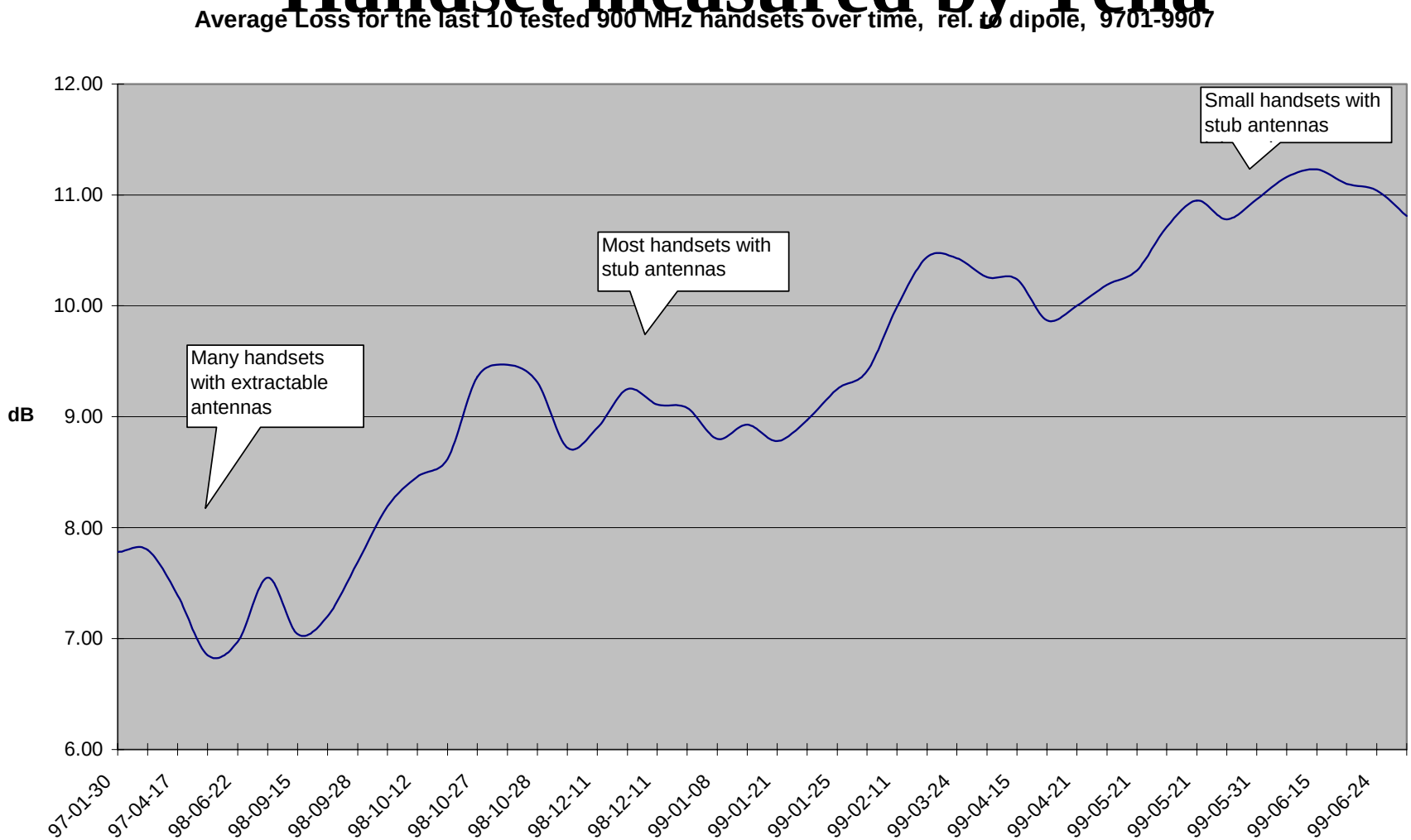
Communication Performance Measurements for 3G User Equipment Including the Antenna

COST273 WG2.2's View

COST273 WG2.2

Handset measured by Telia



The average antenna loss for the 10 latest tested handsets relative to 60° tilted dipole from 97-01-30 until 99-06-24. Measured with phantom and simulated hand [Bo Olsson *et al*, Telia]

What is a Good Antenna for mobile phones?

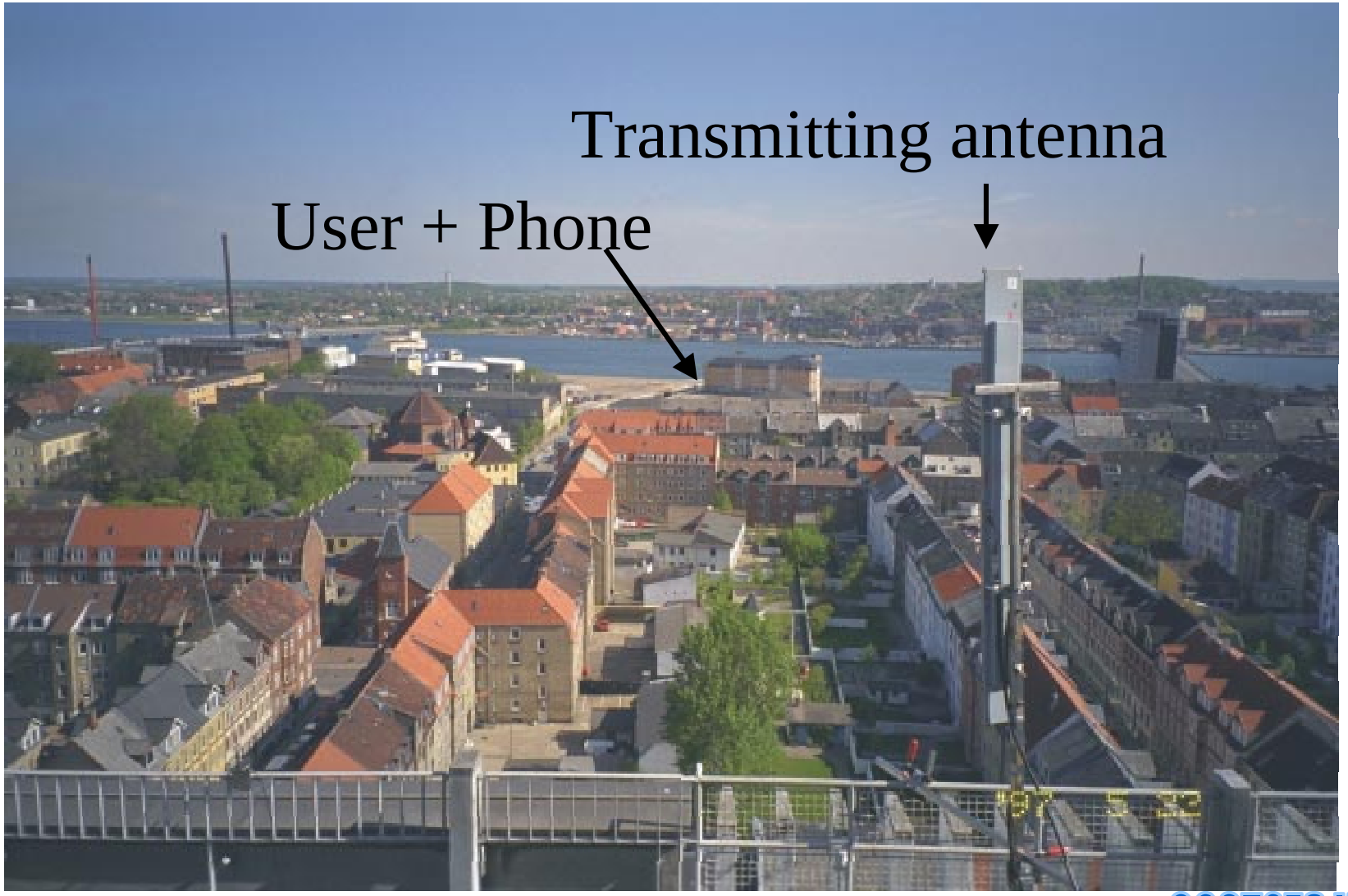
- A Good Communication Preforming Antenna is Defined by: Transmitting and Receiving Relative high amount of power to/from the Basestation.
- Measured in realistic environment.
- Measured in typical use.

- Measurements of Mean Effective Gain (MEG).

Example of MEG measurements for Mock-up Phone with 3 Antennas

- Including 200 users.
- outdoor-to-indoor environment in a city.
- 4 stories building, measurements on each floor from basement to third floor.
- Basestation located outdoor at rooftop level
- Basestation antenna vertical polarised and some 60 deg. Beamwidth
- 3 antennas, Extractable, Patch and Helix.

