NMDG
LEADING BEYOND S-PARAMETERS

ICEBreaker

Complex Sweep Plans for Automatic Component Characterization under Realistic Conditions

- Using your VNA at its full power -

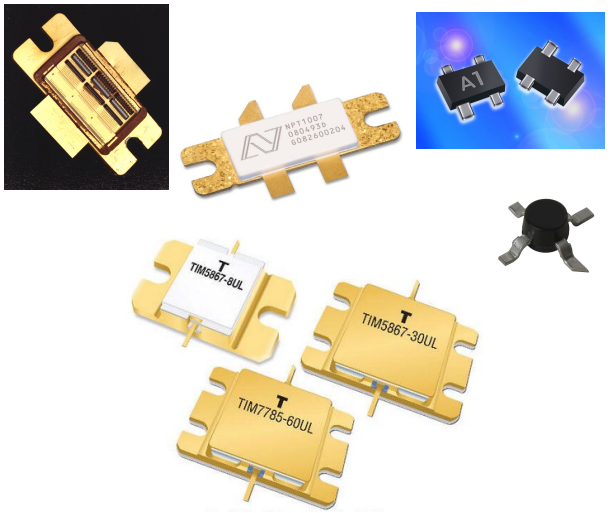
Sept 2010

Outline

- Target Markets
- Adequate Operating Point of Amplifier through Source- and Load-Pull
- Capabilities of ICEBreaker
- Fundamental Source- and Load-Pull Setup
- Advantages of this Setup
- ICEBreaker in action
  - Data Visualization
  - Sweep Plan
  - Data Collection
- Conclusion

Target Markets

- Semiconductor Manufacturers
  - Low cost and fast characterization
  - Minimize the number of measurement setups
  - VNA is typically already being used



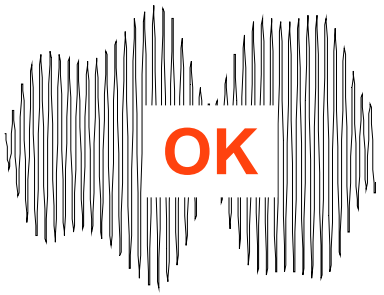
- Handsets
  - Cheap
  - Small
  - Talk forever without recharging
  - Speech, data, movies, conferencing etc...

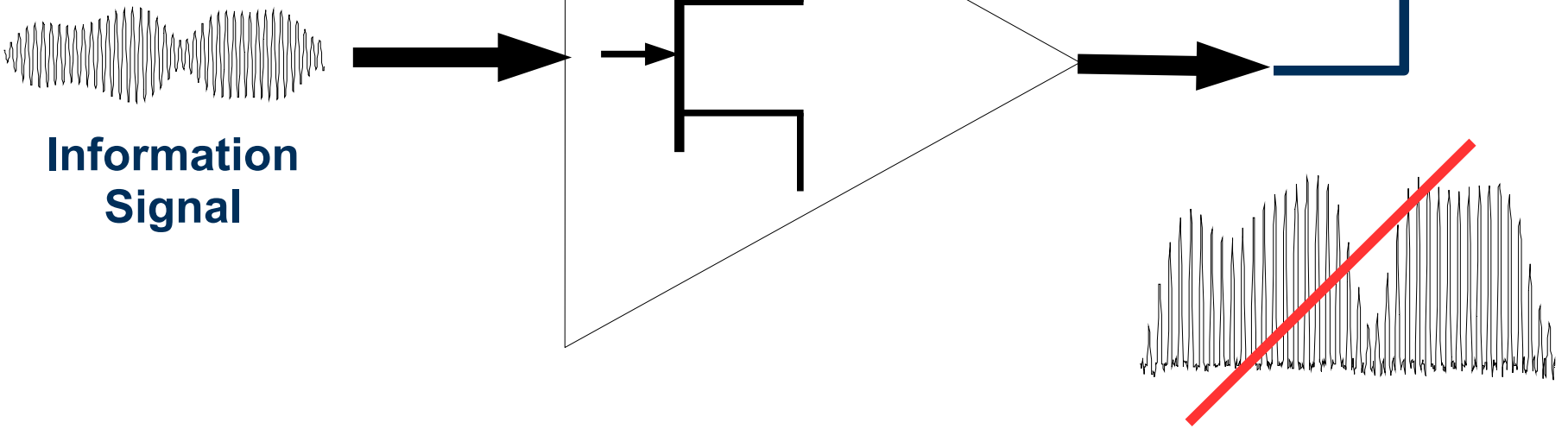
- Base-stations
  - Low maintenance cost
  - More cells
  - Smaller units

The Amplifier as essential Power Transformer

LDMOS
GaN
GaAs
SiGe...

Amplify





Information Signal

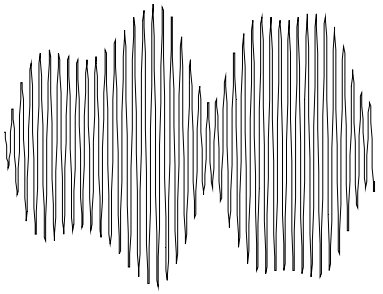
Do not distort

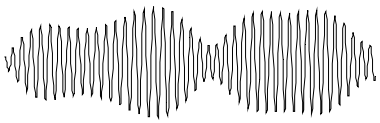
The Amplifier as essential Power Transformer

LDMOS
GaN
GaAs
SiGe...

