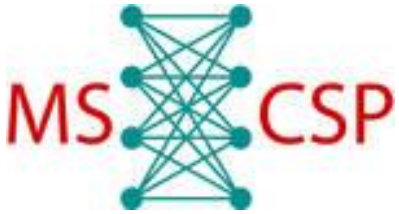
Personal Background

Diego Dupleich



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Home Country: Argentina

Some Important Facts about Argentina

- Capital and largest city: **Buenos Aires** (population 2,890,151)
- Area: 2,780,400 km2 (ranked 8th in the world)
- Population: **43,417,000** (2015)
- Language: **Spanish** (national), Guaraní, Qom, Mocoví and Wichi, between others.
- Human Development Index: 0.827 (very high, ranked 45th)
- Religion: **74% Catholicism**, 15% Non-religious, 8% Protestant, 2% Other, 1% Islam, etc
- Independence from Spain 1816 and first constitution 1853

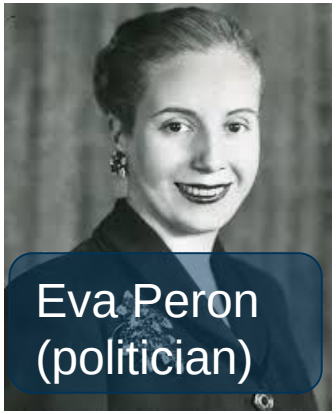
Places you might Know from Argentina

People you might Know from Argentina


Lionel Messi
(football player)


Francisco
(Pope)


Diego Maradona
(football player)


Eva Peron
(politician)


Daniel
Borenboim
(musician)

Some German Connections [1/2]

Last Worldcup Final*: Argentina 3 – Germany 2

[*] in which Argentina played against the Federal Republic of Germany in American territory

Some German Connections [2/2]

Last Match*:
Germany 2 - Argentina 4

[*] international friendly game

Match Report

International Friendly

Wednesday, 3 September 2014,

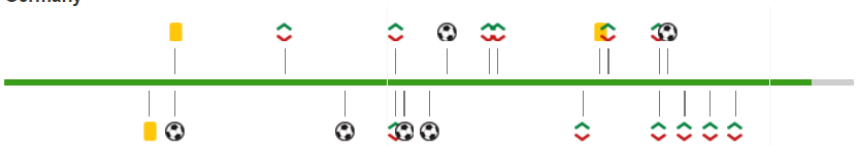
Twitter | Facebook | Email

Germany			Argentina
2	-	4	
	FULL TIME		

Referee: -	Stadium: ESPRIT arena	Attendance: 51,132

André Schürrle '52	20' Sergio Agüero
Mario Götze '78	40' Erik Lamela
	47' Federico Fernández
	50' Ángel Di María

Germany



Argentina

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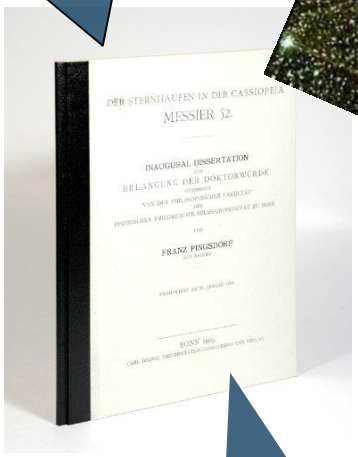
Why Germany?

Franz Lothar Pingsdorf (astronomist)

Observatory “Lo Espejo”, Chile 1911

„Der Sternhaufen in der Cassiopeia Messier 52. Inaugural-Dissertation“

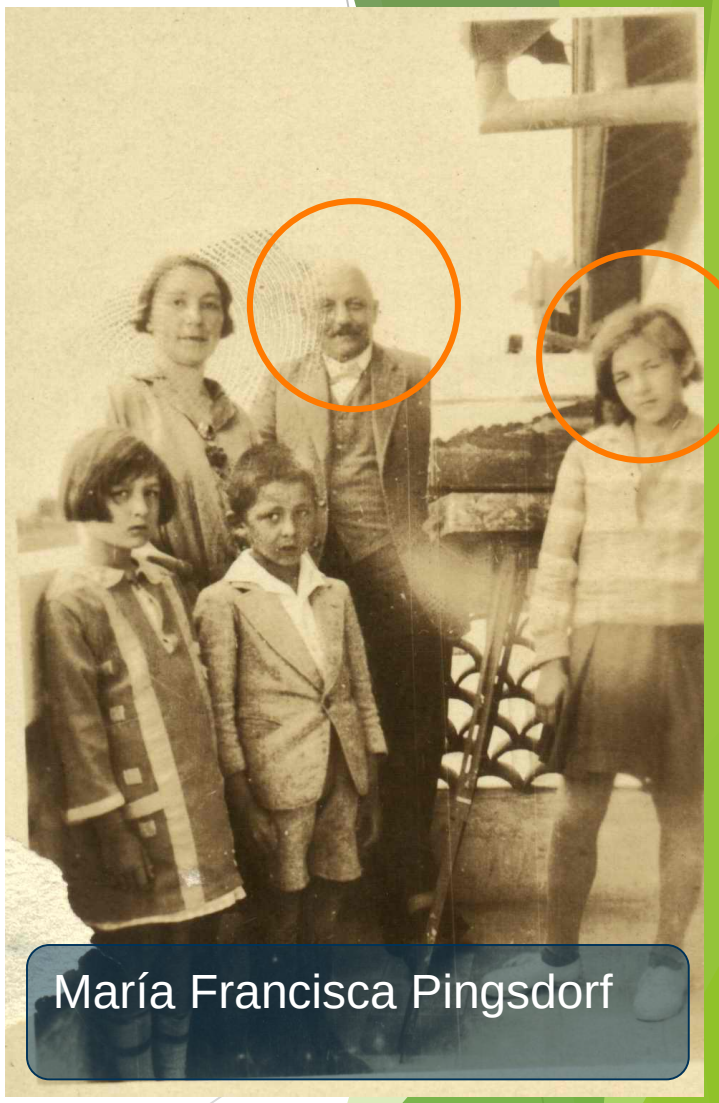


45 € in amazon.de

Cumulus Messier 52

Why Germany?

- 1916: born in Bohn (Germany)
- 1919: moved to Argentina



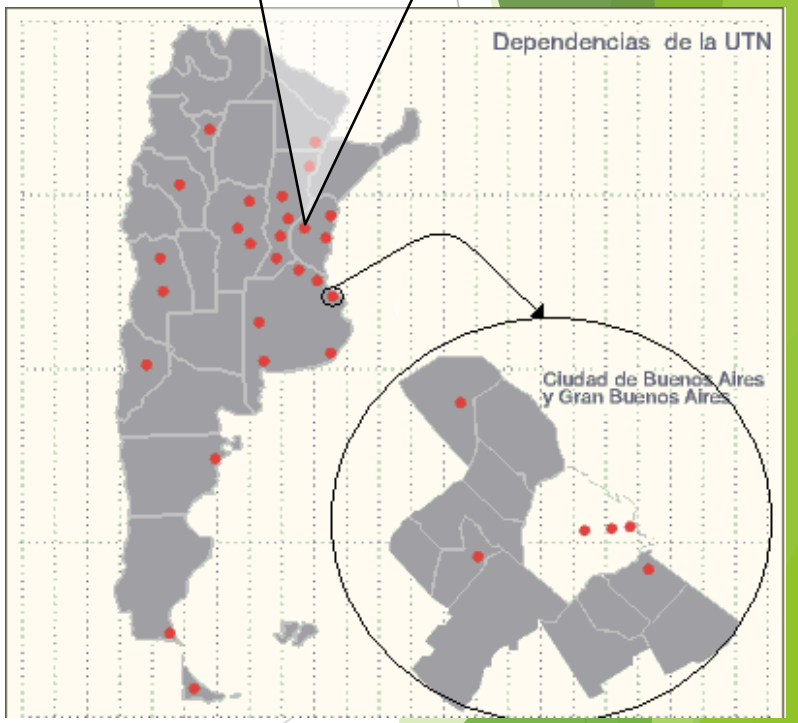

Francisca Pingsdorf (100 years, made in Germany: gute Qualität)

