International HPC Summer School 2019
July 8 - 12, 2019
Riken R-CCS center, Kobe, Japan
Poster ID: D-3

Numerical Study of Heat Transfer Phenomena from Oil Flow to Air Flow in Heat Exchangers for Aero Engines

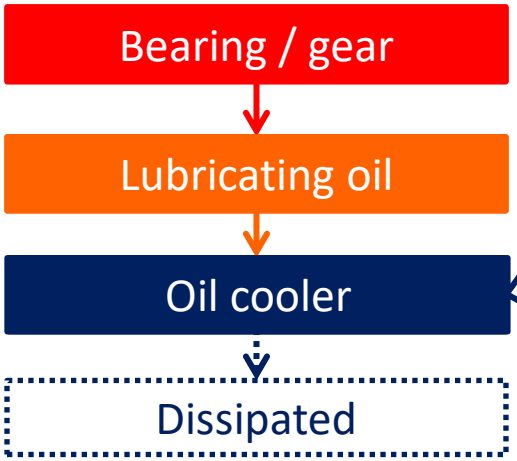
Tsukasa ISHII, Toshinori WATANABE, Takehiro HIMENO,
Yasunori SAKUMA
The University of Tokyo, Japan

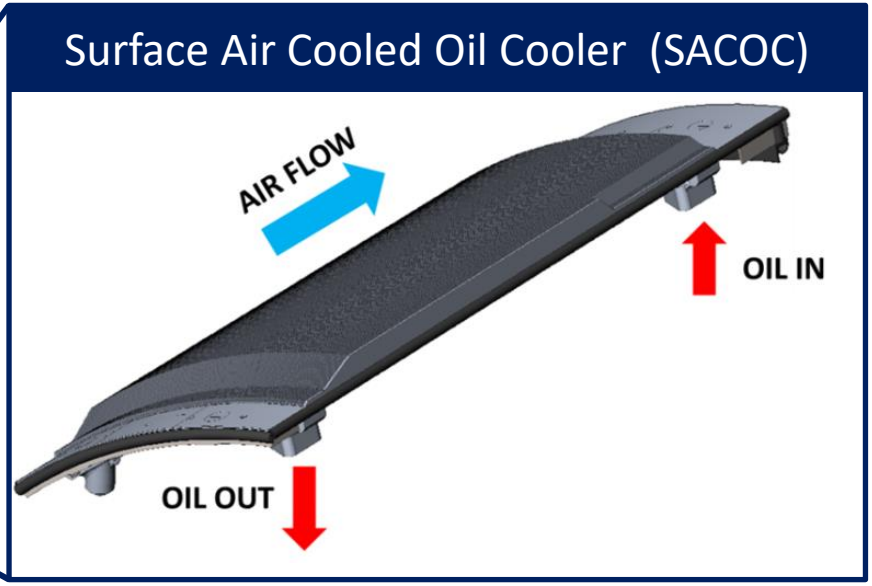
Susumu TOMIDA
Sumitomo Precision Products Co., Japan

UT JET PROPULSION LABORATORY

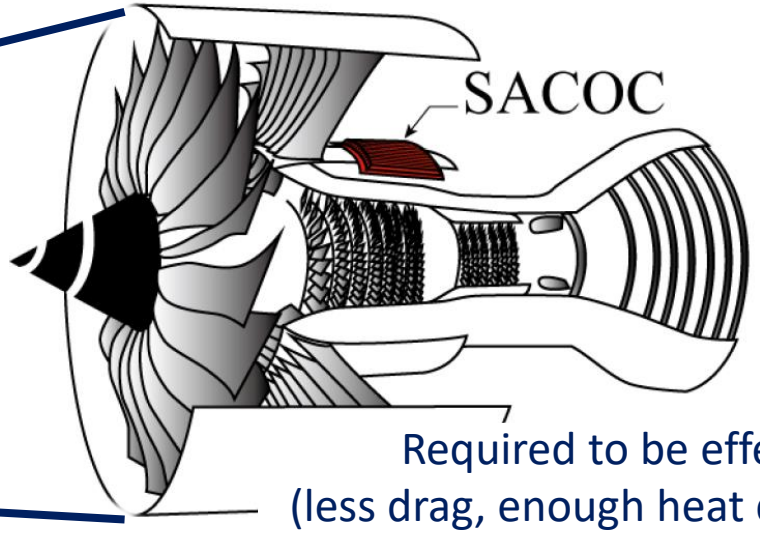
Research object

Cooling of bearings & gears





Installation area

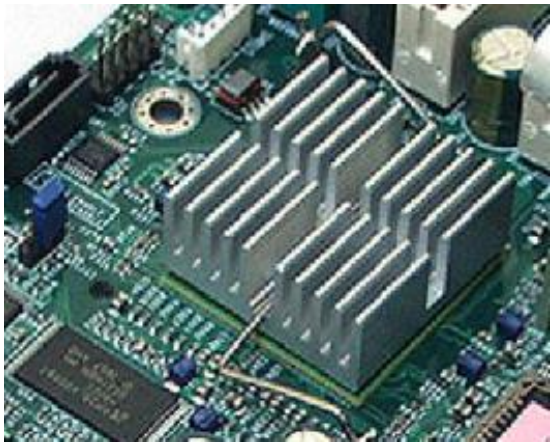


Required to be effective
(less drag, enough heat dissipation)

