ATTACHMENT 3

AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

DCA16FA217

CFM CFM56-7B ESN 874112 event – Fragment Trajectory Analysis, dated October 28, 2018

The Power of Flight

CFM56-7B Southwest ESN874112 event Fragment trajectory analysis

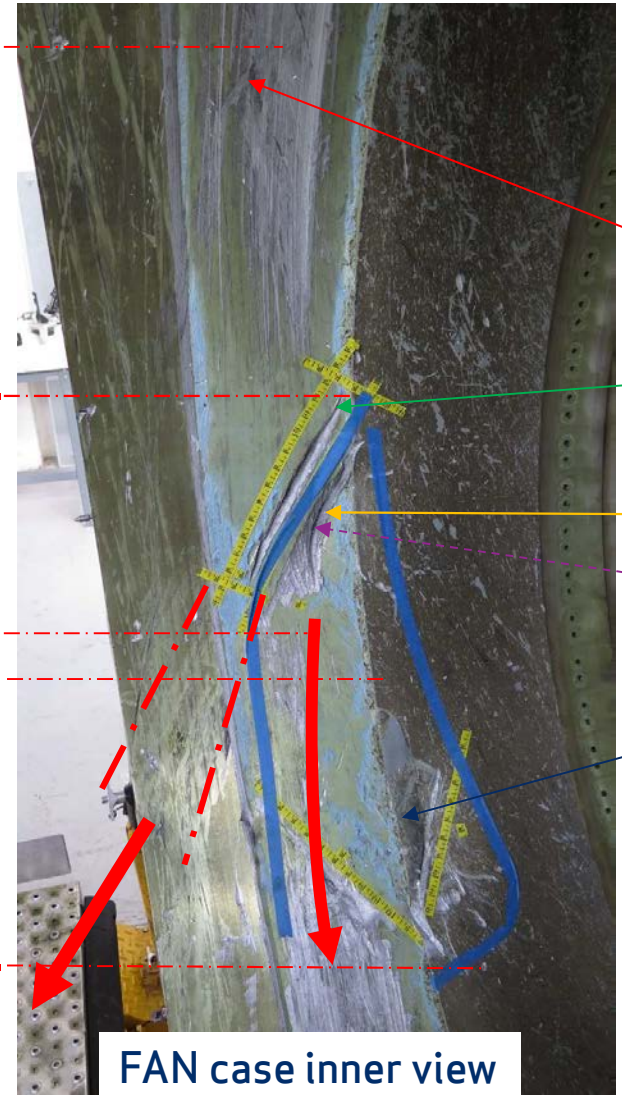
10/28/2018

FAN BLADE FRAGMENTATION SEQUENCE

CFM56-7 N°874112

Marks on fan case suggesting some mid span fragments ejection at 4H30with an angle of ≈ 37°. It could fit with UTAS Assumption of a fragment with 30° angle (see pages #4; #20 & #21

Mid span fragments ejection direction (except one of them w ich was ejected at 8H)



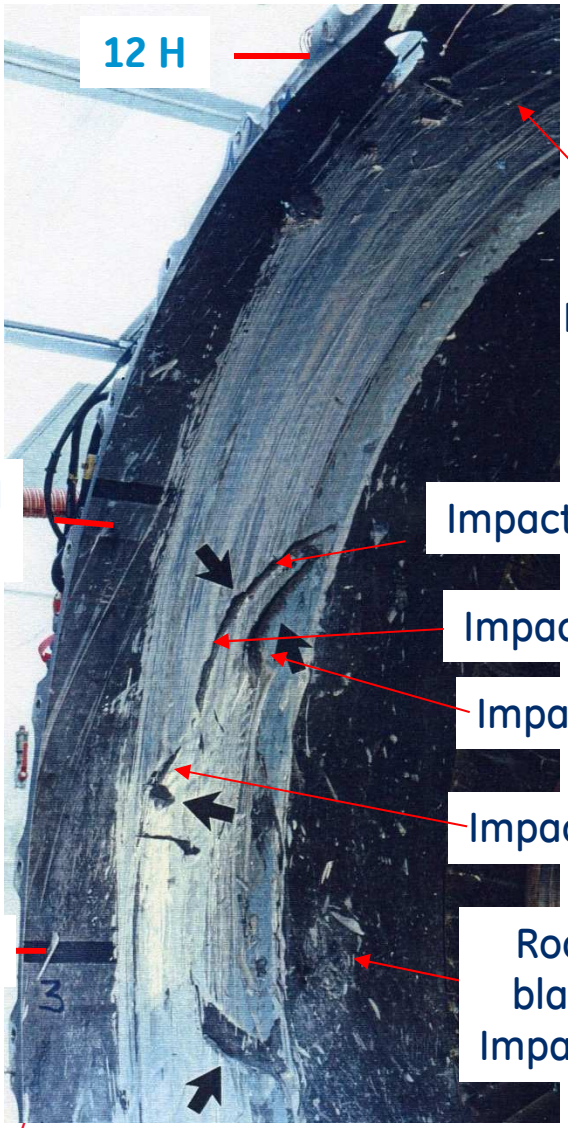
FAN case inner view

After first contact, successive blade bends led to Fracture Plans n° 1 - 2- (3).
Each fracture plan impacted FAN case.
At last, root blade sunction side impacted FAN case

Preliminary data based on non validated assumption

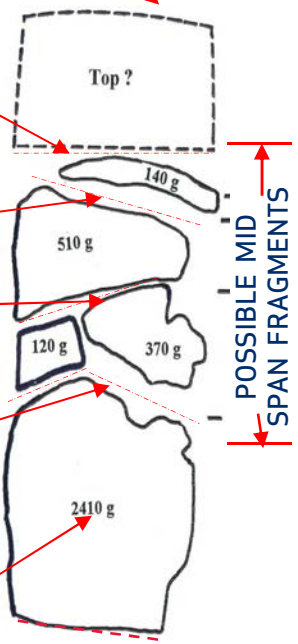
CFM56-7 N°874112

FAN BLADE FRAGMENTATION EXPERIENCE

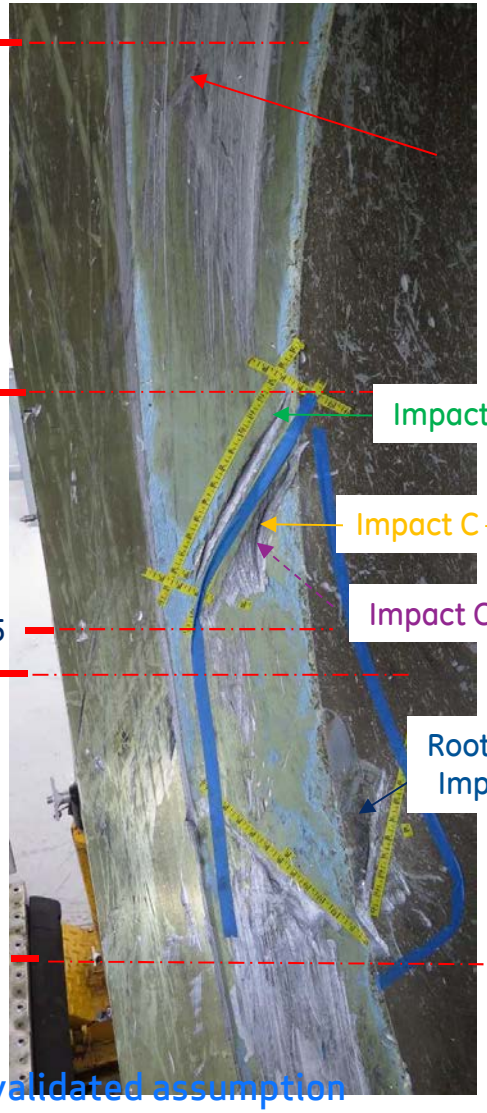


ESN 874002/2
(FBO certif test)

Impact A: 1st contact



ESN 874112

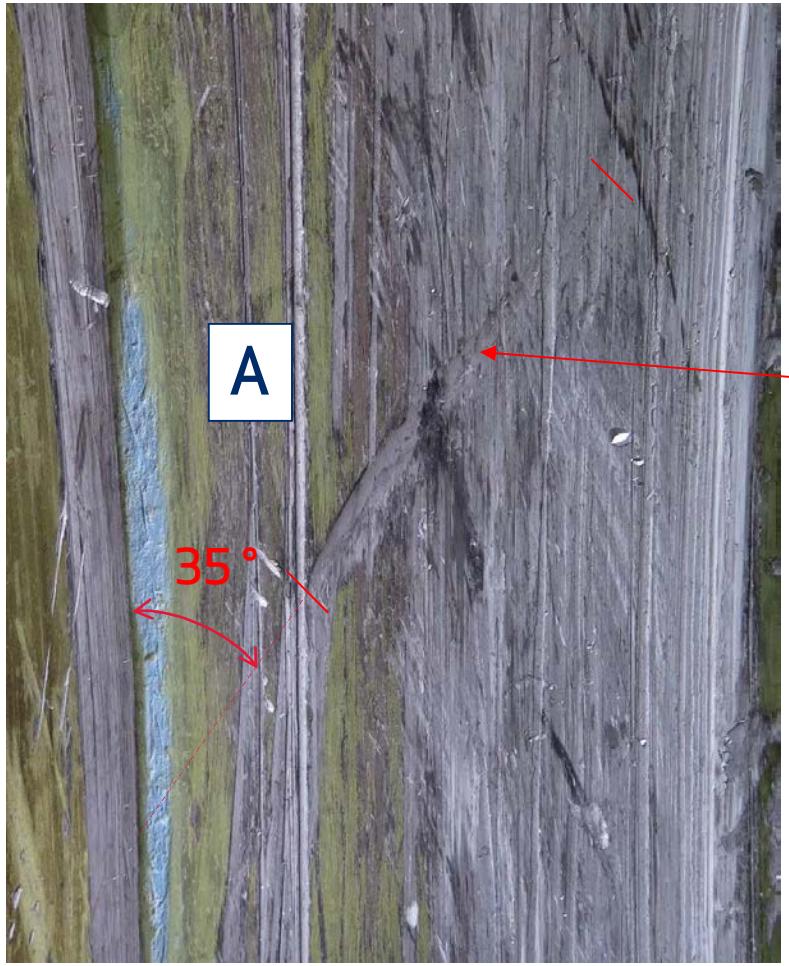


Preliminary data based on non validated assumption

BLADE # 23
TIP PANEL TRAJECTORY

CFM56-7 N°874112

FWD



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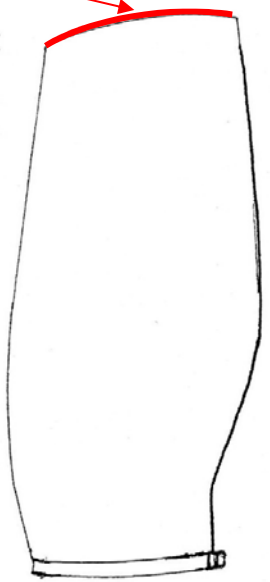
Tip blade Impact A
1st contact detail

