Status of Diamond Work at OSU

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RD42 Meeting
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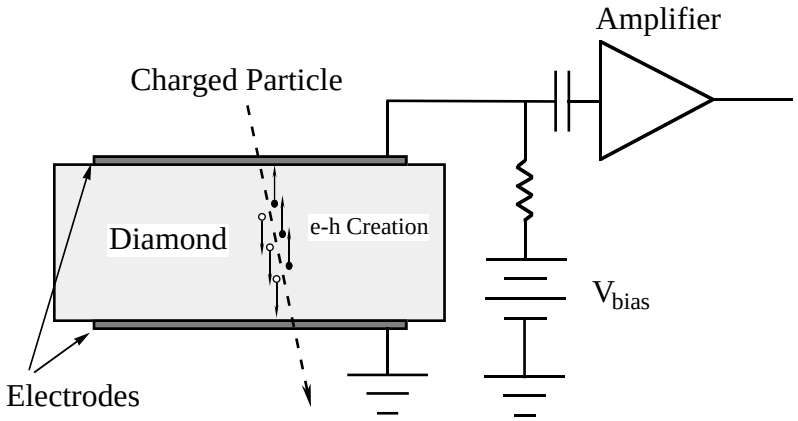
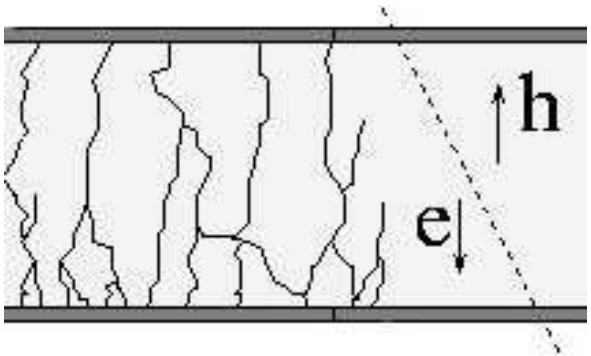
Outline of the Talk

- **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
- $d = (\mu_e \tau_e + \mu_h \tau_h) E$
- $d = \mu E \tau$

