Safety in Spaceflight: Recognizing Narrow Margins

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Mach25Management, LLC
Wallisch and Associates

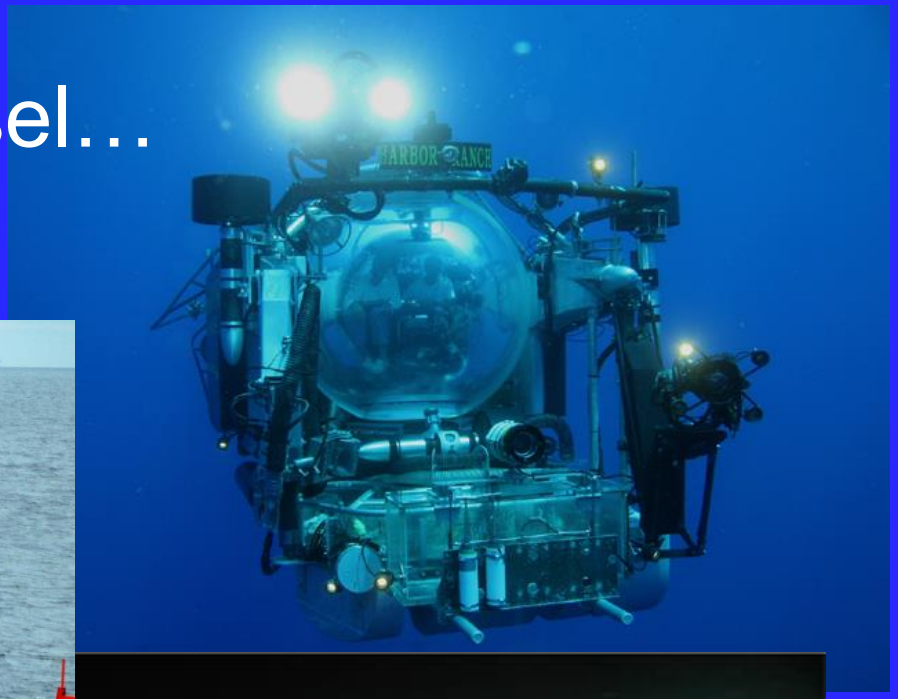
The really BIG Picture

What keeps a Great Team safe?

- Processes
- Procedures
- Tools

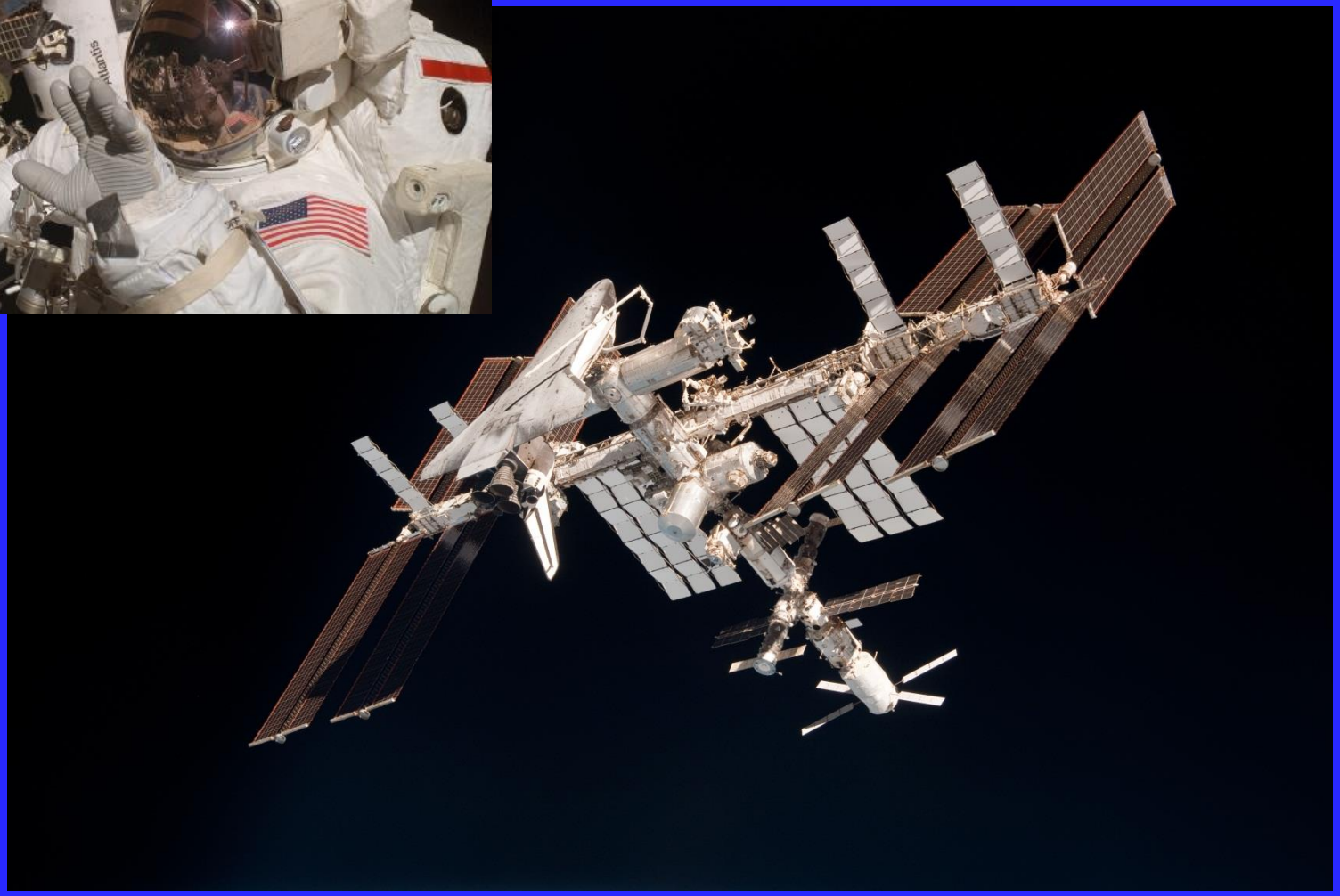
- Most important: People!

Life in a Pressure Vessel…



Forget your margins:
Kill you or your company

Life in a Pressure Vessel, Part II…



Space: can you find the 14 pressure vessels?

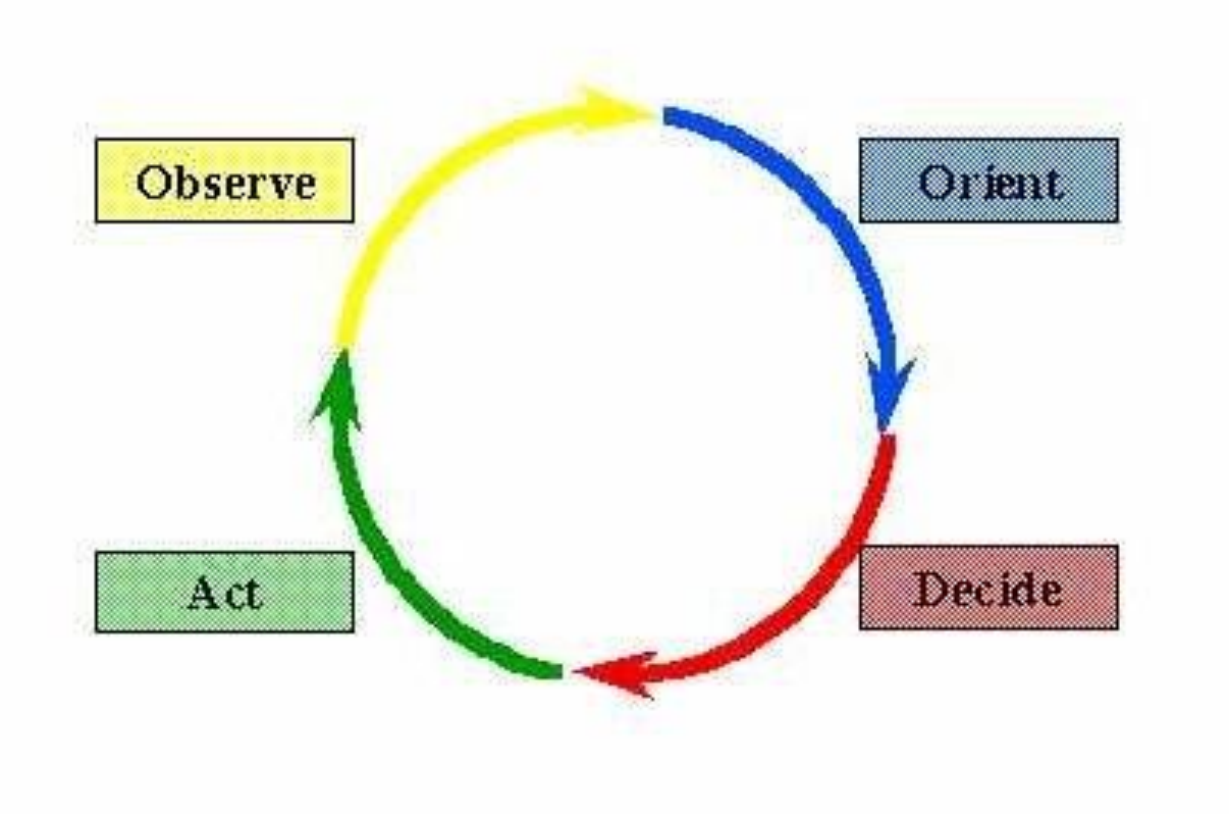
UNITED STATES
MARSHAL

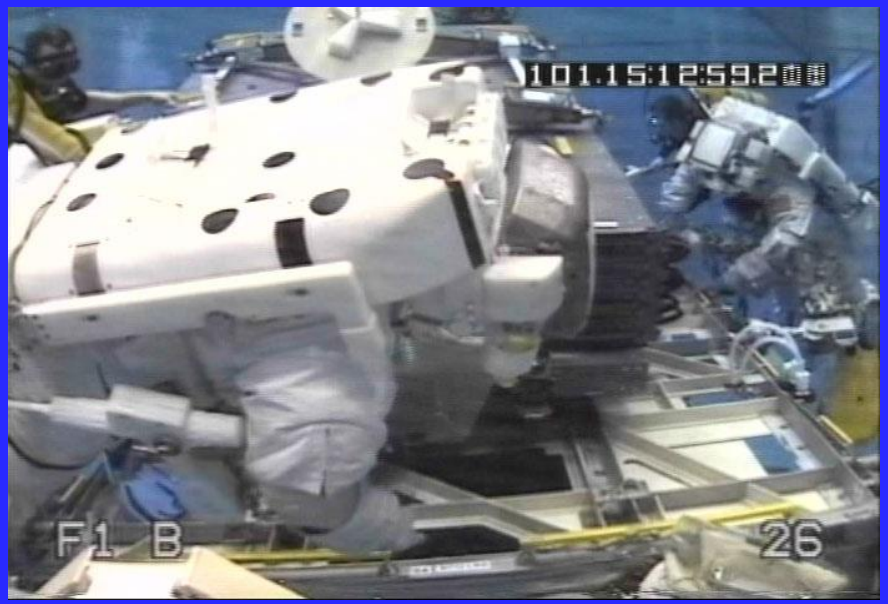
DEPARTMENT OF JUSTICE
1789
JUSTICE
INTEGRITY
SERVICE
UNITED STATES MARSHAL

CI: The recognition that the margin between success and failure is very narrow; test and train to maximum efficiency.

