The new ATLAS Muon Power System for High-Luminosity LHC

D. Calabrò[(a)], T. Cresta[(a),(b),(c)], A. Kourkoumeli-Charalampidi[(a)], A. Lanza[(a)], E. Romano[(a),(d)] on behalf of the ATLAS Pavia group

(a) INFN Pavia, (b) Dipartimento di Fisica, Università di Pavia, (c) CERN, (d) Centro Grandi Strumenti, Università di Pavia

Introduction

For the Phase 2 ATLAS Upgrade, alongside upgrades to the detectors, a full redesign of the modules powering the Muon Detectors is taking place. Before actually producing the modules, prototypes need to be tested to make sure that they deliver the required performance reliably. In particular the modules need to be tested in two different ways:

- **electrical tests**. The output of the module needs to be within specification;
- **environmental tests**. The modules should have a high radiation tolerance and be able to withstand magnetic fields since they are going to be placed in a hostile environment.

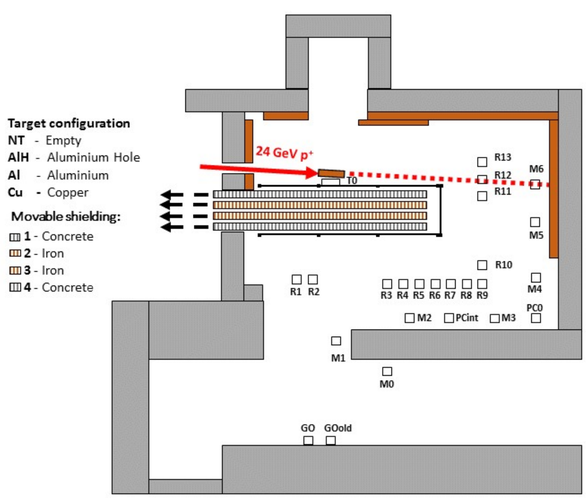
While the electrical tests are carried out in a laboratory, environmental ones need to be performed in specialized facilities. For our radiation tests we use the CHARM facility at CERN, while for the magnetic field ones we use a magnet called MNP-17, also available at CERN.
All the hardware and software needed to test these new boards has been developed in Pavia thanks to the Laboratorio di Servizio Elettronica and Laboratorio di Prototipazione Scientifica.

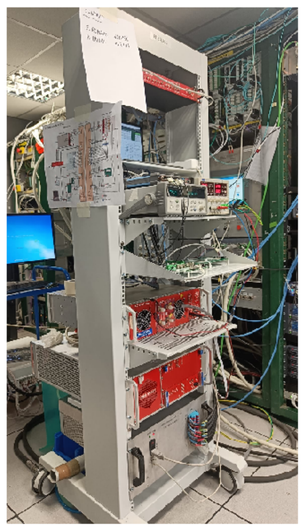
CHARM Facility

CHARM is a unique irradiation infrastructure at CERN, used to test electronic equipment for experiments. It uses protons from the PS and a fixed target to produce radiation similar to the one present inside the experimental caverns at the LHC. In particular, the targets needed in order to qualify a new module are:

- $140 Gy$ of Total Ionizing Dose
- $1.2 \cdot 10^{12} 1/cm^2$ Fluece of Neutrons
- $2.7 \cdot 10^{11} 1/cm^2$ Fluence of High Energy Hadrons

