



# Rolls-Royce

## FETE 2011 Presentation Cambridge University

Mark S. Thomas  
Chief Engineer – Trent 900

21<sup>st</sup> July 2011

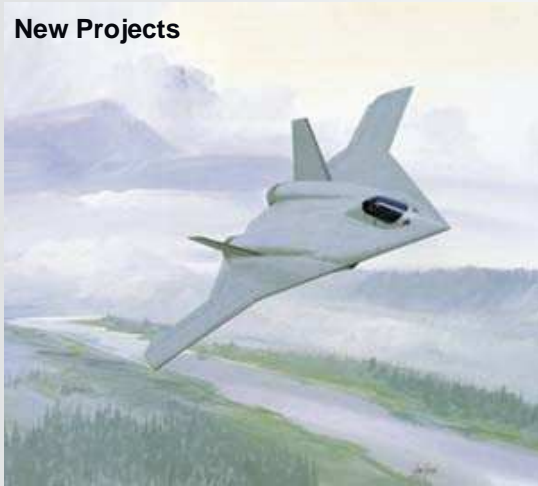
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# Career Experiences...

New Projects



Research & Technology



Red Arrows



US Navy HSRIP First Flight



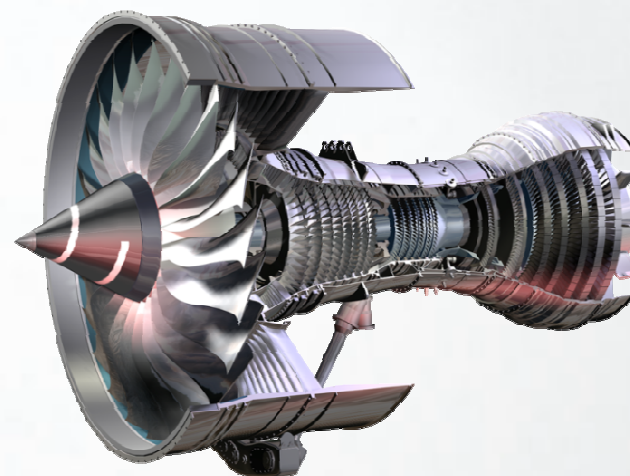
EJ200 Development Programme



Typhoon In-Service Support



# Current Role: Trent 900 (Airbus A380)



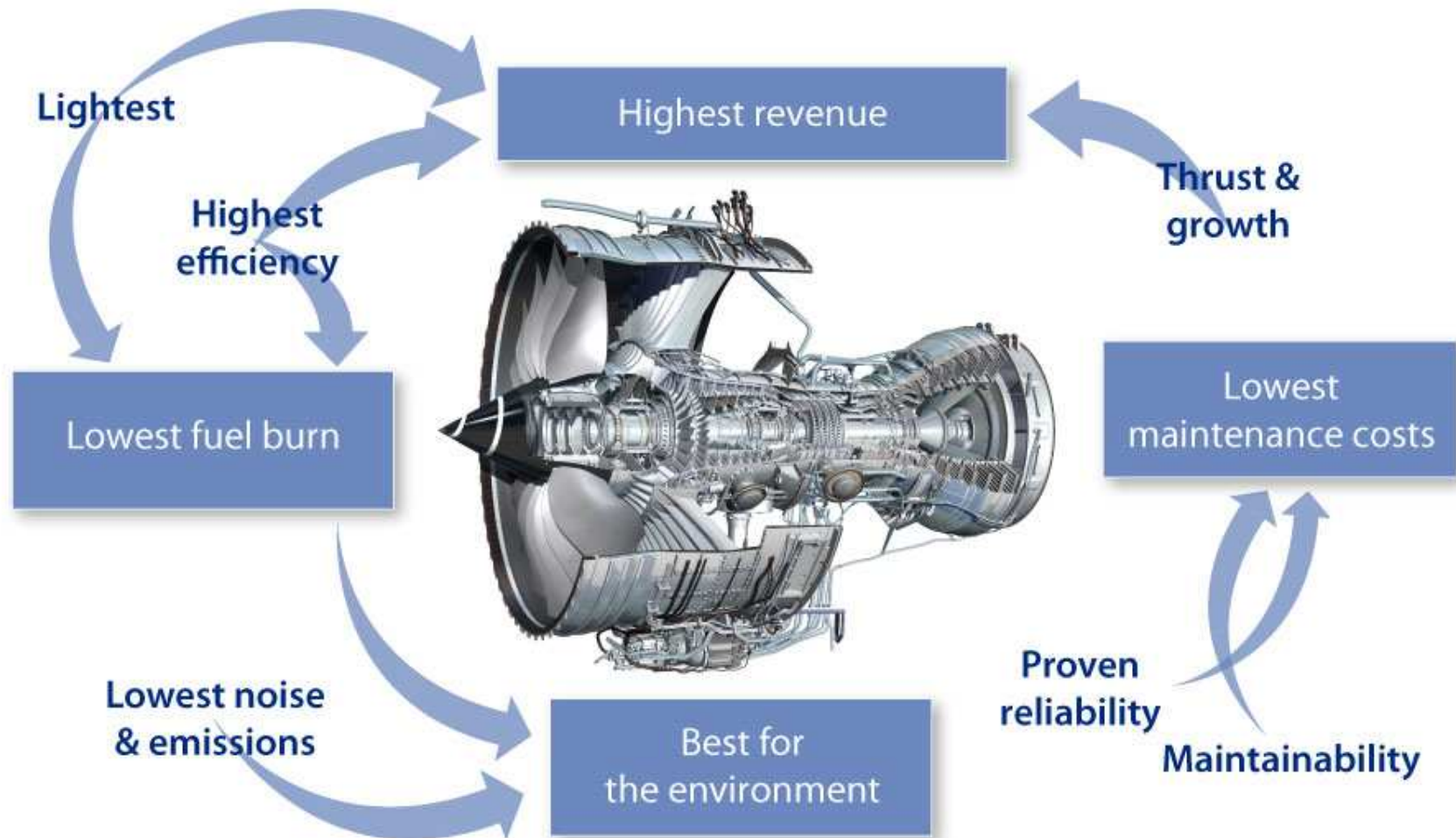