- Details missed CAN kill you (kill your brand)
- Question EVERYTHING
- Act like everyone has your life (career) in their hands
- Plan, brief, execute, debrief (PBED), REPLAN…
- Communicate objectives and expectations

Col John Boyd's "OODA Loop"

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03/20/2007

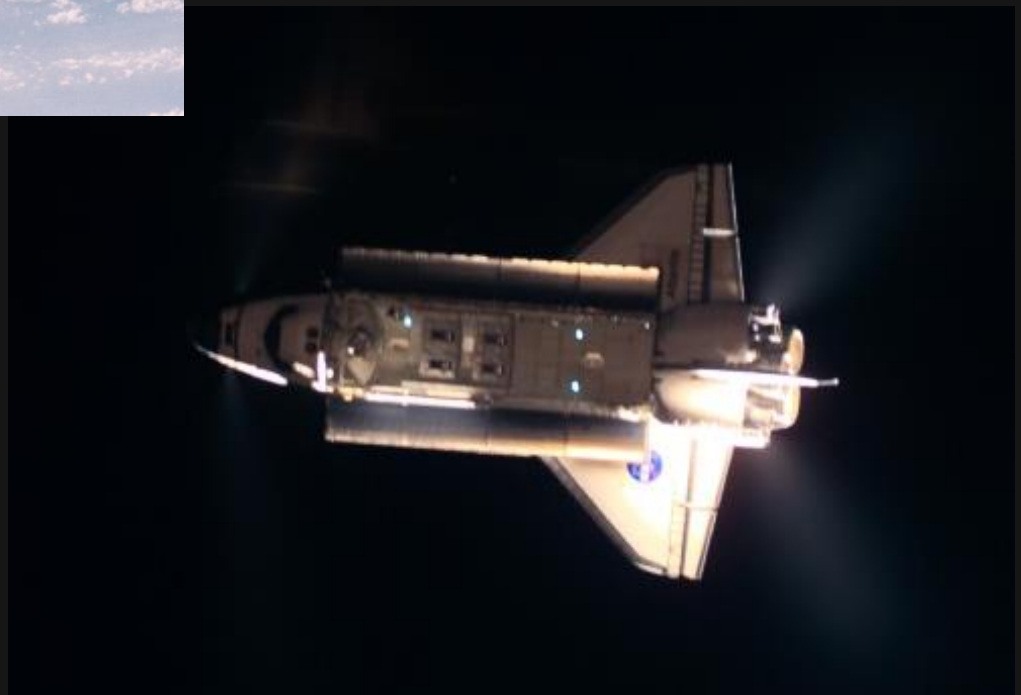

CAUTION
RELEASES BASKET

First Crew:

- STS-89: Culture challenges
- STS-104:
- STS-117:

Three Things:

- Do you have a plan?
- Is it working?
- Are you ahead or behind?



Fourth thing:

- What would you do differently?
- PBED!

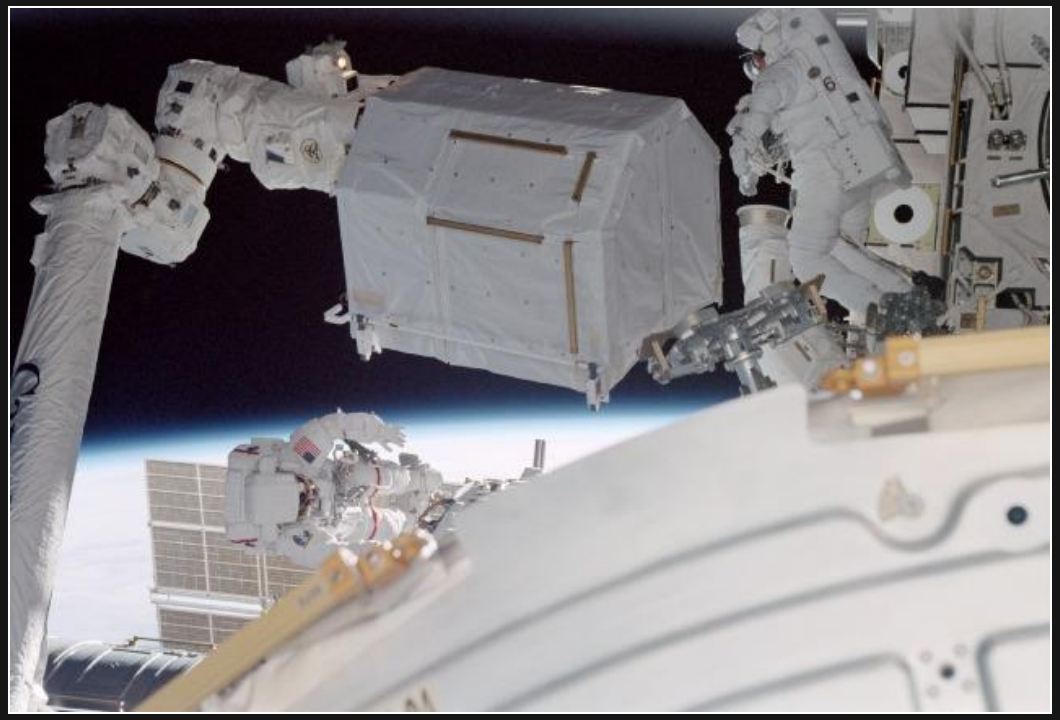
Train like you fly, fly like you train!

Second Crew:

- STS-89:
- STS-104: Overachievers
- STS-117:

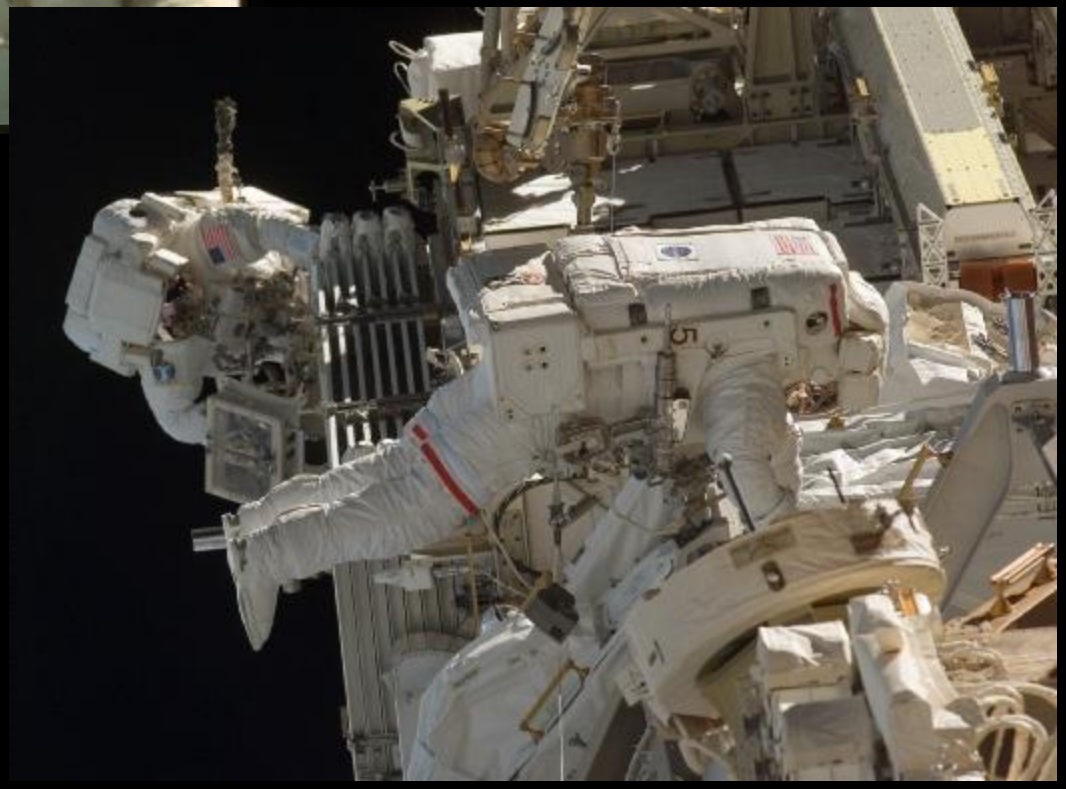

Challenger


NASA
MISSION CONTROL



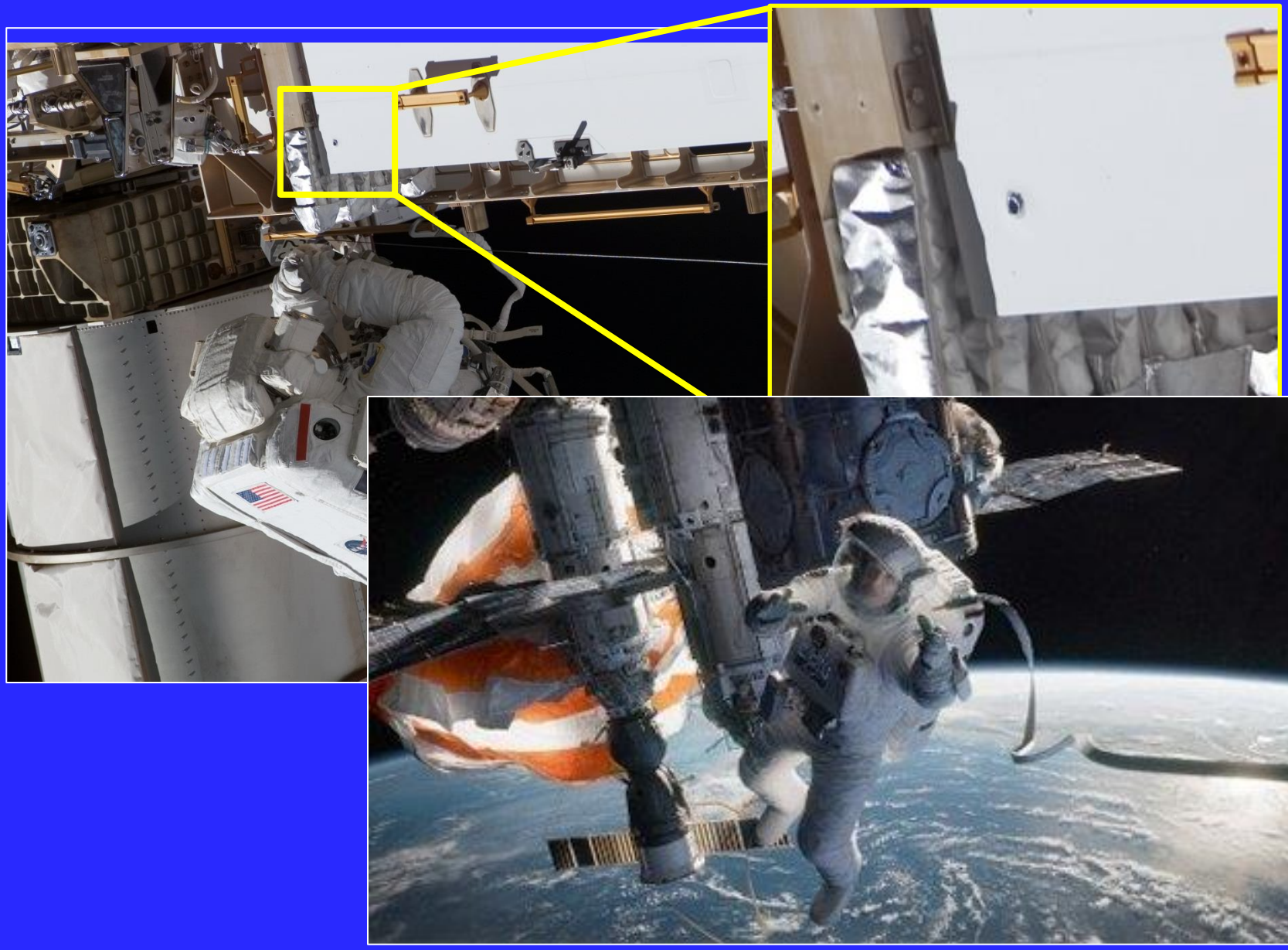
Your life depends on your team!

Each procedure a series of tasks



Each task evaluated for safety and efficiency

MMOD – Impact (literally)

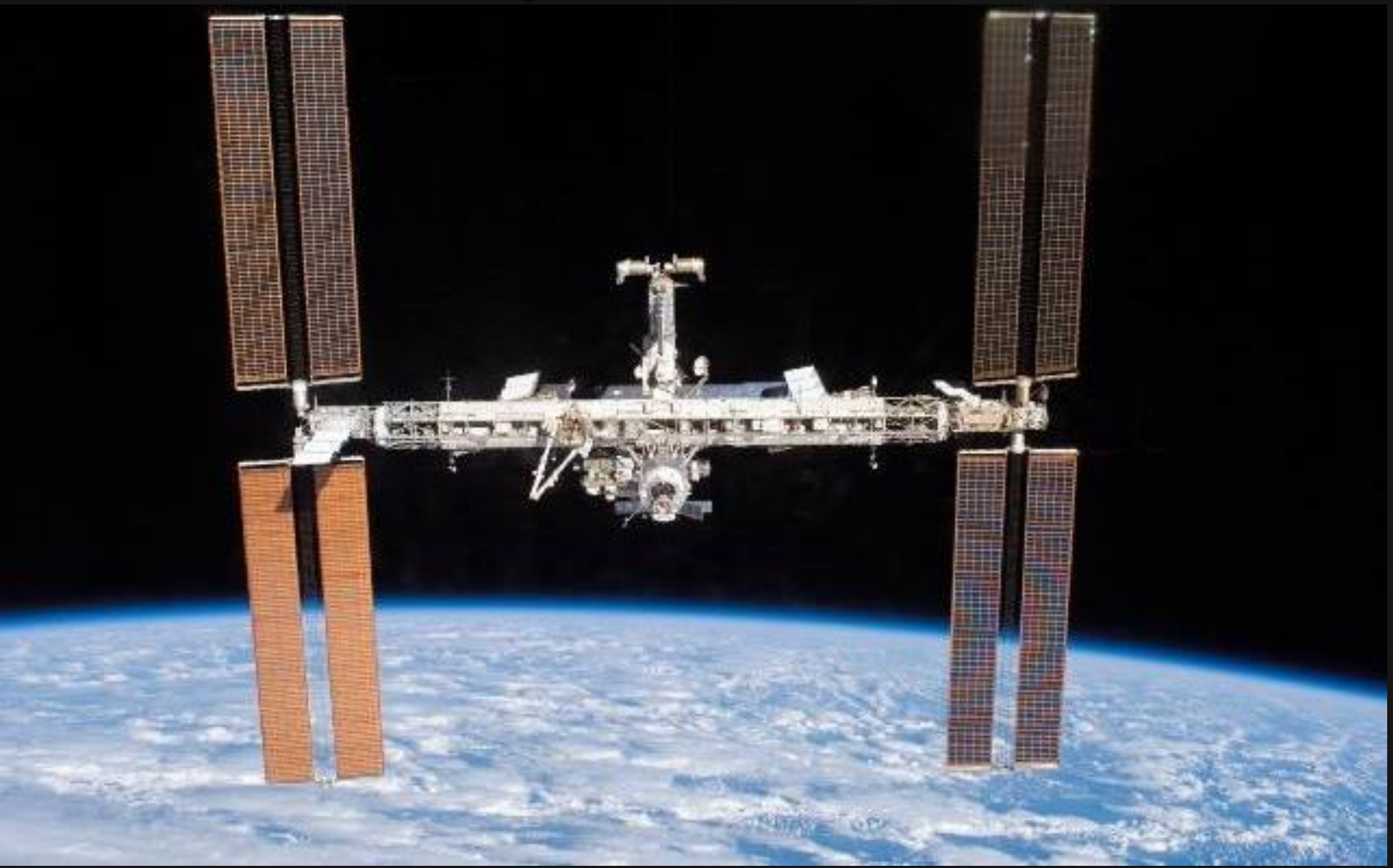


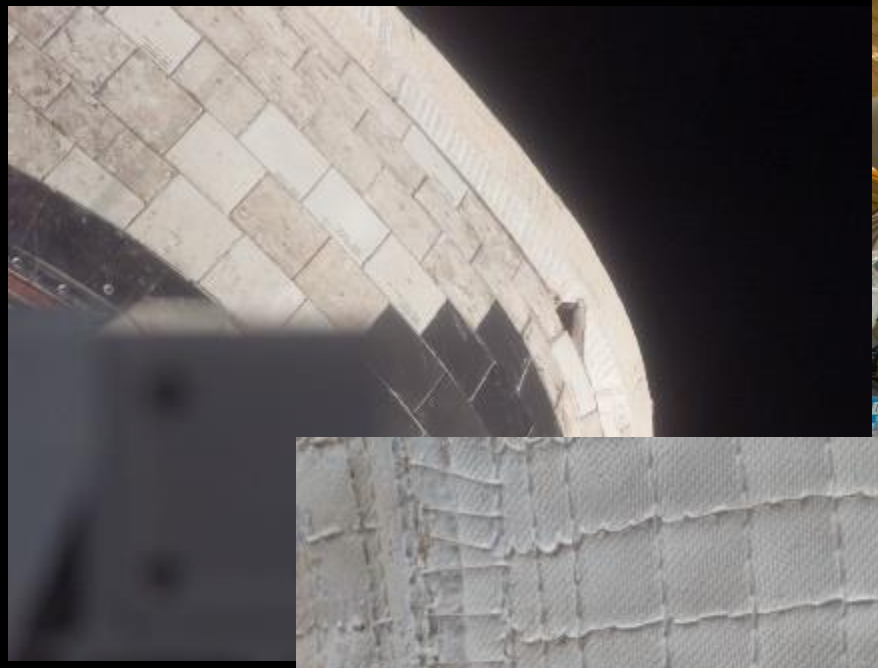
Third Crew:

- STS-89:
- STS-104:
- STS-117: Leaders All – Team Challenges

Install the S3-S4 Truss and Solar arrays

- Faced lots of unanticipated challenges






United States


220 orbits, 5.81 million miles in 13 days,
20 hrs, 12 min. 44 sec.

Three Different Teams: All Successful!

- The Mission is CRITICAL
  - Each has a role required for success
- Fun is contagious and cements the team
  - STS-104, Southwest Airlines
- Train like you fly; fly like you train
  - Make CI part of your training and mission
- Question EVERYTHING
  - If getting relaxed, start checking details
- Continuous Improvement is a lifestyle…
  - CI rests on a foundation of communication


Atlantis

Simple Rules for Great Teams

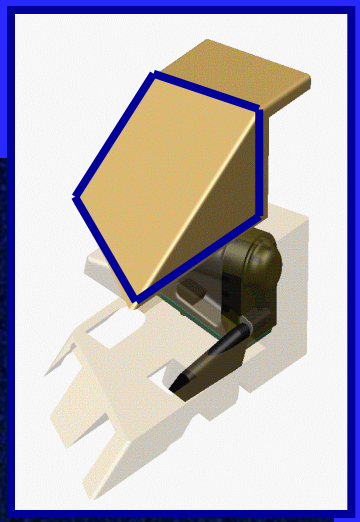
- Know your team
- Know your mission
- Work together for success
- Protect your Margins
- Enjoy the ride!

