Rapporto attività LNF 2019

NA62

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The NA62 Experiment

The branching ratio (BR) for the decay $K^+ \rightarrow \pi^+\nu\nu$ can be related to the value of the CKM matrix element V_{td} with minimal theoretical uncertainty, providing a sensitive probe of the flavor sector of the Standard Model (SM). The goal of the NA62 experiment at the CERN SPS is to detect ~100 $K^+ \rightarrow \pi^+\nu\nu$ decays with a S/B ratio of 10:1.

The experiment makes use of a 75 GeV unseparated positive secondary beam. The total beam rate is 800 MHz, providing ~50 MHz of K^+s. The decay volume begins 102 m downstream of the production target. 5 MHz of kaon decays are observed in the 65-m long fiducial vacuum decay region by means of tracking and particle identification systems. Ring-shaped large-angle photon vetoes (LAVs) are placed at 12 stations along the decay region and provide full coverage for decay photons with 8.5 mrad $< \theta <$ 50 mrad. The last 35m of the decay region hosts a dipole spectrometer with four straw-tracker stations operated in vacuum. The NA48 liquid-krypton calorimeter (LKr) is used to veto high-energy photons at small angle. Additional detectors further downstream extend the coverage of the photon veto system (e.g., for particles traveling in the beam pipe).

LNF group activity: Large Angle Veto detectors

The principal achievements of the photon-veto working group in 2019 were in the assessing the performances of the Large-Angle Veto (LAV) system, and of the Small photon veto system (SAV) which are a responsibility of the LNF group, as well as providing general support to the experiment, assisting with run planning and coordination, and participating in data taking. Particular progress on the was made in the following areas:

- Improvement of the level-zero trigger firmware of the level-one trigger.
- Implementation and optimization of the reconstruction code.
- Improvement of the tools for data quality monitoring.
- Analysis of 2016, 2017 data and measurement of system performances.
- Coordination of the exotic physics working group.
- Feasibility studies for the experimental program after the end of LHC Run 2.

The LAV system consists of 12 detector stations arranged at intervals of 6 to 10 m along the vacuum tank along its entire length. Each station consists of four or five rings of lead glass blocks, with the blocks staggered in azimuth in successive rings. The total depth of a five-layer station is 27 radiation lengths. This structure guarantees high efficiency, hermeticity, and uniformity of response.

The readout chain for the LAV stations consists of two different types of boards, a dedicated front-end board (LAV-FEE) developed for the LAV detector, and a common digital readout board called TEL62, used by many of the NA62 detectors. This allows the measurement of the time with a resolution of about 1 ns, fig. **LAV-1** and gives a measurement of the amplitudes using the time-over-threshold (ToT); moreover FPGAs on board the TEL62 are used to correct raw hit times for slewing and to produce a level-zero (L0) trigger primitive.

The particles traversing the LAV detectors mainly consist of photons from kaon decays, as well as muons and pions in the beam halo. For each incoming particle, the veto detectors are expected to provide a time measurement with 1-ns resolution and an energy measurement of moderate precision (of order 10%). To maintain the detection efficiency as high as possible for muons and low energy photons, the system must be operated with thresholds of a few millivolts, i.e., well below the signal amplitude for minimum-ionizing particles (MIP).

We have studied the detection efficiency for photons using a clean sample of $K^+ \rightarrow \pi^+\pi^0$ decays in which the π^+ track is reconstructed, one of the two photons from the π^0 is detected as an LKr calorimeter cluster, and the second photon is expected to be found in one of the LAV detectors on the basis of kinematic closure. A complete kinematic fit making use of all available information on the K^+ trajectory from the Gigatracker is then performed. Events are considered to be successfully matched if they contain at least one LAV block fired within 5 ns of the $K^+ \rightarrow \pi^+\pi^0$ event time from the reference detector. MC studies demonstrate that the photon detection inefficiency as determined by this method is dominated by geometrical inefficiencies and upstream photon conversions, which are quite important for the downstream LAVs. Relying on the MC estimate for the contribution from the former effects, we find the intrinsic inefficiency to be a few 10^{-3}. The measured efficiency as function of the photon energy is shown in fig. **LAV-2.** We note, however, that obtaining an accurate tag for the determination of the single-photon detection efficiency at the level of 10^{-3} or lower is difficult; determination of the experiment's π^0 overall rejection power is both easier and more directly relevant for the measurement of BR $K^+ \to \pi^+ \nu\nu$