Low energy
No
external deformation
or tear

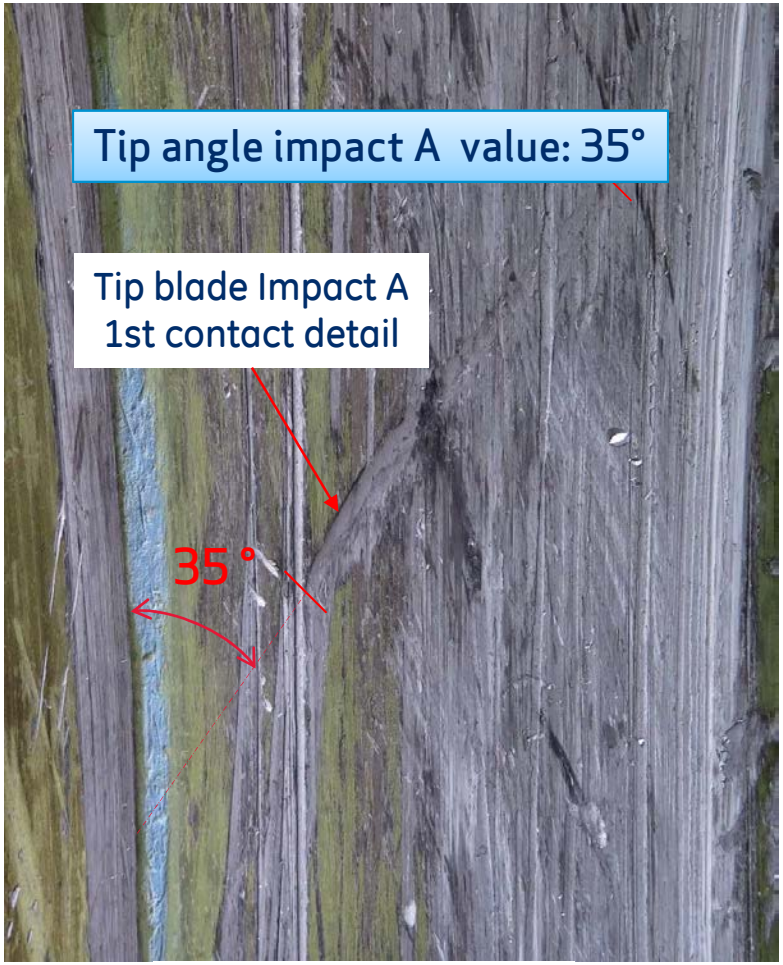


FAN case inner view

Preliminary data based on non validated assumption

CFM56-7 N°874112

FWD



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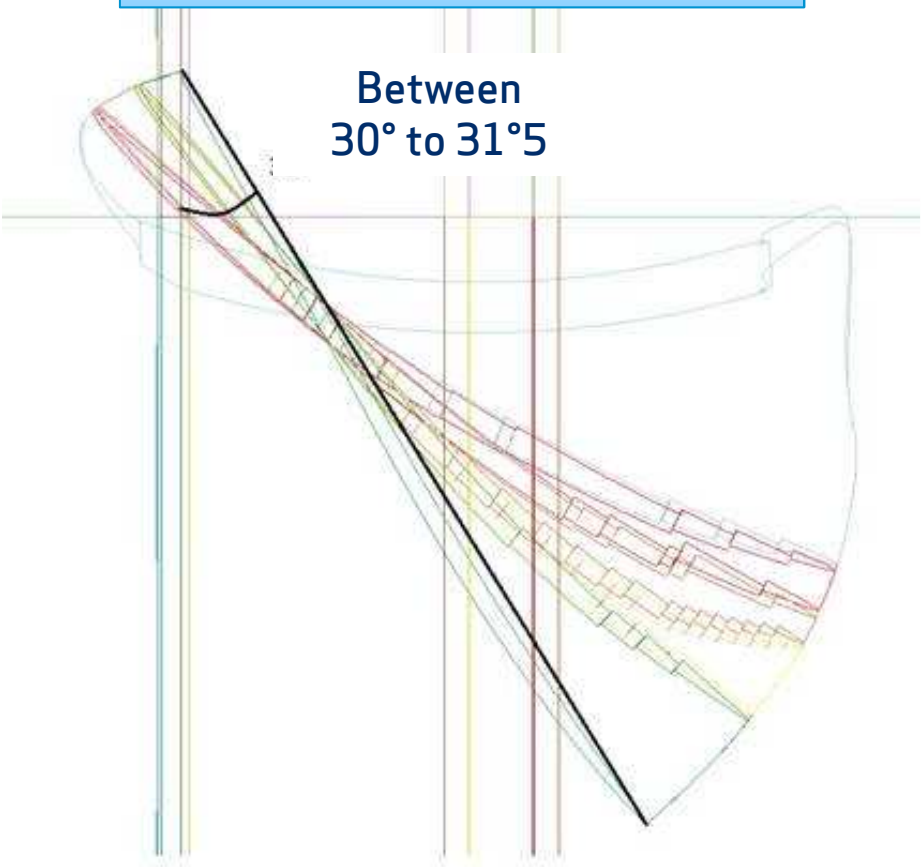
FAN case inner view

Theoretic tip angle at climb value:
between 30° to 31°5

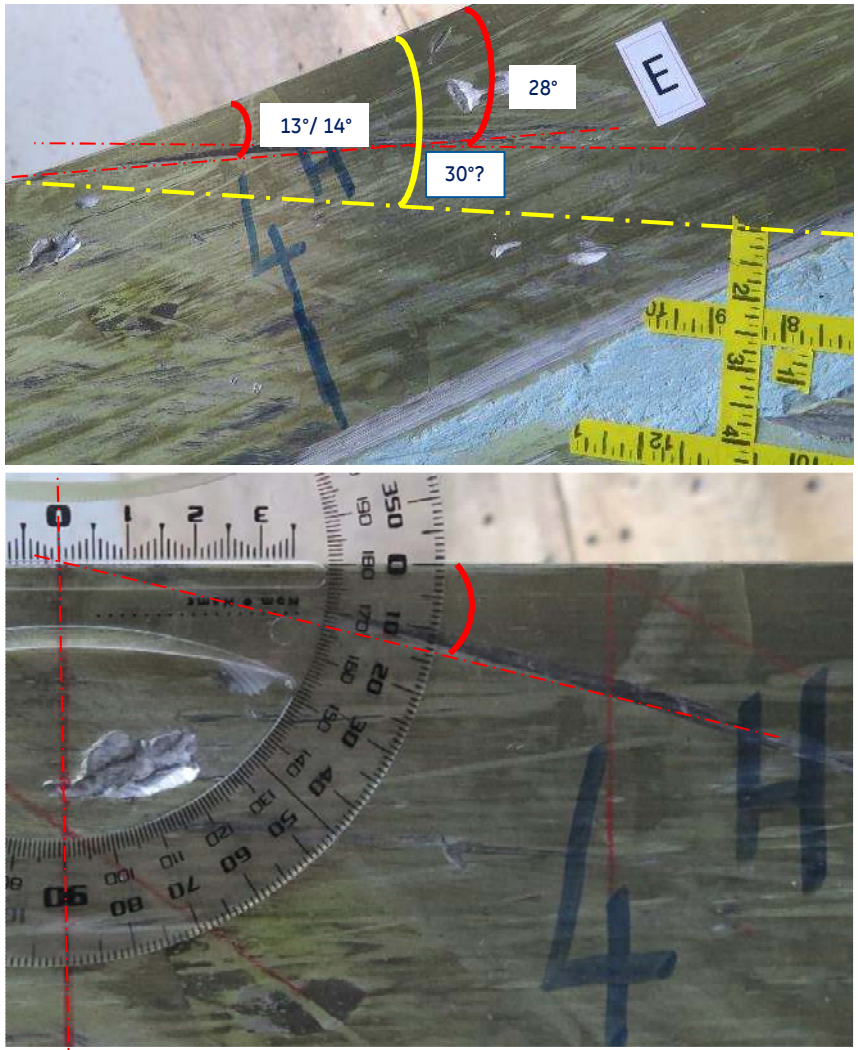


First impact tip angle value close to theoretictip running angle value

CFM56-7 N°874112

SOUTHWEST

FAN BLADE # 23 TIP PANEL TRAJECTORY



CFM analysis:

- Fan case experienced impact deformation during event around tip panel exit area (close to B & C impact location)
- This deformation causes deviation in the trajectory of the tip panel (from ≈ 28° to ≈ 14°)

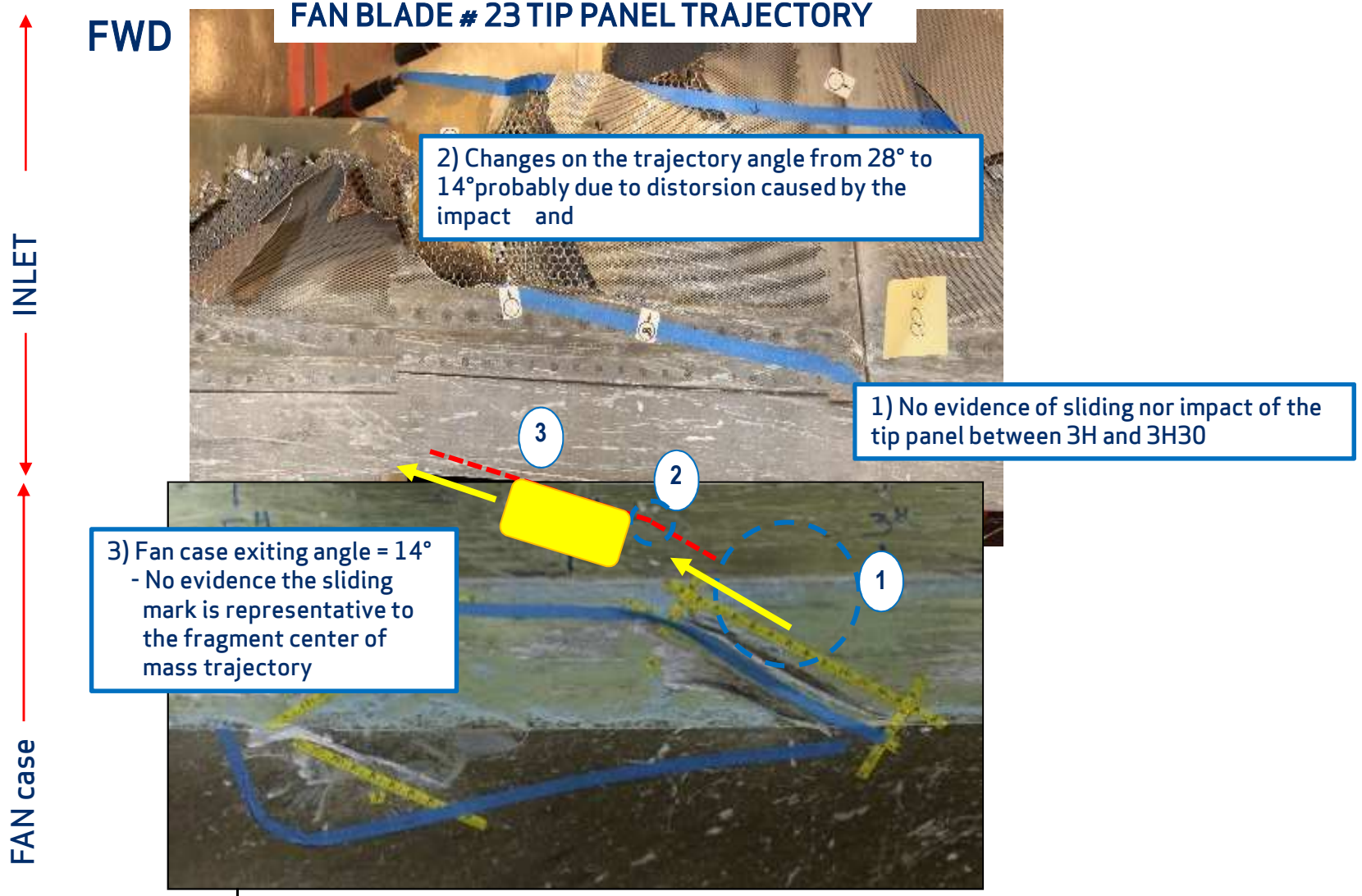
➔ **Tip panel fan case exiting angle = 14°**

➔ A 30° fan case exiting angle seems not consistent with the marks in the fan case (see upper picture)

