

# 13<sup>th</sup> IUVSTA School on Vacuum Gas Dynamics: Theory, Experiments and Applications

<http://iuvsta-school2015.mie.uth.gr>

Thessaloniki Greece, 17-21 May 2015

## REPORT

by

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### 1. Introduction

The 13<sup>th</sup> IUVSTA School has been organized in the framework of the IUVSTA educational program in Thessaloniki Greece on 17-21 May 2015. The School was designed for scientists, engineers and post-graduate students who are applying rarefied/vacuum gas dynamics in their every-day work but they are not experts in this field. The main objective of the School was to educate and train the participants in applying vacuum gas dynamics and also fill the gap between complicated theory and practical needs.

The event has been co-chaired by Prof. Felix Sharipov (Brazil), Dr. Oleg Malyshev (UK) and Prof. D. Valougeorgis (Greece), who was also the local Organizer. The School speakers included the three chairmen as well as Dr. Karl Jousten (Germany), Dr. Roberto Kersevan (Switzerland) and Dr. S. Naris (Greece). The School was sponsored by IUVSTA, while a bronze sponsorship was provided by Hidden Analytical. Totally 47 delegates participated in the School including 40 students, 6 lecturers and 1 technical staff.

### 2. School participants

The School students came from various countries in Europe and few of them from USA, Canada and China. A detailed list of the country of work origin of all students is given in Table 1, where it is seen that they are coming from 14 countries. The type of working environment of participants is given in Table 2, which shows that 17 participants are from research institutes/centers, 16 from universities and 7 from the companies/industry. Their professional status is shown in Table 3, with the majority of them being Ph.D. students and vacuum scientists/engineers, while about 7 are senior engineers or group leaders.

From the Tables 1, 2 and 3 it may be concluded that the School audience was diverse concerning the scientific background and interests of the participants in accordance with the organizers objectives. This diversity was very stimulating for the students triggering interesting questions to the lecturers during sessions and coffee breaks, making however, the lectures' presentations quite challenging in order to cover all questions and needs.

Table 1: Country of origin of participants

Belgium	1	Italy	1
Canada	1	Kosovo	1
China	2	Netherlands	1
Czech Republic	2	Sweden	7
France	2	Switzerland	3
Germany	13	UK	1
Greece	4	USA	1

Table 2: Type of working environment of participants

Research institutes	Universities	Companies/ Industry	Sum
17	16	7	40

Table 3: Professional status of participants

Ph.D. students	Vacuum scientist/engineer	Senior engineer	Group leader	Other
14	14	5	2	5

### 3. School topics

Totally 10 Lectures and 6 Practical Sessions were presented covering many topics in the field of Vacuum Gas Dynamics (see the School Program in Appendix A). The theoretical and computational parts were focused on kinetic theory, kinetic models, gas-surface interaction, test particle and direct simulation Monte Carlo methods (TPMC and DSMC), while the experimental part was focused on methods of measurements and standards in vacuum systems and vacuum metrology. The part related to applications was on vacuum gas dynamics in pipes, pumps, gauges, small and large vacuum systems (networks, accelerators) using Molflow software, numerical codes based on DSMC and discrete velocity methods as well as diffusion modeling.

An interesting part of the School was the Practical Sessions where the students were requested to solve specific problems and exercises related to the material of the lectures. These Sessions were running in parallel in two groups (about 20 students per group) supervised by 2-3 lecturers at the same time in order to help the students more effectively and to increase interaction between students and lecturers. Most of the students were happily engaged in this process trying hard to get the correct answers which were delivered to the students for comparison purposes.

It is important to note that all material related to the Lectures and Practical Sessions has been uploaded to the School website about two weeks before its start and all registered participants had (and still have) access to it in order to better prepare themselves in all sessions. Updated versions of the Lectures and Practical Sessions may be available for downloading until the end of June 2015.

At the beginning of the event (Monday morning) a short presentation on IUVSTA was given emphasizing on the importance of IUVSTA on educational activities (schools, fellowships, etc.). The duration of all Lectures and Practical Sessions was 1hr and 15 min with a coffee break of 30min between sessions.

The detailed program of the School is given in Appendix A, while some photos of the School may be found in Appendix B.

