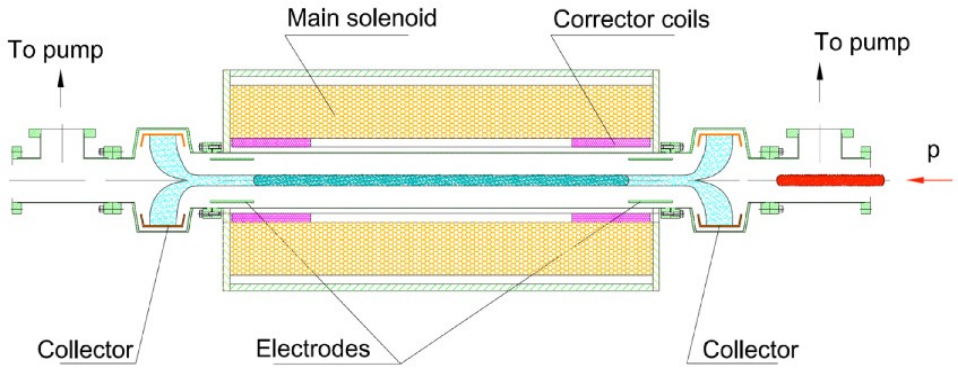
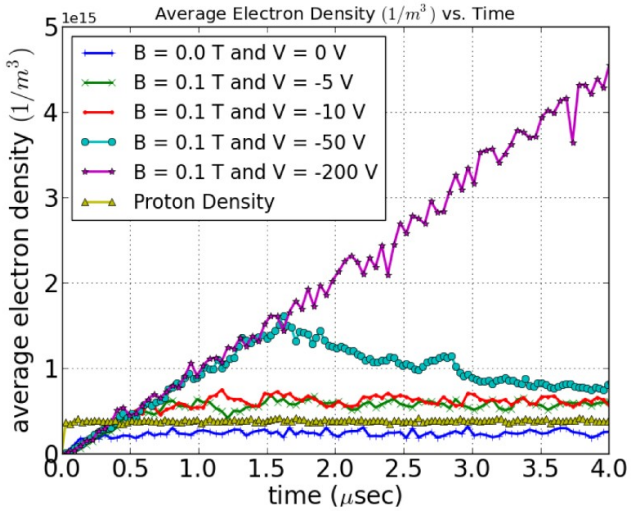
Past Results

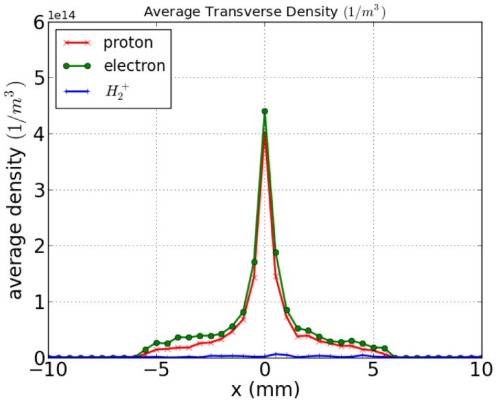
C.S. Park, et al, NAPAC'16



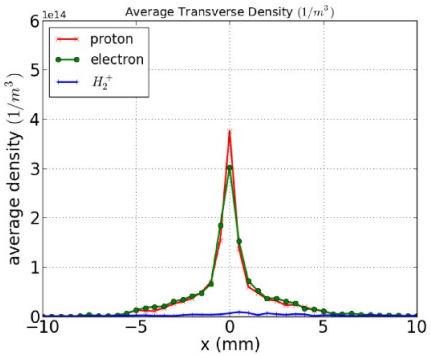
	Value	Unit
Beam current (avg.)	8	mA
Beam size (RMS)	5.5	mm
Column length	1	m
Solenoid field	0 – 0.2	T
Electrode voltage	-200 – 0	V
Gas pressure	10^{-5} – 10^{-3}	torr



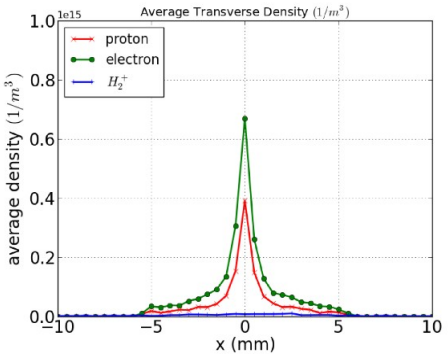
- Electron density evolution as function of B & V studied (left)
- Transverse particle density as function of B & V at 10^{-3} torr (bottom)
- Matched transverse densities at 0.1 T, -5 V & 5×10^{-4} torr (right)



