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Novel integration methodology for an inward turning waverider forebody/inlet

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Key words:

Hypersonic; Basic flow mode; Streamline tracing; Inward turning inlet

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Design principles

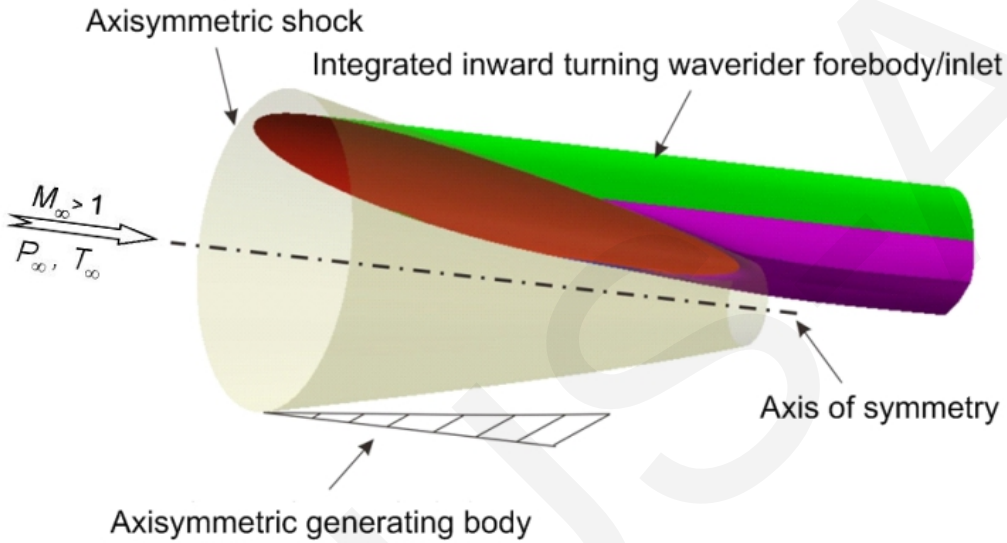

Fig. 1 Design principle of the integrated inward turning waverider forebody/inlet

- **Under the design conditions, the leading-edge shock wave is produced when the axisymmetric generating body is determined, and the lip of the inlet is attached to the axisymmetric shock, thereby forcing higher pressure air below the lower surface.**

