

LAPTAG

LOS ANGELES PHYSICS TEACHERS ALLIANCE GROUP

Students

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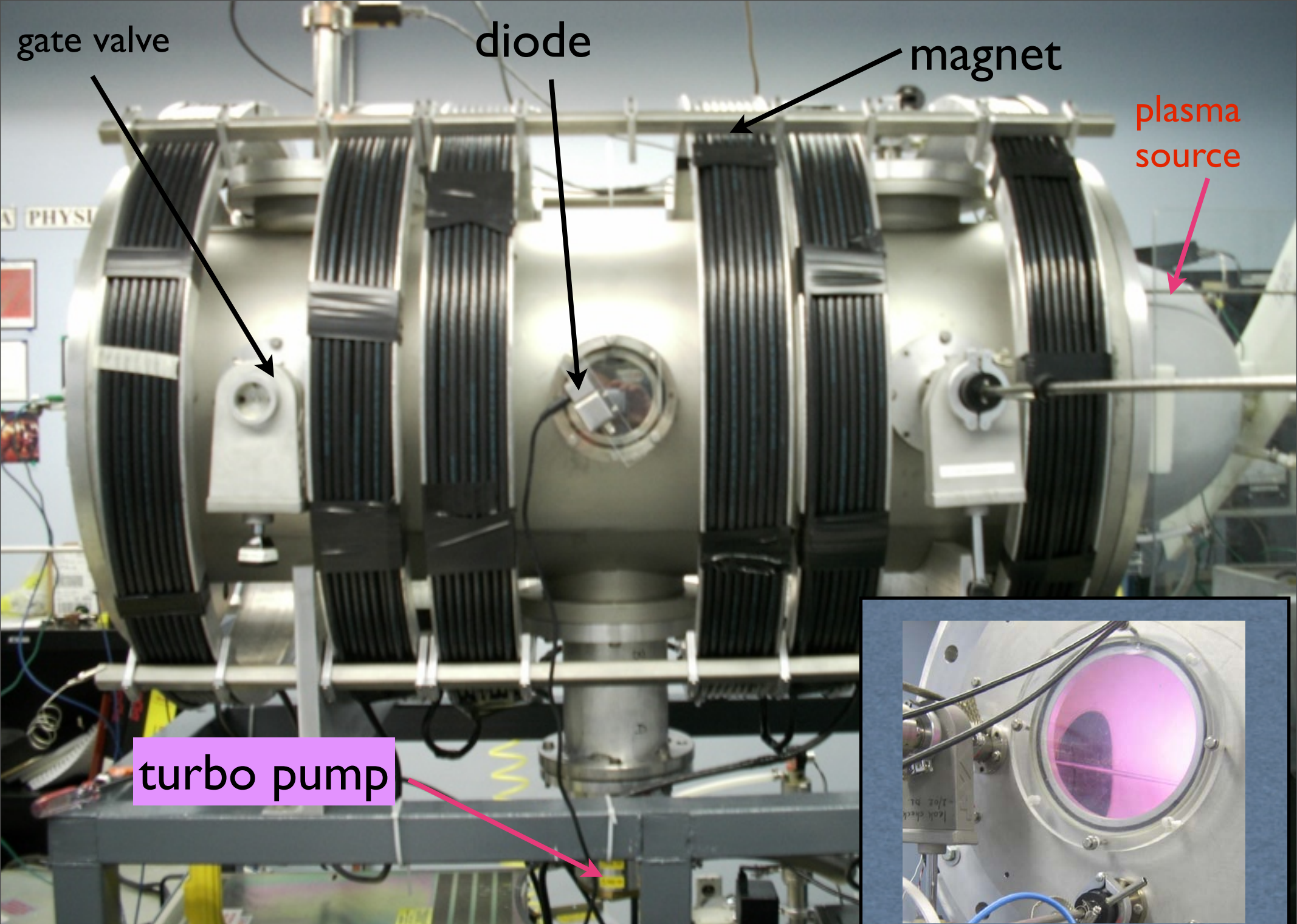
Faculty

Walter Gekelman – UCLA Dept. Physics

Joe Wise – New Roads School

Bob Baker – University High School





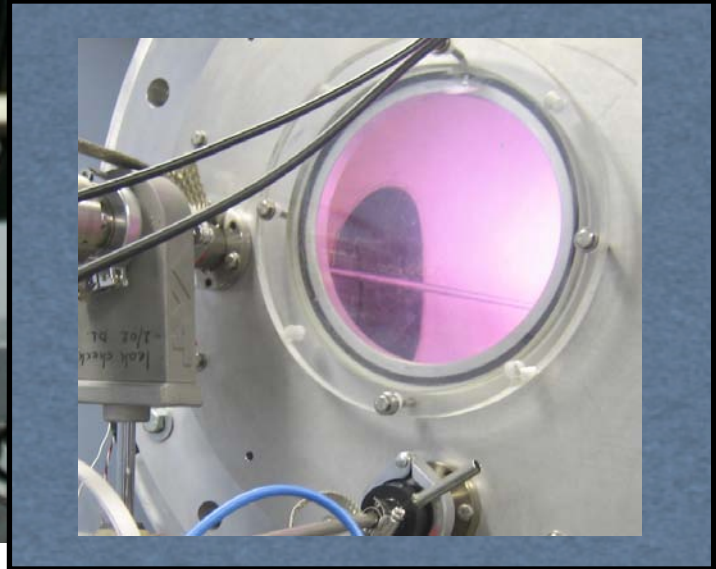
gate valve

diode

magnet

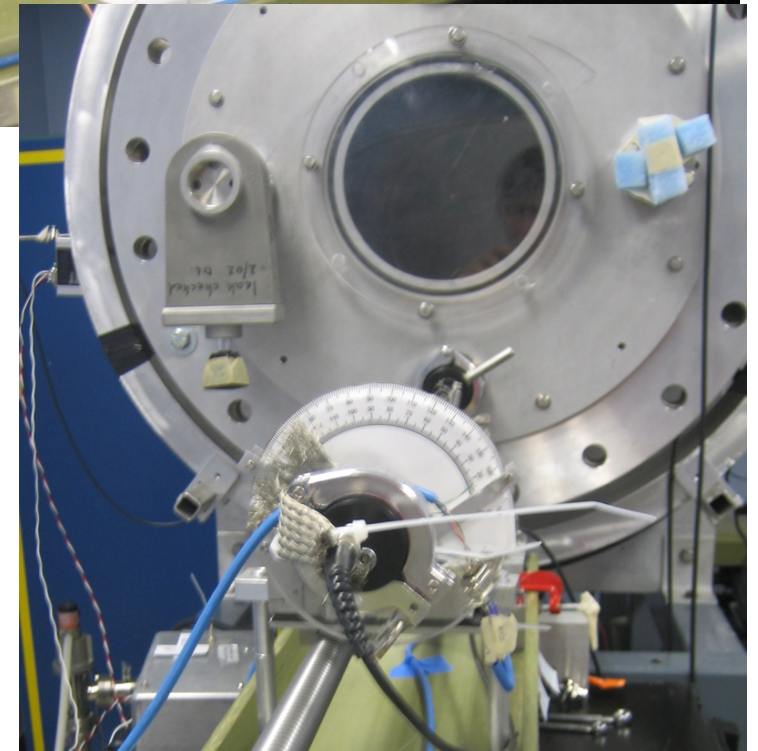
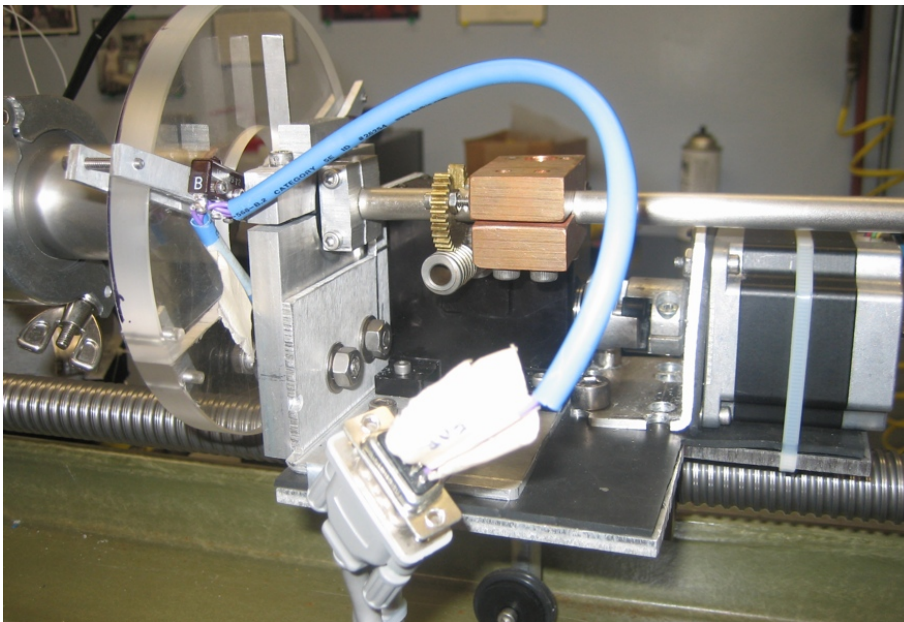
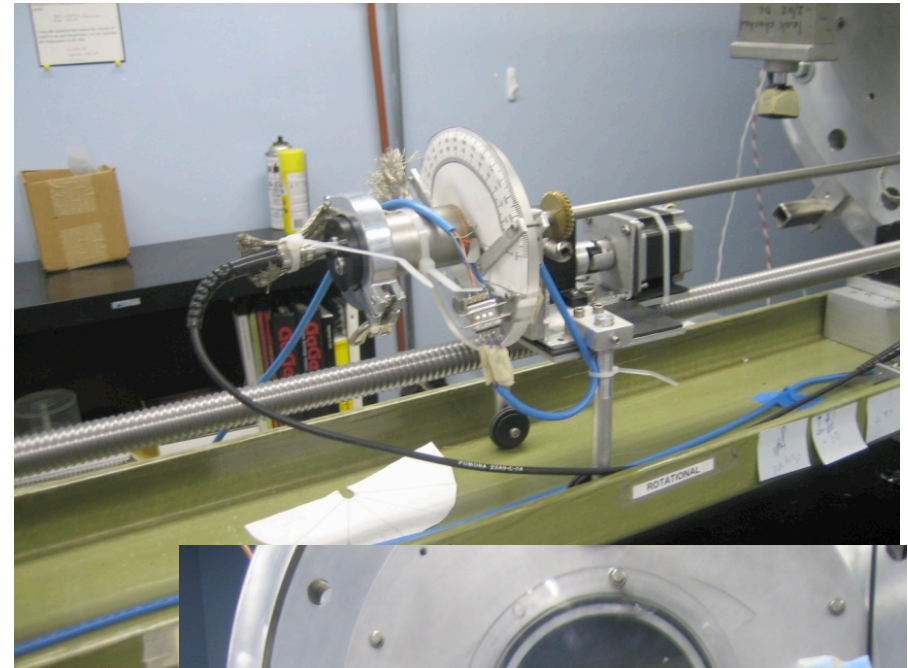
plasma source

