Padova, November 4th, 2020

Report about Alberto Bragagnolo PhD activity.

Alberto Bragagnolo carried on his research activity in particle physics as a member of the "B Physics Analysis Group" of the CMS collaboration at CERN, dedicated to the study of heavy quarks physics.
His work was mainly devoted to the combined measurement of the CP-violating phase Φ_s and of the decay width difference $\Delta\Gamma_s$ between the light and the heavy B_s mass eigenstates, exploiting the $B_s \rightarrow J/\psi\Phi$ decay. This measurement, pursued using an innovative trigger path and a flavor tagging strategy based on multivariate analysis techniques, is the topic of Alberto's PhD thesis. This argument was selected as the subject of a "Physics briefing" of the CMS collaboration in spring 2020, "Crack in the Mirror", of whom Alberto is one of the authors. He is currently the CMS contact person for the combination of the Φ_s measurement with the corresponding results from the ATLAS and LHCb collaborations. He is one of the authors of the HL/HE-LHC Flavour Physics Yellow Report (arXiv:1812.07638), where he partecipated to the extraction of the predictions about the precision of the Φ_s measurement that will be reached during the future High Luminosity phase of the LHC accelerator.
In addition to the analysis tasks, Alberto had the responsibility of the implementation of the low pT muon discriminator in the official CMS code, originally developed for the search for the rare $B^0_{(s)} \rightarrow \mu\mu$ decay. He covered the position of "Trigger and Data Quality validator" of the B Physics Analysis Group for the period 2018-2020, and he developed an event display tool for a test of the Drift Tubes of the CMS muon detector.
He was selected as CMS speaker for the ALPS2019 Conference (Obergurgl (Austria), April 22-27, 2019), he gave a CERN seminar on the topic of his thesis in March 2020, a seminar for the theory group at the Padova Physics and Astronomy Department in summer 2020, and he presented the preliminary results of the $B_s \rightarrow J/\psi\Phi$ analysis at the LHCP2020 Conference in May 2020.
Alberto completed his formation by participating to three schools of statistics, machine learning for high energy physics, and data analysis. He was the winner of the award for the best presentation at the CMS Data Analysis School (2018), and one of the winners ex aequo of the "Machine Learning hackaton" of the INFN Statistics School (2019).
At the Padova University, Alberto coordinated the "CMS International Masterclass" for the period 2018-2019, and he was selected as one of the tutors of the Physics courses for the Engineering students and the Machine Learning laboratory for the period 2018-2020.
In addition, he is one of the qualified guides for the visits at the CMS experiment at CERN.
In his work, Alberto showed a great ability in data analysis, he demonstrated to have a very good sensitivity in understanding the experimental problems, and very good skills in software and computing techniques. He proved to be a very motivated and cooperative physicist, with high level communication skills and an excellent capacity to work in the complex environment of an high-energy experimental collaboration.
In conclusion, I rate as "excellent" his activity as PhD student.

Martino Margoni

Prof. Enrico Napolitani
DIPARTIMENTO DI FISICA E ASTRONOMIA
"Galileo Galilei" – DFA

via F. Marzolo, 8
35131 Padova

tel +39 049 8277001
enrico.napolitani@unipd.it

Padova, 10 November 2020

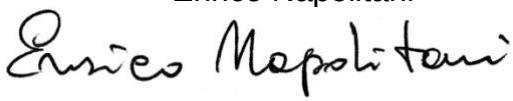
OGGETTO: Supervisor's evaluation of the PhD student in Physics Chiara Carraro.

During her three-year PHD period, Chiara Carraro investigated the effects of laser processing of semiconductors, with a main focus on the hyper-doping of Ge by Sb sputter deposition and Pulsed Laser Melting (PLM) for applications in nanoelectronics, photonics, and HPGe gamma-ray detectors. Chiara described in detail the diffusion and electrical activation phenomena of Sb during melting and recrystallization of Ge upon PLM, demonstrating that Sb doping can be successfully achieved well above the solubility limit (hyper-doping), with excellent electrical and crystalline properties.

The activity has been developed using two different facilities: during the first half of PHD she used a Nd-Yag laser equipped with a third harmonic generator emitting at 355 nm and located at the LNL-INFN in Legnaro, while during the second half of the PHD she used the new laboratory for Laser Processing installed at the Department of Physics and Astronomy in Padova at the beginning of 2019, equipped with a KrF Excimer laser emitting at 248 nm. It is worth mentioning that Chiara played an important active role in the start-up of the new laboratory and to the developing of the measurement protocols with the new instrument. All this, added to the investigations described above, contributed her to build a significant experience on laser processing of semiconductors and their characterization.

Chiara demonstrated a good capacity to carry on the research activity in a team environment, obtaining very good results, and therefore I propose the following overall evaluation: Very good.

Enrico Napolitani



Report on research activities

Student: Giorgia Mantovani

The research activities of Giorgia Mantovani was carried out within a co-tutelage between the Universities of Padova and Santiago de Compostela . She was involved in the analysis of data obtained in a nuclear physics experiment performed at the French national accelerator in GANIL.
Her research activities related to the analysis data is well reported here below by dr. Manuel Camano.

