

ICEBreaker

Complex Sweep Plans
for Automatic Component
Characterization
under Realistic Conditions

- Using your VNA at its full power -



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



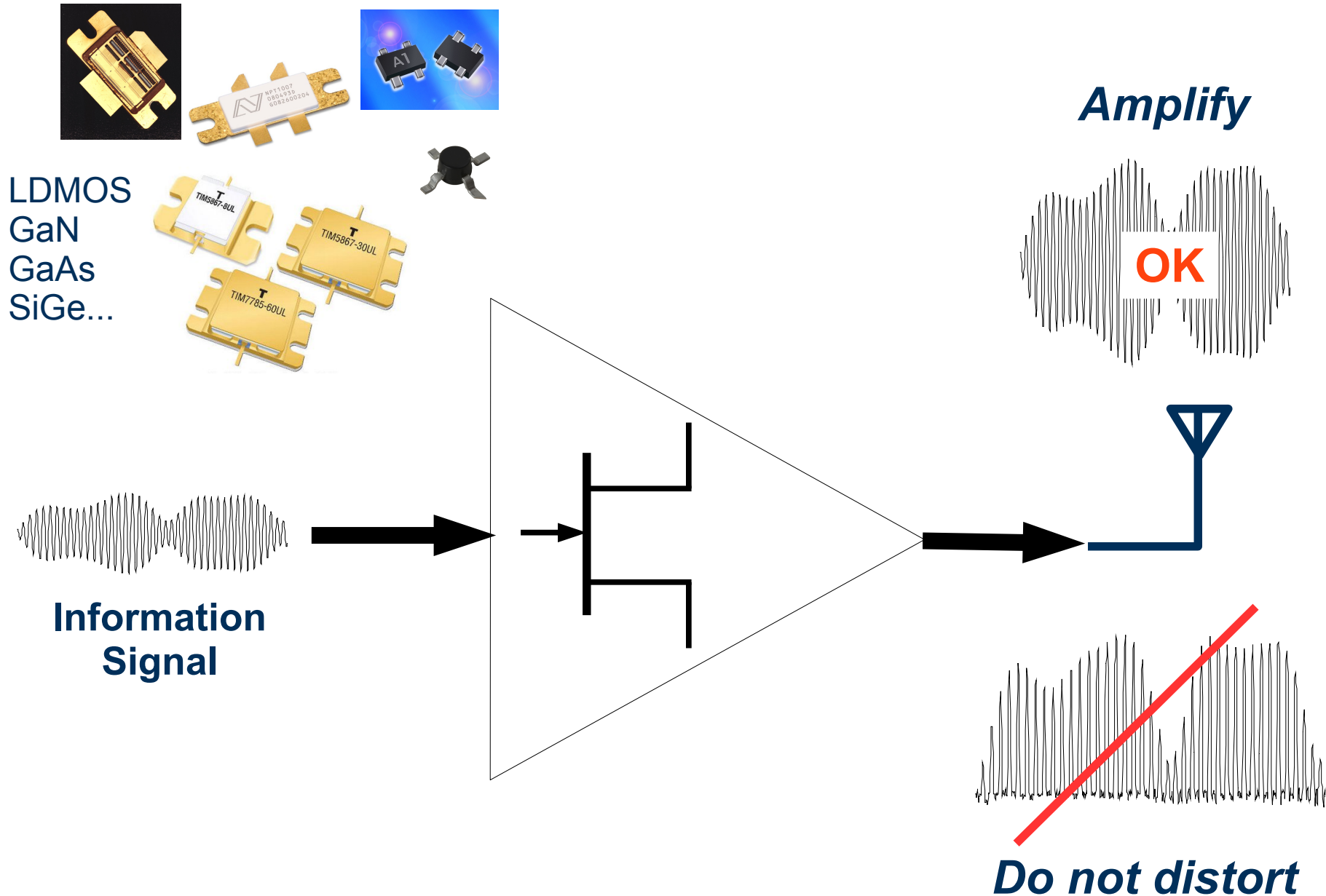
- Handsets
 - Cheap
 - Small
 - Talk forever without recharging
 - Speech, data, movies, conferencing etc...



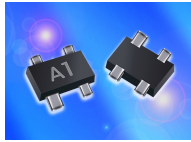
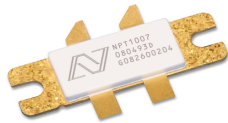
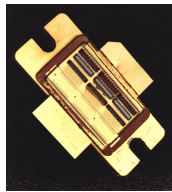
- Base-stations
 - Low maintenance cost
 - More cells
 - Smaller units



