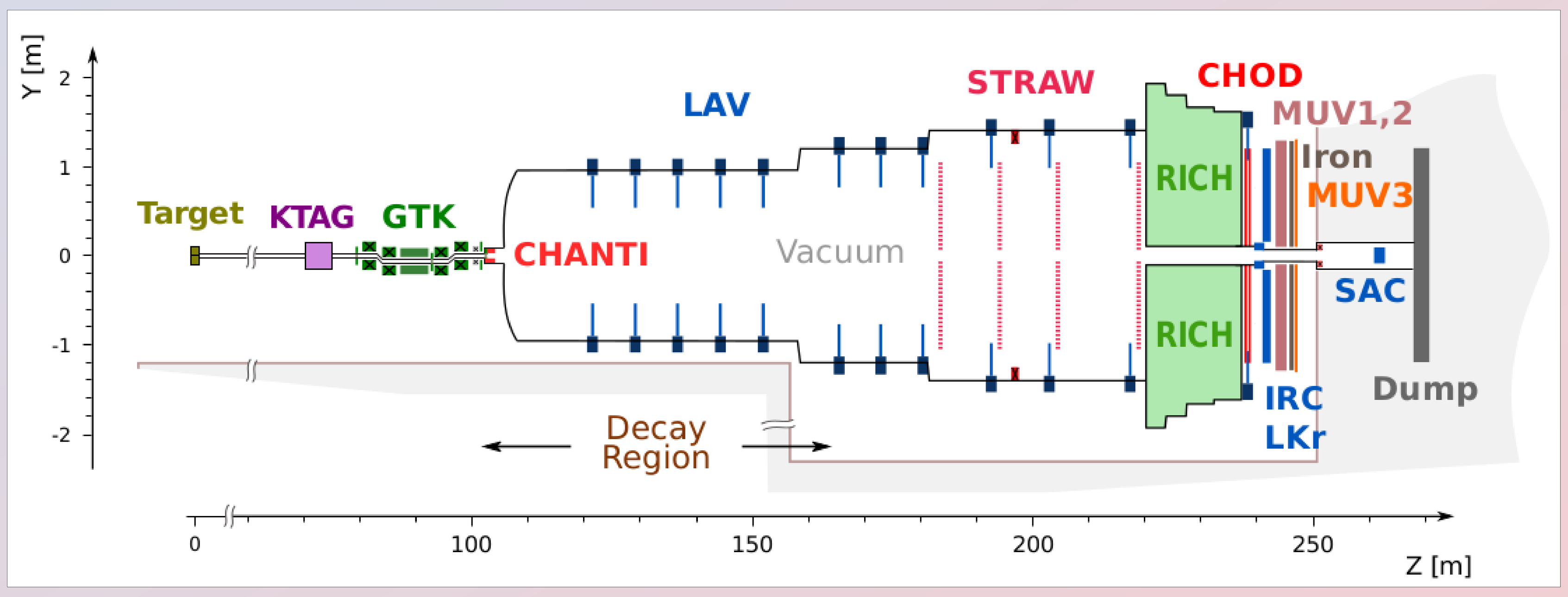
New veto hodoscope ANTI-0 of the NA62 experiment at CERN

H. Danielsson[1], O. Gavrishchuk[2], P. A. Giudici[1], E. Goudzovski[3], **S. Kholodenko**[4], M. Kholodenko[4], I. Mannelli[5], V. Obraztsov[4], V. Sugonyaev[4], R. Wanke[6]

1. CERN, European Organization for Nuclear Research, Geneva, Switzerland
2. Joint Institute for Nuclear Research, Dubna, Russia
3. University of Birmingham, Birmingham, United Kingdom
4. NRC "Kurchatov Institute – IHEP", Protvino, Russia
5. Scuola Normale Superiore e INFN, Sezione di Pisa, Pisa, Italy
6. Institut für Physik and PRISMA Cluster of excellence, Universität Mainz, Mainz, Germany

The NA62 Experiment

- Fixed target experiment at CERN SPS (North Area)
- Main goal: measure of ultra-rare $K^+\to\pi^+\nu\bar{\nu}$ decay with 10% precision
- Primary 400 GeV/c proton beam impinges Be target
- Secondary beam: 75 GeV/c (750 MHz with 6% K^+)



