

Plasma focus as an Ion Beam Source

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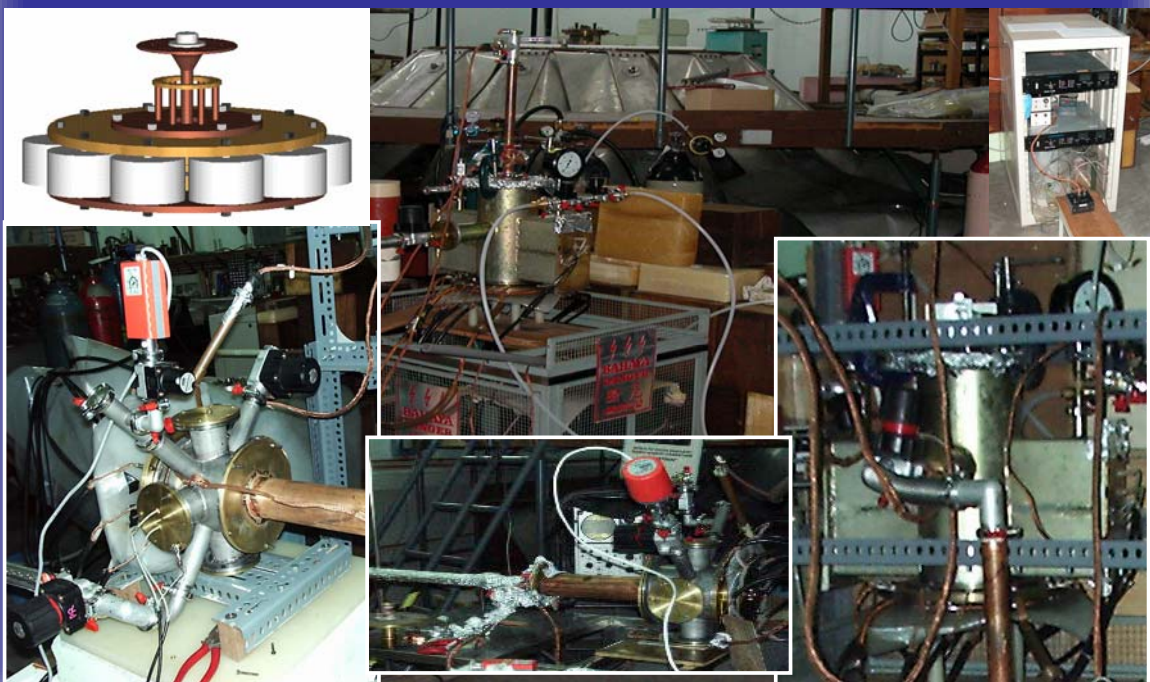
Plasma Focus Ion Beam Source

Our plasma focus devices
Ion beam measurements (Deuterium, Nitrogen, Argon)
Results and Summary

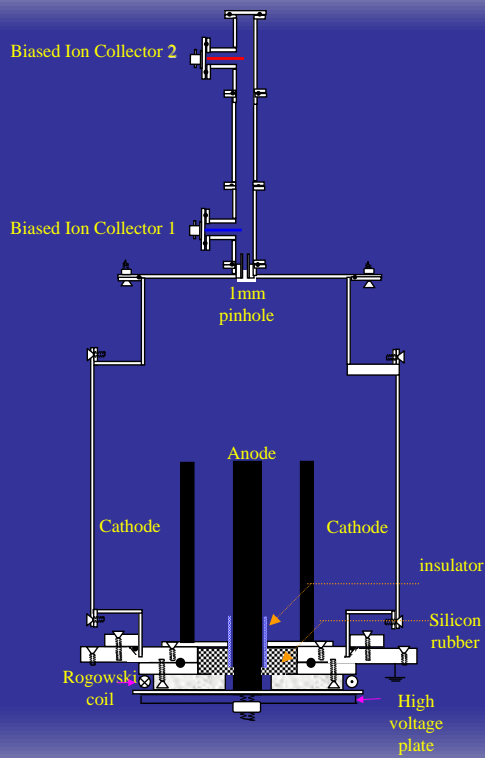


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Plasma Focus Devices (6 J – 3.3 kJ)