The Amplifier as essential Power Transformer



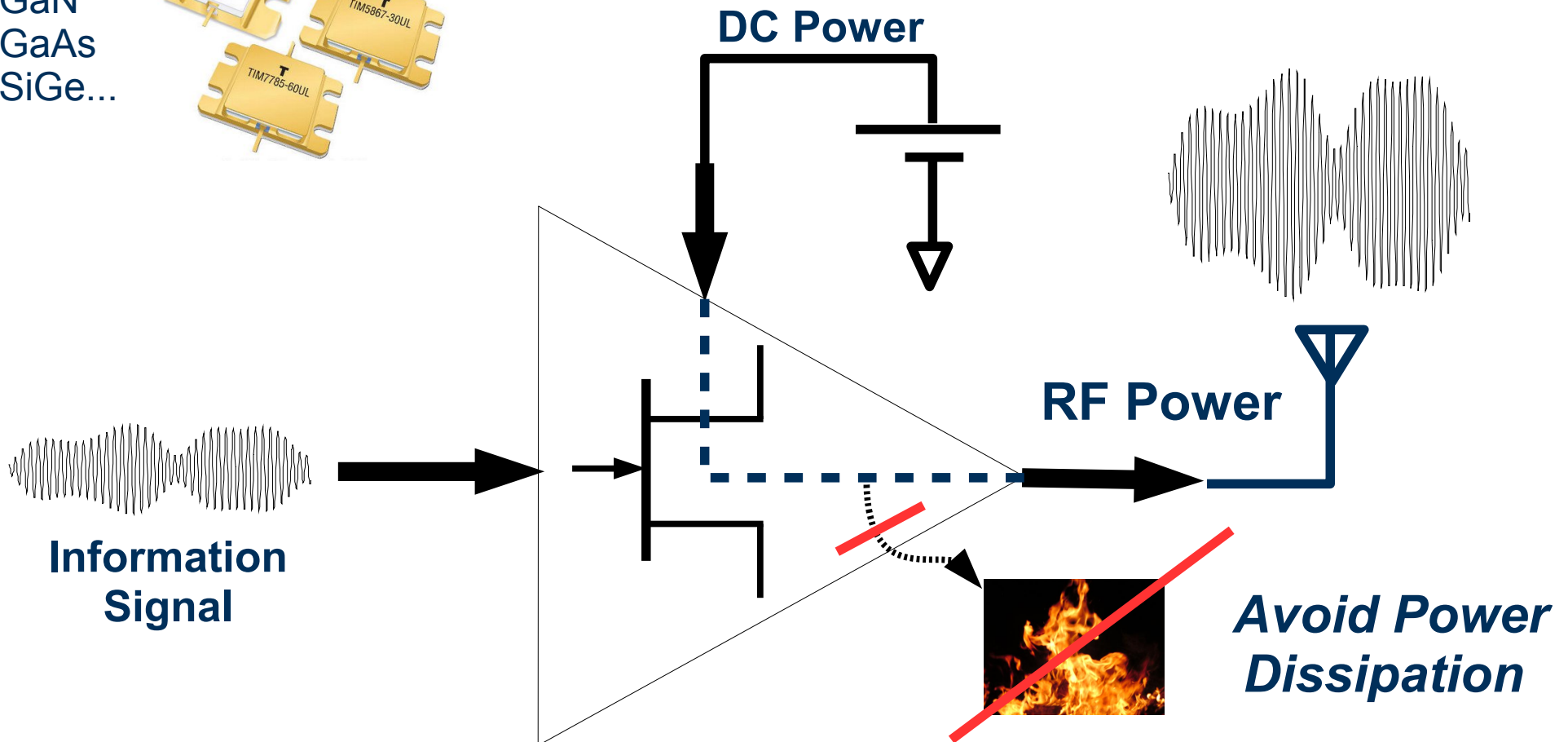
The Amplifier as essential Power Transformer



LDMOS
GaN
GaAs
SiGe...

