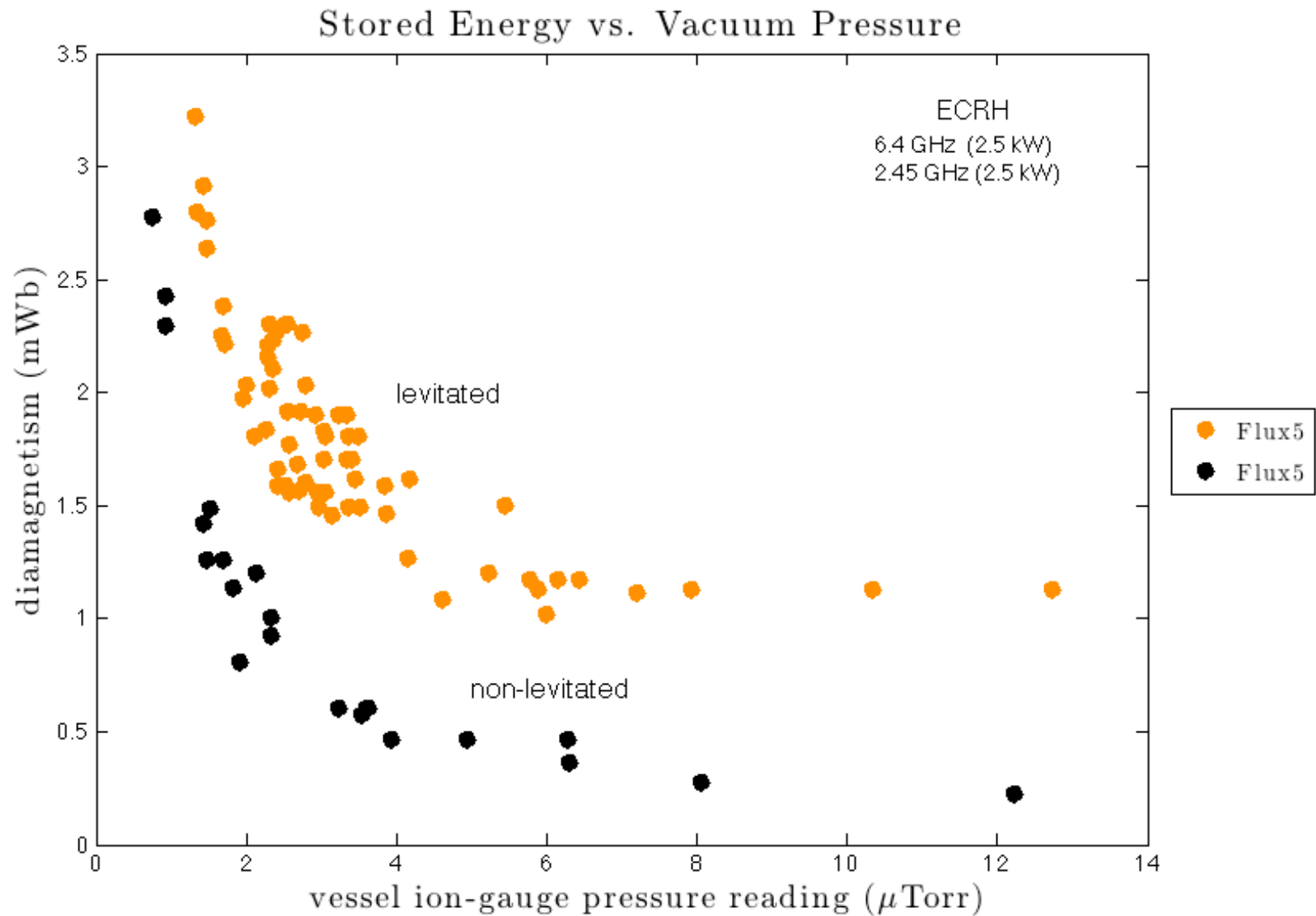
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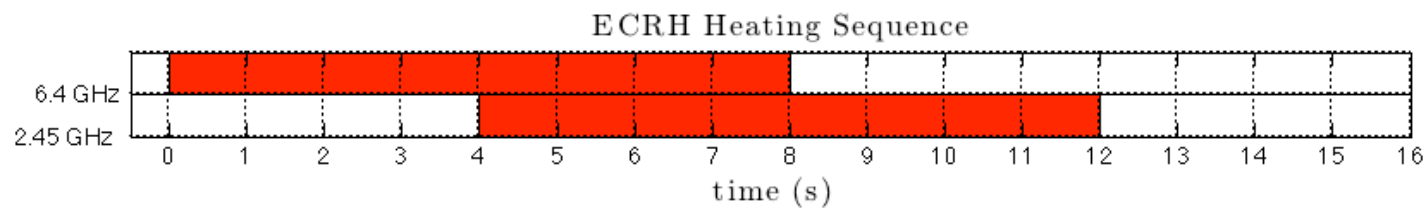
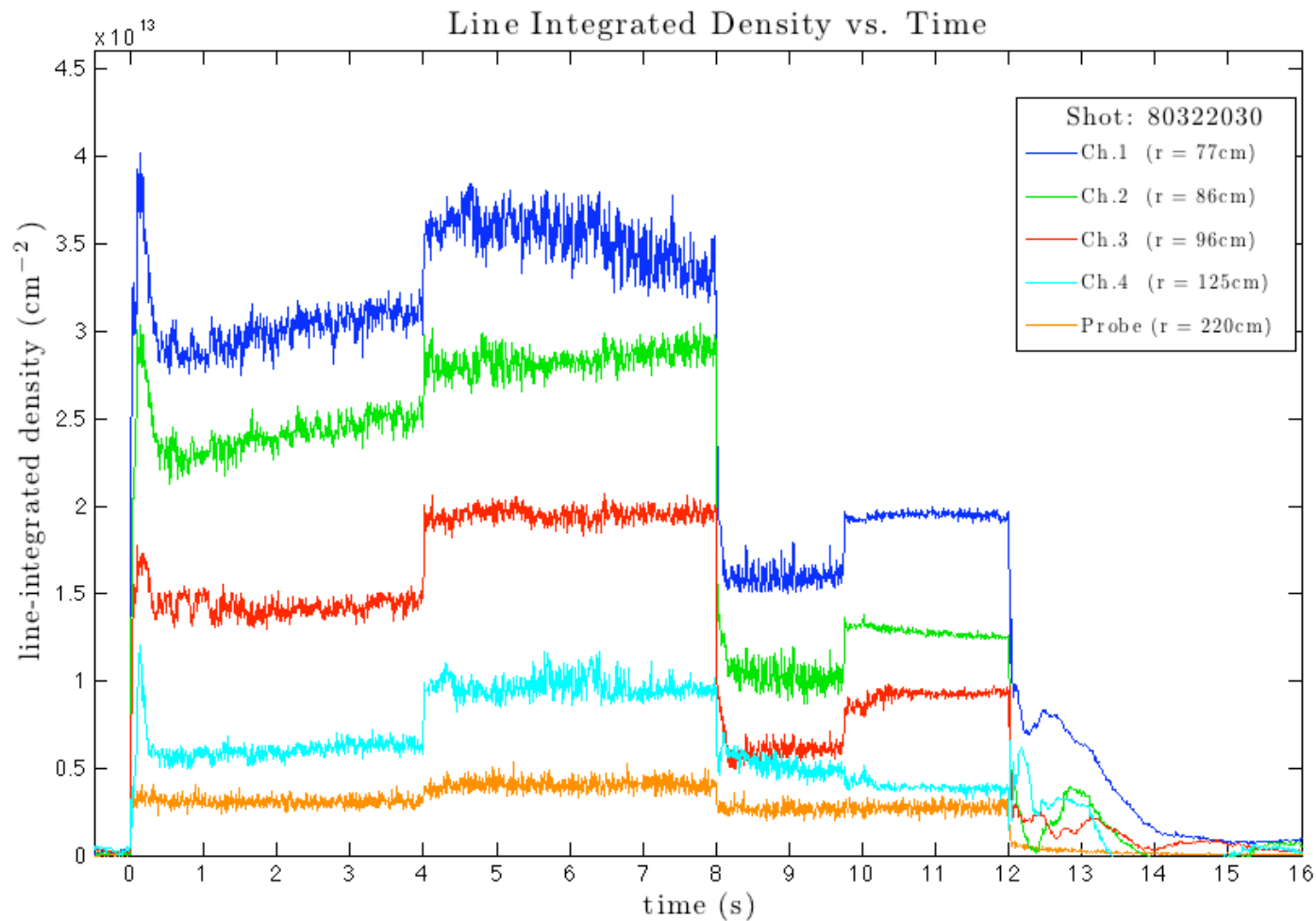
