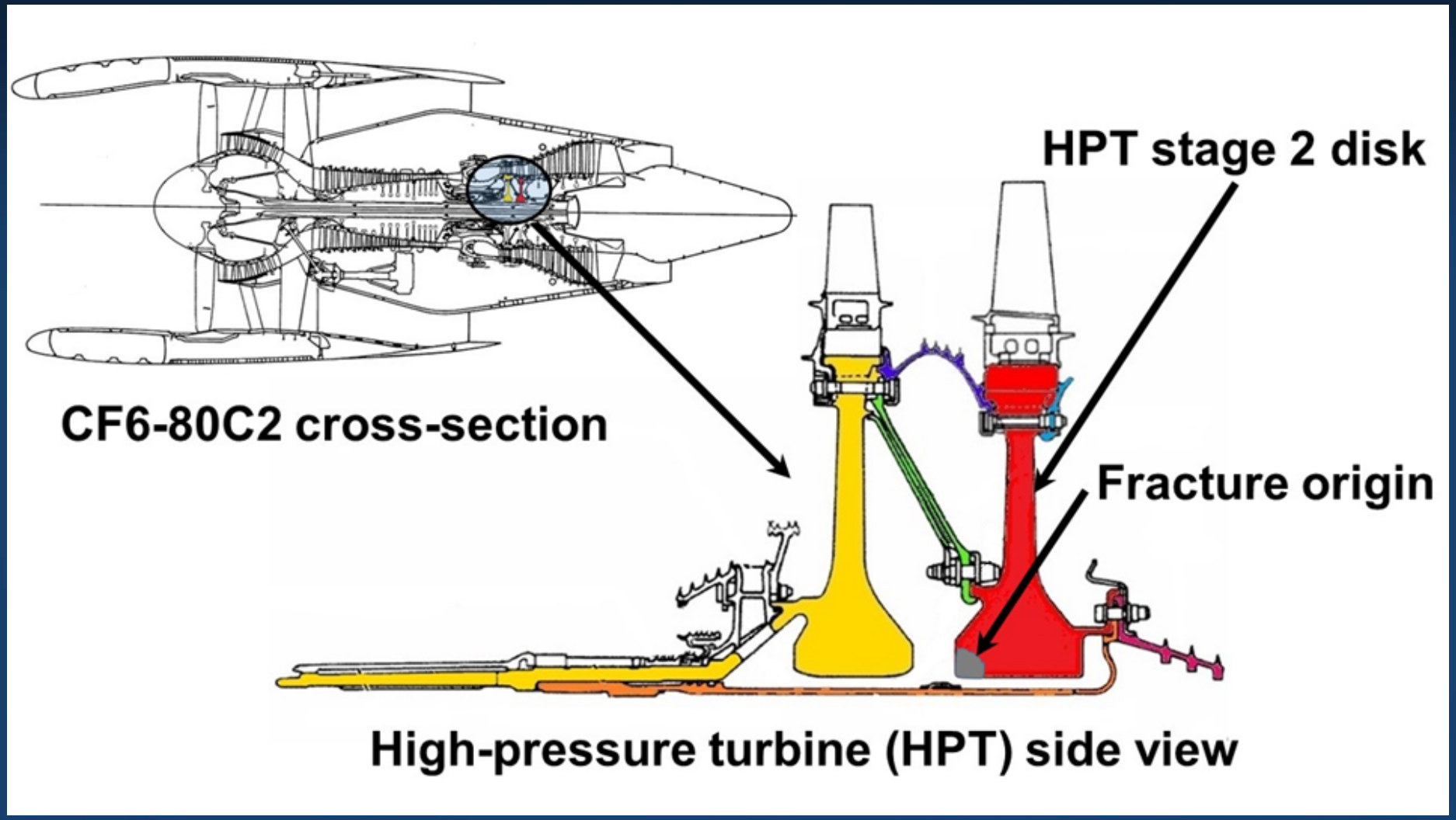
National Transportation Safety Board

Uncontained Engine Failure and Subsequent Fire
American Airlines Flight 383
Chicago, Illinois
October 28, 2016

