

# GdR META kick-off

## Metamaterials for aeronautics

22/01/2016

# SAFRAN group

→ 69,000 employees in nearly 60 countries

→ 2014 turnover of 15,4 billion euros

→ 3 core businesses:



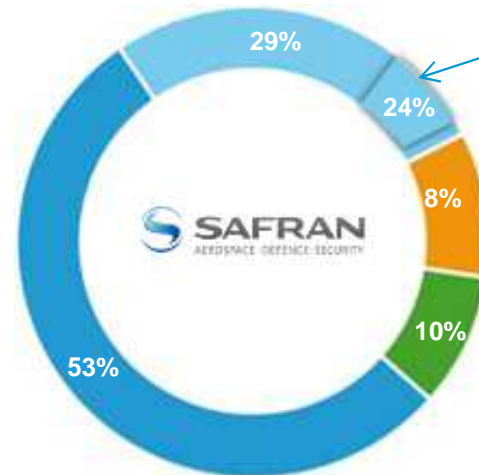
## Aerospace Propulsion

- Main companies in the group
- Snecma
  - Herakles
  - Turbomeca
  - Techspace Aero

## Aircraft Equipment

Main companies in the group

- Aircelle
- Messier-Bugatti-Dowty
- Hispano-Suiza
- Labinal



## Defence

Main company in the group

- Sagem

## Security

Main company in the group

- Morpho

# Aircelle, the nacelle integrator from SAFRAN

- European leader and second in the world for design, manufacturing and after-sales support of engine nacelles
- The only nacelles integrator present in every market segment, from business jets to wide-body airliners



**Nacelle design using high technology composites**



**Complete propulsion system integrator**

Manufacturing, integration & certification, composites, nozzles, painting, final assembly...



**Services to operators**

Support, spares, maintenance, repair...



**3 800 employees**  
**1 B€ turnover**

# Nacelle functions

## → Aerodynamic and thermal functions

- To ensure the protection of the engine and the ducting of secondary air flow
- To manage differences between the internal and external temperatures

## → Structural function

- To ensure the take-up of strain between the engine and the pylon, including during thrust reverser operation

## → Acoustic function

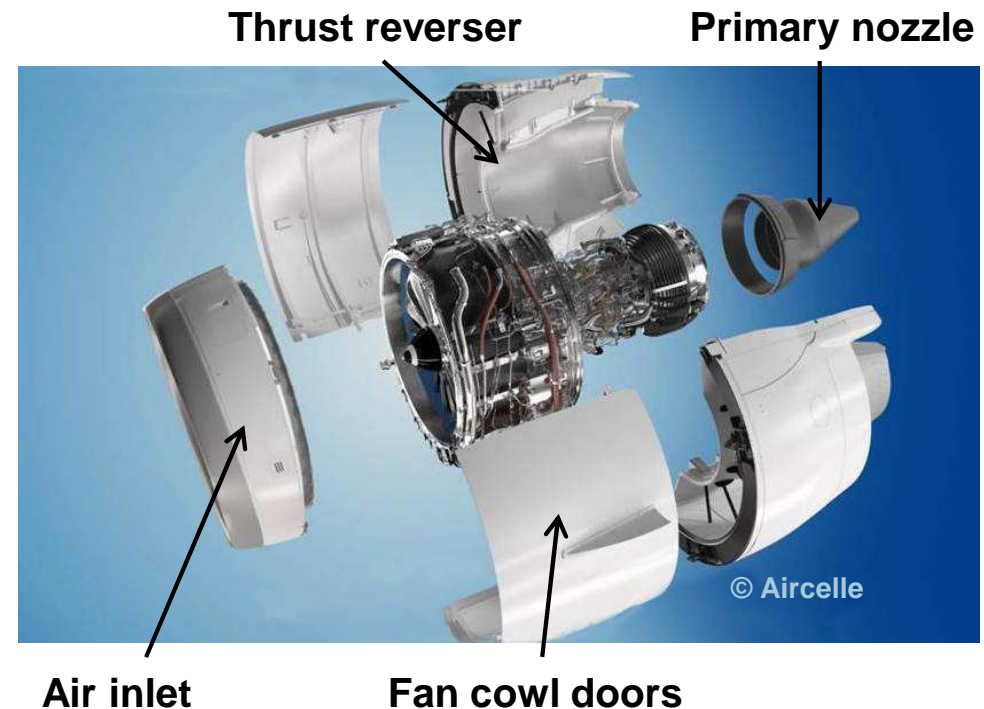
- To ensure acoustic attenuation of engine noise