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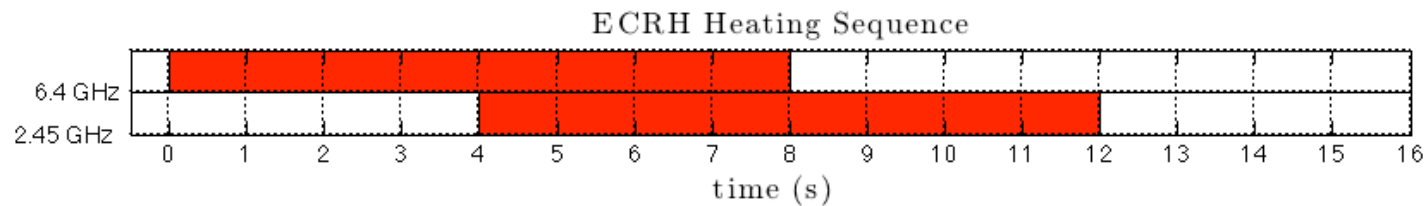
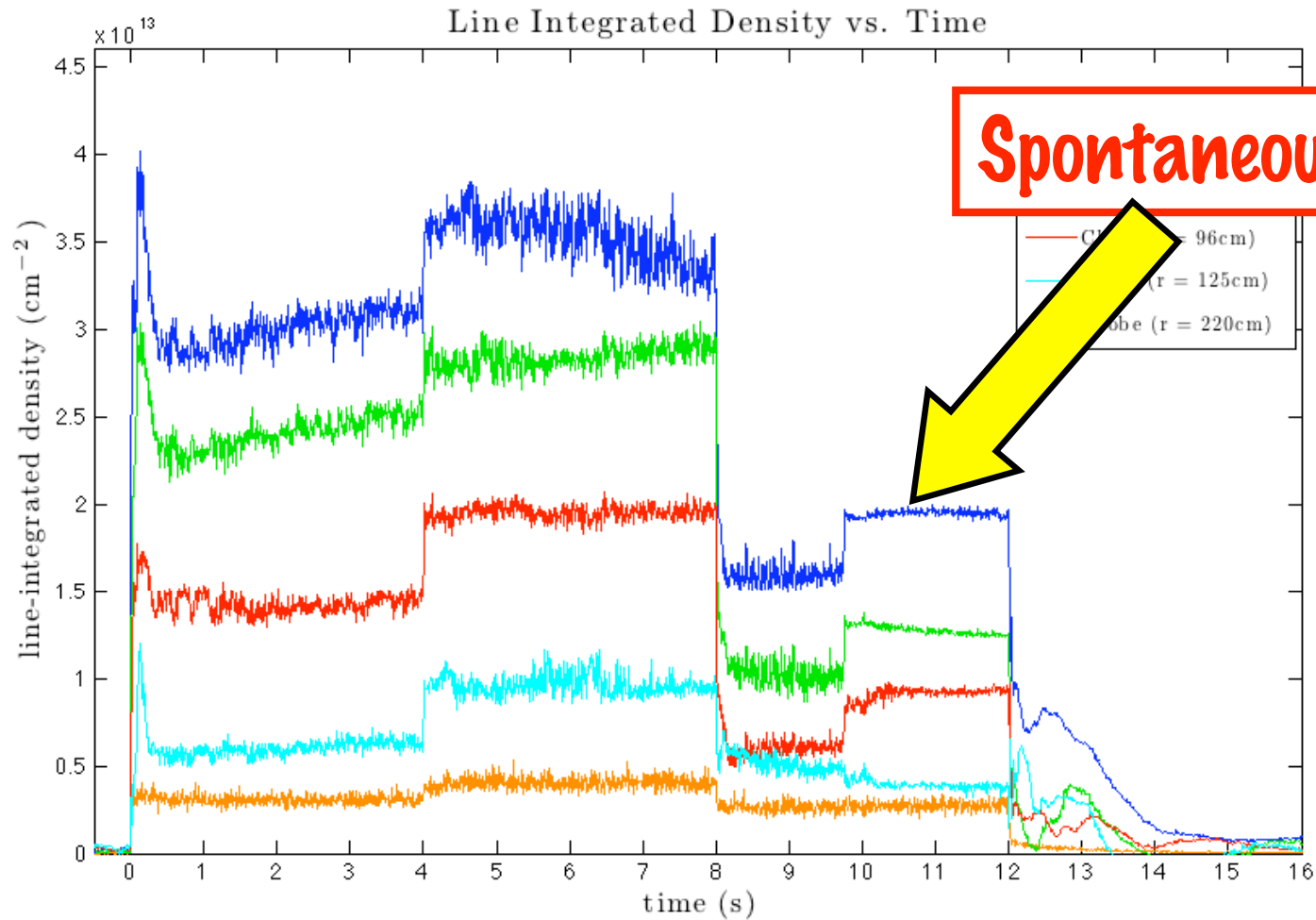