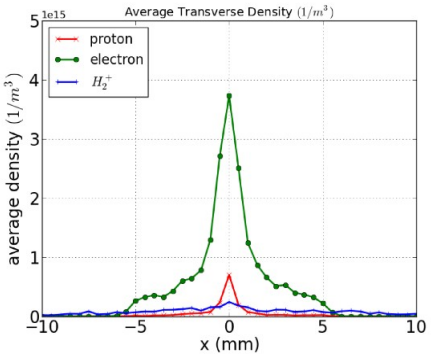
(a) Transverse density profile



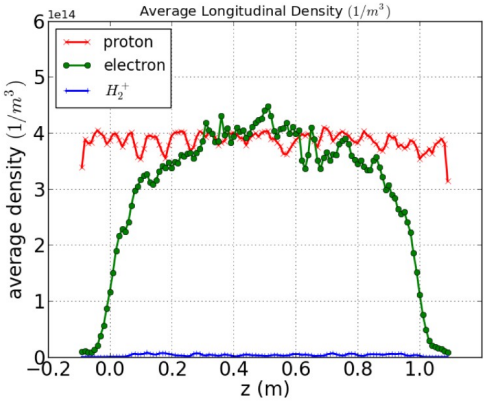
(a) $B = 0.0\ T$ and $V = 0.0\ V$



(b) $B = 0.1\ T$ and $V = -5.0\ V$



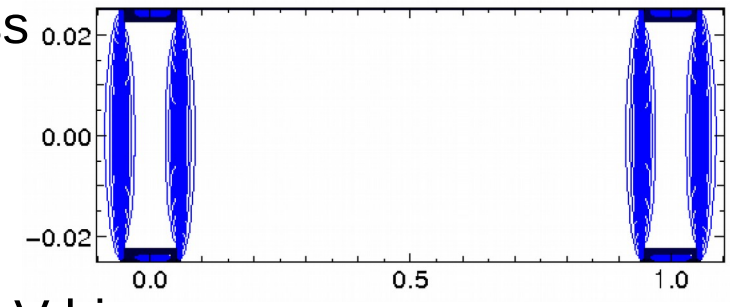
(c) $B = 0.1\ T$ and $V = -200.0\ V$



(b) Longitudinal density profile

Simulation Parameters

- 2.5 MeV protons
- 8 mA beam current – constant injection, single pass
- 1 m column length
- 5 cm diameter beampipe



- Electrodes 10 cm long and 4.5 cm in diameter, -10 V bias
- 0.1 T solenoidal magnetic field
- Grid spacing 0.5 mm in x and y, 1 mm in z
- 100 macroparticles injected every time step (7,500 real particles per macroparticle)
- Time step 15 psec (357 ps cyclotron period, 35.2 ps plasma period (10^{19} m^{-3} cold electrons), 22.8 ps proton grid travel time)
- 450 ns (30,000 time steps)
- 1.0 cm initial horizontal and vertical beam width, 5.5 mm source radius

Plasma Parameters

- Hydrogen gas density 3.54×10^{19} m^{-3} (1.08×10^{-3} torr @ 293 K)
- Plasma processes included:
  - Single ionization of hydrogen by protons $p + H_2 \rightarrow p + H_2^+ + e^-$
  - Single ionization of hydrogen by electrons $e^- + H_2 \rightarrow 2e^- + H_2^+$
- Max. kinetic energy of ionization electrons 5.4 keV
- Plasma processes **<u>not</u>** included:
  - Formation of hydrogen clusters $H_2^+ + H_2 \rightarrow H_3^+ + H$ $H_n^+ + H_2 + H_2 \rightarrow H_{n+2}^+ + H_2$
  - Recombination of electrons and hydrogen ions $e^- + H_n^+ \rightarrow neutrals$
  - Double ionization of hydrogen
  - Dissociative ionization of hydrogen
- Proton on hydrogen cross section 1.5×10^{-21} m^2
- Electron on hydrogen cross section 1.3×10^{-20} m^2
- Ionization products have specified energy

Pulsed Beam

- Same parameters as before (450 ns simulation length)
  - But turn off beam after 100 ns