$K^+ \to \pi^+ \nu\bar{\nu}$: First Result from the NA62 Experiment

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EP Seminar

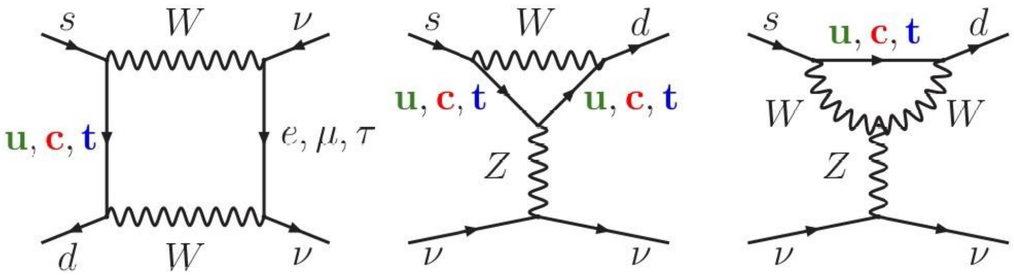
CERN, 27/03/2018

Content

- $K^+ \rightarrow \pi^+ \nu\bar{\nu}$
- NA62

The K → πνν̄ decays: a theoretical clean environment

- FCNC loop processes: s→d coupling and highest CKM suppression



- Very clean theoretically: Short distance contribution. No hadronic uncertainties.

- SM predictions [Buras et al. JHEP 1511 (2015) 33]

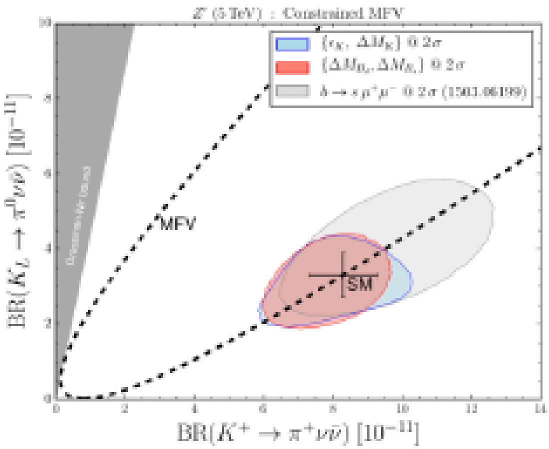
$$BR(K^+ \to \pi^+ \nu\bar{\nu}) = (8.39 \pm 0.30) \cdot 10^{-11} \left(\frac{|V_{cb}|}{0.0407}\right)^{2.8} \left(\frac{\gamma}{73.2°}\right)^{0.74} = (0.84 \pm 0.10) \cdot 10^{-10}$$

$$BR(K_L \to \pi^0 \nu\bar{\nu}) = (3.36 \pm 0.05) \cdot 10^{-11} \left(\frac{|V_{ub}|}{0.00388}\right)^{2} \left(\frac{|V_{cb}|}{0.0407}\right)^{2} \left(\frac{\sin\gamma}{\sin 73.2}\right)^{2} = (0.34 \pm 0.06) \cdot 10^{-10}$$

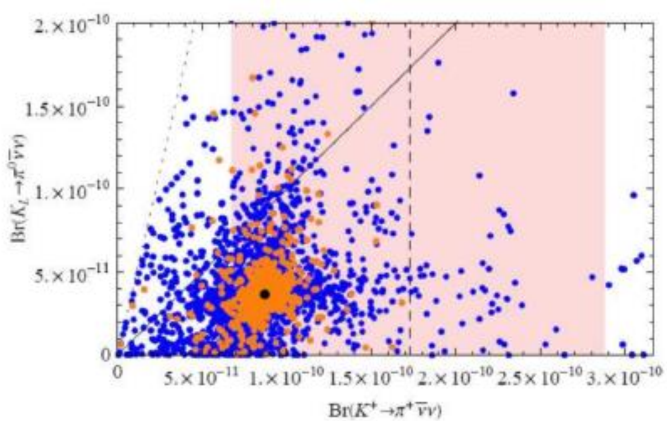
K → πνν̄ NP Sensitivity

- Simplified Z, Z' models [Buras, Buttazzo,Knegjens, JHEP 1511 (2015) 166]
- Littlest Higgs with T-parity [Blanke, Buras, Recksiegel, EPJ C76 (2016) no.4 182]
- Custodial Randall-Sundrum [Blanke, Buras, Duling, Gemmler, Gori, JHEP 0903 (2009) 108]
- MSSM non-MFV [Tanimoto, Yamamoto, PTEP 2016 (2016) no.12, 123B02; Blazek, Matak, IntlJModPhys.A 29 (2014), 1450162; Isidori et al. JHEP 0608 (2006) 064]
- LFU violation models [Isidori et. al., Eur. Phys. J. C (2017) 77]
- Constraints from existing measurements (correlations model dependent):
  - Kaon mixing and CPV, CKM fit, K,B rare meson decays, NP limits from direct searches

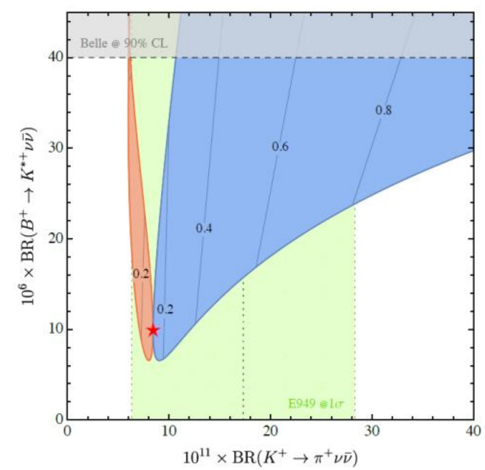
Z' (5 TeV) in constrained MFV



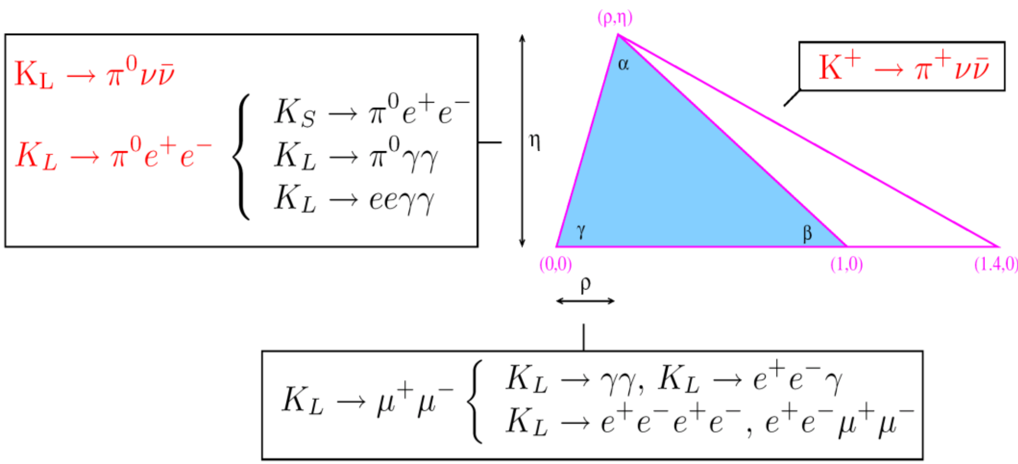
Randall - Sundrum

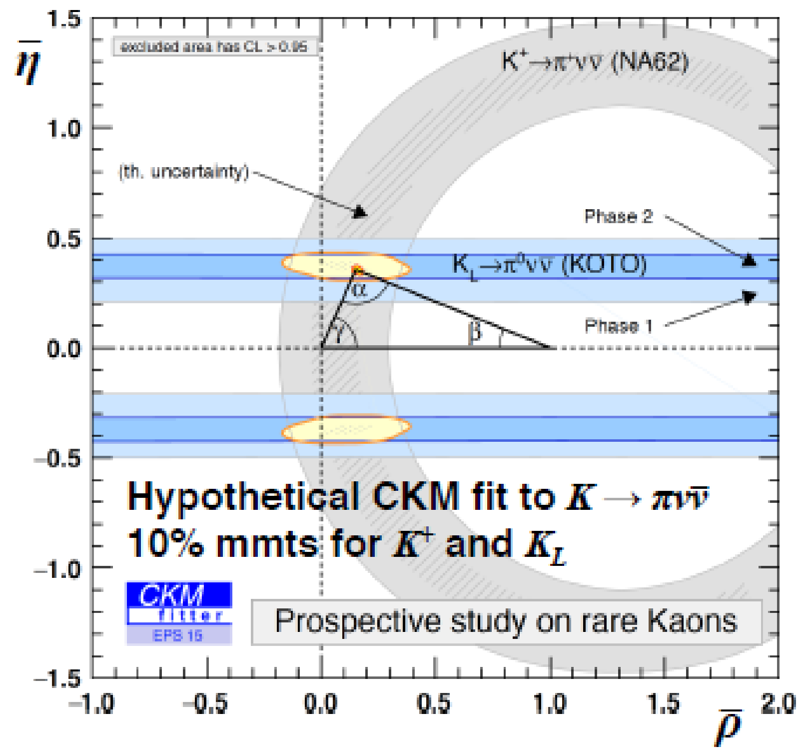


LFU violation



Connection with Flavour Physics



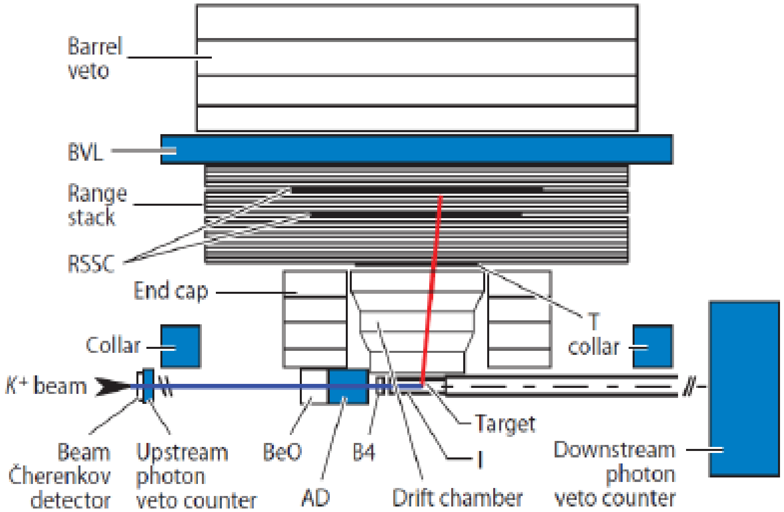


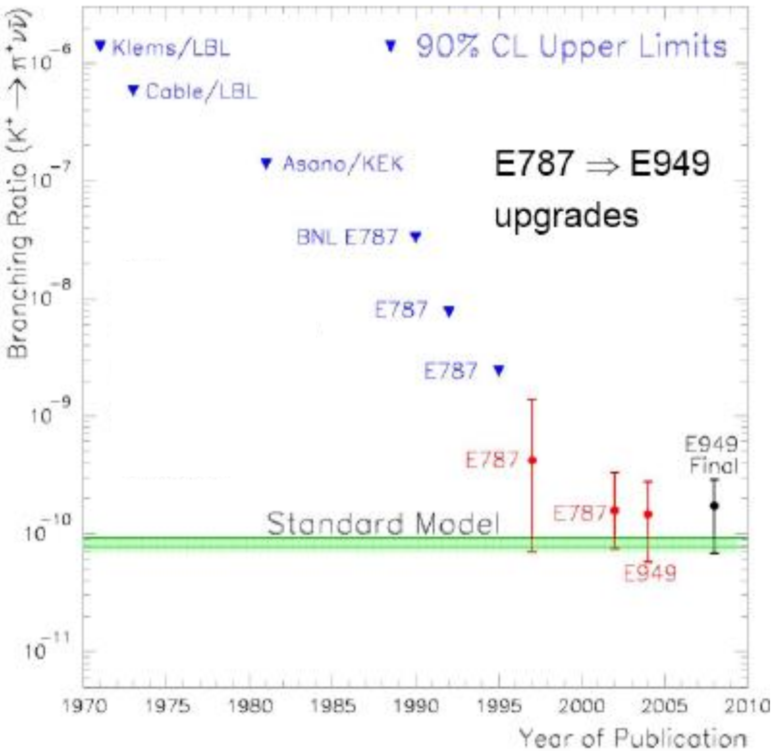
K physics alone can fully constrain the CKM unitarity triangle.

Comparison with B physics can provide description of NP flavour dynamics

$K^+ \to \pi^+\nu\bar{\nu}$ Experimental State of the Art

BNL E787/E949





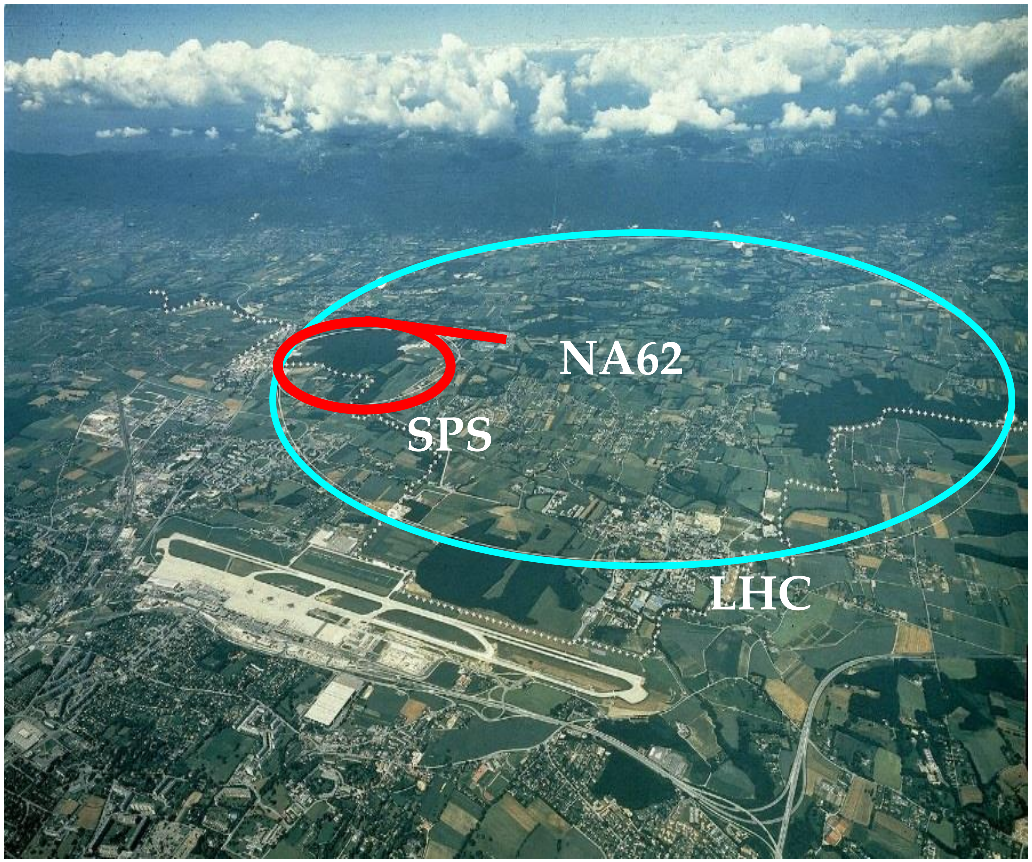
- «Kaon decay at rest» technique
- E787/E949: K^+ decays: $\sim 3.5 \times 10^{12}$, Single Event Sensitivity: $\sim 0.8 \cdot 10^{-10}$

$$\mathrm{BR}(K^+ \to \pi^+\nu\bar{\nu}) = \left(1.73^{+1.15}_{-1.05}\right) \times 10^{-10}$$

Phys. Rev. D 77, 052003 (2008),
Phys. Rev. D 79, 092004 (2009)

NA62 @ CERN - SPS

Birmingham, Bratislava, Bristol, Bucharest, CERN, Dubna (JINR), Fairfax (GMU), Ferrara, Florence, Frascati, Glasgow, Lancaster, Liverpool, Louvain-la-Neuve, Mainz, Moscow (INR), Naples, Perugia, Pisa, Prague, Protvino (IHEP) , Rome I, Rome II, San Luis Potosi, Sofia, TRIUMF, Turin, Vancouver (UBC)



Primary goal:

Measurement of $BR(K^+ \to \pi^+ \nu\bar{\nu})$

Technique:

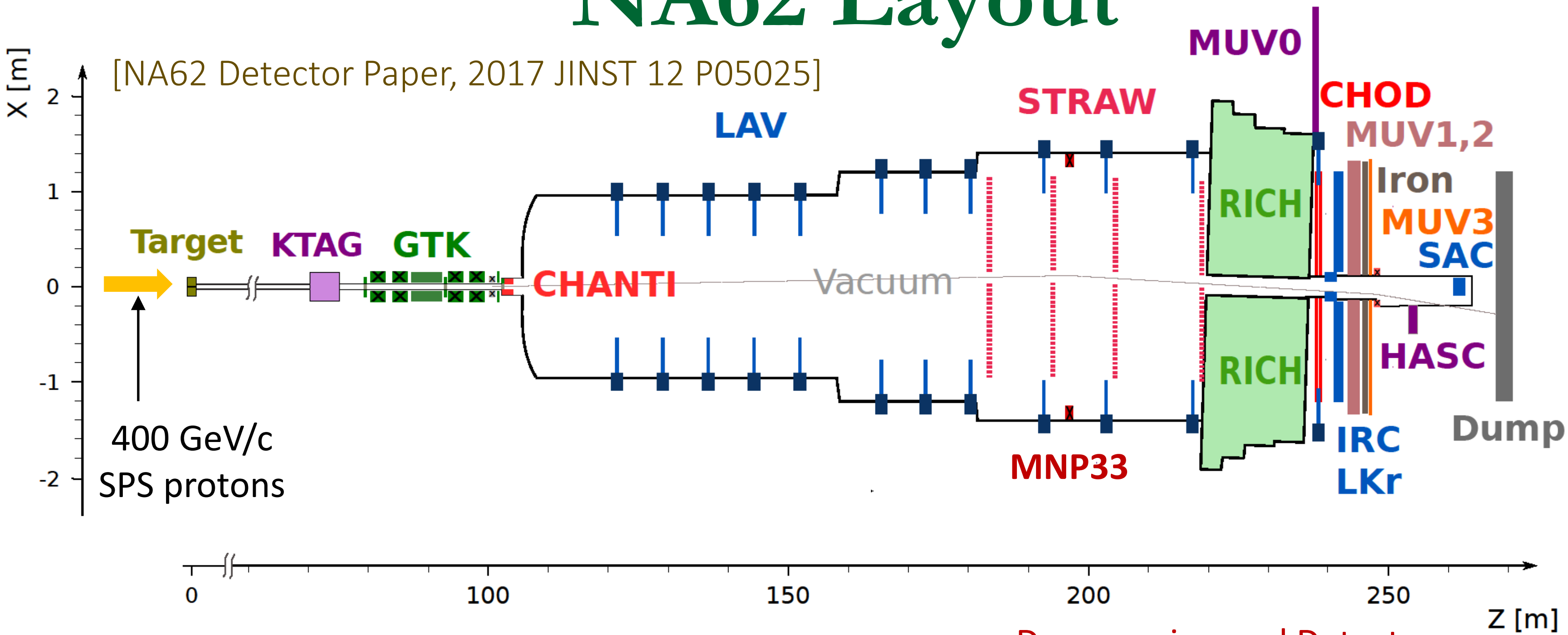
K Decay – in – flight

Requirements:

- K decays 10^{13}
- Signal acceptance $\mathcal{O}(10\%)$
- $\mathcal{O}(10^{12})$ background rejection

Broader Physics program

NA62 Layout



Secondary positive beam	
Momentum	75 GeV/c, 1% bite
Divergence (RMS)	100 μrad
Transverse Size	$60 \times 30\text{mm}^2$
Composition	$K^+(6\%)/\pi^+(70\%)/p(24\%)$
Nominal Intensity	33×10^{11} ppp (750 MHz at GTK3)

Decay region and Detectors	
Fiducial region	60 m
K^+ decay rate	$\sim$ 5 MHz
Vacuum	$\mathcal{O}(10^{-6})$ mbar

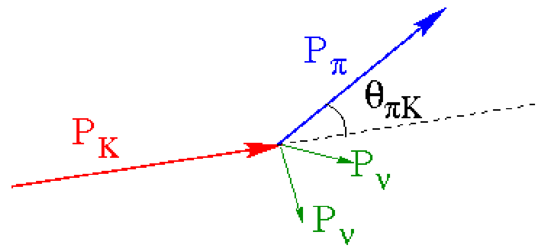
Si pixel beam tracker + Straw tracker

LKr Calorimeter from NA48

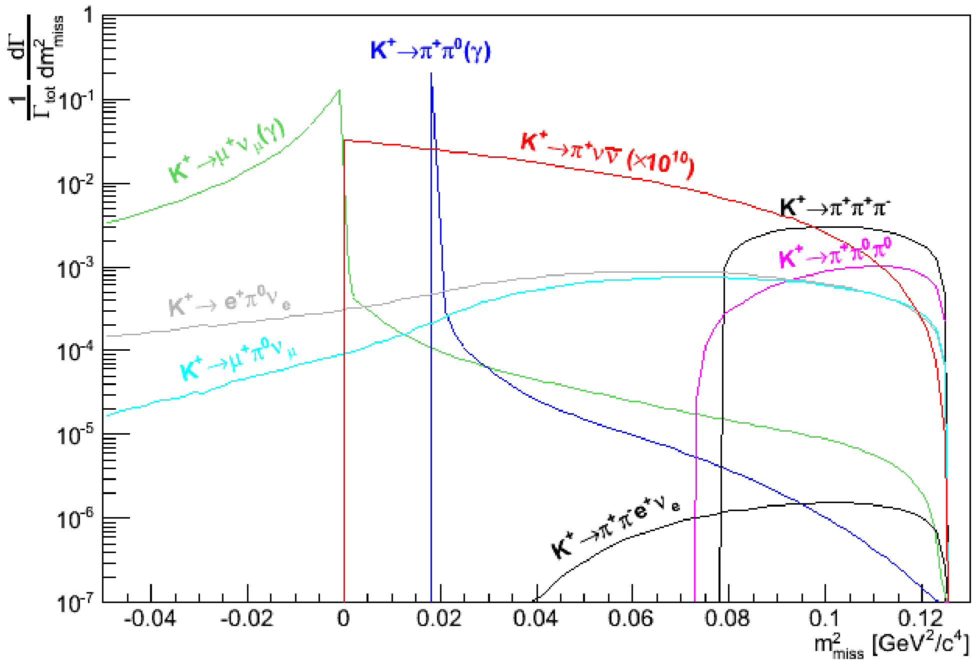
Cerenkov counter for K id, RICH for π/μ id

NA62 $K^+ \to \pi^+\nu\bar{\nu}$: Analysis Method

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



Process	*Branching ratio*
$K^+ \to \pi^+\pi^0(\gamma)$	0.2067
$K^+ \to \mu^+\nu(\gamma)$	0.6356
$K^+ \to \pi^+\pi^+\pi^-$	0.0558
$K^+ \to \pi^+\pi^-e^+\nu$	$4.25 \cdot 10^{-5}$



+

$15 < P_{\pi^+} < 35$ GeV/c

Particle ID (Cherenkov detectors)

Particle ID (Calorimeters)