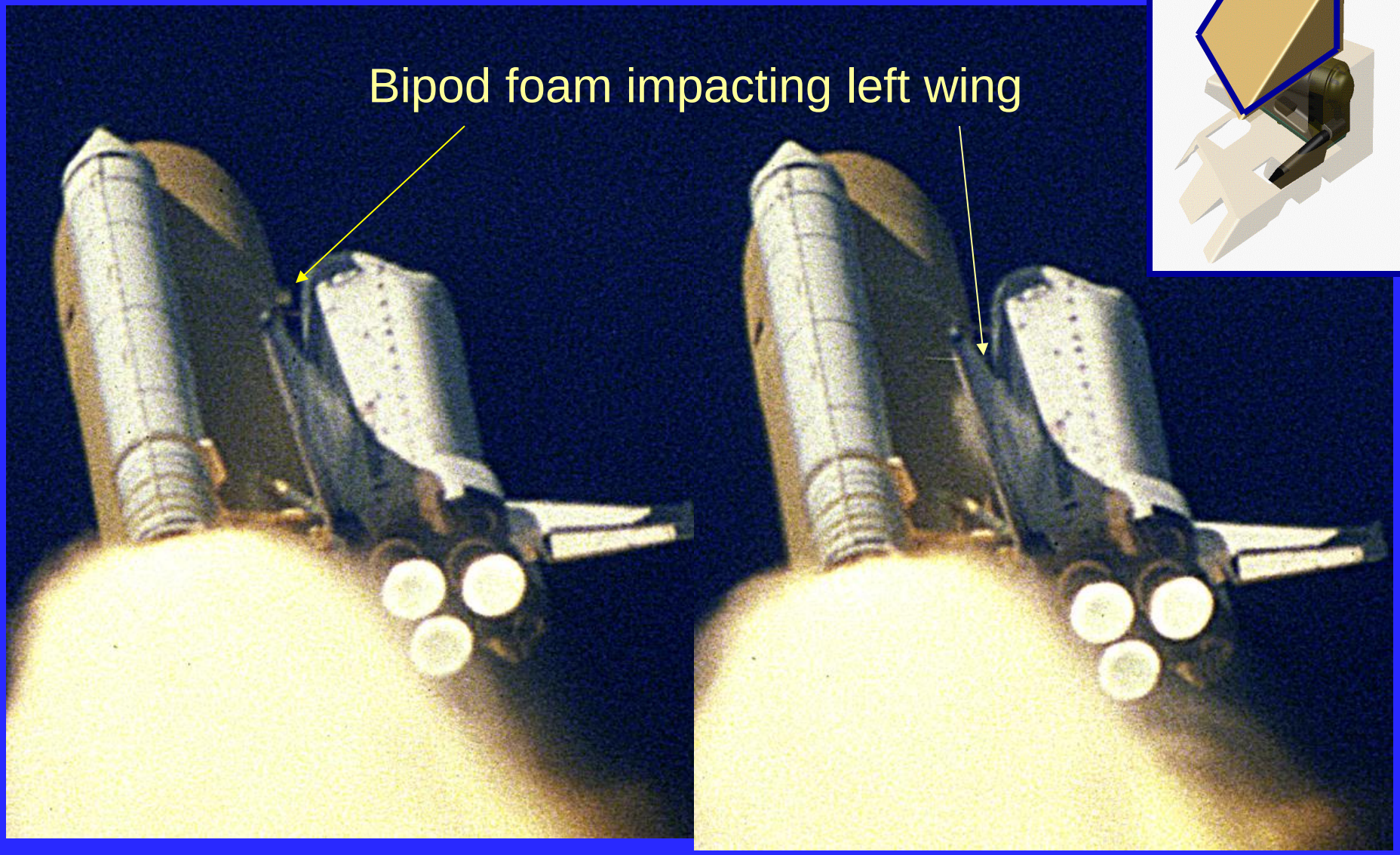
Space Shuttle *Columbia* accident:

Teamwork and Communications Failure Case

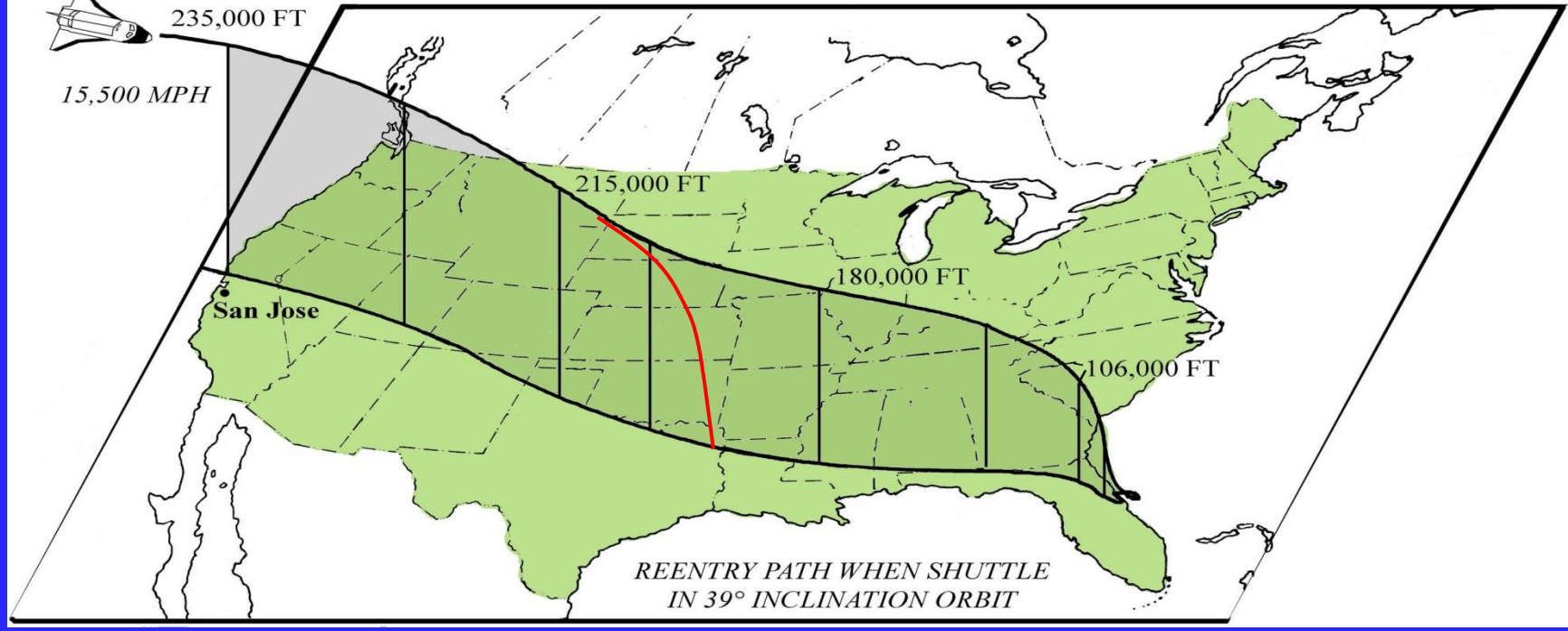

NASA

The bad news: a pound and a half of foam hitting the wing…



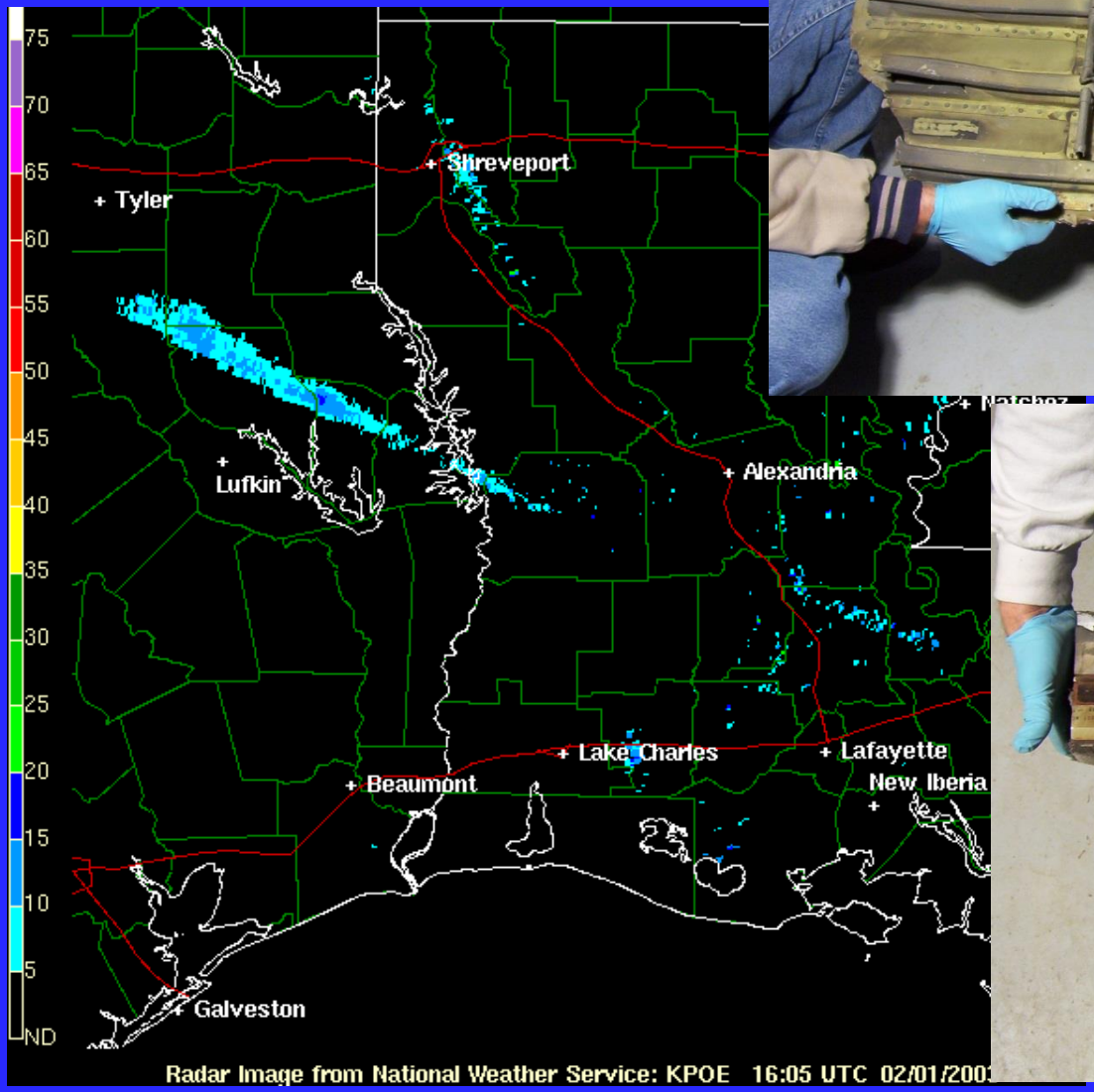


The really bad news: this foam had been shed before and we knew it…


235,000 FT
15,500 MPH
215,000 FT
180,000 FT
San Jose
106,000 FT
REENTRY PATH WHEN SHUTTLE
IN 39° INCLINATION ORBIT


KSC 1st Opportunity...
Deorbit Burn - 7:15 am CST
Landing - 8:16 am CST

What happened?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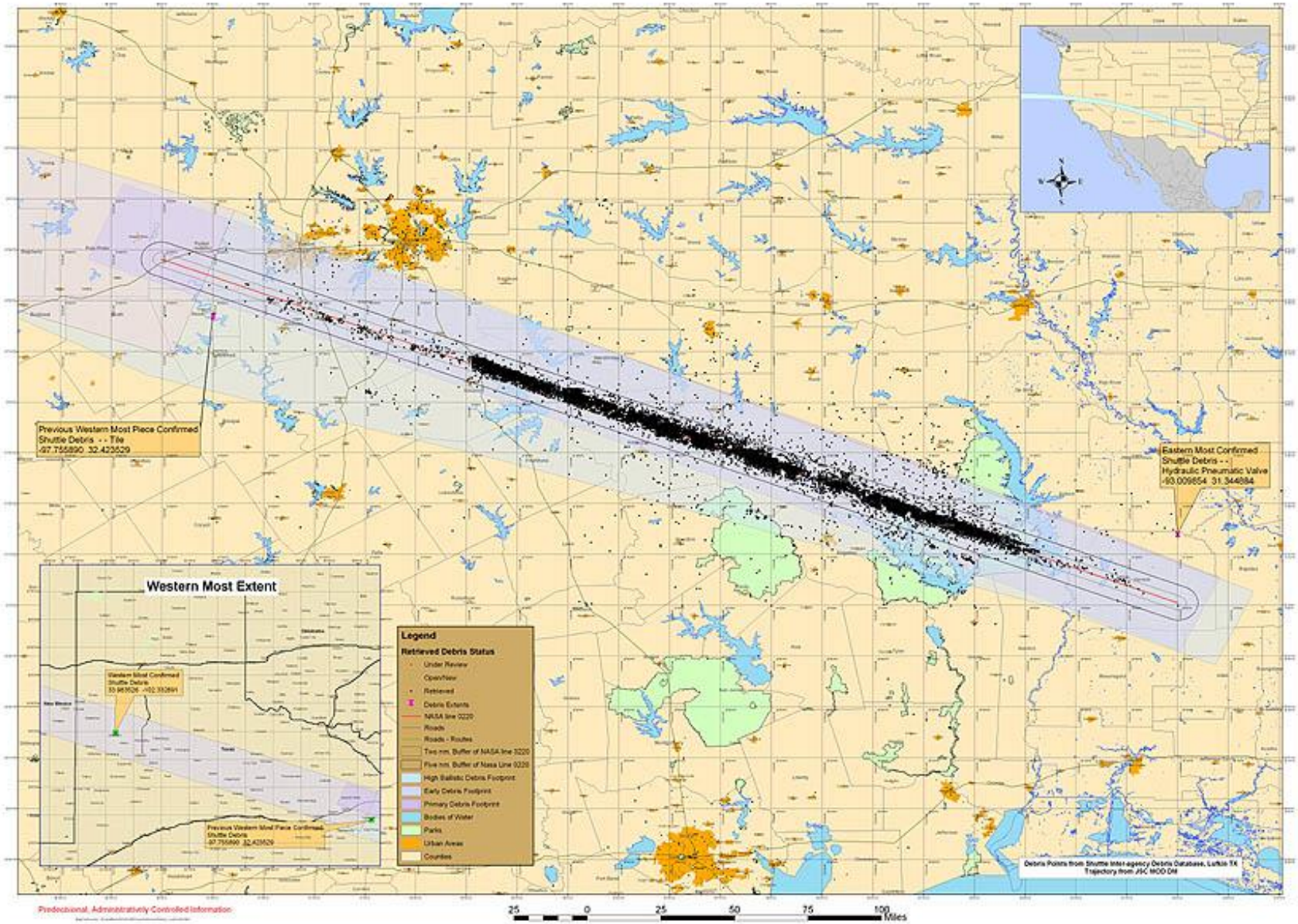
ND
Shreveport
Tyler
Lufkin
Alexandria
Lake Charles
Lafayette
Beaumont
New Iberia
Galveston
Radar Image from National Weather Service: KPOE 16:05 UTC 02/01/200

