Diamond detectors

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INFN-LNF

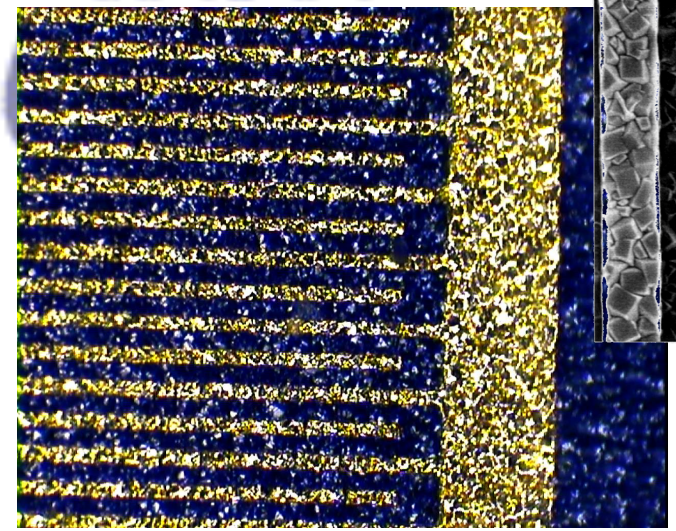
Ideal UV detector

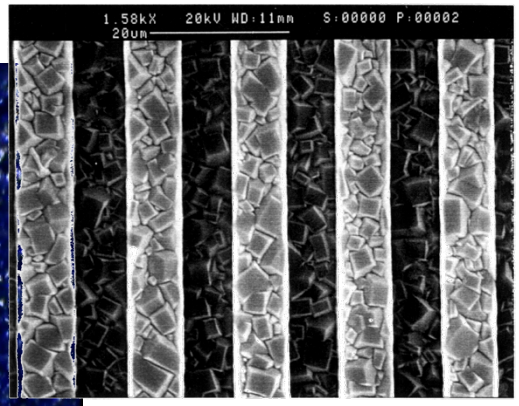
- High signal to noise
  - Low dark current
  - High responsivity
- Linearity
- Large area
- High speed
- Solar blindness
- Radiation hardness

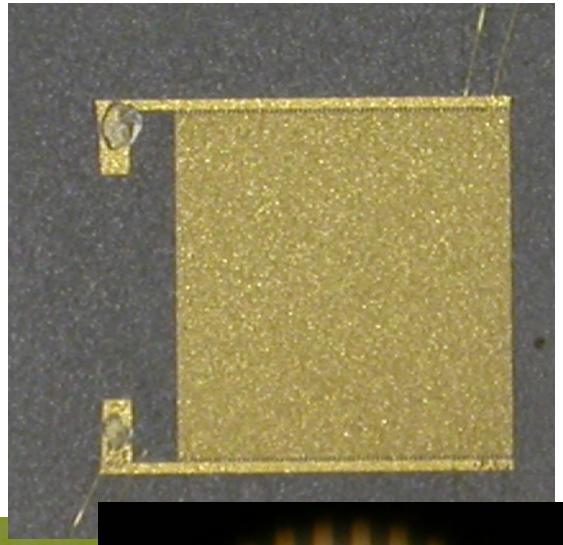
Diamond properties

- Large band gap 5.5 eV
- Low capacitance 2 pF
- Ohmic or Schottky contacts
- Low voltage bias
- High voltage breakdown 10^7 V

Diamond XUV photodetectors

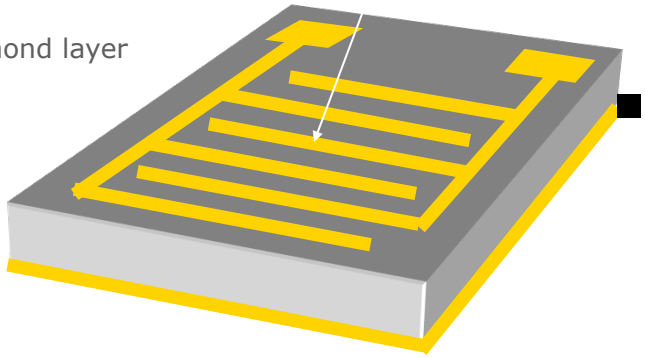


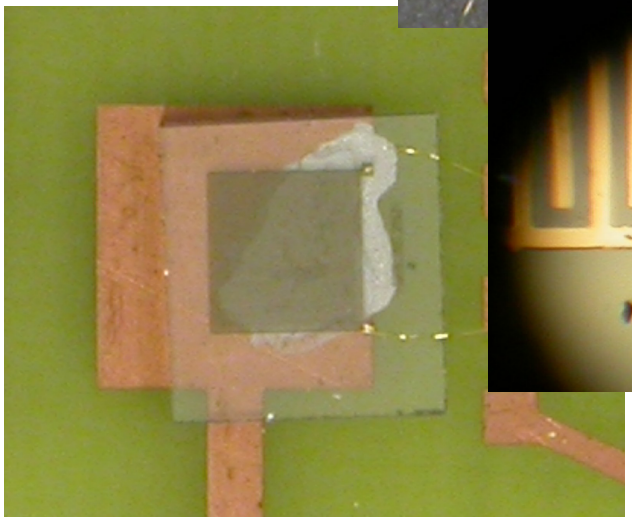


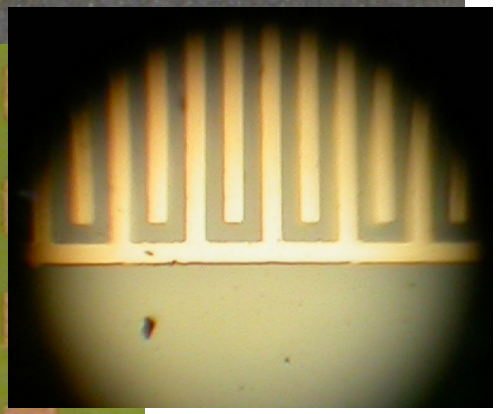


Interdigitated electrodes

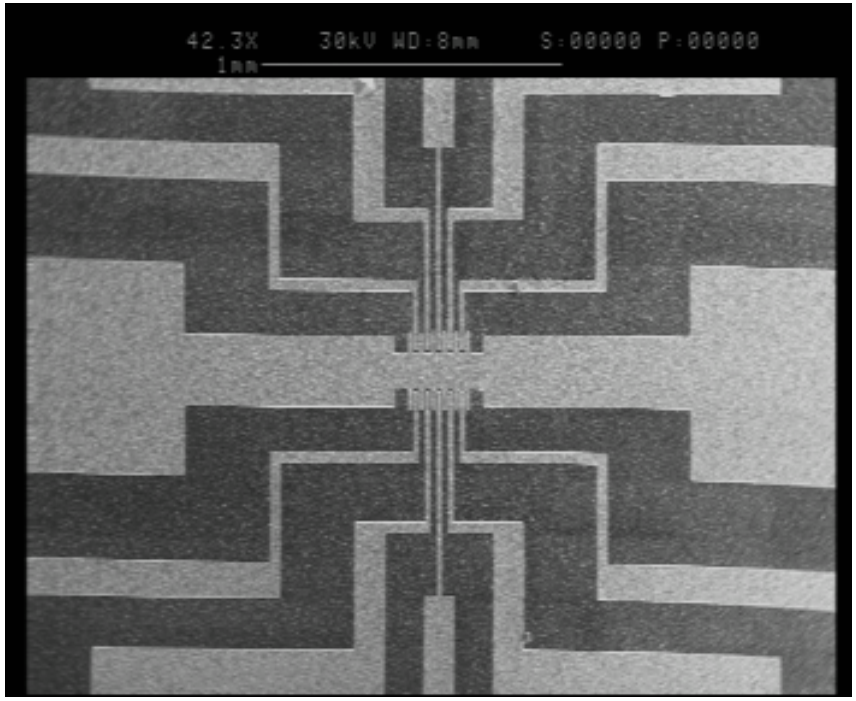
Diamond layer

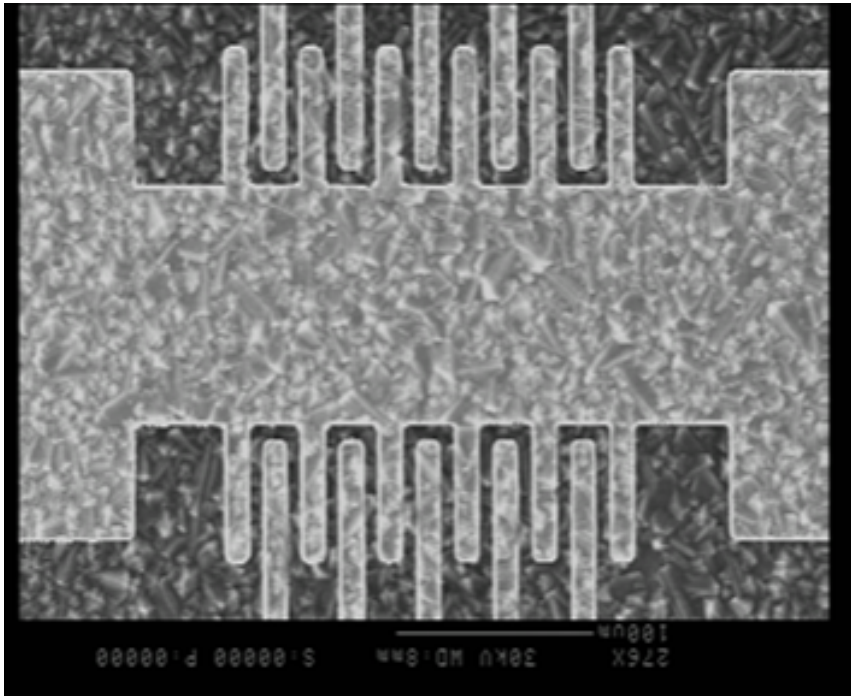




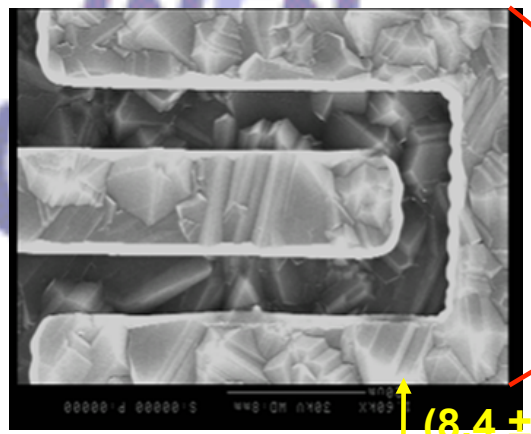


Pixel arrays

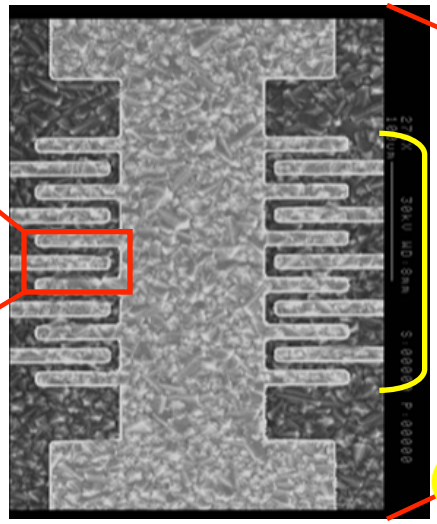




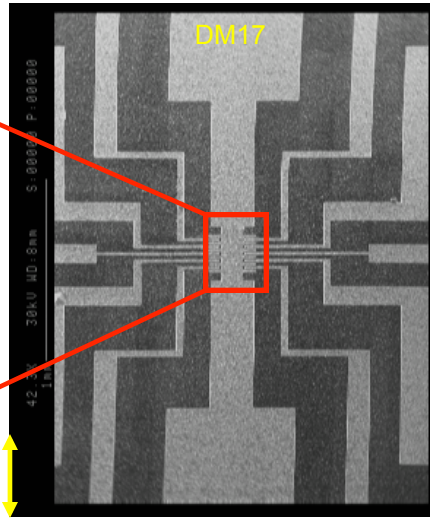
Electronic structures



(8,4 ± 0,4) µm



250 µm



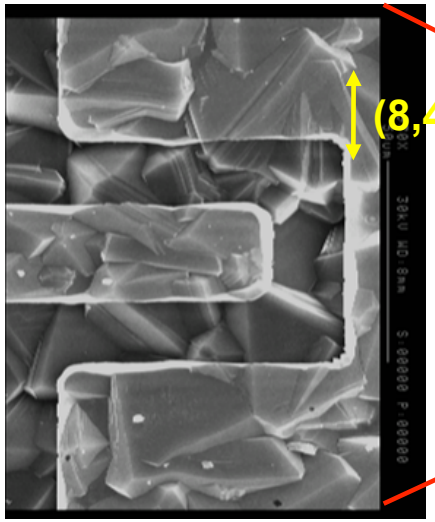
(15 ± 1)µm

(52,9 ±0,4) µm

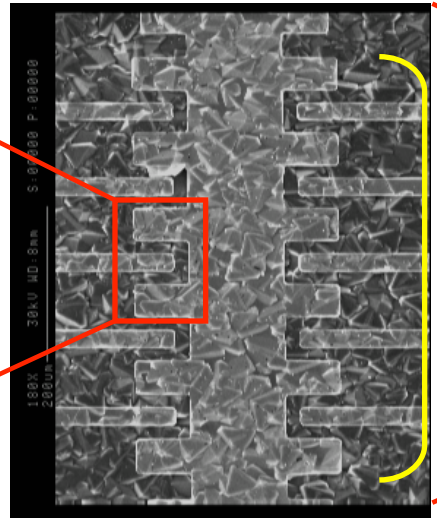
(6,8 ± 5) µm

(18 ± 1) µm

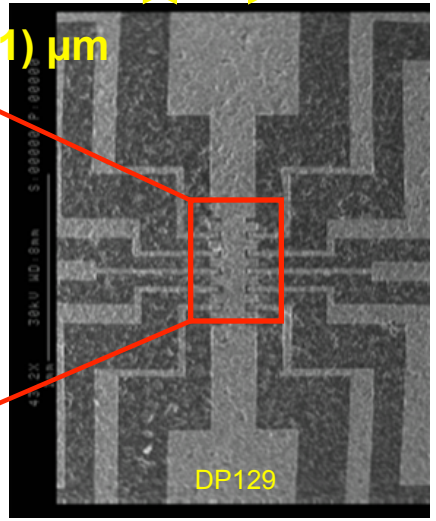
(54 ± 1) µm



(8,4 ± 0,4) µm

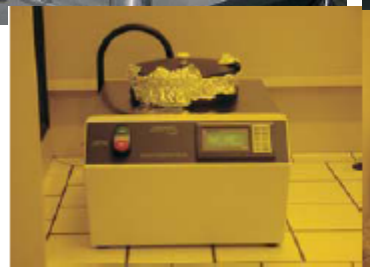


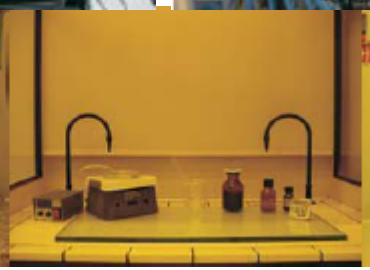
650 µm



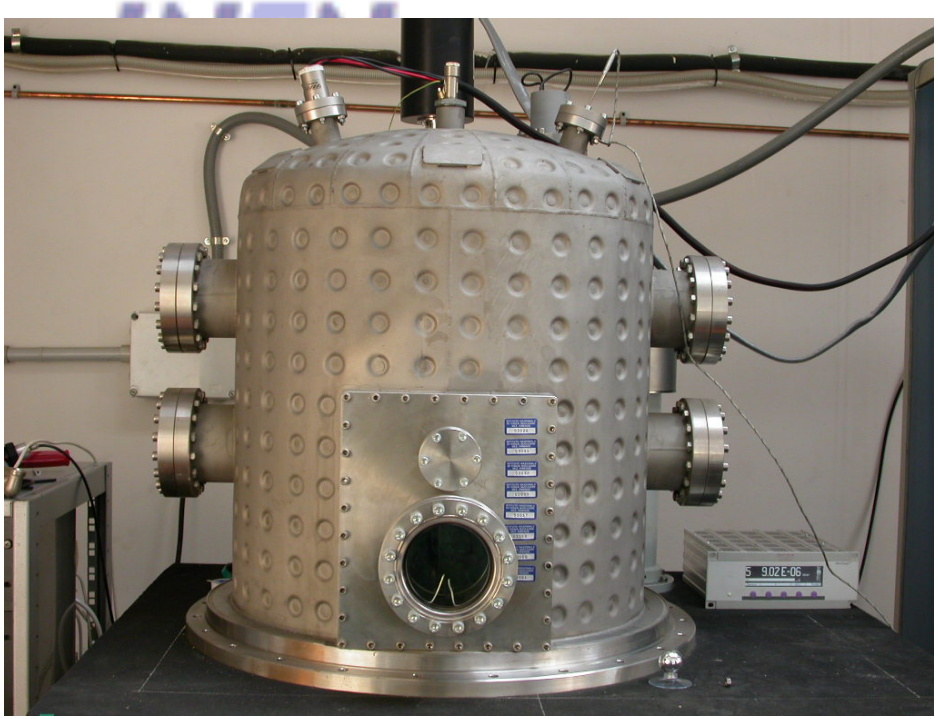
Laboratories

- Thermal & gas treatments
- Device processing
- Device packaging
- Coatings lab
- VUV-IR testing
- Clean room 1000



