Uncertainty on Signal

The total yield at the peak of D mass N_p and and at the D mass sieband N_s are given by the sum of signal and background

$$N_p = S_p + B_p$$
$$N_s = S_s + B_s$$

where S_p and B_p are the signal yield and background yield at the D mass peak, and S_s and B_s are the signal yield and background yield at the D mass sideband. The B_p can be a sum of a peaking background $(B_p)_{\text{peak}}$ and a continuum/combinatorial background $(B_p)_{\text{cont}}$

$$B_p = (B_p)_{\text{peak}} + (B_p)_{\text{cont}}$$

The B_s is approximately

$$B_s = (B_p)_{\text{cont}} \qquad \Rightarrow \qquad B_p = (B_p)_{\text{peak}} + B_s$$

Hence, if you do not perform sideband subtraction, the signal yield is

$$S = N_p - B_p = S_p$$

and the variant on it is

$$\sigma_S^2 = N_p = S_p + B_p$$

Hencs uncertainty is given by

$$\frac{\sigma_S}{S} = \frac{\sqrt{S_p + B_p}}{S_p}$$

If you perform sideband subtraction

$$S = N_p - N_s - (B_p)_{\text{peak}} = (S_p + B_p) - (S_s + B_s) - (B_p - B_s) = S_p - S_s$$

and

$$\sigma_S^2 = N_p + N_s + \sigma_{\text{peaking}}^2 = S_p + B_p + S_s + B_s + \sigma_{\text{peaking}}^2$$

where σ_{peaking} is the uncertainty on peaking backgeound. Therefore

$$\frac{\sigma_S}{S} = \frac{\sqrt{S_p + B_p + S_s + B_s + \sigma_{\text{peaking}}^2}}{S_p - S_s}$$

Supposing σ_{peaking} is proportional to the peaking background $(B_p)_{\text{peak}}$,

$$\sigma_{\text{peaking}} = \rho \cdot (B_p)_{\text{peak}}$$

where ρ is the coefficient. Then,

$$\frac{\sigma_S}{S} = \frac{\sqrt{S_p + B_p + S_s + B_s + [\rho \cdot (B_p)_{\text{peak}}]^2}}{S_p - S_s}$$