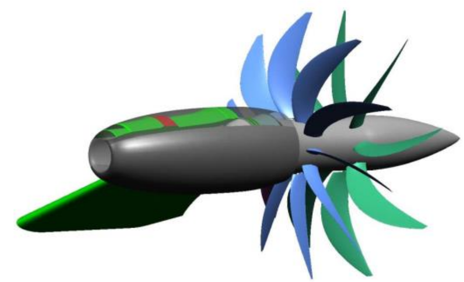
La Nuova Generazione Motori Aeronautici
Nuovi Concetti e le Sfide Ambientali



3° Incontro - Napoli, 25 Ottobre 2014

Scuola Politecnica e delle Scienze di Base
Piazzale V. Tecchio 80, 80125 Napoli

Mi Presento

Luigi Cascone – Socio Aeropolis

- Laurea in Ingegneria Aeronautica Politecnico di Napoli; in AleniaAermacchi dal giugno 1980 al novembre 2012.
- Topics di carriera: Responsabile Avamprogetto Velivoli da Trasporto Civili e Militari AleniaAermacchi Pomigliano D’Arco.
- Programmi: G222 Libia, A320, ATR42/72, R92/122, Anfibio, Supersonico, AirJet Family, C27J, AIA Family, A400M, SSJ100, NTP.
- Programmi di ricerca: VMA, VTA, Cryoplane, Awiator, Hisac, JTI

Introduzione

La filosofia di progetto di un nuovo velivolo ha subito negli anni una radicale trasformazione.

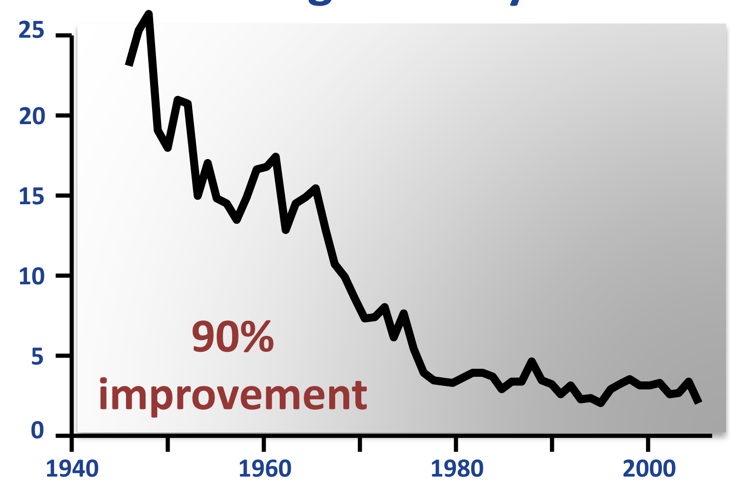
Il mercato richiede macchine sempre più efficienti:

- **Riduzione dei costi di esercizio**
  - Bassi consumi
  - Manutenzione facile ed economica
- **Migliore Impatto ambientale**
- **Maggiore confort per il passeggero**

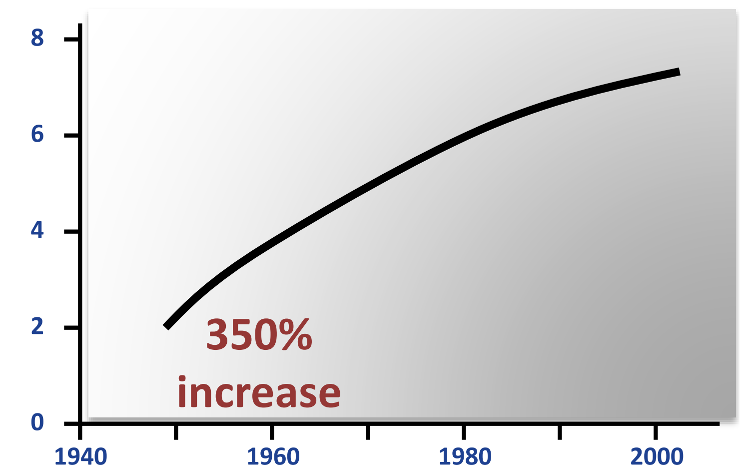
La propulsione permette di ottener per nuovo prodotto i vantaggi più rilevanti in termini di consumo e impatto ambientale e quindi di costi operativi.

50 years of engine improvements

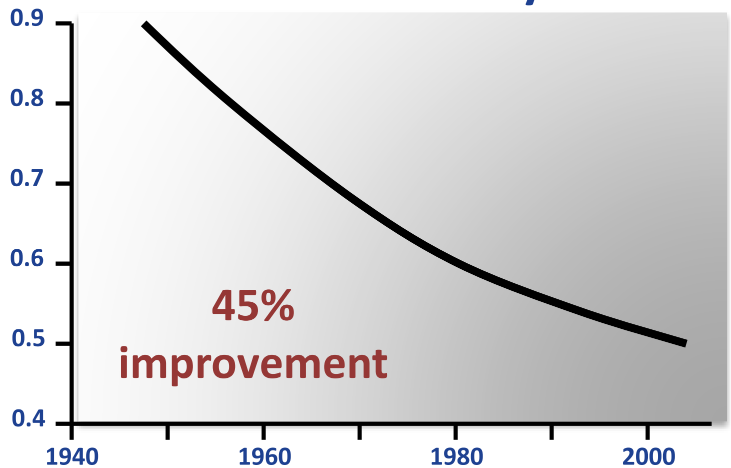
Flight Safety



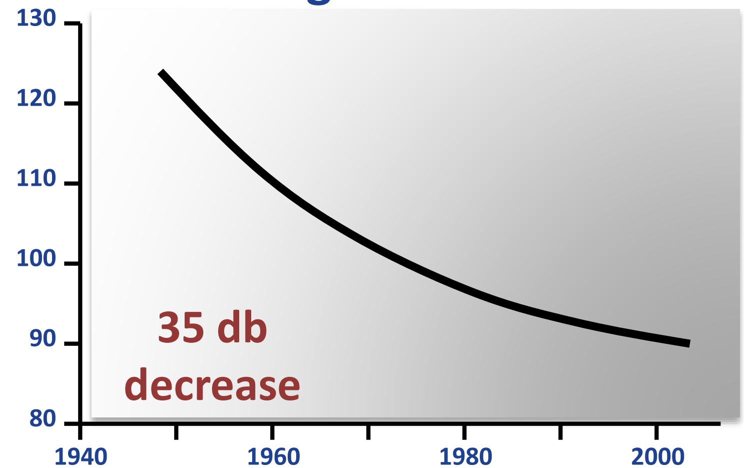
Thrust to Weight



Fuel Efficiency

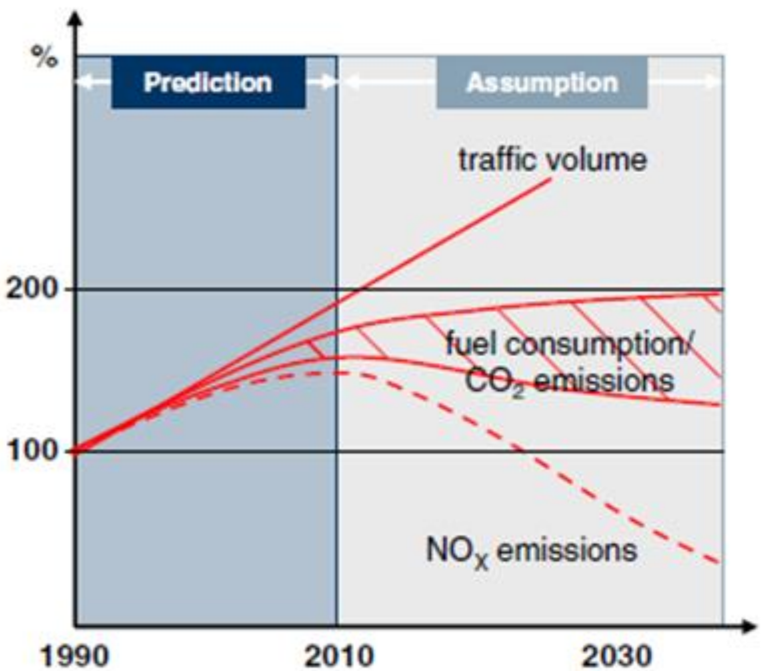


Engine Noise



Crescita del Traffico

Studies show that emissions can be limited by the help of new environmentally friendly engines



Sources: Airbus; DLR

Further reduction in CO_2 – emissions and fuel consumption by

- *advanced aircrafts (weight, aerodynamics)*
- *more efficient engines*
- *improved air traffic management (ATM)*

Requisiti

Commercial requirements for next generation of aircraft impose significant challenges

	2012-2015 short / mean term	2020 (ACARE)
Fuel Burn, CO_2	-15%	-20% (engine)
Noise Reduction (rel. to stage 4)	-20dB	-30 dB
NO_x, CO and HC (rel. to CAEP 2)	-60%	-80%
Maintenance Cost	-30%	-40-50%
Accident Rate		-80% (IFSD->0)

Next Generation´s Commercial Aircraft Concepts

Quiter, Cleaner, Reduced Greenhouse Effect

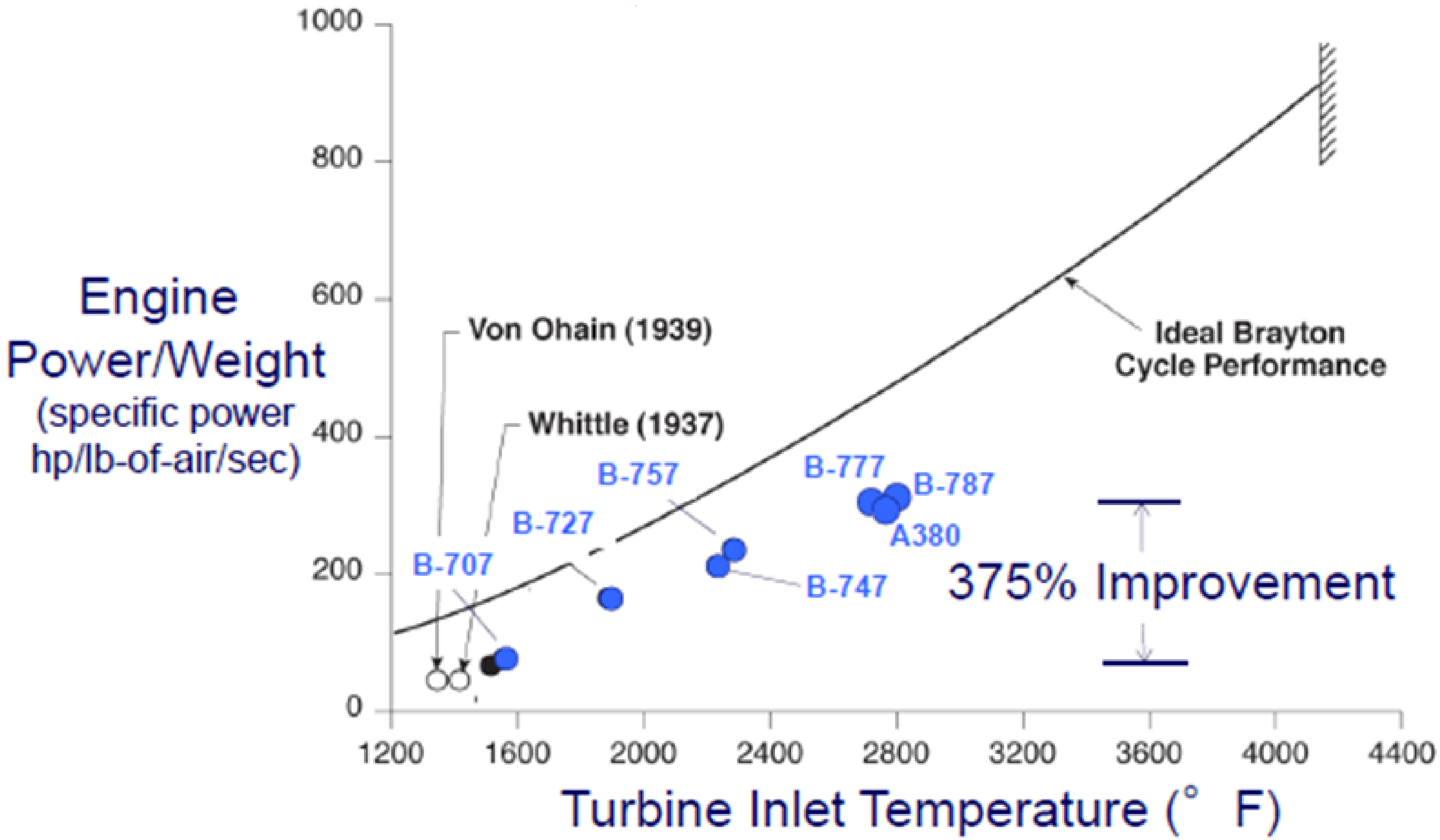
Reduced Cost Improved Economics

Improved Reliability

→ Noise features strong economic impact
→ Noise and C02 Emission constraints have to be resolved together

