Pressure monitoring system for the CMS muon chambers

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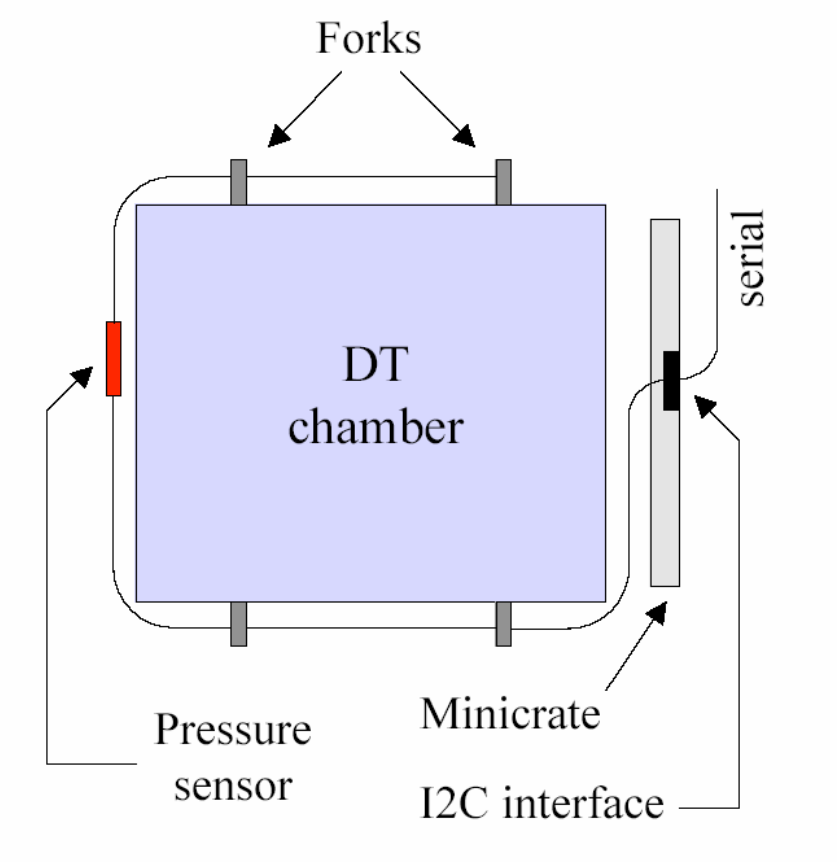
Introduction

- The Muon Detector System of the CMS detector at LHC will use gas filled Drift Tube (DT) Chambers detect the muons in the Barrel region. The drift velocity that is directly connected to the muon track measurement depends – among other parameters- on the gas pressure inside the chambers. Therefore the gas pressure has to be kept at a constant level and this level has to be monitored. The monitoring is also needed to have information about the performance of the gas sytem and detect any possible failure. Different solutions of this task have been studied and electronic boards (PADC) have been developed by the Aachen group to regularly read out the sensors and to send the pressure data to the Detector Control System (DCS).

- The irradiations were carried out at two different facilities. The proton irradiation was performed at the The Svedberg Laboratory in Uppsala, Sweden, while the neutron irradiation was done at ATOMKI (Debrecen, Hungary).