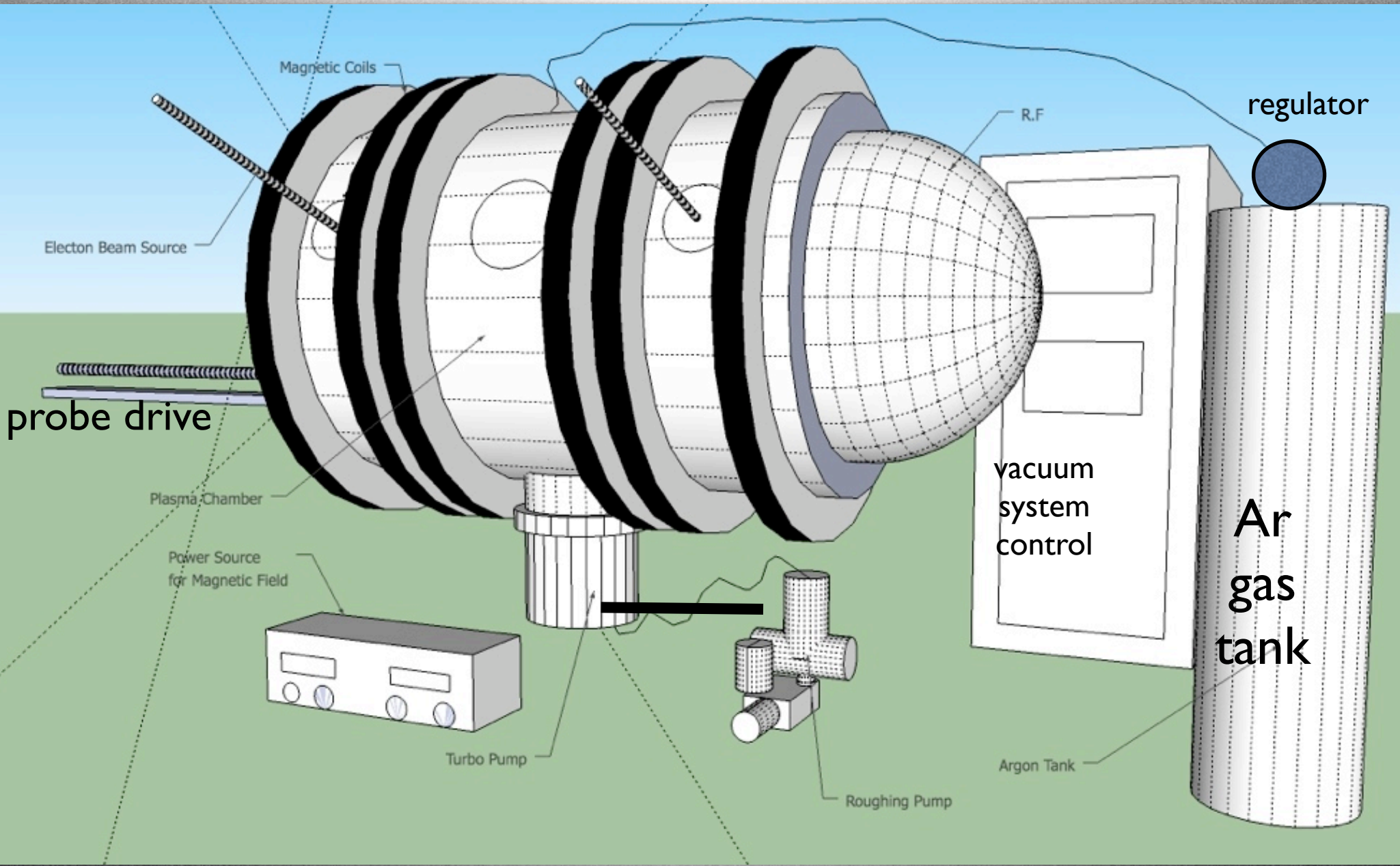
turbo pump



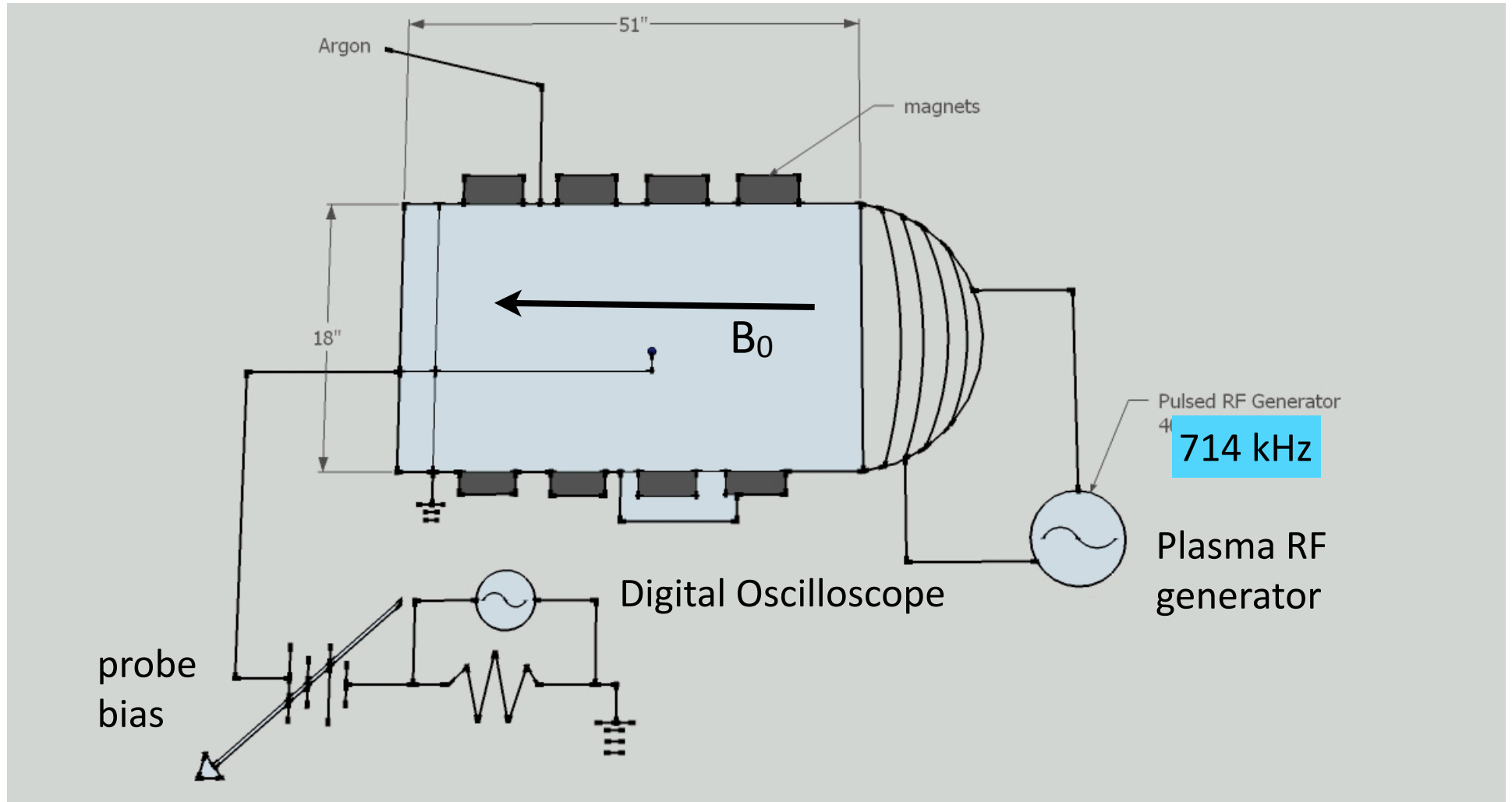
Probe Drive

- The probe drive is designed with two movable parts, a rotational axis for turning the probe while inside the plasma device and a horizontal axis for moving the probe in and out of the machine

