New measurement of $K^+ \to \pi^+ \nu \bar{\nu}$ branching ratio at the NA62 experiment

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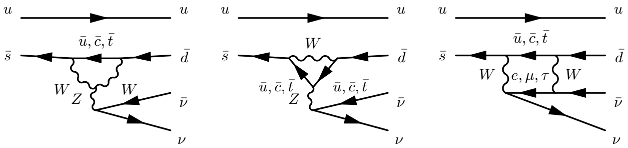
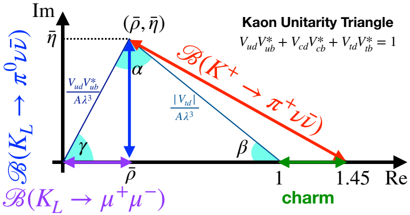
Moriond EW, La Thuile, Italy, 15th - 22nd March 2026

$K \to \pi\nu\bar{\nu}$: a golden channel in flavor physics





- Flavor Changing Neutral Current;
- $\mathcal{B}(K \to \pi\nu\bar{\nu})$ highly suppressed in SM:
  - GIM mechanism + CKM matrix element suppression
- Theoretically clean:
  - Dominated by short distance contributions;
  - Hadronic matrix element extracted from $K \to \pi\ell\nu$.

	$\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu})$	$\mathcal{B}(K_L \to \pi^0\nu\bar{\nu})$
Buras et al. [EPJC 82 (2022) 615]	$(8.60 \pm 0.42) \times 10^{-11}$	$(2.94 \pm 0.15) \times 10^{-11}$
D'Ambrosio et al. [JHEP 09 (2022) 148]	$(7.86 \pm 0.61) \times 10^{-11}$	$(2.68 \pm 0.30) \times 10^{-11}$
Experimental status	$(13.0^{+3.3}_{-3.0}) \times 10^{-11}$ NA62 2016–2022 [JHEP 02 (2025) 191]	2.2×10^{-9} @ 90% C.L. KOTO 2021 [PRL 134 (2025) 081802]

Benchmark SM value for this talk: $\mathcal{B}^{SM}(K^+ \to \pi^+\nu\bar{\nu}) = 8.4 \times 10^{-11}$ [JHEP 11 (2015) 033]

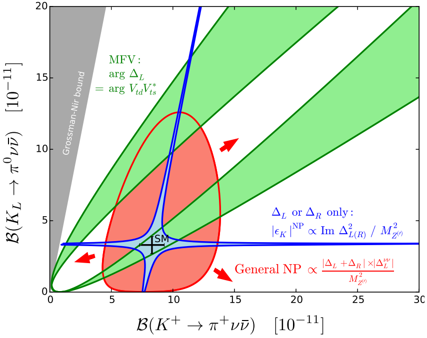
$K \to \pi\nu\bar{\nu}$: Beyond the Standard Model

Correlation between neutral and charged channels:

- Model-independent Grossman-Nir bound [PLB 398 (1997) 163]

$$\frac{\mathcal{B}(K_L \to \pi^0\nu\bar{\nu})/\tau_{K_L}}{\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu})/\tau_{K^+}} \lesssim 1$$

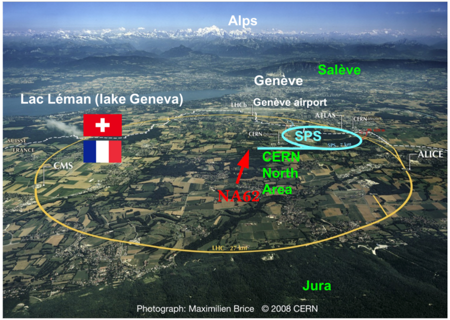
- New Z' boson [JHEP 11 (2015) 166, JHEP 12 (2020) 097]:
  - Minimal Flavour Violation: Z' with CKM-like structure;
  - Z' with pure LH / RH couplings;
  - General Z'
- Majorana neutrinos [JHEP 12 (2020) 186, EPJC 84 (2024) 680].
- Leptoquarks [JHEP 02 (2018) 101, EPJC 82 (2022) 320, PLB 835 (2022) 137525].
- General LFUV / LNV correlating with rare b decays [EPJC 77 (2017) 618, PLB 809 (2020) 135769, JHEP 10 (2024) 087].



[JHEP 11 (2015) 166]

The NA62 experiment

~200 collaborators from 35 institutions



High-precision kaon experiment:

- **Primary goal**: $\mathcal{B}(K^+ \to \pi^+ \nu\bar{\nu})$ measurement;
- **Technique**: Fixed target & decay-in-flight
- **Broader physics program** [see backup for references]:
  - Precision measurements of kaon and pion decays;
  - HNL and LNV/LFV searches in kaon decays;
  - Hidden Sector searches with kaons and in dump mode;
  - Neutrino tagging.

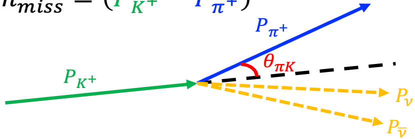
This talk

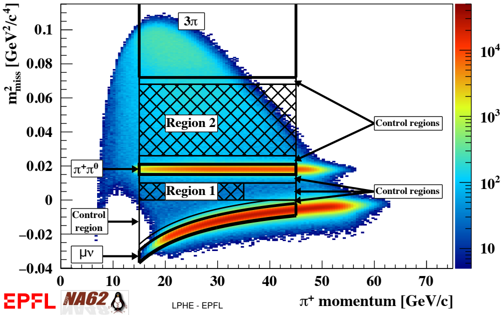
Commissioning	2016	2017	2018	LS2	2021	2022	2023	2024	2025	2026
	45 days	160 days	217 days	Upgrades	85 days	215 days	140 days	185 days	210 days	

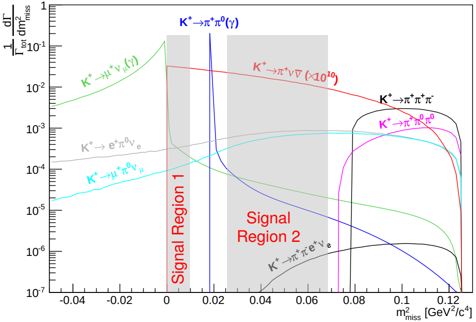
$K^+ \to \pi^+ \nu \bar{\nu}$ @ NA62: experimental strategy

