# Further Comparison of CDM and FDM

**IEEE 802.16 Presentation Submission Template (Rev. 9)**

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Alexei Davydov alexei.davydov@intel.com

Intel Corporation

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Purpose:

Discussion and approval

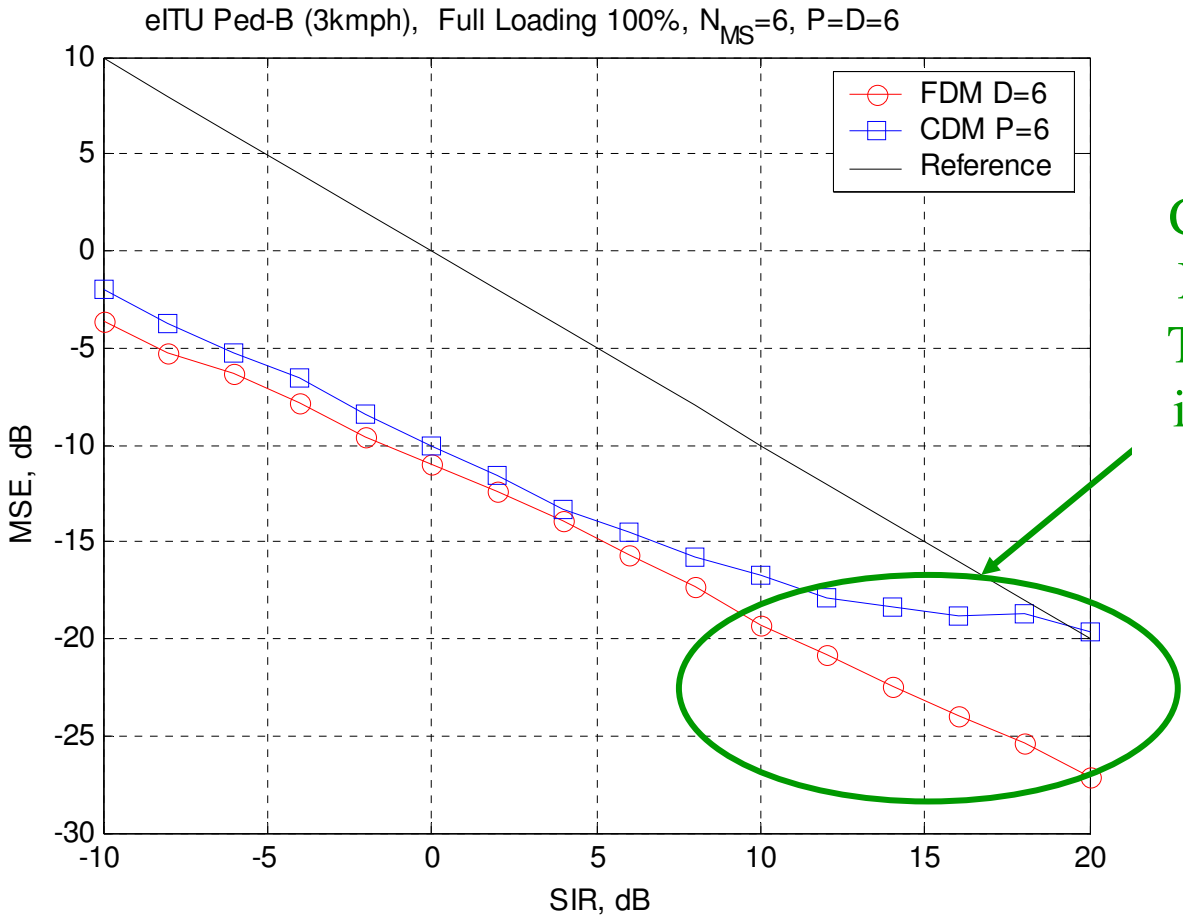
# Introduction

- A link level performance comparison of the CDM and FDM has been conducted in [09/0683], [09/850r1]. It has been found in [09/0683] that FDM outperforms CDM in the full loading scenario in both noise and interference limited scenarios
- A similar performance for FDM and CDM for the full loading scenario has been shown in [09/850r1], but for the partial loading scenario it has been found that CDM outperforms FDM in interference limited scenario. It should be noted that analysis [09/850r1] considers only single interfering source which does not represent a realistic interference scenario
- In this presentation CDM and FDM performance is addressed for both full and partial loading scenarios on the system and link level using more realistic multiple interference sources model