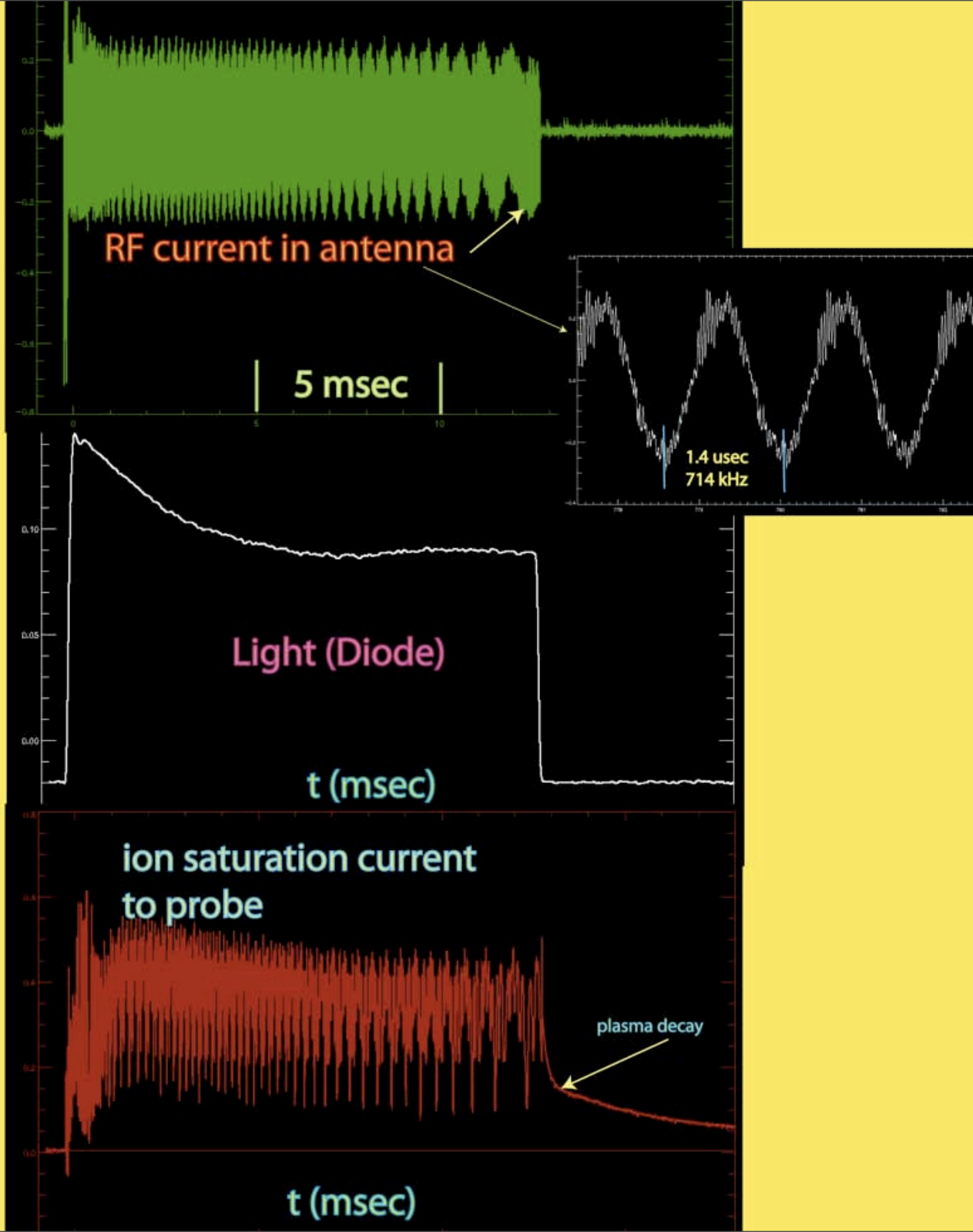




Plasma Machine Schematic

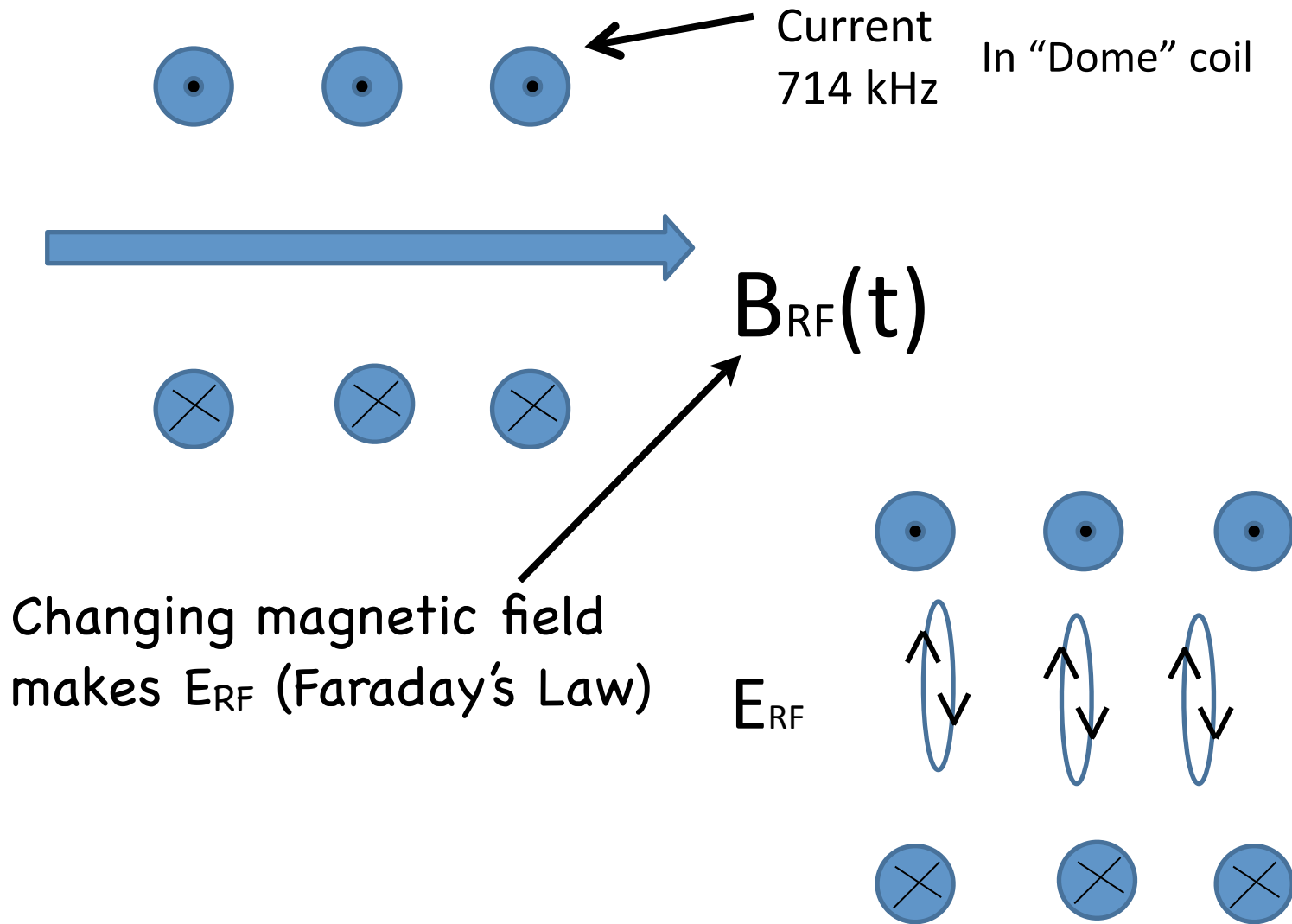


The plasma is pulsed

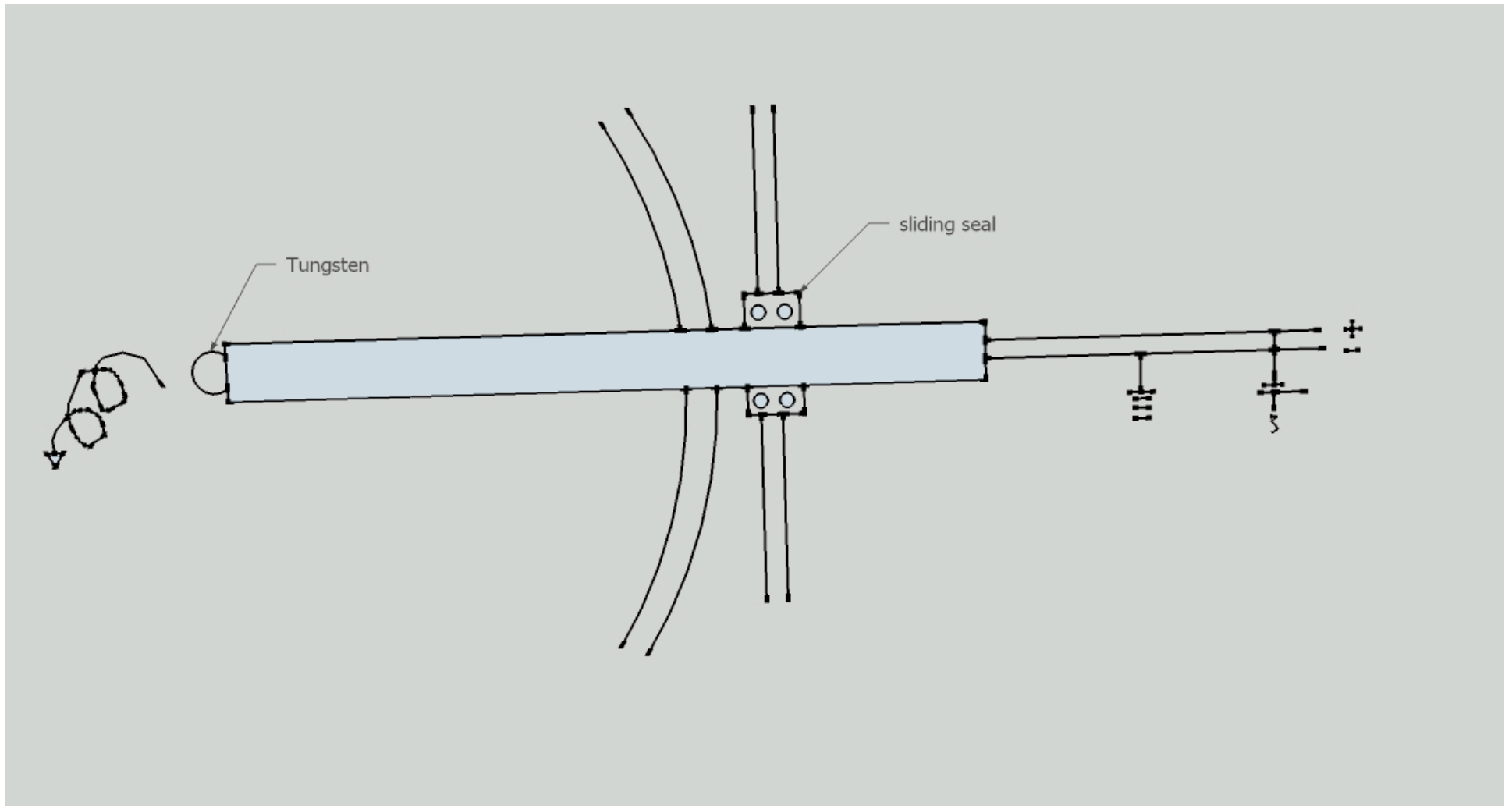


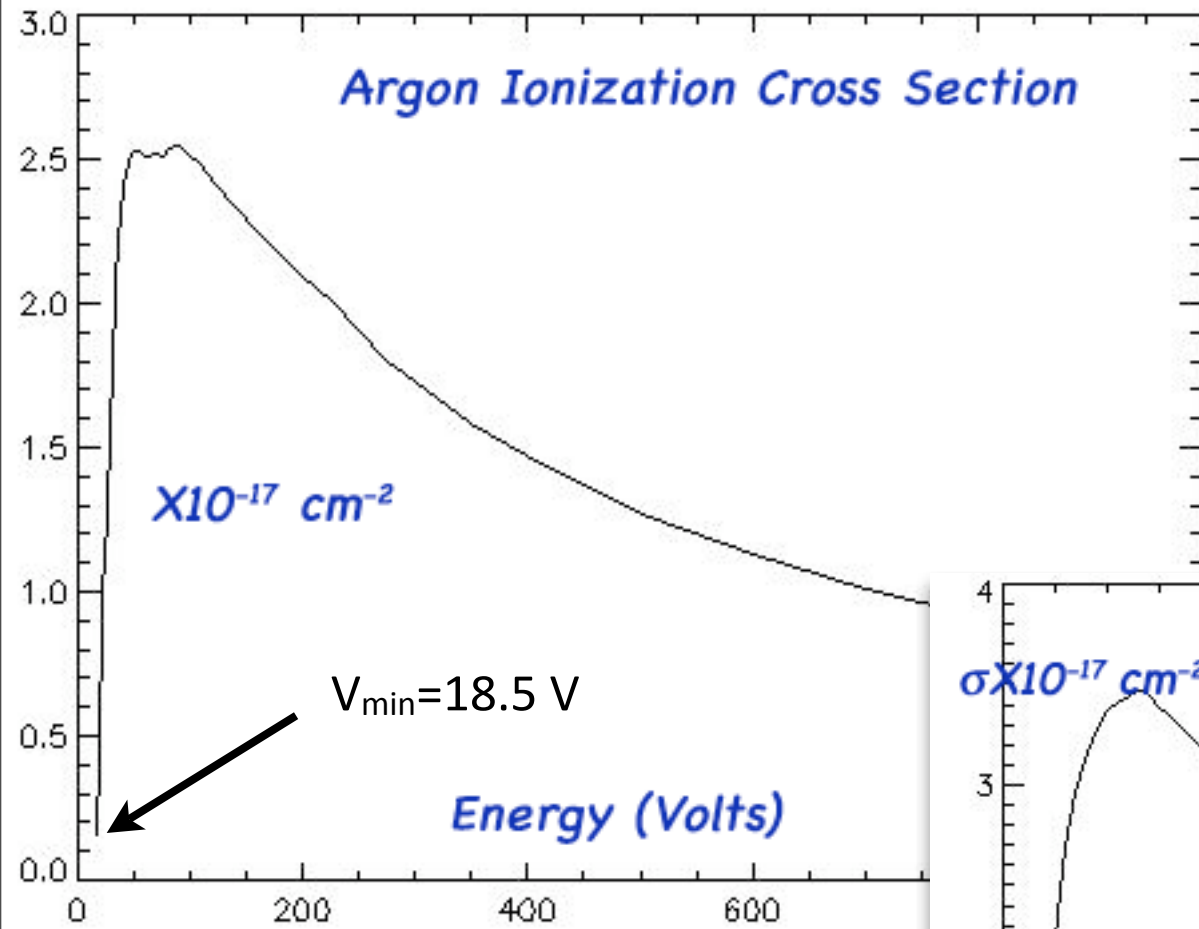
Antenna - 1 kW
(714 kHz)