Decay modes	Branching ratio [PDG]
$K^+ \to \mu^+ \nu_\mu$	$(63.56 \pm 0.11)\%$
$K^+ \to \pi^+ \pi^0$	$(20.67 \pm 0.08)\%$
$K^+ \to \pi^+ \pi^+ \pi^-$	$(5.583 \pm 0.024)\%$
$K^+ \to \pi^+ \pi^- e^+ \nu_e$	$(4.247 \pm 0.024) \times 10^{-5}$
$K^+ \to \pi^+ \nu \bar{\nu}$	$\mathcal{O}(10^{-10})$

$$m^2_{miss} = (P_{K^+} - P_{\pi^+})^2$$

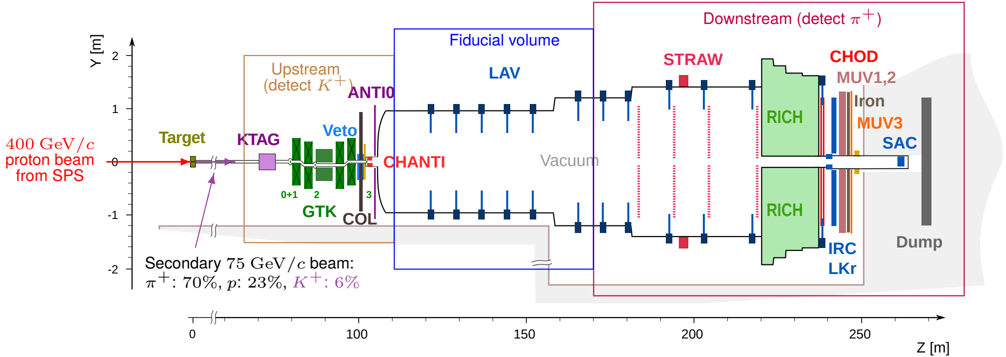






$\mathcal{O}(10^4)$ background suppression from kinematics

The NA62 detector



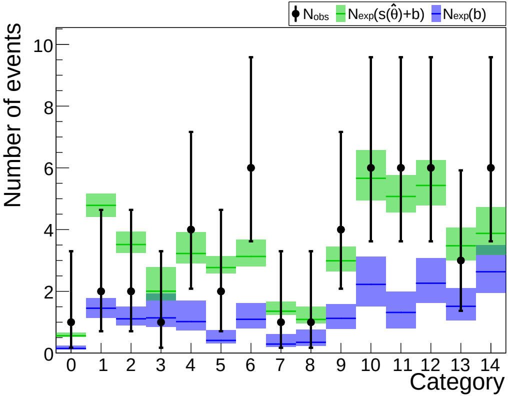
- **Particle tracking**: GTK - beam particle, STRAW - downstream tracks.
- **PID**: Cherenkov detectors (KTAG - K^+, RICH - π^+), calorimeters (LKr, MUV1,2), muon (MUV3)
- **Comprehensive veto system**:
  - Upstream: VetoCounter (early decays), CHANTI (beam interactions), ANTI0 (halo particles)
  - Downstream: LAV, LKr, IRC, SAC (photon), MUV0 (multiplicity), HASC (photon conversion)

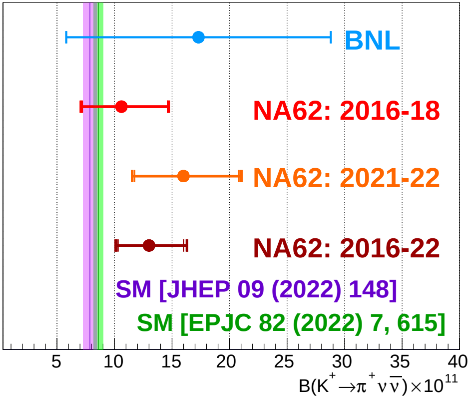
- $\mathcal{O}(100\ \text{ps})$ sub-detector time resolution
- $\mathcal{O}(10^7)$ muon suppression
- $\mathcal{O}(10^8)$ π^0 veto

Previous results

[JHEP 02 (2025) 191]

- Integrated 2016–2022 dataset: $N_{bg} = 18^{+3}_{-2}$, $N_{obs} = 51$.

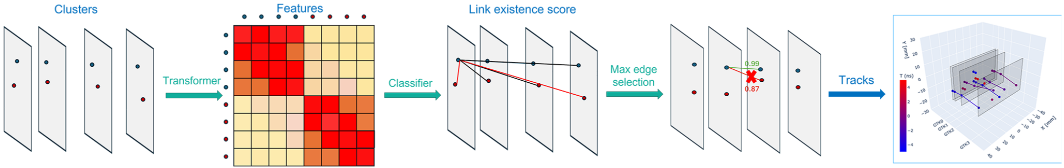


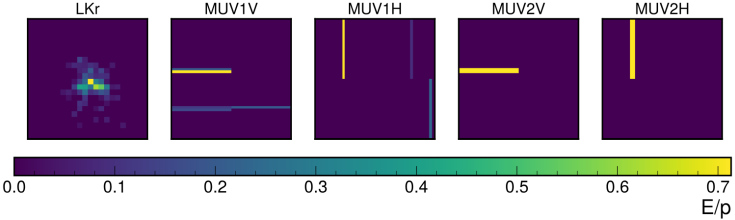


$$\mathcal{B}_{16-22}(K^+ \to \pi^+\nu\bar{\nu}) = (13.0^{+3.0}_{-2.7}|_{stat}\ ^{+1.3}_{-1.3}|_{syst}) \times 10^{-11} = (13.0^{+3.3}_{-3.0}) \times 10^{-11}$$

25% fractional uncertainty; smallest branching ratio observed with $> 5\sigma$ significance.

Improvements: Machine Learning technique





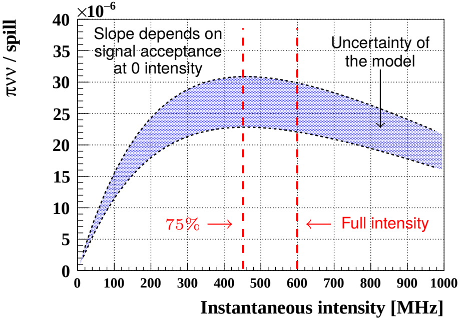
↑ Transformer based GTK track reco.

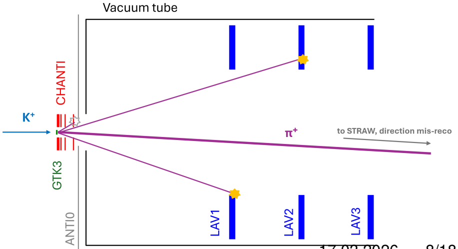
← CNN based calorimetric PID.

- Transformer GTK reco: $\boldsymbol{K}$–$\boldsymbol{\pi}$ **mis-matching probability** (K not reconstructed): $\mathbf{6\%} \rightarrow \mathbf{4\%}$.
- CNN Calo PID:
  - $\sim 16\%$ less $K^+ \rightarrow \mu^+\nu_\mu$ background.
  - $\boldsymbol{\sim 70\%}$ **less** $\boldsymbol{K^+ \rightarrow \mu^+\nu_\mu\gamma}$ **background with** $\boldsymbol{\mu^+}$ **and** $\boldsymbol{\gamma}$ **overlap in LKr**.

Improvements: beam, hardware, trigger, selections...

- Optimal intensity:
  - Saturation due to paralyzable dead time;
  - Operated at 450 MHz (75% of full intensity) since August 2023.
- KTAG N_2 based $\rightarrow$ H_2 based: efficiency: $99.5\% \rightarrow 99.7\%$, material: $3.9\% X_0 \rightarrow 0.7\% X_0$.
- LAV Trigger veto: all LAV stations from the 2nd $\rightarrow$ only LAV stations downstream of vertex.
  - $K^+ \rightarrow \pi^+\pi^0$ background under control;
  - Increased upstream interaction events $\rightarrow$ used for background study.
- **Offline LAV1 veto**:
  - stronger upstream interaction suppression;
  - $\sim 40\%$ **less upstream background** ($= \sim 30\%$ **less total background**).
- Re-tuned selections.





2023–2024 dataset: signal sensitivity

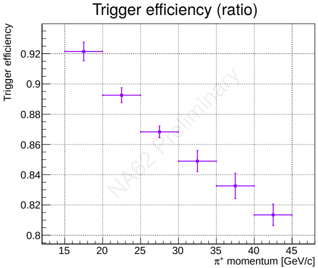
Normalization channel:
$K^+ \to \pi^+\pi^0$.

