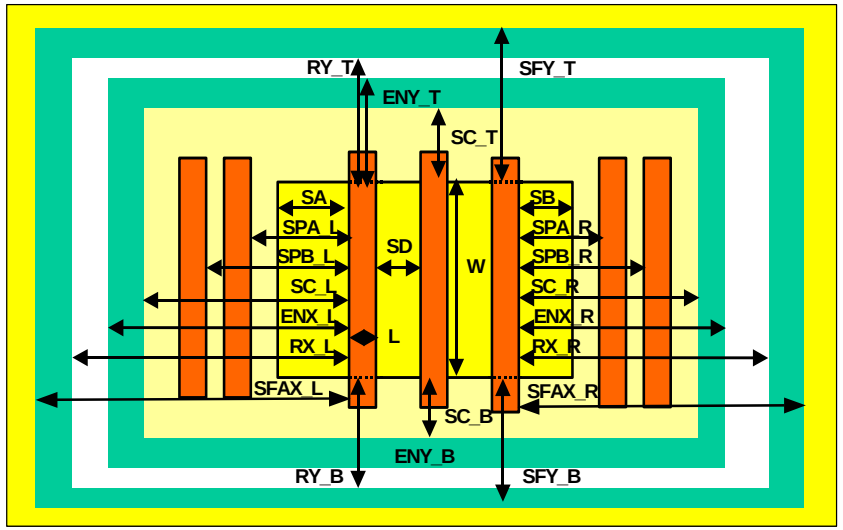
Layout Dependent Effect Setup Usage

Layout Dependent Effect

- **Concept**
  - Define layout dependent effect (LDE) parameters by layer boundary and calculate effective parameters in pre-layout stage
- **Method**
  - New adjustable parameters based on layout geometry are added into device CDF for layout dependent effect calculation
  - User preset function is provided for customer's pre-defined values
  - Utility is provided to allow user to specify those parameters by selected instance.

New CDF Parameters



* 20 new CDF paramaters are introduced:

(a) PSE: SPA_L, SPA_R, SPB_L, SPB_R

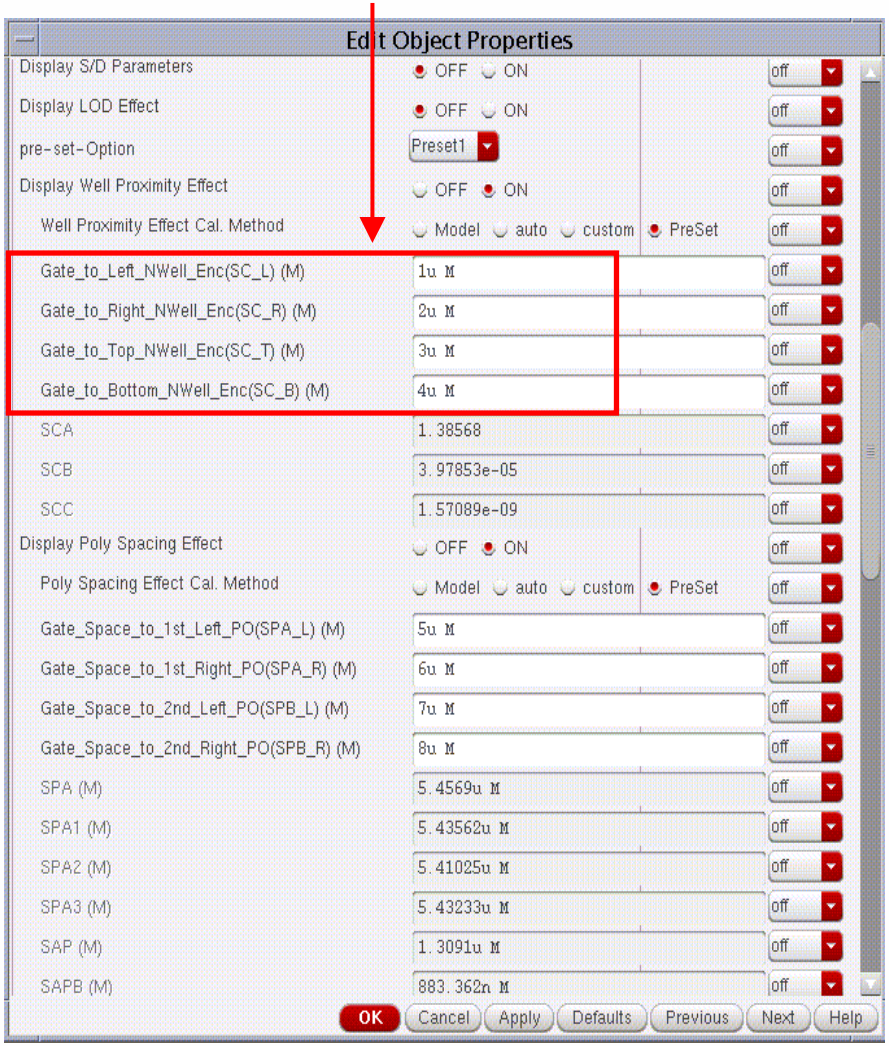
(b) WPE: SC_L, SC_R, SC_T, SC_B

(c) BE: ENX_L, ENX_R, ENY_T, ENY_B, RX_L, RX_R, RY_T, RY_B

(d) OSE: SFAX_L, SFAX_R, SFY_T, SFY_B

WPE parameters

Add SC_L, SC_R, SC_T, SC_B CDF parameters



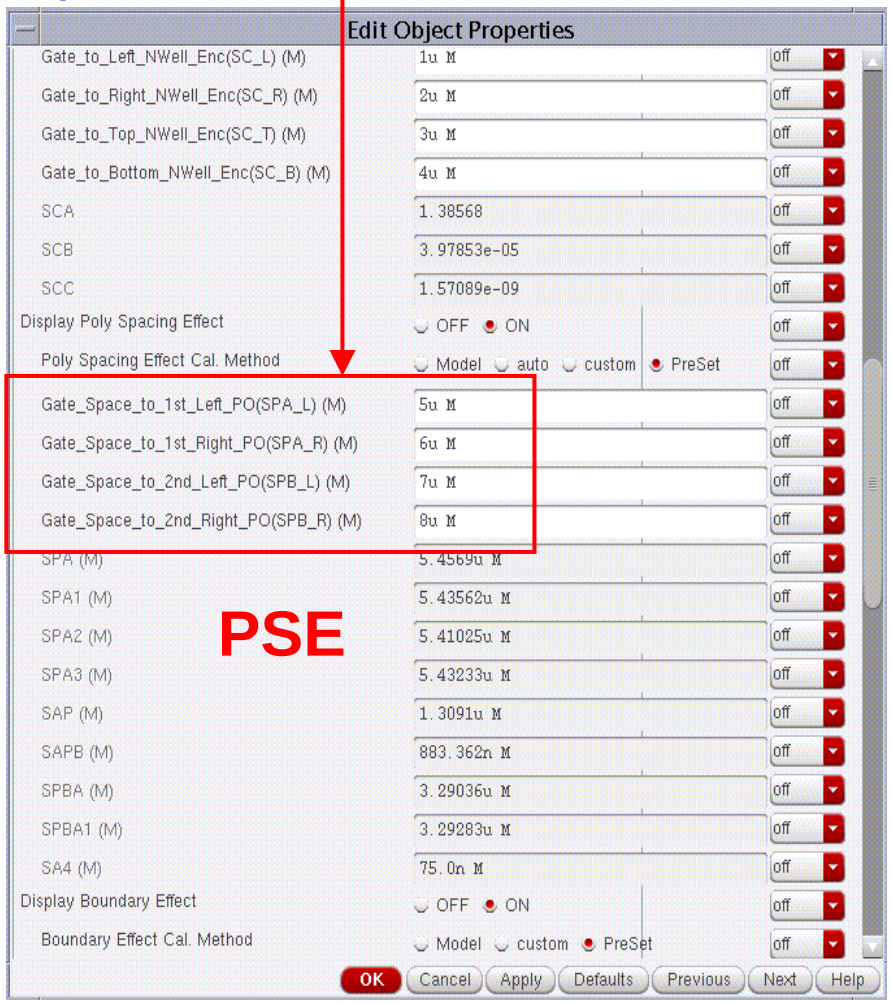
	New layout related input in CDF	layout dependent effect instance parameters
PSE	SPA_L, SPA_R, SPB_L, SPB_R	SPA, SPA1, SPA2, SPA3, SAP, SA4, SPBA, SPBA1, SAPB
WPE	SC_L, SC_R, SC_T, SC_B	SCA, SCB, SCC
BE (D-CESL)	ENX_L, ENX_R, ENY_T, ENY_B, RX_L, RX_R, RY_T, RY_B	ENX, ENX1, ENY, ENY1, ENY2, REX, REY
OSE	SFAX_L, SFAX_R, SFY_T, SFY_B	SODX, SODX1, SODX2, SA5, SA6, SODY

