Space Shuttle Debris Transport

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Debris Sources

Liftoff Debris
rust, uncontained hardware, etc.

Foam, ice, gap fillers, ceramic inserts, many other smaller and lower likelihood sources.

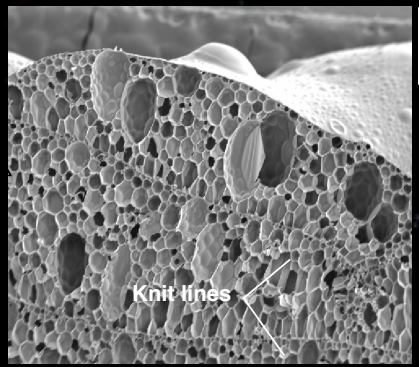
Ascent Debris

Orbital Debris
> 3 km/sec
> 9,800 ft/sec

Probabilistic Debris Process

$$Pr(failure) = Pr(E_1 \cap E_2 \cap E_3)$$
$$= Pr(E_1)Pr(E_2 \mid E_1)Pr(E_3 \mid E_1 \cap E_2)$$

E_1 Debris Released



Void distributions, material properties, heating, etc.

E_2 Debris Impacts Surface

Flowfield, mass, drag coefficient, crossrange, etc.

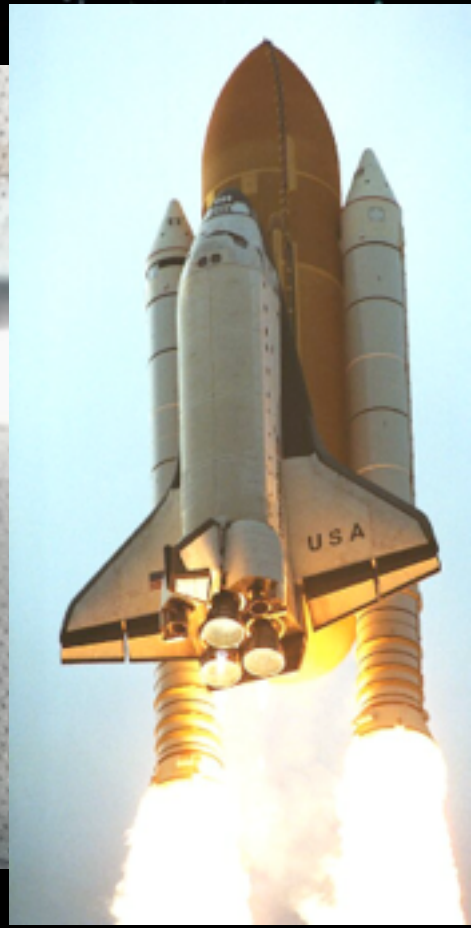
E_3 Impact Exceeds Capability

RCC, tile, windows, ...
f(mass,velocity,angle,material,...)

