HYDRO

RADIAL FAN LAYOUT: TOWARDS AN AUTOMATED OPTIMIZED, FAST AND RELIABLE DESIGN

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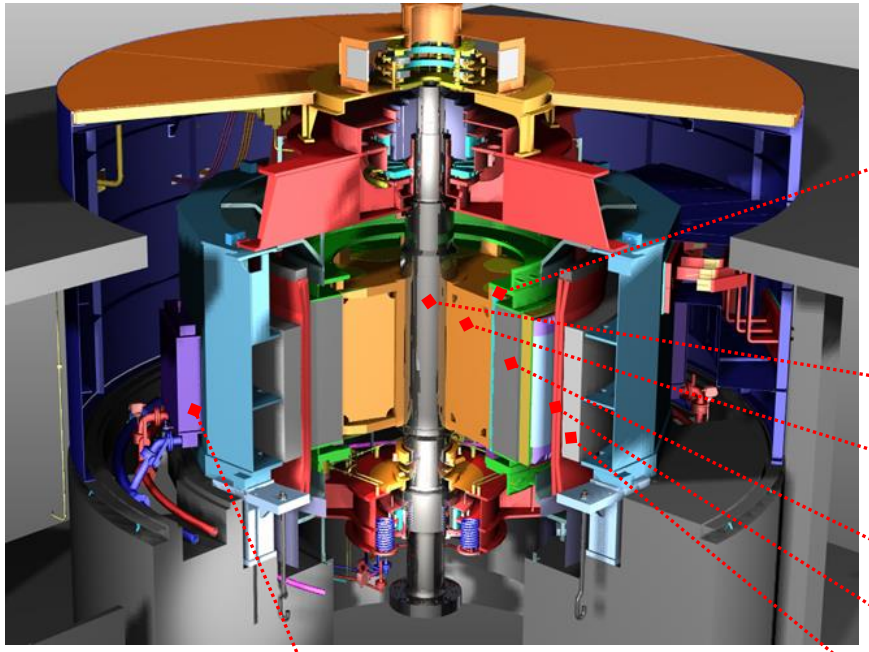
ENGINEERED SUCCESS

OUTLINE

- Generator cooling
  - Air cooling of a hydro generator?
  - How much power needs to be dissipated?
- Design of radial fans
  - Current approach
- Optimization process
  - Strategy
  - Comparison executed projects
- WebApp

