Summary

Experimental investigation on flow characteristics of a transverse jet with an upstream vortex generator

Authors

Yan-hui Zhao, Jian-han Liang, Shun-ping Zhang, Hong-yu Ren, Yu-xin Zhao, Shun-hua Yang

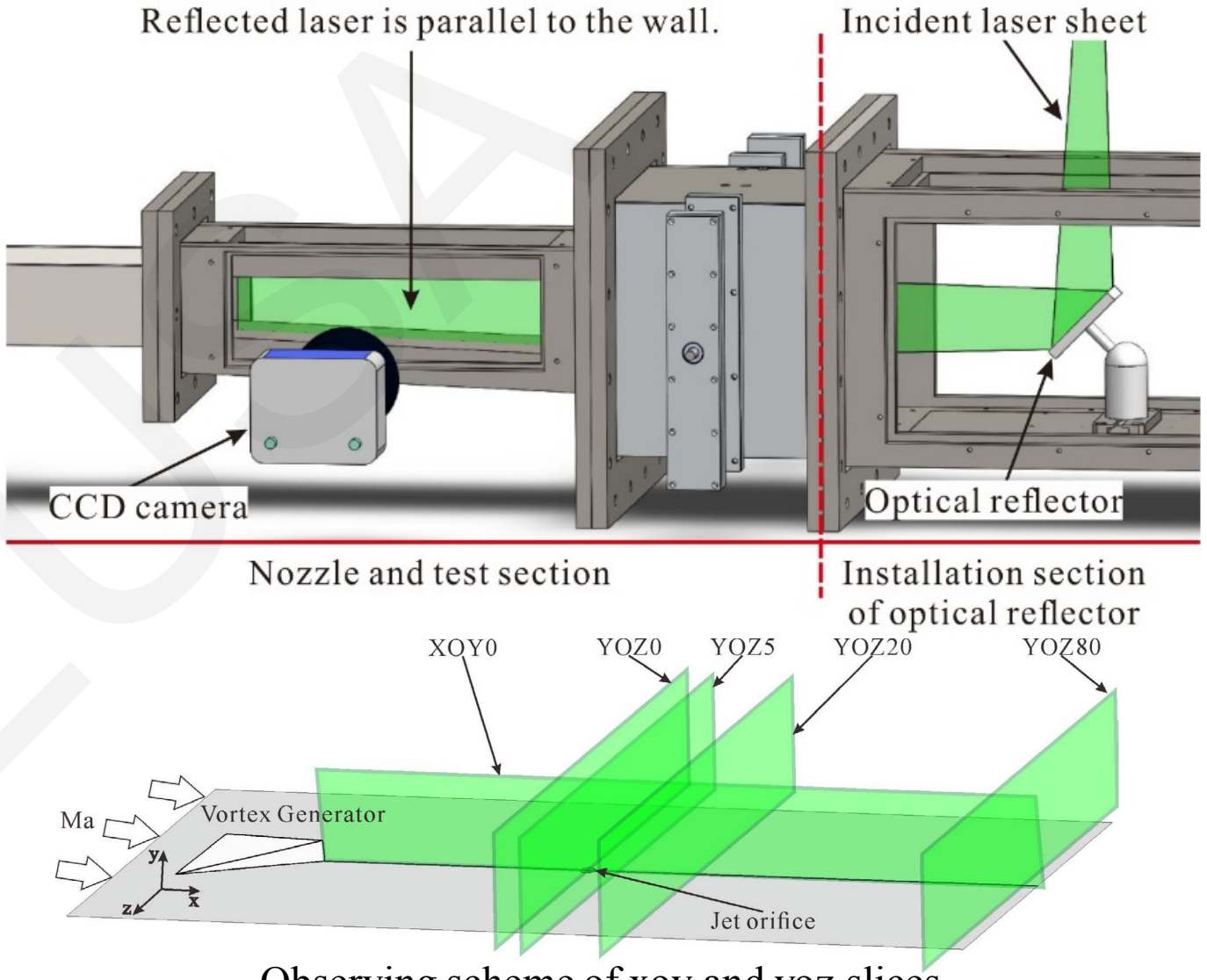
Department

Science and Technology on Scramjet Laboratory of CARDC, Mianyang city, Sichuan province, 621000, China

