Dose Scenarios for PXD/DEPFET

13th International Workshop on DEPFET Detectors and Apllications

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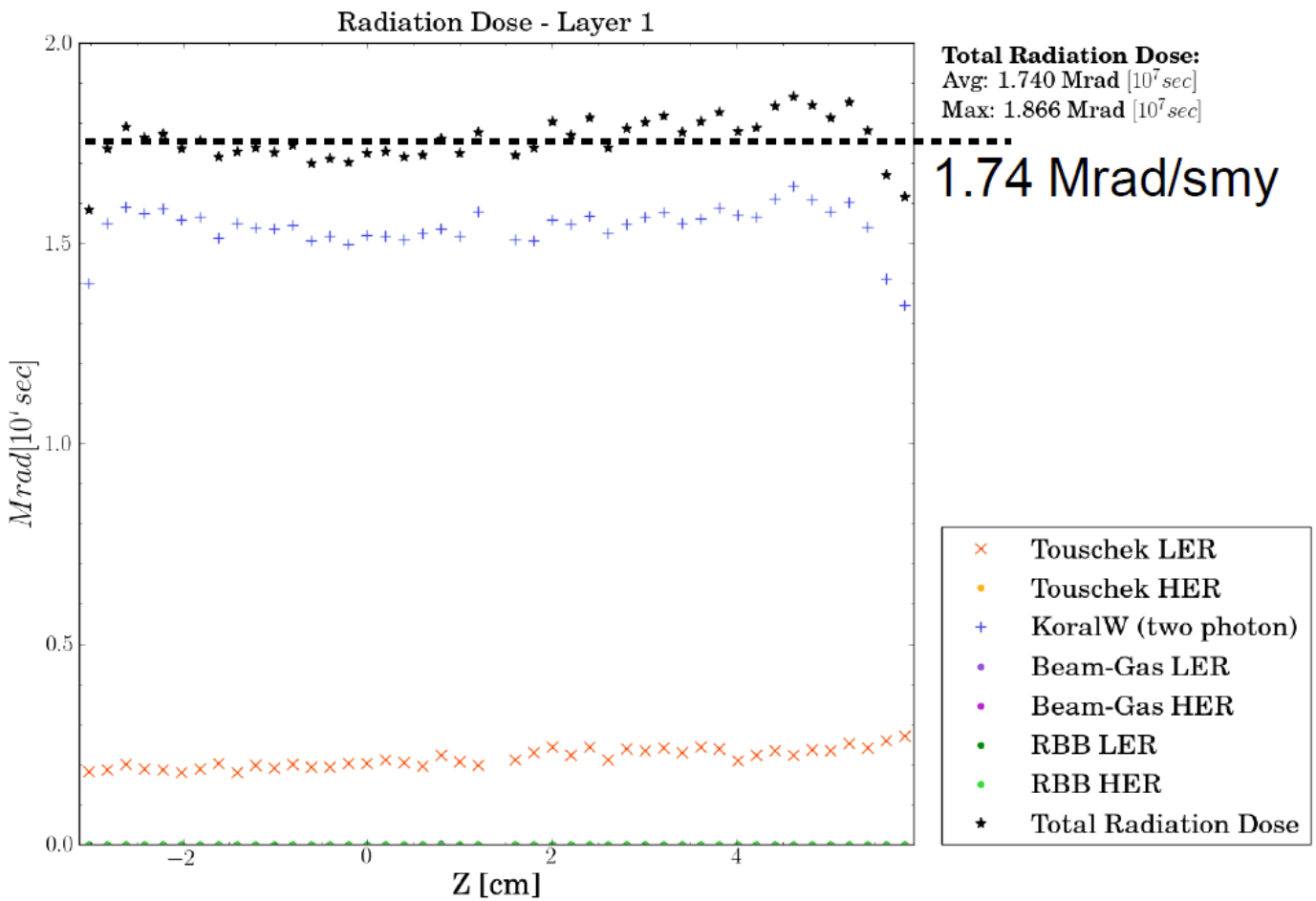
Andreas Ritter