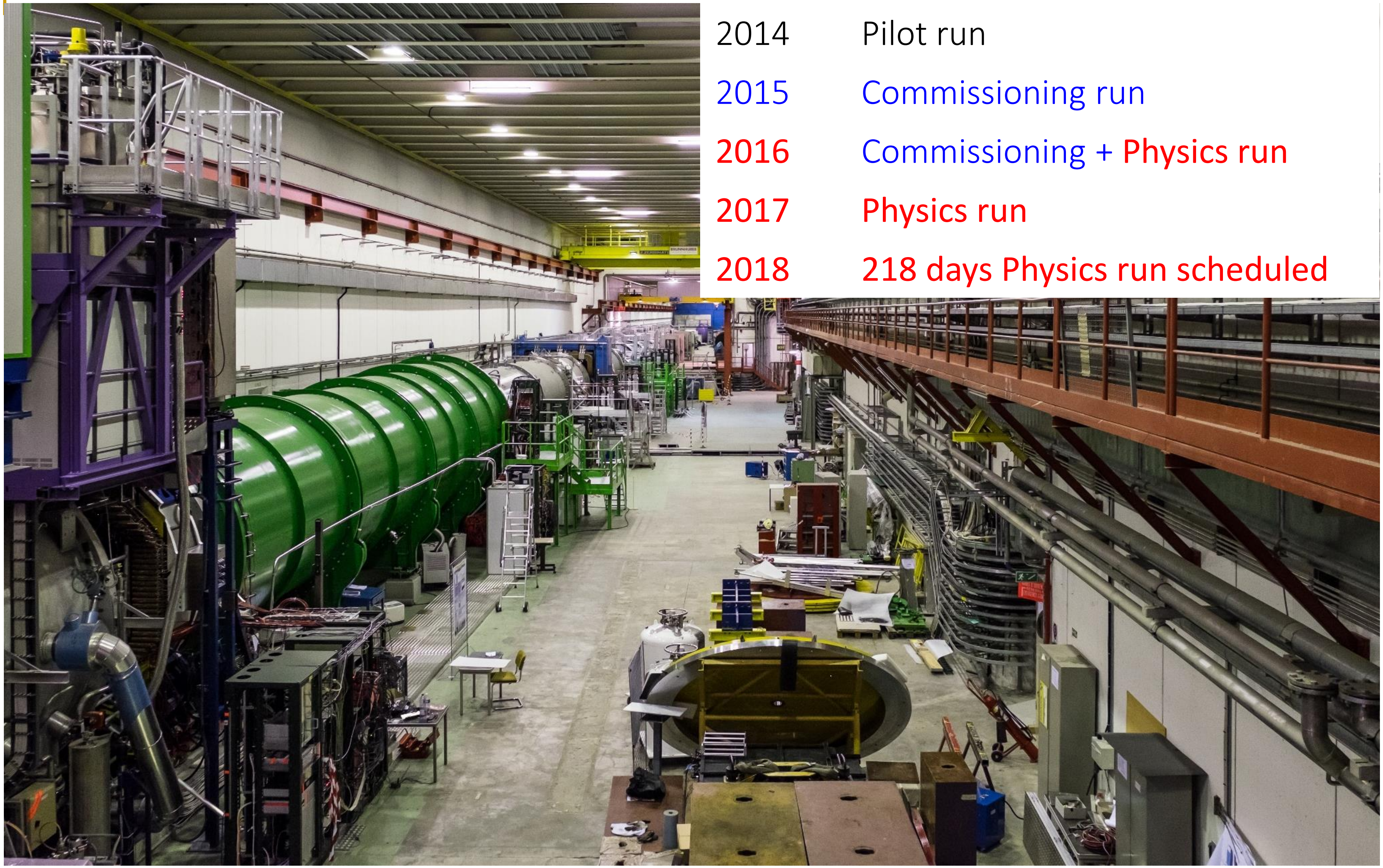
Photon veto

Keystones

$\mathcal{O}(100\ \mathrm{ps})$	Timing between sub-detectors
$\mathcal{O}(10^4)$	Background suppression from kinematics
$> 10^7$	Muon suppression
$> 10^7$	π^0 (from $K^+ \rightarrow \pi^+\pi^0$) suppression

NA62 Runs

2014	Pilot run
2015	Commissioning run
2016	Commissioning + Physics run
2017	Physics run
2018	218 days Physics run scheduled

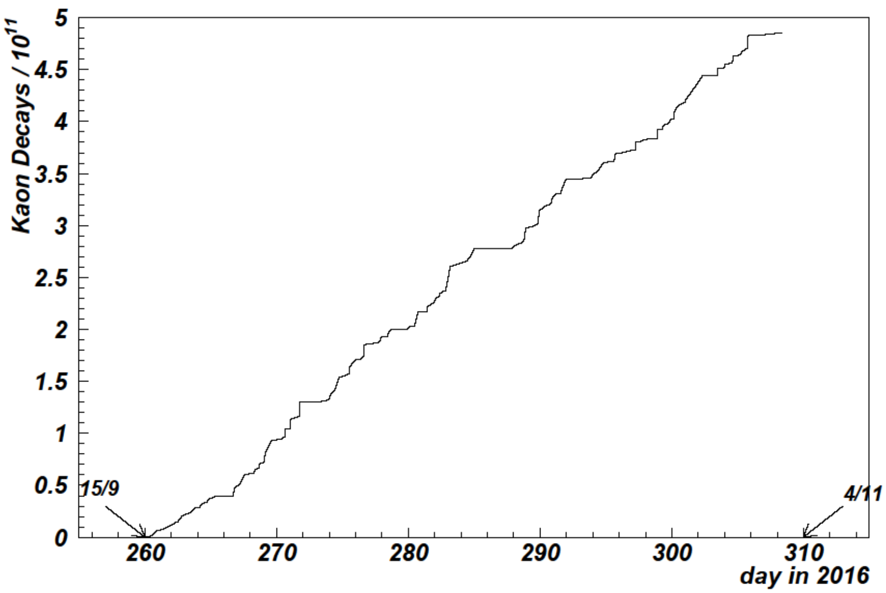


NA62 «Luminosity»

2016 run

13×10^{11} ppp on target (40% nominal)

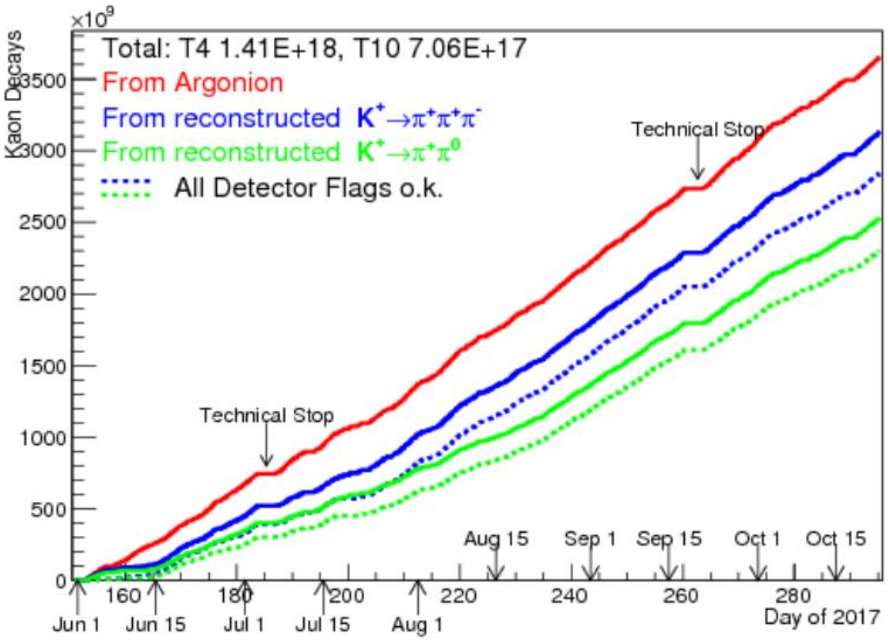
$\sim 1 \times 10^{11}$ K^+ decays useful for $\pi\nu\nu$



2017 run

20×10^{11} ppp on target (60% nominal)

$> 3 \times 10^{12}$ K^+ decays collected



Data Analyzed

- 2016 Data, 4 weeks of data taking (<60'000 good spills)
- Trigger streams:

1. «PNN»:
   - «Hardware» (L0): RICH hits, Hodoscope, No muons, < 20 GeV in LKr
   - Software (L1): KTAG in time, No signals in LAV, Momentum in straw < 50 GeV/c
2. Control (minimum bias, downscaled):
   - L0: Hodoscope hits

- Offline Analysis:
  - Bad data based on detector performances identified on spill by spill basis
  - Data samples: **PNN**; **Control**: $K^+ \to \pi^+\pi^0$, $K^+ \to \mu^+\nu$, $K^+ \to \pi^+\pi^+\pi^-$
  - Signal selection tuned on MC, 10% PNN data, control data
  - Analysis in 4 π^+ momentum bins, 5 GeV/c wide from 15 to 35 GeV/c
  - Blind analysis procedure: signal and control regions kept masked for the whole analysis

Analysis Steps

1. Selection

- K^+ decays with a single charged particle in final state
- Particle ID: π^+
- Photon & Multiple charged particle rejection
- Kinematic Selection of Signal Regions

2. Determination of the Single Event Sensitivity (SES)

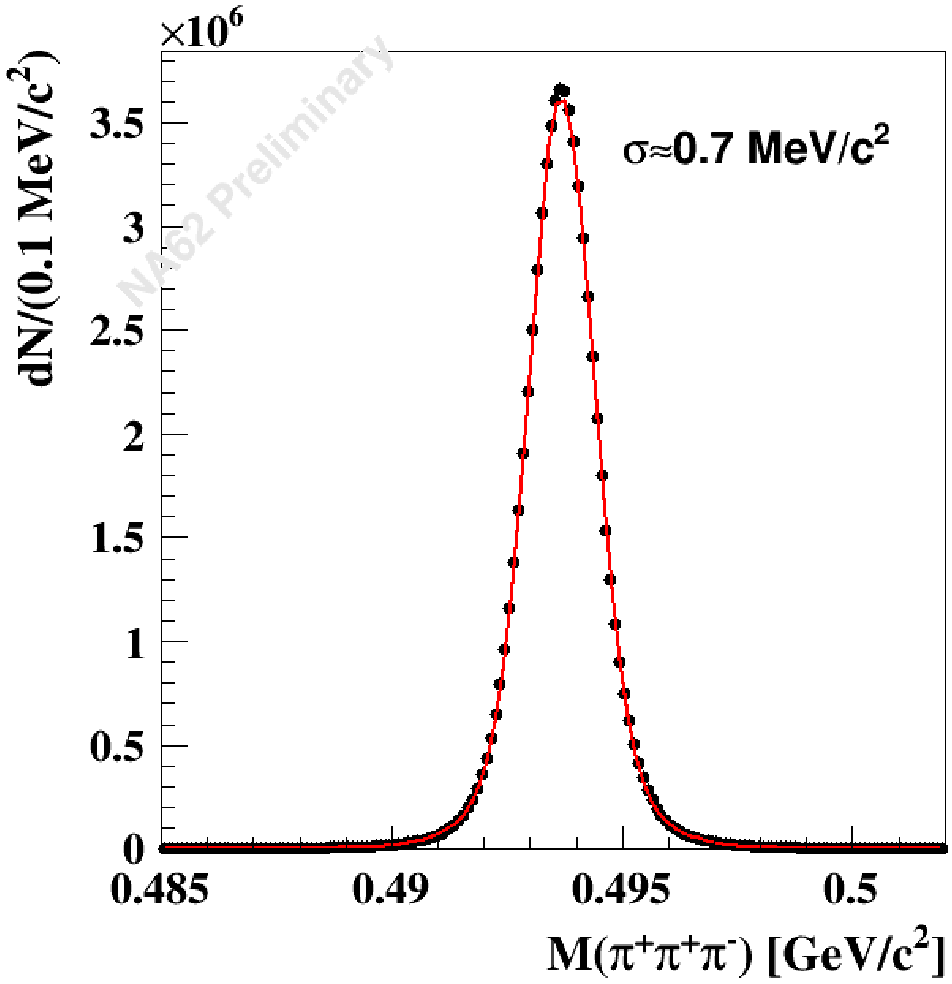
3. Estimation and validation of the expected background

4. Opening of the signal regions and results

1. Selection

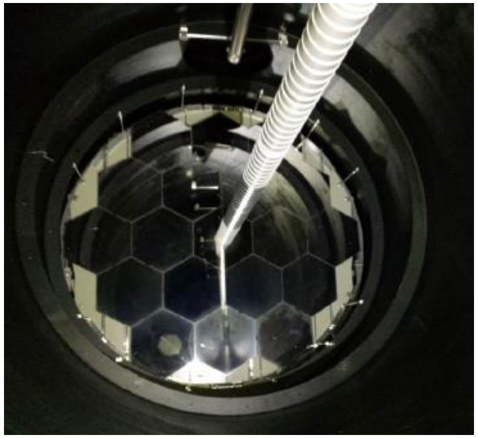
«π^+» tracking: Straw Spectrometer

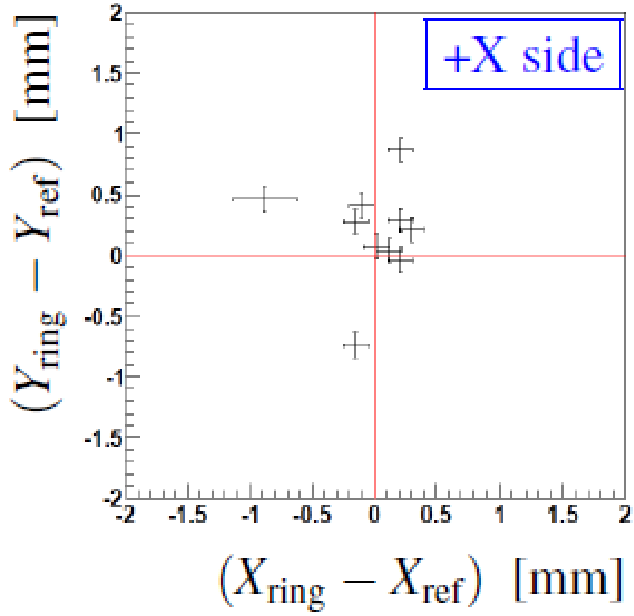
- Straws aligned in time and drift time measured vs trigger time
- Straws aligned geometrically using straight tracks
- Measured 3D B map and stray field included in track reconstruction
- >95% reconstruction efficiency
- Final calibration using $K^+ \to \pi^+\pi^+\pi^-$

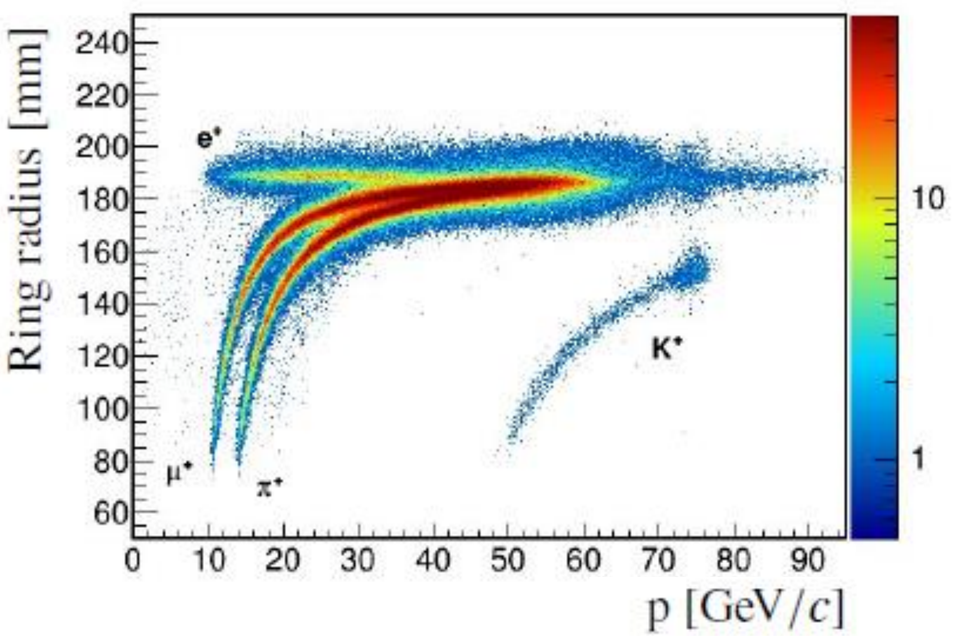


«π^+»- ID: RICH

- Mirrors aligned using: laser, tracks reconstructed from straw spectrometer
- n_{Ne} monitored using e^+ (~16 hits / e^+ ring)
- PM's aligned vs KTAG time: ring $\sigma(t) \sim 80$ ps
- Ring - spectrometer track matched comparing ring centre and flight direction

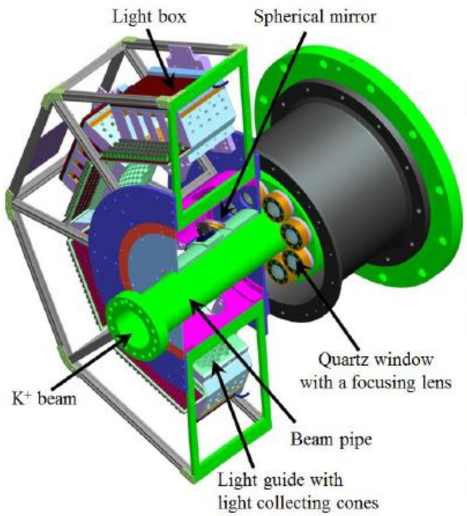


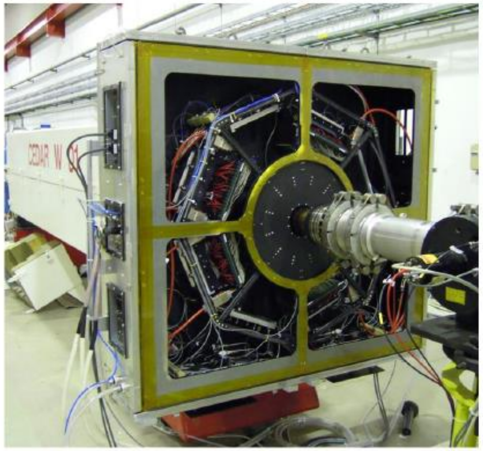


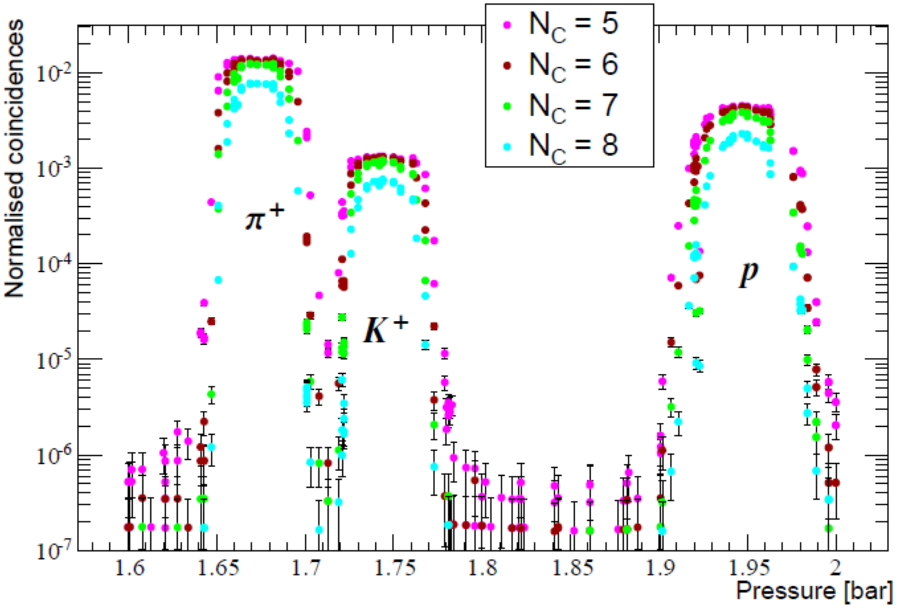


K^+- ID: KTAG

- Geometrically aligned with the beam
- Pressure scan: optimal working point for K^+
- PM's time alignement and time walk corrections: $\sigma(t) \sim 70$ ps
- K^+ signal from at least 5-fold coincidence (>95% efficiency)

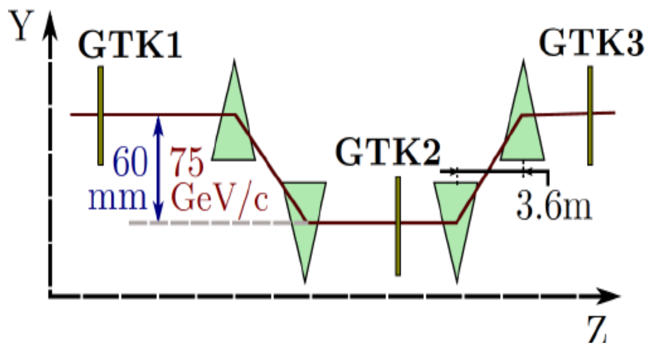


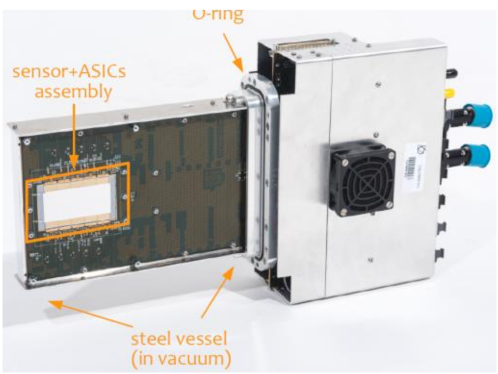


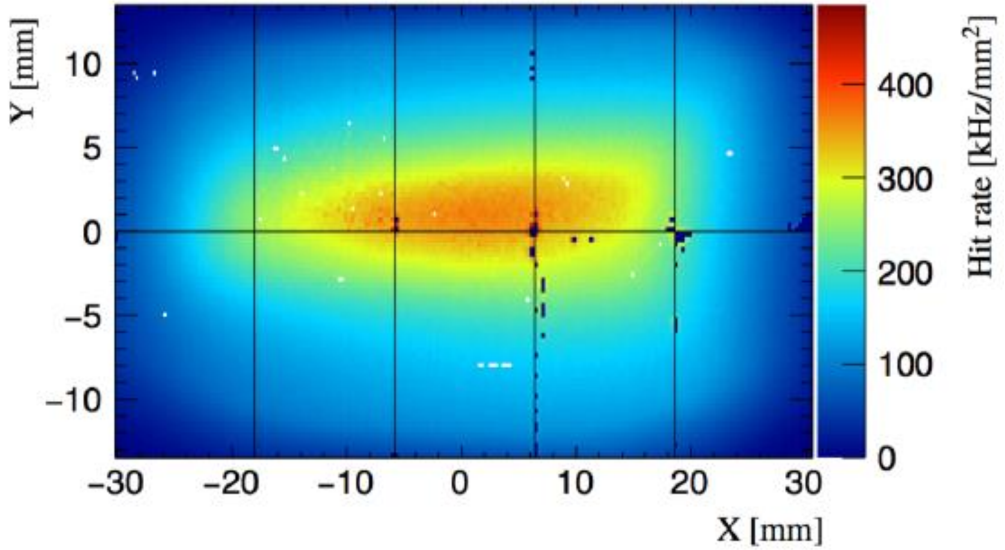


«K^+» tracking: GigaTracker

- «4D» kaon track reconstruction using trigger and KTAG as time reference
- Time offset corrections dependent on Station, Chip, Column, Row of the pixel
- Pixel – by- Pixel time walk corrections ($\sigma(t)$ < 150 ps per station)
- Stations aligned with straw Spectrometer and calibrated using $K^+ \rightarrow \pi^+\pi^+\pi^-$

