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OMICS Group International is a pioneer and leading science event organizer, which publishes around 400 open access journals and conducts over 300 Medical, Clinical, Engineering, Life Sciences, Pharma scientific conferences all over the globe annually with the support of more than 1000 scientific associations and 30,000 editorial board members and 3.5 million followers to its credit.

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On Exotic Nanostructure for bio-FET

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*Dept. Elec. & Comp. Eng., National Chiao Tung University

**High Energy Accelerator Research Organization

Motivation

Koike, et.al.

25 μm long
and 2.4mm wide

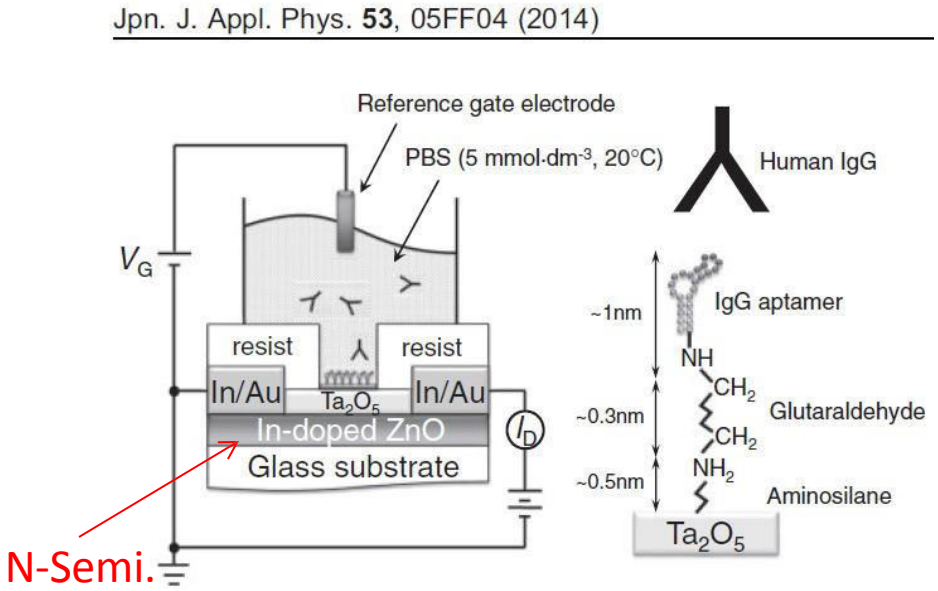
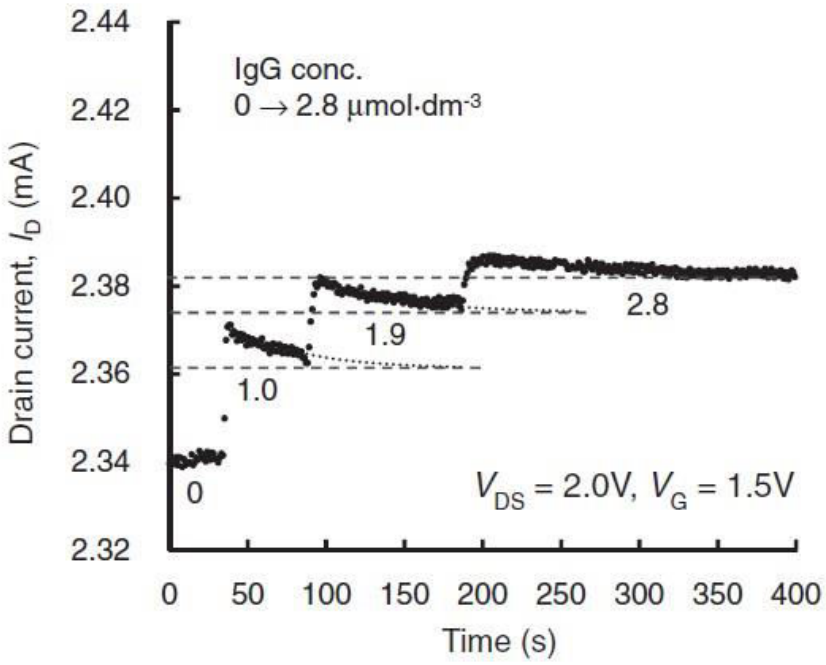


Fig. 1. Schematic diagram of the device structure together with the measurement setup (left), and detailed illustration of the aptamer-modified gate surface (right).