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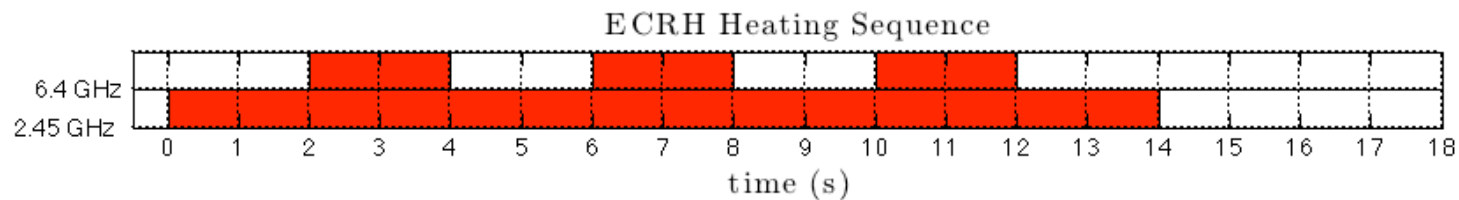
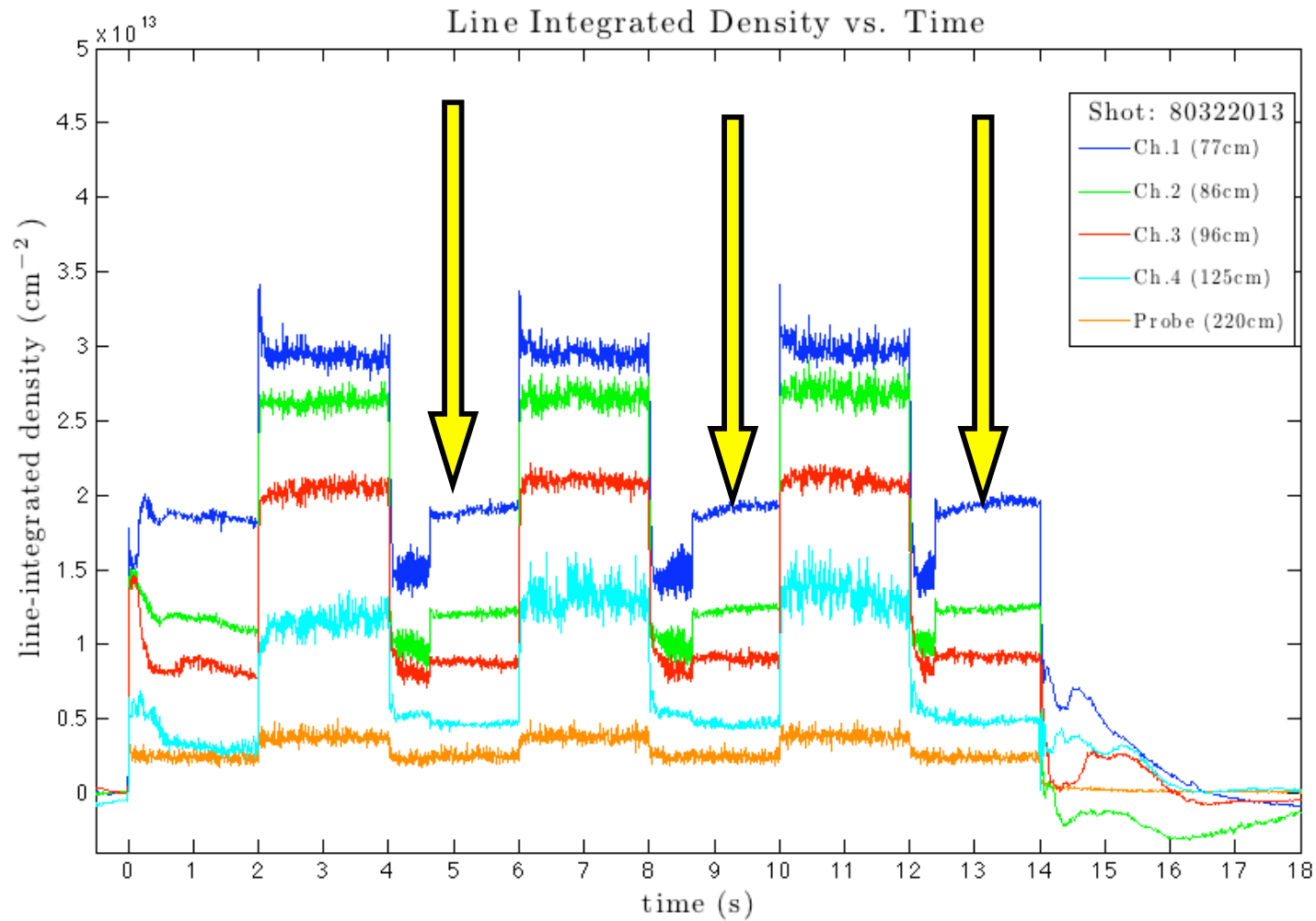
Density Self-Organization



