Winner+ channel model calibration methodology

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http://projects.celtic-initiative.org/winner+/WINNER+ Evaluation Group.html

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General approach

- Define some metrics that
  - are welldefined and measureable
  - all can agree on
  - offer some degree of confidence that implementations are reasonably identical
- Winner+ did this in a 2-step approach
  - Large scale metrics: do the statistics from the different implementations agree on a high level?
    - Pathgain and Geometry
  - Small scale metrics: do the statistics from the different implementations agree on a detailed level?
    - Delay spread and angular spread distributions
- Other metrics than those chosen by Winner+ could have been possible since we use them for comparison only.

Calibration Assumptions

- Evaluations following the evaluation principles in [M.2135] and the clarifications in [IMT-A Guidelines]
- Additional assumptions
  - Cell selection: 1 dB handover margin
  - Feeder loss: 2 dB
  - BS antenna tilt (degrees)

InH	UMi	UMa	RMa	SMa
N.A	12	12	6	6

Calibration of large scale metrics

- Pathloss (to serving cell) and wideband SINR (”geometry”) from five WINNER+ organizations

- In addition, results from the Chinese evaluation group are inserted for comparison
  - (People’s Republic of) China ”Proposal on Evaluation Calibration among Evaluation Groups”, input #486 to the 5th ITU-R WP5D meeting in Geneva, Switzerland, June 2009

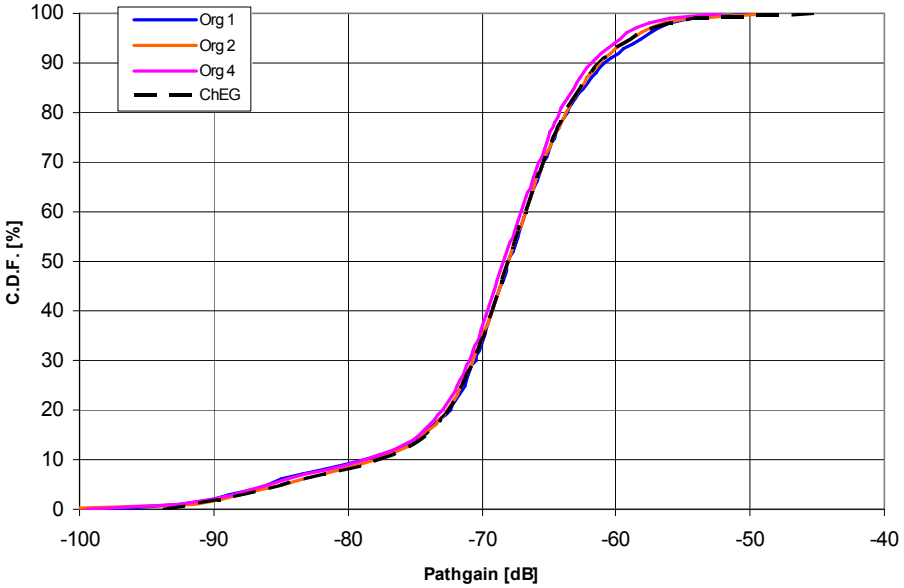
Definition

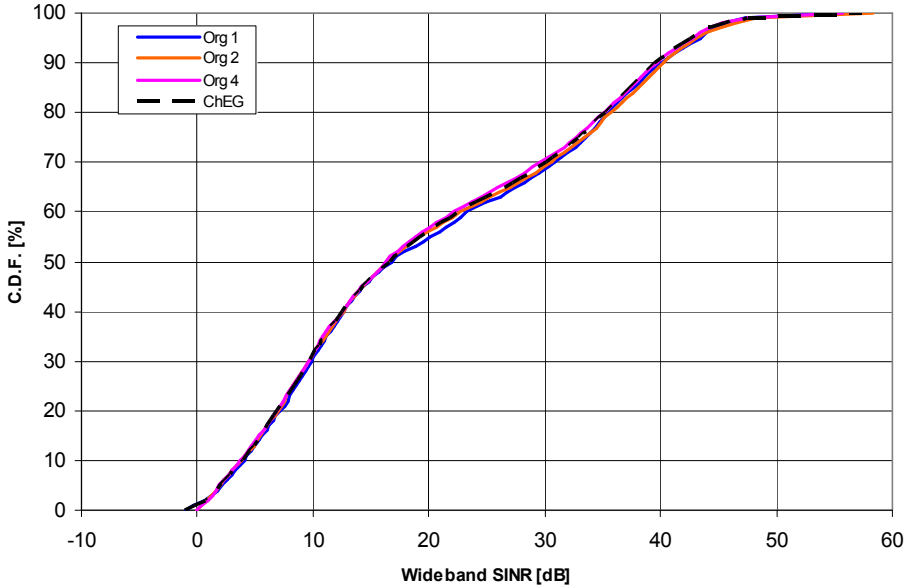
The pathgain between two nodes is the average difference between received and transmitted power (incl effects of shadowing).

Here we study pathgain distribution between all user terminals and their associated cell, i.e., the gain to the serving cell.

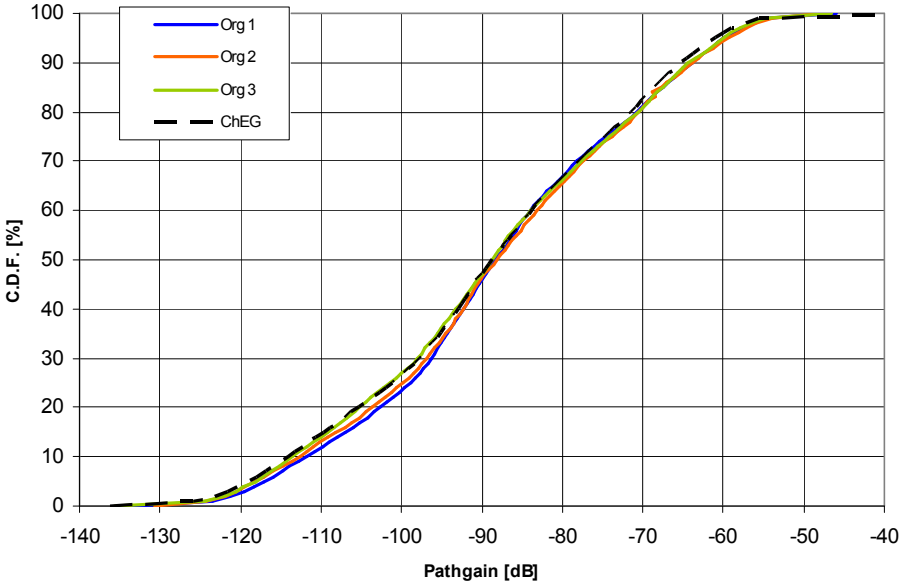
The wideband SINR, sometimes also referred to as geometry, is the relation between the average power received from the serving cell and the average received power from all other cell in the network plus the noise power in the terminal receiver.