Convert DC Power into RF Power

DC Power





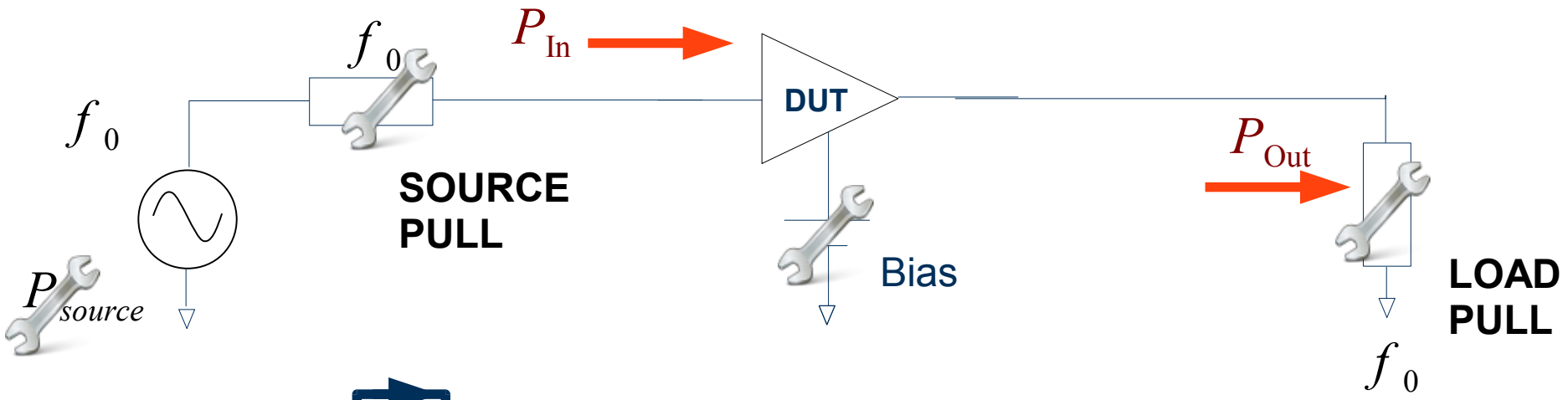
Information Signal

RF Power

Avoid Power Dissipation

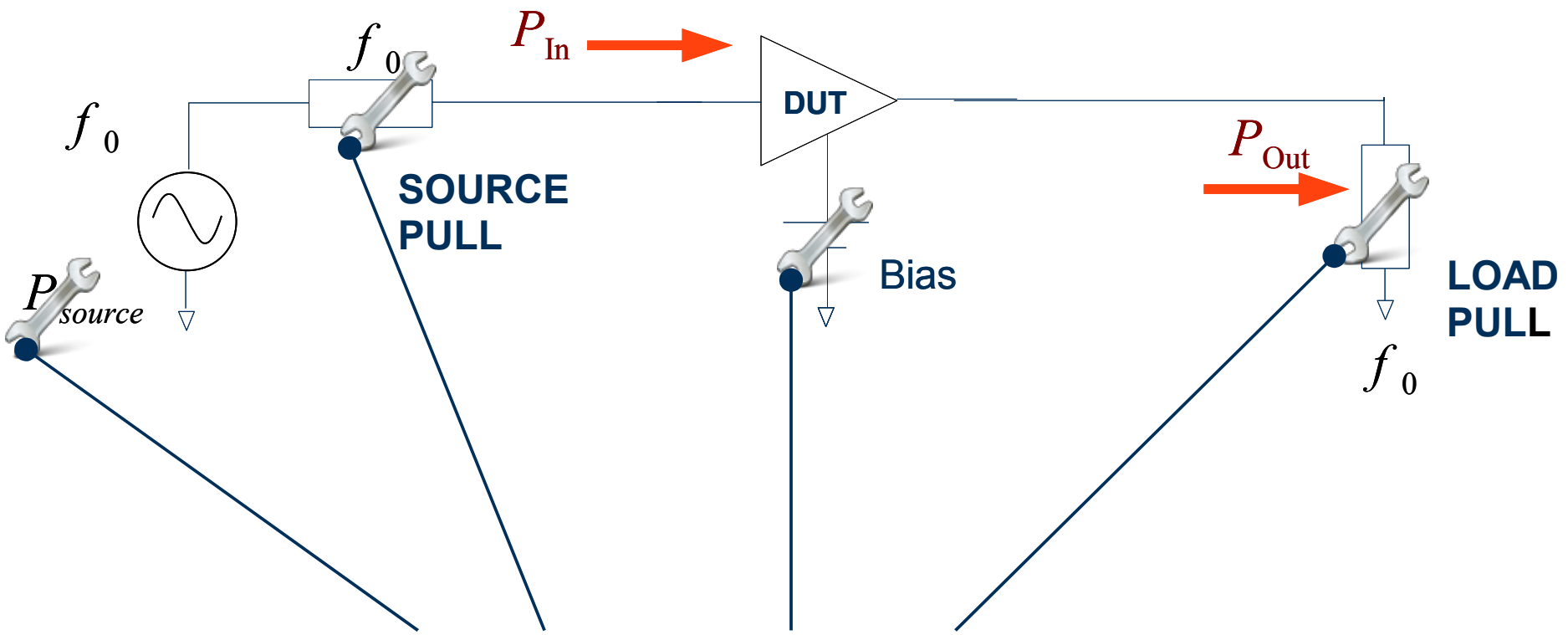
Finding Adequate Operating Point of Amplifier

Source- and Load-Pull



- Measure
  - Input and output DC and RF power
- For different values of
  - Input power
  - Bias
  - Load impedances
  - Source impedances
- Display and analyse collected data
- Until “some optimal” point is reached

ICEBreaker



ICEBreaker

- Measures
  - Input and output DC and RF power
- For different values of
  - Input power
  - Bias
  - Load impedances
  - Source impedances
- Displays and analyses collected data

Capabilities of ICEBreaker

The Differentiator from Other Solutions

- Measuring error-corrected incident and reflected waves in a frequency selective way at the device under test under sweepplan conditions
  - Amplitude only or Amplitude and phase, depending on receiver capability

- Off-line Visualization of Measurements, performed by Sweepplan

- Configuring and Calibrating a Measurement Setup
  - DC : Sources - Pulsers, Voltmeters and Currentmeters
  - RF : Sources - Pulsers
  - Passive and Active Source and Load Tuners
  - Receivers: (Large-Signal) Network Analyzers, Oscilloscopes, ...

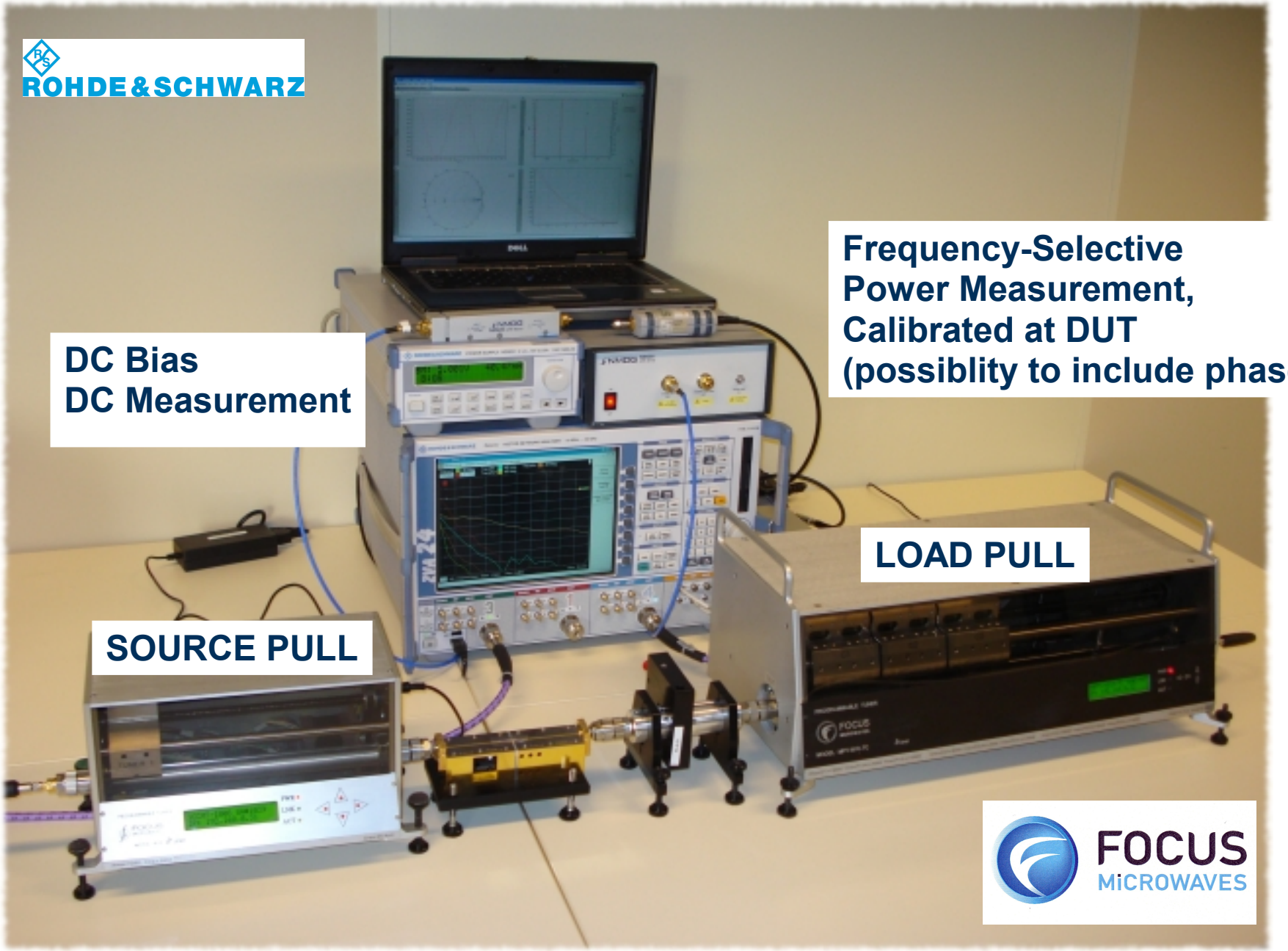
- Composing and execution of a Sweepplan