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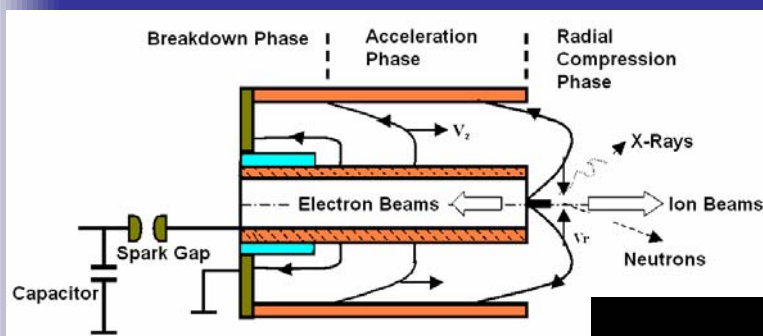
Operating Parameters

- Energy : ~ 3.3 kJ
- Bank capacitance : 30 μ F
- Charging Voltage : 15 kV
- Gas : Deuterium, Nitrogen, Argon
- Anode Diameter : 19mm
- Cathode Diameter : 64mm
- Maximum Current : 150 kA



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Three Phases of Plasma Focus Discharge



STOP



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OPERATION OF THE PLASMA FOCUS FOR ION BEAM GENERATION

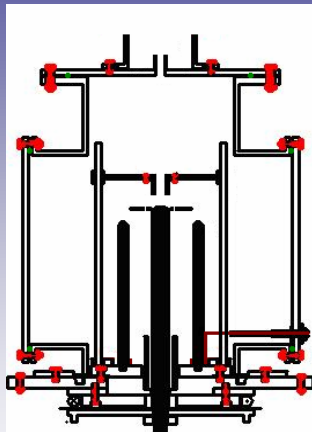
1. Discharge Energy
2. Working Gas and Pressure
3. Focusing or Non Focusing Mode
4. Electrodes Length



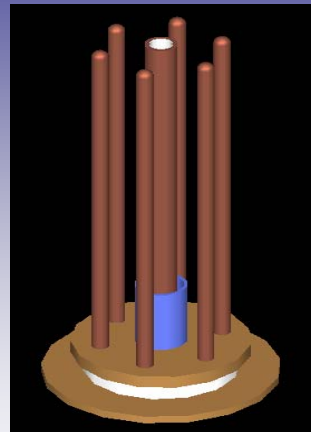
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Configuration of Electrodes

