FEE-DD Simulations: Preliminary Analyze of first DOI measurement results

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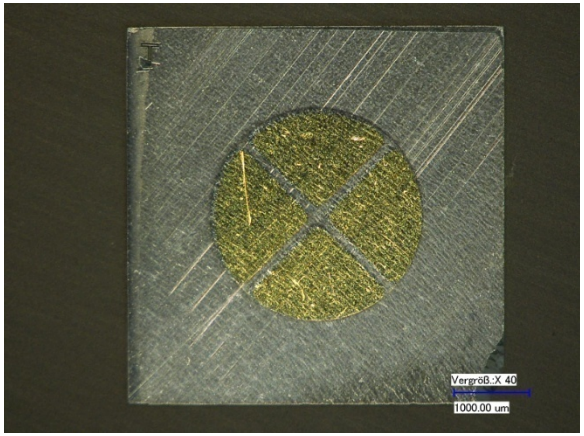
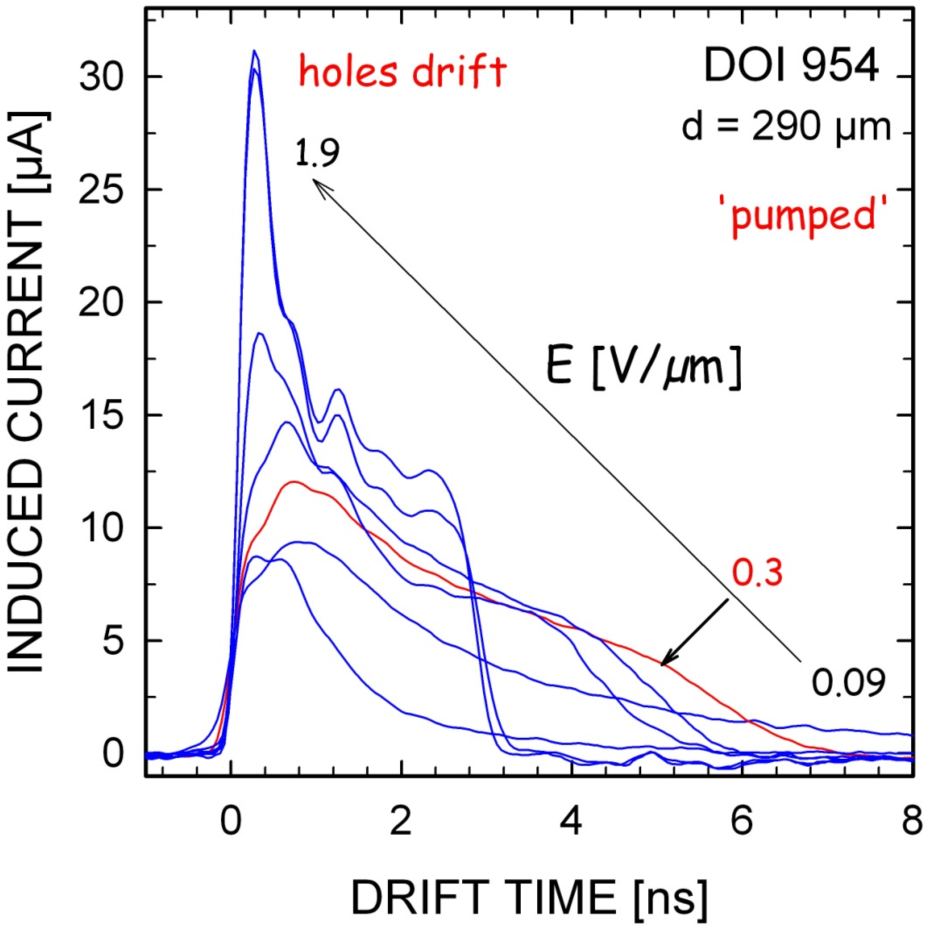
Outline

- Motivation.
- Trials for evaluation of the sc. species / total species ratio.
- Summary and Outlook.

