Modeling Cyclotron Resonances in ECLOUD

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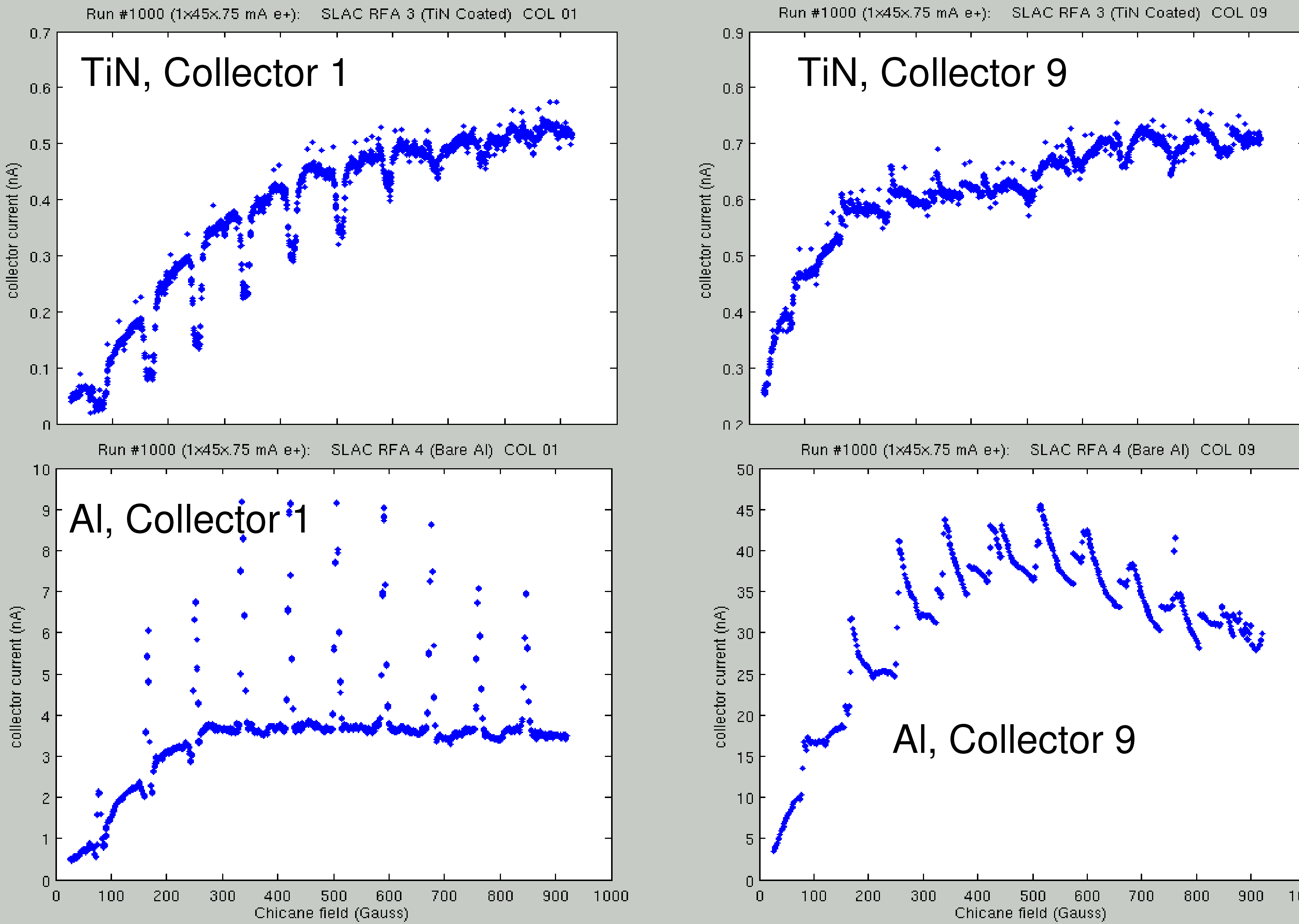
CTA09
CesrTA Electron Cloud R&D Program for Linear Collider Damping Rings
25 June 2009

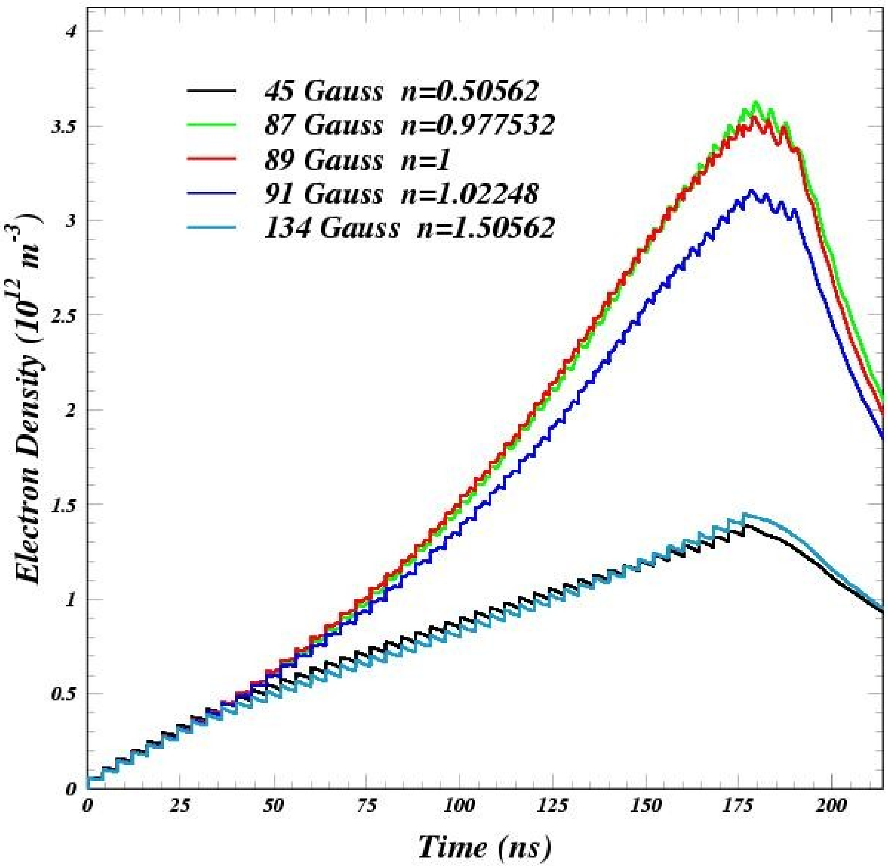
Cornell University
Laboratory for Elementary-Particle Physics

