

Forward Link Simulation Results for HSDPA

TSG-RAN Working Group1 meeting#16 TSGR1#16(00)1241
Pusan, Korea , 10th-13th Oct 2000
Agenda Item: AdHoc#24, HSDPA
Source: Motorola



- Carrier Frequency=2GHz
- Rayleigh fading using Jakes model
- Channel: 1 ray and 2 equal rays
- Soft-Decision
- Turbo code rates: 1/4, 1/2 and 3/4
- Spreading: 3.84Mcps
- Pilot=-10dB
- E_c/I_{or} =-1dB
- Number of Orthogonal codes: 1 and 2
- Ideal Channel Estimation (ICE)
- QPSK, 8-PSK, 16-QAM, 64-QAM

FER versus Ior/Ioc

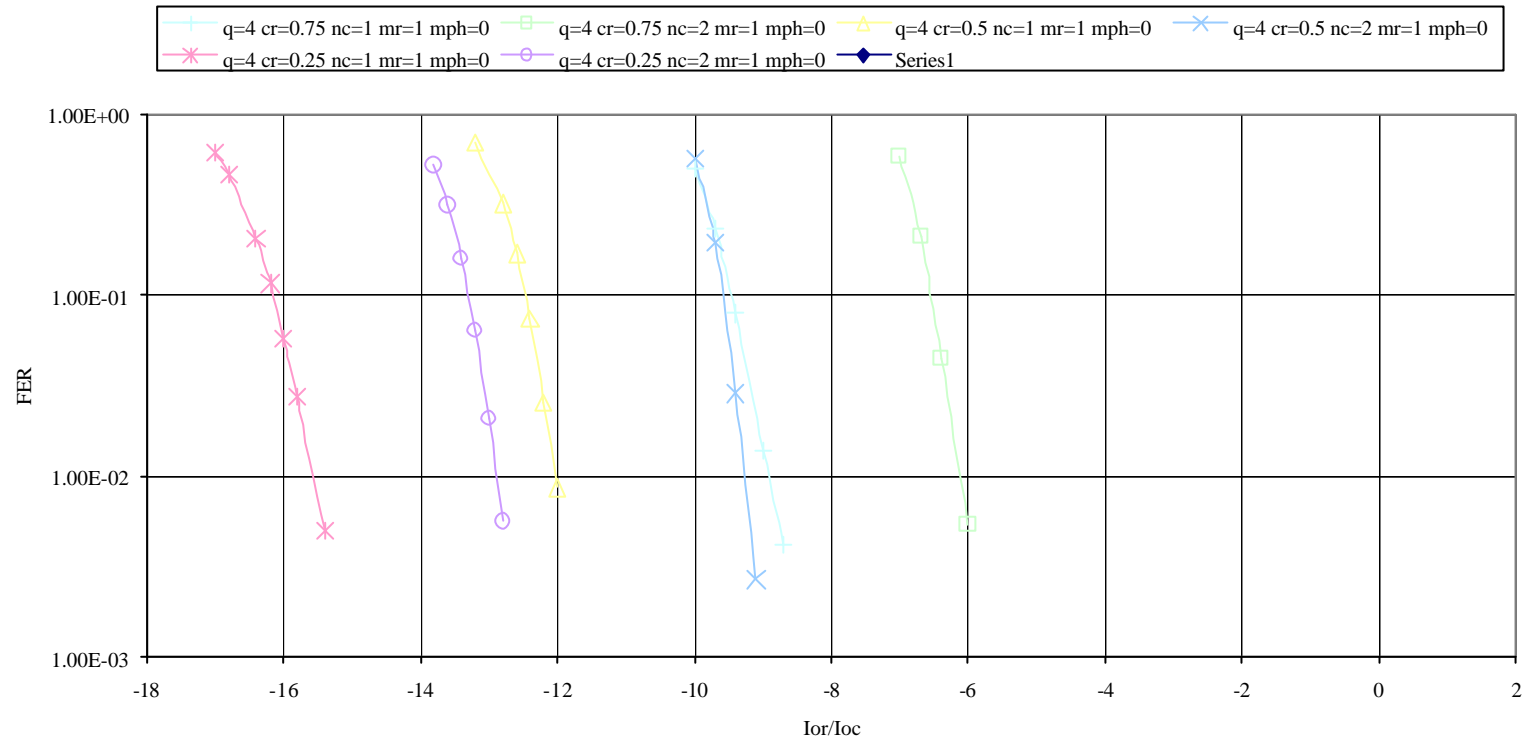
QPSK

MCS 1, 2 and 3

Static - QPSK

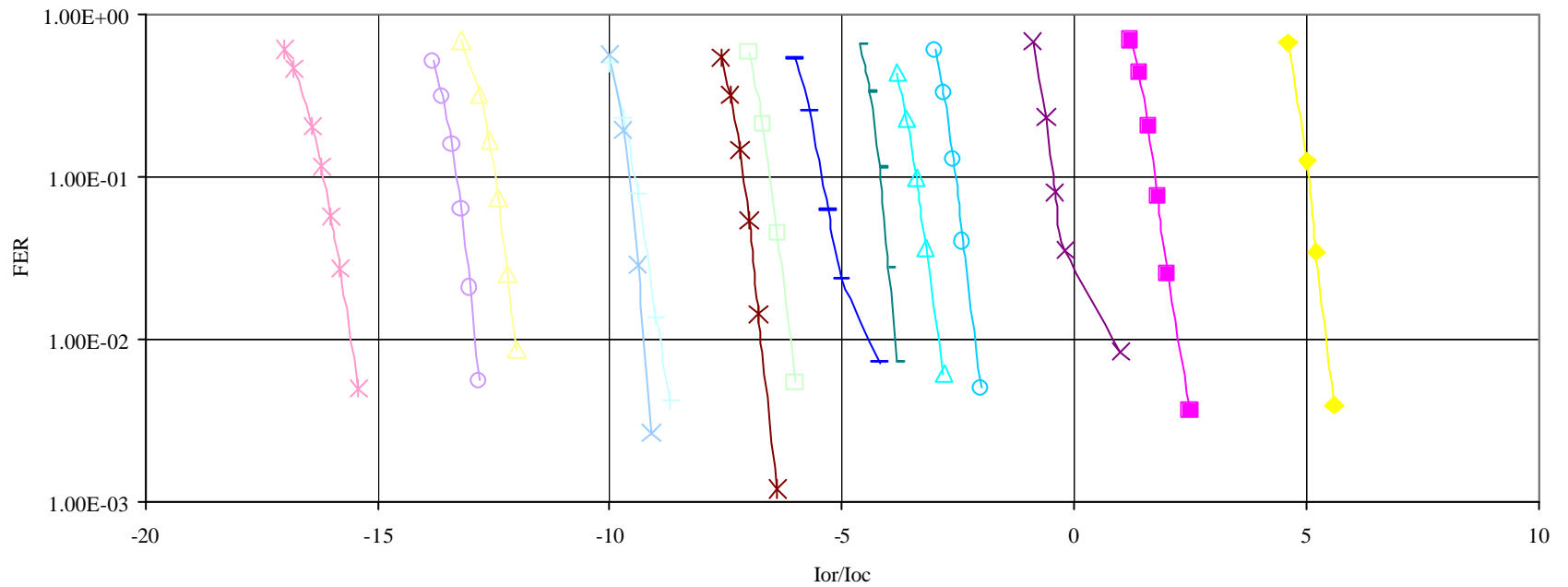
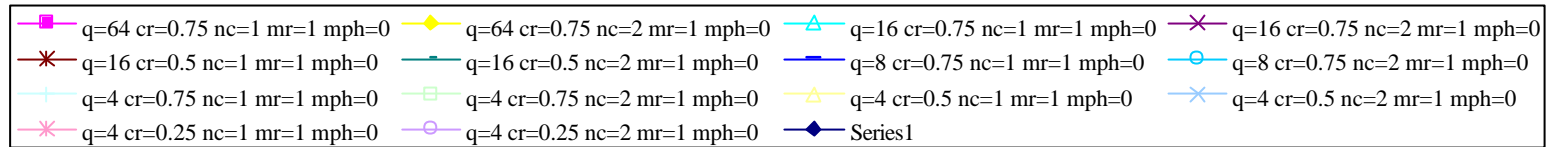


ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1





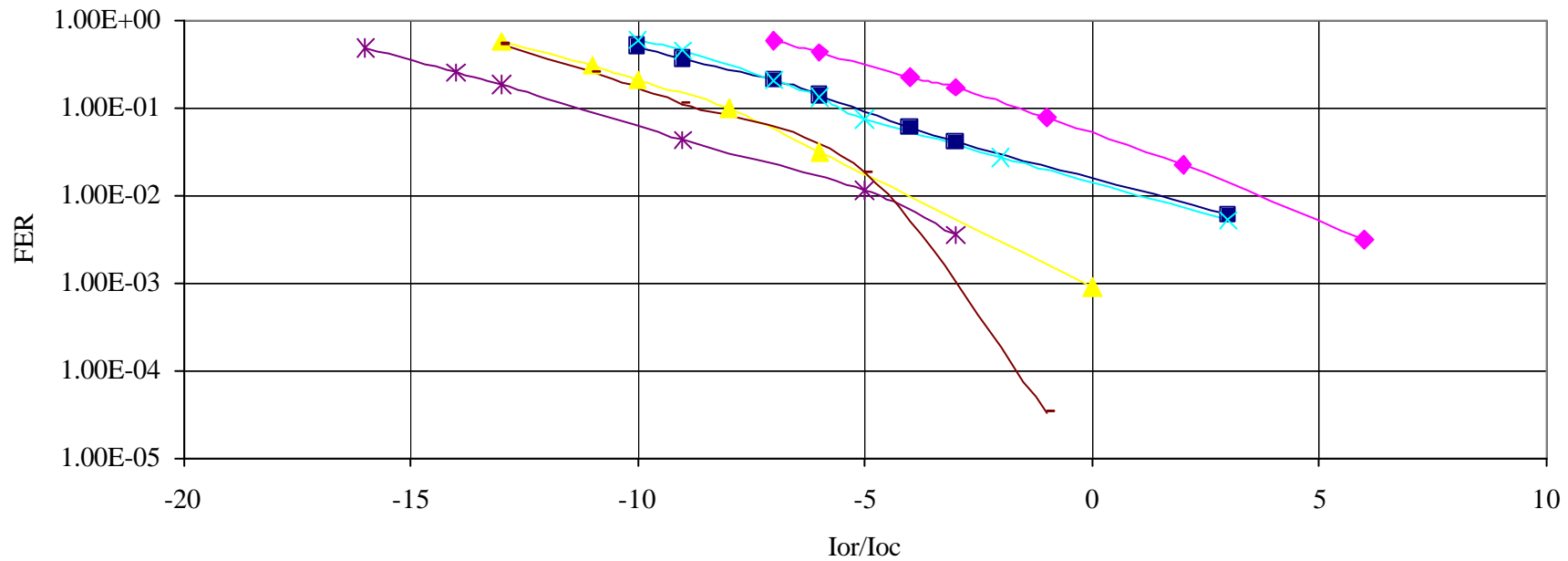
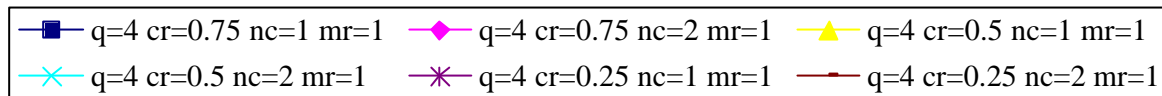
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1



3Kmph 1-path QPSK STTD=1



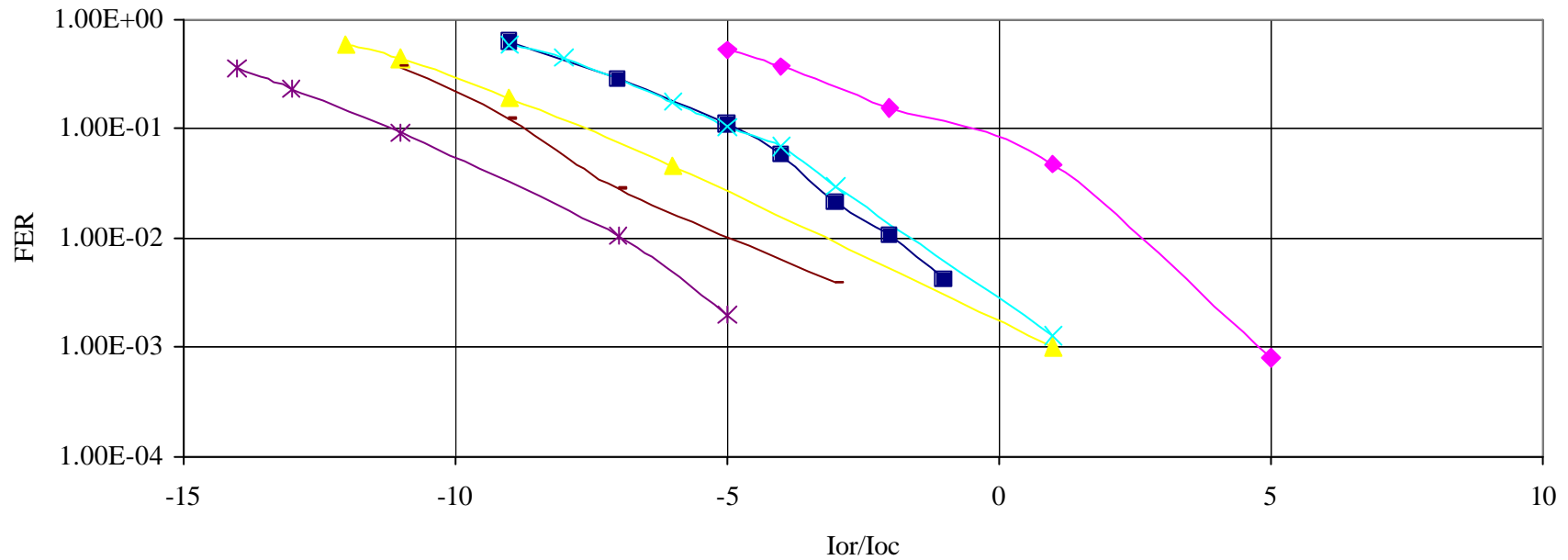
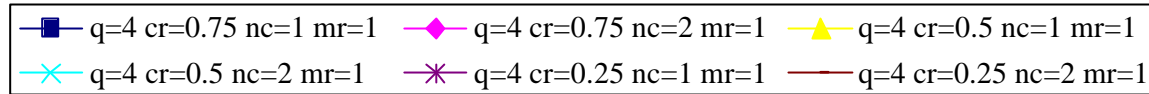
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path QPSK STTD=1



ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86

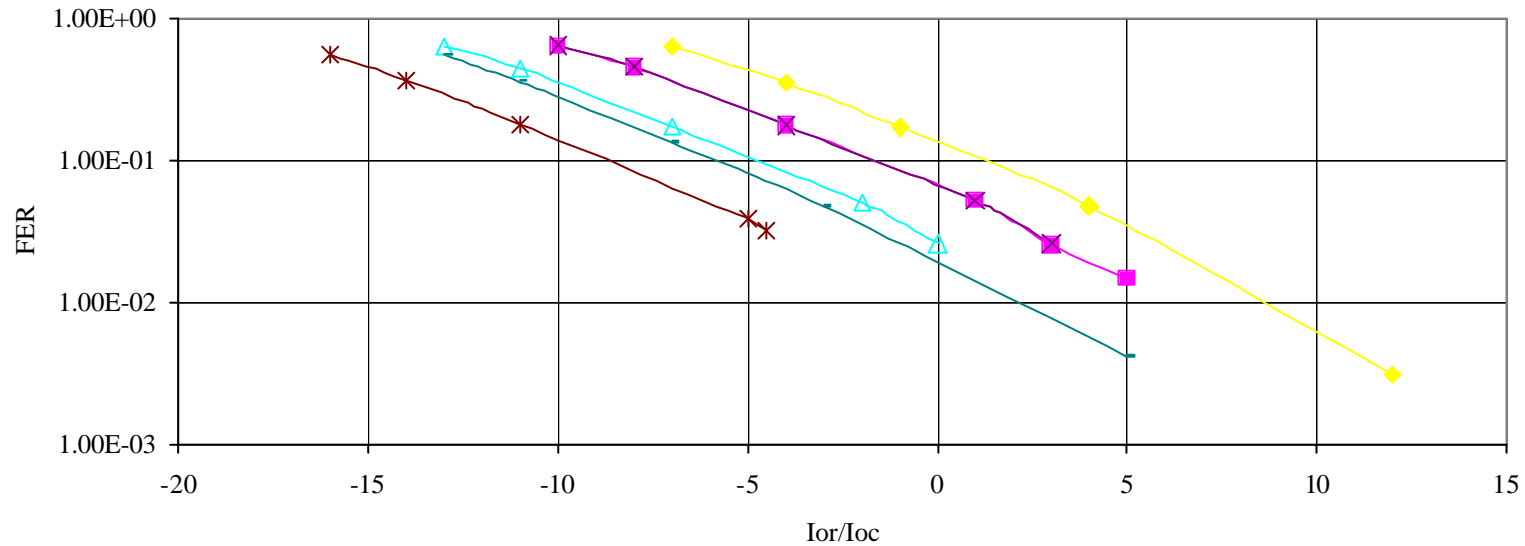


3Kmph 1-path QPSK STTD=0



ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecor=-1 mph=1.86

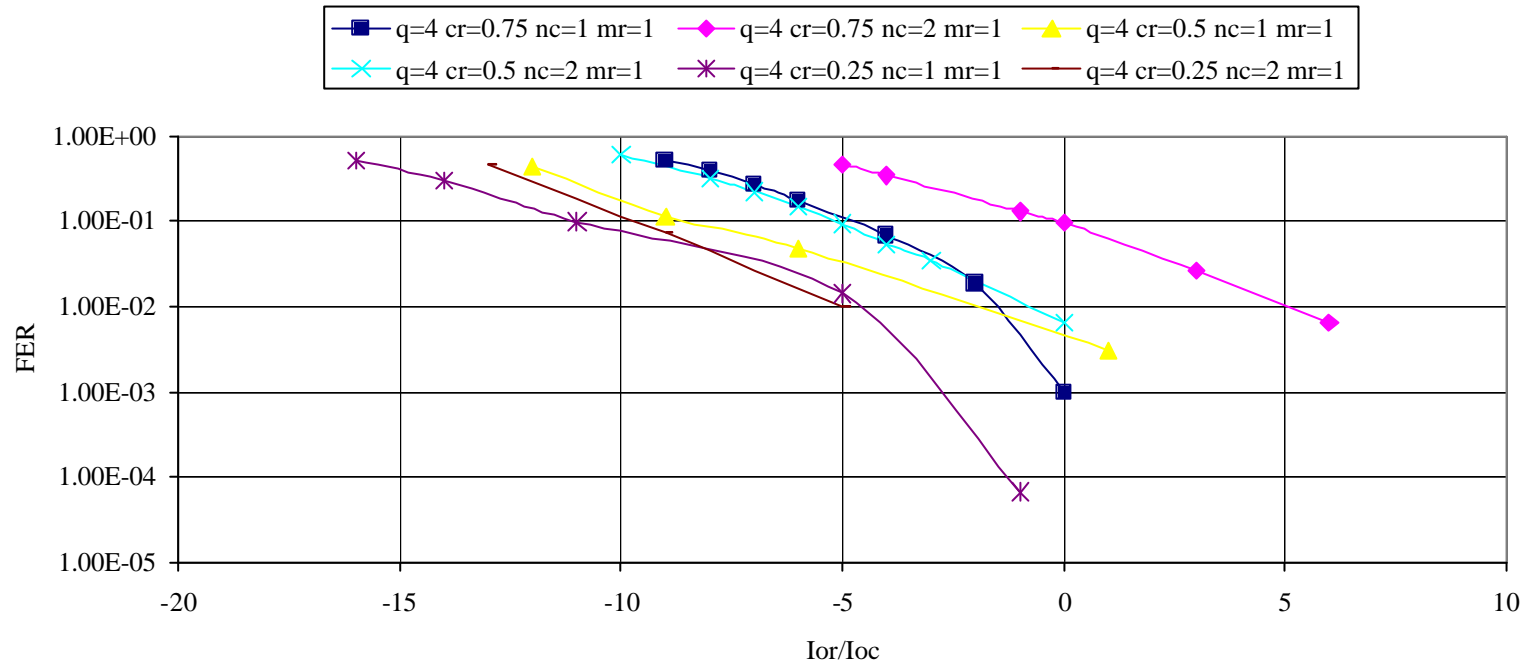
■ q=4 cr=0.75 nc=1 mr=1	◆ q=4 cr=0.75 nc=2 mr=1	△ q=4 cr=0.5 nc=1 mr=1	✕ q=4 cr=0.5 nc=2 mr=1
* q=4 cr=0.25 nc=1 mr=1	— q=4 cr=0.25 nc=2 mr=1	◆ Series1	



3Kmph 2-path QPSK STTD=0



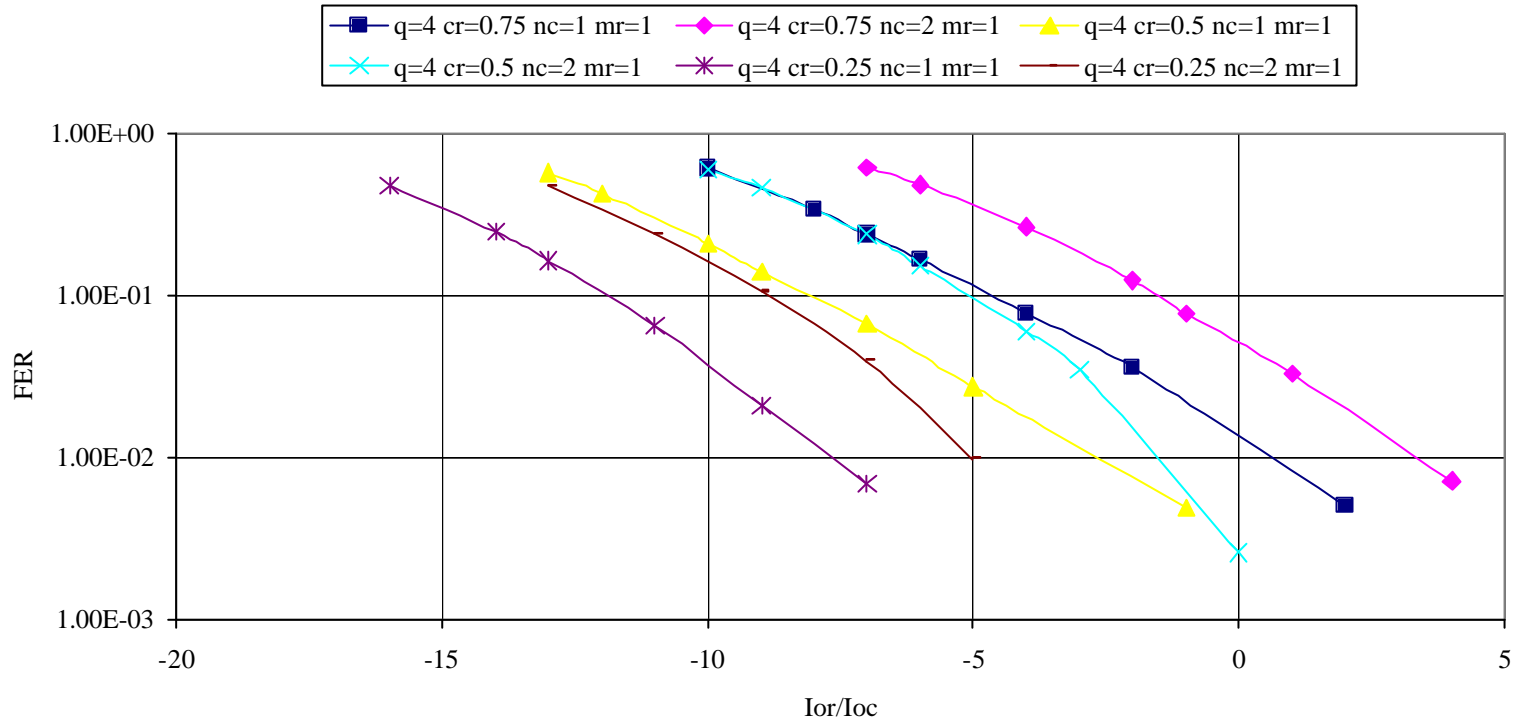
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



30Kmph 1-path QPSK STTD=1



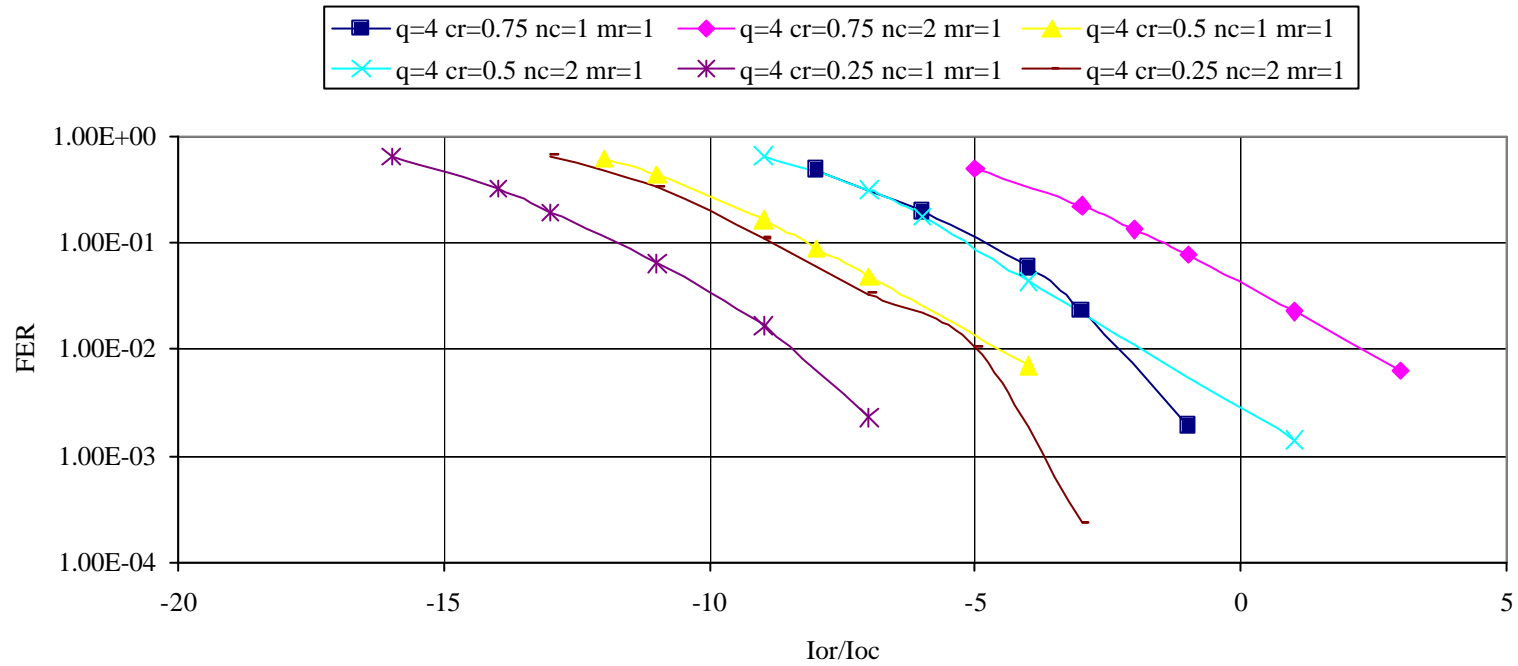
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecor=-1 mph=18.64



30Kmph 2-path QPSK STTD=1



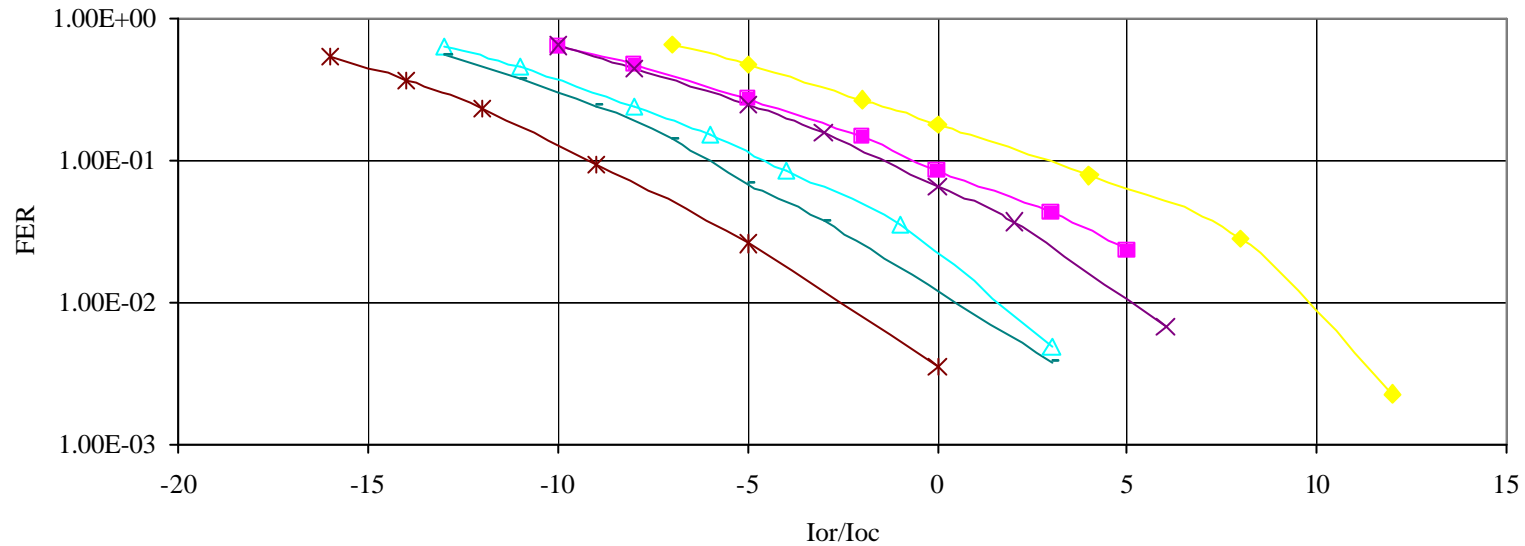
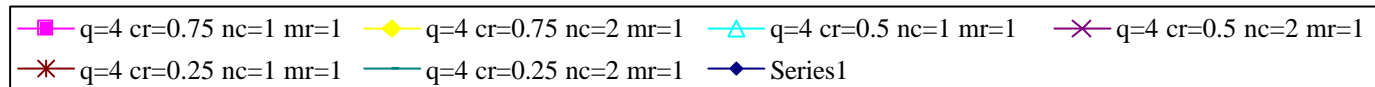
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 1-path QPSK STTD=0