RELEVANT COMPONENTS FOR AIR COOLING



Fan

Shaft

Rotor hub

Poles

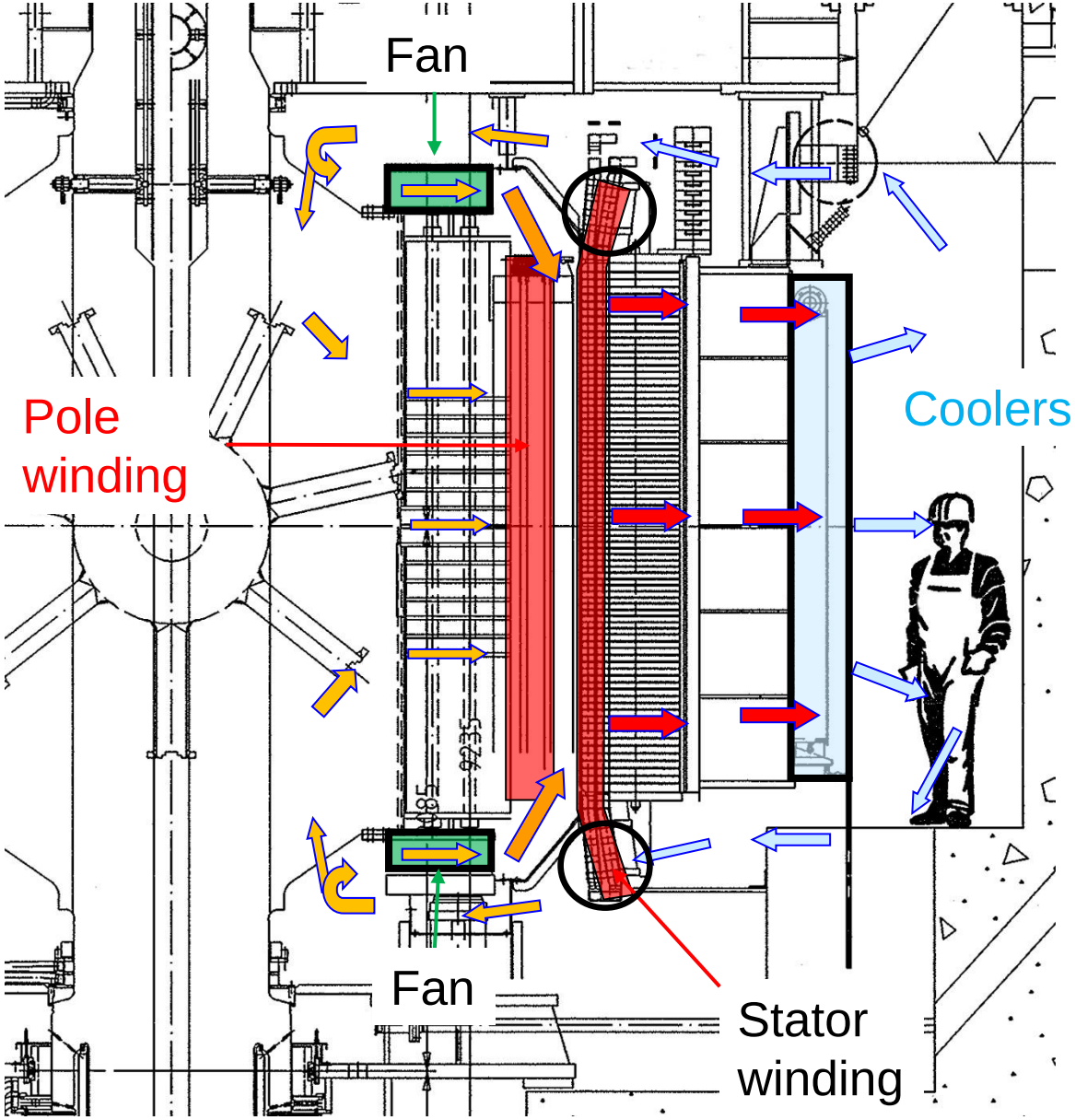
Stator winding

Stator core

Air-cooler

Generators can be very big …

COOLING AIR FLOW



In a closed ventilation circuit cold air enters the generator, and passes in general

- the endwinding Zone,
- the fans,
- the rimducts (if present),
- the interpolar space,
- the stator ventilation ducts,
- the coolers,
- and enters the generator again.

DISSIPATED POWER

~2 Million mobile phones

21000 refrigerators

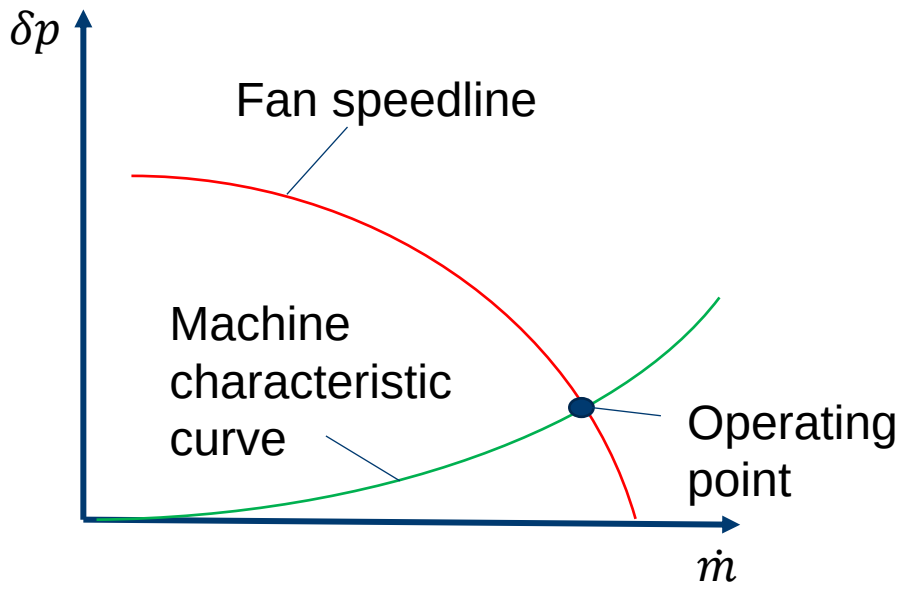
For large projects, cooling air has to dissipate a power loss of about 3 MW