Plasma production

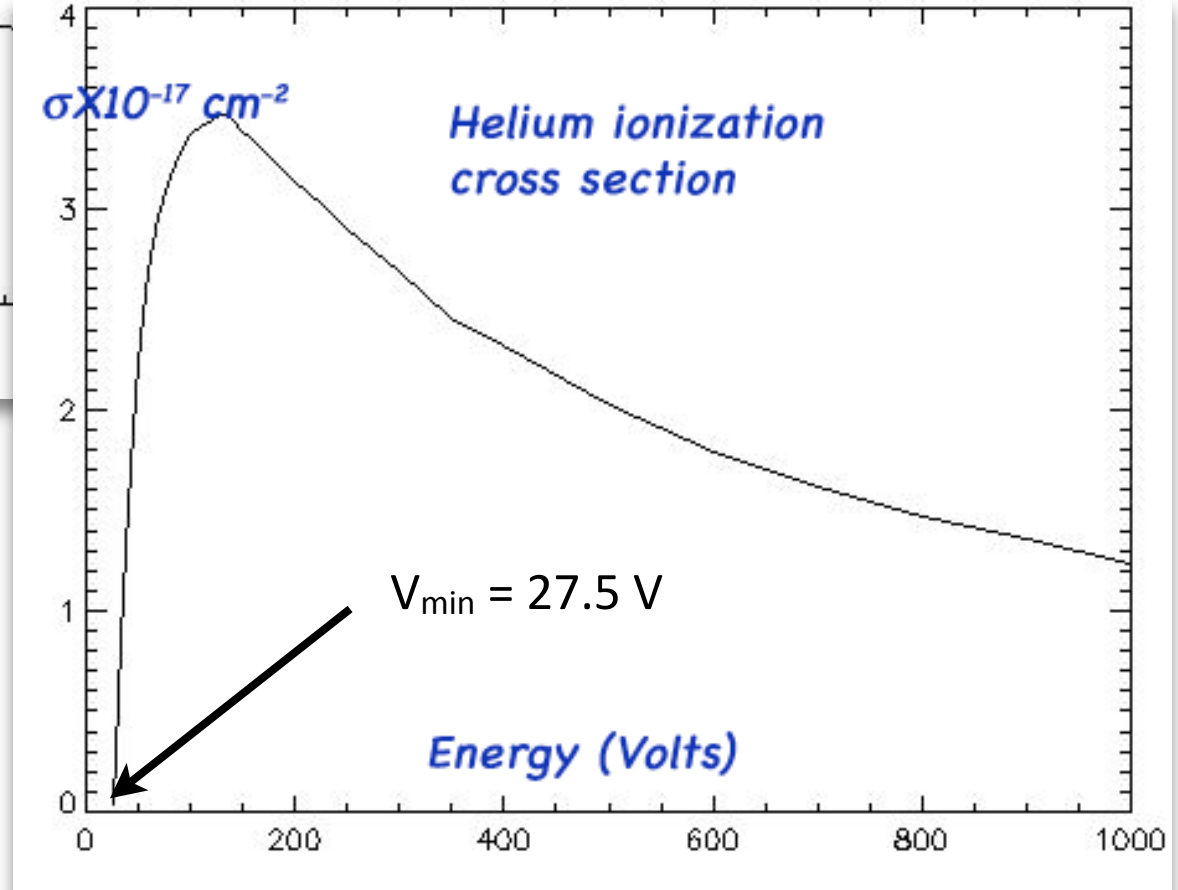


Electron Beam Source Schematic



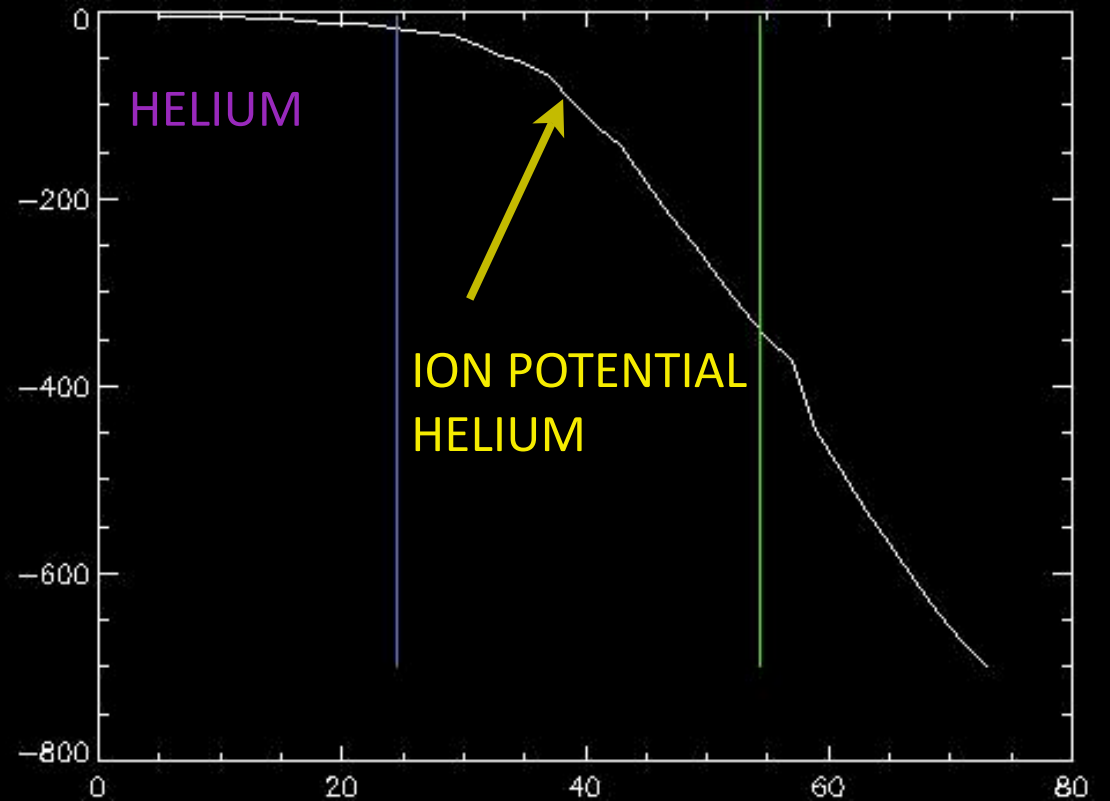
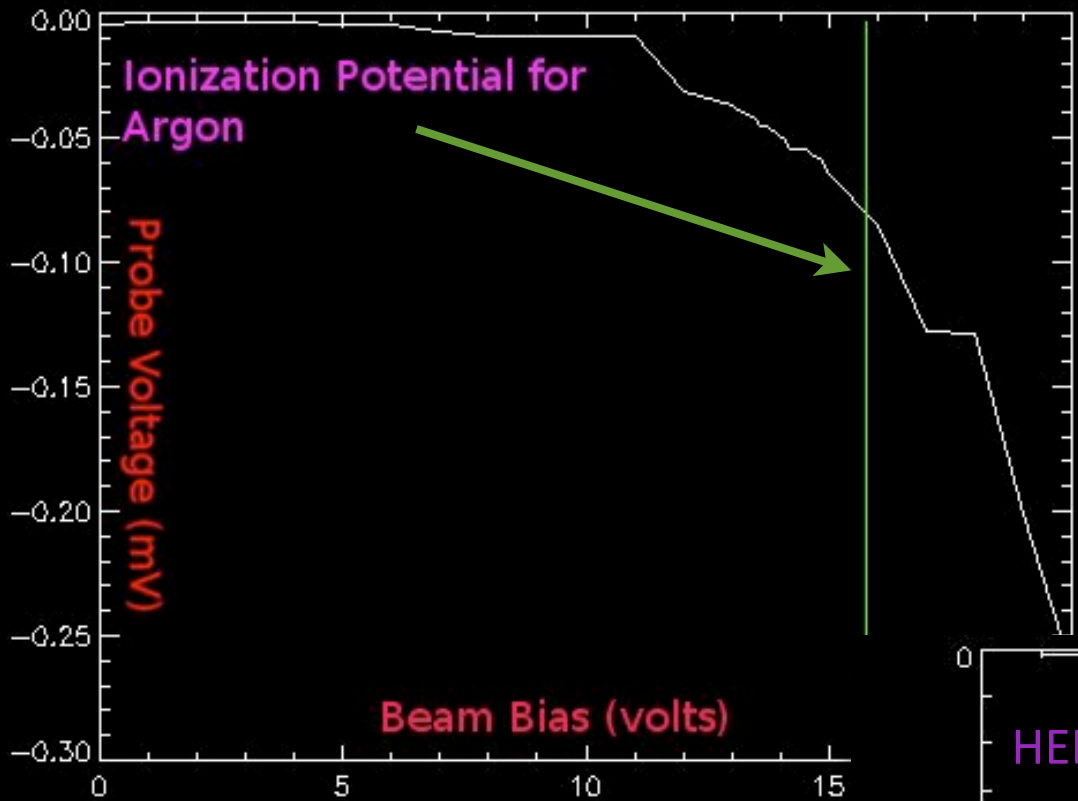


