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LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA ○ LOS ALAMOS NEW MEXICO

QUARTERLY STATUS REPORT OF THE LASL CONTROLLED THERMONUCLEAR RESEARCH PROGRAM FOR PERIOD ENDING AUGUST 20, 1962

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LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

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All LAMS reports are informal documents, usually prepared for a special purpose. This LAMS report has been prepared, as the title indicates, to present the status of the LASL program for controlled thermonuclear research. It has not been reviewed or verified for accuracy in the interest of prompt distribution. All LAMS reports express the views of the authors as of the time they were written and do not necessarily reflect the opinions of the Los Alamos Scientific Laboratory or the final opinion of the authors on the subject.

PICKET FENCE IIB

Further work on the signals obtained from the "neutron" scintillation detector used with the Picket Fence IIB indicates unexpectedly that hard x-rays produce the dominant signal for magnetic cusped fields $B > 4.5$ kG. In the experiment the signal amplitudes with and without a 1/8-in. Pb absorber in front of the 1/4-in. brass walled detector were compared. For $B < 4$ kG little attenuation was observed in agreement with previous checks with 1/8 in. of Pb at 3.2 and 3.5 kG fields, but for $B > 4.5$ kG the signal was typically reduced by a factor of 10. The latter result requires a definite change in interpretation of the data for $B > 4.5$ kG from "neutron" signals due to energetic confined deuterons to predominantly hard x-rays from confined very energetic electrons.

Tentatively no change in interpretation appears necessary for $B < 4.5$ kG. However, a definitive proof of confined energetic deuterons will require (1) a more complete set of Pb absorption data, (2) a statistical review of the ratio of the moderately small neutron signal to the expected (n,γ) background in this magnetic field range, and (3) a mass and energy analysis of the ions escaping from the cusp regions - previous ion loss measurements at 100 and 300 μsec after injection were based on a simple momentum analysis with D^+ assumed to dominate in the reduction of data -,and (4) an accurate determination of the space charge potential present in the picket fence. The recent data are sufficient to indicate that there is no longer any evidence for burnout or for characteristic ion confinement times of $\tau_{1/e} > 200$ μsec (at B = 4.2 kG).

A movable x-ray detector located near the ring cusp for $B_{max} = 5$ kG shows that the energetic electron flux there is in a narrow ring (< 0.4 cm wide) and falls off rapidly for axial radii > 18 cm. The ring is displaced ~ 015 cm off the median plane toward the exit cusp side. A few x-ray signals have been observed showing ~ 10 μsec modulation (for B ≈ 4.2 kG) which would suggest an asymmetric plasma distribution which rotates.

PICKET FENCE III

The prolonged penetrating radiation previously thought to be neutrons has been found to be x-rays. The identification was made using Al and Pb absorbers.

The x-rays are not produced with the picket fence magnetic field turned off; so either the gun operation is greatly changed by the presence of a small fringing field or some electrons gain energy at the expense of ion energy during the injection or trapping processes. Absorption measurements with Al show that the average x-ray energy is ~ 100 keV with no evidence of a strong low-energy component penetrating a 0.050-in. Cu window. The relative number of energetic electrons within the machine as a function of time has been calculated by an integration of the x-ray signal to be an exponential,within an accuracy of 10%. This exponential decay is a linear function of the confining magnetic field (35 msec at 2.3 kG) and extrapolates to zero confinement at zero field.

The region of the vacuum chamber wall over which the x-rays are produced was studied using x-ray film as a detector. At the far end of the chamber away from the gun the intensity distribution peaks on the chamber axis; the radius of the distribution at half intensity is inversely proportional to the magnetic field strength. In absolute value this radius is what would be expected for a deuteron of 4 keV perpendicular energy. Along the side of the chamber the peak of the distribution is displaced beyond the median plane by several cm; again, the displacement is inversely proportional to the magnetic field. The intensity distribution is skewed and shows that the escaping electrons do not cross the median plane. Further, this result demonstrates once more that the plasma is trapped on the far side of the zero in the magnetic field.

The energy spectrum of the deuterons ejected by the coaxial gun has been measured with no picket fence magnetic field. The most probable ion energy is 7 keV; at both 1.5-2 keV and at 34 keV, dN/dE has dropped to ~ 15% of its peak value.