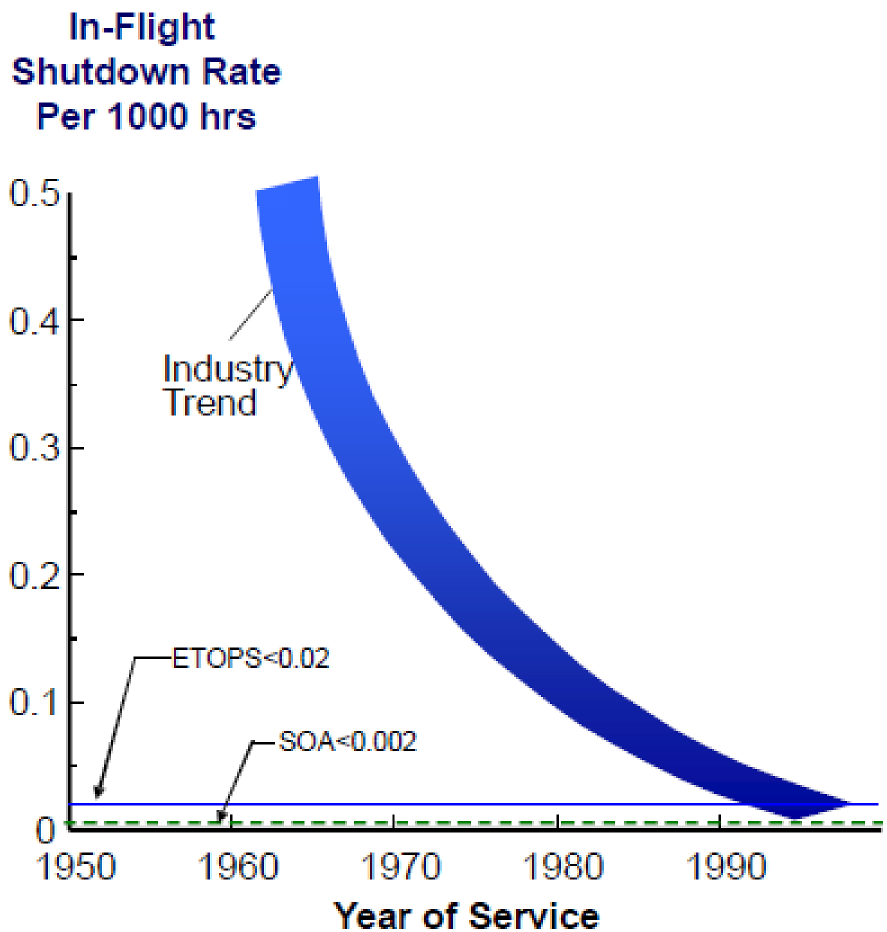
The Problem of the Aviation Engine

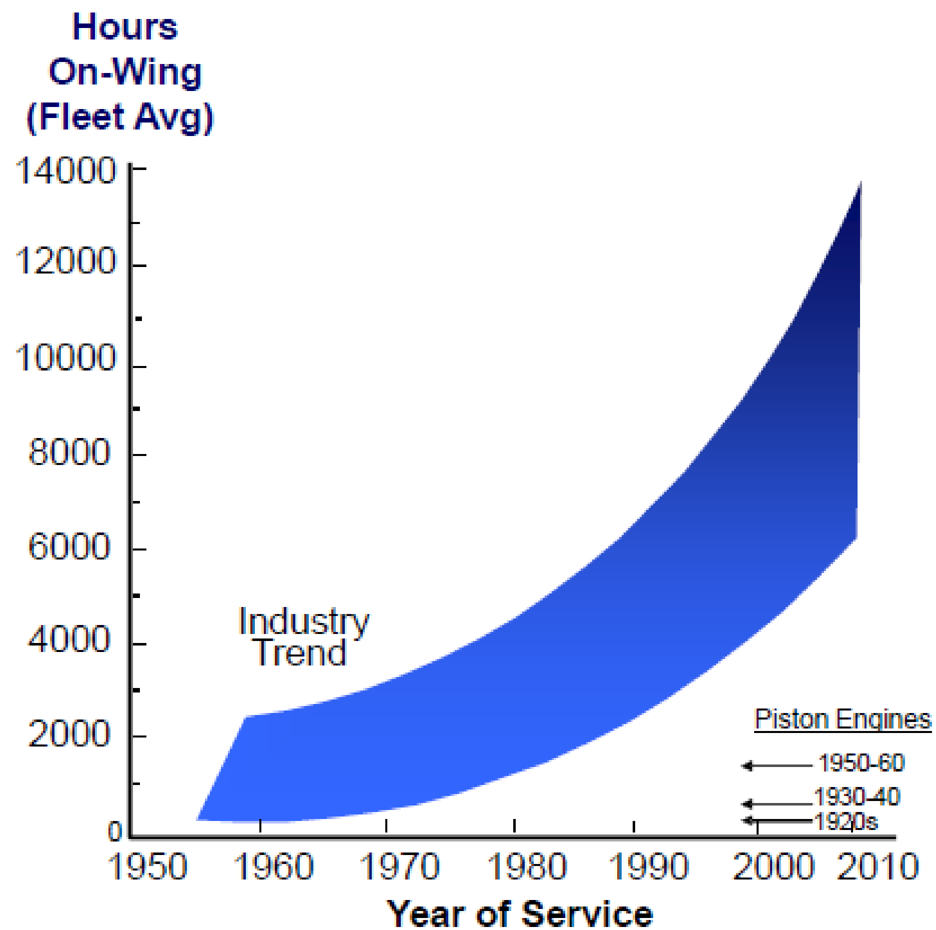
Is the combination of power and lightness……….



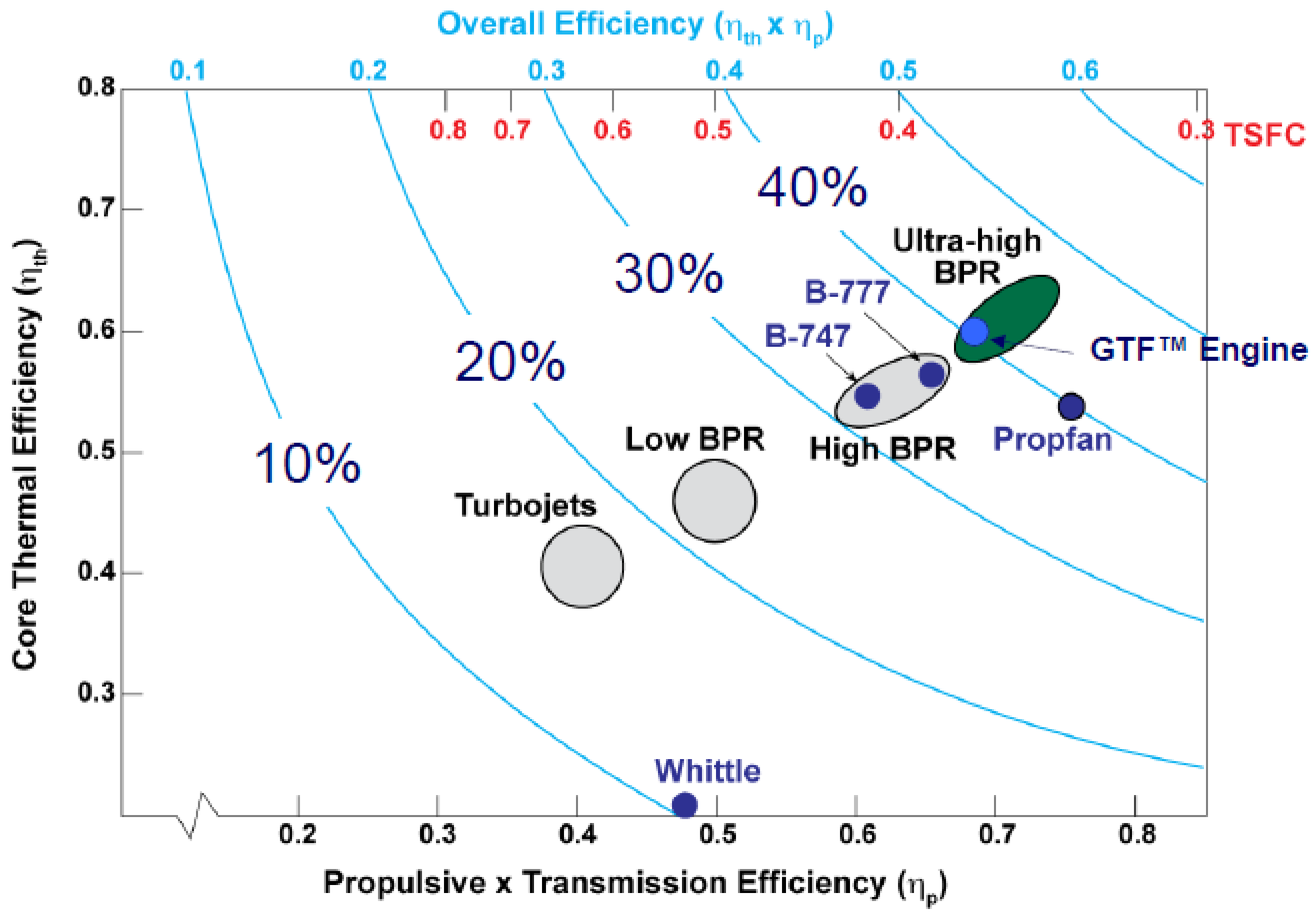
The Problem of the Aviation Engine

Is ……and reliability.

