Probleme bei der Parameterextraktion an Raumladungskapazitäten?

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Bipolar-Arbeitskreis 2002

Junction capacitance formula

$$Cj(V) = \frac{Cj(0)}{\left(1 - \frac{V}{VJ}\right)^{MJ}}$$

$$\underbrace{\lg Cj(V)}_{\textbf{Y}} = \lg Cj(0) - MJ \bullet \underbrace{\lg\left(1 - \frac{V}{VJ}\right)}_{\textbf{X}}$$

→ **to check for correct junction capacitance behaviour**
(slope MJ (=derivative) should be constant)

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Junction capacitance formula

$$Cj(V) = \frac{Cj(0)}{\left(1 - \frac{V}{VJ}\right)^{MJ}} + Cox$$

$$\underbrace{Cj(V)}_{\mathbf{Y}} = Cj(0) \bullet \underbrace{\left(1 - \frac{V}{VJ}\right)^{-MJ}}_{\mathbf{X}} + Cox$$

optimize VJ + MJ, calculate linear regression → slope = Cj(0), y(0) = Cox

→ **to determine constant capacitance contributions**
(overlap capacitance, pad + interconnect contributions)

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CBE: CJ0 + Cox determination

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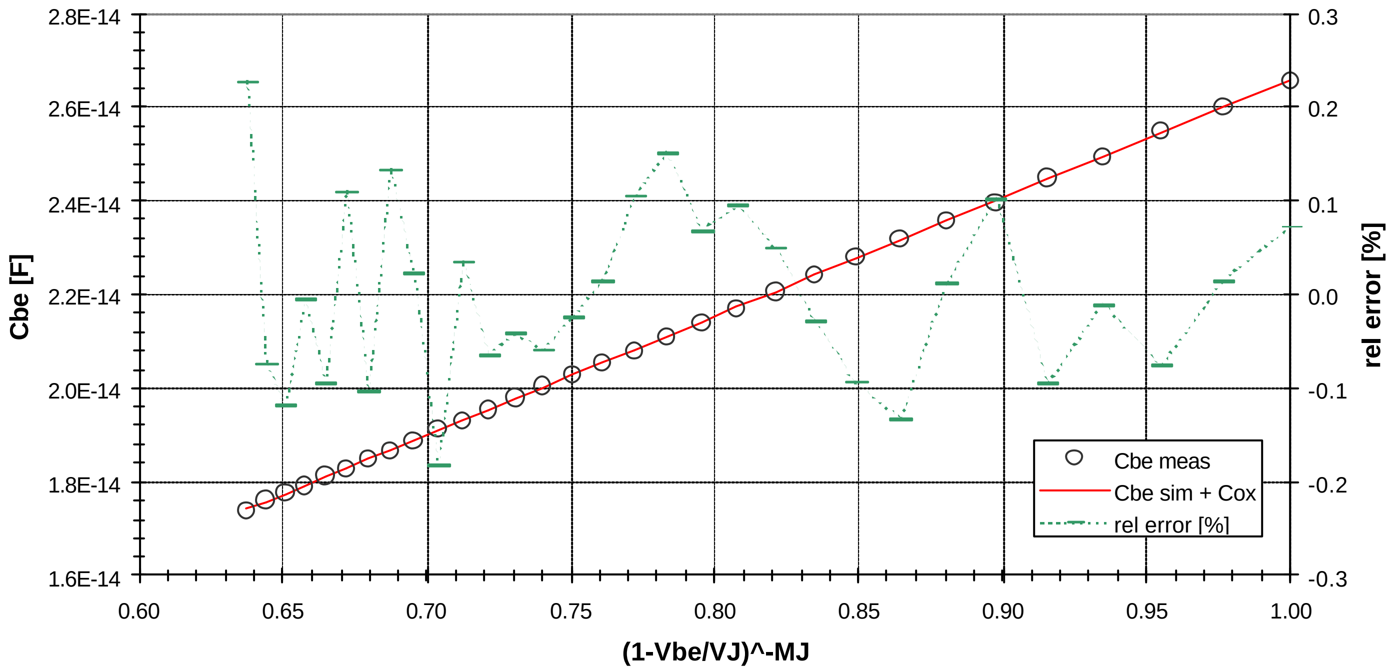
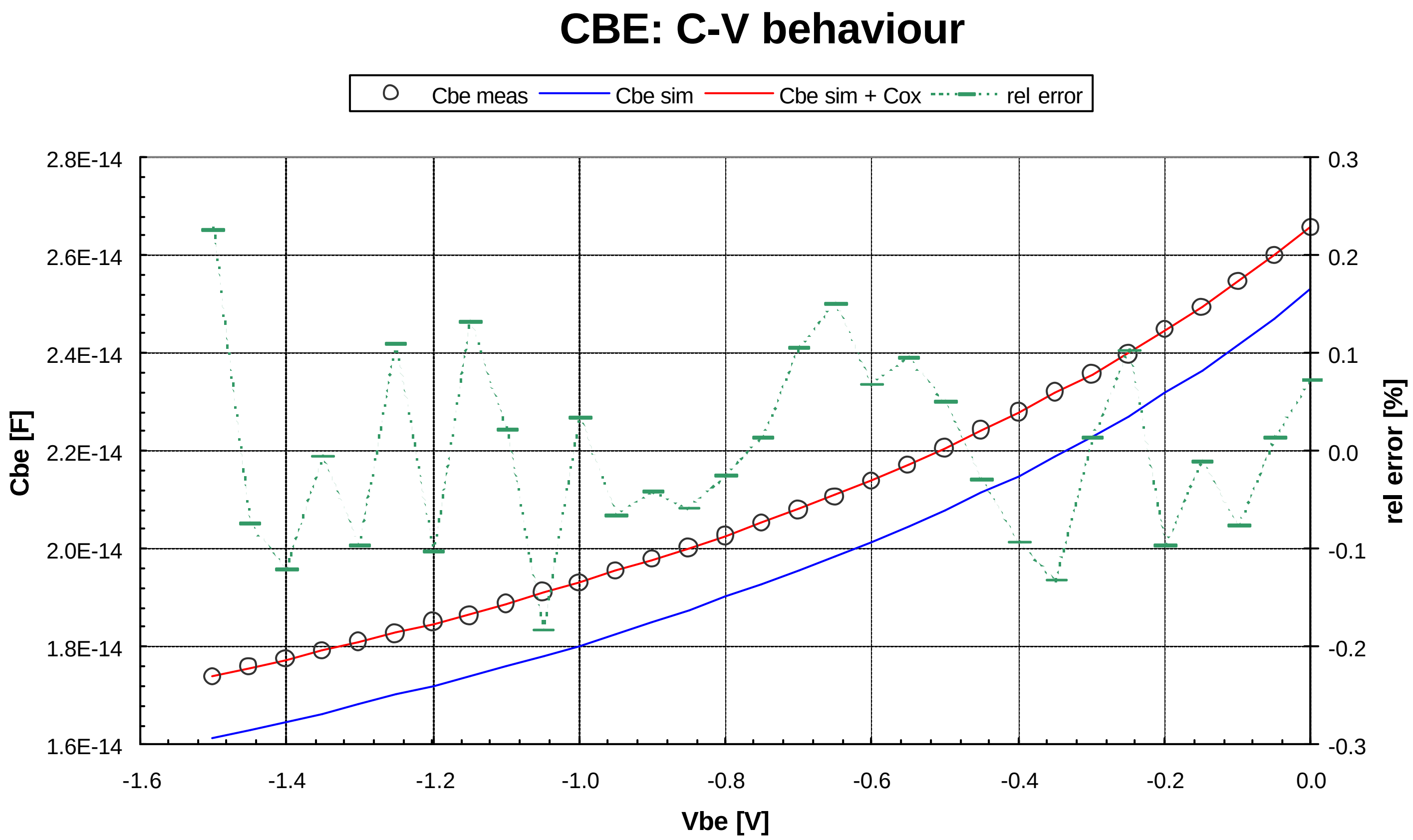