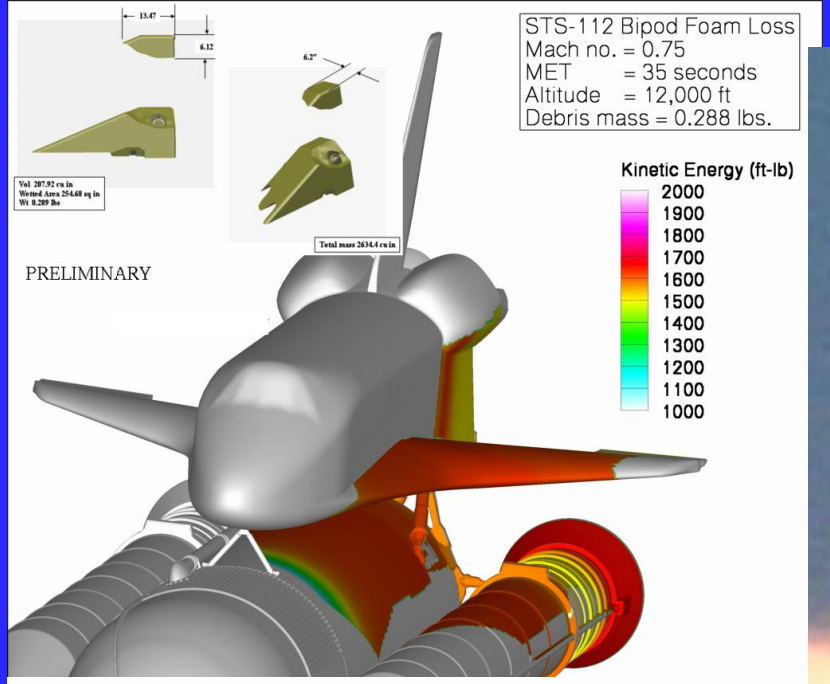
Confirmed Debris - 3/29/03

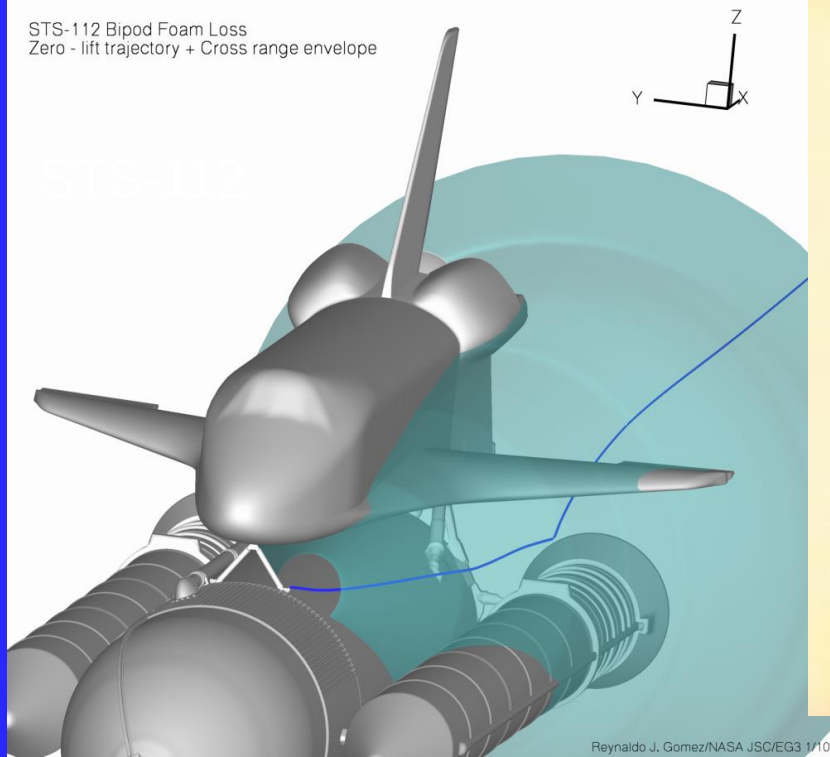


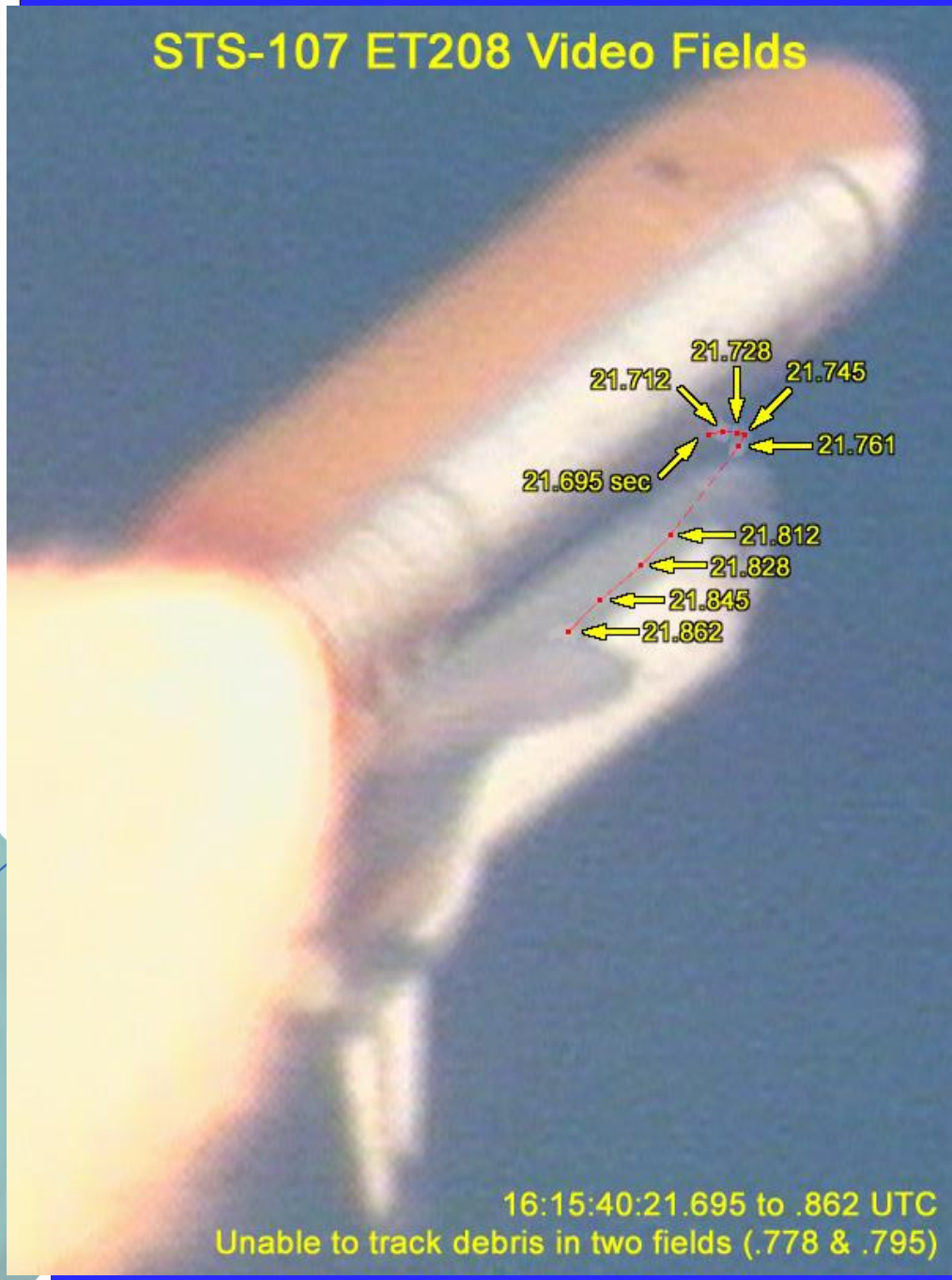
Predecisional, Administratively Controlled Information

First job: find our crew

Second job: find the fault

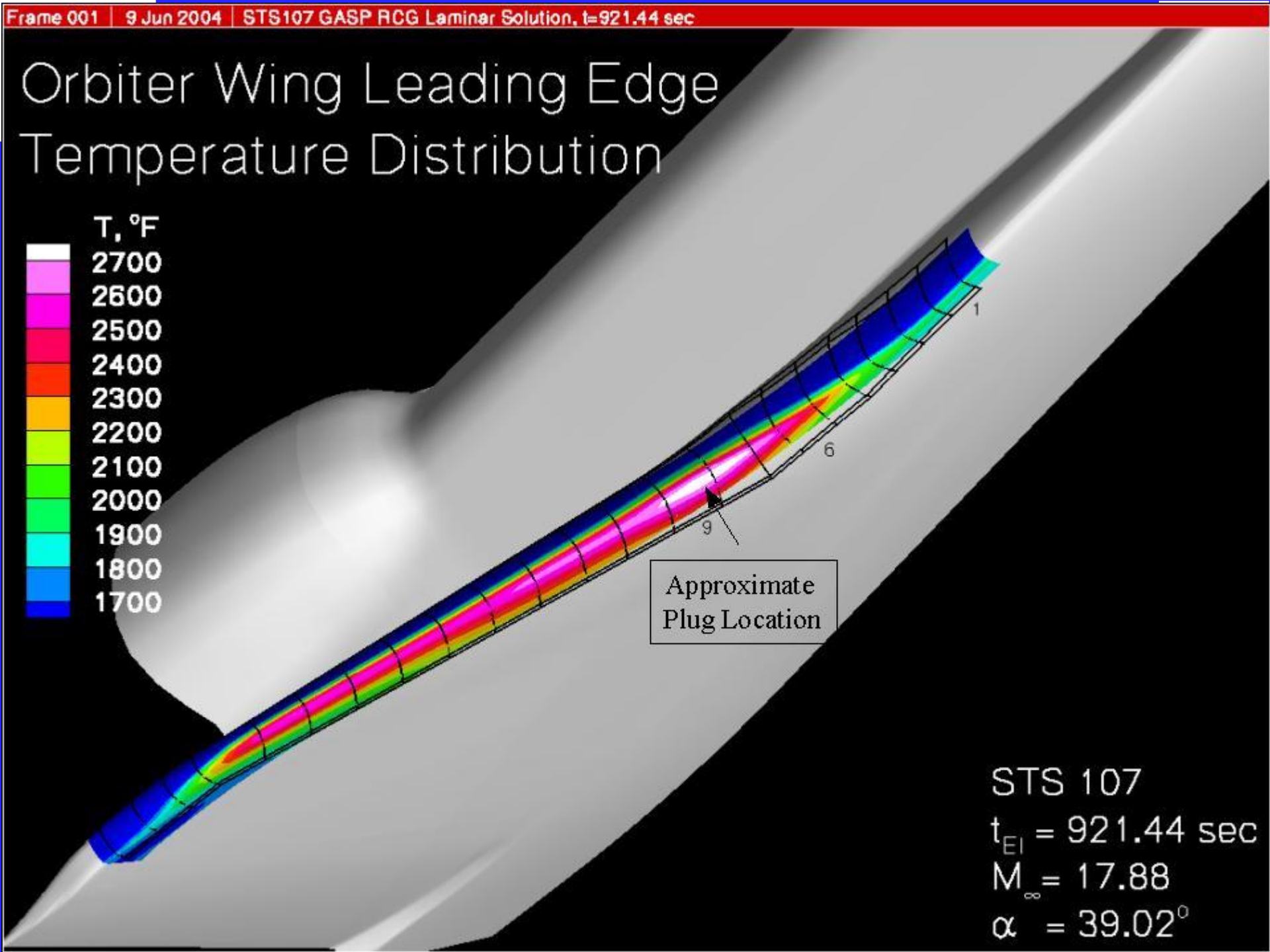






Reynaldo J. Gomez/NASA JSC/EG3 1/10/05

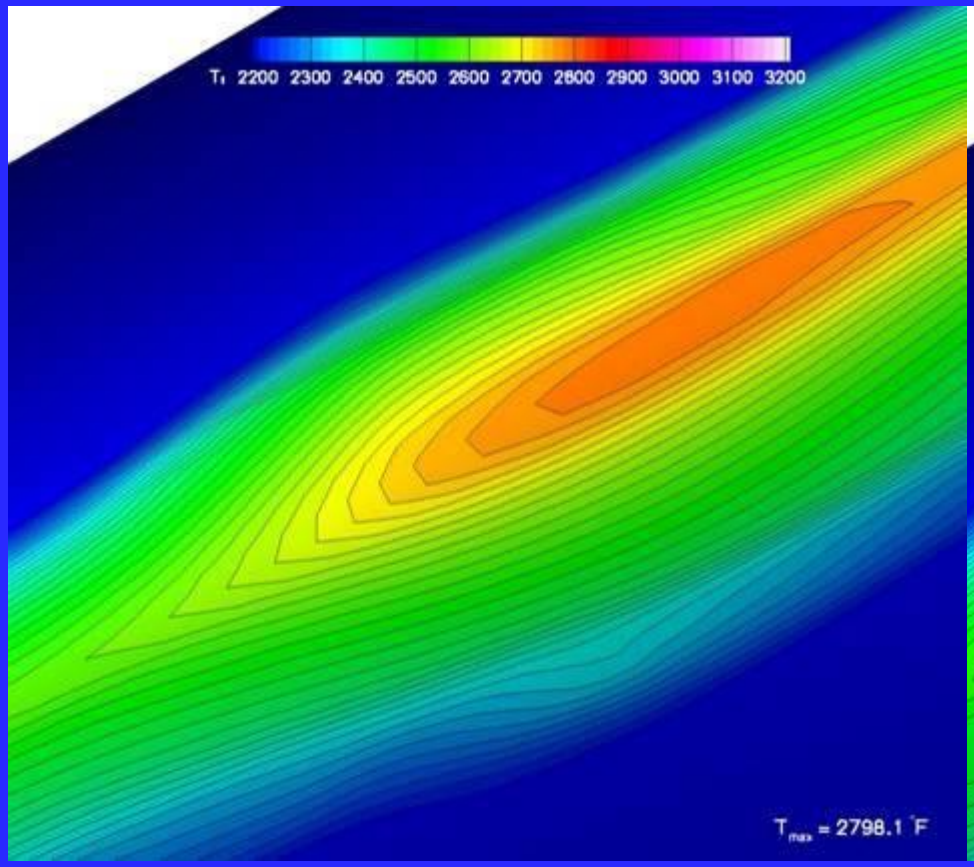
Orbiter Wing Leading Edge Temperature Distribution