2002 – 2008: Background Studies

Engineering in Electronics at the

Universidad Tecnológica Nacional, Facultad Regional Paraná

- 11 semesters + Thesis
- Currently 70 000 students in Engineering (50% of all the engineering students in Argentina)
- DAAD exchange program with Germany: every year they send 60 students to Germany for a semester (Winter Semester ☹)



2007: A semester in Germany at the TU Ilmenau

- Winter Semester 2007
- First contact with Germany, and the TUI
- Wonderful interpersonal experience and exchange of culture

2009 – 2010: Emerging Markets Communications

- Mobile communications service provider
- Satellite Operator
- Teleports around the world (Hawai, England, Germany, etc.)
- Customers:
  - UN (UNICEF, WFP, UNHCR, etc.)
  - World Bank
  - CIA, Blackwater, etc…

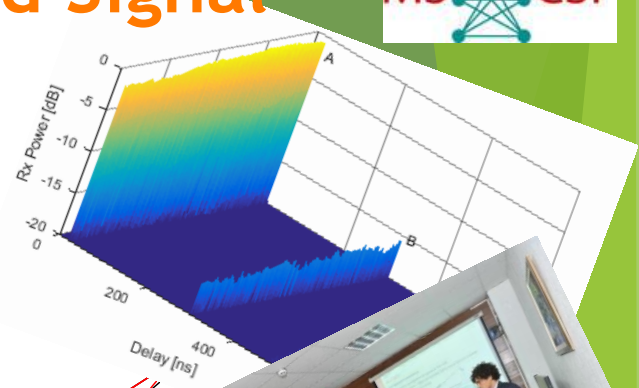
- **From 2009 to 2010 as RF Specialist and Field Engineer**
- First contact with adaptive filters: **NRS (noise reduction system, echo canceller)** United States Patent 7522877)

Contents

2010 – 2013: Communications and Signal Processing

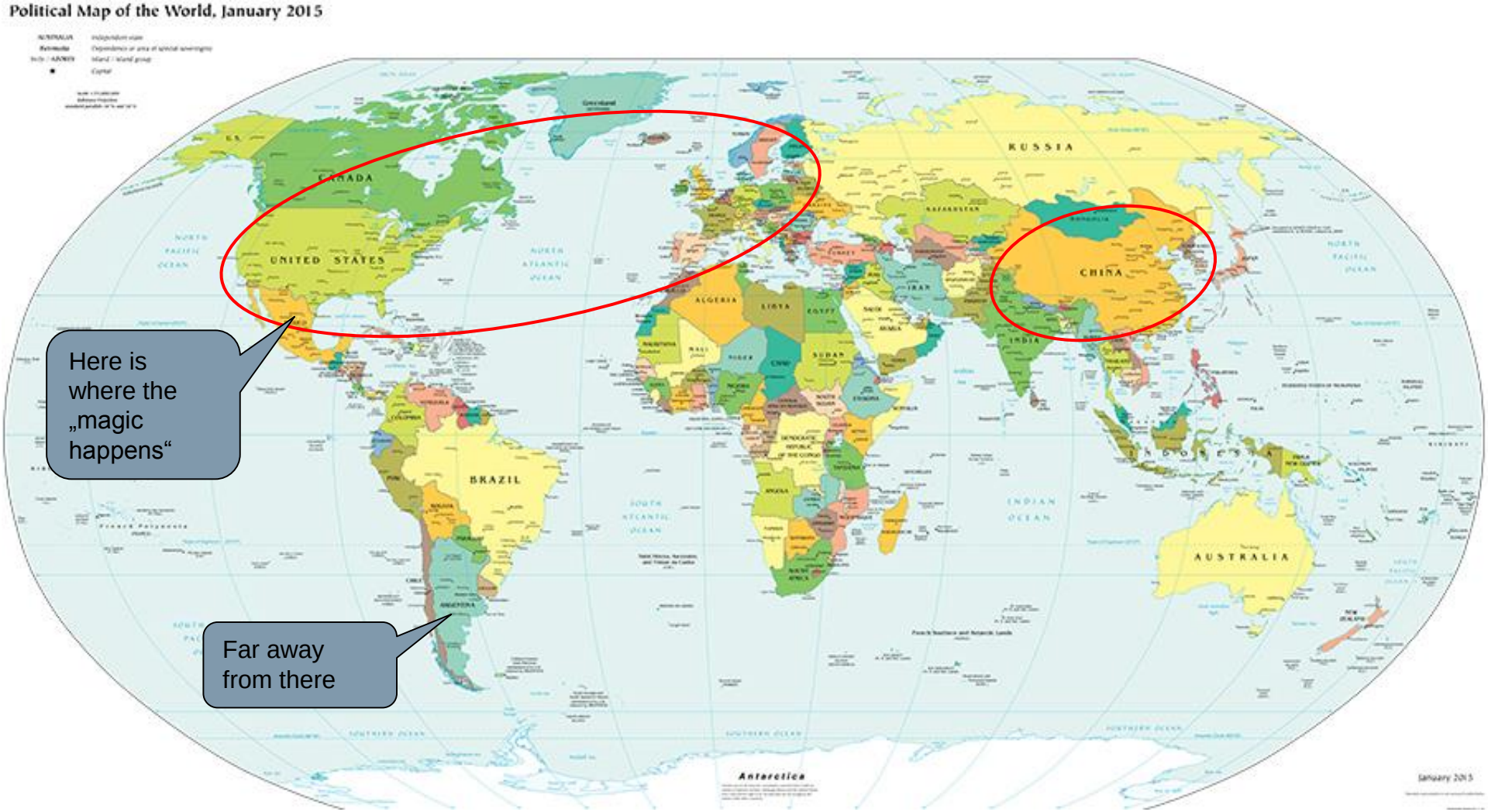
Academical life

- Program highly focused on signal processing
- Direct contact with Professors
- Hi-tech Labs with hands-on possibilities
- Thesis: “Mitigation of non-linearly induced interference in wideband receivers under fading conditions”



Personal life during these years…

- Student life in the campus: “Studentenclubs”, ISWI, Berg-fest, etc.
- Intercultural experience: students from all around the world
- Sports, environment close to nature, healthy life


Political Map of the World, January 2015
CANADA
UNITED STATES
RUSSIA
CHINA
INDIA
BRAZIL
AUSTRALIA
Antarctica
Here is where the „magic happens“
Far away from there

Contents

2013 – Present: PhD at the Technische Universität Ilmenau

- Department: Electronic Measurement Research Lab → Future: EMS
- Professor: **Prof. Dr.-Ing. habil. Reiner Thomä**
- Topic: mm-wave communications
- Estimated finishing time: somewhere and somehow in 2018

