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Complex Differential Error Regions: Software Tools

**Complex Differential Error Regions : Software Tools
by Nikolitsa Giannopoulou and Petros Zimourtopoulos**

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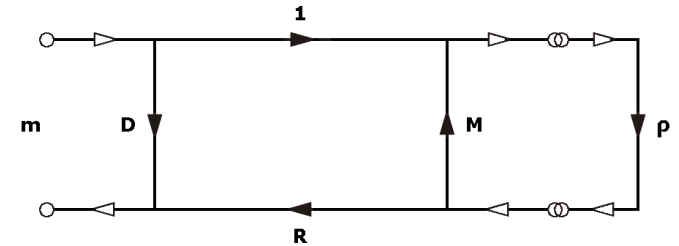
Version : 20190923

In "Building Complex Differential Error Regions", 30th ANAMET meeting, for one-port calibration VNA measurements, we concluded that the differentials:

$$d\rho = \frac{-R dD - (m - D)^2 dM - (m - D) dR + R dm}{[M(m - D) + R]^2}$$

$$dZ = \frac{2Z_0}{(1 - \rho)^2} d\rho$$

can be used for ρ and Z uncertainty estimation.

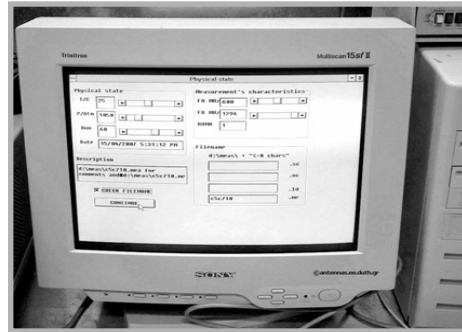


Now, two **Free Libre Open Source Software** tools were developed as complete replacements of Mathematica 3/4/5/6/7 software we used:

- The **REGION CLI-Tool**, using the **Open Watcom FORTRAN F77 Compiler 1.8**
- The **DERDEI GUI-Tool**, using the **Open Source Maxima 5.17.1**

The ANALYSE tool

The **ANALYSE GUI-Tool** was developed using MS VB 3.0 to control our ANA system via HP-IB and collect the measurements.



ANALYSE also produces four **4** output text-files: **SH.SC**, **LD.LD**, **OP.OC** and **ME.ME** for further data processing.

Physical state

Physical state

T/C 25

P/Atm 1050

Hum 60

Date 30/11/1999 11:46:53 AM

Description

d:\meas\me.me for measurement

CHECK FILENAME

CONTINUE

(c)Antennas Research Group

Measurement's characteristics

FA MHz 600

FB MHz 1000

STEP 4 KHz

Filename

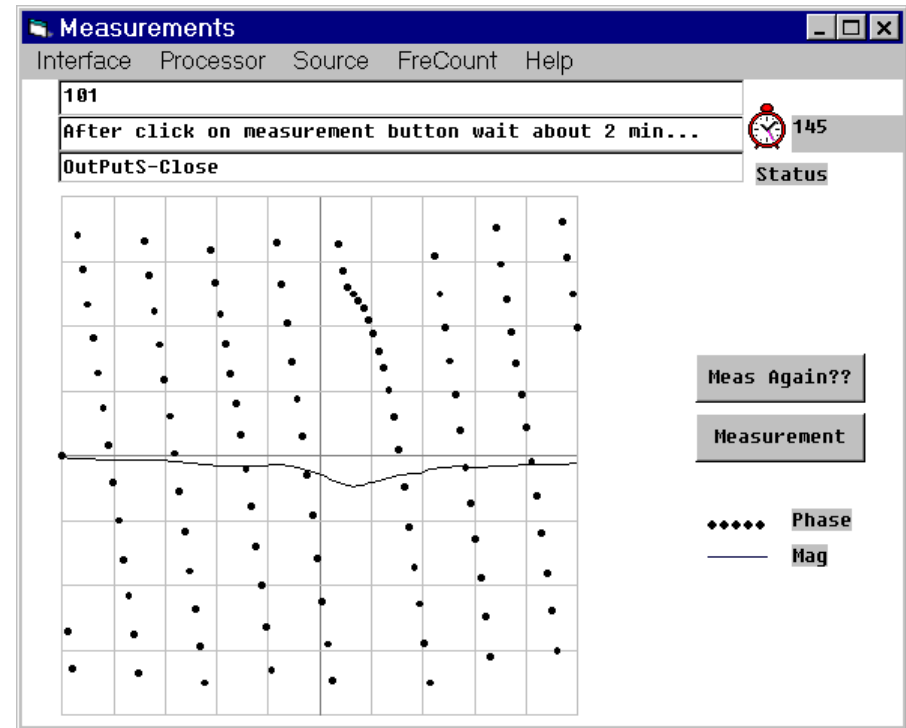
d:\meas\ + "<=8 chars"

.SC

.OC

.ld

.me



GUI-Input : Environment, Frequency Range and Output Filenames

GUI-Output : Measurement Data Mag and Phase versus Frequency

REGION Input may be the four **4 ANALYSE** Output text-files:

```
SH.SC - Notepad
File Edit Format View Help
0932.0000 -0147E-2 +0122E-0
```

```
LD.LD - Notepad
File Edit Format View Help
0932.0001 -0250E-1 +0449E-1
```

```
OP.OC - Notepad
File Edit Format View Help
0932.0001 -0140E-2 -0435E-1
```

```
ME.ME - Notepad
File Edit Format View Help
0932.0001 -0821E-2 -0155E-0
```

NOTE : Any same name text-files may serve, if they are formatted as follows:

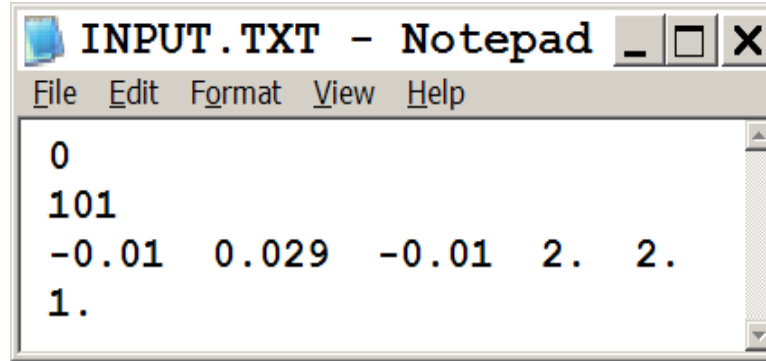
A. For **each** Data Line, N = Mantissa digit, M = Exponent digit and s = Sign:

#	Field	Length	Characters	Aligned	Format
1	Frequency in MHz	9	01 - 09	Right	NNNN.NNNN
2	2 spaces	2	10 - 11		
3	Magnitude in dB	8	12 - 19	Right	sNNNNEsM
4	2 spaces	2	20 - 21		
5	Phase in Degrees	8	22 - 29	Right	sNNNNEsM

B. Add **one** Empty Line after **each** Data Line

REGION needs the additional text-file **INPUT.TXT** to compute the Uncertainties

A Sample text-file :



```

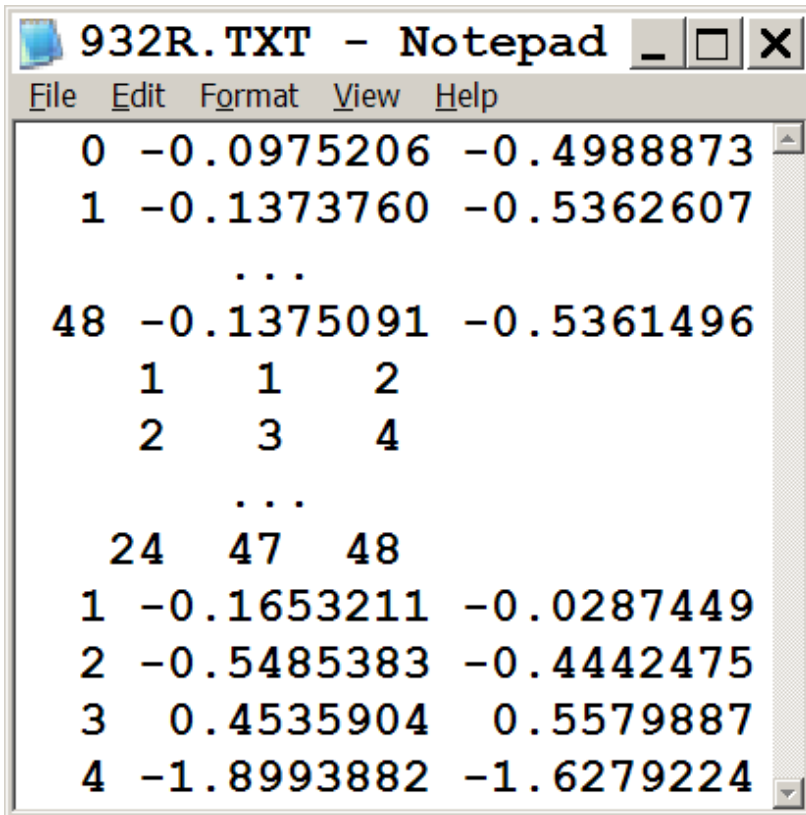
INPUT.TXT - Notepad
File Edit Format View Help
0
101
-0.01 0.029 -0.01 2. 2.
1.
  
```

Text-file structure

#	Data Type	Sample	Meaning
1	INTEGER	0	ρ -DER computations
		1	Z-DER computations
2	INTEGER	101	Number of frequencies
3	REAL	-0.01	Short magnitude uncertainty
		0.029	Load magnitude uncertainty
		-0.01	Open magnitude uncertainty
		2.	Short argument uncertainty
		2.	Open argument uncertainty
4	REAL	1.	Measurement inaccuracy in LSDs

REGION : 1st Output text-file : **One** file for **each** frequency : **NNNR.TXT**

A sample text-file for **932** MHz:



```

932R.TXT - Notepad
File Edit Format View Help
0 -0.0975206 -0.4988873
1 -0.1373760 -0.5362607
...
48 -0.1375091 -0.5361496
1 1 2
2 3 4
...
24 47 48
1 -0.1653211 -0.0287449
2 -0.5485383 -0.4442475
3 0.4535904 0.5579887
4 -1.8993882 -1.6279224

```

Text-file structure

```

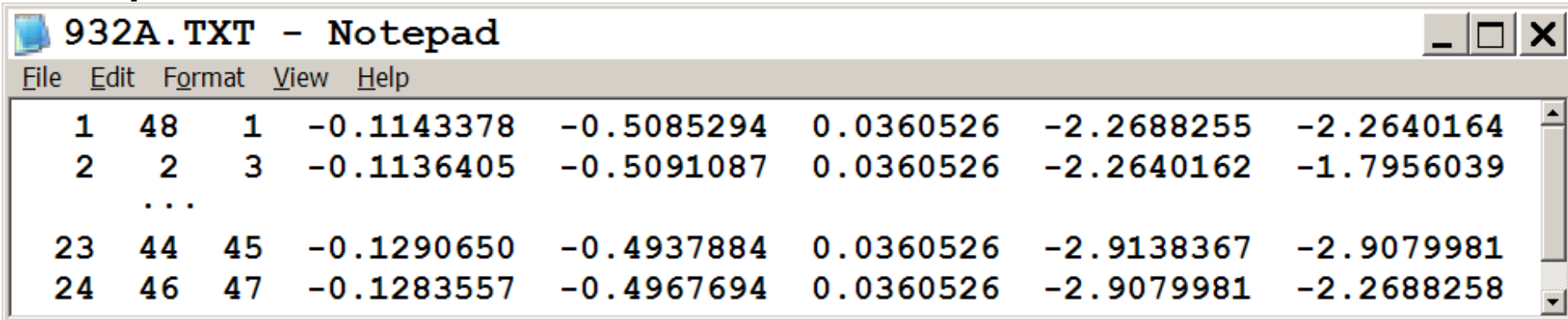
0 :  $\rho$  coordinates ( $\rho'$ ,  $\rho''$ ) 1 : Z
1
... : 1 to 48  $\rho$ -DER vertices ( $\rho'$ ,  $\rho''$ )
48
1
2
... : 1 to 24 segment vertices (N, M)
24
1 : Min-Max of  $\rho'$  Real part
2 : Min-Max of  $\rho''$  Imaginary part
3 : Min-Max of  $\rho$  Magnitude
4 : Min-Max of  $\rho$  Argument

