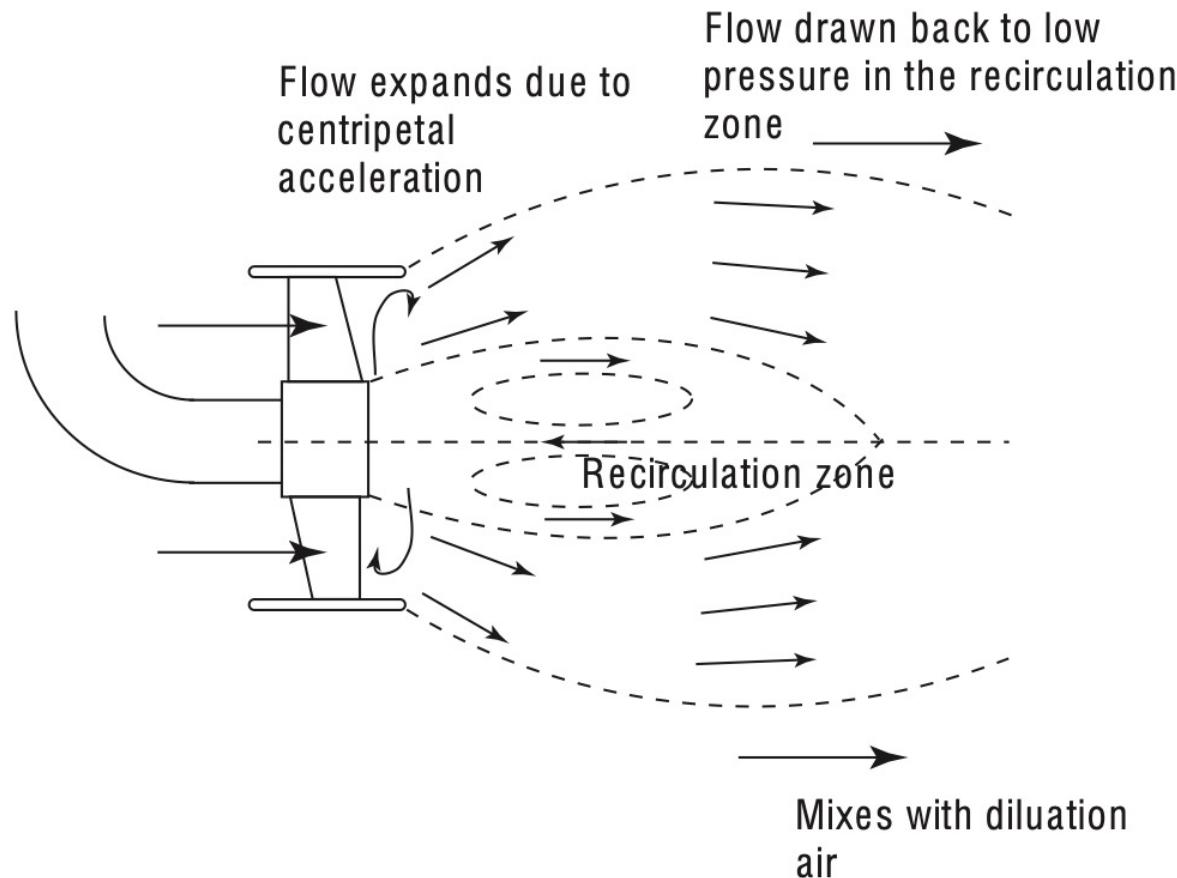


# Components

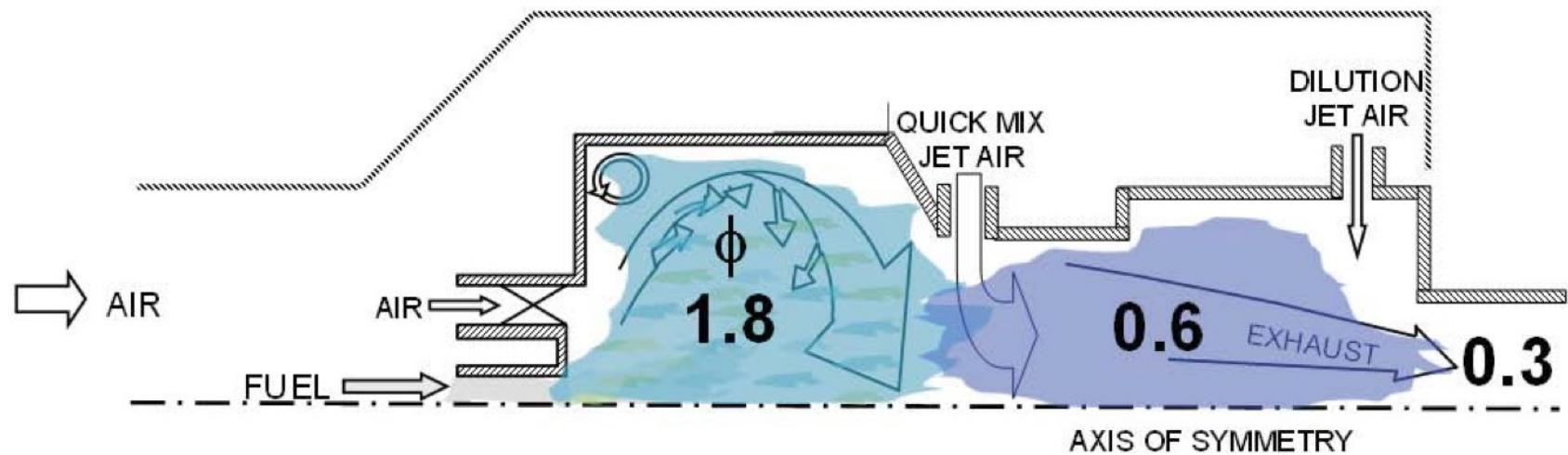
(AE 234)

