

# Burst Marker Analysis

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# **TERNARY SEQUENCES AUTO AND CROSS-CORRELATION**

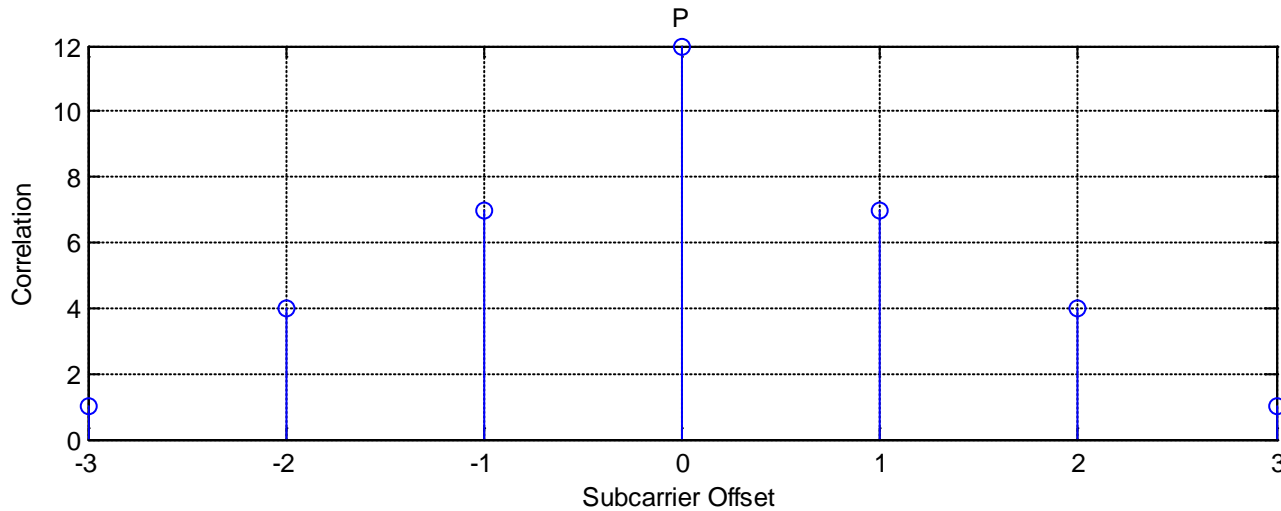
# Baseline Ternary Burst Marker Detection [1,2]

- Four profiles identified by N location.
- BM detector use energy detection:
  - **P** detector is sum power at P locations
  - **N** detector is sum power at N locations
- Threshold is scaled **P** detector output
- BM detection relies on the ratio of N to P energy, N to P ratio is 1/3.
- BM is interleaved with data and pilots.

[1] Dallas, November 2013, [rahman\\_syed\\_3bn\\_03\\_1113.pdf](#)

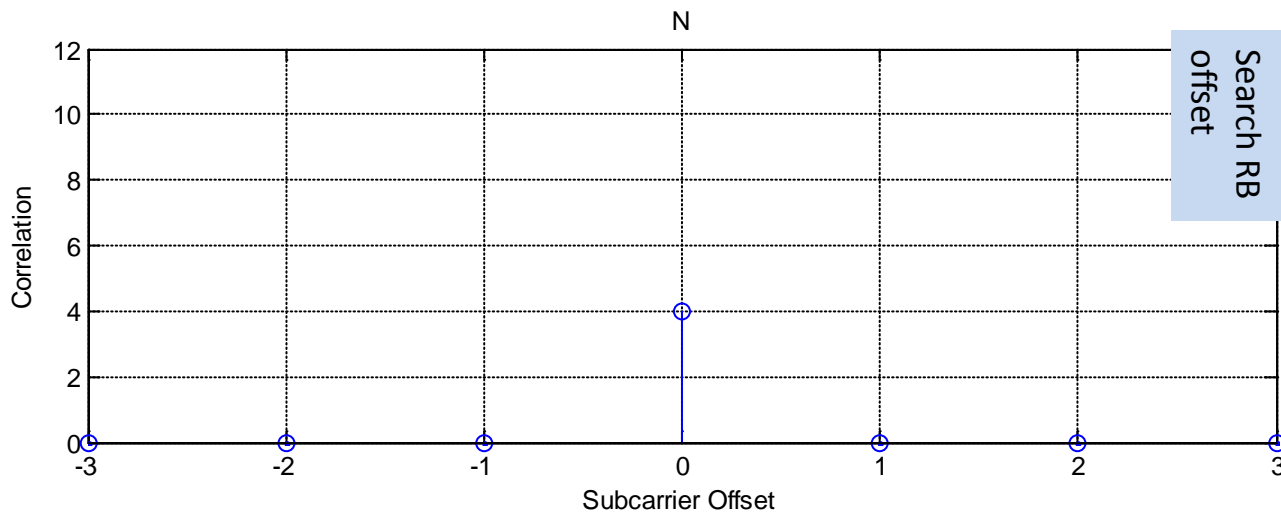
[2] Dallas, November 2013, [rahman\\_syed\\_3bn\\_01\\_1113.pdf](#)

# BM #3, length=16, RB=1x8



RB are shown with lowest frequency at top, highest at bottom

Note: Table list BM elements, interleaved data RE not shown.