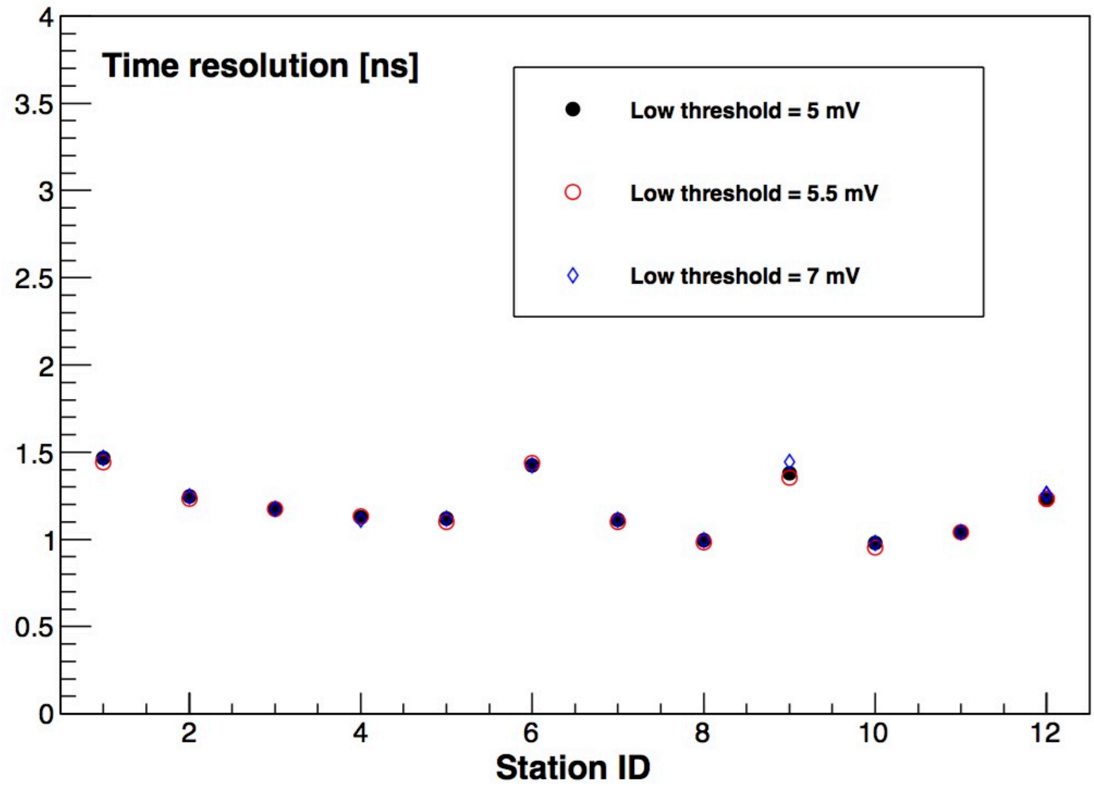


Figure LAV-1. Difference between LAV hit time and event time from KTAG (ns) for different thresholds, for the twelve stations.

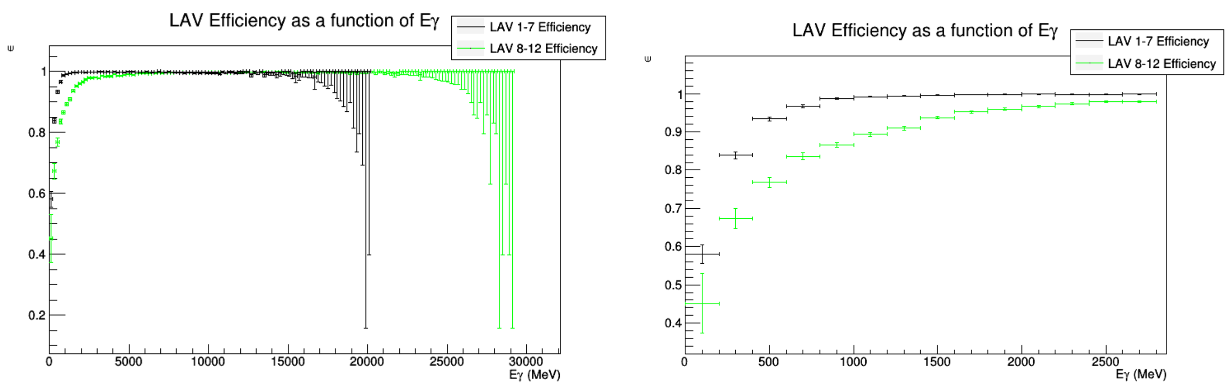


Figure LAV-2. LAV efficiency as function of the photon energy.

LNF group activity: SAC and IRC

The small-angle veto detectors, SAC and IRC, are shashlyk type electromagnetic calorimeters that provide veto coverage for photons with polar angles down to zero degrees. They are exposed to a very high rate of photons from kaon decays and, for the IRC, muons from pion and kaon decays. After a comprehensive design review in early 2014, the IRC was assembled at Frascati and shipped to CERN for installation before the first NA62 run. The performance of these detectors was studied in detail in 2019.

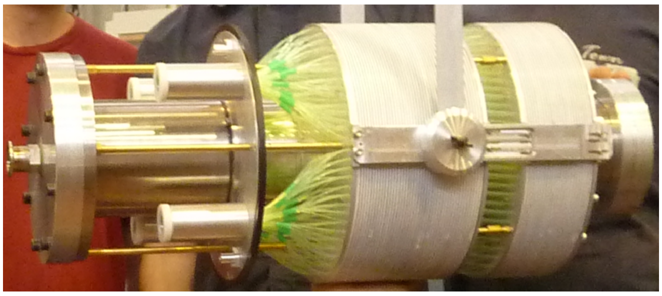


Figure SAV-1. The IRC assembly before shipping to CERN.

Both detectors have been operated since the beginning of NA62 data taking. The signals were read out with the standard NA62 readout system, based on the LAV-FEE and TEL62 boards, as described above. In the same way as for as for LAV12, L0 primitives were generated for the IRC and SAC. Copies of the IRC and SAC signals were also provided to the LKr calorimeter readout modules, so that the SAC and IRC were also available for use in the L0 trigger from the calorimeter readout chain.

A simple online monitor was implemented for the SAC and IRC, based only on the total normalized rate, defined as the total number of hits in each detector normalized to the total number of recorded events for each burst, as shown in Figure SAV-2. This allowed monitoring of changes in the trigger definition and beam alignment, in addition to the proper operational status of the detectors.