```

48 Vertex, **24** Segment and **4** Min-Max Data Lines to prepare DER and DEI drawing

REGION : 2nd Output text-file : **One** file for **each** frequency : **NNNA.TXT**

A sample text-file for **932** MHz:



#	S	E	X	Y	R	Start	End
			Center		Radius	Arc in radians	

Text-file structure

24 Circular Arc Data Lines to complete DER and DEI drawing

REGION text output files for DEI drawing against Frequency

A. RDEIS.TXT : Rectangular DEIs versus Frequency - Sample text-file:

```
RDEIS.TXT - Notepad
File Edit Format View Help
932.00 -0.0975206 -0.1653211 -0.0287449 -0.4988873 -0.5485383 -0.4442475
```

f	Value	Min	Max	Value	Min	Max
	Real Part			Imaginary Part		

Text-file structure

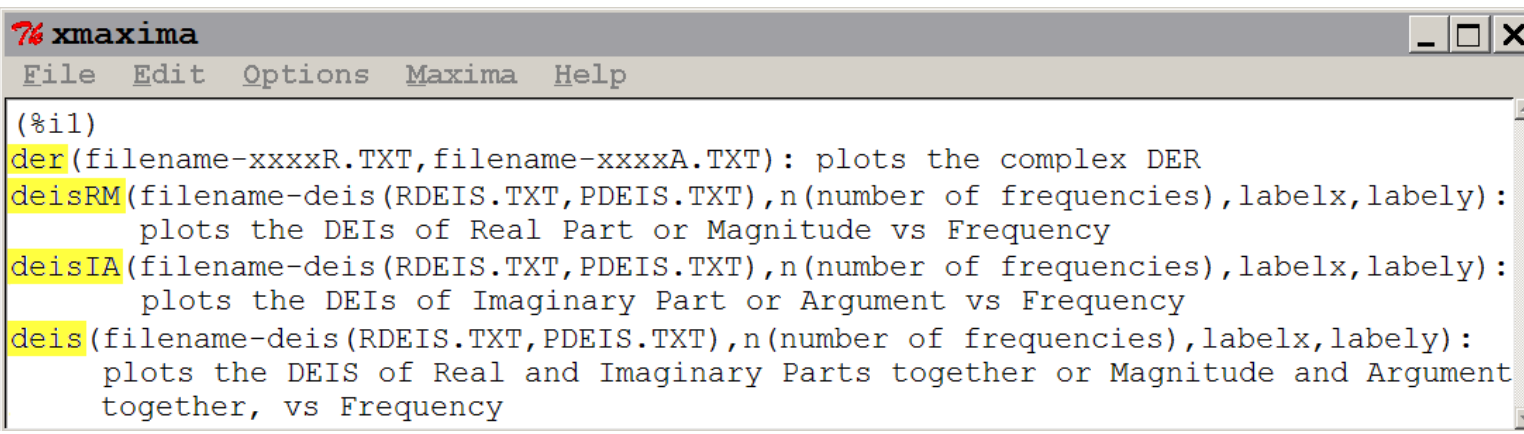
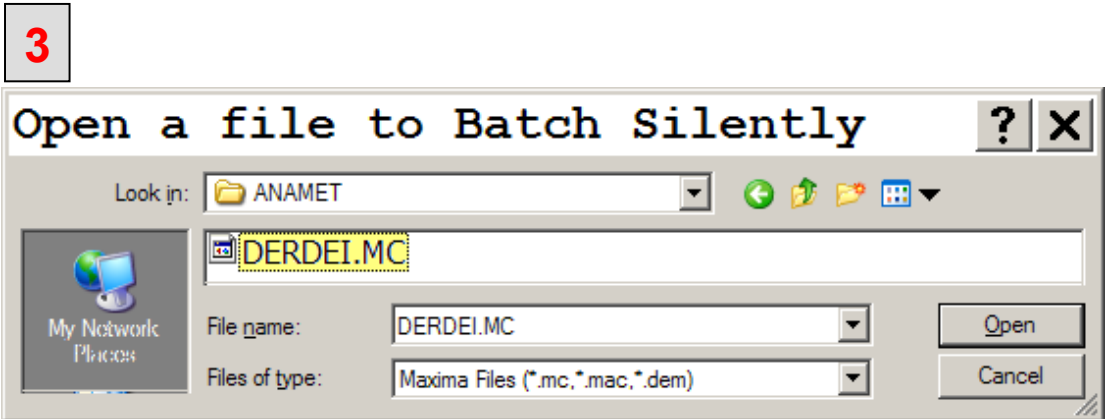
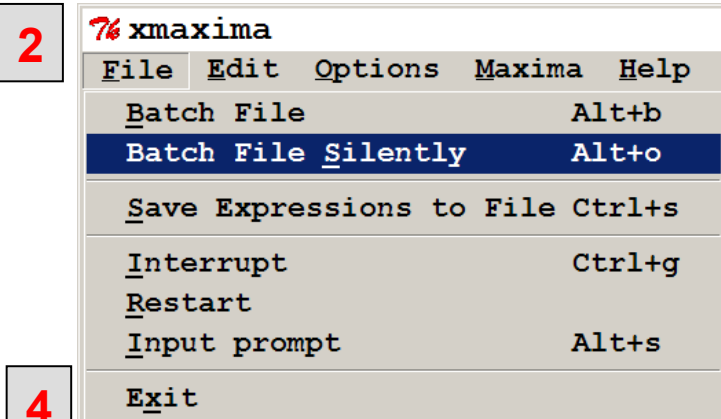
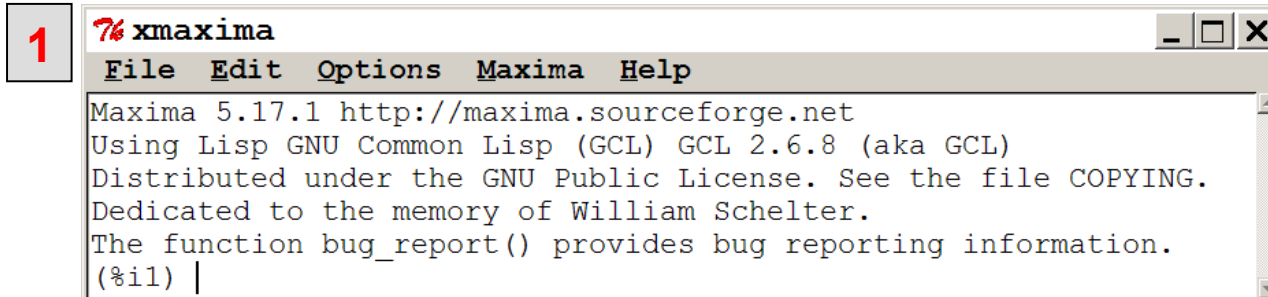
B. PDEIS.TXT : Polar DEIs versus Frequency - Sample text-file:

```
PDEIS.TXT - Notepad
File Edit Format View Help
932.00 0.5083295 0.4535904 0.5579887 -1.7638383 -1.8993882 -1.6279224
```