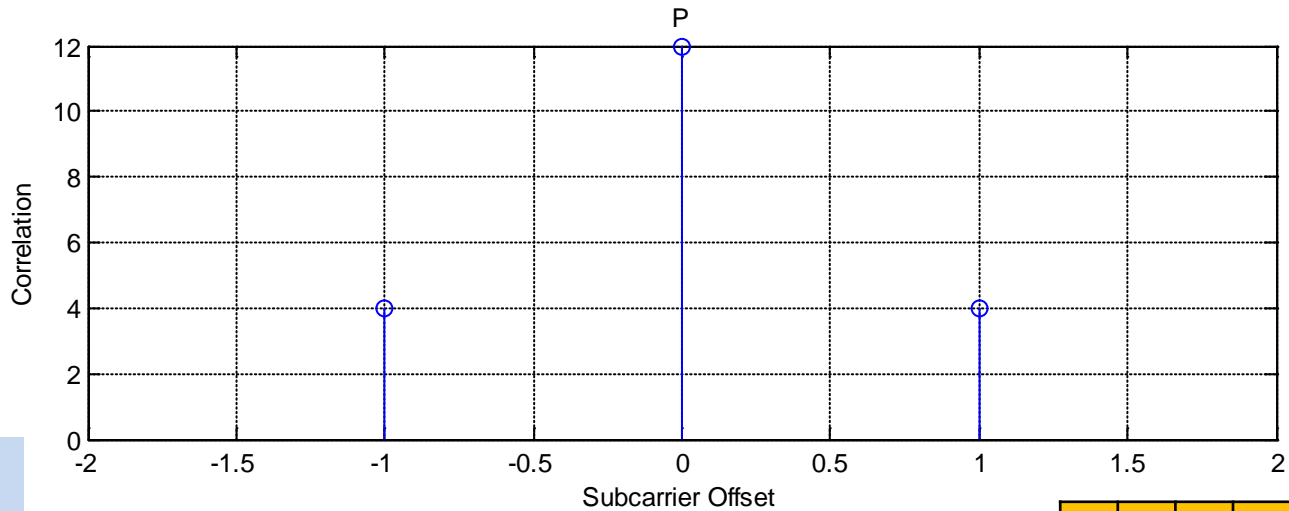


Search RB offset

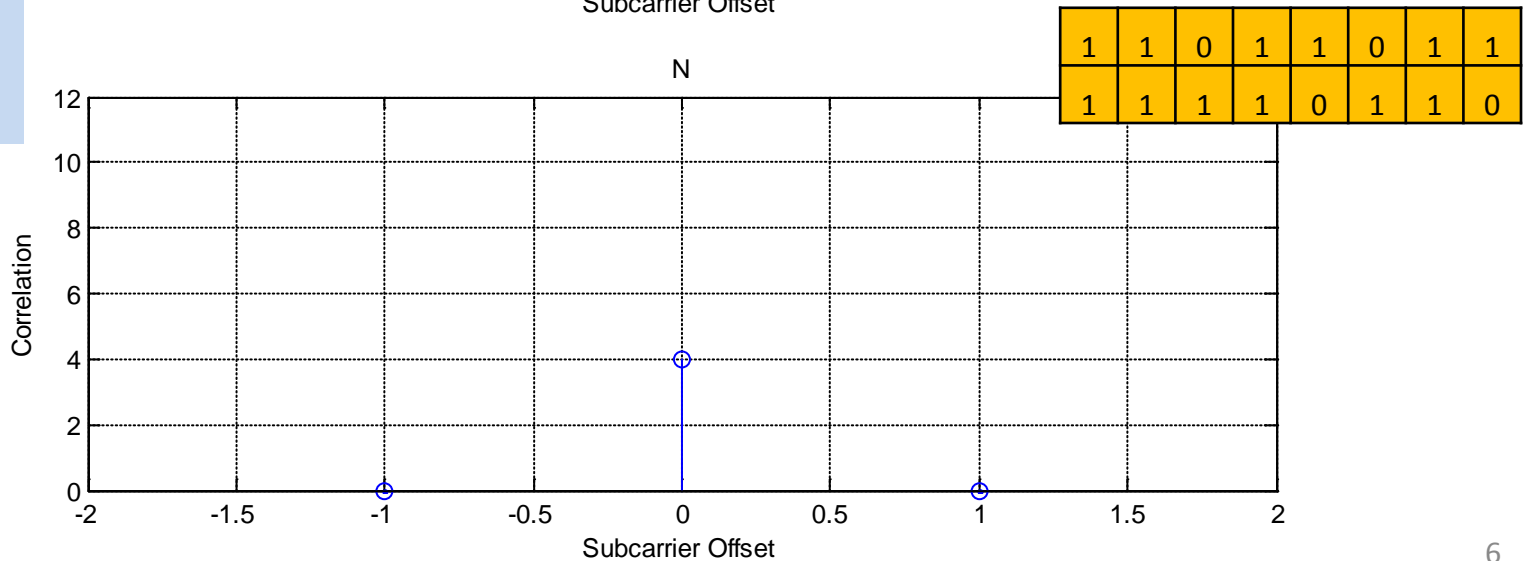
1	1	0	1
1	0	1	1
1	1	1	1
0	1	1	0

1 : P location  
0 : N location  
- : do not care

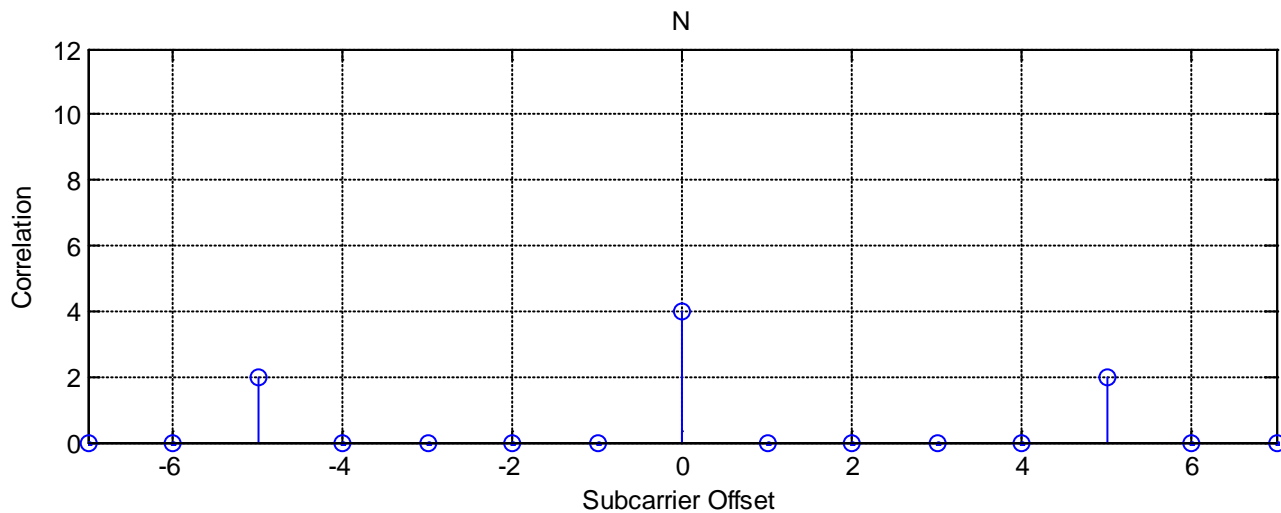
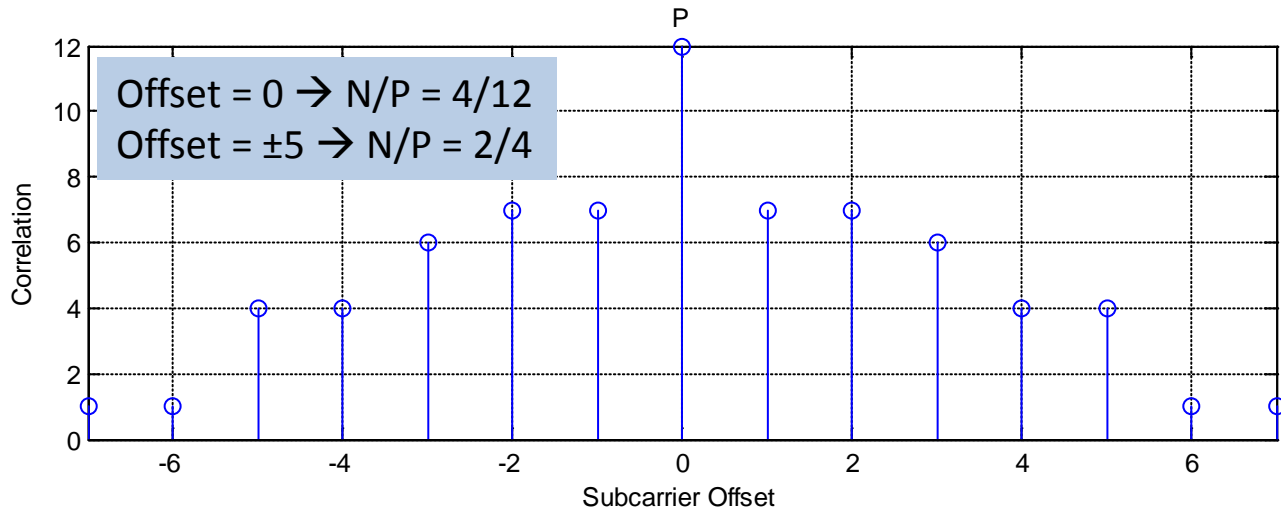
# BM #3, length=16, RB=1x16