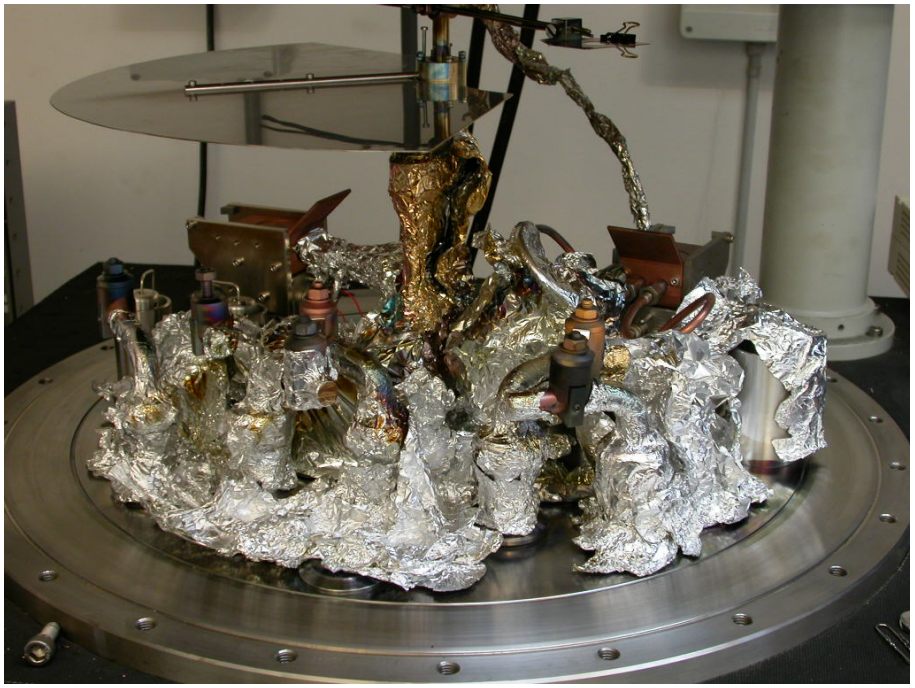


Metal deposition



Evaporators

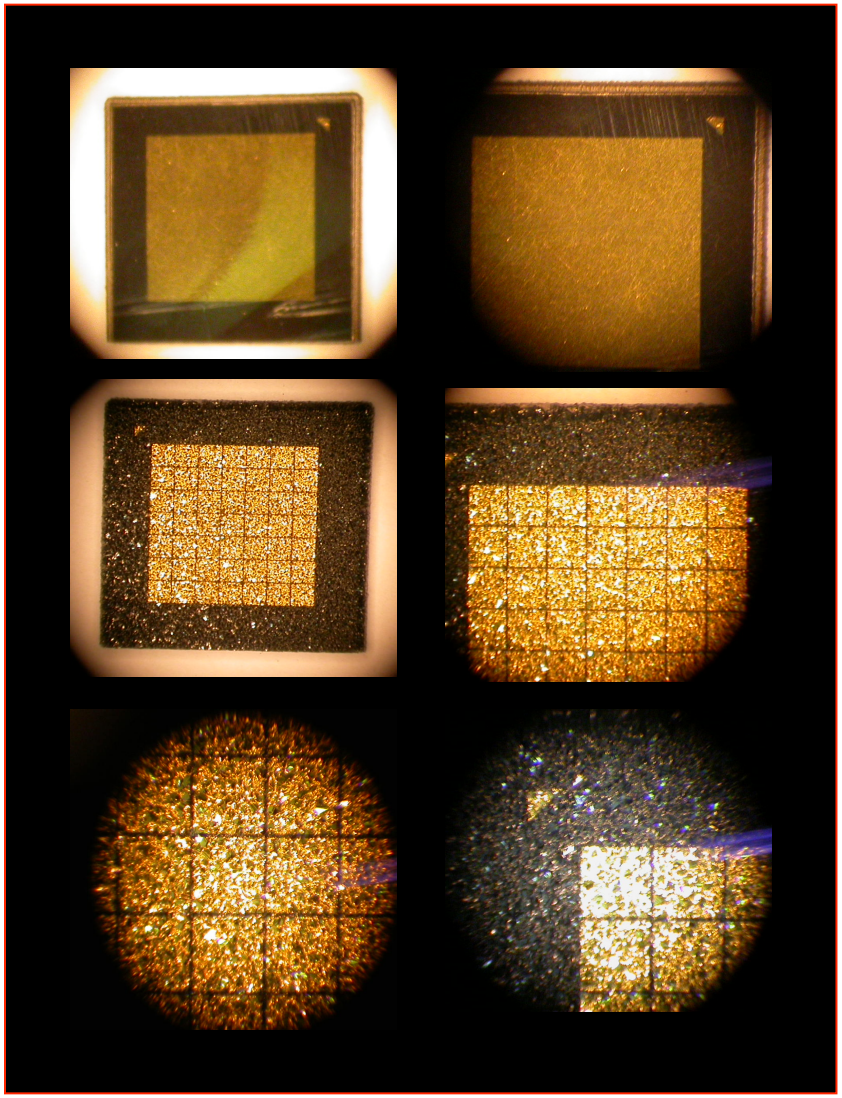
- ✓ High vacuum
- ✓ Substrate heating
- ✓ Substrate rotation
- ✓ Shutter
- ✓ Quartz Microbalance
- ✓ Monitoring vacuum quality



Deposition sources

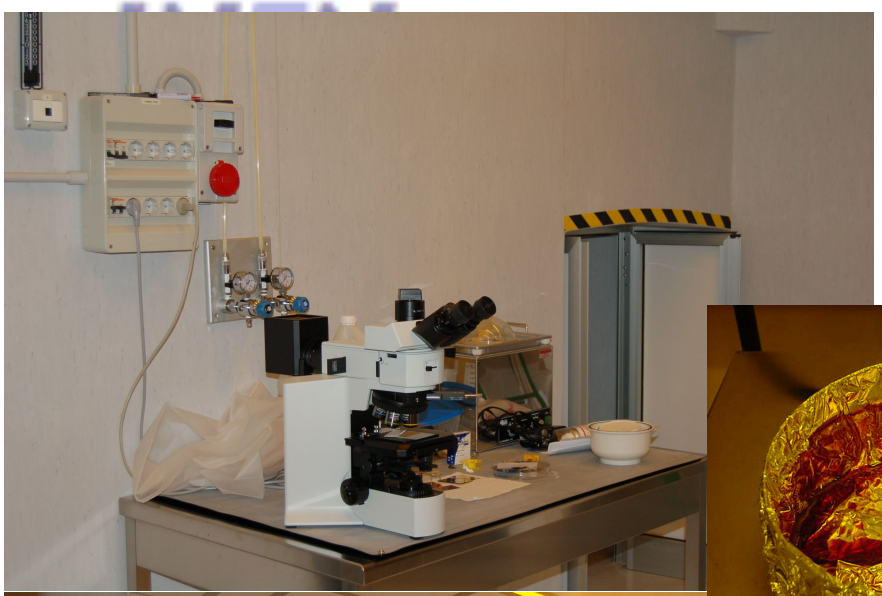
- ✓ 3 x 1.5 kW Joule-effect crucibles
- ✓ 2 electron guns with axial sweep

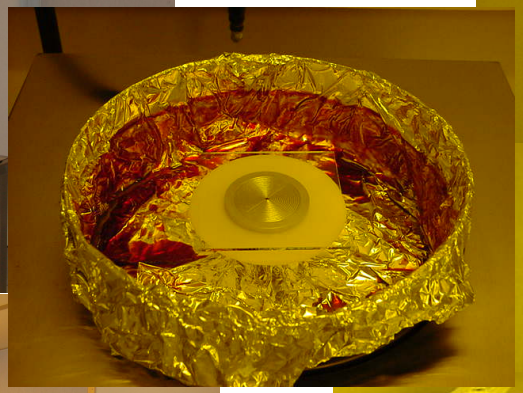
Electric contacts



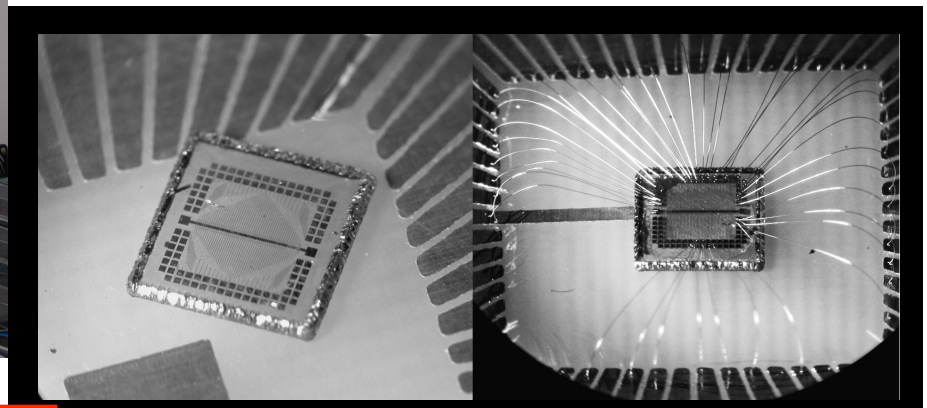
Example of pixellated detector based on as grown synthetic diamond substrates. The surface roughness is comparable with the mean size of the grains (≈ 100 μm). One back contact against 49 pixels (900 μm side and 50 μm gap) on the front surface.

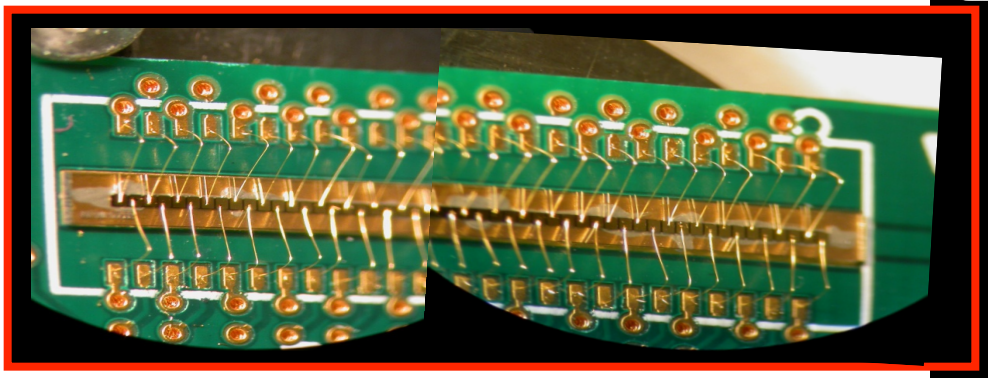
Clean room 1000 class

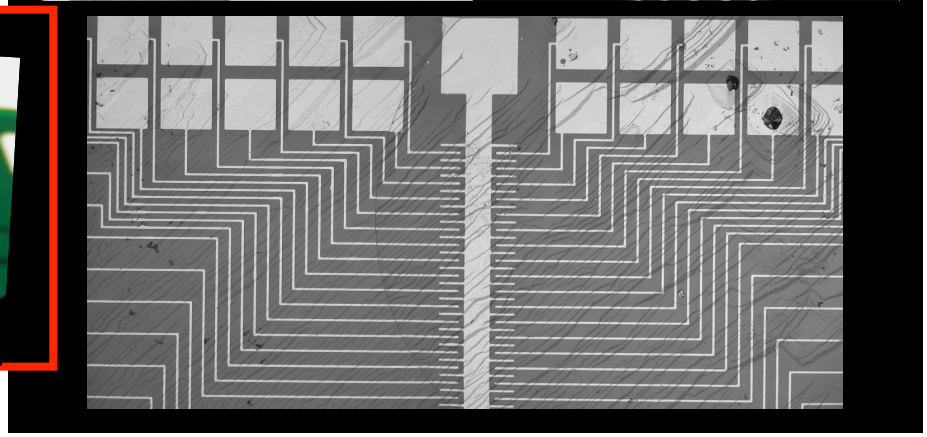




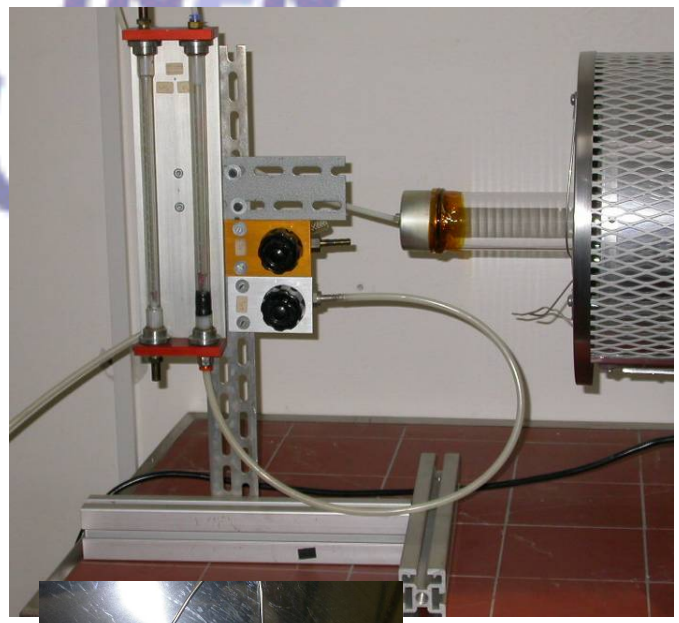
Bonding & packaging

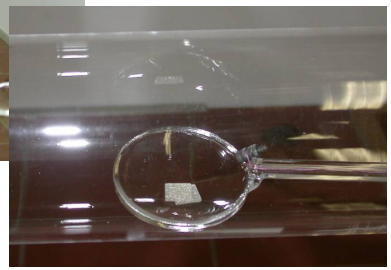






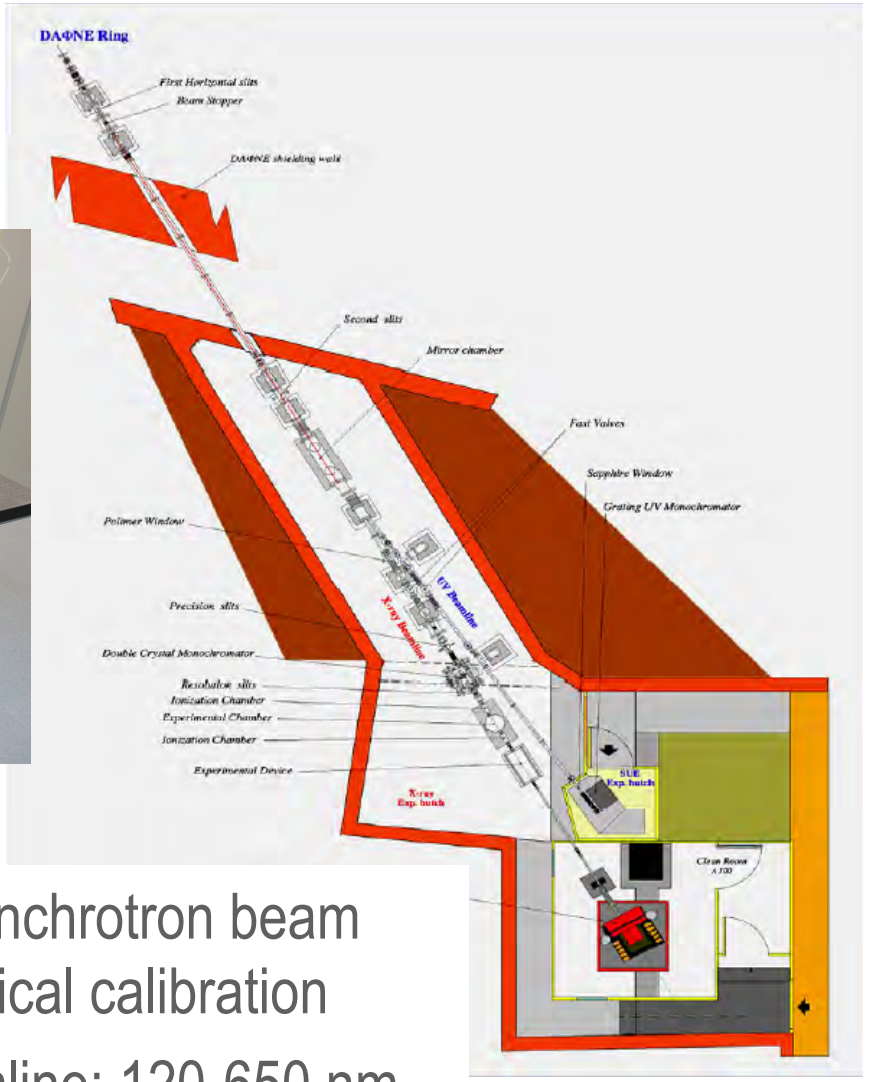
Thermal treatments

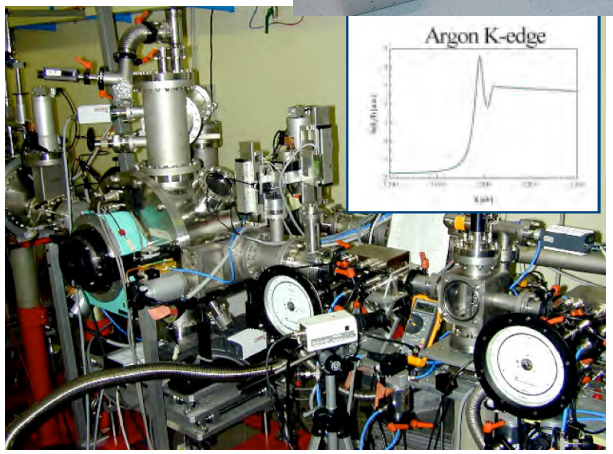




Tubular owen
Thermal treatments at 800°C in a controlled atmosphere (Ar, N_2, etc.).

SOURCE: OGSE





DAFNE-L: synchrotron beam facility for optical calibration

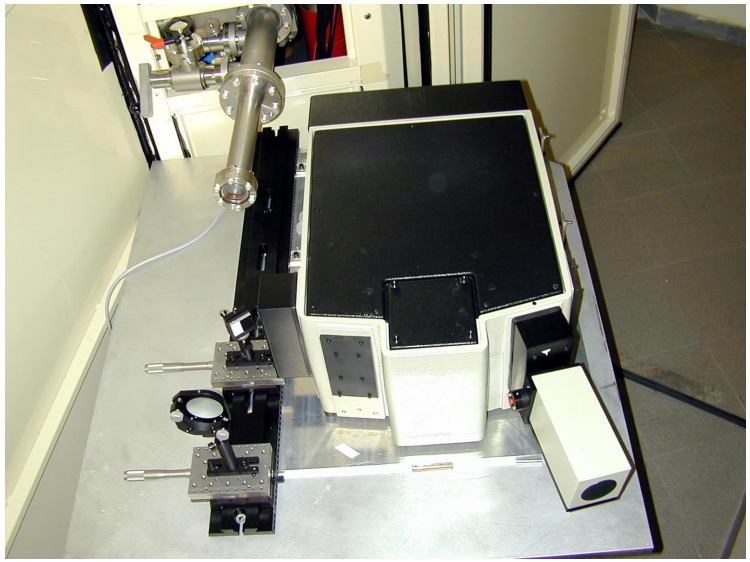
VIS-UV beamline: 120-650 nm.

Optical systems up to 4 m.

SOURCE @ DAFNE
Branchlines

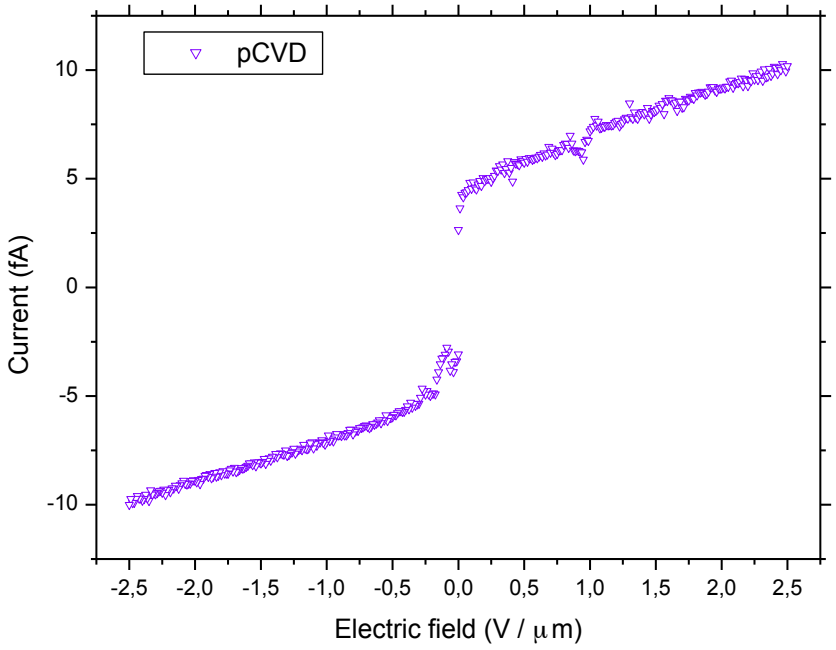
1. The UV-VIS monochromatic radiation source (180-650 nm) already existing and to be upgraded before the end of 2008

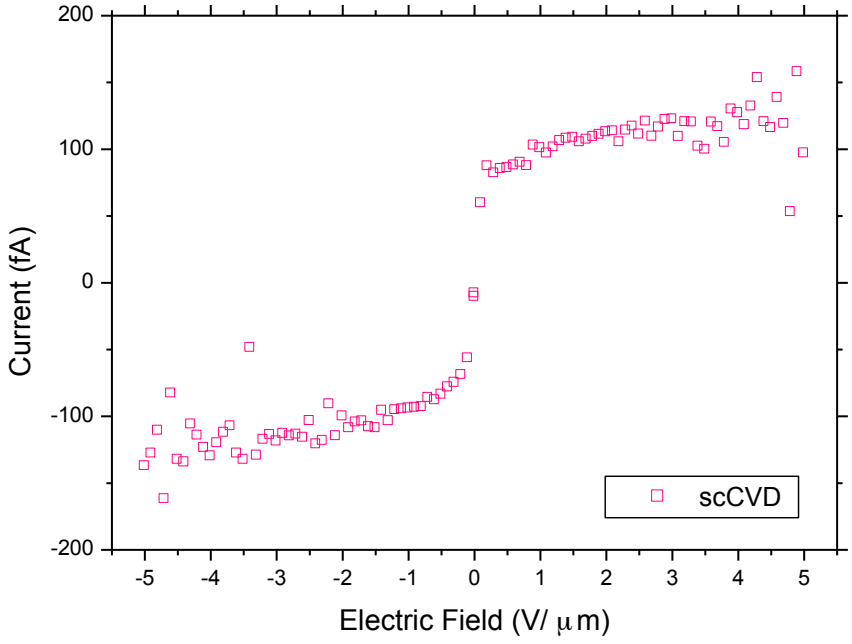
2. The VUV monochromatic radiation source (120-250 nm) that is mounted in a 10000-class cleanroom and operating from the end of 2008



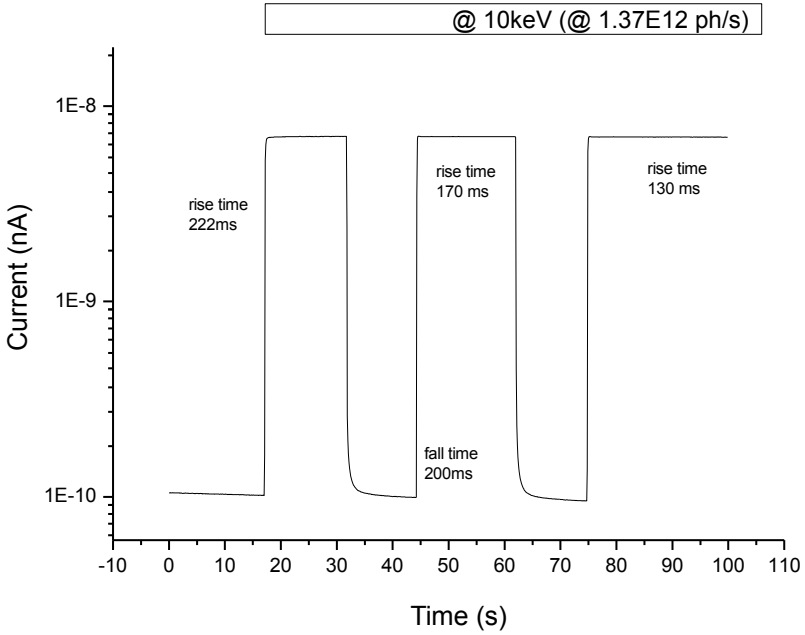
3. The UV-VIS radiation source (200-650 nm) that will be mounted in a 10000-class cleanroom and completed before the end of June 2009. This channel will be used to measure the performance of large and very large optical systems (up to 4 meters).

