

Engine Deterioration and Maintenance Actions

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imagination at work



Measures for fuel and emissions reduction – engines

- Performance Deterioration
- Maintenance Actions
- Fuel efficient design trends





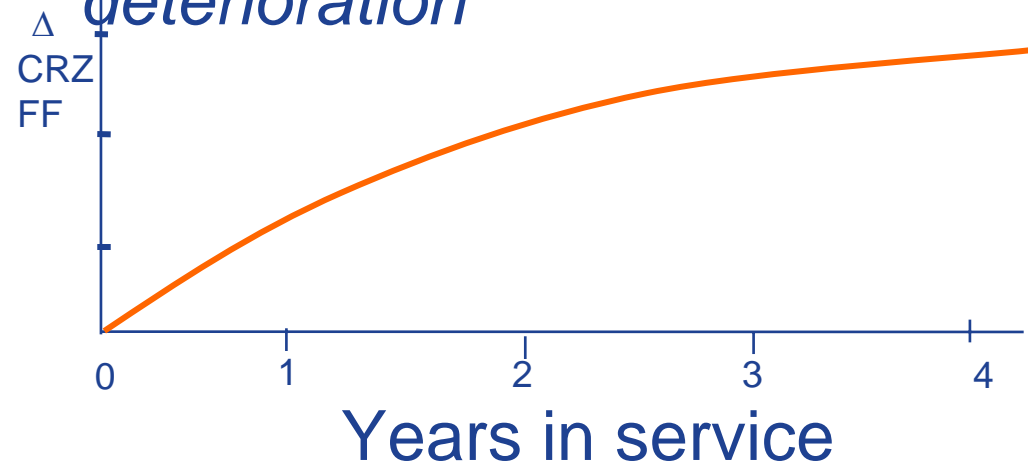
Engine performance

Cruise fuel mileage deteriorates over engine on wing life



- Dirt accumulation
- Mechanical wear & erosion

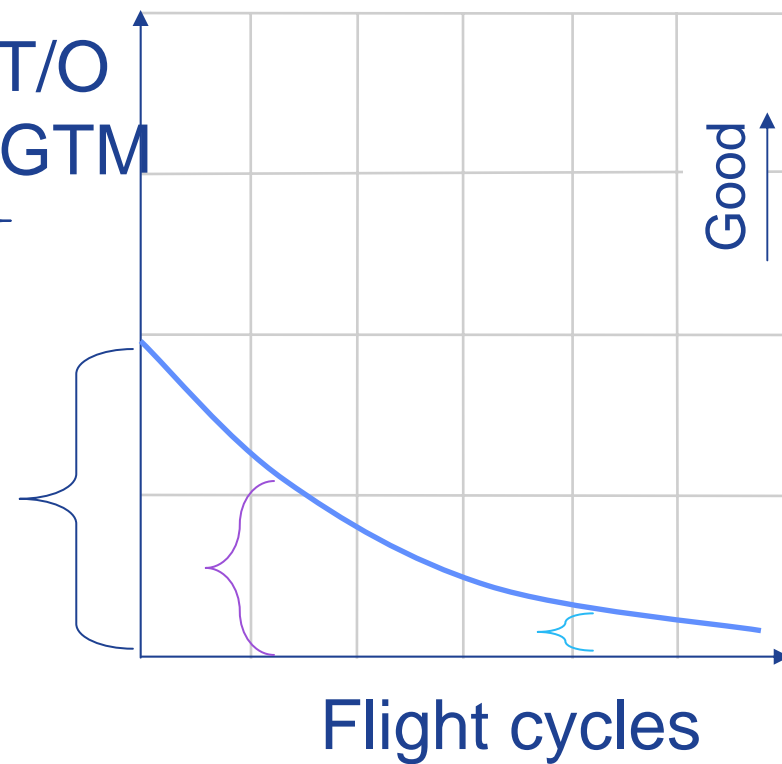
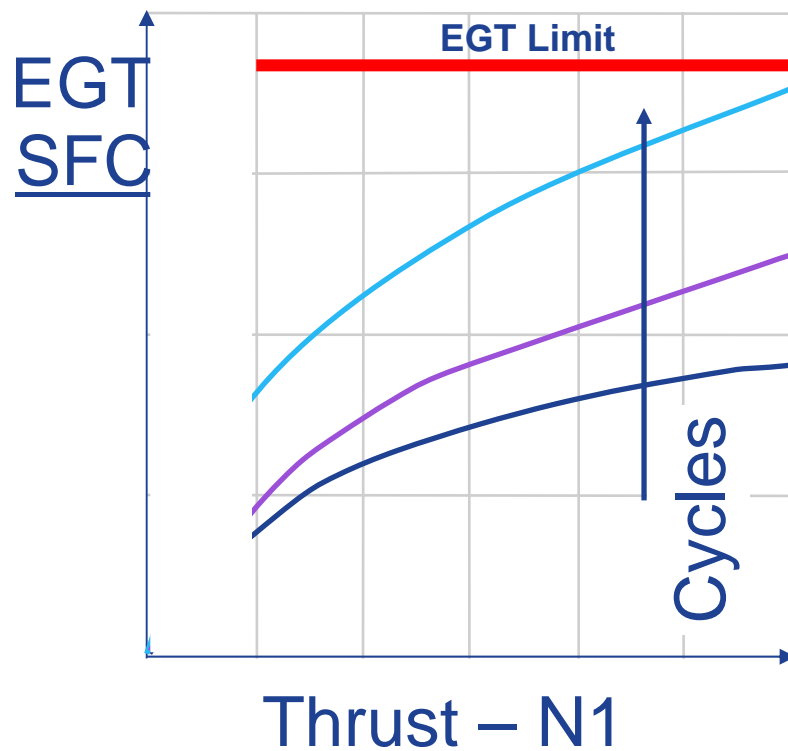
⇒ *Cruise fuel mileage deterioration*