CFM56-7 N°874112

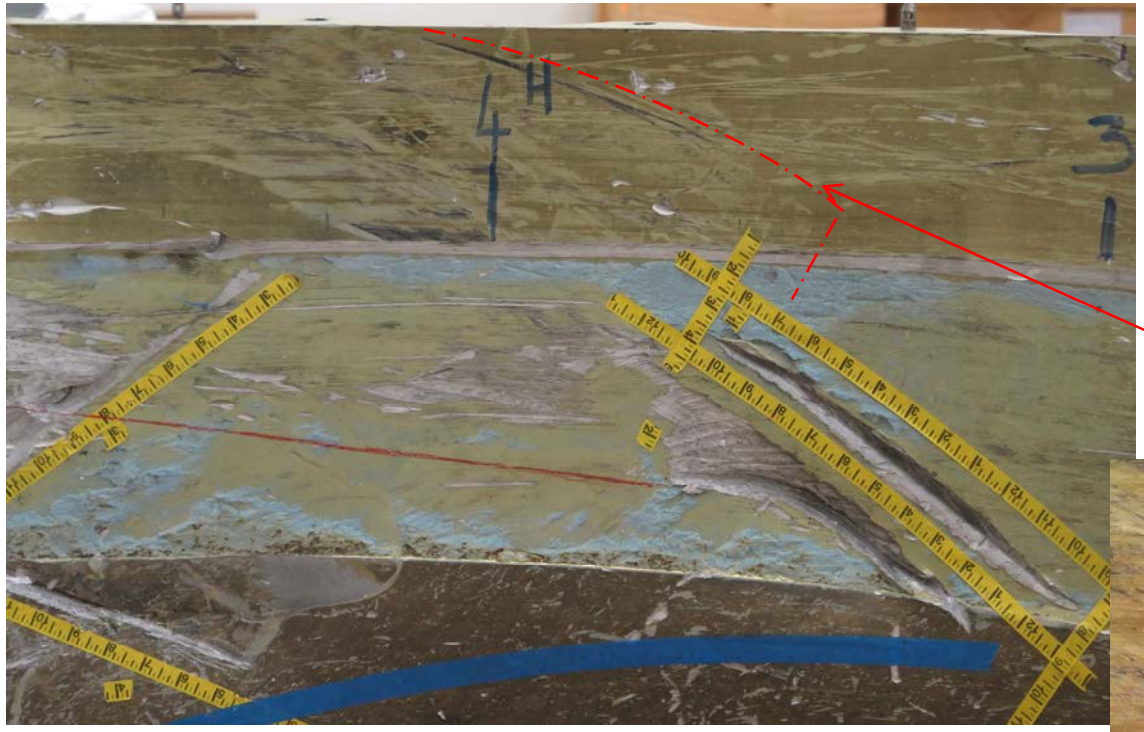
SOUTHWEST

FAN BLADE # 23 TIP PANEL TRAJECTORY



BLADE # 23
UPPER SPAN FRAGMENT TRAJECTORY

CFM56-7 N°874112

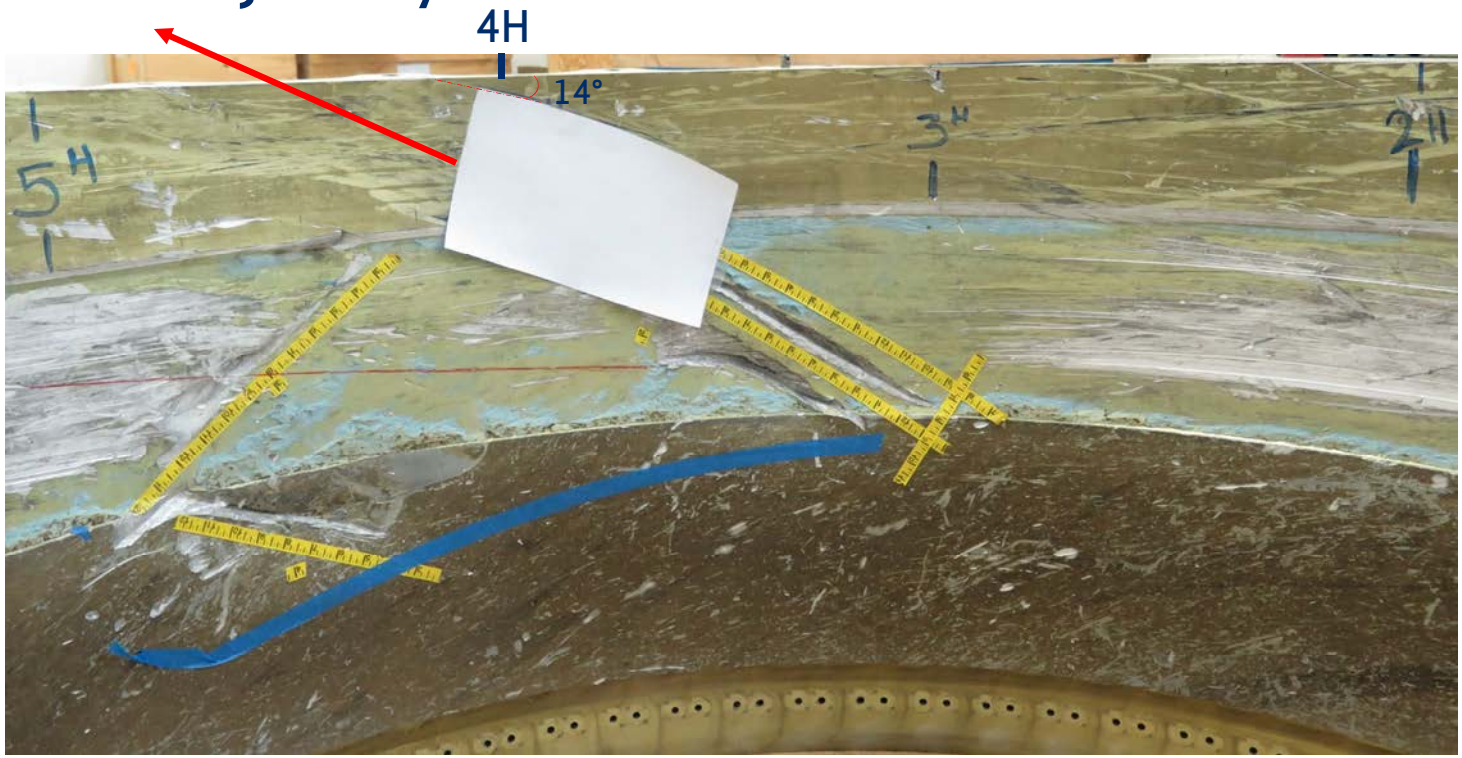


Upper panel print

CFM56-7 N°874112

Upper panel was exited between 4H & 5H

Upper panel trajectory



BLADE # 23
MID SPAN FRAGMENTS TRAJECTORIES

CFM56-7 N°874112

FWD

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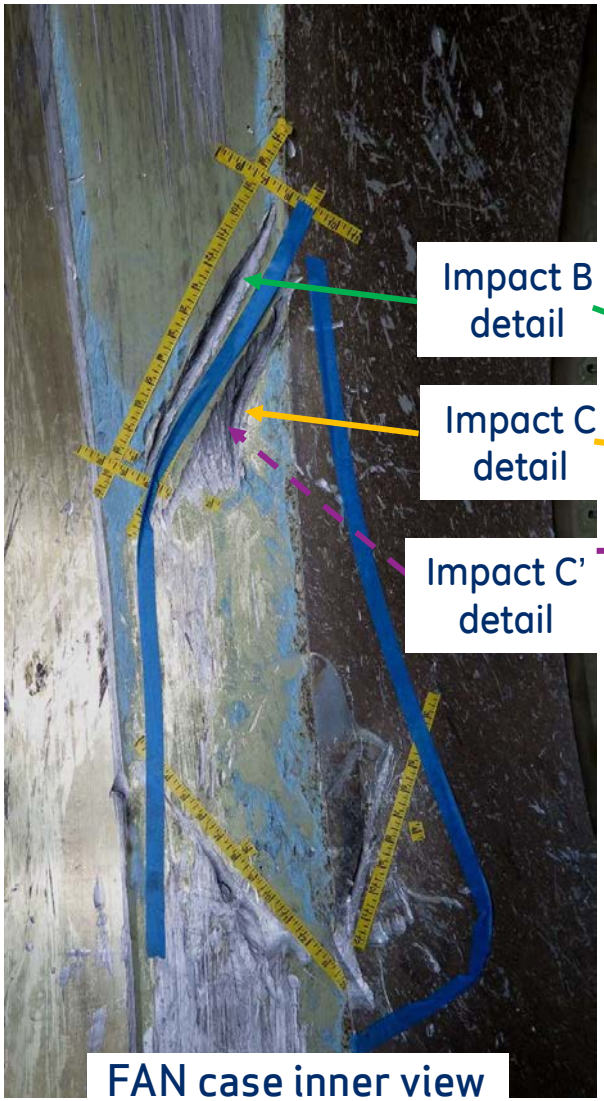
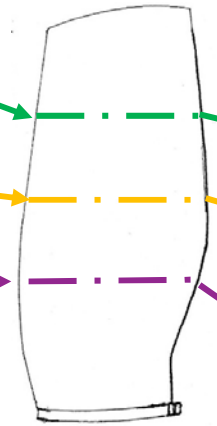
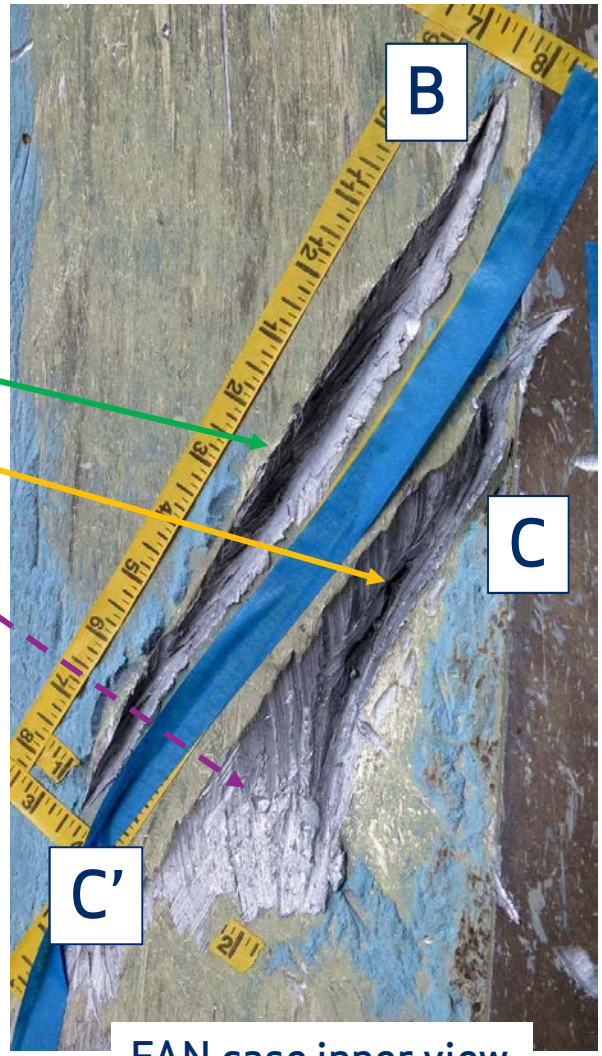


