Wireless Sensor Networks

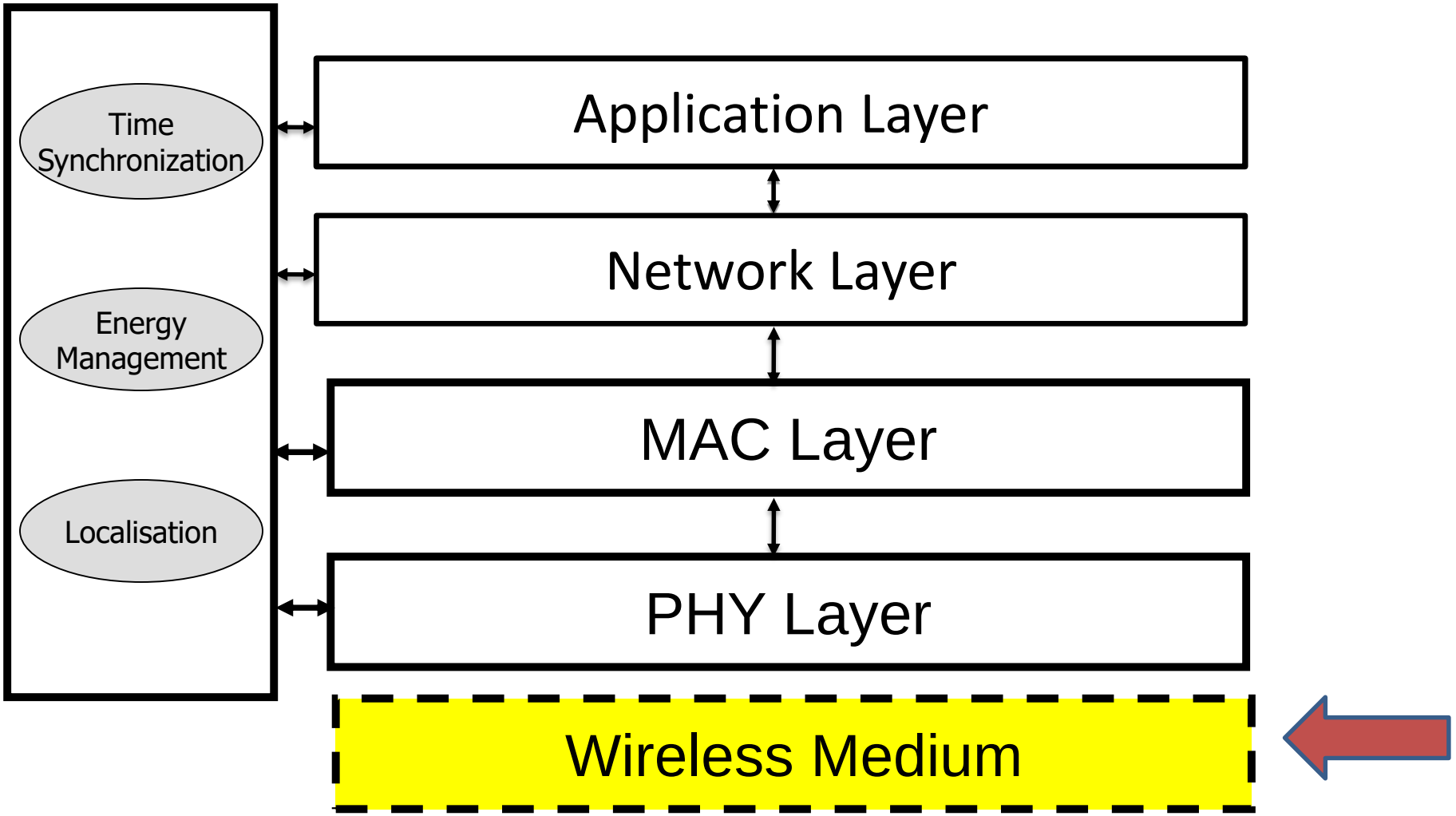
Chiara Buratti

c.buratti@unibo.it
+39 051 20 93147

Office Hours:
Tuesday 3 – 5 pm @ Main Building, third floor

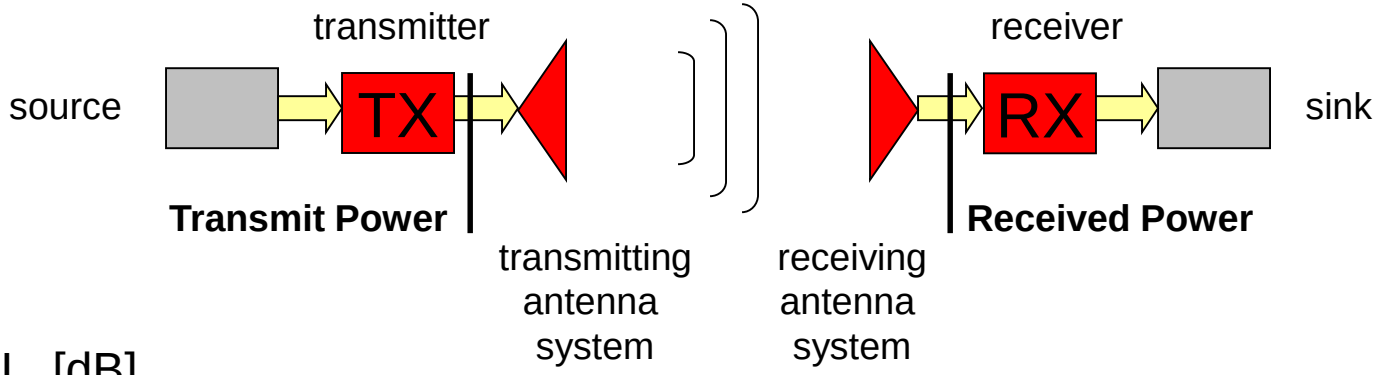
Credits: 6

Protocol Stack



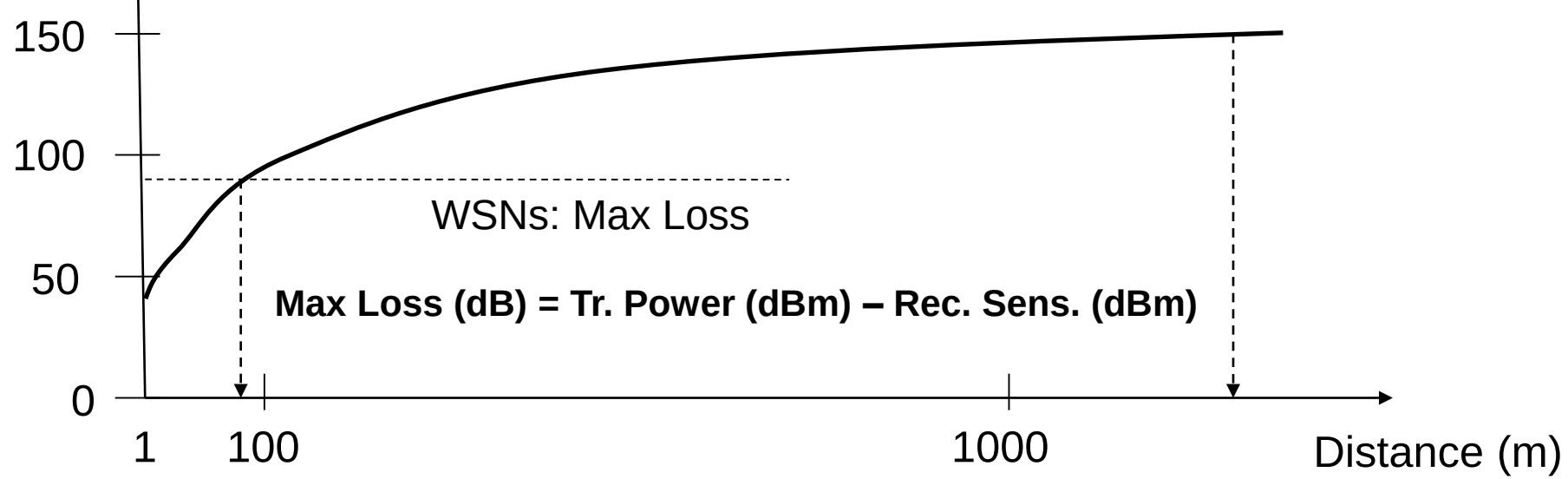
Chiara Buratti
DEI, University of Bologna

A Model for Channel Fluctuations



Pr [dBm] = Pt [dBm] – L [dB]

Power Loss (dB) = Transmit Power (dBm) – Received Power (dBm)



A Model for Channel Fluctuations

$Pr = Pt - L$ logarithmic units

$L = k_0 + k_1 \ln(d) + s$

$k_0 = 10 \log_{10}(4\pi/\lambda)^2$ → Path loss at a distance of 1 meter
$k_1 = 10\ \beta / \ln(10)$ → β propagation coefficient

