



**ERCOFTAC**

European Research Community On  
Flow, Turbulence And Combustion

# *Welcome by the Chair & co-Chairs*

Opening session of



**NICFD 2020**  
for Propulsion & Power



*M. Pini*

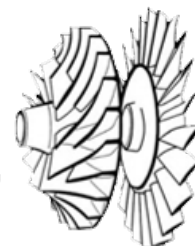
**Propulsion and Power**

**Delft, October 29-30<sup>th</sup>, 2020**

RUHR  
UNIVERSITÄT  
BOCHUM

**RUB**

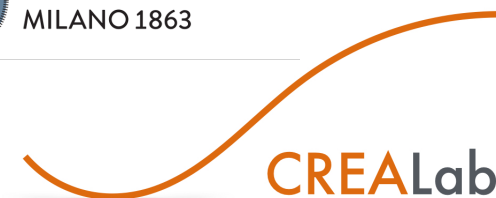
**TTF**



**vito**



**POLITECNICO  
MILANO 1863**



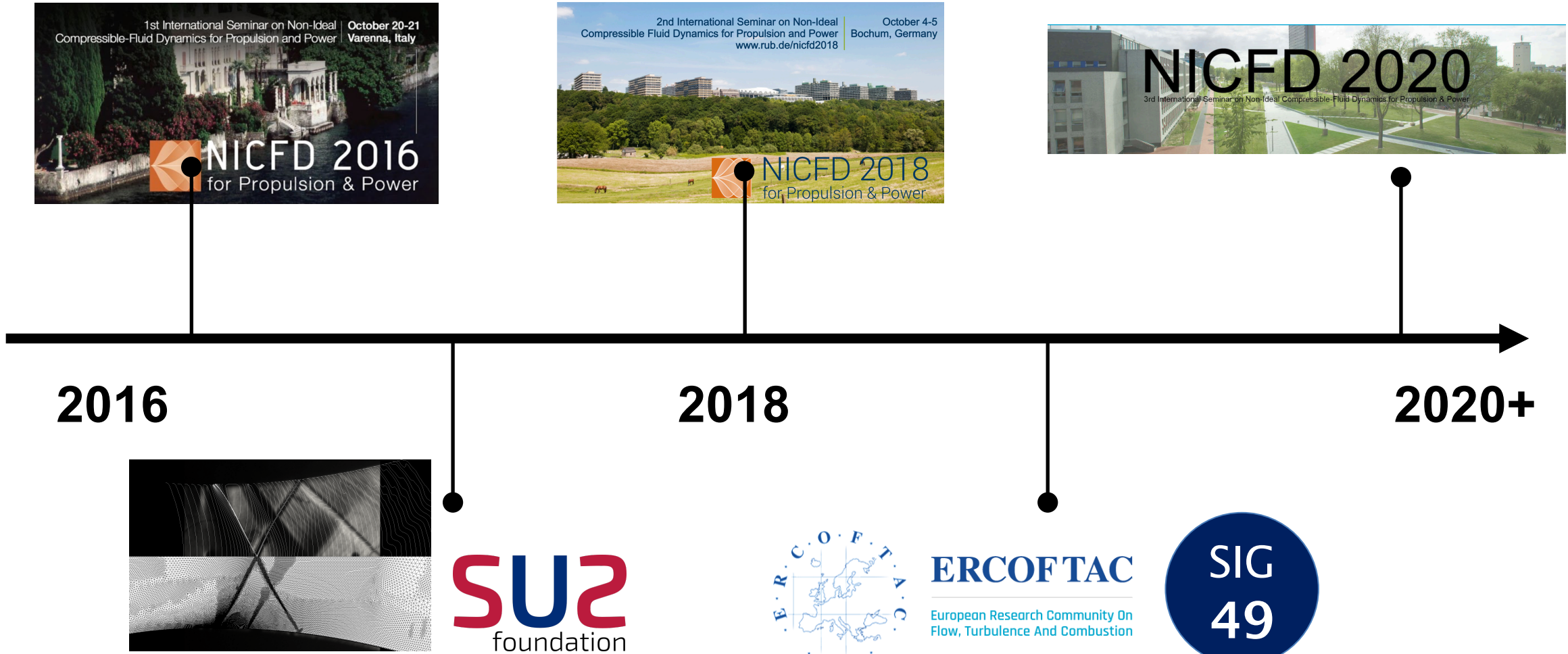
**CREALab**

# *Original Motivation*

*“Gathering under the same umbrella researchers working in the realm of fluid-dynamics of flows in non-ideal thermodynamic state*

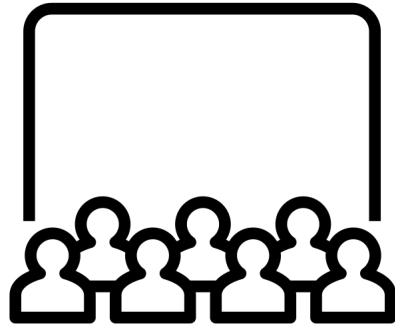
*Cross-fertilize among different scientific disciplines and engineering fields where flows of this type are of relevance”*

