

Multipath Simulator (MPS) for over the air system tests

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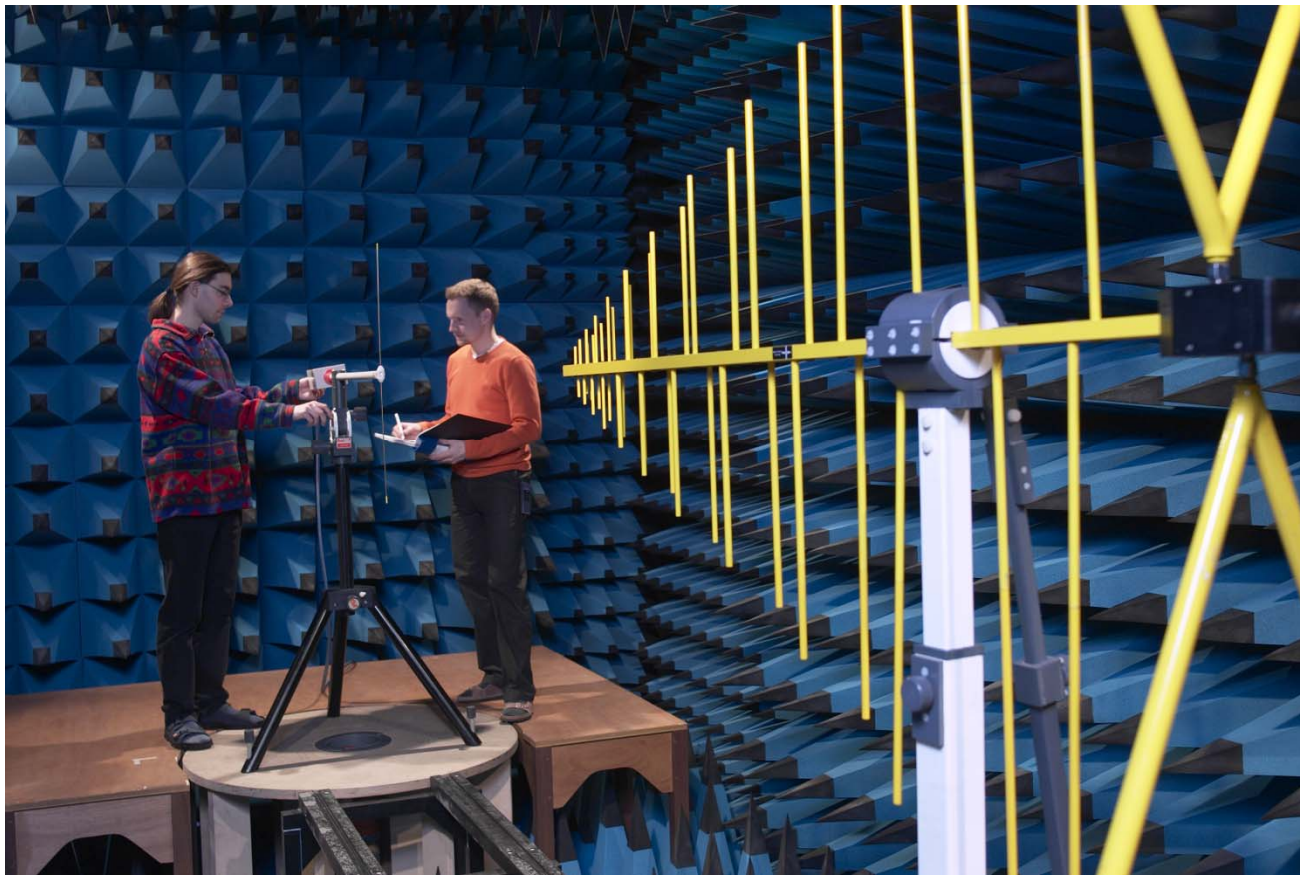
Presented by Christer Karlsson¹

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RFMTC 2009

Traditional radio test



Conditions:

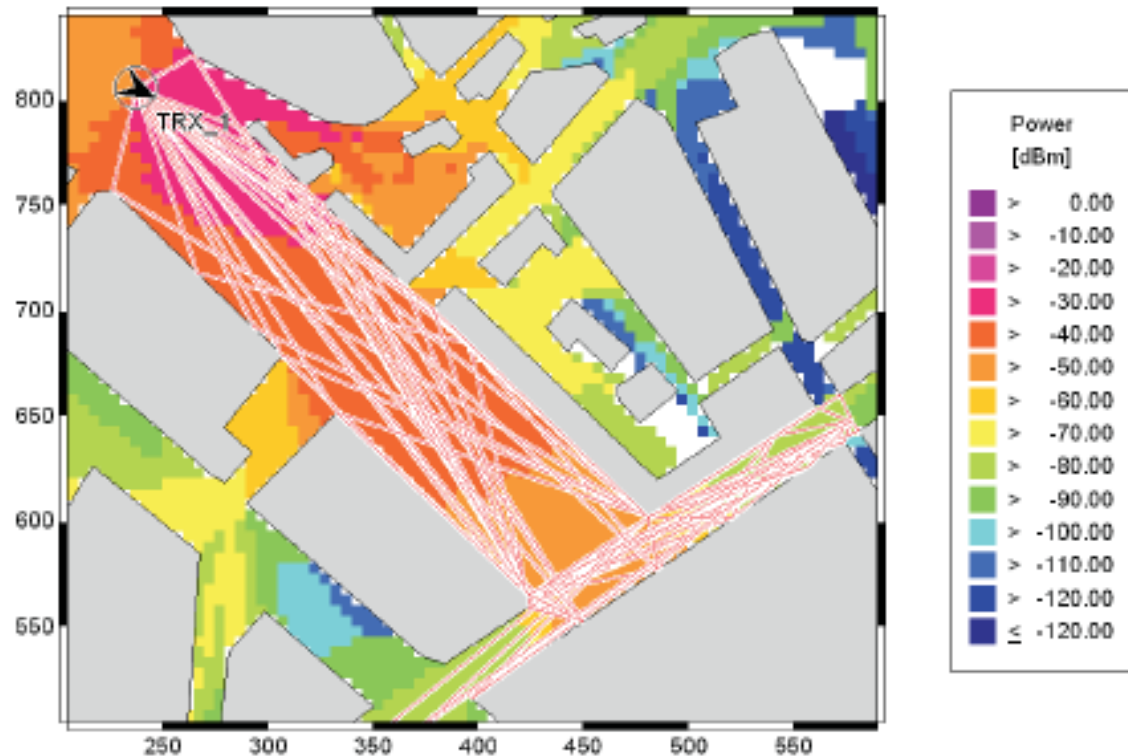
- line of sight

Measurements:

- frequency use
- radiated power
- sensitivity
- etc.

Wave propagation in the reality

- Multipath and
 - Mobility
- results in
- Delay spread
 - Doppler spread
 - Angular distribution



(picture WinProp)

Features of modern communication systems

- *Adaptivity* – power, modulation and coding is adapted to load and conditions (sometimes in intervals of 1 ms)
- *Channel estimation* – equalizers and Rake receivers are used to compensate for the time dispersion
- *Antenna systems* – multiple antennas are used to fight fast fading (diversity) and together with signal processing increase throughput/reliability (MIMO)