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01 Experimental facilities and observing methods

- To obtain a parallel incident laser sheet, an optical reflector is added and installed. The reflected laser is parallel to the wall. In this way, the background generated by the wall can be eliminated.
- Observing methods employed in this study include NPLS and SPIV technology, which are conducted via the Dantec Dynamics system. This system can be utilized in xoy slices directly. But a Schimpflug mount is needed to observe the flowfield of yoz slices.
- The xoy and yoz observing slices are characterized by z and x coordinates, respectively. XOY0 stands for the xoy slice at z=0mm. YOZ0 is the yoz slice at the center of the jet orifice. YOZ20, YOZ80 and YOZ100 represent the observing slices which are 20mm, 80mm and 100mm downstream from the jet orifice.



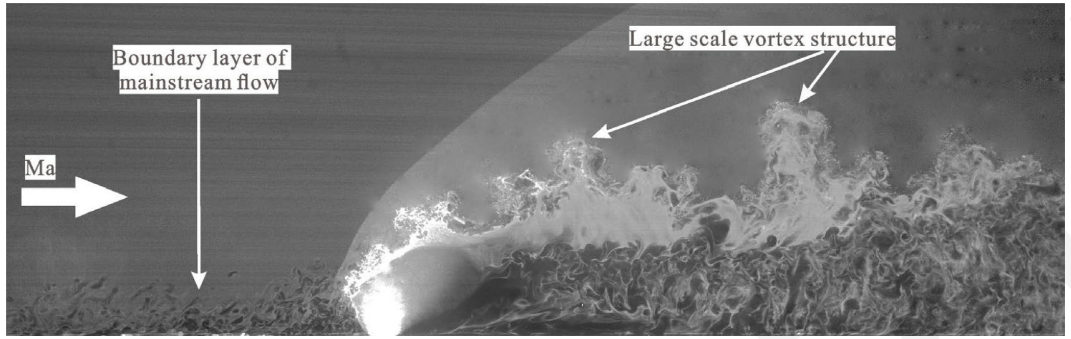
Observing scheme of xoy and yoz slices

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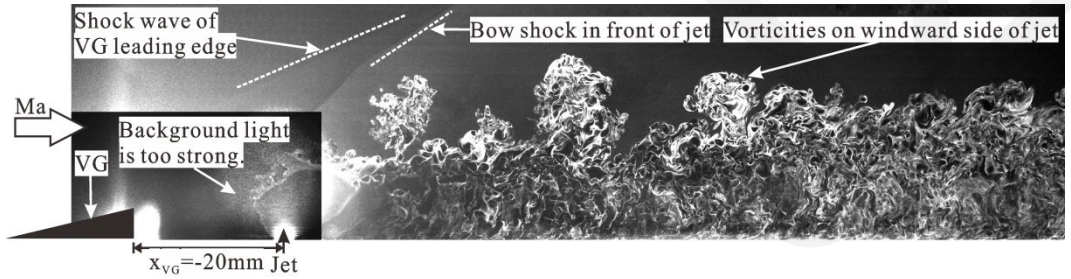
02 Flow characteristics of JISC with upstream VG in XOY0 slices

- Classic shock waves system and coherent large-eddy structures of JISC flowfield.
- Large-scale eddies of the VG wake enter the windward side of the jet through the bow shock, resulting in the deformation of the barrel shock. Strong disturbance is produced in the upwind shear layer of the jet plume.

Experimental cases	Relationship between VG and jet orifice
CASE0	There is no VG interacting with JISC.
CASE1	VG is located 20mm upstream of the jet orifice (x_{VG}=-20mm).
CASE2	VG is located 80mm upstream of the jet orifice (x_{VG}=-80mm).

