Next Generation Test Chambers

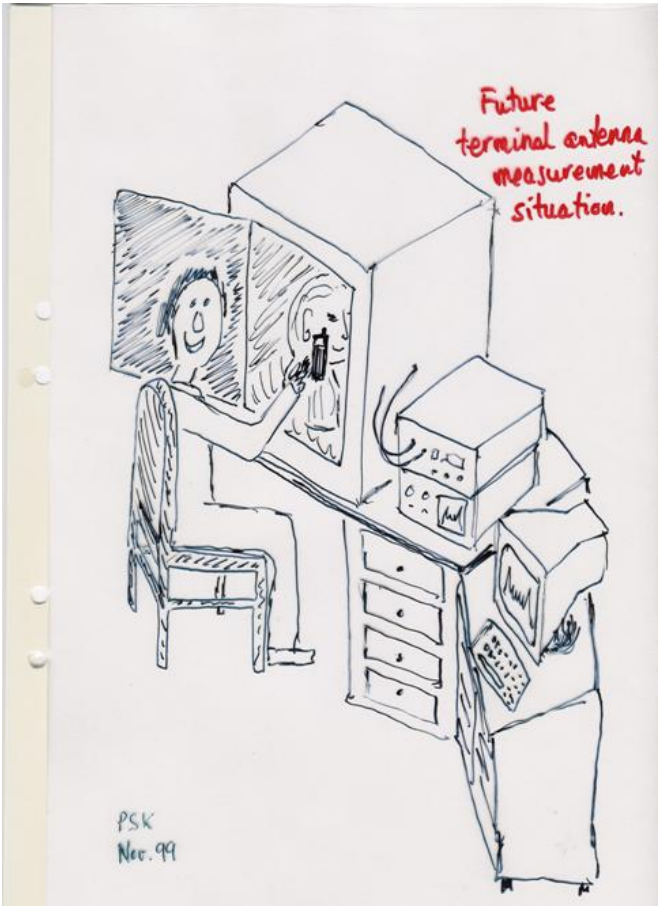
Bluetest Background

- Founded in 2001 by Professor Kildal at Chalmers University, Gothenburg, Sweden

- The vision was to perform tests:
  - Fast
  - Easy
  - Cost effectively

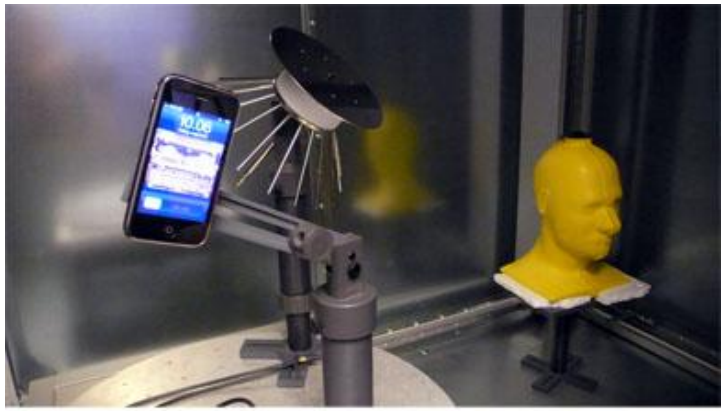
- 2006: High Performance (HP) chamber

- 2006 – 2009: large sales growth



Bluetest Today

- 35 customers world wide
- CTIA TRP and TIS procedure ready
- Proposed for 3GPP MIMO OTA tests
- Bluetest delivers:
  - World leading MIMO/Diversity tests
  - Fastest available TRP/TIS tests
  - Test for all leading cellular standards
  - Most cost effective OTA tests