30 cars

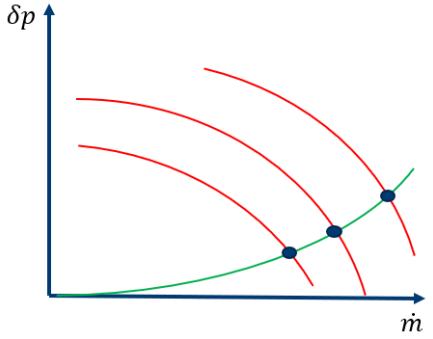
1 steam locomotive

VENTILATION LAYOUT

Cooling layout



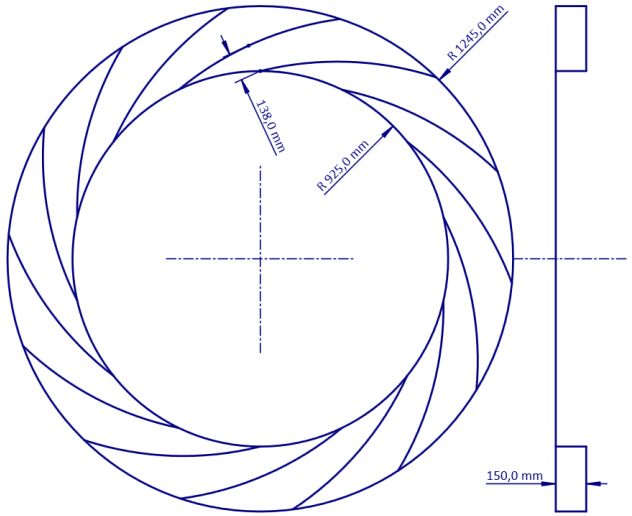
- Ventilation calculations are done by different layout tools
- Operating point chosen so that all temperature requirements are met → Different fan geometries

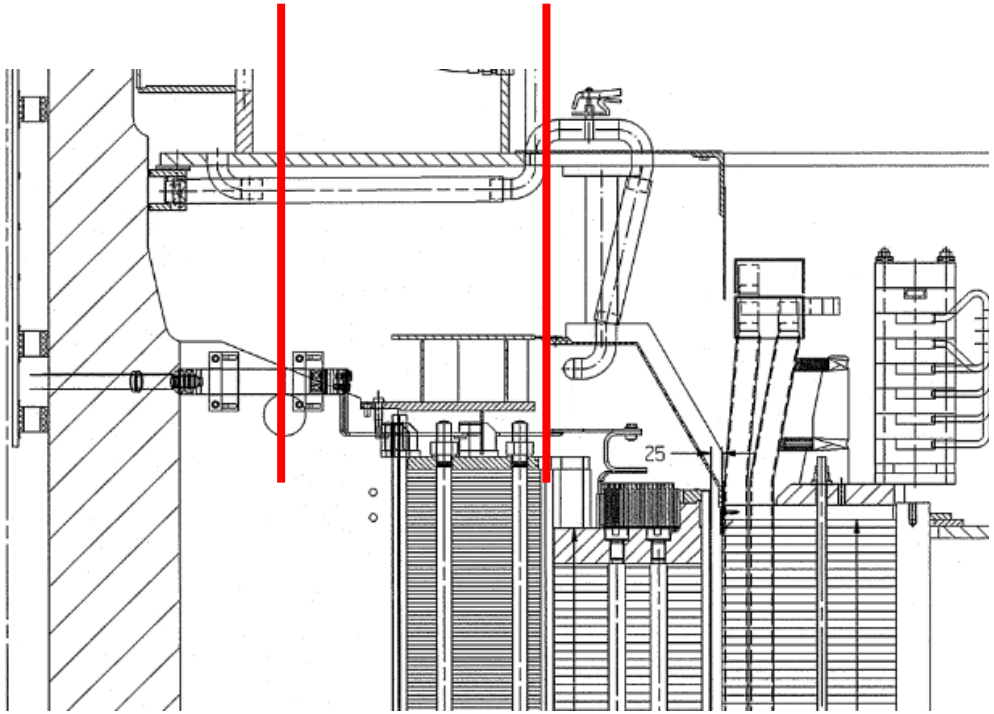


- Drawbacks:
  - Manual work necessary to get the desired pressure rise at the given flow rate
  - Different engineers will design different fans
  - Manual optimization requires effort