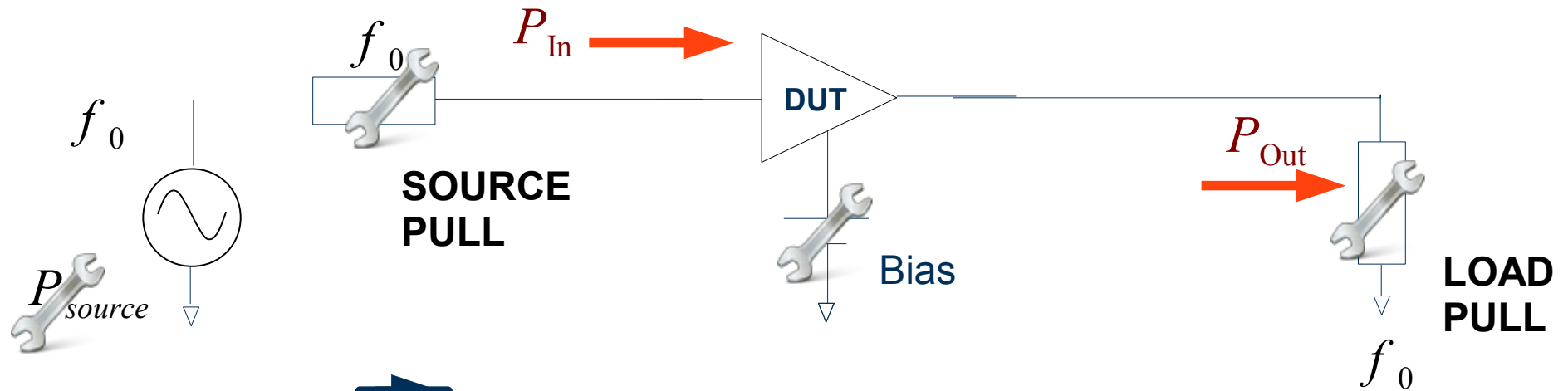


*Convert DC Power
into RF Power*



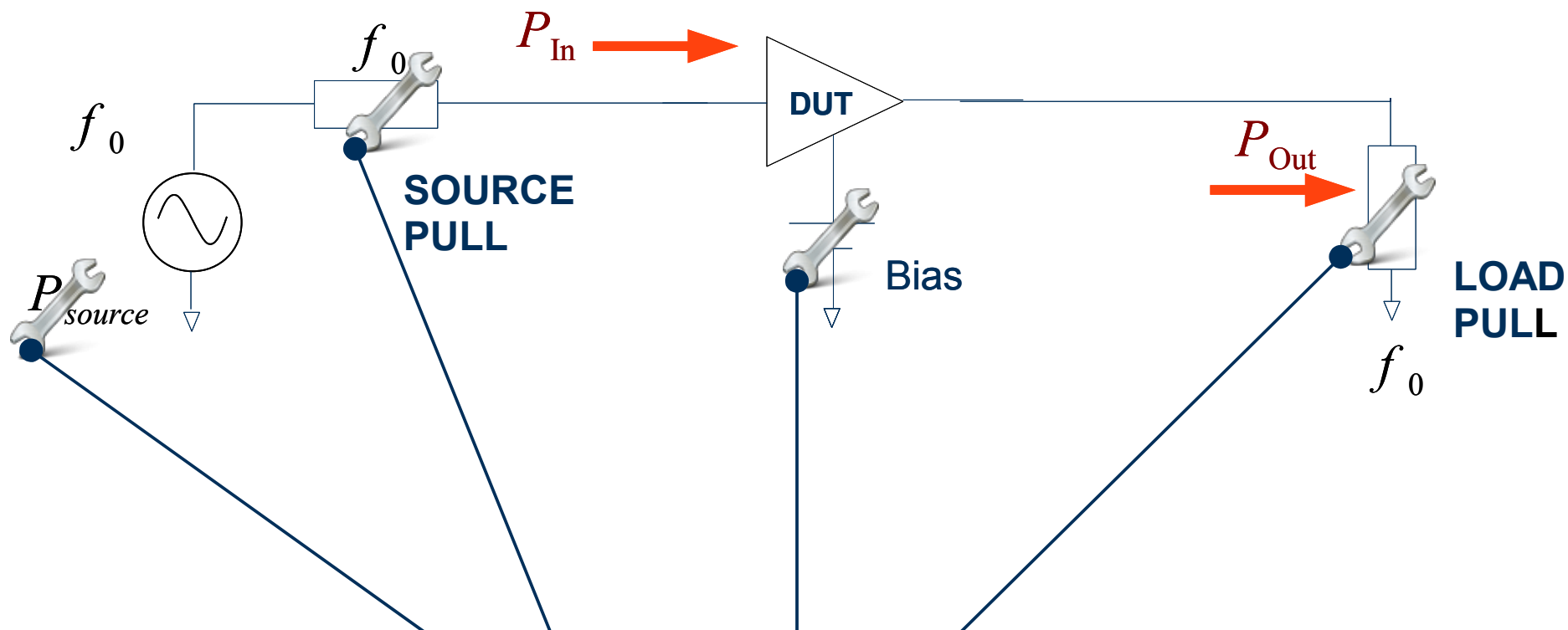
Finding Adequate Operating Point of Amplifier

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



DC Bias
DC Measurement

Frequency-Selective
Power Measurement,
Calibrated at DUT
(possibility to include phase)