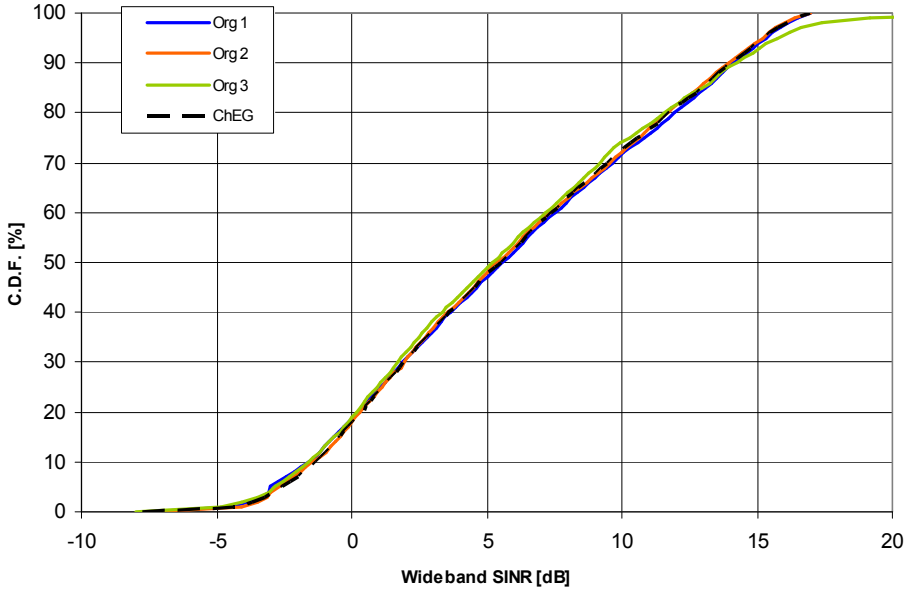
Large scale metric calibration Results: InH



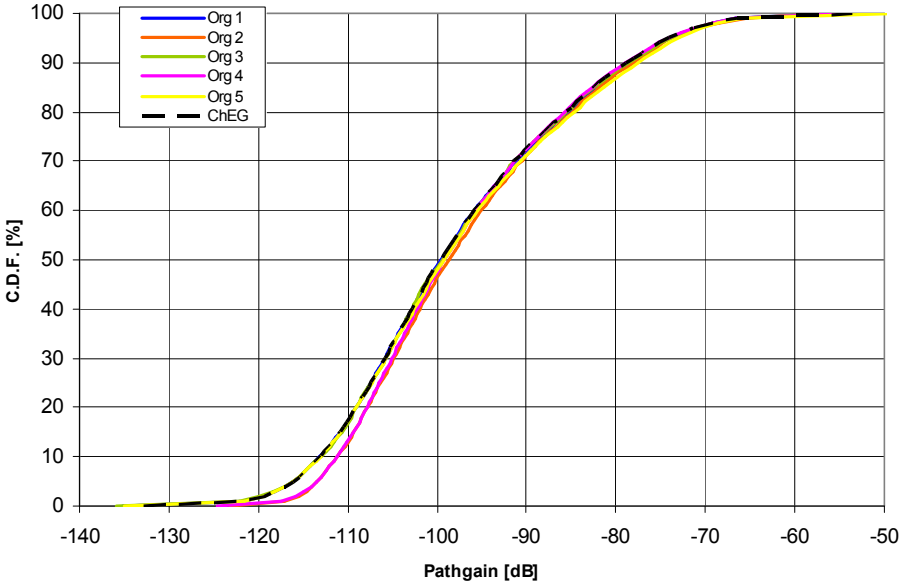


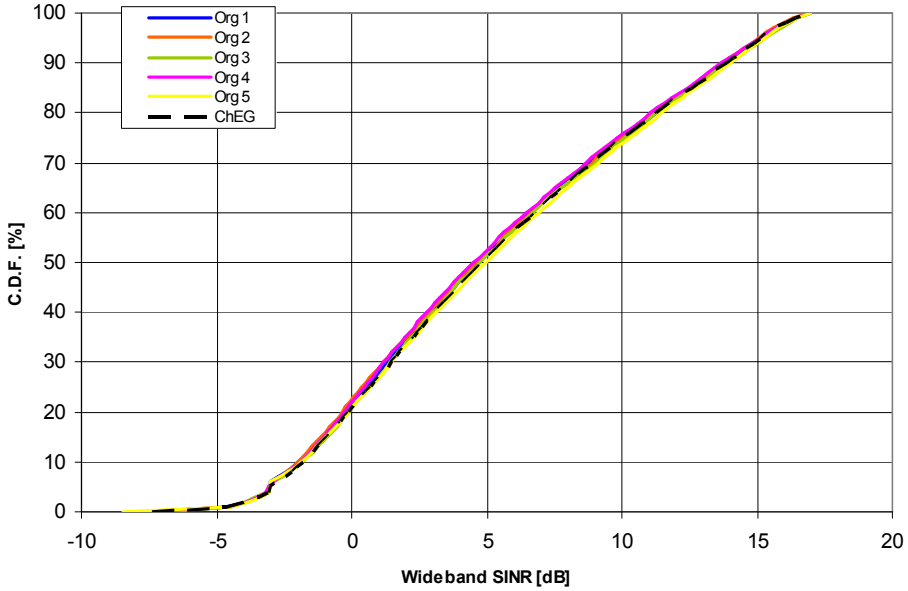
Large scale metric calibration Results: UMi