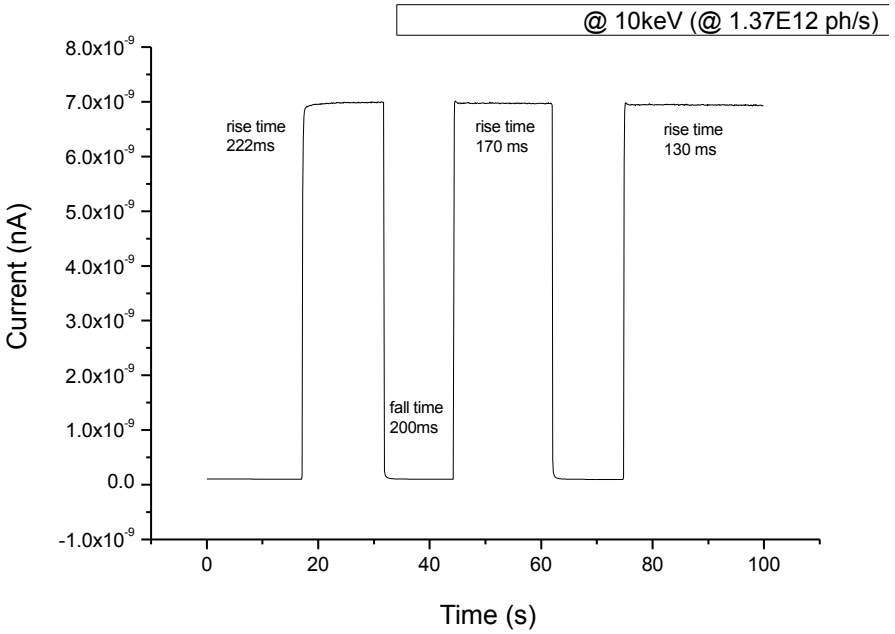
Diamond detectors
Dark current





Diamond detectors
Response time

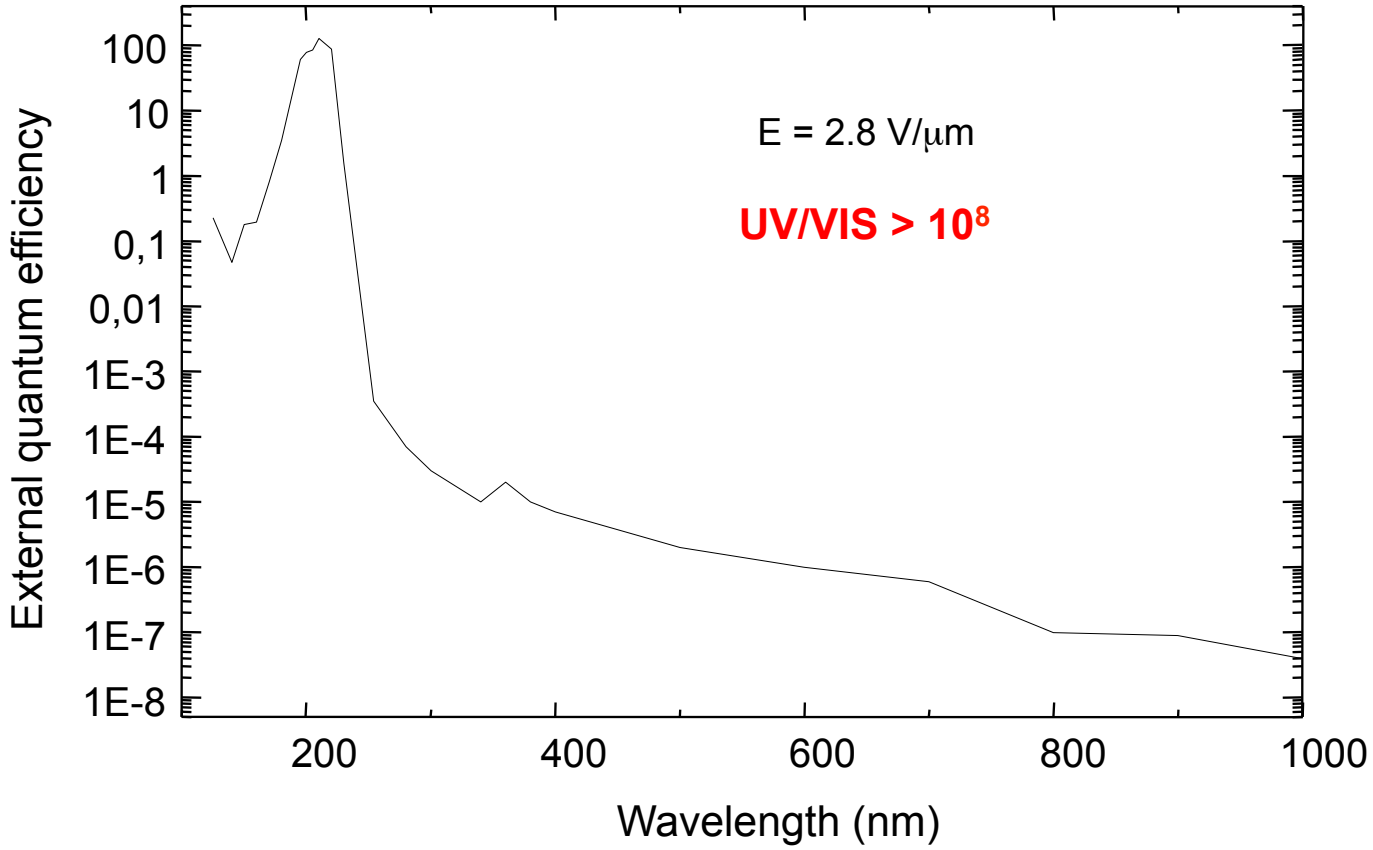




Diamond detectors
Sensitivity

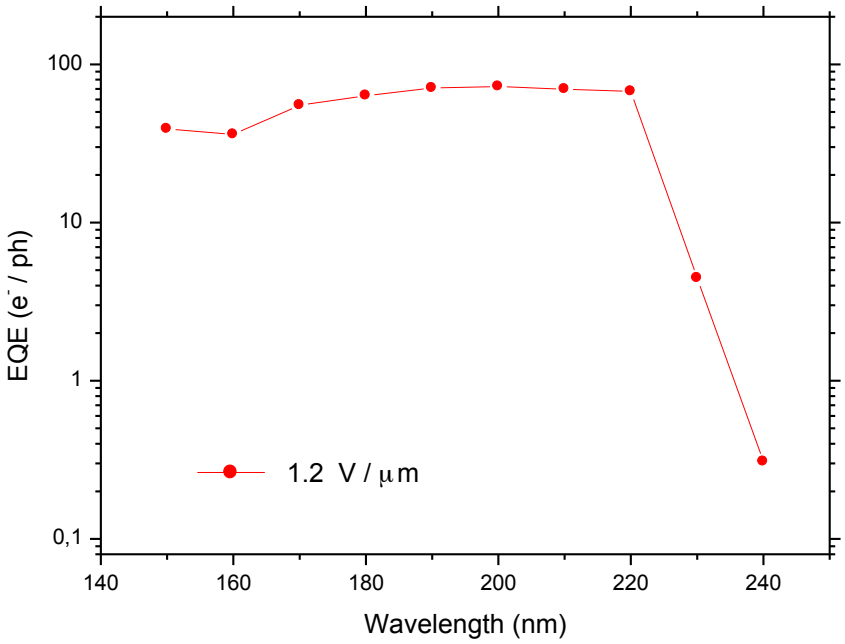
E. Pace et al., Diam. Rel. Mater. 9 (2000) 987-993.