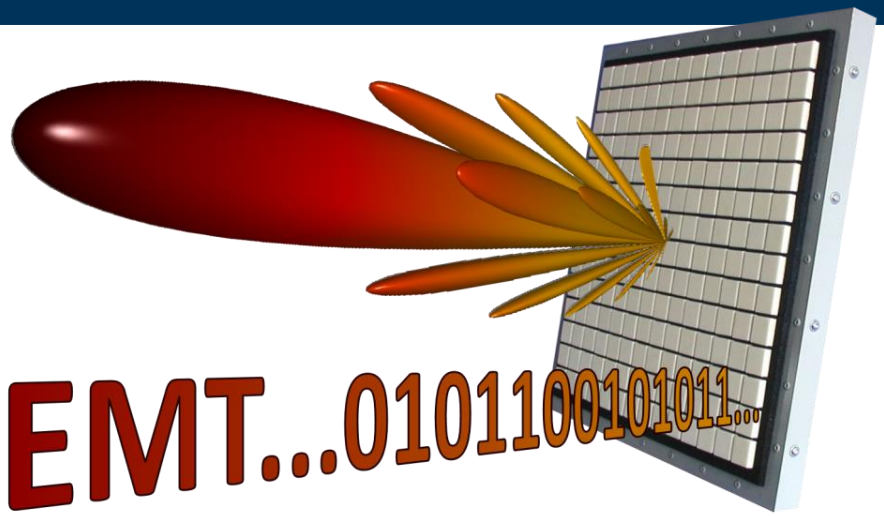
- Good opportunity to join the leading international community of researchers in world wide known conferences as EUCAP, PIMRC, VTC; research communities as COST actions, IRACON; and standardization bodies as ITU, IEEE NG60, etc…

Playing in the Main Leagues

mm-Wave Communications: Channel Measurements at mm-Waves

Diego Dupleich

HUAWEI



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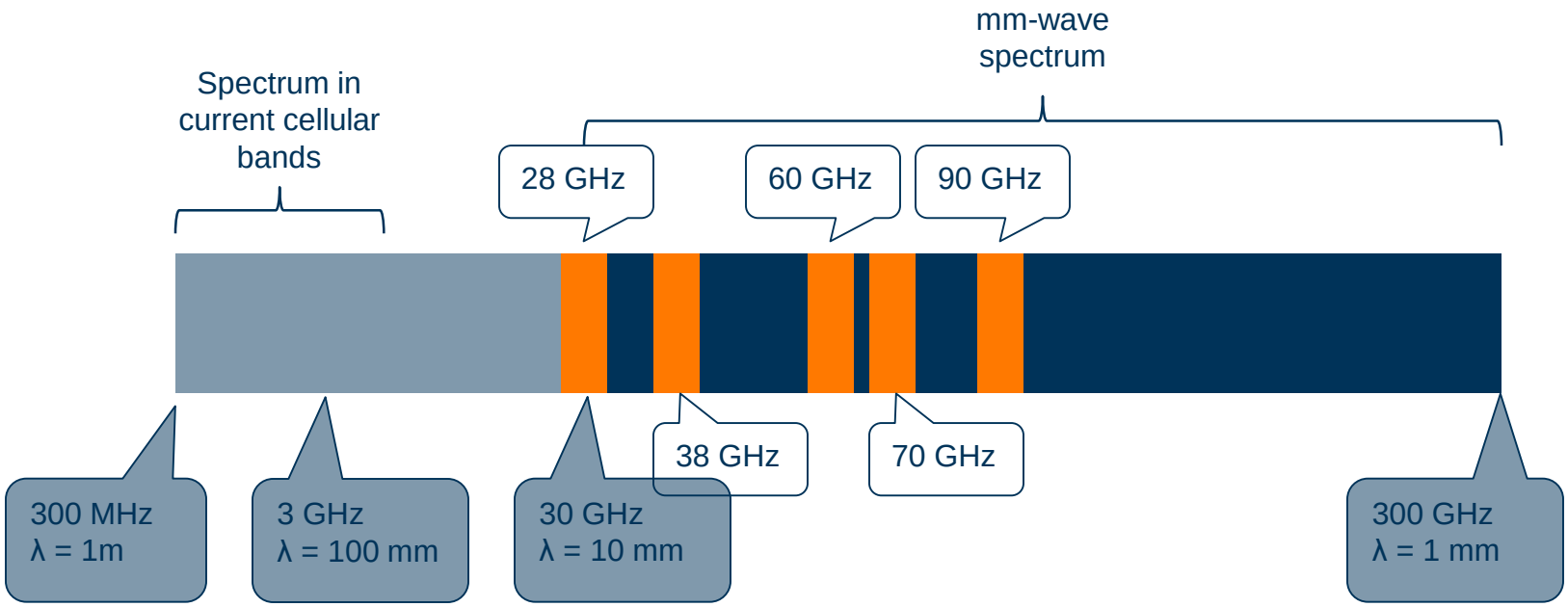
Why mm-Waves?

- Shortage of spectrum at sub-6 GHz bands
- 1000 times of wireless traffic growth in the period 2010 to beyond 2020



Propagation vs System Aspects at mm-Waves

Propagation aspects

- High path-loss with isotropic antennas→ Large arrays/high directive antennas
- High penetration loss → Enhanced reflections, intra-room communications, severe human shadowing effects
- Smaller objects become scatterers due to relative size to wavelength → More interactions in the environment

System aspects

- High directivity (antennas/beam-forming) → Reduced delay spread, more deterministic taps due to the lower superimposition of waves impinging from different directions
- Large bandwidth → Resolution of paths in the delay domain

The equivalent channel becomes more sparse and deterministic

Channel Modelling and System Design

Channel modelling

- Extension of current SCM models considering deterministic components
  - Map-based METIS model
  - MIWEBA: quasi-deterministic modelling approach

System design

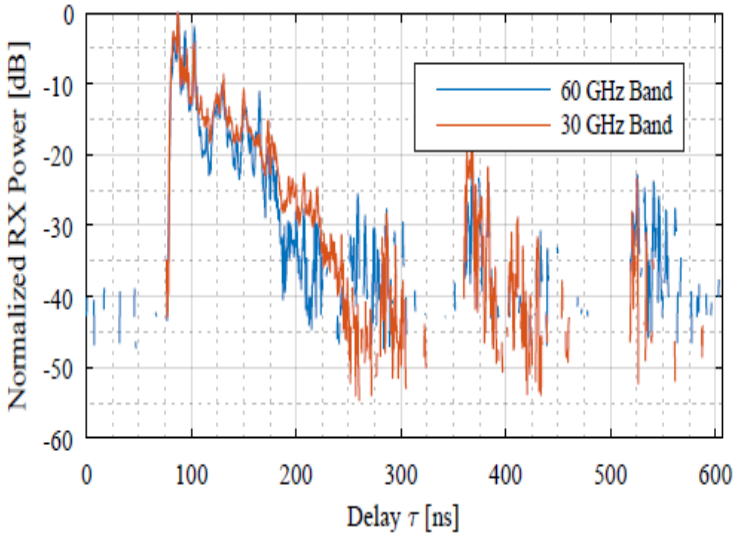
- Communication systems have to match very well the propagation characteristics of the few available paths:

Contents

Channel Measurements

Dual-polarized Multi-channel Channel Sounder developed at the TU Ilmenau

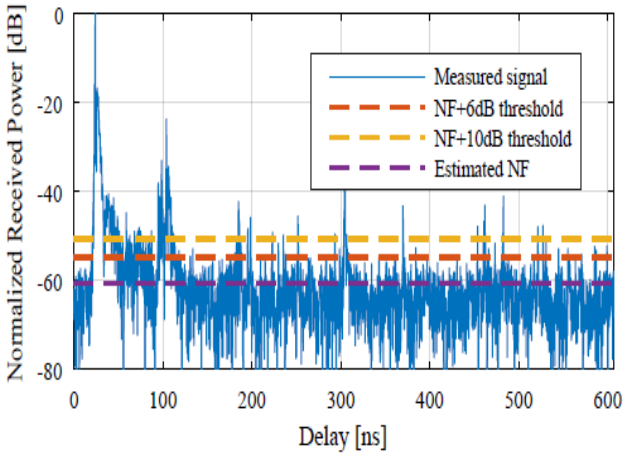
- UWB: 5.1 GHz null-to-null BW after calibration
- 70 dB dynamic range
- Multi-band channel measurements

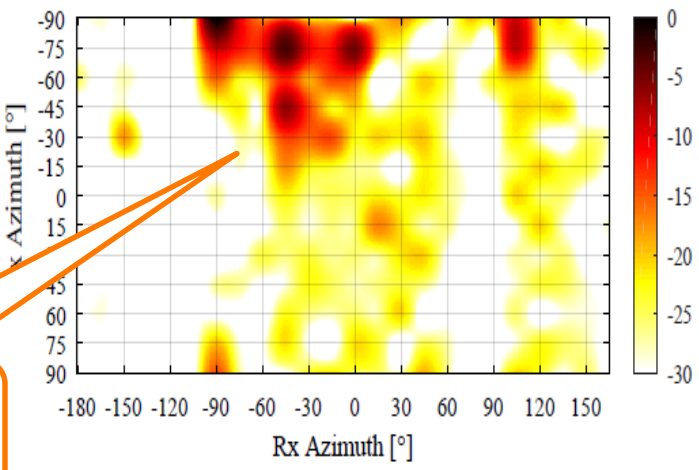


Channel Measurements

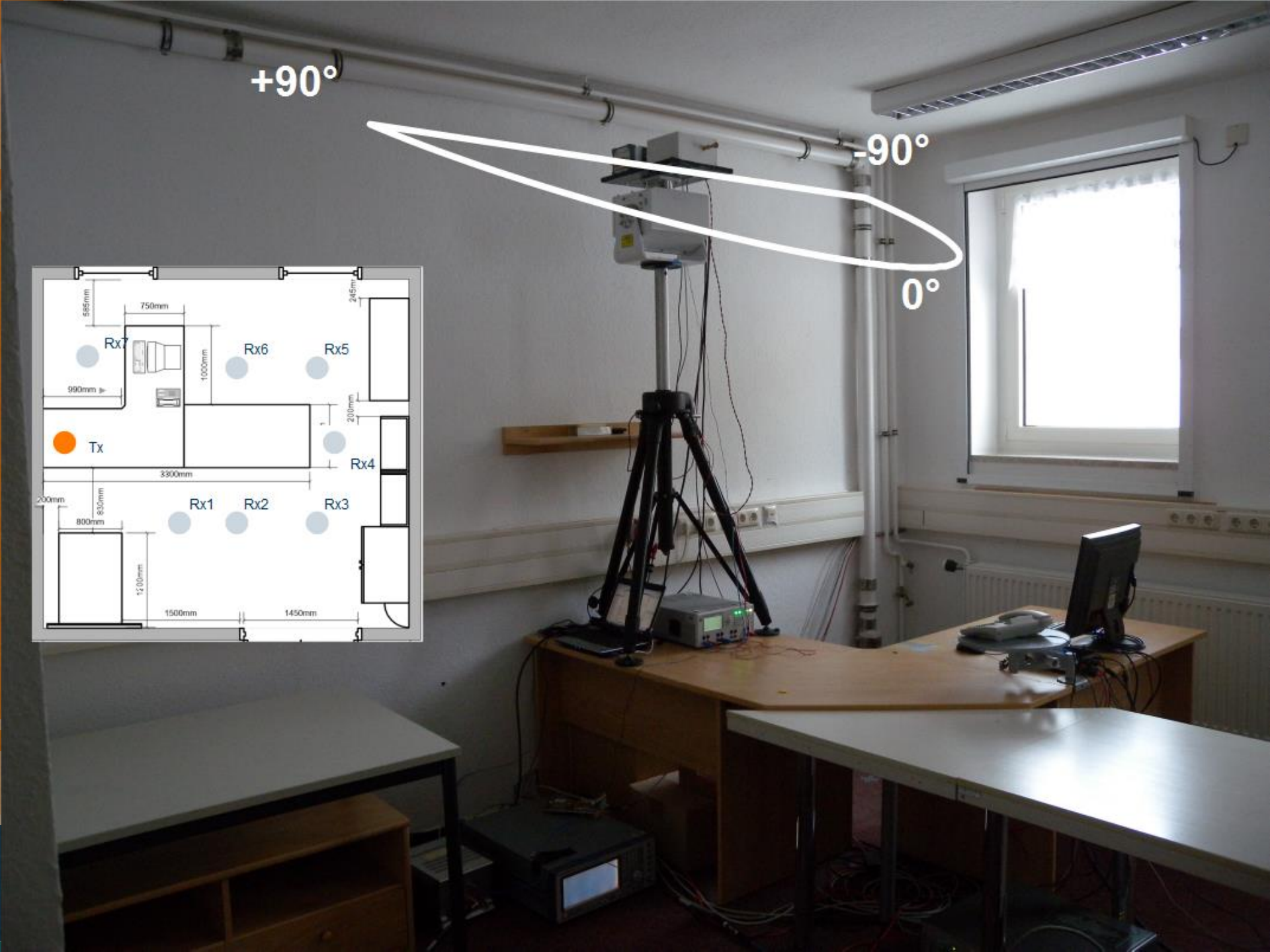
Limitations on the current channel measurements

