OVERVIEW OF IEC AT THE UNIVERSITY OF SYDNEY

Joe Khachan,

Matthew Carr, Scott Cornish, David Gummersall, Adam Israel, Colin Tuft

School of Physics

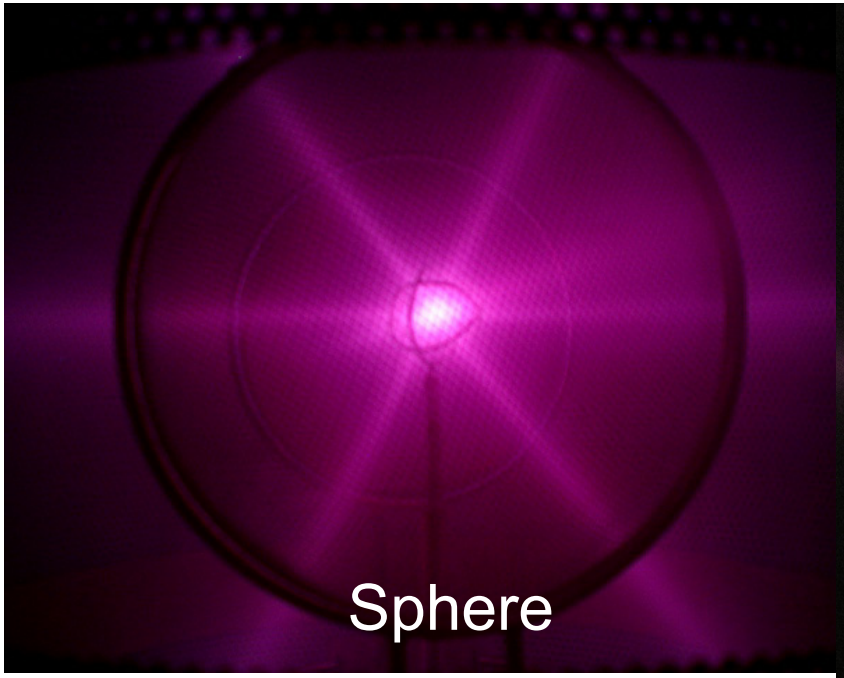
University of Sydney

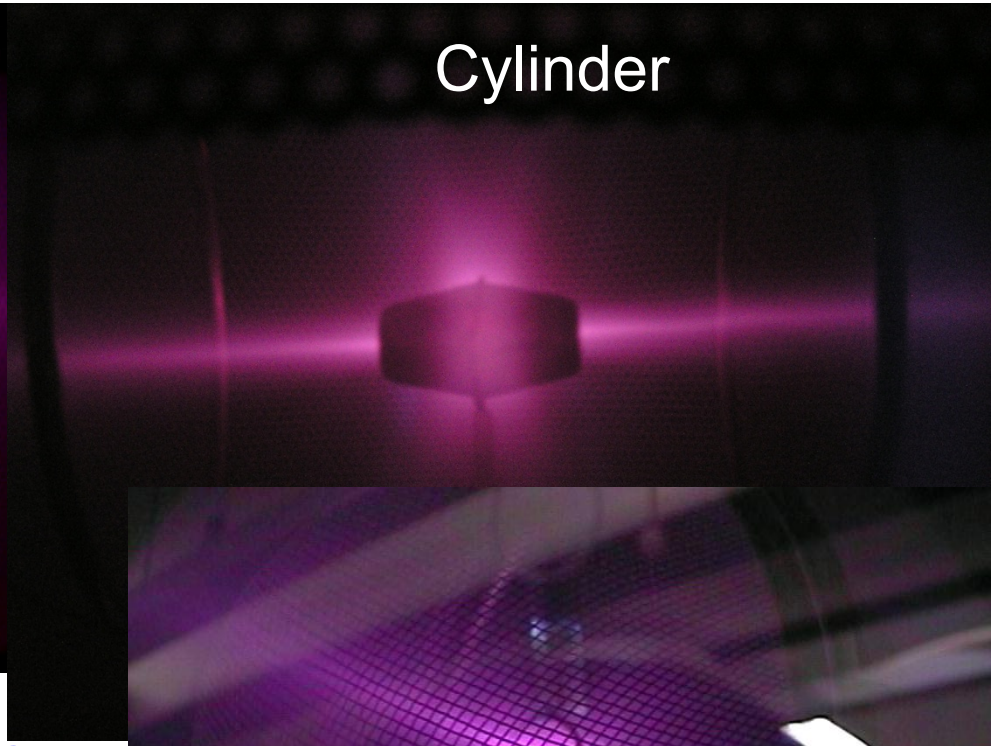
Australia

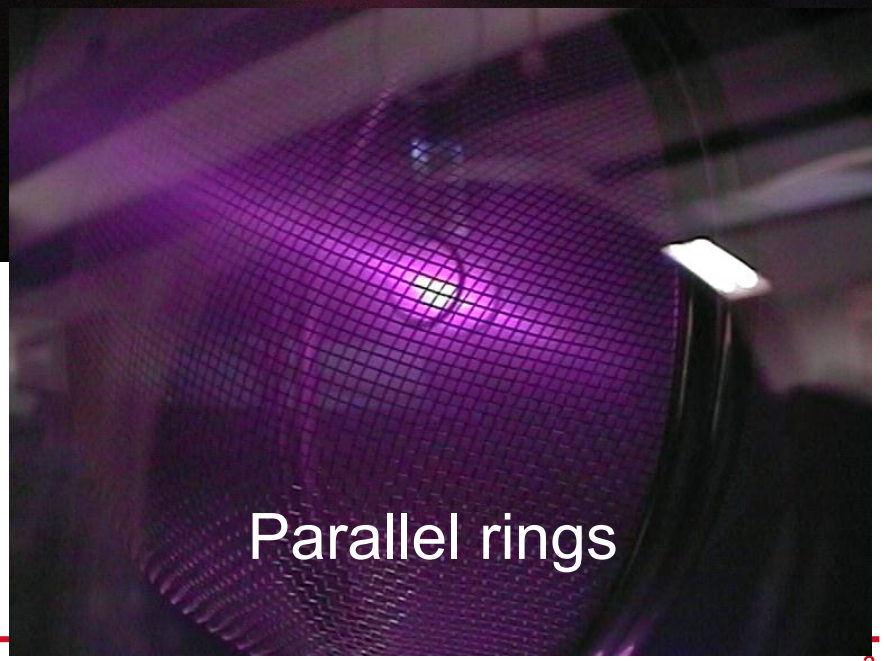
TALK OUTLINE

OUTLINE OF INERTIAL ELECTROSTATIC CONFINEMENT WORK AT THE UNIVERSITY OF SYDNEY OVER THE LAST 10 YEARS.

DOPPLER SPECTROSCOPY ON MANY GEOMETRIES OF IEC DISCHARGES



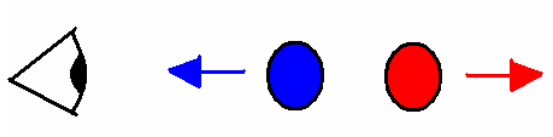




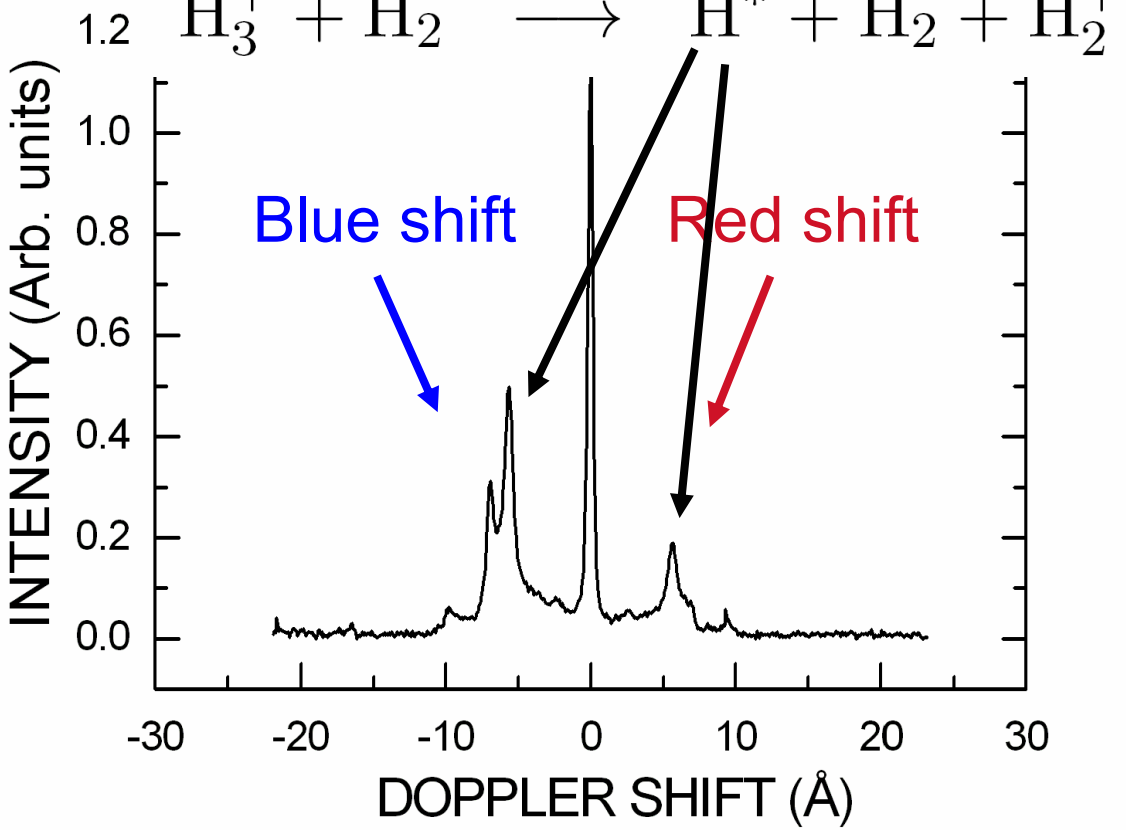
Many types of IEC discharges have been explored. Doppler spectroscopy was used to find ion energies and relative density distributions.