An energetic-ion detector has been placed inside the confinement volume of the picket fence magnetic field. The detector uses the magnetic field to analyze the particles and accepts only positive charged particles with momenta equivalent to that of > 8 keV deuterons (dependent on the local magnetic field at the detector). An ion density can be calculated from the detector response and preliminary data give ~ 10^9 per cm^3 for particles with momenta equal to that of deuterons > 30 keV. This density is in reasonable agreement with that of 10^{11} per cm^3 for all ions of energy > 1.5 keV and the measured ion energy spectrum. The ion containment time ($1/e \approx 25$ μsec) as measured with the energetic-ion detector is seriously reduced by the presence of the detector but is about that calculated from the detector's cross sectional area, velocity of the particles (assumed to be deuterons), and the confinement volume. These data are tentative until the mass of the particles has been determined.

COAXIAL GUN RESEARCH

No evidence for high energy electrons has been found with the particular gun geometry employed. On the other hand, 18 cm of paraffin reduces the (neutron) pulse by a factor of ~ 10.

The initial gas distribution from the fast electromagnetic gas valve in the annulus appears to be azimuthally asymmetric, i.e., the gas jets through the radial gas ports without showing any appreciable spreading in azimuth. No systematic study of the initial distribution has been made in terms of gun performance.

A D_2O ice target located at the end of the center electrode gives strong evidence that the upstream neutron yield (in the gun) is produced by deuterons accelerated toward the center electrode from a region below. Whether the same accelerating mechanism or a similar reversed streaming contributes to the production of high-energy deuterons downstream is uncertain.

Measurements of the current of energetic deuterons accelerated along the axis out of the gun do not show a correlation with the neutron yield produced on a deuterium loaded plate located beyond the gun muzzle. This result implies that the accelerating mechanism may not be centrally located.

PLASMA GUN RESEARCH FACILITY

Electric probe signals from the fast plasma ($\sim 4 \times 10^8$ cm/sec) are correlated in time with neutron production both at the gun and later 125 cm away at the end plate of the tank. Such signals confirm a fast plasma component with hydrogen and argon as well as with deuterium, provided the gun is fired while the neutral injected gas is located near the gas ports.

The fast deuterium plasma produced the same neutron yield downstream for two different gun energy storage systems: 5 μF, 18 kV, 1 kJ; and 45 μF, 14.5 kV, 4.9 kJ.

The fast component ($\sim 7.5 \times 10^7$ cm/sec) of argon causes much more ablation to thin downstream target foils than does its deuterium counterpart, suggesting either very energetic argon ions, or an electrostatic Z-dependent destruction mechanism.

FAST GAS VALVE RESEARCH

An investigation has been made of the flow of gas from an electromagnetically operated valve designed for use in plasma guns where a localized volume of gas is required. In these studies a fast ion gage was used which consisted of an open 6AH6 electron tube with the emission current regulated by a cathode follower to keep the emission constant during rapidly changing load conditions. A photograph of the valve, disassembled, is shown in Fig. 1.

In operation, the magnetic field of the current ring produces an impulsive force on the edge of the diaphragm which lifts the diaphragm clear of the O-ring seat. The valve may be constructed with two different types of diaphragms, one with a stem in the center as in Fig. 1, and the other a flat disk which is centered by the ribs as shown in Fig. 2. In the former, the gas pulse, measured 10 cm downstream from the valve, rose in ~ 25 μsec, and appeared to travel somewhat faster than expected for a Maxwellian velocity distribution. This behavior is attributed to a selection of velocities due to the short open time (~ 40-60 μsec), and is confirmed by the short pulse width (~ 60 μsec) at 10 cm distance. With the stem, the valve admits gas loads up to ~ 0.2 cm^3-atm in this pulse. Without a stem, the gas pulse rises in ~ 150 μsec, has a width of ~ 300 μsec, and admits gas loads of 4-5 cm^3-atm.