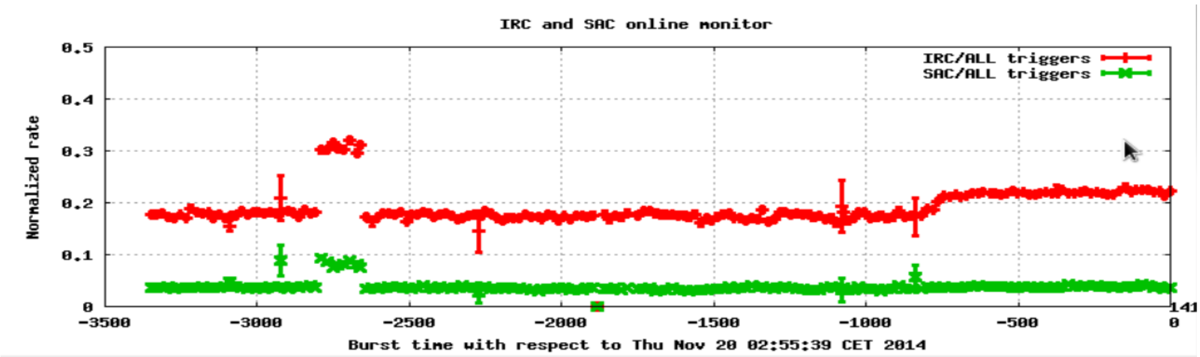


Figure SAV-2. The online monitor for the SAC and IRC.

The response of both detectors to MIPs was studied with data from muon runs. The SAC and IRC event rates for different thresholds were fit with a cumulative Landau distribution function. The most probable value for the MIP signal amplitude was found to be around 4 mV, which is consistent with expectation, and stable in both data sets. The time resolution for muons was better than 2 ns for the SAC and better than 1.6 ns for the IRC, while the time resolution measured with tagged photons from $K^+ \to \pi^+\pi^0$ decays was better than 1 ns. The IRC inefficiency was measured with $K^+ \to \pi^+\pi^0$ decays; an inefficiency on the order of a few 10^{-4} was obtained.

LNF group activity: Data analysis

The NA62 experiment collected data throughout the period 2016-2018 for a total of about $6x10^{12}$ kaon decays in the fiducial volume. Major achievements from the first NA62 run include the following:

- The new in-flight technique to measure the branching ratio of the ultra-rare decay $K^+ \to \pi^+\nu\nu$ has been established and proven to work.
- The first NA62 physics result on $K^+ \to \pi^+\nu\nu$, based on the 2016 data set, was obtained in 2018 and published in early 2019 [1].
- The analysis of the 2017 data set has been completed and the preliminary results shown at major conferences.

The 2018 data taking lasted for 217 days. The beam intensity was kept stable at 60-70% of the nominal value, corresponding to about 2 – 2.3 $x10^{12}$ protons per pulse (ppp), an optimal value for efficient data taking. Towards the end of 2018 data taking, several test runs were taken at 100% nominal beam intensity to investigate trigger and detector performance. In addition, about one week was dedicated to data collection in beam dump mode. The 2018 data taking was very successful and proceeded very smoothly, mainly due to the stable beam delivered by the SPS and the good performance of the hardware. The LNF group had a crucial role in data taking and analysis.

The first $K^+ \to \pi^+\nu\nu$ analysis was performed on a sample of data taken from mid-September to mid-October 2016. This data set was acquired at an average intensity of 35-40% of the nominal value. In 2016, the spill structure of the SPS beam was irregular, with intensity spikes causing NA62 to sustain running at instantaneous intensities significantly greater than the nominal intensity for periods lasting for several ms.

A blind procedure was adopted for the 2016 analysis, with signal and control regions kept masked until the evaluation of the expected signal and background was completed. The branching ratio of $K^+ \rightarrow \pi^+\nu\nu$ predicted by the SM is $BR(K^+ \rightarrow \pi^+\nu\nu) = (0.84 \pm 0.10) \times 10^{-10}$. Specifically selected control samples of $K^+ \rightarrow \pi^+\pi^0(\gamma)$, $K^+ \rightarrow \pi^+\nu(\gamma)$ and $K^+ \rightarrow \pi^+\pi^+\pi^-$ decays are employed for background studies.

The analysis is mostly based on kinematic cuts and particle identification. The invariant $m^2_{miss} = (p_{K+} - p_{\pi+})^2$ is used to discriminate between the signal and background kinematics, where p_{K+} and $p_{\pi+}$ are the K^+ and π^+ 4-momenta, respectively. Figure **ANA-1** (left) shows the distribution of the selected K^+ decays in the $(m^2_{miss}, P_{\pi+})$ plane, with $P_{\pi+}$ the magnitude of the π^+ 3-momentum. Regions populated mostly by $K^+ \rightarrow \pi^+\pi^0(\gamma)$, $K^+ \rightarrow \pi^+\nu(\gamma)$ and $K^+ \rightarrow \pi^+\pi^+\pi^-$ are visible. Two signal regions are defined: the region at lower (higher) m^2_{miss} is referred as region 1 (2). The m^2_{miss} resolution is of the order of 10^{-3} GeV^2/c^4 for the $K^+ \rightarrow \pi^+\pi^0(\gamma)$, and this drives the choice of the boundaries of these regions.

The analysis is restricted to $15 < P_{\pi+} < 35$ GeV/c. This cut reduces the signal acceptance by half, but ensures that there is at least 40 GeV/c of missing energy, improving significantly the π^0 detection. The calorimeters and RICH provide π^+ identification and the photon veto system ensures rejection of photons with angles from 0 up to 50 mrad with respect to the beam axis.