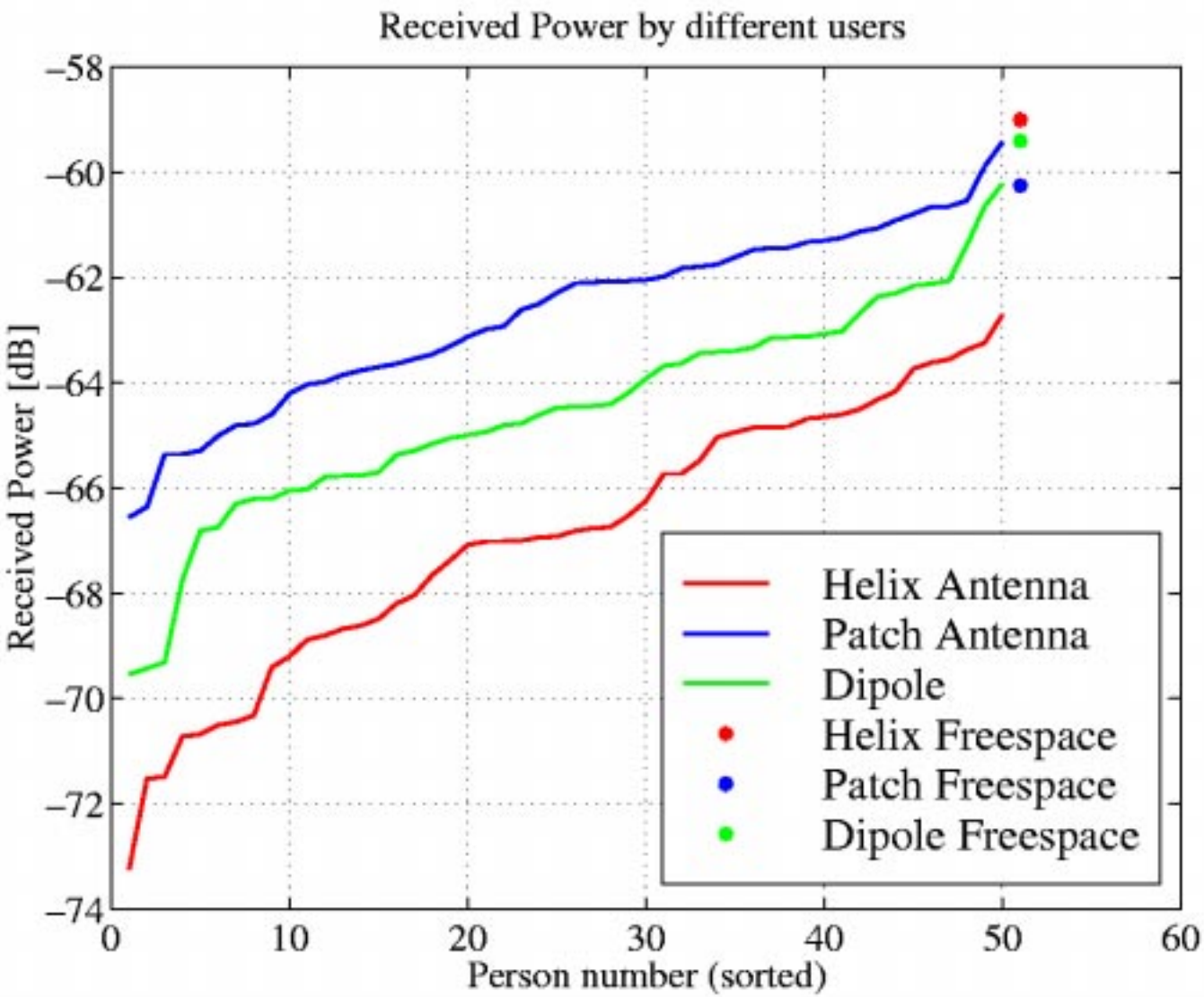
Basestation site in Aalborg



Handset and User

- 50 users on each floor.
- 2 antennas recorded at the same time.
- 2 recordings for each person, First Extractable and Patch then Helix and Patch.
- Each user is instructed to walk on 4 by 2 meter path marked on the floor
- Each user was asked to use the phone in the way he or she felt naturally.

Received Power, 50 Users, 3 Antennas



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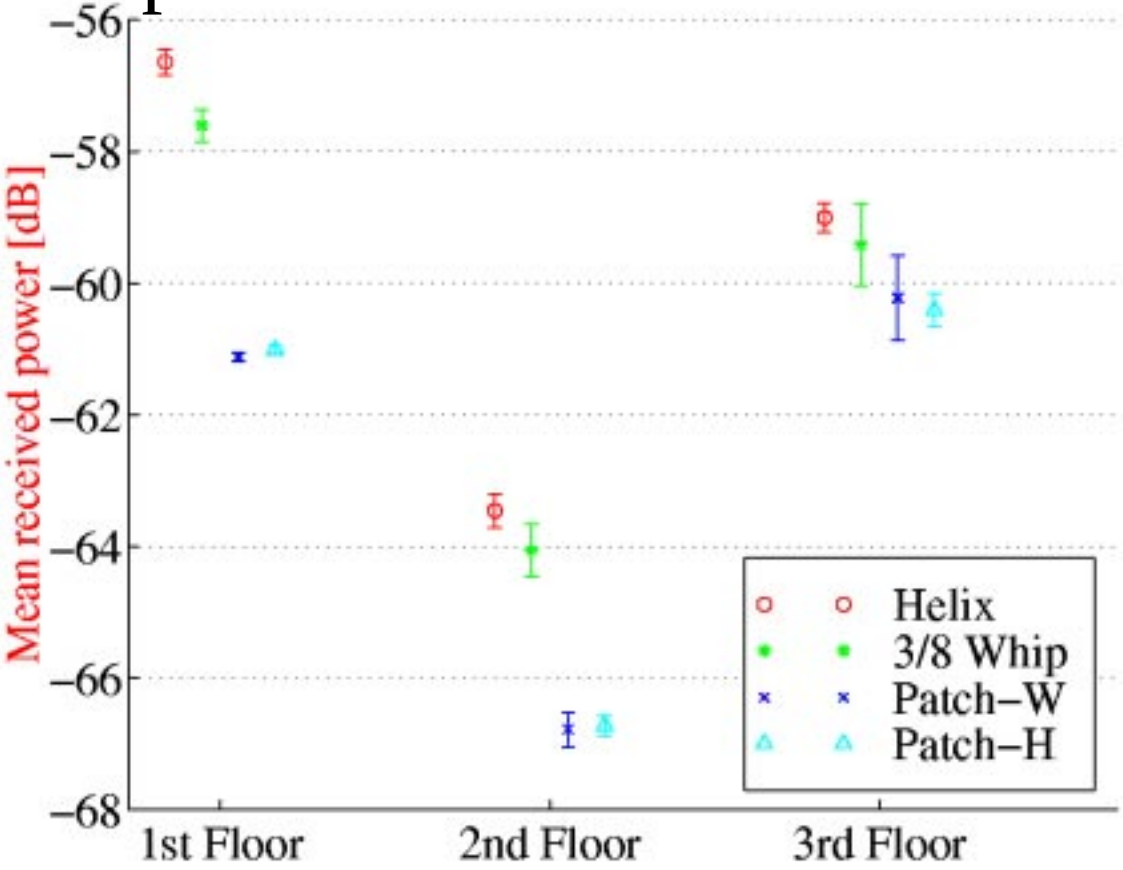
Free-space Measurements

Each measurement repeated 5 times, the min. and max. values are plotted as error bars