Design methodology

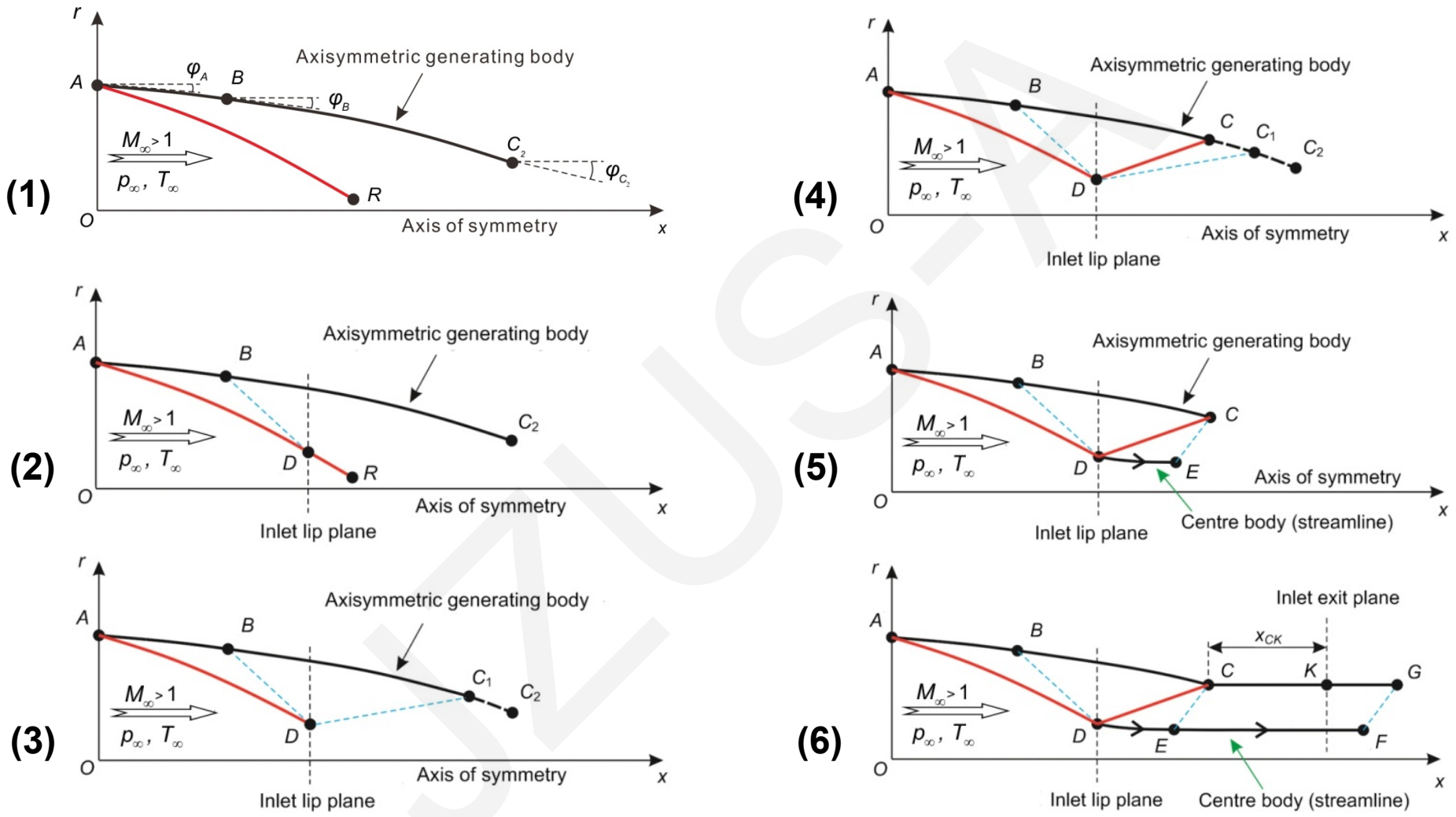

Fig. 2 Design method of the axisymmetric reference flow model

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Design methodology

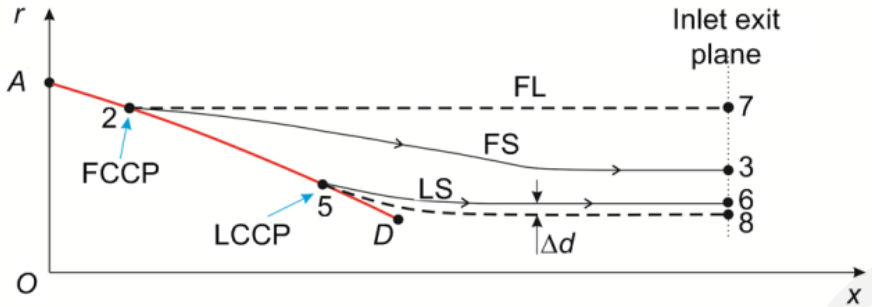

Fig. 3 Design of the profiles of the front external surface and lip external surface