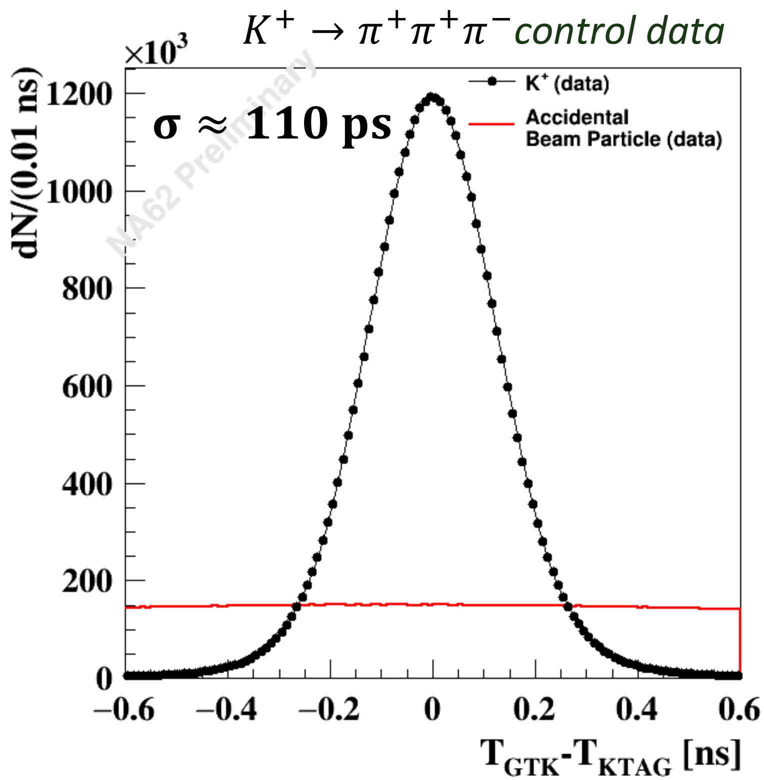


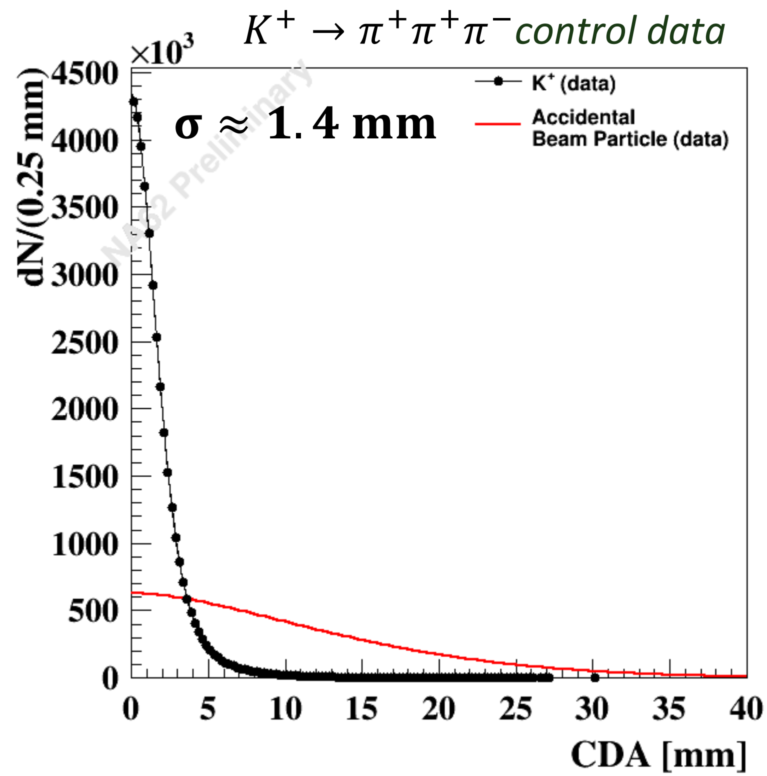




K - π matching

- KTAG – GigaTracker – RICH time matching → Kaon decay time (t_{decay})
- GigaTracker – Straw Spectrometer spatial matching (CDA)
- 3.5% (<1%) K^+ mis-tag if K^+ track (not) present, dependent on beam intensity
- 75% K^+ reconstruction and ID efficiency





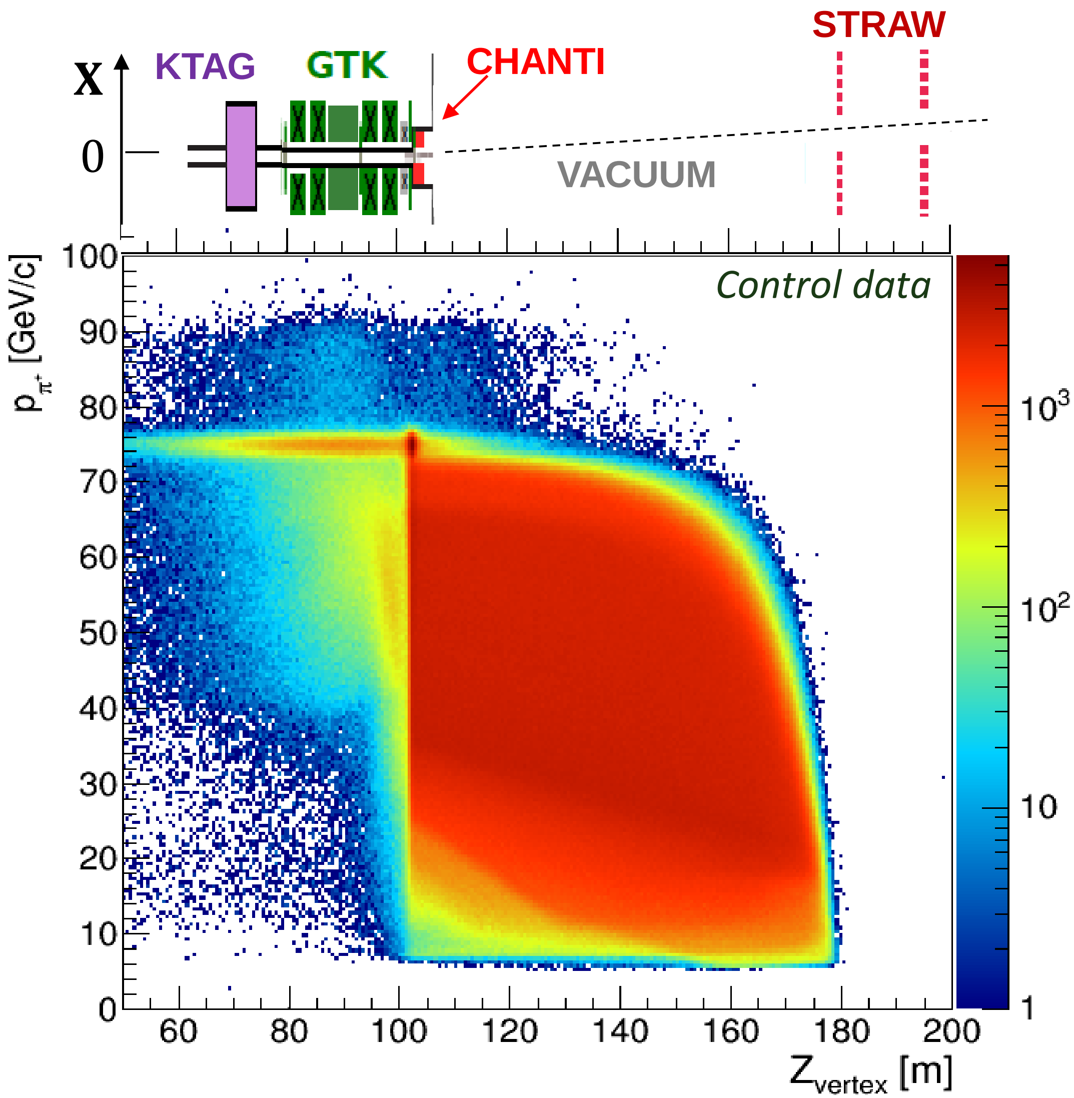
Selection of Kaon Decays

Selection of K decays

- $K^+ - \pi^+$ matching
- Z vertex (110 and 165 m)
- Track slope
- Track projection at collimator
- No activity in CHANTI

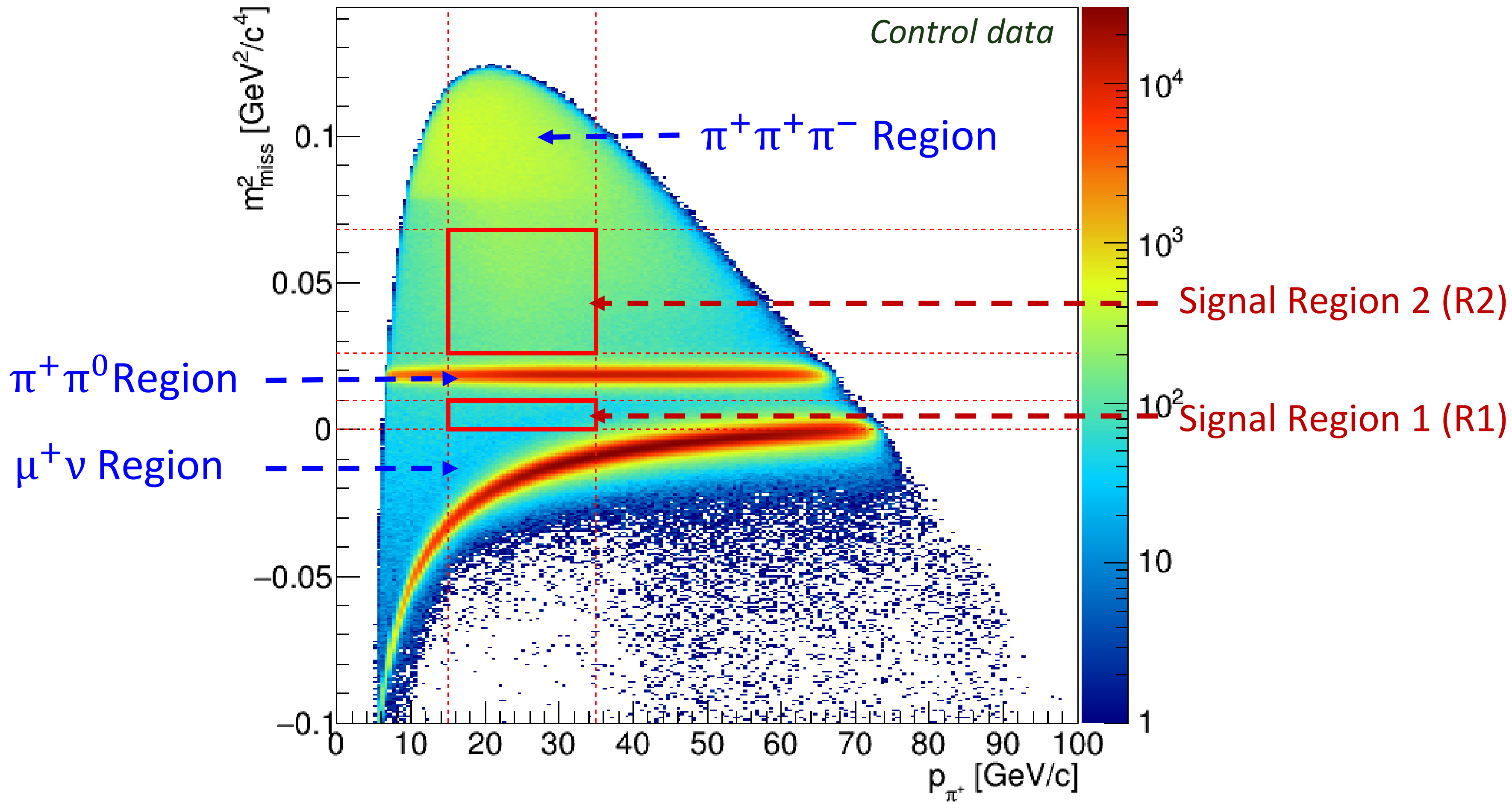
Tracks from «upstream»

- K^+mismatching in GTK
- Decays along the beam line
- Beam particle interactions in GTK

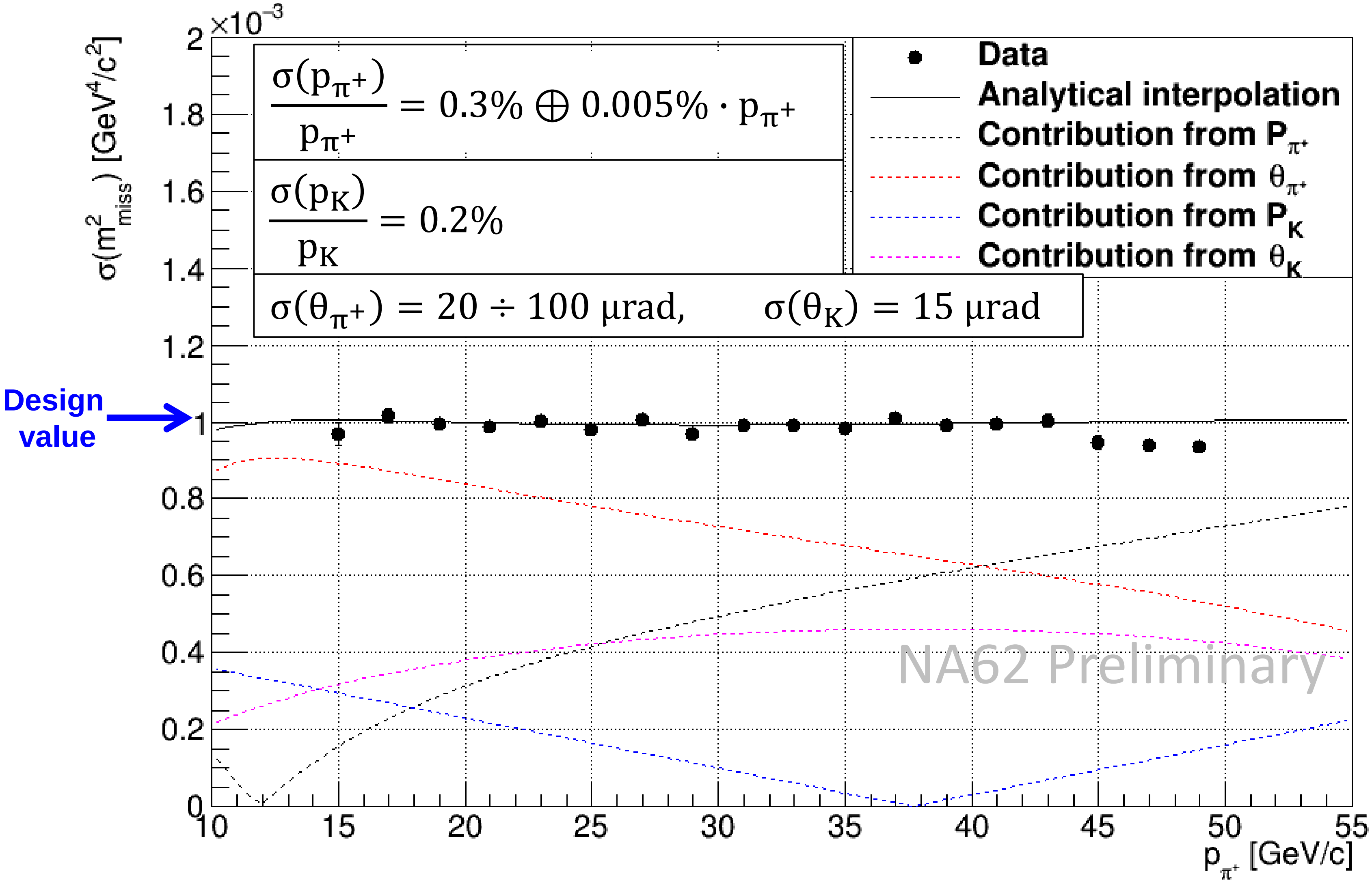


Kaon Decays and Kinematics

$m^2_{miss} \equiv m^2_{miss}(\text{Straw}, \text{GTK}) = (P_{\pi^+} - P_{K^+})^2$, m_{π^+} hypothesis

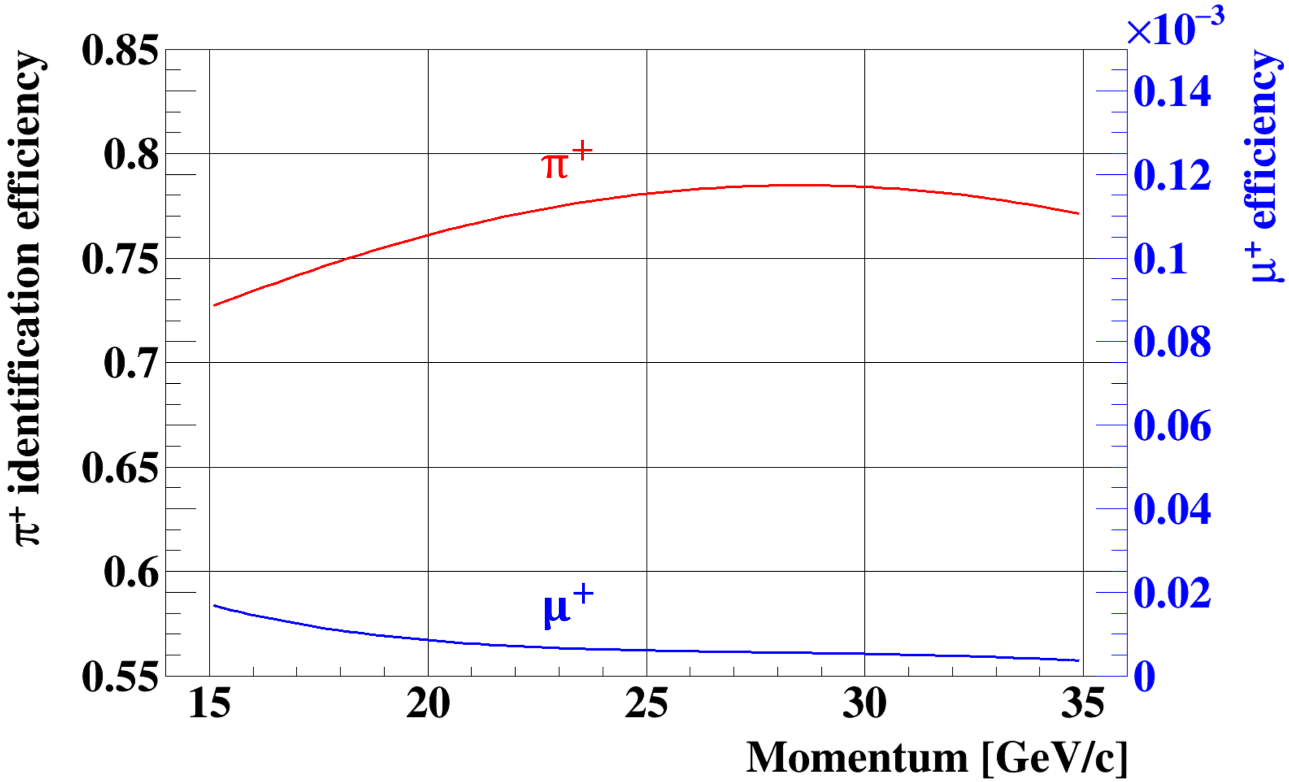


Kinematic Resolution



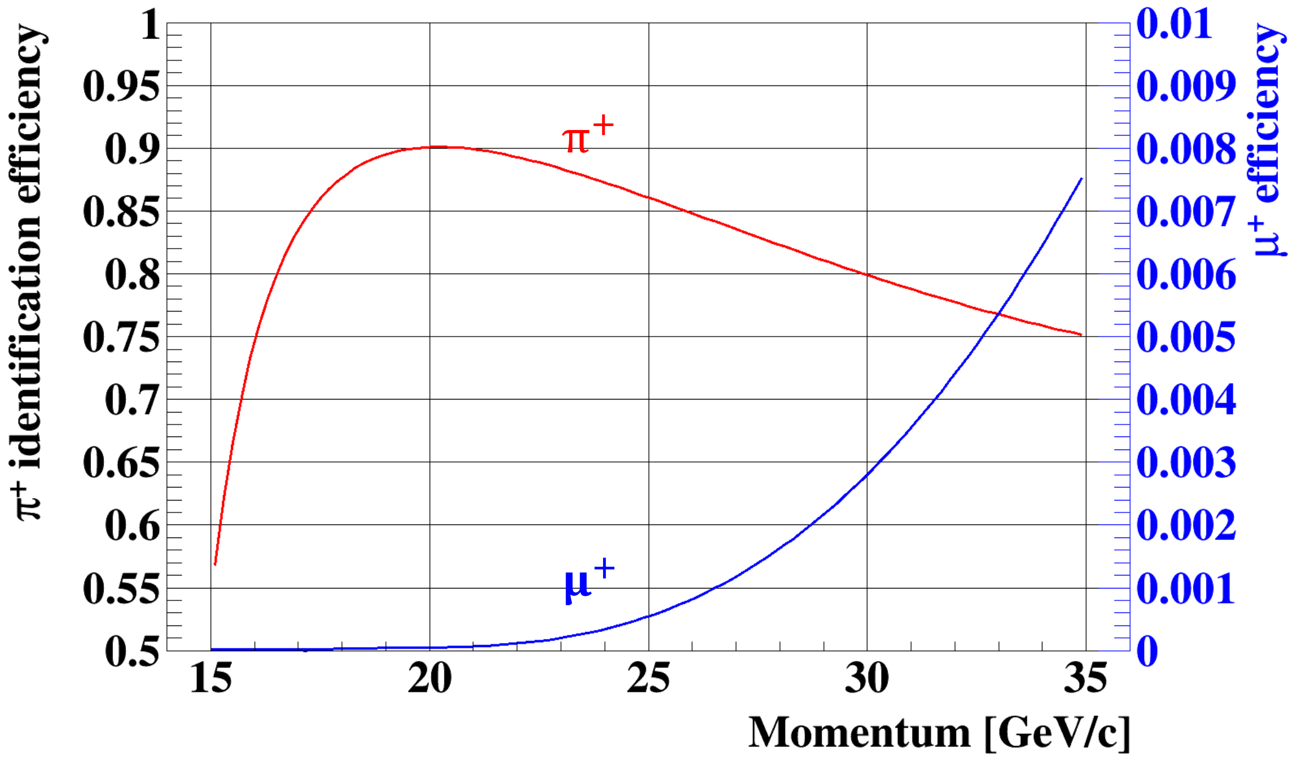
Particle ID Calorimeters

- Electromagnetic calo (LKr), Hadronic calo (MUV1,2), scintillator pads (MUV3)
- MUV3+BDT classifier using: energy, energy sharing, clusters shape
- $0.6 \cdot 10^{-5}\ \mu^+$ efficiency vs 77% π^+ efficiency