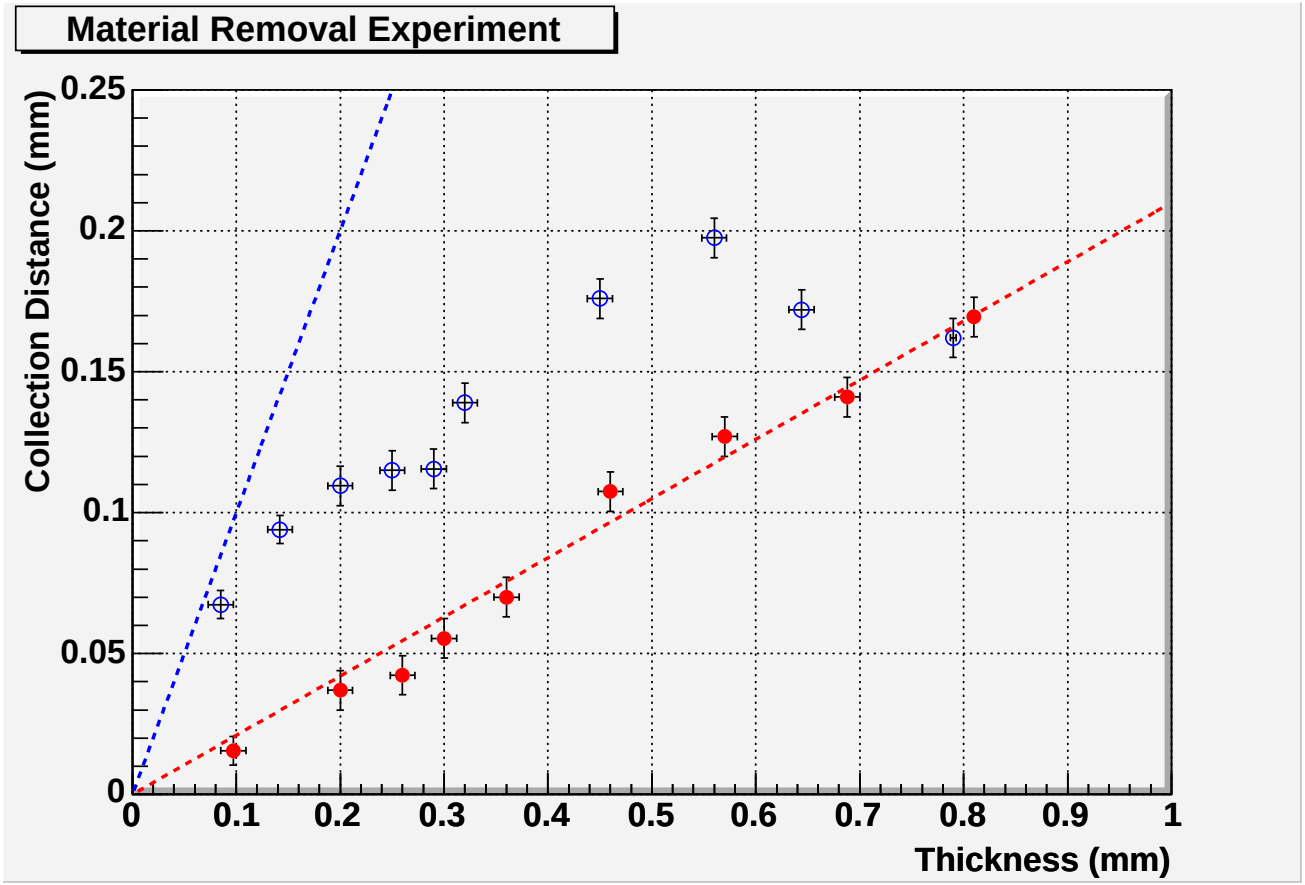
  with $\mu = \mu_e + \mu_h$

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

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

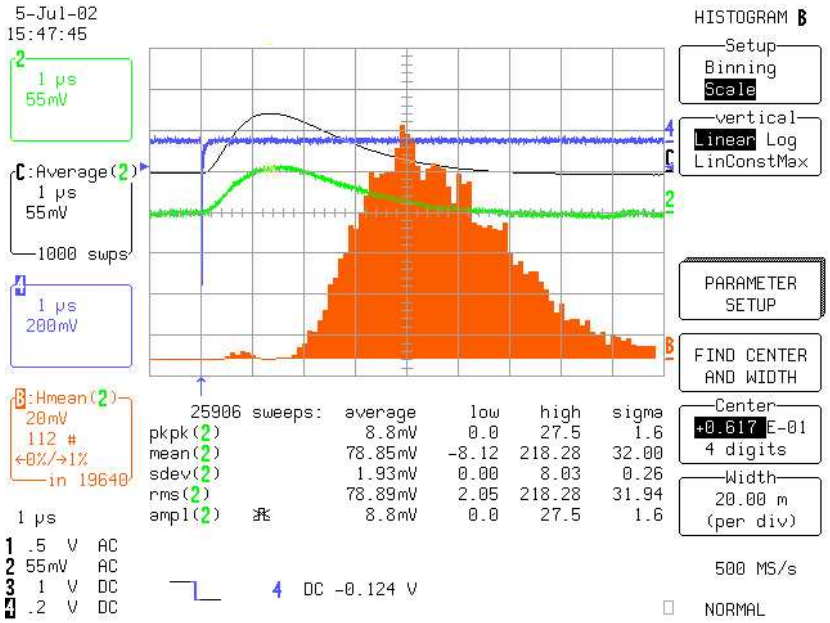
(Courtesy of Element Six)

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}Sr Source:

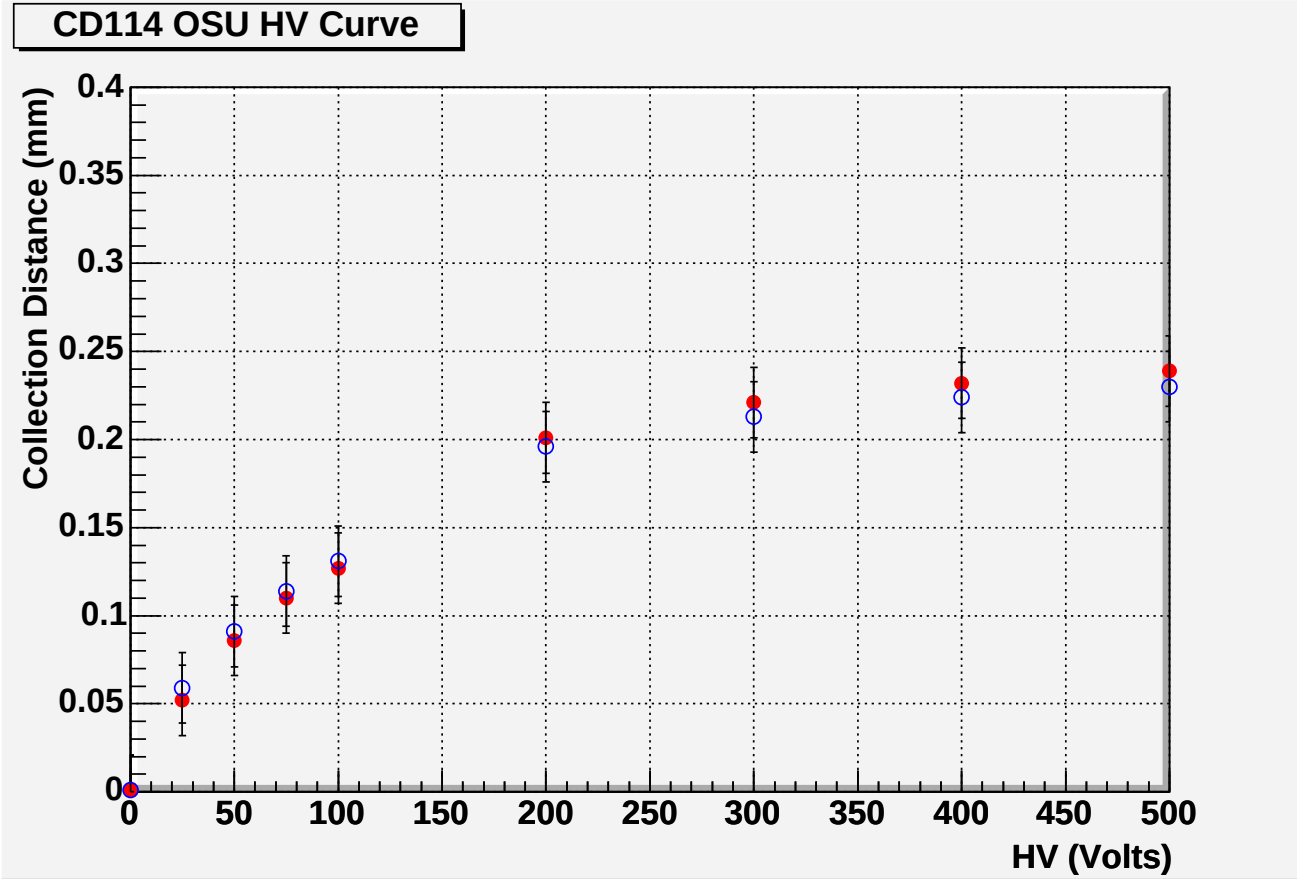


- System Gain = 124 e/mV
- Q_{MP} = 62mV = 7600e
- Mean Charge = 79mV = 9800e

- Source data well separated from 0
- Collection Distance now 275μm
- 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