Good contrast between N & P

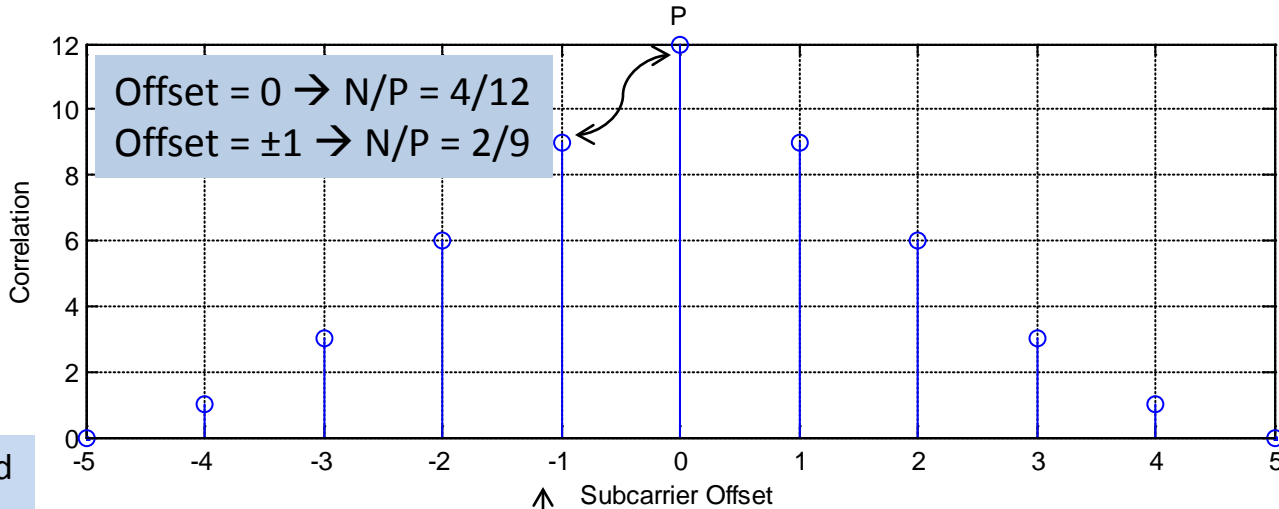


# BM #3, length=16, RB=1x4

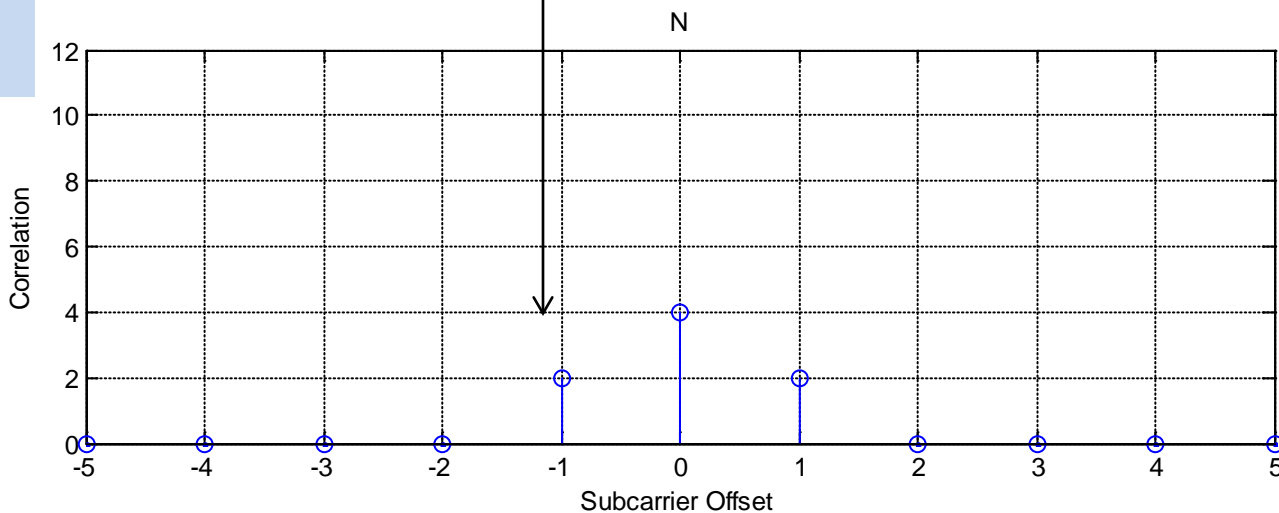


1	1
0	1
1	0
1	1
1	1
1	1
0	1
1	0

# BM #3, length=16, RB=1x6



Degraded contrast between N & P



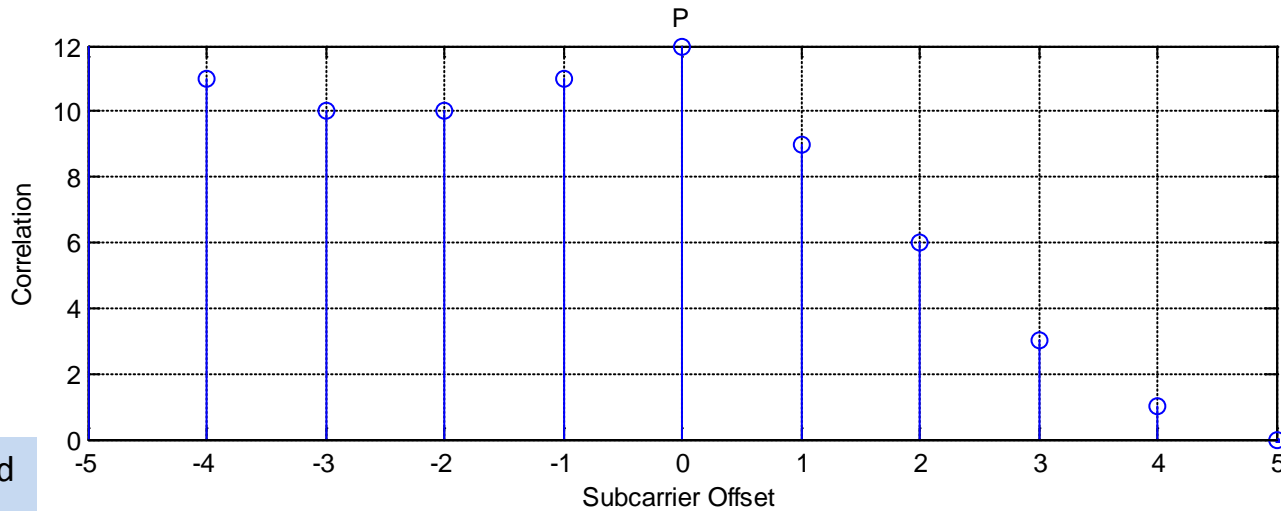
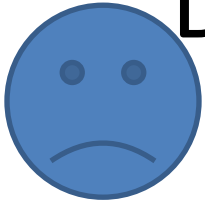
1	1	0
1	1	0
1	1	1
1	1	1
0	1	1
0	X	X

