



# Status of Diamond Work at OSU

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RD42 Meeting  
May. 14, 2004

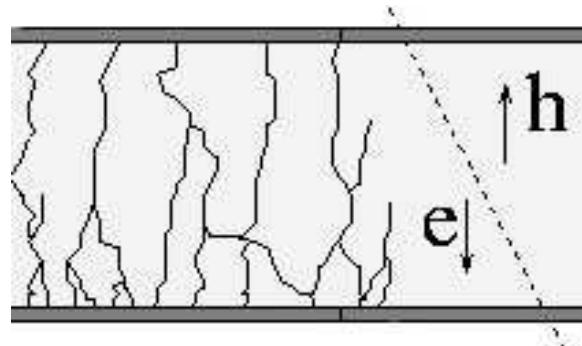
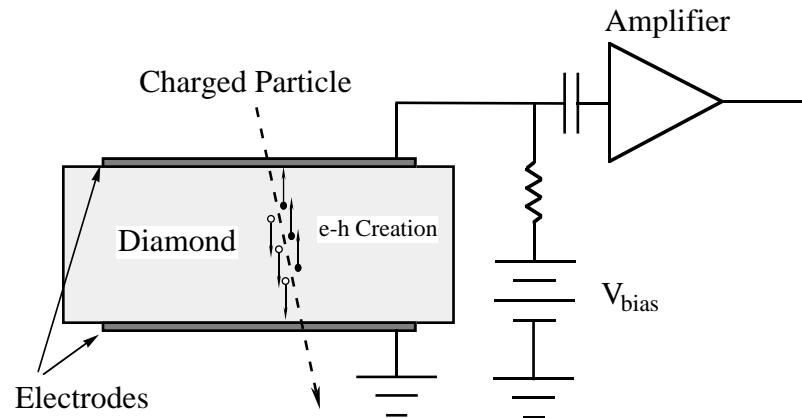
## Outline of the Talk

- ❖ OSU Test System
- ❖ Results on Latest pCVD Diamonds
- ❖ Results on Latest scCVD Diamonds



## Characterization of Diamond:

### Signal formation



◆  $Q = \frac{d}{t} Q_0$  where  $d$  = collection distance = distance e-h pair move apart

◆  $d = (\mu_e \tau_e + \mu_h \tau_h) E$

◆  $d = \mu E \tau$

with  $\mu = \mu_e + \mu_h$

and  $\tau = \frac{\mu_e \tau_e + \mu_h \tau_h}{\mu_e + \mu_h}$



*pCVD Diamond*



*Growth side of a recent polycrystalline CVD (pCVD) diamond.*



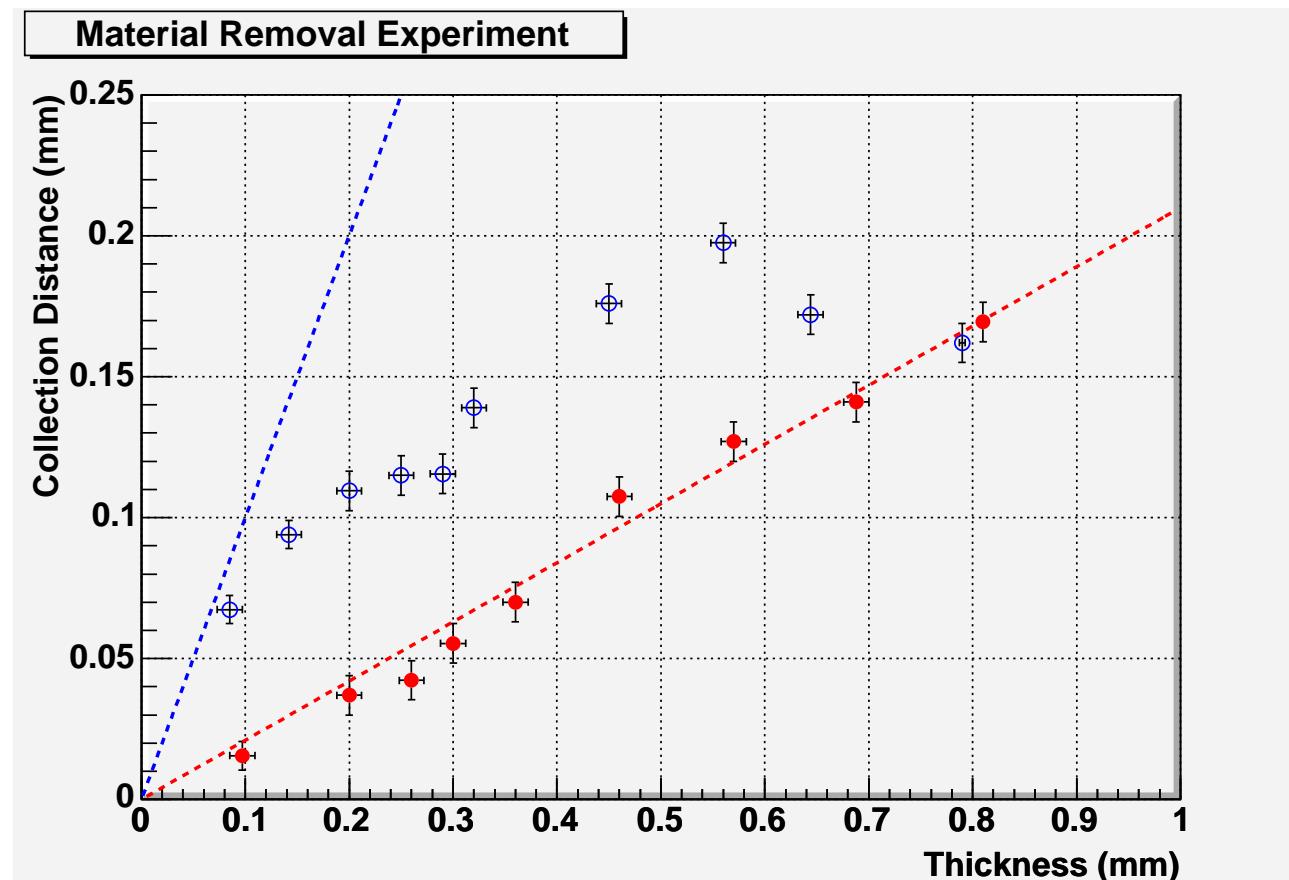
(Courtesy of Element Six)



