Impedance & SEY of grooved Surface

Ecloud in Quadpole

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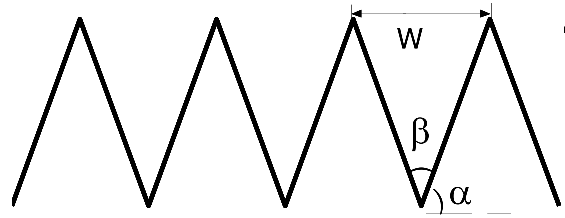
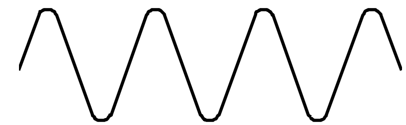
Impedance enhancement factor

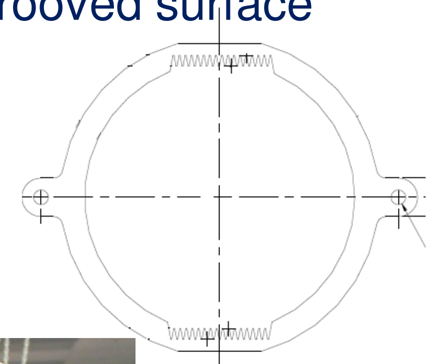
(Code : Finite Element Method, PAC07 THPAS067, L Wang)

$$\eta = \frac{Z_{groovedsurface}}{Z_{smoothsurface}} = \frac{\int H^2 ds}{H_0^2 W}$$





The total impedance enhancement= η * percentage of grooved surface
*percentage chamber length with grooved surface



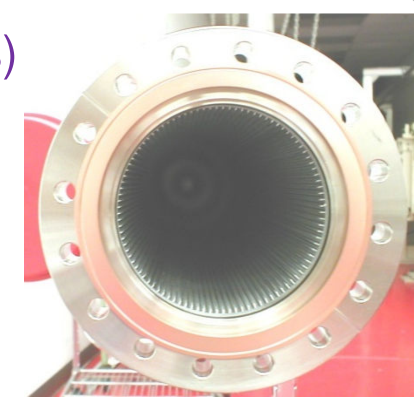
Triangular groove in dipole and wiggler magnets

Round Chamber with radius: 30 mm or 23 mm (two types)
Width of grooves inside chamber: 25 mm on top and 25 mm on bottom

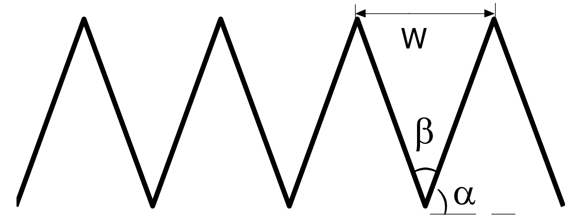
percentage of grooved surface=26.5%(34.6%)

Rectangular groove in drift region

percentage of grooved surface=100%



Triangular Grooved surface in Magnet(dipole & wiggler)

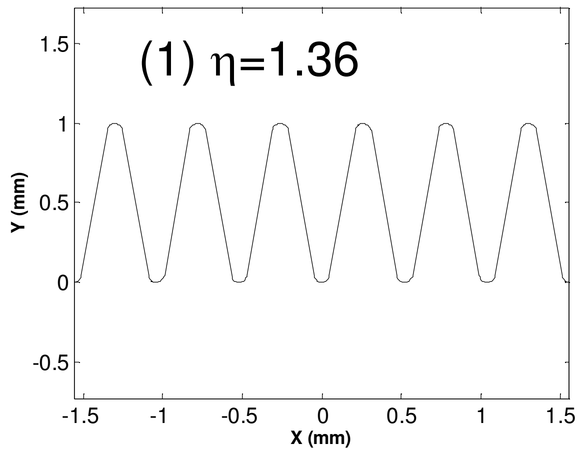


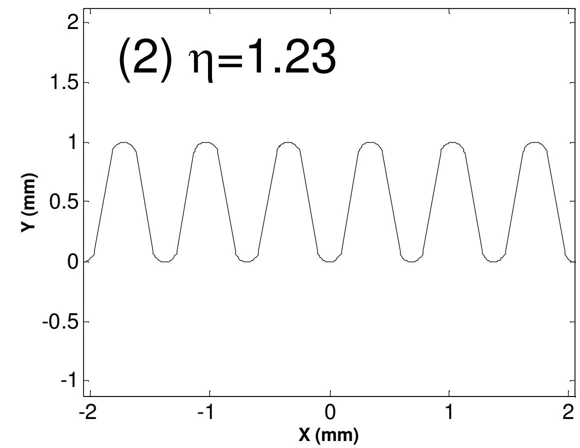
(1) α =80
  Groove depth: 1 mm
  Roundness: 50 um
  η=1.36

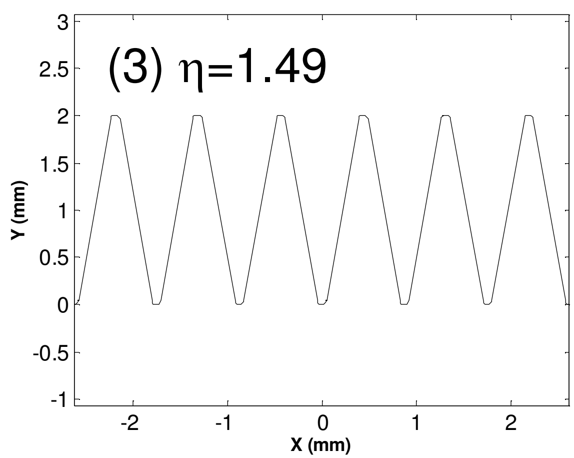
(2) α =80
  Groove depth: 1 mm
  Roundness: 100 um
  η =1.23