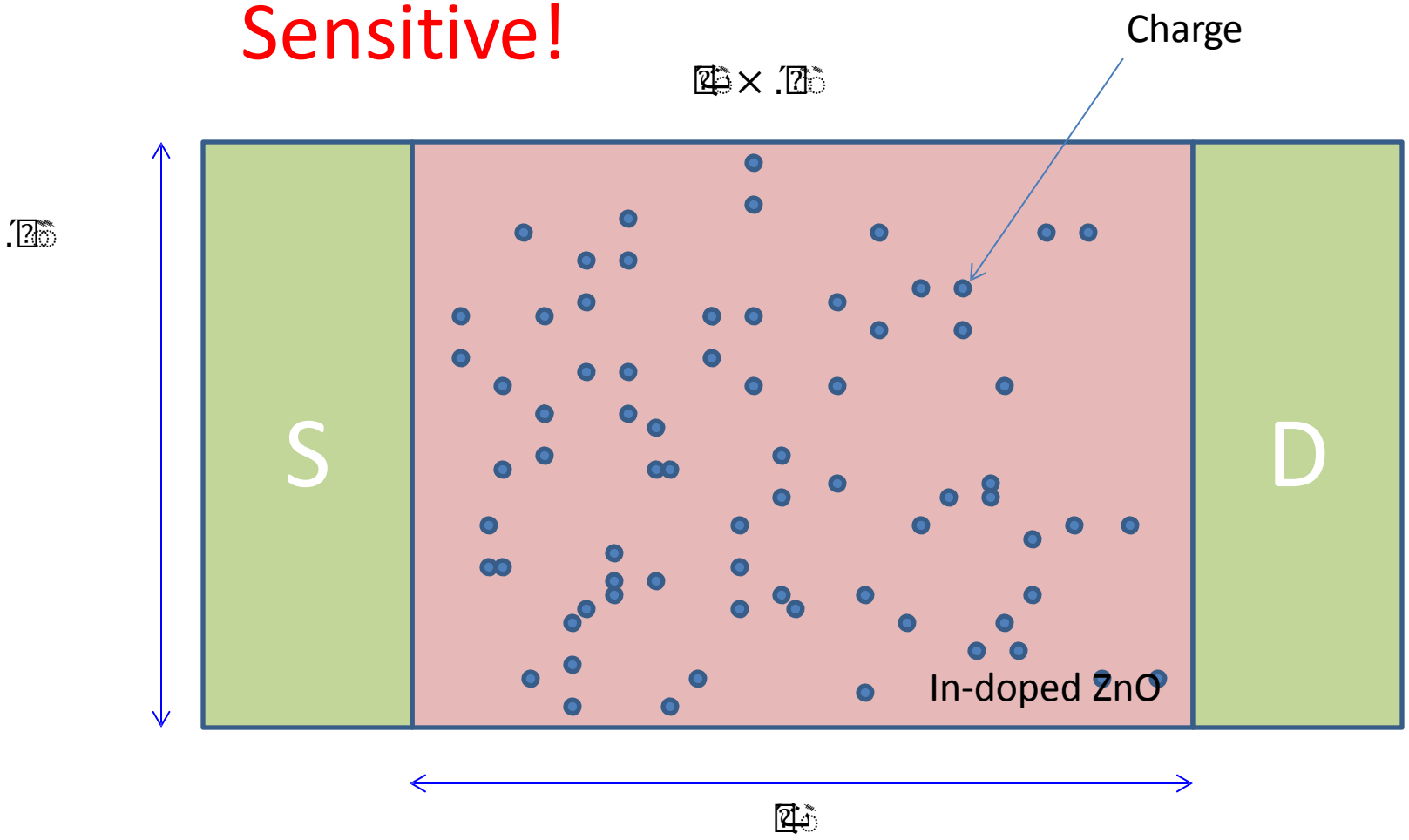


Ta2O7 (6nm) : K=27 → EOT=0.9nm

EOT+1.8nm = 2.7nm —tailing→ ~2nm

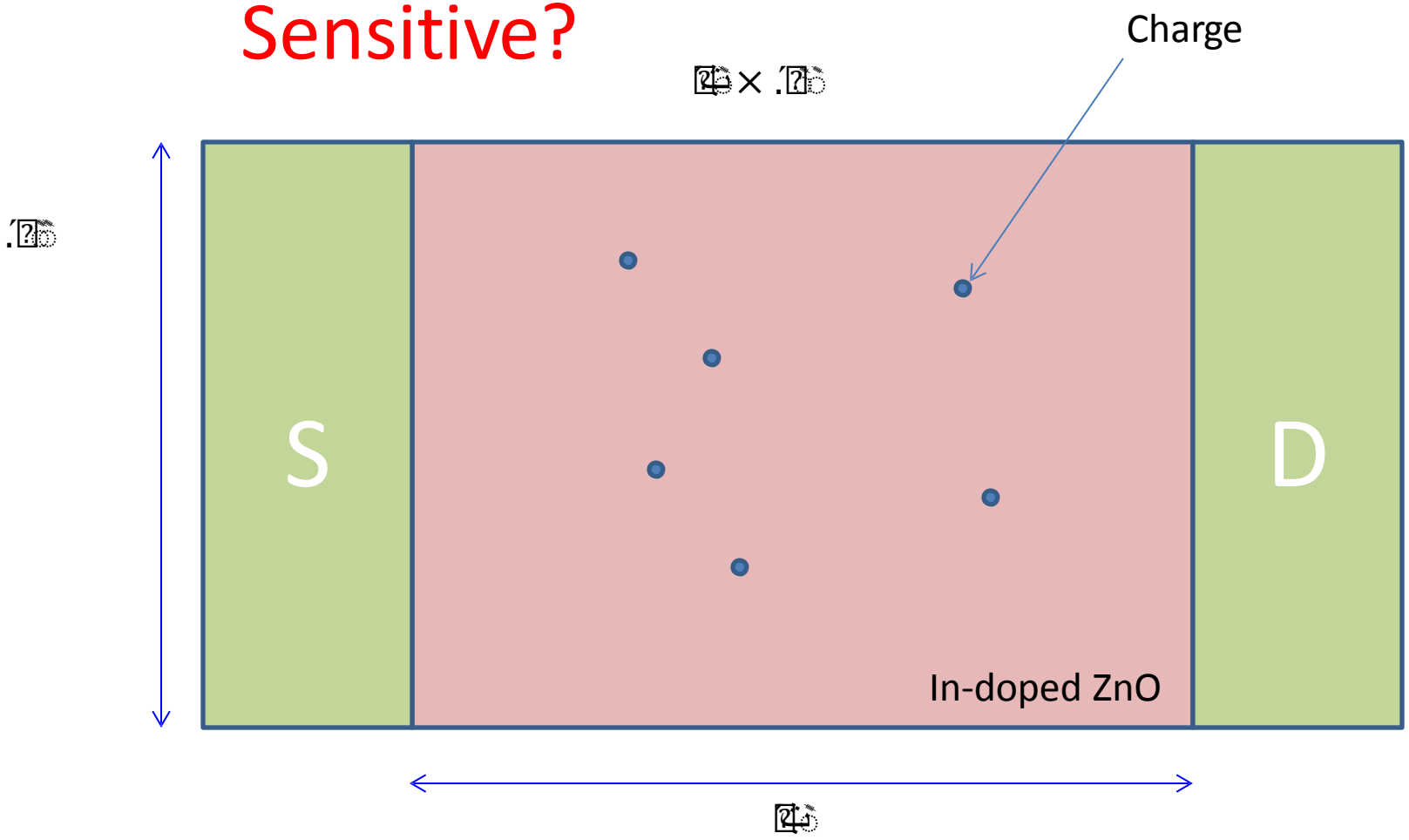
Surface Charge

Sensitive!