*pCVD Diamond*



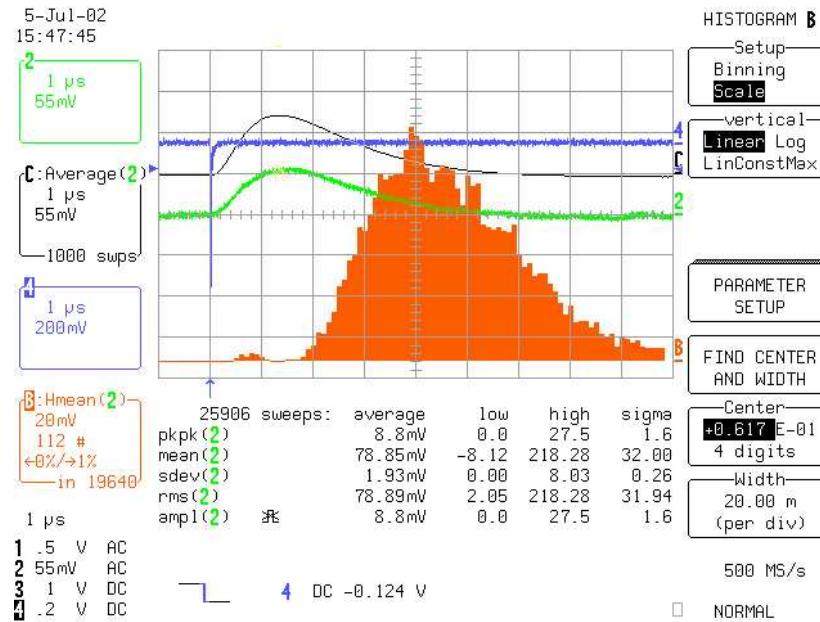
*Processing pCVD diamond.*





In 2000 RD42 entered into a *Research Program* with Element Six to increase the charge collected from pCVD diamond.

2002 Diamond CD114 Measured with a  $^{90}\text{Sr}$  Source:

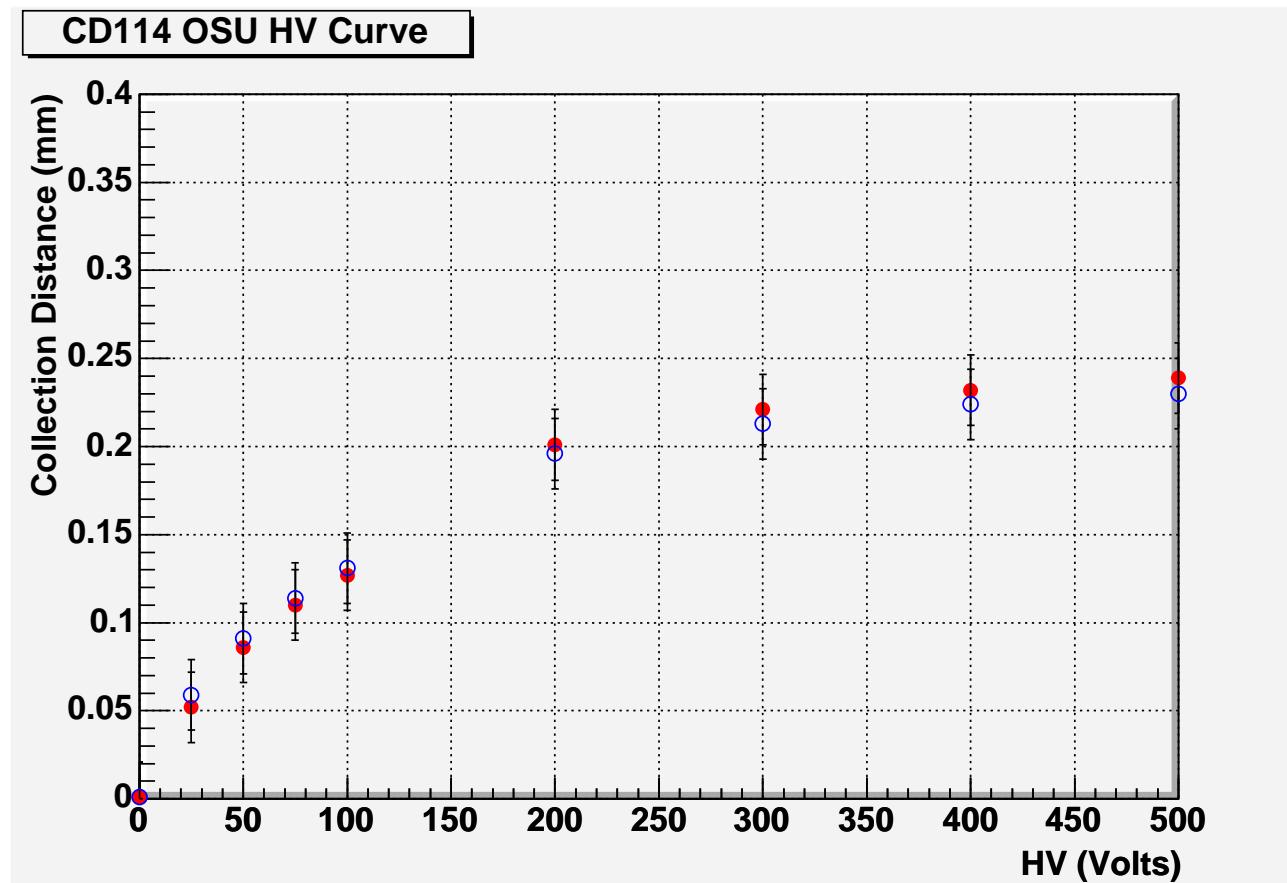


- ◆ System Gain =  $124 \text{ e/mV}$
- ◆  $Q_{MP} = 62\text{mV} = 7600e$
- ◆ Mean Charge =  $79\text{mV} = 9800e$
  