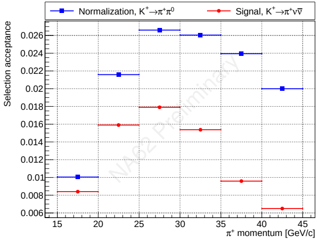
$N_{\pi\pi}$	3.93×10^8
$A_{\pi\pi}$	$(12.971 \pm 0.009)\%$
N_K	$(5.93 \pm 0.02) \times 10^{12}$
$A_{\pi\nu\bar{\nu}}$	$(7.36 \pm 0.33)\%$
ε_{RV}	$(72.3 \pm 0.7)\%$
ε_{trig}	$(86.4 \pm 1.2)\%$
$\mathcal{B}_{SES}$	$(0.37 \pm 0.02) \times 10^{-11}$
$N^{SM}_{\pi\nu\bar{\nu}}$	22.9 ± 1.1

$$N^{SM}_{\pi\nu\bar{\nu}} = \mathcal{B}^{SM}_{\pi\nu\bar{\nu}} / \mathcal{B}_{SES}$$

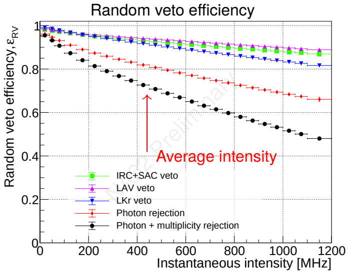
$$\mathcal{B}_{SES} = \frac{\mathcal{B}_{\pi\pi} A_{\pi\pi}}{N_{\pi\pi} D_0 A_{\pi\nu\bar{\nu}} \varepsilon_{RV} \varepsilon_{trig}}$$

Downscaling factor of normalization trigger (400)





Selection acceptance



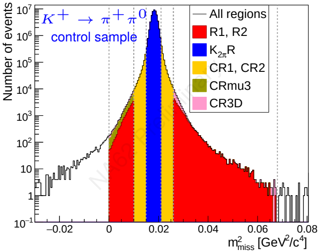
Together with 2016–2022 dataset:

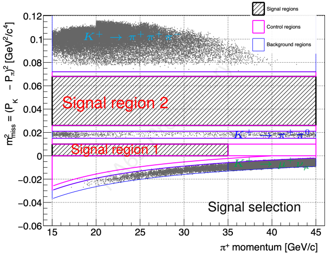
- $\mathcal{O}(10^{13})$ effective K^+ decays;
- > 40 SM $K^+ \to \pi^+\nu\bar{\nu}$ events expected.

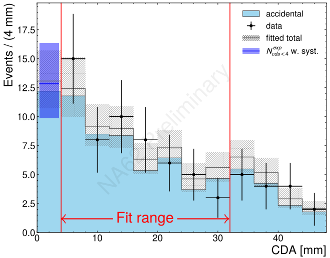
2023–2024 dataset: background evaluation

- "Peaking" backgrounds: $K^+ \to \pi^+\pi^0$, $\mu^+\nu_\mu$, $\pi^+\pi^+\pi^-$:
  - evaluate tail fraction from control samples.
- $K^+ \to \pi^+\pi^-e^+\nu_e$, $\pi^+\gamma\gamma$, $\pi^0\ell^+\nu$:
  - evaluate acceptance with MC simulation.
- Upstream background:
  - tail in CDA: Closest Distance of Approach between K^+ and π^+ tracks;
  - extrapolate via **template fit***.

Background	N_{bg}^{exp}
$K^+ \to \pi^+\pi^0(\gamma)$	1.19 ± 0.10
$K^+ \to \mu^+\nu(\gamma)$	1.39 ± 0.29
$K^+ \to \pi^+\pi^+\pi^-$	0.25 ± 0.05
$K^+ \to \pi^+\pi^-e^+\nu$	$1.59^{+0.51}_{-0.43}$
$K^+ \to \pi^+\gamma\gamma$	0.04 ± 0.04
$K^+ \to \pi^0\ell^+\nu$	< 0.001
Upstream	$7.4^{+2.8}_{-2.2}$
Total	$11.9^{+2.9}_{-2.3}$





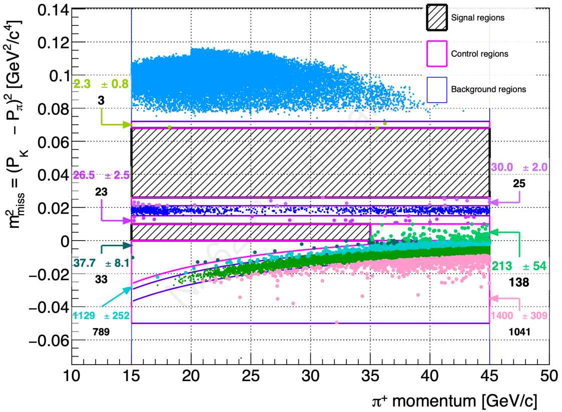


* New method in 2023–2024 analysis. Previously using a linear approximation.

2023–2024 dataset: background evaluation

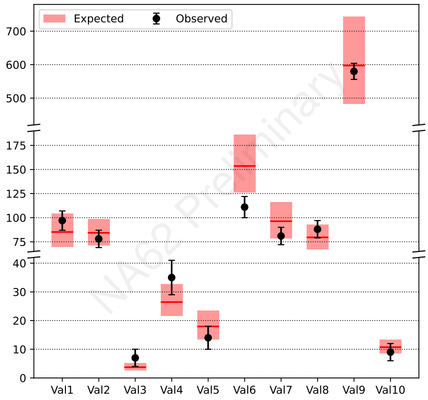
Validation of background evaluation

Control region prediction (colored) v.s. observation



p-value $= 0.65$

Upstream validation samples



p-value $= 0.79$

Analysis summary & comparison

	2021–2022	2023–2024
$N_{\pi\pi}$ $[\times 10^8]$	$\mathbf{1.95}$	$\mathbf{3.93}$
$A_{\pi\pi}$ [%]	13.410 ± 0.005	12.971 ± 0.009
N_K $[\times 10^{12}]$	2.85 ± 0.01	5.93 ± 0.02
$A_{\pi\nu\bar{\nu}}$ [%]	7.62 ± 0.22	7.36 ± 0.33
ε_{RV} [%]	$\mathbf{63.2 \pm 0.6}$	$\mathbf{72.3 \pm 0.7}$
ε_{trig} [%]	85.9 ± 1.4	86.4 ± 1.2
$\mathcal{B}_{SES}$ $[\times 10^{-11}]$	0.85 ± 0.03	0.37 ± 0.02
$N^{SM}_{\pi\nu\bar{\nu}}$	$\mathbf{9.9 \pm 0.3}$	$\mathbf{22.9 \pm 1.1}$