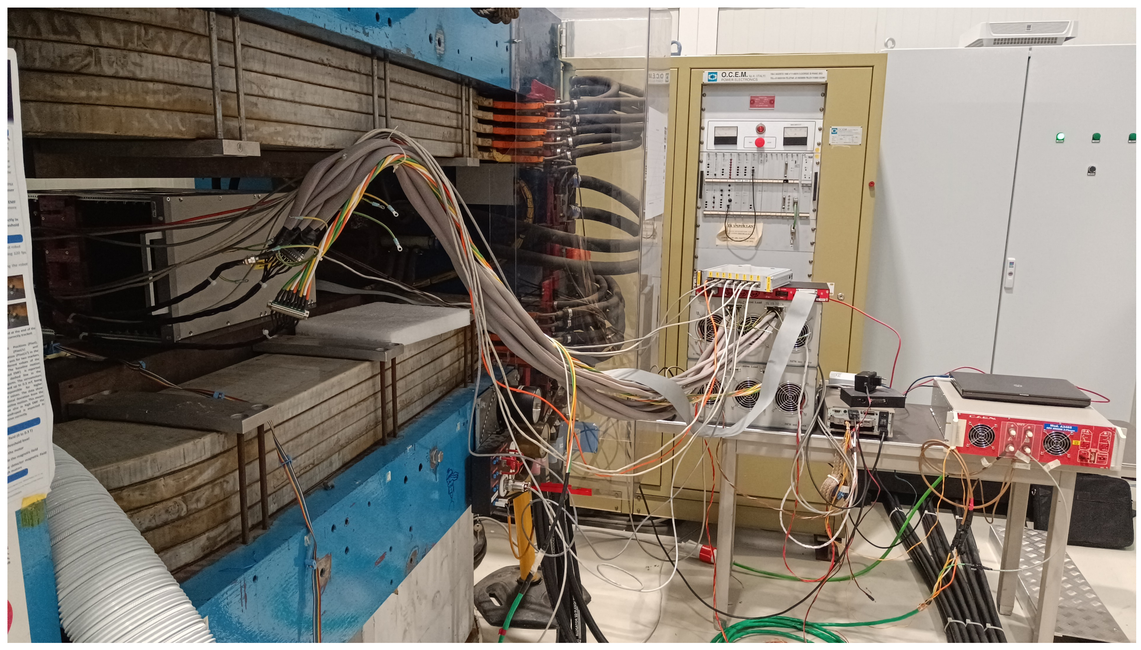
For these tests the biggest difficulty is finding the most efficient way of measuring the voltages and currents of interest with a limited amount of connections allowed in a hostile environment.