Calculate effective SCA, SCB, SCC

Ex :SCA_{eff} = f (W, L, NF, SD, SC_L, SC_R, SC_T, SC_B)

PSE parameters

Add SPA_L, SPA_R, SPB_L, SPB_R **CDF parameters**



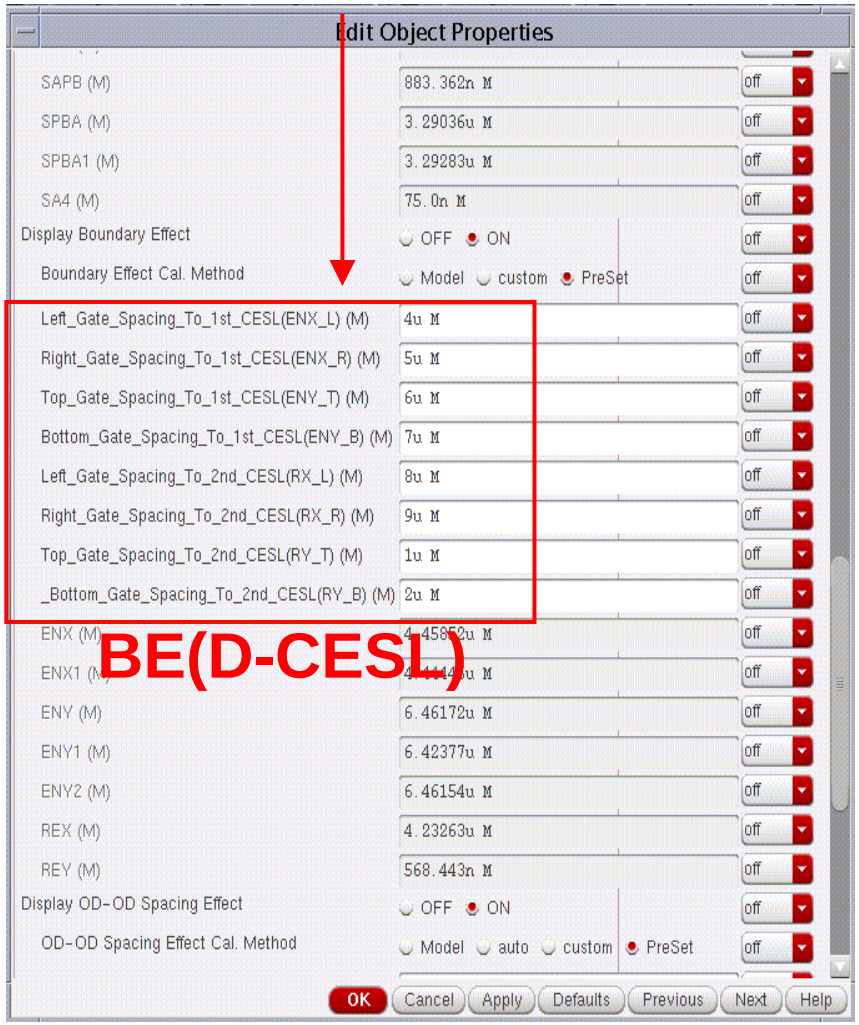
	New layout related input in CDF	layout dependent effect instance parameters
PSE	SPA_L, SPA_R, SPB_L, SPB_R	SPA, SPA1, SPA2, SPA3, SAP, SA4, SPBA, SPBA1, SAPB
WPE	SC_L, SC_R, SC_T, SC_B	SCA, SCB, SCC
BE (D-CESL)	ENX_L, ENX_R, ENY_T, ENY_B, RX_L, RX_R, RY_T, RY_B	ENX, ENX1, ENY1, ENY2, REX, REY
OSE	SFAX_L, SFAX_R, SFY_T, SFY_B	SODX, SODX1, SODX2, SA5, SA6, SODY

- **PSE (Poly Spacing Effect) parameters are adjustable in CDF for callback calculation**

Boundary Effect parameters

Add ENX_L,ENX_R,ENY_T,ENY_B,

RX_L,RX_R,RY_T,RY_B **CDF parameters**

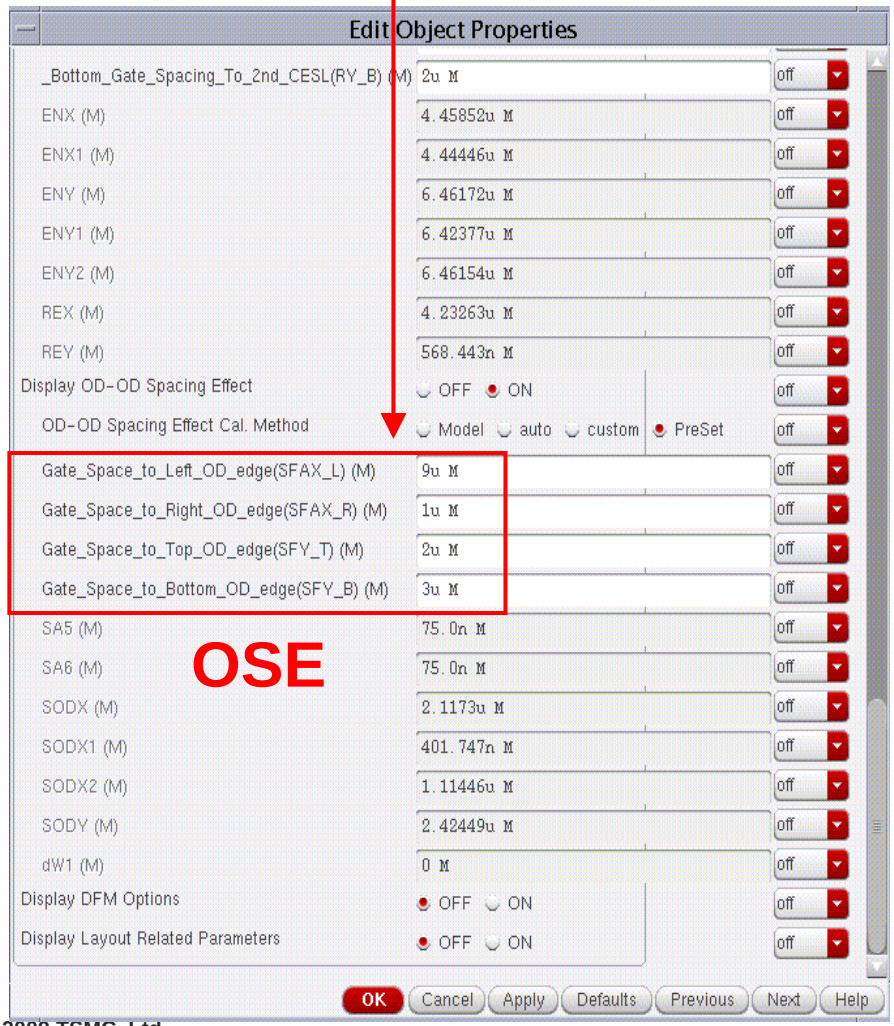


	New layout related input in CDF	layout dependent effect instance parameters
PSE	SPA_L, SPA_R, SPB_L, SPB_R	SPA, SPA1, SPA2, SPA3, SAP, SA4, SPBA, SPBA1, SAPB
WPE	SC_L, SC_R, SC_T, SC_B	SCA, SCB, SCC
BE (D-CESL)	ENX_L, ENX_R, ENY_T, ENY_B, RX_L, RX_R, RY_T, RY_B	ENX, ENX1, ENY, ENY1, ENY2, REX, REY
OSE	SFAX_L, SFAX_R, SFY_T, SFY_B	SODX, SODX1, SODX2, SA5, SA6, SODY

- **BE (D-CESL Effect) parameters are adjustable in CDF for callback calculation**