	2021–2022	2023–2024
$K^+ \to \pi^+\pi^0(\gamma)$	0.83 ± 0.05	1.19 ± 0.10
$K^+ \to \mu^+\nu(\gamma)$	$\mathbf{1.70 \pm 0.47}$	$\mathbf{1.39 \pm 0.29}$
$K^+ \to \pi^+\pi^+\pi^-$	0.11 ± 0.03	0.25 ± 0.05
$K^+ \to \pi^+\pi^-e^+\nu$	$0.89^{+0.33}_{-0.27}$	$1.59^{+0.51}_{-0.43}$
$K^+ \to \pi^+\gamma\gamma$	0.01 ± 0.01	0.04 ± 0.04
$K^+ \to \pi^0\ell^+\nu$	< 0.001	< 0.001
Upstream	$\mathbf{7.4^{+2.1}_{-1.8}}$	$\mathbf{7.4^{+2.8}_{-2.2}}$
Total	$11.0^{+2.1}_{-1.9}$	$11.9^{+2.9}_{-2.3}$

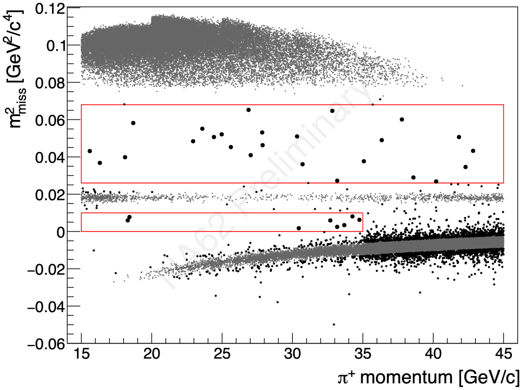
- $2\times$ statistics, $2.3\times$ signal events expected;
- 14% improvement in random veto efficiency ε_{RV} (lower intensity);
- Significant less $K^+ \to \mu^+\nu_\mu(\gamma)$ background (CNN Calo PID);
- Significant less upstream background (LAV veto, re-tuned selections, new GTK reconstruction, intensity, etc...)
- **Overall $S/\sqrt{S+B}$: $\sim 2.2 \to \sim 3.9$.**

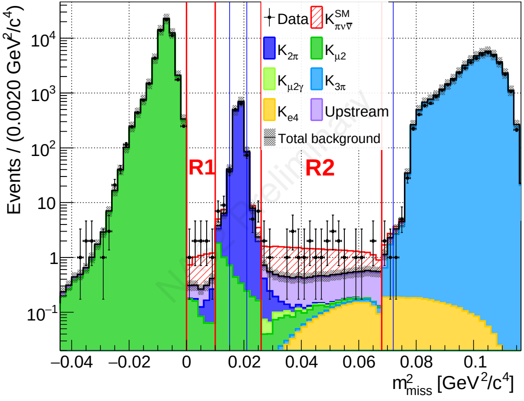
Combined NA62 2016–2024 dataset:

- $N^{exp}_{bg} = 30^{+4}_{-3}$
- $N^{SM}_{\pi\nu\bar{\nu}} = 43 \pm 1$

Expected SM significance $> 5\sigma$.

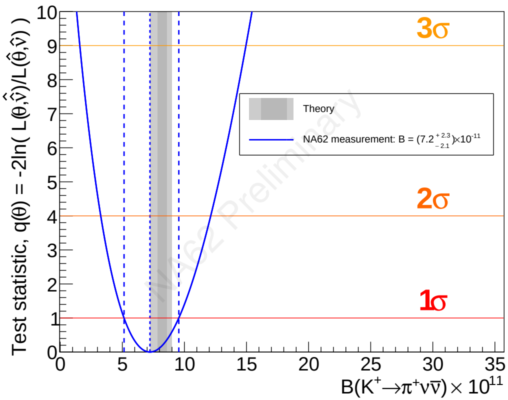
Results: 2023–2024 dataset

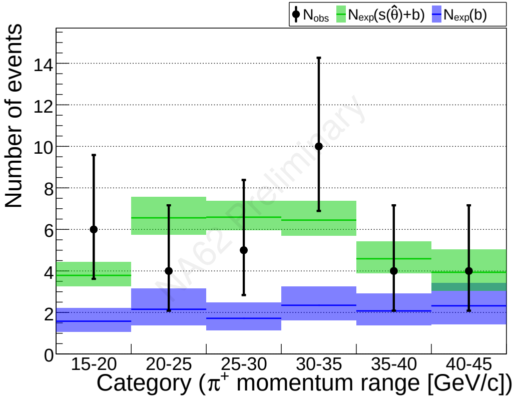




- $N_{bg}^{exp} = 11.9^{+2.9}_{-2.3}$
- $N_{\pi\nu\bar{\nu}}^{SM} = 22.9 \pm 1.1$
- $\boldsymbol{N_{obs} = 33}$

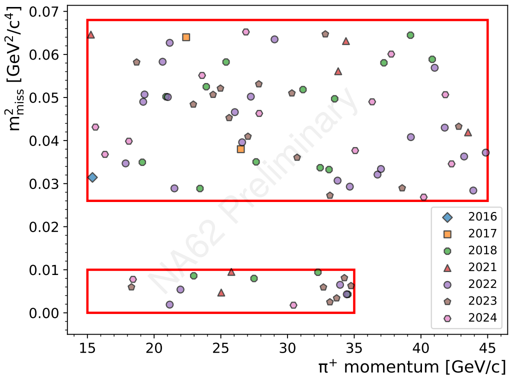
Results: 2023–2024 dataset

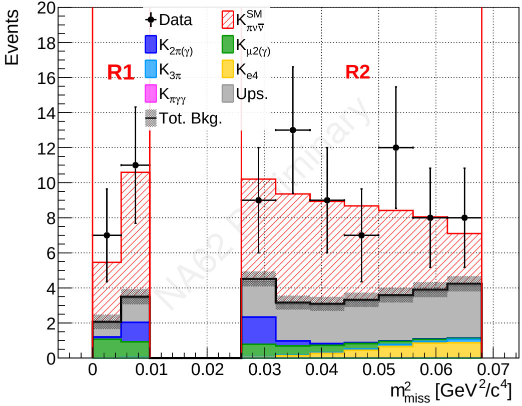




$$\mathcal{B}^{\mathbf{NA62}}_{\mathbf{2023-2024}}(K^+ \to \pi^+ \nu\bar{\nu}) = (7.2^{+2.2}_{-1.9}|_{stat}\ {}^{+0.9}_{-0.9}|_{syst}) \times 10^{-11} = (7.2^{+2.3}_{-2.1}) \times 10^{-11}$$

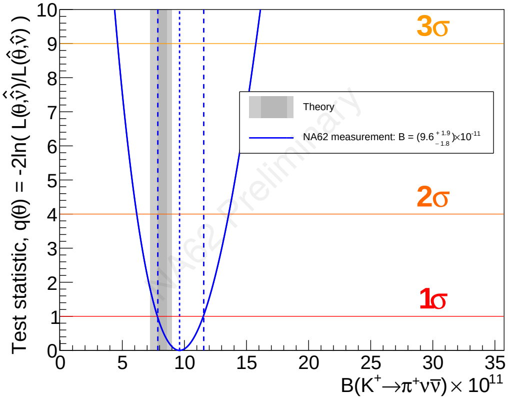
Results: combined 2016–2024 dataset

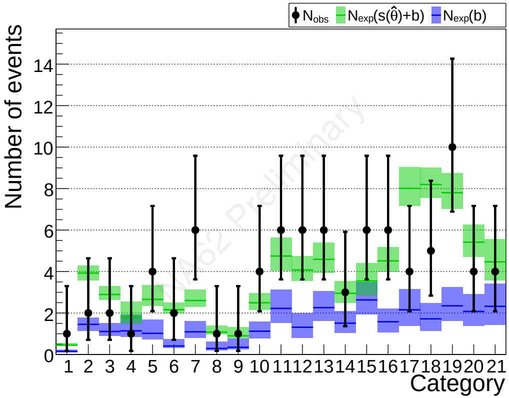




- $N^{exp}_{bg} = 30^{+4}_{-3}$
- $N^{SM}_{\pi\nu\bar{\nu}} = 43 \pm 1$
- $N_{obs} = 84$