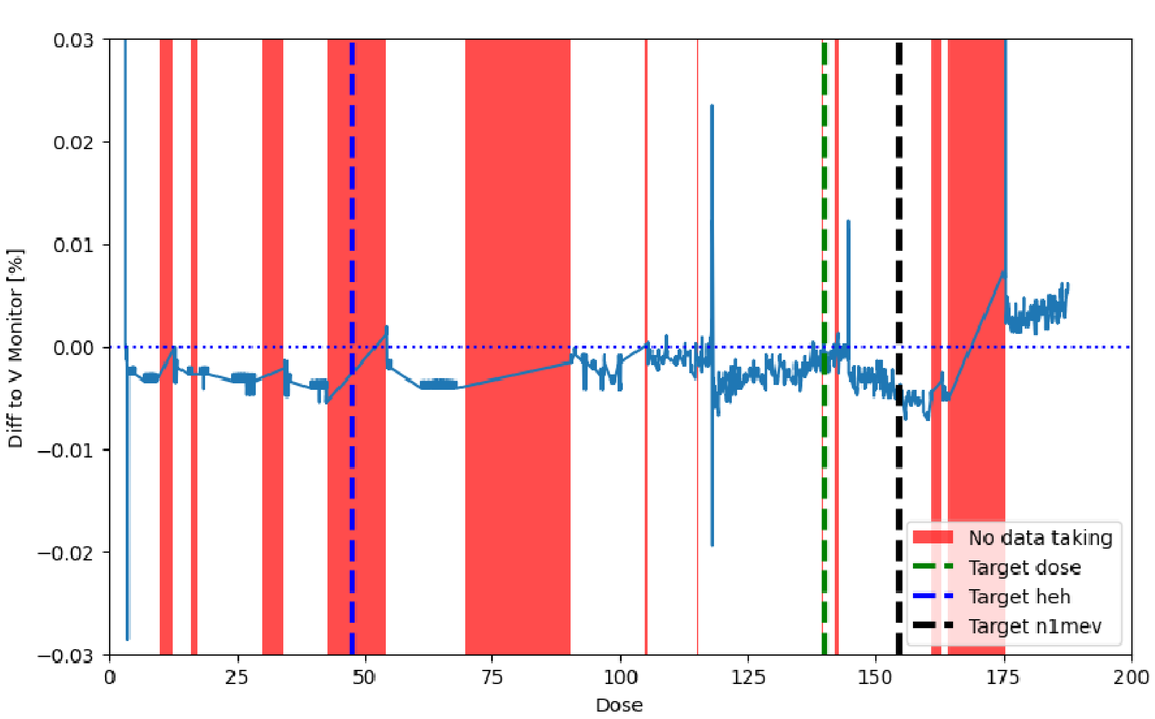


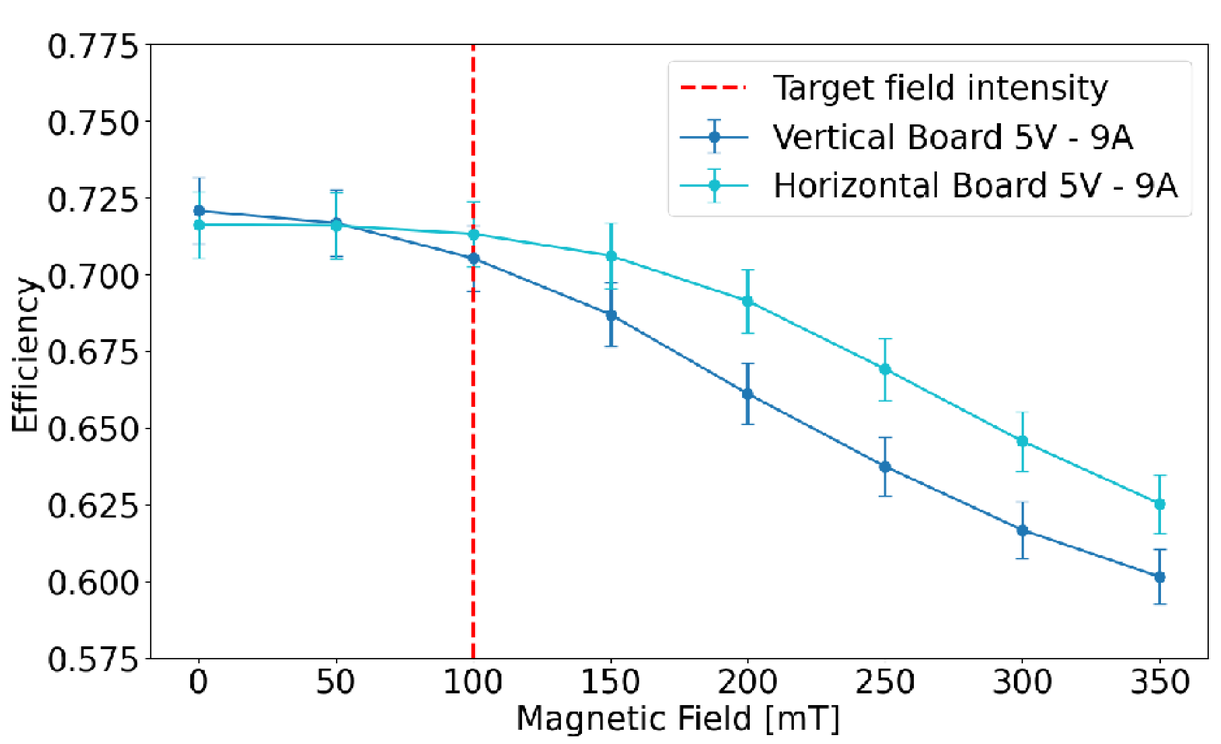
Magnet MNP-17

The magnet at CERN called MNP-17 is a warm, normal-conducting dipole that is perfect for testing the new Muon Power System. This is due to the fact that it has a gap wide enough to insert the prototypes in two different orientations to have a complete test; the magnet is able to produce a field up to $1 T$ against our requirement of $0.1 T$ and it is available for most of the year without any restrictions.
The goal of these tests is to verify that the board still works under magnetic field, but moreover it is important to measure its efficiency as a function of the magnetic field intensity. This is done by measuring the power drawn by the prototype against the output power provided by the same board.



Results





The plot on the left shows a typical result from a radiation test of a module, in this case a Low Voltage board. In particular, the plot shows how the internal monitoring of the board tracks the actual voltage of the output channels of the module. It is important that there is no significant degradation until the required radiation levels are reached, to ensure safe operation of the ATLAS experiment for the following years.
The plot on the right shows the result from the magnetic field test on the same board. In this case we found that at the target magnetic field of $0.1 T$ the board does not exhibit significant efficiency loss and we were able to test its performance up to $0.35 T$.