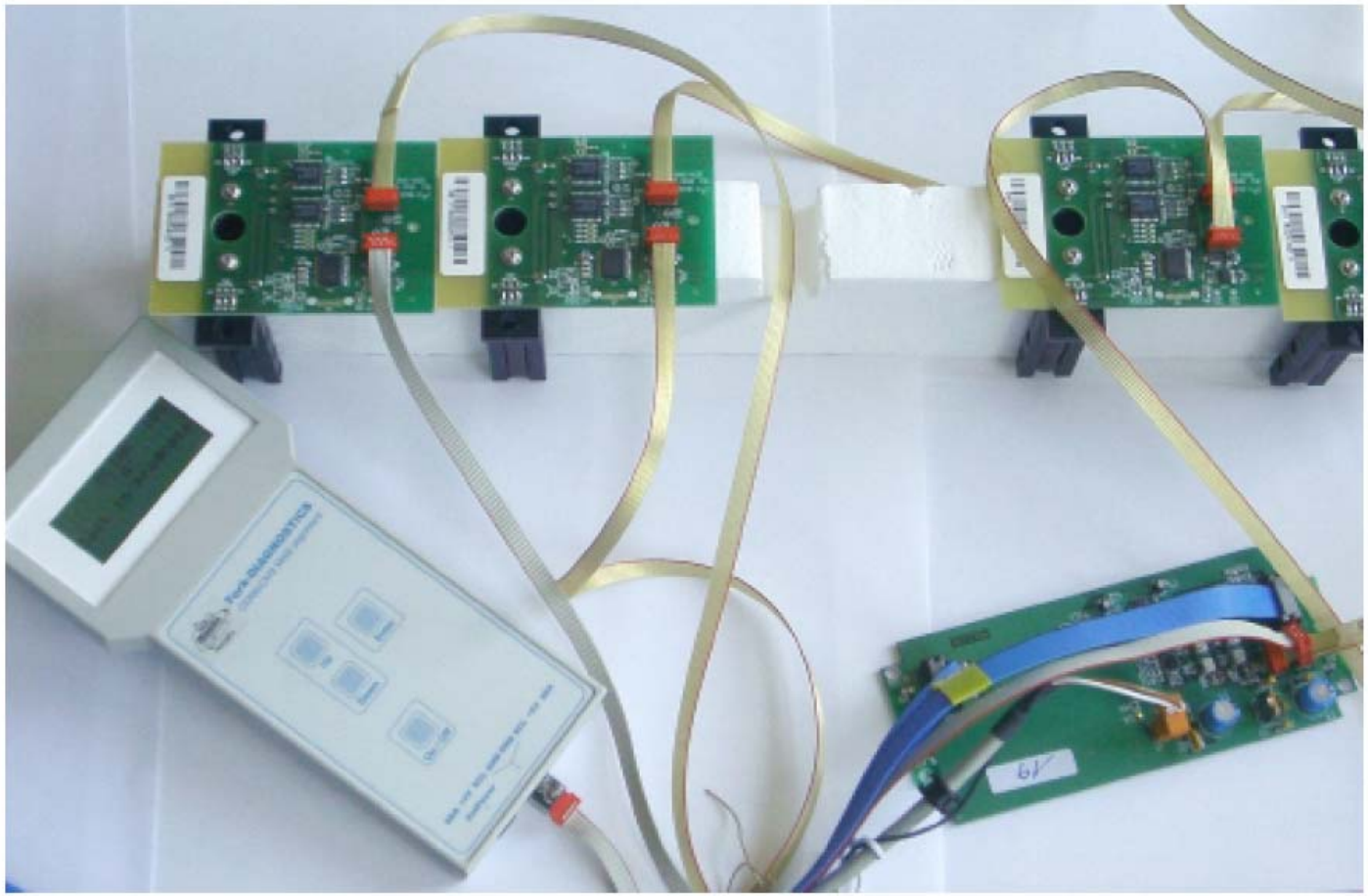
- Special software was developed for testing the PADC boards during irradiation. A readout and data logging PC software was also prepared. During the radiation hardness tests the functions of the Minicrate were emulated by a USB – I2C intelligent media converter developed by the Debrecen group at ATOMKI.