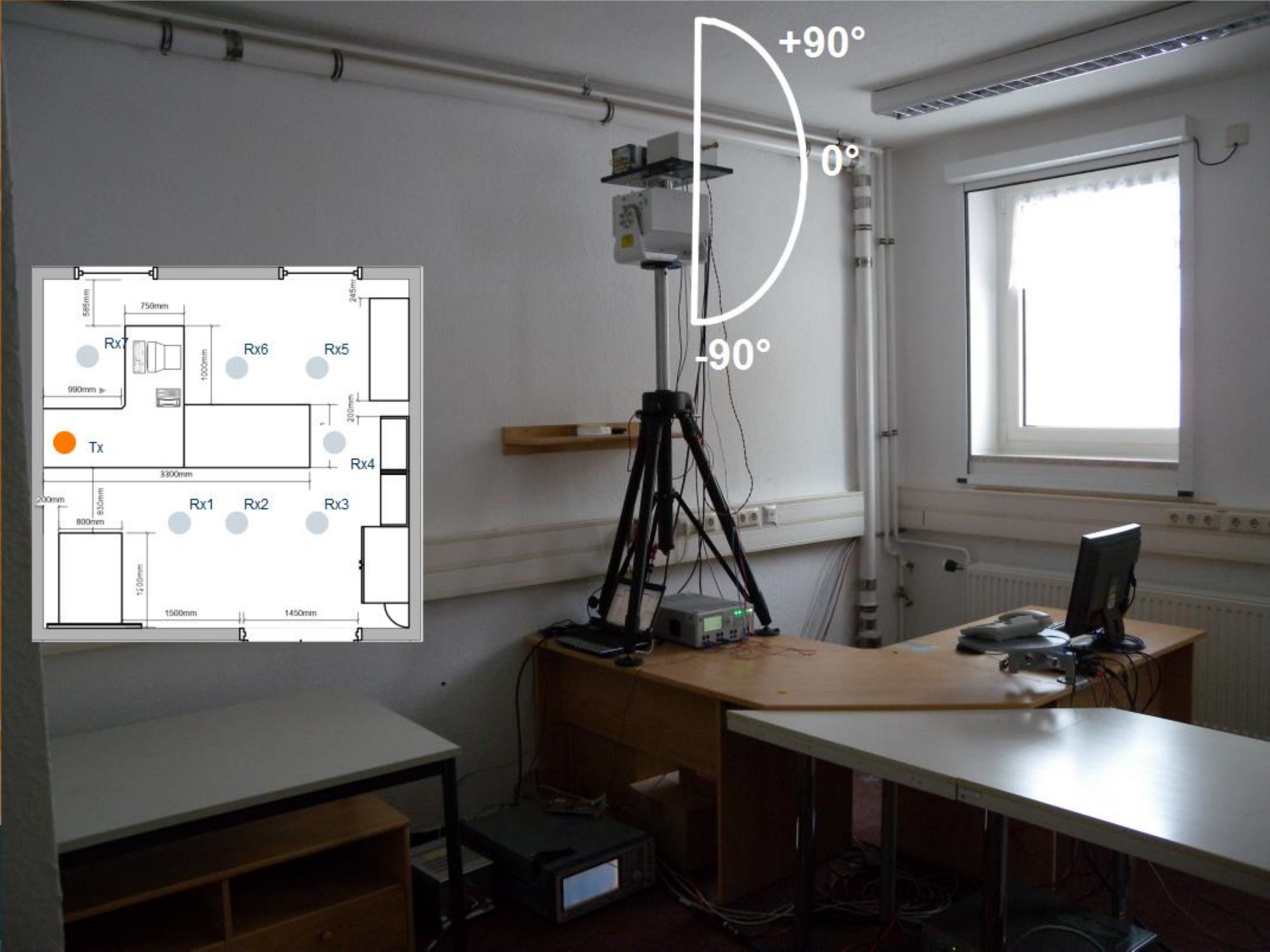
- Lack of antenna arrays and HRPE →
  - Only measurements using directive antennas: power angular profiles (big trade off between measurement time and resolution)
  - No path level information:
    - Clustering becomes challenging
    - Number of path per cluster?
    - Angular distribution of the paths?
    - …etc, etc, etc…





Eye inspection for cluster identification


+90°
-90°
0°
565mm
750mm
245mm
Rx7
Rx6
Rx5
1000mm
990mm
200mm
Tx
Rx4
3800mm
200mm
830mm
800mm
Rx1
Rx2
Rx3
1500mm
1500mm
1450mm


+90°
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Rx7
Rx6
Rx5
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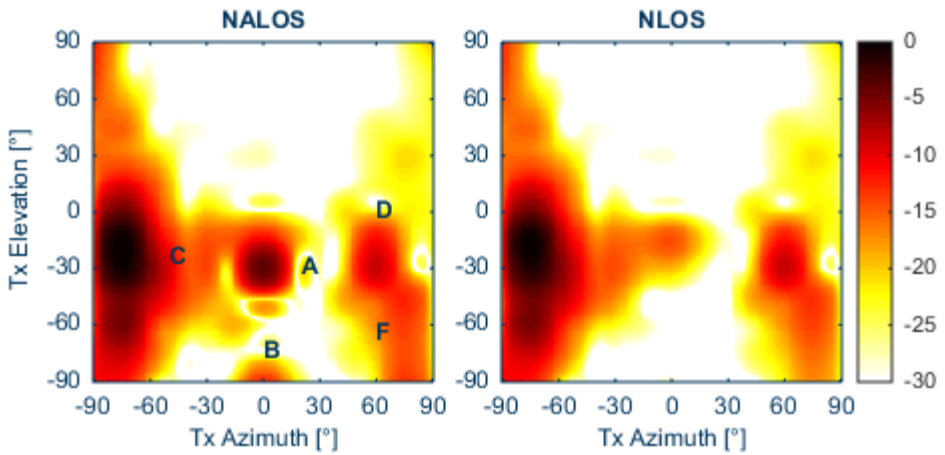
Tx
Rx4
3800mm
200mm
830mm
800mm
Rx1
Rx2
Rx3
1500mm
1500mm
1450mm

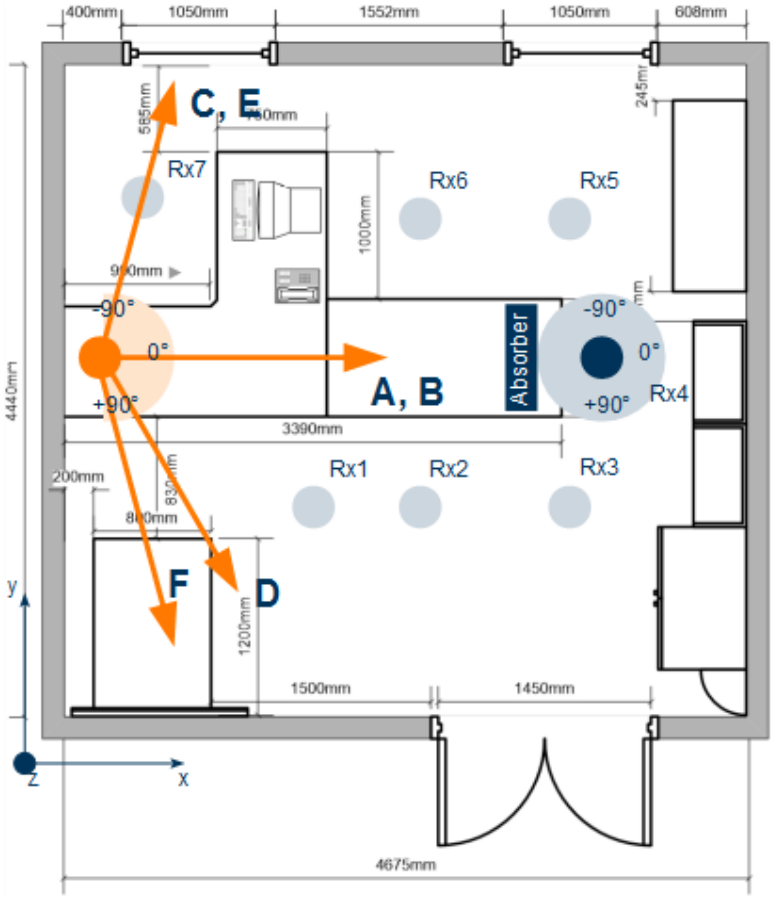

0°
-90°
+90°
-180°
585mm
750mm
245mm
Rx7
Rx6
Rx5
1000mm
990mm
200mm
Tx
Rx4
3300mm
200mm
830mm
Rx1
Rx2
Rx3
800mm
1200mm
1500mm
1450mm