- **Customization on customer request**
  - Additional Instruments, Measurement Features, Special data displays

Sweep Plans

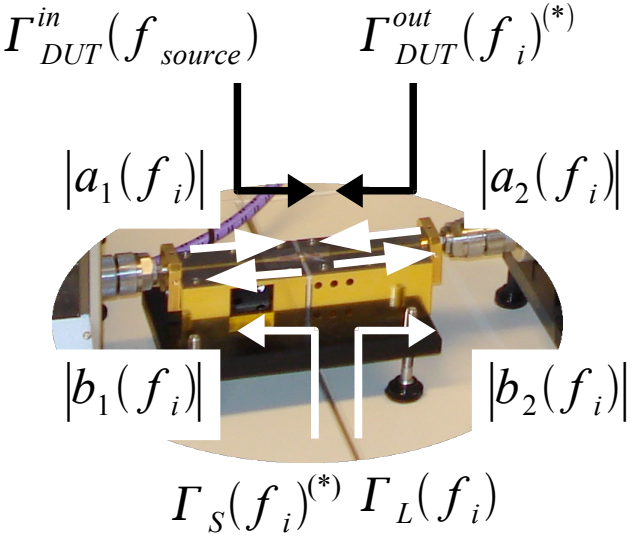
- Combination of
  - DC Sweep
  - RF Power Sweep
  - RF Frequency Sweep
    - Depends on calibrated frequencies
  - Fundamental Passive and Active Load Tuner Sweep
  - Nested Harmonic Load Tuner Sweep
  - Fast Fundamental Source Pull
    - Based on power sweep, possibly combined with prematch tuner

Fundamental Source and Loadpull Setup



Advantages of this Setup

- Frequency Selective Power Measurements
- Incident and Reflected Waves at fundamental and harmonics
- Fully error-corrected measurements and deembedded up to the device



$P_{del,input}(f_i)$
$P_{del,output}(f_i)$
$PAE\ldots$

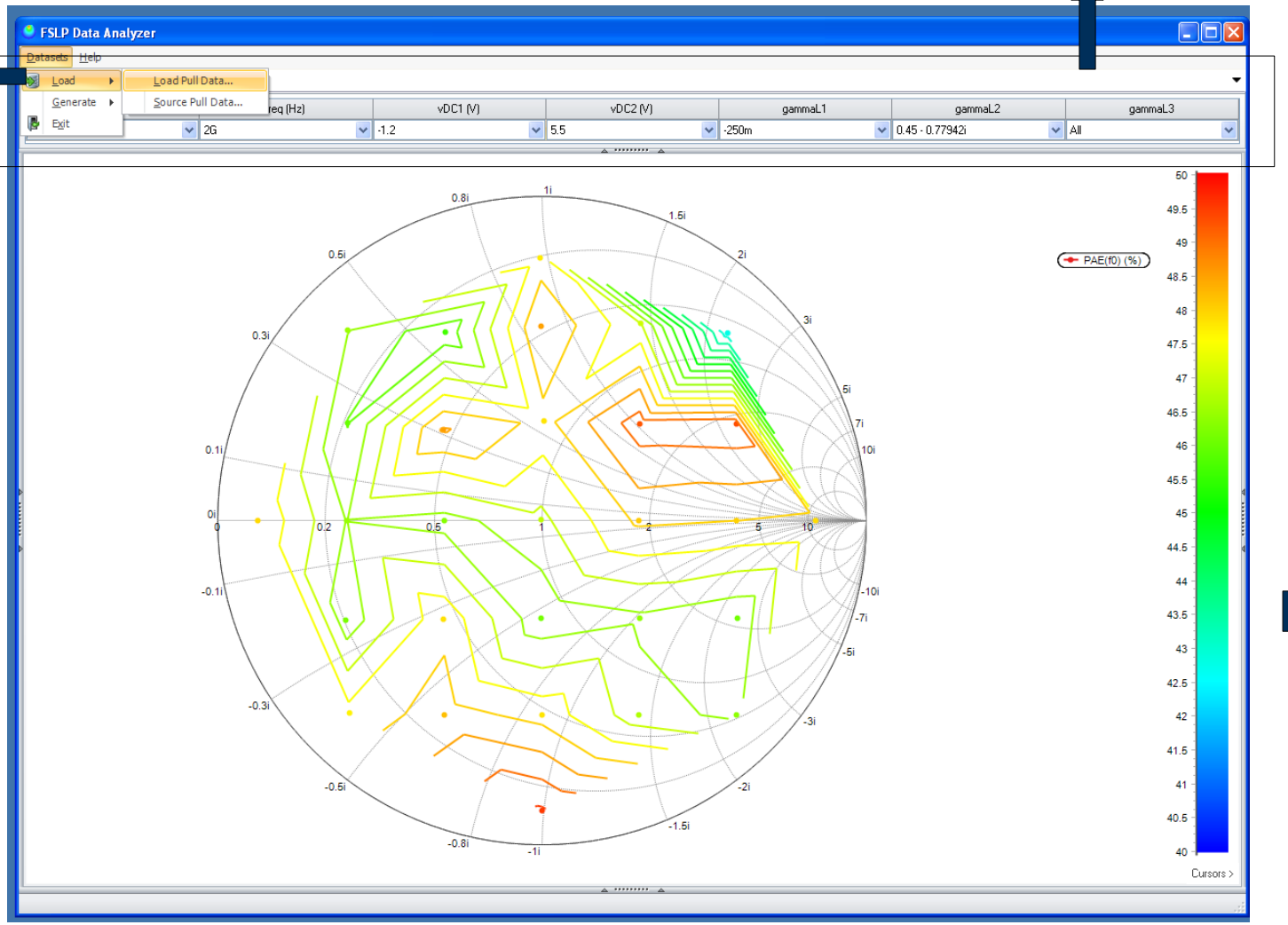
- Speed, Accuracy and Dynamic Range of Network Analyzer
- Measuring phase in addition to power and time-domain waveforms with nonlinear hardware and software extension

