



A Graphical Journey into 3D NAND Program Operations

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Outline

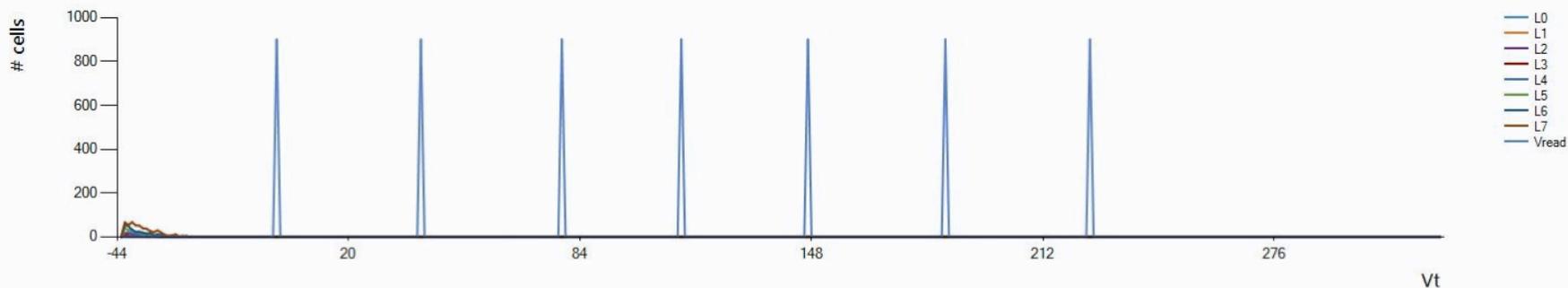
- A graphical journey into four types of program operation
- The reason for 2-Pass program operation: 1-Shot vs 2-Pass
- The shortcoming of 2-Pass program and the solution
- About YeeStor



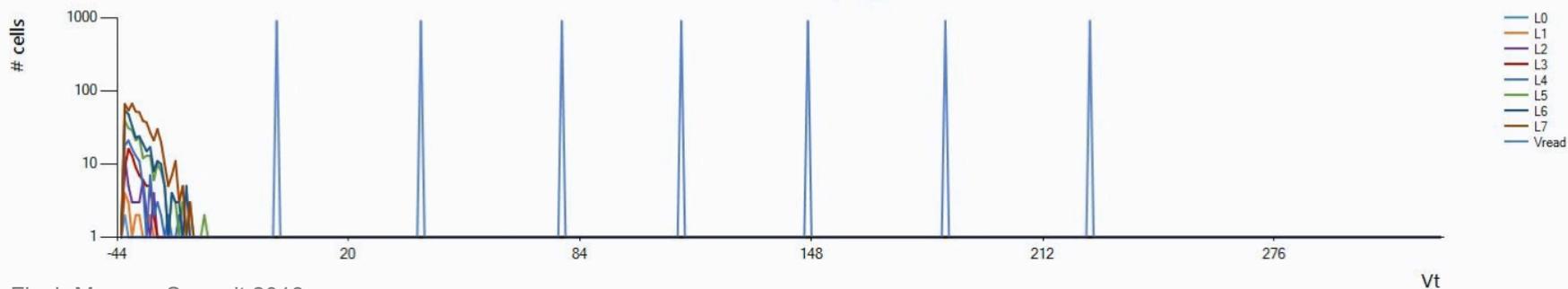
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One Shot TLC Program Operation