New methods are required for new systems

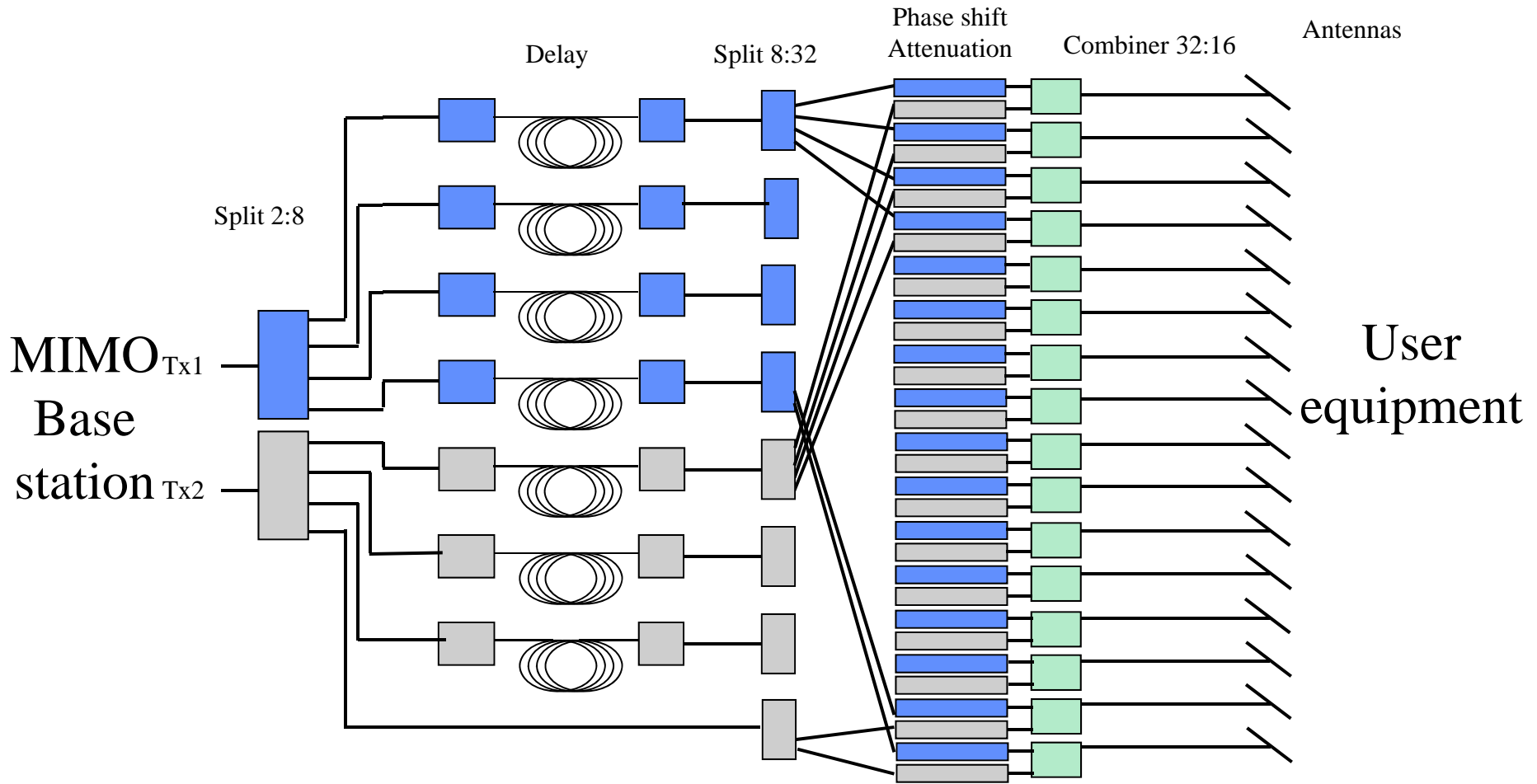
- Line of sight is not adequate
- Mobility is currently not included
- Main figure of merit is not only *sensitivity/power* but also *throughput*
- Realistic performance is estimated in non-repeatable *drive tests*

