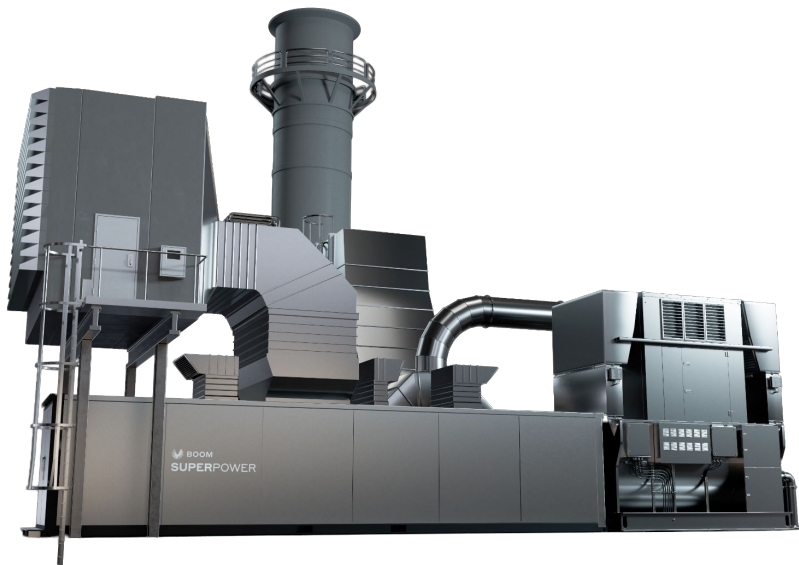




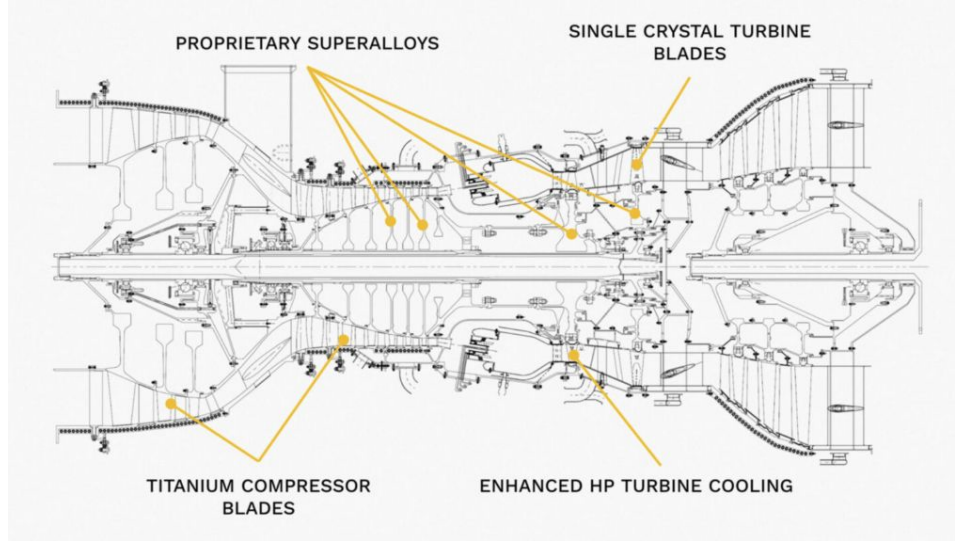
BOOM **SUPERPOWER**

Intern Presentation

THE TERMS AND CONDITIONS OF THE APPLICABLE NON-DISCLOSURE AGREEMENT BETWEEN THE PARTIES GOVERNS THE HANDLING,
REPRODUCTION, STORAGE, AND TRANSMISSION OF THIS DOCUMENT AND ANY CONTENT HEREIN.

How low can you go?