OSE parameters

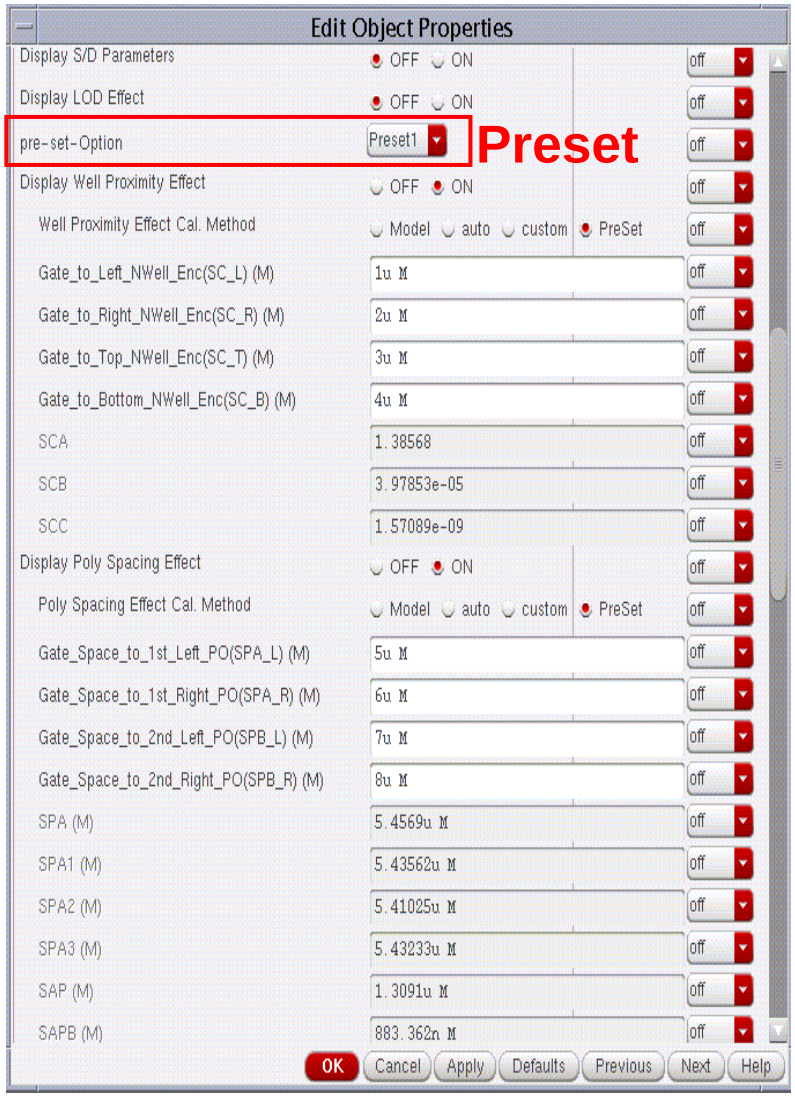
Add SFAX_L, SFAX_R, SFY_T, SFY_B **CDF parameters**



	New layout related input in CDF	layout dependent effect instance parameters
PSE	SPA_L, SPA_R, SPB_L, SPB_R	SPA, SPA1, SPA2, SPA3, SAP, SA4, SPBA, SPBA1, SAPB
WPE	SC_L, SC_R, SC_T, SC_B	SCA, SCB, SCC
BE (D-CESL)	ENX_L, ENX_R, ENY_T, ENY_B, RX_L, RX_R, RY_T, RY_B	ENX, ENX1, ENY, ENY1, ENY2, REX, REY
OSE	SFAX_L, SFAX_R, SFY_T, SFY_B	SODX, SODX1, SODX2, SA5, SA6, SODY

- **OSE (OD Spacing Effect) parameters are adjustable in CDF for callback calculation**

Preset Option



- Preset function is provided for customer's pre-defined parameters
- TSMC utility is provided for user selecting different groups of preset.

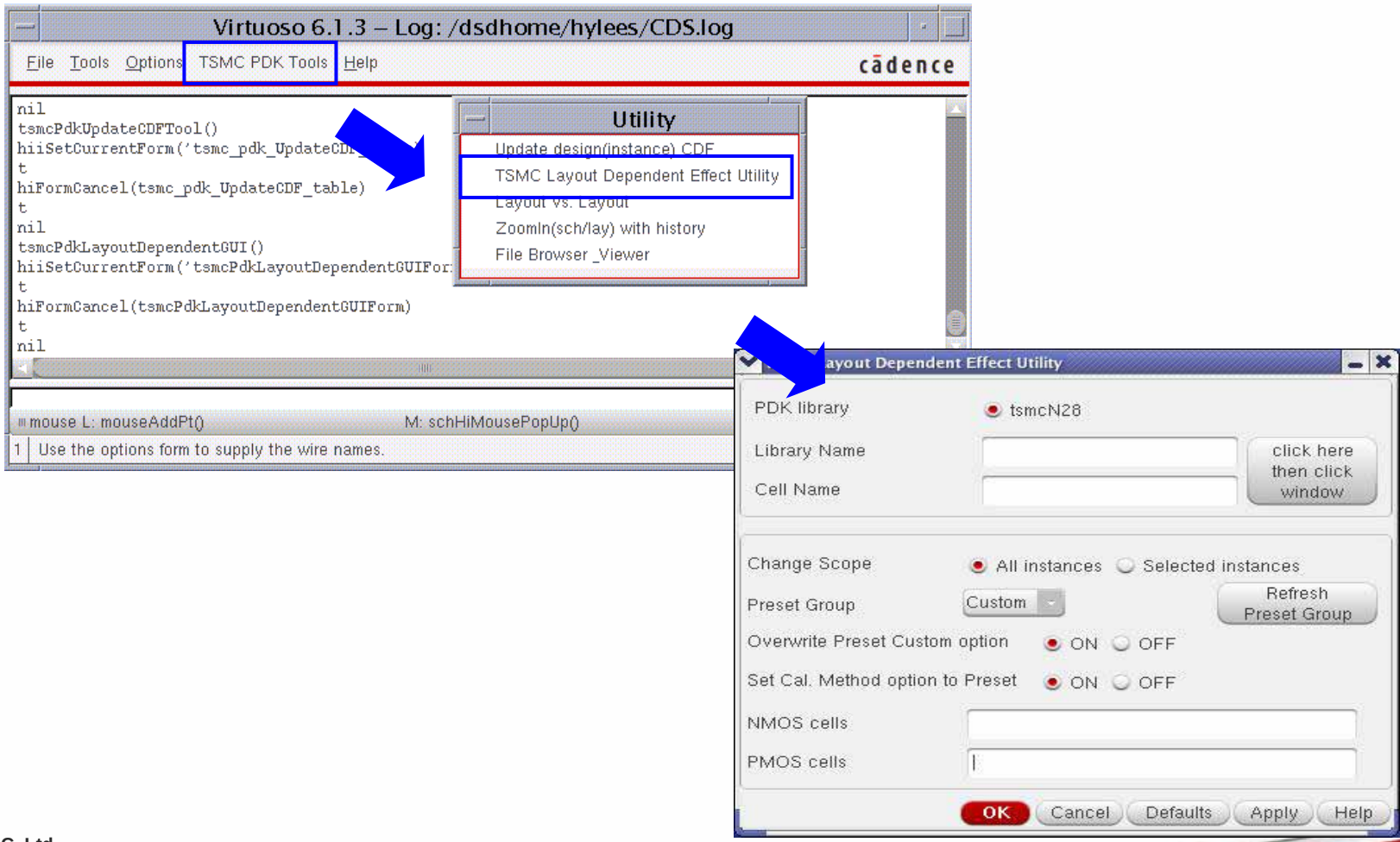
```
I      ./skill/TSMC_LayoutEffect
[Preset1]
    <NMOS>
    <wpe>
        SC_L = 1u
        SC_R = 2u
        SC_T = 3u
        SC_B = 4u
    </wpe>
    <pse>
        SPA_L = 5u
        SPA_R = 6u
        SPB_L = 7u
        SPB_R = 8u
    </pse>
    <ose>
        SFAX_L = 9u
        SFAX_R = 1u
        SFY_T  = 2u
        SFY_B  = 3u
    </ose>
    <cesl>
        ENX_L = 4u
        ENX_R = 5u
        ENY_T = 6u
        ENY_B =7u
        RX_L   =  8u
        RX_R   = 9u
        RY_T   = 1u
        RY_B   = 2u
    </cesl>
    </NMOS>
    <PMOS>
    <wpe>
        SC_L = 1u
        SC_R = 2u
        SC_T = 3u
        SC_B = 4u
    </wpe>
    <pse>
        SPA_L = 5u
        SPA_R = 6u
        SPB_L = 7u
        SPB_R = 8u
    </pse>
```