Inhomogeneous Irradiation along z 1/2



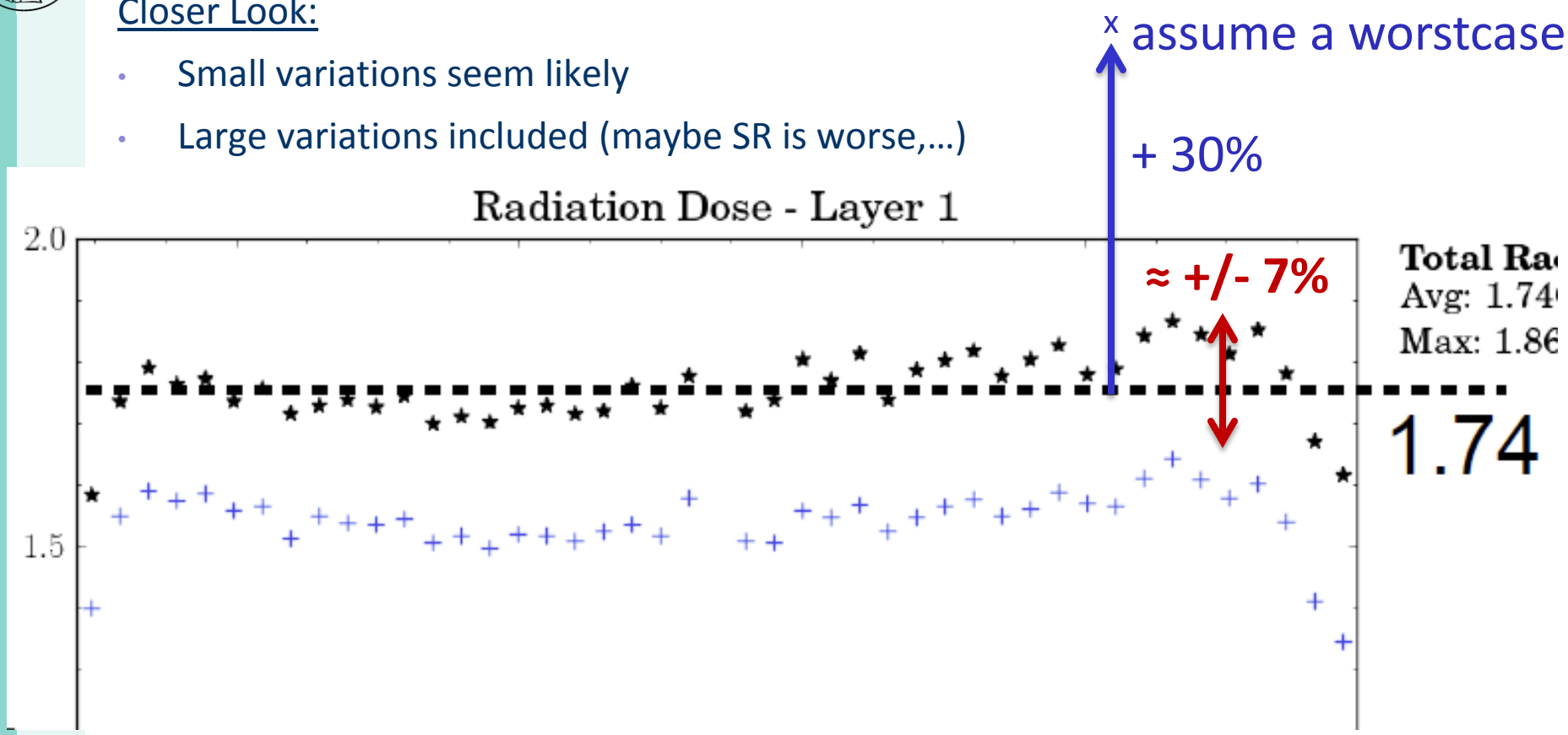
1. Inhomogeneous dose along z is inevitable.
2. Besides the 3-fold segmentation, all DEPFETs get the same gate voltage
3. Difference in various Pixels increase with increasing dose (== operation years)
4. → Some scenarios can be thought of.

[Total Radiation Dose (Layer 1, w/o SR) background, taken from A. Moll, Talk at B2GM Bad Aibling 2012, PXD Background]

Inhomogeneous Irradiation along z 2/2

Closer Look:

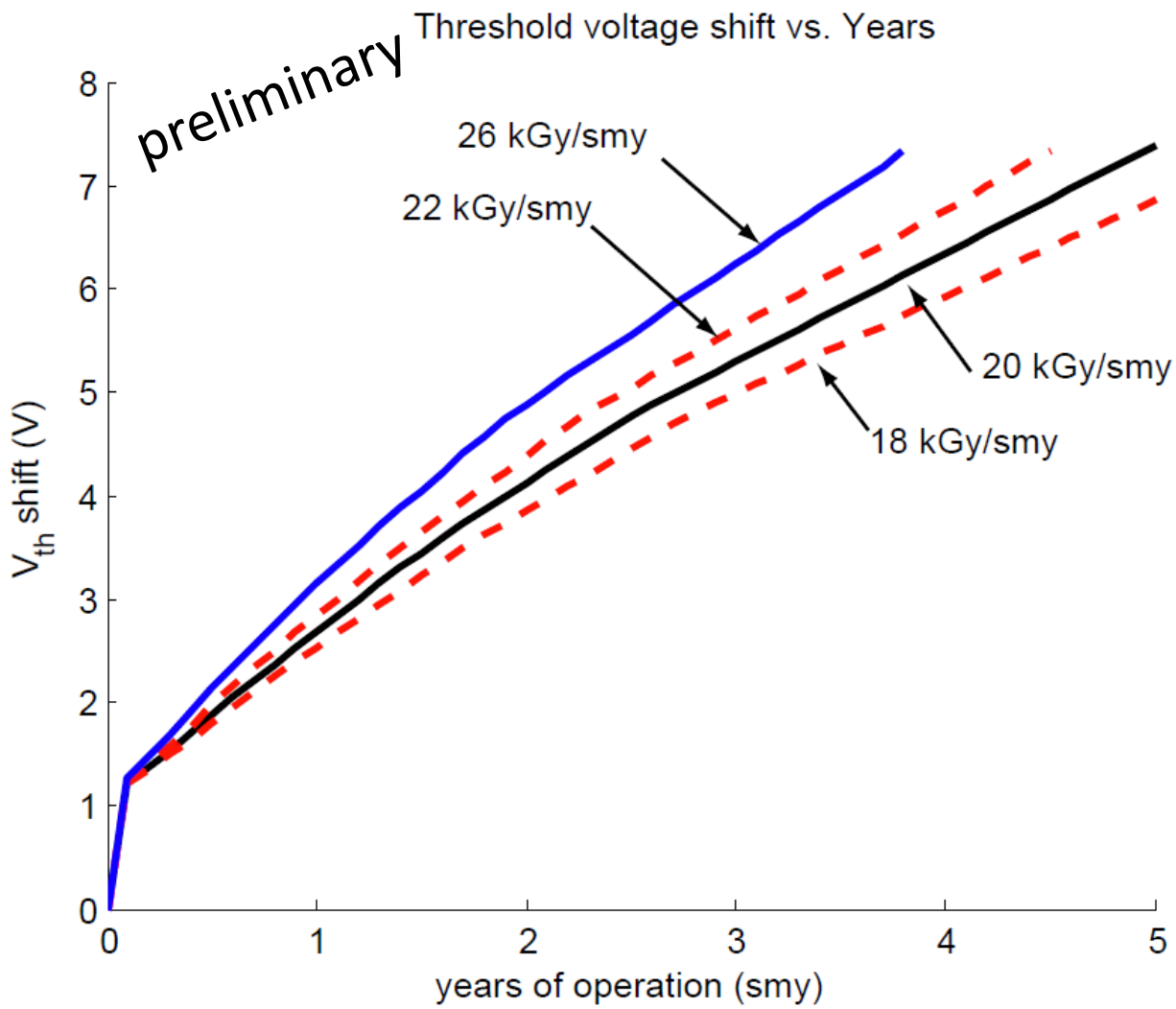
- Small variations seem likely
- Large variations included (maybe SR is worse,…)



