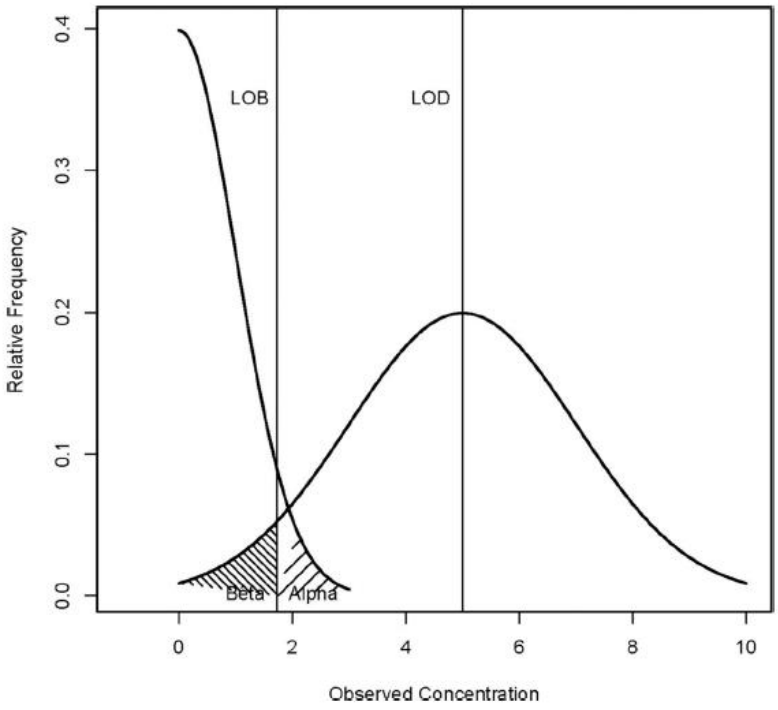
MEMO: How to calculate the limit of detection (LOD)?

a) Definition: the limit of Detection LOD with a power $(1-\beta)$ is defined (in concentration unit) as the minimum concentration for which detecting the target gene in a well is possible with a probability of $1-\beta$.s

In other words, this is the minimum concentration that can be said to be non-zero and statistically higher than the limit of blank LOB with a $1-\beta$ probability (typically 95% for $\beta = 5\%$).



Definition of the sampling limit LOS with a power of $(1-\beta) = 95\%$: the lowest concentration in the well for which the probability of having no target gene in the analyzed sub-sample is $\beta = 5\%$.

b) A calculation method:

1) Determine the limit of blank $LOB(95\%)$ of your experiment by following the method of the memo "How to calculate the limit of blank".

2) Calculate $p_0 = \frac{2b+z^2+z\sqrt{z^2+4b(1-b/N)}}{2N(1+z^2/N)}$

where:

- $b = LOB(95\%)$ is the 95% limit of blank
- $z = 1.645$ is the "one-tail" quantile at 95%
- N is the total number of partitions that are generated on average in a well
- p_0 is the higher-value solution of the following equation (which can be simplified as a second degree equation in p):

$$p = b/N + z\sqrt{p(1-p)/N}$$

3) The LOD with a 95% confidence level is determined as follows (calculation based on the Normal Law approximation and the Poisson Law):

- In concentration in the well (cp / uL):

$$LOD(95\%) = -N\ \ln(1-p_0)/V$$

$$LOD(95\%) = -\ln(1-p_0)/v$$

where $V = N\,v$ is the analyzed volume (cumulative total volume of all the partitions generated in the well, with v the volume of each partition)

- In number of copies included in the volume analyzed in the well:

$$LOD_{cp}(95\%) = \lceil -N\ \ln(1-p_0) \rceil$$

knowing that this unit in number of copies can be approximated as “number of positive partitions” in the well.

  - For example: if $LOB(95\%) = 2,\ \ v = 0.000442$ uL and $N = 28000$, then $LOD(95\%) = 0.49$ cp / uL and $LOD_{cp}(95\%) = 7$ copies (or "positive partitions")

  - Special case: if $LOB(95\%) = 0$ (i.e. false positives are never present) then $LOD(95\%) = 3/V$ and $LOD_{cp}(95\%) = 3$ copies. In fact, if there are never false positives, then the 95% detection limit is equal to the 95% sampling limit which is: $LOS(95\%) = 3/V$ cp / uL.