Because Giorgia's master degree is in Chemist, she spent the main part of the first-year (October 2017 - October 2018) to acquire the main tools to perform data analysis and to reinforce her knowledge of the fission process and the current experimental approaches.
She attended the following classes:
-Nuclear Physics
-Charged Particle Detection Techniques
-Nuclear Structure and Reactions with RIBs
-Nuclear Reactions with Heavy ions
At the same time she joined the experimental activities of the NUCLEX collaboration and contributed to the execution of experiments at Legnaro National Laboratories with the GARFIELD setup and at GANIL with the ACTAR TPC apparatus. Giorgia also actively attended in the meetings of the ACTAR international collaboration and participating in a data collection at GANIL in April 2018.

Report on research activities

Student: Giorgia Mantovani

Part of the research activities inscribed in the PhD of Giorgia Mantovani were carried out within a co-tutelage between the Universities of Padova and Santiago de Compostela (Spain) that was signed on January 2019, and concerned the analysis of experimental data obtained in a nuclear physics experiment performed at the nuclear magnetic spectrometer VAMOS in the French national accelerator GANIL, under my direction. This co-tutelage and her work on the experimental data has began effectively at the end of 2018, amounting merely two years of effective time for the data analysis. In this report, I detail the work performed by Giorgia related with the data analysis in which I was directly involved.

First year

(October 2017 - October 2018)

During the first year of her PhD at the University of Padova, I was not involved in the supervision of the research work of Giorgia nor she was involved in the data analysis of the fission experiment at VAMOS.

Second year

(October 2018 - October 2019)

Giorgia began the second year studying the properties and state-of-the-art in the current knowledge of the fission process and the current experimental approaches, including the techniques used in the experiments at GANIL. She also familiarised herself with the data acquisition code used during the experiment, understanding the treatment of raw signals and the first layer of analysis, and all the derived parameters.

In the first part of the year, she worked and completed the normalisation of the different settings used in the experiment. This is particularly complex because it involves a multidimensional treatment of the kinematical characteristics of the fission fragments measured in VAMOS, event by event. She also worked in the calibration of the measurement of the fragments velocities; a crucial step for the identification of the fragments. The final identification was improved by her work on the calibration of the energy measurement and the determination of the energy loss in the different layers of the spectrometer. This energy cannot be measured but only estimated though indirect methods, which Giorgia applied with success. Her work permitted the identification of more than 300 different isotopes, each one with several charge states, for a total of around 3000 types of detected particles. In general, she optimised the calibration of all the observables and was able to combine the different measurement settings to obtain a unified spectrum of the fission fragments produced in the experiment.

The second part of the year was devoted to reconstruct the angular distribution of each fragment especie detected in the experiment. In order to do so, she had to account for the large distribution of charge states measured for each isotope and the limits in the VAMOS acceptance. These evolve with the nature of each fragment, so she studied this evolution and determined the acceptance correction for each fragment. Finally, she was able to add the charge states distributions for each isotope and obtain the final angular distributions. In order to proceed towards the final calculation

of the fragment yields, she needed to account for the part of the distributions not covered by the VAMOS acceptance. This process involves a detailed and dedicated fit of each case in order to account for spurious effects due to statistical fluctuations and the unavoidable distortions in the large magnetic field of VAMOS.

The work performed the first year left the data analysis in a state almost ready for obtaining meaningful results and effectively contribute to the current corpus of data in nuclear fission.

Besides the work directly related with data analysis, Giorgia was also involved in side projects and activities. As a consequence of her work in the VAMOS data, Giorgia had the opportunity to share and discuss her progress in two international conferences during the first year: the Nuclear Structure and Dynamics 2019 conference in Venice, Italy; and the 2019 International Conference On Nuclear Data for Science and Technology, in Beijing, China.

In a more tangent way, during her stays at the University of Santiago de Compostela and GANIL, she was involved in other projects carried out by members of our investigation group. In particular, she participated actively in nuclear-structure experiments with the new ACTAR active-target, not only in GANIL but also in the LNS/Catania with the demonstrator of the same device.

Third year

(October 2019 - October 2020)

The third year was mostly devoted to obtain the fragment yields and other relevant fission observables. It is worth mentioning the impact on the workflow that the worldwide outbreak of Covid-19: the restrictions applied to travelling and on-site work made a close collaboration between Giorgia and this supervisor impossible during most of the second half of this period. However, the partial results obtained are certainly of merit and very promising.

The first part of this period found Giorgia working in collaboration with D. Ramos (GANIL), one of the spokespersons of the ongoing fission campaign at VAMOS. She employed this time to optimise the fragment identification and perform the data selections needed in order to treat each nuclear system separately. This part of the work was finished in a following stay at the U. of Santiago. Once all systems were identified and separated, the final merging of settings and evaluation of yields have began.