Kowsik Bodi

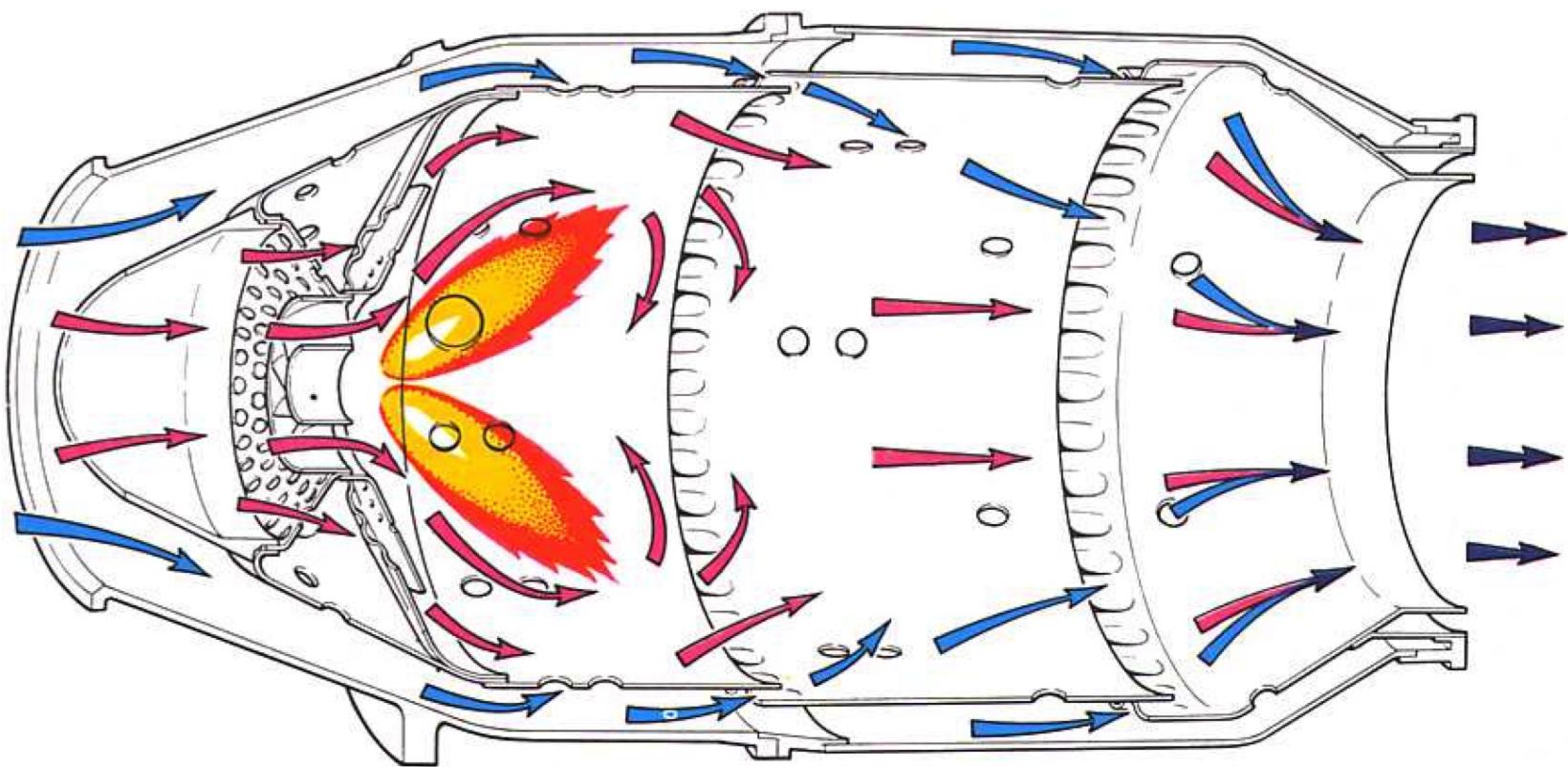
# Combustor Flow -- Concept



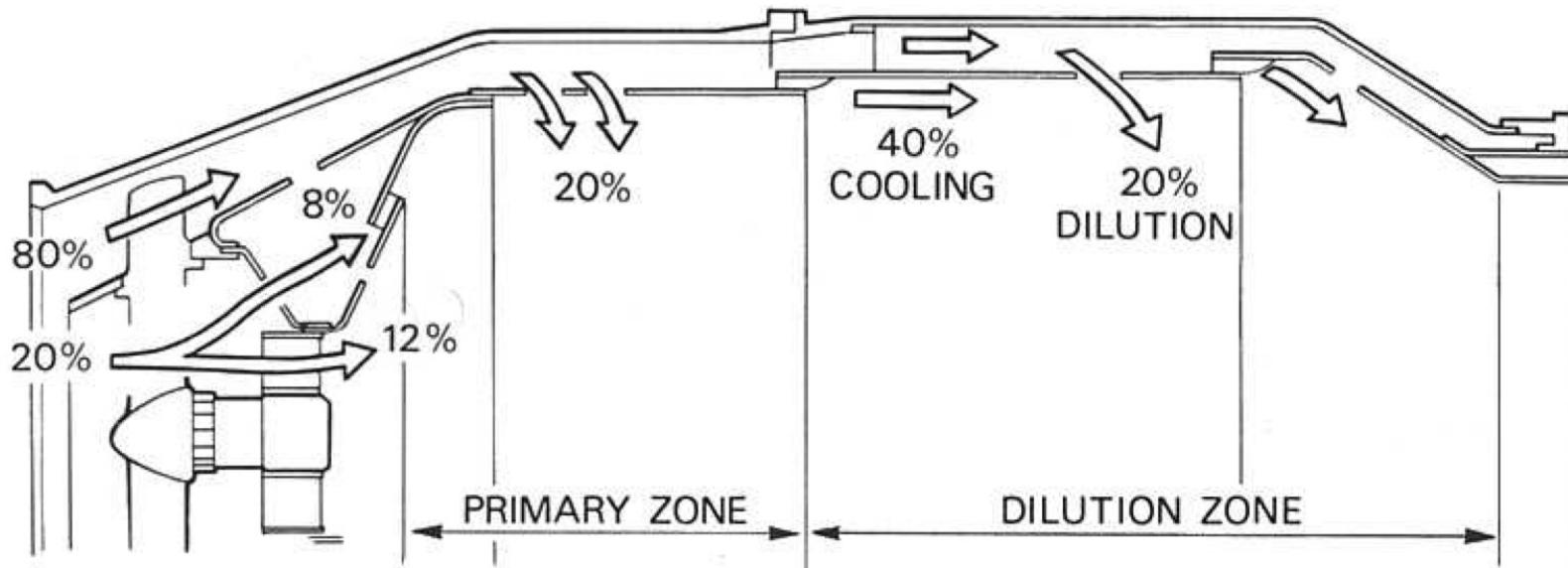
# Combustor fuel-air ratios



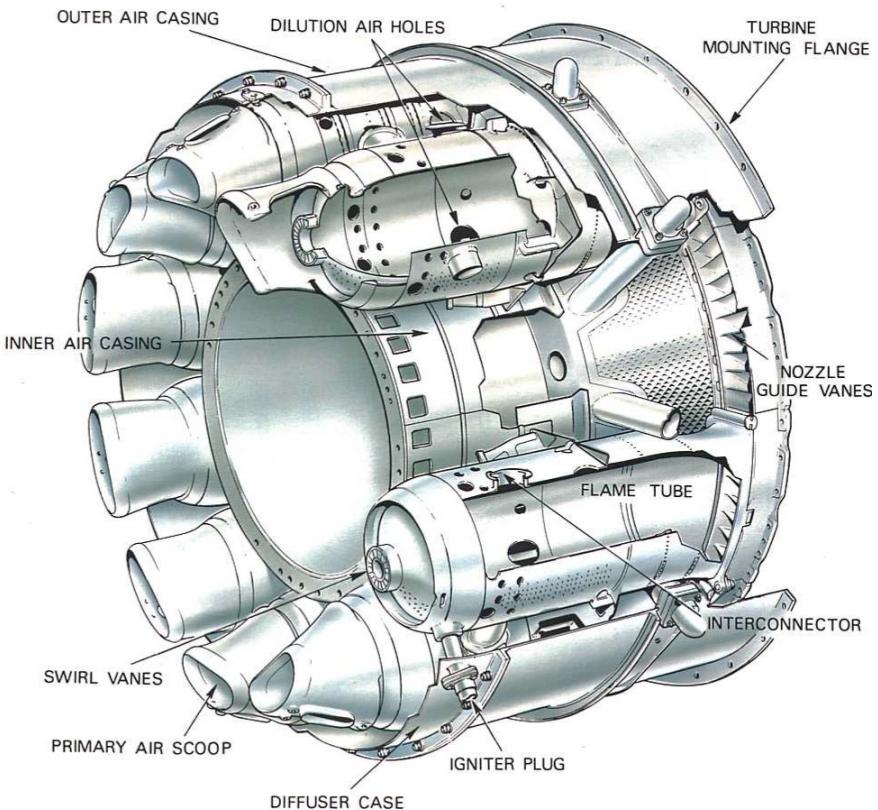
# Combustor air-flow path



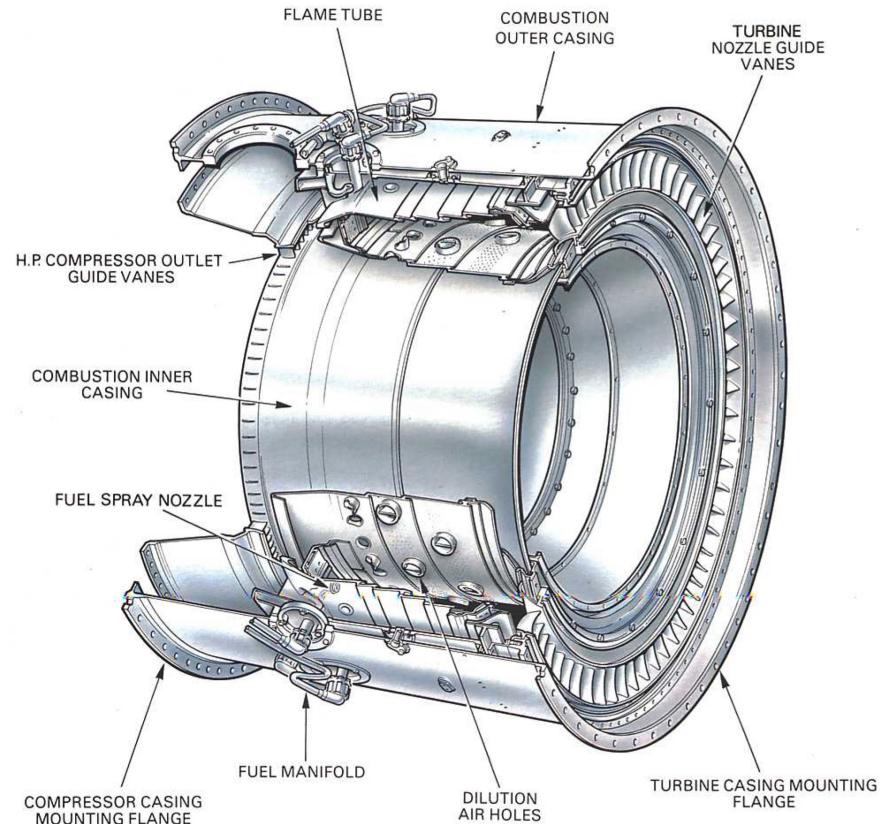
# Combustor air flow distribution



# Combustors

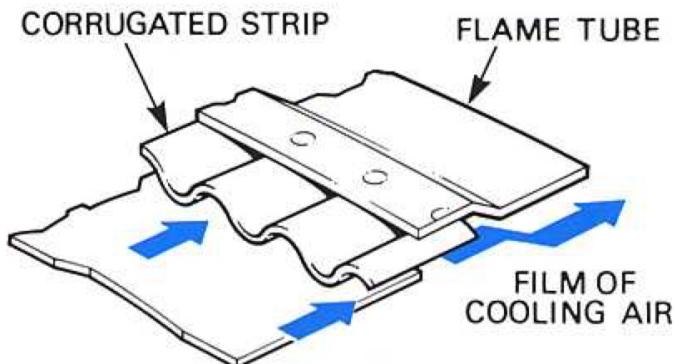


Can-type Combustor

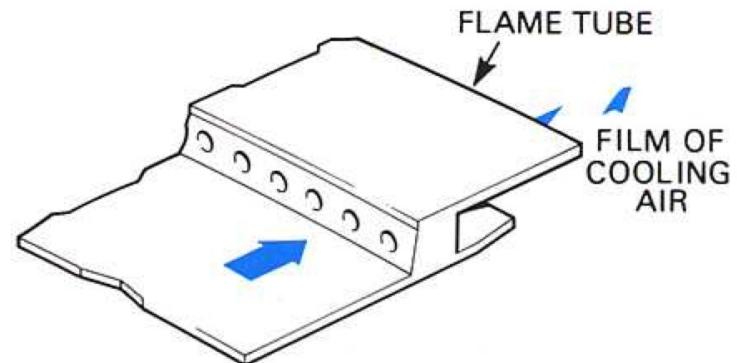


Annular Combustor

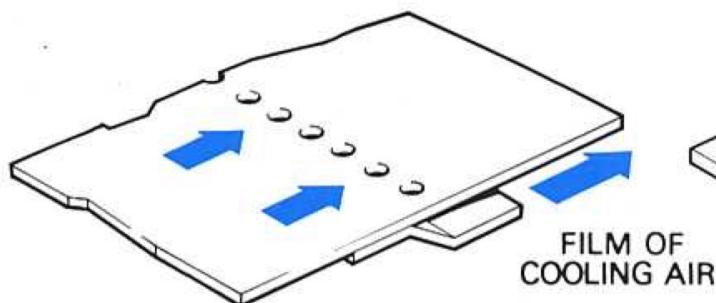
# Combustor Cooling Methods



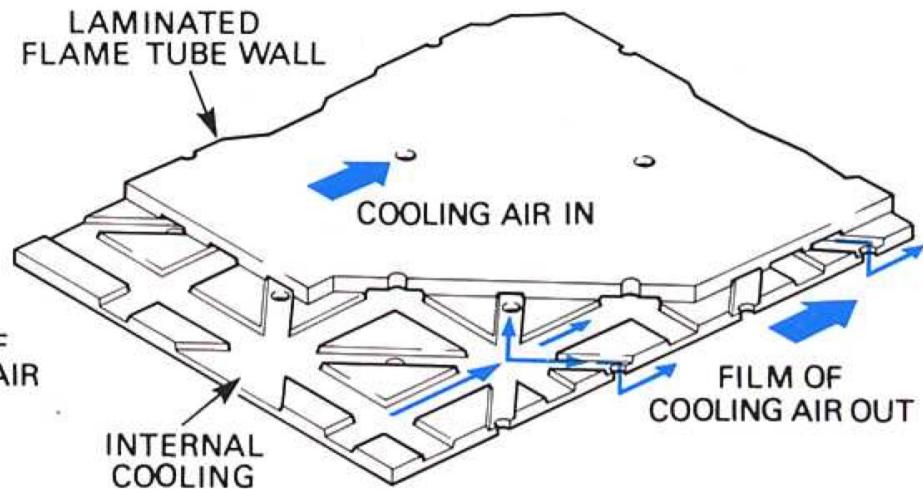
CORRUGATED STRIP COOLING



MACHINED COOLING RING

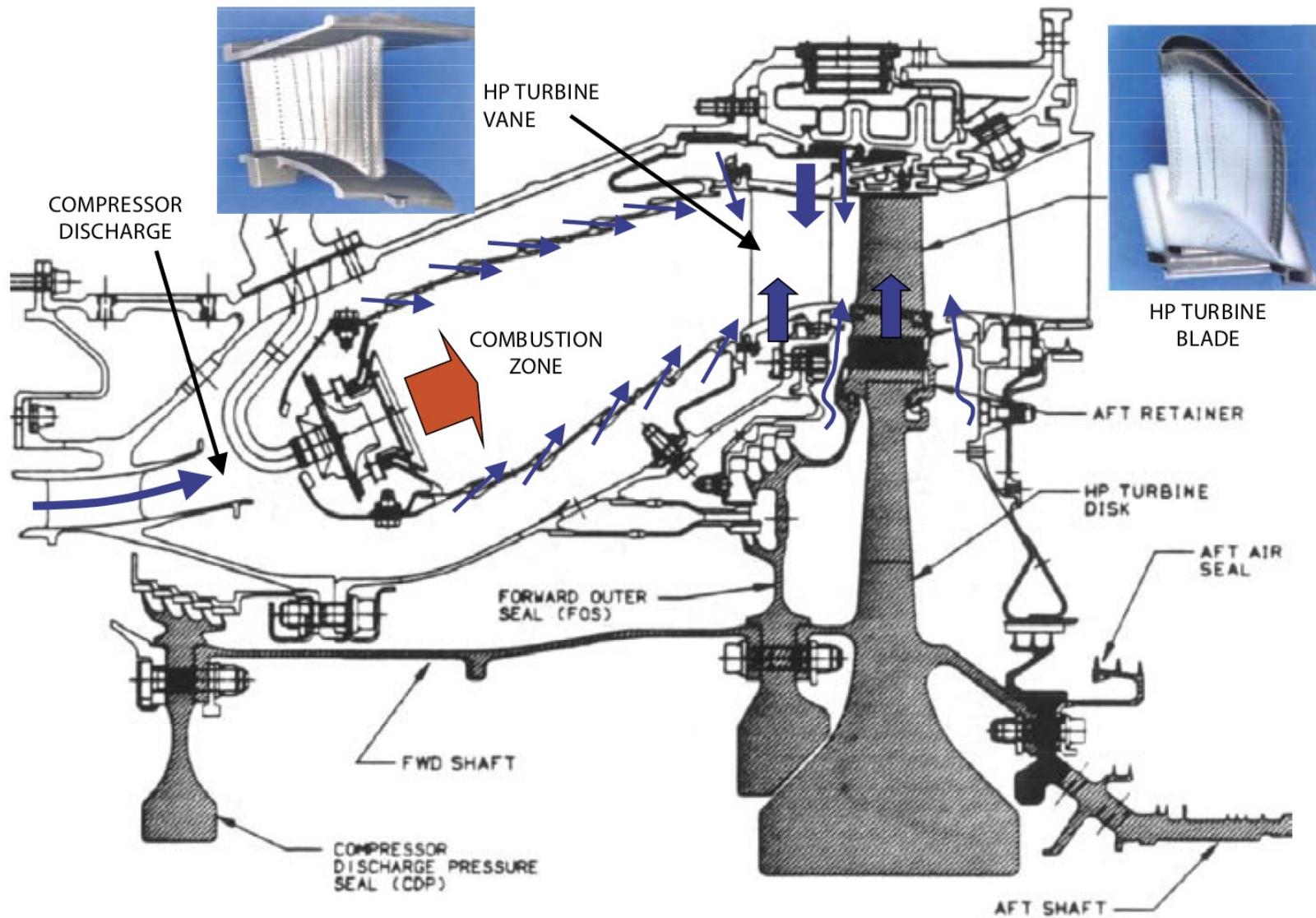


SPLASH COOLING STRIP

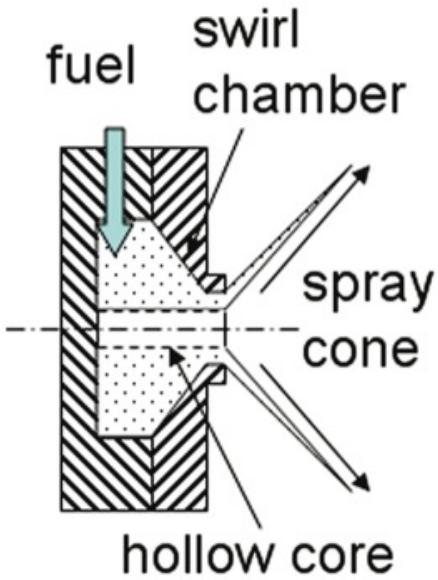


TRANSPIRATION COOLING

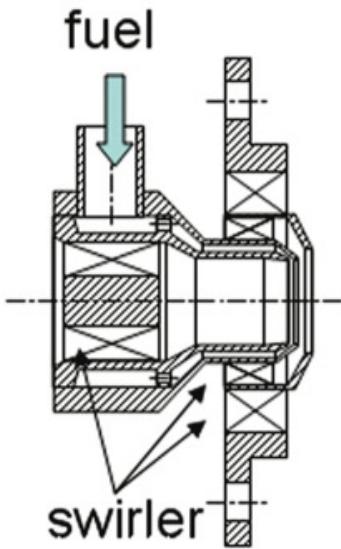
# Combustor position



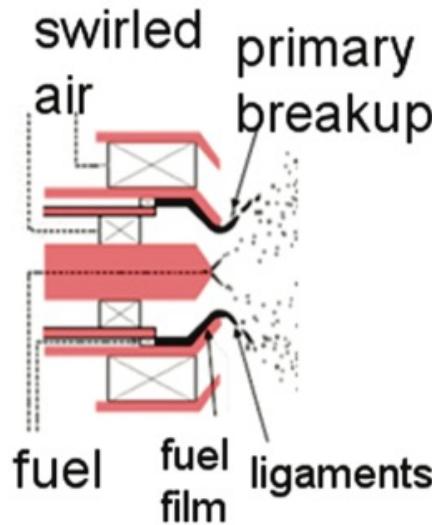
# Fuel Injection



(a) Pressure  
nozzle



(b) Airblast nozzle  
(triple-swirler)

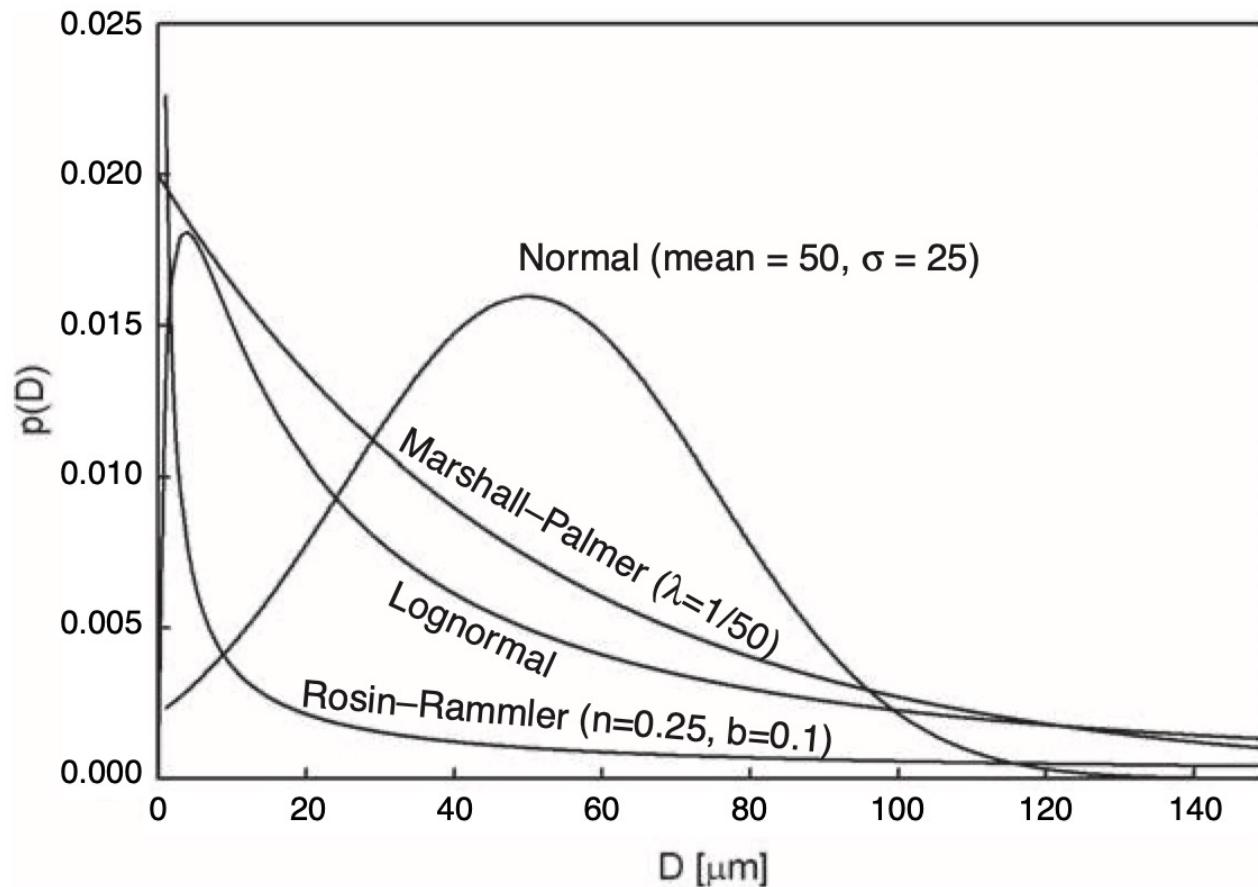


(c) Compound pre-  
filming nozzle  
with pressure pilot

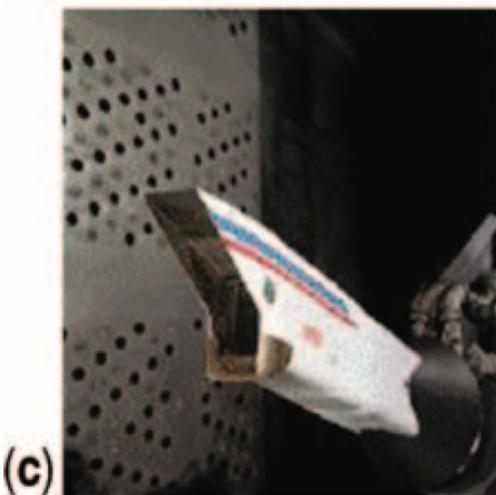
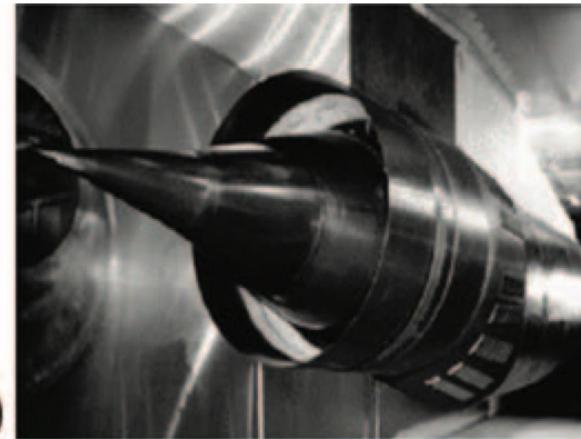
# Fuel Atomization



