Suppression of the effective SEY for a grooved metal surface

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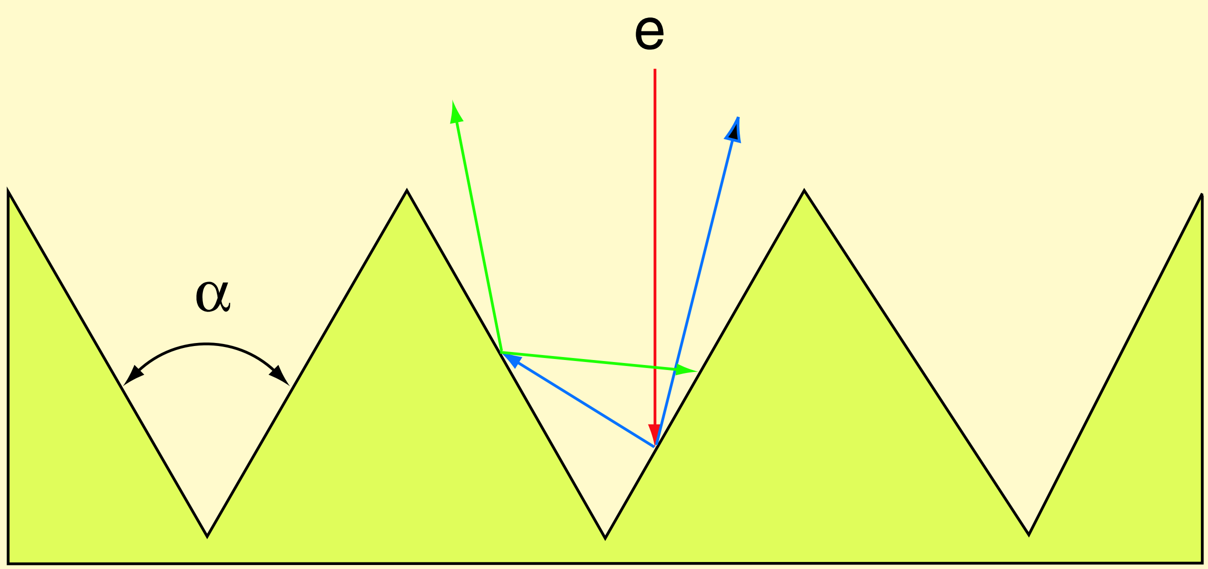
Introduction

- There are well known ways of suppression the secondary emission using coatings and surface treatments, beam scrubbing, solenoidal magnetic field, etc. We want to look here at a simple approach to suppress SEY that uses grooves on the surface.
- The idea is not new (V. Baglin et al. EPAC 2000; A. Krasnov, LHC Project Report 671). A related idea is effect of surface roughness on SEY. Motivation behind this work is to use a modern code to evaluate the performance of such surface. Our goal is to calculate the suppression coefficient for SEY as a function of geometric parameters of the grooves.
- Multipacting is a threshold effect. For NLC DR the critical value of SEY is 1.2.

Triangular corrugations



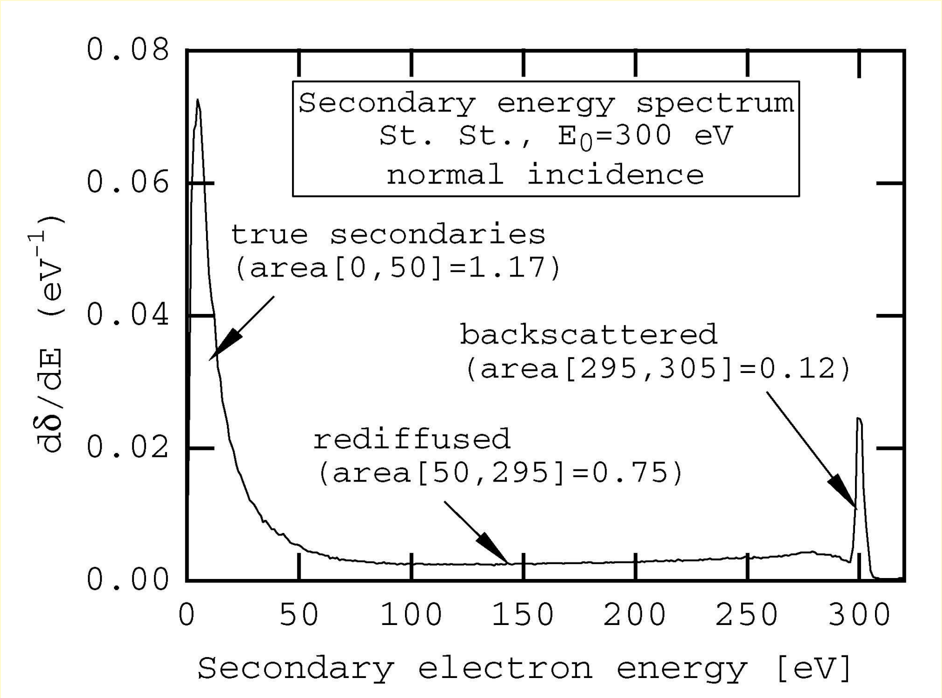
Some secondary electrons will hit the wall and get absorbed. Blue—first generation of SE, green—second generation. A competing factor is that the incidence angle is $< 90^{\circ}$, which increases the SEY.

The effective SEY does not depend on the size of the grooves, it is only a function of angle α.