s is Gaussian (zero mean) with variance σ^2

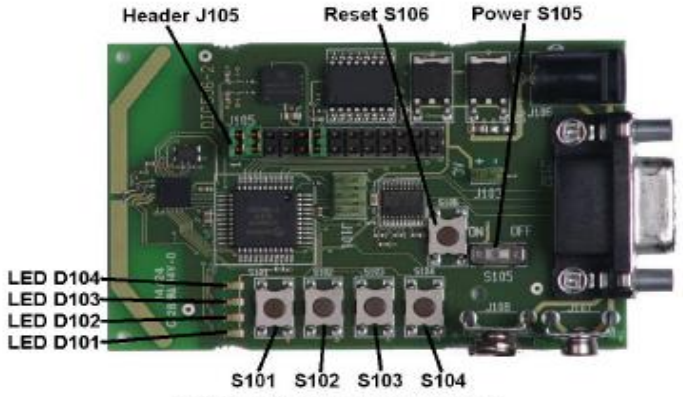
s has time coherence T_{WCOH}

- Fading and shadowing not distinguished
- Variance depends on environment

Experimental Platform

freescale semiconductor

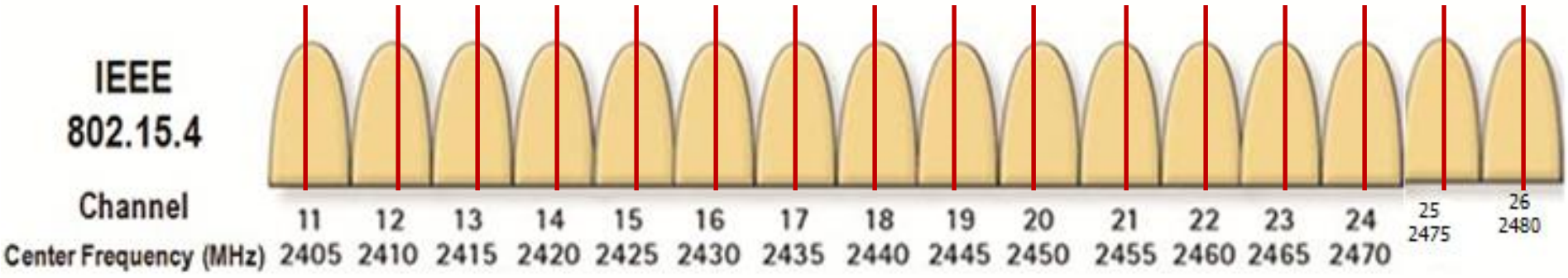
www.freescale.com



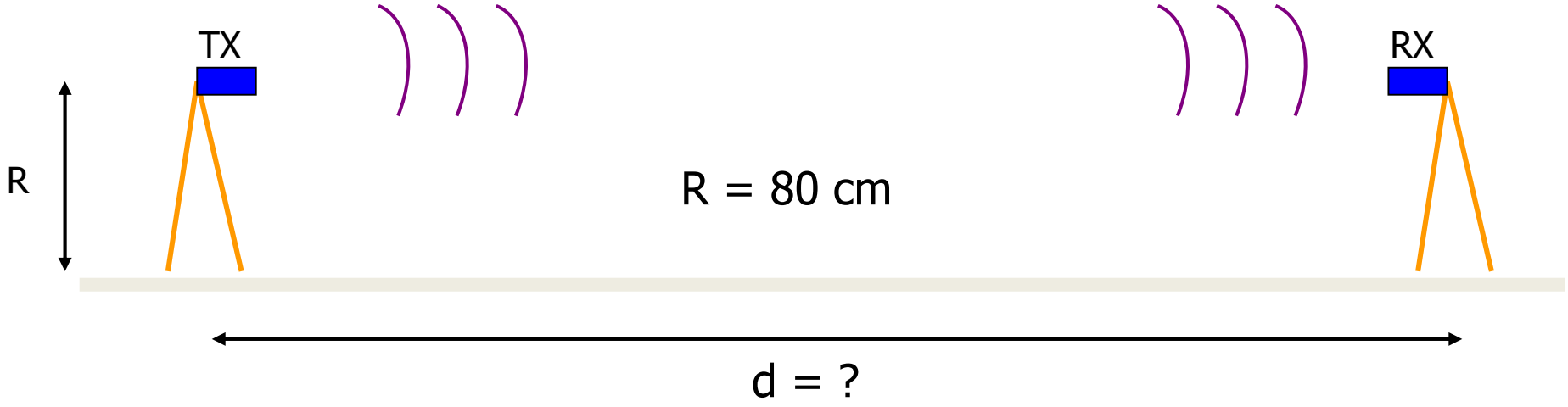
Compliant 802.15.4	Clock	Flash	RAM	Receive Sensitivity	RF Power Min	RF Power Max	Cost	Country
YES	40 MHz	60K	4K	-92 dBm	-16.6 dBm	+3.6 dBm	$ 199	USA

transmit power
(nominal power: 0 dBm)

Frequency Bands Explored



First Ellipsoid free: on asphalt



$$R = \frac{1}{2}\sqrt{\lambda d} \quad \Rightarrow \quad d = \frac{4R^2}{\lambda} \quad con\ \lambda = 0.12245\,m \quad f_{mean} = 2.45GHz \quad \Rightarrow \quad d \sim 20.91\ m$$

⇨ Power Loss ~ 66 dB

⇨ Received Power with nominal transmit power: ~ - 66 dBm

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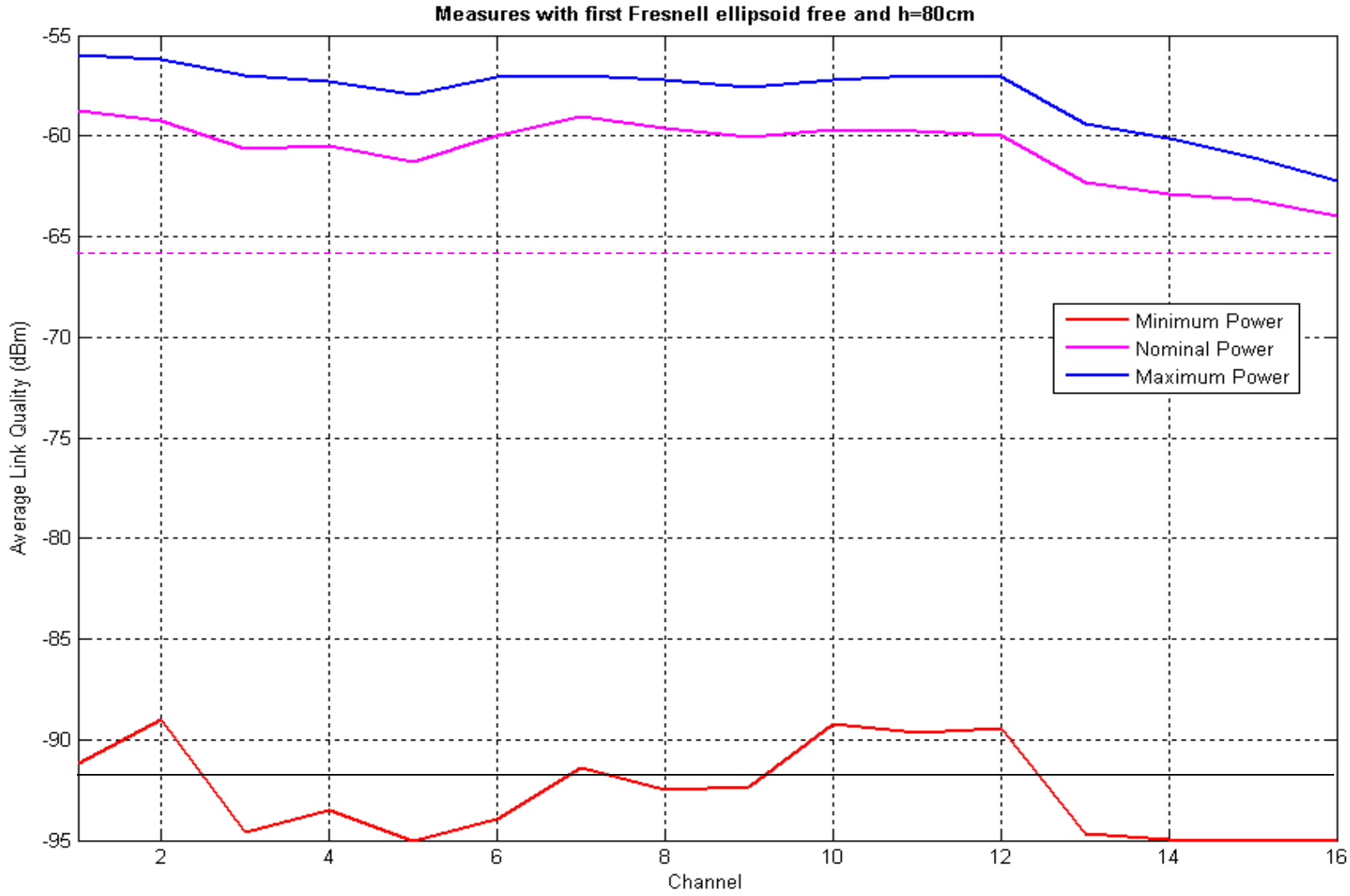

