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Investigation of Elevated Turbulence on High-Lift Low Pressure Turbine Endwall Flows

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Goal: Determine how FSTI effects endwall flow structure behavior and losses in the region

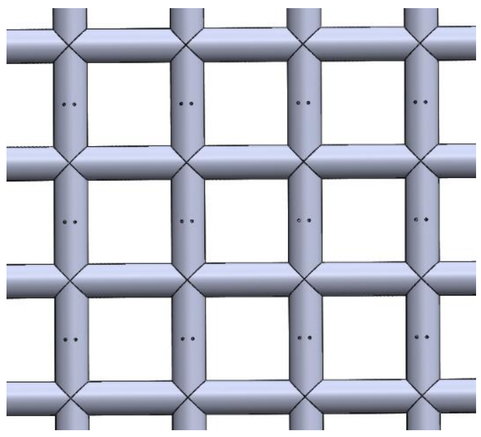
Application: LPT, Endwall Flows, Junction Flows

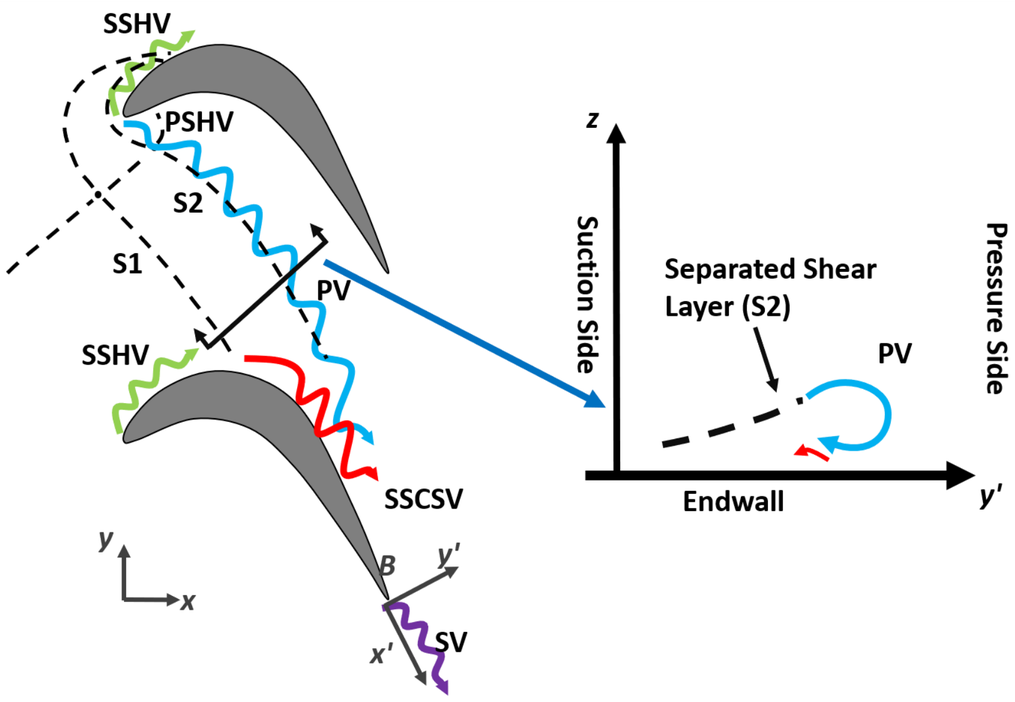
Approach: Vary the incoming FSTI level in a low-speed linear cascade of seven L2F blades by installing a grid 2.3m upstream of cascade with 2.54 cm bars and 7.6 cm center to center spacing. Grid has an active option by having pairs of jets in the tubes angled and oriented downstream. Investigate the flow using high speed SPIV collected in the passage at 2.5kHz.

