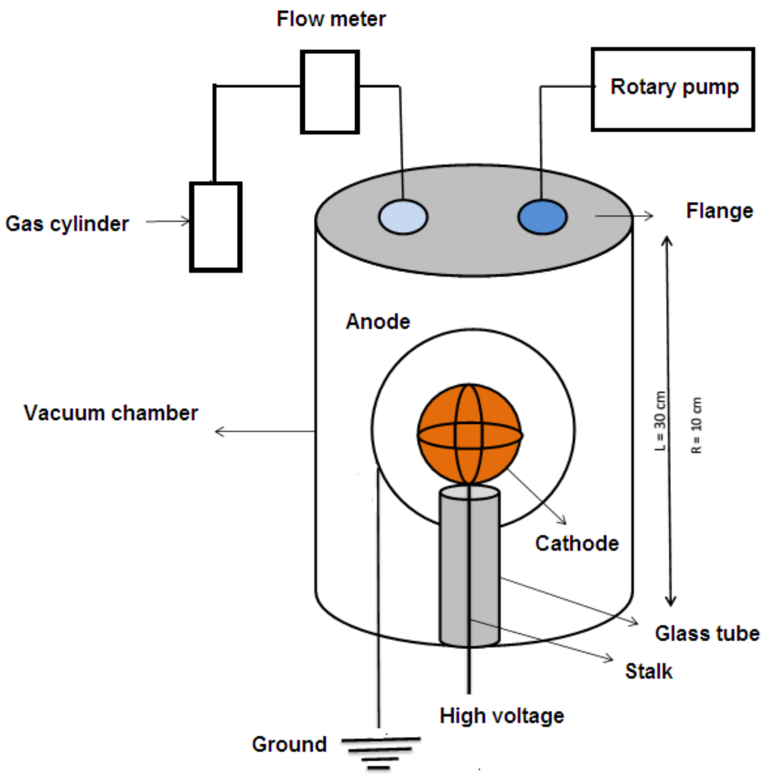
Plasma Diagnostics in the Optical and X-Ray Regions on the IEC Plasma Device

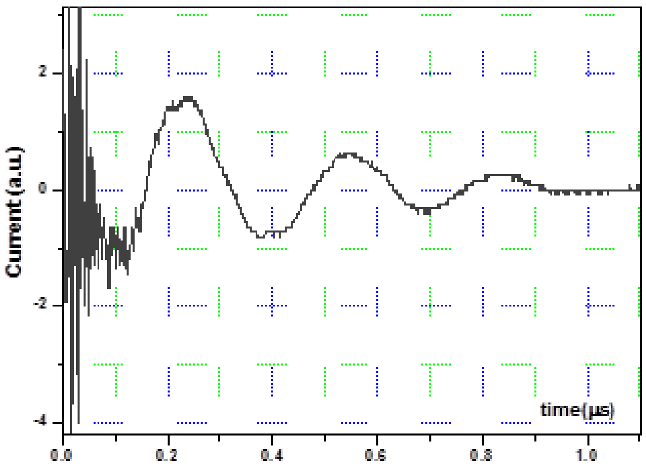
- ***ABSTRACT***
- The design and construction of first Egyptian inertial electrostatic confinement IEC fusion device has been studied [9]. It consists of 2.8 cm stainless steel cathode, 6.5 cm anode diameter with 10 cm diameter 20 cm height vacuum chamber. The operation of IEC experiments has concentrated on pulsed operation to achieve the high currents required to generate increased reactions rates. The discharge voltage waveform with peak voltage 12kV with a full width half maximum (FWHM) of 10 nanoseconds and current pulse waveform has been registered using pick-up coil with peak current about 170mA. Experiments are performed with nitrogen and hydrogen as operating gases at different pressures and voltages. Time resolved of x-ray radiation signals are obtained using fast radiation detector.

