# Out-of-Acceptance Treatment: Concept

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|---|---|---|---|---|---|
| Inside Acceptance | $I_1$ | $I_2$ | $I_3$ | ... | $I_n$ |
| Out of Acceptance | $O_1$ | $O_2$ | $O_3$ | | $O_n$ |

Measurement bins

There are 2n POIs ($I_i$ and $O_i$ for each measurement bin), but only n observables (the bin yield $N_i$). So we need some assumption about the $O_i$ in order to measure the $I_i$ :

- **Option 1**: All the $O_i$ are fully correlated to each other $\Rightarrow$ all scale with a global O parameter - not constrained by data, so fix to the SM.
- **Option 2**: Each $O_i$ is fully correlated to the corresponding $I_i$.
- **Option 3**: All the $O_i$ are fully correlated to each other, and to $\Sigma_i I_i$

# Out-of-Acceptance: Math

Measured bin yields are $N_i = \Sigma_j m_{ij} I_j + \Sigma_j f_{ij} O_j$ where

- $I_i = L.\sigma^{fid}_i$ **:** Fiducial contribution
- $O_i = L.\sigma^{out\text{-}of\text{-}fid}_i = L(\sigma^{tot}_i - \sigma^{fid}_i)$ : Out-of-fiducial contribution
- $m_{ij}$ : migration coefficients for the fiducial contributions into reco bins
- $f_{ij}$ : contamination coefficients for non-fiducial contributions

- **Option 1** : We assume $O_i = \alpha_i O^{SM}$, with $\alpha_i = O_i^{SM}/O^{SM}$ taken from SM MC

  $\Rightarrow N_i = \Sigma_j m_{ij} I_j + \Sigma_j f_{ij} \alpha_j O^{SM}$

- **Option 2** : We assume $O_i = \beta_i I_i$, with $\beta_i = O_i^{SM}/I_i^{SM}$ taken from SM MC

  $\Rightarrow N_i = \Sigma_j (m_{ij} + \beta_i f_{ij}) I_j$

- **Option 3** : We assume $O_i = \gamma_i \Sigma_j I_j$, with $\gamma_i = O_i^{SM}/\Sigma_j I_j^{SM}$ taken from SM MC

  $\Rightarrow N_i = \Sigma_j m_{ij} I_j + \Sigma_j f_{ij} \gamma_j \Sigma_k I_k = \Sigma_j (m_{ij} + \Sigma_k f_{ik} \gamma_k) I_j$

# What can go wrong

- Consider a 1-bin analysis with a spectacularly bad fiducial selection, m=0.1 and f=0.9 $\Rightarrow$ N = 0.1 I + 0.9 O; assume $I_{SM} \sim O_{SM}$ and consider
  - **Case A**: $I_{true} = I_{SM}$ and $O_{true} = O_{SM}$
  - **Case B**: $I_{true} = I_{SM}$ and $O_{true} = 10\ O_{SM}$
  - **Case C**: $I_{true} = 10\ I_{SM}$ and $O_{true} = 10\ O_{SM}$
- **Option 1**: $N = 0.1\ I + 0.9\ O_{SM}$.
  - **Case A**
    - $I = (N - 0.9\ O_{SM})/0.1 = (0.1\ I_{SM} + 0.9\ O_{SM} - 0.9\ O_{SM})/0.1 = I_{SM} = I_{true}$ **accurate**
    - $\delta I = \mathrm{sqrt}(N)/0.1$ : **error larger due to low purity**
  - **Case B**: $I = I_{SM} + 81 O_{SM} \sim 82\ I_{true}$, **biased**
  - **Case C**: $I = 10\ I_{SM} + 81\ O_{SM} \sim 91\ I_{true}$ **biased**
- **Option 2**: $N = (0.1 + 0.9\ O_{SM}/I_{SM})\ I$ (Option 3 is equivalent in this 1-bin case)
  - **Case A**:
    - $I = N/(0.1 + 0.9\ O_{SM}/I_{SM}) = I_{SM} = I_{true}$ **accurate**
    - $\delta I = \mathrm{sqrt}(N)/(0.1 + 0.9\ O_{SM}/I_{SM})$ , **error ~ insensitive to purity**
  - **Case B**: $I = (0.1\ I_{SM} + 9\ O_{SM})/(0.1 + 0.9\ O_{SM}/I_{SM}) \sim 10\ I_{true}$ **biased**
  - **Case C**: $I = (1\ I_{SM} + 9\ O_{SM})/(0.1 + 0.9\ O_{SM}/I_{SM}) = I_{true}$ **accurate**