DOPPLER SPECTROSCOPY ON IEC DISCHARGES

Charge exchange results in excited hydrogen that emits a Doppler shifted spectrum. The wavelength shift and intensity give the energy and relative density of the parent species.



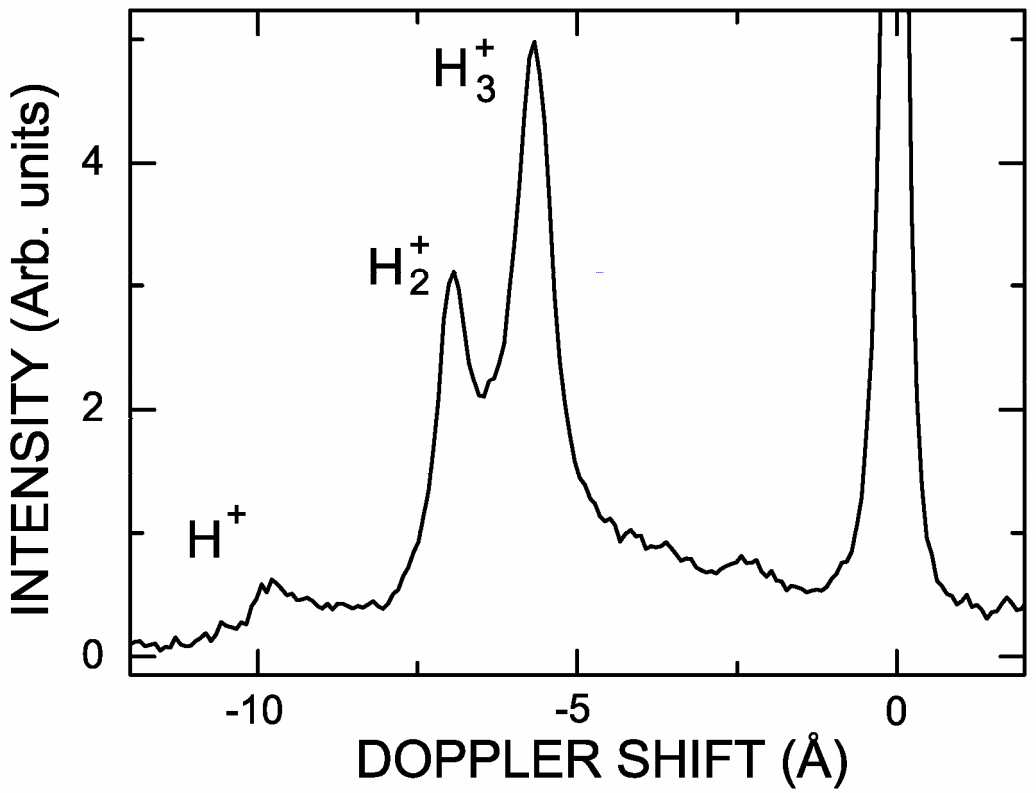
$$H^+ + H_2 \longrightarrow H^* + H_2^+$$
$$H_2^+ + H_2 \longrightarrow H^* + H + H_2^+$$
$$H_3^+ + H_2 \longrightarrow H^* + H_2 + H_2^+$$



DOPPLER SPECTROSCOPY ON IEC DISCHARGES

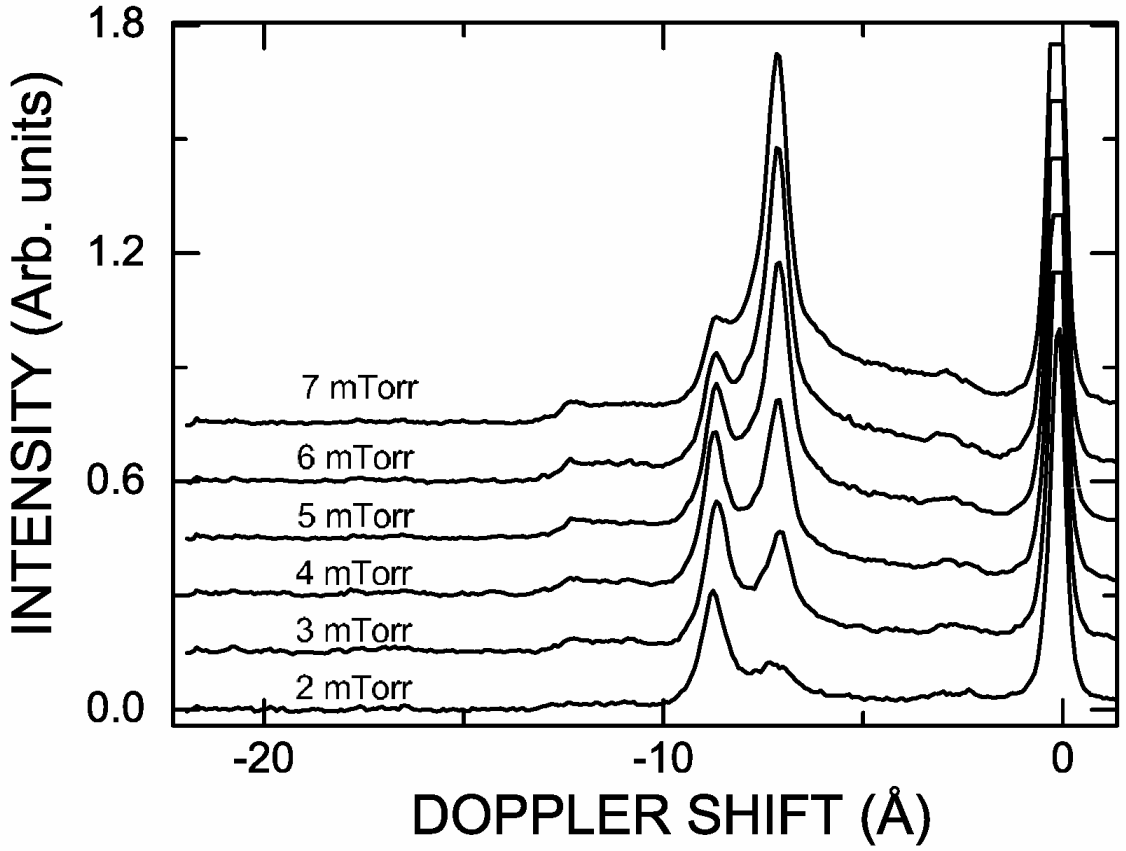
The three peaks are from excited hydrogen due to the three parent ions.

Their x-position and intensity give the energy and relative density of the parent ions.



