



National Transportation Safety Board

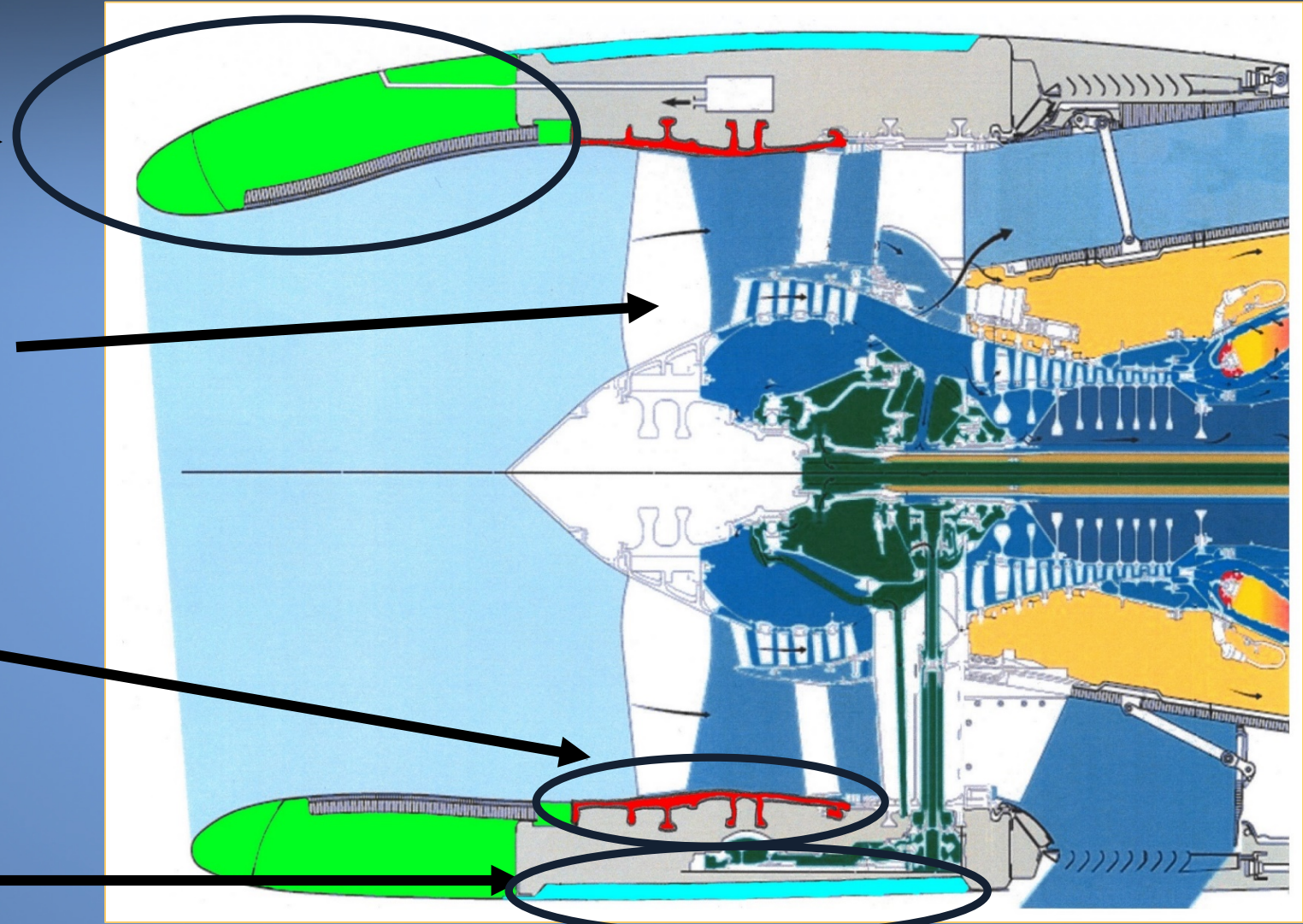
Left Engine Failure and
Subsequent Depressurization
Southwest Airlines Flight 1380
Boeing 737-700
Philadelphia, Pennsylvania
April 17, 2018