EGT margin (EGTM) to measure engine performance deterioration

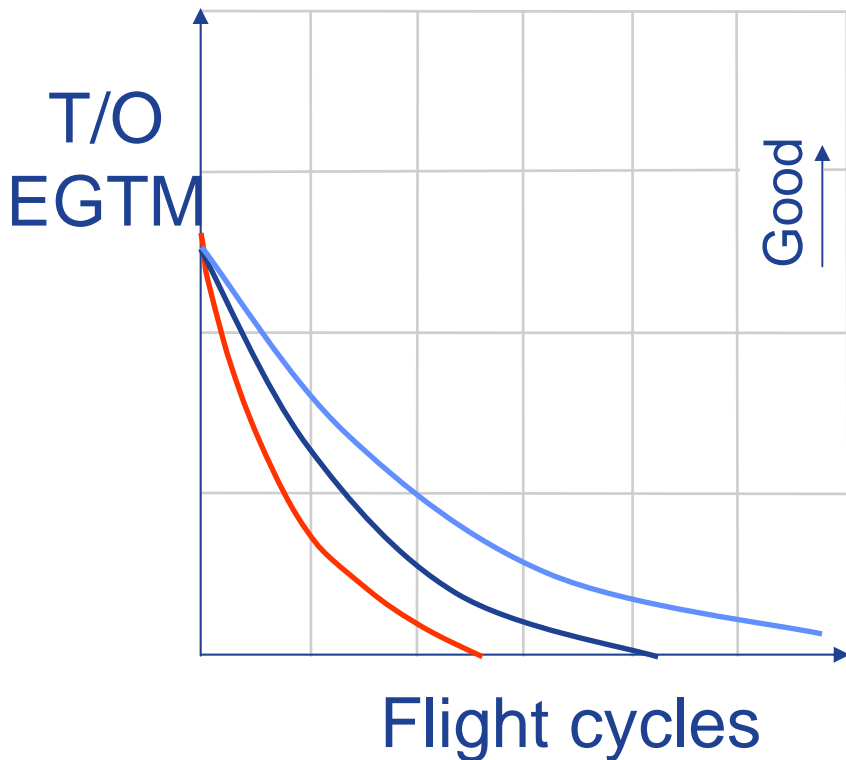
EGT to achieve thrust

EGTM deterioration



What impacts deterioration?