Impact B detail

Impact C detail

Impact C' detail





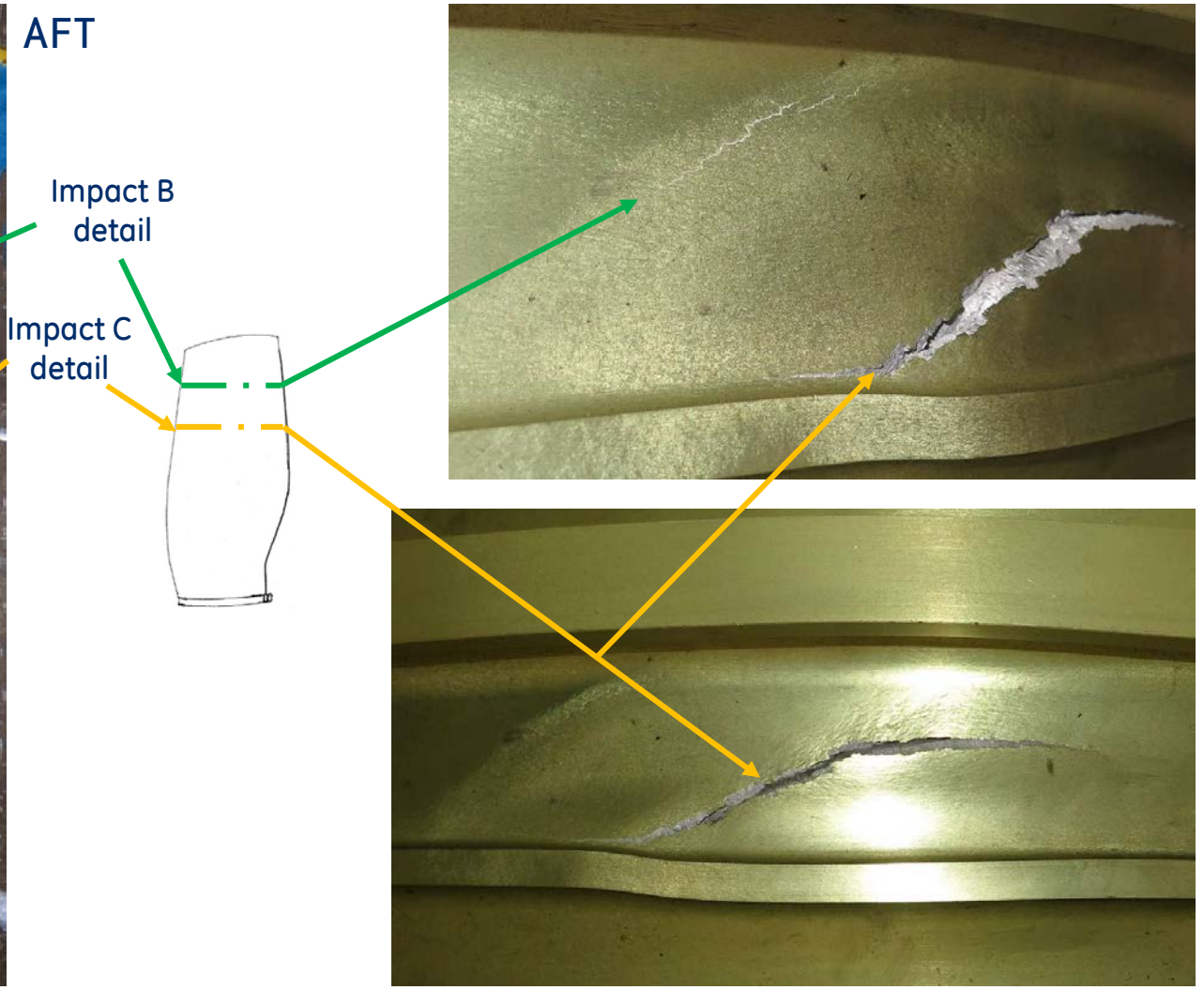
FAN case inner view

FAN case inner view

Preliminary data based on non validated assumption

CFM56-7 N°874112

FAN case inner view



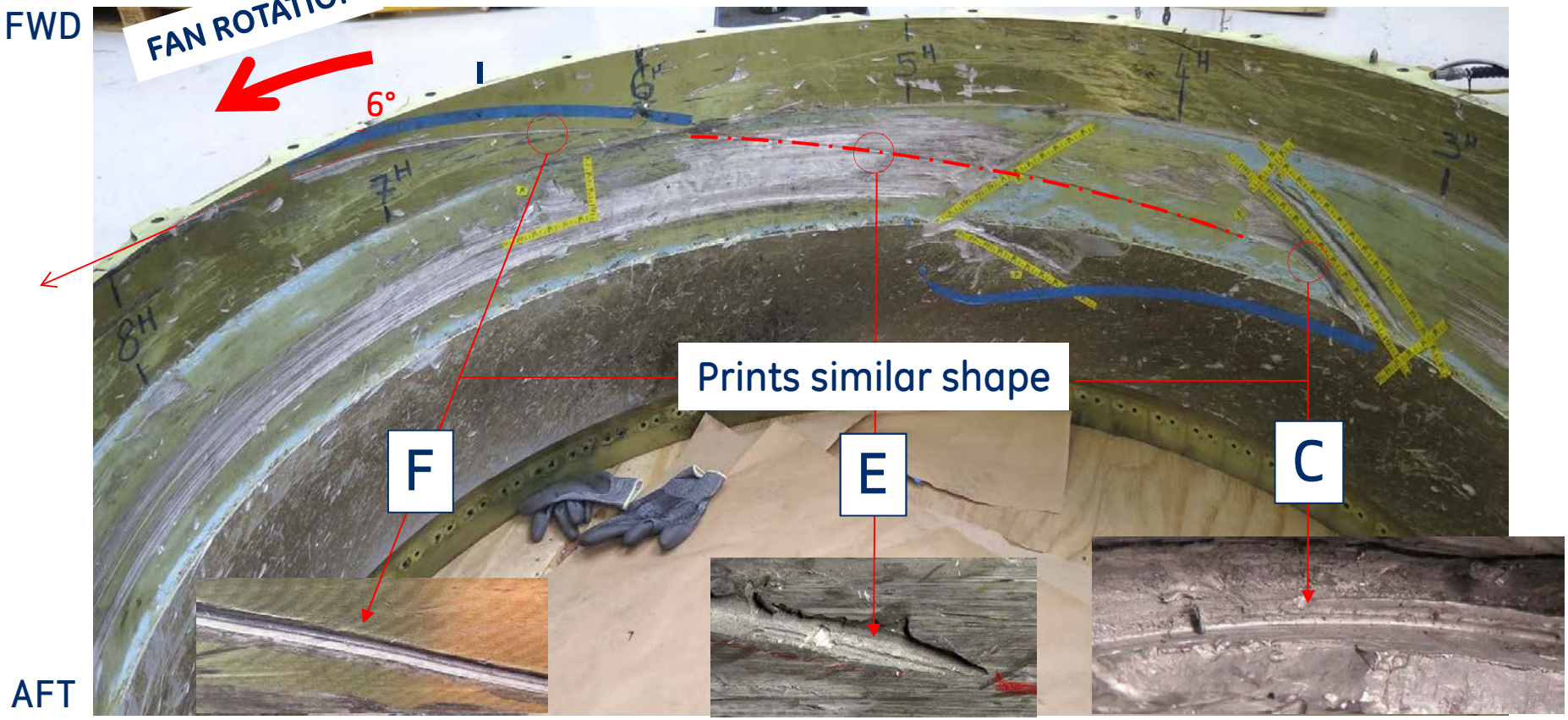
FAN case external views

Preliminary data based on non validated assumption

CFM56-7 N°874112

Mid span fragment exited at 8H

Mid span fragment ejection trajectory



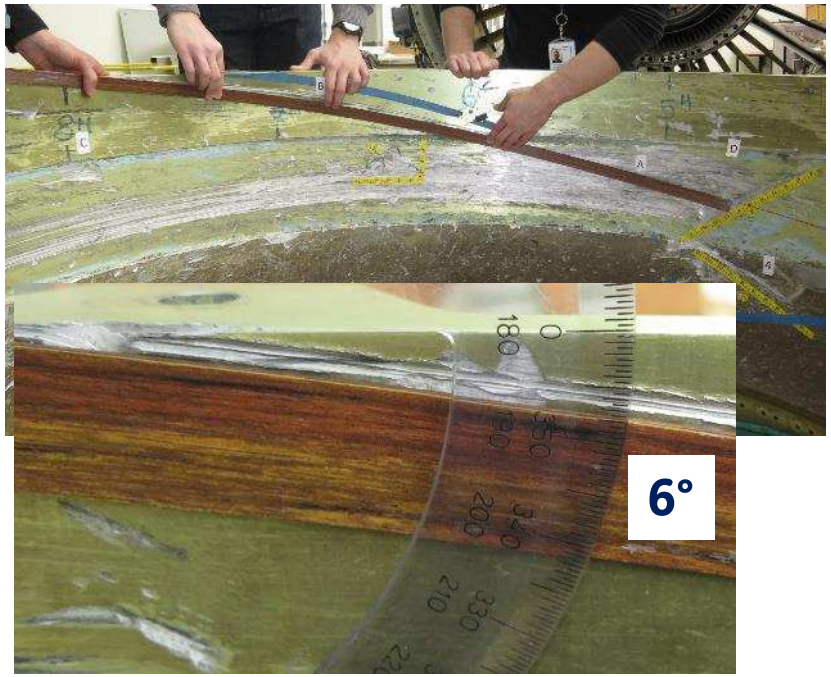
FAN case inner view

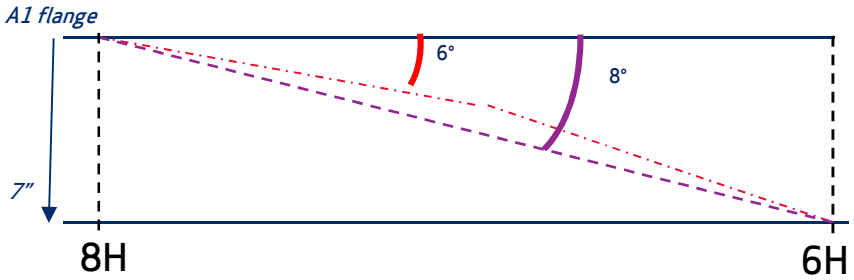
Preliminary data based on non validated assumption

CFM56-7 N°874112

SOUTHWEST

FAN BLADE # 23 MID SPAN #1 FRAGMENT TRAJECTORY





Based on measurement of the fan case

CFM analysis:

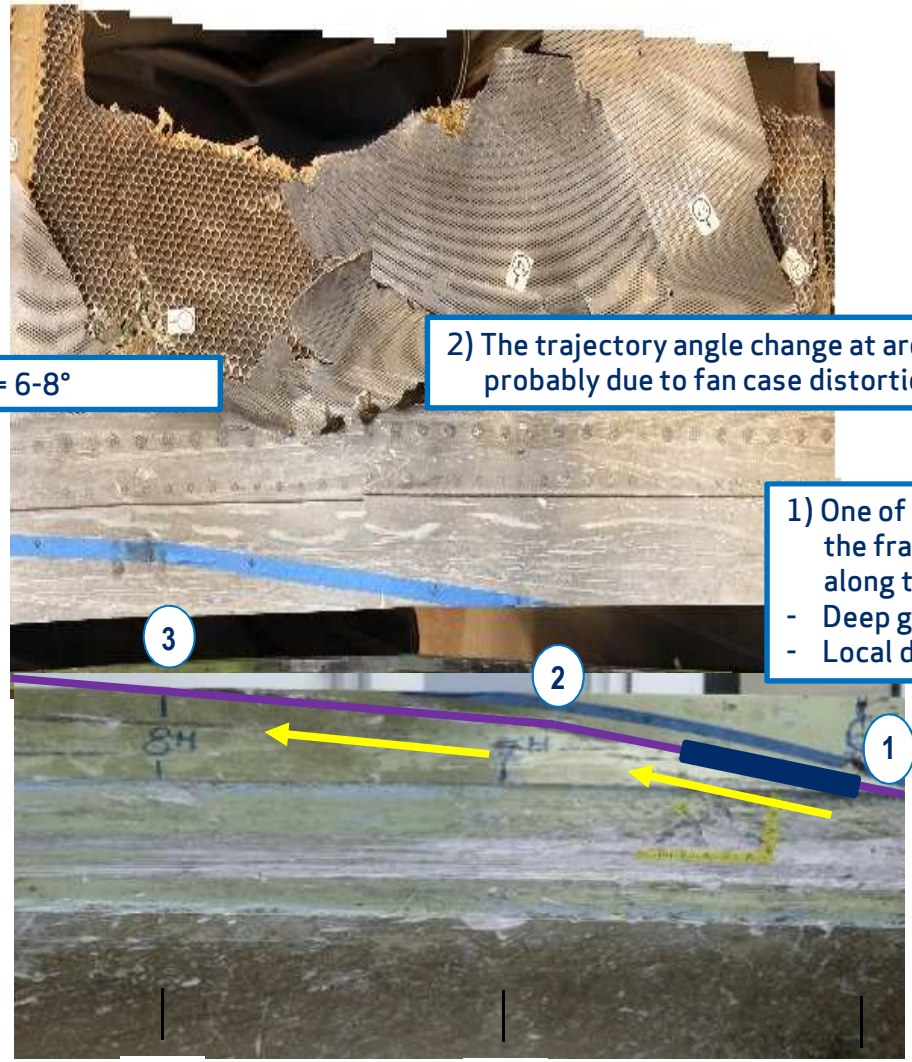
- Local deformation of the fan case along the mid panel trajectory
- Deformation causes deviation of the trajectory
- Direct measurement of the exiting angle at the A1 flange location : 6°
- Exiting angle with linear trajectory based on the marks between abradable and A1 flange : 8°