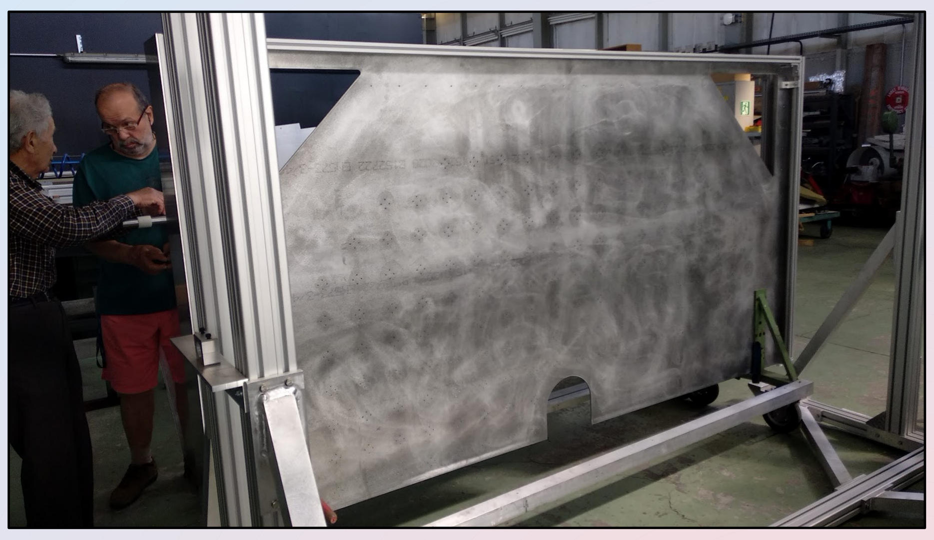
Main purpose for the detector

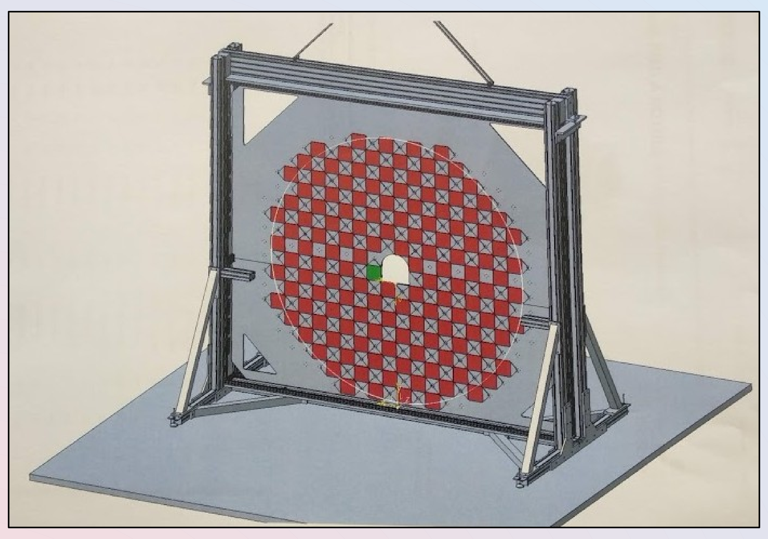
The ANTI0 detector designed to detect beam halo muons entering the decay volume, and prevent these muons being mistakenly accepted as originating from a kaon decay.

To avoid random veto the ANTI0 should have a time resolution as good as possible (< 1ns) and adequate geometrical coverage.

The ANTI-0 detector

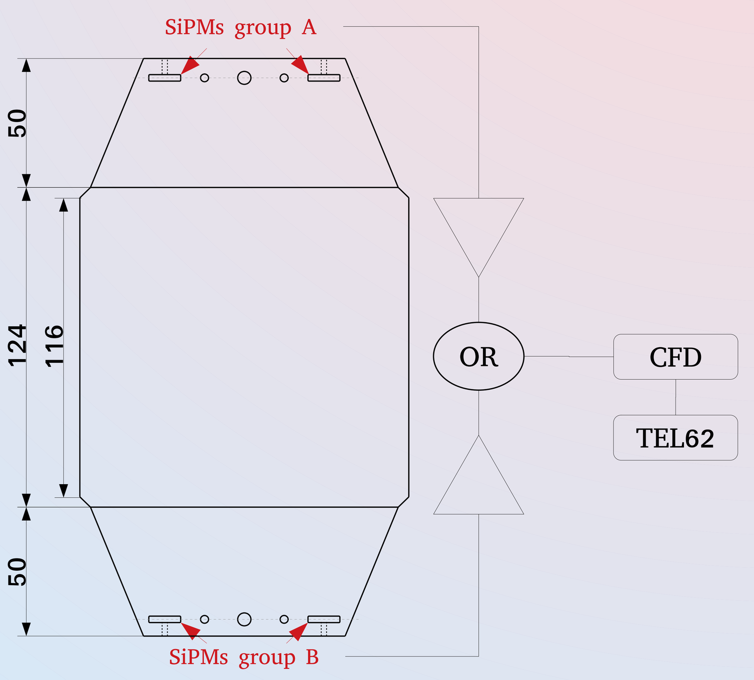
The detector covers the area R=1080mm around the beam pipe and placed between last station of CHANTI and beginning of the decay volume. The main purpose of the detector is to register charged particles (mostly muons) entering the decay volume and originated from the decays upstream.