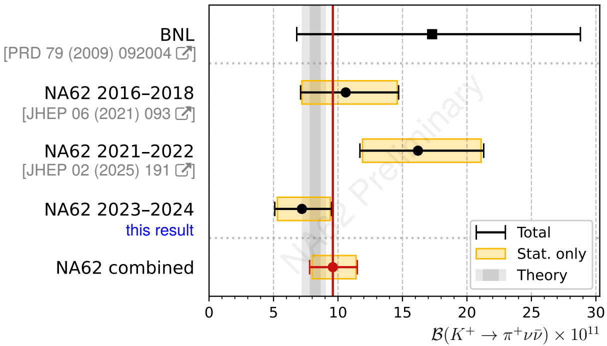
Results: combined 2016–2024 dataset

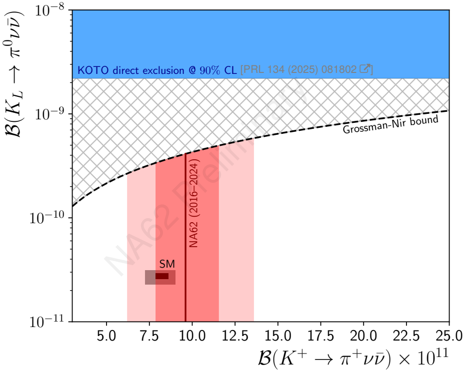




$$\mathcal{B}^{\mathbf{NA62}}_{\mathbf{2016-2024}}(K^+ \to \pi^+\nu\bar{\nu}) = (9.6^{+1.8}_{-1.6}|_{stat}\ ^{+0.8}_{-0.6}|_{syst}) \times 10^{-11} = (9.6^{+1.9}_{-1.8}) \times 10^{-11}$$

Results

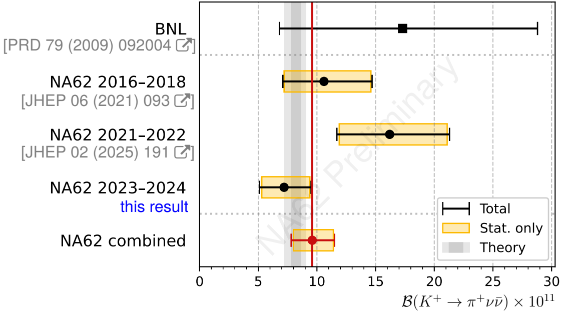




$$\mathcal{B}^{\mathrm{NA62}}_{2016-2024}(K^+ \to \pi^+ \nu\bar{\nu}) = (9.6^{+1.8}_{-1.6}|_{stat}\ {}^{+0.8}_{-0.6}|_{syst}) \times 10^{-11} = (9.6^{+1.9}_{-1.8}) \times 10^{-11}$$

Conclusion

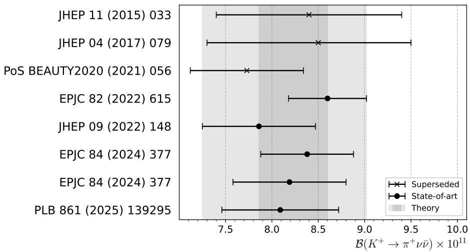
$$\mathcal{B}^{\mathrm{NA62}}_{2016-2024}(K^+ \to \pi^+\nu\bar{\nu}) = (9.6^{+1.9}_{-1.8}) \times 10^{-11}$$

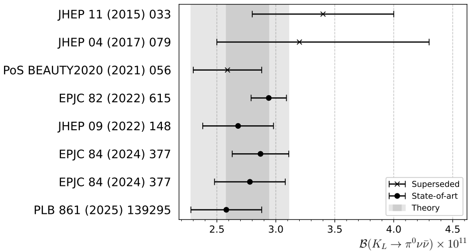


- Expected SM signal more than doubled.
- Background reduced w.r.t. the previous analysis; significant sensitivity boost.
- Expected SM significance $> 5\sigma$.
- Branching ratio measured to $< 20\%$ precision.
- Result compatible with SM prediction.
- NA62 2025–2026 data collection and analysis ongoing.

Backup slides

Recent theory works on $K \to \pi\nu\bar{\nu}$





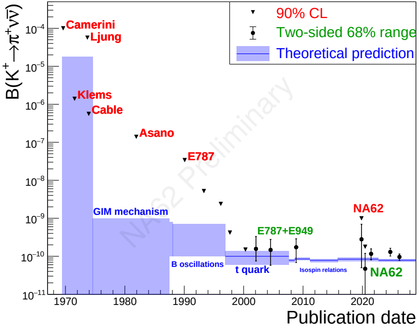
$K^+ \to \pi^+ \nu \bar{\nu}$ bibliography

Experiments:

- Camerini et al. [PRL 23 (1969) 326-329]
- Klems et al. [PRD 4 (1971) 66-80]
- Ljung et al. [PRD 8 (1973) 1307-1330]
- Cable et al. [PRD8 (1973) 3807-3812]
- Asano et al. [PLB 107 (1981) 159]
- E787 :
  - [PRL 64 (1990) 21-24]
  - [PRL 70 (1993) 2521-2524]
  - [PRL 76 (1996) 1421-1424]
  - [PRL 79 (1997) 2204-2207]
  - [PRL 84 (2000) 3768-3770]
  - [PRL 88 (2002) 041803]
- E949 (+E787):
  - [PRL 93 (2004) 031801]
  - [PRL 101 (2008) 191802]
- NA62:
  - 2016 data: [PLB 791 (2019) 156]
  - 2016+17 data: [JHEP 11 (2020) 042]
  - 2016–18 data: [JHEP 06 (2021) 093]
  - 2016–22 data : [JHEP 02 (2025) 191].

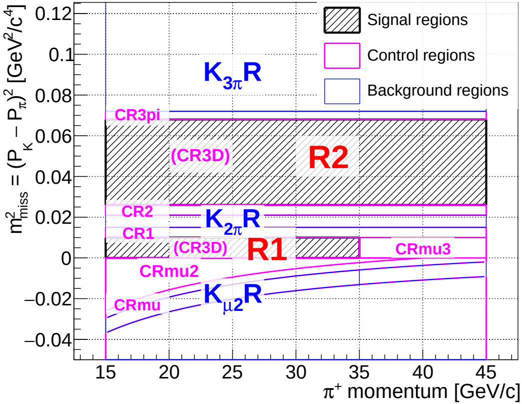
Theory:

- [Phys.Rev. 163 (1967) 1430-1440]
- [PRD 10 (1974) 897]
- [Prog.Theor.Phys. 65 (1981)]
- [PLB 133 (1983) 443-448]
- [PLB 192 (1987) 201-206]
- [Nucl.Phys.B 304 (1988) 205-235]
- [PRD 54 (1996) 6782-6789]
- [PRD 76 (2007) 034017]
- [PRD 78 (2008) 034006]
- [PRD 83 (2011) 034030]
- [JHEP 11 (2015) 033]
- [JHEP 09 (2022) 148]



Kinematic regions

- Signal regions: Sensitive to $K^+ \to \pi^+ \nu \bar{\nu}$;
- Control regions: Used for validating background evaluation;
- Background regions: Reference and normalization for main K^+ decay backgrounds.