# Civil Aerospace Business



# The Civil Battleground

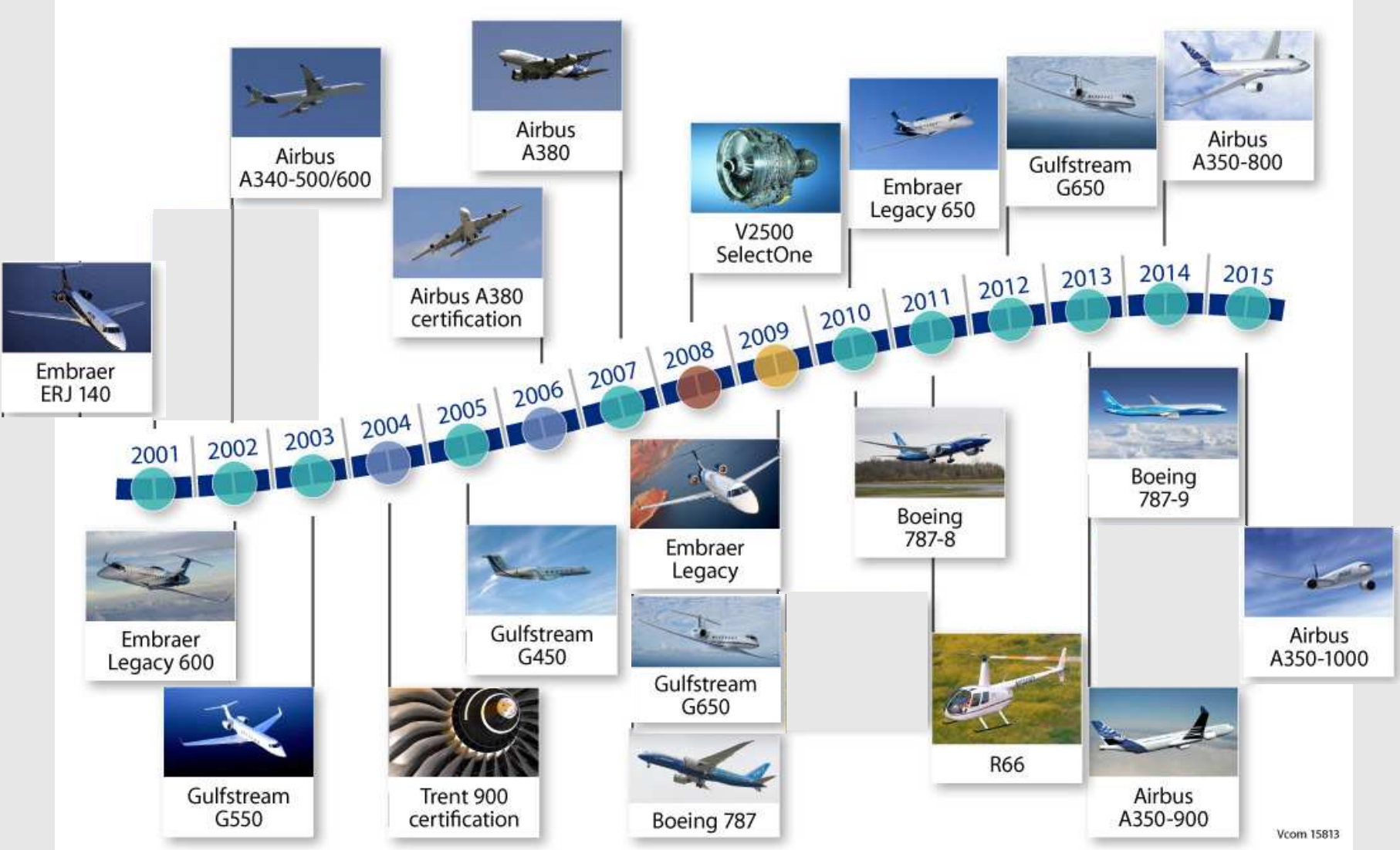
TRENT



003065 1c



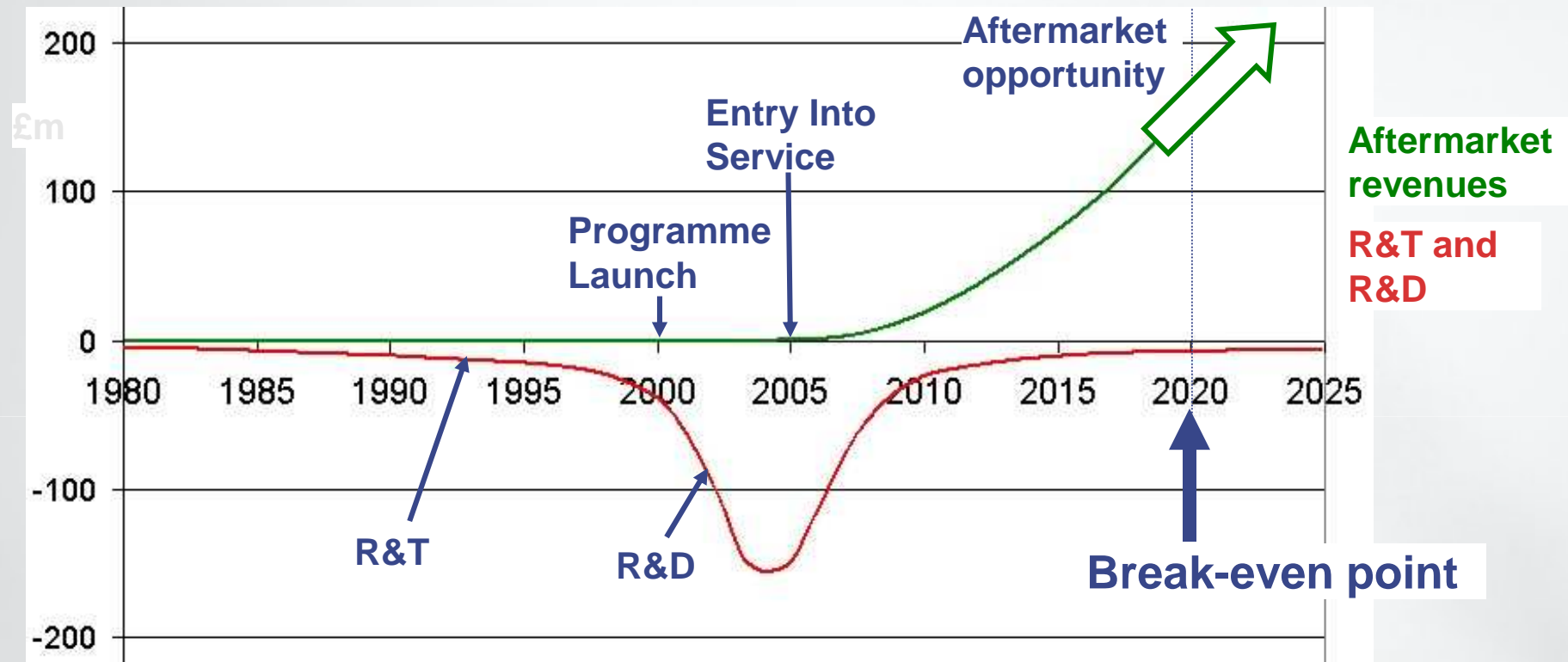
# Consistently winning new business



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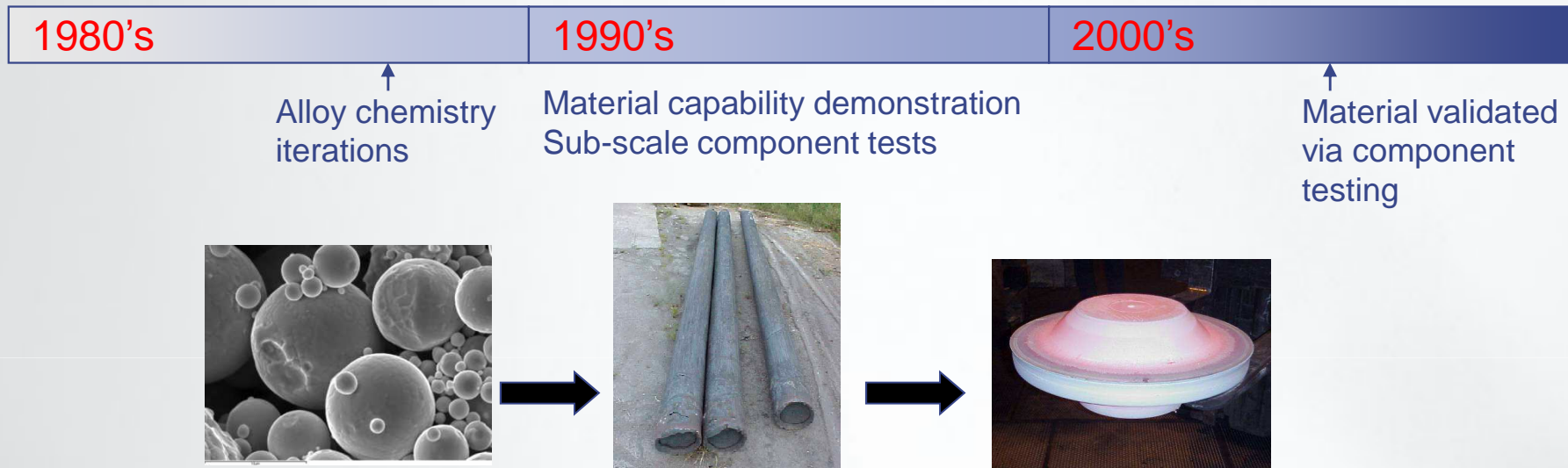
# High barriers to entry: Cost



- £200m investment over 20 years prior to programme launch
- Break-even point 15 years after product Entry Into Service

