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TESTS OF A NEW SECONDARY EMISSION CHAMBER AT THE AGS*

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Abstract

A secondary emission chamber (SEC) has been built using .00025" aluminum foils with a 200Å vacuum-deposited silver coating. After baking the assembly, the foils were cleaned with an argon glow discharge. The chamber was then installed in a primary proton beam at the Brookhaven AGS. A difference in sensitivity of 6% was noted between the chamber's two emitter foils. After exposure to a flux of 10^{18}-10^{19} protons/cm^2, the sensitivity of one of the foils was found to have increased by 0.2% and the other to have decreased by 1.2%. This is substantially better than earlier designs.

Introduction

Essential to any accelerator control system is an accurate measure of the extracted beam intensity. At the Brookhaven National Laboratory Alternating Gradient Synchrotron (AGS), secondary emission chambers (SECs) are used to monitor the proton intensities at the five production targets used in the slow extracted beam (counter) program. Chamber sensitivities have changed by as much as 20% after fluxes of the order of 10^{19} protons/cm^2 have been recorded and this has made accurate evaluation of the performance of the beam extraction system difficult. It has also required frequent SEC recalibration using foil activation counting techniques.

Garwin and Dean[1] have suggested that these changes in chamber sensitivity may be caused by the adsorption of CO gas onto the foil surface, resulting in an altered work function. They advised using silver coated aluminum foils, and this design is based on their ideas.

Construction

The SEC was built using five 0.00025" thick aluminum foils. On each side of the foil, 200Å of silver was vacuum deposited. The foils were mounted between two 4"-diameter stainless steel rings and spot welded together. The foil assemblies were stacked in a collector-emitter-collector-emitter-collector array with each foil electrically insulated and with a 0.3" inter-foil spacer. The collector foils were then connected electrically, but each emitter foil signal was brought out separately.

The foil module was installed in a stainless steel tank with 0.003" aluminum entrance and exit windows. An 8 liter/sec ion pump is an integral part of the structure and a saphhire window enables observation of the foils during the cleaning process. Figure 1 is a photograph of a foil mounted in its frame, and Fig. 2 illustrates the construction of the chamber.

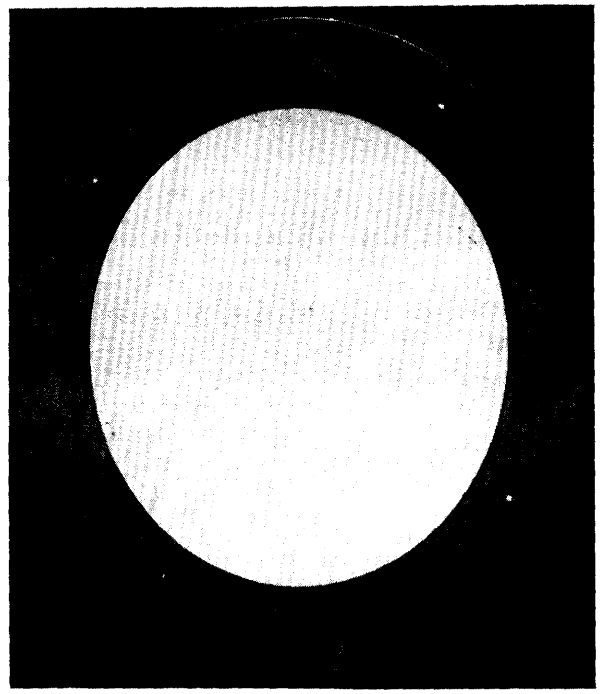

Fig. 1 Foil mounted in frame

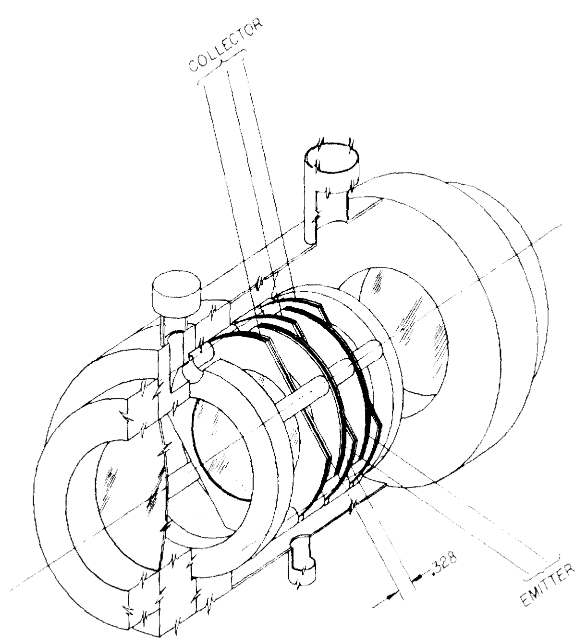

Fig. 2 SEC assembly

Preparation

The ion pump magnet was removed and the SEC assembly was leak checked. The unit was baked for 48 hours at 250°C. (Special covers were made to provide vacuum on the outside of the vacuum windows in order to reduce stress there.) After leak checking the transfer system, argon gas was introduced into

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the chamber until a pressure of 250 microns was reached. A glow discharge was established by applying +200V to one of the emitters for 3 minutes. The discharge was then established from the other emitter, and the whole procedure was repeated with the polarities reversed. The current density in the discharge was $\sim 2 mA/cm^2$ and observation through the sapphire window showed reasonable uniformity over the area of the foils.

When the cleaning procedure was completed, the ion pump was turned on and the chamber pumped to 10^{-8}T.

Test

The SEC was installed upstream of one of the AGS target stations at a point where the proton beam diameter was 2-4 mm. Each emitter was connected to the standard AGS readout electronics[2], employing a low drift differential amplifier followed by an integrator and an A/D converter. At installation, a 6.3% difference in sensitivity was noted between the two emitter foils. A second SEC of an earlier design also intercepted the same proton beam.

The chamber remained in the 28 GeV/c proton beam, which delivered 2-3 x 10^{12} protons every 2.3 seconds, for about 300 hours, or for 10^{18} protons. This represented a proton flux of 10^{18}-$10^{19}/cm^2$ and might have been expected to alter the sensitivity of the chamber in the small area through which the beam passed. After this exposure, the sensitivity of each emitter relative to the second SEC was measured. The chamber was then moved horizontally by 1" (thereby exposing a new area of foil to the beam) and the sensitivity measurements repeated.

The sensitivity of the more sensitive emitter was found to have increased by 0.2% and that of the least sensitive emitter to have decreased by 1.2%. The origin of the differences is not yet understood, but may lie in unknown variations in the glow discharge cleaning process.

Conclusion

Previous experience at the AGS has shown that after exposure to proton fluxes of the order of $10^{19}/cm^2$, the sensitivity of SECs has changed by as much as 20%. A design employing silver-coated aluminum foils seems to have overcome this difficulty, but the tests are continuing. A fundamental limitation may be reached when enough nuclear interactions have taken place in the foil to significantly alter its composition and, hence, its work function.

Acknowledgments

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References

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