➔ **6° < Mid span fan case exiting angle < 8°**

CFM56-7 N°874112

SOUTHWEST

FAN BLADE # 23 MID SPAN #1 FRAGMENT TRAJECTORY

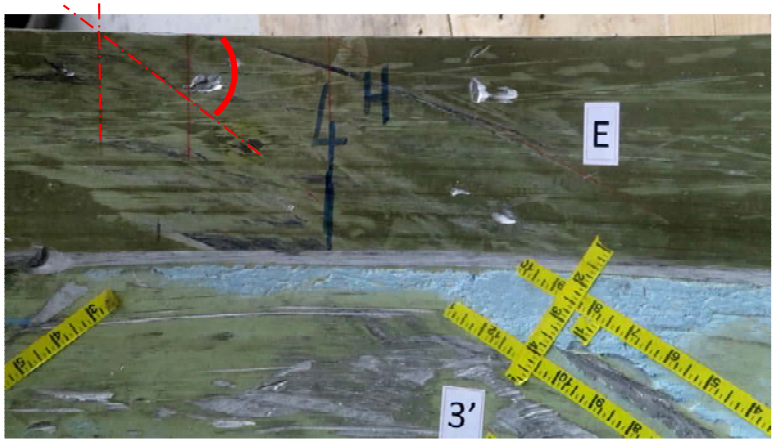


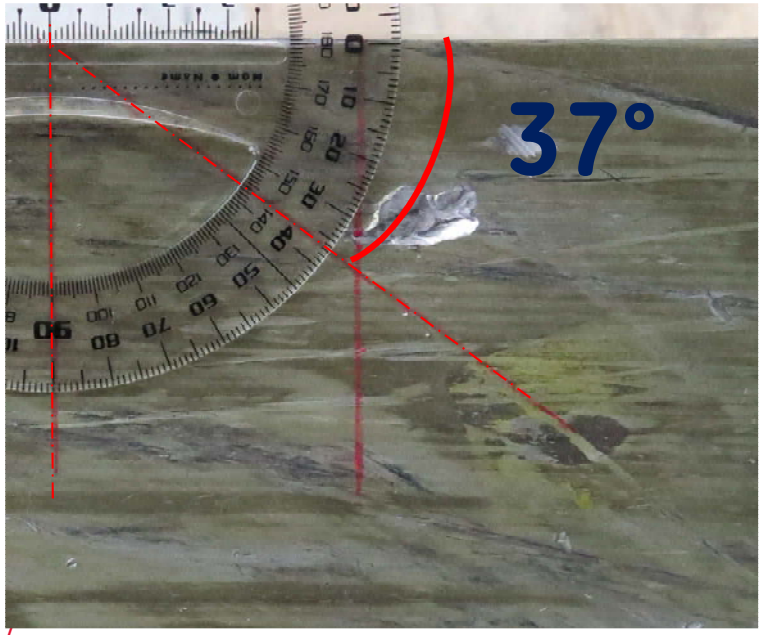
3) Fan case exiting angle = 6-8°

2) The trajectory angle change at around 7H, probably due to fan case distortion

1) One of the mid span **probably** slides on the fracture surface, which causes along the trajectory:
- Deep grove
- Local distortion of the fan case

FAN BLADE # 23 MID SPAN #2 FRAGMENT TRAJECTORY





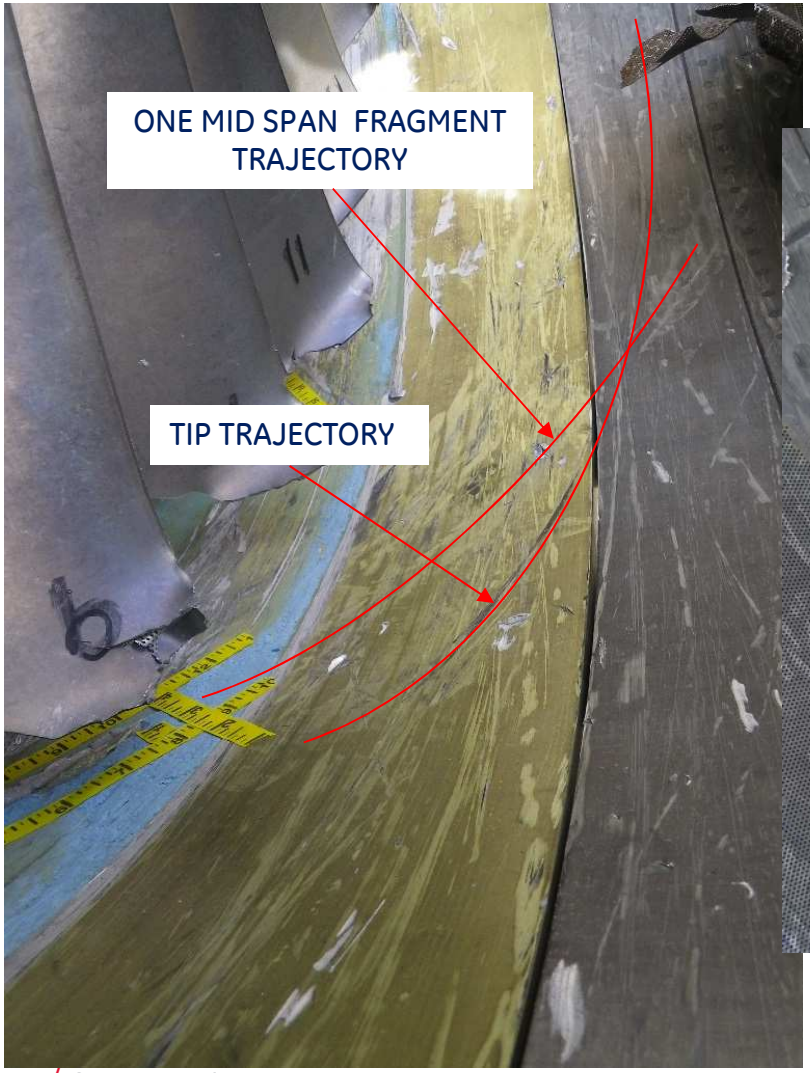
CFM analysis:

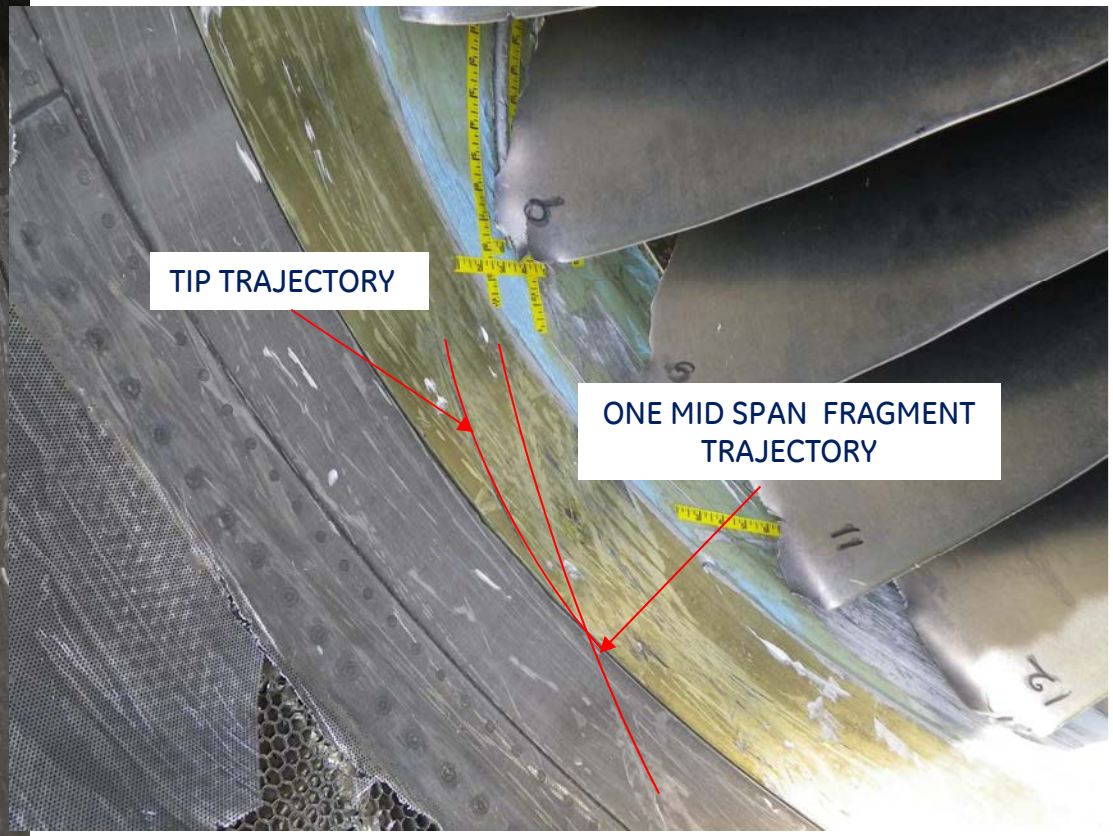
- Many marks in the area around 4H30 suggesting some mid span fragments ejection in the area . The trajectory of these fragments is very close to the tip panel trajectory (see page 21)
- the exiting angle of the deepest mark = 37°

