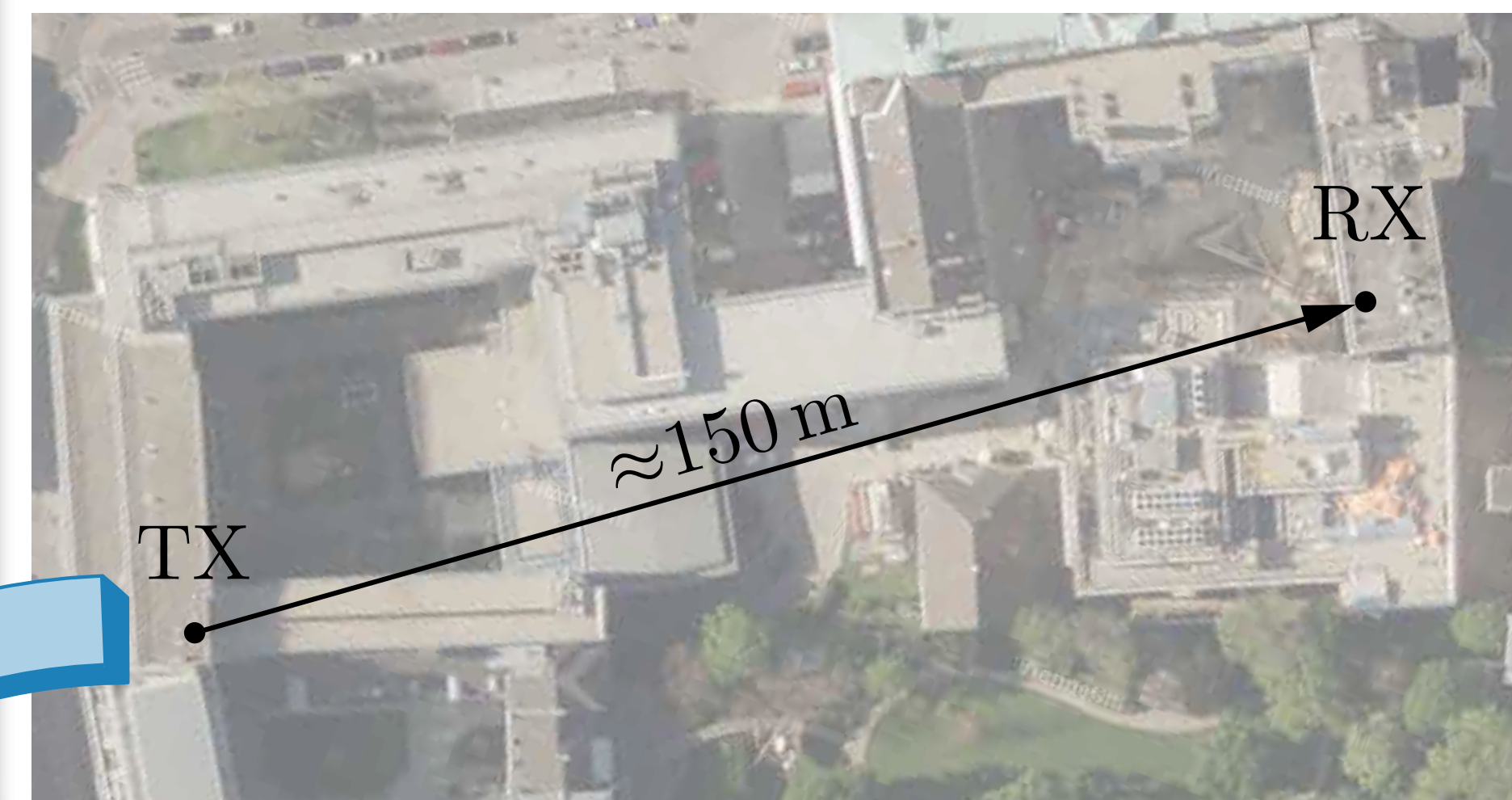


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Idea and Contribution

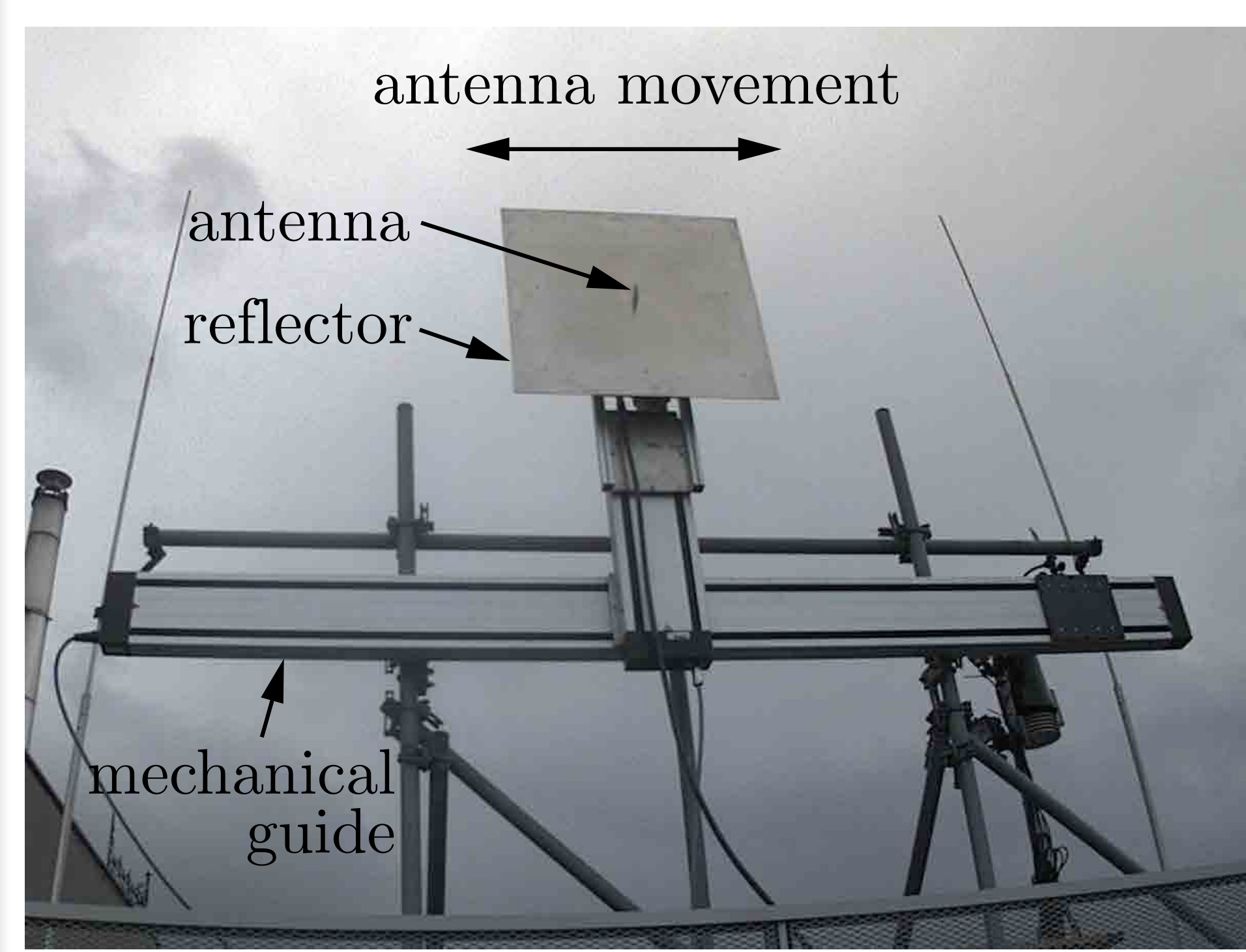
- massive MIMO channel measurements are often done with virtual arrays at 0.5λ spacing
- it is known that mutual coupling effects are zero at $d=0.5\lambda$ only for isotropic elements
- **quantify deviation** of MIMO channels measured with **virtual and full antenna arrays**
- minimize all effects that lead to a difference except for mutual coupling for a fair comparison