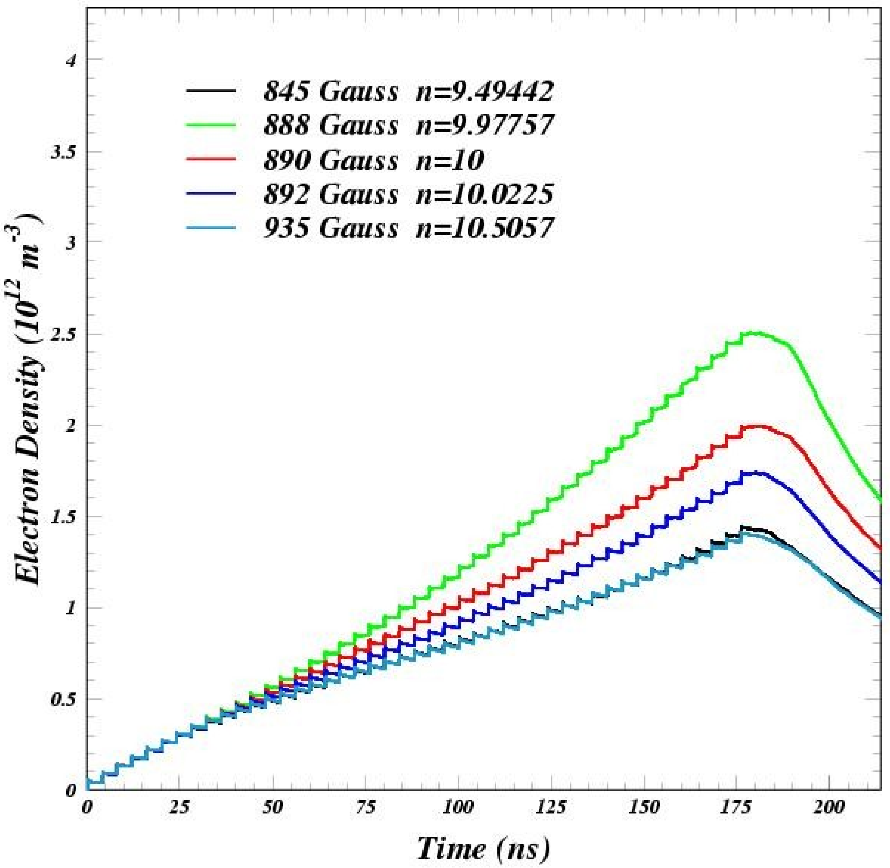
June 2009 CesrTA Measurements
See talk by Joe Calvey, CTA09
4 ns, 2 GeV



45 e^+ bunches, 4-ns spacing, 0.9 mA/bunch

3.5 inch cylindrical v.c. 0.025 p.e./e^+ 100% reflectivity δ_{max} = 2.0 E_{peak} = 310 eV I_b = 1.44e10 e^+/bunch (0.9 mA)

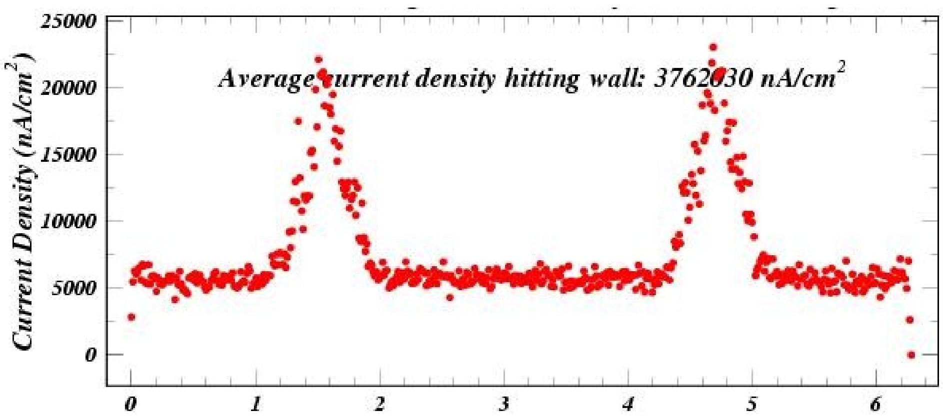




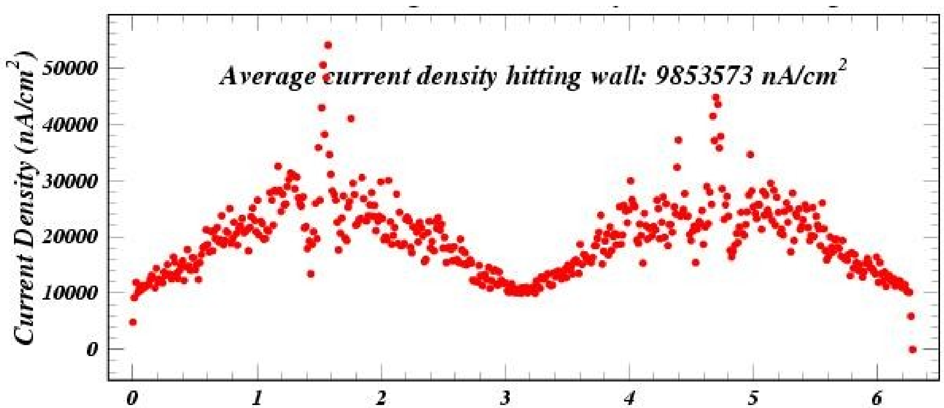
**Resonance more clear with cylindrical vacuum chamber.
Slight offset from n=10.**

Azimuthal Distribution on Vacuum Chamber Wall

Compare n = 0.5 with n = 1.0



n=0.5



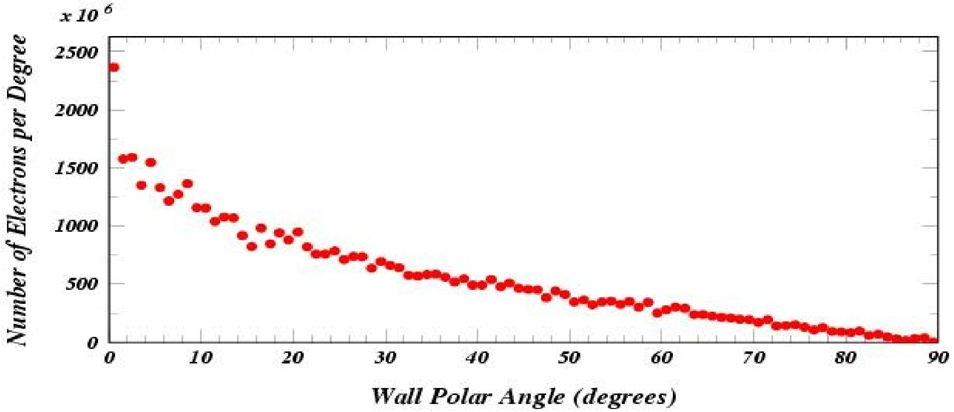
n=1.0

Azimuthal Angle (radians)