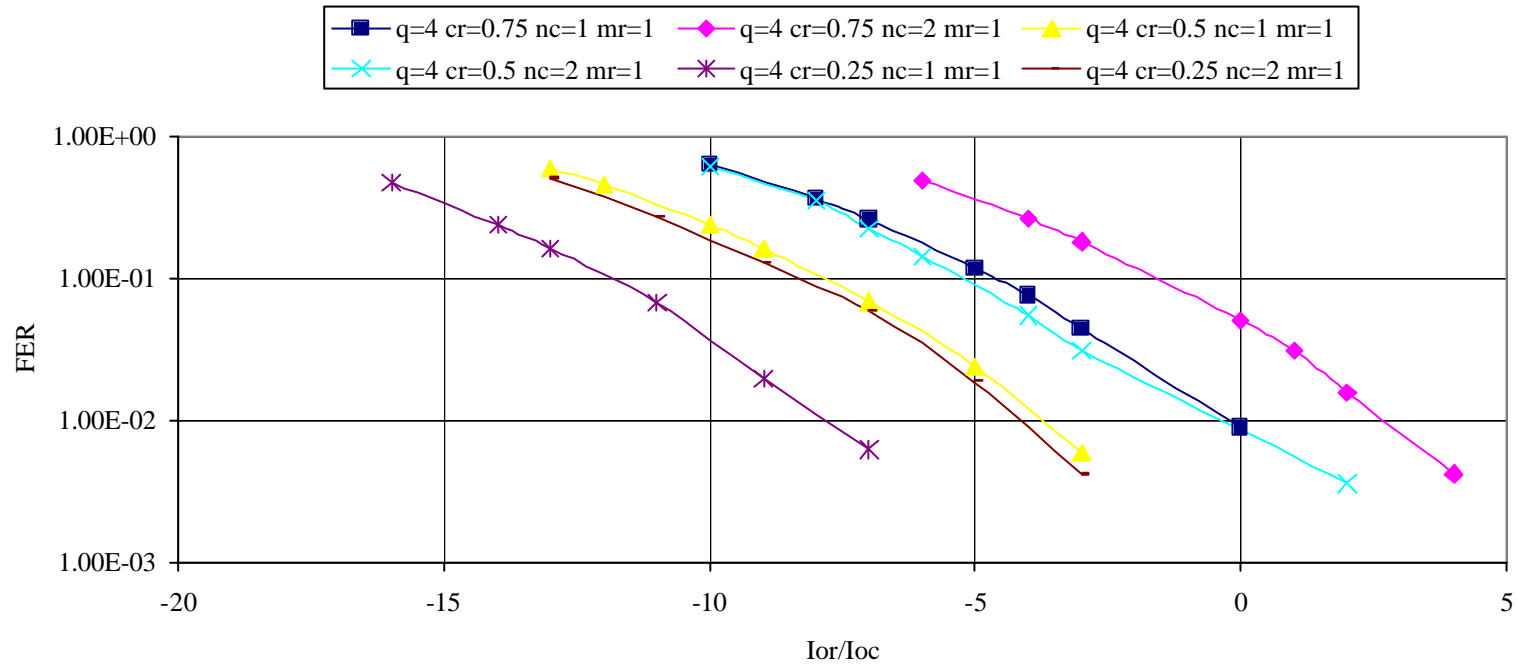
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path QPSK STTD=0



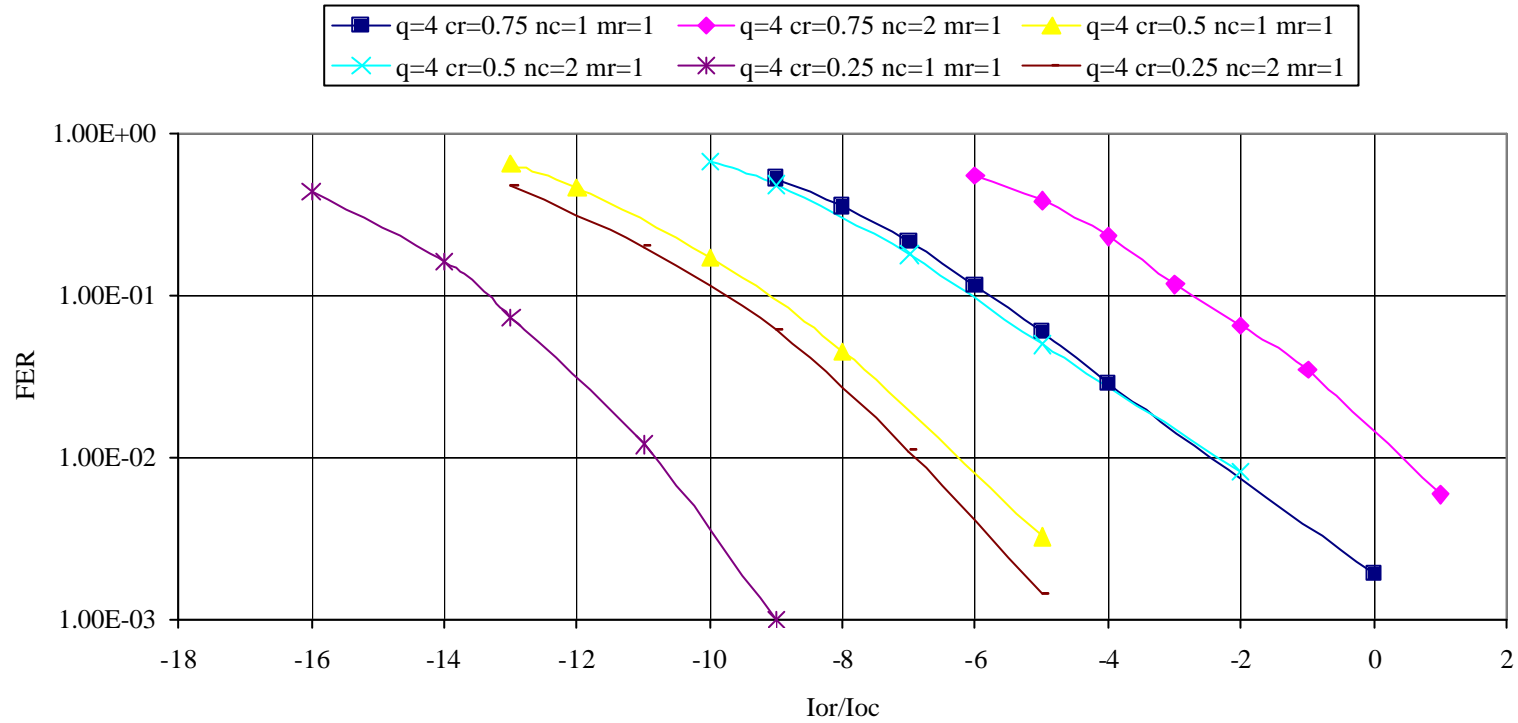
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



120Kmph 1-path QPSK STTD=1



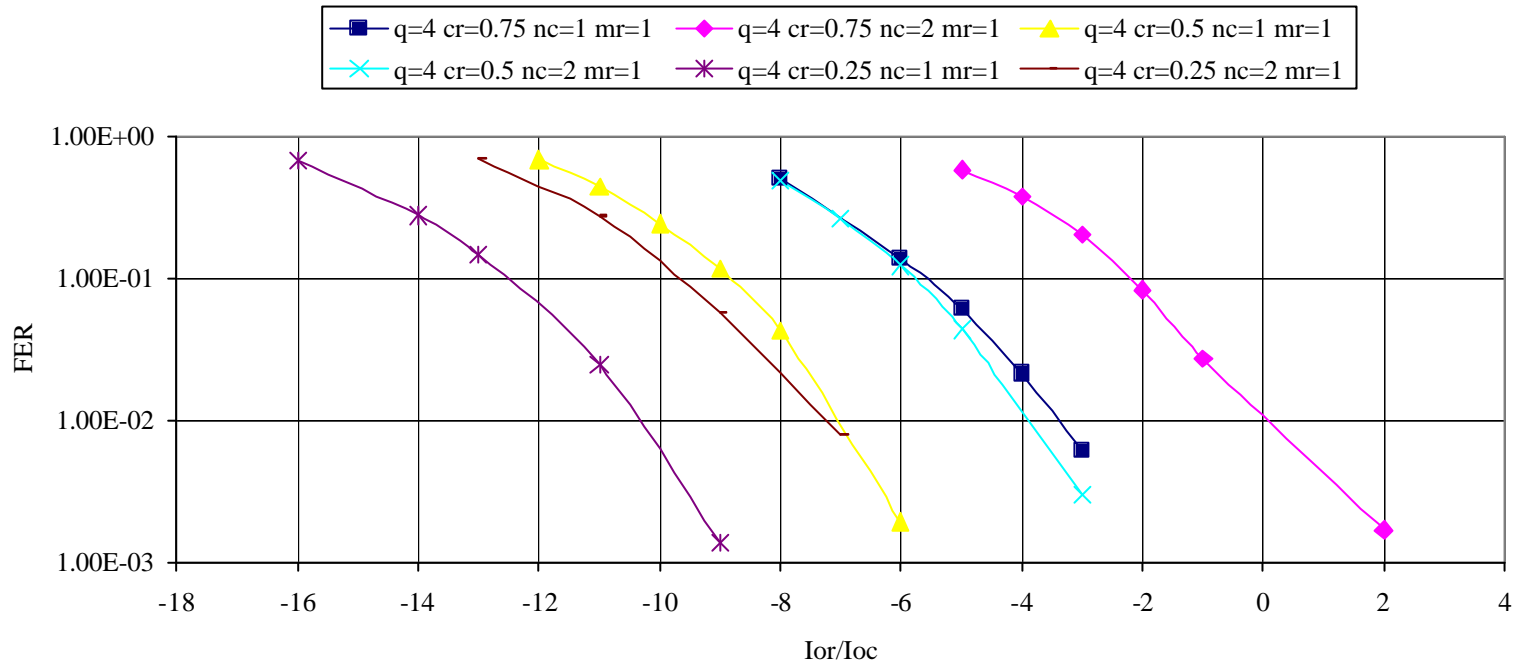
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path QPSK STTD=1



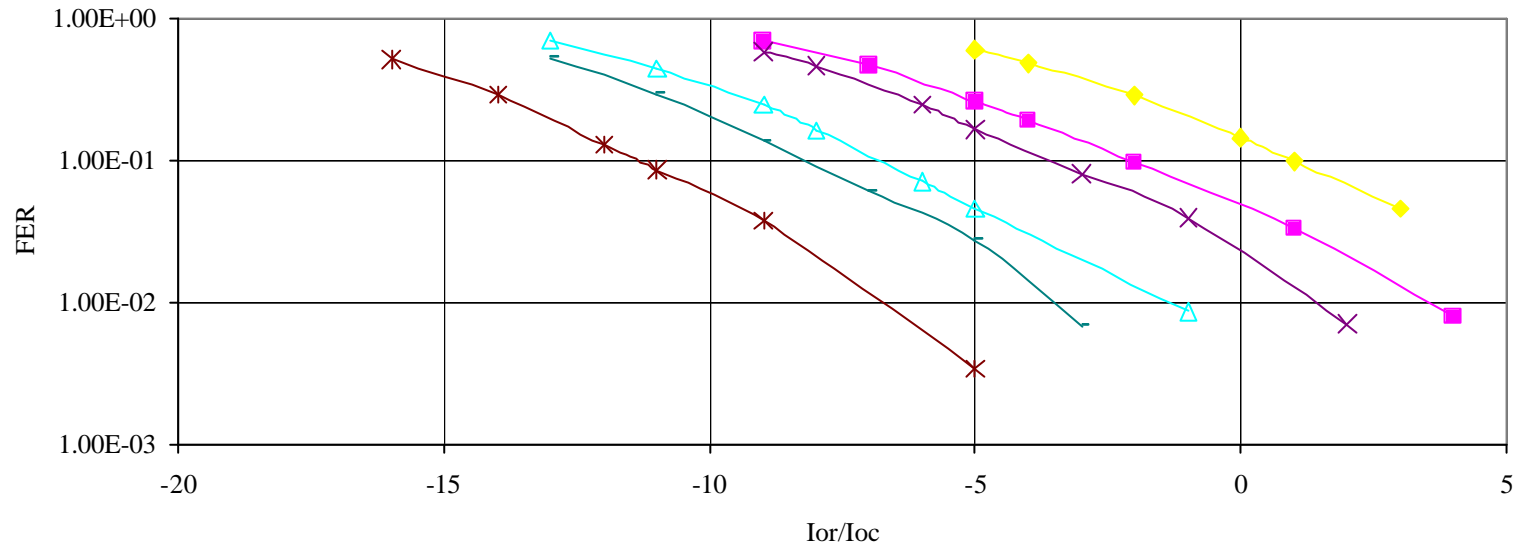
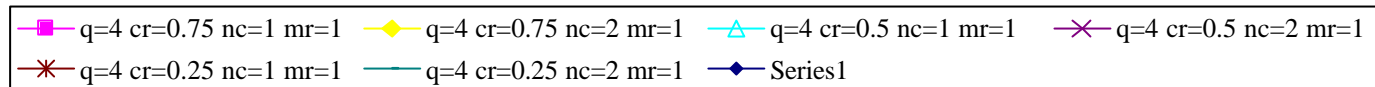
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 1-path QPSK STTD=0



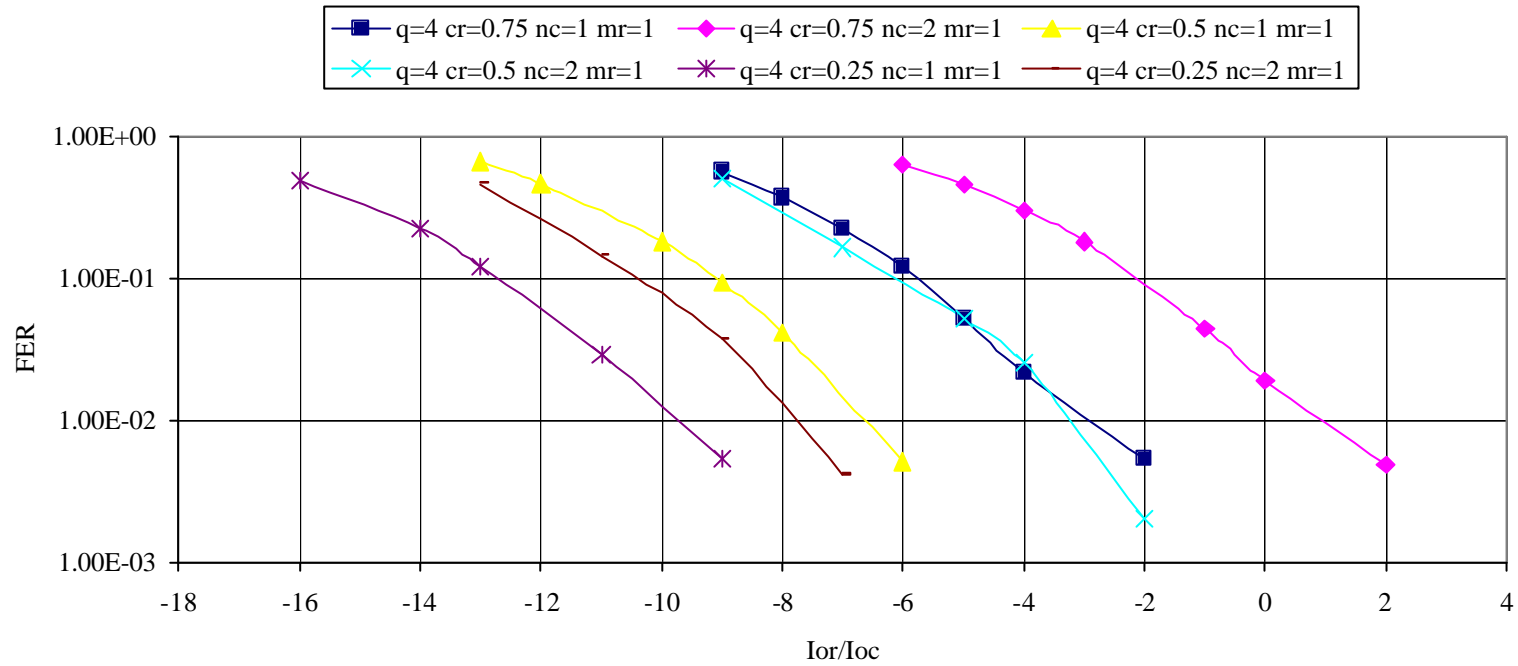
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path QPSK STTD=0



ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



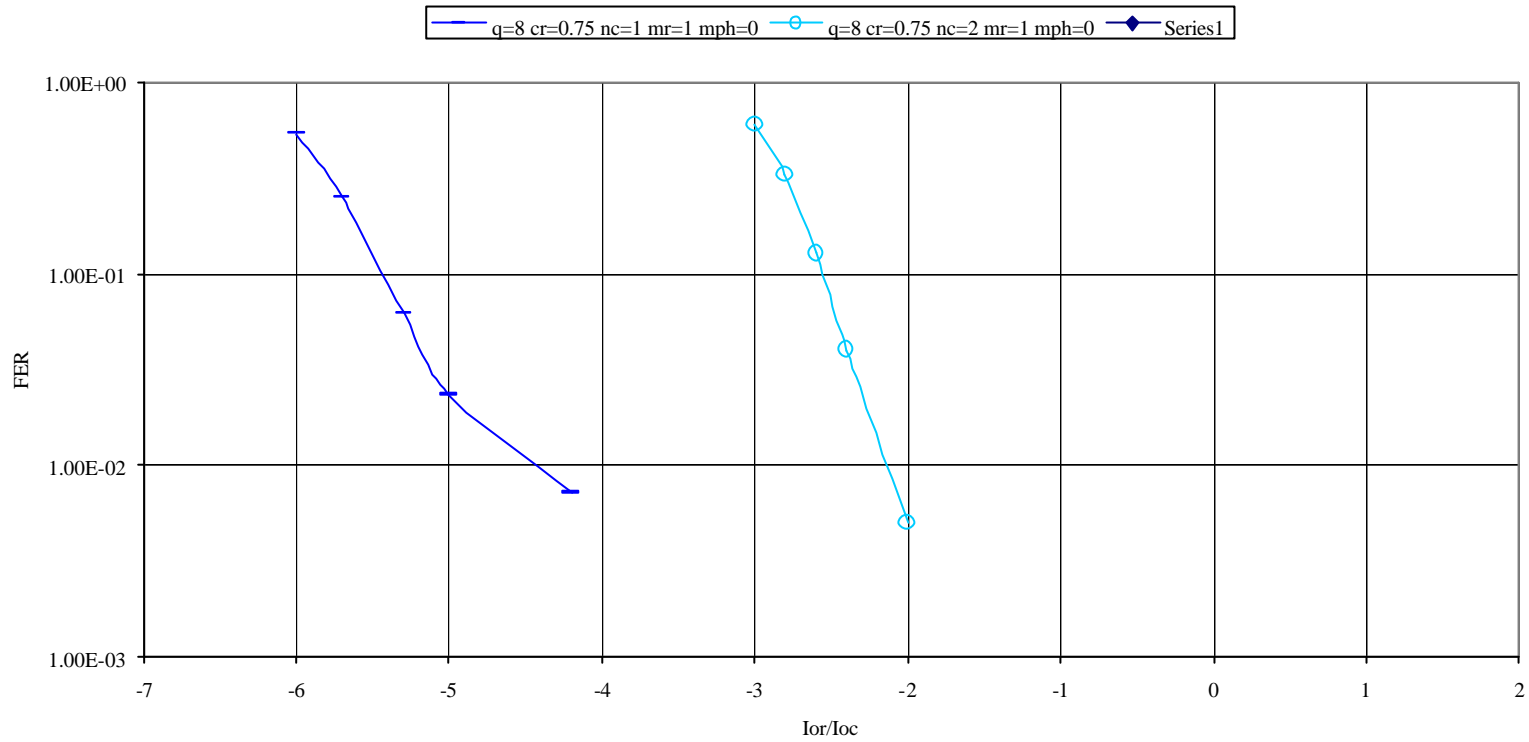
8-PSK

MCS 4

Static 8-PSK



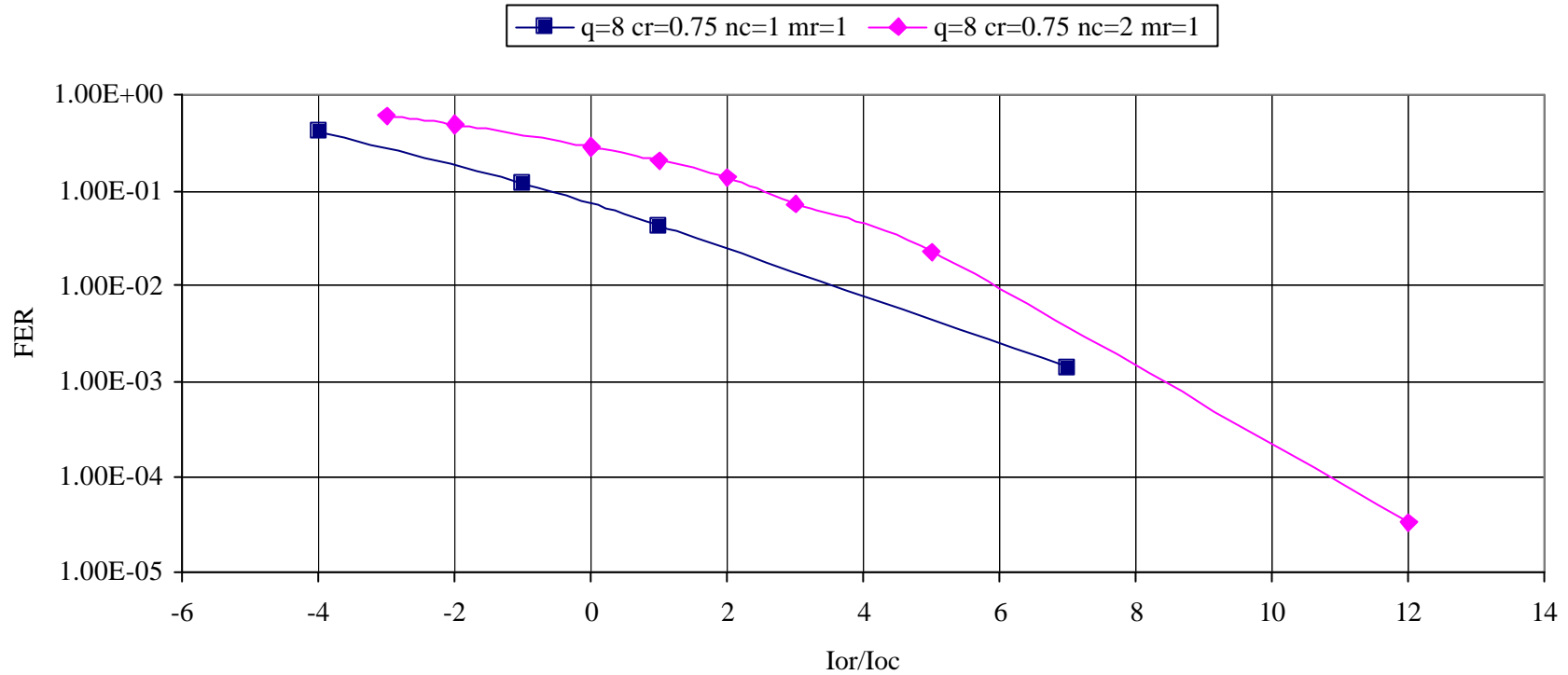
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1



3Kmph 1-path 8-PSK STTD=1



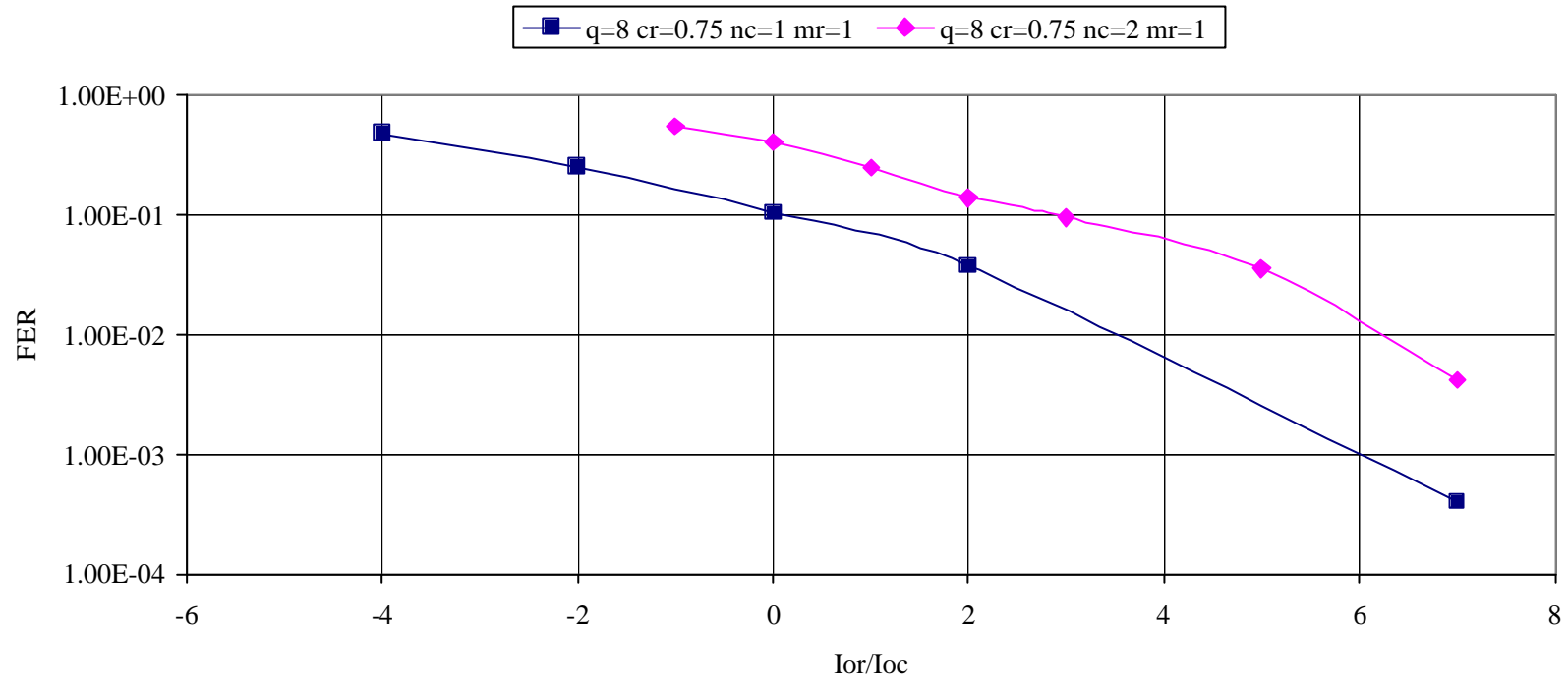
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path 8-PSK STTD=1



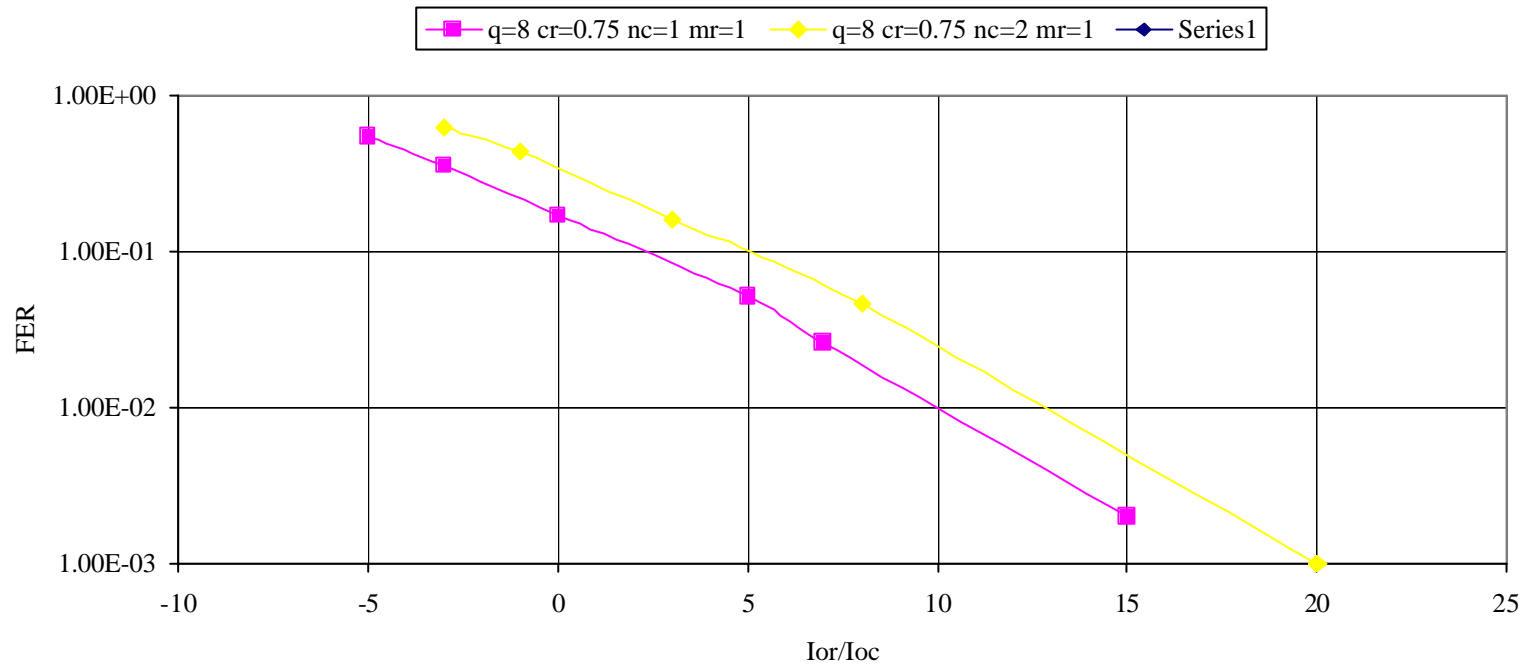
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 1-path 8-PSK STTD=0