Preset1 table

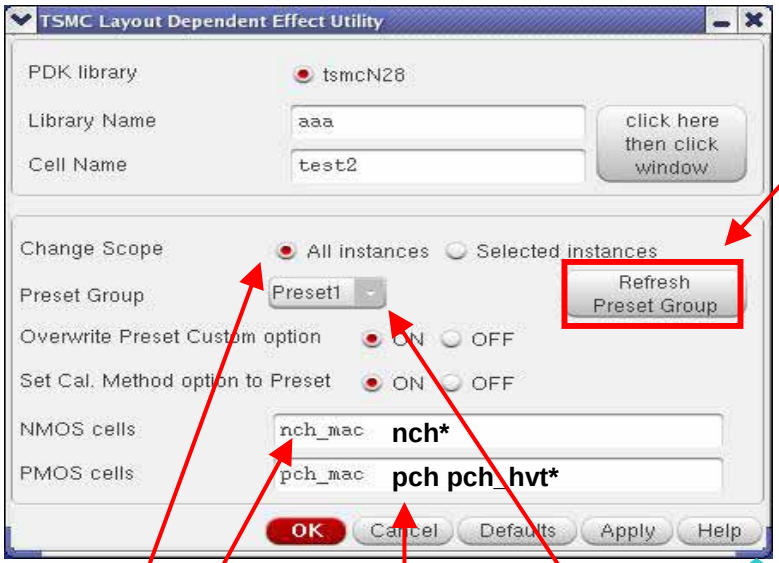
```
IW   TSMC_LayoutEffectTable
[Preset2]
    <NMOS>
    <lod>
        SA = 140n
        SB = 140n
    </lod>
    <wpe>
        SC_L = 1u
        SC_R = 1u
        SC_T = 1u
        SC_B = 1u
    </wpe>
    <pse>
        SPA_L = 0.17u
        SPA_R = 0.17u
        SPB_L = 4u
        SPB_R = 4u
    </pse>
    <ose>
        SFAX_L = 0.24u
        SFAX_R = 0.24u
        SFY_T  = 0.88u
        SFY_B  = 0.88u
    </ose>
    <cesl>
        ENX_L = 4u
        ENX_R = 5u
        ENY_T = 6u
        ENY_B = 7u
        RX_L   = 8u
        RX_R   = 9u
        RY_T   = 1u
        RY_B   = 2u
    </cesl>
    </NMOS>
    <PMOS>
    <lod>
        SA = 110n
        SB = 110n
    </lod>
    <wpe>
        SC_L = 1u
        SC_R = 1u
        SC_T = 1u
        SC_B = 1u
    </wpe>
    <pse>
        SPA_L = 0.14u
        SPA_R = 0.14u
        SPB_L = 4u
        SPB_R = 4u
```

Preset2 table

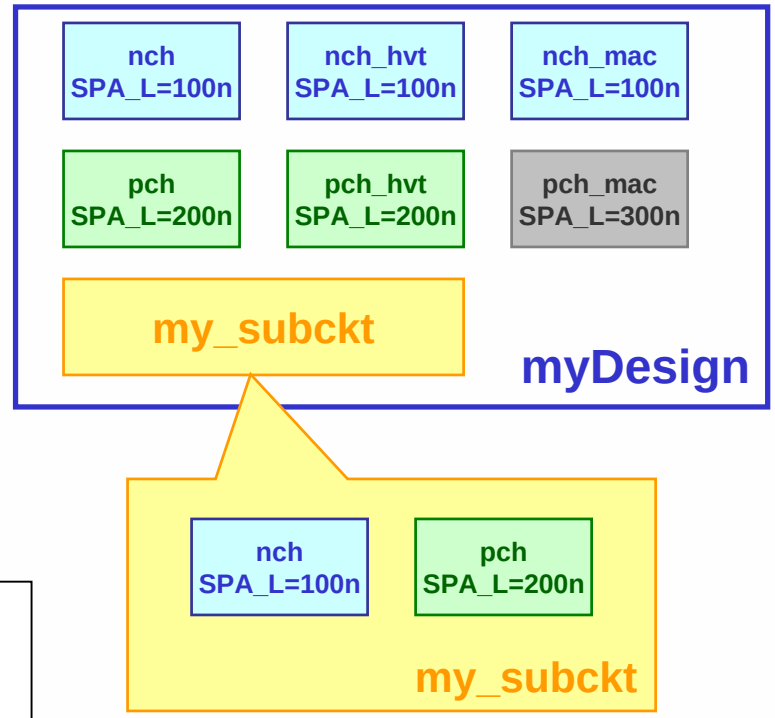
TSMC PDK Tools-Layout Dependent Effect Utility



Specification of Layout Dependent Effect Utility



Press the button to refresh your preset group



Support wildcard and cell list (separated by space)

SPA_L=100n will be applied to "All instances" && "nch*" in cell "myDesign". Which include nch, nch_hvt, nch_mac and my_subckt/nch

SPA_L=200n will be applied to "All instances" && (pch || pch_hvt) in cell "myDesign". Which include pch, pch_hvt and my_subckt/pch.

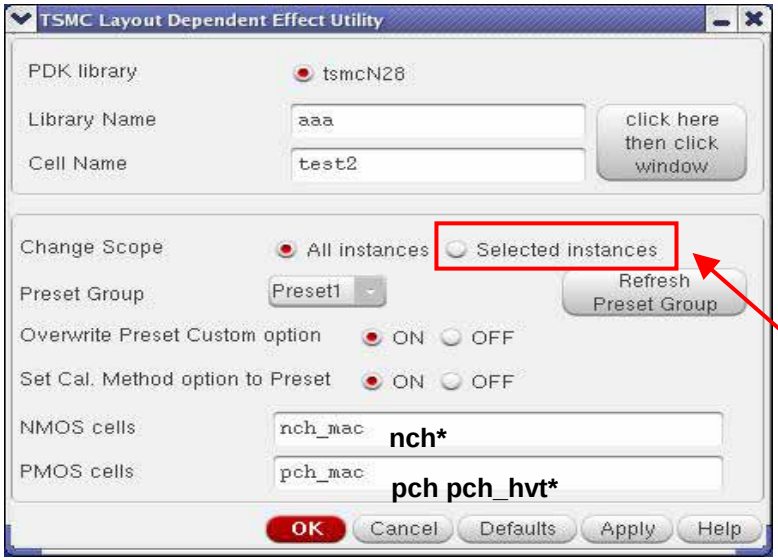
Control File

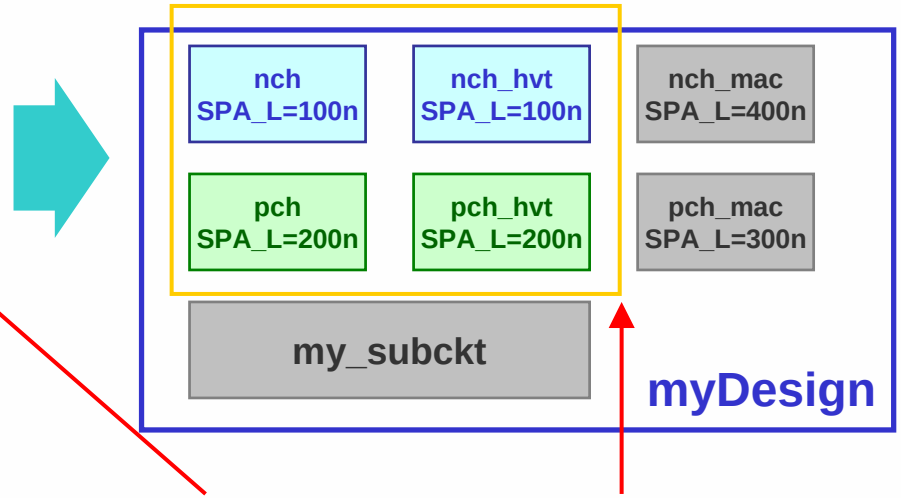
```
<Preset 1>
 NMOS
    SPA_L = 100n
    SPA_R = xxx
    …
 PMOS
    SPA_L = 200n
    SPA_R = xxx
    …
<Preset 2>
…
```

The utility also support hierarchical instances (for more than one level).

**** The utility can only affect those instances with write permission.**

Specification of Layout Dependent Effect Utility (Cont.)





Only apply the change to those instances that selected by mouse.