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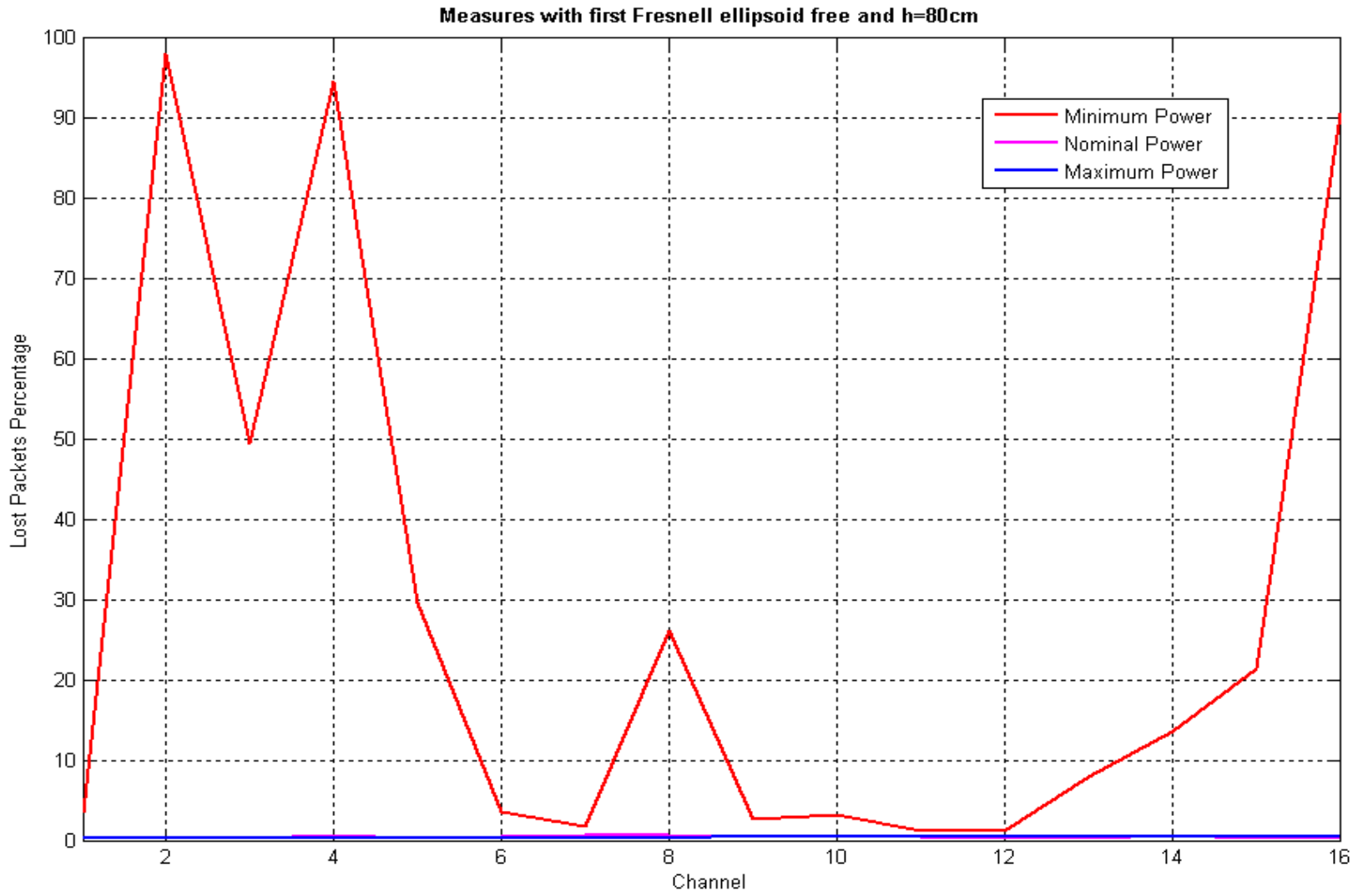
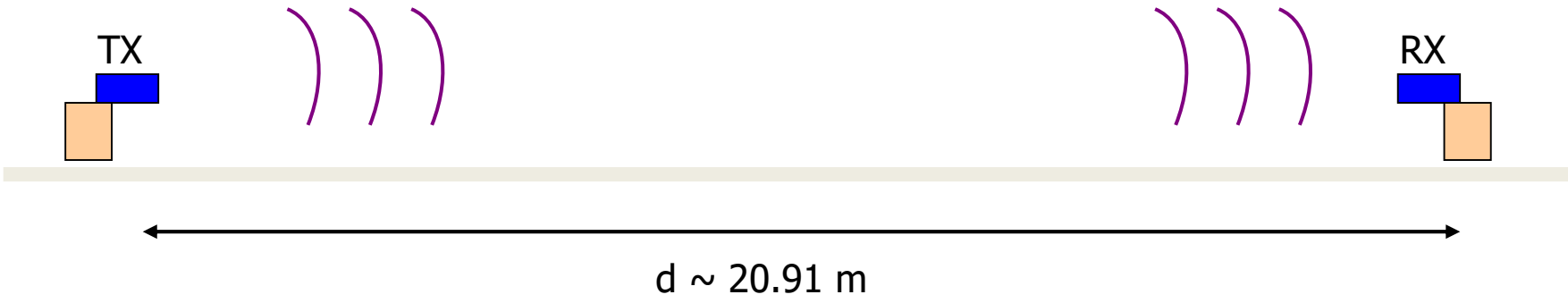
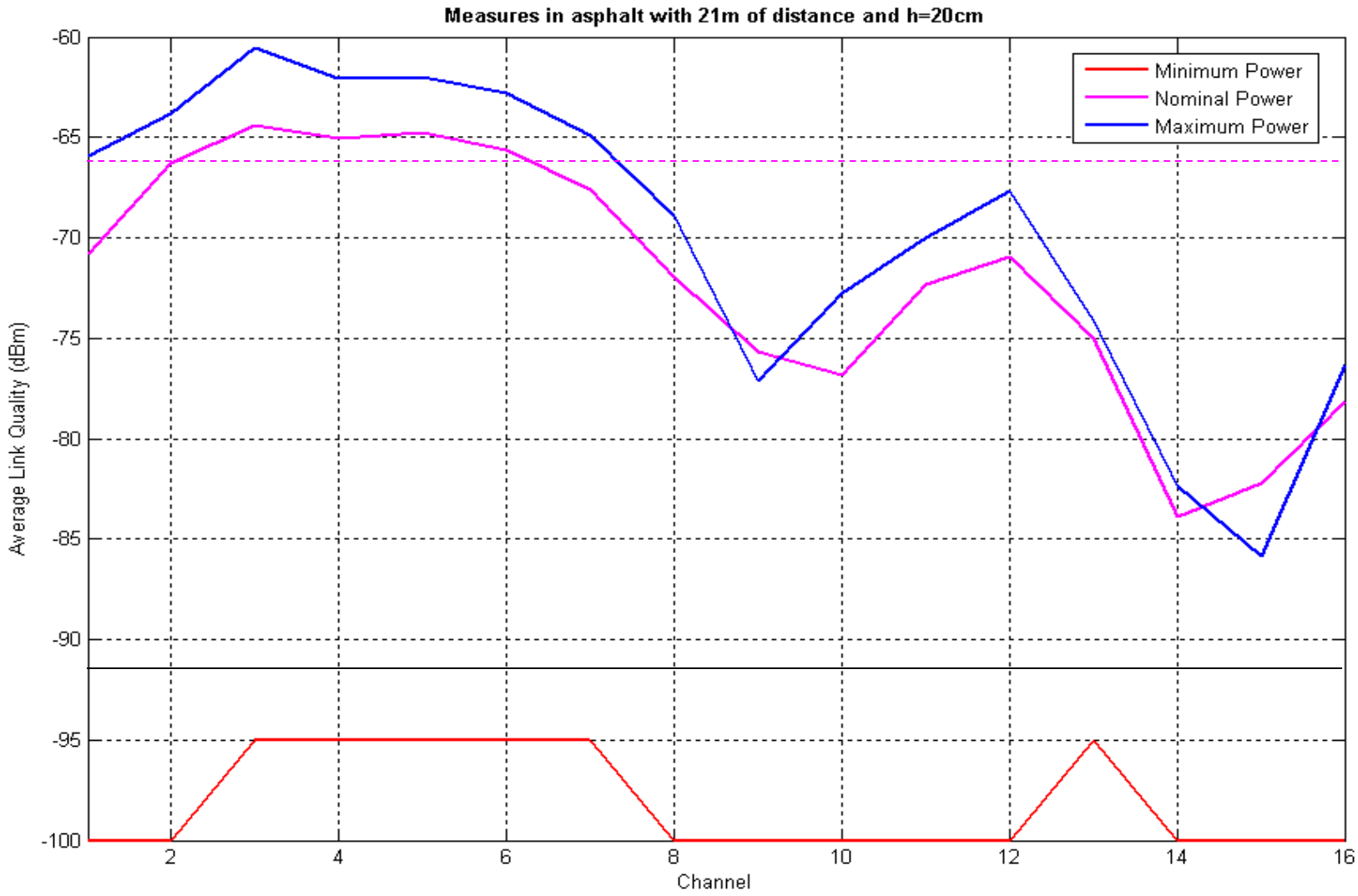


Asphalt



Asphalt


Measures in asphalt with 21m of distance and h=20cm
Minimum Power
Nominal Power
Maximum Power
Average Link Quality (dBm)
-60
-65
-70
-75
-80
-85
-90
-95
-100
2
4
6
8
10
12
14
16
Channel

Asphalt


Measures in asphalt with 21m of distance and h=20cm
Lost Packets Percentage
Channel
Minimum Power
Nominal Power
Maximum Power
0
10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
16

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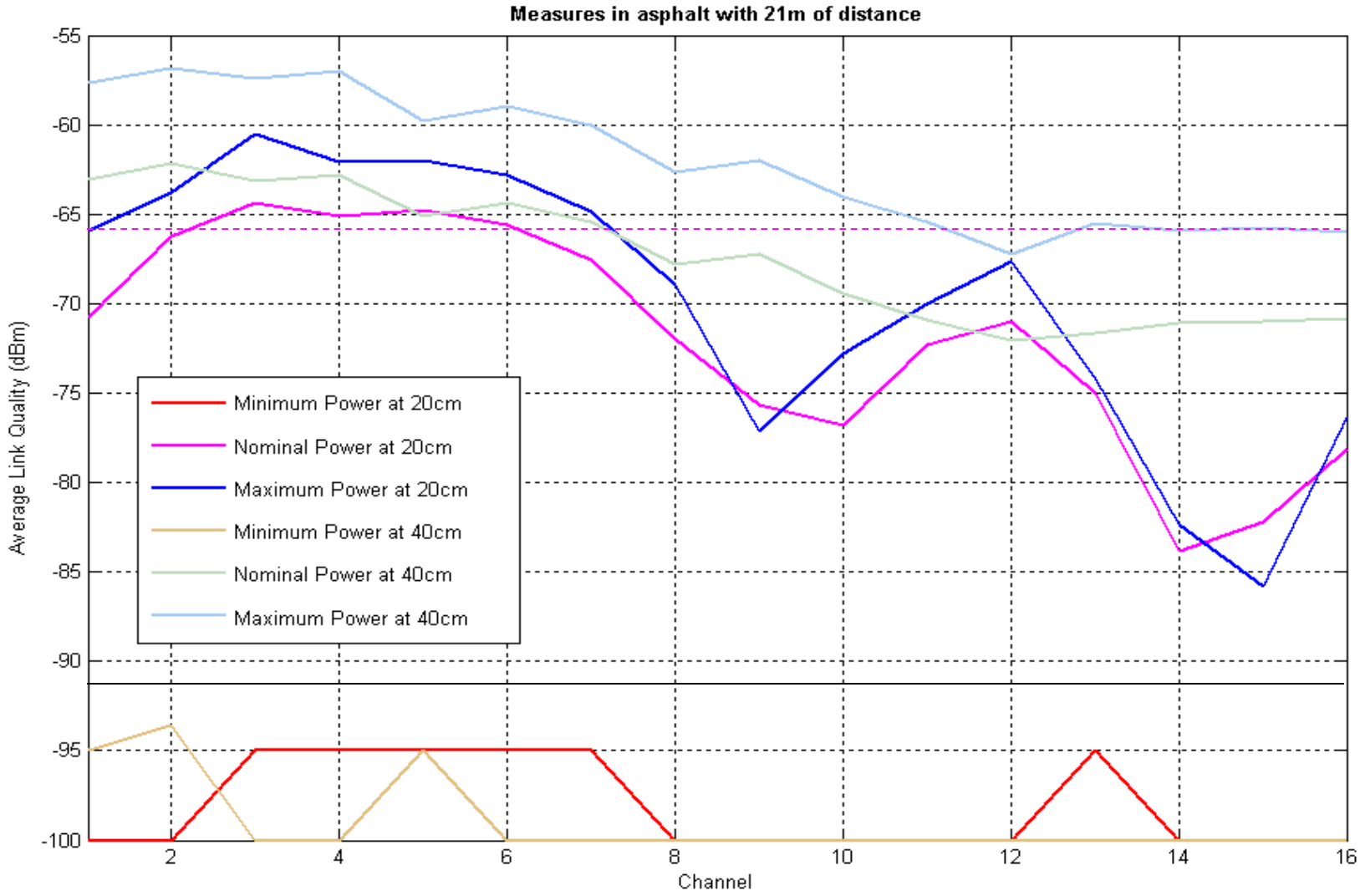
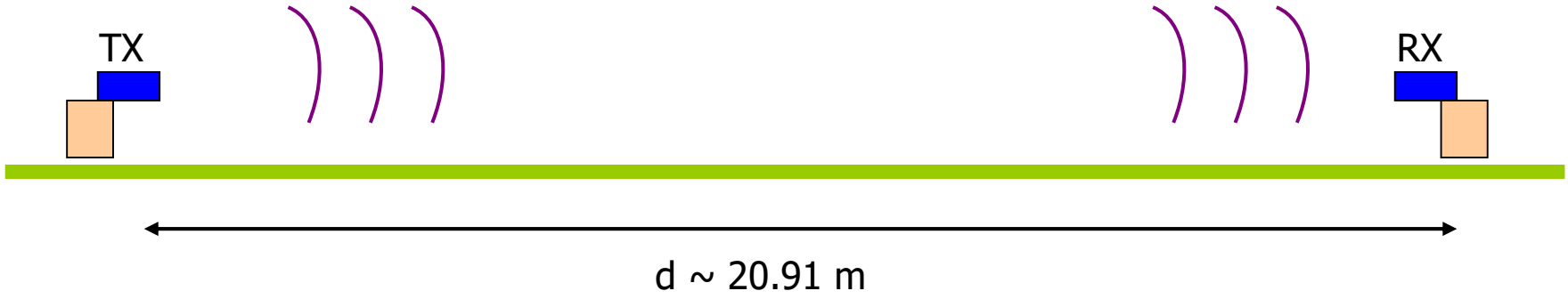
Asphalt