Vt Distribution



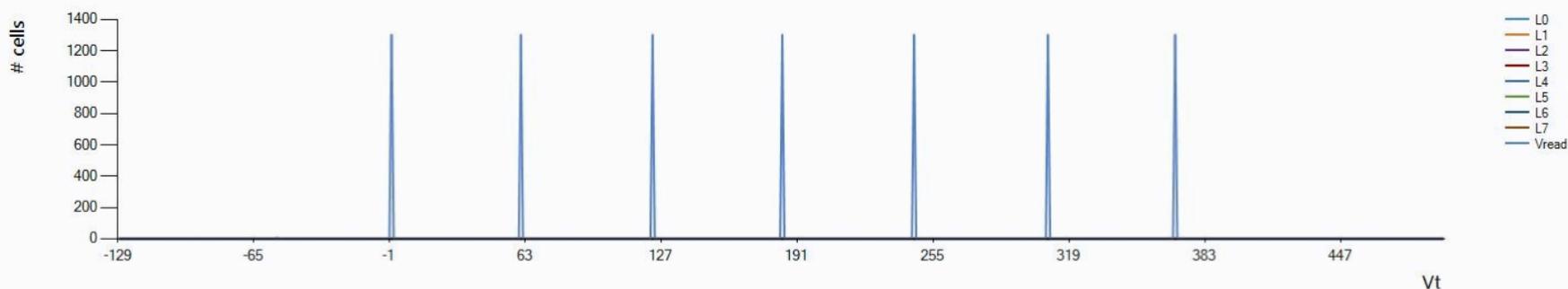
Vt Distribution(Log)



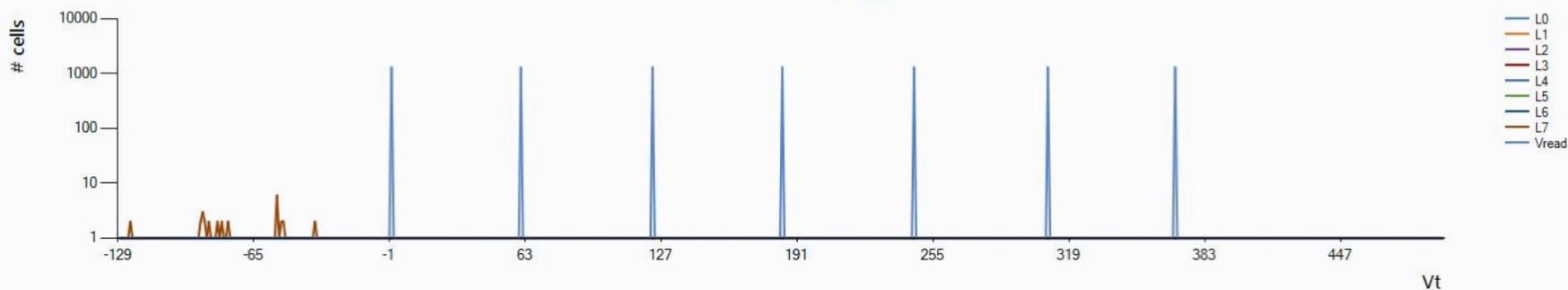


2-Pass TLC Program Operation (4-8)

Vt Distribution



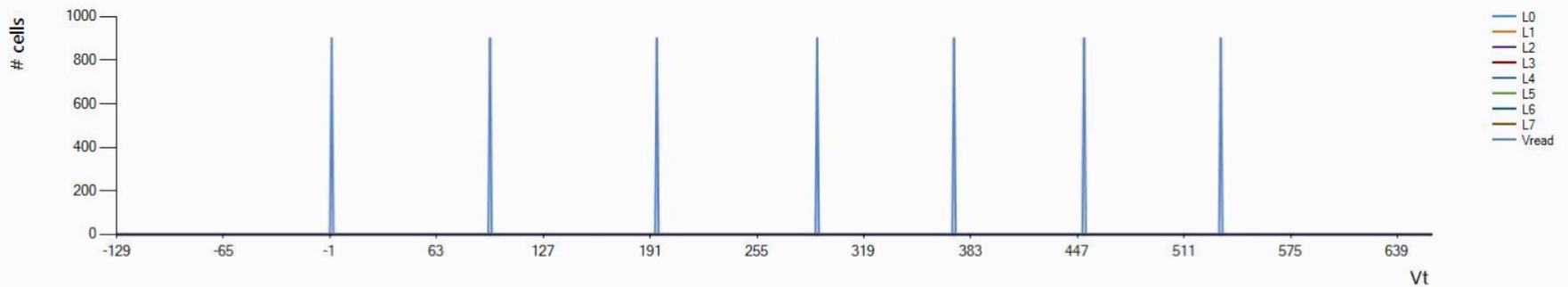
Vt Distribution(Log)



