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METHOD OF STABILIZING HIGH CURRENT SECONDARY EMISSION MONITORS*

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Since the description of the Secondary Emission Monitor (SEM)[1], various attempts[2-4] have been made to fabricate SEM's which exhibit stability in electron beams with current densities in the range 1 - 40 $\mu A/cm^2$. Figure 1 shows the variation of efficiency with transmitted beam (as measured with a toroid monitor) for an SEM made at SLAC by extending the suggestions of the Orsay[2] group. This SEM had 500 Å of gold evaporated on each side of its 7 aluminum foils. The ultra-high vacuum system was ion pumped, and the unit was baked out at 150-200° C after assembly. The SEM was physically wobbled in the beam, which reduced changes of calibration with change of beam position to negligible effects. As is readily seen from Fig. 1, the efficiency change is about 20% for a transmitted charge of about 0.16 Coulomb with a beam of area about 0.08 cm^2. As is true of all "clean" (oil and hydrocarbon free) SEM's in our experience, the efficiency increases with transmitted charge. For "dirty" SEM's, the efficiency decreases. Gold was chosen for coating the foils because it is a noble metal, generally thought to be very stable. While it is true that gold is stable against oxidation, it nevertheless sorbs CO gas[5], which is a main constituent of the residual gas in ultra-high vacuum systems. From studies on tungsten, sorption of CO is known to increase the work function of the surface.[6] We therefore explain the increase in SEM efficiency for gold by noting that when the electron beam desorbs CO, lowering the surface concentration below equilibrium, the work function will decrease, thus increasing the secondary emission coefficient.

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The problem of achieving stability in an SEM is therefore one of finding a foil coating material which does not sorb CO. Silver is such a material[5], although it is not stable against oxidation. The procedure used to construct such an SEM is to vacuum evaporate 500 Å of silver on each side of the aluminum foils, assemble the SEM, and bake it out at 200° C. Figure 2 shows the variations of efficiency of such a 3-foil SEM with transmitted beam. A significant rise in efficiency is observed up to 24×10^{16} electrons transmitted, and a major change in efficiency is seen during this period when the beam is steered over the face of this stationary SEM. This is understood in the light of sorption characteristics of the oxide surface present on the silver-coated foils. In order to remove this coating, the SEM was Argon-ion sputter cleaned by establishing a discharge at a few hundred volts potential, and a current density of about 2.5 mA/cm^2 for 5 minutes. The discharge polarity was then reversed, cleaning the emitting foils last. The SEM was then evacuated again, and the data of Fig. 2 shows that from 25×10^{16} to 100×10^{16} electrons transmitted on a beam area of 0.08 cm^2, the variation of efficiency is less than 1%, and the effect of steering (about 4% prior to ion cleaning) is very small.

Several SEM's of the novel design described here have been assembled and are now being run in a high current density beam at SLAC. Further results will be reported soon.