f	Value	Min	Max	Value	Min	Max
	Magnitude			Argument in radians		

Text-file structure

Using DERDEI in 4 steps



4 functions

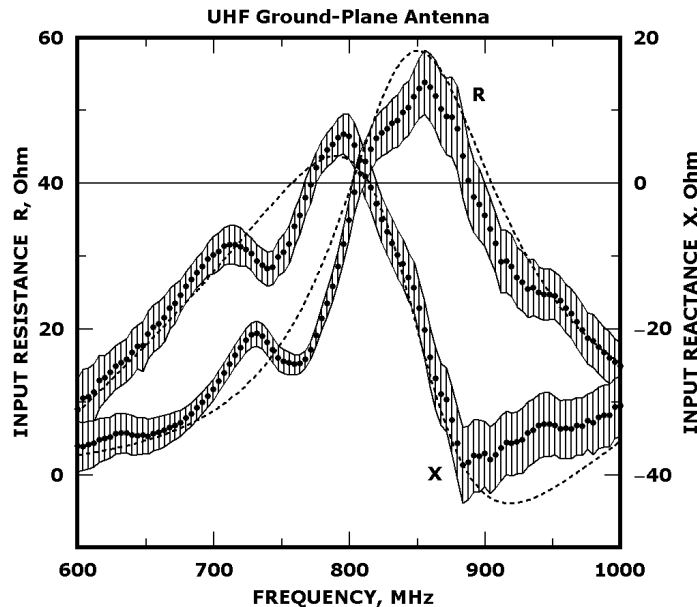
 der
 deisRM
 deisIA
 deis

Sample Application : GUI-Output

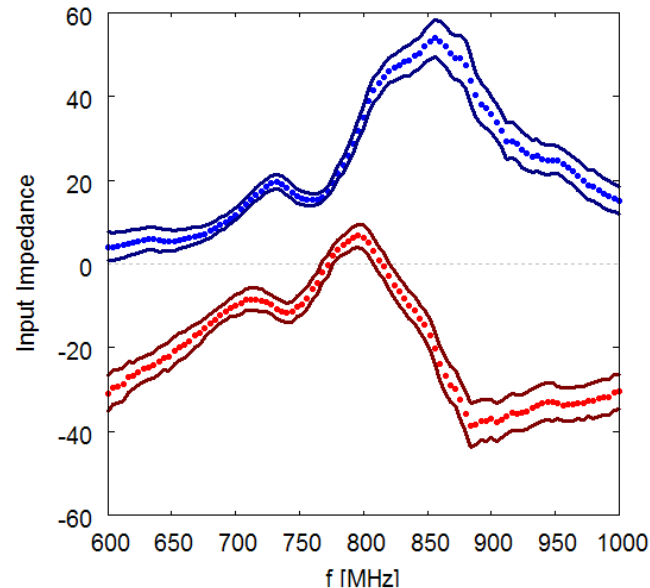
```

xmaxima
File Edit Options Maxima Help

(%i2) der("D:\\ANAMET\\932R.TXT","D:\\ANAMET\\932A.TXT");
(%o2)
(%i3) deisRM("D:\\ANAMET\\RDEIS.TXT",101,"f [MHz]","Input Resistance");
(%o3)
(%i4) deisIA("D:\\ANAMET\\RDEIS.TXT",101,"f [MHz]","Input Reactance");
(%o4)
(%i5) deis("D:\\ANAMET\\RDEIS.TXT",101,"f [MHz]","Input Impedance");
(%o5)
(%i6) deisRM("D:\\ANAMET\\PDEIS.TXT",101,"f [MHz]","Magnitude of RHO");
(%o6)
(%i7) deisIA("D:\\ANAMET\\PDEIS.TXT",101,"f [MHz]","Argument or RHO [rad]");
    
```