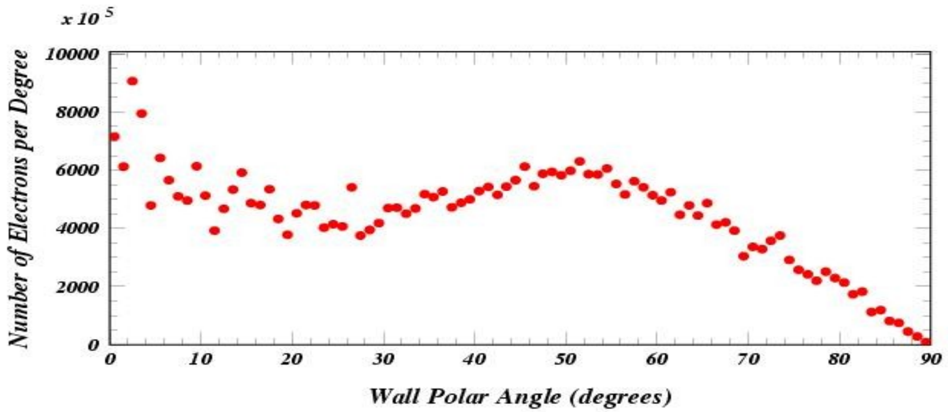
Peaks at top and bottom of chamber more spread out on resonance.
Corresponds to bigger effect for collector 1 than collector 9.
The RFA covers +-0.63 radians (+-36 degrees).

Angle of Incidence on Vacuum Chamber Wall

Compare n = 0.5 with n = 1.0



n=0.5

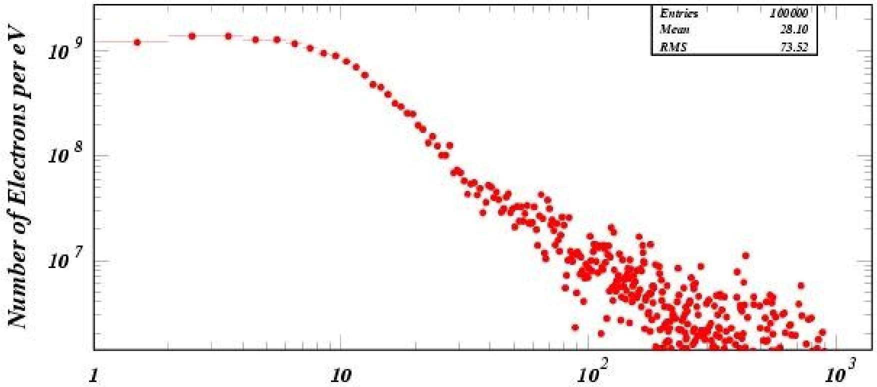


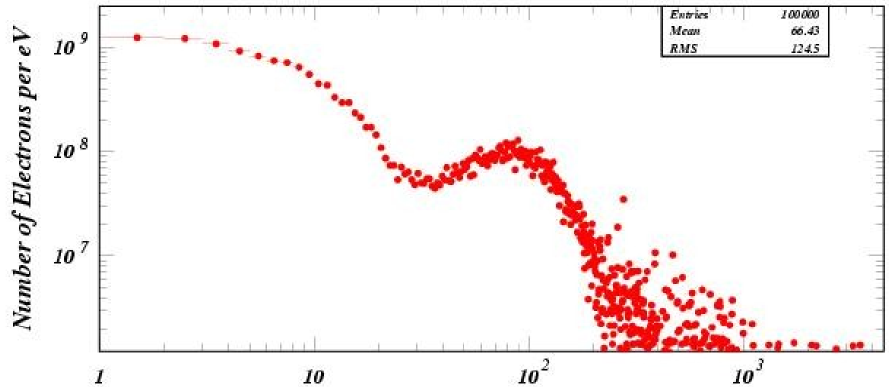
n=1.0

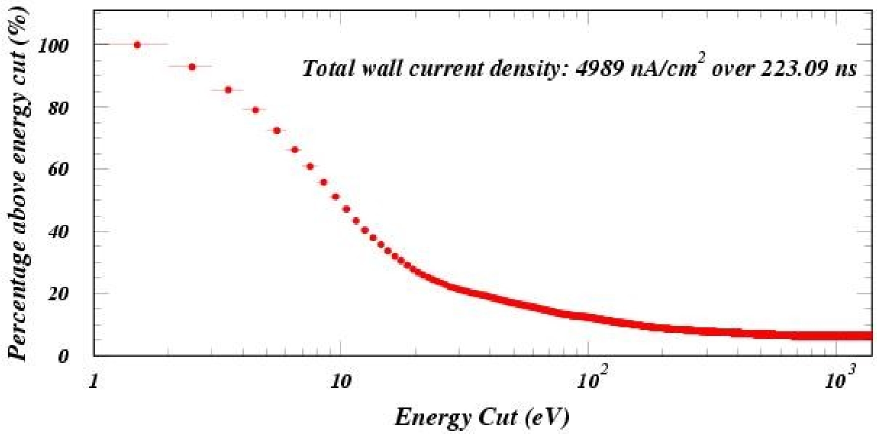
Angles of incidence on wall more glancing on resonance.
Consequences for RFA acceptance. More secondary yield in any case.

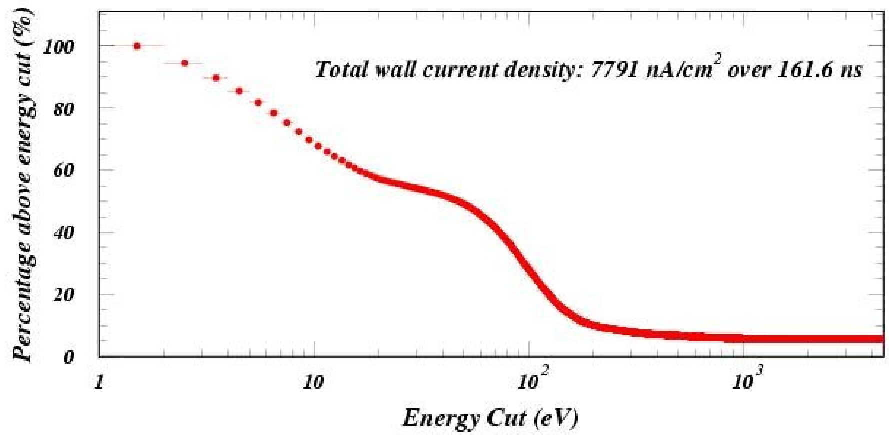
Kinetic Energy Distribution on Vacuum Chamber Wall
Compare n=0.5 with n=1.0

