

HICUM - Productization and Support Update

Michael Schroter, Anindya Mukherjee

Dept. of Electrical and Computer Engin.
University of California at San Diego
USA

CEDIC
University of Technology Dresden
Germany

mschroter@ieee.org

http://www.iee.et.tu-dresden.de/iee/eb/hic_new/hic_start.html

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OUTLINE

- HICUM/L2 Support Activities
- HICUM/L0 Support Activities

HICUM/L2 Support Activities

Version 2.23

- Available on HICUM website along with release note
- Complete and revised L2 documentation incorporating all previous release notes, incl.
 - description of vertical NQS effect implementation
 - noise correlation between base and collector current
 - updated parameter lists
- *Previous action item **closed**:*
use access to the convergence control parameters of simulator (e.g. GMIN) in the VA code
 - `'define Gmin $simparam("gmin",1e-12)'` works with both ADS, SPECTRE (& ADMS, Tiburon)
 - also works with NGSPICE (*Ref: D.Celi, ST*)

HICUM/L2 Support Activities (contd.)

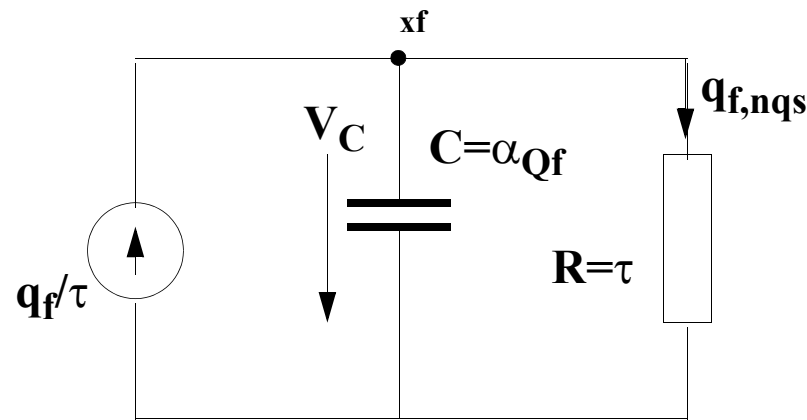
- Minor code related changes:
 - *DT0H* has been assigned the range $(-inf:inf)$
 - The range of *VPT* has been modified to $(0:inf]$ from $[0:inf]$
 - The punch-through voltages should be limited to values > 0
 - Temperature coefficient range has been modified to $[-10:10]$
- Further model improvements towards next version
 - Simplified input NQS adjunct circuit
 - More convenient implementation for correlated noise
- CMC Quality Assurance
 - Setup is complete
 - => see plots later
- Few Simulator related testing issues
 - => see plots later

HICUM/L2 Support Activities (contd.)

Further Improvements (towards next version)

- Simplify input NQS adjunct circuit to RC network
 - goal: save 1 node without loss of accuracy
 - input delay described by first-order approximation