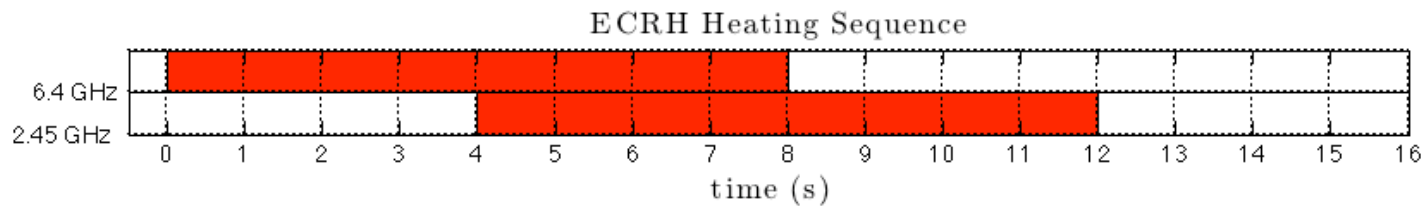
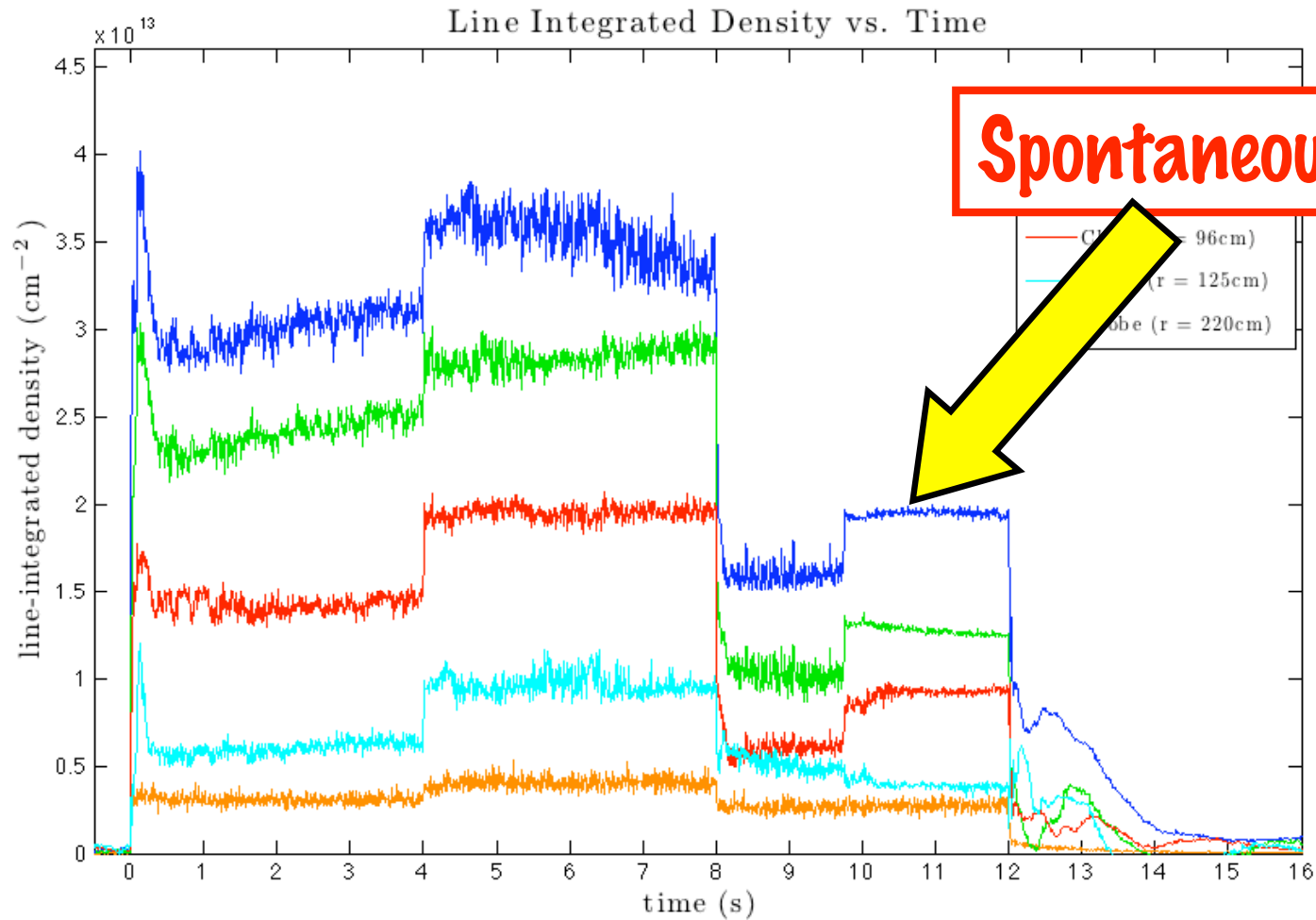
Density Self-Organization