PARTICLE ENERGY ANALYZER FOR CUSP GEOMETRIES

Another approach to the problem of measuring particle loss rate from the end cusp of the Picket Fence IIB device has been taken using an analyzer based on the method of Busch (Physik. Z., 23, 438 (1922)). The device focuses in a parallel magnetic field a divergent beam of particles escaping out of a point cusp. Preliminary analysis indicates that deuterons of axial energy 2-25 keV can be collected and detected in an analyzer of 18 cm diameter and 250 cm length using magnet coils available at LASL and energized by existing power supplies. Field distribution calculations made with the IBM-7090 indicate that the particles can be transferred adiabatically from

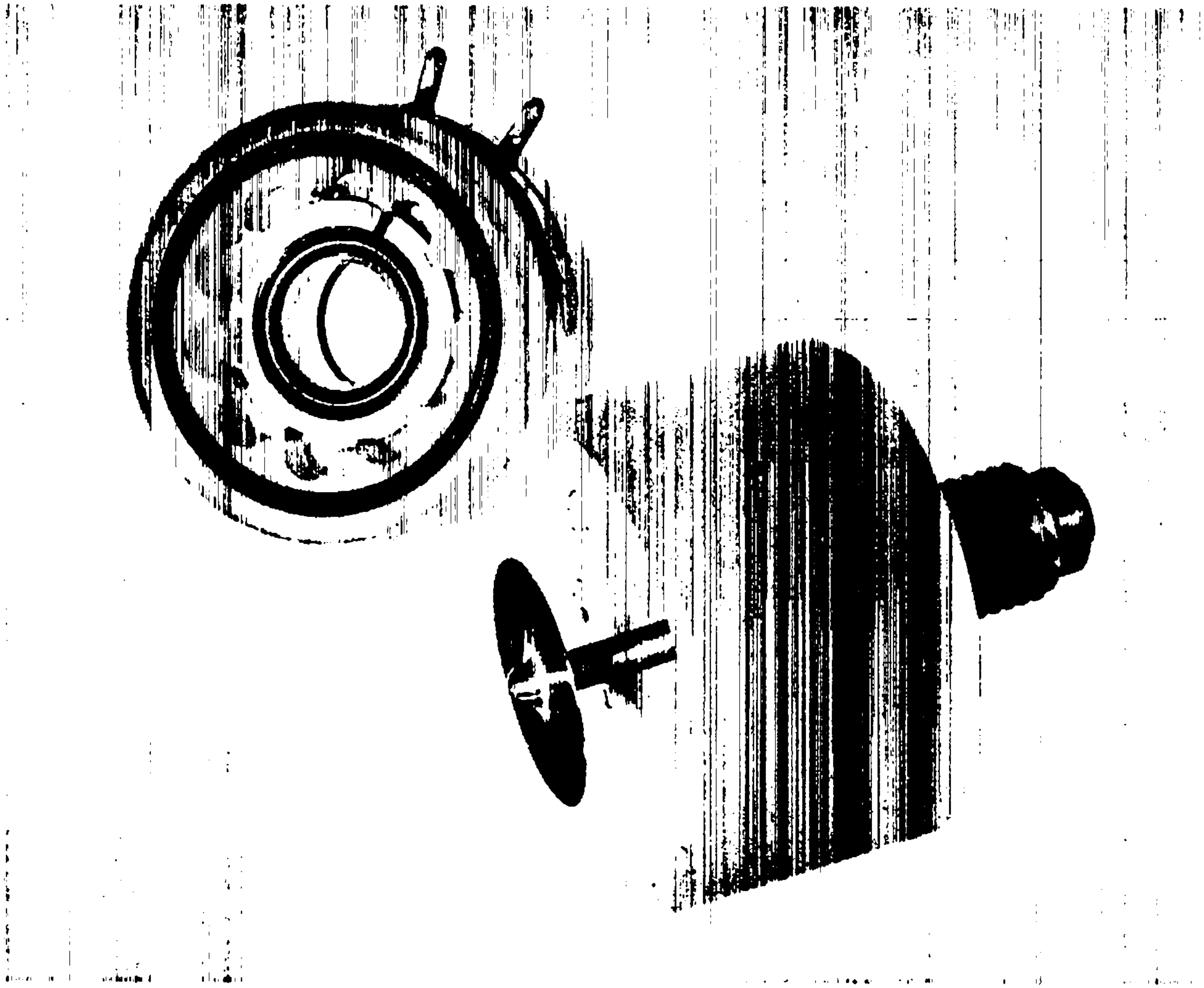

Fig. 1. Electromagnetically operated gas valve for plasma gun

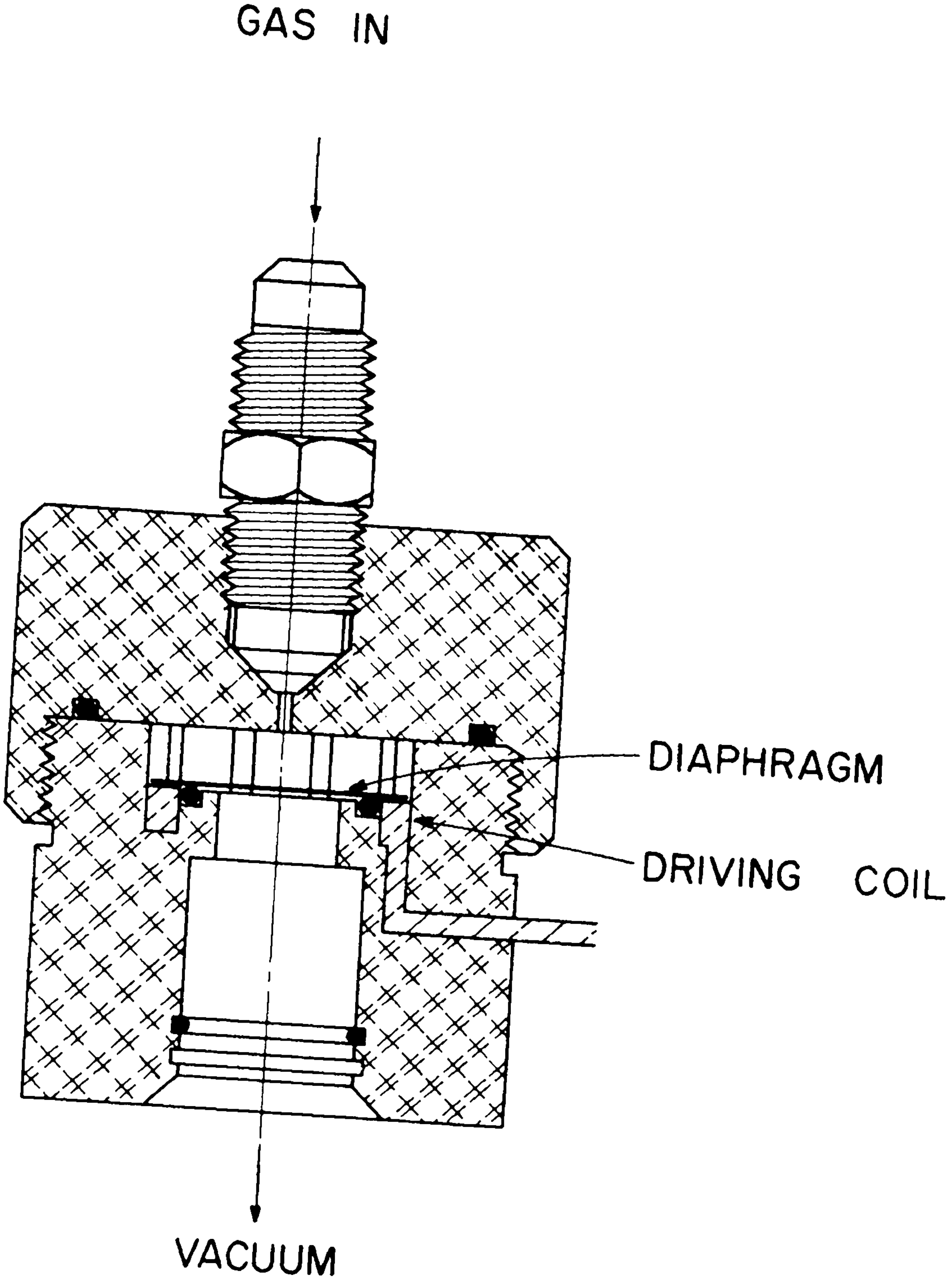

Fig. 2. Gas valve with flat disk diaphragm

the 4000-G cusp field in the machine to the $\sim$ 1000-G field in the analyzer. This reduces the transverse energy component ($W_\perp/B \approx$ constant) so that analysis of the axial energy gives the total particle energy with a maximum error of $\sim$ 25% which is adequate for the present purpose.