Multipath environment ray emulation

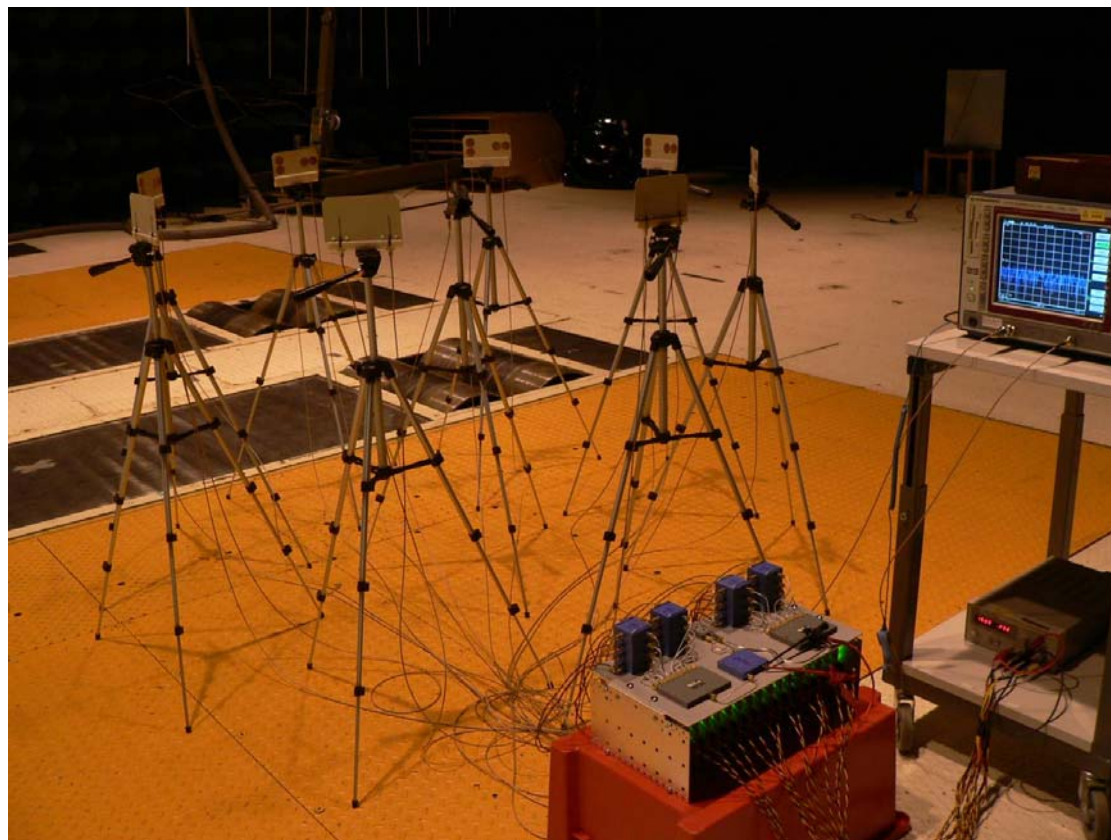
- The MPS:
 - generates a number (16) of independent rays
 - works at the **carrier frequency** and is independent of modulation etc.
 - connects base station and terminal directly – **true system test**
- Each ray is described by its **individual**:
 - direction (2D – horizontal plane)
 - polarization (vertical or horizontal)
 - amplitude
 - Doppler shift (continuous phase shift)
 - delay (delay lines)



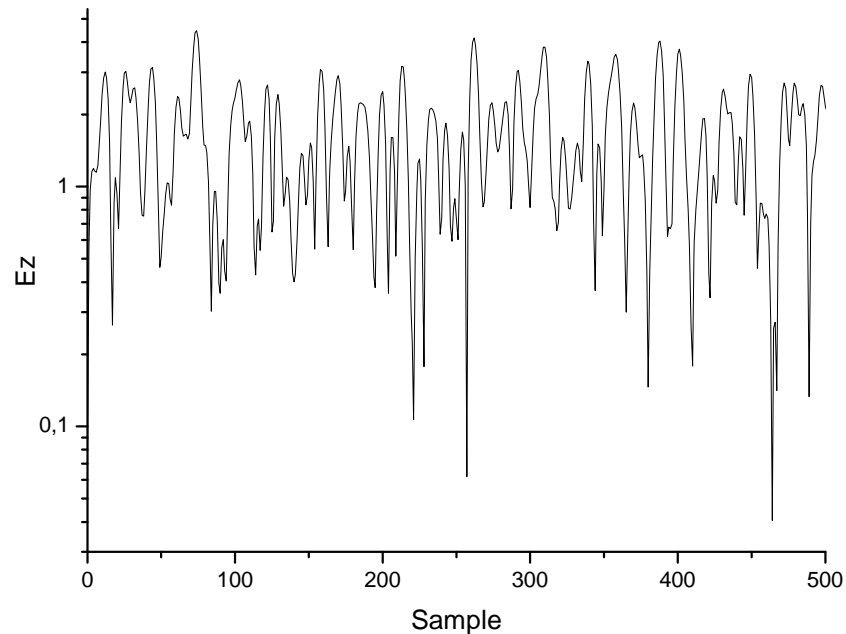
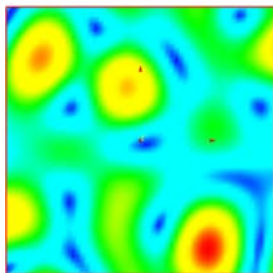
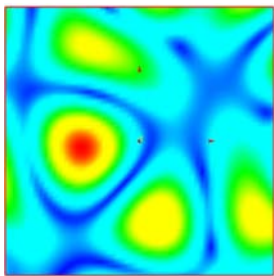
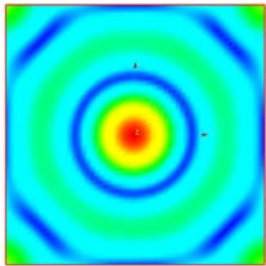
MPS block diagram – Next version