Grass



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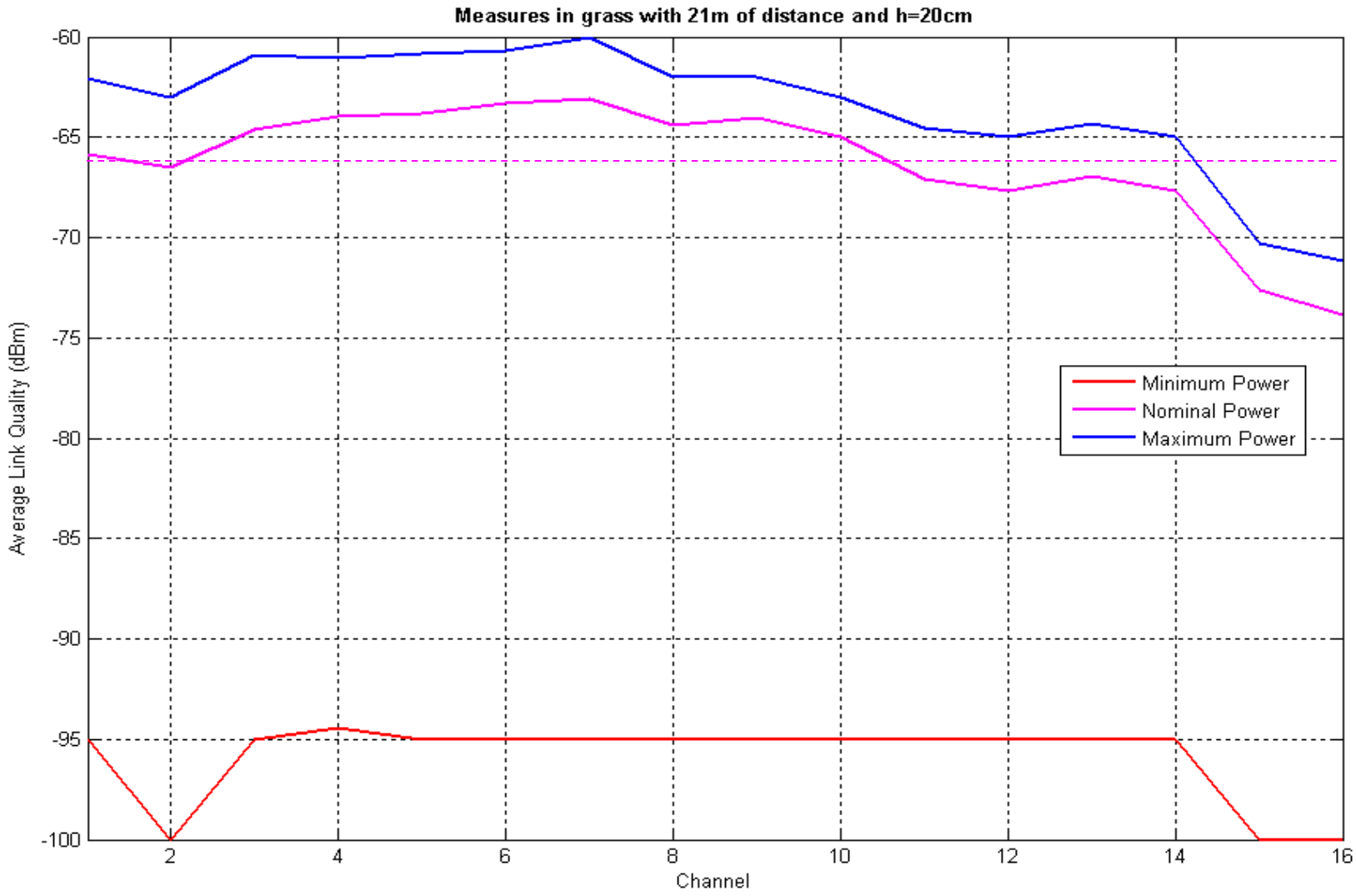
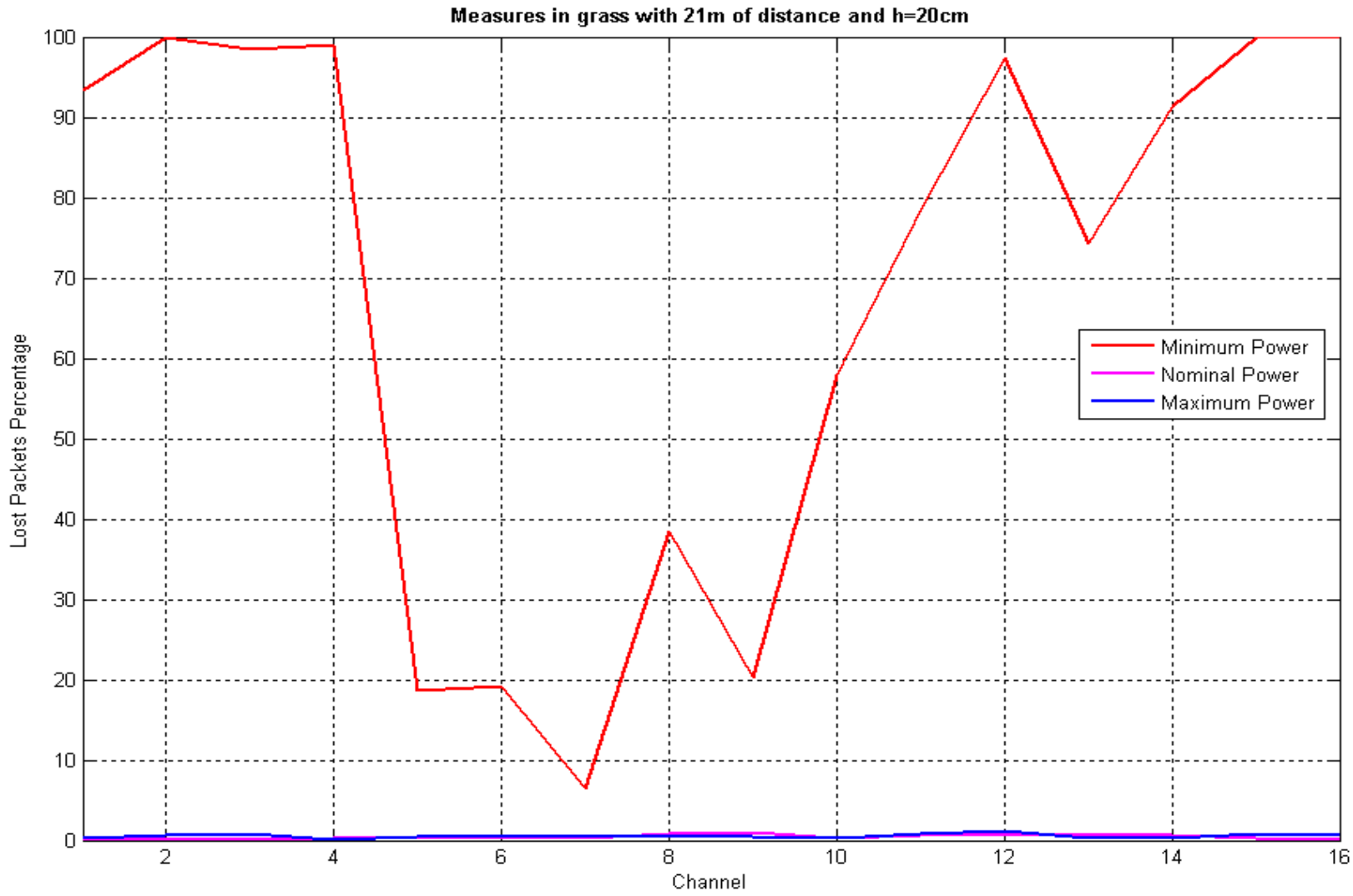
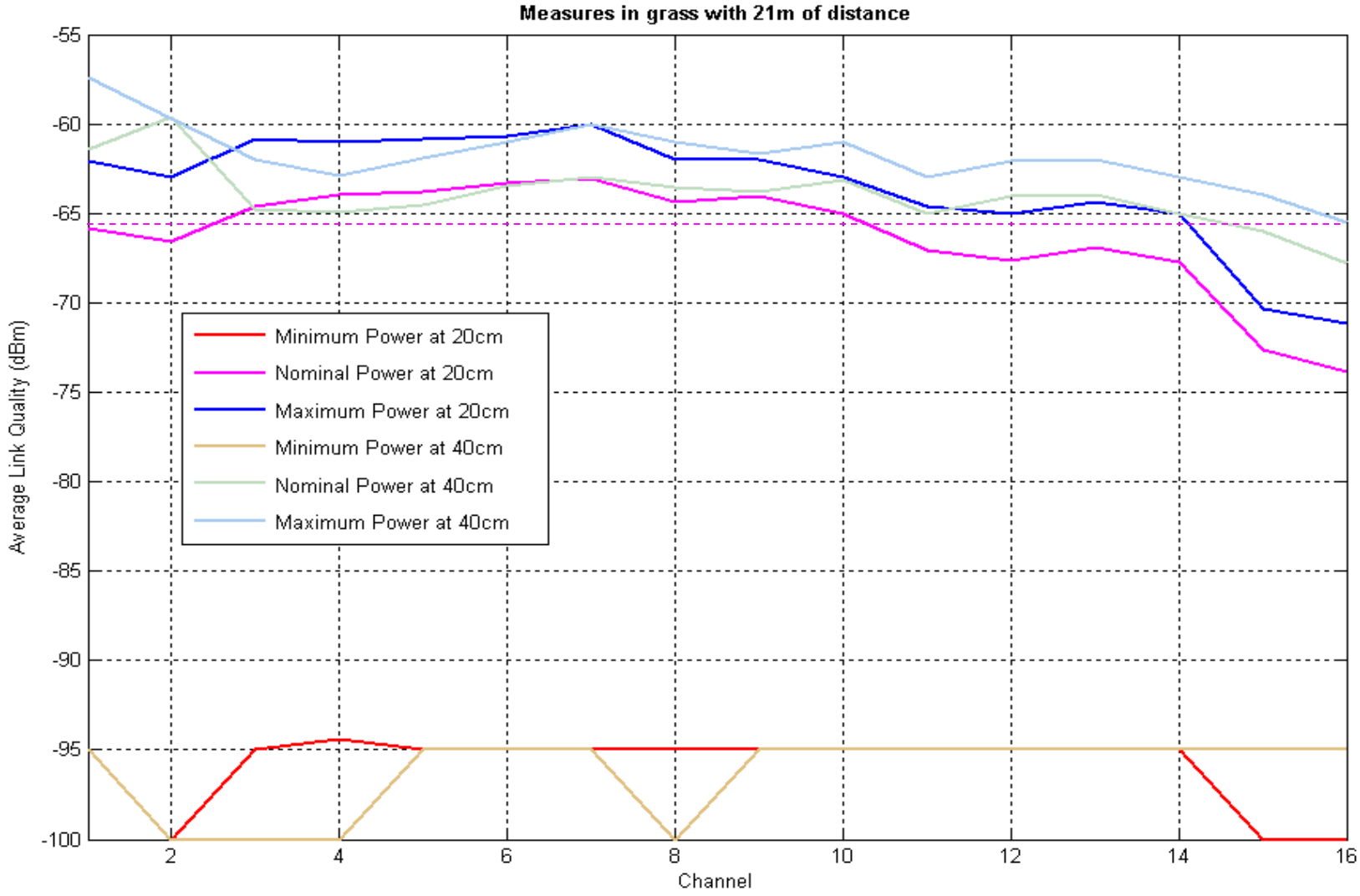
Grass