Non Focusing Mode and Focusing Mode



22cm

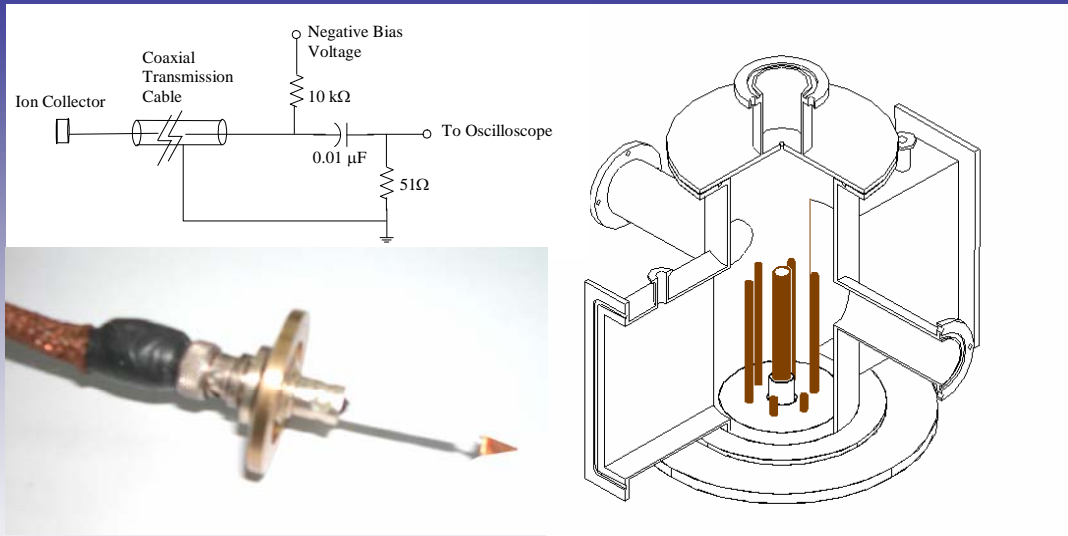


27cm

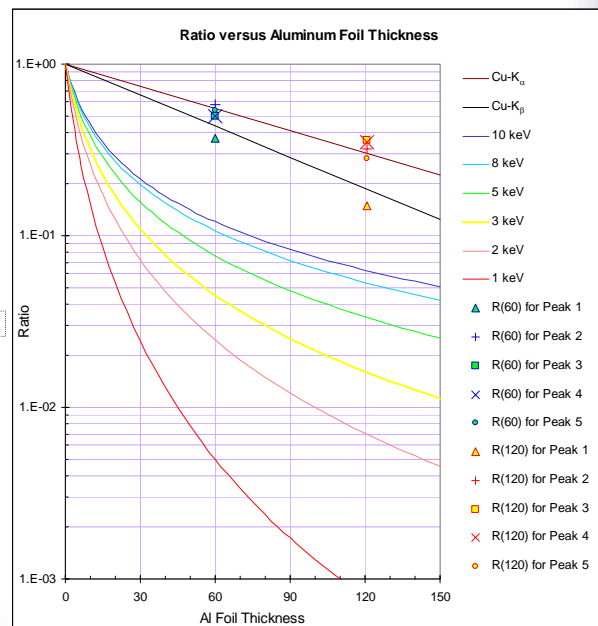
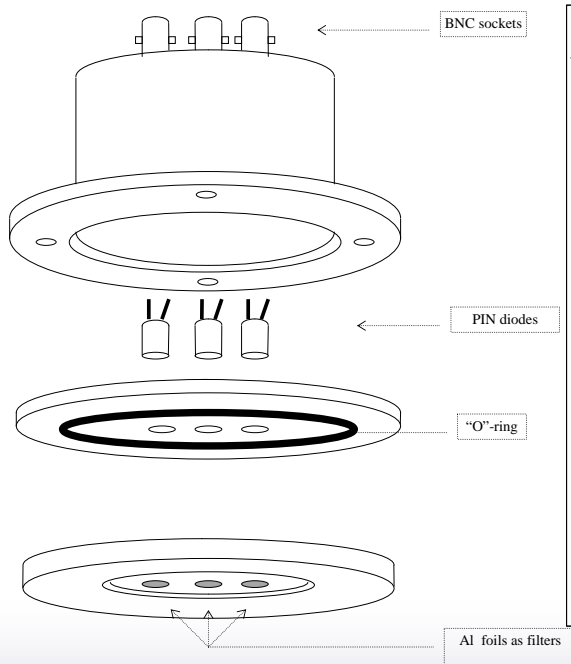


