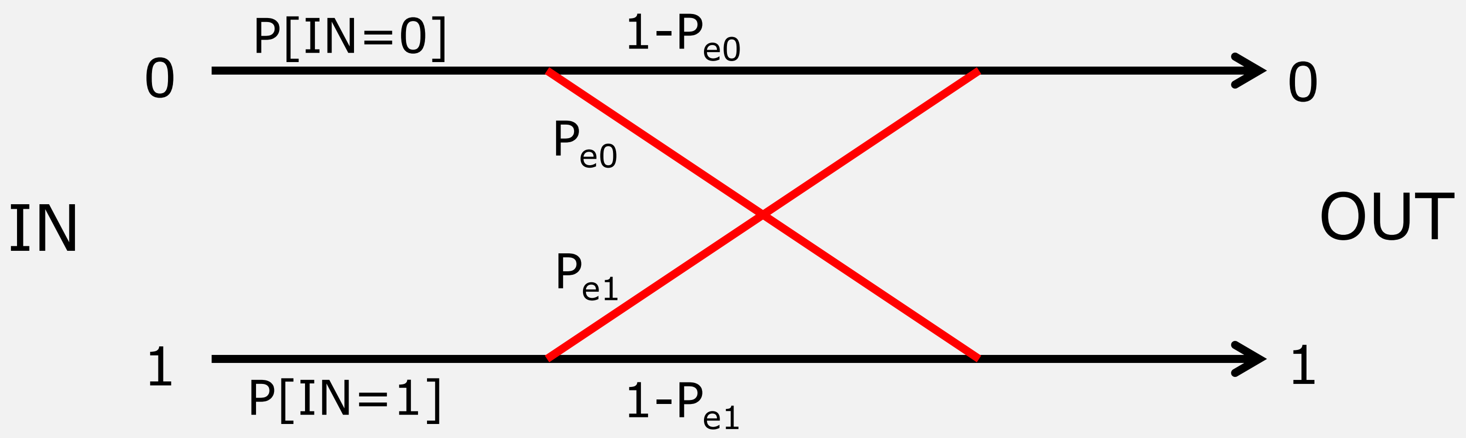
Calculating the BER

Binary Channel Model

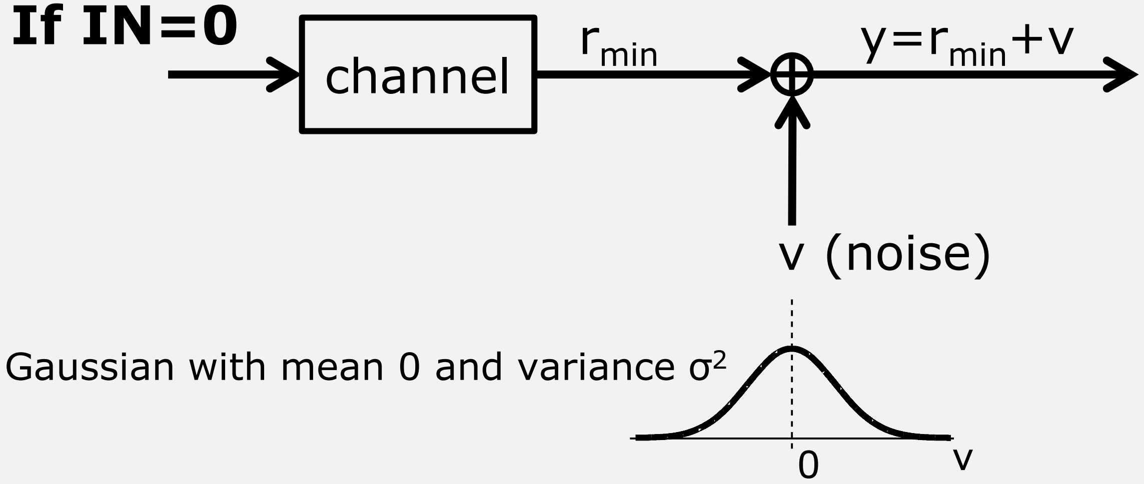


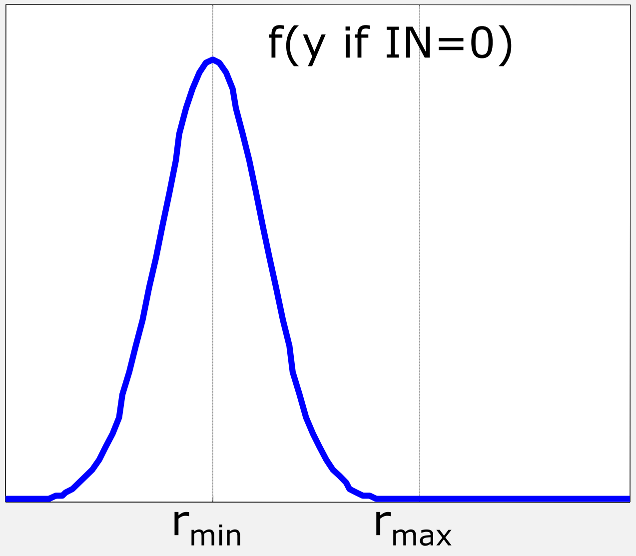
$$BER = P_{e0} \cdot P[IN=0] + P_{e1} \cdot P[IN=1]$$

- The values of P_{e0} and P_{e1} depend upon
  - the transmit levels (r_{min}, r_{max})
  - the power in the noise (σ^2)
  - the threshold (T)