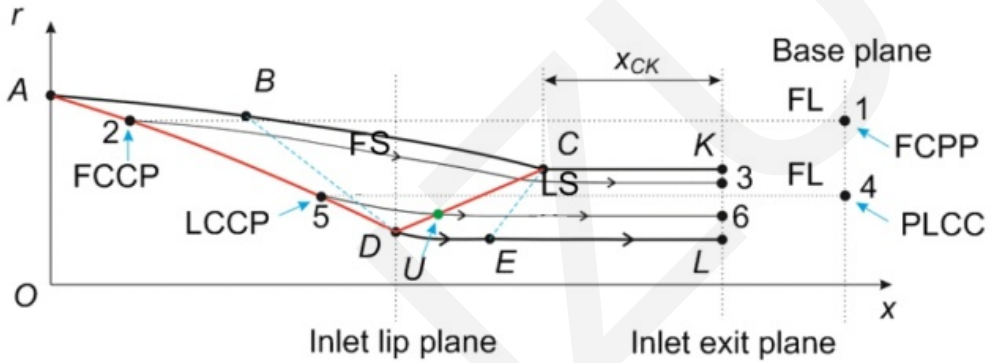

Fig. 4 Design of the forebody streamline (FS) and lip streamline (LS)

- All the FSs form the upper surface of the inward turning inlet.
- All the LSs form the lower surface of the inward turning inlet.
- All the FLs form the front external surface.
- All the lip external surface profile form the lip external surface.

Model and numerical method

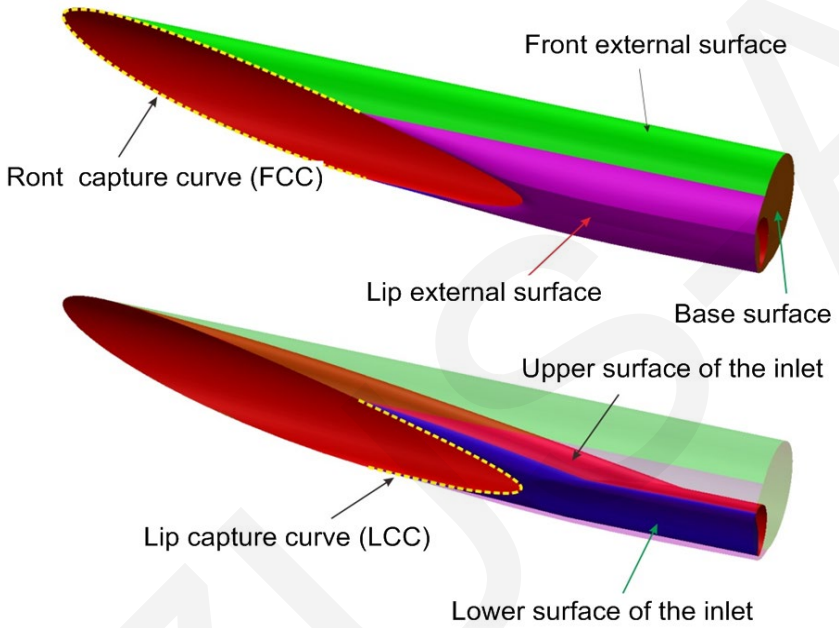

Fig. 5 Constituent parts of the integrated inward turning waverider forebody/inlet

- **The integrated inward turning waverider forebody/inlet (ITWF) is formed with the inlet and three surfaces–the front external surface, the lip external surface, and the base surface.**