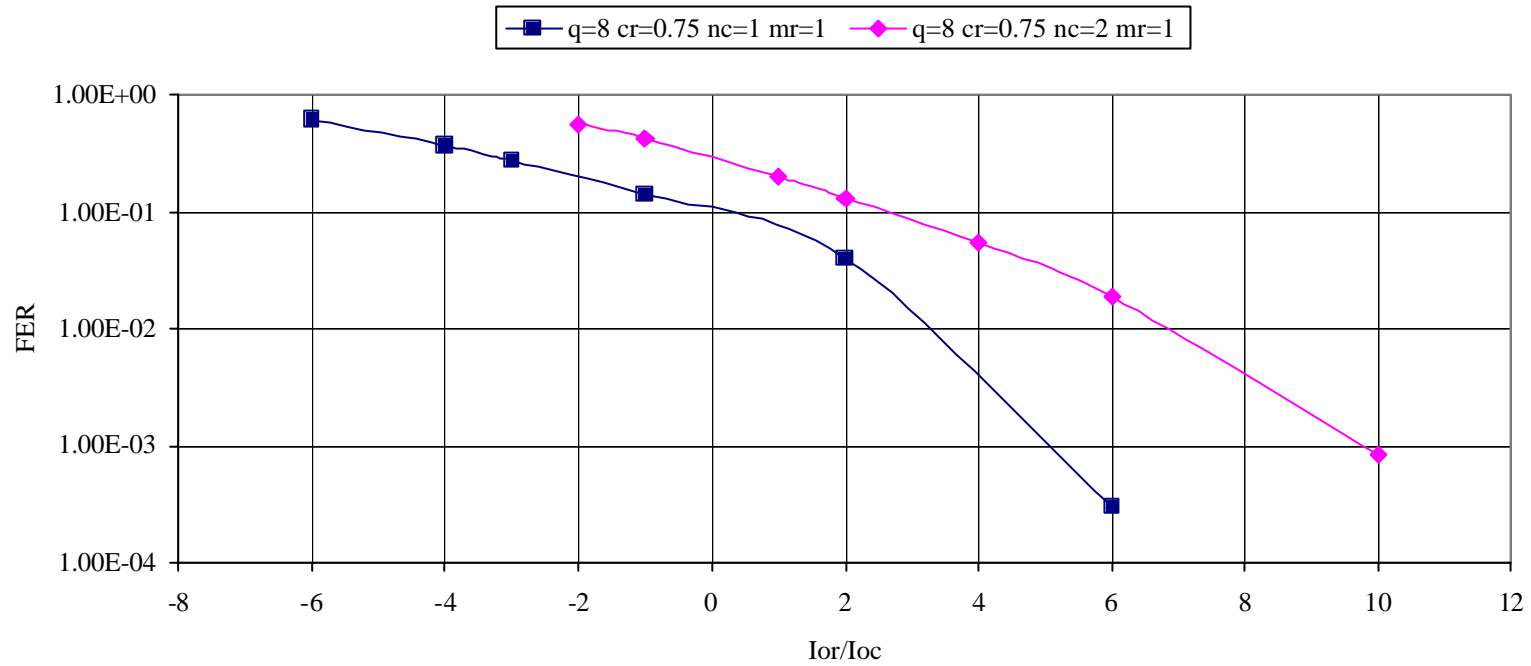
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path 8-PSK STTD=0



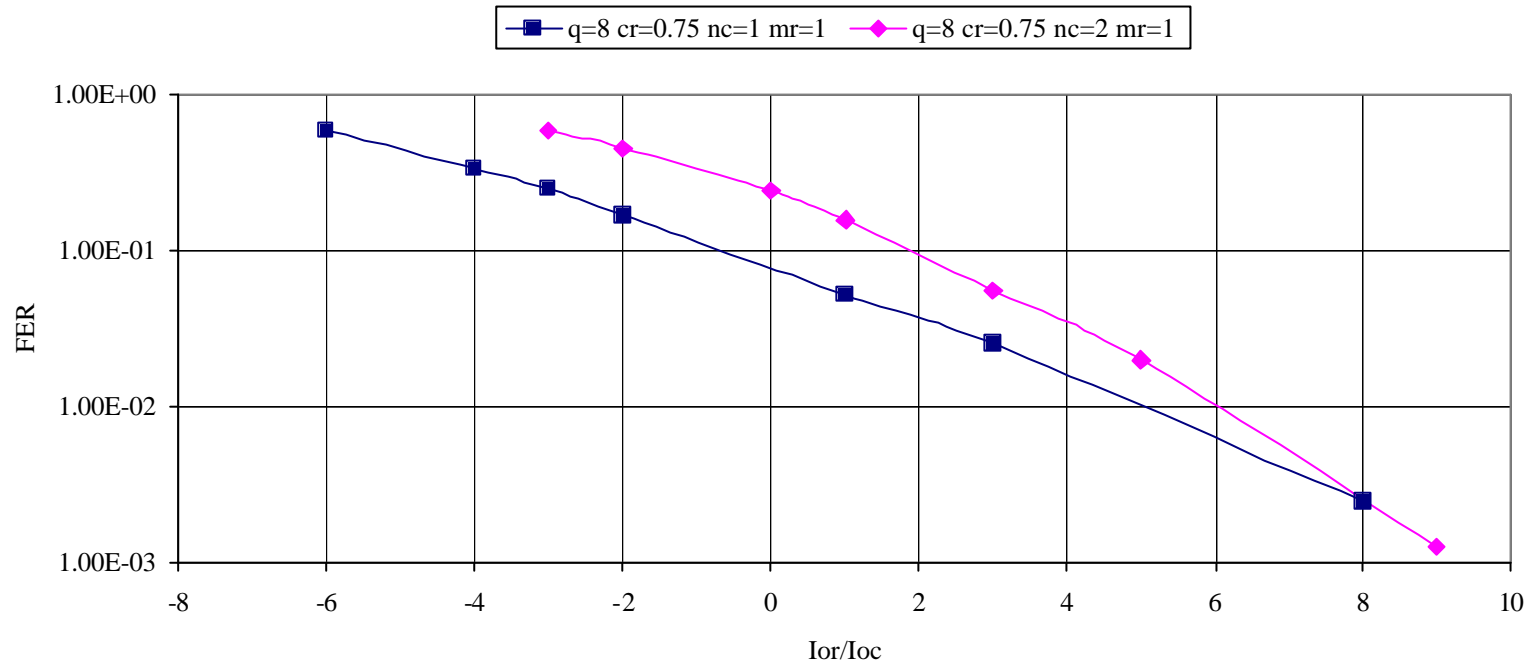
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



30Kmph 1-path 8-PSK STTD=1



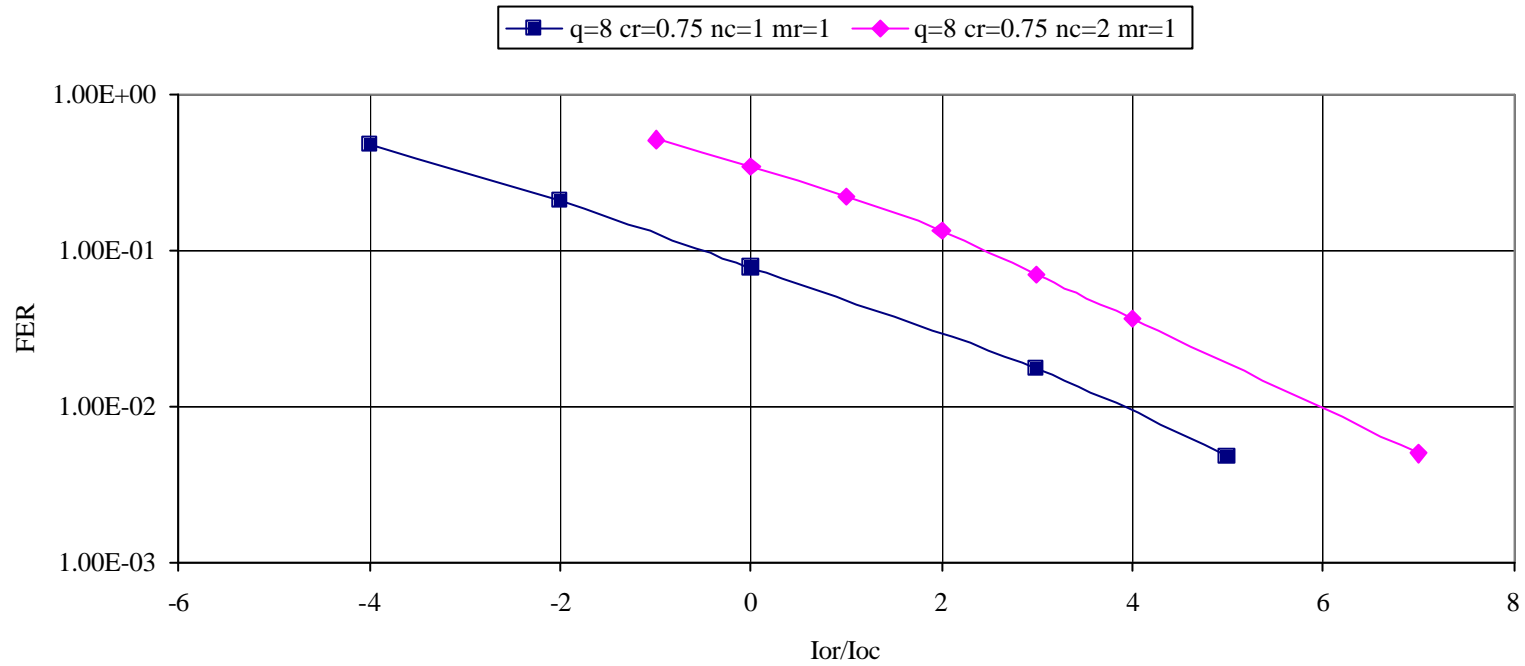
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path 8-PSK STTD=1



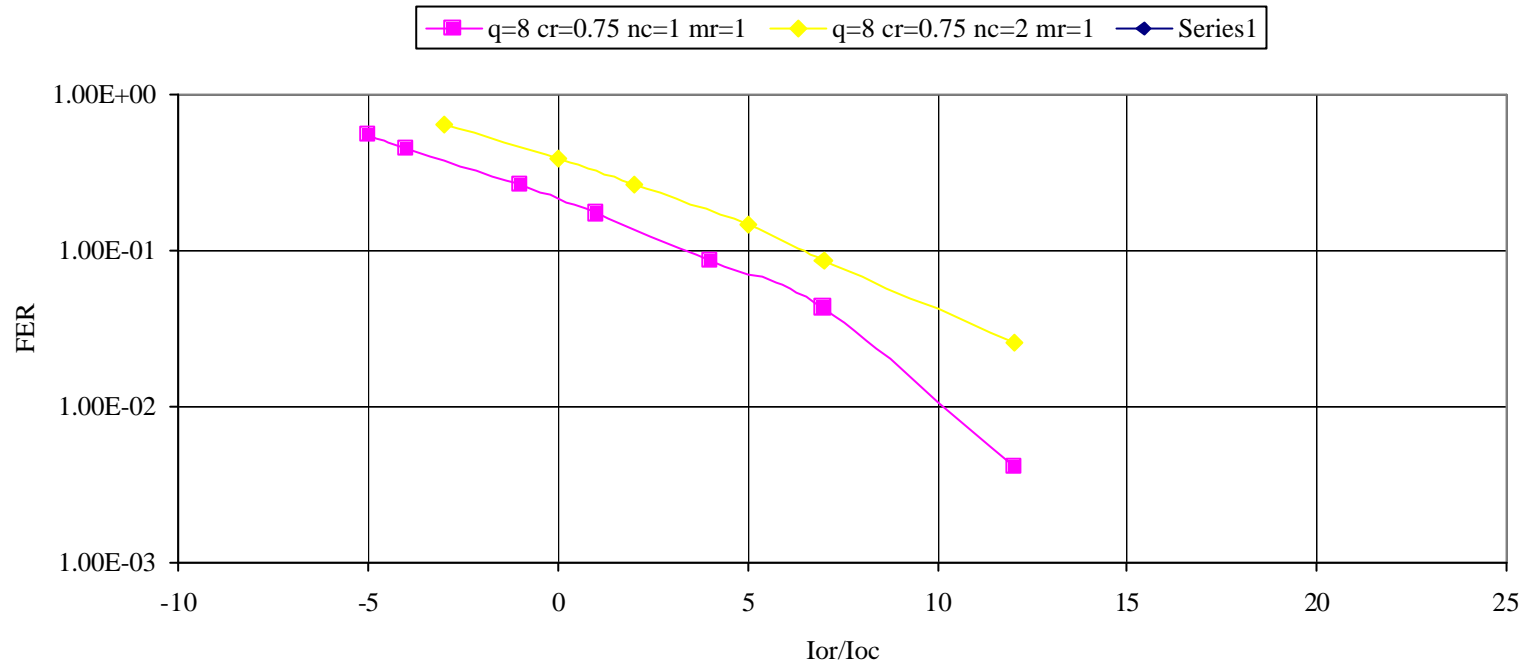
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 1-path 8-PSK STTD=0



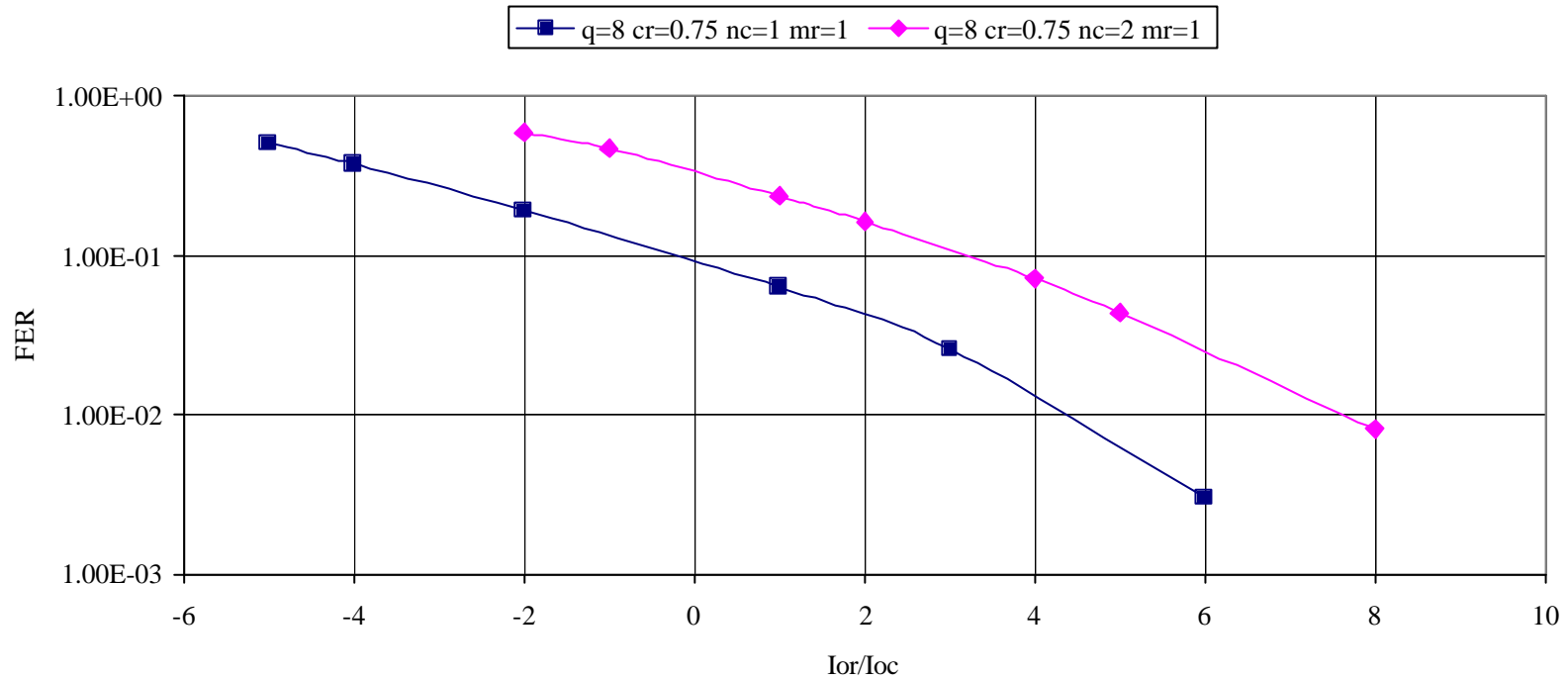
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path 8-PSK STTD=0



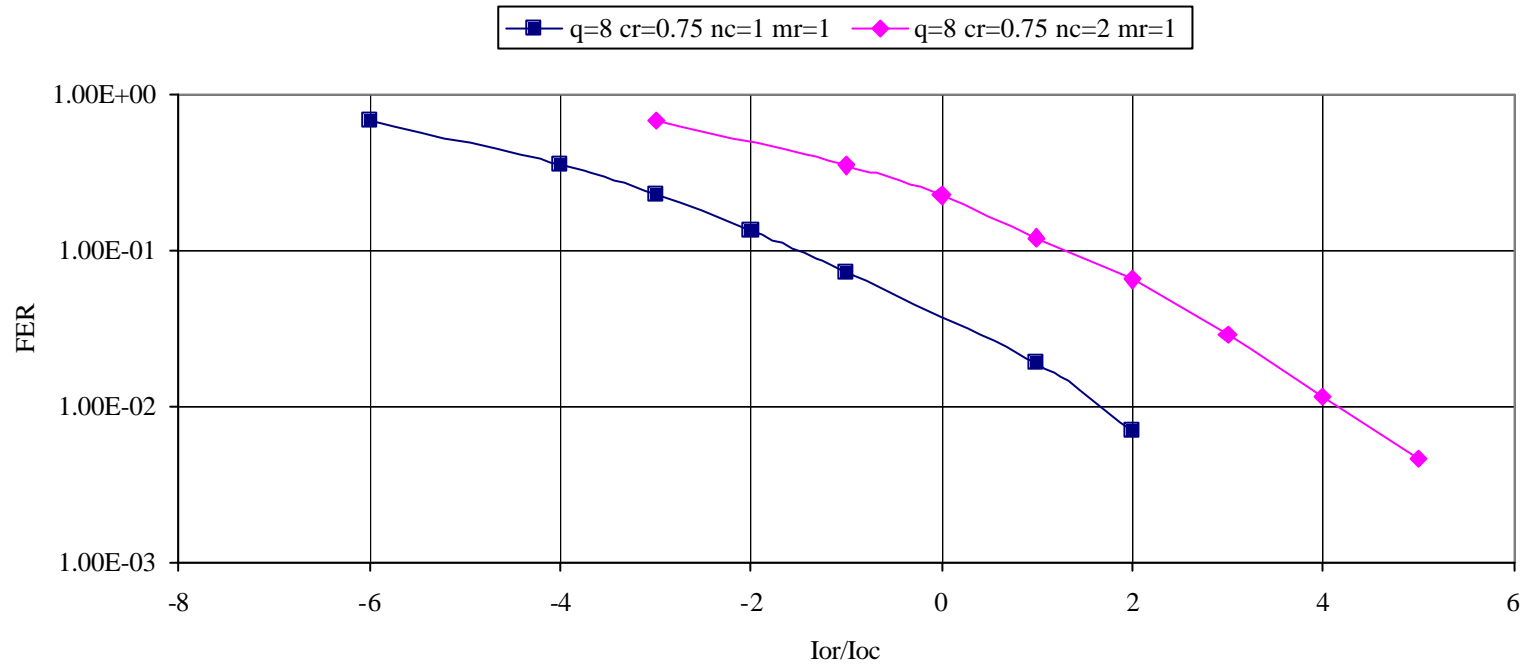
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



120Kmph 1-path 8-PSK STTD=1



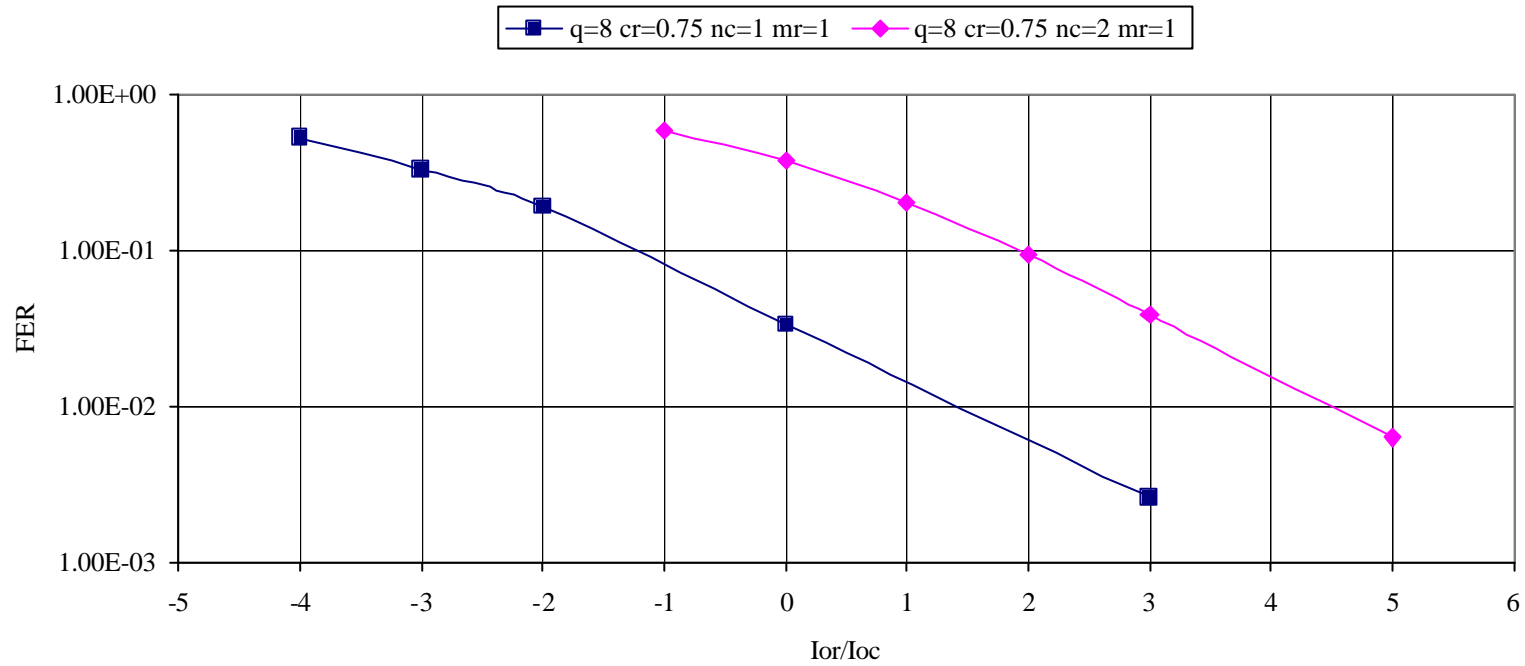
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path 8-PSK STTD=1



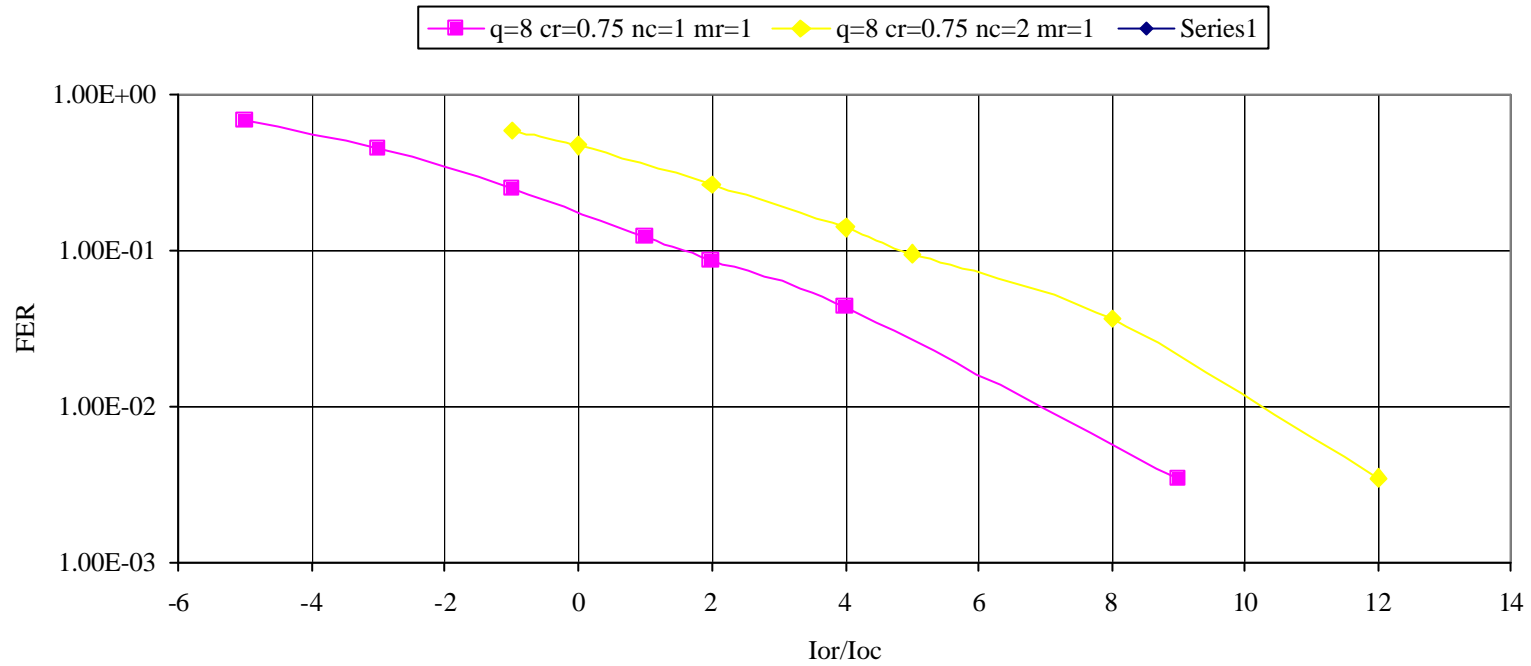
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 1-path 8-PSK STTD=0



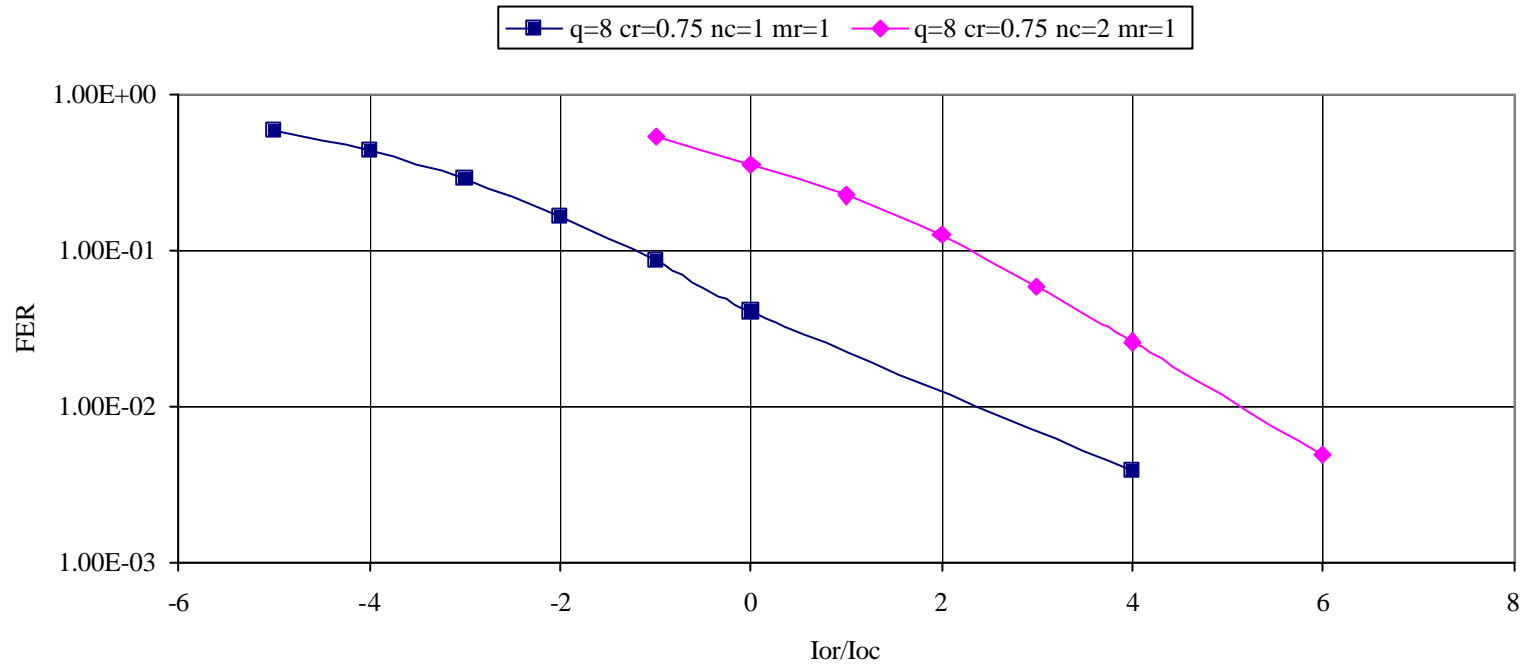
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 1-path 8-PSK STTD=0



ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



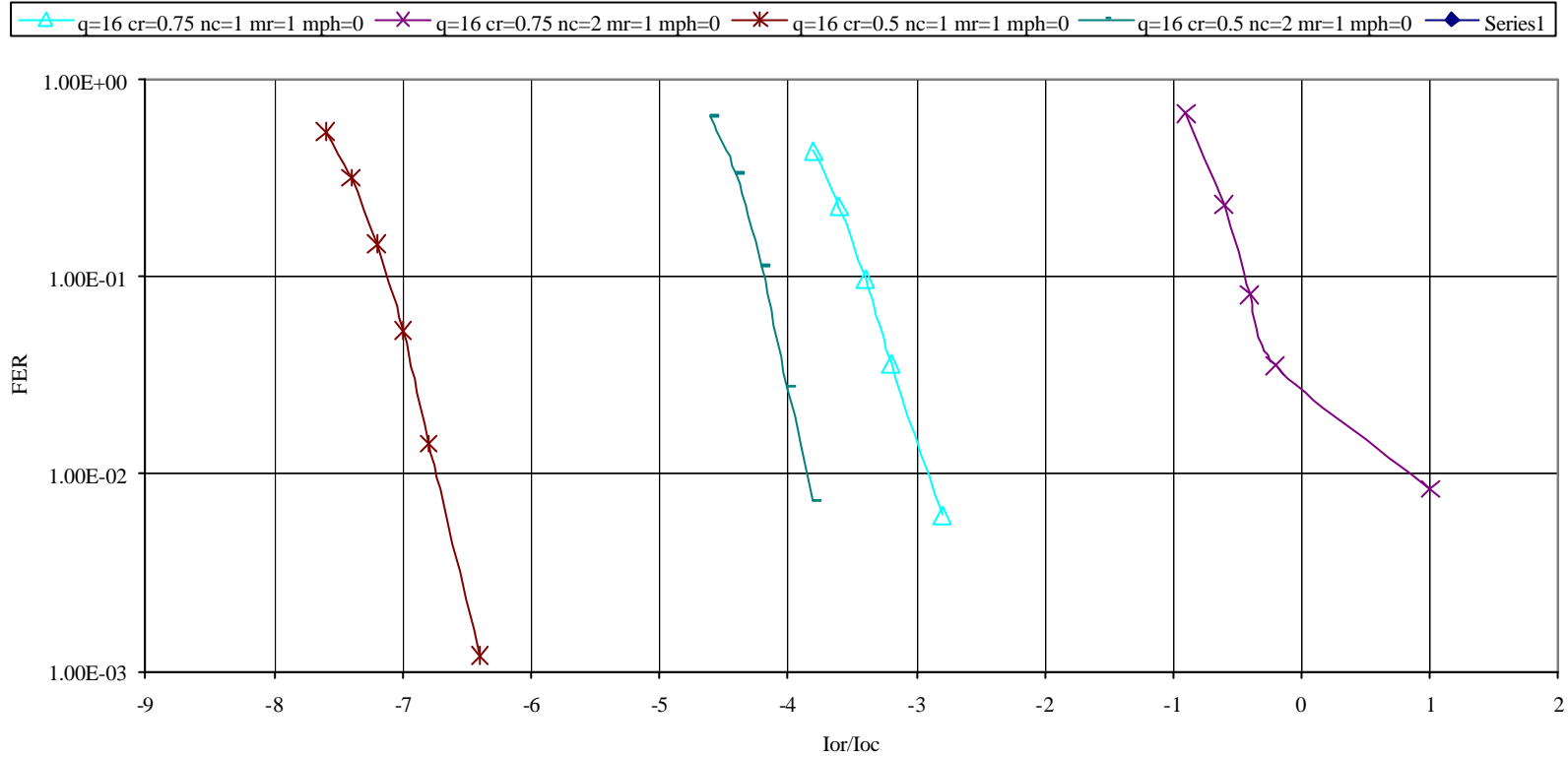
16-QAM

MCS 5 and 6

Static 16-QAM



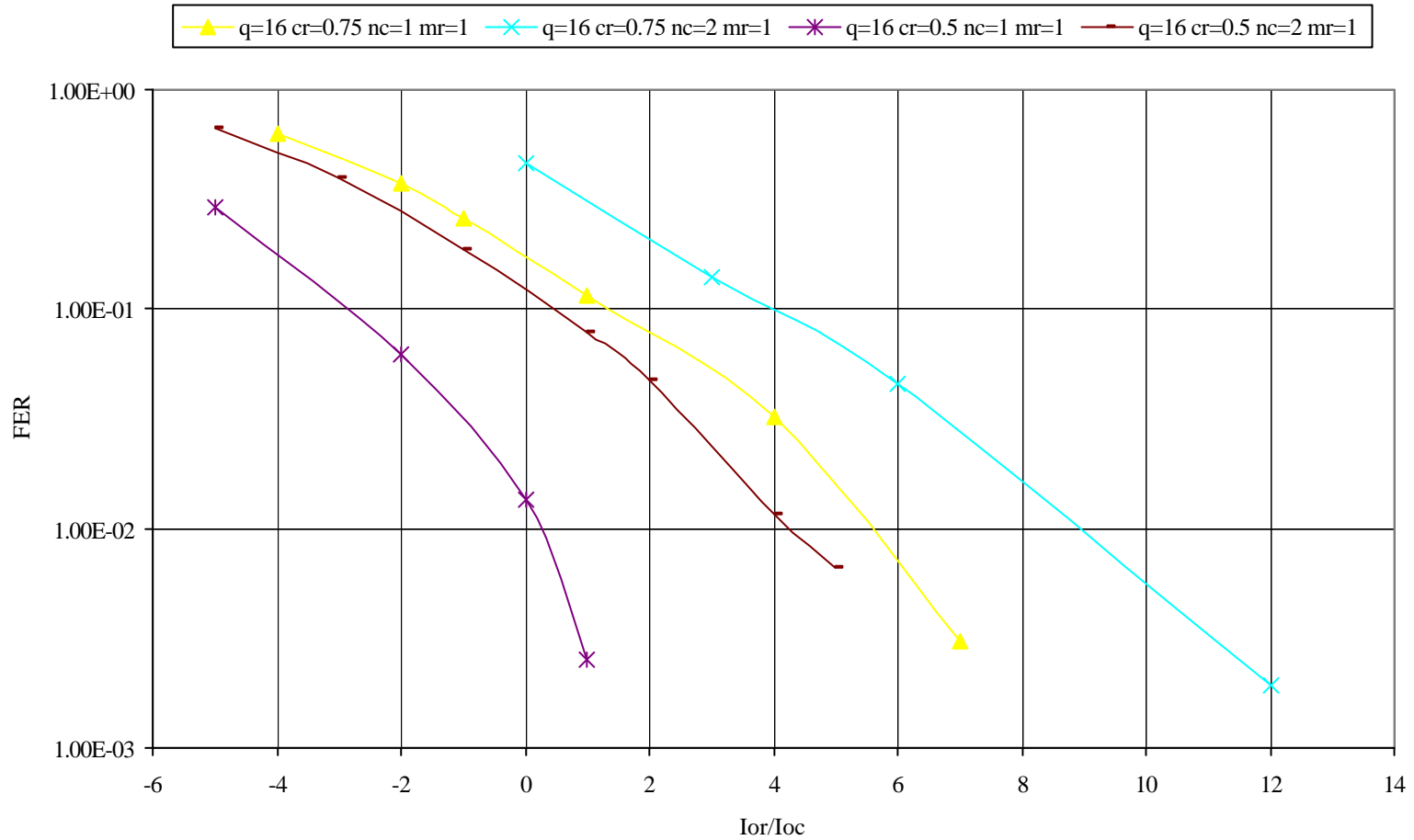
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1



3Kmph 1-path 16-QAM STTD=1



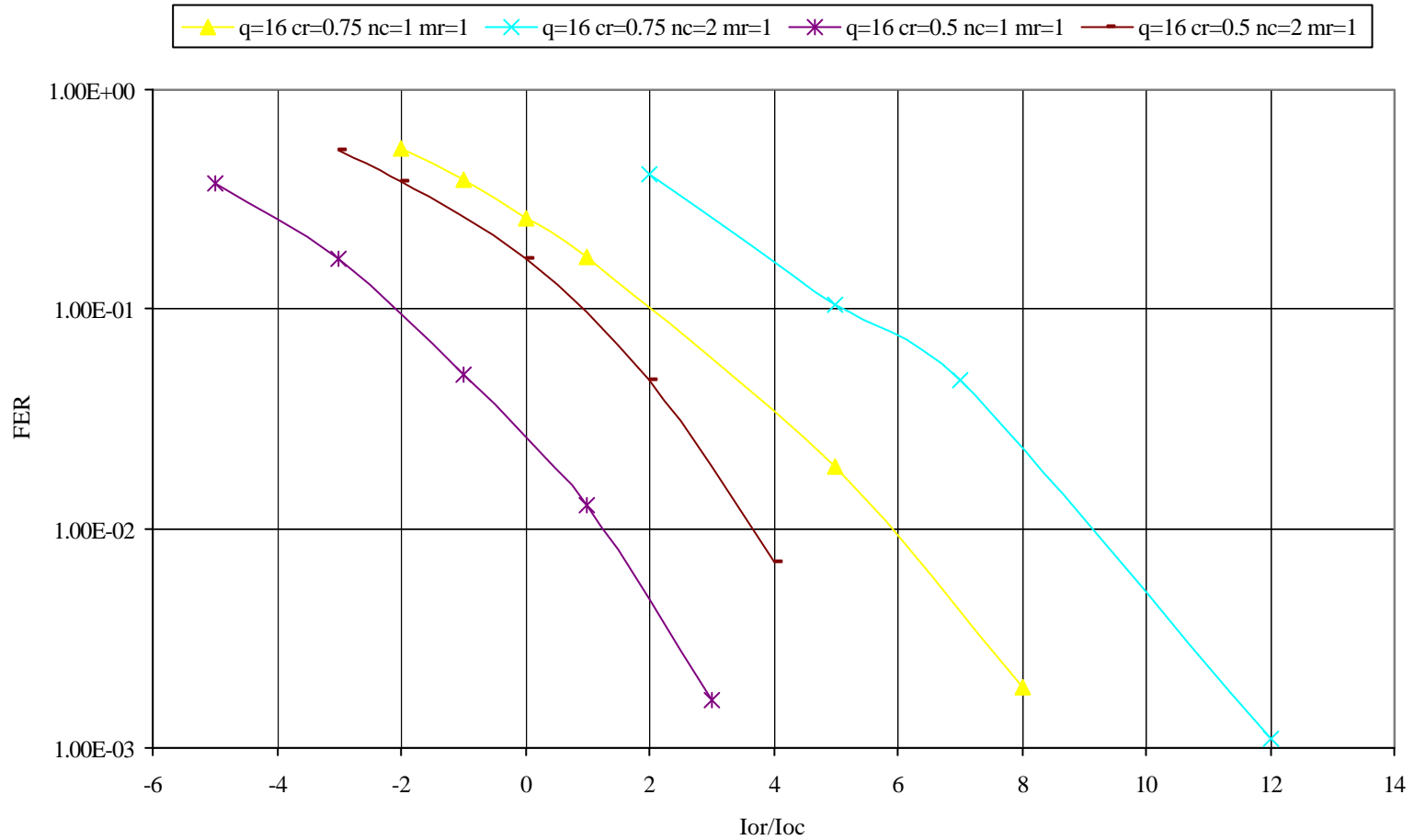
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path 16-QAM STTD=1



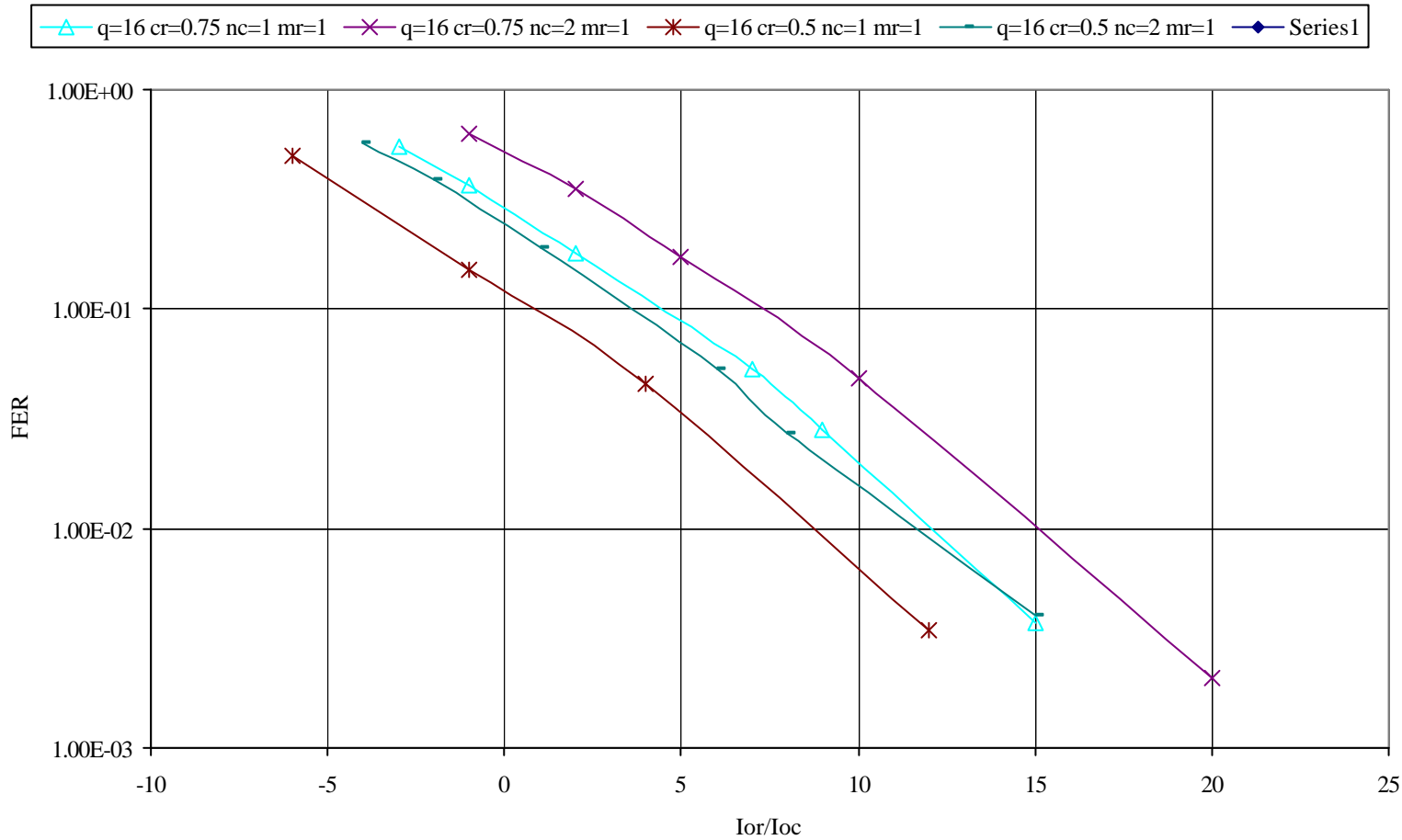
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 1-path 16-QAM STTD=0



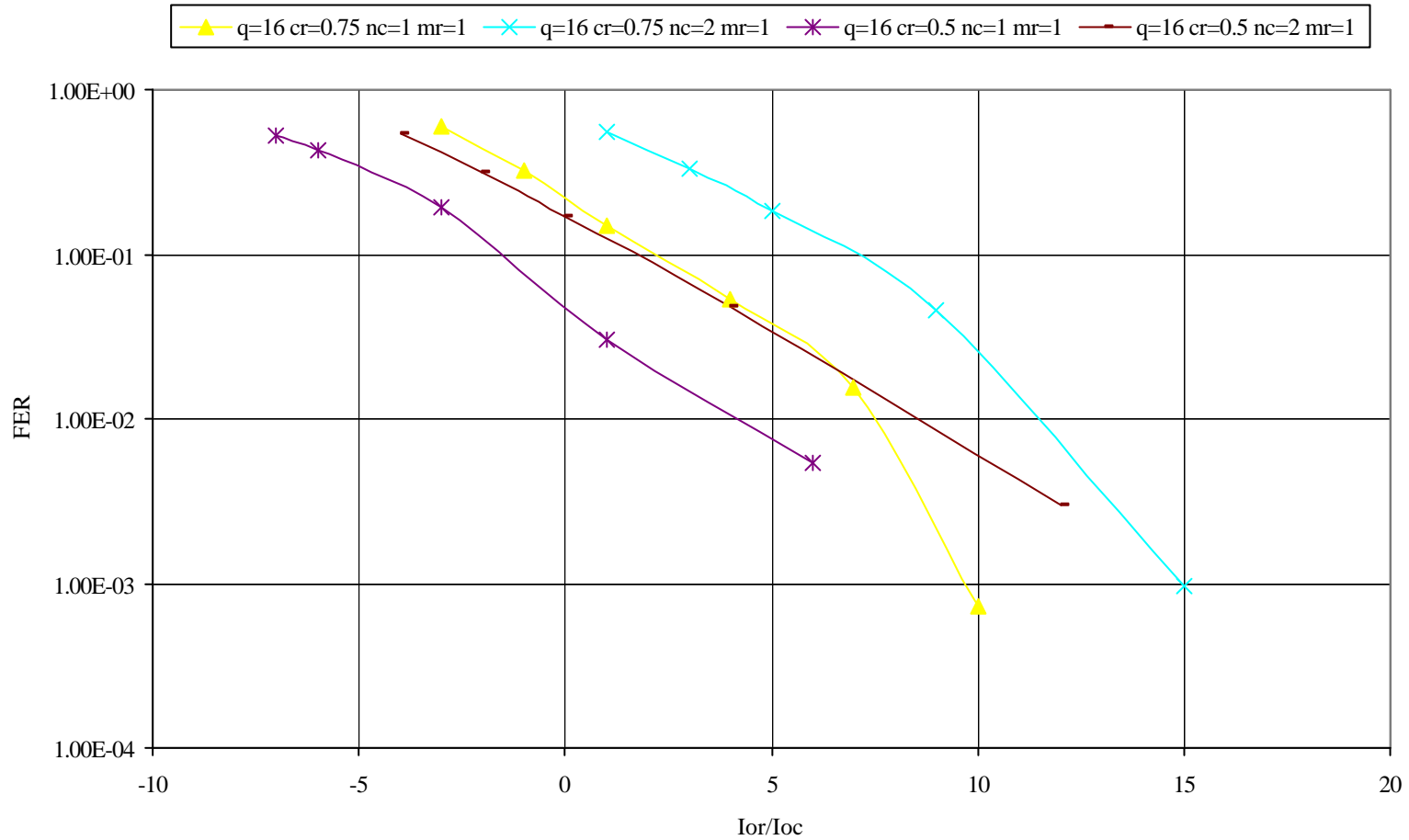
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path 16-QAM STTD=0



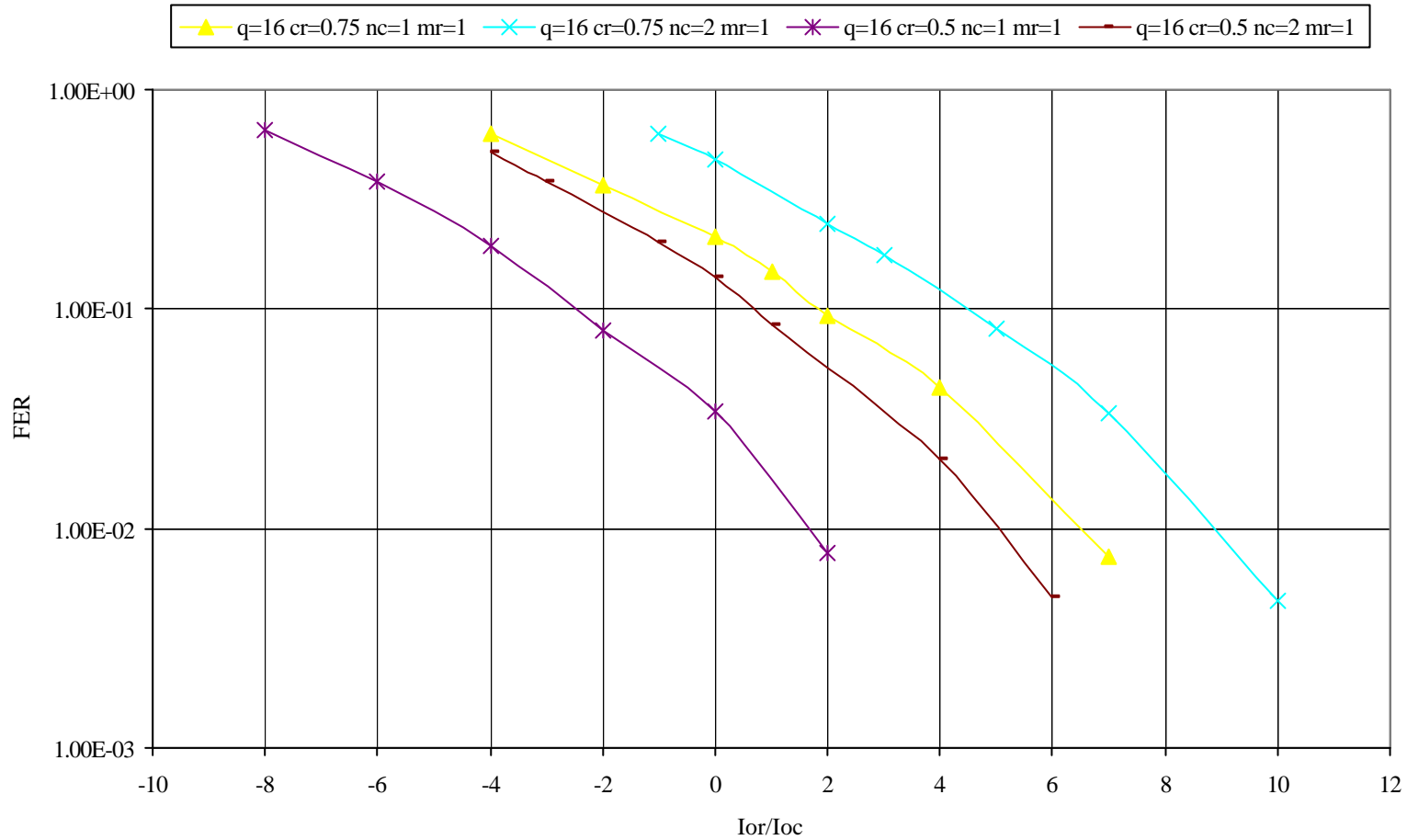
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



30Kmph 1-path 16-QAM STTD=1



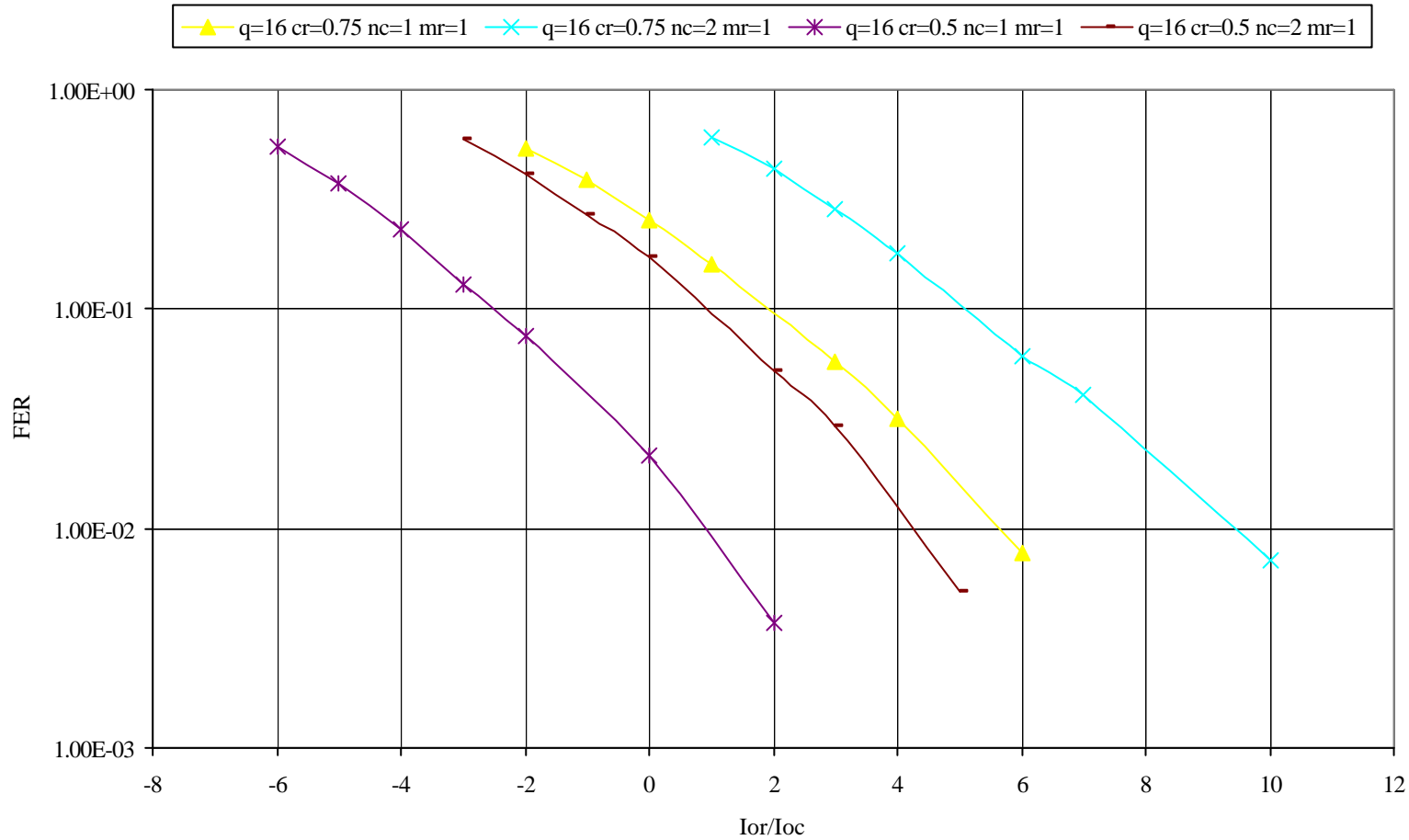
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path 16-QAM STTD=1



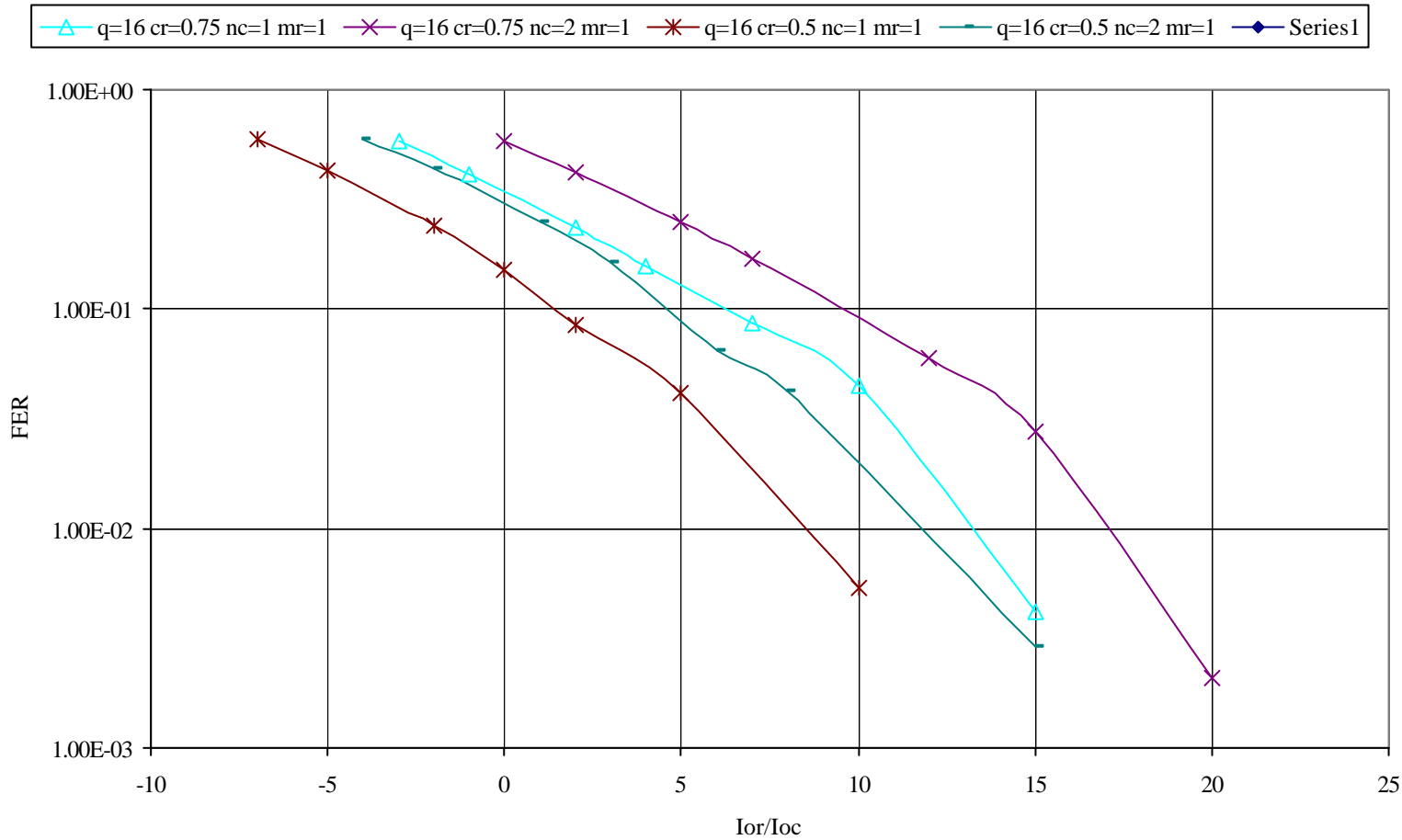
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 1-path 16-QAM STTD=0