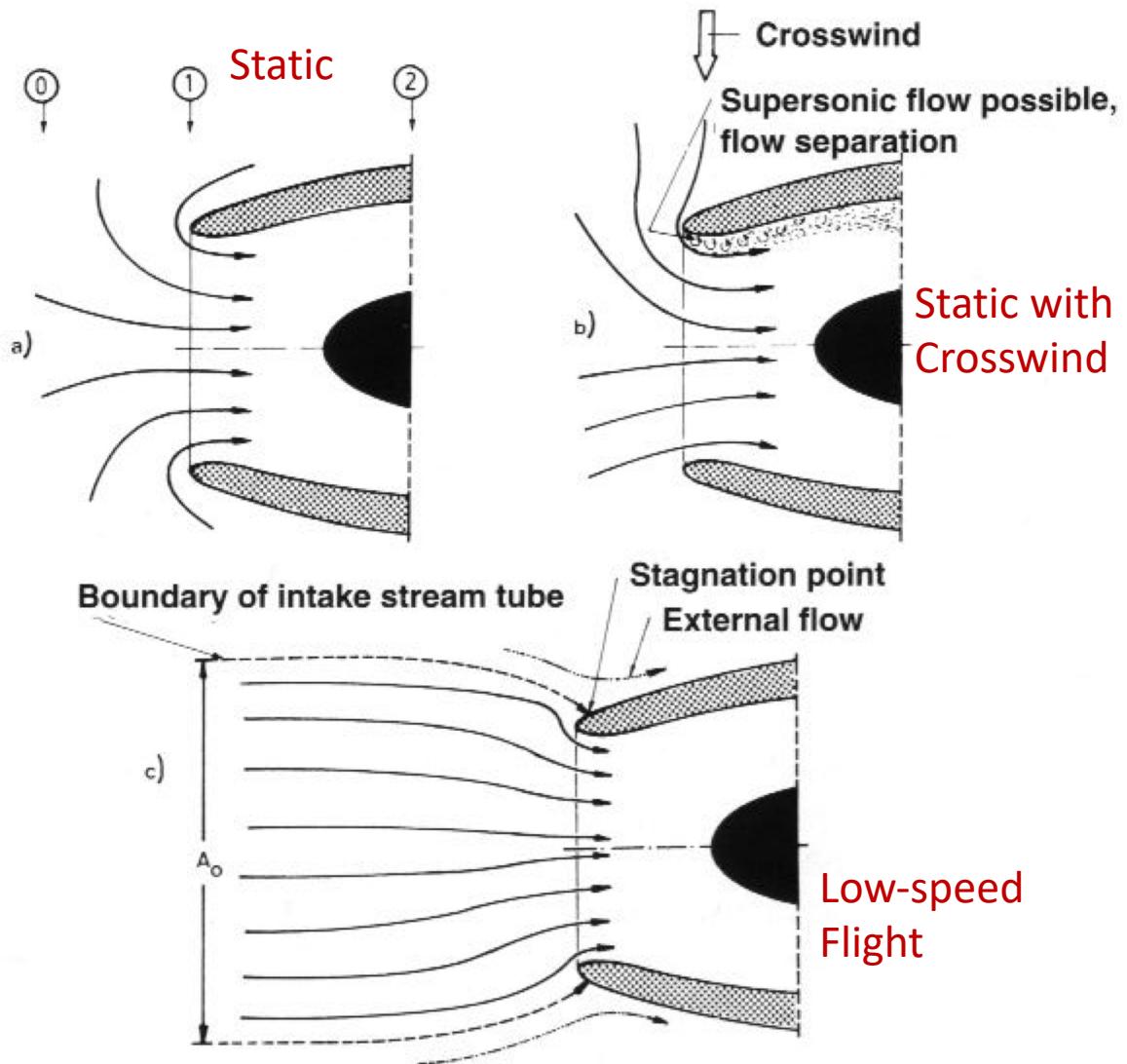
# Droplet Size Distributions



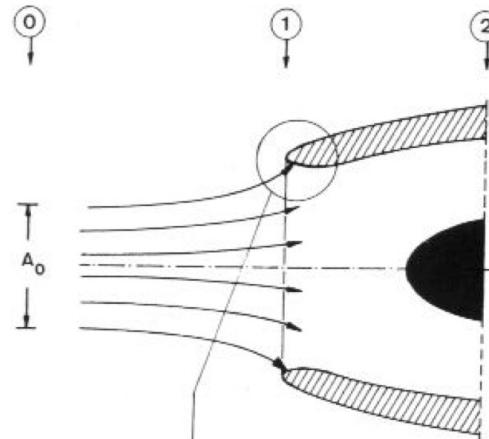
# Intake Types



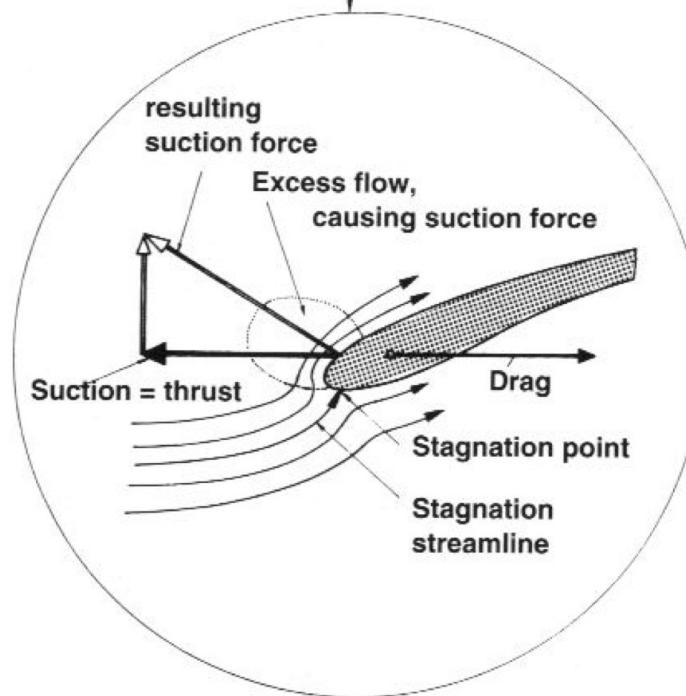
# Intake Air Flow field



# Intake Flowfield



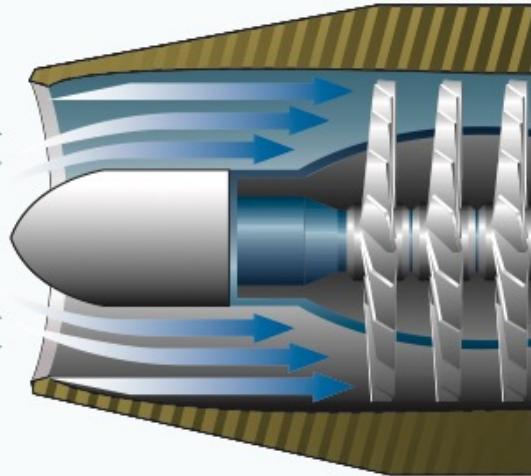
a) Stagnation at high-speed flight



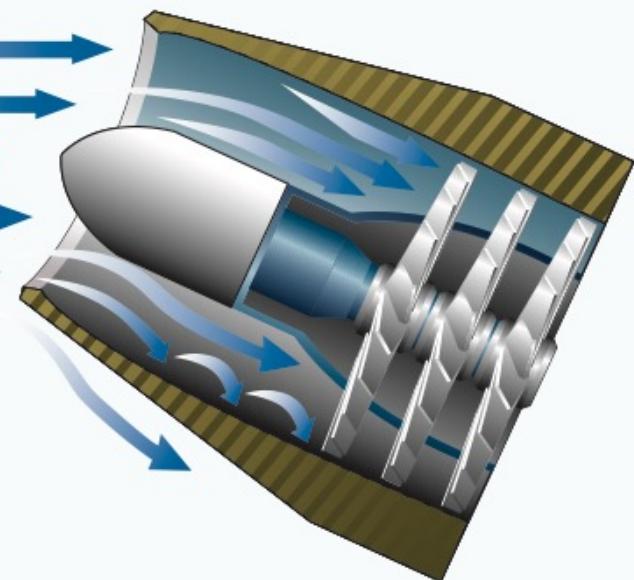
b) Correct nose flow

# Flow Distortion

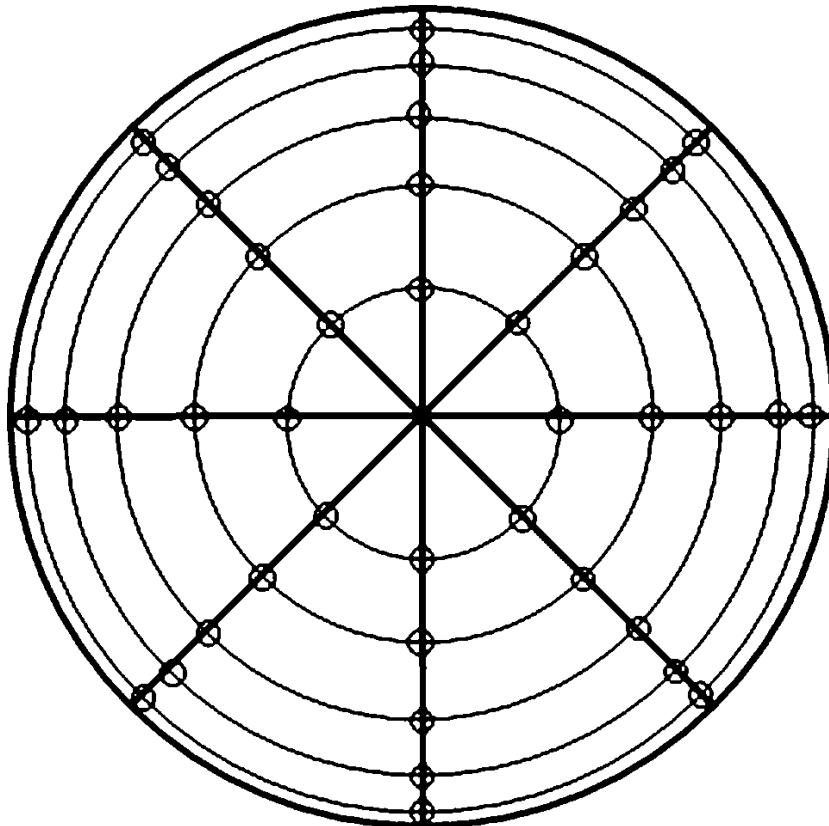
Normal inlet airflow



Distorted inlet airflow

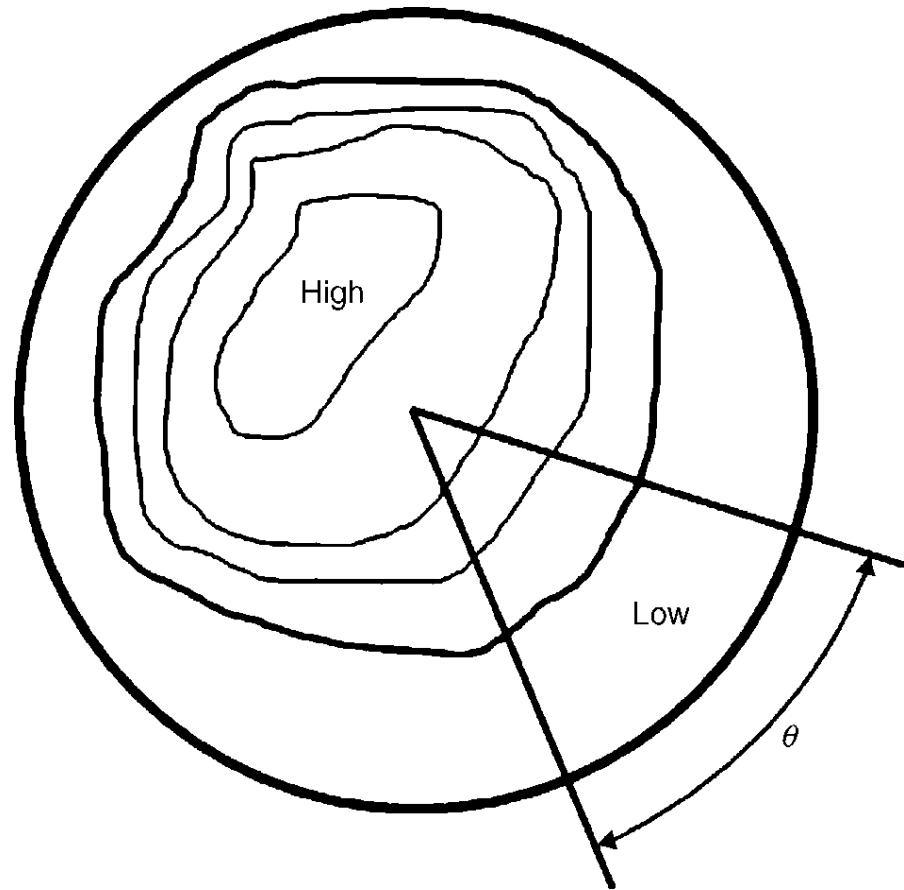


# Distortion Quantification

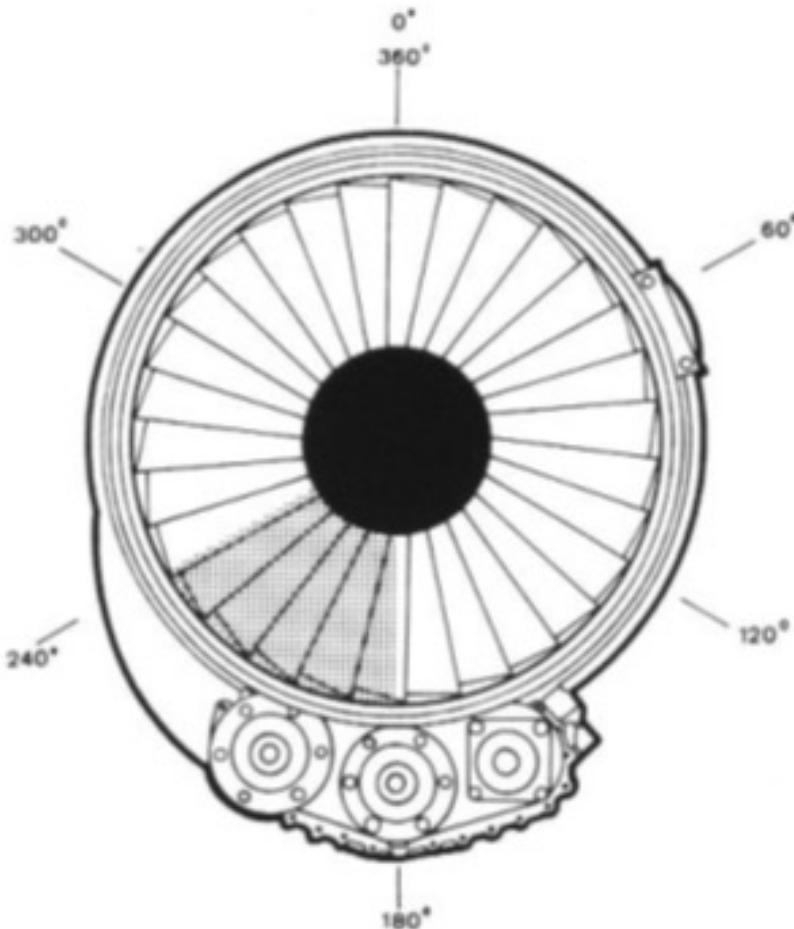


Pressure measurement arrangement

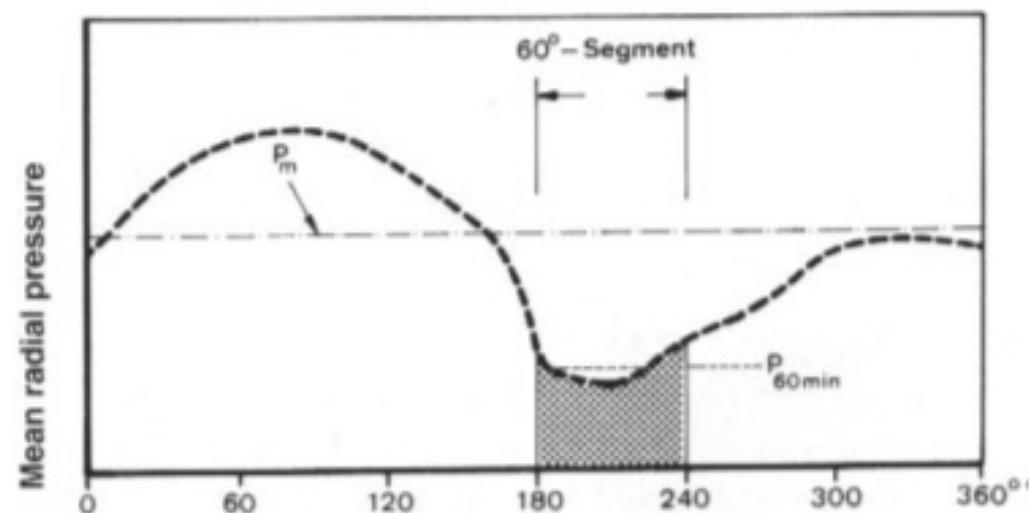
Total Pressure Measurement,  
Critical Sector definition