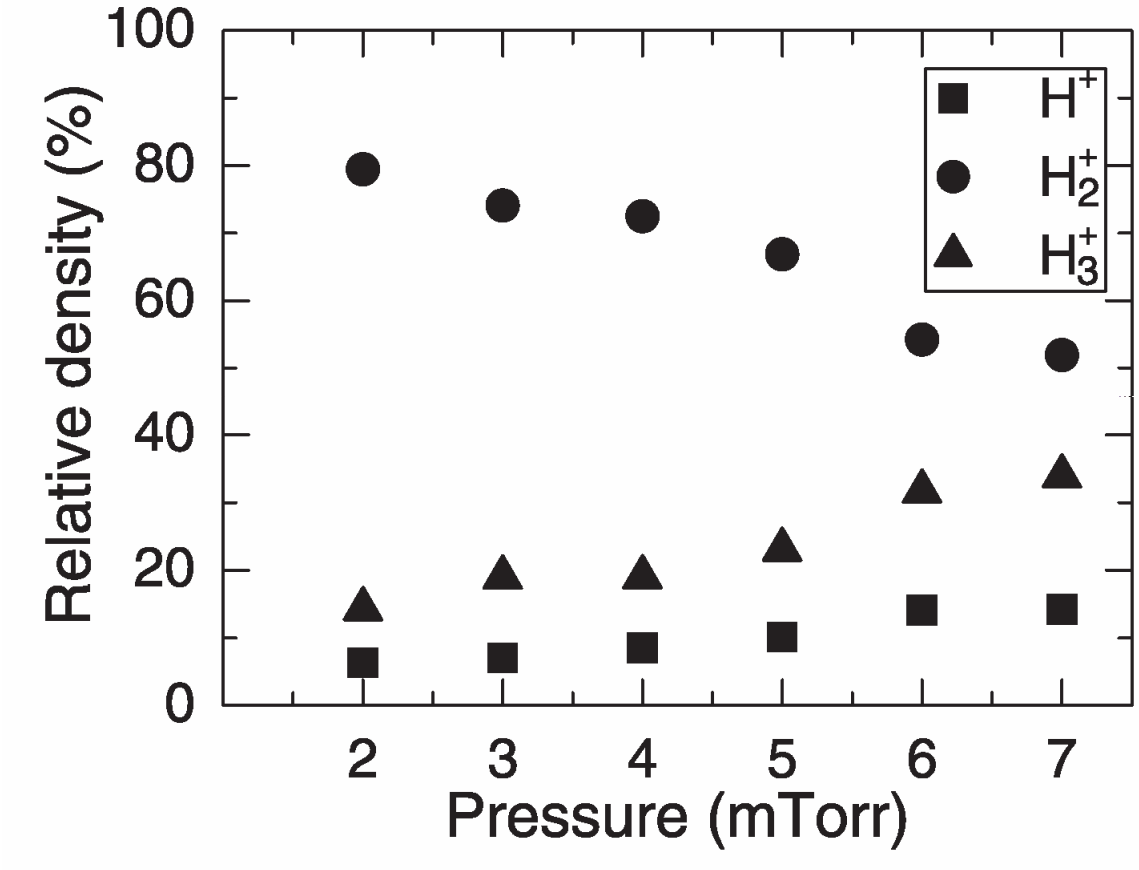
DOPPLER SPECTROSCOPY ON IEC DISCHARGES

The relative intensities of the peaks change with pressure, which indicates a change in relative densities of the parent ions.



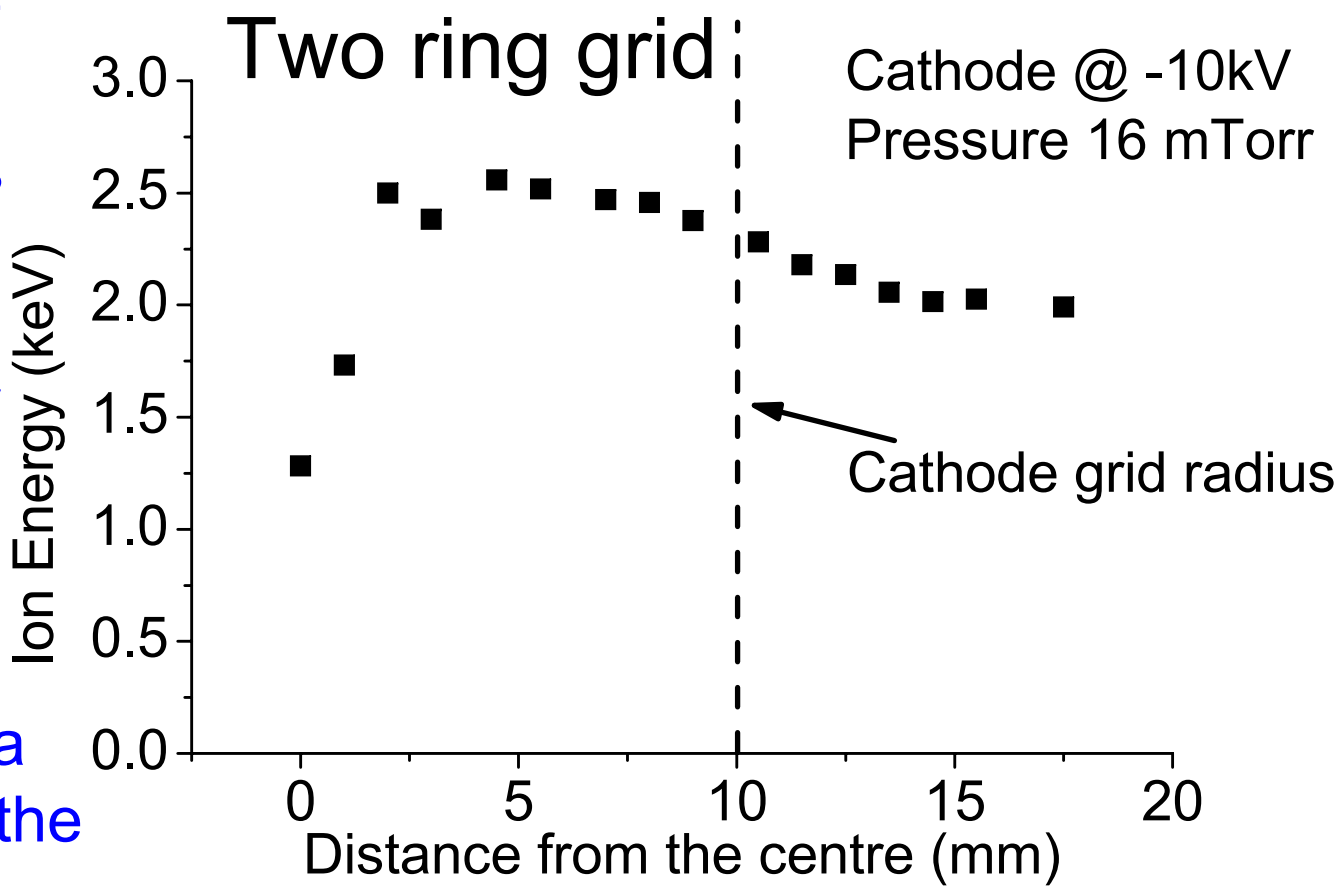
RELATIVE DENSITIES OF IONIC HYDROGEN SPECIES

From the Doppler spectrum we see that the discharge is dominated by H_2^+ at the lower pressures up to 2 mTorr.