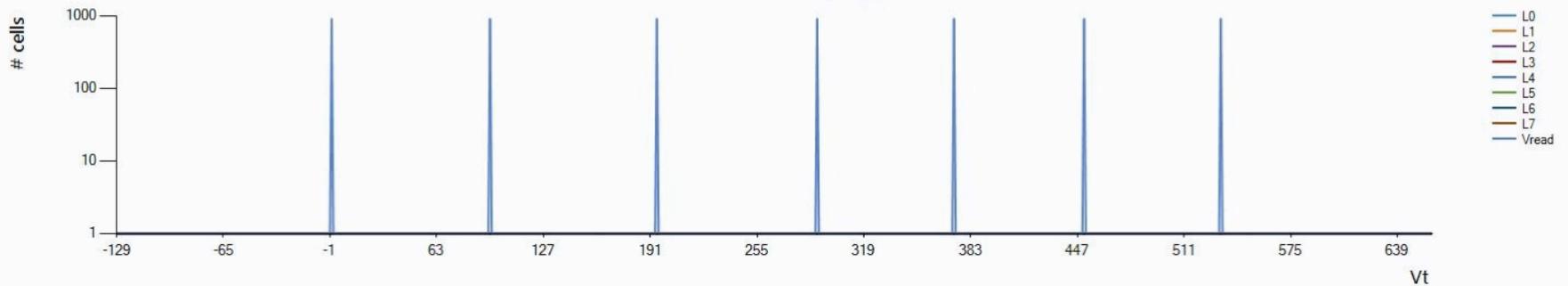


2-Pass TLC Program Operation (2-8)

Vt Distribution



Vt Distribution(Log)