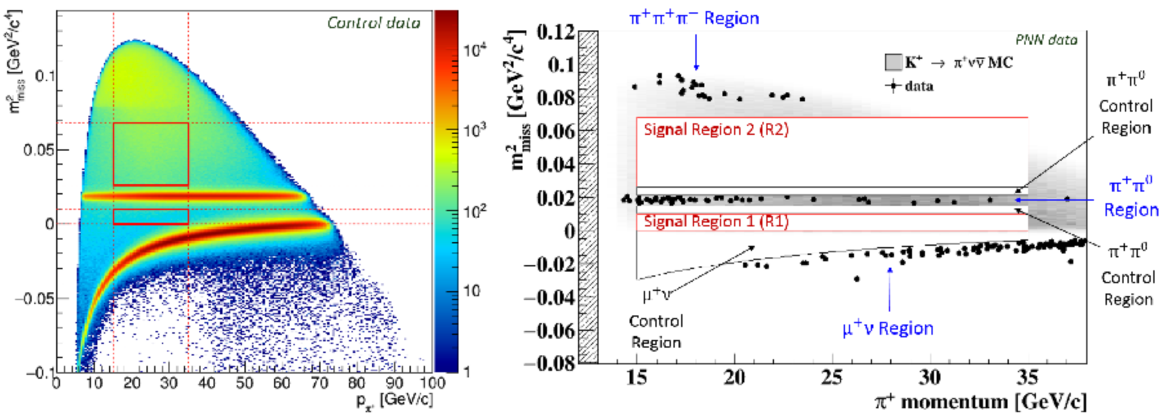


Fig ANA-1 Left: m^2_{miss} as a function of $P_{\pi+}$ for control data after K^+ decay selection. The red boxes define the signal regions. Right: m^2_{miss} as a function of $P_{\pi+}$ for $\pi^+\nu\nu$-triggered events (dots) passing the selection. The grey area corresponds to the distribution of MC signal events, with darker (lighter) grey indicating more (less) populated regions. The red (black) lines define the signal (control) regions and are masked. Three background regions are also shown.

The single-event sensitivity SES is defined as $1/(N_K\, \varepsilon_{\pi+\nu\nu})$, where N_K is the number of K^+ decays in the fiducial volume and $\varepsilon_{\pi+\nu\nu}$ is the signal efficiency for the selection.

Both are derived from the data using control samples and from simulation. The final measured SES and the corresponding total number of SM expected $K^+ \to \pi^+ \nu\nu$ events in signal regions 1 and 2 are

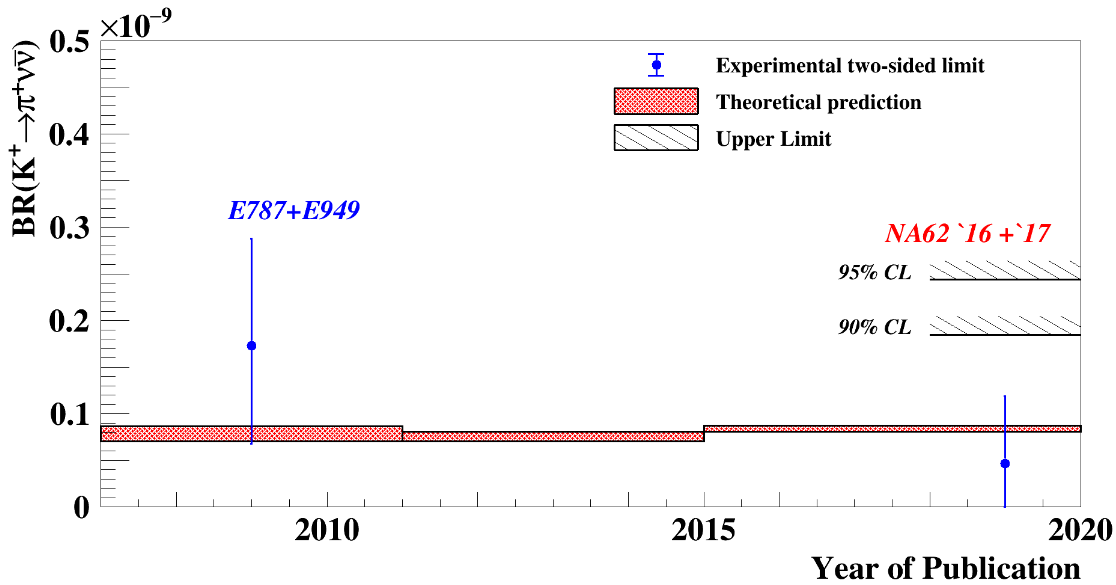
SES = (3.15 ± 0.01stat ± 0.24syst) x10^{-10};
Nexp(SM) = 0.267 ± 0.001stat ± 0.020syst ± 0.032ext.

The fraction of background events entering each signal region via the reconstructed tails of the corresponding m^2_{miss} peak is modeled with data control samples and corrected with MC simulation for biases induced by the selection criteria. The total background is estimated to be 0.15 ± 0.09stat ± 0.01syst events. After un-blinding the signal regions, one event is found in region 2. The corresponding π^+ has a momentum of 15.3 GeV/c. The RICH clearly indicates that it is a pion. A preliminary upper limit on the branching ratio of the $K^+ \to \pi^+ \nu\nu$ decay is derived from these results using the CLs method: BR($K^+ \to \pi^+ \nu\nu$) < 14 x 10^{-10} @ 95% CL. The same analysis has been performed on the 2017 data set, with 2 events found in signal region 2. Combining the 2016-2017 results we obtain:

S.E.S	$(0.346 \pm 0.017) \times 10^{-10}$
Expected background	1.65 ± 0.31
Observed events	3

$$BR(K^+ \to \pi^+ \nu\bar{\nu}) < 1.85 \times 10^{-10} \; @ \, 90\% \; CL$$

$$BR(K^+ \to \pi^+ \nu\bar{\nu}) = 0.47^{+0.72}_{-0.47} \times 10^{-10} \; @ \, 68\% \; CL$$



The LNF group has made fundamental contributions this analysis, in particular, in the measurement of the photon veto efficiency and the determination and improvement of the random veto efficiency.