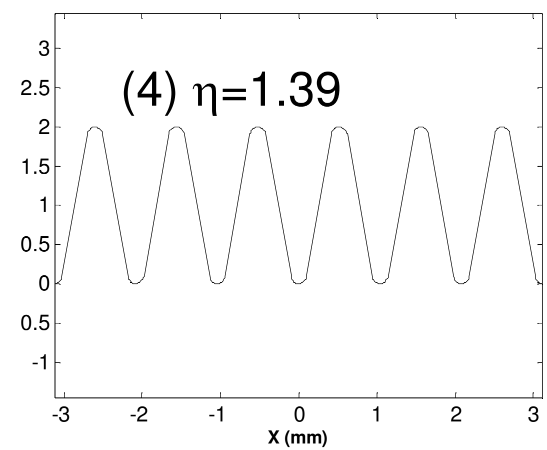
(3) α =80
  Groove depth: 2 mm
  Roundness: 50 um
  η =1.49

(4) α =80
  Groove depth: 2 mm
  Roundness: 100 um
  η =1.39









Rectangular groove

- ***Low impedance with round tips***
- ***There is a small impedance enhancement factor for a larger t/p*** *(*K.Bane and Stupakov slac-pub-11677*)*

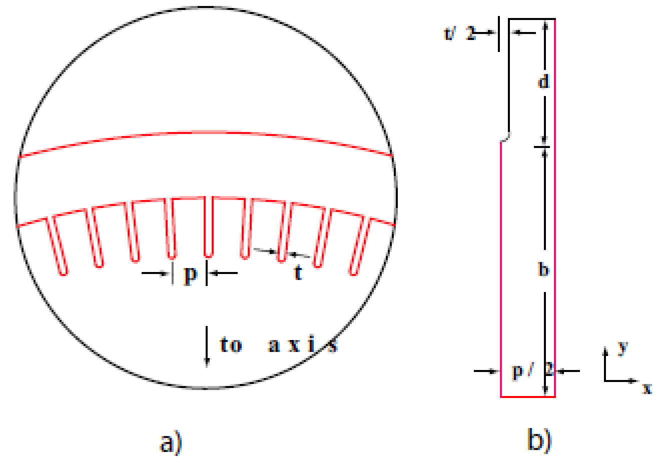


Figure 1: a)—detail of the … amber wall; dimensions shown are per … ness t; b)—

p=1.25mm (period)
d=2.5mm (depth)
t=0.125mm (thickness)

$$\eta = 1.64$$

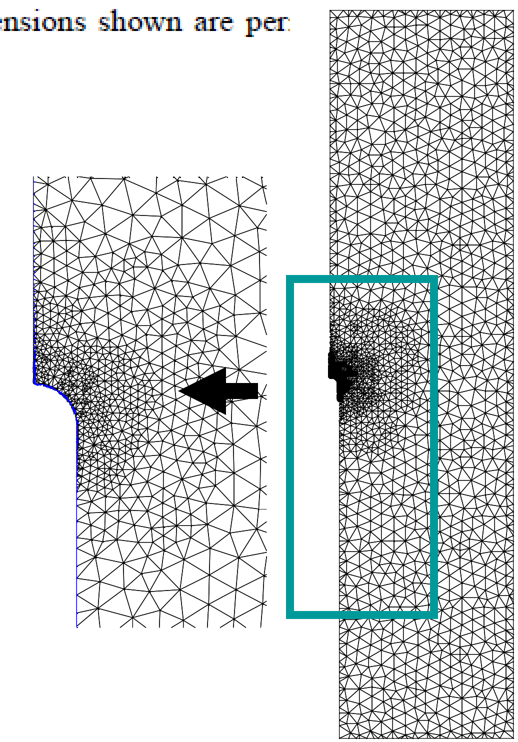
p=1.25mm
d=2.5mm
t=0.25mm

$$\eta = 1.42$$

p=1.25mm
d=3.5mm
t=0.125mm

$$\eta = 1.63$$

Round tips

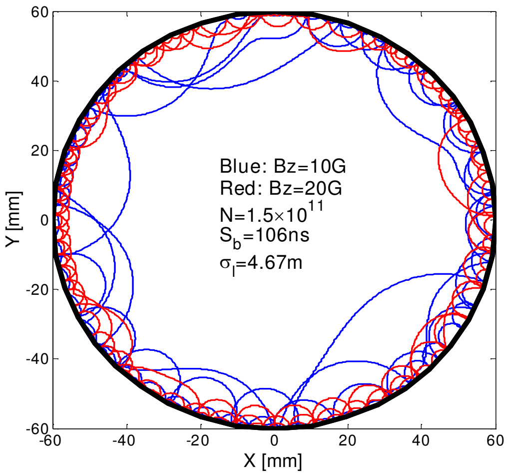


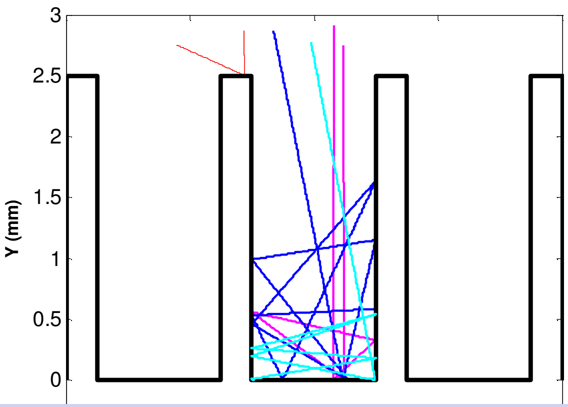
Mechanism of reduction of SEY using grooved surface