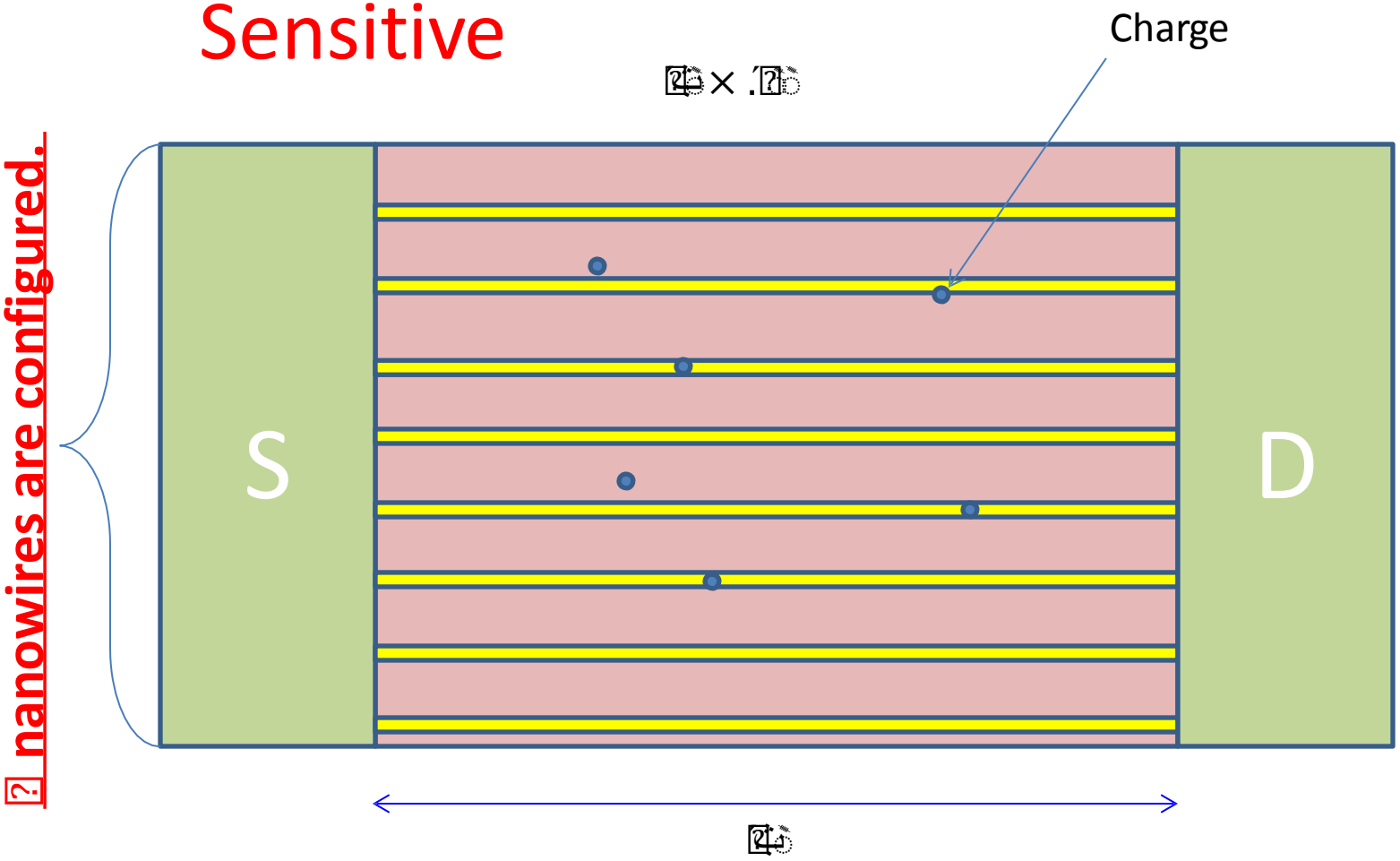


Surface Charge

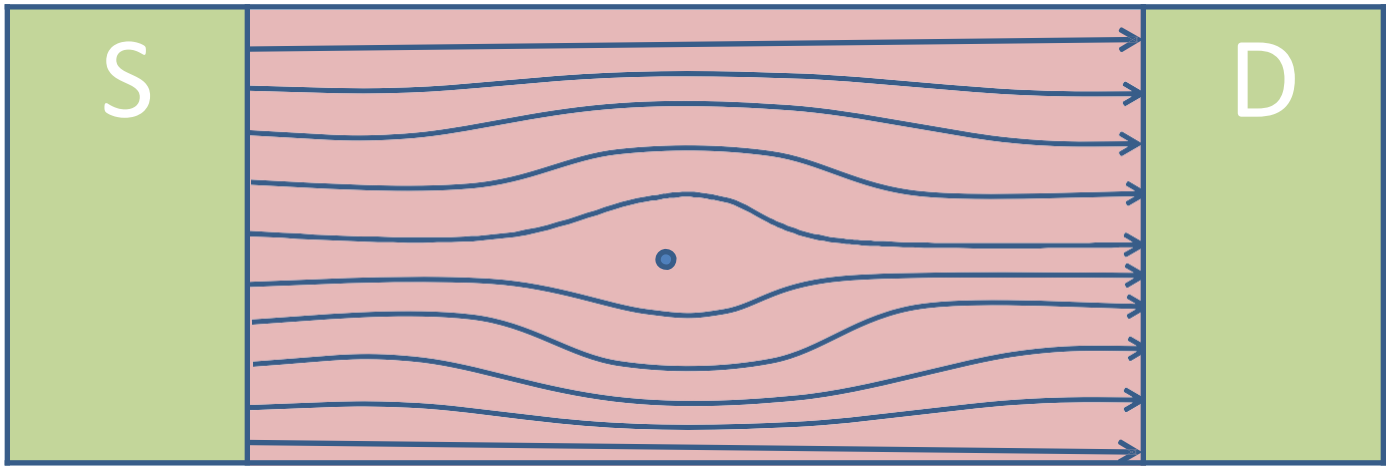
Sensitive?

