Board: E001
Summary Test Report

1   Measurement Status and Summary

Procedure/Parameter	Value	Status
Comm. with ASIC0 (channels: 0-7), registers (write & read)	-	pass
Comm. with ASIC1 (channels: 8-15), registers (write & read)	-	pass
Minimum DNL[1] of Baseline DACs during TOT mesurements	0.49 ns	pass
Minimum (negative) DNL[1] of Treshold DACs during TOT mesurements	-0.10 ns	near
Minimum raw baseline value	15.9 LSB	pass
Maximum raw baseline value	27.0 LSB	pass
Minimum threshold error after baseline correction	-0.40 LSB	pass
Maximum threshold error after baseline correction	0.68 LSB	pass
Maximum Gain variation (max-min)/average ...		
... at configuration: 1mV20ns	5.7 %	pass
... at configuration: 2mV15ns	6.1 %	pass
... at configuration: 2mV20ns	5.3 %	pass
... at configuration: 4mV15ns	3.7 %	pass
... at configuration: 4mV20ns	4.6 %	pass
Maximim Noise (sigma)...		
... at configuration: 1mV20ns	2.45 ke^-	pass
... at configuration: 2mV15ns	1.73 ke^-	pass
... at configuration: 2mV20ns	1.68 ke^-	pass
... at configuration: 4mV15ns	1.88 ke^-	pass
... at configuration: 4mV20ns	1.37 ke^-	pass

2   Measurement configuration and settings names

Measurements were done for the PASTTREC parameters presented in Table 1.

Table 1: Parameters settings used in all measurements configurations.

Configuration name	Gain	T_{peak}	TC_{C1}	TC_{R1}	TC_{C2}	TC_{R2}
1mV20ns	1 mV/fC	20 ns	6.0 pF	23 kΩ	0.6 pF	11 kΩ
2mV15ns	2 mV/fC	15 ns	15.0 pF	7 kΩ	0.6 pF	8 kΩ
2mV20ns	2 mV/fC	20 ns	7.5 pF	27 kΩ	0.75 pF	17 kΩ
4mV15ns	4 mV/fC	15 ns	13.5 pF	19 kΩ	1.5 pF	23 kΩ
4mV20ns	4 mV/fC	20 ns	10.5 pF	27 kΩ	0.9 pF	20 kΩ

All injection boards were calibrated to inject the same charge.

---

[1]In this report DNL shows the difference between the next and previous value (it is not standard DNL definition)

3 Baseline DAC

TOT measurement is done versus baseline DAC setting. Amplitude from generator is set to maximum value (5V), threshold is set to 24. Results of TOT in function of baseline DAC setting with corresponding DNL values are presented in Figure 1. Measurment is done only for 4mV20ns configuration.
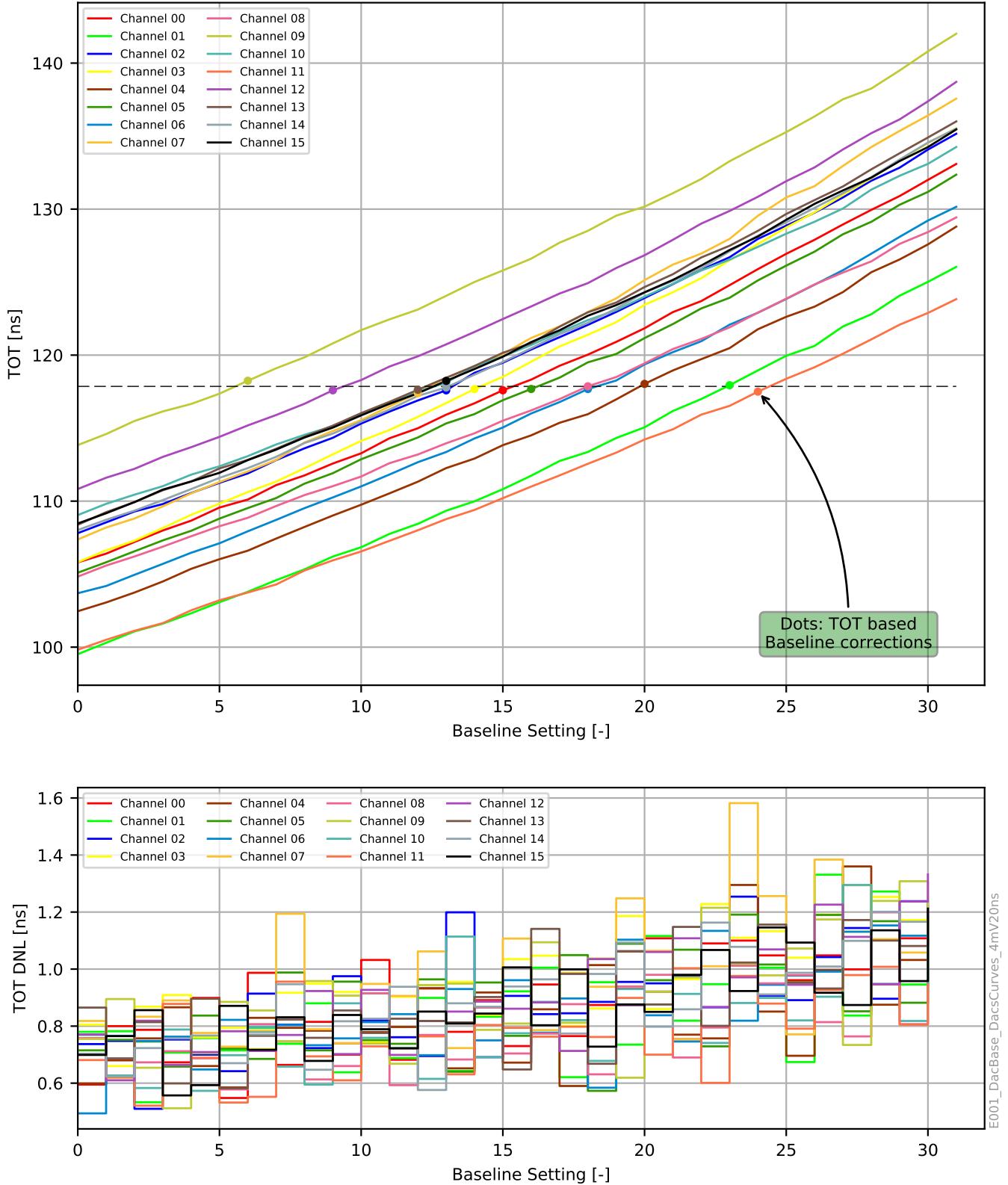

Figure 1: TOT measurement versus baseline DAC setting and its DNL.