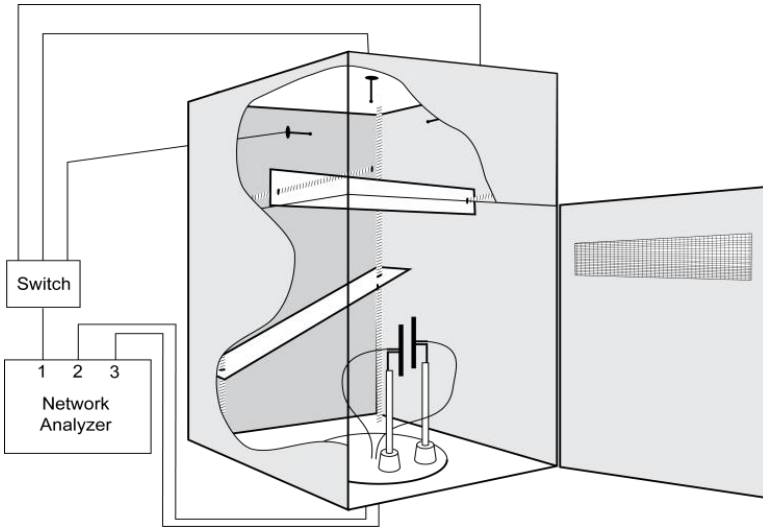


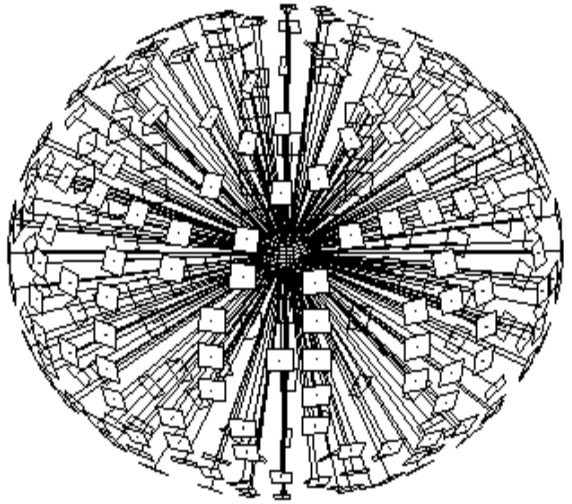
iPhone 3G antenna test
Göteborgs-Posten 080824

How can a Bluetest Reverberation Chamber solve the problems?

What is a Reverberation Chamber?

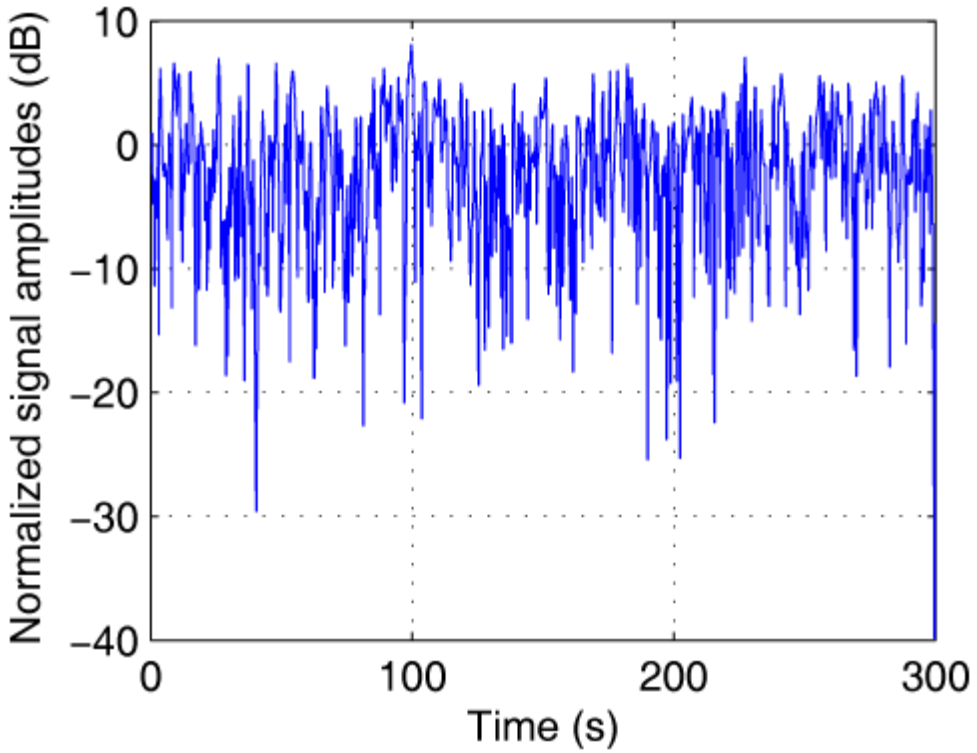
- Reverberation chamber – isotropic Rayleigh fading
- Easy and fast measurements of:
  - Antenna efficiency, TRP and TIS
  - Antenna diversity gain
  - Correlation
  - MIMO capacity, MIMO throughput