pCVD

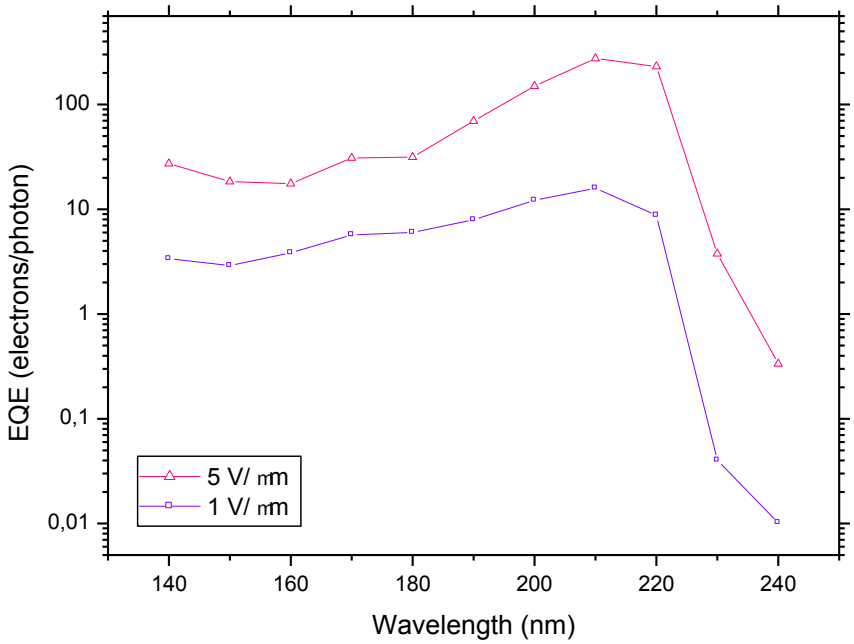


Diamond detectors
VUV efficiency

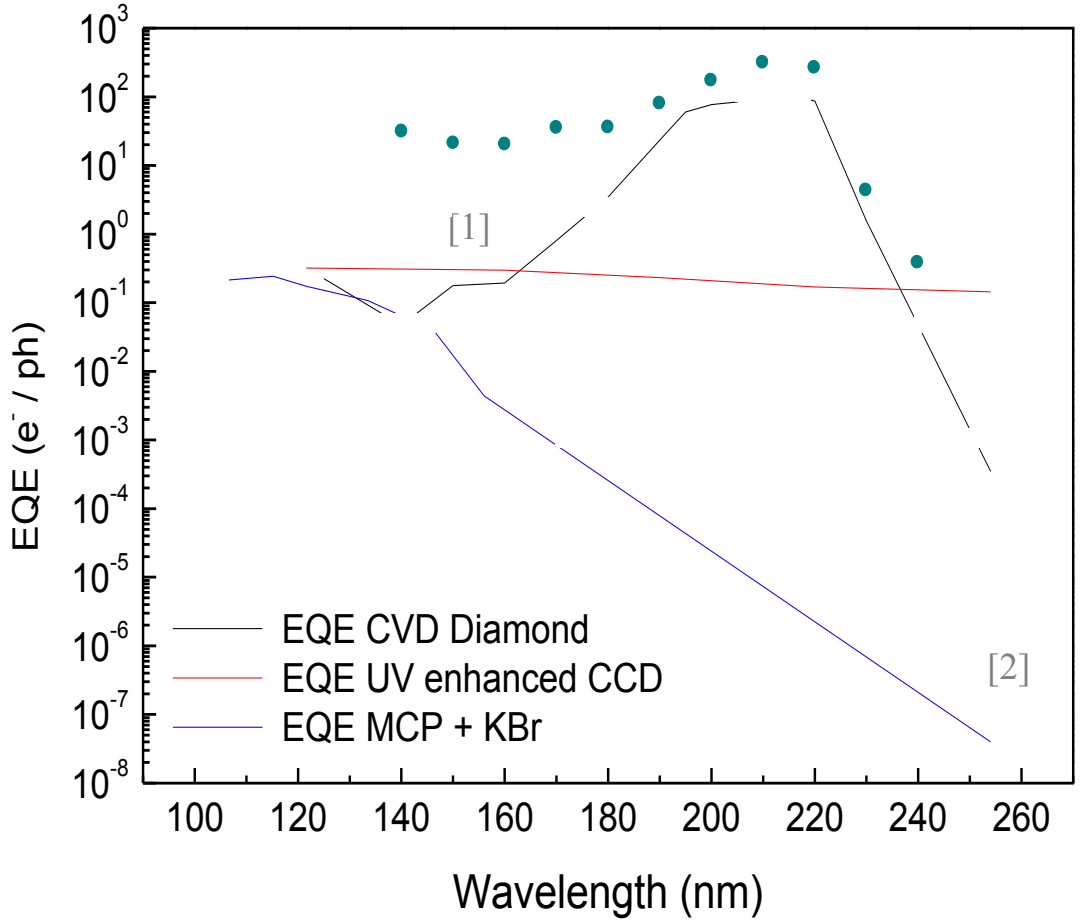
pCVD



scCVD



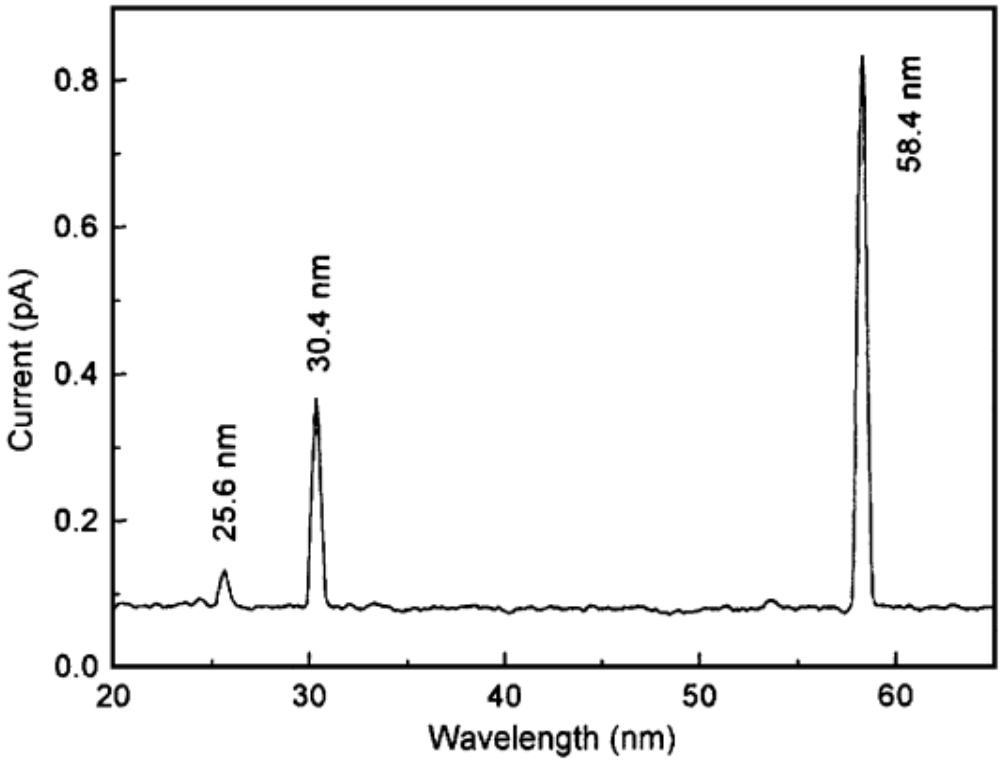
Diamond detectors
Comparison

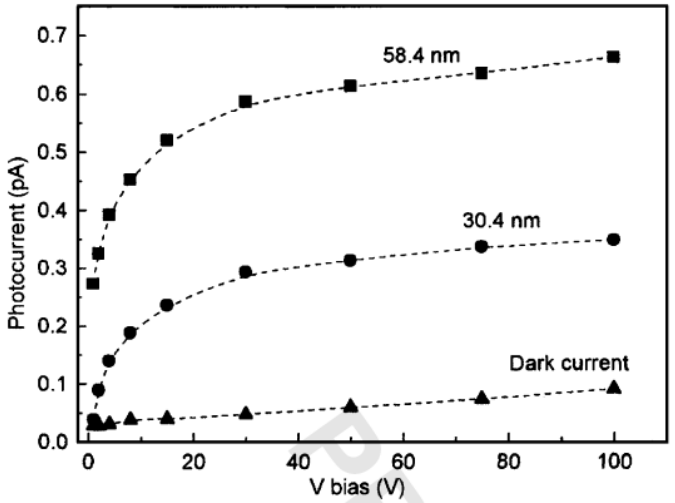


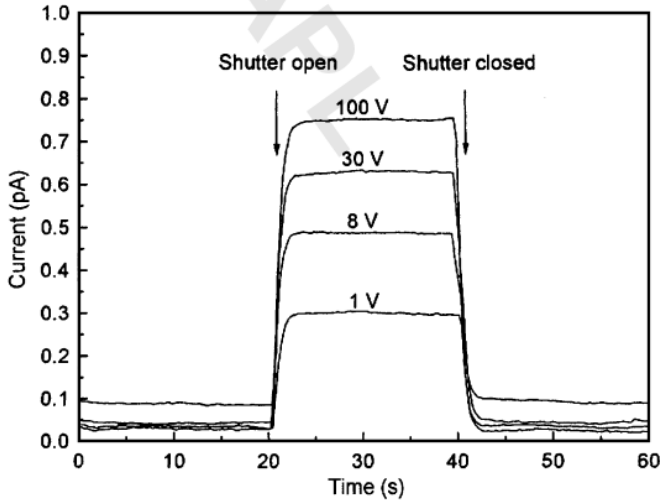
[1] Naletto, Pace et al, 1994

[2] Wilhelm et al.,1995

Diamond detectors
VUV response

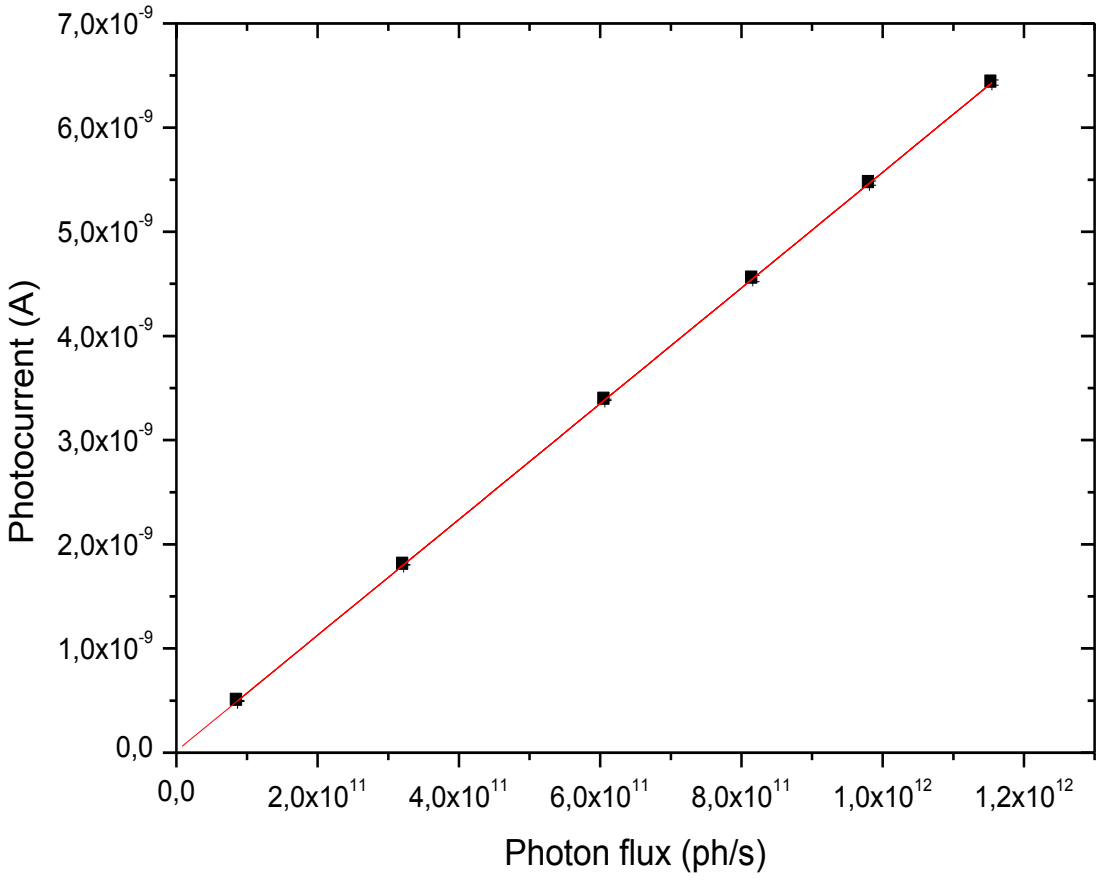


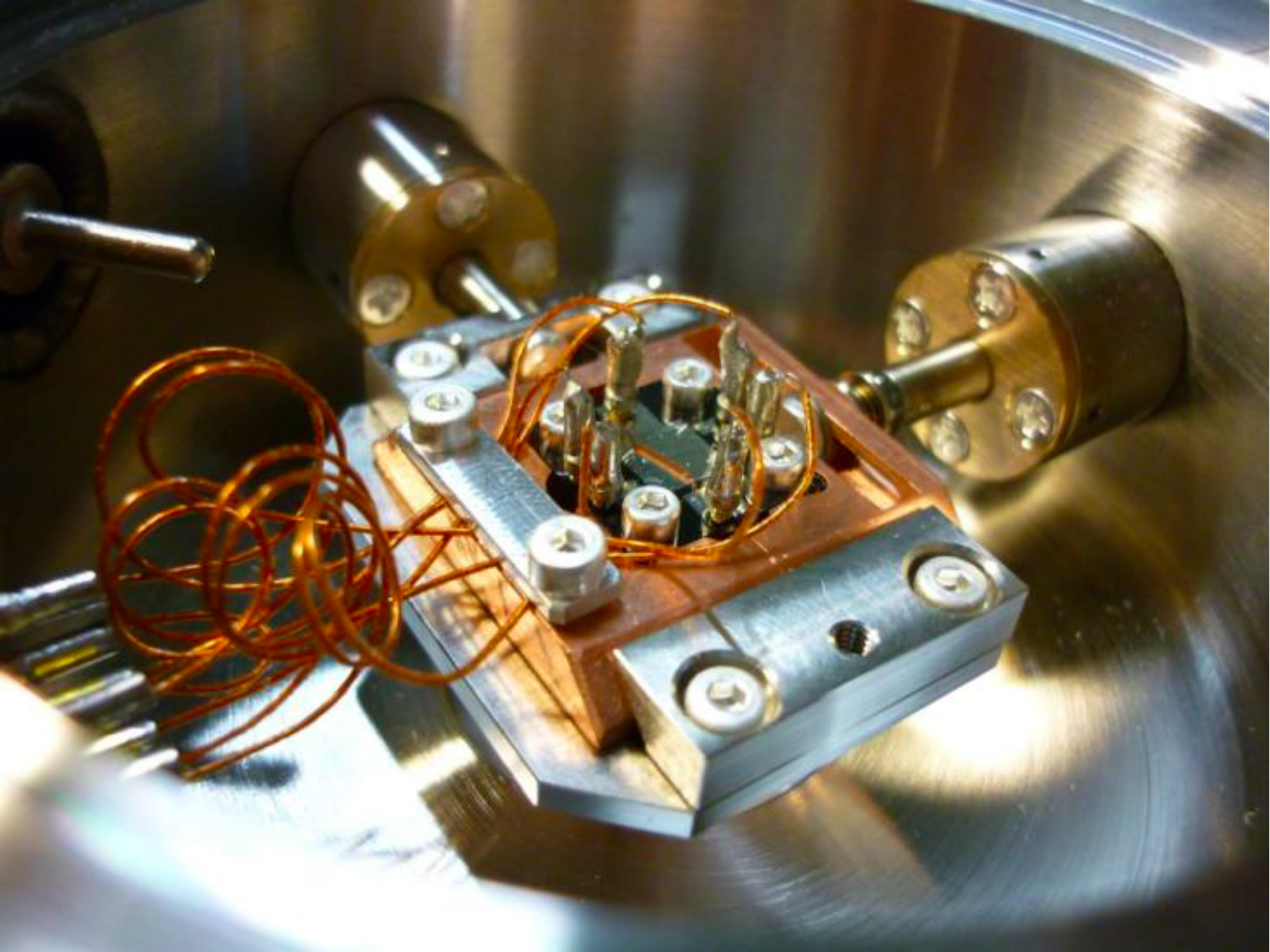


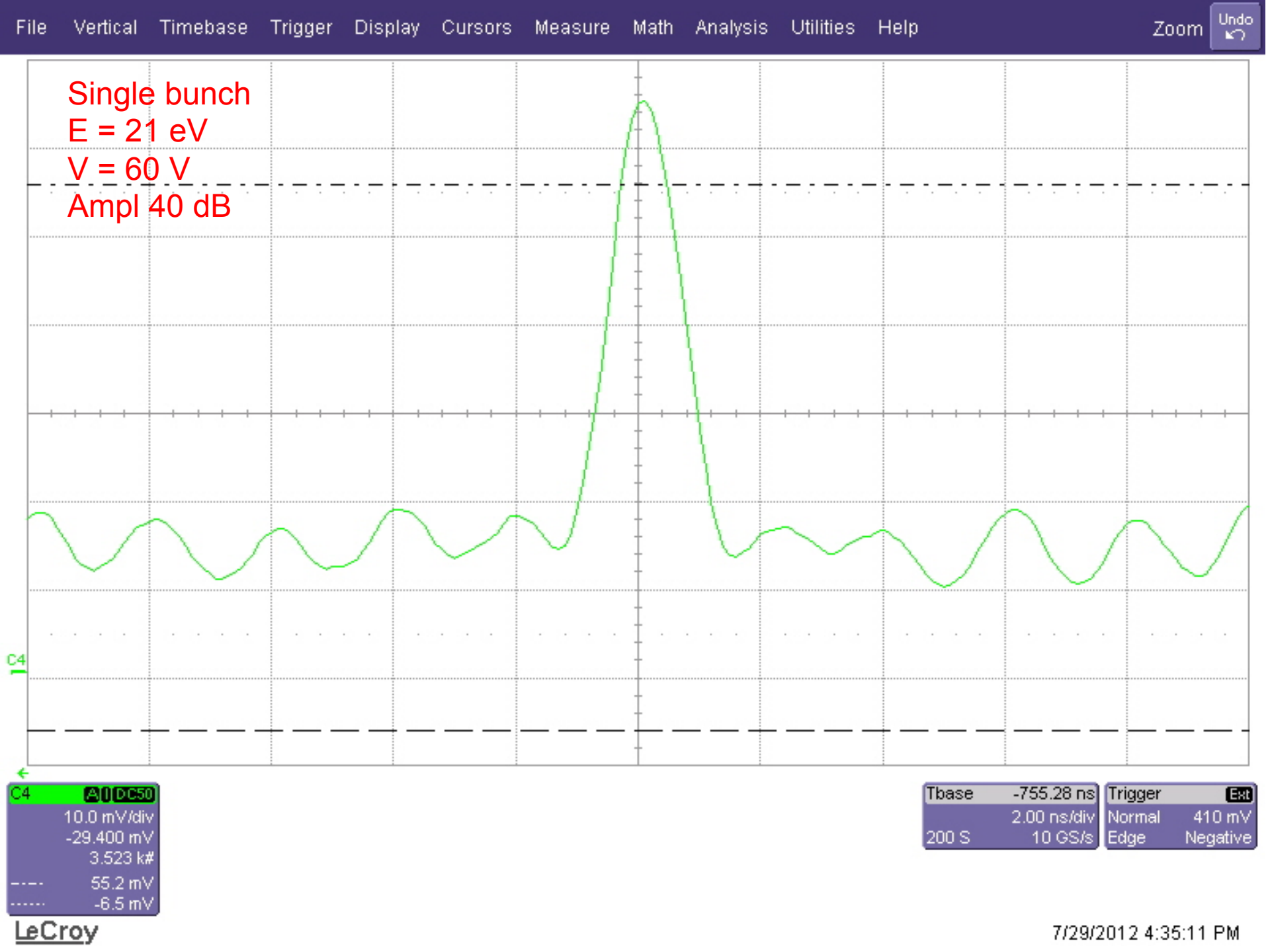


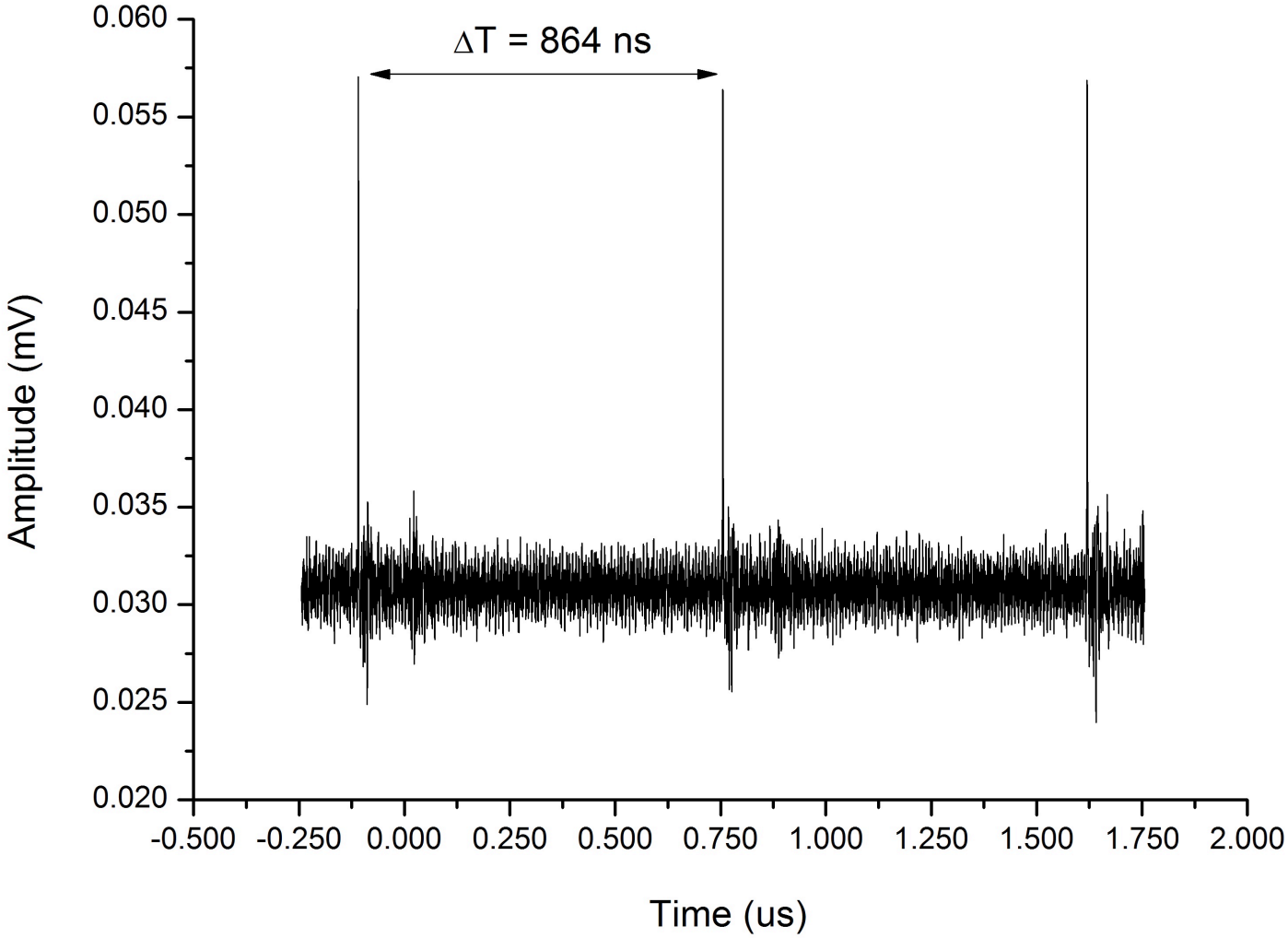
Diamond detectors

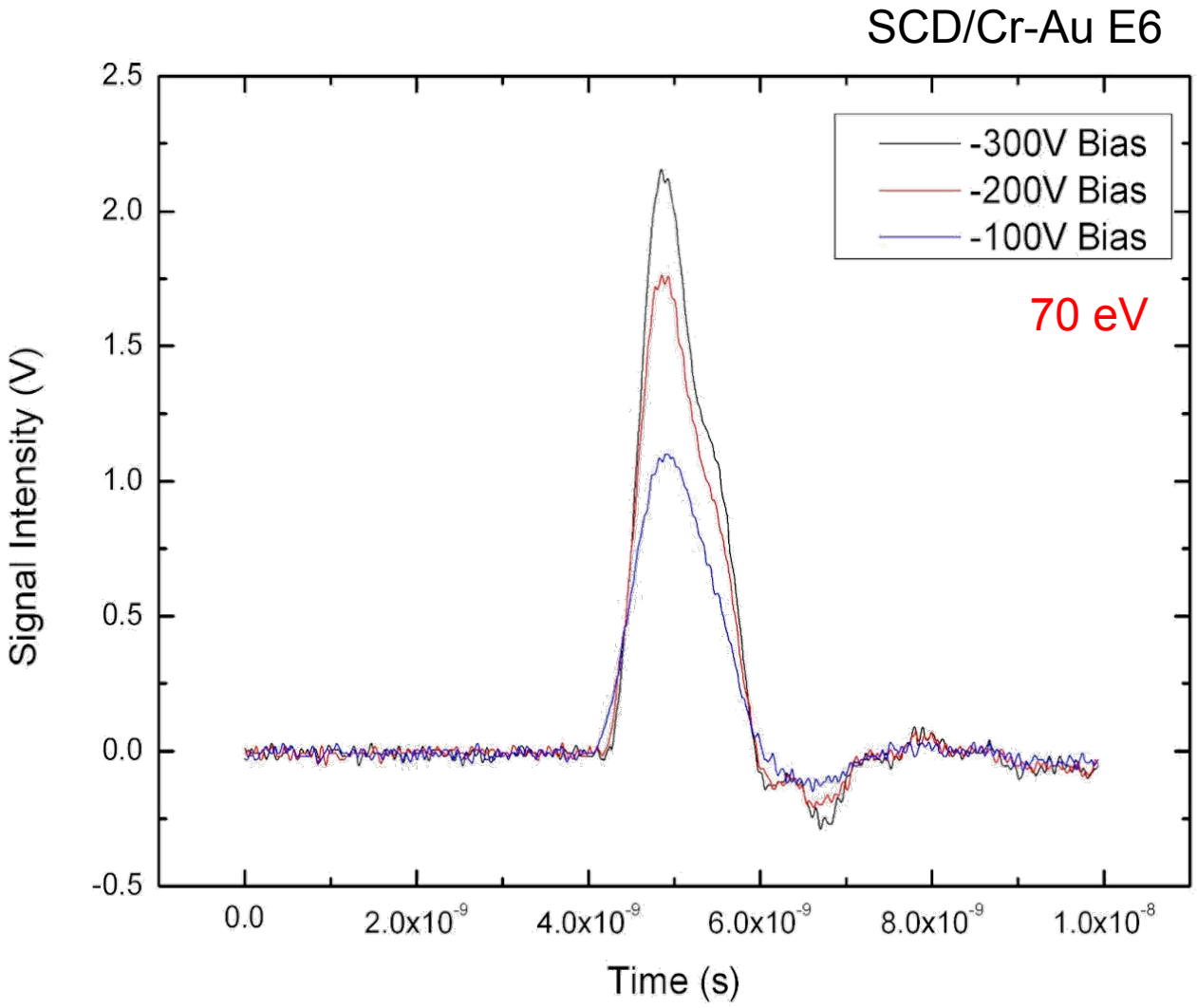
Linearity

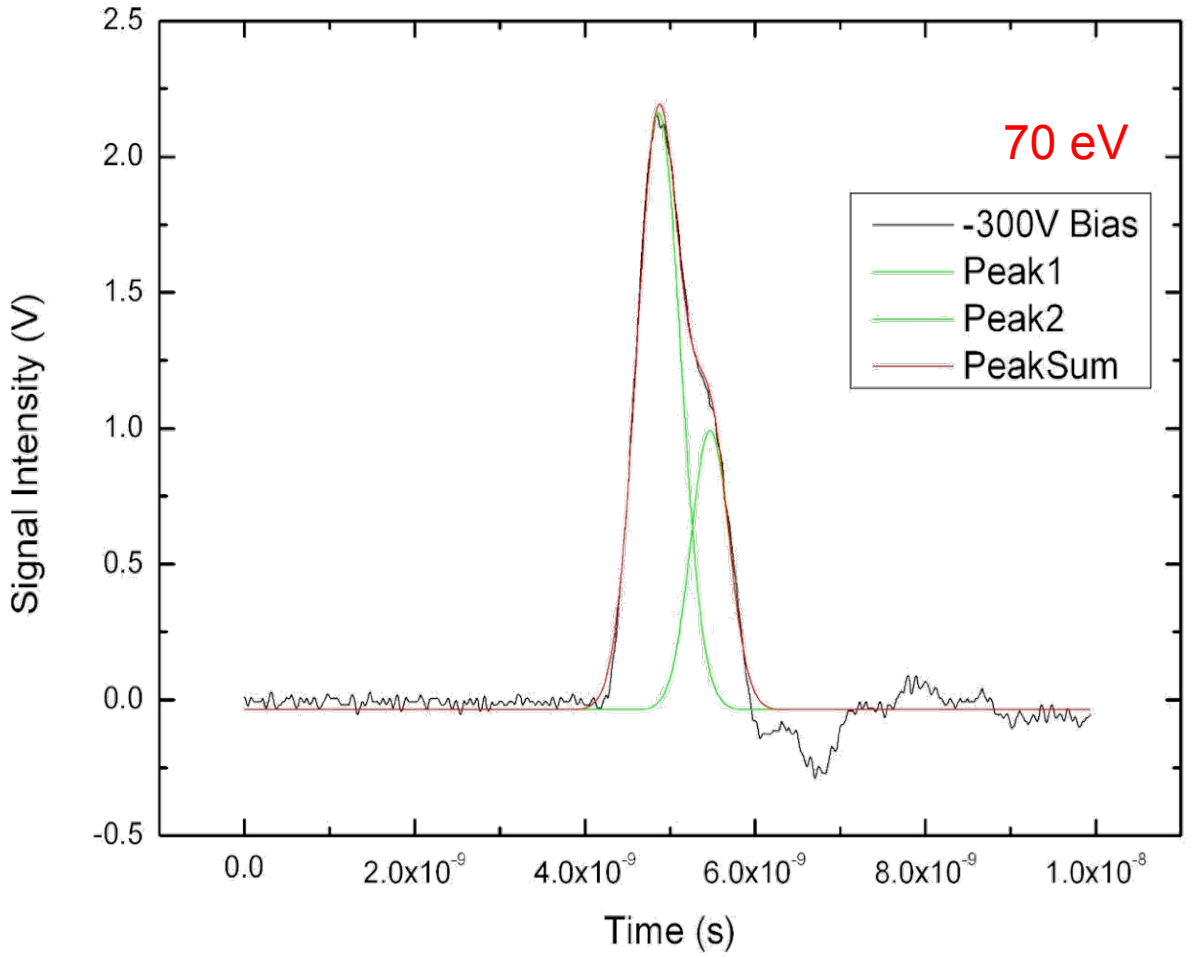


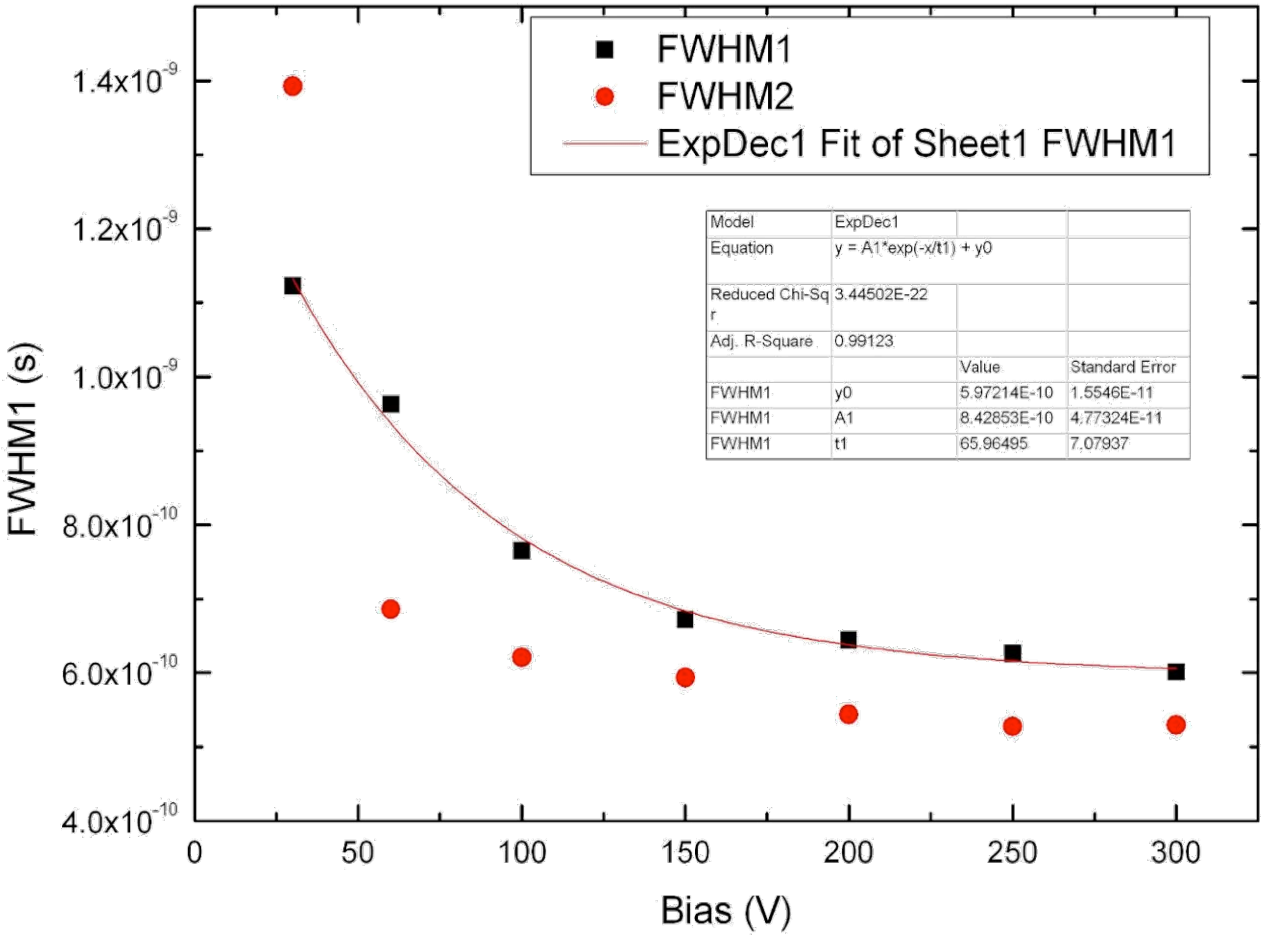



File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
Zoom
Undo
Single bunch
E = 21 eV
V = 60 V
Ampl 40 dB