$(*): f_i \neq f_{source}$ (**): with proper hardware

ICEBreaker

Independent variable selection: power, frequency, bias, harmonic termination

Reading Datasets



Pane for **Quantities Datasets**

Pane for **CURSORS**

Pane for **Data Collection (Option Data Collection)**

Data Visualization

Eliminating running independent variable

(3)

Displayed Quantity

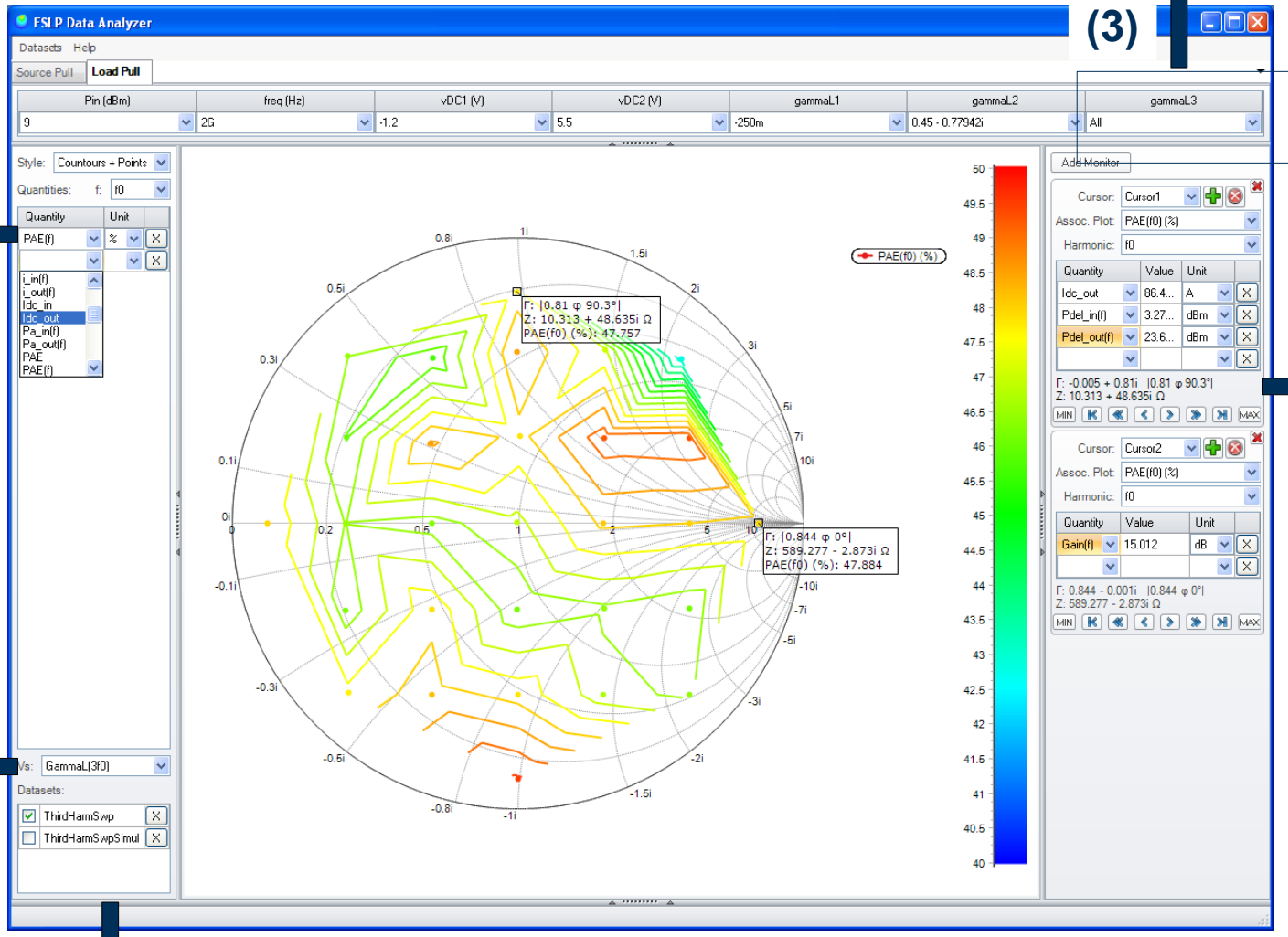
(1)

- **Style**
  - Points
  - Contours
  - Contours + Points
- **Derived Quantity:**
  - Qty & Unit
  - Multiple quantities
  - Frequency selective

Versus Selected Variable

(2)

