Une nouvelle génération de Moteurs Le LEAP

Aviation et Environnement
Pau – 7 Février 2013

LEAP : "Leading Edge in Aviation Propulsion"
The New CFM Engine for Short / Medium Range Aircrafts

LEAP-1A

Dual source
Certification 2015
EIS 2016

AIRBUS

A320neo
600 orders

LEAP-1B

Single source
Certification 2016
EIS 2017

BOEING

737 MAX
1200 orders

LEAP-1C

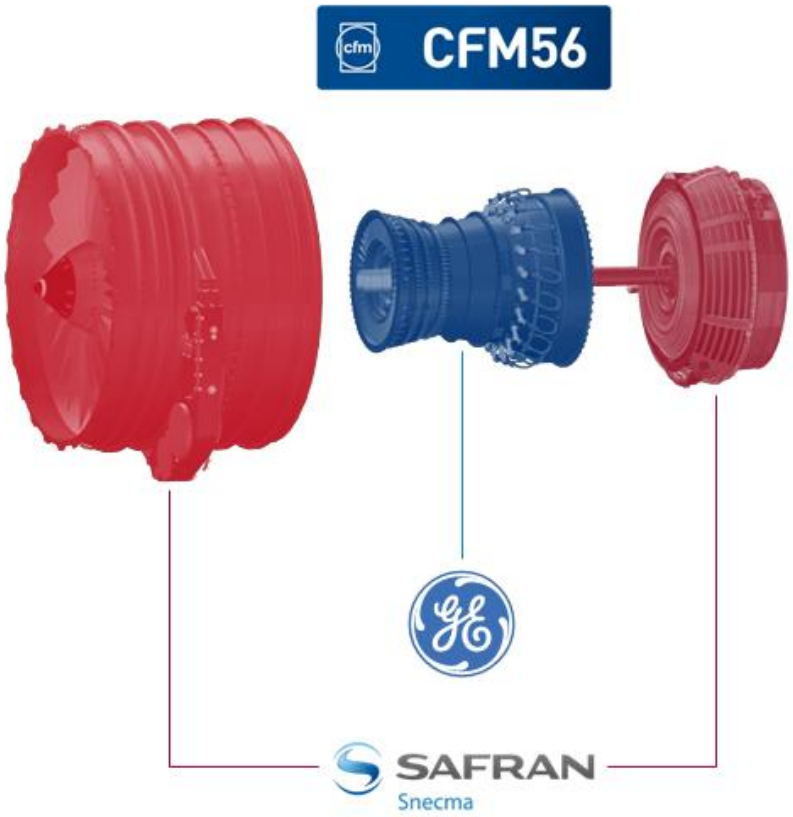
Single western source / IPS
Certification 2015
EIS 2016