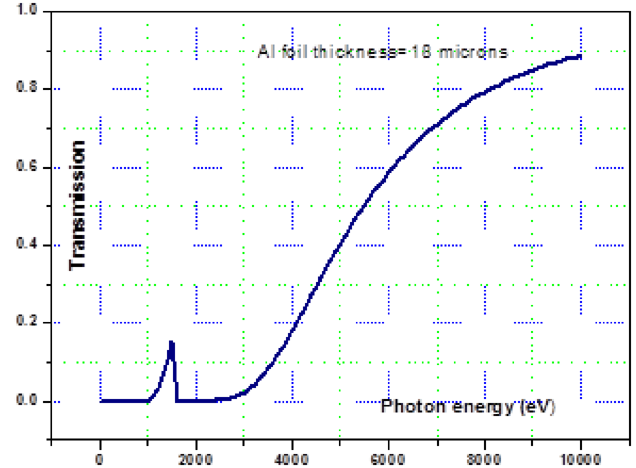
- ***BACKGROUND***
- The IEC concept dates back to the late 60's with the work of Farnsworth and Hirsch [1]. Farnsworth first patented the idea behind IEC [2], and Hirsch built on the work using a strong, negative, electrostatic potential well to promote fusion reactions. Research on IEC is being performed since the 1950's, but only limited in the studies for neutron source application, mainly exists in USA [3], [4] and Japan [5], [6]. Fusion reactions within an IEC device can occur in many different modes: beam-beam, beam-background, beam-target, and fast neutral-background. Beam-beam reactions are due to two accelerated ions fusing with one another. Beam-background reactions are due to an accelerated ion fusing with a background gas molecule. Beam-target reactions occur when ions implant into a solid component such as the cathode; further bombardment by ions can result in fusion reactions within the cathode material. Finally, fast neutral-background reactions occur when an ion charge-exchange with a background gas atom—the resulting fast neutral can then fuse with the background gas. It is important to understand how all of these modes influence the reaction rates both for a better understanding of the physics involved, and for any potential use of the fusion products [7].

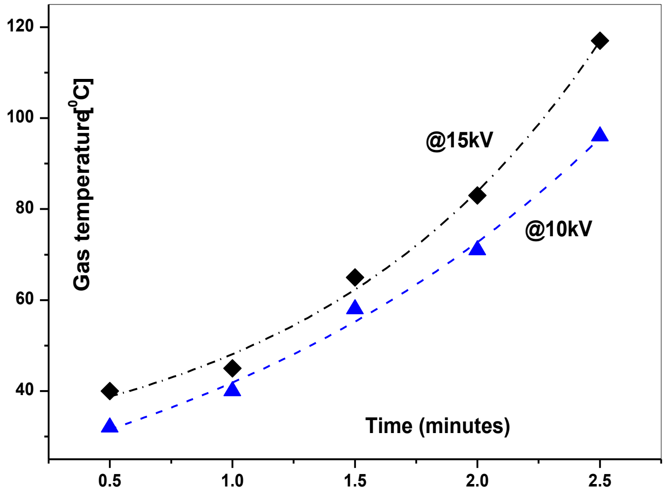
• *EXPERIMENTAL SET-UP*

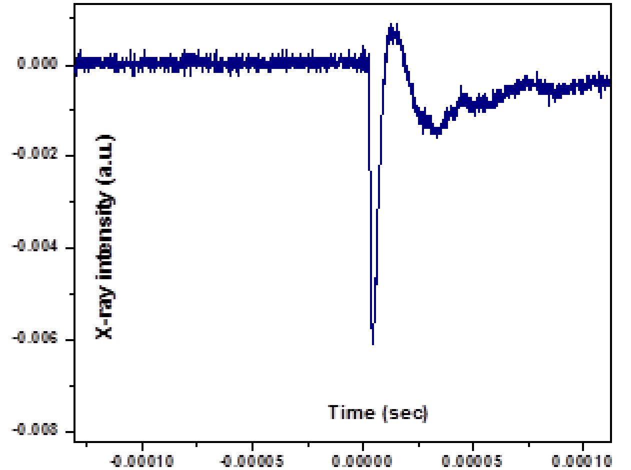
- A schematic of the IEC chamber is shown in Figure 2. A cylindrical glass vacuum vessel measuring 30 cm high and 10 cm in diameter houses the system. The pumping system consists of an Edward rotary vane roughing pump to allow base pressures in the low to mid 0.02 torr range. The base pressure is measured using digital thermocouple gauge. Table 1 shows some parameters of IEC fusion device. A typical grid is shown in Figure 2. The IEC cathode grid was constructed using stainless steel wire of 1 mm in diameter. High voltage insulation is provided using ceramic feed through system that is extended into the center of the chamber and attached to the cathode grid. The outer grid is remains grounded and a high voltage insulator carries the large negative potential to the inner grid. The high voltage power supply has maximum capability of 20 kV.




Current (a.u.)
time(µs)
2
0
-2
-4
0.0
0.2
0.4
0.6
0.8
1.0


Al foil thickness= 18 microns
Transmission
Photon energy (eV)
1.0
0.8
0.6
0.4
0.2
0.0
0
2000
4000
6000
8000
10000


Gas temperature[^{0}C]
@15kV
@10kV
Time (minutes)
120
100
80
60
40
0.5
1.0
1.5
2.0
2.5


X-ray intensity (a.u.)
Time (sec)
0.000
-0.002
-0.004
-0.006
-0.008
-0.00010
-0.00005
0.00000
0.00005
0.00010