1 : P location  
0 : N location  
X : do not care



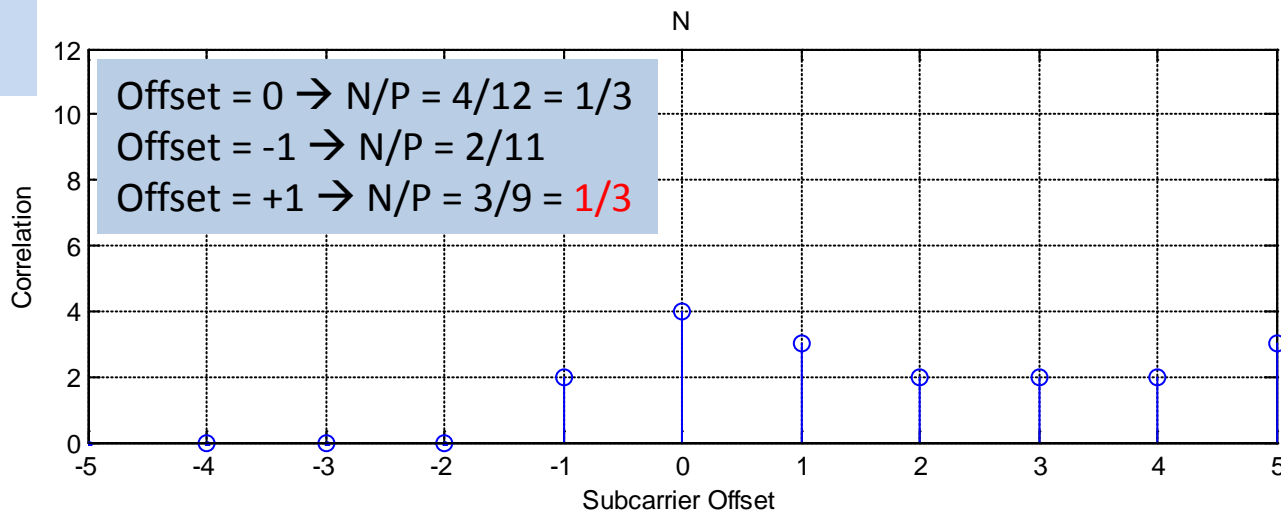
# BM #3, length=16, RB=1x6

## Data and Idle prior and after BM



D	D	D
D	D	D
D	D	D
D	D	D
1	1	0
1	1	0
1	1	1
1	1	1
0	1	1
0	S	S
S	S	S
S	S	S
S	S	S
S	S	S

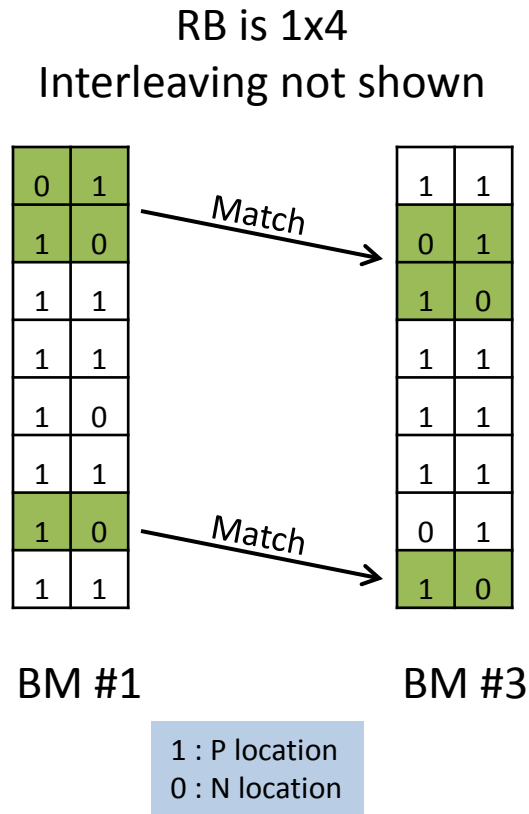
Degraded contrast between N & P



Offset = 0 →  $N/P = 4/12 = 1/3$   
 Offset = -1 →  $N/P = 2/11$   
 Offset = +1 →  $N/P = 3/9 = 1/3$

1 : P location  
 0 : N location  
 - : do not care  
 S : Idle  
 D : Data or Pilots

# Burst Marker Cross-Correlation, RB = 1 subcarrier by 4 symbols



- For RB size other than 1x8 or 1x16 cross-correlation between profile is poor.
- Example: BM #1 and BM #3 have 3 out of 4 N at same location for 1 RB offset.

# Comments on Baseline Burst Marker Auto and Cross-Correlation

- The four sequence are orthogonal only if RB = 1x8, 1x16,.....
- For RB size not multiple of 8 symbols in time, correlation and cross-correlation is poor. Lead to large misdetection and false detection rate.
- Correlation is degraded (by false detection) when BM is preceded or followed by silence (idle)
- Three examples provided but many more cases are problematic.

# **MISDETECTION AND FALSE DETECTION RATE IN PRESENCE OF NOISE**

# Calculation of Missing and False Detection of Burst Marker

- PDF and CDF of **P** and **N** detectors is computed.  
Note: H axis is threshold level, not power.
- **BM present**, Missing probability is:  
 $\text{Prob}(\mathbf{N} > \text{Thresh})$  OR  $\text{Prob}(\mathbf{P} < \text{Thresh})$
- **Data present**, False detect probability is:  
 $\text{Prob}(\mathbf{N} < \text{Thresh})$  AND  $\text{Prob}(\mathbf{P} > \text{Thresh})$
- **Silence present**, False detect probability is:  
 $\text{Prob}(\mathbf{N} < \text{Thresh})$  AND  $\text{Prob}(\mathbf{P} > \text{Thresh})$