Assume for Scenarios:

- Average 20 kGy/smy
- Variations of 2 kGy/smy (+/- 10 %)
- Highly irradiated DEPFET with 26 kGy/smy

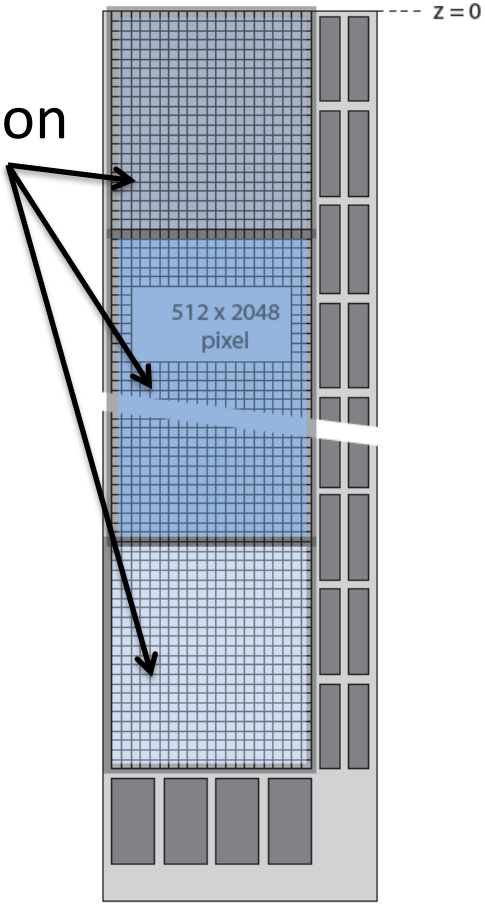
Diff. Dose leads to diff. V_{th}



1. Baseline current is referred to the pixel with the highest dose
2. Other DEPFETs have then a too high voltage at the gate, which leads too a higher drain current.
3. + g_m degradation

3-fold segmentation of half-ladder - Remedy

3-fold Segmentation *(sketch)*



1. „Global“ Shifts in V_{Gate} and $V_{ClearGate}$ can be adapted by adjusting voltages according to the shift.
2. Inhomogeneous Shifts V_{Gate} and $V_{ClearGate}$ can be partially compensated due to 3-fold segmentation of halfladder.
3. However, which current differences arises when inhomogeneity is within one patch?

   → **This Talk gives an overwiev of a work in progress (there is room for improvement…)**