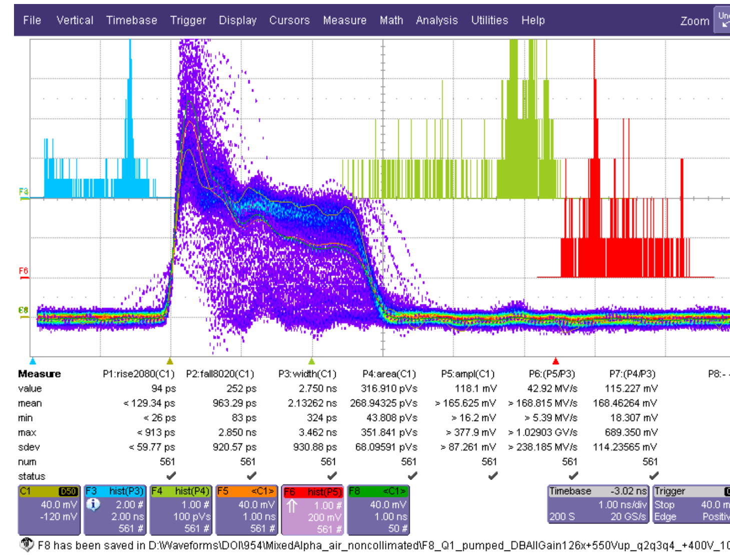
Motivation



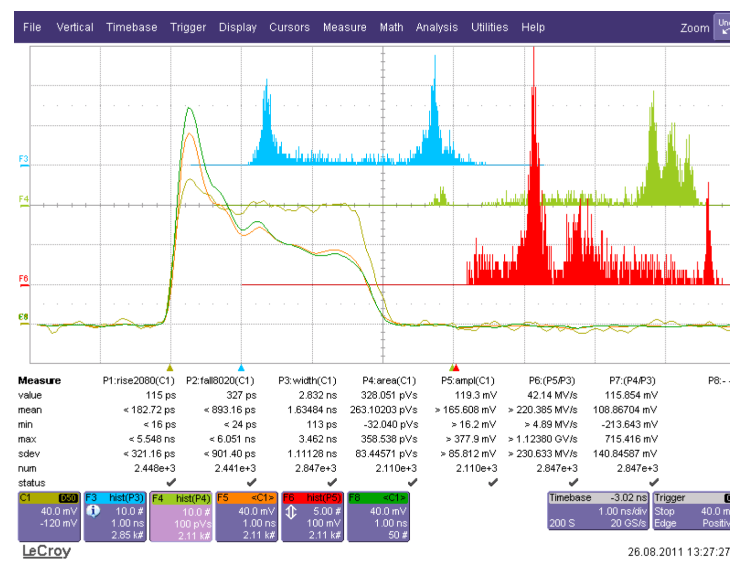
Vergröß.:X 40
1000.00 um



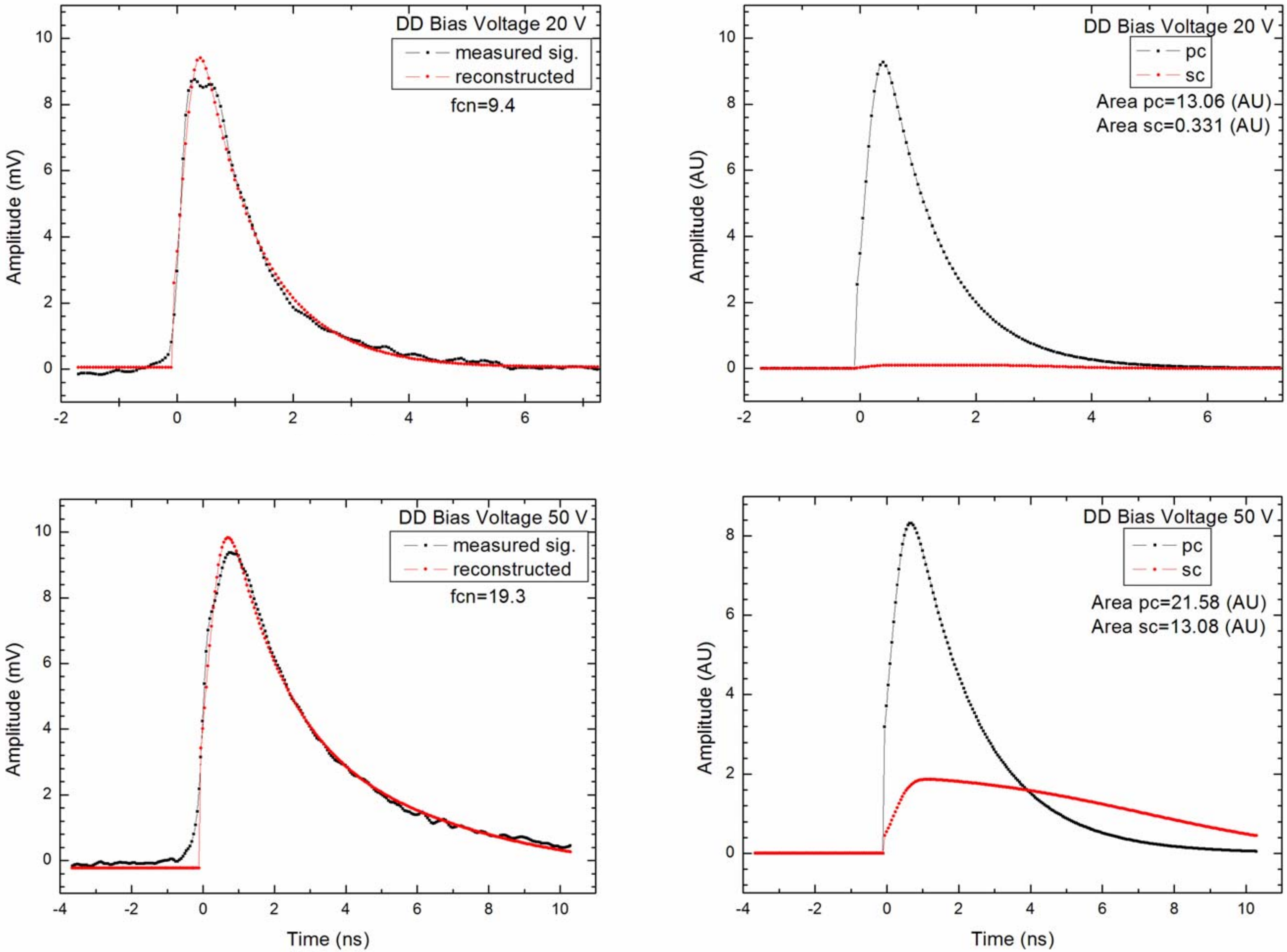
holes drift
DOI 954
d = 290 µm
'pumped'
1.9
E [V/µm]
0.3
0.09
INDUCED CURRENT [µA]
DRIFT TIME [ns]
0
5
10
15
20
25
30
0
2
4
6
8



