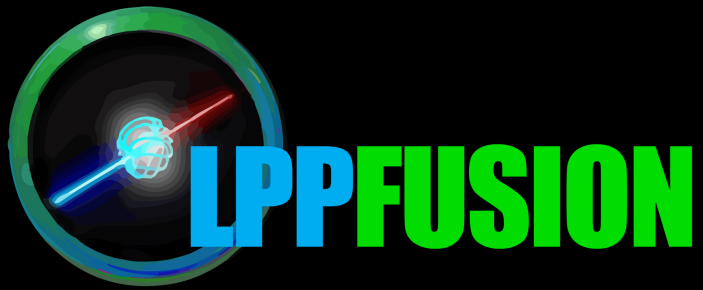
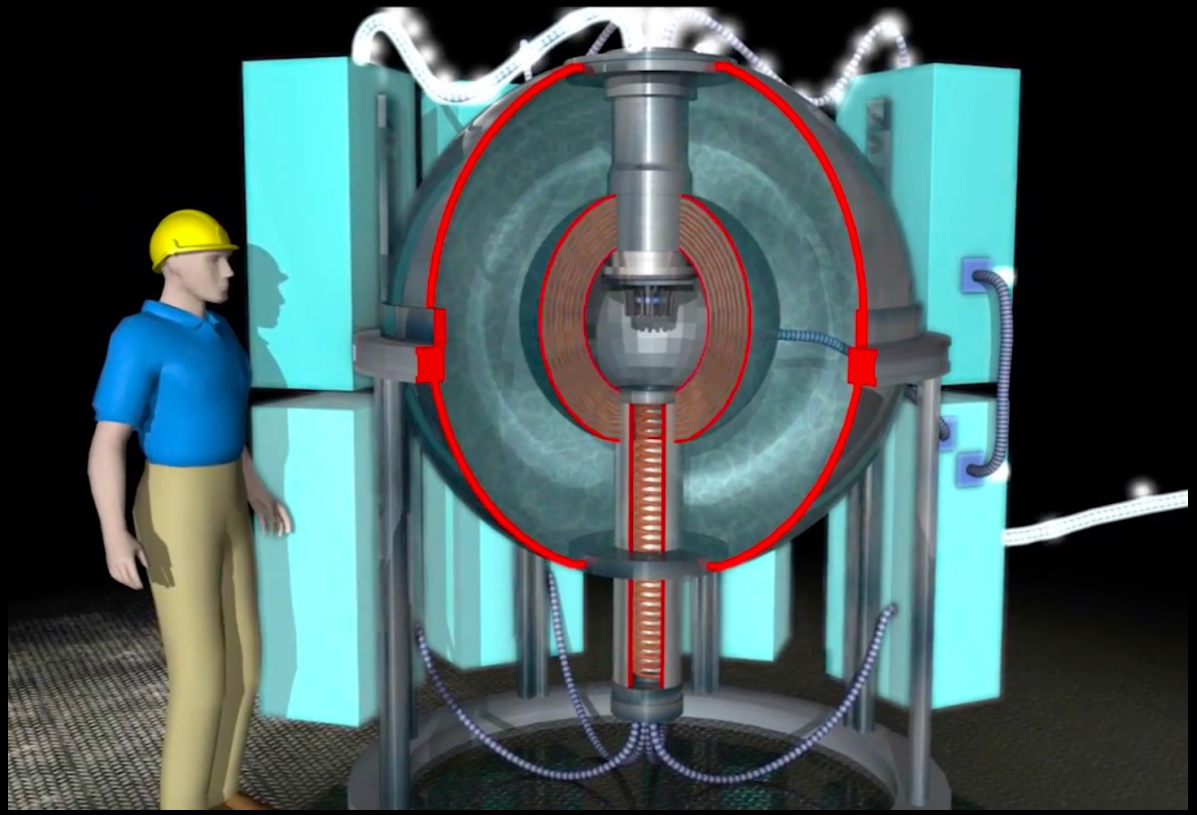
Initial Experiments with Decaborane in a Dense Plasma Focus

Fifth Int'l Workshop on Proton-Boron Fusion
Sept. 8-11, 2025

Eric J. Lerner
Syed Hassan, Ivana Karamitsos,
and Rudy Fritsch
LPPFusion, Inc., NJ, USA



GOAL: 5MW FUSION GENERATOR: SAFE, NO RADIOACTIVE WASTE COMPACT, CHEAP, DECENTRALIZED



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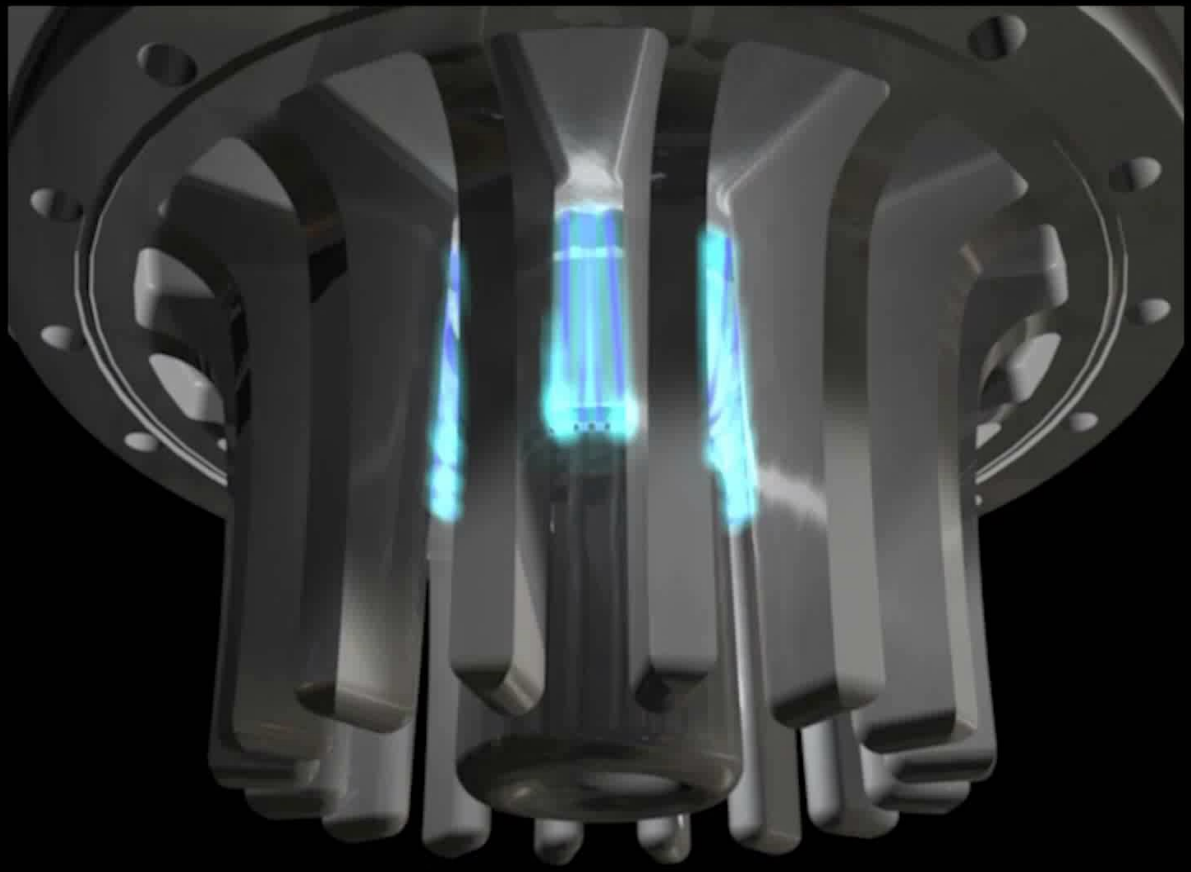
HOW DOES IT WORK?