DEVELOPMENT OF COAXIAL GUN FOR INJECTION INTO MAGNETIC FIELDS

The spill plasma analysis system from the injected Scylla III experiment has been adapted with modifications to the further development of hydromagnetic plasma guns. The system includes a coaxial gun of a particularly flexible design; a low inductance gun bank of 40-μF capacity, 25-kV rated voltage, ignitron switching; a set of four short coils which allow magnetic fields of up to 25 kG to be developed at various positions near the gun muzzle; guide field coils which provide a uniform field of about 3 kG over a drift space of approximately 2.5 m; instrumentation consisting of a D_2O ice target, scintillator detectors to observe neutrons from targets, walls, or volume plasma effects;diamagnetic loops for time of flight observations; and an electrostatic particle energy analyzer.

The initial object of the program was to try to vary gun parameters in such a way as to maximize volume neutrons in a plasma contained by a magnetic field. Any thermonuclear reactor will depend on volume neutrons, but the so-called fast guns, at present applied to the picket fence experiments, have been tuned up on target neutrons. Volume neutron yield varies as $n^2\sigma v$, while target yield goes approximately as $n\sigma R$, where v is the volume of plasma reacting, and R is something like the range of the deuterons in a target. The tune-up of a system on target neutrons tends to favor high particle energy, usually at the expense of plasma density. Volume neutron tune-up is much more favorable to high densities.

In plasma collision experiments reported earlier, volume neutrons observed in a gun plasma stagnated against a large magnetic field. The present experiments were conceived as a simple process of optimization of gun parameters using this effect as the criterion. The system now appears to give volume neutrons. The neutrons are identified as such by a scintillation detector shielded with approximately 2-cm of Pb against x-rays, and the height of the time-resolved pulse observed thereon is well correlated with the response of a Ag radioactivity counter. The neutron yield is a strong function of magnetic field strength, being unobservable at 3 kG beyond the gun muzzle and about 5 x 10^6 /shot at 18 kG. It also increases rapidly with gun voltage.

A shadow bar experiment shows that the neutrons observed are not created at the walls of the glass tube. At least 80% appear to have a source within 5-cm of the axis of the system, whereas the glass tube has an inner radius of 9.5 cm.

It has been shown that there are two distinct groups of neutrons separated in space and time. One, which can be called "gun neutrons," is produced as a short burst in the gun. It is almost always accompanied by hard x-rays and occurs roughly simultaneously with the first plasma to leave the gun muzzle. This is somewhere in the range of 1 to 3 μsec after initial breakdown in the gun, depending on gun parameters. The other group of neutrons is produced not at the gun muzzle, but in the stagnation field region. It is a volume, not a surface, yield. It depends strongly on stagnation field strength and lasts much longer than the gun neutrons (1.5 to 2 μsec full width at half maximum).

The above experiment was performed with gun parameters approximating those used in the Scylla III injection experiments. The coaxial Cu electrode diameters were 1.25 in. and 3.25 in., the gun was 24 in. long, and the gas port was midway along the center electrode. The gun was driven by 40-μF of capacitor bank at 19 kV through low-inductance ignitron switches. The effective circuit inductance for a crowbarred discharge inside the gun (presumably close to the insulator) was 17 nH. Approximately 0.8-cm^3 atmosphere of D_2 gas was admitted by the fast valve and the gun was fired approximately 80 μsec after the earliest possible time, presumably the time when gas first forms a path across the space between the electrodes. This delay was picked as the optimum delay time.

A series of changes were made in gun dimensions, position of gas port, and diameters of the electrodes. Some improvement resulted from the use of a 20-in. gun, and by moving the position of the gas port 2 in. nearer the muzzle. On the other hand, the original outer electrode diameter appears to be not far from the optimum. Not much effect was obtained in a series of experiments where the position of the entire inner electrode was varied around a position flush with the end of the outer electrode. However, smaller yields were obtained when the inner electrode was shortened by 2 in., leaving the position of the gas port fixed.

With optimum gun dimensions there are two distinct modes of operation, one, the normal mode, giving large stagnation yields. The other mode appears at short time delays after gas admission, gives large yields of gun neutrons, small yields of stagnation neutrons, very small diamagnetic signals, and a partially crowbarred current signal. The current rises rapidly for perhaps 0.6 μsec, has a sharp sudden decrease or downward kink, then continues to rise to higher than normal values on a short period as though the gun had broken down along the surface of the insulator inside. The gun neutrons appear as a sharp burst at the time of the kink and are accompanied by hard x-rays.