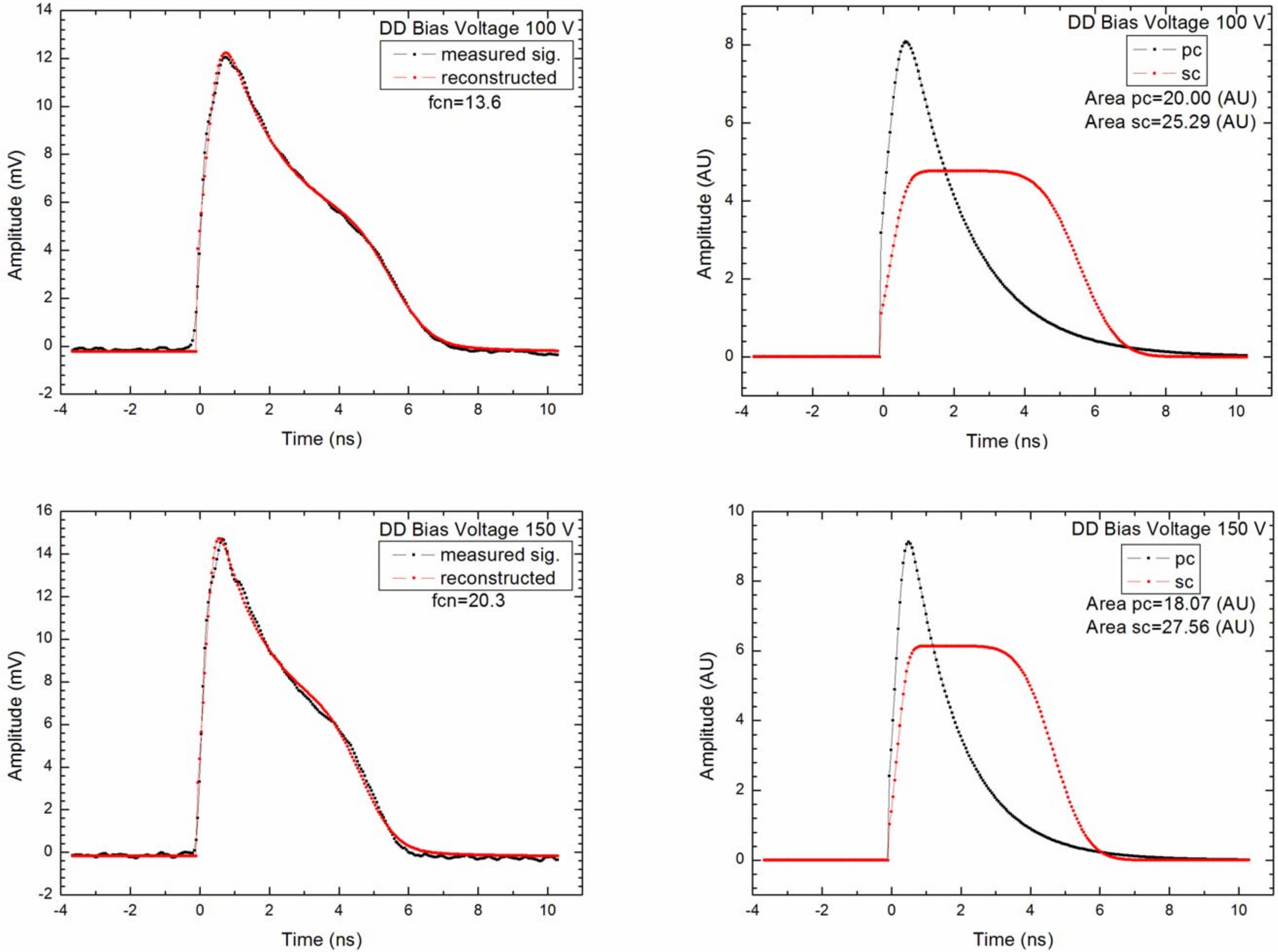
File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
Zoom
Measure P1:rise2080(C1) P2:fall8020(C1) P3:width(C1) P4:area(C1) P5:ampl(C1) P6:(P5/P3) P7:(P4/P3) P8:- - -
value 94 ps 252 ps 2.750 ns 316.910 pVs 118.1 mV 42.92 MV/s 115.227 mV
mean < 129.34 ps 963.29 ps 2.13262 ns 268.94325 pVs > 165.625 mV > 168.815 MV/s 168.46264 mV
min < 26 ps 83 ps 324 ps 43.808 pVs > 16.2 mV > 5.39 MV/s 18.307 mV
max < 913 ps 2.850 ns 3.462 ns 351.841 pVs > 377.9 mV > 1.02903 GV/s 689.350 mV
sdev < 59.77 ps 920.57 ps 930.88 ps 68.09591 pVs > 87.261 mV > 238.185 MV/s 114.23565 mV
num 561 561 561 561 561 561 561
status
F8 has been saved in D:\Waveforms\DOI954\MixedAlpha_air_noncollimated\F8_Q1_pumped_DBAllGain126x+550Vup_q2q3q4_+400V_10mi