4   Threshold DAC

TOT measurement is done versus threshold DAC setting. Amplitude from generator is set to maximum value (5V), all baselines are set to 0. Results of TOT versus threshold DAC setting with corresponding DNL values are presented in Figure 2. Measurment is done only for 4mV20ns configuration.
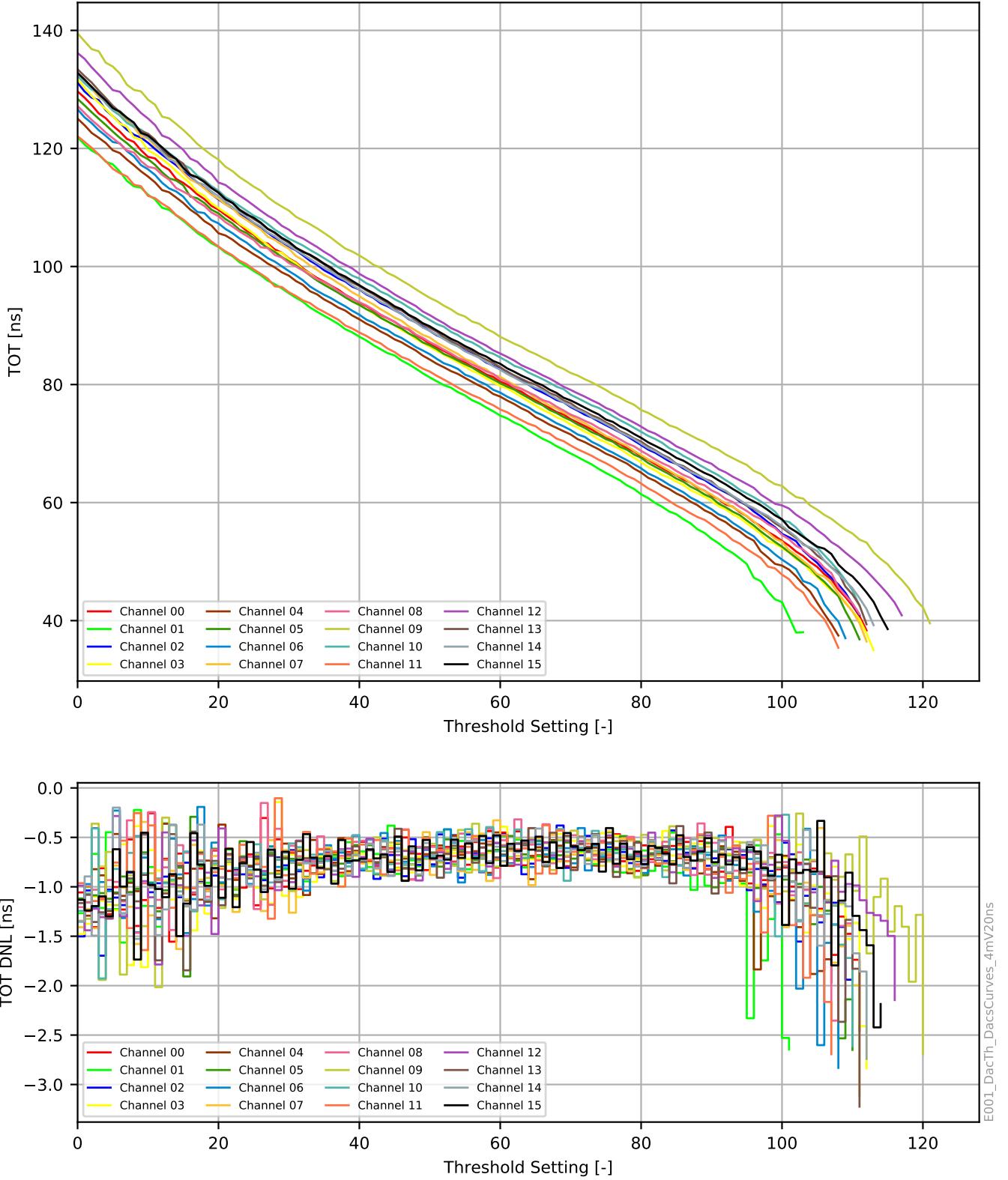

Figure 2: TOT measurement versus threshold DAC setting and its DNL.

5 Baseline calibration

The noise baseline scan was done to calibrate baseline settings to the same level. The scan versus baseline setting is done (threshold DAC is set to 0) and counts from the channels are read in each step. The baseline setting is calculated as weighted average. The results of measurements are presented in Figure 3 - obtained results of baseline settings and their values corrected to mean baseline setting (15). The baseline settings after calibration are presented in Table 2 for all measured configurations. All following measurements are done with calibrated baseline settings.
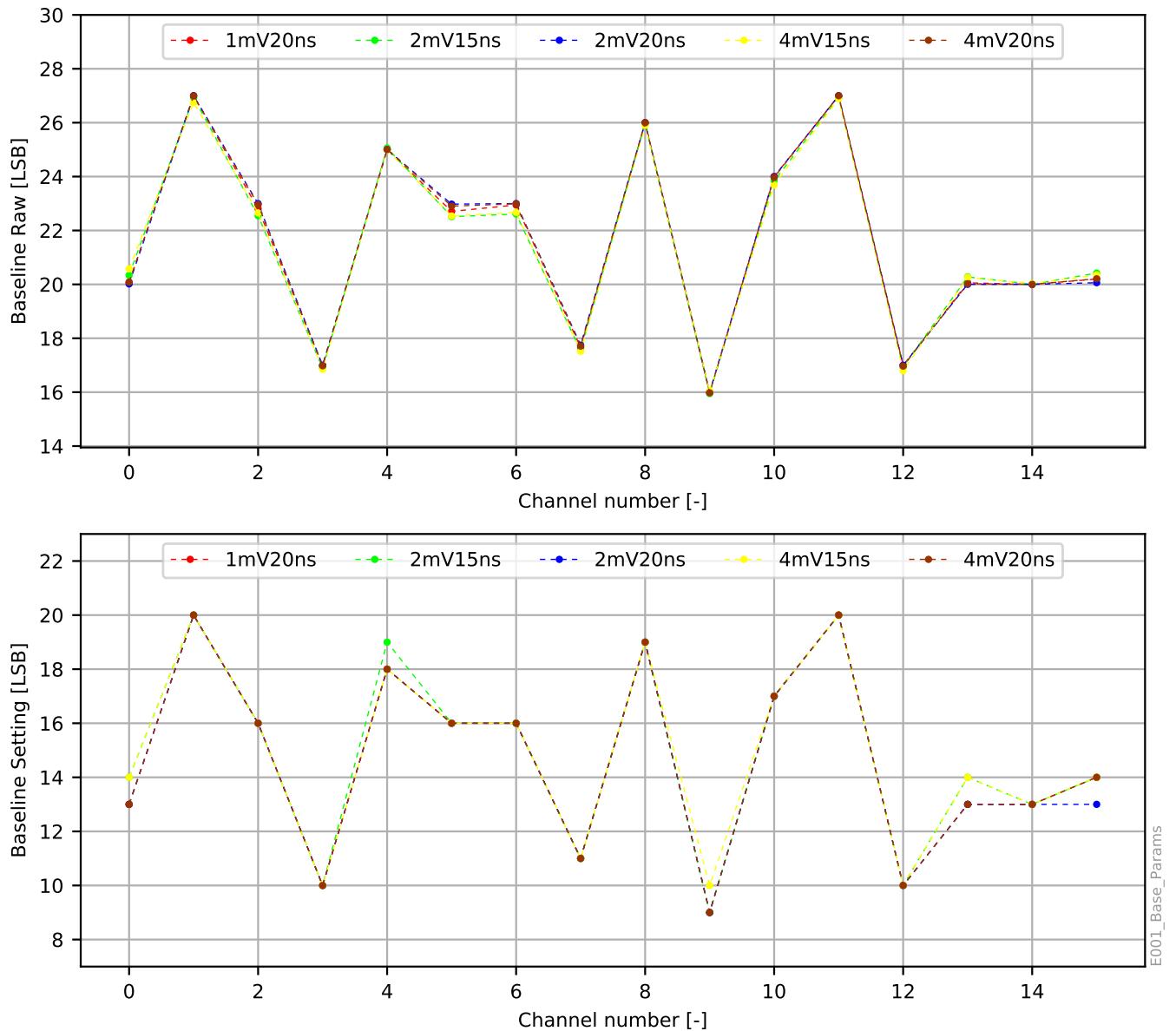

Figure 3: Raw baseline values and baseline setting corrected to center value (15).

Table 2: Baseline settings after calibration.