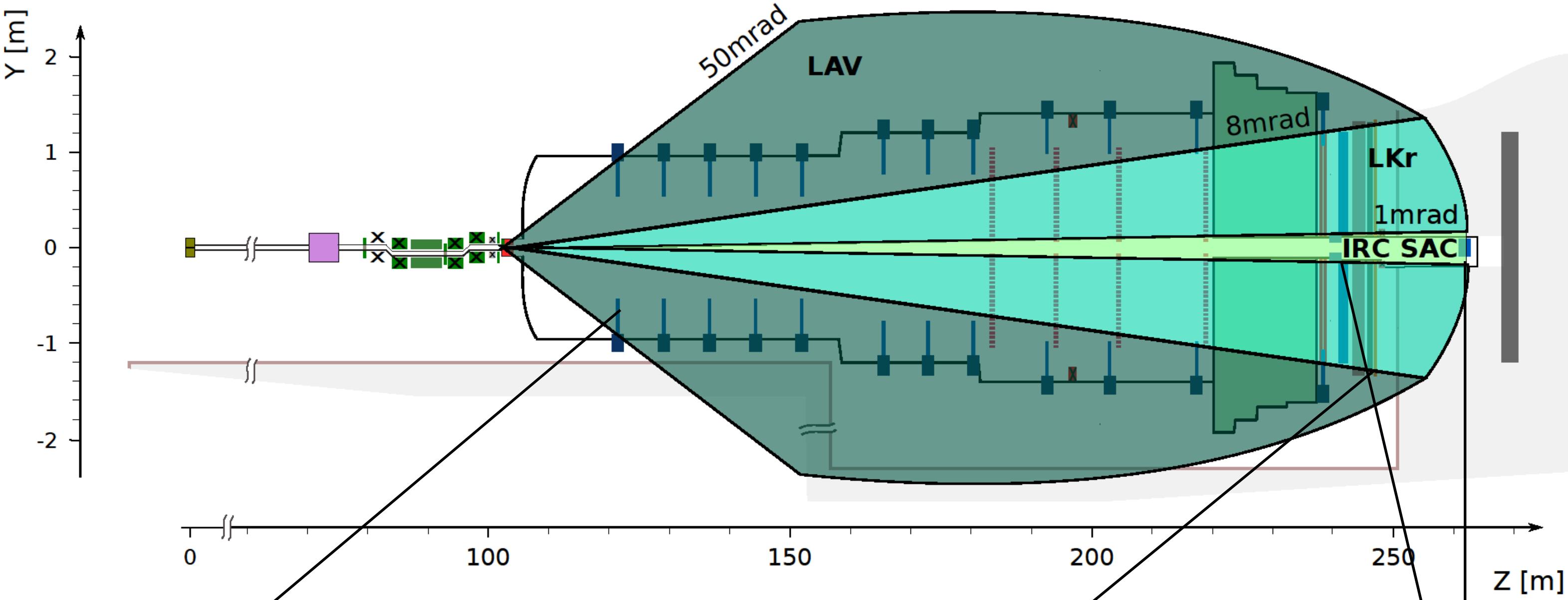


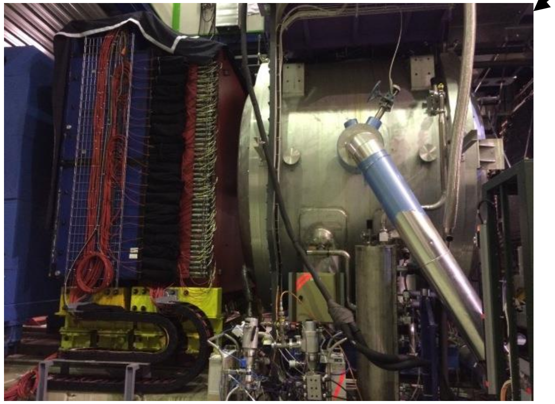
Particle ID RICH

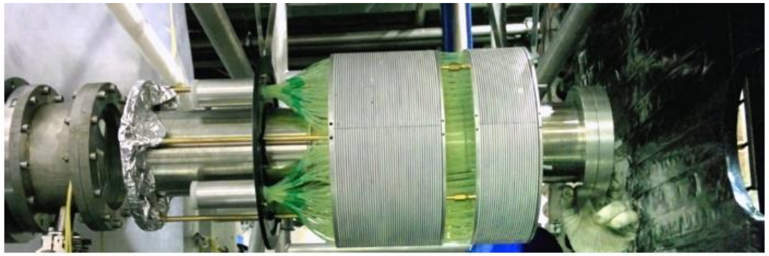
- Track driven Likelihood particle ID discriminant
- Particle mass using track momentum
- Momentum measurement under mass hypothesis (velocity - spectrometer)
- $2.5 \cdot 10^{-3}$ μ^+ efficiency vs 75% π^+ efficiency



Photon Rejection



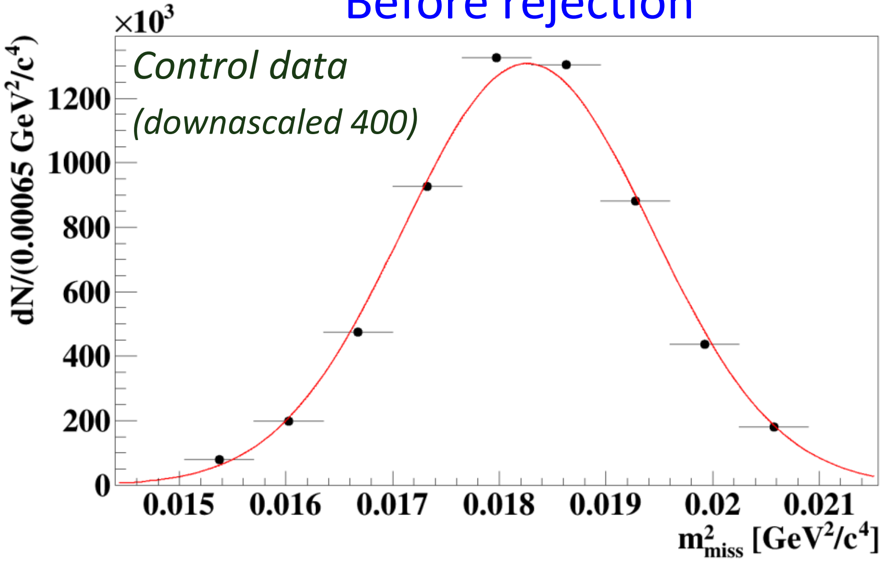




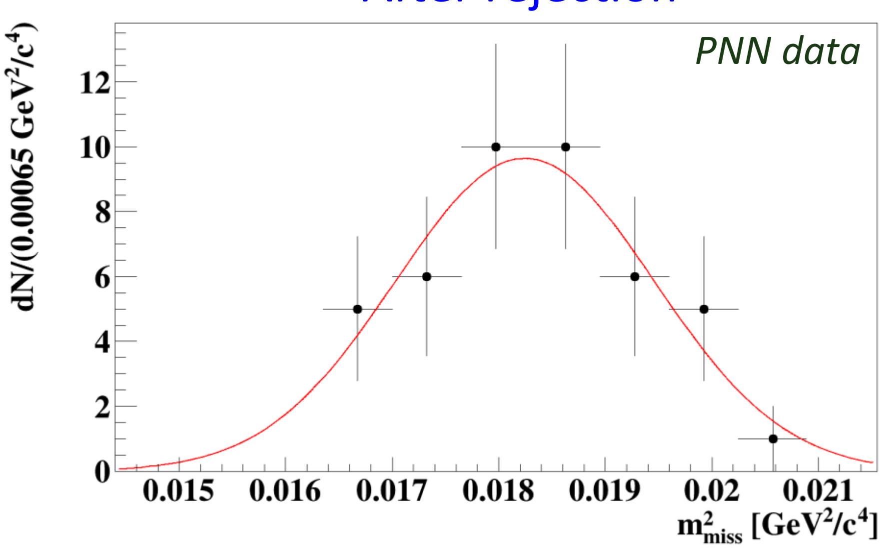
Photon and Multiplicity Rejection

- Timing coincidence of signals in LKr, LAV, SAV not associated to π^+ and t_{decay}
- Coincidences of signals in LKr and hodoscopes not associated to π^+, in time with t_{decay}
- No hits in time in HASC and MUV0 (off-acceptance veto); segments rejection in Straw
- Typical timing coincidences: $\pm 3 \div \pm 5$ ns; energy dependent time cut in LKr
- Fraction of surviving $K^+ \to \pi^+\pi^0$ (15 – 35 momentum range) : $\sim 2.5 \cdot 10^{-8}$
- High suppression of $K^+ \to \pi^+\pi^+\pi^-$, $K^+ \to \pi^+\pi^-e^+\nu$

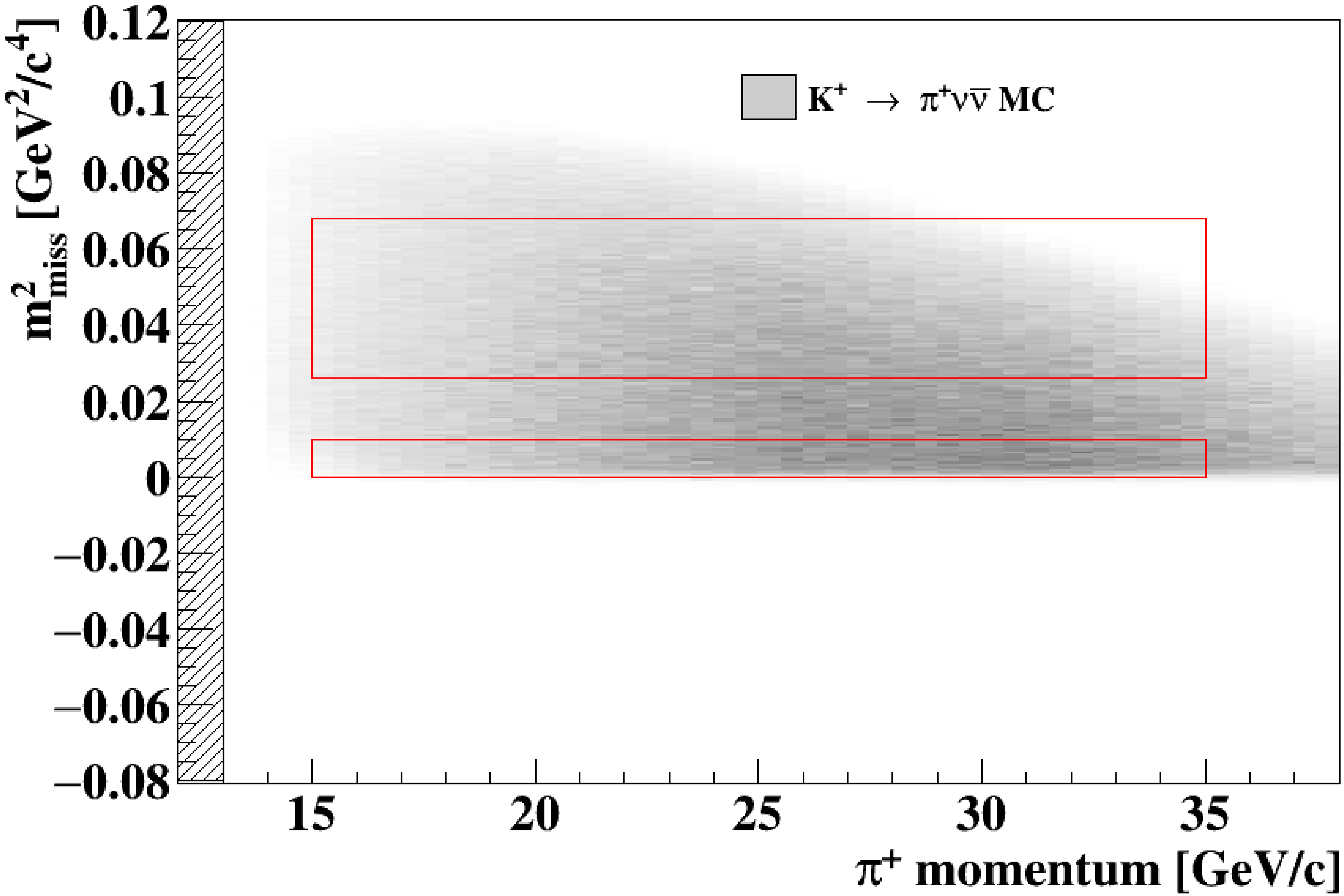
Before rejection



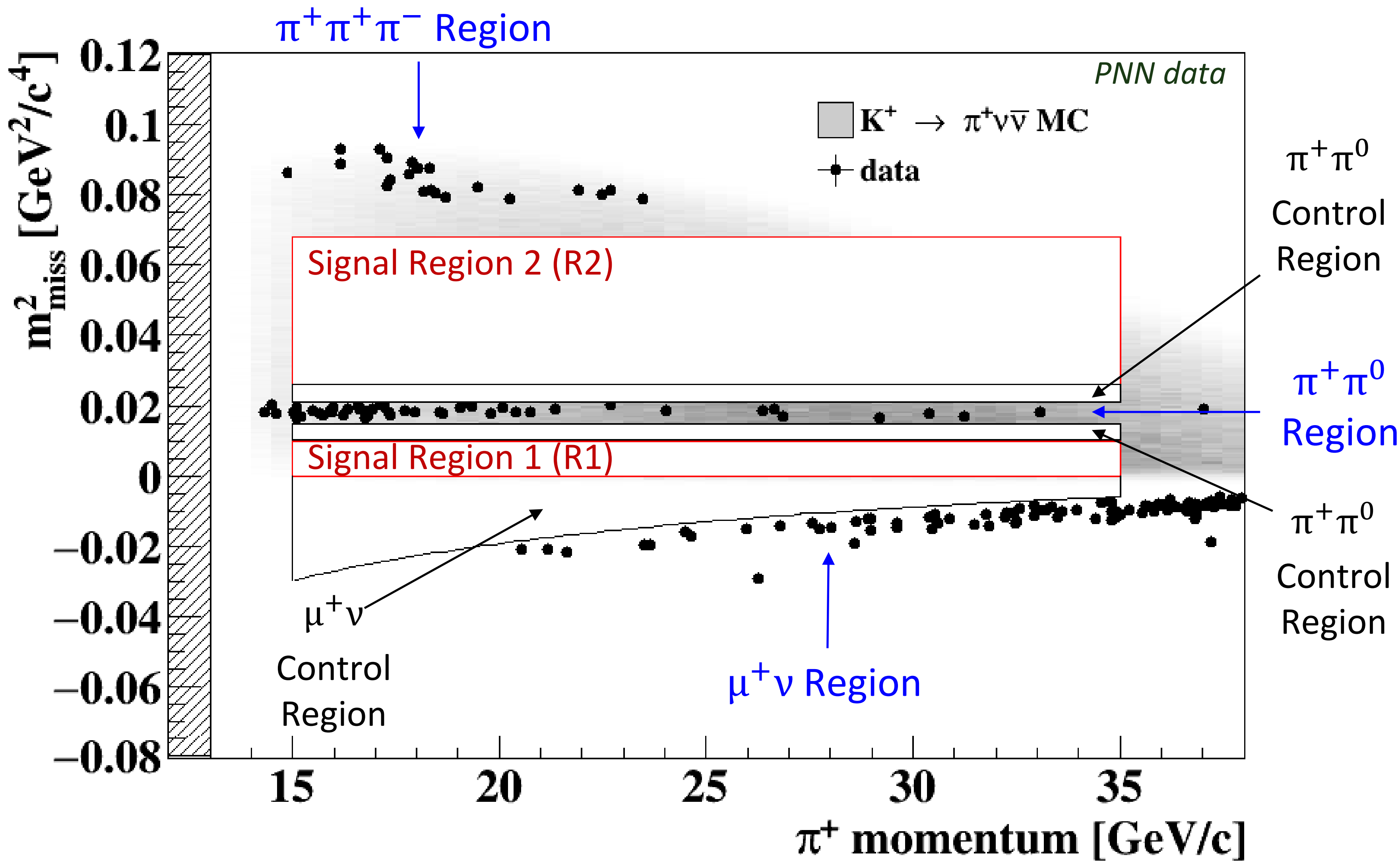
After rejection



MC Signal After Selection



Data After Selection



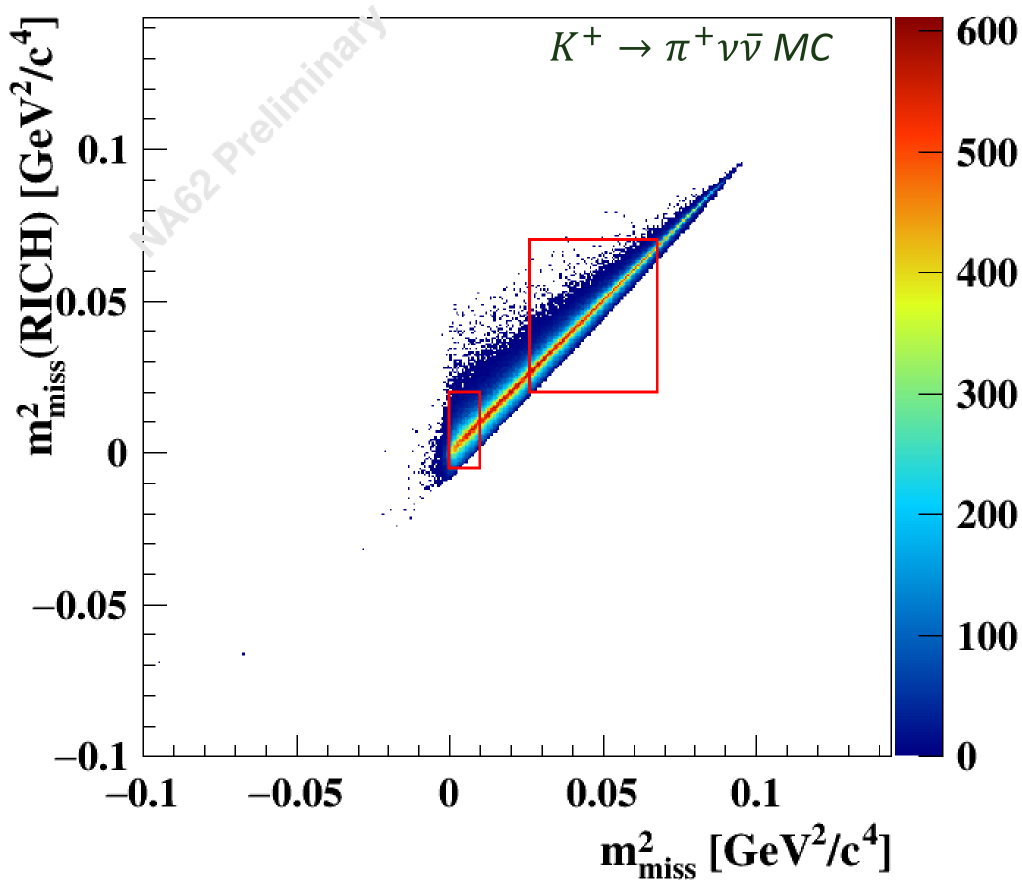
Signal Regions

- Different ways to compute $m^2_{miss} = (P_{\pi^+} - P_{K^+})^2$
- Additional power for background suppression

$m^2_{miss} \equiv m^2_{miss}(\text{Straw}, \text{GTK})$

$m^2_{miss}(\text{RICH}) \equiv m^2_{miss}(\text{RICH}, \text{GTK})$

$m^2_{miss}(\text{Beam}) \equiv m^2_{miss}(\text{Straw}, \text{Beam})$



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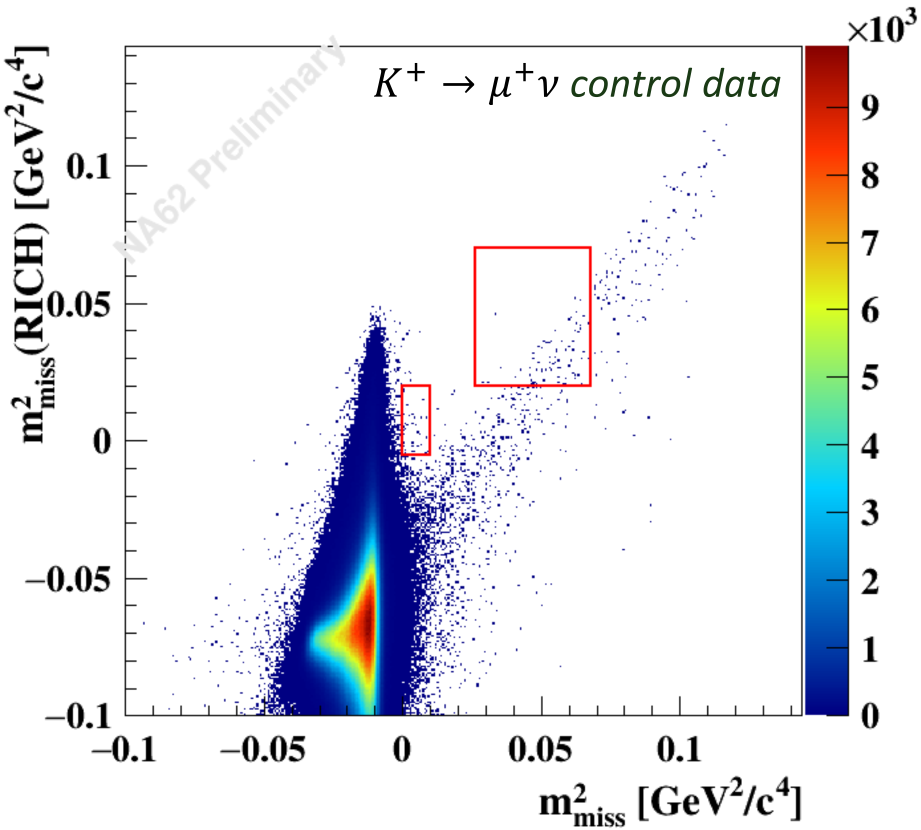
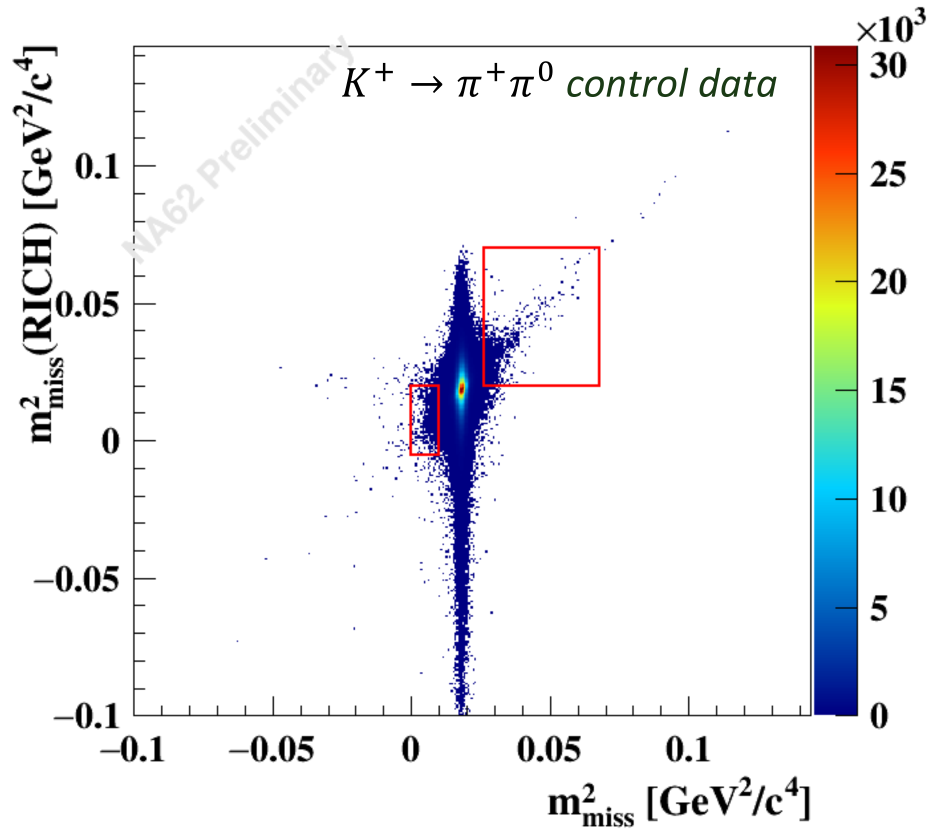




