COMSOL CONFERENCE EUROPE 2012

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Multiphysics Modelling of Spring-Supported Thrust Bearings for Hydropower Applications

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1.1) Thrust Bearings

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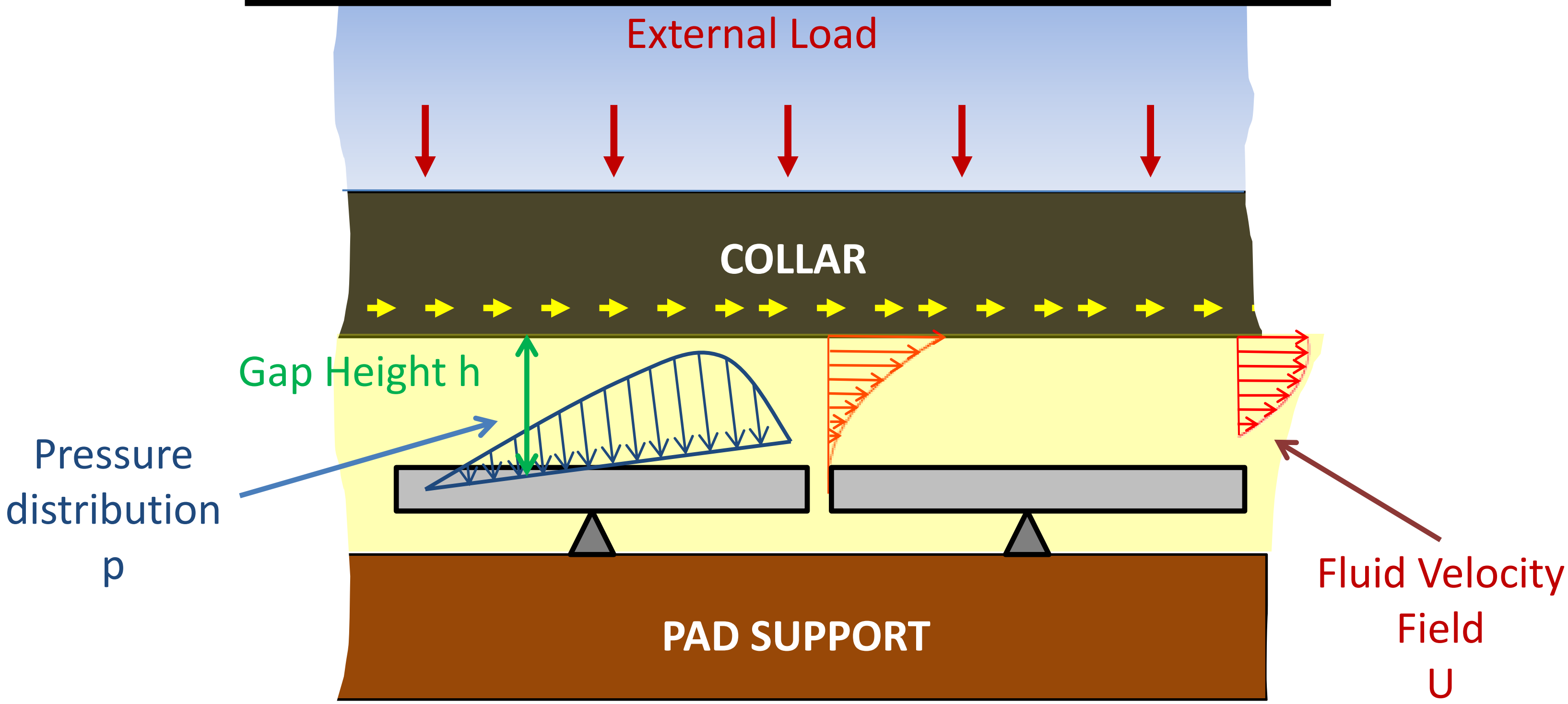
1.2) HOW does it work

The re… …and the pad… …n.

