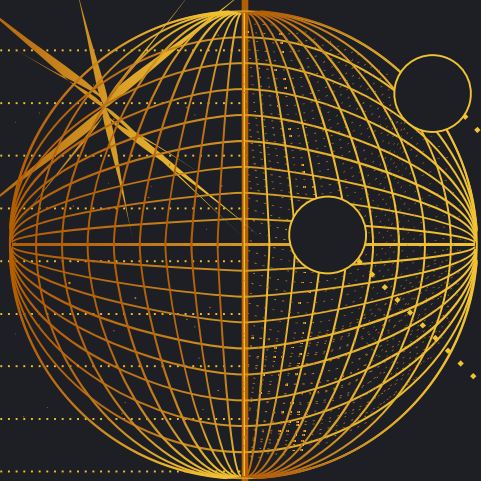
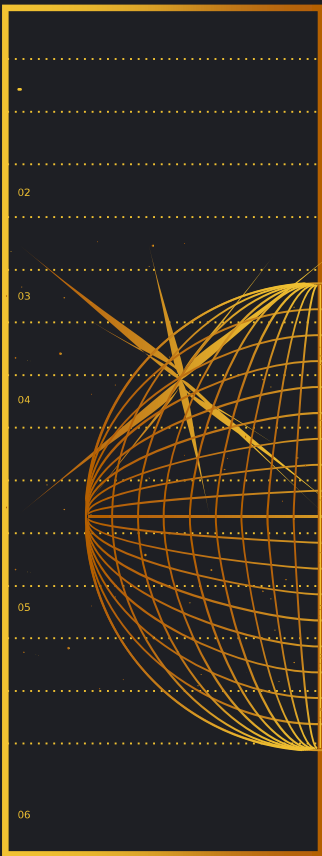




01

Muon detection using NIM based triggers, graphical analysis



ANTLIA
1998

ORION
1998



Petković Mihajlo
Herceg Miloš
Supervisor: Markus Joos

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THE AIM OF THE RESEARCH



MUON DETECTION

Reliable method of
detecting incident
muons



DATA AQUISION

Automatic recording
of events and
logging



ANALYSIS

Visualization of
data through
graphics

DATA ACQUISITION PIPELINE

MUON DETECTOR

Scintillators, photomultiplier tubes

TRIGGER MECHANISM

NIMs system, coincidence trigger

COMPUTER INTERFACE

VMEbus, Linux drivers

ANALYSIS

Graphs and presentation

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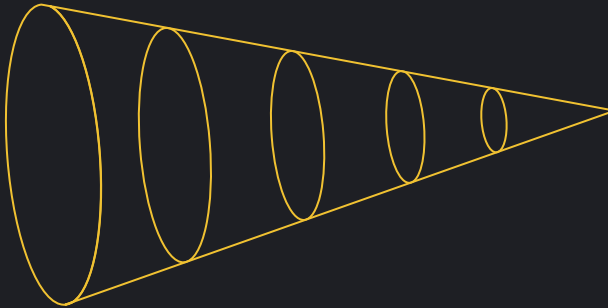
04.



Muon detection

We can detect cosmic radiation from the surface indirectly by detecting the byproducts of the cosmic radiation impacting the atmosphere - muons