OPTIMIZATION - PARAMETERS

- Fan Parameters:
  - Speed
  - Inner and outer fan radius
  - Leading and trailing edge blade angle
  - Blade height
  - Number of blades





Radius restricted by installations, pole dismantling, …

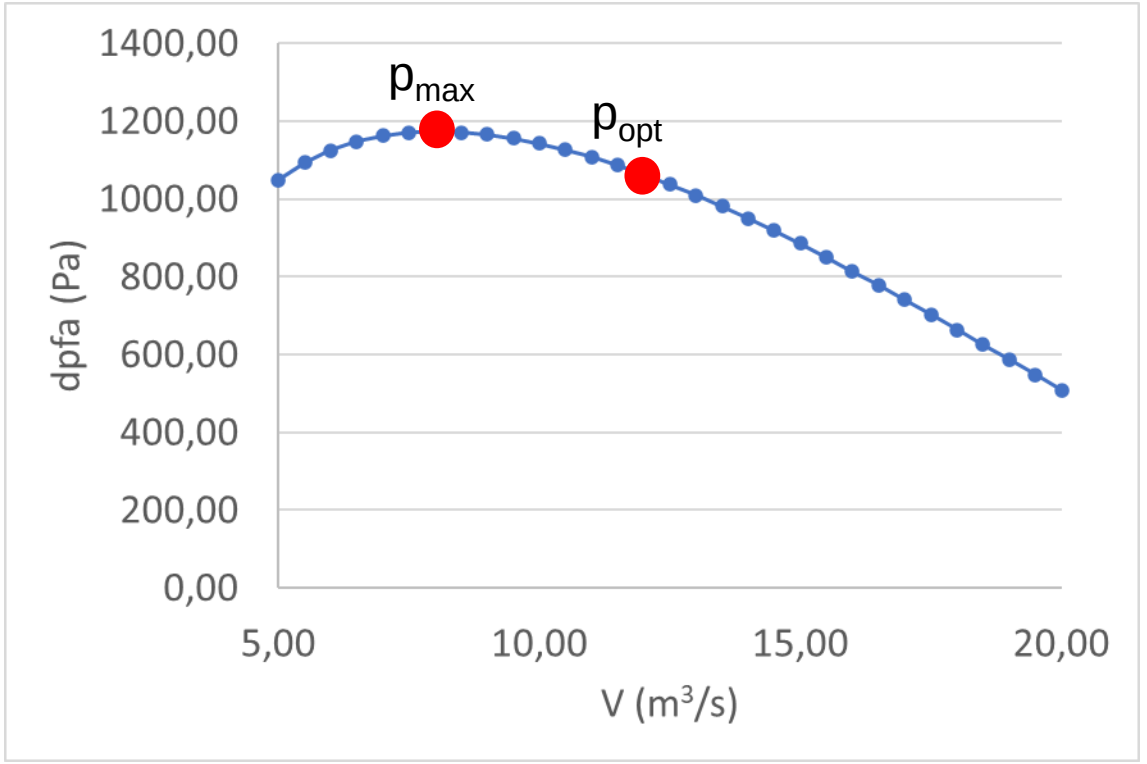
OPTIMIZATION - STRATEGY

User has to define:

- Speed
- Min/Max limits for radius
- Design point

Optimization is done according to:

- $p_{opt} = 0.9\ p_{max}$
- Pressure rise is in the range $p_{def} < p_{opt} < 1.15\ p_{def}$
- Volume flow rate in the range $V_{def} < V_{opt} < 1.15\ V_{def}$
- Losses → MIN



