into the behavior of high-speed machines, even though low-speed machines typically do not simulate the compressibility e ects of high-speed compressors.

Experimental stduies by McDougall et al.[4], Day[5], and Camp[6] showed the existence of two di erent stall inception patterns, known as long-length(modal) and short-length(spike).

Modal inception is characterized by the growth of small-amplitude, two-dimensional, long-length disturbance waves extending axially with length on the order of the rotor circumference[10]. This phenomenon was investigated theoretically by a number of researchers[11, 12, 13]. stur-
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than direct numerical simulation (DNS) but more effort

$$\mathbf{F_v} = \begin{bmatrix} 0 \\ m_k \; u_{xk} \\ m_k \; _{yk} \end{bmatrix}$$

$$\frac{\partial Q}{\partial t} = \frac{3Q^{n+1} - 4Q^n + Q^{n-1}}{2 \Delta t} \qquad (19)$$

where $n - 1$, n and $n + 1$ are three sequential time

cording to the small perturbation theory[40], disturbance wave can propagate to the length scale of $e^{\frac{n}{b}X}$ where X is axial distance and b is the wavelength. This represents a disturbance of wavelength b dies out far upstream of the rotor(at $X = \infty$). Taking into account modal disturbance with its wavelength on the

Figure 7: Circumferentially mass averaged spanwise

length ahead of the rotor tip leading edge assuming that rotating stall advances from rotor tip clearance. It is believed that velocity and pressure uctuations upstream and downstream of the blade row can give a

acteristic measure of this balance is the swirl angle, determined by the ratio of the circumferential and axial velocity, will a ect the vortex and its location of

[15] H. Vo,

[39] Y. Gong, \A Computational Model for Rotating Stall and Inlet Distortions in Multistage Compressors." Ph.D. Thesis, Massachusetts Institute

Figure 13: Pressure rise characteristics from full
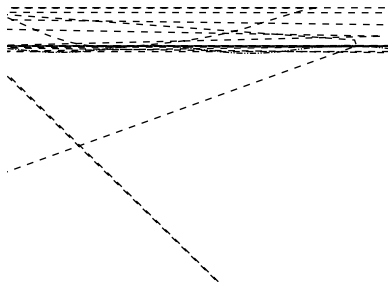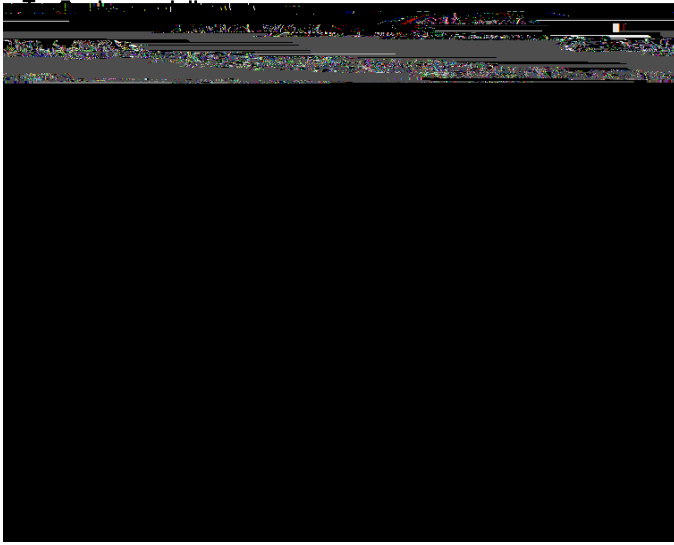annulus simulations

Figure 14: Incoming axial velocity uctuations at 98%
span from DDES

T = 3 rotor revolutions

T = 3.5 rotor revolutions