

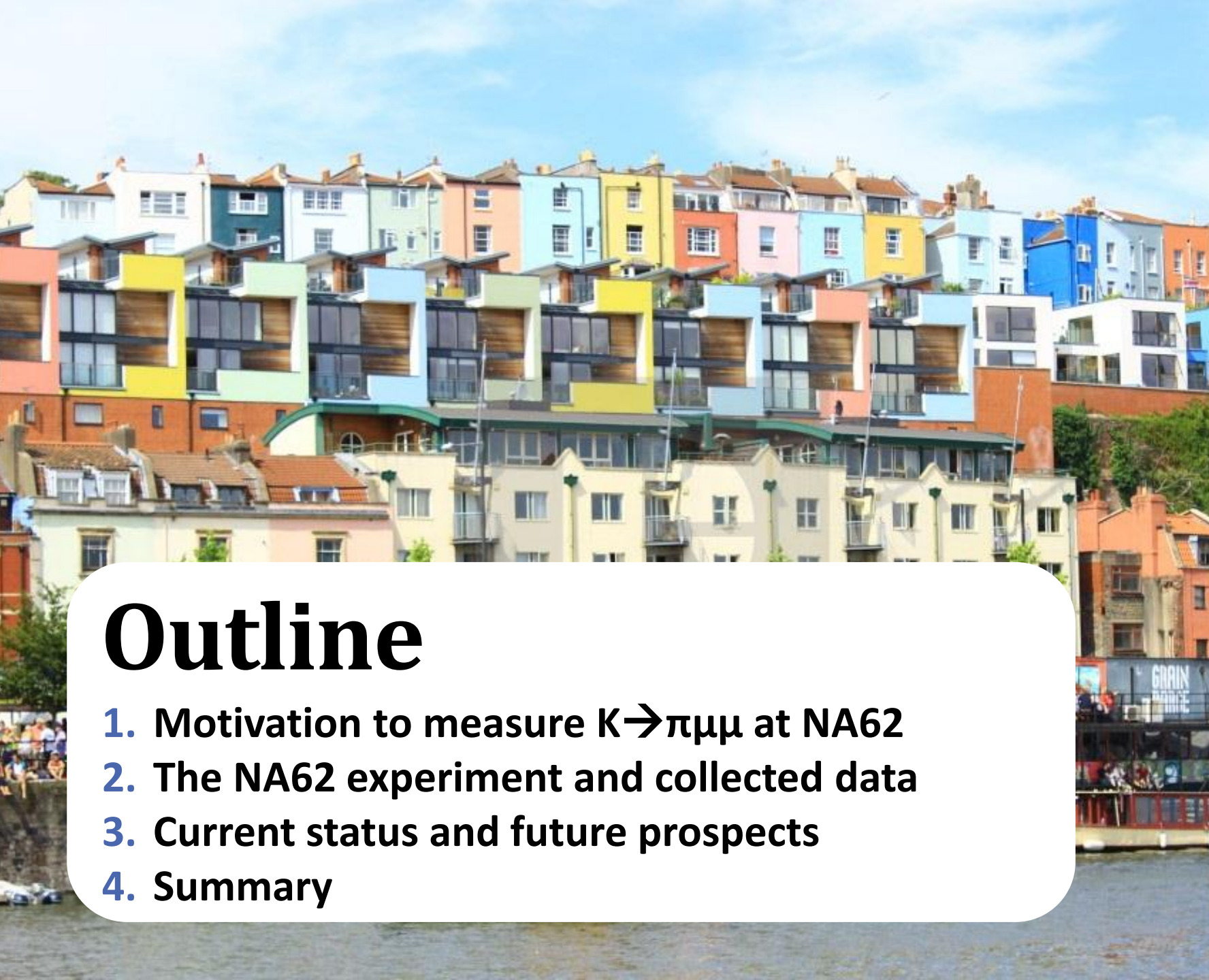


$K \rightarrow \pi\mu\mu$ from NA62

Chris Parkinson, University of Birmingham

IOP Joint APP & HEPP Conference

University of Bristol 2018



Outline

1. Motivation to measure $K \rightarrow \pi\mu\mu$ at NA62
2. The NA62 experiment and collected data
3. Current status and future prospects
4. Summary