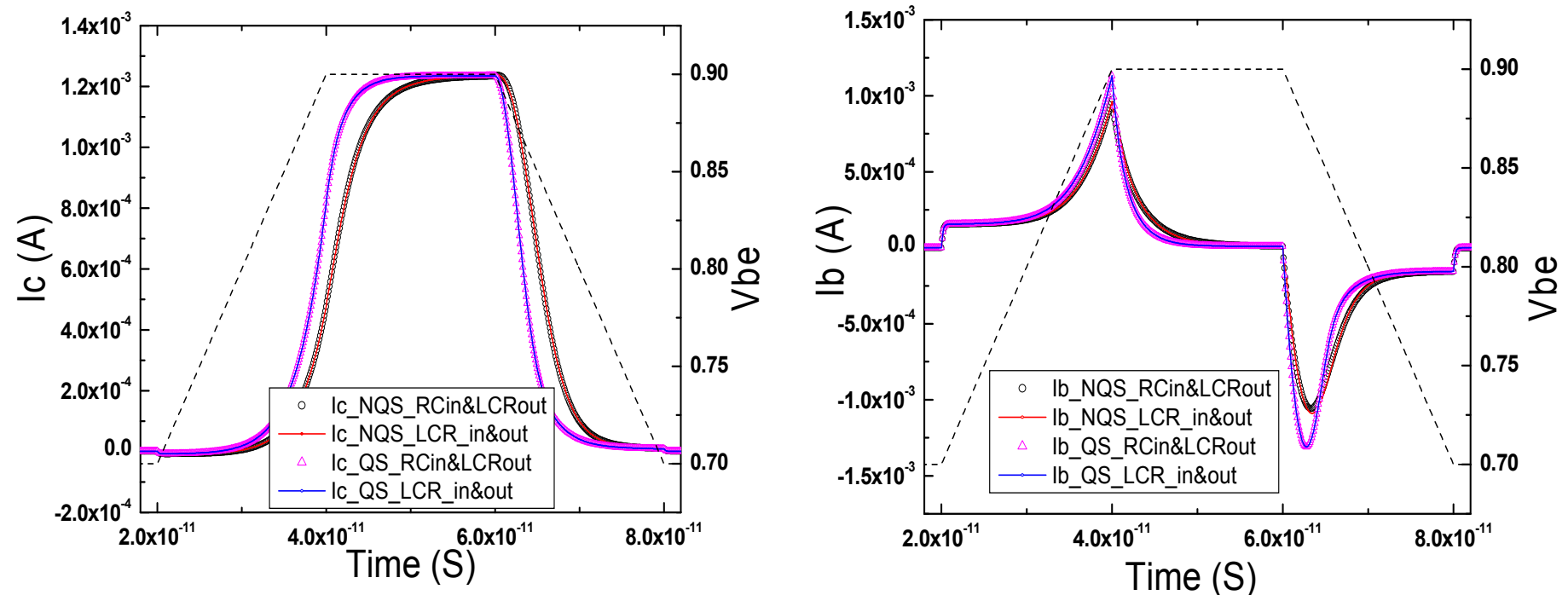
$$\frac{\underline{Q}_{f,nqs}(\omega)}{\underline{Q}_f} = 1 - s\tau \cong \frac{1}{1 + \tau_1 s} \quad \longrightarrow \quad \frac{dq_{f,nqs}}{dt} + q_{f,nqs} = q_f(t)$$



Simplified input NQS effect modeling (1/2)

RC input & LCR-type output adjunct network

- Time domain results: comparison to existing version (LCR also in input)



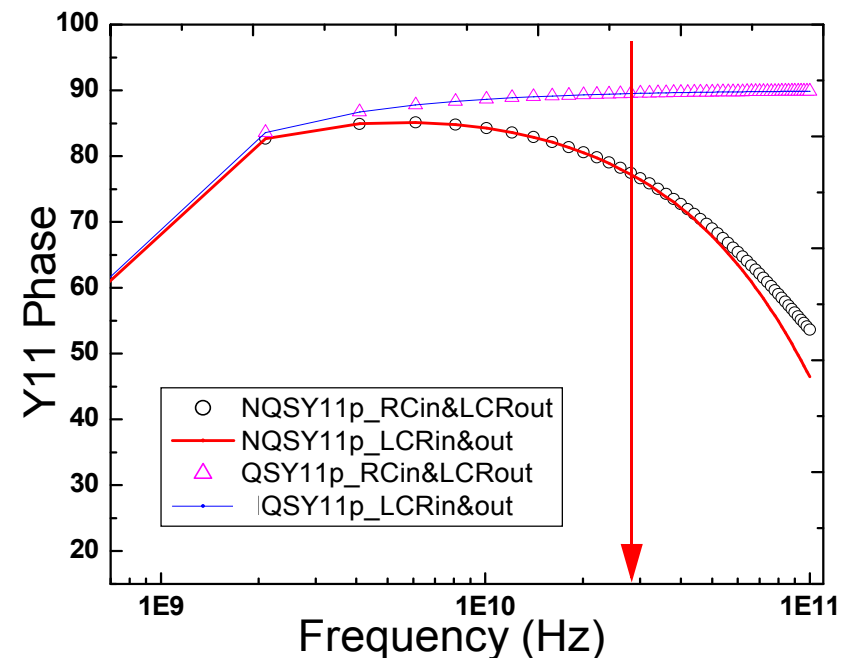
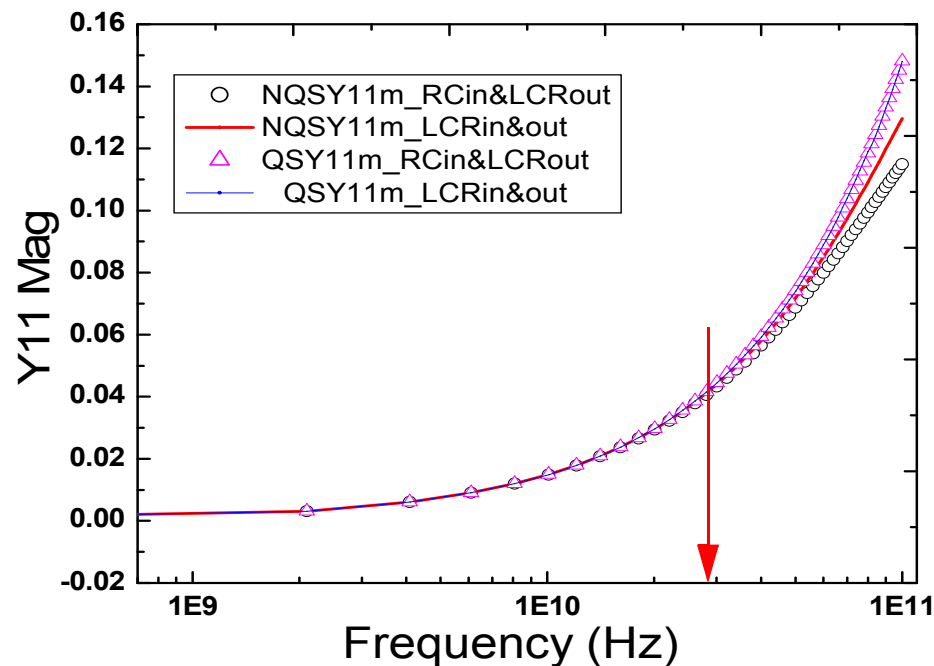
- ringing eliminated by proper normalization

