

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Preliminary Performance of FEC Schemes in TG3d Channels

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Re: n/a

Abstract: This contribution provides a first assessment of the considered modulation and coding schemes for realistic channels from the TG3d channel model.

Purpose: Contribution towards developing the PHY for use in TG 3d

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Preliminary Performance of FEC Schemes in TG3d Channels

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TU Braunschweig

Outline

- MCS / Scenario Overview
- MCS Performance
 - Close Proximity P2P
 - Intra-Device
 - Backhaul / Fronthaul
 - Data Center
- ISI Impact Estimation

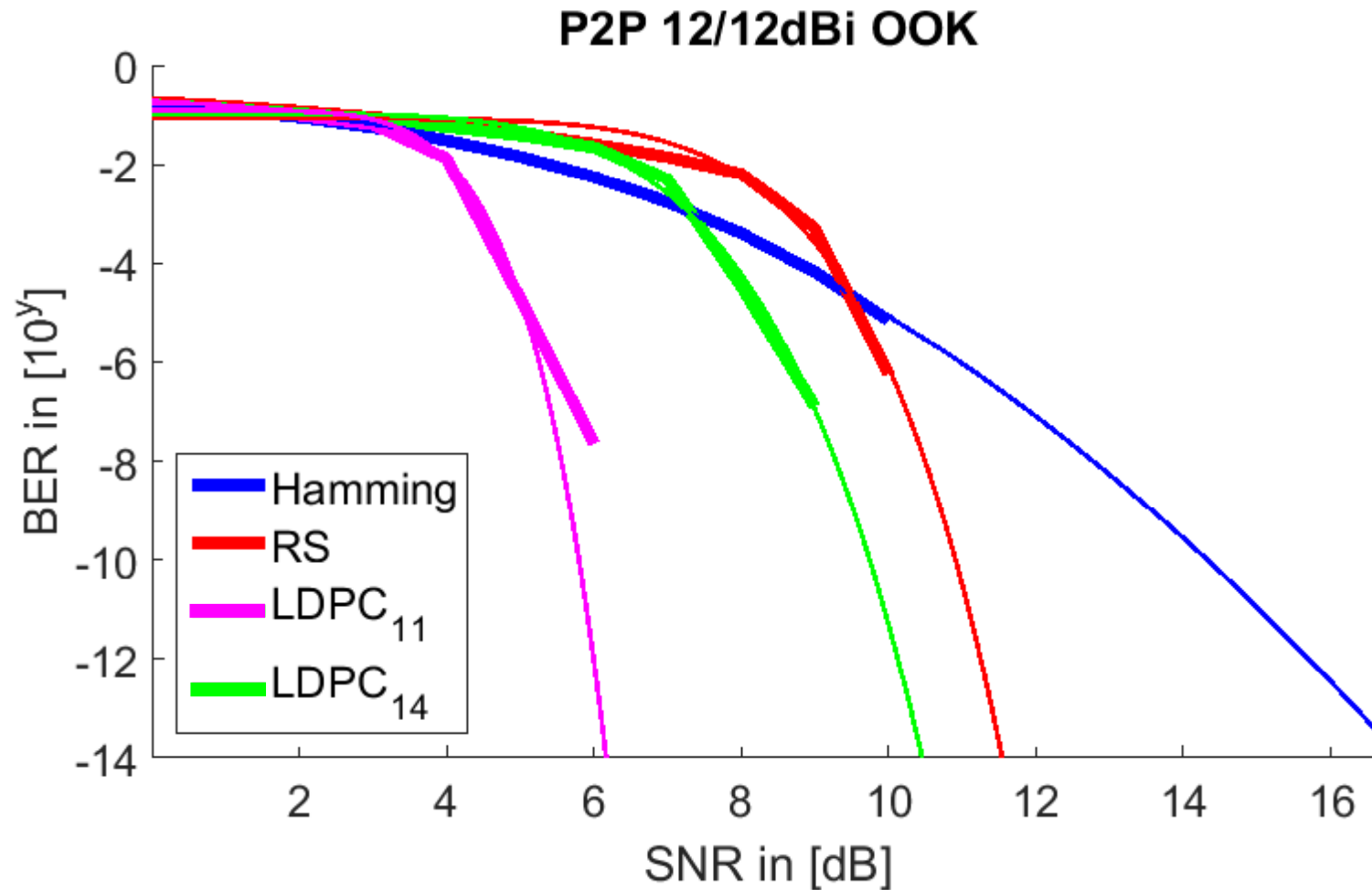
MCS/Scenario Overview

- The following modulation schemes have been simulated so far:
 - On/Off-Keying
 - BPSK
 - QPSK
 - 16-QAM
 - 64-QAM
- The following forward error correction types have been implemented:
 - (7,4) – Hamming code
 - Reed-Solomon Code (255,239) in GF(2⁸)
 - Rate 11/15 LDPC (1440,1056)
 - Rate 14/15 LDPC (1440,1344)
- The following transfer functions from the data sets defined in the CMD have been utilized:
 - Close-Proximity: #m1 of CloseProximityP2P_S1_TX12_RX12.txt
 - Intra-Device: #m1 of TG3d_Intra_Device_B2Bv_6dBi.txt
#m1 of TG3d_Intra_Device_B2Bv_18dBi.txt
 - Back-/Fronthaul: AWGN Channel
 - Data Center: #m1 of TG3d_Data_Center_Type_1&2_position_1_antenna_1.txt
#m1 of TG3d_Data_Center_Type_1&2_position_1_antenna_3.txt

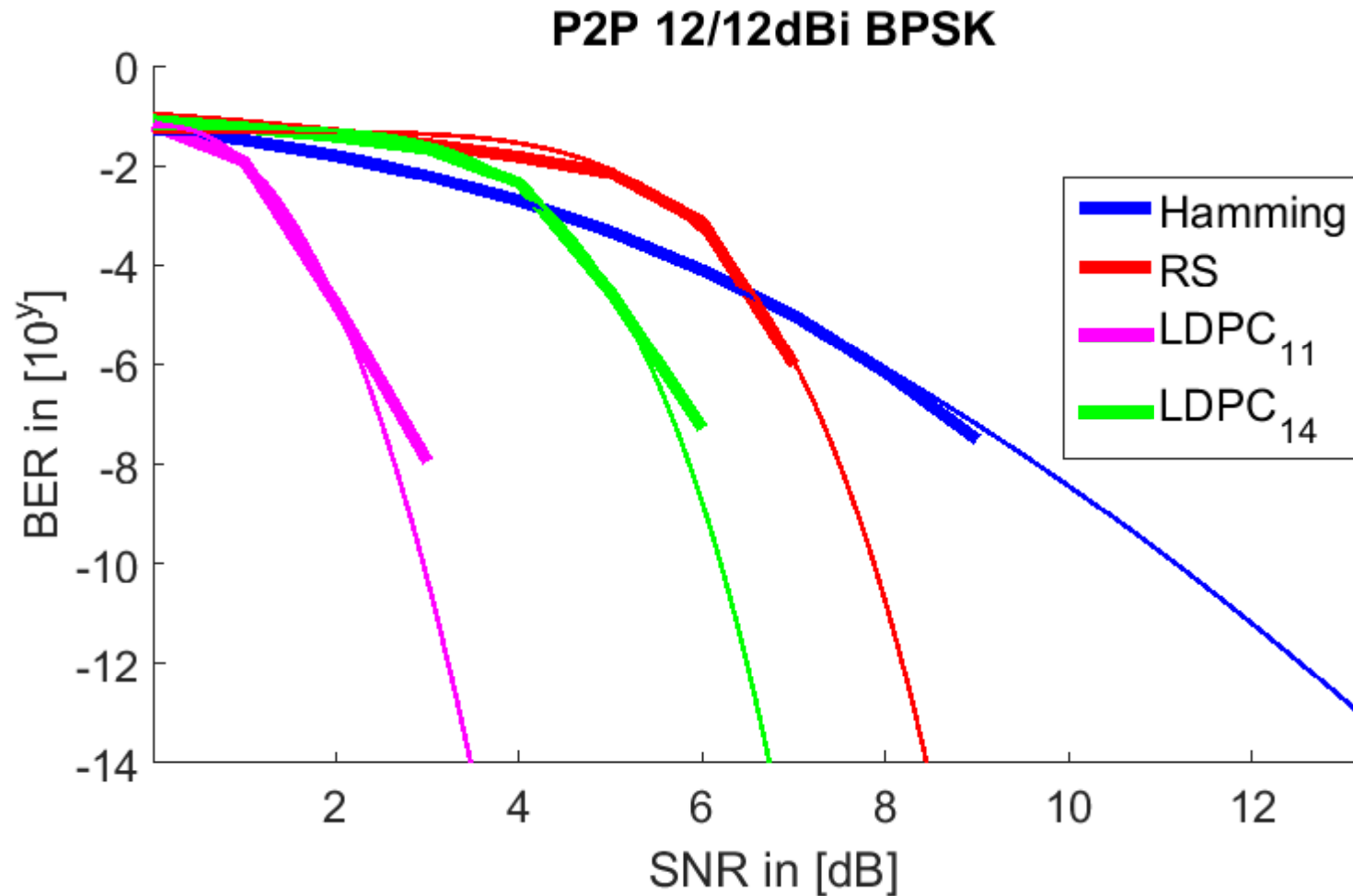
MCS Performance

- Up to now, the MCSs under test have been evaluated by simulations using **at most 10^8 modulation symbols**.
- Above that, the SNR/BER **curves have been extrapolated** based on a function of the form $(\text{BER}_{\log}) = a \cdot (\text{SNR}_{\log})^b + c$ to predict at which SNR a target BER of 10^{-12} is reached
- When the simulations for all envisaged application cases and MCSs are finished, a selected subset of simulations will be performed with a higher number of symbols to **verify the extrapolated behavior**.