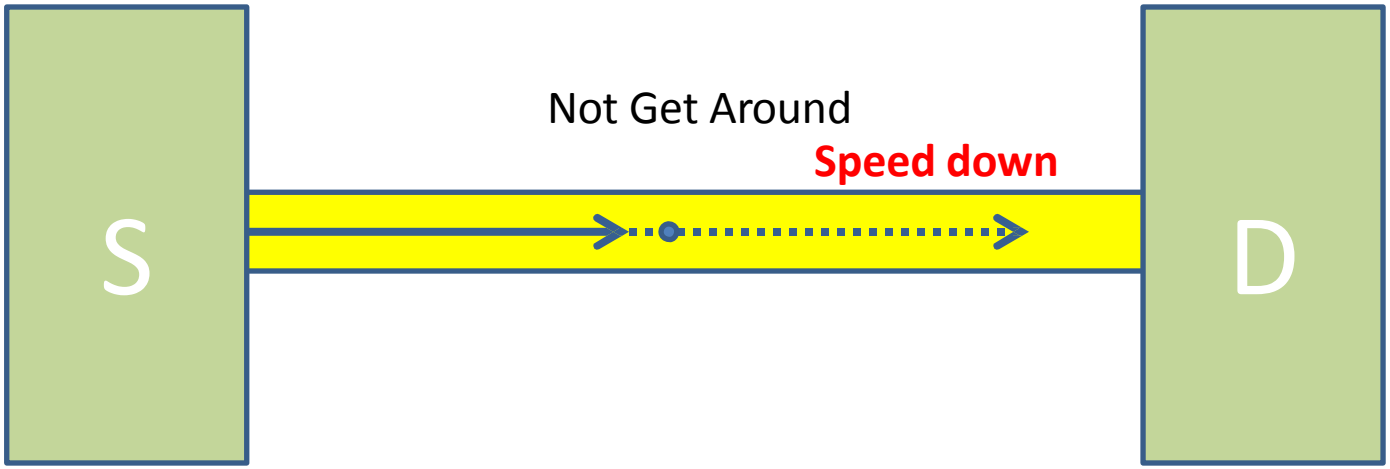


SNW



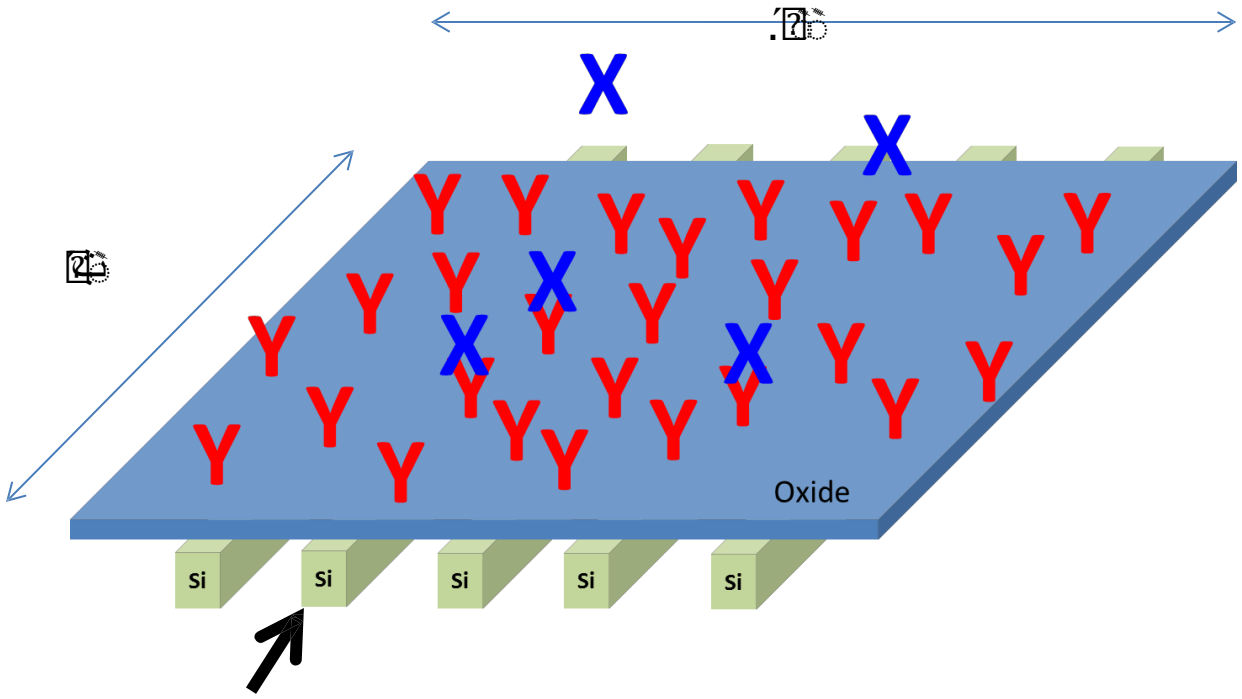
Get Around





X: Target Y: Receptor

$$X + Y \leftrightarrows XY$$



Sense it!!

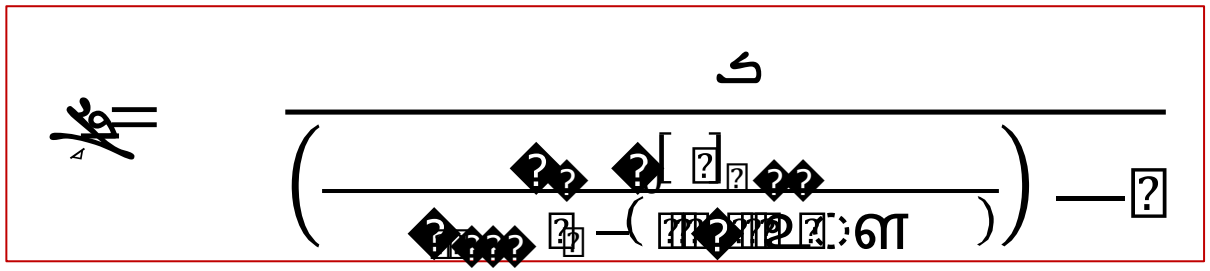
Limit Of Detection (LOD)



K: dissociation Const.

$$\frac{\Delta G}{0} = \Delta = \frac{}{} [\,] \times \frac{[\,]}{[\,] + K} + (\qquad)$$

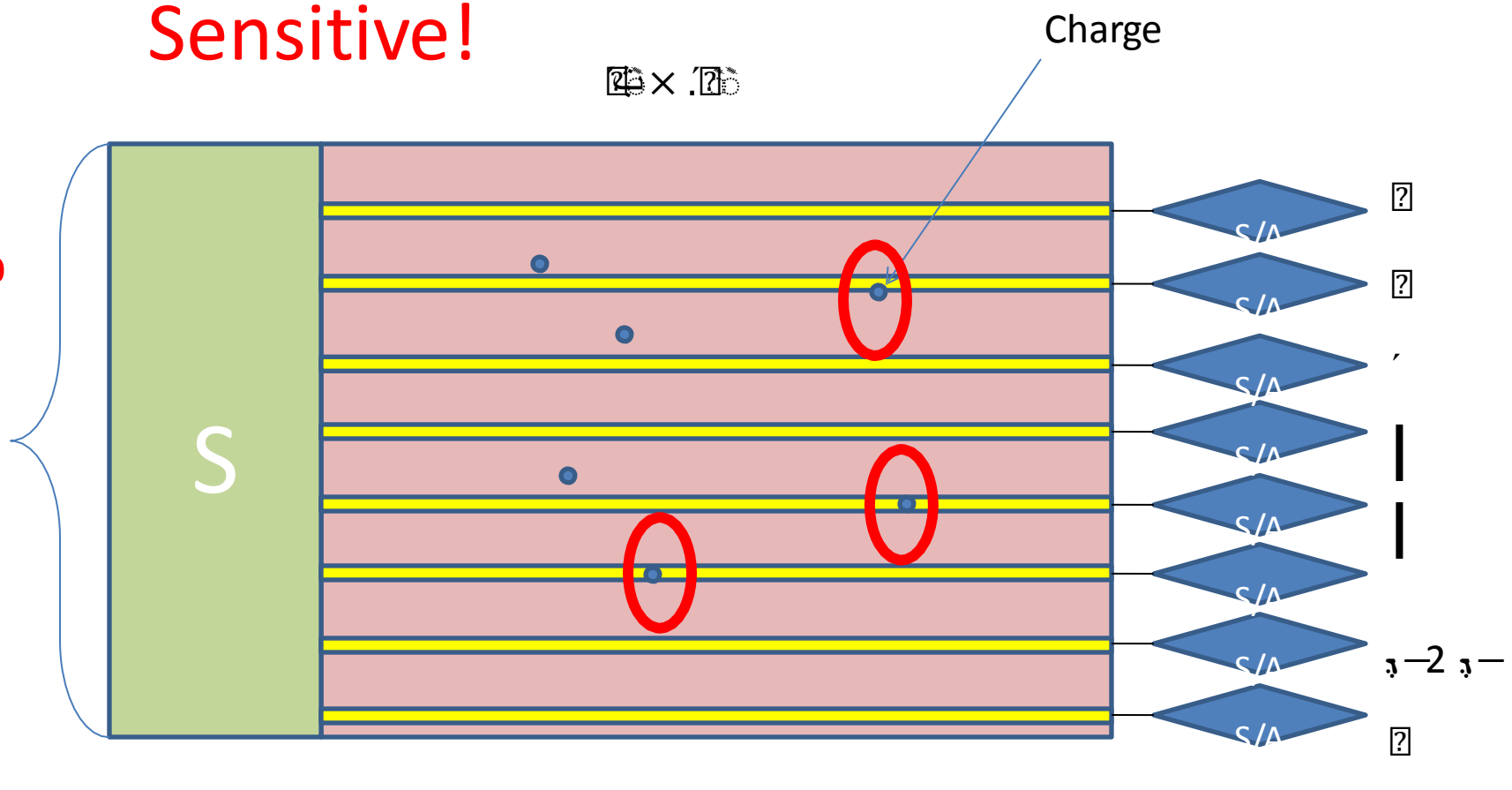
Macroscopic



M. A. Reed, IEDM2013-208

Independent Sense, ε :=

Sensitive!



nanowires are configured.

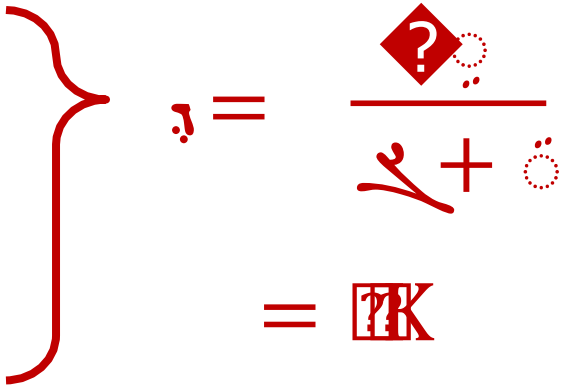
nanowires detected the charge by Human IgG.

