Comparison of the Pulse shape 2nd order polynomial to compute Vbd on the 21/March data

R. de Aguiar, A. Balboni

Objective

- Compare the fitting performance of two different methods (Second order polynomial and pulse shape) for the breakdown voltage estimation using the data acquisition from 21/March;
- Propose a definitive method to estimate the breakdown voltage.

Summary

We can classify the data quality in good if at least one fitting method found a reliable breakdown voltage value and bad if:

- The data set has less than 20 samples;
- There are more than NaN values for the current;
- All current values are negative;
- The currents are too low;
- If none methods found the Vbd (usually this happens if we didn’t reach the reverse voltage)

Data Quality

Mostly of the ‘bad’ data was found for the HPK channels:

FBK: good = 65 , bad = 1

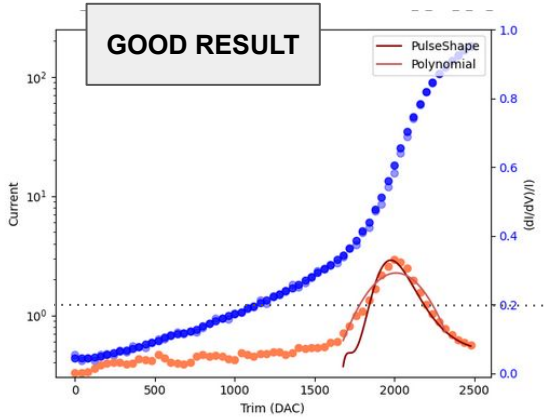
HPK: good = 74 , bad = 17

And the reasons were because currents were too low (checked before the fit application) and the data didn’t reached the breakdown region (checked during the fitting).

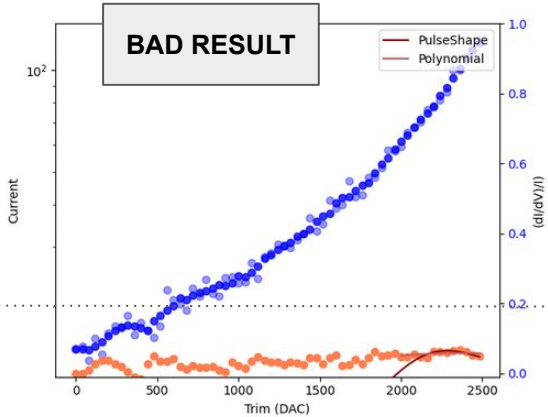
Mar-21-2024_1829_IvCurves_trim_np04_apa1_ip10.73.137.107 apa_1_afe_1_ch_8.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-21-2024_1829_IvCurves_trim_np04_apa2_ip10.73.137.109 apa_2_afe_0_ch_4.root - FBK: ERROR: Wrong current range, check the voltage range !!!
Mar-21-2024_1829_IvCurves_trim_np04_apa2_ip10.73.137.109 apa_2_afe_2_ch_23.root - HPK: Fitting problems
Mar-21-2024_1829_IvCurves_trim_np04_apa2_ip10.73.137.109 apa_2_afe_4_ch_32.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-21-2024_1829_IvCurves_trim_np04_apa2_ip10.73.137.109 apa_2_afe_4_ch_34.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-21-2024_1829_IvCurves_trim_np04_apa2_ip10.73.137.109 apa_2_afe_4_ch_37.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-21-2024_1829_IvCurves_trim_np04_apa2_ip10.73.137.109 apa_2_afe_4_ch_38.root - HPK: Fitting problems
Mar-21-2024_1829_IvCurves_trim_np04_apa3_ip10.73.137.111 apa_3_afe_4_ch_32.root - HPK: Fitting problems
Mar-21-2024_1829_IvCurves_trim_np04_apa3_ip10.73.137.111 apa_3_afe_4_ch_34.root - HPK: Fitting problems
Mar-21-2024_1829_IvCurves_trim_np04_apa3_ip10.73.137.111 apa_3_afe_4_ch_37.root - HPK: Fitting problems
Mar-21-2024_1829_IvCurves_trim_np04_apa3_ip10.73.137.111 apa_3_afe_4_ch_38.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-21-2024_1829_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_1_ch_9.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-22-2024_0001_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_3_ch_27.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-22-2024_0001_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_3_ch_30.root - HPK: Fitting problems
Mar-22-2024_0001_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_3_ch_31.root - HPK: ERROR: Wrong current range, check the voltage range !!!
Mar-22-2024_0001_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_4_ch_32.root - HPK: Fitting problems
Mar-22-2024_0001_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_4_ch_37.root - HPK: Fitting problems
Mar-22-2024_0001_IvCurves_trim_np04_apa4_ip10.73.137.112 apa_4_afe_4_ch_39.root - HPK: ERROR: Wrong current range, check the voltage range !!!