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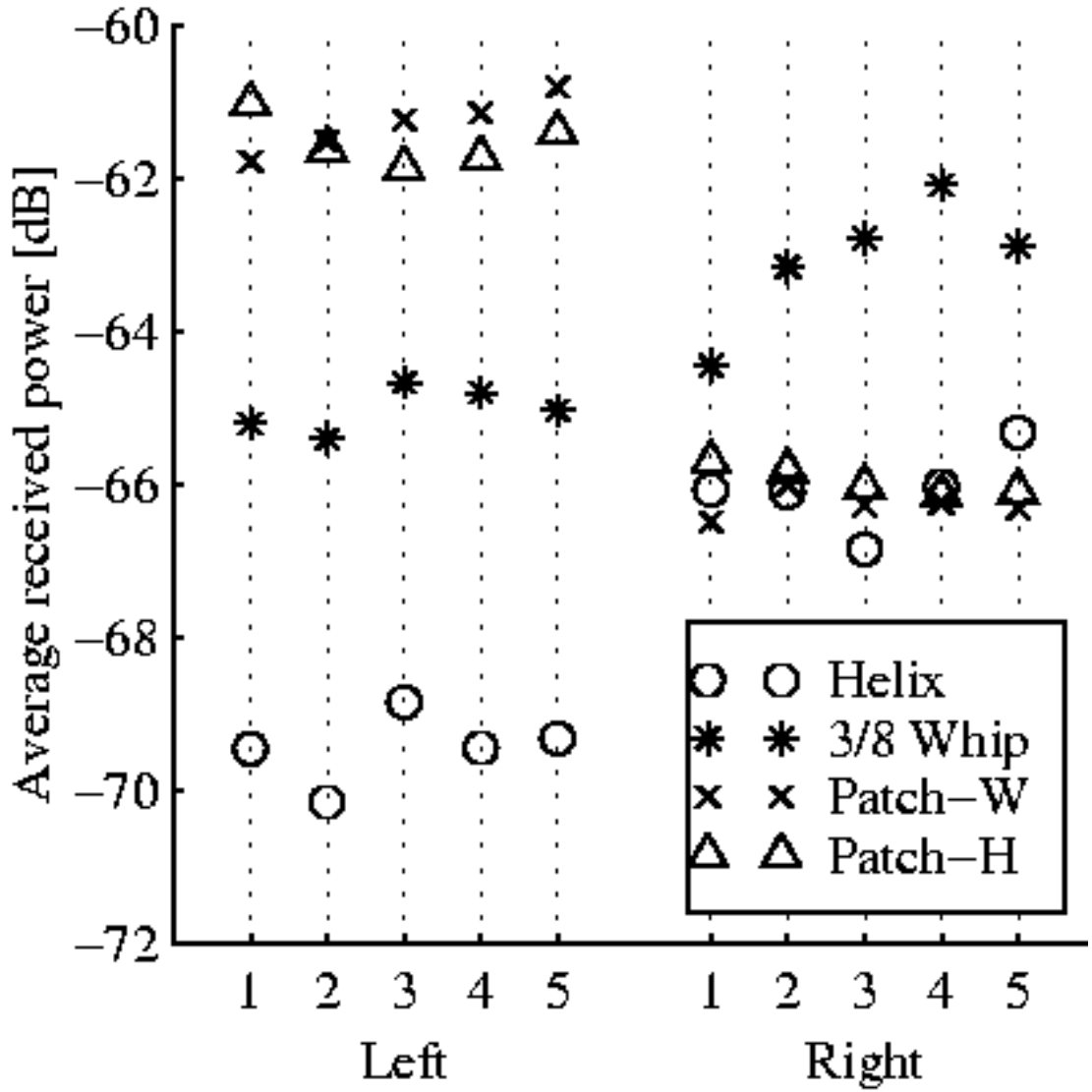
Why the large variation in the MEG

- Height of person/phone? ➡ No.
- Warring Glasses? ➡ No.
- Left or Right hand side of the head? ➡ Some.
- ?



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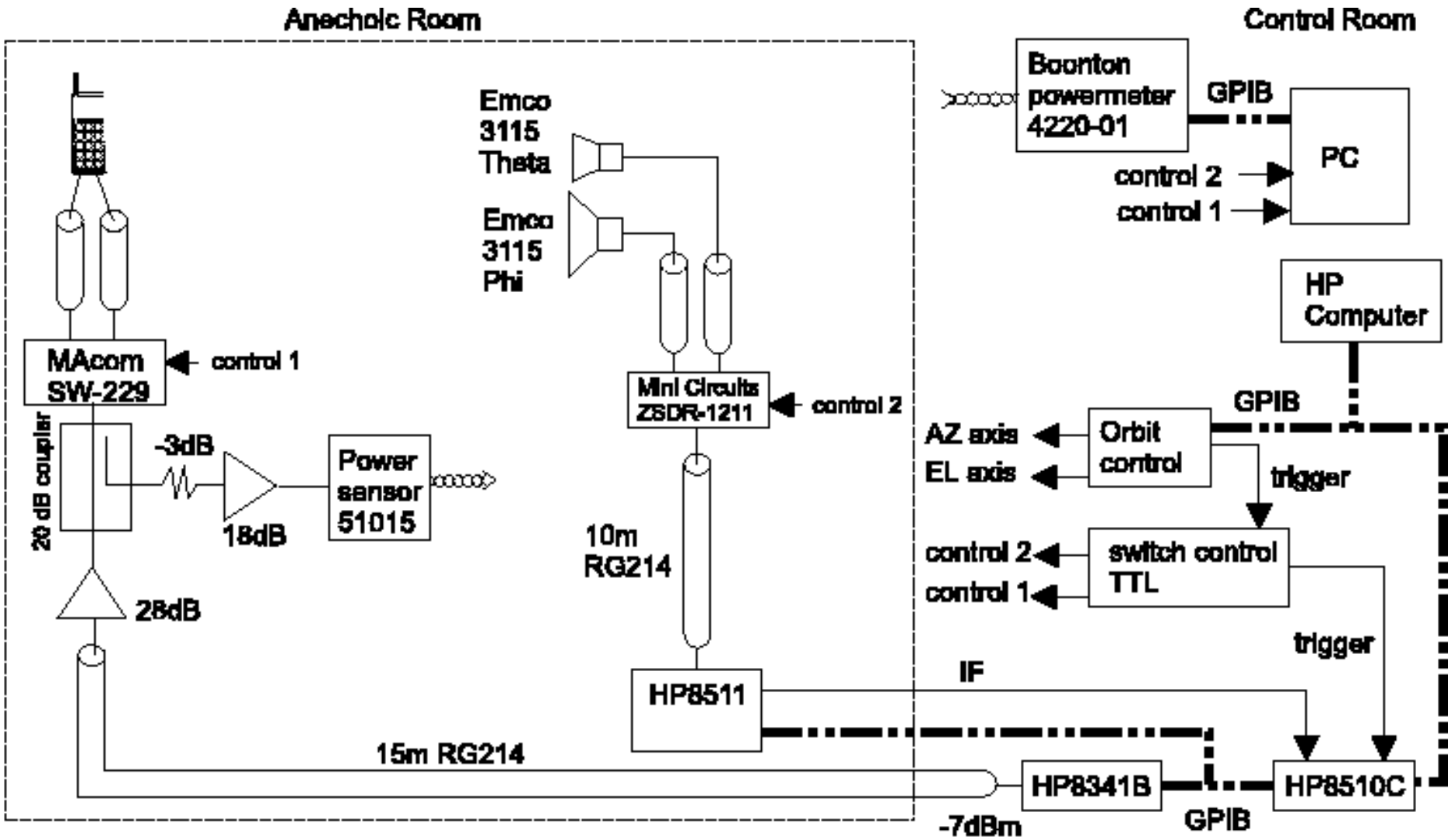
Bodyloss is caused by

1. Aditional Antenna mis-match due to the Body (lower (antenna) efficiency).
2. Absorption in the Body (lower efficiency).
3. Radiation Direction Changed by the Body (MEG change).
4. Polarisation Changed By the Body (MEG change).

Measurement setup made in anechoic Room to investigate the prime source of the Bodyloss/MEG variations.