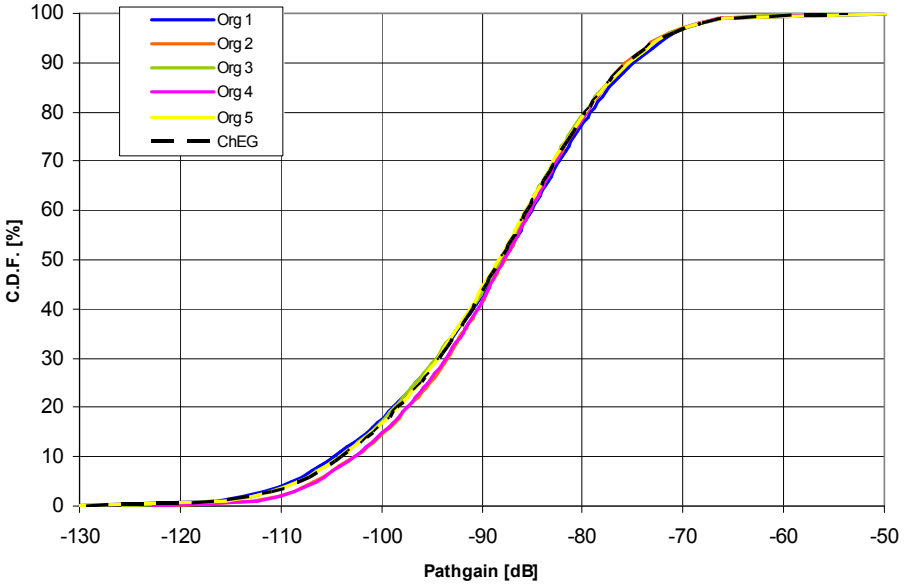


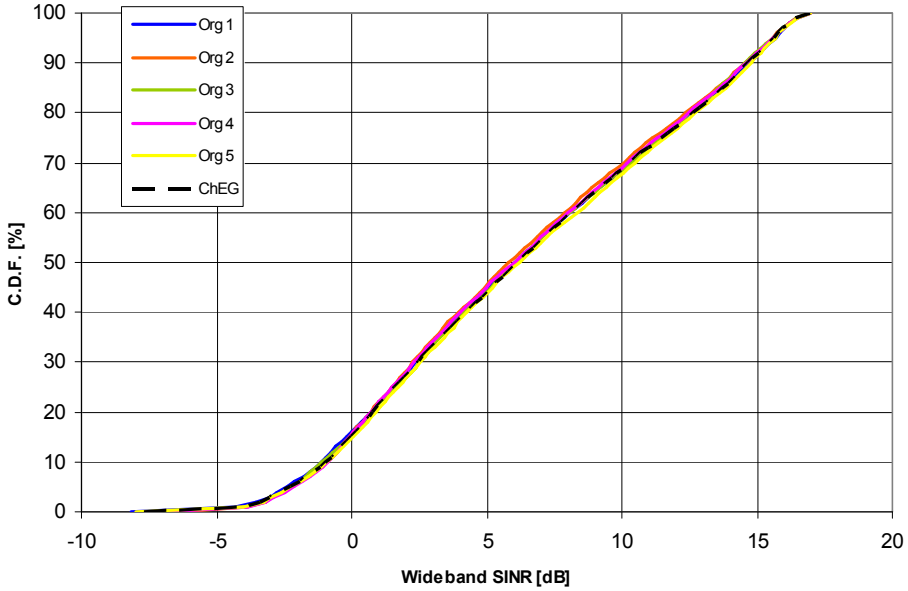
Large scale metric calibration Results: UMa