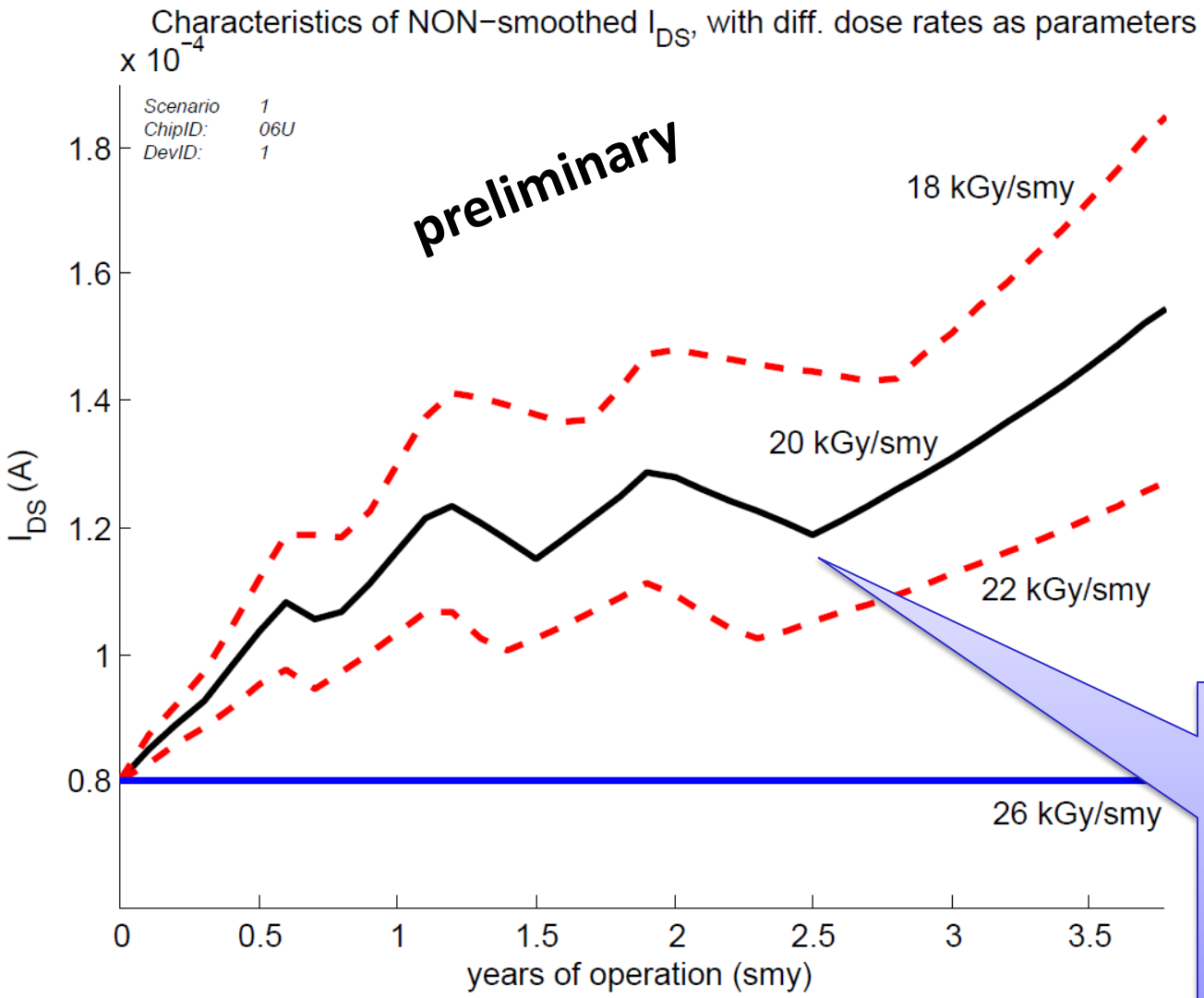
Scenarios

Scenario	Avg. Dose rate	Dose rate variation	I_{DS} baseline current
Scen. 1, Max	20 kGy/smy	6 kGy/smy	80 µA
Scen. 2, Medium	20 kGy/smy	+/- 2 kGy/smy	80 µA
Scen. 3, Max + low I_{DS}	20 kGy/smy	6 kGy/smy	50 µA
Scen. 4, Medium+low I_{DS}	20 kGy/smy	+/- 2 kGy/smy	50 µA

Are these scenarios realistic?

-30 % difference (Max-Scenarios) in irradiation is certainly harsh → Curiosity

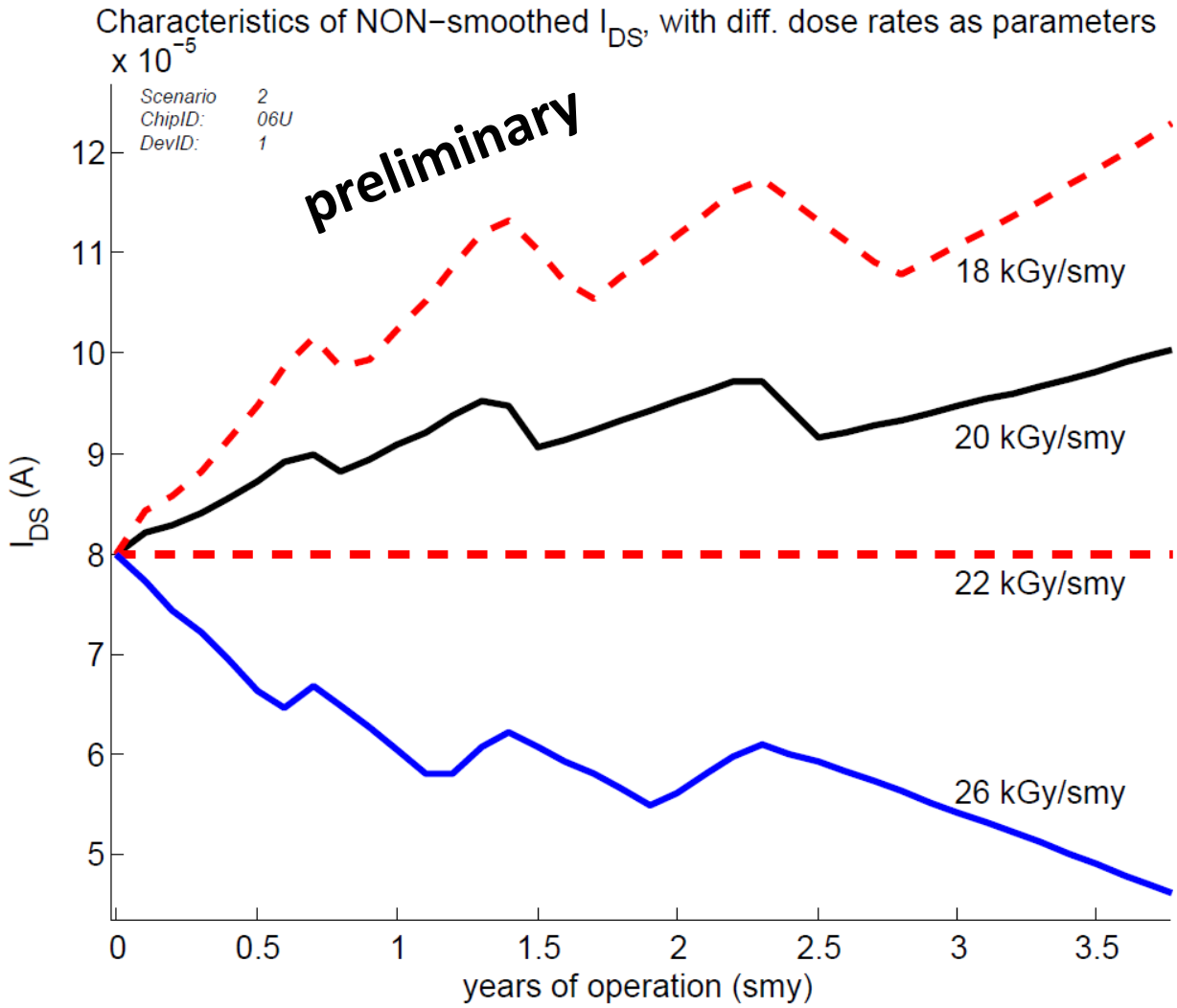
Scenario 1, Max



1. Baseline current is set to 80 µA for the highest irrad. Pixel (26 kGy/smy).
2. Harsh Scenario, leads to big differences in I_{DS}.