CFM56-7 N°874112

SOUTHWEST

FAN BLADE # 23 TIP PANEL & MID SPAN TRAJECTORIES





BLADE # 23
ROOT BLADE TRAJECTORY

CFM56-7 N°874112

FWD

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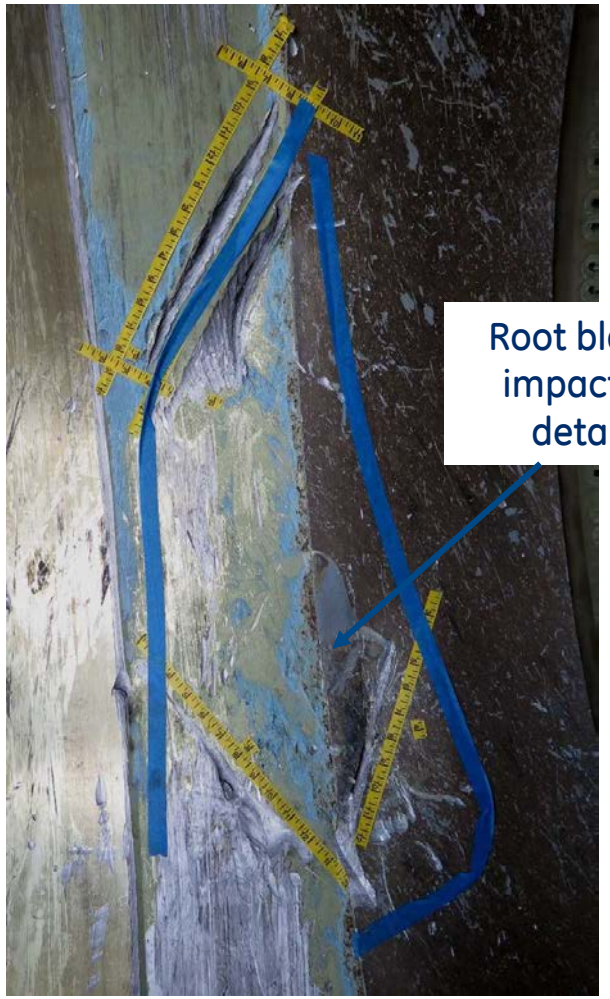
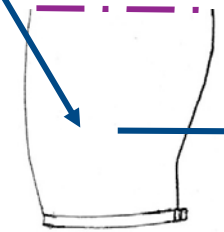
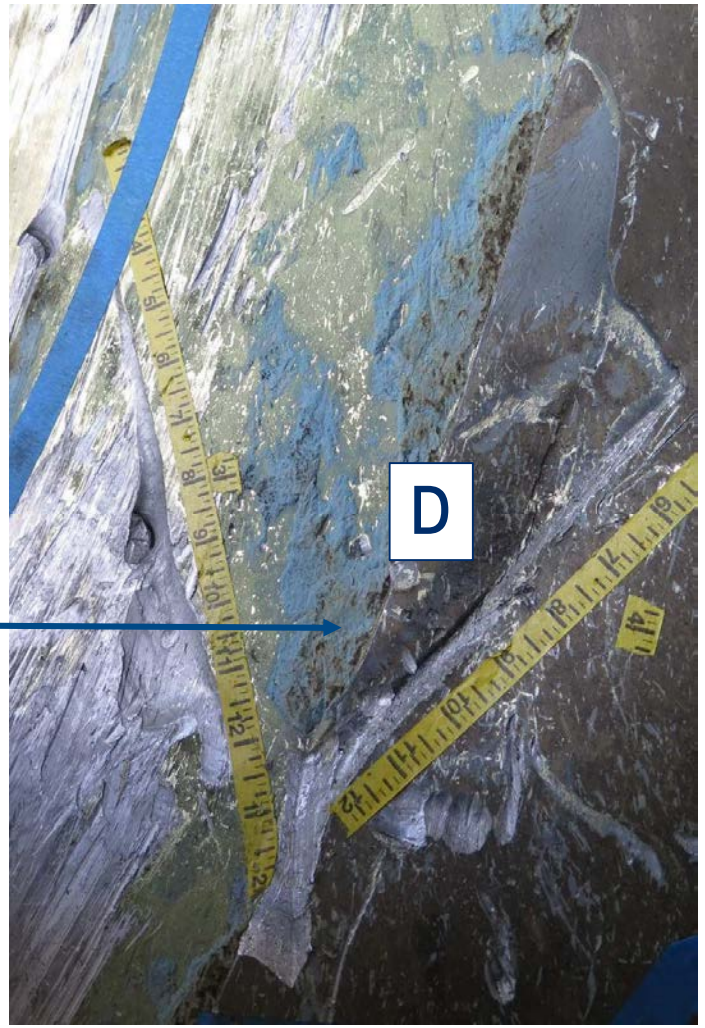


Root blade impact D detail





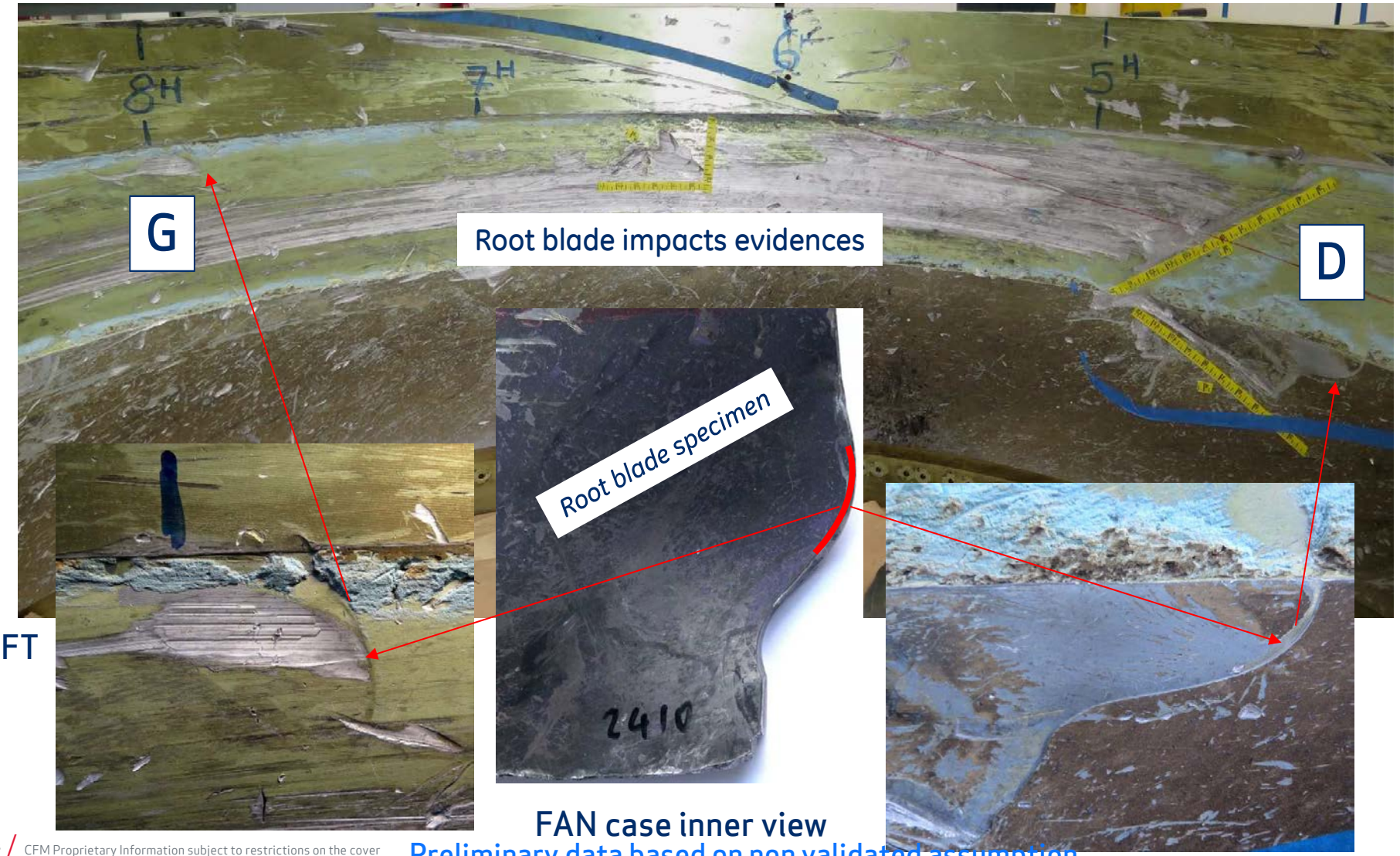
FAN case innerview

FAN case inner view

Preliminary data based on non validated assumption

CFM56-7 N°874112

FWD

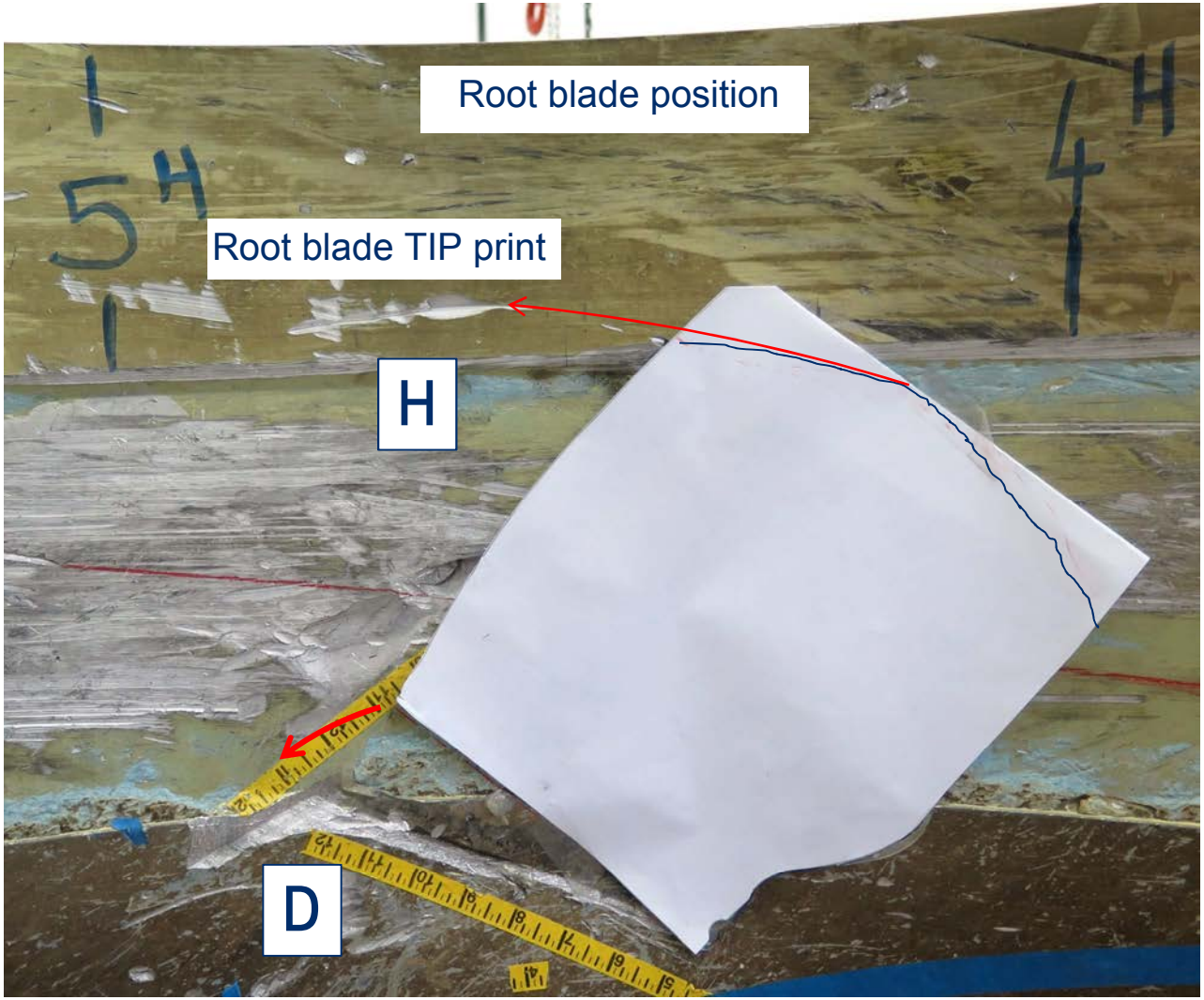


AFT

FAN case inner view

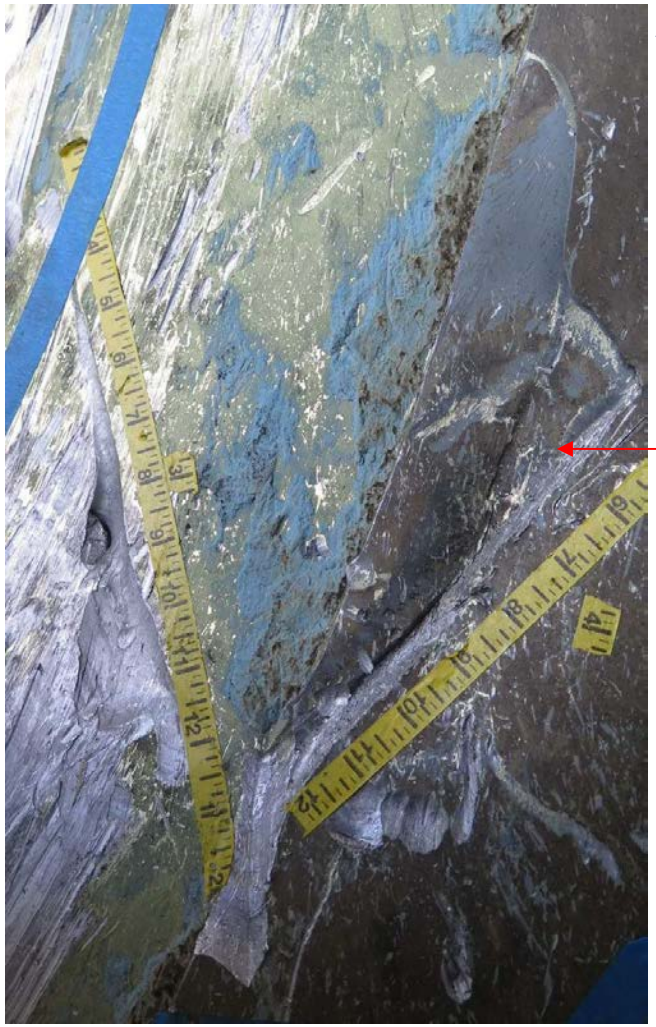
Preliminary data based on non validated assumption