Measurement configuration	Channels															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1mV20ns	13	20	16	10	18	16	16	11	19	9	17	20	10	13	13	14
2mV15ns	14	20	16	10	19	16	16	11	19	9	17	20	10	14	13	14
2mV20ns	13	20	16	10	18	16	16	11	19	9	17	20	10	13	13	13
4mV15ns	14	20	16	10	18	16	16	11	19	10	17	20	10	14	13	14
4mV20ns	13	20	16	10	18	16	16	11	19	9	17	20	10	13	13	14

To check baseline setting correctness a similar test versus threshold DAC setting is done using calibrated baselines. The weighted average of threshold versus FEB channel number and threshold error is presented in Figure 4.
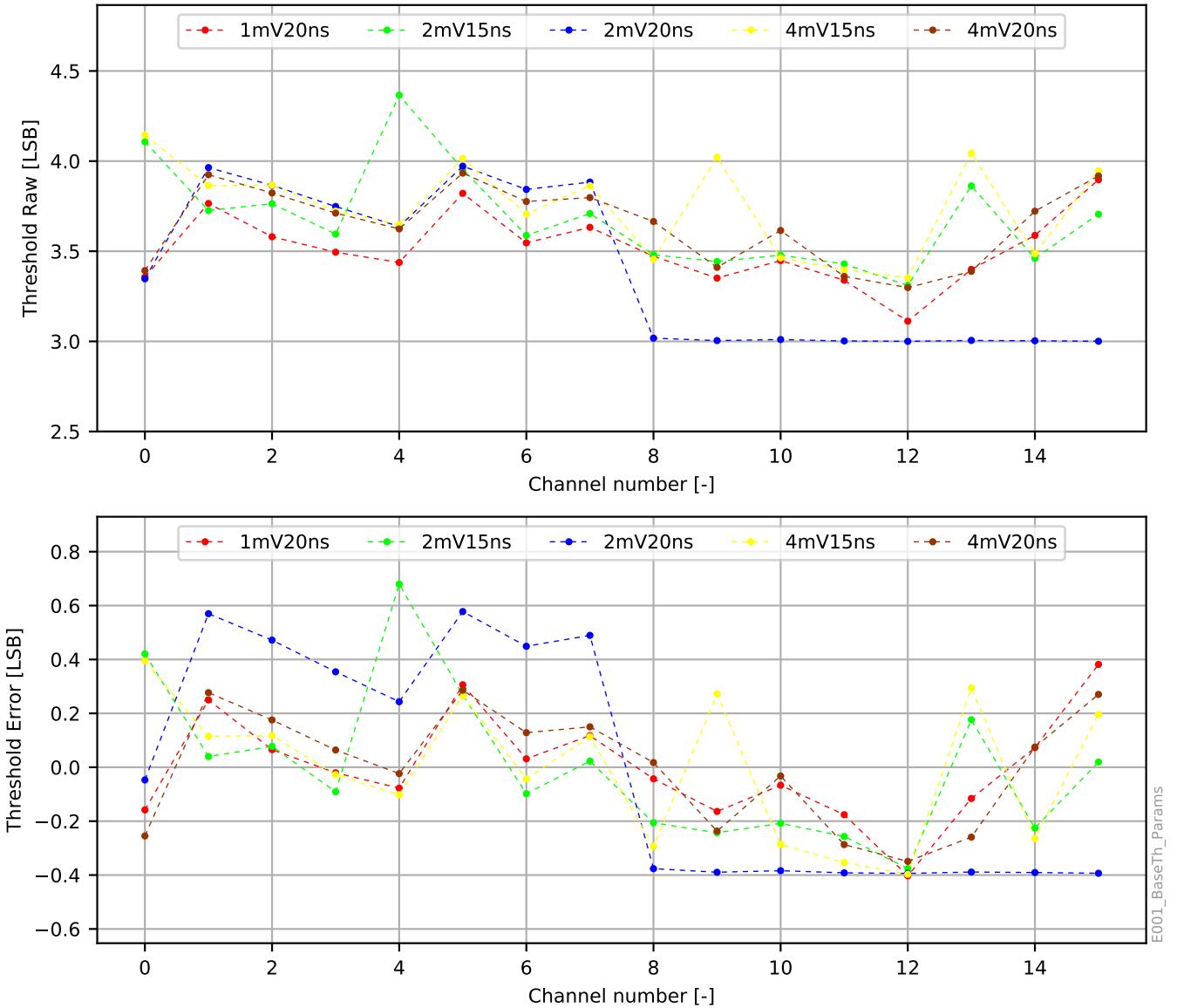
Figure 4: Threshold scan after baseline calibration

6   S-curve noise measurements

S-curve scan measurements were done versus threshold setting, two exemplary results of sigma (noise) and median (injected charge) for threshold: Th=8 and Th=16, for all measurement parameters are presented in Figure 5 and Figure 6.
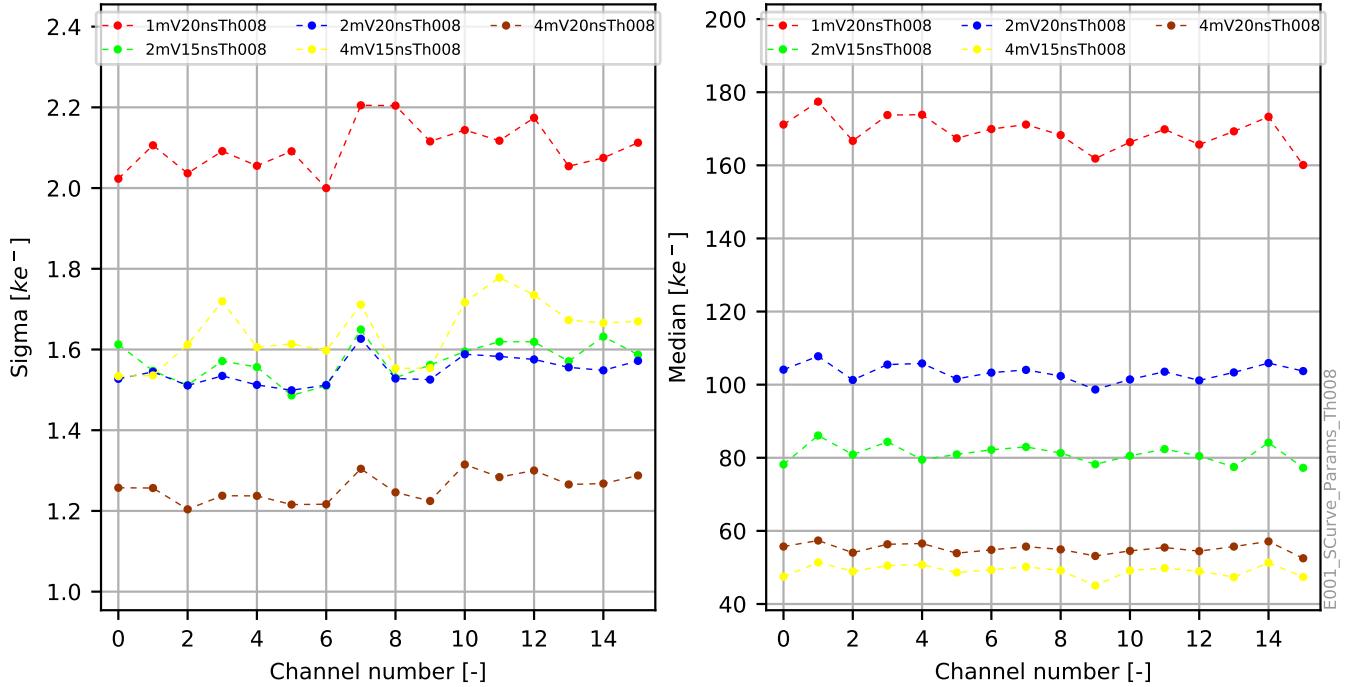
Figure 5: Noise and median distribution for S-curve measurement (Th=8).
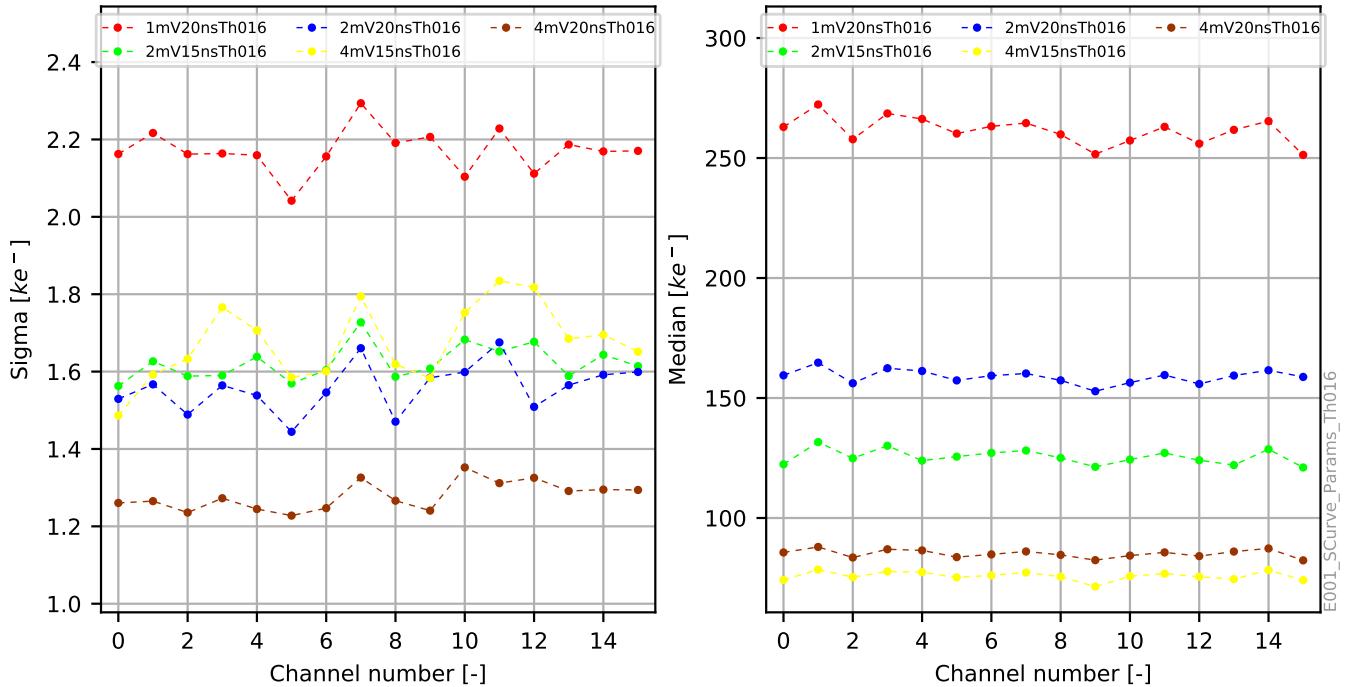
Figure 6: Noise and median distribution for S-curve measurement (Th=16).