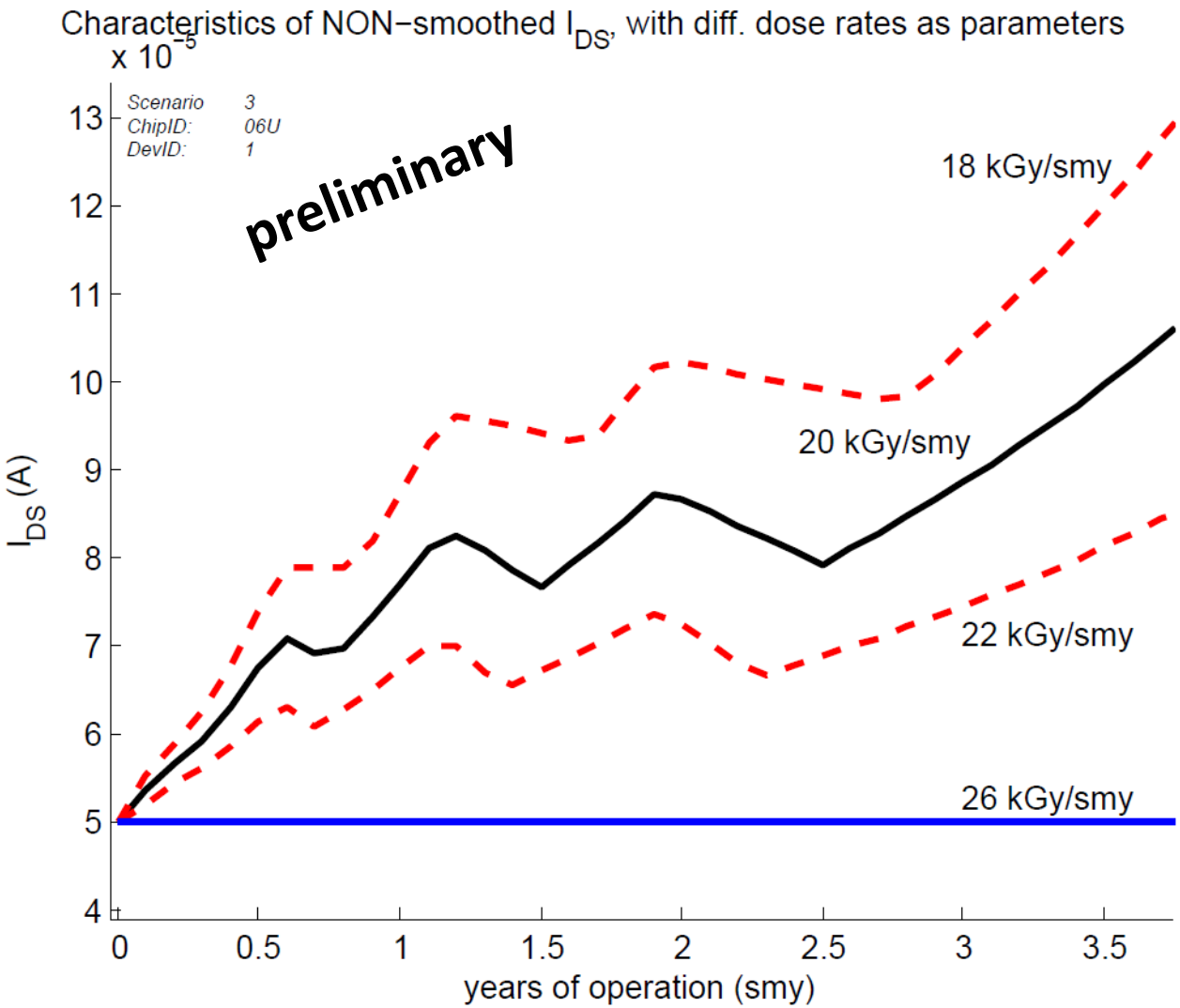
Dips arise from analyse method (generation of $I_{DS}(V_{GS})$ curves)

Scenario 2, Medium



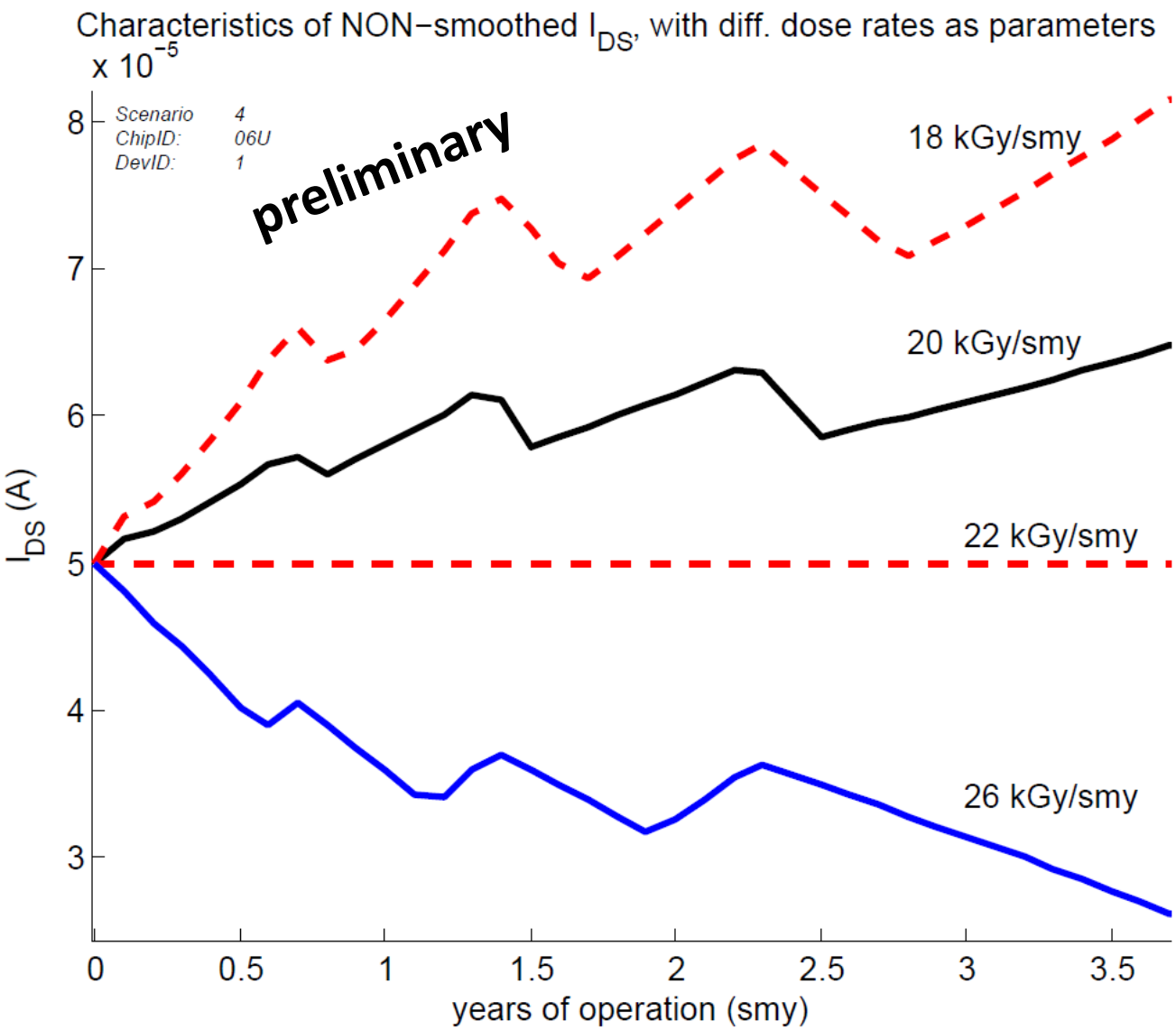
1. Baseline current is set to 80 µA for a medium irrad. Pixel (22 kGy/smy).
2. Differences in I_{DS} is still large, but if highest Irradiation happens only to few pixels it might be OK.