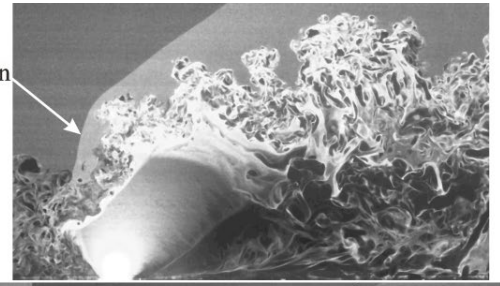


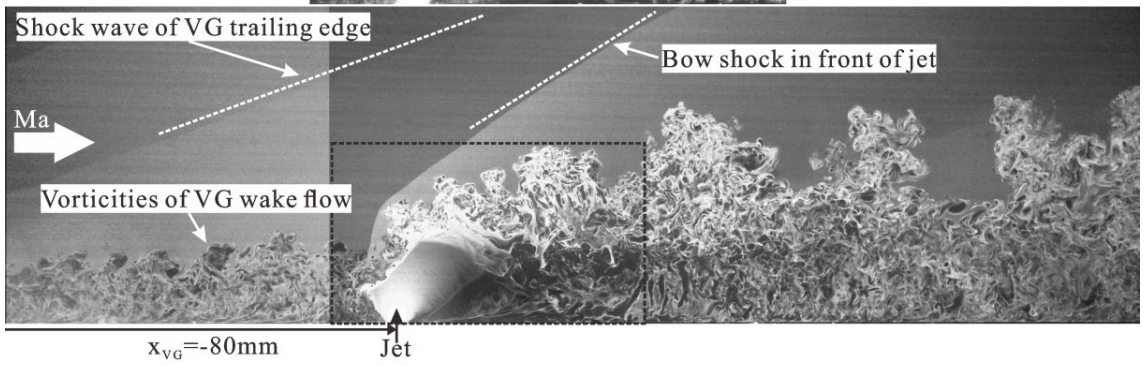
Transient gray images of JISC in XOY0 slice (CASE0)



Transient gray images of JISC with VG in XOY0 slice (CASE1)

Position of xoy and yoz slices



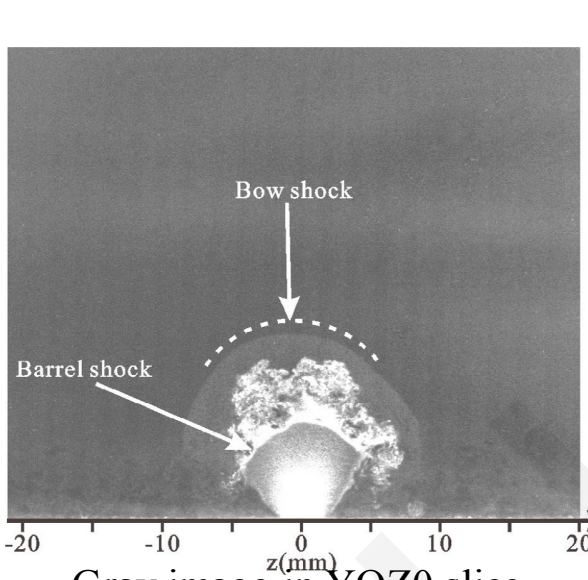


Transient gray images of JISC with VG in XOY0 slice (CASE2)

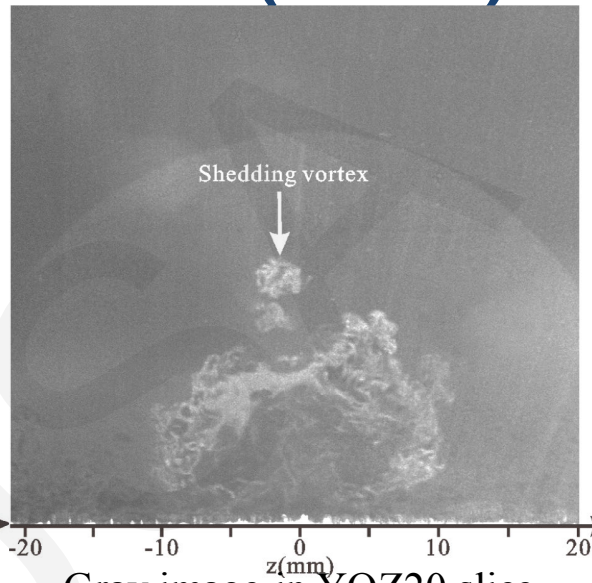
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03 Flow characteristics of JISC in YOZ slices (CASE0)