The LNF group has also carried out a search for the invisible decays of the π^0 in NA62 data. Historically, the decay $\pi^0 \to \nu\nu$ has been of interest for the study of neutrino properties such as mass, helicity and number of families. At present, the main interest in the search for a π^0 decay to any invisible final state is in testing new-physics scenarios involving feebly-interacting or long-lived particles. Any observation of $\pi^0 \to$ invisible at the sensitivity currently achievable would be a clear indication of new physics. The direct experimental limit on the tau neutrino mass and the stringent limit set by cosmological constraints on the sum of the neutrino masses corresponds to $BR(\pi^0 \to \nu\nu) < 5 \times 10^{-10}$ at 90% confidence level (CL) and $BR(\pi^0 \to \nu\nu) < 10^{-24}$, respectively; the latter is well below the achievable experimental sensitivity. The current experimental limit is 2.7×10^{-7} at 90% CL.

The search for $\pi^0 \to$ invisible is performed with the decay chain $K^+ \to \pi^+\pi^0(\gamma)$, $\pi^0 \to$ invisible, inclusive of radiative corrections to the K^+ decay.
With a sample of 4×10^9 tagged π^0 mesons with an expected background rejection of 3×10^{-9}, no signal is found. The resulting 90% CL upper limit on the branching ratio $\pi^0 \to$ invisible is $BR(\pi^0 \to \text{invisible}) < 4.4 \times 10^{-9}$. This limit improves on the present literature by a factor of 60.

Exotic physics searches at NA62 are coordinated by the LNF group and are a major focus of the group's activity. NA62 is particularly suited for searching for new physics effects from different scenarios because of the high-intensity of the beam, the flexibility of the trigger system, and the performance of the detectors for high-frequency beam tracking, redundant PID, and ultra-high-efficiency photon vetoes.

One possible extensions of the SM aimed at explaining the abundance of dark matter in our universe predicts a new U(1) gauge-symmetry sector, with a vector mediator field A', called the "dark photon". In a simple realization of such a scenario, the A' field would (feebly) interact with the SM photon through a kinetic-mixing Lagrangian with a coupling parameter ε. In a general picture, the kinetic-mixing Lagrangian might be accompanied by further interactions, both with SM matter fields and with a secluded, hidden sector of possible dark-matter candidate fields. If these are lighter than the A', the dark photon would decay mostly invisibly, so that a missing-energy signature might reveal its presence.

In NA62, the search for the dark photon A' in the decay chain $K^+ \to \pi^+\pi^0$, $\pi^0 \to A'\gamma$, $A' \to$ invisible has been performed using part of the 2016 data set. The squared missing $m^2_{miss} = (p_K - p_\pi - p_\gamma)^2$ is expected to peak around the value of the squared A' mass for the signal and around zero for the dominant background due to $\pi^0 \to \gamma\gamma$ decays with one photon undetected. A peak search has been conducted, comparing signal-selected samples and data-driven background estimates. No significant statistical excess has been identified and upper limits on the coupling strength ε^2 in the mass range 30-130 MeV/c^2 have been set at the level between 2 x10^{-6} and 2x10^{-7}, improving on the previous limits over the mass range 60-110 MeV/c^2 (fig. **ANA-2**)