# High barriers to entry: Timescales

- 20 years R&T programme – RR1000 material

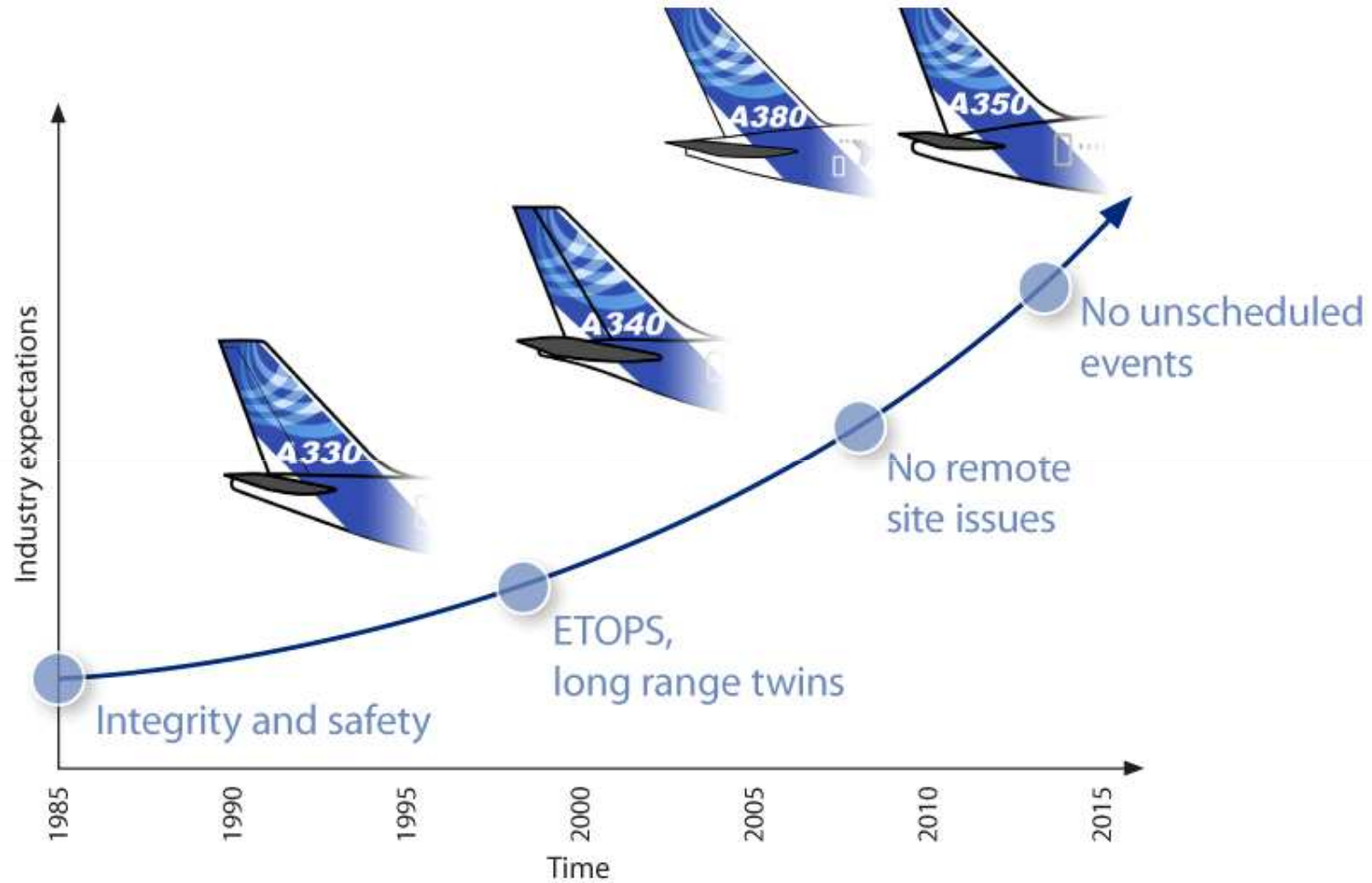


- 5 years R&D programme – Trent Engine



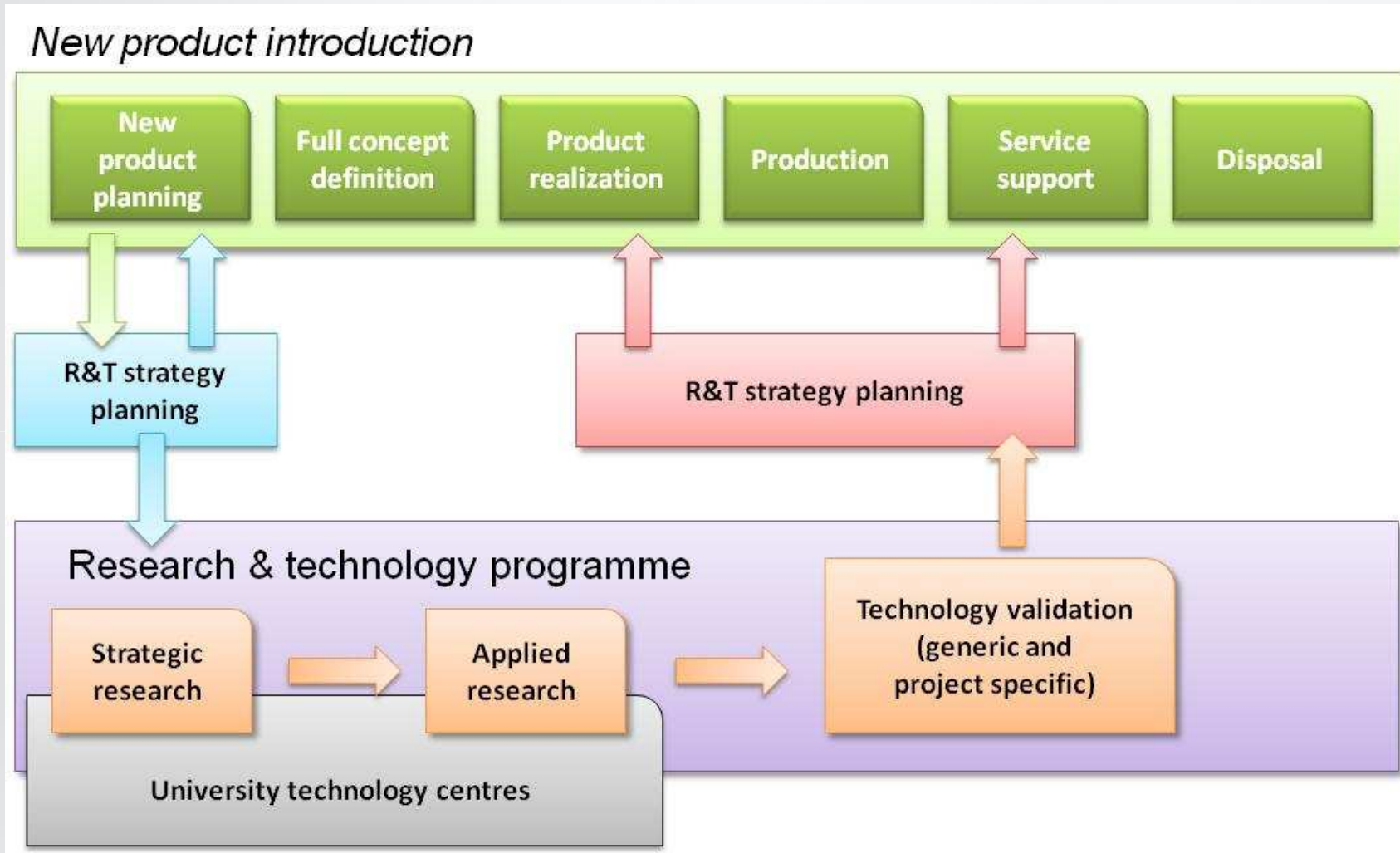


# Customer Expectations

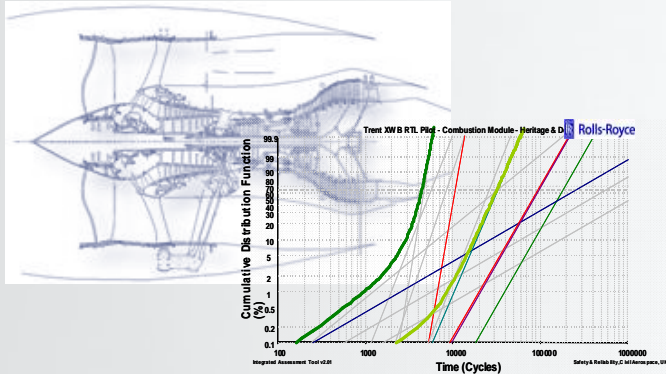


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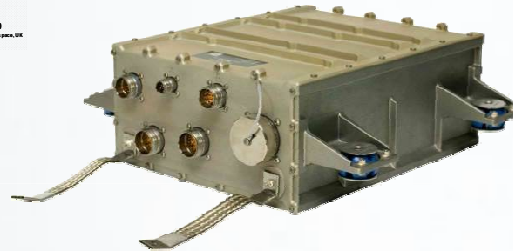
# New Product Introduction



