

# Tips and Tricks for Daily Modeling Work

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Never stop thinking

# Agenda

- During this talk I'm going to present to you some tips and tricks, based on experience, I made since the last AKB in Hamburg at NXP during the daily work. We will consider solutions for a:



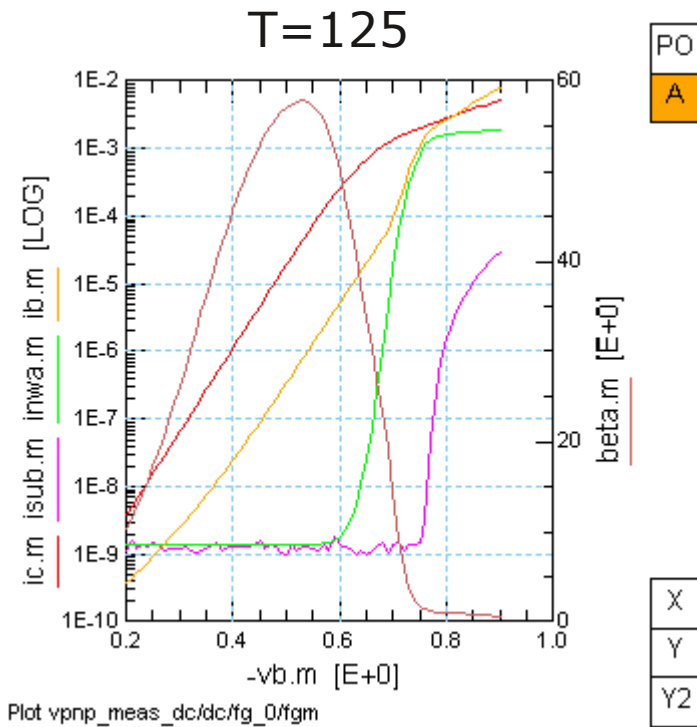
1. DC measurement problem
2. S-parameter measurement problem
3. ICCAP optimization problem and
4. ICCAP plot problem

# Tips and Tricks

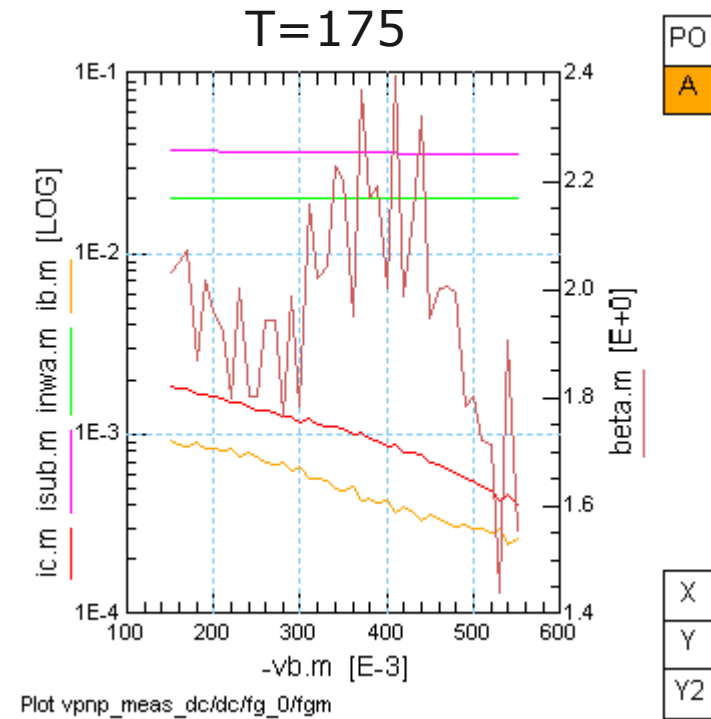
## VPNP forward Gummel measurement (1)



- What happened at T=175 ? Device destroyed by self heating ?