Current status:
**Experimental MPS system built by SP and
Sony Ericsson**

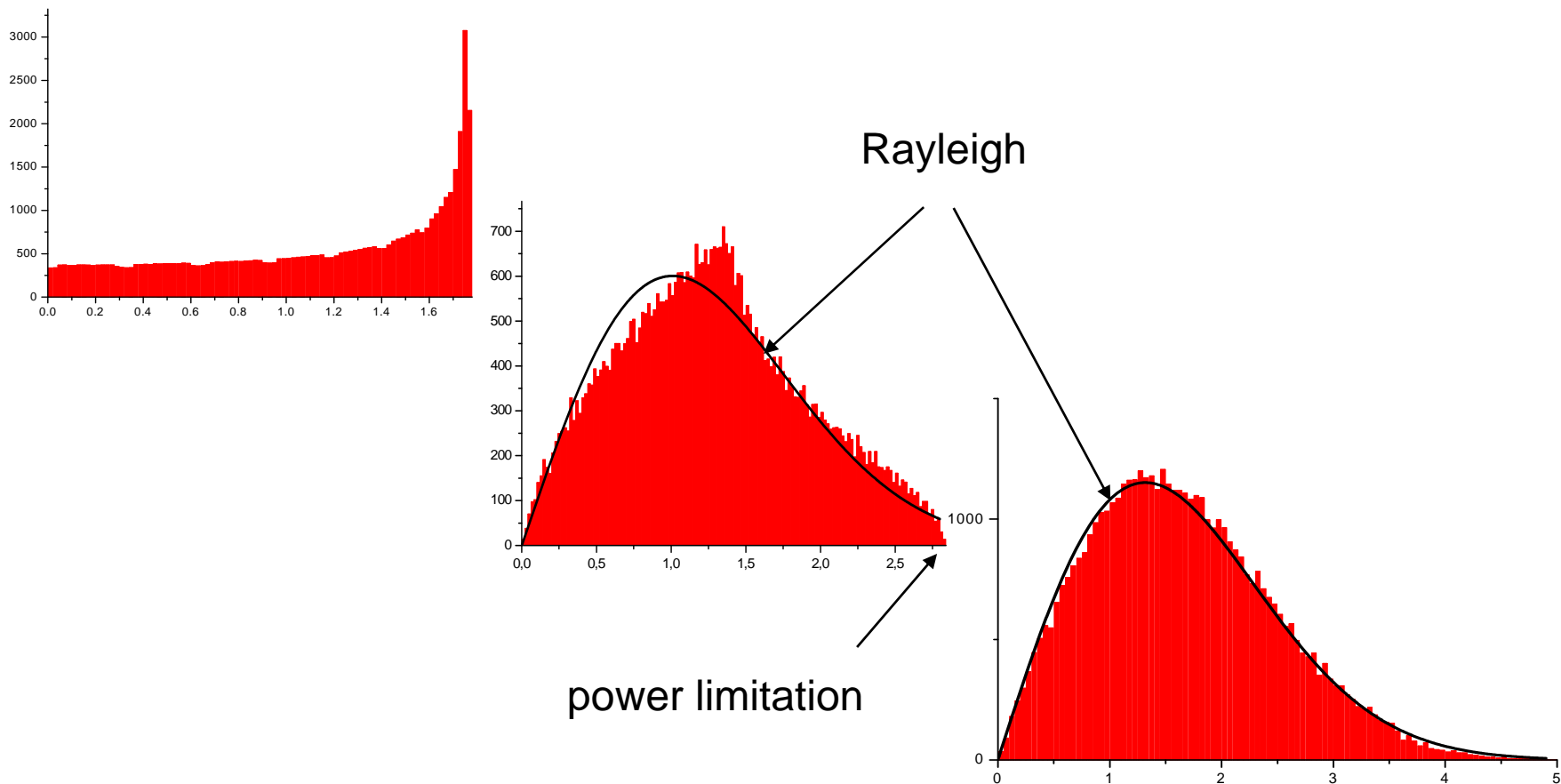


Simulated fading in time domain - 8 antennas (Ez in array center)