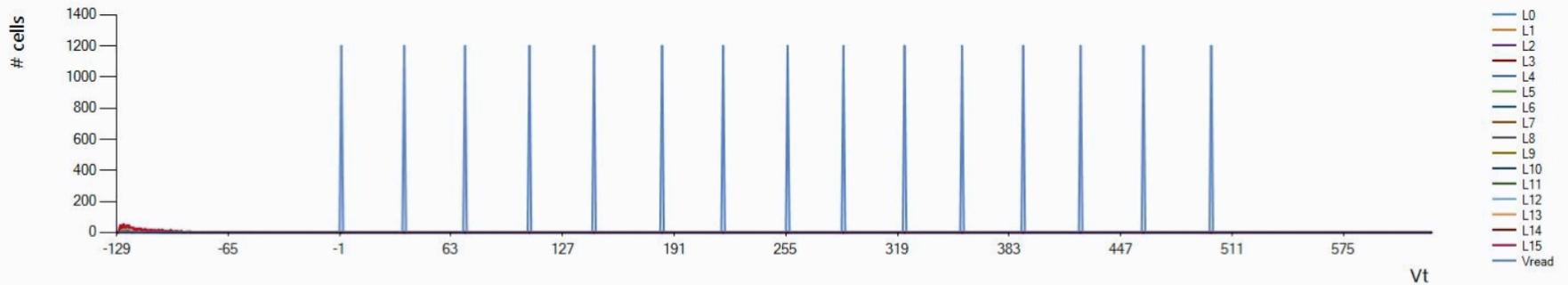




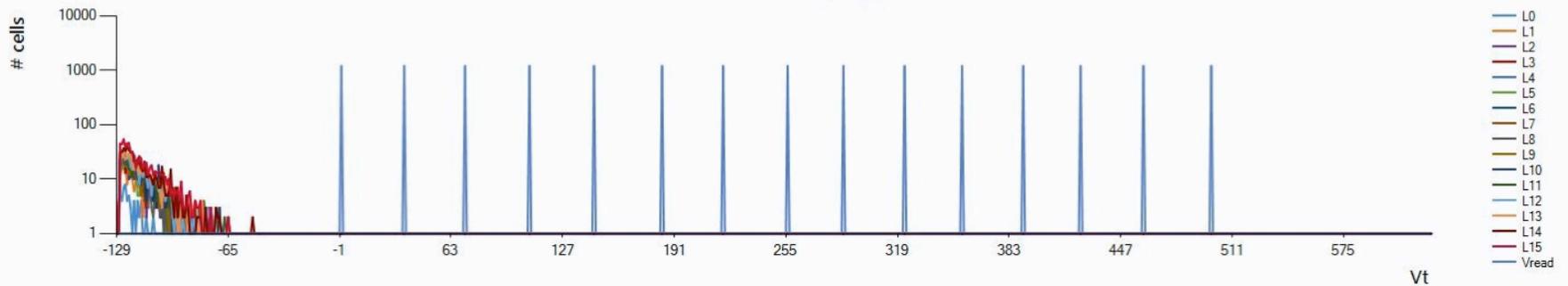
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2-Pass QLC Program Operation (8-16)

Vt Distribution



Vt Distribution(Log)





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1-Shot vs. 2-Pass Program

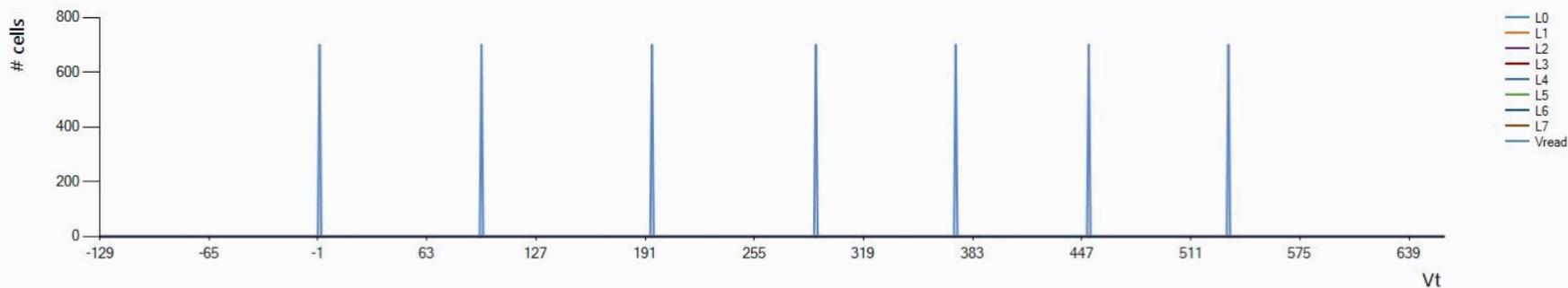
- 1-Shot program operation: Charge Trap Cells 3D NAND
- 2-Pass program operation: Floating Gate Cells 3D NAND
- 2-Pass program operation is much more complex and slower than 1-Shot program.
But why should 2-Pass program be employed by FG 3D NAND?



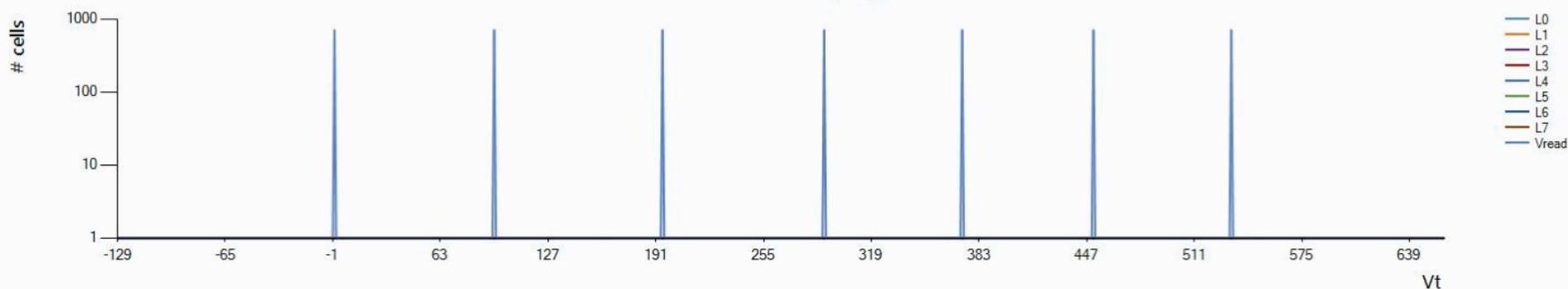
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1-Shot Program for 3D FG NAND

