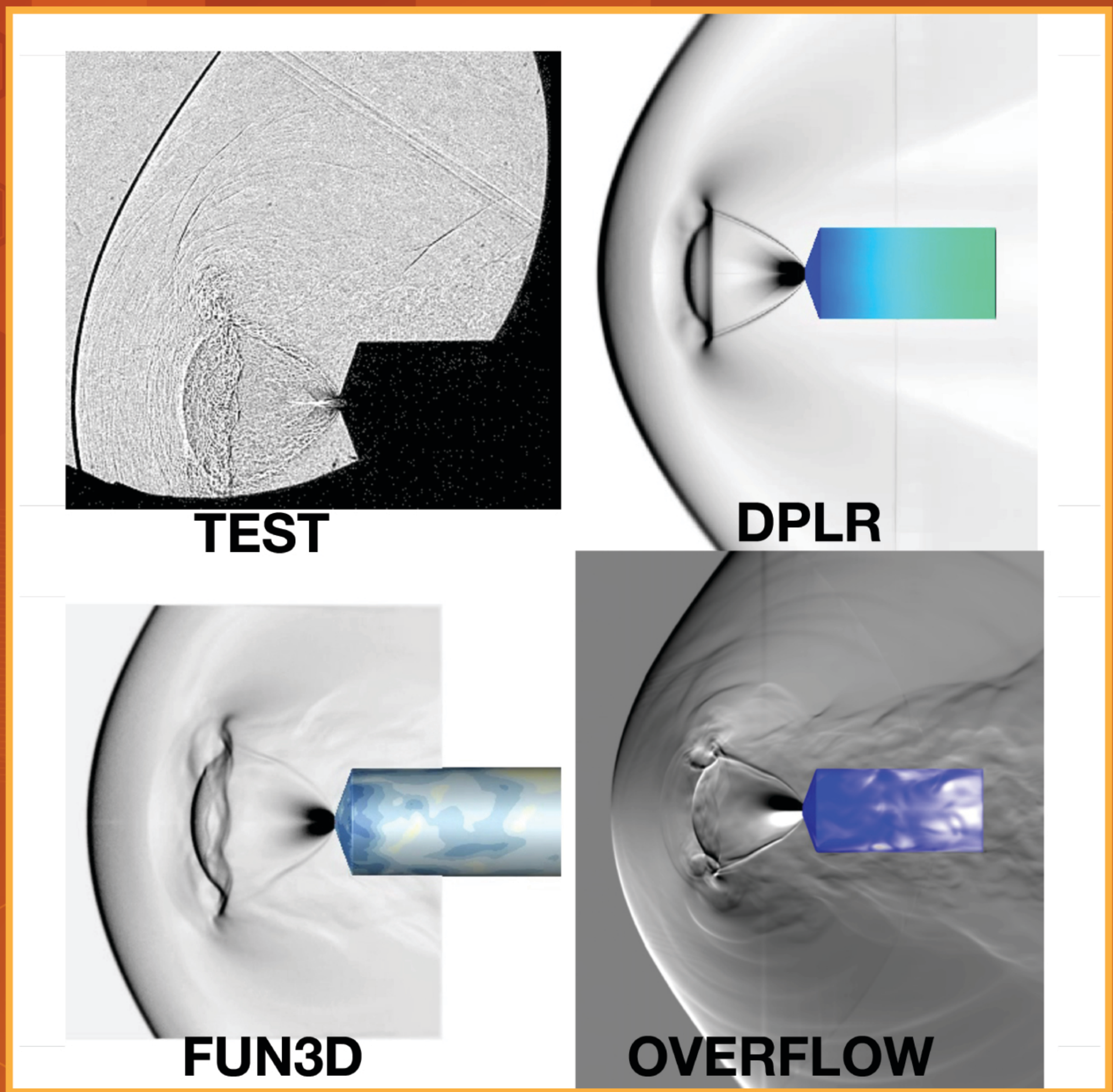
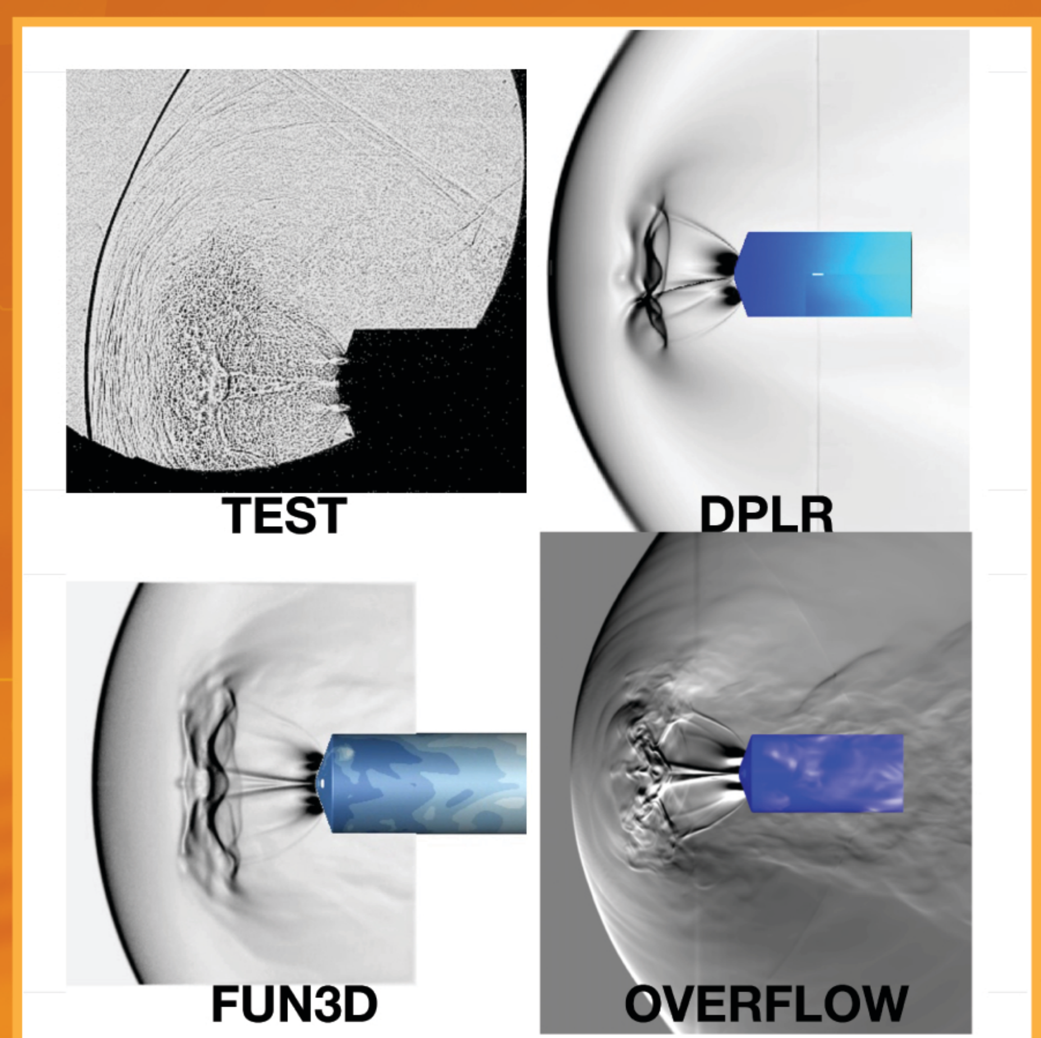
Supersonic Retropropulsion for Mars Entry