Powerplants and Materials
presentation

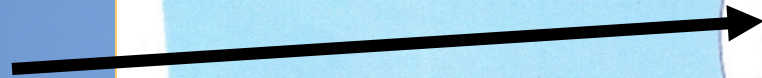


Engine and Nacelle Cross-Section

Inlet



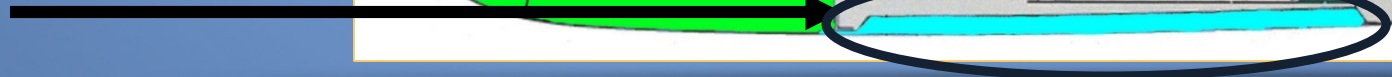
Fan blade (x24)



Fan case



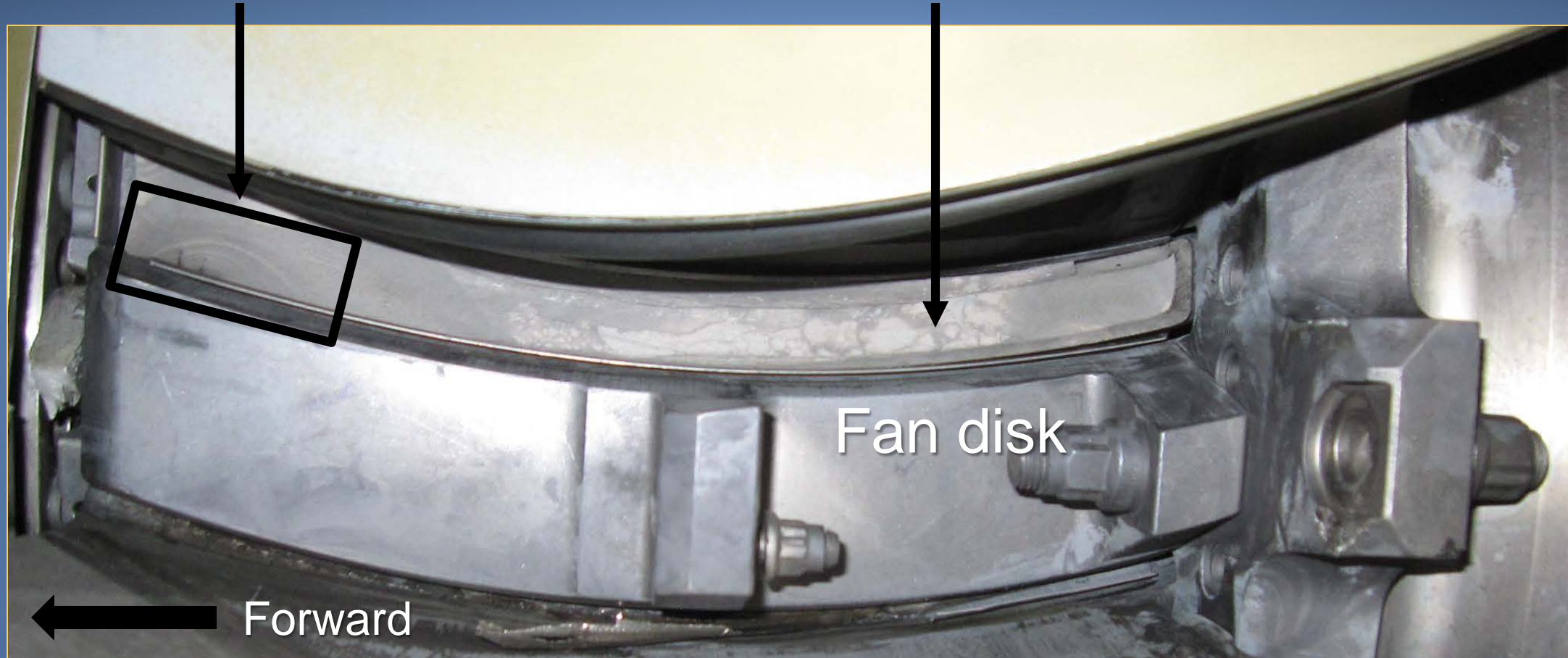
Fan cowl



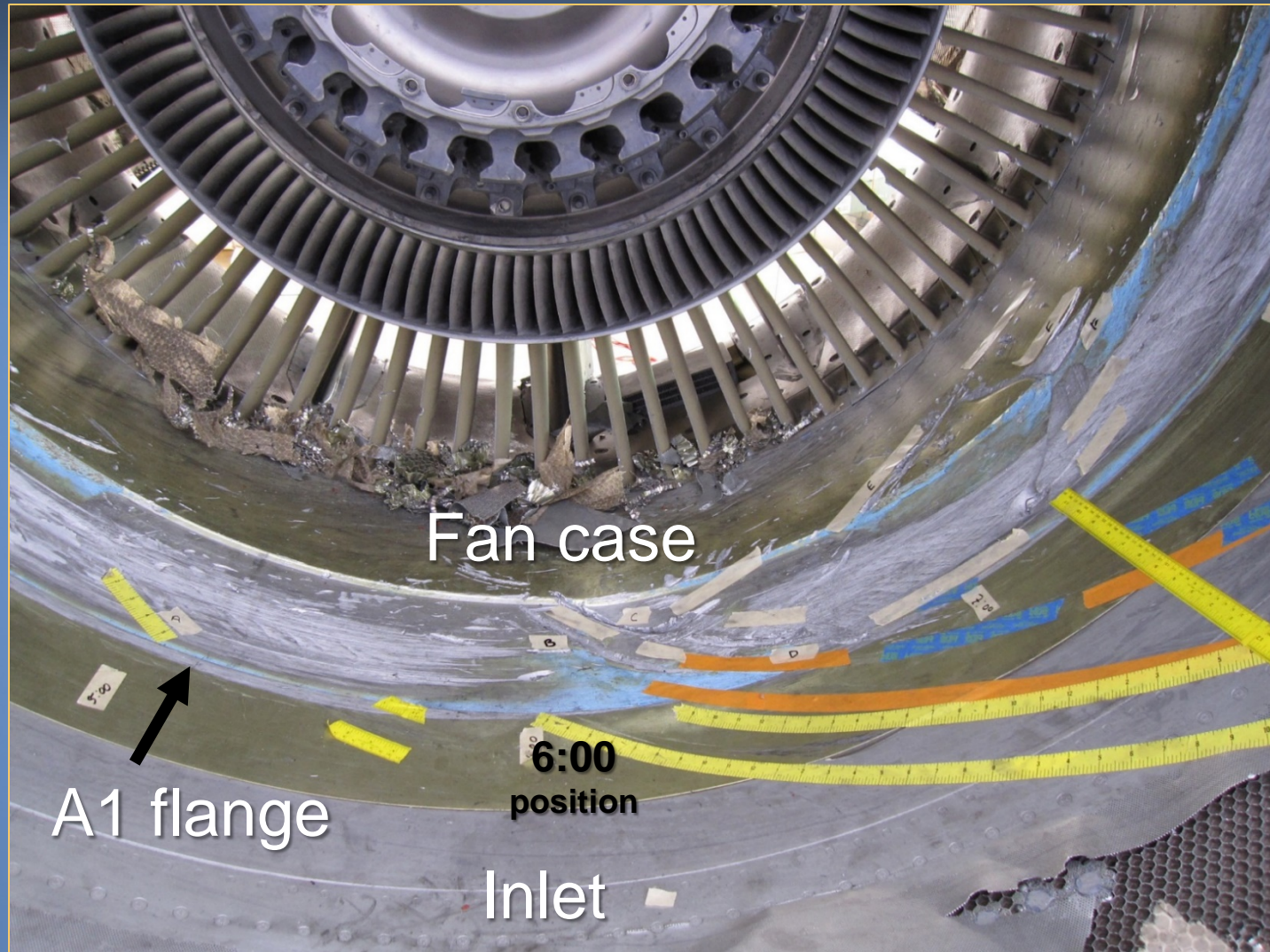
Failed Fan Blade