# Link Level Configuration

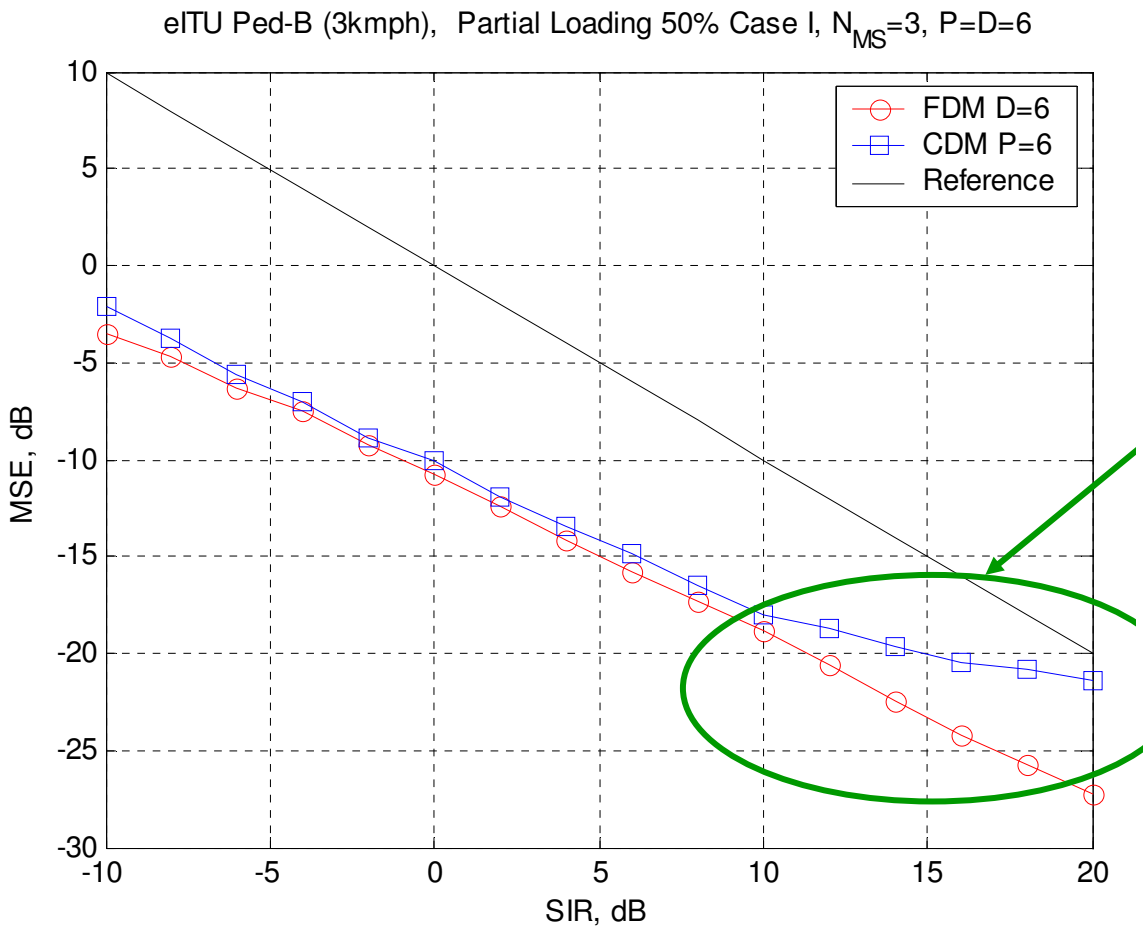
| | |
|---|---|
| System Parameters | 1024 FFT, 10 MHz, 2.4GHz |
| Sounding Sequence | Golay |
| Loading | Full Loading (100%):<br>$N_{MS} = D = P = 6$ |
| | Partial Loading:<br>Case I (50%) $N_{MS} = 3$, $D = P = 6$<br>Case II (33%) $N_{MS} = 6$, $D = P = 18$ |
| Multiplexing | FDM (D decimation), CDM (P max. cyclic shift) |
| Number of interfering sources | 4 sources |
| Estimation | LS+MMSE |