At optimum delay for stagnation neutrons (~ 200 μsec after gas admission) no gun neutrons at all are observed and no hard x-rays. The current rises almost linearly for about 1 μsec or somewhat longer, depending on gas load and gun voltage, and then falls nearly linearly to near zero in a further 3 μsec or so. The plasma appears to leave the gun muzzle just after peak current. The abnormal mode experienced in the past is associated with a voltage spike at current kink time and with large target yields from low-density very fast plasma.

TRANSVERSE MAGNETIC FIELD INJECTION

The techniques described in the last progress report (LAMS-2721, p. 12) have been applied to a plasma stream produced by a gun borrowed from Picket Fence IIB. This gun operates at a much lower injected gas density and produces a higher velocity than the gun used in the previous experiments. The shorting plate with the current detecting loop gives a signal with a peak value of 1.5 kA, lasting approximately 1 μsec. Although the peak current is about the same, its duration is about one-tenth as long as that detected previously. This current indicates that both guns produce stream energy densities which are about equal.

Scintillation detectors located just outside the glass vacuum chamber give signals which have a characteristic spike followed by a tail showing a containment time of about 500 μsec in a 7-kG magnetic field. With further investigation, using Ag activation counters and absorbers, it became evident that the observed extended scintillator counter signals were not neutrons but x-rays. The slopes of attenuation curves for Al indicate x-ray energies up to 62 keV for the first pulse and > 200 keV region for the tail.

The mechanism for the production of the high-energy electrons has not been definitely ascertained. The x-ray tail disappears when no magnetic field is present. The first pulse remains however, and the signals from a photomultiplier near the glass wall opposite the gun muzzle are very field-dependent. The signals for a given B-field were observed vary from shot to shot, from zero up to their maximum values. The magnetic field in general enhances the x-rays, but signals are still present without field.

The total number of x-ray photons in the region 100 keV and above (as estimated from scintillator signals through 1/16 in. of Pb) is about 10^7 per shot. The total x-ray yield outside the glass chamber (determined by an ionization chamber) corresponds to 0.1 mr/shot or about 10^9 photons/shot. The extended nature of the x-ray source makes an exact solid angle correction impossible.

The mechanism of trapping of this "plasma" could be the "shorting" effect that has been described previously. Metal and glass have been used as end surfaces of the chamber outside the mirror to determine any difference which might appear in the trapping signals. No differences outside the shot to shot variation were observed. It is suspected, however, that differences between glass and metal will not be observed when the stream velocity and the B-field are high since under these conditions a glass surface has been observed to be a "good" conductor. Experiments with current loop probes at the end surfaces will be made in order to investigate further the shorting process and its effect as a trapping mechanism.

SCYLLA I ZEEMAN EXPERIMENT

With the improved achromats described in the preceding report (LAMS-2721, p. 11), the Zeeman spectrometer was shown to be functioning properly for a steady light source in a dc magnetic field as well as in both the first and second half-cycles of the Scylla discharge for a spectral line of C III, which originates in relatively cool plasma. Failure to detect the field breakthrough as shown by a material probe in C V light, even in the presence of a probe, is explained on simple physical grounds. The C V light peaks and decays in the central plasma region before the probe breakthrough occurs because the ion loses its fifth electron prior to peak magnetic field.

At the time of occurrence of the C V light during the second half-cycle the magnetic field in the hot plasma is found to be approximately 9 ± 6 kG. This confirms the material probe result, before breakthrough, that the plasma is nearly completely diamagnetic with a small amount of trapped, reversed field.

SCYLLA I X-RAY SPECTROGRAPHY

The x-ray crystal spectrograph has been reassembled with a potassium acid phthalate (KAP) crystal, having 2d = 26.55 Å compared with 15.95 Å for the beryl crystal previously used. KAP crystal will make the spectral region 15-25 Å accessible, so that the O VII resonance series can be observed, as well as O VIII L_α and L_β. A comparison of O VII with O VIII spectra provides valuable information on the ionization and excitation processes in Scylla.