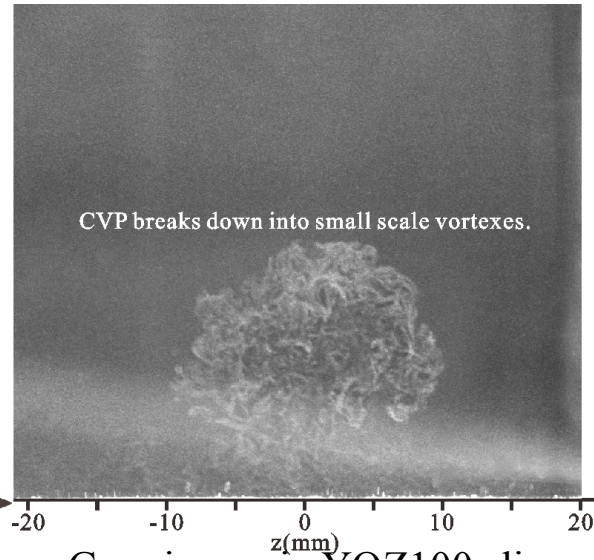
- Bow shock and barrel shock of JISC
- Typical kidney eddies and induced vortices of the CVP
- The breakup process of jet plume
- The developing process of streamwise vortices structures of the jet plume