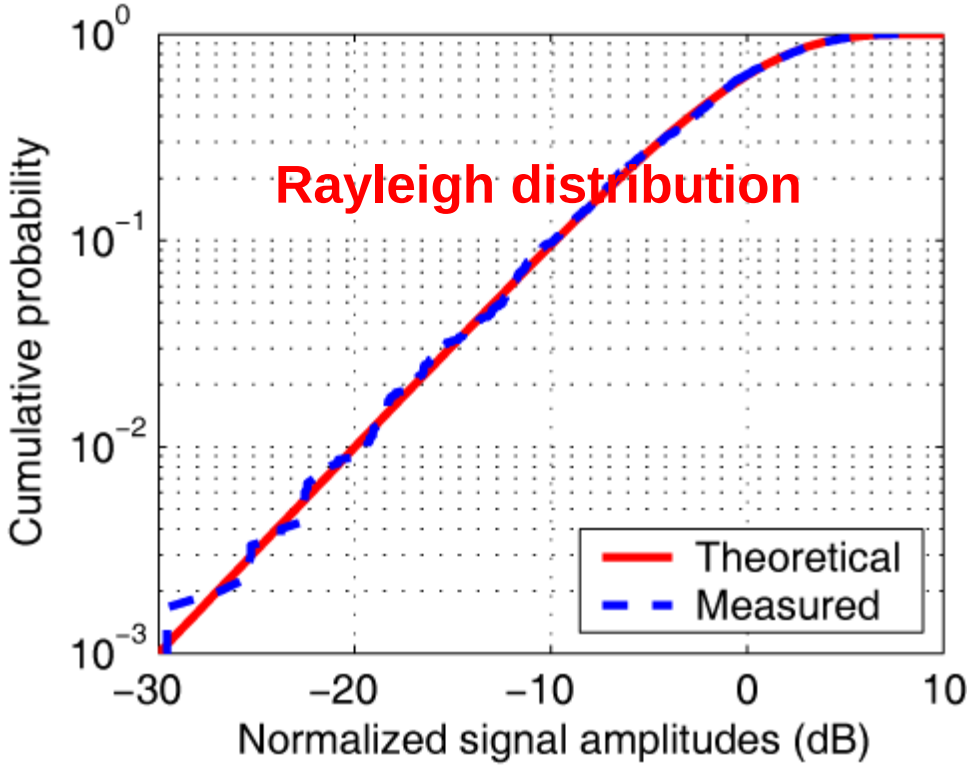


Statistical representation

Rayleigh fading



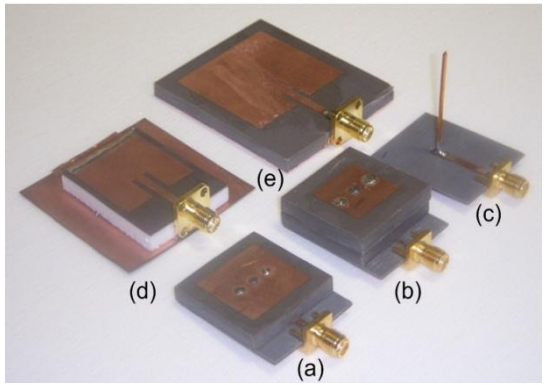
Theoretical value versus measured value in a Bluetest Chamber