After alignment, various target x-ray lines were observed. The CuK_α, FeK_α, AgL_α lines were produced in fluorescence targets excited by a W target spectrum in the demountable x-ray tube. The spectrometer has been installed on Scylla and the spectral lines Na X $1s^2\ {}^1S_0$ - $1s2p\ {}^1P_1$ at 11.00 Å, and Ne IX $1s^2\ {}^1S_0$ - $1s2p\ {}^1P_1$ at 11.54 Å have been observed. A methane filled proportional counter is being used as a detector in place of the scintillation counter used in previous work, because the former is expected to work better than the scintillator in the long wavelength region.

PLASMA ANALYSIS OF INJECTED SCYLLA III

Introduction

As of the last progress report (LAMS-2721, p. 7) the apparatus for the measurement of the ion energy from the injected Scylla III was functioning in a satisfactory manner from an engineering point of view. However, the plasma was not spilling from the end of the compression coil into the magnetic spill and guide fields where the ion energy was to be analyzed. In an effort to aid the spilling of the plasma, a 10% decrease was produced in the magnetic field between the two ends of the compression coil by making a 5% taper on the inside bore of the coil. However, this alteration combined with additional efforts in which the spill magnetic fields were varied over a wide range of magnitudes served only to confirm the initial experiments. In addition various magnetic field configurations were utilized, but still energetic plasma particles failed to spill out of the coil end during the compression phase of the discharge.

Cylindrical Electrostatic Analyzer

In order to insure that the D_2O ice targets in the analyzing region were giving valid results, a 90° cylindrical electrostatic analyzer was constructed. The entrance and exit slits were positioned to approximate the first order focus conditions for a $\pi/\sqrt{2}$ analyzer. The assembly was fitted into a housing which was joined to the detector housing. Following the exit slit is a post-acceleration electrode which serves to accelerate the ions into a 1.5-mm thick scintillator positioned on the end of a light pipe. A 6810 Å photomultiplier tube is utilized on the end of the light pipe exterior to the vacuum system and magnetic fields.

Energy Spectrum of the Gun Plasma

The deuteron energy spectrum in the plasma emitted by the coaxial gun was determined with the electrostatic analyzer after the plasma traversed the magnetic spill and guide fields. The spill field had a maximum of about 50 kG for these measurements. Deuteron energies were observed between 5 and 20 keV with an intensity maximum occurring in the vicinity of 10 keV.

Injected-Compressed Plasma Results

With the rapidly rising compression field applied to the injected plasma, energetic deuterons failed to spill from the compression coil down the magnetic, spill-field system. Spill deuterons were observed on only three discharges out of approximately 250. With the fast magnetic compression field operating in the 60 to 70 kG range, a portion of the injected deuterons were trapped as was evidenced by the neutron emission. However, these deuterons failed to navigate the approximately adiabatic spill system. The maximum of the magnetic spill field, which forms the initial mirror on the spill end of the compression coil, was varied between 0 and 70 kG. Not only was it surprising to find that deuterons failed to spill from the compression coil under these conditions, but it was even more perplexing to find that the neutron emission from the compression coil was not strongly dependent upon the magnitude of the spill coil mirror. In these experiments all the magnetic fields, including the gun guide and B_o fields, were parallel to the compression field.

With the gun guide and B_o fields antiparallel to the compression field, the deuterons still failed to spill from the compression field. This result was again independent of the magnitude of the spill field. Neutron emission resulted from the compression region with larger yields than in the parallel field case. Also, as in the parallel field case, the neutron yield was not strongly dependent on the magnitude of the spill coil mirror.

The apparatus was also operated with the gun guide, B_o, spill, and spill-guide magnetic fields all antiparallel to the main Scylla compression field. In this magnetic field configuration a cusp geometry is formed between the compression field and the spill field. The neutron emission was essentially the same as in the above two cases. It again was not strongly dependent on the magnitude of the spill coil mirror. As before, spill deuterons were not observed.

Conclusions

These experiments strongly suggest that the trapping mechanism for the injected plasma in the fast rising compression field is not a simple single particle phenomenon. This view is substantiated by the absence of strong correlation between the neutron yield and the spill magnetic mirror. In addition, the experiments indicate that the loss or spilling of particles out of the end of the compression coil does not occur on a single particle basis. For example, it is conceivable that the trapped plasma in the compression field possesses a higher β than previously anticipated and to some extent forms its own mirror field. Should this be the case, the spill magnetic mirror would not be essential. Furthermore, it is likely that the trapped deuterons would not spill from the end of the compression coil in the latter case.