Vt Distribution



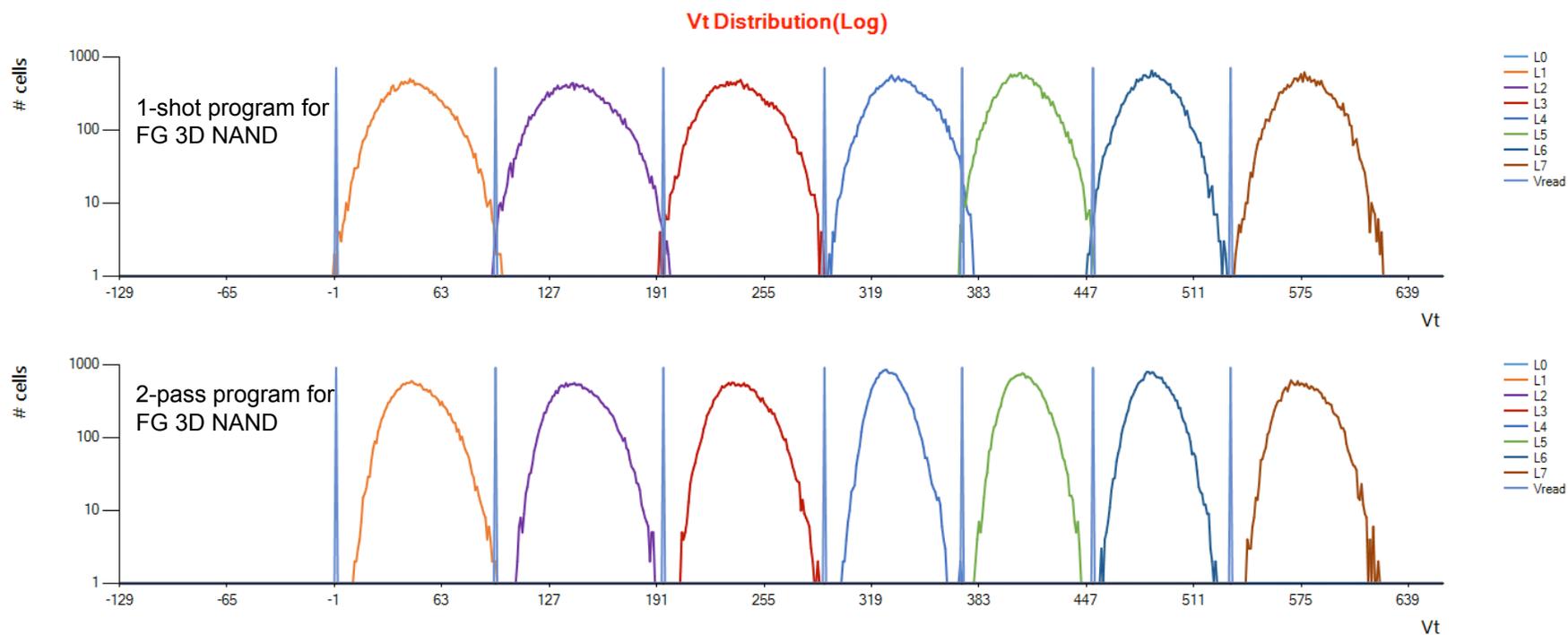
Vt Distribution(Log)