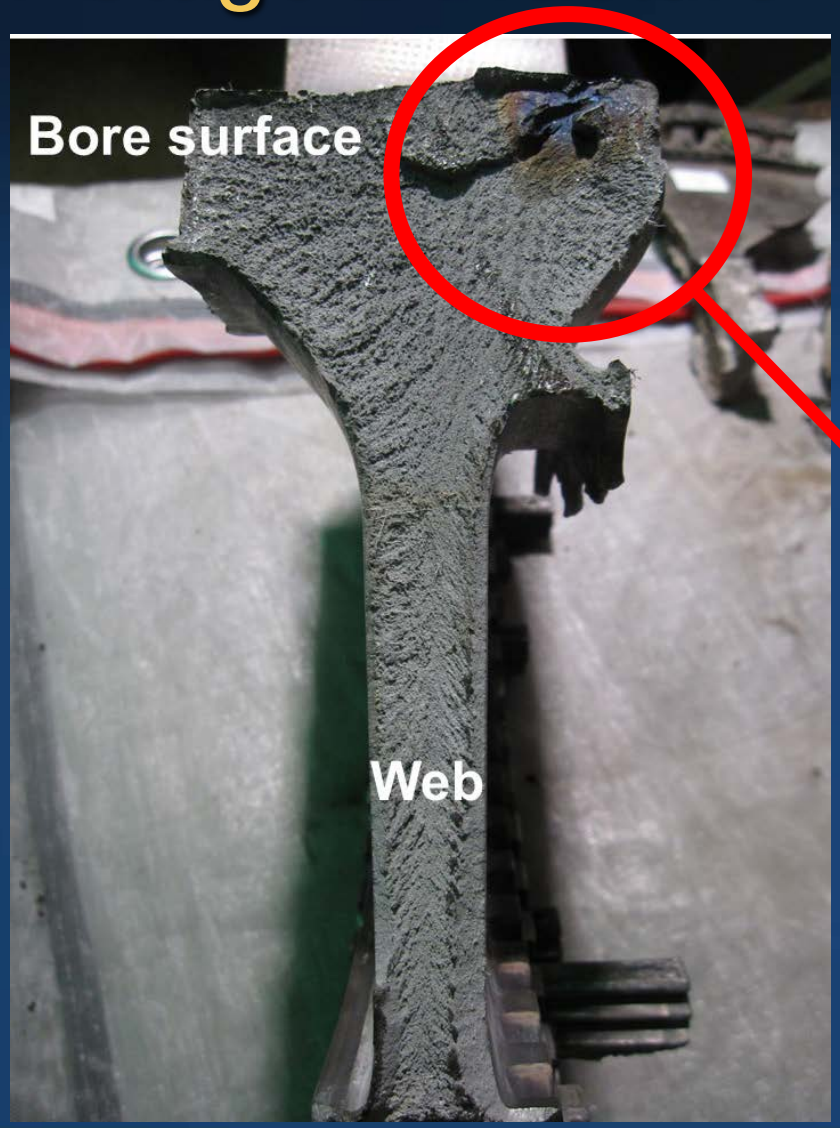
Powerplants and Metallurgy

presentation

Accident Engine Model

