P R O P O S A L

Generating microwave Cerenkov radiation using a chopped 3 KeV electron beam

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As a continuation to my work in Physics 4052W (MXP), I propose to refine the work done previously and to implement some of the ideas presented in the final report for that course. The entire data collection and analysis portions of the experiment will be rebuilt and the code rewritten. The beam "chopper" will also be finished and installed, thereby allowing the intensity of the radiation to be increased. A pulsed beam also gives pulsed radiation. By modulating the chopping frequency, one can easily distinguish the signal from the noise in the frequency domain. More complex signal processing methods shall also be employed. The design of the electron gun will also be examined in greater depth to see if any modifications are warranted. The goal of this experimental project is to observe a clear, clean, and undeniable Cerenkov radiation signature. The MXP project ended with a suspicious data set, with no conclusive results. I know I can do better.

I. Introduction

See MXP final report.

II. Theory

See MXP final report.

III. Apparatus

See MXP final report. I will also finish building the beam "chopper." I'd like to interface the pressure sensors to the computer, so that pressure data can be tied to the diode voltage, but I don't know if that is possible. I'd also like to get dedicated voltage sensors tied to each power supply (and subsequently to the computer) so that the true output of each supply can

be monitored (and recorded in sync with the diode). An amplifier circuit needs to be designed and built to overcome the resolution problems with the multimeter. Since the diode signal is so weak, the multimeter has a hard time reconciling voltages. The single largest apparatus change I'd like to see (but sincerely doubt will come through) is to get a new and better electron gun (with dedicated power supplies, ones designed to operate at 3000 volts and beyond). The gun being used now is somewhat flimsy, and the filament is prone to breaking during repairs. The gun is not designed to operate at such high voltages, leading to numerous difficulties. The power supplies also cause problems, since 3000 volts is at the very top of their operating ranges, making them prone to shorting or sparking in the middle of a trial.

IV. Feasibility

Considering that the majority of the trial and error work has been done, that I am very familiar with the operation of the vacuum chamber, the electron gun, and the current experimental setup (seeing as I built the current setup from scratch), that all the primary theoretical research has been done already, and that several sets of data have already been collected, the feasibility of success seems rather good. The chopping system has already been designed, and construction has already commenced (the system was almost finished in the last week, but with so little time remaining, the emphasis was shifted from construction to data collection in the remaining time). The revised data collection system is mostly a function of what the equipment is capable of. With more multimeters available now, and with more power supplies available, finding the right equipment for the job seems pretty easy. The data analysis problems will be discussed with a professor in the Electrical Engineering department who has expressed a strong interest in the project, specifically on the detection of a weak signal in heavy noise. Given almost ten full weeks of work, the project doesn't seem that impossible.

V. Timeline

From the time I arrive back from South America (June 9th), to the middle of August is roughly 8-9 weeks. I will have to miss the first week of August since I will be presenting a paper at an SPIE conference in Denver. Given this time, I will begin with the design of the amplifier for the diode. I will then focus on getting pressure data from the sensors mounted on the vacuum chamber. I will get new power supplies and rewire the control system (adding voltmeters were able; I don't think that the HP multimeters can measure up to 3000 volts, so some sort of transformer will be needed). The voltmeters are not necessary, but a nice addition is I can manage it. I would also like to look into fixing up the gun. One thing I will need to determine right off the bat, is if the diode is still sensitive when pumped down to a near vacuum. The peculiar behavior of the diode during rapid pressure changes will need to be examined and (hopefully) explained. Hopefully I can borrow a microwave source for a day or two to test the sensor. I hope to accomplish this in the first 3-4 weeks. Once the diode has proven itself (or been replaced), and the control and monitoring system has been modified, the chopper will take center stage. I estimate 1-2 weeks of work to get it finished and operational. So 4-6 weeks into the project and I should be ready to collect data. As soon as I get my first good set of data, I can take it to the EE dept. so I can go over it with the professor I mentioned earlier. So I will have 2-5 weeks of data collection and analysis (with refinements of the experimental system here and there).

VI. Budget

All the equipment I need is already available. If there is any budget for it (I'm sure there isn't, but I have to ask) I'd like a new electron gun and high voltage power supplies. But aside from a few more GPIB cables, an RS232 cable, a few better power supplies, and some high-

voltage coax cables everything I need is in my lab room (or Room 65). I'd like to borrow a microwave transmitter (X-band [10-12 GHz] is preferred), but that would only be for a day or two (of course longer if possible, but at least one full day minimum).

References

See MXP final paper.