EXPERIMENTAL CROSS
SECTION
MEASUREMENTS

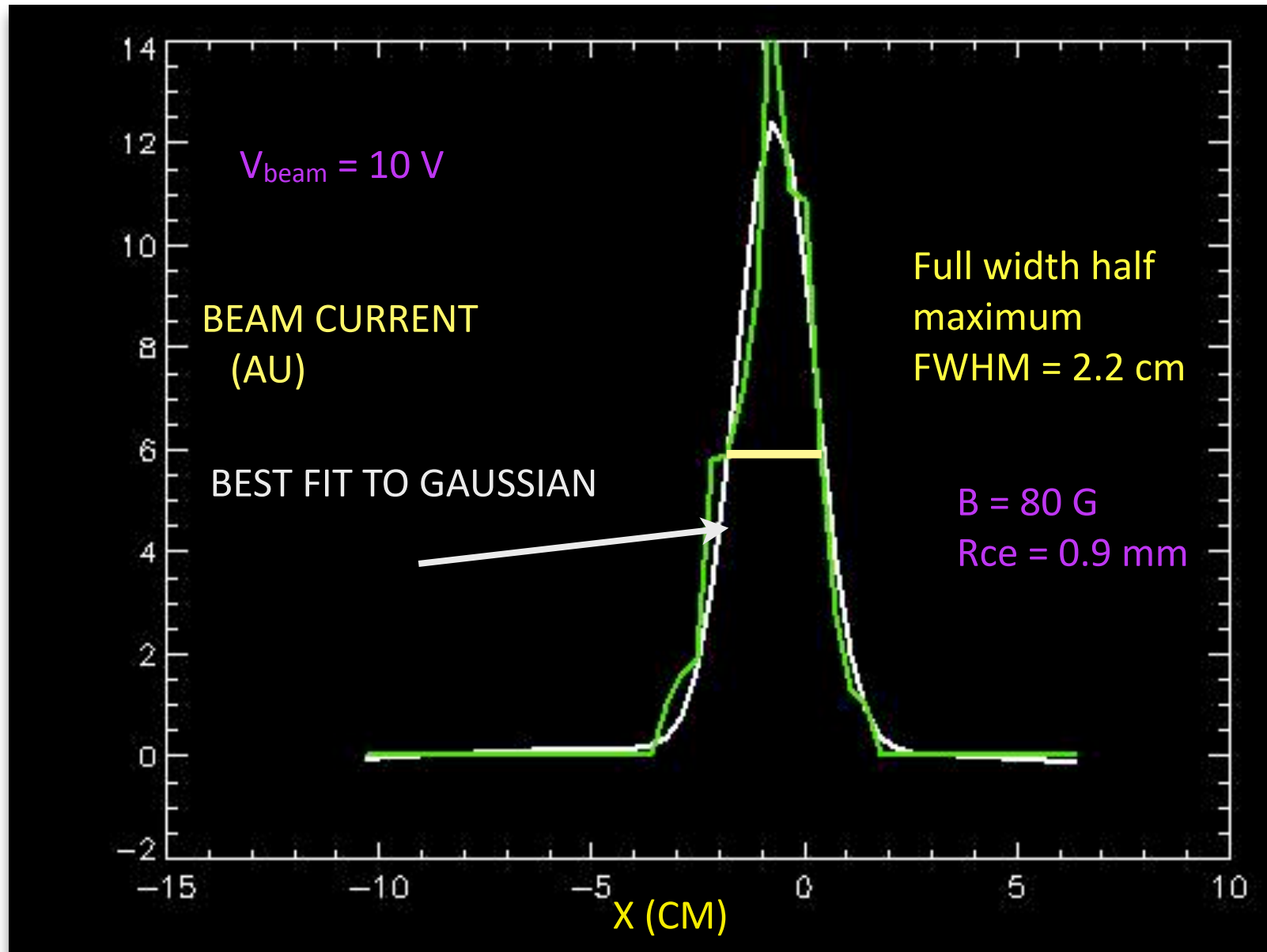


EXPERIMENTAL RESULTS

PRESSURE = 9 MT

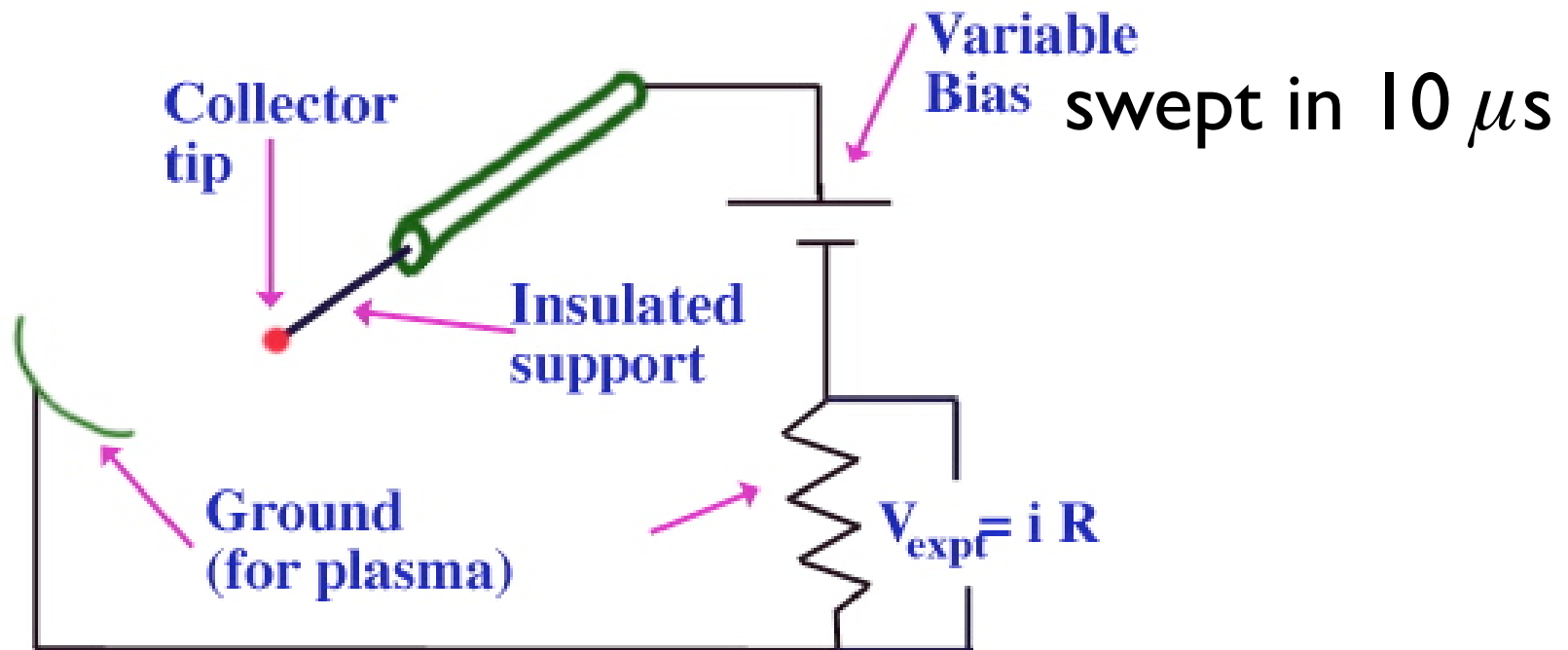


ELECTRON BEAM PROFILE



langmuir probe

Langmuir Probe



$-i_{\text{probe}}$

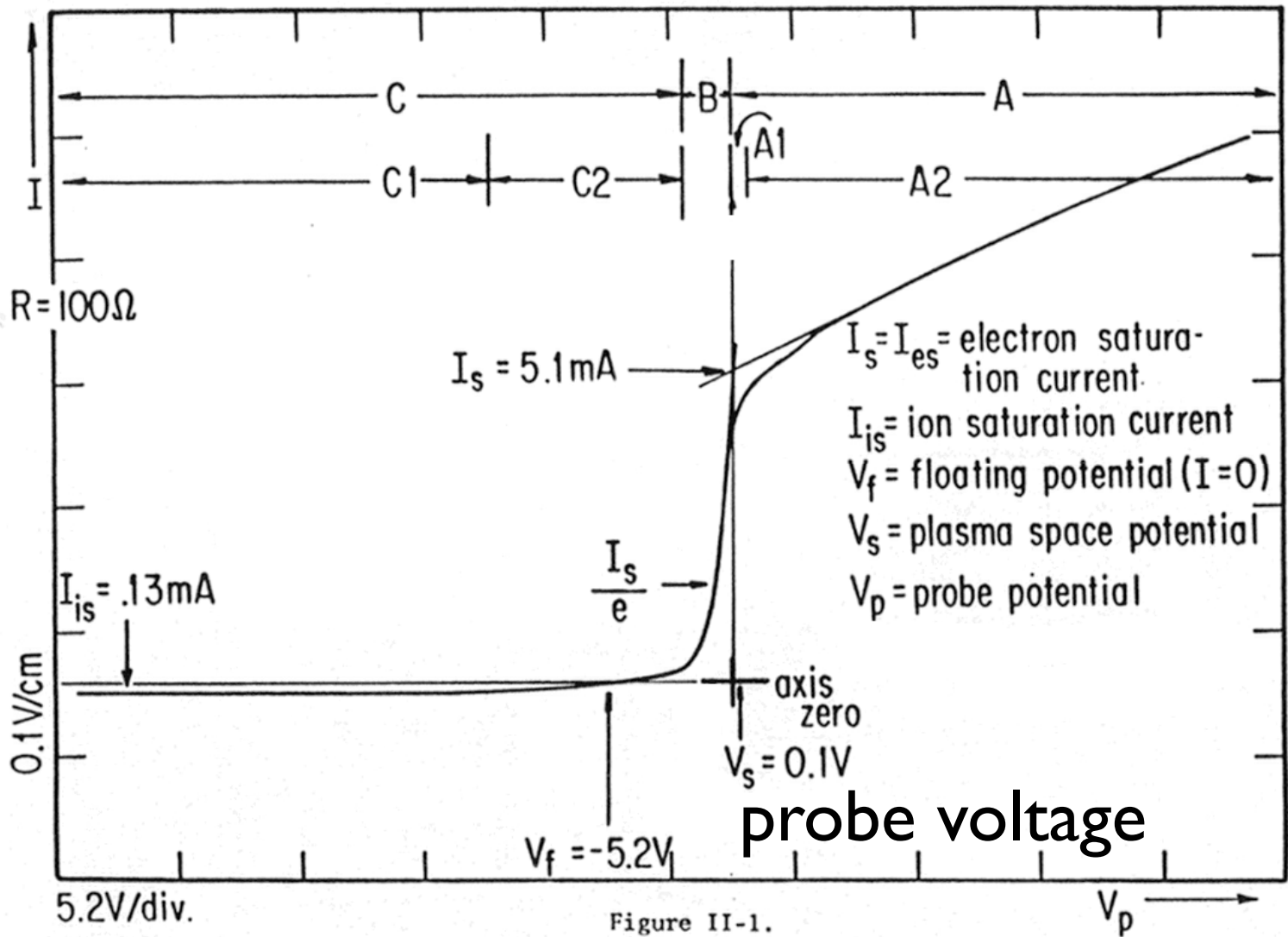
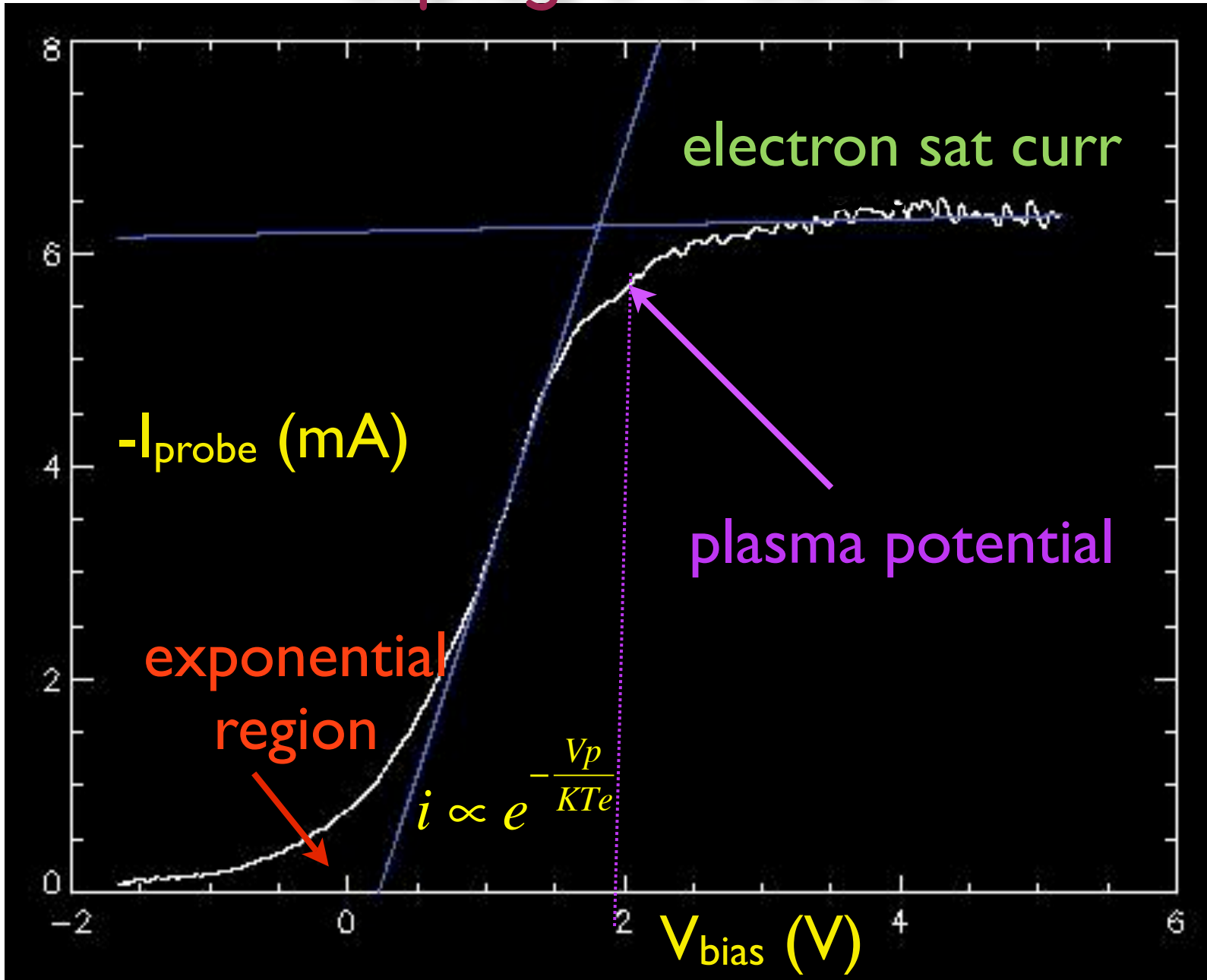