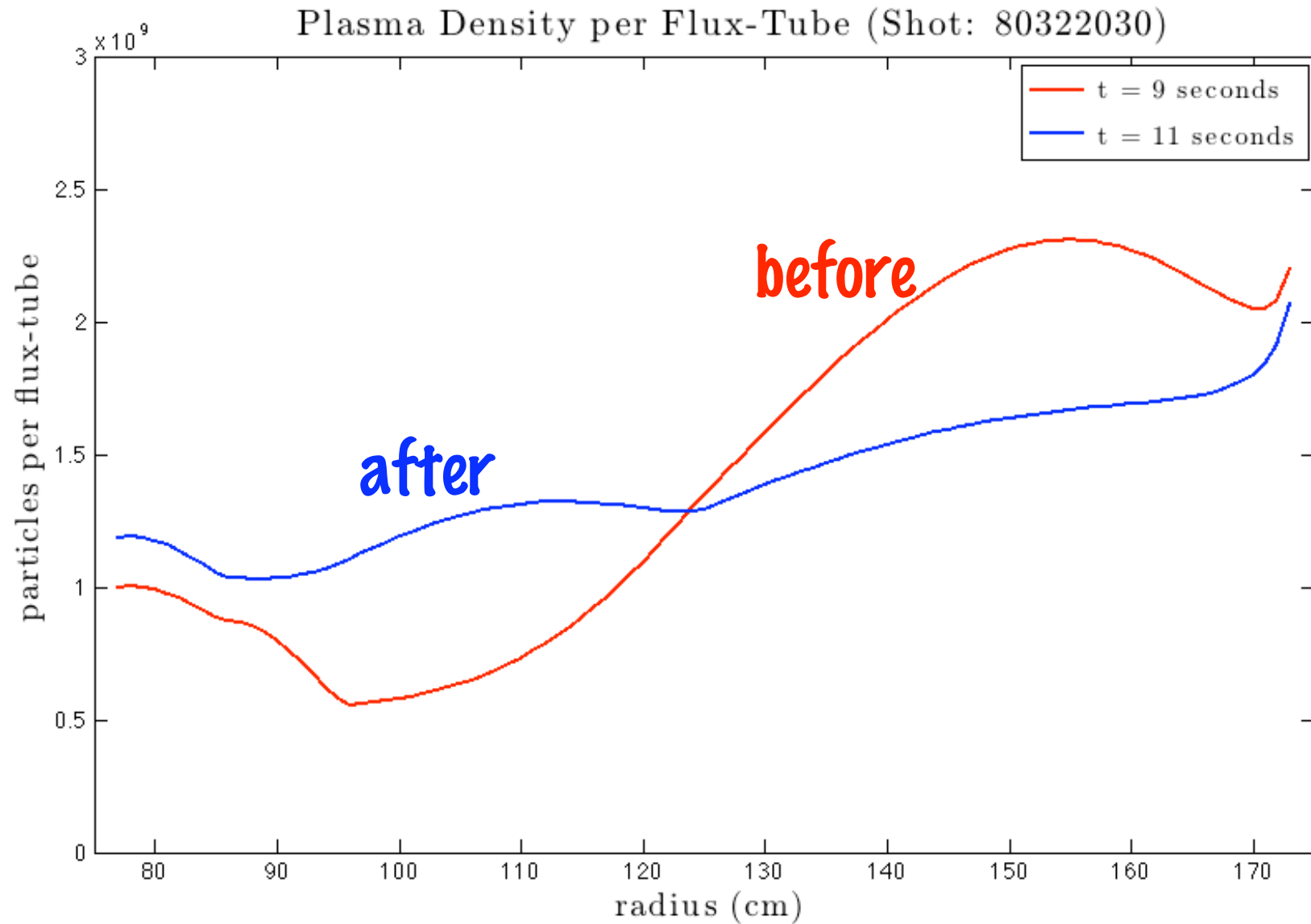
Density Self-Organization



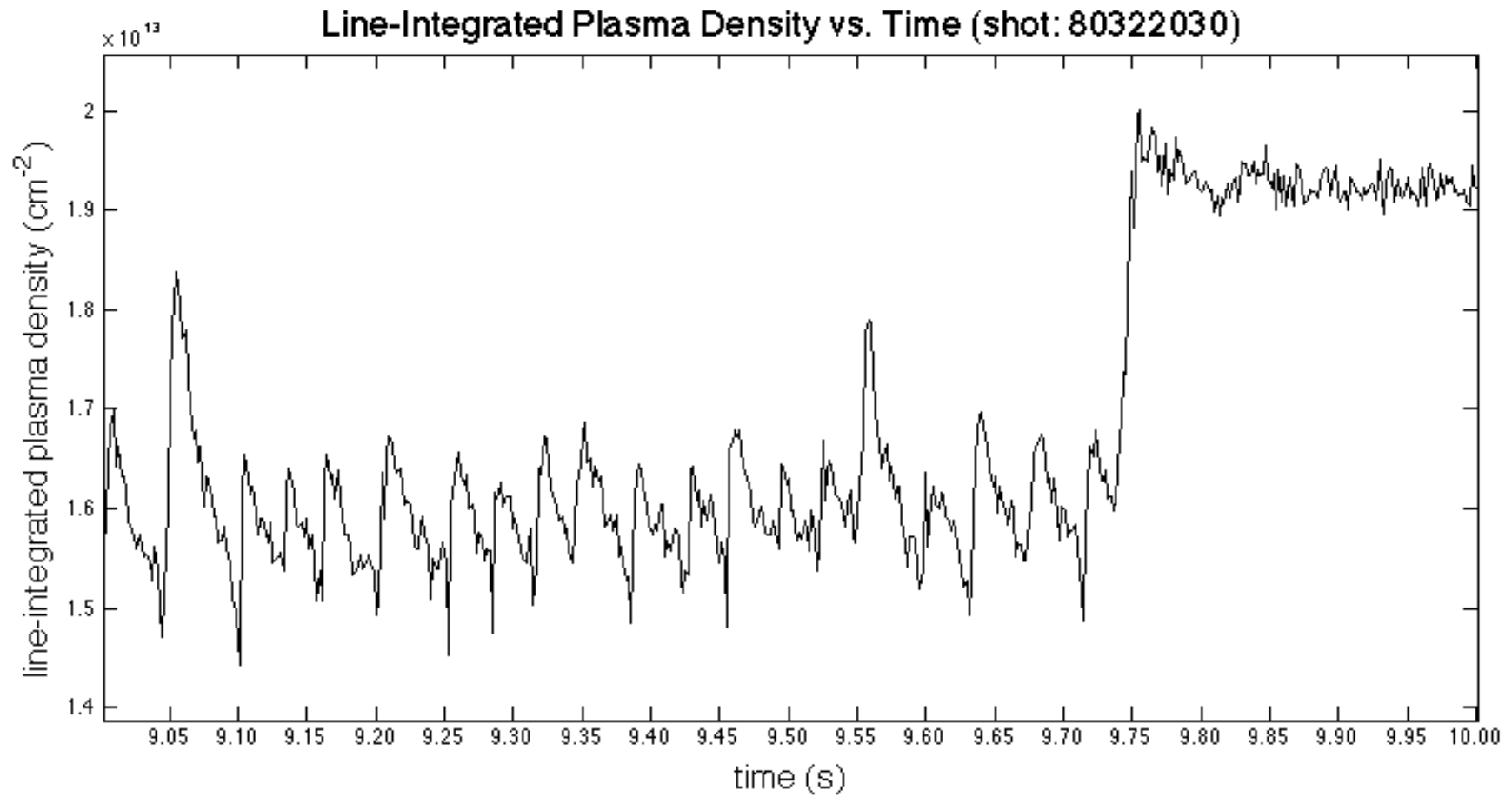
Density Self-Organization



The Transition Equalizes the Particles per Flux-Tube



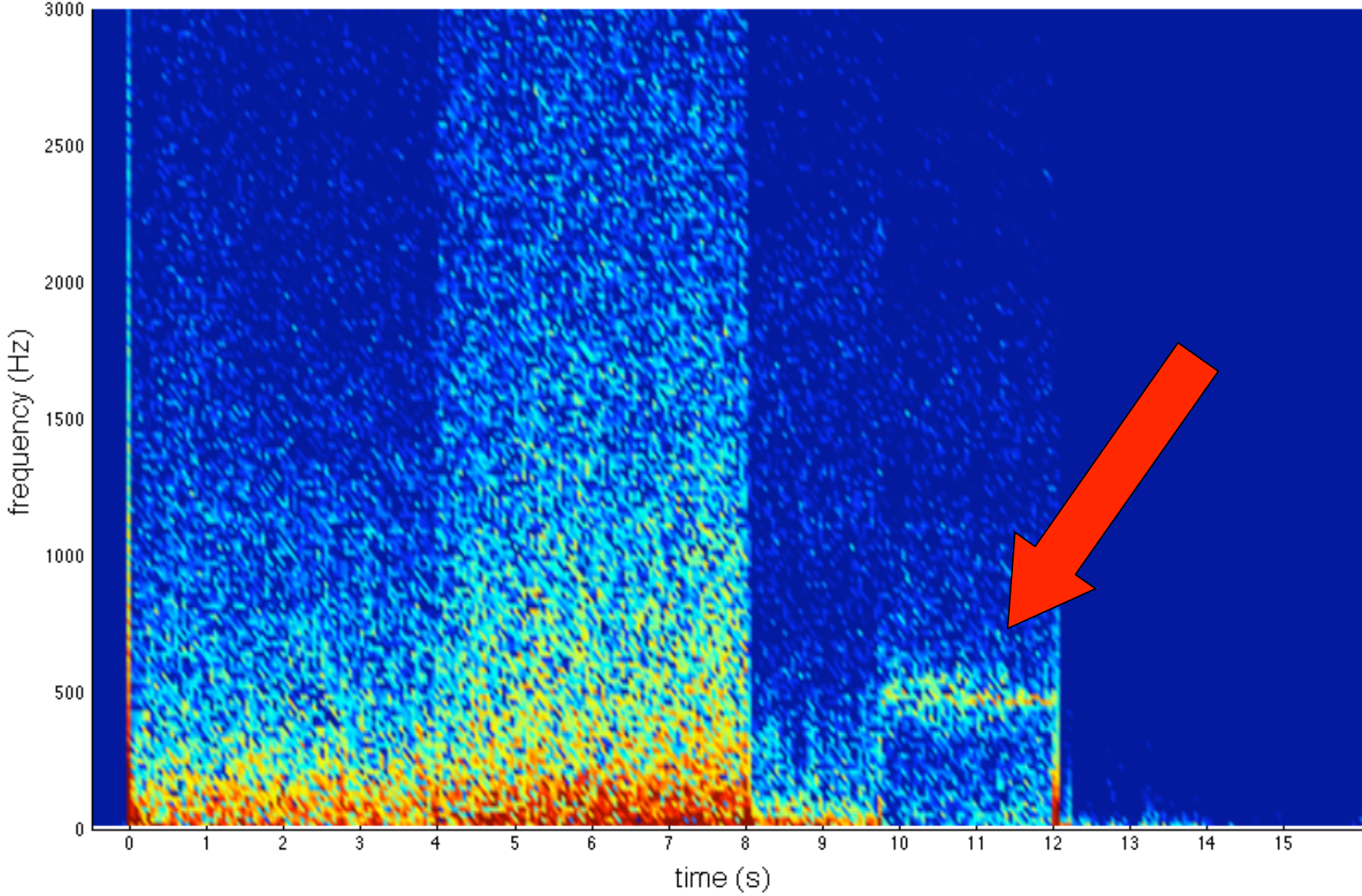
Inverse Sawteeth Precede Self-Organization