Measured Scenario



- outdoor to indoor scenario
- 4 channel transmitter
- indoor receive antenna re-positioned at 49 uncorrelated positions
- channel sounding via multi carrier signal at 2.5 GHz

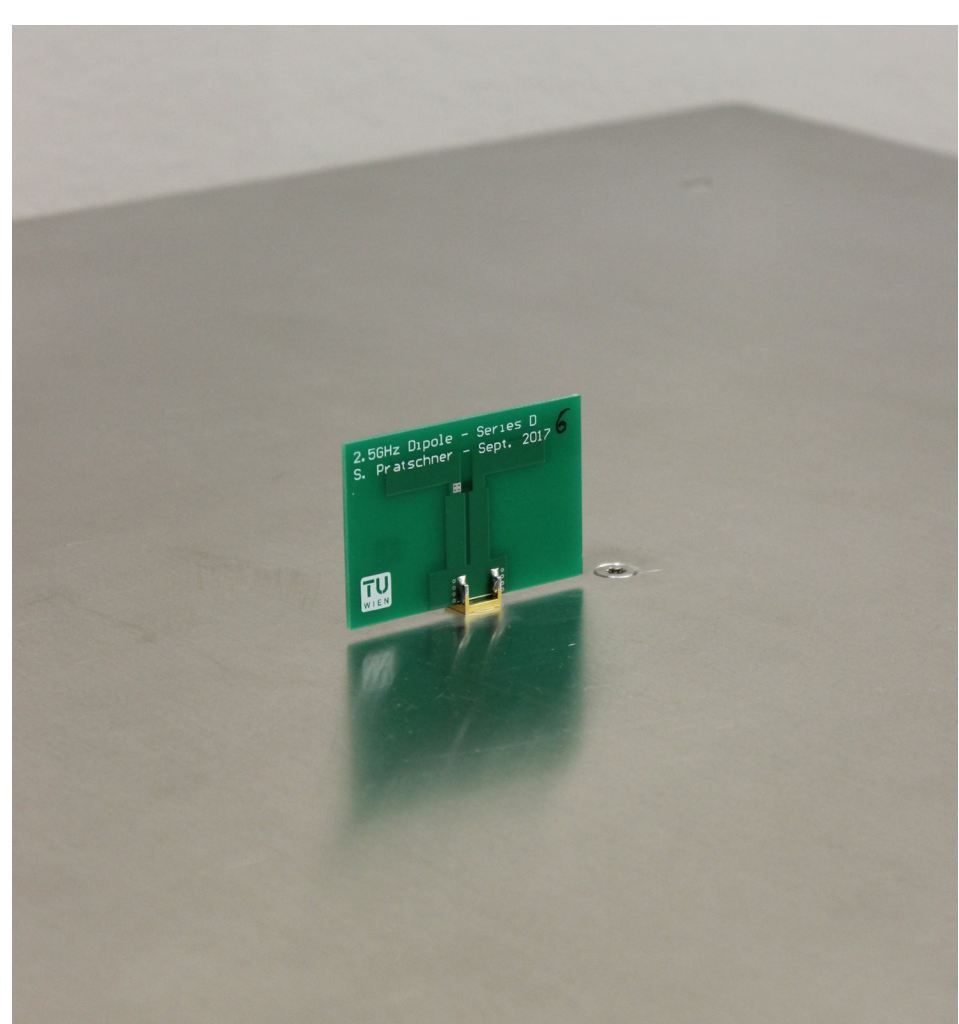
Hardware Setup



Method for Comparison

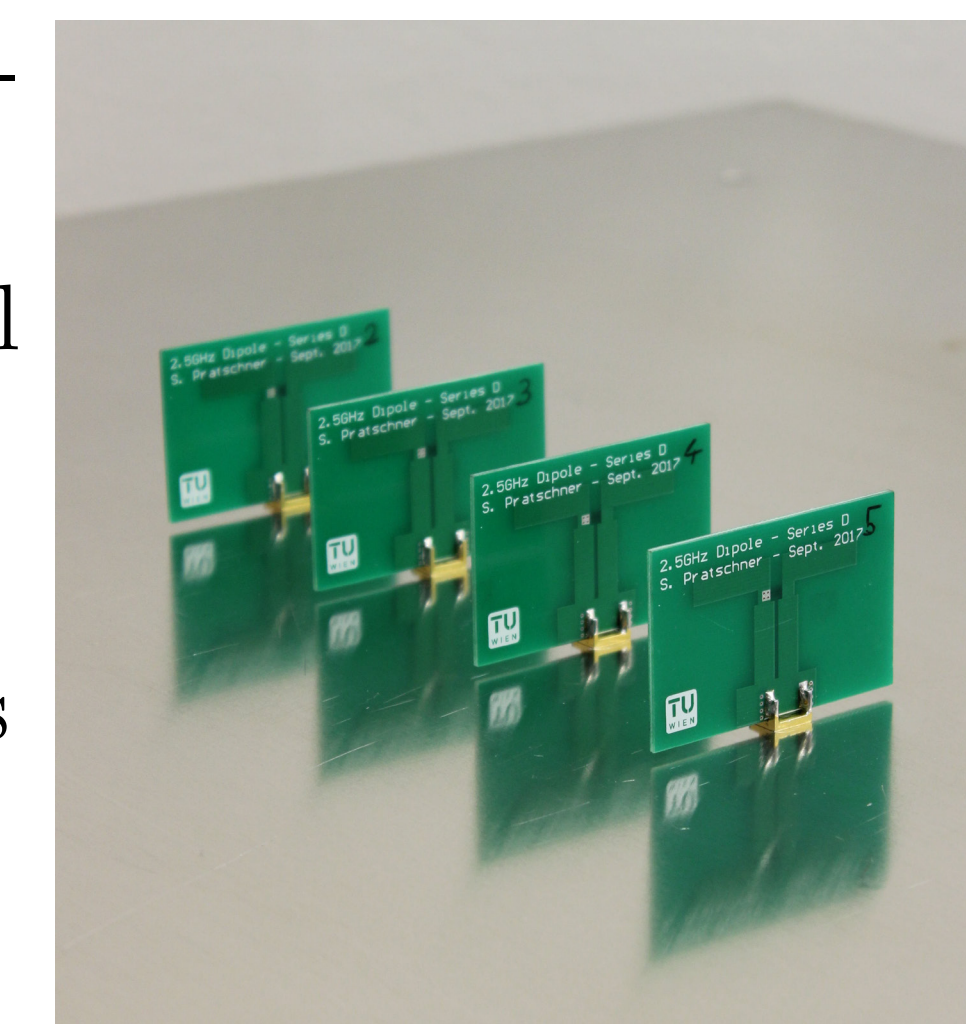
Source of deviation:	Countermeasure:
• influence of the reflector	→ large reflector
• time variance of the setup	→ perform measurement twice
• different TX channels	→ calibrate TX chains
• mutual coupling	→ main source of deviation

Virtual Array



- only a single antenna element present
- measure MIMO channel coefficients sequentially
- reduced complexity
- no mutual coupling