# LLS full loading scenario




FDM outperforms CDM for low MSE region. This region is important for MU-MIMO operation

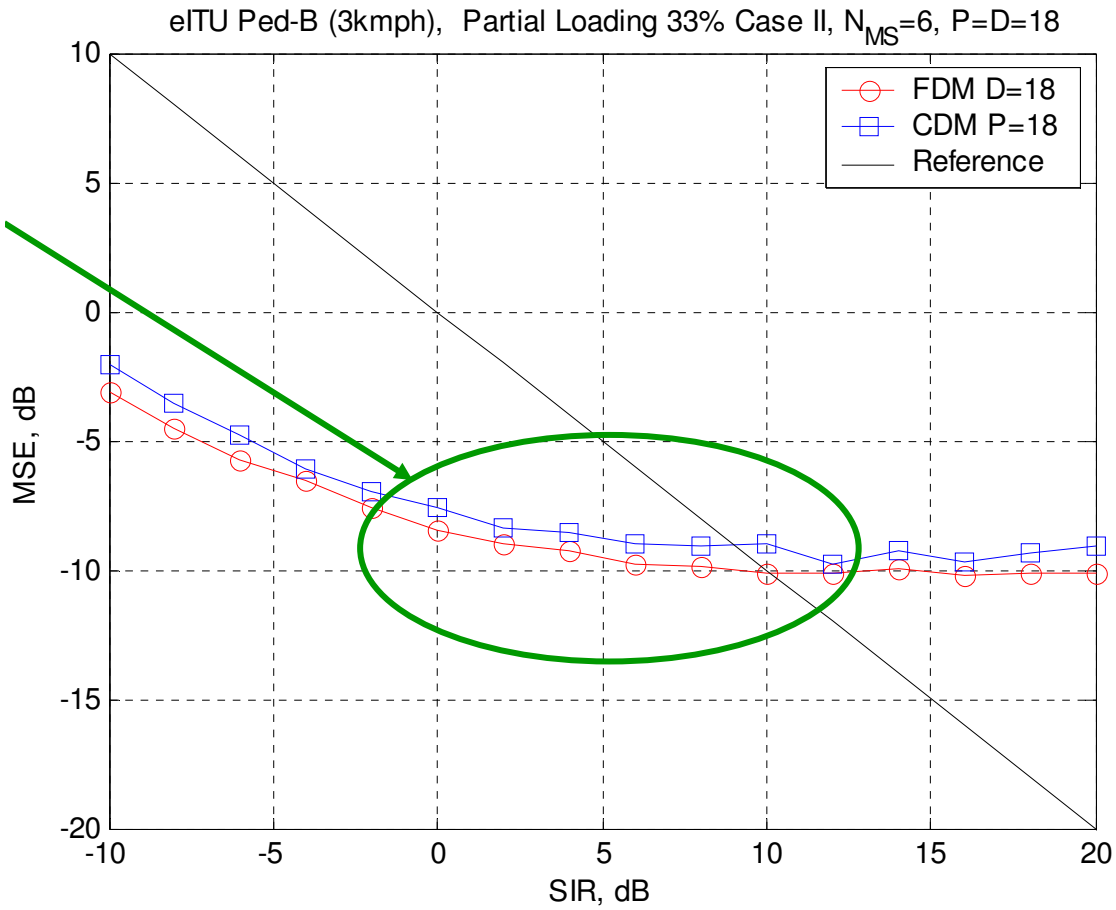
# LLS partial loading scenario: 50% (Case I)




FDM outperforms CDM for low MSE region. These region is important for CL MU-MIMO operation