EGTM deterioration



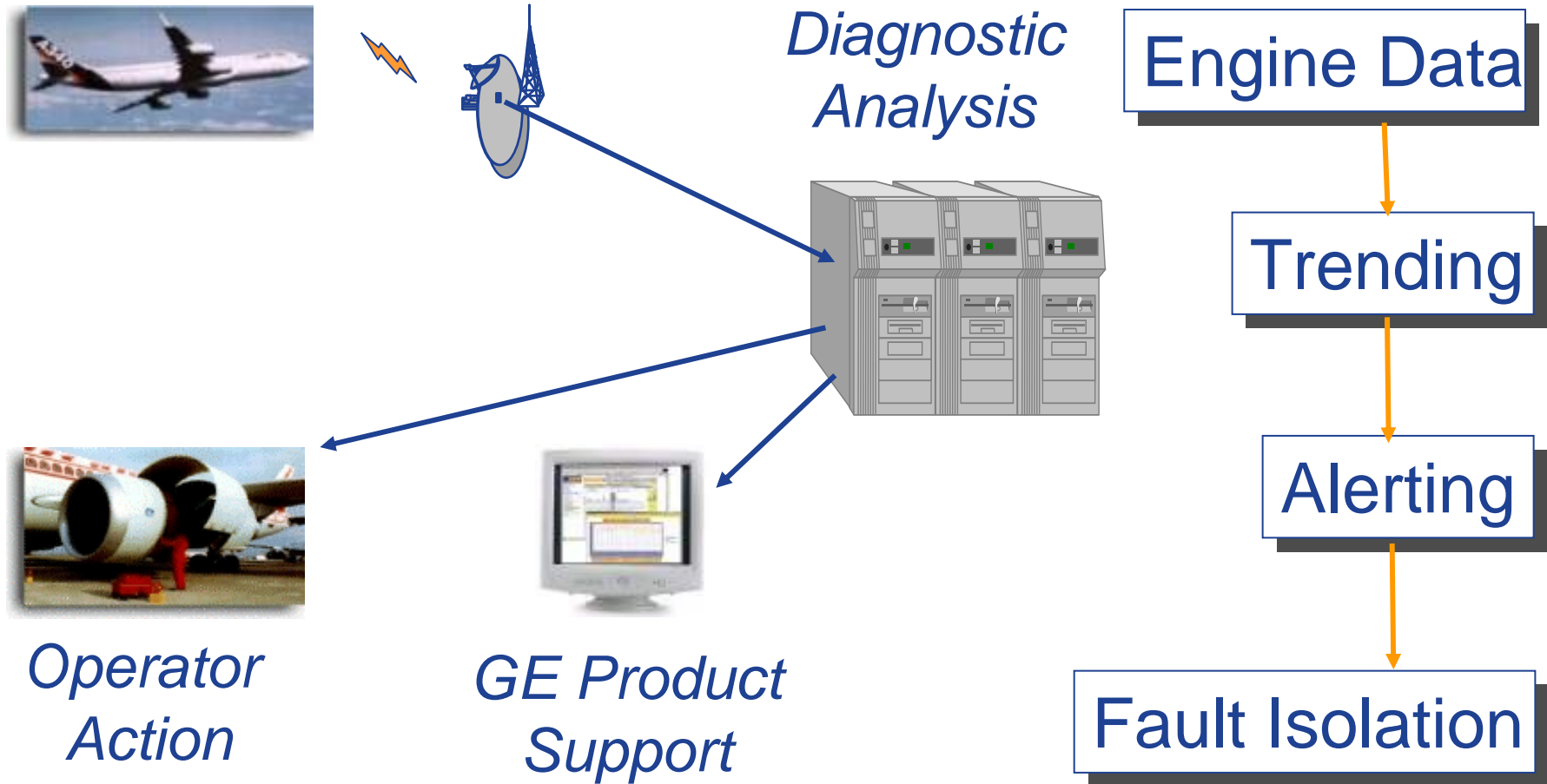
- Flight legs/cycle
- Environmental factors
- Derate
- Overhaul
 - *Workscope planning*
 - *Material Quality*
- On Wing Maintenance