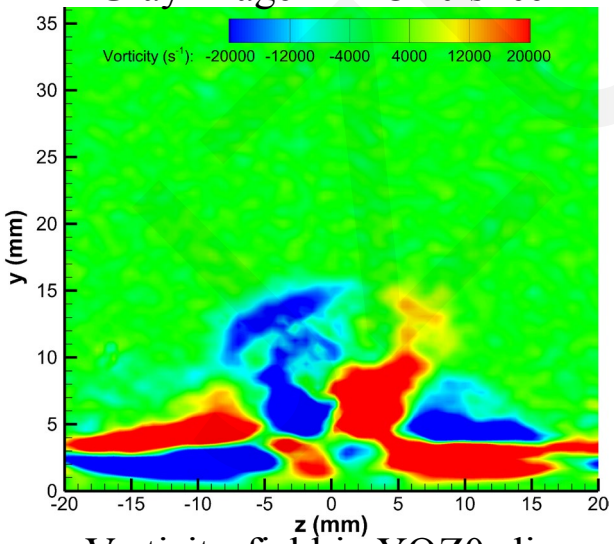
Gray image in YOZ0 slice



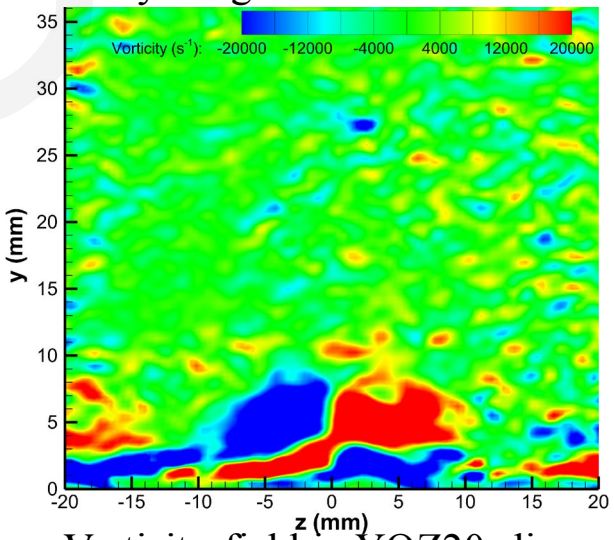
Gray image in YOZ20 slice



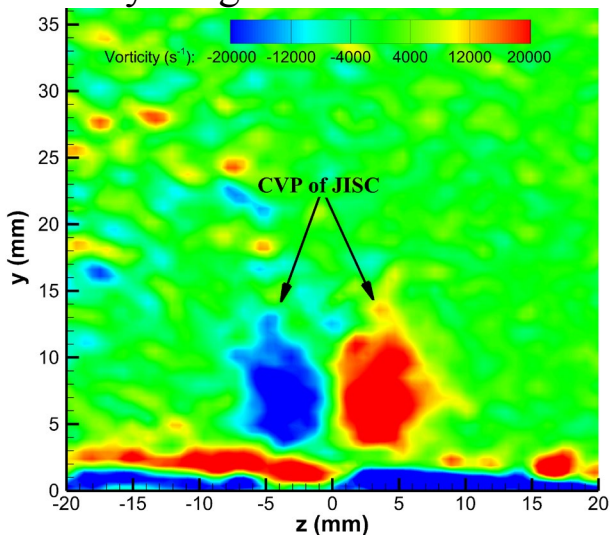
Gray image in YOZ100 slice



Vorticity field in YOZ0 slice



Vorticity field in YOZ20 slice

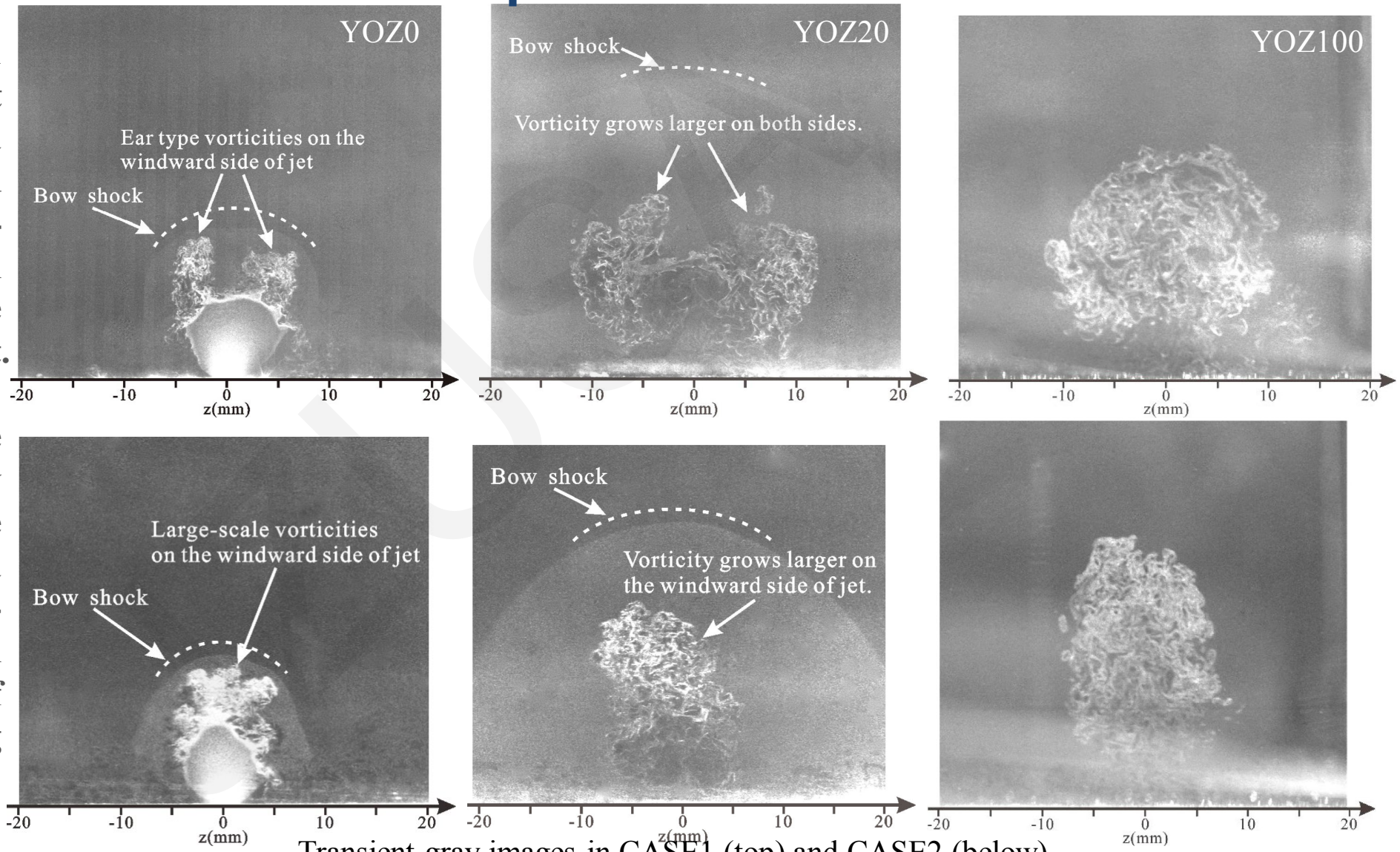


Vorticity field in YOZ80 slice

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04 Flow characteristics of JISC with upstream VG in YOZ slices