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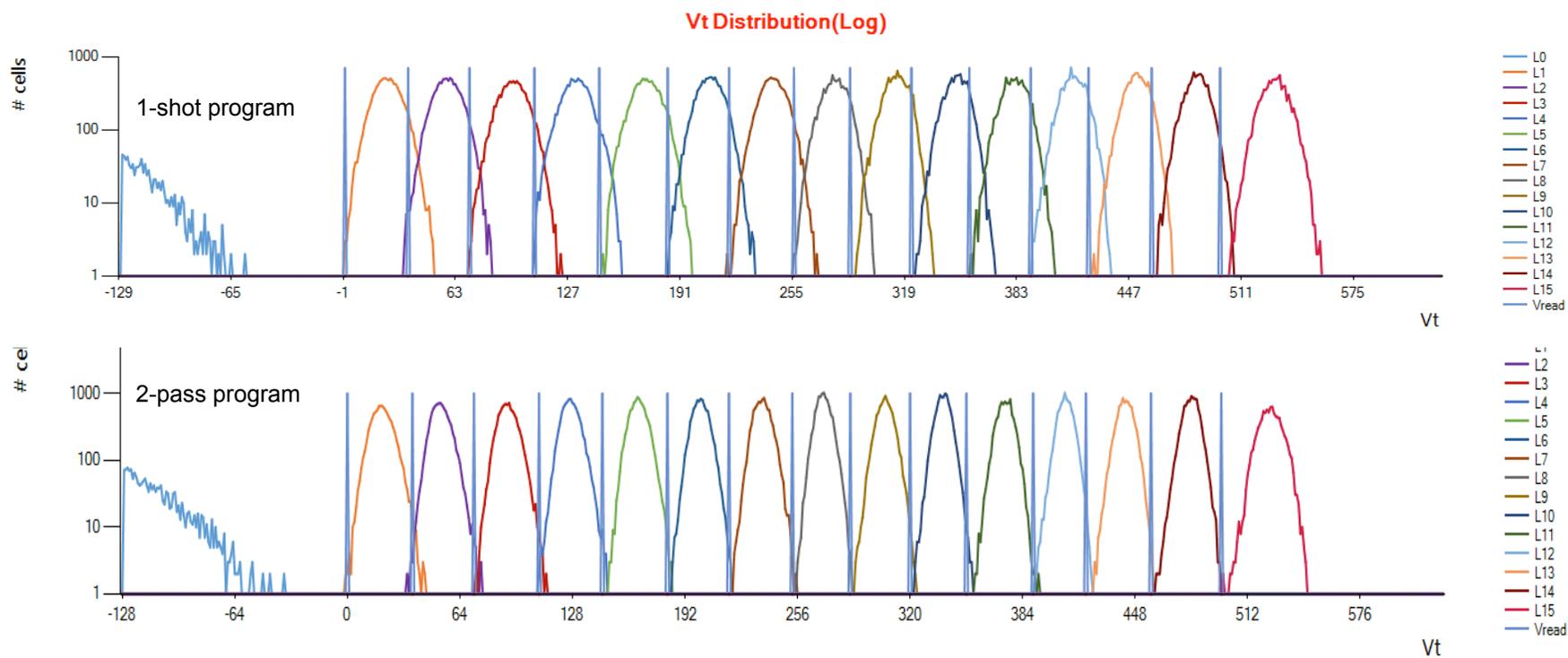
1-Shot vs. 2-Pass for FG 3D NAND(TLC)





