the mean is computed by averaging over $\Delta_k$. In step 2 of the Lloyd’s algorithm outlined in section III-B1 the probabilities are calculated by Monte Carlo simulation over 100,000 vector channel realizations.

![Fig. 10. Outage performance of 1, 2 and 4-bit feedback, full CSI and EPA of the 2-cluster network for $m = 0.5$.](image1)

![Fig. 11. Outage performance of 1, 2 and 4-bit feedback, full CSI and EPA of the 2-cluster network for $m = 2$.](image2)

The near-optimality of the EPPC based algorithm at high average power is illustrated through Fig. 12. This figure shows how the EPPC-based algorithm (SLA combined with EPPR and EPPC) approaches the performance of the SLA-based algorithm (without any further approximations) as the average power increases for the 2-cluster network with 1-bit feedback for $m = 0.5, 1$ and $2$. For $m = 2$, the region that belongs to the high average power is roughly $P_{av} > -40$ dBW, as shown in Fig. 12. Similar results (not included in order to avoid repetition) were seen for other values of $N, m$ and $R$, albeit with different thresholds for $P_{av}$ above, for which the EPPC-based approximations perform close to the SLA-based algorithm.

The outage performance for $N = 6, R = 1, 2, 4$ obtained by using EPA, SLA, SPSA and full CSI for $m = 0.5$ and $m = 2$ are shown in Fig. 13 and Fig. 14 respectively. The parameters used in SPSA here are the same as for $N = 2$. Observe again the effect of diversity gain with the increased number of clusters. The gap between the 4-bit feedback and the full-CSI has widened. This may be due to the fact that the feedback resolution per CH decreases as $N$ increases with a fixed $R$. Simulation results show that at $P_{outage} = 0.1$, having a 4-bit feedback can achieve half the power gain (in dB) than that of EPA relative to full CSI.