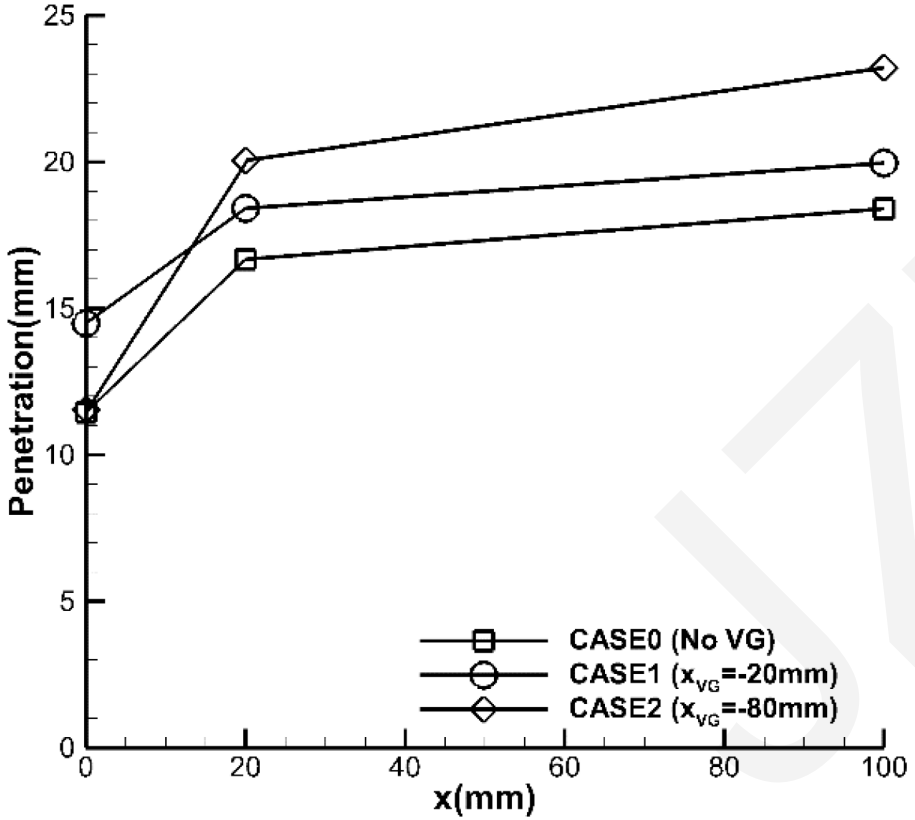
- Two vortices roll up on both sides of the jet plume, and look like a pair of ears as displayed in CASE1, named ear-type eddies. Penetration and lateral diffusion are both improved as a result.
- The windward side of the jet is mainly affected by intermittent large-scale vortices in CASE2. As a result, an overall large-scale vortex emerges in the upwind shear layer of the jet plume, enhancing the penetration greatly.