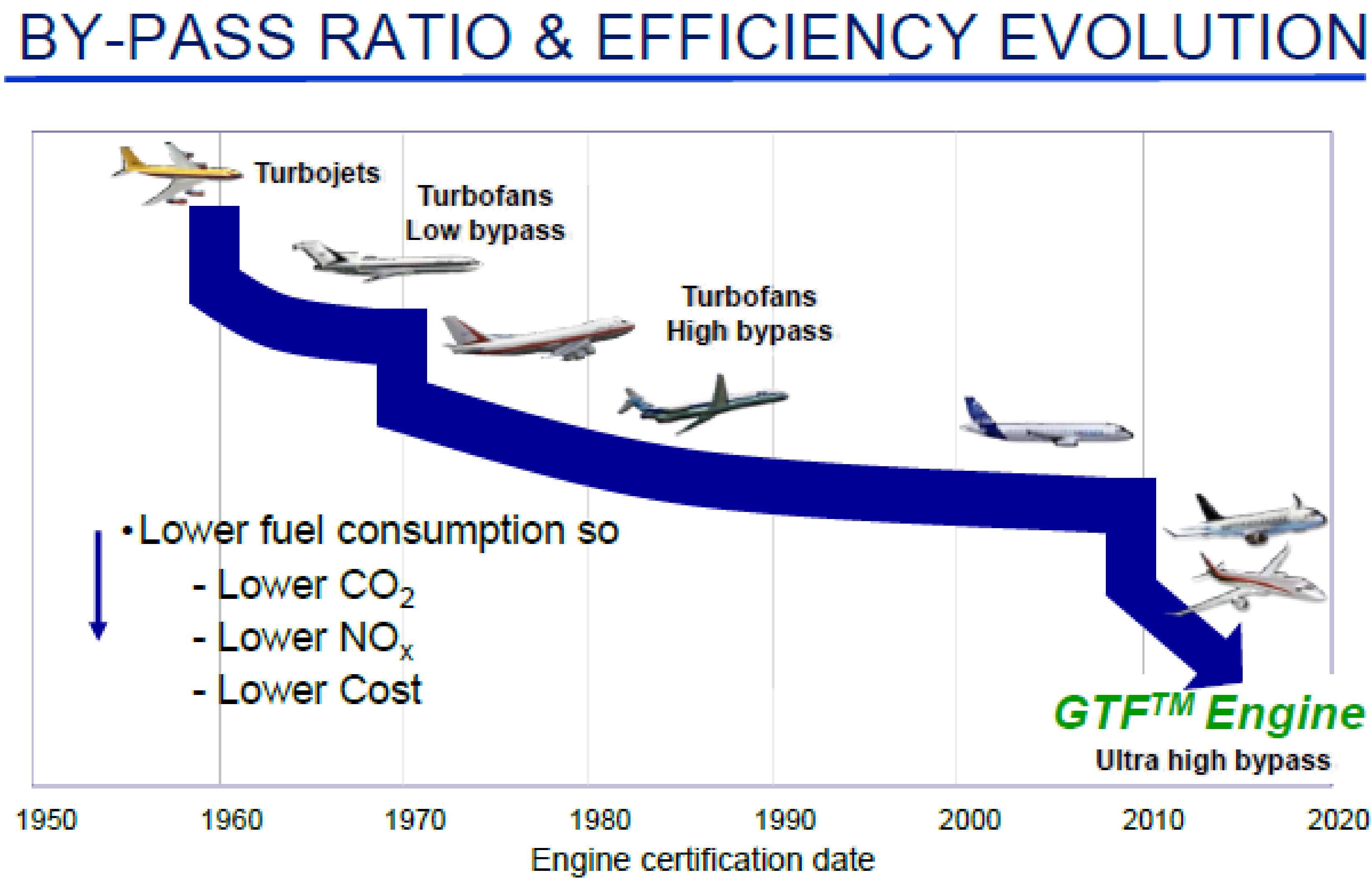




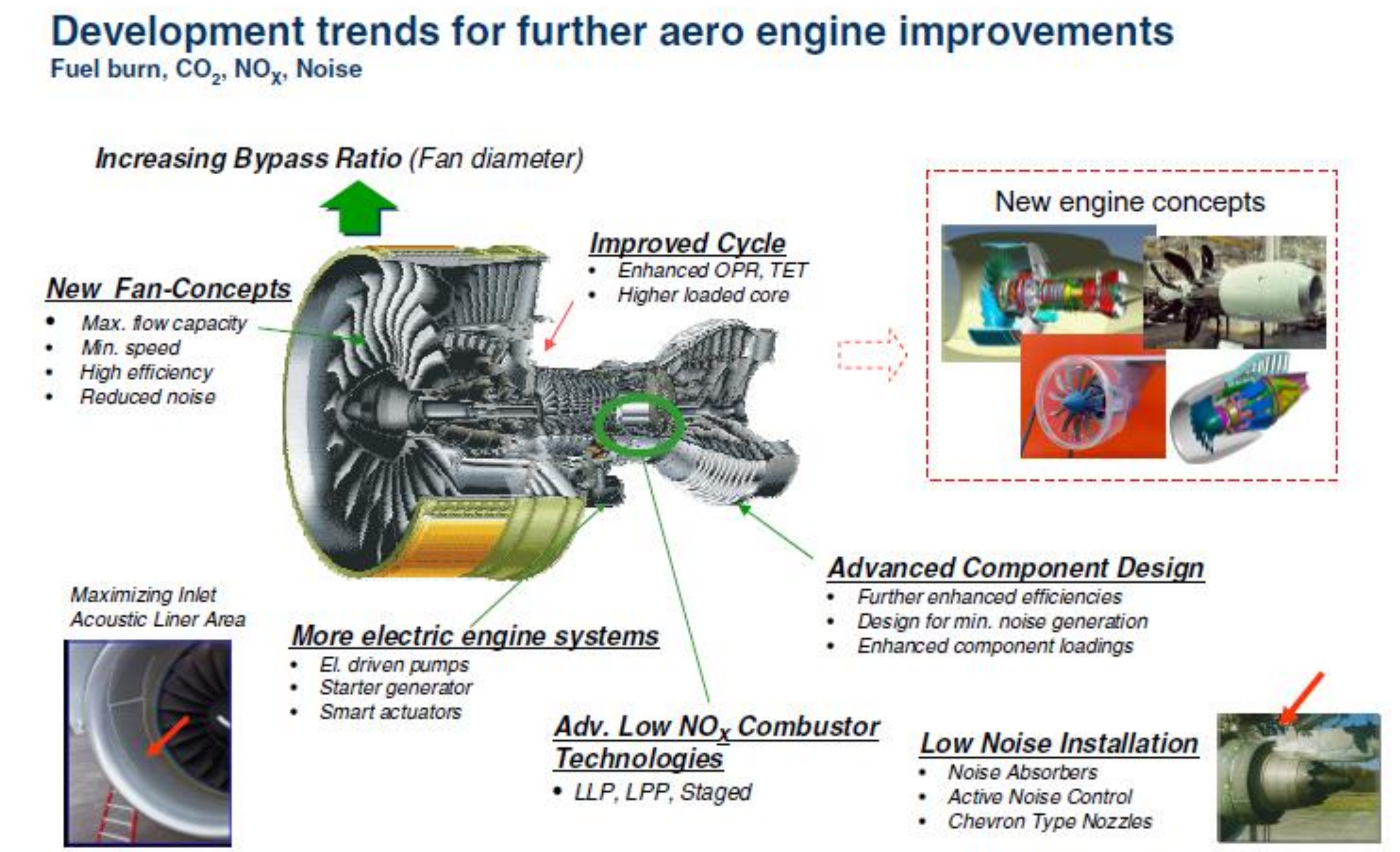
Efficienza dei motori aeronautici



Efficienza dei motori aeronautici



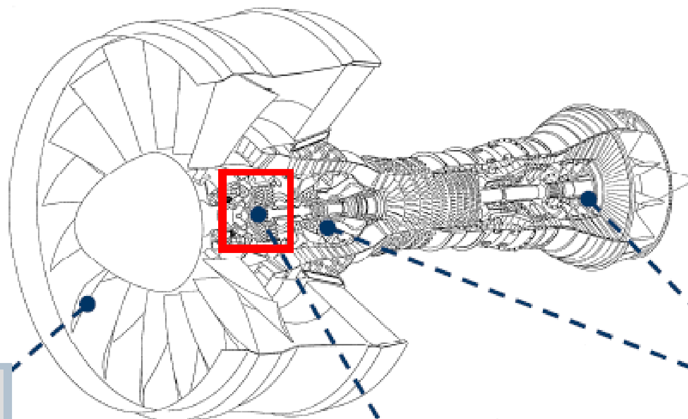
Trend di sviluppo per i nuovi motori aeronautici



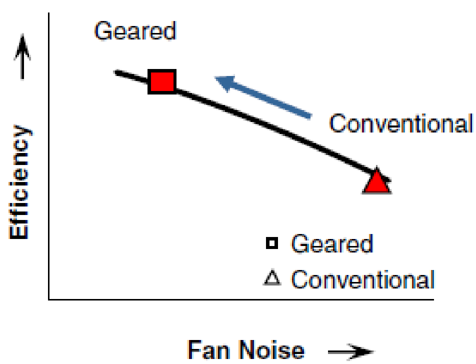
Geared TurboFan GTF

The Geared Turbofan for maximum propulsive efficiency and minimum noise

Geared Turbofan
BPR = 12+
OPR = ~40-50



Low Speed Fan



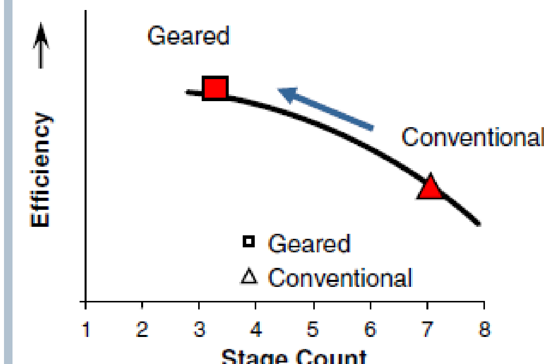
Improved Efficiency
Reduced Noise Level

Gearbox

→ Optimal RPMs for Fan and LPC / LPT

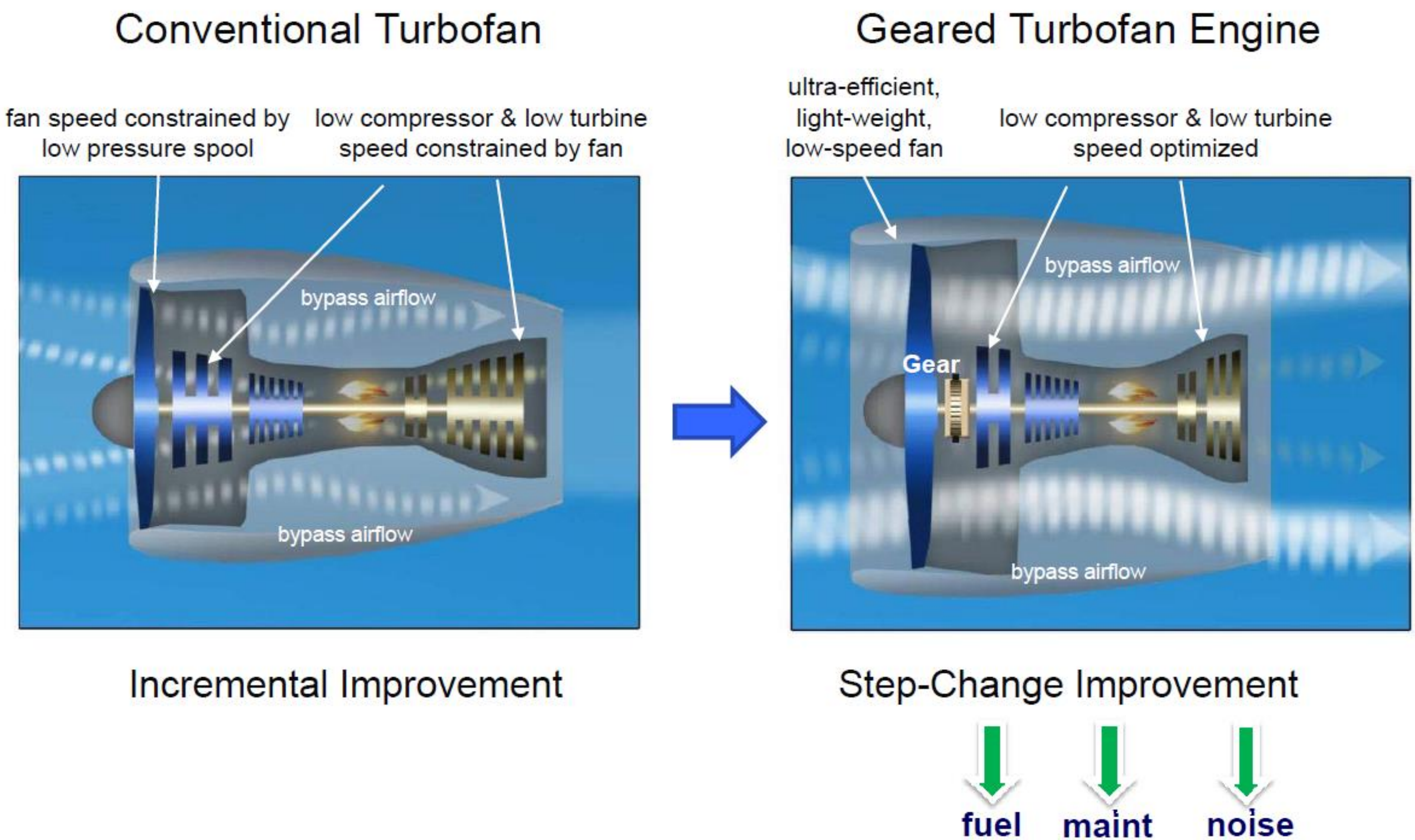
→ Lower SFC
Reduced Noise Level
Lower Emissions