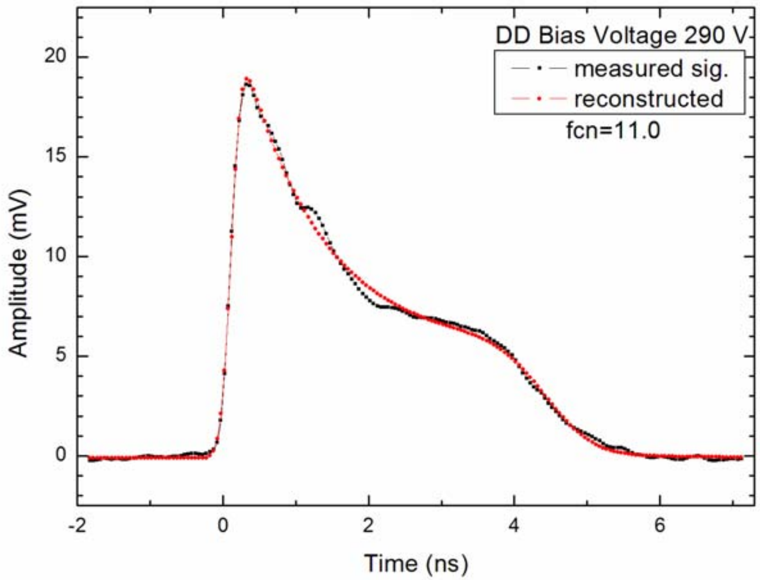


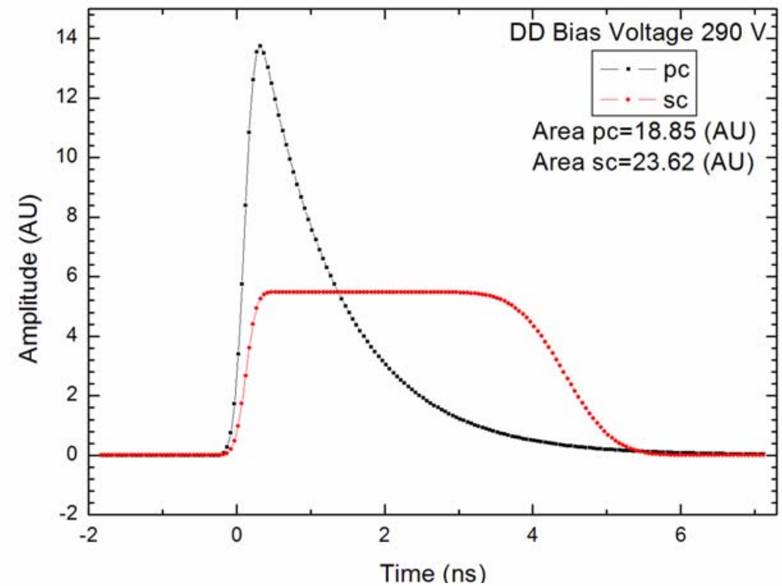
File Vertical Timebase Trigger Display Cursors Measure Math Analysis Utilities Help
Zoom
Measure P1:rise2080(C1) P2:fall8020(C1) P3:width(C1) P4:area(C1) P5:ampl(C1) P6:(P5/P3) P7:(P4/P3) P8:- - -
value 115 ps 327 ps 2.832 ns 328.051 pVs 119.3 mV 42.14 MV/s 115.854 mV
mean < 182.72 ps < 893.16 ps 1.63484 ns 263.10203 pVs > 165.608 mV > 220.385 MV/s 108.86704 mV
min < 16 ps < 24 ps 113 ps -32.040 pVs > 16.2 mV > 4.89 MV/s -213.643 mV
max < 5.548 ns < 6.051 ns 3.462 ns 358.538 pVs > 377.9 mV > 1.12380 GV/s 715.416 mV
sdev < 321.16 ps < 901.40 ps 1.11128 ns 83.44571 pVs > 85.812 mV > 230.633 MV/s 140.84587 mV
num 2.448e+3 2.441e+3 2.847e+3 2.110e+3 2.110e+3 2.847e+3 2.847e+3
status
LeCroy
26.08.2011 13:27:27

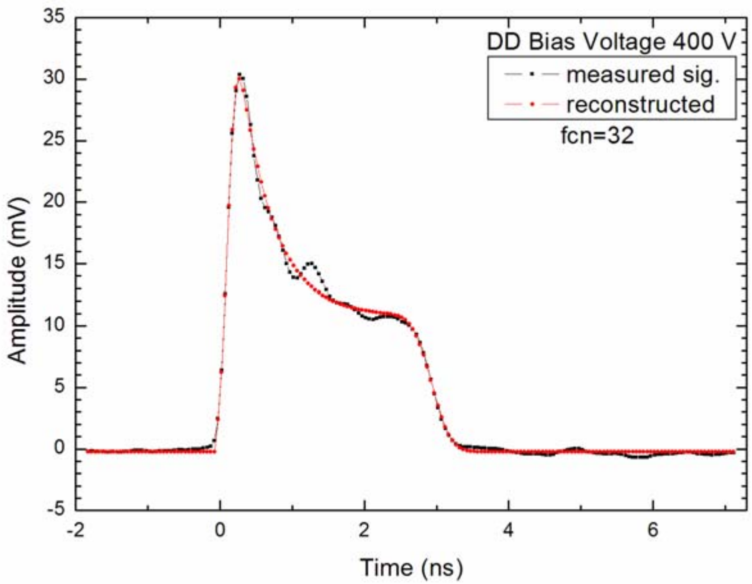


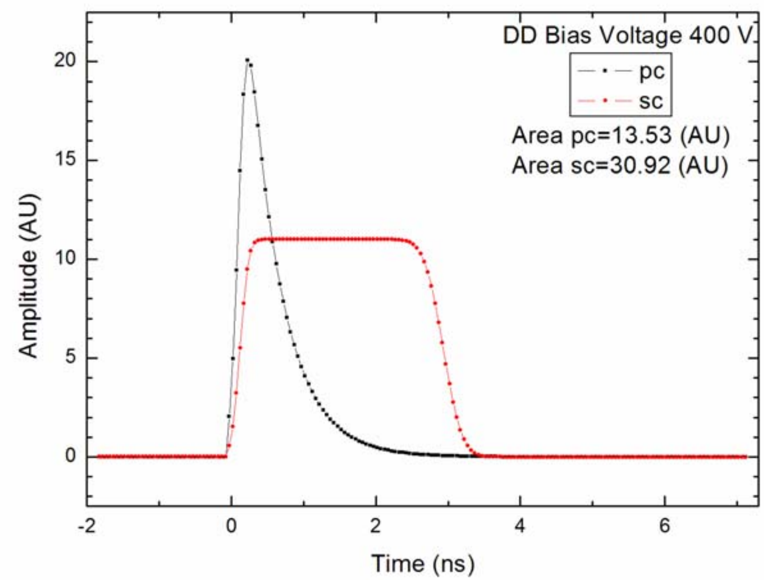
DD Bias Voltage 20 V
measured sig.
reconstructed
fcn=9.4
Amplitude (mV)
DD Bias Voltage 20 V
pc
sc
Area pc=13.06 (AU)
Area sc=0.331 (AU)
Amplitude (AU)
DD Bias Voltage 50 V
measured sig.
reconstructed
fcn=19.3
Amplitude (mV)
Time (ns)
DD Bias Voltage 50 V
pc
sc
Area pc=21.58 (AU)
Area sc=13.08 (AU)
Amplitude (AU)
Time (ns)