Small Office Scenario

Directional / Temporal Analysis

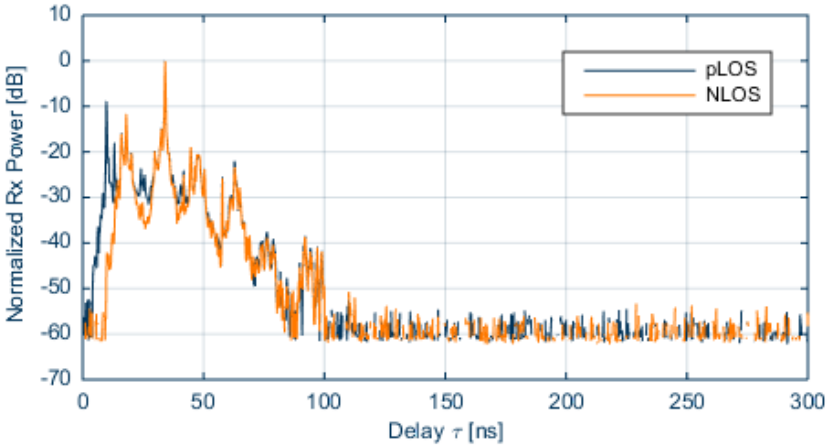


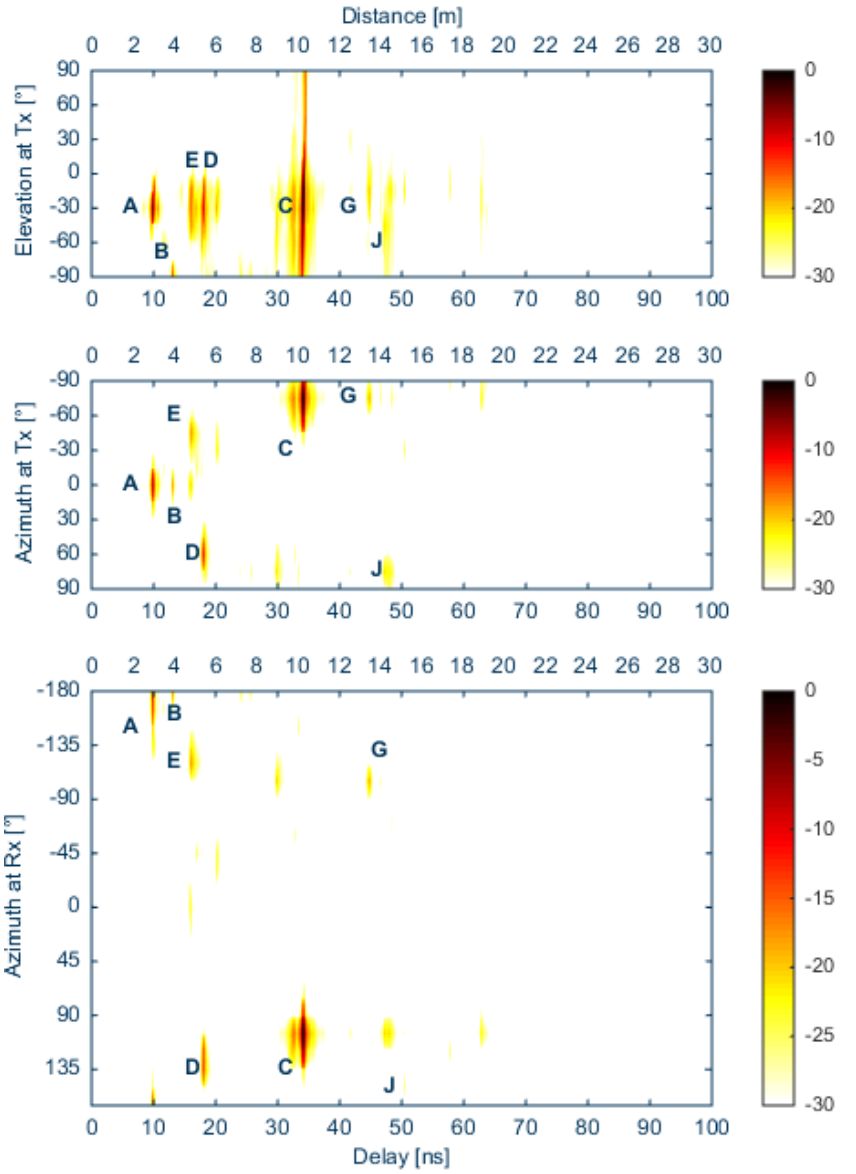
Scatter	Description
A	Direct NALOS component.
B	Scattering on the table.
C	Double reflection.
D	Reflection in the right side wall.
E	Single reflection in the left side wall.
F	Double reflection: right and left side wall.



Directional / Temporal Analysis

- Single DoD with several DoA (Scatter C and G)
- **Sparse directional/temporal** characteristic
- Excess Delay ≈ 50 ns → entrance hall scenario ≈ 150 ns