Published



DERDEI GUI-Output

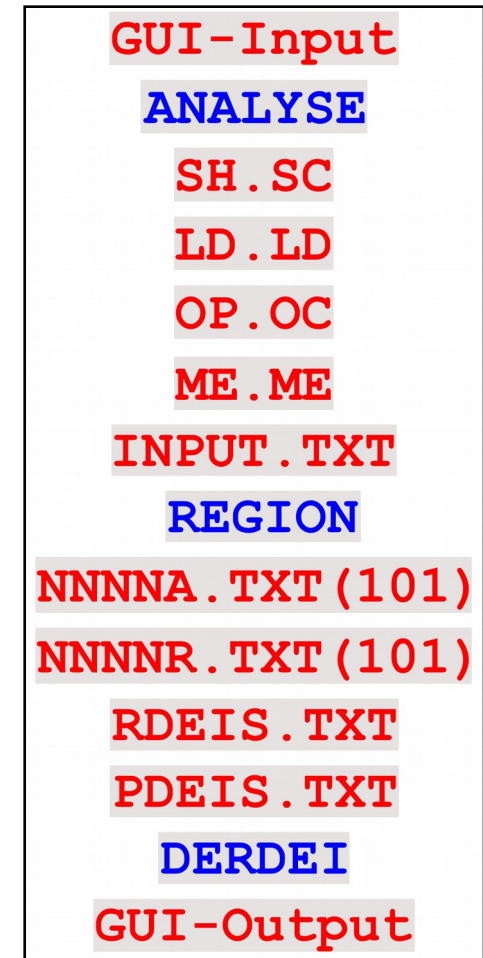
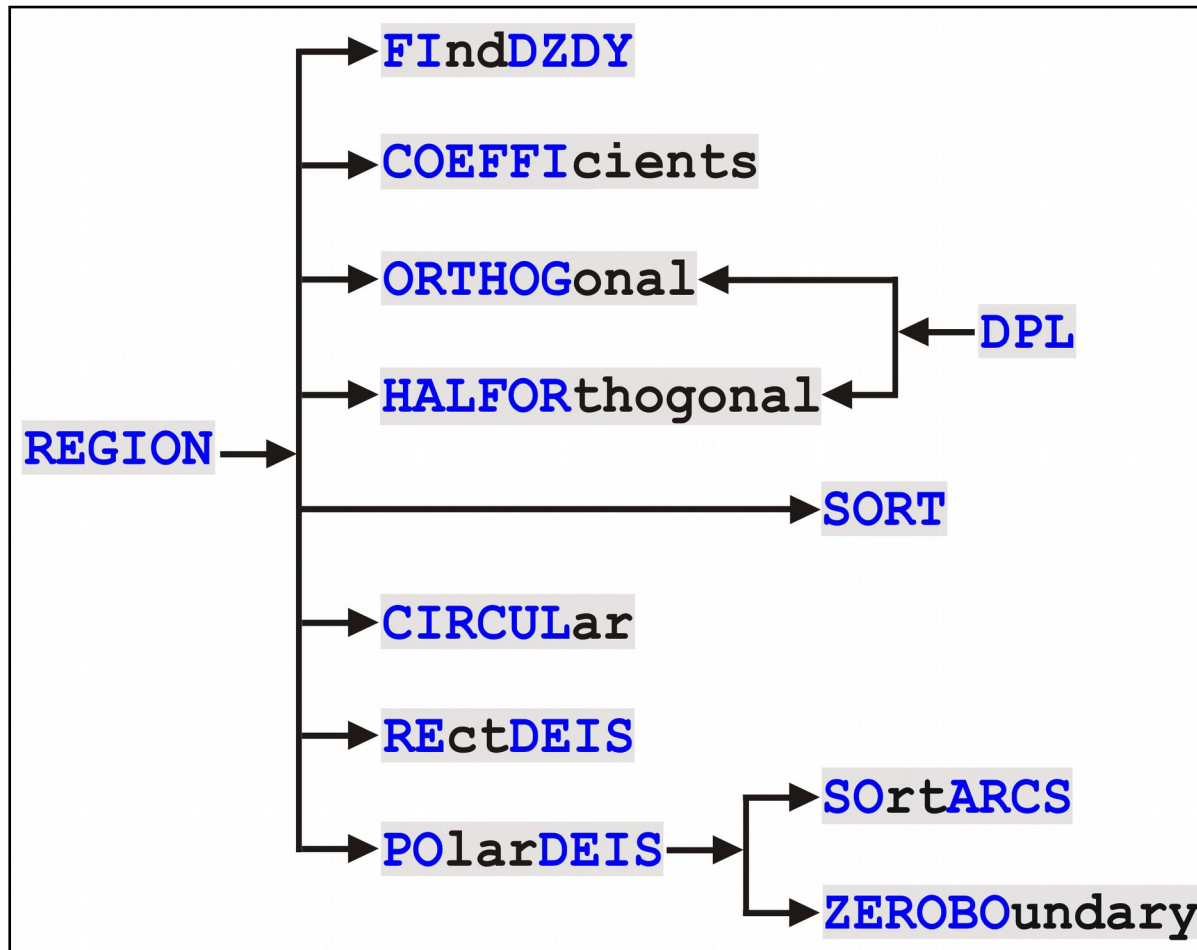
REGION structure