High Speed LPC & LPT



Improved Efficiency at Reduced Stage Count / Costs

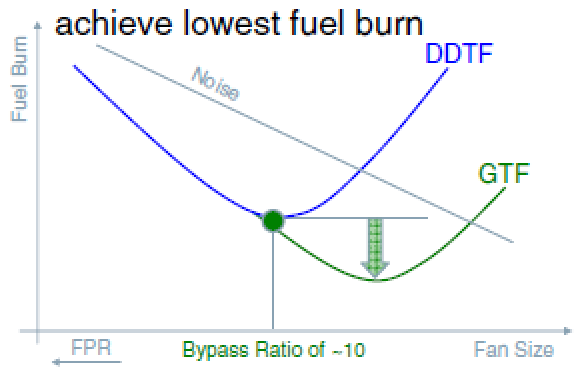
GTF :Step change in efficiency

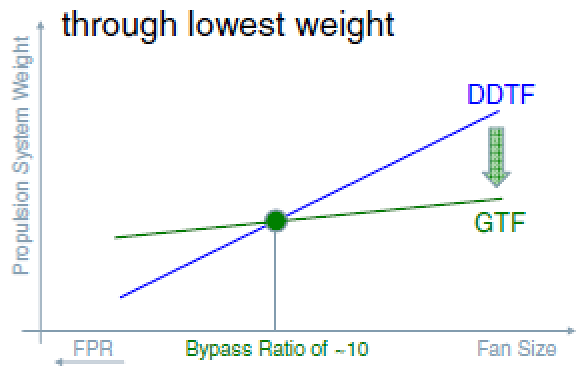


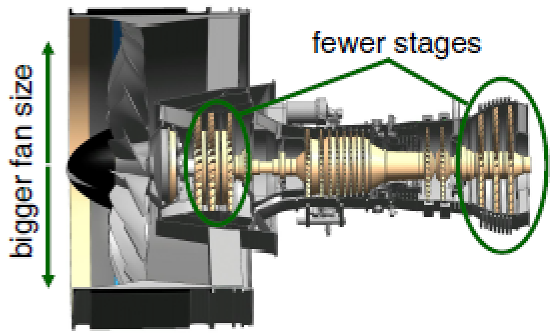
GTF :Step change in efficiency

Resulting benefits from the Geared Turbo Fan Concept

Reduction of Fuel Burn Due to Lower Propulsion System Weight at Higher Bypass Ratios





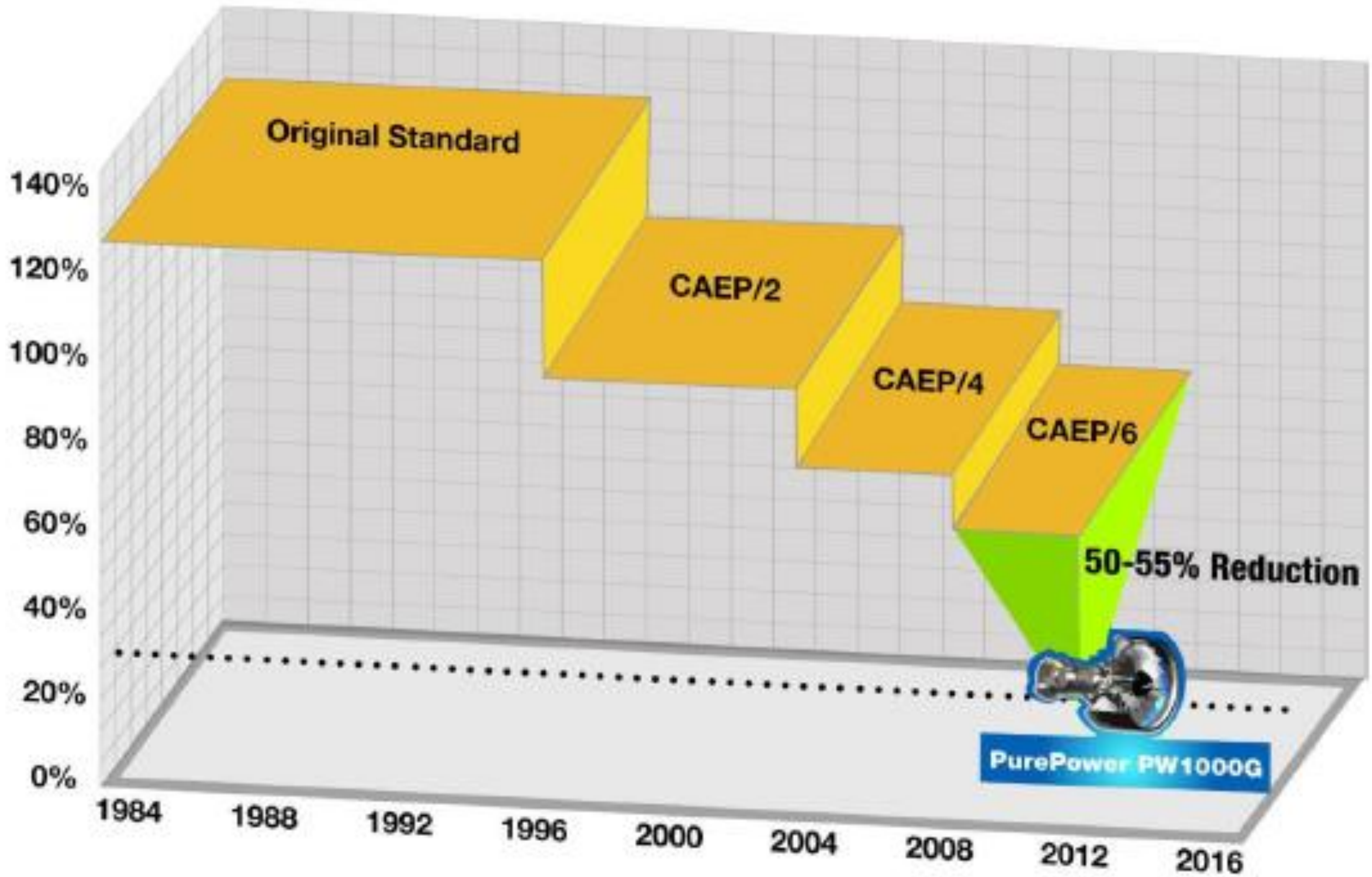


Larger fan and higher BPR w/o weight penalties
Fuelburn optimum moved to higher BPR

GTF :Step change in efficiency

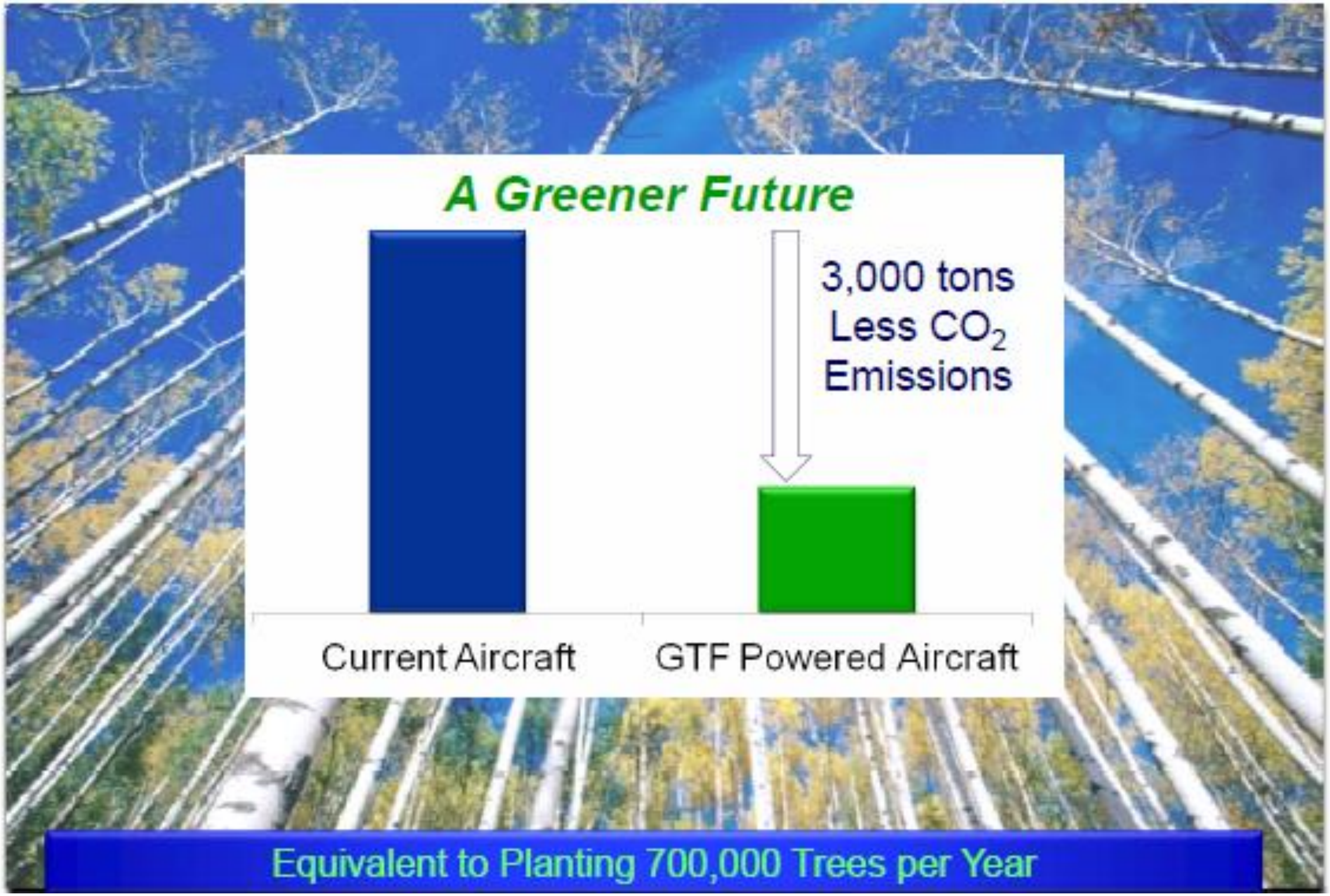
Significativa riduzione di emissioni

Più del 50% di NOx rispetto ai più stingenti regolamenti



GTF :Step change in efficiency

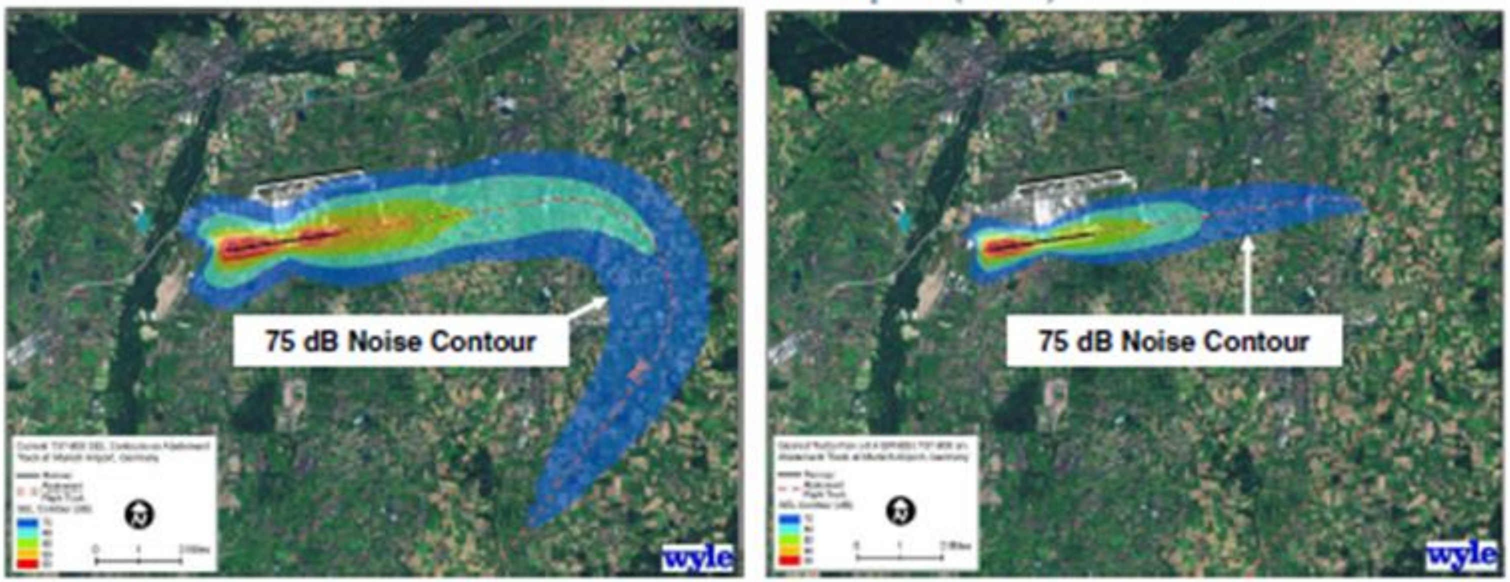
Riduce drasticamente le emissioni di CO_2



GTF :Step change in efficiency

GTF airport noise

Munich International Airport (MUC)