Narrowband signal

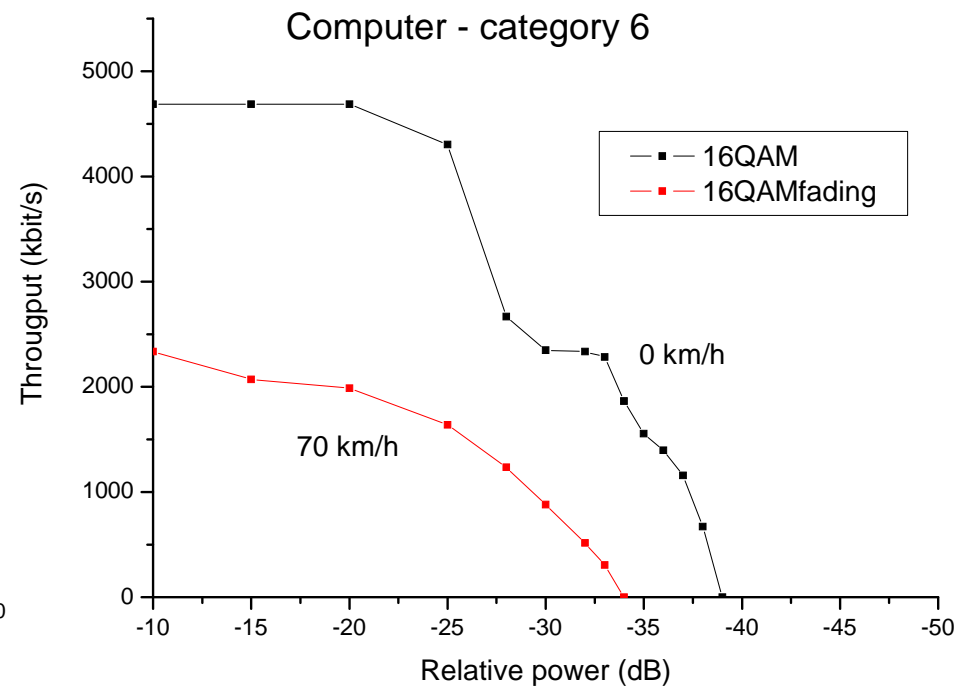
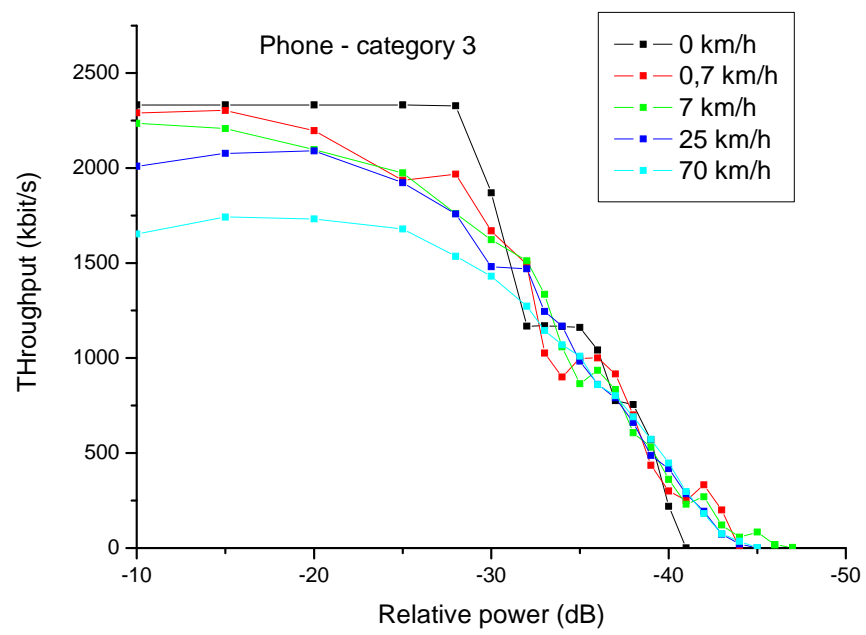
Probability distribution 2, 4 and 8 antennas (Ez in ring centre)