Motivation

- Rare FCNC decay $K^+ \rightarrow \pi^+ \mu^+ \mu^-$ can be studied at **NA62**
- Decay rate accessible via measurement of the **form-factor**
- Decay rate has large long-distance component – new physics sensitivity reduced compared to other FCNCs
- But can be compared to that of the electron mode

$$R_{K3} = \frac{B(K^+ \rightarrow \pi^+ \mu^+ \mu^-)}{B(K^+ \rightarrow \pi^+ e^+ e^-)}$$

- Several interesting forbidden decays with same topology:

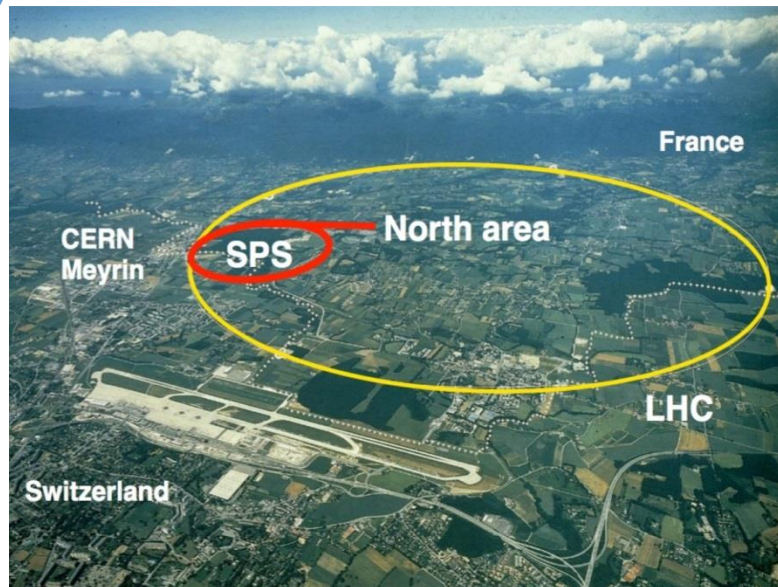
$K^+ \rightarrow \mu^+ N, N \rightarrow \mu^+ \pi^-$ **Heavy Neutrino (LNV)**

$K^+ \rightarrow \mu^+ N, N \rightarrow \pi^+ \mu^-$ **Heavy Neutrino (LNC)**

$K^+ \rightarrow \pi^+ X, X \rightarrow \mu^+ \mu^-$ **$X = \{\text{Inflaton, ...}\}$**

The NA62 experiment

NA62 at CERN



The NA62 collaboration

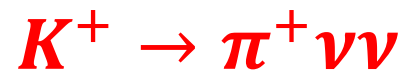
About 200 participants
from 28 institutes

Running periods in **2007-2008**
and **2015-2018**

The NA62 physics programme

R_K (2007)

[Phys.Lett. B719 (2013) 326]



★ Rare/forbidden
Kaon decays ★

Exotic processes

The NA62 experiment

The NA62 physics programme

R_K (2007)

[Phys.Lett. B719 (2013) 326]