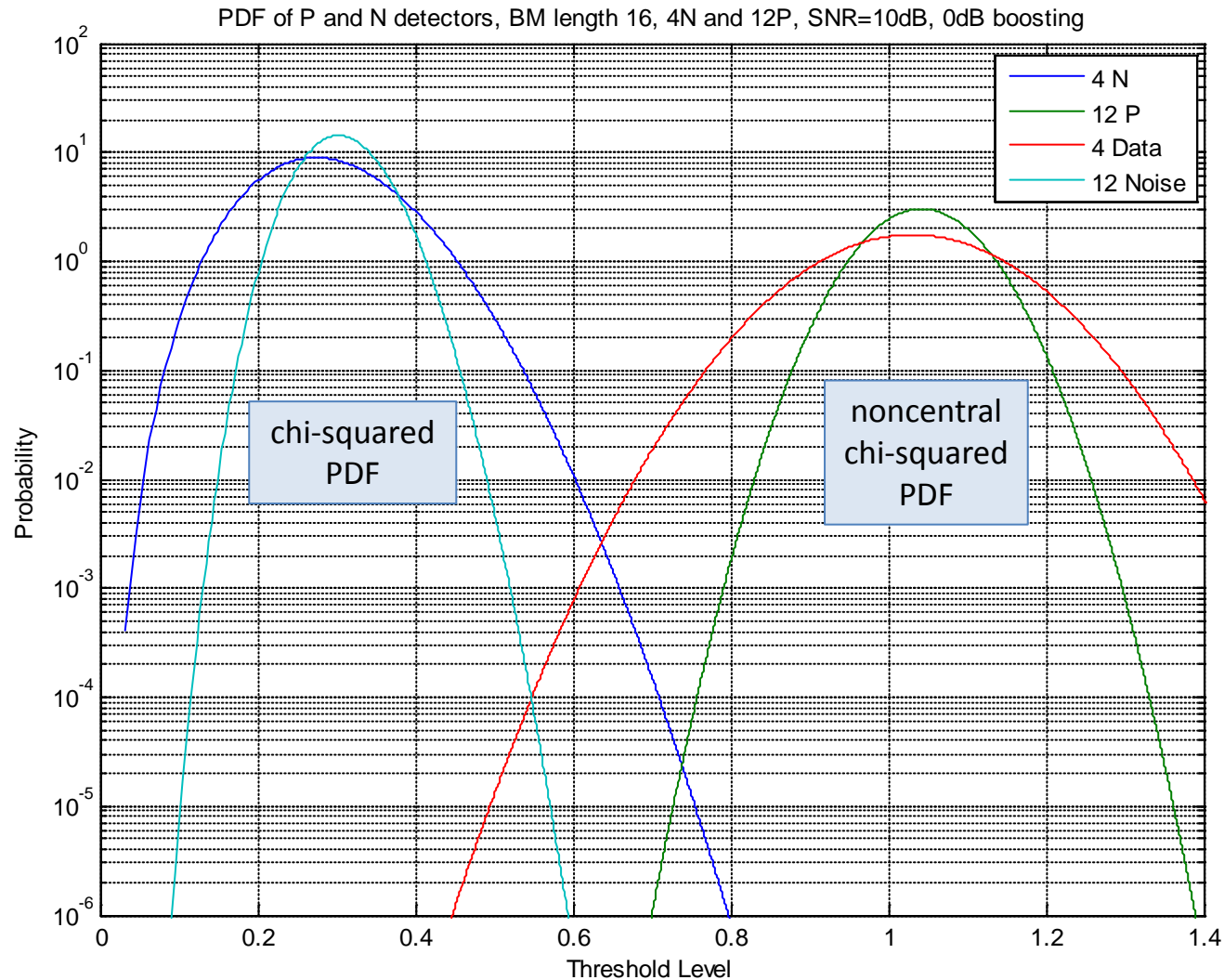
# Packet Error Rate from Burst Marker Missing and False Detection

- **Packet Error Rate =**  
**Prob(Missing Start) + Prob(Missing Stop) +**  
**M\*Prob(False detection)**

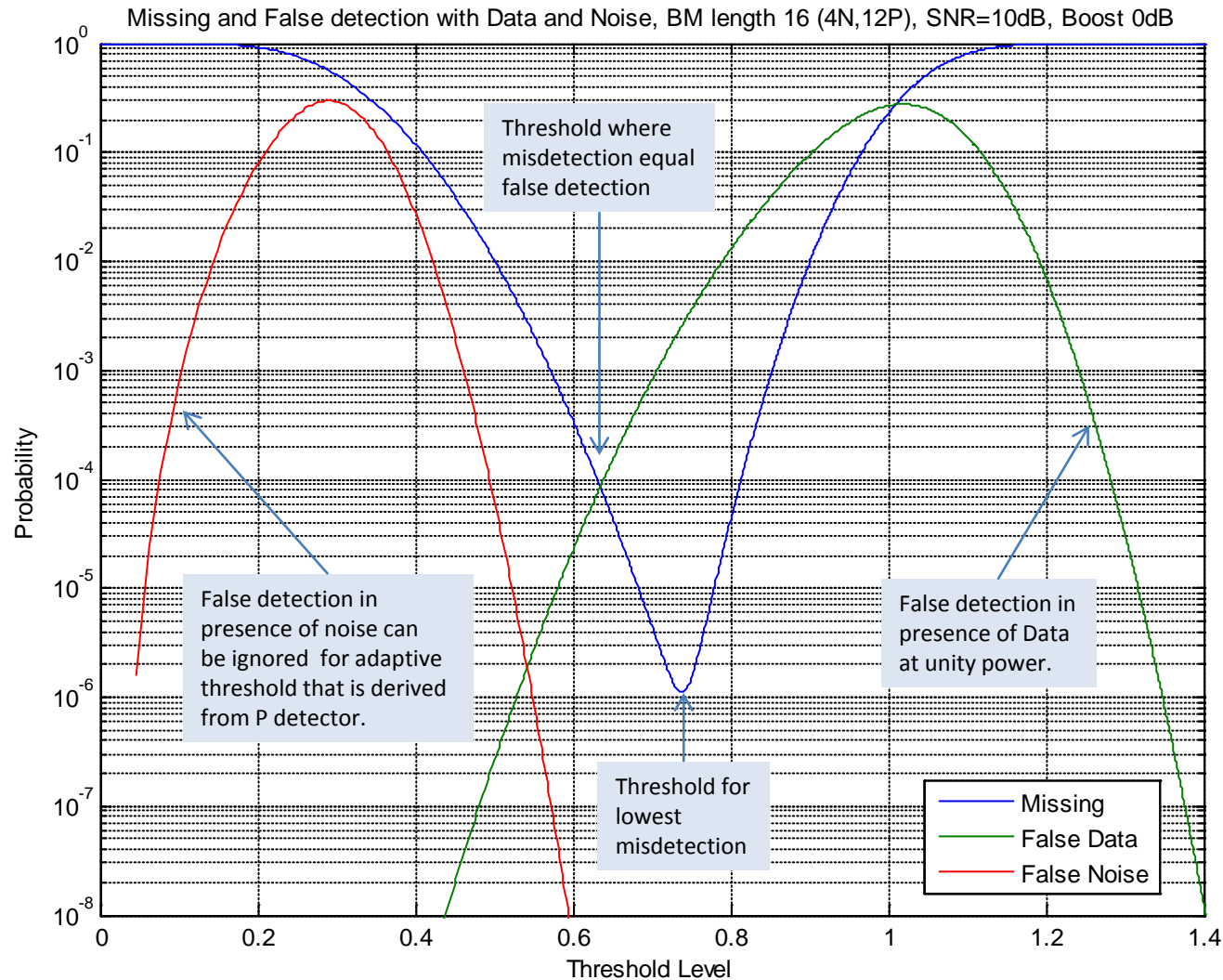
M is the number of search of BM in the packet

1500 Byte packet example: QPSK modulation and RB of 1 subcarrier by 8 symbols. M = 863 because data use 863 RB (or 6900 RE).