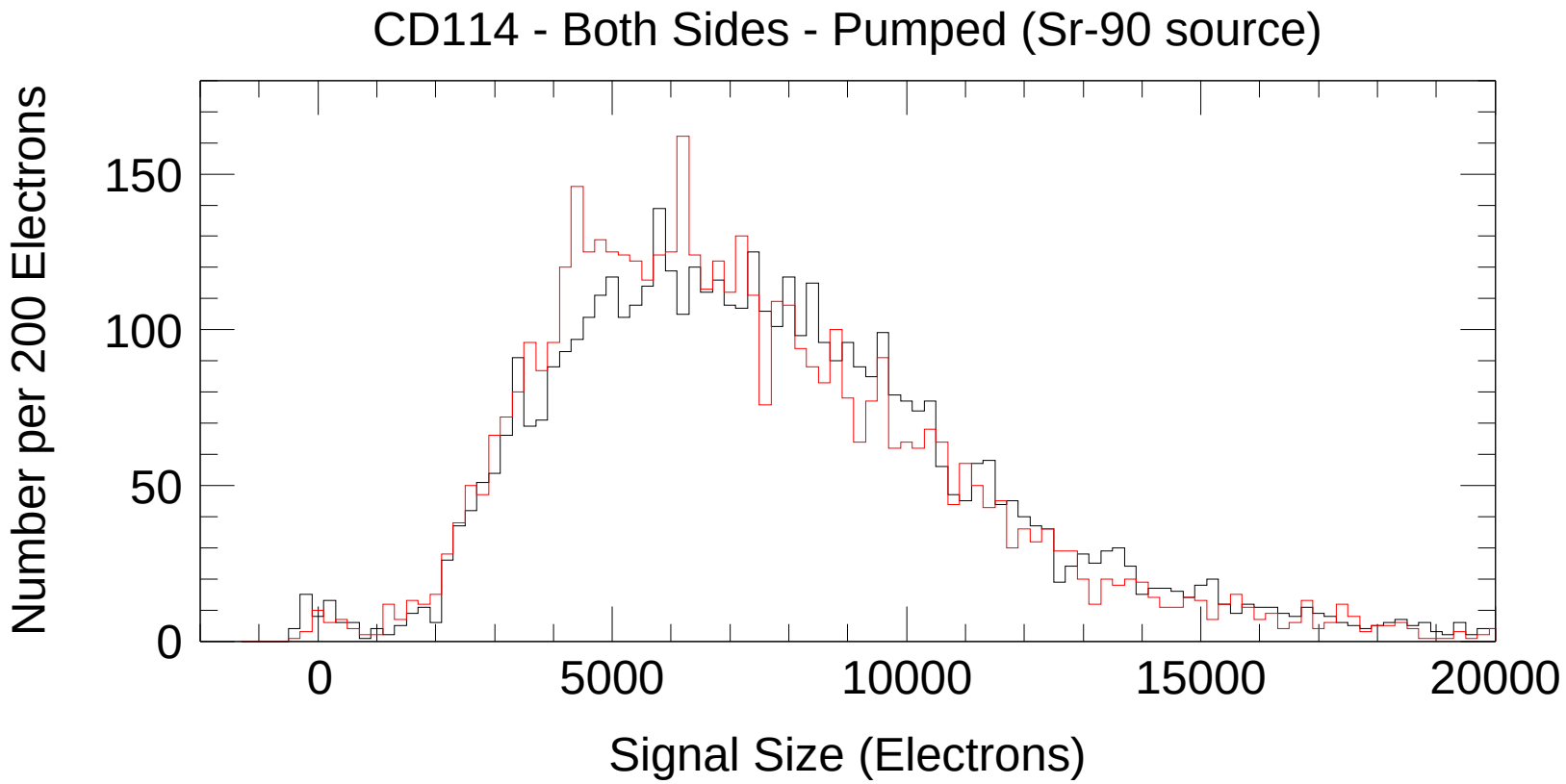
The Research program reached its goal of ccd=250 μm!