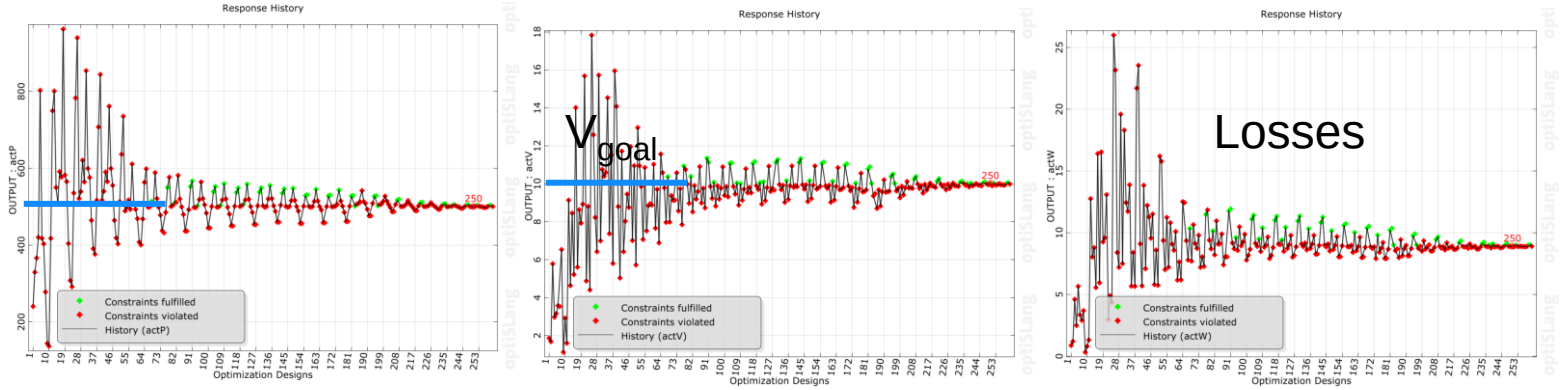
OPTIMIZATION - PROCESS

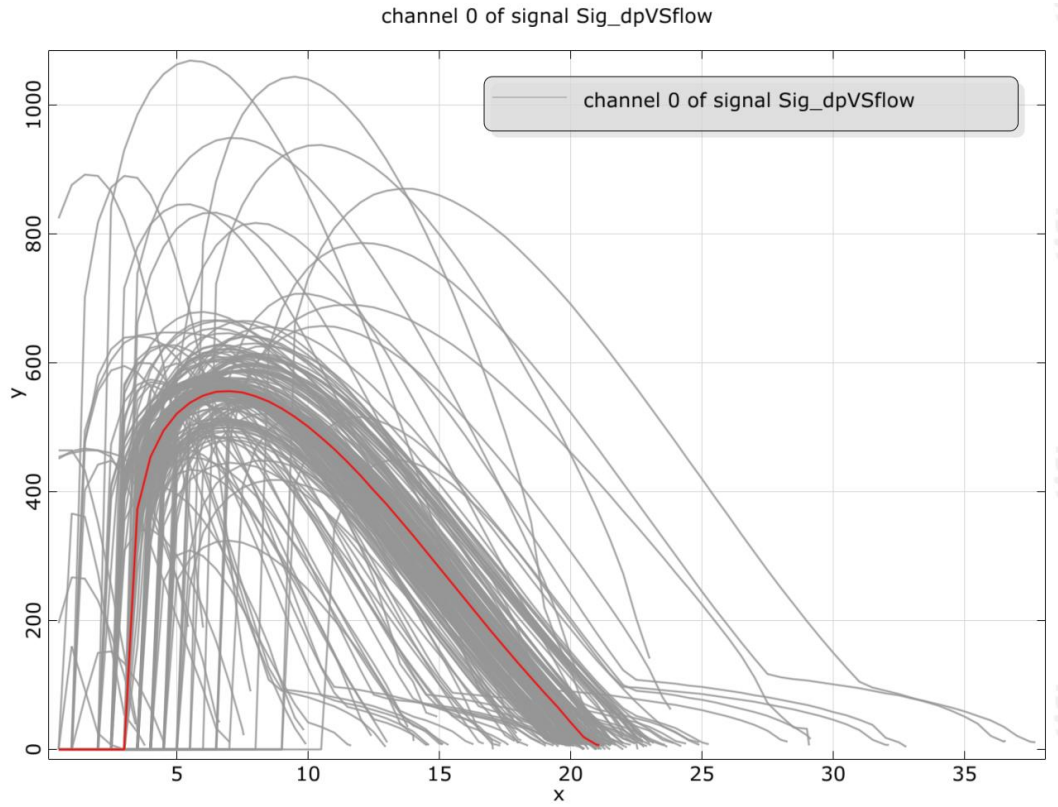
Test Project Optimization
- Design point:
  - dp = 500 (Pa)
  - V = 10 (m^3/s)