Scenario 3, Max + 50µA



1. Baseline current is set to 50 µA for the highest irrad. Pixel (26 kGy/smy).
2. Also not a good Scenario, leads to differences in I_{DS} (yet better as in Scenario 1).

Scenario 4, Medium+ 50µA



1. Baseline current is set to 50 µA for the medium irrad. Pixel (22 kGy/smy).
2. *Good* Scenario. Difference in I_{DS} is small + when neglecting highly irrad. Pixels

→ even better.

Summary & Outlook for non-smoothed data

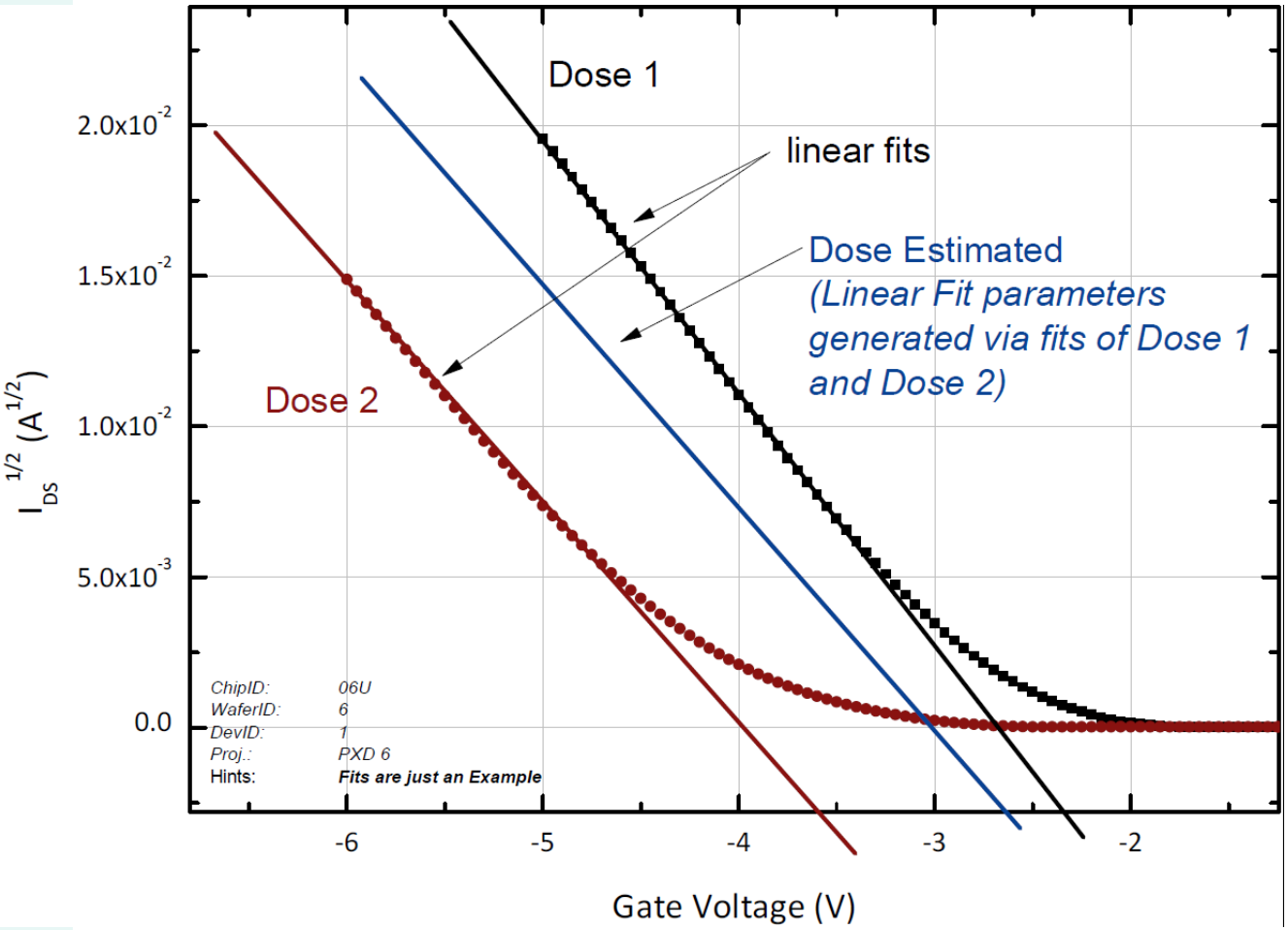
Scenario	I_{DS} diff. at 3.5 years (all)	I_{DS} diff. at 3.5 years (negclecting high irrad.)
Scen. 1, Max	100 µA	-
Scen. 2, Medium	70 µA	40 µA
Scen. 3, Max + low I_{DS}	80 µA	-
Scen. 4, Medium+low I_{DS}	50 µA	30 µA

Summary and Outlook:

- Analysemethod is under discussion/improvement
- If running at lower I_{DS} is possible, it would reduce the amount of I_{DS} difference.
- If negclecting of highly irradiated pixels (or if they don‘t arise at all → *Dose(z) from the beginning predicts ≈7% difference)* could improve the situation. Max scenarios not realistic.
- Does Synchrotron radiation worsen the situation?
- What is possible with the read-out electronic?
- What effect do these scenarios have on the Clear Gates?