Code

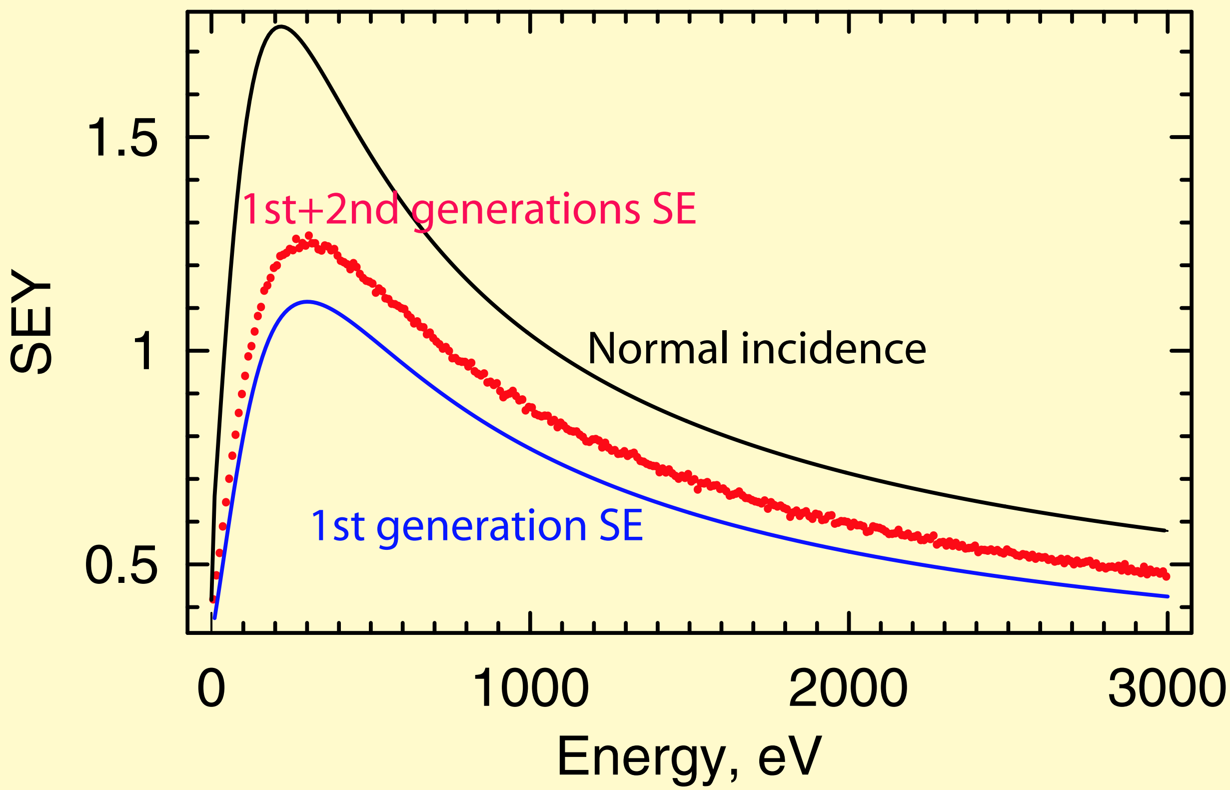
- A fortran subroutine from POSINST code was used for simulation of secondaries. It is based on the model published by M. Furman and M. Pivi (PRSTAB, **5**, 124404 (2002)).
- Primary electrons hit the surface normal to the averaged plane.
- We take into account only first 2 or 3 generations of the electrons. About 2×10^4/groove incident electrons were simulated.
- Effective SEY is averaged over the groove period.

Secondary Emission Model



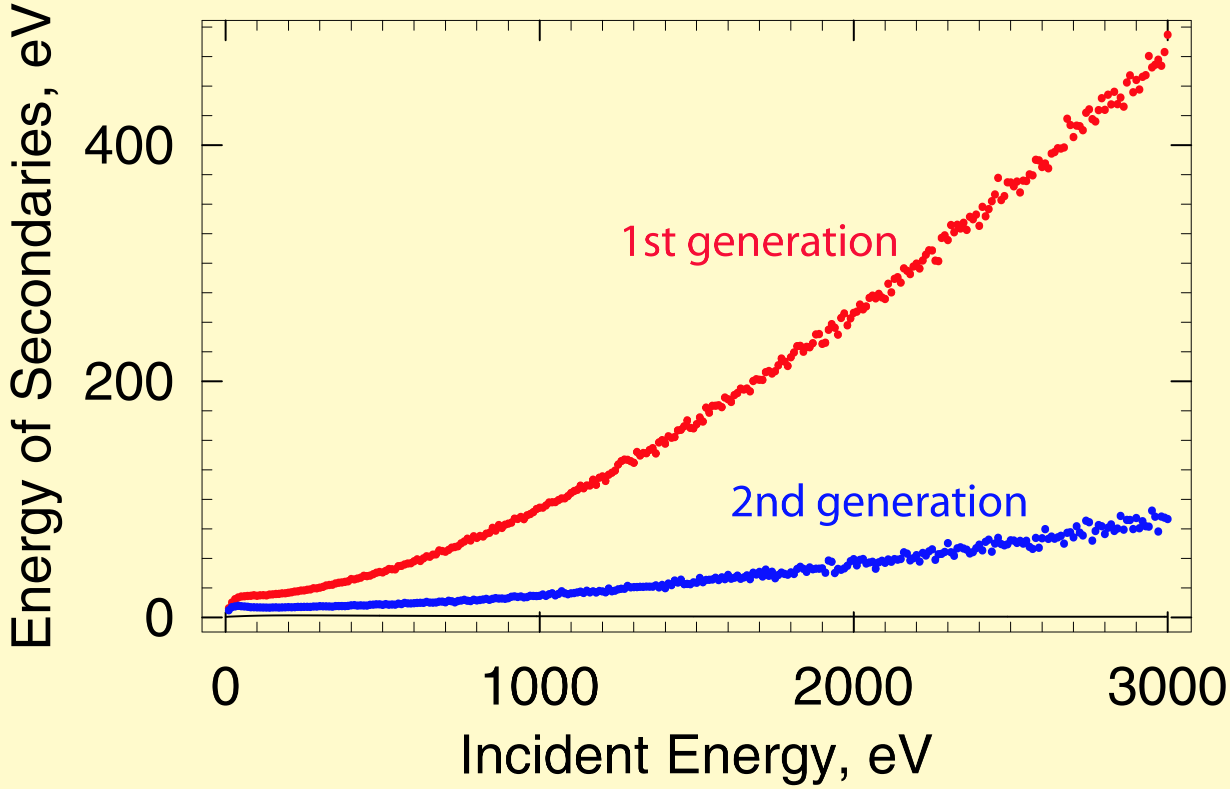
- Angular distribution of secondaries $\propto \cos\theta$.
- Incident-angle dependence $\delta \propto [1 + r_1(1 - \cos^{r_2}\theta_0)]$.
- 22 parameters are used to fit the curve

