

## **NKTH-OTKA Grant 74458 (HA07-C)**

### **Absolute calibration of LHC beam luminosity and determination of total proton - proton cross section in the TOTEM experiment**

**Grant period: March 1 2008- Aug 31, 2009**

#### **Summary:**

Two young postdocs (M. Csanád and T. Novák) received a practical training in high energy particle physics in the TOTEM experiment at CERN LHC with the support of this grant. An MSc student (A. Sótér) completed her first scientific publication on TOTEM Roman Pot detectors. The list of the publications of this project includes one published paper, two conference contributions and three talks, which indicates a successful research, and does not reflect the difficulties that arised soon after the start of the grant period due to the cessation of the operations of the CERN LHC accelerator in September 2008. This difficult situation is expected to be normalized only by a successful restart of CERN LHC, scheduled presently to the end of 2009, after the closing of the grant period.

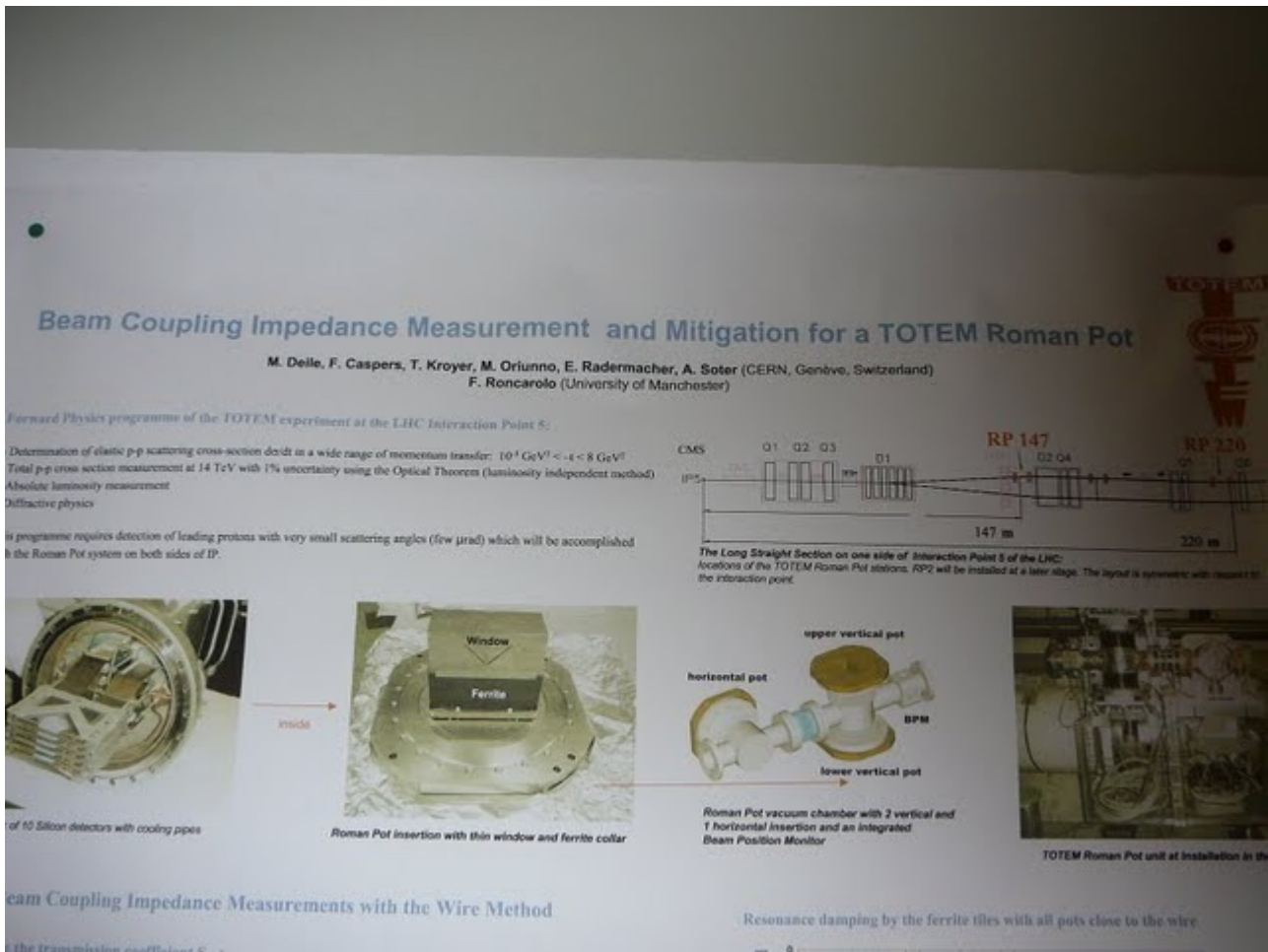
The lack of colliding beams in LHC resulted in a re-scheduling and re-planning of the proposed research: we had to give highest priority to those topics that were most important for the TOTEM experiment in this situation, complicated even further with expected delays in the construction of certain sub-detectors of TOTEM. Our group was focusing on necessary developments for the TOTEM Roman Pot subdetectors, which are fully tested and operational by the end of the grant period (with the exception of the 120 m stations where we want to understand the radiation conditions before installing our silicon detectors). We participated in the beam impedance measurements of the TOTEM Roman Pot stations. We introduced a new data format in the TOTEM online monitoring and data acquisition system. Upon the request of TOTEM we participated in the construction of hardware for the TOTEM Detector Control System. The planned measurement of total cross sections and the absolute calibration of the LHC beam luminosity was postponed due to lack of colliding proton beams and the cessation of LHC operations mentioned above. These measurements will take place after the successful restart of LHC, expected presently in the 2009/10 academic year.