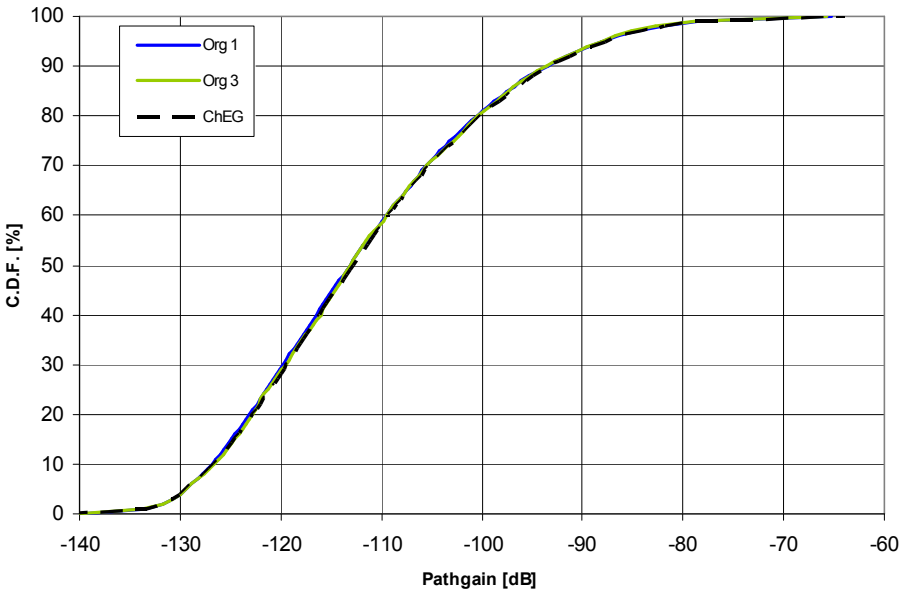


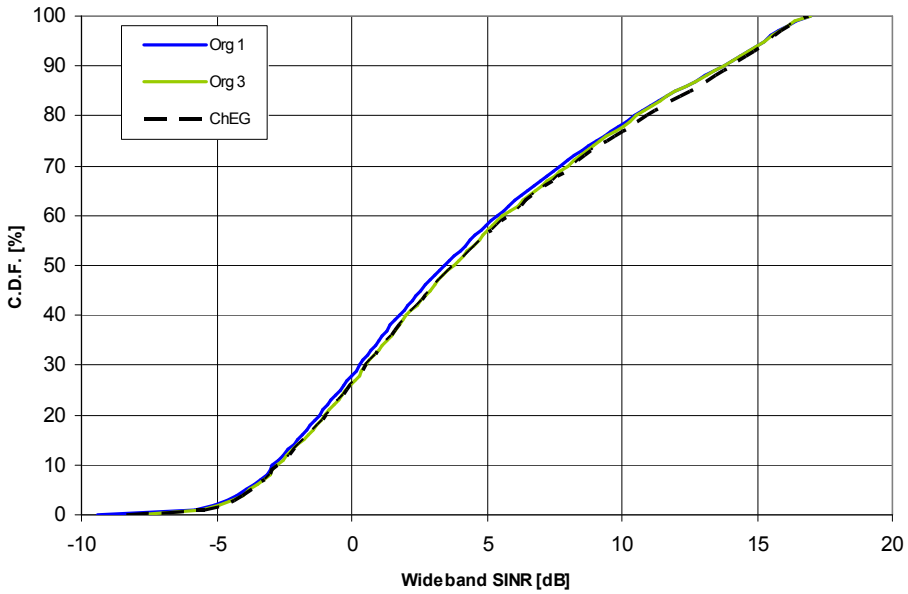
Large scale metric calibration Results: RMa





Large scale metric calibration Results: SMa





Calibration of small scale metrics

- Method: comparison of the delay spread and the angular spread at the base station and at the user terminal.
- The small-scale fading calibration is performed using omni-directional antennas at both the base station and the user terminal.
- The calibrations are performed separately for LoS, NLoS conditions.
  - In addition, outdoor-to-indoor propagation is relevant in the UMi scenario.

Notation

- Assume that each propagation channel comprises *N* clusters and that each cluster comprises *M* rays.
- The delay of ray *m* in cluster *n* is denoted $\tau_{n,m}$ and that the associated power is denoted $p_{n,m}$.
  - In case of LoS propagation the LoS ray is here included as a separate cluster for which, according Report ITU-R M.2135, only the first ray in the cluster has a non-zero power.

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RMS delay spread

To calculate the delay spread the average delay $\overline{\tau}$ is first calculated according to equation (2.1).

$$\overline{\tau} = \frac{\sum_{n=1}^{N}\sum_{m=1}^{M}\tau_{n,m}\cdot p_{n,m}}{\sum_{n=1}^{N}\sum_{m=1}^{M}p_{n,m}}$$

Then, the root-mean-square (RMS) delay spread (σ_τ) is calculated according to

$$\sigma_\tau = \sqrt{\frac{\sum_{n=1}^{N}\sum_{m=1}^{M}(\tau_{n,m}-\overline{\tau})^2\cdot p_{n,m}}{\sum_{n=1}^{N}\sum_{m=1}^{M}p_{n,m}}}$$

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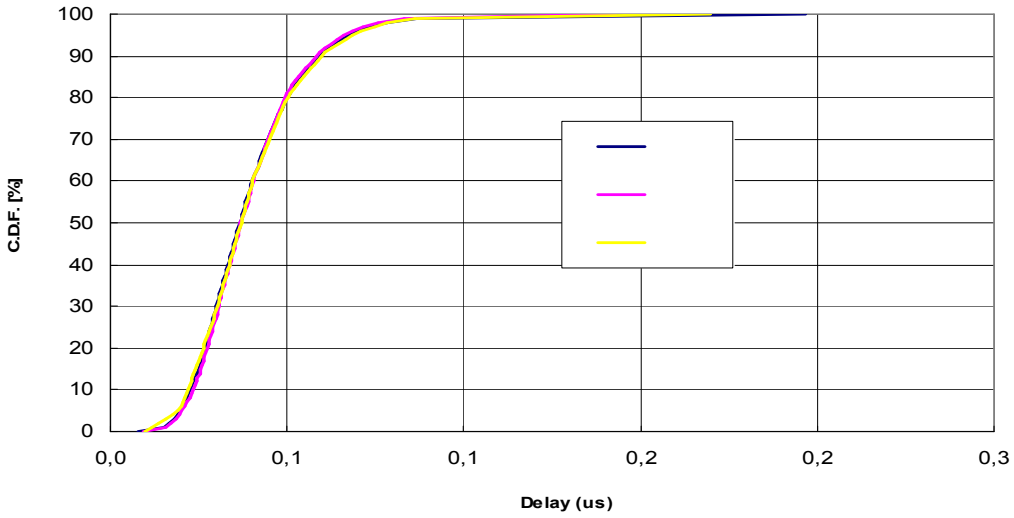
Angular spread

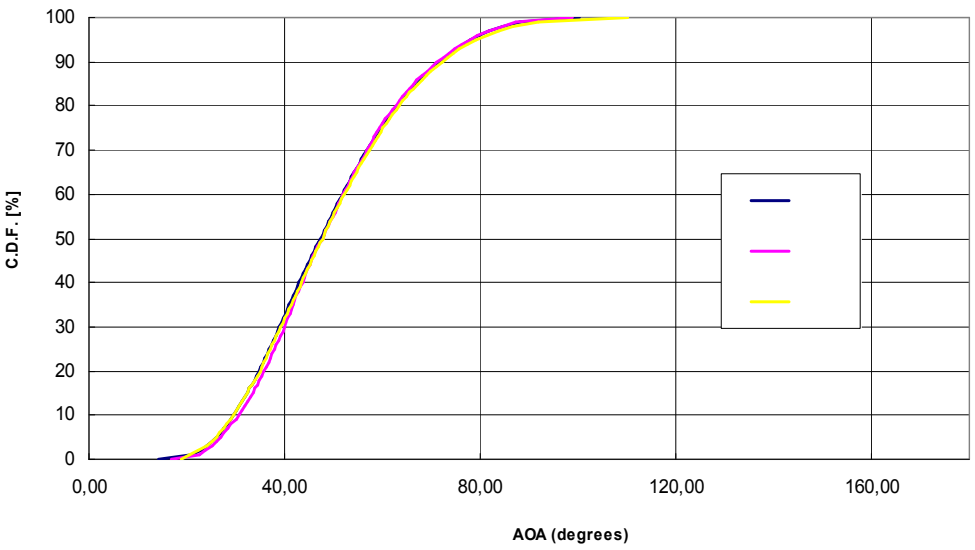
For the angular spread we use the circular angular spread (σ_{AS}) as defined in Annex A of *[3GPP 25.996], where the angular spread is the minimum spread over different linear shifts Δ*. One small addition is used here, however. Before calculating $\theta_{n,m,\mu}(\Delta)$ we wrap the quantity $\mu_\theta(\Delta)$ into the interval [-π, π] according to the equation below. This step is not explicitly stated in [3GPP 25.996].