# Focus on delivering maturity



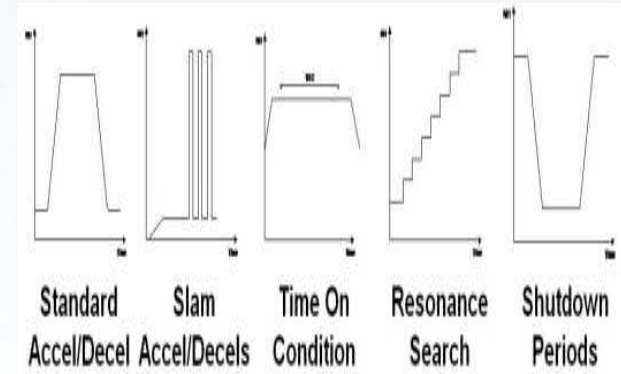
**Risk & reliability processes**  
Structured FMECA and Pareto analysis



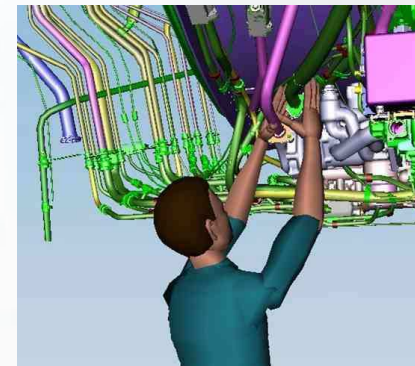
**Health monitoring**  
3<sup>rd</sup> generation health monitoring



**Timely event capture & resolution**  
Experienced, expert team



**Representative testing**  
Component and system level,  
replicating service conditions



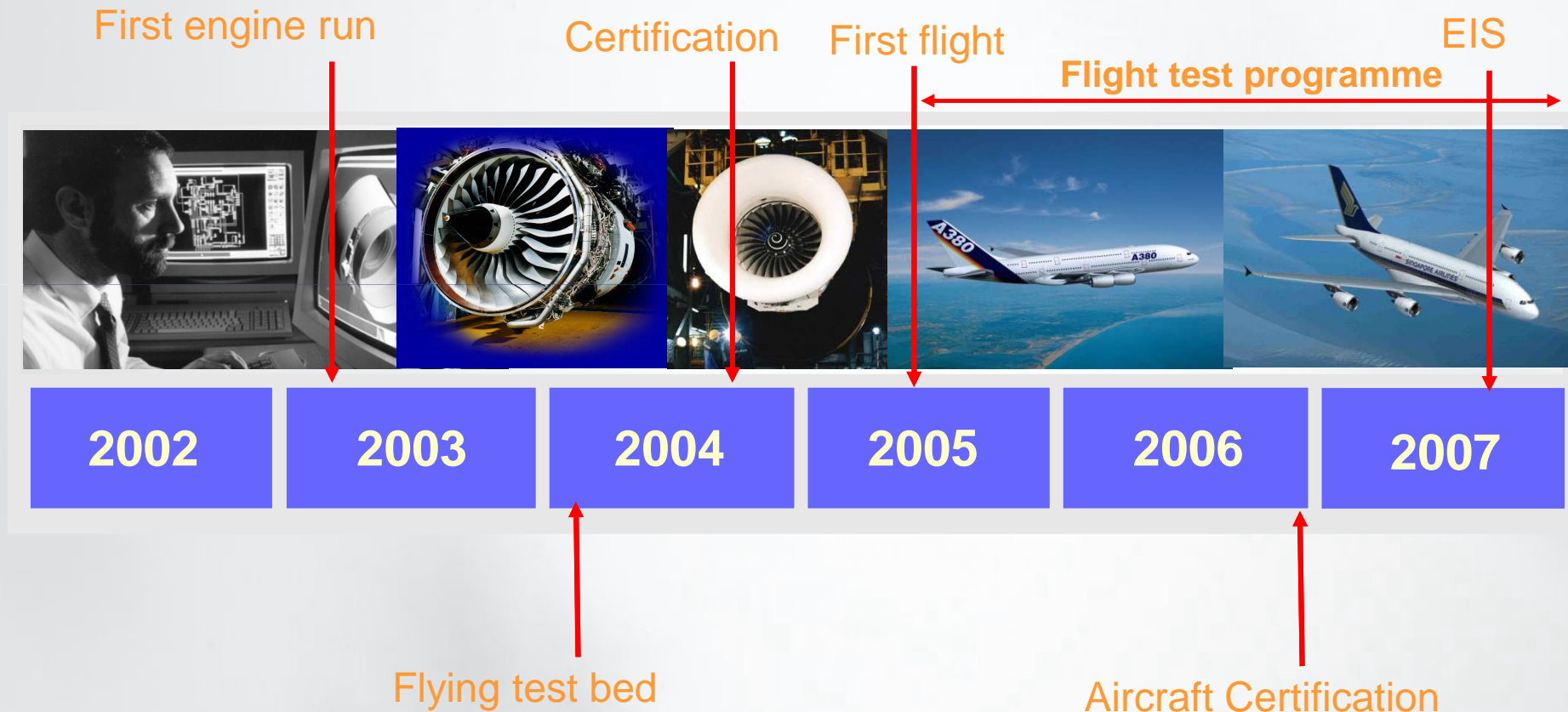
**Maintainability analysis**  
Assessments complete