Independent Sense, ε :=

Gate Width (GW) =

Line (L), SNWØ =

Space (S), SNW-to-SNW =



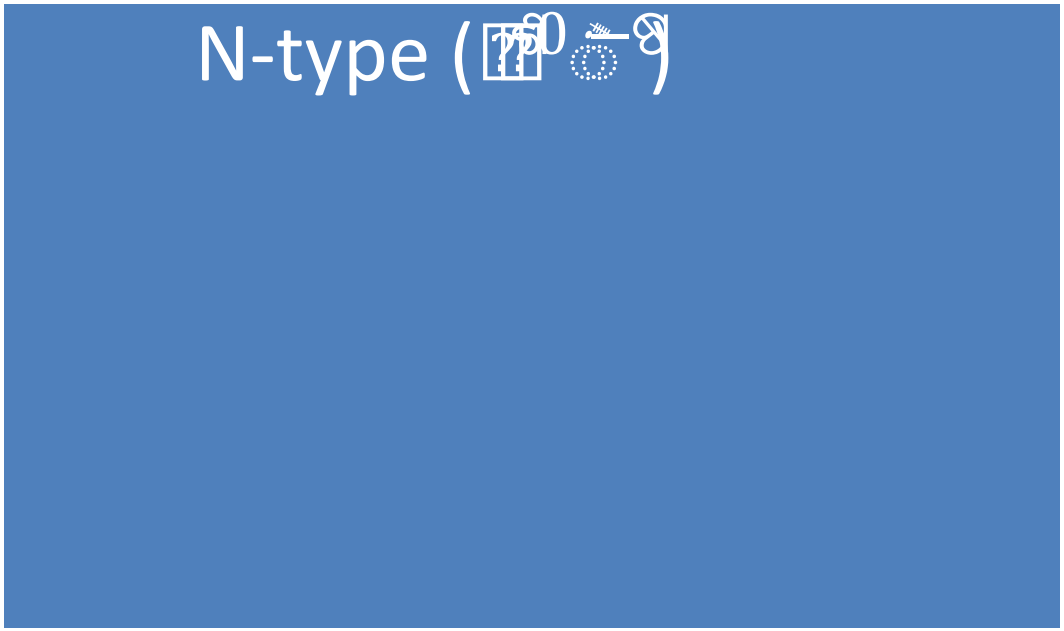
Rev. LOD = × LOD

ε =

=

40 “/A’s detect the signal change.

SOI (~20nm)

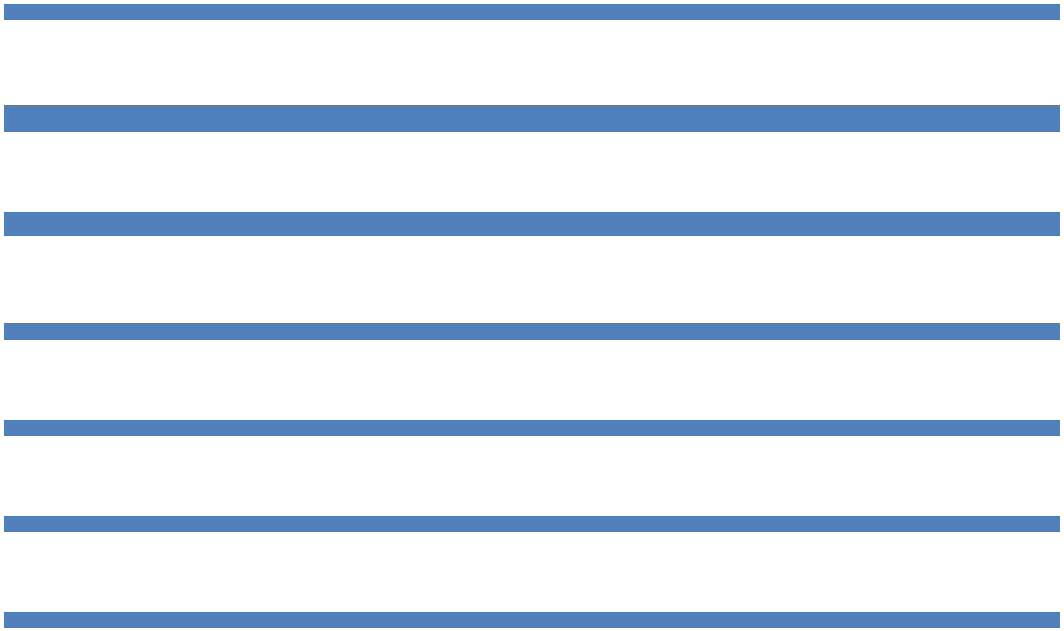


Line / Space by 30nm Tech.