OSU Measurements of CD114 - 490μm thick



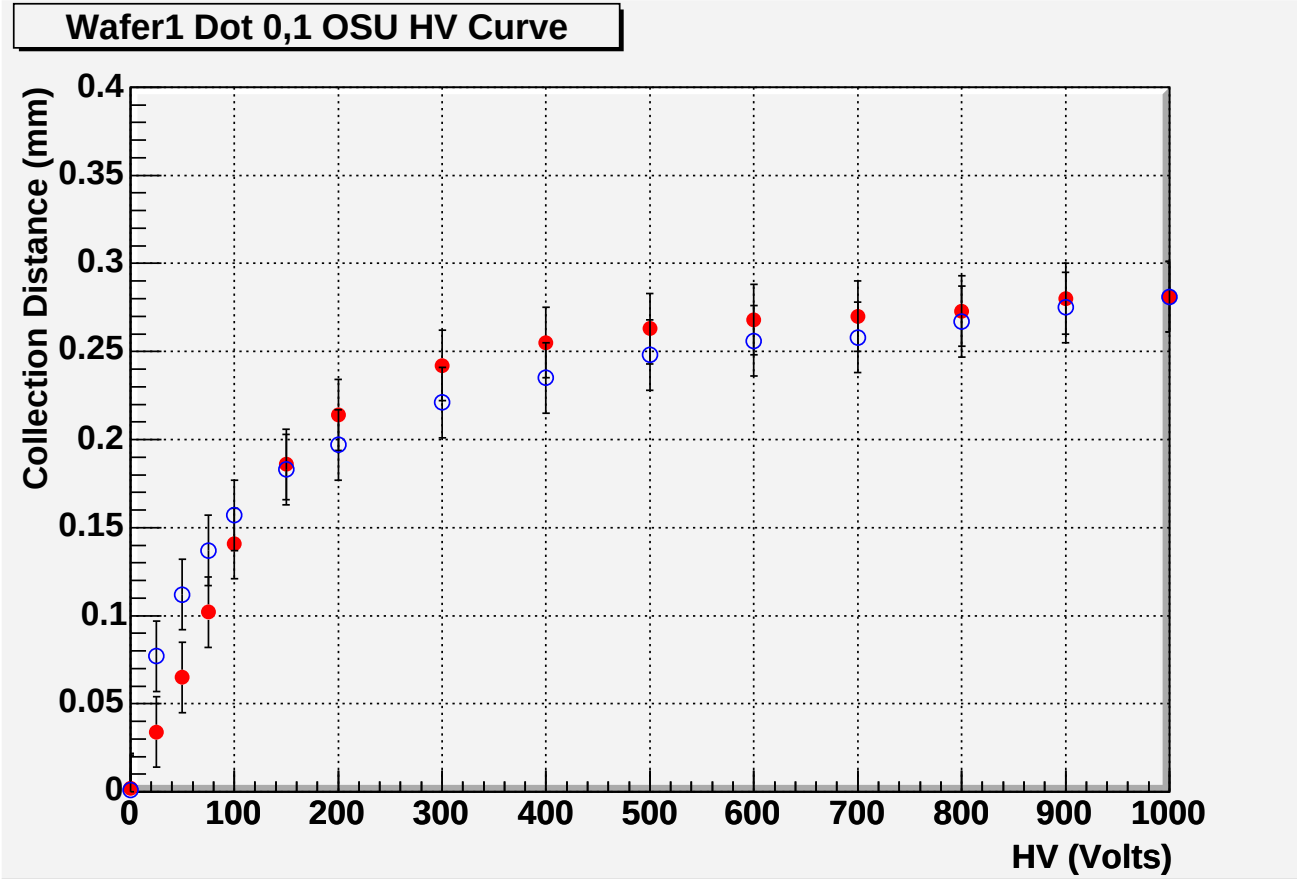
OSU measures a bit lower ccd than CERN (240μm vs 275μm)!

OSU Measurements of CD114



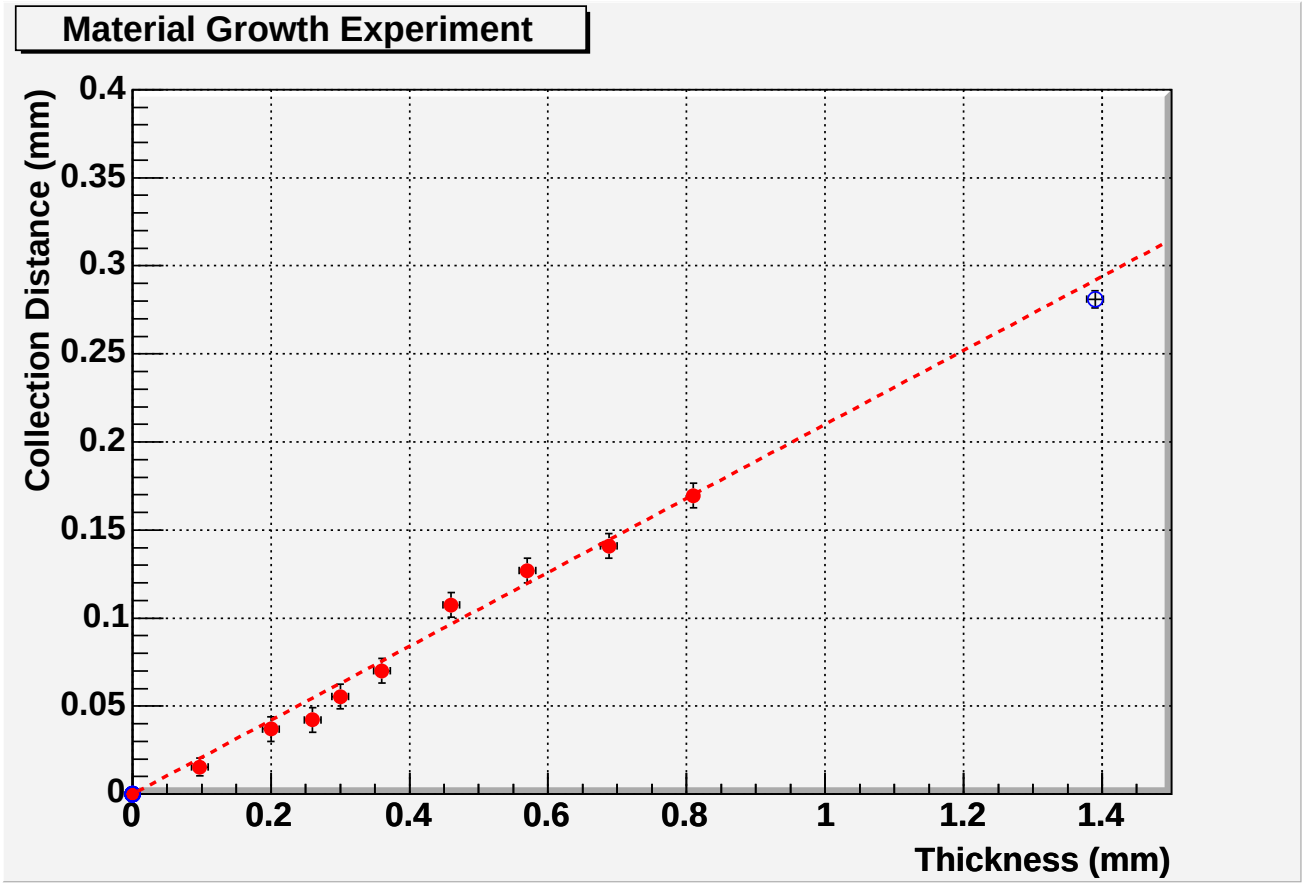
OSU measures a bit wider FWHM/MP than CERN!