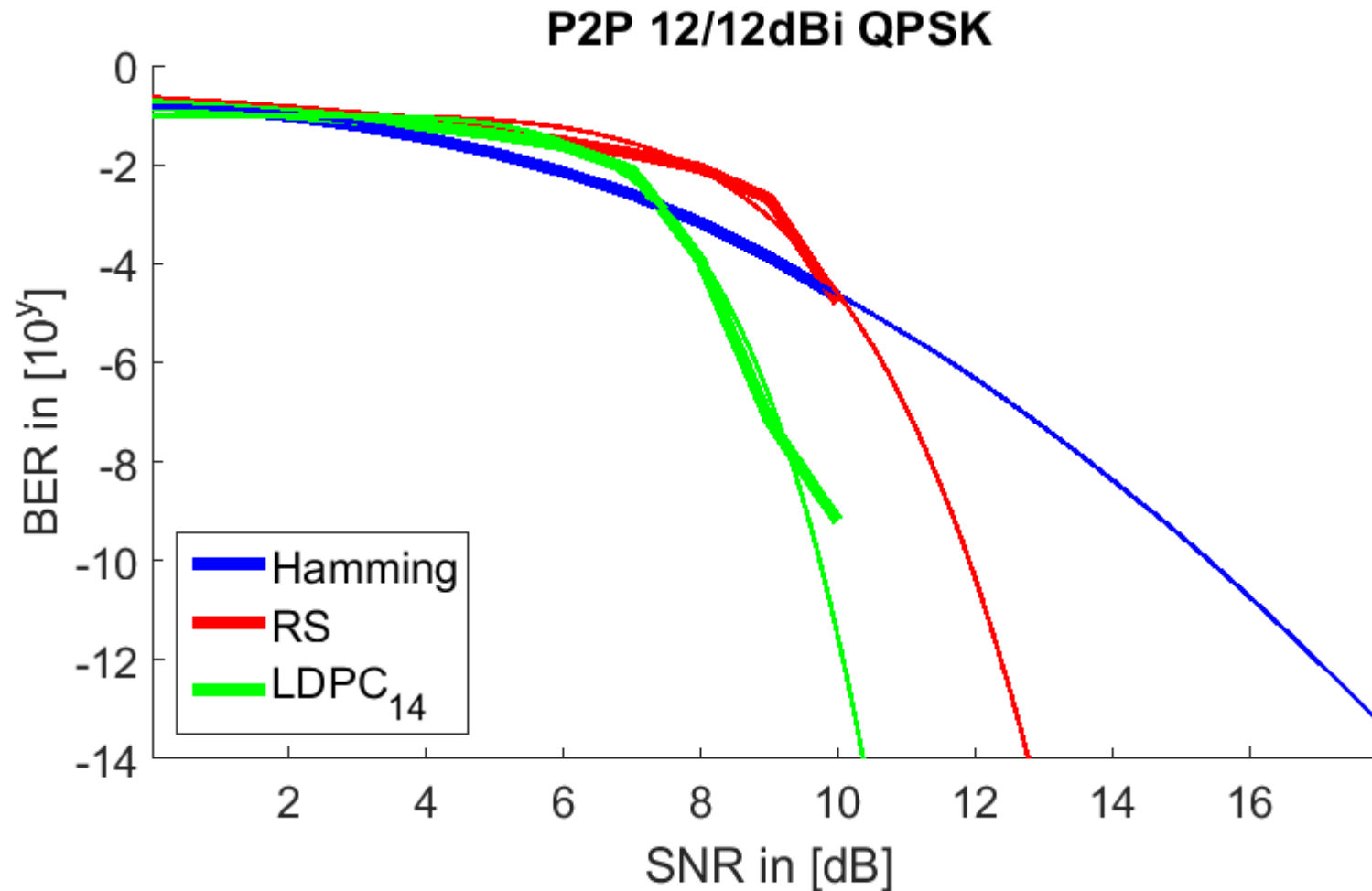
Close Proximity: 12dBi Tx / 12dBi Rx



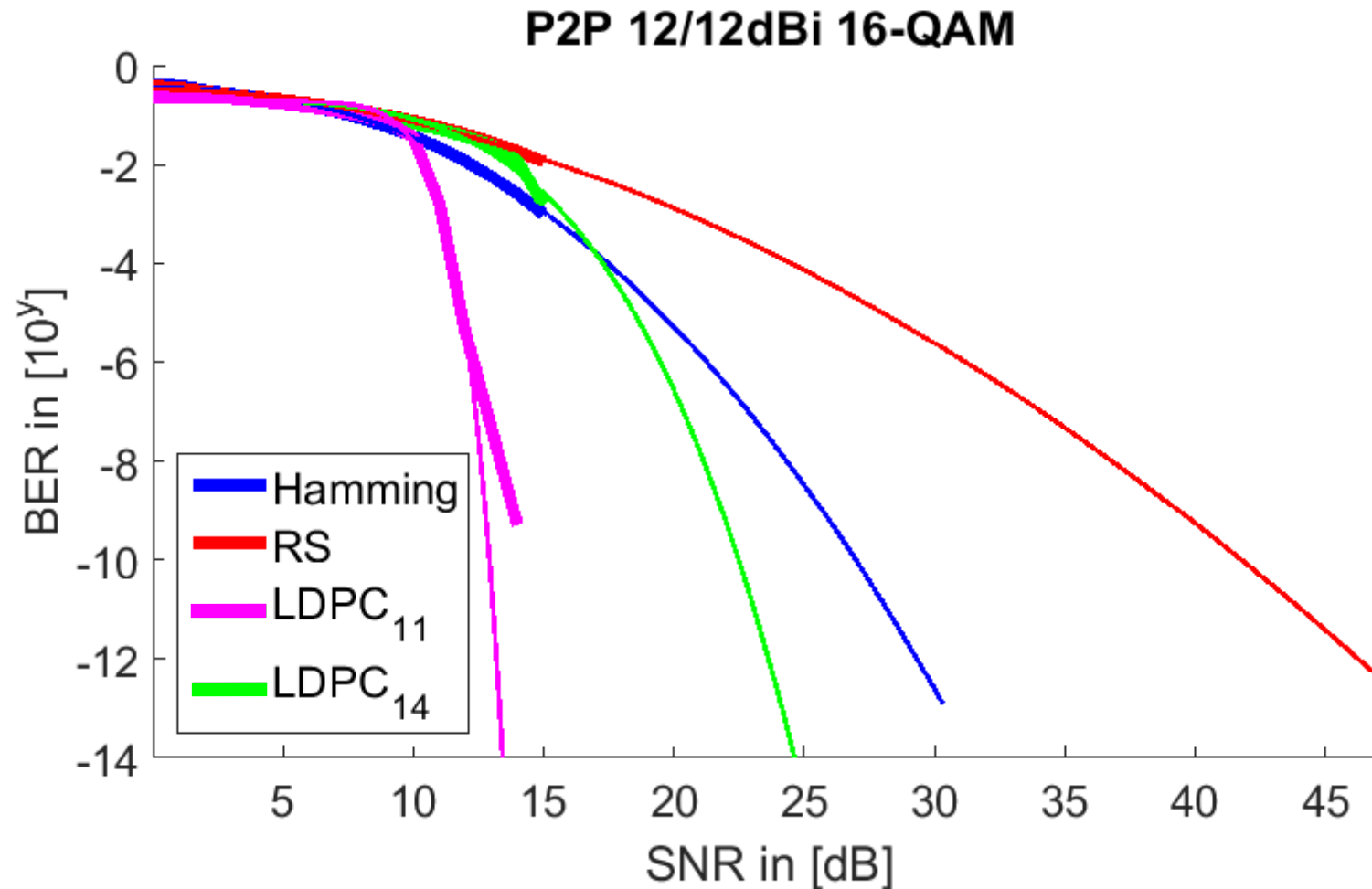
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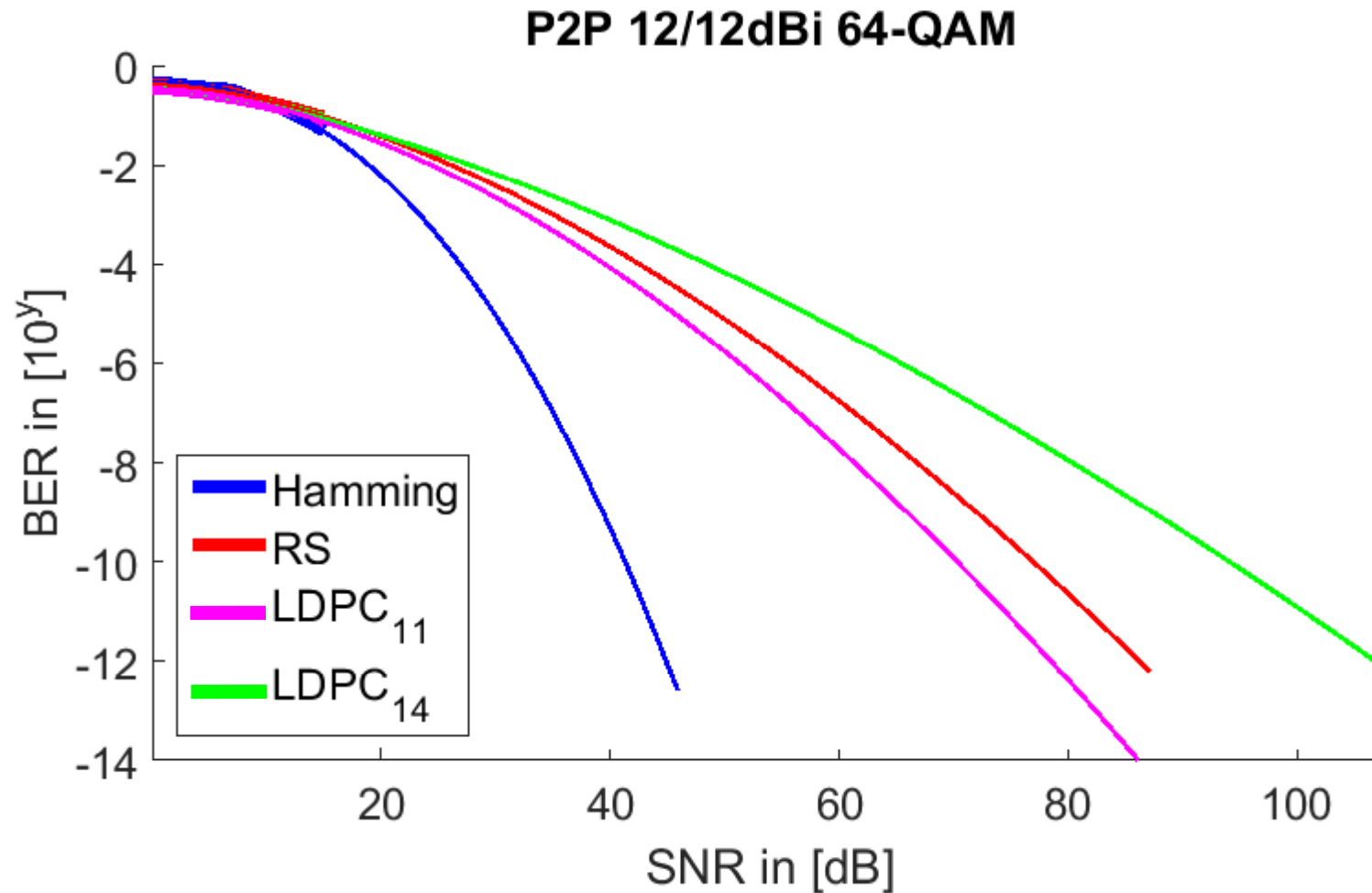
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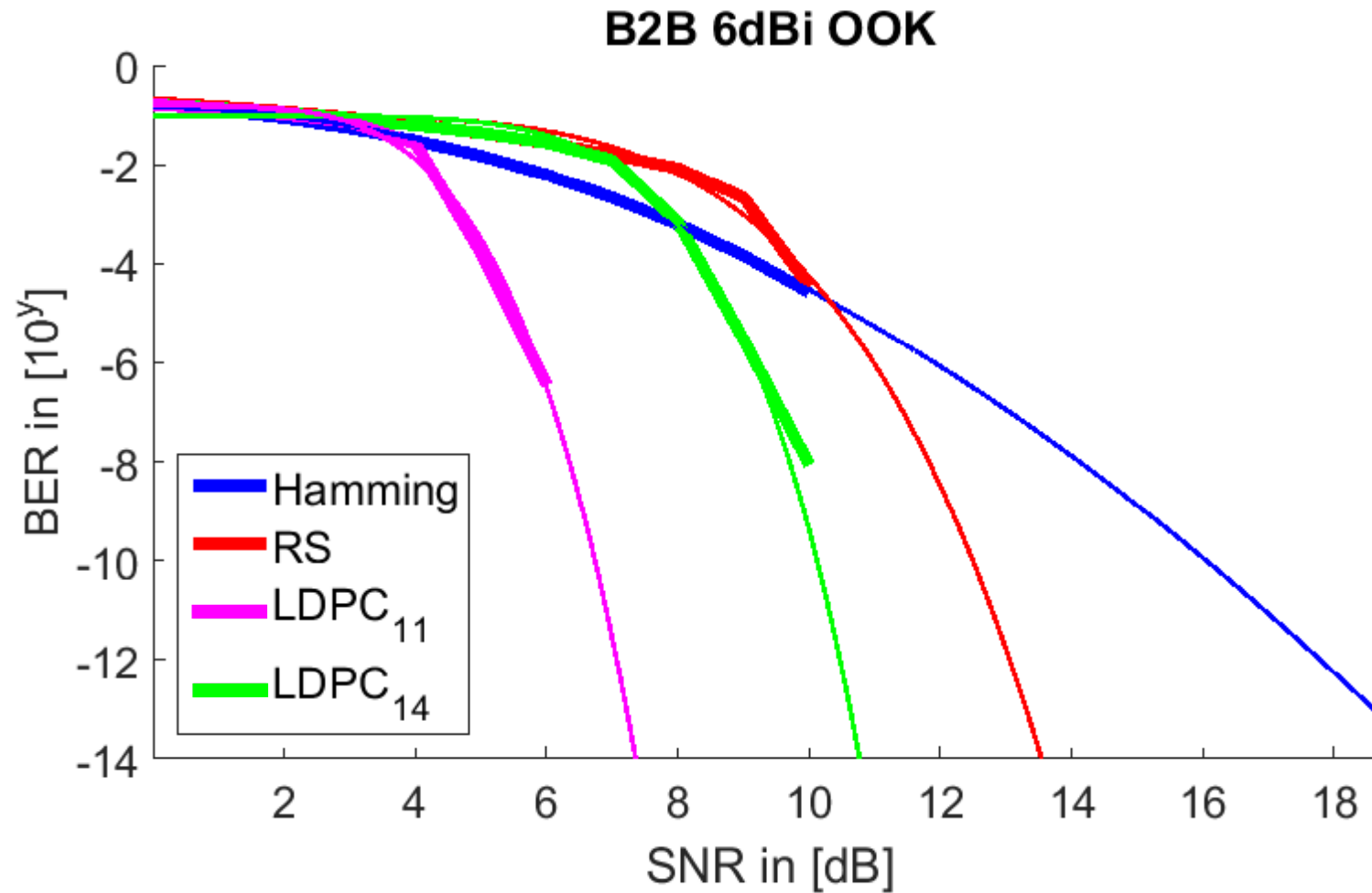
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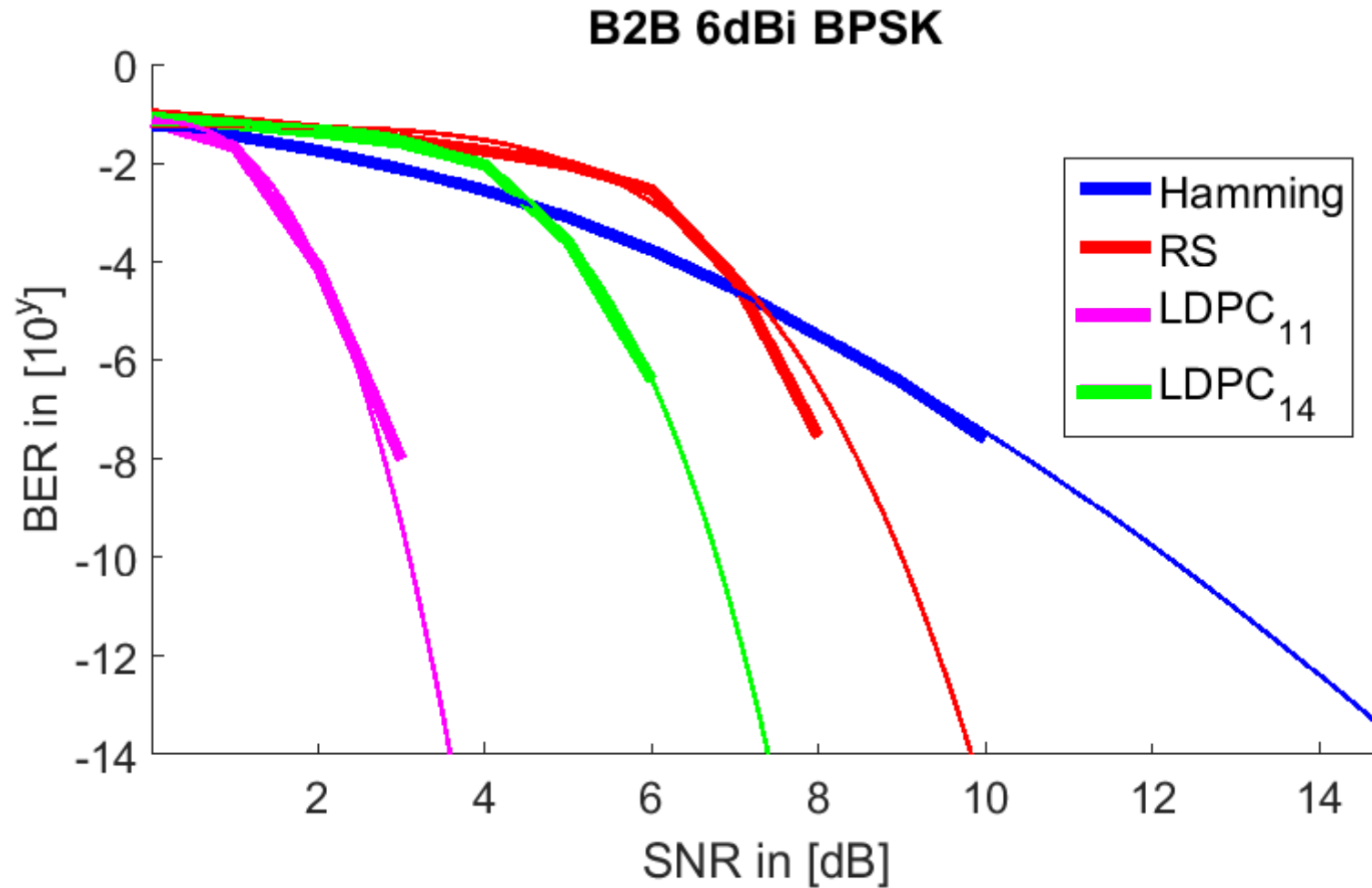
Close Proximity: 12dBi Tx / 12dBi Rx



