



HAL
open science

Transition and control in rotating-disk boundary-layer

Muhammad Ehtisham Siddiqui, Benoît Pier, Mukund Vasudevan, Julian F. Scott, Carlo Cossu, Alexandre Azouzi, Christian Nicot, Roger Michelet

► **To cite this version:**

Muhammad Ehtisham Siddiqui, Benoît Pier, Mukund Vasudevan, Julian F. Scott, Carlo Cossu, et al.. Transition and control in rotating-disk boundary-layer. Euromech Fluid Mechanics Conference 8, Sep 2010, Bad Reichenhall, Germany. hal-00632327

HAL Id: hal-00632327

<https://hal.science/hal-00632327v1>

Submitted on 14 Oct 2011

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Transition and control in rotating-disk boundary-layer

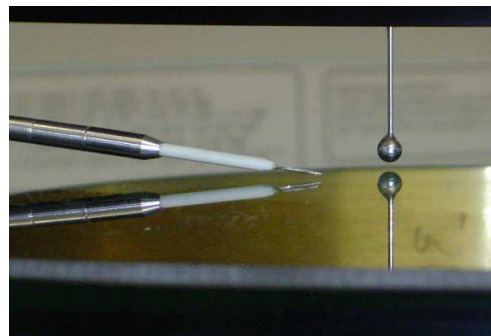
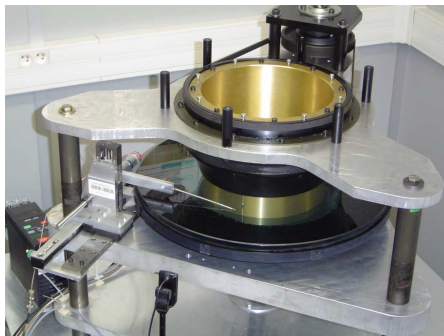
M. E. SIDDIQUI*, B. PIER*, MUKUND V. *, J. SCOTT*,
C. COSSU†, A. AZOUZI*, C. NICOT*, R. MICHELET*

The flow due an infinite disk rotating in otherwise still fluid has served as the archetypical configuration for the study of three-dimensional boundary layers and is known to display a sharp transition from laminar to turbulent flow at a nondimensional critical radius $R \simeq 510$. Using linear stability analysis, this location was found by Lingwood¹ to precisely coincide with the onset of local absolute instability. More recently², a fully nonlinear analysis and a secondary stability analysis have further contributed to the understanding of the complex dynamics prevailing near the transition radius. An open-loop control strategy³ has been theoretically shown⁴ to be applicable in this context. The aim is to delay onset of secondary perturbations, and thus transition, by a controlled modification of the primary nonlinear state.

The present experimental investigation has been undertaken to confirm these predictions and to test the practical applicability of the control method.

The experimental arrangement consists of a 50 cm diameter glass disk that is rotated at constant angular speeds, up to 1500 rpm. Control is applied via a set of needles, evenly distributed on a cylinder placed above the disk. The forcing parameters are adjusted and optimized by changing the number of needles and the rotation rate of the cylinder (which can be varied independently of the disk rotation rate). A second technique, using microstructured roughness elements on the disk surface, is also currently being implemented.

The flow features, with and without control, are characterized by time-resolved local hot-wire measurements. The influence of the different control parameters and forcing strategies will be discussed and compared with theoretical predictions.



*Laboratoire de mécanique des fluides et d'acoustique; CNRS—Université de Lyon ; École centrale de Lyon ; 36 avenue Guy-de-Collongue ; F-69134 Écully cedex.

†Institut de mécanique des fluides de Toulouse ; CNRS—Université de Toulouse ; allée Camille-Soula ; F-31400 Toulouse.

¹Lingwood, *J. Fluid Mech.* **299**, 17–33 (1995).

²Pier, *J. Fluid Mech.* **487**, 315–343 (2003).

³Pier, *Proc. R. Soc. Lond. A* **459**, 1105–1115 (2003).

⁴Pier, *J. Eng. Math.* **57**, 237–251 (2007).