Measurements Comparisons
Anechoic vs. Reverb. Chamber

Comparison of radiation efficiency

Large near-field chamber vs. Bluetest chamber



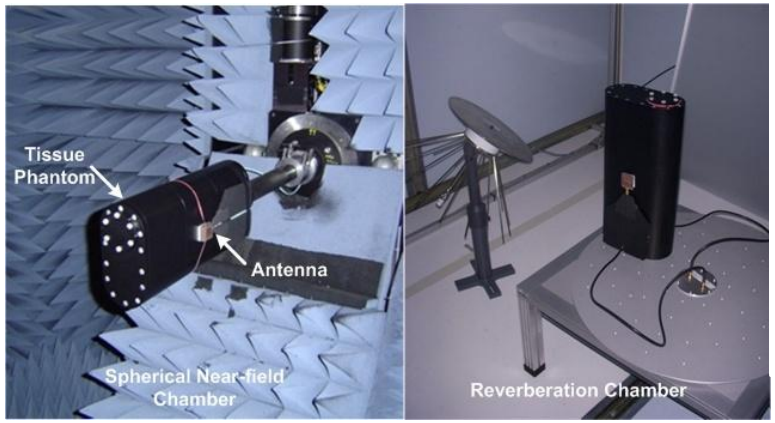


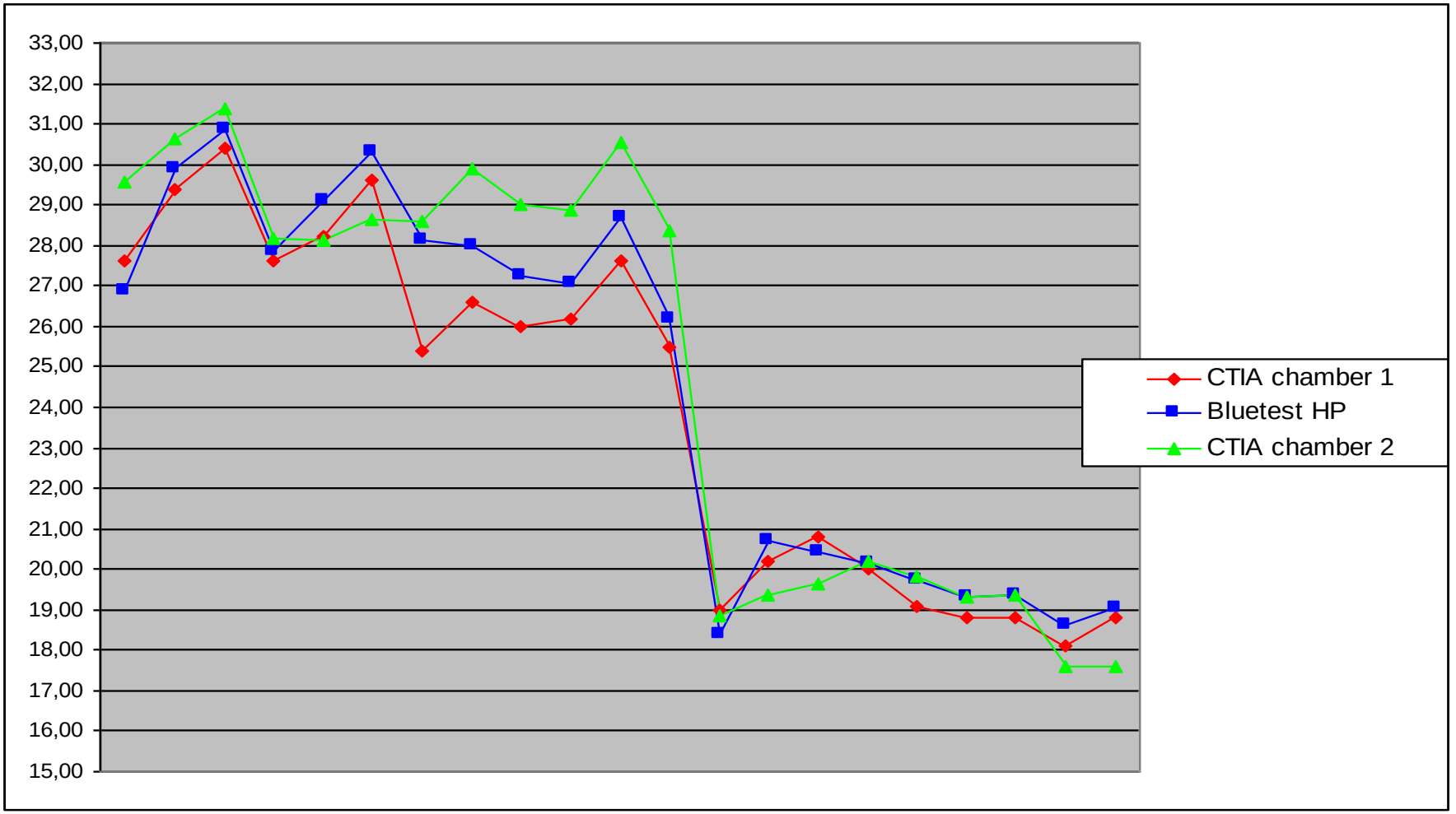
TABLE I
COMPARISON OF MEASURED AND SIMULATED RADIATION EFFICIENCY

Antenna	Phantom Mounted Efficiency at 2.45 GHz (%) [equivalent loss, dB]		
	Simulation	Near-Field	Reverb
HMMPA 10mm	49.0 [3.1]	38.9 [4.1]	42.8 [3.7]
HMMPA 5 mm	45.0 [3.5]	37.6 [4.2]	37.1 [4.3]
Monopole	58.5 [2.3]	51.0 [2.9]	53.4 [2.7]
MPA-F	65.6 [1.8]	67.0 [1.7]	75.1 [1.2]
MPA-S	65.7 [1.8]	61.0 [2.1]	61.2 [2.1]

From measurements by Queen's University Belfast, "In Situ Measurement of UHF Wearable Antenna Radiation Efficiency Using a Reverberation Chamber", IEEE Antennas and Wireless Propagation Letters, Vol. 7, 2008