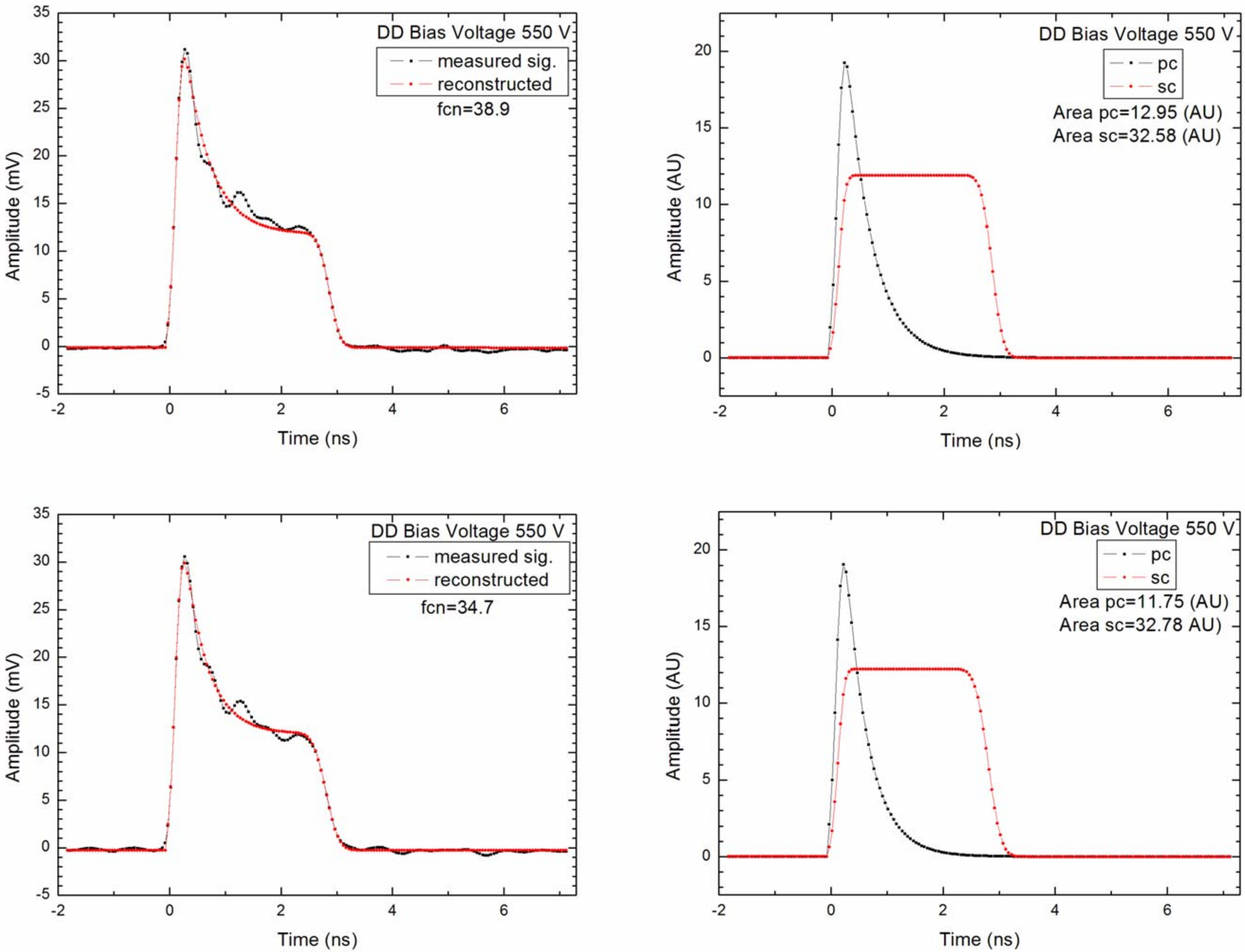

DD Bias Voltage 100 V
measured sig.
reconstructed
fcn=13.6
Amplitude (mV)
Time (ns)
DD Bias Voltage 100 V
pc
sc
Area pc=20.00 (AU)
Area sc=25.29 (AU)
Amplitude (AU)
Time (ns)
DD Bias Voltage 150 V
measured sig.
reconstructed
fcn=20.3
Amplitude (mV)
Time (ns)
DD Bias Voltage 150 V
pc
sc
Area pc=18.07 (AU)
Area sc=27.56 (AU)
Amplitude (AU)
Time (ns)

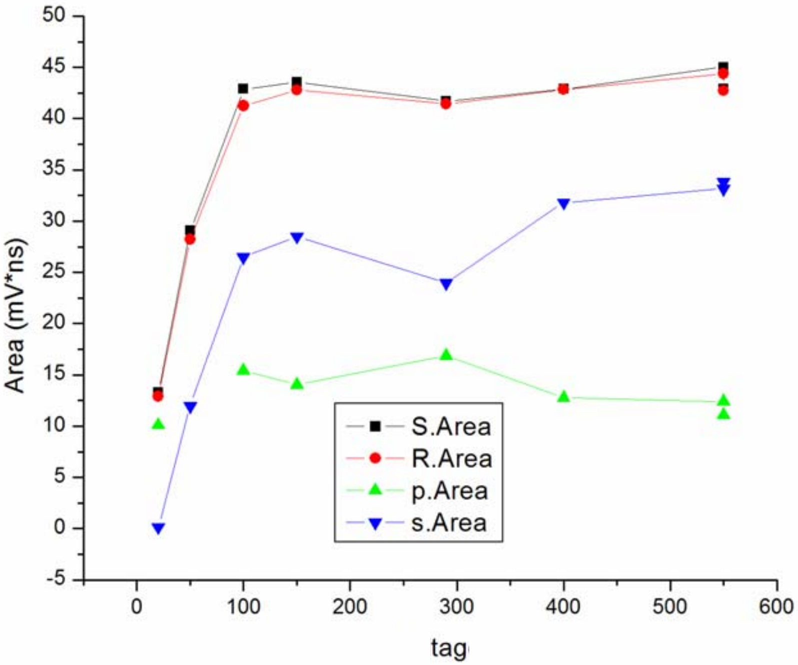

DD Bias Voltage 290 V
measured sig.
reconstructed
fcn=11.0
Amplitude (mV)
Time (ns)