$I_c, I_b, I_{nwa}, I_{sub} = f(V_{be}),$   
 $V_{bc} = 0, T = 125$



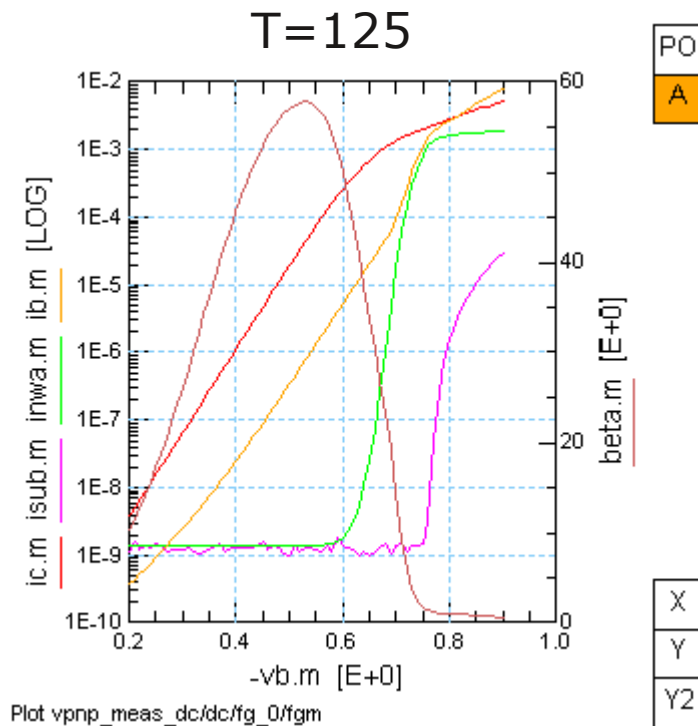
$I_c, I_b, I_{nwa}, I_{sub} = f(V_{be}),$   
 $V_{bc} = 0, T = 175$

# Tips and Tricks

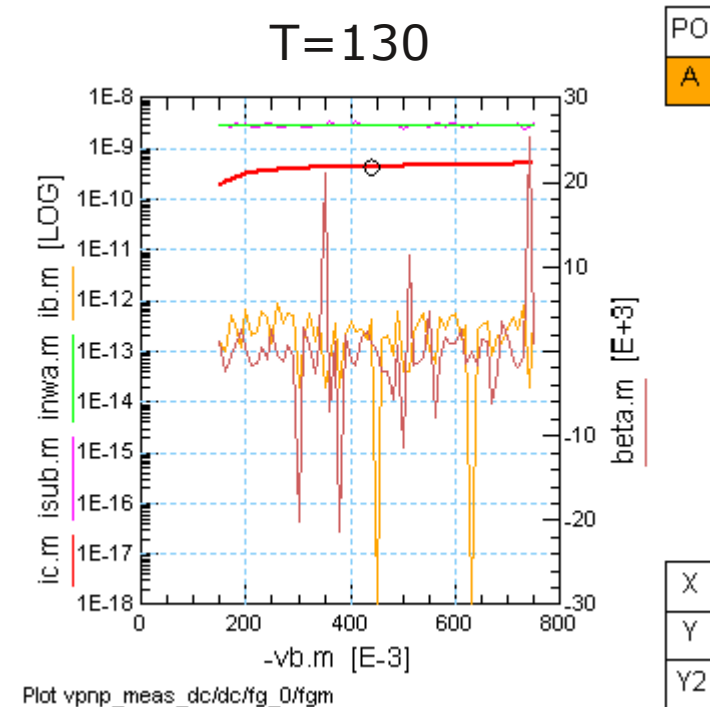
## VPNP forward Gummel measurement (2)



- If temperature was reduced, device was revitalized!
- At T=130 C the effect appeared again, but different curves