- **Trap the electrons near the surface……**

Drift region

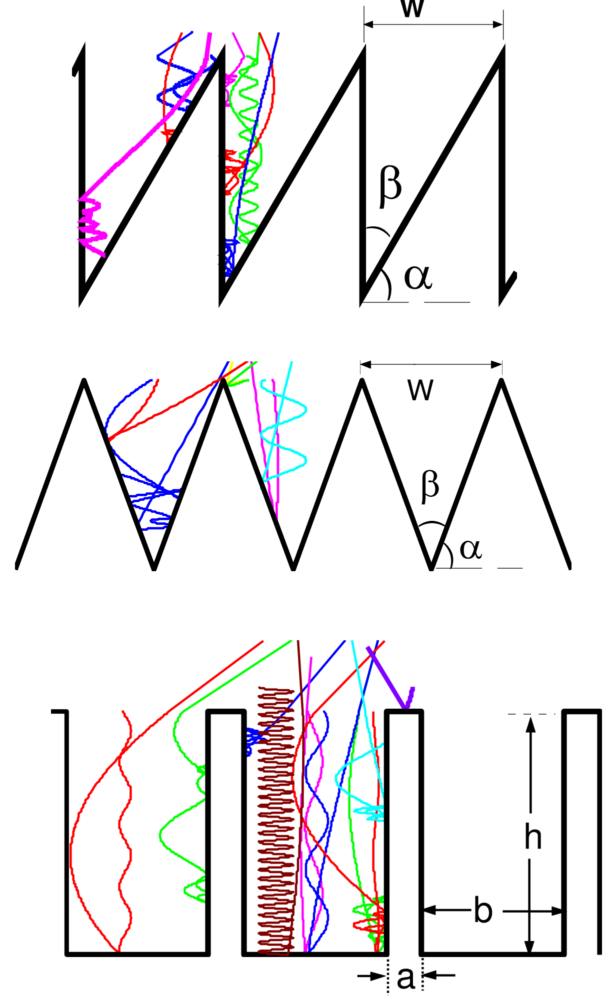
(solenoid)





Rectangular Groove without magnetic field

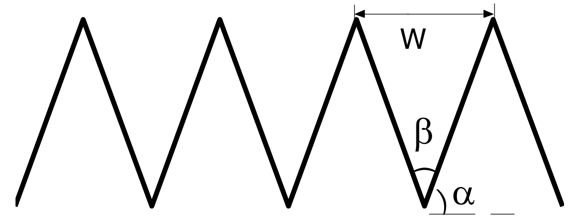
Magnets



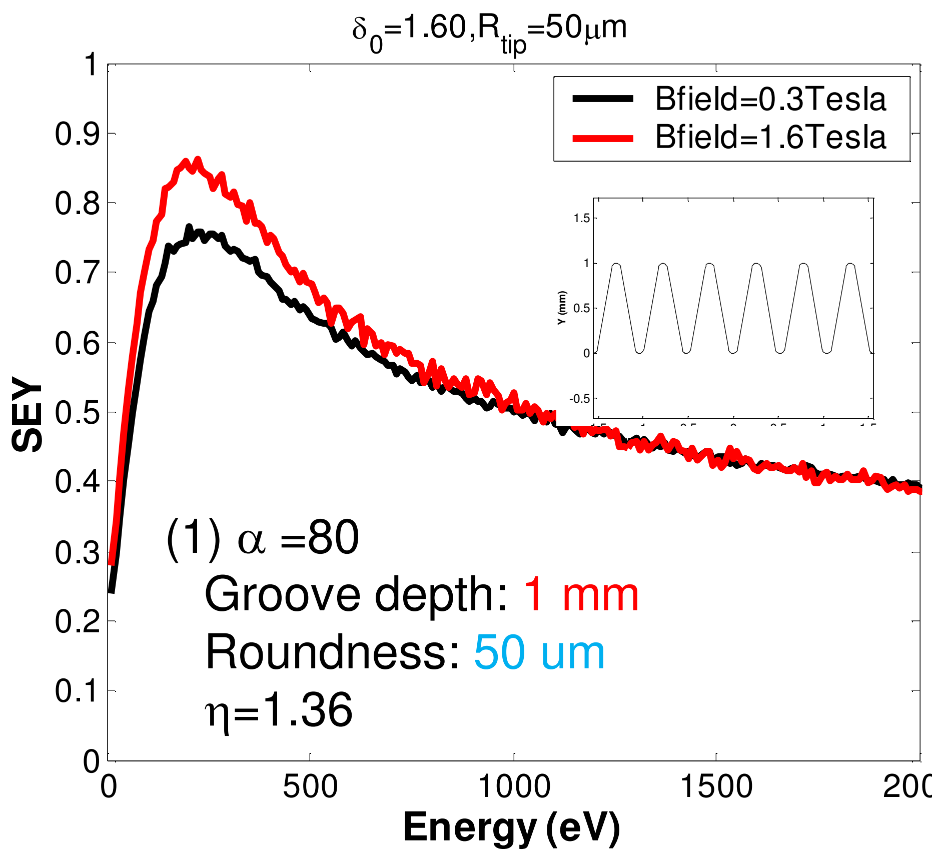
(M. Pivi, PAC05)

