

Advances in MDO at Danfoss

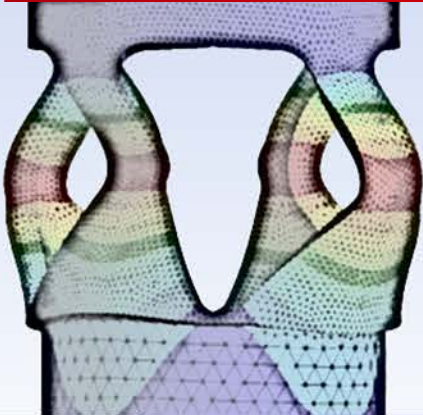
ENGINEERING
TOMORROW



Dynardo Workshop

Carsten M Thomsen

2022, June



```
!refresh
!save

Commands:
1  ! Commands inserted into this file will be executed just prior
2  ! to the start of the solution. These commands may supersede commands entered by Workbench
3
4  ! Active UNIT system in Workbench when this object was created.
5  ! NOTE: Any data that requires units (such as mass) is assumed
6  ! to be in the units of the active unit system. See the help system for more info.
7
8  !Failure strain
9  fail_load=arg1
10 !Number of steps for solve, strain is checked only after we
11 accuracy=arg2
12 P_start=arg3
13 P_end=arg4
14
15 !Find out the final solution time set in Analysis Settings
16 *get, TIME_END, comsoln, ,steps, ,real, 2
17 timeinc=(P_start*(1+accuracy))
18 steps=NINT(log10(P_end/P_start)/log10(1+accuracy))
19 time=timeinc
20 solve
21
22 !,ICOUNT,1,steps-1
23
24 !After the solve, go post process strain.
25 /post1
26 set,last

!limited to Speed Selection "killsize"
cnsel,s,killsize
etable,MYPLAS,s,1
esol,r,etab,MYPLAS,fail_load,2000
*get,ICOUNT,elem,,count

!Create component (Named Selection) of elements that are above
cm,MYELEM,ICOUNT,elem
finish
killsize

!A remark spans the ANSYS restart database (*.rdb) which is used
!to solve command. Therefore, all the stuff above does not exist in
!the restart...
!Write the commands to a file so they can be read in for the
!cavite,teap,ICOUNT,r_db
!Write out the parameters to a file so they can be read in for the
!cavite

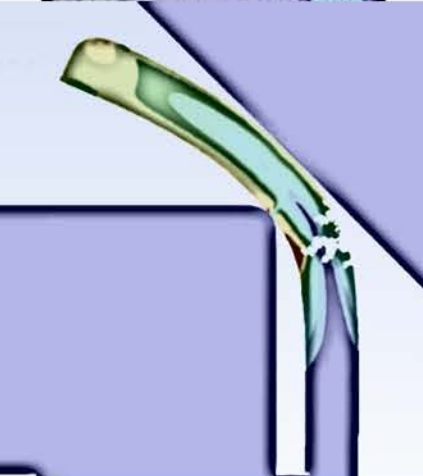
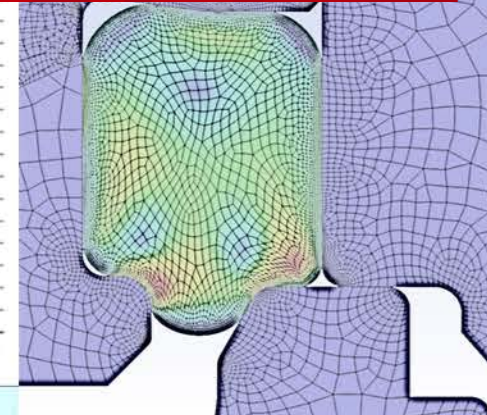
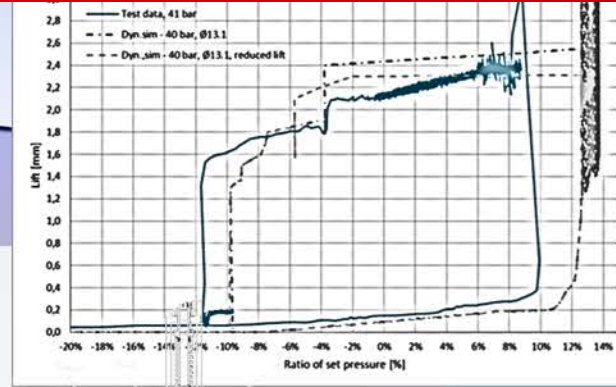
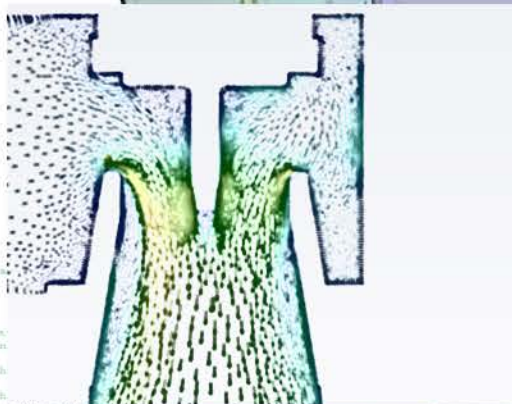
/solu
!Restart wipes out all of the post processing data that we just
!analyzed, so we
anypar,,rest

!Read in the parameters
parres,change

!Read in all components and kill the elements
,r,1,ICOUNT

/geom

!input,teap,3,cm
*GET, exists, COMP, MYELEM, TYPE
*if,exists,ne,0,then
  cnsel,s,MYELEM
  elisc
  skill,all
*endif
```