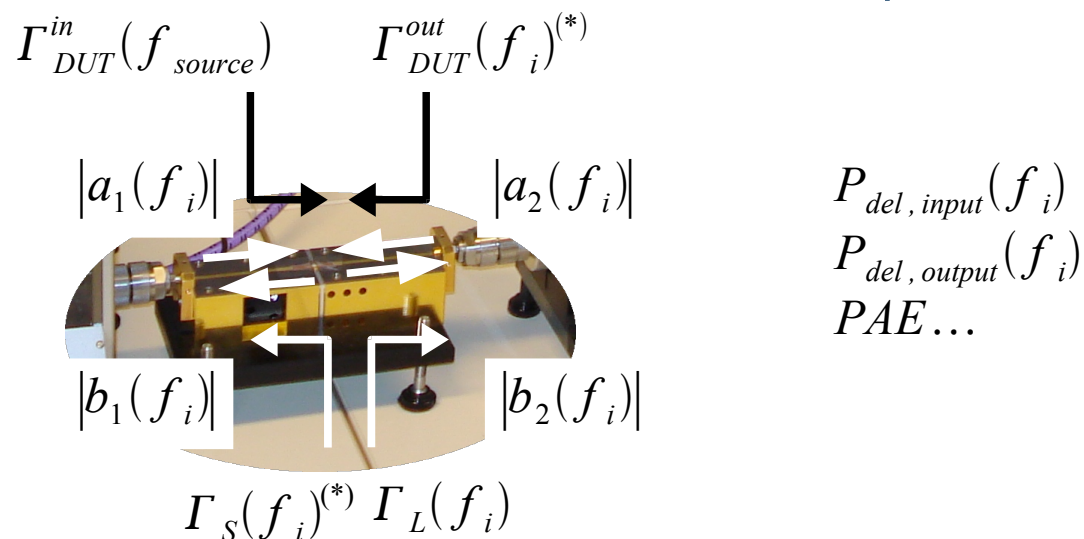
SOURCE PULL

LOAD PULL



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



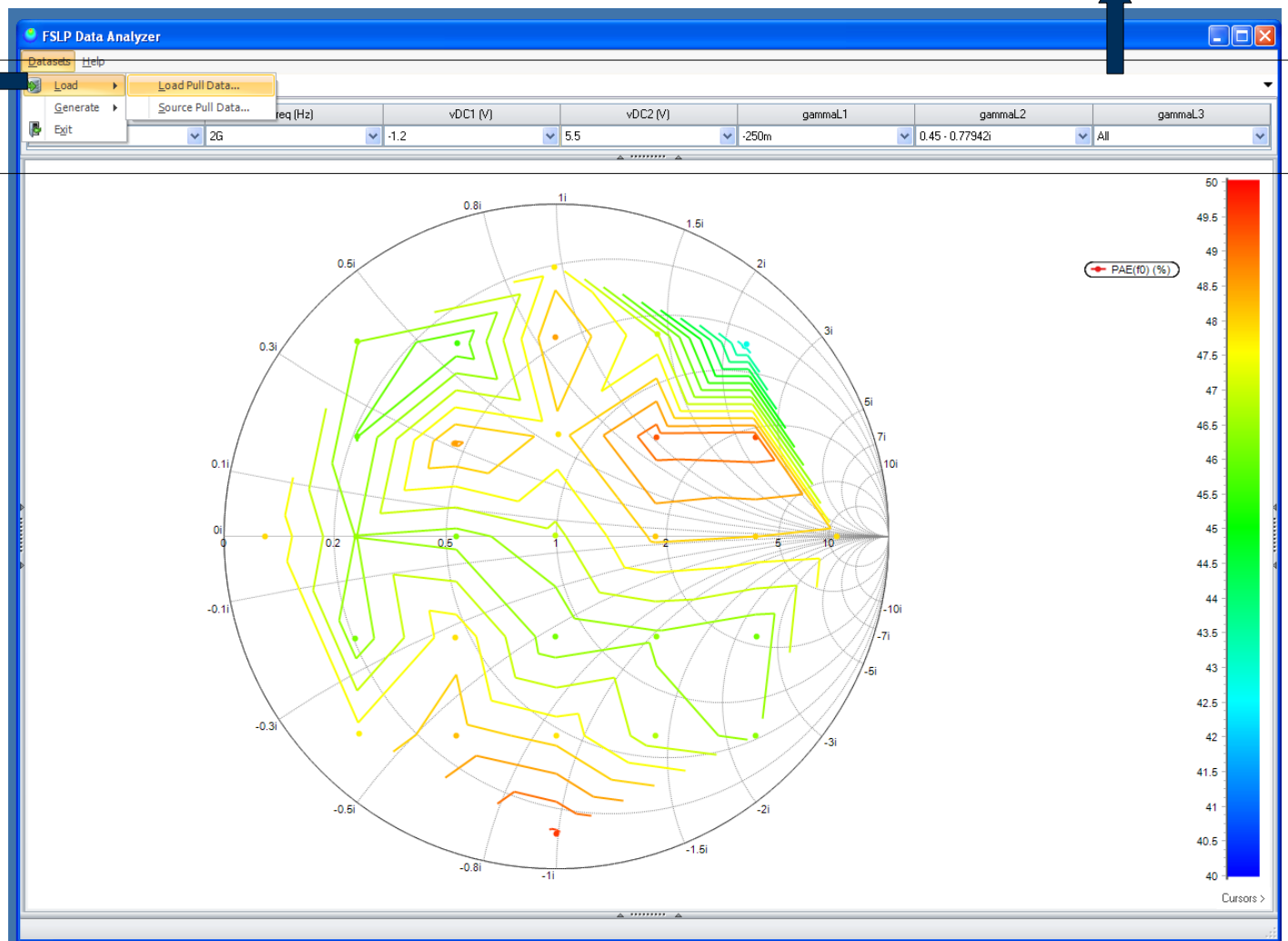
- Speed, Accuracy and Dynamic Range of Network Analyzer
- Measuring phase in addition to power and time-domain waveforms with nonlinear hardware and software extension