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The Biased Ion Collector

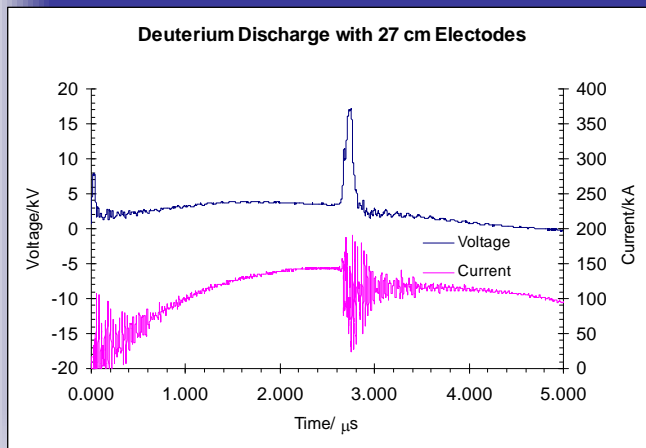


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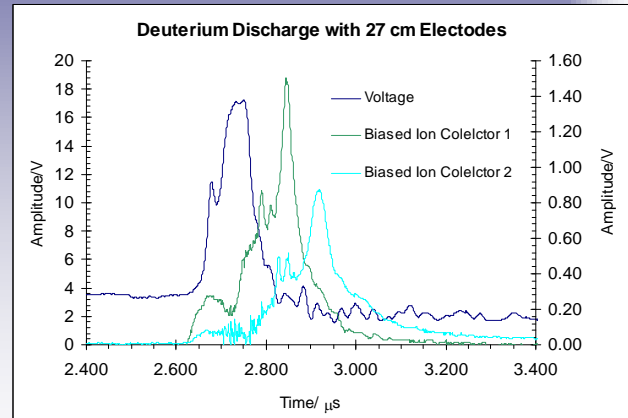


