PhD Thesis - GMINUS2 - Dottorato in Fisica - UniTS

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Precision measurement of the magnetic anomaly of the muon (GMINUS2 experiment at Fermilab)

Abstract
The gyromagnetic ratio for muons (ratio between the particle magnetic moment and the spin angular momentum), normally called "g", is theoretically predicted to be slightly different from 2, and the quantity "g-2", which gives the name to the experiment, is termed the "anomaly". This quantity has great importance since it can be both calculated and measured with great precision, less than a ppm, giving a direct test of the Standard Model of particle physics. The experimental determination of "g-2" consists basically in observing how the magnetic moment of muons precesses in a magnetic field when a muon beam circulates in a storage ring. The measurement is carried out by detecting the decay positrons (electrons in the case of negative muons), which have the direction of the muon magnetic moment. To this end, a series of segmented scintillation calorimeters is positioned along the ring and readout with Si Photo Multipliers (SiPMs).
The muon anomaly has been measured a few years ago at the Brookhaven National Laboratory, USA, where a discrepancy between theory and experiment at the "3 sigma" level was found. If confirmed, this discrepancy would be the first indisputable evidence of a failure of the Standard Model, and of the existence of physical theories beyond it. For this reason, a new experiment with upgraded technologies is now measuring the muon anomaly at Fermilab. Data from the first run have confirmed the discrepancy at the "4.2 sigma" level and the experiment is now continuing to gather a large amount of data at either reaching and surpassing the "5 sigma" discrepancy level, or at disproving the BNL result.
The Italian collaboration (GMINUS2) has developed the critically important laser calibration system for the calorimeters, it is tasked with the responsibility of controlling and operating it, and is fully involved in the running of the experiment at Fermilab including data analysis.

Specific thesis topic
Measurements with the laser calibration system at Fermilab involving both the control and maintenance of the system itself, and the necessary calibrations to be carried out during measurement runs. The thesis work will include laboratory

measurements both locally and at Fermilab, including operation of an optical magnetometer, participation in the data taking runs at Fermilab, and data analysis.

Main experiment location
Fermilab, Batavia (IL) USA - Experiment E989
http://muon-g-2.fnal.gov

Participating Institutions
INFN: Trieste/UD, Pisa, Napoli, Roma Tor Vergata, Lab. Naz. di Frascati dell'INFN
Several international Institutions and Universities (see http://muon-g-2.fnal.gov/collaboration.html)

People locally involved
G. Cantatore (UniTS and INFN Trieste) - supervisor
D. Cauz (UniUD and INFN Trieste)
M. Karuza (INFN Trieste and UniRijeka, Croatia)
L. Santi (UniUD and INFN Trieste)