Control File

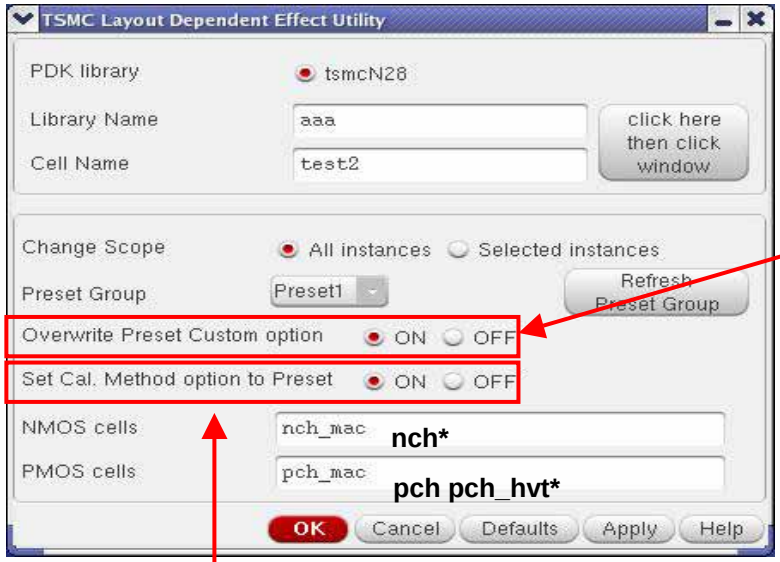
<Preset 1>
NMOS
SPA_L = 100n
SPA_R = xxx
…
PMOS
SPA_L = 200n
SPA_R = xxx
…
<Preset 2>
…

The control file is put at the skill directory named "TSMC_LayoutEffectTable". Hint, there are no limit for preset group.

SPA_L=100n will be applied to "Selected instances" && "nch*" in cell "myDesign". Which include nch, nch_hvt

SPA_L=200n will be applied to "Selected instances" && (pch || pch_hvt) in cell "myDesign". Which include pch, pch_hvt .

Specification of Layout Dependent Effect Utility (Cont.)

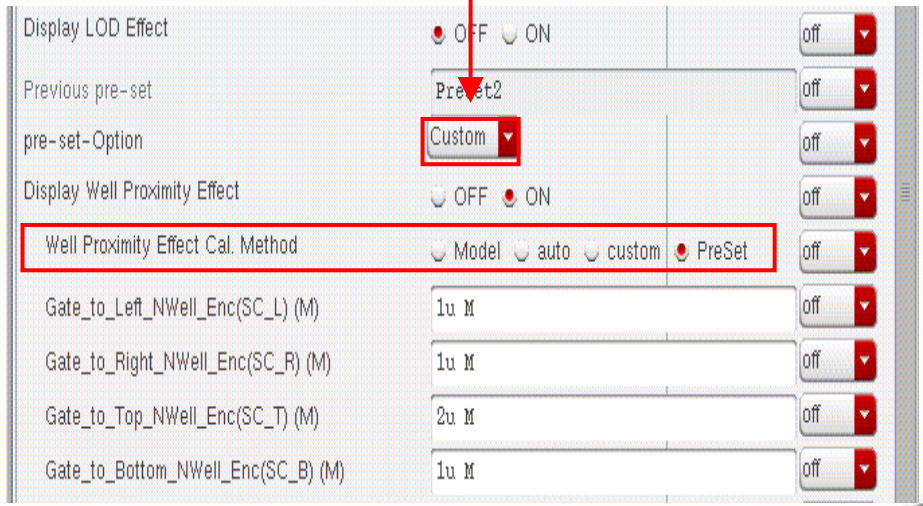


Enable to overwrite the preset option when the original preset option of a instance is "Custom"

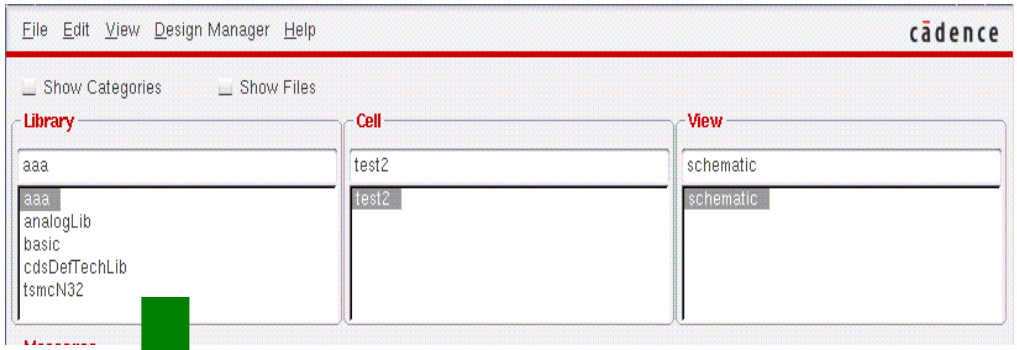
For example, When you turn off this option, This utility will not change the following instance since Its preset option is "Custom"

Enable to reset "Cal. Method option" to Preset

For example, When you turn on this option, This utility will change all Cal. Method CDF options to "Preset".

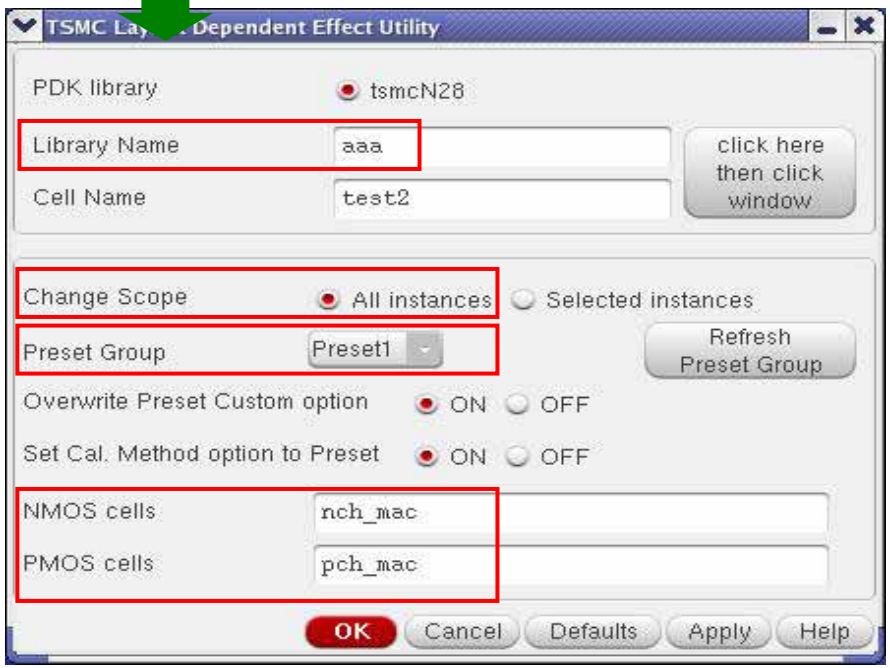


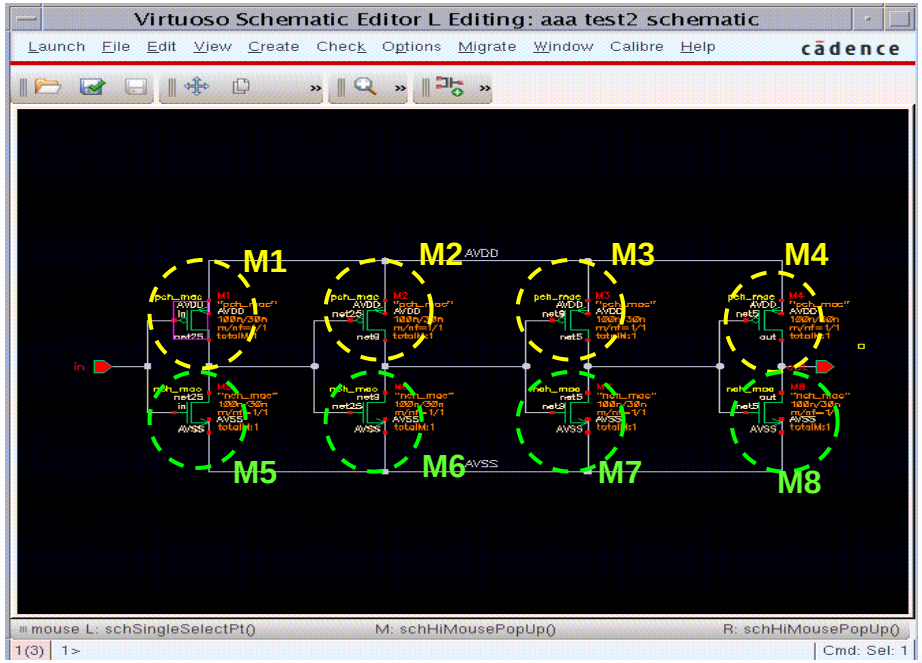
Example 1: Setting LDE parameters of driver by “All instances”