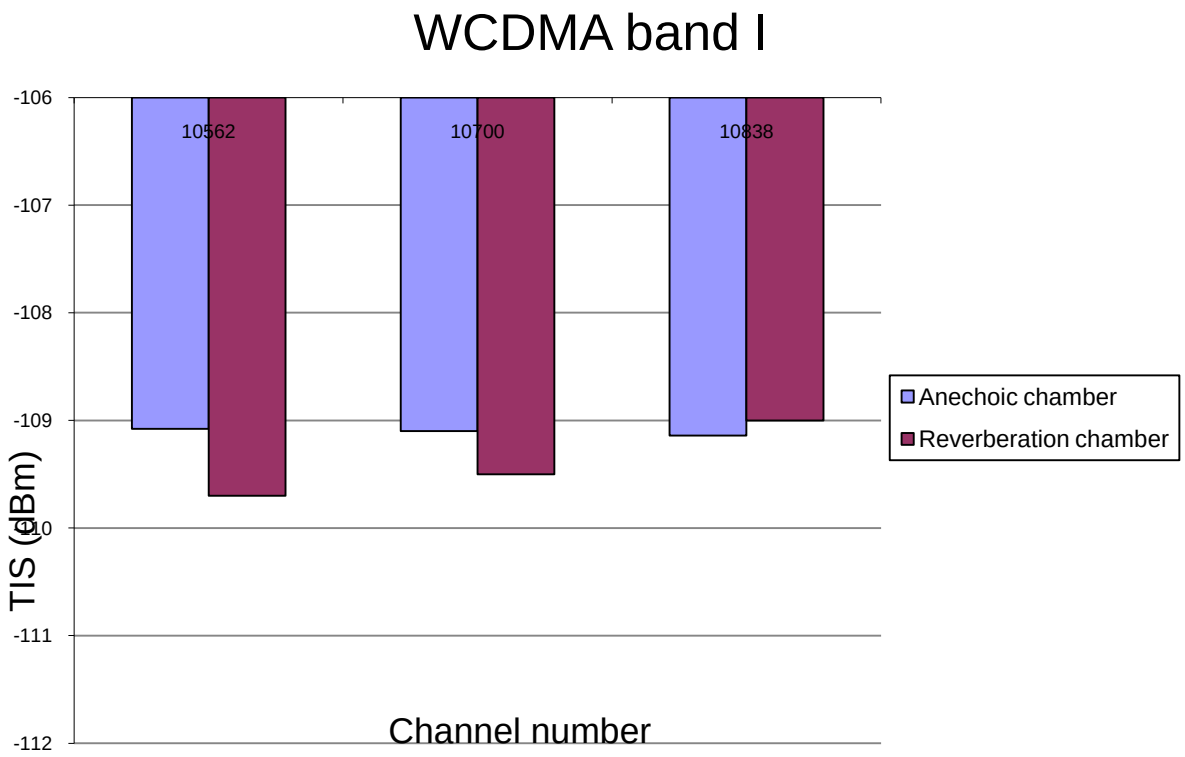
Measured TRP of 21 channels

TRP
dBm



Band	GSM 850	GSM 900	GSM 1800	GSM 1900	WCDMA 850	WCDMA 1900	WCDMA 2100
Channels	128 190 251	975 38 124	512 699 885	512 661 810	4132 4182 4233	9262 9400 9538	9612 9750 9888
Frequencies	824 837 849	880 897 915	1710 1747 1785	1850 1880 1910	826 836 846	1852 1880 1908	1922 1950 1977

TIS: Comparison anechoic - HP reverberation chamber



UMTS (W-CDMA) band I

Downlink frequencies:

2110-2170 MHz

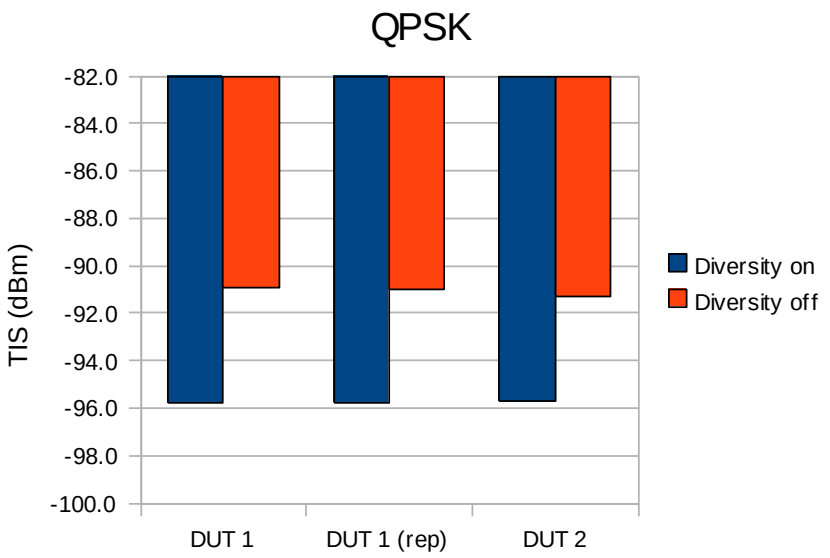
Same phone measured in anechoic chamber and reverberation chamber

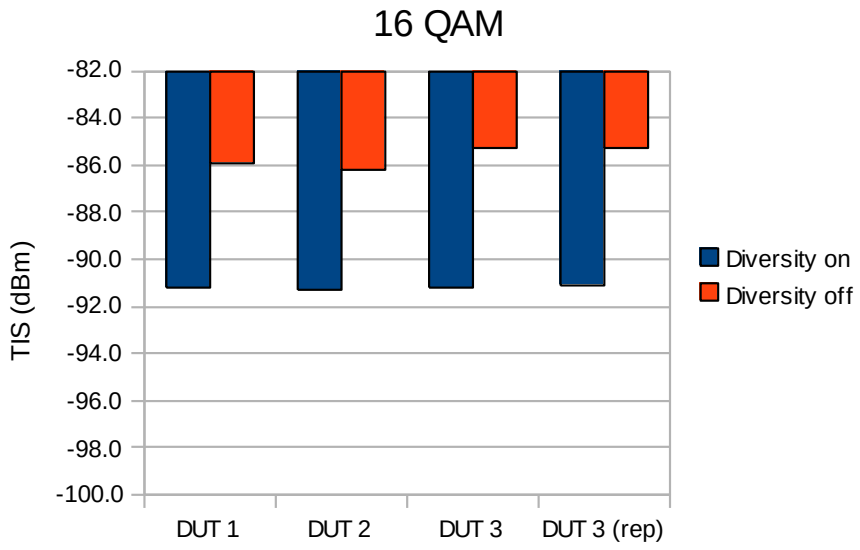
Diversity and MIMO Throughput Measurements

Bluetest unique MIMO and diversity features

- Direct fast MIMO/Diversity antenna tests
- Active MIMO/Diversity throughput tests
- System tests to optimize:
  - Scheduling software in base stations
  - Multi-user MIMO
  - Complete RF chain
  - System capacity
  - Handover performance
  - Co-operative MIMO