DD Bias Voltage 290 V
pc
sc
Area pc=18.85 (AU)
Area sc=23.62 (AU)
Amplitude (AU)
Time (ns)

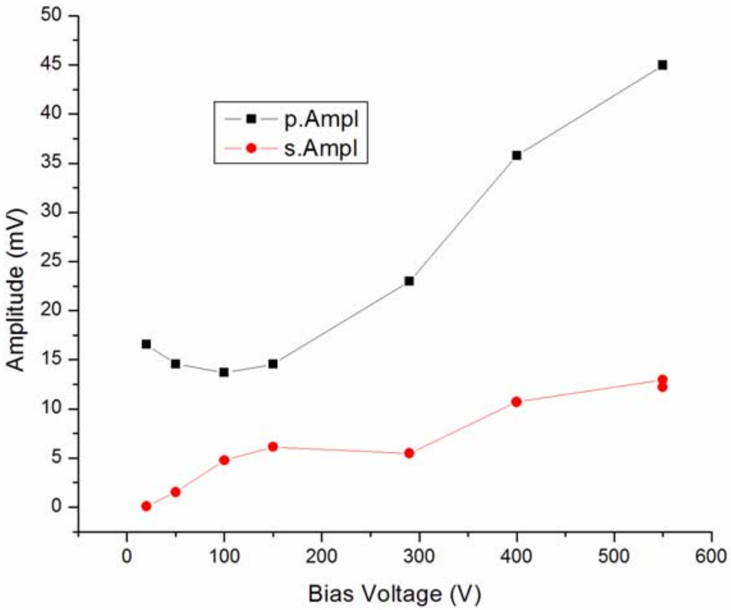

DD Bias Voltage 400 V
measured sig.
reconstructed
fcn=32
Amplitude (mV)
Time (ns)


DD Bias Voltage 400 V
pc
sc
Area pc=13.53 (AU)
Area sc=30.92 (AU)
Amplitude (AU)
Time (ns)

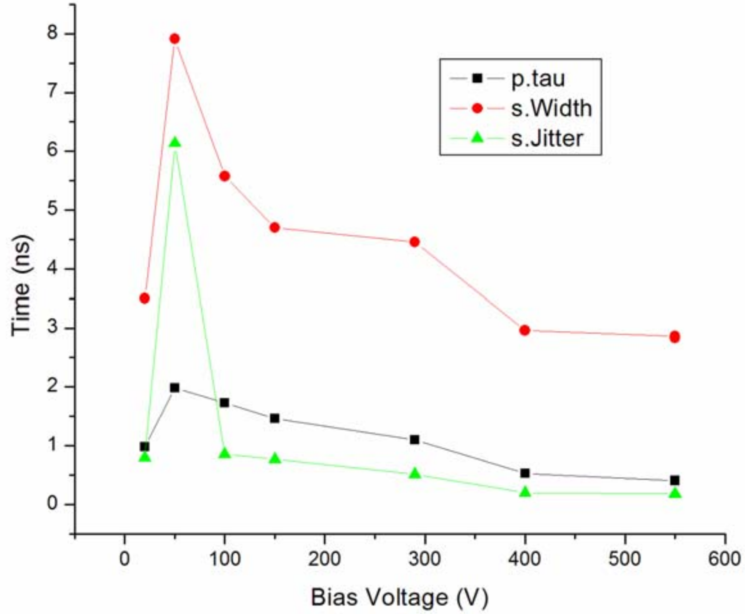

DD Bias Voltage 550 V
measured sig.
reconstructed
fcn=38.9
Amplitude (mV)
Time (ns)
DD Bias Voltage 550 V
pc
sc
Area pc=12.95 (AU)
Area sc=32.58 (AU)
Amplitude (AU)
Time (ns)
DD Bias Voltage 550 V
measured sig.
reconstructed
fcn=34.7
Amplitude (mV)
Time (ns)
DD Bias Voltage 550 V
pc
sc
Area pc=11.75 (AU)
Area sc=32.78 AU)
Amplitude (AU)
Time (ns)



