Report on Tracking Efficiency

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Outline

- Reminder about Tracking efficiency strategy
- Efficiency estimator Vs. efficiency
- Summary

Measurement Strategy

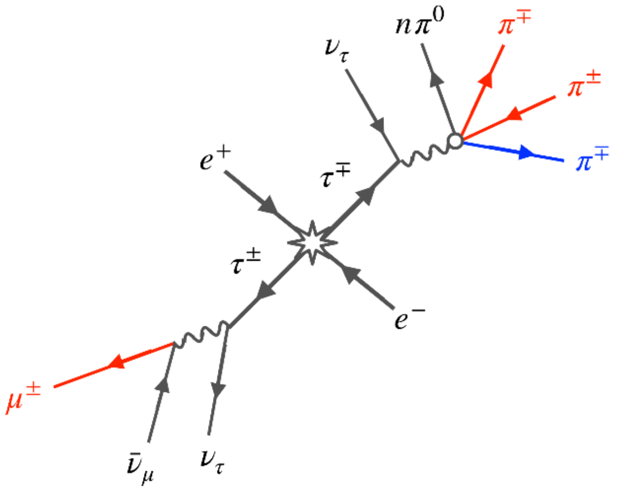
Strategy: exploit charge conservation and kinematic constrains on simple (= with a well recognizable topology) τ-pairs events to deduce the existence of a track.

Reference: "*Track finding efficiency in BaBar*" https://arxiv.org/abs/1207.2849

BaBar strategy was based on *Tau31 events selection:*

- Tracking efficiency, including the detector acceptance, is computed as:
  - $\varepsilon x A = N4/(N3+N4)$
    - N4 = Tau31 events where the 4^{th} track has been found
    - N3 = Tau31 as reconstructed in the 1+2 selection (further details in the next slide) where the 4th is not found.
- MC-data difference in tracking efficiency is then given by:
  - $\Delta = 1- \varepsilon_{MC}/\varepsilon_{data}$
    - With ε the tracking efficiency evaluated respectively on MC/data, including the detector acceptance A.

Measurement Strategy: problem with εxA definition



Tag & **probe** method:

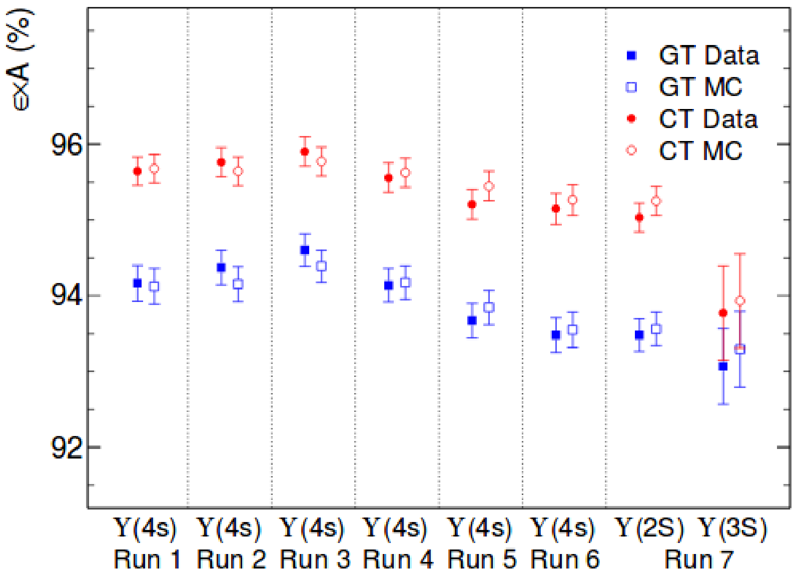
- select events reconstructing one isolated track (consistent with a muon/electron hypothesis → *tag side*) + two "good" tracks on the hadronic side (*probe side*)
- Charge conservation implies the 4th track:
  - **FOUND → N4 ++**
  - **NOT FOUND → N3 ++**
  - Compute N4/(N3+N4) = εxA

Let's call ε the efficiency to find a track and assume we always have one track on the tag side:

- **N4 = ε^3 N BR** *(all 3 tracks on the probe side reconstructed)*
- **N3 = 3 ε^2 (1-ε)N BR** *(only 2 out of 3 probe tracks reconstructed → binomial variable)*

Measurement Strategy: problem with εxA definition (II)

https://arxiv.org/pdf/1207.2849.pdf



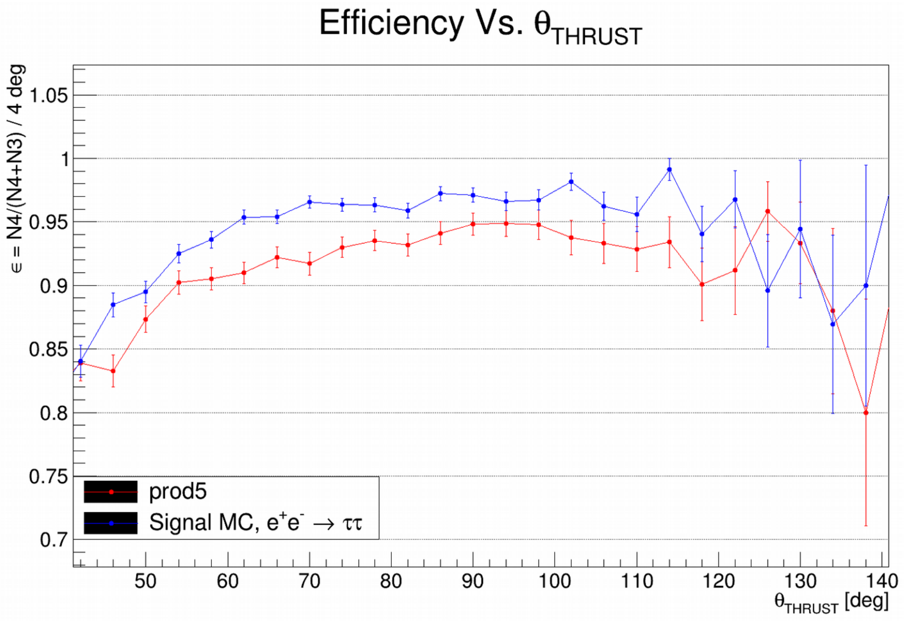
$$\epsilon_{BABAR} \simeq 3\epsilon - 2$$

εxA = N4/(N3+N4)= ε_{BABAR}

$$\epsilon_{BABAR} = \frac{\epsilon^3}{\epsilon^3+3\epsilon^2(1-\epsilon)} = \frac{\epsilon}{3-2\epsilon} = \frac{1-\delta}{1+2\delta} \simeq 1 - 3\delta + o(\delta^2)$$

With δ the probability to loose one track: inefficiency = 1-ε, and ε the real track finding efficiency.

Measurement Strategy: problem with εxA definition (III)



$$\epsilon_{BABAR} \simeq 3\epsilon - 2$$

$$\epsilon_{BelleII} \simeq 2\epsilon - 1$$

εxA = N4/(N3+N4)= ε_{BABAR}

$$\epsilon_{BABAR} = \frac{\epsilon^3}{\epsilon^3+3\epsilon^2(1-\epsilon)} = \frac{\epsilon}{3-2\epsilon} = \frac{1-\delta}{1+2\delta} \simeq 1-3\delta+o(\delta^2)$$