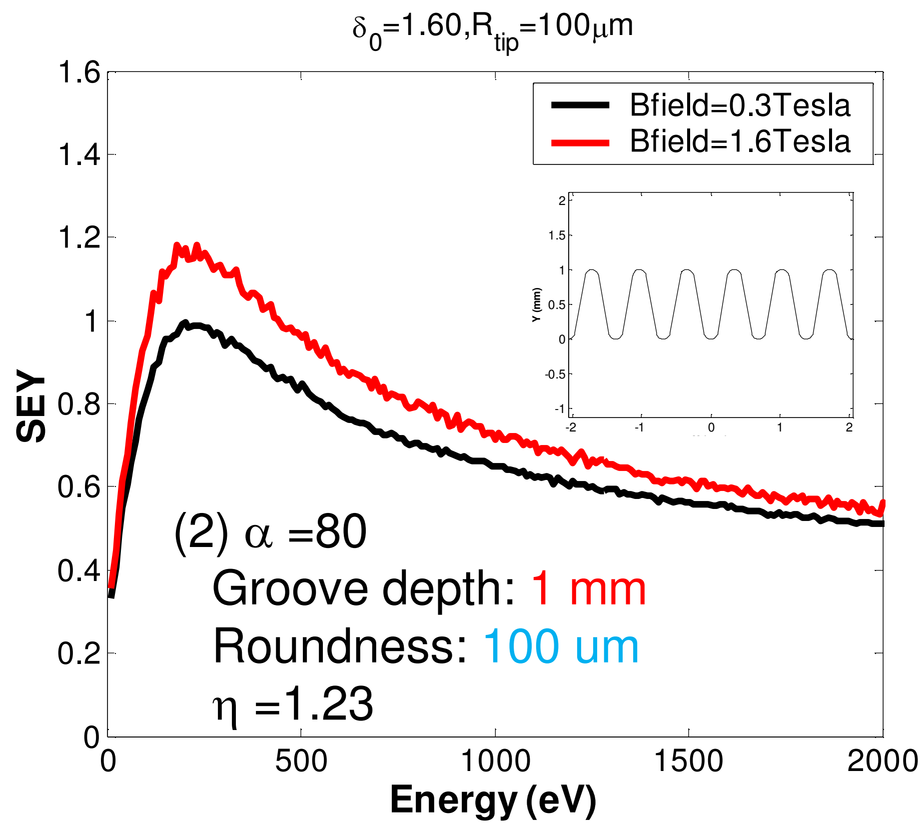
SEY of Triangle Grooved surface

(depth: 1 mm)



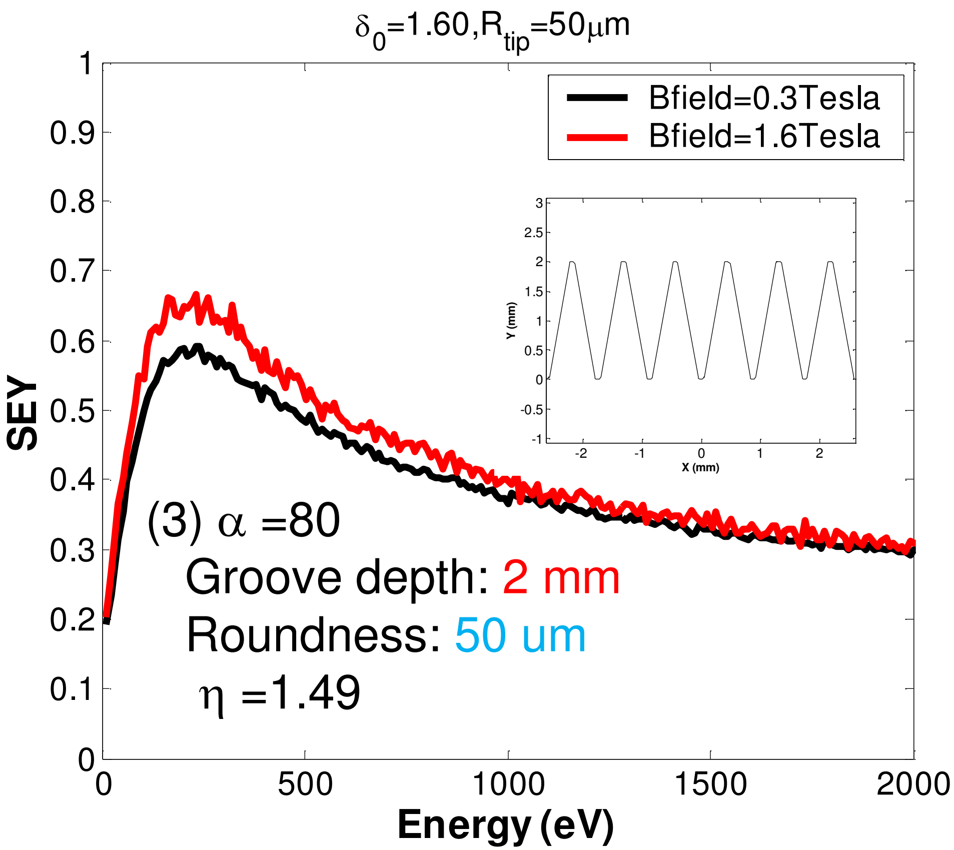
There is smaller SEY with smaller roundness at tips

