

S4. Architecture A vs B comparison pack (most sensitive parameters)

- Purpose: provide a compact, reader-friendly **head-to-head** comparison of the two NOT implementations without requiring the reader to inspect full notebooks.

S4a.1 Summary table (single page)

- Table S4a-1: “Top sensitivities” (A vs B) under two criteria:
 - **BER-impact** (impact $\pm 1\sigma$ on BER at $p_{\text{test}}=0.5$, same γ and decision model)
 - **Margin-impact** (impact $\pm 1\sigma$ on margin = $1 - q_{0.05}(|C|)$)
- Recommended parameter sets (kept consistent with S2/S3 definitions):
 - A: pbs_ER_dB (or leakage power), imbalance_dB, detector_noise_rel, hwp_theta_err_deg, hwp_delta_deg.
 - B: analyzer_ER_dB (or leakage power), detector_noise_rel, $\Delta\lambda$ (via λ detuning), common-mode $\Delta\theta$, common-mode $\Delta\delta$.

S4a.2 Comparison figures (2–4 total, matched axes)

- Fig. S4a-1: **BER vs common-mode $\Delta\theta$** (A vs B on the same axes).
Goal: isolate “HWP angle tolerance” differences independent of PBS/ER.
- Fig. S4a-2: **Margin vs leakage/ER proxy** (A: PBS leakage; B: analyzer leakage) on a shared x-axis of leakage power.
Goal: show why leakage tends to be much more visible in margin than in Δp_{max} .

S4a.3 Short explanatory note (≤ 10 lines)

- Harmonized comparison settings: S4a uses the same decision settings as S3, i.e. $\gamma = 0.60$ and **erasure window** = **0.35** (with the same p_{test} and margin quantile q).
- Why **Δp_{max} probability boundaries** can appear similar across A and B when leakage is modelled symmetrically and errors are common-mode.
- Why **BER/margin** criteria separate architectures more strongly (leakage reduces contrast first; BER rises once the decision threshold is crossed).

Fig S4a-1 (harmonized): BER vs $\Delta\theta$ (A vs B)

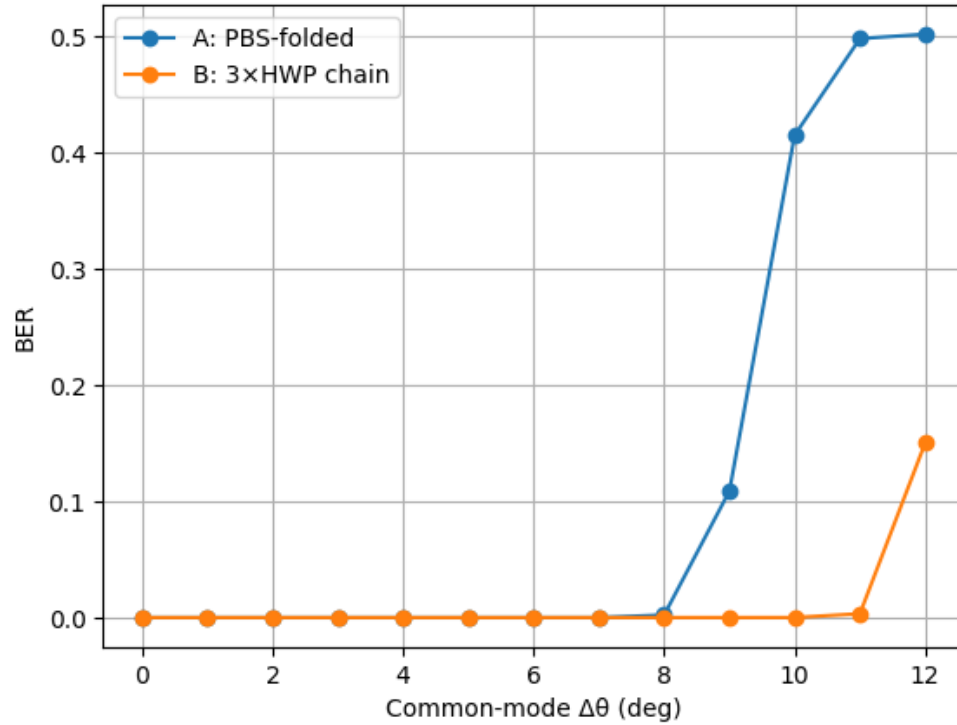


Fig S4a-2 (harmonized): Margin vs leakage power (A vs B)