- ◆ Source data well separated from 0
- ◆ Collection Distance now  $275\mu\text{m}$
- ◆ Most Probable Charge now  $\approx 8000e$
- ◆ 99% of PH distribution now above  $3000e$
- ◆ FWHM/MP  $\approx 0.95$  — Si has  $\approx 0.5$
- ◆ This diamond available in large sizes

*The Research program reached its goal of ccd=250  $\mu\text{m}$ !*



## OSU Measurements of CD114 - 490 $\mu$ m thick

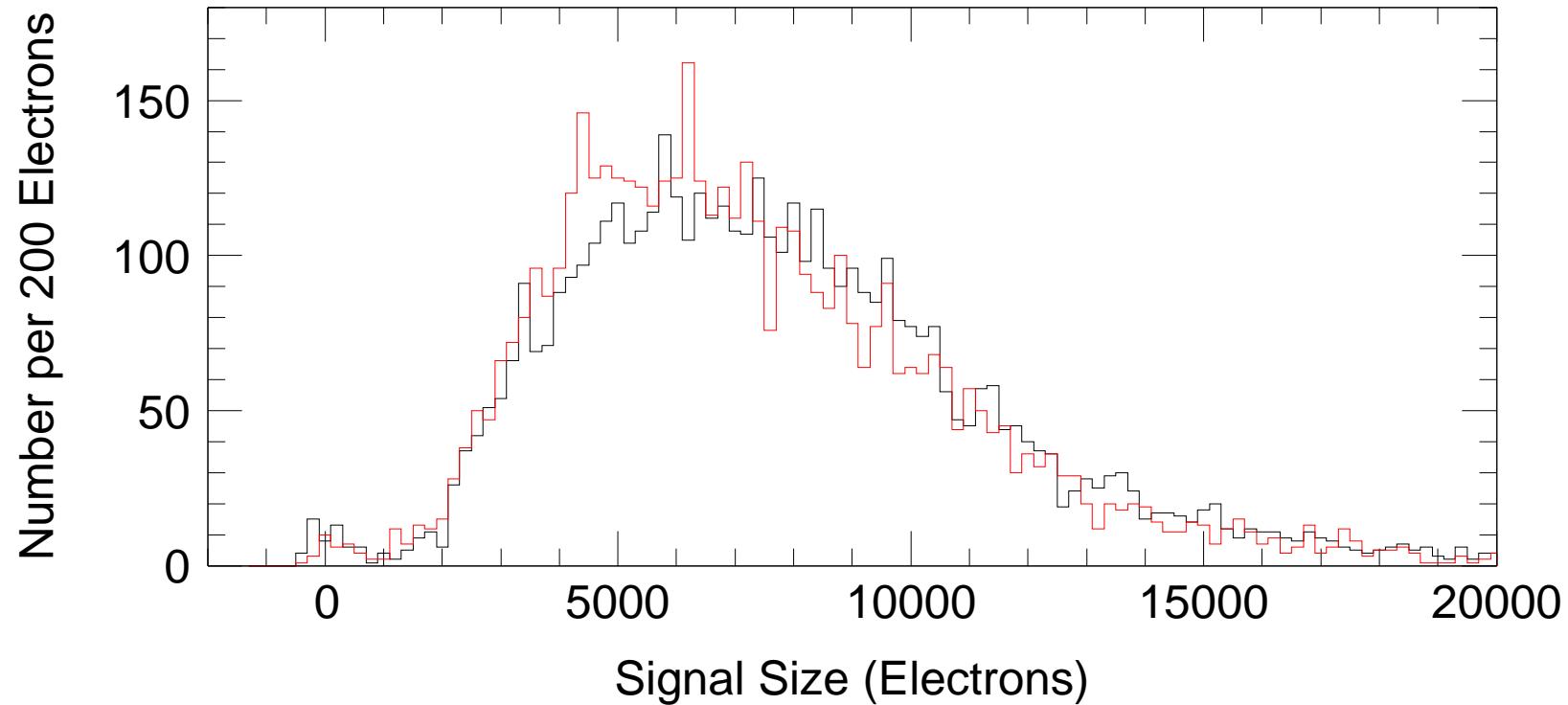


*OSU measures a bit lower ccd than CERN (240 $\mu$ m vs 275 $\mu$ m)!*



## OSU Measurements of CD114

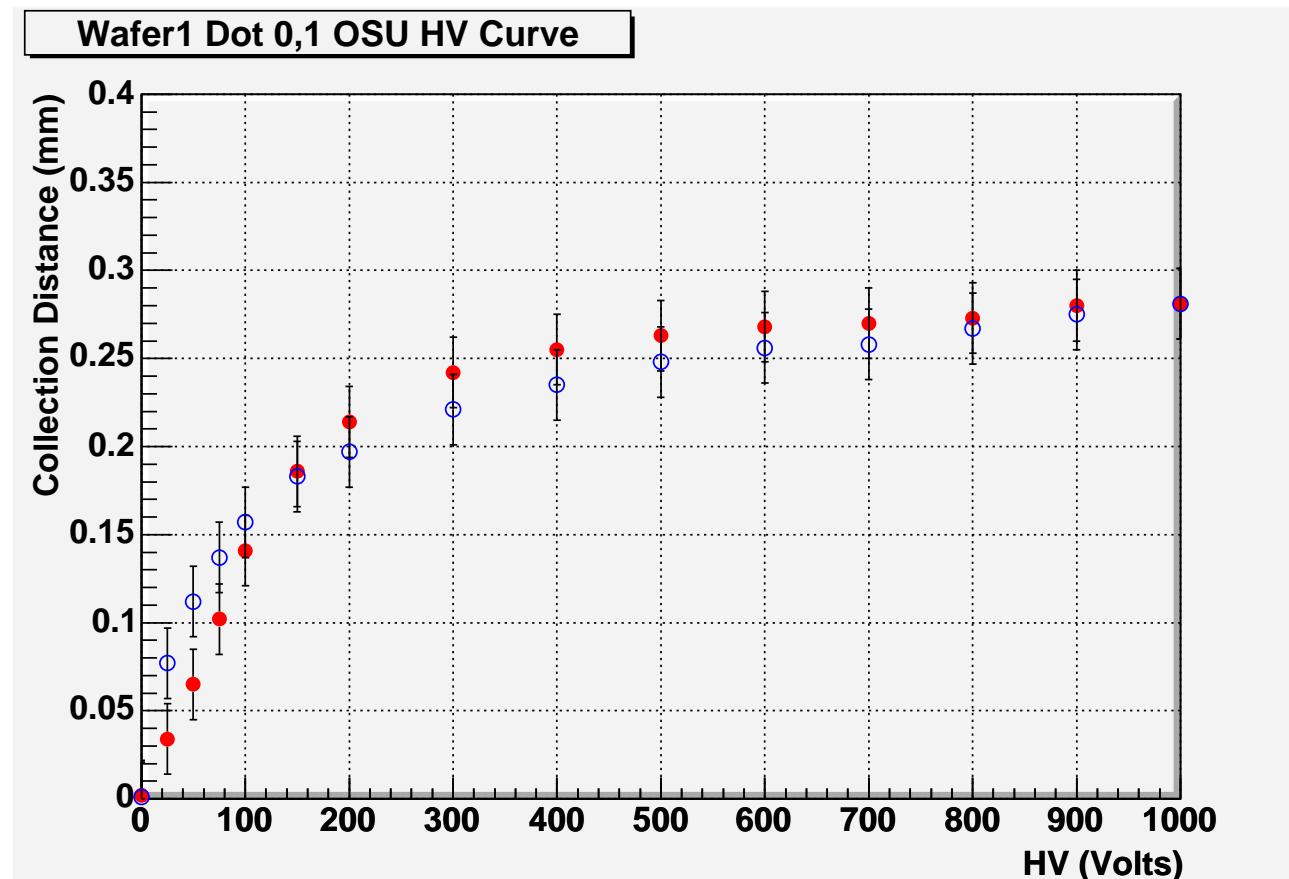
CD114 - Both Sides - Pumped (Sr-90 source)



*OSU measures a bit wider FWHM/MP than CERN!*



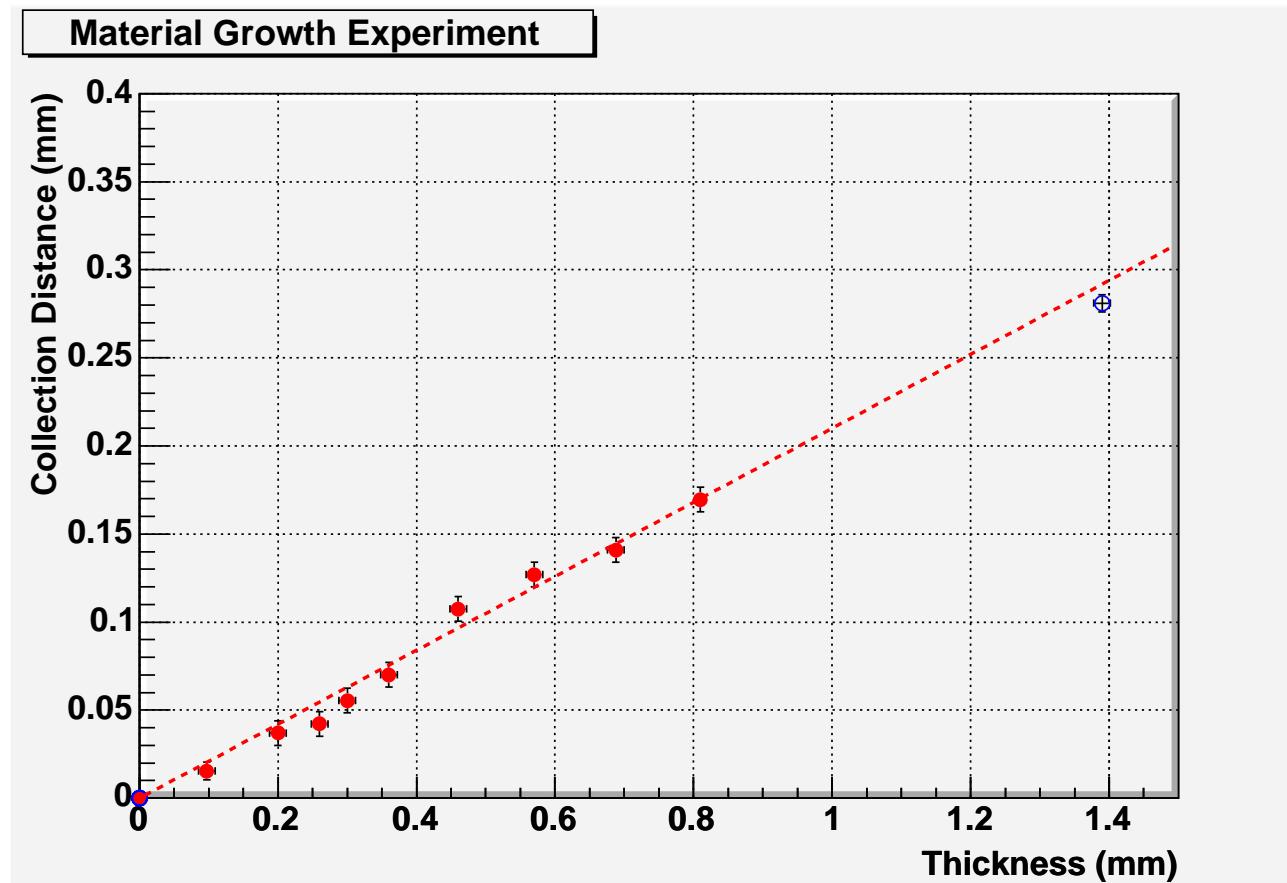
Latest as grown Diamond -  $1390\mu\text{m}$  thick