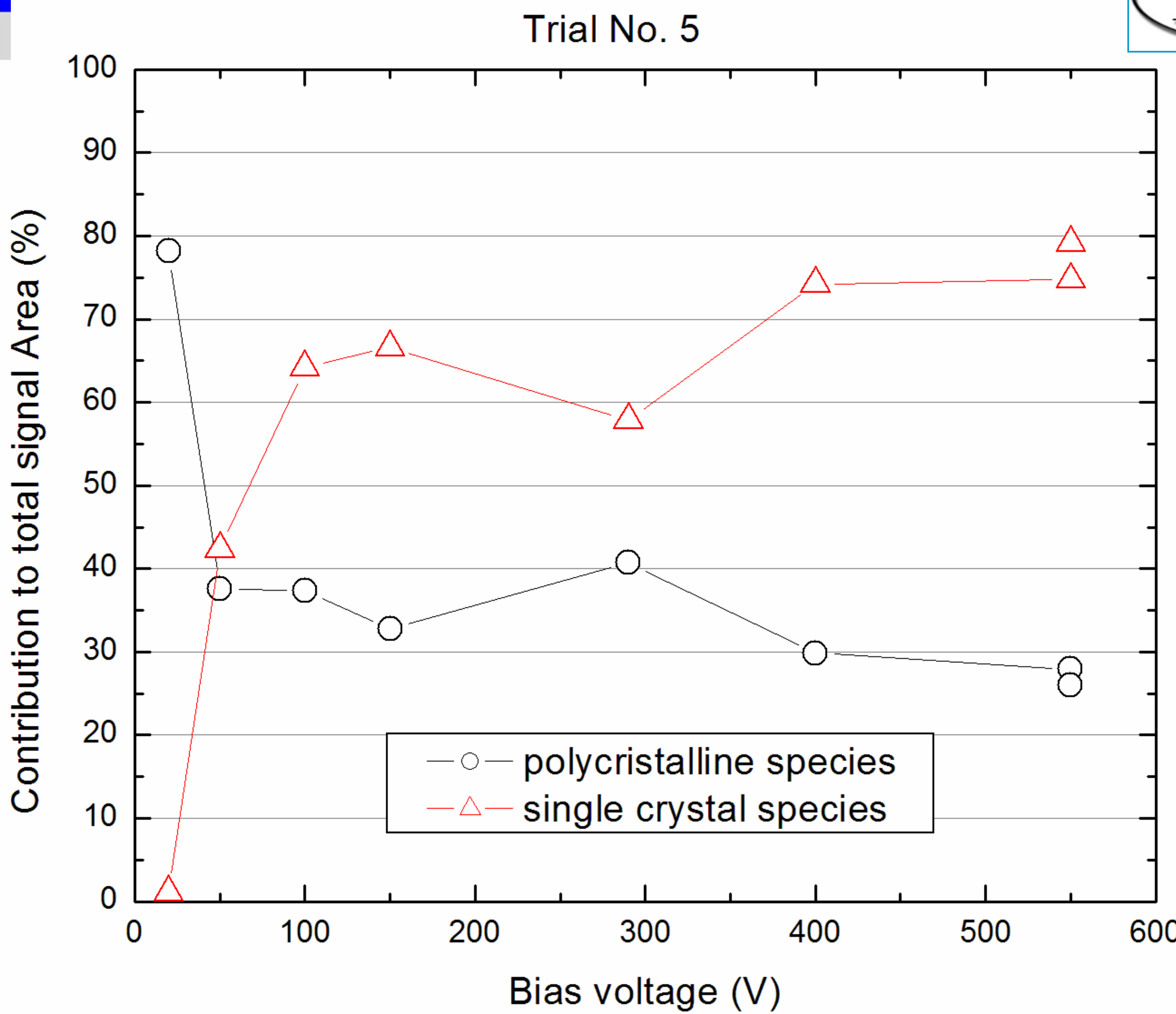
Area (mV*ns)
tag
S.Area
R.Area
p.Area
s.Area



Amplitude (mV)
Bias Voltage (V)
p.Ampl
s.Ampl



Time (ns)
Bias Voltage (V)
p.tau
s.Width
s.Jitter


Trial No. 5
Contribution to total signal Area (%)
Bias voltage (V)
polycristalline species
single crystal species
0
10
20
30
40
50
60
70
80
90
100
0
100
200
300
400
500
600

Functions used in calculations:

1) Noise distribution: Gaussian with x_N and w_N parameters $f_1(x) = \frac{1}{w_N \cdot \sqrt{2\pi}} e^{-\frac{(x-x_N)^2}{2w_N^2}}$

Correction for a Gaussian noise jitter: $f_2(x_i) = \sum_1^i f_1(x) \cdot \frac{1}{20}$; (1 bin has 0.02 ns)

2)Polycrystalline species description: Exponential function: For $x < x_{EX}$, $f_3(x) = 0$

For $x \geq x_{EX}$, $f_3(x) = A_{EX} \cdot e^{-\frac{x-x_{EX}}{\tau_{EX}}}$; with A_{EX}, x_{EX} and τ_{EX} parameters

3a) Single crystal species description by a pulse with parameters: A_{SC} is the amplitude, x_{SC} the delay and w_{SC} the width of the pulse. For $x < x_{SC}$, $f_4(x) = 0$

For $x \geq x_{SC}$, $f_4(x) = \frac{1}{w_{SC} \cdot \sqrt{2\pi}} e^{-\frac{(x-x_{SC})^2}{2w_N^2}}$, $\int_0^\infty f_1(x)dx = 1$

Correction for a Gaussian noise jitter: $f_5(x_i) = \sum_1^i f_4(x) \cdot \frac{1}{20}$; (1 bin has 0.02 ns)

3b) Single crystal species description by a pulse which take into account the Bragg effect: The width of the sc DD is d~0.3 mm. The energy of α particles is deposited in ~60 μm (0.8d). If we approximate the deposited energy by a linear dependence with the depth, we expect for the detected signal a rectangular shape till 0.8 of the carrier drift time and after then a linear decrease to 1/3 of the pulse amplitude. The 3a) correction is applied too for this case.

4) Correction for the Signal and Amplifier time constant (τ_S and τ_A), convolution with the unity delta response of the FEE.

$\tau_S = 0.43\,pF \cdot 50\Omega = 21.5\,ps$; $\tau_A = \frac{1}{2 \cdot \pi \cdot 2.3GHz} = 70\,ps$ The Front End Electronics response to $Q_{COL} * \delta(t)$ function is:

$v_{out}(t) = \frac{Q_{COL}}{C_D} \cdot G_0 \cdot \frac{\tau_S}{\tau_S - \tau_A} \cdot (e^{-\frac{t}{\tau_S}} - e^{-\frac{t}{\tau A}})$. The response to unity $\delta(t)$ is: $v_{out\,\delta}(t) = v_{out}(t) / Q_{COL}$.

The response to $i(t)$ function is:

$$v_P(t) = v_{out\,\delta}(t) \otimes i(t) = \int_0^t v_{out\,\delta}(u) \cdot i(t-u) \cdot du$$

Implementation: i=1,ndate k=1,i

For $x < x_{SC}$, $f_7(x_i) = 0$

For $x \ge x_{SC}$, $f_7(x_i) = \sum_1^i f_6(x_k) \cdot \frac{\tau_S}{\tau_S - \tau_A} \cdot (e^{-\frac{x_k - x_{SC}}{\tau_S}} - e^{-\frac{x_k - x_{SC}}{\tau_A}})$