$$\frac{d}{dx}\left(\frac{\rho \cdot h^3}{12 \cdot \eta}\frac{dp}{dx}\right) - \frac{U}{2}\frac{d}{dx}(\rho \cdot h) = 0$$



GAP GEOMETRY

- Tilting
- Elastic Deformation
- Thermal Expansion

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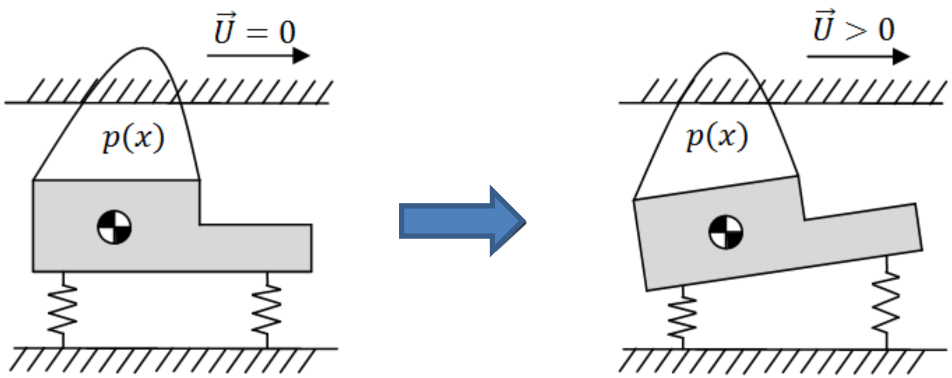
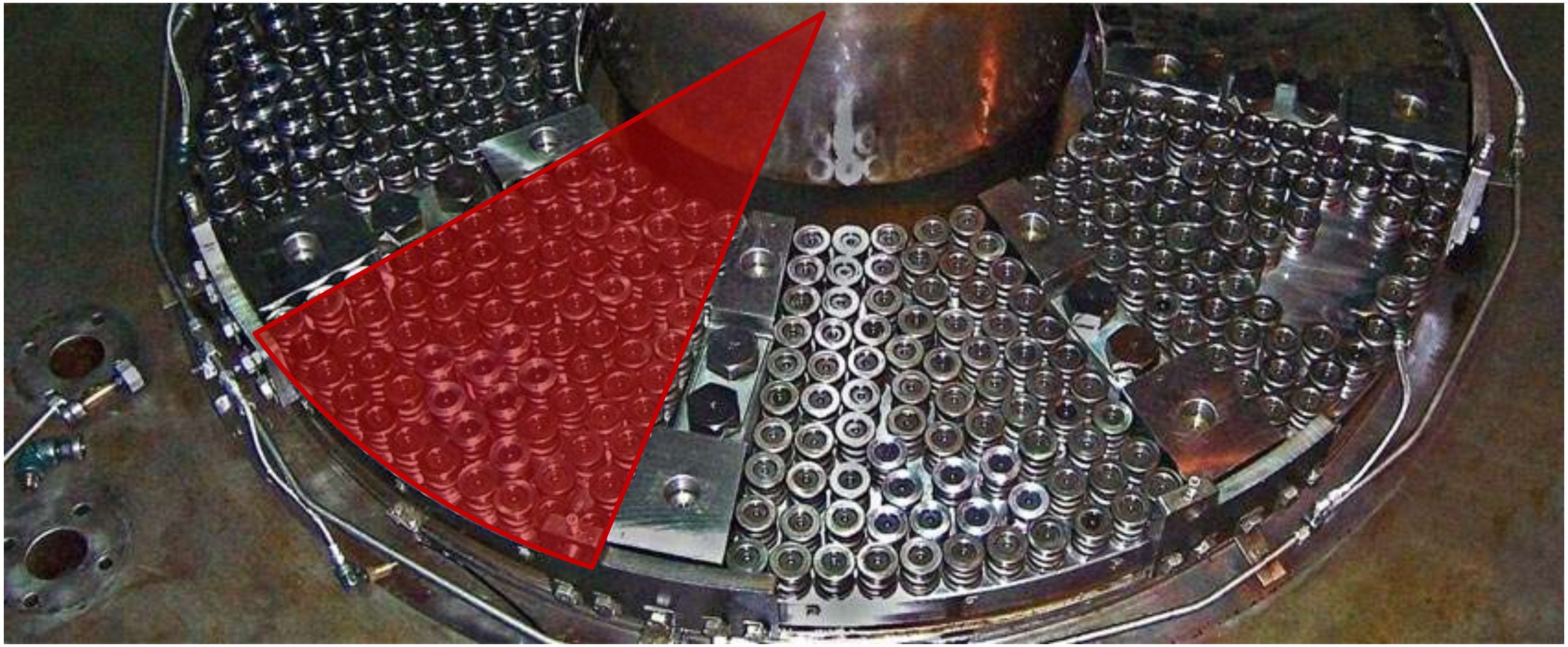
1.3) Spring-Supported