Using Natural Instabilities, Not Fighting Them



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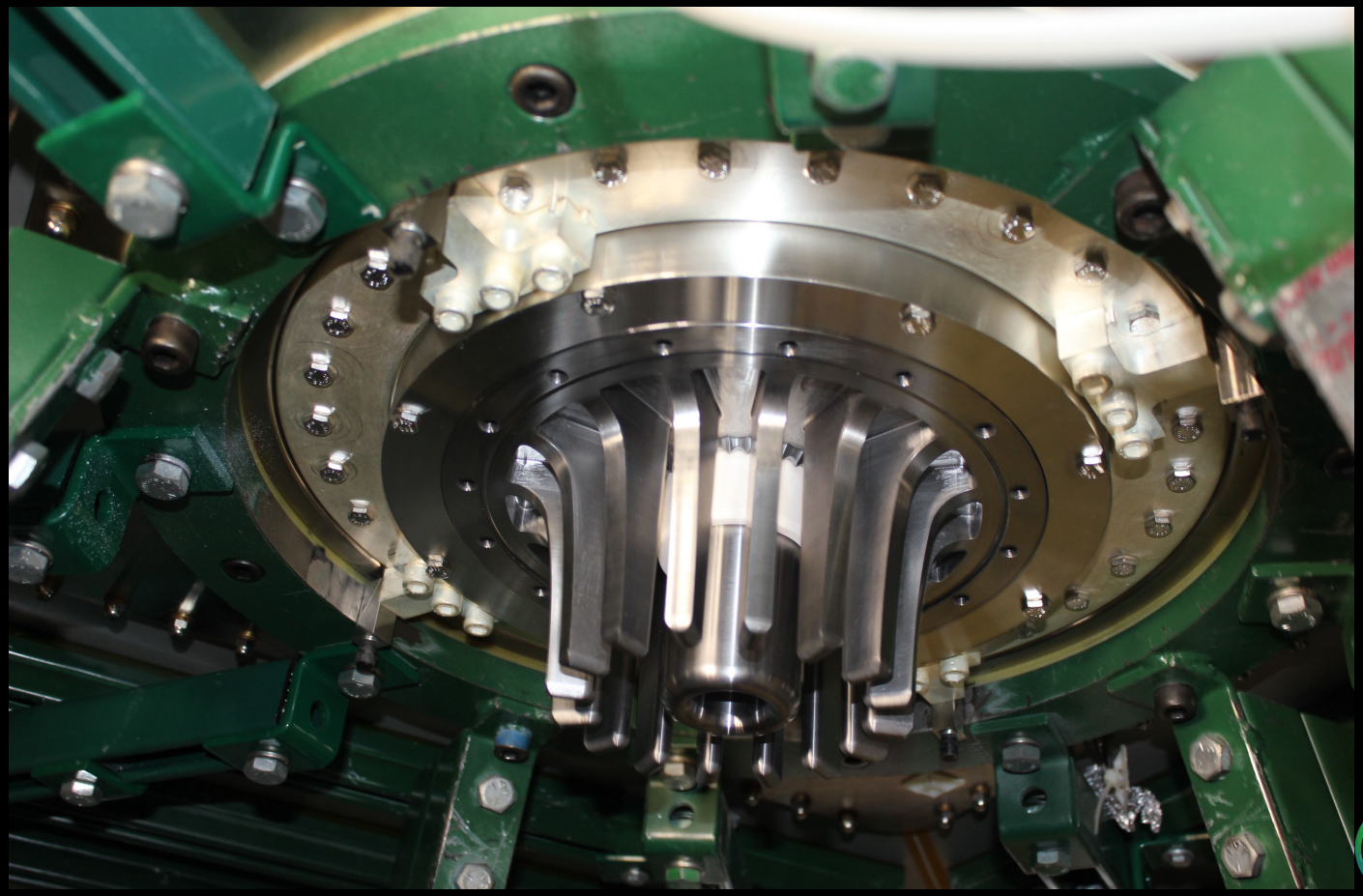
FF-2B
FUSION EXPERIMENTAL DEVICE
BERYLLIUM CATHODE 5 CM RADIUS
BERYLLIUM ANODE 2.8 CM RADIUS



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EXTREMELY COMPACT VACUUM CHAMBER AND DRIFT TUBE < 2M TALL

Capacitor Bank: 60 kJ, 40 kV,
Peak Current 1.6 MA, Peak Power 60 GW

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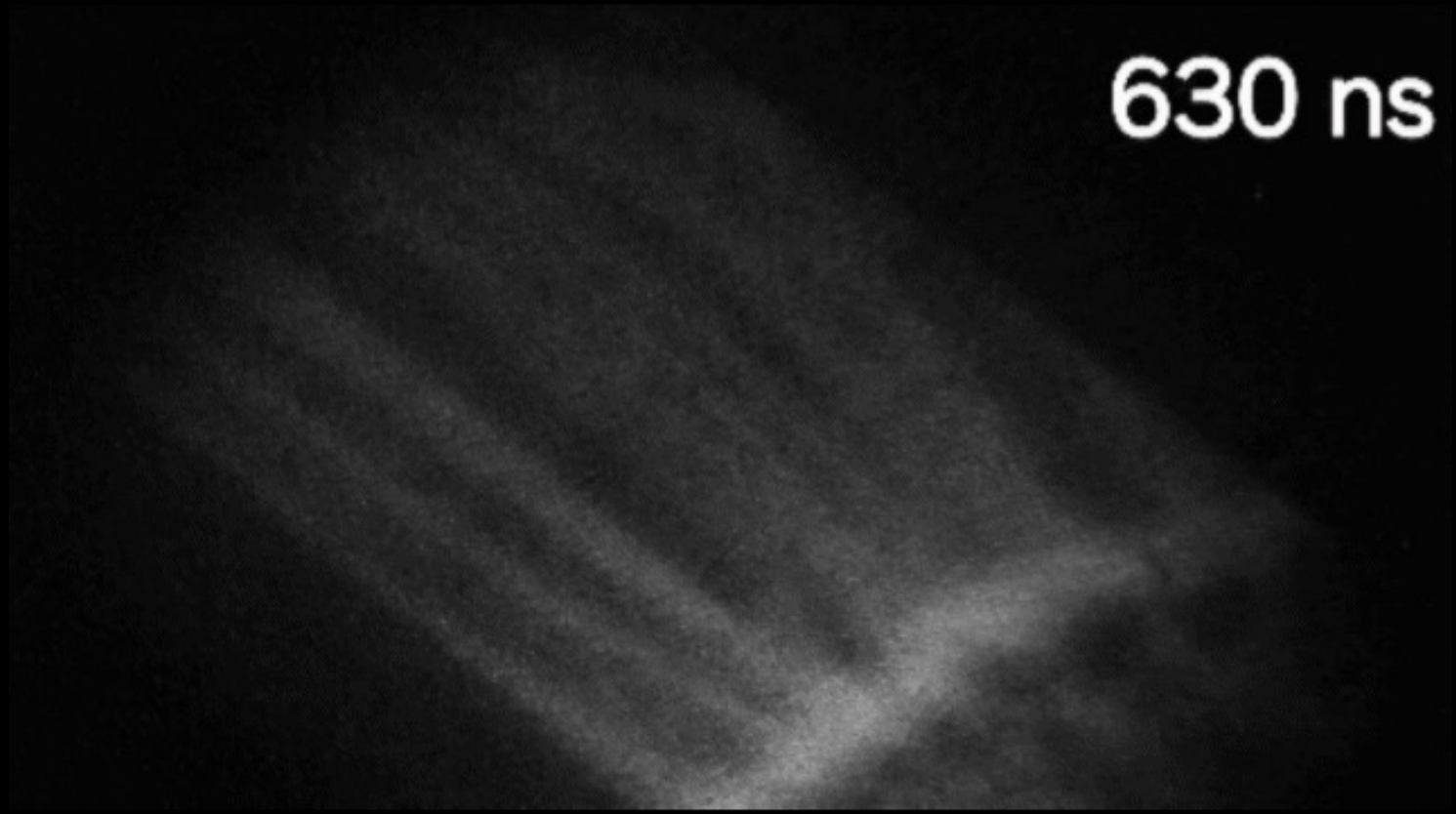
OUTLINE

