

# Three-dimensional rainbow schlieren measurements in underexpanded sonic jets from axisymmetric convergent nozzles

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[Hirofumi Takano](#), [Daigu Kamikihara](#), [Daisuke Ono](#), [Shinichiro Nakao](#), [Hideaki Yamamoto](#) & [Yoshiaki Miyamoto](#)

# STRUCTURE OF UNDEREXPANDED SUPERSONIC JETS FROM AXISYMMETRIC LAVAL NOZZLES

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**Hirosaki Maeda** (Corresponding author: [maeda@kaiyodai.ac.jp](mailto:maeda@kaiyodai.ac.jp))

University of Kaiyodai, 7-1, Hibikino, Wakamatsu-ku, Kaiyodai, Fukuoka, 808-0133 Japan

**H. Fukuda**

University of Kaiyodai, 7-1, Hibikino, Wakamatsu-ku, Kaiyodai, Fukuoka, 808-0133 Japan

**K. Kuba**

Amey Electric Co., Ltd., 2220 Nagatsumamachi, Isumi-shi, Gunma, 372-8585 Japan

**Shinichiro Nakao**

University of Kaiyodai, 7-1, Hibikino, Wakamatsu-ku, Kaiyodai, Fukuoka, 808-0133 Japan

**D. Gao**

University of Kaiyodai, 7-1, Hibikino, Wakamatsu-ku, Kaiyodai, Fukuoka, 808-0133 Japan

**Yoshiaki Miyazawa**

University of Kaiyodai, 7-1, Hibikino, Wakamatsu-ku, Kaiyodai, Fukuoka, 808-0133 Japan





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APPLICATION OF MARK-JOHANSEN  
INTERFEROMETER FOR VISUALIZATION OF CHOCK TRAINSTakamata Toshiaki, Nakao  
Shinjiro, Miyazawa Toshiaki

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**Abstract** A Mark-Johansen interferometer system combined with a high-speed camera is applied for a chock train in a constant-area straight duct to clarify its unsteady characteristics in which just upstream of the chock train the downstream Mach number is 1.44, the inlet Reynolds number is  $4.97 \times 10^5 \text{ m}^{-1}$ , and the boundary layer thickness is 0.432 mm. An instantaneous two-dimensional density field in the chock train is quantitatively obtained with high spatial resolution. The present Mark-Johansen interferometer system is found to be effective for unsteady density measurements in chock-dominated flows in a two-dimensional duct. The oscillatory characteristic of each chock in the chock train is demonstrated by power spectral analysis of the unsteady density field.

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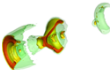
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# Three-dimensional reconstruction of a microjet with a Mach disk by Mach-Zehnder interferometers

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S. Sugawara, S. Nakao, Y. Miyamoto , Y. Ishino and K. Miki



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Shota Yoshimi , Takahiro Yamashita <sup>1</sup> , Shinichiro Nakao <sup>1</sup> , Yoshiaki Miyazato <sup>1</sup>  

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# Mach–Zehnder interferometry for transient shock-dominated flows in a confined duct

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