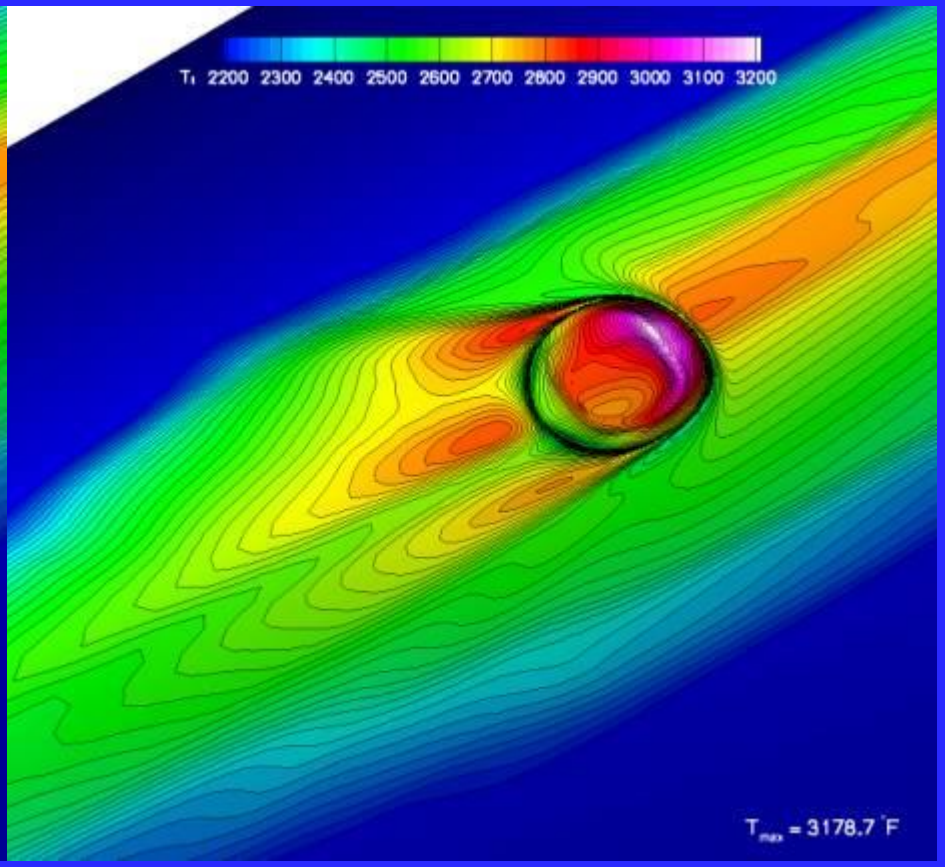
Repair site CFD Solutions
Mach 18 Temperatures

DPLR Alternate Physical Model

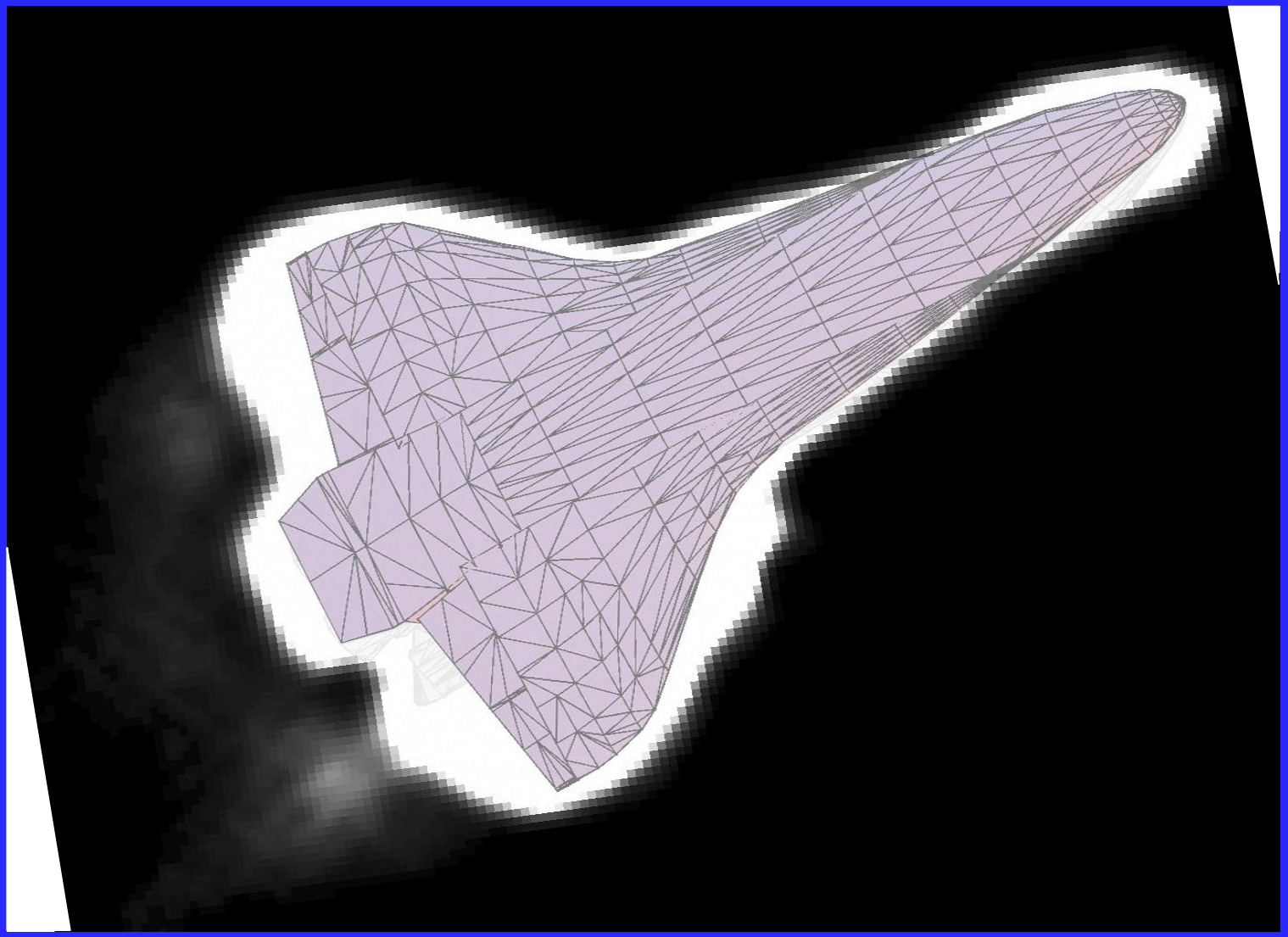
Baseline



Distorted Airflow

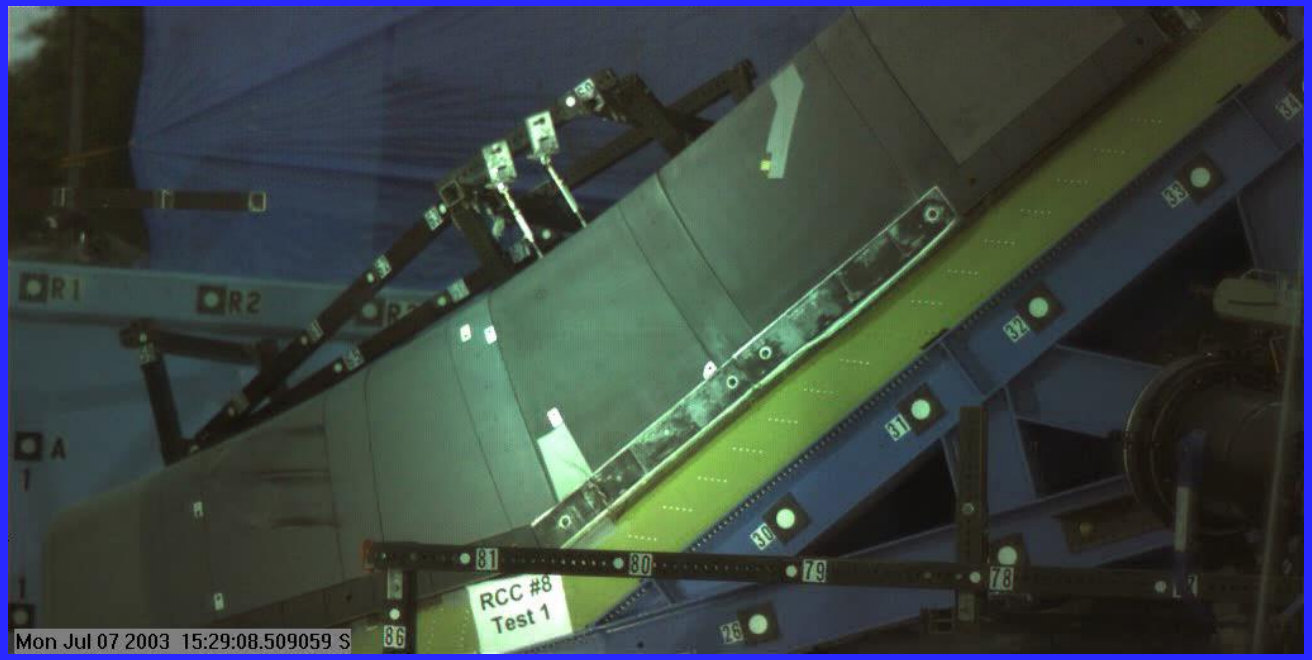


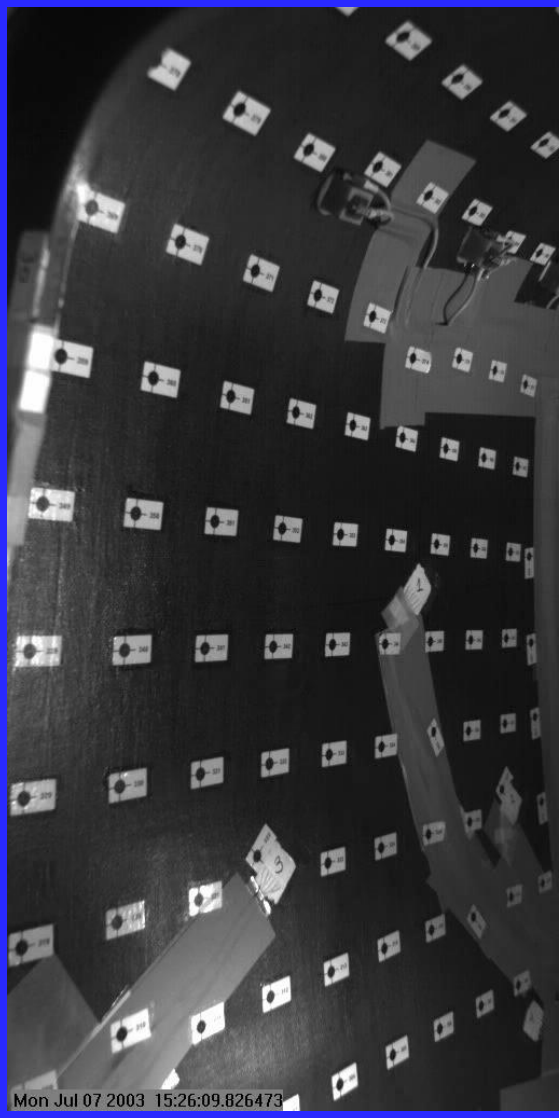
Kirtland Photo Seems to Show a Disturbed Flow Field in Front of the Left Hand Wing