example: BE capacitance, resulting from S-parameter measurements

reasonable results: CJ0 = 25.31 fF VJ = 1.061 V MJ = 0.5113 Cox = 1.28 fF
R coefficient = 0.999975

CBE: C-V behaviour



RMS error = 0.0895%

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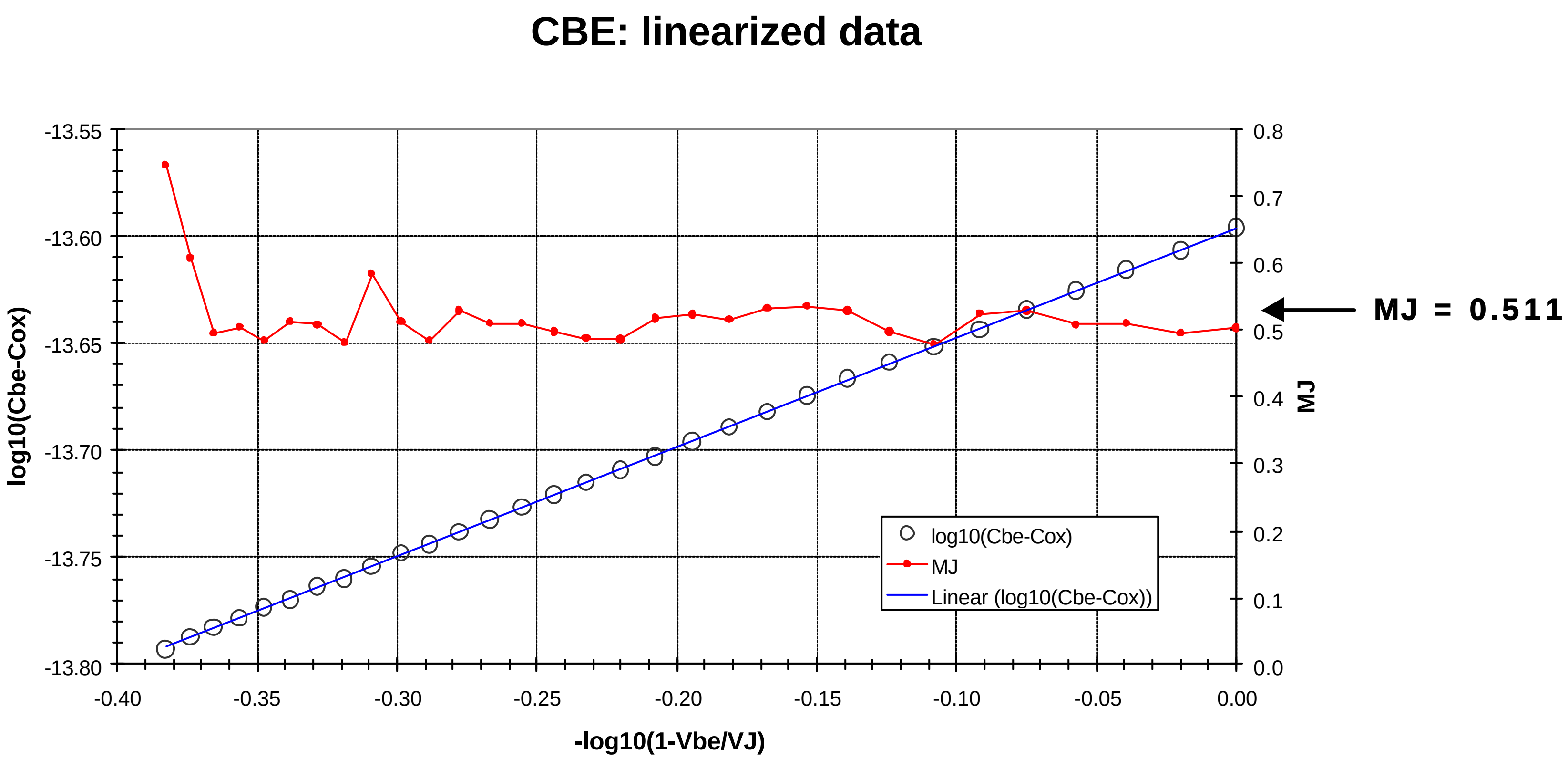
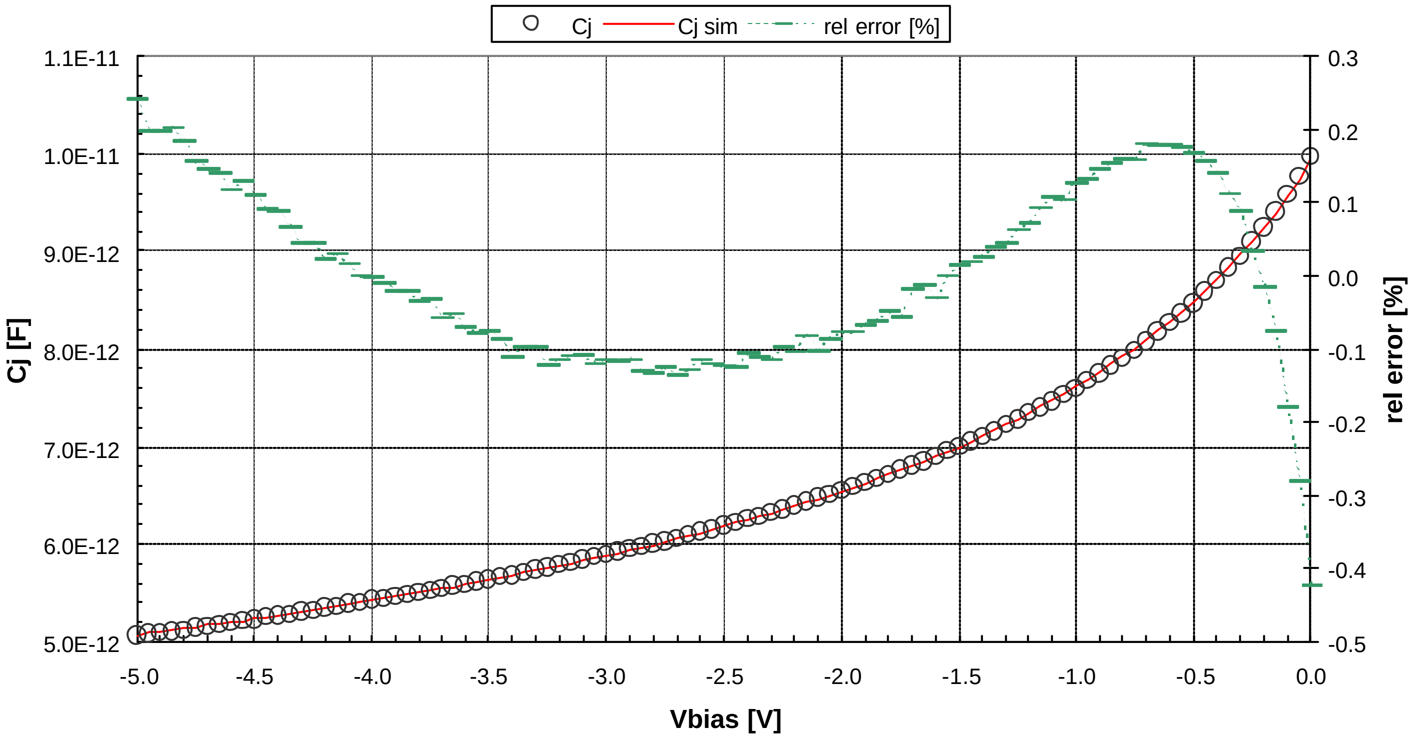
CBE: linearized data