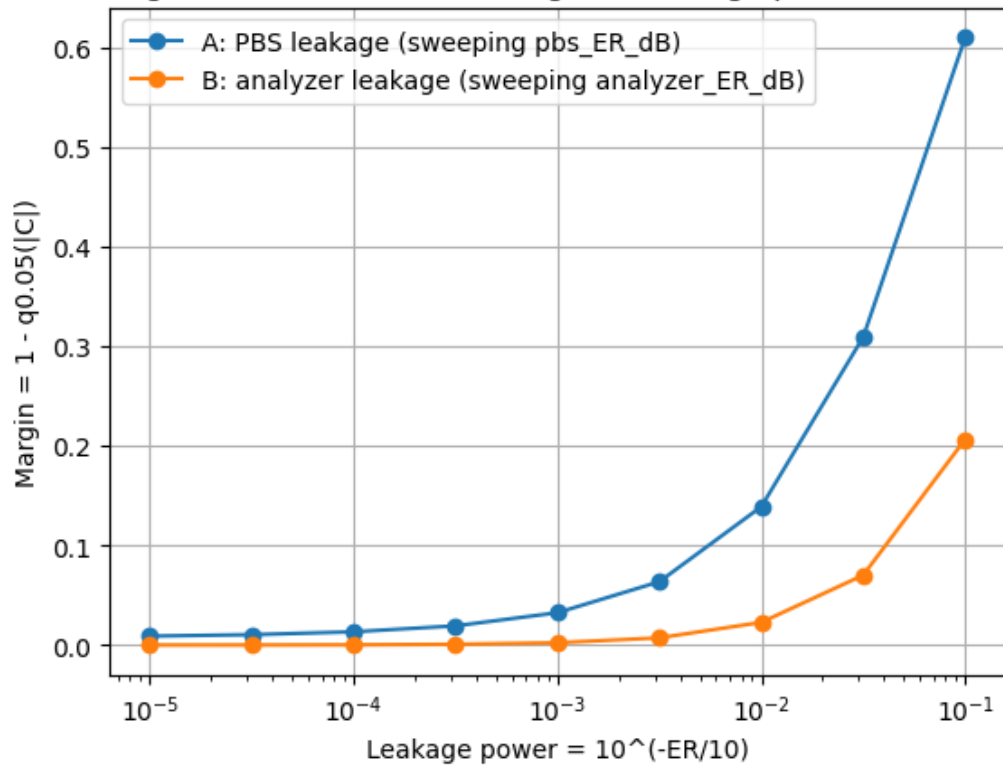


Table S4a-1. Impact-based sensitivity ranking ($\pm 1\sigma$) for Architectures A and B (harmonized comparison).

For each architecture, parameters are perturbed individually to $\mu \pm \sigma$ and evaluated at $p_{\text{test}}=0.5$ under the same decision settings ($\gamma=0.60$, erasure window 0.35; $q=0.05$ for margin). The reported **impact** equals $|m(\mu+\sigma) - m(\mu-\sigma)|/2$, where m is either BER or margin = $1 - q0.05(|C|)$, and $C=(I_H-I_V)/(I_H+I_V)$. Extinction ratio effects are compared using the equivalent leakage power $10^{(-ER/10)}$, enabling a consistent interpretation across A (PBS leakage) and B (analyser leakage).

	param	impact_pm1 sigma	arch	criterion
0	pbs_ER_dB (reported as leakage power)	0.000000	A	BER impact
1	imbalance_dB	0.000000	A	BER impact
2	detector_noise_rel	0.000000	A	BER impact
3	pbs_ER_dB (reported as leakage power)	0.053154	A	Margin impact
4	common-mode $\Delta\theta$ (deg)	0.004897	A	Margin impact
5	detector_noise_rel	0.003803	A	Margin impact
6	analyzer_ER_dB (reported as leakage power)	0.000000	B	BER impact
7	detector_noise_rel	0.000000	B	BER impact
8	$\Delta\lambda$ via lambda_nm (nm)	0.000000	B	BER impact
9	analyzer_ER_dB (reported as leakage power)	0.010222	B	Margin impact
10	detector_noise_rel	0.000507	B	Margin impact
11	$\Delta\lambda$ via lambda_nm (nm)	0.000172	B	Margin impact

Note: Unless otherwise stated, σ values correspond to the default tolerances used in the S4a notebook and can be replaced by measured specifications.