# Distortion Quantification

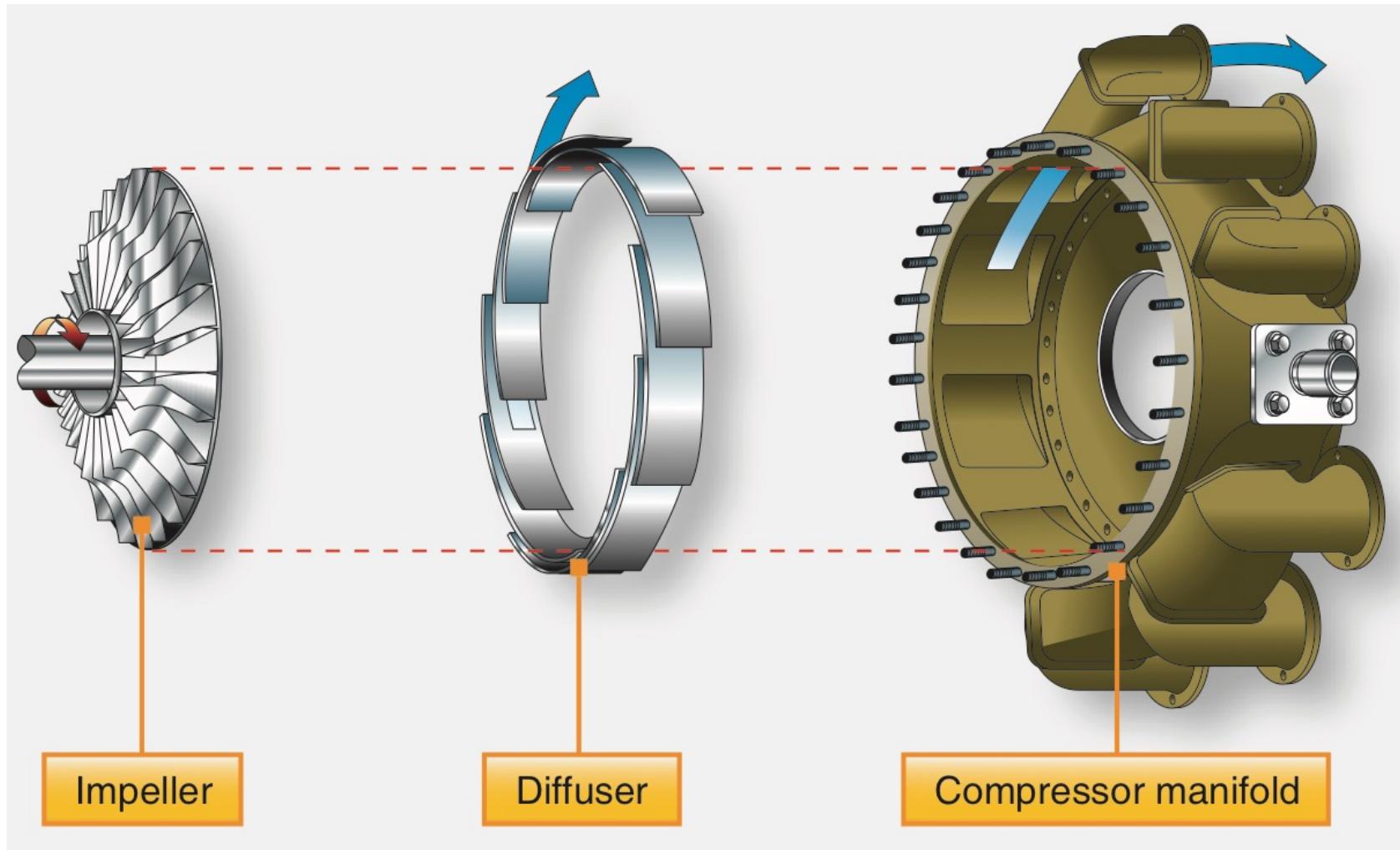


$$\text{Distortion parameter DC60} = \frac{P_m - P_{60\text{min}}}{q}$$

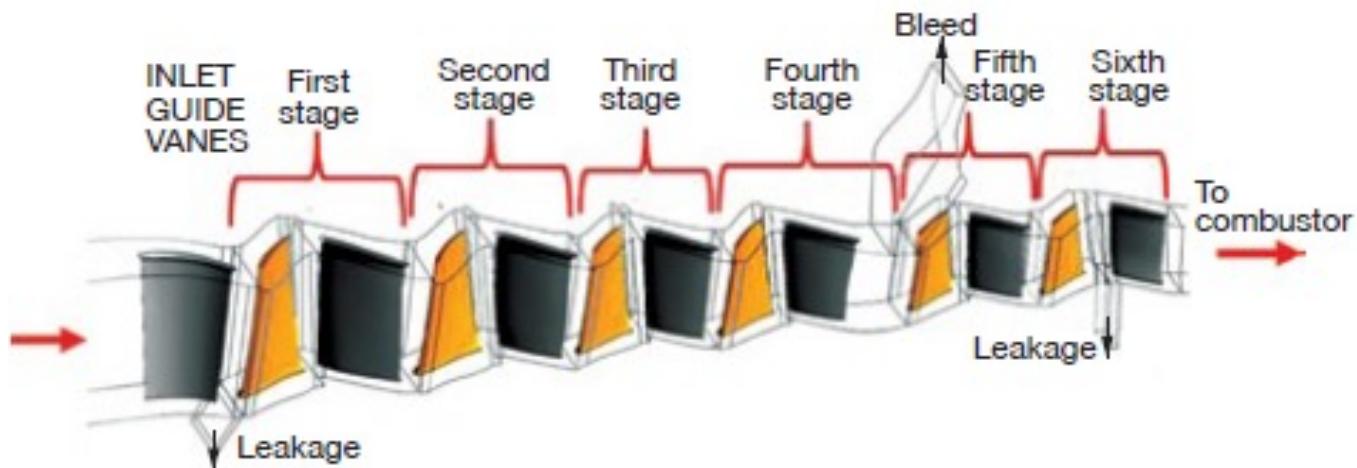


**Fig 3-5** Explaining distortion factor

# Centrifugal Compressors

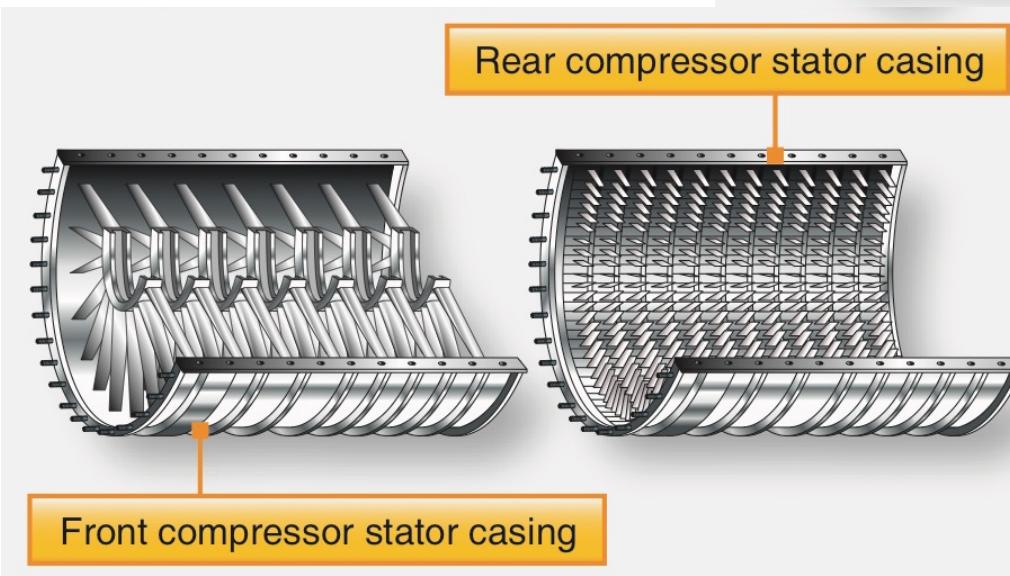
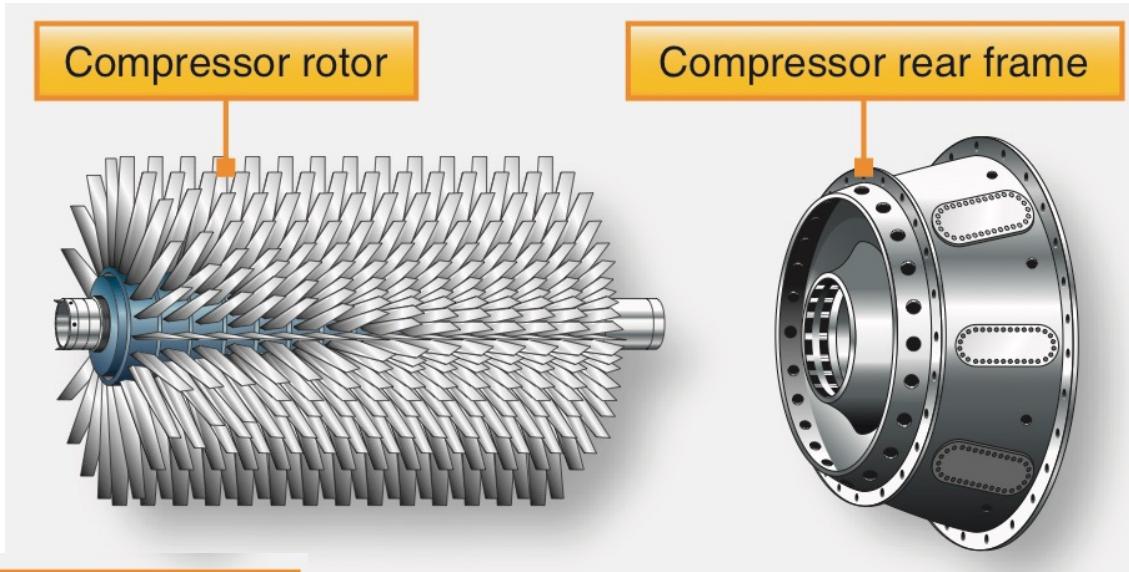


# Axial Compressors

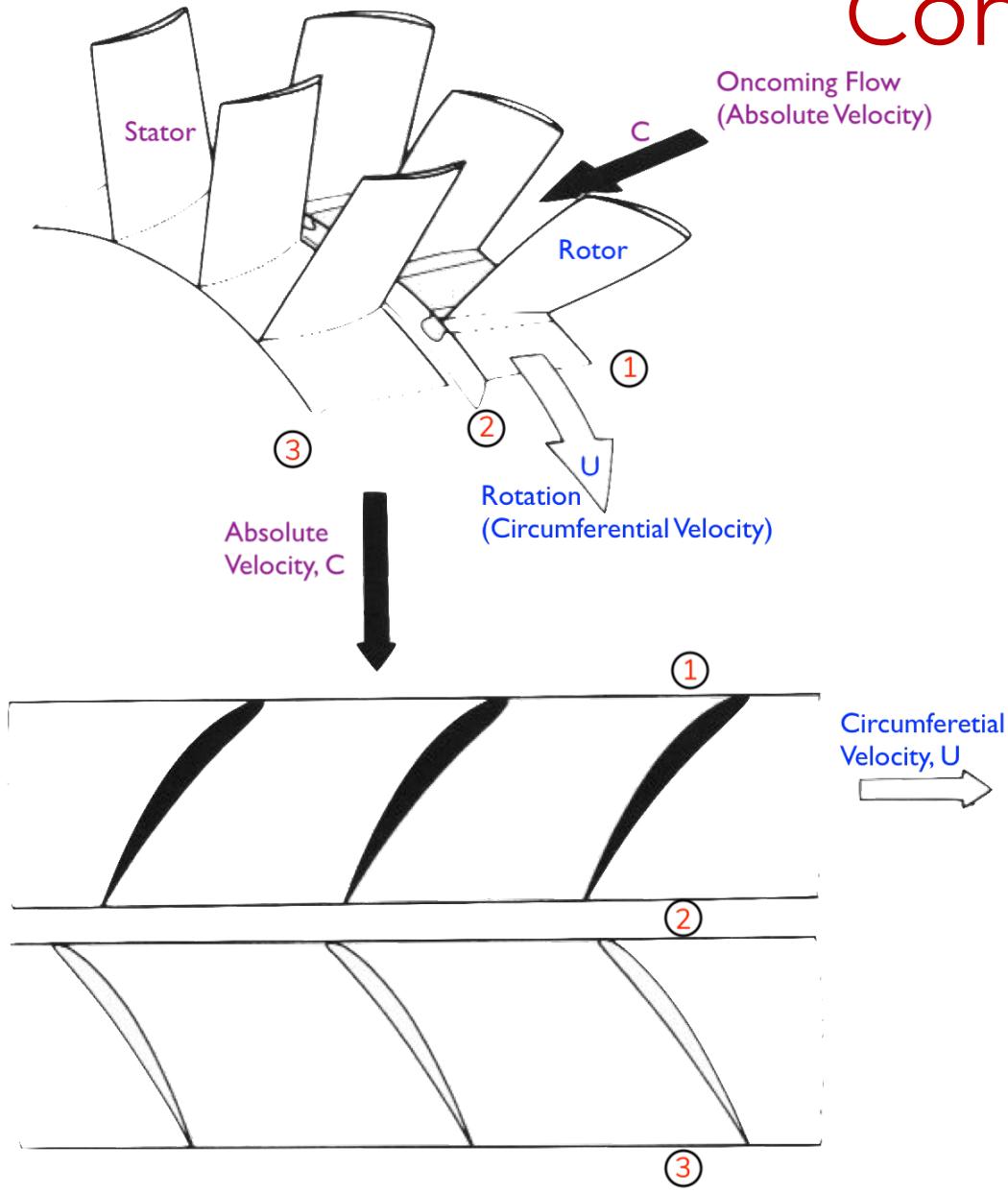


1. Gas path is traced through inlet guide vanes, rotating blades, and stationary vanes in a gas turbine's six-stage axial compressor