Triangular grooves, 60 degrees



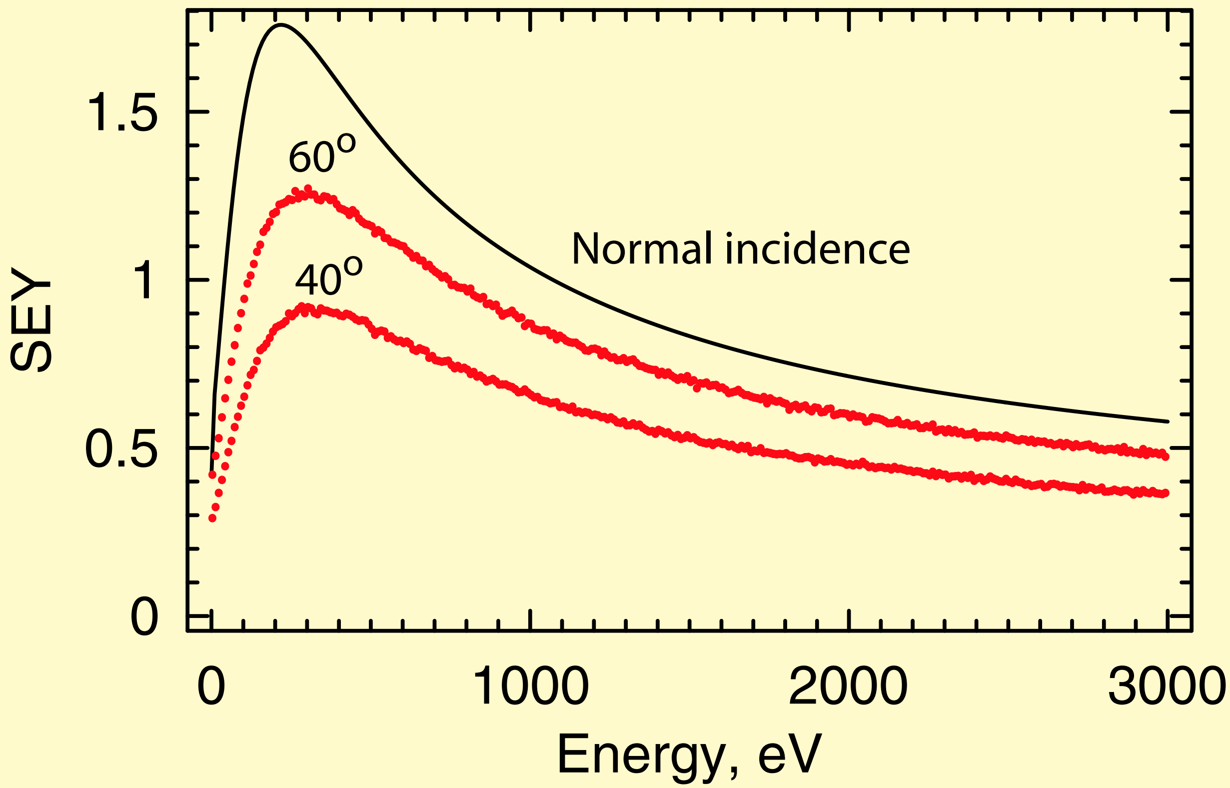
Copper, max SEY 1.75, 60 degrees triangular grooves.

