

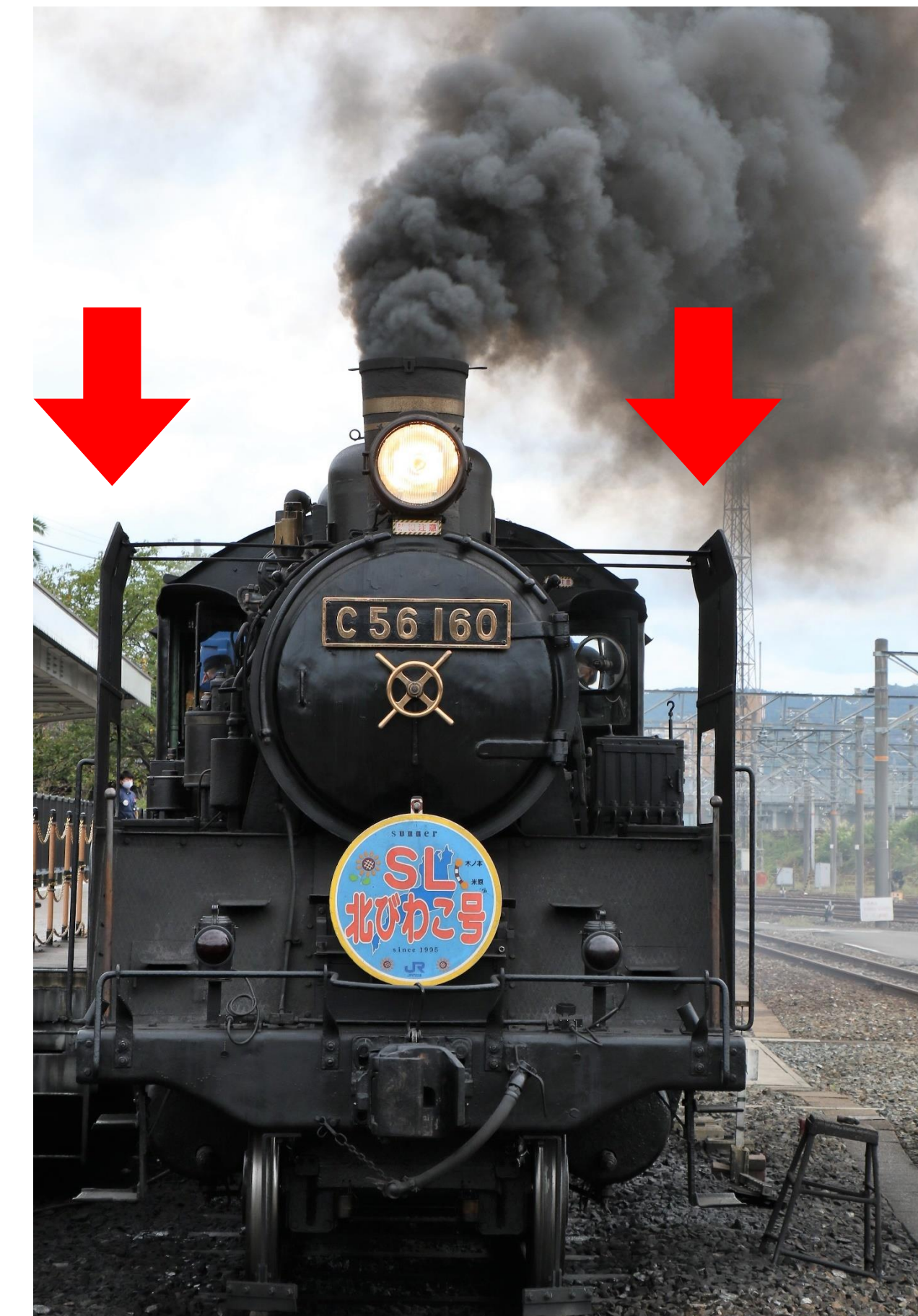
Effect of deflectors on steam locomotives

1. About deflector

Planks on both sides of a steam locomotive. They are installed for the purpose of diverting the wind from the front upward and preventing the smoke from blocking the view. More than half a century has passed without the detailed effect being known.

2. Objective

To visualize airflow with fluid simulation to reveal the effect of deflectors.