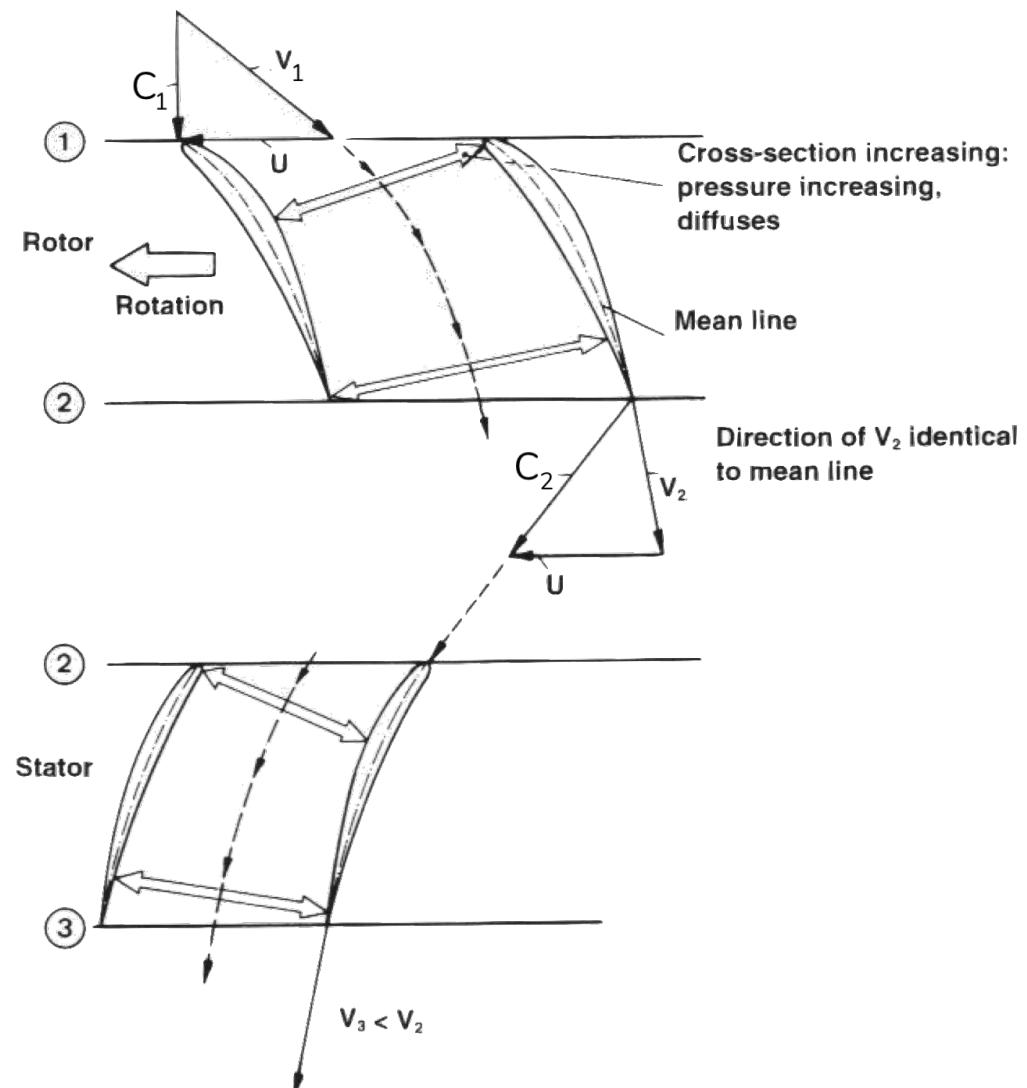
# Axial Compressors



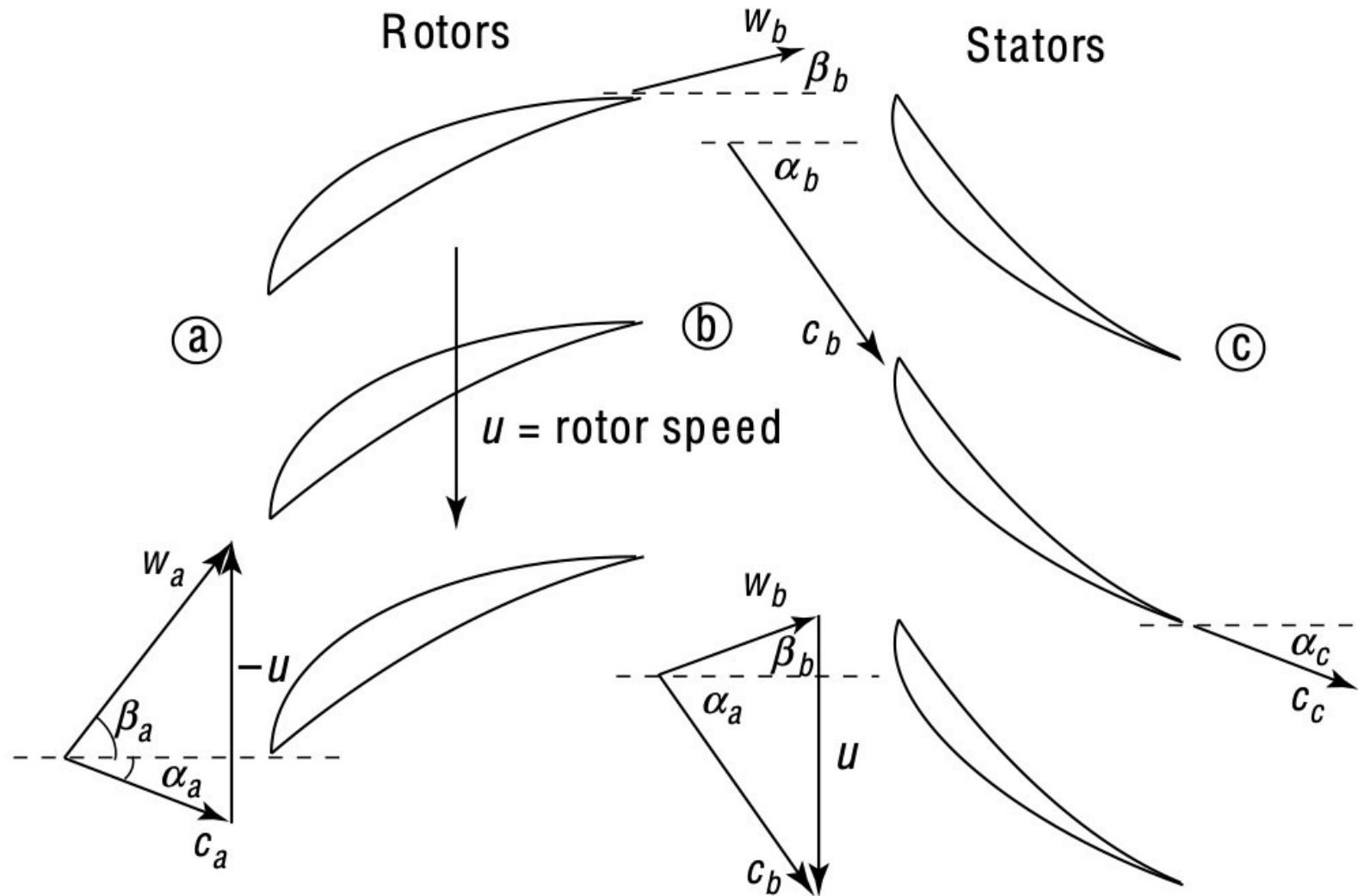
# Compressor Stage



# Compressor Flow Path

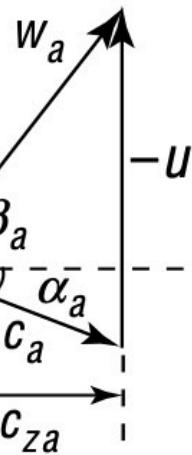
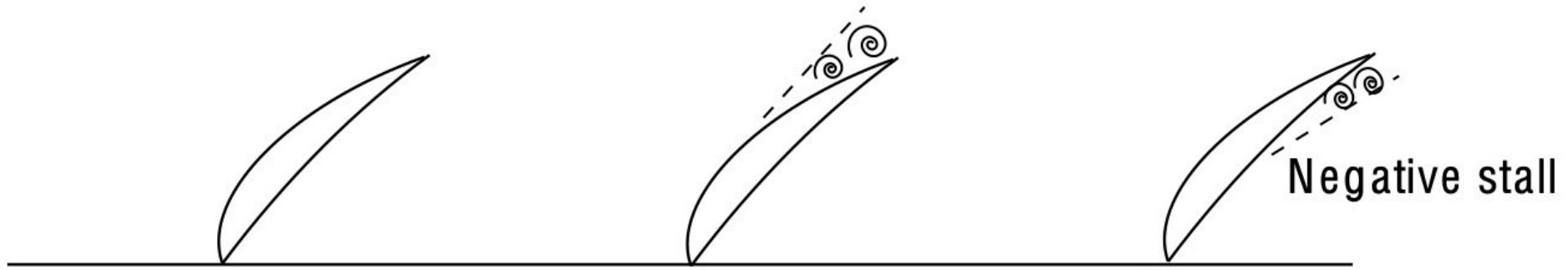