- **Measured harmonic termination**
- **Synthesized harmonic termination**

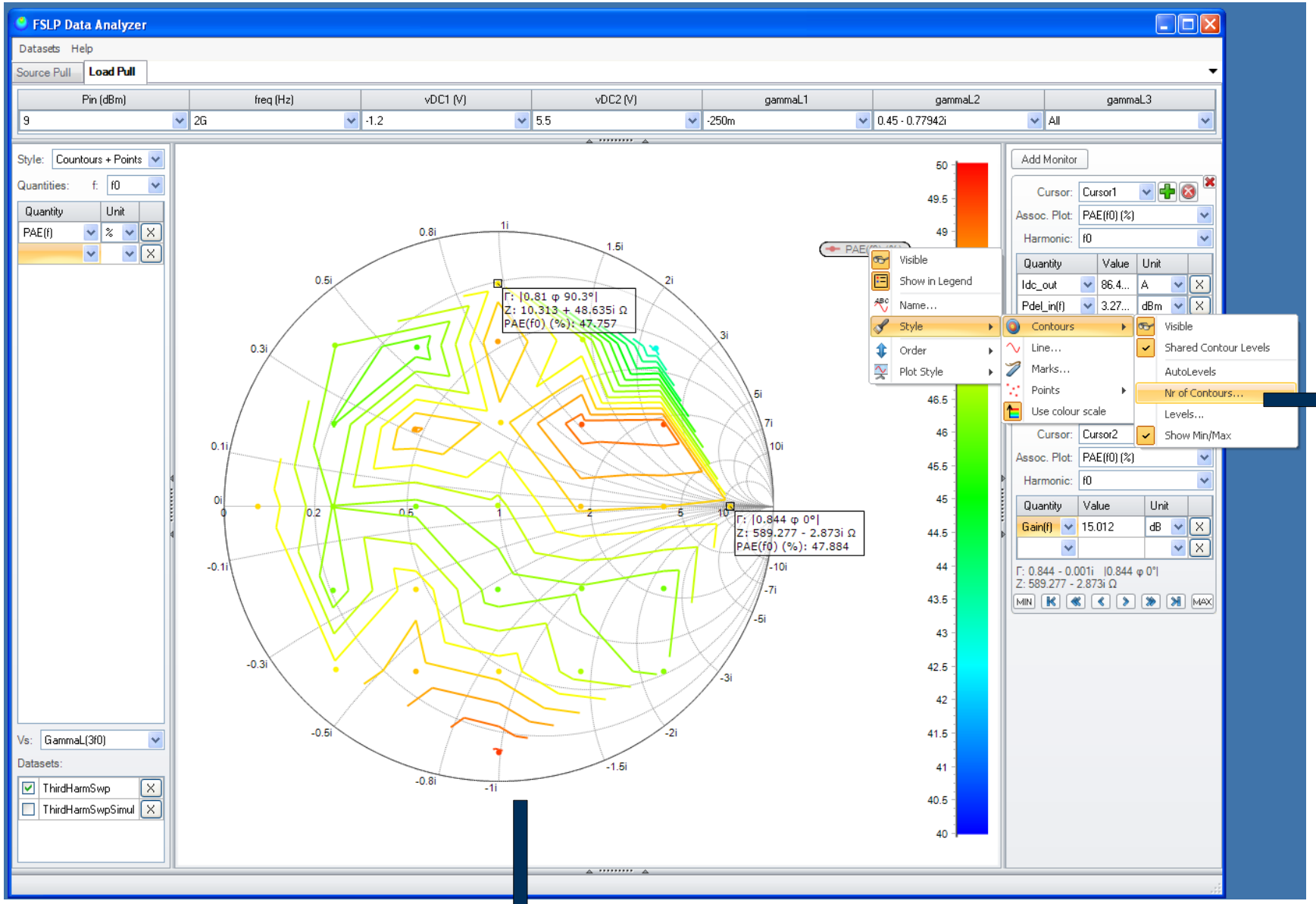


Multiple Cursors

- **Style**
  - Plot Selection
  - Frequency
  - Formats
  - Controls
- **Derived Quantity:**
  - Qty & Unit
  - Multiple quantities

Multiple Datasets

Contour Settings



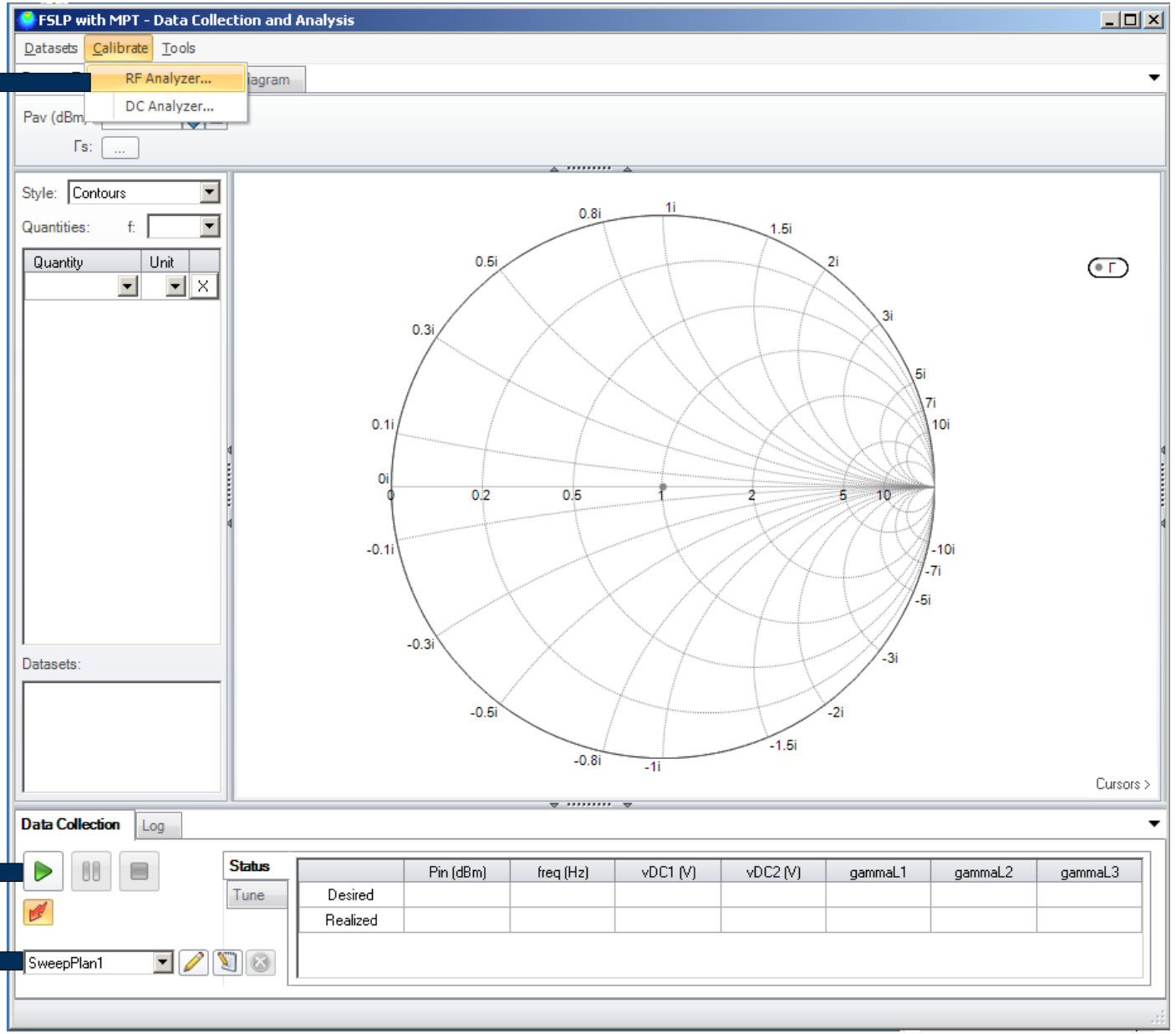
Contour Settings

- **Style**
  - Autolevel
  - Nr of Ctrs
  - Level Settings
- **Multiple Datasets**
  - Sharing or unsharing ctr levels