Hotwire FSTI Measurements

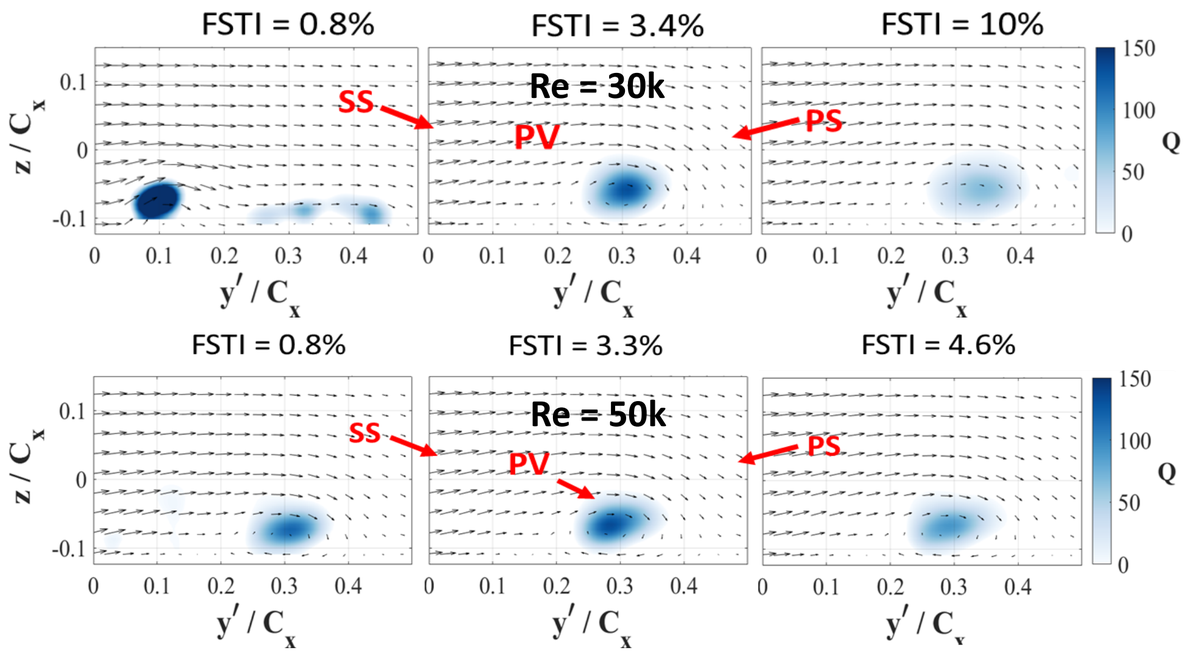
Reynolds Number	Condition	FSTI (%)
30k	No Grid	0.84
30k	Passive	3.4
30k	Active	10
50k	No Grid	0.81
50k	Passive	3.3
50k	Active	4.6