$I_c, I_b, I_{nwa}, I_{sub} = f(V_{be}),$   
 $V_{bc} = 0, T = 125 \text{ C}$

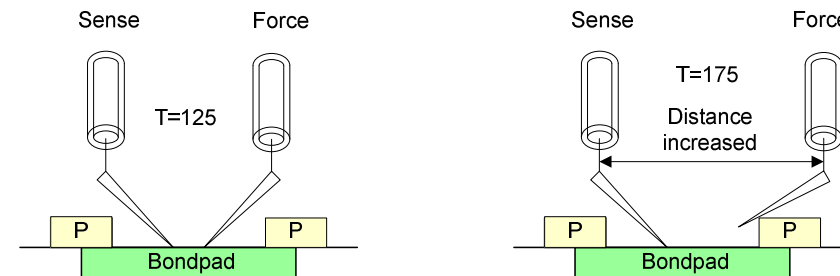


$I_c, I_b, I_{nwa}, I_{sub} = f(V_{be}),$   
 $V_{bc} = 0, T = 130 \text{ C}$


# Tips and Tricks

## VPNP forward Gummel measurement (3)

- The reason was simple, but difficult to detect
- We used force-sense-probes at B and E
- Distance between force- and sense probes was increased with rising temperature
- Because of the small bond pad dimensions, this caused a missing contact at the force probe at high temperatures
- Solution: Increase pad dimensions or don't use FS probes for high temperature measurements



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# Tips and Tricks

## Measurements with Agilent's E5071C (1)

- The E5071C covers a frequency range from 100 kHz to 8.5 GHz
- It is appropriate for BJT two port s-parameter measurements for lower ft-technologies, like power technologies
- ICCAP 2006 includes a driver, but it has several restrictions:
  - a) Log freq-sweep is not possible
  - b) We found, that the number of measurement points must not exceed 1575



$$pts_{max} = pts_{freq} * pts_{vb} * pts_{vc} \leq 1575$$

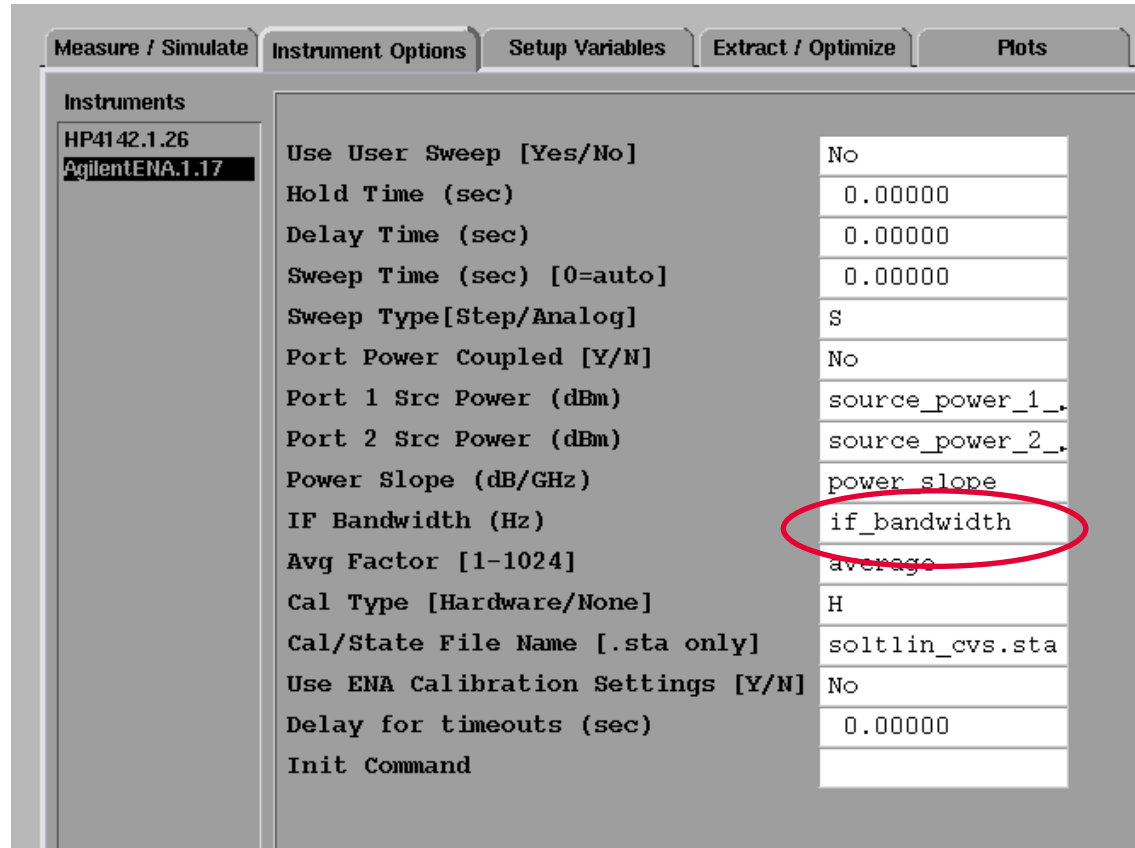
- For these reasons, it is recommended to use ICCAP 2008, which in turn needs SUN Solaris10 or RedHat4.0