ION ENERGY FROM DOPPLER SPECTA

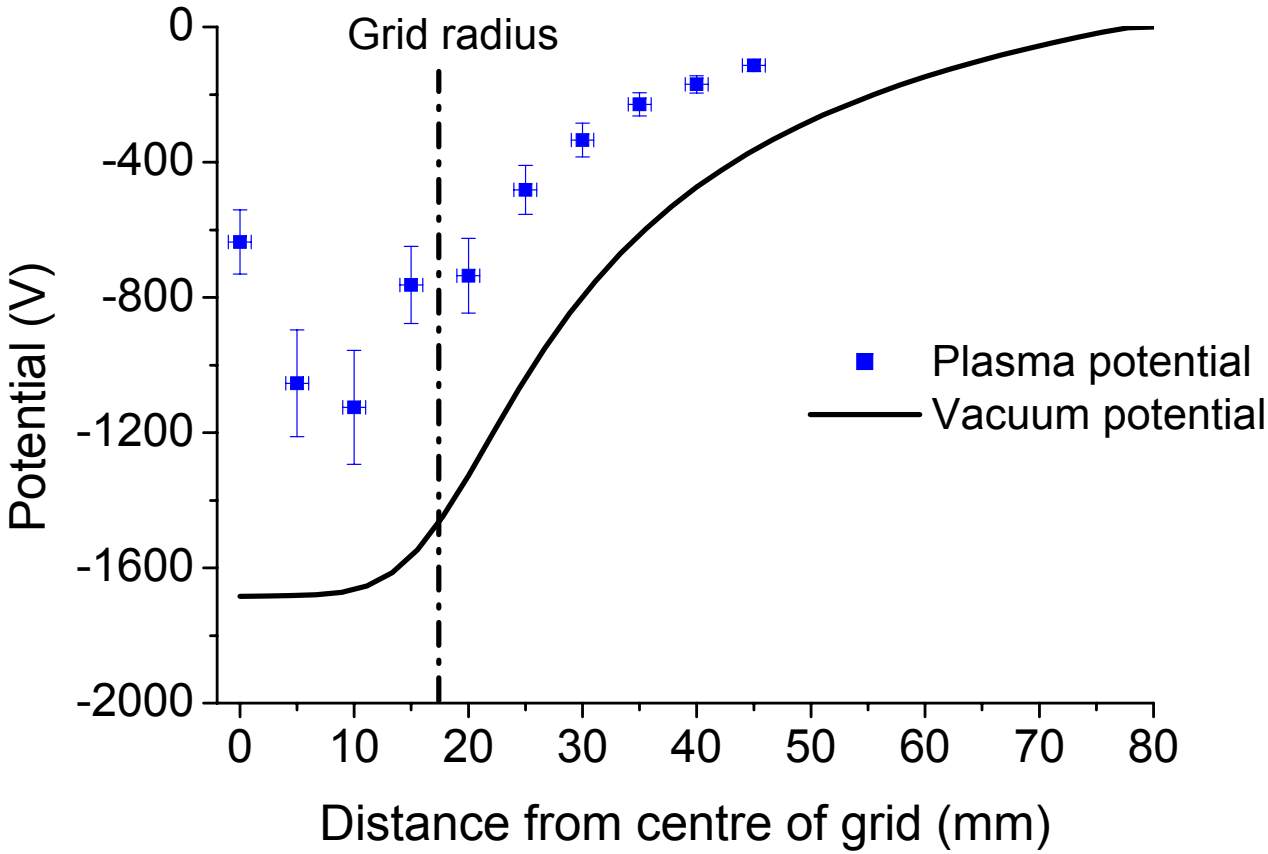
Kinetic energy of a large fraction of ions increases from the grid center and **neutrals appear to move outwards**.



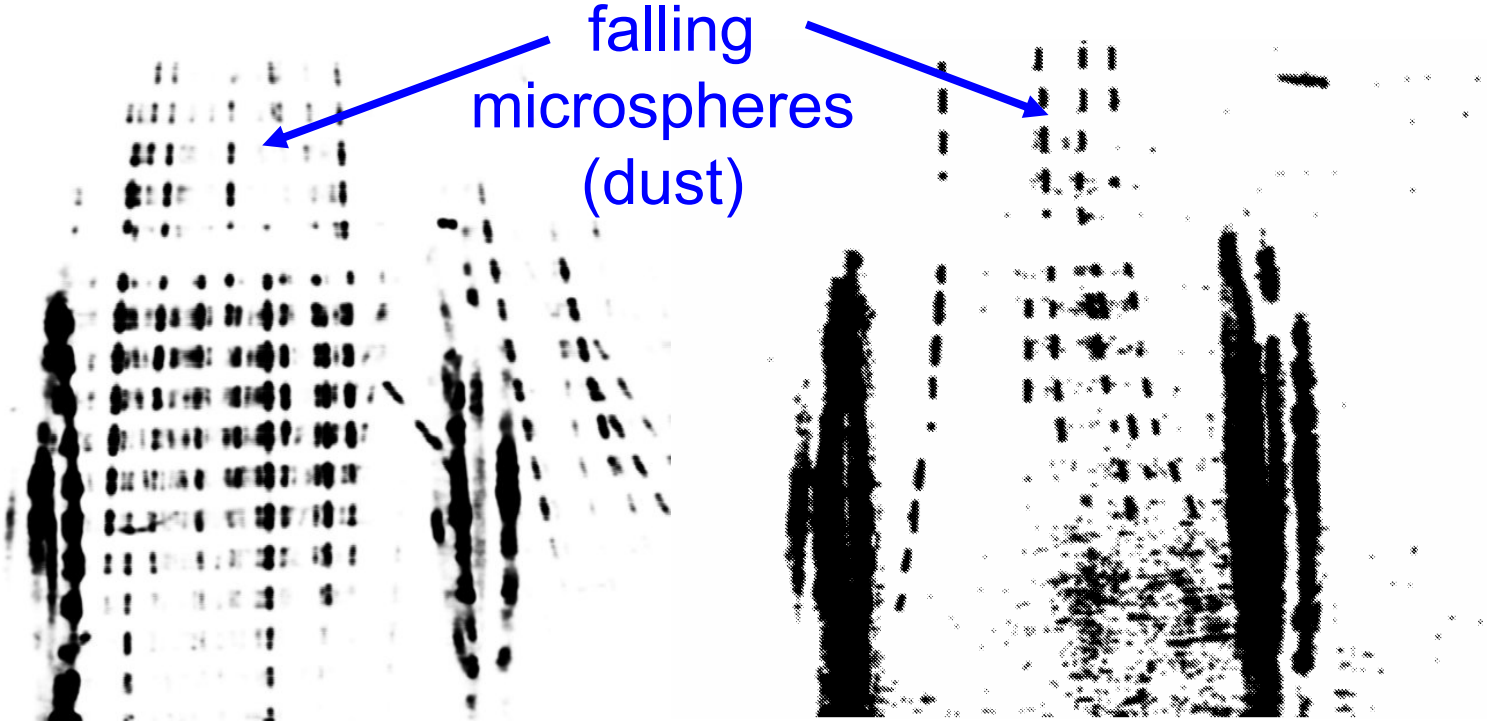
Possibly due to a virtual anode at the center from converging ions.

LANGMUIR PROBE MEASUREMENT OF PLASMA POTENTIAL

Plasma potential rises at the center indicating a possible virtual anode.



DUSTY PLASMA DIAGNOSTICS

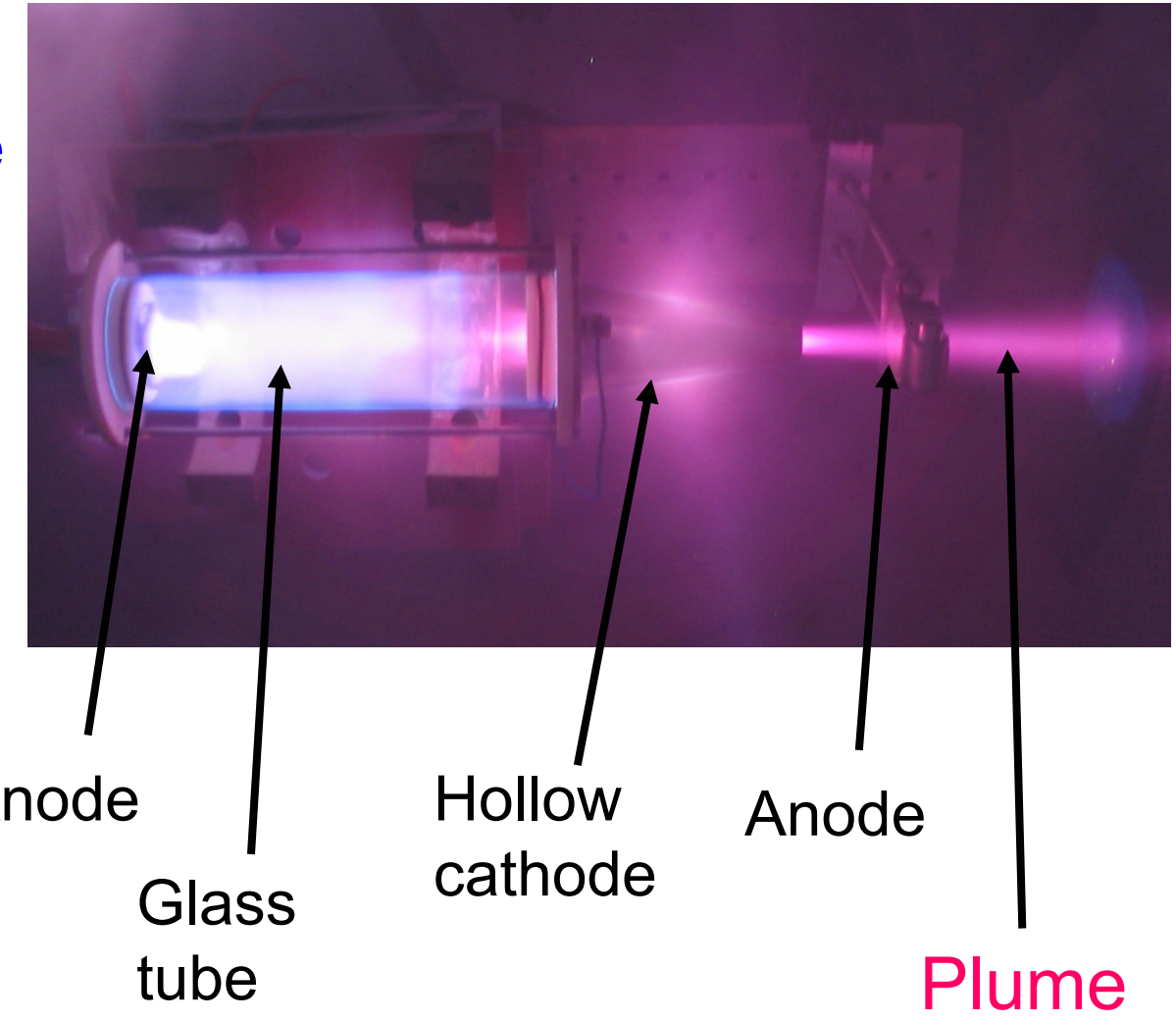


No discharge – no dust deflection

IEC Discharge results in dust deflection away from the center due to momentum from ion flux. Predicts ion density ~ **$10^8 – 10^9$ cm^{-3}**