A Coherent Mode Sustains the New Profile

Spectrogram (Shot: 80322030)

Interferometer Ch. 1



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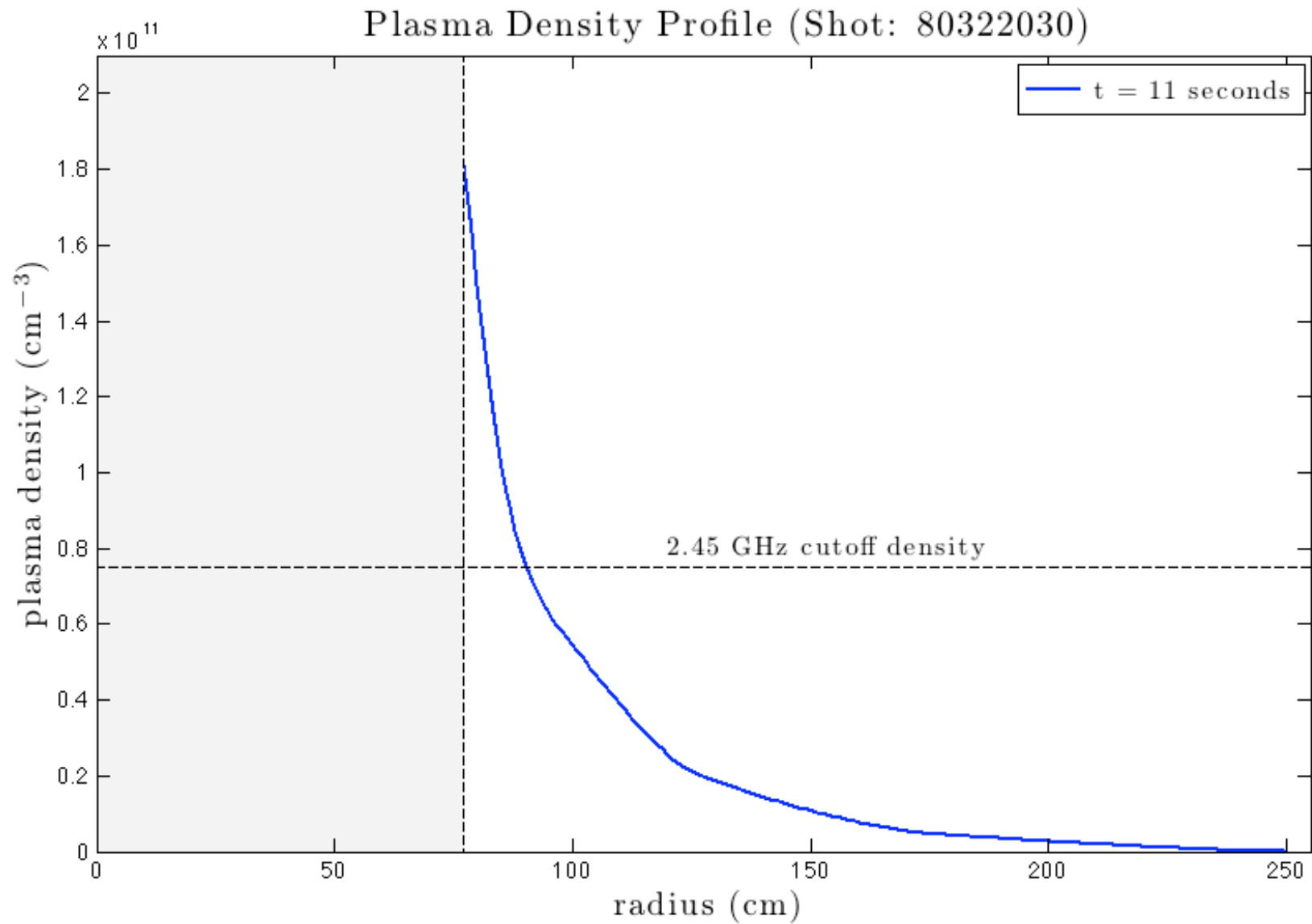
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Plasmas are Overdense with 2.45 GHz ECRH