=> Good agreement with existing solution

Simplified input NQS effect modeling (2/2)

RC input & LCR-type output adjunct network

- Frequency domain results: RC input & LCR-type output adjunct network compared to existing version ($V_{BC} = 0V$, $I_C = 1.1974e-3$, $f_T = 29$ GHz)



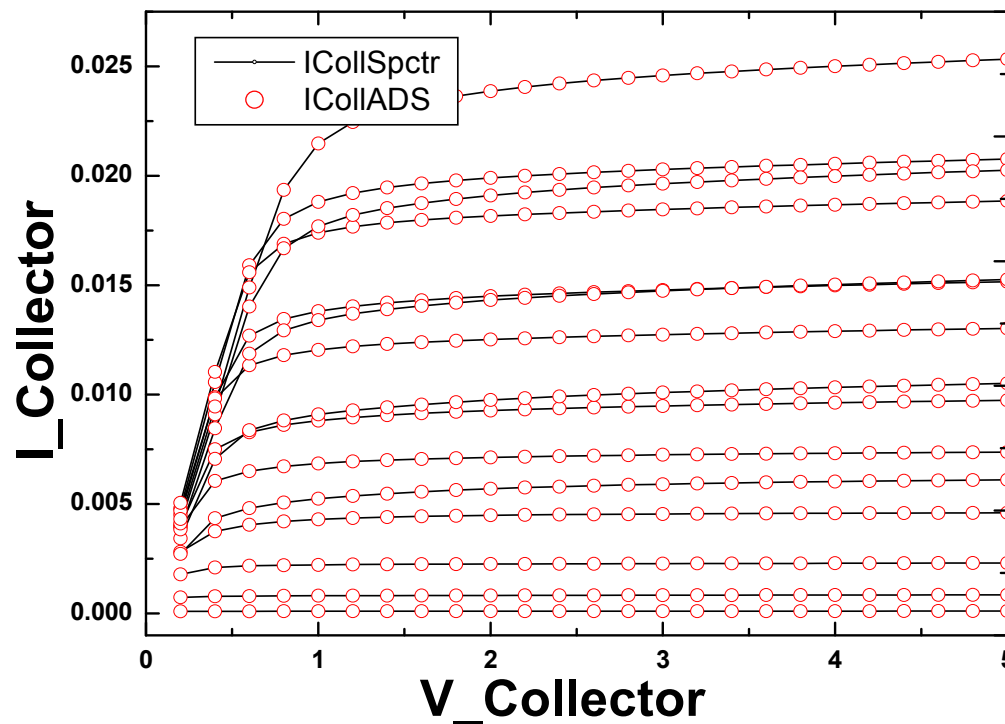
=> same trend as in comparison with device simulation
=> accurate beyond f_T