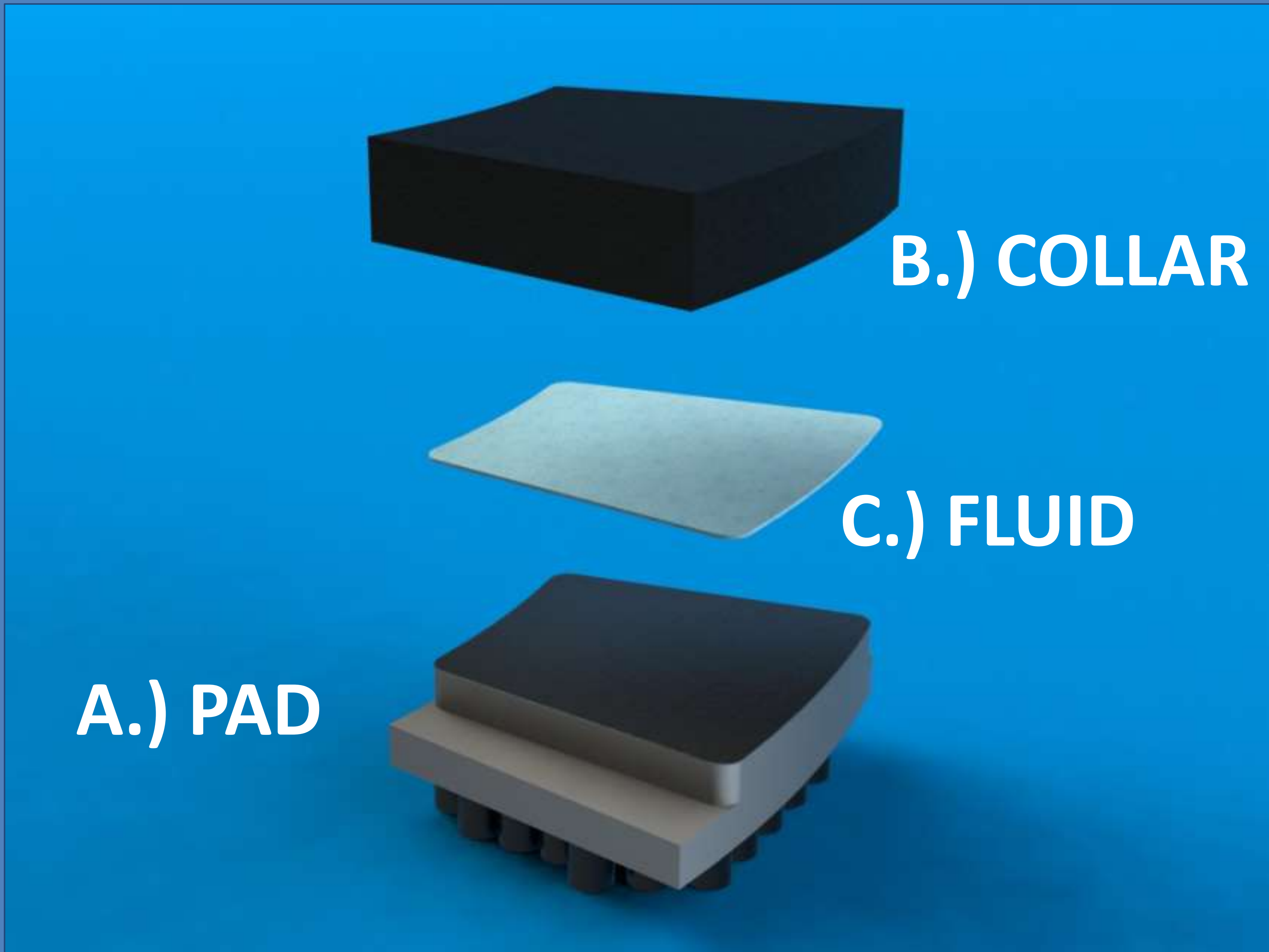


The pad is supported by a spring mattress.

