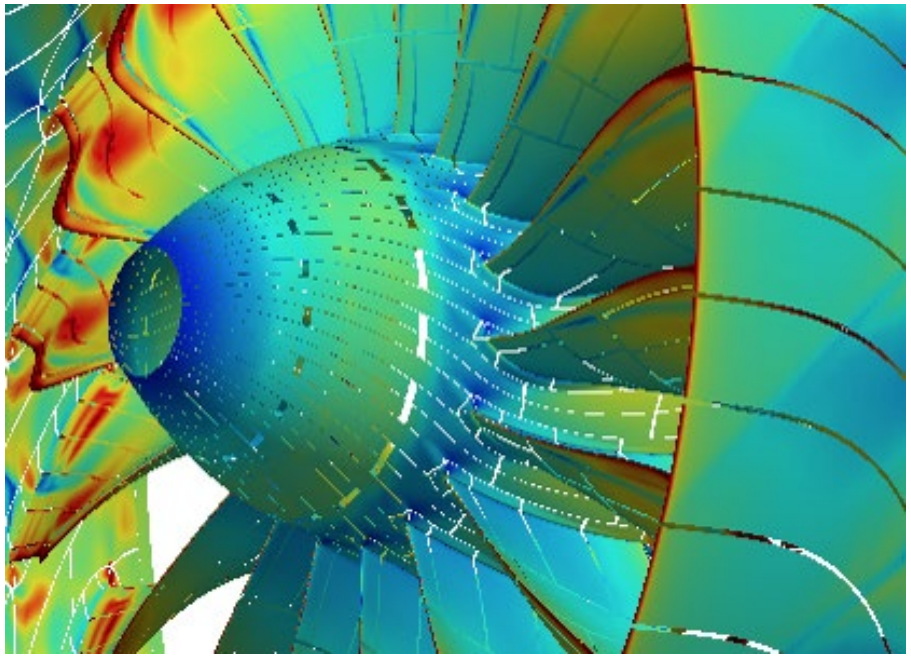


LA SIMULATION ET LES DONNÉES, UN DES ÉLÉMENTS CLÉ DE LA PERFORMANCE

14 JUIN 2022

SAFRAN

An industrial high technology group

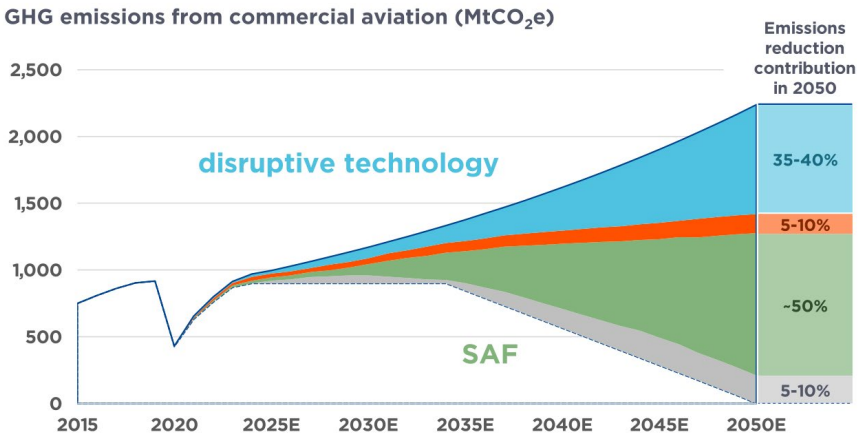
76,800
employees

€15.3
billion in revenues
in 2021

125 years
of history: the oldest aero-engine manufacturer in the world

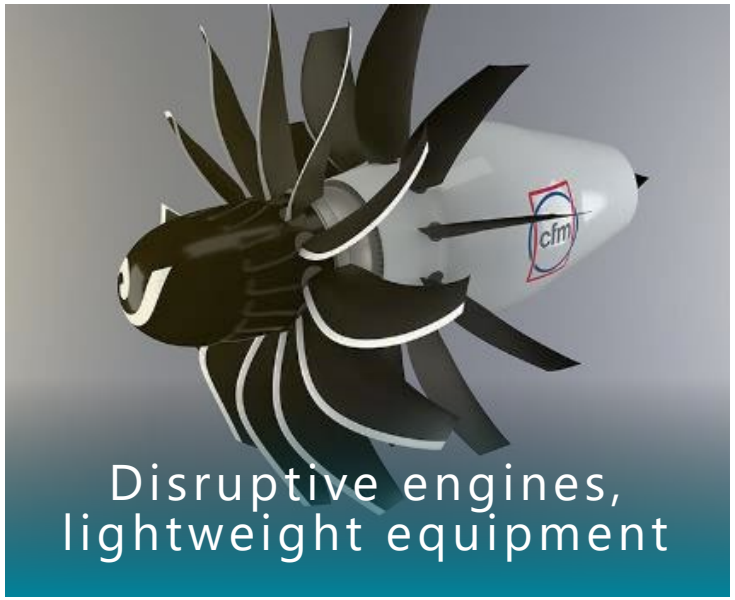
No.3
aerospace company worldwide (excluding aircraft manufacturers)

