APISAT 2019

2019 ASIA PACIFIC INTERNATIONAL SYMPOSIUM ON AEROSPACE TECHNOLOGY

SURFERS PARADISE MARRIOTT RESORT,
GOLD COAST
4 – 6 DECEMBER 2019

ENGINEERS
AUSTRALIA

APISAT 2019

Thermal Analysis

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Study of Heat Transfer Characteristics of Single-Jet Impingement on Leading Edge of Sharp Cone

ENGINEERS AUSTRALIA

ROYAL AERONAUTICAL SOCIETY AUSTRALIAN DIVISION

Outline

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2. Computational Model and Numerical Method

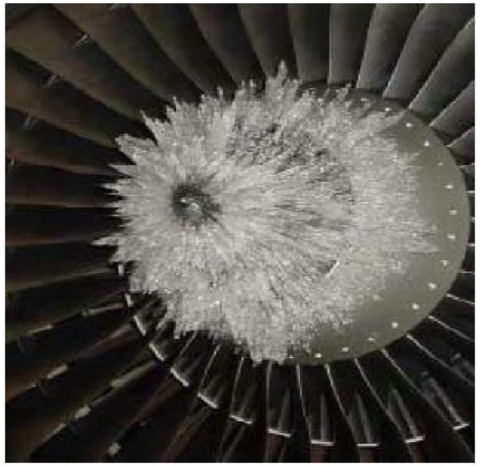
3. Validation of Numerical Method

4. Results and Discussions

- *Influence of Reynolds number on Heat Transfer Characteristics*
- *Influence of Impingement Distance on Heat Transfer Characteristics*

5. Conclusions

Introduction



When flying under icying weather conditions, freezing may occur on the cone of aeroengine.

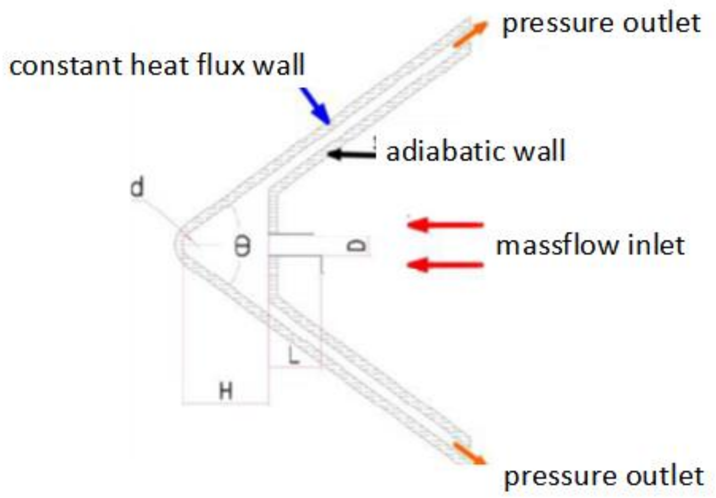
Icing has a great impact on the safe flight of aircraft.
According to a survey conducted by the US National Transportation Safety Administration, about 100 icing-related faults and 28 crashes occurred every year in the entire aviation industry.

Therefore, relevant anti-icing measures must be taken!