# Tips and Tricks Measurements with Agilent E5071C (2)



- E5071 allows to reduce the IF bandwidth instead of increase the average
- It is recommend to use this possibility to increase the measurement accuracy

Option	value
source_power_1_E5071C	-30
source_power_2_E5071C	-30
power_slope	0.2
if_bandwidth	10
average	1

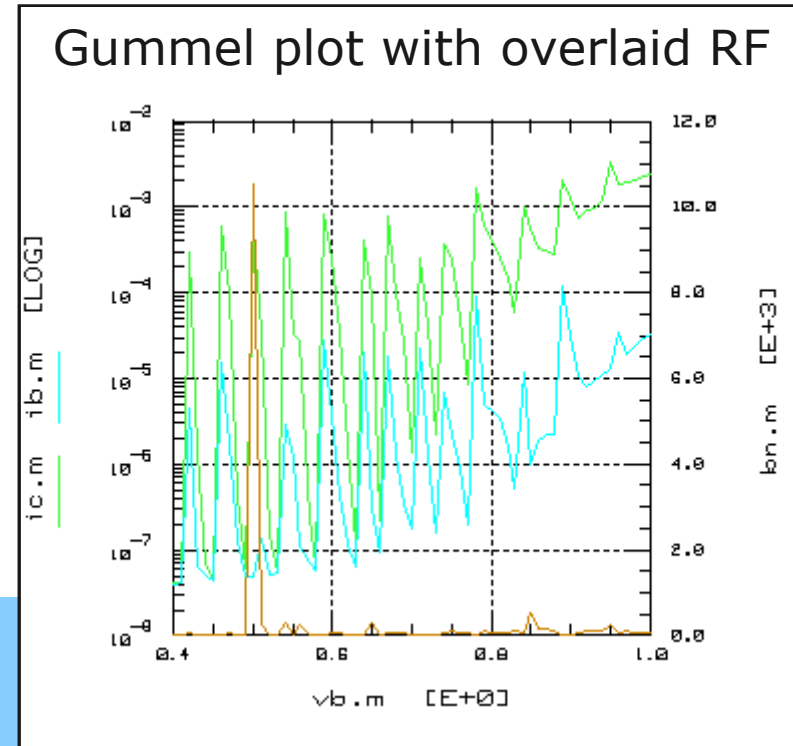


# Tips and Tricks

## Measurements with Agilent's E5071C (3)



- If you want to avoid these kind of "nice" Gummel plots, you have to make sure, that the RF Output of the E5071C is OFF, before you run DC measurements
- You may set it by hand or use two lines of the following script in your do\_it\_measure-transform



```

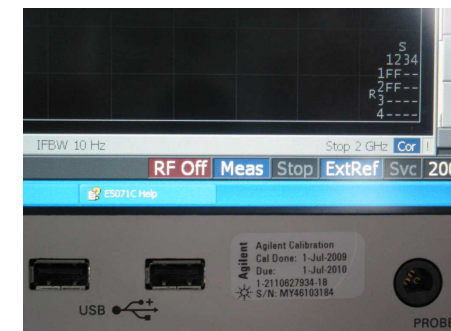
!----- ac measurement -----
LINPUT "do_it_meas

Run cvs(vb) measurement ?


                                0/1",1, answer