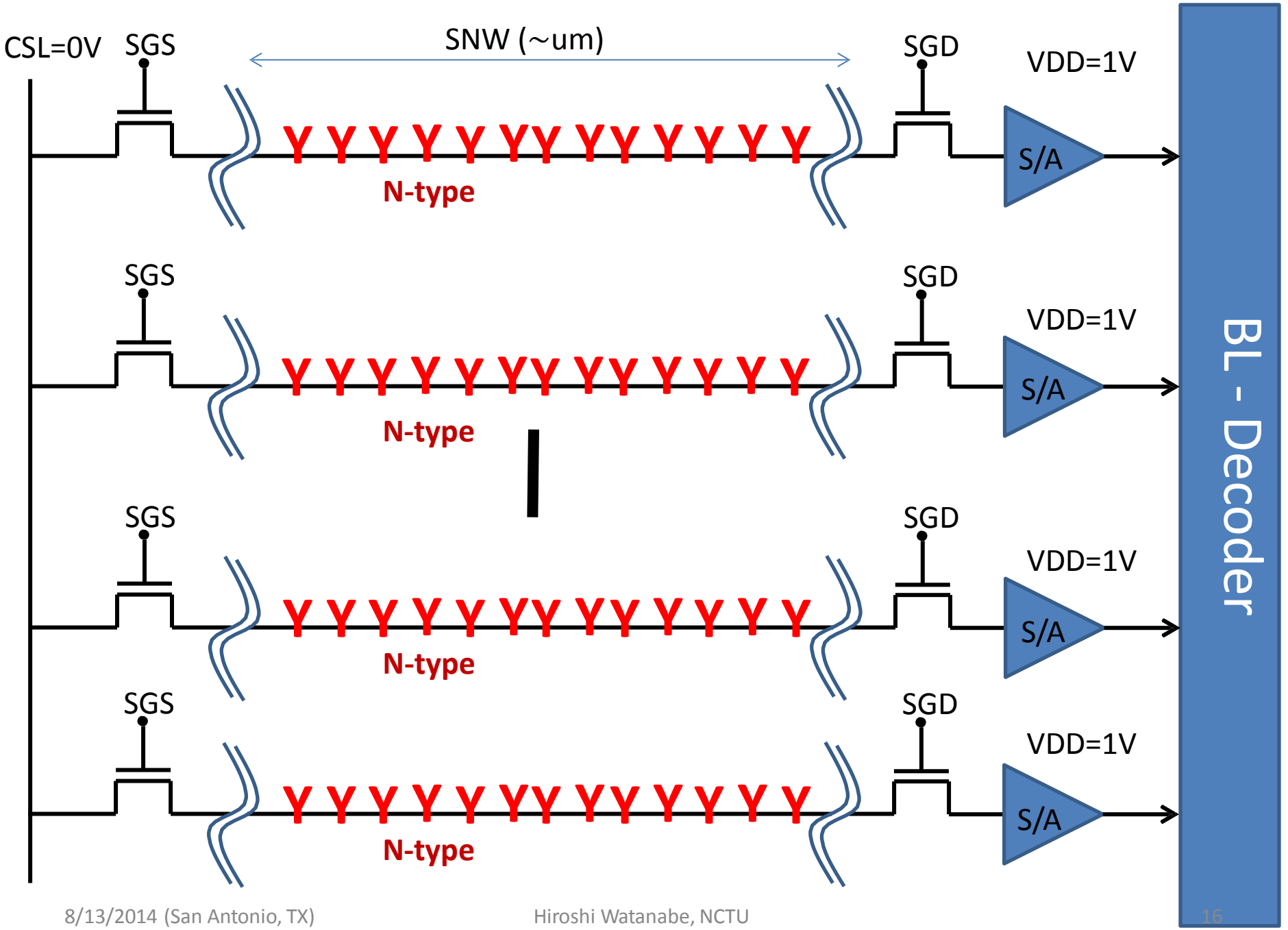
Sliming

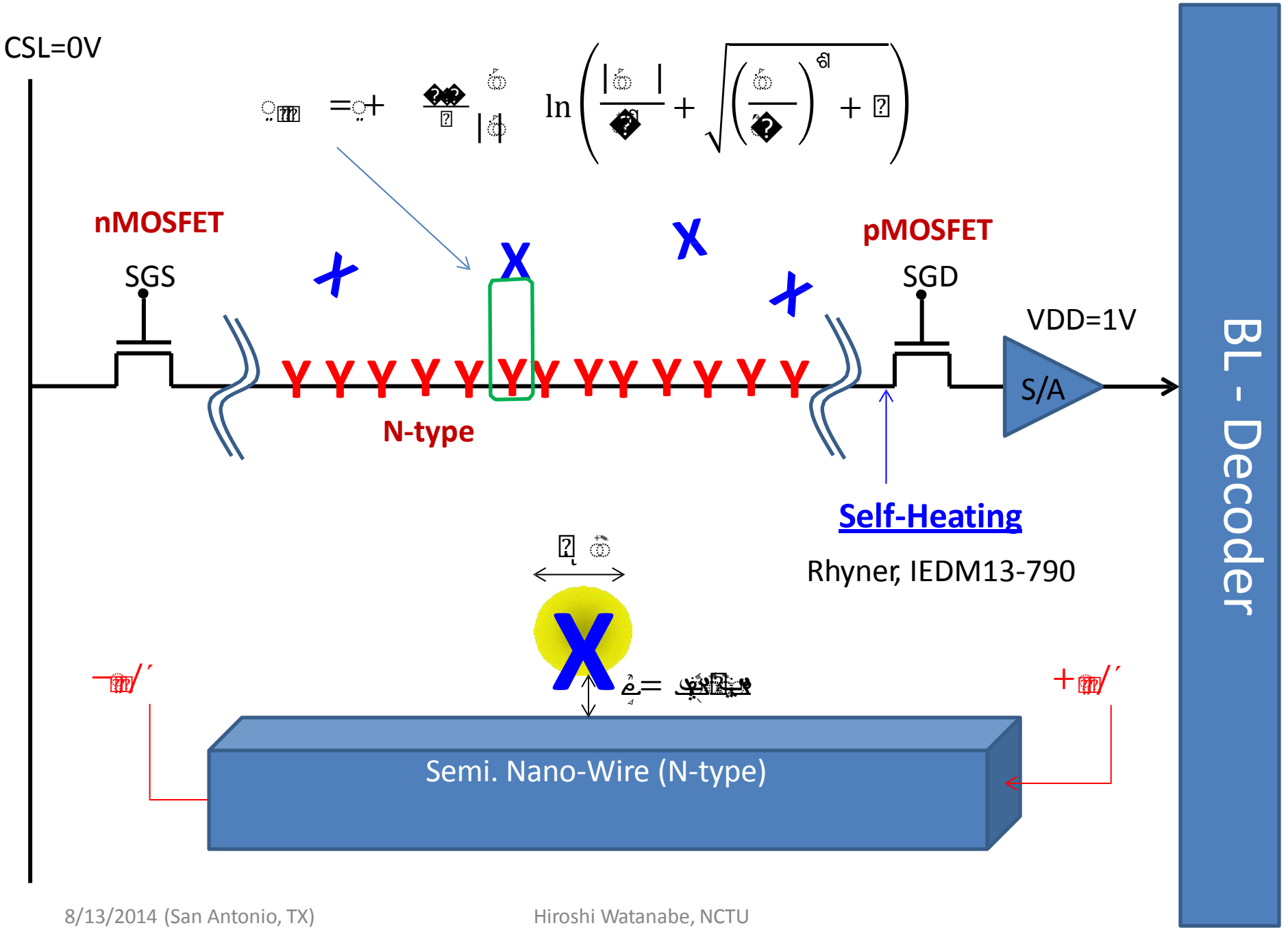
$< \phi >=$ 



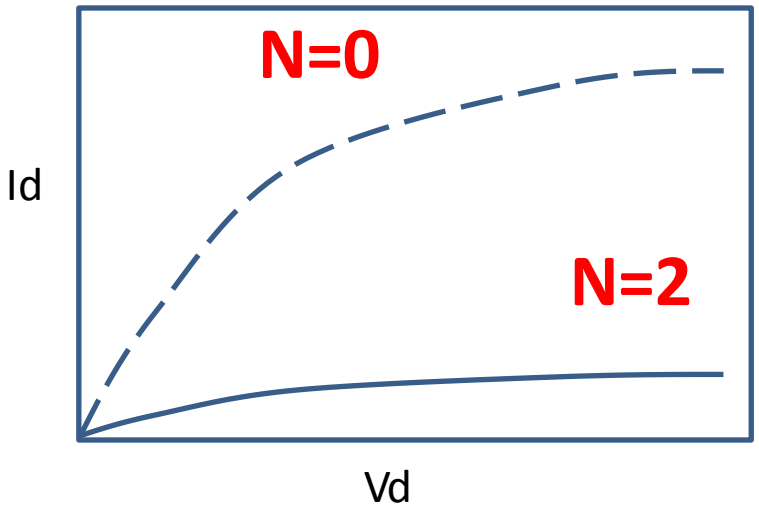


<S> = 57nm


CSL=0V
SGS
SNW (~um)
SGD
VDD=1V
S/A
N-type
SGS
SGD
VDD=1V
S/A
N-type
SGS
SGD
VDD=1V
S/A
N-type
SGS
SGD
VDD=1V
S/A
N-type
BL - Decoder


CSL=0V
nMOSFET
SGS
pMOSFET
SGD
VDD=1V
S/A
N-type
Self-Heating
Rhyner, IEDM13-790
BL - Decoder
Semi. Nano-Wire (N-type)