Decarbonizing aviation, our strategic priority

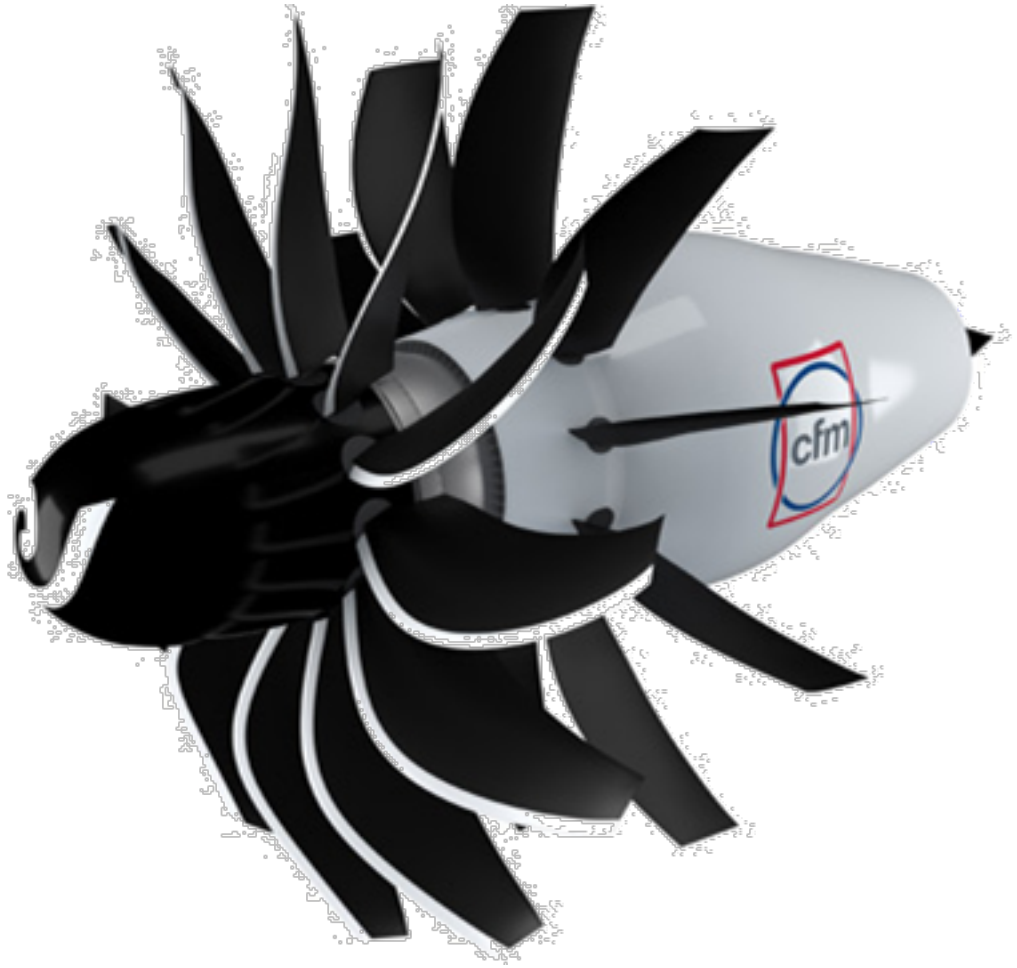


Innovative technologies

to contribute to a "zero emission" aviation by 2050



Towards breakthrough products & systems to meet future RISE challenges : decrease by 20% CO_2 emissions



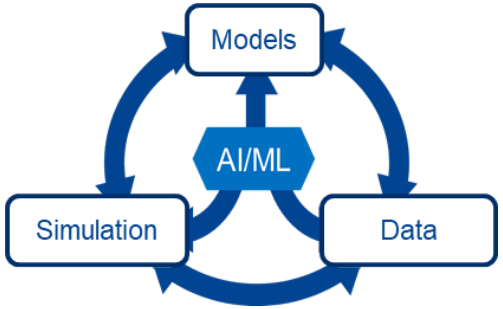
This level of ambition requires to:

- Develop multiscale and multiphysics models, bridging scales from micro to macro scale
- Develop new physical models (eg electromagnetics)

- Bridge the gap between data, models & simulation
- Develop digital non destructive testing technologies
- Master uncertainties quantification
- Develop computations automation
- Master the use of HPC and HPDA, and related infrastructures

Bridging the gap between data, model and simulation

- Leveraging model & simulation & data
  - > Physics-based knowledge (i.e. PDE, ODE …)
  - > Sensor, Image, Video, Text (bench, production, control, operation, maintenance)
  - > Business expert-based knowledge



- Data & computing & software ecosystem
  - > Next-generation high-performance computing core (CPU, GPU)
  - > Simulation platform (collaborative, interoperable)
  - > Data model (International standards, public)

