



## NASA STTR 2004 Phase I Solicitation

### T8.02 Advanced High Fidelity Design and Analysis Tools For Space Propulsion

Lead Center: MSFC

The pace at which the United States, through NASA, explores space will largely be driven by the cost of developing the systems required to make future explorations practical. The nation's ability to decrease the cost and schedule required to develop new space transportation systems that are required to support NASA's exploration missions is hampered by inadequacies in our design tools and databases. Space Transportation systems operate at the extremes of our materials capabilities, therefore, any shortcomings in our ability to predict the internal operating environments during the design process will almost always lead to redesigns during the development of the system. These redesigns are costly and always compromise the project's schedule. One way to address this issue is to increase the fidelity and accuracy of the tools used to predict the internal operating environments during design.

Universities are at the leading edge of development of new, "first principles" physical models, of development of new high fidelity numerical approaches for simulating operation of space transportation systems, and of development of the experimental approaches and data required to validate these tools. Transition of that technology, however, from the academic setting to a production, applications-centered environment where it can be applied to the design of NASA's space transportation systems requires focused effort. Efficient and timely transfer of these capabilities from the university setting to the operational (production) setting is required to reduce the developmental risks associated with NASA's space transportation systems and to maximize the return on the NASA's investments at the Nation's colleges and universities.

This subtopic solicits partnerships between academic institutions and small business for the purpose of developing novel design and analysis approaches, and the methods by which to validate them, into useful production tools that can be used to develop NASA's space transportation systems. Examples of specific areas where innovations are sought follow:

- Efficient, three-dimensional (3-D), time accurate analysis tools for modern rocket engine combustion chamber and turbomachinery environments and performance;
- Efficient, three-dimensional (3-D), time accurate analysis tools for predicting the environment and loads internal to valves, lines, and ducts in modern rocket engines;
- Practical 3-D steady and time-accurate multidisciplinary analysis (MDA) tools for design of space

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transportations systems components and subsystems;

- Practical approaches for predicting the time varying 3D flow field in cases involving relative motion between objects;
- Practical Large Eddy Simulation (LES) tools for the analysis of high pressure reacting flows;
- Automated hybrid grid generation tools and grid adaptation tools;
- Efficient and accurate fluid properties routines for the range of conditions applicable to rocket engines;
- Automated approaches for extracting key engineering information and flow features from 3-D flow simulations;
- Automated approaches for validating and assuring quality of application software;
- Practical unsteady 3-D cavitation models for implementation into Reynolds-Averaged Navier-Stokes (RANS) analysis codes;
- Advanced instrumentation and diagnostic techniques necessary for acquisition of steady and unsteady code validation data; and
- Validation data for all of the tool types mentioned above.