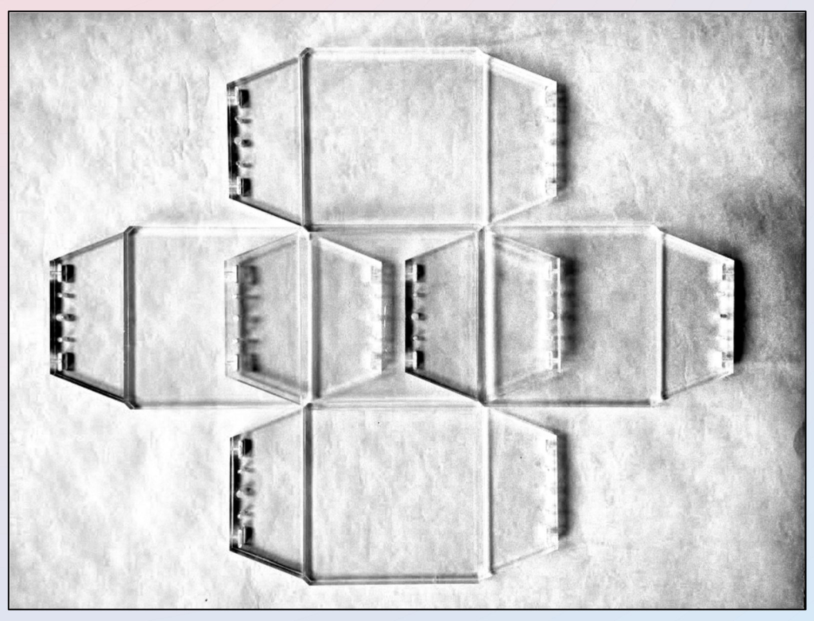




The detector is a cell structure hodoscope consisting of 280 scintillation counters. Each counter consist of scintillating tile with the size of 124x124x10 mm³ that is read by two groups of two SiPMs from the opposite sides. Two S14160-6050HS SiPMs from the same group are connected in series (for AC). The output signals from the groups are amplified (x30) and connected in analog "OR". Thus, each tile is read as a single electronic channel.

To ensure the uniformity in both amplitude and timing properties SiPMs are displaced from the edge of the scintillator tile by 40 mm by using the Plexiglas lightguide.





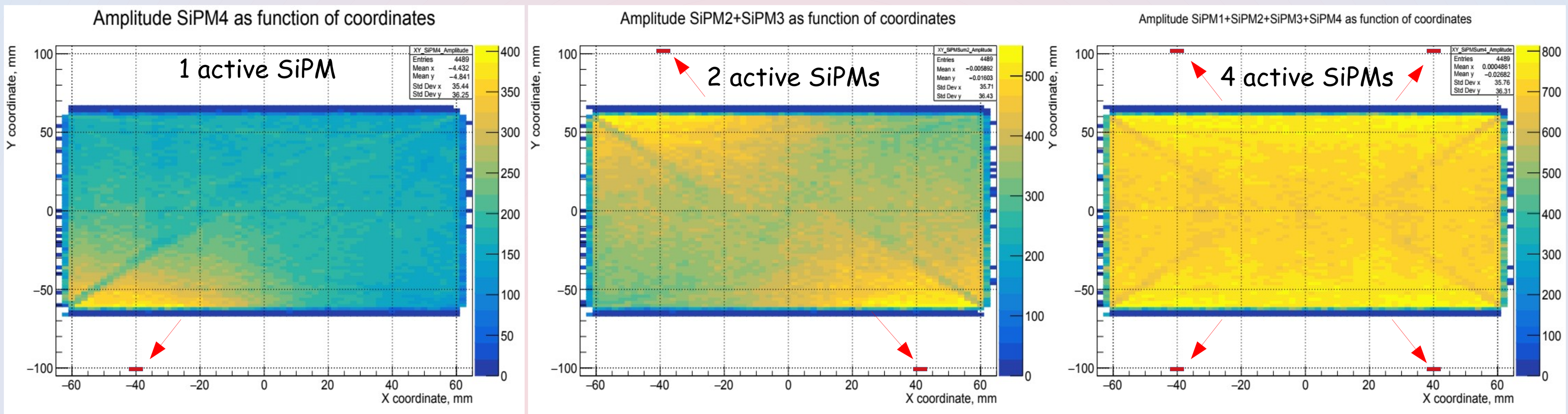
The tiles are fixed on both sides of aluminum frame in chessboard style with step of 120 mm, that makes 2 mm overlap of all neighboring counters.