# Compressor Velocity Triangles

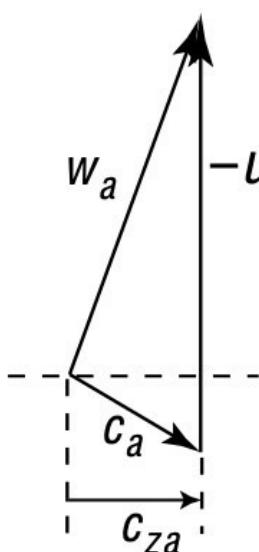


# Stall

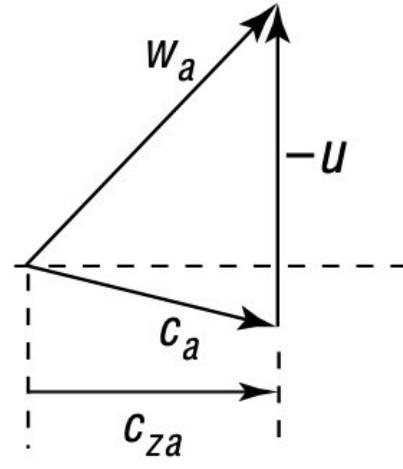
Positive stall



Normal  
operation

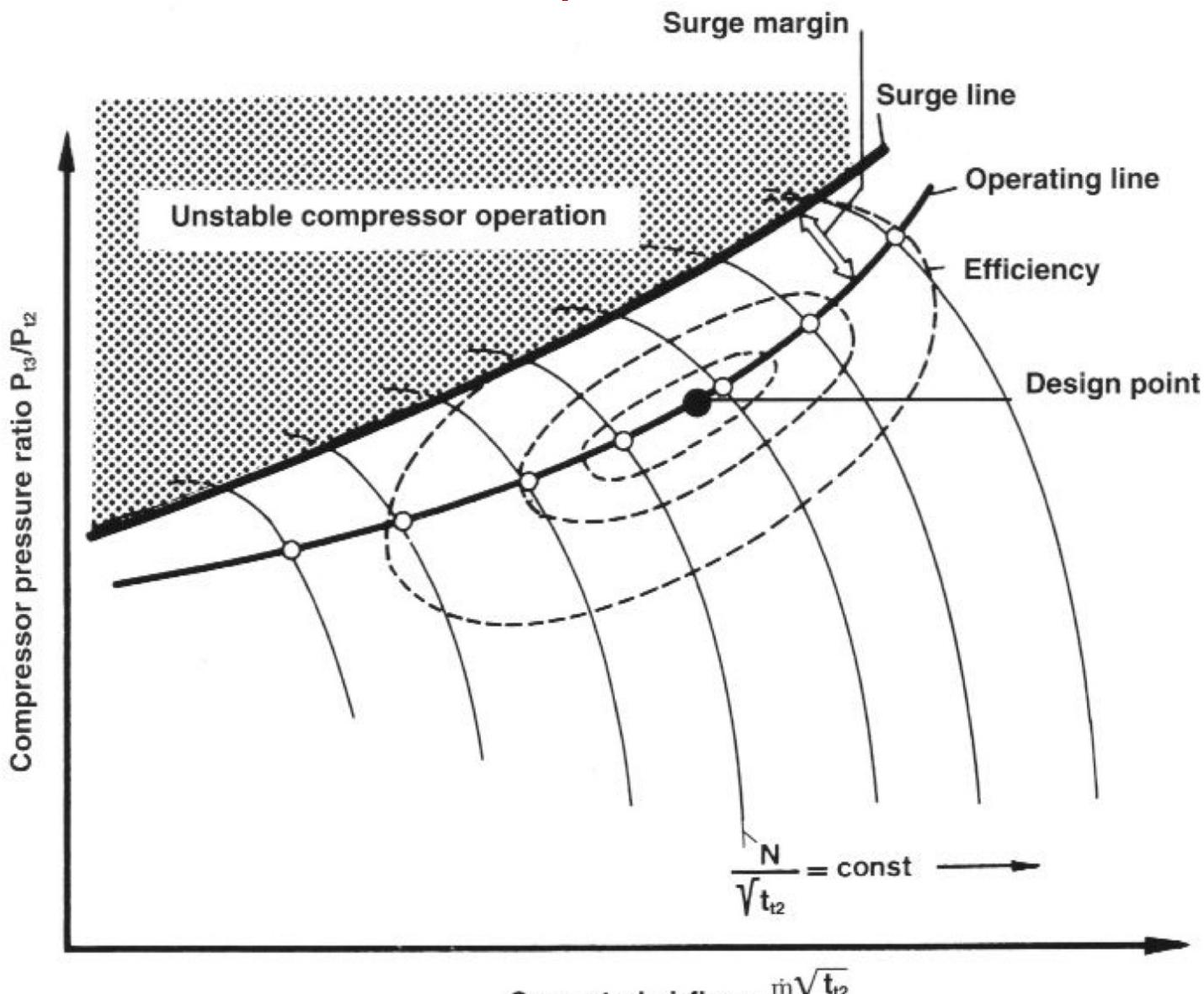


Low flow/  
high rpm

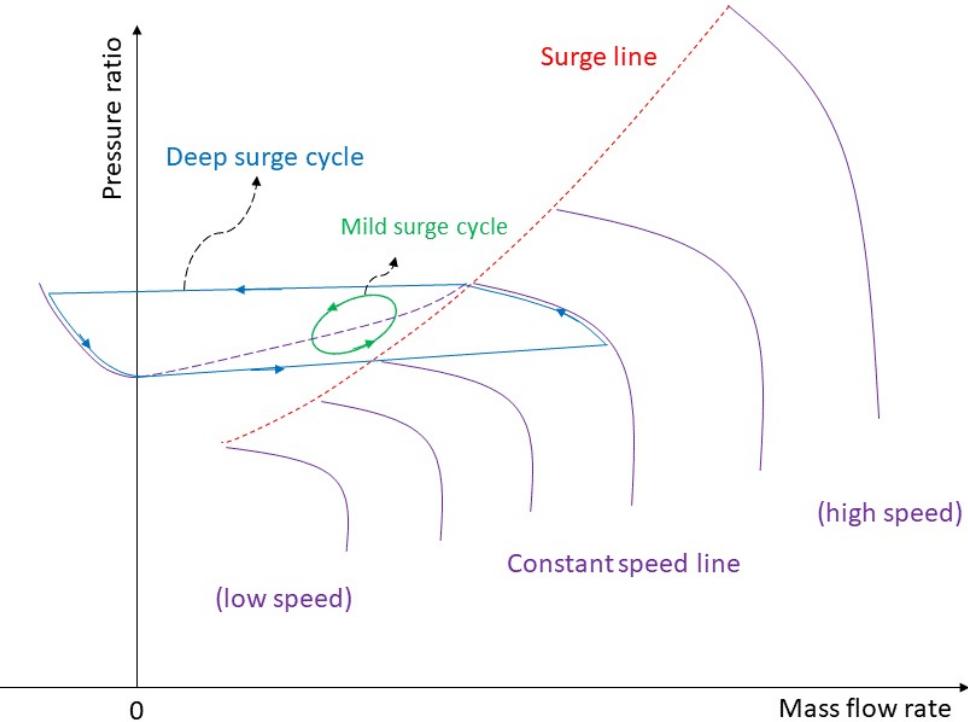


High flow/  
low rpm

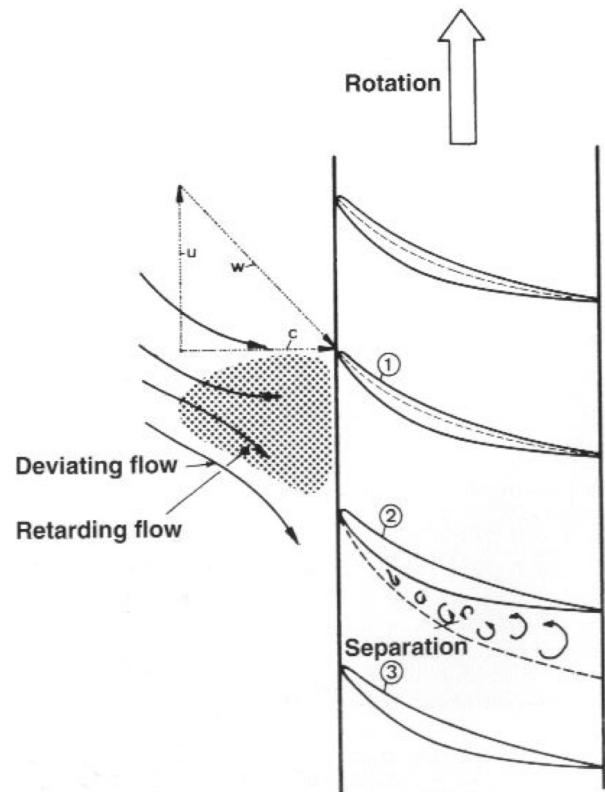
# Performance Map



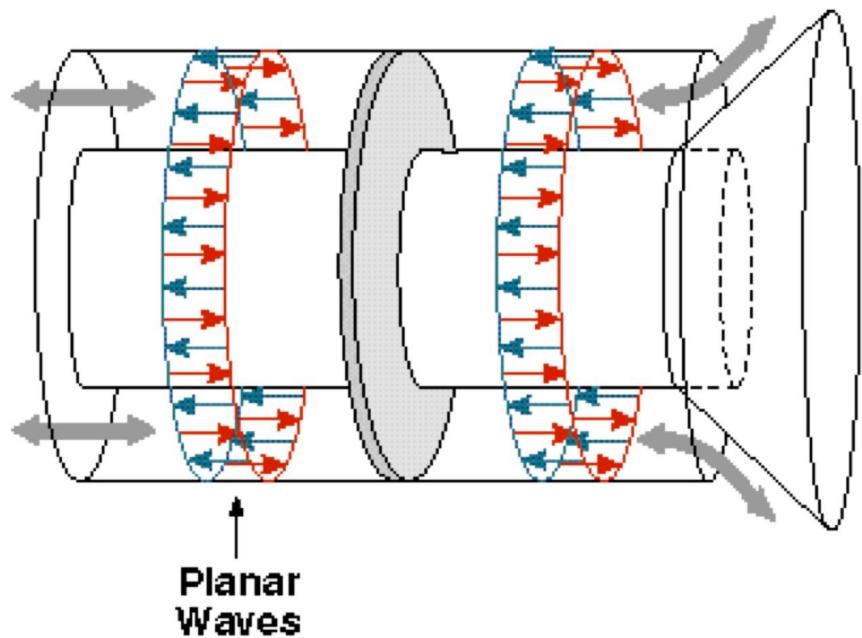
# Surge



# Rotating Stall

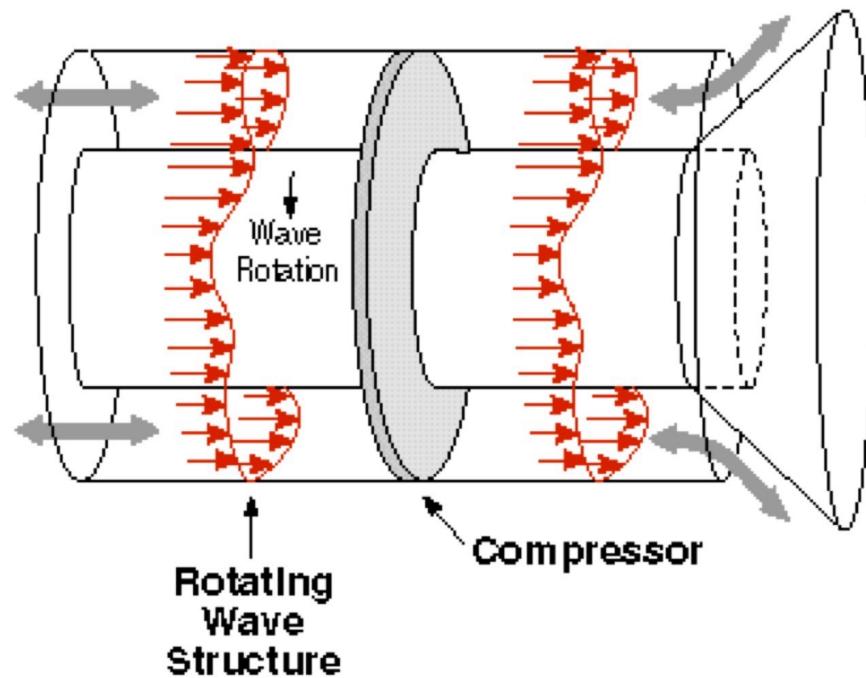


## **Global (Lowest Order)**



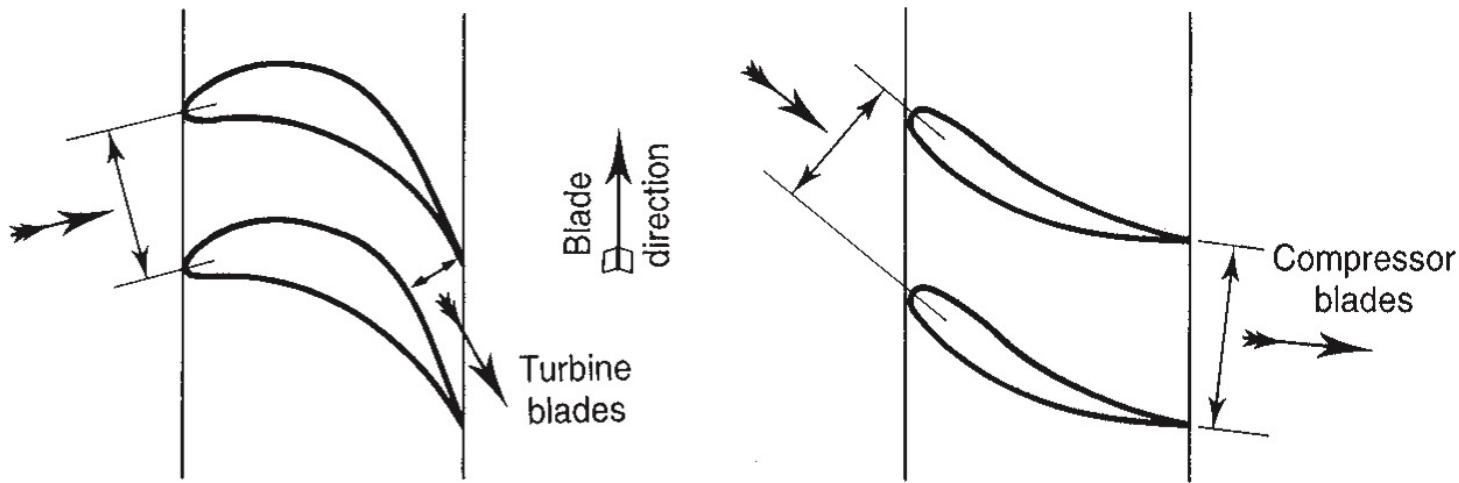
**Surge**

## **Local (Higher Order)**

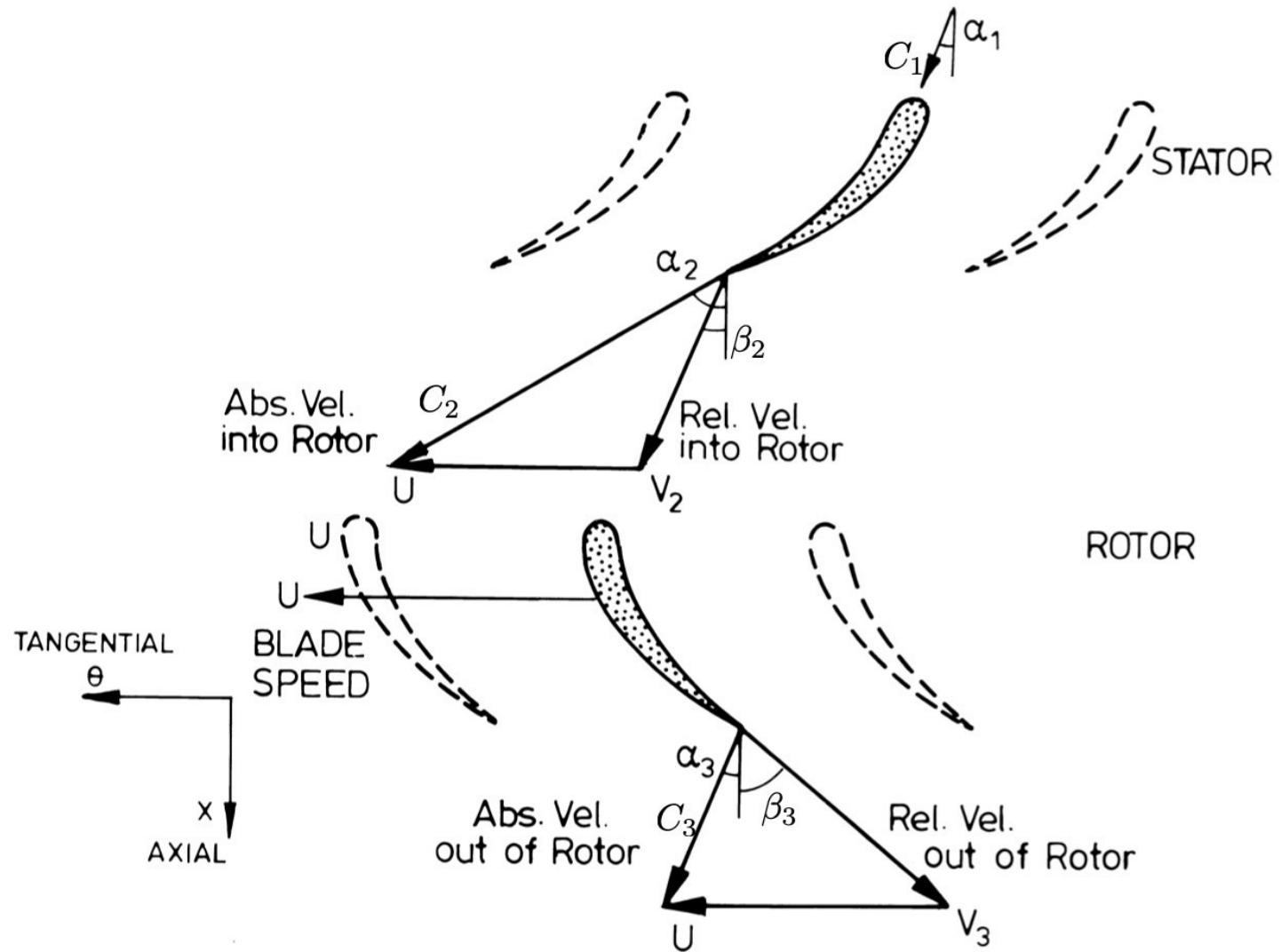


**Rotating Stall**

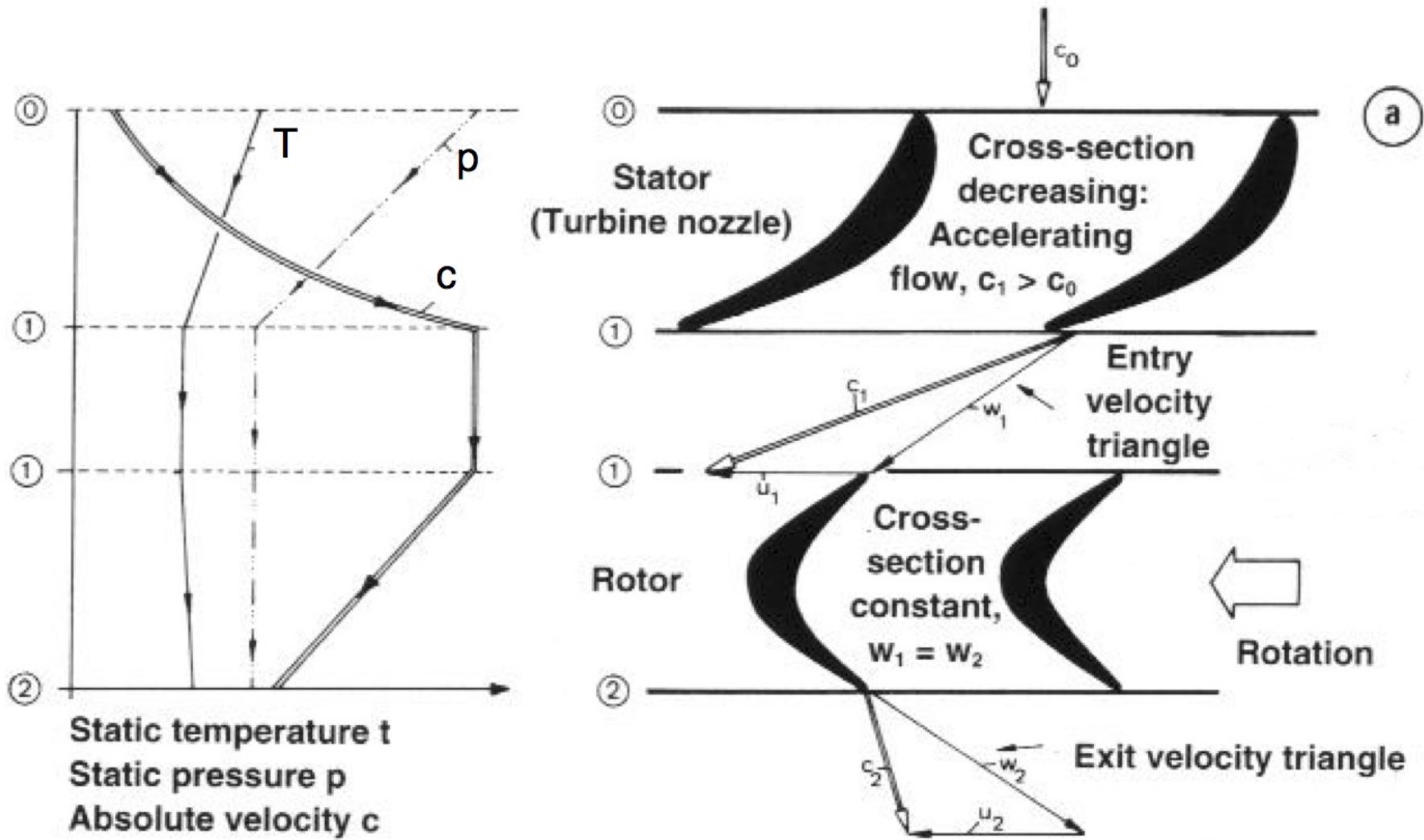