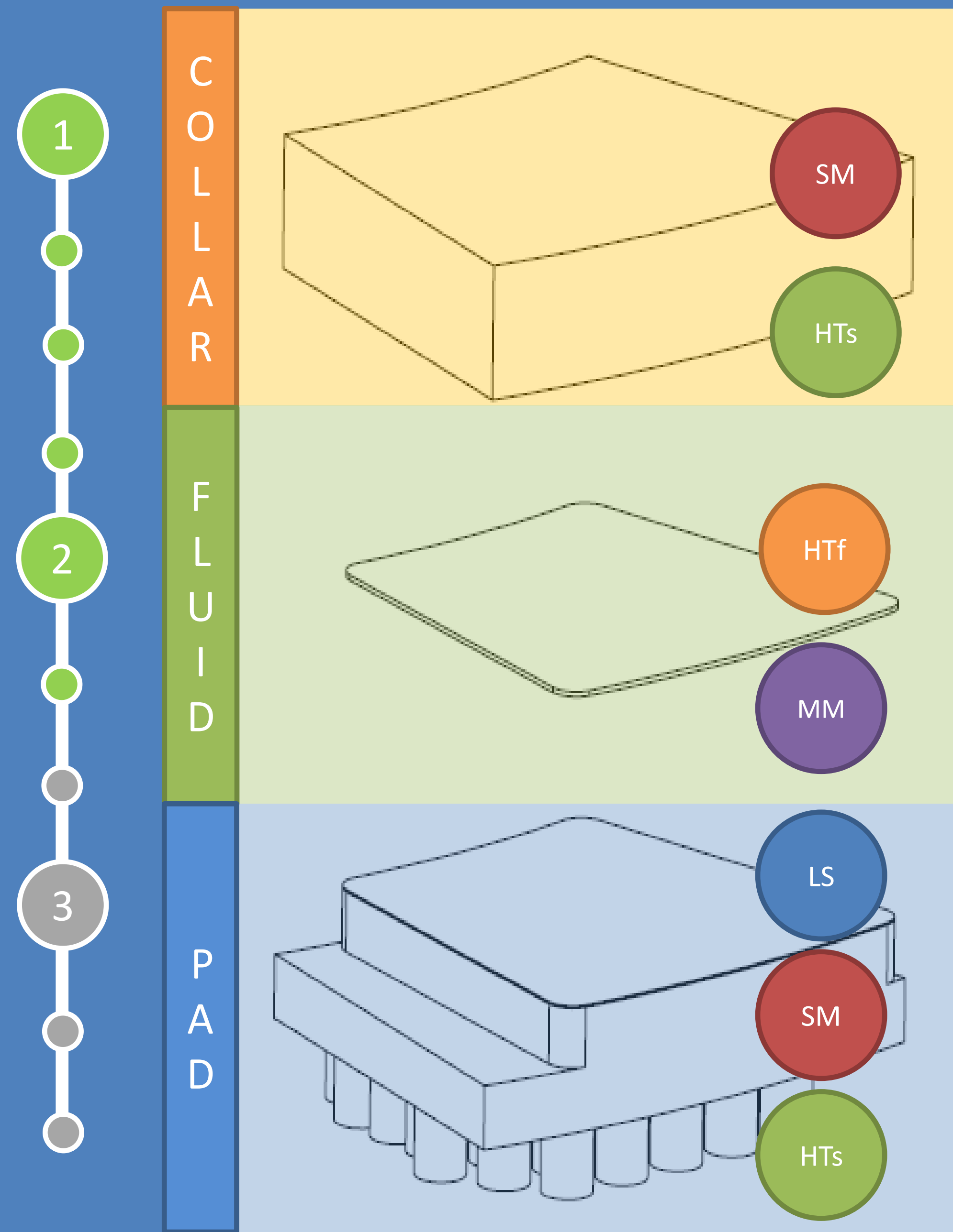
There is not a defined pivot point.