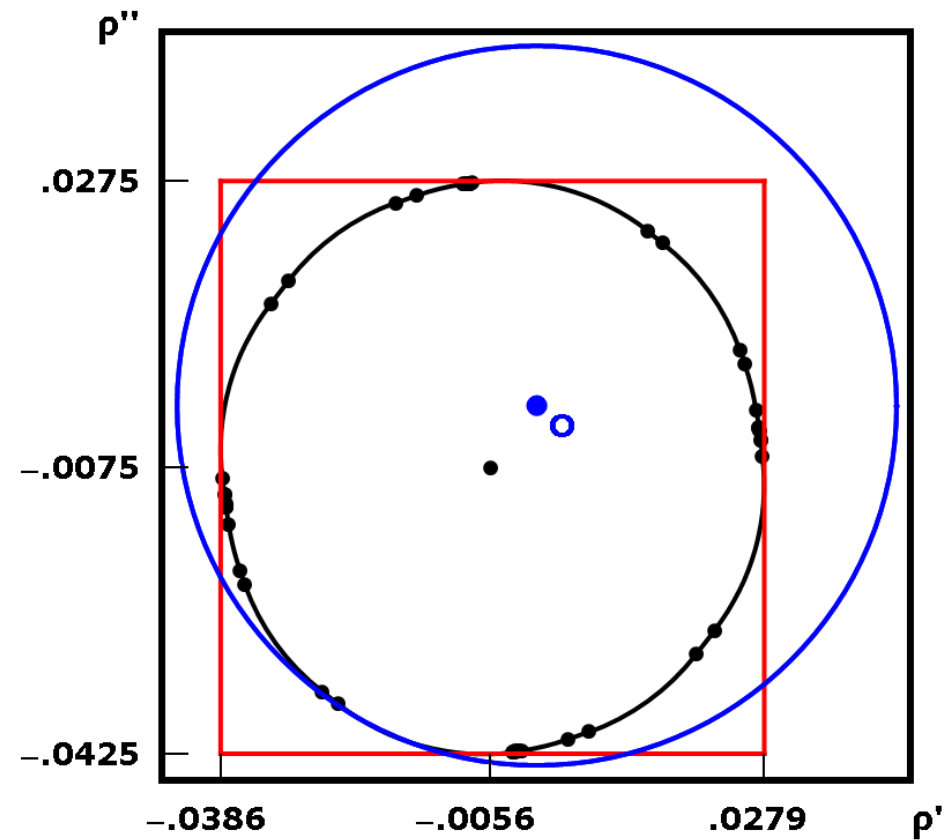
Main
program

7 Basic
subroutines

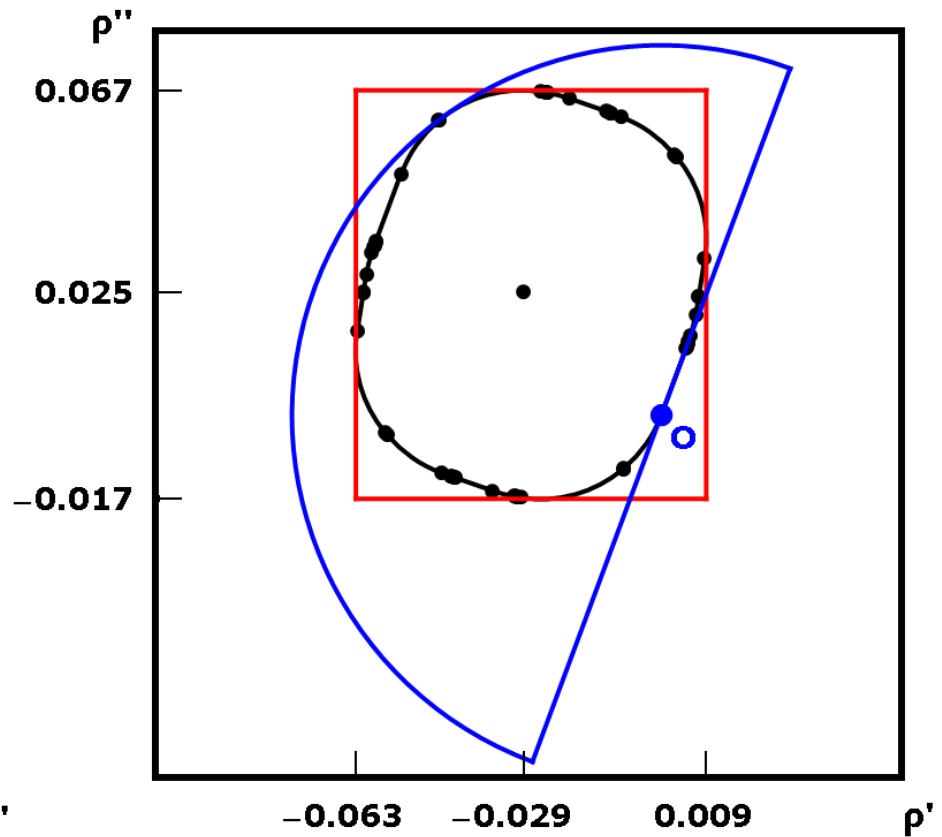
4 Support
subroutines

Software Tools
Interoperability





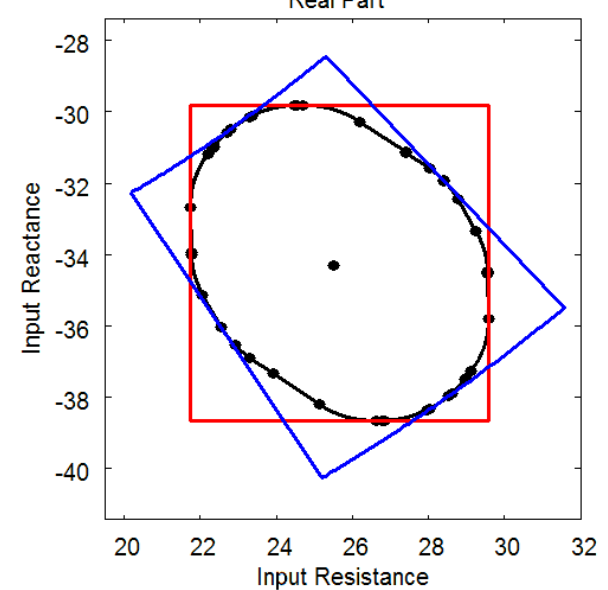
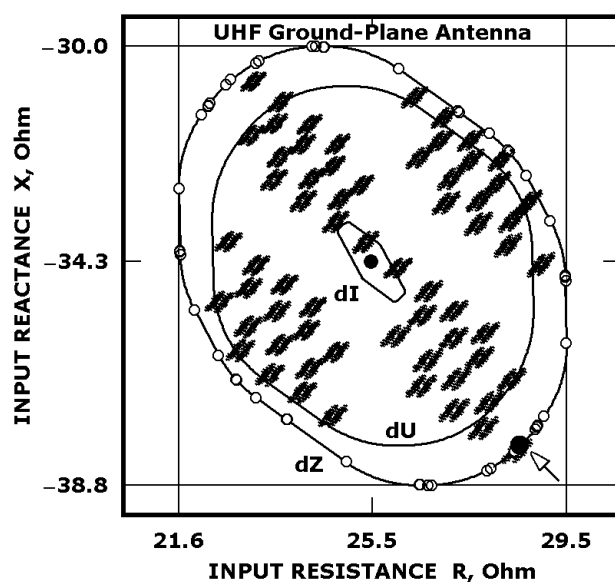
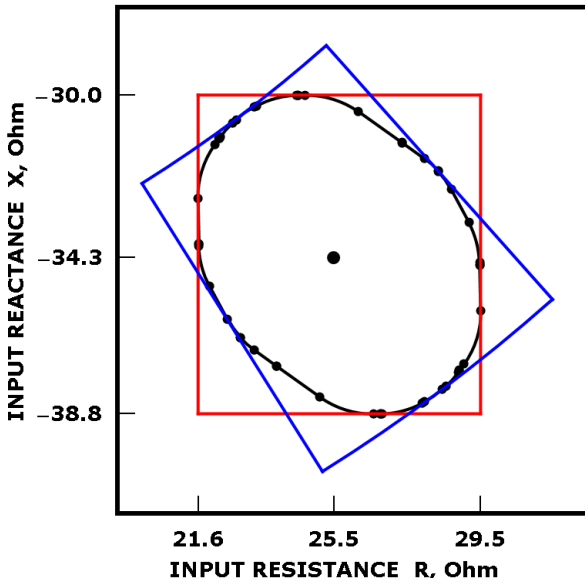