- CPU Time ~ 3-4 minutes

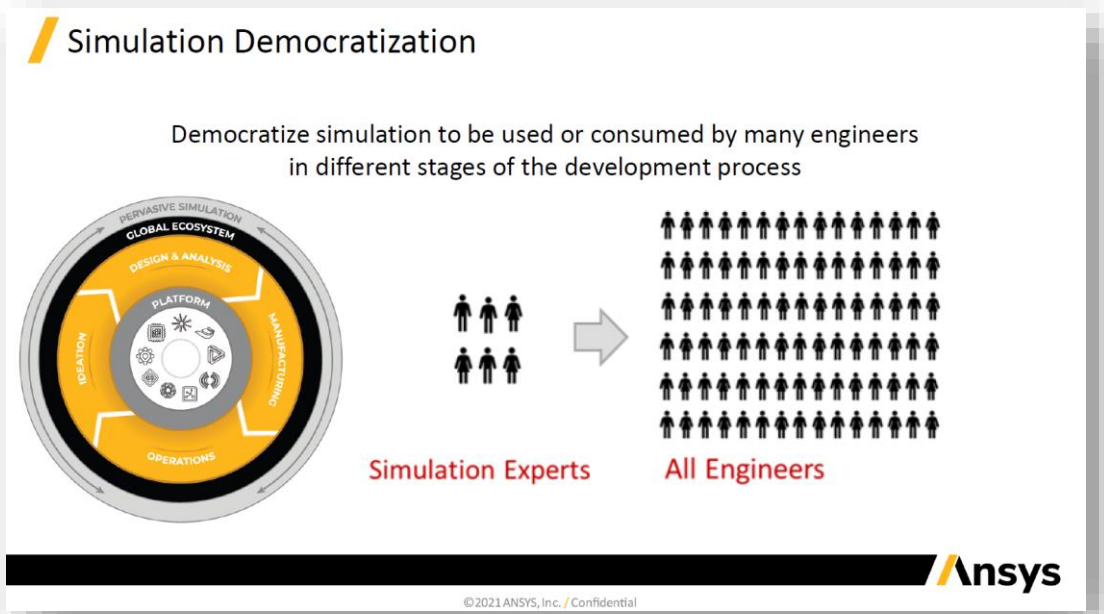
- 261 Designs calculated

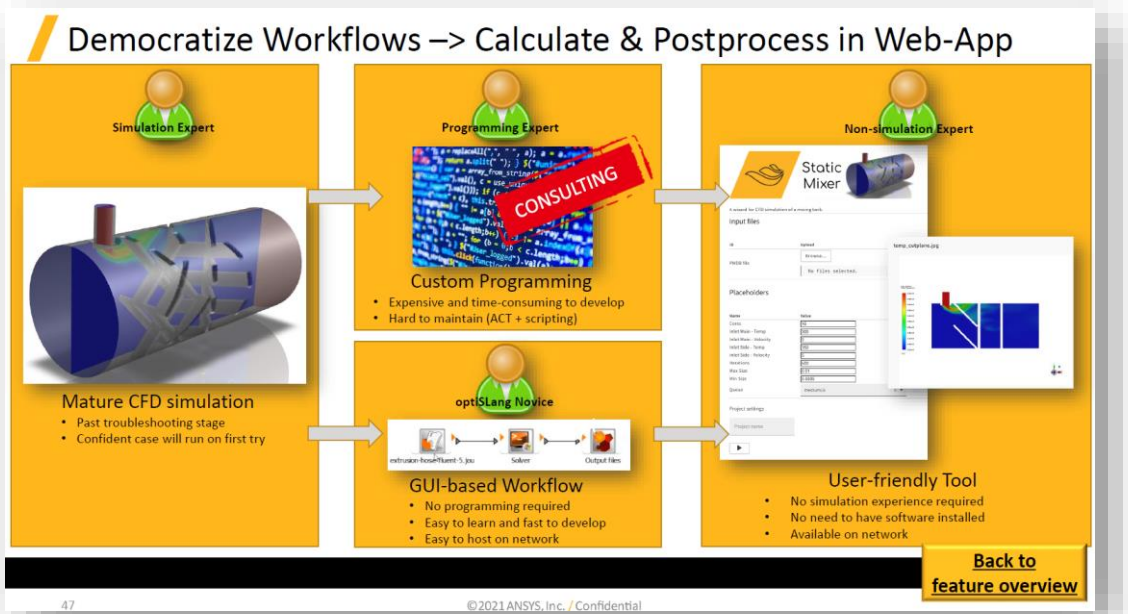
How to make this process accessible for many users?