The failure of the plasma to spill might also be attributed to the development of an instability which causes the trapped plasma to be lost in the radial direction, i.e., across magnetic field lines to the discharge tube walls.

The ion energy measurement experiment, which thus far has yielded a negative result, has not been pursued further at this time because of the need for additional gun research and the Scylla IV program. However, it can be said with some certainty that energetic deuterons from the compressed plasma do not traverse the magnetic spill system, whereas some deuterons from the gun do traverse this system. These latter particles clearly show that the spill system with the D_2O ice targets and electrostatic energy analyzer are functioning properly.

SCYLLA IV

Construction of the 50-kV portion of the Scylla IV machine is nearing completion. It is anticipated that the 50-kV primary bank, the preionization bank, and the bias field bank will become operational some time during the month of September, 1962.

The installation of the collector plates with polyethylene insulation (7-10 mil layers) and the "tie-through" bolts has been completed. The bottom plates were leveled on the support tables to within 10 mils over their 15 ft x 15 ft area. Difficulty was encountered in the collector plate assembly with the steel washers used under socket head screws. In order to utilize the high tensile strength of the socket head screws, it was necessary to fabricate and heat treat washers from high-strength steel.

The side header sections, which accommodate the 1296 primary bank load cables and the 180 preionization bank load cables, have been installed on the collector plates. These header sections employ a combination of polyethylene insulating hats and polyethylene sheet to provide a minimum-inductance configuration. The 216, 50-kV capacitors for the primary bank have been received and installed, and spark gap switches have been installed on all of the primary bank capacitors. The installation of the 1296 primary bank load cables is complete. Six RG 17/14 cables connect each individual spark gap-capacitor unit into the collector plate headers. The 100-kV, 0.8 μF capacitors for the preionization bank have been received and installed with individual spark gap switches to form the preionization bank.

The construction of the main and crowbar vacuum systems has been completed. Both units have been helium leak tested. The installation of the blast shield wall has been essentially completed. The crowbar spark gaps and their collector plate adaptors which connect onto the rear headers are on hand and will be installed soon. The control system has been completed. All components are on hand for the triggering and monitoring system and are being installed.

RUBY LASER

A ruby laser has been constructed for illuminating a Mach-Zehnder interferometer intended for measurement of plasma electron densities in Scylla. In addition, the long Scylla IV plasma should produce a measurable Faraday rotation of the plane of polarization, allowing mapping of the magnetic field in the plasma.

A ruby rod with nonreflecting end coatings was operated between external mirrors and pumped with special xenon flash tubes. It has a lasing threshold of 650 J energy input to the flash tube. This laser has been successfully operated in the "giant pulse" mode by inserting a biased Kerr cell and a Rochon prism into the optical train. The effect of these elements is to block the optical path of the polarized light from the Ruby (exit at 90° to its geometric axis) while it is being pumped. A pulse to the Kerr cell then opens the path, allowing the ruby to dump its energy in a single pulse, instead of the usual irregular train of pulses. Single pulses with a duration of 0.1 μsec and a peak power of 24 kW have been obtained. These should be quite adequate for obtaining time-resolved plasma measurements.

50-KV IGNITRONS

Two experimental 50-kV ignitrons were delivered from General Electric Co. These tubes, which can be triggered with anode voltage below 1 kV, appear to have adequate current capability. Their inductance is considerably lower than the Scylla IV 50-kV spark-gap when used in the same configuration. However, the high-voltage reliability of these tubes is inadequate. Both units were able to reach 50-kV initially but only for a couple of shots, after which breakdown occurred at quite low voltage. One tube was aged by firing at lower voltage and ultimately ran for over 10,000 discharges before the test was discontinued due to capacitor failure. The last 1200 shots were at 50 kV. It has been possible to show that the glass seal region of the lower section of the tube was responsible for the failures. A flux plot of this region indicates a nonuniform field along the glass which could be a contributory factor. More plots will be made to find a better configuration.

PARALLEL PLATE CAPACITORS

There have been a large number of failures of the parallel plate capacitors during acceptance tests. Most of these failures occur in the header region. It is possible that the requirements are too stringent for manufacture and that the header region should be enlarged even at the cost of higher inductance.

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