# Key Milestones

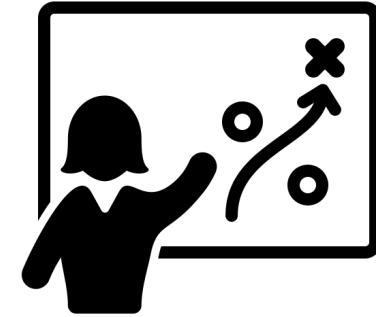


# NICFD2020 in Numbers

+ 50 participants



+ 20 high-level presentations



3 keynotes

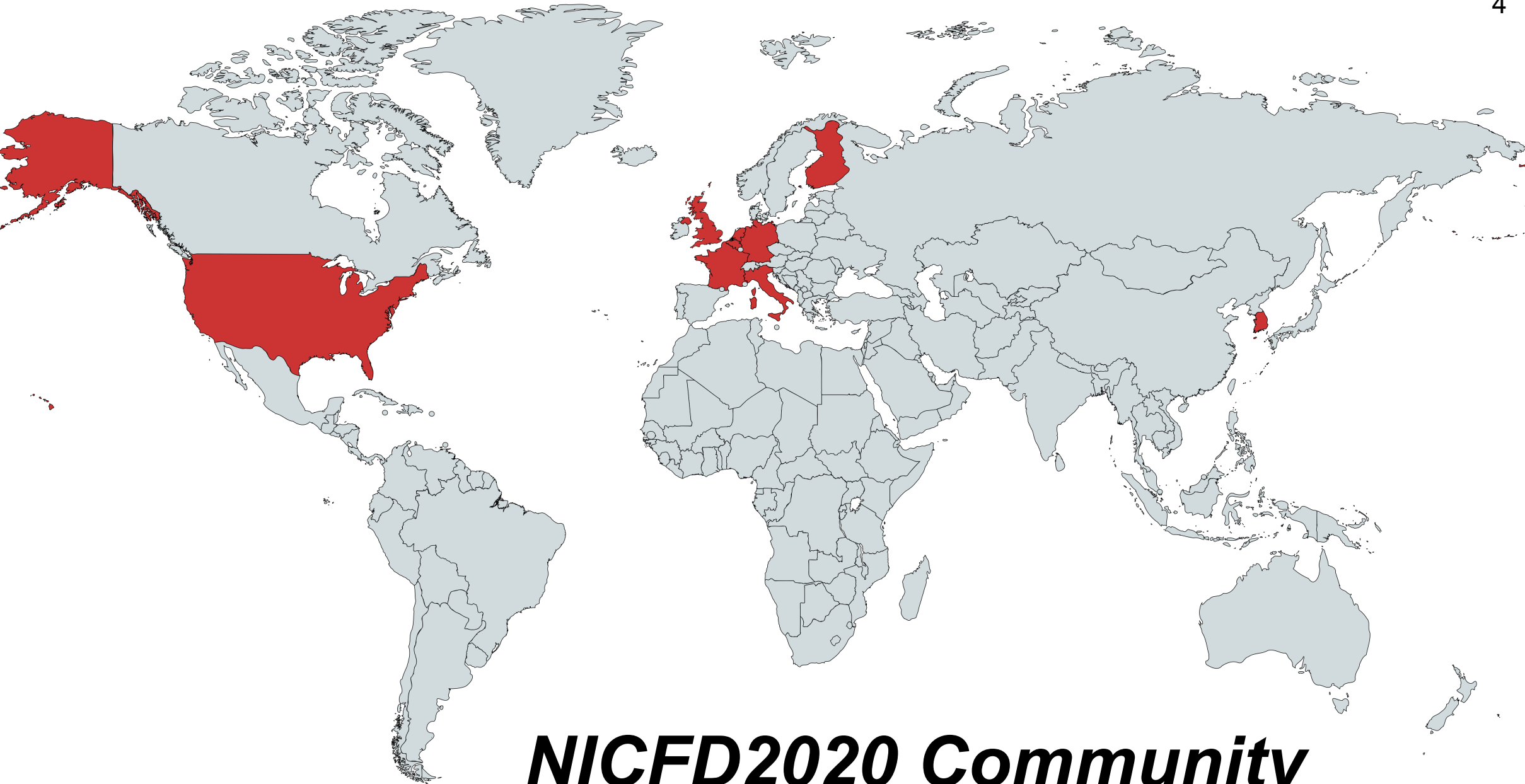


Thematic workshop



**NIST**  
National Institute of  
Standards and Technology  
U.S. Department of Commerce





# ***NICFD2020 Community***

# What is NICFD?

“Non-ideal compressible fluid dynamics (NICFD) concerns **non-reacting** and **reactive** flows of fluids in non-ideal thermodynamic state.

It therefore **deals with** dense vapor flows, compressible liquid flows, and multi-phase flows”

$$\boxed{Pv \neq RT} \quad \left\{ \begin{array}{l} \Gamma \neq \frac{\gamma + 1}{2} \\ \gamma_{Pv} \neq \gamma \end{array} \right.$$