1) Confirmation of theoretical predictions with deuterium shots

2) Initial results with decaborane: problems and solutions

3) Next steps

THEORY BASED ON FILAMENTATION: PREVIOUSLY FILAMENTS WERE DISRUPTED DURING RUNDOWN



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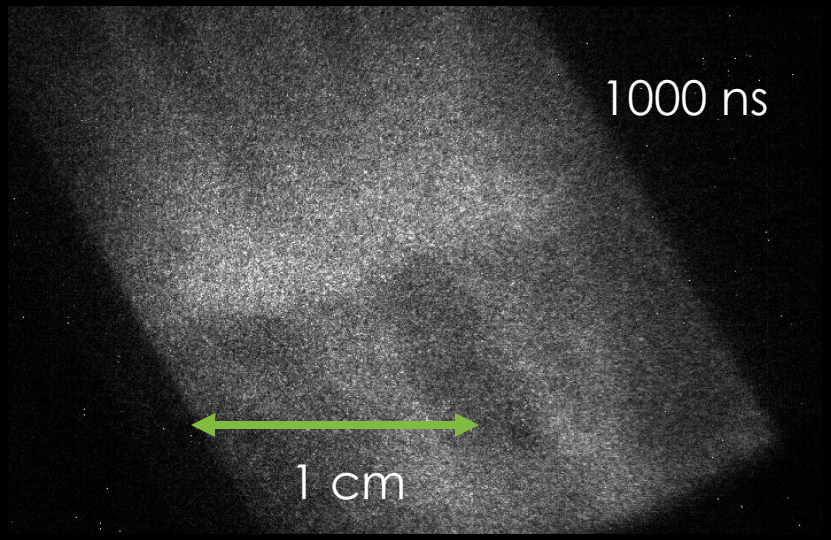
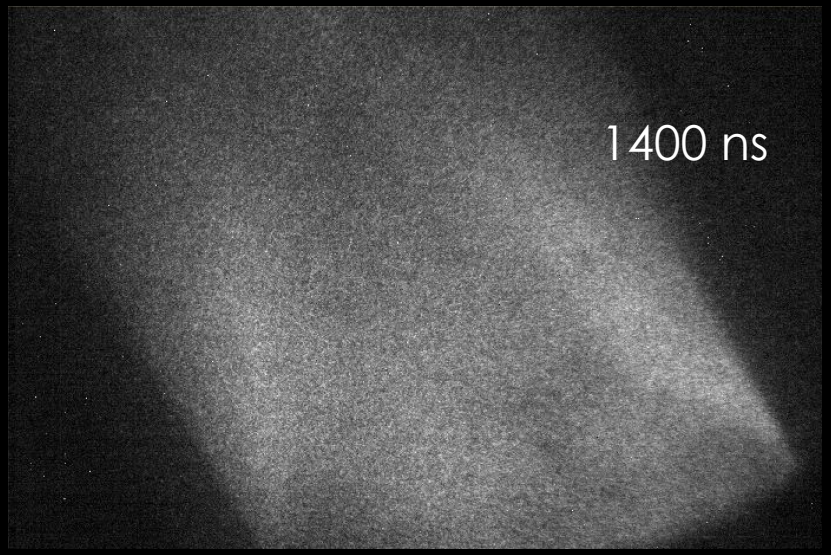
NOW FILAMENTS SURVIVE TO COMPRESSION





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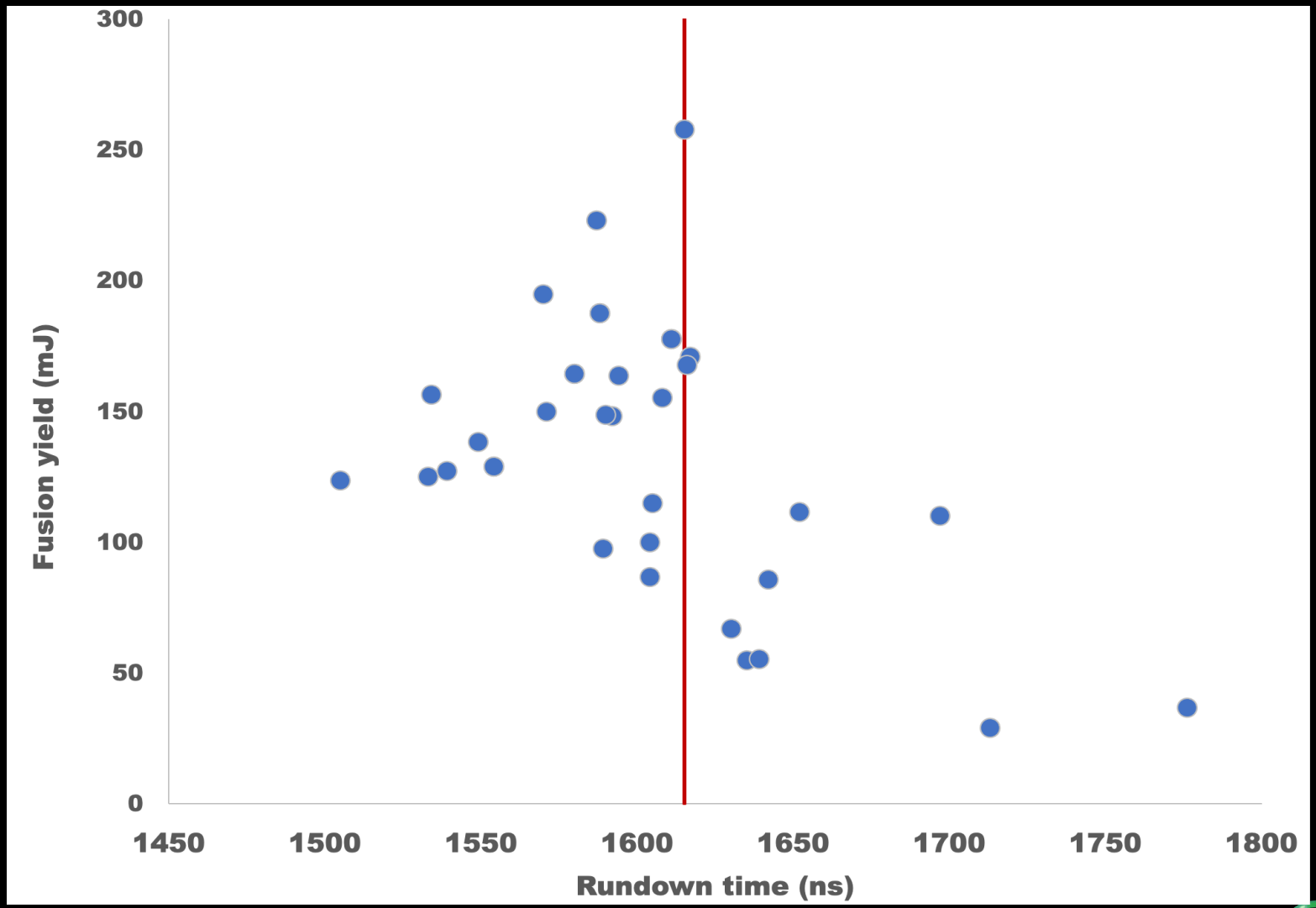
CONFIRMATION OF OPTIMAL VELOCITY