$K^+ \rightarrow \pi^+ \nu \nu$

★ Rare/forbidden
Kaon decays ★

Exotic processes

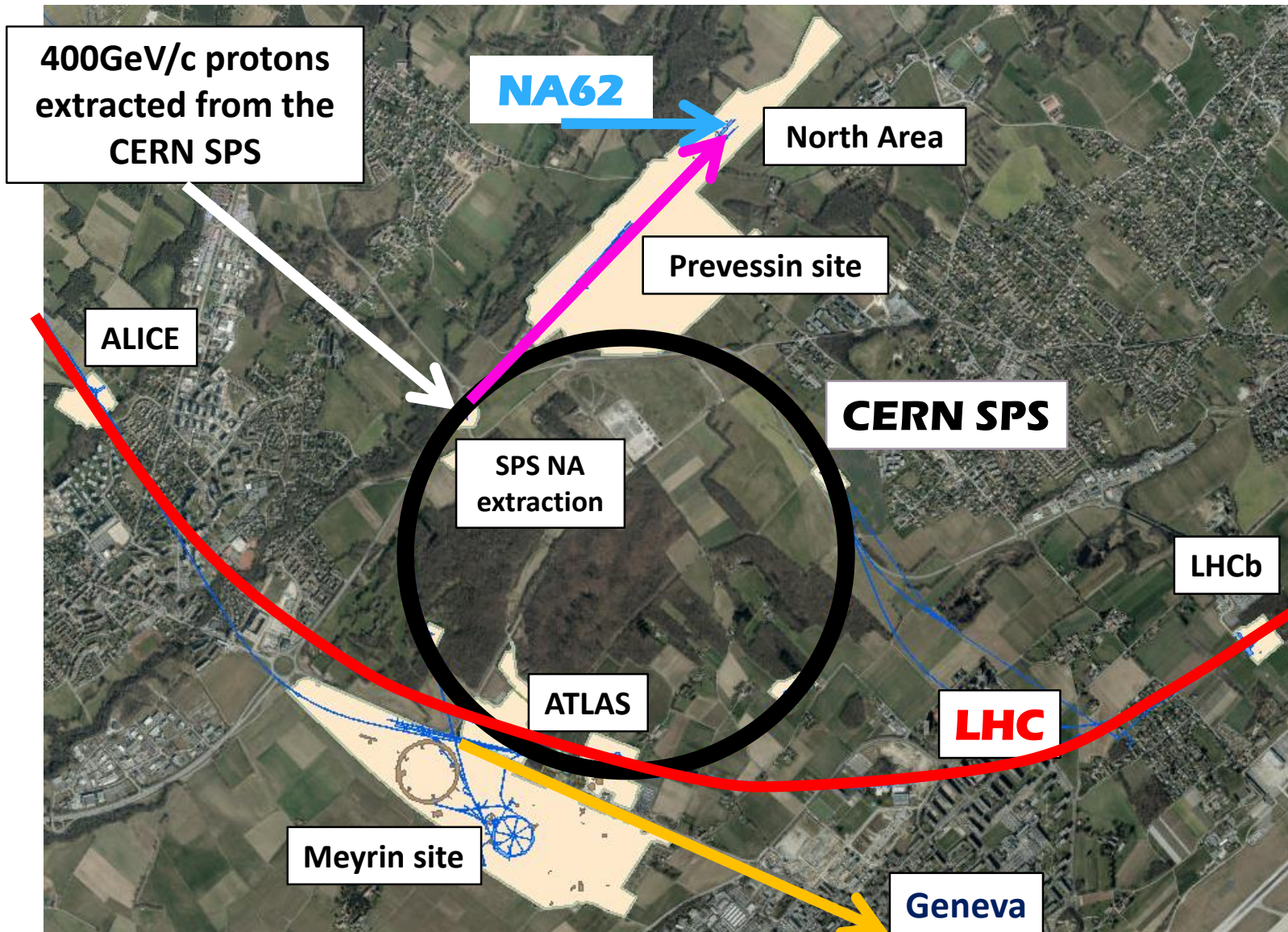
At this conference:

New results in talk by **A. Romano**

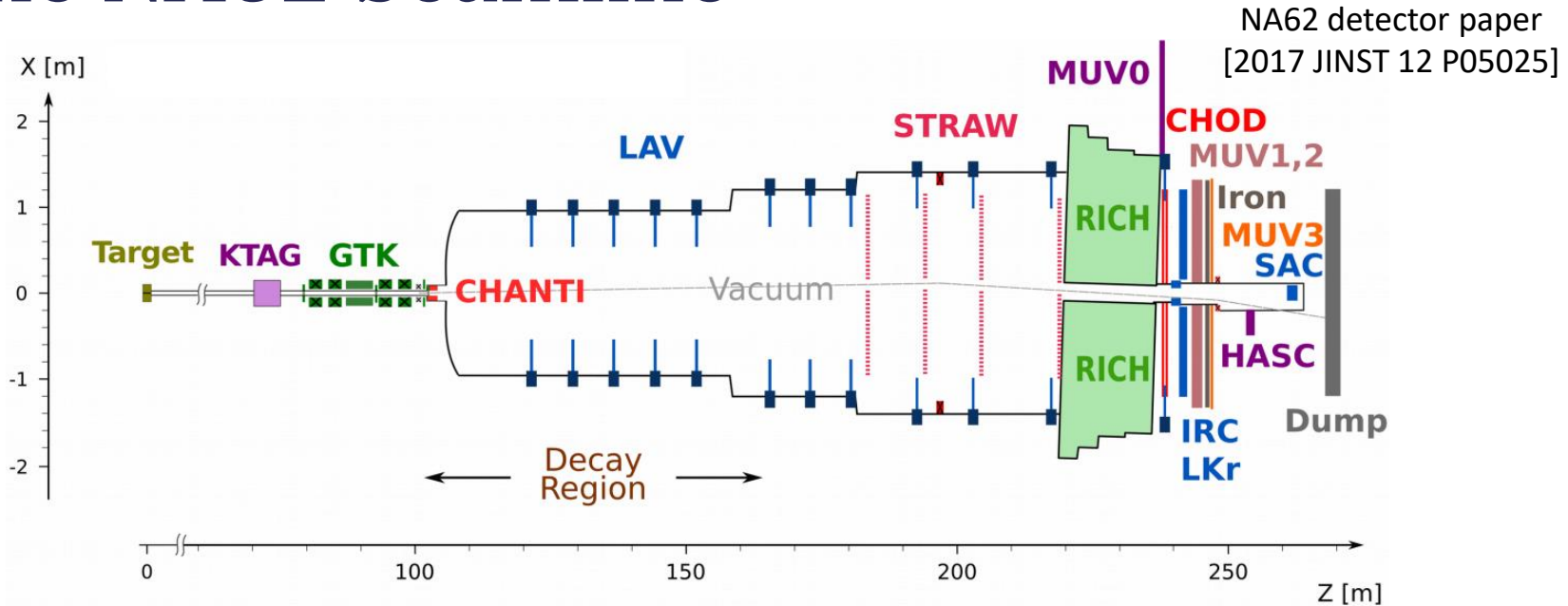
Talk and poster by **M. B. Brunetti**
Talk by **S. Duk**
Talk by **S. Trilov**