# The Trent 900 Story





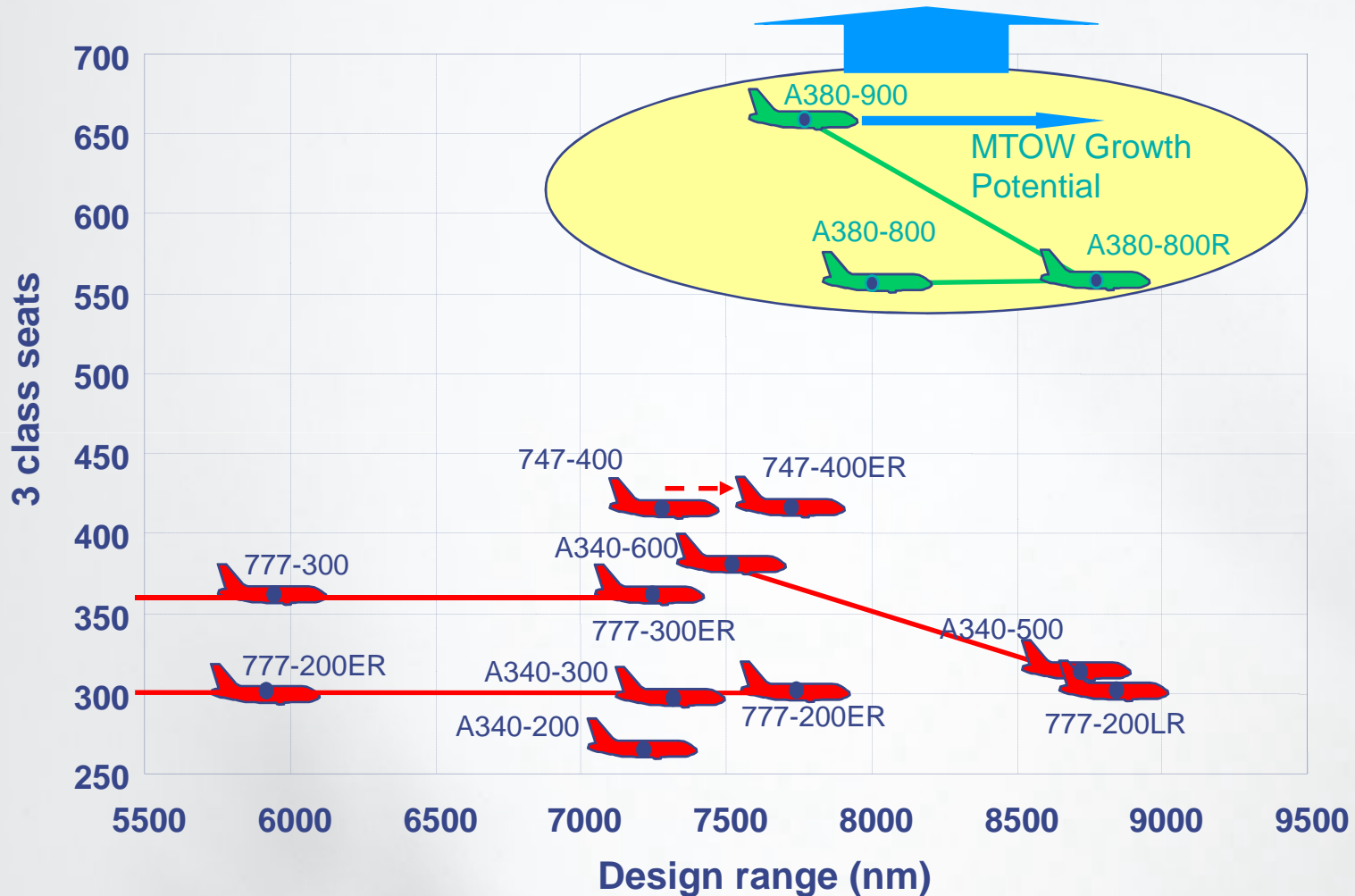
# Trent 900 – Lead Engine On The A380



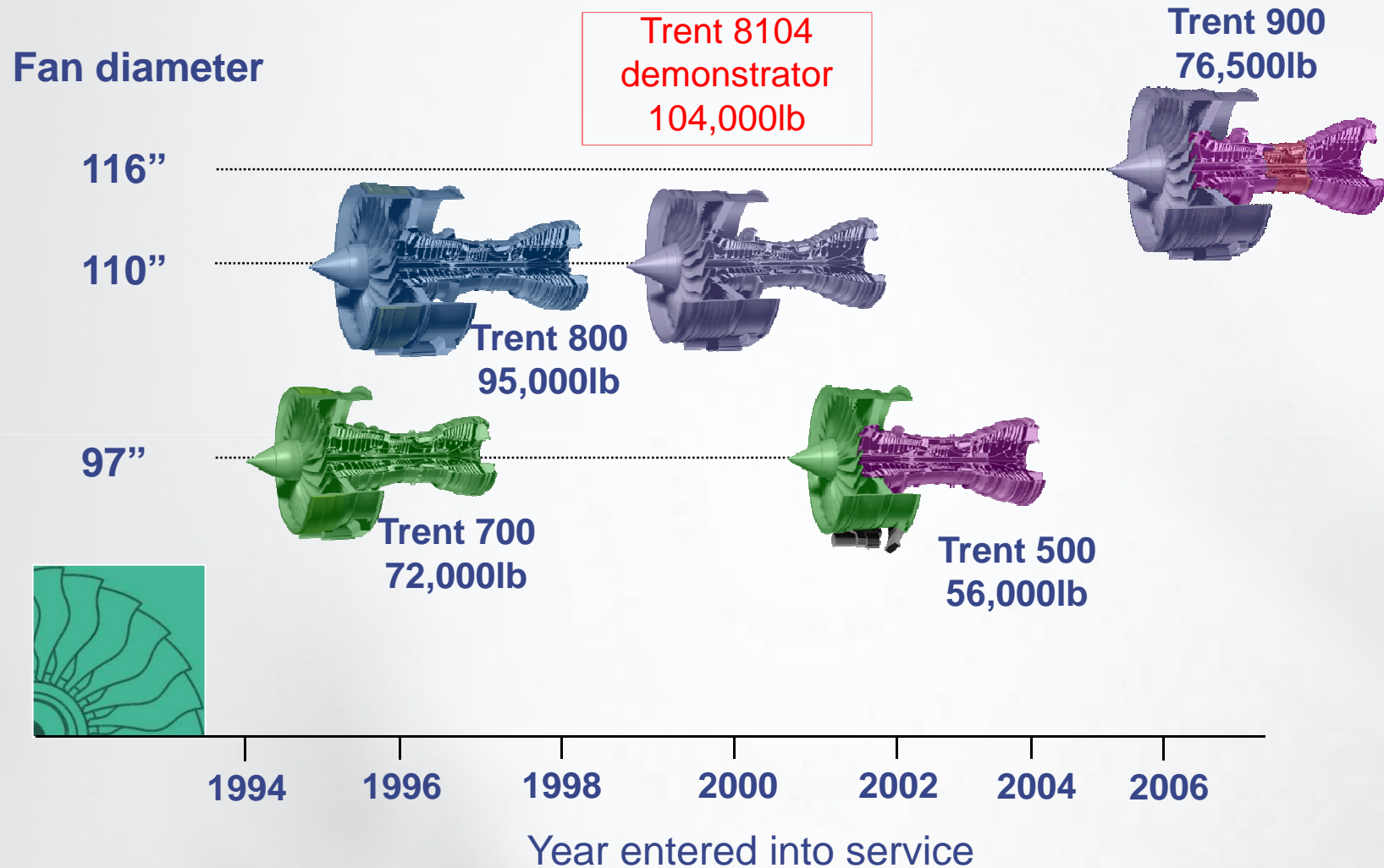
# A380: Position In the Market Place

Seats-range for long range aircraft

Seats growth nominally limited by 80m length limit



# The Trent family evolution



# Trent 900 – Key Technologies

Ribbed titanium containment case

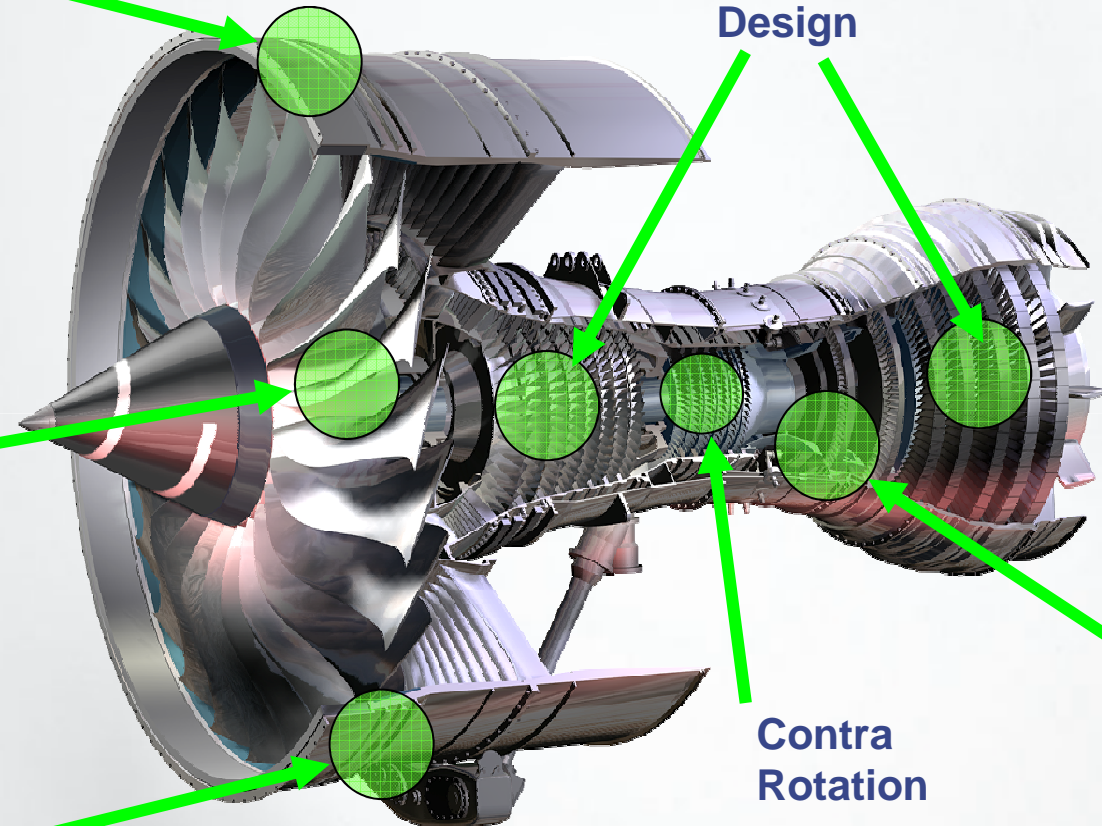
3D Aero Design

Swept fan blade

Engine Health Monitoring