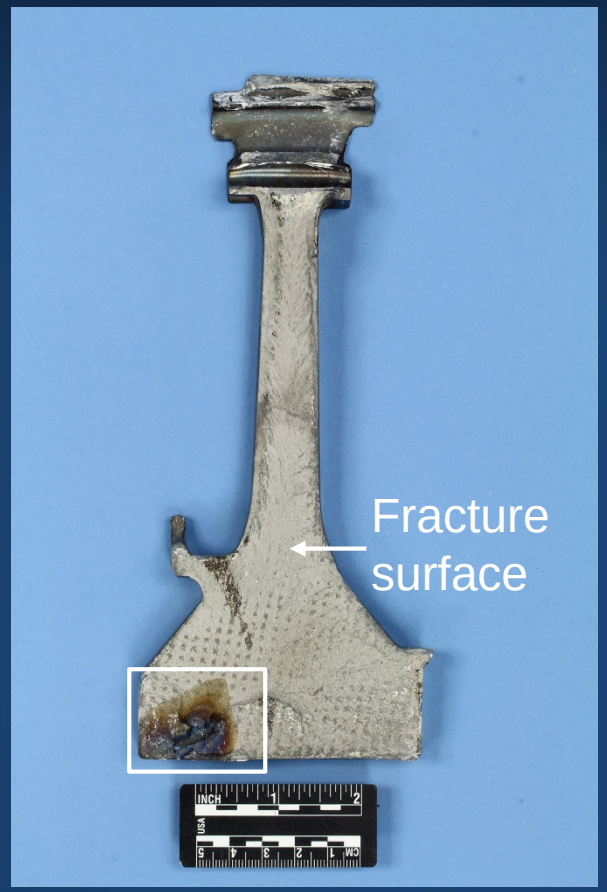


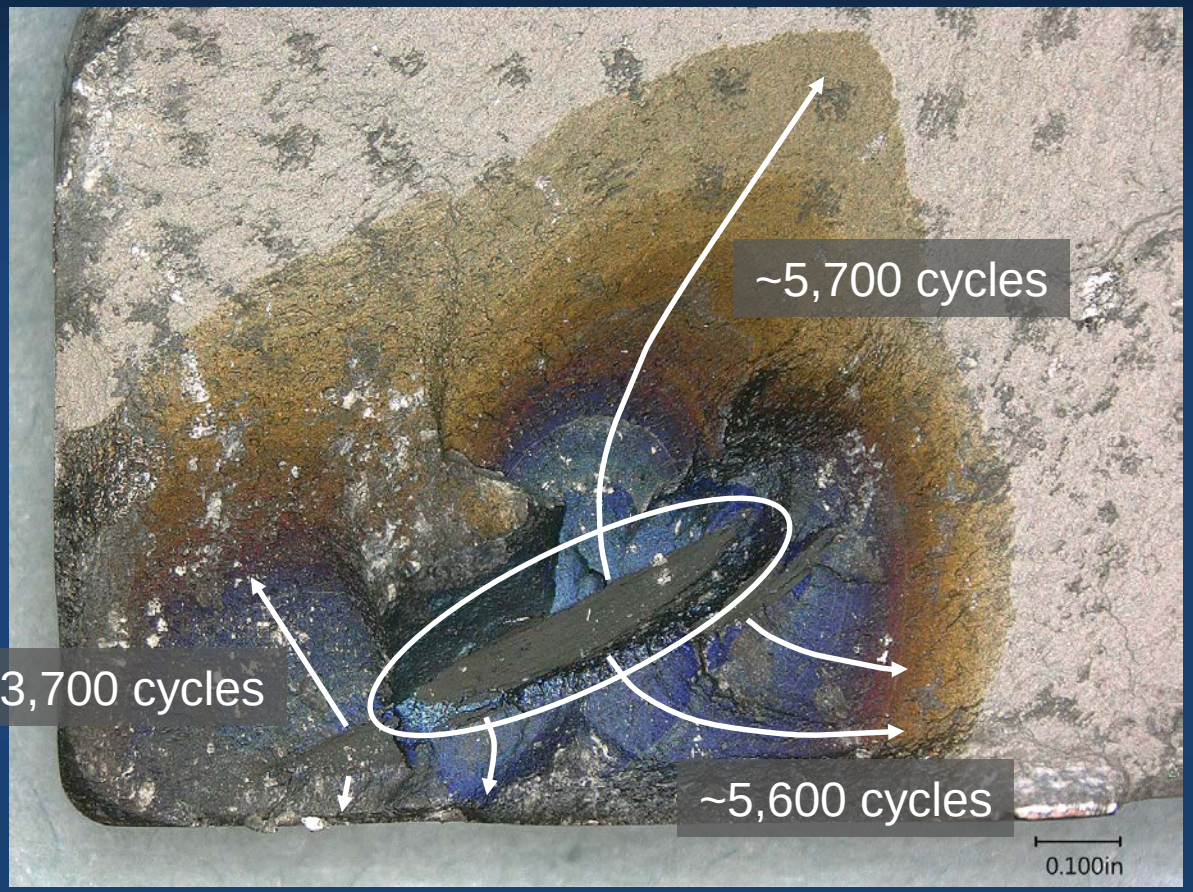
HPT Stage 2 Fracture