# A Conceptual Nugget

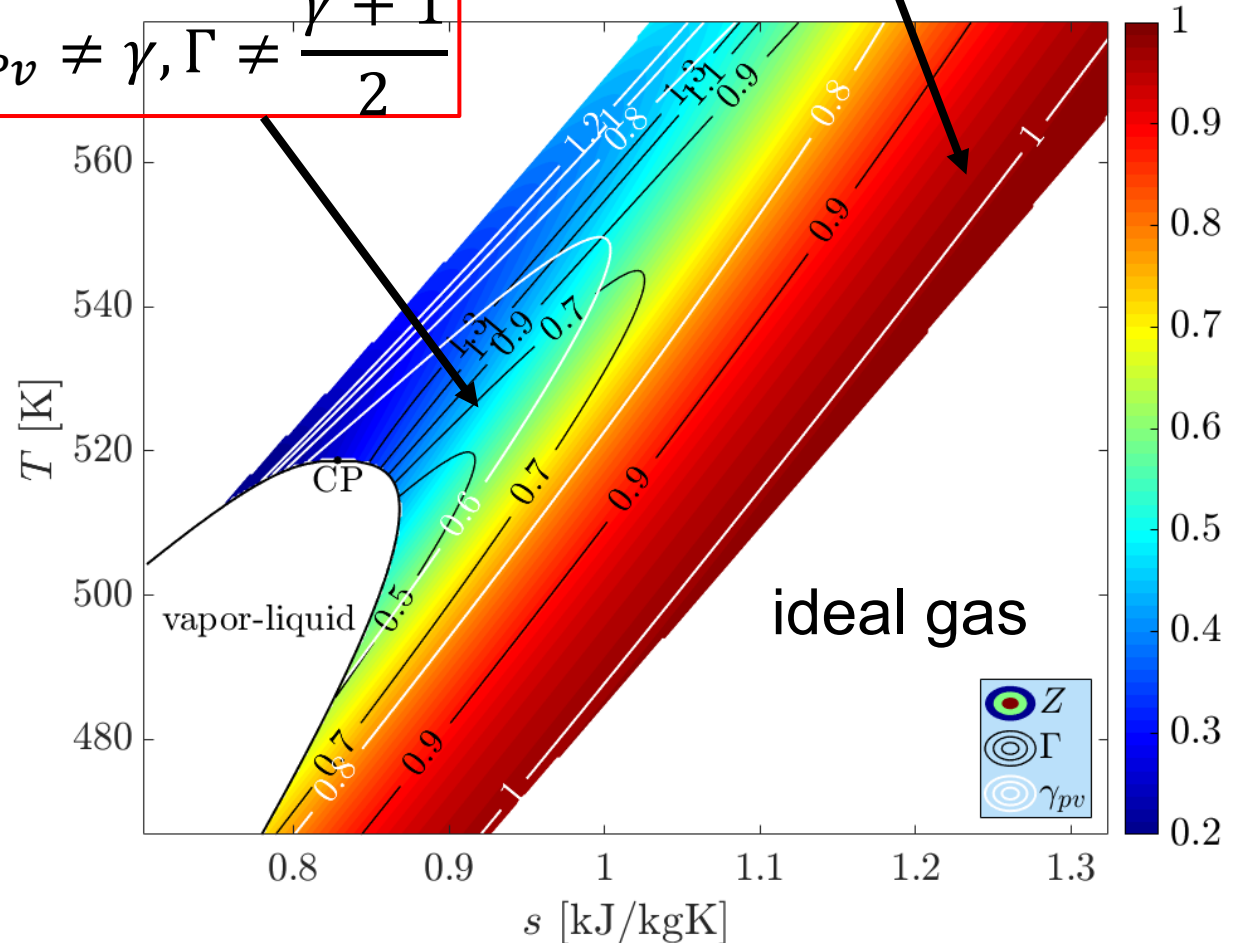
$$Z \approx 1, \gamma_{pv} \approx \gamma, \Gamma \approx \frac{\gamma + 1}{2}$$

$$\Gamma \approx \frac{\gamma_{pv} + 1}{2}$$

$$\gamma_{pv} = -\gamma \left. \frac{v}{P} \frac{\partial P}{\partial v} \right|_T = \frac{\gamma}{\beta_T P}$$

$$\beta_T = \frac{1}{P} + \frac{1}{Z} \left. \frac{\partial Z}{\partial P} \right|_T$$

