

A Simple GNU Octave-Based Tool for Extraction of MOSFET Parameters

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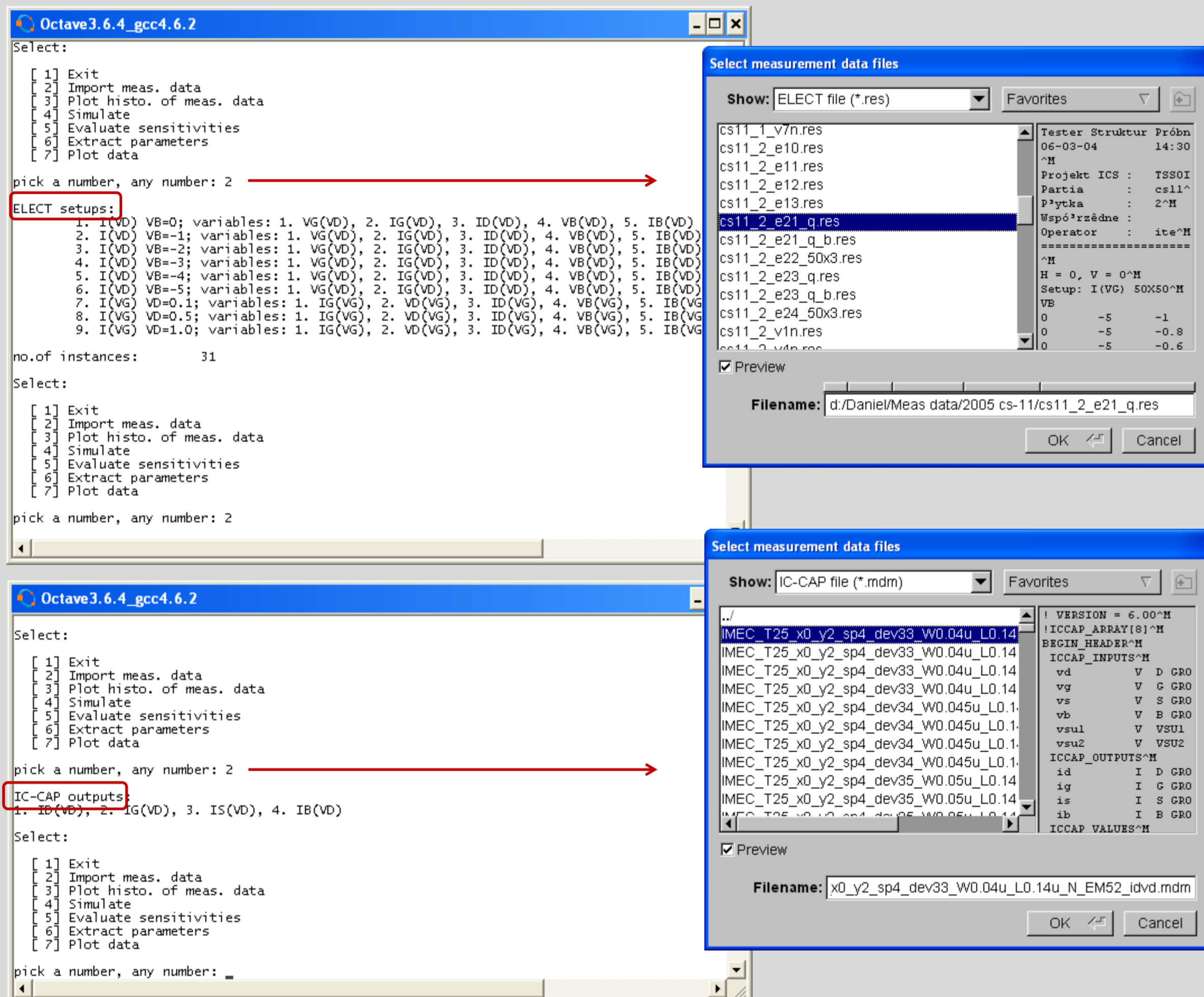
Motivation