C4
C4 A I DC50
10.0 mV/div
-29.400 mV
3.523 k#
55.2 mV
-6.5 mV
Tbase -755.28 ns
2.00 ns/div
200 S 10 GS/s
Trigger Ext
Normal 410 mV
Edge Negative
LeCroy
7/29/2012 4:35:11 PM

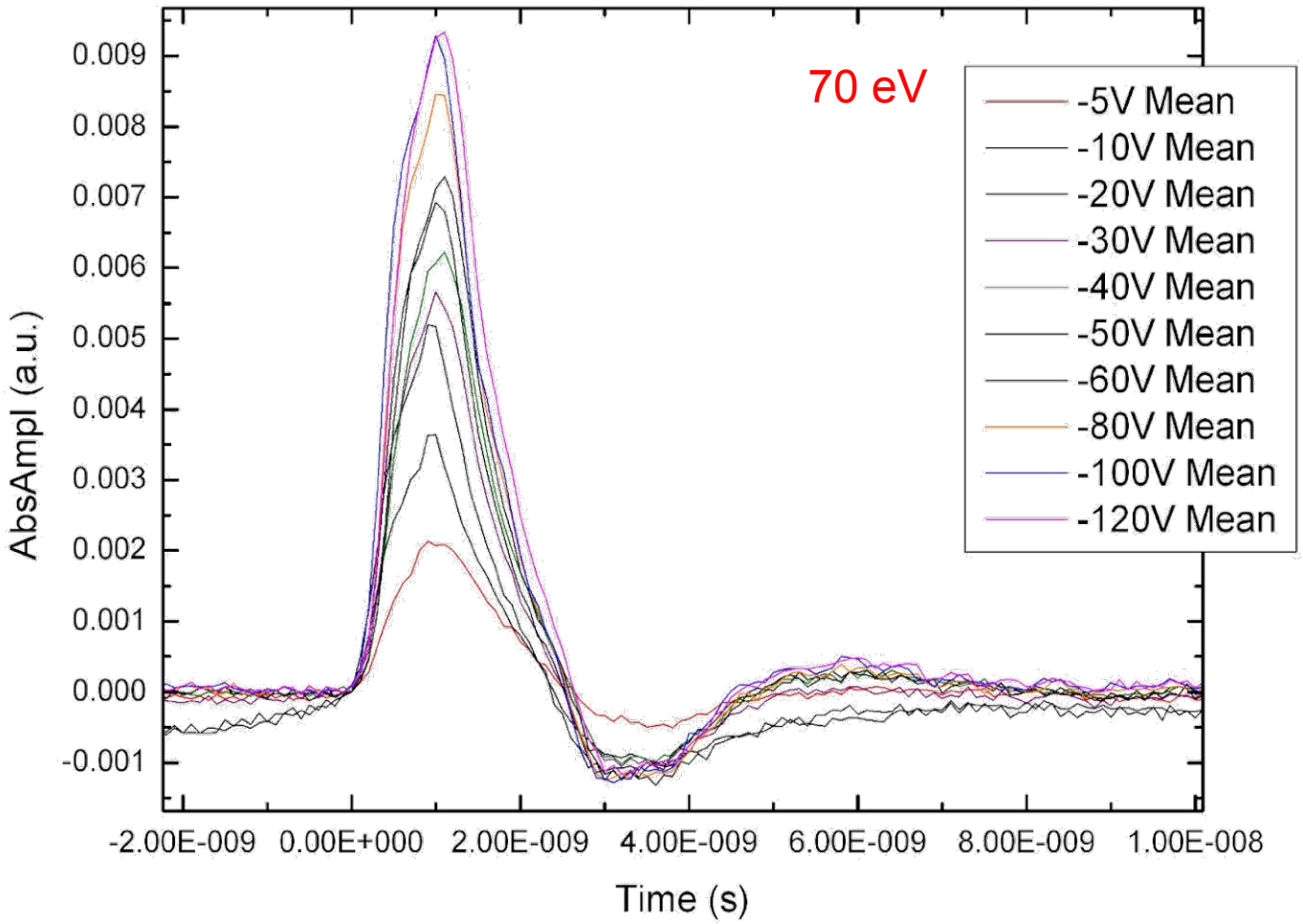

ΔT = 864 ns
Amplitude (mV)
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
-0.500
-0.250
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
Time (us)

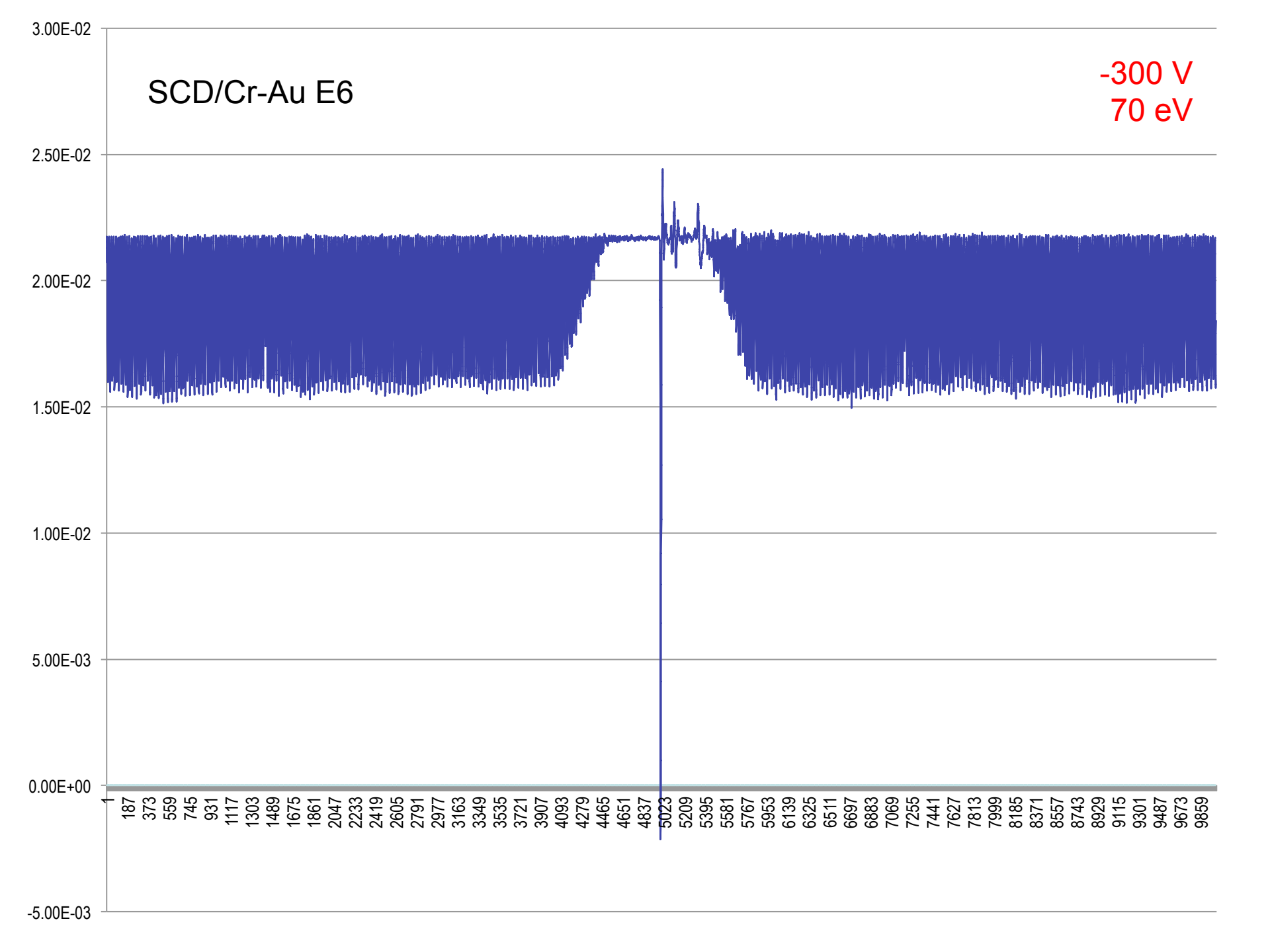

SCD/Cr-Au E6
-300V Bias
-200V Bias
-100V Bias
70 eV
Signal Intensity (V)
Time (s)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0.0
2.0x10-9
4.0x10-9
6.0x10-9
8.0x10-9
1.0x10-8

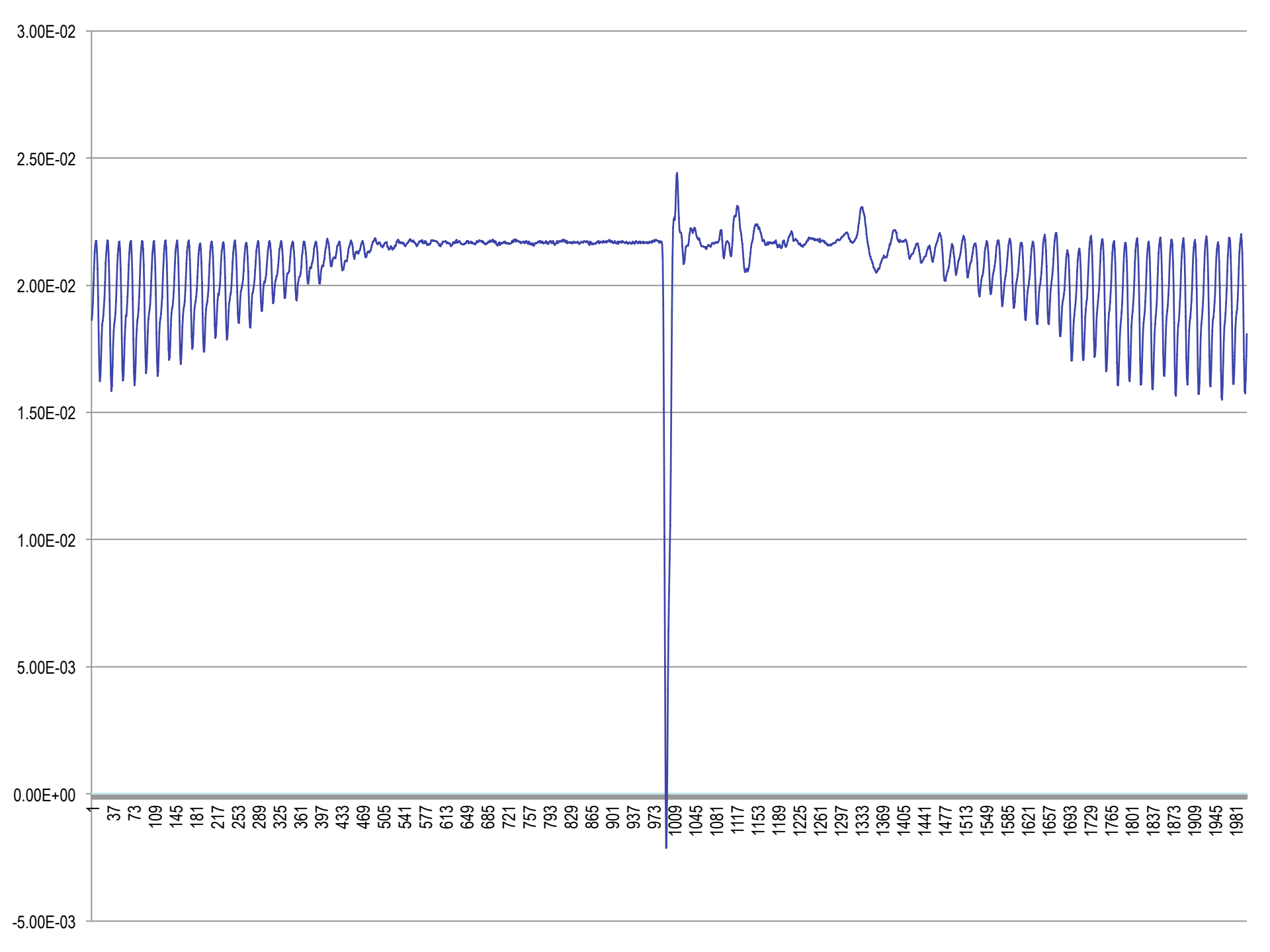

70 eV
-300V Bias
Peak1
Peak2
PeakSum
Signal Intensity (V)
Time (s)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0.0
2.0x10-9
4.0x10-9
6.0x10-9
8.0x10-9
1.0x10-8