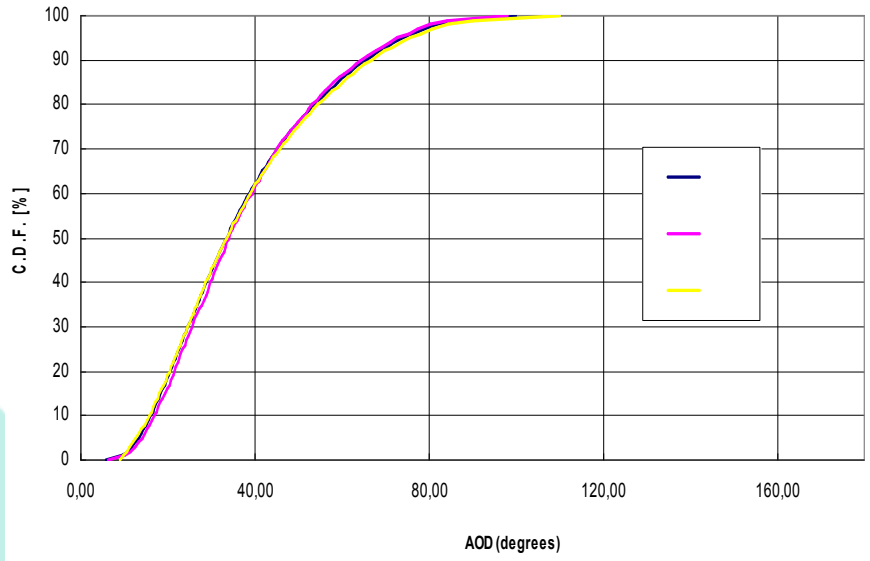
$$\mu_\theta(\Delta) = \begin{cases} 2\pi + \mu_\theta(\Delta) & if\ \mu_\theta(\Delta) < -\pi \\ \mu_\theta(\Delta) & if\ |\mu_\theta(\Delta)| \le \pi \\ \mu_\theta(\Delta) - 2\pi & if\ \mu_\theta(\Delta) > \pi \end{cases}$$

- The RMS delay spread (σ_τ) and the circular angular spread (σ_{AS}) at the base station and at the user terminal are calculated for a large number of radio links and in the calibrations we compare the corresponding distributions.
- Taking a downlink perspective on the radio channel, the angular spread at the base station and at the user terminal are denoted angle of departure (AoD) and angle of arrival (AoA), respectively.

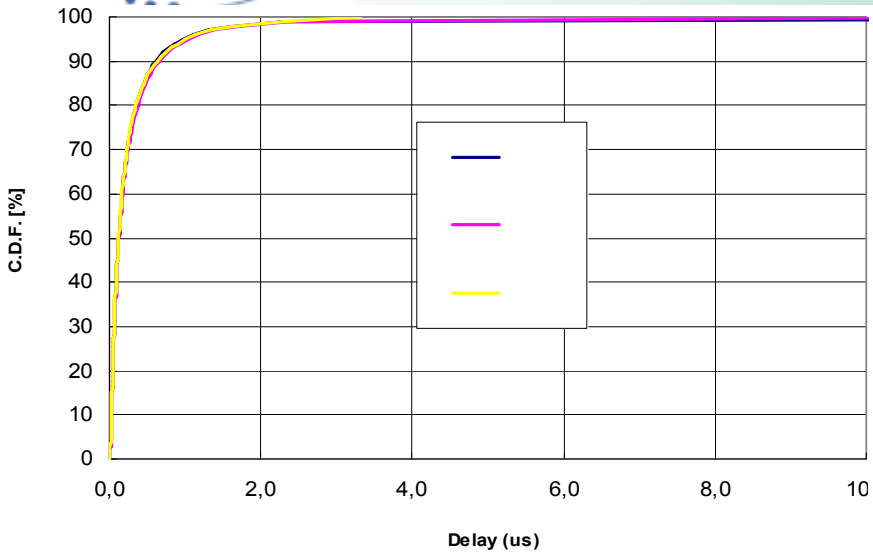
Small scale metric calibration: Indoor NLOS