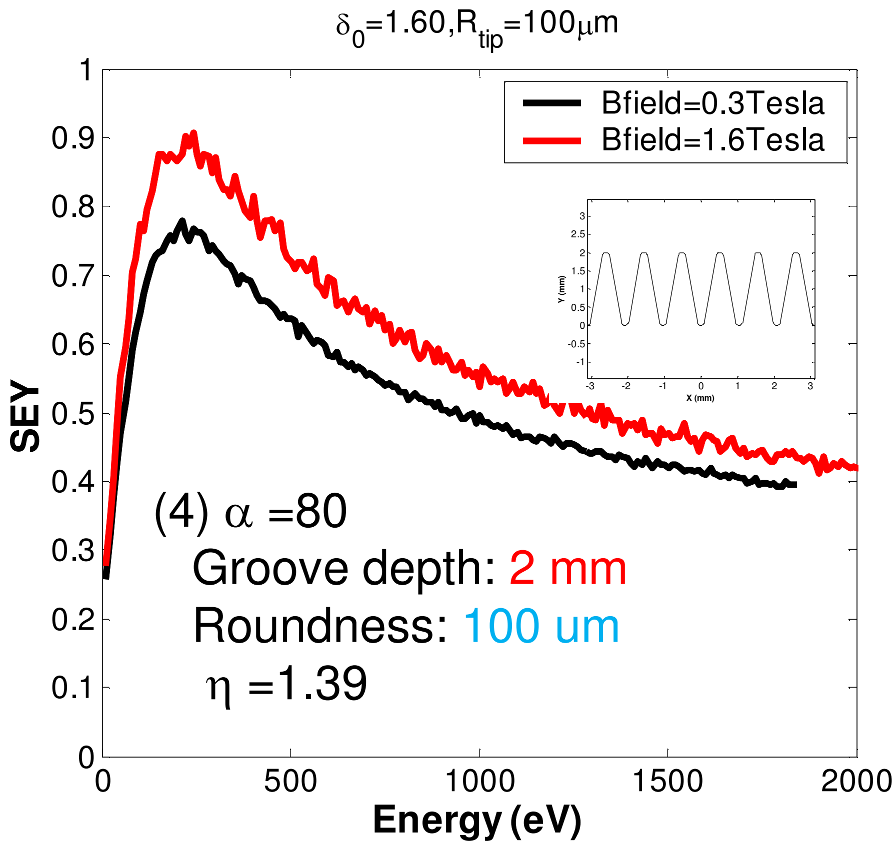




Triangular Groove (depth: 2 mm)

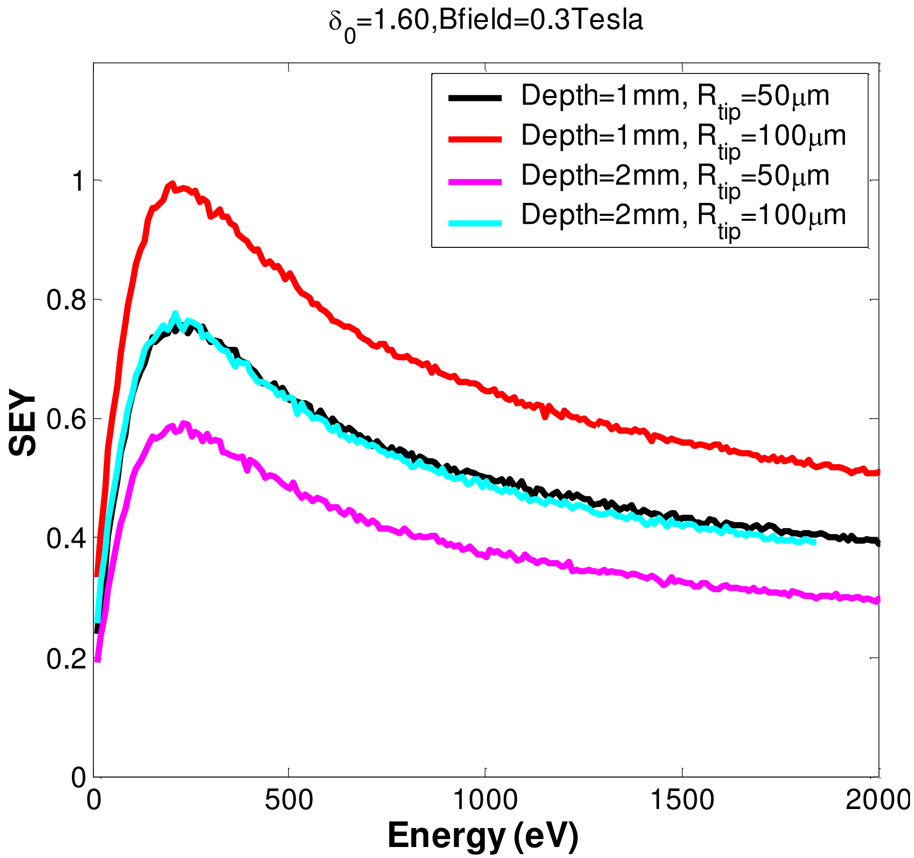
There is smaller SEY for lager size of groove with the same roundness