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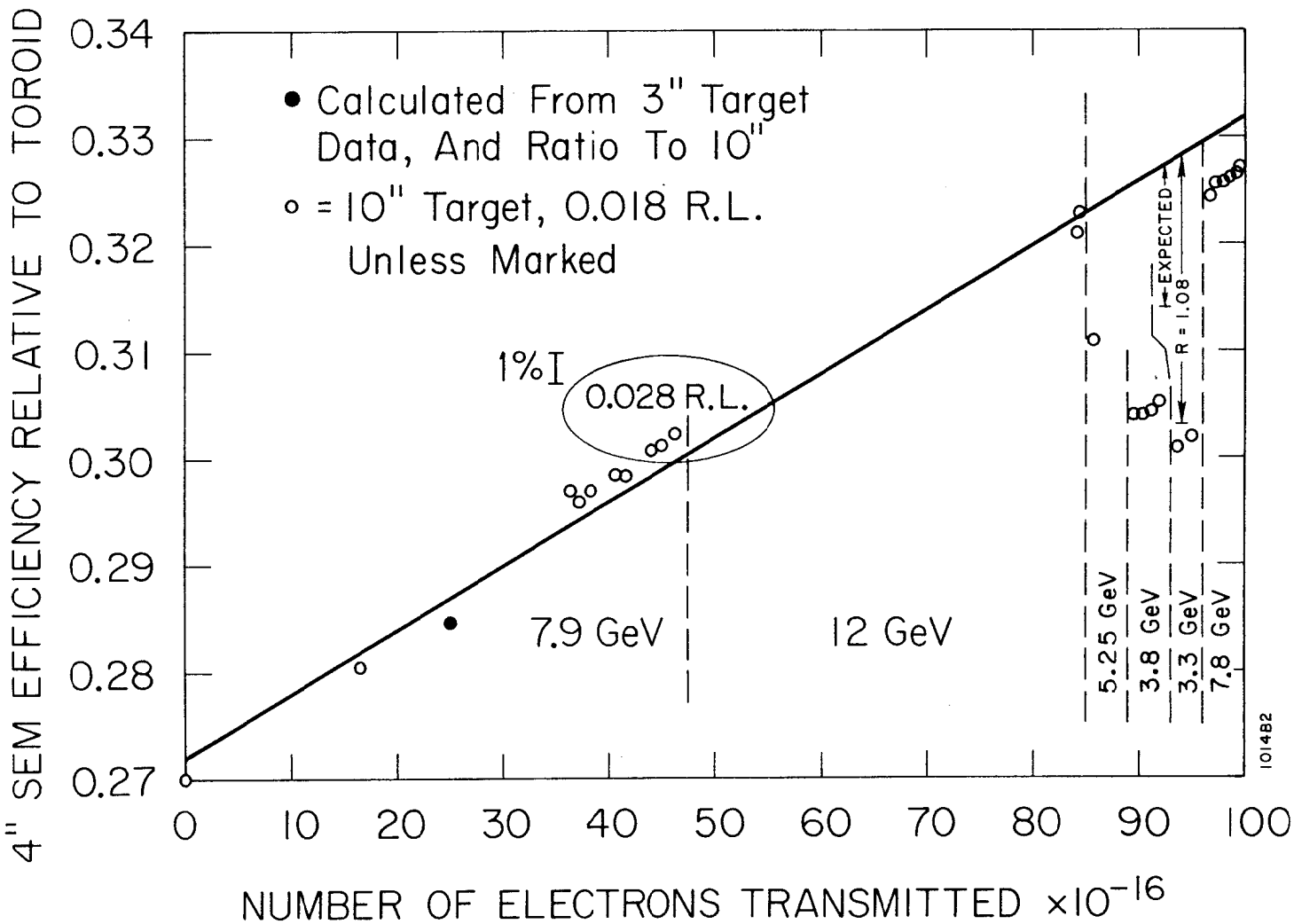
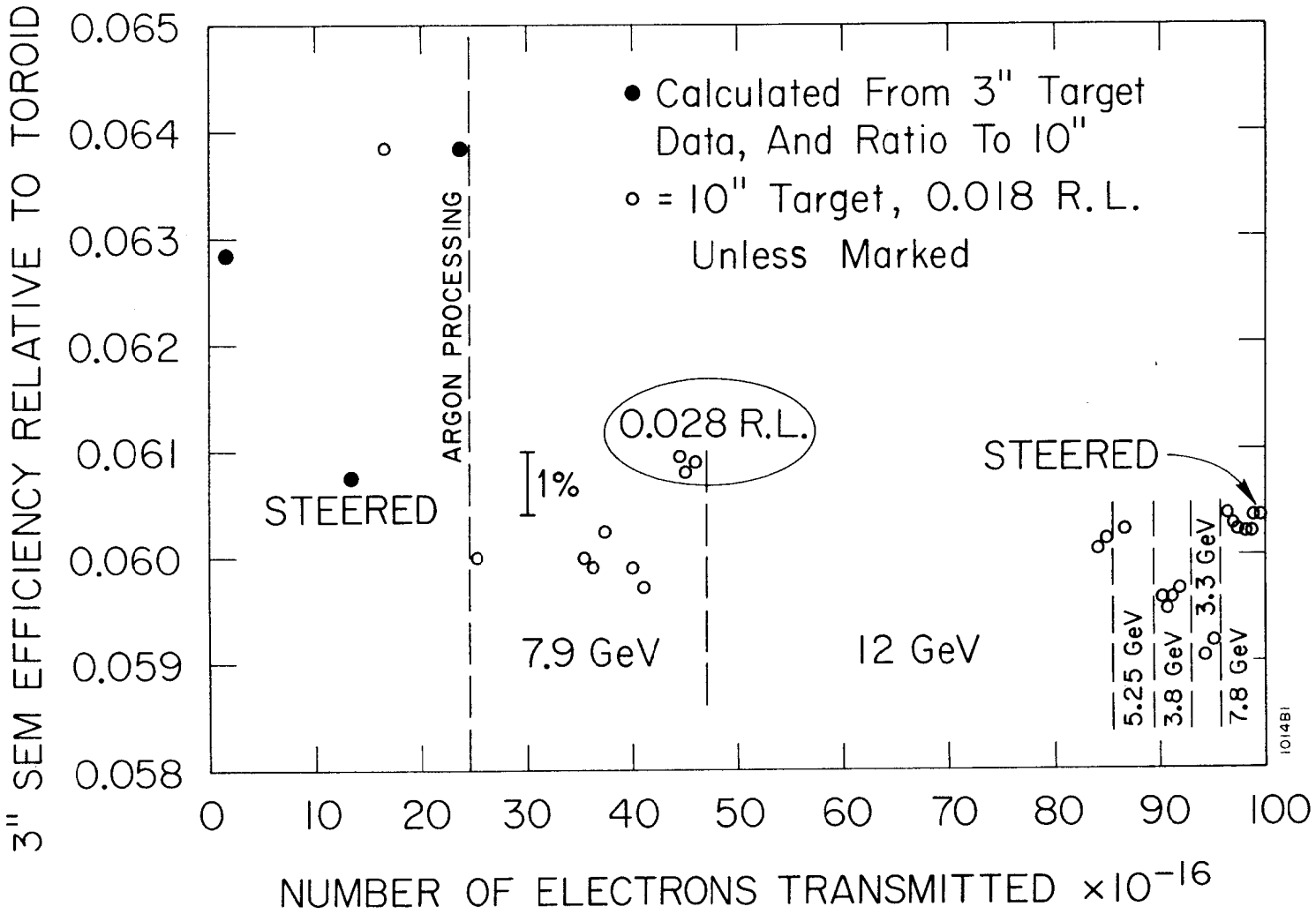


4" WOBBLED SEM vs Q TRANSMITTED

Fig. 1



3" STATIONARY SEM vs Q TRANSMITTED

Fig. 2