n=0.5	n=1.0







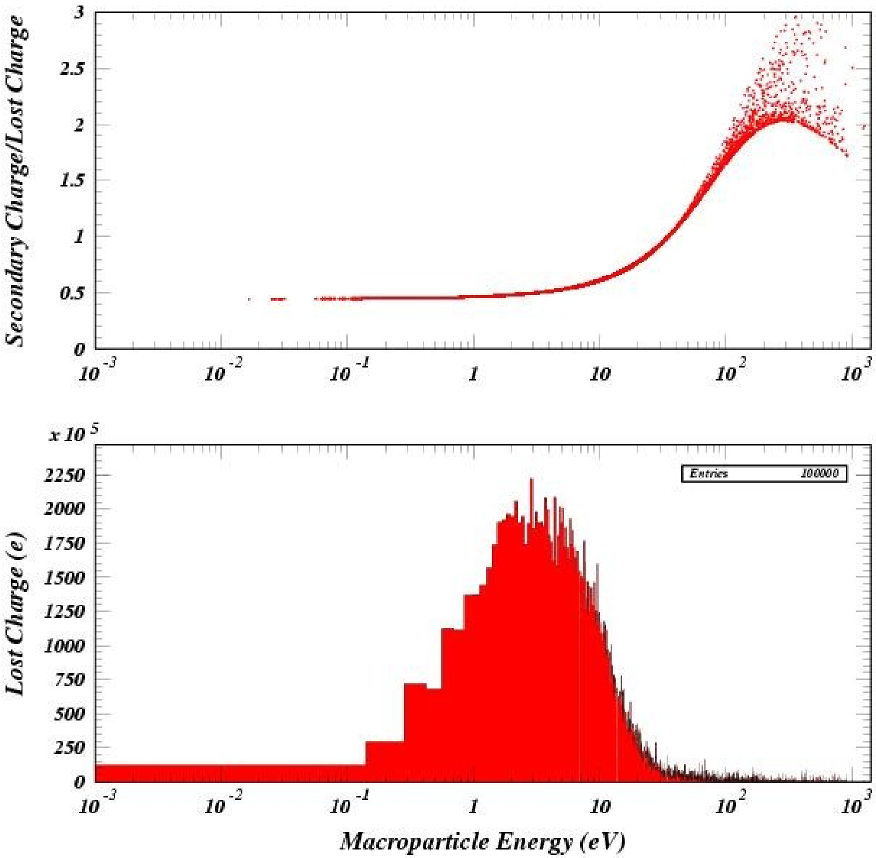


Higher energies on resonance.