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

ICEBreaker

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

Reading
Datasets

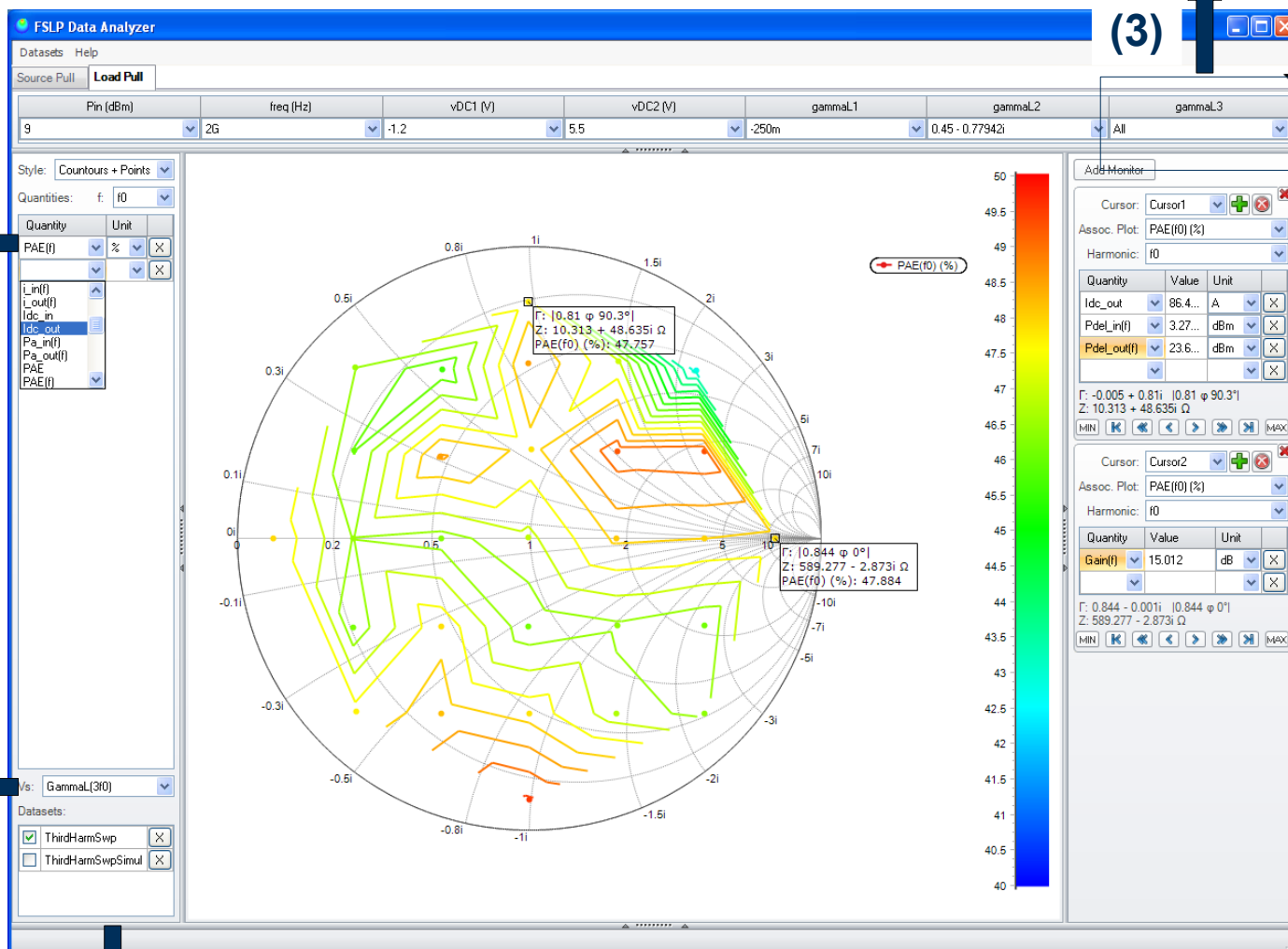


Pane for
Quantities
Datasets

Pane for
CURSORS

Pane for
Data Collection (Option Data Collection)

Eliminating running independent variable



Displayed Quantity

(1)

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

Versus Selected Variable

(2)

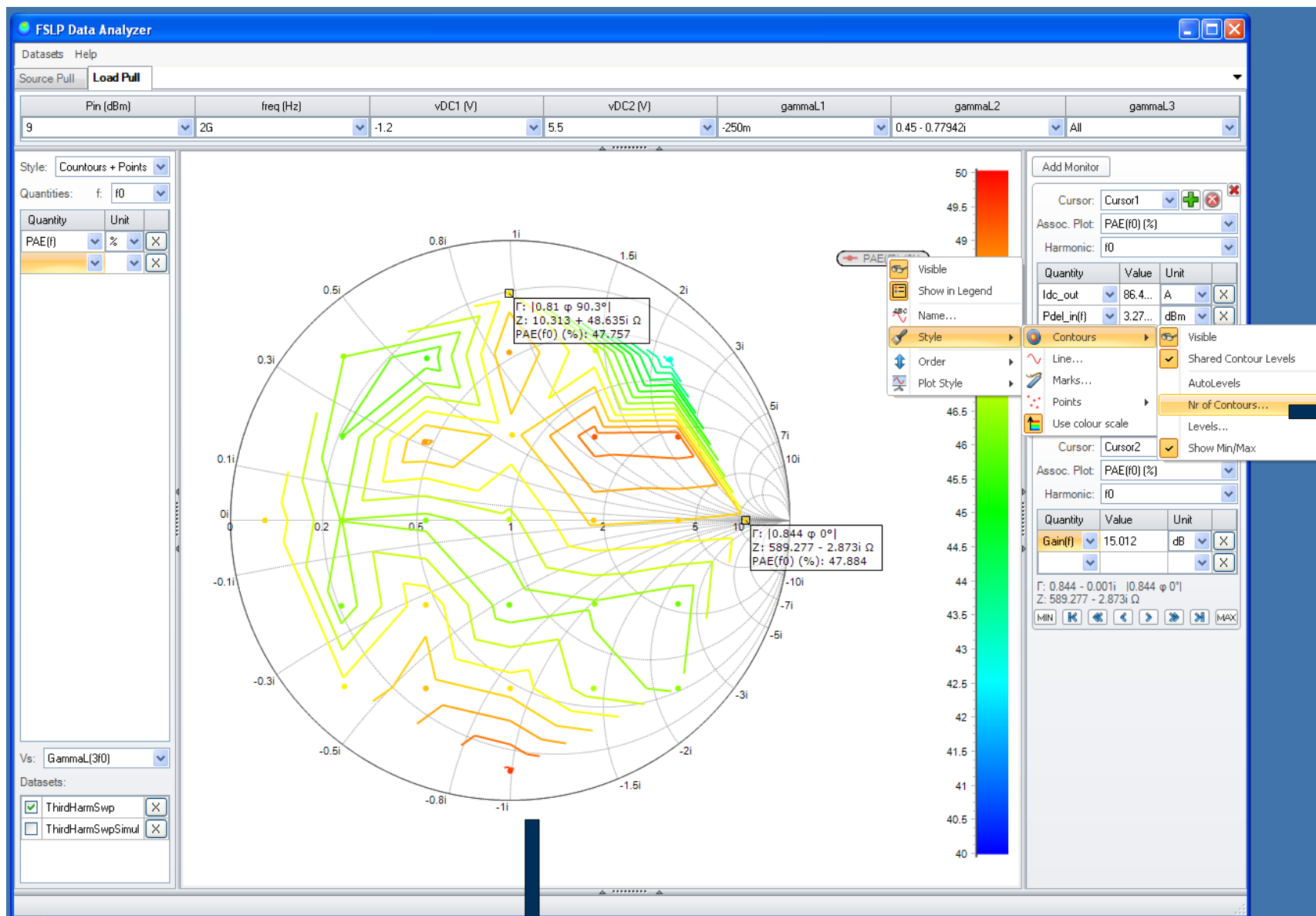
- Measured harmonic termination
- Synthesized harmonic termination

Multiple Datasets

Multiple Cursors

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

Contour Settings



Contour Settings

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

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

Data Collection

The screenshot shows the 'FSLP with MPT - Data Collection and Analysis' software interface. The window title is 'FSLP with MPT - Data Collection and Analysis'. The menu bar includes 'Datasets', 'Calibrate', and 'Tools'. A 'Calibrate' dropdown menu is open, showing 'RF Analyzer...' and 'DC Analyzer...'. The main area displays a Smith chart with a grid and a point marked '1'. The left sidebar contains 'Style: Contours', 'Quantities: f:', and a table for 'Quantity' and 'Unit'. The bottom section has 'Data Collection' and 'Log' tabs, a 'Status' table, and a 'SweepPlan1' dropdown.