Export as image (.png, .jepg) and Direct Printing

Data Collection

Possibility to Calibrate Instruments



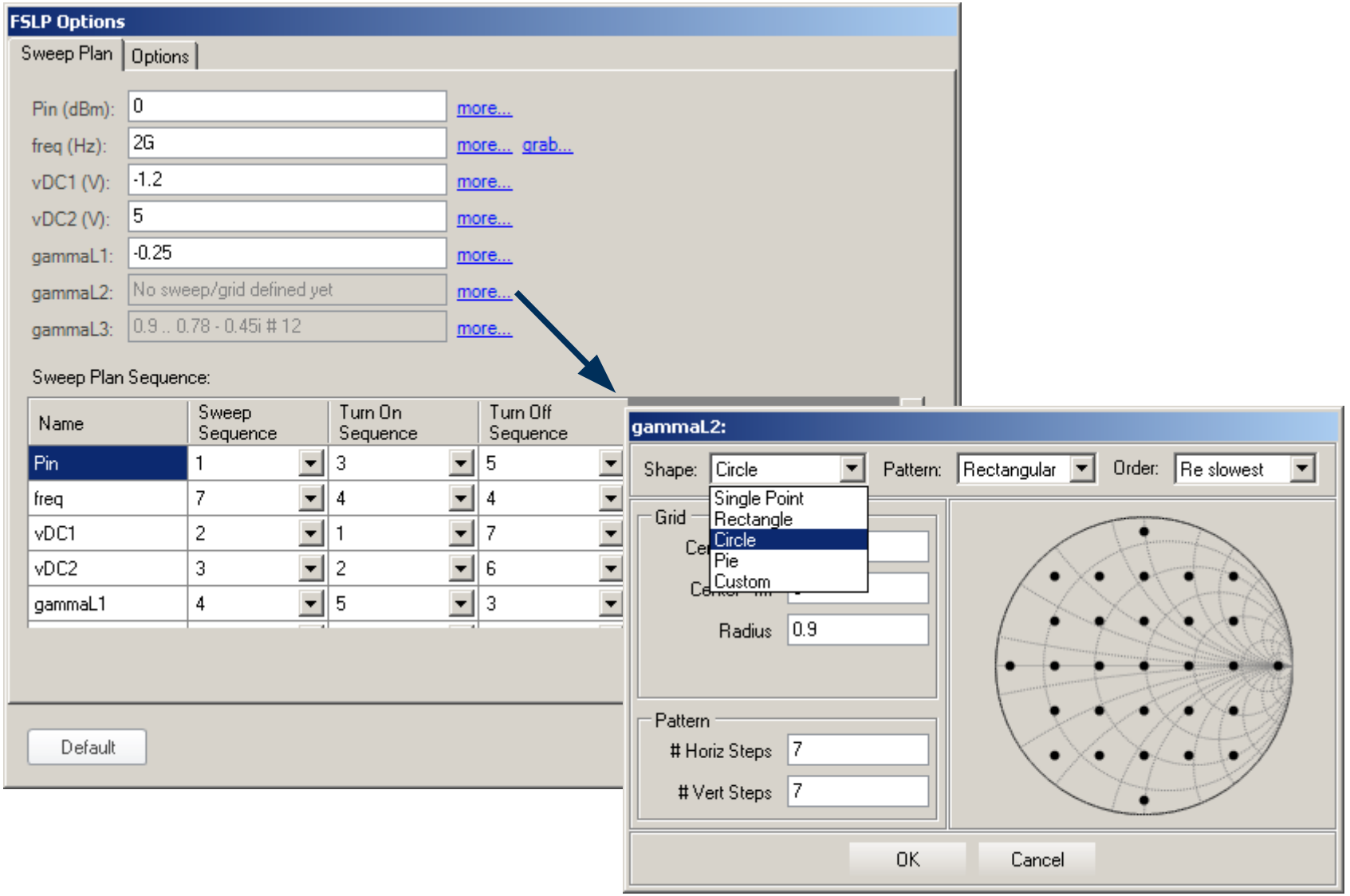
Sweep Plan Execution

Sweep Plan Definition

Data Collection

Sweep Plans

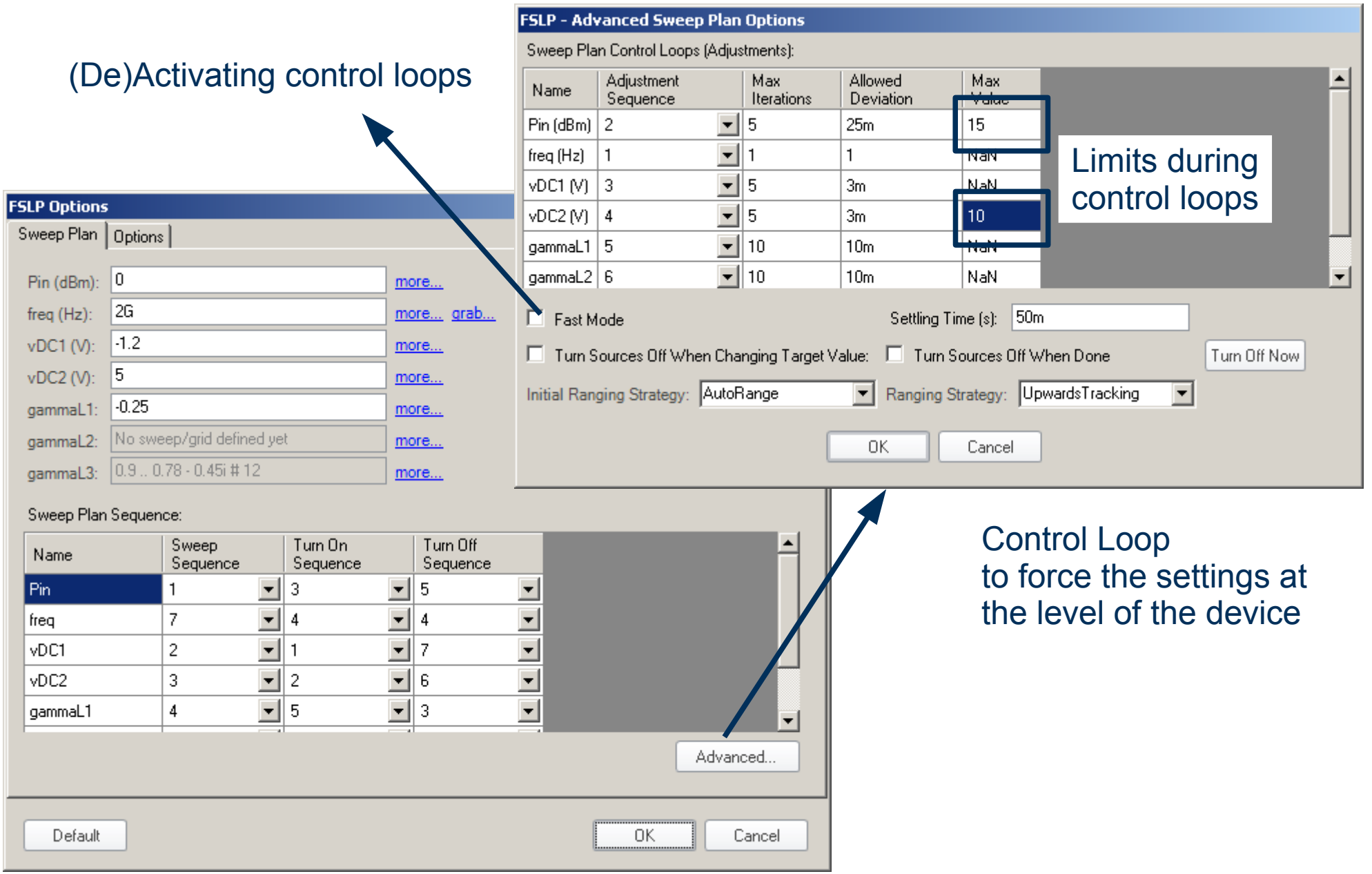
- Power
- Frequency
- Bias
- Multi-Harmonic Load
- Sweep Sequence
- Turn On/Off Sequence