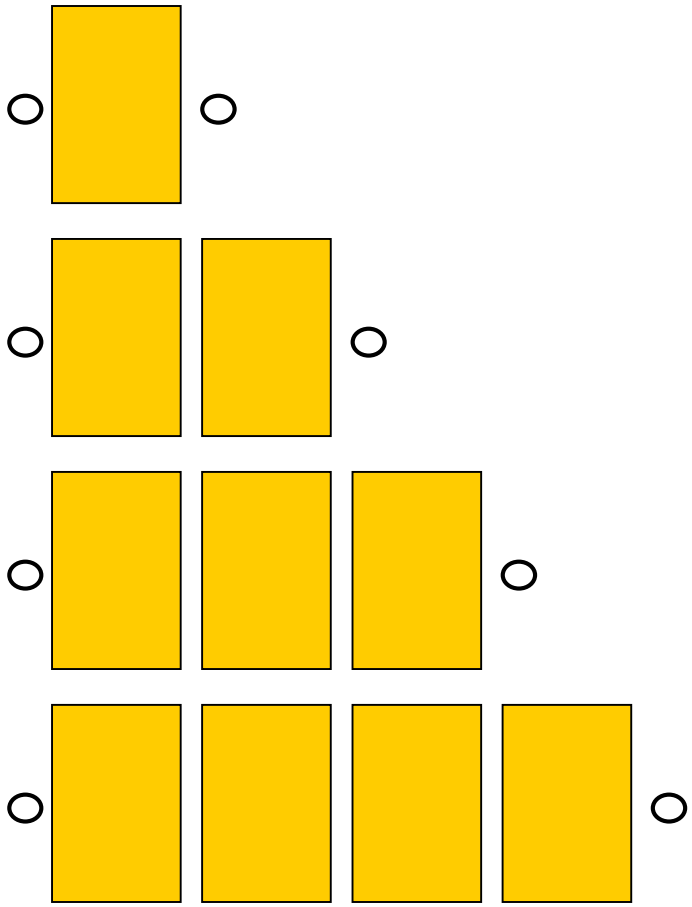
Grass

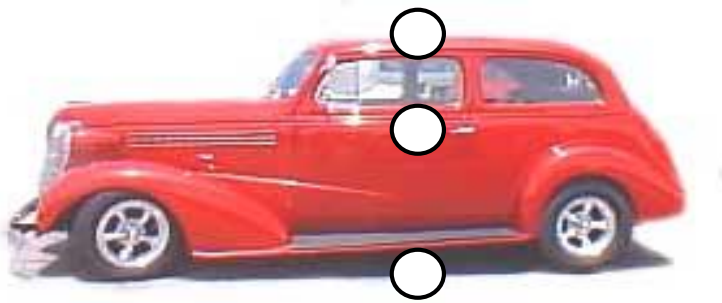

Measures in grass with 21m of distance and h=20cm
Lost Packets Percentage
Channel
Minimum Power
Nominal Power
Maximum Power
0
10
20
30
40
50
60
70
80
90
100
2
4
6
8
10
12
14
16

Grass


Measures in grass with 21m of distance
Average Link Quality (dBm)
Channel
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
2
4
6
8
10
12
14
16
Minimum Power at 20cm
Nominal Power at 20cm
Maximum Power at 20cm
Minimum Power at 40cm
Nominal Power at 40cm
Maximum Power at 40cm

Urban Environment

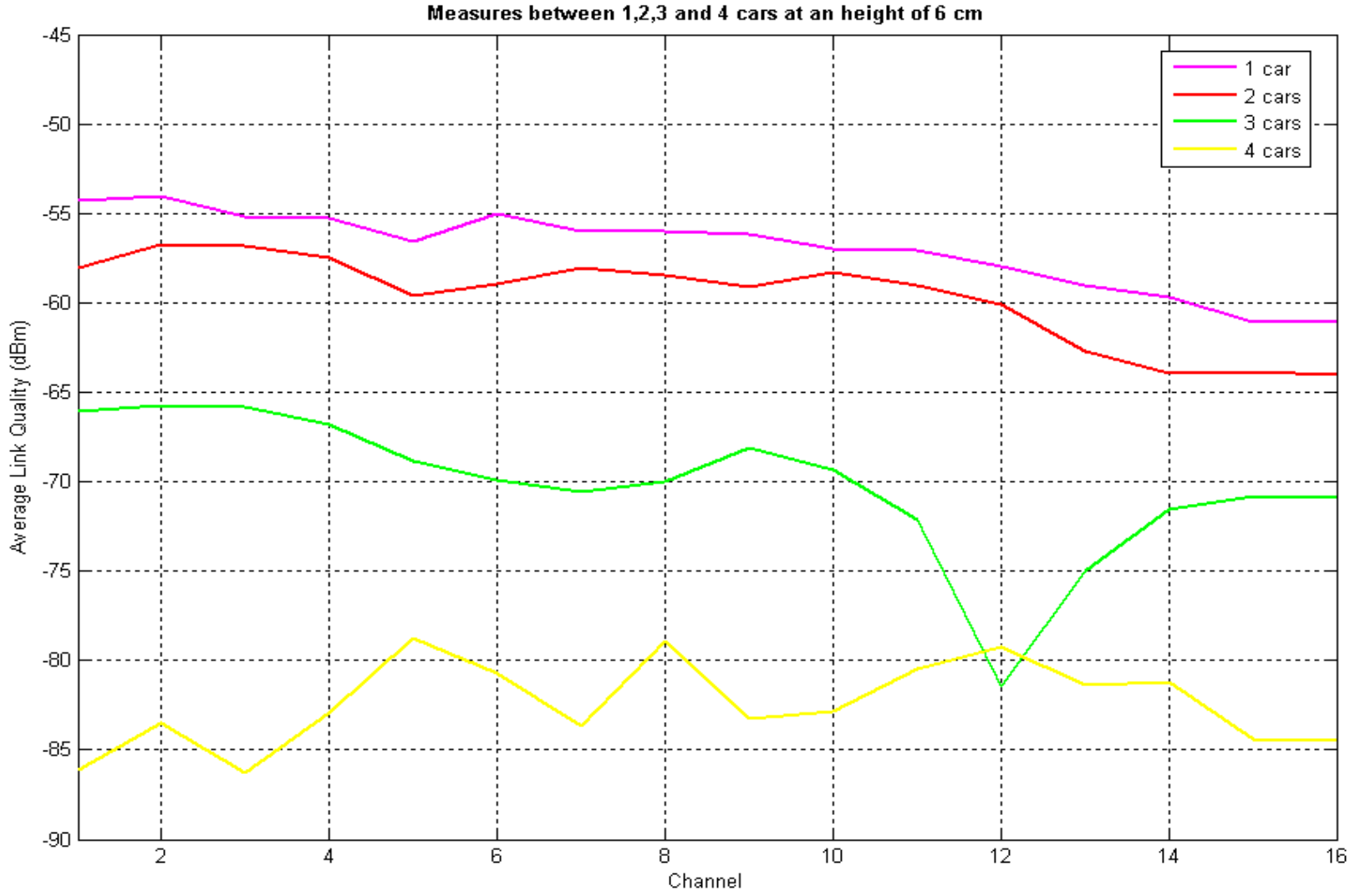




Three heights:

- 6 cm
- 80 cm
- 160 cm

Urban Environment



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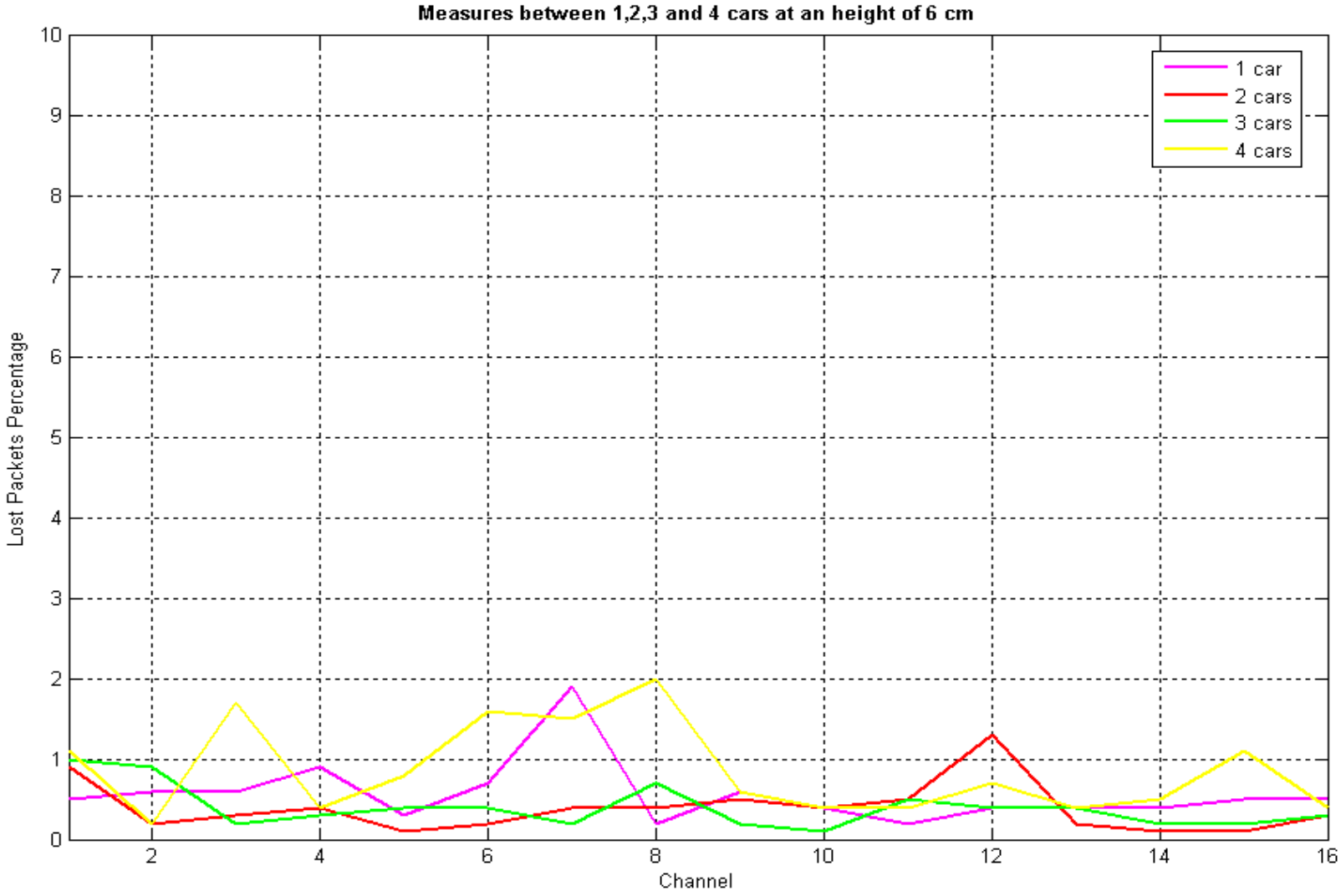
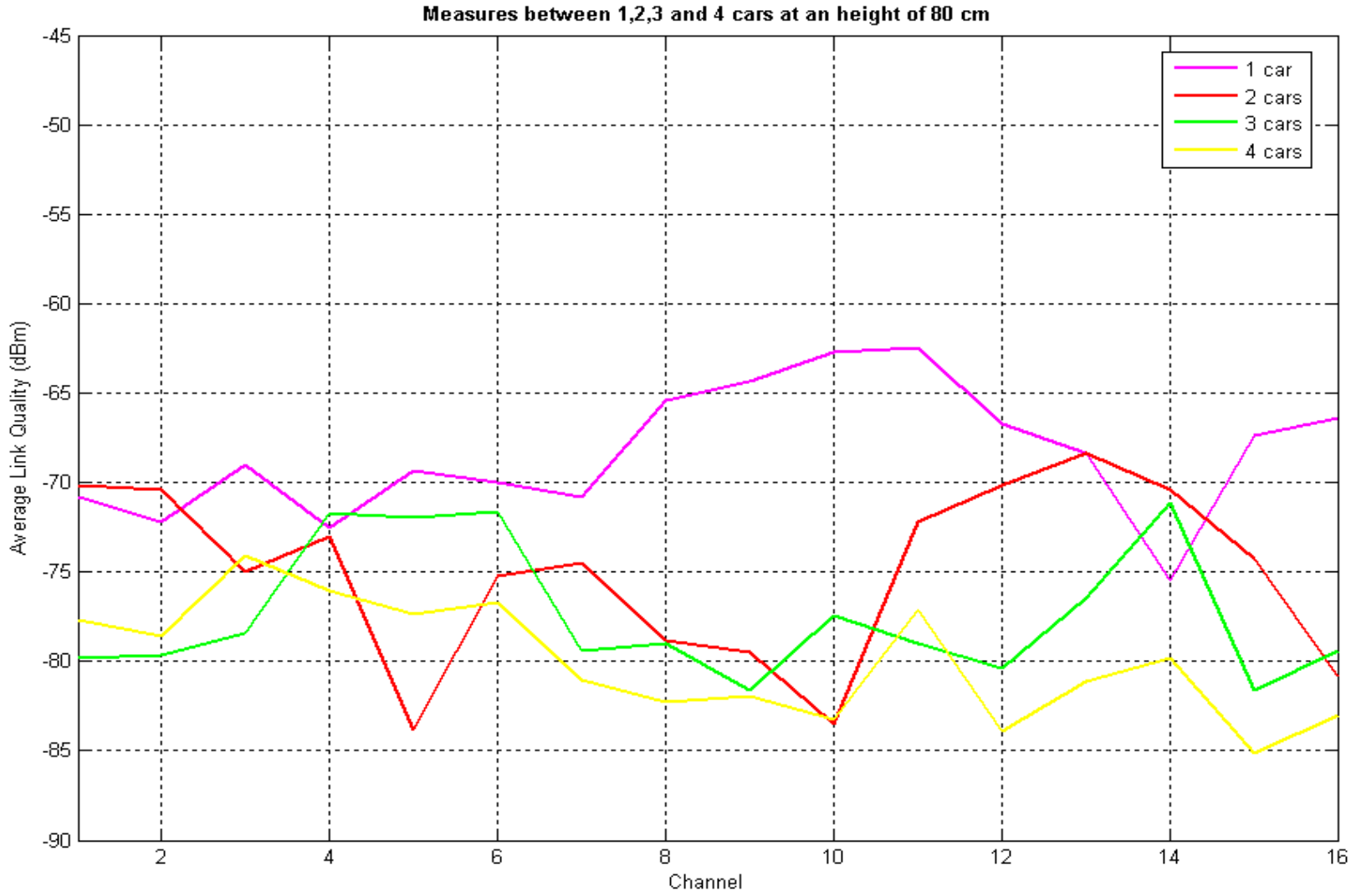
Urban Environment



Urban Environment



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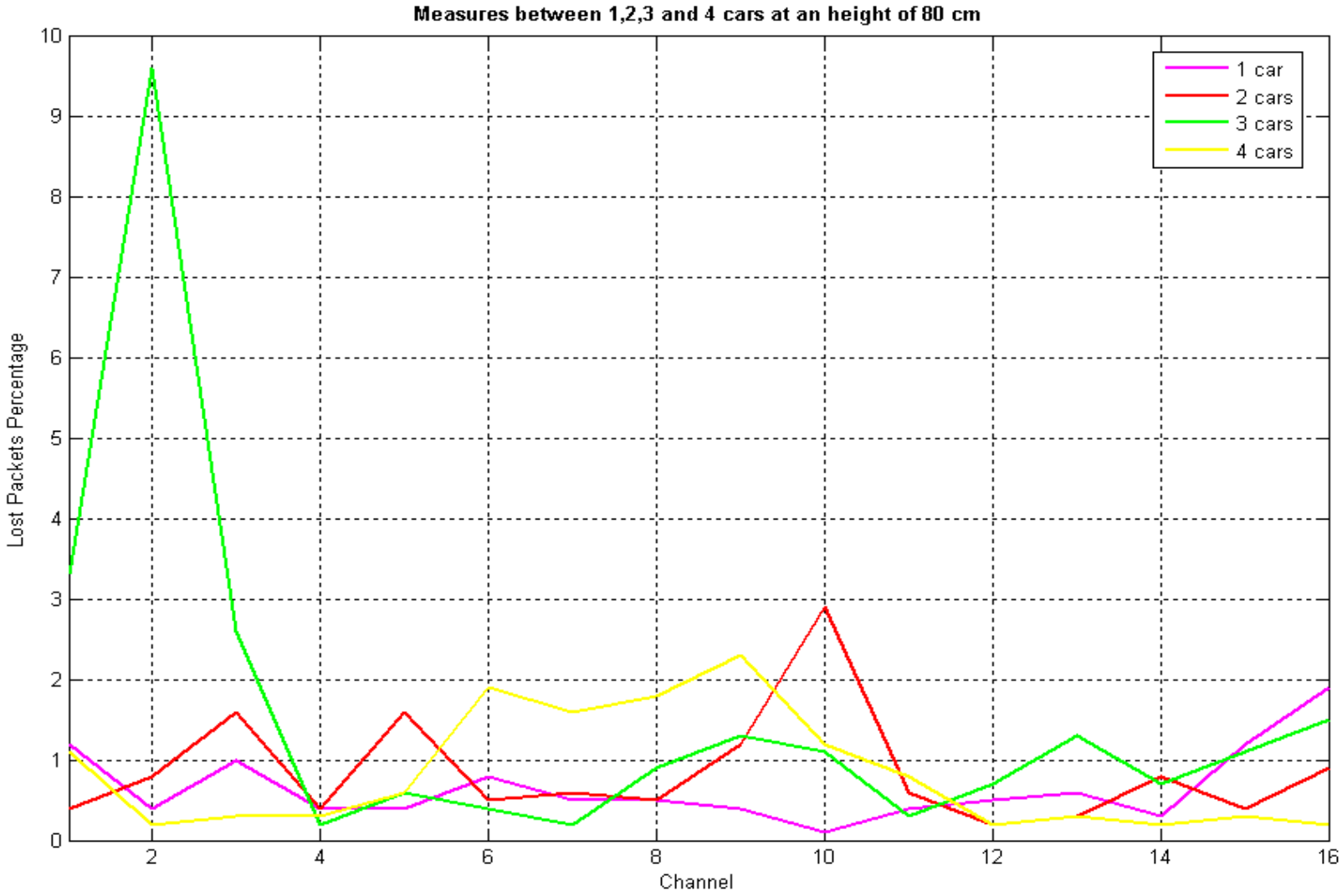