Triangular grooves, 60 degrees

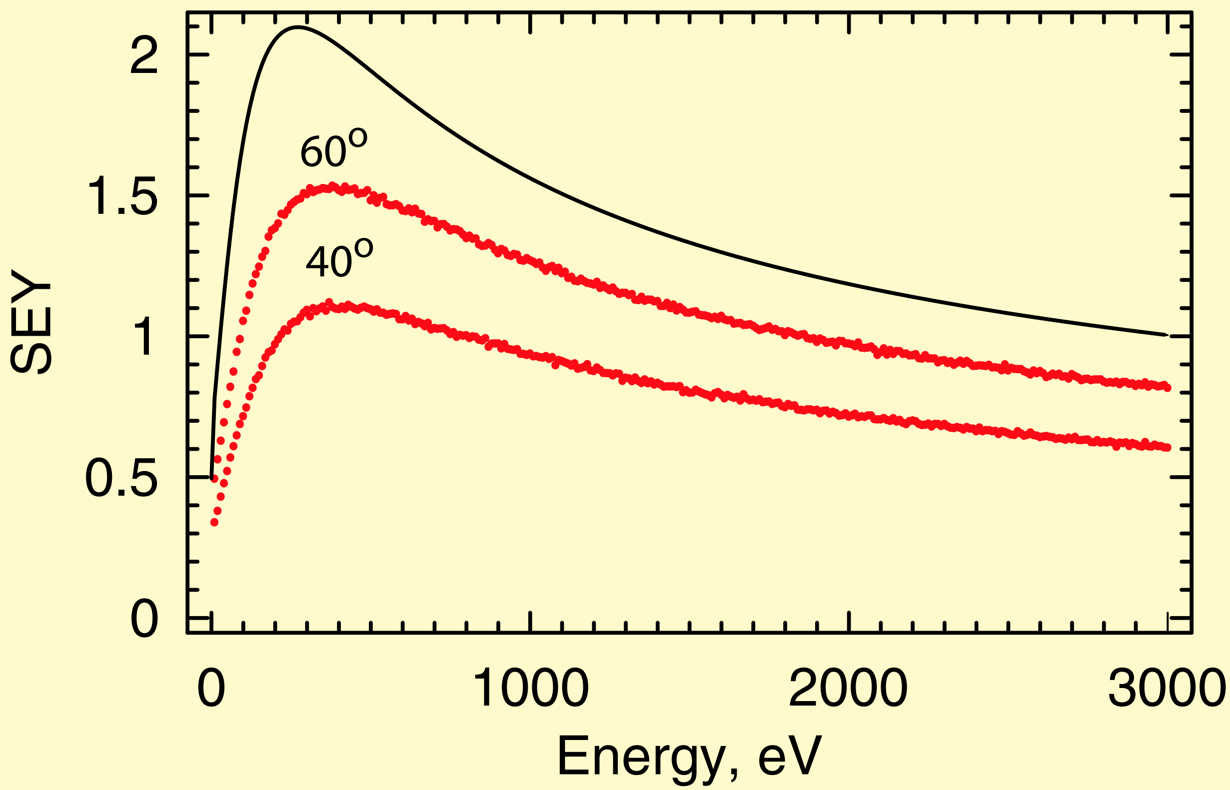


Energy of secondaries versus incident energy.