#### **Details:**

Formally, in the call for proposals, the grant period was announced to be started in December 2007. We learned that our proposal was accepted in January 2008, but the contract was signed only in April and funding started only in July 2008. Thus actual travels and work could be started only in August 2008 and due to these time delays the one year funding period allowed us to conduct research at CERN until August 2009. Soon after the funding started, LHC started to operate and successfully circulated a proton beam in the LHC ring on September 10, 2008. However, no p+p collisions were achieved before an incident happened in Sector 3-4 on September 19, 2008, which lead to a cessation of LHC operations until present. Current expectations are that beams will circulate in LHC again in November 2009. First collisions can be expected at the end of 2009 or in the beginning of 2010 depending on experience with beam physics in the re-installed LHC. These events formed the environment that conditioned the performance of our NKTH-OTKA grant.

In this report, let me summarize our activities along the time-lines of the project:

- 1. Measurement of beam impedance of TOTEM Roman Pot Stations (A. Sótér)**
- 2. Contributions to TOTEM on-line Monitoring & Data Acquisition system (M. Csanád)**
- 3. Efficiency determination for TOTEM Roman Pot Si detectors (T. Novák)**
- 4. Creation of the web-pages for TOTEM-Hungary**



**Fig. 1.** Poster of Anna Sótér, M.Sc. Student, presented during the grant period. A conference talk was given by Mario Deile, her supervisor, in the same period, and the written version of the poster appeared in the proceedings as detailed in the list of publications.

### 1. Measurement of beam impedance of TOTEM Roman Pot Stations (A. Sótér)

A. Sótér started as a CERN Summer Student for TOTEM in 2007. She participated in the activities of the CERN subgroup of TOTEM, responsible for the Roman Pot subdetectors. A. Sótér participated in the beam impedance measurements of the Roman Pot stations, and she was part of the Hungarian TOTEM team at the time of the start of this project, however, by the time of the start of the funding, she left TOTEM for the CERN experiment ASAKUSA. Her research was however completed in an orderly manner, during the grant period a conference contribution has been submitted and accepted for publication on her research topic, as given in the list of publications. She also participated in the preparation of a TOTEM poster in the grant period. A photo of this poster (indicating her contributions) is shown in Fig. 1.

Although A. Sótér contributed scientifically and performed the proposed research as planned, she did not receive funding from this grant, because of the above mentioned facts: the funding started only in July 2008 and by that time she changed her research topic.

Note also that the grant was awarded and funded after the period when students of her age typically choose a topic for their M.Sc. dissertation. However, her participation in TOTEM lead to her first scientific publication and contributed significantly to the development of human capital and student training in an globally leading, inspiring international research environment.

## **2. Contributions to TOTEM on-line Monitoring & Data Acquisition system (M. Csanád)**

The formal acceptance of the Hungarian team by the TOTEM Collaboration Board occurred in April 2008 which was followed by signing a Memorandum of Understanding between CERN and the TOTEM – Hungary team in November 2008. With the help of the present funding, M. Csanád, a young and very successful member of our team spent 6 months at CERN starting from August 2008 until January 2009. Previously he had been responsible for the ZDC on-line monitoring codes of the PHENIX Collaboration, which provided a nice background for him when he started his work on the development of the on-line monitoring system of TOTEM. He developed various data interpreting algorithms (Slink → MulitSlink and MulitSlink → VME) and also developed real time diagnostic software for detector components (VFAT chips), he contributed to various processor optimized digital reading codes of TOTEM detector components and bad event rejection methods in real time diagnostics. He contributed to general development of the TOTEM on-line monitoring system and corrected bugs based on reports from users of the code. He participated in the meetings of the TOTEM Software groups and had several small reports, including one TOTEM talk (December 9, 2008) on the introduction of a new data format in TOTEM on-line monitoring. His personality matches well this very challenging task and integrated well into the TOTEM DAQ/Monitoring group. Emilio Radicioni, the group leader of TOTEM DAQ prepared a brief report evaluating M. Csanád's performance during this visit. A copy of his letter is attached to the end of this Report.