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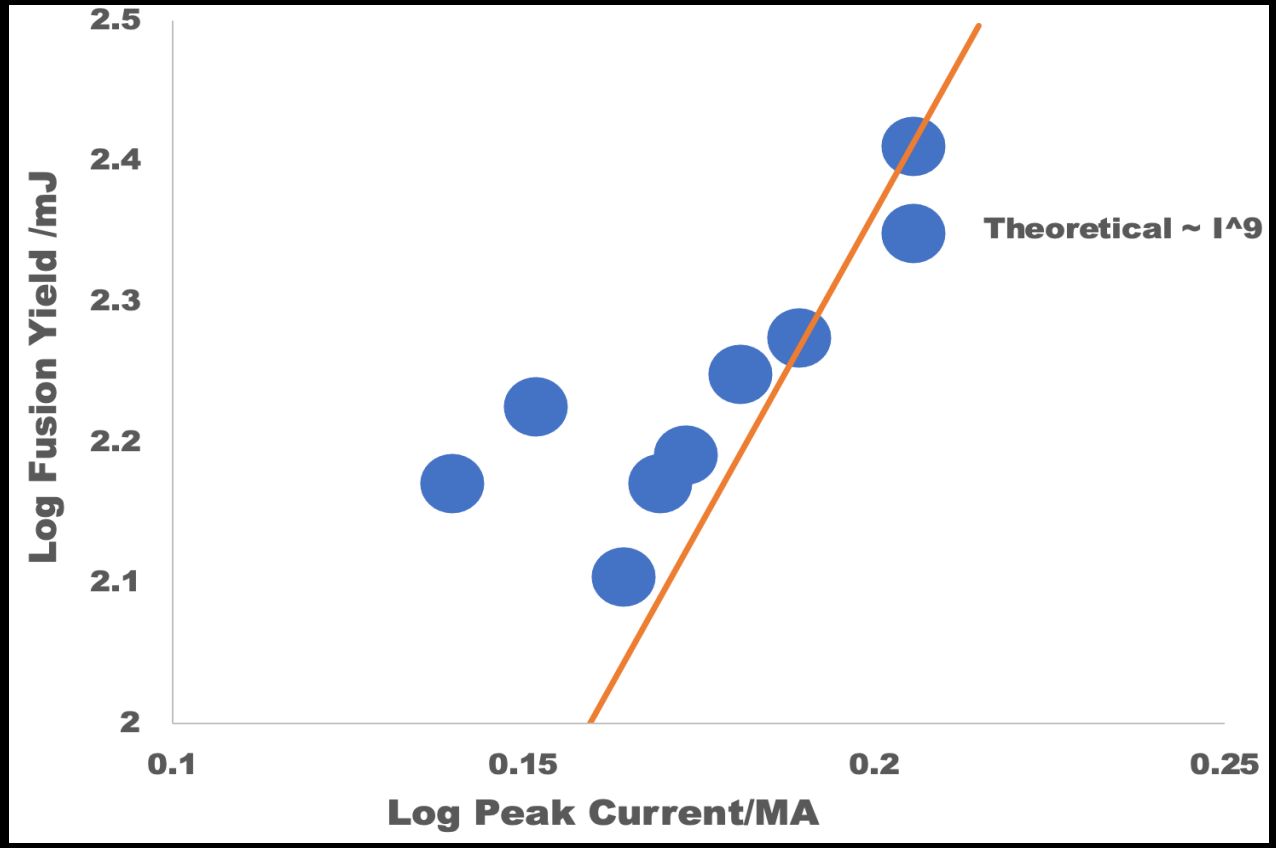
PRELIMINARY CONFIRMATION OF FUSION YIELD SCALING



New Record Yield: 0.26 J

±25% Yield Variation

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ACHIEVED PLASMA PARAMETERS

$n = 3 \times 10^{19} /cm^3$

$T_i = 70$ keV

$\tau = 60$ ns

Earlier result with tungsten: 250 keV

Goals for pB11:

$n = 10^{23} /cm^3$ $T_i = 600$ keV $\tau = 6$ ns

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SERIES OF IMPROVEMENTS

1) Higher currents with dual switches

2) Fewer filaments/higher filament currents

3) Cleaning shots

4) Higher Preionization current

13% of capacitor energy to plasmoid

DECABORANE SHOTS STARTING NOV. ‘24

Decaborane: B10H14

Solid at Room Temp

Heating Required for Vapor Generation

Heating Problems:

All Parts of system > 75 C

Allow Fill Pressure > 2 torr

Mylar Insulation < 100 C

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SOLUTIONS BY JUNE ‘25

Comprehensive Insulation

Optimized Thermocouple Placement

Heated Gauges

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DECABORANE IN SAMPLE CONTAINER

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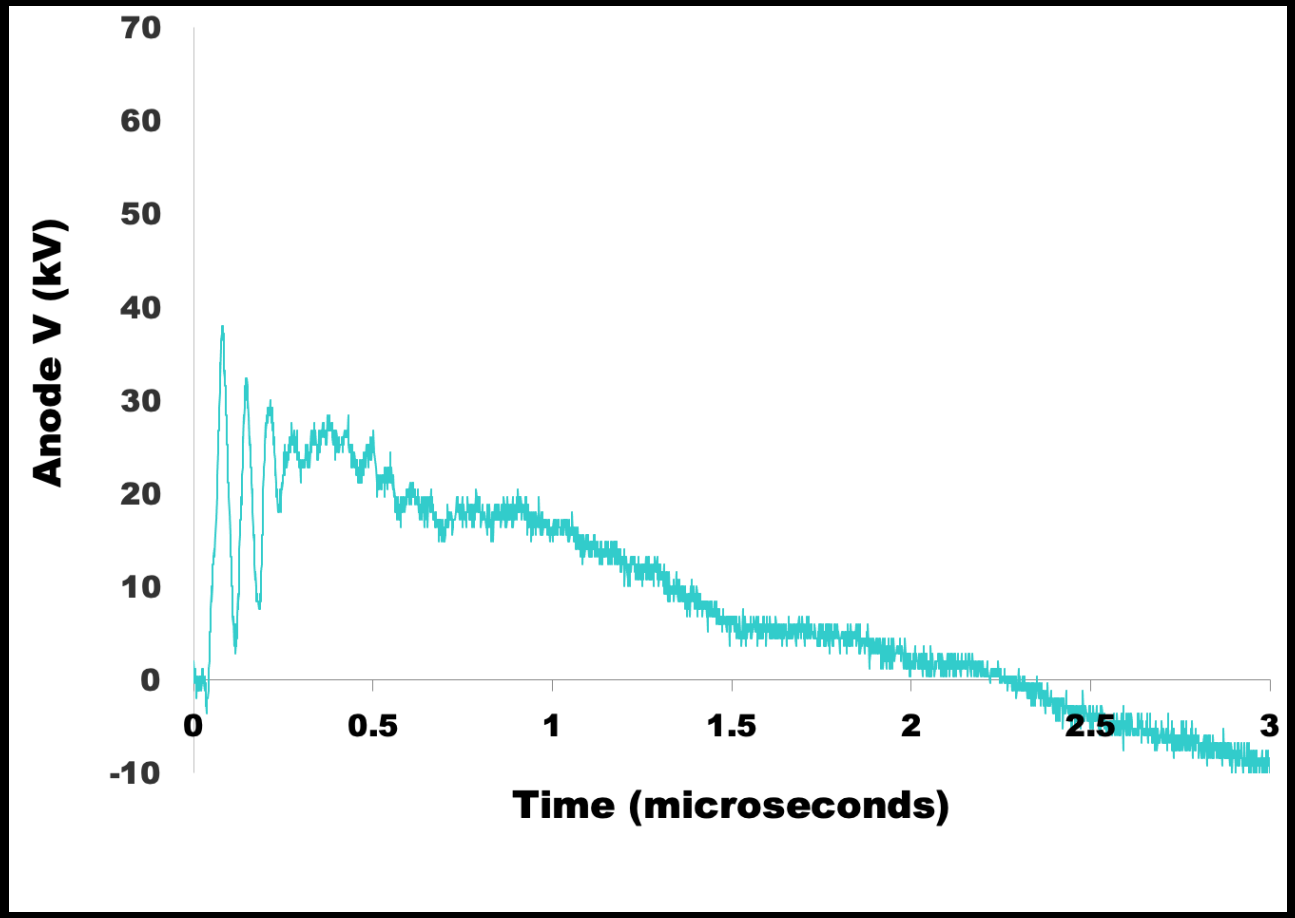
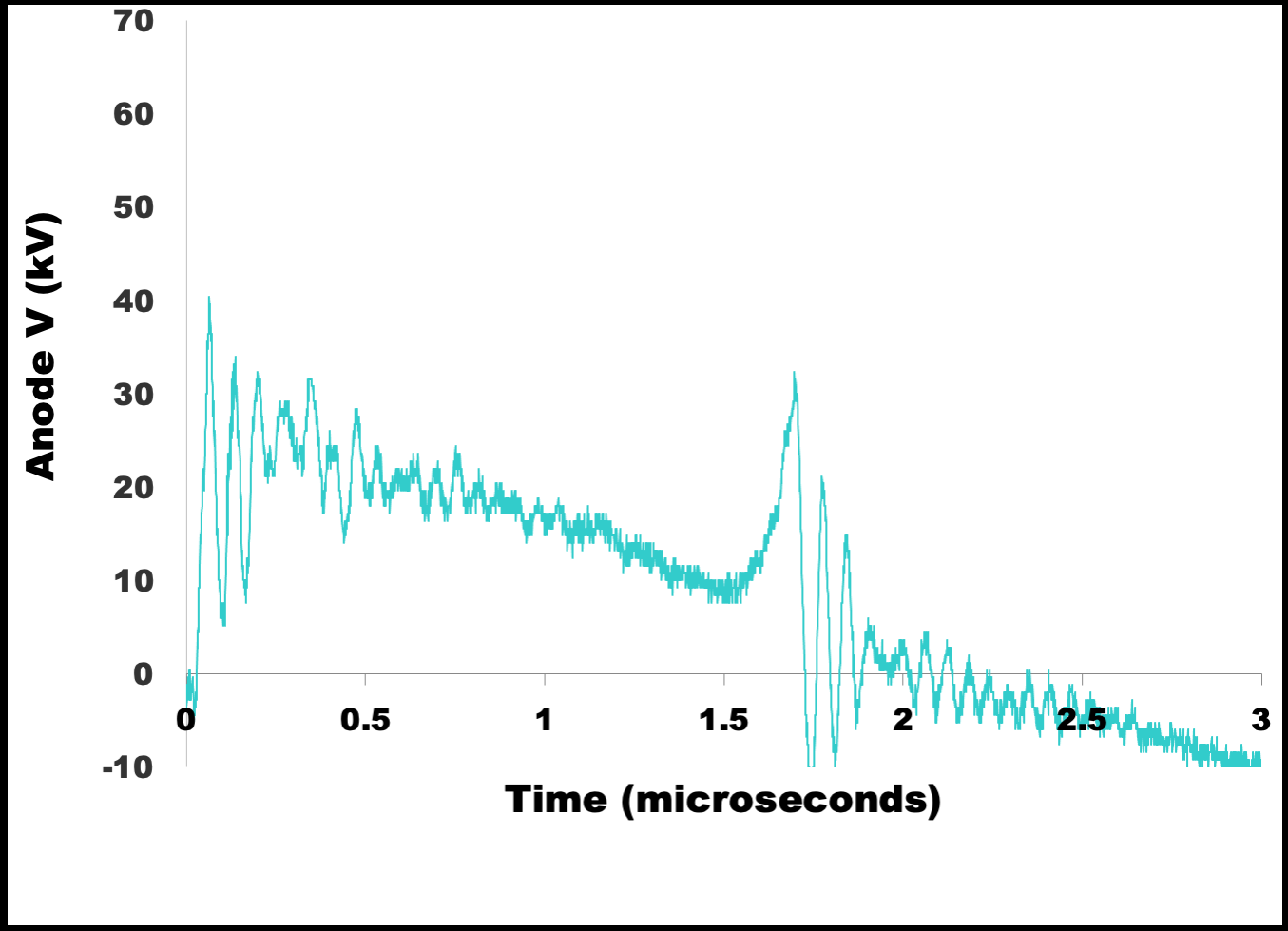
PROBLEM: LACK OF PINCH
SOLUTION: CLEANING SHOTS AND DEUTERIUM MIX