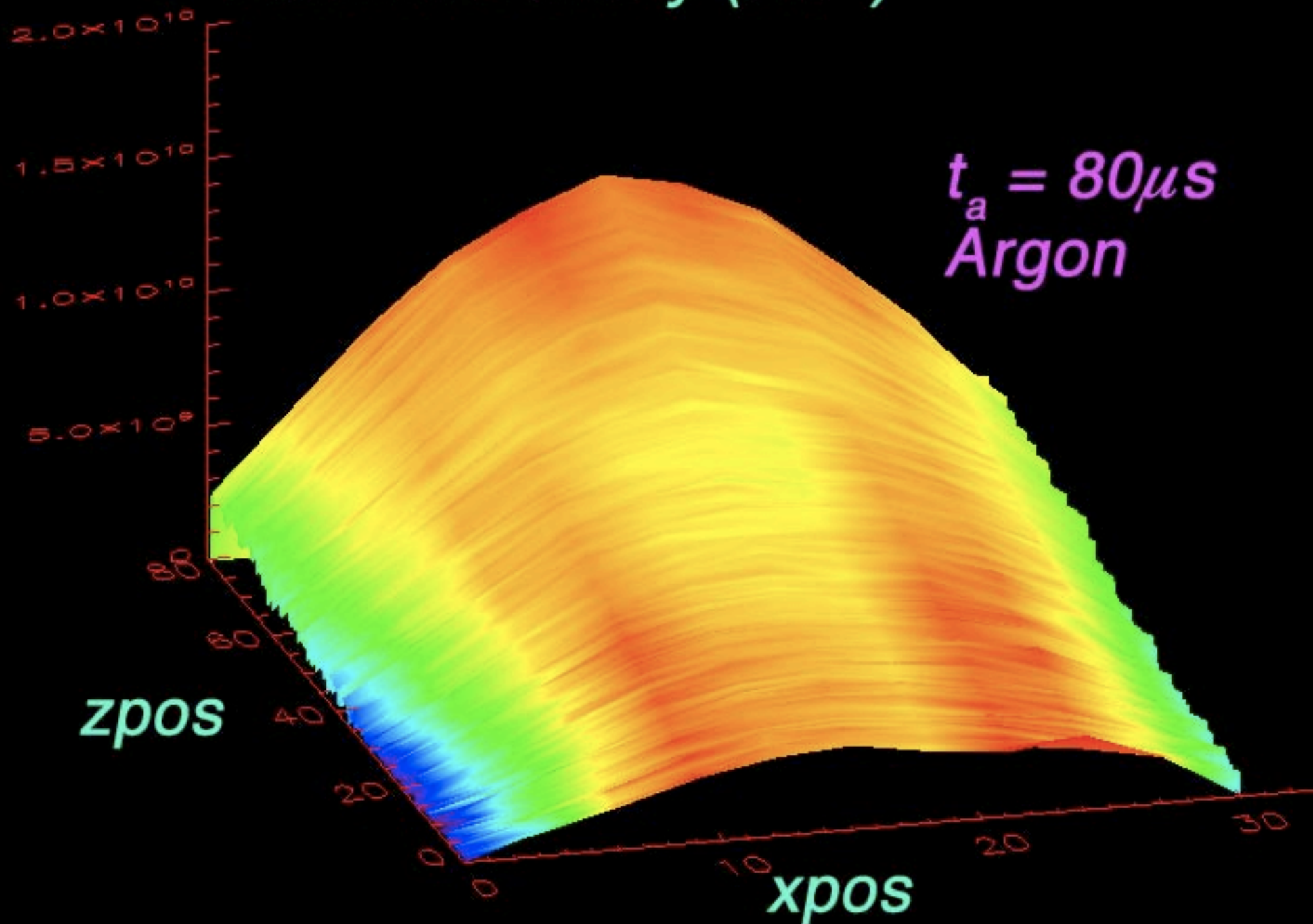
Figure II-1.

Sample Langmuir Probe Characteristic (Radial disc probe placed near center of single plasma): Region C1 - Ion saturation (electrons repelled); Region C2 - Ion saturation plus small primary electron current; Region B - Secondary electrons added to current of primaries and ions; X - Probe at space potential (zero electric probe field); Region A1 - Electron saturation with cooler ions being repelled; Region A2 - Electron saturation, no ion current.
 T_e (1.0 eV for this data).

Laptag I-V data

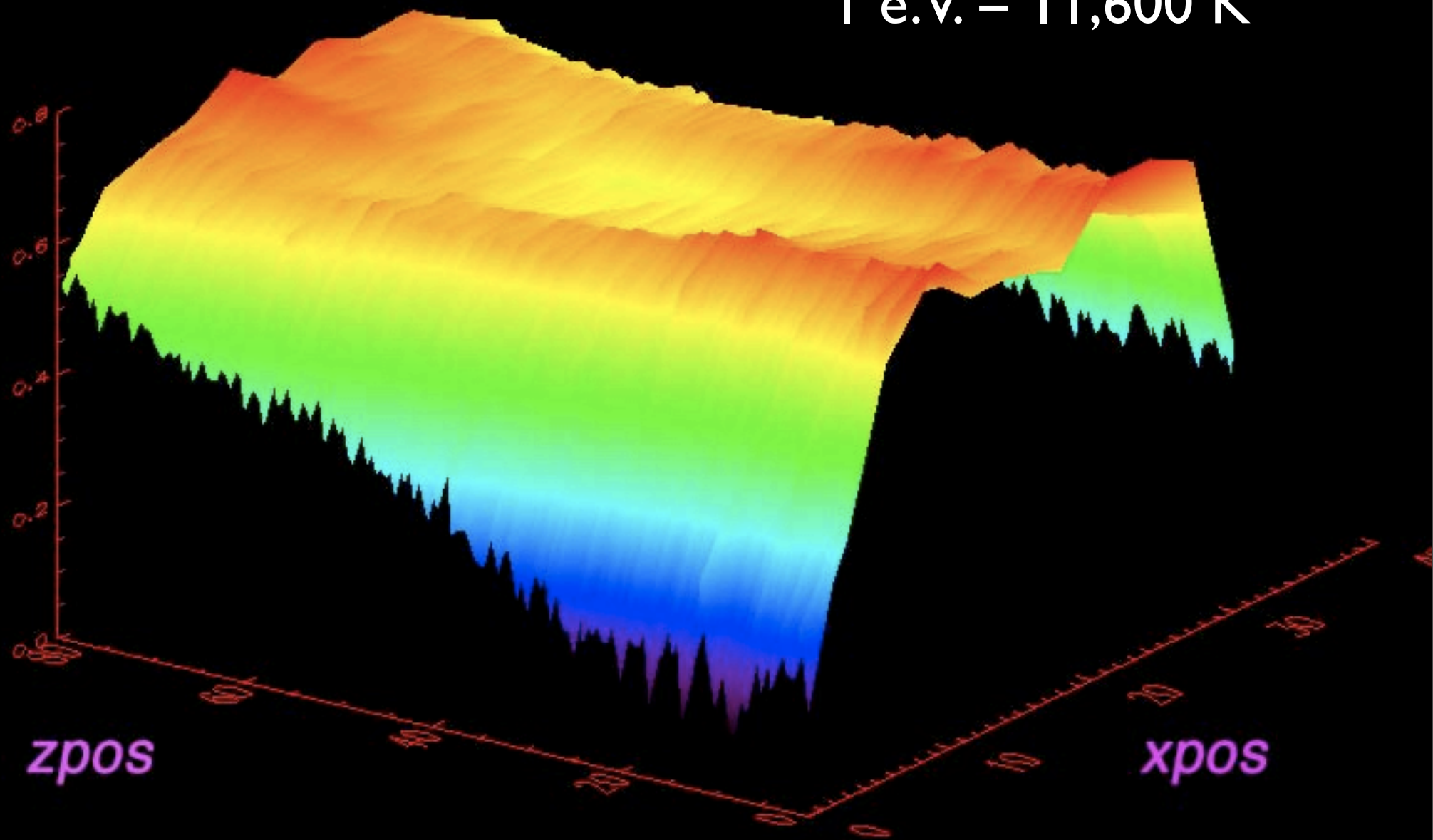


Plasma Density (cm^{-3})