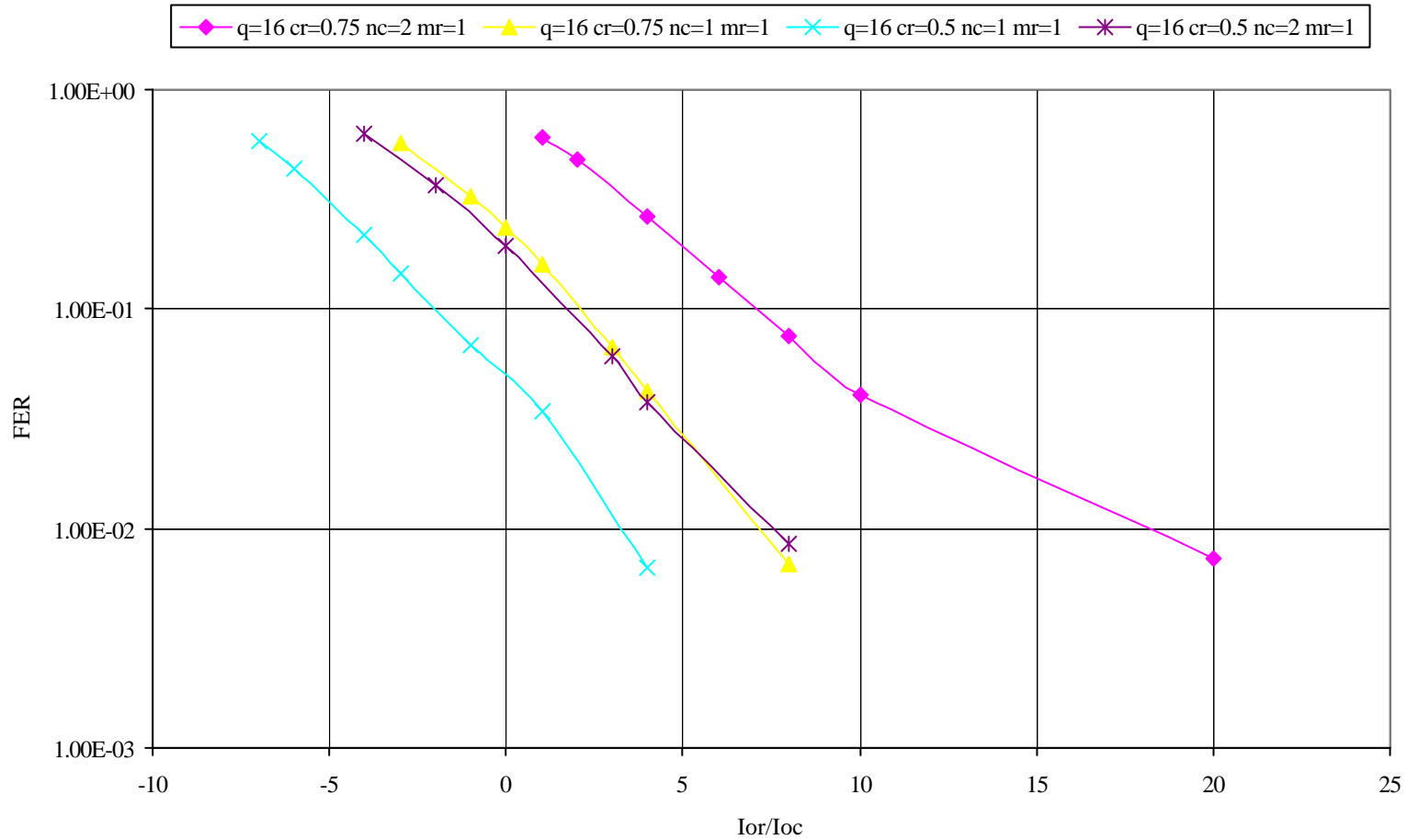
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path 16-QAM STTD=0



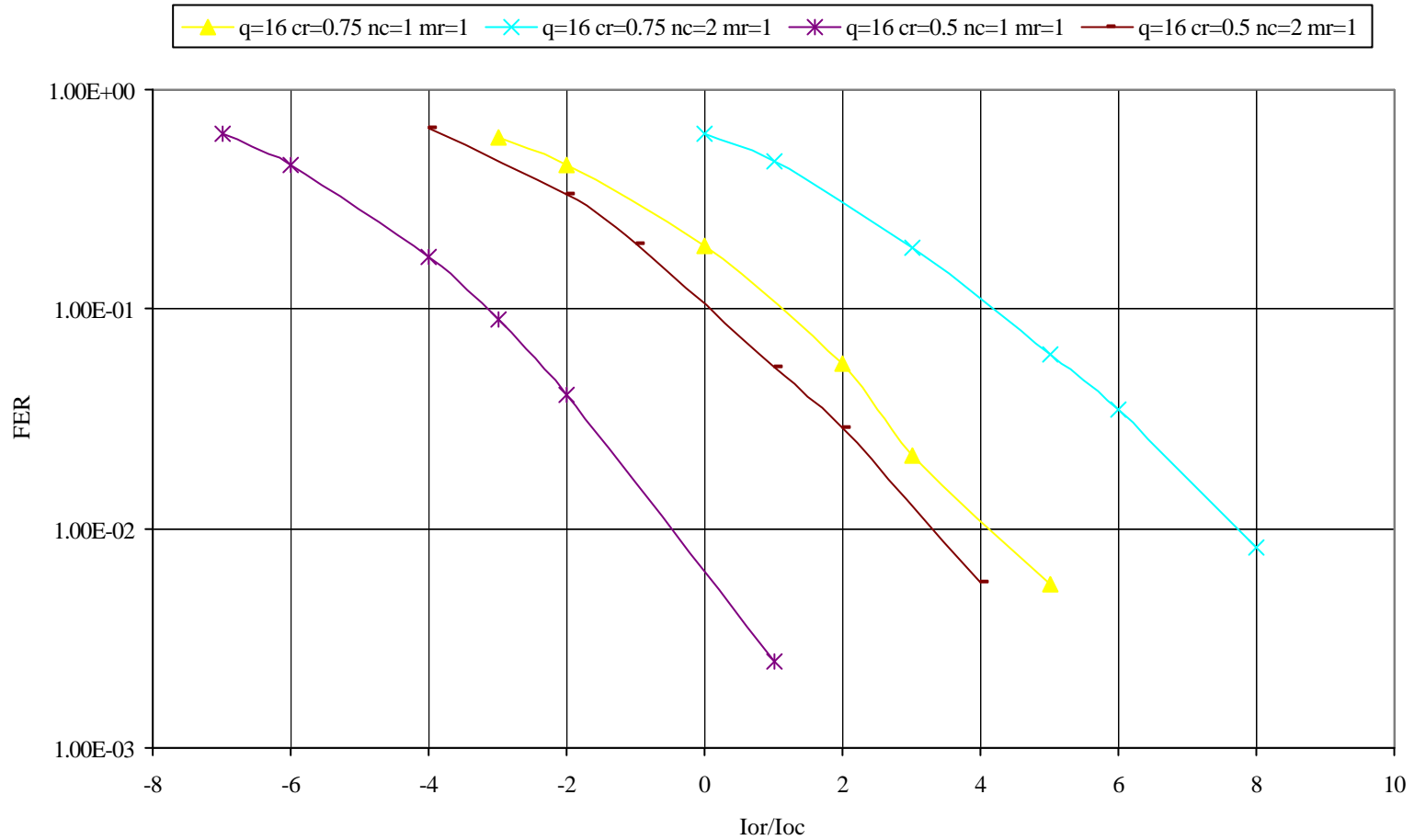
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



120Kmph 1-path 16-QAM STTD=1



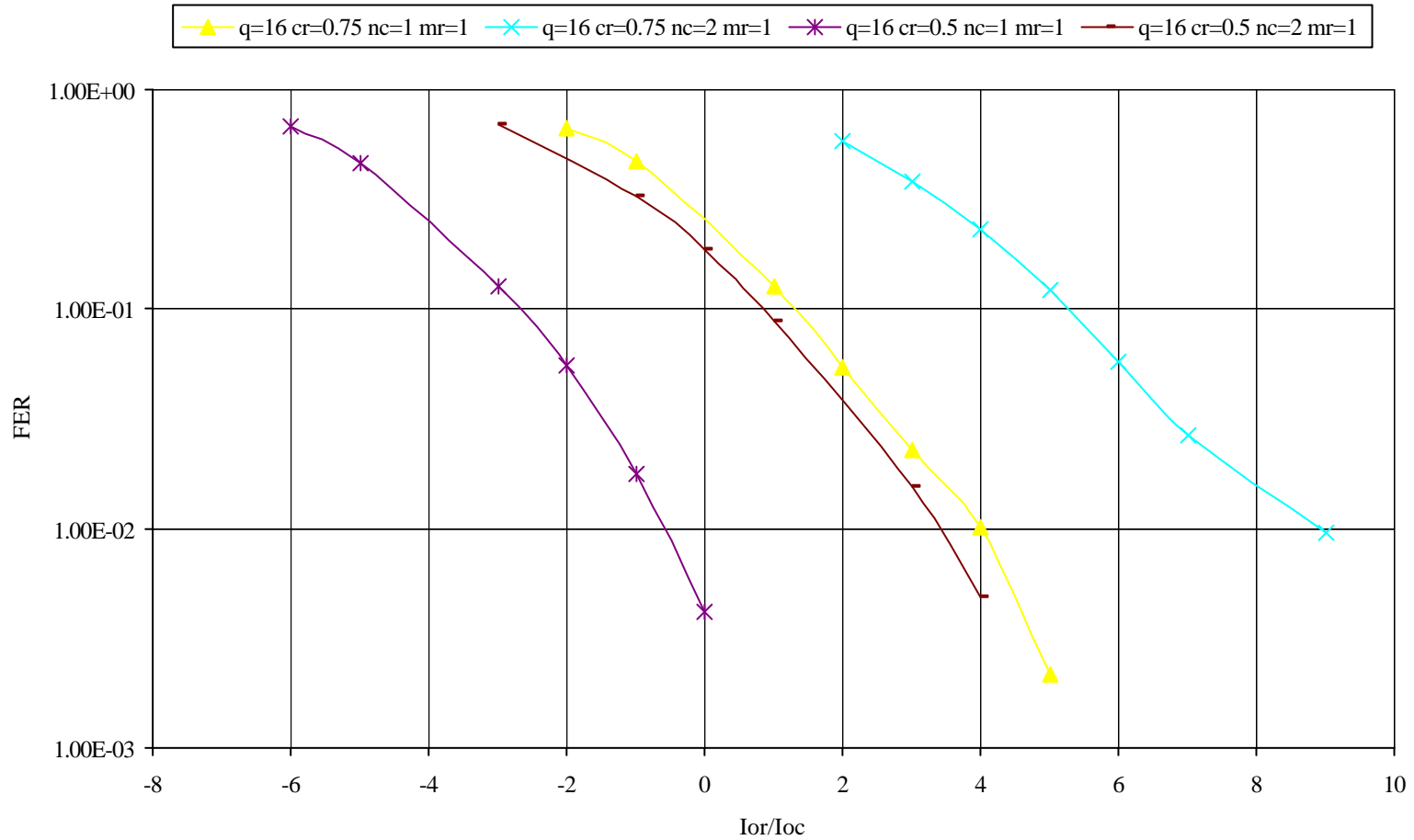
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path 16-QAM STTD=1



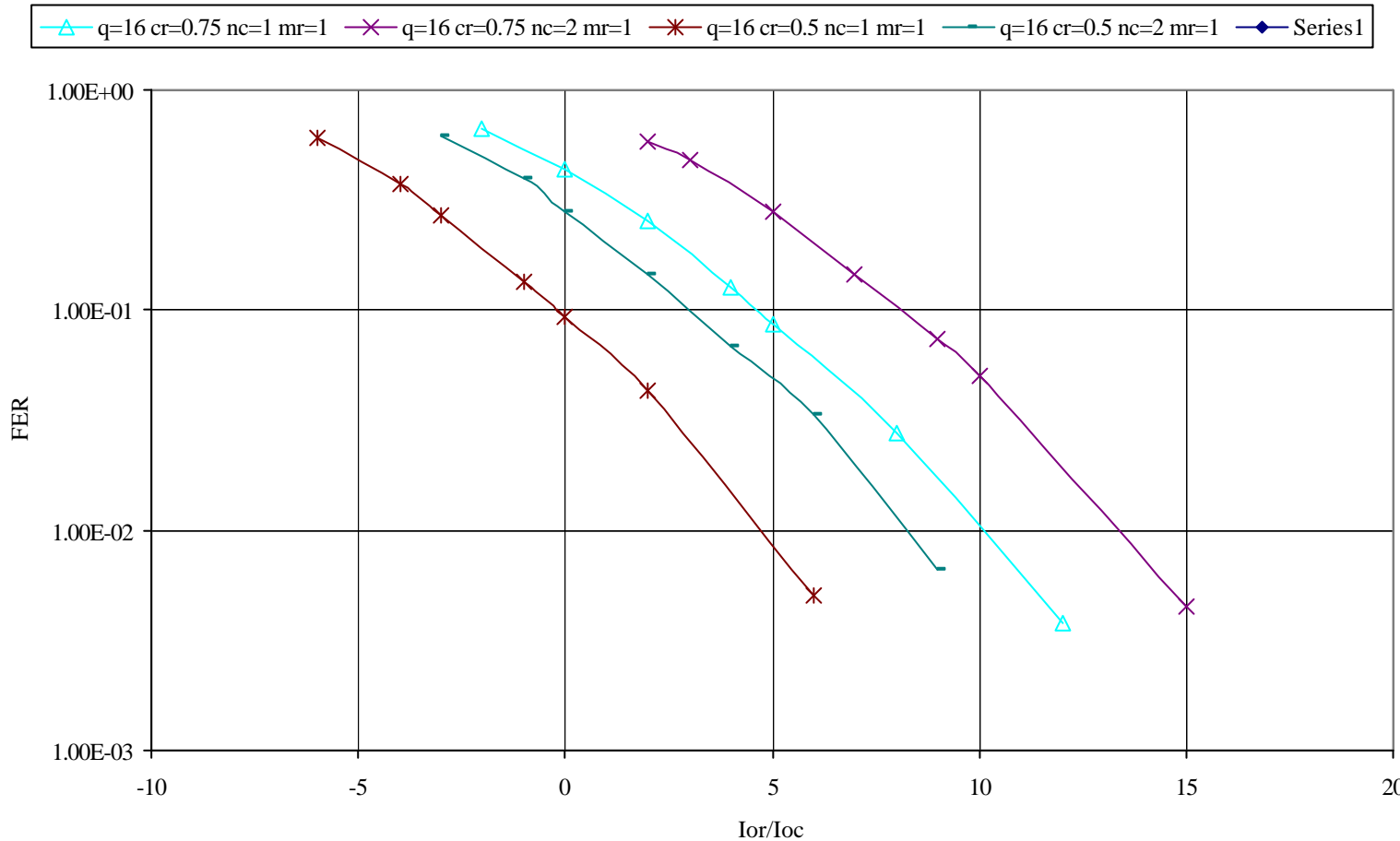
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 1-path 16-QAM STTD=0



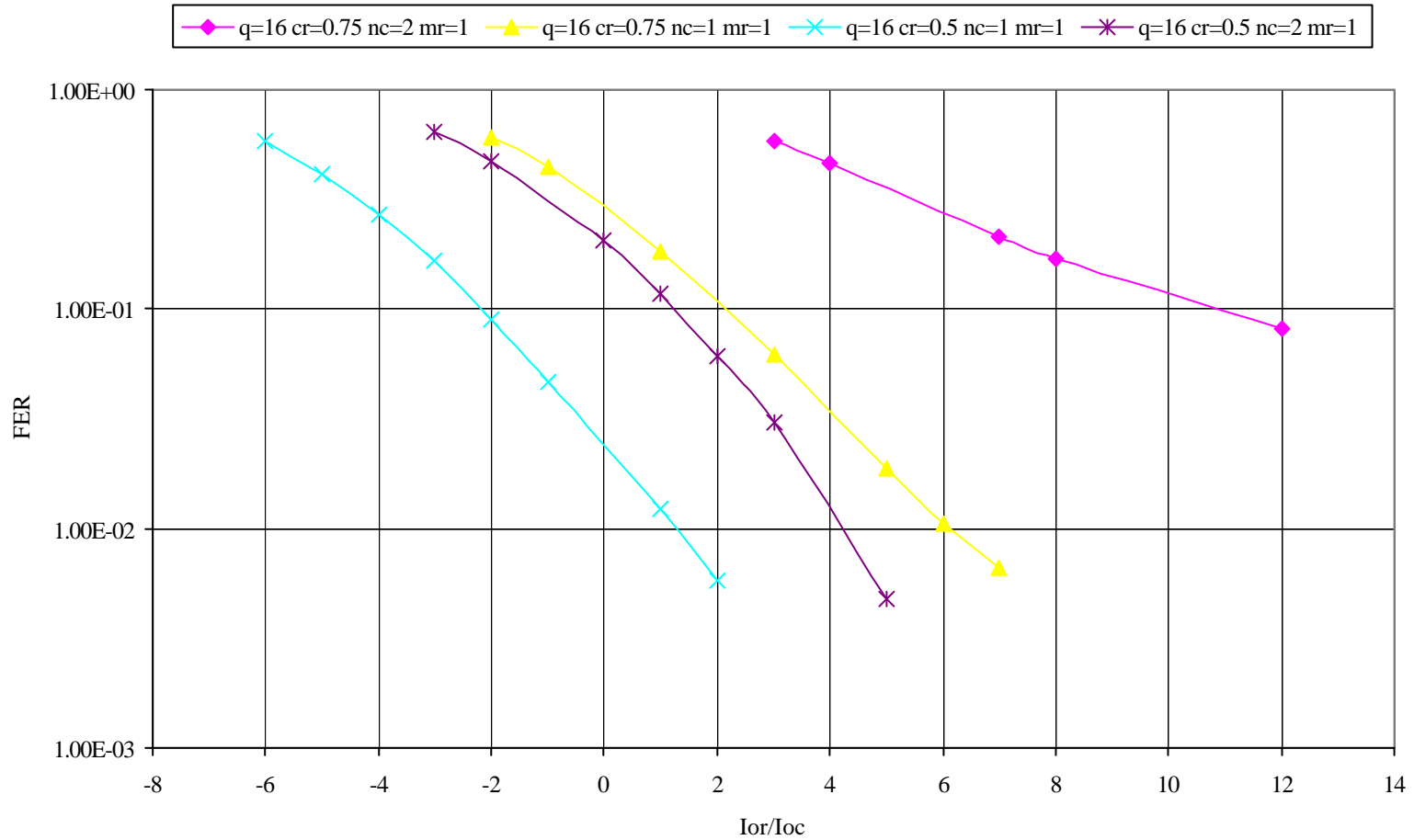
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path 16-QAM STTD=0



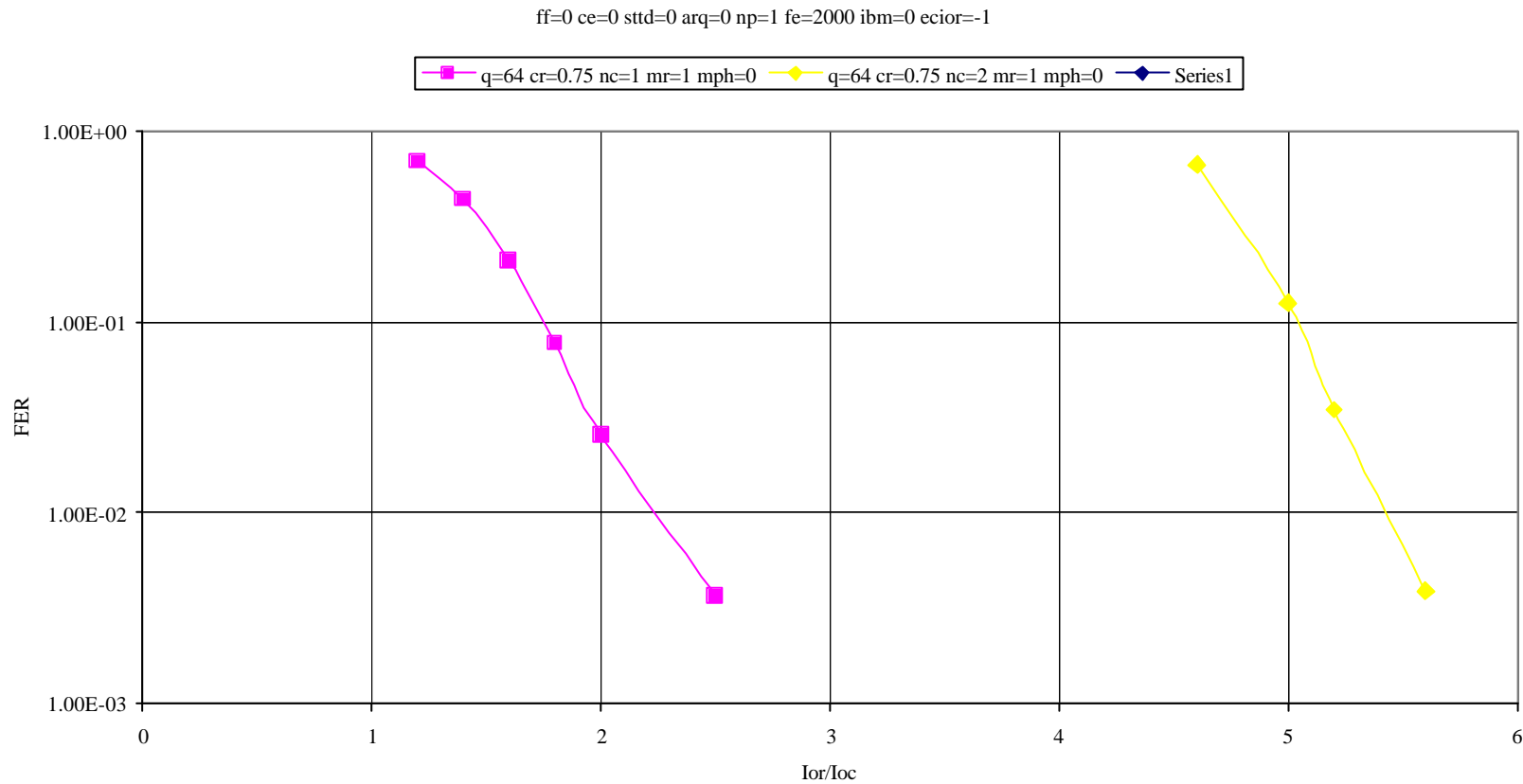
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



64-QAM

MCS 7

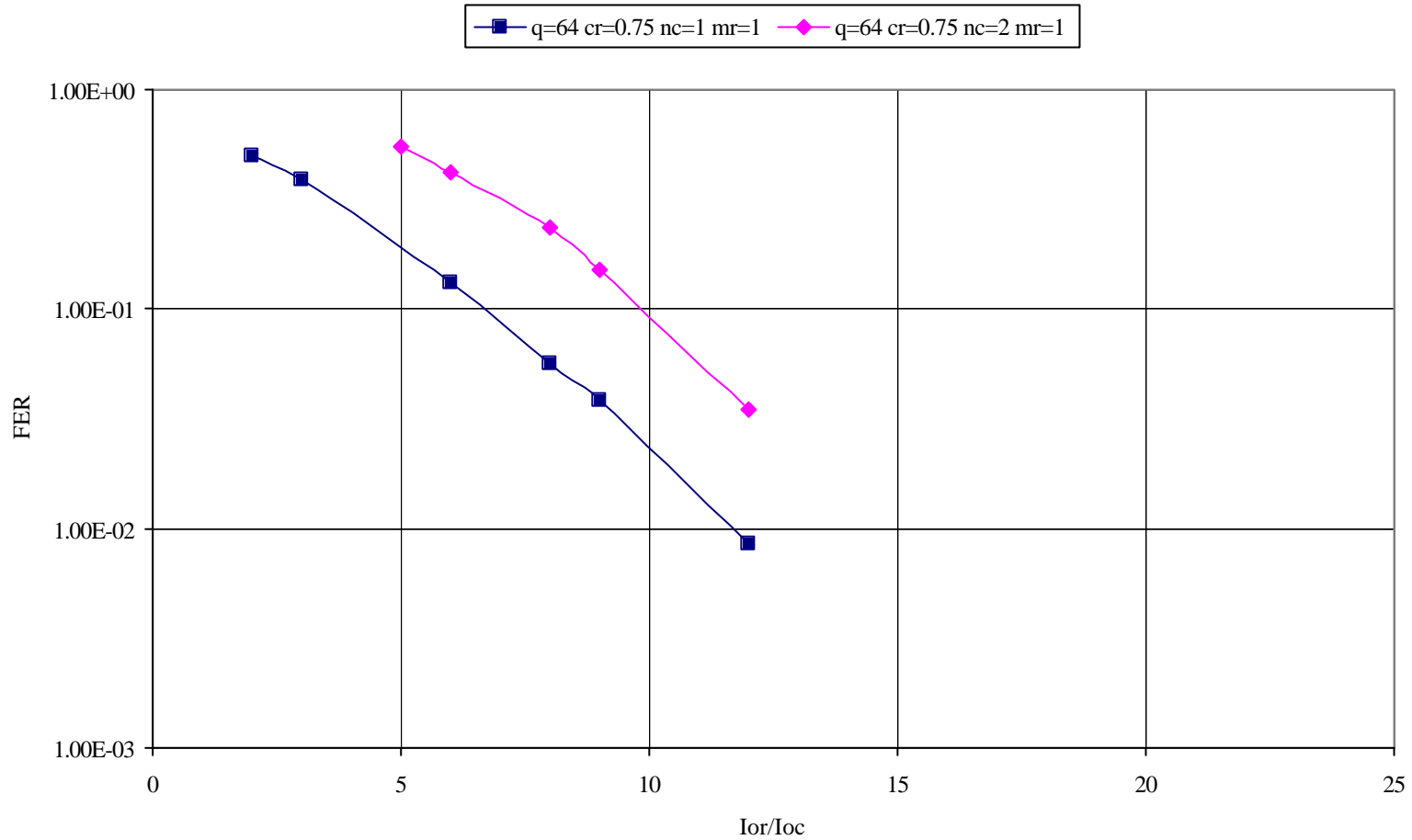
Static 64-QAM



3Kmph 1-path 64-QAM STTD=1



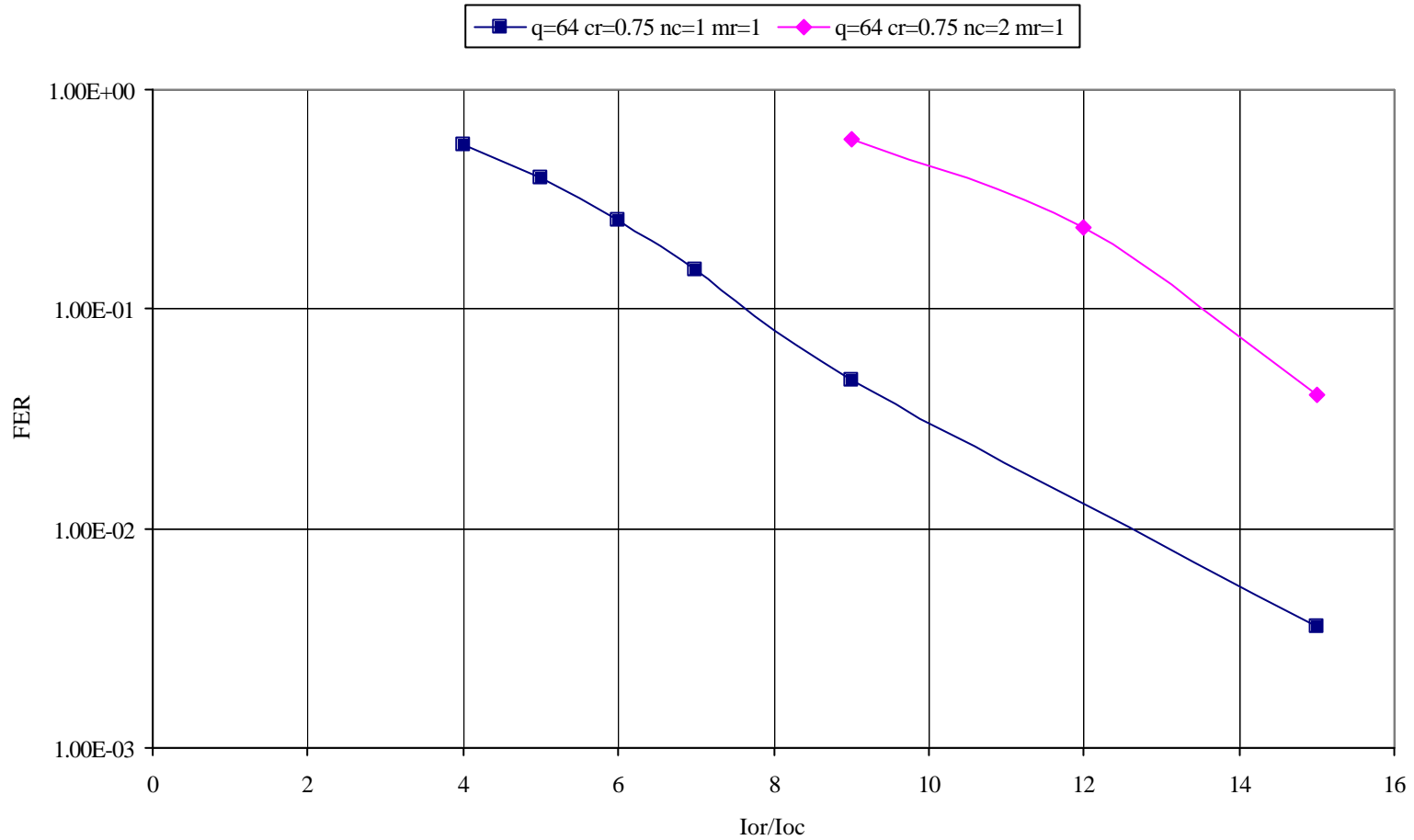
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path 64-QAM STTD=1



ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86

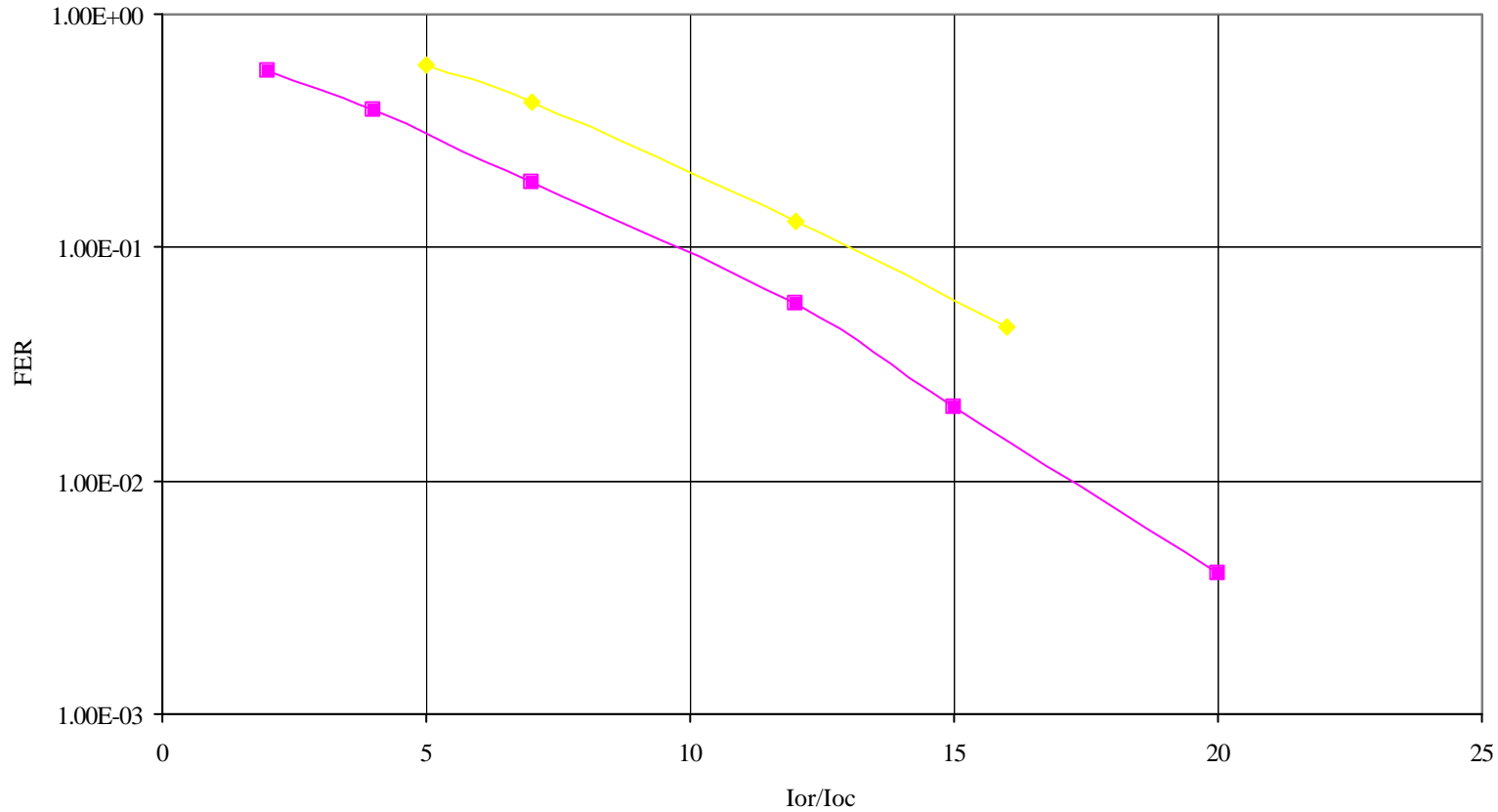


3Kmph 1-path 64-QAM STTD=0



ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86

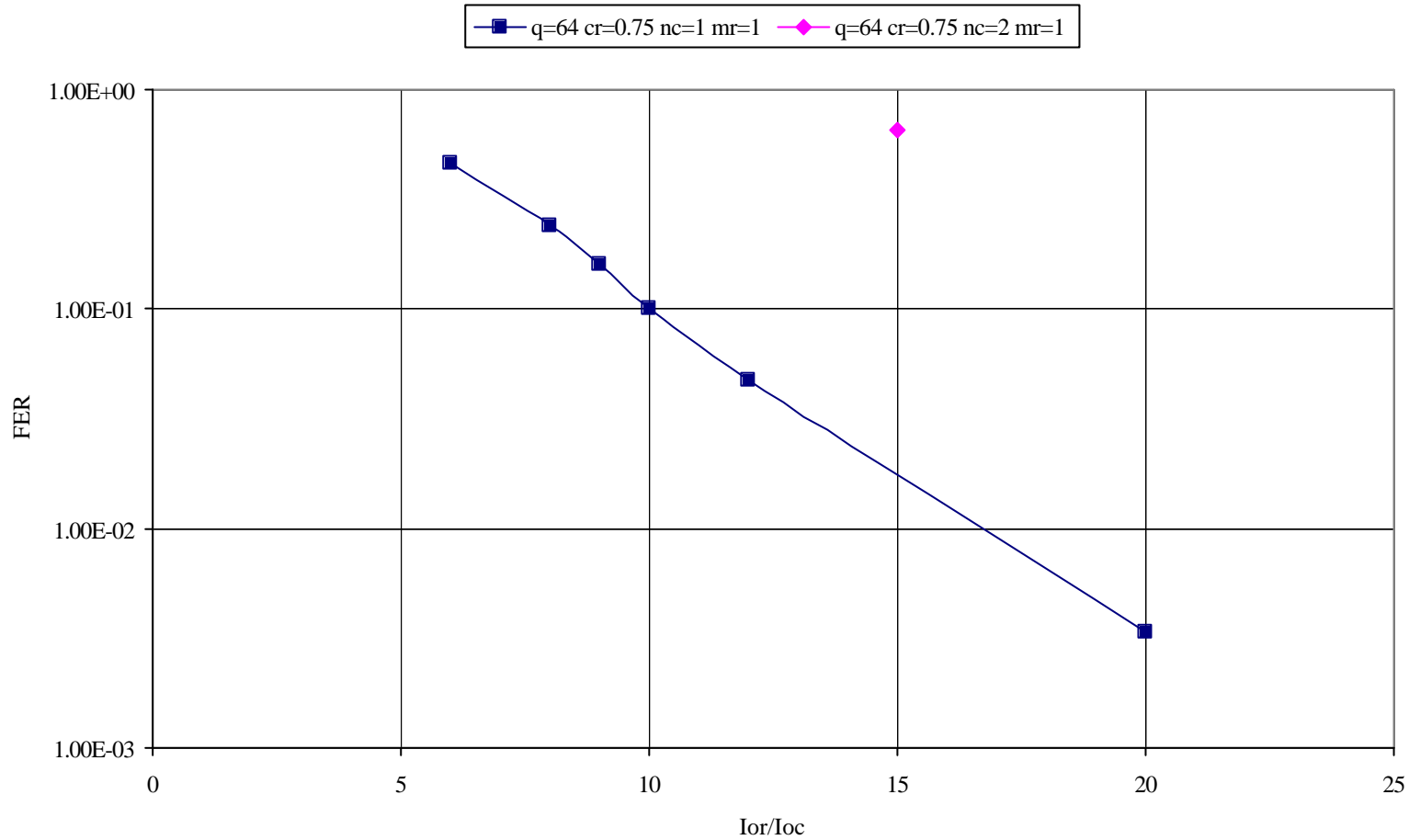
■ q=64 cr=0.75 nc=1 mr=1
 ◆ q=64 cr=0.75 nc=2 mr=1
 ◆ Series1



3Kmph 2-path 64-QAM STTD=0



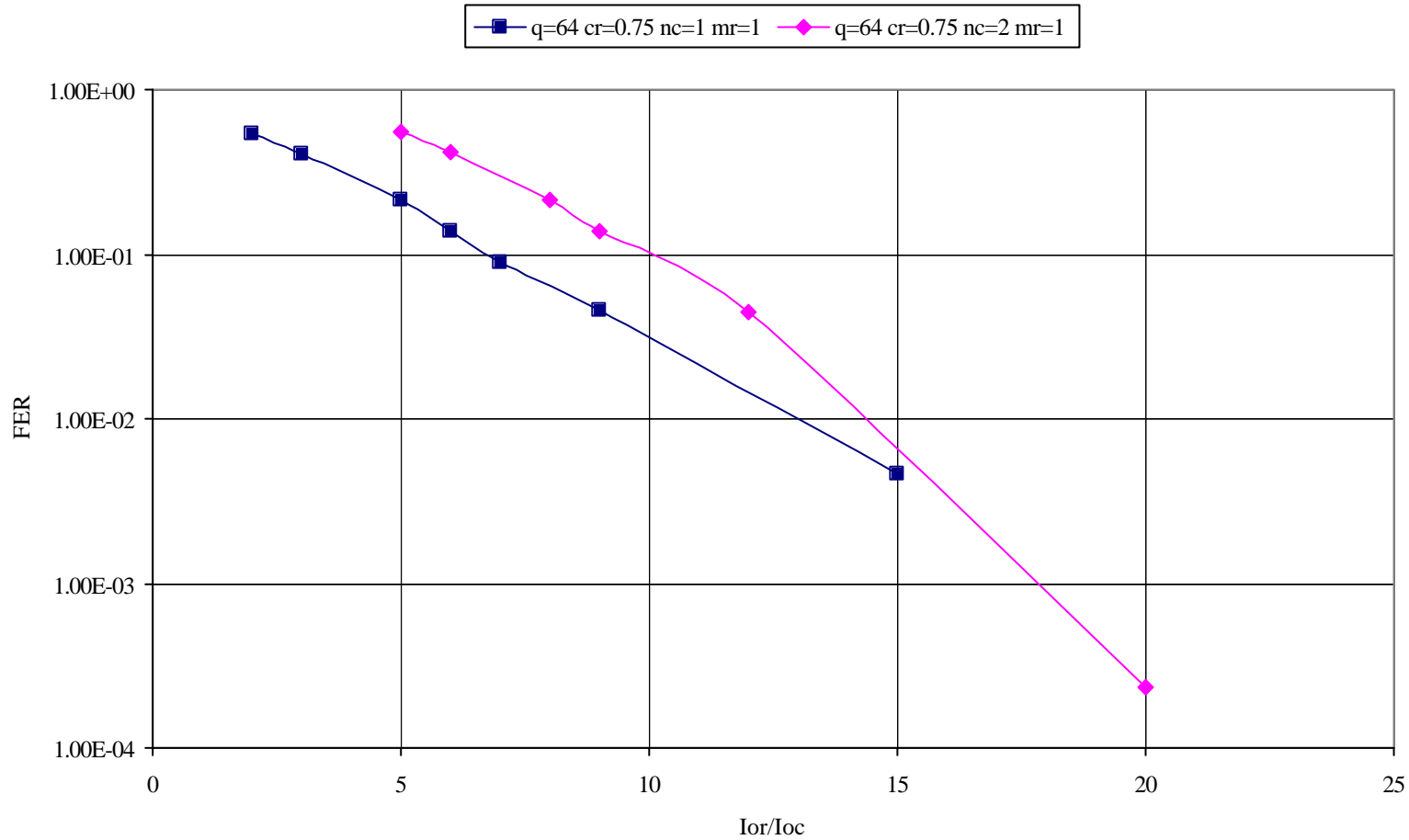
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



30Kmph 1-path 64-QAM STTD=1



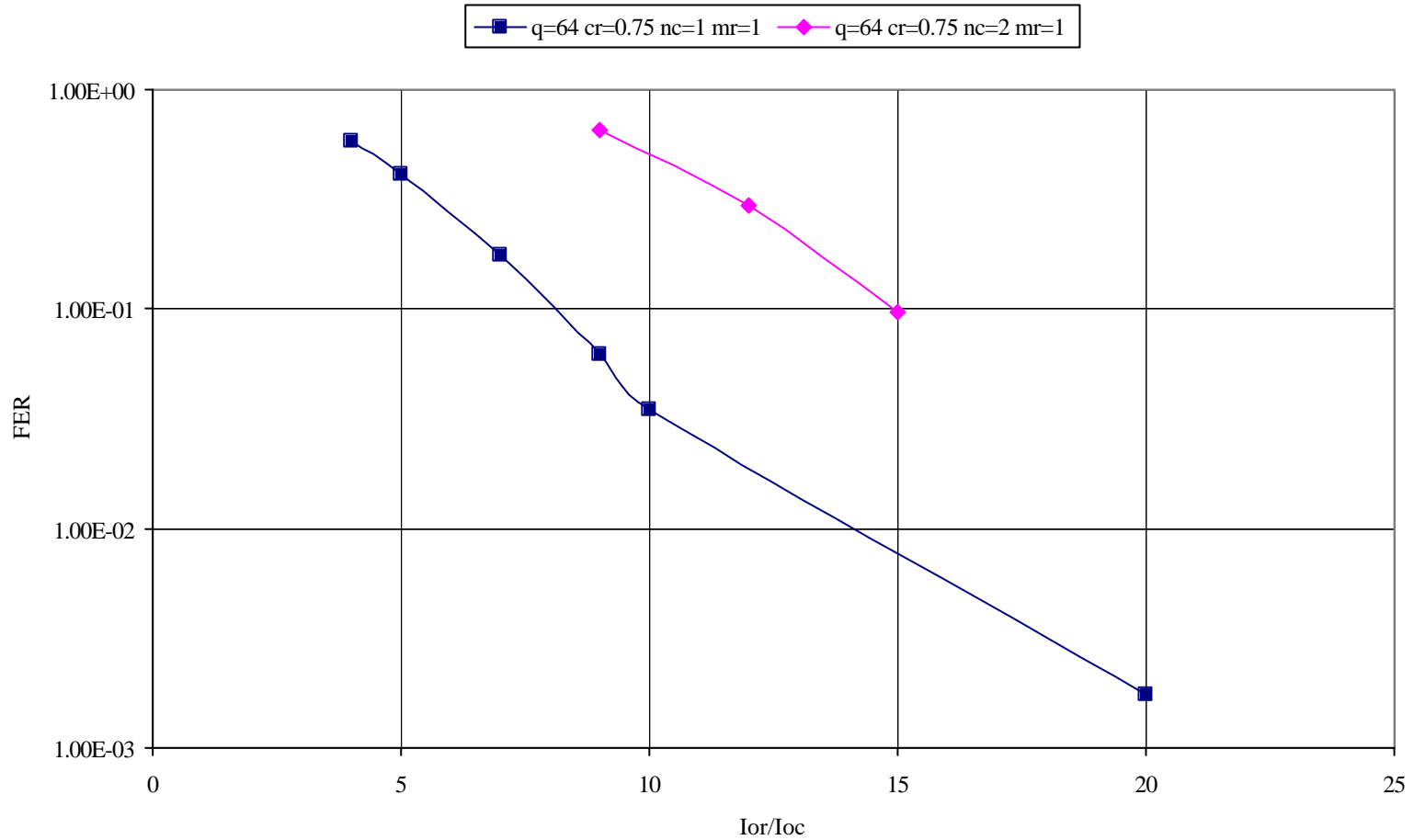
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path 64-QAM STTD=1



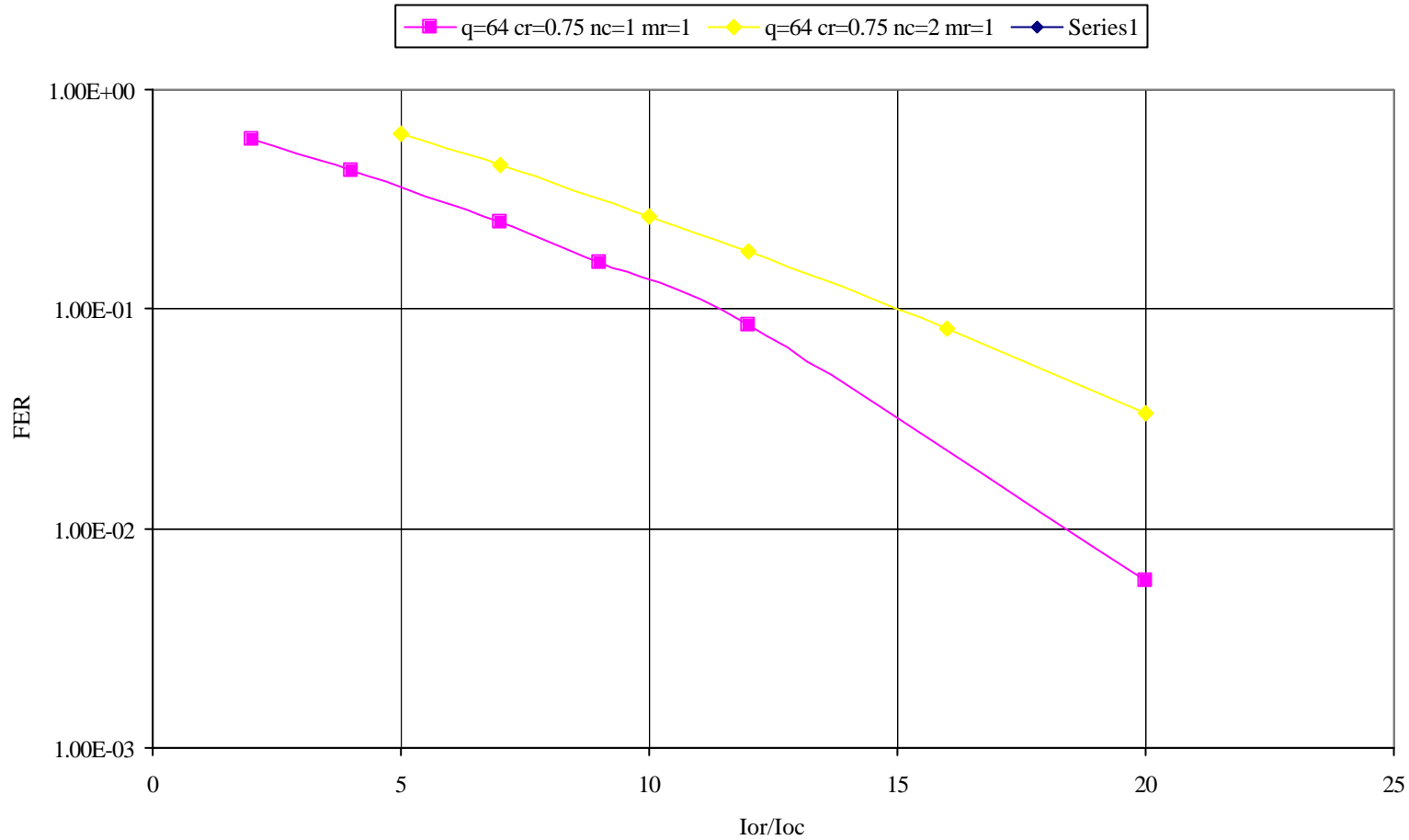
ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 1-path 64-QAM STTD=0



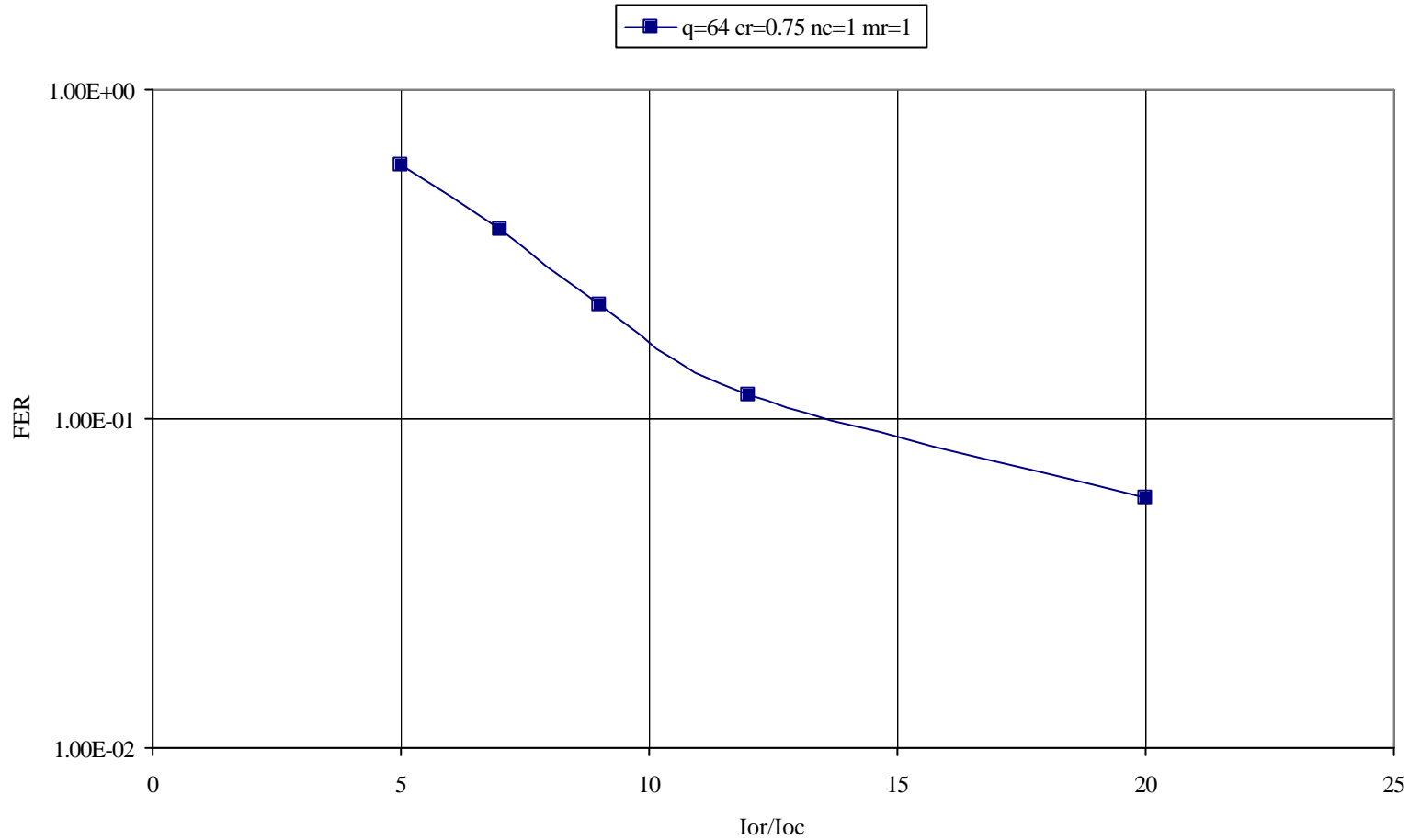
ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path 64-QAM STTD=0



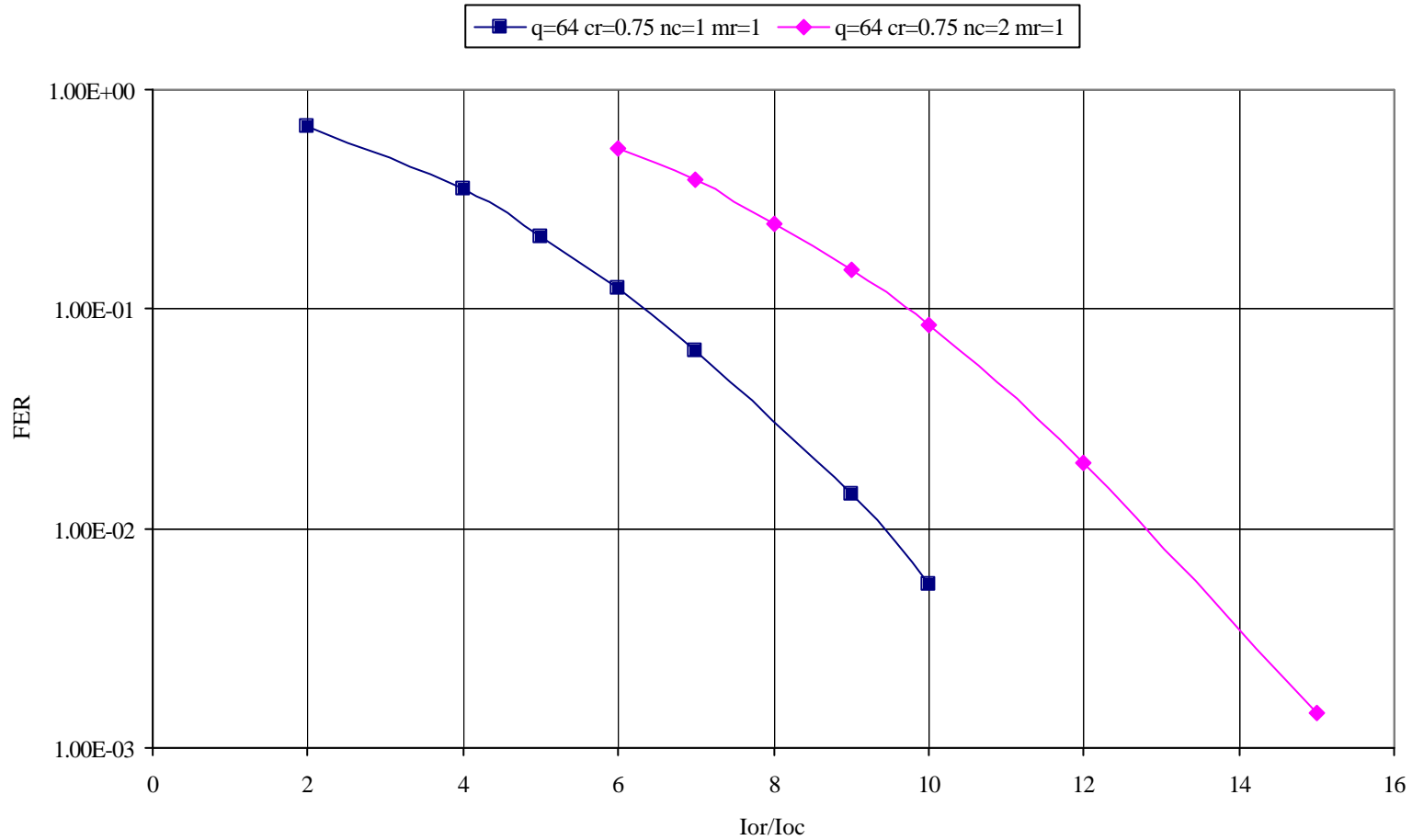
ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