Contra Rotation

Tiled Combustor



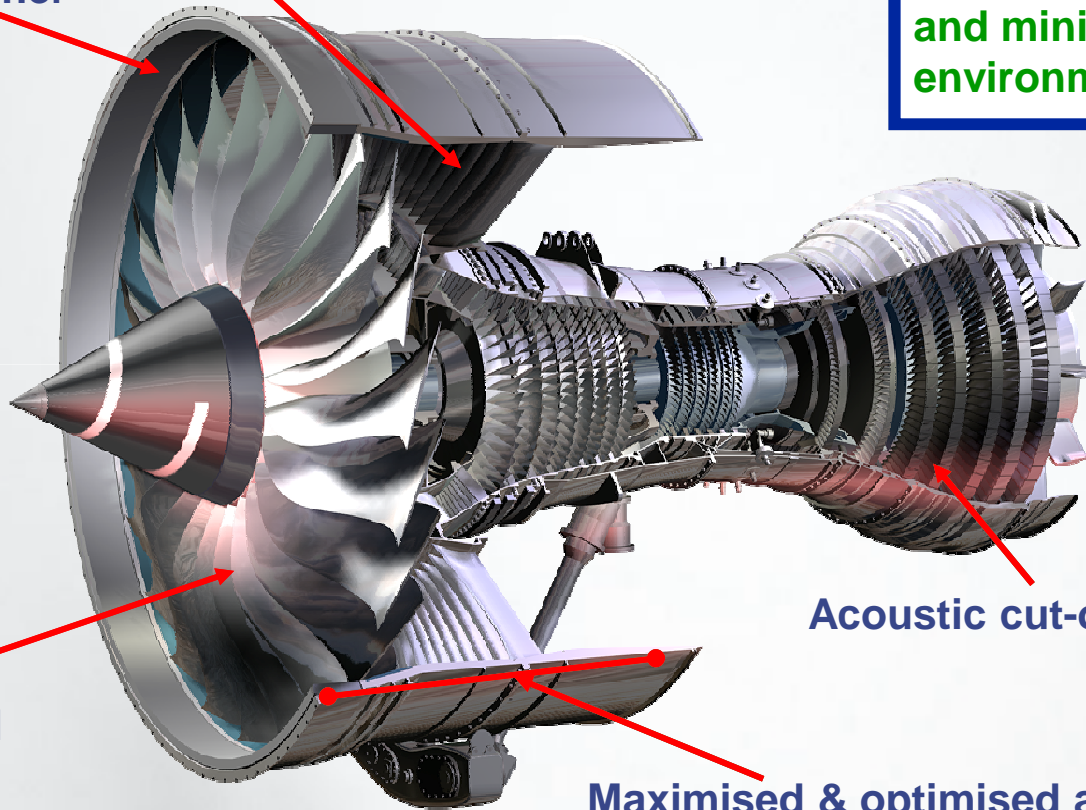


# Trent 900 – Noise Reduction Technology

Swept OGV with optimised count

Novel fan-case liner

Cycle and components designed for low noise and minimum environmental impact



Swept, low speed  
Wide Chord Fan

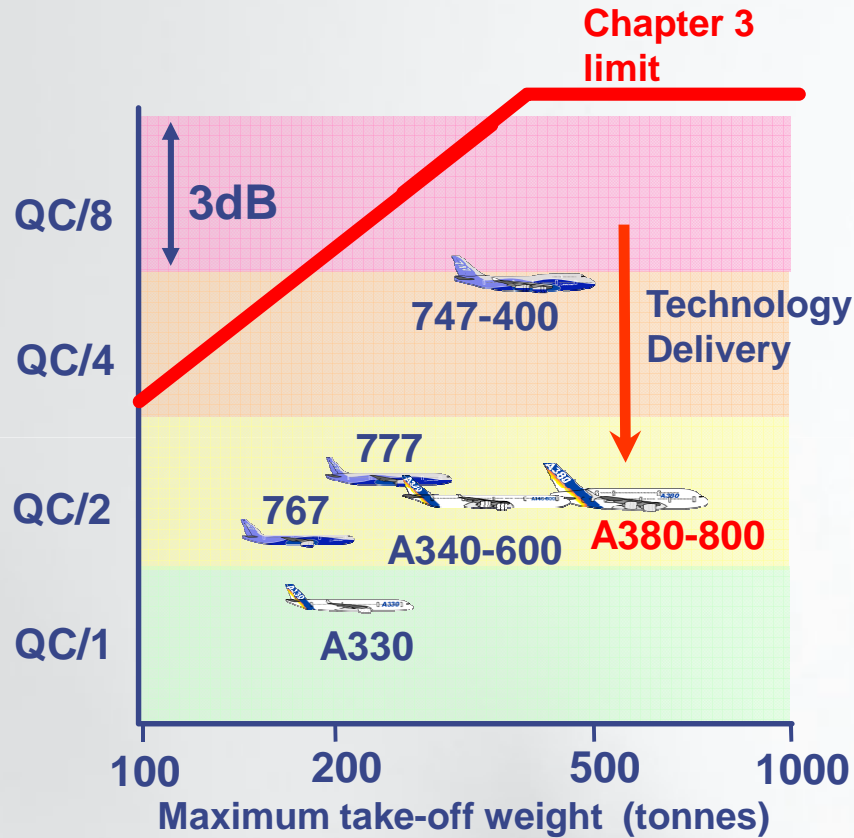
Acoustic cut-off LP turbine

Maximised & optimised acoustic liners

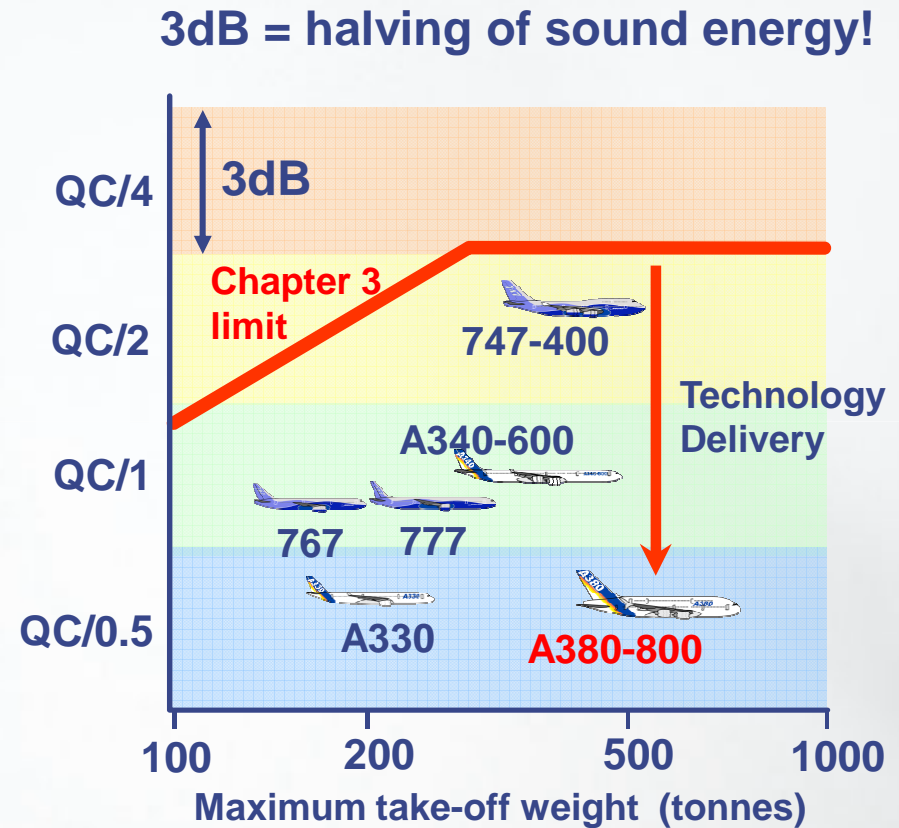
High Bypass Ratio:  
2.95m (116 inch) Diameter Fan