IF val$(answer)=="0" THEN
    print "transform aborted!"
    COMPLEX tmp[1]
    return tmp
END IF

IF val$(answer)=="1" THEN
    IF val$(sw_measure)=="1" THEN
        ICCAP_FUNC(setup_path,"Measure")
        ICCAP_FUNC("Hardware","HPIB Analyzer/Set Active Address","17")
        ICCAP_FUNC("Hardware","HPIB Analyzer/Send String", ":OUTPUT:STATE OFF")
    END IF
END IF
    
```



# Agenda

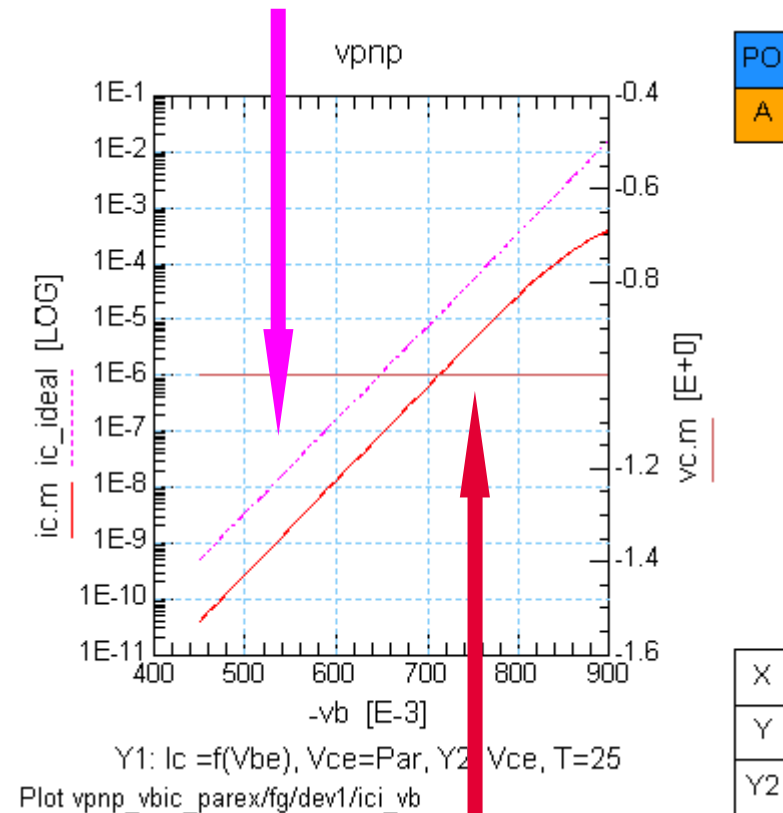
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# Tips and Tricks ICCAP-Optimizer (1)



- Situation:  
Sometimes it gives advantage to use a **calculated** quantity instead of a simulated as the “simulated” quantity in an ICCAP-optimizer
- Advantage:  
A calculation is running much faster, than a simulation.  
Consequently, the optimization is running much faster.