Computational Model and Numerical Method

Numerical method

- RANS with ANSYS CFX
- SST *k*-ω turbulence model



30°

Inlet

- ***mass-flow-inlet(caculated by Reynolds number)***

  $Re=4\times10^4, 11\times10^4, 18\times10^4$, $Tg=323K$

  Reynolds number

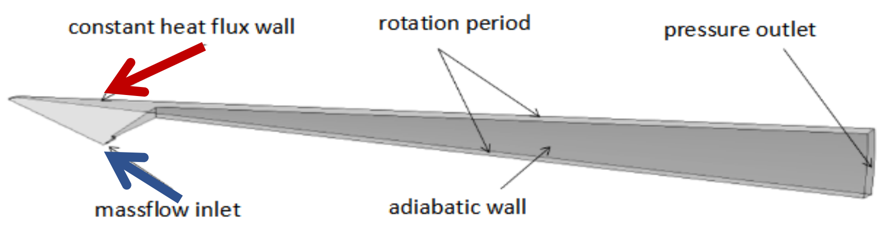
  $Re=\rho uD/\mu$

- ***Dimensionless Impingement Distance***

  $H/D=0.75,3.5,6$

- ***pressure-outlet***

  gauge pressure is fixed at 0 Pa

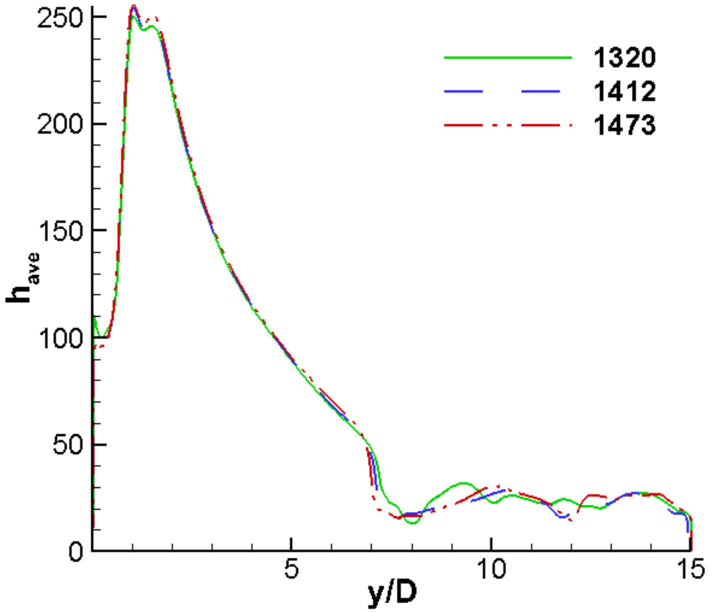


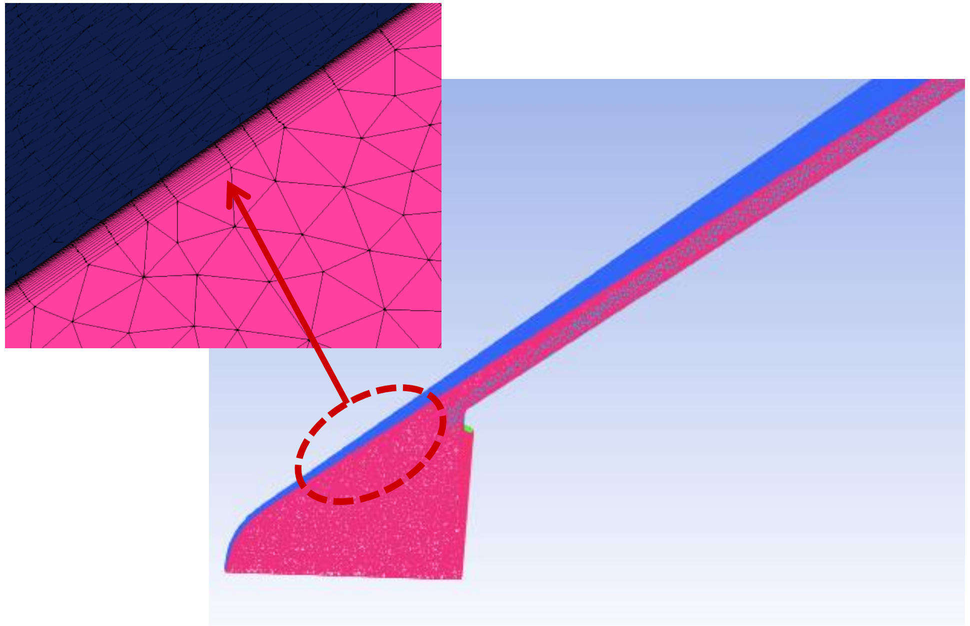
Validation of Numerical Method

Grid independent validation

Non-structured grid

- Grid A: about 13.2 million
- Grid B: about 14.12 million
- Grid C: about 14.73million