7 S-curve gain measurements

S-curve scan measurements are done for threshold setting from 0 to 25 and it is presented versus median value from which the real gain value is obtained. The summary gain and offset results for all configurations are presented in Figure 7. The obtained values of gains are presented in Table 3. The detailed measurements results are shown in figures 8-12.
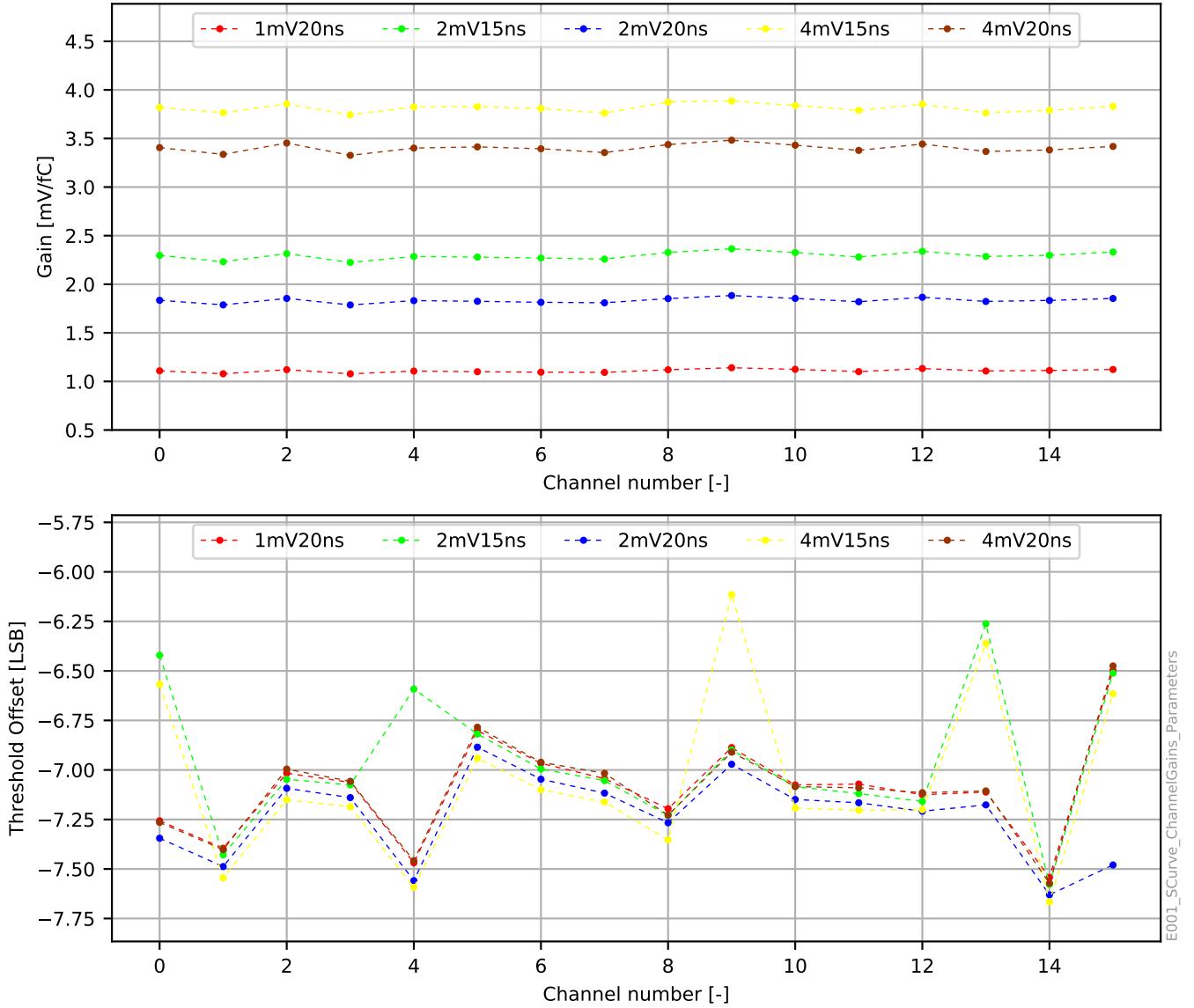
Figure 7: Summary of gain and threshold error from threshold versus median measurements.

Table 3: Summary of gain values for all measurement configurations.