PDF of Received Signal + Noise

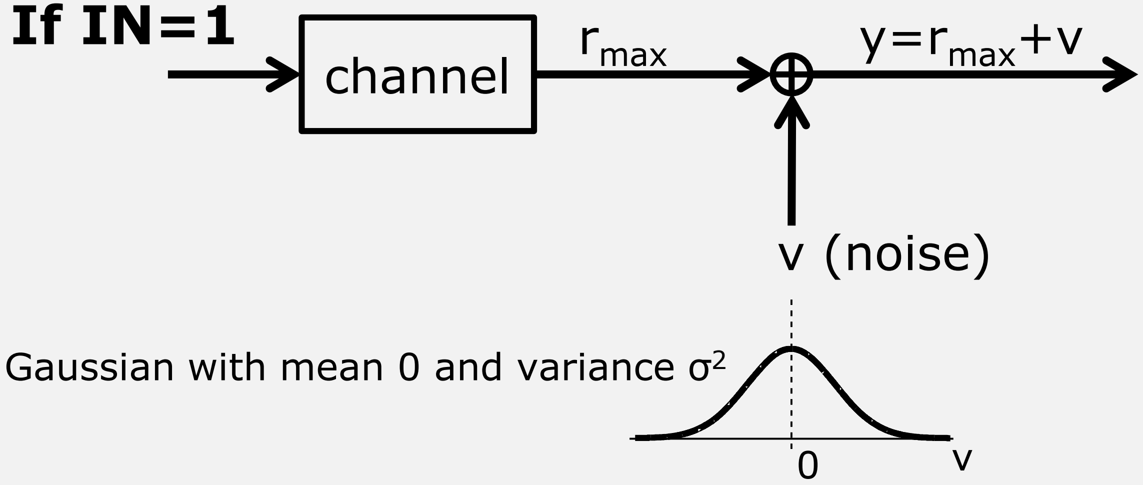
- **If IN=0**

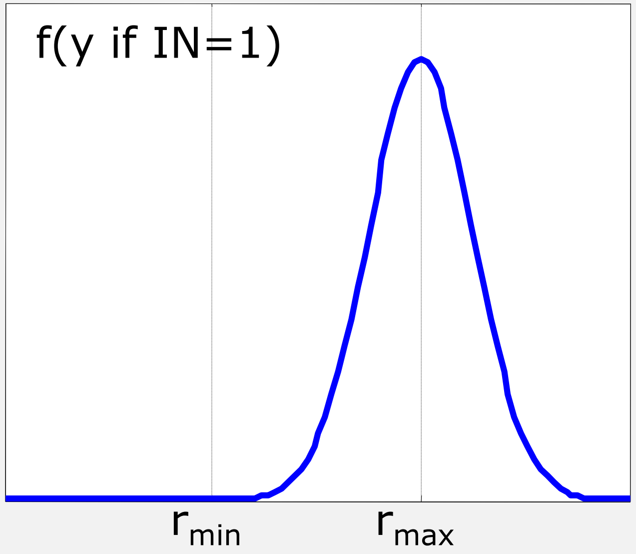




y is Gaussian with
- mean r_{min}
- variance σ^2