Status	Pin (dBm)	freq (Hz)	vDC1 (V)	vDC2 (V)	gammaL1	gammaL2	gammaL3
Desired							
Realized							

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

FSLP Options

Sweep Plan | Options

Pin (dBm): 0 [more...](#)

freq (Hz): 2G [more...](#) [grab...](#)

vDC1 (V): -1.2 [more...](#)

vDC2 (V): 5 [more...](#)

gammaL1: -0.25 [more...](#)

gammaL2: No sweep/grid defined yet [more...](#)

gammaL3: 0.9 .. 0.78 - 0.45i # 12 [more...](#)

Sweep Plan Sequence:

Name	Sweep Sequence	Turn On Sequence	Turn Off Sequence
Pin	1	3	5
freq	7	4	4
vDC1	2	1	7
vDC2	3	2	6
gammaL1	4	5	3

Default

gammaL2:

Shape: Circle [more...](#) Pattern: Rectangular Order: Re slowest

Grid

- Single Point
- Rectangle
- Circle
- Pie
- Custom

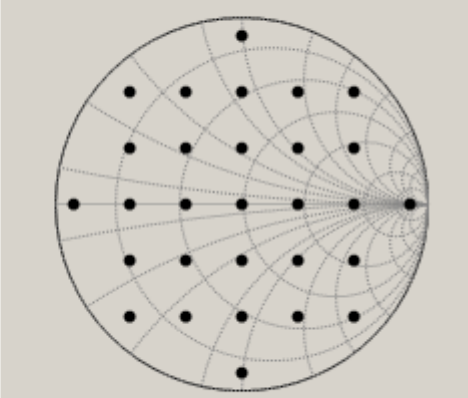
Radius: 0.9

Pattern

Horiz Steps: 7

Vert Steps: 7

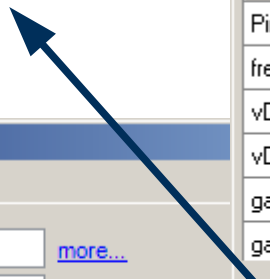
OK Cancel



Define Shapes and Fill Patterns

Control Loops

(De)Activating control loops



FSLP Options

Sweep Plan: Options

Pin (dBm): 0 [more...](#)

freq (Hz): 2G [more...](#) [grab...](#)

vDC1 (V): -1.2 [more...](#)

vDC2 (V): 5 [more...](#)

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Sweep Plan Sequence:

Name	Sweep Sequence	Turn On Sequence	Turn Off Sequence
Pin	1	3	5
freq	7	4	4
vDC1	2	1	7
vDC2	3	2	6
gammaL1	4	5	3

Default OK Cancel

Advanced...

FSLP - Advanced Sweep Plan Options

Sweep Plan Control Loops (Adjustments):

Name	Adjustment Sequence	Max Iterations	Allowed Deviation	Max Value
Pin (dBm)	2	5	25m	15
freq (Hz)	1	1	1	NaN
vDC1 (V)	3	5	3m	NaN
vDC2 (V)	4	5	3m	10
gammaL1	5	10	10m	NaN
gammaL2	6	10	10m	NaN

Fast Mode Settling Time (s): 50m

Turn Sources Off When Changing Target Value: Turn Sources Off When Done [Turn Off Now](#)

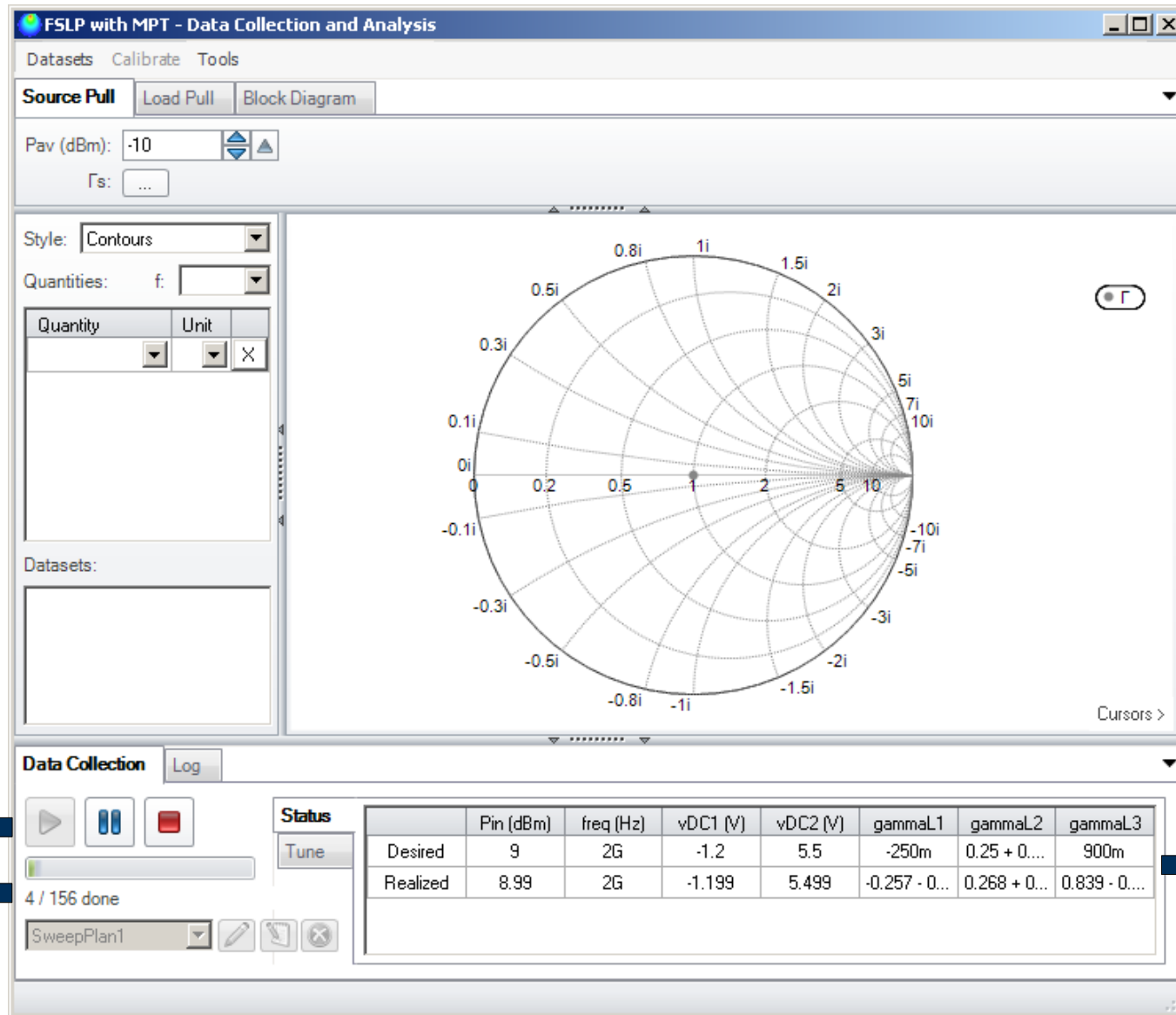
Initial Ranging Strategy: AutoRange Ranging Strategy: UpwardsTracking