OPTIMIZATION - PROCESS





New OptiSlang version offers:

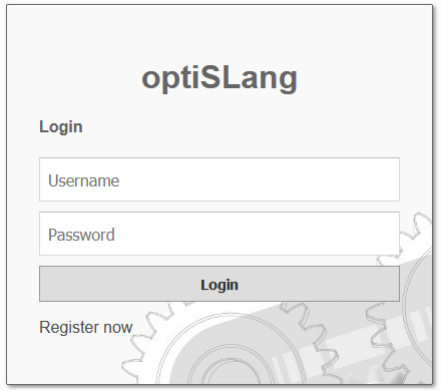
- Way to publish workflows in a webapp
- Host a webservice
- Automated post processing of the results

Automated post processing not suited for our needs

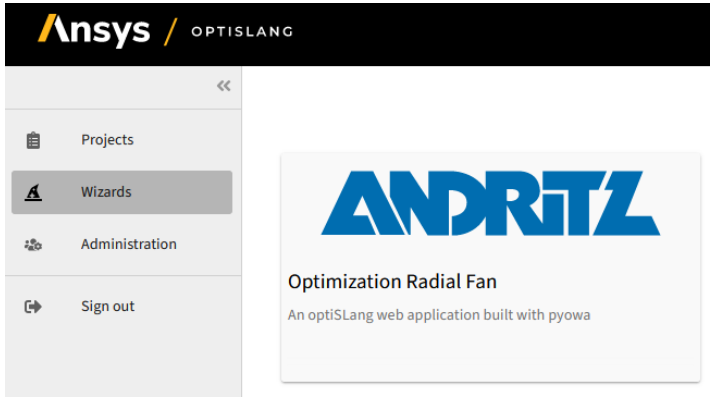
- Project together with ANSYS to customize the webapp

ANDRITZ + Ansys

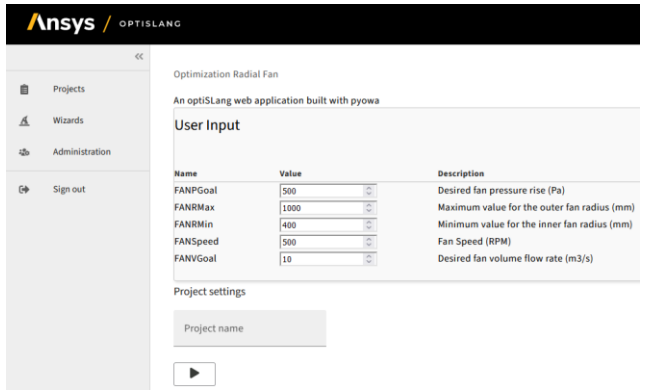
OPTIMIZATION - PROCESS



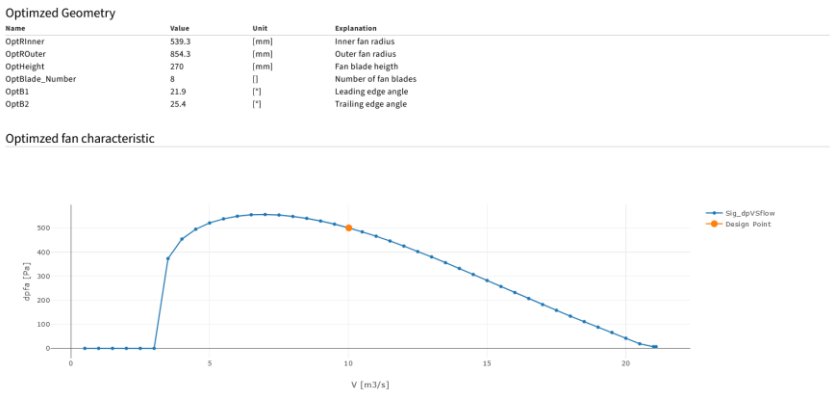
Login



Different “Wizards”



User input



Results

SUMMARY

- Optimization process based on existing layout tools for radials fans was developed
- To enable this process to as many engineers as possible a webapp was established
- Improvements of the optimization process were demonstrated by real application
- Next steps:
  - Introduce reduction of cost as optimization goal
  - Extend the workflow to axial fans