Bridging the gap between data, model and simulation

… for a **simulation-based design cycle**

faster, reliable, robust & integrated

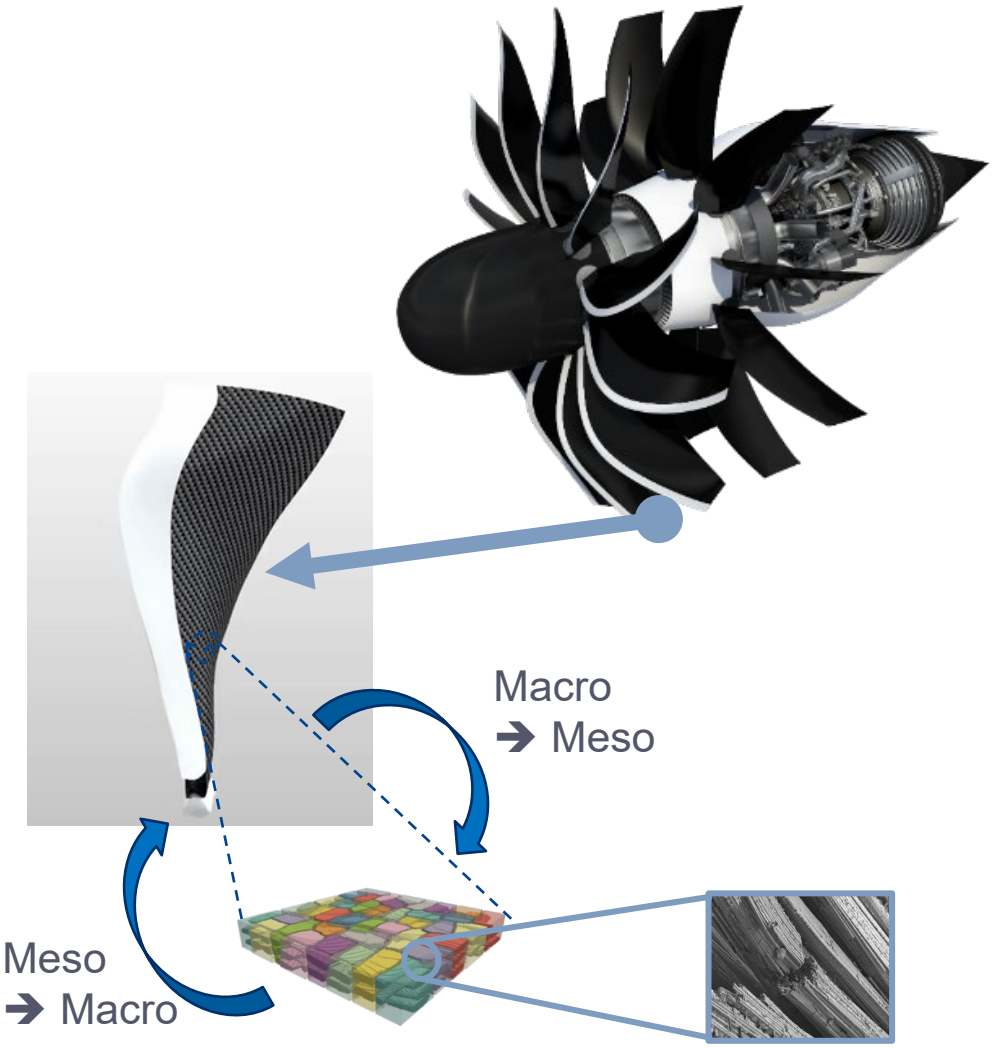
serving **exploration, control & maintenance**

Some applications: multi-scale analysis of materials & structures

- **Context**
  - > New engine architectures
  - > 3D woven composite parts + Polycrystalline structures
  - > Physical mechanisms leading to a macroscopic failure starts at the microscale

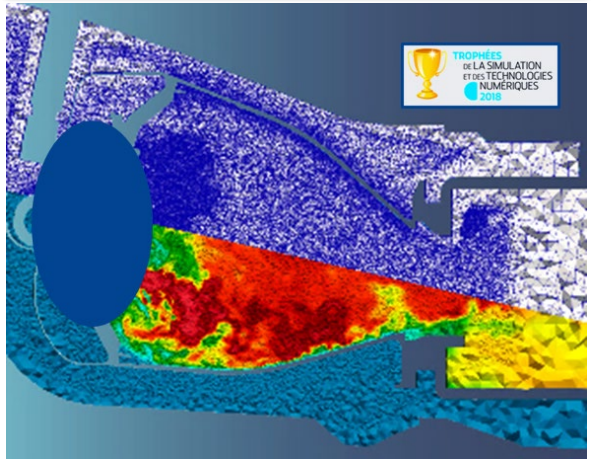
- **Operationnal issues**
  - > **Multiscale analysis of first damage prediction** (lifetime)
    - **Global (macroscopic)** analysis
    - **Local (mesoscopic)** analysis in a region of interest

- **Challenge**
  - > Bi-directional Multi-scale analysis (macro ⇆ meso)
  - > Different models in local and global regions
  - > Extremely fine and large mesoscale problems