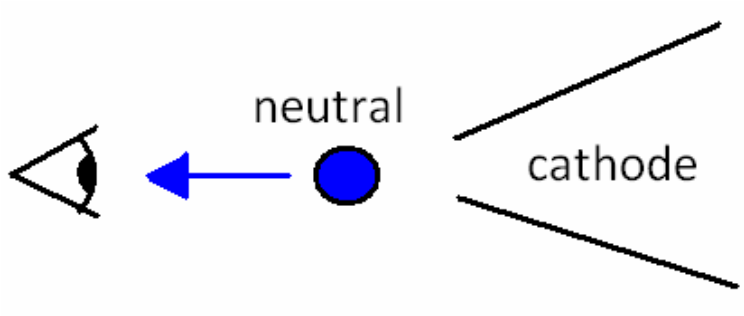
MICROCHANNEL USED FOR ELECTRIC PROPULSION OF SPACE-CRAFT

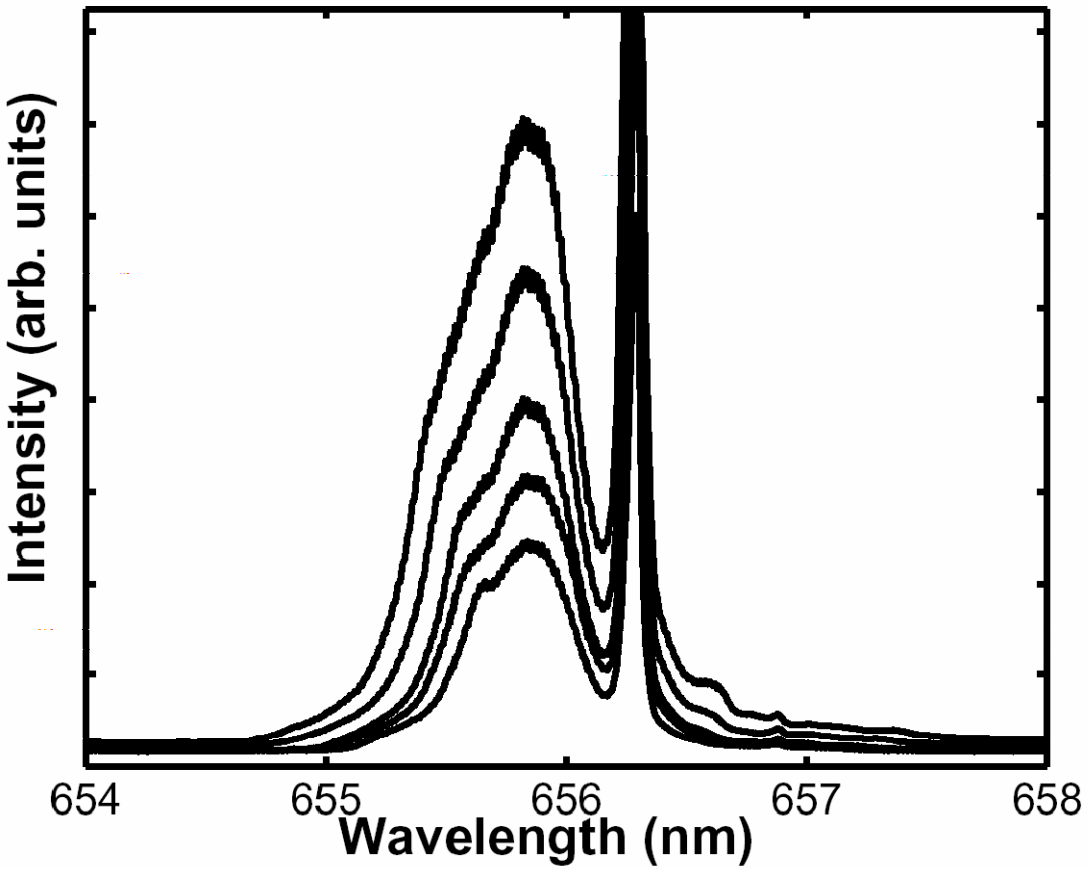
The exiting neutrals from the cathode were applied to producing a thruster for electric propulsion of space-craft.



DOPPLER SPECTRUM OF THURSTER PLUME

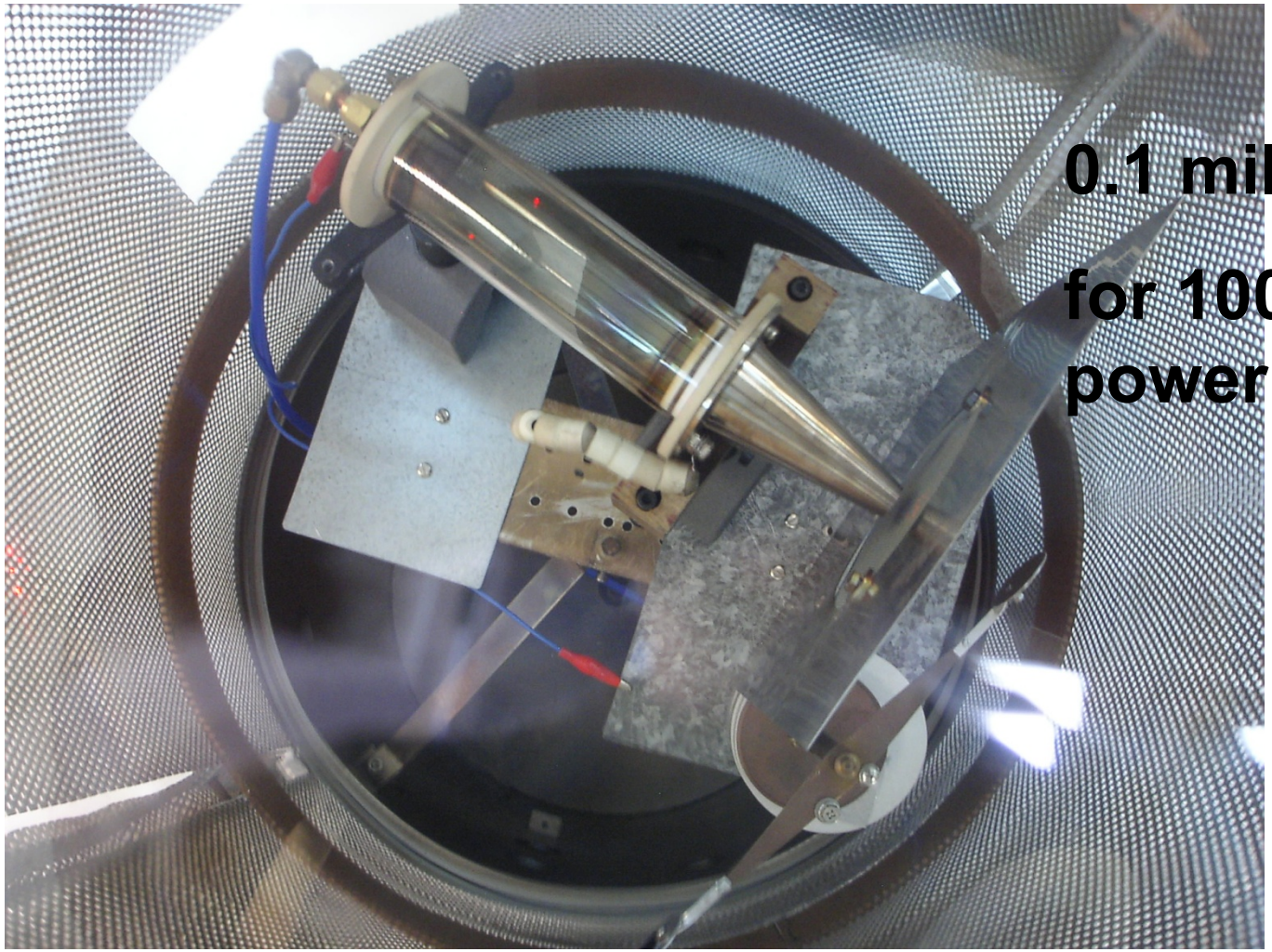
The blue shifted Doppler spectrum from the plume indicates that there is a collimated beam of high energy neutrals traveling out of the cathode, which can provide thrust.