$$Z < 1, \gamma_{pv} \neq \gamma, \Gamma \neq \frac{\gamma + 1}{2}$$

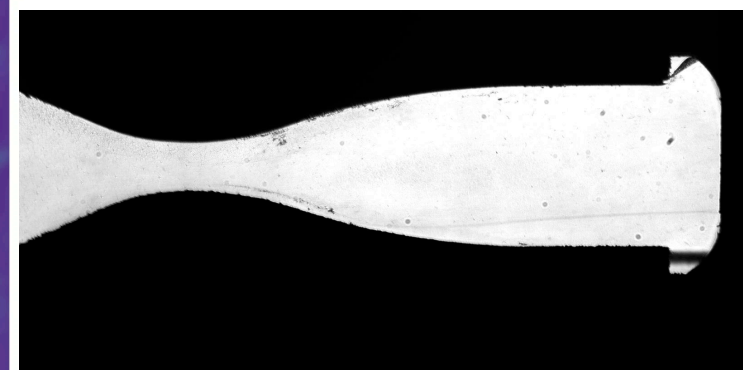
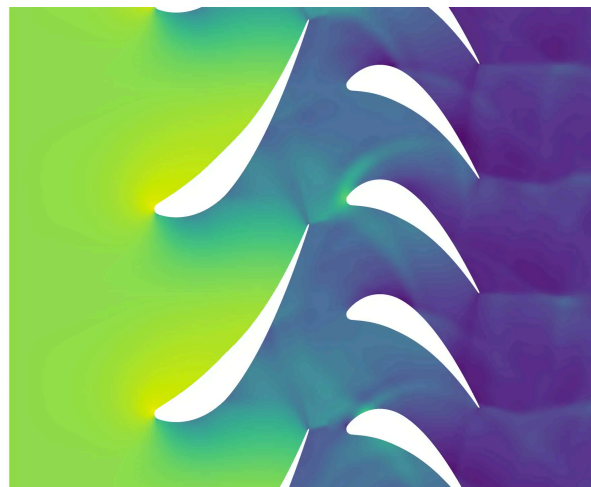
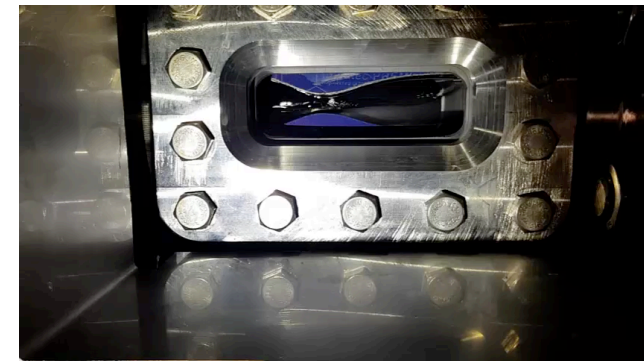
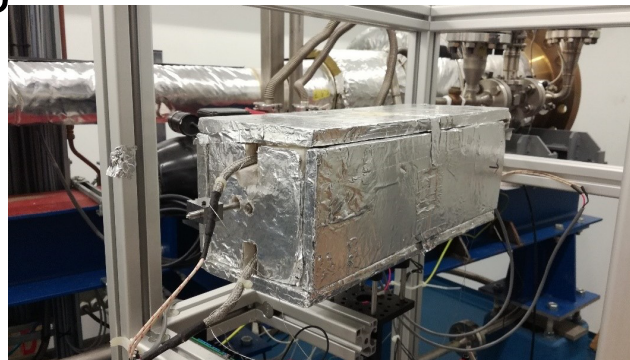
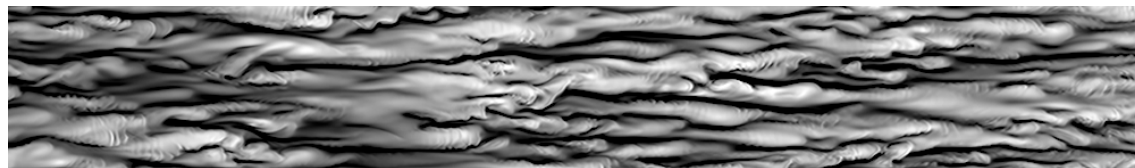


**NICFD “characterizing properties”  
are all intertwined!**

# NICFD in Science...

- Shock and oblique shock-waves
- Turbulence and turbulence modeling
- BL stability & transition
- Heat transfer
- Loss mechanisms
- BZT effects
- Evaporation/condensation
- Acoustics
- ...