Model and numerical method

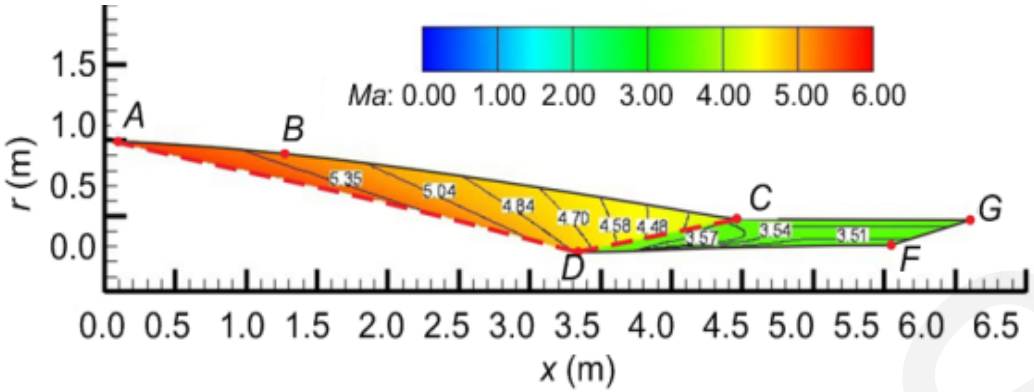

Fig. 6 Mach number contour of the reference flow model obtained by the MOC

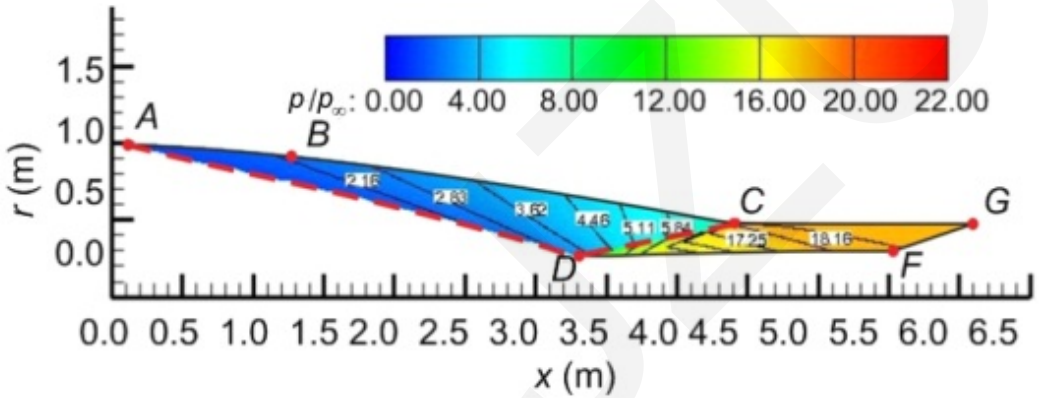

Fig. 7 Non-dimensional pressure contour of the reference flow model obtained by the MOC

- **The numerical simulation results shown above validate the correctness of the design methodology for the basic flow mode.**