# LLS partial loading scenario: 33% (Case II)

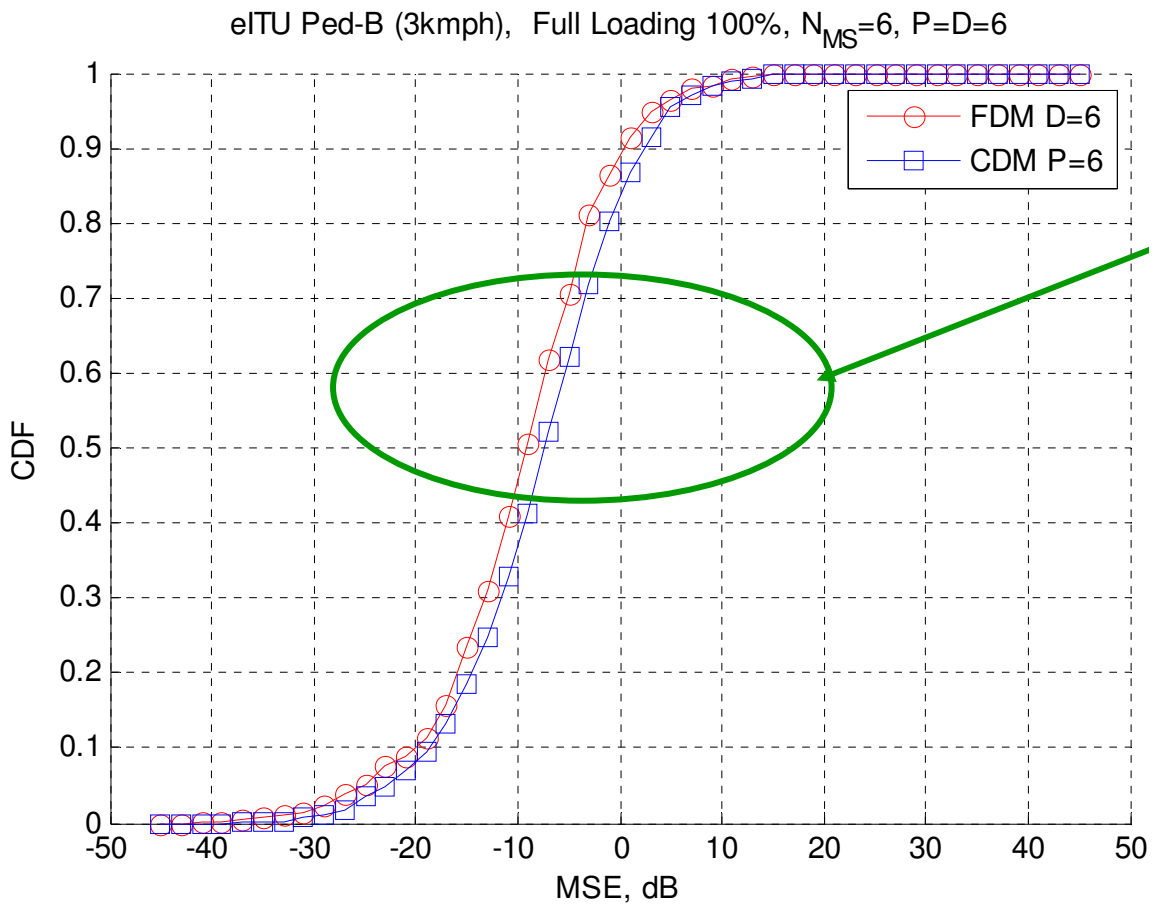
FDM and CDM shows similar performance for all MSE range