Triangular grooves, 40 and 60 degrees

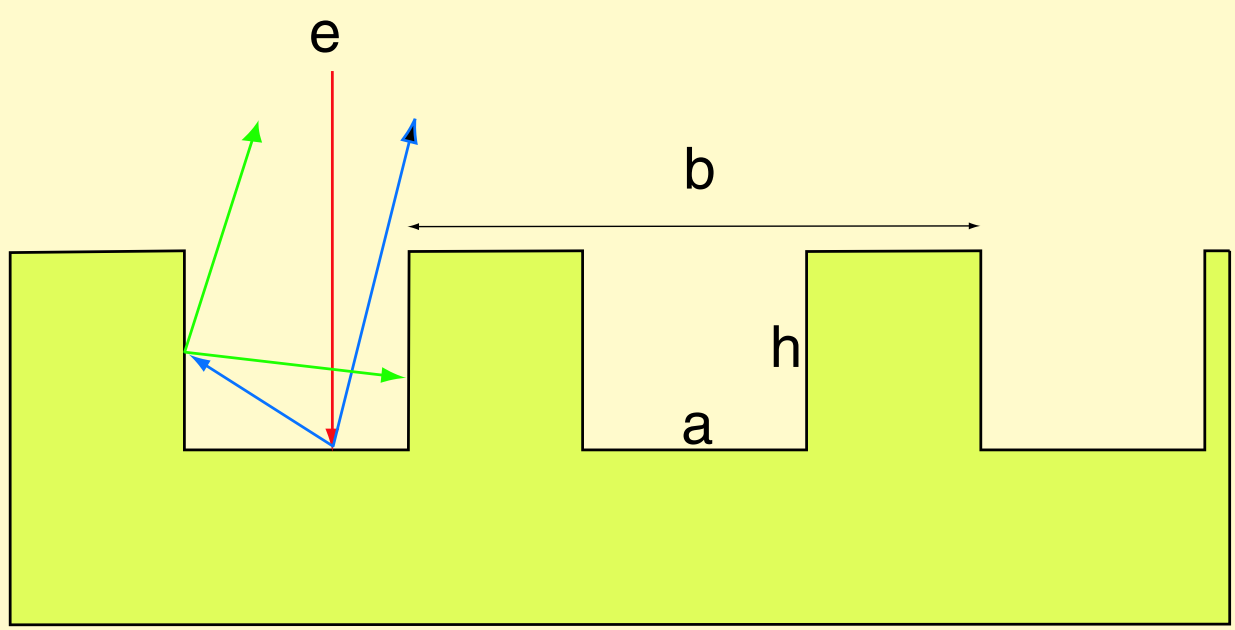


Triangular grooves, 40 and 60 degrees



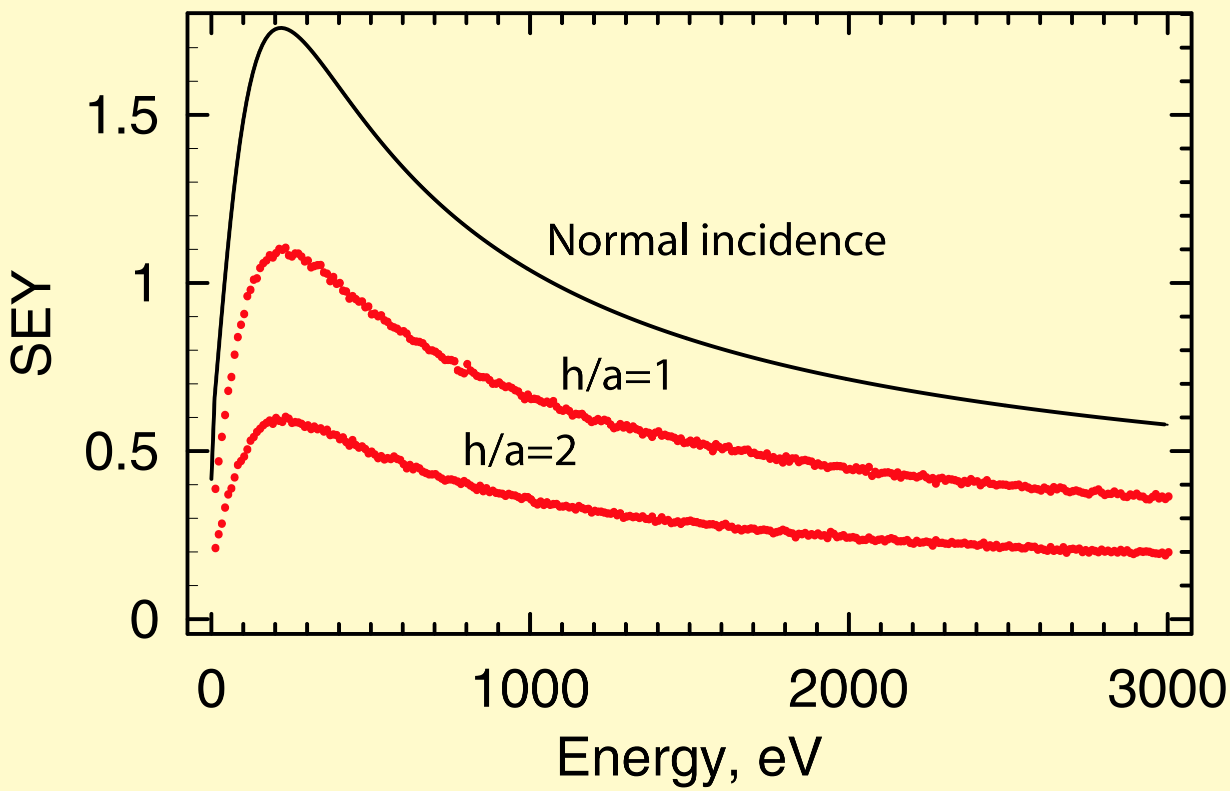
Copper, max SEY 2.1

Rectangular corrugations



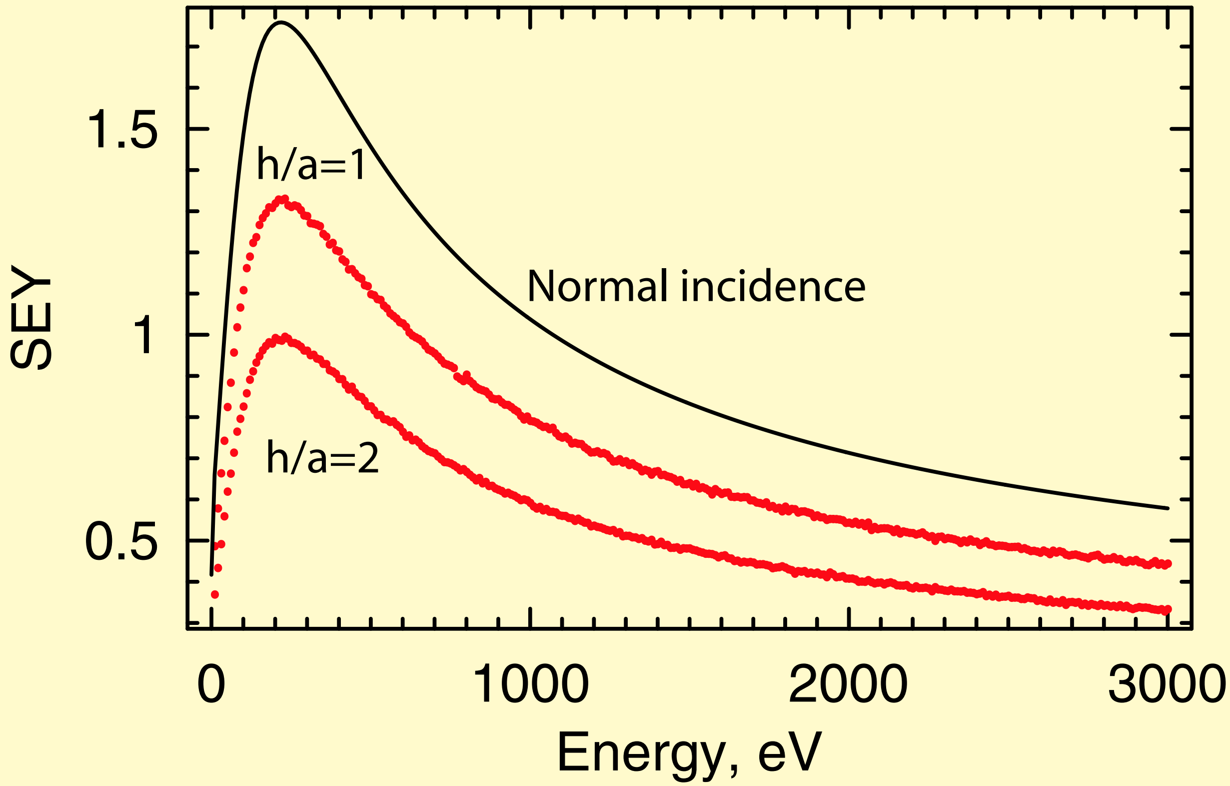
b – the period, *h* – the height, *a* – the width.