2. Single Event Sensitivity

Single Event Sensitivity (SES): Definition

- Normalization: $K^+ \to \pi^+\pi^0$ from control data
- Same $\pi^+\nu\bar{\nu}$ selection: γ, multiplicity rejection not applied; m^2_{miss} cuts modified

$$N_K = \frac{N_{\pi\pi} \cdot D}{A_{\pi\pi} \cdot BR_{\pi\pi}}$$

$$SES = \frac{1}{N_K \sum_j \left(A^j_{\pi\nu\nu} \cdot \epsilon^j_{RV} \cdot \epsilon^j_{trig}\right)}$$

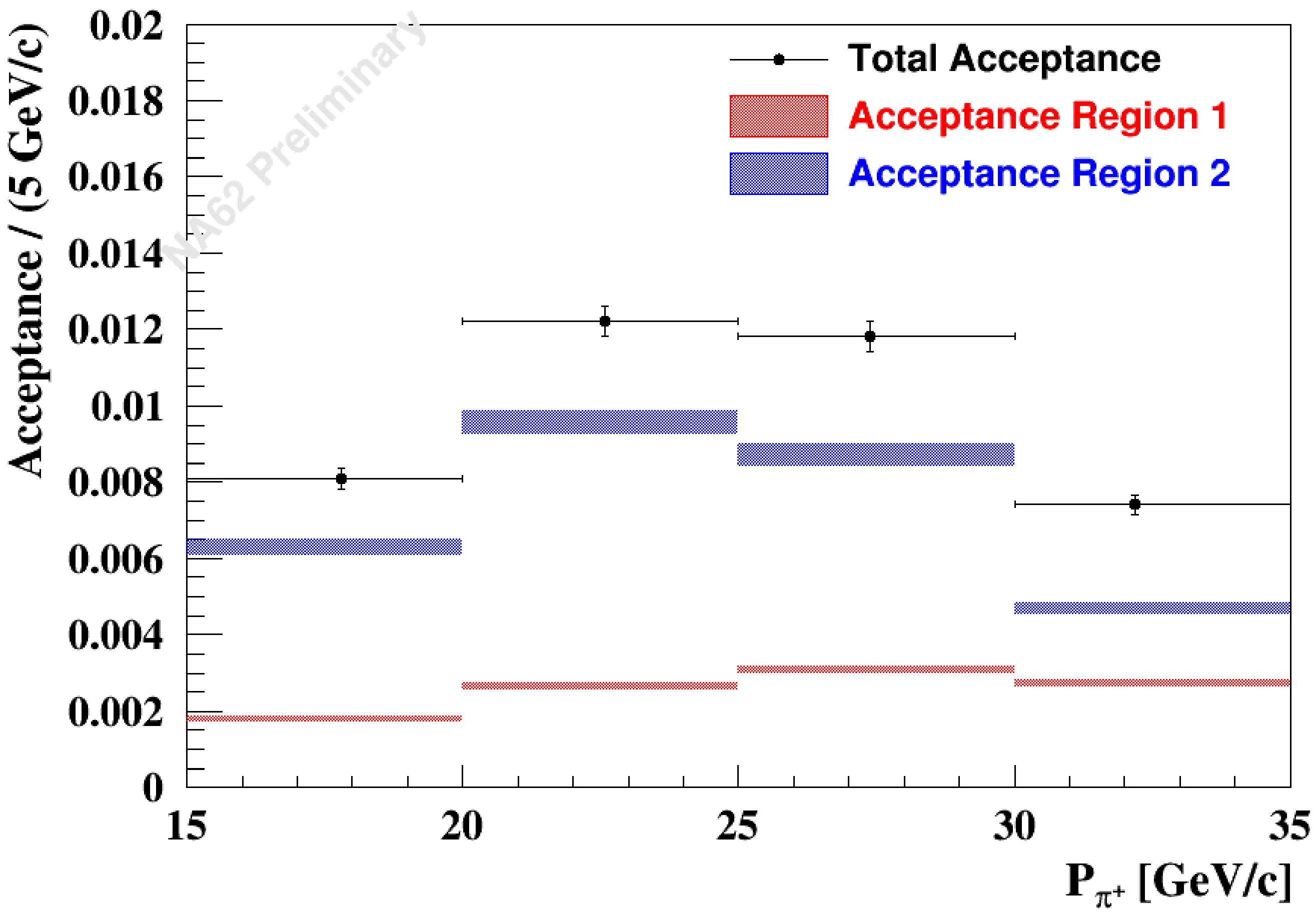
N_K	Number of K^+ decays
$N_{\pi\pi} \sim 6 \cdot 10^6$	Number of $K^+ \to \pi^+\pi^0$
$A_{\pi\pi} \sim 0.1$	Normalization acceptance
$D = 400$	Control Trigger Downscaling

ϵ_{RV}	Random veto efficiency
ϵ_{trig}	Trigger efficiency
$A_{\pi\nu\nu}$	Signal acceptance
J	π^+ momentum bin

$$N_{K^+} = (1.21 \pm 0.02) \times 10^{11}$$

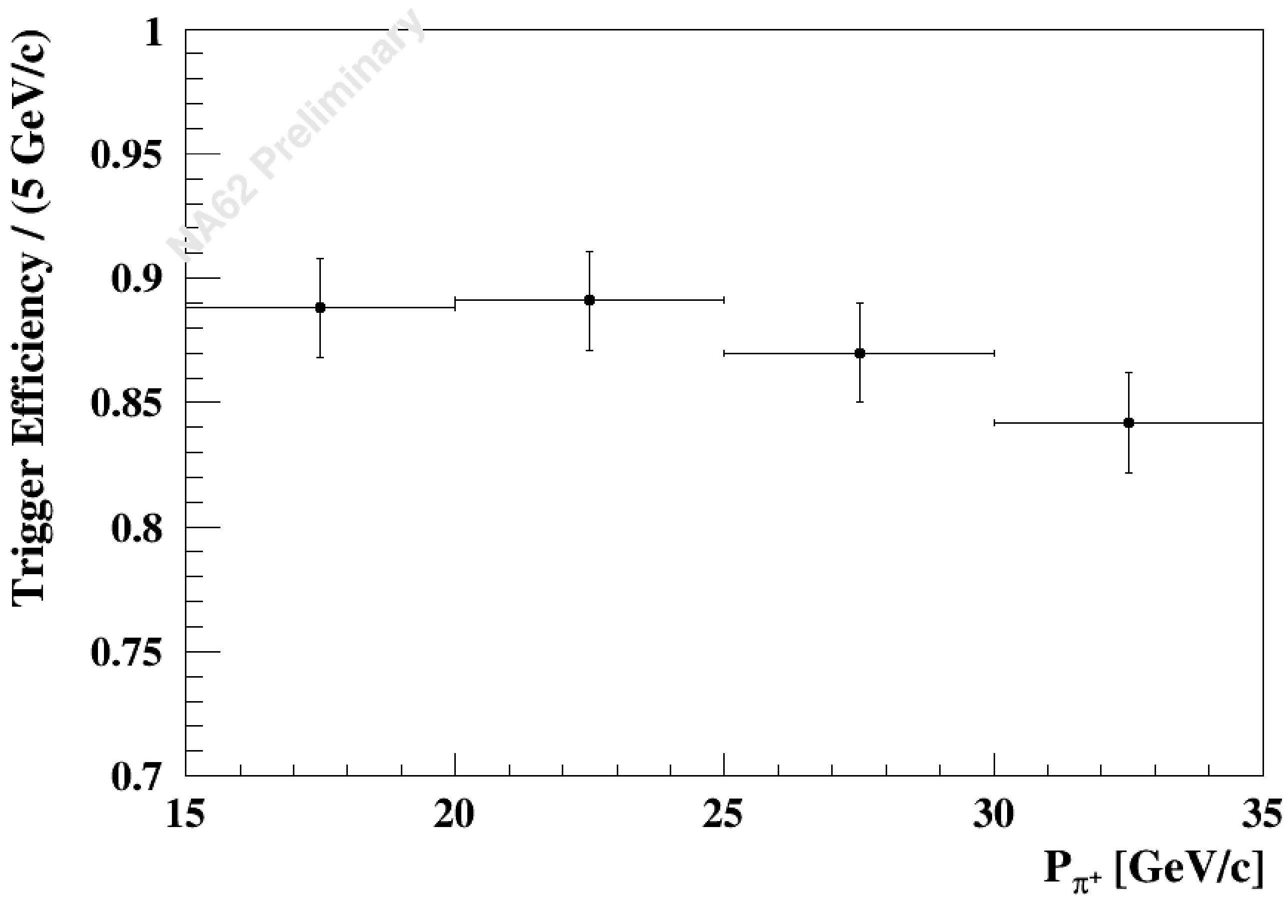
Signal Acceptance

- Computed with MC
- Particle ID, losses due to π^+ interaction included



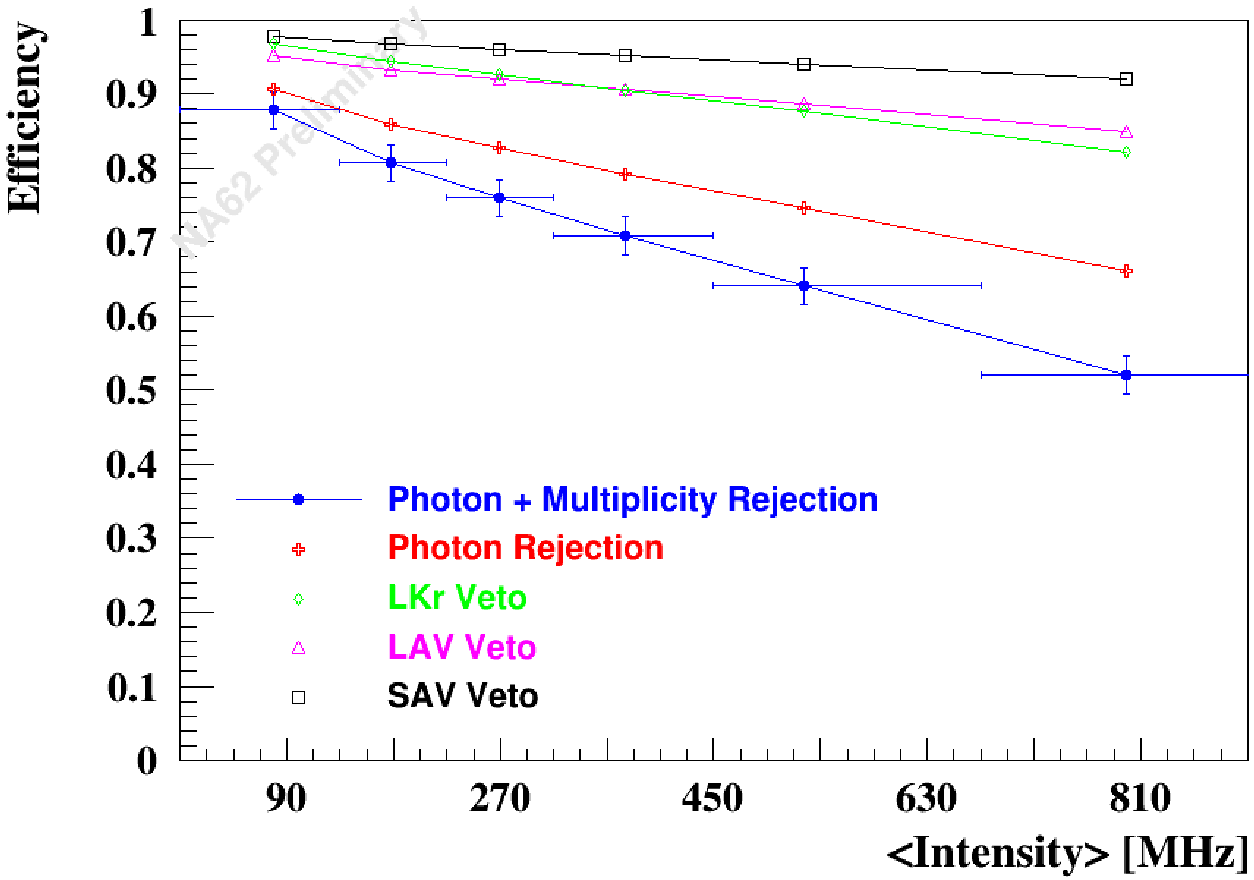
Trigger Efficiency

- Measured on data using $K^+ \to \pi^+\pi^0$ selected from control triggers
- Losses mainly from level 0, L1 efficiency ~0.97



Random Veto

- Random signal losses due to γ + multiplicity rejection measured with $K^+ \to \mu^+\nu$
- $\langle\epsilon_{RV}\rangle \approx 0.76$ independent from P_{π^+}, dependent on instantaneous intensity



Single Event Sensitivity: Result

$$SES = (3.15 \pm 0.01_{stat} \pm 0.24_{syst}) \times 10^{-10}$$

$$N^{exp}_{\pi\nu\nu}(SM) = 0.267 \pm 0.001_{stat} \pm 0.020_{syst} \pm 0.032_{ext}$$

Acceptance $K^+ \to \pi^+ \nu \bar{\nu}$	4.0 ± 0.1
PNN trigger efficiency	0.87 ± 0.2
Random veto	0.76 ± 0.04

Source	δSES (10^{-10})
Random Veto	± 0.17
N_K	± 0.05
Trigger efficiency	± 0.04
Definition of $\pi^+\pi^0$ region	± 0.10
Momentum spectrum	± 0.01
Simulation of $\pi+$ interactions	± 0.09
Extra activity	± 0.02
GTK Pileup simulation	± 0.02
Total	± 0.24

3. Background Studies

$K^+ \to \pi^+\pi^0(\gamma)$ Background

Events in $\pi^+\pi^0$ region after $\pi^+\nu\bar{\nu}$ selection

$$N^{exp}_{\pi\pi}(region) = \sum_j \left[N_{\pi\pi}(\pi^+\pi^0)_j \cdot f^{kin}_j(region) \right]$$

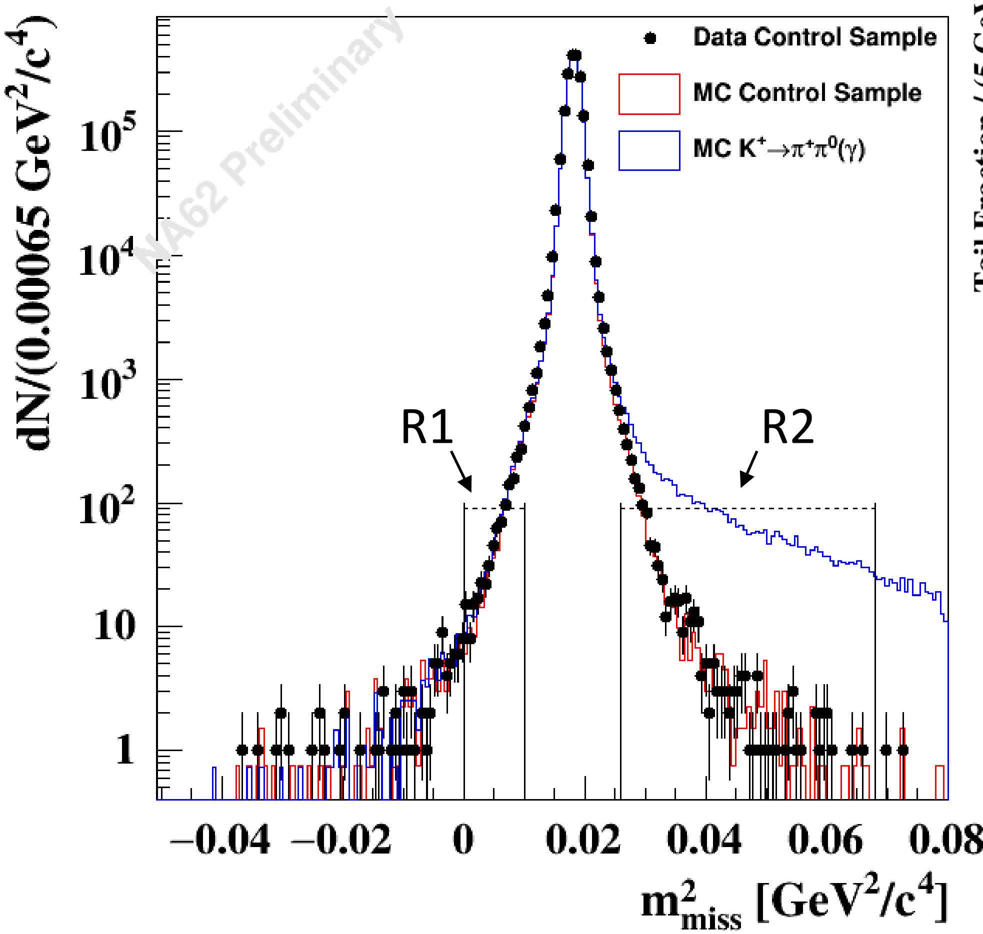
Expected events

j: π^+momentum bin

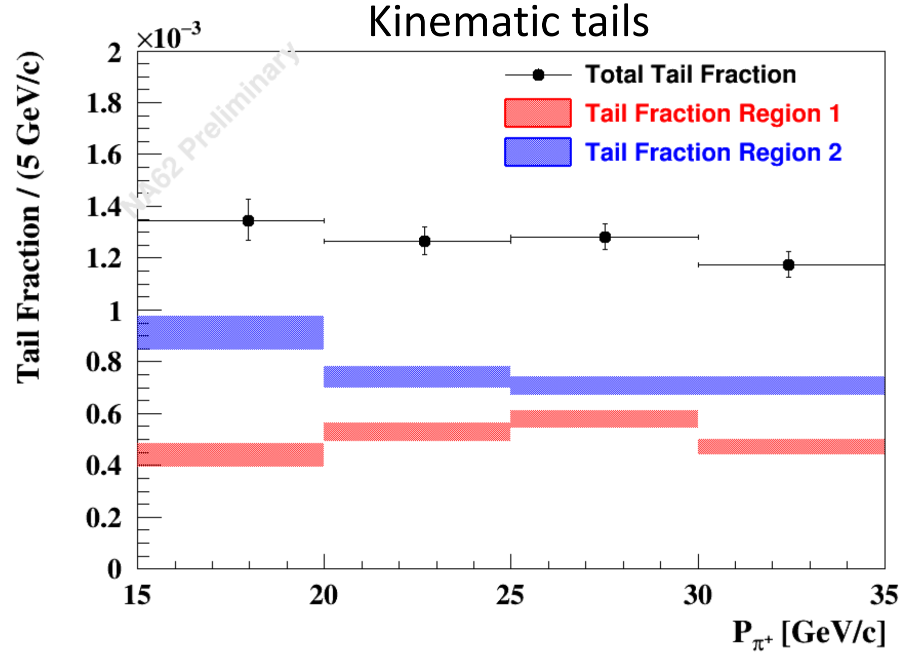
Fraction of events in region *region*

- $f^{kin}_j(region)$ measured: $\pi^+\pi^0$ sample selected tagging the π^0 with 2 γ's in LKr
- MC studies with and without π^0 tagging
- π^0 and kinematic rejection assumed independent

$K^+ \rightarrow \pi^+\pi^0$ Background



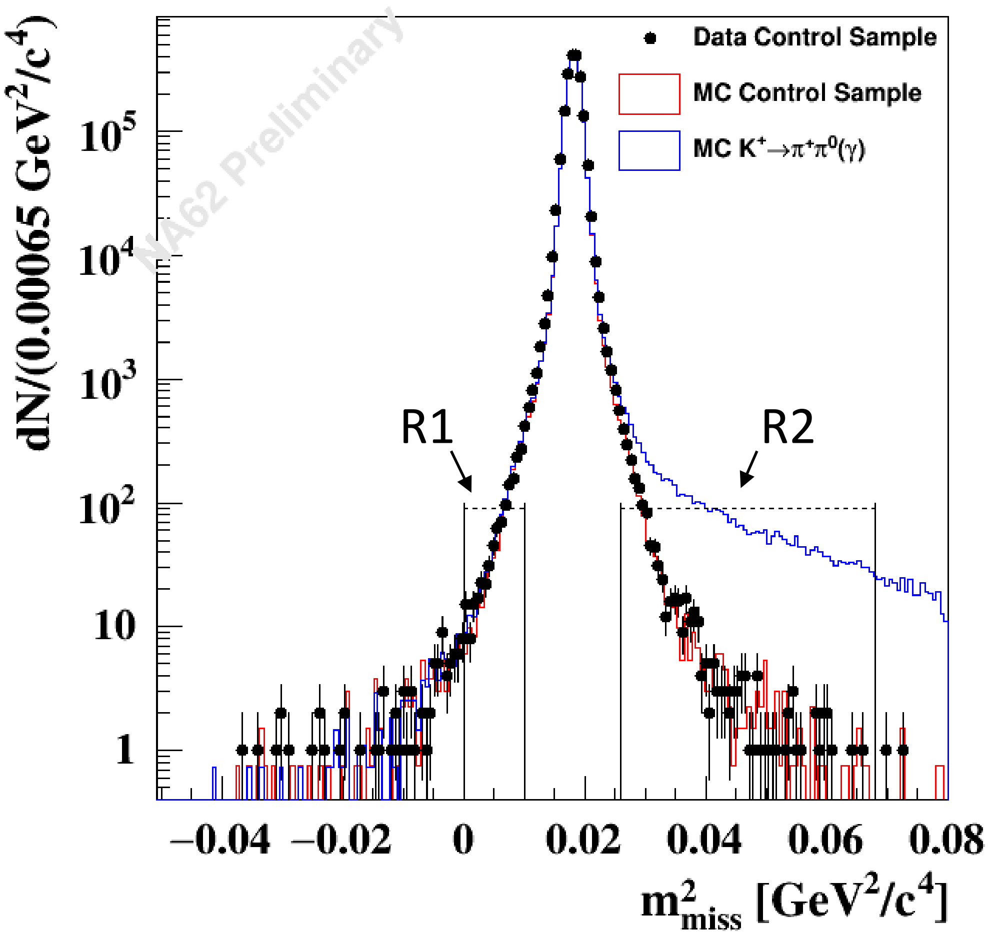
Kinematic tails



Number of expected events

Region	$\pi^+\pi^0$
R1	$0.022 \pm 0.004_{stat} \pm 0.002_{syst}$
R2	$0.037 \pm 0.006_{stat} \pm 0.003_{syst}$