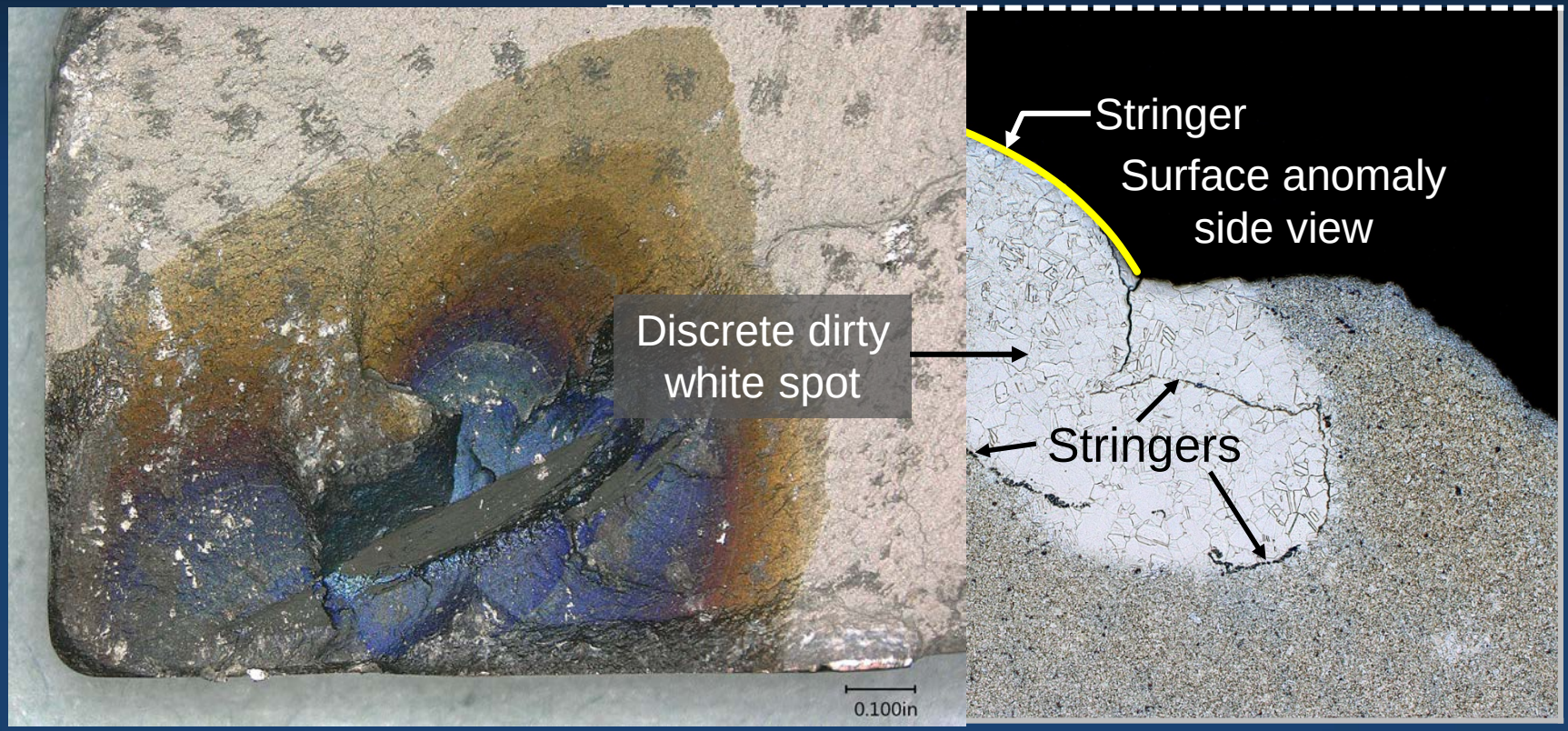
- Internal defect found near bore
- NTSB Materials Laboratory performed examination