CFM56-7 N°874112



CFM56-7 N°874112

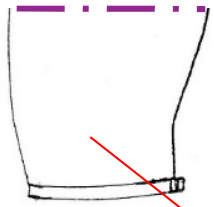
FWD



AFT

FAN case innerview

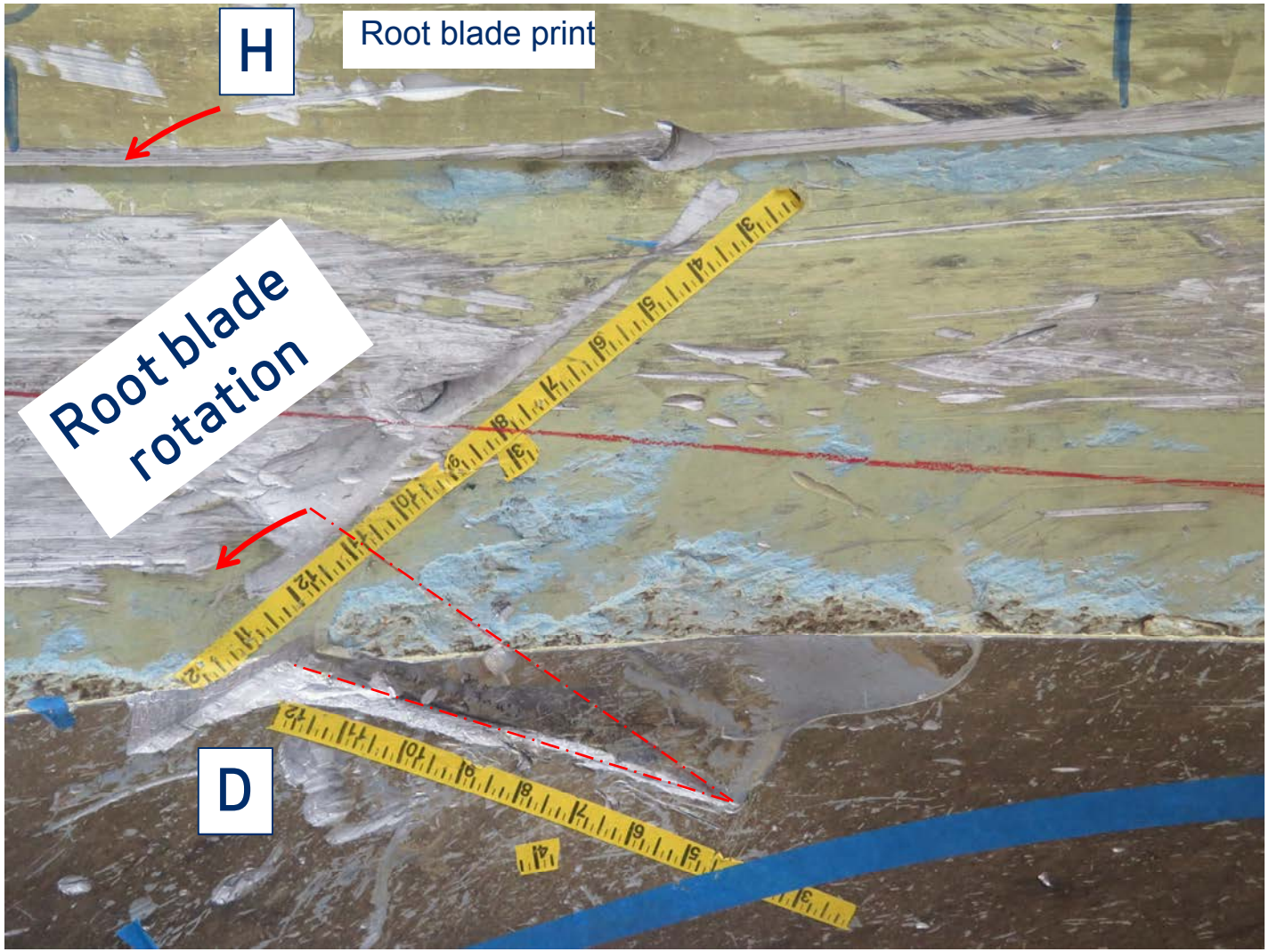
Root blade impact D detail



FAN case external view

Preliminary data based on non validated assumption

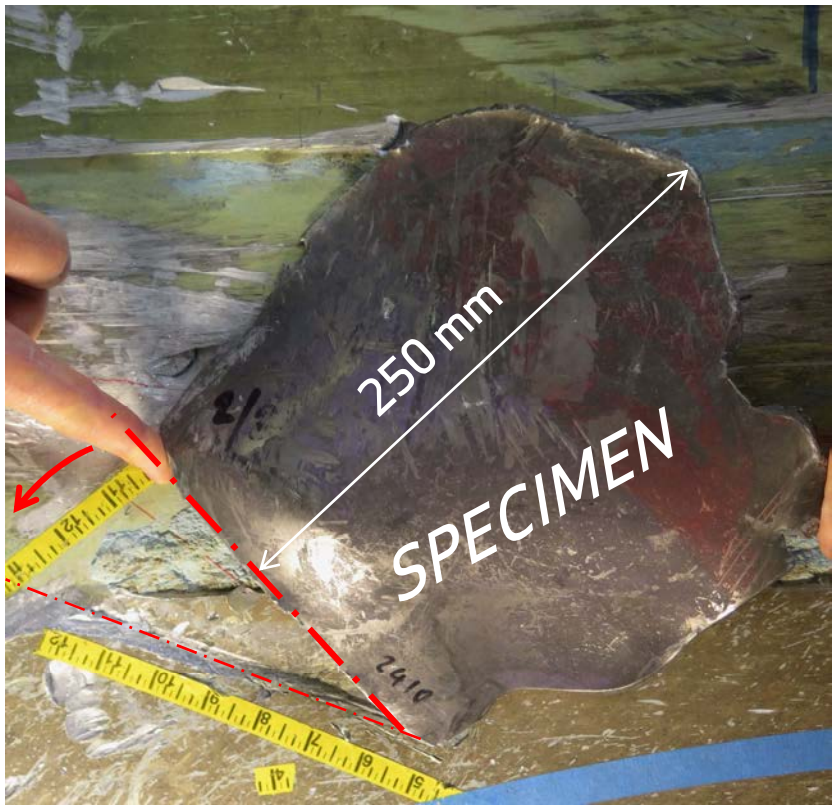
CFM56-7 N°874112



CFM56-7 N°874112

Root blade trajectory analysis

Step 1 : FAN case impact



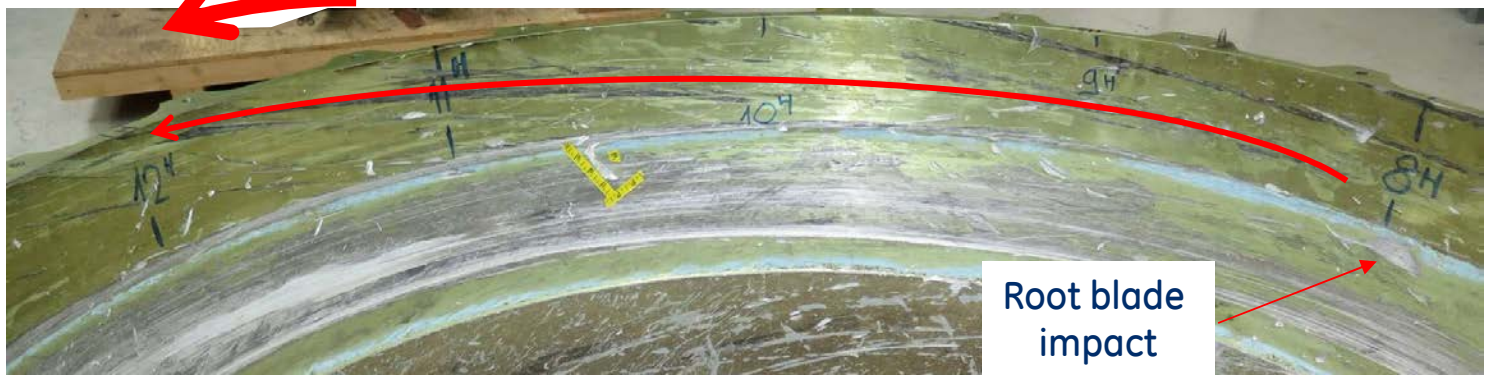
Step 2: Root blade rotation

CFM56-7 N°874112

Root blade exited at 12H

FAN ROTATION

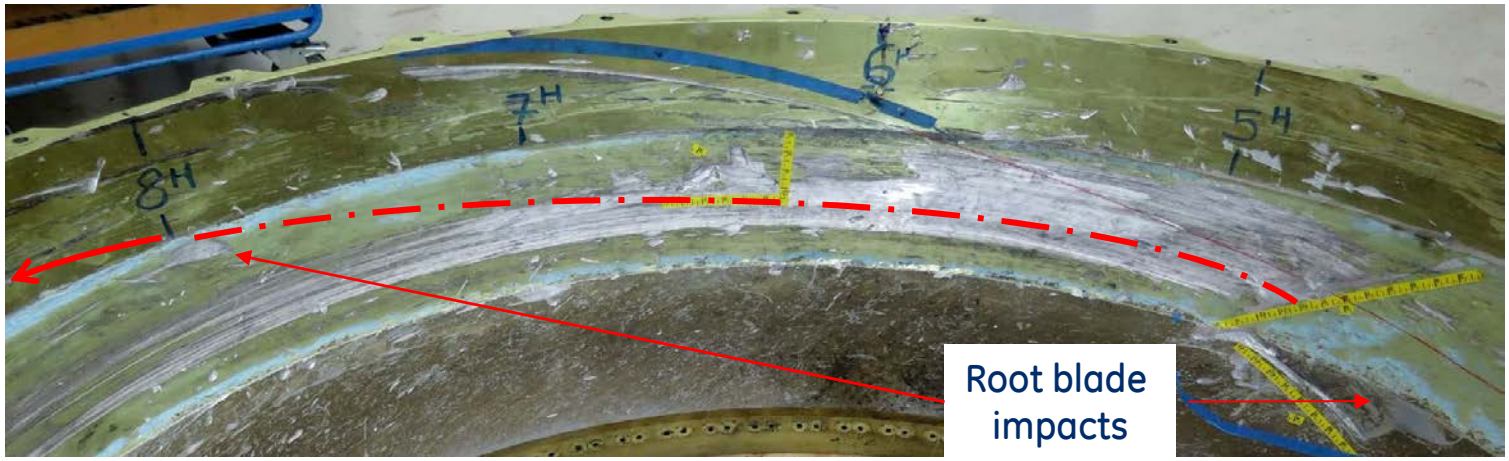
Root blade ejection trajectory



FWD

AFT

FWD



AFT

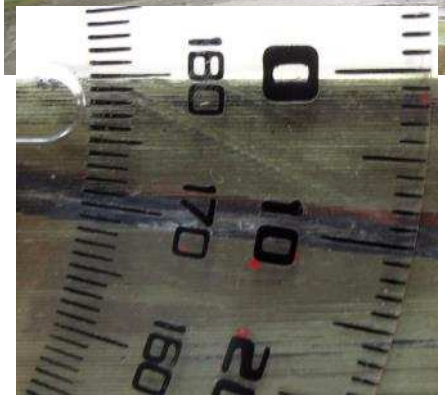
FAN case inner view

Preliminary data based on non validated assumption

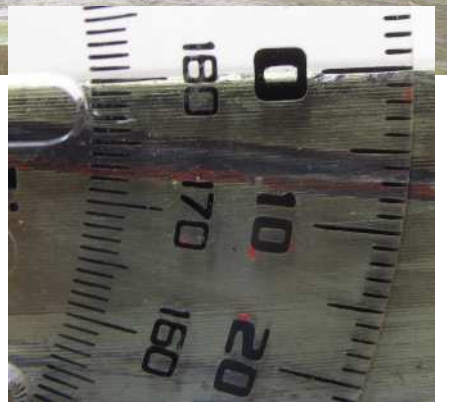
CFM56-7 N°874112

SOUTHWEST

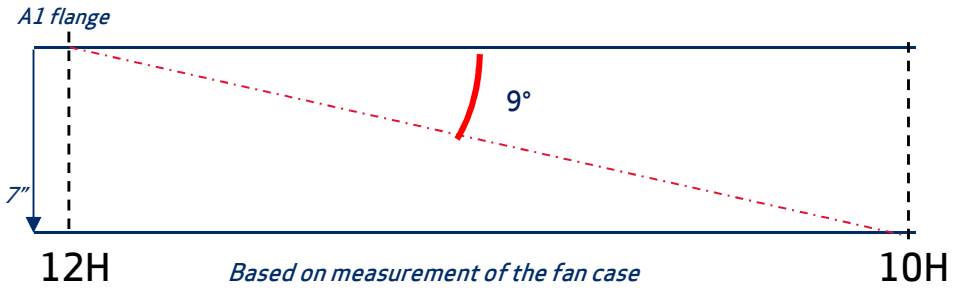