$K^+ \to \pi^+\pi^0\gamma$ Background



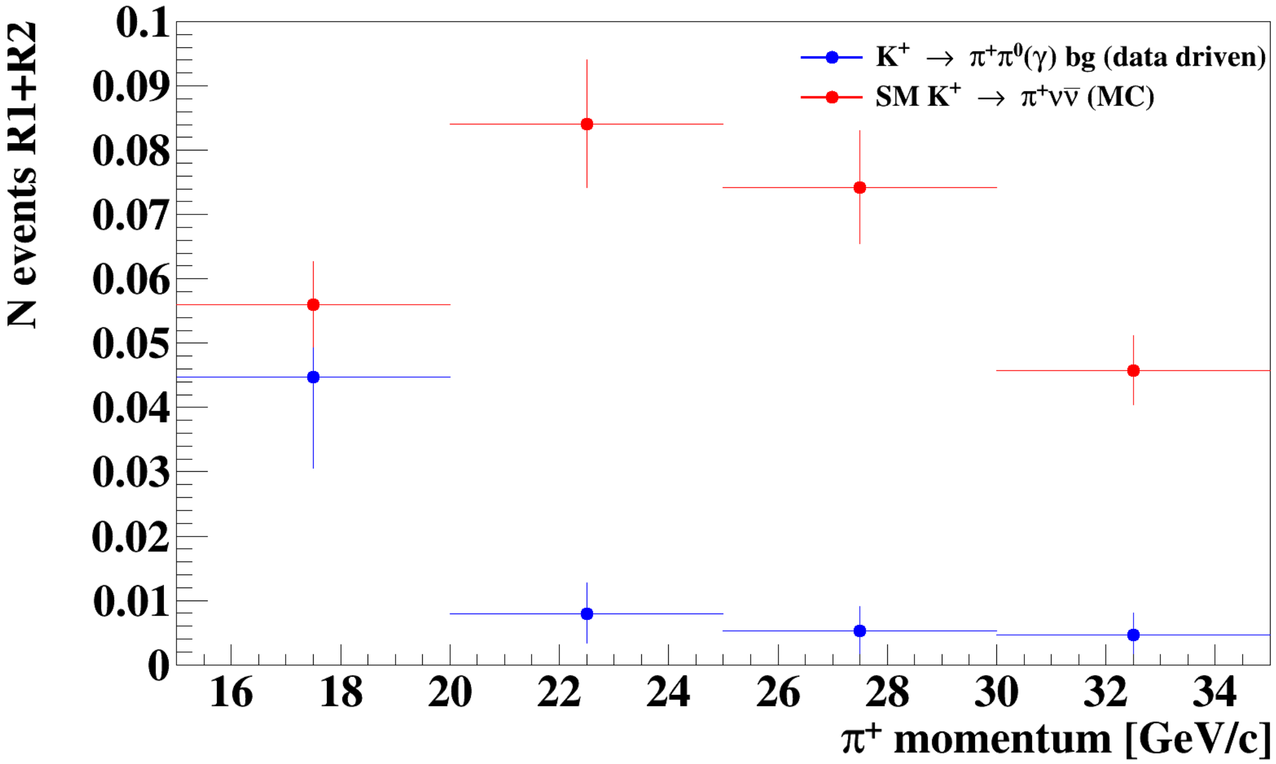
- Radiative tail in R2 estimated from MC:
  - × 6 than kinematic tails
- Single-γ veto efficiency measured on data
- Measured π^0 rejection reproduced on MC
- $\pi^0\gamma$ rejection of the radiative tail in R2 estimated from MC:
  - × 30 than single π^0 rejection

Number of expected events

Region	$\pi^+\pi^0\gamma$
R1	0
R2	$0.005 \pm 0.005_{syst}$

$K^+ \to \pi^+\pi^0(\gamma)$ Background: Result

$$N^{expected}_{\pi\pi(\gamma)} = 0.064 \pm 0.007_{stat} \pm 0.006_{syst}$$

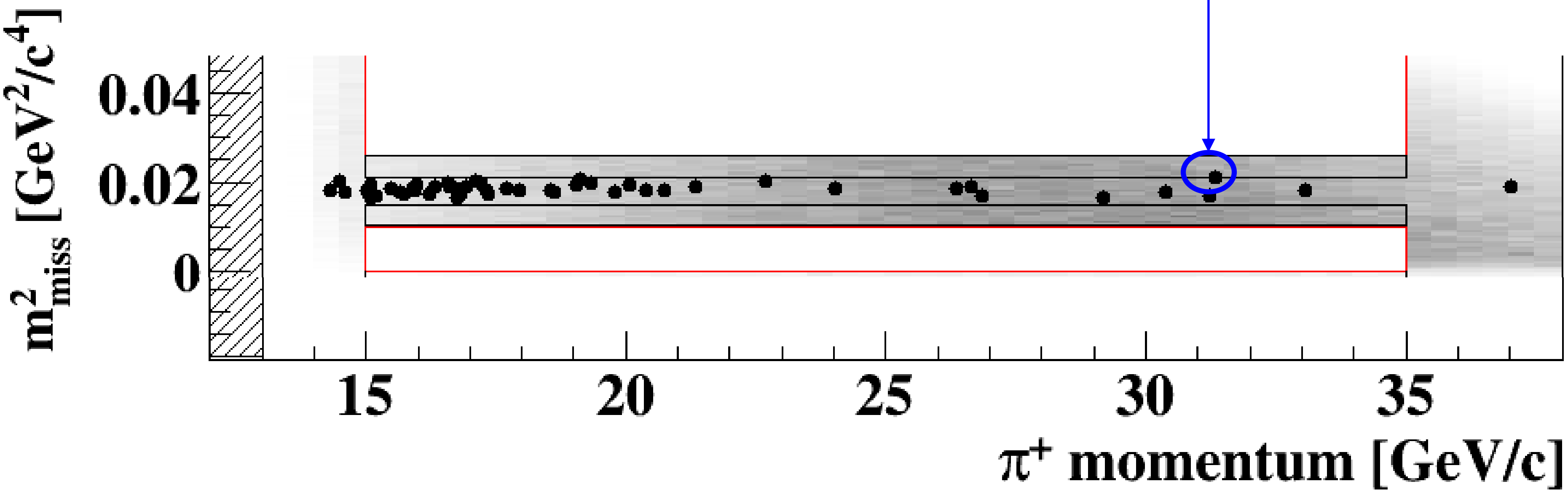


$K^+ \to \pi^+\pi^0(\gamma)$ Background: Validation

Region	$\pi^+\pi^0$
CR1	$0.52 \pm 0.08_{stat} \pm 0.03_{syst}$
CR2	$0.94 \pm 0.14_{stat} \pm 0.05_{syst}$

Events observed CR1: **0**

Events observed CR2: **1**



$K^+ \to \mu^+\nu(\gamma)$ Background

Events in $\mu^+\nu$ region after $\pi^+\nu\bar{\nu}$ selection

$$\underbrace{N_{\mu\nu}^{exp}(region)}_{\text{Expected events}} = \sum_j \left[N(\mu^+\nu)_j \cdot \underbrace{f_j^{kin}(region)}_{\text{Fraction of events in region } region} \right]$$

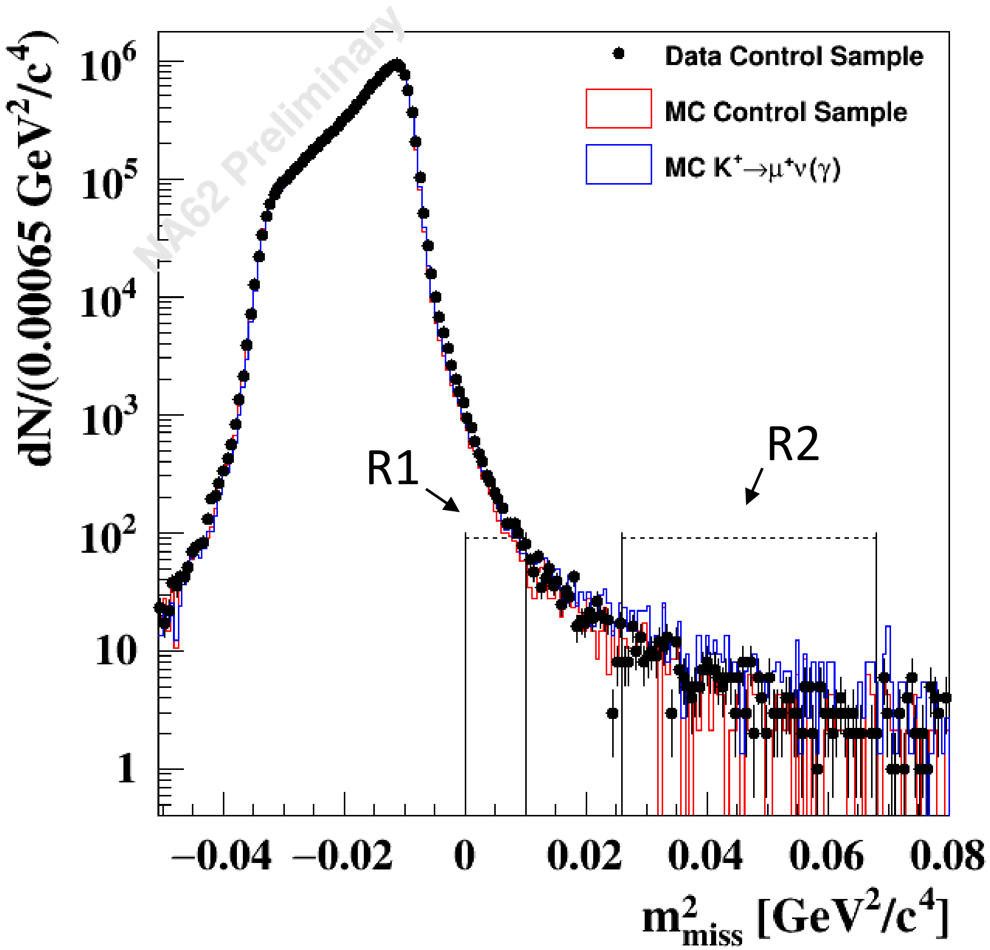
Expected events

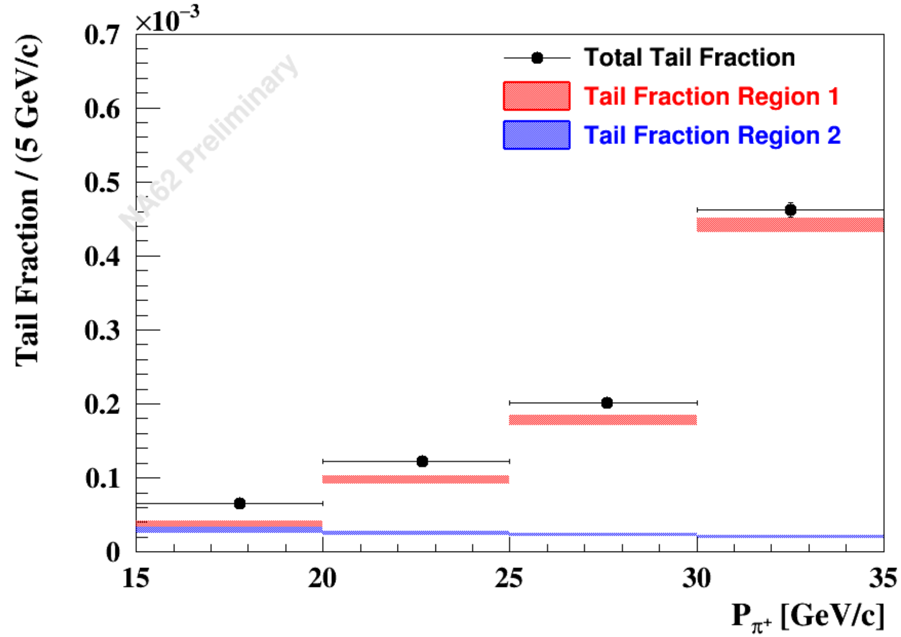
j: π^+ momentum bin

Fraction of events in region *region*

- $f_j^{kin}(region)$ measured: $\mu^+\nu$ sample selected tagging μ^+ and applying γ rejection
- Same method applied to MC
- PID and kinematic rejection assumed independent
  - Independence tested measuring muon PID with RICH directly on tails.

$K^+ \rightarrow \mu^+\nu(\gamma)$ Background



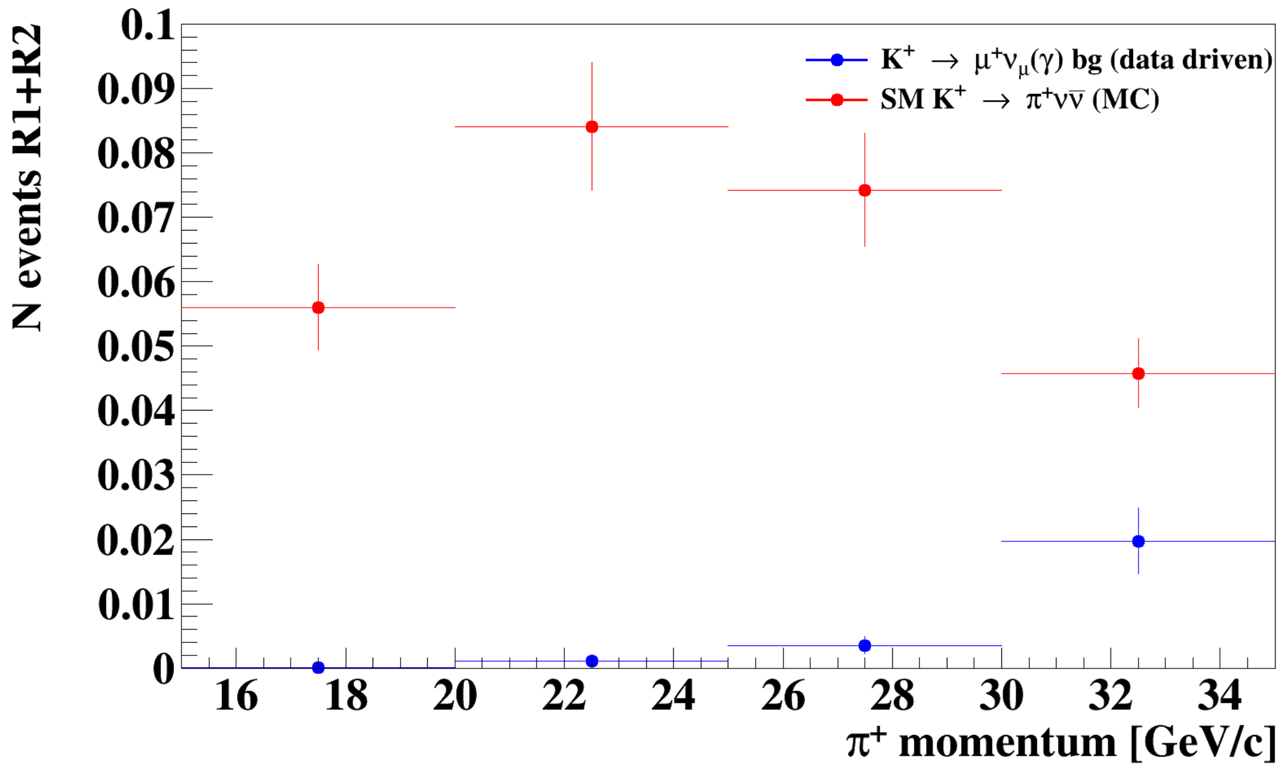


Number of expected events

Region	$K_{\mu 2}(\gamma)$
R1	$0.019 \pm 0.003_{stat} \pm 0.003_{syst}$
R2	$0.0012 \pm 0.0002_{stat} \pm 0.0006_{syst}$

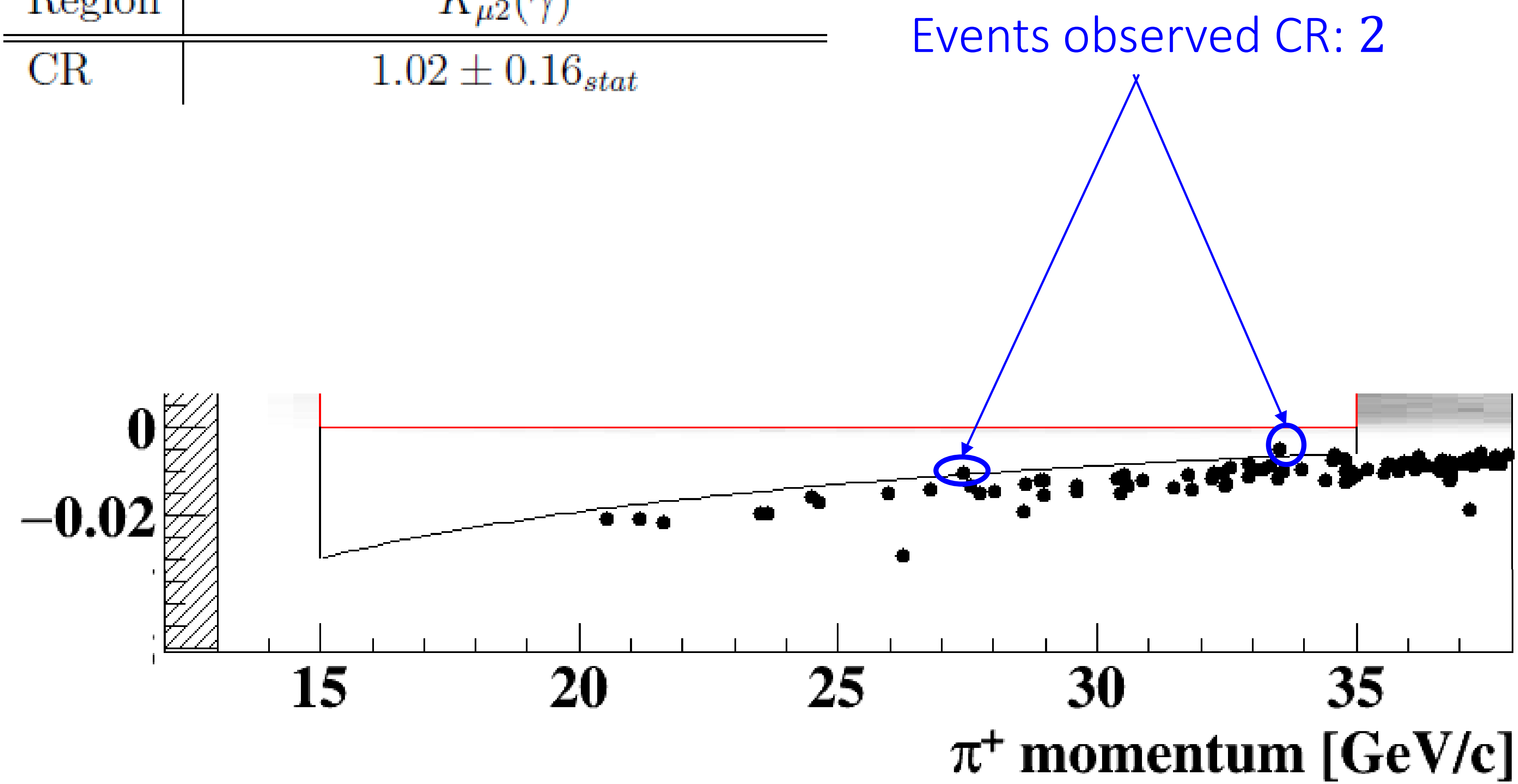
$K^+ \rightarrow \mu^+\nu(\gamma)$ Background: Result

$$N^{expected}_{\mu\nu(\gamma)} = 0.020 \pm 0.003_{stat} \pm 0.003_{syst}$$



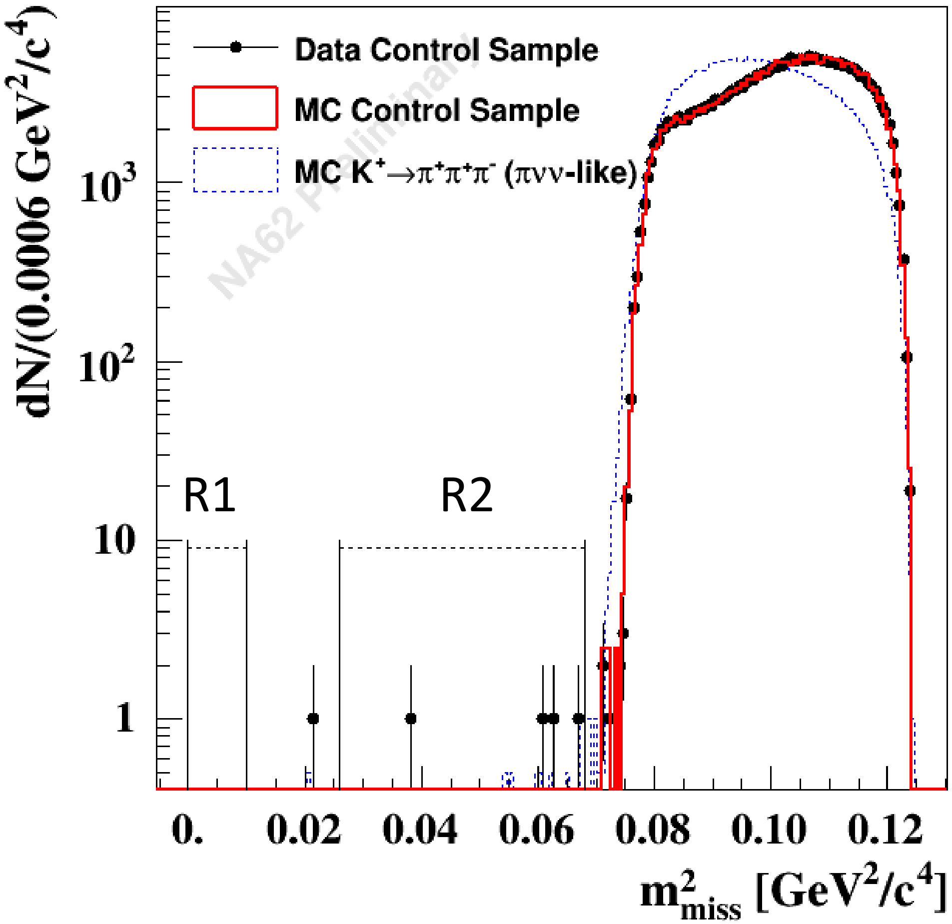
$K^+ \to \mu^+\nu(\gamma)$ Background: Validation

Region	$K_{\mu 2}(\gamma)$
CR	$1.02 \pm 0.16_{stat}$



$K^+ \to \pi^+\pi^+\pi^-$ Background

$$N_{\pi\pi\pi}^{exp} = N(\pi^+\pi^+\pi^-) \cdot f^{kin}(R2)$$

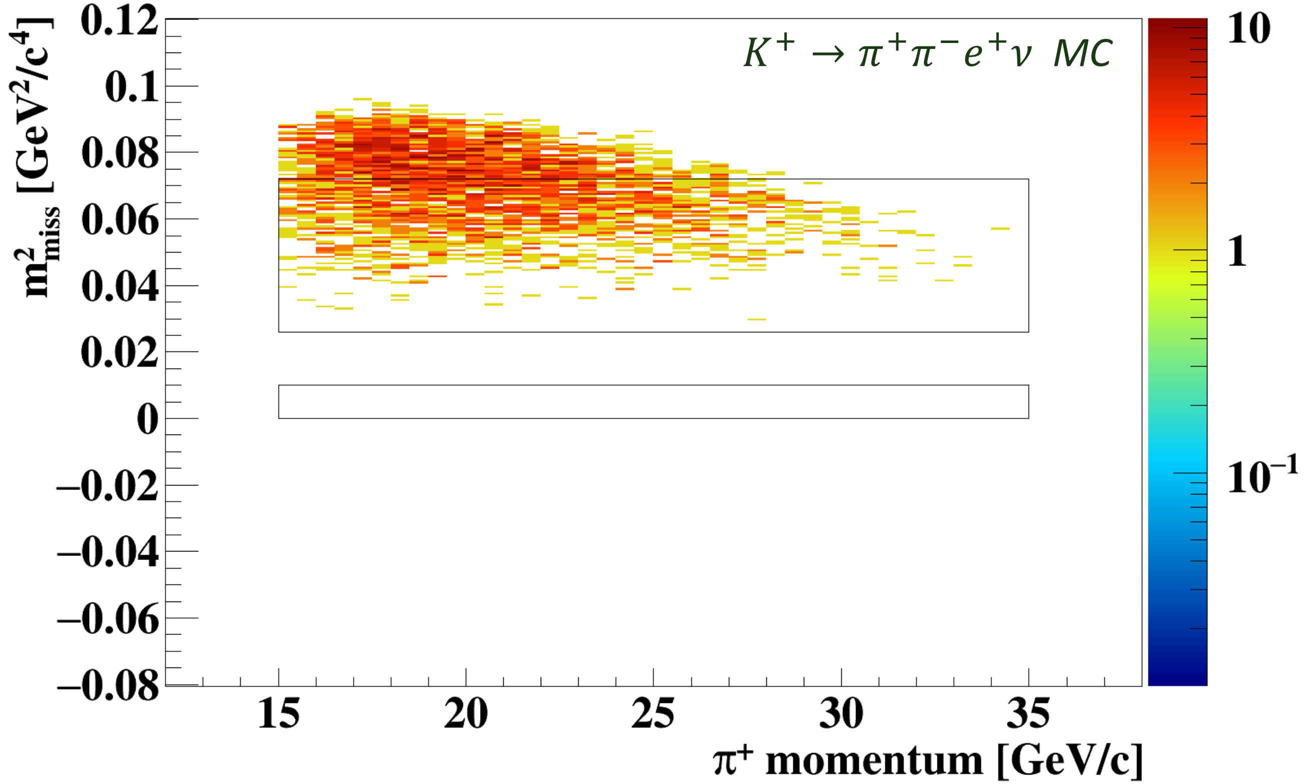


- $N(\pi^+\pi^+\pi^-)$: Event in $\pi^+\pi^+\pi^-$ region after $\pi^+\nu\bar{\nu}$ selection
- f^{kin} measured on a $\pi^+\pi^+\pi^-$ control sample selected tagging the $\pi^+\pi^-$ pair
- Kinematic rejection factor corrected for biases induced by the control sample selection using MC
- $f^{kin}(R2) \leq 10^{-4}$