Radiation Measurements in Anechoic Room

Block diagram of Measurement setup



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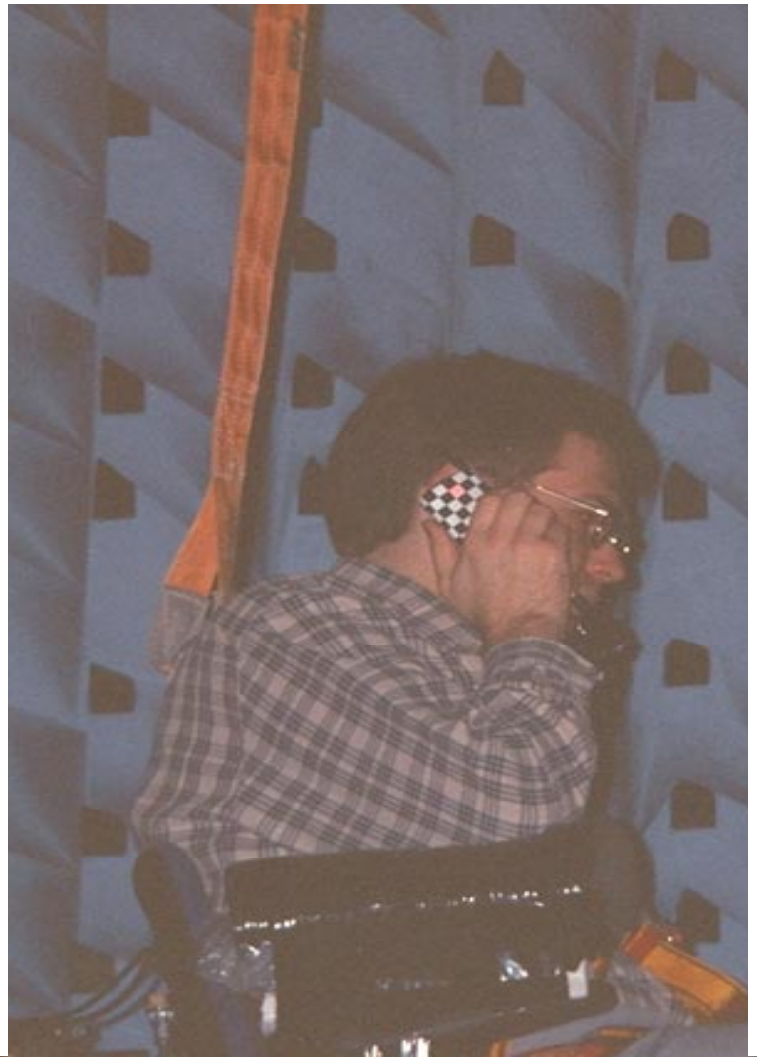
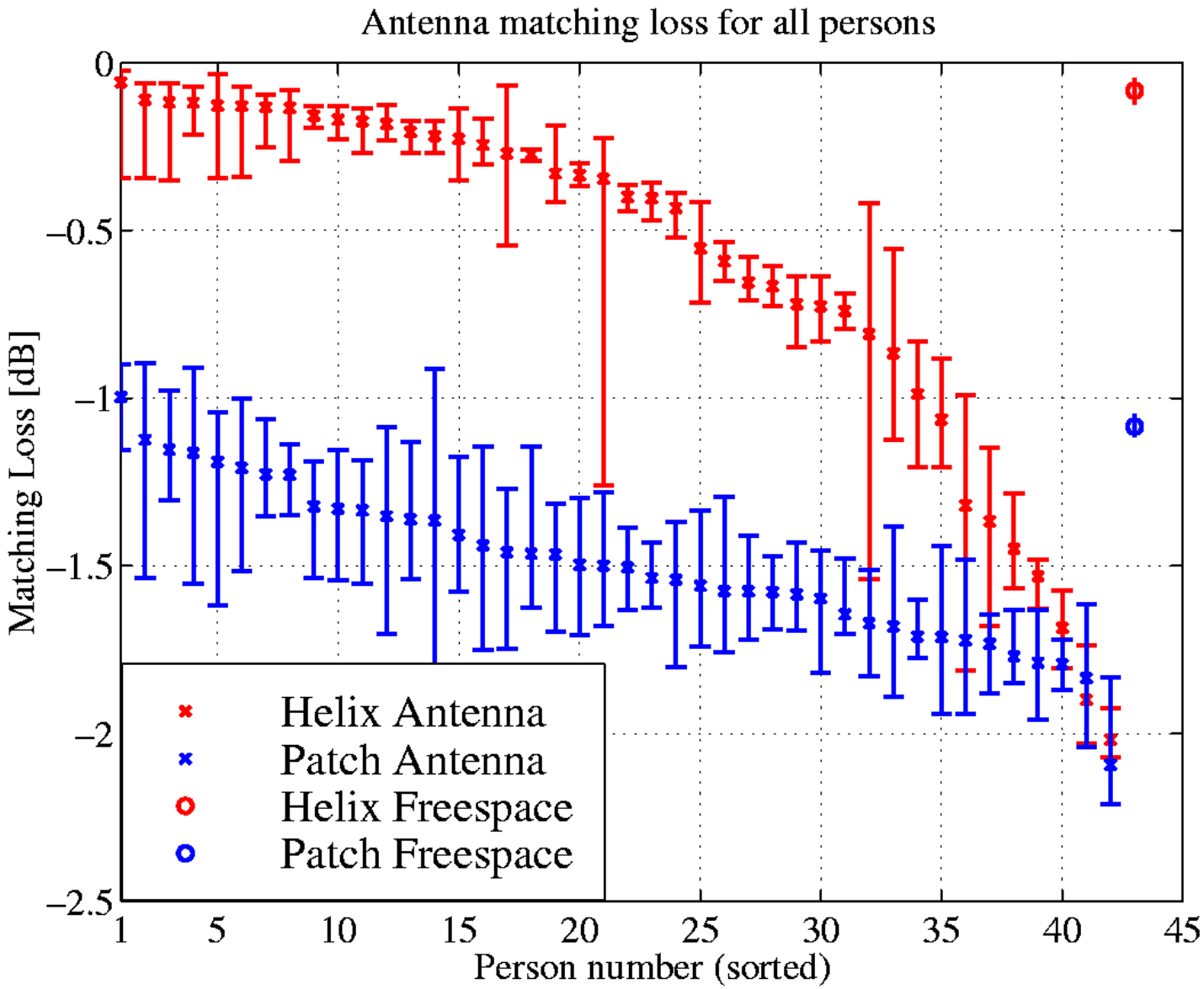
Setup in Control Room

Control of position of Persons!



Antenna Mis-match



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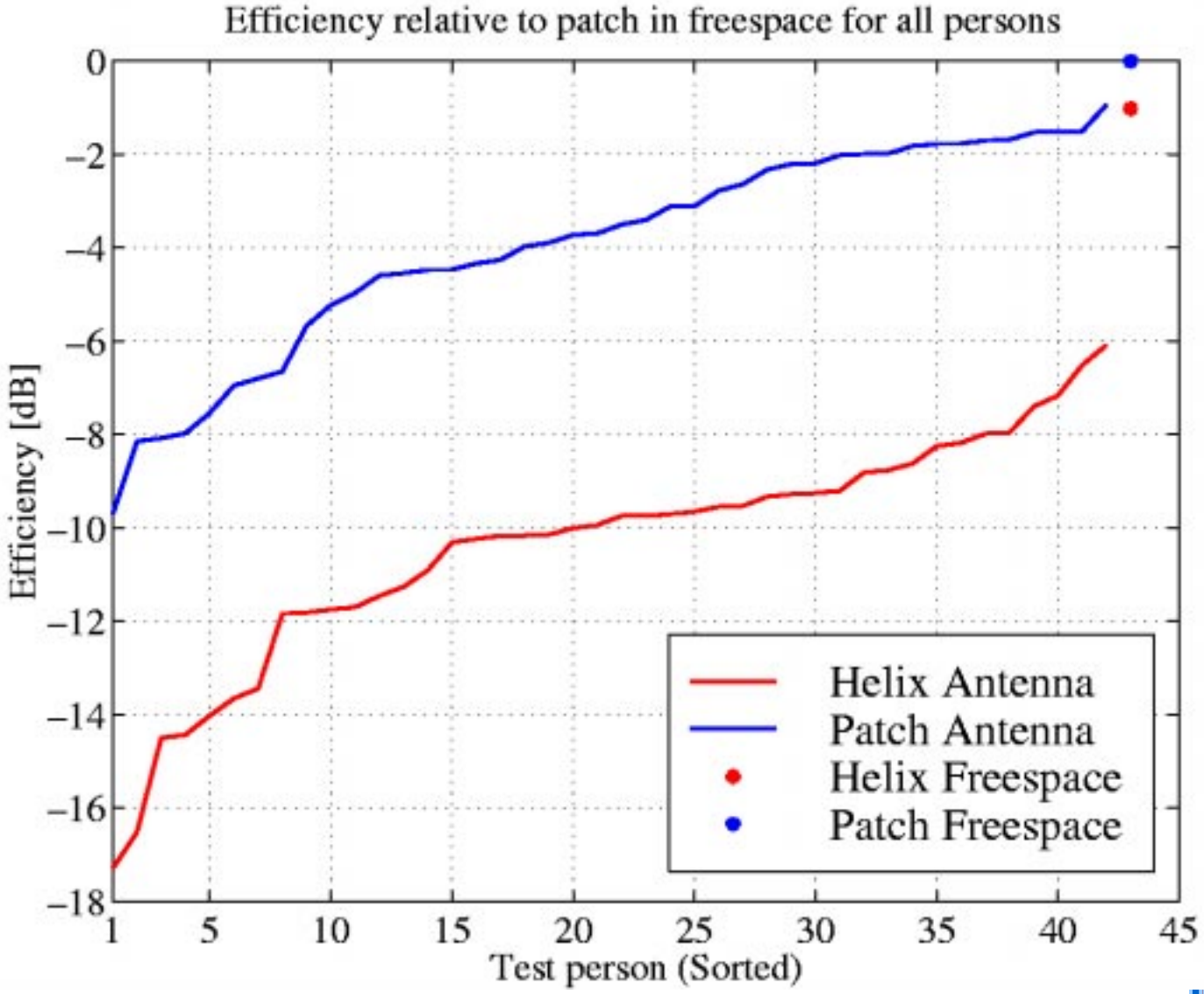
Antenna efficiency including the User. (relative to best antenna in freespace)