COMAC

C919
380 orders

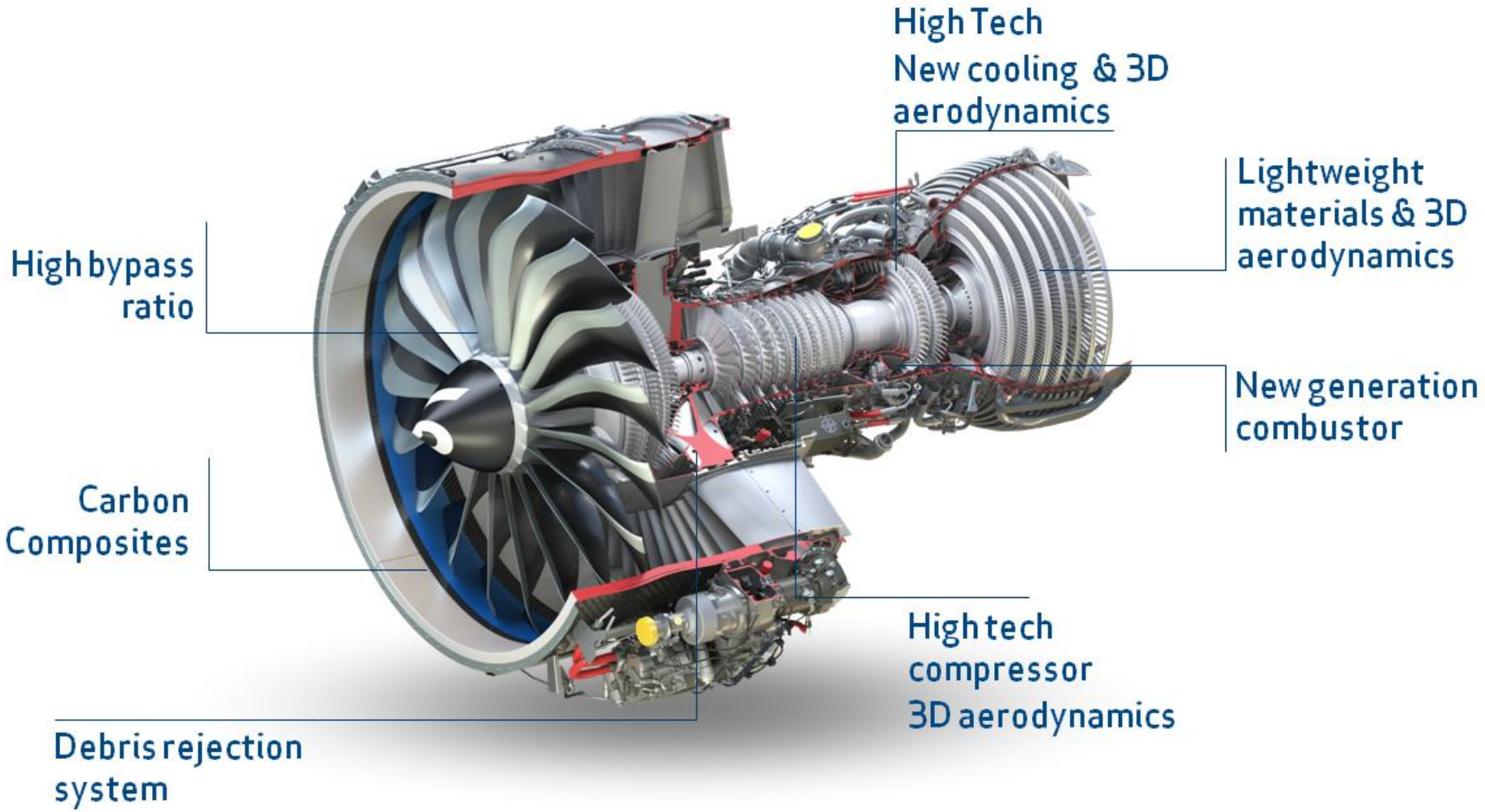
LEAP, the succession of the 'Best Seller' CFM56

LEAP : a CFM Engine



*All activities shared 50/50:
R&D, engineering, sales and marketing, product support, manufacturing and services