Latest as grown Diamond - 1390μm thick



OSU measures ccd=280μm!

Latest as grown Diamond

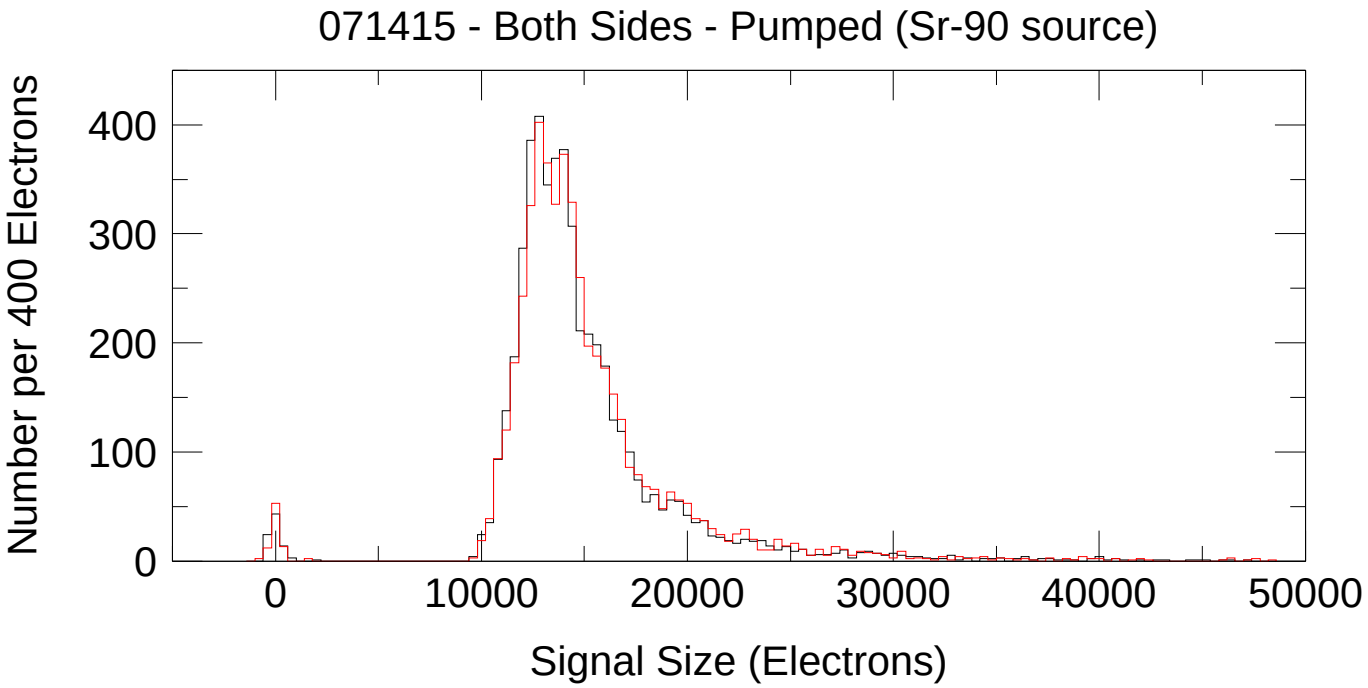


Growth still linear out to thickness of 1390μm!
There may be problem with processing!