→ **MJ is constant**

C-V curve: standard parameter extraction

Junction capacitance:
C-V behaviour with standard parameter extraction



example: special test structure (100x100 µm²) measured with LCR meter

Results: CJ0 = 9.926 pF VJ = 0.9166 V MJ = 0.3599
RMS error = 0.1328 %

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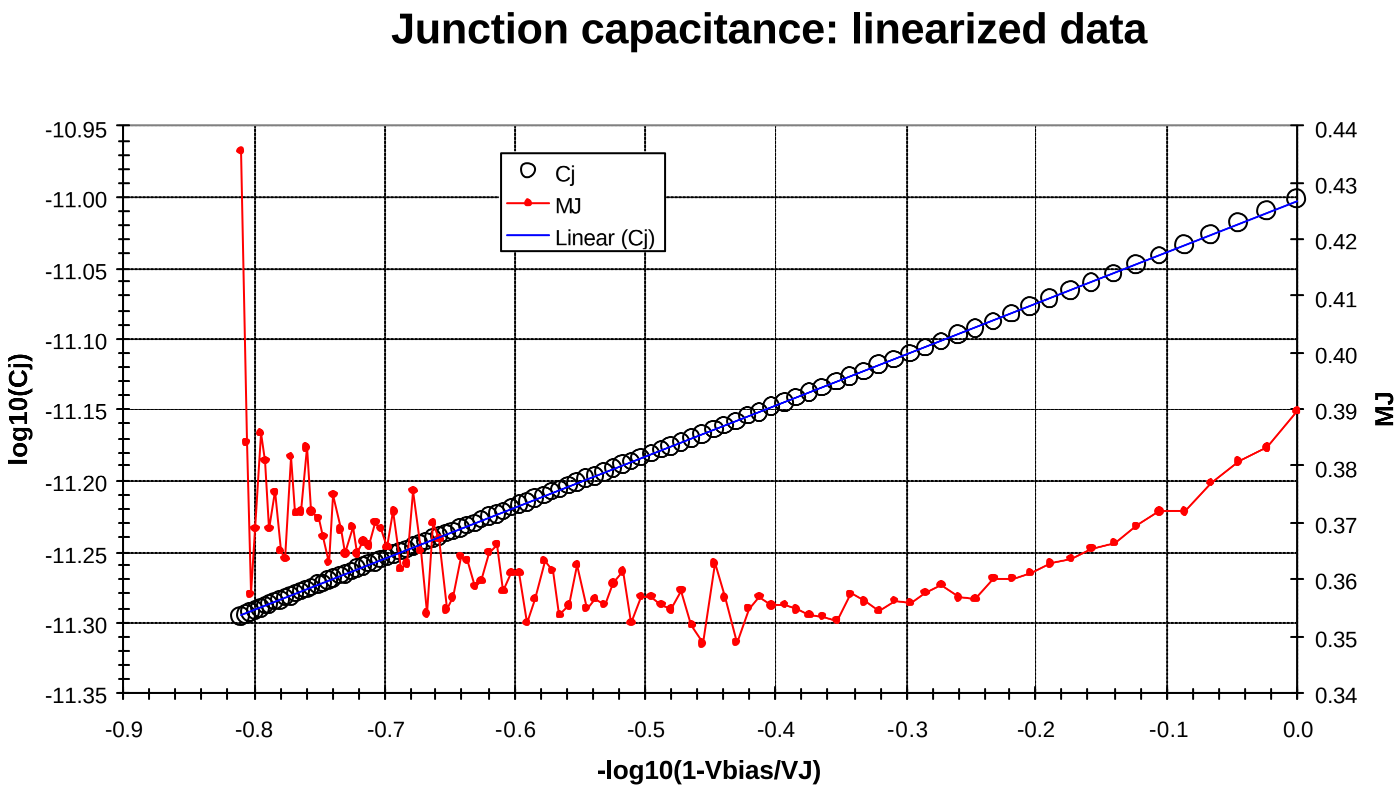
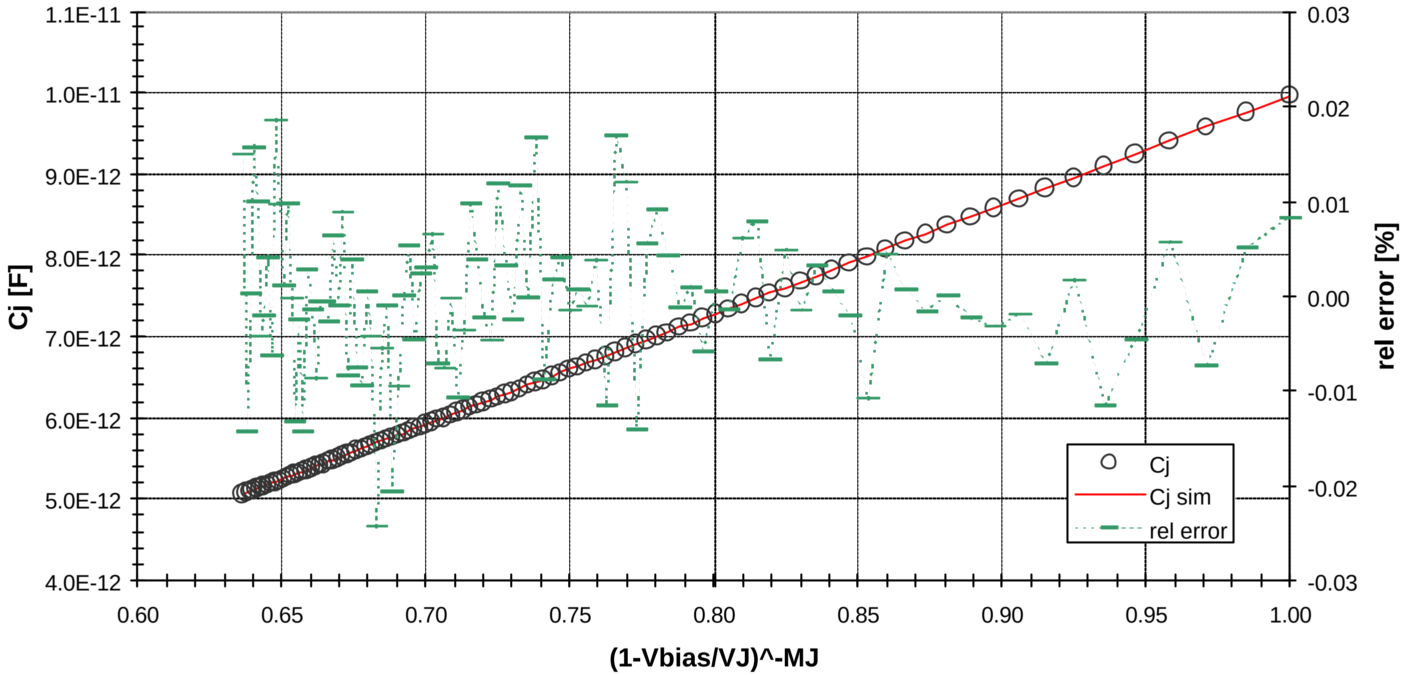
Junction capacitance: linearized data



→ **MJ is not constant!**

Junction capacitance: CJ0 + Cox determination



questionable results: CJ0 = 13.497 pF VJ = 0.6765 V MJ = 0.2124 Cox = -3.528 pF
R coefficient = 1

although fit is excellent (R=1!) the resulting Cox is negative!