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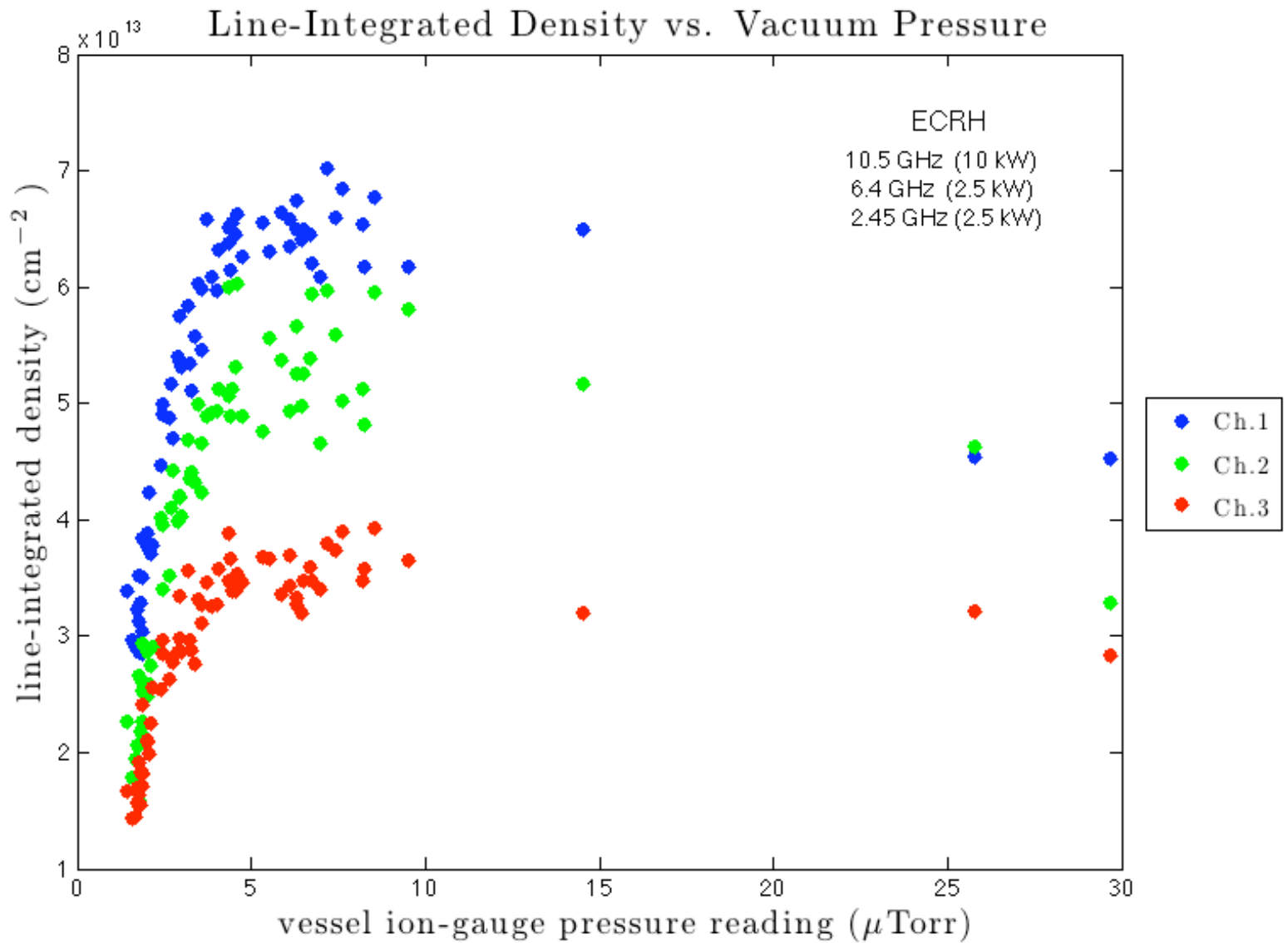
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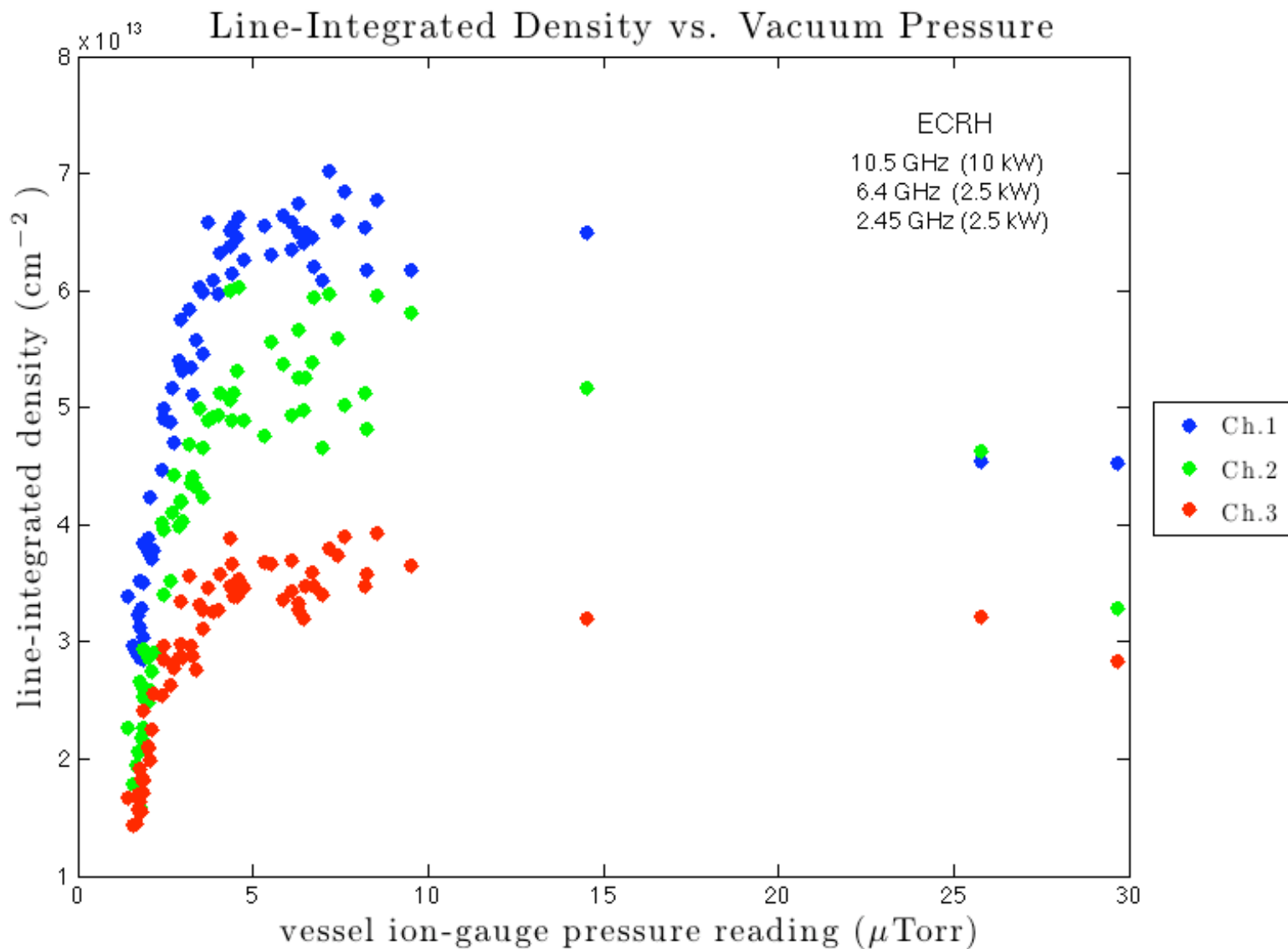
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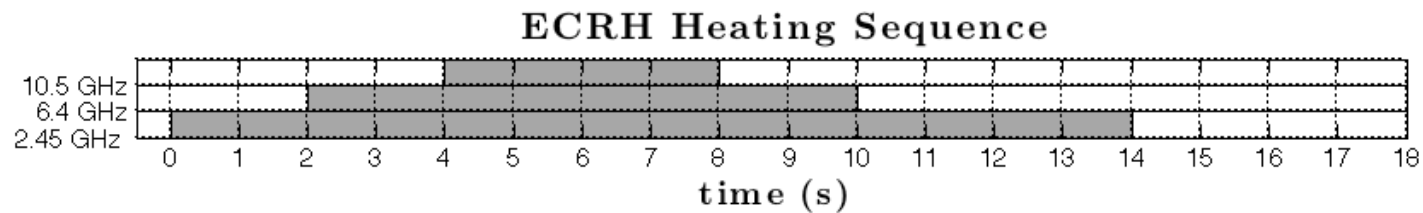