*OSU measures ccd=280 $\mu\text{m}$ !*



## Latest as grown Diamond



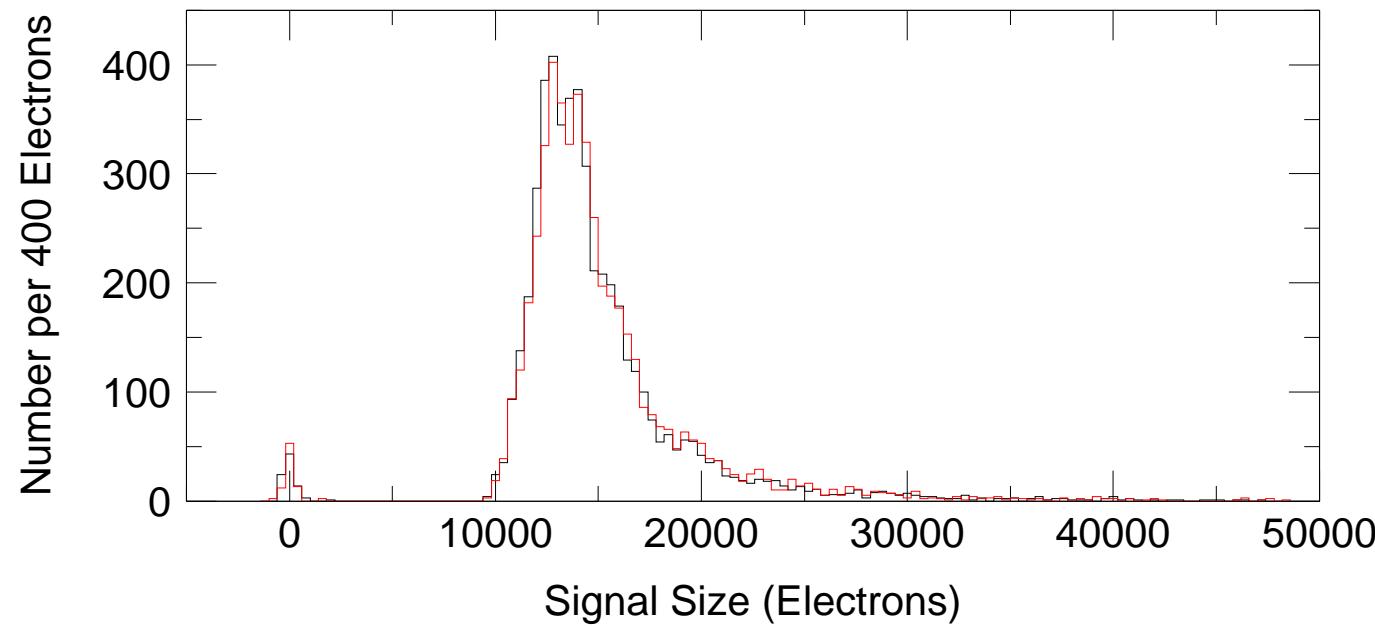
*Growth still linear out to thickness of 1390 $\mu$ m!  
There may be problem with processing!*



Could we make a CVD diamond with improved characteristics?

