Researchers at Johns Hopkins University have conducted a set of experiments under a NASA Research Announcement (NRA), that measure and demonstrate the effect of varying rotor tip clearances in a low-speed axial compressor. Detailed stereo PIV measurements of the tip flow field were obtained in their optically index-matched facility. To help understand the complex flow phenomena associated with the tip clearances, the researchers used rotor and stator blades based on the first 1.5 stages of the Low-Speed Axial Compressor (LSAC) at NASA Glenn Research Center. Data was collected at both high flow coefficient, $\phi = 0.35$; design condition, $\phi = 0.38$; and low flow $\phi = 0.25$, which also represented pre-stall conditions. The tip clearance over the rotor were set (and measured) to be 0.49% (small tip gap) and 2.3% (large tip gap) of the total axial chord. Various casing treatments were then tested to determine the effect on the large tip clearance flow and their effect to the onset of stall. NASA has acquired over 300 GB of processed SPIV data (over 300 files) and will make this data available to the public.

We are currently working with Code V personnel to stand up a web tool/public server that will allow us to package the data by configuration and flow rate and provide the data to interested researchers at universities and in industry. The chart below describes all test cases at NASA:

Casing Treatment (tip gap size)	Plane		Flow Rate	Co-ordinate systems (x,y)		Phases
Smooth end wall (small tip gap)	**Meridional planes**		**0.25**	**(z,r)**		**6**
			0.35	**(z,r)**		**6**
Smooth end wall (large tip gap)	**Meridional planes**		**0.25**	**(z,r)**		**14**
			0.35	**(z,r)**		**14**
Semicircular Axial Casing Groove (large tip gap)	**Meridional planes**	**theta 1**	**0.25**	**L1**	**(z,r)**	**14**
		theta 2	**0.25**	**L1**	**(z,r)**	**14**
			0.35	**L1** **L2**	**(z,r)**	**14**
			0.38	**L1** **L2**	**(z,r)**	**14**
		theta 3	**0.25**	**L1**	**(z,r)**	**14**
	Radial planes	**Tip plane (R1)**	**0.25**	**(z,-θ)**		**14**
			0.35	**(z,-θ)**		**14**
			0.38	**(z,-θ)**		**14**
		Tip Gap (R2)	**0.35**	**(z,-θ)**		**14**
			0.38	**(z,-θ)**		**14**
U-Groove (large tip gap)	**Radial**	**Tip Plane (R1)**	0.25	**(z,-θ)**		14
			0.35			14
			0.38			14
		Tip Gap (R2)	0.25	**(z,-θ)**		14
			0.35			14
			0.38			14
	Meridional		0.25	**(z,r)**		14