Signals from the counters are discriminated with CFDs and registered with TDC TEL62 (DAQ board of the NA62 experiment)

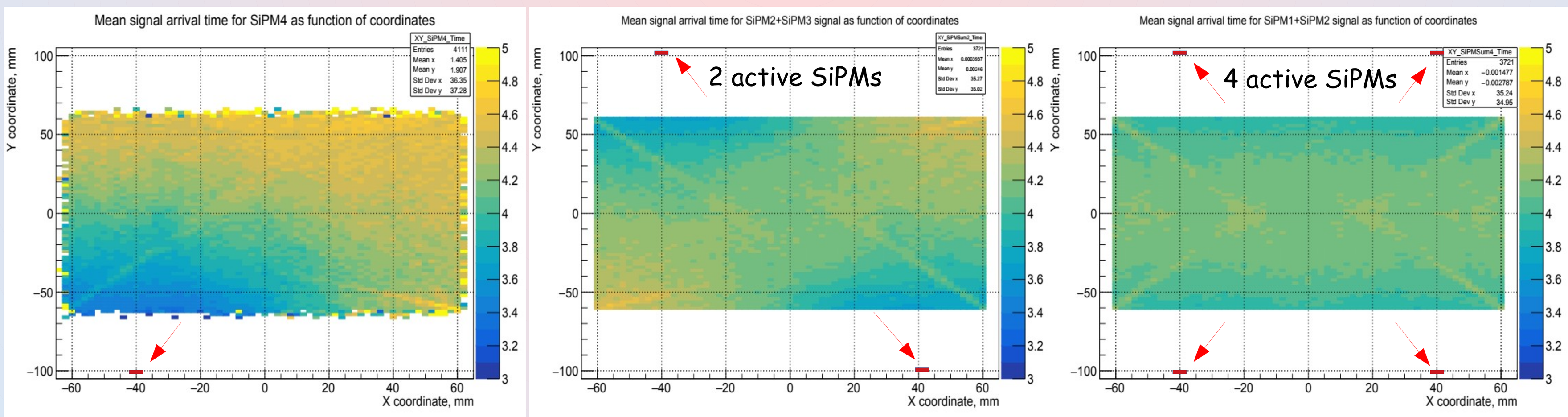
MC Simulation:

The design of individual counters were studied with Geant4. Optical photons (scintillation and Cherenkov) are produced by interaction of charged particle (muon) with scintillator. Detector response is simulated as a convolution of optical photon arrival time and single photoelectron signal shape randomly selected from the data sample recorded with oscilloscope. CFD output time simulated by triggering on 20% of peak amplitude.

