Propagation of **errors** in the evaluation of efficiency

From a recent (2020) 'tesi di laurea' in Rome ('quadriennale') (undergraduate thesis)

Da questa analisi si ottengono

$$N = (82502 \pm 287) \qquad n_S = (82378 \pm 287).$$

dove $\sigma_{N(n)} = \sqrt{N(n)}$.
Da N e n_S si ricava il valore dell'efficienza in Pos 1:

$$\epsilon_{S(Pos1)} = \frac{n_S}{N} = (99.847)\%$$

σ_N: ???
σ_n: ???
(hereafter $n_s \to n$)

- $N - n = 124$
  $\to$ with $\sigma_N = \sigma_n = 287$: efficiency could be > 1: **???**

Propagation of **errors** in the evaluation of efficiency

- Errore statistico. La stima di questo errore si ottiene con la propagazione degli errori di una funzione di due variabili sperimentali indipendenti (N,n) e si ricava dalla seguente espressione:

$$\sigma = \frac{1}{\mathrm{N}}\sqrt{\mathrm{n} + \frac{\mathrm{n}^2}{\mathrm{N}}} \qquad (4.51)$$

- Statistical 'error' (meant as 'uncertainty') obtained propagating the **errors** (this time they are really errors)...
- ...from two independent experimental values (N, n) **???**
- Eq. (4.51) correctly follows from the bad reasoning $\surd$
  $\rightarrow \sigma_\epsilon = 0.0049 \approx 0.005$
- How much is it wrong?

$$\frac{\sigma(\epsilon)^{wrong}}{\sigma(\epsilon)^{correct}} = \frac{1/\sqrt{N}\sqrt{n/N \cdot (1 + n/N)}}{1/\sqrt{N}\sqrt{n/N \cdot (1 - n/N)}} = \sqrt{\frac{1+\epsilon_m}{1-\epsilon_m}}$$
$$= 36$$

Propagation of errors. . . and of mistakes

> Eseguendo queste operazioni otteniamo il seguente risultato:
>
> $$\epsilon_{S(Pos1)} = (99.847 \pm 0,005^{(stat)} \pm 0,010^{(sist)})\%.$$

- Finally,
  the wrong $\sigma_\epsilon = 0.005 = 0.5\%$ becomes $0.005\% = 0.00005$

Good luck to the experiment!