Picture from CAIB (Jim Arnold)

RCC Panel 6 775 fps, 1.5 lbs.-m. Test Video

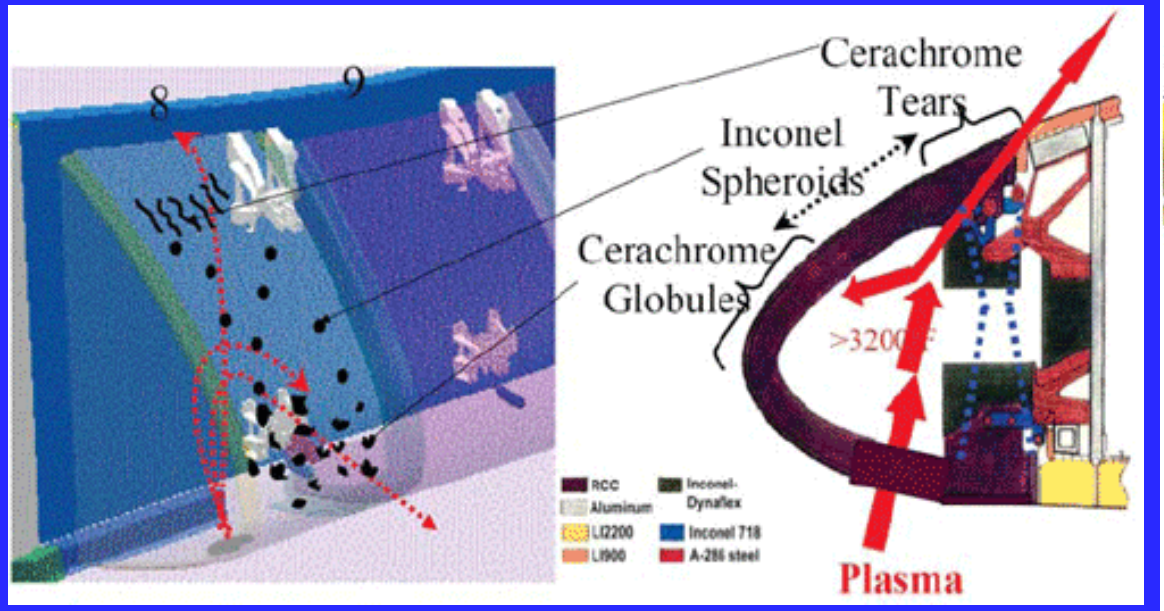




What happened on the day of launch?

How did it happen?

More difficult question…


8
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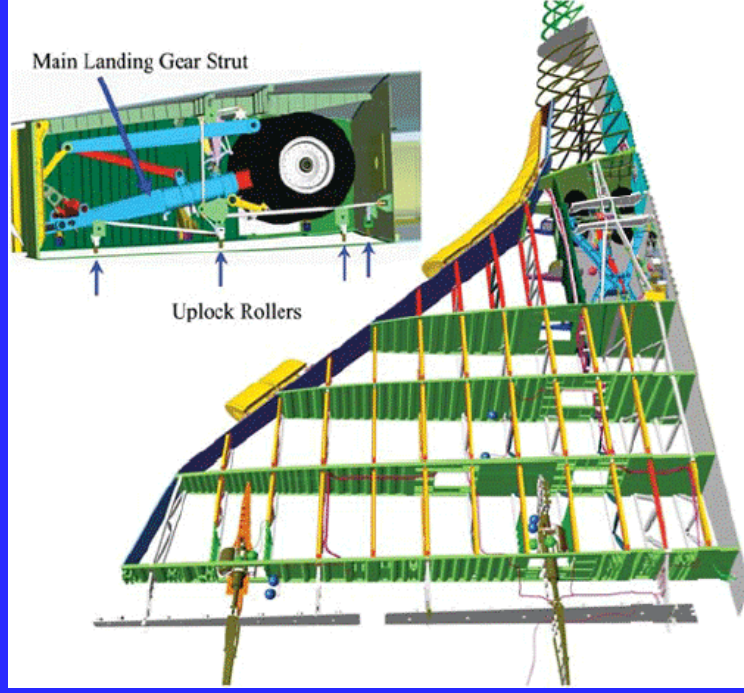
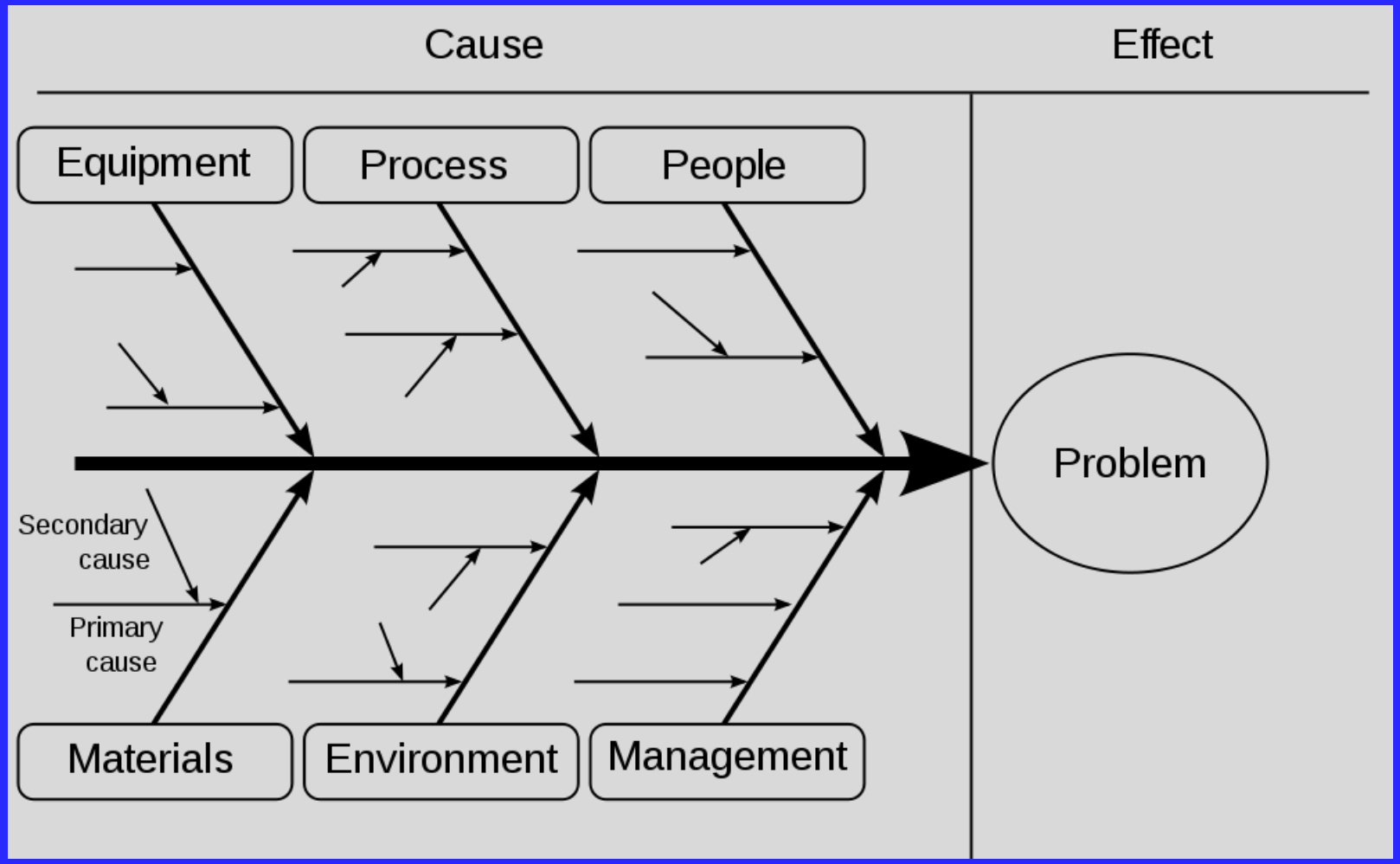
Cerachrome
Tears
Inconel
Spheroids
Cerachrome
Globules
>3200
RCC
Aluminum
LI2200
LI900
Inconel-
Dynaflex
Inconel 718
A-286 steel
Plasma


Main Landing Gear Strut
Uplock Rollers


LH RCC Panels
RCC 8
RCC 9
RCC 5
RCC 6
RCC 7

Columbia reconstruction: not the usual a/c case.

How to begin the failure analysis



Change the decision-making culture

- Move away from the “prove it isn’t safe” to back to the “prove it’s safe”
  - We operate at the ragged edge of physics
  - Every time we forgot this we killed someone
- Overused term: Empower…but it is applicable
  - Make sure everyone is heard
  - Don’t let the desire to “check the box” drive your decision
- Remember that schedules are only a guideline
- Listen to your troops!!
- ***Listen to your troops!!***

Apollo 1
January, 1967

Challenger,
January 1986


UNITED
STATES

Basics of a good Team:

- ✓ Belief
- ✓ Trust
- ✓ Respect
- ✓ COMMUNICATION!

INTEGRITY!