Air cooling fins seem familiar, but …

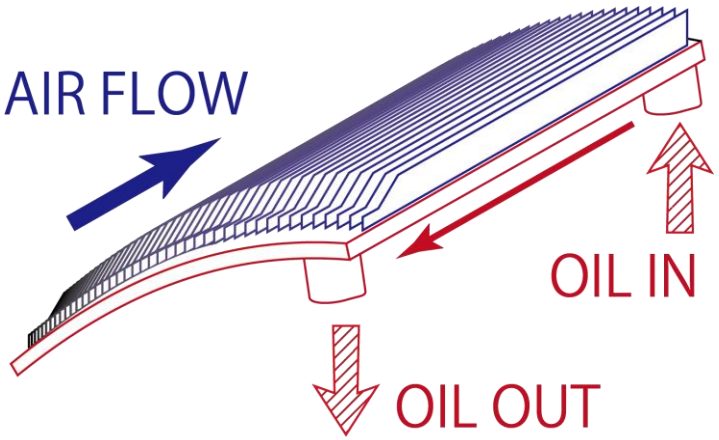
Issues on air cooling fin of SACOC

Conventional fin



- **Slow** air flow (U ～ 1 m/s)
- Well-known characteristics

Air cooling fin of SACOC



- **Fast** air flow (U～10^2m/s)
- No formula to predict the characteristics

Research objectives

- **To obtain guideline** of SACOC fin shape **of high efficiency**

⇒ **CFD** research has been carried out on the flow field around **various fin shapes**

What is CFD ?

Computational Fluid Dynamics

Governing Eq. of fluid

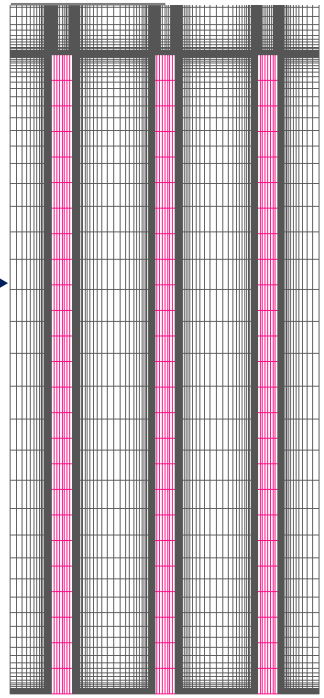
$$\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u_i)}{\partial x_i} = 0$$

$$\frac{\partial (\rho u_i)}{\partial t} + \frac{\partial (\rho u_i u_j)}{\partial x_j} = -\frac{\partial p}{\partial x_i} + \frac{\partial \tau_{ij}}{\partial x_j} + \rho k_i$$

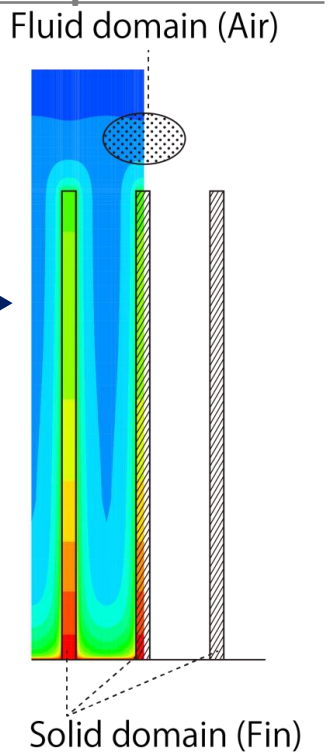
$$\frac{\partial (\rho e_t)}{\partial t} + \frac{\partial (\rho h_t u_j)}{\partial x_j} = \frac{\partial (\tau_{ij}\, u_i)}{\partial x_j} + \rho k_i u_i + \lambda \Delta T$$

- No analytic solution (difficult!)
- Each term is approximated by discrete values (on meshes)
- More meshes for more precise simulation, **which requires HPC technique**