Number of expected events

$$N_{\pi\pi\pi}^{exp} = 0.002 \pm 0.001_{stat} \pm 0.002_{syst}$$

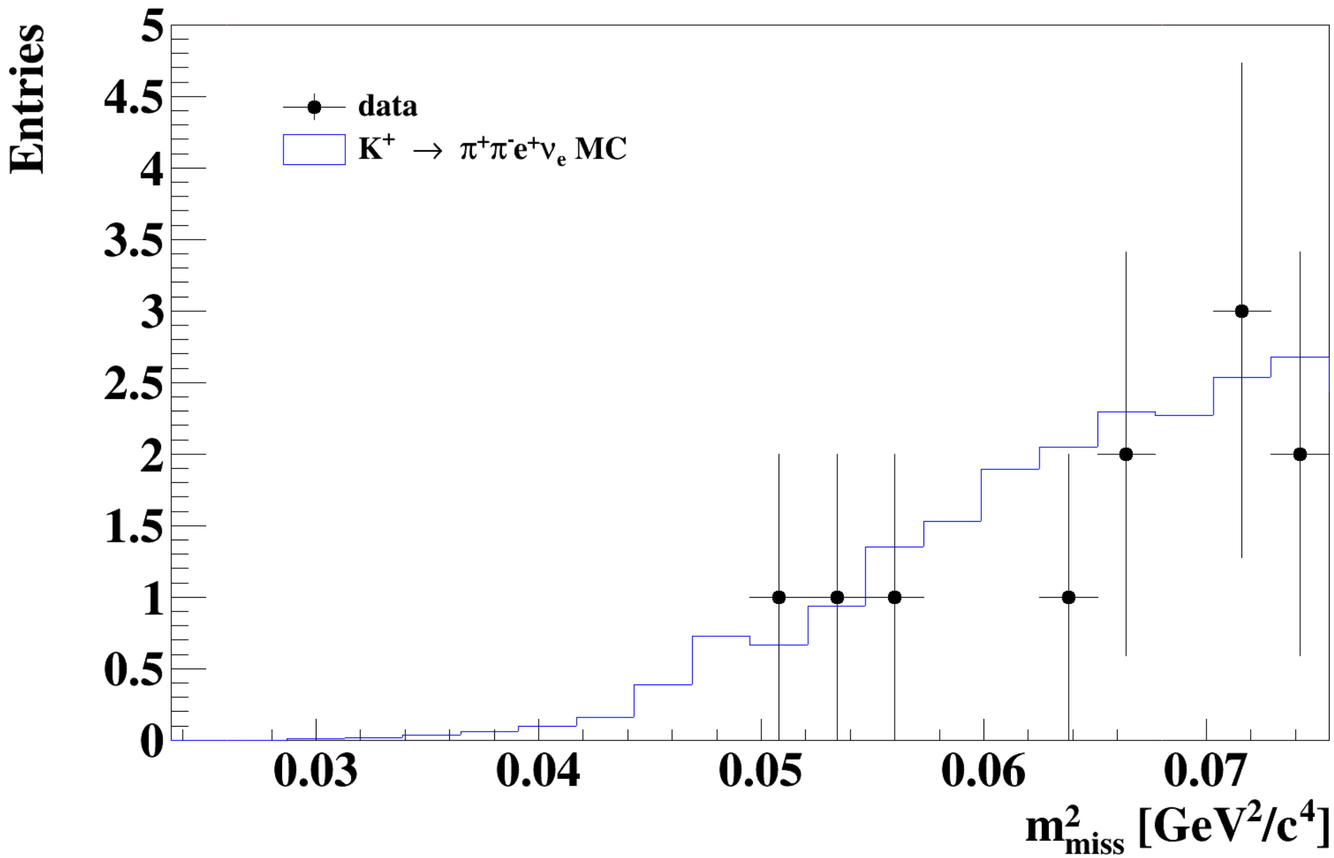
$K^+ \to \pi^+\pi^-e^+\nu$ Background



- Estimated using MC ($\sim 4 \times 10^8$ events generated)
- Validated using different control samples $K^+ \to \pi^+\pi^-e^+\nu$ - enriched

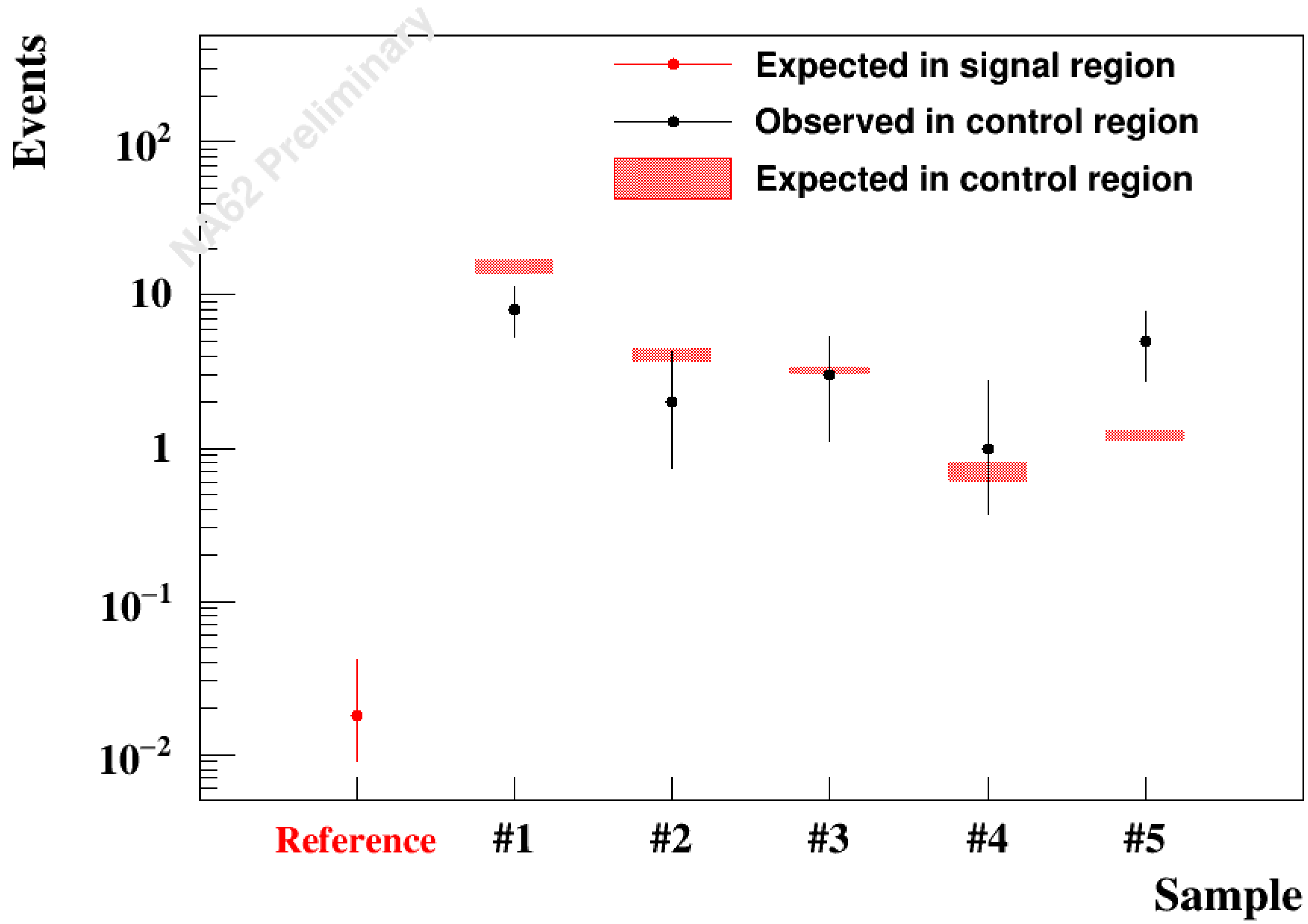
$K^+ \to \pi^+\pi^-e^+\nu$ Background: Validation

- Single - π^- events, full $\pi\nu\nu$ selection, straw - multiplicity cuts inverted
- Control region: $0.026 < m^2_{miss} < 0.072\ GeV^2/c^4$



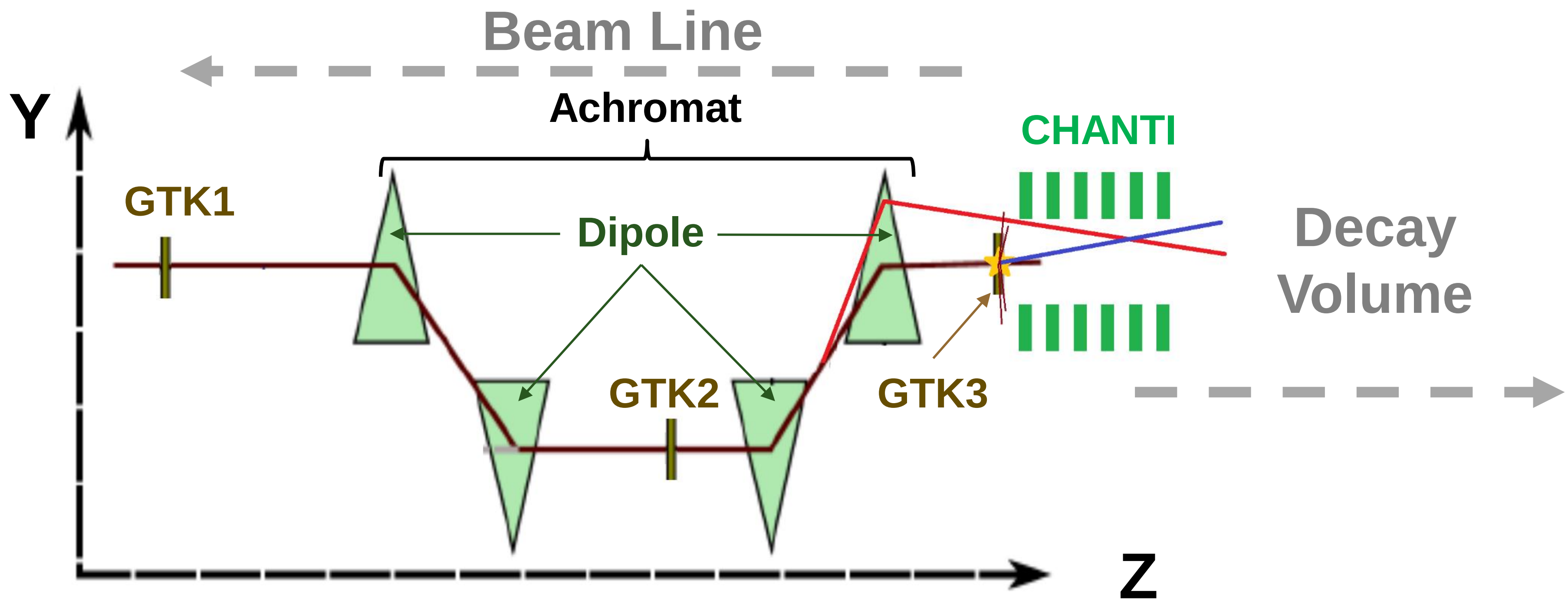
$K^+ \to \pi^+\pi^-e^+\nu$ Background: Result

$$N_{\pi\pi e\nu}^{expected} = 0.018^{+0.024}_{-0.017}|_{stat} \pm 0.009_{syst}$$



Upstream Background

- Decays along the beam line; beam particle interactions in GTK
- Random track matched in GTK and/or possible additional energy not detected



- Specific cuts against upstream background

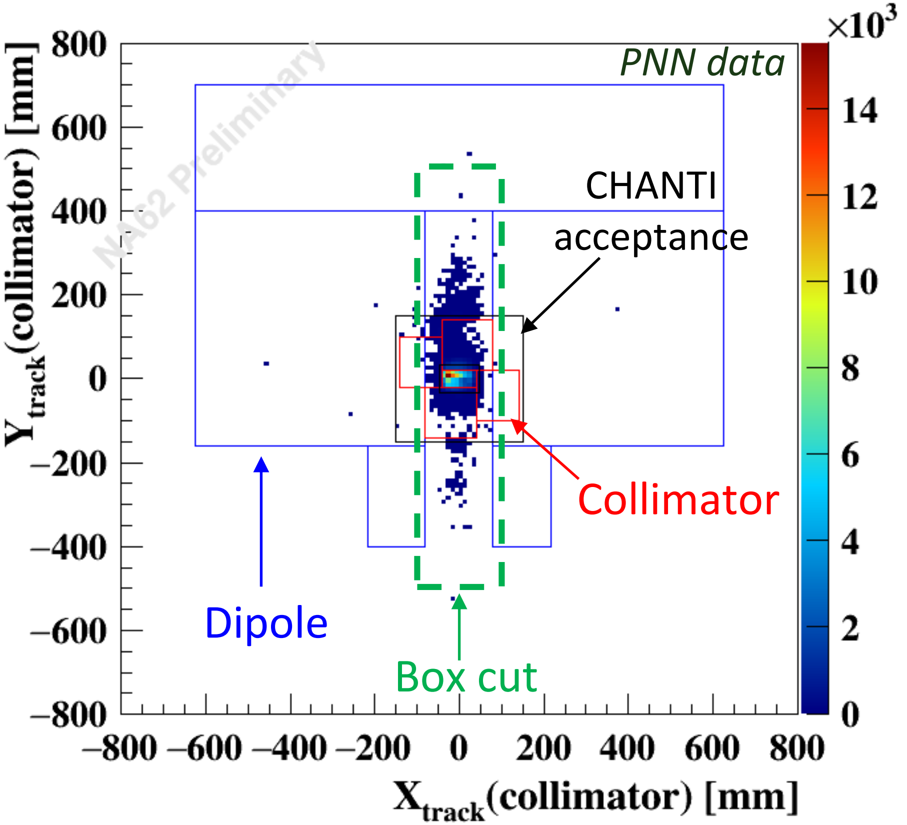
1) $K-\pi$ matching 2) Z_{vertex} 3) CHANTI veto

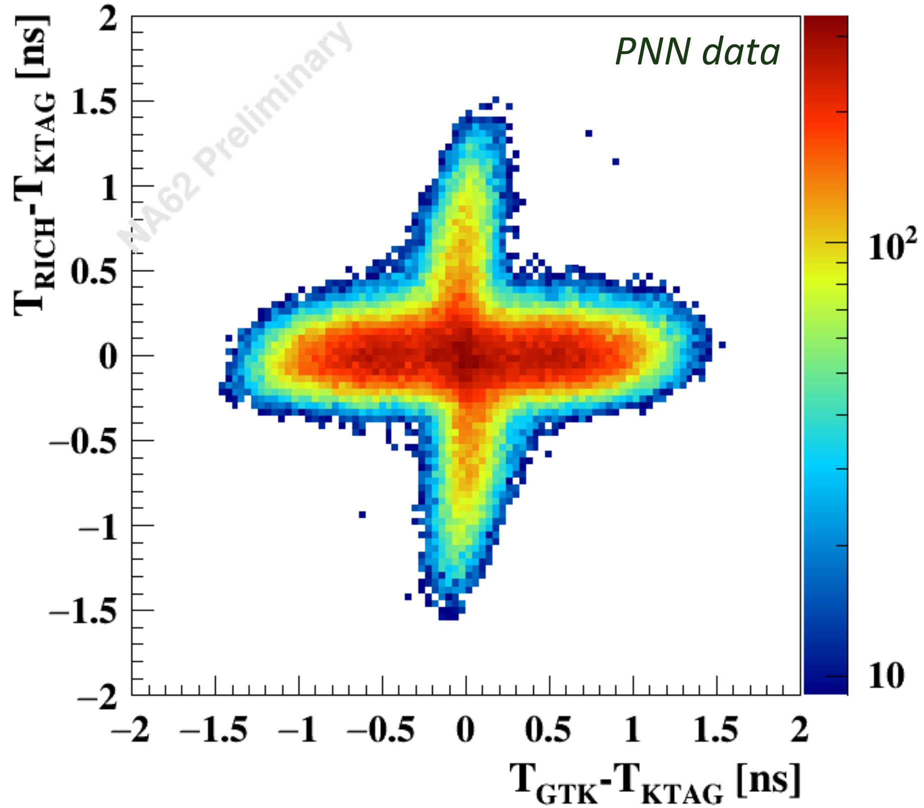
4) Cut on X,Y π^+ at the entrance of the decay volume («Box cut»)

Upstream Background

- Decays along the beam line; beam particle interactions in GTK
- Random track matched in GTK and/or possible additional energy not detected

PNN data: $\pi\nu\nu$ selection, $K-\pi$ matching inverted, Z_{vertex}, Box cut and CHANTI not applied



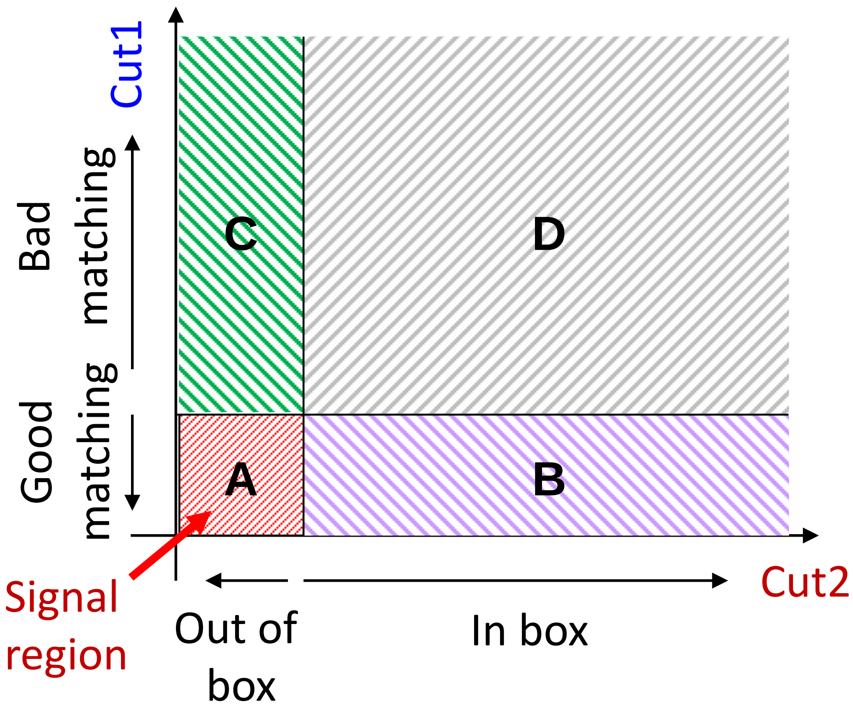


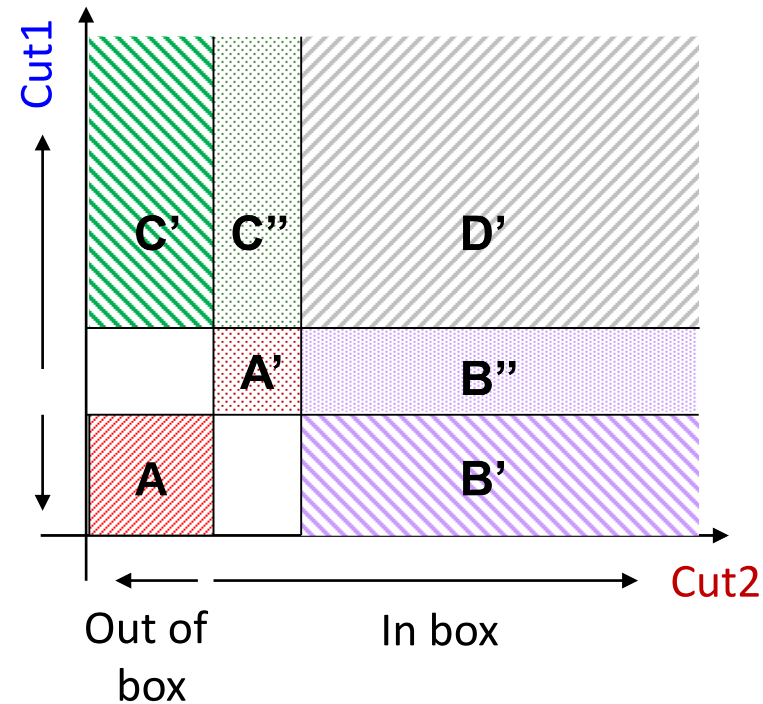
Upstream Background: Estimation

- Bifurcation on PNN triggered data inverting: $K-\pi$ matching (cut1); Cut box (cut2)
- BCD: reference sample; B'C'D'B''C'': control samples → *4 control samples studied*
- A: signal region; A': control region

$$A(\exp) = \frac{B \cdot C}{D}$$

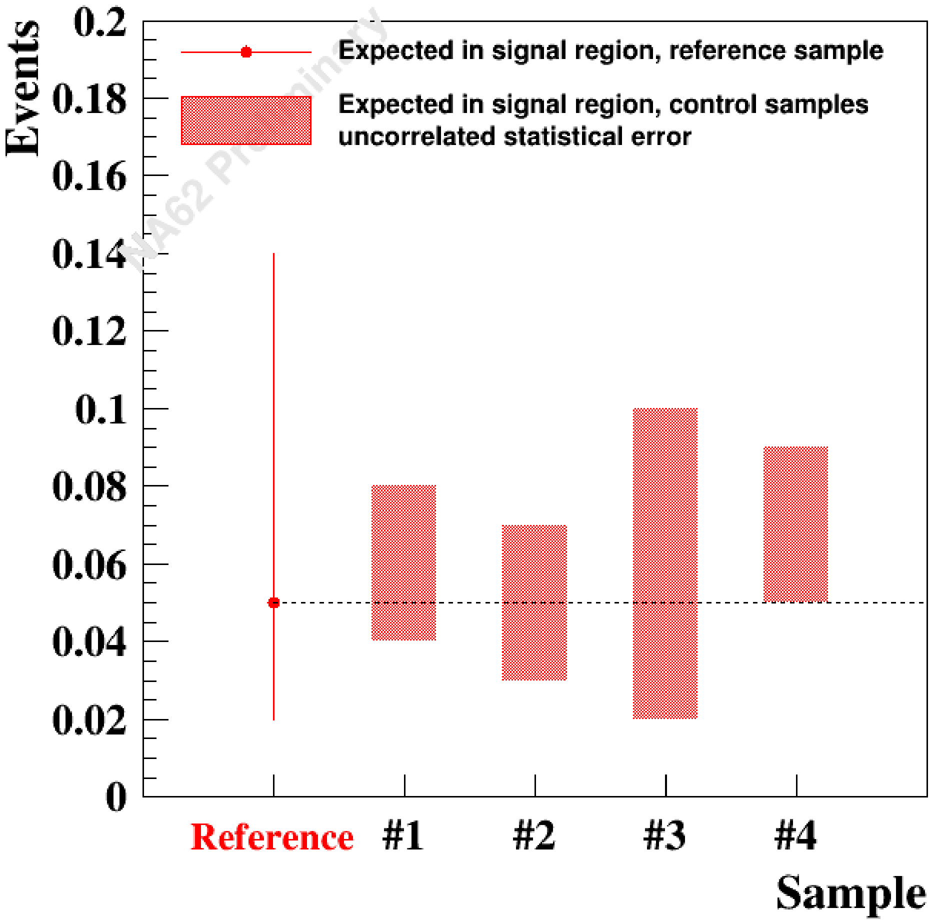
$$A(\exp) = \frac{B' \cdot C'}{D'} \qquad A'(\exp) = \frac{B'' \cdot C''}{D'}$$