Next generation of breakthrough technologies & innovations

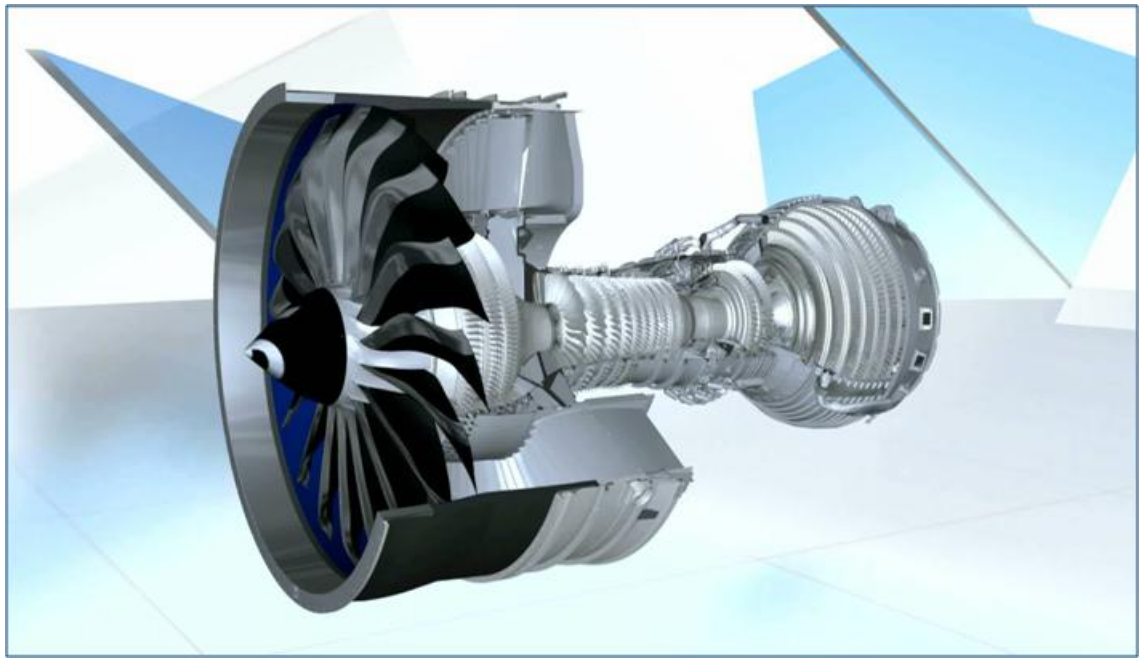


Meeting performance requirements with CFM reliability

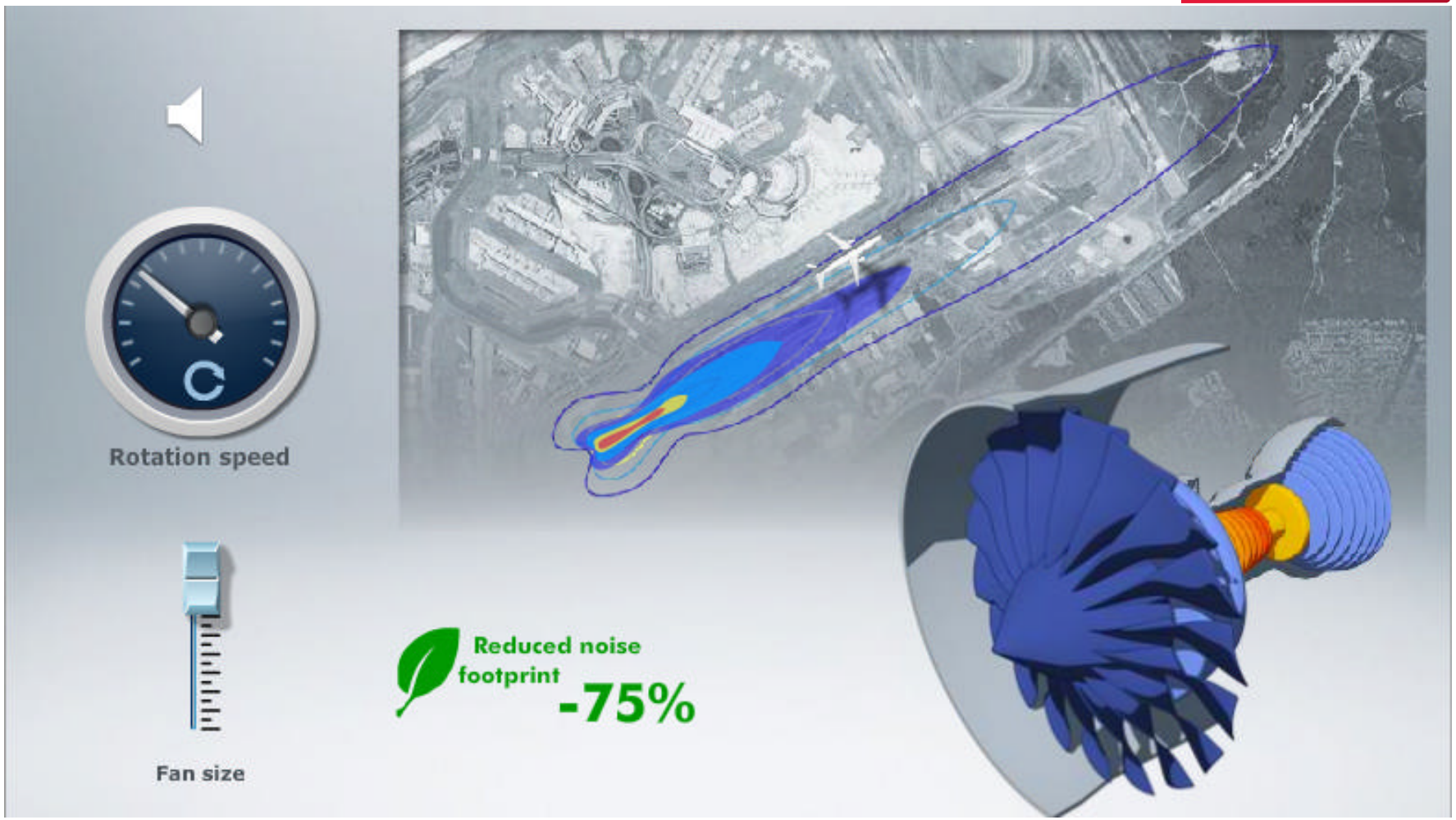
Fuel efficiency	NOx	Noise	Reliability	Maint. cost
15% better	**50%** lower vs. CAEP 6	**New** regulation compliant (chapter 5)	**Same as CFM56** ... best in industry	