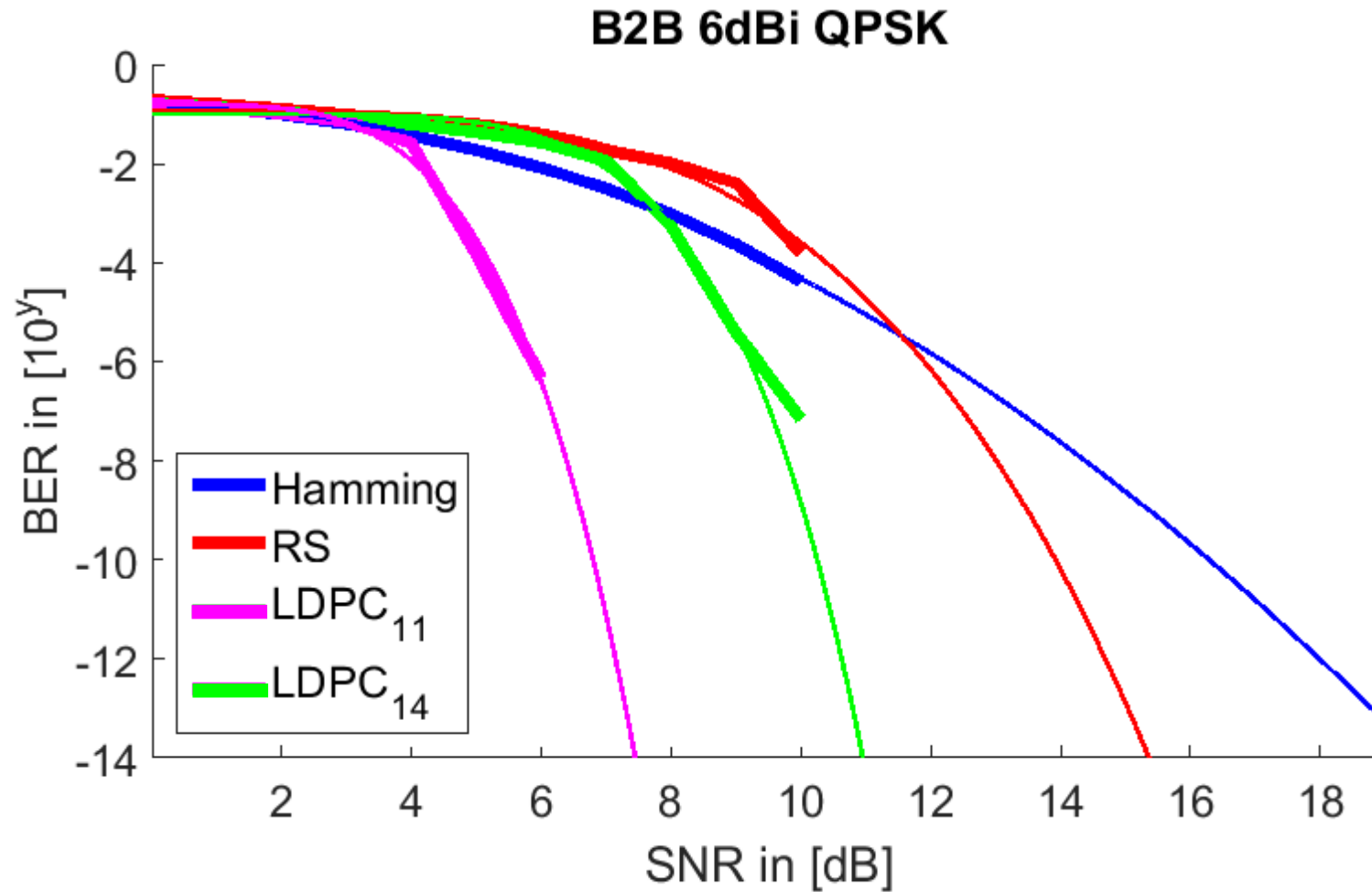
Intra-Device: 6dBi



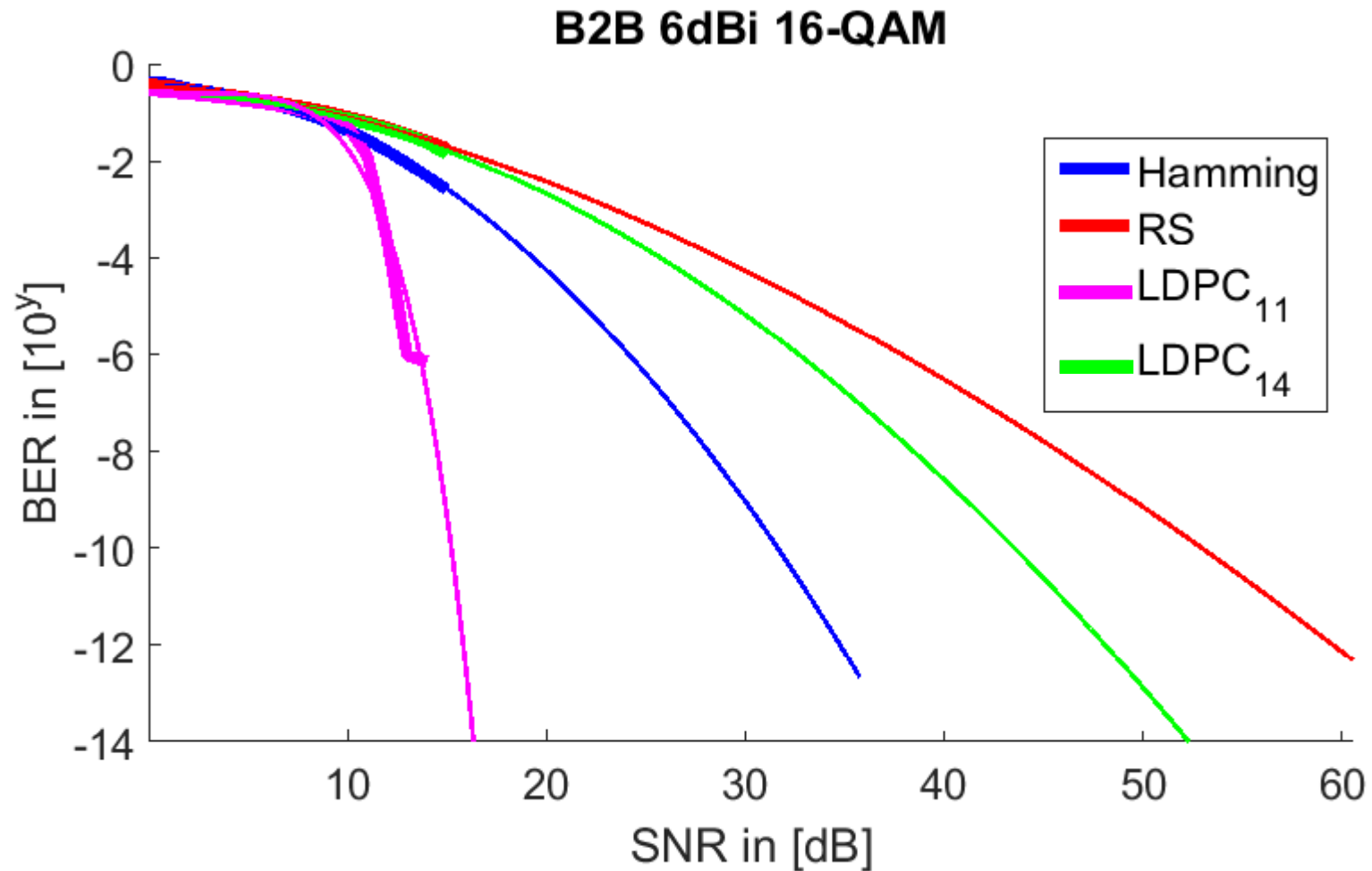
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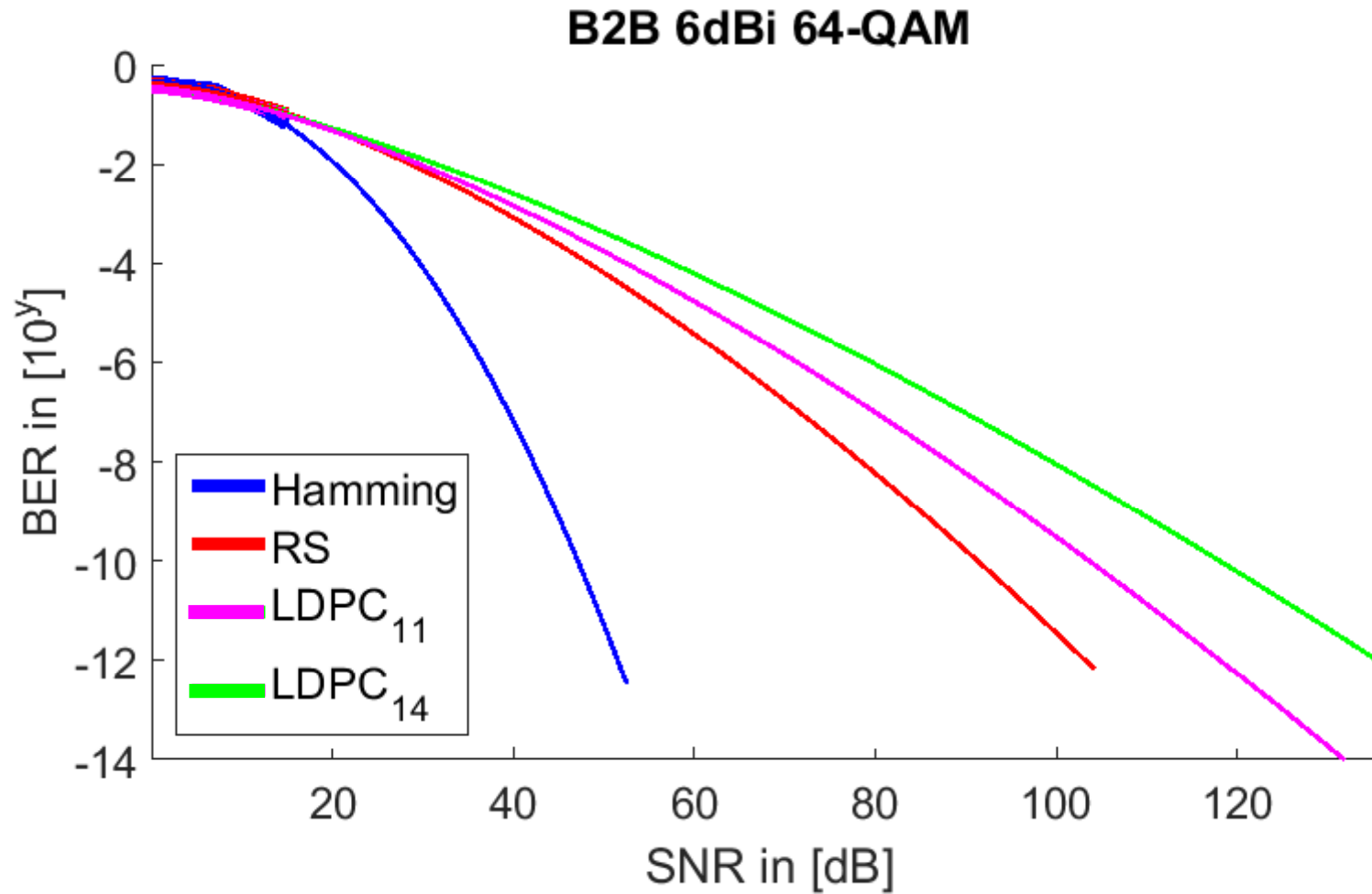
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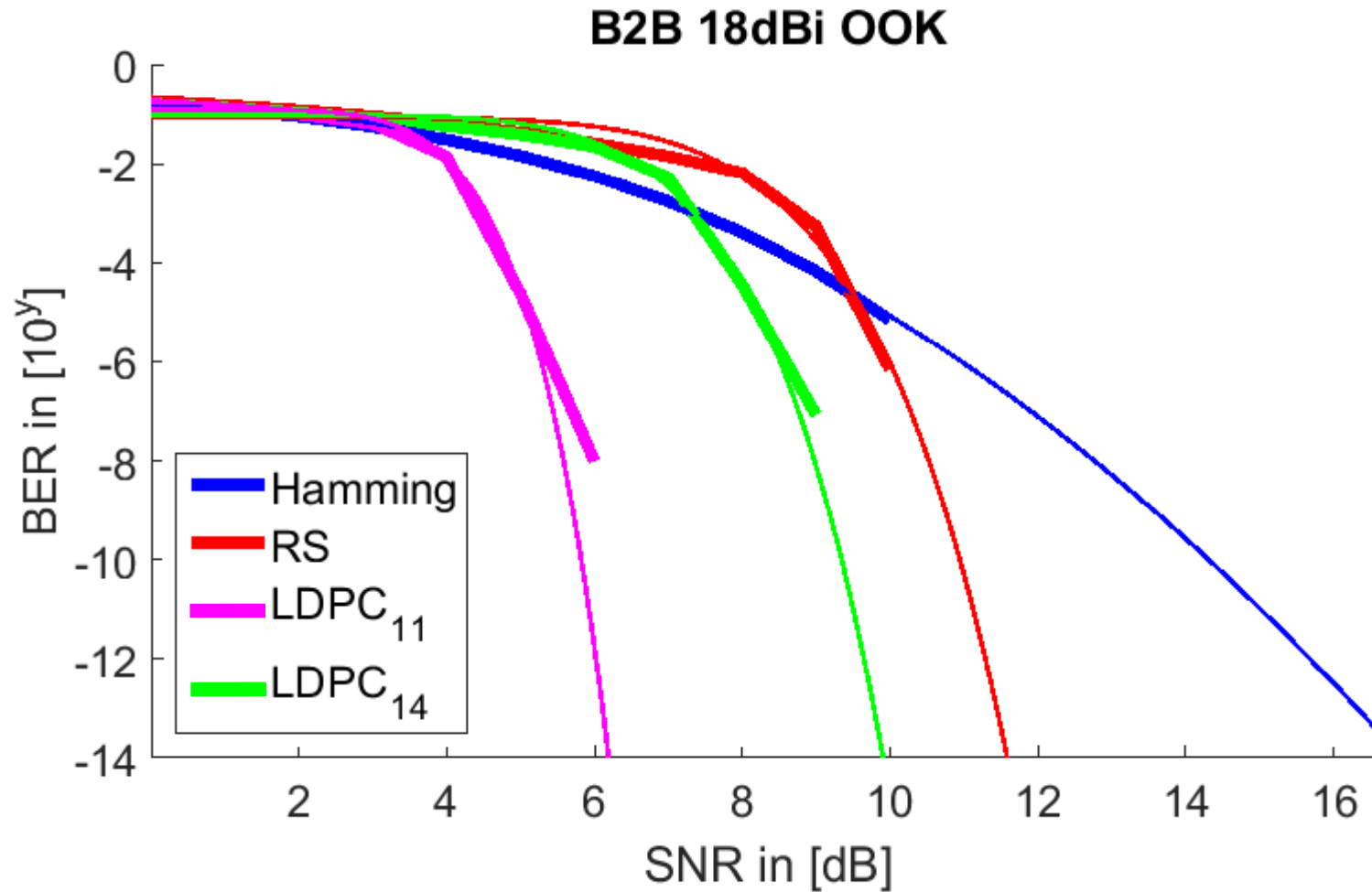
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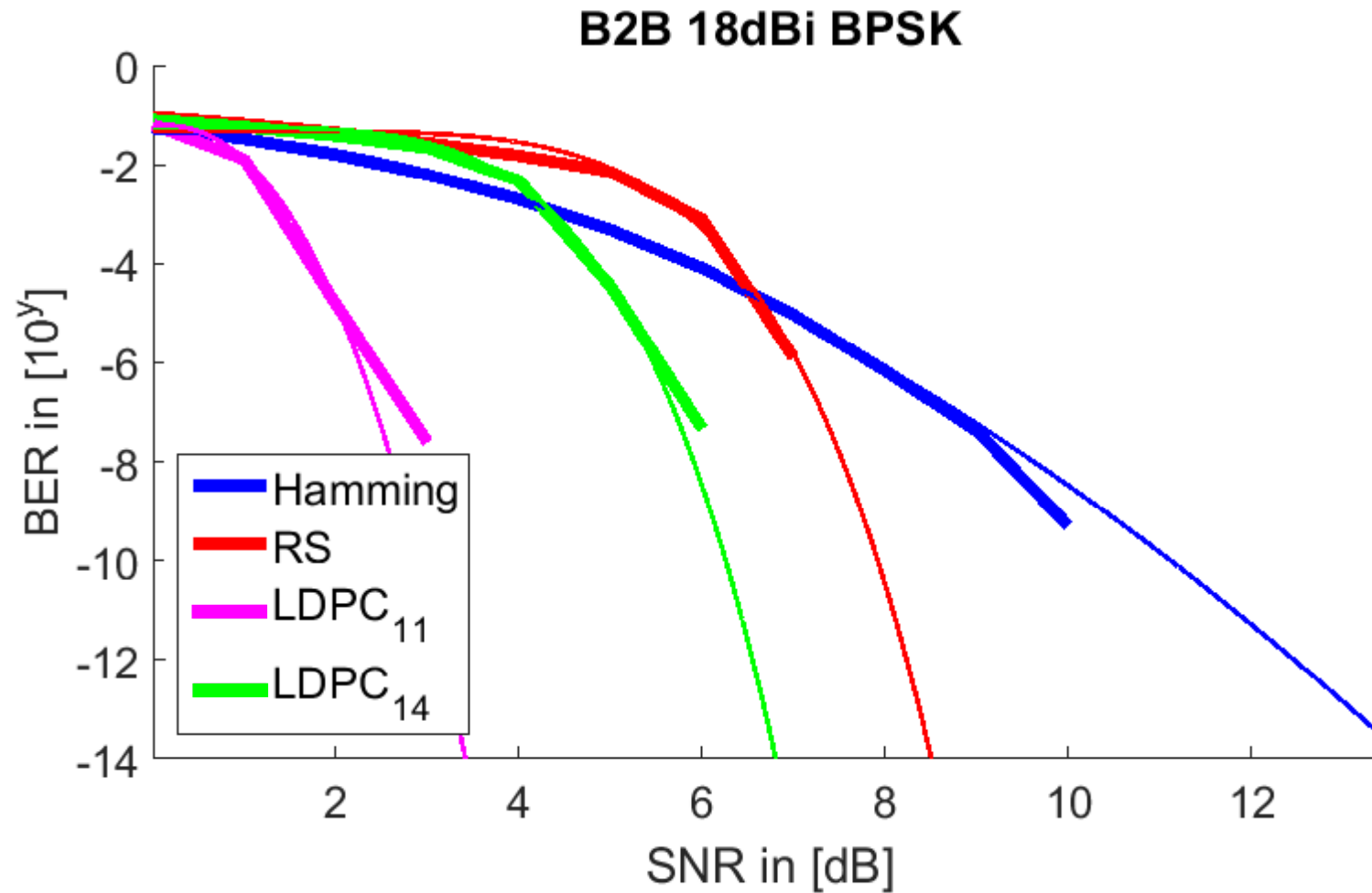
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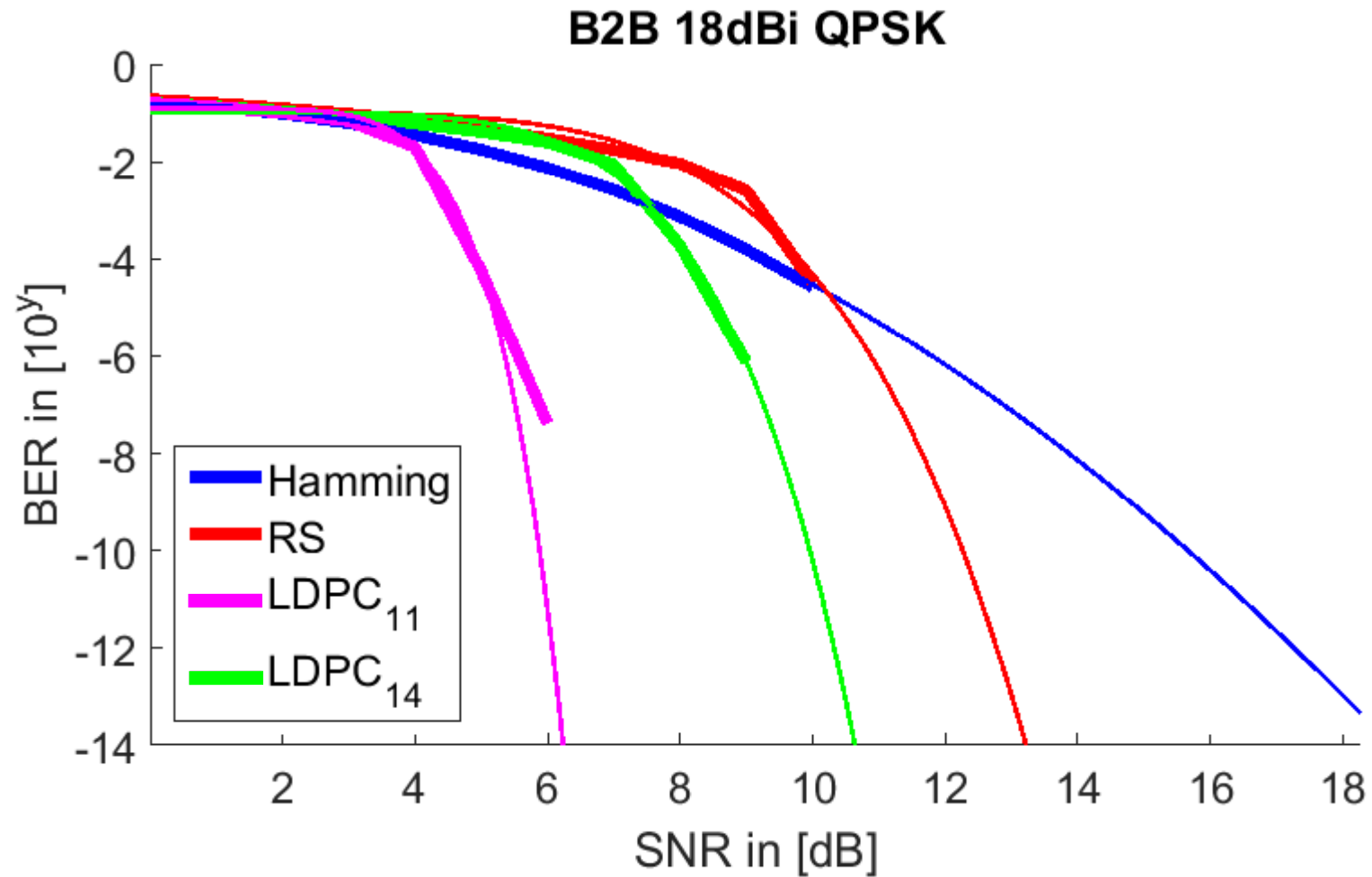
Intra-Device: 18dBi