A memoir of cold day sync

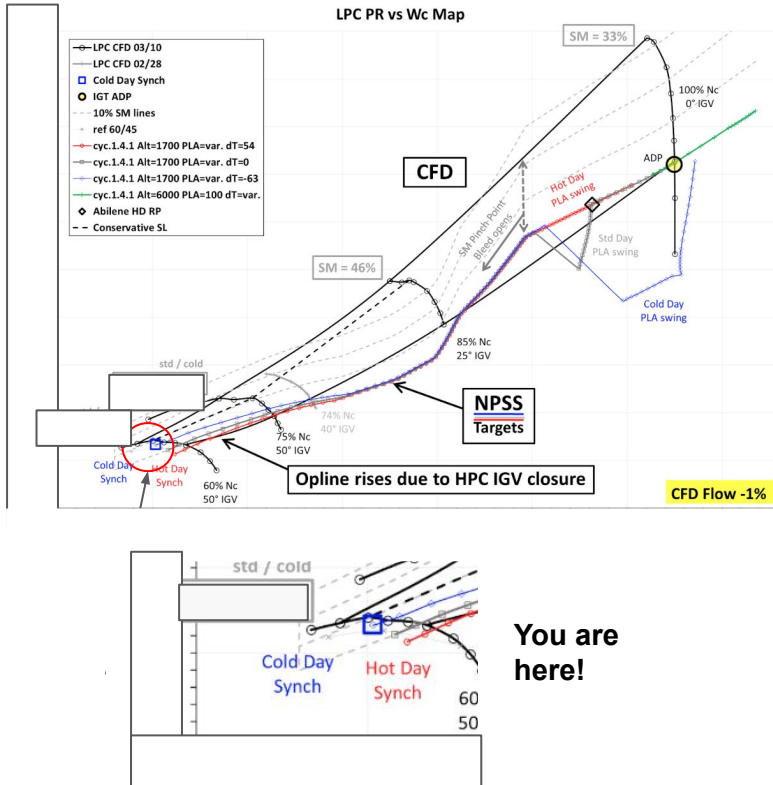


At the cold day sync conditions the engine is essentially idling, while producing just enough enthalpy to spin the free power turbine (Without the generator connected) up to...

3600 RPM!!!!



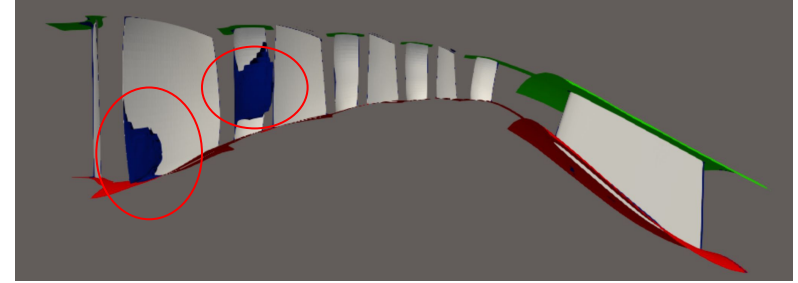
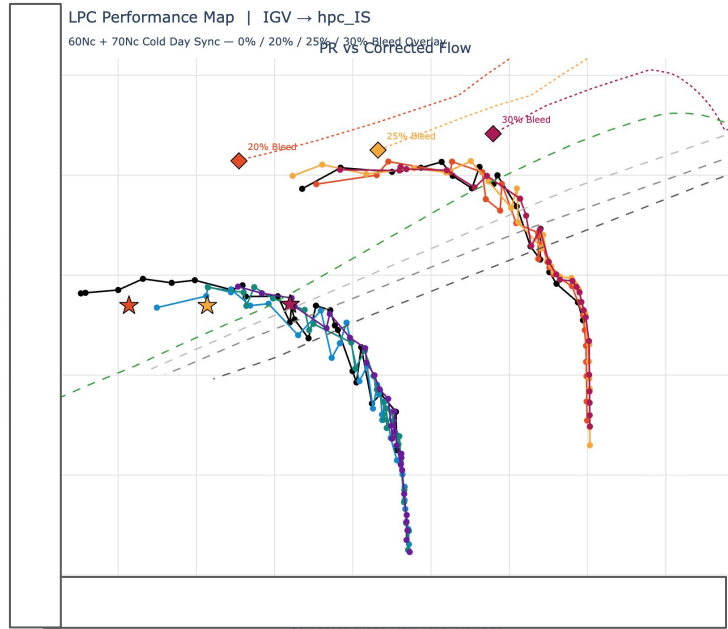
So why is this special?