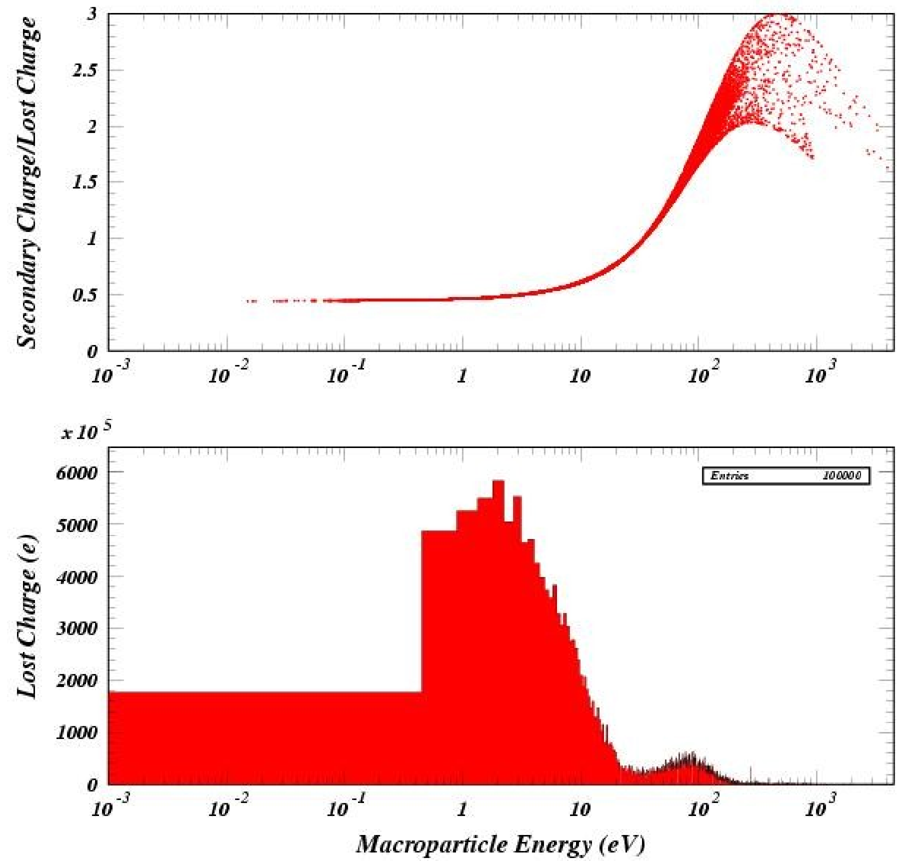
Population of SEY Curve

Compare n=0.5 with n=1.0

n=0.5

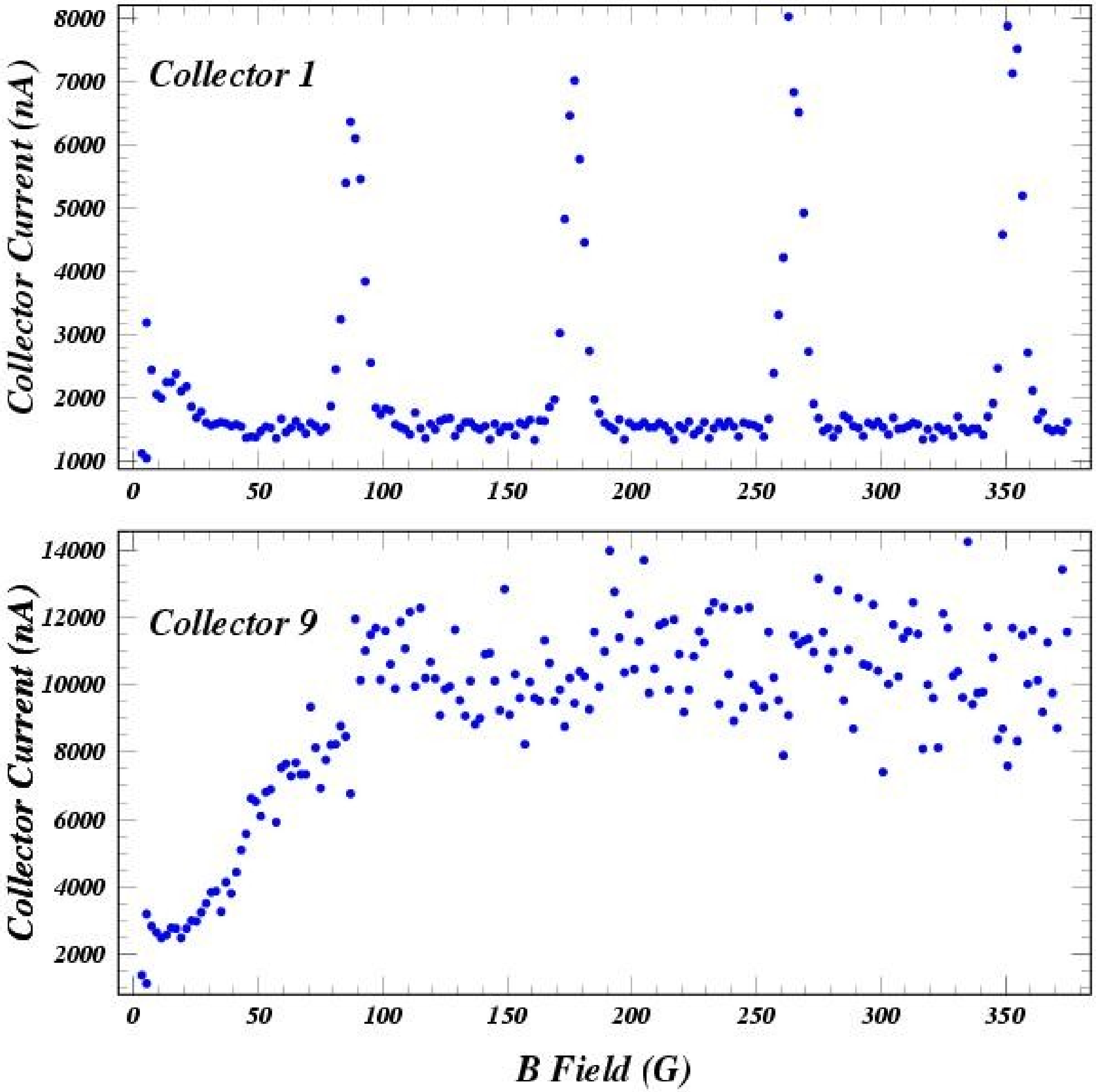


n=1.0



Higher yields on resonance.
Higher energies and more grazing angles.
ECLOUD SEY model sets $\cos\Theta < 0.2$ to $\cos\Theta = 0.2$ for yield calculation (78 degrees).

ECLOUD Magnetic Field Scan

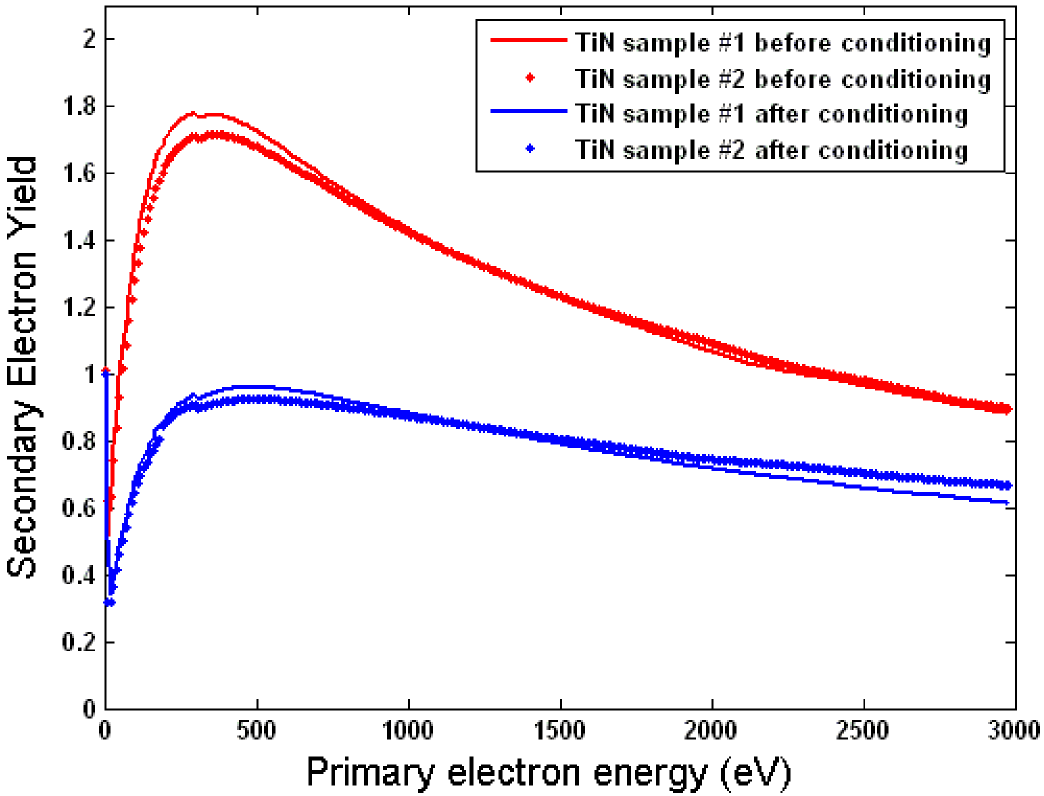


Choose azimuthal bins corresponding to the chicane RFA collectors.

<u>ECLOUD sees the resonances!</u>

NB: The RFA transparency has been accounted for, but no correction has been made for either angles of incidence or cyclotron radius.

What about the TiN minima?



Thanks to Mauro for these SEY curves.

Since the peak energy is so high, the resonant enhancement of the energy will not suffice to produce the reduction in yield necessary to produce the minima.

So I investigated the ECLOUD option to independently set the yield at low energy.

I scanned through values 0.6, 0.8, 1.0,1.2 and found that a value of 1.0 produces maxima for Al and minima for TiN most clearly. Other values may do so as well.