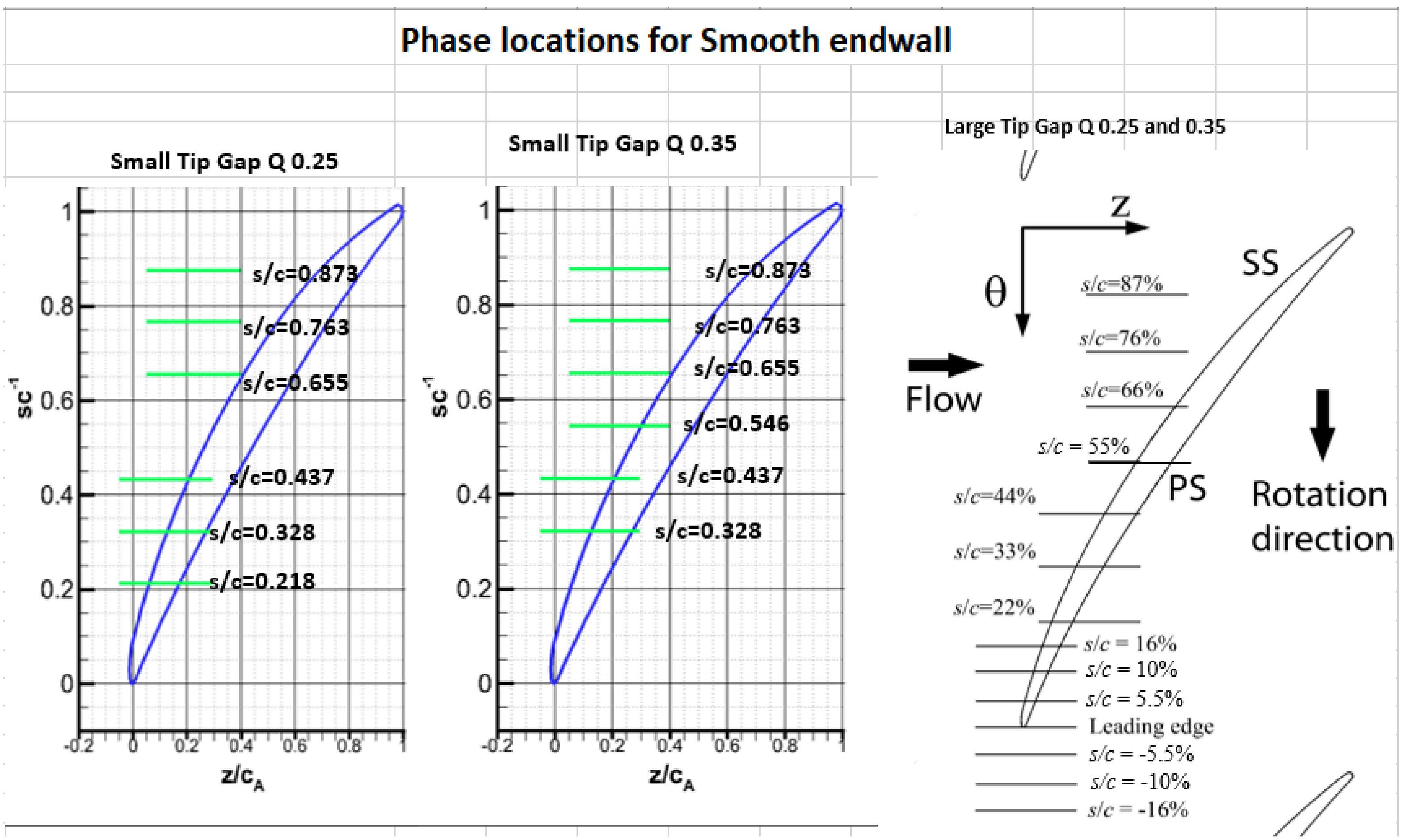
		0 deg (M1)	0.35		14
			0.38		14
		3 deg (M2)	0.25	(z,r)	14
			0.35		14
			0.38		14
	Axial	s/c=0.86	0.25	(θ,r)	1
			0.38		1
S-Groove (large tip gap)	Radial	Tip Plane (R1)	0.25	(z,-θ)	14
			0.35		14
			0.38		14
		Tip Gap (R2)	0.25	(z,-θ)	14
			0.35		14
			0.38		14
	Meridional	0 deg (M1)	0.25	(z,r)	14
			0.35		14
			0.38		14
		3 deg (M1)	0.25	(z,r)	14
			0.35		14
			0.38		14
	Axial	s/c=0.86	0.25	(θ,r)	1
			0.38		1

Each MATLAB data file contains approximately 30 arrays which include velocity, vorticity, TKE, turbulence quantities and are described below:

Name	size	Description
Zmesh:	[184×129 double]	Mesh grid in Z direction (horizontal axis, in mm)
Rmesh:	[184×129 double]	Mesh grid in R direction (vertical axis, in mm)
qmesh:	[184×129 double]	Mesh grid in θ direction (out-of-plane axis, in mm)
Vz:	[184×129×2500 double]	Instantaneous Z velocity (axial velocity, uz, 2500 samples, in m/s)
Vr:	[184×129×2500 double]	Instantaneous R velocity (radial velocity, ur, 2500 samples, in m/s)
Vq:	[184×129×2500 double]	Instantaneous θ velocity (circumferential velocity, u_θ, 2500 samples, in m/s)
vor:	[184×129×2500 double]	Instantaneous θ vorticity (circumferential vorticity, ω_θ, 2500 samples, in s^{-1})
Vz_mean:	[184×129 double]	Ensemble-averaged Z velocity (axial velocity, Uz, in m/s)
Vr_mean:	[184×129 double]	Ensemble-averaged R velocity (radial velocity, Ur, in m/s)
Vq_mean:	[184×129 double]	Ensemble-averaged θ velocity (circumferential velocity, U_θ, in m/s)
vor_mean:	[184×129 double]	Ensemble-averaged θ vorticity (circumferential vorticity, $\langle\omega_\theta\rangle$, in s-1)