## → Braking function (thrust reverser)

- To generate thrust reversal during landing

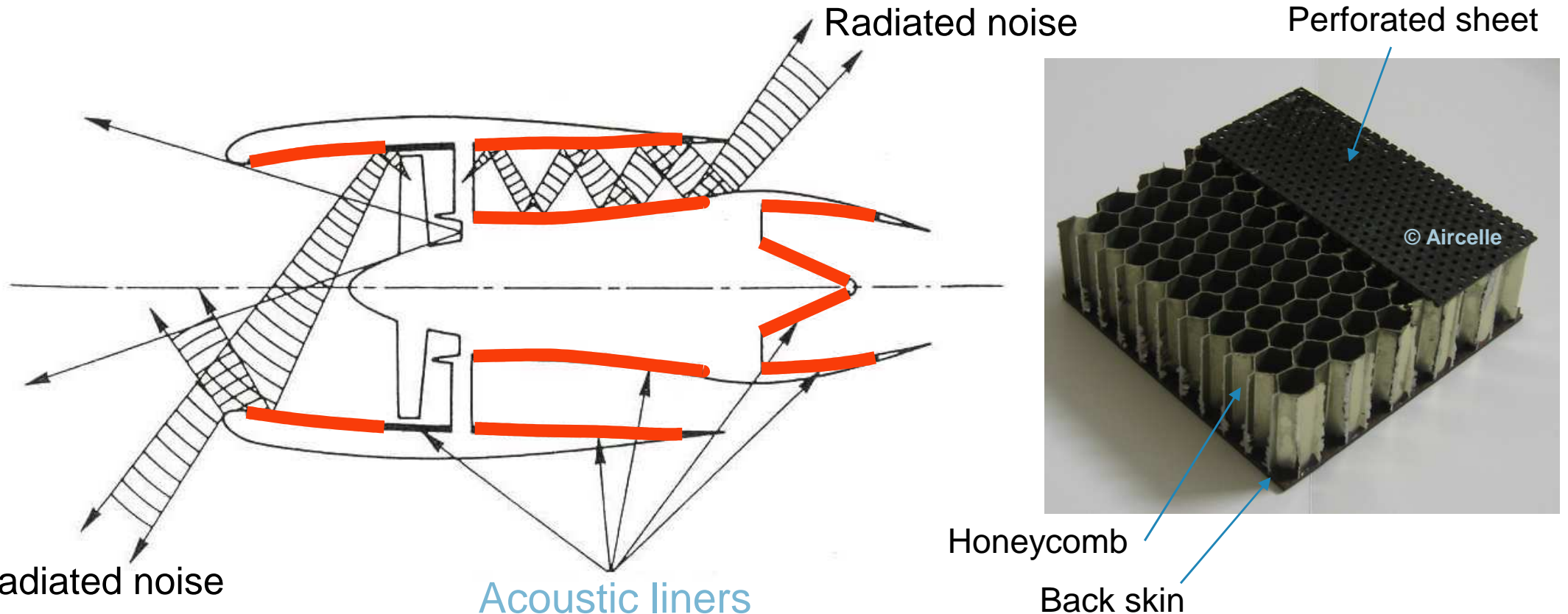
## → Esthetic function

- To personalize with the colors of the airline company



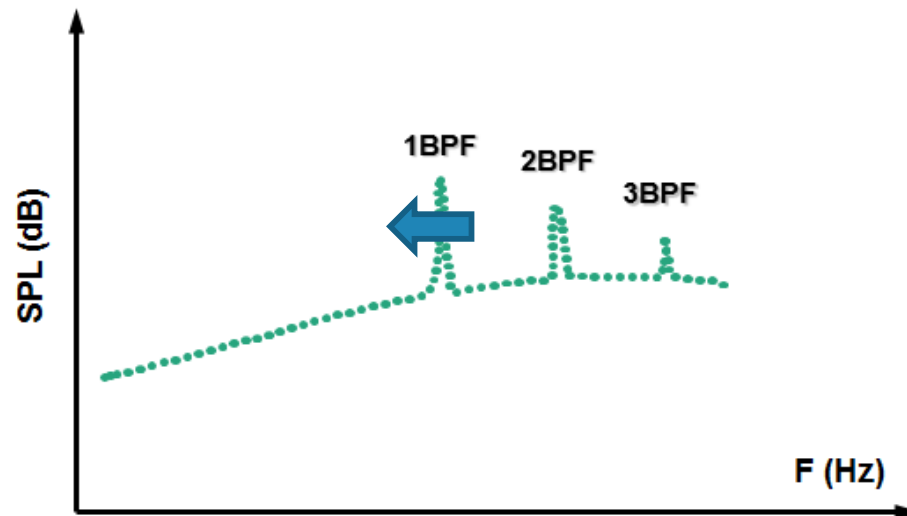
# The nacelle acoustic function

- One of the nacelle functions is to attenuate the engine noise when propagating within the nacelle
- Conventional liners are based on the Helmholtz resonator principle



# Acoustic challenge for next generation engines

- To reduce fuel burn, engine fan diameter will keep increasing
- Fan tone noise will shift towards lower frequencies



- Conventional acoustic liners may become too thick to be integrated to the nacelle
- Acoustic metamaterials may attenuate low frequency (500Hz - 1000Hz) noise with a limited thickness (up to 40mm)

# Nacelle main integration constraints

		Inlet and thrust reverser	Primary exhaust
<b>Acoustic</b>	<b>Frequencies</b>	500Hz to 3000Hz	4kHz to 6kHz
	<b>Attenuation level</b>	Doubled compared to SDOF (at iso area)	
<b>Weight</b>		To be minimized (ref: 10lbs/m <sup>2</sup> )	
<b>Thickness</b>		Up to 40mm	Up to 15mm (nozzle) Up to 200mm (plug)
<b>Temperature</b>		Inlet: -70°C to +100°C T/R: -70°C to +180°C	Up to 700°C
<b>Grazing flow velocity</b>		Up to Mach 0.6	Up to Mach 1.0

# Thank you for your attention