→ what is the reason??

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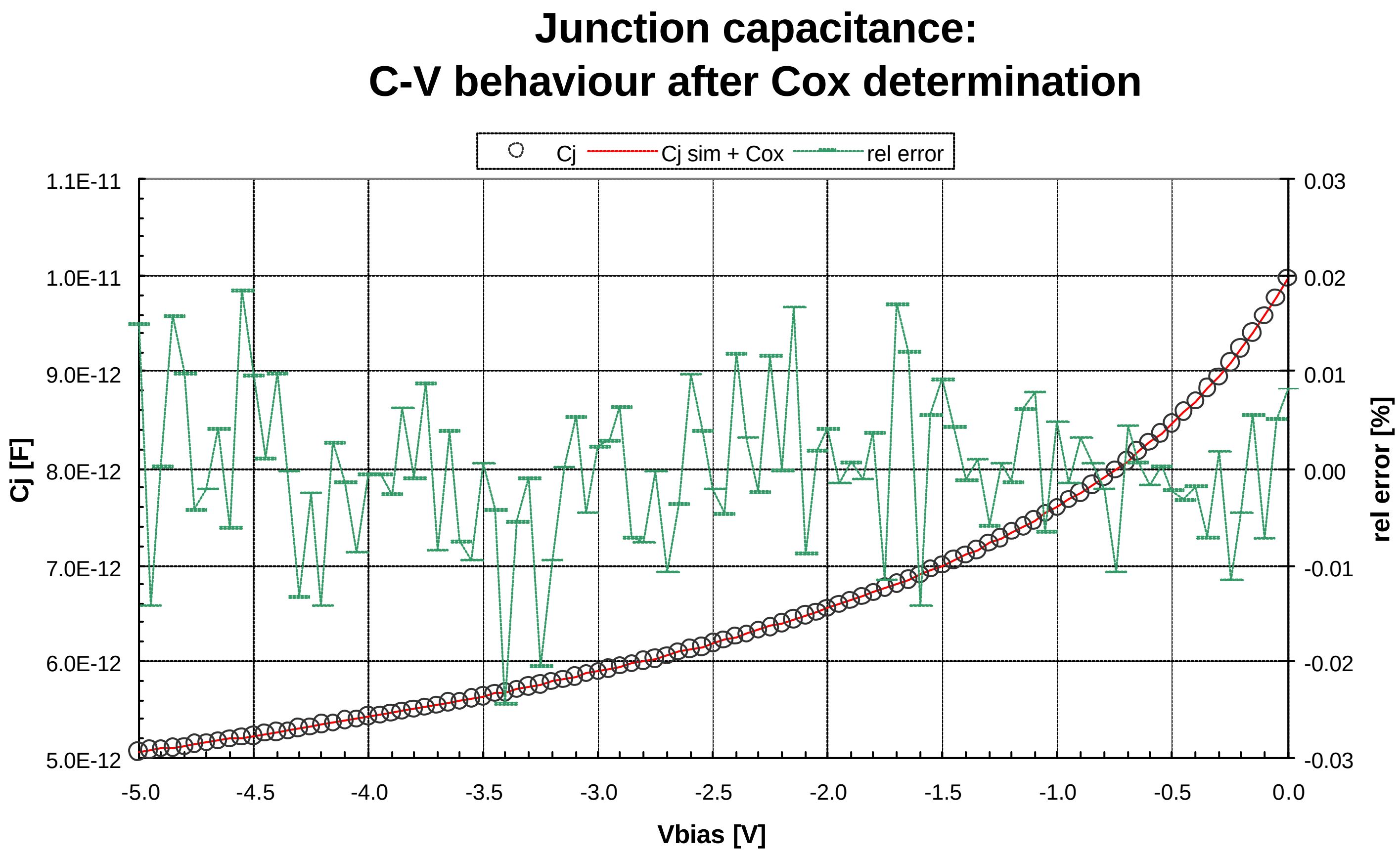
Cj: C-V behaviour including Cox contribution