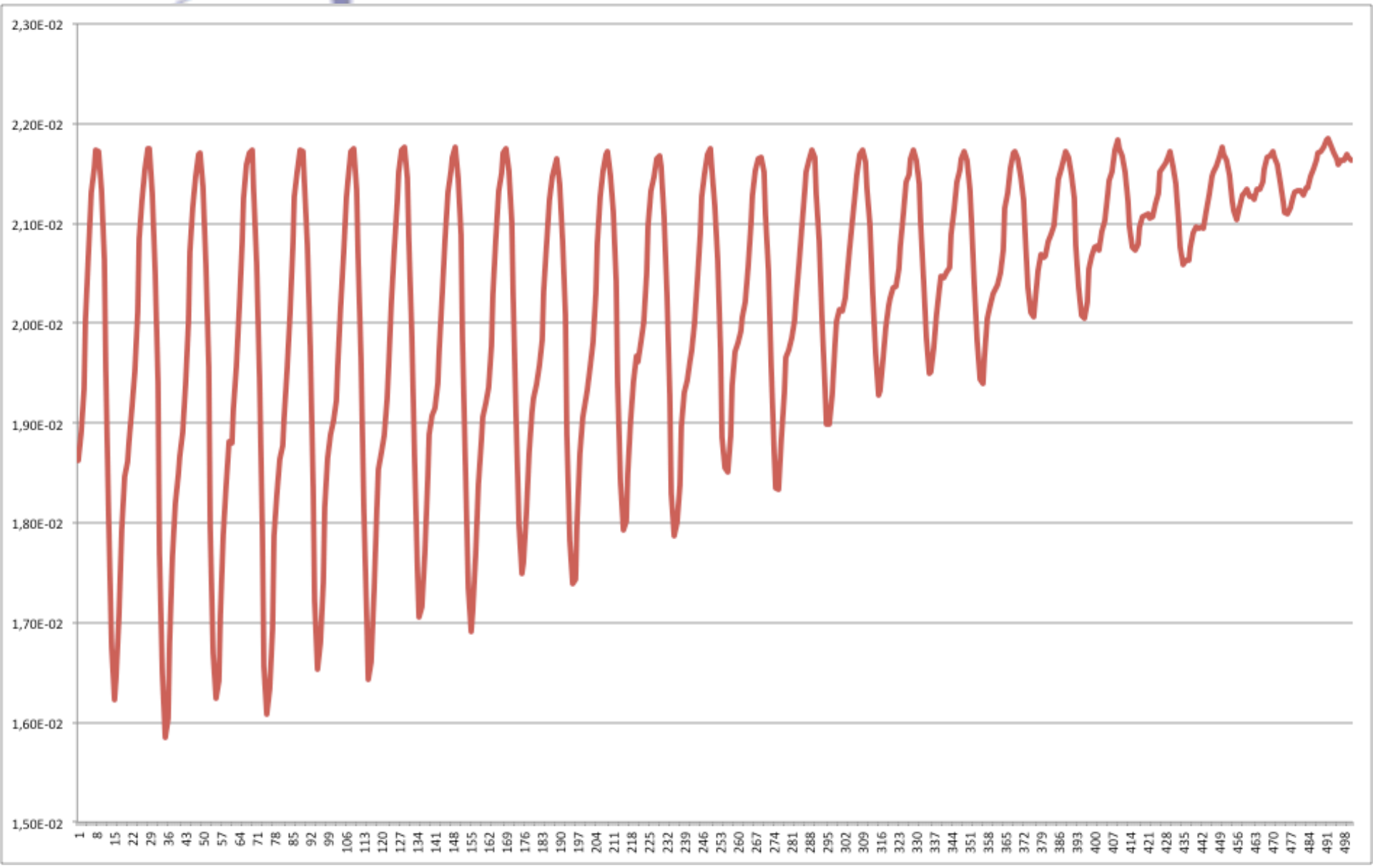

FWHM1
FWHM2
ExpDec1 Fit of Sheet1 FWHM1
Model ExpDec1
Equation y = A1*exp(-x/t1) + y0
Reduced Chi-Sqr 3.44502E-22
Adj. R-Square 0.99123
Value Standard Error
FWHM1 y0 5.97214E-10 1.5546E-11
FWHM1 A1 8.42853E-10 4.77324E-11
FWHM1 t1 65.96495 7.07937
FWHM1 (s)
1.4x10-9
1.2x10-9
1.0x10-9
8.0x10-10
6.0x10-10
4.0x10-10
0
50
100
150
200
250
300
Bias (V)

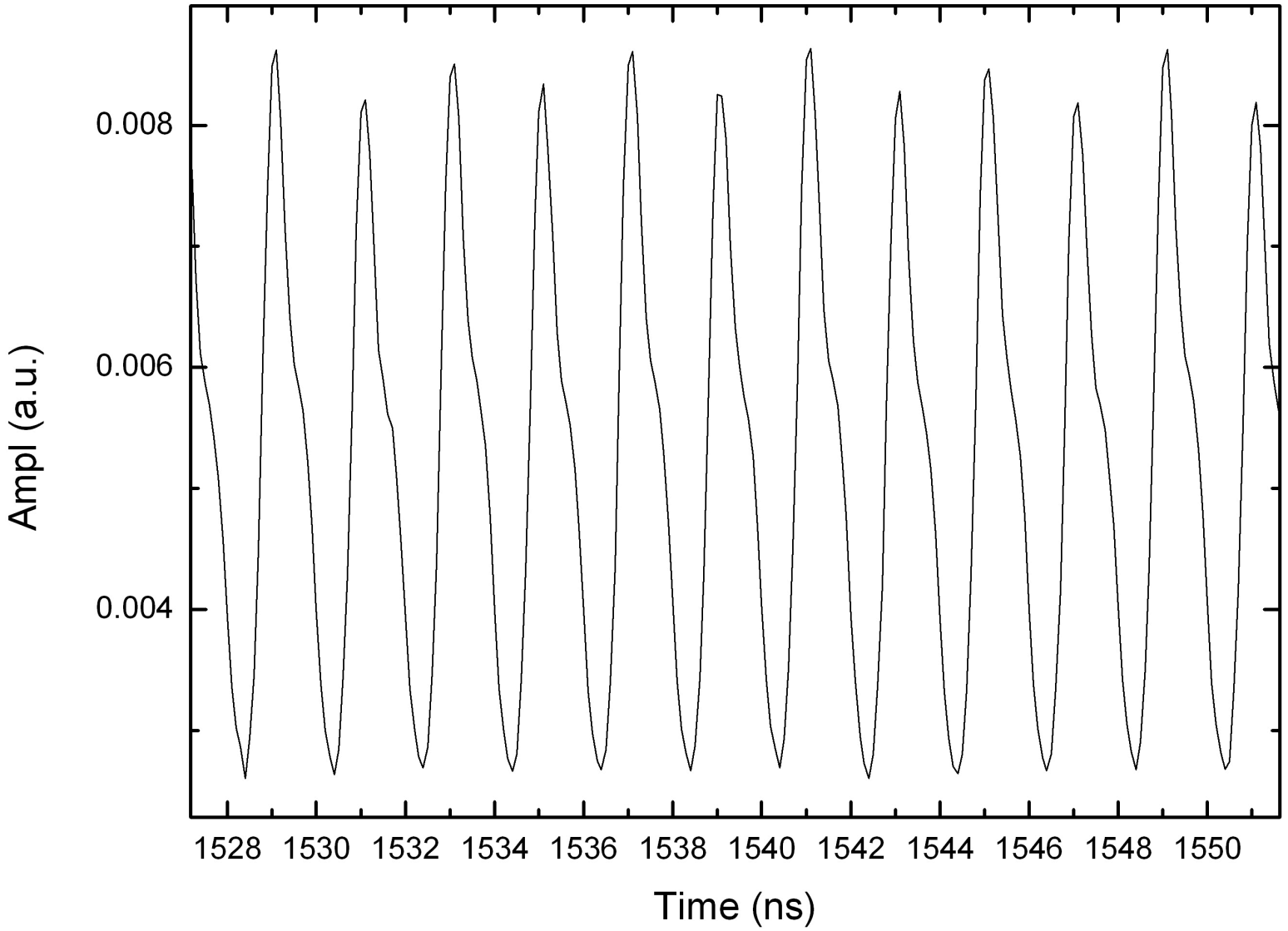
SCD/Al interdigitated UTOV

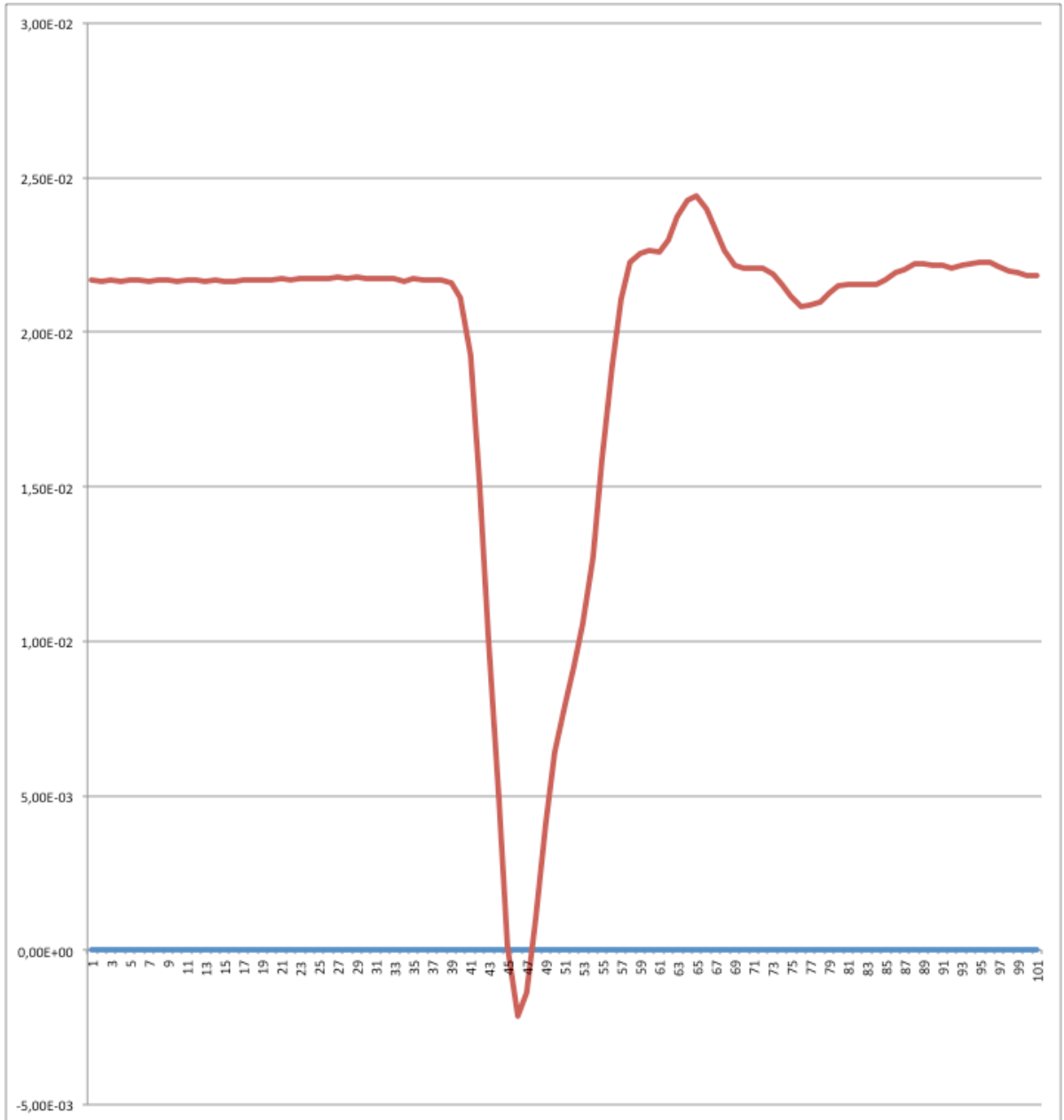



SCD/Cr-Au E6
-300 V
70 eV
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
-5.00E-03
1
187
373
559
745
931
1117
1303
1489
1675
1861
2047
2233
2419
2605
2791
2977
3163
3349
3535
3721
3907
4093
4279
4465
4651
4837
5023
5209
5395
5581
5767
5953
6139
6325
6511
6697
6883
7069
7255
7441
7627
7813
7999
8185
8371
8557
8743
8929
9115
9301
9487
9673
9859


3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
-5.00E-03
1
37
73
109
145
181
217
253
289
325
361
397
433
469
505
541
577
613
649
685
721
757
793
829
865
901
937
973
1009
1045
1081
1117
1153
1189
1225
1261
1297
1333
1369
1405
1441
1477
1513
1549
1585
1621
1657
1693
1729
1765
1801
1837
1873
1909
1945
1981


2,30E-02
2,20E-02
2,10E-02
2,00E-02
1,90E-02
1,80E-02
1,70E-02
1,60E-02
1,50E-02
1 8 15 22 29 36 43 50 57 64 71 78 85 92 99 106 113 120 127 134 141 148 155 162 169 176 183 190 197 204 211 218 225 232 239 246 253 260 267 274 281 288 295 302 309 316 323 330 337 344 351 358 365 372 379 386 393 400 407 414 421 428 435 442 449 456 463 470 477 484 491 498


0.008
0.006
0.004
Ampl (a.u.)
1528
1530
1532
1534
1536
1538
1540
1542
1544
1546
1548
1550
Time (ns)


3,00E-02
2,50E-02
2,00E-02
1,50E-02
1,00E-02
5,00E-03
0,00E+00
-5,00E-03
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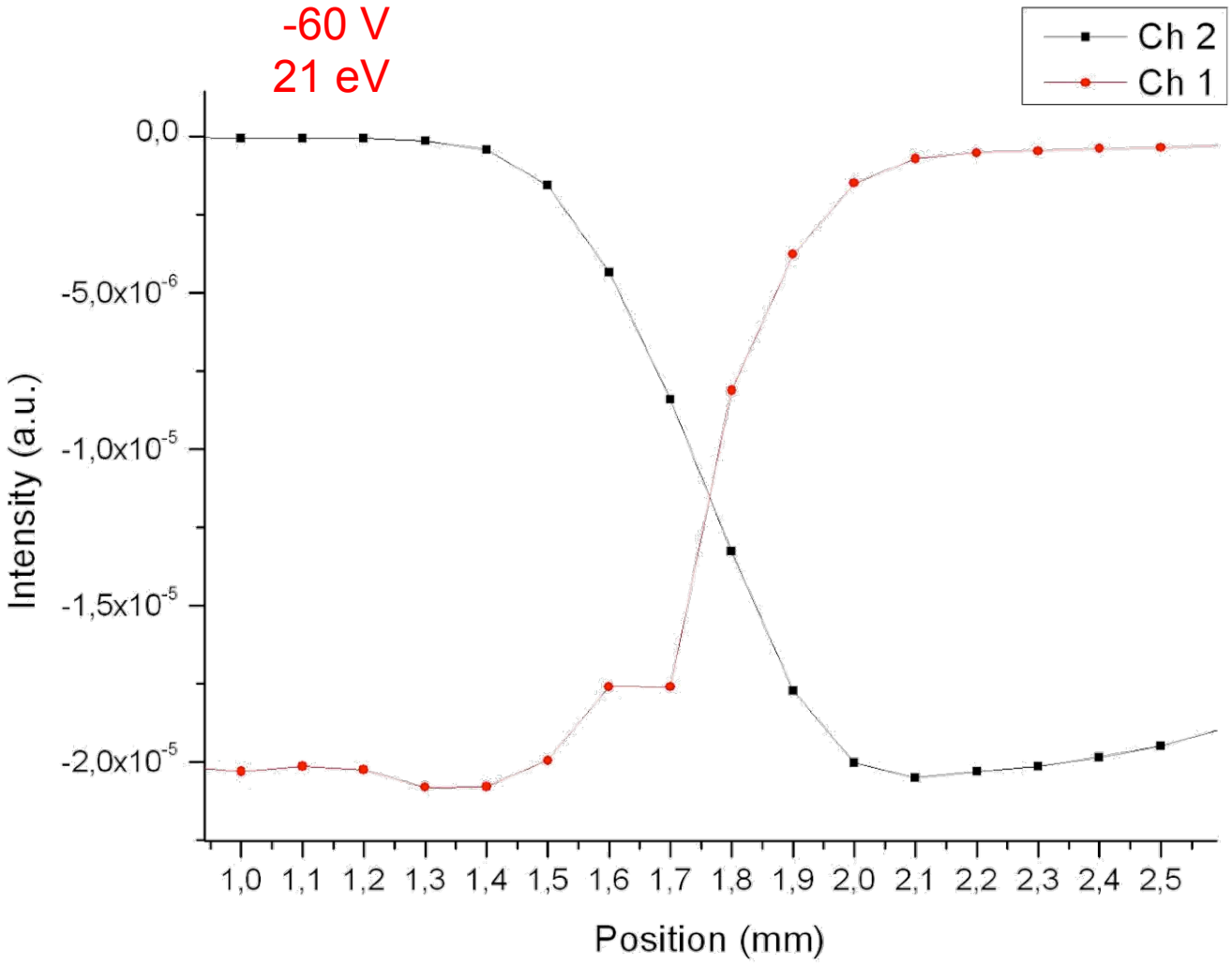
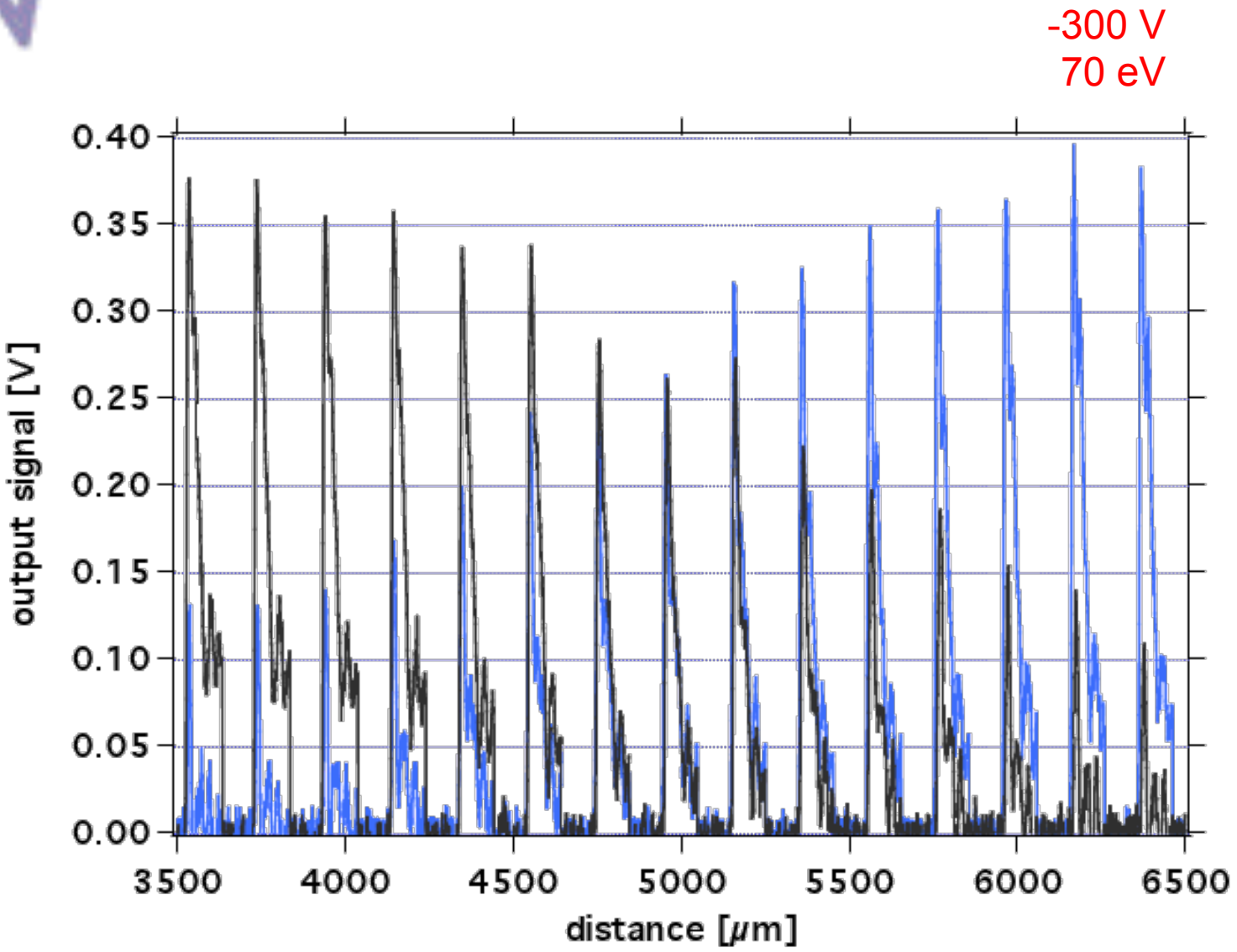
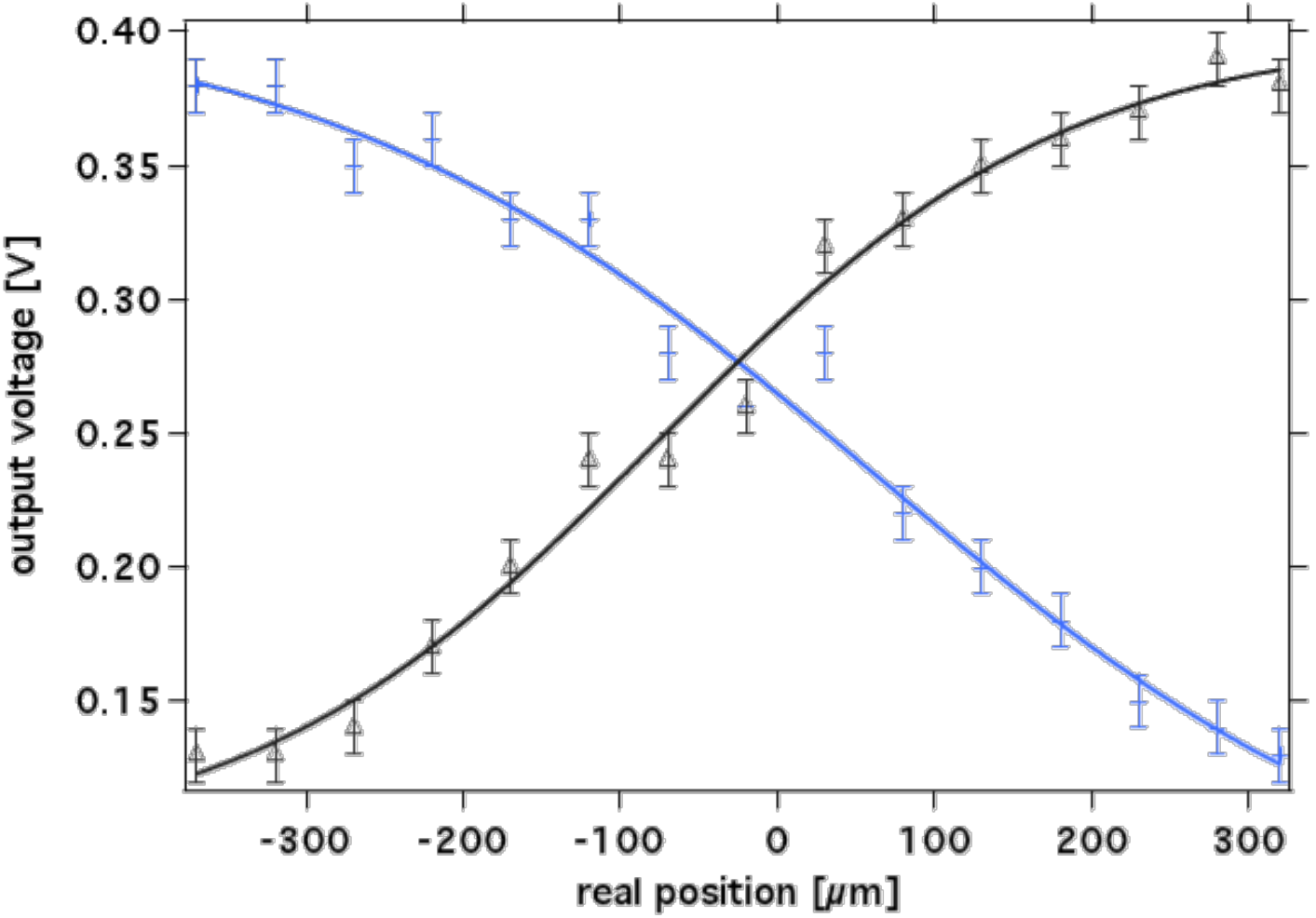
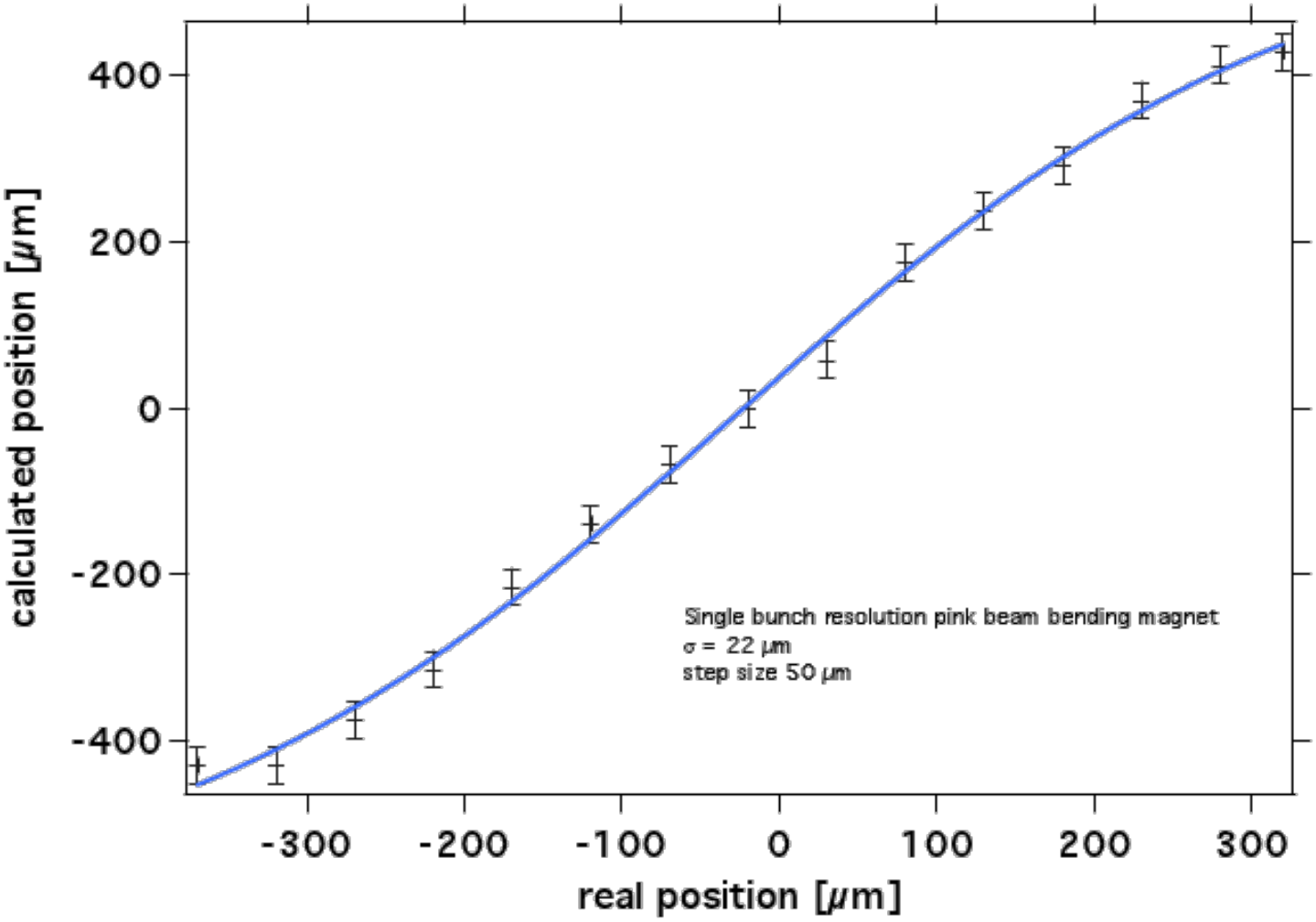