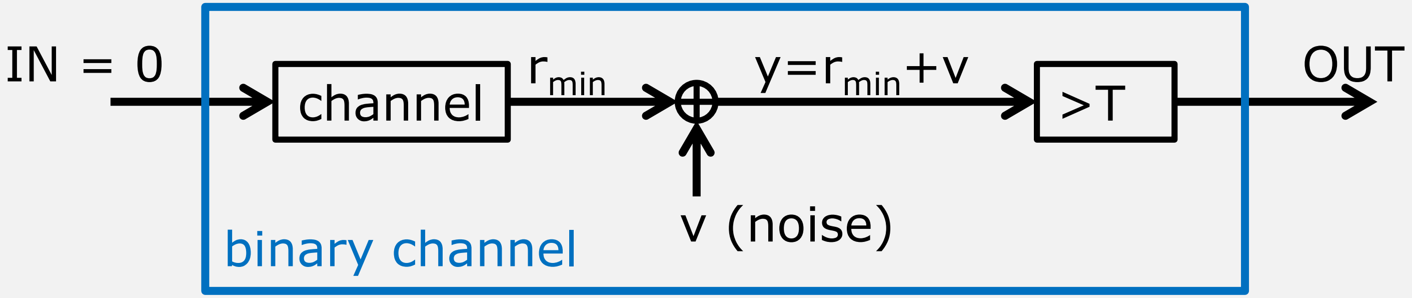
- **If IN=1**

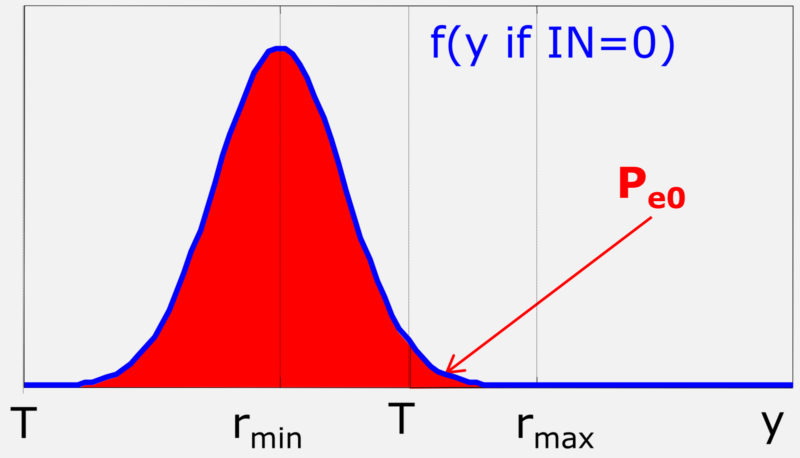




y is Gaussian with
- mean r_{max}
- variance σ^2

P_{e0} (Probability of Error if IN=0)