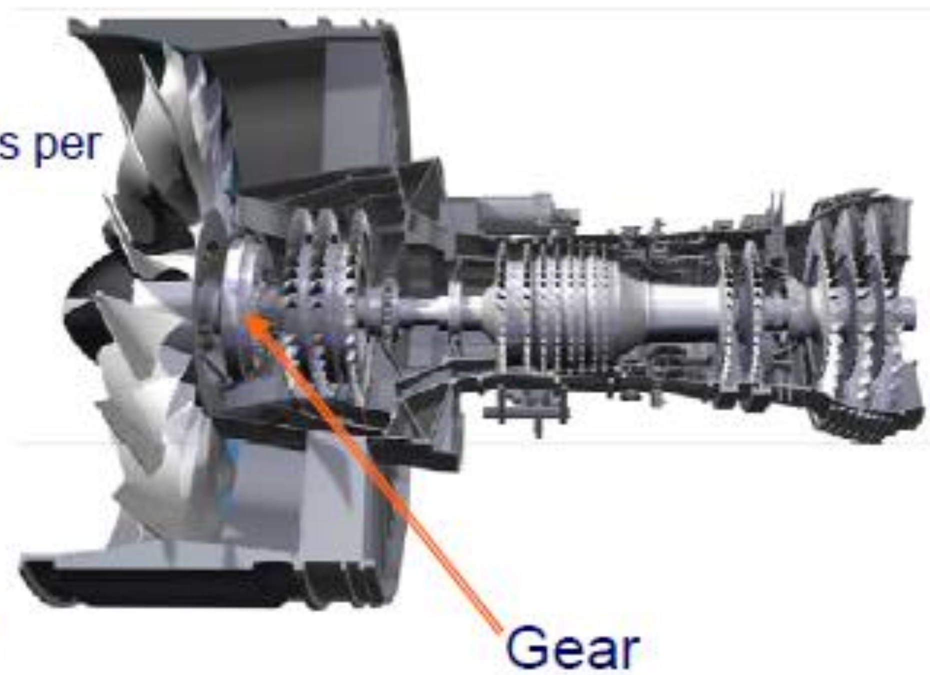
Today's Aircraft | GTF Powered Next Generation Aircraft

72% reduction in 75dB Single Event Noise Contour

GTF :Innovative New Engine Design

Engine benefits

- Fuel burn improvement 16%
- CO_2 emissions reduced by 3000 Tonnes per aircraft per year
- NOx emissions cut in half
- Noise levels of Stage 4 minus 20 dB
- 1,500 fewer airfoils
- Lower maintenance cost
- $1.5M annual cost savings per aircraft

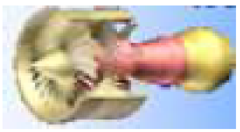


The Comprehensive Approach to Economic and Environmental Operation

GTF :Step change in efficiency

Necessità di una forte crescita tecnologica e di utilizzo nuovi materiali per recuperare il ritardo con GTF

Adv. Turbofans



3- spool

- High stage count (20+)
- Big size and volume (LPT)
  => weight

2- spool

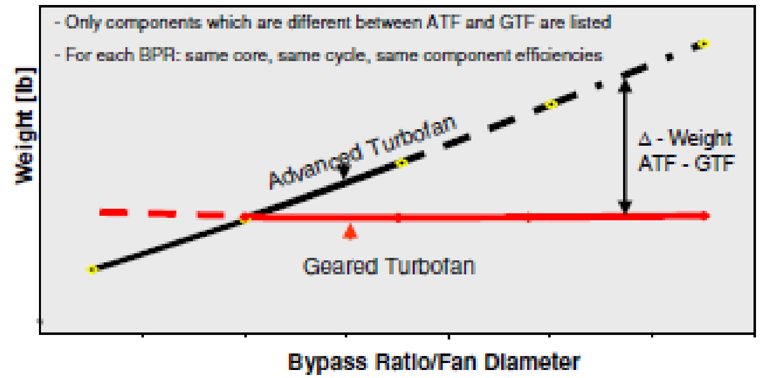
- Ultra high loaded low spool (aerod.)
- New lightweight materials beyond TiAl
- High torque shaft for small cores
- etc

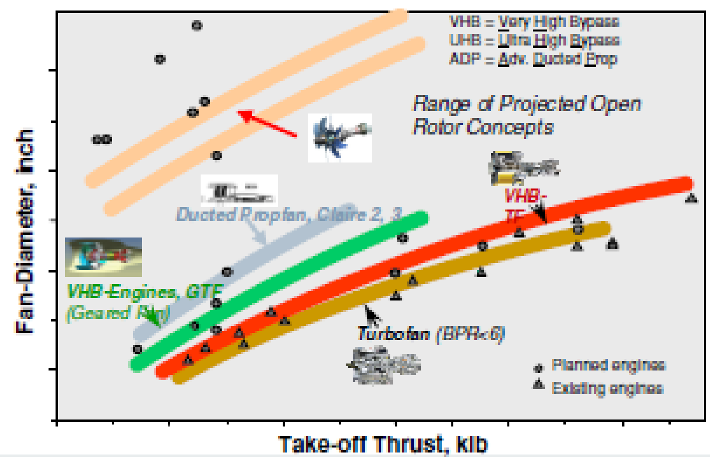
Open rotor

Tractor

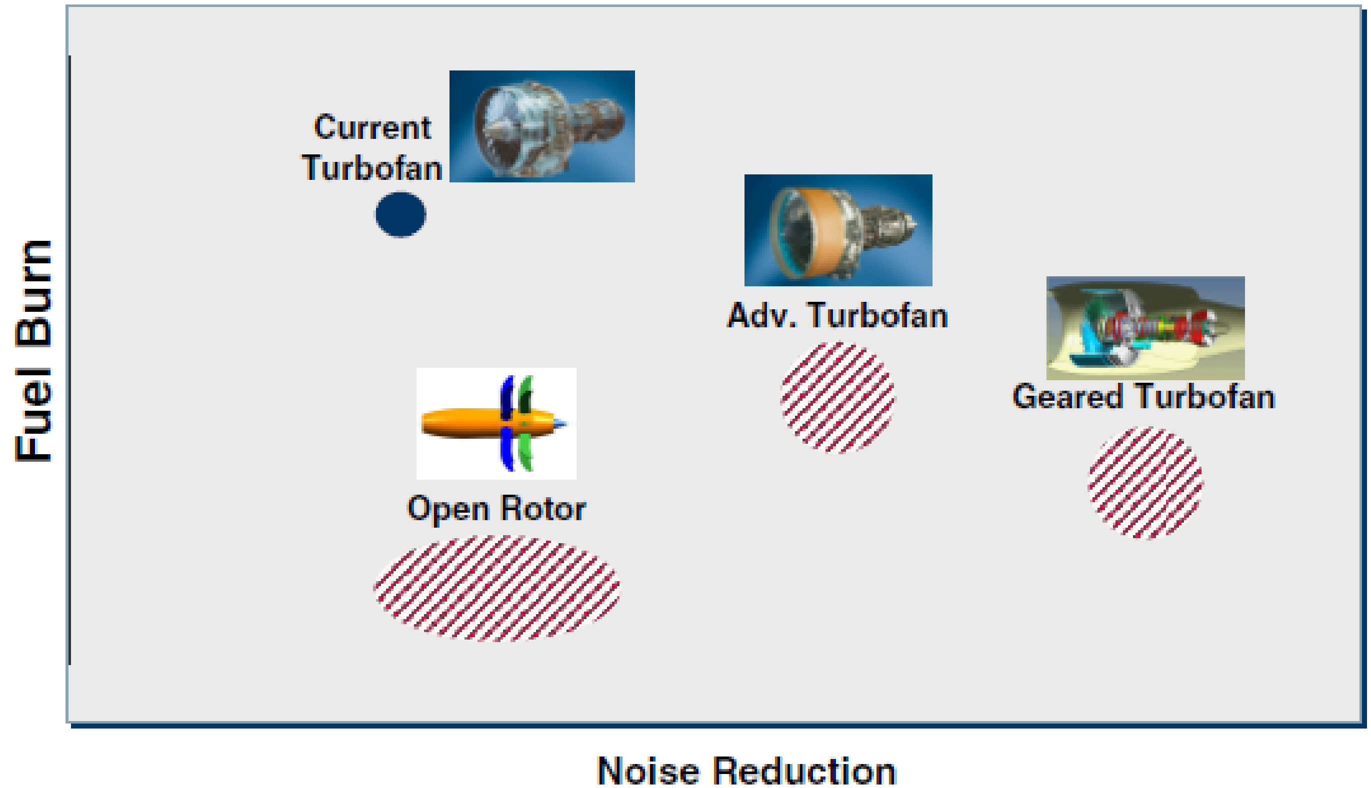
Pusher

- Big Propeller diameters
- Noise and installation issues
- Geared vs. direct drive Propeller
- Variable Prop. pitch mechanism
- Certification criteria
- Tractor or pusher architecture





GTF Positioning



- GTF appears most promising for future civil aircraft propulsion;
- Noise and installation deficits may jeopardize the Open Rotor

Next Generation Regional Turboprop NGRT

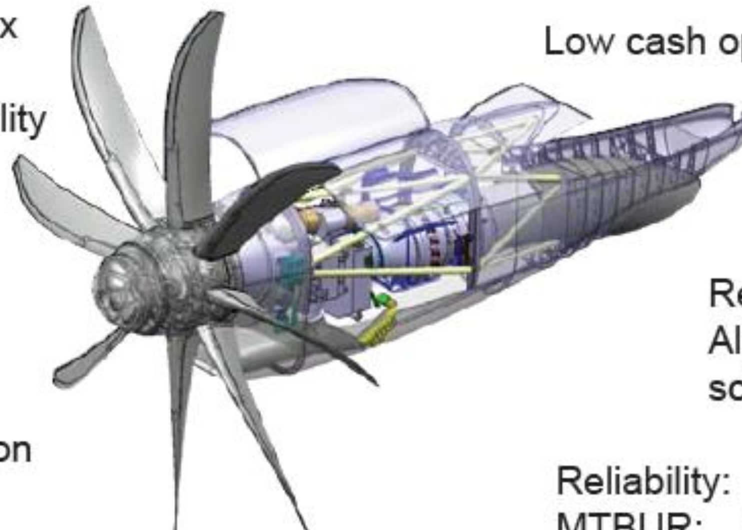
Design Objectives

Reduced Noise & Emissions (NOx, CO2)

20% fuel saving vs current fleet
Minimum frontal area / Minimize drag

Platform for 70-100 pax
turboprop application
Built-in Growth Capability

Low cash operating cost



Integrated Powerplant

2016 EIS availability

Reduced Maintenance Tasks
Alignment with aircraft
scheduled maintenance

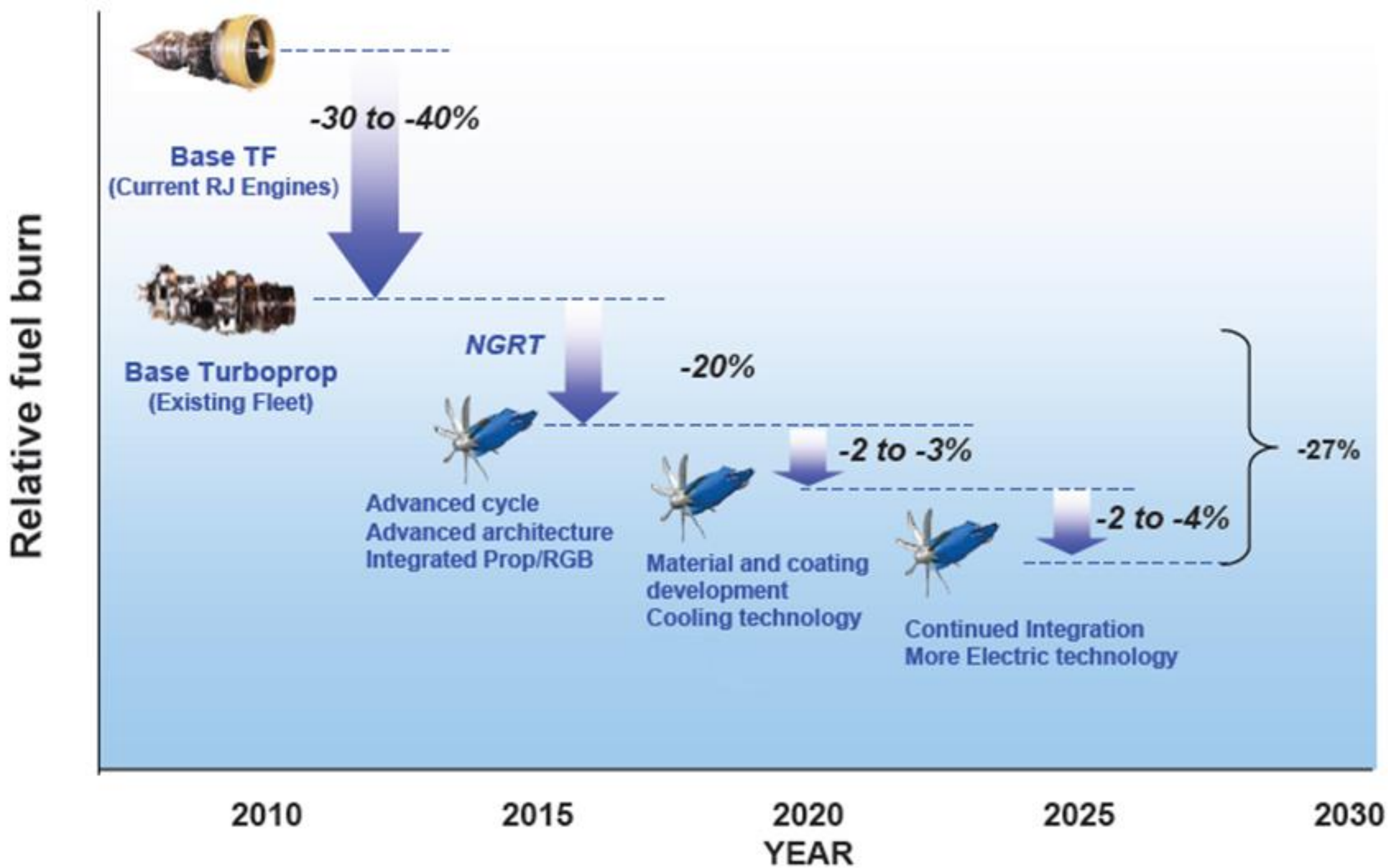
Leverage Next Generation
Product Family (NGPF)
Technology