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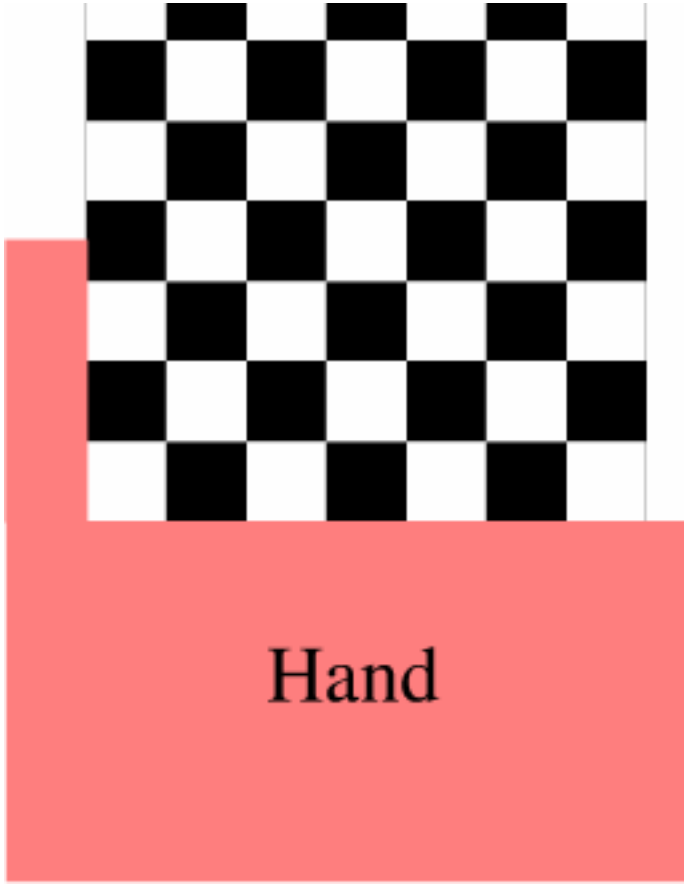
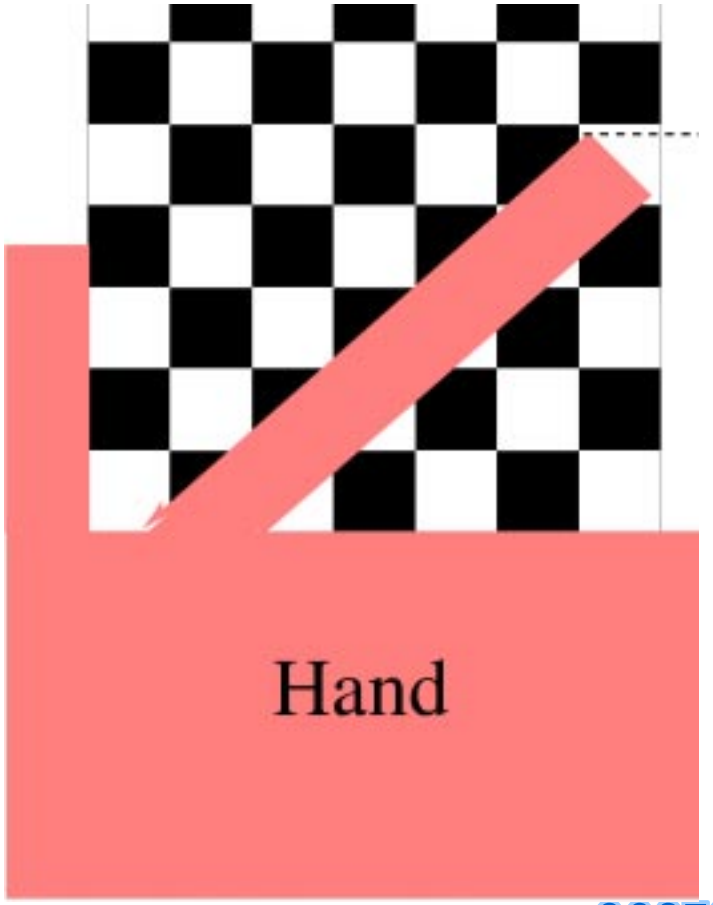
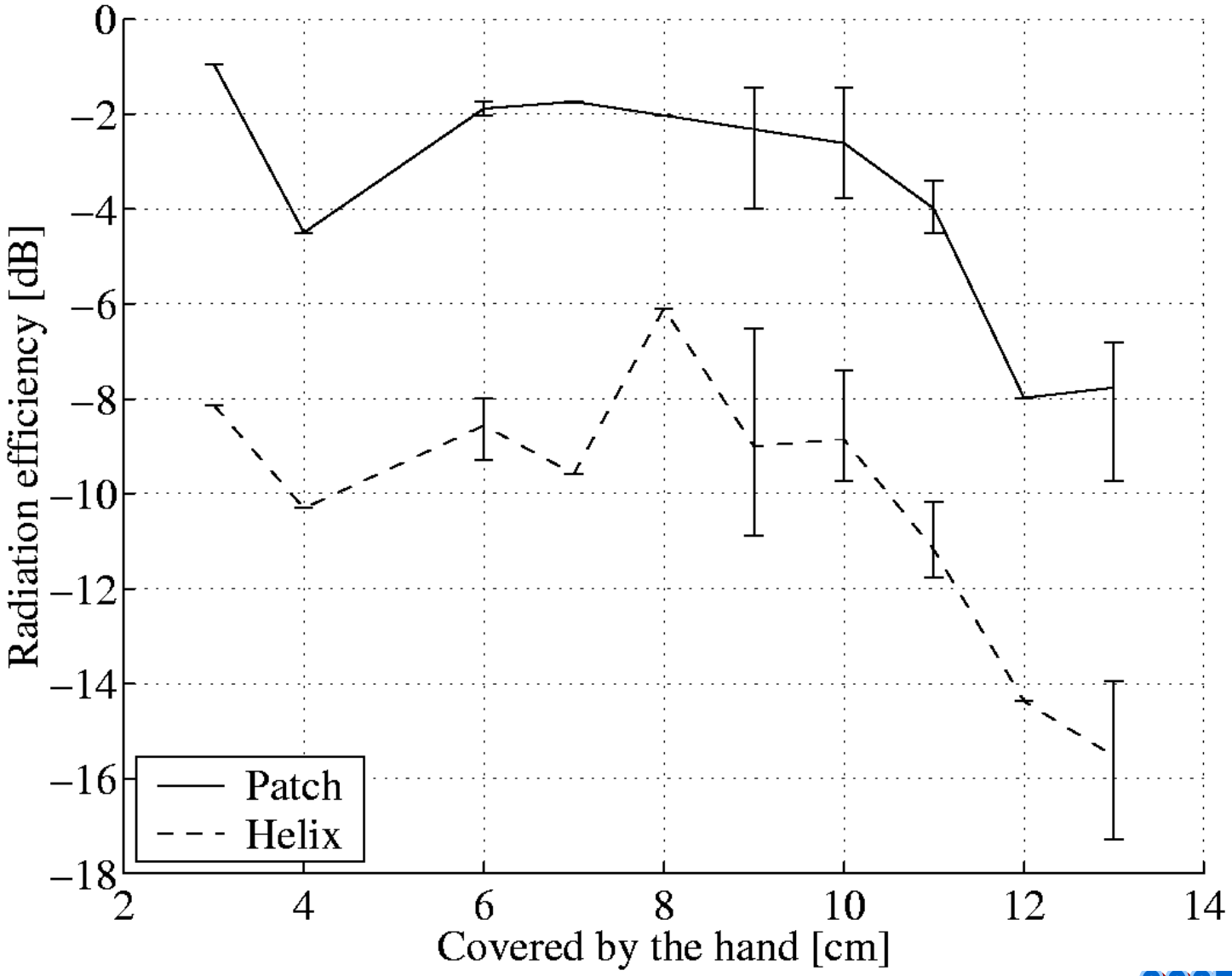
Influence of the hand on the efficiency





Efficiency vs. Position of hand



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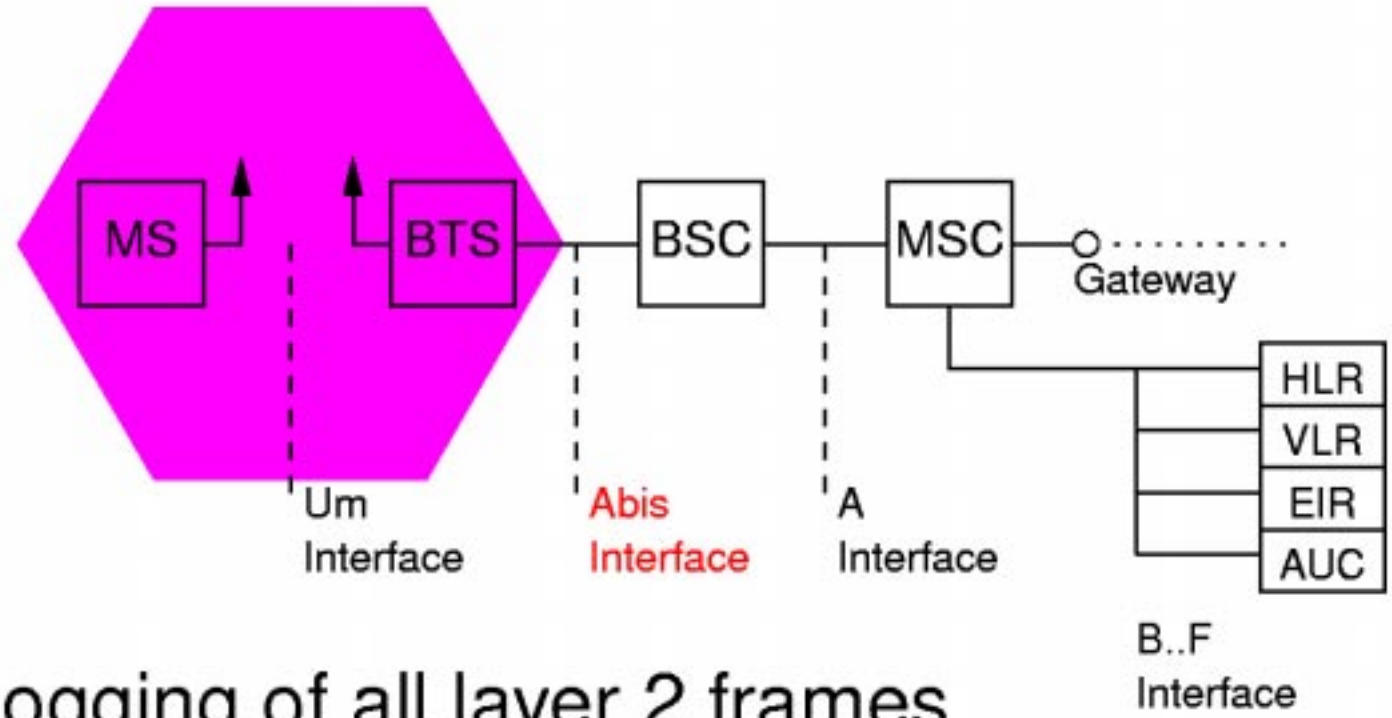
Real Phones in a Real Network vs. the Mockup Phone in the measurement setup