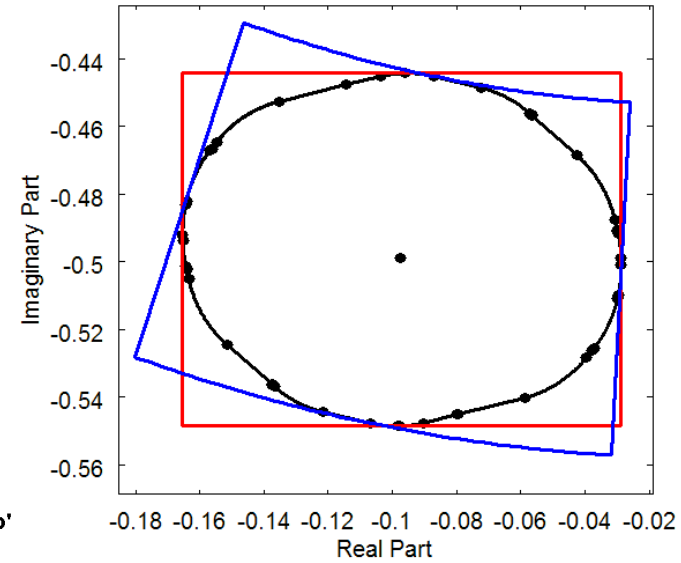
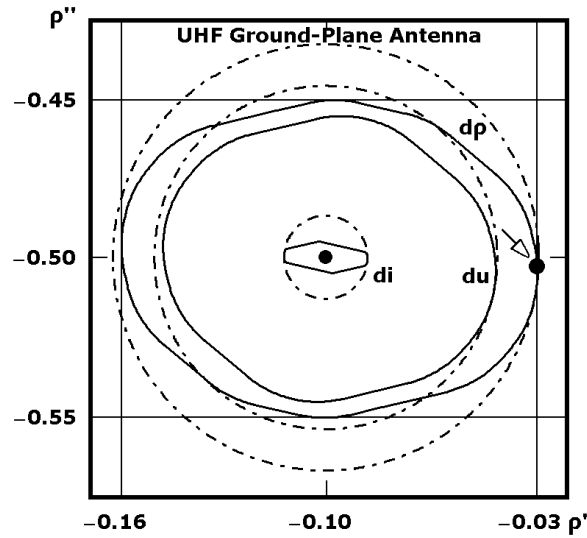
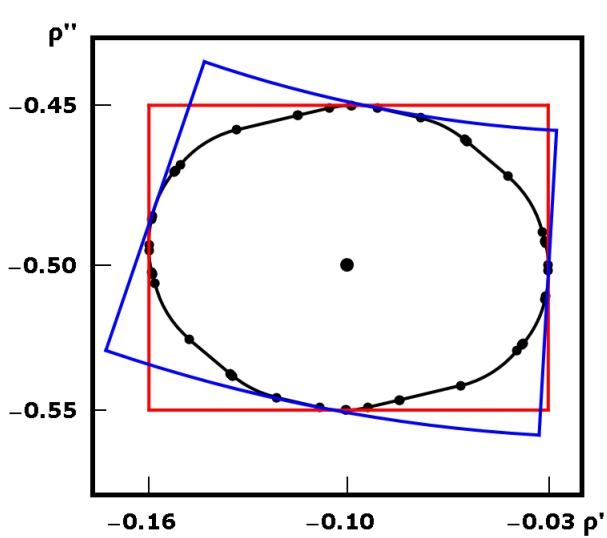
Case 1: DER includes the origin O as an **internal** point.



Case 2: DER includes the origin O as a **contour** point.

Further special cases concern the intersection of a ρ -DER with the unit- ρ boundary.