OK Cancel

Limits during control loops

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

Collecting Measurements



Run
Pause
Abort

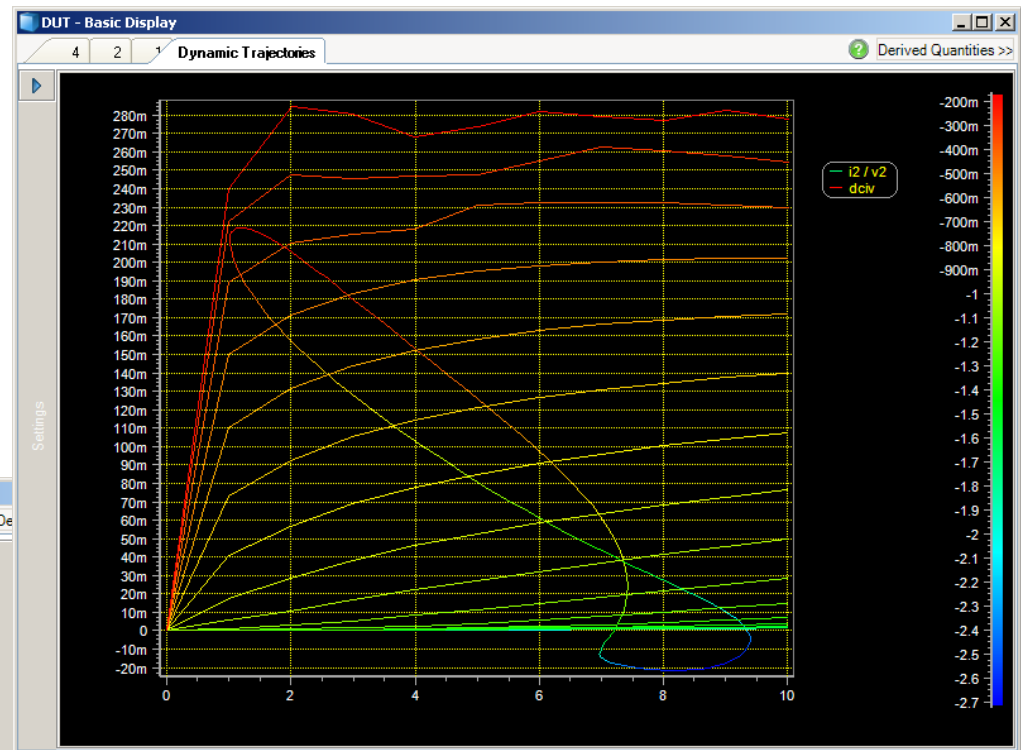
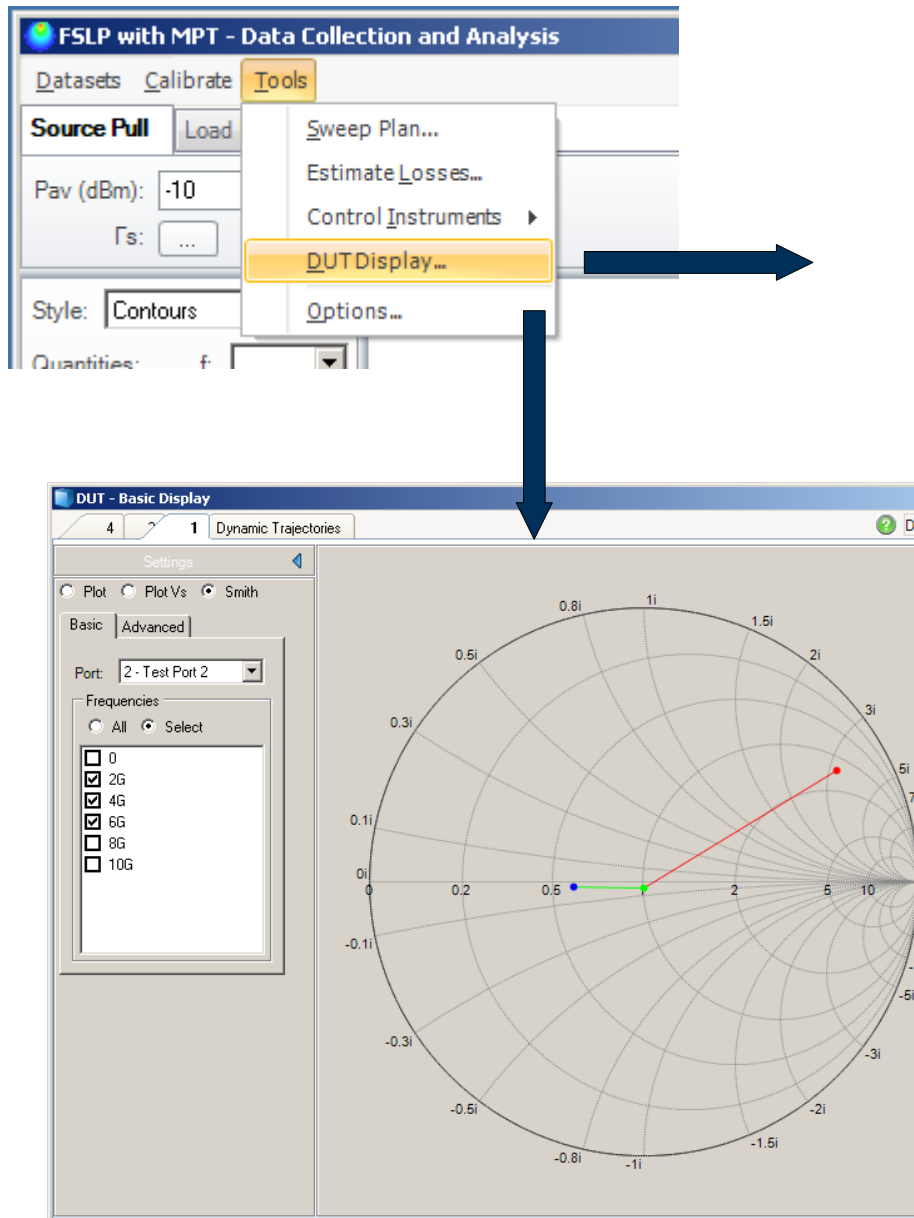