- Using the GSM network it self as measuring system for MEG.
- Using 4 ordinate mobile phones.
- Including 20 test users.
- Measure on two levels - Basement and Second Floor.
- Outdoor Basestation, small cell.

Abis Logging / Measurements

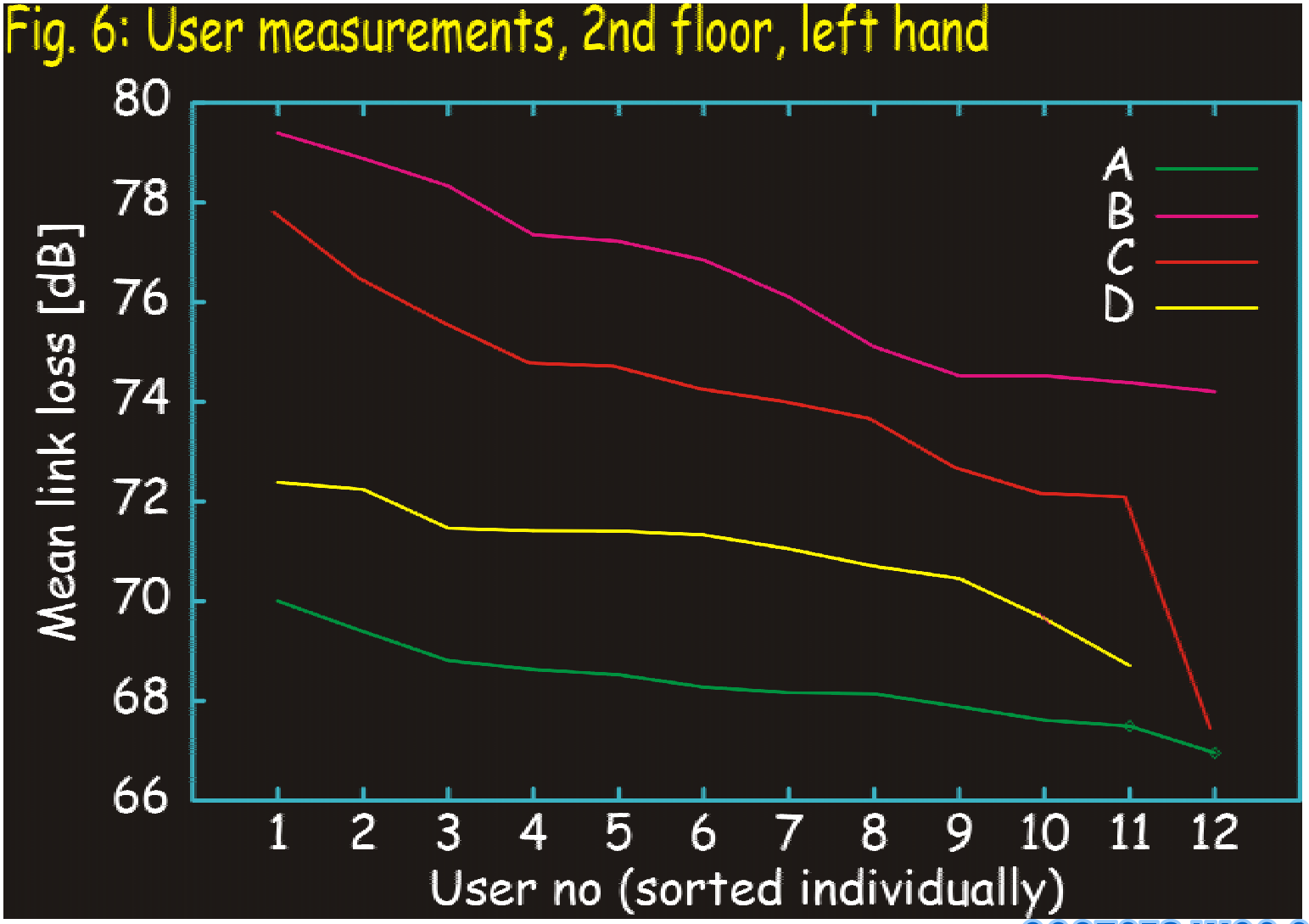


1. Logging of all layer 2 frames
2. Extraction of layer 3 frames → Call Traces
3. Post processing (RxLev, Tx power)

One user, during the In-net measurements.

Measured MEG (Received power)

Phone A to D



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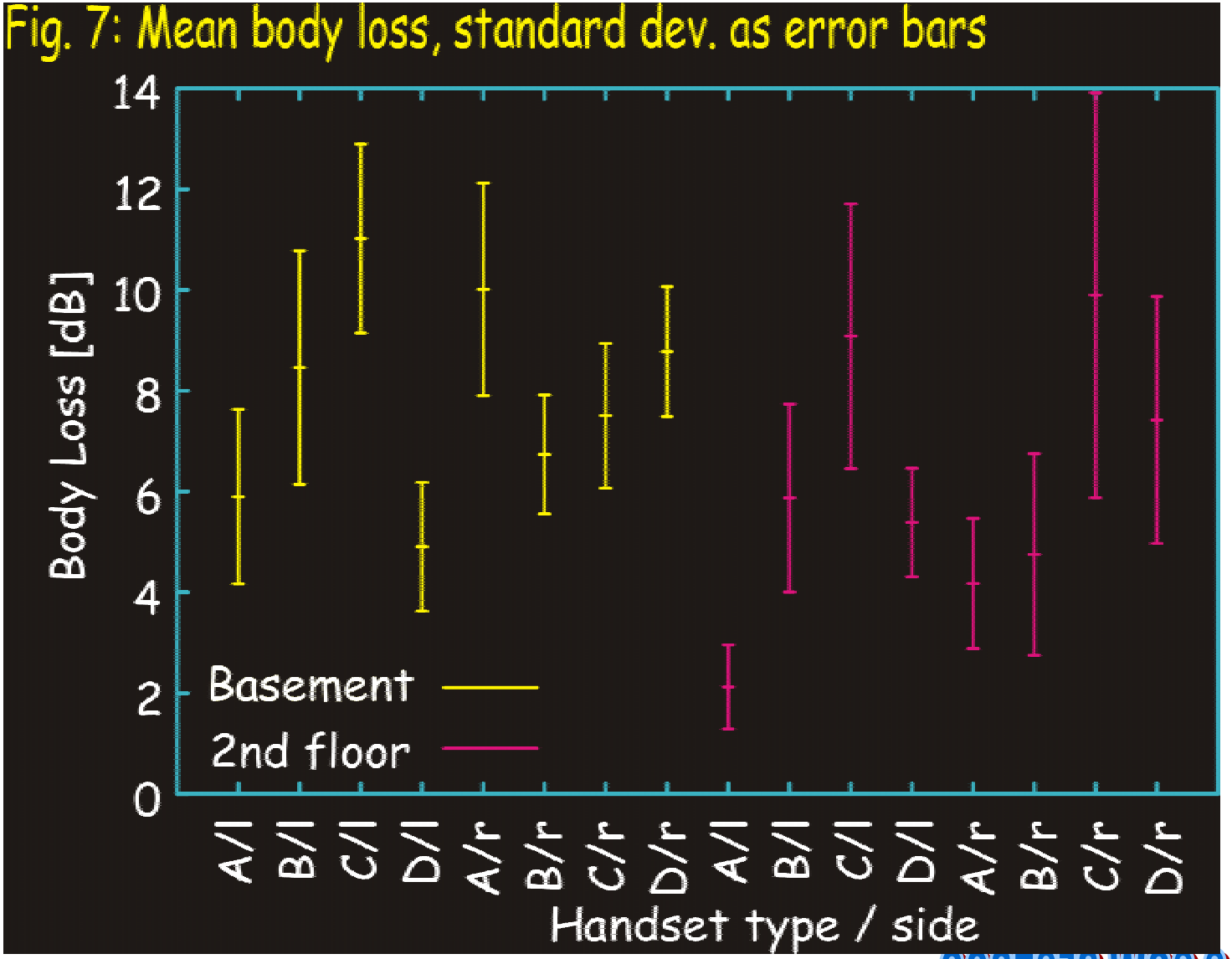
Bodyloss for Left/Right hand side

Bodyloss is defined as the difference between the power received without the user present and with the user present



Phantom vs. Real Users

- Advantages of using a phantom of the user.
  - Avoid involving many test users.
  - Repetitions are easier.
  - Shorter measuring time.
- Disadvantages.
  - Agreement between Phantom and real user?
  - To make a practical phantom that match results of real users.