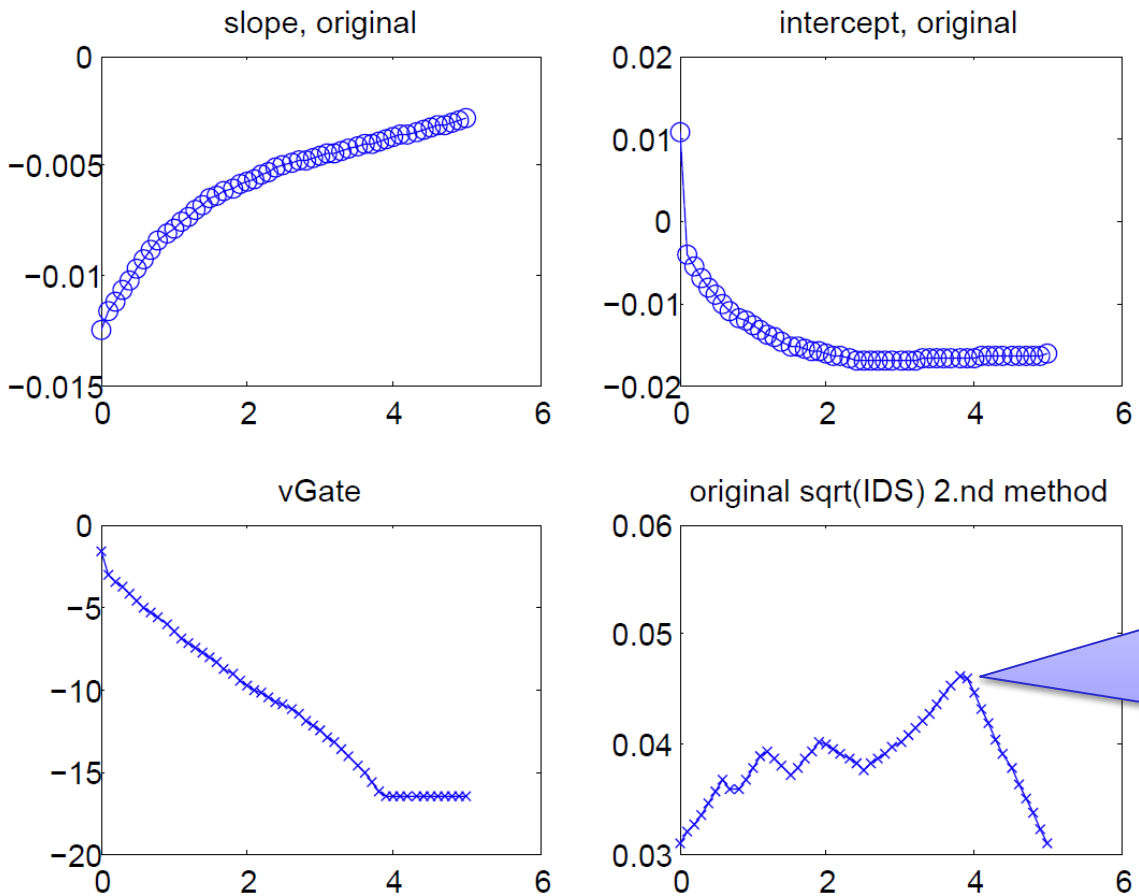
Backup

Analysis Approach 1/4



Generate linear fit params at desired dose (sqrt Parameters)