Rectangular grooves, neglect ridges



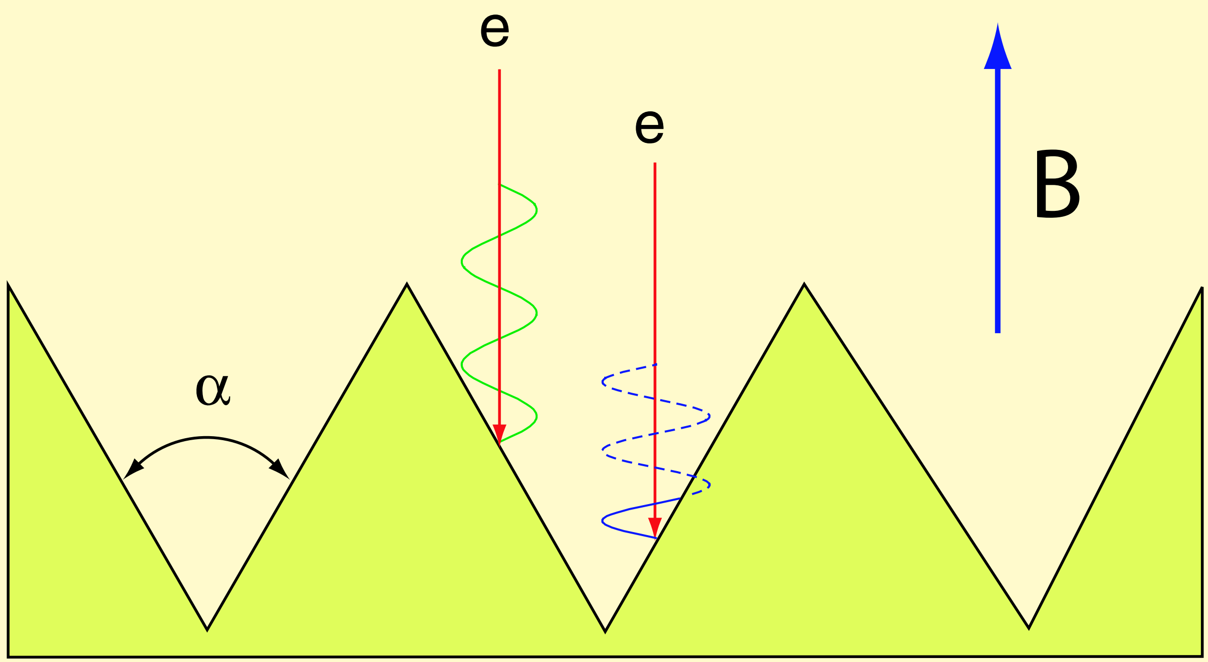
Assume $b = a$

Rectangular grooves, $a = \frac{2}{3}b$



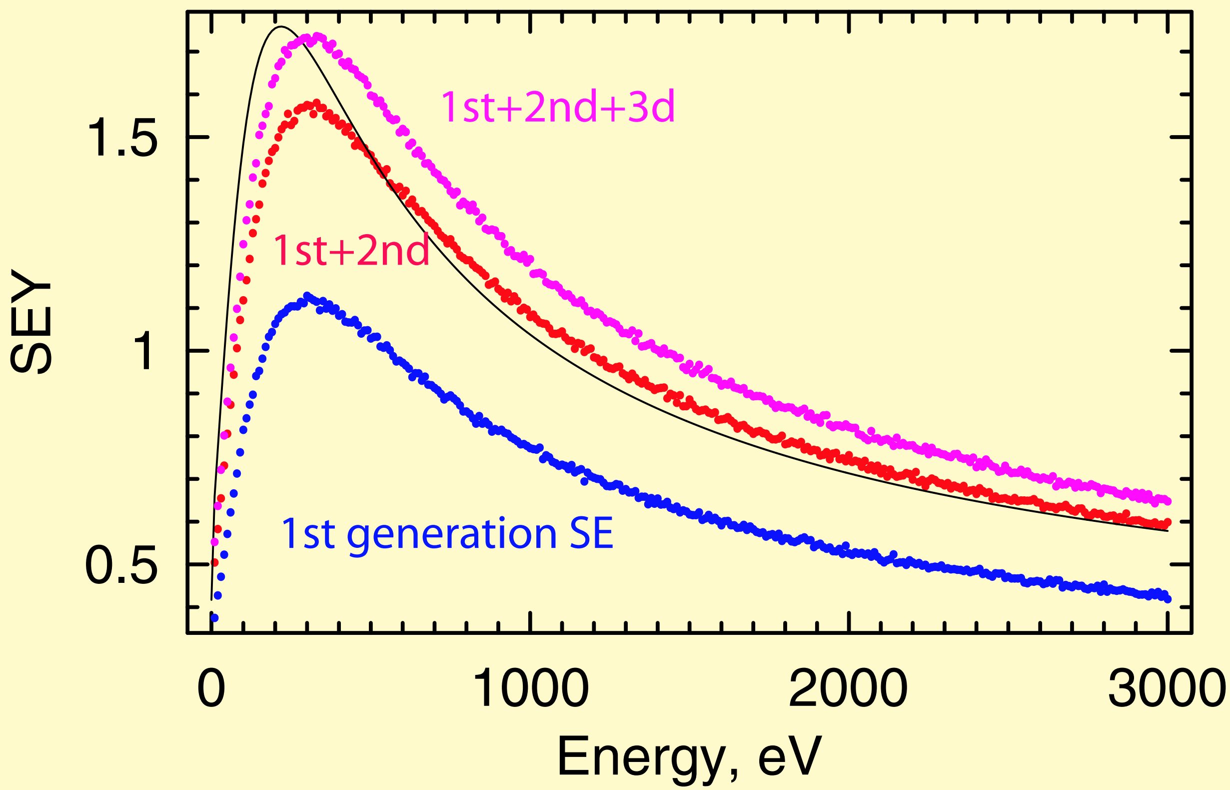
$a = \frac{2}{3}b$

Effect of magnetic field



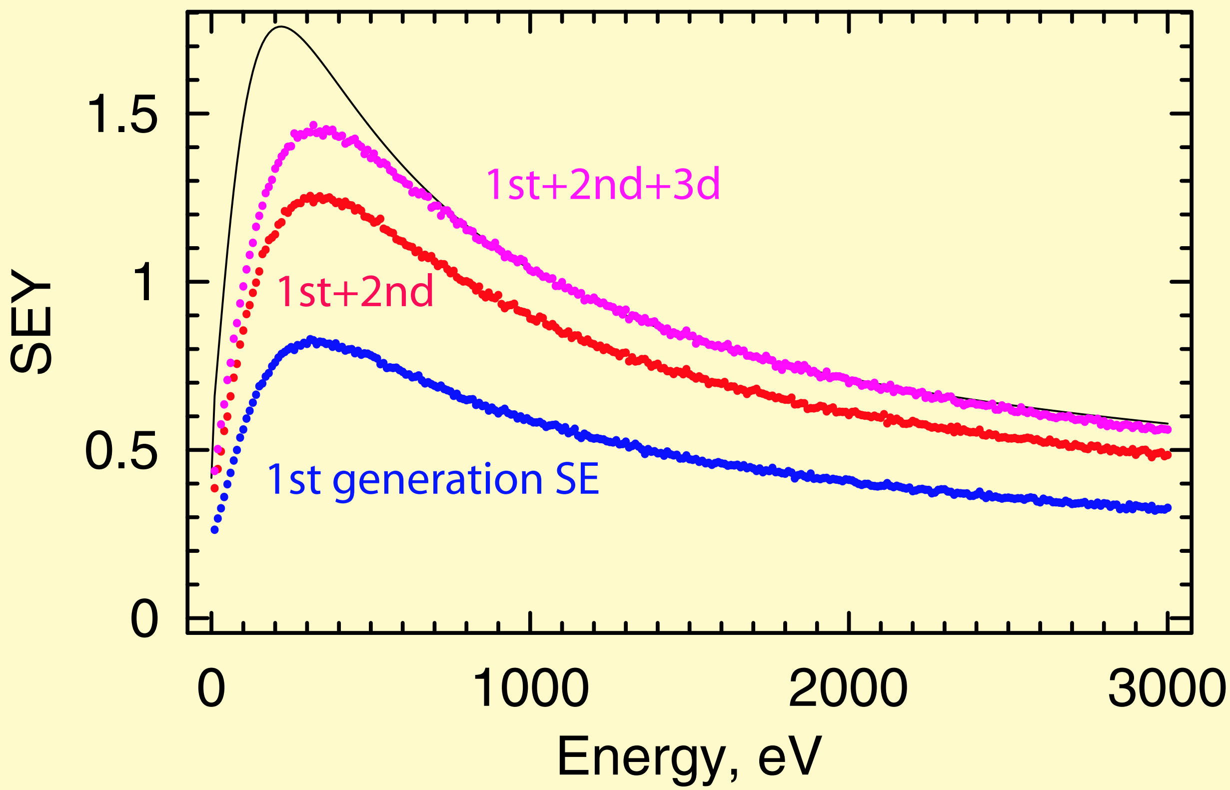
For 200 eV electron, the Larmor radius r_L in 1 Tesla field is about 25 microns. In