The integration of the PADC board to the DCS

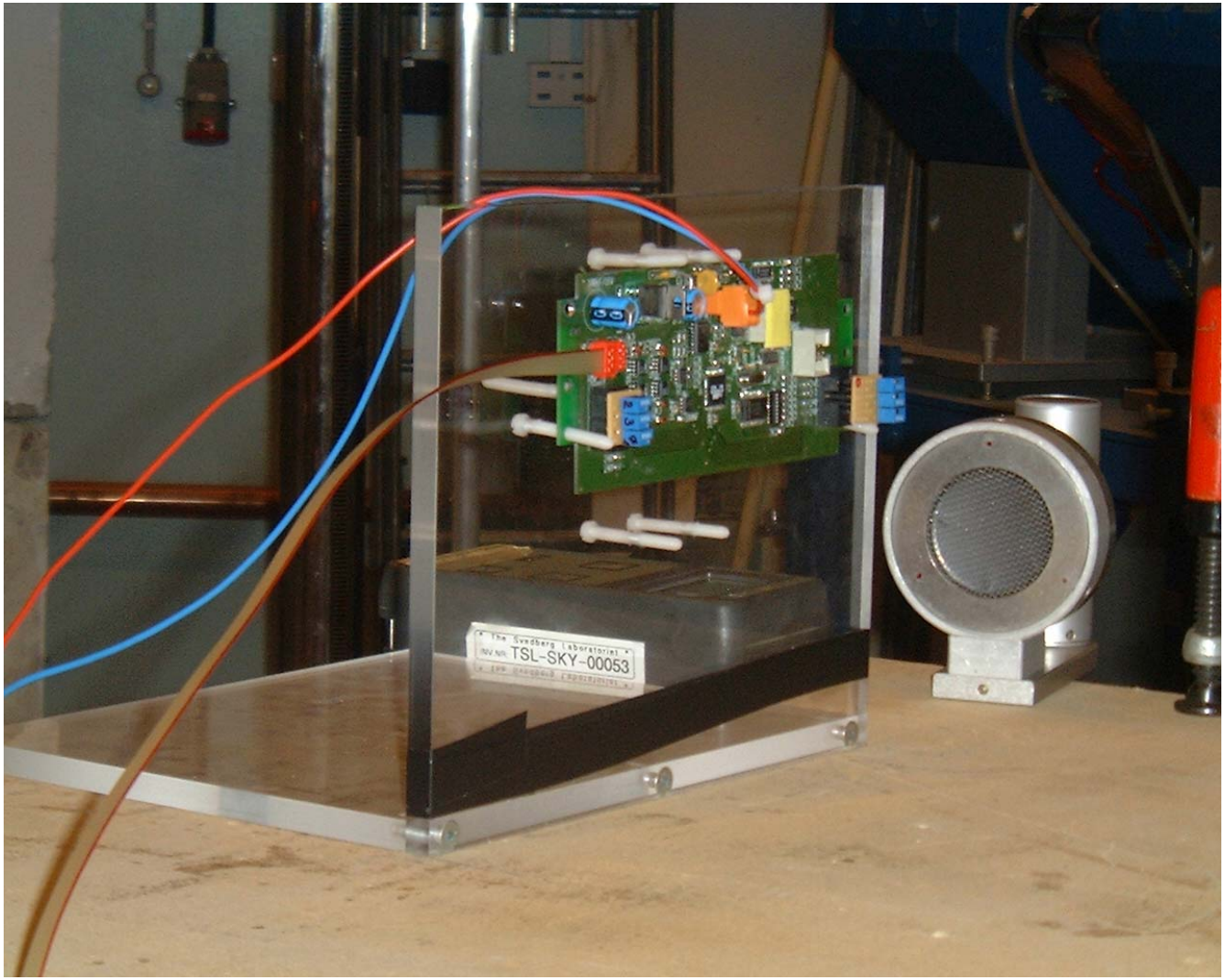


- The PADC boards will be connected to the Minicrate (a local interface between the DCS and the muon chamber related control units) using the same I2C bus which connects the Minicrate to the LED Driver boards of the Muon Barrel Alignment (MBA) system. The Minicrate is supervised by the DCS through the slow control part.
- PADC boards will be installed on each of the 240 pieces of Barrel Muon Chambers. The pressure monitoring electronics will operate in intense radiation environment; therefore, radiation hardness tests are of primary importance.

LED holders and the PADC module controlled by the portable diagnostic box.