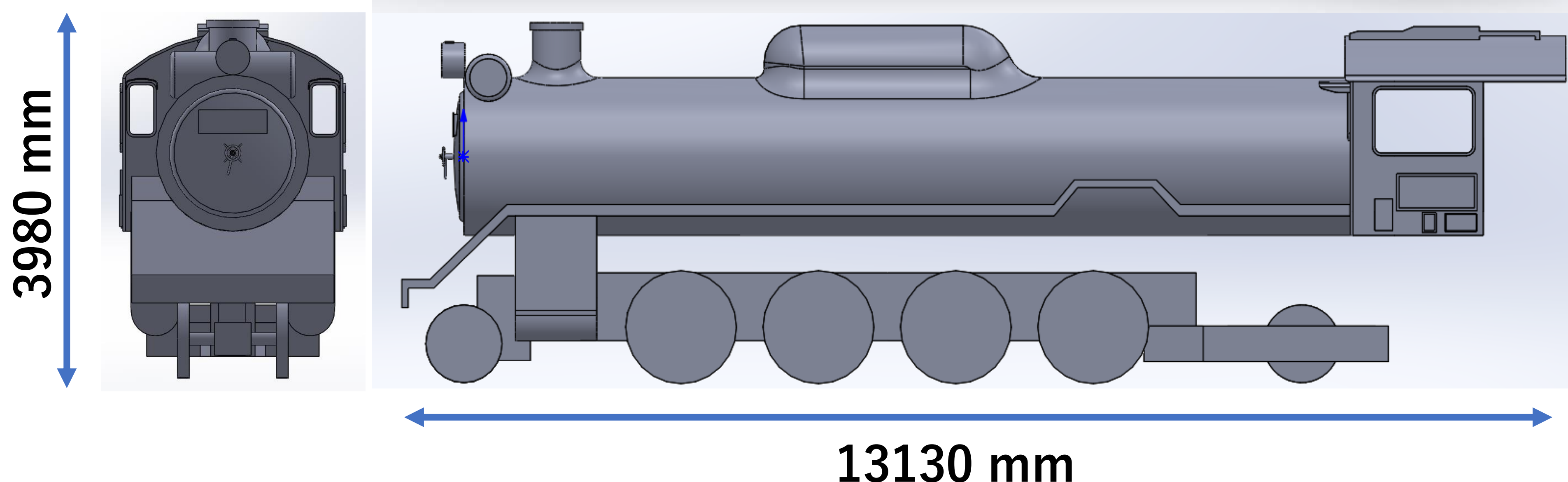
Arrow = position of deflector.

3. Research Flow

- ① Created a model of a steam locomotive using 3D CAD software.
- ② Simulation of air flow and velocity around a locomotive using fluid analysis software “Ansys Discovery Live”.
- ③ Evaluate the effect of deflectors based on simulation results.