Combining technology, experience & execution for

Performance
Environment
Reliability



Community Noise Footprint Reduction



Fan module

Technologies

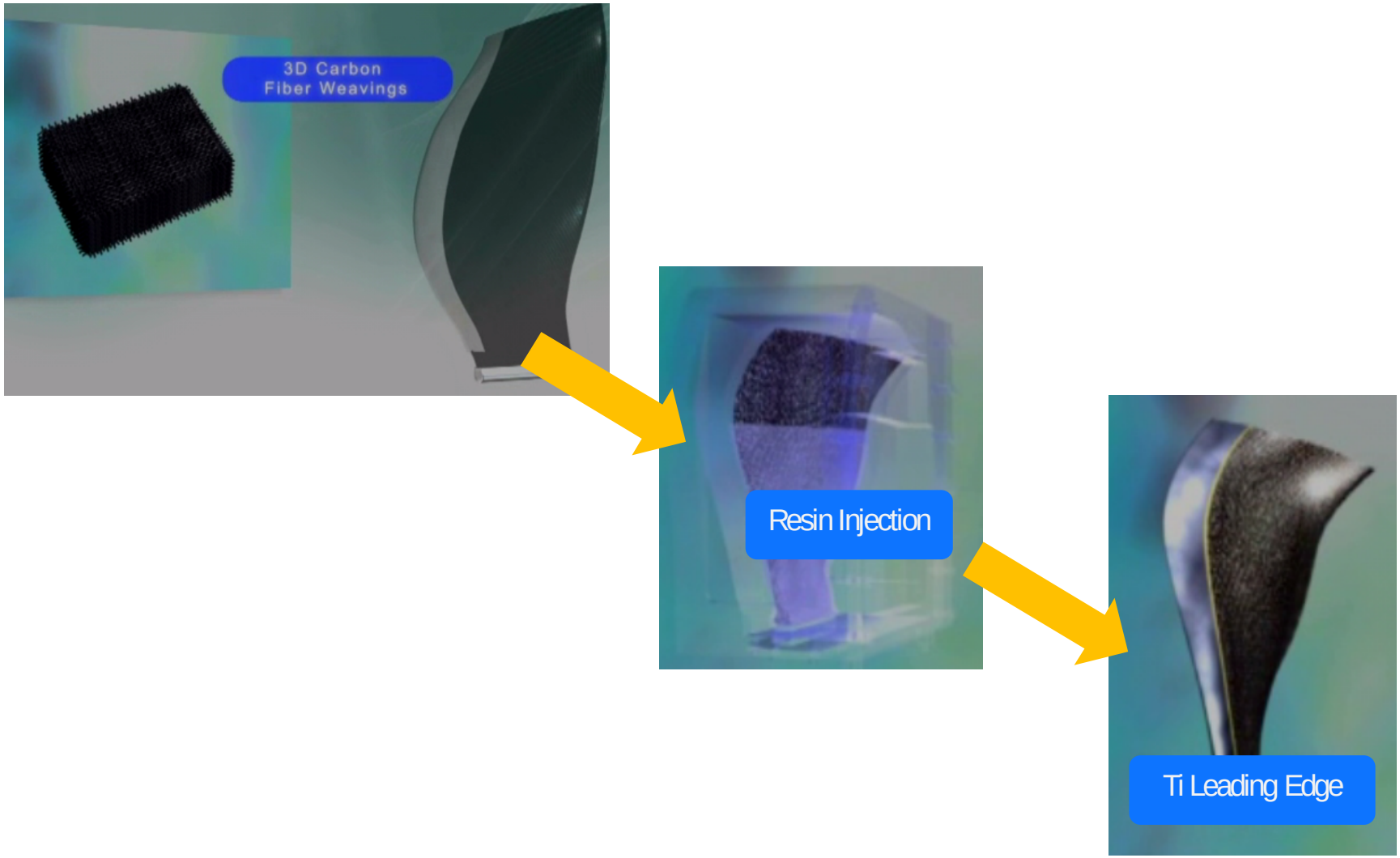
Fan blades technology … weight, noise and durability