F. Le Pimpec, R. Kirby, F. King and M. Pivi
Nucl. Instr. and Meth. NIM A 551 (2005) 187-199

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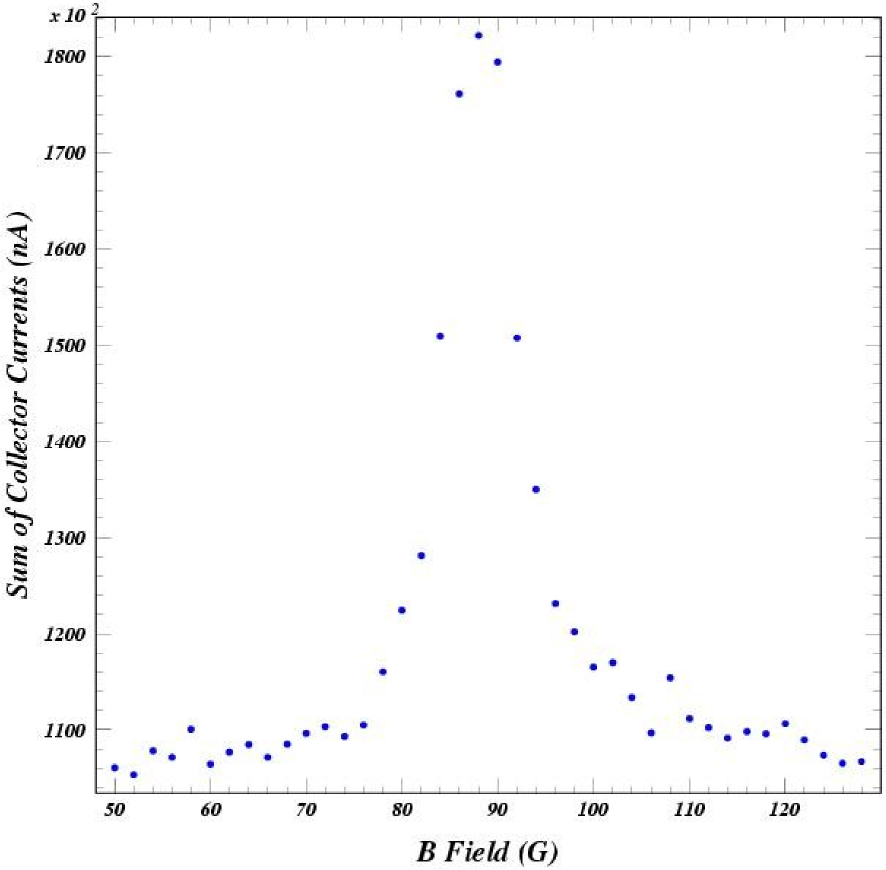
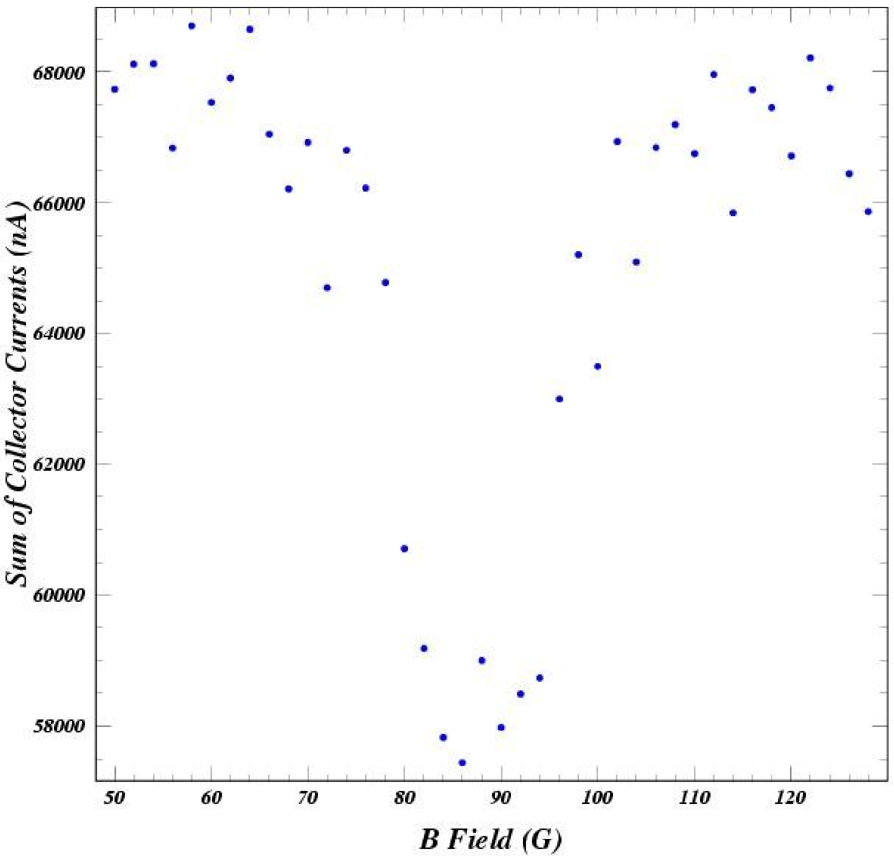
Scan over n=1 for Al and TiN with $\delta(0)=1.0$

Al: $\delta_{peak} = 2.0$ $E_{peak} = 310$ eV



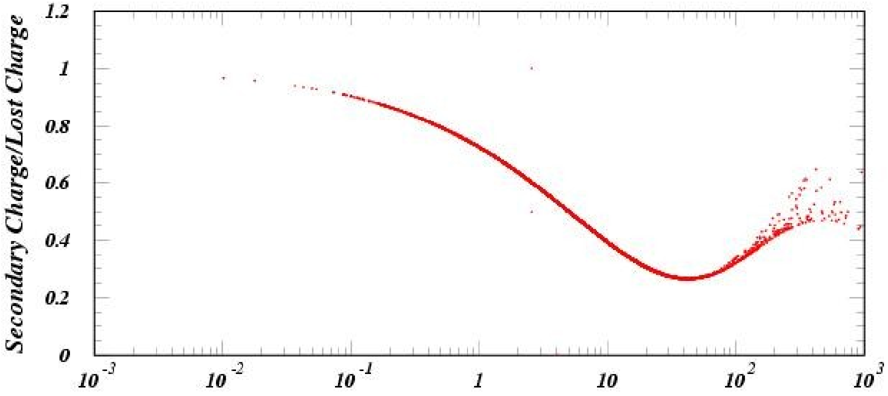
TiN: $\delta_{peak} = 0.95$ $E_{peak} = 500$ eV