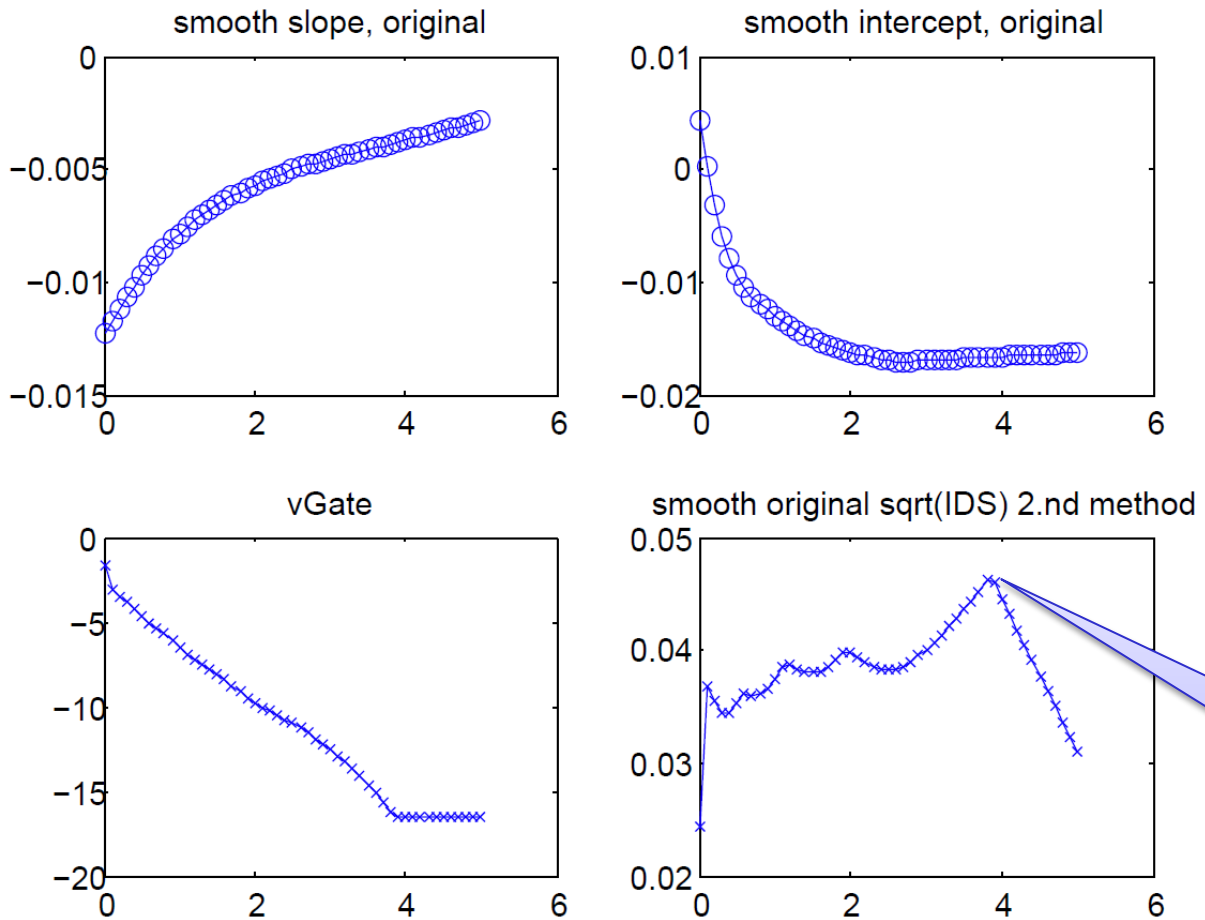
Analysis Approach 2/4



Sqrt linear fit params and vGate (set by highest irradiated DEPFET) set I_DS

vGate = const, slope decrease further…

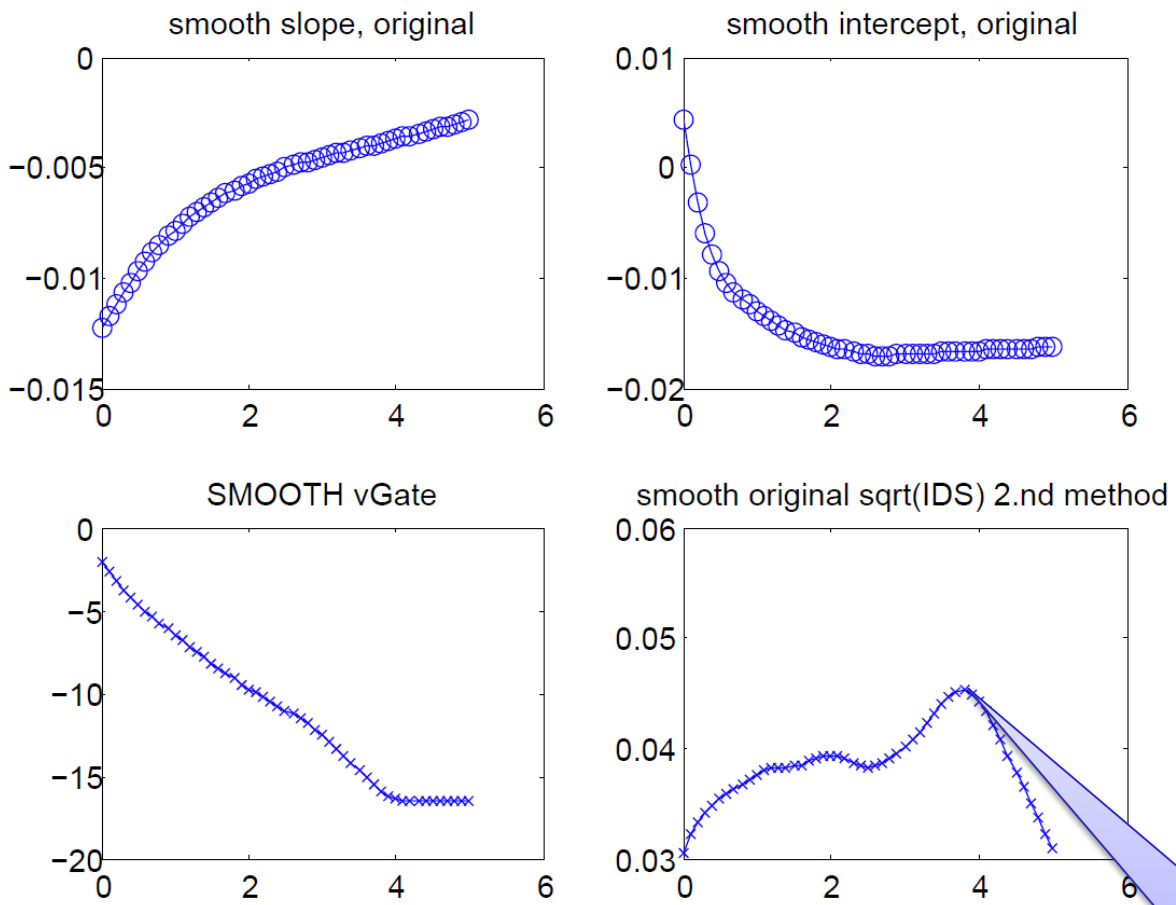
Analysis Approach 3/4



To avoid bumps in slope and intercept a soft smoothing was applied to them. Still bumbps and kinks in sqrt(I_DS) due to bumps in vGate.

vGate = const, slope decrease further…

Analysis Approach 4/4



In addition to smoothing of slope and intercept, also vGate was smoothed. This changed also a bit the baselinecurrent. I_DS was again set to baseline an the other DEPFETs were shifted accordingly

vGate = const, slope decrease further…