Define Shapes and Fill Patterns

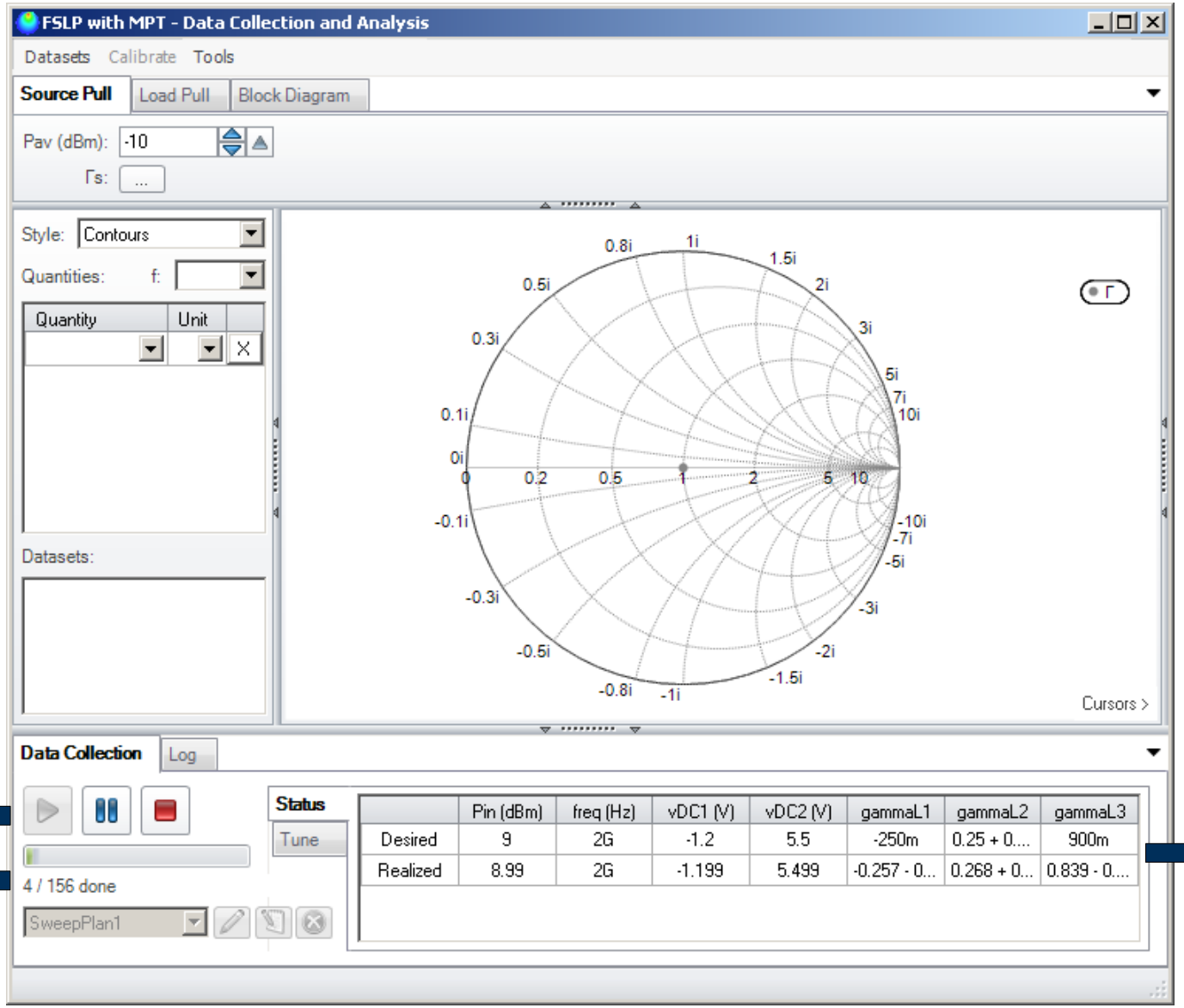
Control Loops

(De)Activating control loops



Control Loop
to force the settings at
the level of the device

Collecting Measurements

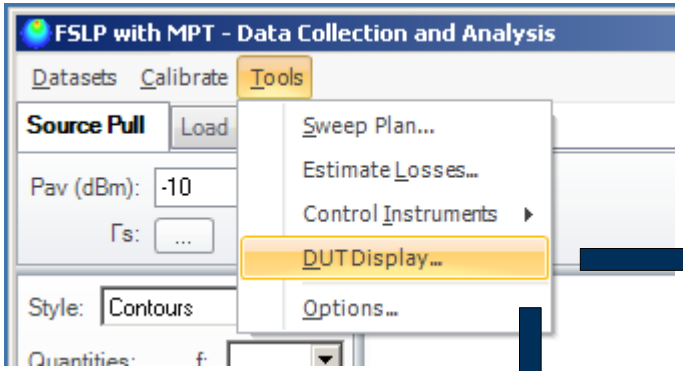


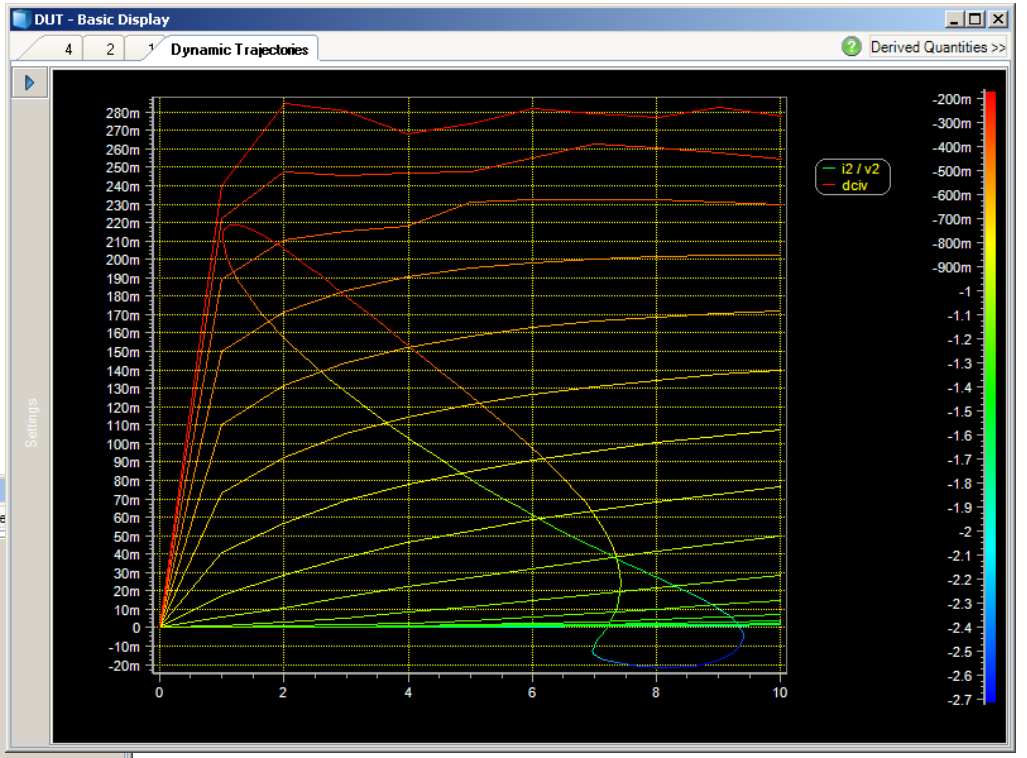
Run
Pause
Abort

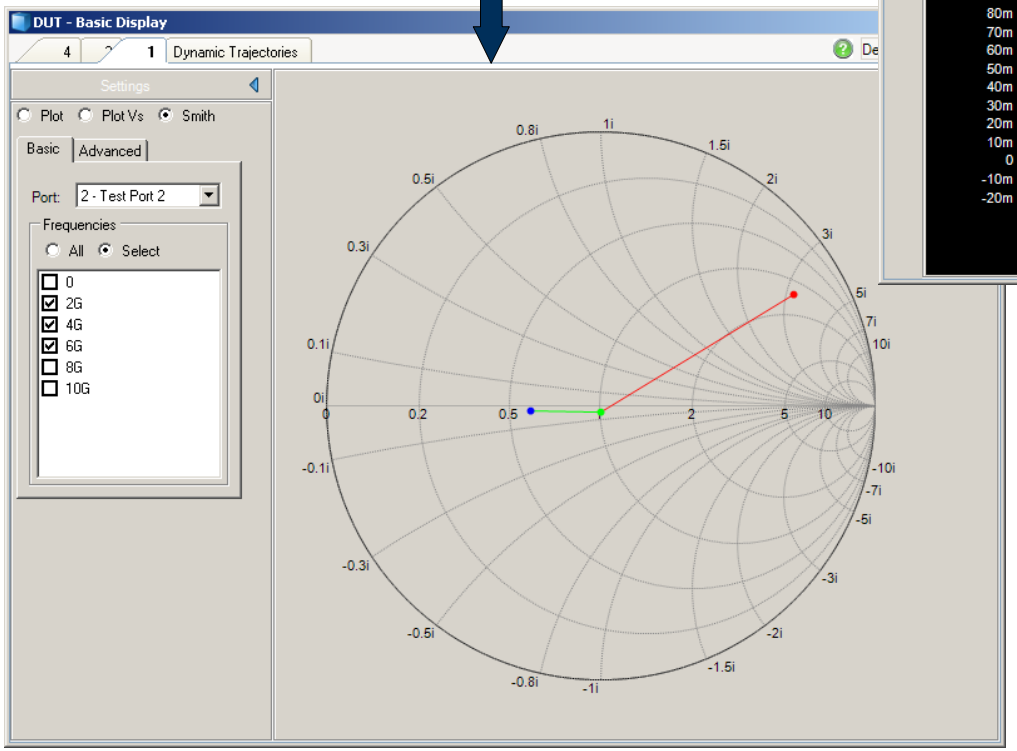
Overview
Progress

Overview
Realization

Monitoring Device Behaviour during Sweep Plan

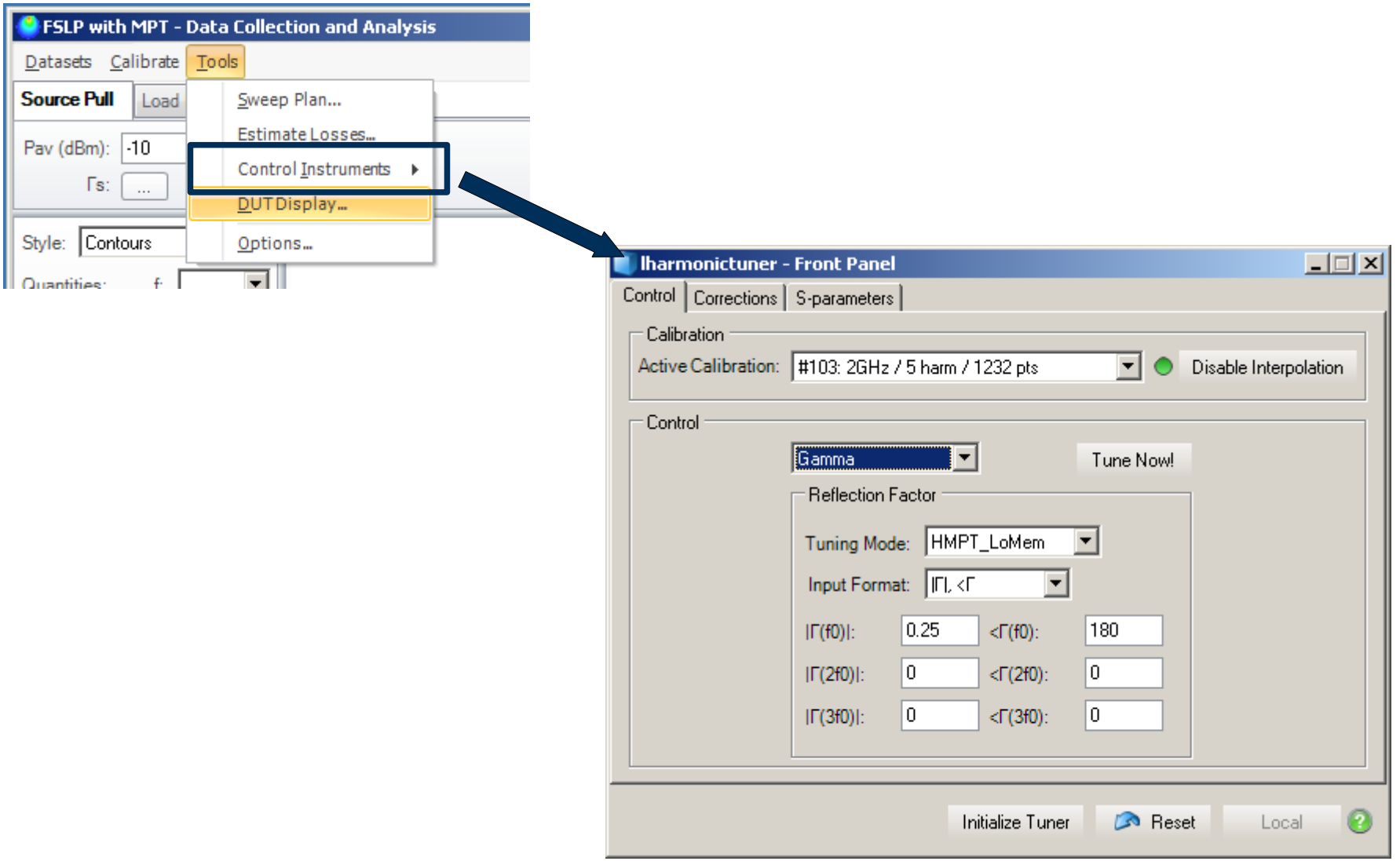






and more displays ...

Direct Access to Instruments



Multi-harmonic Tuner Control
(MPT – Focus Microwaves)

Conclusions

- ICEBreaker performs
  - Complex sweep plans, supporting instruments to create realistic conditions
  - Including nested harmonic load-pull
  - To characterize the nonlinear behavior of a device
  - In a frequency – selective way
  - Taking advantage of the performance of vector network analysers

- Use your VNA at its full power -

For more information info@nmdg.be

www.nmdg.be

Want to try?

Contact us
at
icesupport@nmdg.be