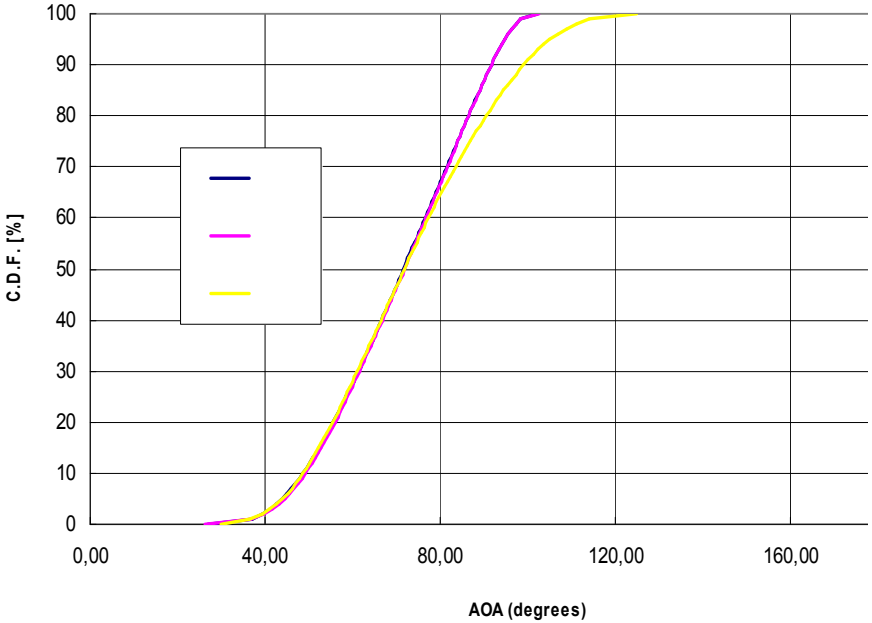


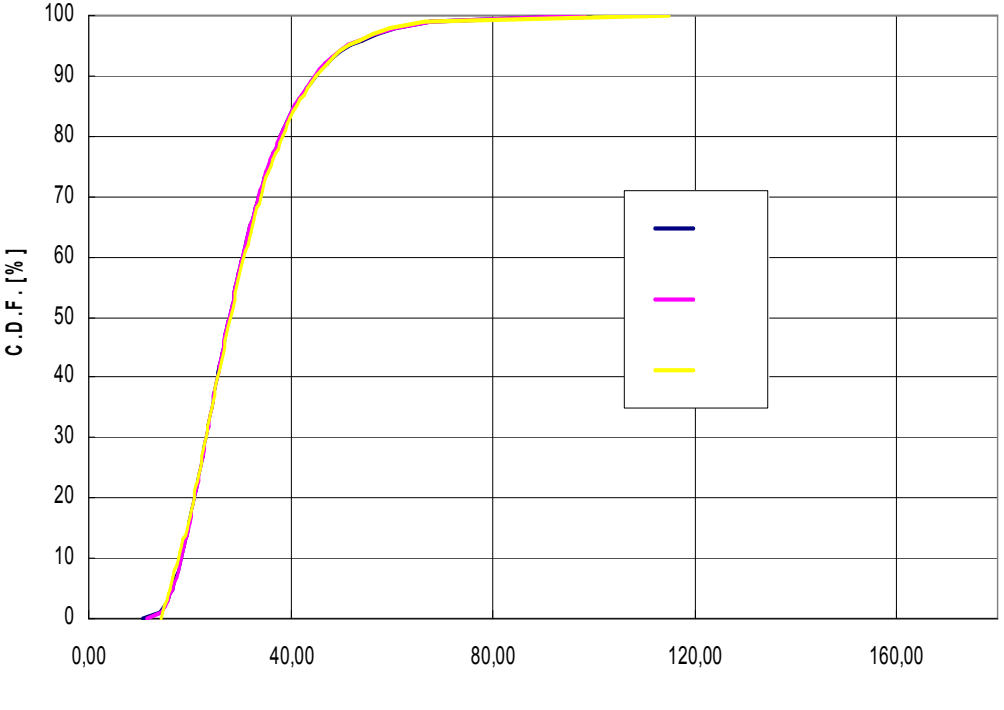




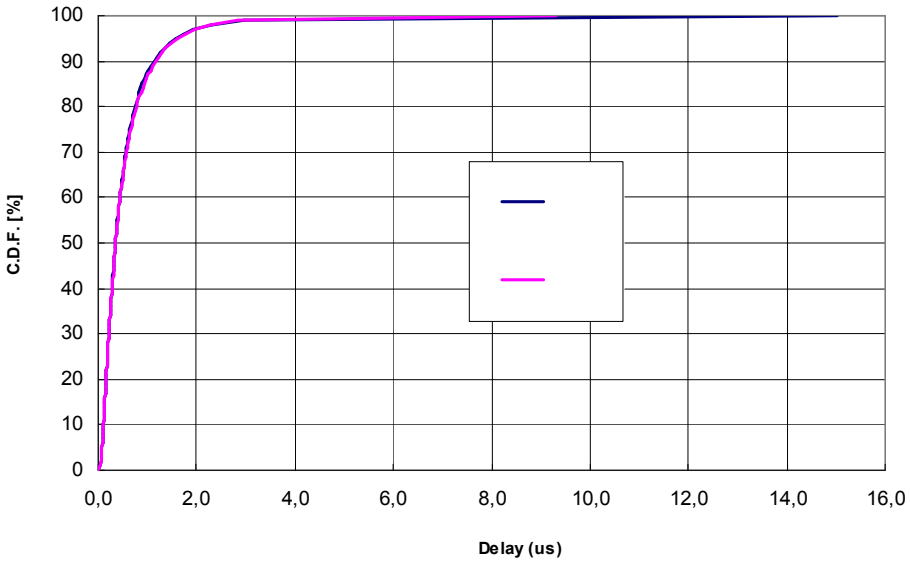
Small scale metric calibration: Urban Micro NLOS