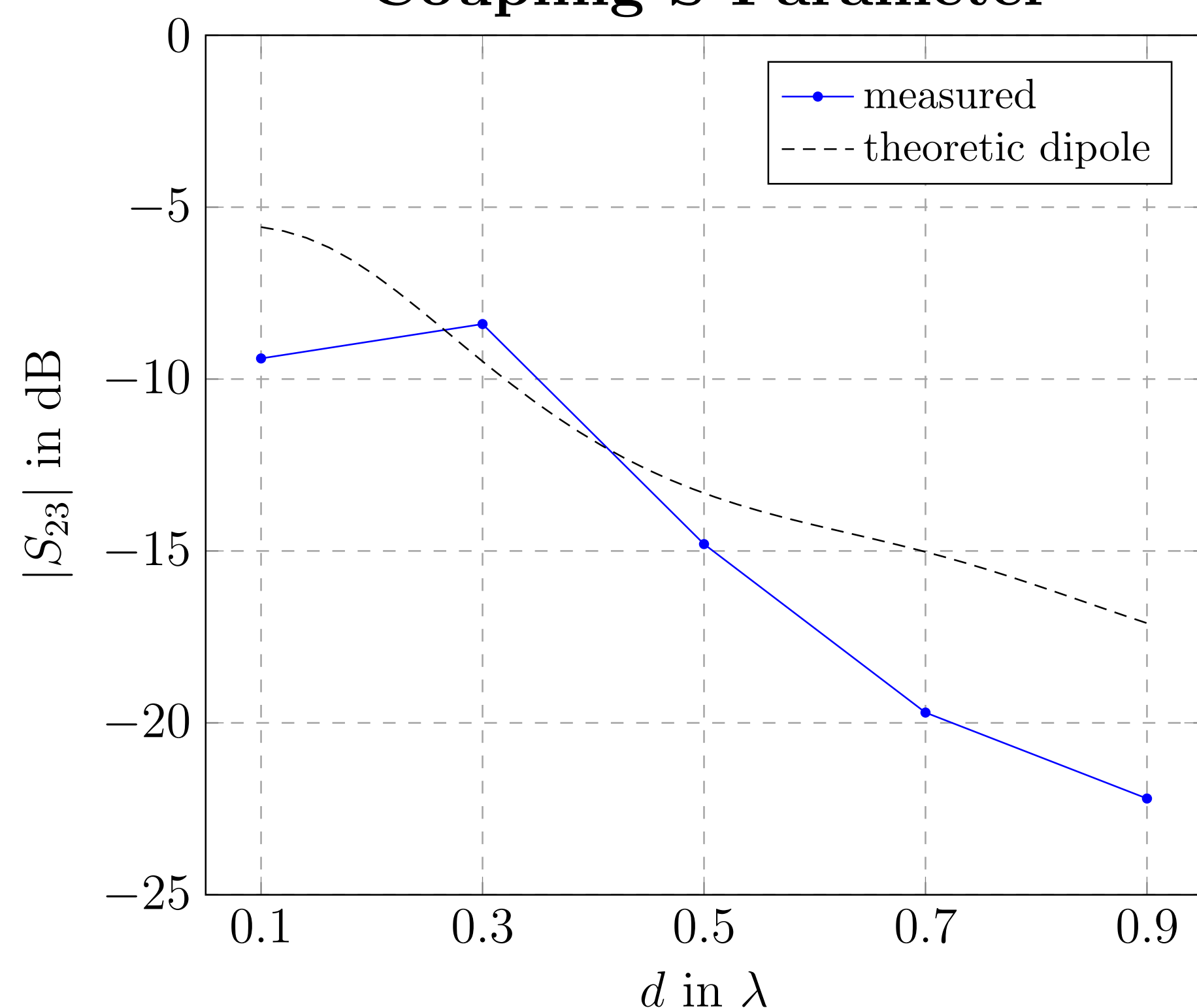
Full Array



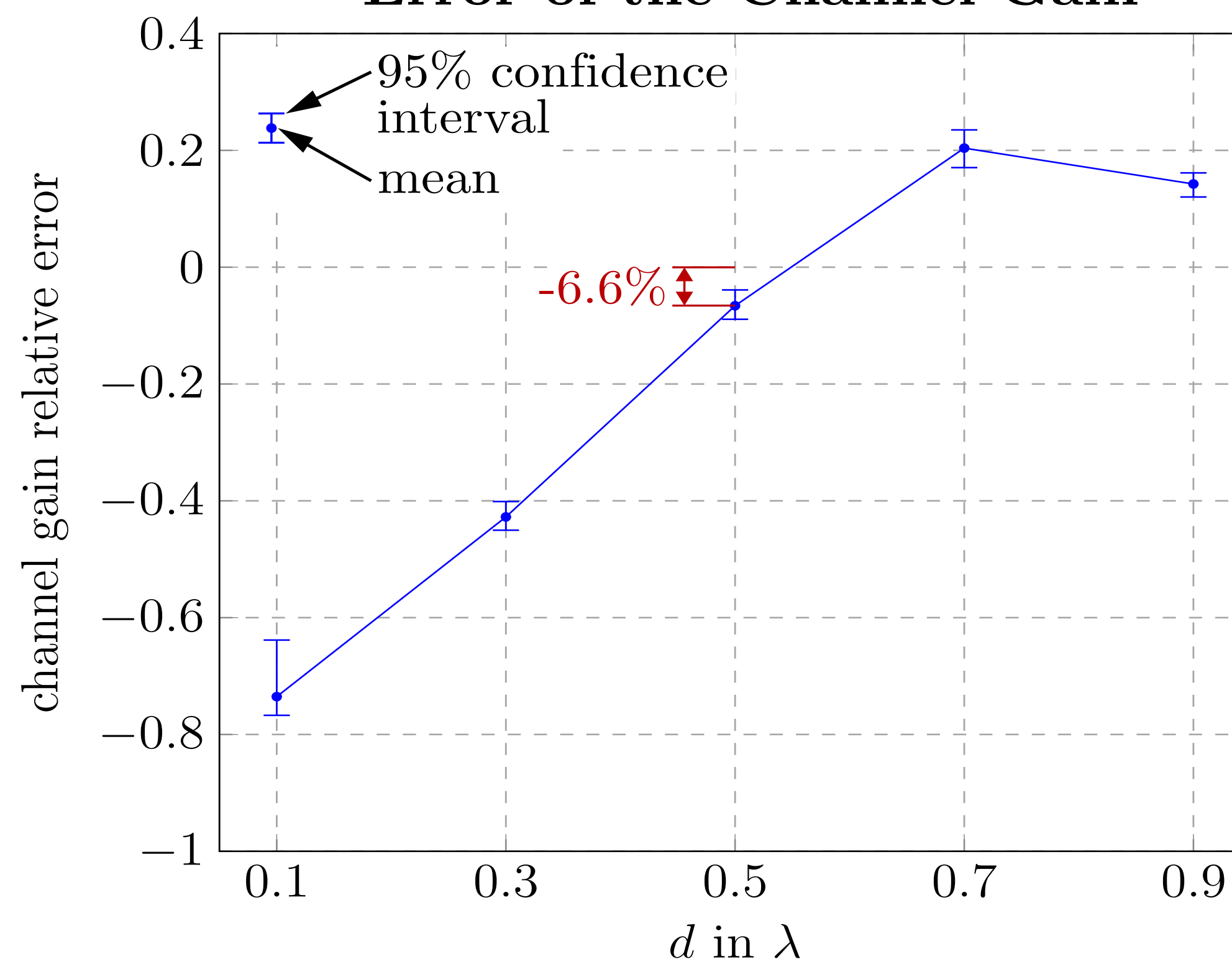
- all antenna elements physically present
- measure all MIMO channel coefficients at once
- very complex approach
- includes all physical effects

Measurement Results

Coupling S-Parameter



Error of the Channel Gain



- antenna element mutual coupling S_{23} relatively close to analytic solution
- relative error in channel gain indicates how much received power is lost compared to the uncoupled case
- large mutual coupling impact at small spacings
- deviation between virtual and full array even at $d=0.5\lambda$
- difference depends on the antenna element