Channels	Gain [mv/fC] for all configurations				
	1mV20ns	2mV15ns	2mV20ns	4mV15ns	4mV20ns
0	1.109	2.297	1.835	3.818	3.406
1	1.079	2.231	1.788	3.765	3.337
2	1.121	2.315	1.854	3.856	3.453
3	1.078	2.225	1.787	3.743	3.326
4	1.106	2.286	1.832	3.824	3.401
5	1.100	2.279	1.825	3.826	3.413
6	1.095	2.270	1.814	3.809	3.394
7	1.093	2.259	1.809	3.762	3.355
8	1.120	2.328	1.852	3.876	3.437
9	1.141	2.365	1.884	3.886	3.482
10	1.125	2.327	1.854	3.839	3.431
11	1.101	2.280	1.820	3.790	3.378
12	1.132	2.339	1.866	3.854	3.443
13	1.107	2.286	1.823	3.764	3.366
14	1.113	2.298	1.833	3.791	3.382
15	1.123	2.331	1.854	3.830	3.418
Max Variation	5.7 %	6.1 %	5.3 %	3.7 %	4.6 %
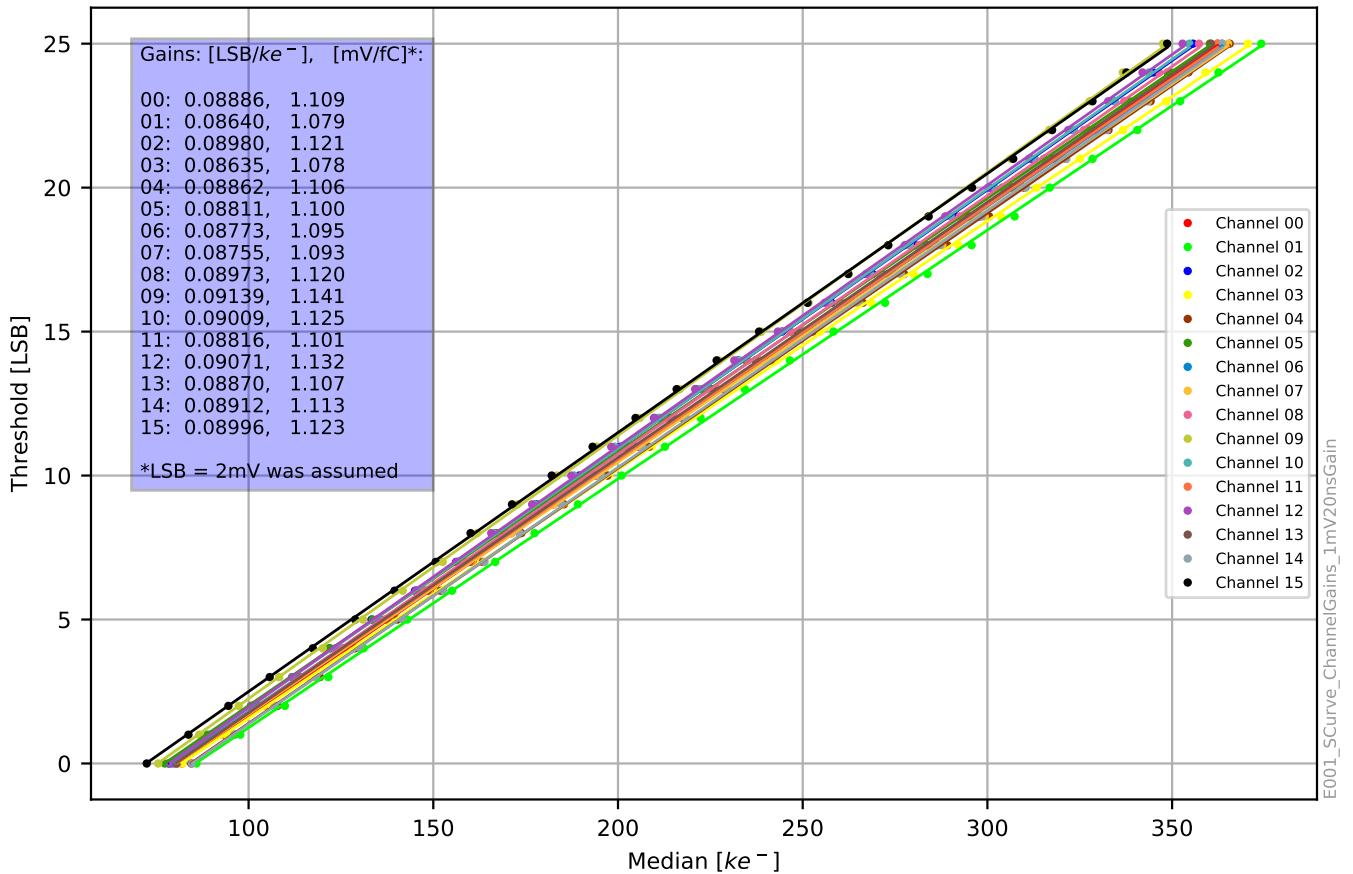
Figure 8: Threshold setting versus median from S-curve measurements (setting: 1mV20ns).
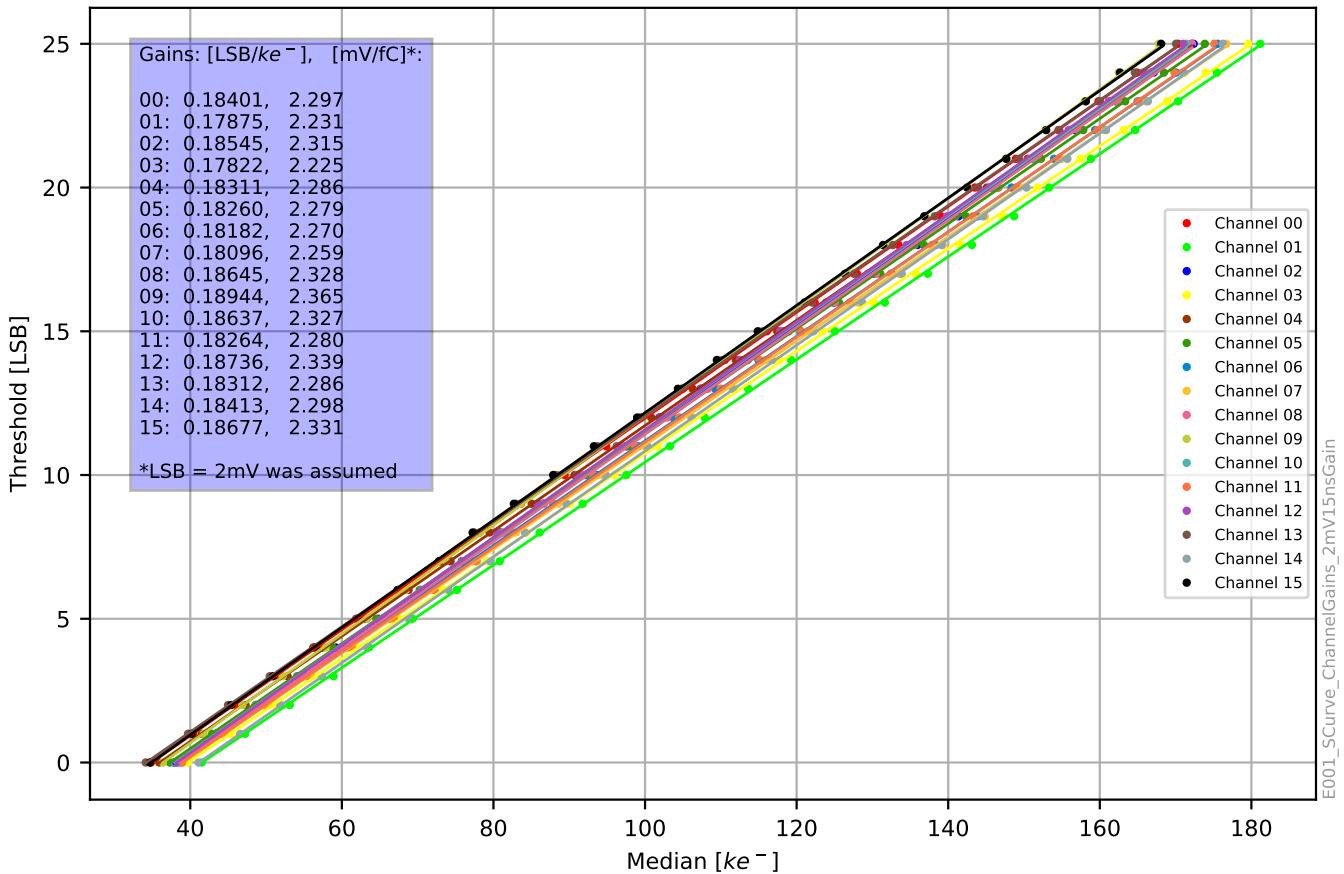
Figure 9: Threshold setting versus median from S-curve measurements (setting: 2mV15ns).
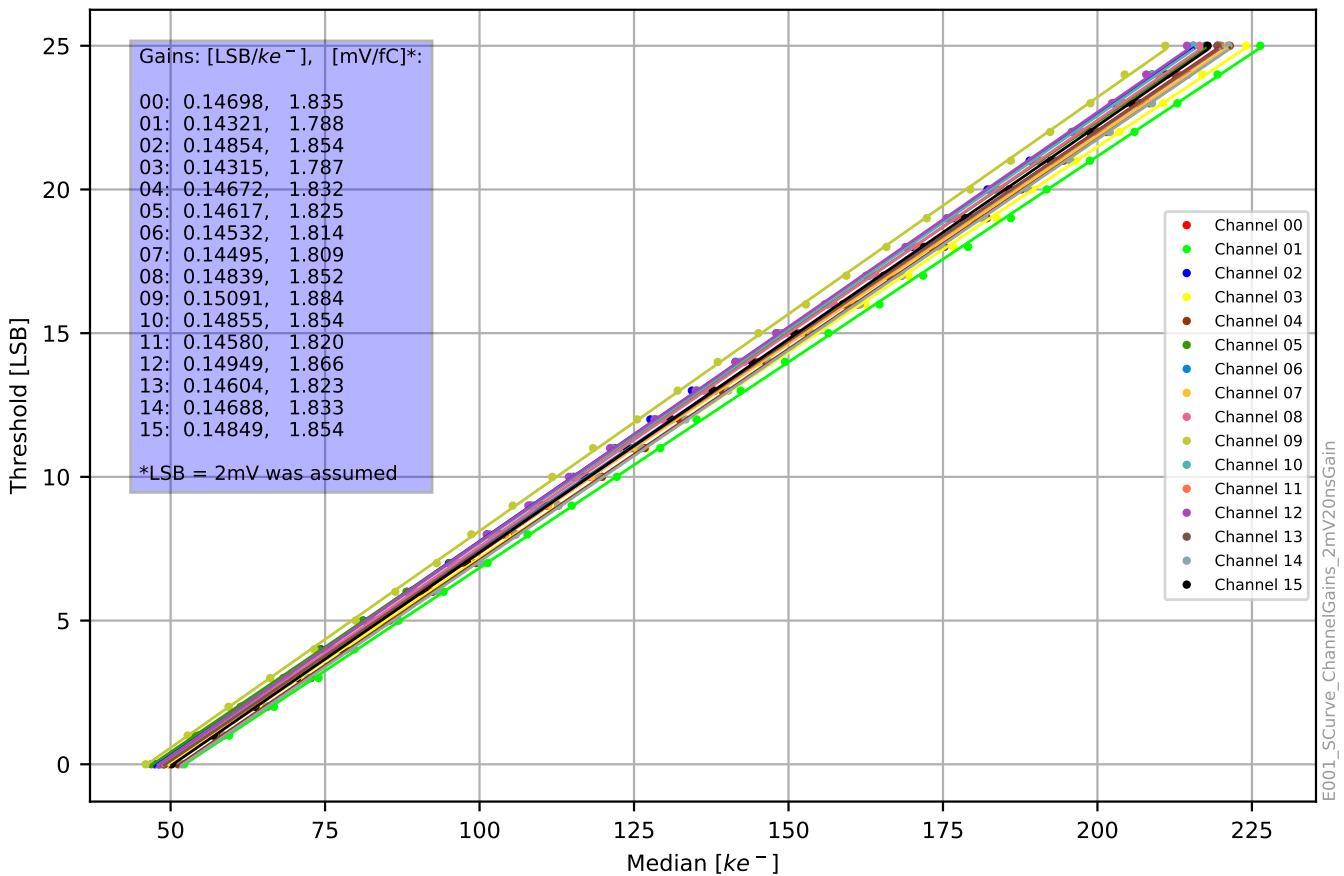
Figure 10: Threshold setting versus median from S-curve measurements (setting: 2mV20ns).
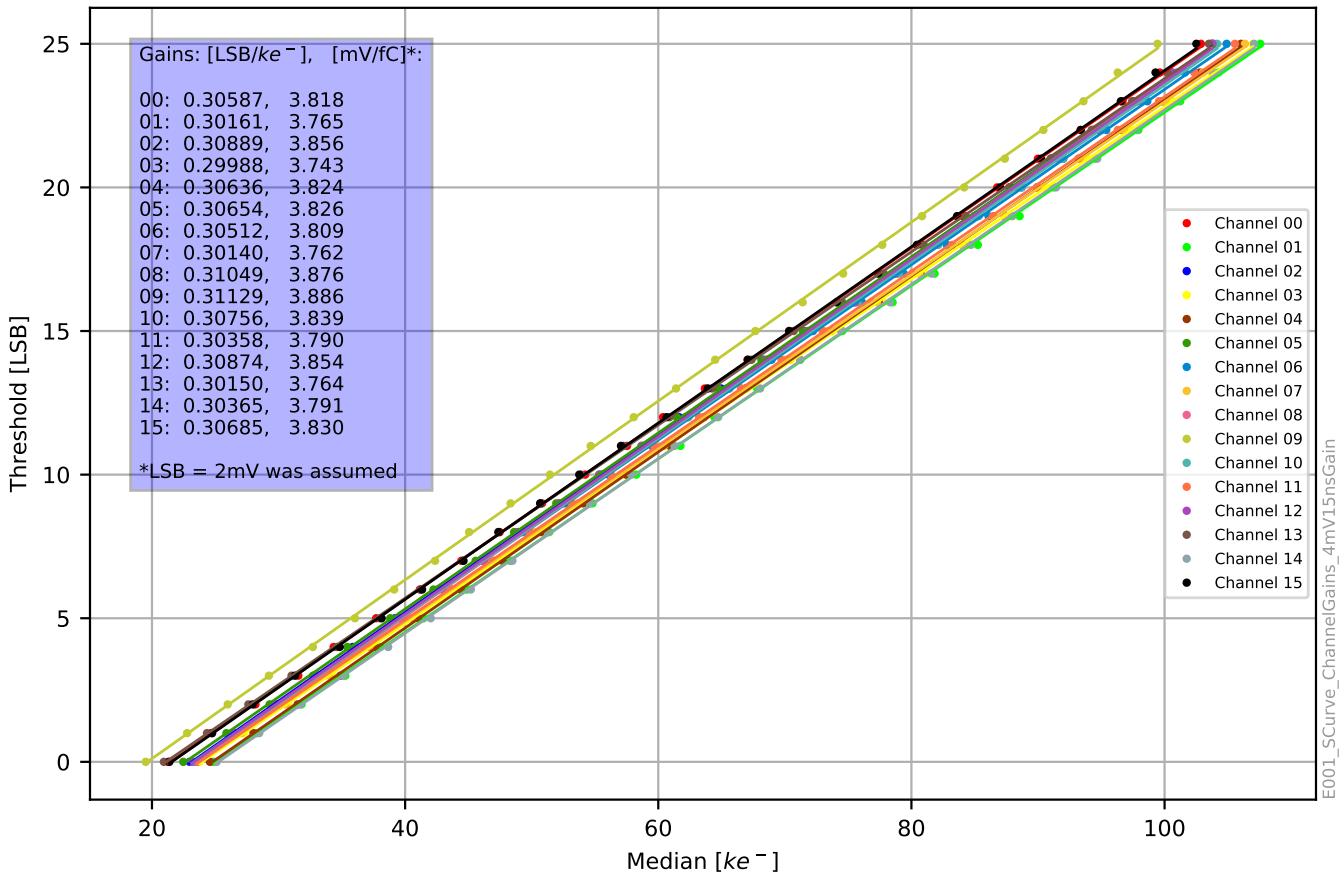
Figure 11: Threshold setting versus median from S-curve measurements (setting: 4mV15ns).
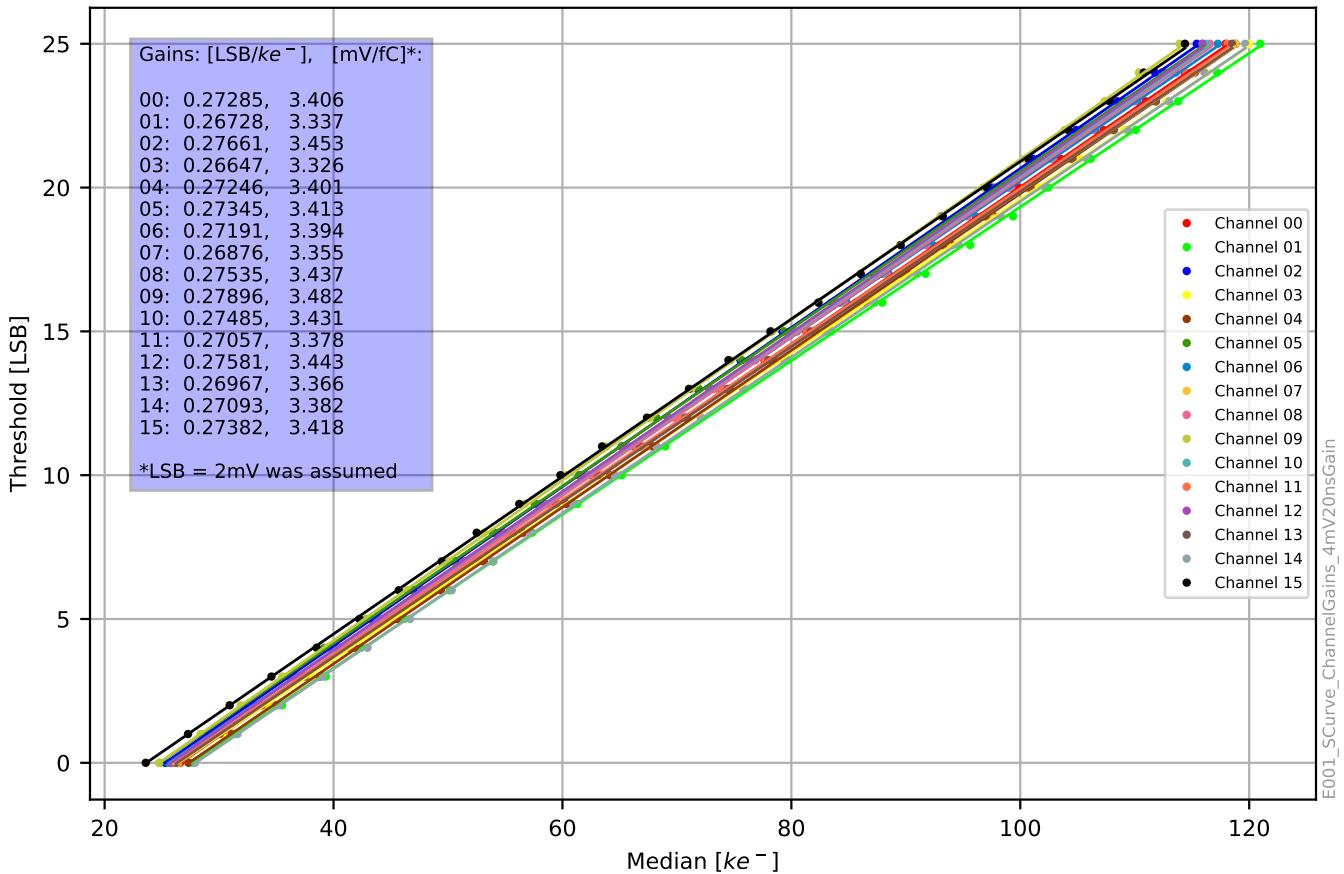
Figure 12: Threshold setting versus median from S-curve measurements (setting: 4mV20ns).