Amplitude (mV) as a function of coordinates

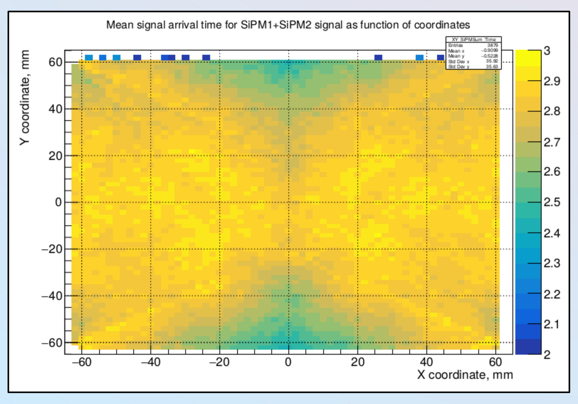


Average time of the signal vs particle coordinates

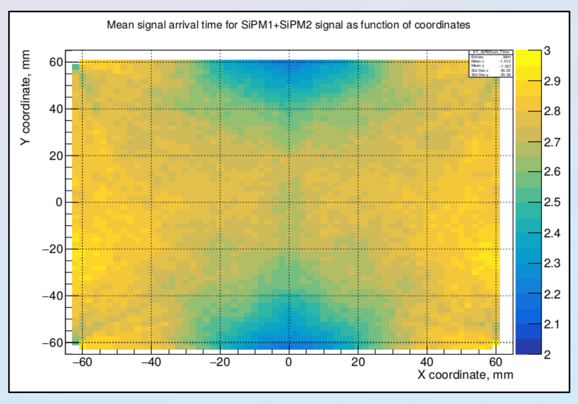


Average time of the signal arrival for the different length of lightguides

40 mm

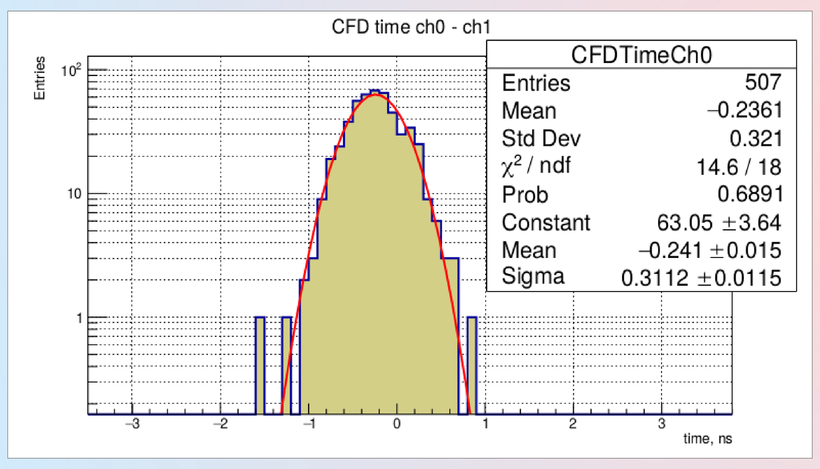


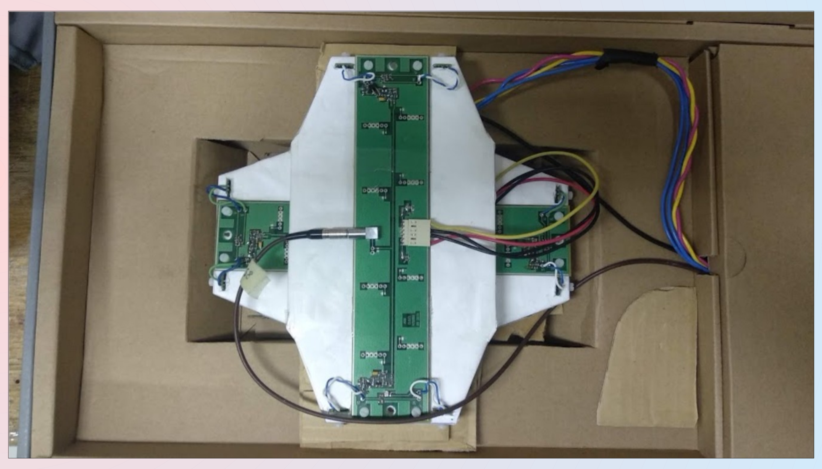
20 mm



Time resolution

Time resolution measured with cosmic rays. Time difference between signal arrival (discriminated with CFD, threshold = 0.2) from two identical tiles described Gaussian with sigma = 310 ps

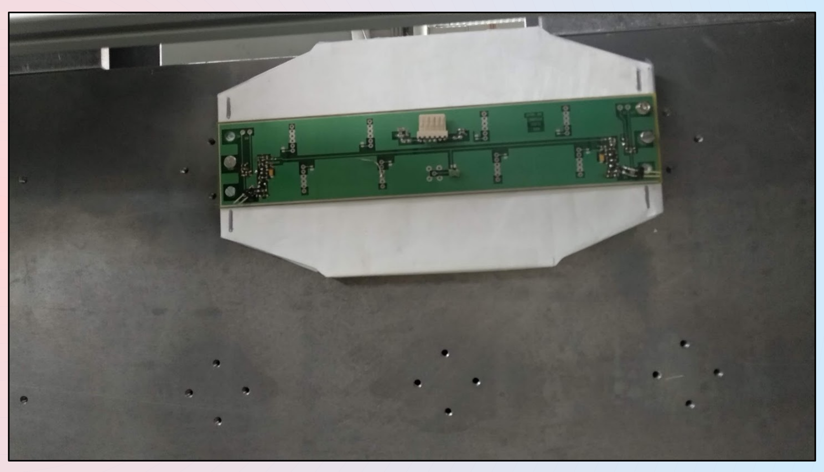




Since counters are identical, time resolution of individual counter could be estimated as $\sigma = 310 / \sqrt{2} = 220$ ps.

Lightguides tooling for gluing

First tile installed on the mainframe



Summary:

The new detector is being assembled at CERN

Aug – 2020: Detector Installation in the experimental hall

May – 2021: Commissioning and first run of data-taking

Acknowledgments:

This work is partly supported with ERC starting grant 336581.

Poster presented at the International Conference on Instrumentation for Colliding Beam Physics INSTR – 2020, 24 – 28 February 2020, BINP, Novosibirsk, Russia