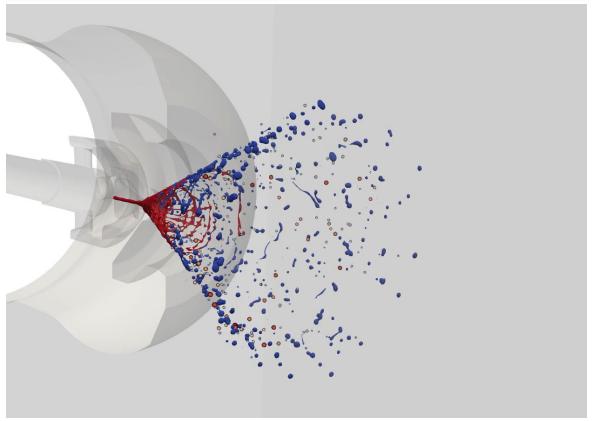


Some applications : Combustion & multiphase flows

Reactive Flows



Sprays



Based on elementary physical models

Versatil softwares, highly CPU efficient, confident, validated

HPC capacities and adapted softwares are game changers

CPU capacities is the main limiting factor

Adaptation to future aviation fuels

Some applications : Combustion & multiphase flows

New products & new needs in Safran

➔ Our existing HPC and high-fidelity software open up new capabilities

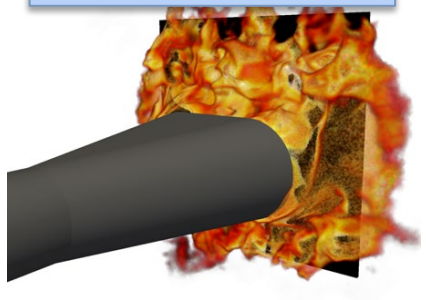
Based on the same elementary physcial models