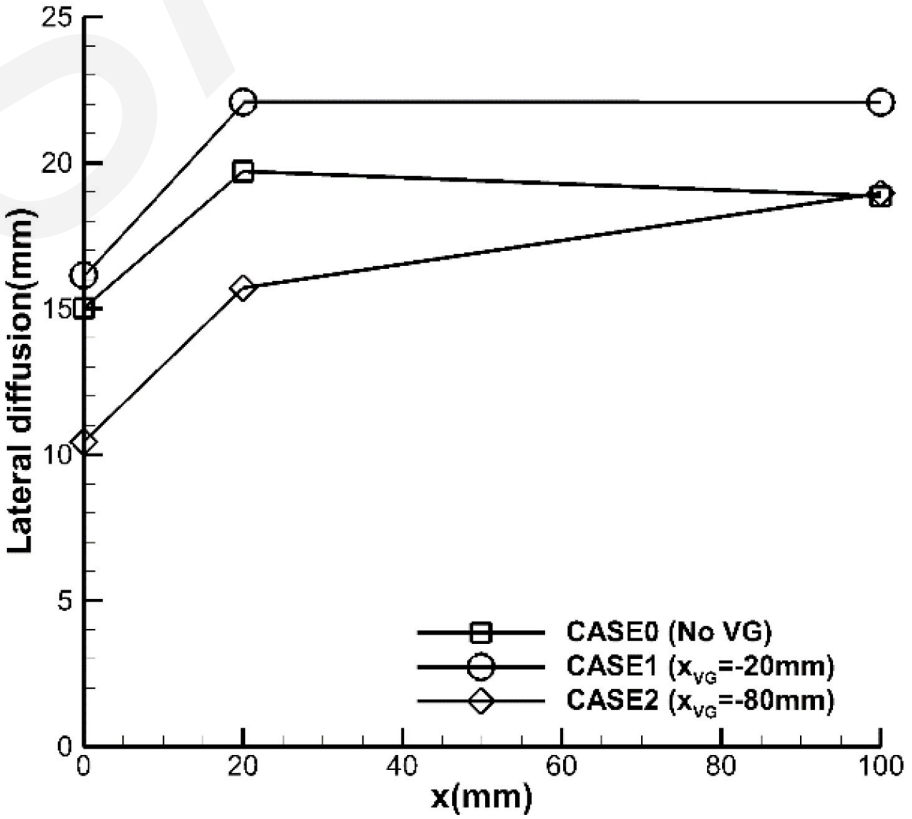
Transient gray images in CASE1 (top) and CASE2 (below)

05 Penetration and lateral diffusion of JISC with upstream VG

- The penetration boundary at YOZ20 is 10.5% higher in CASE1 than that in CASE0, while it is 20.2% higher in CASE2 in comparison with CASE0. The increase becomes 8.5% and 26.2% at YOZ100. According to Fig. 14(b), the lateral diffusion boundary in CASE1 is increased by 12.1% at YOZ20 and 17.0% at YOZ100 compared to CASE0. However, in CASE2 it is 20.3% less at YOZ20, while the deviation is 0.5% at YOZ100.