**Theory, models, experiments**

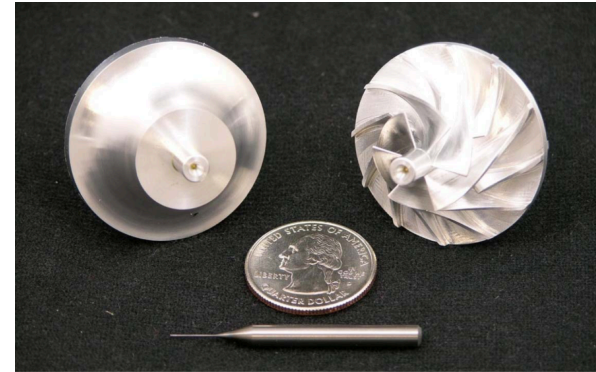




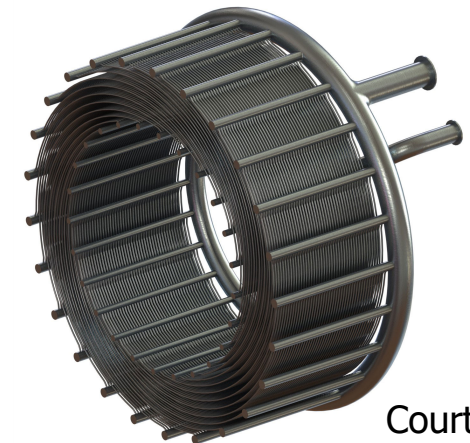
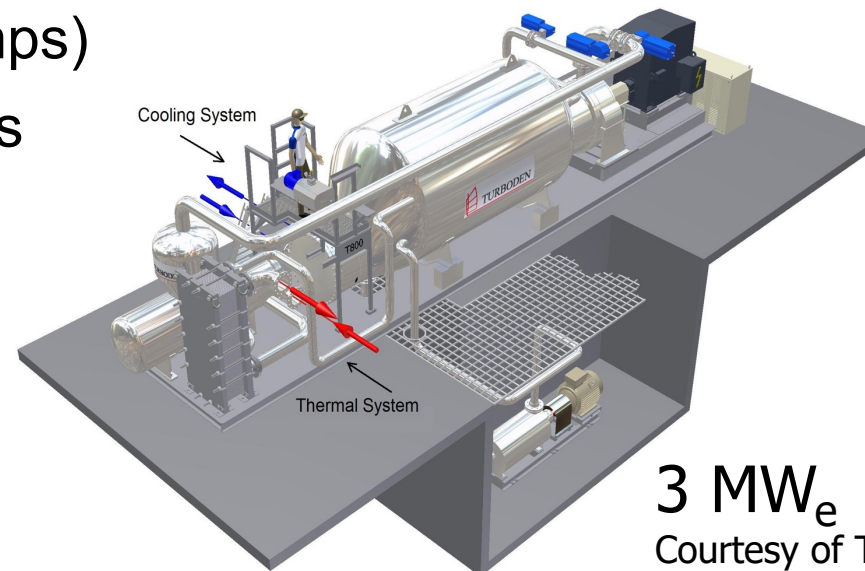
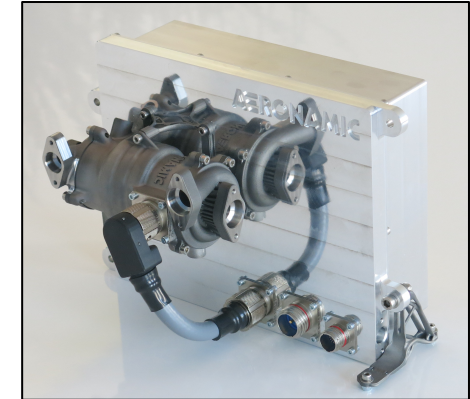
# ...and Relevance in Engineering

- ORC/sCO<sub>2</sub> power systems
- Trans-critical heat exchangers
- Oil and Gas compressors/expanders
- Super / transcritical fuel injection
- Cryogenic processes
- Rocket engines (turbopumps)
- Refrigeration / Heat-pumps
- Chemical processes
- ...

Courtesy of Sandia Lab



Courtesy of Aeronamic



Courtesy of  
Reaction Engines

3 MW<sub>e</sub>  
Courtesy of Turboden MHPS

# *Acknowledgments*

- Authors & reviewers
- Organizing & scientific committee
- Managing team → Trudy, Vanessa, Federica, Francesco



*Thank you  
and Enjoy!*