Talk and poster by **L. Iacobuzio**

The NA62 experiment

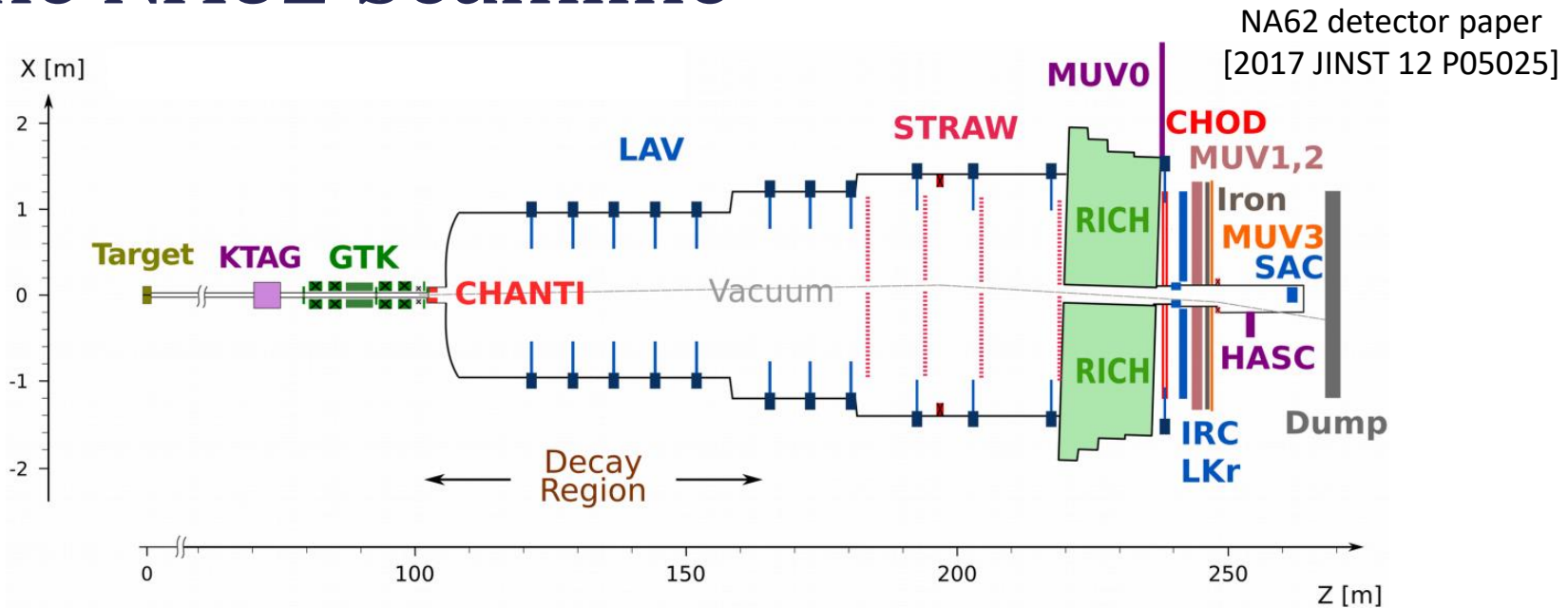


The NA62 beamline



- Protons with momenta of **400 GeV/c** from the CERN SPS are extracted to the North Area in **spills of 5 seconds duration**
- Interactions with the **target** produce a secondary beam of hadrons
- **Positive hadrons** are momentum-selected to **within 1% of 75GeV/c**
 - **750 MHz** of particles in the beam
 - 70% pions, 24% protons, **6% kaons**

The NA62 beamline



- Positive hadrons are transported from the **target** to the ~ 75 m long **vacuum decay region** (105 to 180m), passing through the upstream detectors: **KTAG**, **GTK**
- About **20%** of Kaons decay within the vacuum decay region
- The Kaon decay products traverse the downstream detectors for particle measurement (**STRAW**, **CHOD**), particle identification (**RICH**, **LKr**, **MUV**) and photon rejection (**LAV**, **IRC**, **SAC**)

NA62 data sets (relevant to this talk)