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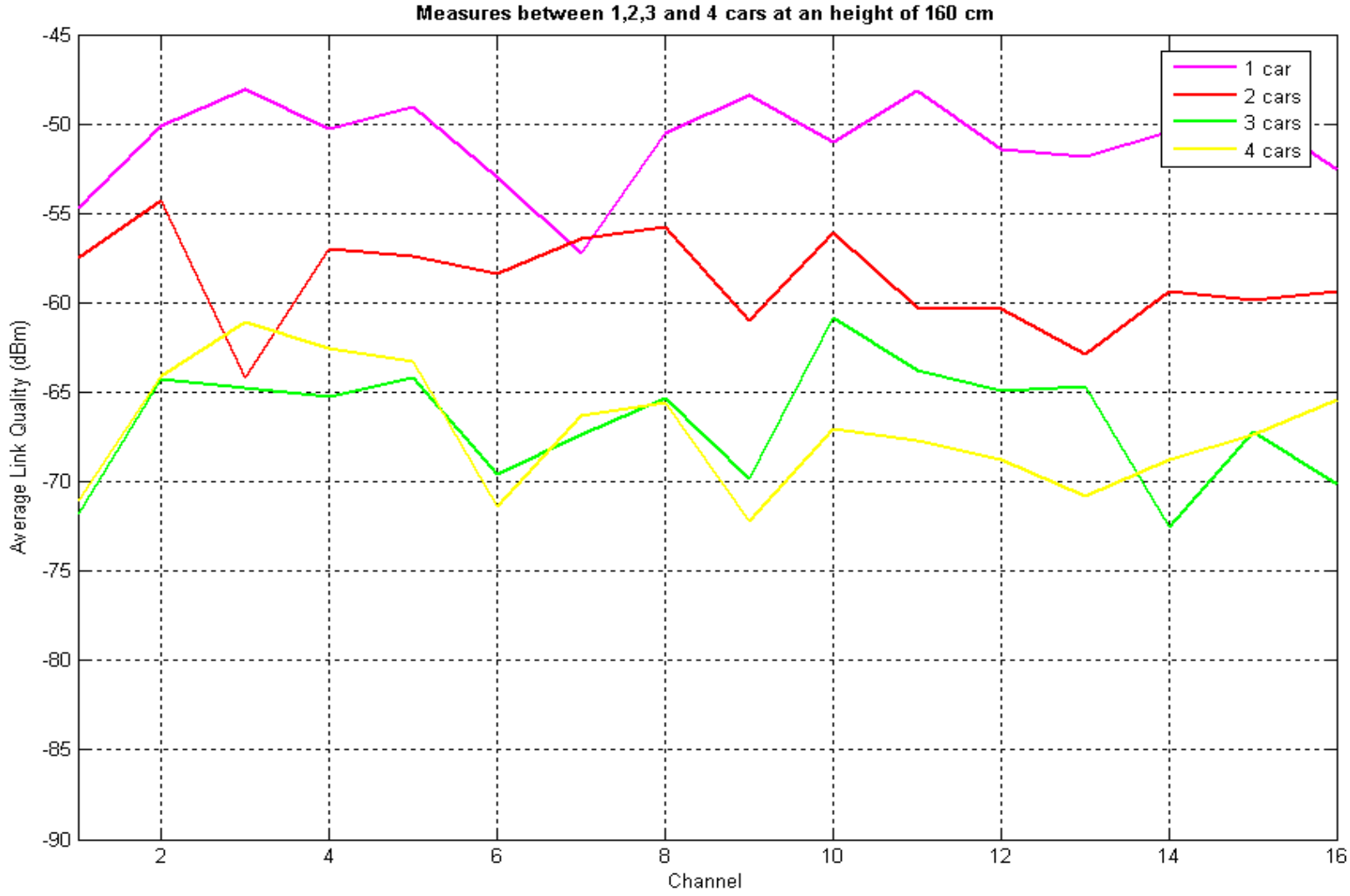

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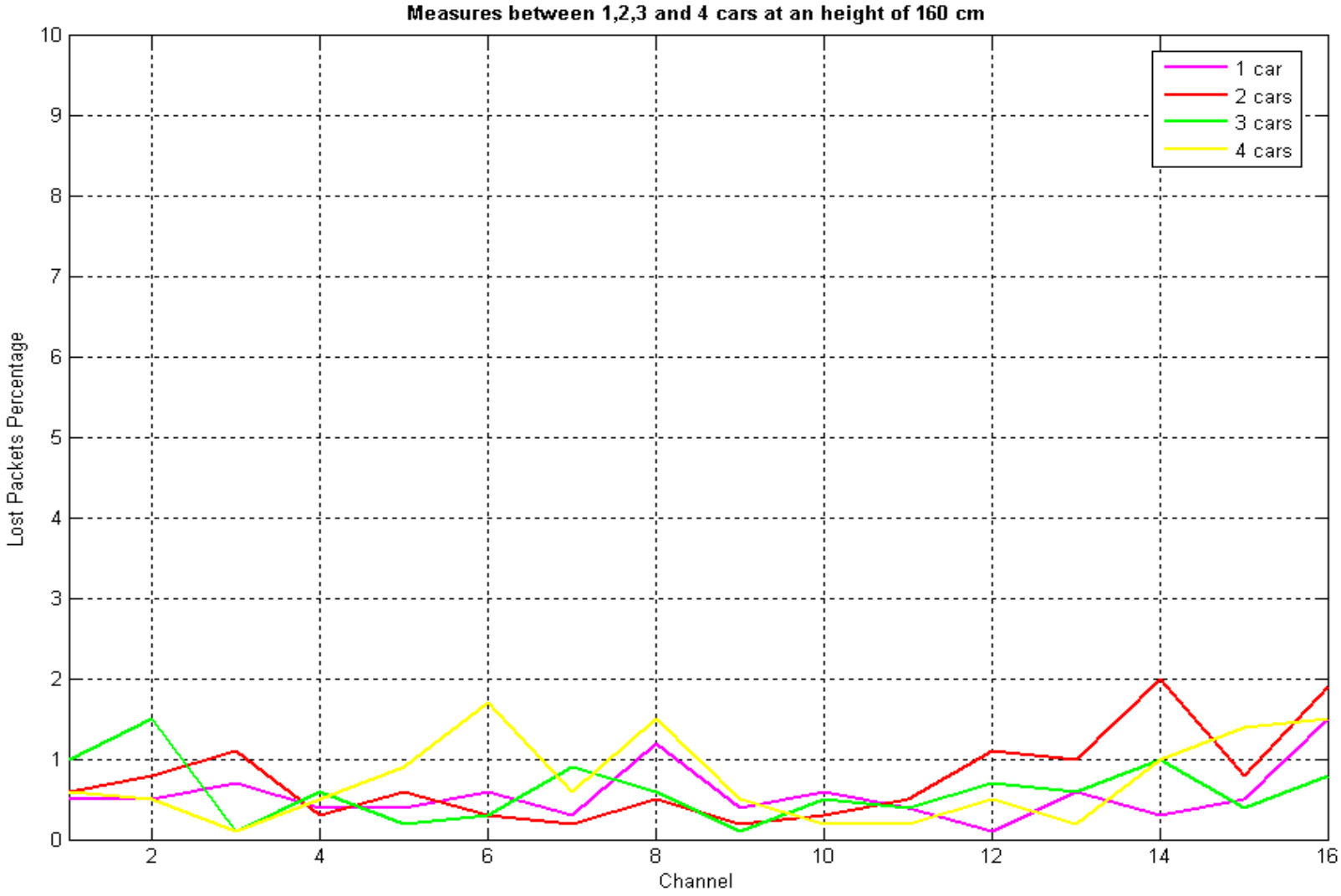
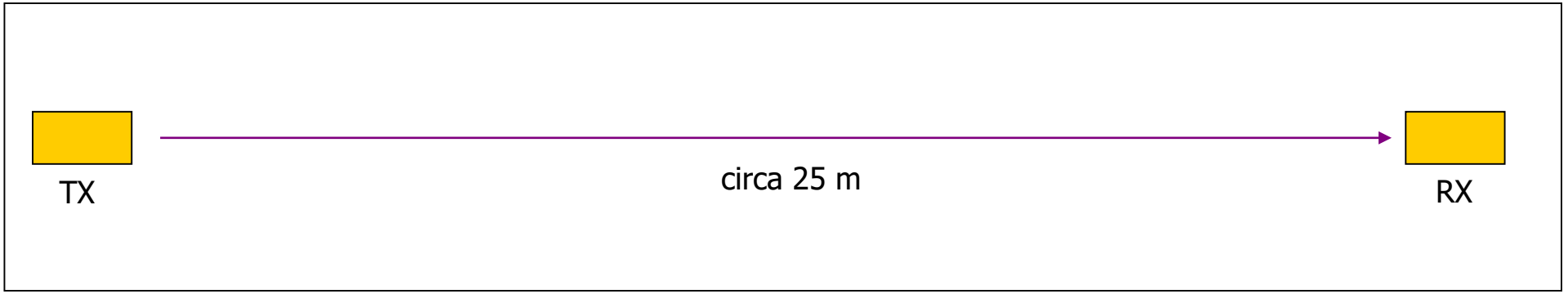
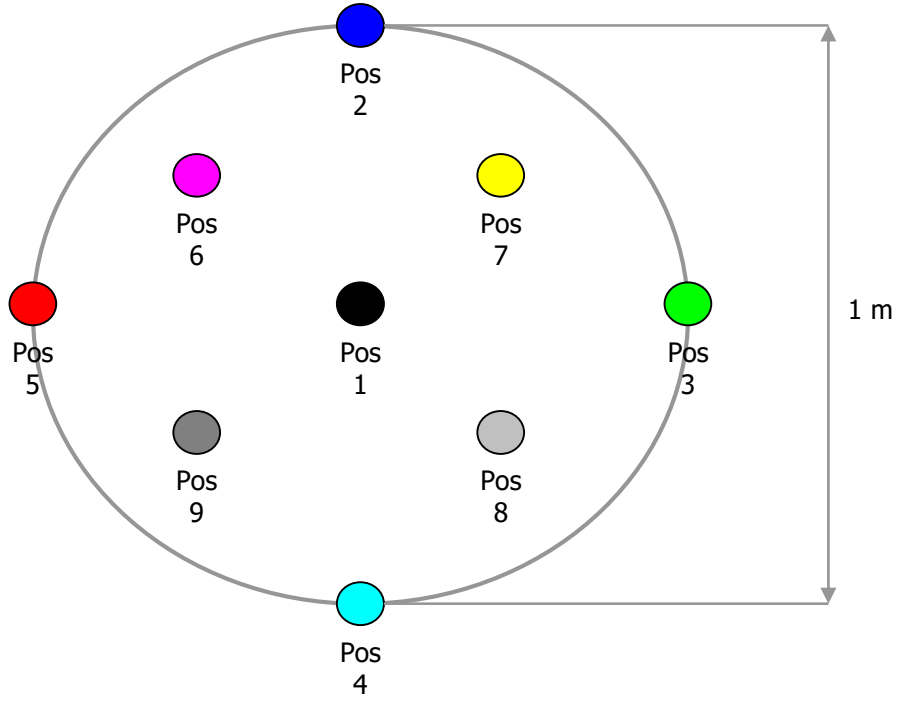