Versatil softwares, highly CPU efficient, confident, validated

HPC capacities and adapted software are available

COVID / Cabin ventillation

Certification / Compartment fires



Manufactoring processes

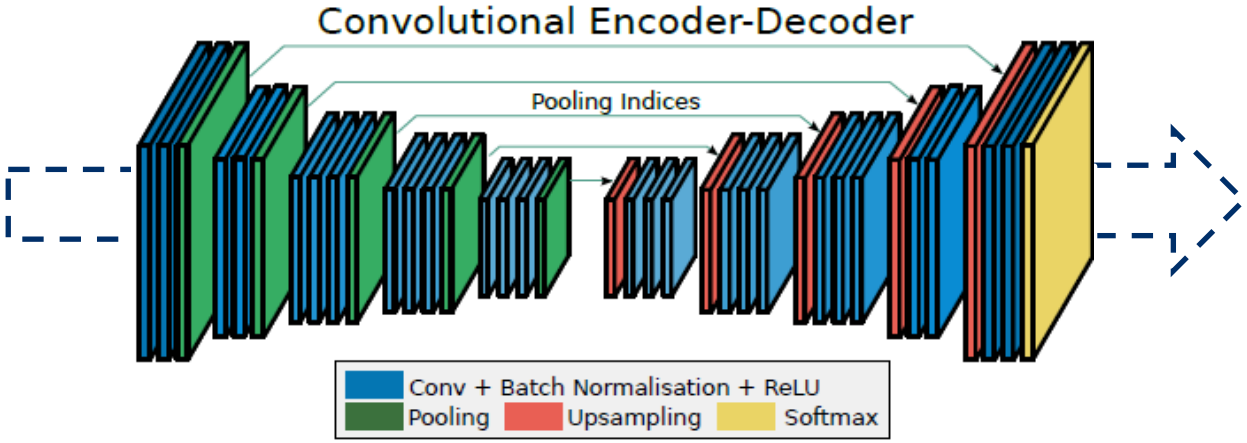
Lubrication

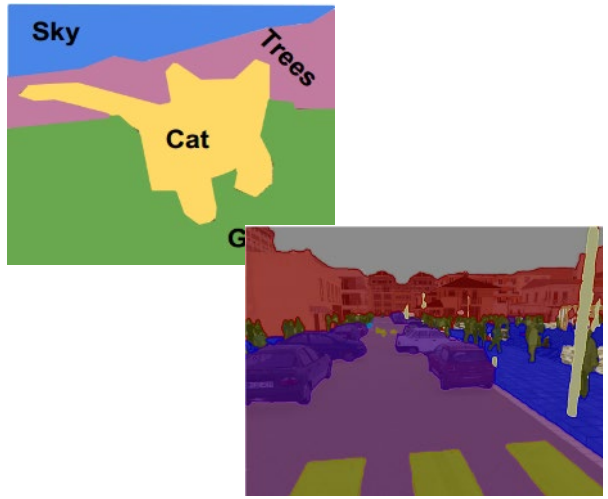
Sloshing in tanks, cavitation