FAN BLADE # 23 ROOT TRAJECTORY



Measurement 1



Measurement 2



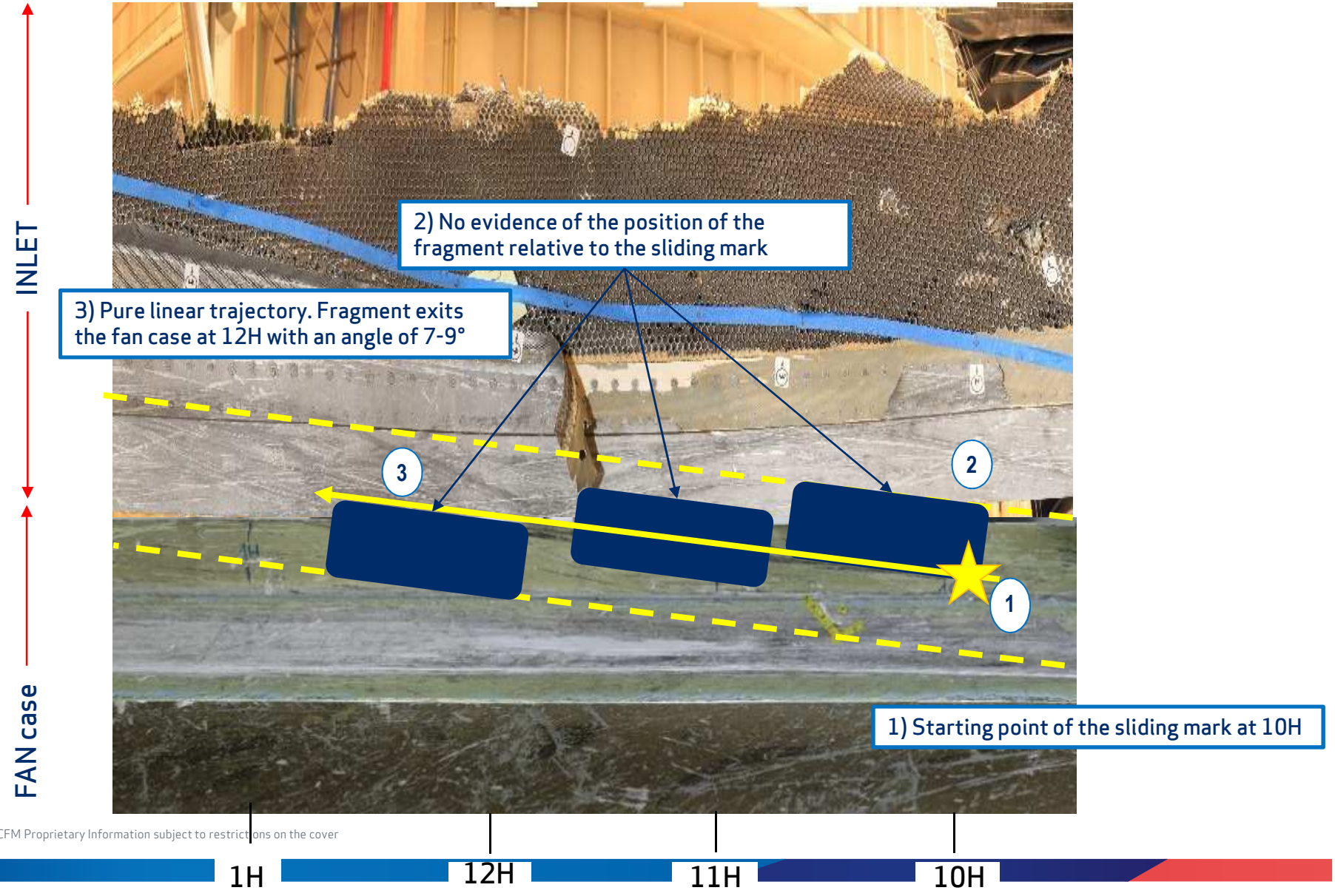
CFM analysis:

- No deformation of the fan case in the root panel trajectory area
- 1st impact of the root panel in the fan case noticed around 5H45
- From 5H45 to 10H:
  - Evidences of root panel rolling inside the fan case
  - no evidence of sliding.
- Direct measurement of the exiting angle at the A1 flange location : 7-9° (incertitude due to the width of the mark)

➔ **7° < Root fan case exiting angle < 9°**

CFM56-7 N°874112

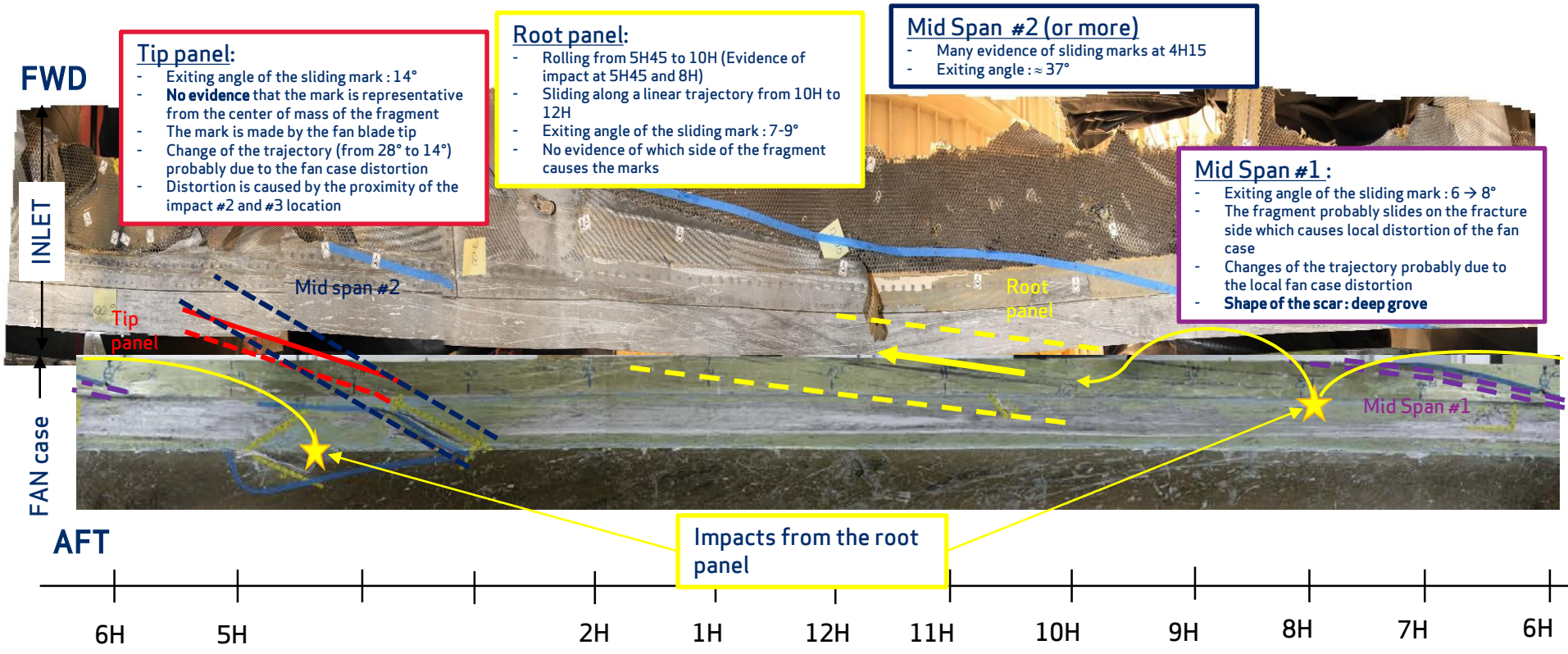
SOUTHWEST



CFM56-7 N°874112

SOUTHWEST

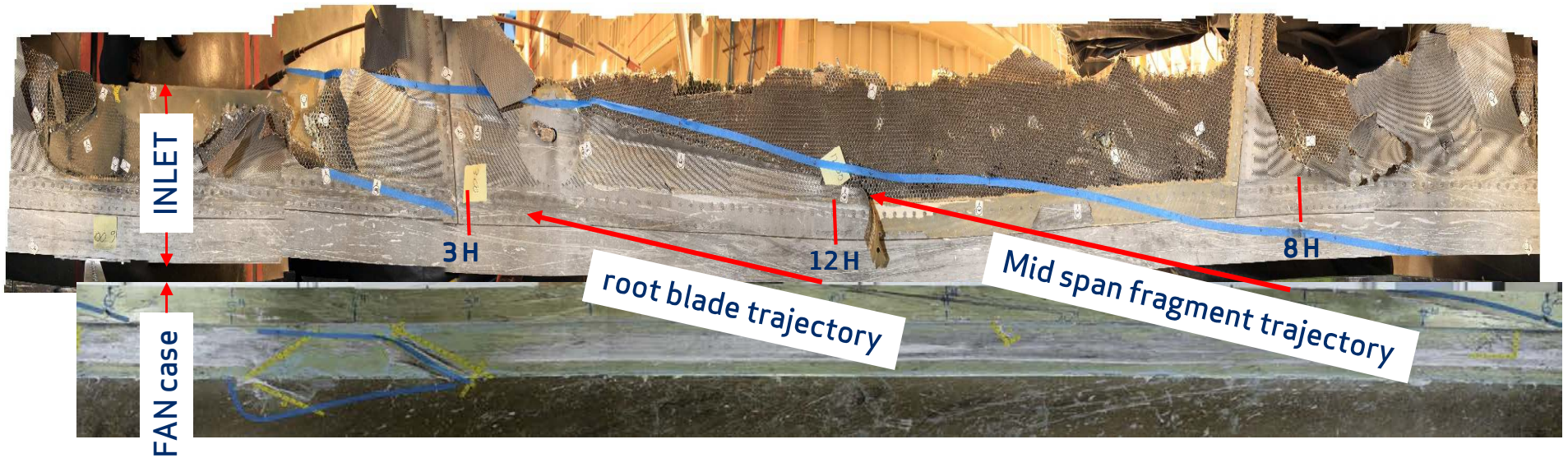
INLET/ FAN CASE PANORAMIC VIEW



CFM56-7 N°874112

INLET/ FAN CASE PANORAMIC VIEW

FWD



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Preliminary data based on non validated assumption