120Kmph 1-path 64-QAM STTD=1



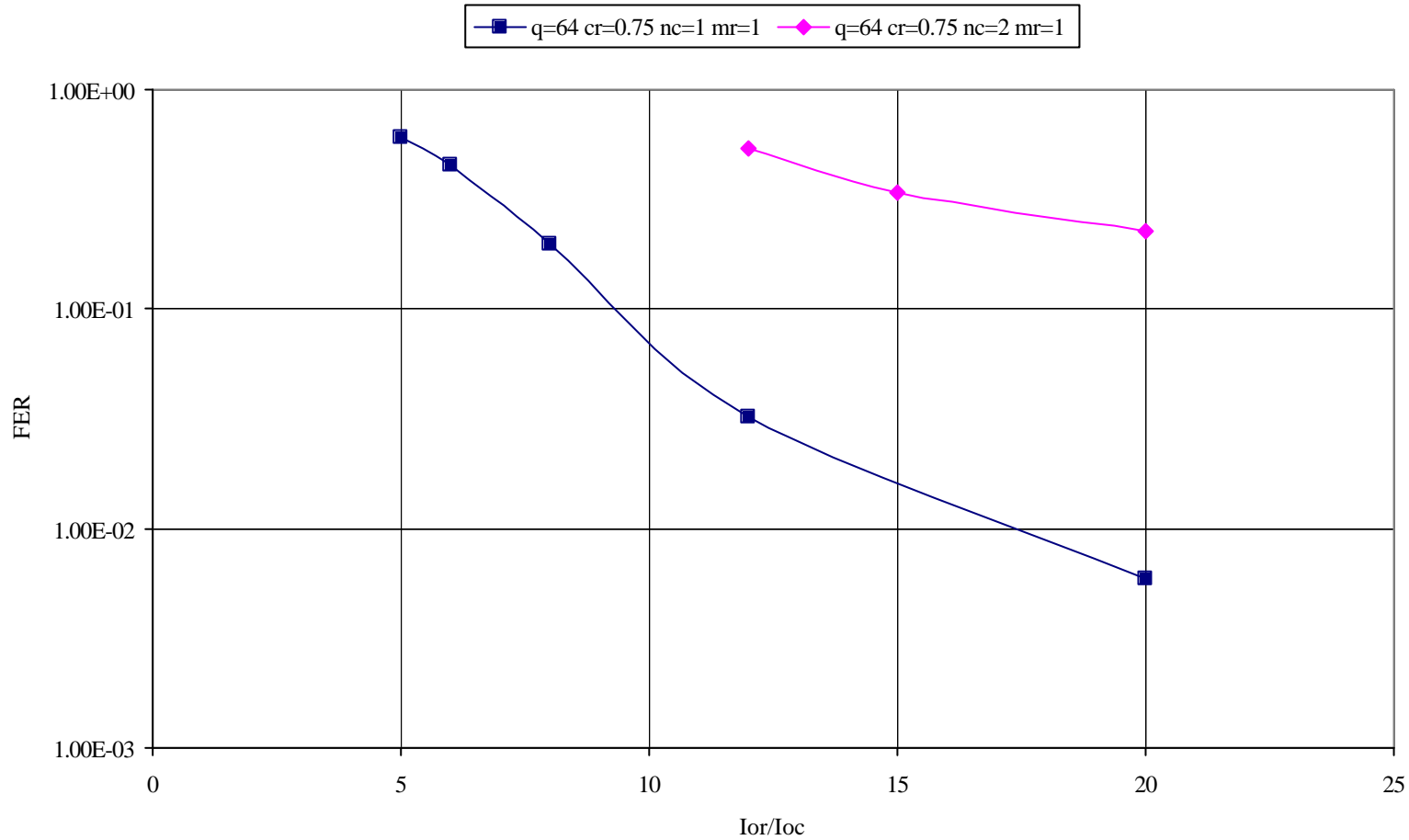
ff=0 ce=0 sttd=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path 64-QAM STTD=1



ff=0 ce=0 sttd=1 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58

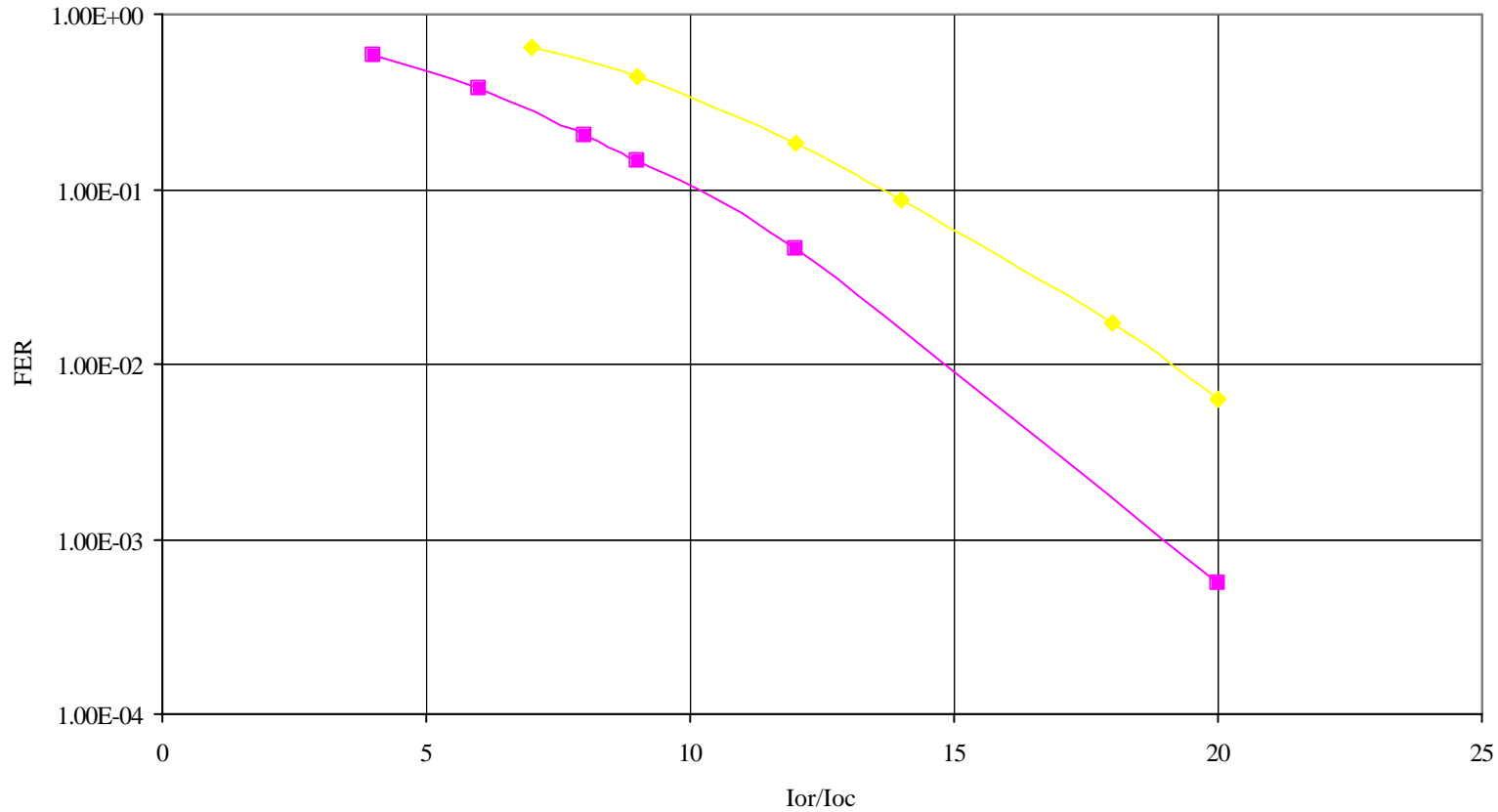


120Kmph 1-path 64-QAM STTD=0



ff=0 ce=0 sttd=0 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58

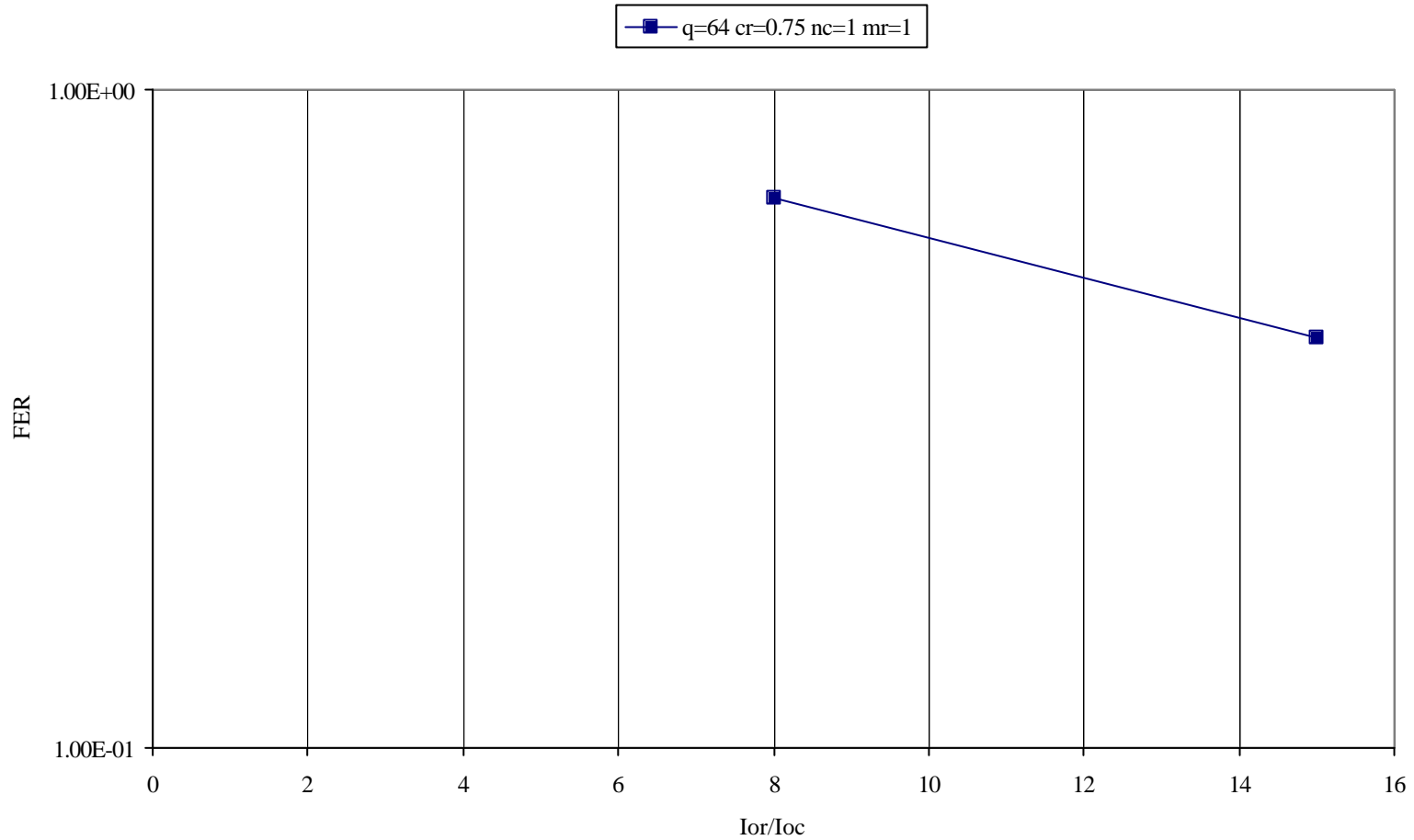
■ q=64 cr=0.75 nc=1 mr=1
 ◆ q=64 cr=0.75 nc=2 mr=1
 ◆ Series1



120Kmph 2-path 64-QAM STTD=0



ff=0 ce=0 sttd=0 arq=0 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



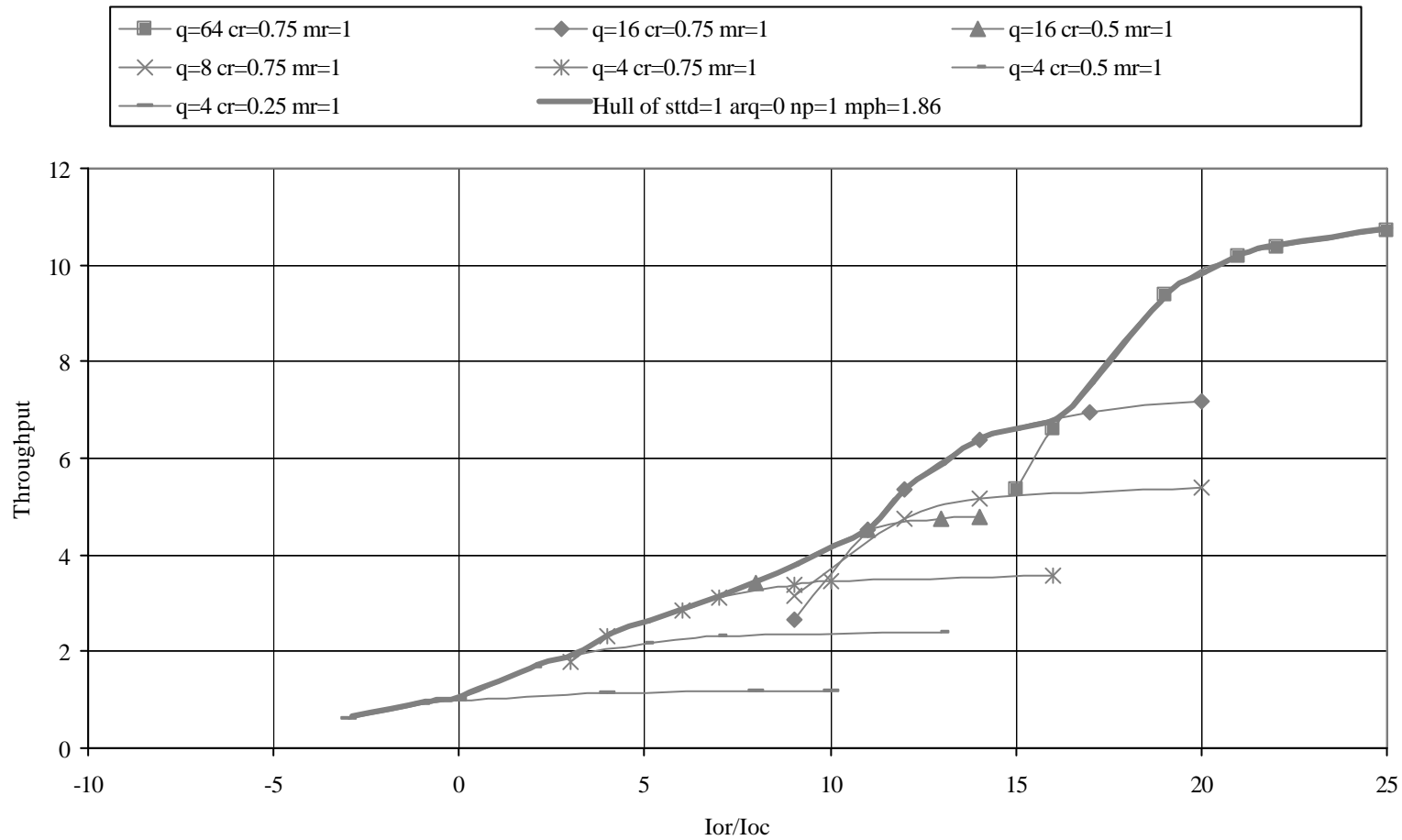
Hull Curves

3Kmph

3Kmph 1-path STTD=1 HARQ=0



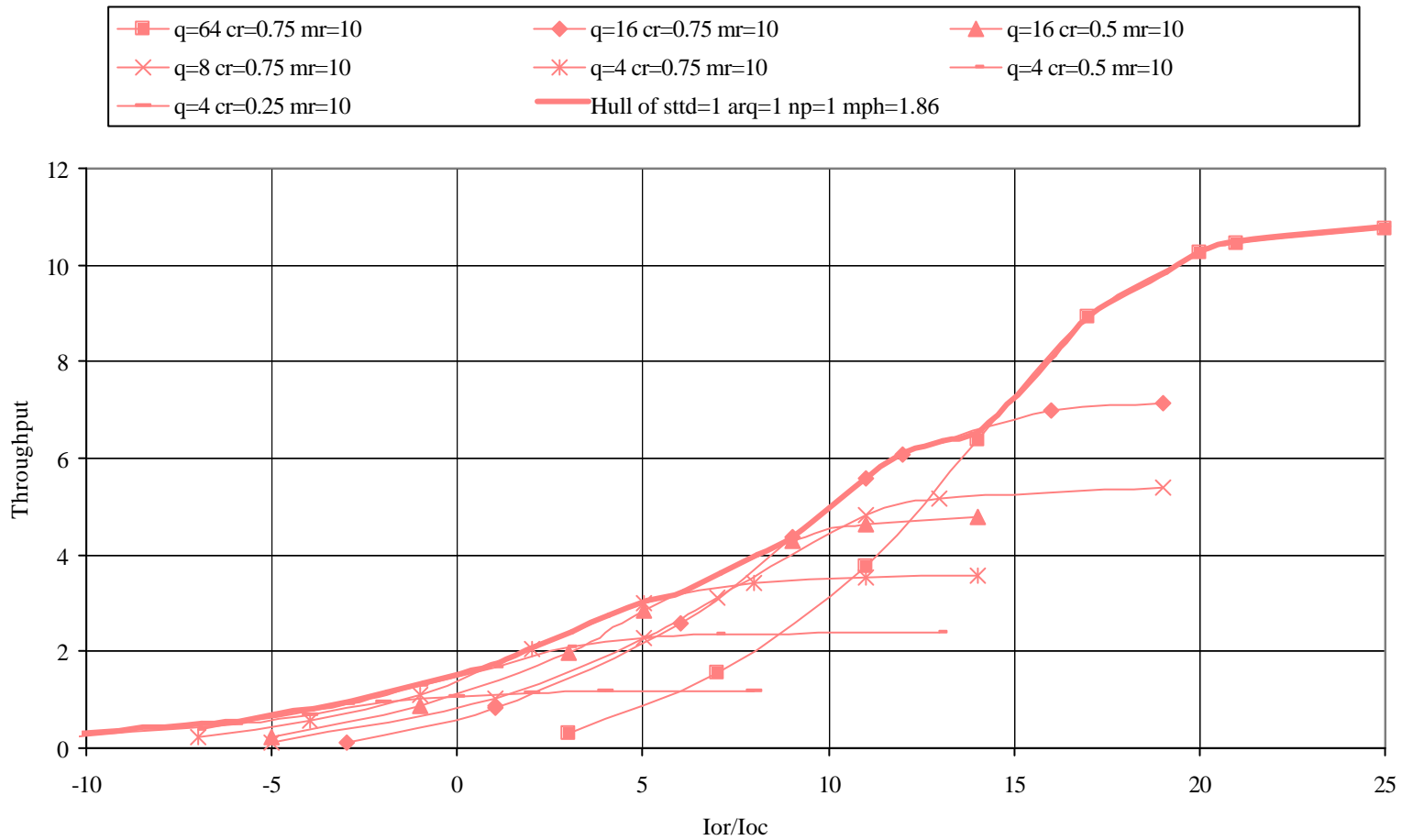
ff=0 ce=0 sttd=1 nc=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 1-path STTD=1 HARQ=1



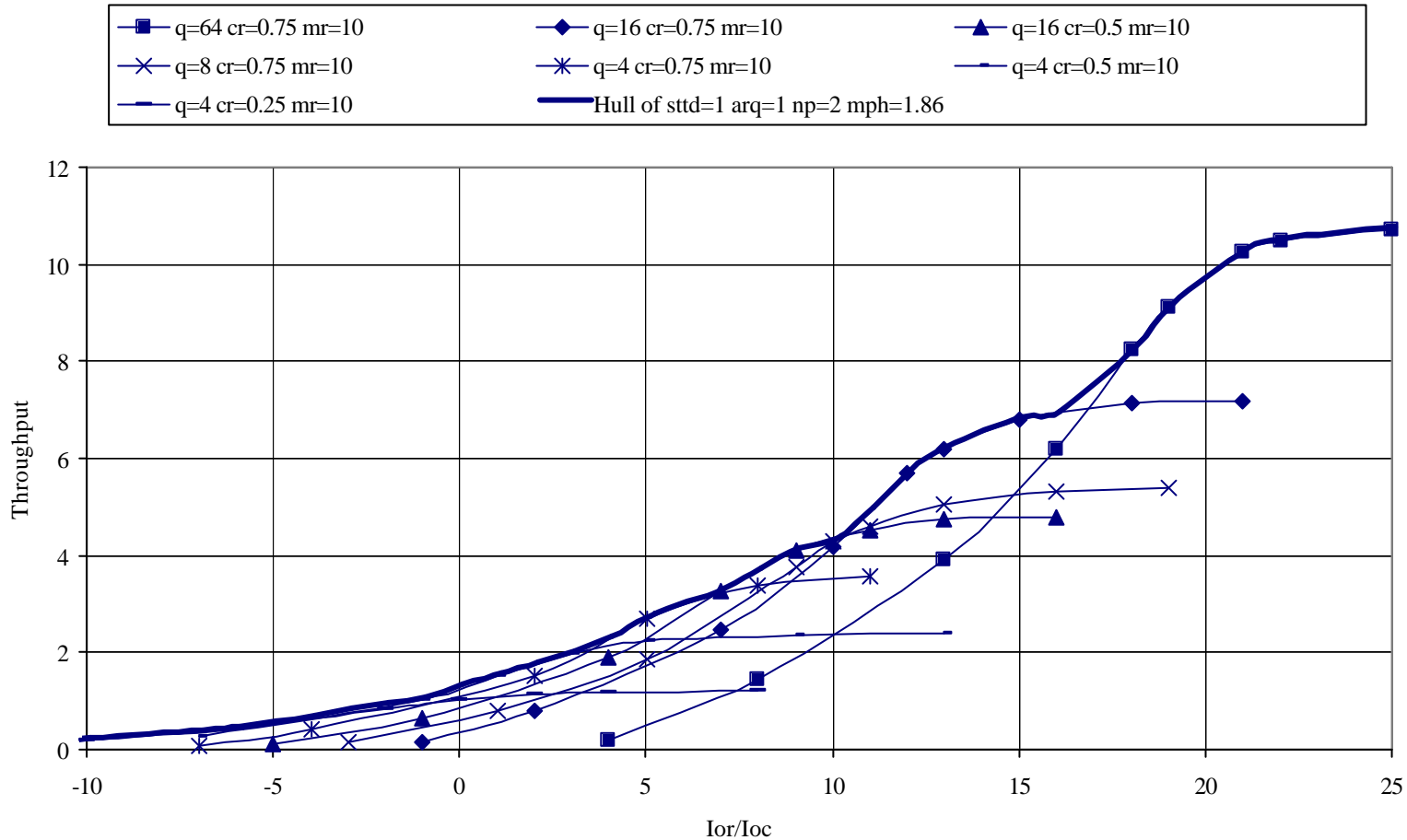
ff=0 ce=0 sttd=1 nc=1 arq=1 np=1 fe=2000 ibm=0 ecior=-1 mph=1.86



3Kmph 2-path STTD=1 HARQ=1



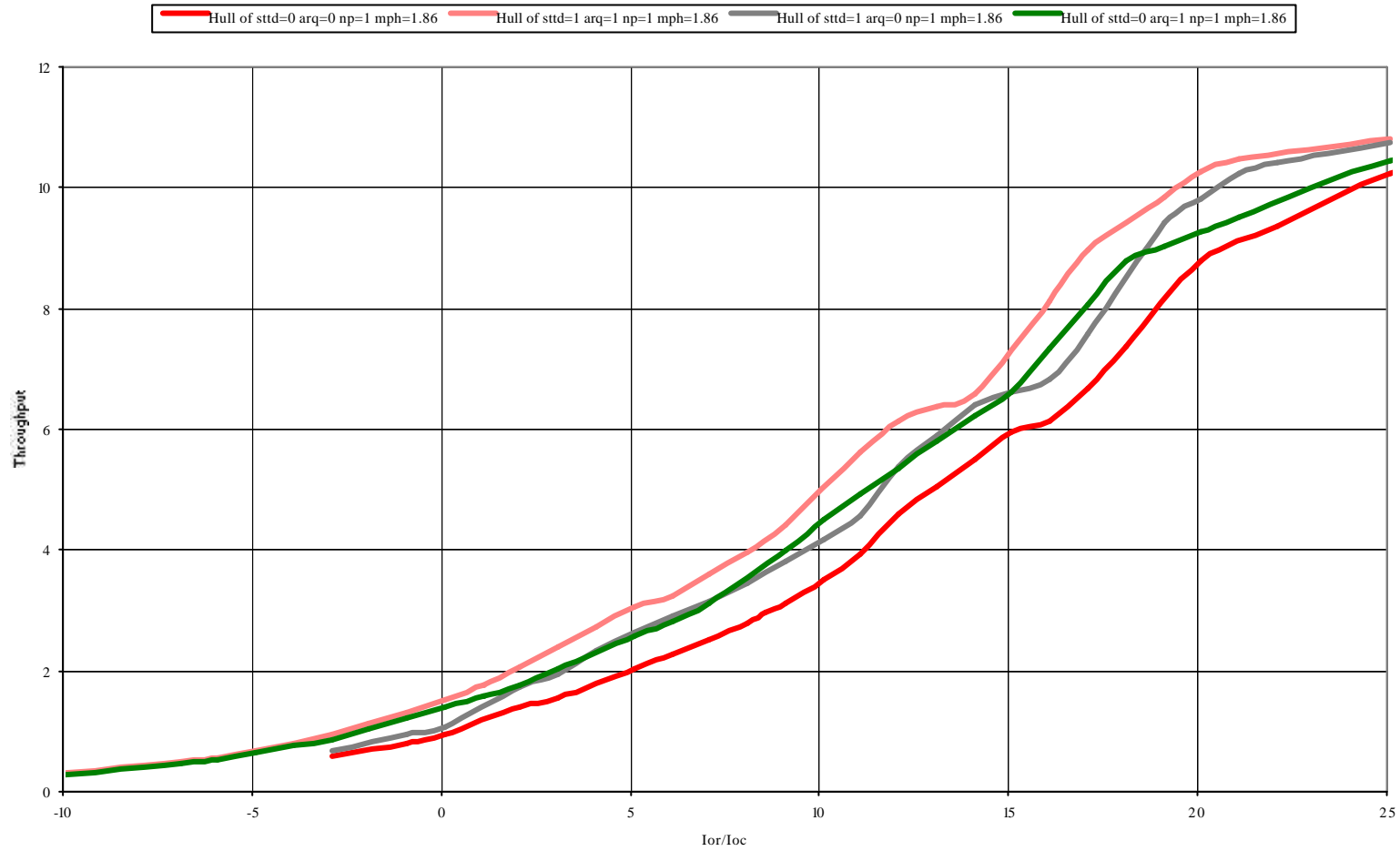
ff=0 ce=0 sttd=1 nc=1 arq=1 np=2 fe=2000 ibm=0 ecior=-1 mph=1.86



Hull - 3Kmph



Hulls of ff=0 ce=0 nc=1 fe=2000 ibm=0 ecior=-1

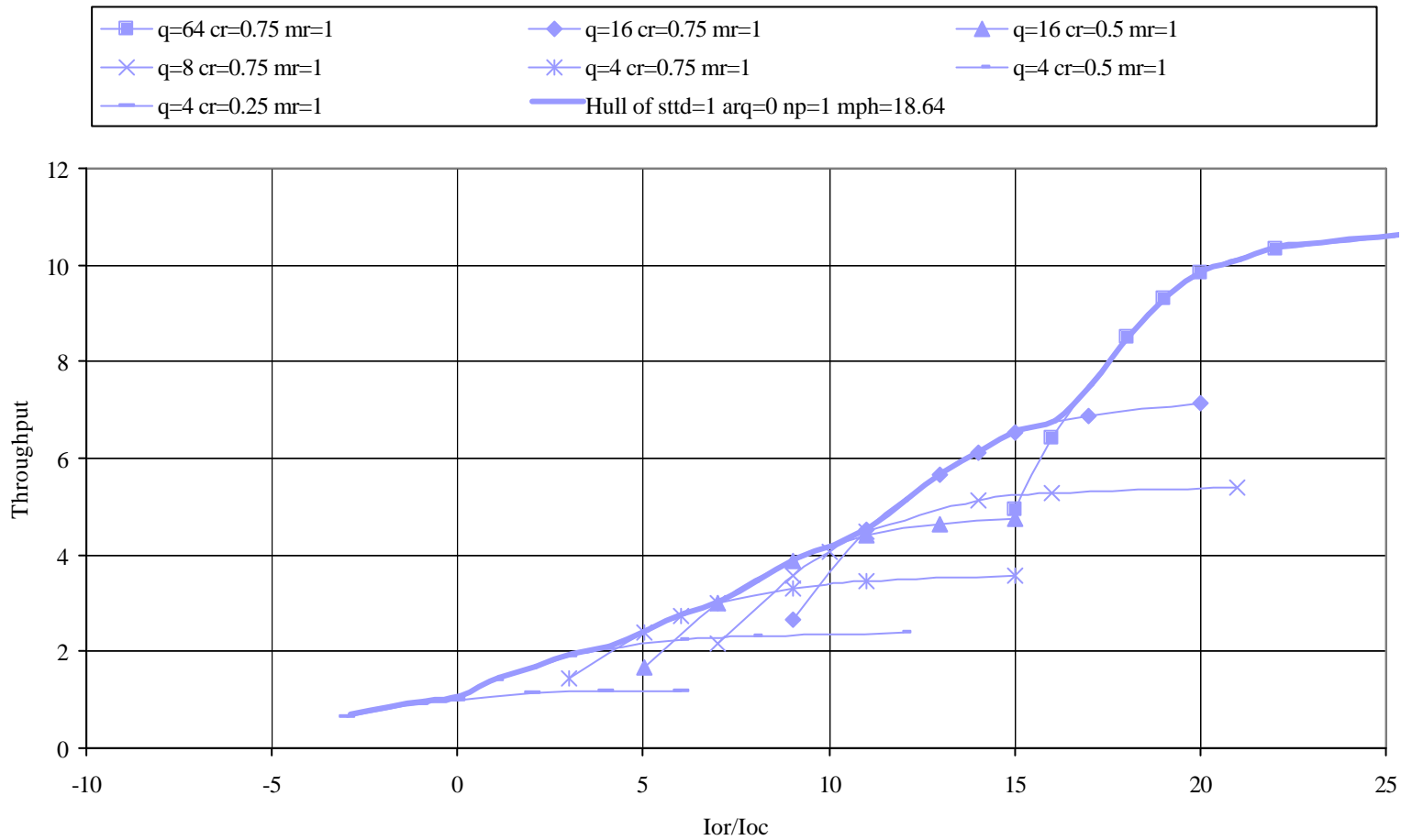


30Kmph

30Kmph 1-path STTD=1 HARQ=0



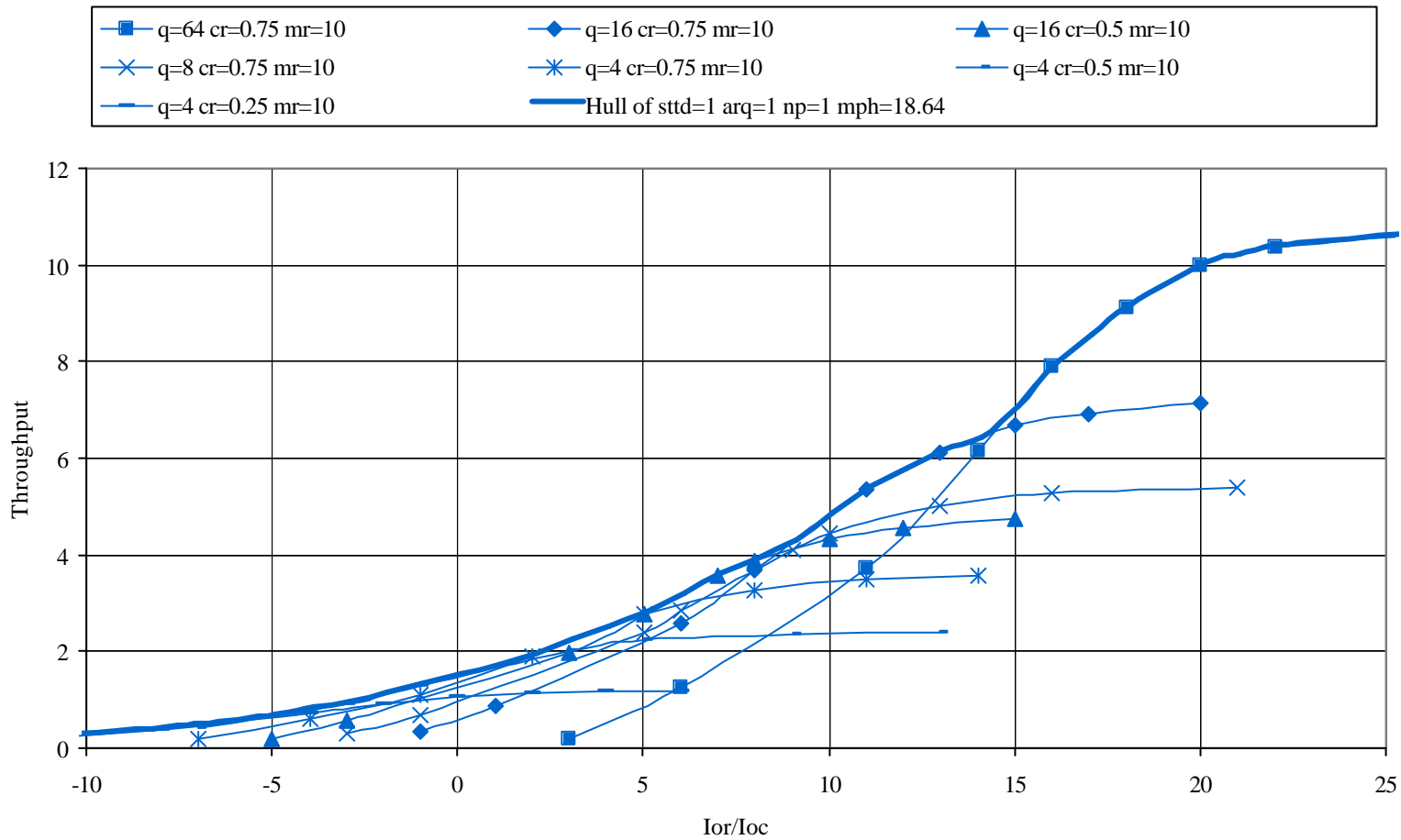
ff=0 ce=0 sttd=1 nc=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 1-path STTD=1 HARQ=1