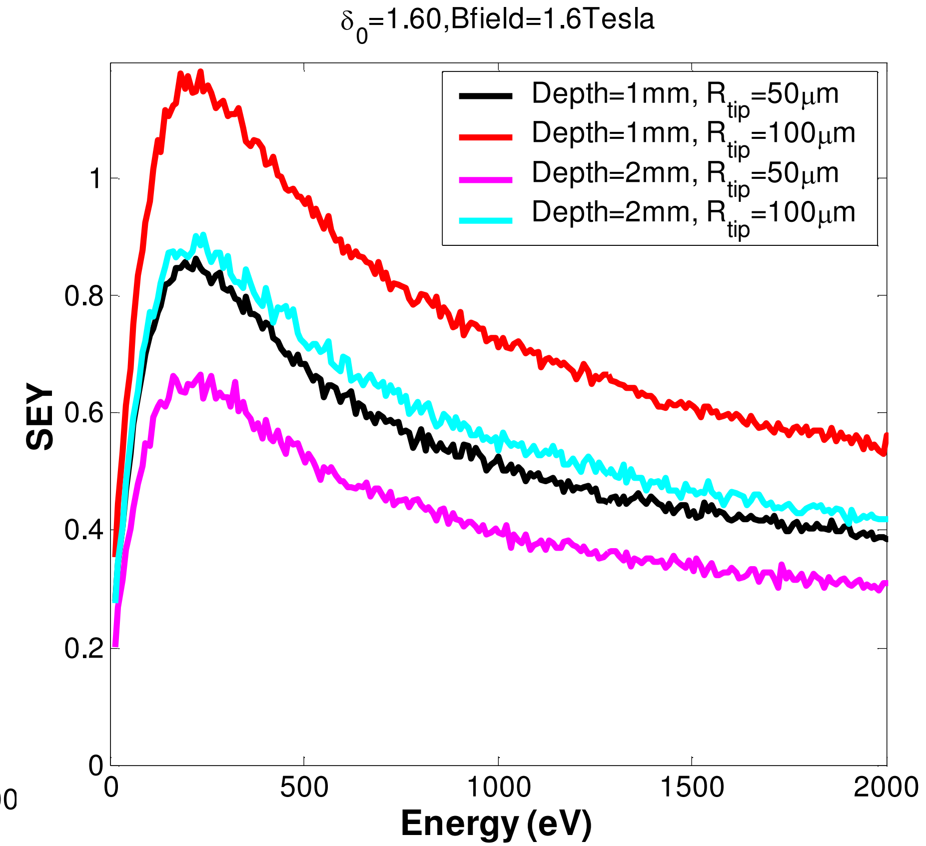


Summary of the effect of Bfield and shape

- **There is a lager SEY in a stronger magnet**
- **There is a smaller SEY for larger groove with smaller roundness**
- **(a sharper tip is desired in order to reduce SEY!!)**



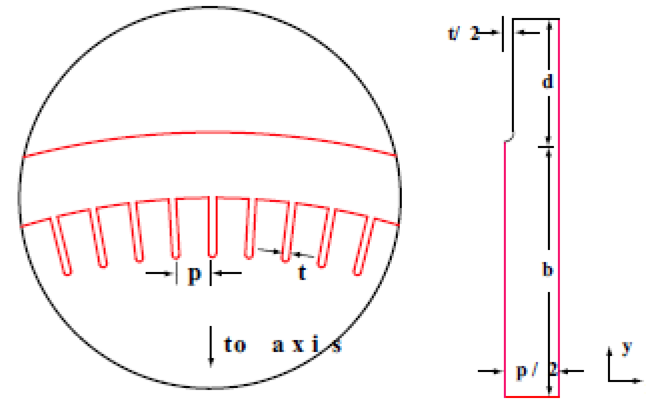
SEY with Dipole field=0.3T



SEY with Dipole field=1.6T

Rectangular groove
(Drift region only)

- ➢ **Deeper groove has smaller SEY**
- ➢ **Shorter shoulder has smaller SEY**



a) b)

amber wall;
ness t; b)—

(5)p=1.25mm (period)

d=2.5mm (depth)

t=0.125mm (thickness)

(6)p=1.25mm

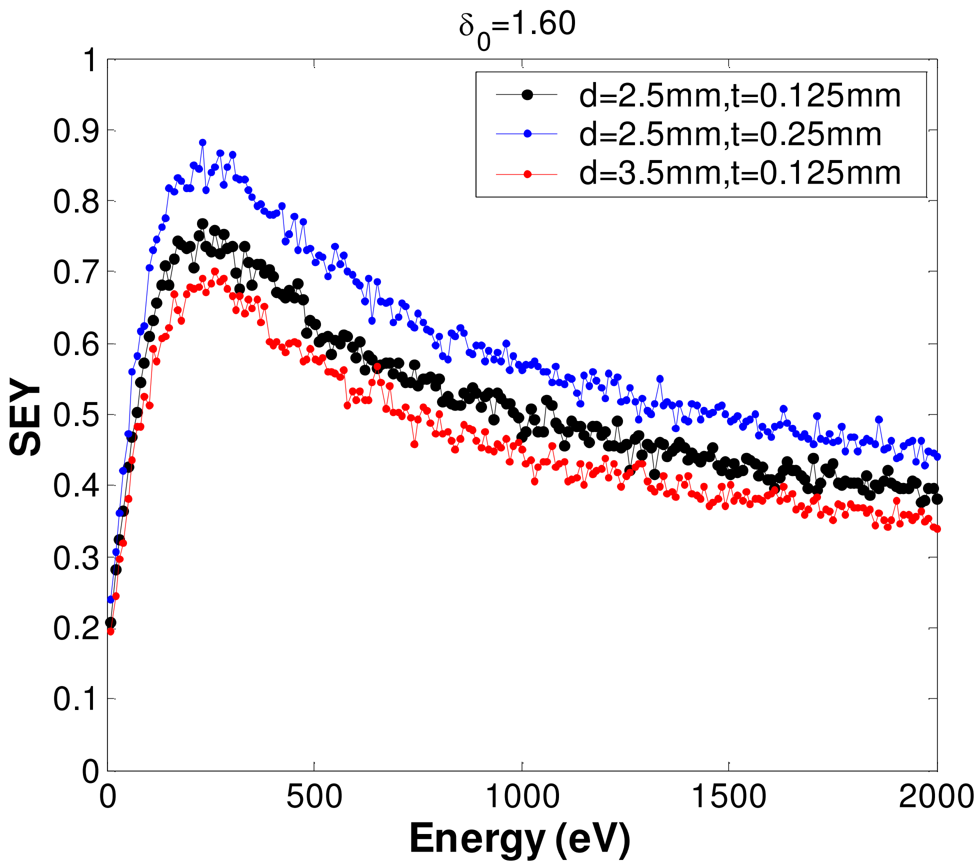
d=2.5mm

t=0.25mm

(7)p=1.25mm

d=3.5mm

t=0.125mm



Summary

Triangular Groove in Dipole Magnets

Groove Type	Depth 1mm Roundness 50 um	Depth 1mm Roundness 100 um	Depth 2mm Roundness 50 um	Depth 2mm Roundness 100 um
Impedance enhancement η	1.36	1.23	1.49	1.39
Peak SEY(δ_0=1.6) at B=0.3Tesla	0.77	0.99	0.59	0.78
Peak SEY(δ_0=1.6) at B=1.6 Tesla	**0.86**	**1.18**	**0.67**	**0.91**