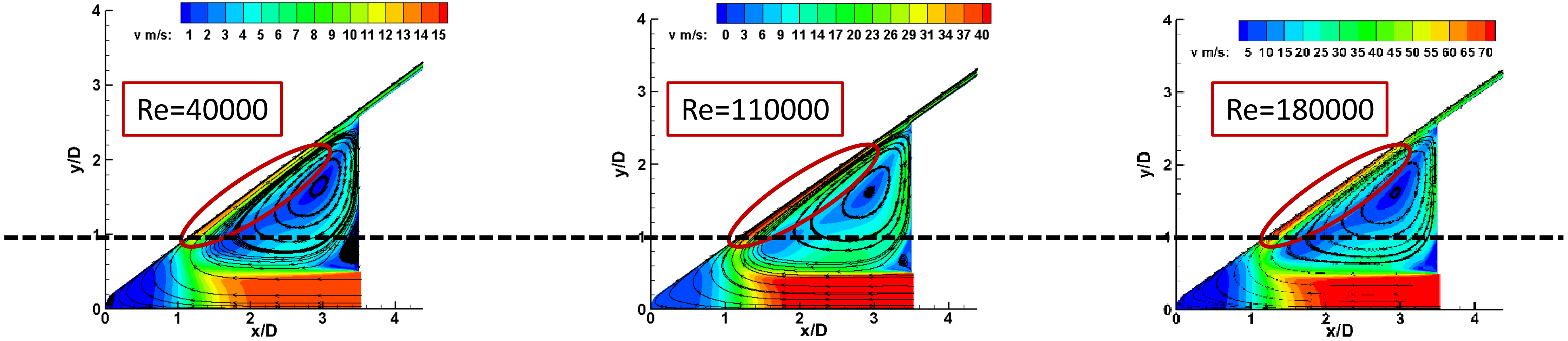




- 14.12 million grid nodes has already reached the grid independence requirement

Results and Discussions

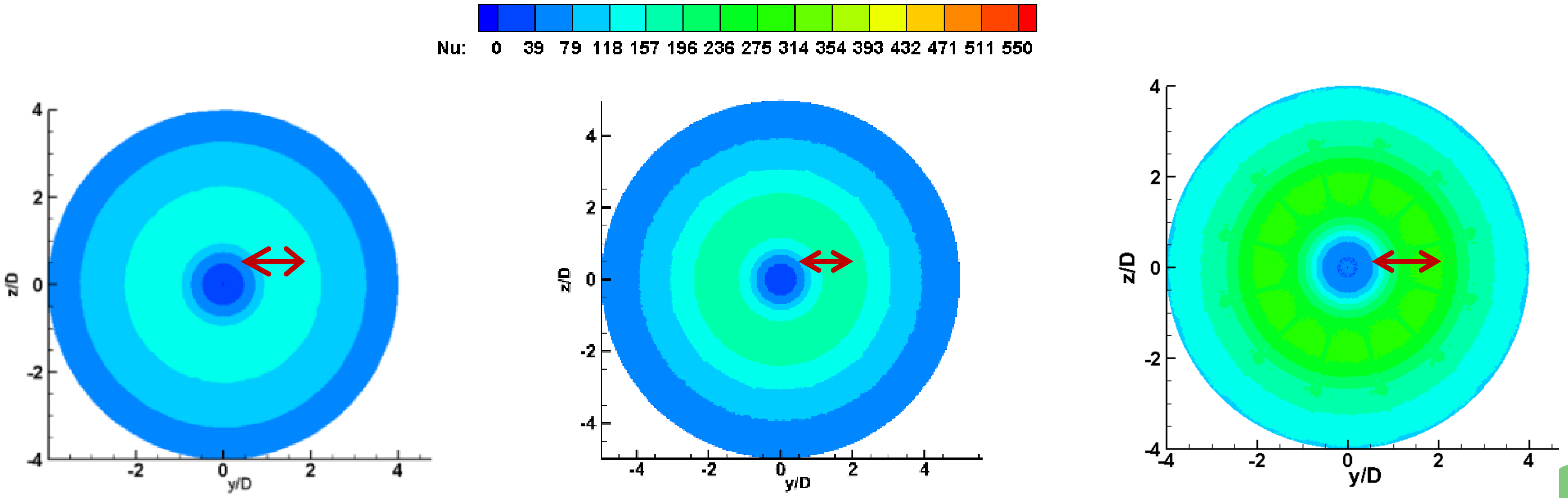
*Influence of **Reynolds Number** on Heat Transfer Characteristics* **(H/D=3.5)**



With the increase of impingement Reynolds number , the length of the jet core segment increases, and the velocity of the impingement region increases. While the distribution of the flow field is consistent.