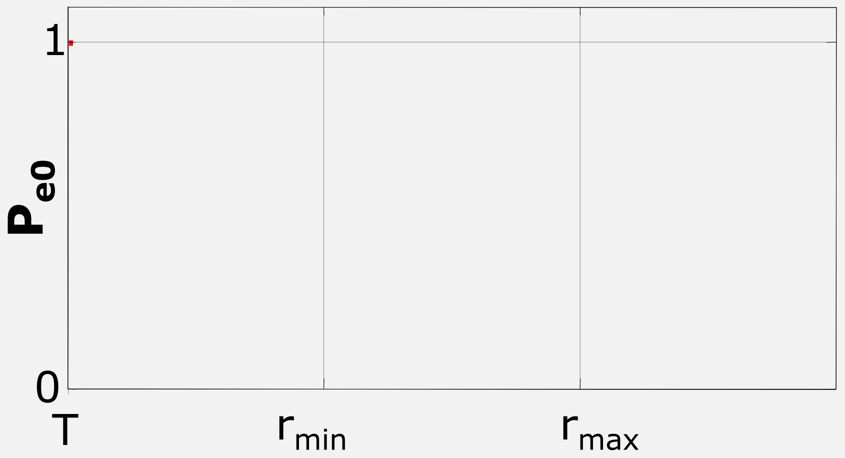




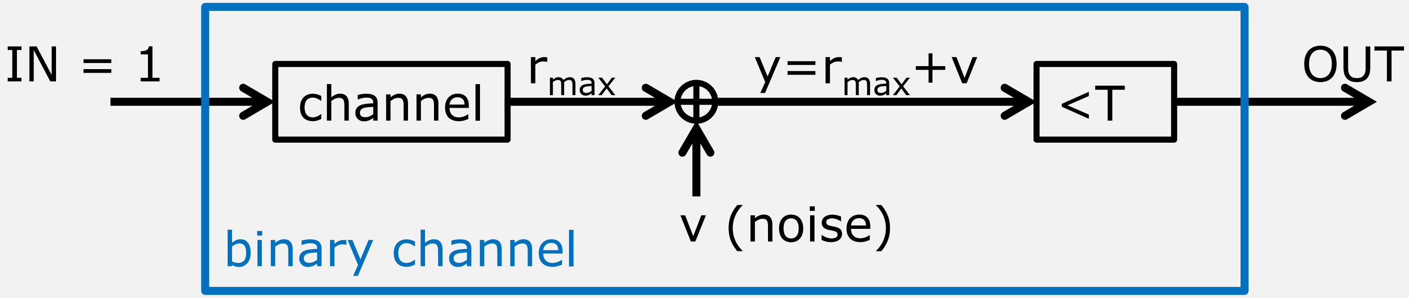
- There is an error if
  - OUT = 1
  - The noise pushes y **above** T

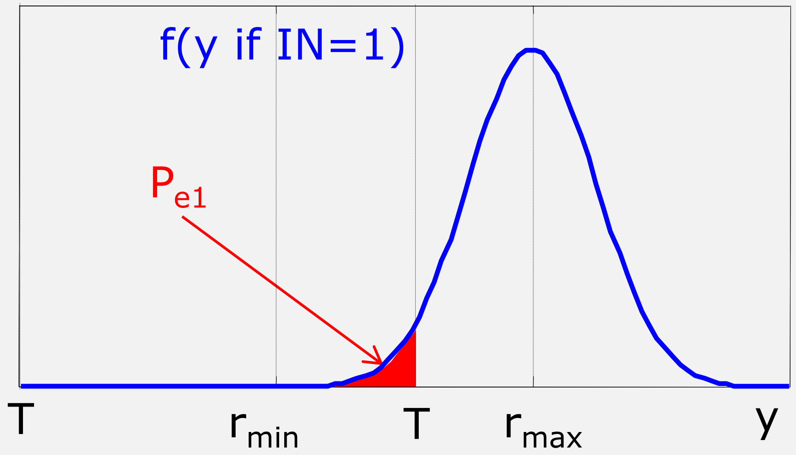
$$P_{e0} = P[y > T \text{ if IN} = 0]$$

- The probability of error **decreases** as T increases.