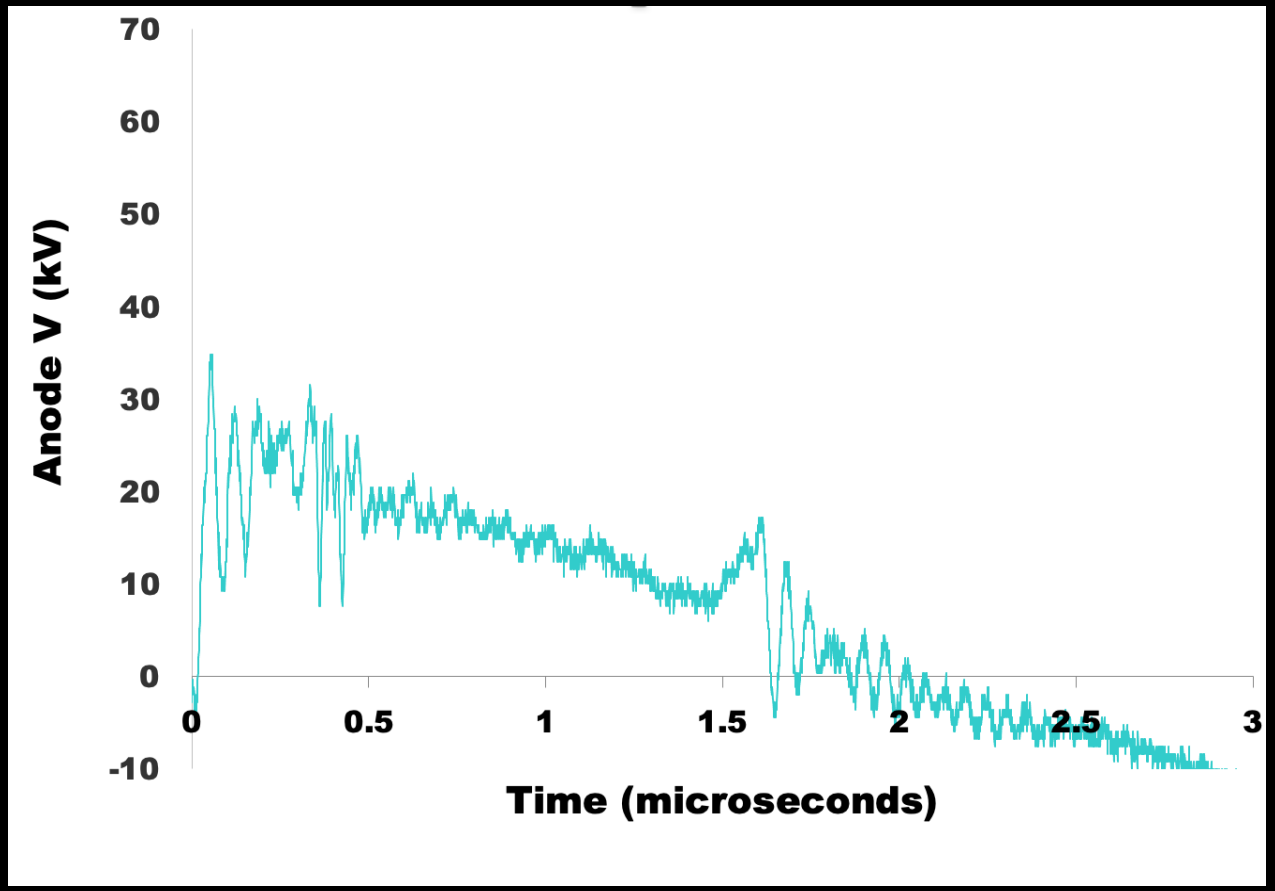
Feb. 14 shot 1:
1.5 torr deca, 2.5 torr D