Calculated ideal collector current  
 $ic\_ideal = SIMULATED$

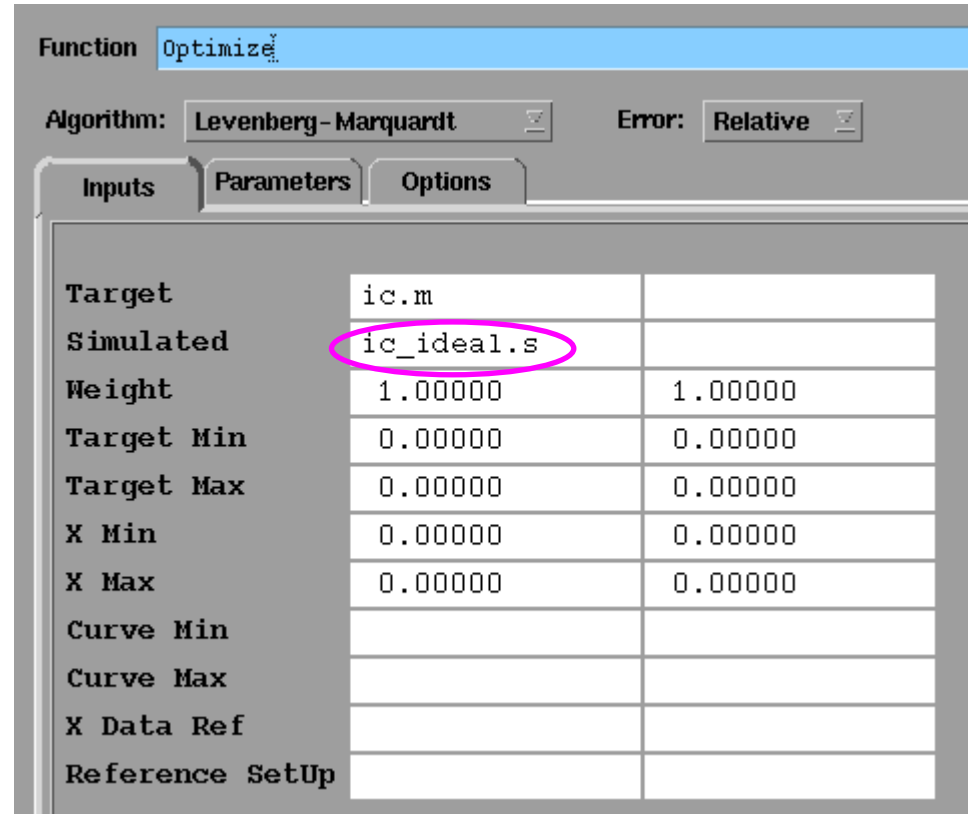


Measured collector current  
 $ic.m = TARGET$

# Tips and Tricks ICCAP-Optimizer (2)



- Problem: If you run an optimization, in sometimes ICCAP starts simulations, despite you have defined a **calculated** quantity instead of a simulated as "SIMULATED" quantity in an ICCAP-optimizer
- Consequence: Contrary to your goal, no time will be saved
- What is the reason?



```
|----- ic_ideal calculation -----|
s=size(tmp_v)
COMPLEX tmp_i,s[s]
i=0
WHILE i<s
    tmp_i,s[i]=tmp_is*exp(tmp_v[i]/(tmp_vt*tmp_nf))
i=i+1
END WHILE
```

# Tips and Tricks ICCAP-Optimizer (3)



- `ic_ideal` is calculated using a PEL transform
- If you use both the sweep-variable (`Vb` in this case) as input and an additional output (e.g. `ic.m`) for this transform, ICCAP will start a simulation for each optimization loop
- If you, however, use only the sweep-variable (`Vb`) as input for this transform, optimization is running fast without starting a simulation

```
!090616
!090617
!-----
print
IF VAL$(debug)=="1" THEN print "ic_ideal ...", setup_path

!----- inputs -----
tmp_v=abs(vb)
TEMP_K=TEMP+273
tmp_nf=pnp.nf
tmp_vt=k*TEMP_K//q
tmp_is=scaling_slope*aer+scaling_y0

!----- ic_ideal calculation -----
s=size(tmp_v)
[COMPLEX tmp_i,s[s]
i=0
WHILE i<s
    tmp_i,s[i]=tmp_is*exp(tmp_v[i]//(tmp_vt*tmp_nf))
i=i+1
END WHILE

!----- return -----
IF VAL$(device_type)=="pnp" OR VAL$(device_type)=="vpnp" THEN
    return -tmp_i
ELSE
    return tmp_i
ENDIF
```