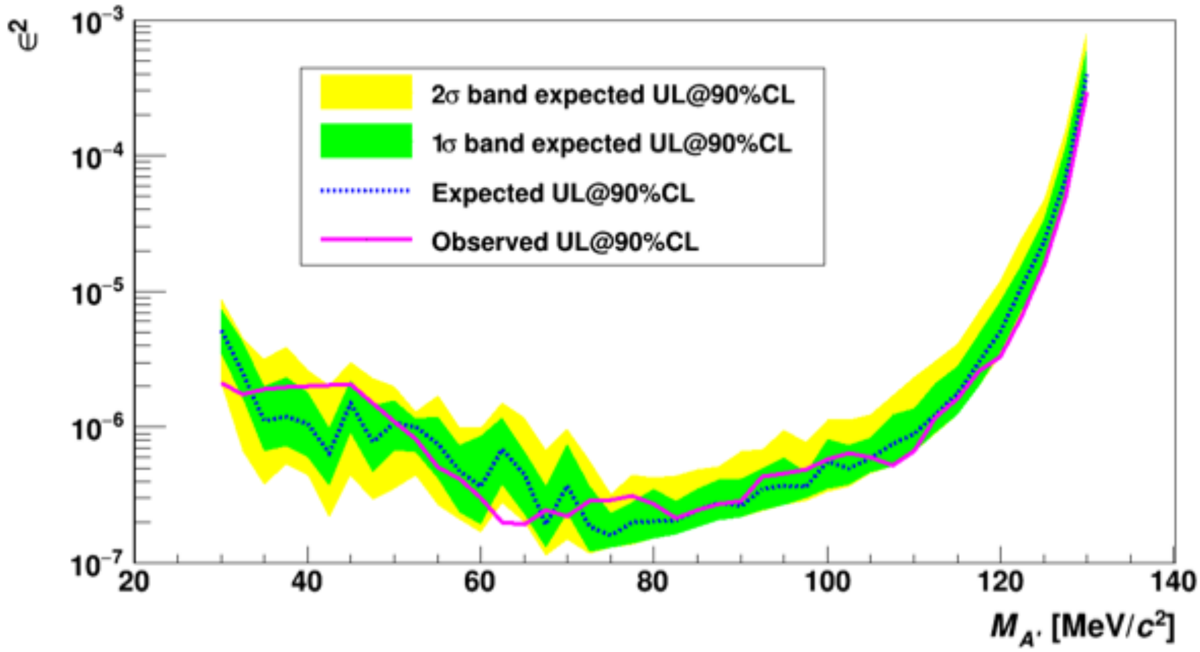


Fig **ANA-2**: 90%-CL upper limit in the ε^2 vs M_A plane. The limit obtained from data (solid line) should be compared to that expected in the absence of signal: the median of the upper-limit distribution in the background-only hypothesis is shown by the dashed line and the corresponding fluctuation bands with 68% and 95% coverage are shown by the shaded areas.

LNF group activity: Future activties

For the past few years, the LNF group has been leading the effort within the NA62 Collaboration to develop a vision for the evolution of the experimental program after the end of LHC Run 2. LNF group members represent NA62 in the CERN Physics Beyond Colliders working group in two different areas: in initiatives to carry out exotic physics searches in NA62 and a possible NA62 run in dump mode, and for feasibility studies for a future measurement of the BR($K_L \rightarrow \pi^0 \nu\nu$).

Exotic physics :
A one-year-long run in “beam-dump” mode using the NA62 detector will allow access to a new program of NP searches for MeV-GeV mass hidden-sector candidates, including dark photons, heavy neutral leptons, and axion-like particles (ALPs). Dark photons and heavy neutral leptons can be identified as displaced leptonic or semileptonic two-body decays originating from the T10 target,
Assuming a total exposure of 2x10^{18} 400-GeV POT and zero background, the expected 90%-CL exclusion plots for dark photon and heavy neutral lepton production are obtained, as shown in fig. **ANA-3.**

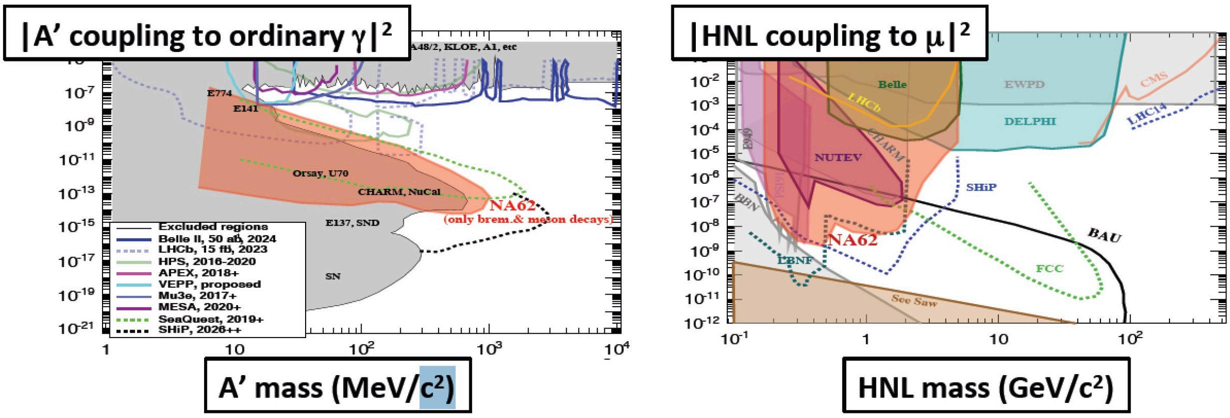


Fig **ANA-3**: Expected 90% CL upper limits in the coupling vs mass plane for dark photons (left) and heavy neutral leptons (right).

The search for axion-like particles produced by the Primakov process in the TAX collimator has been also studied**.** The expected 90%-CL exclusion plot for ALP decays to γγ in the NA62 fiducial volume assuming zero-background is shown in fig **ANA-4**.