# P and N detectors PDF in presence of: Burst Marker, Data and Silence

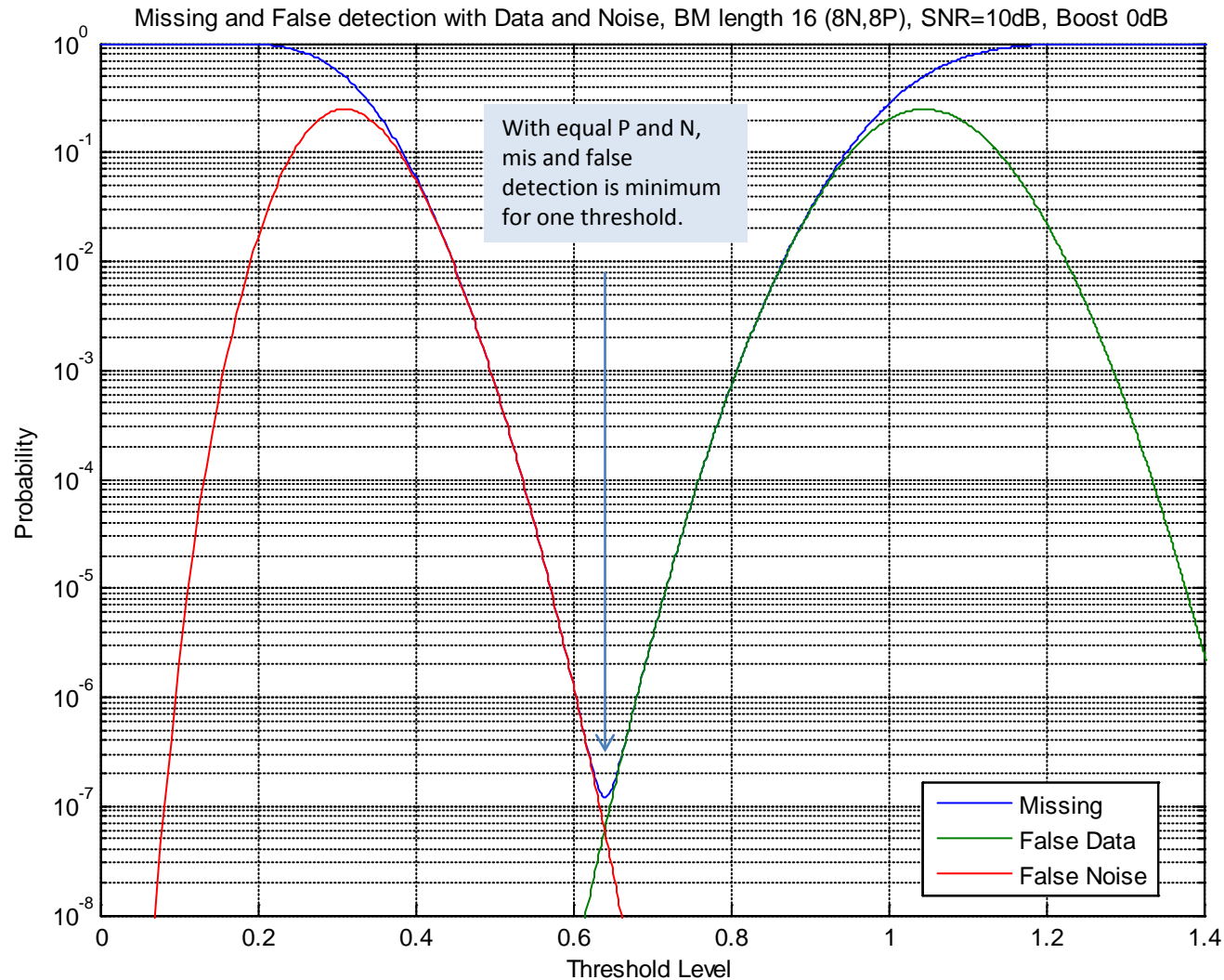


# Mis and False Detection vs Threshold, BM 16 (4N,12P), SNR=10dB

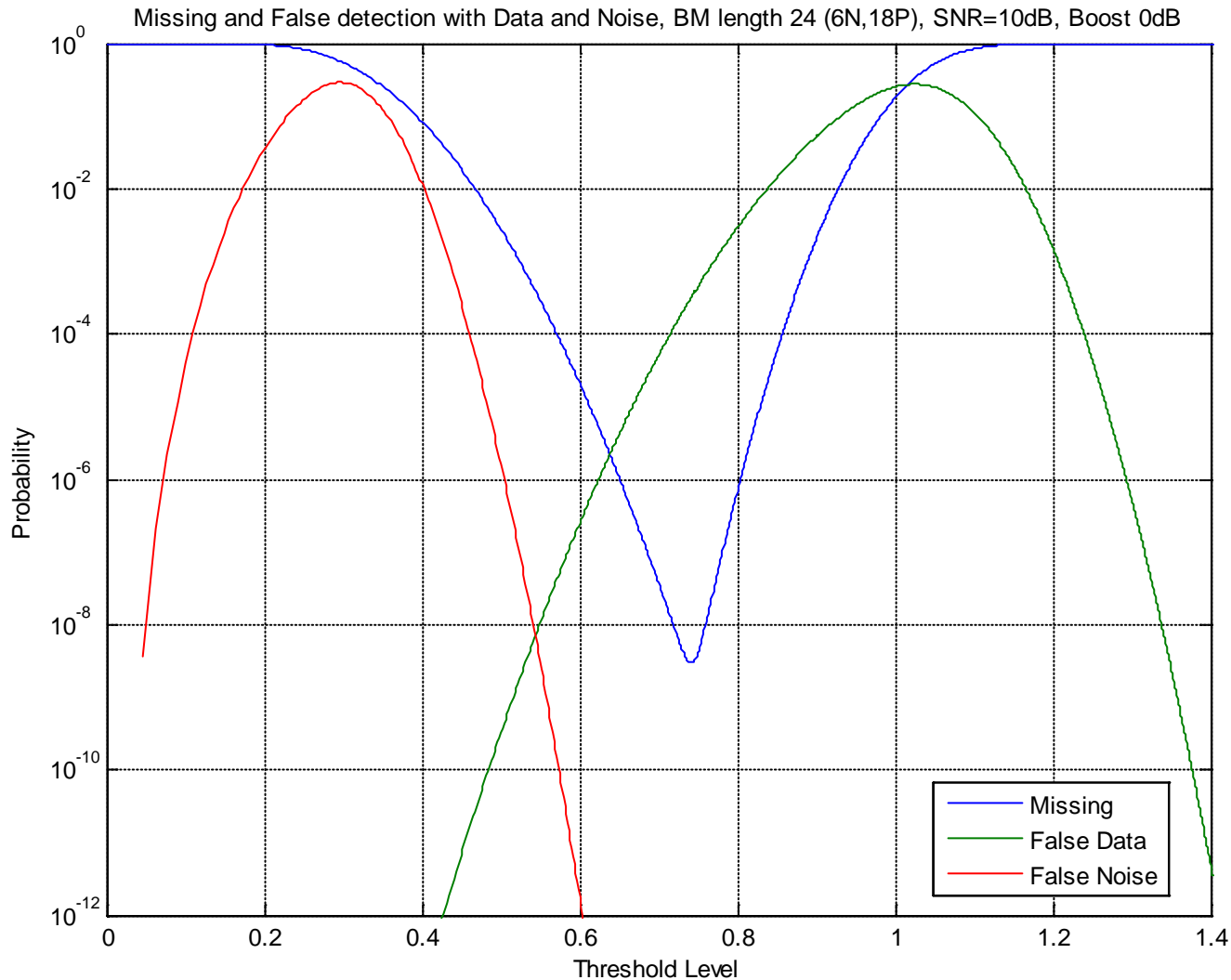