CMC Quality Assurance

- Proposed by CMC: standard way of testing compact models to help model developers, model implementers, and model users
- Purpose
 - verify correctness of the definition/implementations of a model in circuit simulators
 - An individual test specification exists for each model
 - Tests are defined for DC, AC, and noise simulations, over a frequency and temperature
 - Tests can be performed with different simulators
 - Presently, no tests are defined for *Transient Analysis*
 - Only voltage biasing available, no *current* controlled biasing is allowed
- All the tests modules are written in PERL

CMC Quality Assurance (contd.)

- Setup has been completed for Spectre and ADS
 - DC tests: pin Voltage & Currents
 - AC tests: Y parameters

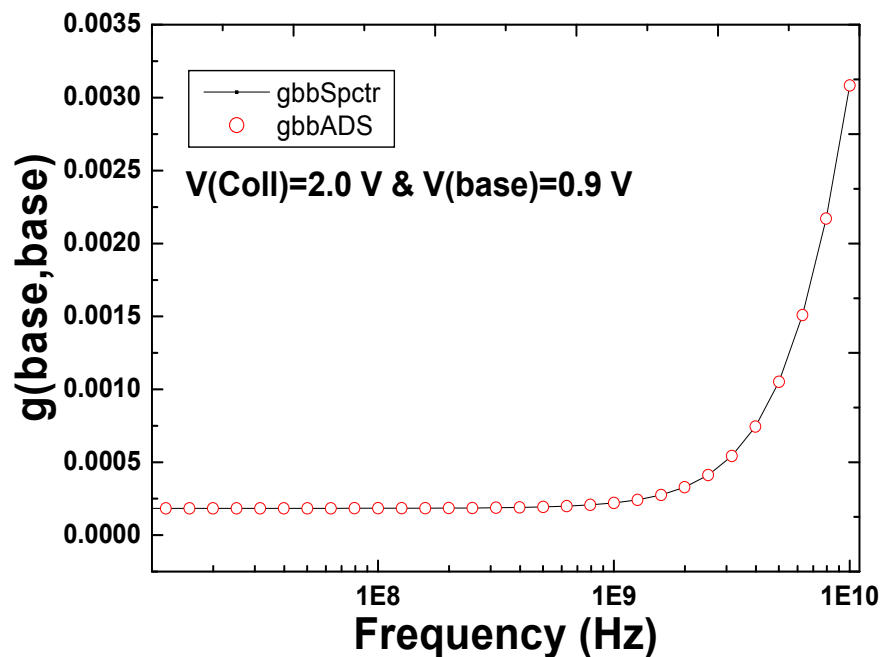


Tests have been done with latest HICUM/L2 VA Code

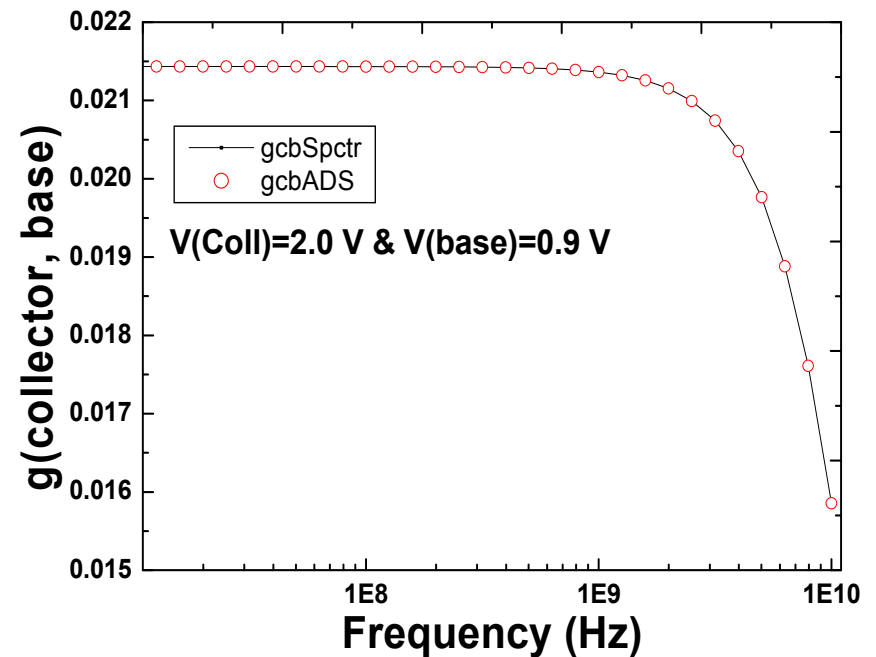
CMC Quality Assurance (contd.)