Reliability:
MTBUR: 1 event / 50,000 EFH
IFSD: 1 event / 200,000 EFH

30% improved power/weight vs PW127

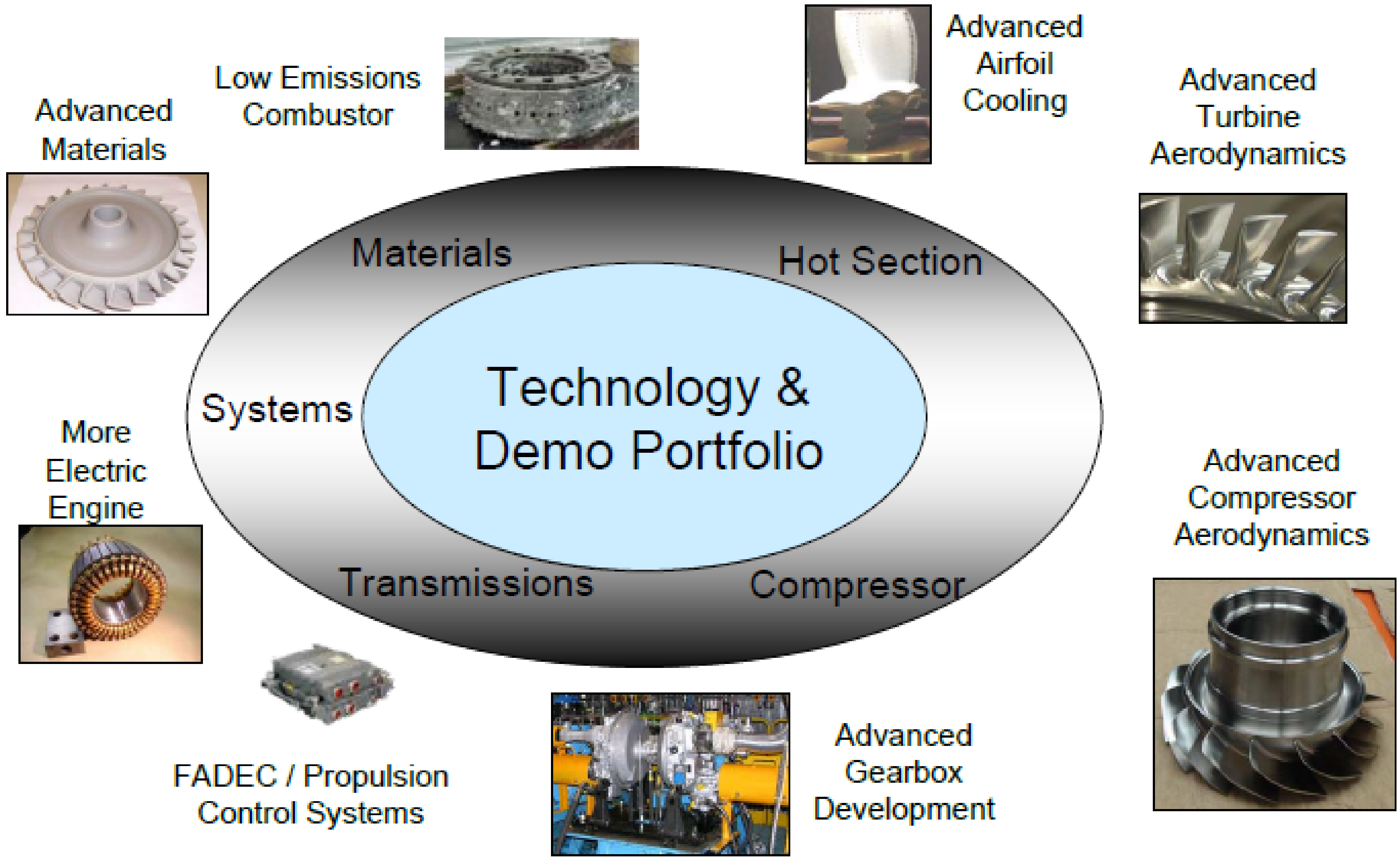
Durability:
15,000 hours on wing
15,000 cycles minimum LCF