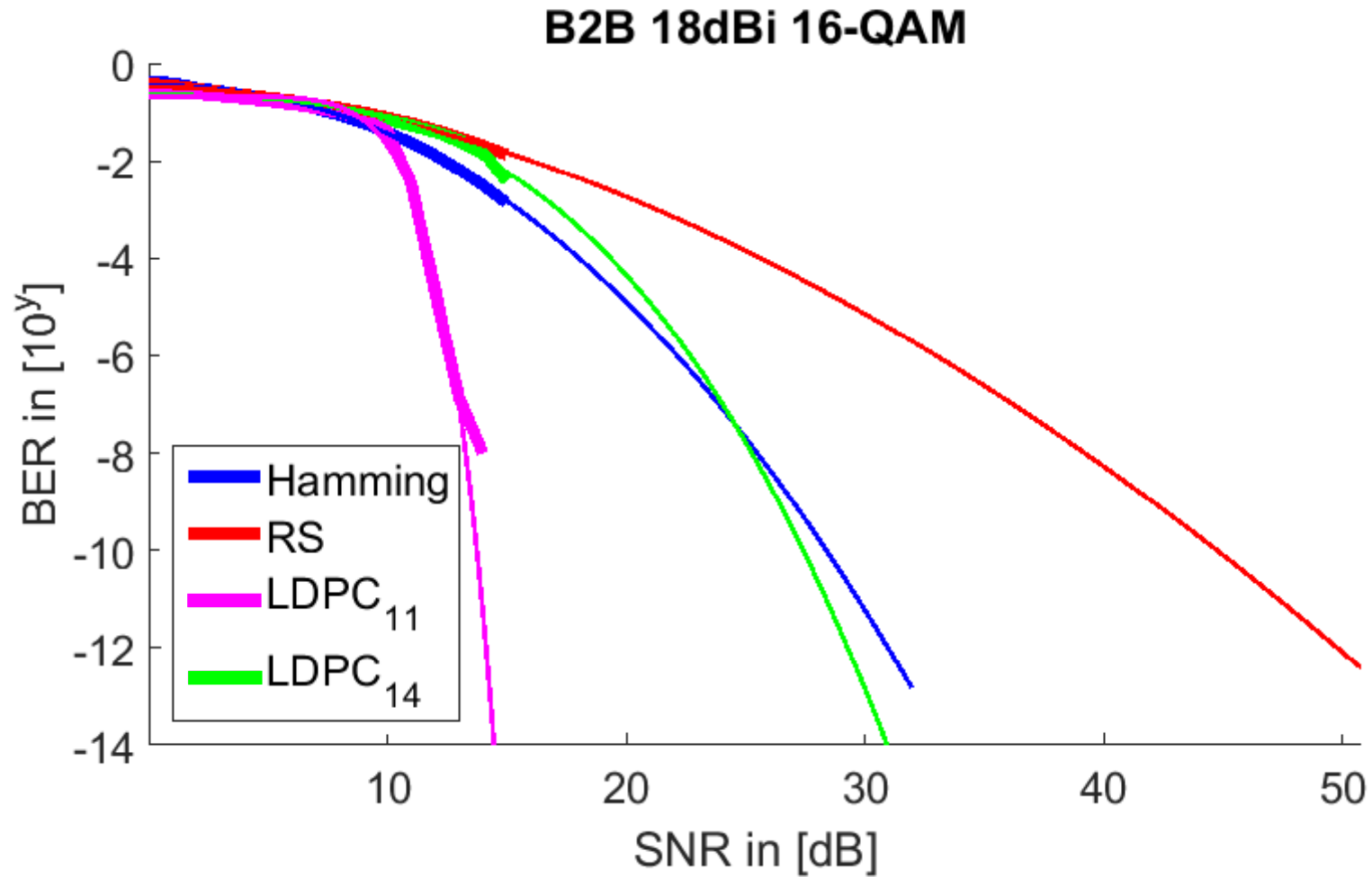
Intra-Device: 18dBi



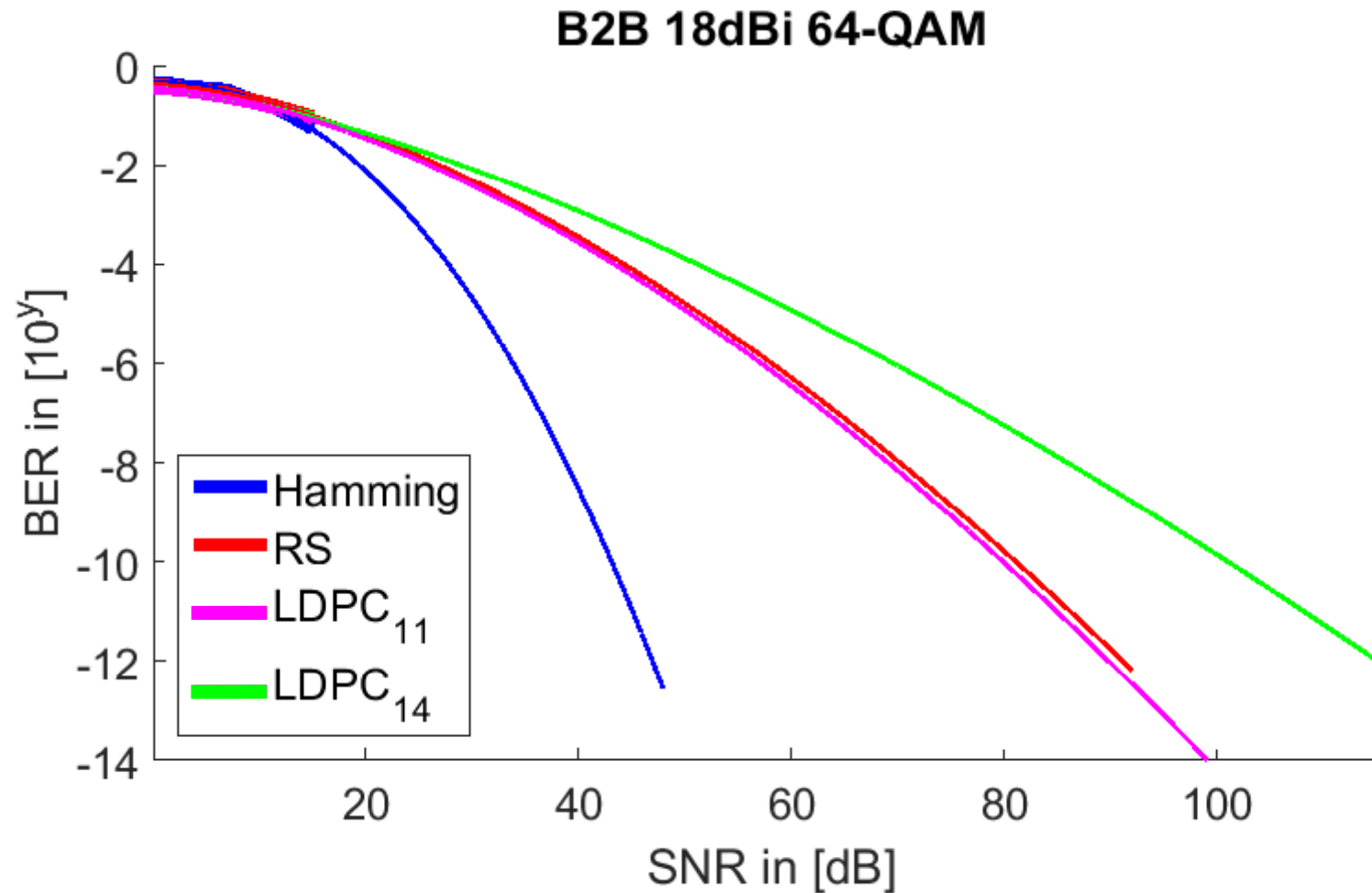
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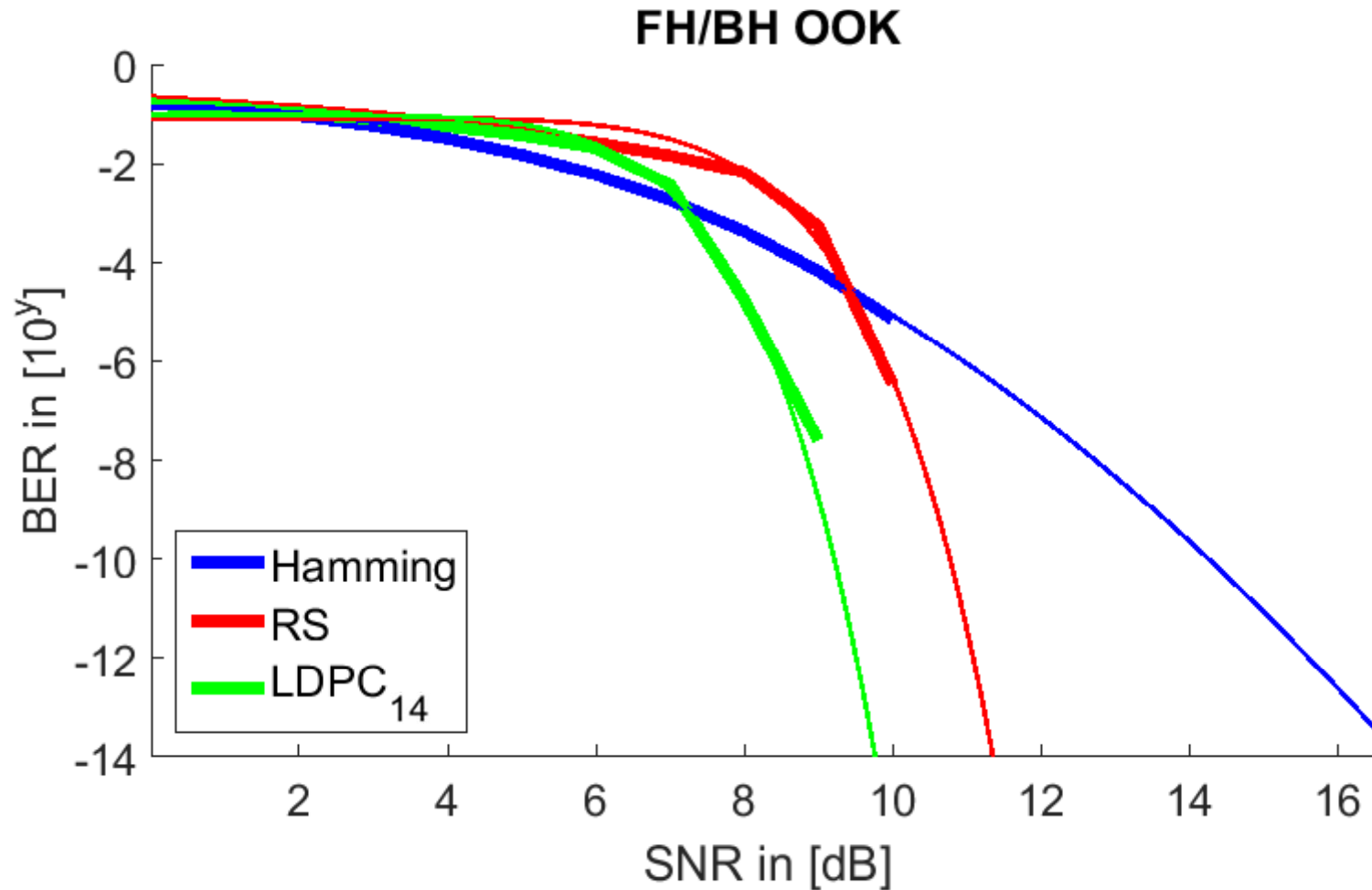
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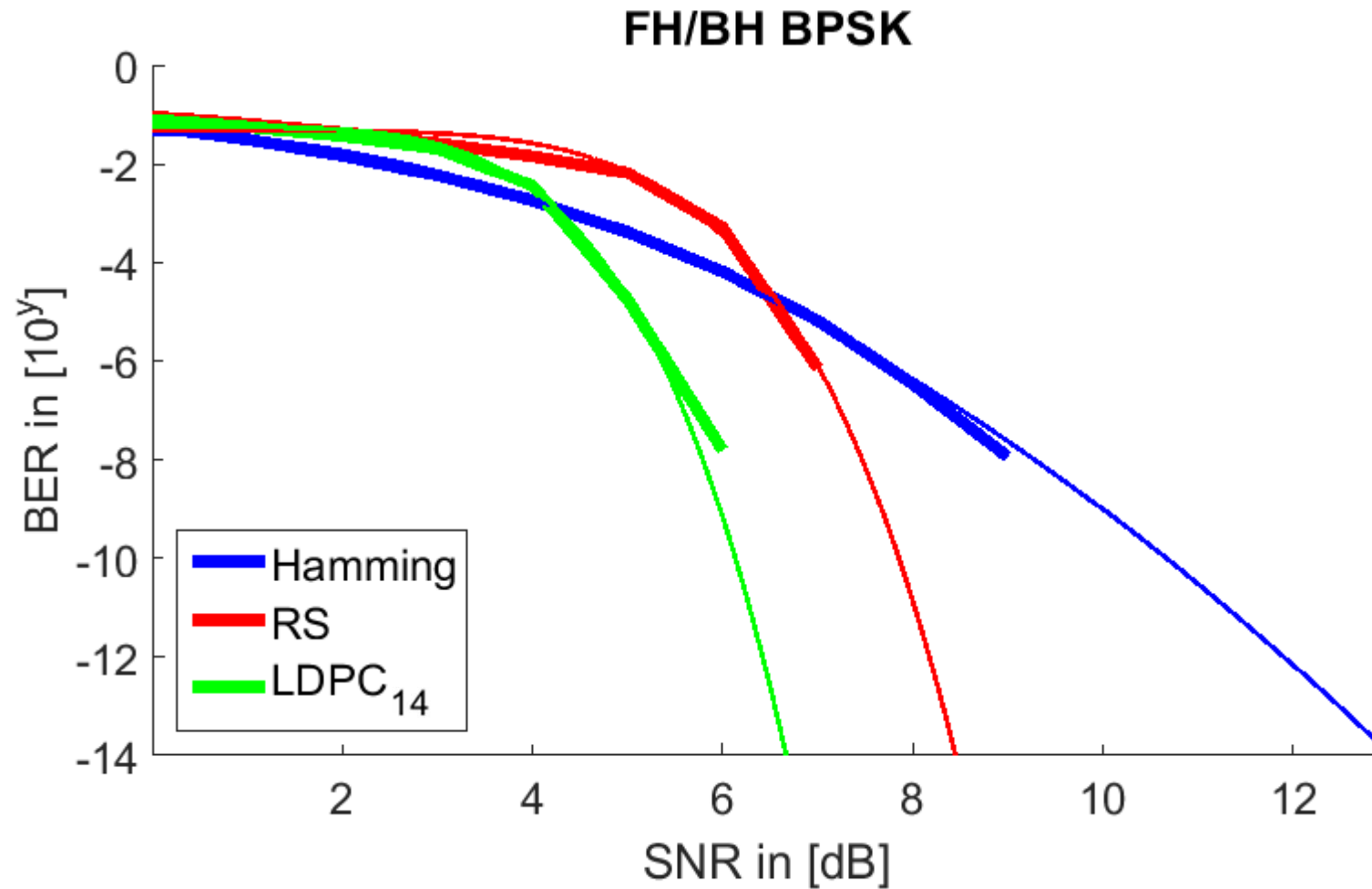
Intra-Device: 18dBi