Despite the short lifetime of $2.2 \mu\text{s}$, muons still reach the surface



$\approx 105.66 \text{ MeV}/c^2$
 -1
 $\frac{1}{2}$



Muon

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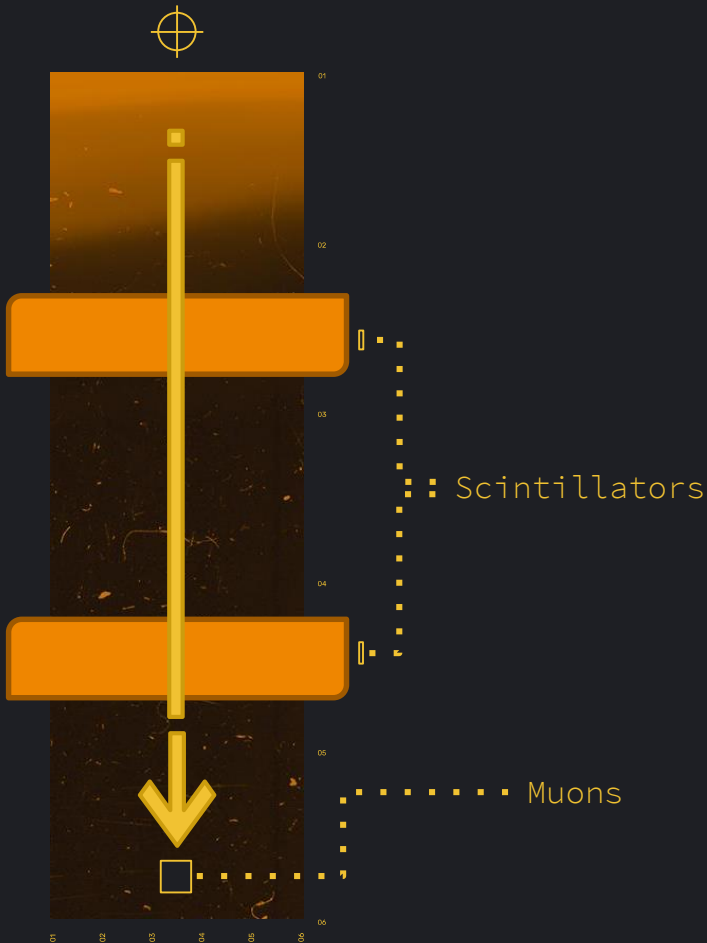
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SCINTILLATORS

PHOTOMULTIPLIER TUBES

Muons passing through a scintillator emit photons

Photomultiplier tubes convert incident photons into electrical signals



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003-1040559

1250 003-77156.8

1760 0009-14563.7

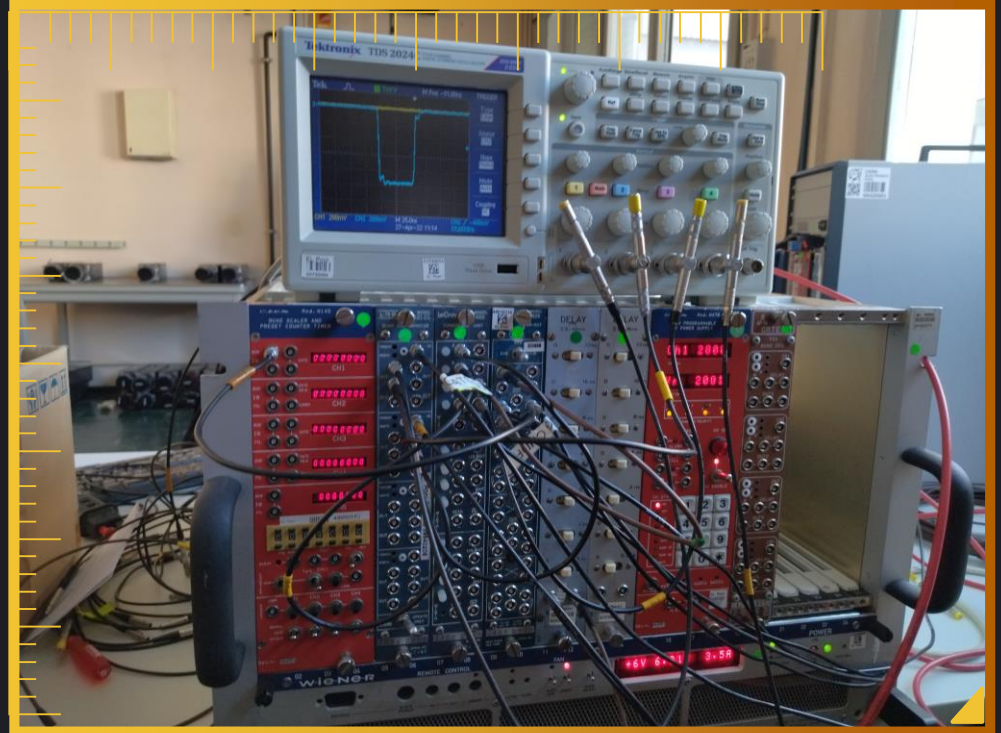
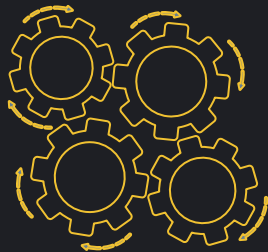
73273