Inputs and Outputs used in transform <code>ic_ideal</code>	Simulator	Optimization speed
<code>vb</code> (= sweep) <code>ic.m</code>	will run	slow
<code>vb</code> (= sweep)	will NOT run	fast

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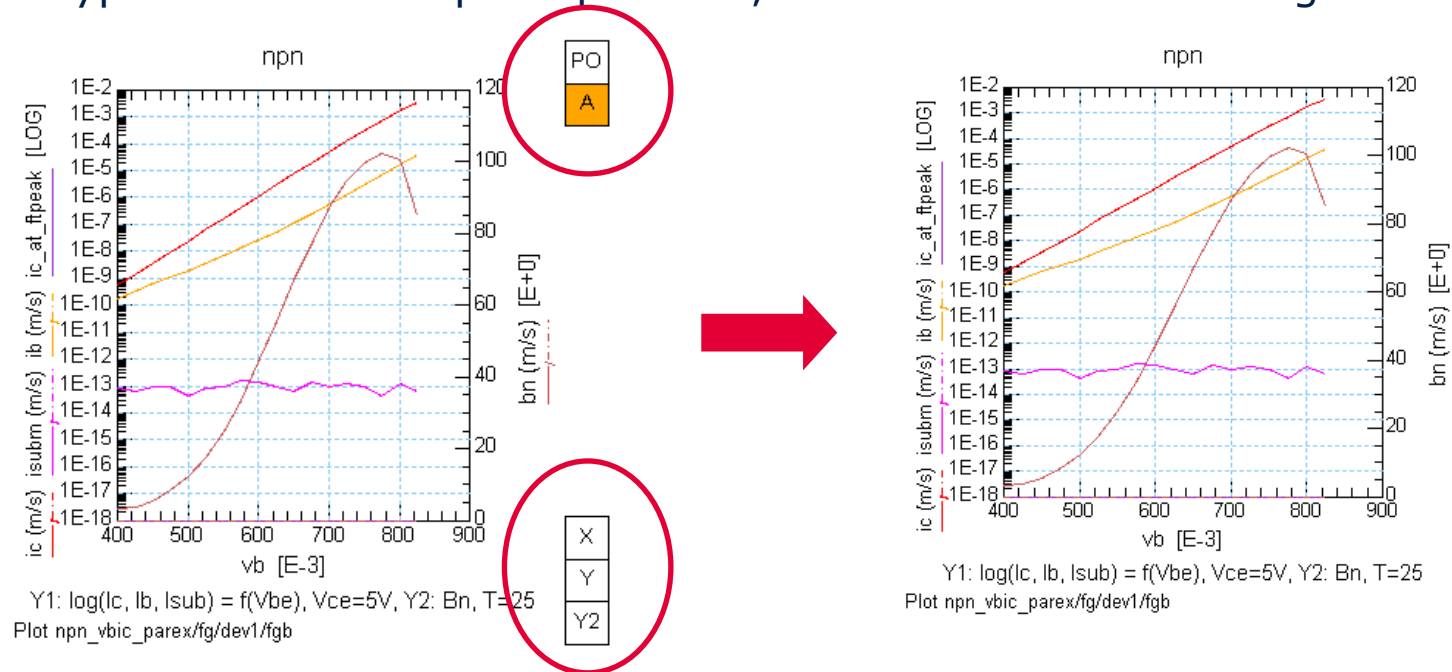
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# Tips and Tricks

## Area tools in ICCAP plots

- Since ICCAP 2006 you may use the so called plot area tools, useful to switch the axis type or to run the plot optimizer, but sometimes confusing for non-experts



- You may switch on / off these tools using the following two lines

```

IF VAL$(plot_area_tools)=="0" THEN
    ICCAP_FUNC(plot_select_sim[0][i],"Area Tools Off")
ELSE
    ICCAP_FUNC(plot_select_sim[0][i],"Area Tools On")
ENDIF
ICCAP_FUNC(VAL$(plot_select_sim[0][i]),"Display Plot")
    
```

Thank you for your attention!