	CFM56-5B	LEAP
Diameter	68in	78in
Blades count	24	18
Blades Material	Solid titanium	3-D woven RTM composite
Weight	BASE	50% less

Performance impact

- 11 BPR without weight penalties
- Enabling chapter 5 noise compliance
- High durability
- Maintenance free

Fan techno revolutionary in this thrust class



High pressure modules

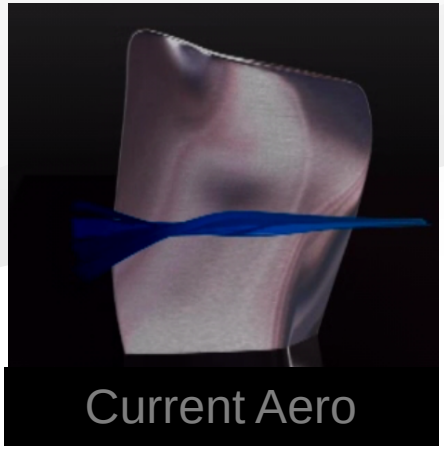
Technologies

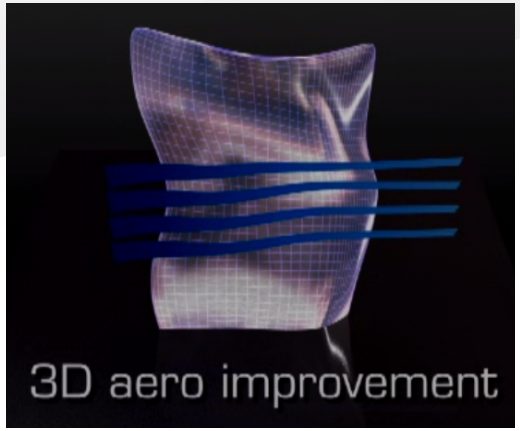
HPC third-generation 3-D aero blades

Leading edge design based on:

Advanced computer codes

- Airfoil shape optimized to reduce losses
- Blages long-term wear modeled to reduce deterioration