RMS error = 0.00737 %

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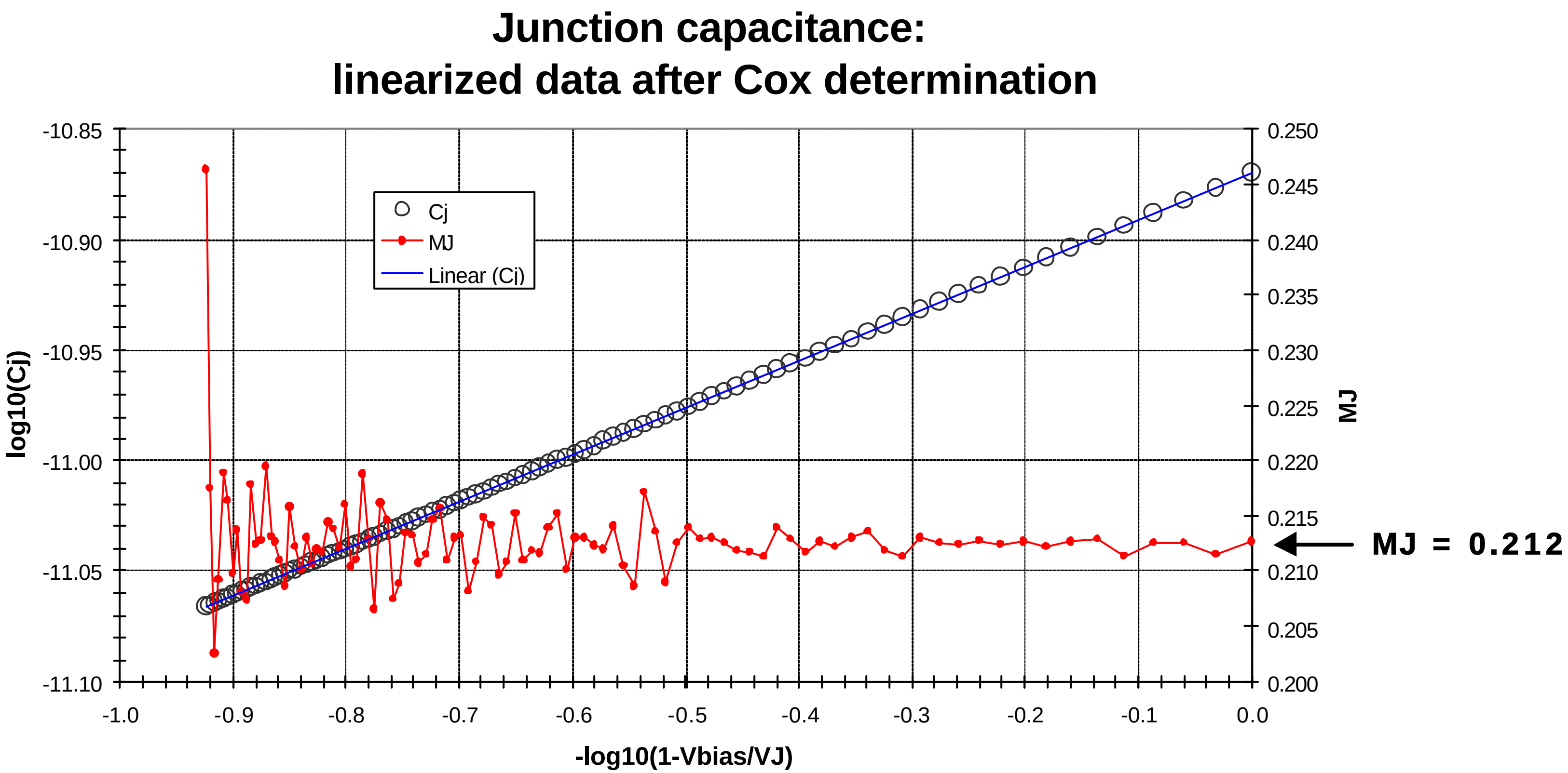
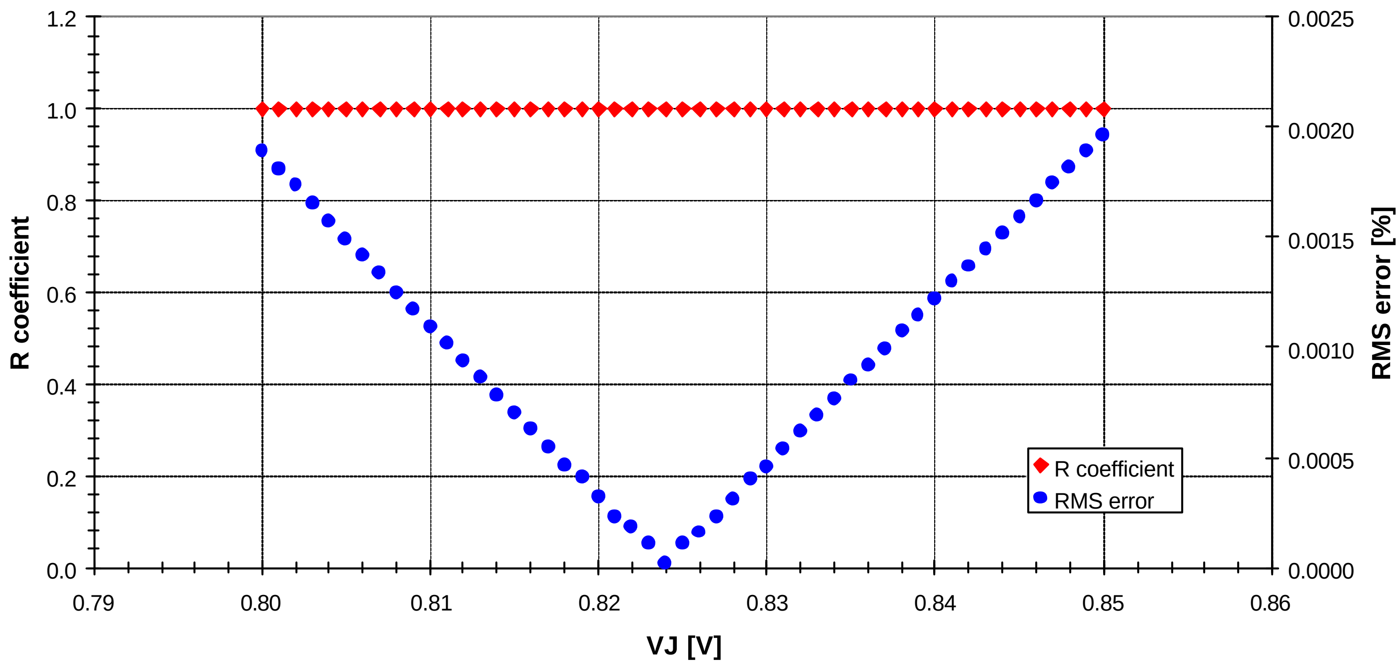
Cj: linearized data including Cox



MJ is constant!