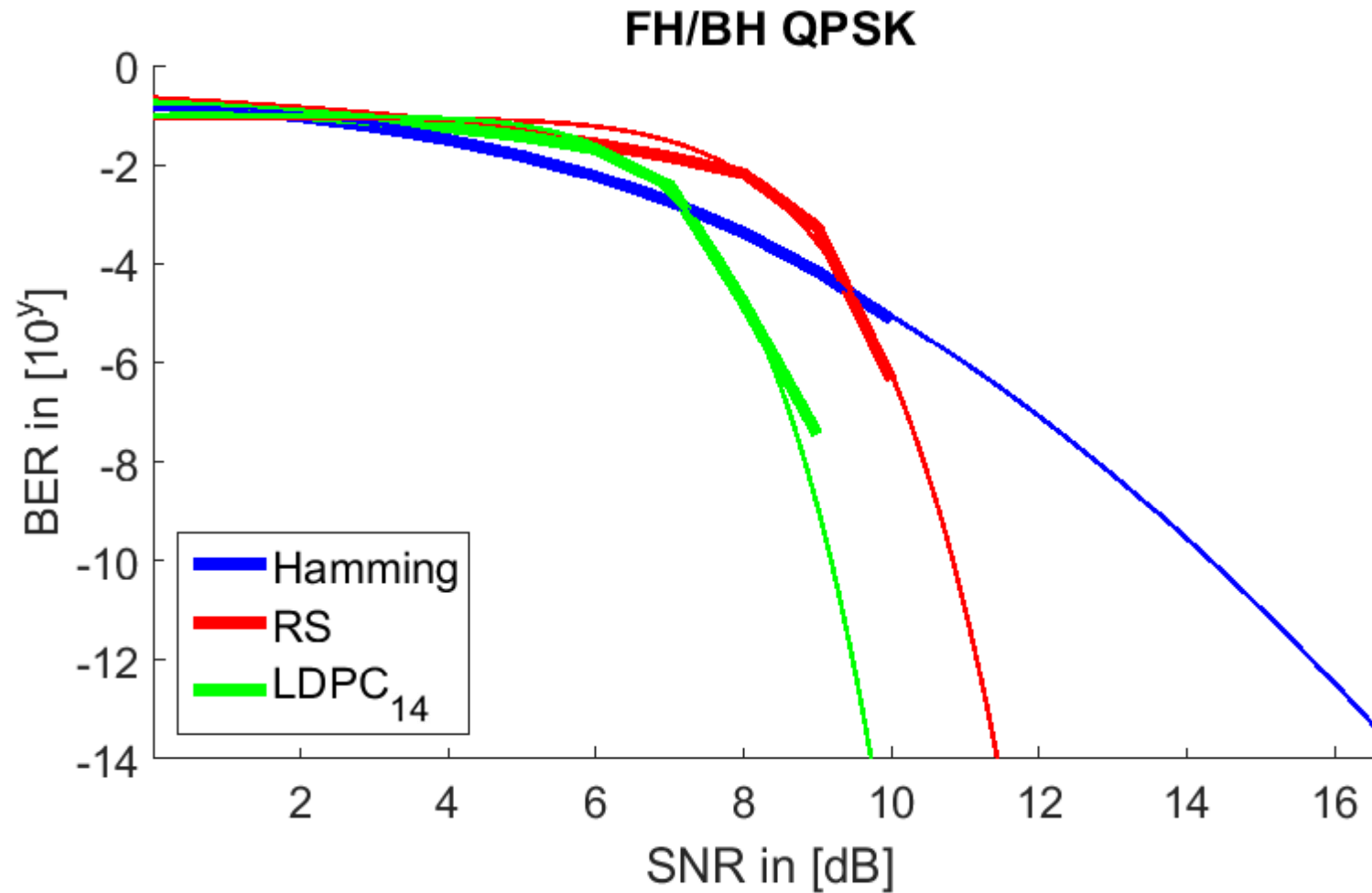
Backhaul/Fronthaul: AWGN



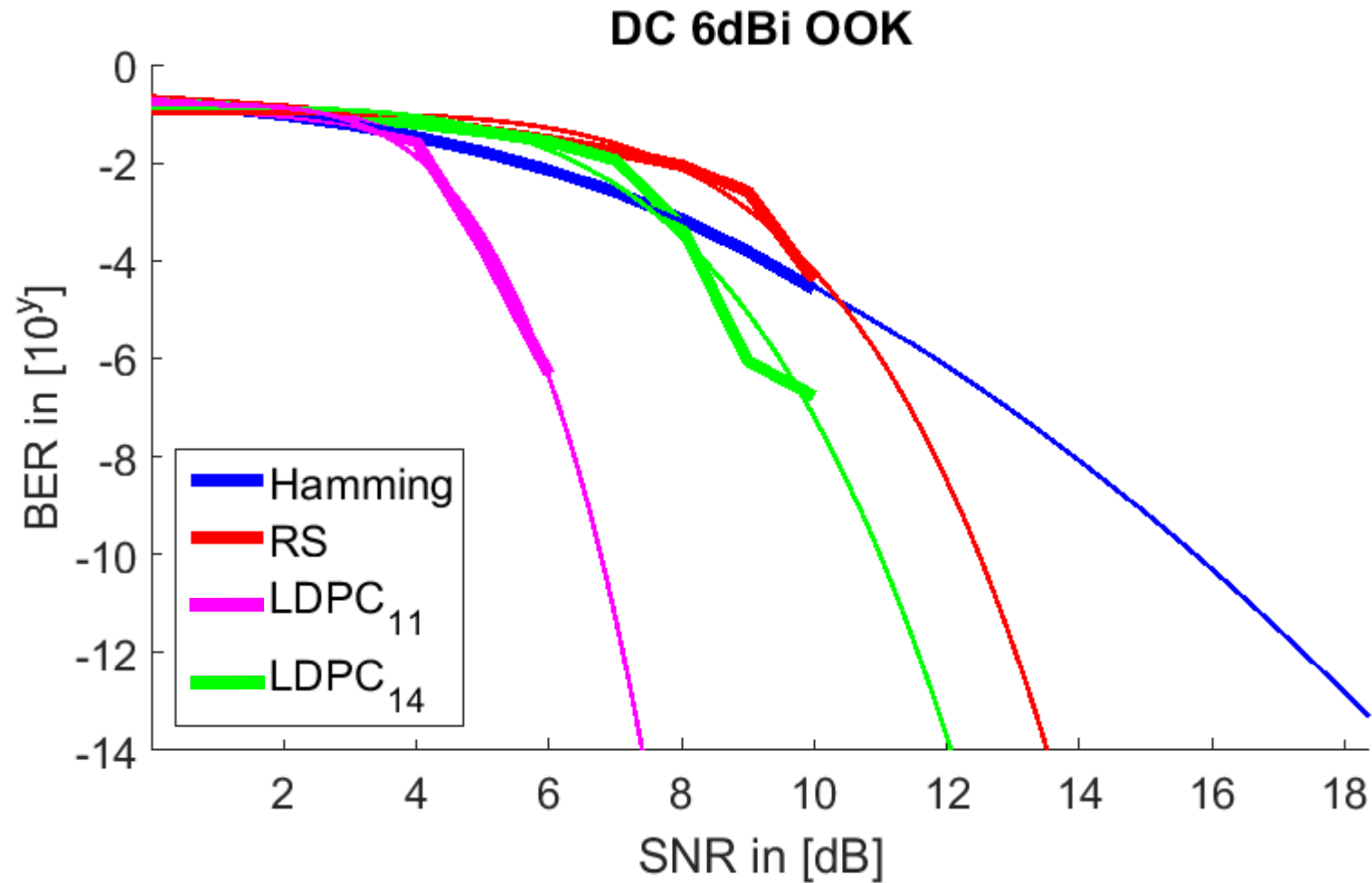
Backhaul/Fronthaul: AWGN



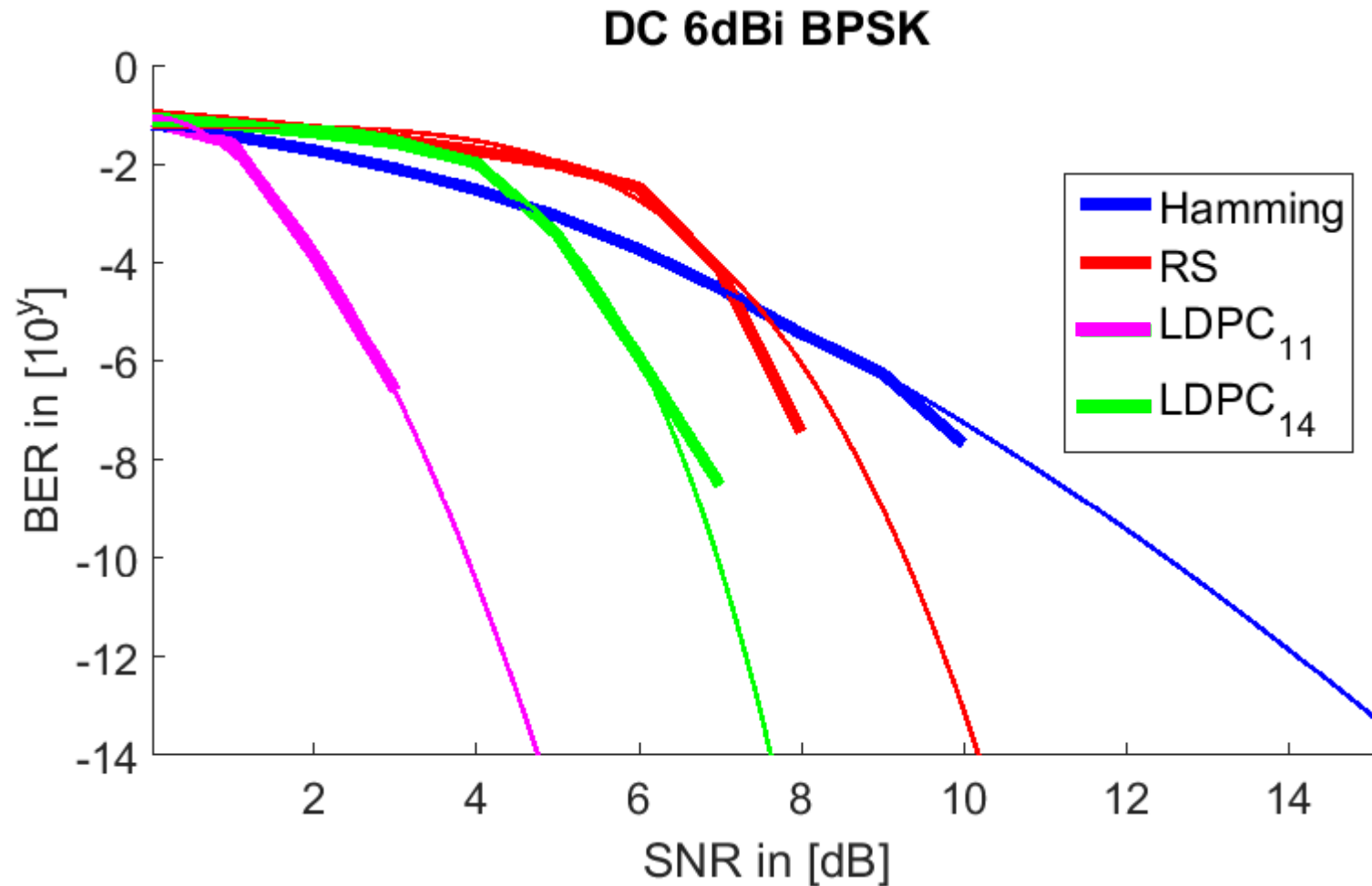
Backhaul/Fronthaul: AWGN



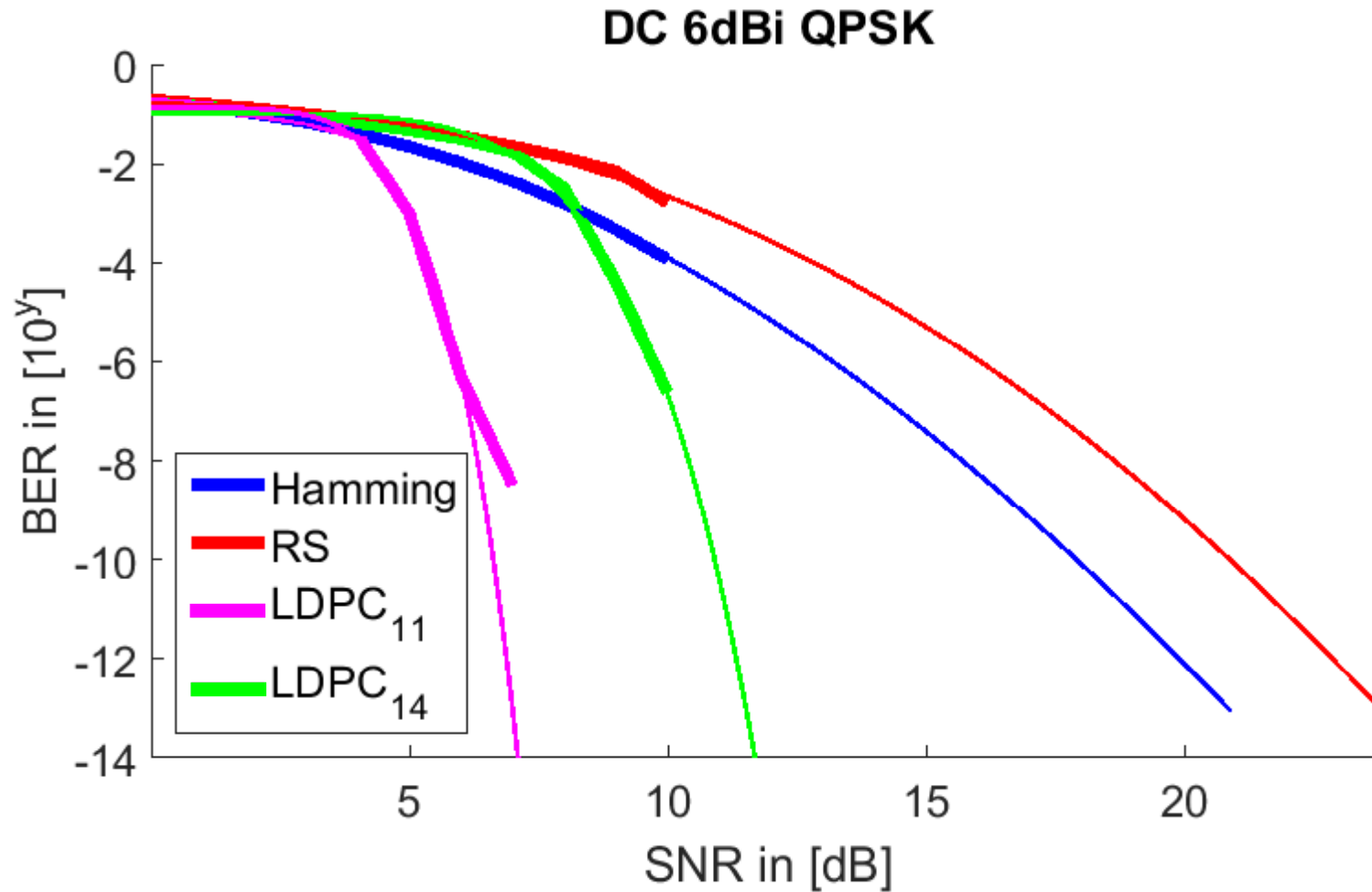
Data Center: 6dBi



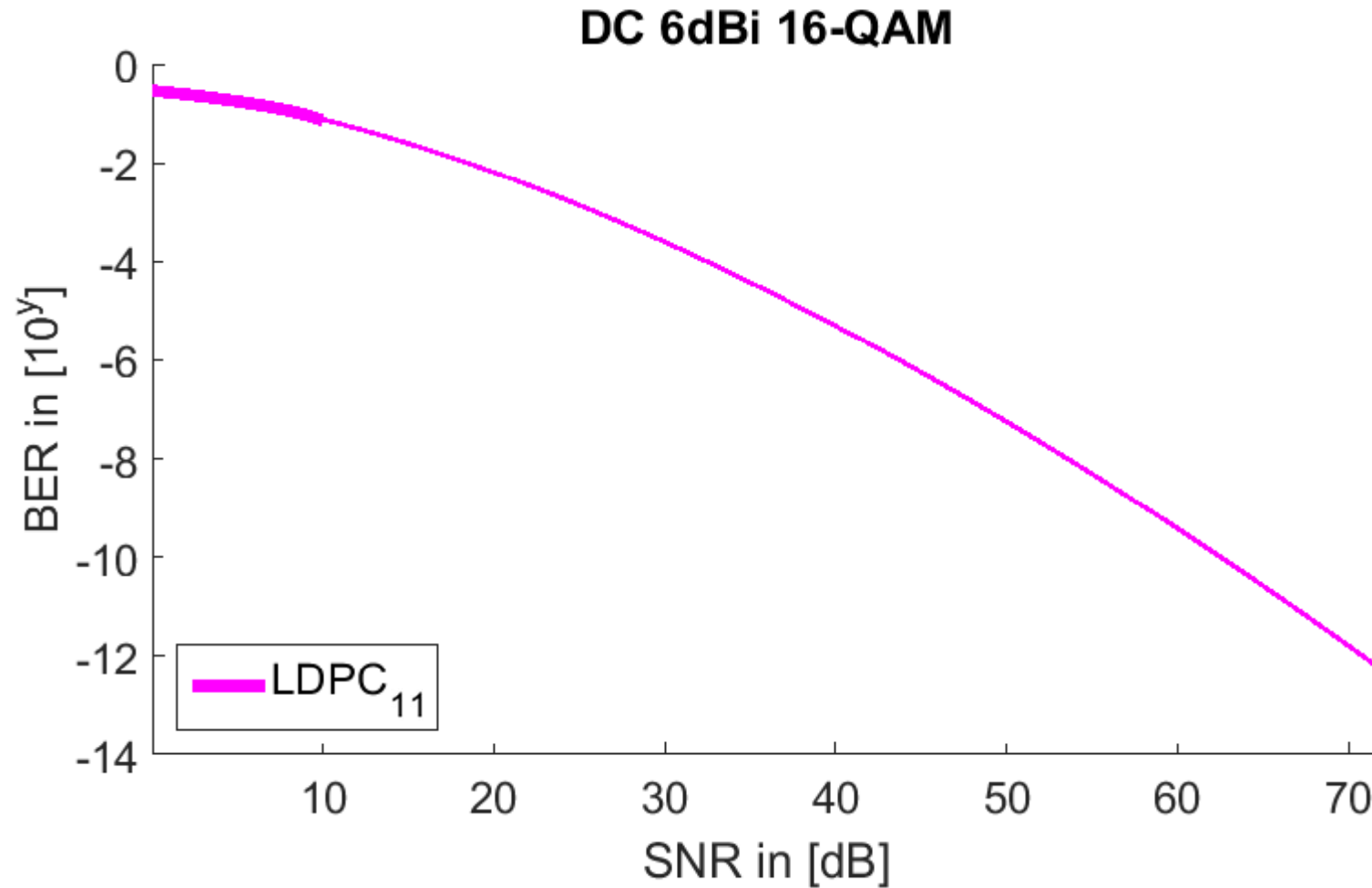