8 TOT

TOT measurements versus injected charge were done, the 5th order polynomials were fitted to obtained values. The results are presented in Figure 13-17 for all measurement configurations.
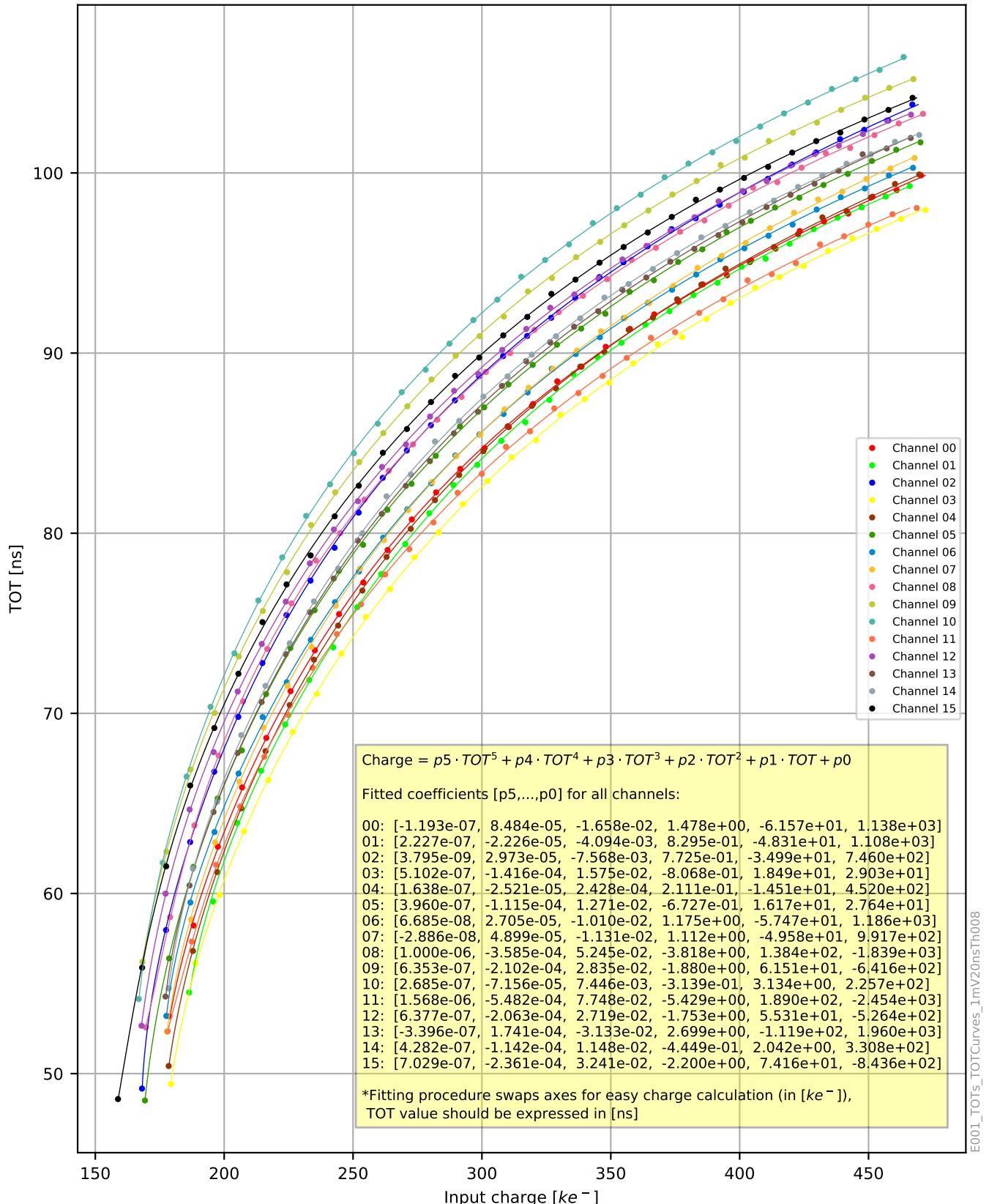
Figure 13: TOT versus input charge with fitted polynomials for Th=8 (setting: 1mV20ns).

Figure 14: TOT versus input charge with fitted polynomials for Th=8 (setting: 2mV15ns).