Engineering Tools

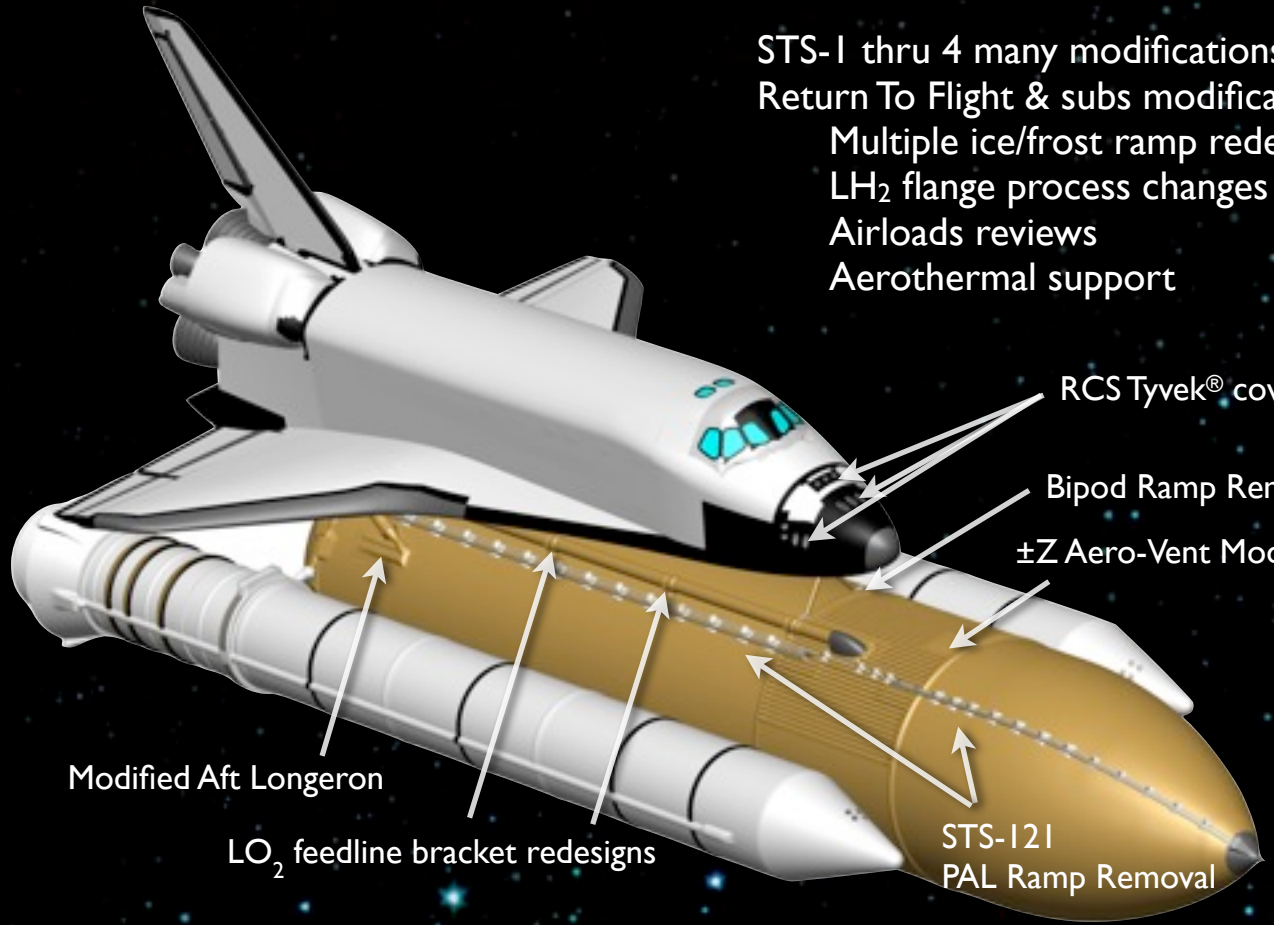
Modeling & Simulation

Ground/Subscale Test

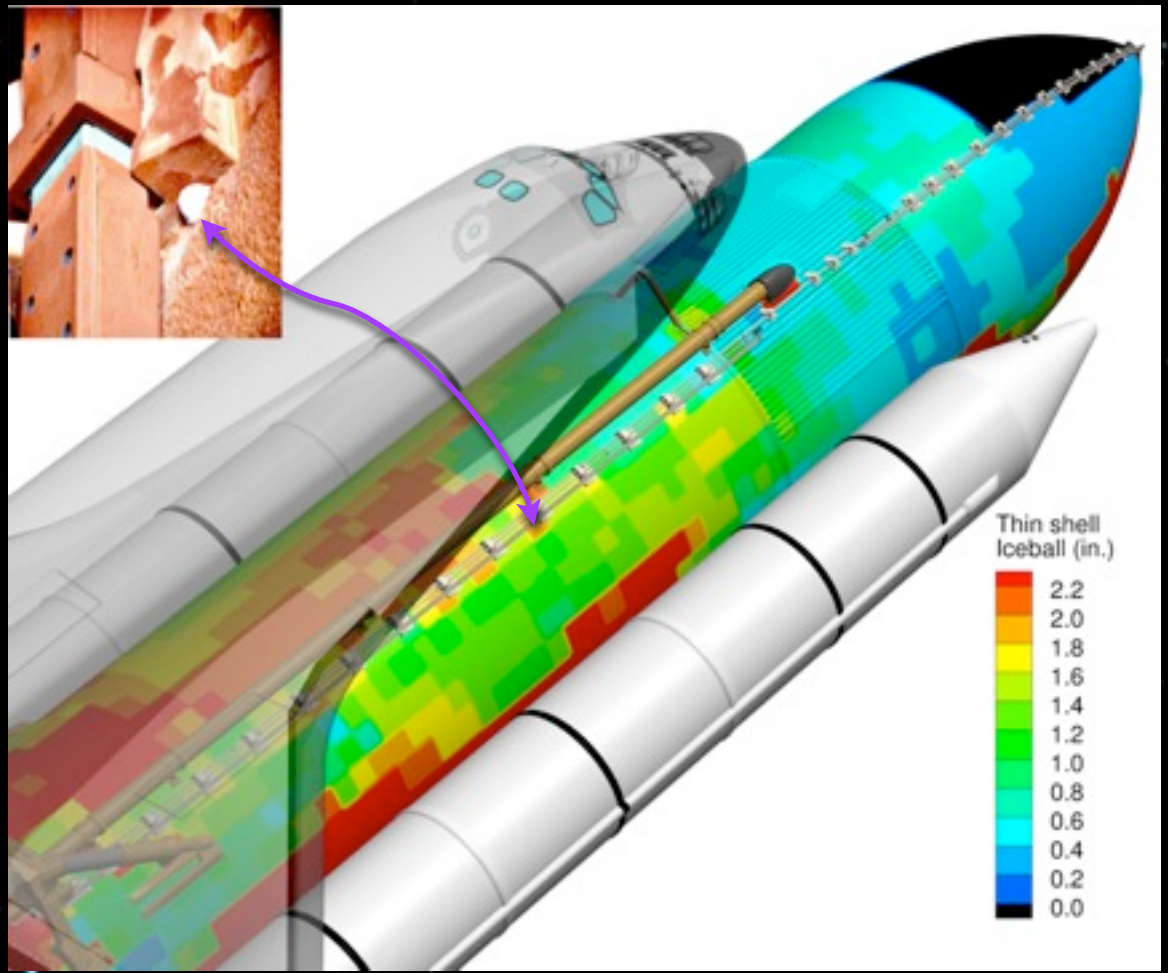


Flight/Full scale Test

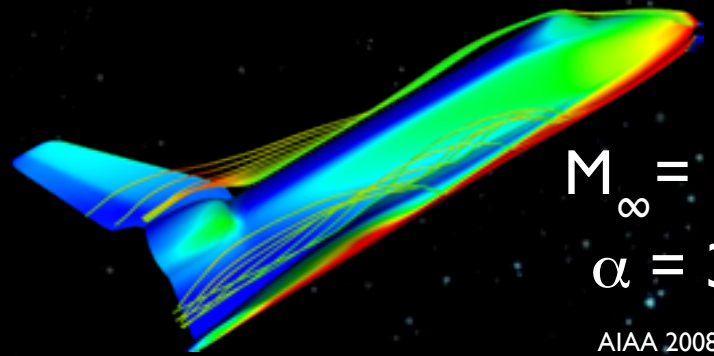
Eliminating Debris Sources



Prelaunch Iceball Assessment Tools



Inflight Damage Assessments



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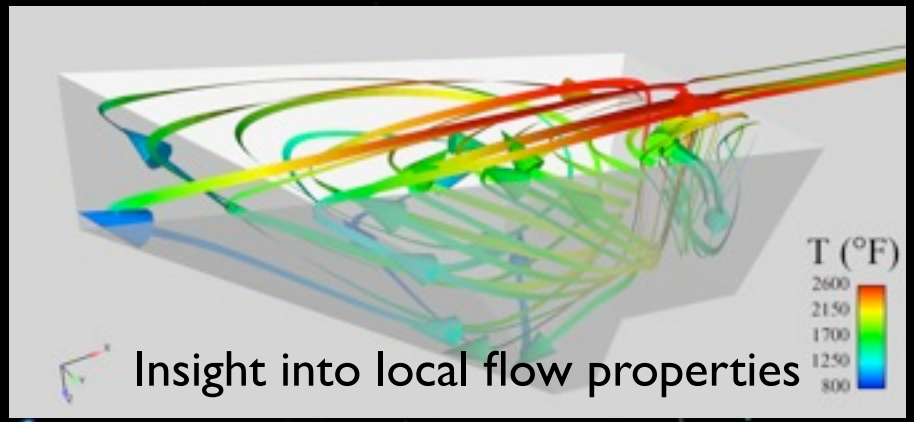