Initiation at Internal Anomaly by Low-Cycle Fatigue





Metallurgical Characterization of Anomaly



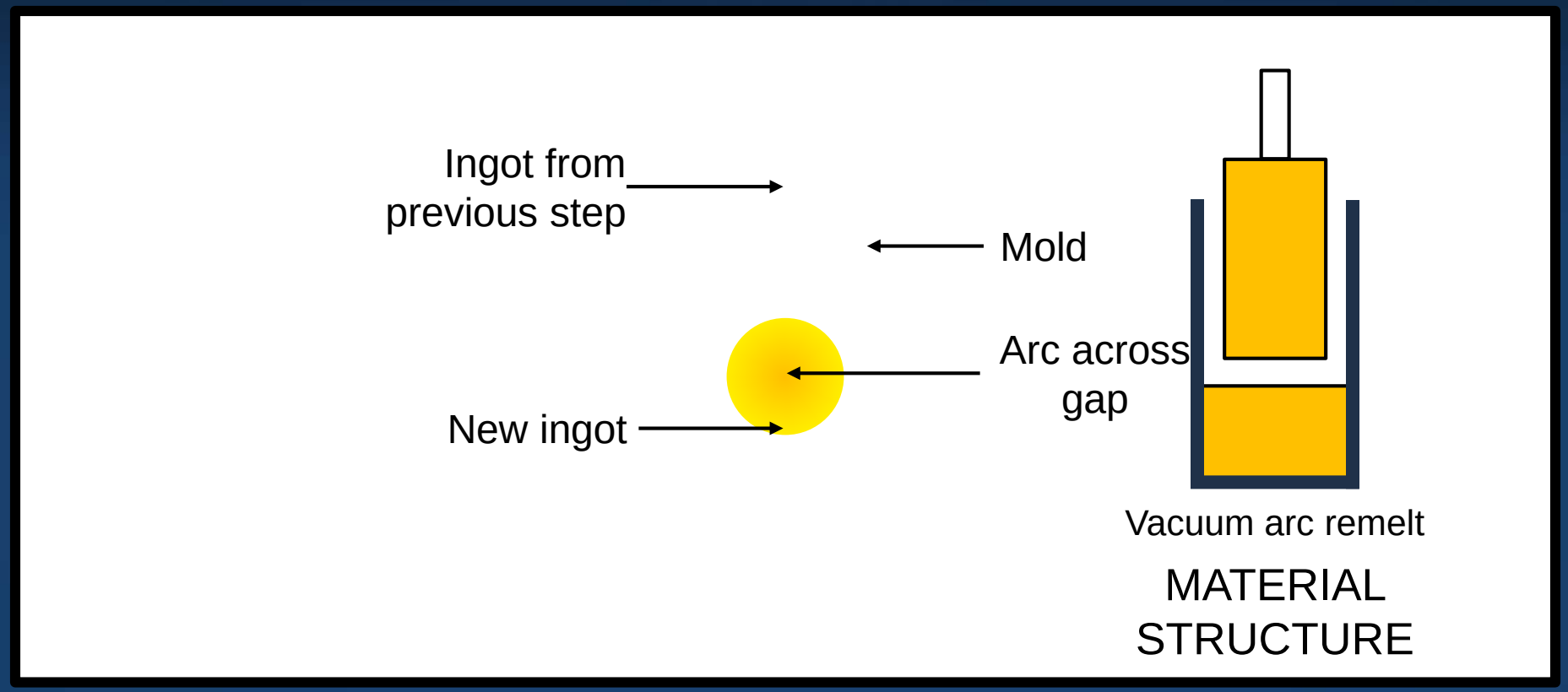
Top-down view

Cross-section view

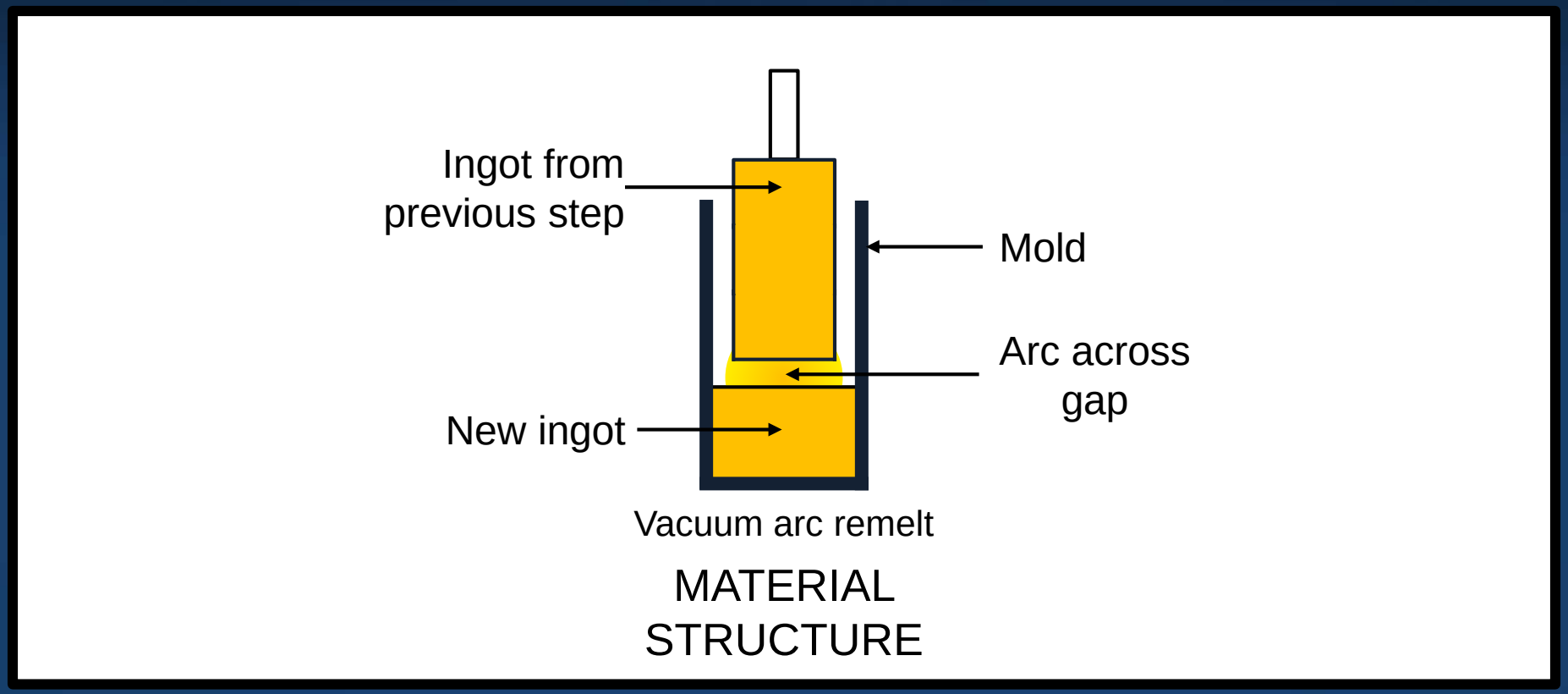
Stage 2 Disk Material