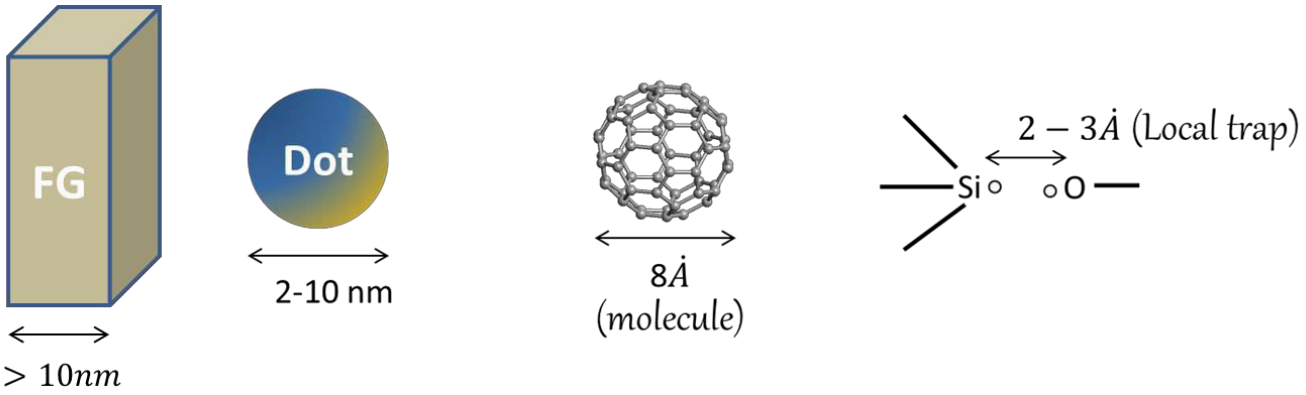
Modeling for Device Simulation



We may sense this change.



Electrically Floating Island



How to determine the potential?

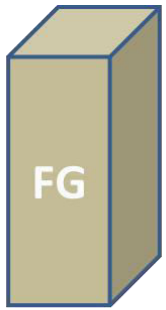
Adopted Capacitance so far.

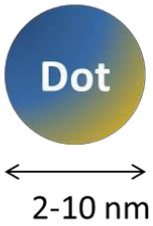
$$\Delta E = \frac{\square}{\square}$$

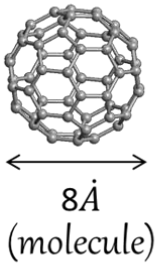
$$\square = \left(\frac{\square}{\square - (\square)} \right) - \square$$

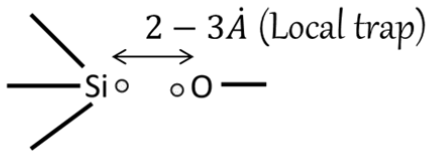
How to know Capacitance?

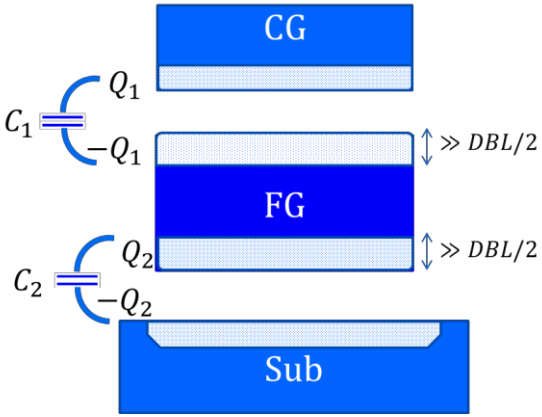
Electrically Floating Island









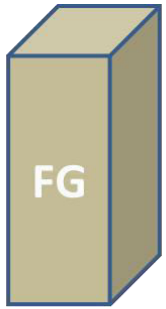


DBL ≅ ?

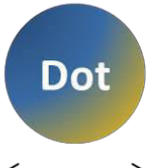
Know the potential without Capacitance.

How to know Capacitance?

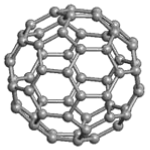
Electrically Floating Island



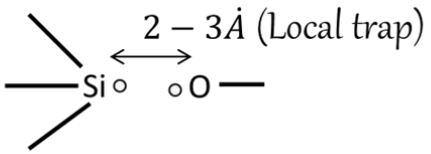
$> 10nm$

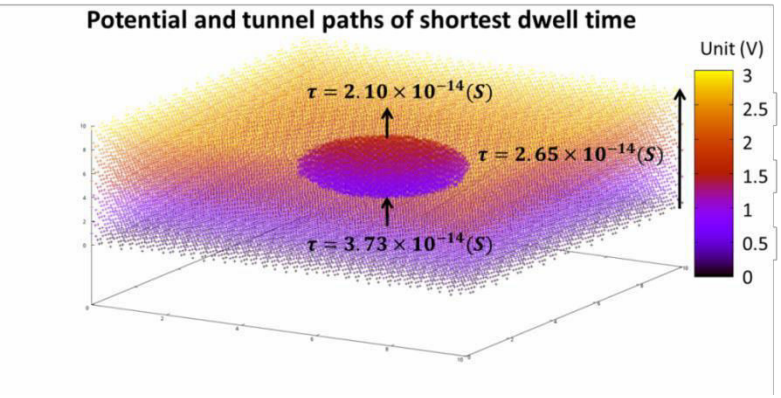


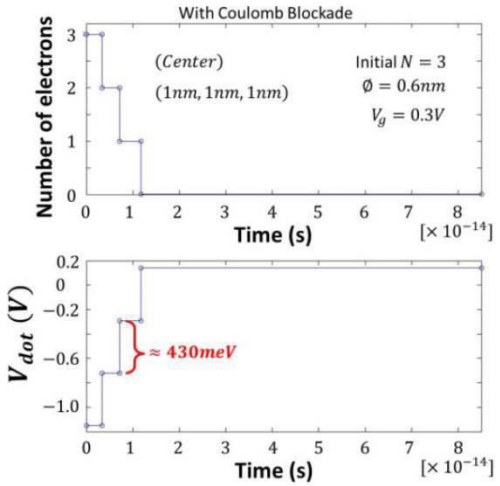
2-10 nm

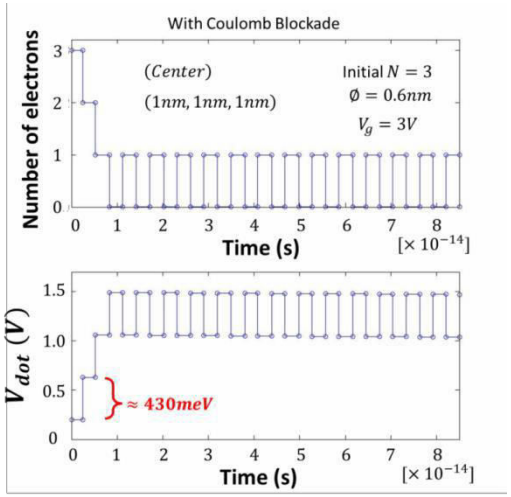


$8\dot{A}$
(molecule)