# Trent 900 Noise Reduction

## The magnitude of the achievement

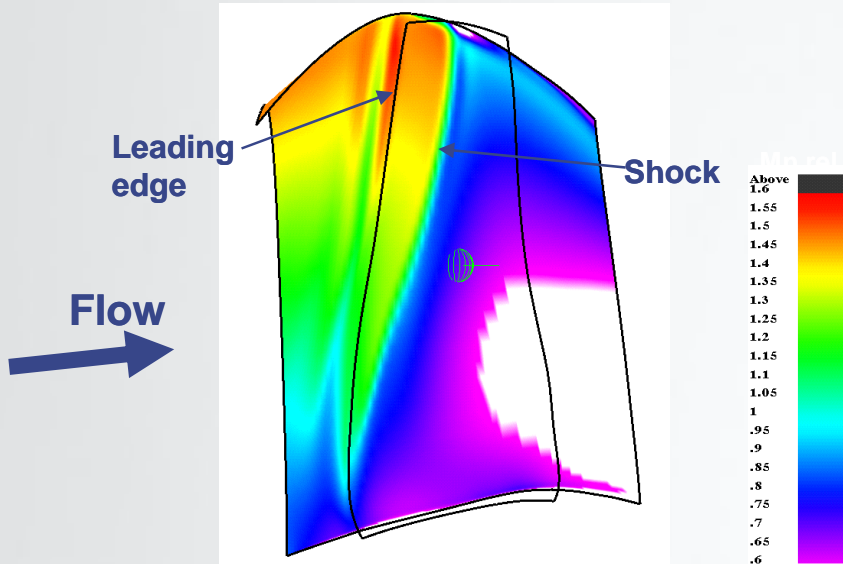


London Departure

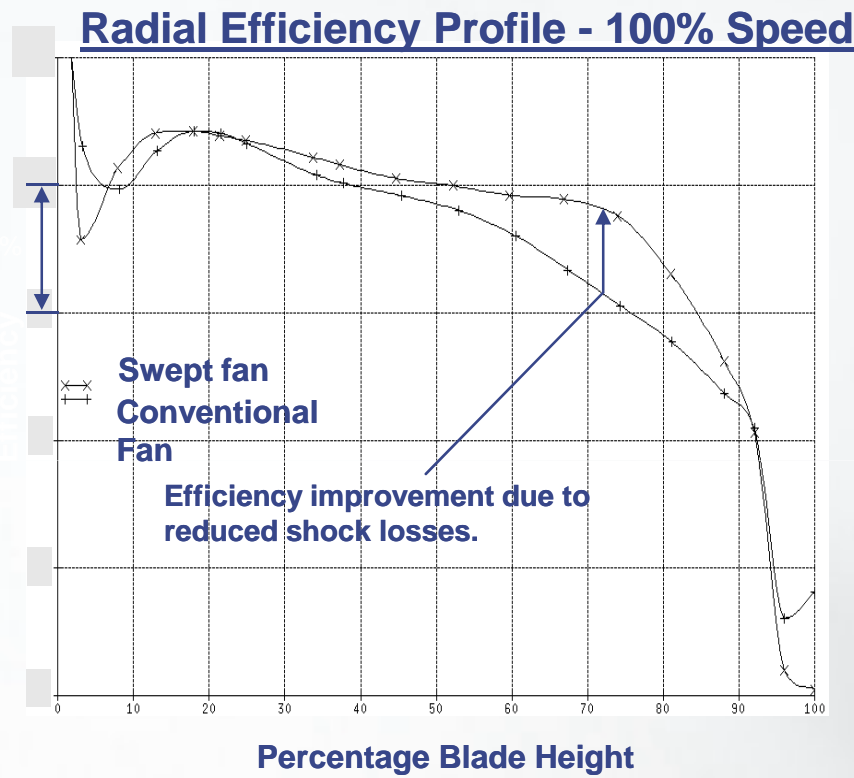


London Arrival

# Trent 900 Swept Fan – Aerodynamic Design

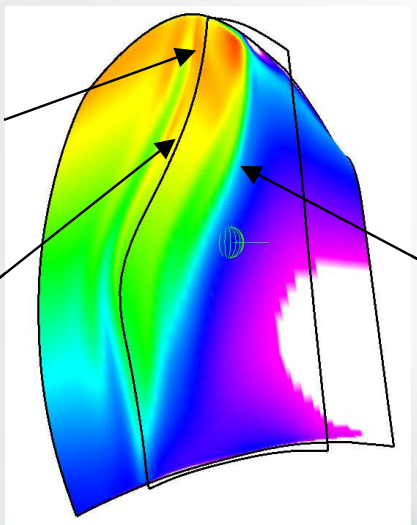


**Conventional Trent Fan**



Reduced axial velocity at tip gives lower Mn, high blade angles and a large birdstrike benefit.

Leading edge swept rearwards



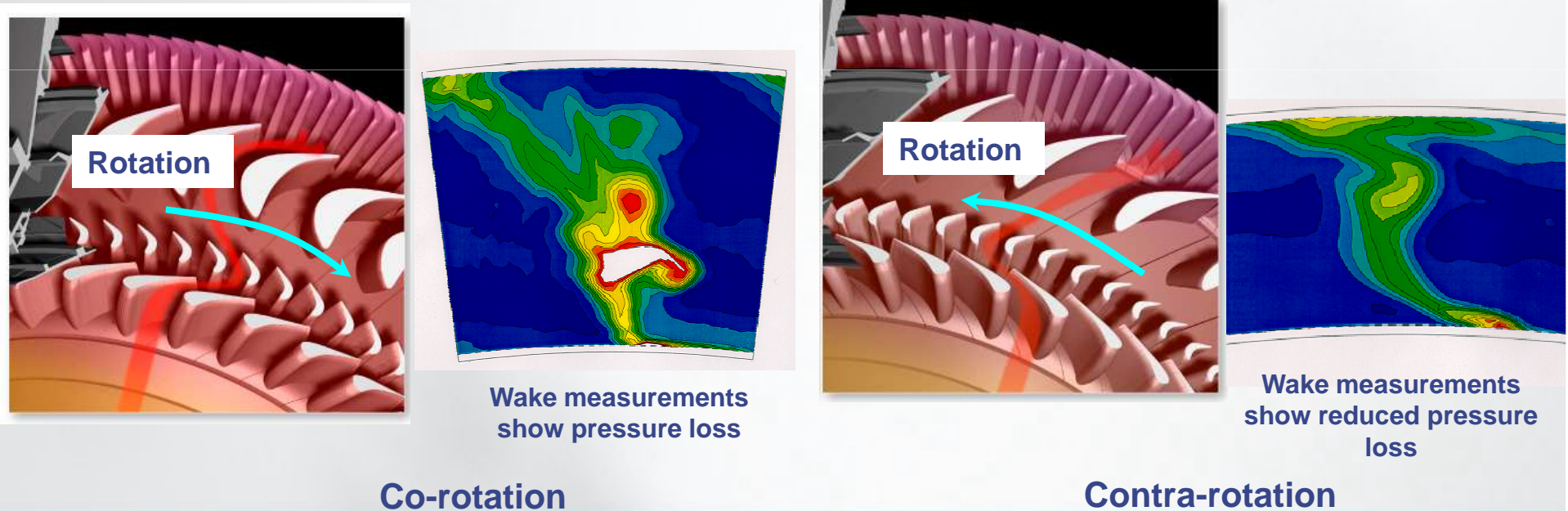
More oblique shock with lower losses.