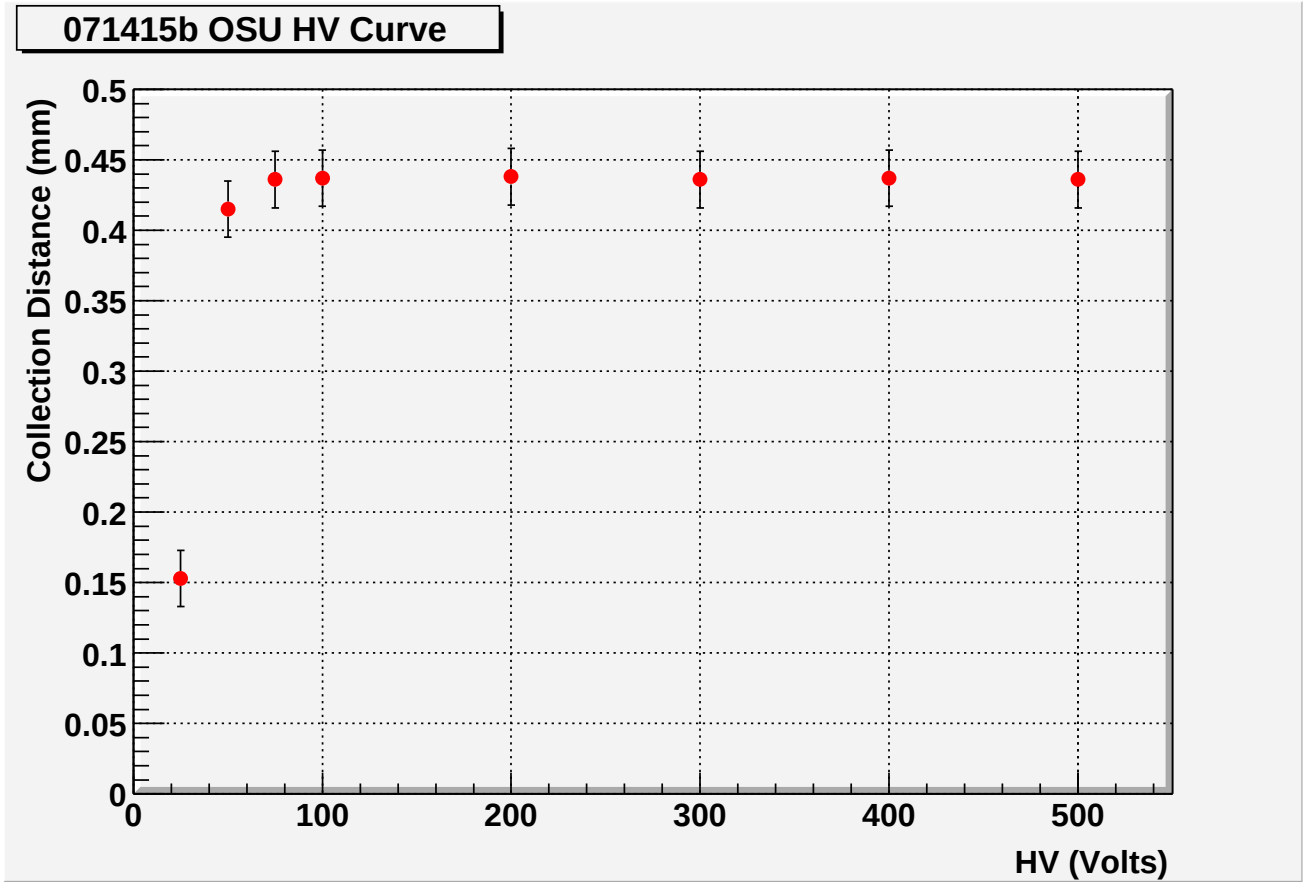
Could we make a CVD diamond with improved characteristics?

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

Single crystal CVD (scCVD) diamond: [Isberg *et al.*, Science 297 (2002) 1670].