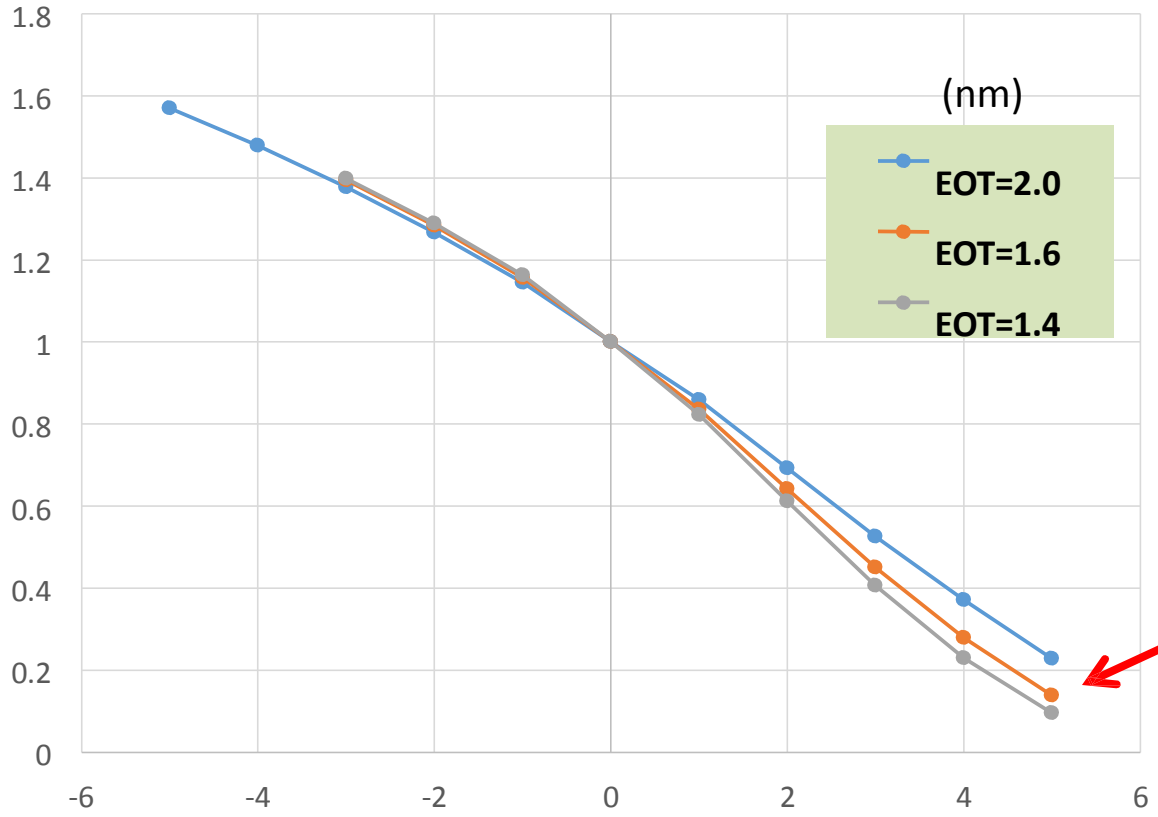




H. Watanabe, et. al., IEEE TED vol. 61, pp. 1145-1152, 2014.

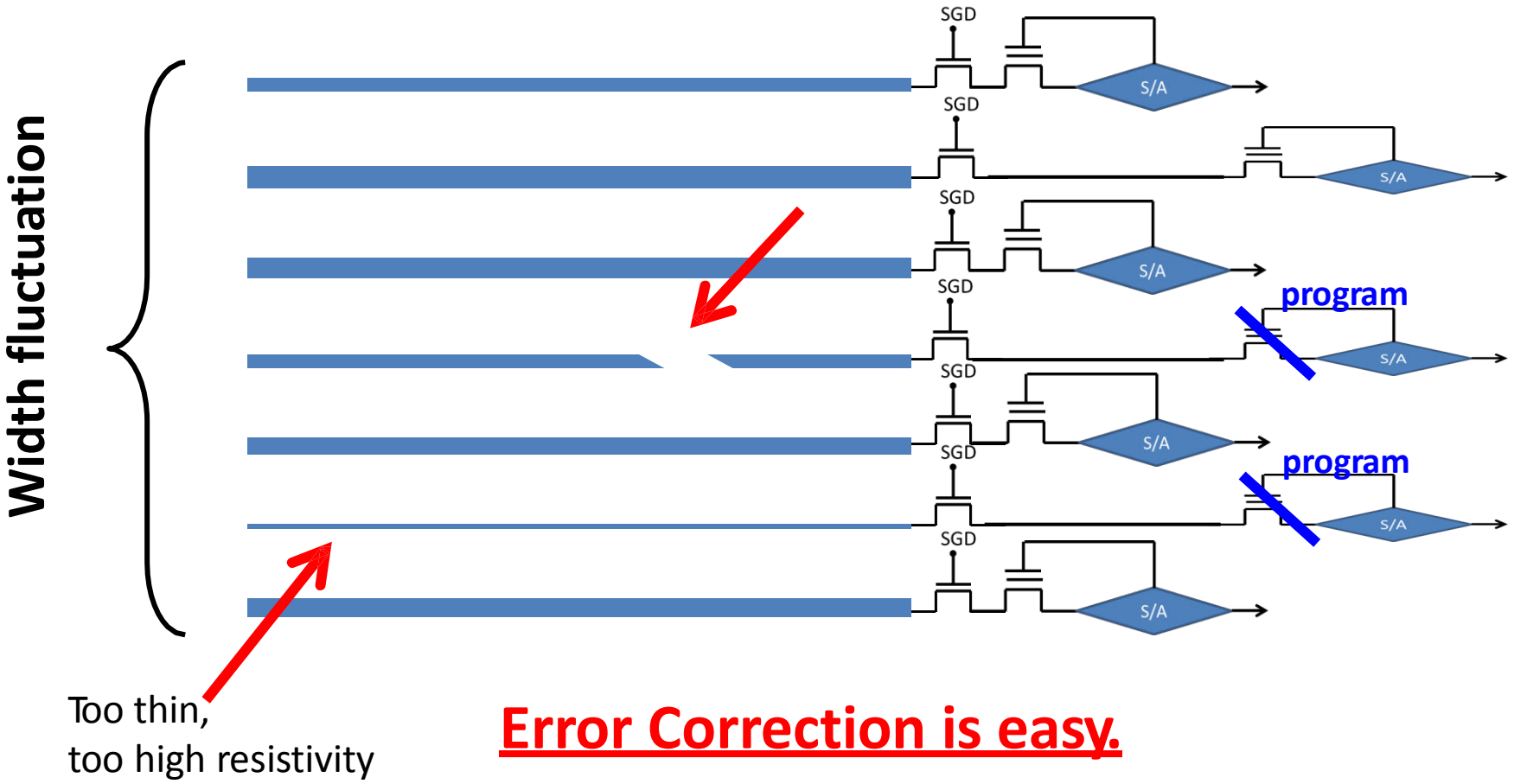
Sim. Results

$$\left| \frac{\vec{J}_{elec}(N)}{\vec{J}_{elec}(N=0)} \right|$$



On fabrication Tolerance

Before exposed to solution



Error Correction is easy.

By Thinking Exp. & Device Simulation

1. Independent Sense System
2. Powerful Error Correction
3. Optimization of bio-FETs

Acknowledgement:

The authors appreciate Prof. Koike (OIT) for helpful discussions.

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