# Compressors and Turbines



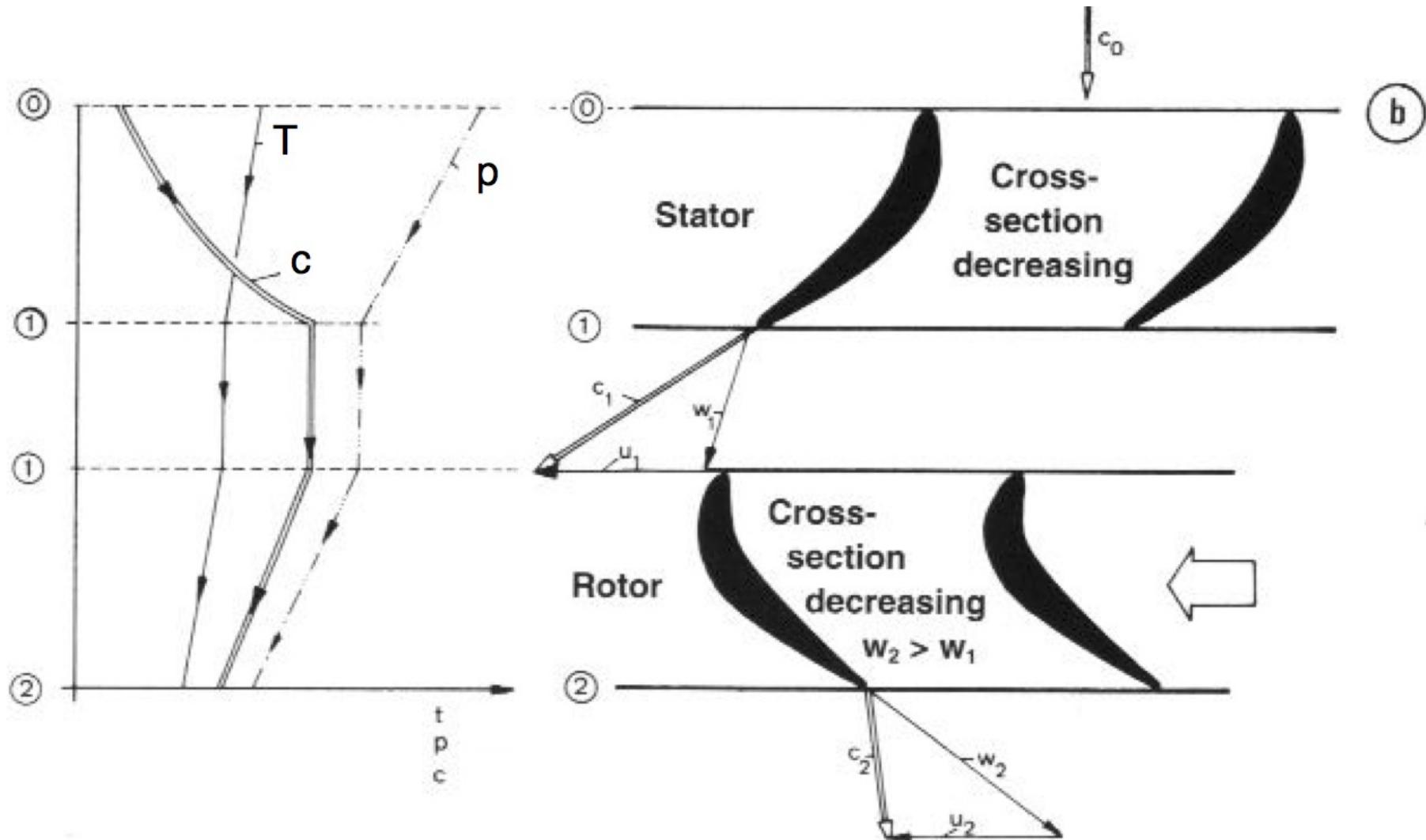
# Turbine Flow Path



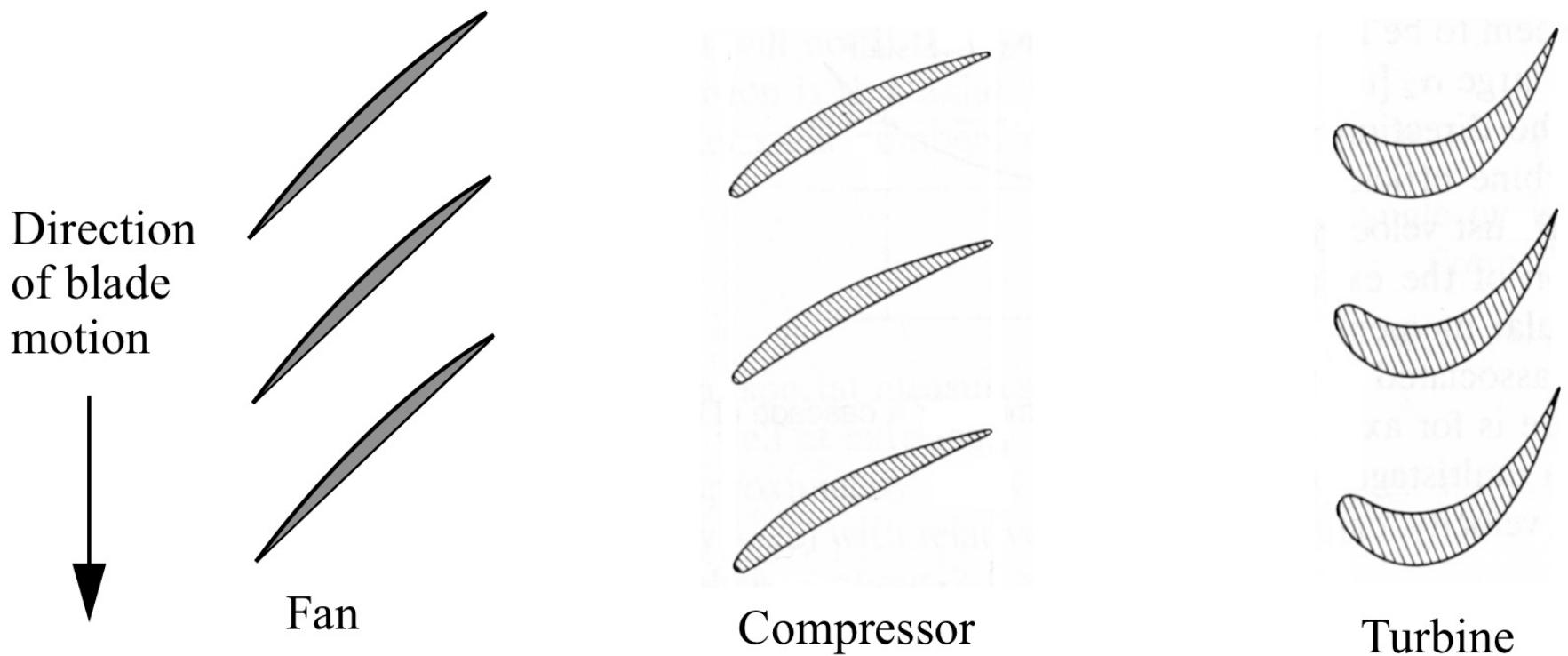
# Impulse Turbine



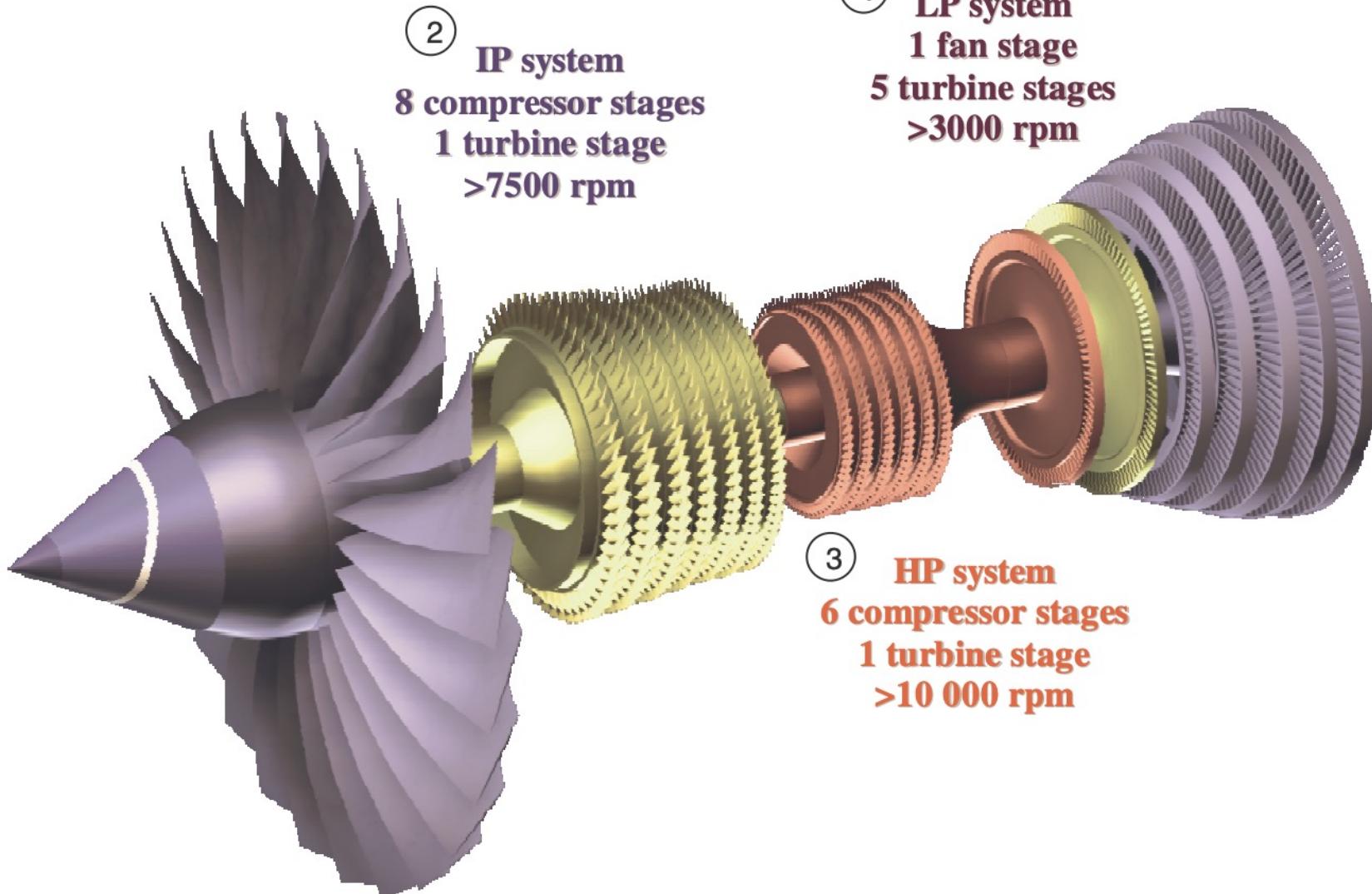
# Reaction Turbine



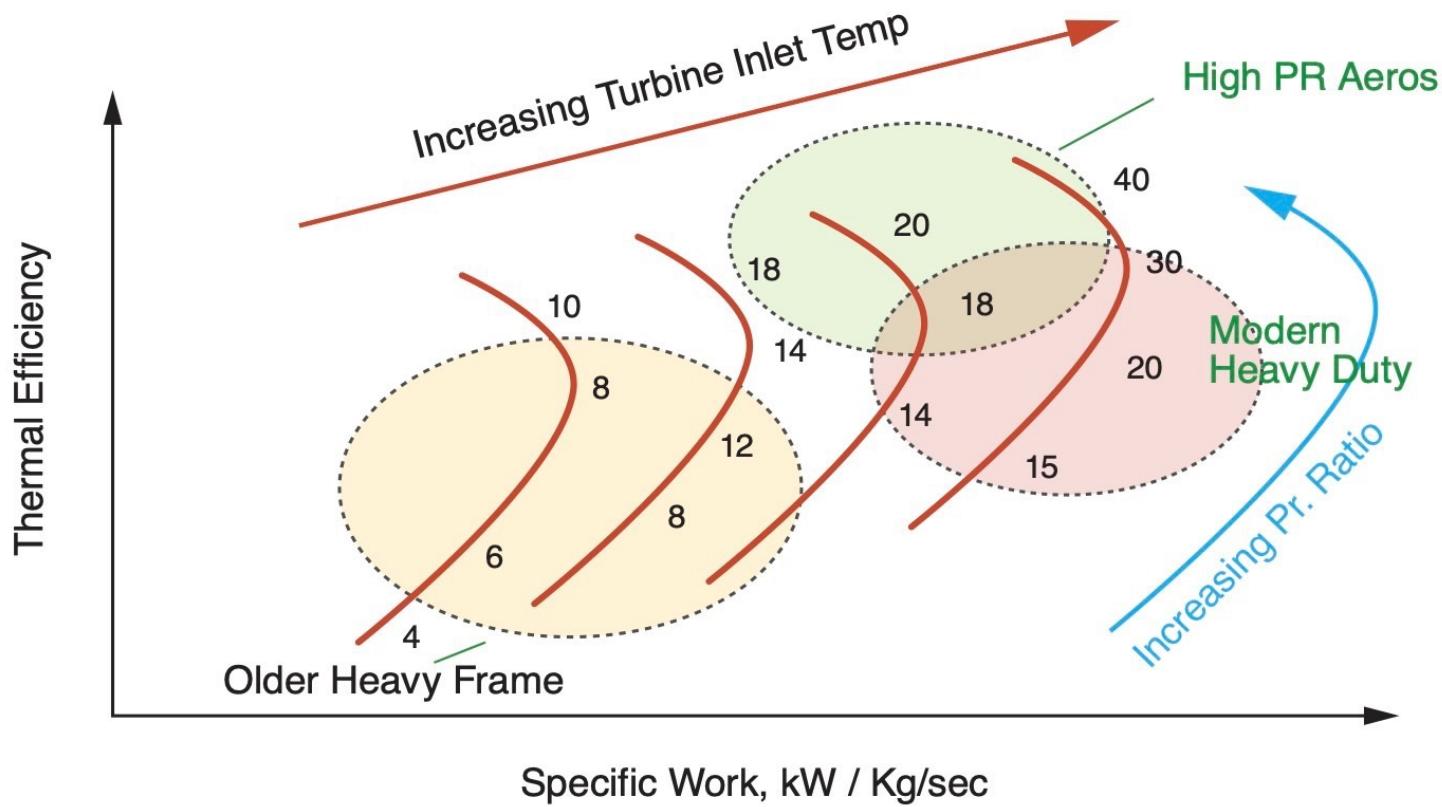
# Comparing blade shapes



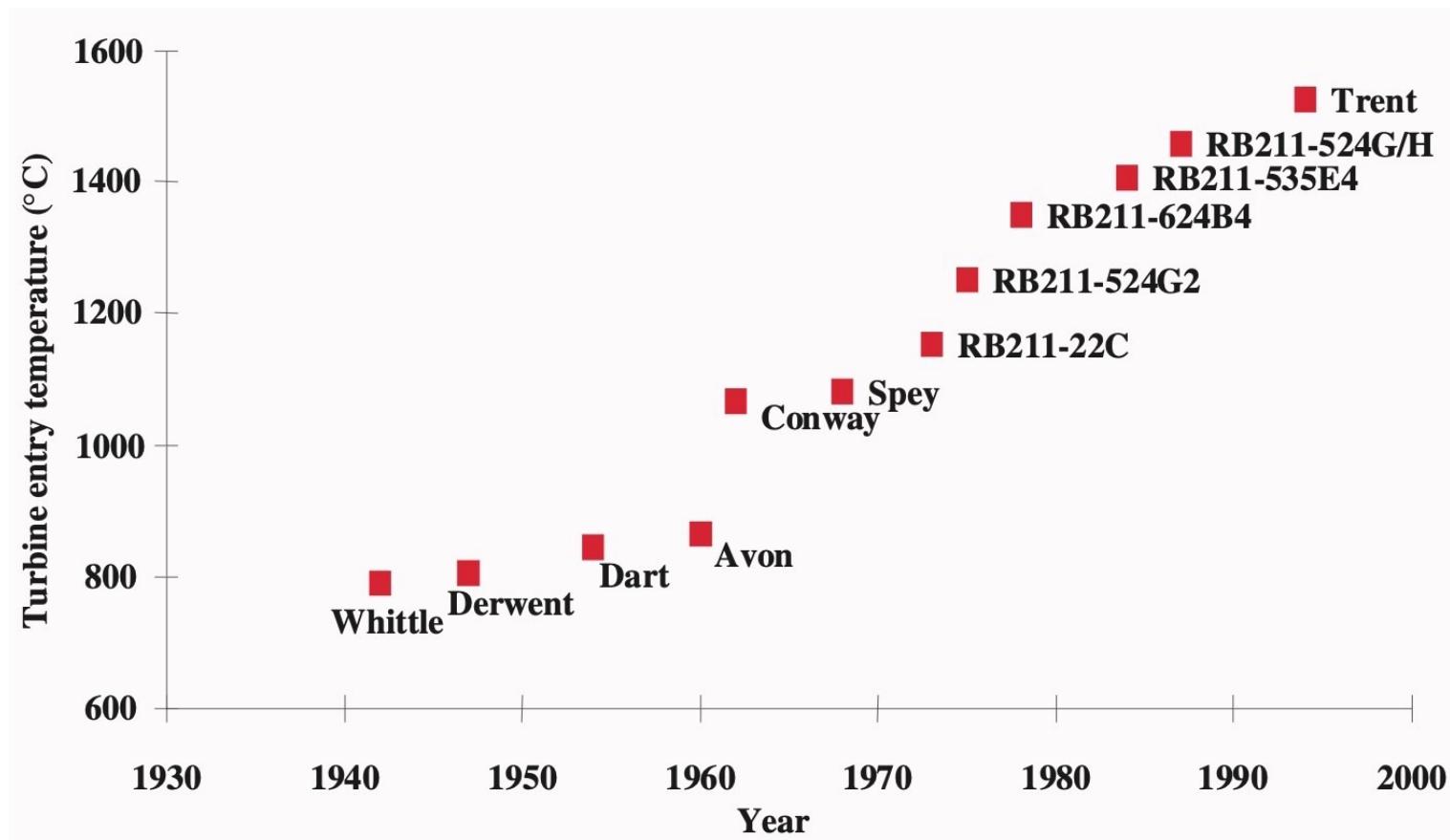
# 3-shaft engine



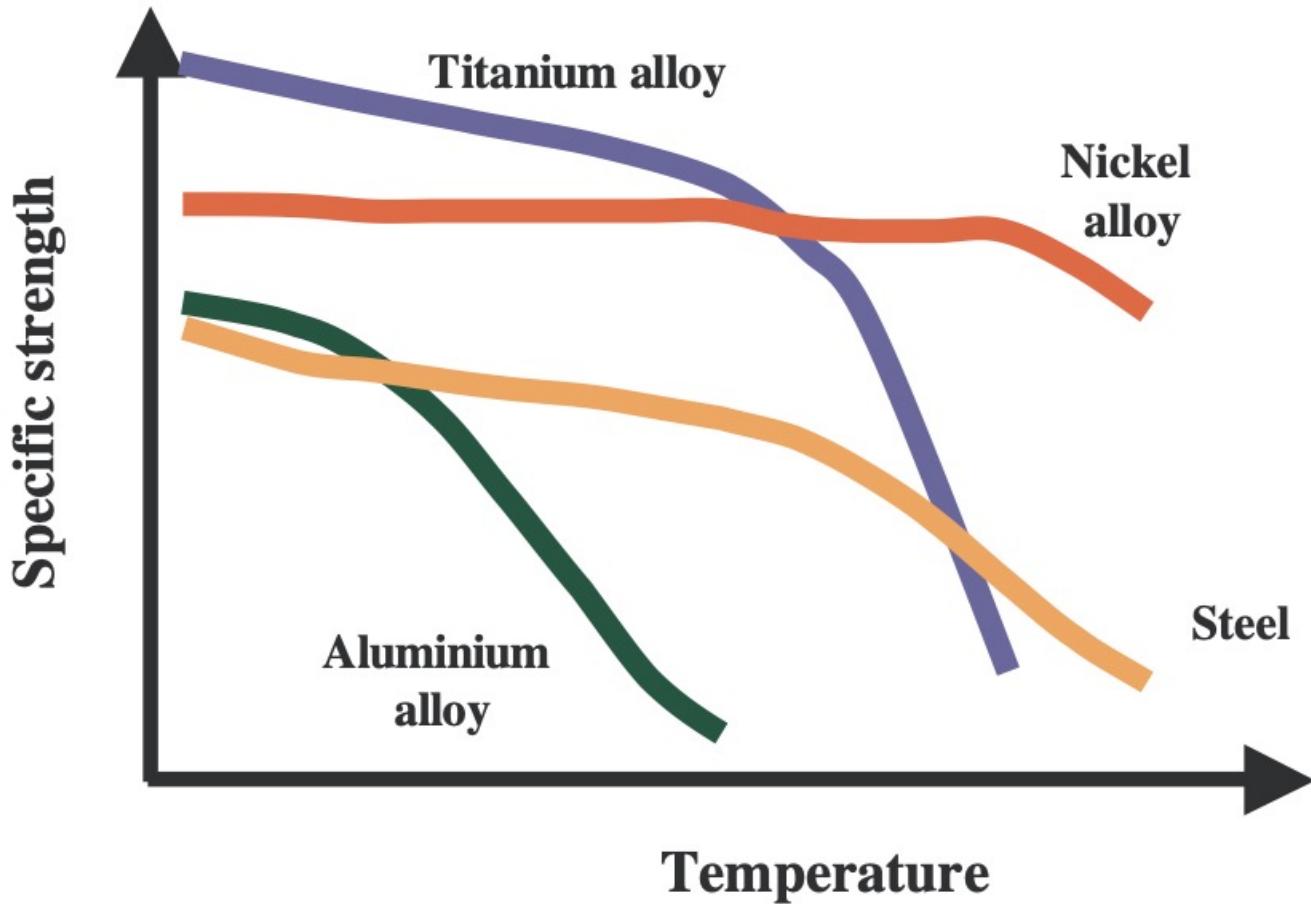
# Turbine Entry Temperature



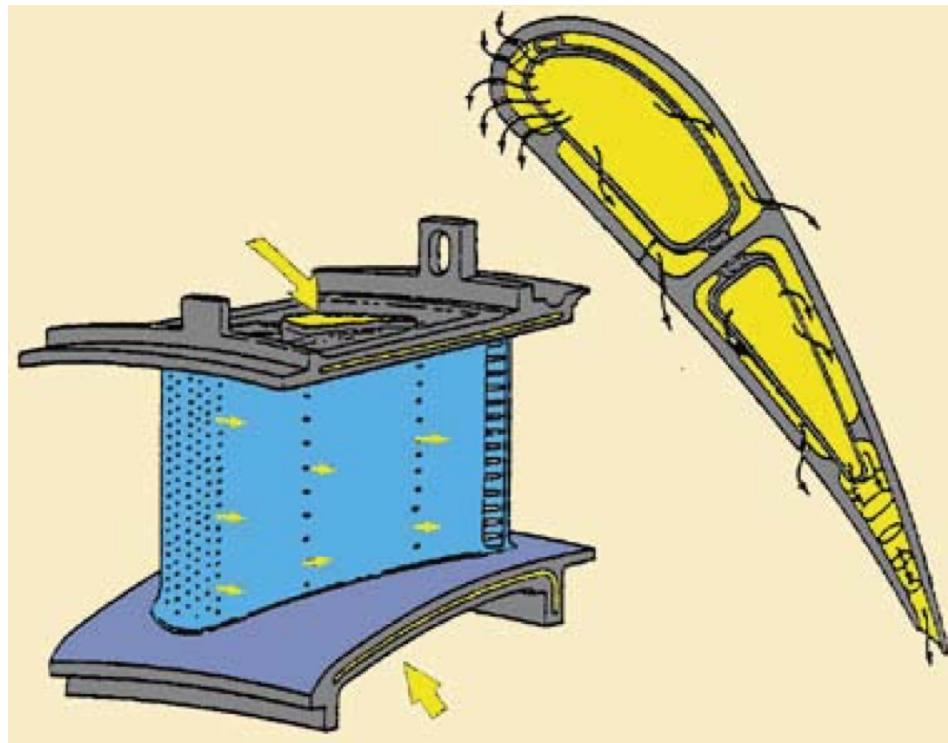
# Turbine Entry Temperature



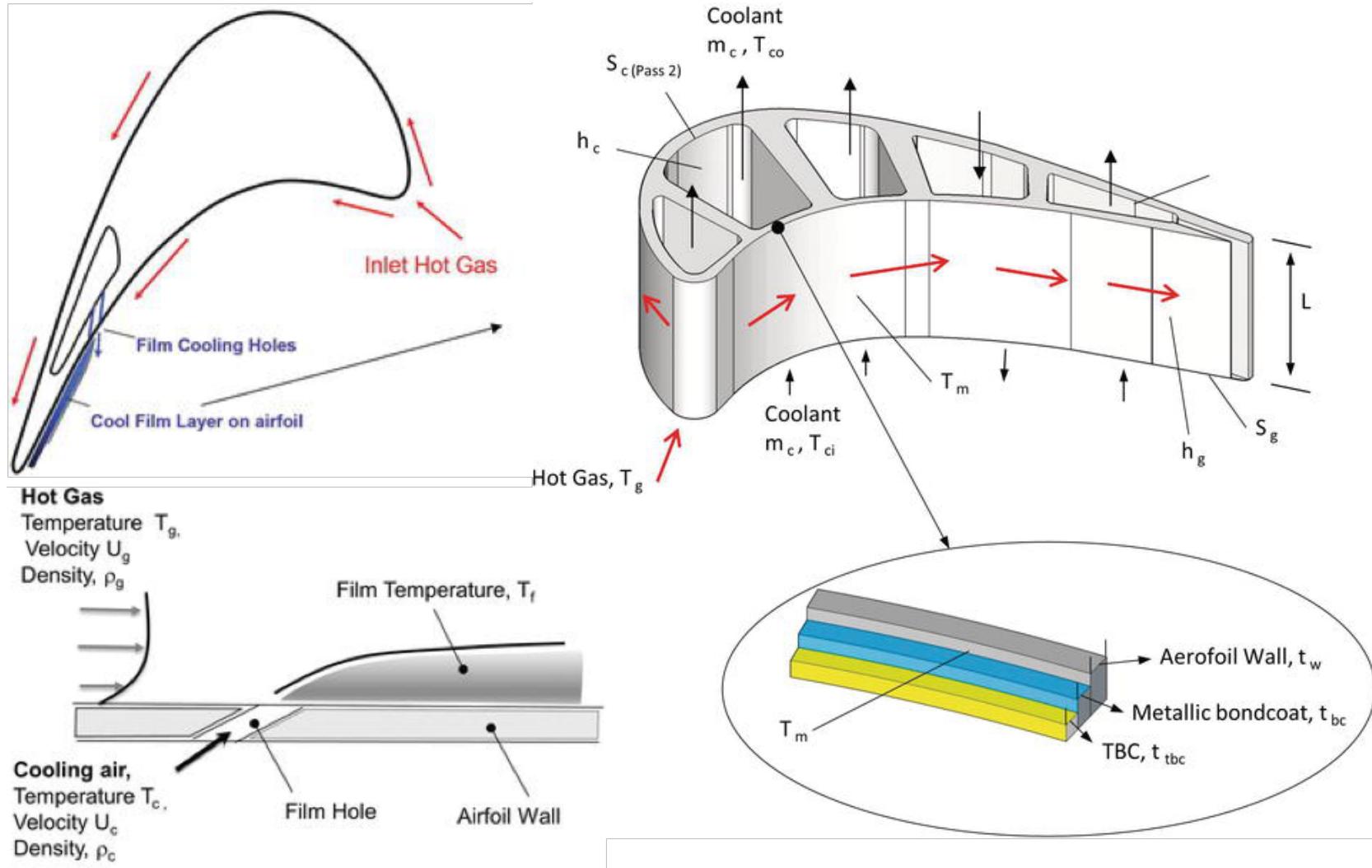
# Material Strength



# Cool using air ‘bled’ from HPC

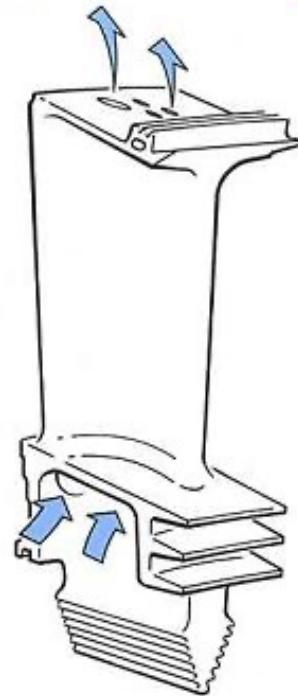


# Cool using air ‘bled’ from HPC



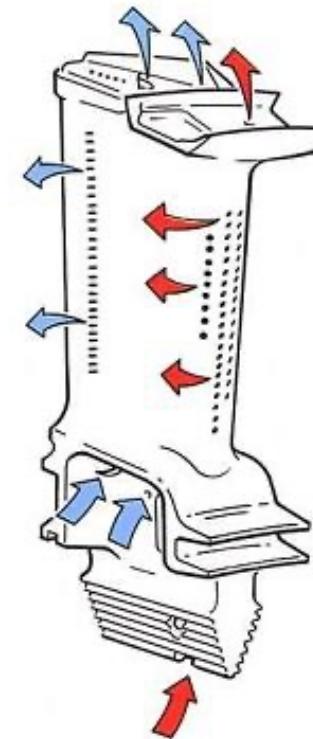