P_{e1} (Probability of Error if IN=1)

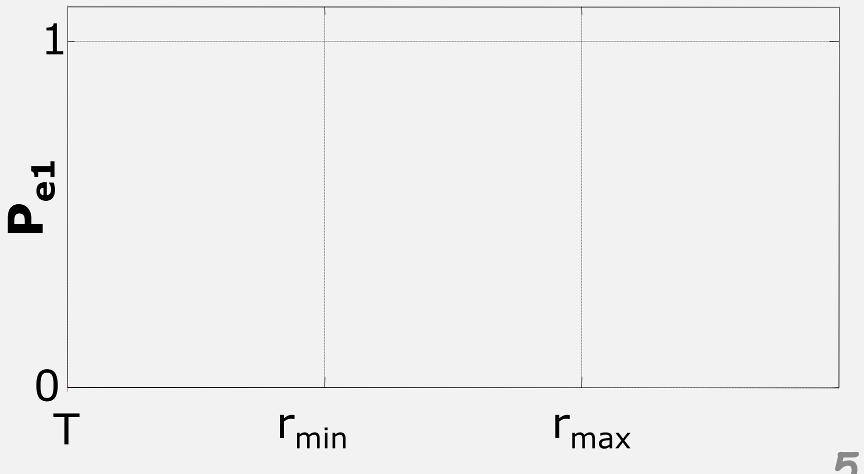




- There is an error if
  - OUT = 0
  - The noise pushes y **below** T

$$P_{e1} = P[y < T \text{ if } IN = 1]$$

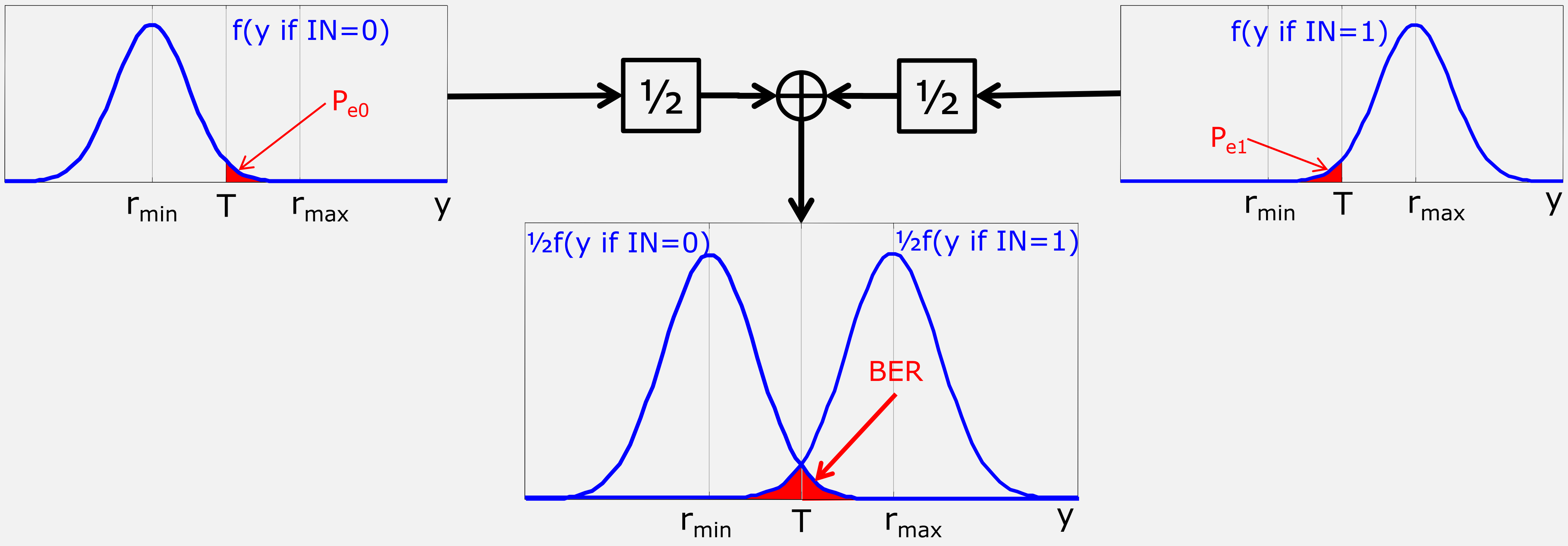
- The probability of error **increases** T increases.