Data Quality

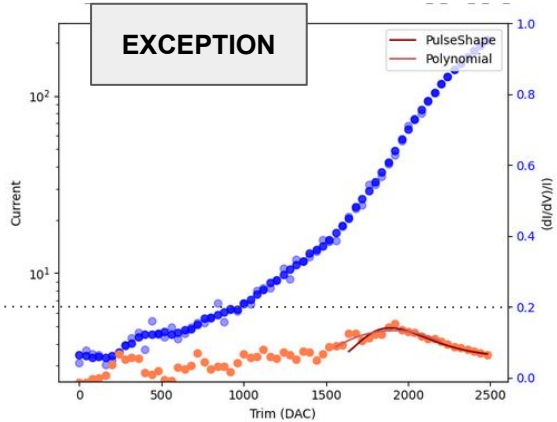
It was also observed is that if the maximum of the relative derivative is lower than 0.2, there are some inconsistencies on the computed Vbd as shown below. The increase of 0.5V (or 500 DACt) might be beneficial for the Vbd estimation.



ip10.73.137.105 apa_1_afe_0_ch_7



ip10.73.137.107 apa_1_afe_1_ch_10

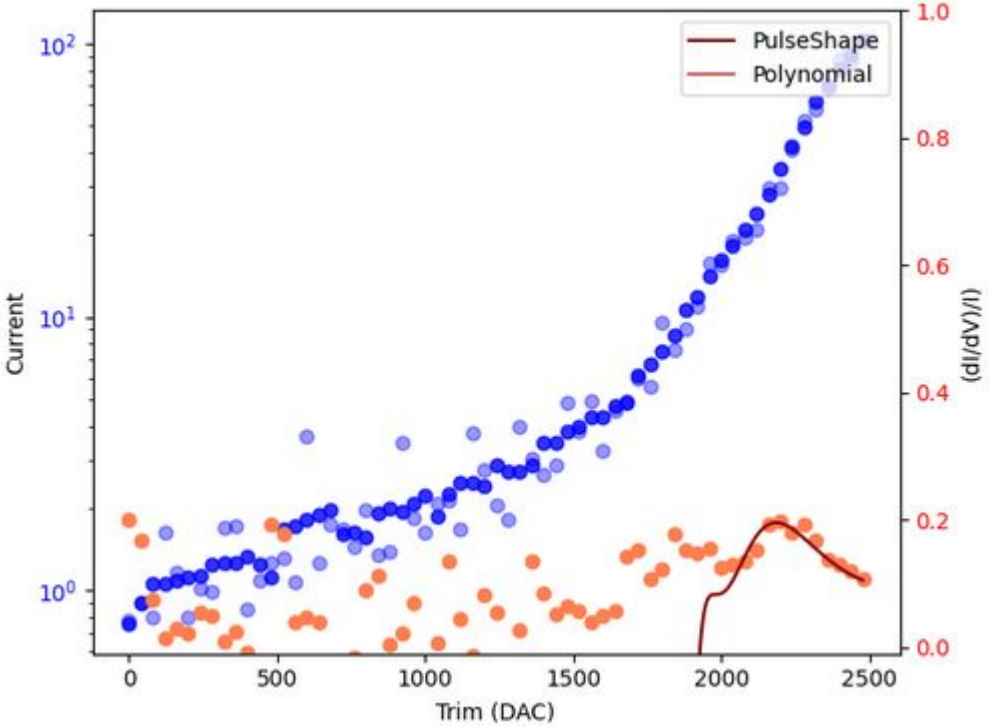


ip10.73.137.105 apa_1_afe_2_ch_20.root

Comparison between the fit methods

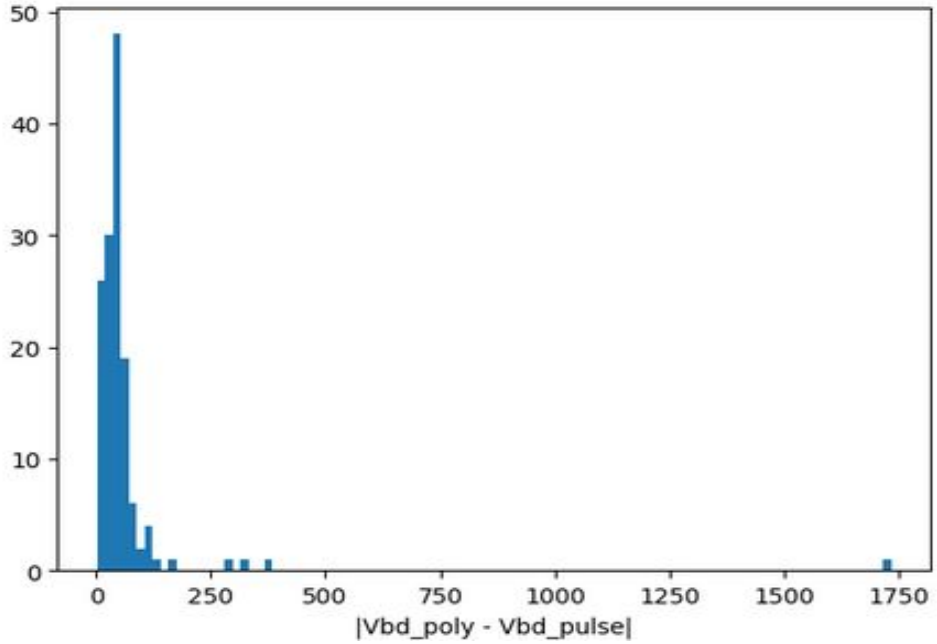
In general, both methods were able to perform the fitting on the good data group, but on the following files, just the pulse shape function was able to commute the Vbd:

- 10.73.137.109 apa_2_afe_2_ch_23, Vbd = 2186 DAC
- 10.73.137.111 apa_3_afe_4_ch_32 Vbd = 2201 DAC
- 10.73.137.111 apa_3_afe_4_ch_37 Vbd = 2392 DAC
- 10.73.137.112 apa_4_afe_3_ch_30 Vbd = 2377 DAC
- 10.73.137.112 apa_4_afe_4_ch_32 Vbd = 2390 DAC
- 10.73.137.112 apa_4_afe_4_ch_37 Vbd = 2366 DAC



Comparison between the fit methods

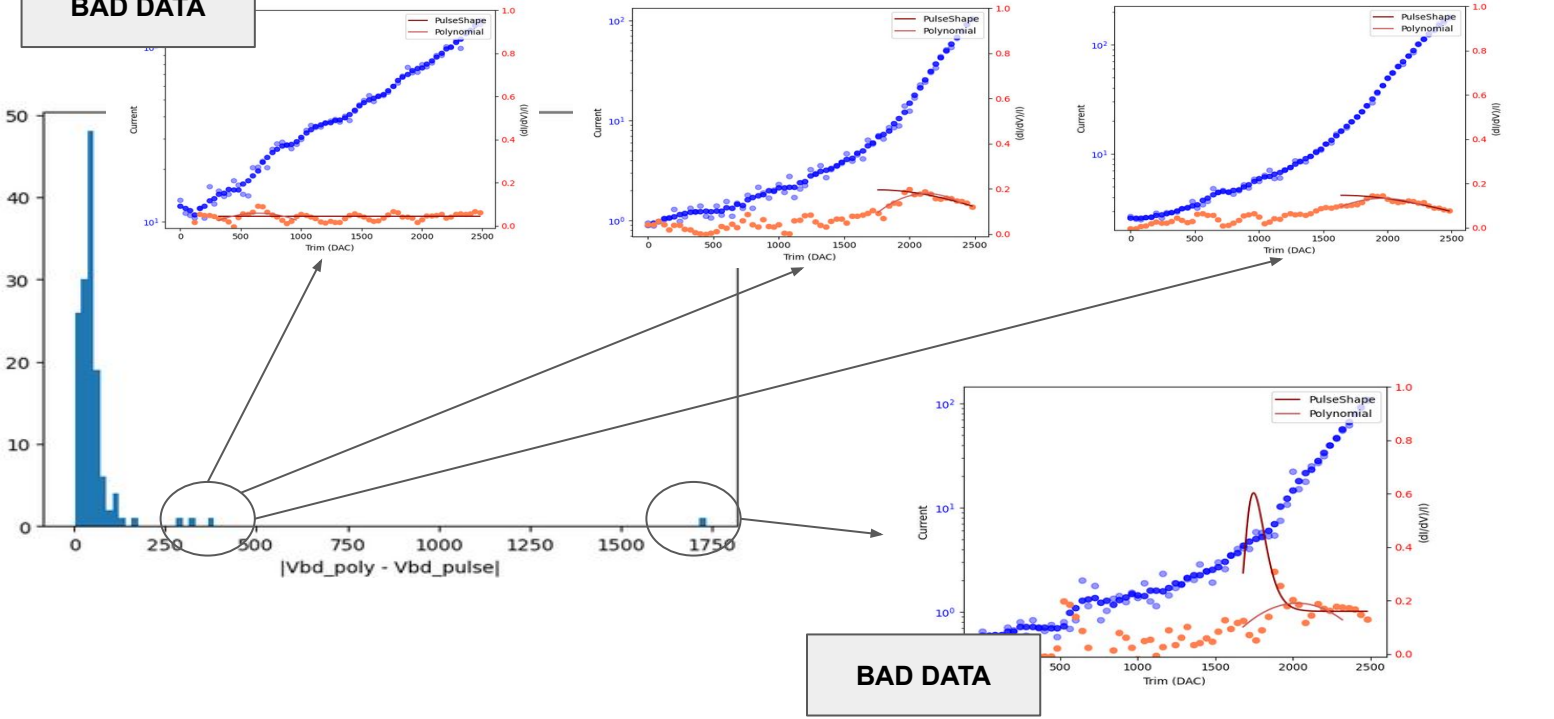
In order to compare both fitting methods, it was plotted the histogram of the absolute difference between the estimated Vbd using both methods and computed the mean value and the standard deviation of the difference. However, some outliers were detected.