- **2016A**: 75k bursts at 40% nominal beam intensity

πμμ

RICH & QX & MO2

D=1

KTAG → !LAV → STRAW

Κ3π

RICH & QX

D=50

KTAG → !LAV → STRAW

- **2017**: 340k bursts at 60% nominal beam intensity

- **2017A**: 85k bursts of 2017 dataset

πμμ

RICH & QX & MO2

D=2

KTAG → STRAW

Κ3π

RICH & QX

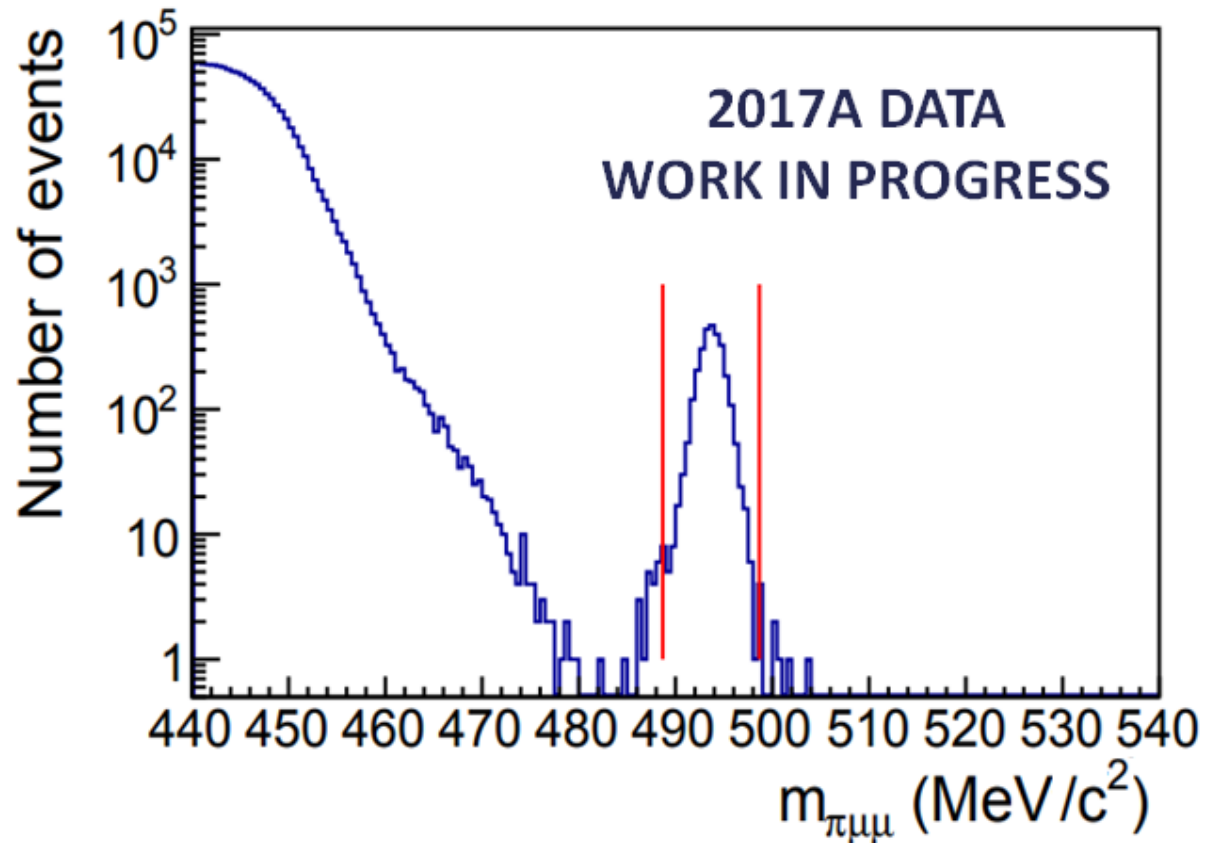
D=100

KTAG → STRAW

- **2018**: Expecting another “2017” dataset

$K \rightarrow \pi \mu \mu$ event sample

- Sample of **2780 $K \rightarrow \pi \mu \mu$** events well separated from the specific **$K3\pi \rightarrow 2\mu$** background
- Expect **$\sim 22\text{k}$** candidates from the “Run2” dataset
(more than **7x** current largest sample)



Future prospects and outlook

- With **2750** candidates in **2017A**, we expect:
 - **2017** to contain **11000** candidates
 - **2018** to contain a further **11000** candidates
- A total of **22k candidates** (>**7x** current largest sample)
- **Background reduced to a very low level**
 - Mass resolution: $\sigma_m \approx 1.1 \text{ MeV}^2/c^4$
 - Signal events **well separated from background**
- Large event sample **excellent to search for forbidden decays**
- Measurement of **SM form-factor** needs good control of **systematic uncertainties** (at the level of 1%)
 - Experimental environment in **NA62** is challenging
 - **Work is ongoing** to control **systematic uncertainties**, particularly those related to **the trigger**

Summary

- The **NA62** experiment is **taking data** at CERNs North Area
- Data collected in **2016, 2017** (and **2018**) with multi-track triggers → **SM measurements** and **searches for BSM physics**
- NA62 expects to collect about **22k** $K \rightarrow \pi \mu \mu$ decays by the end of 2018 (more than **7x** the current largest dataset)
- Good prospects of searches for **BSM physics**
- Work continuing on **measurement of SM form-factor**