Doppler spectra with increasing voltage from -4kV to -7kV

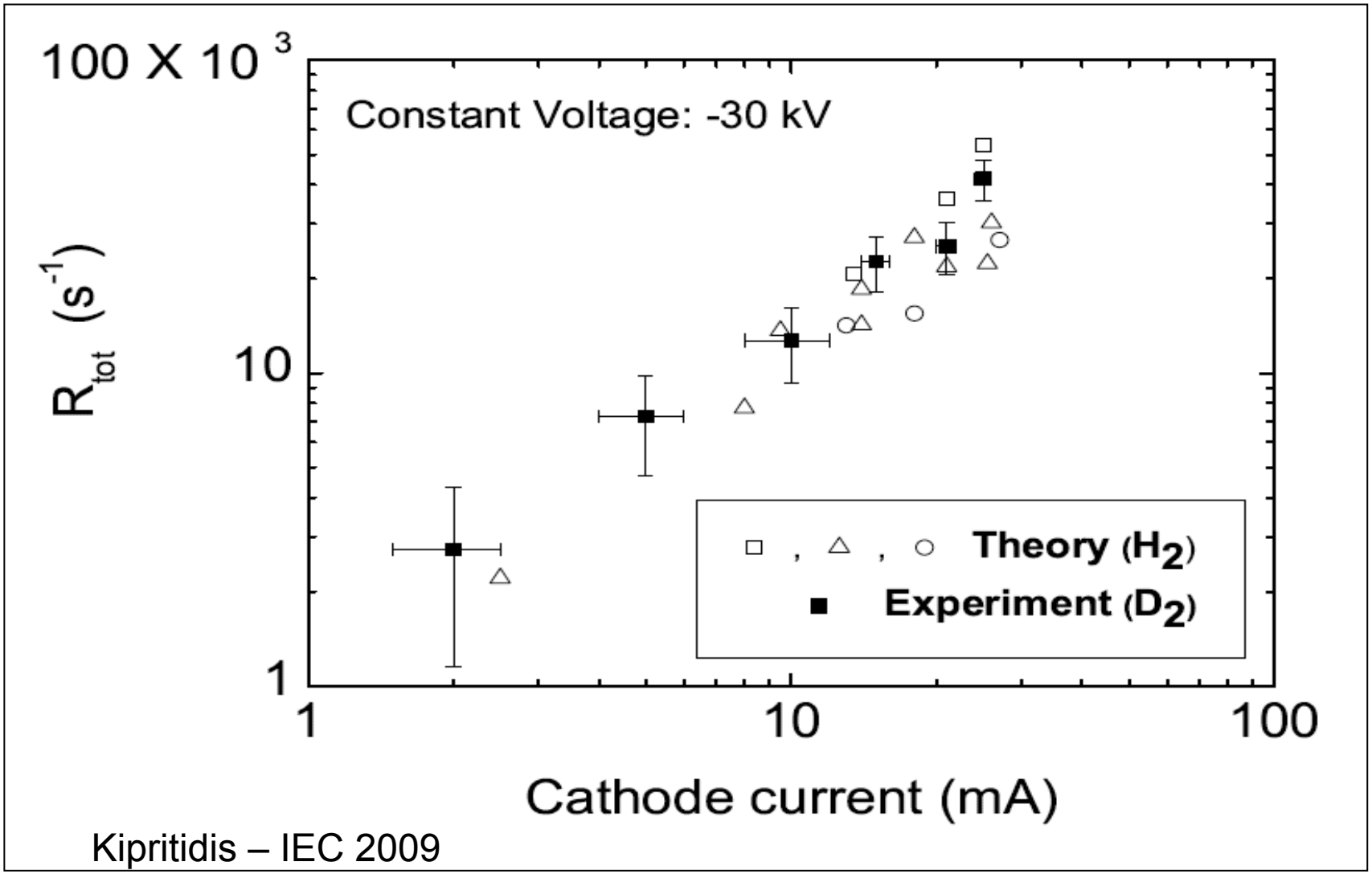
MEASUREMENT OF THRUST



0.1 millinewton

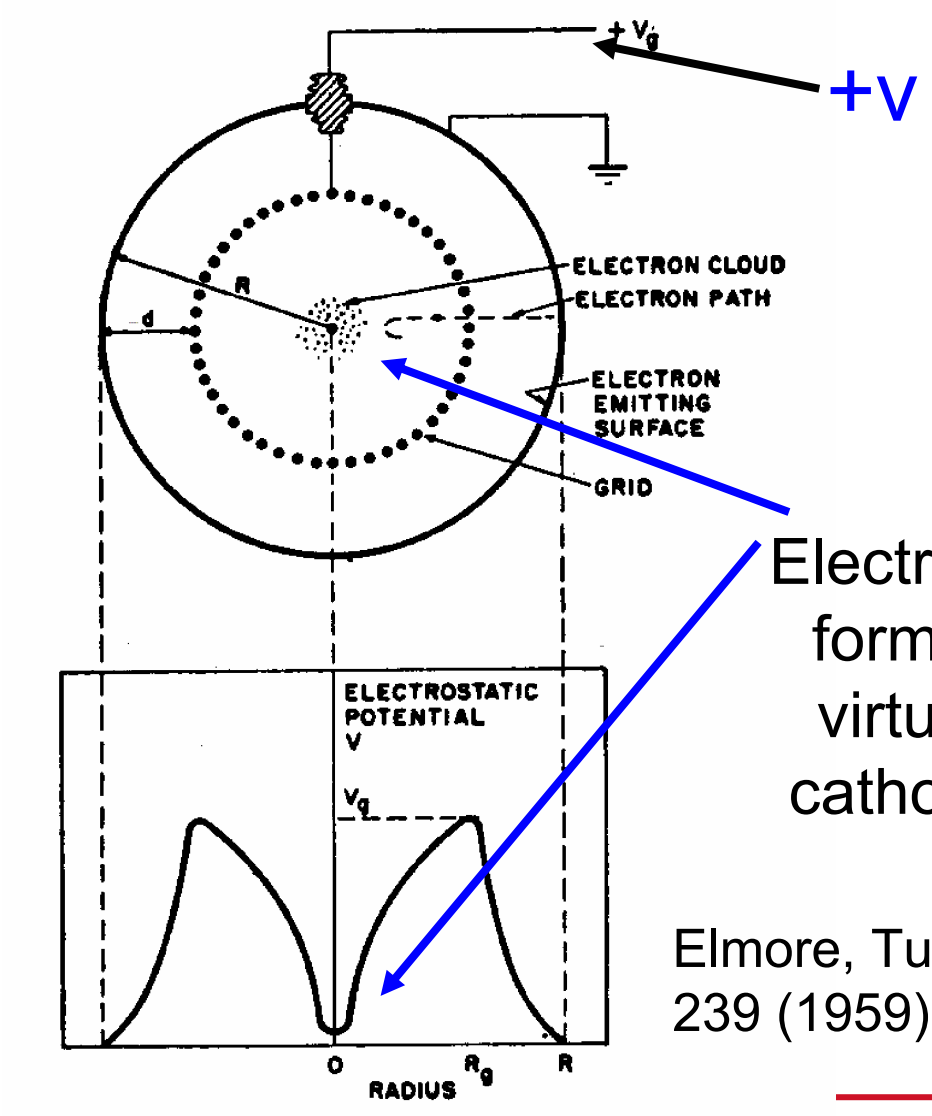
for 100 Watts of power

SPECTROSCOPY USED TO SUCCESSFULLY PREDICT NEUTRON COUNT RATES



Kipritidis – IEC 2009

REVERSE POLARITY IEC



Experiment proposed by Elmore, Tuck and Watson. Apply positive voltage to the inner grid to produce a virtual cathode from the convergent electron focus.