PROBLEM: LACK OF PINCH
SOLUTION: CLEANING SHOTS AND DEUTERIUM MIX



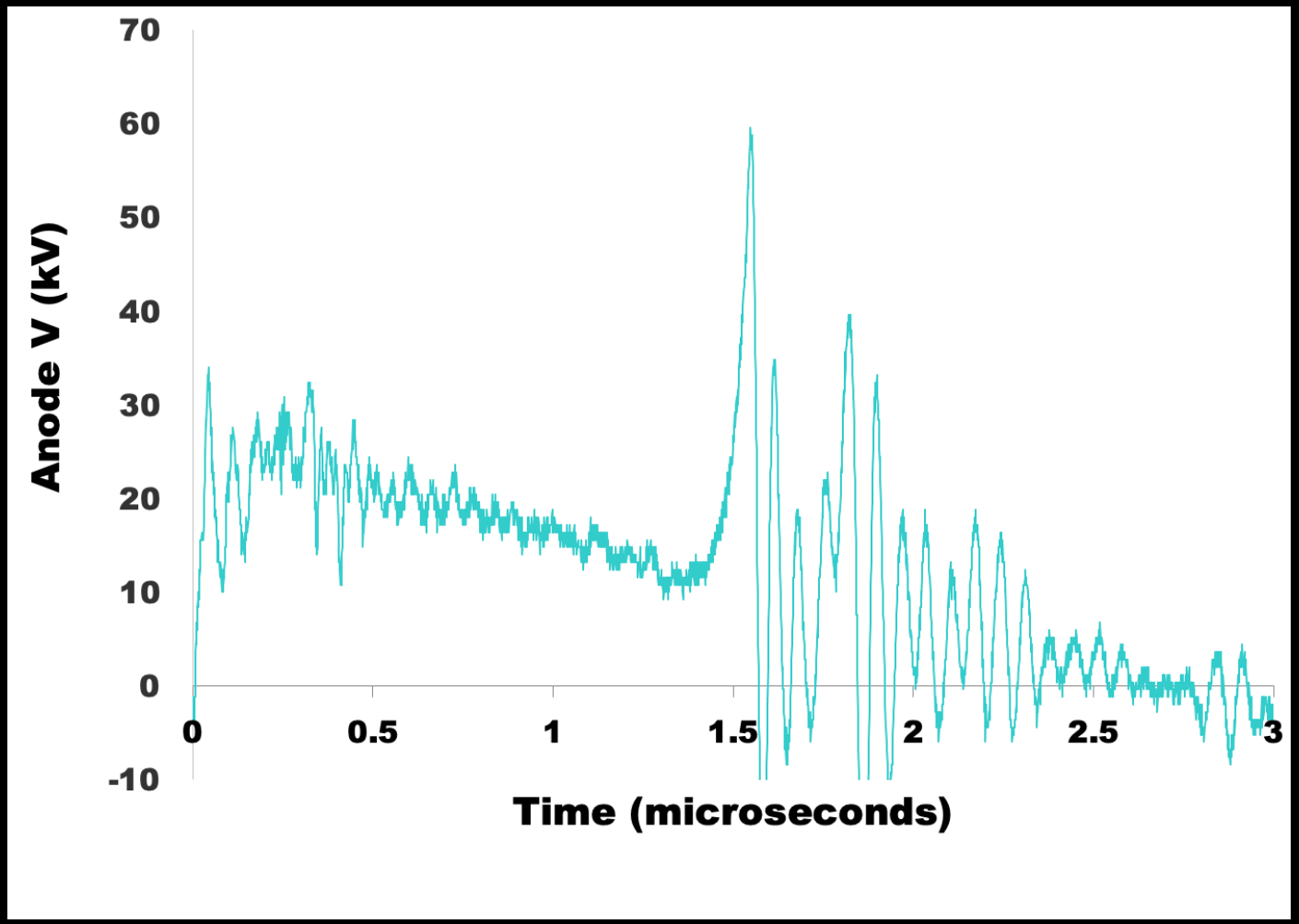
Jun. 4 shot 4: 0.75 torr deca, 21.8 torr D After D-N cleaning shots. Y = 6 x 10^9 from D

CONFIRMATION OF CLEANING SHOTS WITH DEUTERIUM



Jun. 6 shot 1: 26.8 torr D, after deca Y = 5.5 x 10^9

CONFIRMATION OF CLEANING SHOTS WITH DEUTERIUM



Jun. 6 shot 3: 27.3 torr D After D-N cleaning shots Y = 1.4 x 10^{11}

25 x more

PROBLEM WE'RE WORKING ON: SEPARATION OF H, D AND B IONS

Alfven Critical Velocity
Speed Limit for Boron, Not D or H

$$E_i = \tfrac{1}{2} M v_c^2$$

Conflict with Optimal D
V = 8.2 cm/μsec

Boron Ionization State	Ionization Energy (eV)	Critical Velocity (cm/μ sec)	Time of V_c (μsec)
2	25	2.1	0.4
3	38	2.6	0.5
4	259	6.7	1.3

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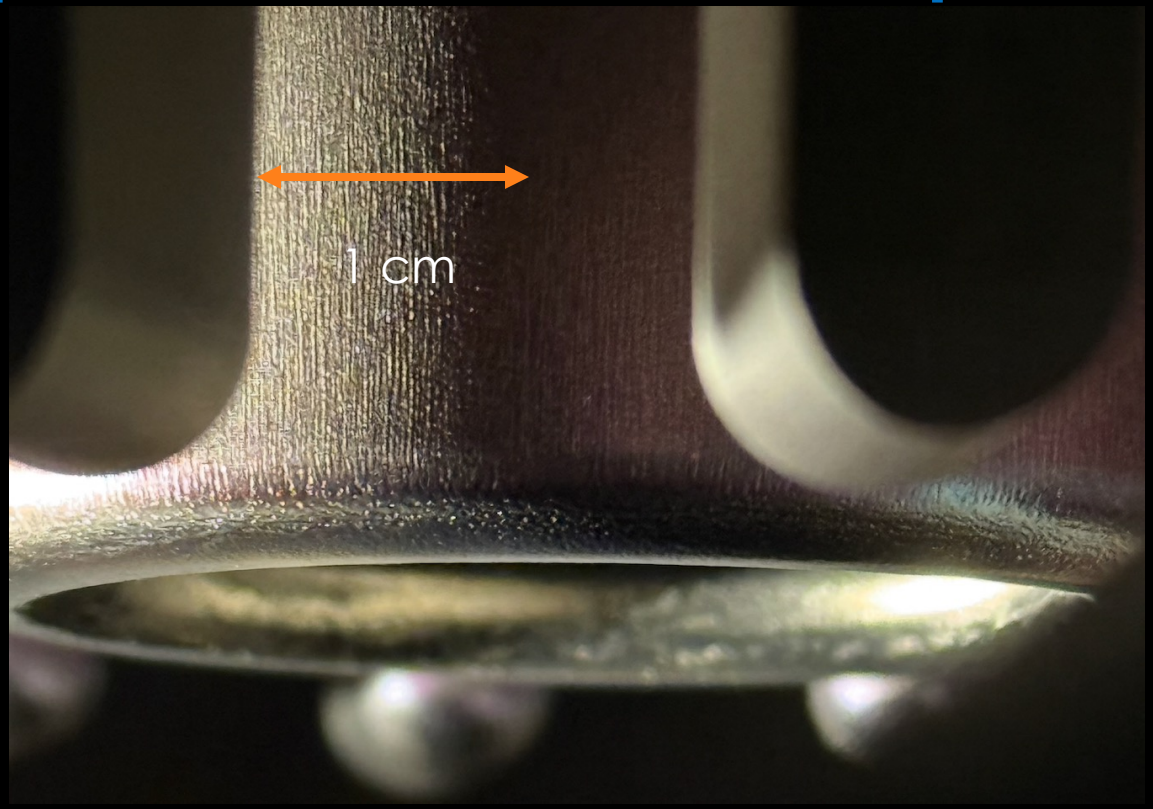
EVIDENCE FOR SEPARATION: DEVIATION AND DEPOSITION