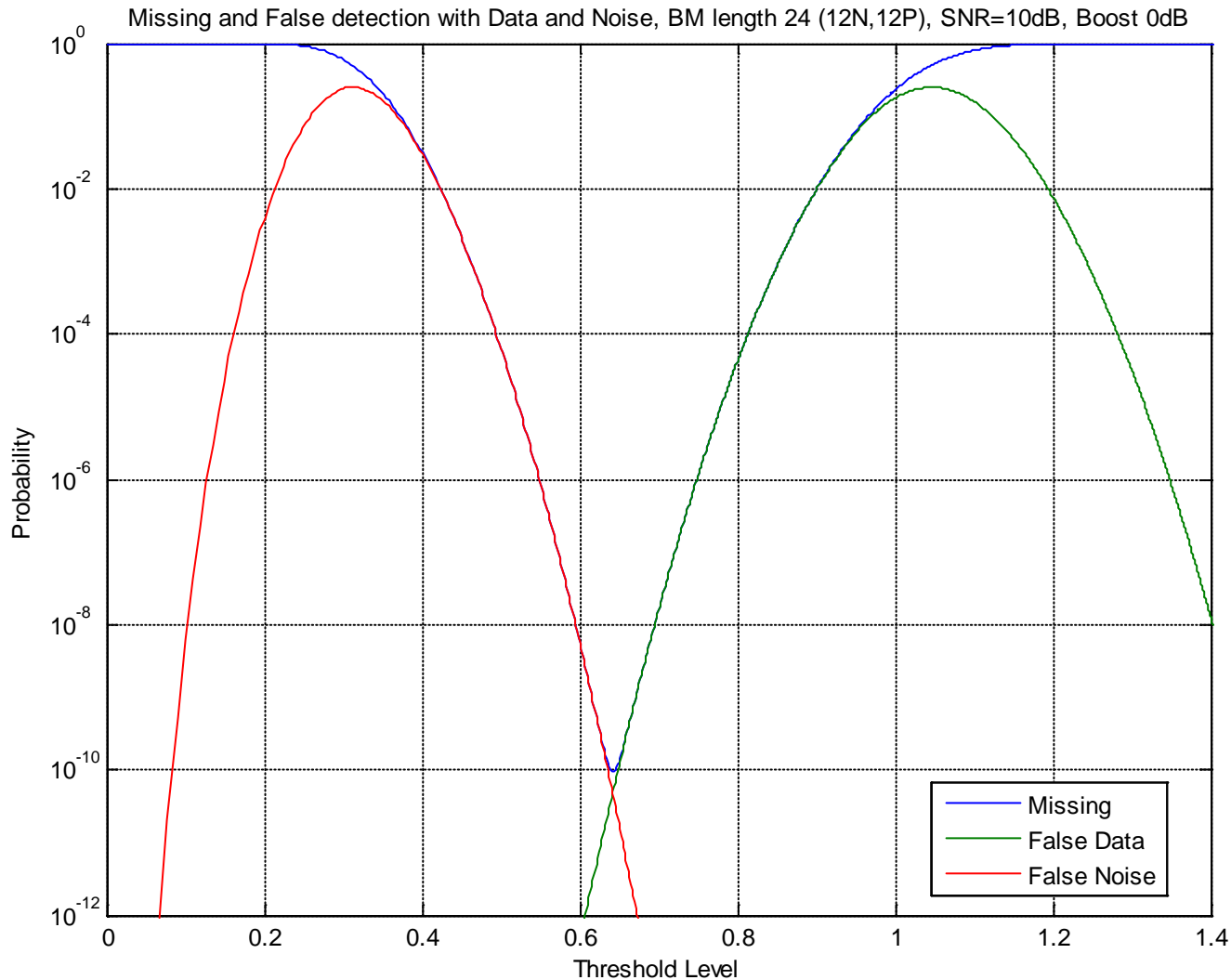
# Mis and False Detection vs Threshold, BM 16 (8N,8P), SNR=10dB



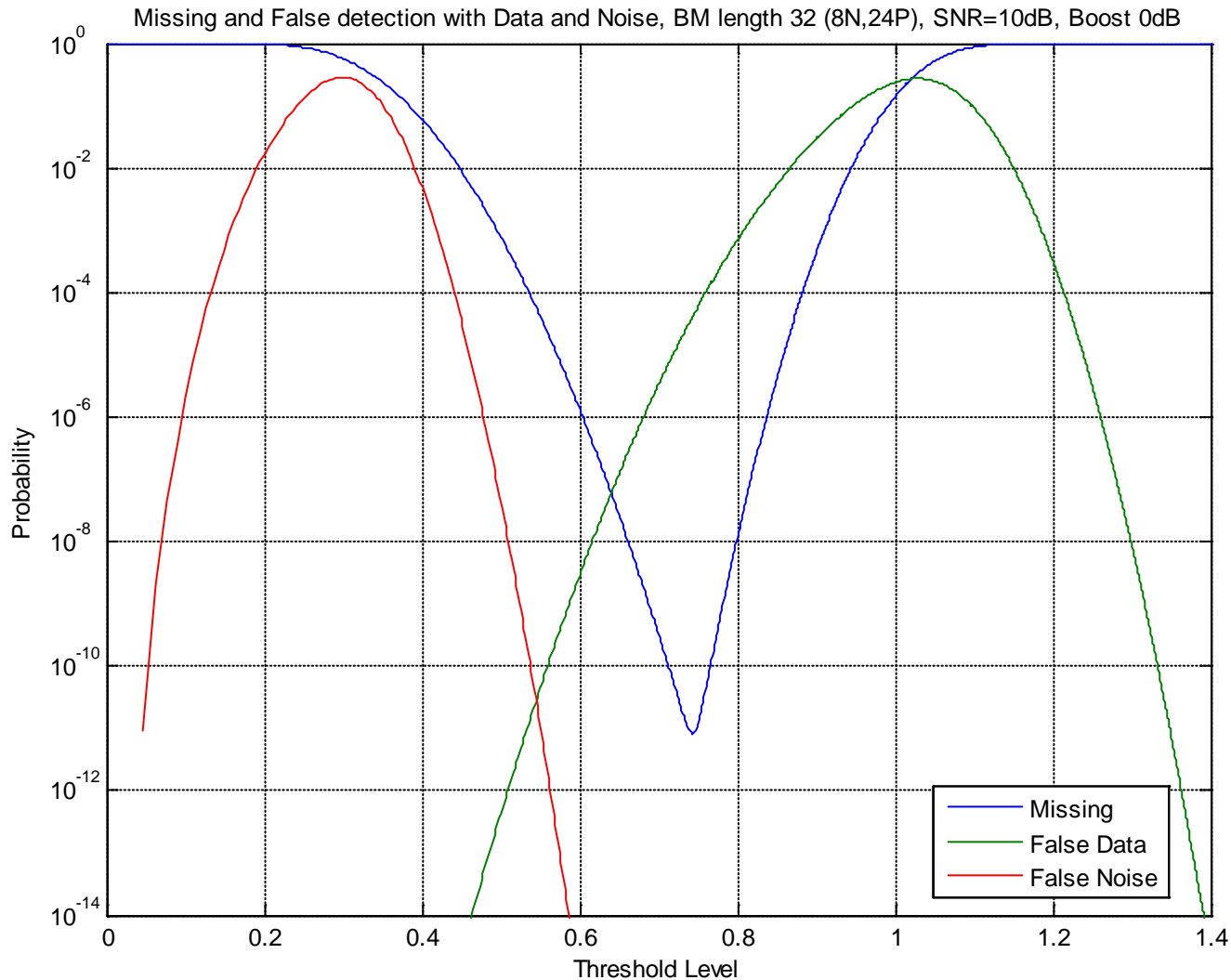
# Mis and False Detection vs Threshold, BM 24 (6N,18P), SNR=10dB