**Trent 900 Swept Fan**



# Advances In Turbine Aerodynamics

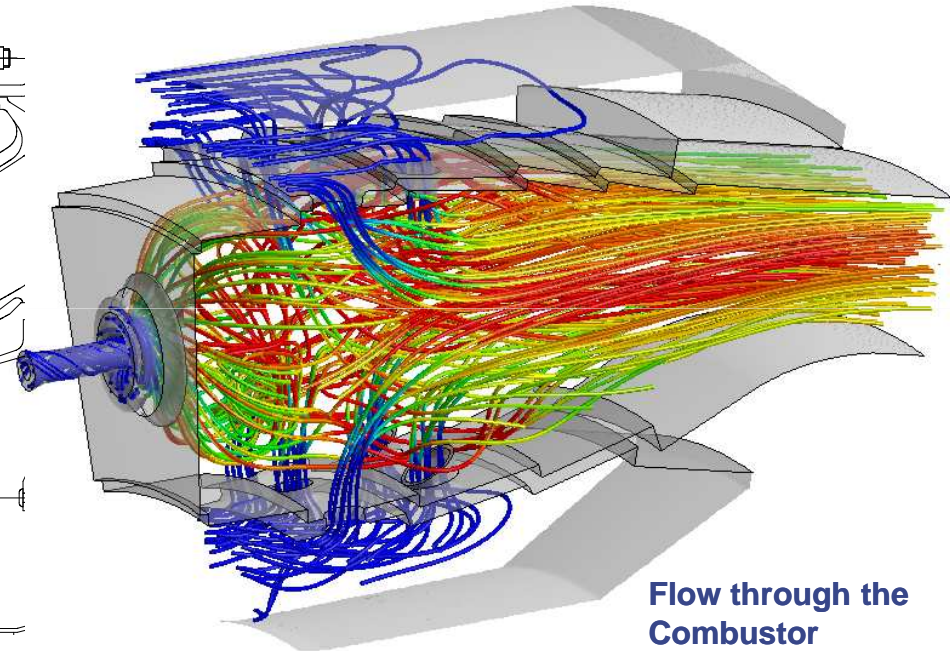
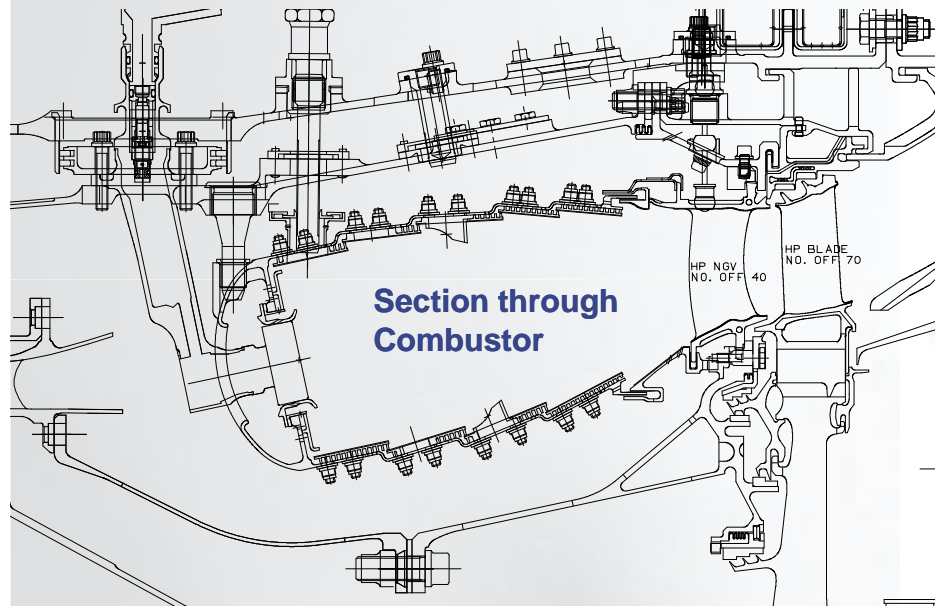
- Contra rotation was used for the first time in a large Civil Turbofan
  - Reduces the amount of turning by the gas in the Turbine stages
  - Minimises Turbine loss
  - Rig tested prior to application in the Trent 900
  - Reduces parts count – takes out cost and weight





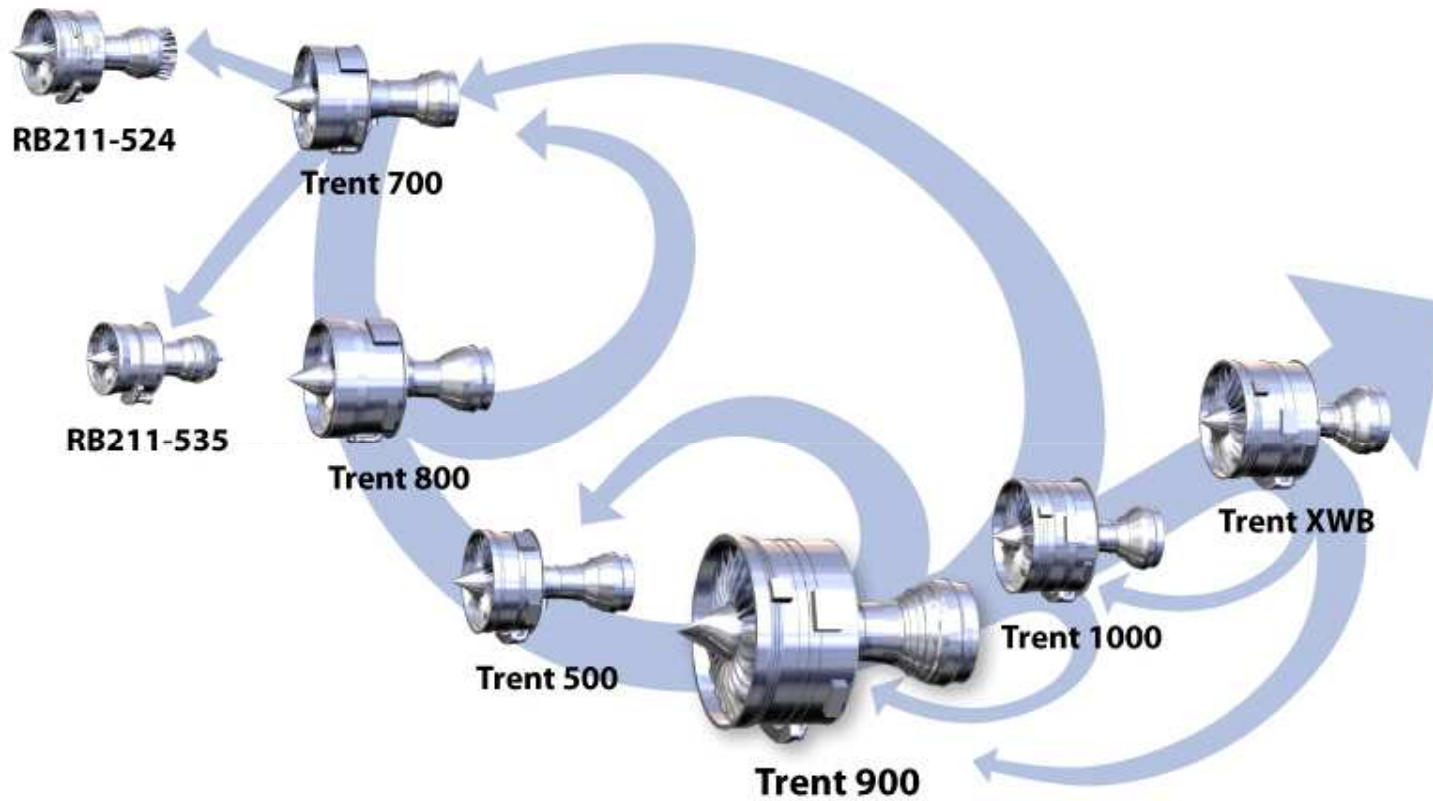
# Advances in Combustion

- The Thermal Barrier Coated tiles are designed in harmony with CFD predictions of hot gasses within the Combustion Chamber



- **Cooling flows behind the tiles are matched to the hottest regions**
  - Minimises cooling flow to maximise Combustor efficiency

# Continuous Improvement



Enabled by new technology

Vcor009966

# Trent 900 Programme Achievements

## Excellence in service

**800,000** engine flying hours, **90,000** cycles

World class mature operation with **99.9%** underlying dispatch reliability

**Now 29 aircraft** in operation

Airlines **praise** Rolls-Royce for **proactive support**

“Smoothest entry into service ever” – Singapore Airlines  
*Flight International*

004588

TRENT900

# Trent 900 the engine of Choice



Selected by 10 out of 15 customers

Vcom 15966









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