HSPA Active Diversity : TIS

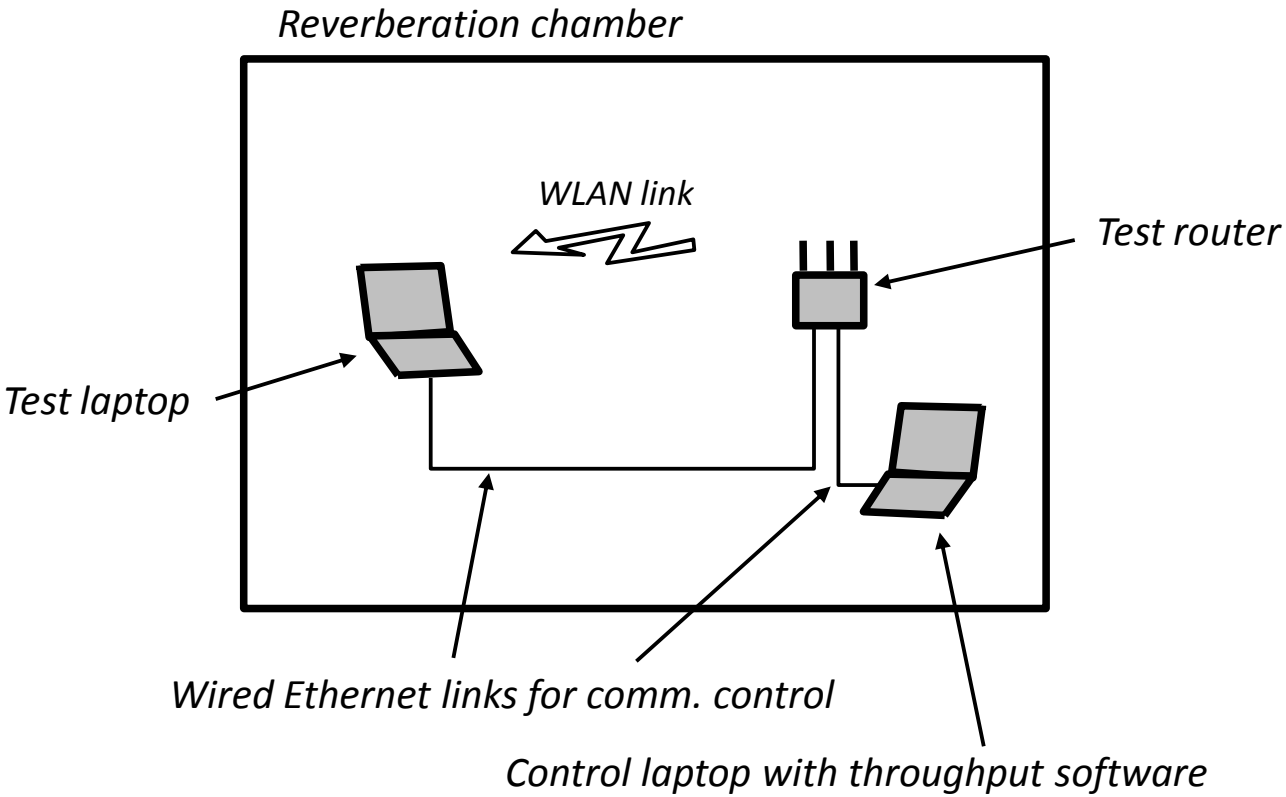




- Two cases tested: QPSK and 16 QAM modulation
- Significant and repeatable difference between diversity on/off cases

Measurement results from anonymous terminal manufacturer

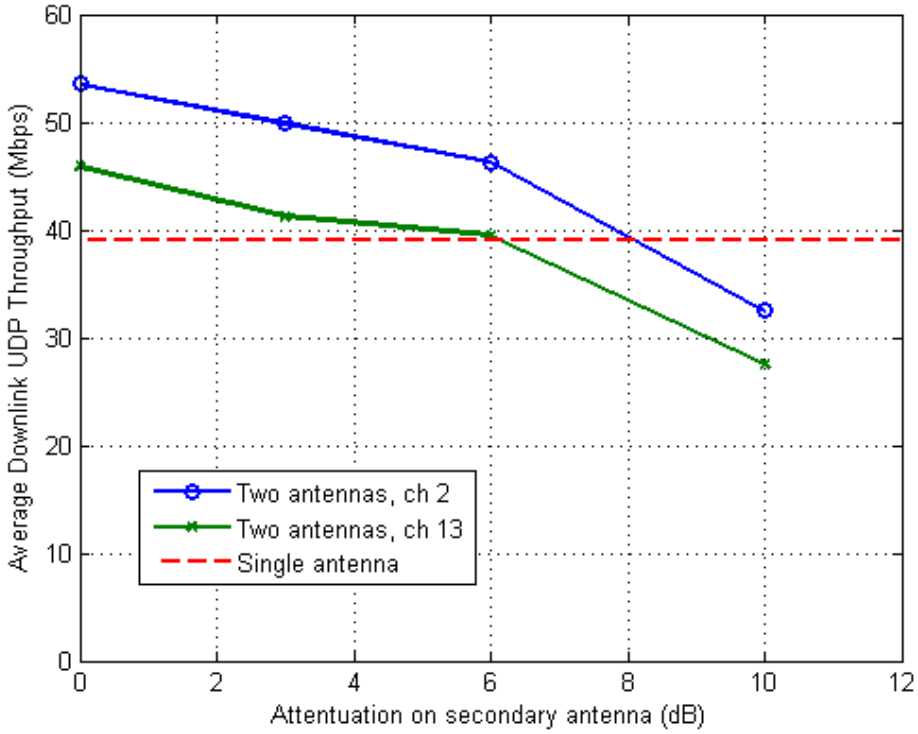
MIMO Throughput Measurements



Tests performed in collaboration with Sony Ericsson and presented at AP-S 2008 in San Diego