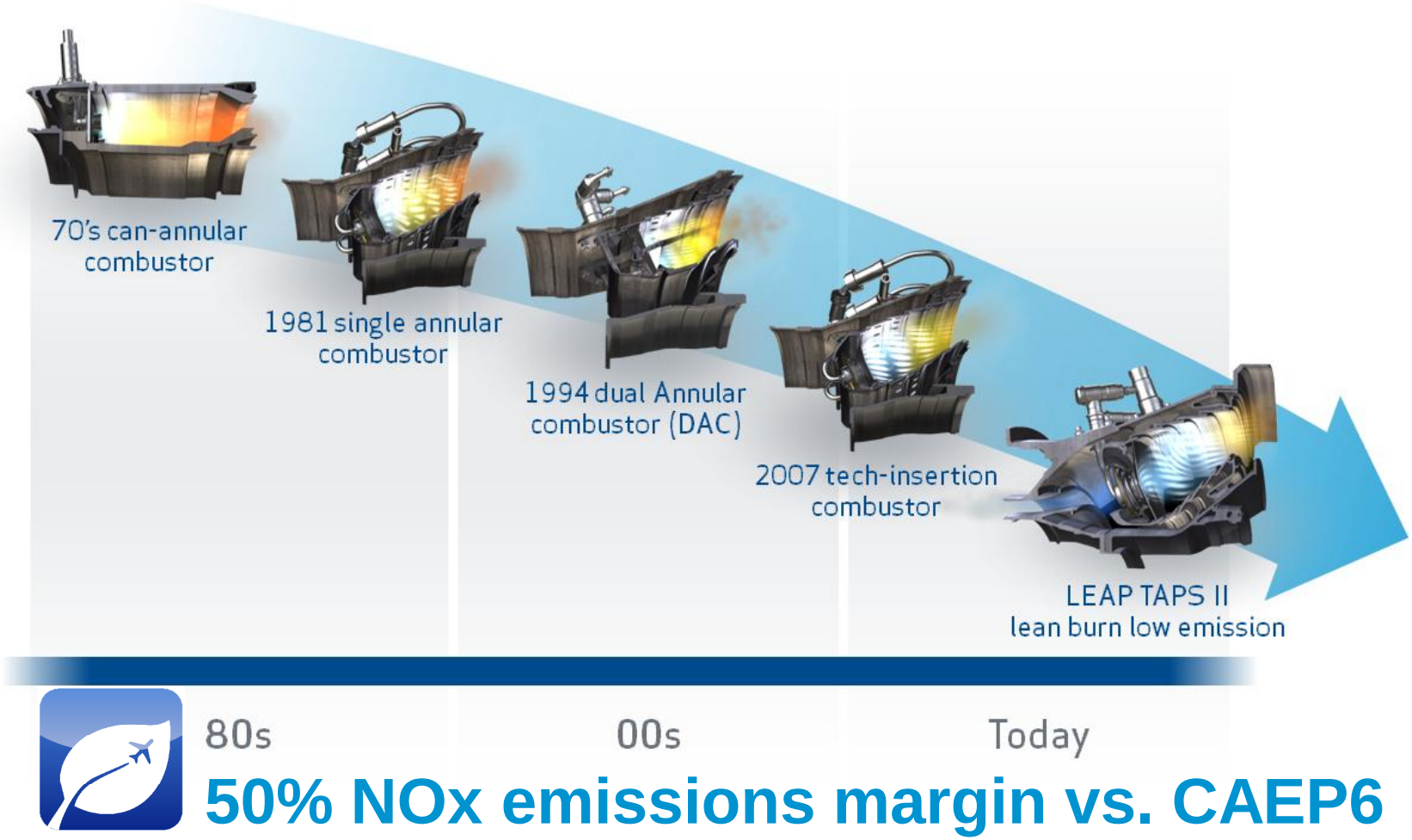


Increased efficiency

Reduced sensitivity to deterioration

Improved operability

Twin Annular Pre-Swirl (TAPS) Combustor : Dedicated technology to lower emissions