Fatigue crack

Fractured fan blade dovetail



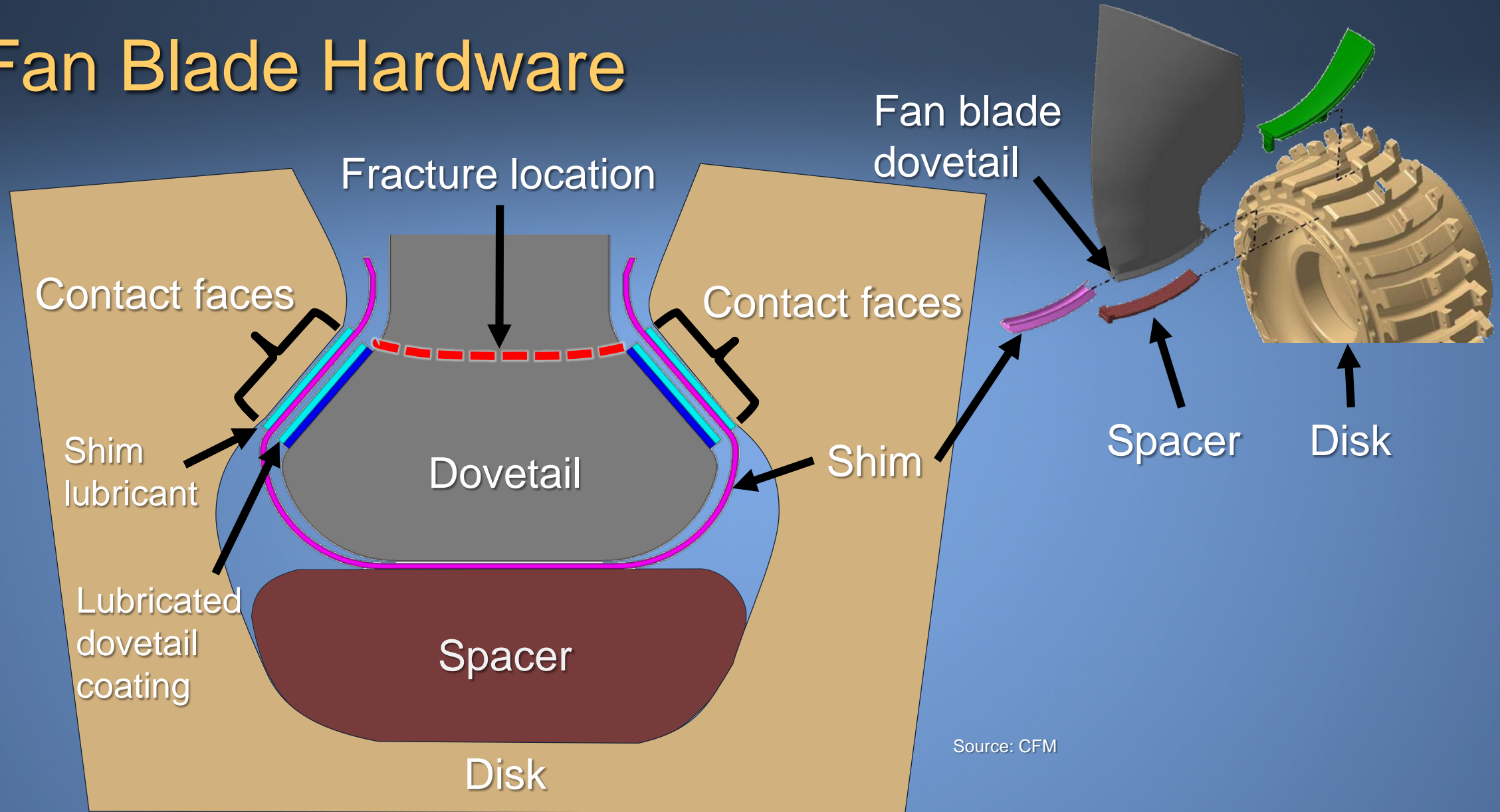
Fan Case and Inlet Damage and Blade Fragment Trajectories