- NQS test in frequency domain
 - Comparing the conductances

$$g(\text{base}, \text{base}) = \text{Re}(y_{11})$$



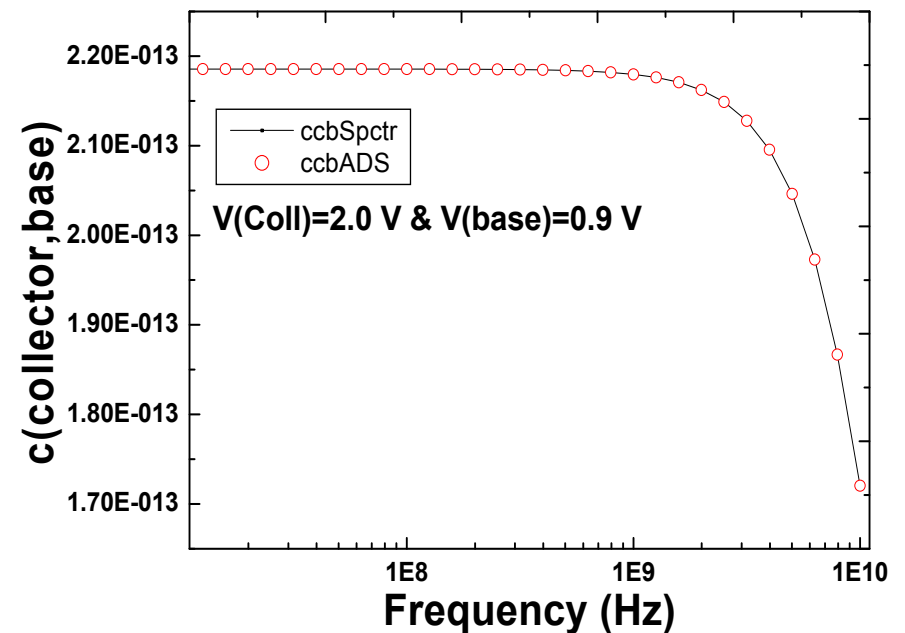
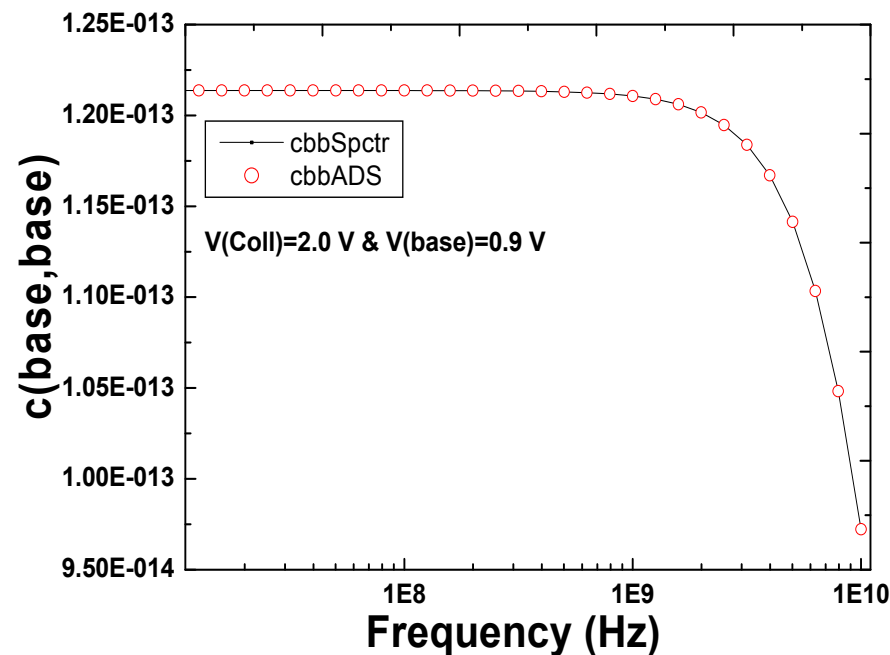
$$g(\text{collector}, \text{base}) = \text{Re}(y_{21})$$