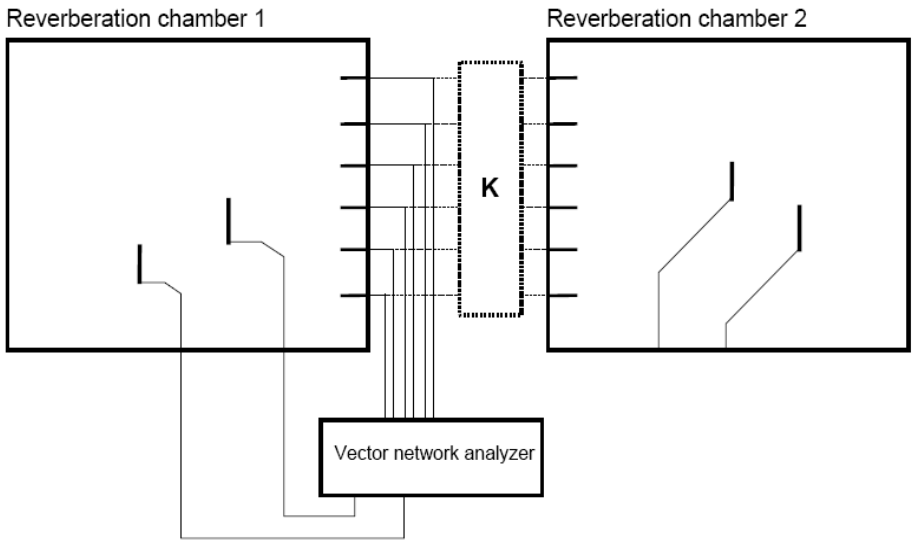
Unbalanced Channel Cases

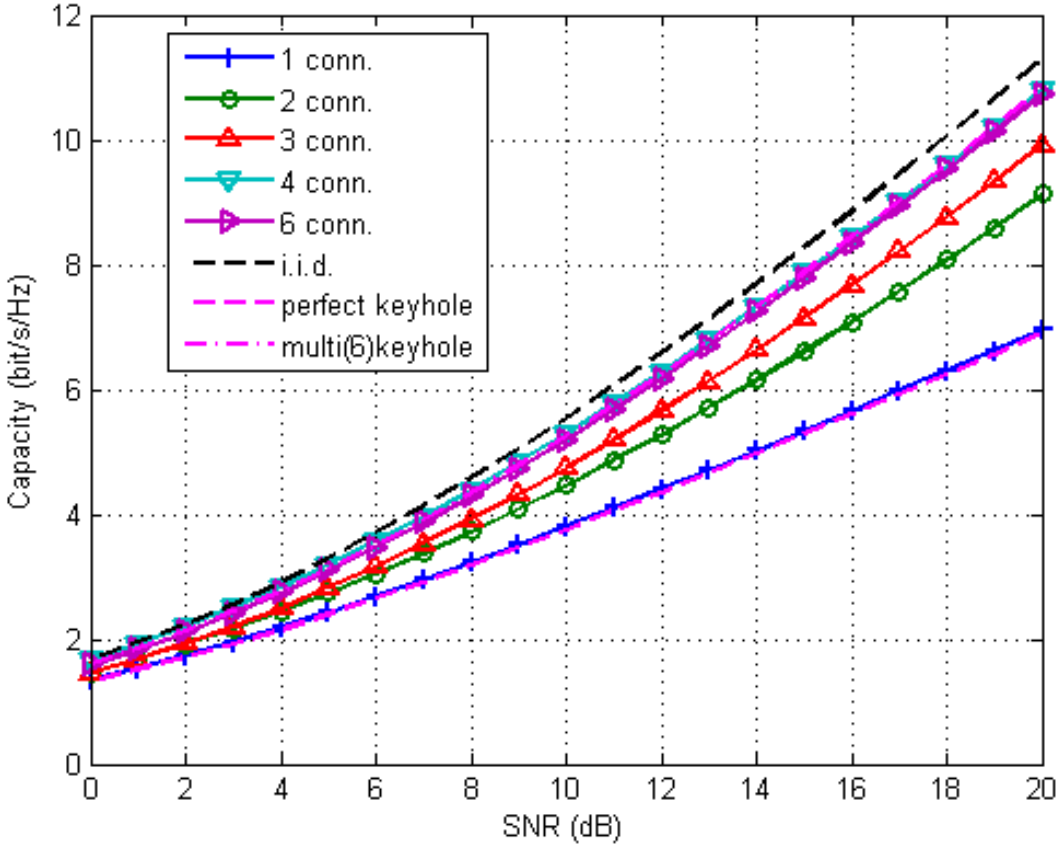
- Antennas in the MIMO set having different efficiencies,
- Two antennas used in router, one of them attenuated with 0, 3, 6 or 10 dB.
- Secondary antenna with low efficiency improves the throughput as long as the efficiency is not too bad