Rectangular Groove in Drift Region

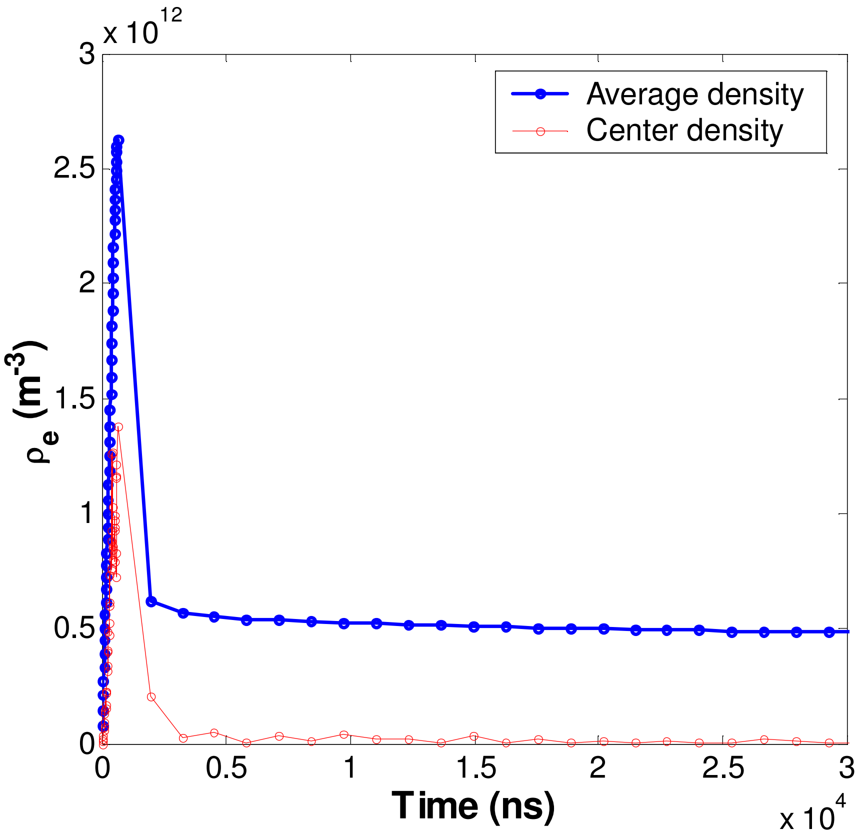
Groove Type	d=2.5mm t=0.125mm	d=2.5mm t=0.25mm	d=3.5mm t=0.125mm
Impedance enhancement η	1.64	1.42	1.63
Peak SEY(δ_0=1.6)	0.77	0.88	0.7

E-cloud Trapping in Quadrupole

- Sigz=15mm
- Ib=1.3mA
- BunchSp=14ns
- K2=0.517T/m
- R=1.0
- SEY=2.0
- Emax=276eV

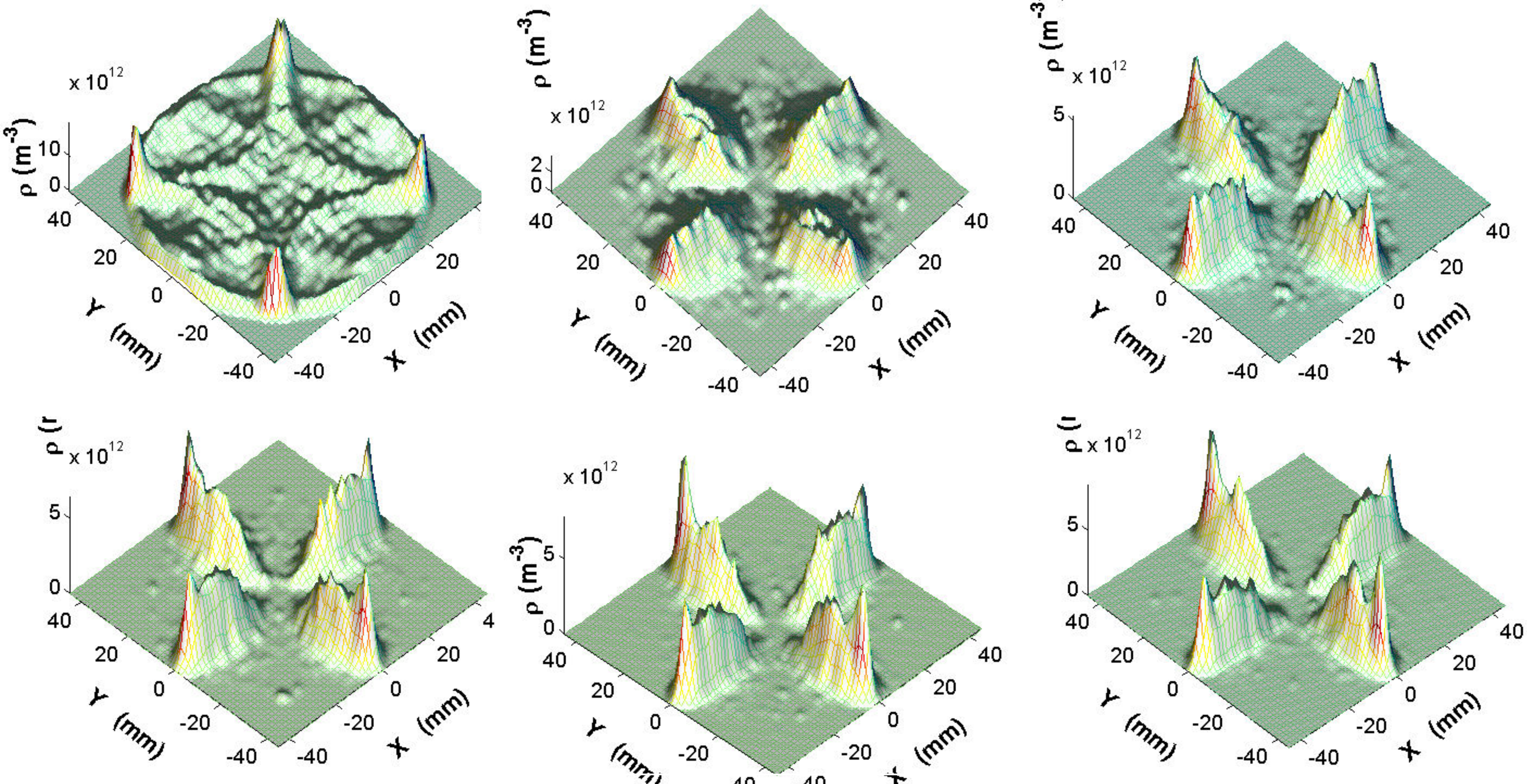
(courtesy J. Calvey)

