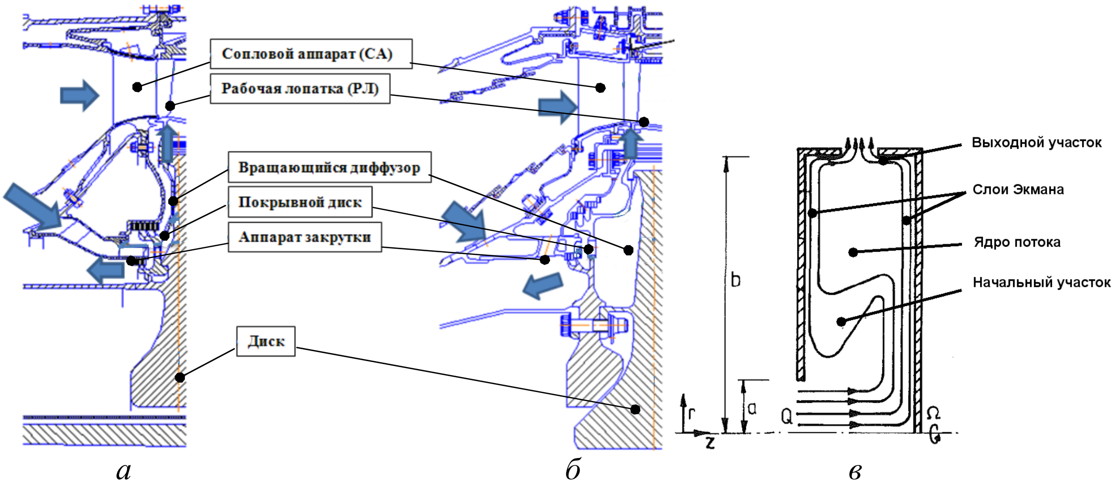

Рис. 1. Системы подвода с различной шириной вращающегося диффузора
а) Двигатель GE90, б) Двигатель CFM56, в) Схематическое представление структуры течения в полости вращающегося диффузора

1. В диапазоне критериев подобия, соответствующих режиму работы реального ГТД $0.375 < \lambda_T < 0.75$, $1.69 \cdot 10^7 < \mathrm{Re}_\varphi < 2.33 \cdot 10^7$, $2.79 \cdot 10^5 < C_w < 5.73 \cdot 10^5$, $0.548 < \beta < 2.5$ проведено исследование влияния ширины $S_{отн} = 0.01, 0.04, 0.2$ диффузора на показатели эффективности системы подвода воздуха к рабочей лопатке турбины для различных радиусов расположения аппарата закрутки.

2. В исследованном диапазоне чисел Рейнольдса и безразмерного расхода результаты расчетов показали, что в узком вращающемся диффузоре слои Экмана отсутствуют, в диффузоре средней ширины слои Экмана исчезают при увеличении C_w, в широком присутствуют, но занимают незначительную часть области течения у вращающихся стенок. Таким образом, при увеличении ширины диффузора проявлялись слои Экмана, но их влияние на интегральные характеристики потока не обнаружено. В итоге для режимов течения, обеспечивающих снижение температуры и давления под лопаткой (для нижнего расположения $\beta_0 > 2$, для среднего $\beta_0 > 1.2$ и для верхнего $\beta_0 > 0.75$) не обнаружено влияние ширины дисковой полости на адиабатическую эффективность и безразмерное снижение давления. несущественным.

3. Полученные результаты качественно согласуются с данными в работах других авторов, для параметров $0.1 < \lambda_T < 0.4$, $0.6 \cdot 10^6 < \mathrm{Re}_\varphi < 1.8 \cdot 10^6$, не соответствующих реальным режимам работы ГТД.

4. Ширину вращающегося диффузора выбирает конструктор исходя из конструктивной необходимости, прочности, массы и динамических характеристик ротора турбины.

OPTICAL DIAGNOSTICS FOR AVIATION ENGINE RESEARCH: PART 1. SPRAY DIAGNOSTICS

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Fuel sprays are still the mainstream industrial application for introducing fuel into combustion chambers in jet engines. With the advances in the laser technology, optical diagnostics has become the key tool for research in aviation engines. Today, it is possible to deliver very coherent, spectrally pure, constant intensity beam into the measurement volume. Regardless of the technique used, these properties of laser light allows for a controlled input to the experiment thereby providing an accuracy value often limited by the laser wavelength.

The point measurements of velocity, particle size and temperature utilize the LDA, PDA and Dual-band LIF techniques respectively. Because PDA and LIF hardware can be an extension of the LDA system, the simultaneous measurements of velocity, droplet size and temperature is possible. While point measurements provide sufficient accuracy and spatial resolution, often the global behaviour of the process is of interest. For this purpose, the laser beam is stretched into a thin sheet to illuminate a planar measurement area. In such planar measurements, often a high-quantum efficiency camera is used, thus the planar measurement techniques are also called the imaging techniques. These include Interferometric Particle Imaging (IPI), Shadow sizing and Spray geometry for droplet size and spray shape measurements and Particle Image Velocimetry (PIV) and Particle Tracking Velocimetry (PTV) for velocity measurements.

PIV has matured over a quarter century and is now an established tool in fluid diagnostics. The development of the technique has been tremendous due to relentless advances in laser, detector, and CPU processor technology: In 25 years, the technique evolved from the manual construction of a 2-component velocity field from a double-exposed particle image on a single photographic paper, to digital storage and computation of 3-component velocity fields in liter-sized volumes in a time resolved fashion. Along the way, several other sub-techniques and names, such as Digital-PIV, Micro-PIV, Nano-PIV, Holo-PIV, Stereo-PIV, Endoscopic-PIV have been introduced to describe certain variations of the technique.

With the availability of high-power-, high-repetition rate lasers and high-speed cameras the laser beam can be expanded to illuminate a 3-D volume for volumetric velocity measurements. This means, the measurement of unsteady, inertial and viscous terms of the Navier-Stokes equation is possible using time resolved volumetric velocimetry, allowing the estimation of the volumetric pressure distribution in the measurement volume.

Application examples and corresponding results will follow the presentation of each technique.

OPTICAL DIAGNOSTICS FOR AVIATION ENGINE RESEARCH: PART 2. COMBUSTION DIAGNOSTICS

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Laser-based imaging techniques have proven to be valuable tools in combustion research as well as in many other fields. Techniques such as Laser-Induced Incandescence (LII), Rayleigh Thermometry and Laser-Induced Fluorescence (LIF), can, correctly used, provide non-intrusive measurements with high spatial and temporal resolution of a range of combustion properties. All these techniques utilize ultra short exposure times, making them suitable for instantaneous imaging even in turbulent environments, such as in gas turbine combustors.

The need to reduce emissions of pollutants from combustion processes is becoming increasingly important due to their impact on global warming and human health. In many combustion applications soot is a result of incomplete combustion and a source of pollution in e.g. diesel engine combustion. Laser-Induced Incandescence is a laser-based imaging technique used for soot diagnostics. The technique allows for in-situ measurements of soot-volume-fraction to be made to reveal where in the combustion chamber the soot is formed.

Temperature is a key parameter in all combustion research and is directly related to the heat release from the fuel as a result of the chemical reactions taking place. In very clean combustion environments instantaneous tem-