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Model and numerical method

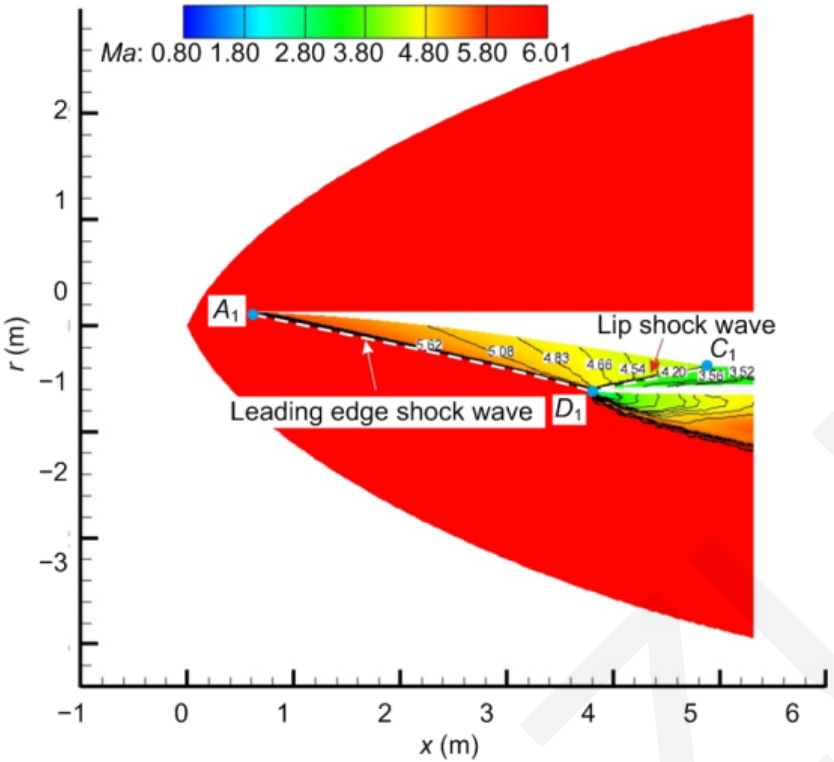


Fig. 8 Mach number contour in the symmetry plane of the case

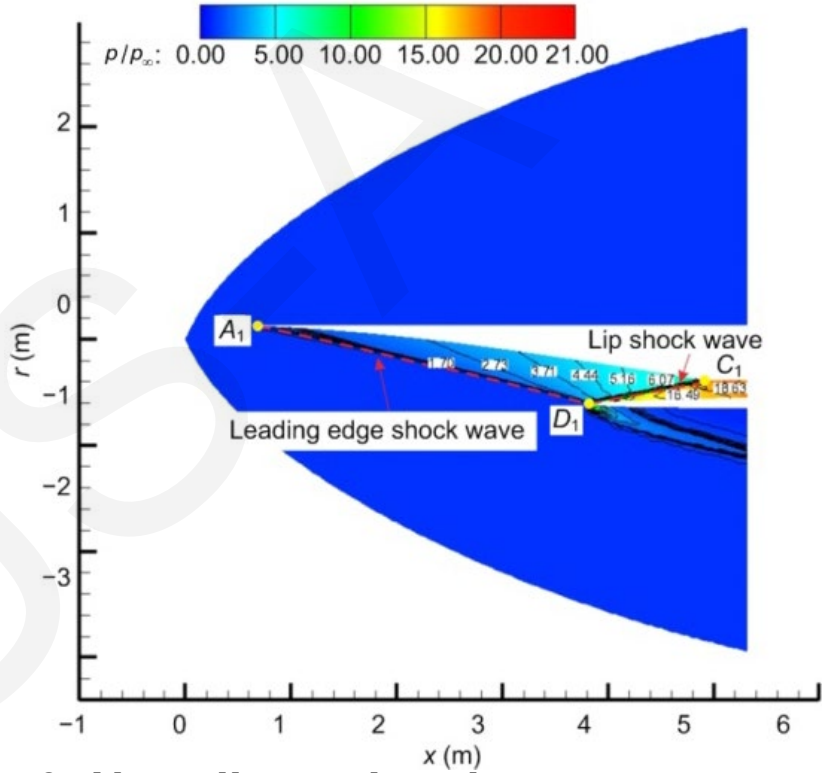


Fig. 9 Non-dimensional pressure contour in the symmetry plane of the case

- It is clear from Figs. 8 and 9 that the numerical simulation results of the shape and location of the shock wave are in accordance with those obtained using the MOC.