Turbulence Grid

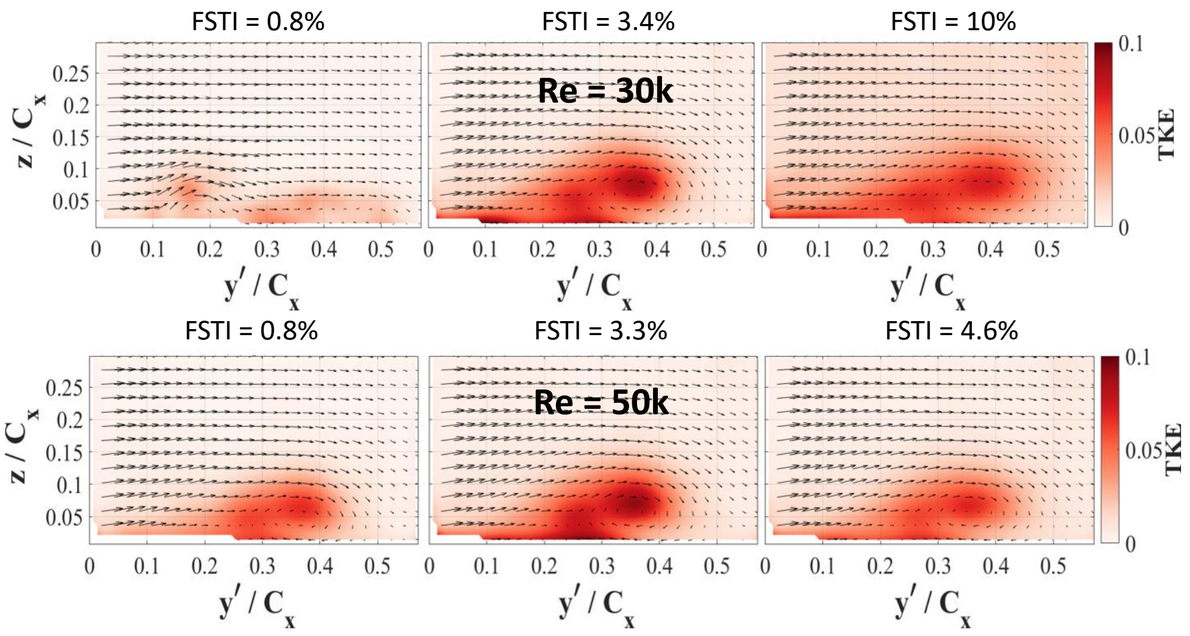




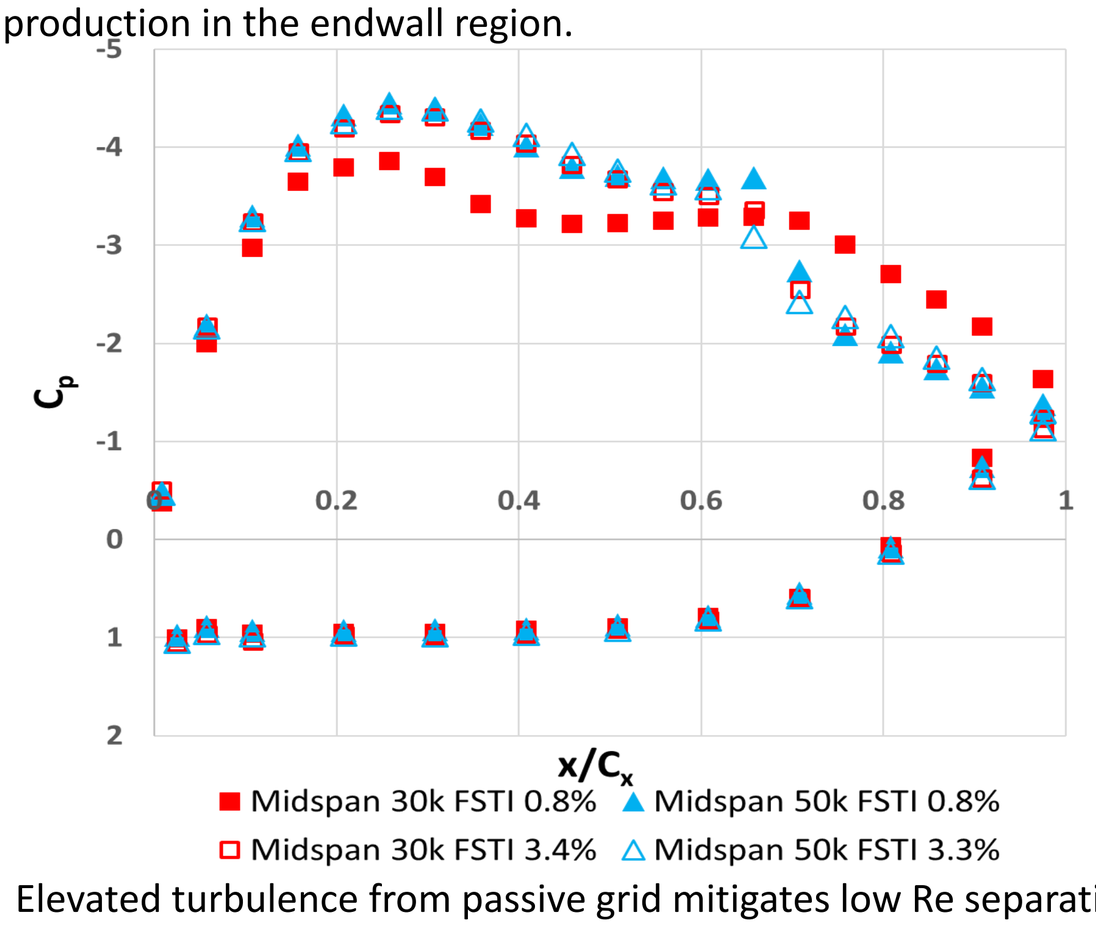
Typical observed endwall flow topology for the L2F