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Deuterium Plasma

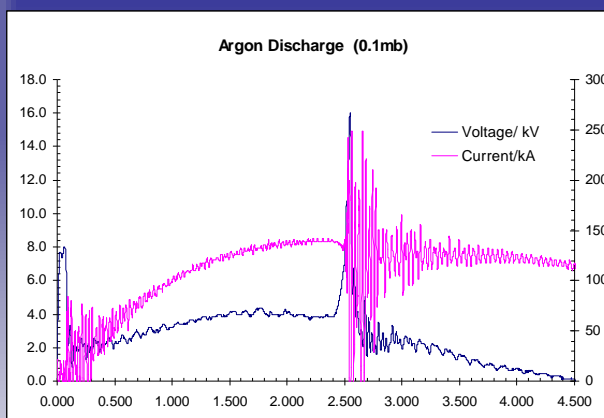


Optimum Pressure : 0.1-0.7 mbar

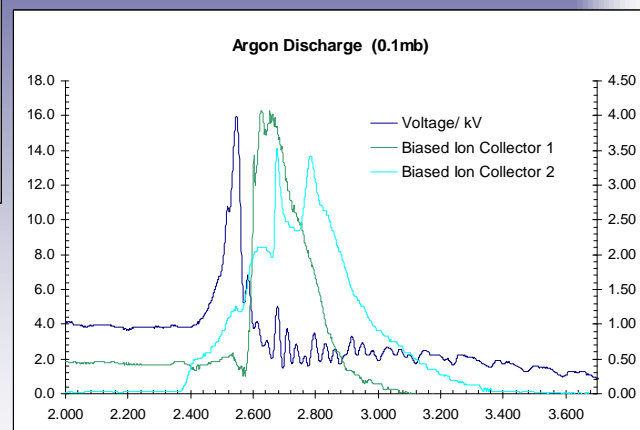


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Argon Plasma

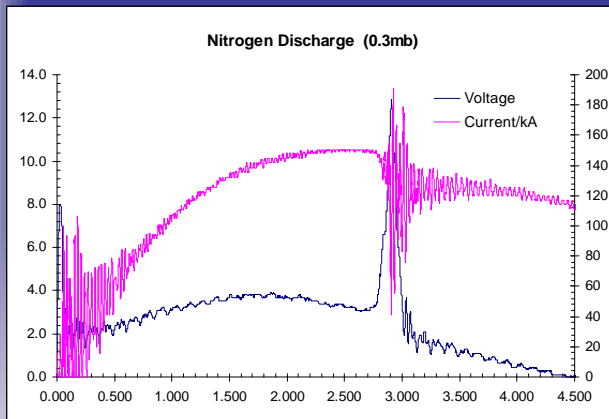


Optimum Pressure :
0.05 – 0.3 mbar

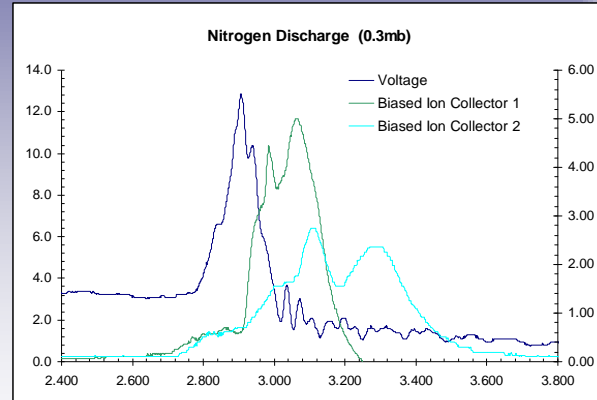


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Nitrogen Plasma

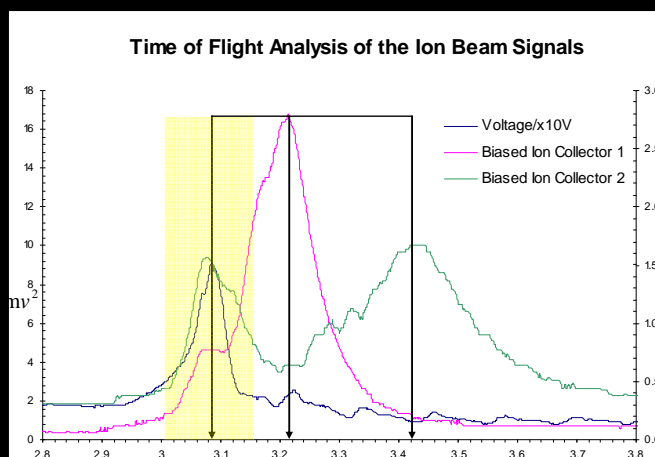


Optimum Pressure :
0.05 – 0.6 mbar



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Time of flight measurements



Pulses shadowed in the yellow box are measured at the same time by the two biased ion collector. Thus this group of pulses are due to be the photoemission

Following pulses are registered after a period of time from the voltage spike, and they are measured by the two biased ion collectors with a time difference.

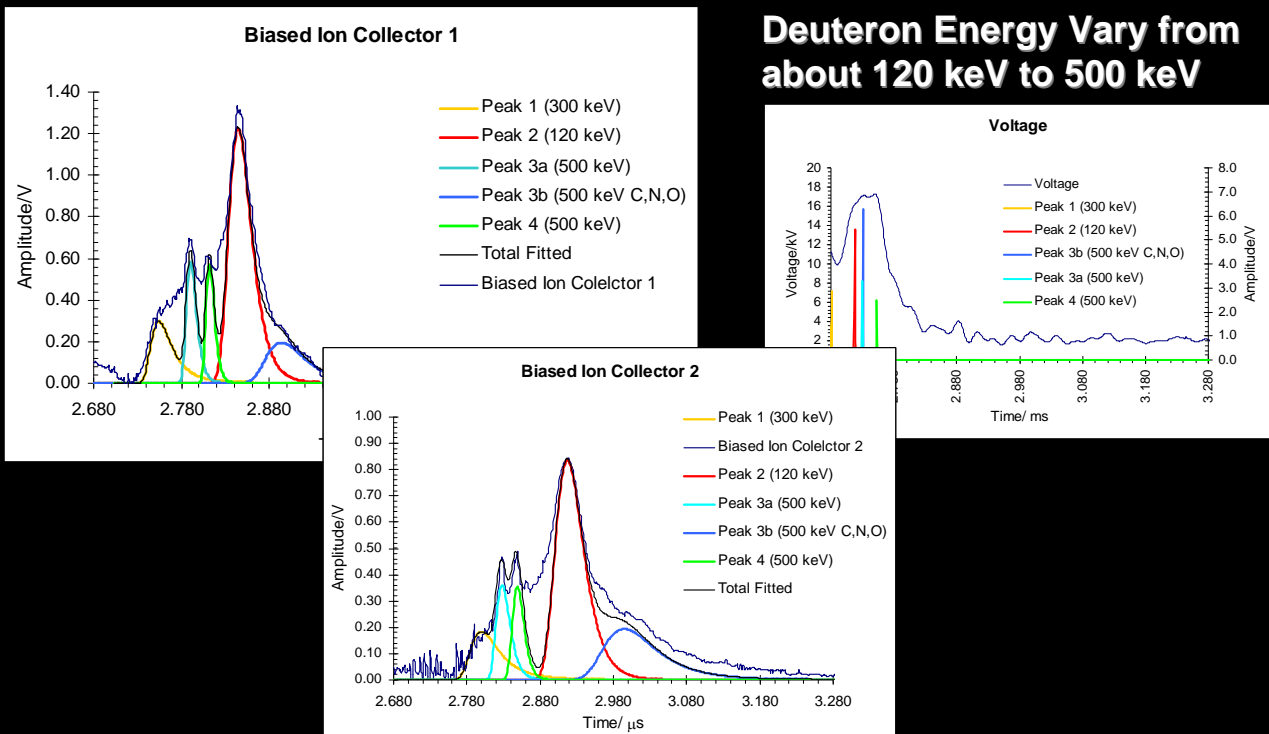
The time of flight is used to calculate the deuteron energy, based on the kinetic expression :