Maintenance Actions

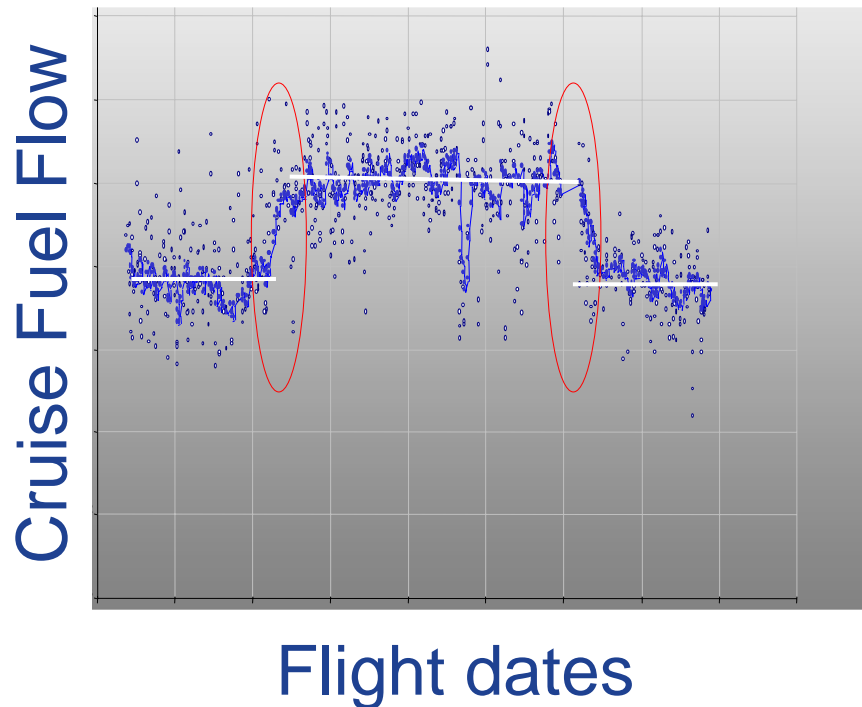


- *Diagnostic trending*
- *Core wash*

GE provides diagnostic support for 60% of its operating engines



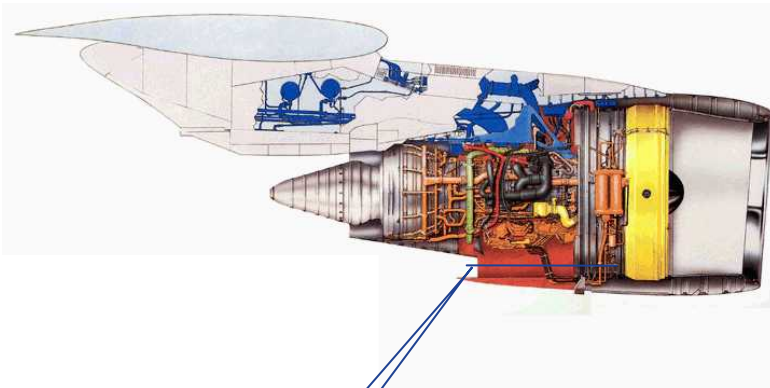
In-flight diagnostic trending to recover fuel efficiency on wing