Comparison of the penetration of JISC with upstream VG

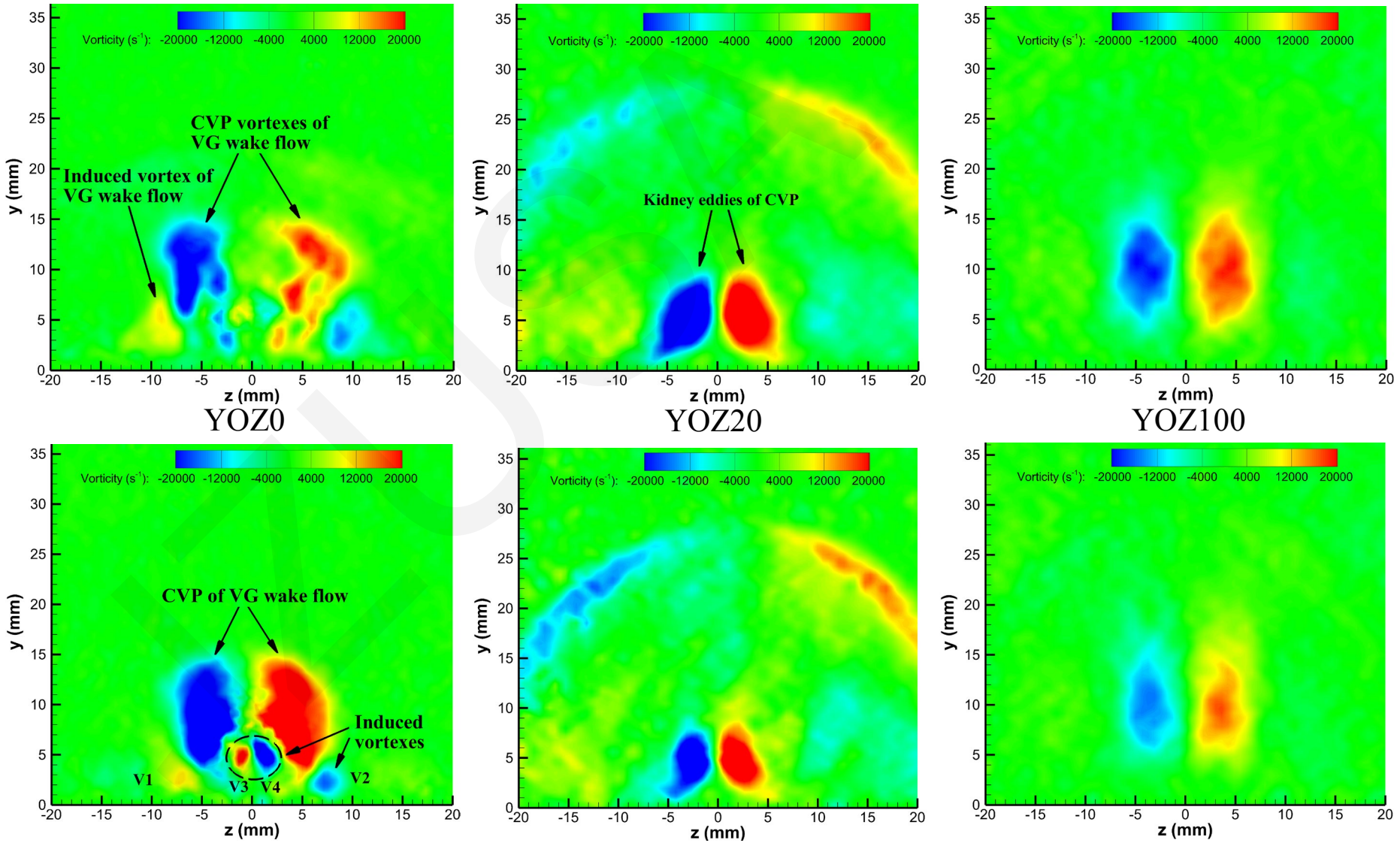


Comparison of the lateral diffusion of JISC with upstream VG

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06 Streamwise vortices development of JISC with upstream VG

- The CVP is dominant at YOZ0, inducing two pairs of vortices. One pair is generated on the outside of the CVP marked as V1 and V2, while the other emerges on the inside and marked as V3 and V4.
- The induced vortices V3 and V4 merge together with the CVP at YOZ20, forming kidney. The induced vortices V1 and V2 start to dissipate.
- The kidney eddies develop and grow gradually. play a dominant role in the far-field mixing process.



Vorticiey fields in CASE1 (top) and CASE2 (below)

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THANK YOU !

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