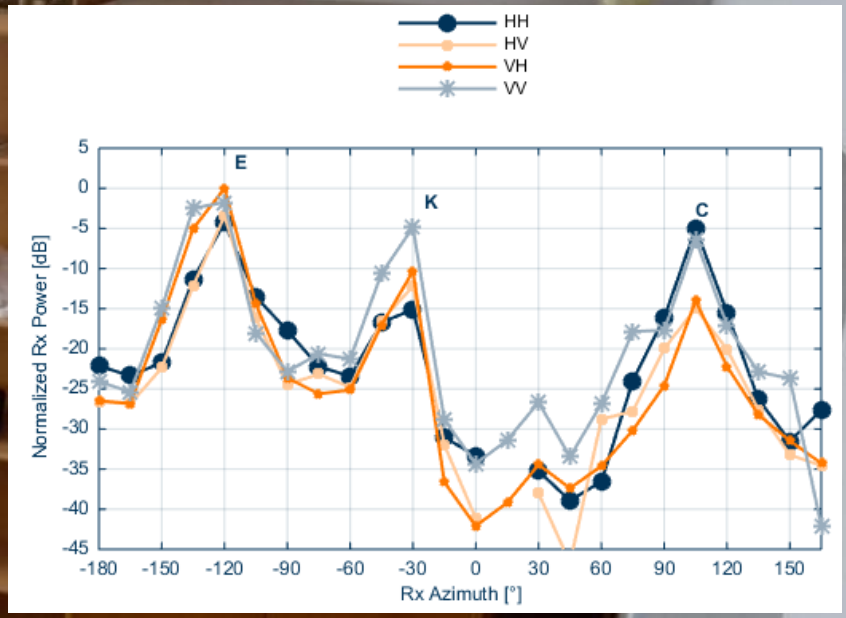




Single beam at TX

$\phi_{\mathrm{TX}} = -45°$

$\theta_{\mathrm{TX}} = -30°$



-30°

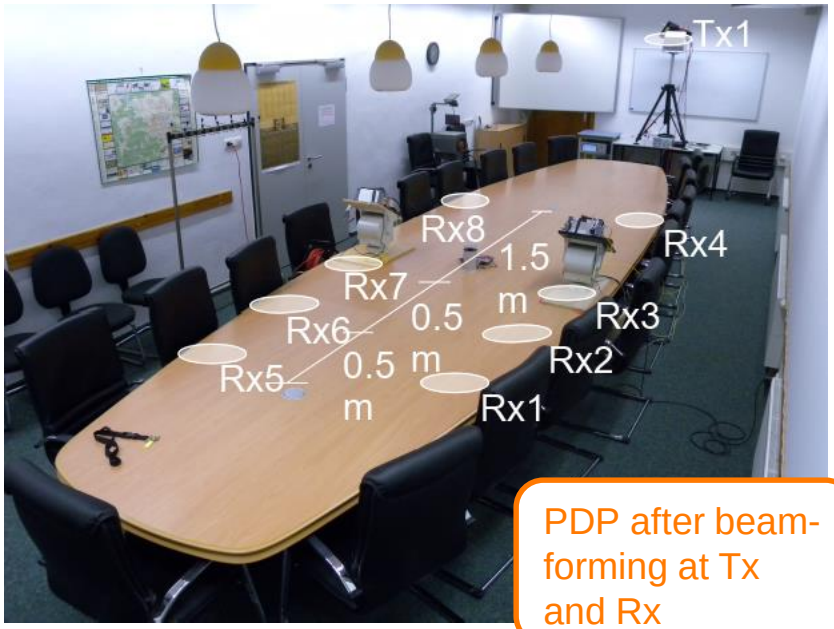
-120°

105°

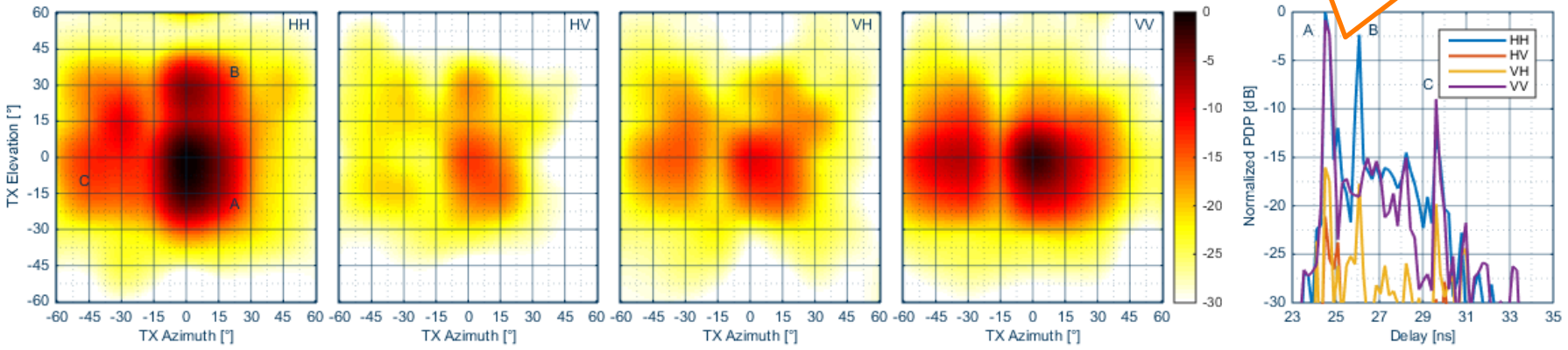
Conference Room Scenario

Conference room scenario

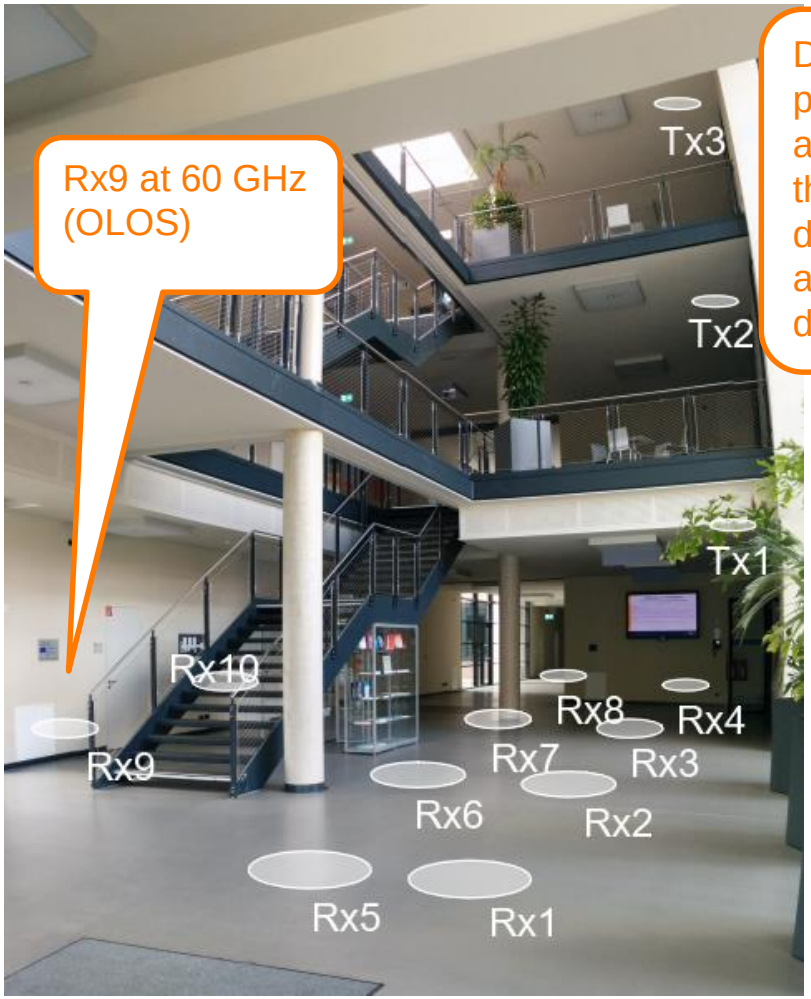
- 1 Tx at AP level
- 8 Rx on the table emulating users
- Double-directional 3D scan:
  - Tx Azimuth: -60:15:60
  - Tx Elevation: -60:15:60
  - Rx Azimuth: -180:60:120
  - Rx Elevation: -30:30



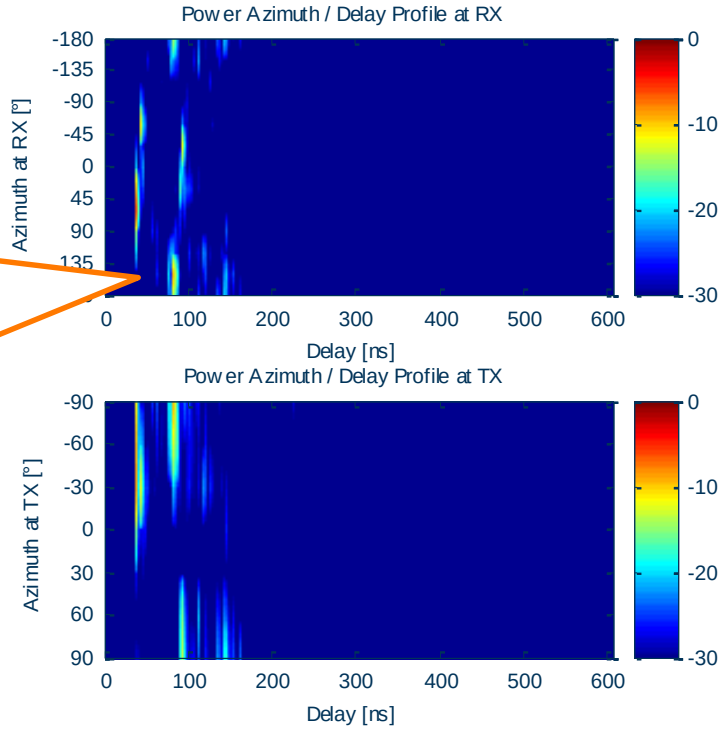
PDP after beam-forming at Tx and Rx



Large Hall Scenario



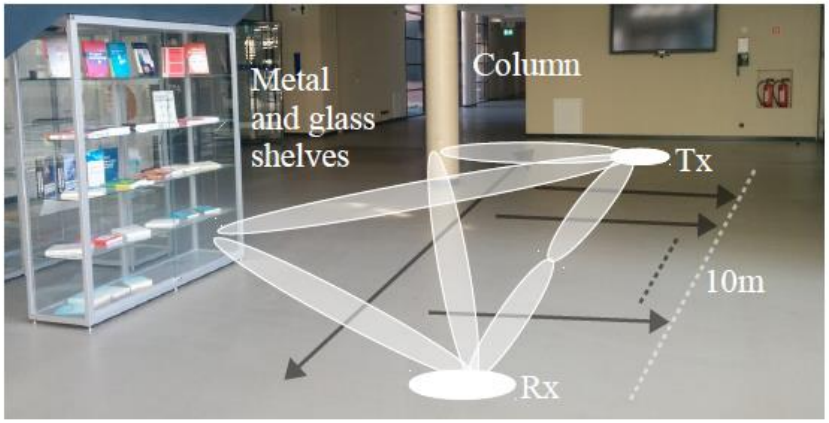
Different paths arriving at the Rx in different angles and delay