- Triple-melt nickel-based alloy made by ATI Specialty Materials in 1997
- Triple-melt material used by GE and other engine manufacturers
- Same triple-melt process still in use

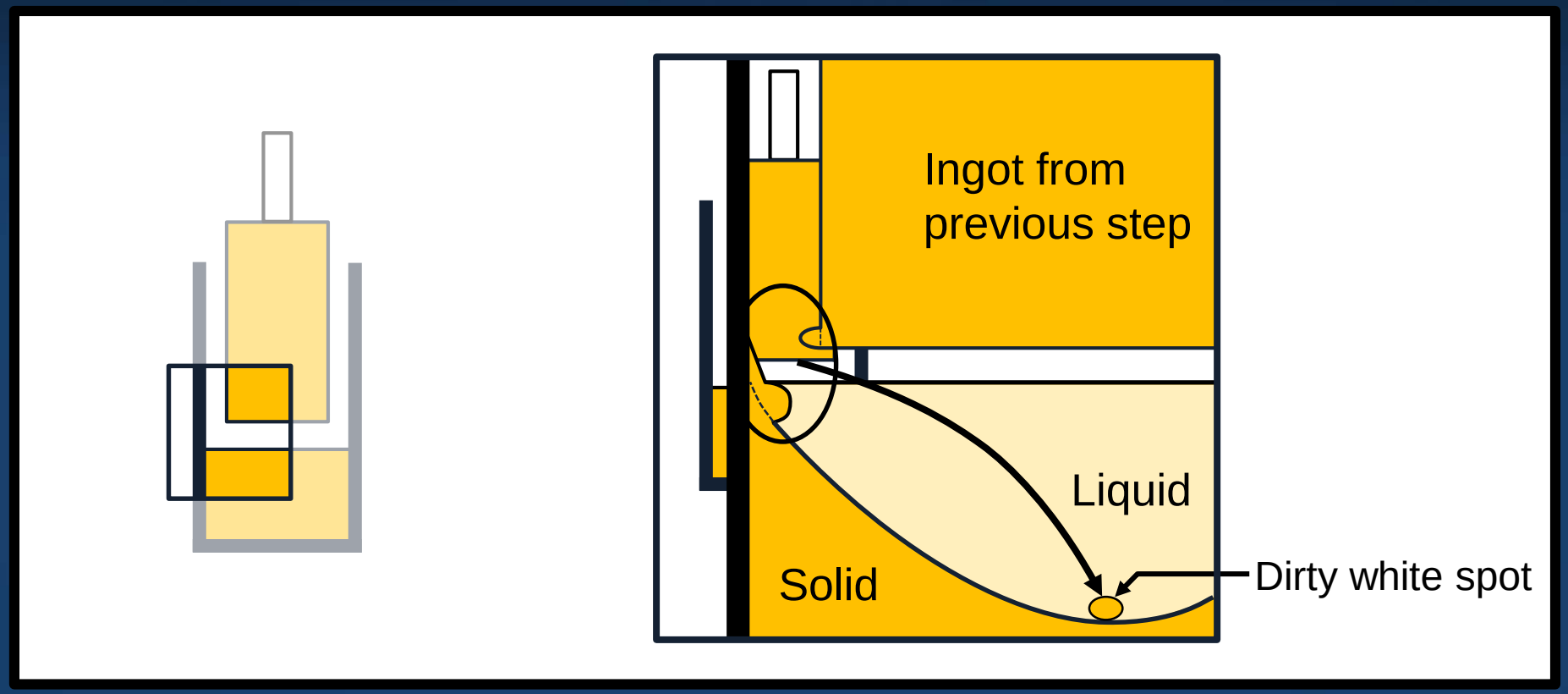
Triple-Melt Process for Nickel Alloy Ingot



