

# Graph-based Full Event Interpretation: a graph neural network for event reconstruction in Belle II

GRAFEI - CHEP 2024

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# State of the art

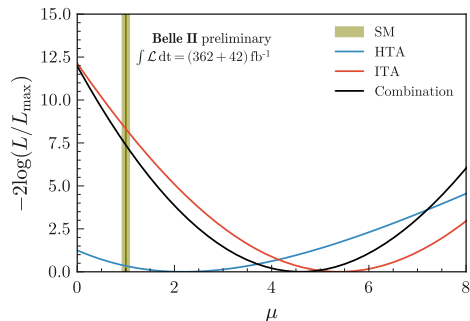
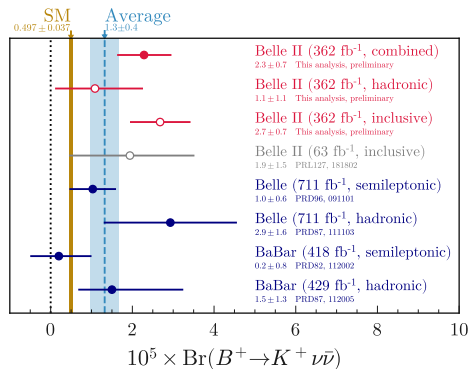


Figure: from [arXiv:2301.06990](https://arxiv.org/abs/2301.06990)

$$\mu = \frac{\mathcal{B}(B^+ \rightarrow K^+ \nu \bar{\nu} | \text{exp})}{\mathcal{B}(B^+ \rightarrow K^+ \nu \bar{\nu} | \text{SM})}$$

# GTA Workflow

Let's define the GRAFEI-based Tagged Anaysis (GTA):

1. Reconstruction + Preselection:

- LCAS must contain only signal-side Kaon and  $B_{\text{tag}}$
- Cut on GRAFEI *probability*, or *B probability*, BGEOM, *derived from cross-entropy*
- Apply other *preselection cuts* (more details in the backup)

2. Train classifier

3. Apply *signal region cut*: BDT output  $> 0.8$

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# GTA Workflow

Let's define the GRAFEI-based Tagged Analysis (GTA):

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# Comparison between analyses

Signal purity:

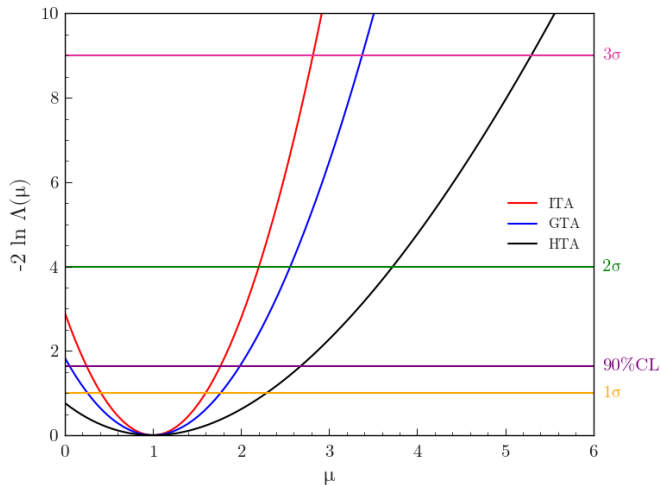
$$\mathcal{P}^{\text{sig}} = \frac{N_{\text{sig}}}{N_{\text{bkg}} + N_{\text{sig}}}$$

**Comparing efficiencies and signal purities:**

	$\epsilon[\%]$	$\mathcal{P}^{\text{sig}}[\%]$
HTA	0.4	3.5
ITA	8	0.8
<b>GTA</b>	<b>2.7</b>	<b>1.3</b>



# Comparison between analyses



*N.B.:* No systematic uncertainties considered in this study.

- [1] Belle II Collaboration, *Evidence for  $B^+ \rightarrow K^+ \nu \bar{\nu}$  decays*, (2024), [arXiv:2301.06990](#).