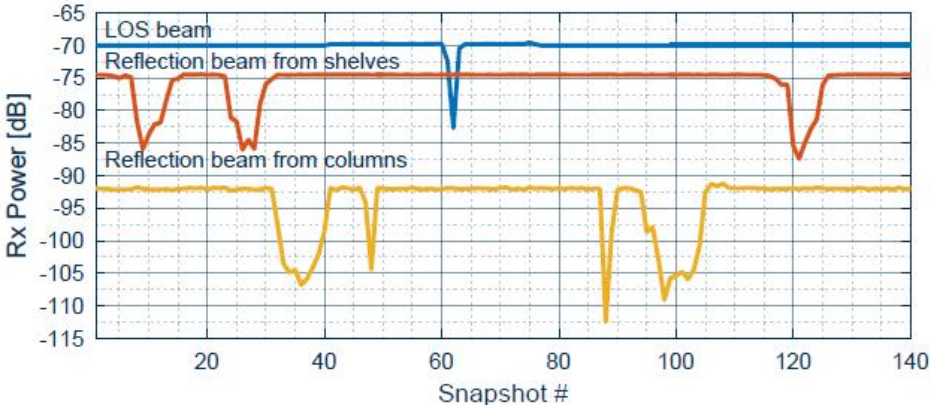


Shadowing Measurements

LOS and reflected beams

- Frequency: 70 GHz (4 GHz BW)
- Horn antennas (15° HPBW) → Results using Tx V - Rx V
- Person interrupting LOS every 1m → Diffraction effects
  - Mean: 20 dB
  - Min.: 12.41 dB
  - Max.: 27.81 dB
- Good matching with the **Double Knife-Edge Diffraction** model in LOS
- Composite scenario shows **multi-beam benefits**



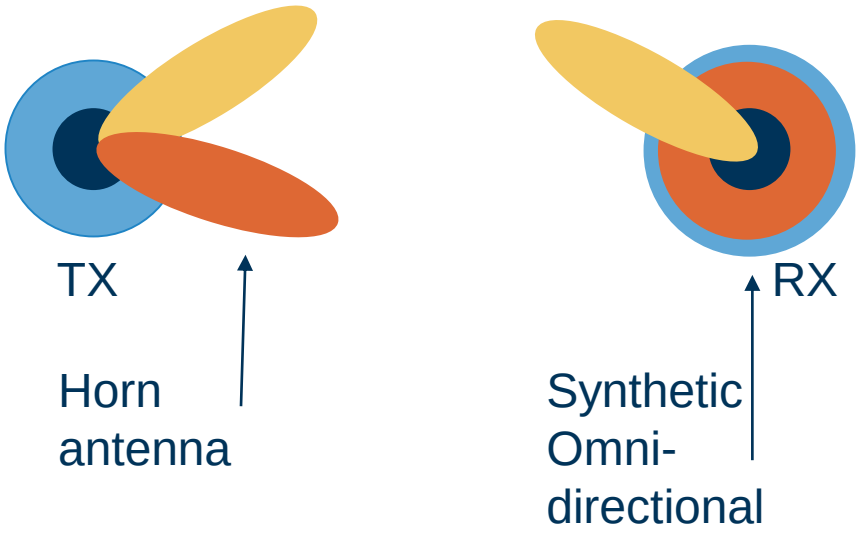


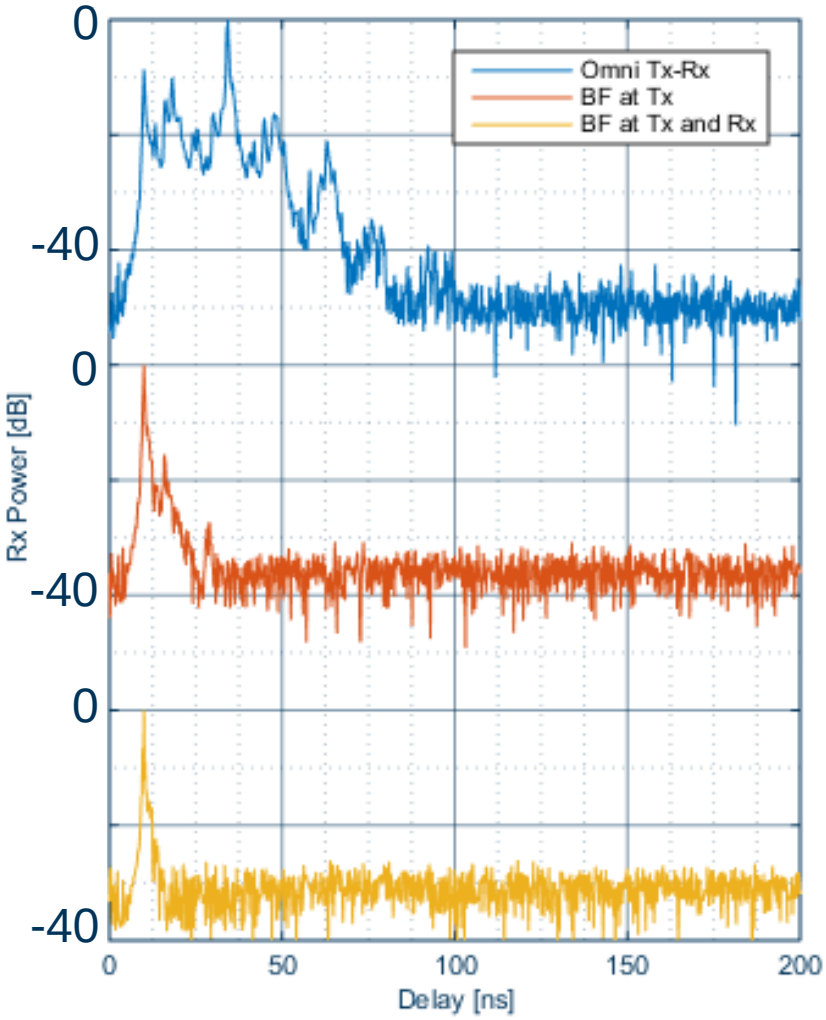
Directivity and Influence on the Delay Spread

BF/directivite antennas reduces DS and Excess Delay

- 88% DS reduction from Omni to Bf at Tx
- 93% DS reduction from Omni to Bf at Tx and Rx

Influence on CP, equalization, etc...





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Key Findings from Measurements

Spatial and temporal characteristics

- Reflection dominant scenarios
  - Dominant specular reflections → Geometry of the scenario is more deterministic → Need of **spatial consistency** in models
  - High order reflections are considerable → Still influence of the antenna
  - Different Delay Spreads (DS) and Excess Delay (ED) in multiple environments (yard, small office, large entrance hall)
- Reduced DS using directive antennas/beam-forming
- Sparse spatio/temporal characteristic of the channel → Paths mostly arriving from different directions at different times