

# The NA64 $\mu$ experiment at the CERN SPS

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2018 Experimental proposal	<b>2021</b>	<b>2022</b>	2023	2024	2025	163	
	5x10 <sup>9</sup> MOT	4x10 <sup>10</sup> MOT		Phase 1		LJJ	

## introduction

The NA64 experiment is a fix-target experiment at the CERN SPS combining the active beam dump and missing energy techniques to search for rare events by colliding 100-150 GeV energy electron or muon beams onto an active target. The NA64 $\mu$  is a muon subprogram of the NA64 experiment.



The NA64µ looks for a light  $Z_{\mu}$  vector boson produced in the bremsstrahlung reaction  $\mu Z \rightarrow \mu Z Z_{\mu}$  and coupled to the second lepton generations through the  $L_{\mu}-L_{\tau}$  current. The existence of this boson could explain the (g-2) muon anomaly.

**Motivation**: discrepancy between the measured and the predicted value of anomalous muon magnetic moment  $a_{\mu} = (g - 2)/2$ 





B. Abi et al. Muon g-2 collaboration Phys. Rev. Lett. 126, 141801 T. Aoyama et al. Phys. Rept. 887 (2020) 1-166

#### main physics goals

Search for new physics beyond the SM:

- $Z_{\mu}$  light boson coupled to the muon, as a remaining low mass explanation of the (g-2)<sub>µ</sub> (the muon anomaly)
- LDM interacting with the Standard Matter via a new gauge vector-boson mediator  $Z_{\mu}$
- Scalar, Axion Like Particles coupled to the muon
- Lepton Flavour Violation in  $\mu \rightarrow \tau$  and  $\mu \rightarrow e$  conversion

S. Gninenko et al. PLB796, 117 (2019) D. Banerjee et al. [NA64 Collaboration]. CERN-SPSC-2019-002 / SPSC-P-359, January 14, 2019. Boson vertex corrections could explain the discrepancy  $(g-2)_{\mu}$ . The existence of a new light vector boson Z', interacting mainly with leptons of the second and third generations through the lepton current  $L_{\mu} - L_{\tau}$ .

The Z' vector boson decays invisibly to SM neutrinos in the case  $m_{Z'} < 2m_{\mu}$ 





Schematic view of the NA64 $\mu$  setup in April 2022 to search for the invisible decay of the Z<sub> $\mu$ </sub> boson. MS1 and MS2 comprise a set of detectors for measuring the momentum of initial and scattered muons.

Signature: missing energy and momentum

- Initial  $\mu$ -momentum 160 GeV (@MS1)
- Scattered μ-momentum < 80 GeV (@MS2)</li>
- No energy in all calorimeters, ECAL, HCAL and VHCAL (energy deposit compatible with a MIP)



D. Banerjee et al. [NA64 Collaboration], CERN-SPSC-2019-002 / SPSC-P-359, 2019 S. Gninenko et al. PLB796, 117, 2019

#### NA64µ results



Results of cut-flow analysis for the 2021 run for  $5 \times 10^9$  MOT in the total energy deposit in all calorimeters ( $E_{ECAL} + E_{HCAL} + E_{VHCAL}$ ) vs reconstructed momentum with MS2 plane.

#### No signals were observed

### summary and plans

The NA64mu was successful started. 5x10<sup>9</sup> MOT and 4x10<sup>10</sup> MOT were collected in the 2021 pilot run and 2022 physical runs, respectively. No signal evets were obtained through analysis data of the pilot run data. Analysis of the 2022 run data is in progress. These data will allow demonstrate feasibility of the technique and optimistic prospects for the next physics run.

Also it is planed to do DAQ and electronics upgrade as well as increase the number of tracking detectors (namely Straw stations) to be able operate with higher beam intensity