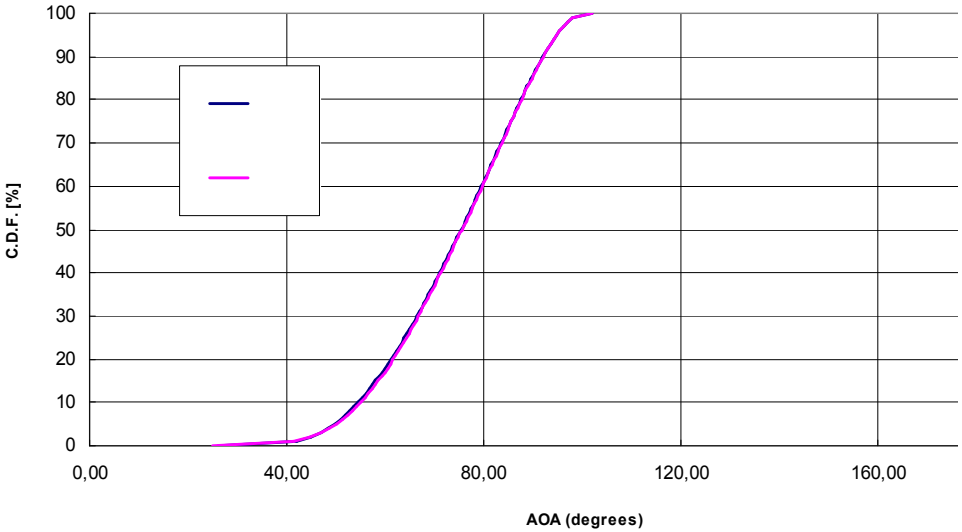


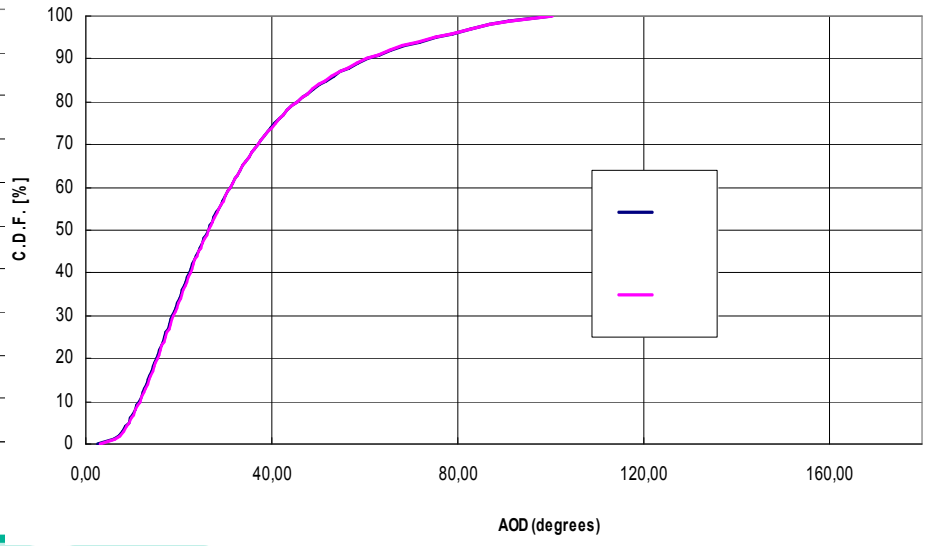




Small scale metric calibration: Urban Macro NLOS







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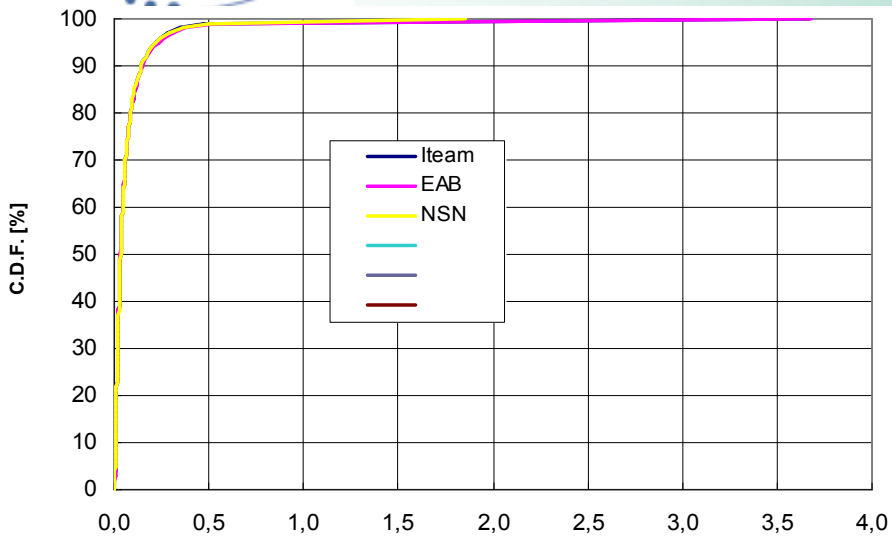
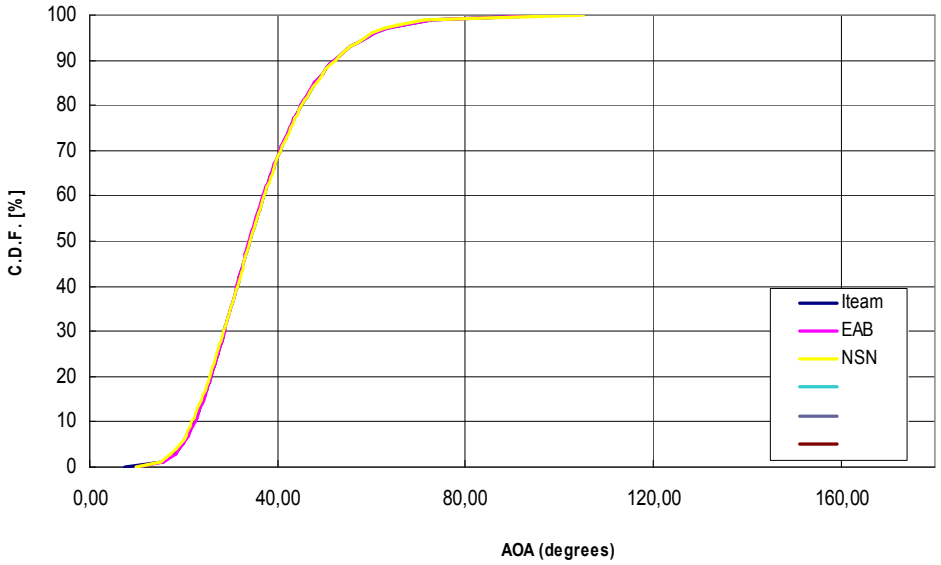
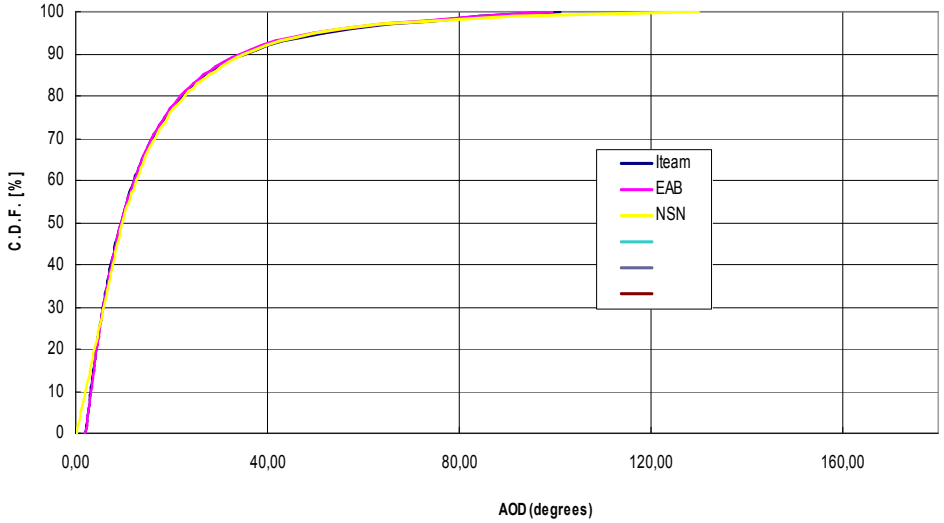
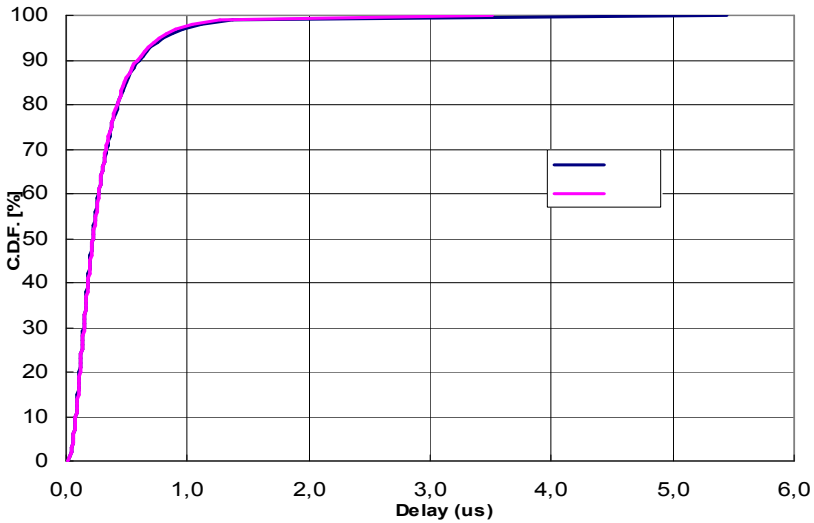
Small scale metric calibration: Rural Macro NLOS