# System Level Configuration

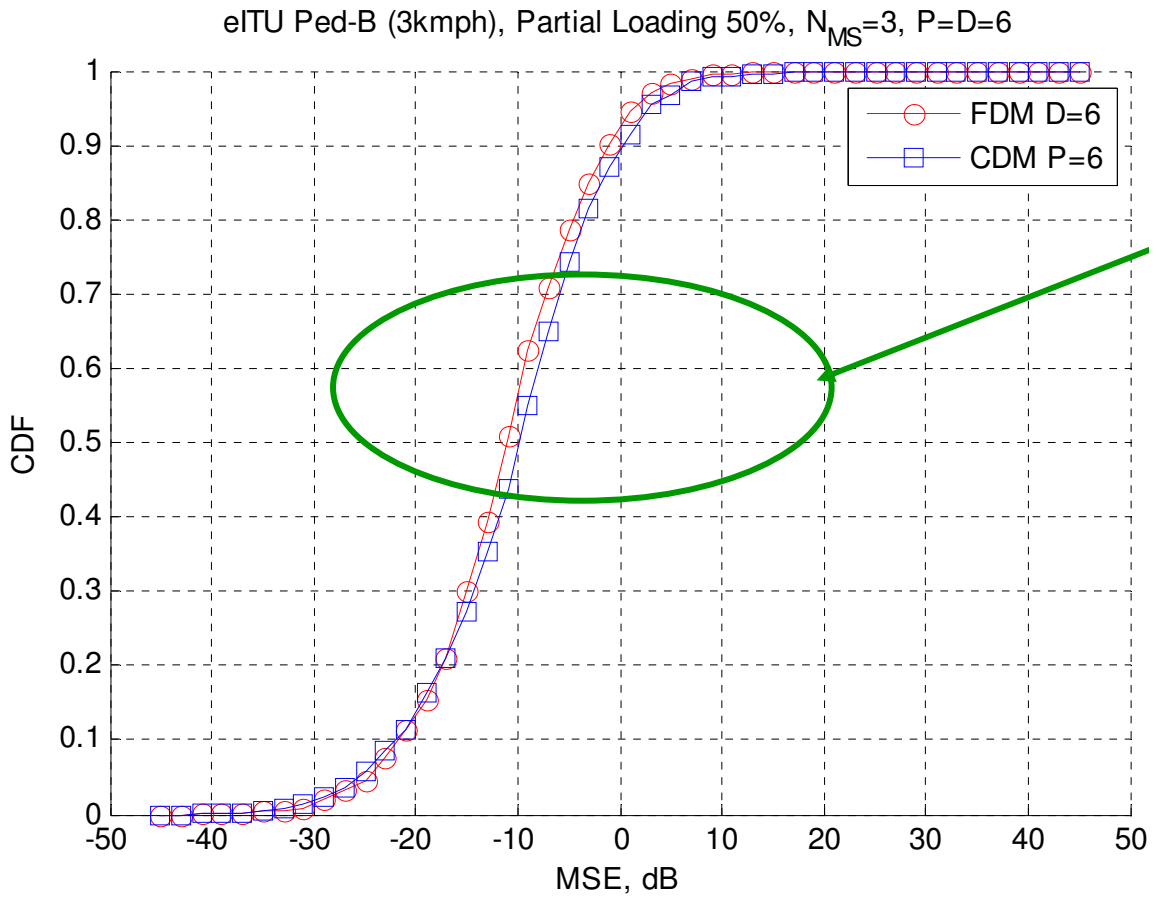
| | |
|---|---|
| System Parameters | 1024 FFT, 10 MHz, 2.4GHz |
| Sounding Sequence | Golay |
| Loading | Full Loading (100%):<br>$N_{MS} = D = P = 6$ |
| | Partial Loading:<br>Case I (50%) $N_{MS} = 3$, $D = P = 6$<br>Case II (33%) $N_{MS} = 6$, $D = P = 18$ |
| Multiplexing | FDM (D decimation), CDM (P max. cyclic shift) |
| Number of interfering sources | 57 sectors |
| Target SINR | 10 dB |
| Estimation | LS+MMSE, 18 subcarriers |