the limit when $r_L \ll$ size of grooves, the effective SEY does not depend on r_L and is only a function of α.

Triangular grooves, 60, magnetic field



Copper, max SEY 1.75, 60 degrees triangular grooves.

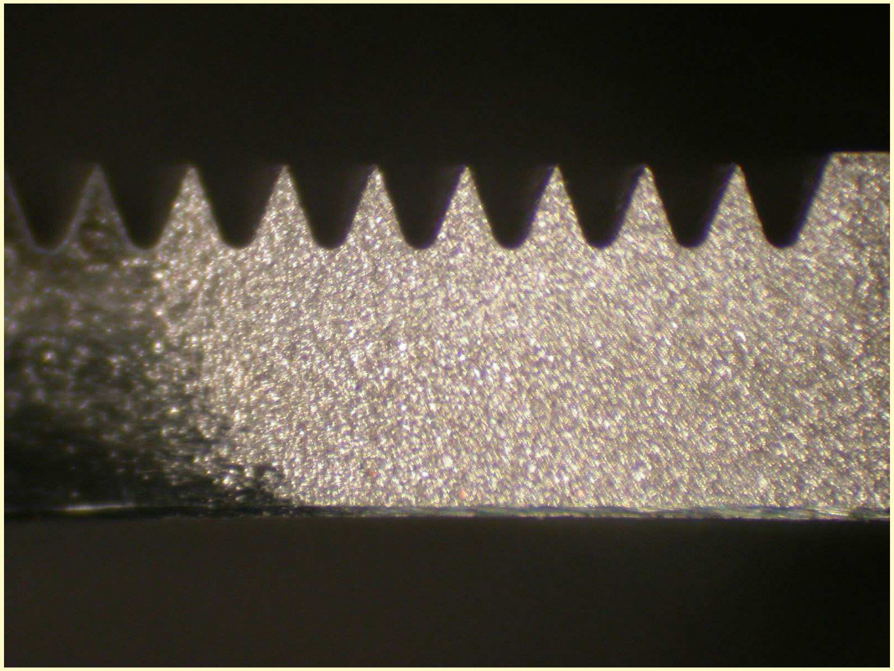
Triangular grooves, 40, magnetic field



Copper, max SEY 1.75, 40 degrees triangular grooves.