The Q-criterion highlights rotational flows or vortices. The PV is the main vortex in the field of view. For Re = 30k at the low FSTI the PV is located close to the SS and is the strongest. At all other conditions, the PV is located closer to the PS. The PV strength is weakest at highest FSTI at both Re.

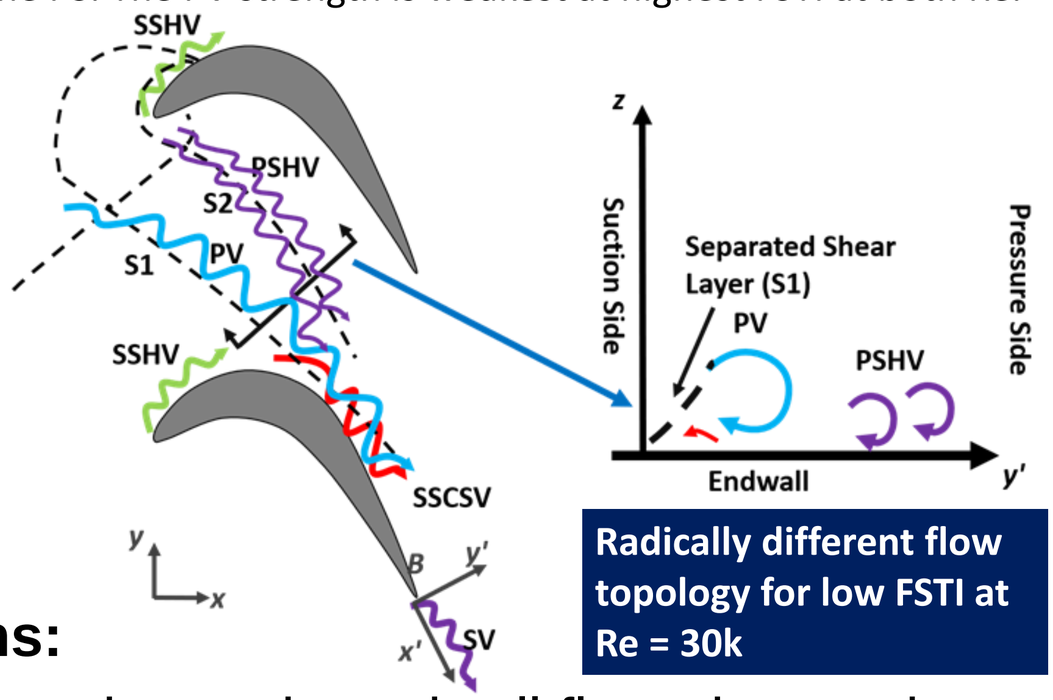


There is a dramatic difference in the low FSTI case at Re = 30k and the low fluctuations are consistent with an in coming laminar BL. For both Re the TKE is the largest at the moderate FSTI level. The TKE is elevated over entire plane at the high FSTI condition. The high levels of FSTI likely lead to an increase in loss production in the endwall region.



Elevated turbulence from passive grid mitigates low Re separation.

More Information can be found in 2021 Scitech Paper "Investigation of Elevated Turbulence on High-Lift Low Pressure Turbine Endwall Flows" AIAA 2021-0389.



Radically different flow topology for low FSTI at Re = 30k

Conclusions:

1. Significant change in endwall flow observed at lowest Re number (30k) and lowest incoming FSTI, PV location is shifted towards the SS, additional vortices are present with same rotational direction as PV.
2. Elevated FSTI cases: Lower time average PV strength, overall increase in TKE in region of investigation, increase in TKE suggest total pressure losses in endwall region may be higher