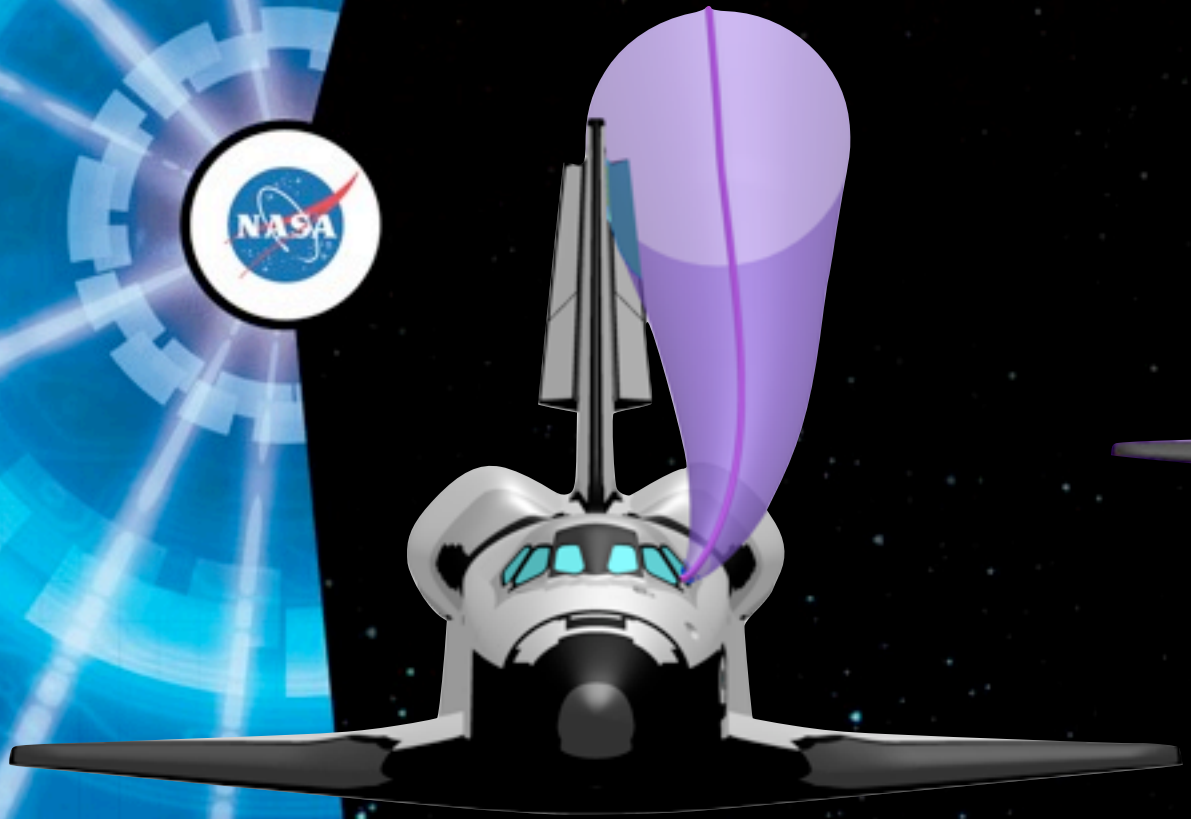


Inflight/Postflight Debris Assessments



Mach 3 Simulation of tile ceramic insert debris

Reaction Control System cover trajectory reconstruction

Computing & Overset Space Shuttle Applications

Cray X-MP
0.2 GFLOPS

Cray Y-MP
2.5 GFLOPS

SGI Origin 2000
128 GFLOPS

SGI Altix
2.3 TFLOPS

SGI ICE /Pleiades
608 TFLOPS

NAS
Begins

Cray 2
2 GFLOPS

Cray C90
15 GFLOPS

SGI Origin 3800
1.2 TFLOPS

SGI Altix / Columbia
67 TFLOPS

ARC3D

F3D

Chimera
Grid Tools

PEGASUS 5

OVERFLOW 2.1

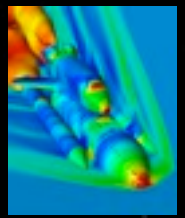
OVERFLOW 2.2

INS3D

OVERFLOW 1.6

OVERFLOW 1.8

OVERFLOW 2.0



STS-51L

STS-107

1980 1985 1990 1995 2000 2005 2010

10^5 grid points

10^6 grid points

10^7 grid points

10^8 grid points