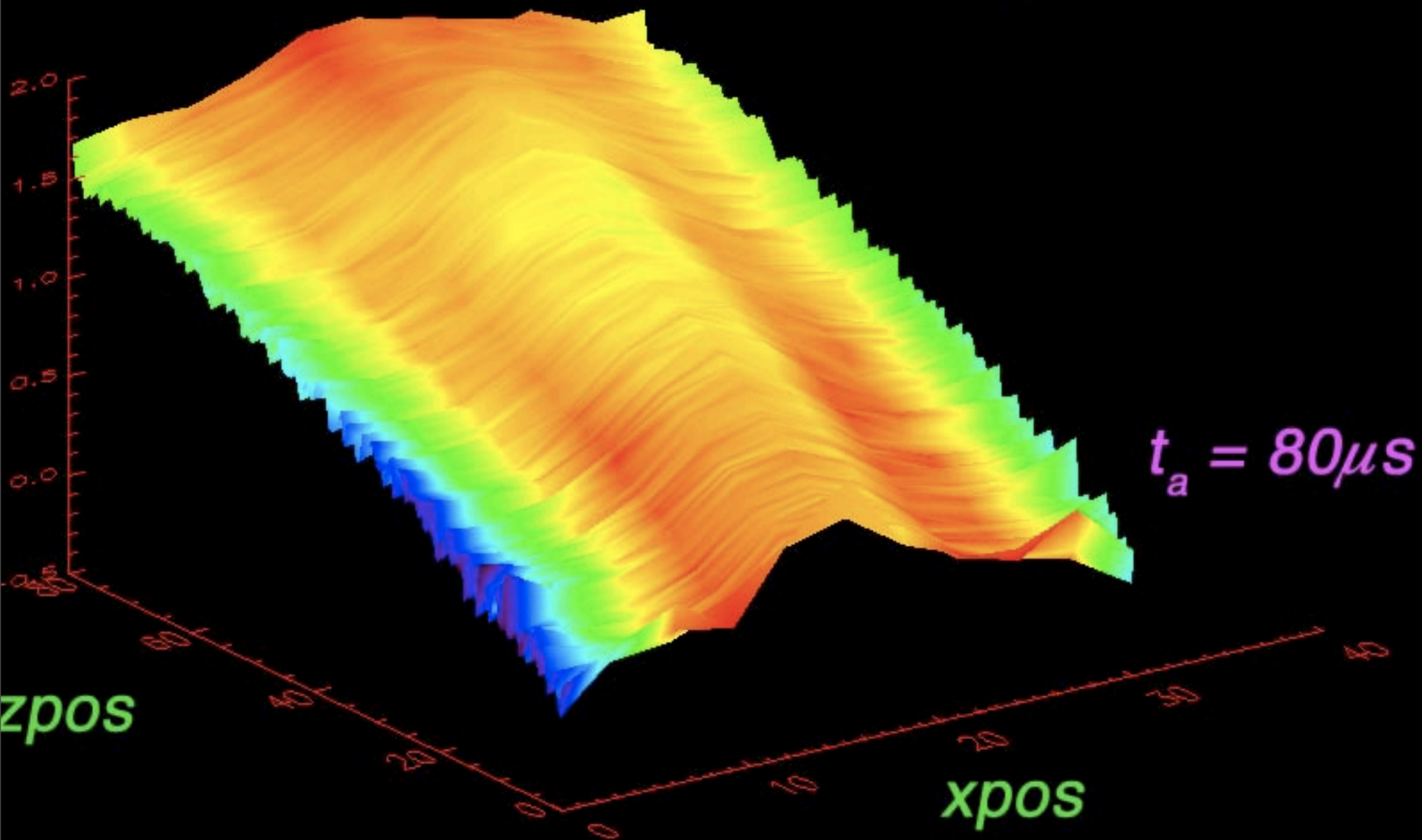


Electron Temperature (e.V.)

1 e.V. = 11,600 K



Plasma Potential (e.V.)



j/cm^4

Force -grad(P)

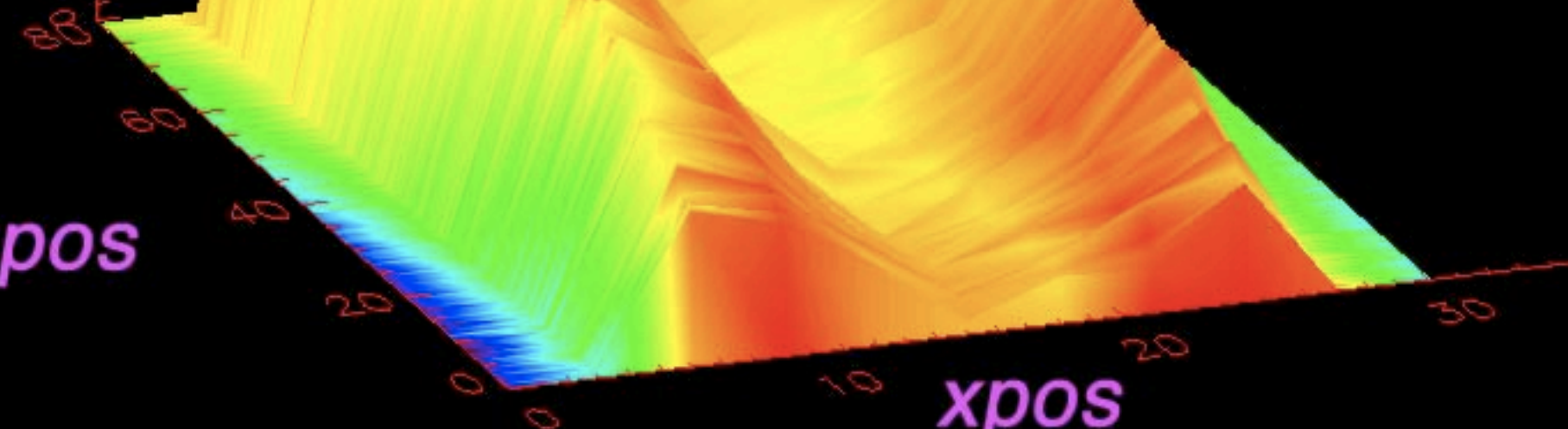
N/cm^2

$t_a = 80\mu\text{s}$

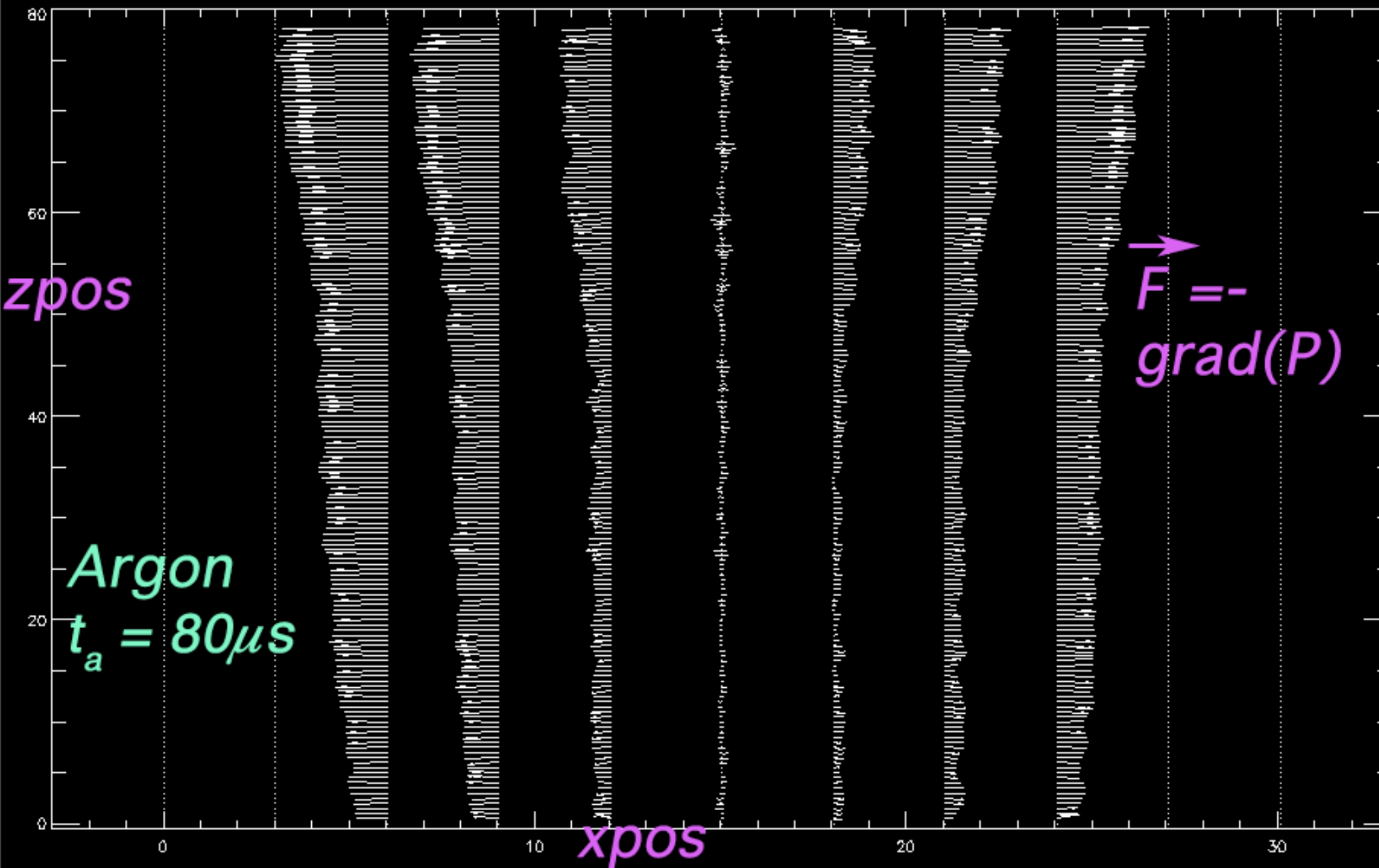
4×10^{-10}
 3×10^{-10}
 2×10^{-10}
 1×10^{-10}