Results and Discussions

Influence of ***Reynolds Number*** *on Heat Transfer Characteristics* ***(H/D=3.5)***



Re=4000
0

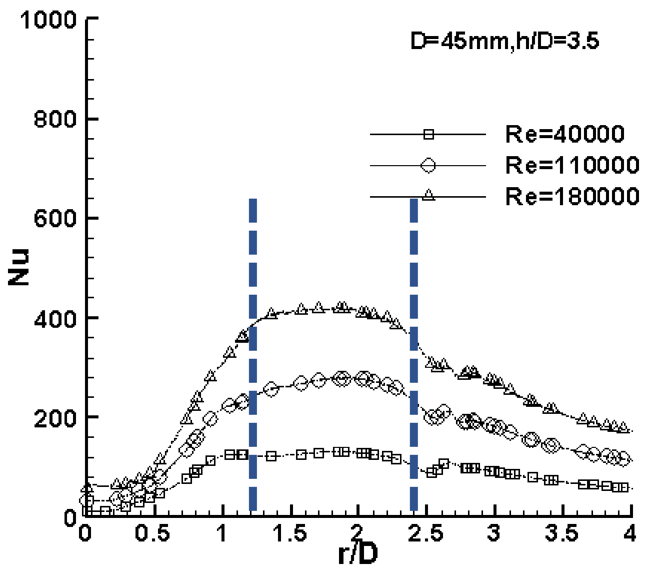
Re=110000

Re=180000

- With the increases of impingement Reynolds number , the heat transfer in the observation area increases significantly.
- High heat exchange area exists in the range of y/d=1-2.5.

Results and Discussions

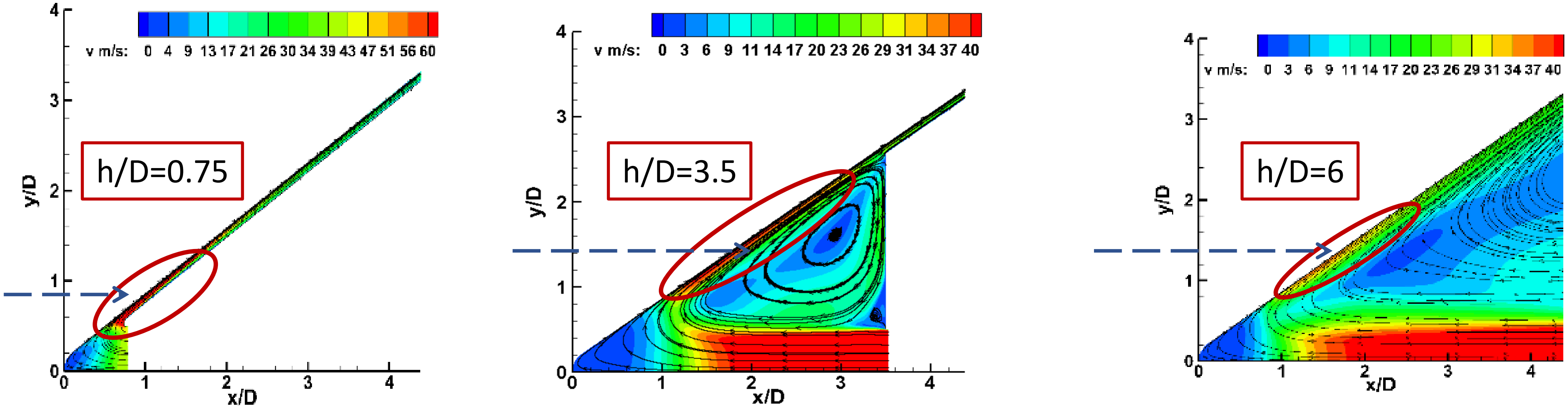
Influence of ***Reynolds Number*** *on Heat Transfer Characteristics* ***(H/D=3.5)***



- With the increases of impingement Reynolds number , the heat transfer in the observation area increases significant.
- Due to the influence of the vortex structure, there is a high heat exchange area in the range of y/d= 1-2.5.