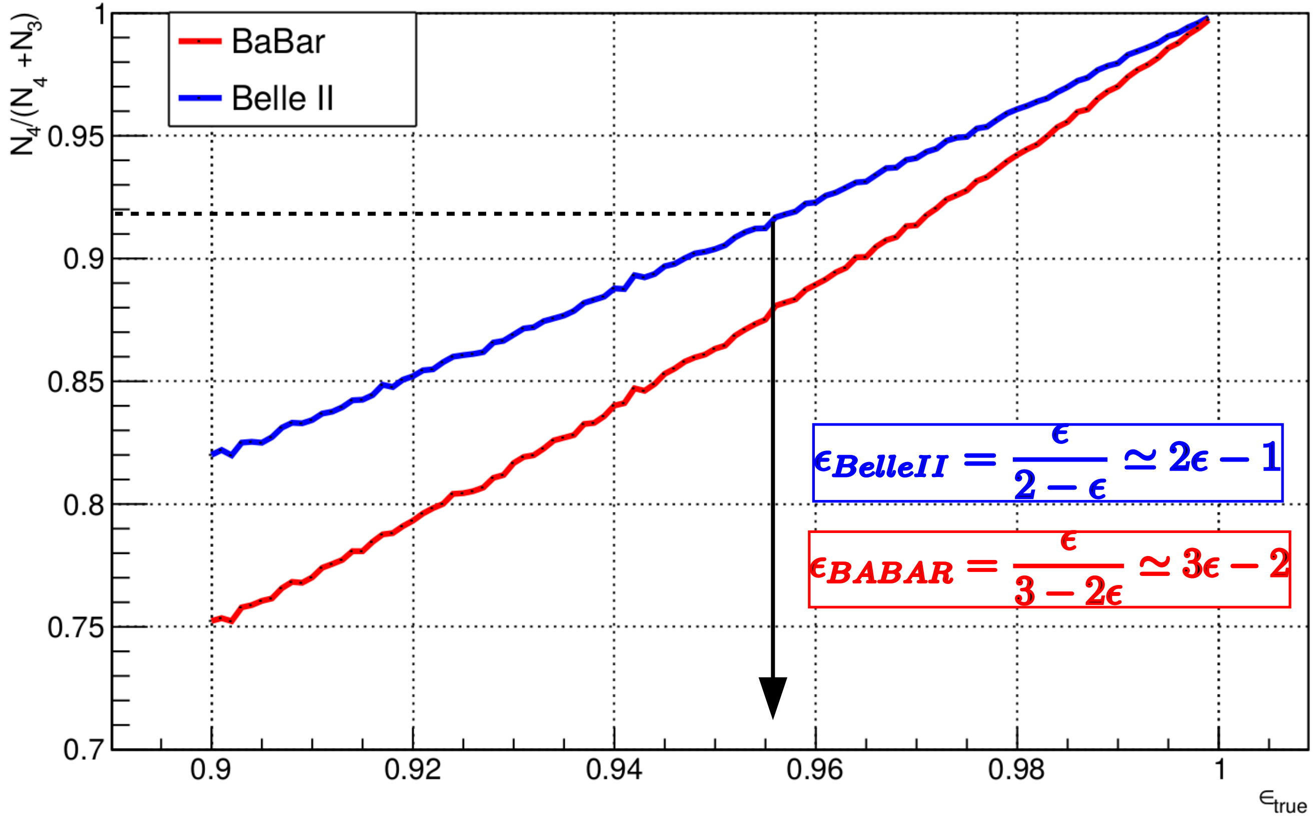
With δ the probability to loose one track: inefficiency = 1-ε, and ε the real track finding efficiency.

For the Belle II case:

- currently we reconstruct only the "opposite" sign case, so **N3 = 2ε² (1-ε)N BR** (2 remaining tracks with *same sign* out of the 3 → event not reconstructed)

$$\epsilon_{BelleII} = \frac{\epsilon^3}{\epsilon^3+2\epsilon^2(1-\epsilon)} = \frac{\epsilon}{2-\epsilon} = \frac{1-\delta}{1+\delta} \simeq 1-2\delta+o(\delta^2)$$

Toy MC: N4/(N3+N4) Vs ε



- 100k events generated for each points in the range $0.9 < \varepsilon_{true} < 1$, step size=0.001
- Each of the 3 prongs(probe side) is a random variable uniformly distributed in [0,1] and if …
  - … < ε_{true} → detected
  - … > ε_{true} → undetected
- Define N3 and N4 favorable cases and compute the estimator N4/(N3+N4) for each given ε_{true}
- Measured efficiency around ~ 92% should correspond to ~ 95.5% real finding efficiency per track

Summary

- N4/(N3+N4) underestimates the real efficiency
- The discrepancy between data and MC is also affected and should be corrected
- Investigate corrections (if) applied by BaBar