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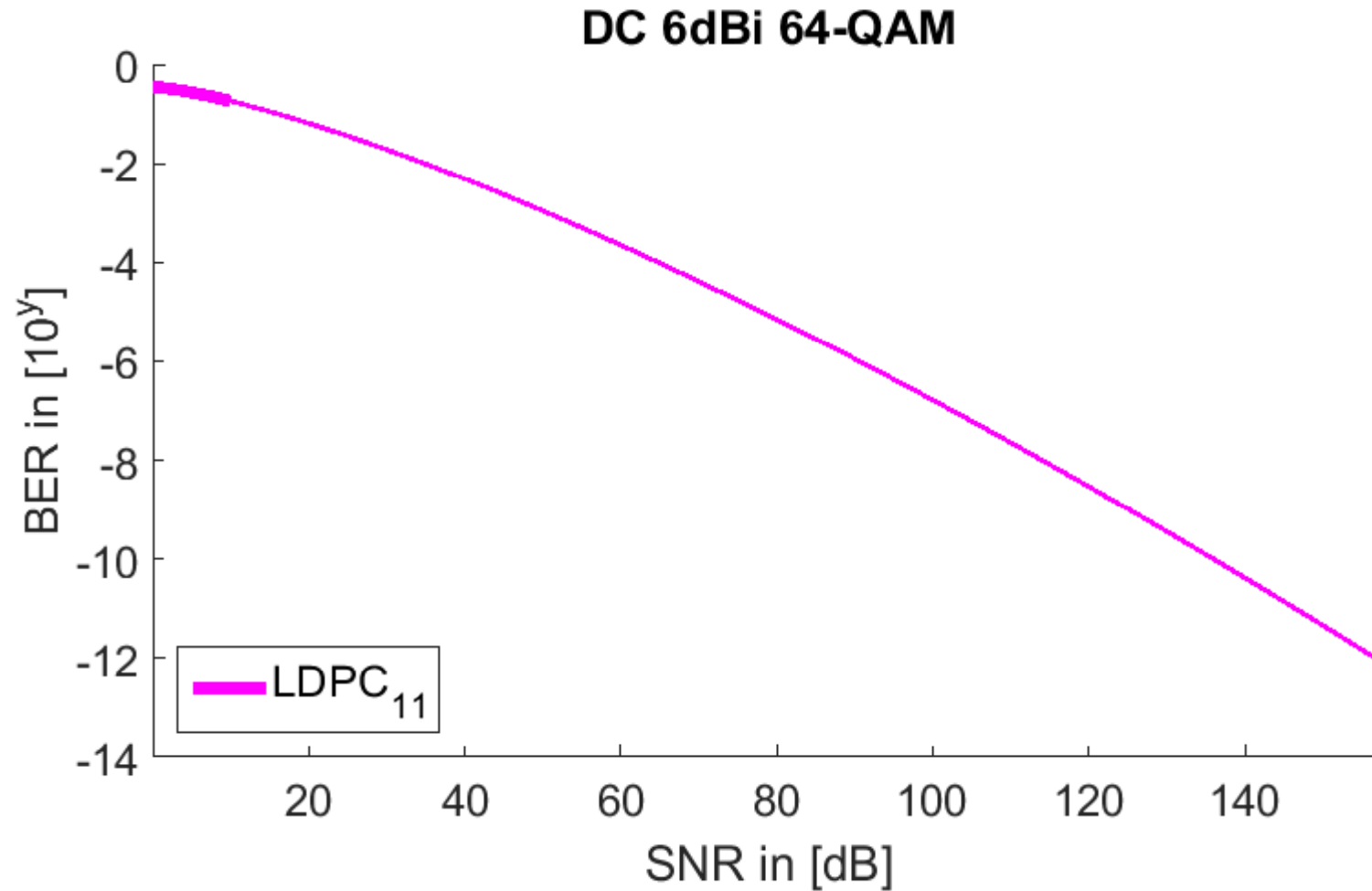
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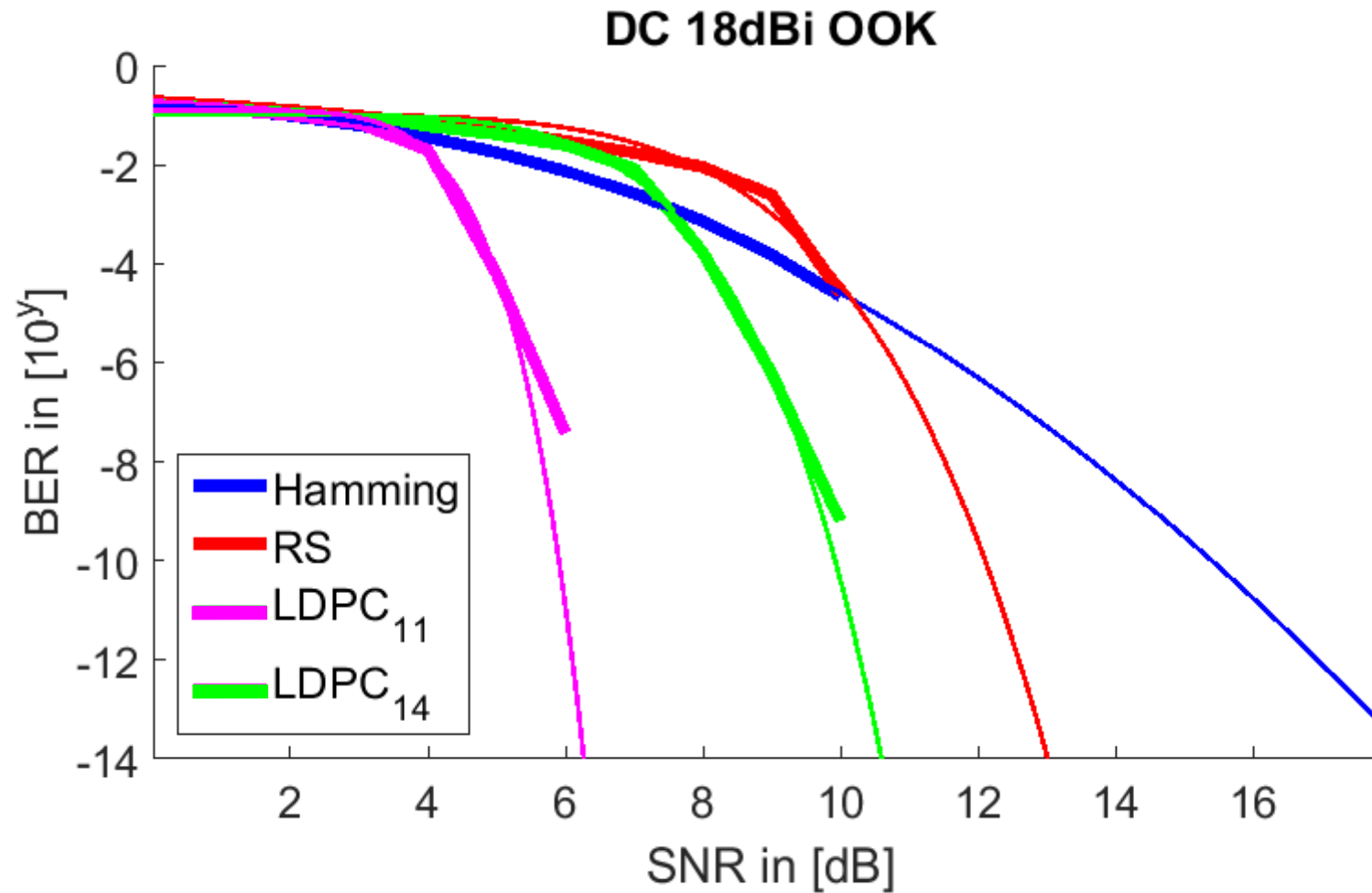
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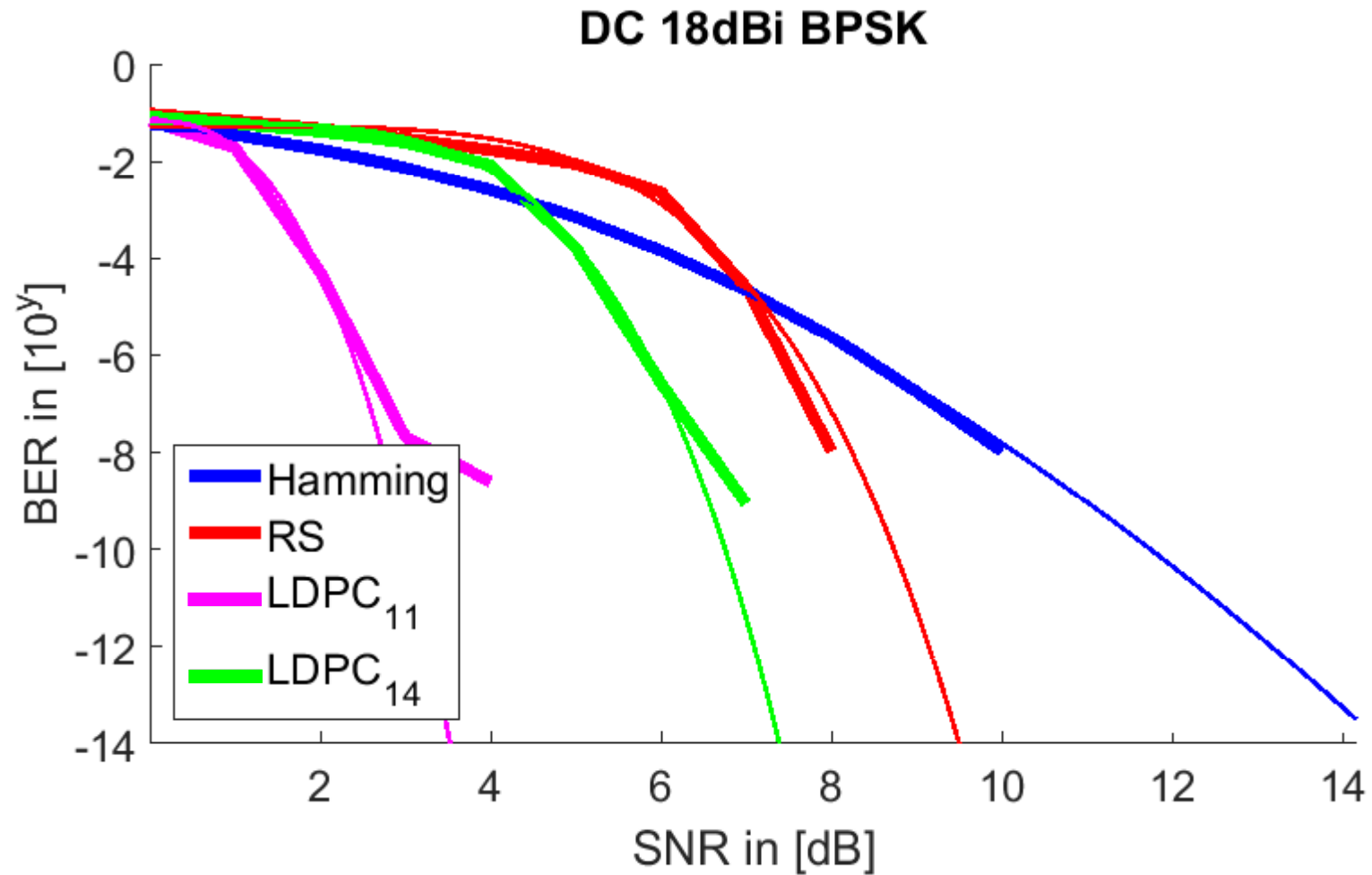
Data Center: 6dBi