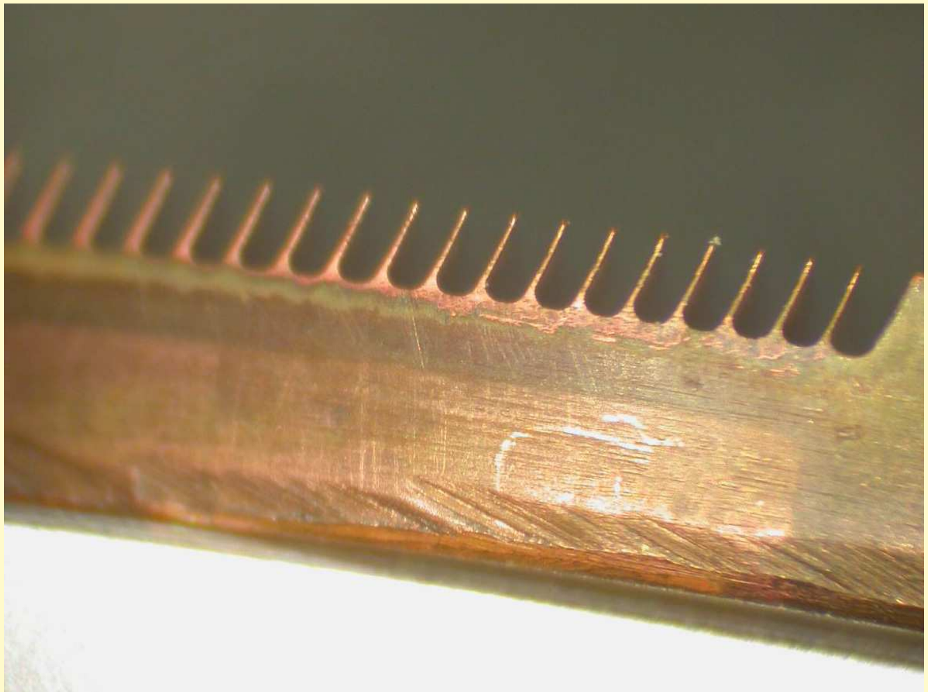
Experiment at SLAC

R. Kirby, M. Pivi and F. Le Pimpec are making experimental measurements of the SEY for grooved surfaces.



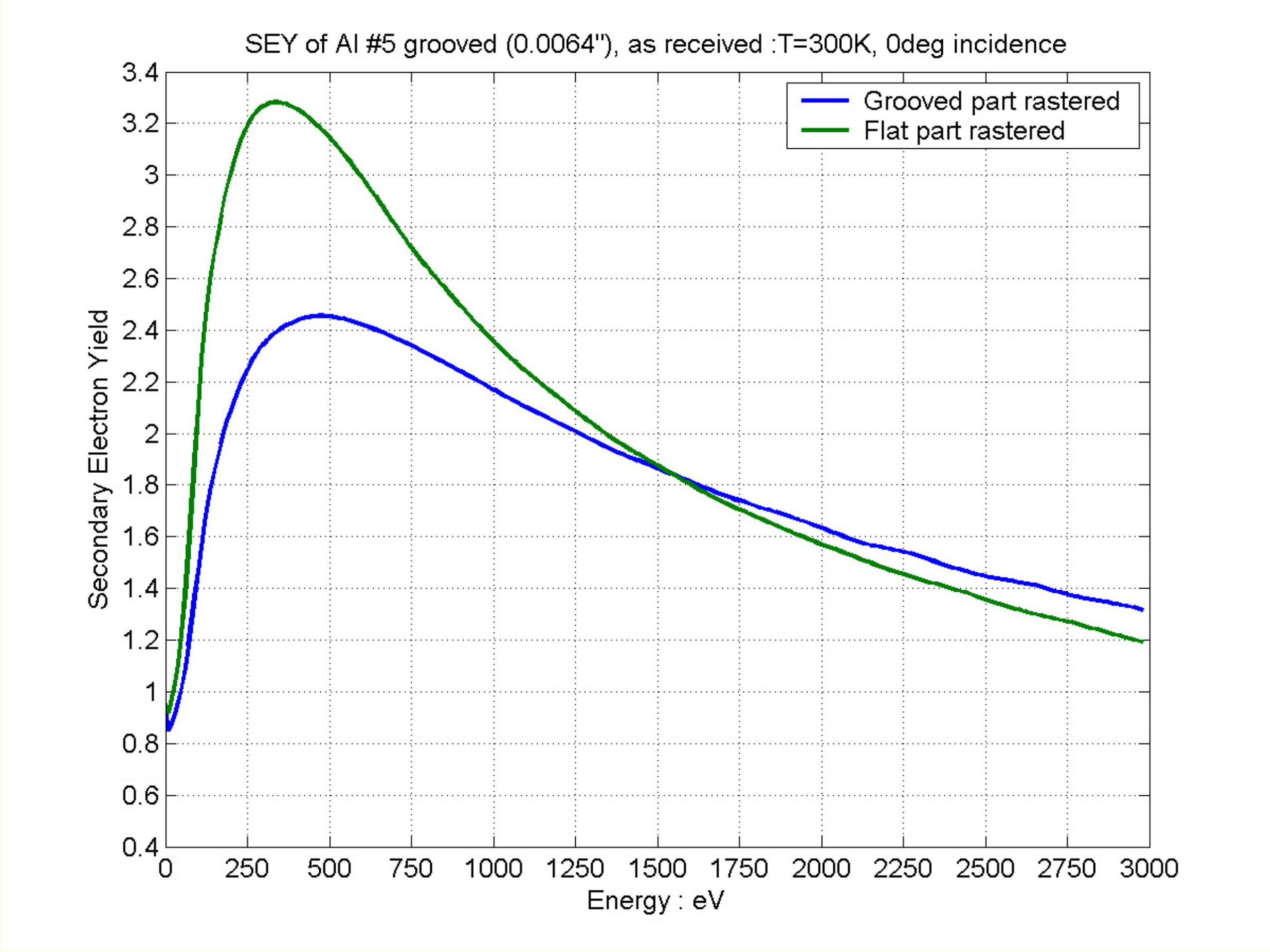
Aluminium sample with $\alpha = 40$ and depth about 1mm.

Experiment at SLAC



Copper sample

Experiment at SLAC



Summary and Discussion

- One can suppress SEY using grooves on the surface of the vacuum chamber. The amount of suppression depends on how deep are the grooves. We developed a code that calculates the suppression for given geometrical parameters of the grooves.
- Without magnetic field, the suppression depends only on groove angle or aspect ratio—it does not depend on physical dimensions of the grooves. The same is true in the limit $r_L \ll$ size of grooves.
- SEY suppressions in strong magnetic field is not so effective. Further studies are required.

Summary and Discussion

- To minimize impedance, the grooves should be oriented along the beam orbit. Grooves increase the area of the surface of the vacuum champer.

- Experiment is being carried out at SLAC, and first results confirm the effect of suppression.