Comparison between the fit methods

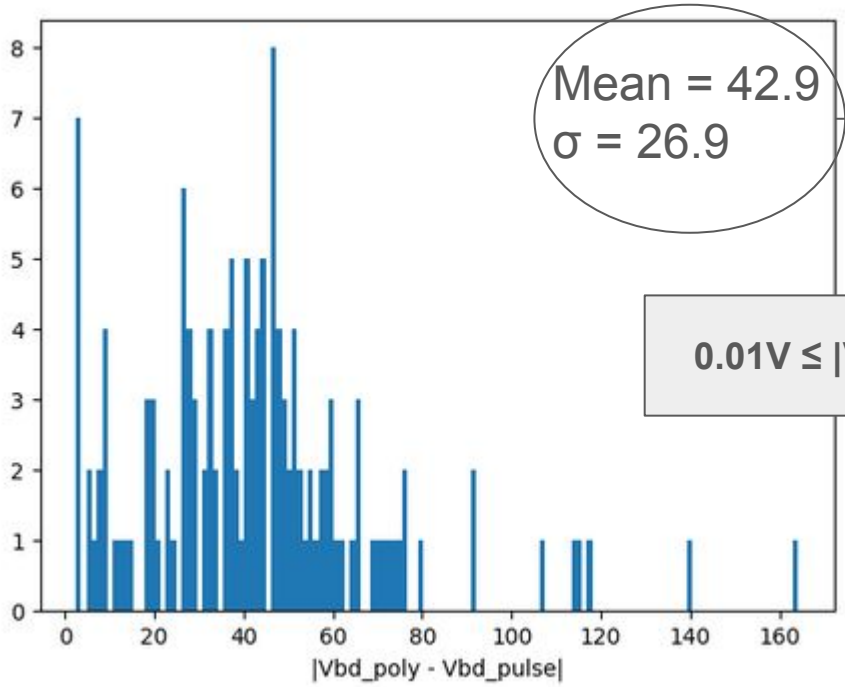
For those cases, the problem was the pulse shape function that didn't performed well.

BAD DATA



Comparison between the fit methods

After removing the outliers:



Merging proposal

Since both fitting methods are based on the shape of I’/I and doesn't have a physical meaning, it is hard to conclude which one is the best for the breakdown voltage. Suppose that method A was chosen as the default, but in fact, method B is the closest to the real Vbd. In the worst case, the selected Vbd is 0.07 V away from what it should be. To avoid this, the selected Vdb must be the average of methods A and B, therefore the greatest distance from the real value will be around 0.03 V.

Merging proposal

Therefore, the proposal script will perform the following tasks:

- Data quality verification;
- If one fit method fails, return just the value of the other one with a warning message;
- Discard the data If the difference is greater than 250 DAC
- Return the average Vbd of both fit methods per channel.