- Development of a tool for evaluation of MOSFET models implemented in the existing EDA tools and for extraction of their parameters:
 - ✓ no need for model implementation; the models have been earlier implemented and tested; their implementation is fully consistent with the model specification;
 - ✓ direct access to the state-of-the-art models; a straightforward comparison with available MOSFET measurement data;
- GNU Octave – based:
 - ✓ commonly used environment for engineering calculations; easy exchange of code;

References: Agilent Model Builder Program (MBP), Agilent Model Quality Assurance (MQA), Hong-Kong Uni. <http://i-mos.org/imos/project>;

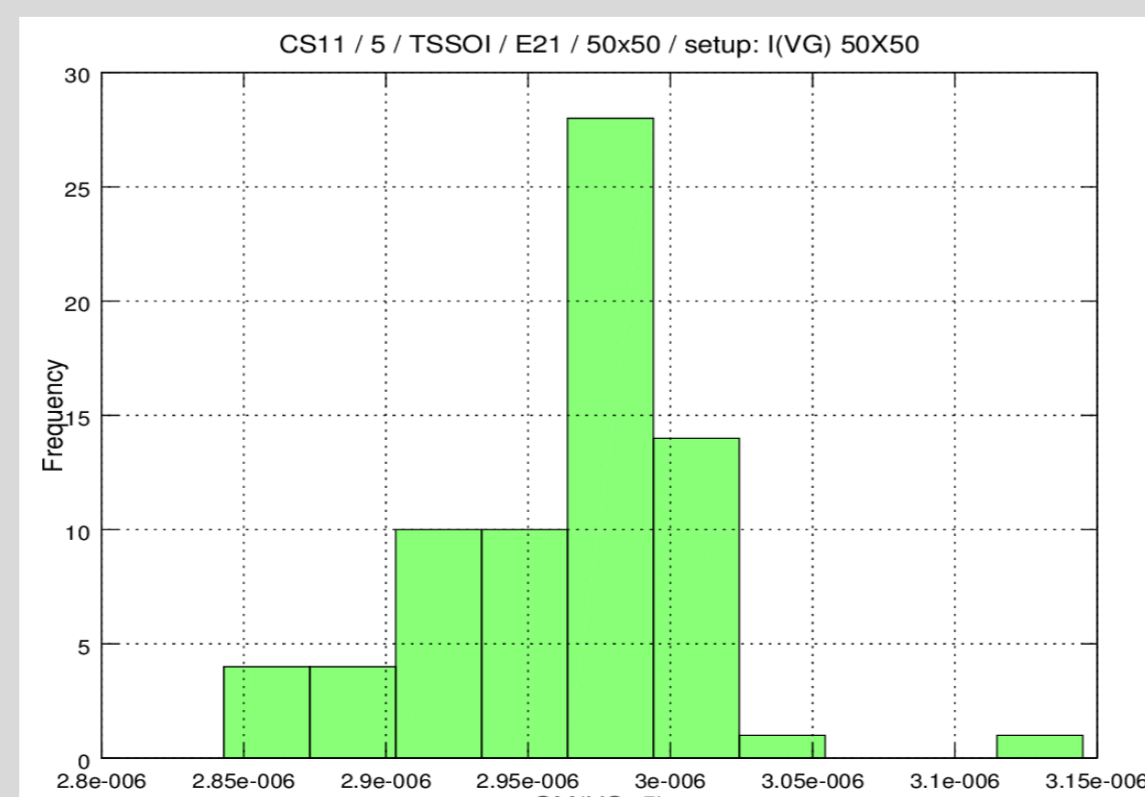
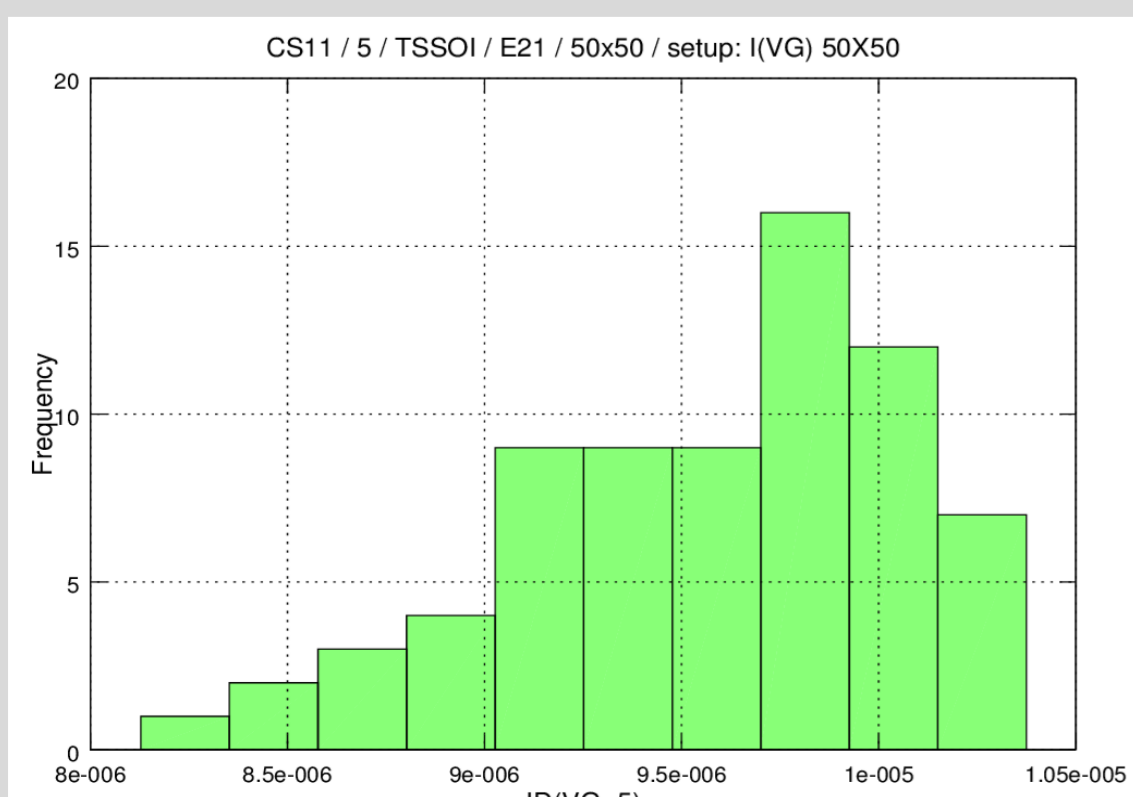
Program structure