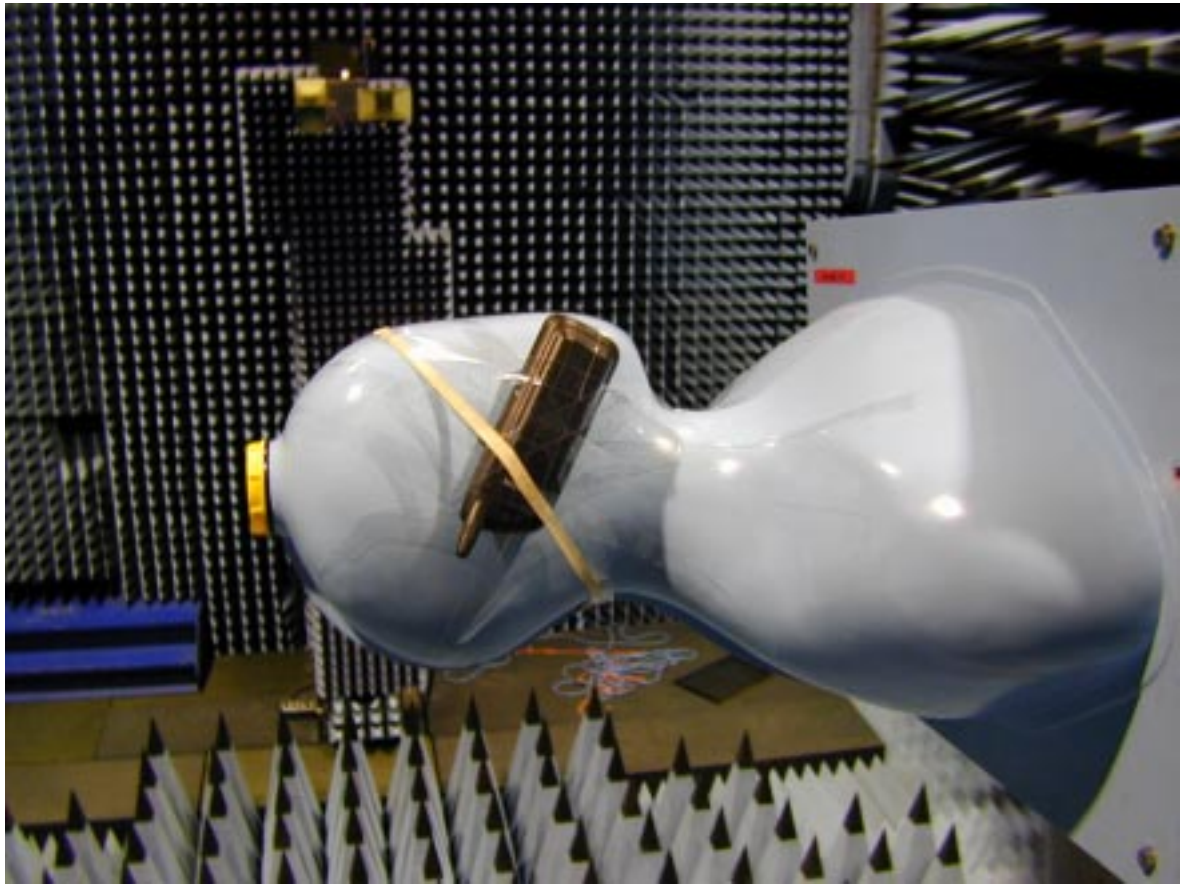
- Investigation: Influence of Liquid type in Phantom.

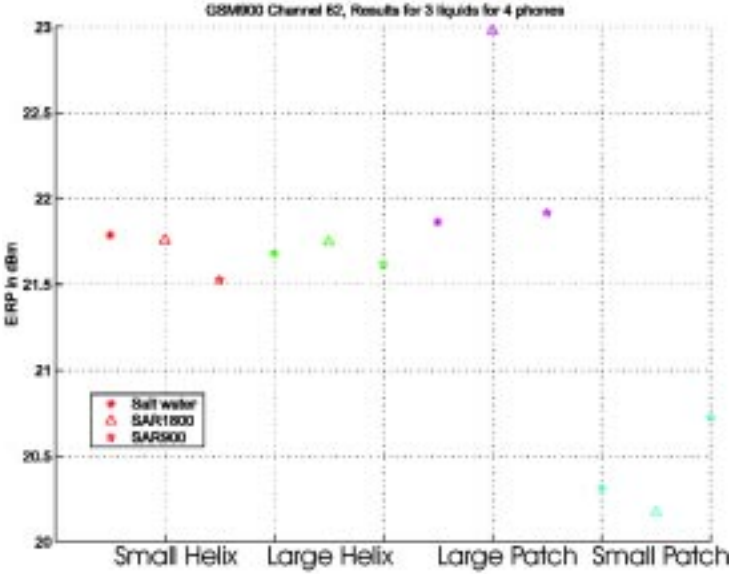
Head & Hand Phantom

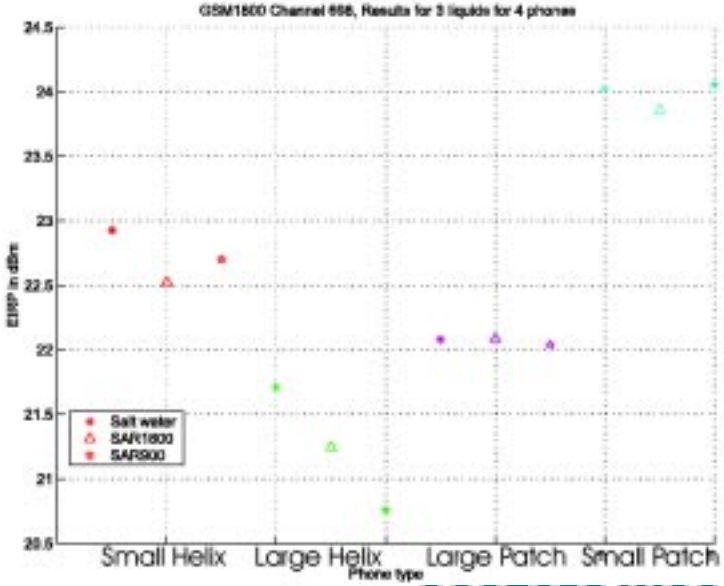
Positions:

- α: Hand low
- β: Hand high

Phantom Measurements – Liquid influence







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Conclusion on Liquid in Phantom

- In-Net measurements:
  - Most phones within 2 dB

- Anechoic Room measurements:
  - Difference below 1 dB (Aalborg Study)
  - Difference below 0.7 dB (Nokia Study)

UE On Body

- Measured body loss for body carried UEs.
- Measured body loss for full body phantom.

Test User Measurements

- 18 test users
- Two positions:

α

β

Full Body Phantom

Positions:

- α: Front, display outwards
- β: Side/low, display outwards
- γ: Front, display inwards

Results of Body carried UE

- Difference between handsets for real users:
  - α-position 1 dB
  - β-position 1.5 dB

- Difference between handsets for Phantom:
  - α-position 2-3 dB
  - β-position 3-6 dB

- Handset ranking based on full body phantom is NOT the same as handset ranking based on real users.
- Difference in Body loss between Basement and Second floor is 3dB!
- Variation in MEG much lower than for talk position.

