



MA|AM Course 2016

Microphone Arrays for Aeroacoustic Measurements Theory and Practice, May 23-25, 2016

The MA|AM course

Aim of this course is to improve the knowledge for the practical application of microphone array measurements in wind tunnels, including the post-processing and the interpretation of the achieved results. Test engineers can participate to obtain the necessary knowledge to improve the quality of aeroacoustic measurements with microphone arrays and prevent costly errors. Contractors and end-users of array measurement results will learn how to assess the potential of aeroacoustic wind tunnel measurements and how to interpret the achieved results appropriately.

In this course a knowledge base regarding the necessary theoretical background, practical knowledge about the hardware requirements and the potential of post processing will be taught. The theoretical part will concentrate on those aspects of aeroacoustics relevant to microphone array measurements. Besides giving lectures on the fundamental aspects, special emphasis will be placed on solutions of the practical problems which are faced during the implementation of this technique in wind tunnels. During practice the participants will have the opportunity in small groups to carry out recording and evaluation of data, with special emphasis being given to the impact of experimental settings on the beamforming results. The post processing and particularly the various deconvolu-

tion algorithms, including their advantages and disadvantages, will be explained and demonstrated.

Who should attend?

This course is mainly intended for engineers and scientists who already have basic knowledge of acoustics or aeroacoustics and already work or will work with microphone arrays or with the results of microphone array measurements in industrial or scientific applications. Besides this, the course is intended for engineers who need to understand the possibilities and limitations of microphone array measurements. During the course many problems arising in aeroacoustic measurements and microphone arrays will be treated - in theory as well as in practice.

Lecturers

Prof. Robert Dougherty, Optinav Inc. / University of Washington, USA

Dr. Klaus Ehrenfried, German Aerospace Center, Germany

Dr. Lars Koop, German Aerospace Center, Germany

Prof. Ennes Sarradj, Brandenburg University of Technology, Germany

Dr. Pieter Sijtsma, National Aerospace Laboratory, Netherlands

Dr. Carsten Spehr, German Aerospace Center, Germany

Together with Dr. Thomas Ahlefeldt, Tobias Berkefeld, Daniel Ernst, Stefan Haxter and Dr. Arne Henning from DLR, they will present their knowledge and experience in different areas of the microphone array measurement technique.

Course Details

The course runs from Monday (May 23, 2016) to Wednesday (May 25, 2016). Registration will begin at 08:15 on Monday.

The course is divided in half day lectures and practices. Each course day includes a one hour lunch break and coffee breaks. A detailed time table will be made available to registered participants. All presentations will be given in English.

The welcome party at the DLR will take place at 18:30 on Monday, May 23, 2016 and a dinner is planned at a restaurant in the Göttingen town center at 19:30 on Tuesday, May 24, 2016.



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Preliminary lecture outline

May 23, 2016, 09:00-18:00 Registration 08:15-09:00. Welcome. Fundamentals: *signal processing, aeroacoustic sources and wave propagation, beamforming, array design, steering vectors*. Practice.

May 24, 2016, 09:00-18:00 Application: *aeroacoustic source models, measurements in open and closed test sections, data analysis, hardware requirements, installation of measurement equipment in wind tunnels*. Practice.

May 25, 2016, 09:00-16:30 Practice. Advanced techniques and applications: *deconvolution, shear layer correction, boundary layer effects, Reynolds number effects, hydrodynamical and acoustical pressure fluctuations*. Final discussion.

Course Organisation

Scientific organisation:

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Preliminary practice outline

- I. Closed test section: *background noise, diagonal removal, reflections, flow correction, directivity, typical errors*
- II. Open test section: *shear layer correction, haystacking, turbulent scattering, calibration of microphone positions, combination with PIV*
- III. Array properties in aeroacoustics: *array layout, point spread function, identification of aeroacoustic sources, 3D-beamforming*
- IV. Demonstration: *application and characteristics of deconvolution algorithm, post processing, discussion*

Course Registration

Early registration is strongly recommended due to the limited space available in the laboratory. Registration should be online only and will be possible in October 2016 using the link:

<http://maamcourse.dlr.de>.

The registration fee of 1480 € includes course notes, lunches and refreshments during the course, the Tuesday welcome party and the Wednesday evening dinner. The fee for participation is free of VAT as far as the German Umsatzsteuergesetz (UStG) is concerned. The organizers reserve the right to cancel the course in case of too few participants. A cancellation fee of 400 € will be charged from registered persons who cancel their participation after April 15, 2016.



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