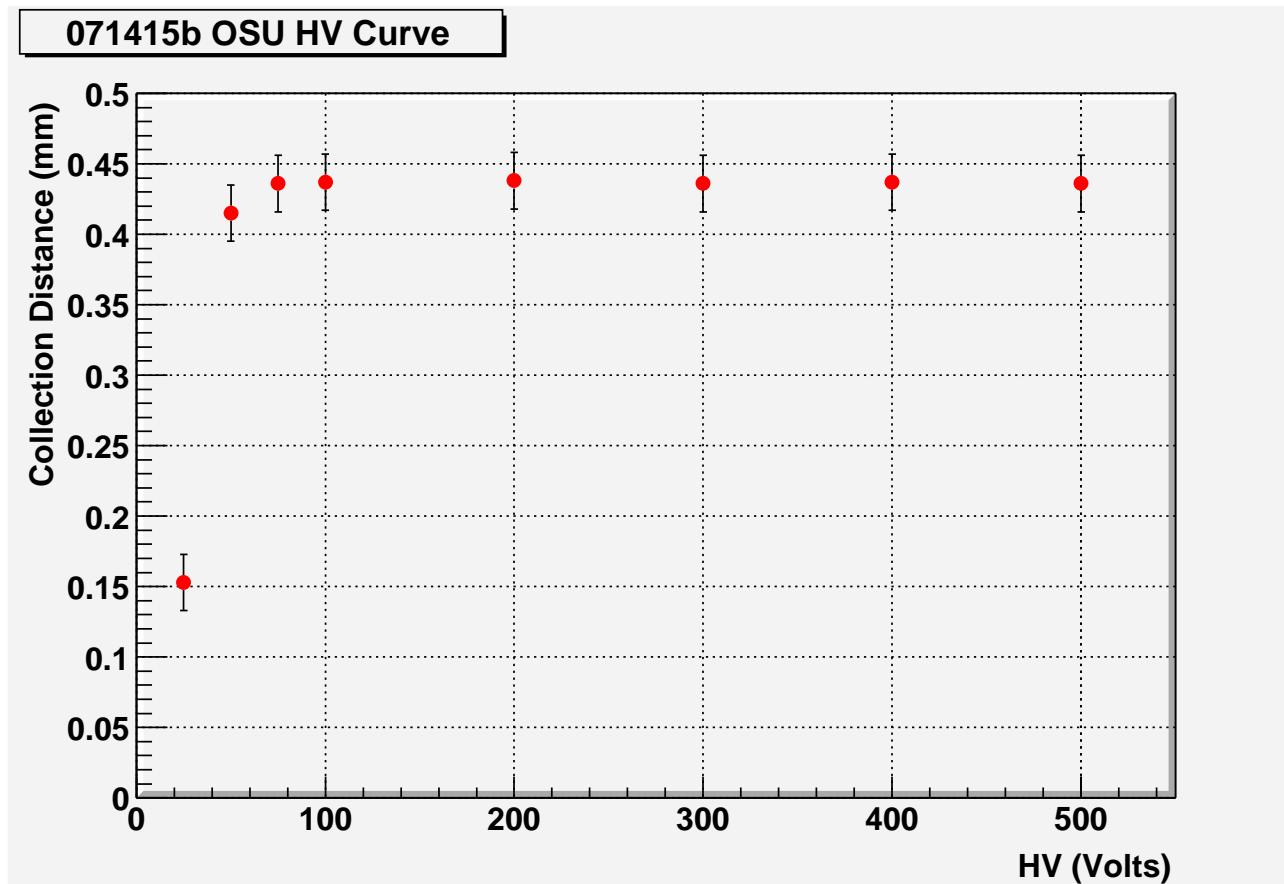
- ❖ Remove the grain boundaries, defects , etc.
- ❖ Lower operating voltage.
- ❖ Eliminate pumping.

Single crystal CVD (scCVD) diamond: [Isberg *et al.*, Science 297 (2002) 1670].  
071415 - Both Sides - Pumped (Sr-90 source)





