A Comparison between Radial Rakes of Sensors and Axial Arrays of Microphones for the Experimental Investigation of Tone Noise in LPTs

F. Taddei [1] and M. De Lucia [2]
University of Florence, Florence, Italy, 50139

D. Torzo[3] and E. Spano[4]
Avio group S.p.A., Rivalta di Torino, Italy, 10040

The experimental investigation of turbomachinery noise requires to measure the acoustic field within annular test rigs. For this purpose, different in-duct measurement techniques are available. The most widely used are the arrays of flush-mounted microphones installed at the duct walls and the rakes of dynamic pressure sensors placed along the radial direction of the duct. Both methods have been implemented and used for several test campaigns performed at the Avio cold flow rig in Turin (Italy), in order to assess the acoustic performances, from the tonal noise point of view, of a model low-pressure-turbine representative of modern turbofan applications. This paper aims at performing a back-to-back comparison between the results obtained by using these different experimental techniques. The results allowed to make assessments about the effectiveness of each experimental technique at analyzing tonal noise, highlighting the peculiar features of the two methods and their relative advantages and drawbacks.

Nomenclature

AA	=	axial array arrangement
RR	=	radial rakes arrangement
B	=	rotor row
V	=	stator row
BPF	=	Blade Passage Frequency
Bn	=	blades count of the rotor of the n-th stage
Vn	=	vanes count of the stator of the n-th stage
K	=	condition number
RF	=	Rear Frame, Rear Frame vanes count
m	=	azimuthal mode order
n	=	radial mode order
$P_{mn}^{\pm}$	=	modal power level for the azimuthal mode order *m*; + and – indicate, respectively, downstream and upstream propagation
$A_{mn}^{\pm}$	=	amplitude of the radial mode for the azimuthal mode order *m*; + and – indicate, respectively, downstream and upstream propagation
h	=	harmonic index
k_{RF}	=	scattering index for the Rear Frame

[1] Ph.D. research fellow, Energy Department S.Stecco, via S. Marta 3, 50139, Florence, Italy.
[2] Full professor, Energy Department S.Stecco, via S. Marta 3, 50139, Florence, Italy.
[3] Ph.D., R&D, Avio group S.p.A., via 1° maggio 56, Rivalta di Torino, 10040, Italy.
[4] R&D lead engineer, Avio group S.p.A., via 1° maggio 56, Rivalta di Torino, 10040, Italy.