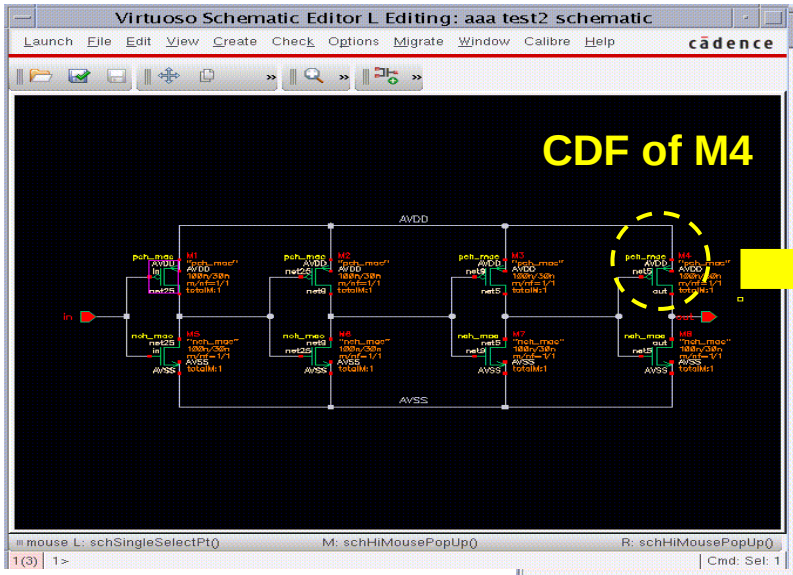
NMOS LDE parameters set to “Preset1” (M1~M4)

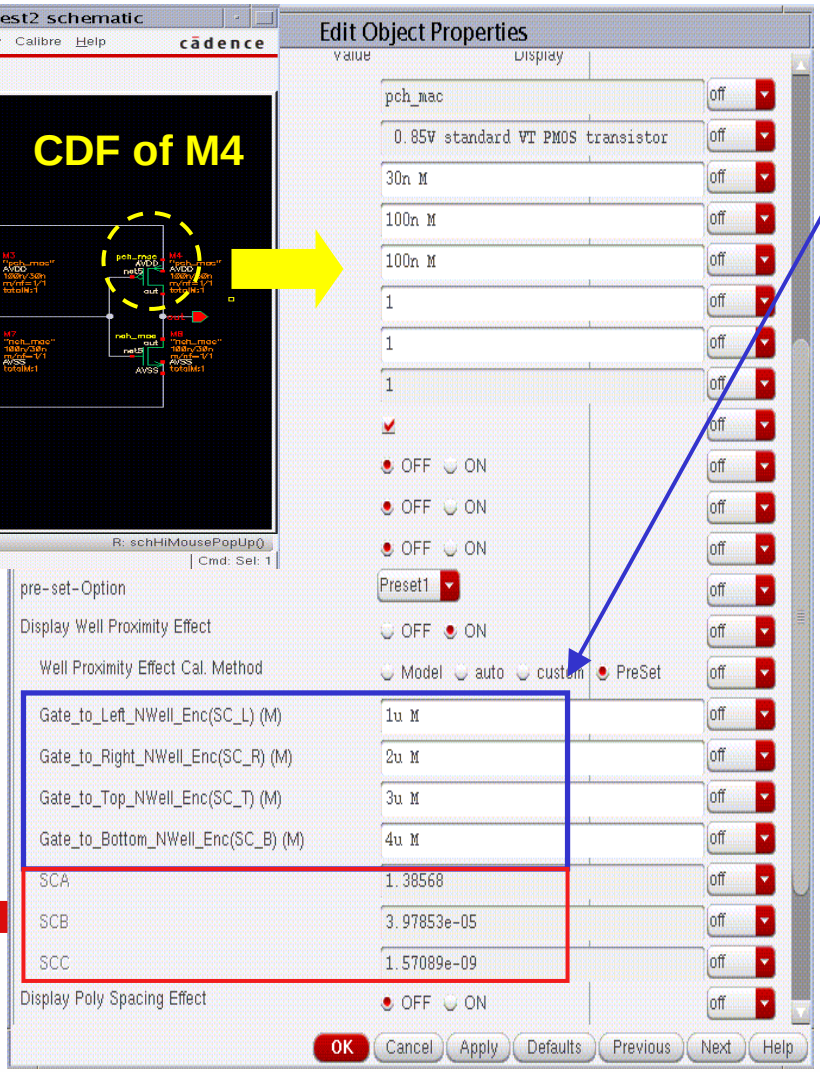
PMOS LDE parameters set to “Preset1” (M5~M8)





Example 1: Setting LDE parameters of driver by “All instances” (Cont.)

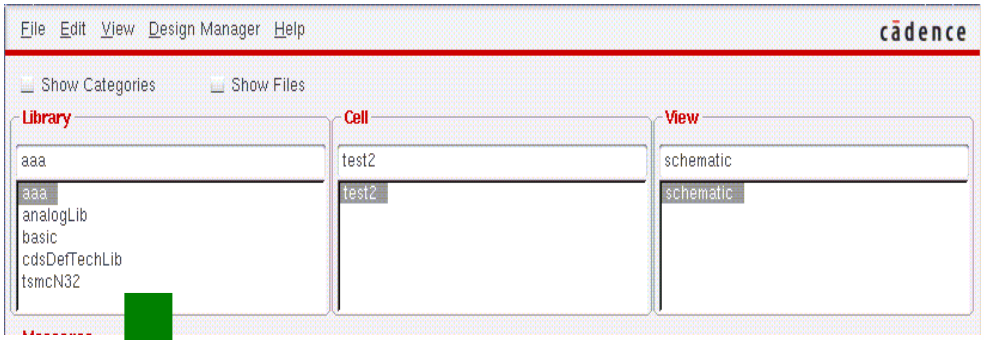




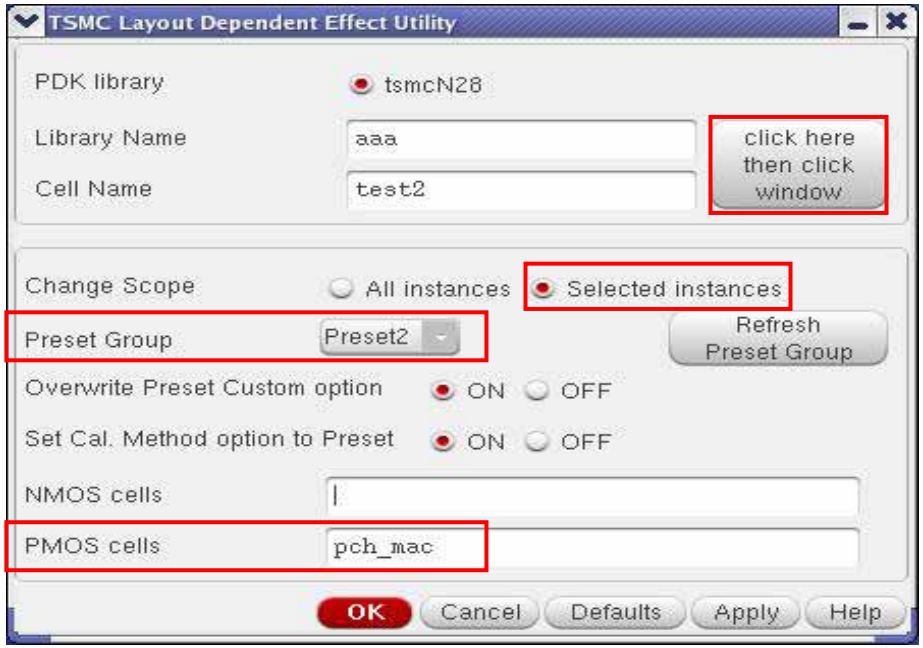

```
I    ./skill/TSMC_LayoutEffect
[Preset1]
  <NMOS>
    <wpe>
        SC_L = 1u
        SC_R = 2u
        SC_T = 3u
        SC_B = 4u
    </wpe>
    <pse>
        SPA_L = 5u
        SPA_R = 6u
        SPB_L = 7u
        SPB_R = 8u
    </pse>
    <ose>
        SFAX_L = 9u
        SFAX_R = 1u
        SFY_T  = 2u
        SFY_B  = 3u
    </ose>
    <cesl>
        ENX_L = 4u
        ENX_R = 5u
        ENY_T = 6u
        ENY_B =7u
        RX_L  =  8u
        RX_R  = 9u
        RY_T  = 1u
        RY_B  = 2u
    </cesl>
    </NMOS>
    <PMOS>
    <wpe>
        SC_L = 1u
        SC_R = 2u
        SC_T = 3u
        SC_B = 4u
    </wpe>
    <pse>
        SPA_L = 5u
        SPA_R = 6u
        SPB_L = 7u
        SPB_R = 8u
    </pse>
```