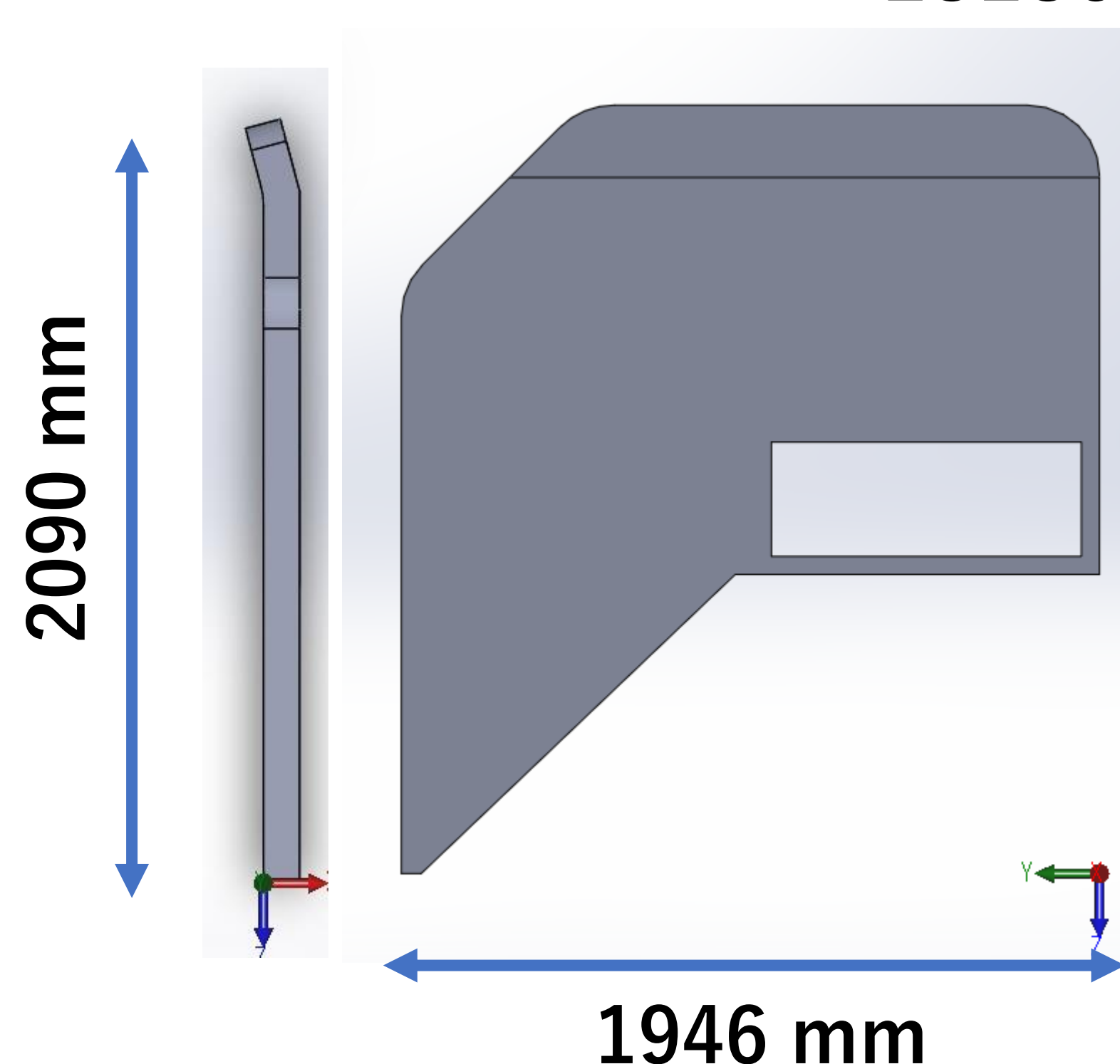
4. 3D models

Type D51 locomotive 3D model



Type D51

Deflector 3D model



Thickness adjusted to 100 mm as recognised by the software.



Measuring and 3D modelling the deflector of Type D51 at the Kyoto Railway Museum.

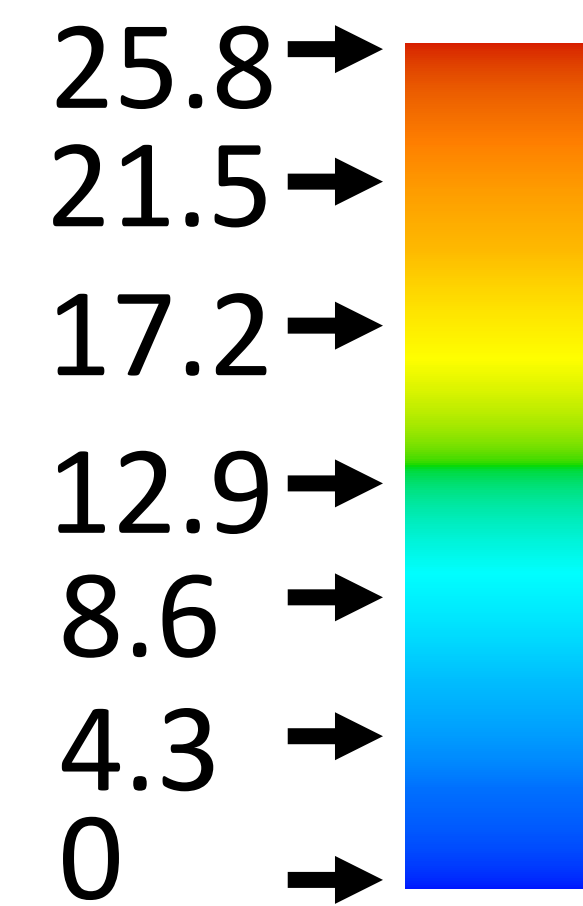
5. Analysis conditions

- Assuming a wind speed of 13.8m/s (50 km/h), wind from the front, and no crosswind
- The analysis is performed in two planes, one horizontal to the ground and one perpendicular to the ground passing through the midpoint between the boiler and the deflector.
- Horizontal viewpoint resolution 0.065m, upper viewpoint resolution 0.08m (because the deflector is too thin to be recognized)