-60 V
21 eV
Ch 2
Ch 1
0,0
-5,0x10-6
-1,0x10-5
-1,5x10-5
-2,0x10-5
Intensity (a.u.)
1,0 1,1 1,2 1,3 1,4 1,5 1,6 1,7 1,8 1,9 2,0 2,1 2,2 2,3 2,4 2,5
Position (mm)


-300 V
70 eV
output signal [V]
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
3500
4000
4500
5000
5500
6000
6500
distance [μm]

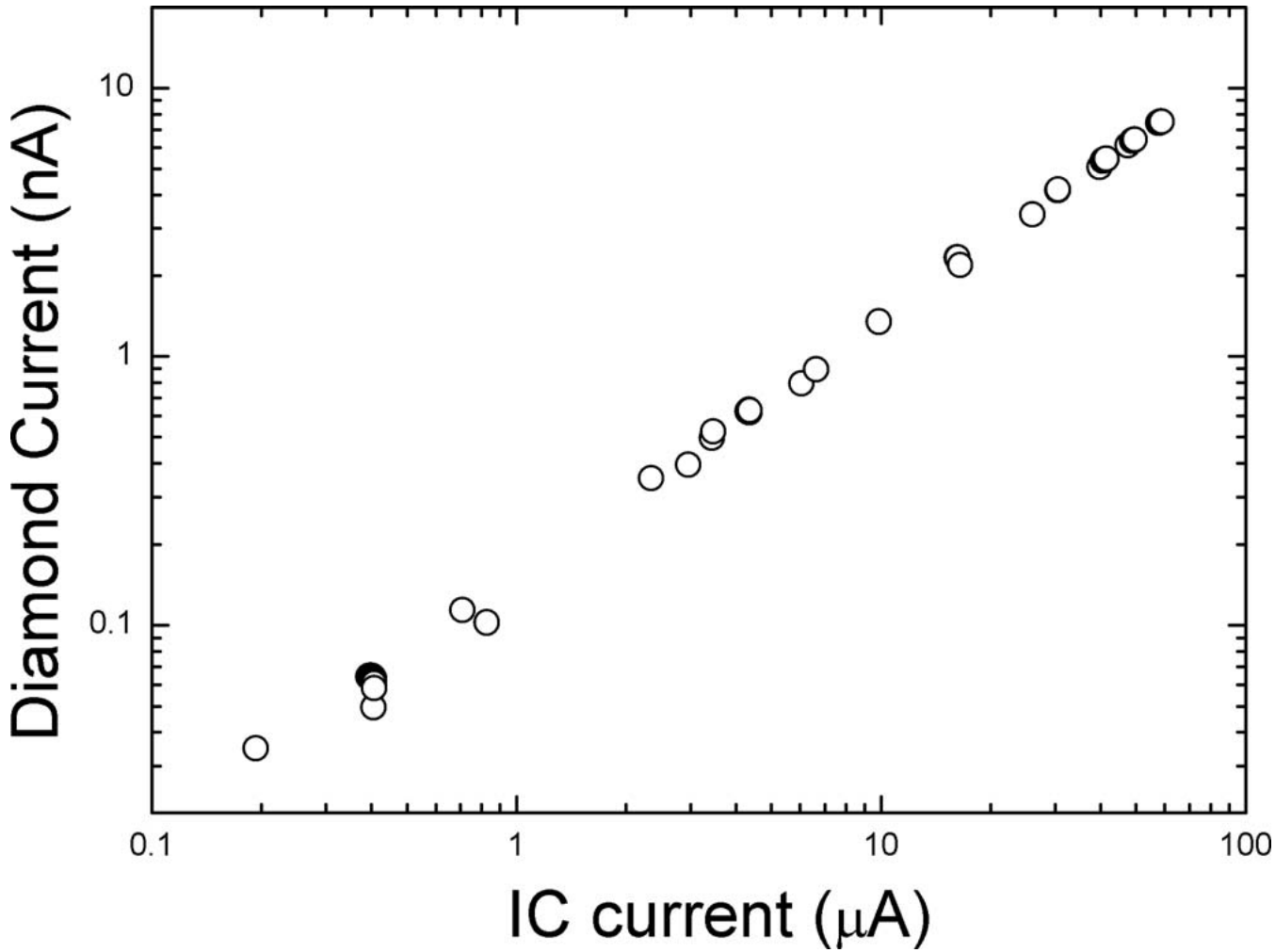

0.40
0.35
0.30
0.25
0.20
0.15
output voltage [V]
-300
-200
-100
0
100
200
300
real position [μm]

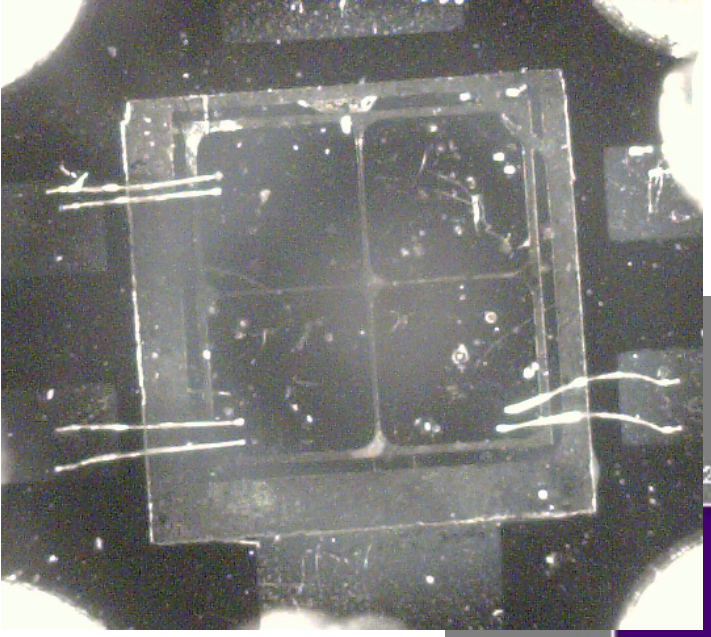

400
200
0
-200
-400
calculated position [μm]
-300
-200
-100
0
100
200
300
real position [μm]
Single bunch resolution pink beam bending magnet
σ = 22 μm
step size 50 μm