Decaborane HVP, Current Traces Deviate From D at ~0.5 μ sec and 1.1-1.3 μ sec

Separation Leads to Structured Deposits of BeB



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DEPOSITION
STARTS AT 2/3
DOWN ANODE
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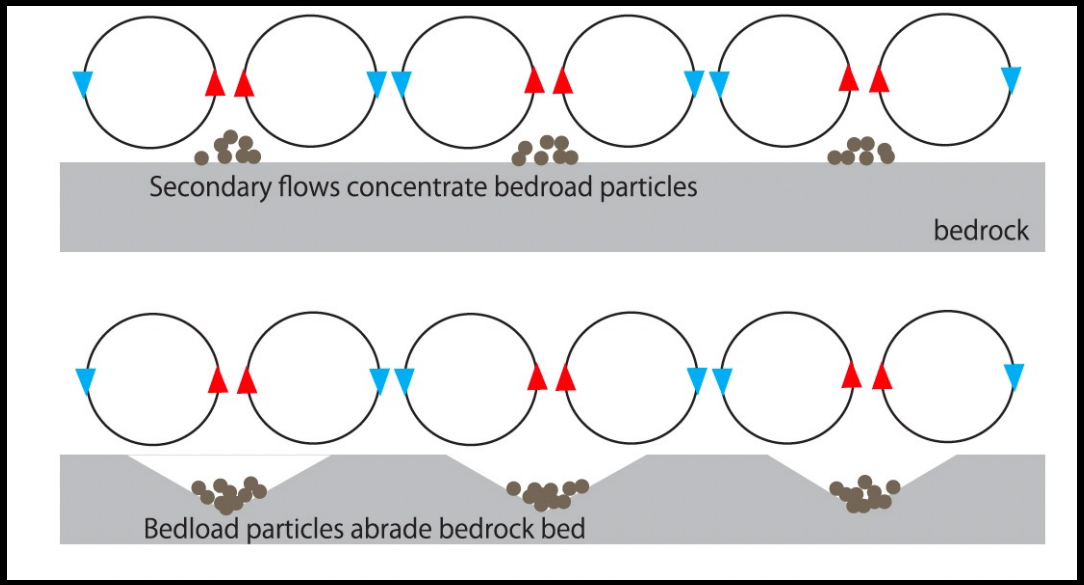
150-MICRON MINIFILAMENTS STRUCTURE BeB DEPOSITS



Analogous to Hydrodynamic Erosion But Electric Current Must Cut Through BeB Layer

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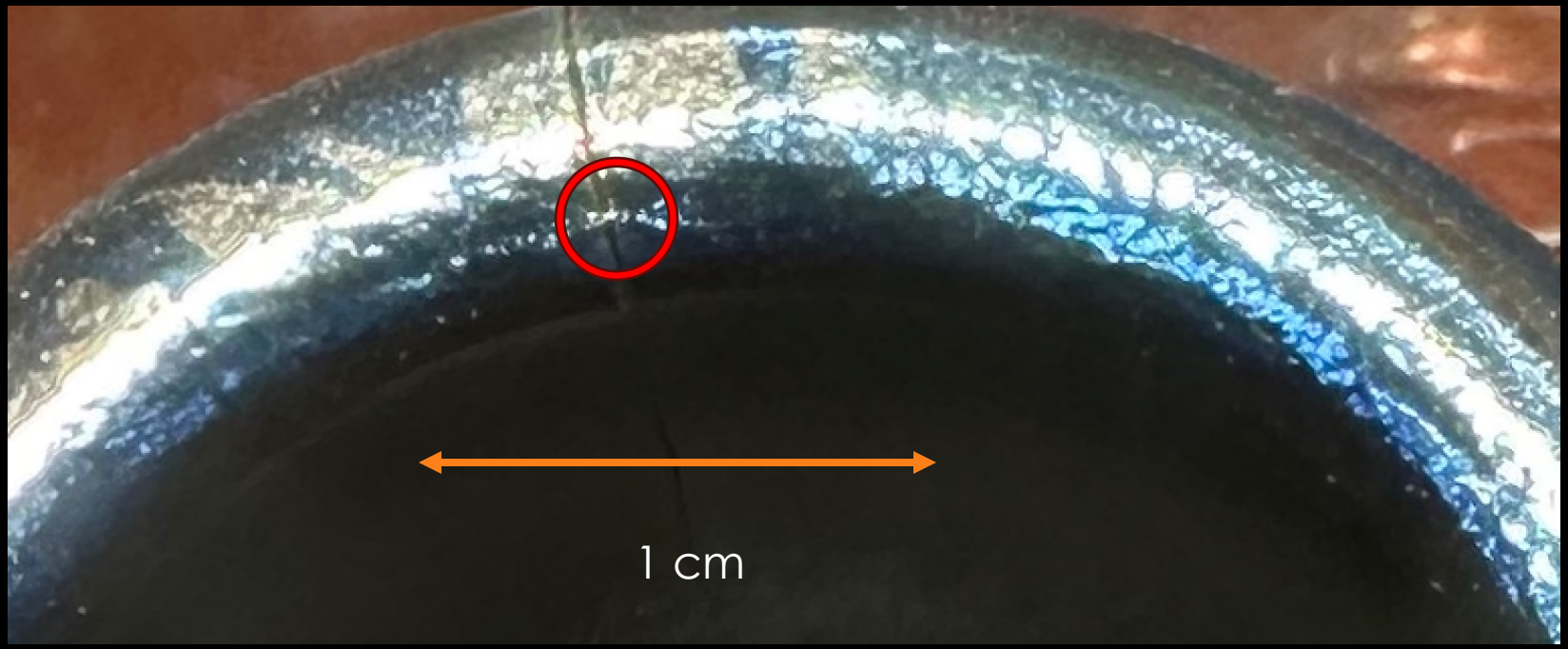
30-MICRON GROOVES CONCENTRATE CURRENT, LEADING TO CRACKED ANODE



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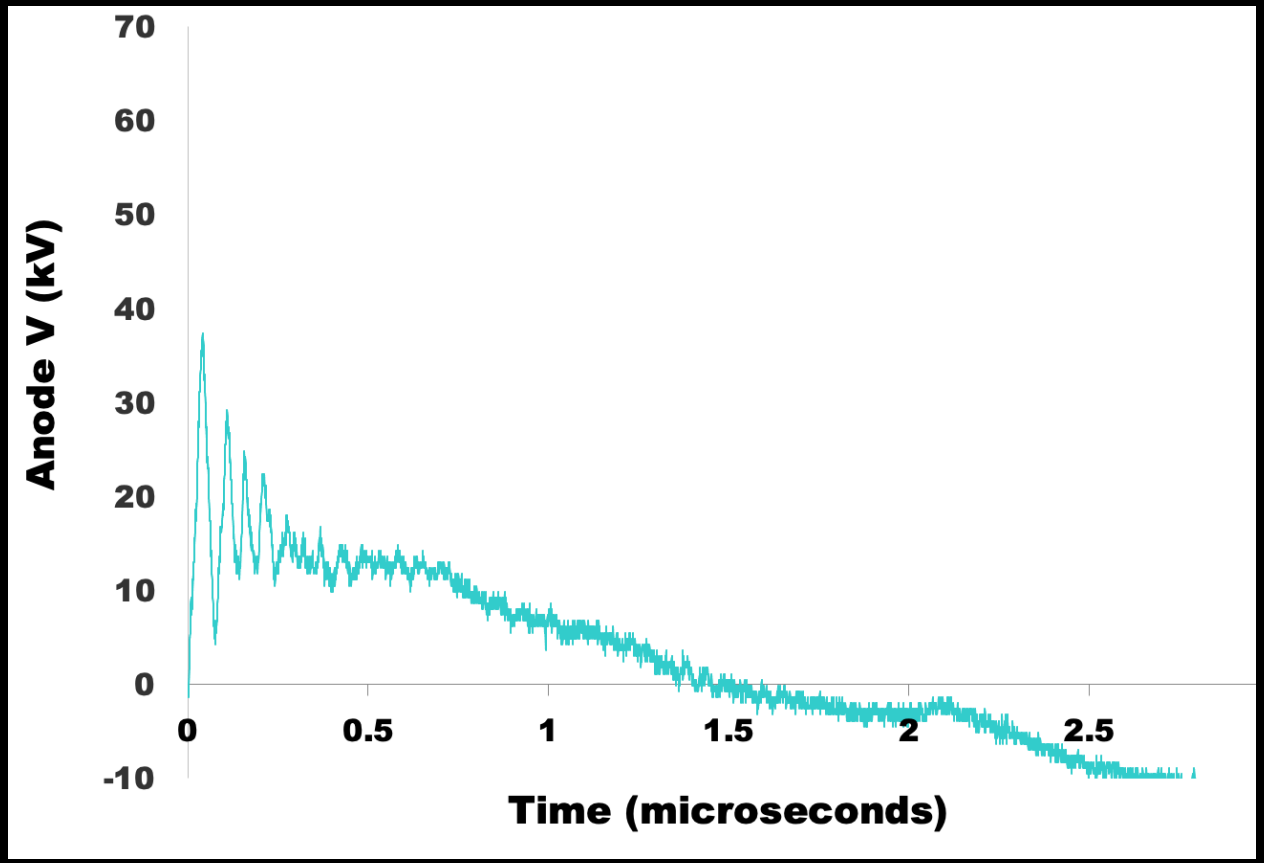
LAST SHOT, AUG. 14, SHOWED FIRST PINCH WITH NEAR-PURE DECABORANE