Antenna DER Uncertainty Estimation Comparison

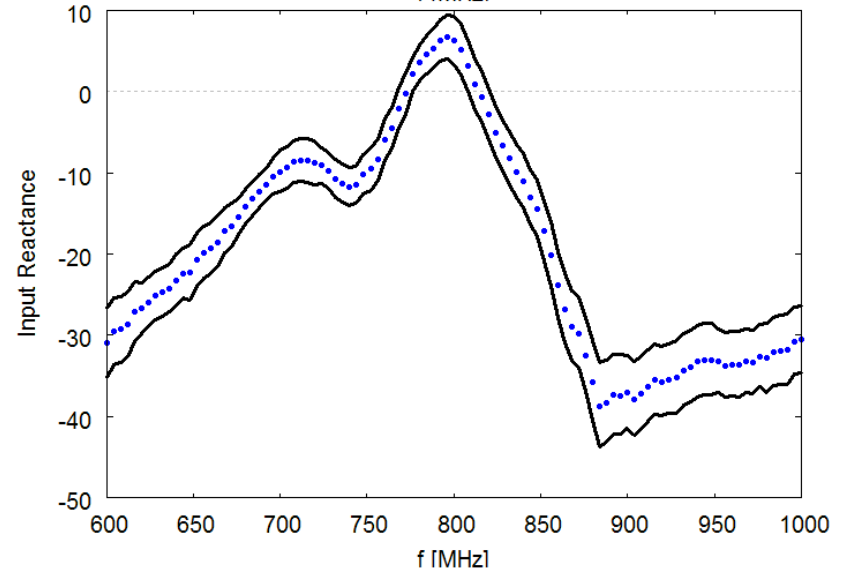
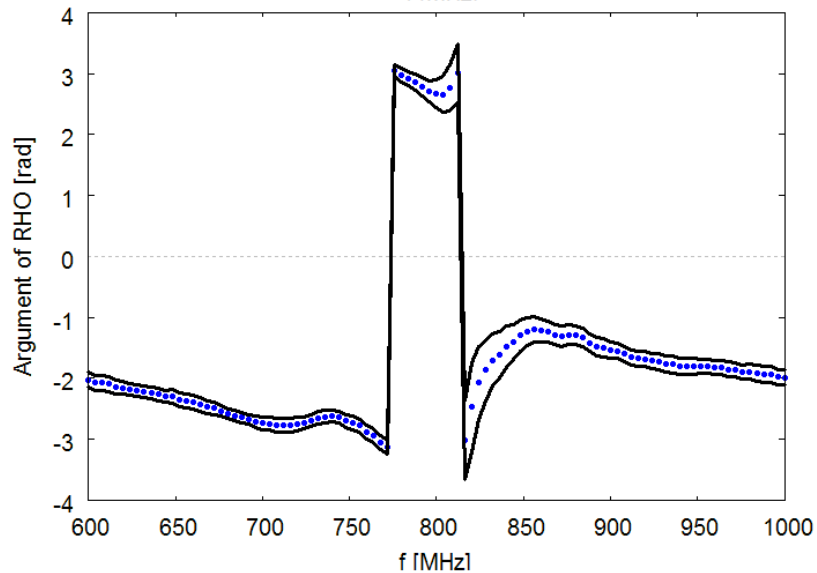
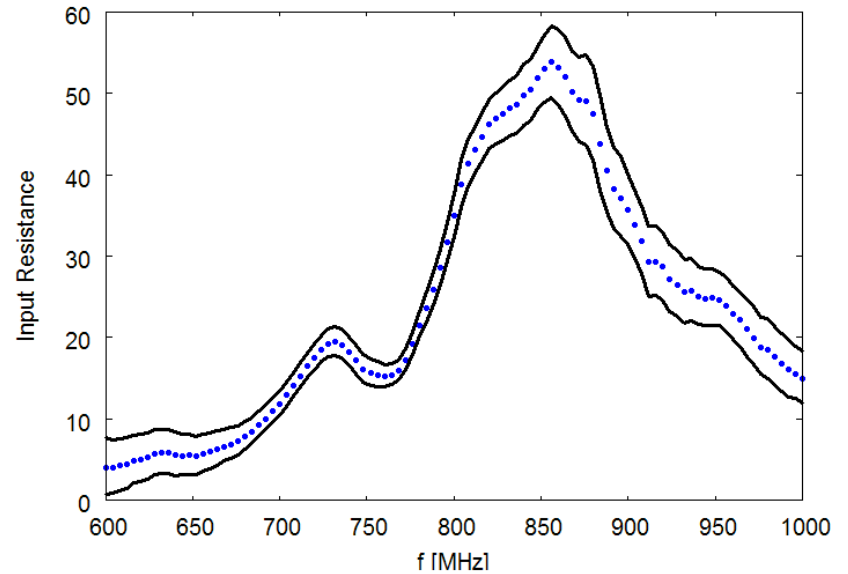
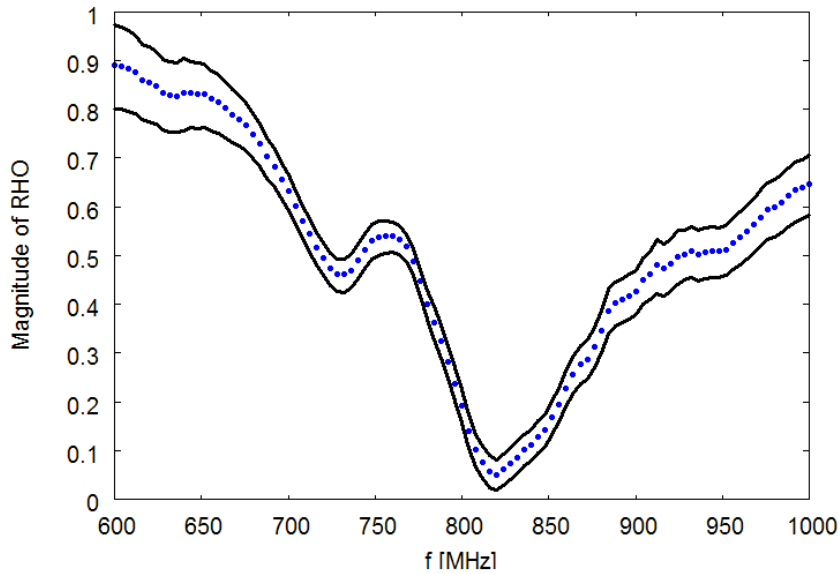


Mathematica

Published

Software Tools

Antenna Uncertainties versus Frequency



Reflection Coefficient

Antenna Impedance

Complex Differential Error Regions: Software Tools
References, Computer Programs, Updated Material

www.op4.eu/anamet/31

Thank you for your attention