- Menu driven; Octave `menu()` function has been used



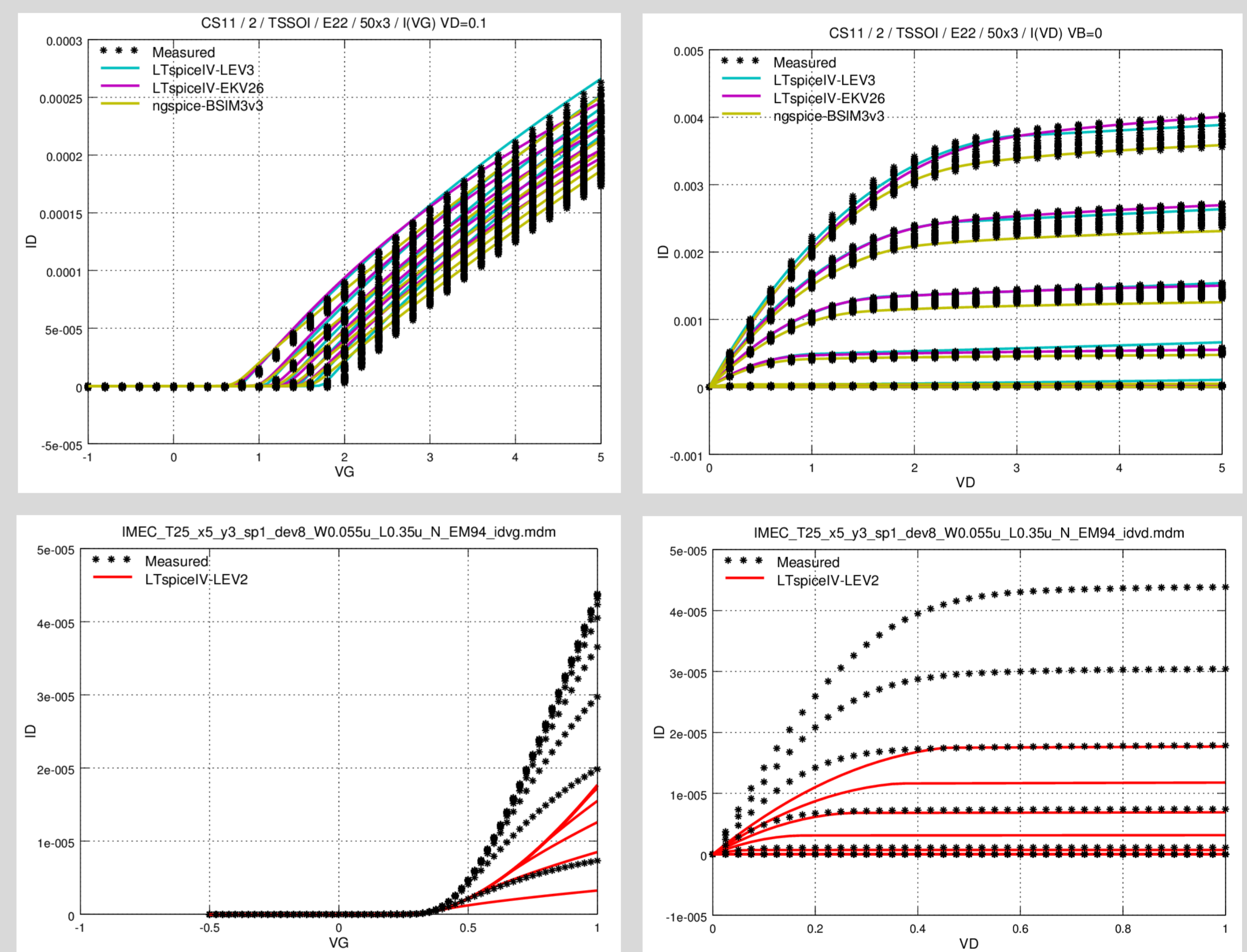
Data import/postprocessing

- Octave `uigetfile()` function is used for data file selection;
- Currently, three ASCII data formats are accepted:
 - ✓ *.mdm - files generated by IC-CAP,
 - ✓ *.res - files generated by proprietary ELECT measurement system,
 - ✓ *.kdf - files generated by 4200-SCS measurement system; ready (used for data transformation), but not fully implemented yet;
- Import procedure generates a hierarchical data structure in the program space, allowing for flexible data manipulation/transformation;
- In the case of *.res files additionally a database of available test structures and their modules is established, where a device topography is stored;
- The input data visualization: plots, and histograms;
- Characteristics variability observation; useful for statistical modeling;
- Data for devices of different topologies may be imported in one run; useful for scaling effect analysis;



MOSFET modeling

- MOSFET models are available via the IC electrical simulation programs;
- Currently, three simulation tools are available:
 - ✓ LTspiceIV,
 - ✓ ngspice
 - ✓ Qucs (not fully implemented yet);
- Currently, the following MOSFET models are available: LEVEL=1,2,3, BSIM3v3, EKV2.6, HiSIM2;
- For the models in use the model card files may be edited in parallel using a text editor; they are automatically used in the *.cir files by the .include directive;
- For the selected set of measurement setup specified directly (*.mdm file), or indirectly (*.res file) *.cir files are created depending on the selected program-model pairs; different devices and their different characteristics may be taken into account in a "single" Octave program run;
- A dedicated data structure is created to store information about the set of *.cir files, types of I-V characteristics, simulation sequence;
- Simulation programs are invoked in sequence;
- The simulation results may be compared with the corresponding measurement data; model characteristics are extracted from the *.raw files in accordance with the specified measurement setup and characteristics.



Example: the simple MOSFET model is inadequate for FinFET characteristics

Current/future work

- Full Implementation of *.kdf files import (in progress);
- Implementation of I-V characteristics differentiation (in progress);
- Implementation of numerical index of the model and experimental data misfit;
- Implementation of extraction procedures based on local fitting sequences for the given models;
- Full implementation of Qucs/QucsStudio (in progress);
- Nonlinear optimization, evolutionary algorithms ?

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