# SLS full loading scenario



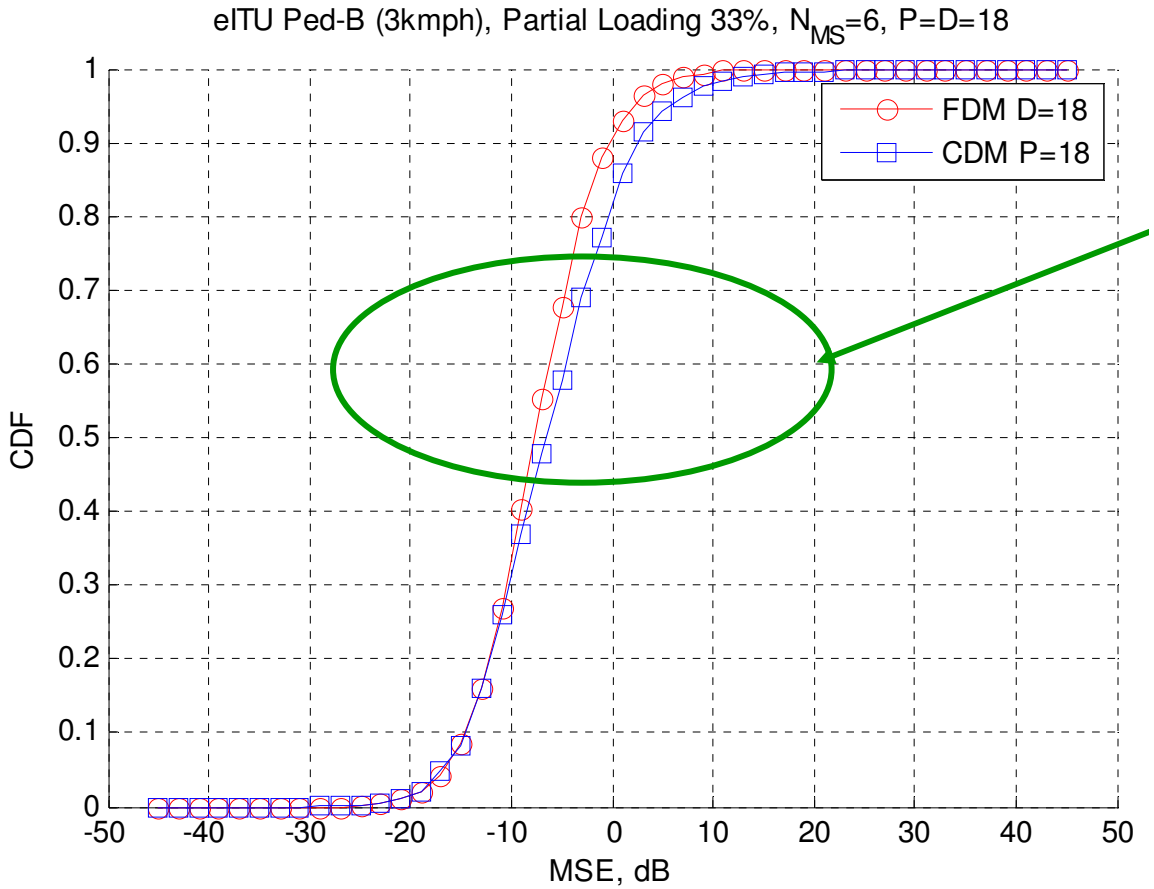

FDM outperforms CDM for almost all MSE region

# SLS partial loading scenario: 50% (Case I)




FDM outperforms CDM for almost all MSE region

# SLS partial loading scenario: 33% (Case II)

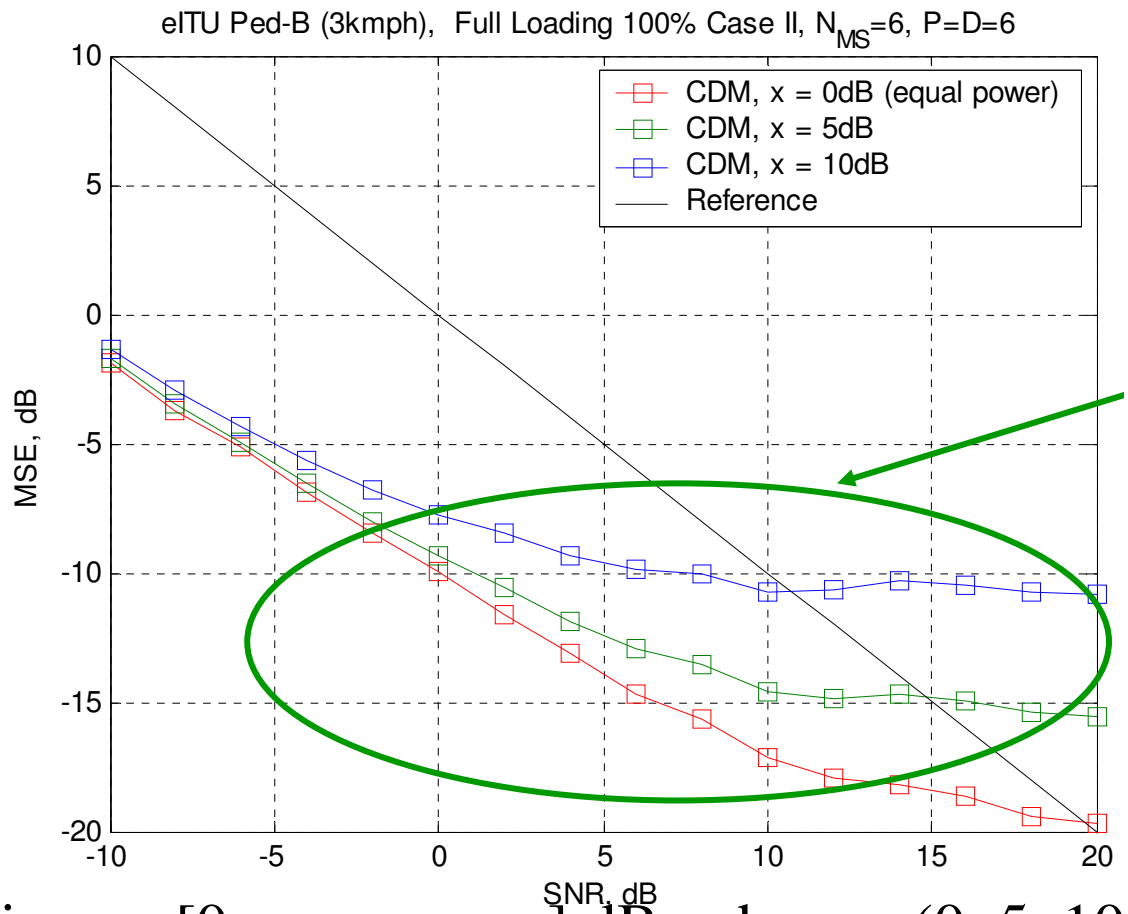



FDM outperforms CDM for almost all MSE region

# Further considerations

- Multi-target power control
  - Due to loss of code orthogonality in frequency selective channels low power CDM MS suffers from the same sector interference noise of high power MS (well known near-far problem inherent to all code division multiplexing systems) . FDM is robust to multi target power control settings
- Timing error
  - CDM is sensitive to the timing errors (see [09/0683])

# CDM with multi-target CINR power control




Low power CDM MS is suffering from same sector interference of high power MS in low and medium MSE regions. These regions are important for CL MU-MIMO operation

MS power settings = [0, x, x, x, x, x] dB, where x (0, 5, 10 dB) is relative received power diff. between analyzed MS and high power MS

# Conclusions

- FDM shows similar or better performance in noise and interference limited scenarios for different loading configurations
- FDM is more robust to the timing and power control errors
- FDM can easily support multi-target uplink power control without scarifying performance of low power MSs

# Proposed remedy

***Modify the text in lines 65, page 118 (section 15.3.9.2.3.2.)***

***15.3.9.2.3.2 Multiplexing for multi-antenna and multi-AMS***

AMS and multiple antennas per AMS can be multiplexed through ~~[Option 1: decimation separation or cyclic shift separation][Option2:~~ decimation separation] in each sounding allocation. Also, in case of multiple UL subframes for sounding, time division separation can be applied by assigning different AMS to different UL subframe. ~~For cyclic shift separation each AMS occupies all subcarriers within sounding allocation and uses the different sounding waveform [Editor's note: remove this sentence if Option 2 will be adopted]~~. For frequency decimation separation each AMS uses decimated subcarrier subset from the sounding allocation set with different frequency offset. For antenna switching capable AMS, ABS can command the AMS to switch the physical transmit antenna(s) for sounding transmission. The details for supporting antenna switching on sounding is TBD.