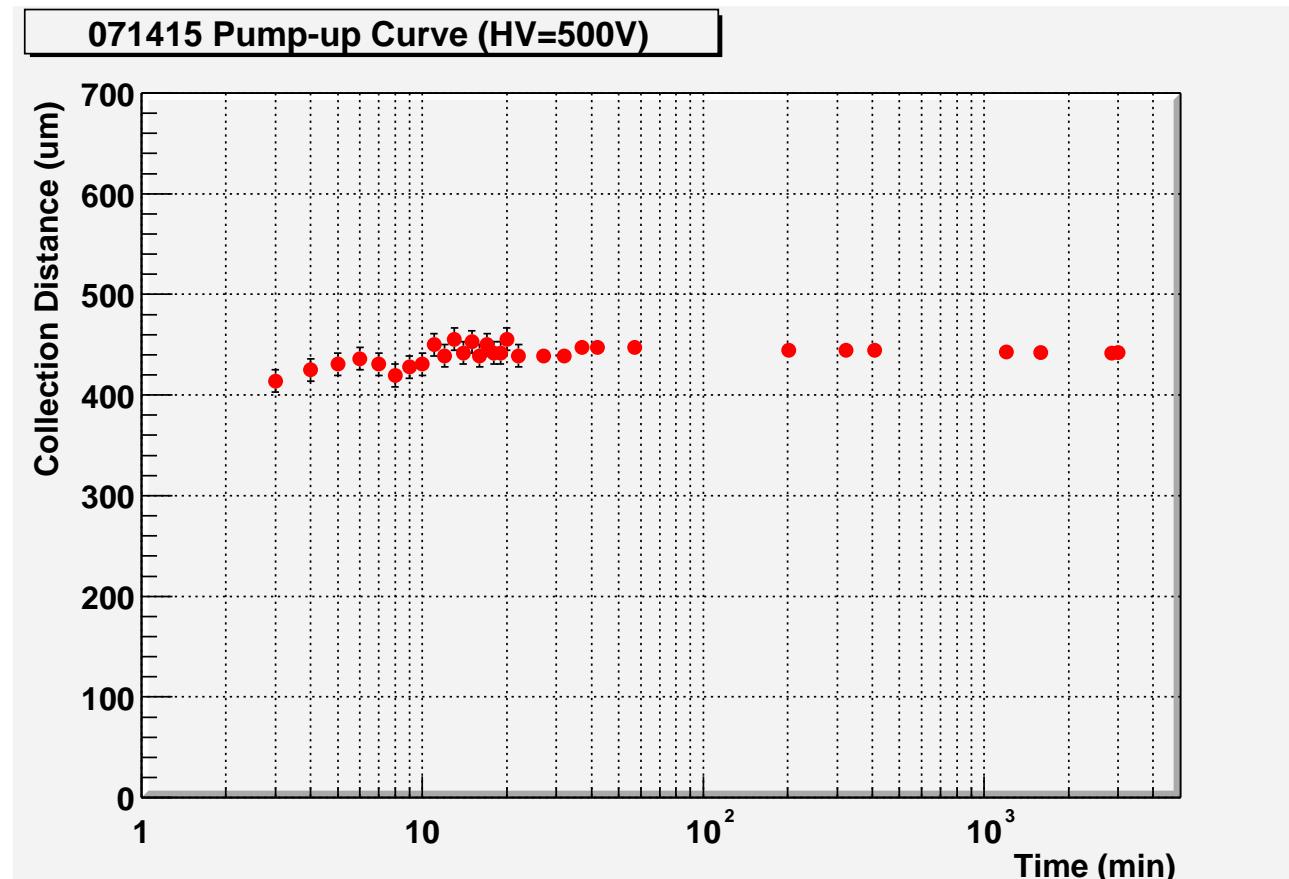
## HV characteristics



*Full charge collection at  $E < 0.2 \text{ V}/\mu\text{m}$ !*



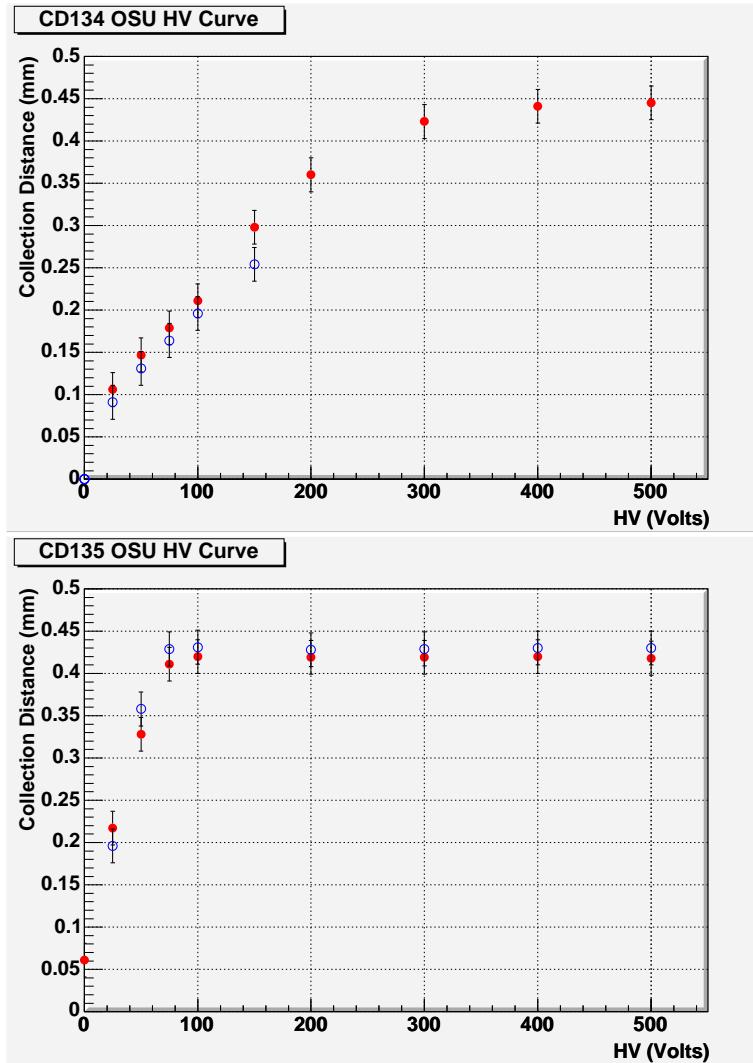
## Stability characteristics



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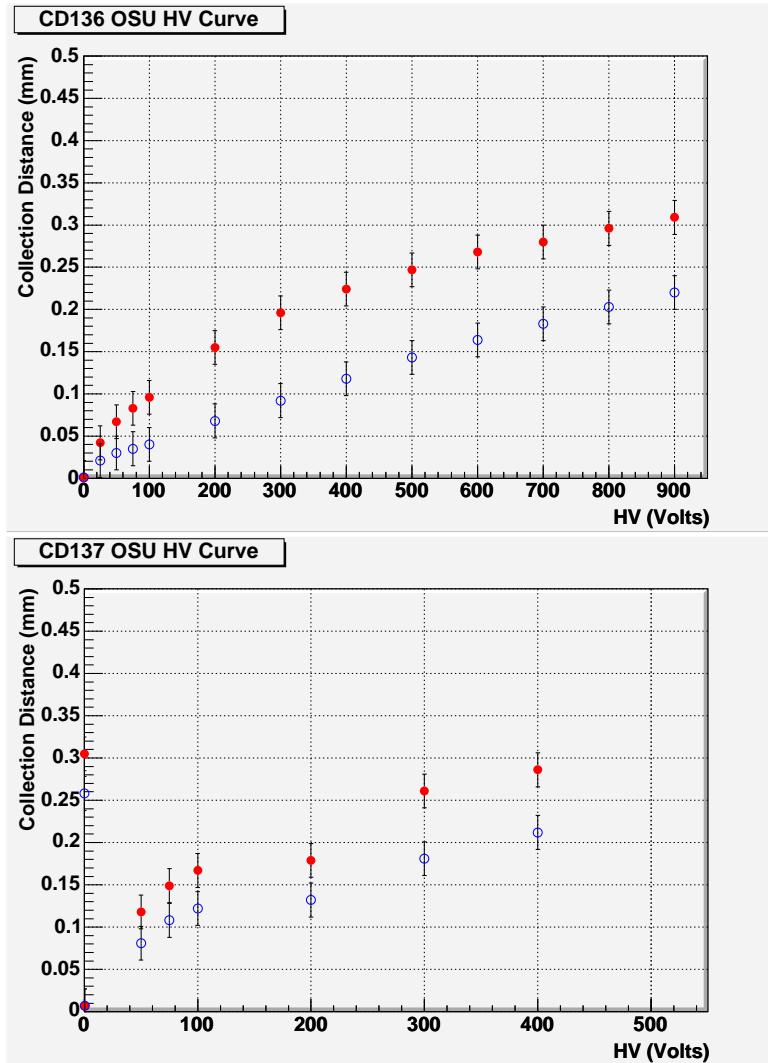