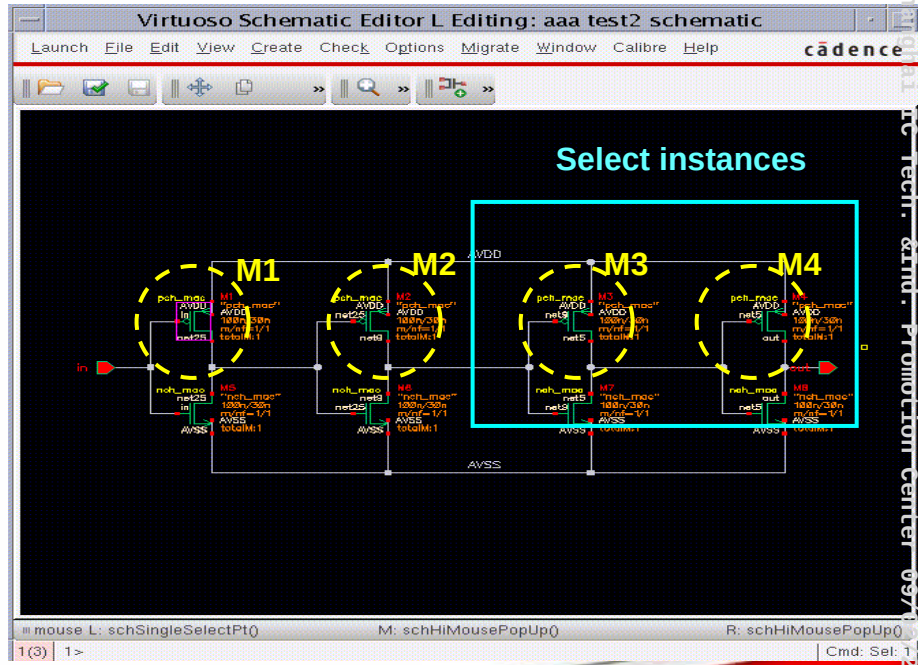
SCA =1.38568
SCB =3.97853e-05
SCC =1.57089e-09

Example 2: Setting LDE parameters of driver by “Select instances”

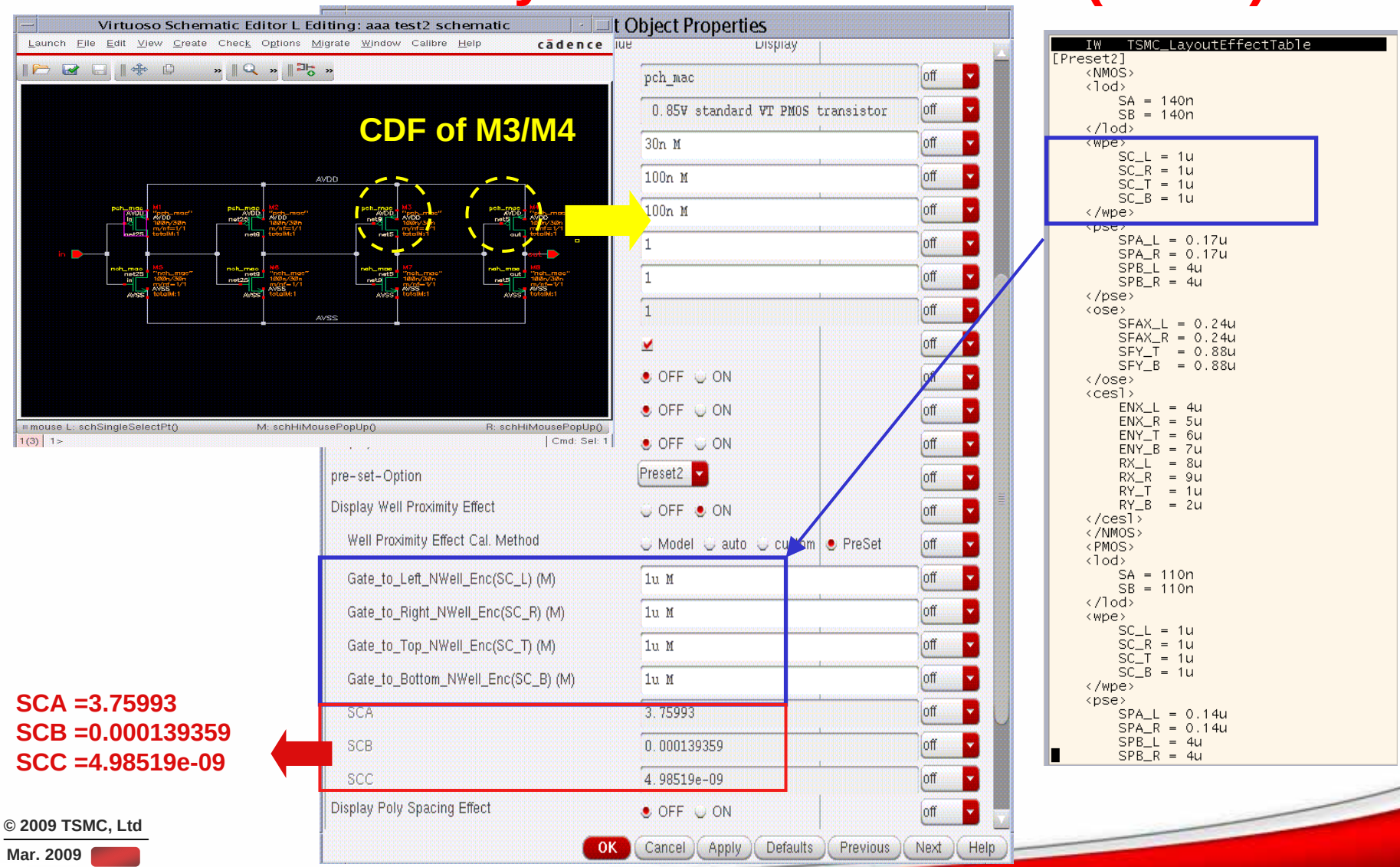


PMOS LDE parameters set to “Preset2” (M3~M4)





Example 2: Setting LDE parameters of driver by “Select instances” (Cont.)




```
IW   TSMC_LayoutEffectTable
[Preset2]
    <NMOS>
    <lod>
        SA = 140n
        SB = 140n
    </lod>
    <wpe>
        SC_L = 1u
        SC_R = 1u
        SC_T = 1u
        SC_B = 1u
    </wpe>
    <pse>
        SPA_L = 0.17u
        SPA_R = 0.17u
        SPB_L = 4u
        SPB_R = 4u
    </pse>
    <ose>
        SFAX_L = 0.24u
        SFAX_R = 0.24u
        SFY_T  = 0.88u
        SFY_B  = 0.88u
    </ose>
    <cesl>
        ENX_L = 4u
        ENX_R = 5u
        ENY_T = 6u
        ENY_B = 7u
        RX_L  = 8u
        RX_R  = 9u
        RY_T  = 1u
        RY_B  = 2u
    </cesl>
    </NMOS>
    <PMOS>
    <lod>
        SA = 110n
        SB = 110n
    </lod>
    <wpe>
        SC_L = 1u
        SC_R = 1u
        SC_T = 1u
        SC_B = 1u
    </wpe>
    <pse>
        SPA_L = 0.14u
        SPA_R = 0.14u
        SPB_L = 4u
        SPB_R = 4u
```

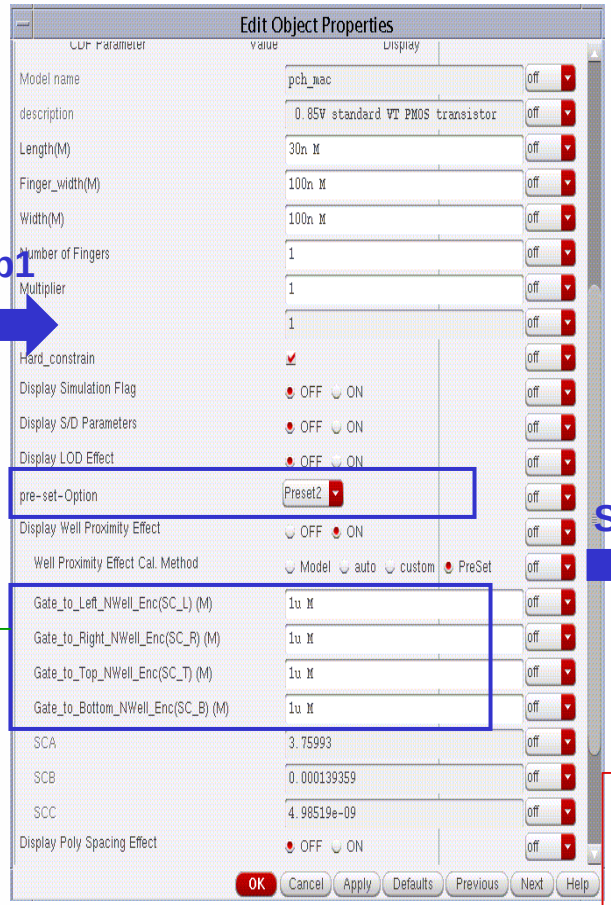
SCA =3.75993
SCB =0.000139359
SCC =4.98519e-09