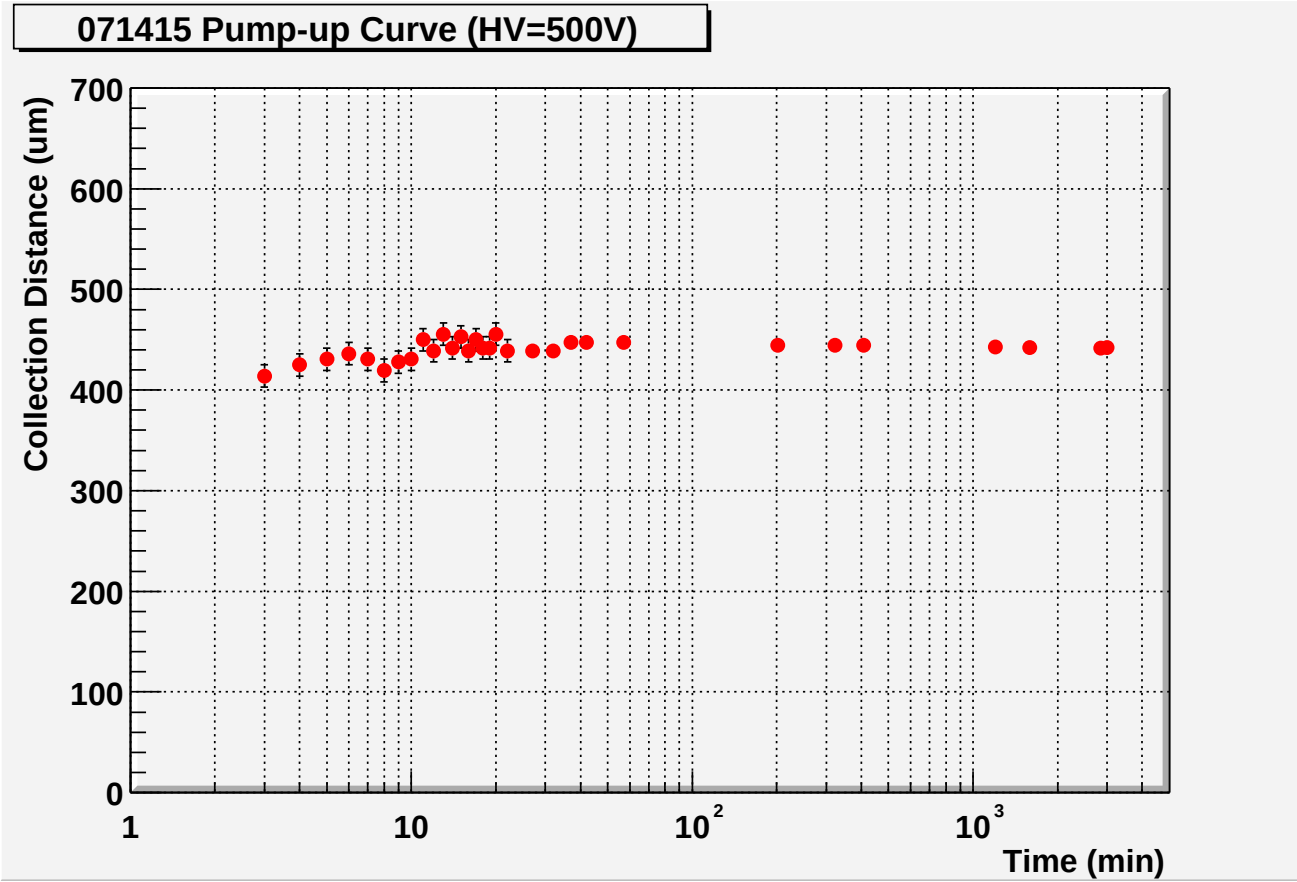


HV characteristics



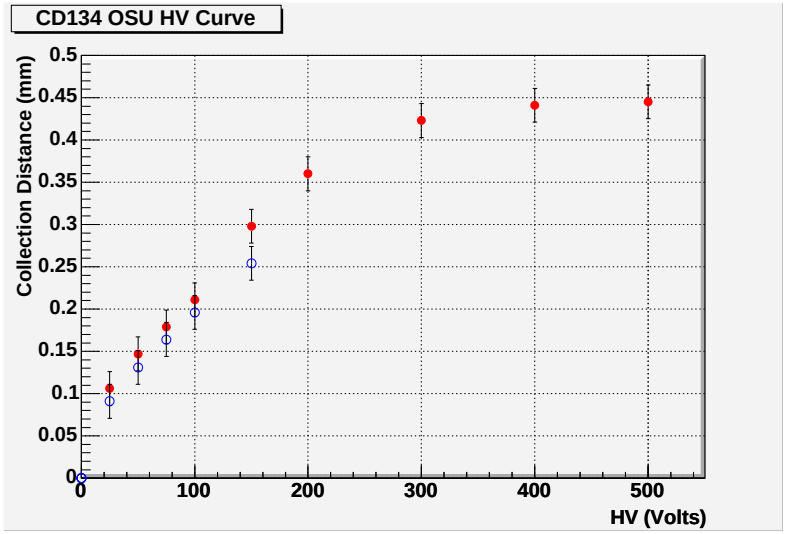
Full charge collection at E<0.2V/μm!

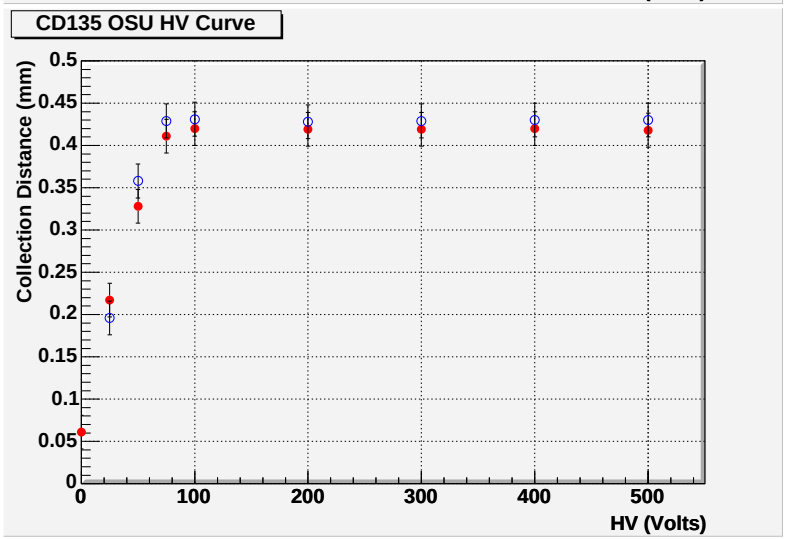
Stability characteristics



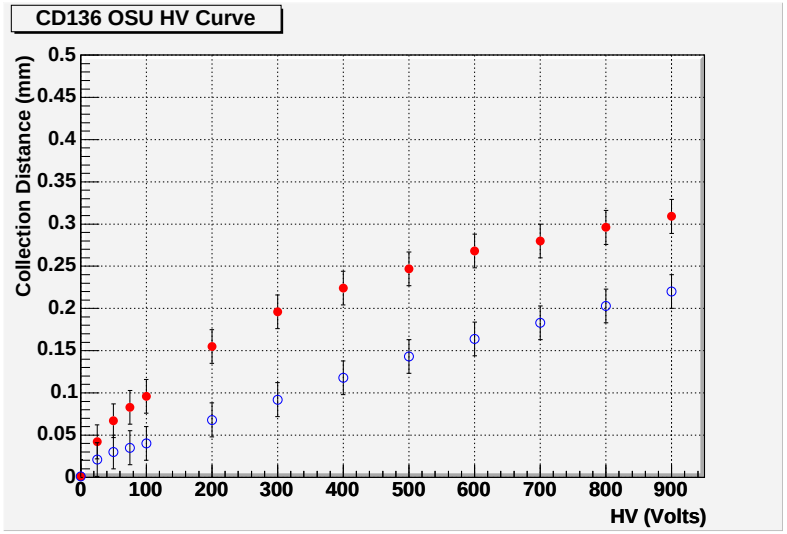
Little or no pumping!

