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

GraFEI - CHEP 2024

Merna AbuMusabh, Jacopo Cerasoli, Giulio Dujany, <u>Corentin Santos</u>

Institut Pluridisciplinaire Hubert Curien
University of Strasbourg

22 October 2024

Table of Contents

1. Feasibility study with the search for $B^+ \to K^+ \nu\bar{\nu}$ at Belle II

1. Feasibility study with the search for $B^+ \rightarrow K^+ \nu \bar{\nu}$ at Belle II
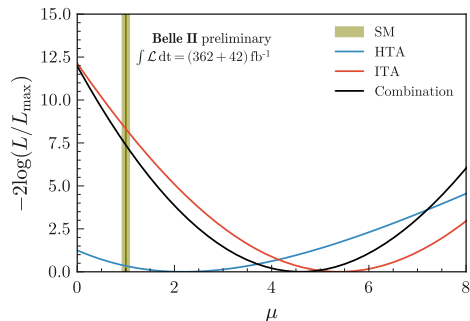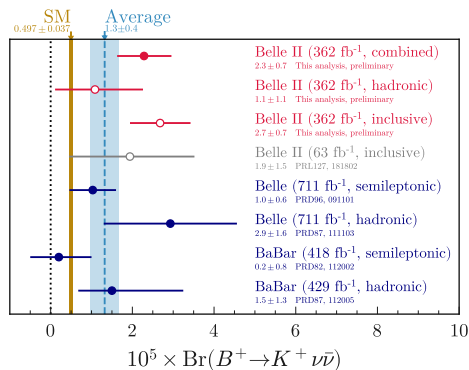
State of the art

Figure: from `arXiv:2301.06990`

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

GTA Workflow

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

1. Reconstruction + Preselection:

- LCAS must contain only signal-side Kaon and B_{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

GTA Workflow

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

1. Reconstruction + Preselection:
   - LCAS must contain only signal-side Kaon and B_{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

GTA Workflow

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

1. Reconstruction + Preselection:
   - LCAS must contain only signal-side Kaon and B_{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
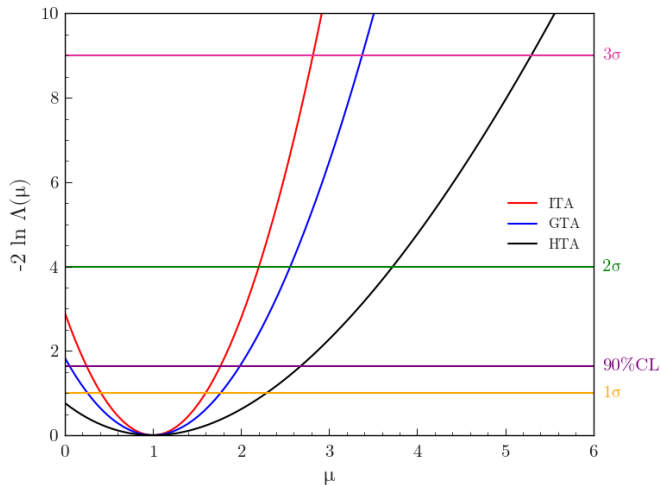3. Apply *signal region cut*: BDT output > 0.8

Comparison between analyses

Signal purity:

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

Comparing efficiencies and signal purities:

	$\varepsilon[\%]$	$\mathcal{P}^{\text{sig}}[\%]$
HTA	0.4	3.5
ITA	8	0.8
GTA	**2.7**	**1.3**

Comparison between analyses

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

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