# Cool using air ‘bled’ from HPC

■ L.P. cooling air ■ H.P. cooling air



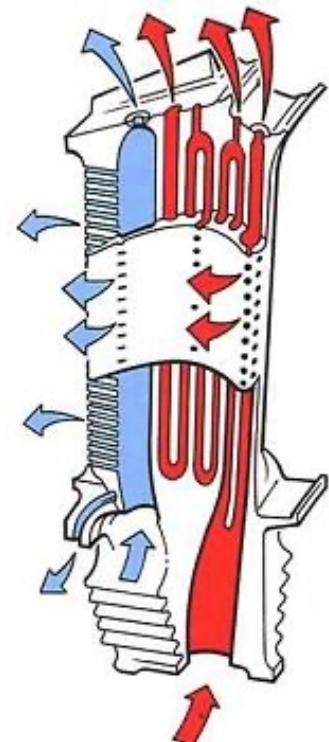
SINGLE PASS,  
INTERNAL COOLING  
(1960's)

SINGLE PASS,  
INTERNAL COOLING  
(1960's)



SINGLE PASS,  
MULTI-FEED  
INTERNAL COOLING  
WITH FILM COOLING  
(1970's)

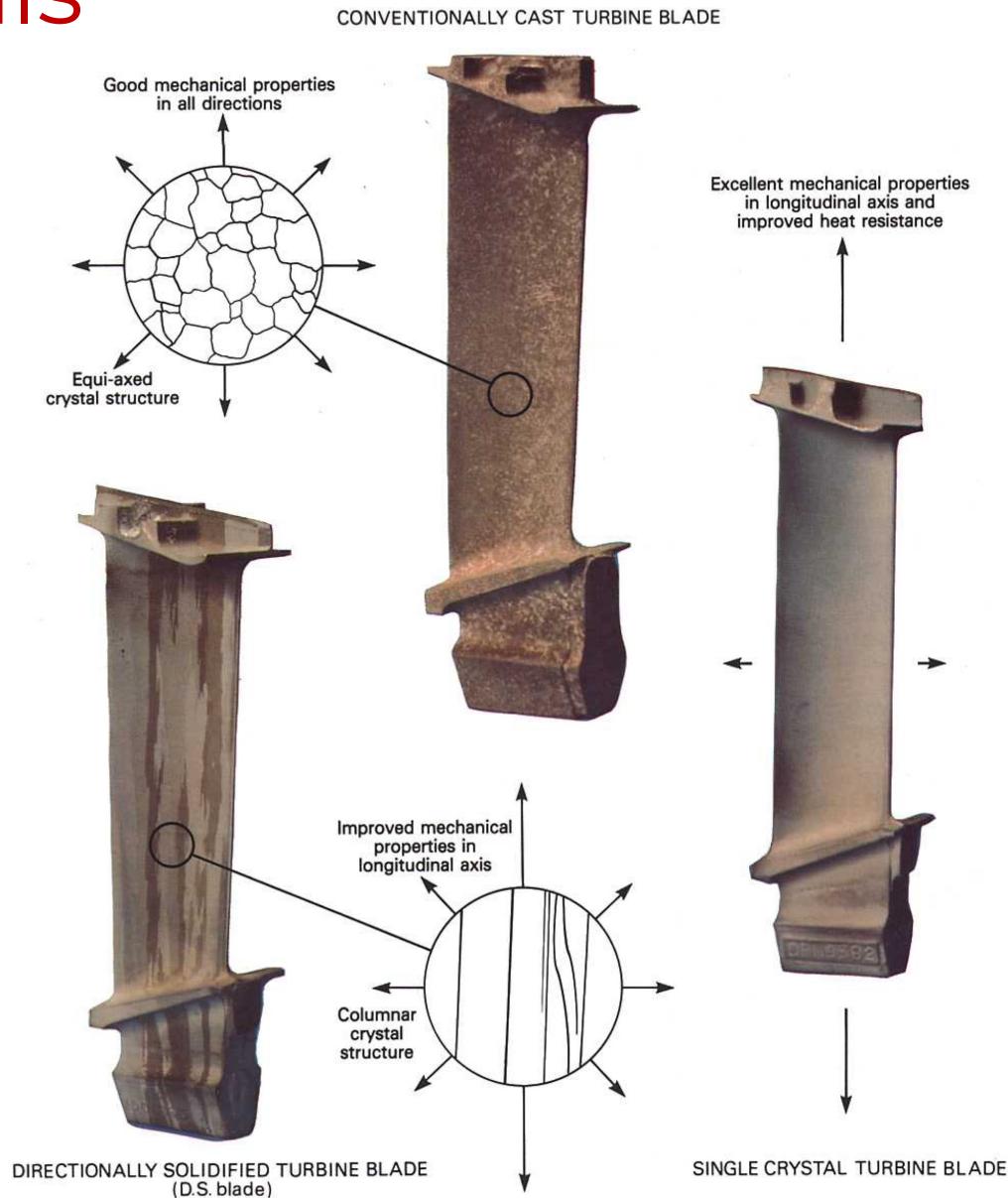
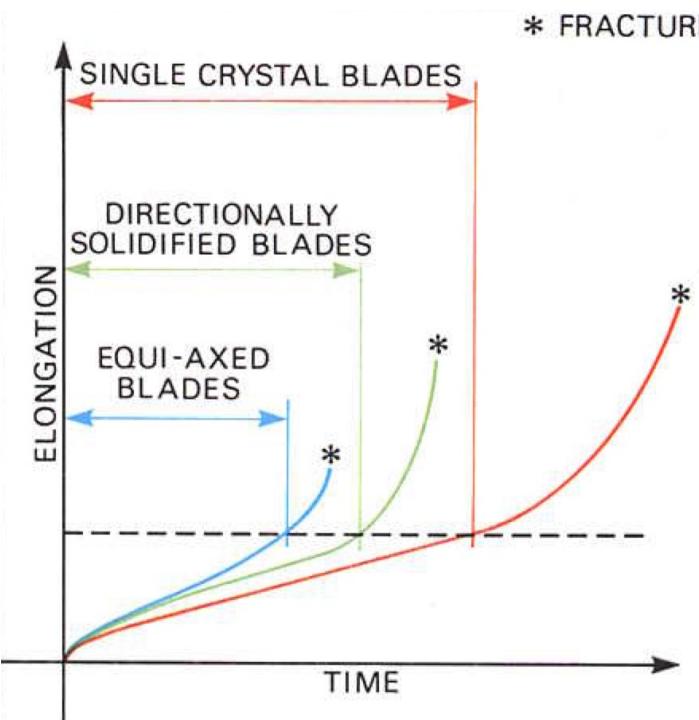
SINGLE PASS,  
MULTI-FEED  
INTERNAL COOLING  
WITH FILM COOLING  
(1970's)



QUINTUPLE PASS,  
MULTI-FEED  
INTERNAL COOLING  
WITH EXTENSIVE  
FILM COOLING

QUINTUPLE PASS,  
MULTI-FEED  
INTERNAL COOLING  
WITH EXTENSIVE  
FILM COOLING

# Turbine Materials



# Turbine Entry Temperature