2) Model



2.1) Physics Applied



LS — **Lubricant Shell**

$$\nabla\left(\frac{\rho \cdot h^3}{12 \cdot \eta} \cdot \nabla p\right) = \nabla\begin{pmatrix}U_x \\ U_y\end{pmatrix} \cdot \rho \cdot h$$

SM — **Solid Mechanics**

$$\sigma = E \cdot \varepsilon \qquad \frac{\Delta L}{L} = \alpha_L \cdot \Delta T$$

HTf — **Heat Transfer in Fluids**

$$\rho \cdot C_p \cdot \left(u_f \cdot \frac{\partial T}{\partial x} + v_f \cdot \frac{\partial T}{\partial y}\right) - k \cdot \frac{\partial^2 T}{\partial z^2} =$$
$$= \eta \cdot \left[\left(\frac{\partial u_f}{\partial z}\right)^2 + \left(\frac{\partial v_f}{\partial z}\right)^2\right] - \frac{T}{\rho} \cdot \frac{\partial \rho}{\partial T} \cdot \left(u_f \cdot \frac{\partial p}{\partial x} + v_f \cdot \frac{\partial p}{\partial y}\right)$$

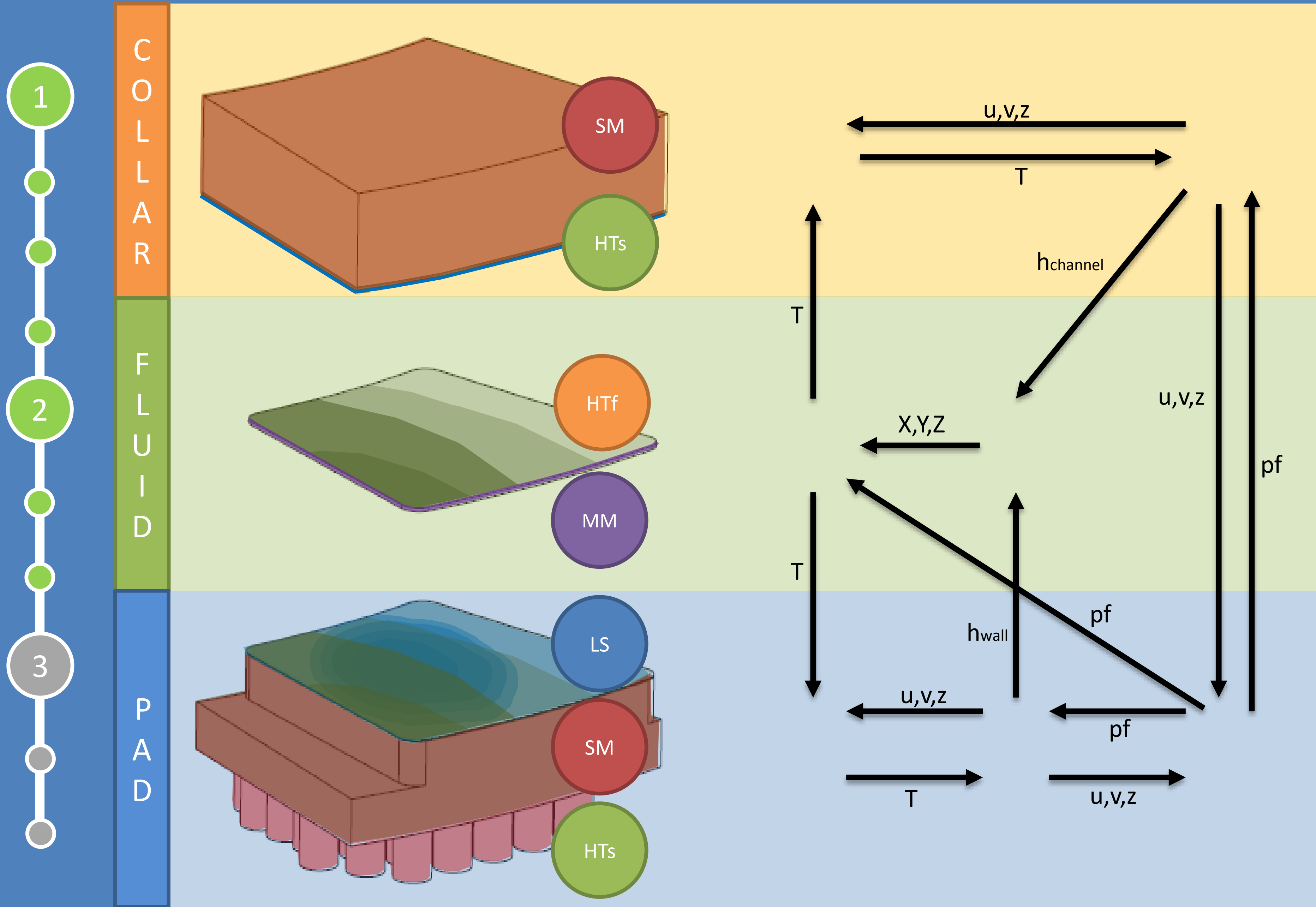
HTs — **Heat Transfer in Solids**

$$\rho \cdot C_p \cdot U_{trans} \cdot \nabla T = \nabla \cdot (k \cdot \nabla T) + Q$$

MM — **Moving Mesh**

(mesh deformation)

2.2) Model Coupling



3) RESULTS: Global Scheme

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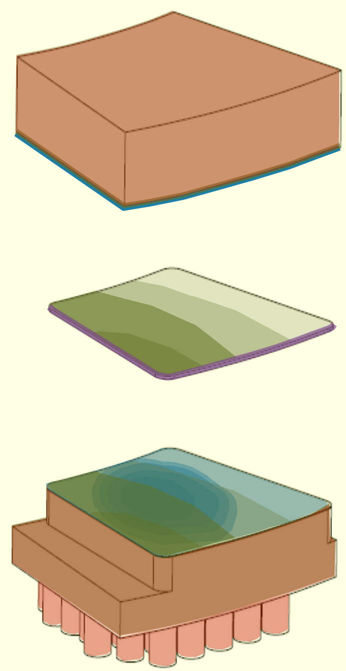
INPUTS
Shaft Angular Velocity
External Load Applied
Bath Temperature
Geometry Parameters
Material Proprieties
Springs Pattern Characteristics

→

Spring-Supported Thrust Bearing Model



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OUTPUTS	
Pressure on the Gap	
PAD	Deformation
	Temperature
COLLAR	Deformation
	Temperature
FLUID	Film Thickness
	Temperature
Power Losses	