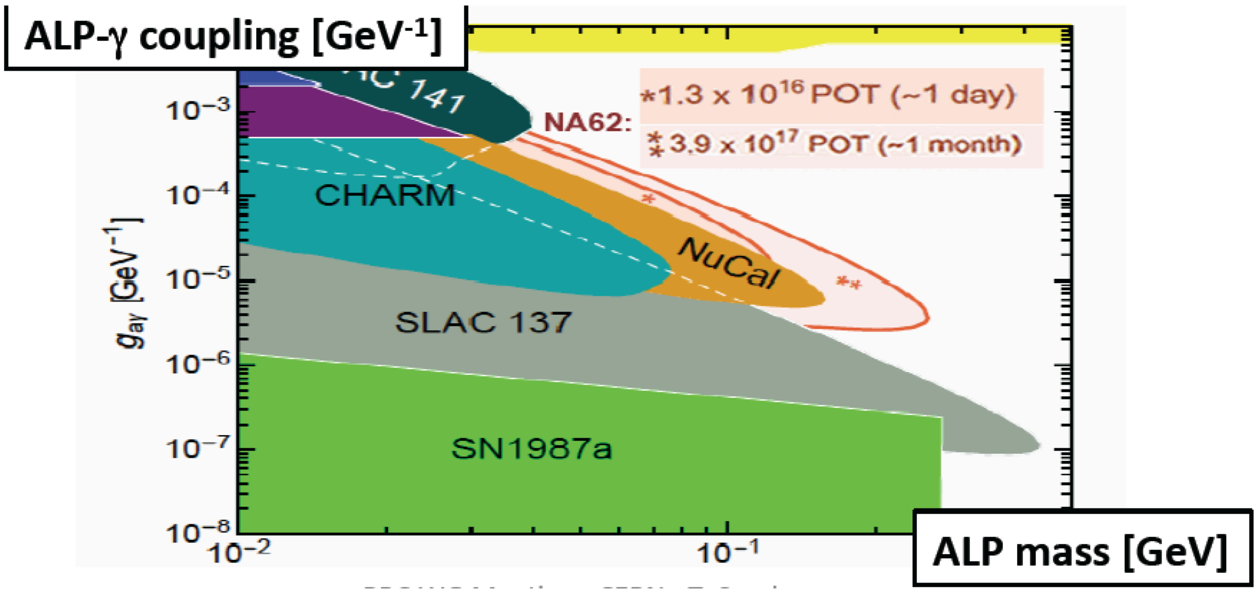


Fig **ANA-4**: 90%-CL upper limit in the coupling vs mass plane for ALPs

For this search, two dedicated runs of a few hours each were taken in November 2016. In these runs the T10 target was removed and the proton beam was dumped entirely into the TAX collimators. If backgrounds can be sufficiently rejected, the data taken so far could be enough to slightly improve the sensitivity for these particles beyond existing limits in the region of a few tens of MeV in an as-yet untested region of the two-photon coupling. For the analysis of these runs, the data reconstruction has recently been adapted to facilitate background rejection.

KLEVER:

In order to make full use of the power of the $K \rightarrow \pi\nu\nu$ decays in the search for new physics, it is important to measure both decay modes, $K^+ \rightarrow \pi^+\nu\nu$ and $K_L \rightarrow \pi^0\nu\nu$.The LNF group is leading the effort to perform detailed design studies for an experiment (KLEVER) to measure BR($K_L \rightarrow \pi^0\nu\nu$) at the CERN SPS to succeed NA62.

During 2019, there was significant progress on feasibility studies for KLEVER. Following up on the optimization of the experimental layout and beamline performed in 2018, a detailed simulation of the neutral beam with FLUKA was used to calculate hit and event rates on all of the detectors, and further optimizations to the collimation and muon-sweeping schemes were made to ensure that the rate of accidental coincidences can be handled. Radiation dose rates at the surface above the ECN3 experimental hall were estimated and mitigation measures proposed to keep surface doses to acceptable levels in the area just downstream of the experiment. Thermal simulations of the present target and dump collimator were performed and showed the need for substantial upgrades. A CNGS-like target design with a beryllium or carbon target, carbon-fiber supports and pressurized air cooling was proposed, together with a collimator design incorporating water cooling tubes placed closer to the beam impact region. The FLUKA Monte Carlo was also used to estimate the number of background events from the interactions of beam particles on residual gas in the vacuum and showed that such background would be negligible if the vacuum can be maintained at 10^{-7} mbar.

An economical, highly efficient, and very fast replacement for the NA48 liquid-krypton calorimeter is desirable, principally because of limitations imposed by the timing resolution of the NA48 calorimeter. In 2018, a concept for a shashlyk calorimeter capable of providing information on longitudinal shower development was developed, in which thick scintillator tiles optically isolated from the main WLS readout fibers are included at certain positions in the shashlyk stack. The light from each of these "spy" tiles is read through a dedicated fiber. A prototype module was built at Protvino and briefly exposed to the beam in the OKA line in April 2018. In November 2019, this module was also tested at DESY with electron beams from 1 to 6 GeV and its performance was compared to the LHCb shashlyk calorimeter. The results of the test beam were promising, although due to shower leakage affecting the small prototype module, the need for further simulations and studies with module assemblies was made evident. A proposal to measure the efficiency of the module with 500 MeV electrons at the Frascati BTF was submitted in 2019: the test program can run as soon as the BTF2 beamline is ready.

The small-angle calorimeter (SAC) occludes the downstream beam exit for photons from K_L decays. A design based on a sampling calorimeter with a crystalline tungsten absorber is under consideration. This design would exploit the increase in the pair conversion cross section from the coherent interaction between a high energy photon and the crystal lattice. The same effect could be used to minimize the thickness of the photon converter in the beam. Both concepts were tested in the summer of 2018 in the H2 line at the SPS in collaboration with the AXIAL group (CSN5). In these tests, a photon beam tagged with energies up to 80 GeV was obtained from a 120-GeV electron beam, and the interactions of photons with 2 mm and 10 mm thick tungsten crystals were studied as a function of energy and angle of incidence. The data collected were analyzed during 2019, with much of the emphasis on time stabilization and equalization of the lead-glass calorimeter modules used to measure the deflected electron beam energy. Preliminary results show a significant increase in the probability for pair conversion when the crystal axis and the beam are aligned. The effect is smaller in magnitude for the thick crystal (which is of commercial quality), but, probably due to the mosaicity of the sample, is observed over a wider angular range (of a few mrad, compared to about 1 mrad for the thin crystal, which is of considerably higher quality). The analysis is essentially complete and a publication is in preparation. Coherent effects are intrinsic to the interaction of high-energy photons with crystal lattices and are present for all types of crystals, including scintillating and optical crystals. This consideration has led to an alternate design for the SAC based on oriented Cerenkov crystals. A novel calorimeter of this type would have excellent timing resolution and rate resistance and would be of significant interest for all types of high-intensity fixed-target experiments. In 2019, the LNF NA62 group, together with other Italian members of KLEVER project and the LNF PADME group, joined a project to investigate the properties of candidate crystals for this purpose as part of the AIDAnova framework. The LNF NA62 and PADME groups also collaborated on an ERC Starting Grant proposal for the development of an innovative crystal calorimeter of this type.