size:	[184 129 2500]	Data set size (horizontal, verical, total instantaneous samples)
norm_Zmesh:	[184×129 double]	Normalized mesh grid in Z direction (horizontal axis, normalized using c_A=53.5mm)
norm_Rmesh:	[184×129 double]	Normalized mesh grid in R direction (vertical axis, normalized using L=45.6mm)
norm_Zmask:	[1×1667419 double]	Normalized coordinates for the mask (Z axis)
norm_Rmask:	[1×1667419 double]	Normalized coordinates for the mask (R axis)
log_mask:	[184×129 double]	Logical mask (0 is the mask)
Vzz:	[184×129 double]	velocity gradient (dUz/dz)
Vrr:	[184×129 double]	velocity gradient (dUr/dr)
Vzr:	[184×129 double]	velocity gradient (dUz/dr)
Vrz:	[184×129 double]	velocity gradient (dUr/dz)
Vqz:	[184×129 double]	velocity gradient (dU_θ/dz)
Vqr:	[184×129 double]	velocity gradient (dU_θ/dr)
Vqq:	[184×129 double]	velocity gradient (dU_θ/d_θ)
VrVr_:	[184×129 double]	Reynolds stress term: mean((ur -Ur)^2)
VrVz_:	[184×129 double]	Reynolds stress term: mean((ur -Ur)*(uz -Uz))
VrVq_:	[184×129 double]	Reynolds stress term: mean((ur -Ur)*(u_θ -$U_{\theta)}$)
VzVz_:	[184×129 double]	Reynolds stress term: mean((uz -Uz)^2)
VzVq_:	[184×129 double]	Reynolds stress term: mean((uz -Uz)*(u_θ -U_θ))
VqVq_:	[184×129 double]	Reynolds stress term: mean((u_θ -U_θ)^2)
TKE:	[184×129 double]	Turbulent kinect energy: 0.5(mean((uz -Uz)^2)+mean((ur -Ur)^2)+mean((u_θ -U_θ)^2))

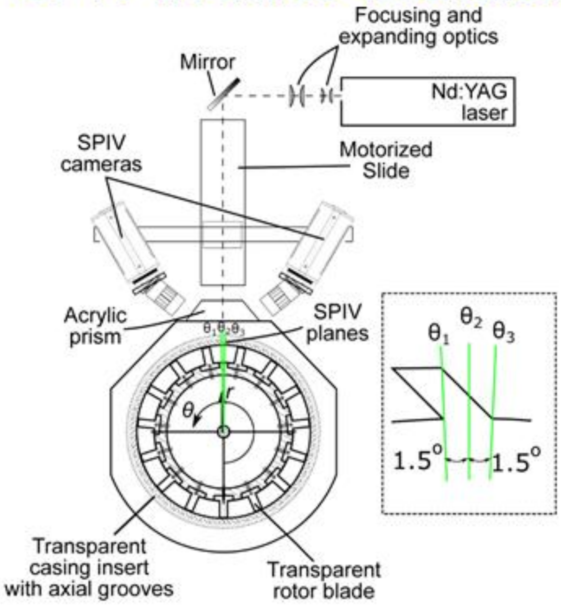
Additional figures to help describe the test cases:

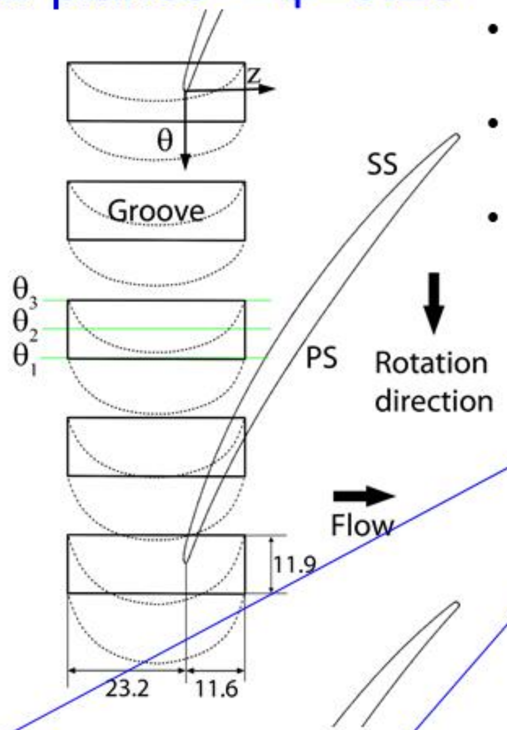


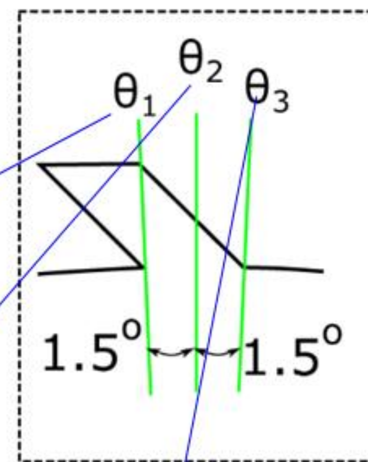
SPIV in three meridional planes – φ=0.25