$$E = \frac{1}{2}mv^2$$



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Time of flight + Curve fitting



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Ion Beam Characteristic For Focusing Mode

Ion Beam Energy : 20keV – 2 MeV

- Higher energy ion beam may not be able to resolved with the current TOF method.

Purity of Ion Beam : About 40%-50%

- Impurities originate partly from the residual gas in the vacuum system.
- Absorbed molecules on the electrodes and the metallic ions evaporated from the electrodes surface.
- Background gas molecules



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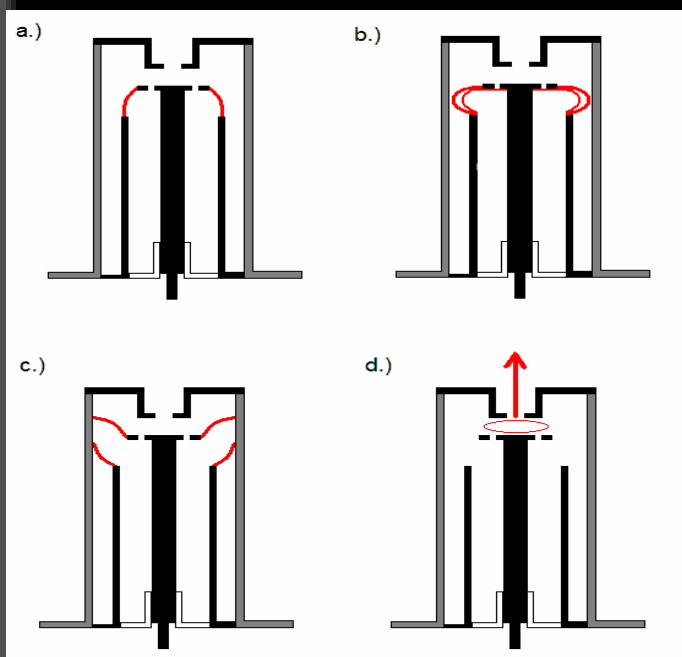
SUMMARY OF THE FOCUSING MODE OPERATION

Operating gas	Deuterium	Nitrogen	Argon
Operation Pressure/ mbar	0.1-1	0.05-0.6	0.05-0.3
Average Ion Energy (TOF)	200 keV	1.5 MeV	2 MeV
Possible Component	D ⁺	N ⁺ - N ⁸⁺	Ar ⁺ - Ar ¹⁰⁺



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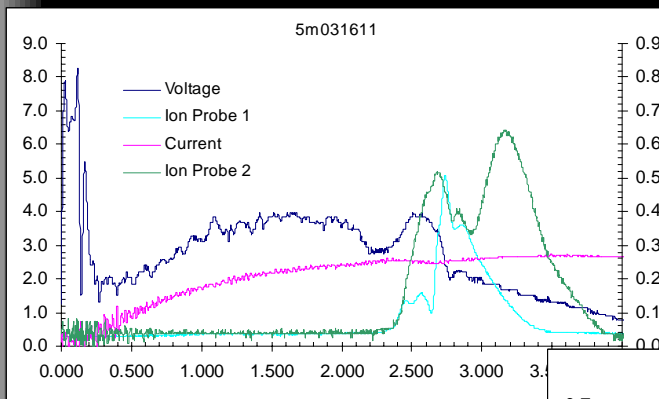
Non Focusing Mode Operation