NGRT Design Objectives



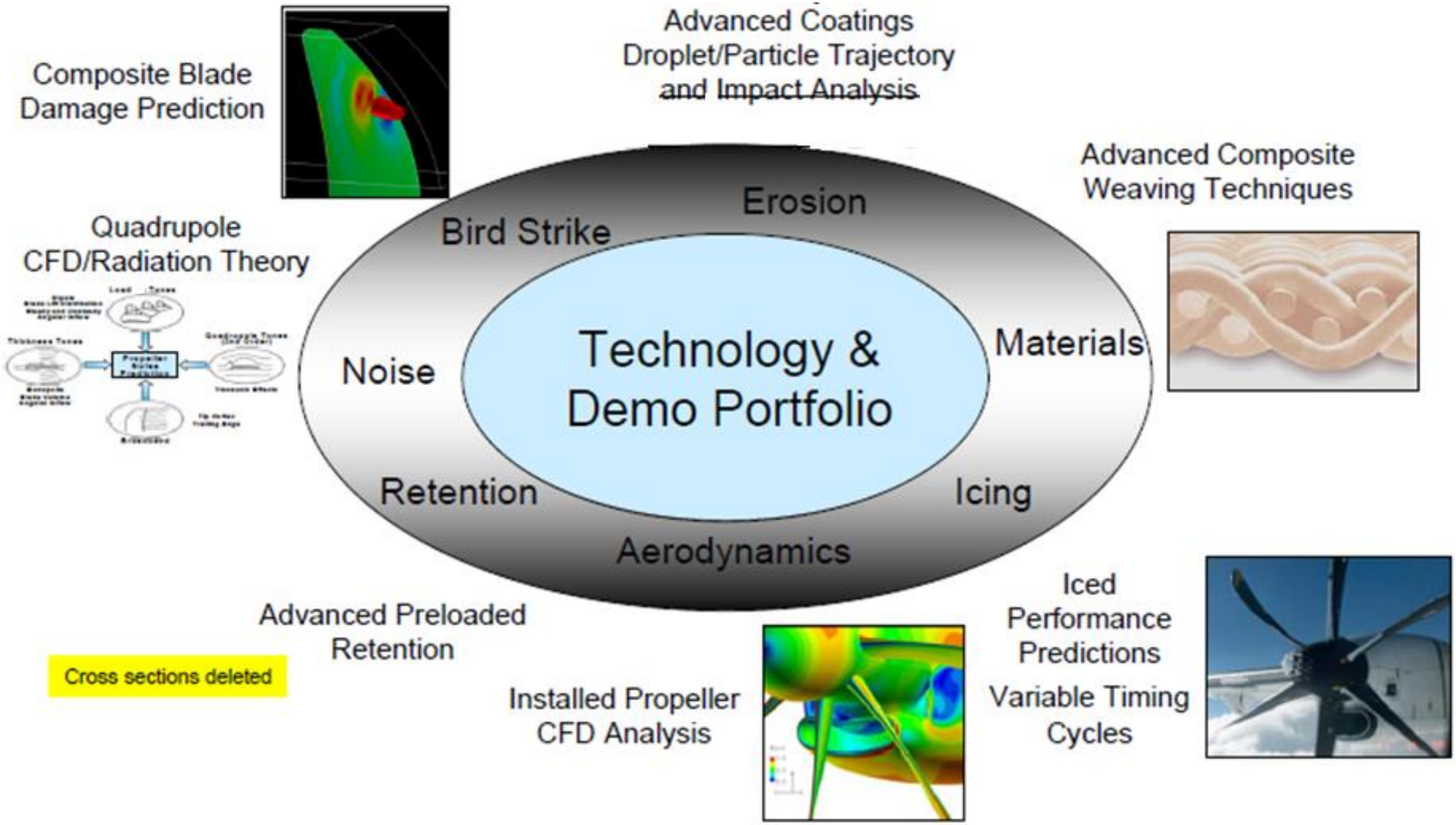
NGRT Technology

Engine



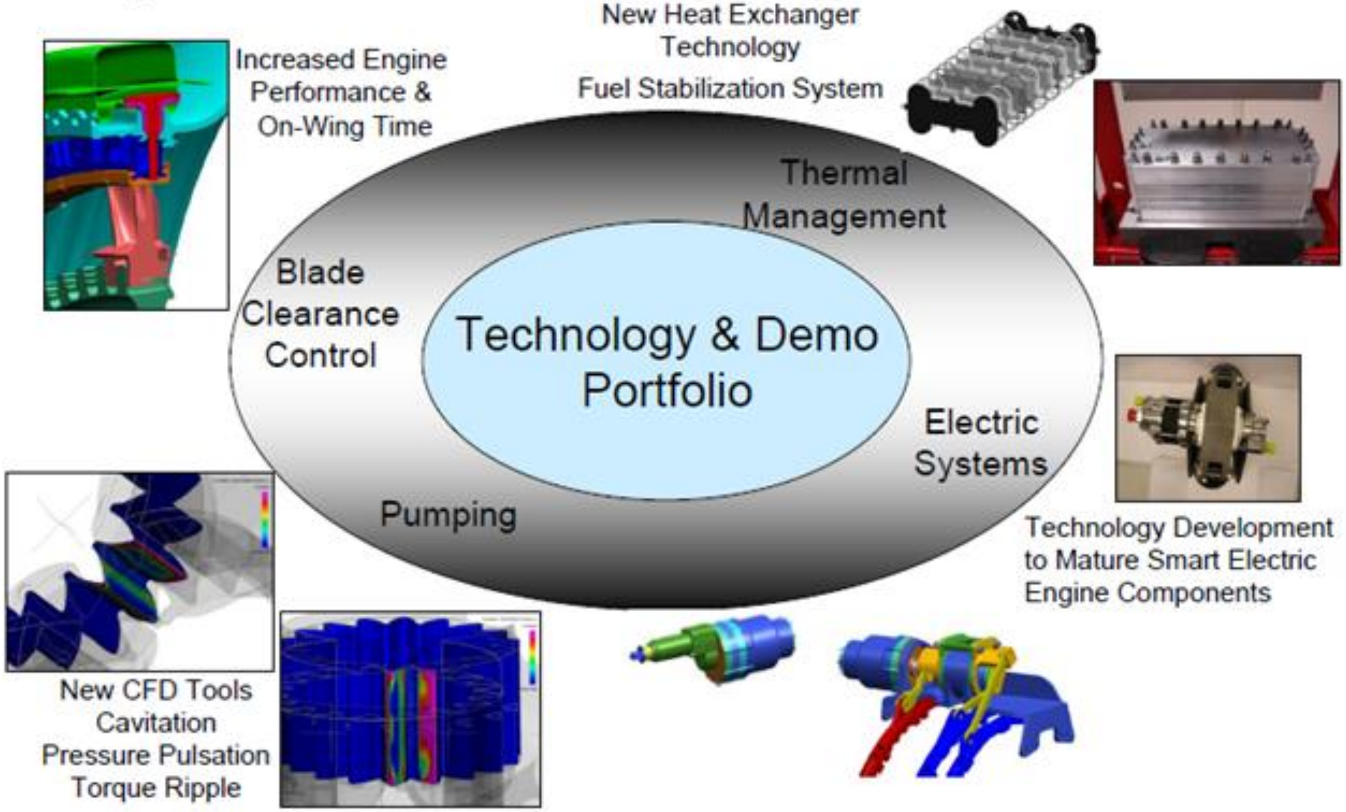
NGRT Technology

Propeller



NGRT Technology

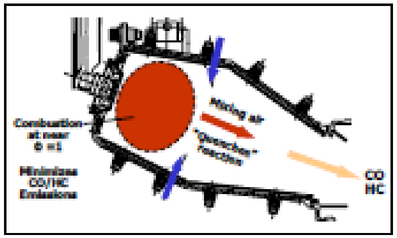
Accessories & Controls



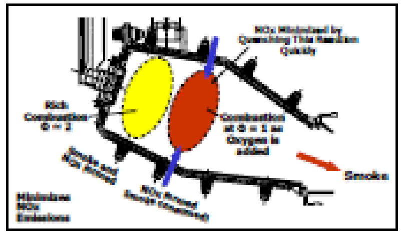
NGRT Technology

Talon Combustion System

Conventional Combustor



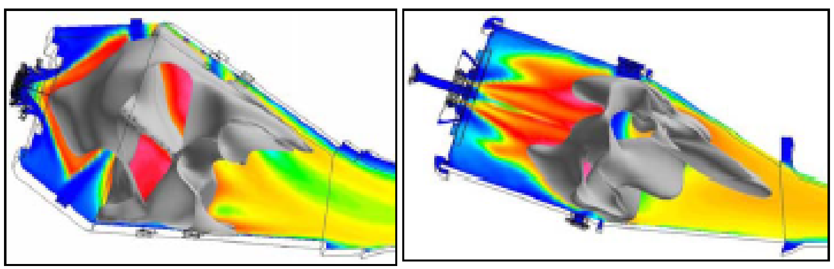
P&W TALON Combustor



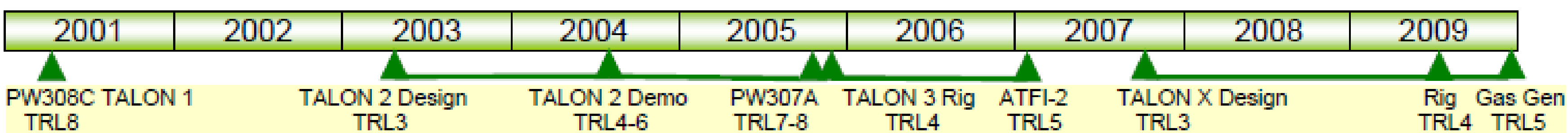
Cross sections deleted

Motivation:
To achieve Zurich 5 emissions standard using RQL

Predicted Improvement:
Improved combustor durability with sacrificial heat shield
Manufacturing process on laser drilling
Lower UHC, CO, NOx and Smoke No.
Achieved 50+% NOx reduction over CAEP2
Achieved Zurich 4 with TALON 1
Achieved Zurich 5 with TALON 2
Demonstrated Zurich 5 with TALON 3-X

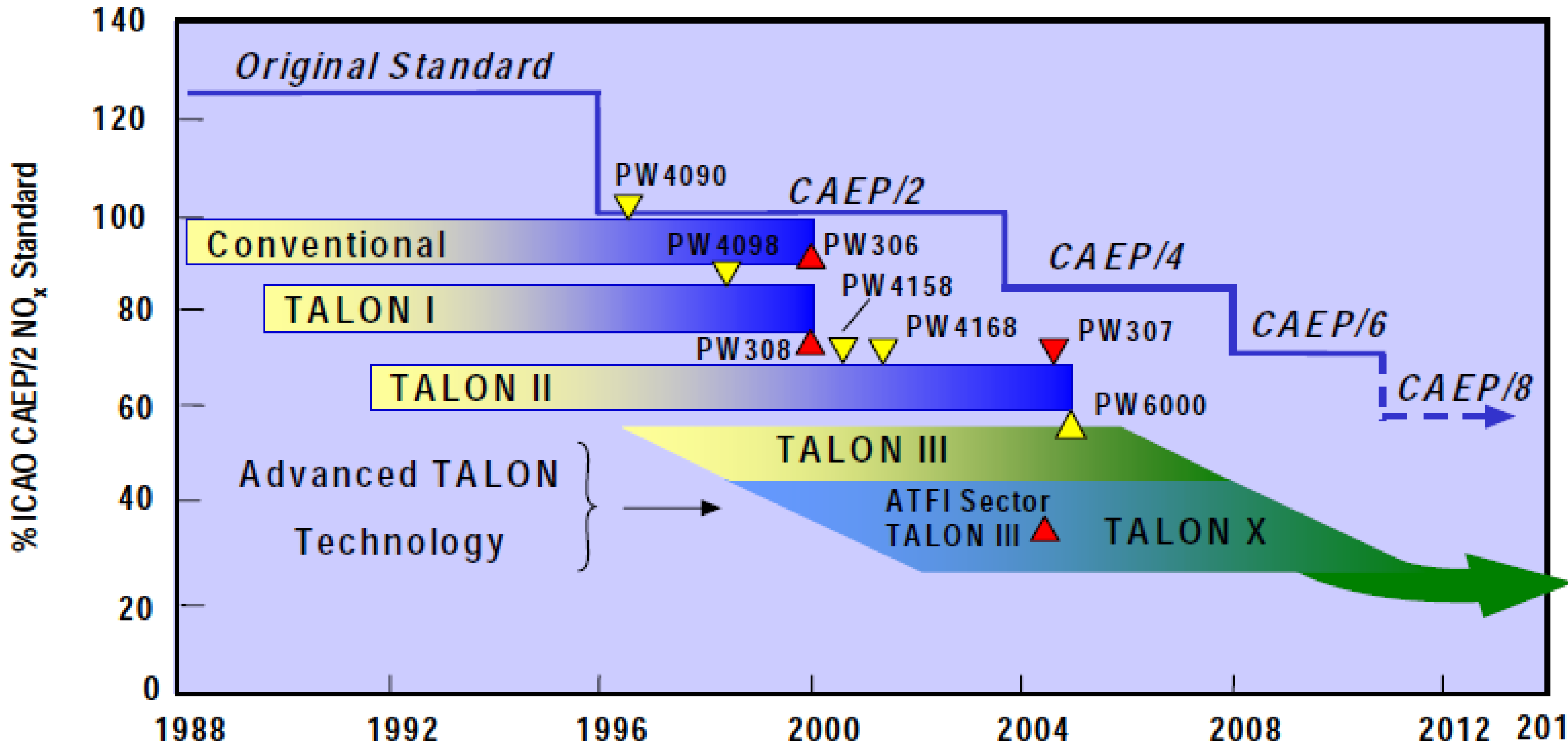


CFD Predicted Gas Temp & NO conc'n



NGRT Technology

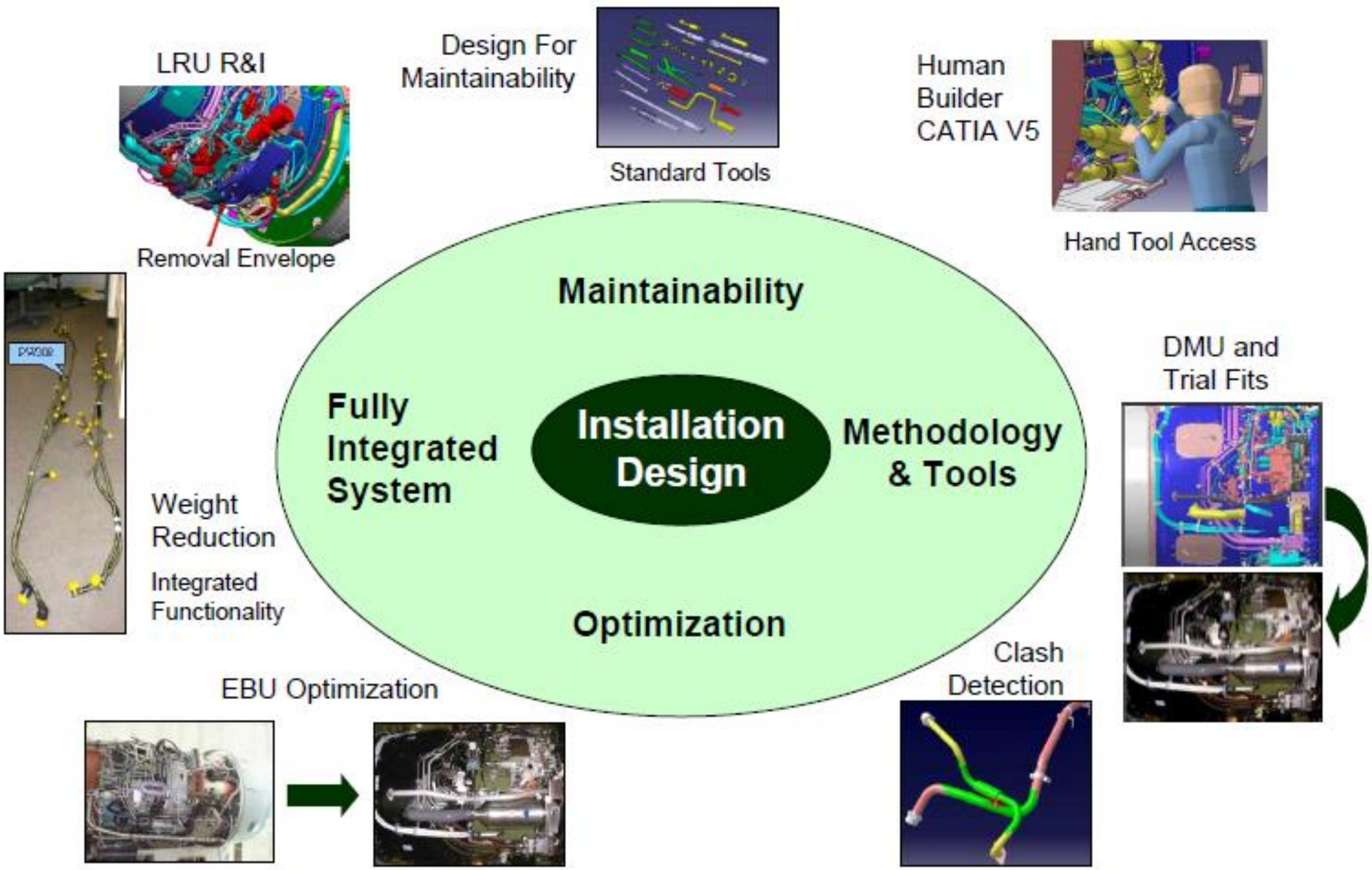
Progress in Nox Reduction



P&WC has achieved over 50% NOx reduction using TALON technology

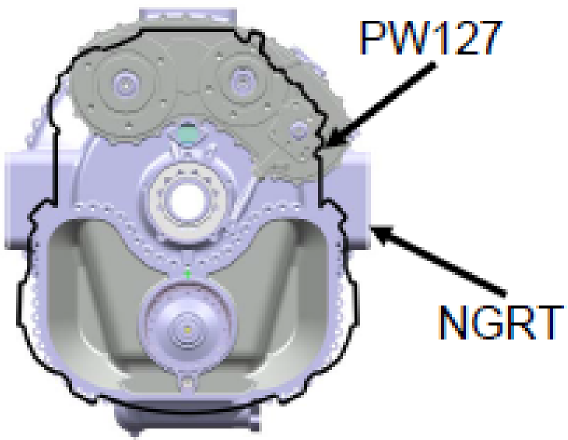
NGRT Technology

Installation Design



Next Generation Regional Turboprop

NGRT Reduction Gearbox



Double helical, offset first-stage (std. rotation)

First-stage support suitable for both rotational directions with minor modification