CMC Quality Assurance (contd.)

- NQS test in frequency domain

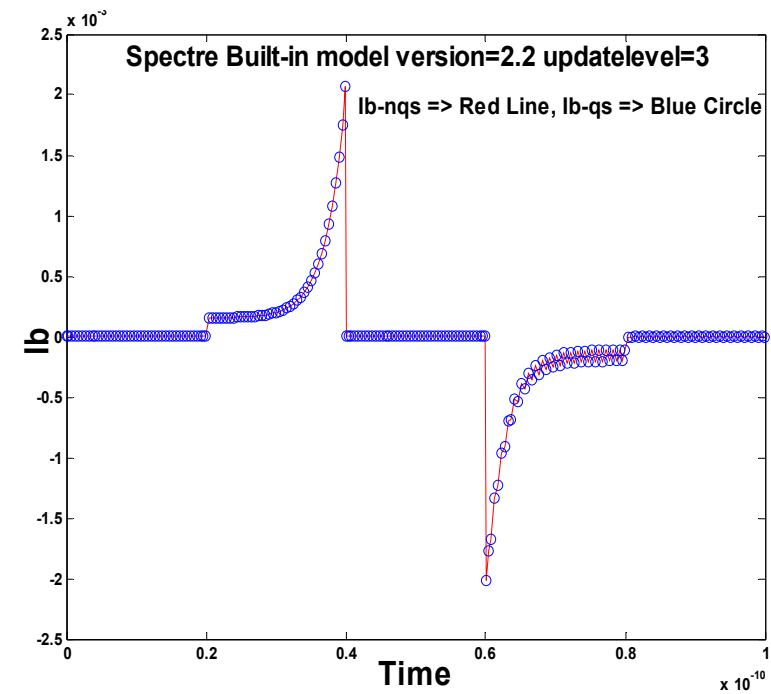
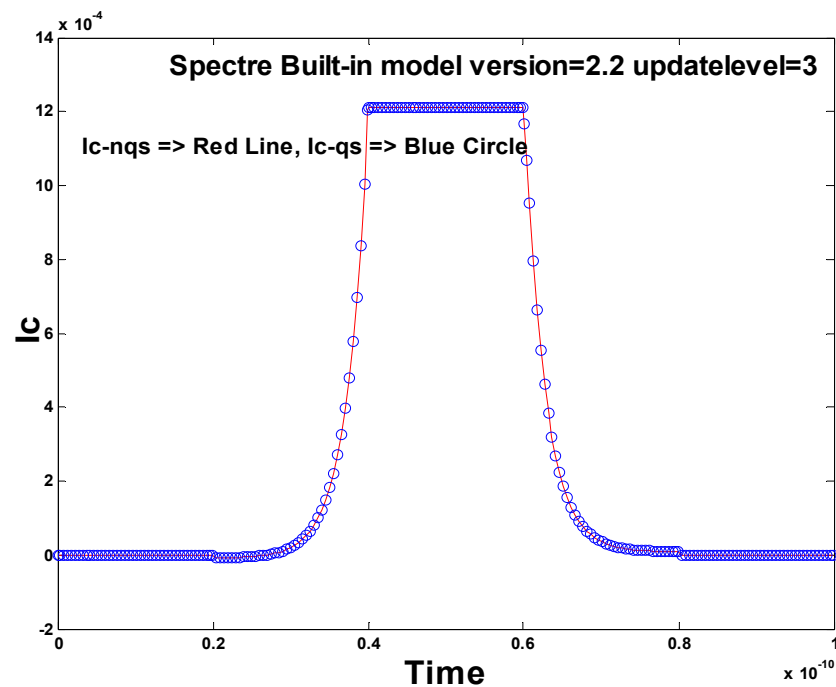
$$c(,) = \text{Im}(y)/(2*\pi*f)$$