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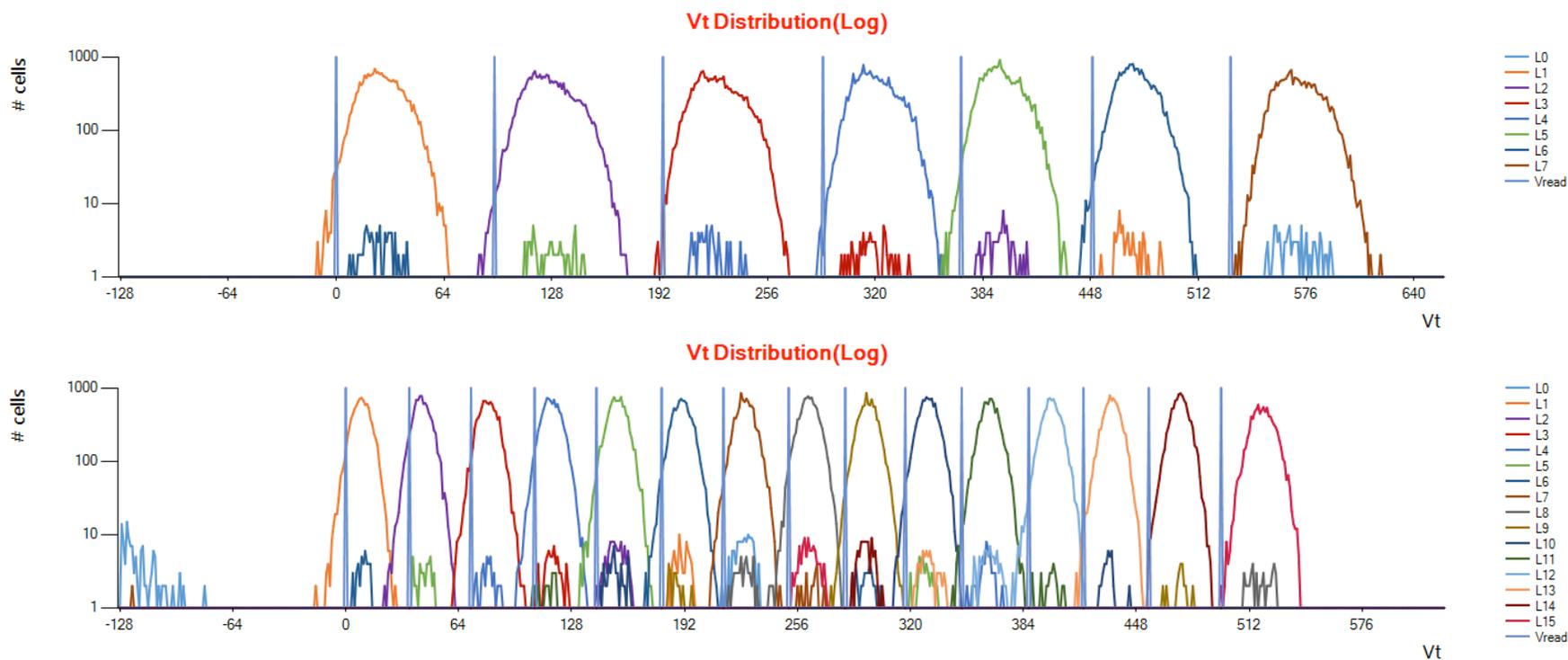
1-Shot vs. 2-Pass for FG 3D NAND(QLC)





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The shortcoming of 2-Pass program