Triple-Melt Process for Nickel Alloy Ingot



Formation of Dirty White Spot

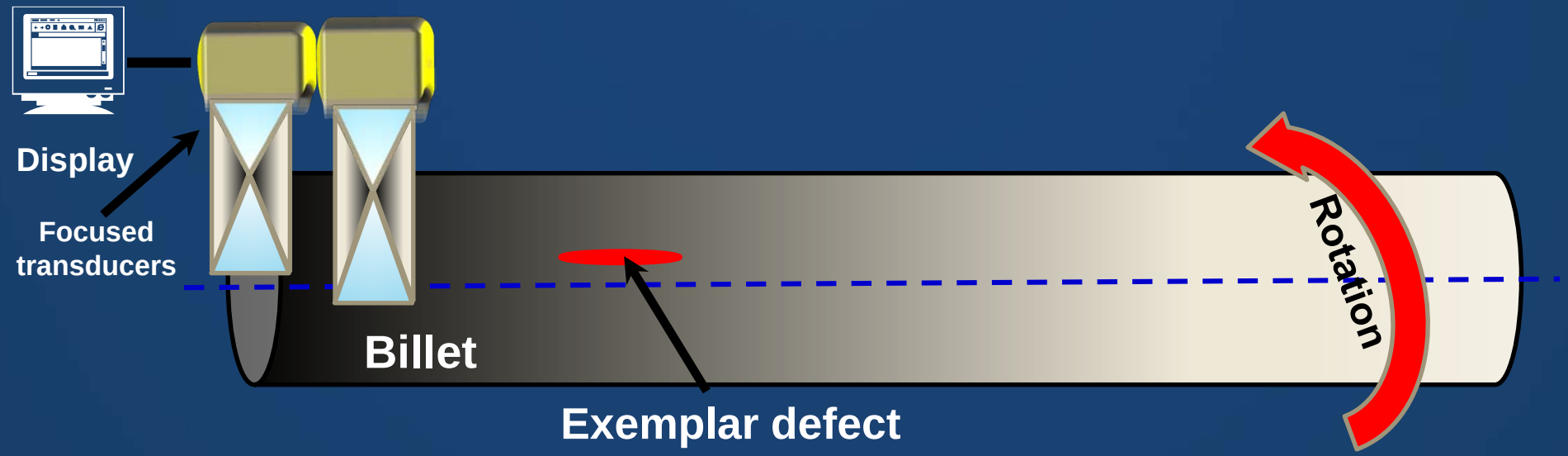


Dirty White Spot Formation and Detection

- No discrepancies found in production records
- Dirty white spots known to reduce low-cycle fatigue life
- Typically detected by ultrasonic inspection