In this mode of operation, the final phase of the plasma focus that is the pinch phase is prevented by the stopper at the end of the anode. A series of opening on the stopper act as the apertures to allow the plasma to fill the diode region.

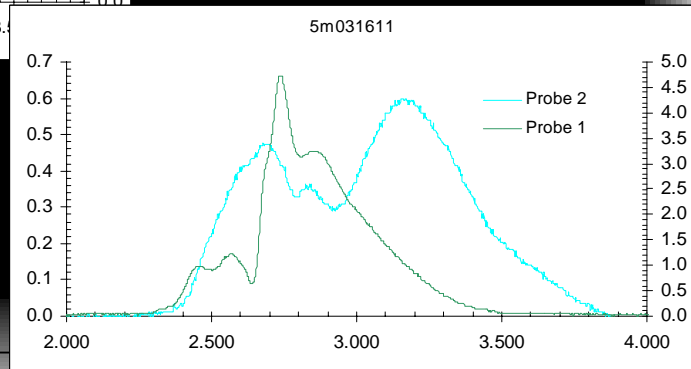
Sudden increase in the plasma resistivity occurs during the outward expansion of the current sheath. Ion beam is extracted from the plasma due to the transient high electric field induced by the opening switch.

Non-Normal Focusing Mode



Time of emission of ions range from 2.308 μ s to 2.645 μ s

Ion energy range from few keV to 350keV



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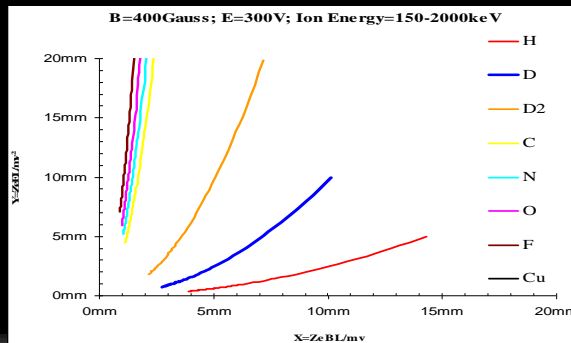
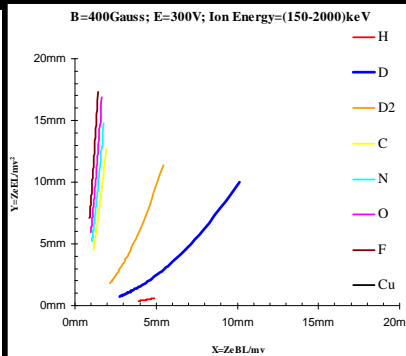
SUMMARY OF NON FOCUSING MODE OPERATION

Operating gas	Deuterium	Nitrogen	Argon
Operation Pressure/ mbar	10^{-1} to 10^{-3}	10^{-3}	10^{-3}
Average Ion Energy (TOF)	200 keV	220 keV	280 keV
Possible Component	D ⁺	N ⁺ - N ²⁺	Ar ⁺ - Ar ²⁺



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Ion Analysis with Thomson Parabola Spectrometer



Ion Species and Energy :
D⁺ : 100-2000keV
H⁺ : 800-2000keV
CNOF : 800-2000keV
Cu : Not available



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PLASMA FOCUS AS AN ION BEAM SOURCE

- Ion beam with high intensity up to MeV of energy can be obtained in normal focusing mode.
- Higher energy ion beam present at a relatively lower intensity (<20%).
- High energy beam (Deuteron) can be obtained in non-focusing mode (up to 2MeV).

Ion beam with high purity (-anode material) can be obtain in non-focusing mode.



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Thank You



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