50% NOx emissions margin vs. CAEP6

High-tech High Pressure Turbine … maintenance cost under control

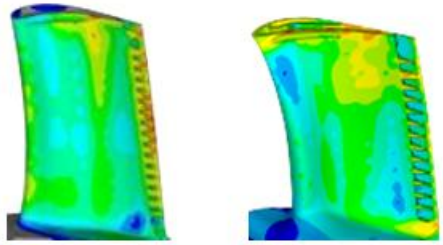
Advanced design

Better casting improved air passages

Better efficiency

Comparable metal temps

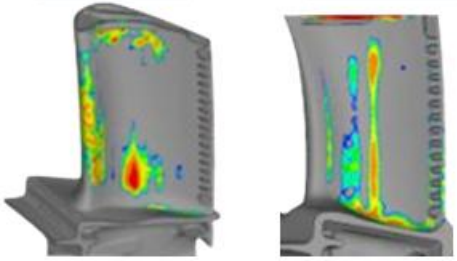
CFM56 LEAP



Hotter — Cooler

Similar LCF life

CFM56 LEAP



Δ-0°

As compared to CFM56

Same base material

Improved cooling

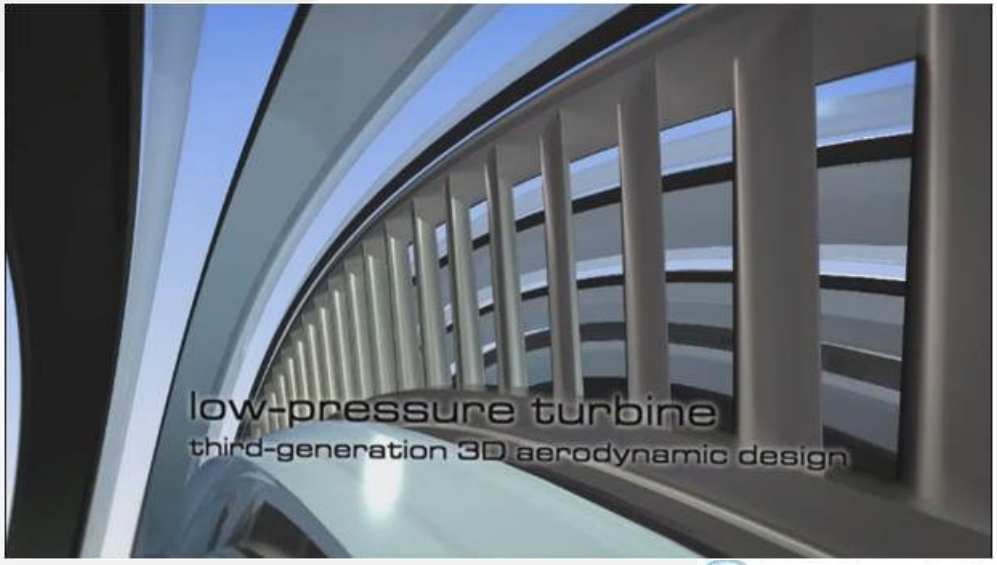
Better coatings

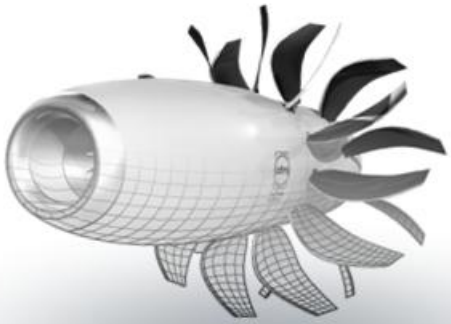
Low pressure turbine module

Technologies

LPT blades …
simple design, ultra high efficiency

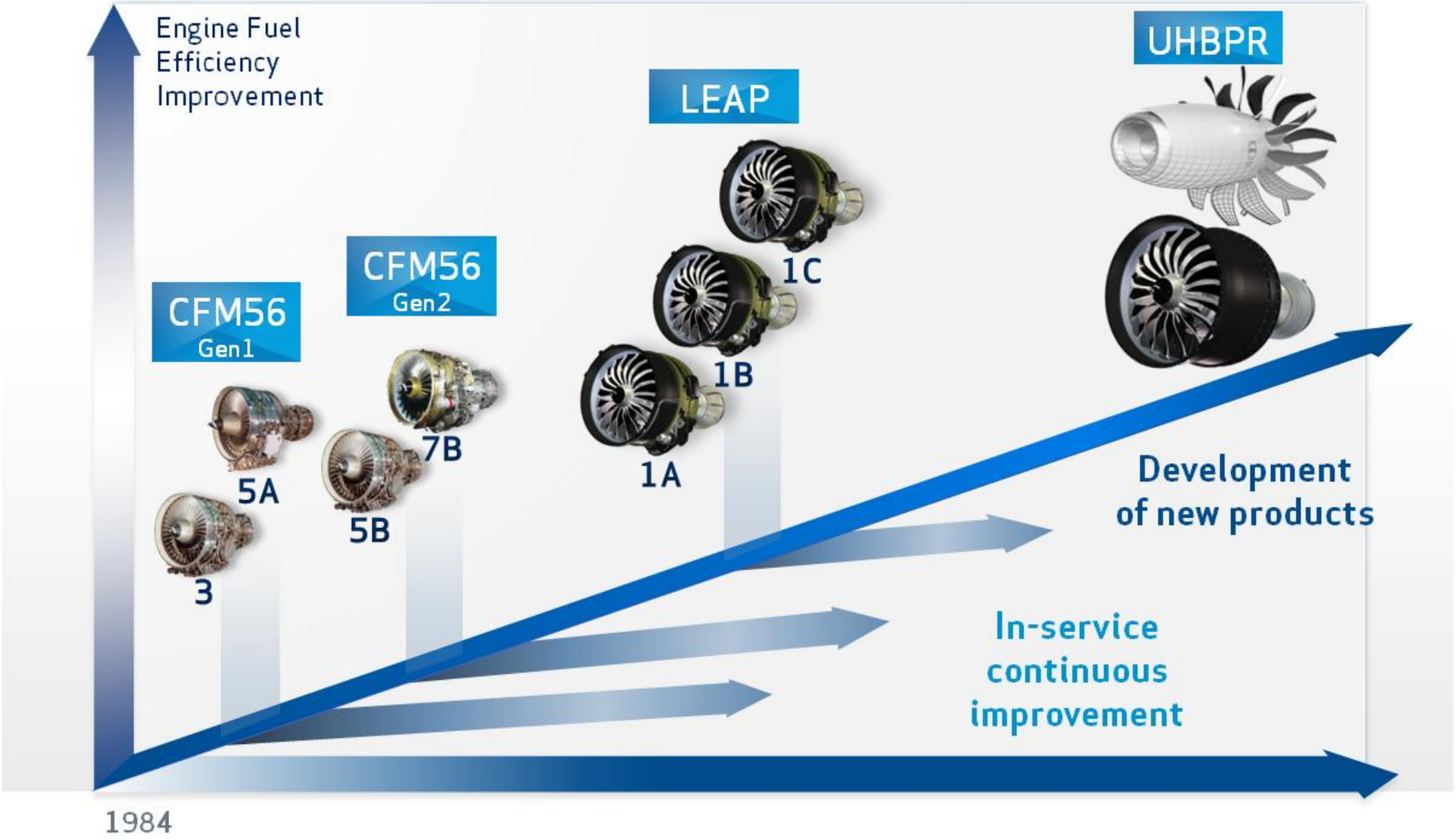
- Simple proven design
  - Low speed
  - Uncooled blades
- Increased performance
  - 3D aerodynamics
  - Multi-Stage 3D aero optimization
  - Blades & Vanes Clocking
  - New proven lightweight materials (TiAl)