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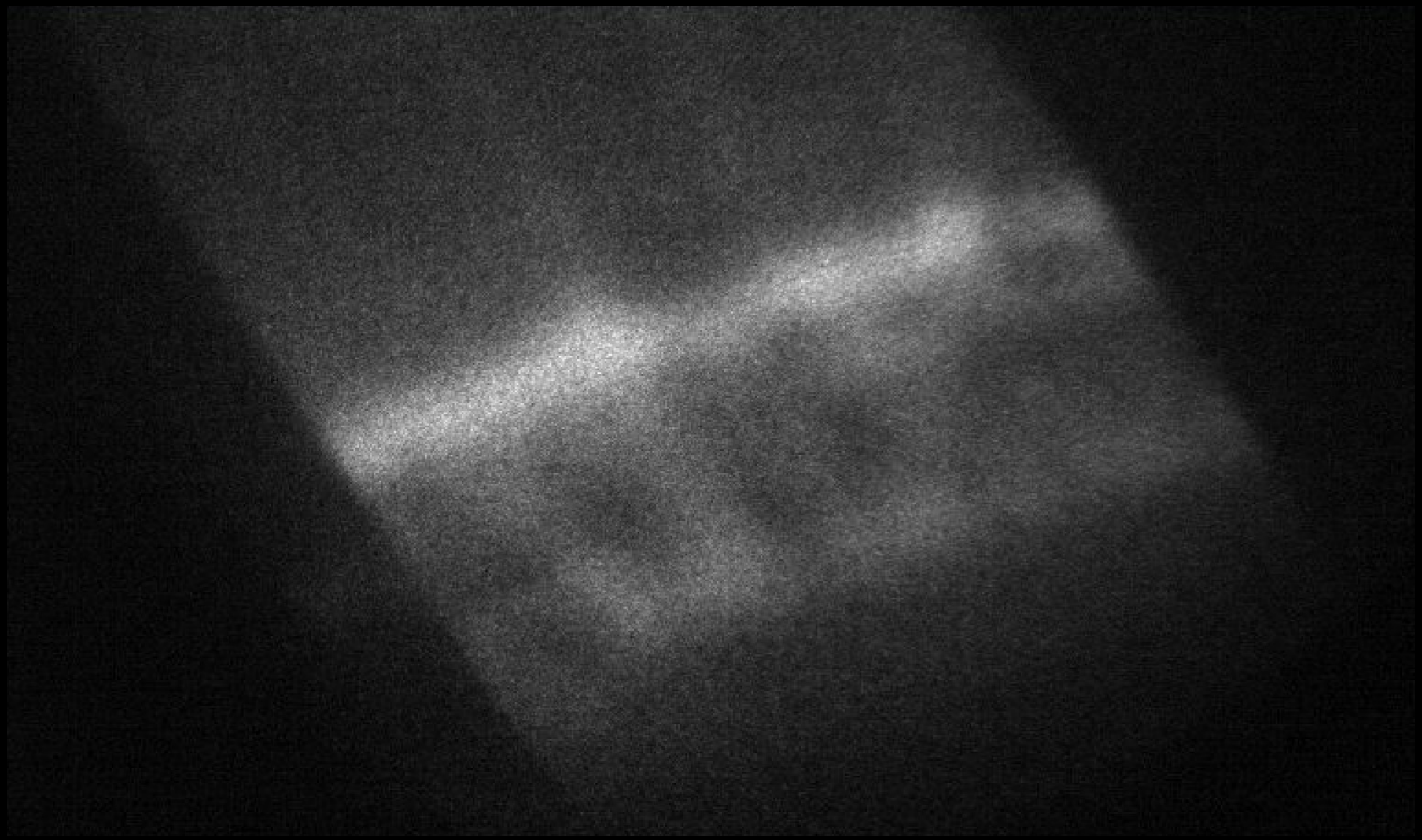
LAST SHOT ALSO SHOWED FIRST IMAGE OF FILAMENTATION WITH NEAR-PURE DECABORANE



NEXT STEPS

1) First Goal: Measurable Fusion Yield from Decaborane (0.5 J)

2) New (Spare) Anode Installed, Baked Out by Nov.1

3) Prevention of Separation, BeB Deposition with Sub-Critical Rundown Velocity

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NEXT STEPS

4) Second Goal: 100 J fusion yield by optimizing rundown velocity, cleaning mix, axial field

5) Upgrade to 12 capacitors, 2.4 MA
Goal: Net Energy Out of Device

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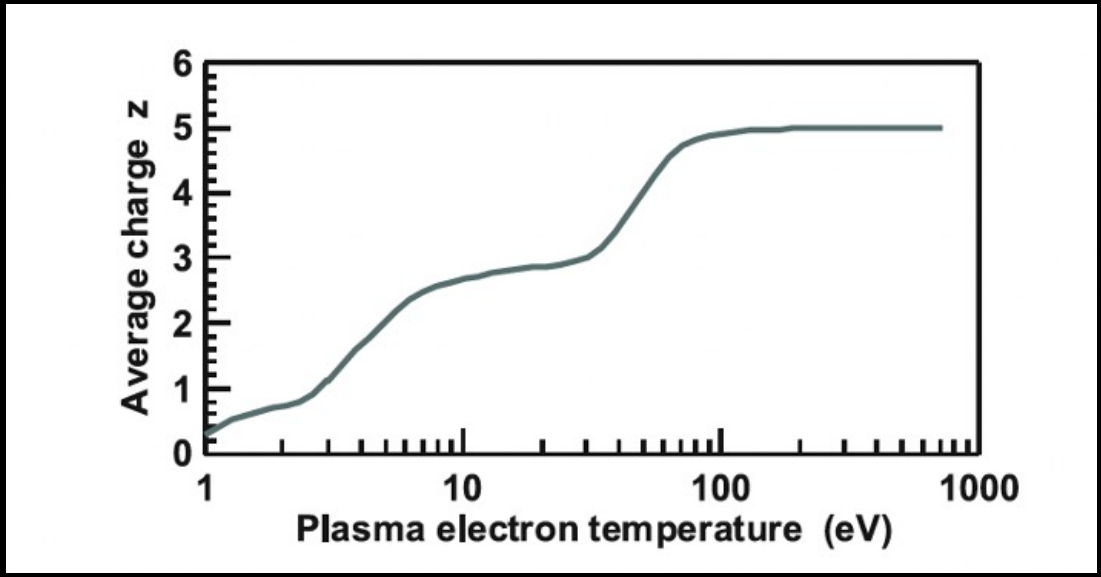
THANKS TO: LPPFUSION'S FUNDERS— ABELL FOUNDATION, INVESTORS AND DONORS

AND PROBONO ORGANIZERS

THANK YOU

NEXT STEPS

6) Elimination of Critical Velocity Problem with Lower Ionization Levels by Electron Heating $25ev>T_e>10eV$



Enhanced Preionization to Increase T_e

UNCLEANED SHOTS WITH DEUTERIUM DECREASE RAPIDLY