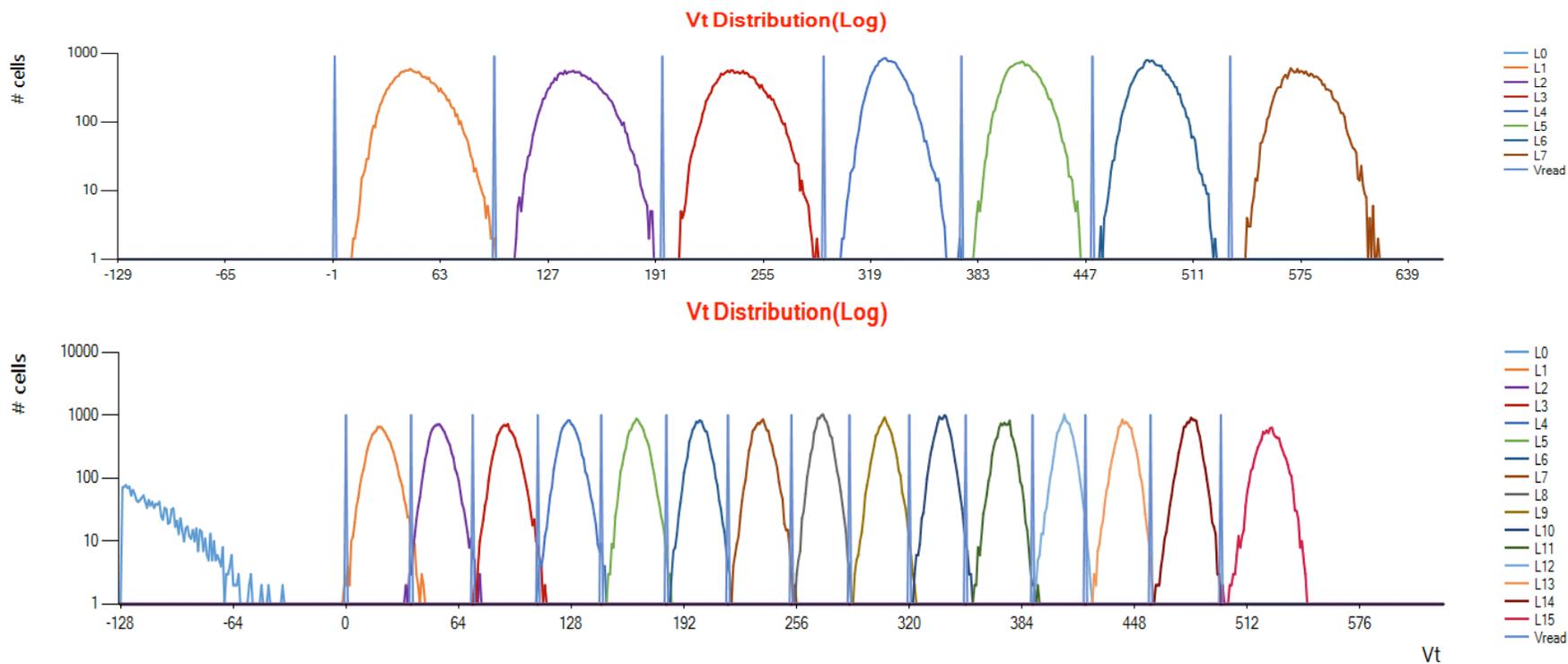


The reason and the solution

- The possibility of introducing HRE (High Reliable Error) is the key shortcoming of 2-Pass program, which is especially harmful for LDPC soft bit decode.
- The reason is the second pass program have to read the result of first pass programed data, which will introduce some bit errors. These bit errors will be expanded by the second pass program operation.
- The solution is re-inputting the first-pass data for second pass program, instead of reading from the first programed WL.



Result with re-input first pass data



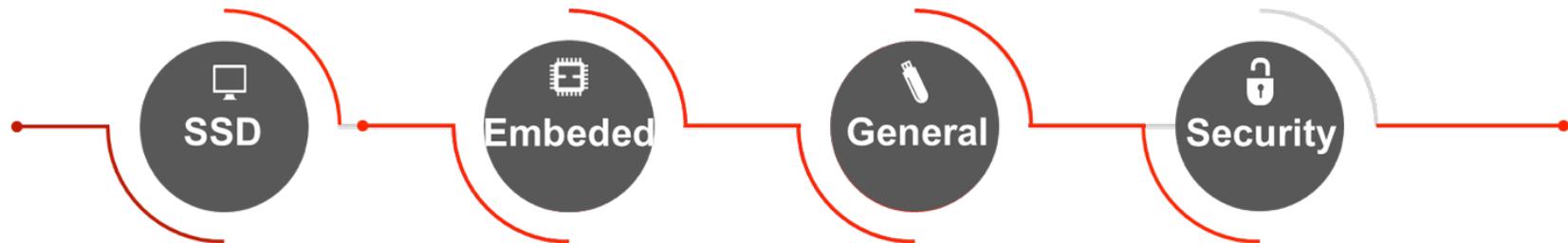
About YeeStor


YEESTOR =  *SiliconGo* +  *Auspitek*

Established in 2017

Established in 2007

Established in 2015



- ◎ SATA SSD Controller
- ◎ PCIe SSD Controller
- ◎ NoF SSD Controller

- ◎ UFS Controller
- ◎ eMMC Controller
- ◎ SPI NAND Controller

- ◎ USB Controller
- ◎ SD Controller

- ◎ Security SSD Controller
- ◎ Other security Controller&solution



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Thank you.

Feel free to email me with any questions & feedback
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