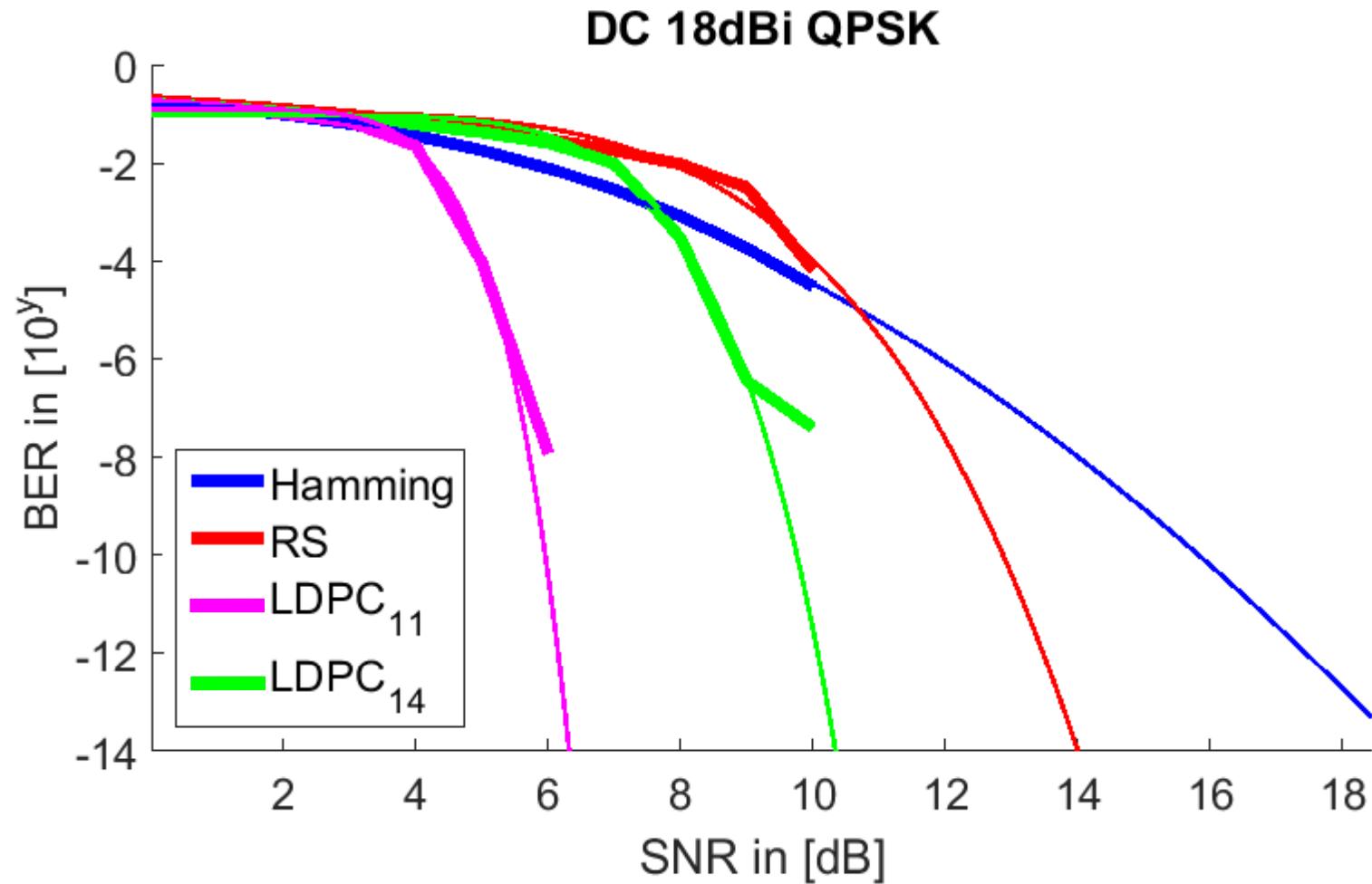
Data Center: 18dBi



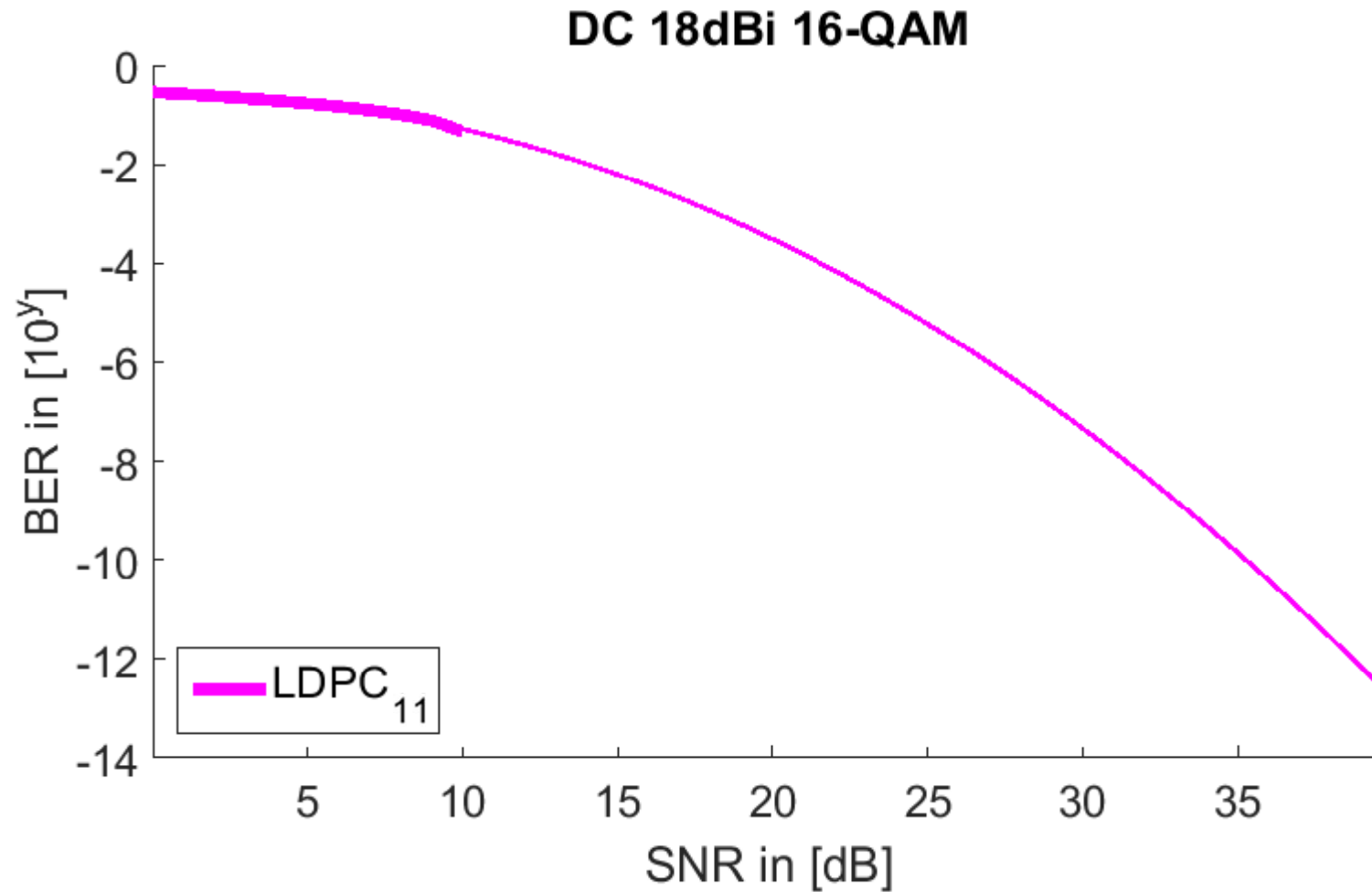
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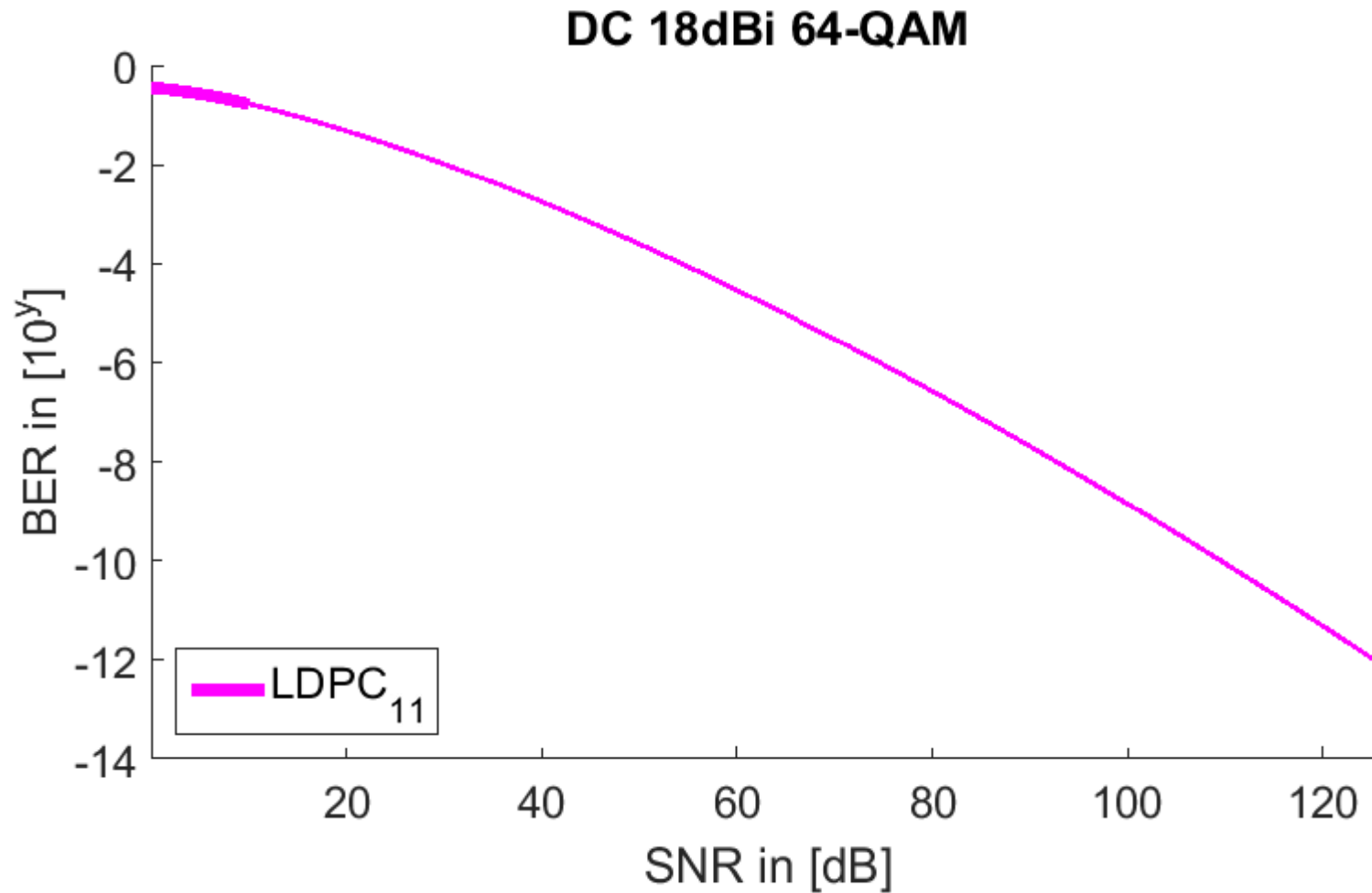
Data Center: 18dBi