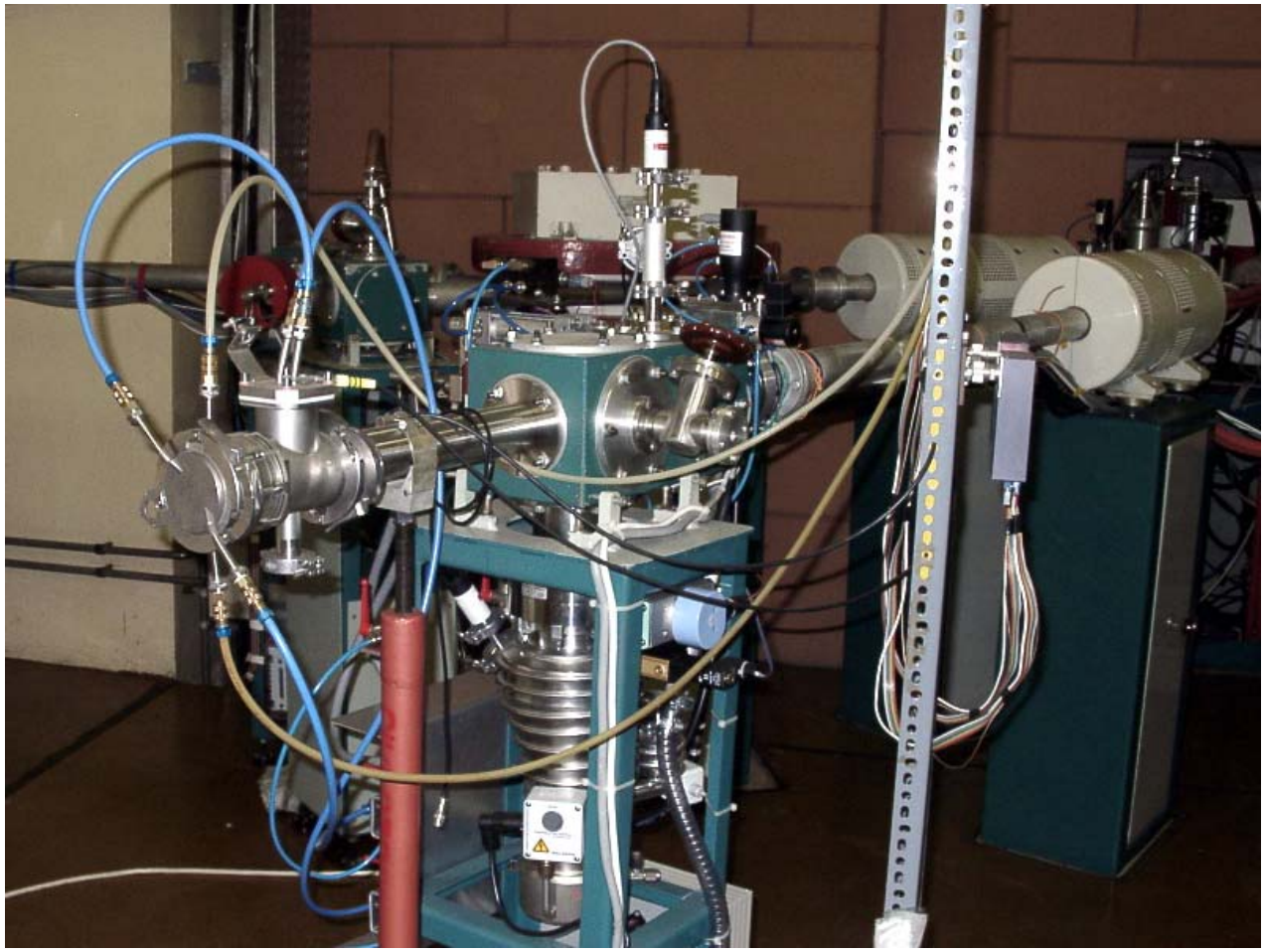


The proton beam-line at TSL



The proton beam of 50, 100 and 180 MeV was produced at the TSL cyclotron. It was broadened by a scatterer and was extracted to air.

The neutron irradiation setup at ATOMKI



The 20 MeV neutron irradiation was done at the neutron irradiation facility at the MGC-20E cyclotron at ATOMKI, Debrecen with p(20MeV)+Be reaction. Neutrons with a broad spectrum (En<20MeV, <En>=3.5MeV) were produced by bombarding a 3 mm thick target by protons.

Result of proton irradiation of the PADC boards

Proton energy (MeV)	Board	Nr. of protons (p/cm^2)	Total dose (krad)	Remarks
171	AT 90S8535	**3.0×10^9**	0.18	No SEU-s, 1 fatal error
171	AT 90S8535	**2.2×10^9**	0.136	2 upsets
171	ATMEGA	**2.2×10^9**	0.136	No upsets
171	MAX127	**2.2×10^9**	0.136	No upsets
171	MAX1138	**2.2×10^9**	0.136	No upsets
94	AT 90S8535	**3.56×10^9**	0.367	Latch up, no fatal errors
94	ATMEGA	**3.56×10^9**	0.364	No upsets
94	MAX127	**3.56×10^9**	0.367	No upsets
94	MAX1138	**3.78×10^9**	0.389	No upsets
48	AT 90S8535	**5.73×10^9**	0.945	No upsets
48	ATMEGA	**5.72×10^9**	0.944	No upsets
48	MAX127	**5.74×10^9**	0.947	No upsets
48	MAX1138	**5.76×10^9**	0.95	No upsets

Conclusions

The PADC modules were irradiated by protons of different energies and with neutrons. The board with the ATMEL 90S8535 processor had several failures, but the other three boards performed well, so any of the latter modules can be chosen for production from the radiation point of view. The PADC board with the MAX 1138 chip was finally selected for the pressure monitoring application. The production of the boards is on the way.

PADC board with the MAX 1138 chip