Future Technologies

CFM's legacy


Engine Fuel Efficiency Improvement
CFM56 Gen1
CFM56 Gen2
LEAP
UHBPR
3
5A
5B
7B
1A
1B
1C
Development of new products
In-service continuous improvement
1984

Composite development timeline

Technology maturation and advancement

Unducted, composite fan blades (UDF)

80's

Composite fan blades (GE90)

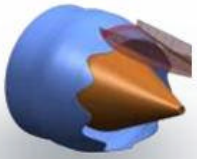
90's

Composite fan blades **and** case (GEnx)

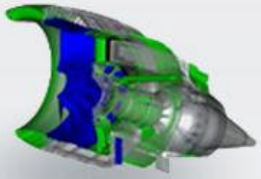
00's

High temp composites (turbine blade)

Moderate-temp composites (Core nozzle)



Expanded low-temp composites



10's

Future fuel burn reduction requires more than an engine

New engine
(technologies, architecture …)

New concepts in engine / aircraft integration

Electric aircraft

New Alternative Fuels

- Safran is part of national or international Research Programmes (Calin, Dream, Alfabird, Swafea, CAER, etc..)
- Contributes to the establishment of Alternative Fuels Roadmaps through Corac (CoFrance), ACARE (Europe), CAAFI (USA), etc..
- Supports to the development of biofuels production demonstration units
- Contributes in evaluation and qualification of new alternative fuels through ASTM International
  - Direct involvement or involvement via CFM including engines ground tests and flight demonstrations

Illustration : usage of reports of a Continental flight with CFM56 engine in a research report to ASTM

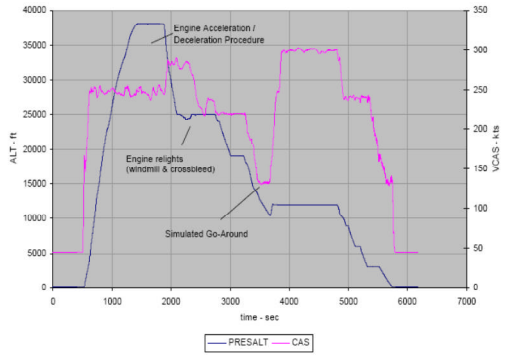


Figure 3-25. Continental Airlines 737-800 Flight Test Profile on January 7, 2009

Evaluation of Bio-Derived Synthetic Paraffinic Kerosenes (Bio-SPKs) PAGE 130 of 137
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- No specific change requested in Engine design

§ Corac : Conseil pour la Recherche Aéronautique Civile
§ ACARE : Advisory Committee for Aviation Research and Innovation in Europe
§ CAAFI : Commercial Aviation Alternative Fuels Initiative