### 4. School evaluation and concluding remarks

In the last day of the event questionnaires were delivered and filled by the students. There was a very positive reply by the vast majority of the participants being very much satisfied by the School and saying that they would recommend a similar School to their colleagues. They were also very much satisfied by the scientific level of the lectures finding them comprehensive and interesting. There were some concerns about the practical sessions saying that although they were well connected to the lectures it was difficult to follow and proposing having more time to

tackle the exercises. They found the 30min coffee breaks between the intensive sessions very helpful for discussions and relax. From the lecturers' point of view the feedback was also very positive inspite the diversity of the audience, the extension of the material covered and the intensive time program. Overall it is considered as a very successful school fulfilling most of its objectives.

## Appendix A: School program

<b>Sunday 17th May</b>		
18:00-20:00	Registration	
18:30-20:00	Welcome meeting and reception	
20:00	Dinner	
<b>Monday 18th May</b>		
07:30-08:00	Registration	
08:00-08:30	General information	
08:30-09:30	<b>Lecture 1:</b> Basics in kinetic theory, vacuum gas dynamics (FS)	
09:30-10:00	Coffee	
10:00-11:15	<b>Lecture 2:</b> Gas-surface interaction (FS)	
11:15-11:45	Coffee	
11:45-13:00	<b>Lecture 3:</b> Test particle Monte Carlo method and its realization in Molflow code (RK)	
13:00-14:30	Lunch	
14:30-15:45	<b>Practical session 1:</b> Kinetic theory (FS,DV,SN) Group 1	<b>Practical session 2:</b> TPMC (RK,OM) Group 2
15:45-16:15	Coffee	
16:15-17:30	<b>Practical session 1:</b> Kinetic theory (FS,DV,SN) Group 2	<b>Practical session 2:</b> TPMC (RK,OM) Group 1
19:00	Dinner	
<b>Tuesday 19th May</b>		
08:15-09:30	<b>Lecture 4:</b> DSMC (FS)	
09:30-10:00	Coffee	
10:00-11:15	<b>Lecture 5:</b> Model equations (DV)	
11:15-11:45	Coffee	
11:45-13:00	<b>Lecture 6:</b> Experimental data and input parameters for modelling in UHV (OM)	
13:00-14:30	Lunch	
16:00-23:00	Excursion with dinner	
<b>Wednesday 20th May</b>		
08:15-09:30	<b>Lecture 7:</b> Pipes flows, time dependent flows, mixtures and polyatomic gases (FS,DV)	
09:30-10:00	Coffee	
10:00-11:15	<b>Lecture 8:</b> Pump and gauge modeling (SN)	
11:15-11:45	Coffee	
11:45-13:00	<b>Lecture 9:</b> Experimental methods and standards in vacuum (KJ)	

13:00-14:30	Lunch	
14:30-15:45	<b>Practical session 3:</b> Model equations (DV,SN) Group 1	<b>Practical session 4:</b> DSMC (FS) Group 2
15:45-16:15	Coffee	
16:15-17:30	<b>Practical session 3:</b> Model equations (DV,SN) Group 2	<b>Practical session 4:</b> DSMC (FS) Group 1
19:00	Dinner	
<b>Thursday 21th May</b>		
08:15-09:30	<b>Lecture 10:</b> Modeling of vacuum system for particle accelerators (OM)	
09:30-10:00	Coffee	
10:00-11:15	<b>Practical sessions 5:</b> Modeling of vacuum system for particle accelerators (OM,RK) Group 1	<b>Practical sessions 6:</b> Metrology in vacuum (KJ) Group 2
11:15-11:45	Coffee	
11:45-13:00	<b>Practical sessions 5:</b> Modeling of vacuum system for particle accelerators (OM,RK) Group 2	<b>Practical sessions 6:</b> Metrology in vacuum (KJ) Group 1
13:00-13:30	<b>Closing:</b> School evaluation, discussion and future actions (all)	
13:30-14:30	Lunch and departure	

**Speakers:** Felix Sharipov (FS), Roberto Kersevan (RK), Dimitris Valougeorgis (DV), Oleg Malyshev (OM), Steryios Naris (SN), Karl Jousten (KJ)

## Appendix B: School photo



For more photos please visit <http://iuvsta-school2015.mie.uth.gr/photos.html>