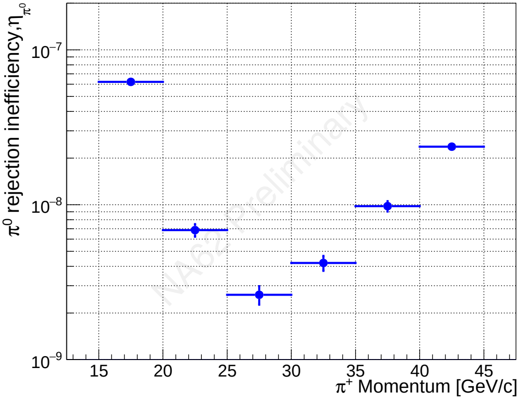


NA62 performance: photon veto

- Overall:

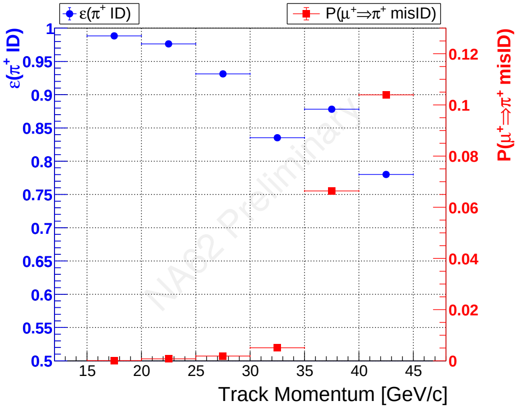
$$\eta_{\pi^0} = (1.24 \pm 0.04) \times 10^{-8}$$

- c.f. 2021–2022: $(1.72 \pm 0.07) \times 10^{-8}$.

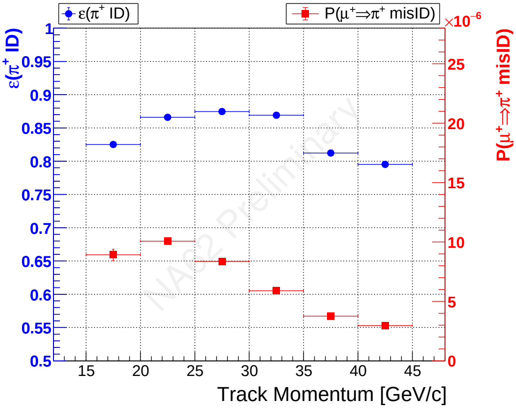


NA62 performance: PID

RICH



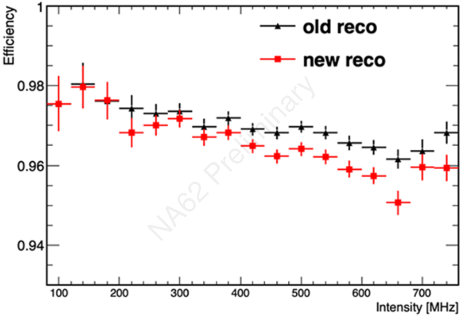
Calorimetric: LKr+MUV12+MUV3

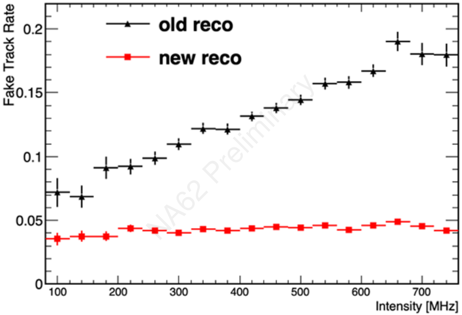


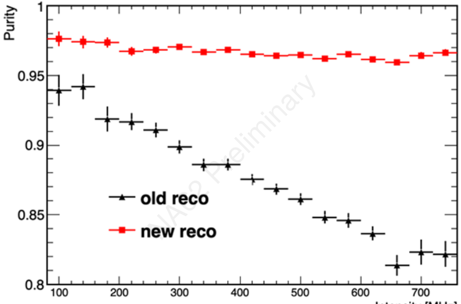
Overall: $\varepsilon_{\pi^+} = 75.3\%$, muon mis-ID $P_{\mu^+\Rightarrow\pi^+} = (1.31 \pm 0.11) \times 10^{-7}$.

GTK reconstruction performance

- Old reco: based on combinatorics;
- New reco: ML-driven;
- Metrics evaluated on MC.

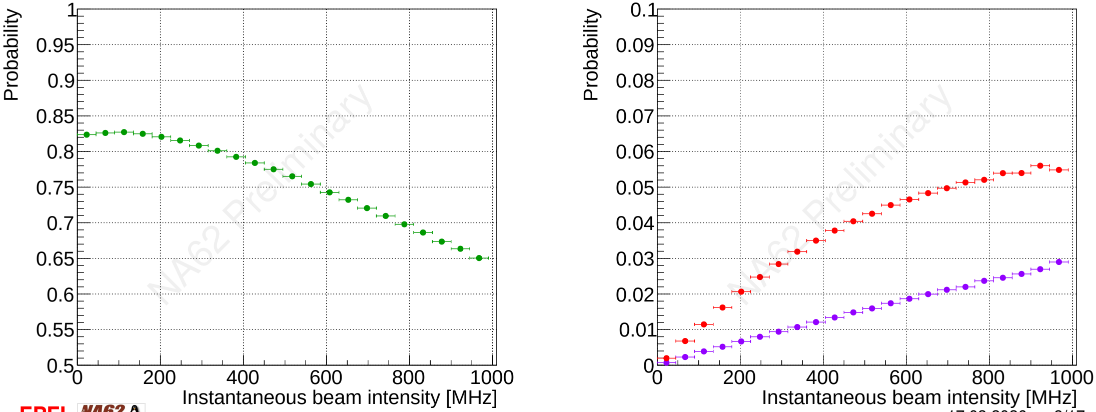






GTK reconstruction performance

- Use $K^+ \to \pi^+\pi^+\pi^-$ sample, reconstruct the **true K^+** from 3 downstream $\pi^+\pi^+\pi^-$ tracks;
- Compare with the GTK reconstructed K^+ track from the K–π matching in signal selection:
  - matching efficiency (true K^+ selected): 79%;
  - true K^+ not selected: true K^+ not in GTK candidates: 4%;
  - true K^+ not selected: true K^+ in GTK candidates: 2%.



Analysis strategy

- Selections:
  - **Normalization** $K^+ \to \pi^+\pi^0$: 1 downstream track (only); identified as π^+; K–π matching (space & time); upstream vetos.
  - **Signal** $K^+ \to \pi^+\nu\bar{\nu}$: normalization selection + full photon and detector multiplicity cuts (reject all extra activity).

$$N_{SR}^{obs} = \overbrace{\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu})/\mathcal{B}_{SES}}^{N_{\pi\nu\bar{\nu}}} + N_{bg}$$

Observed events in signal region

Evaluated background

$$\mathcal{B}_{SES} = \frac{1}{N_K \varepsilon_{RV} \varepsilon_{trig} A_{\pi\nu\bar{\nu}}}, N_K = \frac{N_{\pi\pi} D_0}{\mathcal{B}_{\pi\pi} A_{\pi\pi}}$$

Number of normalization events

Down-scaling factor of normalization trigger (generally 400)

Acceptance of normalization

Random veto efficiency

Trigger efficiency (ratio)

Signal selection acceptance

$K^+ \to \pi^+\pi^0$ branching ratio

- Performing the analysis in bins of π^+ momentum (categories). Fitting all the categories to get the final $\mathcal{B}(K^+ \to \pi^+\nu\bar{\nu})$.