Five planet epicyclic second-stage

Prop shaft free of gear loads

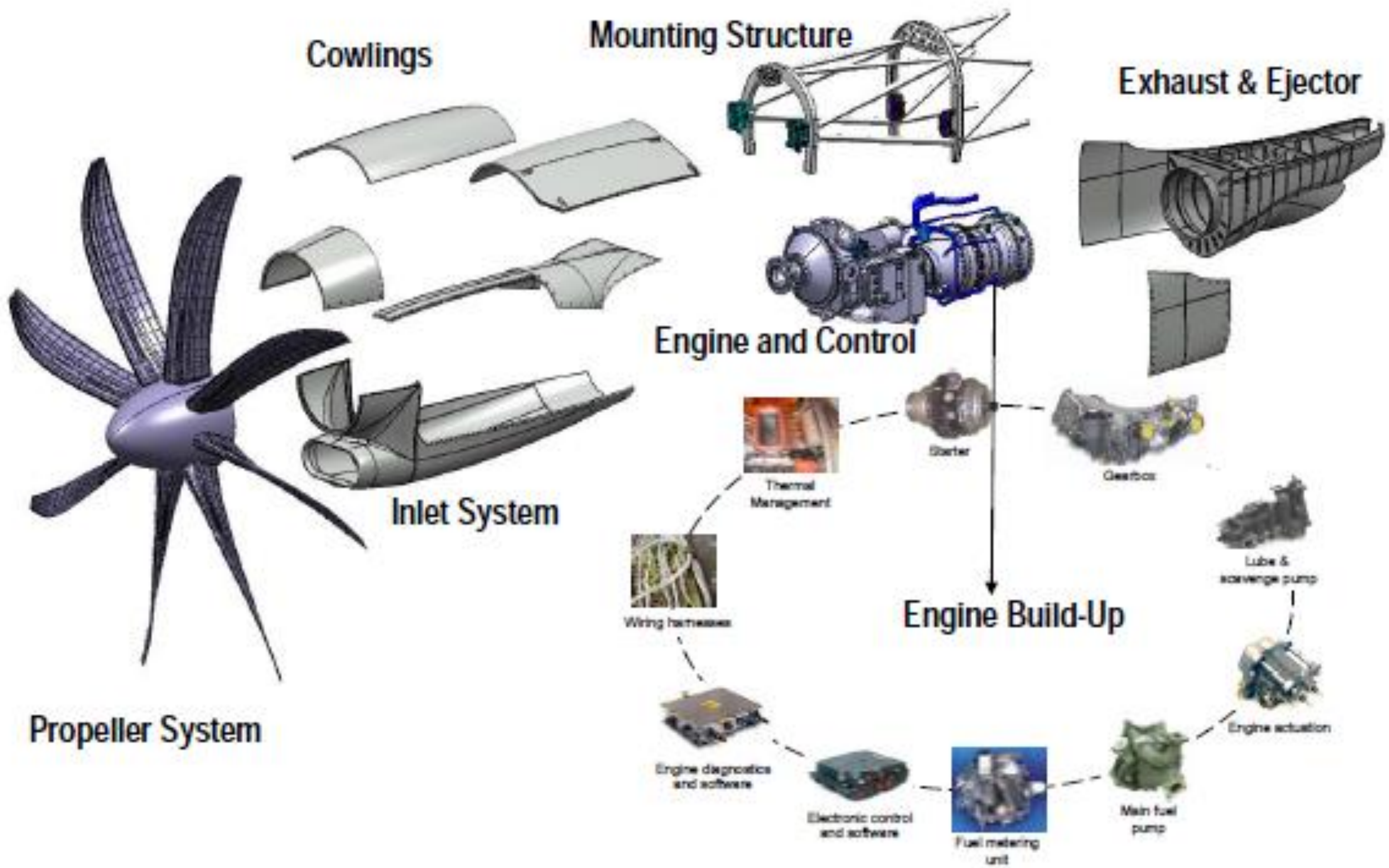
Drive shaft torque-meter

Reduced frontal area
  Weight and drag reduced

81% more mechanical power within similar frontal area

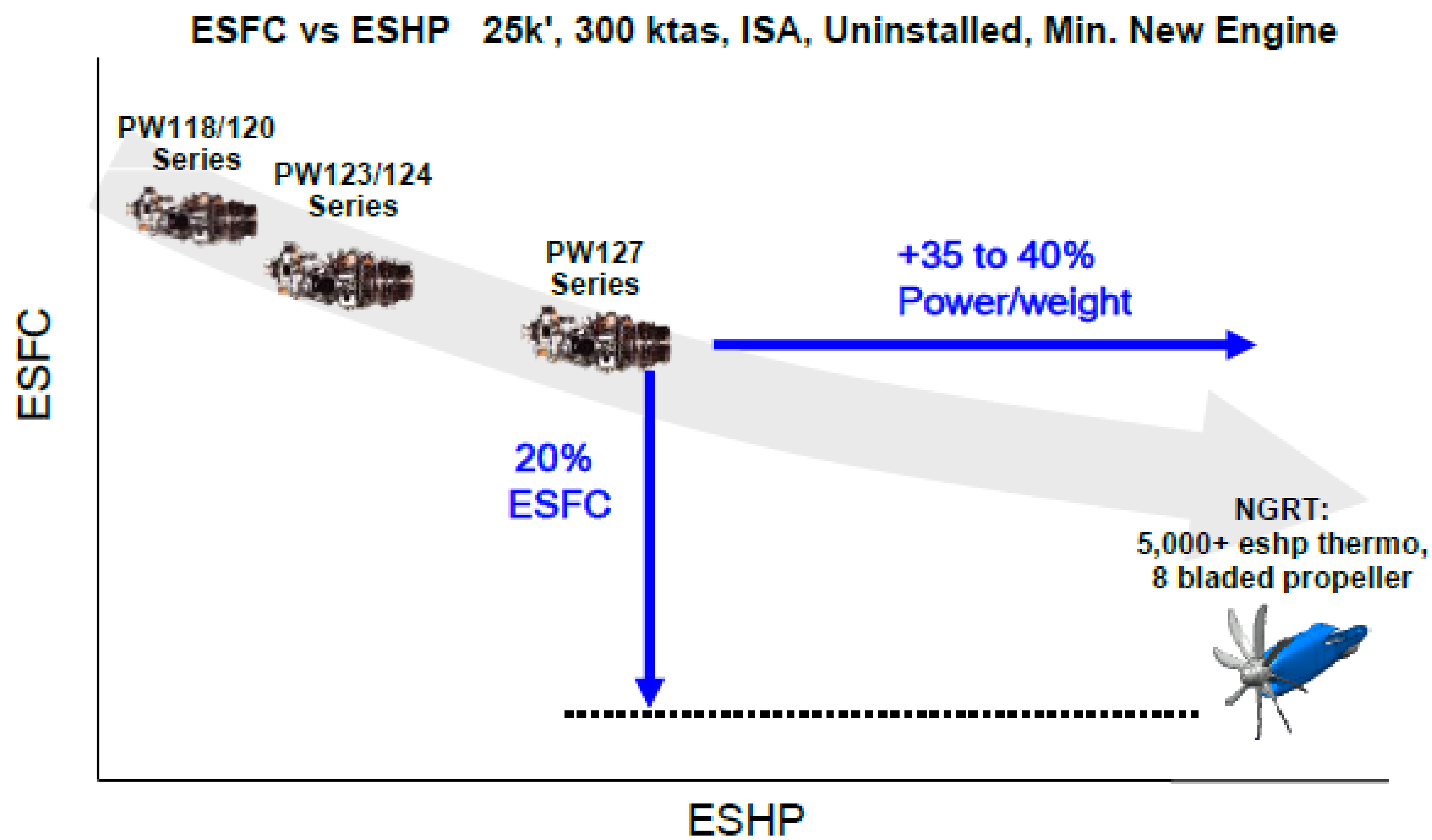
Next Generation Regional Turboprop

Integrated Powerplant System (IPPS)



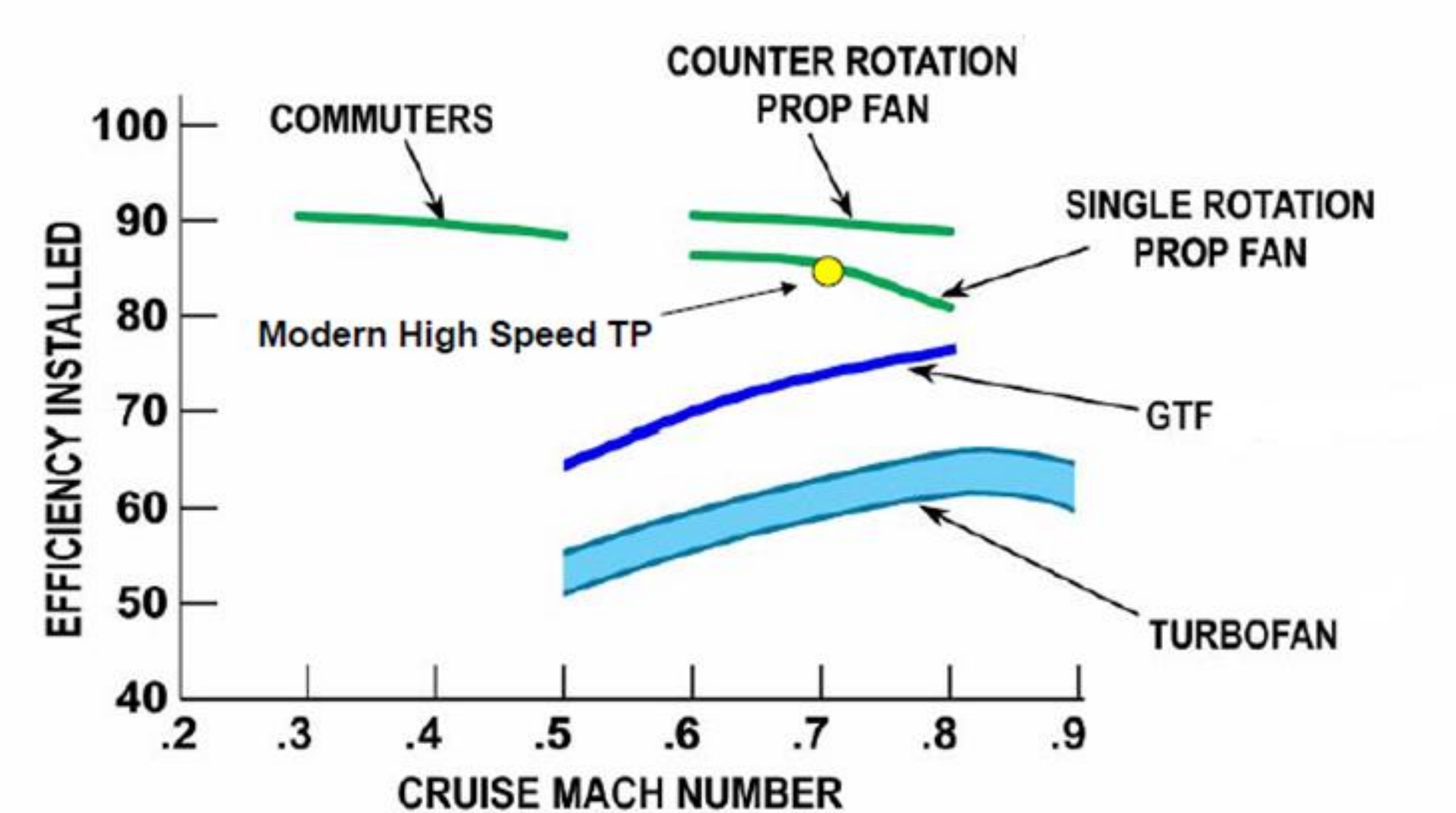
Next Generation Regional Turboprop

Best in class



Propfan

Propulsive Efficiency Comparison



Propfan

Open Rotor Challenges

Increased Cabin Noise
Challenged to mitigate cabin noise and vibration

Increased Aircraft Weight
Pylon and shielding weight are major contributors

PBR Protection
VTP & HTP structural mods for Propeller Blade Release protection will add weight

Ice Ingestion
Threat of wing root ice impact on propfan

Aerodynamic Integration
Prop/Airframe flowfield impact on fuelburn

Increased Community Noise
Challenged to meet Stg 4

....and installation issues...

DMC

Maintenance
15 to 25% higher DMC

.75 Vs .8+ Mn

Operation
ATC impact of lower flight MN

ETOPS?

Certification
Challenged to be ETOPS certified at EIS

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GRAZIE PER LA
VOSTRA ATTENZIONE

3° Incontro - Napoli, 25 Ottobre 2014