Junction parameter extraction based on simulated data

Cj parameter extraction with simulated data:
sweep VJ + optimize MJ



to check optimizer reliability: sweep VJ + optimize only MJ

→ **find VJ with smallest error**

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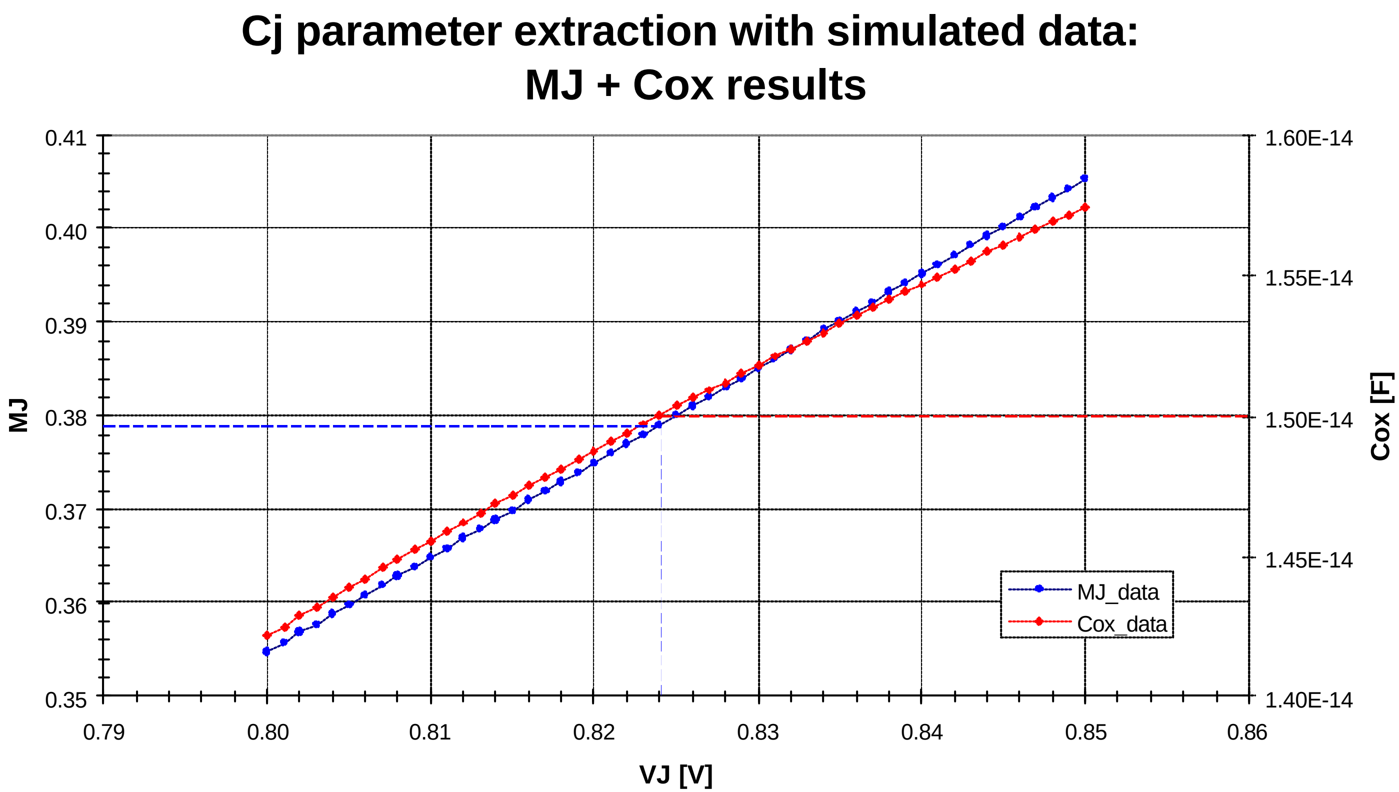
Junction parameter extraction based on simulated data