SAFRAN

CFD ONLINE - MACHINE LEARNING & PHYSICS-BASED MODELING AND SIMULATION

> 1 000 000 images



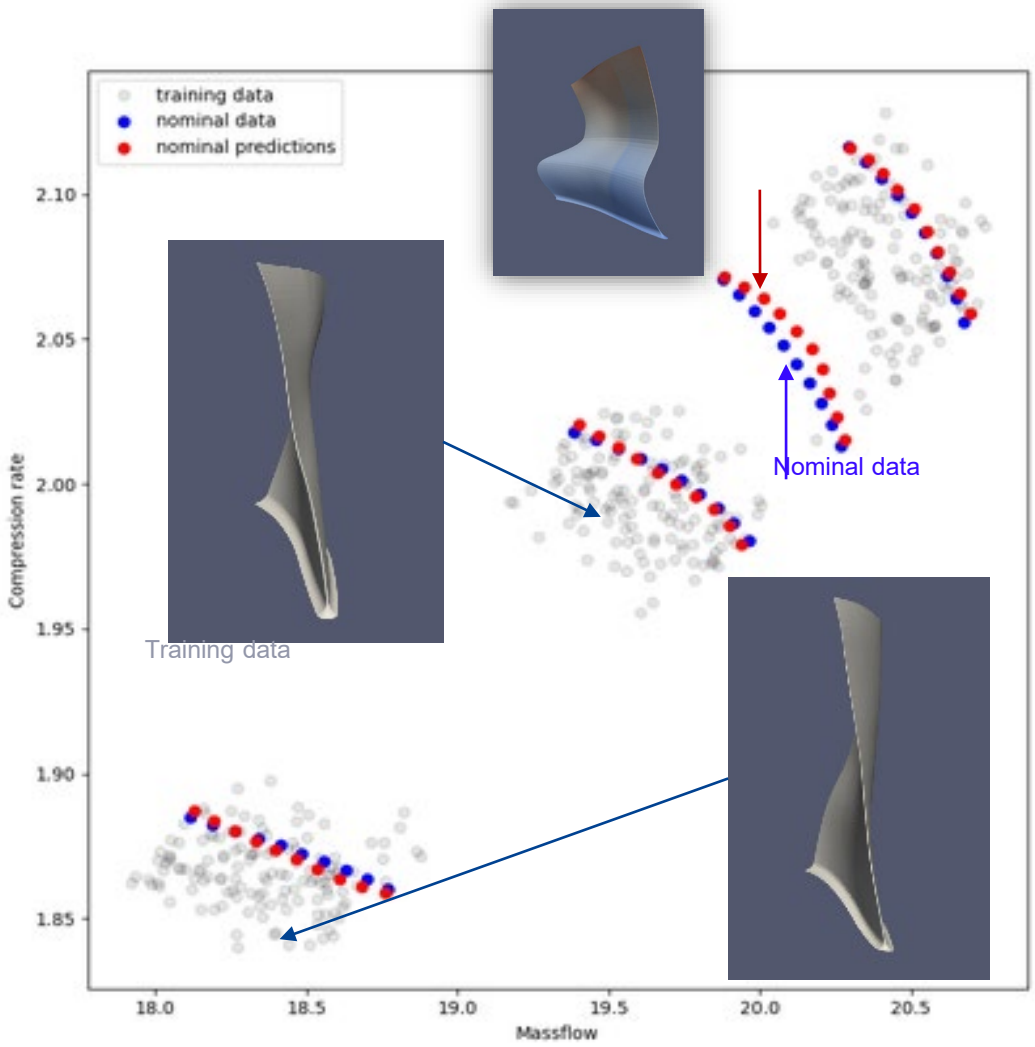


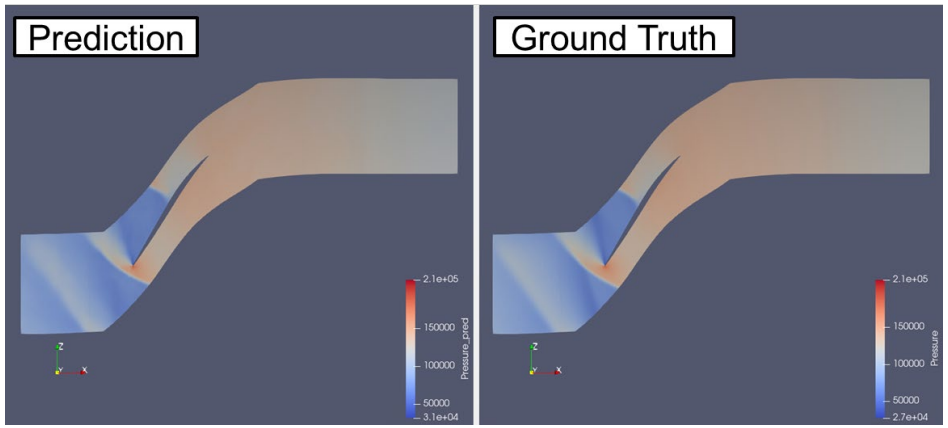
Can we also do this ?

…in quasi **real-time**
… for **physics-based simulation**
… with relevant **confidence indicators**