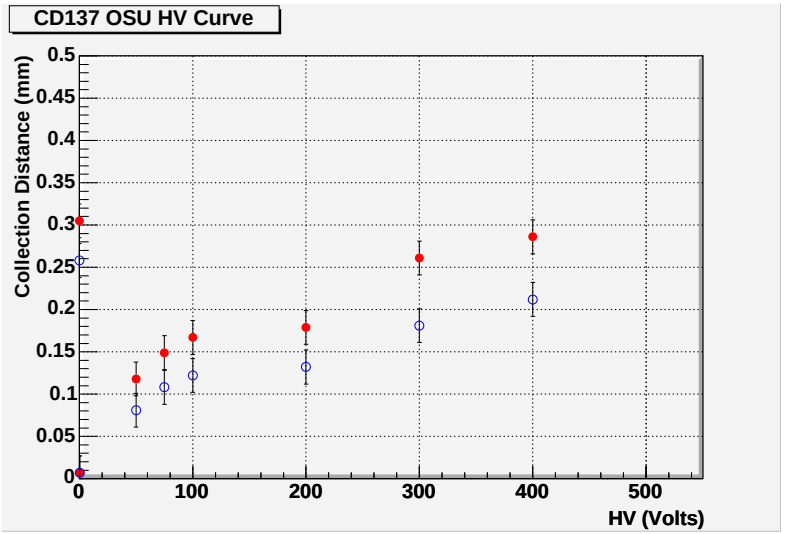
Other Diamonds



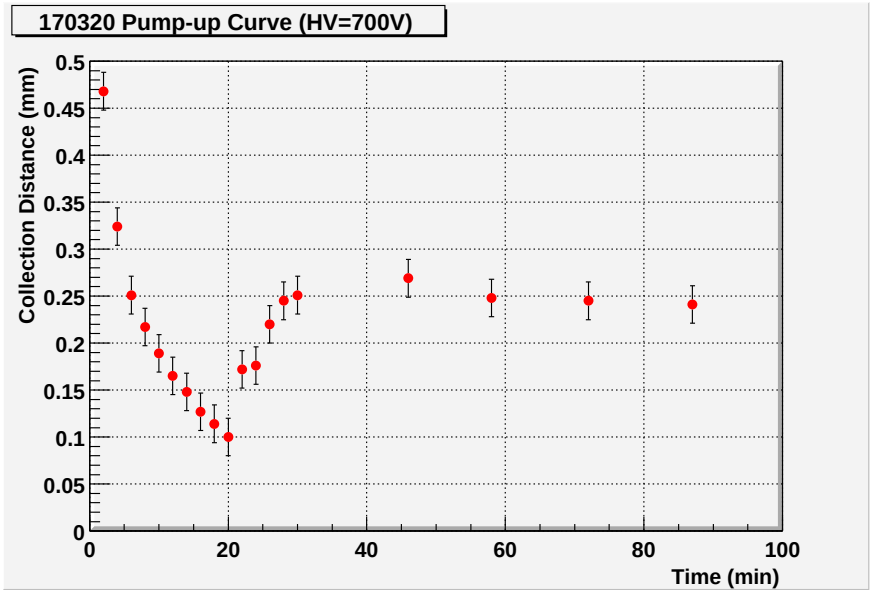


Other Diamonds



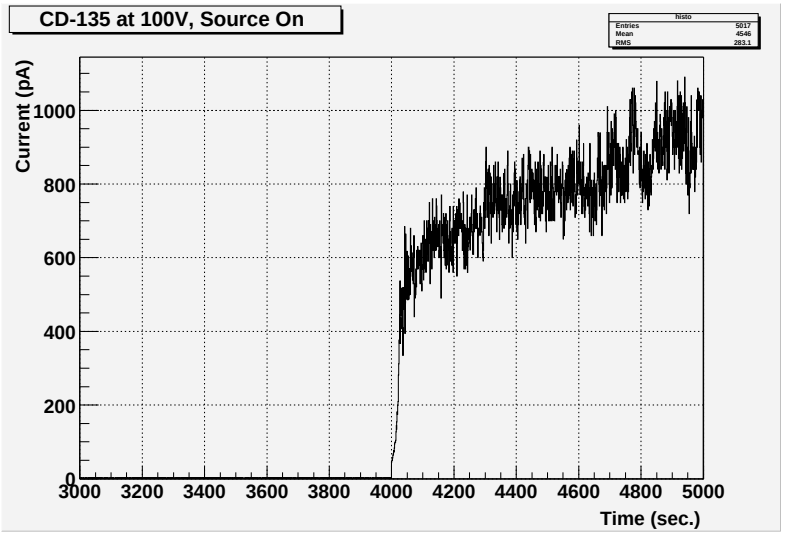


Other Diamonds



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}Co tested below with ^{90}Sr



Summary

- **pCVD Charge Collection**
  - 275 μm 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 μm collection distance attained in unprocessed diamond
  - Work proceeding to produce $>$ 300μm 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!