zpos

xpos

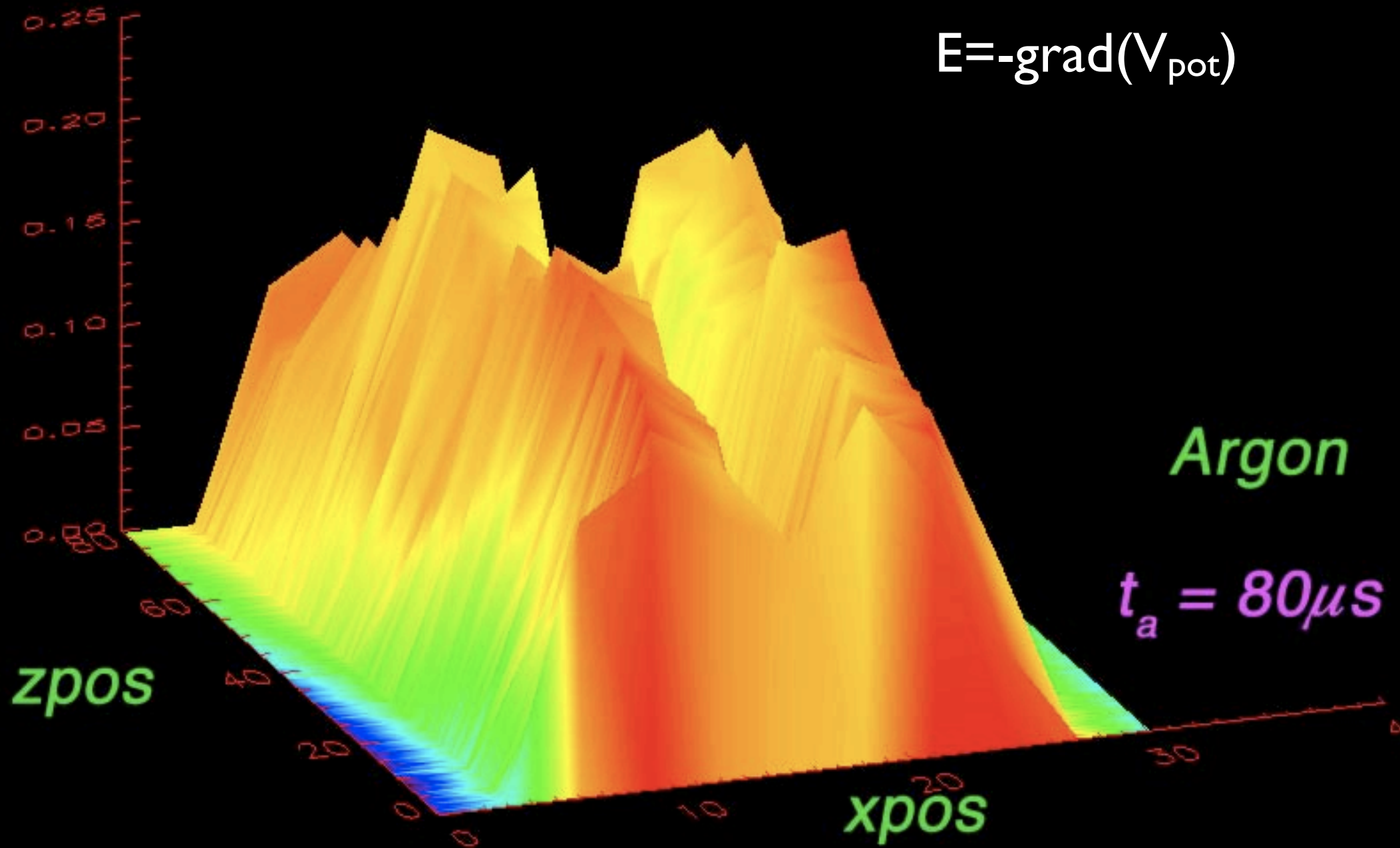


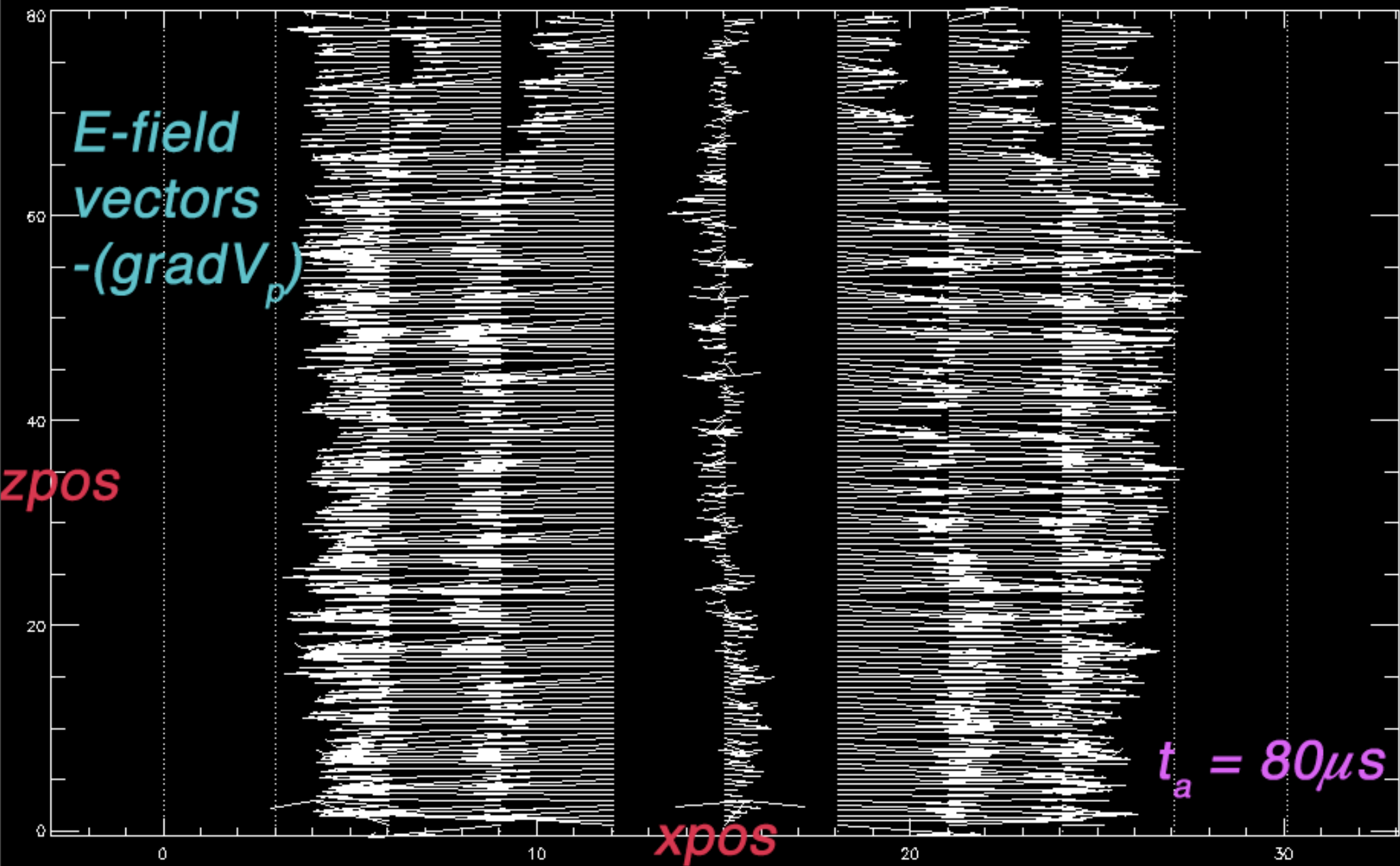
vectors of Force



Electric Field (V/cm)

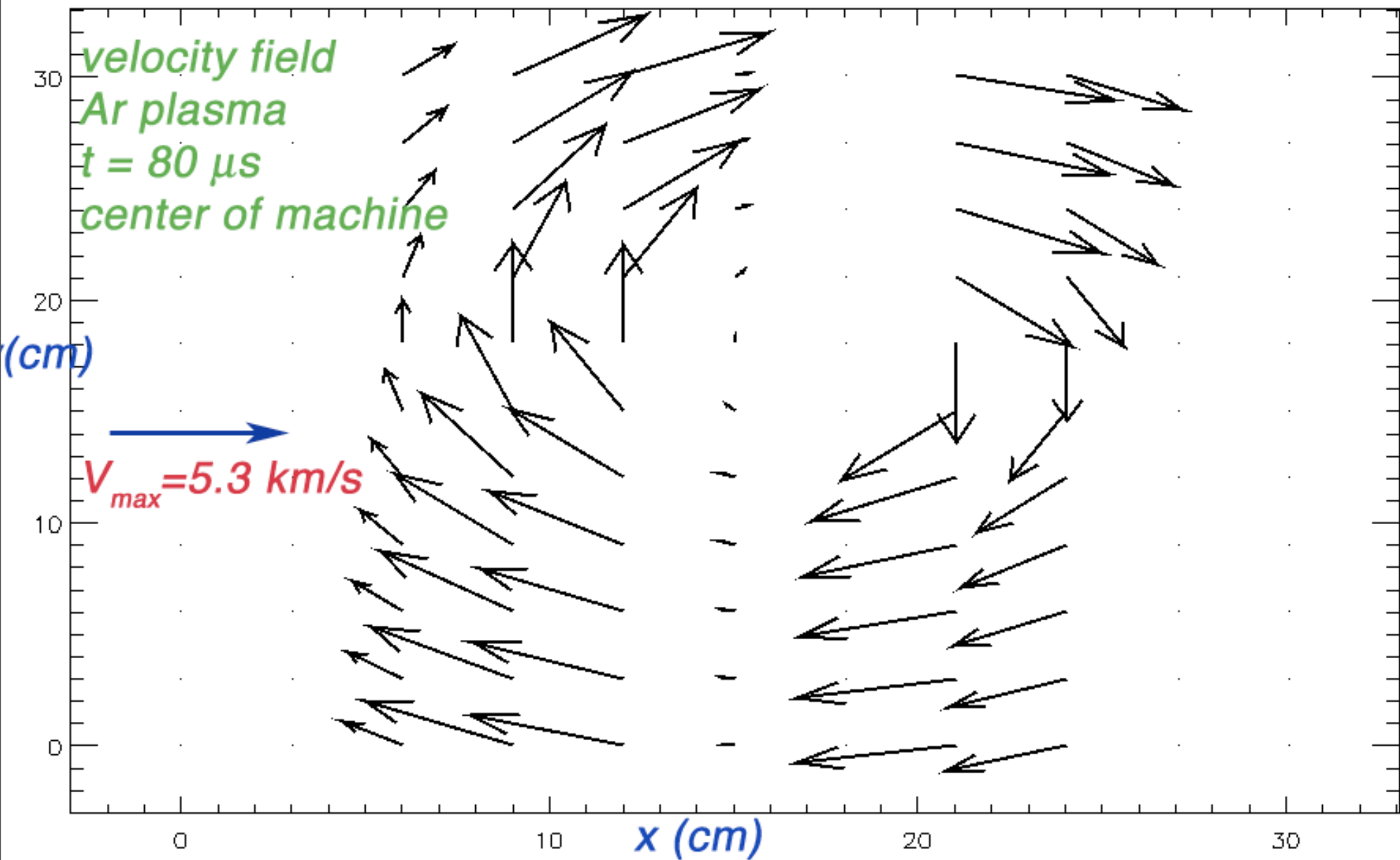
$$E = -\text{grad}(V_{\text{pot}})$$





PLASMA Drift

$$\vec{v} = \frac{\vec{E} \times \vec{B}}{B^2} \quad |v| = \frac{E}{B}$$



$v_{\text{eth}} = 400 \text{ km/s}$

Plasma density		$n = 1.5 \times 10^{10} \text{ cm}^{-3}$
Electron Temperature (e.V.)	Note 1 e.V. = 11,600 K	$T_e = 0.8 \text{ e.V.}$
Magnetic Field (center)		$B_{0z} = 30 \text{ G}$
electron plasma frequency	$f_{pe} = \sqrt{\frac{4\pi e^2 n_e}{m_e}} = 8.98 \times 10^3 \sqrt{n_e}$	$f_{pe} = 1.1 \times 10^9 \text{ Hz}$
electron cyclotron frequency	$f_{ce} = \frac{eB}{cm_e} = 2.8 \times 10^6 B(\text{Gauss})$	$f_{ce} = 8.4 \times 10^7 \text{ Hz}$
Ion plasma frequency	$f_{pi} = \sqrt{\frac{4\pi e^2 n_i}{M_i}} = 210 \sqrt{\frac{n_i}{\mu}} ; \mu = \frac{M_i}{m_p}$	$f_{pi} = 4.06 \times 10^6 \text{ Hz}$
Ion cyclotron frequency	$f_{ci} = \frac{eB}{cM_i} = 1.52 \times 10^3 \sqrt{\frac{B}{\mu}} (\text{Gauss})$	$f_{ci} = 1.14 \times 10^3 \text{ Hz}$
electron thermal speed	$v_{\text{the}} = \sqrt{\frac{KT_e}{m_e}} = 4.19 \times 10^7 \sqrt{T_e}$	$v_{\text{the}} = 3.8 \times 10^7 \text{ cm/s}$
electron Gyroradius	$r_{ce} = \frac{m_e v_{\perp e}}{eB} = 2.38 \frac{\sqrt{T_e}}{B}$	$r_{ce} = 7 \times 10^{-2} \text{ cm}$ (.7 mm)
Ion Gyroradius	$R_{ci} = \frac{m_i v_{\perp i}}{eB} = 102 \frac{\sqrt{T_i}}{\sqrt{\mu} B}$	$R_{ci} = 15.2 \text{ cm}$

Argon Plasma 80 μ s after the RF producing the plasma is shut off