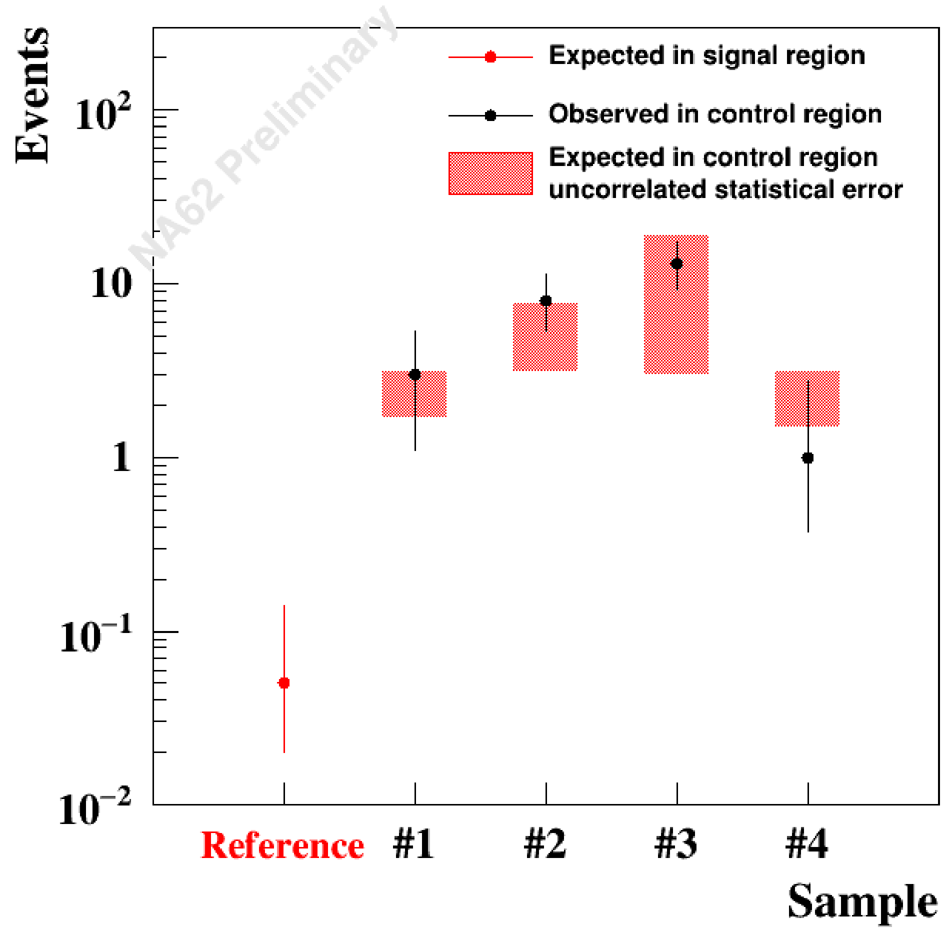




Upstream Background: Result

$$N^{exp}_{upstream} = 0.050^{+0.090}_{-0.030}|_{stat}$$



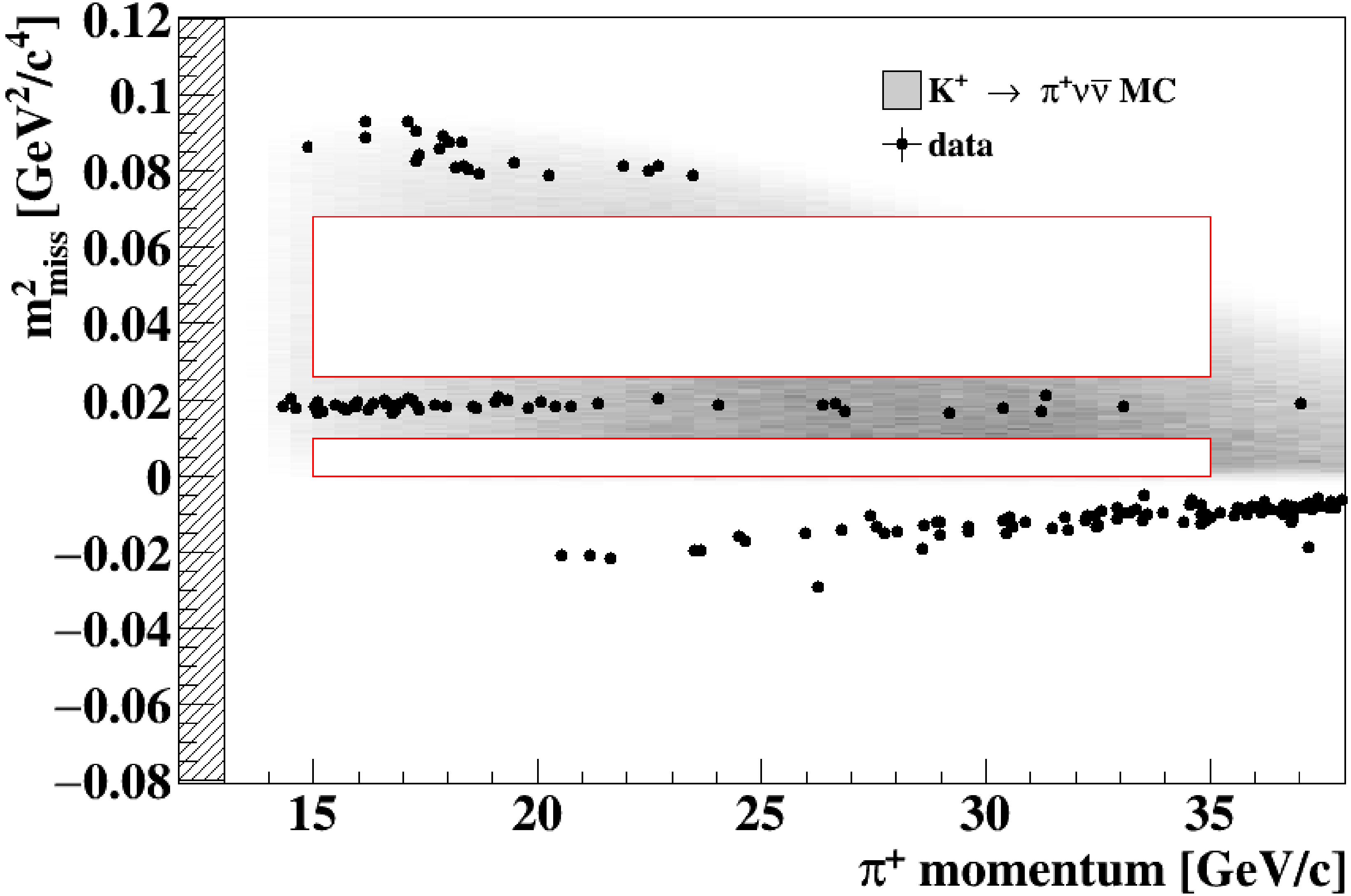


Background Summary

Process	Expected events in R1+R2
$K^+ \to \pi^+ \nu\bar{\nu}$ (SM)	$0.267 \pm 0.001_{stat} \pm 0.020_{syst} \pm 0.032_{ext}$
Total Background	$0.15 \pm 0.09_{\mathrm{stat}} \pm 0.01_{\mathrm{syst}}$
$K^+ \to \pi^+\pi^0(\gamma)$ IB	$0.064 \pm 0.007_{stat} \pm 0.006_{syst}$
$K^+ \to \mu^+\nu(\gamma)$ IB	$0.020 \pm 0.003_{stat} \pm 0.003_{syst}$
$K^+ \to \pi^+\pi^-e^+\nu$	$0.018^{+0.024}_{-0.017}\|_{stat} \pm 0.009_{syst}$
$K^+ \to \pi^+\pi^+\pi^-$	$0.002 \pm 0.001_{stat} \pm 0.002_{syst}$
Upstream Background	$0.050^{+0.090}_{-0.030}\|_{stat}$

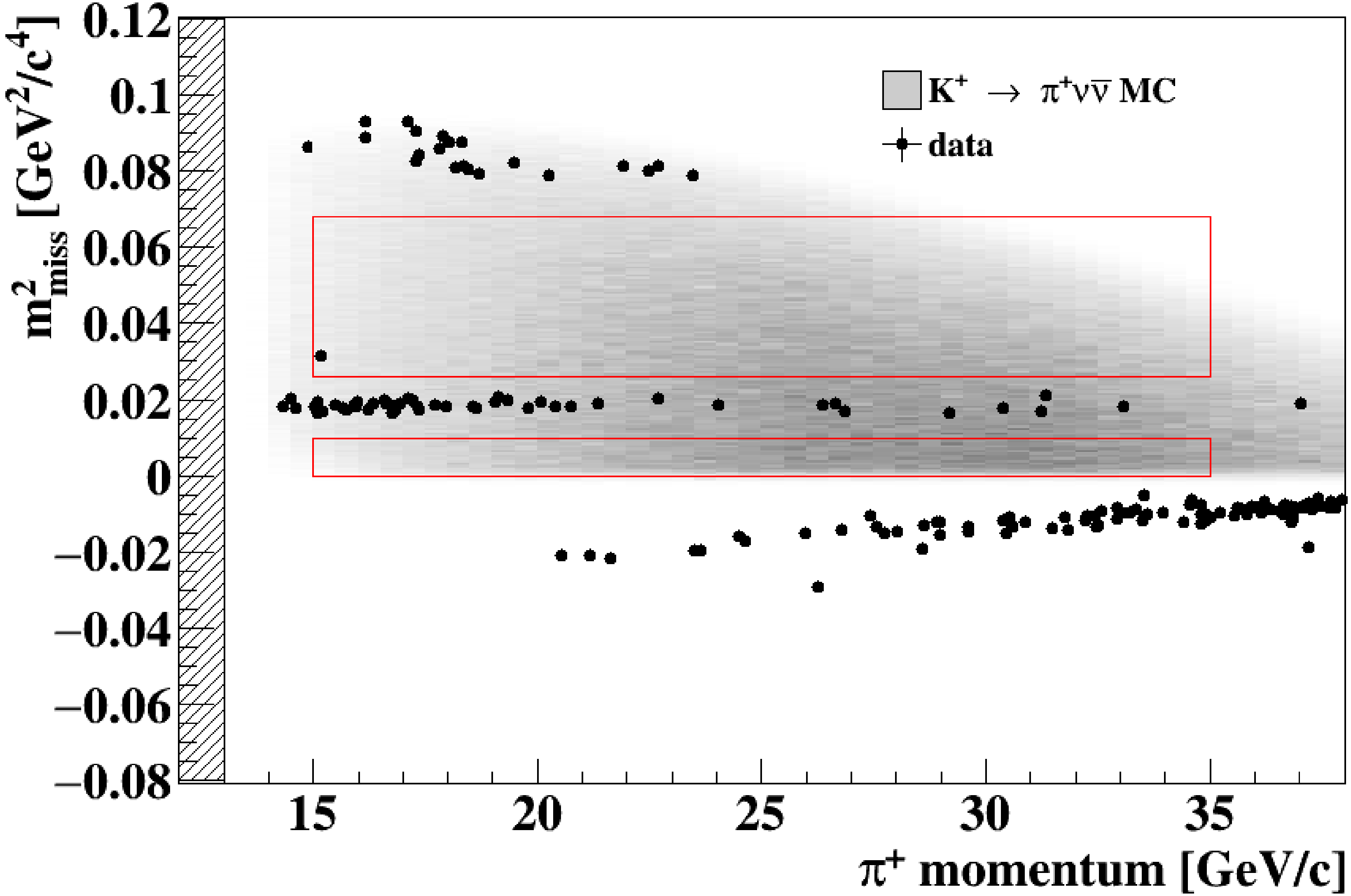
4. Result

Result



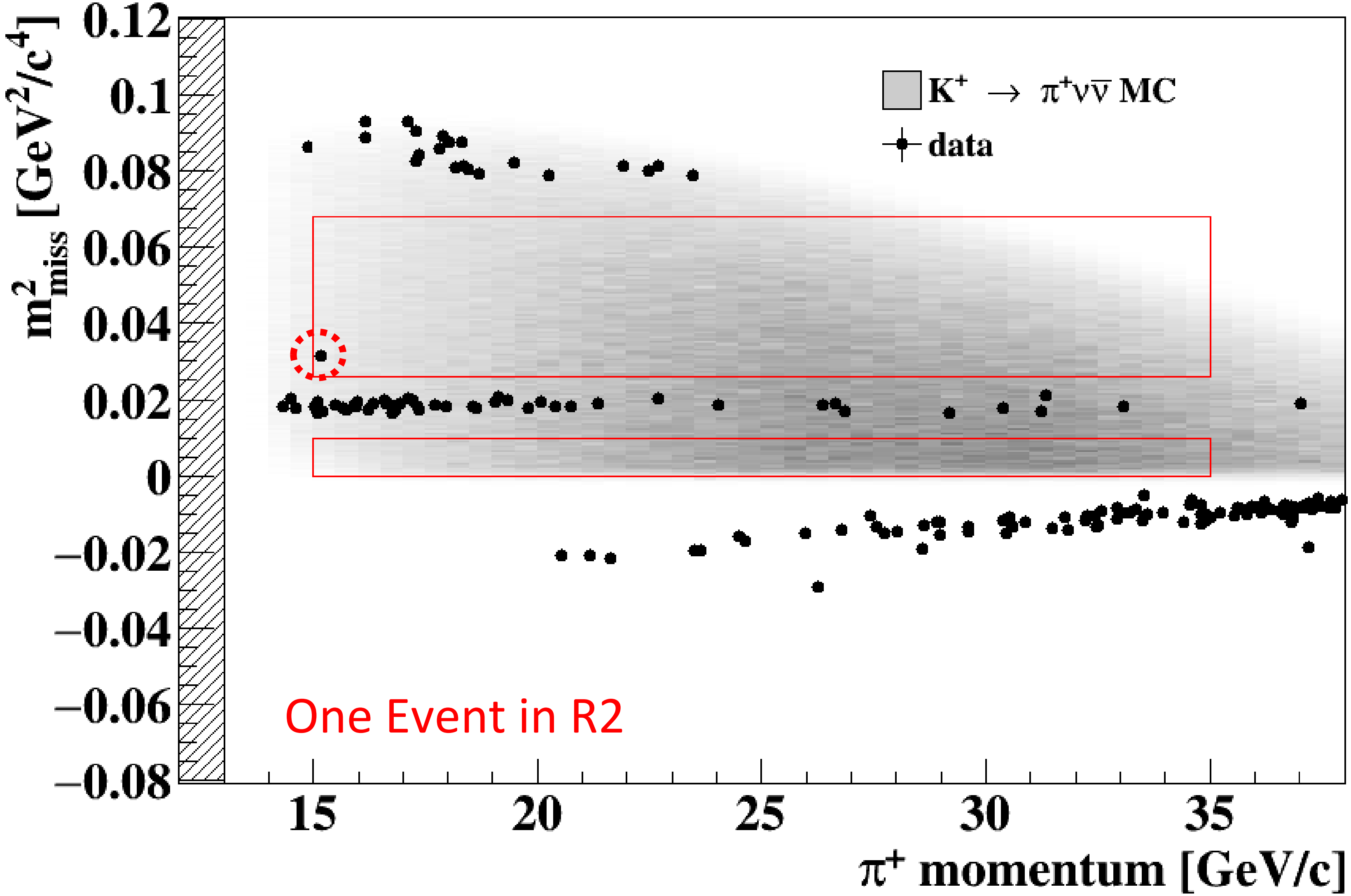
m^2_{miss} [GeV^2/c^4]
0.12
0.1
0.08
0.06
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
15
20
25
30
35
π^+ momentum [GeV/c]
$K^+ \to \pi^+\nu\bar{\nu}$ MC
data

Result



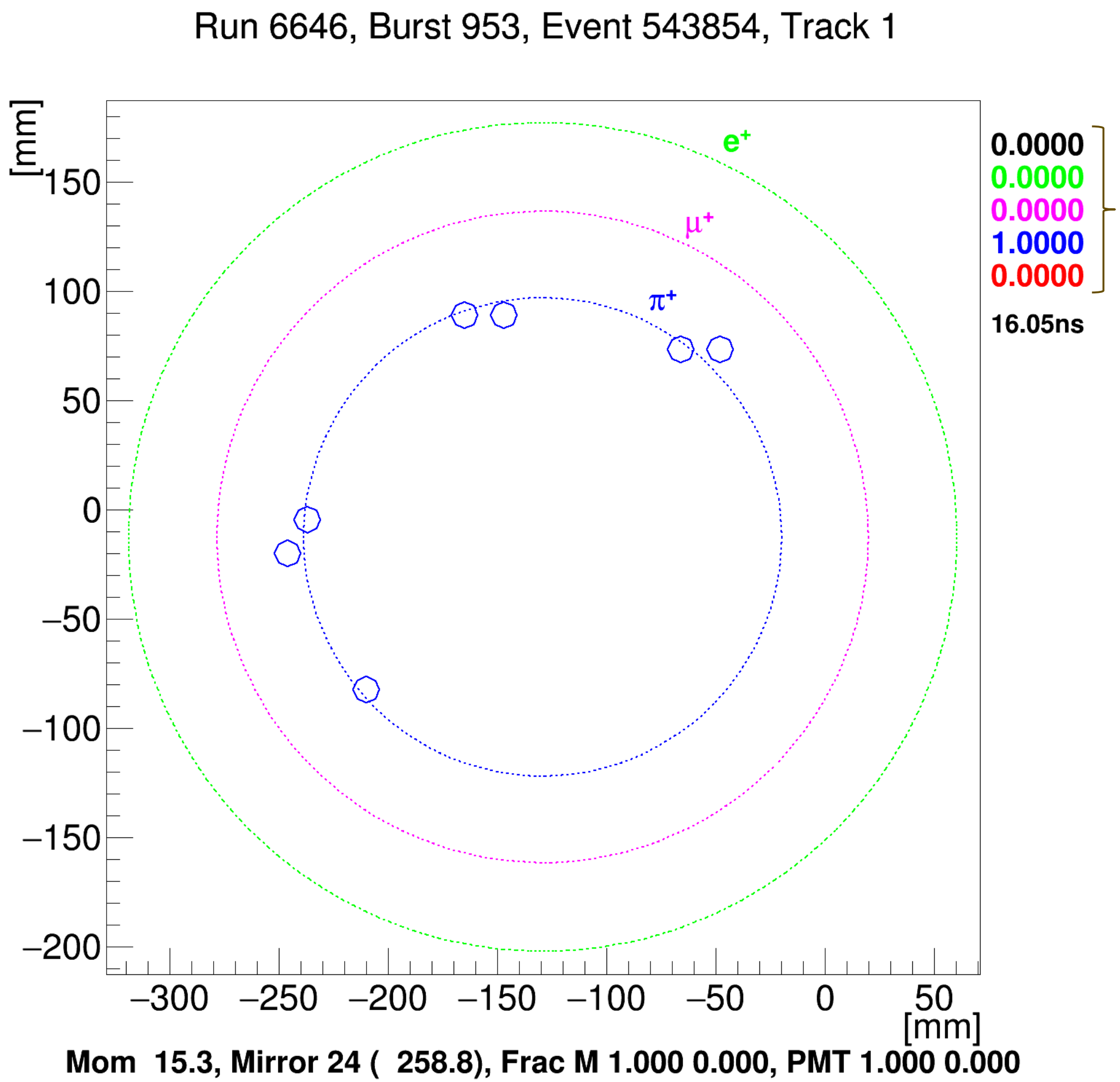
$K^+ \rightarrow \pi^+\nu\bar{\nu}$ MC
data
m^2_{miss} [GeV^2/c^4]
0.12
0.1
0.08
0.06
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
15
20
25
30
35
π^+ momentum [GeV/c]

Result



m^2_{miss} [GeV^2/c^4]
0.12
0.1
0.08
0.06
0.04
0.02
0
−0.02
−0.04
−0.06
−0.08
15
20
25
30
35
π^+ momentum [GeV/c]
$K^+ \rightarrow \pi^+\nu\bar{\nu}$ MC
data
One Event in R2

The Event in the RICH



Likelihood value under different mass hypothesis

Preliminary Results

Events Observed	1
SES	$(3.15 \pm 0.01_{\text{stat}} \pm 0.24_{\text{syst}}) \cdot 10^{-10}$
Expected Background	$0.15 \pm 0.09_{\text{stat}} \pm 0.01_{\text{syst}}$

$$BR(K^+ \to \pi^+\nu\bar{\nu}) < 11 \times 10^{-10} \text{ @ } 90\% \; CL$$

$$BR(K^+ \to \pi^+\nu\bar{\nu}) < 14 \times 10^{-10} \text{ @ } 95\% \; CL$$

- Expected limit: $BR(K^+ \to \pi^+\nu\bar{\nu}) < 10 \times 10^{-10} \text{ @ } 95\% \; CL$
- For comparison $BR(K^+ \to \pi^+\nu\bar{\nu}) = 2.8^{+4.4}_{-2.3} \times 10^{-10} \text{ @ } 68\% \; CL$

$BR(K^+ \to \pi^+\nu\bar{\nu})_{SM} = (0.84 \pm 0.10) \times 10^{-10}$ SM prediction

$BR(K^+ \to \pi^+\nu\bar{\nu}) = (1.73^{+1.15}_{-1.05}) \times 10^{-10}$ BNL E949/E787 Kaon Decay at Rest

Prospects

- Processing of 2017 data on going
  - 20 more than the presented statistic
  - Upstream background reduction expected
  - Improvements on reconstruction efficiency
- Preparing 2018 data taking
  - 218 days including stops
  - Studies to improve signal acceptance on going
- 20 SM events expected before LS2
- Running after 2018 to be approved
  - Conditions for ultimate sensitivity under evaluation

Summary

- The new NA62 decay in flight technique to study $K^+ \to \pi^+ \nu\bar{\nu}$ works
- One event observed in 2016 data
- $BR(K^+ \to \pi^+ \nu\bar{\nu}) < 14 \times 10^{-10}$ @ 95% CL Preliminary
- O(20) events expected from 2017+2018 data.