Electrons form a virtual cathode

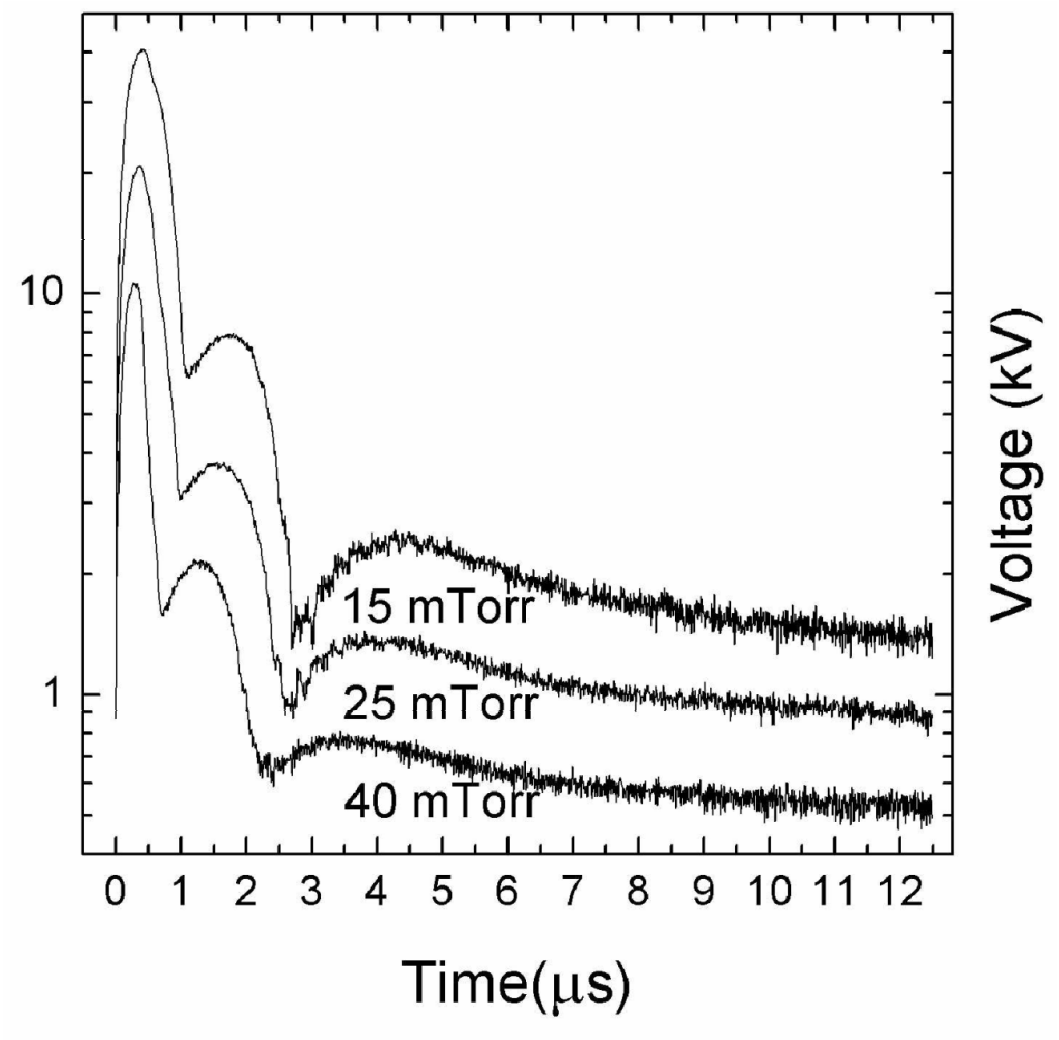
Elmore, Tuck and Watson, Phys. Fluids, **2,** 239 (1959)

REVERSE POLARITY IEC

Discharge is contained mostly within the anode during a high voltage pulse.

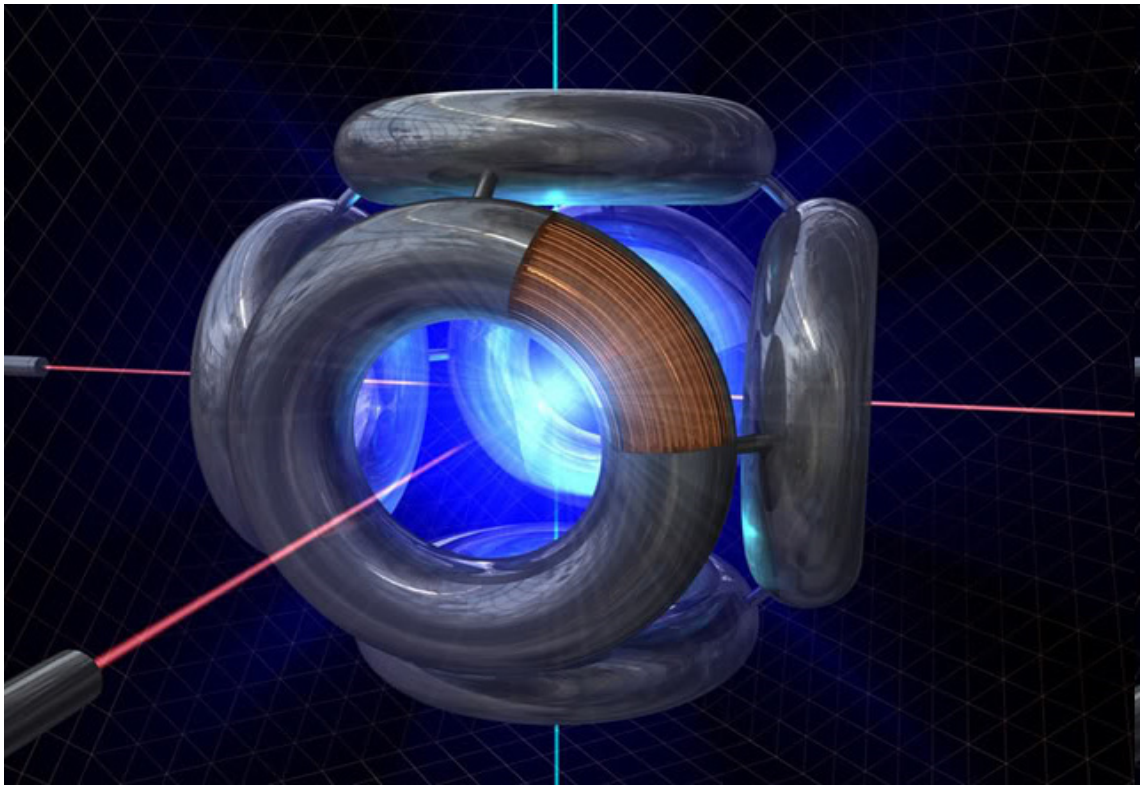
The color of the discharge is white indicating high energy and density electrons.

REVERSE POLARITY IEC



The voltage on the anode oscillates due to periodically oscillating ions – similar to the periodically oscillating plasma sphere (POPS) proposed by Rick Nebel's group at Los Alamos.

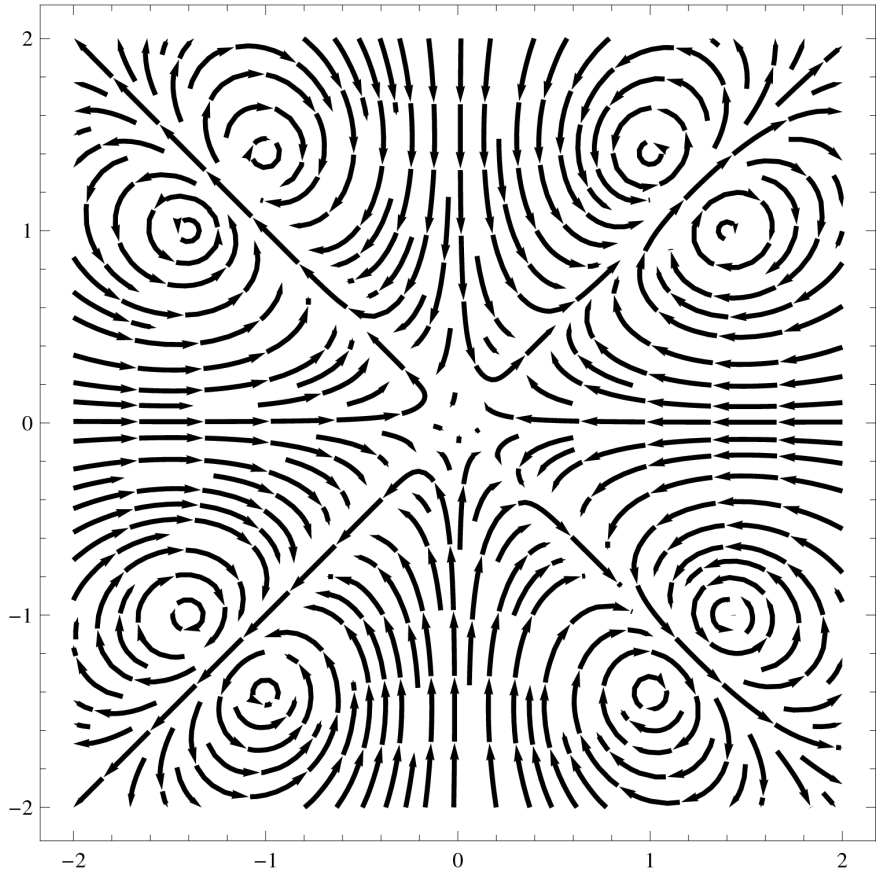
THE POLYWELL



Three dimensional magnetic cusps to trap electron at the center resulting in a deep potential well