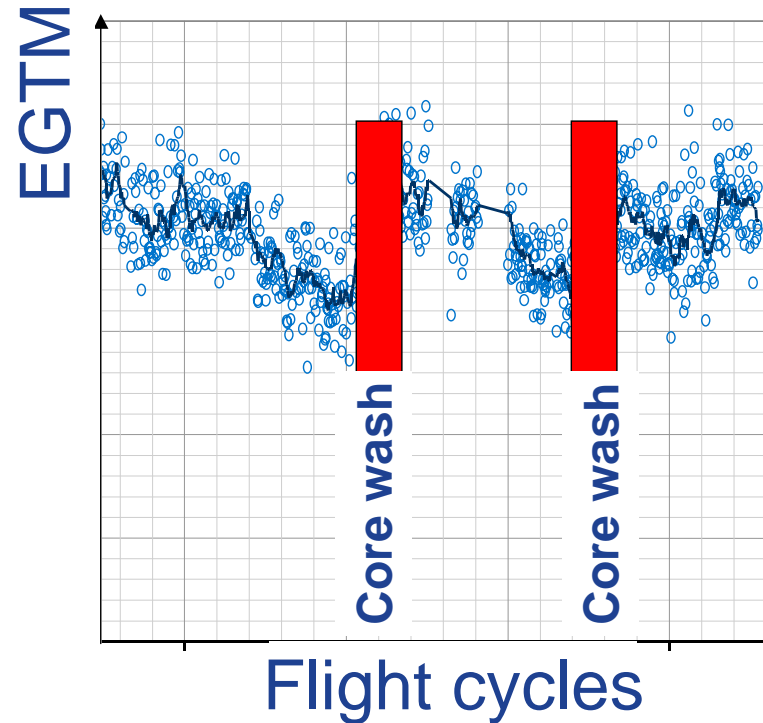
- Performance shift detected
- Operating limits not approached
- Maintenance action recovered 1.3% fuel flow on wing