input data: CJ0 = 19.44 fF VJ = 0.824 V MJ = 0.379 Cox = 15 fF

→ **these data can be extracted exactly!**

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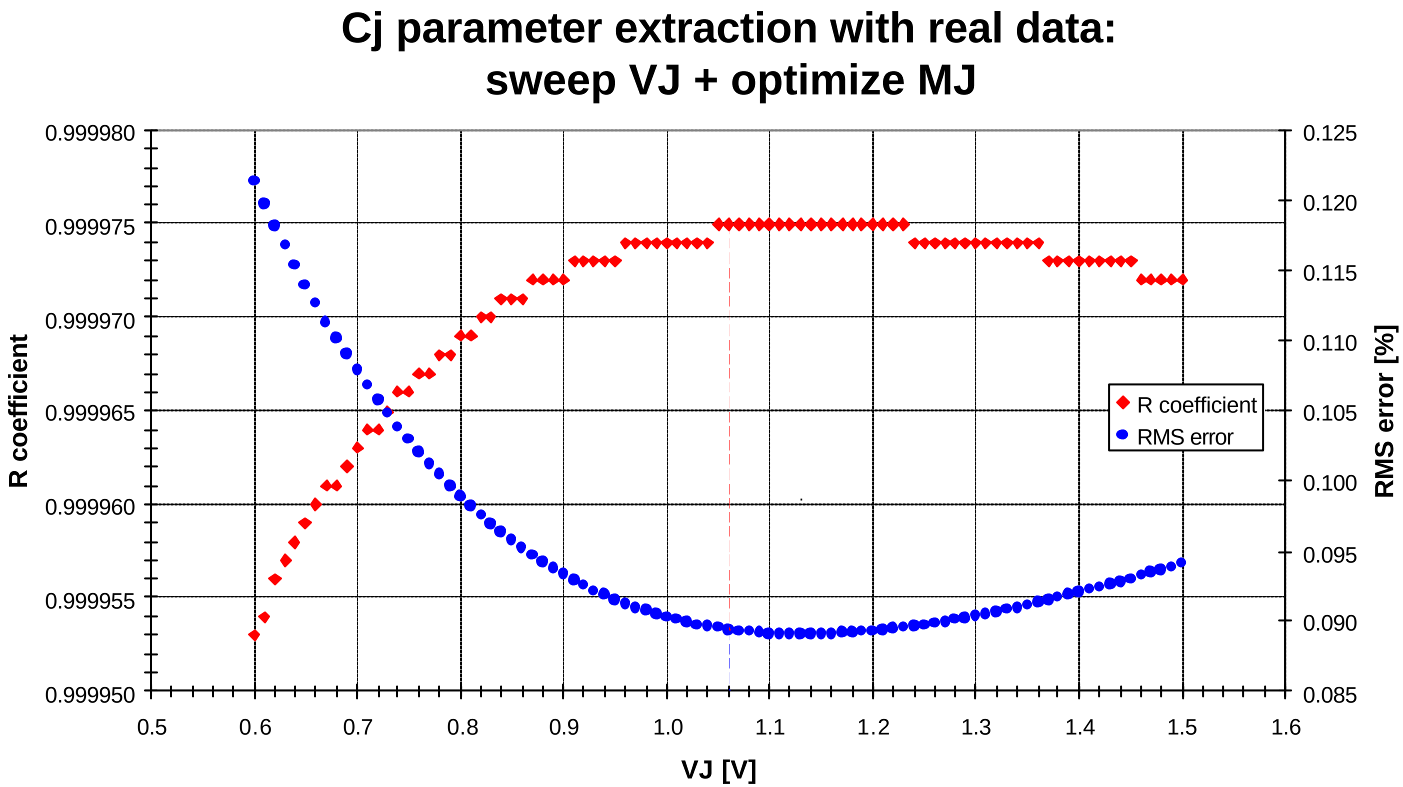
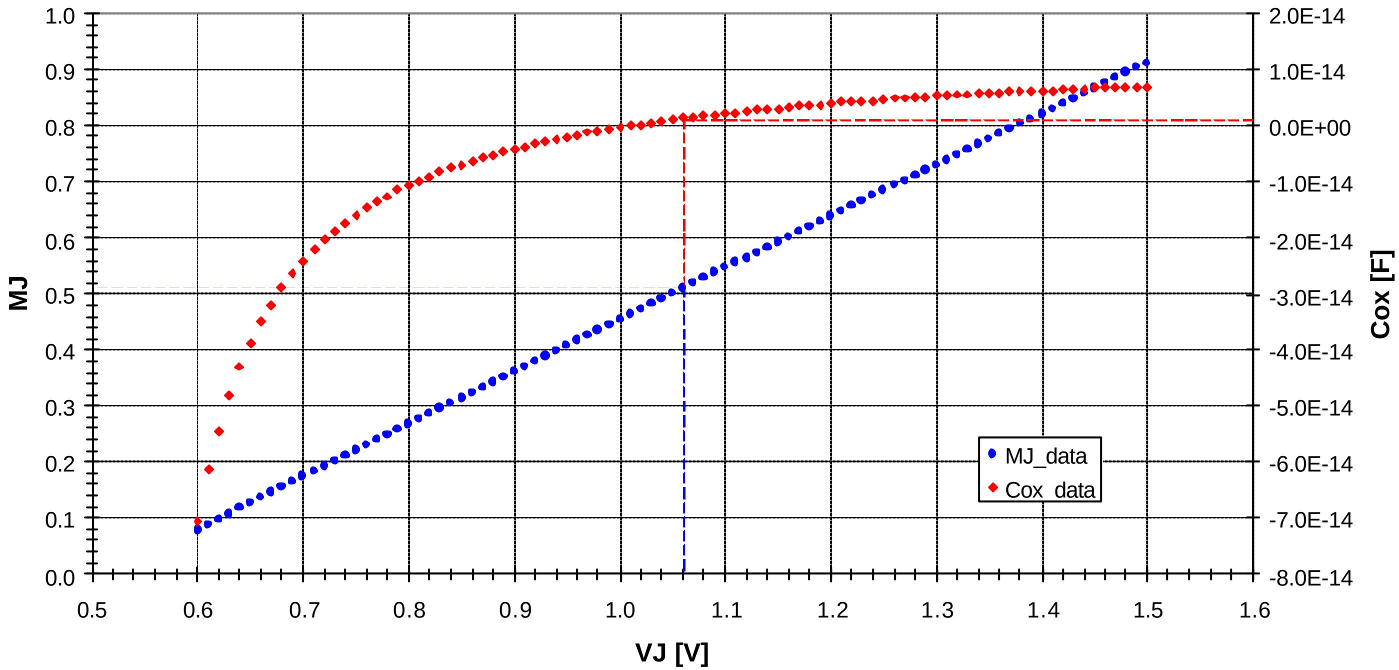
Junction parameter extraction based on real data



example is already mentioned BE capacitance

Junction parameter extraction based on real data

Cj parameter extraction with real data:
MJ + Cox results



dashed lines show the results gained with the original Cox determination method as described before

→ **results from the two methods are not exactly identical**

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