During 2019, much emphasis was placed on finding new resources and collaborators for the drafting of a formal KLEVER proposal to the SPSC. The KLEVER project was presented by Italian collaborators at three international conferences, including at KAON 2019 in Perguia. KLEVER was included in the Physics Beyond Colliders study at CERN, which concluded in 2019 with the preparation of a document for the update of the European Strategy for Particle Physics (ESPP) [arXiv: 1901.03099]. While awaiting the outcome of the update process, which is expected by mid-2020, an expression of interest to the SPSC for the KLEVER project is currently under preparation.

In 2019, KLEVER members also participated as a partner in discussions with the NA62 and KOTO experiments on the future of rare-kaon decay experiments. This process, which started with a dedicated meeting at KAON 2019, has led to periodic, structured discussions between the collaborations focused on items of common interest, including Monte Carlo production techniques, simulation benchmarking, and advanced detector concepts. In October 2019, the KOTO and KLEVER collaborations jointly submitted a proposal for Italian Ministry of Foreign Affairs (MAECI) funds to support joint detector R&D and the exchange of students and early-career researchers.

Published papers

First search for the K+ to pi+ nu nubar decay using the decay-in-flight

technique
Author : E.Cortina Gil et al, NA62 Collaboration
arXiv.1811.08508 [hep-ex] , Phys. Lett. B 791 (2019) 156-166

Searches for lepton number violating K+ decays
Author : E.Cortina Gil et al, NA62 Collaboration:
arXiv.1905.07770 [hep-ex] , Phys. Lett. B 797 (2019) 134794

Search for production of an invisible dark photon in pi0 decays
Author : E.Cortina Gil et al, NA62 Collaboration arXiv.1903.08767 [hep-ex], Journal of High Energy Physics, Volume 2019, Issue 05, page 182

CONFERENCE TALKS, 2018

A.Antonelli

NA62 Ultra-rare decay, results and prospects
LISHEP 2018, Salvador de Bhaia 9-14 Settembre 2018

V. Kozhuharov

Search for heavy neutrinos @ CERN SPS
NuPhys2018, Londra 19-21 Dicembre 2018

G. Lanfranchi

Search for exotics decays with NA62
ALPS 2018, Obergurgl 15-20 Aprile 2018

S. Martellotti

An experiment to measure BR(KL → π0νν) at the CERN SPS
Birmingham. 2018, January 17th Seminario

$K^+ \to \pi^+ \nu\nu$ decay and NP searches at NA62
La Thuile 2018. February 28th.
(Les Rencontres de Physique de la Vallée d'Aoste)

$K^+ \to \pi^+ \nu\nu$: first NA62 results
Laboratori Nazionali di Frascati. 2018, April 18th. Seminario

M. Moulson

KLEVER: An experiment to measure BR($K_L \to \pi^0 \nu\nu$)) at the CERN SPS (Institute of

Physics Full-Day Meeting: New physics in kaon and beam-dump experiments, Birmingham, UK, 3-Dec-18)

Searches for exotic particles at NA62 (ICHEP 2018, Seoul, 7-Jul-18)

KLEVER: An experiment to measure BR($K_L \rightarrow \pi^0 \nu\nu$)) at the CERN SPS (ICHEP 2018, Seoul, 7-Jul-18)]

KLEVER: An experiment to measure BR($K_L \rightarrow \pi^0 \nu\nu$) at the CERN SPS (Fundamental Physics Seminar, INFN Frascati, 21-Jun-18) [seminar]

Kaon experiments: Status and outlook (Exotic Hadrons and Flavor Physics, Simons Center for Geometry and Physics, Stony Brook University NY, USA, 1-Jun-18]

$K_L \rightarrow \pi^0 \nu\nu$): Results and prospects (Frontier Objects in Astrophysics and Particle Physics, Vulcano, Sicily, 25-May-18)

KLEVER: An experiment to measure BR($K_L \rightarrow \pi^0 \nu\nu$)) at the CERN SPS (First Forum on Rare Kaon Decays, Edinburgh, 22-Feb-18)

Kaon Physics (GdR-InF Workshop: The Future of the Intensity Frontier, CERN, 2-Feb-2018)

KLEVER: An experiment to measure BR($K_L \rightarrow \pi^0 \nu\nu$)) at the CERN SPS (DPhP Seminar, IRFU, CEA Saclay, 22-Jan-2018)

T. Spadaro

Exotic Decays at NA62
32th Rencontres De Physique De La Vallee D'Aoste
La Thuile, 25 Febbraio- 3 Marzo 2018

CONFERENCE TALKS, 2019

S. Martellotti

$K^+ \rightarrow \pi^+ \nu\nu$ decay and NP searches at NA62, Excited QCD 2019 , Schladming, Austria, 30 Jan-3 Feb 2019

Exotic searches at NA62 experiment
RKF: 2nd Forum on Rare Kaon decays - May 29-31, 2019, Anacapri

New result on $K^+ \rightarrow \pi^+ \nu\nu$ from the NA62 experiment

La Sapienza: Roma, 18 November 2019

E. Minucci

Search for an invisible vector boson from pi0 decays at NA62, EPS-HEP 2019 , Ghent, Belgium, 10-17 Jul 2019

M. Moulson

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