Background evaluation

"Peaking" backgrounds: $K^+ \to \pi^+\pi^0$, $\mu^+\nu_\mu$, $\pi^+\pi^+\pi^-$:

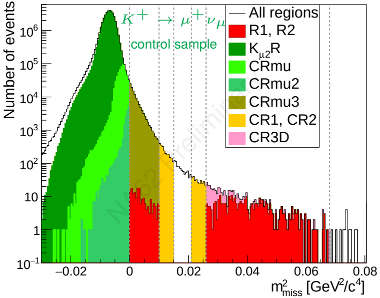
$$N_{bg} = N_{bgR}^{PNNsel} \cdot f_{tail} = N_{bgR}^{PNNsel} \cdot \frac{N_{SR}^{Ctrl}}{N_{bgR}^{Ctrl}}$$

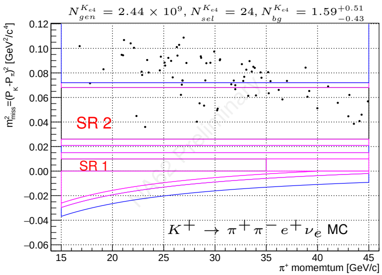
- N_{bgR}^{PNNsel}: Number of events passing signal selection in background region
- N_{SR}^{Ctrl}: Control sample events in Signal Regions
- N_{bgR}^{Ctrl}: Control sample events in Background Region
- Control samples:

$K^+ \to \pi^+\pi^- e^+\nu_e$, $\pi^+\gamma\gamma$, $\pi^0\ell^+\nu$:

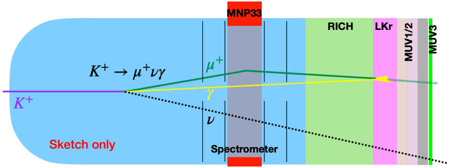
$$N_{bg} = \frac{\mathcal{B}_{bg}}{\mathcal{B}_{SES}^{bg}} = \mathcal{B}_{bg} \cdot N_K \varepsilon_{RV} \varepsilon_{trig} A_{bg}$$

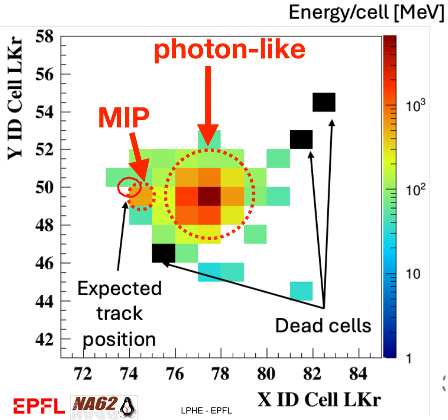
- A_{bg}: acceptance of signal selection for the background decay channel;
- $\mathcal{B}_{bg}$: branching ratio of the background decay channel;
- $N_K \varepsilon_{RV} \varepsilon_{trig}$: same as signal $\mathcal{B}_{SES}$.



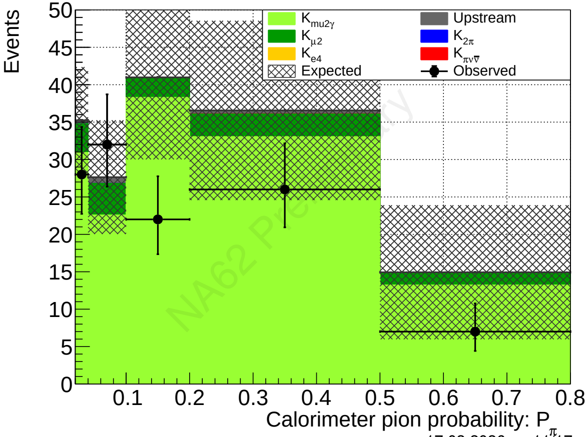


$K^+ \to \mu^+ \nu_\mu \gamma$ background



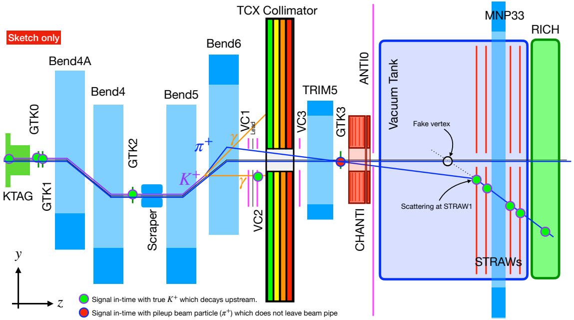


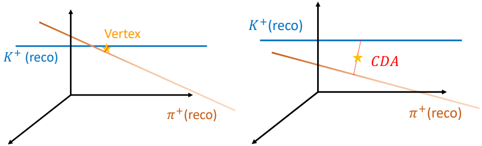
- μ^+ and γ overlap in LKr;
- Evaluated with f_{tail}s in kinematic and PID variables;
- Validation:



Upstream background

- π^+ coming from upstream of the fiducial volume;
- source: early decay, interactions, etc.
- **62% of total background**.





Suspression:

- upstream veto detectors;
- ΔT between the reconstructed K^+ and π^+;
- a BDT using spatial information of the reconstructed K^+ and π^+ tracks.

Estimation:

- use Upstream Reference Sample (URS);
- extrapolation in CDA.

Validation:

- 10 validation samples modifying the upstream vetos;
- each enriches upstream background from different mechanisms.

Upstream background: Evaluation

Upstream Reference Sample: from signal selection

- remove K-π matching;
- require $CDA > 4$ mm.

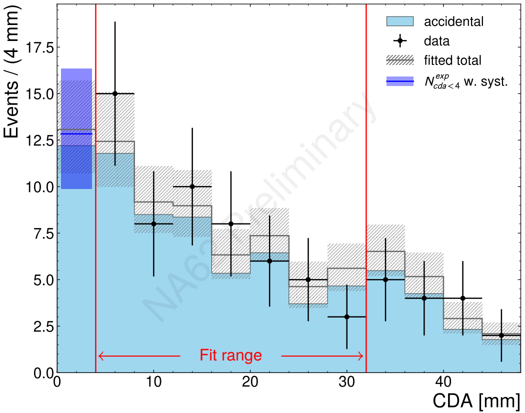
Evaluation step 1: $CDA > 4\ \text{mm} \to CDA < 4\ \text{mm}$.

- Two CDA templates from samples enriching interaction and accidental like events;
- Fit to URS CDA distribution in $(4, 32)$ mm;
- Extrapolate to $CDA < 4$ mm:

$$f_{CDA} = N^{exp}_{CDA<4} / N^{URS}$$

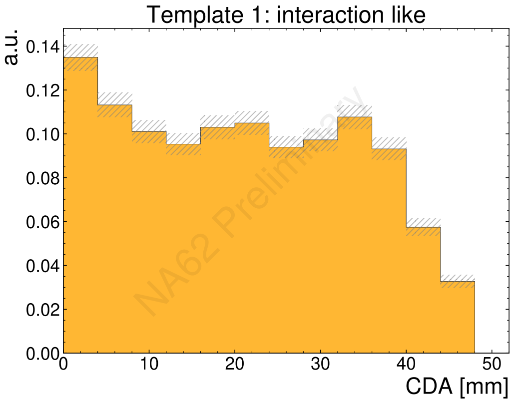
- Systematics:
  - selections of the template samples;
  - bin by bin fluctuation of the templates.
- New method:
  - more appropriate evaluation of systematics;
  - more knowledge on background mechanisms.