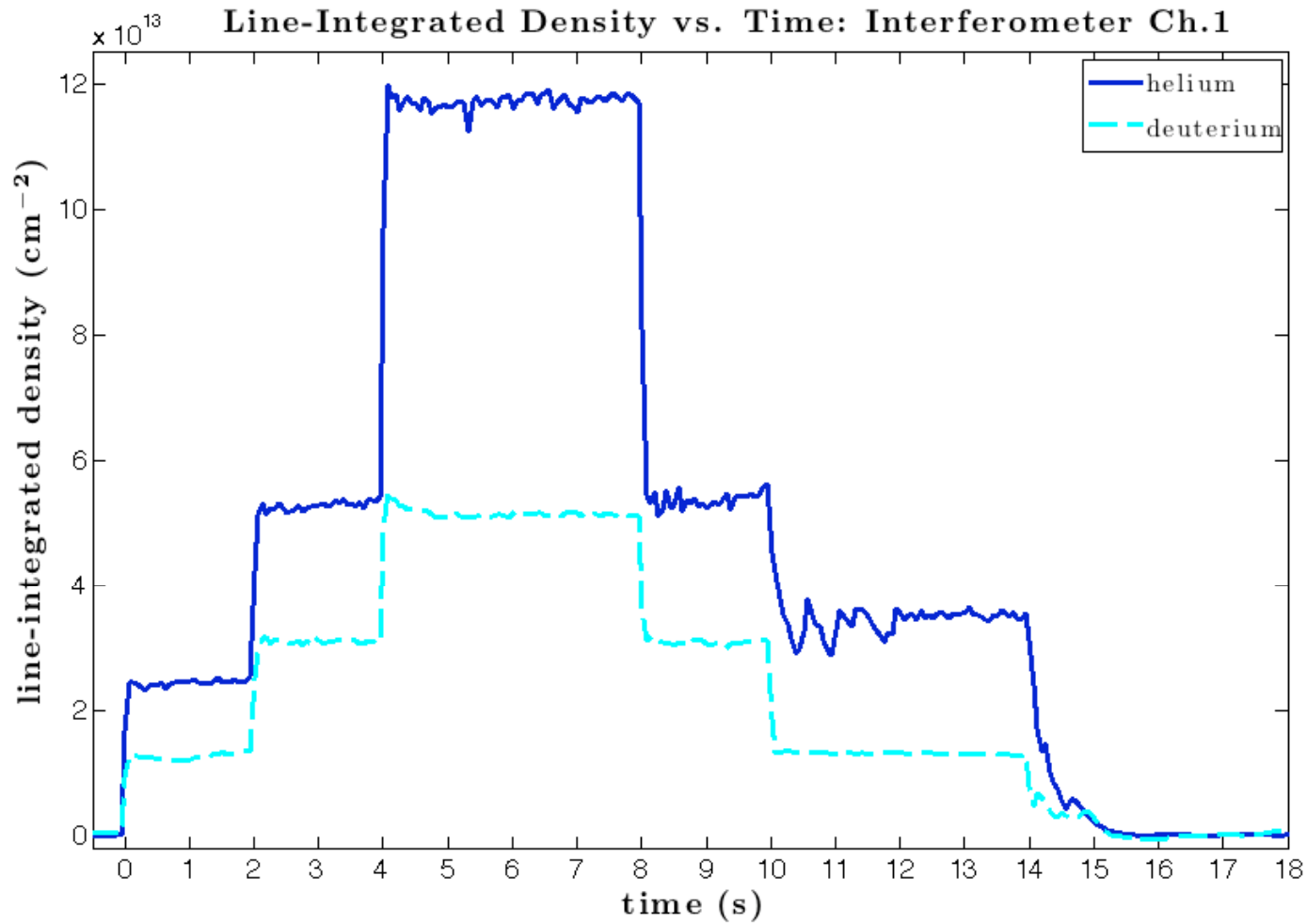
Something is limiting the density...



but is not the ECRH cutoff since...



Helium Plasmas Have Twice the Density



Summary

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THE

END