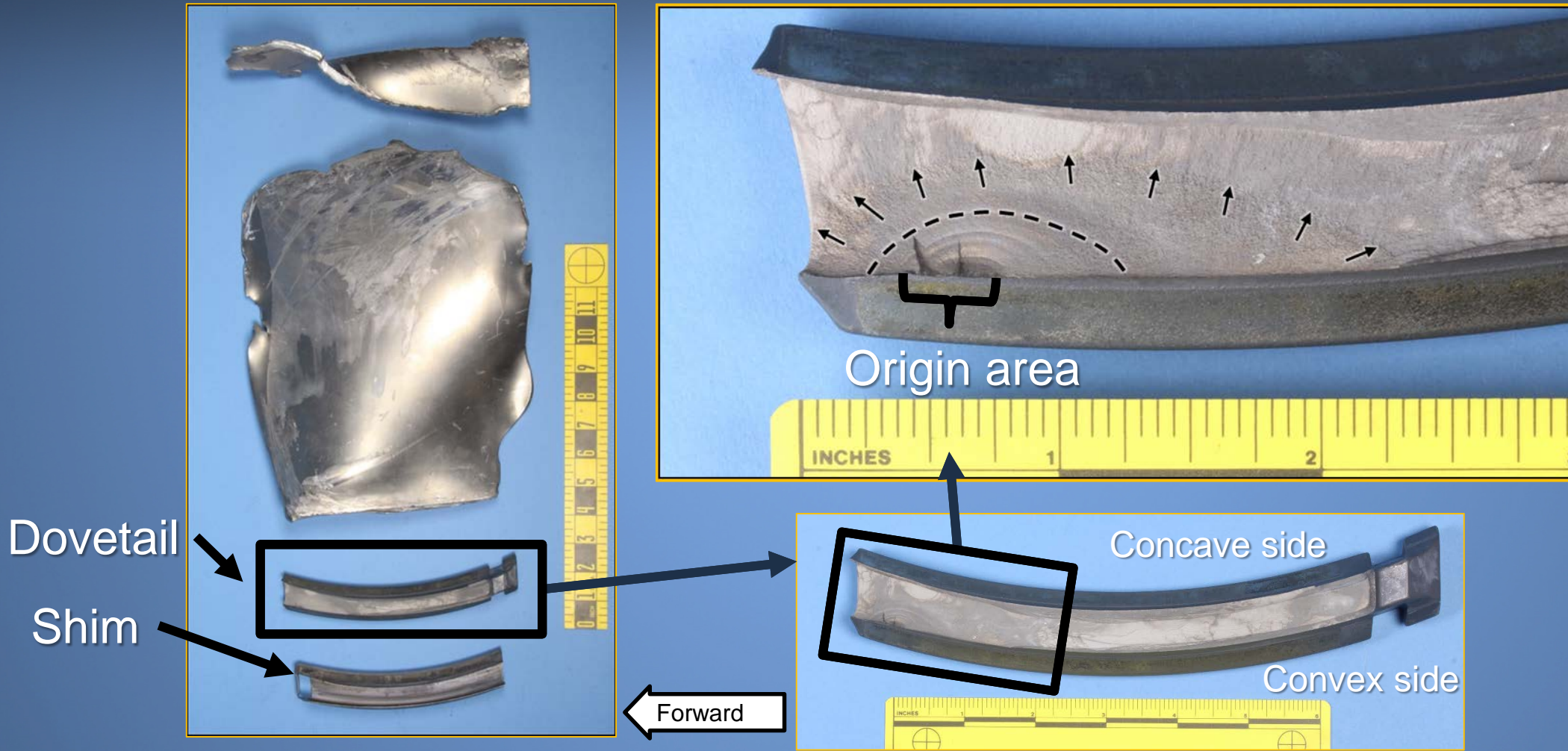
Fan Blade Operational, Inspection, and Repair History

- Fan blades manufactured in 2000 and installed in 2001
- Fan blade set accumulated 32,636 cycles since new
- Overhauled in March 2004 and September 2012
 - Visual and fluorescent penetrant inspections (FPI) performed with no cracks founds
- CFM-recommended relubrication every 3,000 flight cycles
- Southwest Airlines relubed accident fan blade set more frequently

Fan Blade Hardware



Fatigue Fracture



Likely Cause of Fatigue Crack Initiation

- Dovetail stresses greater than expected
- Dovetail coating damage and thickness variations
- Pressure face friction and edge loading
- Loss or relaxation of compressive residual stress

Fatigue Crack Growth

- One fatigue striation approximates one flight cycle
- Estimated 20,000 flight cycles total crack growth
- 10,712 flight cycles since last overhaul
- Crack likely not detectable by FPI at last overhaul or by visual inspections at relubrication

Overhaul Shop Corrective Action

- Two new nondestructive inspection techniques developed to detect dovetail cracks: eddy current inspection (ECI) and ultrasonic testing (UT)
- ECI requirement added in November 2016
- ECI performed with dovetail coating removed (FPI still required)



On-Wing Corrective Action

- UT introduced by CFM in March 2017
 - On-wing inspection with coated dovetail
- FAA and EASA issued total of 10 airworthiness directives mandating on-wing UT inspections



Additional Corrective Actions and Inspection Results

- Relubrication interval reduced from 3,000 to 1,600 flight cycles
- Fleet and shop inspections confirmed 15 additional cracked fan blades
- Cracks found with both ECI and UT and across multiple operators
- Total number of CFM56-7B cracked fan blades: 23



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