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3.1) Results

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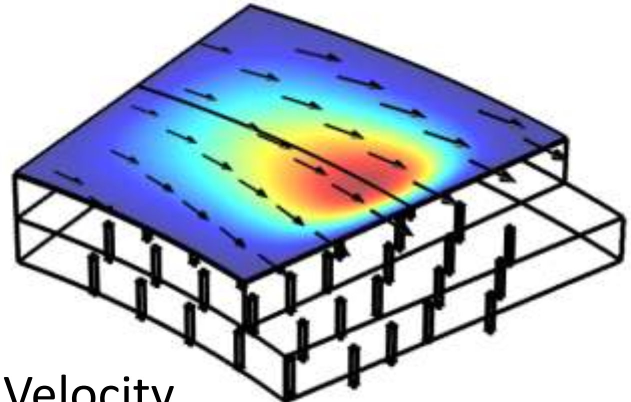
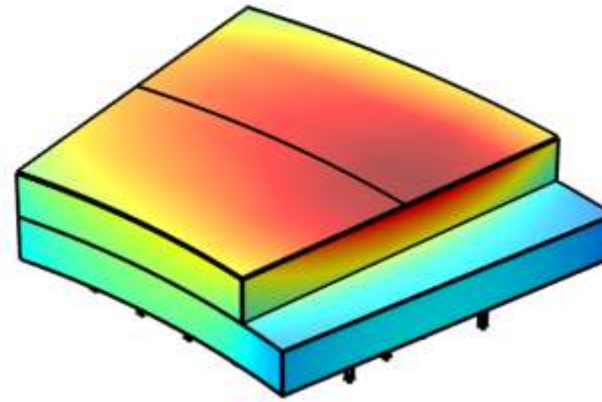
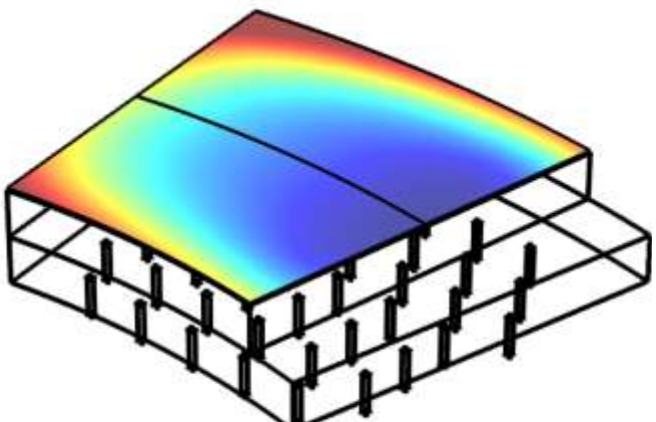
Pressure on the Gap



Fluid Velocity Field

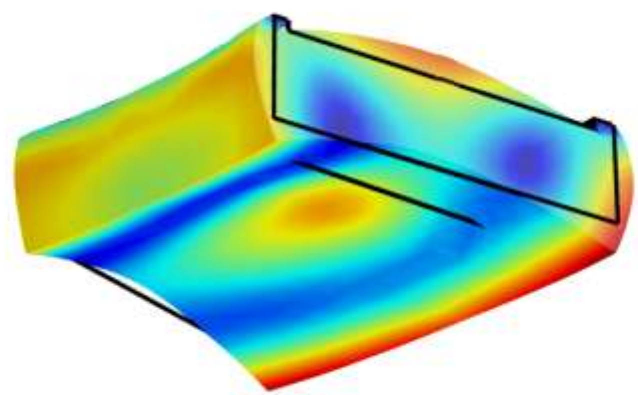
Pad Temperature





Fluid Film Thickness

Collar Displacement



3.2) Applications of the Model

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- Varying operating conditions:
  a) Load
  b) Angular Velocity
  c) Bath Temperature
  d) Springs Patterns
- Test different kinds of lubricants.
- Test different compounds materials.
- Test shape improvements.

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