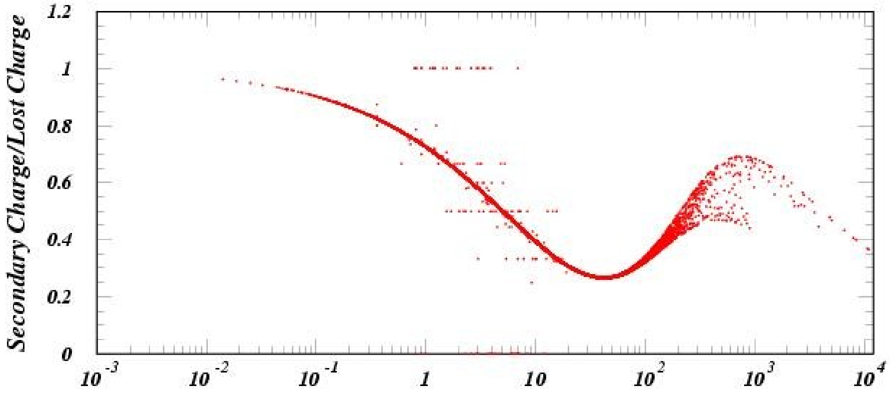


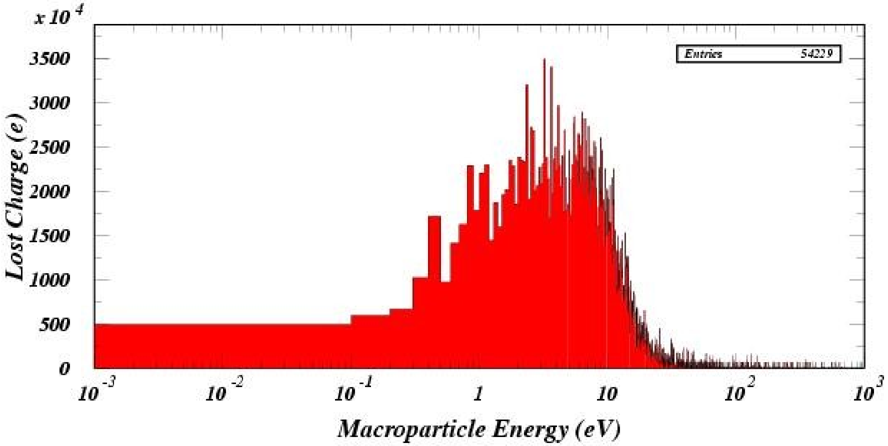
ECLOUD can produce maxima for Al and minima for TiN for the same value of the yield at low energy $\delta(0)=1.0$

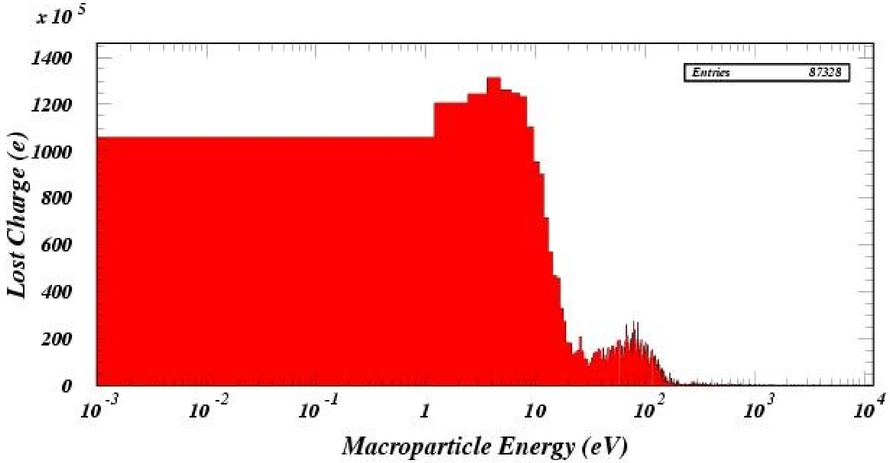
ECLOUD Secondary Yield Distribution for TiN

Off resonance	*On resonance*









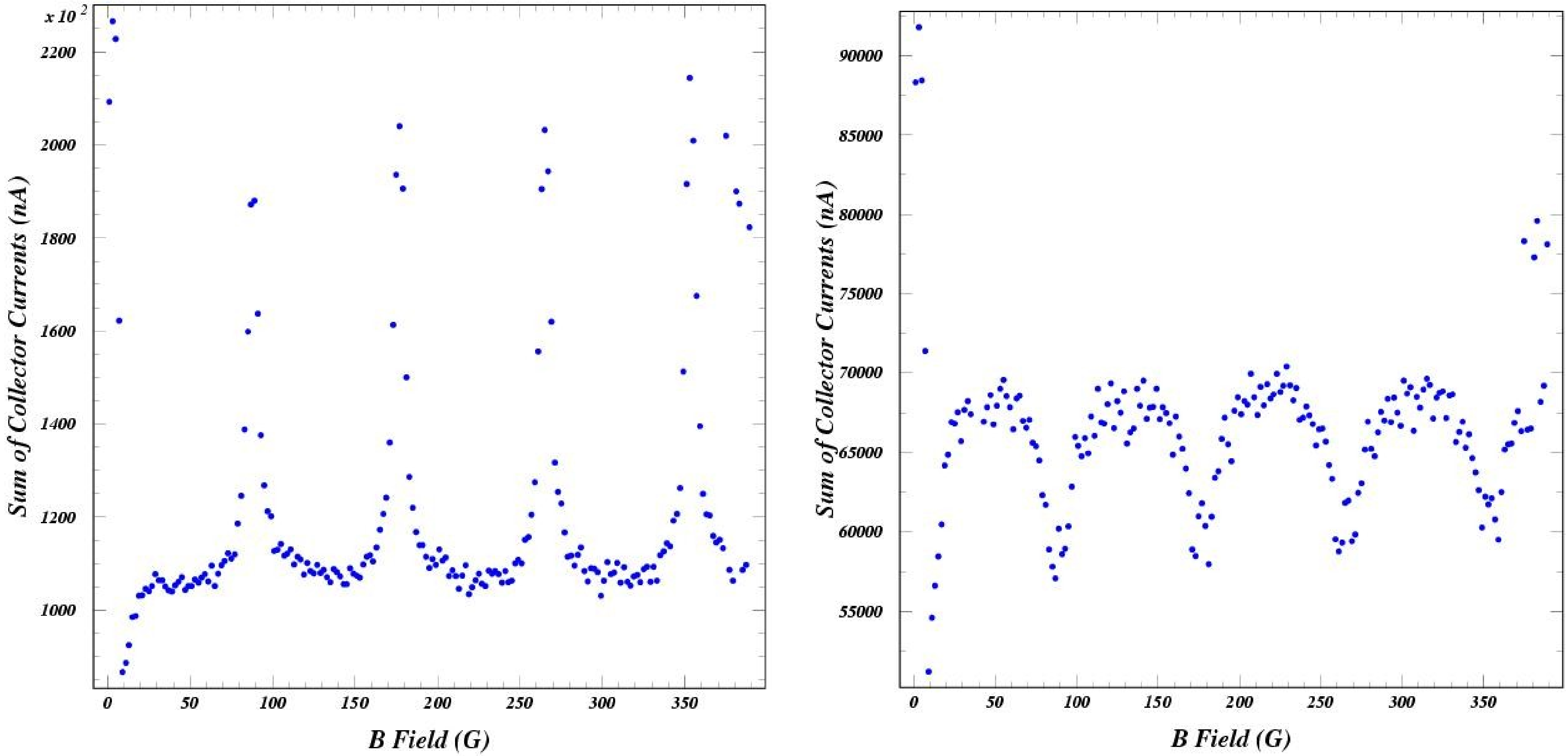
The SEY curve for TiN results in a low yield region being populated by the resonant energy enhancement.