Keeping the gas path clean improves fuel economy and on wing life

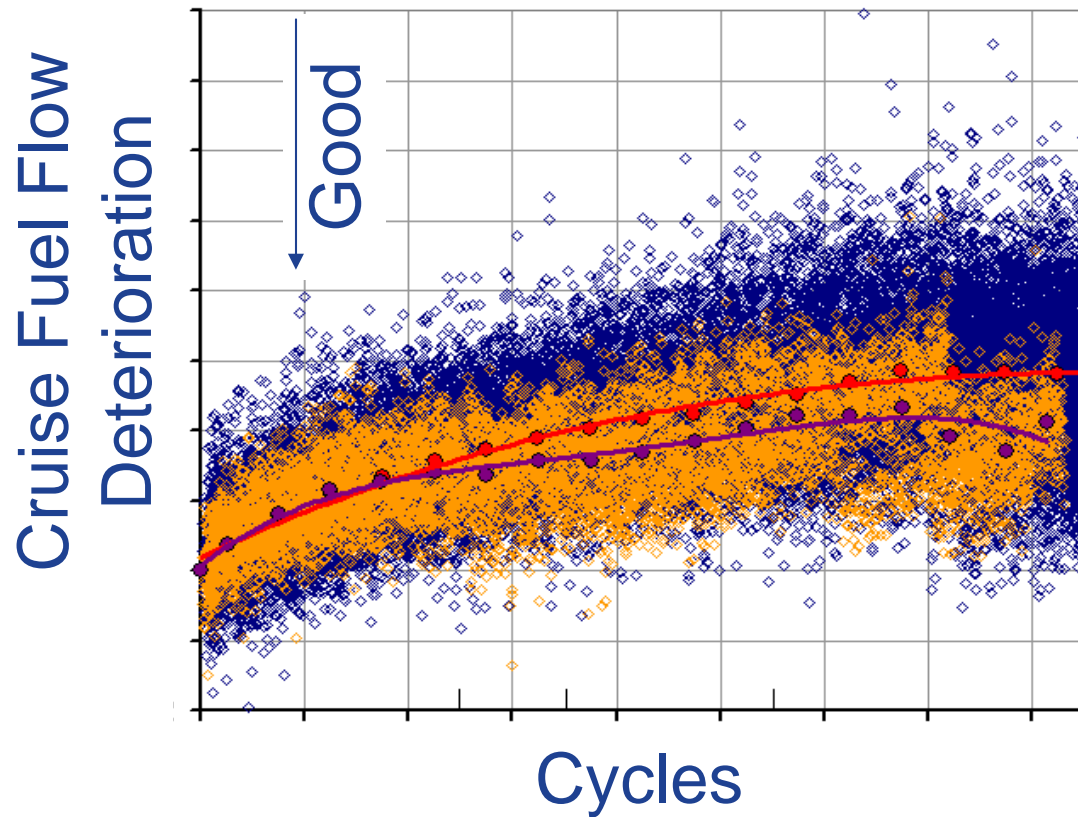
Engine core wash



EGTM recovery 5-15°C



In-flight diagnostic data show regular core wash delivers fuel economy



No core

Aircraft fuel

} savings

~1.3% ~ \$200k*

Regular core wash

*\$2/gallon



GE Customer & Product Support assist to optimize fuel efficiency

AMM Core wash updates



- Reduced dry out run
- Idle wash – no dry out
- no effluent

CF6

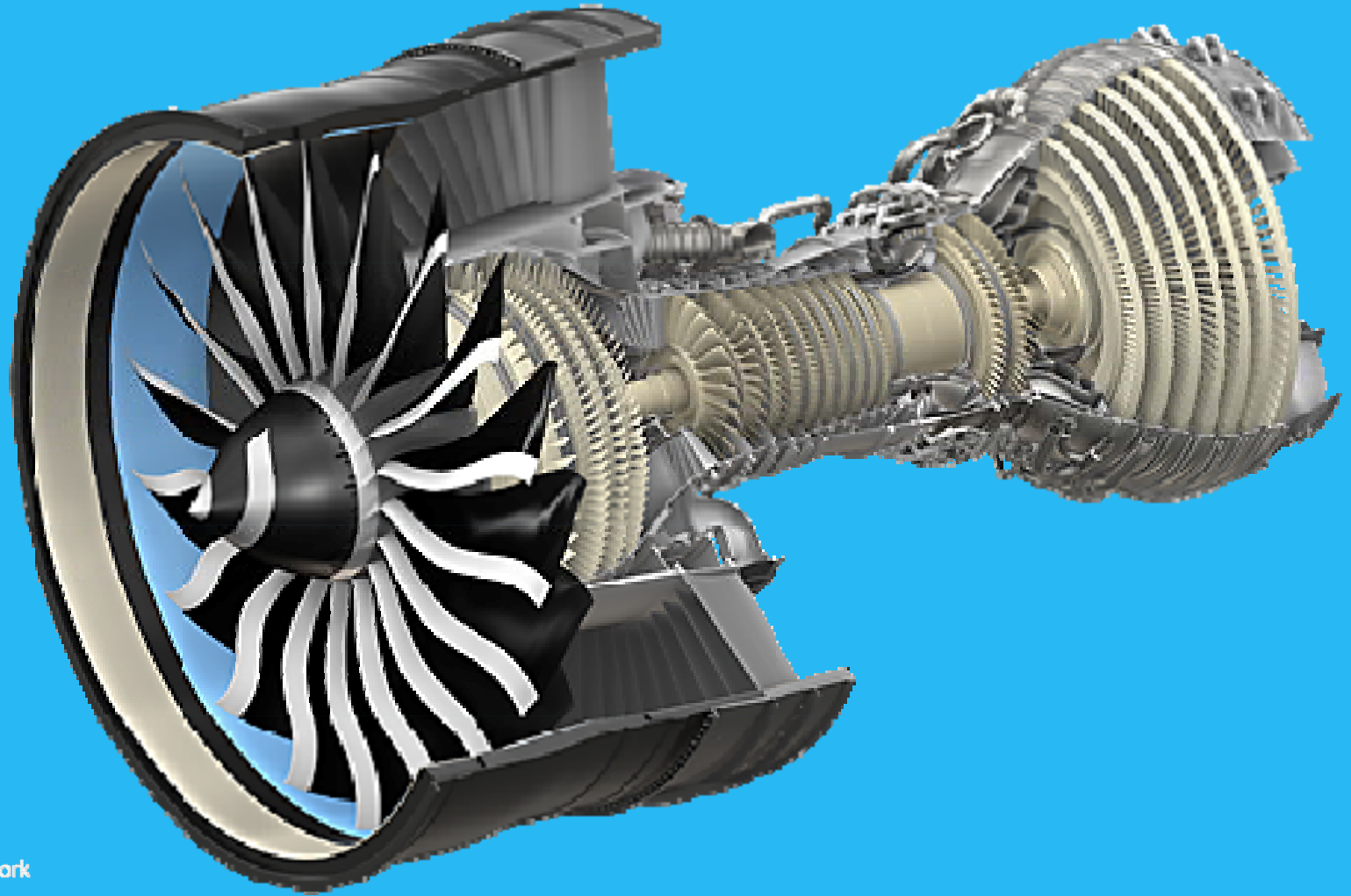
- VSV/VBV driver
- Procedural simplification