These images show a close correlation between the comparison of computational fluid dynamics (CFD) simulations to a wind tunnel test of 1-nozzle supersonic retropropulsion. The CFD simulations closely matched shock standoff distances as well as plume shape and behavior. *Karl Edquist, NASA/Langley; Kerry Zarchi, NASA/Ames*



Comparison of CFD simulations to a wind tunnel test of 3-nozzle supersonic retropropulsion. The jet and shock structures in the CFD compare well to the test, particularly the well-defined shear layers between multiple barrel plumes. *Bil Kleb, NASA/Langley; Guy Schauerhamer, NASA/Johnson*

Supersonic retropropulsion (SRP), which employs jets opposing a supersonic freestream, is a potential method to decelerate future large-mass spacecraft entering the Martian atmosphere. This technology is needed because current methods of supersonic deceleration do not scale to exploration-class vehicles (tens of metric tons). Since flight and ground testing at Mars entry conditions is difficult and cost-prohibitive, the use of computational fluid dynamics (CFD) is critical to analyzing the complex physics of SRP. However, CFD must first be validated at these conditions.

- To validate the CFD methods, researchers used three NASA-developed flow solvers (DPLR, FUN3D, and OVERFLOW), which were run using NASA's supercomputing resources
- In addition, two wind tunnel tests were conducted in the Unitary Plan Wind Tunnels at NASA Ames and NASA Langley Research Centers. Qualitative and quantitative comparisons between the code simulation results and the test data show that CFD methods are highly capable of simulating SRP flowfields
- With CFD validation, it will be possible to use CFD for parametric studies, vehicle control and stability analysis, and accurate prediction of the complex physics of SRP at Mars entry conditions

These CFD validation studies required time-accurate simulations, which used millions of processor hours on NASA's supercomputing resources and created terabytes of data.

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