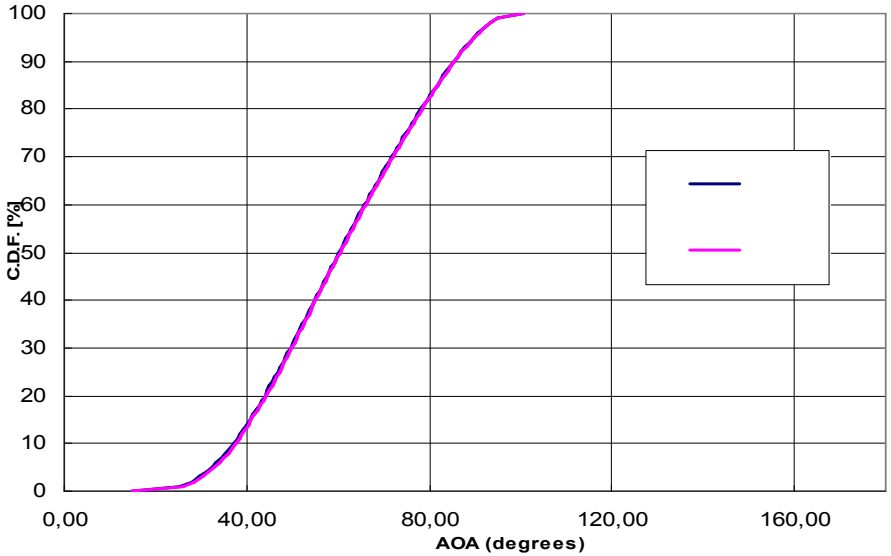


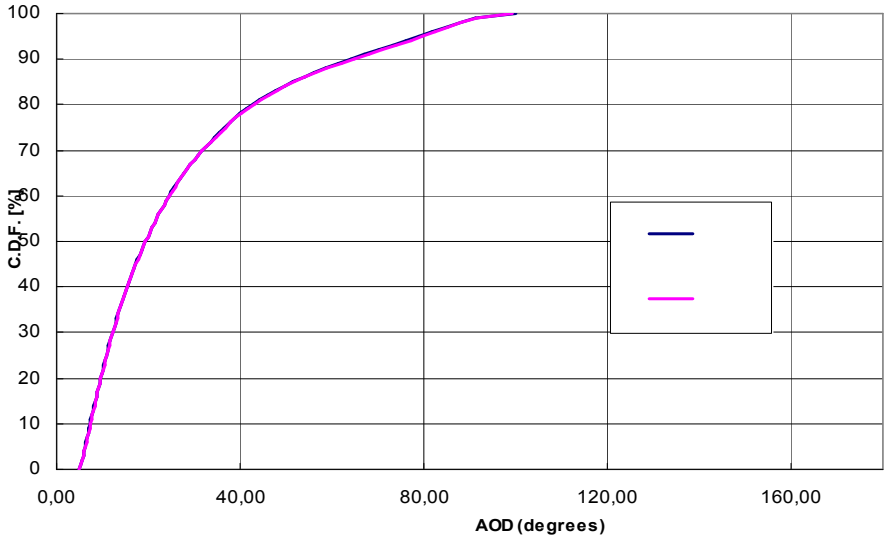




Small scale metric calibration: Urban Micro Outdoor-to-Indoor







Small scale metric calibration reults

- Winner+ is awaiting more results from other partners
- Good alignment in LoS, NLoS and Indoor-to-outdoor cases for first partners

Lessons learned...(so far)

- Identify some metrics that can be used as measures and agree between partners
- Define the metrics well, preferrably using mathematical notation
- Agree on non-specified assumptions
  - BS antenna tilt, feeder loss and handover margin
- Check one metric at the time starting with the most basic
- Good engineering work is key to success
  - Be careful and thourough – calibration may take longer than expected
- The fact that results show agreement within Winner+ and partially also to ChEG is so good, suggest that the models are well defined

Thank you!