Model and numerical method

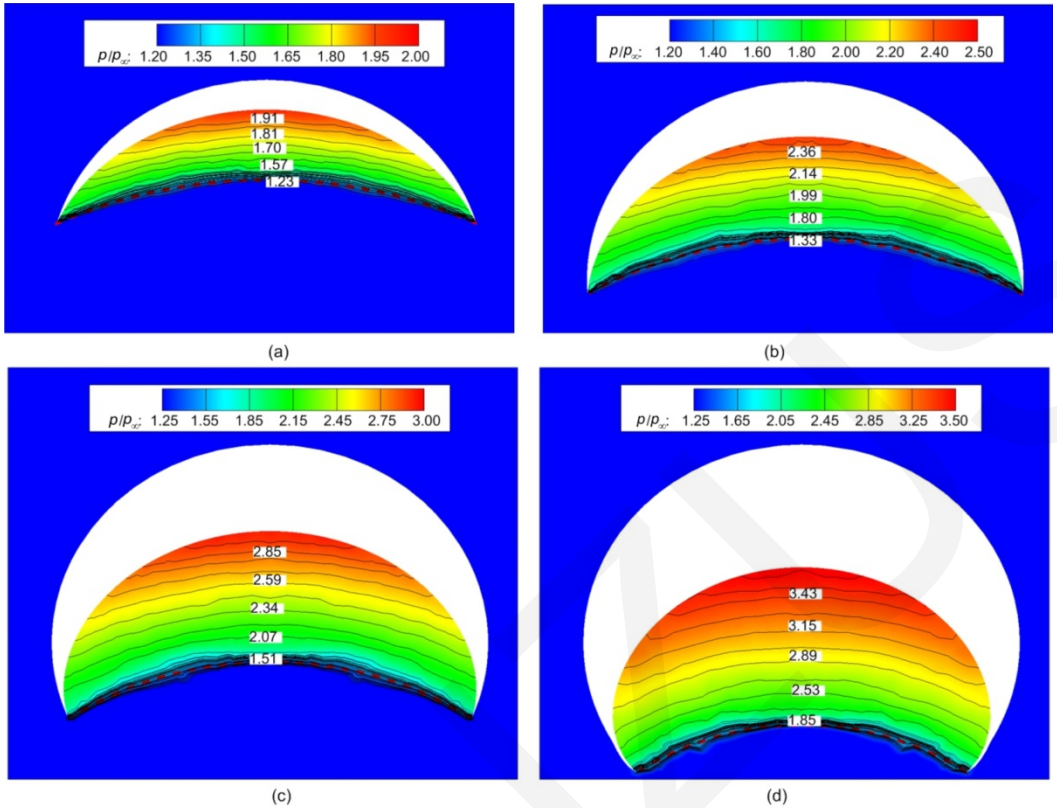


Fig. 10 Inviscid non-dimensional pressure contour at each cross-section of the case (a) x=1.5 m; (b) x=2.0 m; (c) x=2.5 m; (d) x=3.0 m

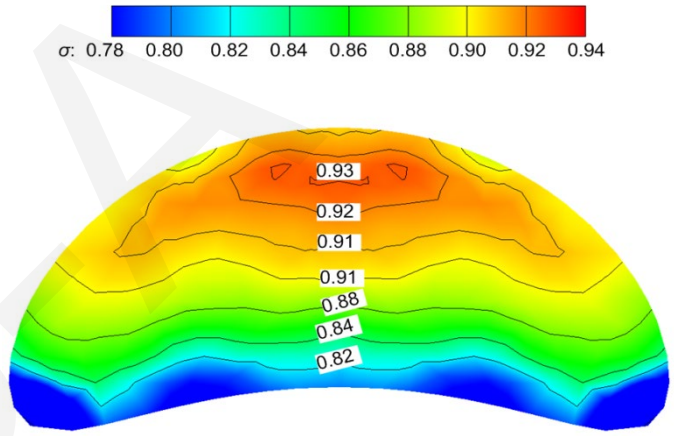
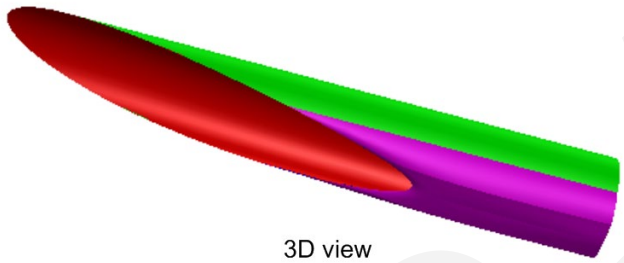


Fig. 11 Total pressure recovery coefficient in inlet exit plane

- The higher pressure air is confined between the shock wave and the lower surface, which essentially achieves full flow capture.
- High total pressure recovery coefficient of the inward turning inlet.

Conclusions



3D view

- The axisymmetric reference flow model was designed based on the MOC. In this model, the inward turning inlet and the external surface were designed and generated simultaneously.
- The design method of the integrated configuration conforms to aerodynamic principles. In this paper, the accuracy and validity of the design method were verified by comparing the results of inviscid numerical simulation with theoretical design values.
- The results presented above validate the correctness and feasibility of the design methodology for the integrated configuration under the inviscid condition. The numerical results verify that the integrated configuration has high flow capture efficiency and the designed inlet has a high total pressure recovery coefficient.