NUCLEAR INSTRUMENTATION MODULES

A mechanical and electrical standard meant for nuclear and particle physics

Current based logic operation

Found in many CERN experiments today

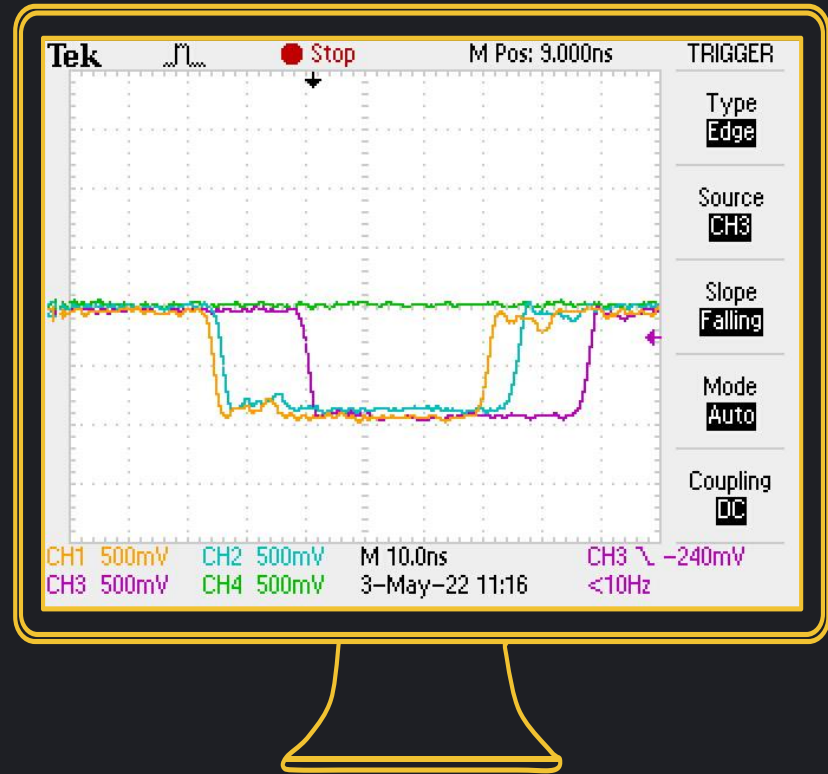




TRIGGER MECHANISM

Data is recorded when signals from both scintillators occur within a short time period one from another

Oscilloscopes were crucial in figuring out the thresholds for the trigger mechanism