Predicting BER

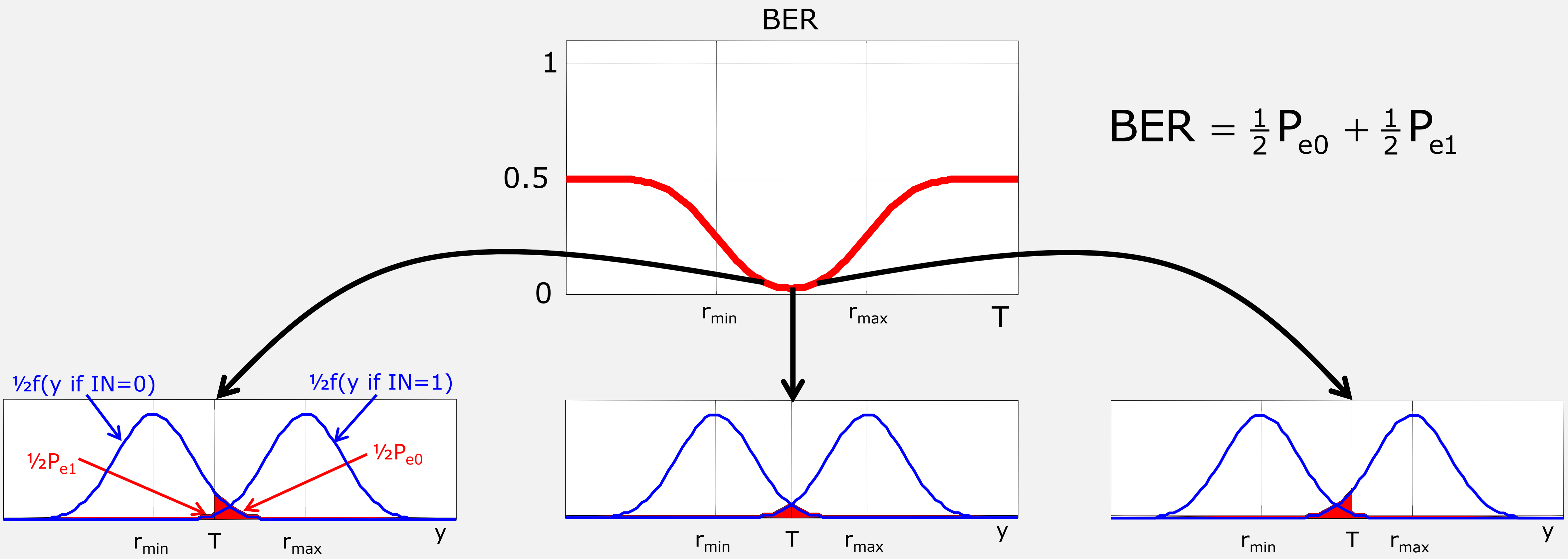
If 0 and 1 input bits are equally likely,

$$\mathrm{BER} = \tfrac{1}{2} P_{e0} + \tfrac{1}{2} P_{e1}$$



Changing the Threshold

- **Choosing T is a tradeoff between minimizing P_{e0} and P_{e1}.**



$$\text{BER} = \tfrac{1}{2}P_{e0} + \tfrac{1}{2}P_{e1}$$

best threshold if P[IN = 0] = P[IN = 1]

$$T = \tfrac{1}{2}\left(r_{min} + r_{max}\right)$$