Ecloud can be deeply trapped!!!



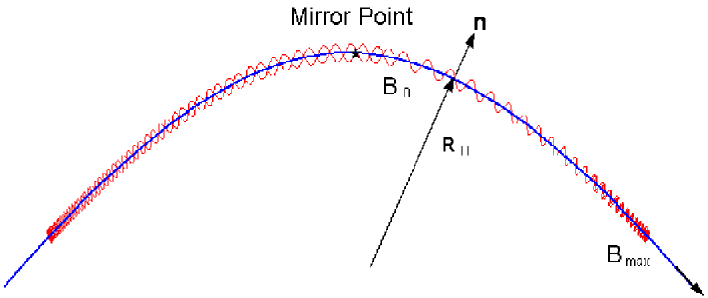
Build-up of electrons and its decay during the train gap

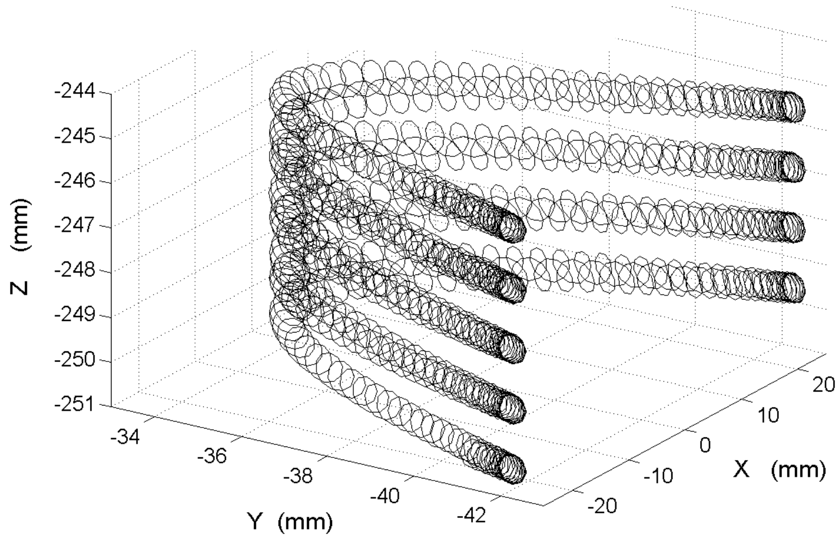
Slow decay of ecloud during the train gap



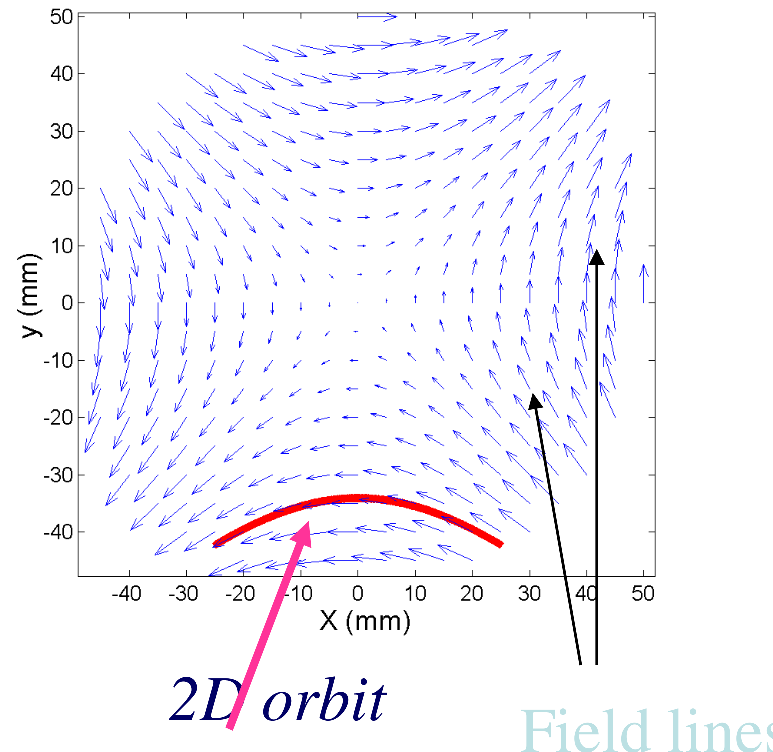
Evolution of e-cloud during the train gap, Δt=70ns

Mirror field Trapping in a quadrupole magnet





3D orbit



Orbit of a trapped photoelectron in normal quadrupole magnet during the train gap (field gradient=0.5T/m)