Scan n=1,2,3,4 for Al and TiN with $\delta(0)=1.0$

Sum of 17 Collectors

Al: $\delta_{peak} = 2.0$ $E_{peak} = 310$ eV

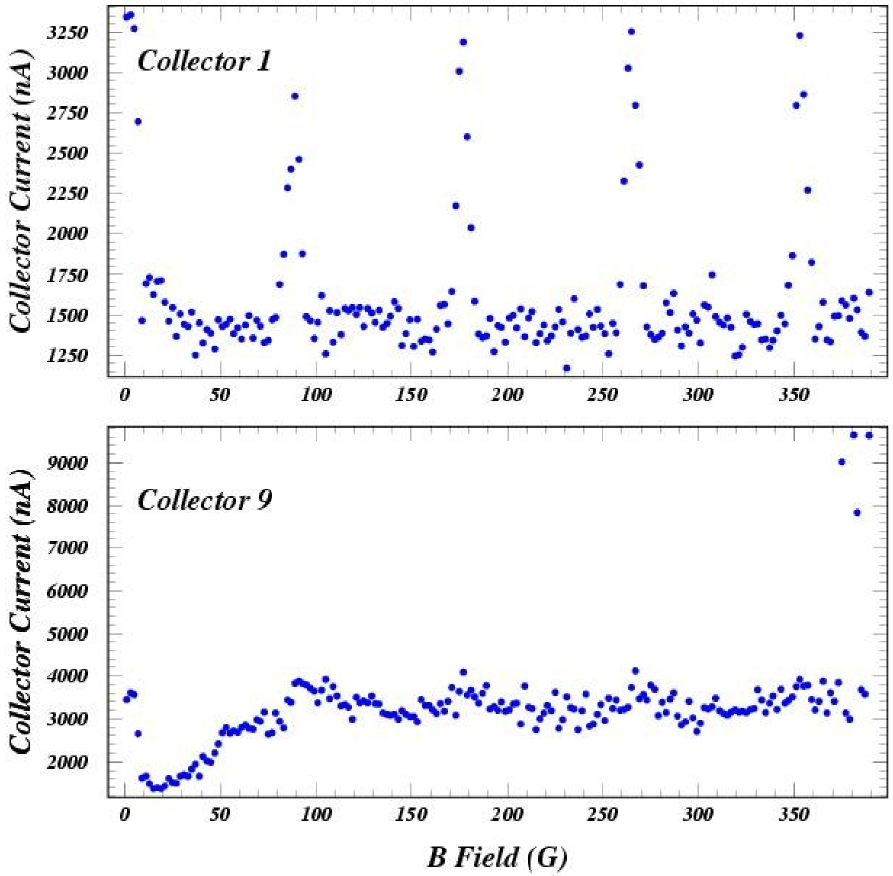
TiN: $\delta_{peak} = 0.95$ $E_{peak} = 500$ eV



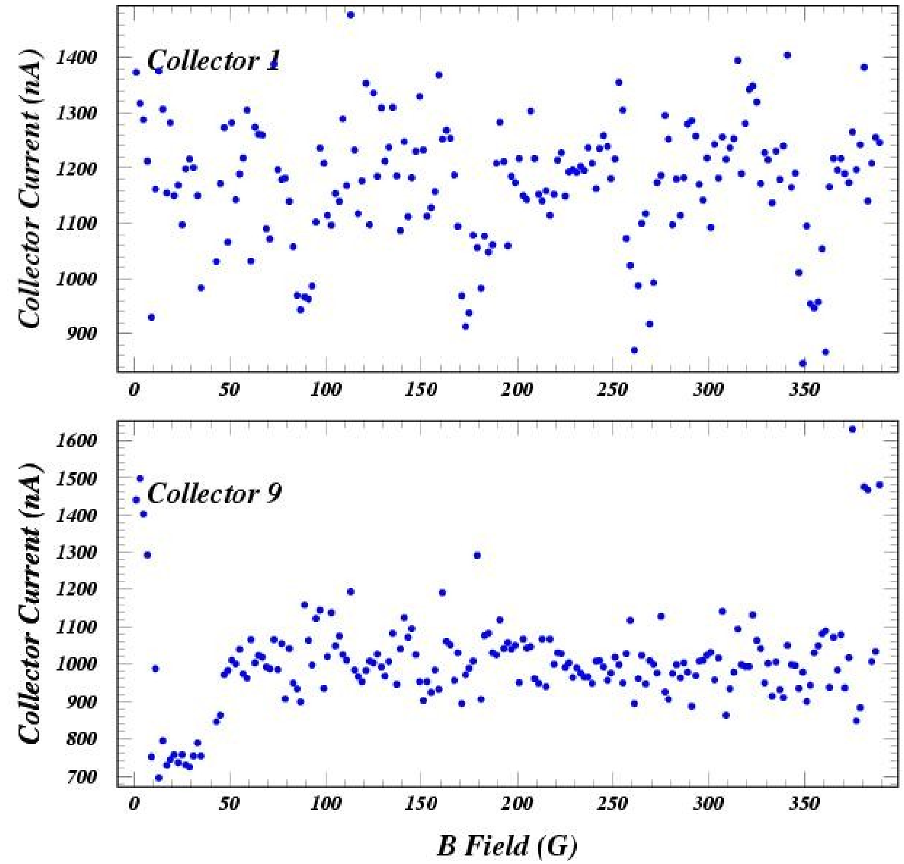
ECLOUD can produce maxima for Al and minima for TiN for the same value of the yield at low energy $\delta(0)=1.0$

Scan n=1,2,3,4 for Al and TiN with $\delta(0)=1.0$
Collectors 1 and 9

Al: $\delta_{peak} = 2.0 \quad E_{peak} = 310$ eV



TiN: $\delta_{peak} = 0.95 \quad E_{peak} = 500$ eV



Collectors 1 and 9 show the resonances less clearly.

Conclusions

The cyclotron resonances provide a means of mapping out the energy dependence of the secondary yield without varying the bunch current.

Much work remains to be done.