Legend:
- Channel 00
- Channel 01
- Channel 02
- Channel 03
- Channel 04
- Channel 05
- Channel 06
- Channel 07
- Channel 08
- Channel 09
- Channel 10
- Channel 11
- Channel 12
- Channel 13
- Channel 14
- Channel 15

Charge = $p5 \cdot TOT^5 + p4 \cdot TOT^4 + p3 \cdot TOT^3 + p2 \cdot TOT^2 + p1 \cdot TOT + p0$

Fitted coefficients [p5,…,p0] for all channels:

```
00: [1.156e-06, -4.045e-04,  5.726e-02, -4.031e+00,  1.412e+02, -1.893e+03]
01: [1.438e-06, -5.176e-04,  7.522e-02, -5.440e+00,  1.958e+02, -2.723e+03]
02: [1.316e-06, -4.858e-04,  7.206e-02, -5.298e+00,  1.929e+02, -2.704e+03]
03: [7.903e-07, -2.502e-04,  3.217e-02, -2.047e+00,  6.476e+01, -7.358e+02]
04: [1.113e-06, -3.879e-04,  5.464e-02, -3.825e+00,  1.331e+02, -1.767e+03]
05: [1.328e-06, -4.814e-04,  7.023e-02, -5.080e+00,  1.820e+02, -2.504e+03]
06: [1.511e-06, -5.437e-04,  7.861e-02, -5.630e+00,  1.995e+02, -2.712e+03]
07: [1.377e-06, -4.899e-04,  6.991e-02, -4.924e+00,  1.710e+02, -2.259e+03]
08: [2.041e-06, -7.813e-04,  1.200e-01, -9.150e+00,  3.460e+02, -5.108e+03]
09: [1.464e-06, -5.517e-04,  8.377e-02, -6.333e+00,  2.382e+02, -3.490e+03]
10: [1.412e-06, -5.393e-04,  8.280e-02, -6.320e+00,  2.395e+02, -3.526e+03]
11: [1.172e-06, -3.937e-04,  5.353e-02, -3.614e+00,  1.213e+02, -1.537e+03]
12: [1.011e-06, -3.566e-04,  5.091e-02, -3.616e+00,  1.278e+02, -1.720e+03]
13: [1.593e-06, -6.033e-04,  9.206e-02, -6.995e+00,  2.643e+02, -3.897e+03]
14: [1.440e-06, -5.257e-04,  7.714e-02, -5.612e+00,  2.022e+02, -2.803e+03]
15: [1.946e-06, -7.491e-04,  1.158e-01, -8.895e+00,  3.393e+02, -5.061e+03]
```

*Fitting procedure swaps axes for easy charge calculation (in [ke^-]),
 TOT value should be expressed in [ns]

TOT [ns] (y-axis)

Input charge [ke^-] (x-axis)

E001_TOTs_TOTCurves_2mV15nsTh008

Charge = $p5 \cdot TOT^5 + p4 \cdot TOT^4 + p3 \cdot TOT^3 + p2 \cdot TOT^2 + p1 \cdot TOT + p0$

Fitted coefficients [p5,…,p0] for all channels:

```
00: [7.399e-07, -2.702e-04,  4.000e-02, -2.938e+00,  1.073e+02, -1.462e+03]
01: [4.058e-07, -1.367e-04,  1.896e-02, -1.303e+00,  4.479e+01, -5.150e+02]
02: [3.782e-07, -1.328e-04,  1.911e-02, -1.358e+00,  4.793e+01, -5.750e+02]
03: [2.430e-07, -6.683e-05,  7.374e-03, -3.668e-01,  7.796e+00,  5.656e+01]
04: [5.977e-07, -2.210e-04,  3.353e-02, -2.543e+00,  9.668e+01, -1.371e+03]
05: [6.517e-07, -2.404e-04,  3.584e-02, -2.637e+00,  9.585e+01, -1.278e+03]
06: [7.405e-07, -2.772e-04,  4.212e-02, -3.181e+00,  1.196e+02, -1.692e+03]
07: [6.732e-07, -2.557e-04,  3.962e-02, -3.064e+00,  1.185e+02, -1.732e+03]
08: [8.264e-07, -3.130e-04,  4.766e-02, -3.583e+00,  1.329e+02, -1.847e+03]
09: [1.038e-06, -4.236e-04,  6.955e-02, -5.670e+00,  2.292e+02, -3.579e+03]
10: [9.010e-07, -3.597e-04,  5.766e-02, -4.572e+00,  1.791e+02, -2.675e+03]
11: [3.605e-07, -1.085e-04,  1.306e-02, -7.369e-01,  1.907e+01, -7.010e+01]
12: [5.046e-07, -1.797e-04,  2.598e-02, -1.859e+00,  6.600e+01, -8.367e+02]
13: [7.490e-07, -2.879e-04,  4.487e-02, -3.477e+00,  1.340e+02, -1.955e+03]
14: [8.100e-07, -3.128e-04,  4.892e-02, -3.805e+00,  1.473e+02, -2.170e+03]
15: [6.059e-07, -2.290e-04,  3.532e-02, -2.719e+00,  1.046e+02, -1.510e+03]
```

*Fitting procedure swaps axes for easy charge calculation (in [ke^-]),
 TOT value should be expressed in [ns]

Figure 15: TOT versus input charge with fitted polynomials for Th=8 (setting: 2mV20ns).

Figure 16: TOT versus input charge with fitted polynomials for Th=8 (setting: 4mV15ns).

The chart contains the following annotation box:

Charge $= p5 \cdot TOT^5 + p4 \cdot TOT^4 + p3 \cdot TOT^3 + p2 \cdot TOT^2 + p1 \cdot TOT + p0$

Fitted coefficients [p5,...,p0] for all channels:

00: [3.603e-06, -9.911e-04, 1.096e-01, -5.999e+00, 1.615e+02, -1.657e+03]
01: [2.243e-06, -5.195e-04, 4.556e-02, -1.727e+00, 2.188e+01, 1.335e+02]
02: [-1.235e-06, 6.751e-04, -1.210e-01, 9.960e+00, -3.887e+02, 5.887e+03]
03: [5.175e-06, -1.486e-03, 1.730e-01, -1.008e+01, 2.935e+02, -3.363e+03]
04: [1.607e-06, -3.156e-04, 1.929e-02, -3.221e-02, -3.280e+01, 8.379e+02]
05: [2.524e-06, -6.287e-04, 6.087e-02, -2.741e+00, 5.395e+01, -2.568e+02]
06: [4.252e-06, -1.217e-03, 1.410e-01, -8.147e+00, 2.346e+02, -2.645e+03]
07: [6.577e-07, -1.382e-05, -1.918e-02, 2.413e+00, -1.100e+02, 1.806e+03]
08: [4.313e-06, -1.254e-03, 1.467e-01, -8.534e+00, 2.460e+02, -2.761e+03]
09: [2.893e-06, -8.071e-04, 8.972e-02, -4.897e+00, 1.306e+02, -1.316e+03]
10: [1.532e-06, -3.107e-04, 1.631e-02, 5.840e-01, -7.510e+01, 1.779e+03]
11: [4.724e-06, -1.302e-03, 1.446e-01, -7.992e+00, 2.195e+02, -2.347e+03]
12: [1.128e-06, -1.073e-04, -1.715e-02, 3.061e+00, -1.598e+02, 2.855e+03]
13: [3.030e-06, -8.412e-04, 9.402e-02, -5.220e+00, 1.438e+02, -1.527e+03]
14: [4.063e-06, -1.185e-03, 1.397e-01, -8.219e+00, 2.408e+02, -2.763e+03]
15: [3.854e-06, -1.125e-03, 1.325e-01, -7.775e+00, 2.272e+02, -2.598e+03]

*Fitting procedure swaps axes for easy charge calculation (in [ke^-]),
 TOT value should be expressed in [ns]

14

Figure 17: TOT versus input charge with fitted polynomials for Th=8 (setting: 4mV20ns).