Example 3: Record the history of modification

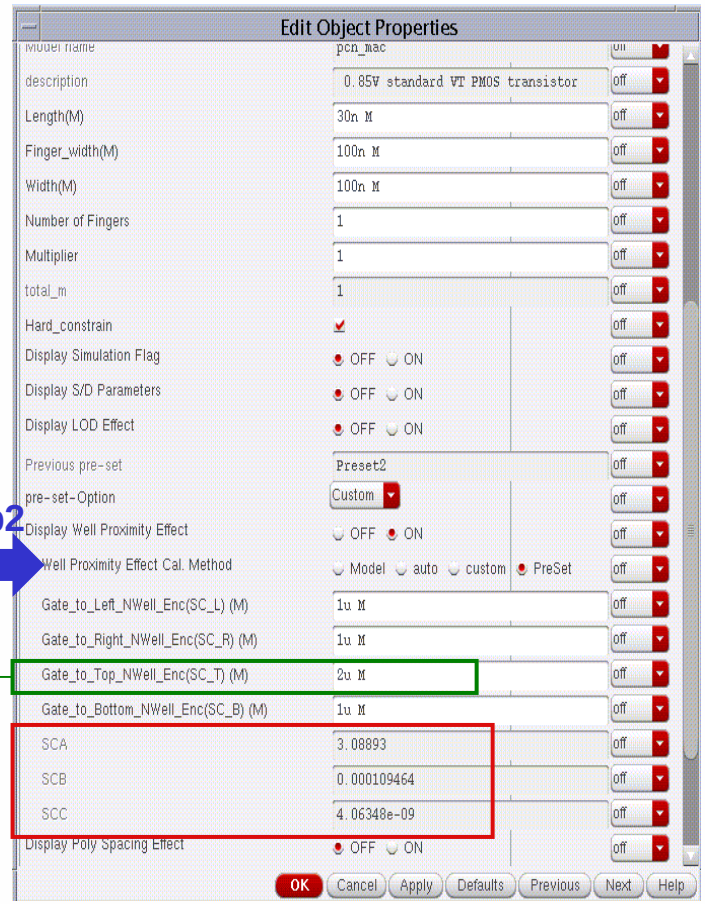
Step1:TSMC preset LDE table of “Preset2”
Step2:Modify SC_T=1u => 2u

```
IW   TSMC_LayoutEffectTable
[Preset2]
    <NMOS>
    <lod>
        SA = 140n
        SB = 140n
    </lod>
    <wpe>
        SC_L = 1u
        SC_R = 1u
        SC_T = 1u
        SC_B = 1u
    </wpe>
    <pse>
        SPA_L = 0.17u
        SPA_R = 0.17u
        SPB_L = 4u
        SPB_R = 4u
    </pse>
    <ose>
        SFAX_L = 0.24u
        SFAX_R = 0.24u
        SFY_T  = 0.88u
        SFY_B  = 0.88u
    </ose>
    <cesl>
        ENX_L = 4u
        ENX_R = 5u
        ENY_T = 6u
        ENY_B = 7u
        RX_L  = 8u
        RX_R  = 9u
        RY_T  = 1u
        RY_B  = 2u
    </cesl>
    </NMOS>
    <PMOS>
    <lod>
        SA = 110n
        SB = 110n
    </lod>
    <wpe>
        SC_L = 1u
        SC_R = 1u
        SC_T = 1u
        SC_B = 1u
    </wpe>
    <pse>
        SPA_L = 0.14u
        SPA_R = 0.14u
        SPB_L = 4u
        SPB_R = 4u
```

Step1



Step2



- Users still can change LDE parameters
  For example of “***SC_T***”

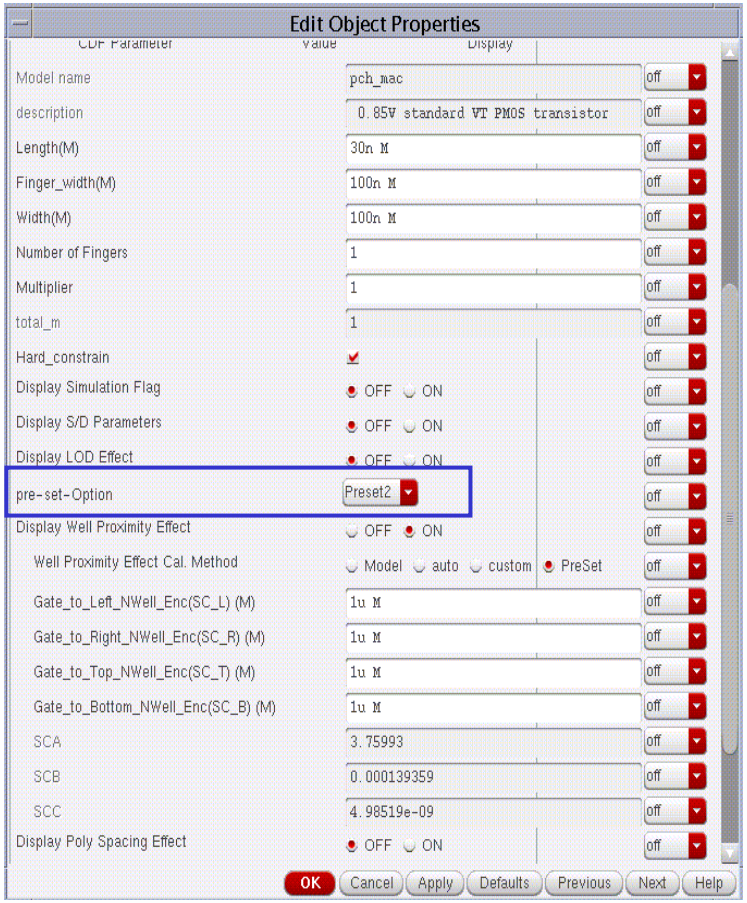
- User modify “***SC_T to 2um “***

- **Get new effective WPE parameters**
  SCA =3.08893
  SCB =0.000109464
  SCC =4.06348e-09

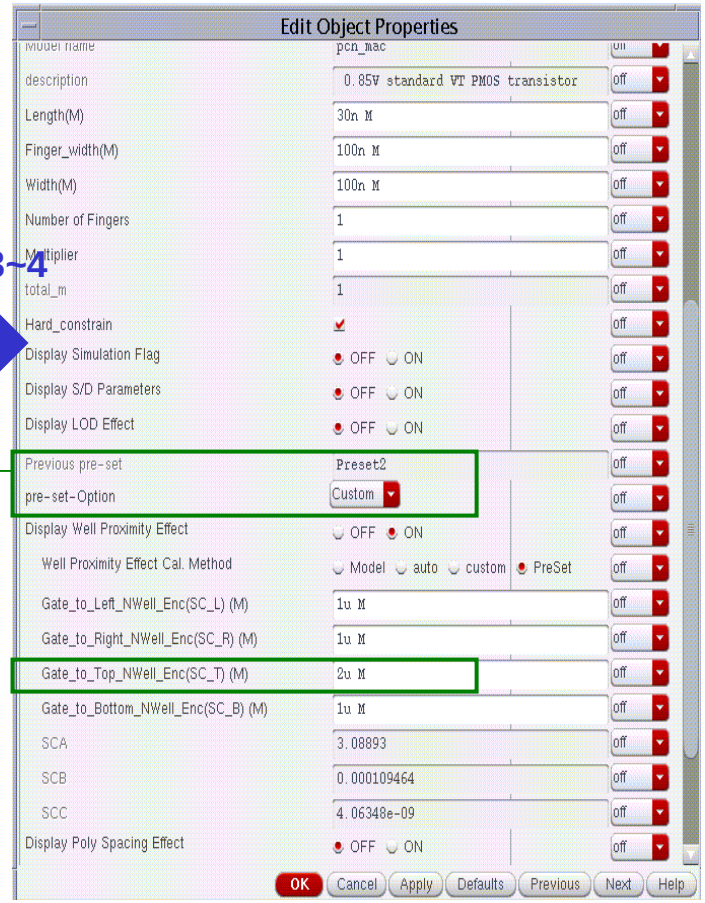
Example 3: Record the history of modification (Cont.)

Step3: CDF shows ***pre-set-Option*** has been modified by custom

Step4: CDF records original LDE parameters from "***Preset2***"



Step3~4



- Now CDF shows "***Custom***" modify
- Record the previous "***pre-set***" table from ***Preset2***