The second part of this year, from March onwards, was planned for the determination of the yields and fission observables. However, due to the aforementioned world health crisis, her work and my availability were stalled for several months. And, actually, it continues as I write this report. The de-correlation between the measures put in place in Italy and Spain made very difficult the supervision of Georgia's progress and impossible any visit. However, even under these circumstances, Giorgia was able to obtain the first results on observables from 238U+27Al fusion-fission reactions in inverse kinematics.

The correction of the acceptance in the angular distribution carried a nice side-effect: Giorgia fitted each fragment angular distribution and thus she was able to obtain for the first time the evolution of the fission angular anisotropy as a function of the mass and atomic number of the fragments. This observable was never obtained experimentally with such details and it is very important to understand the fission process and the dynamics close to the fission barrier. The final yields were also obtained at the end of this period. In order to get the final numbers, Giorgia needed to subtract the contribution from less probable background channels, such as transfer-fission, which requested a detailed analysis of each isotopic distribution.

The collection of isotopic yield distributions permits the calculation of other observables, such as the neutron-to-proton ratio in the fragments, which gives unique information about the role of nuclear structure on the process; and the neutron evaporation, which serves as an indication of the thermodynamics of the fission. Giorgia is obtaining all these observables with a level of detail never achieved: she was able to report them also as a function of the angle in the centre of mass of the fissioning system. This is not only relevant for the fission process, but it is also very important to understand quasi-fission reactions. These incomplete fission events are extremely sensitive to shell effects and to the time scale of the reaction. The data Giorgia obtained will help to constrain our understanding of this process and it will be a challenge for the current theoretical models aiming to describe fission and quasi-fission. Unfortunately, and due to the restrictions and difficulties imposed upon us due to the limited time and current conditions, refined results and elaborated conclusions from Giorgia's work would not be available before the end of this PhD period.

Research assessment

As co-supervisor of Giorgia Mantovani in these past two years, I appreciate all the effort and work she has done on the data analysis. Two things in particular help to raise this appreciation: the learning curve she followed in such a short time, considering her somehow distinct background, was remarkable; and the results obtained within the current conditions are certainly noteworthy.

With all things considered, I cannot give in good faith an assessment of Giorgia's research work different than ***EXCELLENT***.

Dr. Manuel Caamaño Fresco

Associate Professor of Particle Physics
IGFAE - Dpto de Física de Partículas
University of Santiago de Compostela
manuel.fresco@usc.es
+34 8818 13626

Summary of research activity of Dr. Matteo Presilla during his PhD

Supervisor: Prof. Roberto Rossin, Co-Supervisor: Dr. Patrizia Azzi

Dr. Presilla has started his PhD at the University of Padova in 2017 joining the group working on the CMS experiment. The first of the PhD program in Padova is characterized by a set of courses with final exams.

- Theoretical work:
    - [2018] publication of the paper "Non-Commutativity effects in the Dirac equation in crossed electric and magnetic fields" (EPL 123 (2018) no.2, 20008)) in collaboration with D. Nath, O. Panella, P. Roy
    - [2018] publication of the description of a new physics composite model ("Like-sign dileptons with mirror type composite neutrinos at the HL-LHC") as a theory contribution in the CERN Yellow Report of the HL/HE-LHC (CERN-2019-007) with O. Panella (continuation of Laurea Thesis work)
    - [2019] publication of "Perturbative Unitarity Bound in effective composite models" Phys.Lett.B 795 (2019) 644-64, which is extremely useful in the interpretation of experimental results and limit setting for new physics searches.
- Experimental work:
    - [2018] Publication of the "Search for heavy composite Majorana neutrinos (HCMN) at the HL/HE-LHC", FTR-18-006 and CERN HL/HE-Yellow Report (CERN-2019-007). This is a search for new physics in the channel with two leptons and one jet with the CMS Phase-2 upgraded detector. This document includes for the first time the application of the unitarity constraints as described in the previous paper.
    - [2019-2020] "Search for heavy composite Majorana neutrinos" (EXO-20-011) with P. Azzi and V. Mariani. This is a search for a heavy composite Majorana neutrinos in the channel with two high pt leptons and one large radius jet, reoptimized using unitarity constraint, and using the full CMS run 2 statistics. He is the main contact for this analysis. Analysis in the final phases of the publication process.
    - [2019-2020] "Search for EWK and anomalous EWK production of a ZV boson pair plus two jets with full Run 2 data" at CMS, AN-2020/076 with P. Azzi, JB Sauvan, A. Hakimi. He is the main contact for this analysis. This analysis is currently in progress and going for publication in Spring 2021.
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Dr. Presilla has also spent one year at CERN (6/2019-6/2020) as a CERN COAS position (INFN Associate Fellow). He has been also contributing with service work to the CMS experiment as contact for the MonteCarlo production of the StandardModel Physics Group.
The quality, quantity and diversity of the research expressed by Dr. Presilla in the three years of PhD is exceptional, in my experience. He is an excellent student that I recommend for a PhD with honors.

Patrizia Azzi Roberto Rossin