φ=0.25

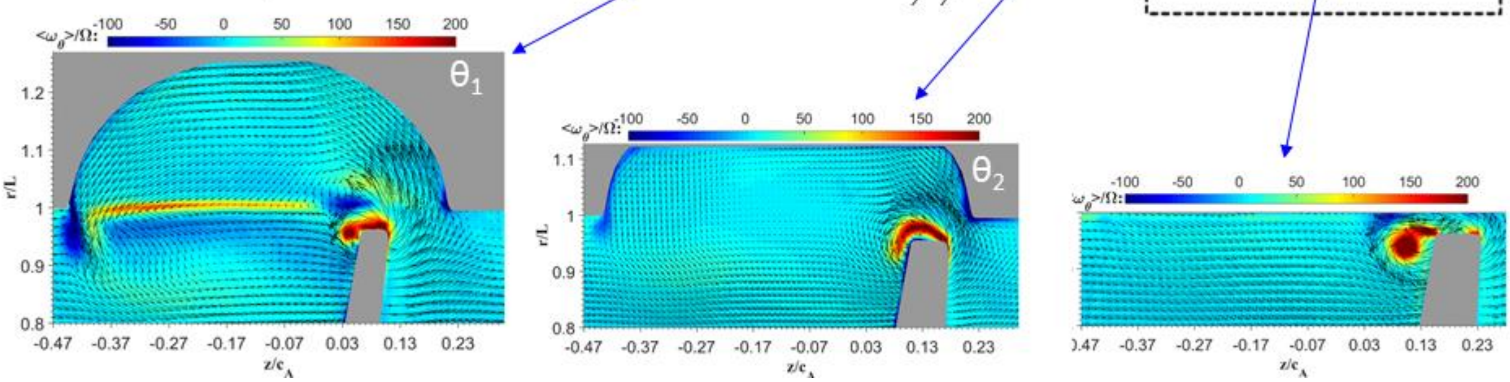
- Three meridional planes, θ_1, θ_2, θ_3.
- θ_1 and θ_3 passing through edges of a groove
- θ_2 is centered at a groove







- High resolution camera, 6600 x 4400 px



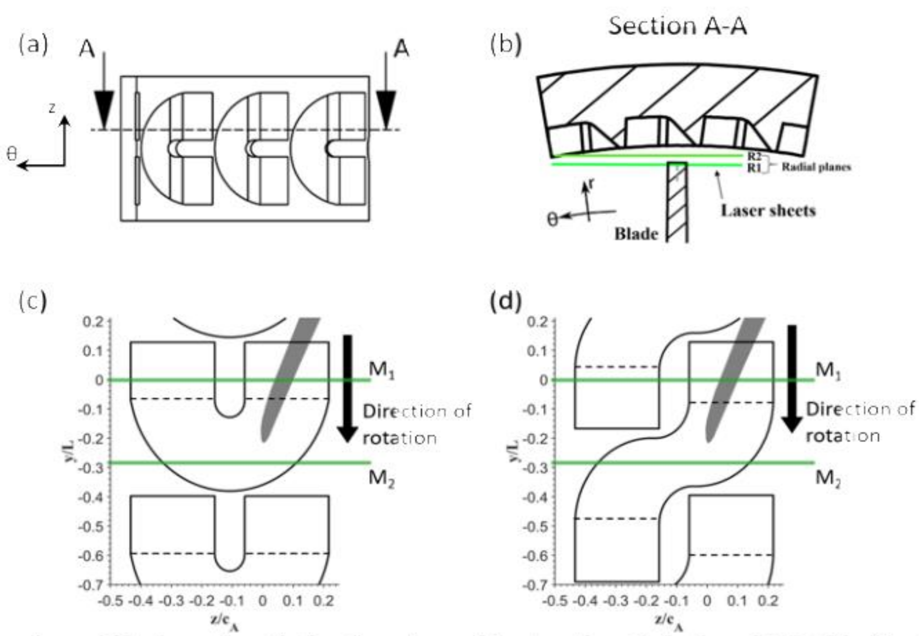


Figure 4: a) Showing the grooves in a radial plane where the location of an axial cut section AA is shown b) Details of section AA where the grooves are cut in an axial plane , the two radial plane is shown where data is acquired R1= Tip plane and R2 = Tip gap plane, The radial plane of c) U groove, and d) S groove is shown, along with the location of two meridional planes M1 (0° meridional plane) and M2 (3° meridional plane)