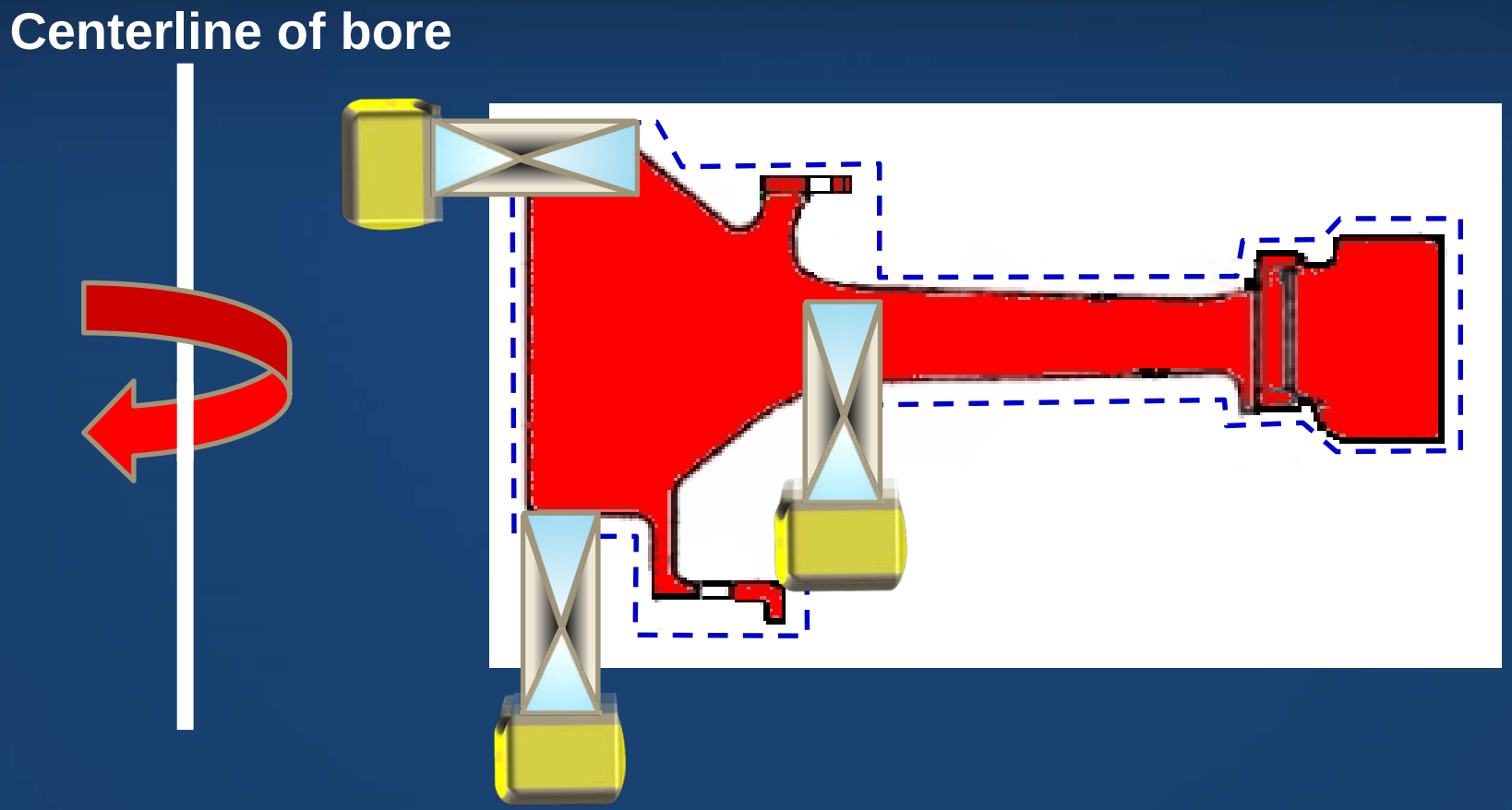
HPT Stage 2 Disk Inspections

- Event disk subjected to four inspections - two production and two in-service
- Production inspections - immersion ultrasonic inspections
  - Excellent for subsurface detection
  - Billet inspected by ATI Specialty Materials; no defects reported



HPT Stage 2 Disk Inspection History

- “Sonic shape” inspected by MTU using combination of scanning techniques; no defects reported



HPT Stage 2 Disk Inspection History

- American Airlines (AA) performed fluorescent penetrant and eddy current nondestructive inspections
  - No defects in bore reported
  - Inspections are surface based; defect was subsurface
  - Internal cracks had not reached surface when AA inspected disk
  - Cracks should have been detectable with subsurface inspection techniques

Corrective Actions Taken

- All aviation parts made from same material as failed disk removed from service; no defects reported
- Service bulletins (SB) calling for ultrasonic inspections of all CF6-80A/C2 HPT stage 1 and 2 disks produced before 2000
- Notice of proposed rulemaking to mandate inspections in SBs

Uncontained Engine Failure Design Considerations

- Advisory Circular (AC) 20-128A issued in March 1997 in response to NTSB recommendations
- AC provides guidance for minimizing hazards from uncontained engine failures
- More than 40 uncontained rotor burst events have occurred since AC 20-128A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