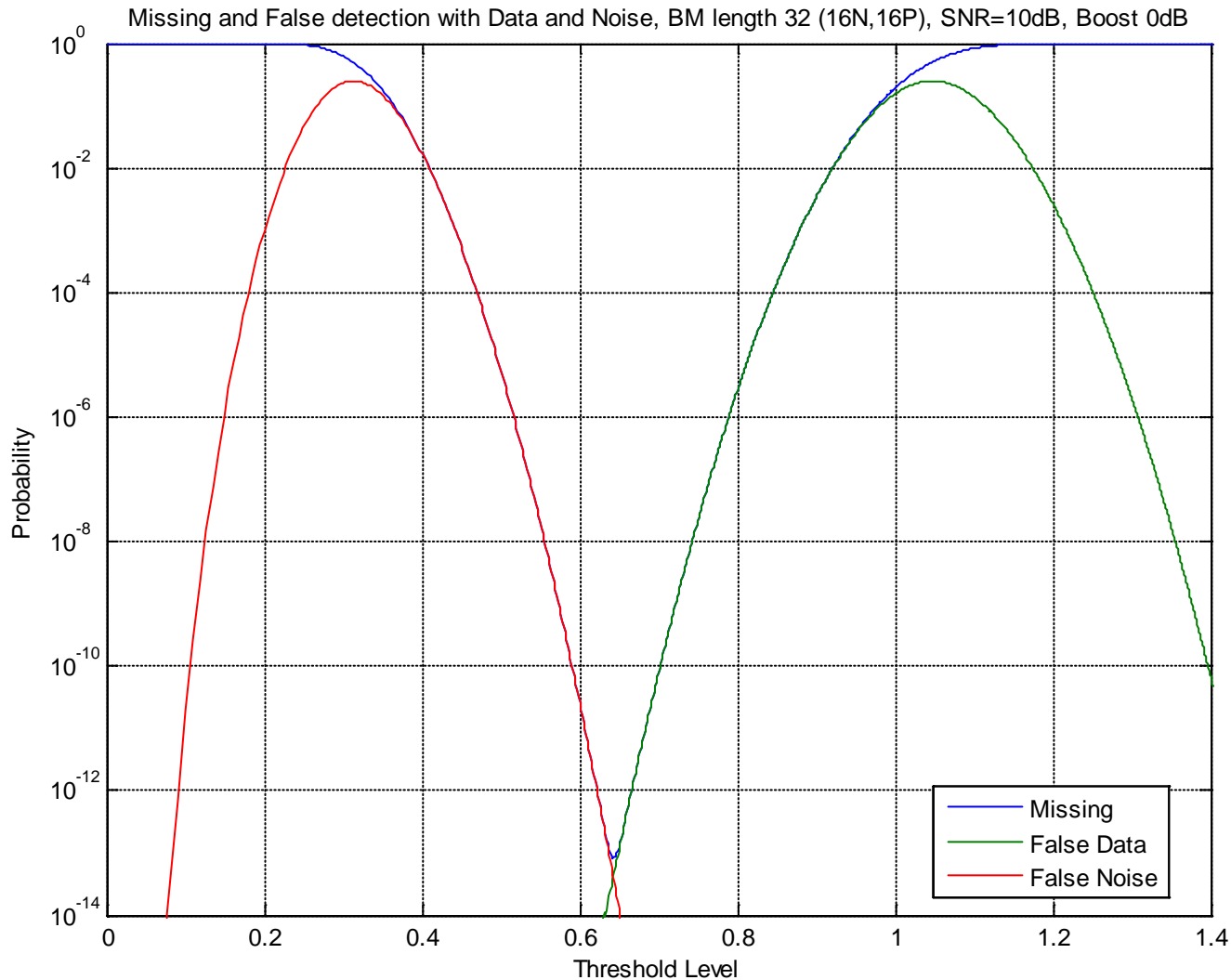
# Mis and False Detection vs Threshold, BM 24 (12N,12P), SNR=10dB



# Mis and False Detection vs Threshold, BM 32 (8N,24P), SNR=10dB



# Mis and False Detection vs Threshold, BM 32 (16N,16P), SNR=10dB



# Comments on Baseline Burst Marker Mis and False Detection in Noise

- Ternary sequences are useful at differentiating the BM from the data.
- In noise, false detection rate is the limiting factor.
- False detection rate could be reduced ( $<1/1000$ ) by selecting a N/P ratio of 1.
- A N/P ratio of 1 allow a power boosting of 3 dB.

# Burst Marker Questions?

- What is the minimum SNR requirements?
  - BM should be reliable for SNR  $\geq 12$  dB (16-QAM FEC threshold)
  - 10 dB is proposed in [1] is also a good target
- What is the target misdetection and false detection rate?
  - For a target packet error rate is  $5e-5$ , misdetection rate (start + end BM) should be less than  $5e-6$  as recommended in [3]
  - False detection rate depend on packet and RB size. RB size has not been decided. Preliminary guideline could be  $1/100$  to  $1/1000$  the packet error rate. This is different from [3].
  - Rate should decrease for increasing SNR, **no error floor**. BM error rate should not limit the packet error rate at high SNR.
- Is the BM aligned with Resource Block?
  - Yes, but it introduce jitter. Jitter has to be removed in the 1-D to 2-D mapping by padding front and back of packet with idle.

[3] Geneva, July 2013 [rahman\\_syed\\_3bn\\_01\\_0713.pdf](#)

# Burst Marker Questions?

- Could the BM span over multiple Resource Blocks?
  - Yes, if BM size larger than one RB (see next presentation)
- Could the BM span over 2 OFDMA frame?
  - Yes, if BM size larger than one RB
- How many profiles?
  - Unknown. We need proposals and decisions in this area
- Could the profiles be encoded in the BPSK signal instead of the N pattern?
  - Yes, it is possible (see next presentation)
- Are two type of signaling for the BM (BPSK and ternary) needed?
  - No, we should use one type if all requirements are met