Performance Measures

Based on spherical radiation patterns:

- Total Radiated Power (TRP) for Uplink (UL)
  - Channel not included
  - Simple computation
- Total Receiver Sensitivity (TRS) for Downlink (DL)
- Mean Effective Gain (MEG) for UL/DL:
  - Includes polarization and direction
  - Increased complexity

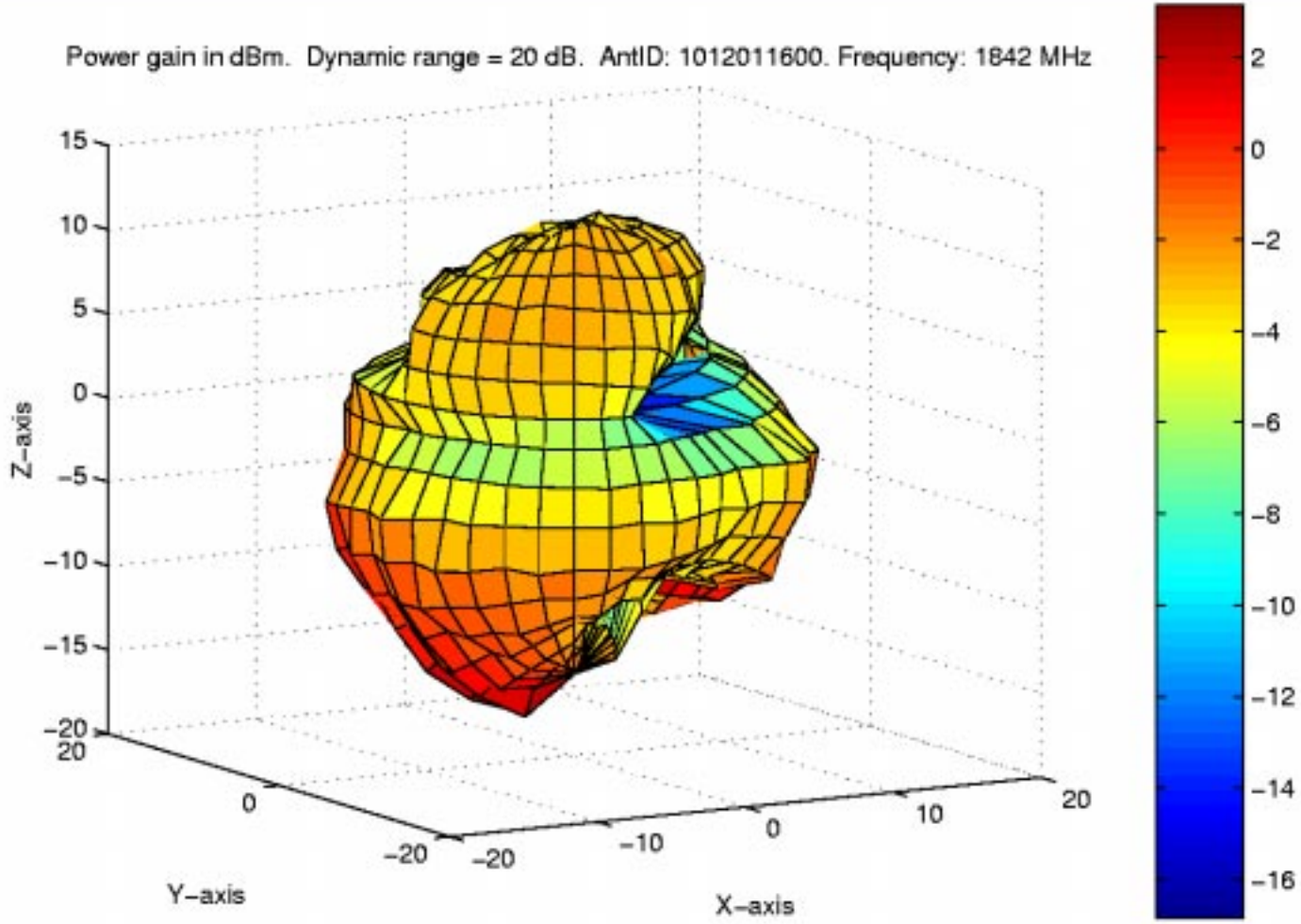
Current Work

- Investigate:
  - Compare TRP, TRS, and MEG
  - Influence of sampling density on MEG
- Conditions / Scenario:
  - Four different mobile handsets
  - Four propagation channels (models)
  - Sampling intervals: 10°, 20°, 30°, 60°

Spherical Radiation Pattern Meas.

- Four handsets
- Free space
- Phantom head/shoulder
- Measured with GSM base station simulator
- Frequency: GSM channel 698
- Both UL and DL

Ex. of Meas. Radiation Pattern



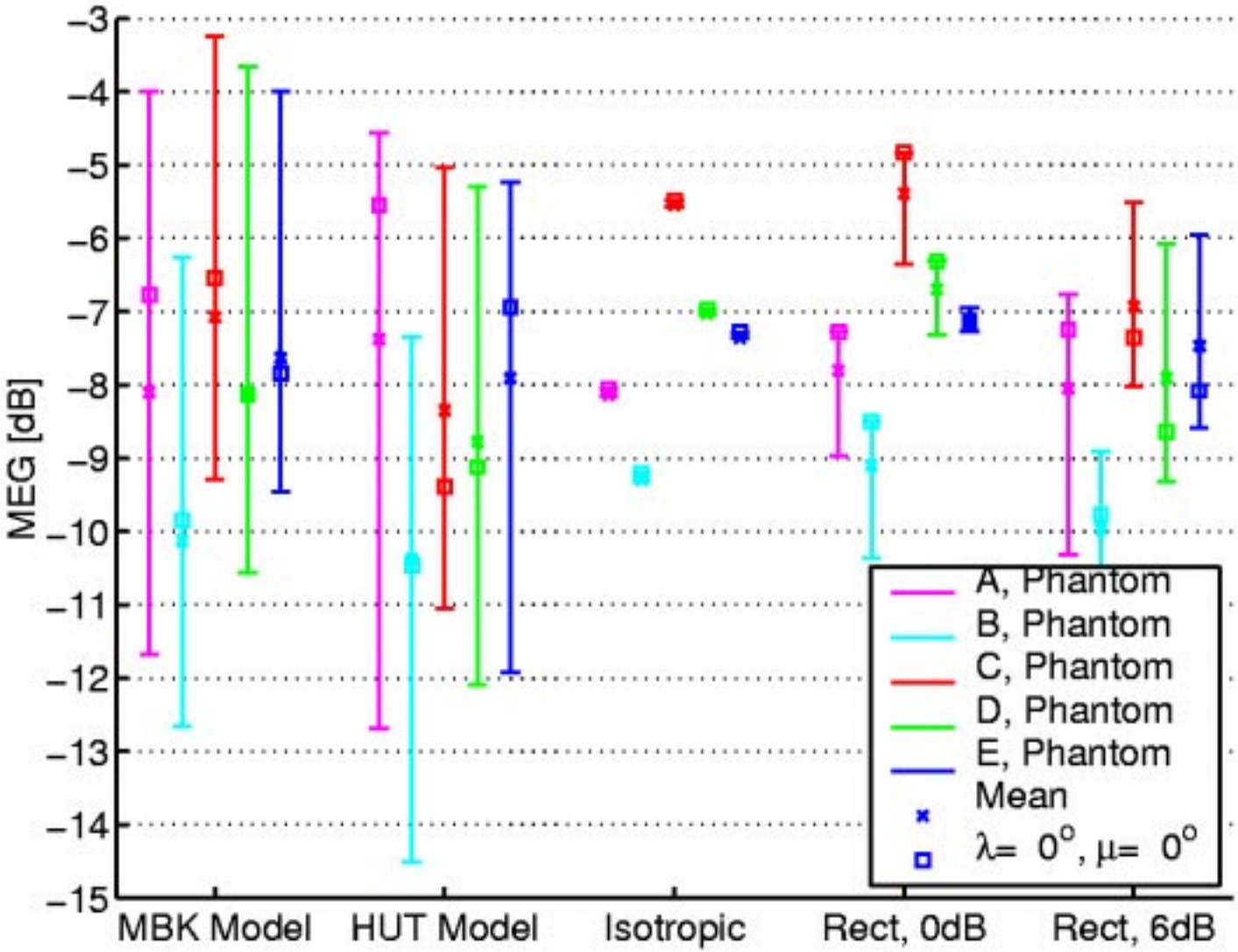
9/1, 2002, 16:57. File: . EIRS = –2.0 dBm

Handsets

Four different handsets:

- A: Large, external ant.
- B: Large, internal ant.
- C: Small, internal ant.
- D: Small, external ant.
- E: Same as D, with other ant. (1)
- F: Same as D, with other ant. (2)

Phantom Results, DL



Conclusion (1/2)

- A standard test for User Equipment is needed due to large variations among mobile phones for 2G.
  - Operators gain more high performing phones.
  - Manufactures gain one single transparent test.
- Several 2G test exist but they provide widely different results and due only cover 2G phones - not 3G, and not User Equipment.
- 3G is different concerning:
  - Different types of UE.
  - Test with also cover future terminals with several antennas.
  - Practical down link measurements
  - Phantom for various UE types.
- More solid technical knowledge is needed but it seems strait forward.
- COST273 WG2.2 is able and ready to provide the technical basis for a test of Communication Performance of 3G User Equipment.

Conclusion (2/2), Work Plan

- Total Radiated Power, TRP based on radiation pattern:
  - Uncertainties.
  - Groups of UE and accordingly typical test positions.
  - Phantom Head/hand.

- Total Receiver Sensitivity, TRS based on radiation pattern:
  - Uncertainties.
  - Practical Down Link Measurements.

- Mean Effective Gain (MEG).

- Test of Future UE with more Antennas (enhanced Down link).

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