## Other Diamonds



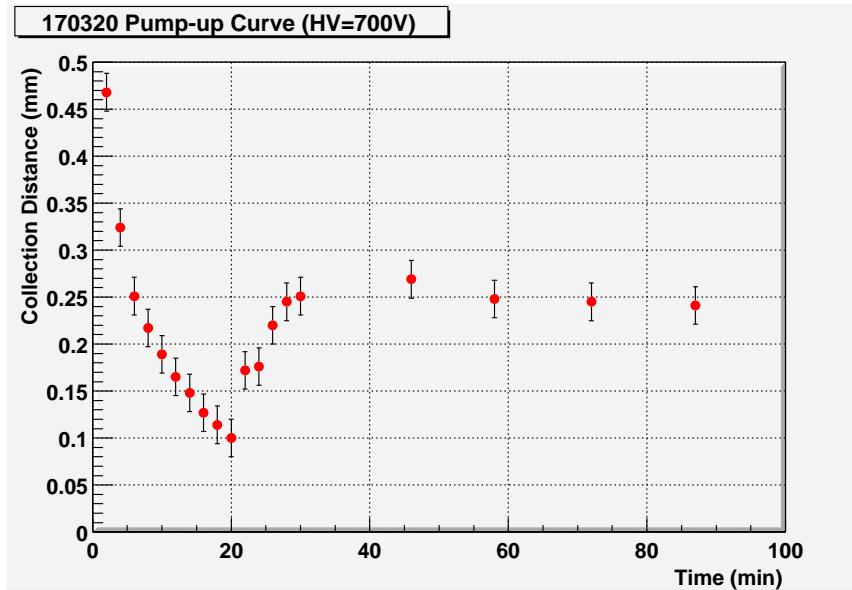


## Other Diamonds





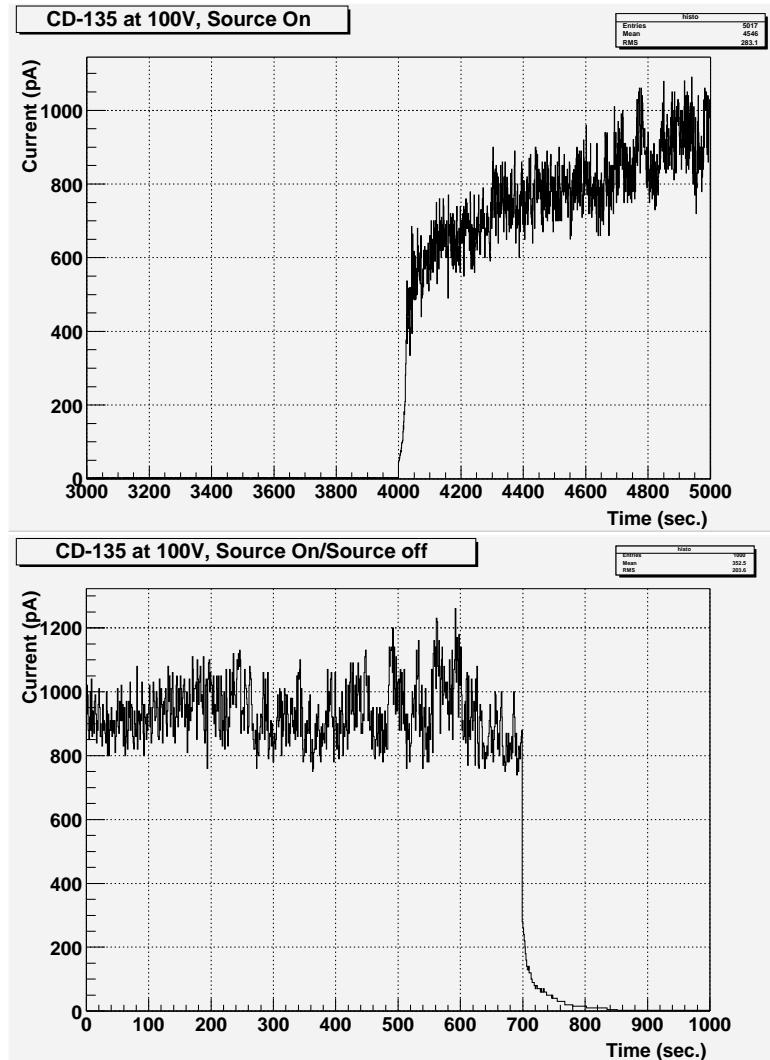
## Other Diamonds



*Can have defects in scCVD if problems arise in growth!  
Many of the problems above are due to surface contamination*



*CD135 after irradiation with  $^{60}\text{Co}$  tested below with  $^{90}\text{Sr}$*





### ◆ pCVD Charge Collection

275  $\mu\text{m}$  collection distance diamond attained in research contract

MP signal  $\approx 8000 e$

99% of charge distribution above 3000  $e$

FWHM/MP  $\sim 0.95$  – Working with manufacturers to increase uniformity

This diamond process now in production reactors

300  $\mu\text{m}$  collection distance attained in unprocessed diamond

Work proceeding to produce  $> 300\mu\text{m}$  collection distance pCVD diamond

### ◆ scCVD Charge Collection

Collection distance can be the thickness of the diamond.

Parameters must be controlled for good growth!

Research contract with Element Six underway.

Significant progress in the last year!