=> Good agreement between Spectre & ADS results

Simulator related testing issues

- Remaining simulator related testing issues (requests by users)
 - Behavior of 'FLNQS' in Spectre *version=2.2 updatelevel=3* (R.Murty, IBM)
 - Transient analysis with Spectre HICUM *Built-in* model *version=2.2 updatelevel=3*

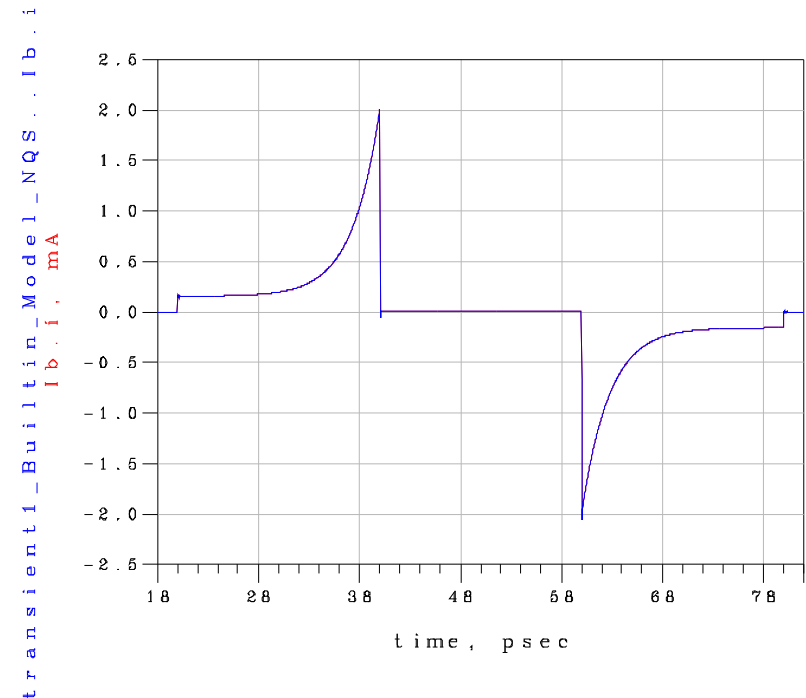
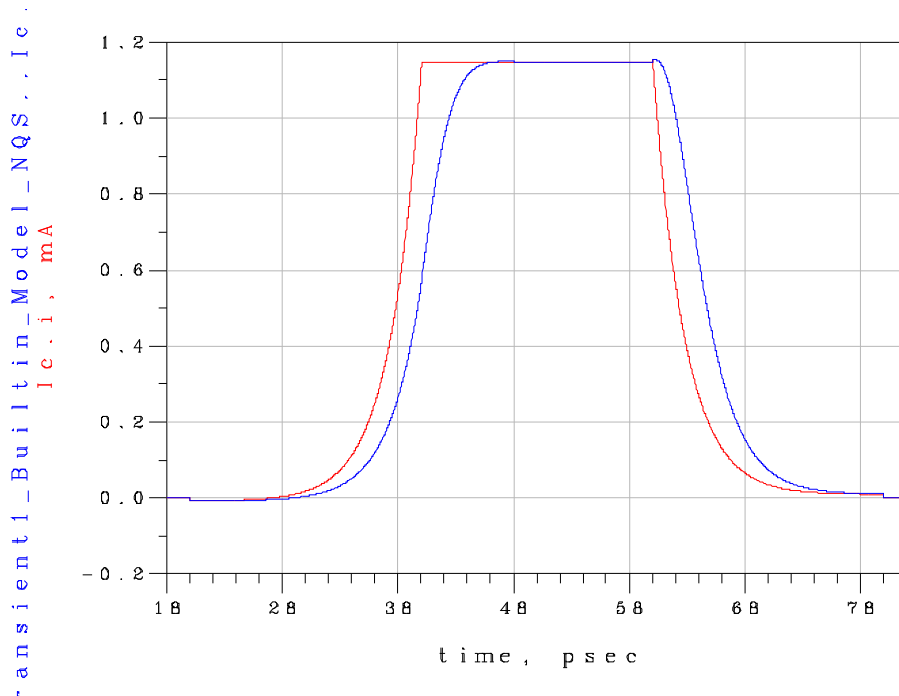


=> Implementation problem in model *version=2.2 updatelevel=3*

No such problem with Spectre HICUM *Built-in* model *version=2.2 updatelevel=2*

Simulator related testing issues (contd.)