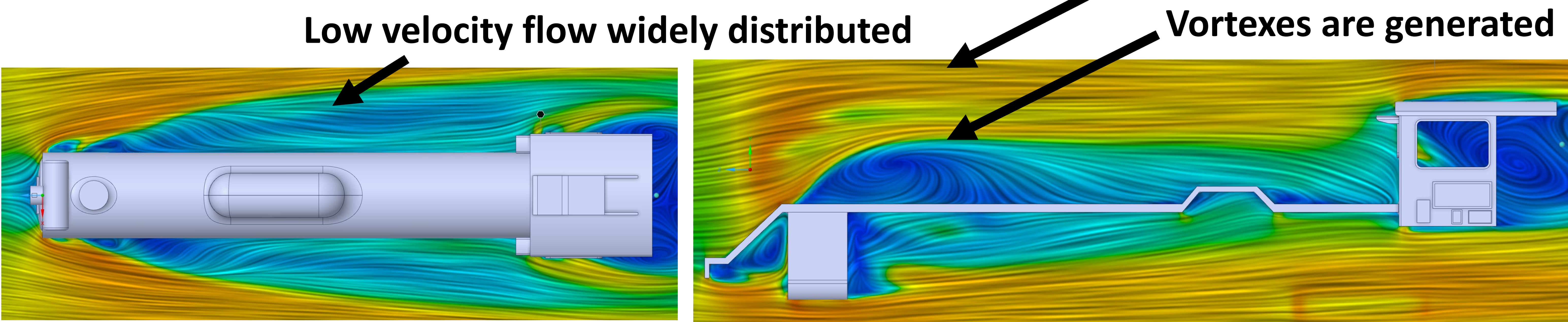
6. Analysis results (flow velocity)

The colors in the figure below indicate the velocity of the flow, and the black streaks represent streamlines.

Value of flow velocity [m/s]

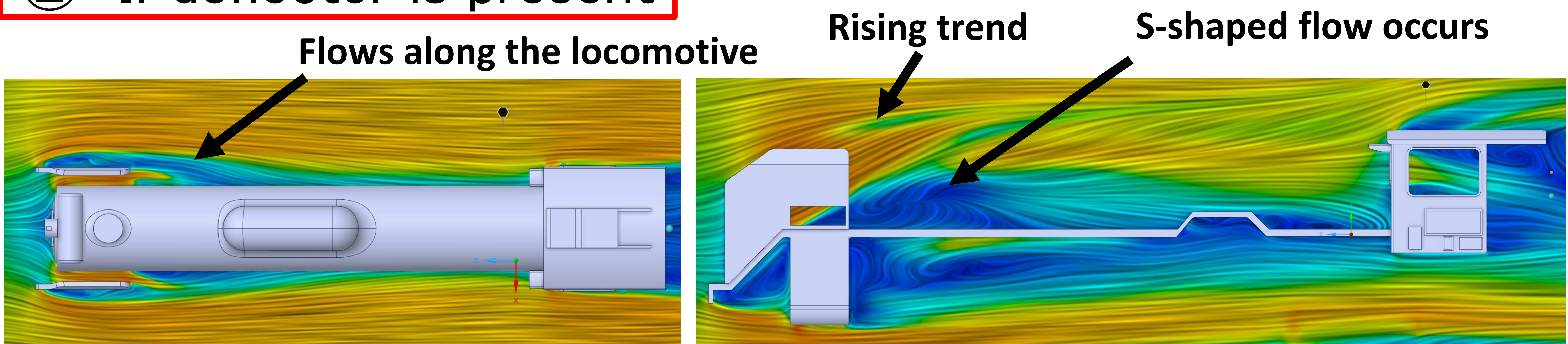


① Without deflector



Air hitting the front of the locomotive slows down and is distributed so that it expands to the left and right. On the side of the locomotive, the slow-flowing air swirls counterclockwise and flows horizontally to avoid this vortex.

② If deflector is present



Air hitting the front of the locomotive is decelerated outside the deflector, but accelerated inside. The decelerated air flows along the locomotive body without expanding to the left and right. There is an S-shaped flow on the side, and there is a flow rising from the deflector at the top.

7. Conclusion

The simulation results suggest that the deflector has the effect of rectifying the flow of decelerated air along the locomotive fuselage and generating an updraft.

8. Future Outlook

The mechanism by which air flow changes with and without deflectors should be considered, and an effective shape should be explored.

Cooperation
: Kyoto Railway Museum