Connected Reverberation Chambers

MIMO channel simulator





From measurements by Bluetest, " Connected Reverberation Chambers with Variable Channel Rank for Measurement of MIMO Antenna System Performance, IEEE AP-S International Symposium on Antennas and Propagation, Charleston, USA, June 1-5, (2009)

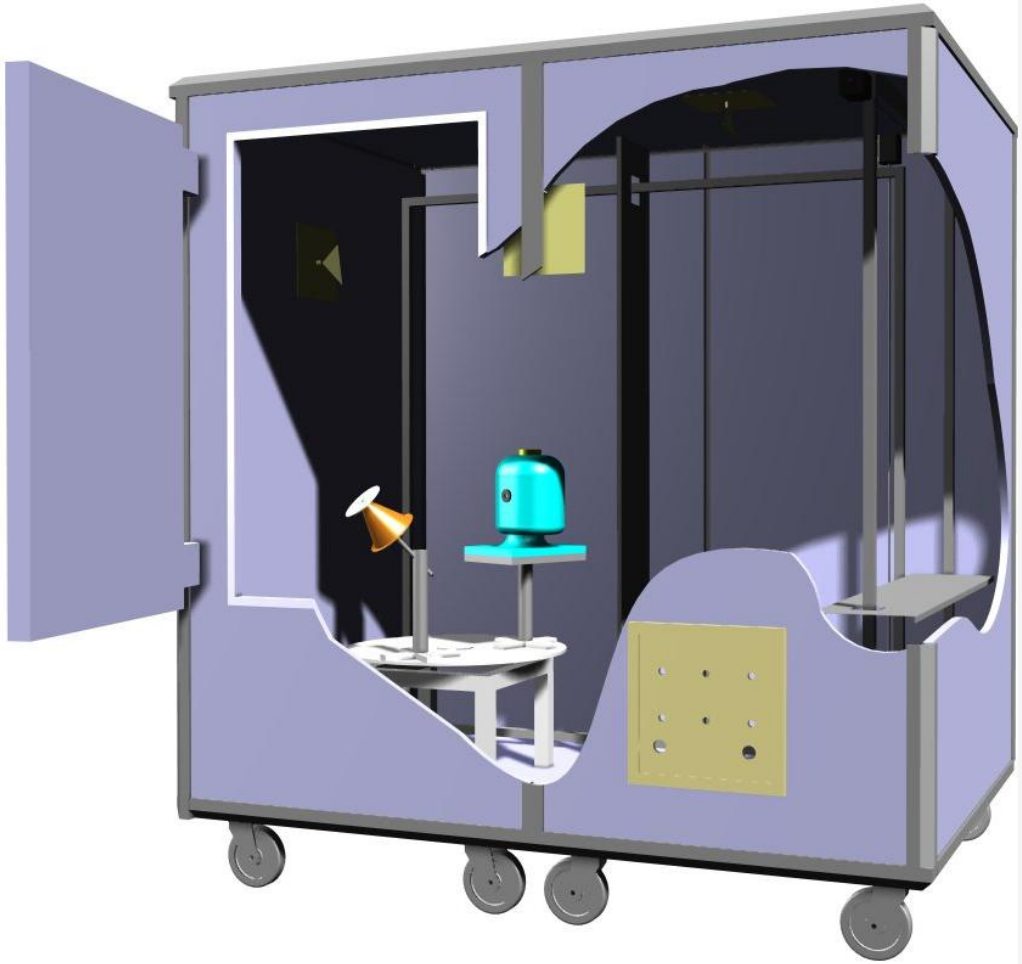
Advantages with Bluetest Reverberation Chambers

- No quiet zone
  - Easy and fast placement of the DUT
  - DUT Size up to 0.8m
  - Complete systems tests are fast, easy and cost effective
- Reflections do not cause errors
- Easy to calibrate
- Easy and cost effective to service and maintain

Summary

- The most cost effective solution on the market
- The fastest available solution
- Future proof
  - Echoic chamber, simulates a real environment
  - Easily adapted to new technology
- MIMO and Diversity test available today
- Proven Technology, 30 customers World Wide:
  - The Biggest Operators
  - The Largest Mobile Phone Manufacturers
  - Antenna Manufacturers

HP 700 - High Performance Chamber



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HP700

General Specification

Frequency Range:	650 – 6000 MHz
Accuracy TRP:	0.5 dB (STD)
Accuracy TIS:	0.7 dB (STD)
Repeatability:	0.2 dB (STD)
Test time TRP (typical):	1 min/channel
Test Time TIS (typical):	10 min/channel
Test Time TIS (Fast TIS option):	3 min/channel*

*GSM and WCDMA

Dimensions (outside)

Length:	2000 mm
Height:	2000 mm
Depth:	1400 mm

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HP700

Supported Technologies

TRP/TIS Measurements:	GSM
	GPRS/EDGE
	WCDMA
	HSPA
	CDMA2000
	EVDO Rev 0 and A
	LTE (MIMO 2x2)
	Bluetooth
	WLAN 802.11b/g
Throughput Measurements:	LTE (MIMO 2x2)
	WLAN 802.11b/g /n

Supported Base Station Simulators

Agilent	8960/N4010A
Anritsu	MT8815/8820/8860
Rohde & Schwarz	CMU 200/CMW 500