At this off design condition where low ambient temps of -10F increase air density, flow into the engine must decrease to maintain precise FPT RPM.



So what's the issue?



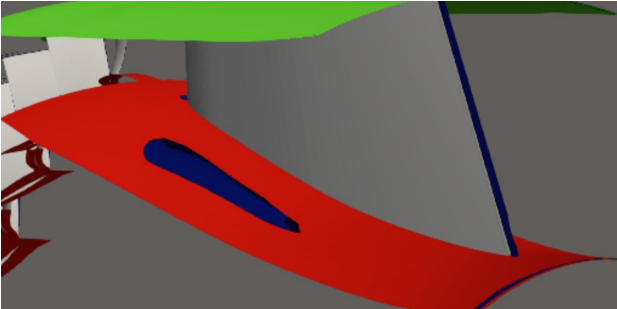
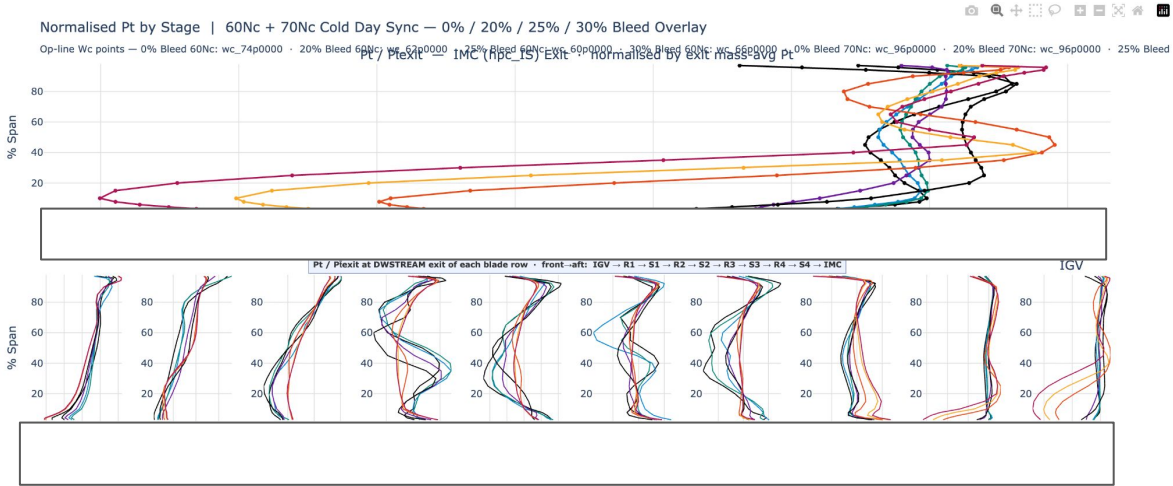
- At these low RPM's and high IGV angles flow starts to separate off of the airfoil at Rotor one and Stator one
- One solution was to increase bleed which I found was possible up to 30% of total flow.

$$\text{Correct mass flow} = \text{Actual mass flow} * \sqrt{\frac{T}{T_{ref}}} * \frac{P_{ref}}{P}$$

The rotational speed also needs to be corrected by the equation:

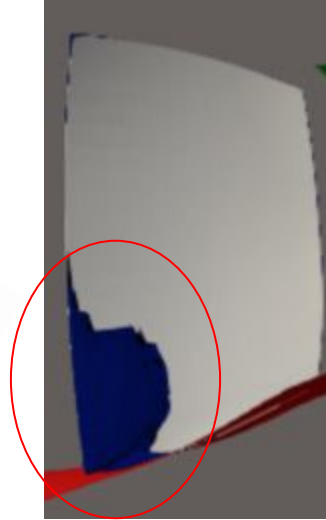
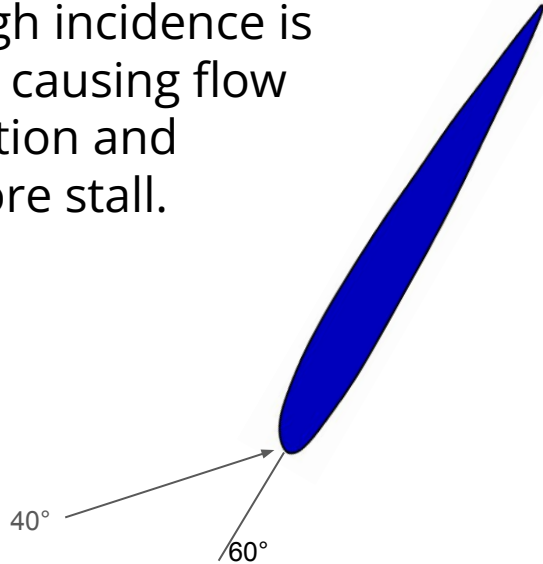
$$\text{Corrected speed} = \text{Actual speed} / \sqrt{T/T_{ref}}$$

Let's stick to 25%!

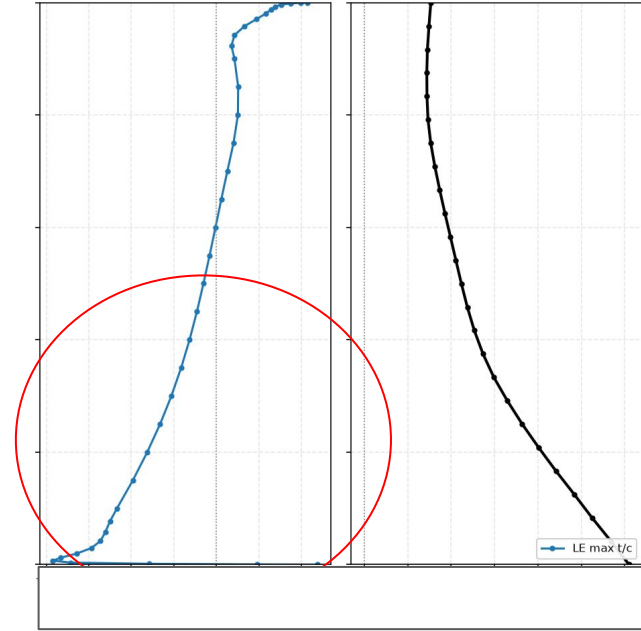


Why is this happening?

- At this high IGV angle the flow is being overturned into the rotor near the hub. This high incidence is what is causing flow separation and therefore stall.



al Angle / Incidence / Camber
ne (design pt: wc_106p0000)



How can we solve this? - The easy way or the hard way?

Let's start with the easy way!

To decrease incidence just lower IGV Angle to 45°!

19:09:45.480	INFO	non_perfect	Copied:	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unsteady_45_IGV
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19:09:45.479	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
19:09:45.480	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
19:09:45.480	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
19:09:45.480	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
19:09:45.480	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
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19:09:45.481	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
19:09:45.481	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
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19:09:45.481	INFO	non_perfect	Copied (de-hashed):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unst
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TA				
19:09:45.484	INFO	non_perfect	Copied (sidecar):	/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unstea
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19:09:45.504	INFO	non_perfect	Submitted DTS warm-start-run to Slurm: 142454	
jeffrey.buskirk@banhesse:/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unsteady_45_IGV_60Nc/igv_60pct_wc_87p00				
JOBID PARTITION NAME USER ST TIME NODES NODELIST(REASON)				
142454	main	jeffrey.jeffrey.R	R	0:05 1 banshee
jeffrey.buskirk@banhesse:/scratch/simulation/superpower/lpc/4stg/steady/IGV_45_Study/unsteady_45_IGV_60Nc/igv_60pct_wc_87p00				

```
# --- Rotations
```

rotations:

- **name:** lpc_IGV

```
angles: [-50]
```

axis vector:

axis point:

- name: hpc_IGV

```
angles:
```

axis vector:

axis point:

```

- name: hpc_S1

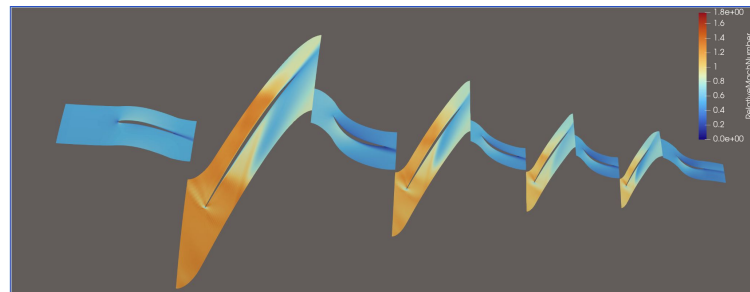
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```
angles:
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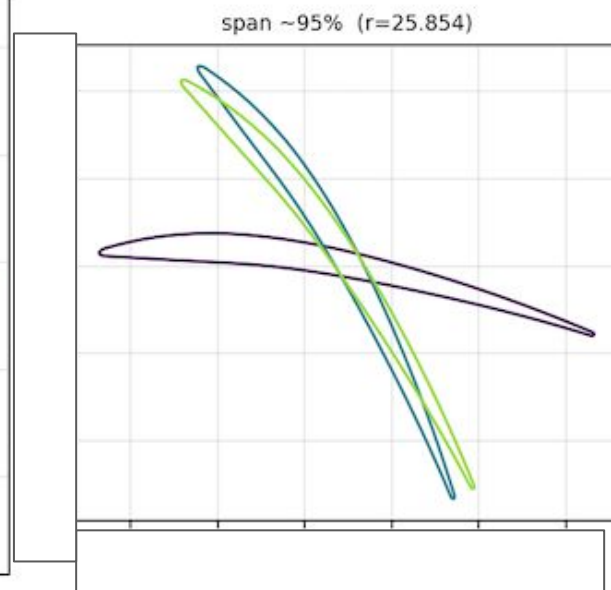
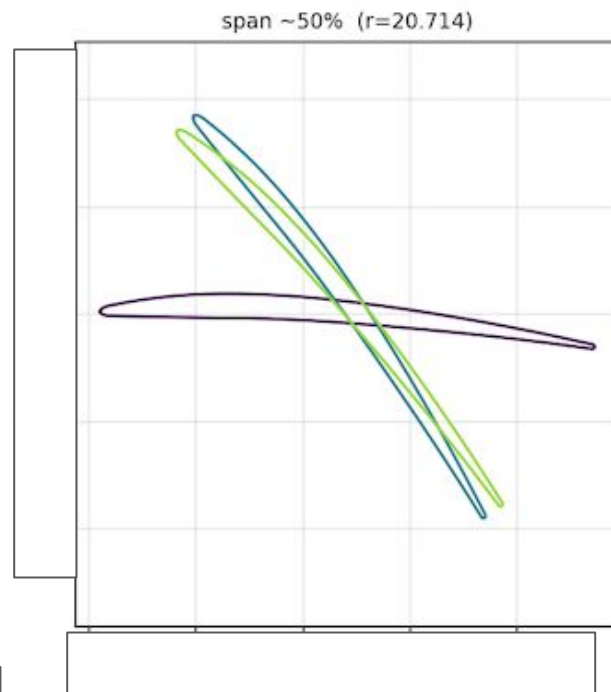
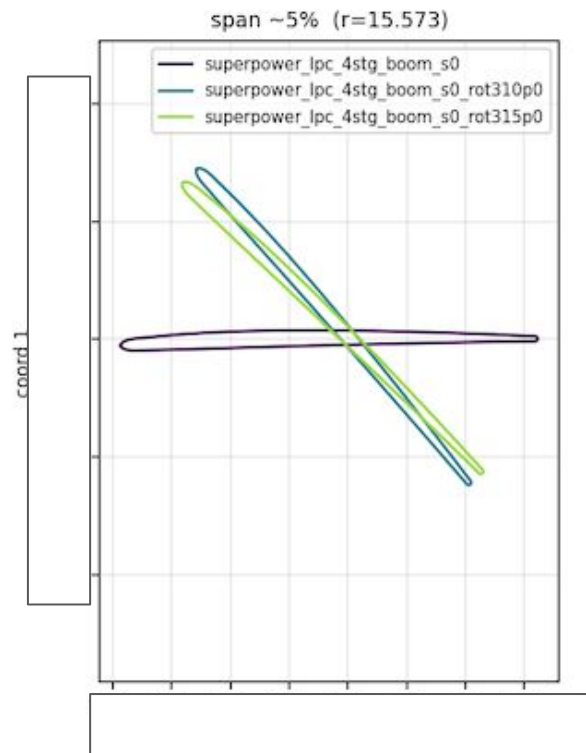
axis vector:

```
axis_point:
```

ax±0_point:

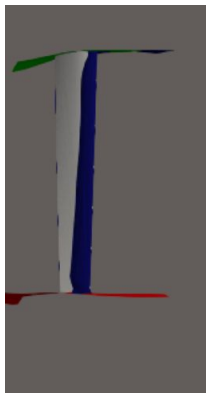


Section overlays at selected span stations

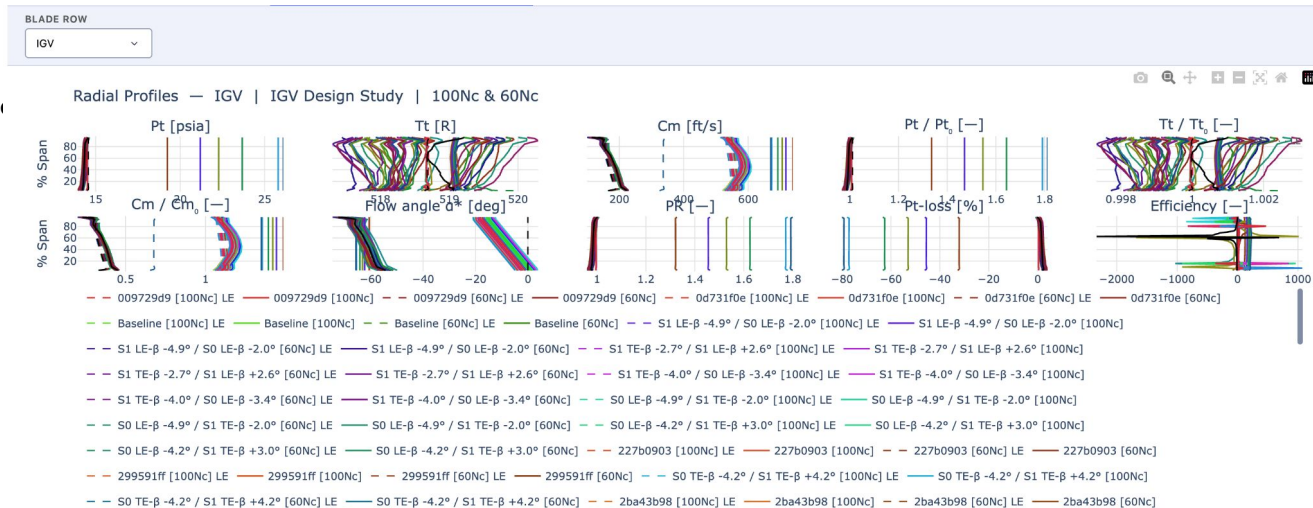


But Wait There's More!

At this off design condition the Leading edge of the IGV is also stalling. To fix this issue, a plethora of solutions are being investigated.



The Plethora in Question:



The Hard Way

Because of the high incidence on Rotor one one way to solve the issue is to turn the airfoil from 0% span to 40% more into the flow.