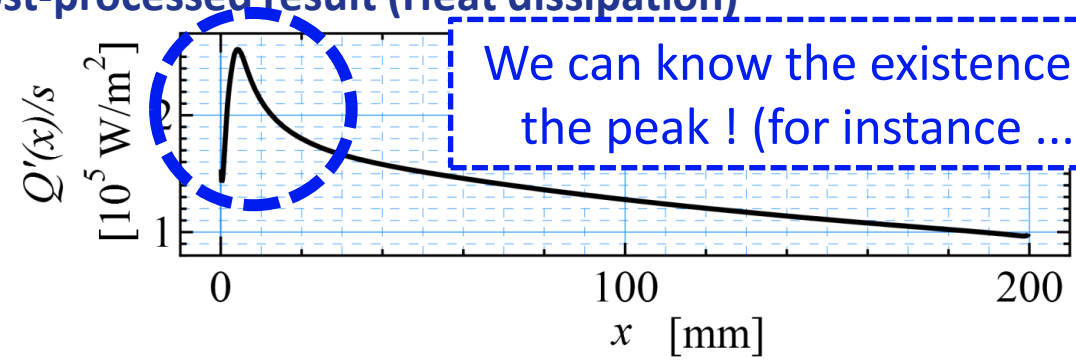
Meshes



Temp. around fin

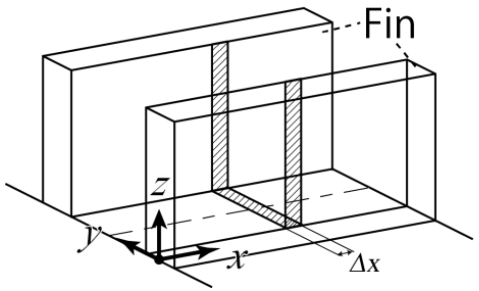


Post-processed result (Heat dissipation)



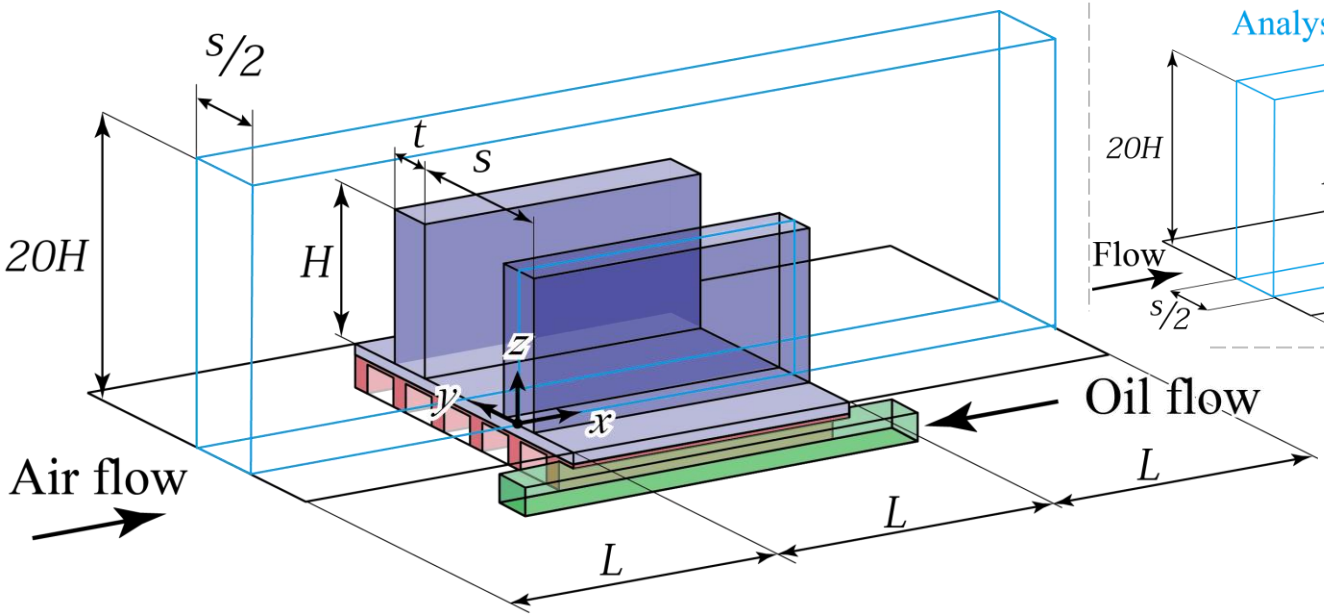
We can know the existence of the peak ! (for instance ...)

Lengthwise variation



On-going construction of multi-fluid solver

New test configuration (w/ Oil passage under fins)

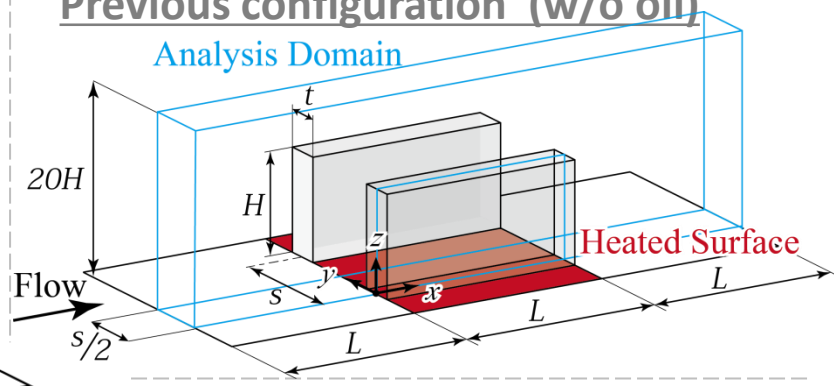


Analysis Domain (air)

Solid structure

Oil passage

Previous configuration (w/o oil)



- Currently we are working on constructing simulation code for **gas**, **solid**, and **liquid** (**air**, **structure**, and **oil**)
- **More computational cost** than ever

⇒ The code is being constructed for developing SACOC, but we are planning using the new code for **the whole heat controlling system of jet engines in the future**