Results and Discussions

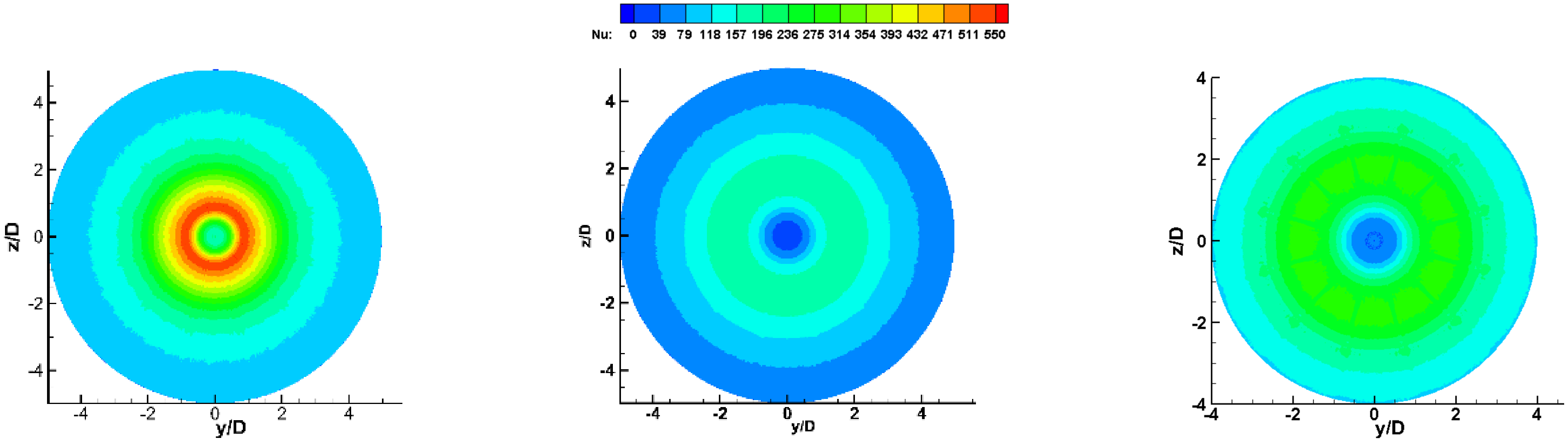
Influence of ***Impingement Distance*** *on heat transfer characteristics(****Re=110000****)*



- The flow velocity of the impingement region increase significantly and the length of the jet segment increases.
- With the increase of the impingement distance, the space of the leading edge cavity is increased, and a more fully developed rolling vortex can be formed in the inner cavity.
- As the impact distance increases, the channel vortex center moves up.

Results and Discussions

Influence of ***Impingement Distance*** *on heat transfer characteristics(****Re=110000****)*



h/D=0.75

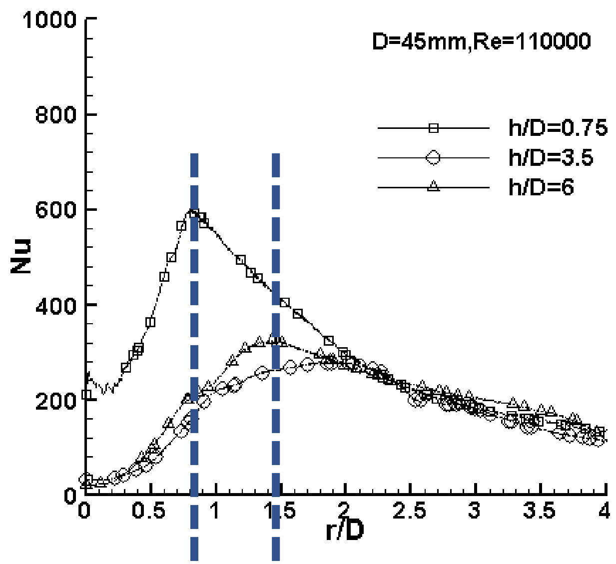
h/D=3.5

h/D=6

- When the Reynolds number is the same, when the dimensionless impingement distance increases from 0.75 to 3.5, the heat transfer in the stagnation zone is obviously weakened.
- While when the dimensionless impingement distance increases from 3.5 to 6, the heat transfer in the stagnation zone does not change significantly .

Results and Discussions

Influence of ***Impingement Distance*** *on heat transfer characteristics(****Re=110000****)*



- As the Impingement distance increases, the heat transfer increases first and then decreases.
- The perk of the nusselt number moved far away from the stagation.

Conclusions

1. With the increase of Reynolds number , the length of the jet core segment increases, and the velocity of the impingement region increases. While the distribution of the flow field is consistent.
2. With the increase of the jet Reynolds number, the heat transfer in the observation area increases significantly.

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3. As the impact distance increases, the channel vortex center moves up. And the perk of the nusselt number moved far away from the stagation.
4. When the impingement distance is 3.5, under the influence of the channel vortex, there is a high heat exchange zone in the range of $1<r/D<2.5$.
5. In the range of parameters studied, when the impingement distance is increased from 0.75 to 3.5, the Nusselt number is significantly reduced in the range of $r/D<2$, and the impingement distance is increased from 3.5 to 6, the Nusselt number does not change significantly.

Thank you!

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