Program optimization

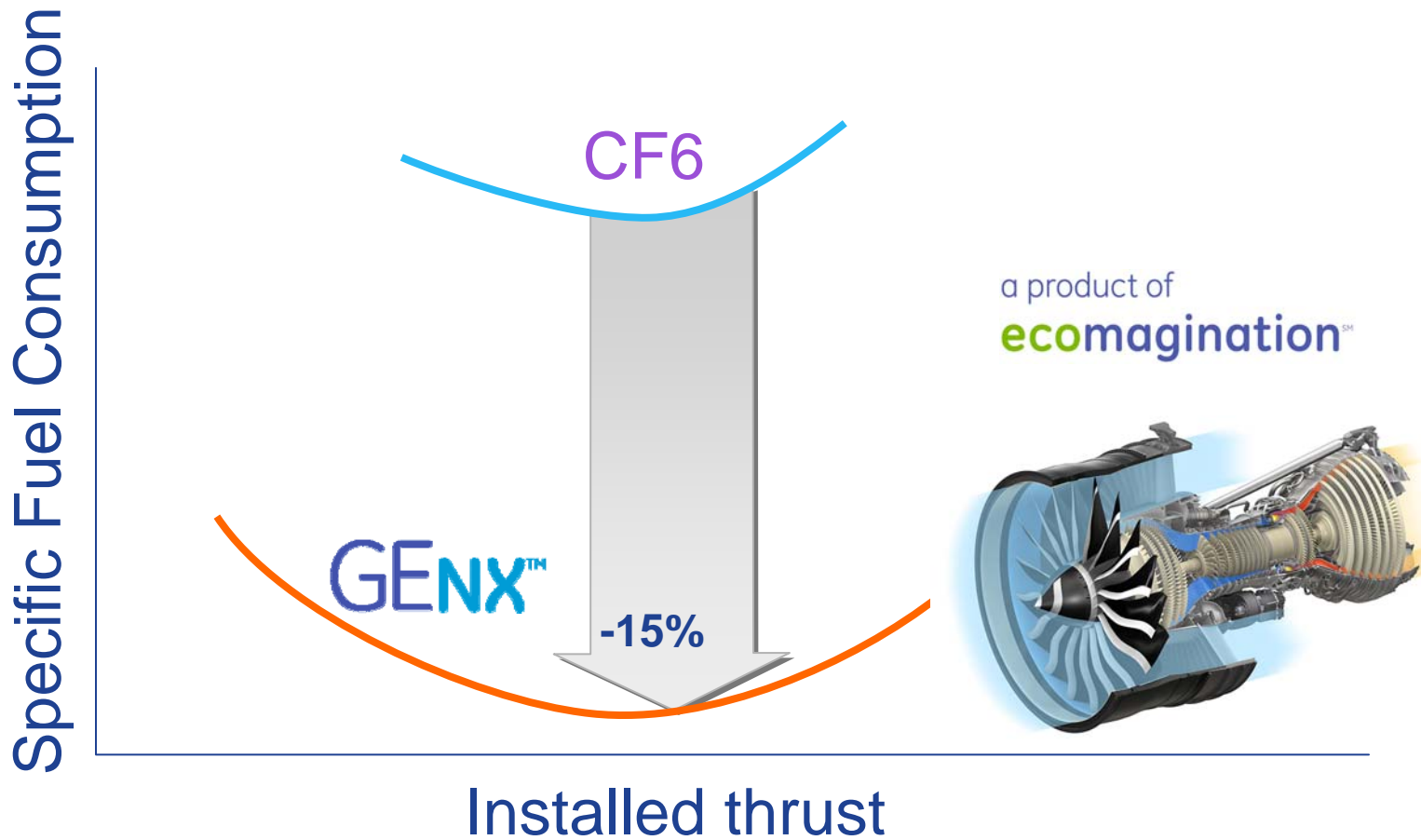
- Diagnostic solutions
- CRZ FF/TOW benefit
- Environmental impact
- Select procedure
- Determine frequency