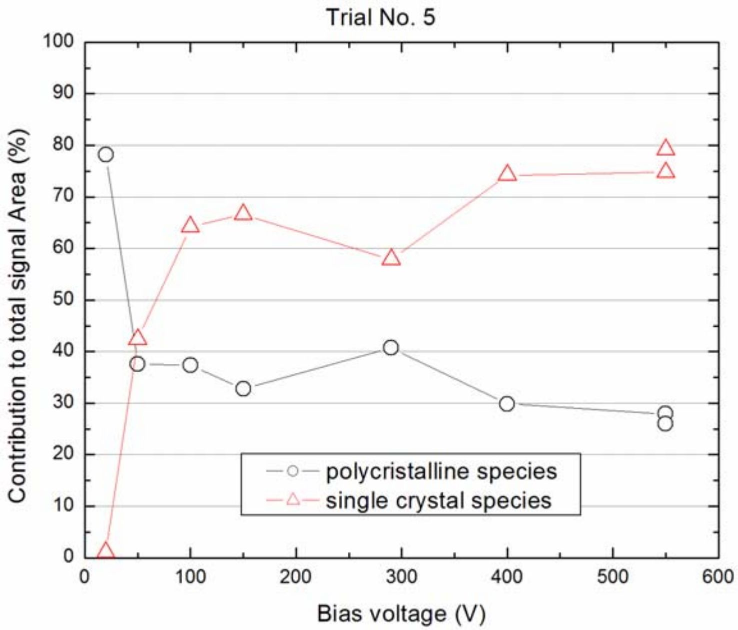
5) Correction **of the amplifier noise which generate a Trigger jitter of the Scope**.

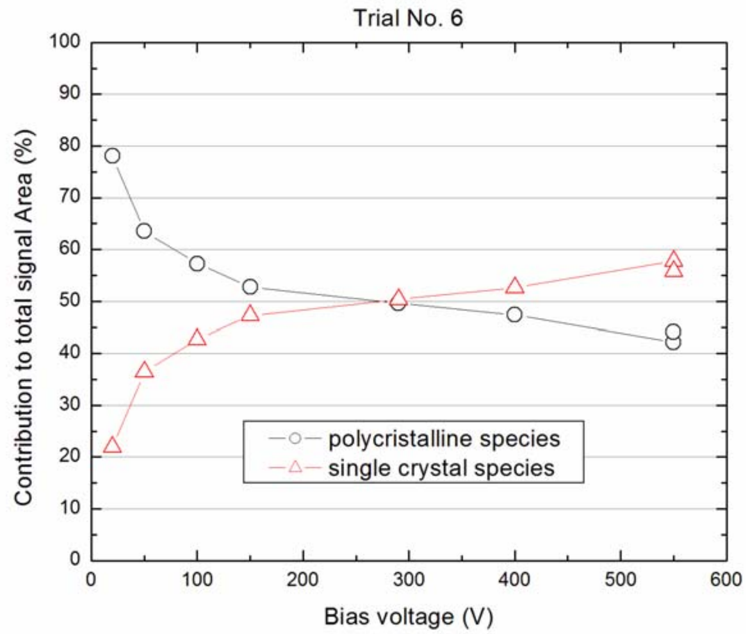
Implementation: i=1,ndate k=-20,20

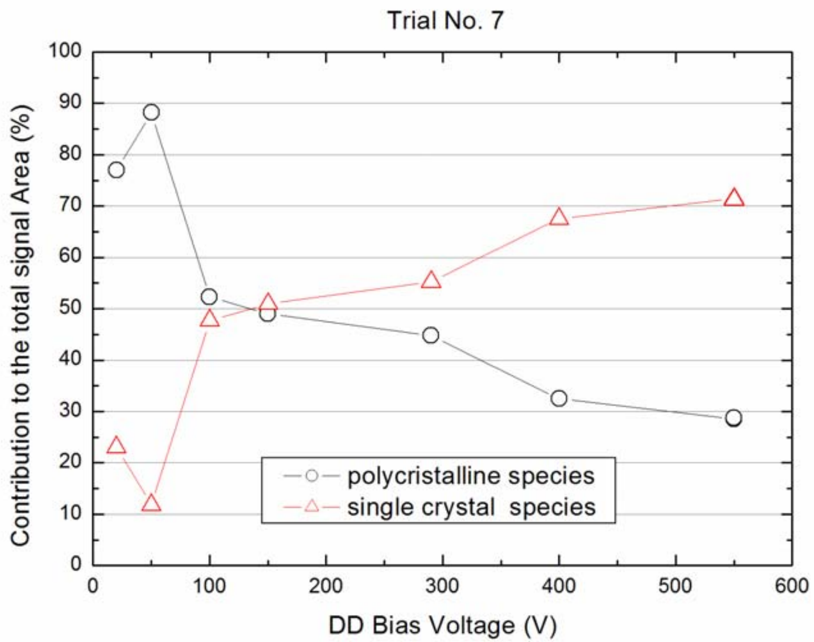
$$f_8(x_i) = \sum_{-20}^{20} f_7(x_{i+k}) / 40$$

6) The final function applied to MINUIT program for error minimization:

$$fcn = \sum_1^{ndate} (f_8(xi) - v(x_i))^2$$


Trial No. 5
Contribution to total signal Area (%)
Bias voltage (V)
polycristalline species
single crystal species


Trial No. 6
Contribution to total signal Area (%)
Bias voltage (V)
polycristalline species
single crystal species


Trial No. 7
Contribution to the total signal Area (%)
DD Bias Voltage (V)
polycristalline species
single crystal species

Summary

The MINUIT algorithm used to fit the experimental data with a set of analytical formulas need to set the initial value and limits of all parameters. In our case, there are used successive formulas, and the minimization process which have a few iterations, is time consuming.

We made a few trials and the results of the last three are described. The main result is the ratio of pc. species / total species which has a big dispersion (57% - 72% - 77%).

Outlook

In order to increase the reconstruction accuracy, we must:

1. To modify the DD metallization mask to include a guard ring to avoid the DD edge signals. A collimator can prevent the edge signals too.
2. To connect all unused pad's and guard ring to ground.
3. To identify on the Scope, by single sweeps, the main classes of signals.
4. To avoid changes of the Scope parameters in the time of registration.