Overview
Progress

Overview
Realization

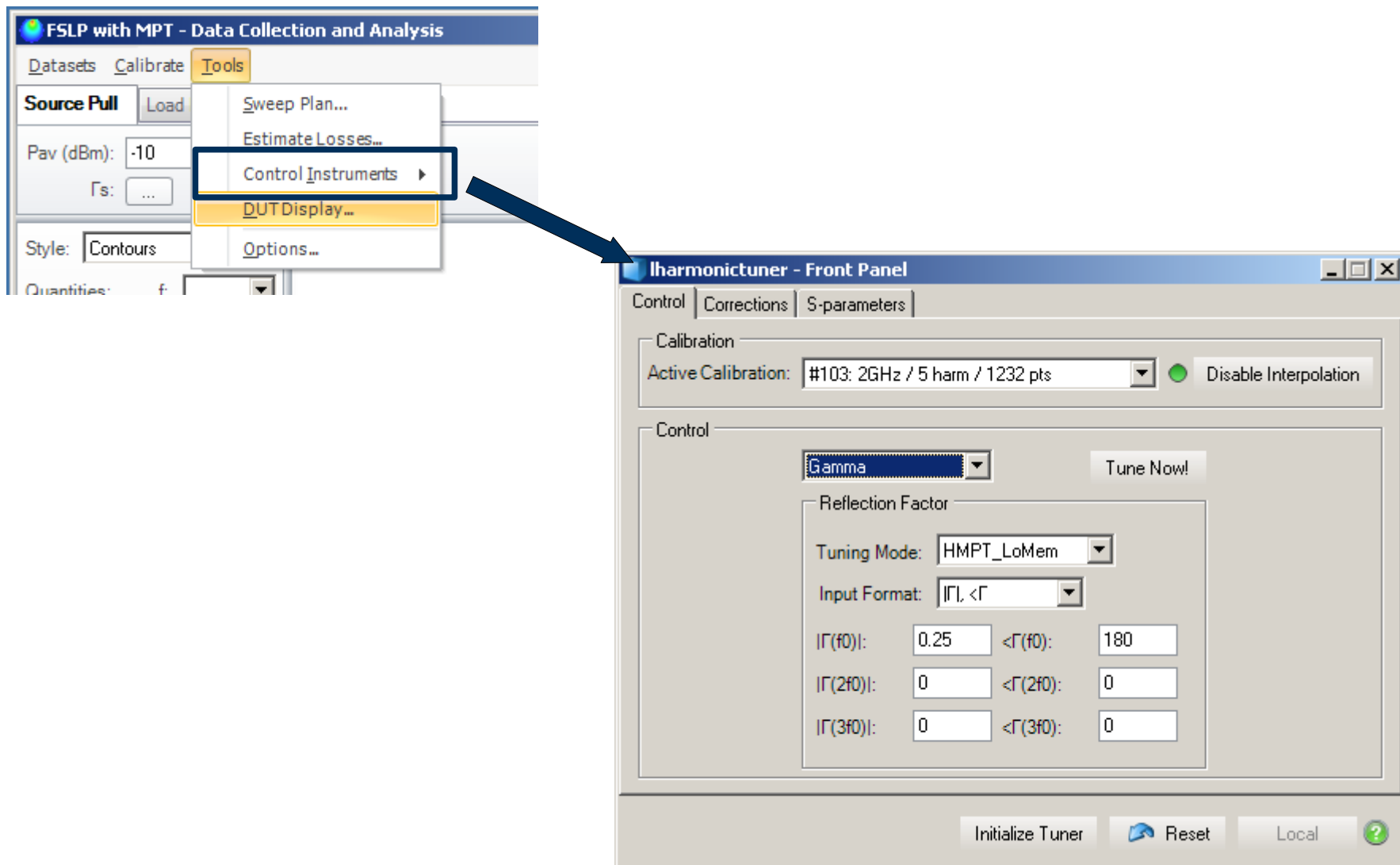


Monitoring Device Behaviour during Sweep Plan



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

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www.nmdg.be

Want to try?
Contact us
at
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