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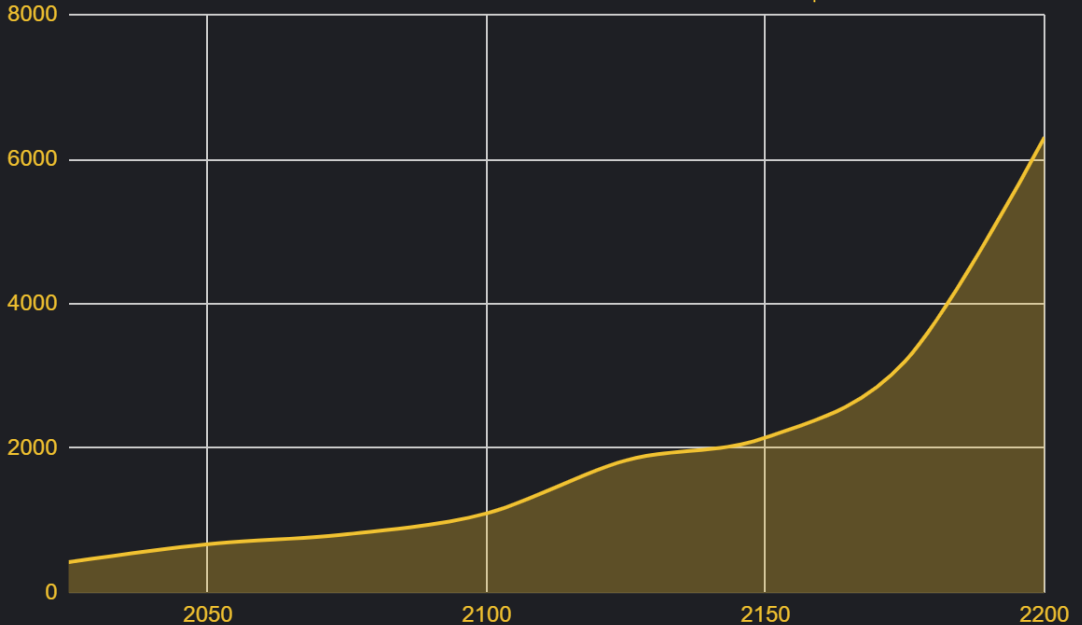
DETECTOR EVENTS AND NOISE

Time period: 50"

Photoamplifier tubes are noisy due to various factors, such as imperfections in their construction

The amount of noise proportionally impacts randomly occurring coincidences in the trigger mechanism

● DETECTED EVENTS

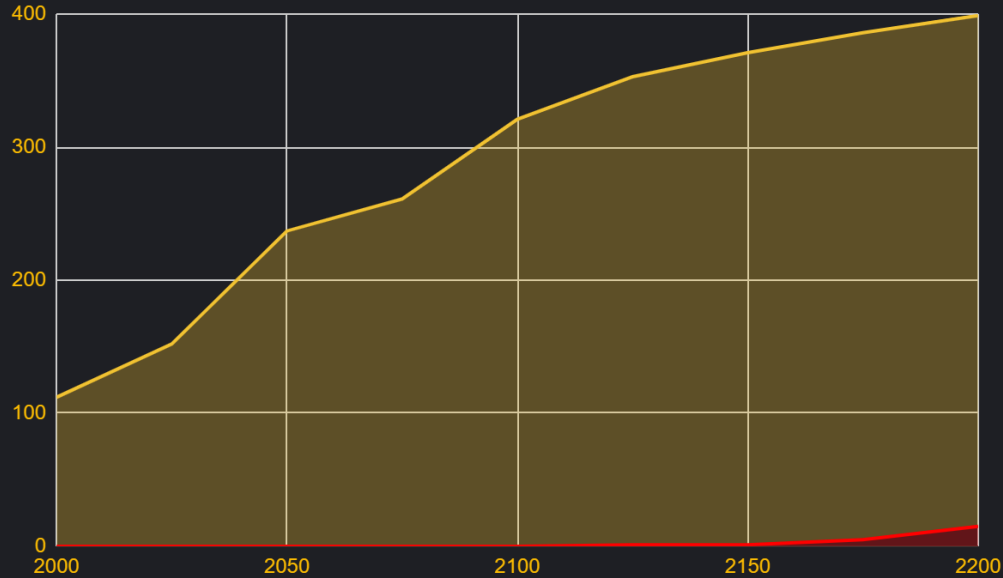


● SCINTILLATOR VOLTAGE

01 02 03 04 05 06

MUON DETECTION BASED ON VOLTAGE

Time period: 50"



● DETECTED MUONS

Amount of muons detected over a time period

● RANDOM COINCIDENCES

Randomly occurring events coinciding with the muon trigger

● SCINTILLATOR VOLTAGE

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THE RESULTS

Time period: 50"