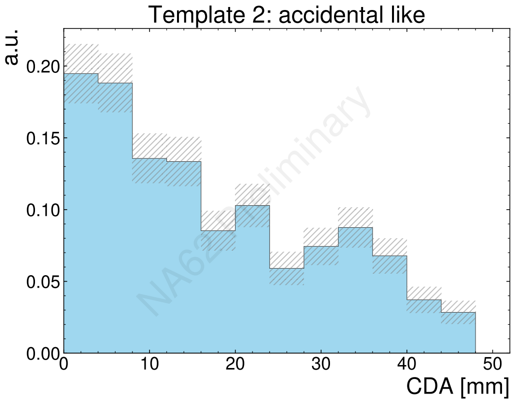
$$N^{ups}_{bg} = f^{match}_{corr} \cdot \sum_i N_i f_{CDA} P^{match}_i$$



Upstream background

CDA distribution of templates





Upstream background: Evaluation

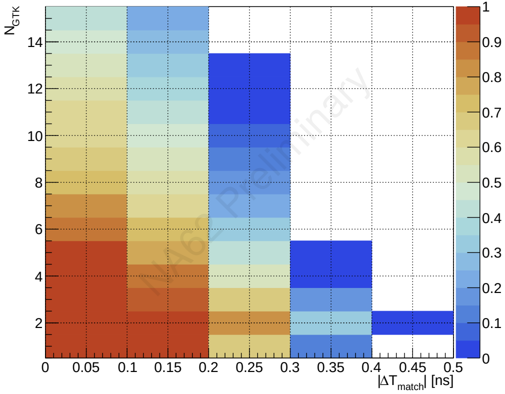
$$N_{bg}^{ups} = f_{corr}^{match} \cdot \sum_i N_i f_{CDA} P_i^{match}$$

Upstream Reference Sample: from signal selection

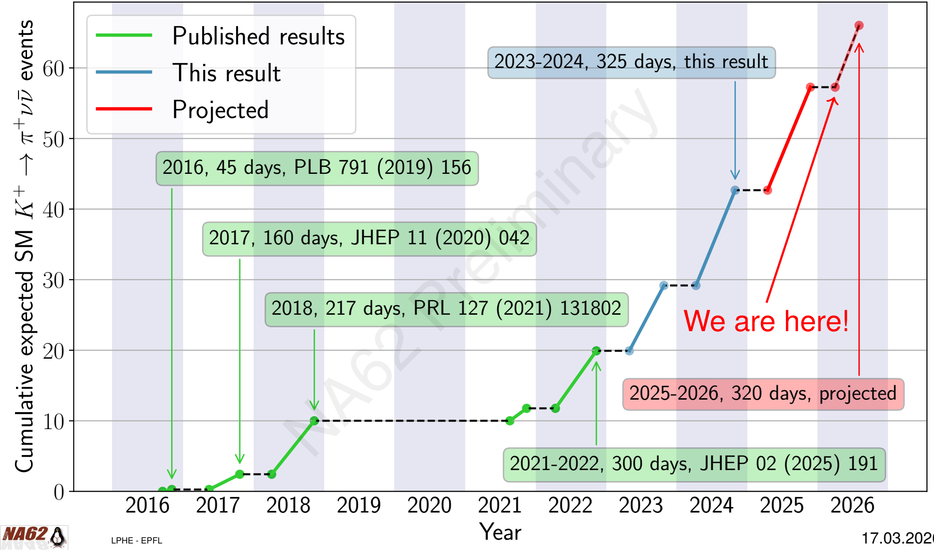
- remove K-π matching;
- require $CDA > 4$ mm

Evaluation step 2: Restore K-π matching.

- Evaluate $P^{match}(\Delta T_{match}, N_{GTK})$:
  - probability of events passing K-π matching;
  - a function of $(\Delta T_{match}, N_{GTK})$.
- Use URS events to represent upstream background with $CDA < 4$ mm:
  - N_i: number of URS events in ΔT_{match} v.s. N_{GTK} bin i;
- f_{corr}^{match}: correction for difference in ΔT_{match} v.s. N_{GTK} distribution in URS events and upstream background with $CDA < 4$ mm.



Prospects



Published results
This result
Projected
2023-2024, 325 days, this result
2016, 45 days, PLB 791 (2019) 156
2017, 160 days, JHEP 11 (2020) 042
2018, 217 days, PRL 127 (2021) 131802
We are here!
2025-2026, 320 days, projected
2021-2022, 300 days, JHEP 02 (2025) 191
NA62 Preliminary
Cumulative expected SM $K^+ \to \pi^+ \nu \bar{\nu}$ events
0
10
20
30
40
50
60
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
Year

Broader physics program

Precision measurements & rare decays:

- $K^+ \to \pi^+ \mu^+ \mu^-$: [JHEP 11 (2022) 011]
- $K^+ \to \pi^0 e^+ \nu_e \gamma$: [JHEP 09 (2023) 040]
- $K^+ \to \pi^+ e^+ e^- e^+ e^-$: [PLB 846 (2023) 138193]
- $K^+ \to \pi^+ \gamma\gamma$: [PLB 850 (2024) 138513]
- $\pi^0 \to e^+ e^-$: [MORIOND2024]
- $K^+ \to \mu^+ \nu_\mu \mu^+ \mu^-$: [KAON2025]
- $K^+ \to e^+ \nu_e \gamma$: [KAON2025]
- $K^+ \to \pi^+ \pi^+ \pi^- \gamma$: [KAON2025]

Forbidden decays:

- $K^+ \to \pi^- \ell^+ \ell^+$: [PLB 797 (2019) 134794]
- $K^+ \to \pi \mu e^+$ & $\pi^0 \to \mu^- e^+$: [PRL 127 (2021) 131802]
- $K^+ \to \pi^- (\pi^0) e^+ e^+$: [PLB 830 (2022) 132172]
- $K^+ \to \mu^- \nu e^+ e^+$: [PLB 838 (2023) 137679]
- $K^+ \to \pi^0 \pi \mu e$: [PLB 859 (2024) 139122]

Invisible particle search:

- $\pi^0 \to \gamma A'$: [JHEP 05 (2019) 182]
- $K^+ \to e^+ N$: [PLB 807 (2020) 135599]
- $\pi^0 \to$ inv.: [JHEP 02 (2021) 201]
- $K^+ \to \mu^+ +$ inv.: [PLB 816 (2021) 136259]
- $K^+ \to \pi^+ +$ inv.: [JHEP 11 (2025) 143]
- $\pi^+ \to e^+ N$: [PLB 872 (2026) 140119]

Dark sector in dump mode:

- $\mu^+ \mu^-$ final state: [JHEP 09 (2023) 035]
- $e^+ e^-$ final state: [PRL 133 (2024) 111802]
- Hadrons final state: [EPJC 85 (2025) 571]

Neutrino tagging: [PLB 863 (2025) 139345]