## **3. Efficiency determination for TOTEM Roman Pot Si detectors (T. Novák)**

T. Novák worked for seven months with TOTEM at CERN during 2009, ending his visit to TOTEM in August. He joined the Offline Software working group. His main task was to perform the analysis of the test beam data of the silicon detectors that are by now installed in the 220 m Roman Pot stations of TOTEM. His work required to program in C++ and in the ROOT framework. He studied the efficiency of the silicon detectors by using reconstructed tracks, analyzing the detector response for various threshold cuts and estimated the level of the noise. T. Novák also used the TOTEM Simulation and Reconstruction program and he was able to implement some on-line monitoring tools, collaborating with M. Csanád on this. His software related works were funded by the current grant, however, he was helping out the collaboration on a hardware work as well. The TOTEM running depends crucially on the proper installation of a Detector Control System (DCS) without which the detector is not allowed to operate. During the grant period, the TOTEM DCS group lacked man-power in a time-critical path and Tamás Novák helped them out by participating in the construction of DCS hardware components for T1 and T2 subdetectors. His hardware work was tested and again his timely and precise work has received a positive echo in the Collaboration. As a documentation, Fig. 2 indicates T. Novák with one of the TOTEM DCS boxes that he assembled. A letter from Valentina Avati, the group leader of the TOTEM Software group is attached to document the software contributions from T. Novák, while the pictures document his participation in the construction of DCS crates.

## **4. Creation of the web-pages for TOTEM-Hungary (M. Csanád)**

This task was to be given to a student as an outreach project, however, finally M. Csanád developed them given the delays in the start of the funding. The main topics are the introduction of TOTEM, the LHC, discussing our activity and role and acknowledging the support of our funding agencies. Also during this project we created some nice pictures e.g. the TOTEM Map of the World. We hope that some elements of these web-pages will be useful also for other members of the Collaboration. See <http://totem.kfki.hu/> for details.



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To whom it may concerns

Mate Csanad was involved in the Online working group of the TOTEM experiment during six months in the academic year 2008/2009. TOTEM is an experiment at the CERN LHC dedicated to the measurement of Total and Elastic Cross-Sections and to the study of Diffractive Scattering.

His was in charge of the Online Monitoring program, used by detector groups to visualize histograms and perform detector calibration. His task was to implement new features following the developments in the firmware of the front-end electronics, to follow the ongoing work during the detector commissioning by providing new histogram sets, and to help detector groups by improving the data quality checks.

His work required to code programs in C++ using the ROOT framework; it also needed to acquire the necessary knowledge about the structure of the front-end Electronics and the mode of operation of the Data Acquisition System.

Being the Online Monitoring a key element in between Electronics, Data Acquisition and Detector, Mate had to collaborate in a multi-disciplinary environment, with several people from different groups and with different levels of technical skills. He did it effectively and with clear sense of responsibility. His personal qualities emerged in this occasion, where good communication and open-minded attitude were essential. It would be a pleasure to keep collaborating with Mate in the future.

Yours sincerely,

Emilio Radicioni

(TOTEM Online Coordinator)

A handwritten signature in black ink, appearing to read "Emilio Radicioni".



**Fig. 2.a** T. Novák working on the TOTEM Detector Control System at CERN.



**Fig. 2.b** T. Novák with a completed TOTEM DCS module at CERN.

**Finally I would like to close this grant report with a surprise picture.**



**Visit of professor Roy Glauber (Harvard University, USA, Nobel laureate in physics 2005) to the Hungarian TOTEM team at CERN in July 2009.** From left to right: K. Eggert, (Spokesman of TOTEM, CERN), A. Ster (MTA KFKI RMKI, Budapest, Hungary), M. Csanád (ELTE University, Budapest), P. Osland (University of Bergen, Norway), T. Csörgő (Principal Investigator for TOTEM-Hungary, MTA KFKI RMKI, Budapest, Hungary), R. Glauber (Harvard University, Cambridge, MA, USA), J. Sziklai (MTA KFKI RMKI, Budapest, Hungary) and T. Novák (MTA KFKI RMKI, Budapest, Hungary and KRF, Gyöngyös, Hungary).

This visit of professor Glauber to CERN and in particular to TOTEM was organized by T. Csörgő, the Principal Investigator of the Hungarian TOTEM team. It was a most inspiring event for all, in particular for the junior generation of TOTEMians. Professor Glauber spent half a day at TOTEM in July 2009 and had a private meeting with the Hungarian members of the team. He is one of the founding fathers of nuclear diffraction theory a central physics topics of the TOTEM experiment at LHC.