- Transient analysis with ADS 2008 updatelevel=2
 - (Built-in model instance name HICUMM1)

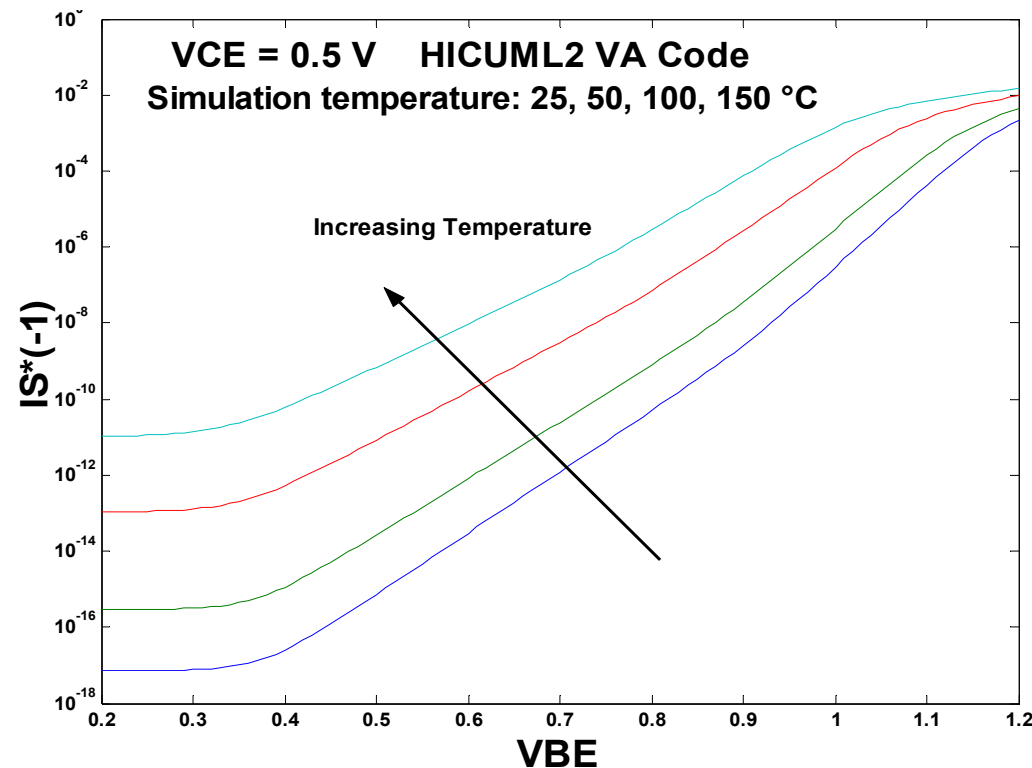


- collector current is correct, but NQS effect missing in base current

=> Needed to be fixed by the vendor

Simulator related testing issues (contd.)

- Checking the temperature dependence of substrate current



=> correct in VA version

- In Spectre *Built-in* model *version=2.2 updatelevel=3*: IS always comes to the value $2.5e-12$ irrespective of the temperature => IS independent of T => wrong....

HICUM/L0 Support Activities

- Present public L0 version is 1.12 => available on website
- HICUM/L0 V1.2 => Improvements in cooperation with ST, IFX & successfully verified on 5 different processes.
 - Parameters can be generated from existing HICUM/L2 set or directly from single transistor structures
- Access of source code, doc restricted to users providing *support for model development* (see also CMC's move to new funding model)
- Few minor model parameter range modifications,
 - added gmin declaration: `'define Gmin $simparam("gmin",1e-12)'`
 - The range of ZEDC has been modified to (0:5) excluding 1.0
 - New range of ZETA/QF => [-2:2]
 - New range for ZETARTH => [0:5]
 - All the temperature coefficients have been set ranges [-10:10].
- A new L0 document incorporating all previous release notes and updated parameter list will be planned to be made available