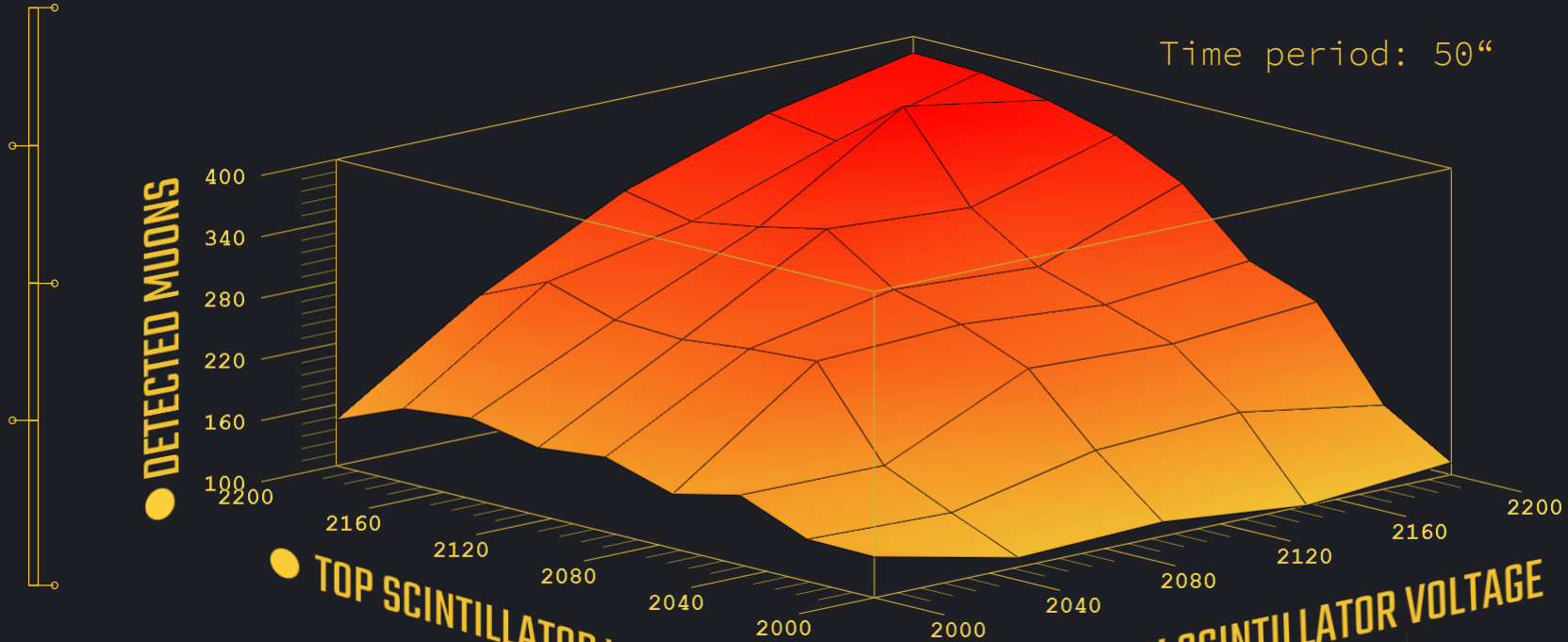
● DETECTED MUONS

400
340
280
220
160
100

● TOP SCINTILLATOR VOLTAGE

● BOTTOM SCINTILLATOR VOLTAGE

2200 2160 2120 2080 2040 2000 2000 2040 2080 2120 2160 2200



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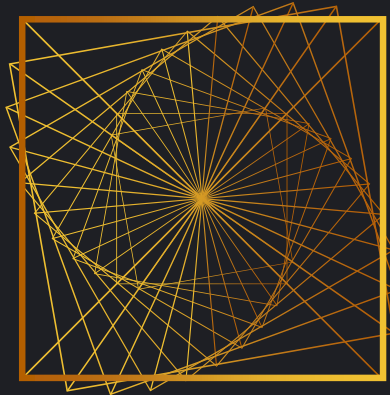
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FURTHER DEVELOPMENT POSSIBILITIES - VMEbus

THE PROBLEM

Data acquisition requires a fast and reliable method of transmitting data between the detector and storage for further analysis



THE SOLUTION

VMEbus offers a standardised bus system for communication between NIMs and personal computers or other data processing hardware



THANK YOU FOR YOUR ATTENTION

Big thanks to our supervisor Markus Joos!