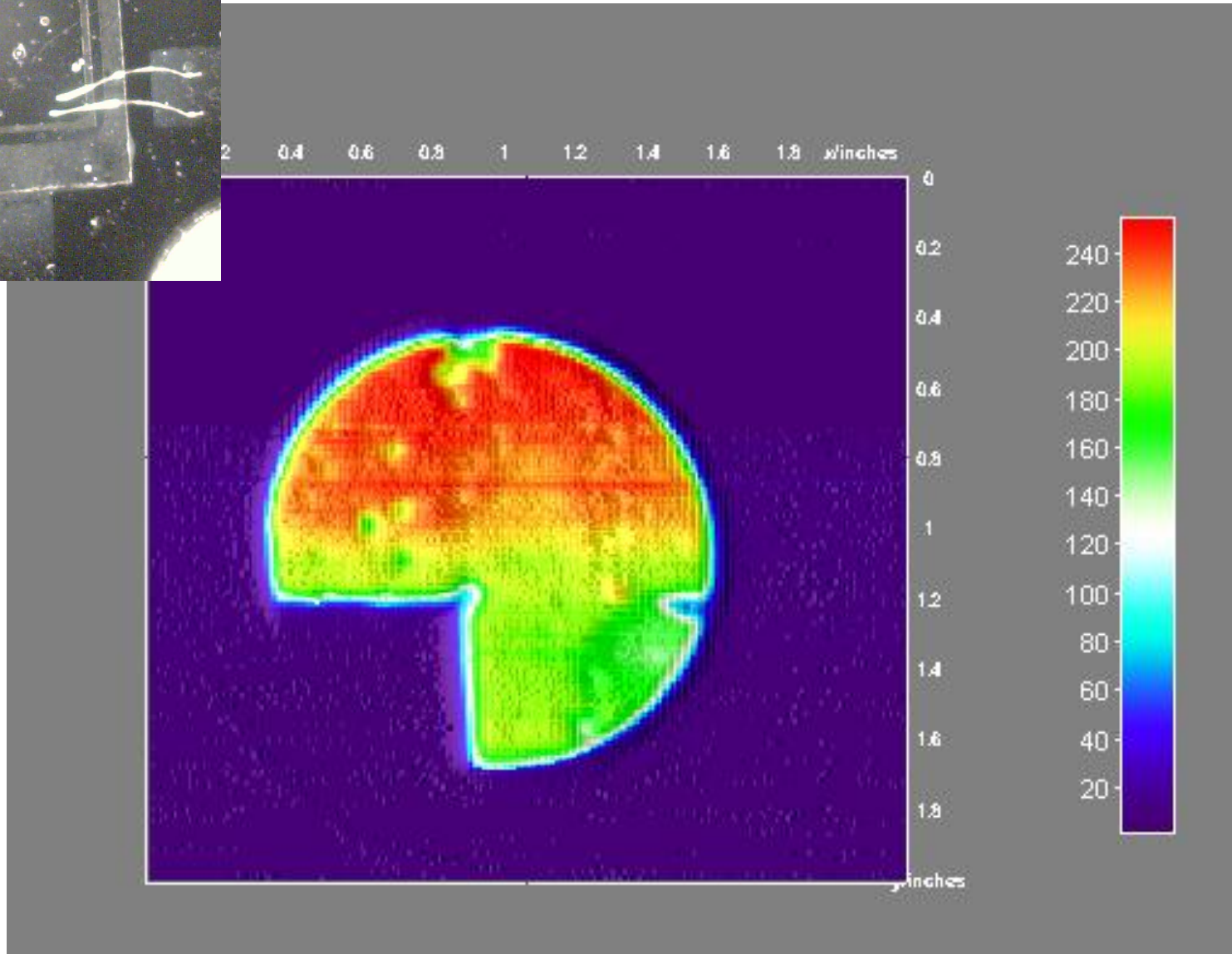
SCD/Cr-Au UNIFI

@ GILDA/ESRF

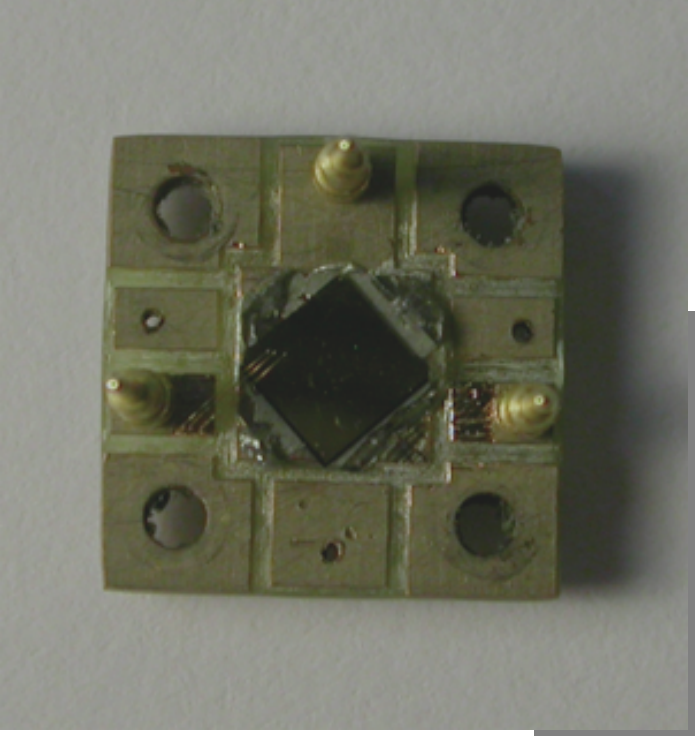
Fe **K**-edge $\mathbf{E}_0$ =7112 eV



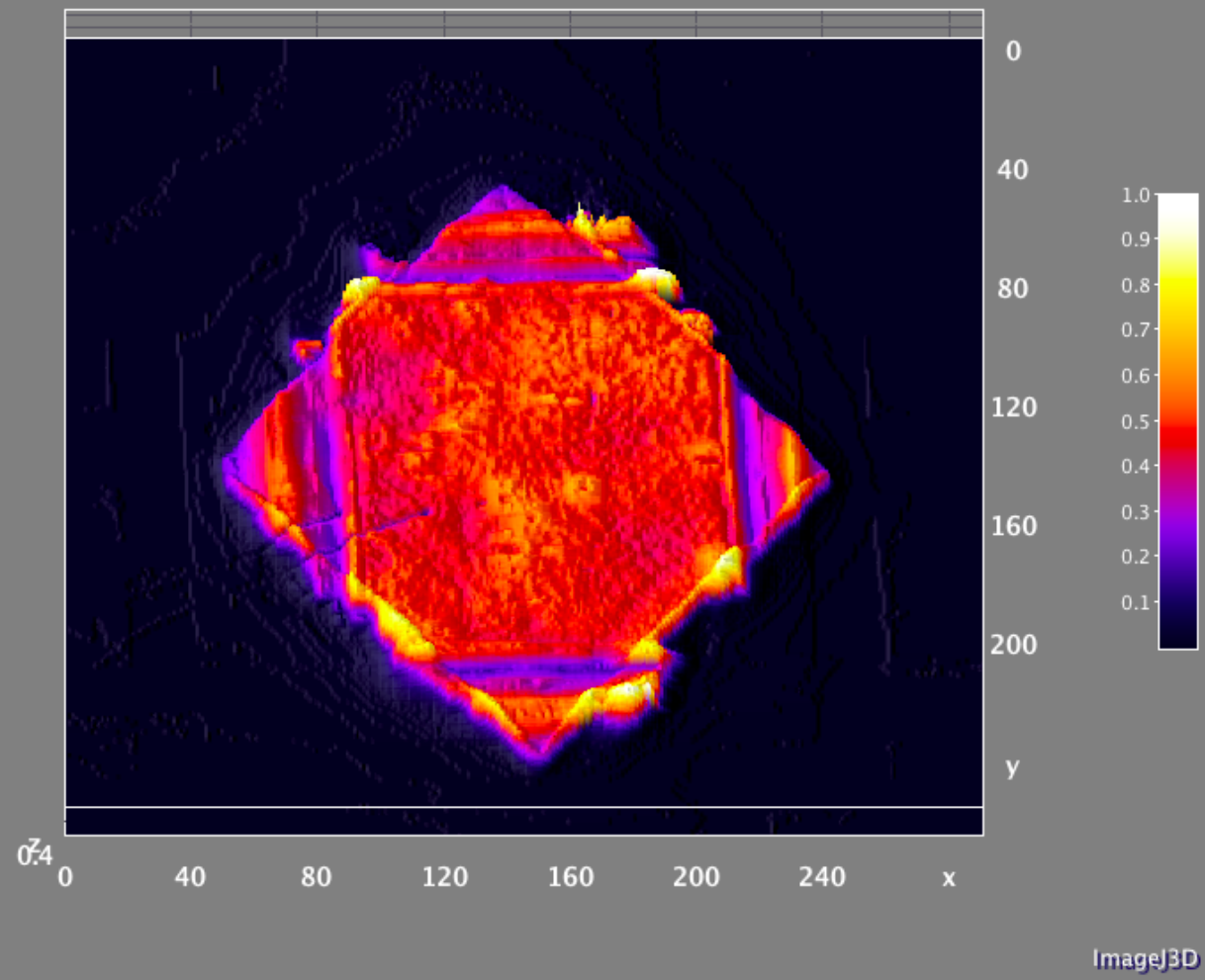




70 eV
300 V
150 μm spot size



SCD/Cr-Au CNRS/UniFi



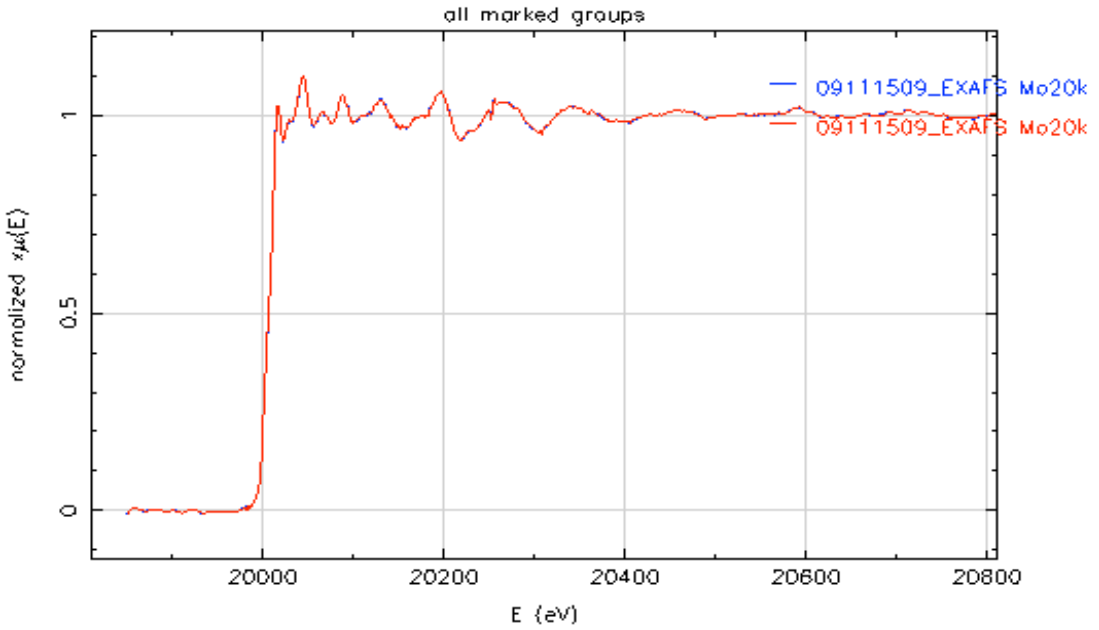
10 keV
60 V
50 μm spot size

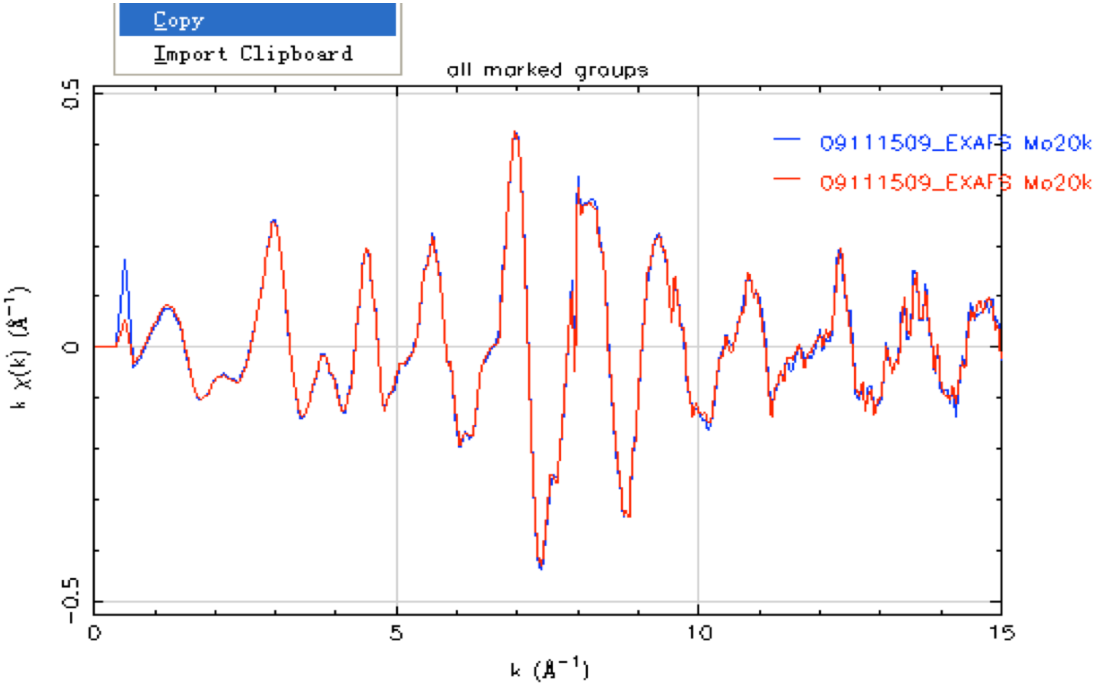
Spettri EXAFS

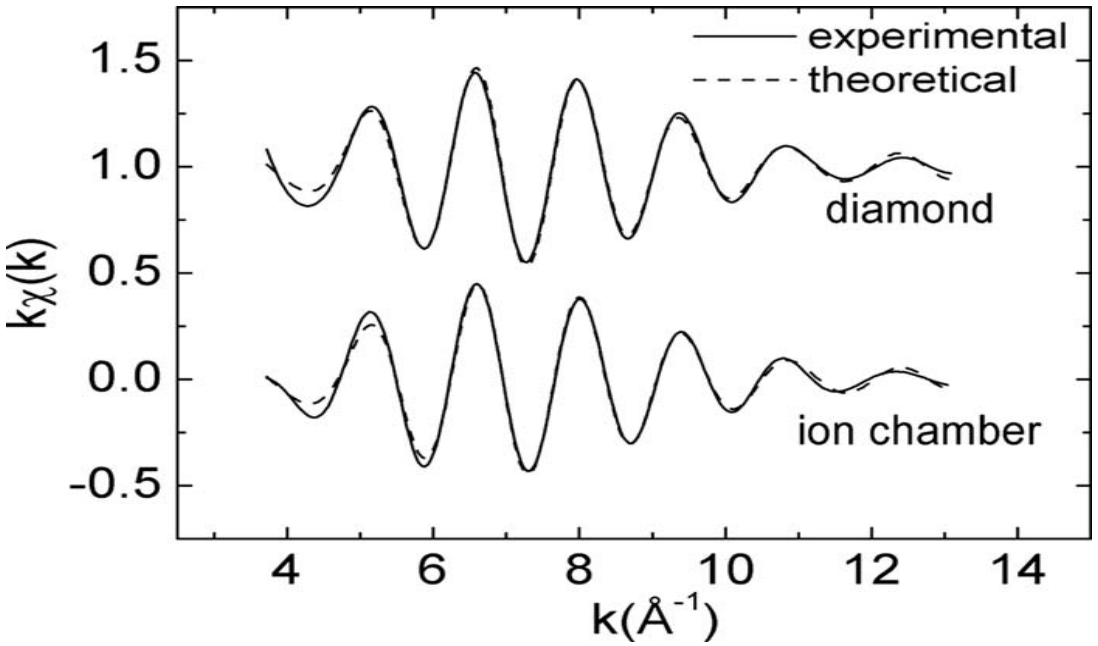
SCD/Cr-Au UNIFI

@ SSRF R.P. China

Mo **K**-edge $\mathbf{E}_0$ = 20 keV





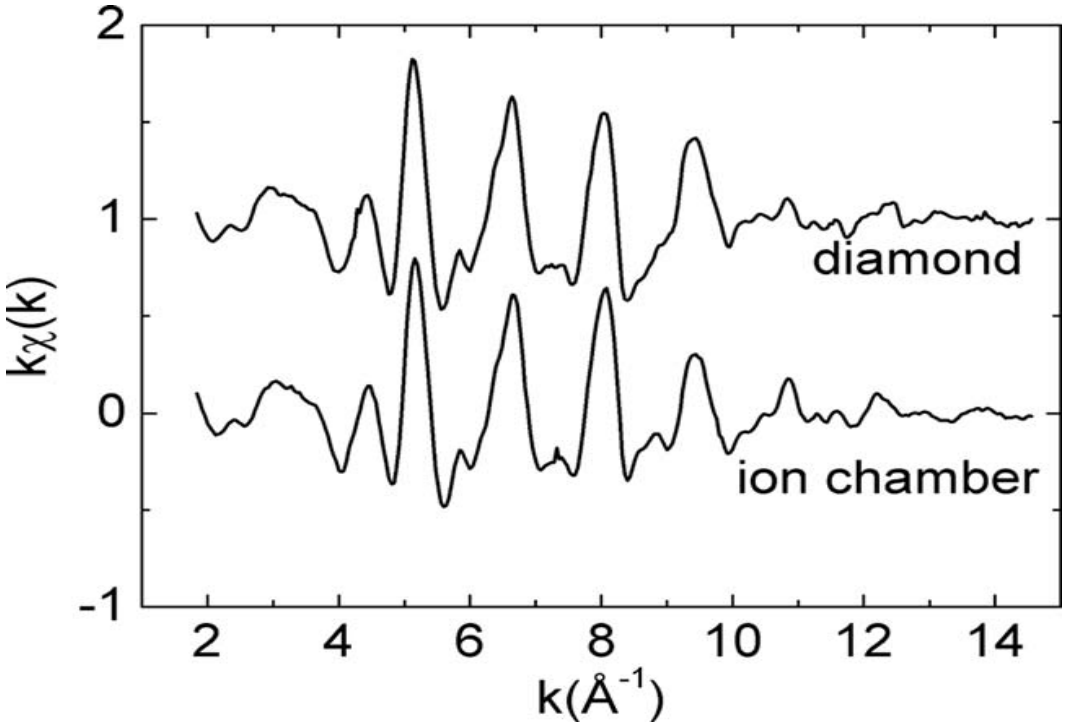


Spettri EXAFS

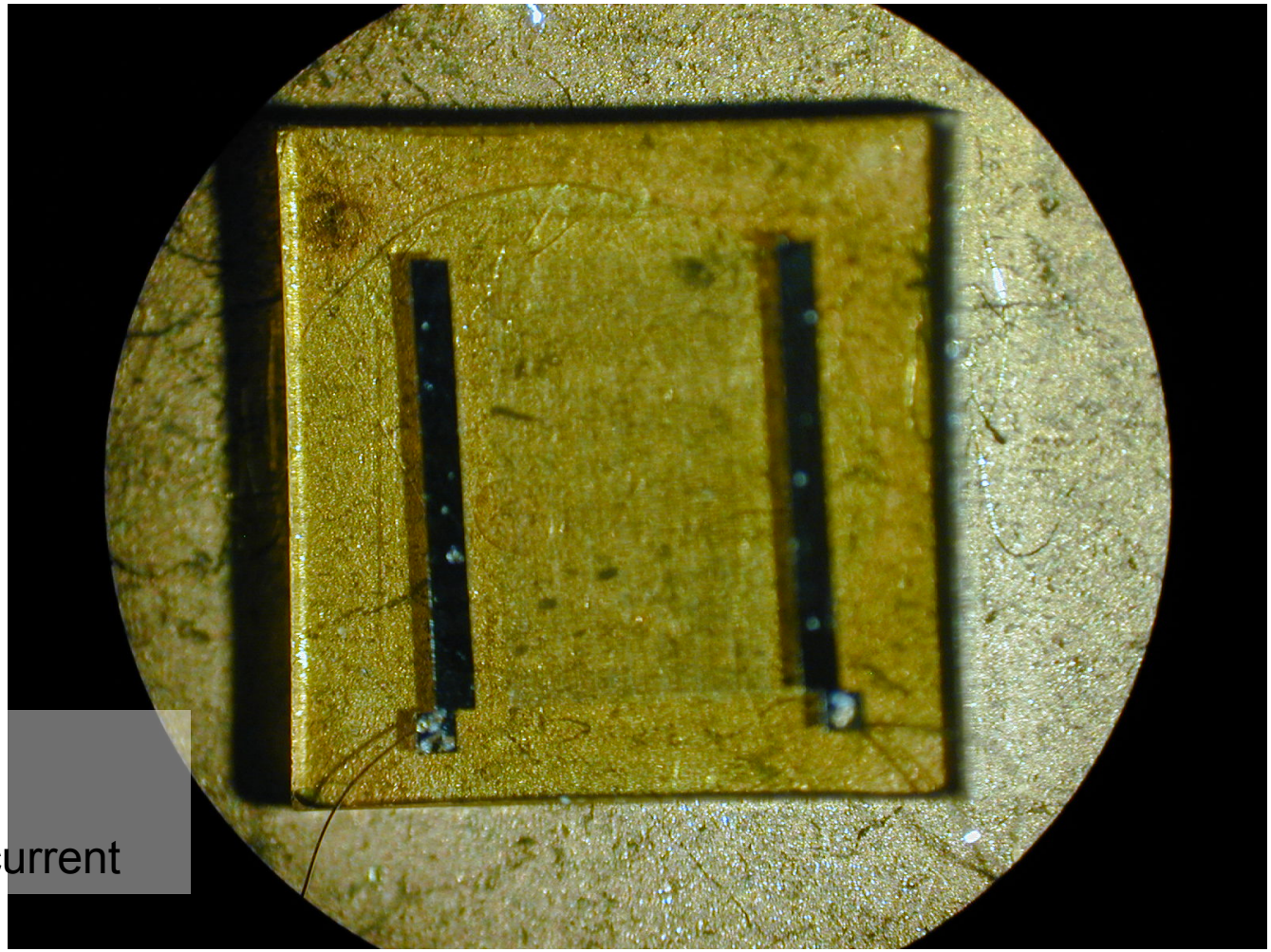
SCD/Cr-Au UNIFI

@ GILDA/ESRF

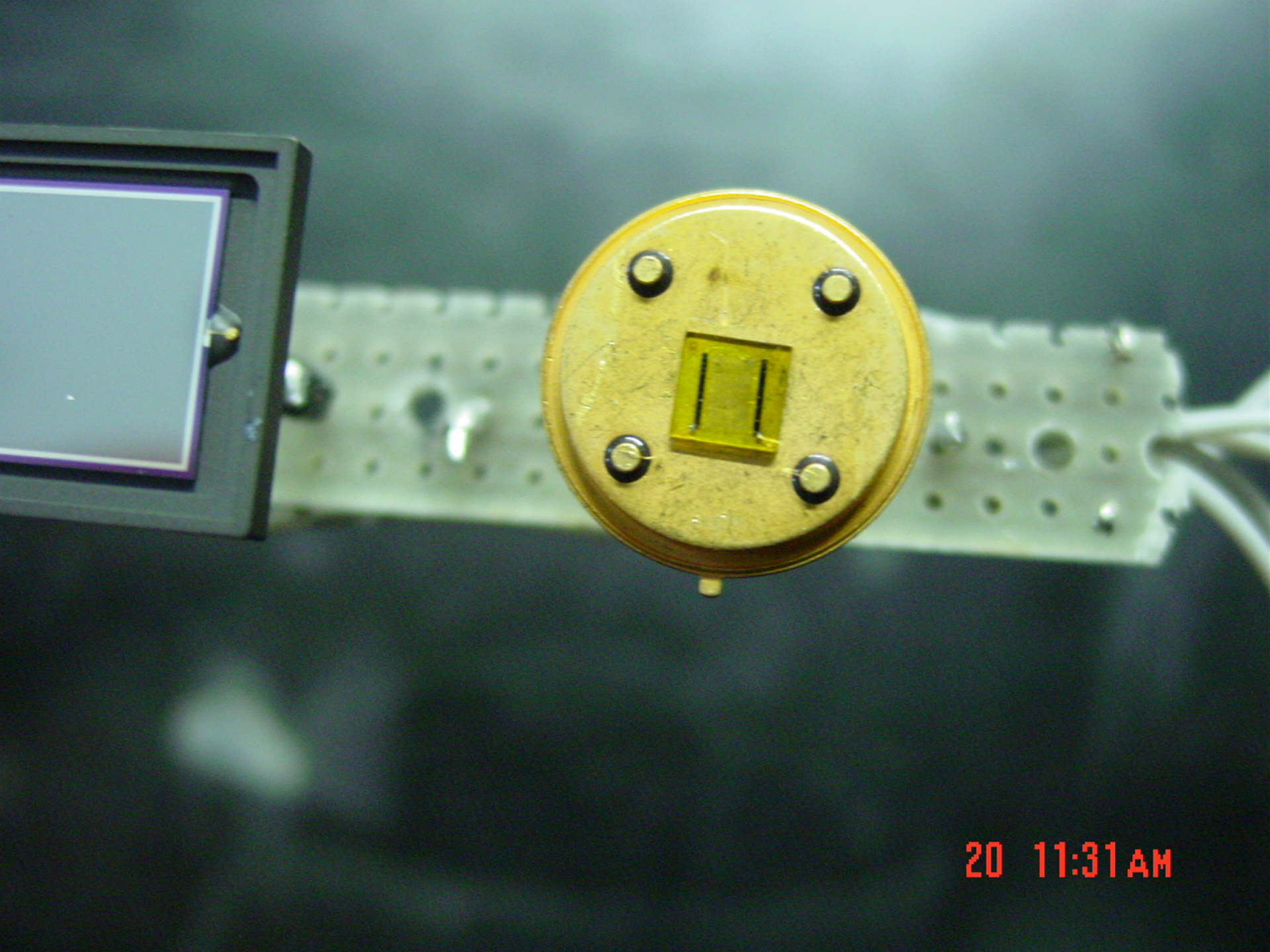
Fe **K**-edge $\mathbf{E}_0$ =7112 eV



Diamond detectors
Experiment



Measurement of
1. Dark current
2. Spectral photocurrent


20 11:31 AM