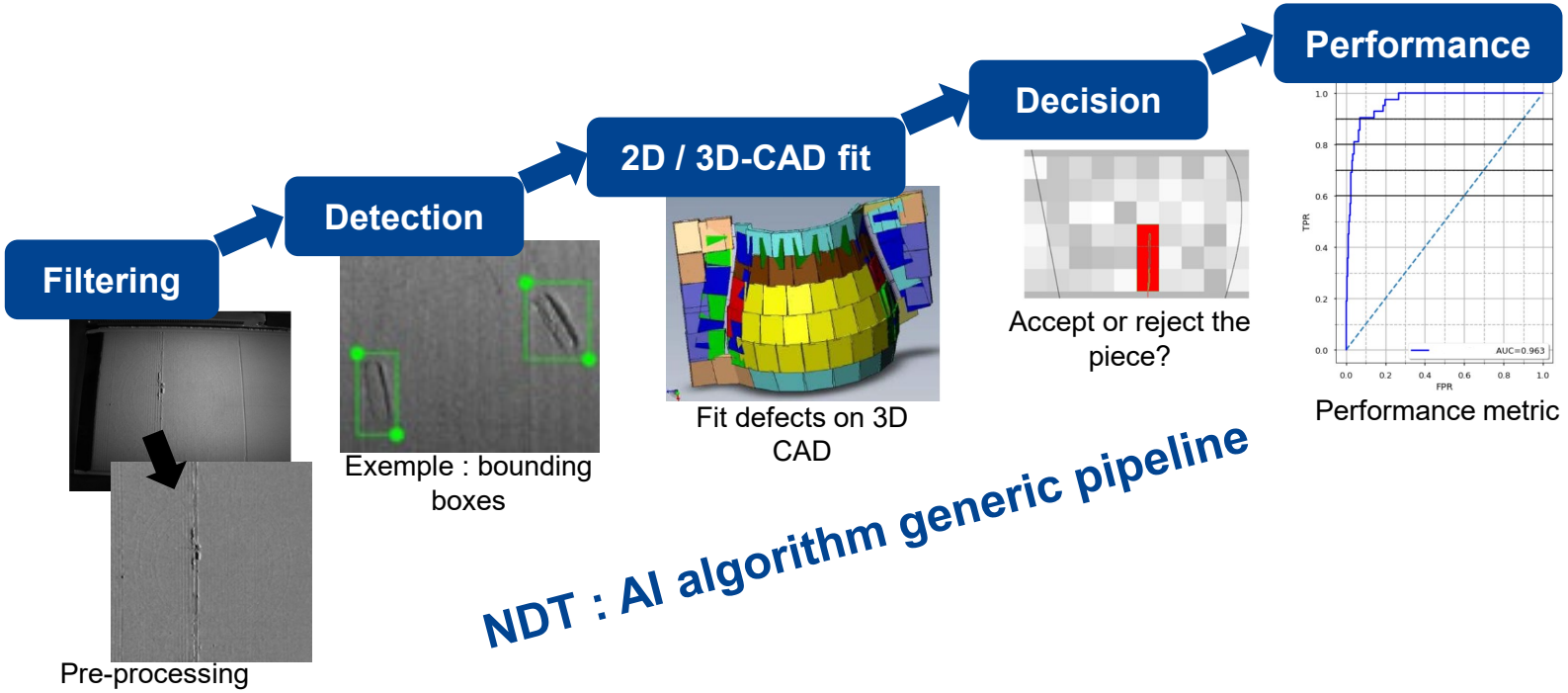
CFD ONLINE - MACHINE LEARNING & PHYSICS-BASED MODELING AND SIMULATION

First experiments (300 physics-based simulations)





Artificial intelligence (AI) for non destructive testing

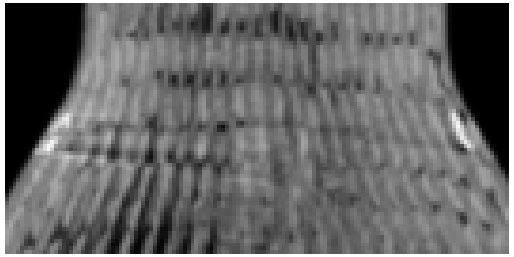


NDT IA challenges:

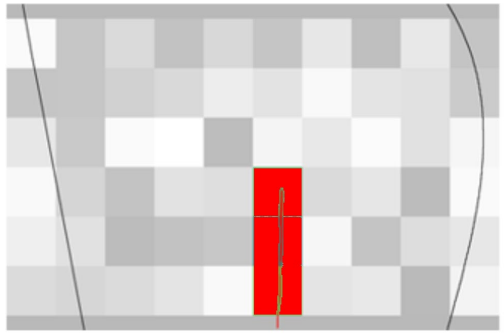
- Low amount of data
- Noisy annotations
- Drastic specifications (True Positive Rate ↗, False Positive Rate ↘)
- Images & annotations are very specific wrt. existing scientific bibliography

Artificial intelligence (AI) for non destructive testing, examples

Woven composites: binary sanction



Tomography X (3D)



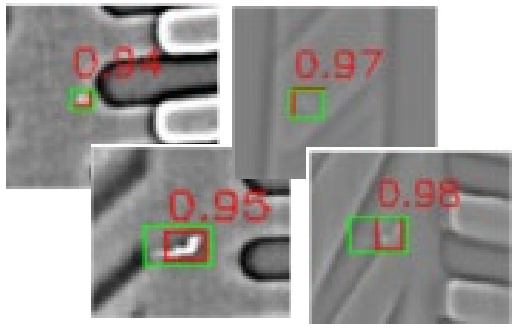
Scoring on predefined bounding boxes

Help the operator by showing questionable regions and scoring

Need for massive GPU & HPDA Capabilities to train neural networks

Bounding boxes for complex foundry components

Radiography X (2D)



Bounding boxes + scoring