Graphic form http://www.talk-polywell.org

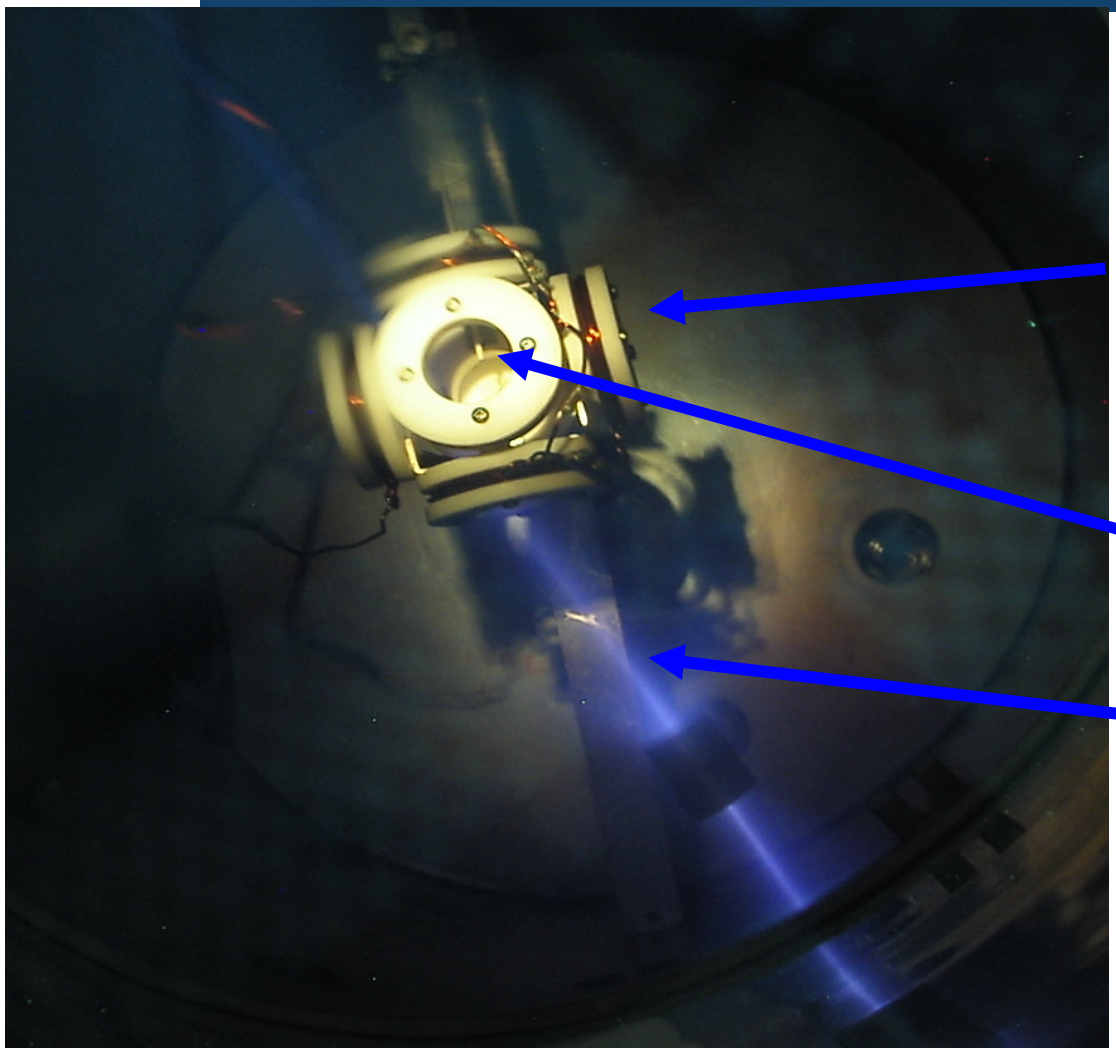
THE POLYWELL



The magnetic field lines on a plane within the Polywell.

Both experimental and theoretical work is being carried out .

THE POLYWELL

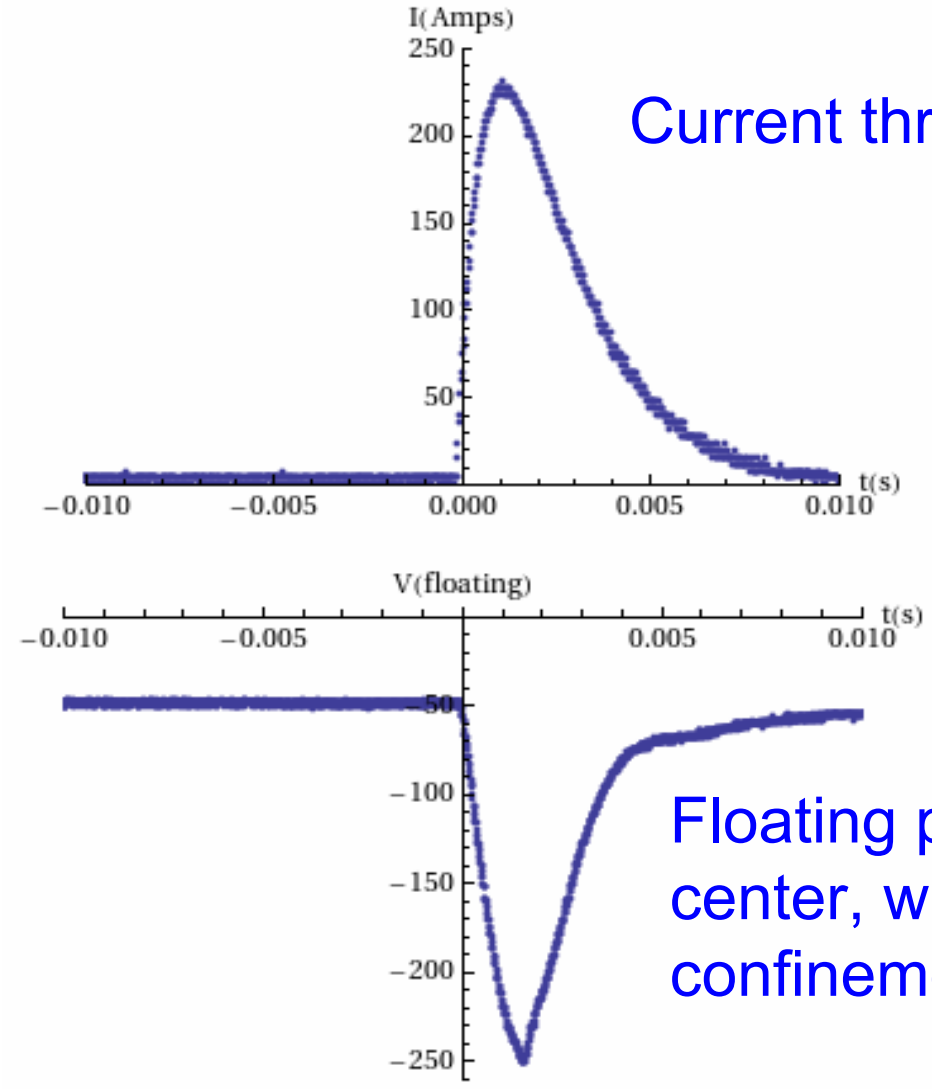


Our Polywell arrangement.

Langmuir probe

Electron beam

THE POLYWELL



Current through coils

Floating potential from probe at the center, which is due to electron confinement within the Polywell.

MANY THANKS GO TO THE RESEARCH STUDENTS WHO HAVE MADE CONTRIBUTIONS TO IEC AT SYDNEY UNI OVER THE LAST 10 YEARS

Andrew Allen

Henry Bilinsky

Lachlan Blackhall

Matthew Carr

Scott Collis

Scott Cornish

Alex Davidson

Nick Evans

Michael Fitzgerald

Kristie Foulkes

David Gummersall

Adam Israel

John Kipritidis

Daniel Moore

Peter Moore

Oded Shrier

Krishna Siveraman

Collin Tuft