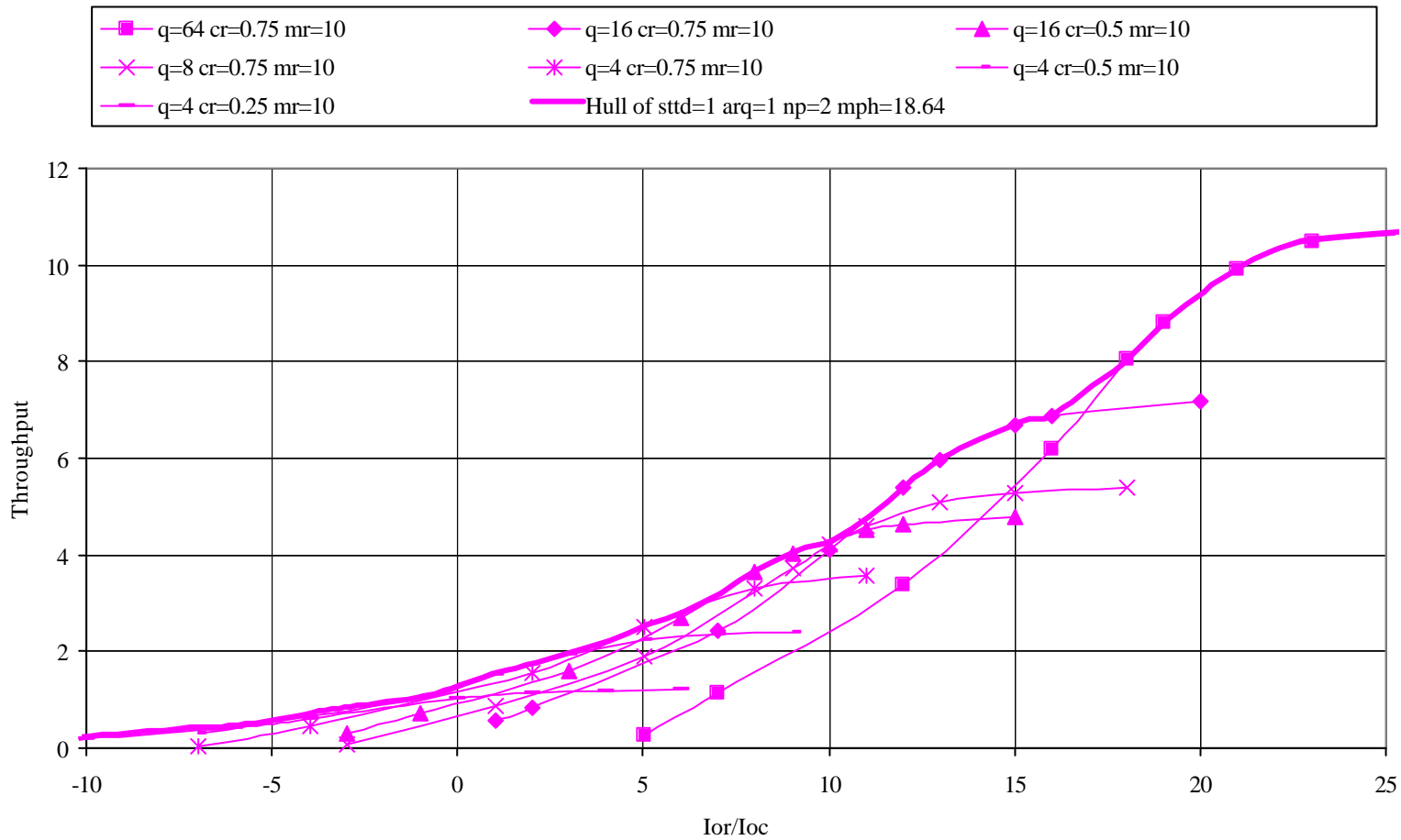
ff=0 ce=0 sttd=1 nc=1 arq=1 np=1 fe=2000 ibm=0 ecior=-1 mph=18.64



30Kmph 2-path STTD=1 HARQ=1



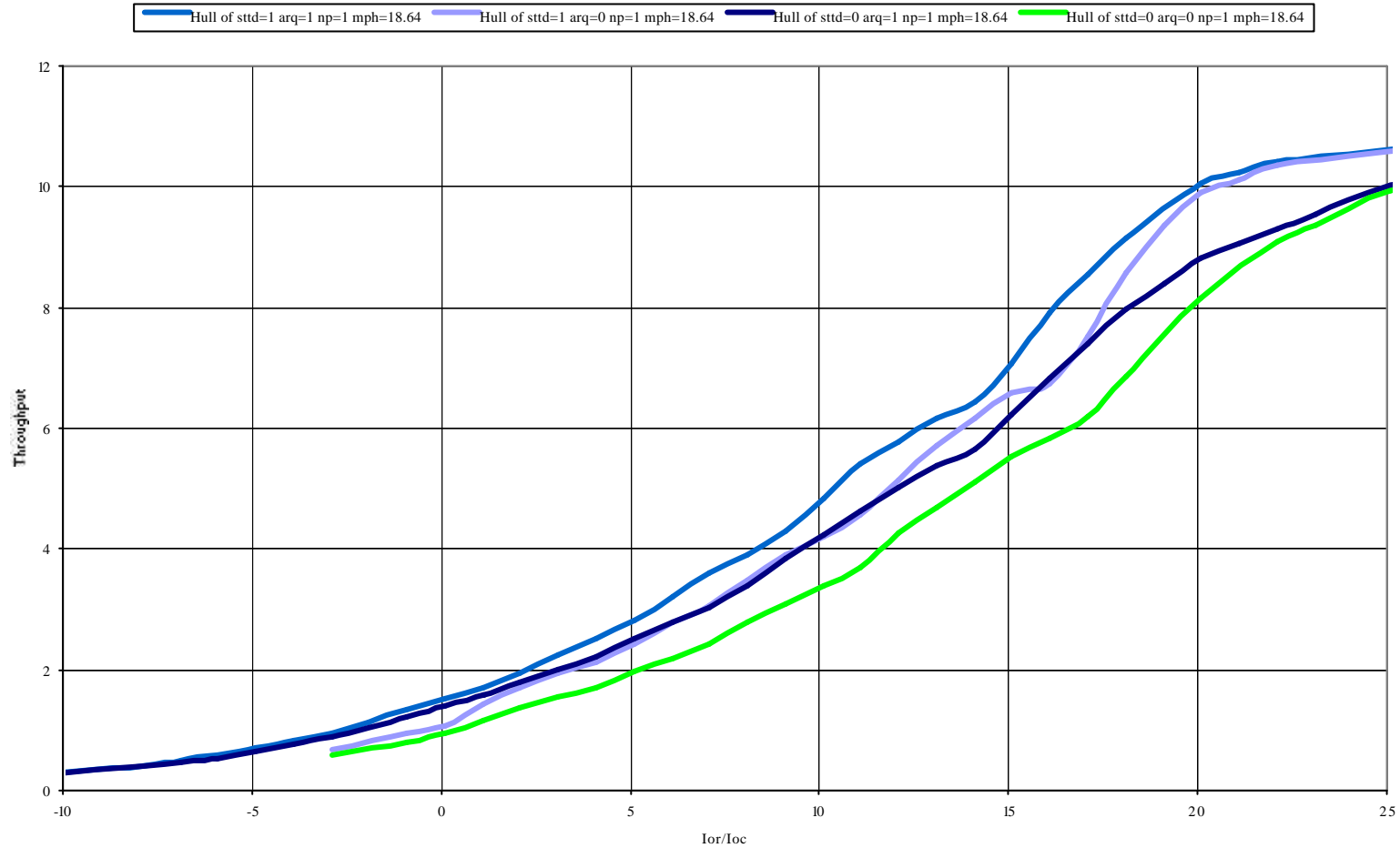
ff=0 ce=0 sttd=1 nc=1 arq=1 np=2 fe=2000 ibm=0 ecior=-1 mph=18.64



Hull 30Kmph



Hulls of ff=0 ce=0 nc=1 fe=2000 ibm=0 ecior=-1

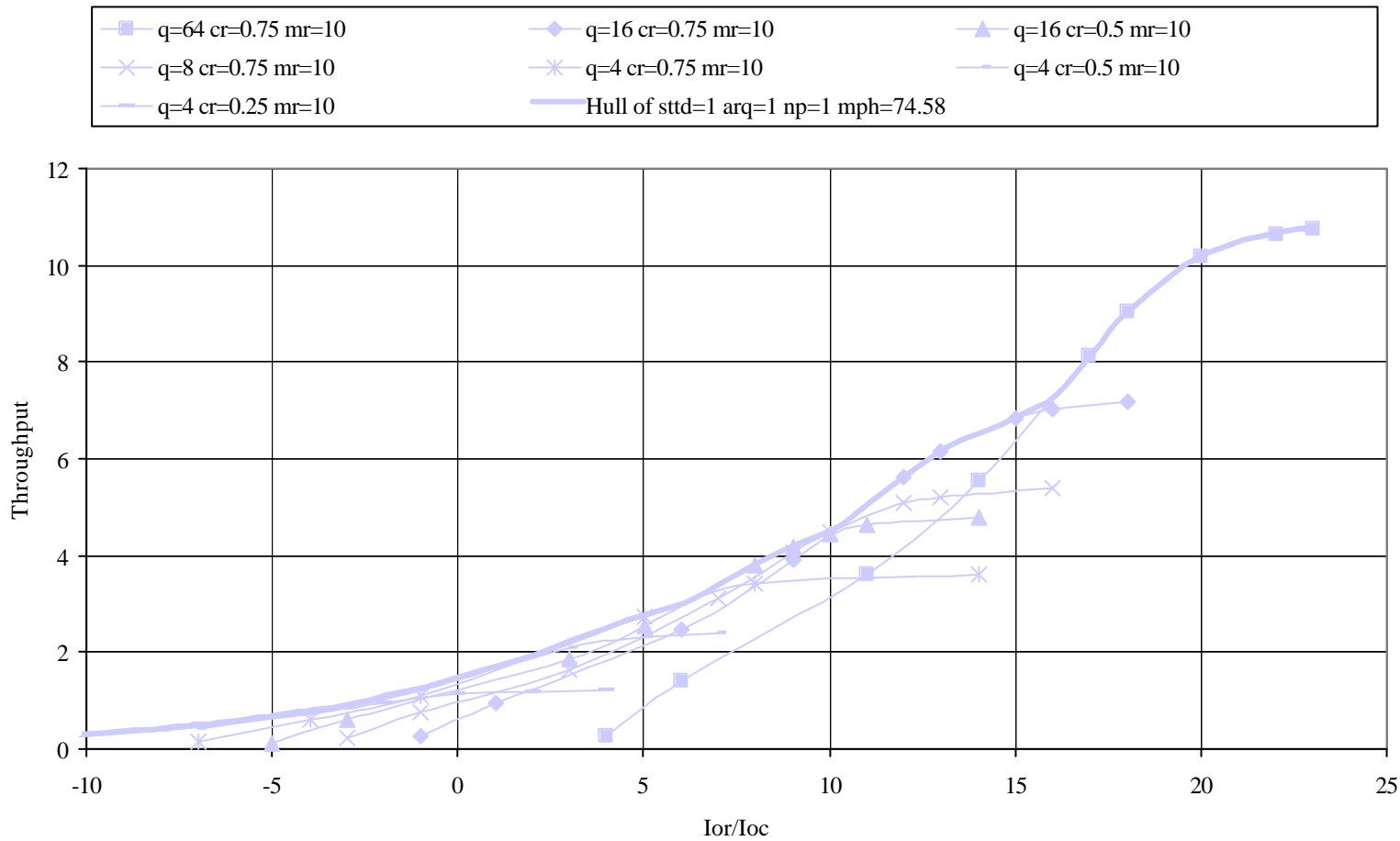


120Kmph

120Kmph 1-path STTD=1 HARQ=1



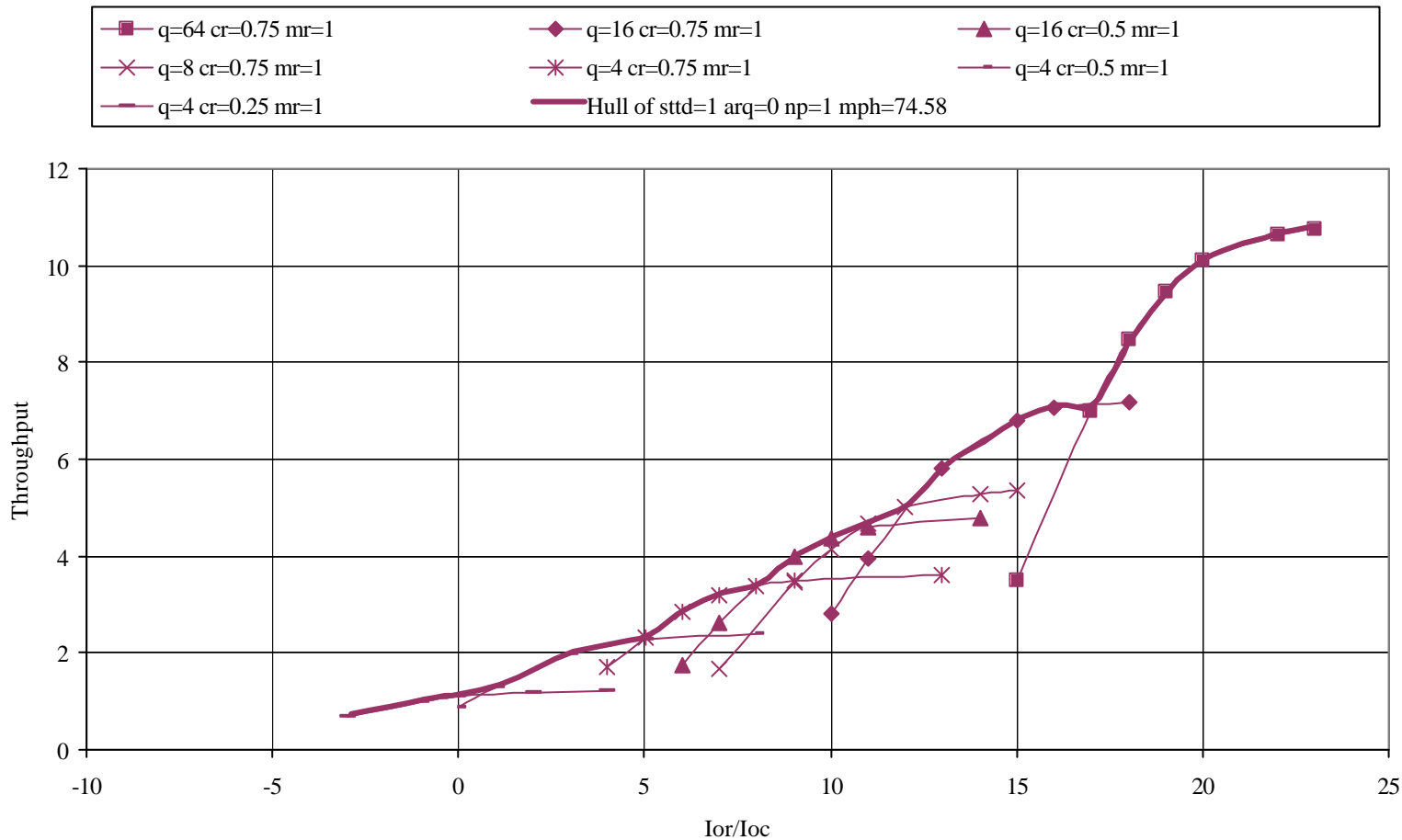
ff=0 ce=0 sttd=1 nc=1 arq=1 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 1-path STTD=1 HARQ=0



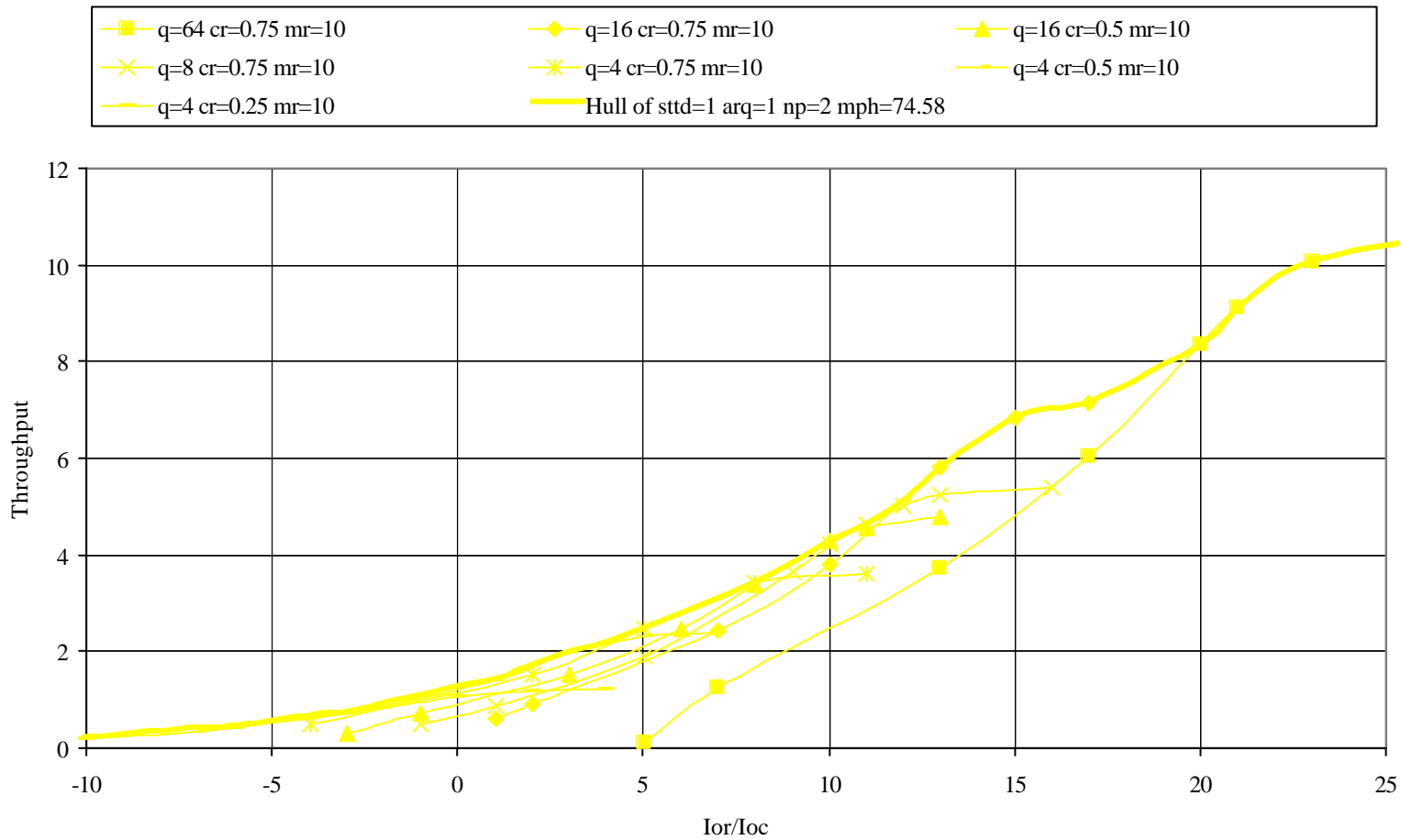
ff=0 ce=0 sttd=1 nc=1 arq=0 np=1 fe=2000 ibm=0 ecior=-1 mph=74.58



120Kmph 2-path STTD=1 HARQ=1



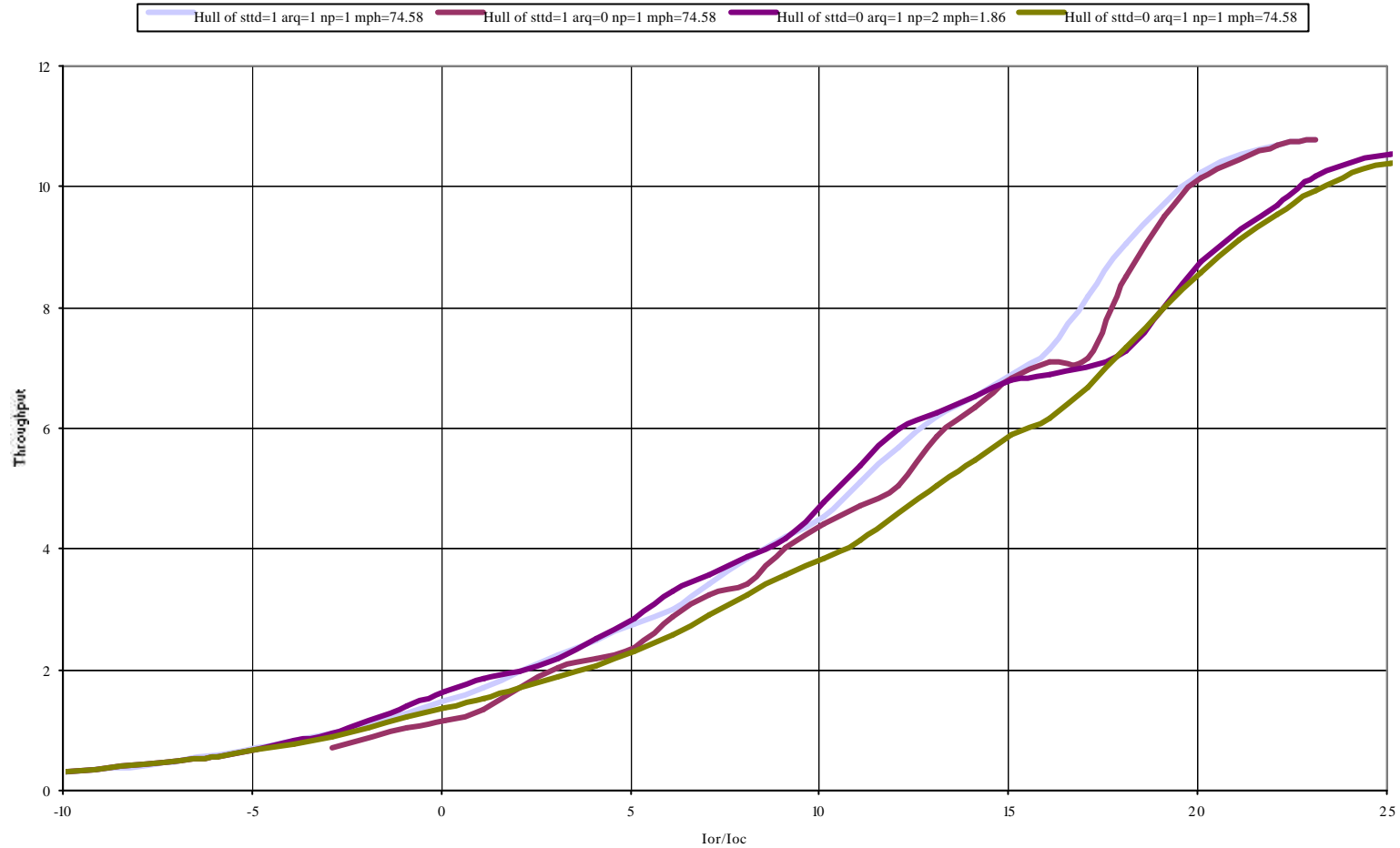
ff=0 ce=0 sttd=1 nc=1 arq=1 np=2 fe=2000 ibm=0 ecior=-1 mph=74.58



Hull 120Kmph



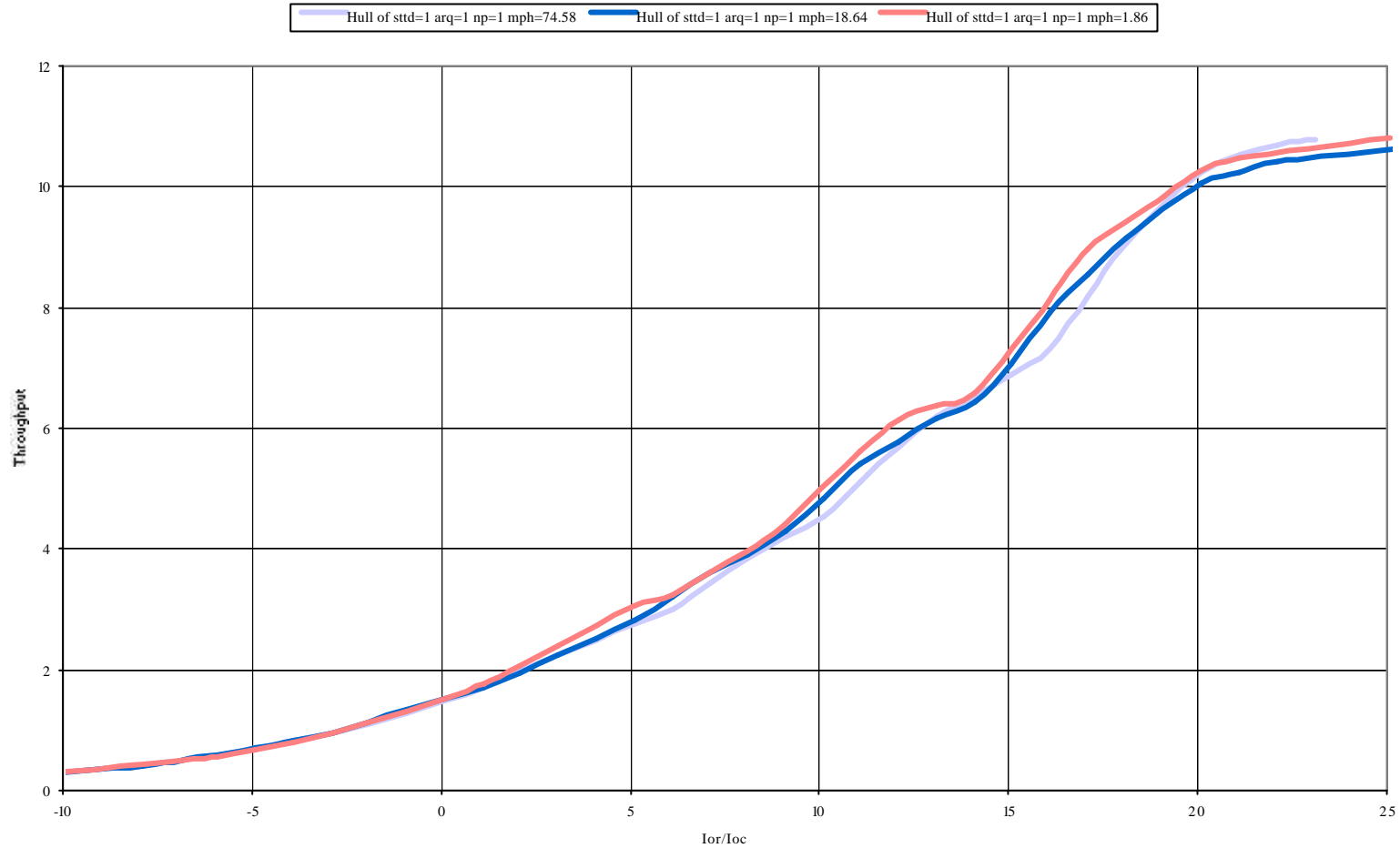
Hulls of ff=0 ce=0 nc=1 fe=2000 ibm=0 ecior=-1



Hull Curves, STTD=1, ARQ=1, NP=1



Hulls of ff=0 ce=0 nc=1 fe=2000 ibm=0 ecior=-1





Sector Throughput- Equal Average Power Scheduler 20 Multicodes



Family ID	Equal Ave Power		
sttd=0 arq=1 np=1 mph=0	2996277.9		
sttd=1 arq=1 np=1 mph=1.86	2594812.5		
sttd=0 arq=0 np=1 mph=0	2516164.4		
sttd=0 arq=1 np=2 mph=1.86	2515469.8		
sttd=1 arq=1 np=1 mph=18.64	2510924.7		
sttd=1 arq=1 np=1 mph=74.58	2446897.4		
sttd=0 arq=1 np=2 mph=18.64	2407780.1		
sttd=0 arq=1 np=2 mph=74.58	2346084.1		
sttd=1 arq=1 np=2 mph=1.86	2317019.1		
sttd=0 arq=1 np=1 mph=1.86	2301557.3		
sttd=1 arq=1 np=2 mph=18.64	2259831.8		
sttd=0 arq=1 np=1 mph=18.64	2224312.4		
sttd=1 arq=1 np=2 mph=74.58	2221821.2		
sttd=1 arq=0 np=1 mph=74.58	2203010.8		
sttd=1 arq=0 np=1 mph=1.86	2180388.9		
sttd=1 arq=0 np=1 mph=18.64	2145465.1		
sttd=0 arq=1 np=1 mph=74.58	2099856.9		
sttd=0 arq=0 np=2 mph=74.58	2083388.6		
sttd=1 arq=0 np=2 mph=74.58	2058475.3		
sttd=0 arq=0 np=2 mph=18.64	2053583.3		
sttd=0 arq=0 np=2 mph=1.86	2038100.5		
sttd=1 arq=0 np=2 mph=1.86	1990285.8		
sttd=1 arq=0 np=2 mph=18.64	1984978.8		
sttd=0 arq=0 np=1 mph=1.86	1794048.8		
sttd=0 arq=0 np=1 mph=74.58	1755018.5		
sttd=0 arq=0 np=1 mph=18.64	1733212.5		



- With Hybrid ARQ and STTD a gain of approximately 4dB is achieved over all range of vehicle speed over a system without Hybrid ARQ and STTD.
- Under multipath, the performance of 64-QAM modulation degrades at high values of vehicle speeds due to self-interference.
- As the number of codes are doubled, the power requirement is also doubled.
- Average sector throughput of approximately 2.6 Mbps can be achieved at slow speed and 20 codes with Equal Average Power Scheduler.
- Increasing the number of codes will improve the average throughput but there may be a shortage of OVSF codes to support the overhead and control channels.