Data Center: 18dBi



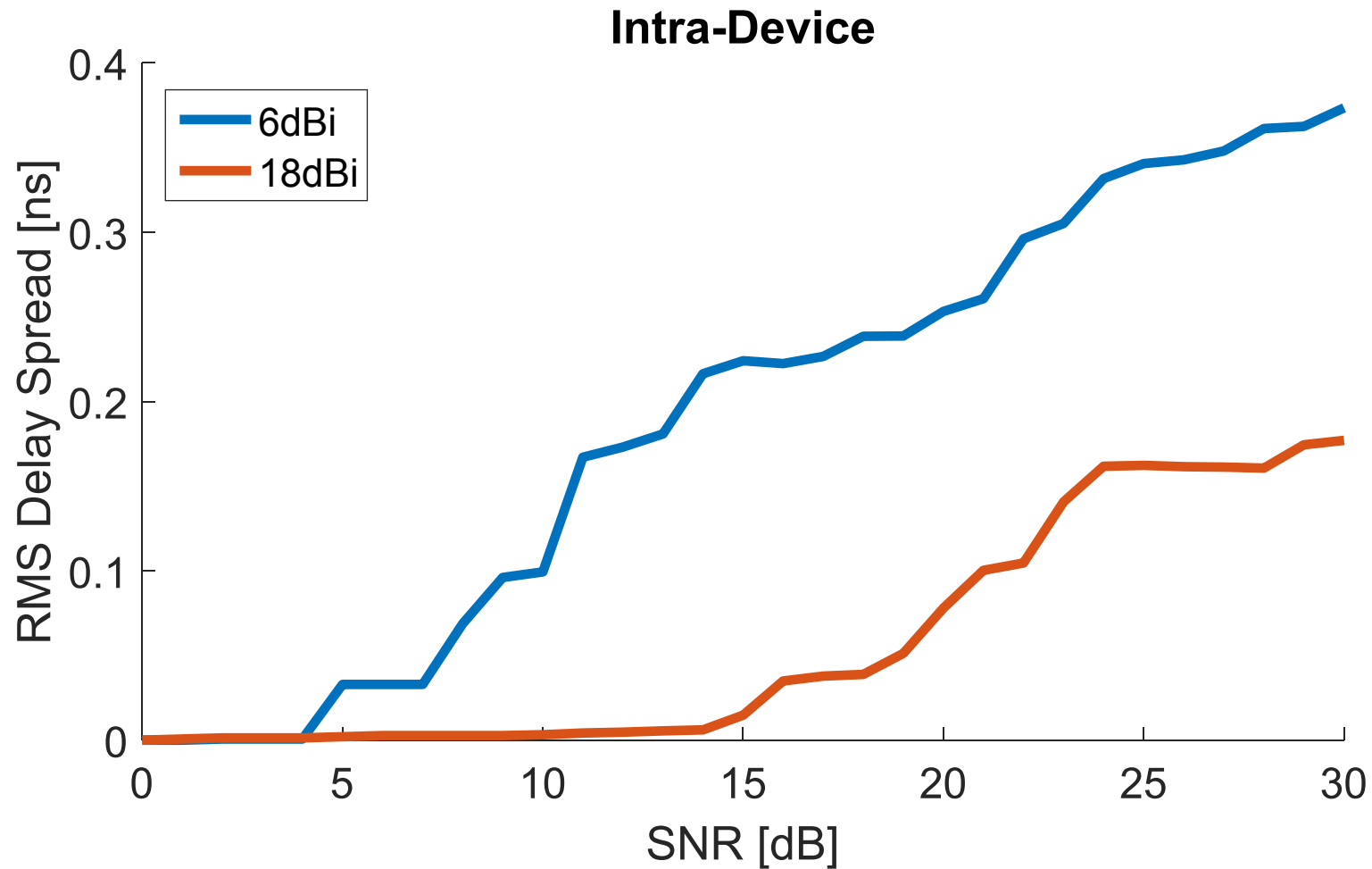
Data Center: 18dBi



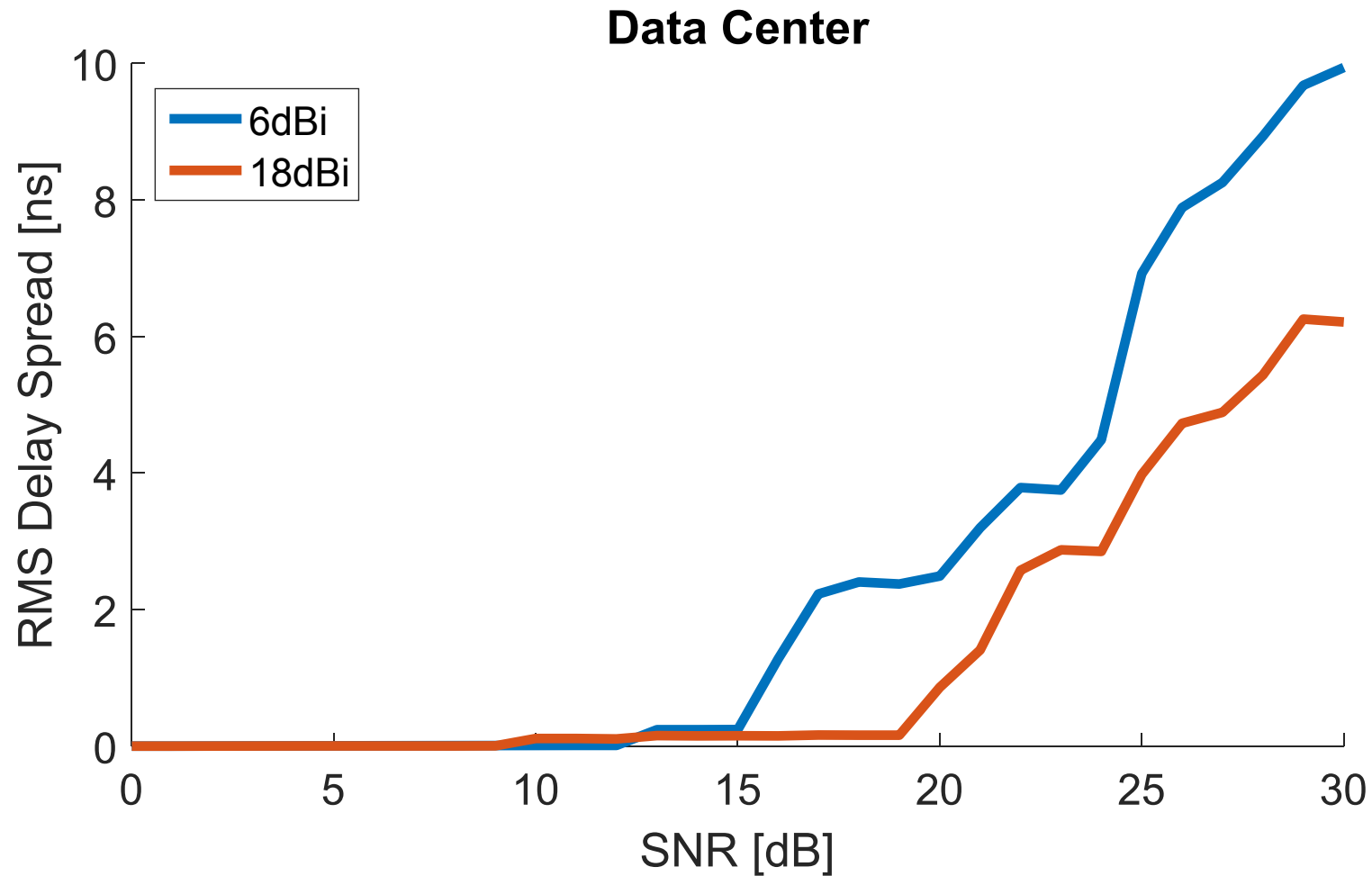
Impact of ISI

- The FEC simulations have so far not shown any error floor
- Since at most 10^8 have been simulated so far, the BER-SNR curves have been extrapolated to allow an estimate of the SNR required to achieve the target BER of 10^{-12}
- Error floors may appear due to Intersymbol Interference (ISI)
- A rough estimate to check, whether ISI may become an issue the RMS delay spread for each channel model is calculated
- In order to calculate the RMS delay spread noise clipping has to be applied, i. e. multipath signals whose amplitude is below a value of maximum peak minus the SNR is discarded. Hence the RMS delay spread becomes a function of the SNR
- If the RMS delay spread is much larger compared to the symbol duration (duration of a chip), ISI may be neglected.
- The chip duration is between ~ 0.023 ns (bandwidth 2.16 GHz) and ~ 0.568 (bandwidth of 69.120 GHz)

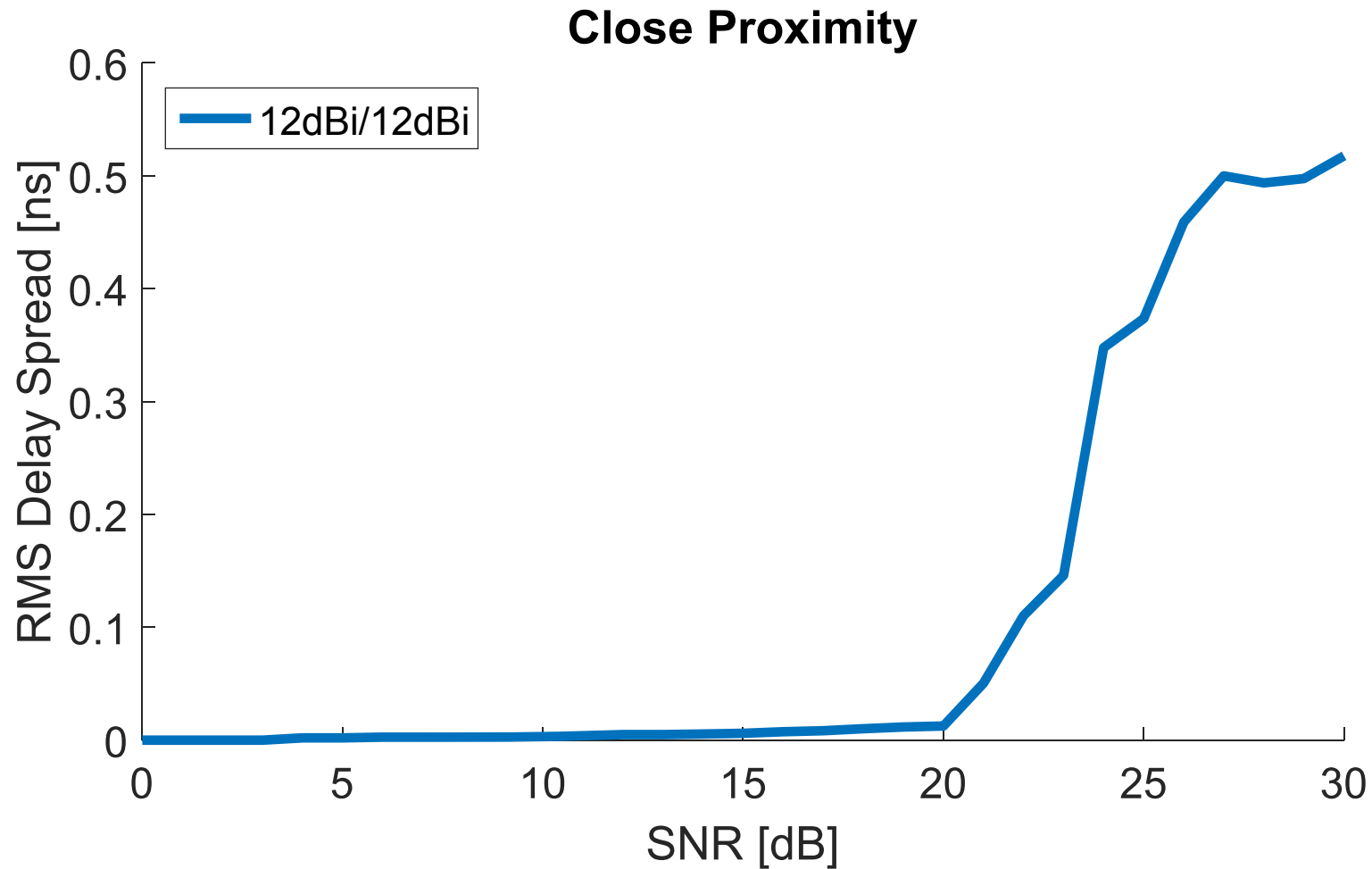
ISI Impact Estimation



ISI Impact Estimation



ISI Impact Estimation



Conclusions on Preliminary Results

- The simulation results show that a BER of 10^{-12} can be achieved in most cases for an SNR in the order of 4-10 dB for OOK, BPSK and QPSK
- First results for 16-QAM and 64-QAM show that it might be difficult to achieve the target BER for reasonable BER. More simulations are needed to confirm this.
- The RMS delay spread is significantly below the RMS delay spread for SNR < 15 dB if antennas with 18 dBi are used. In the intra-device case using antennas with a gain of 6 dBi ISI becomes critical

Thank You
for Your Attention