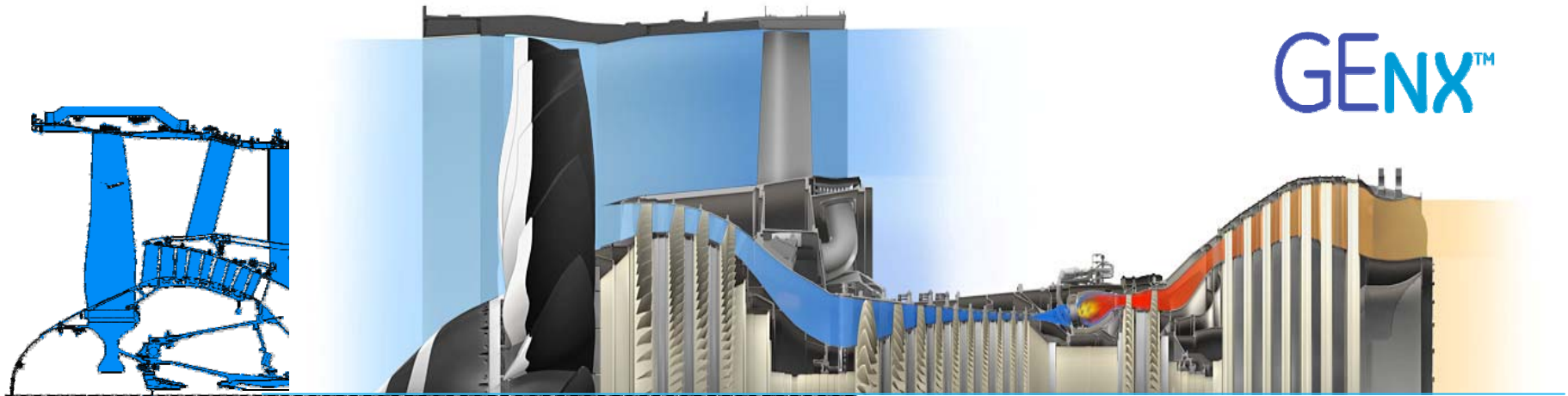
Fuel efficient design trends



New generation engines offer big fuel efficiency gains and lower emissions



Fuel efficient, balanced design



Configuration

- 80% increase in BPR
- 30% increase in OPR
- Counter rotating spools

Hardware

- Swept fan aerodynamics
- 3D aero HPC airfoils
- Advanced alloys, coatings