Indoor Environment





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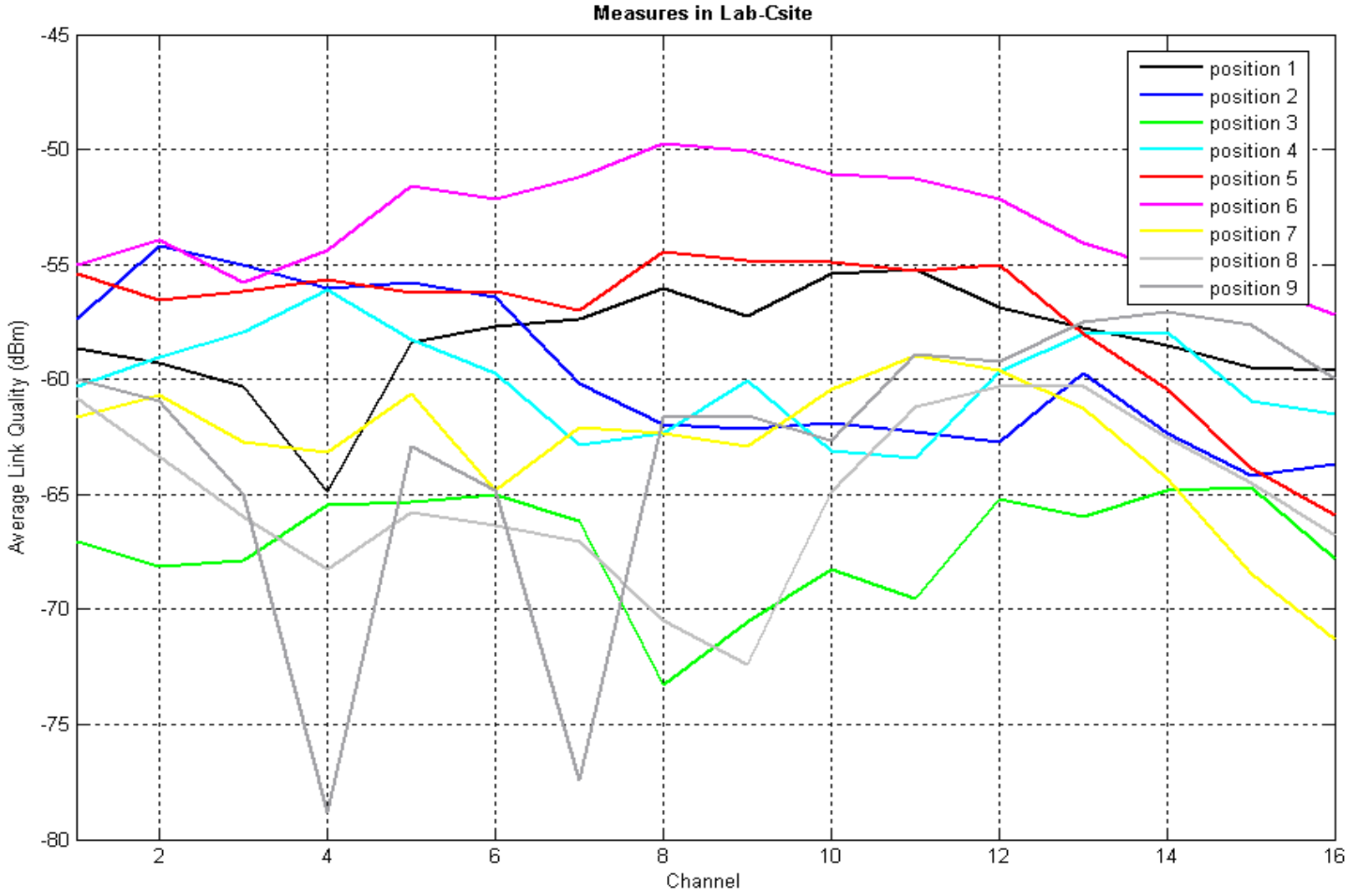

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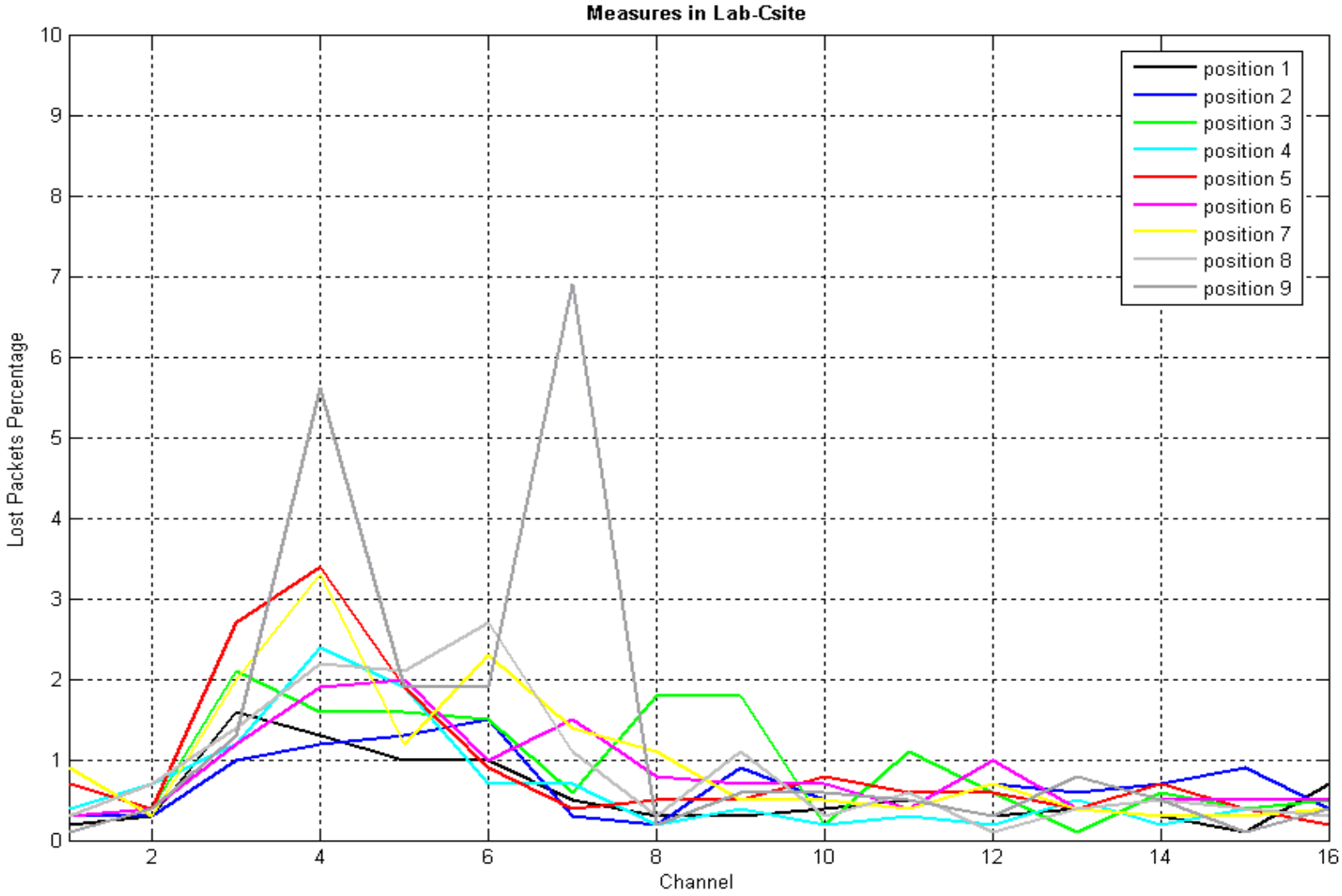

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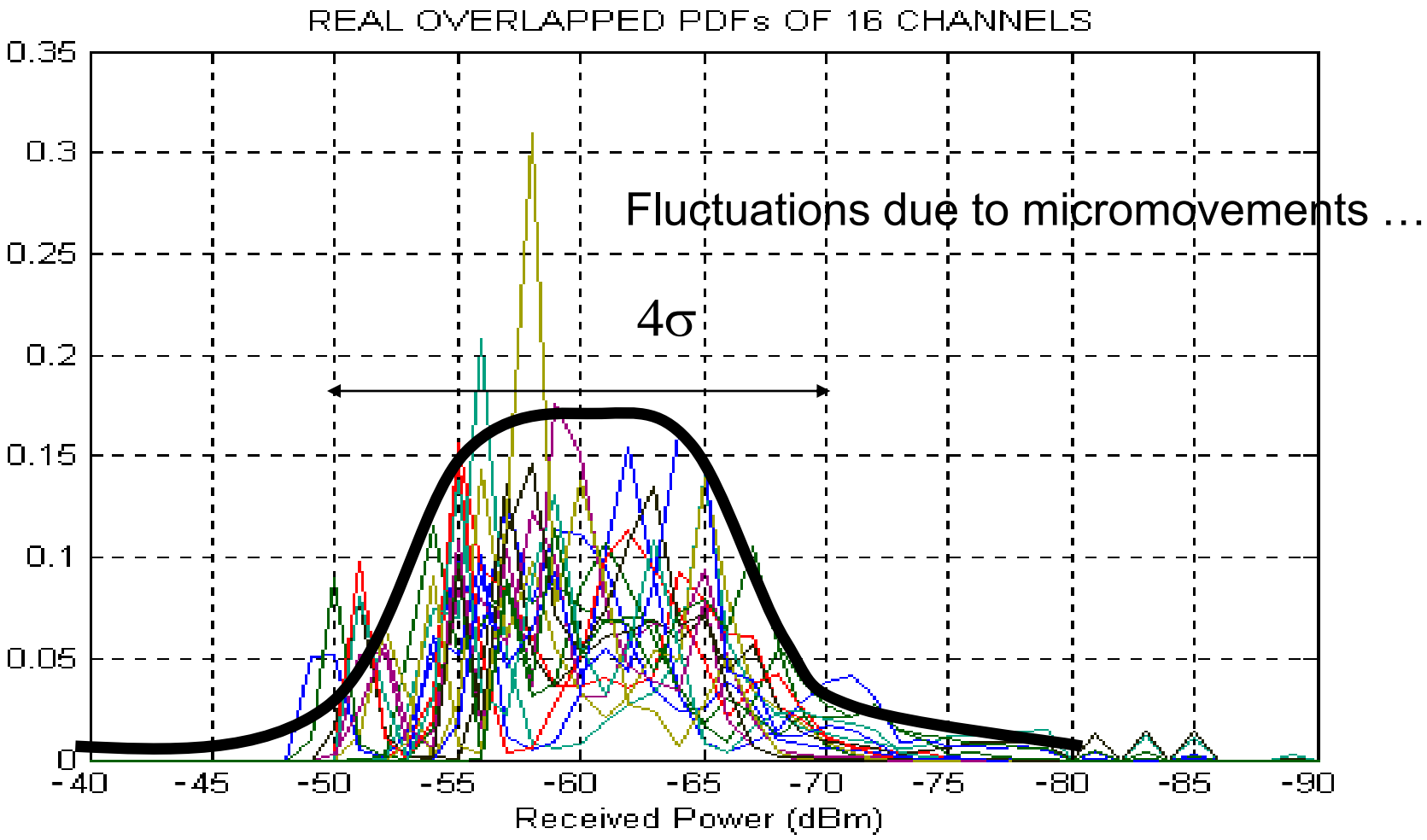

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s is Gaussian (zero mean) with variance σ^2

s has time coherence T_{WCOH}

- Fading and shadowing not distinguished
- Variance depends on environment

A Model for Channel Fluctuations

A Gaussian approximation for loss in dB seems to be a good approximation, with values of sigma which depend on the environment (indoor, rural, etc)

Indoor: $\sigma = 5$
Rural: $\sigma = 2 - 4$

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