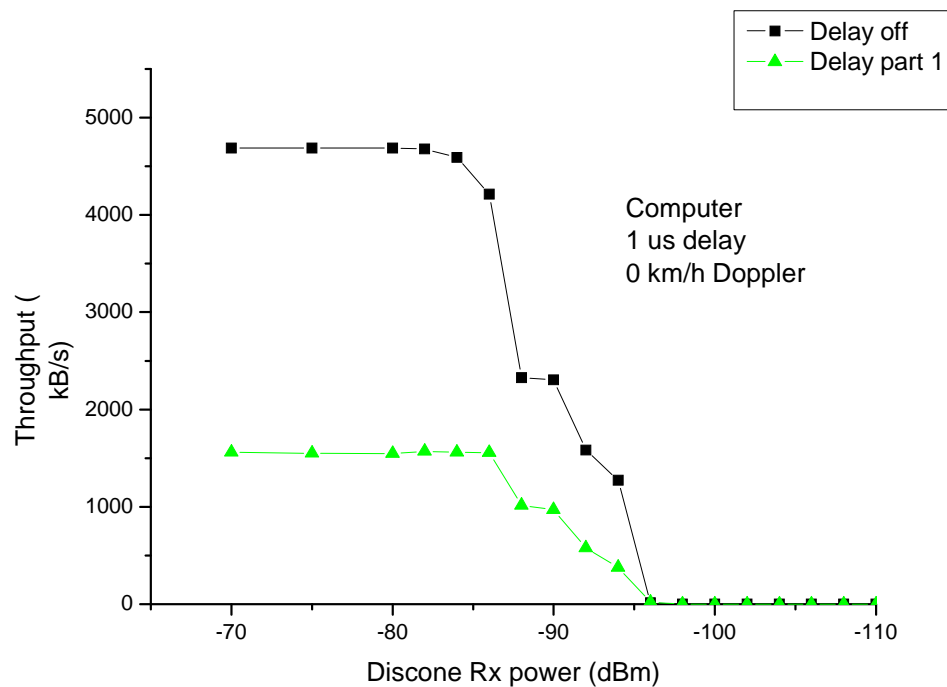
Preliminary results on experimental MPS

- Some initial measurements are carried out:
- **Fading statistics**
- **Mean effective gain measurement**
- **BER – WCDMA, GSM** (phone and CMU 200)
- **Throughput HSDPA** (phones and computer)

Influence of Doppler spread



Influence of delay profile



1 us delay line is added
to 4 of the 8 antennas

Conclusions

- The multipath fading simulator generates a flexible 2D “over the air” test environment that can be used for terminal characterization.
- The MPS is a complement to current systems
- Its main advantage is its potential ability to emulate realistic 2D wave propagation models including
 - Angle of arrival
 - Delay spread
 - Doppler spread