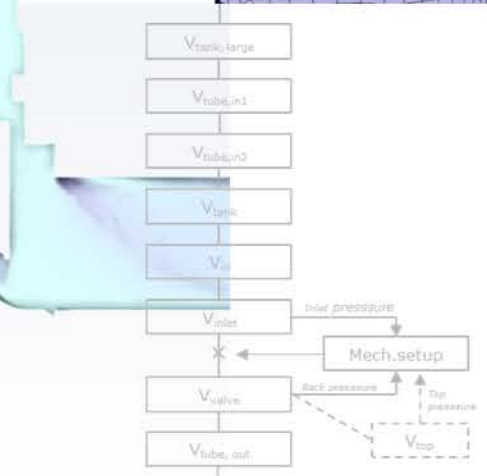
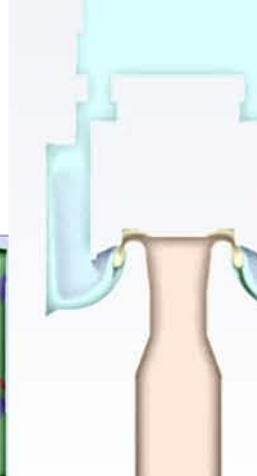
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Introduction



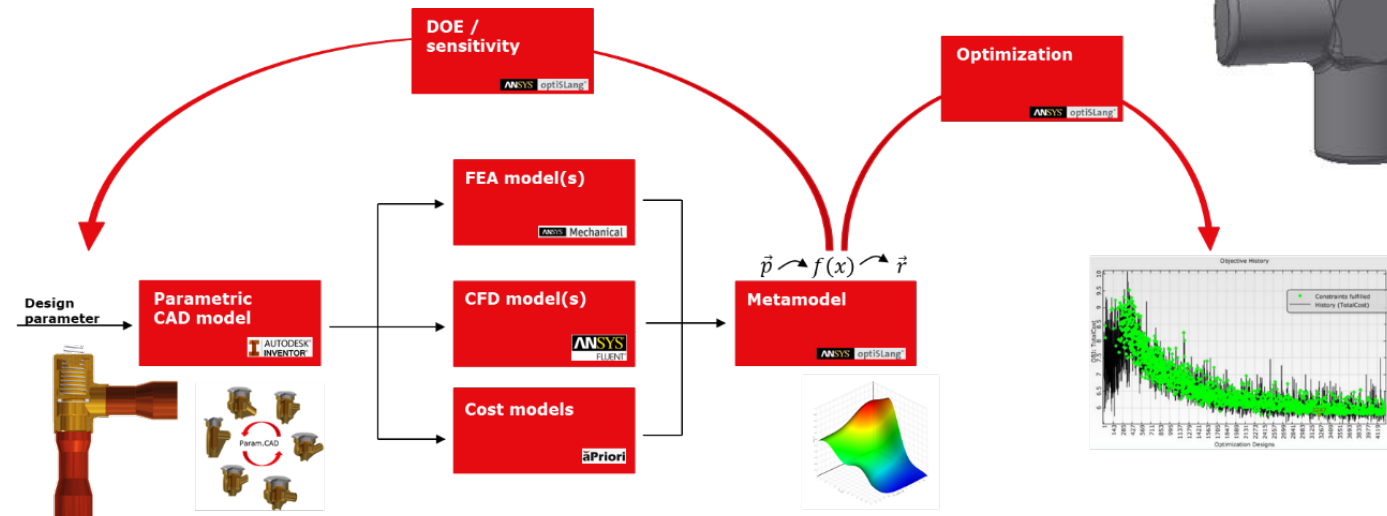
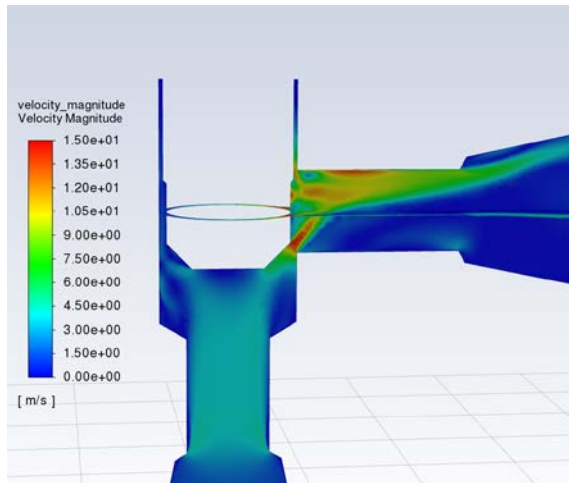
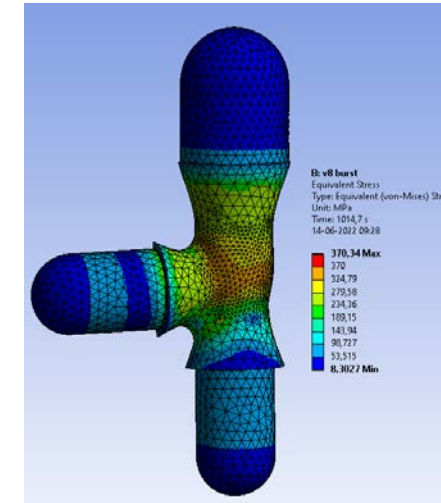
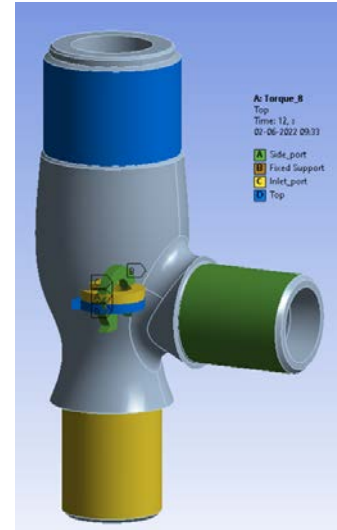
- Context:
 - Another MDO example
 - Further MDO development
 - Family parametrization
 - System model
- Other business unit examples:
 - HEX: dimple optimization
 - SiliconPower: cooling channel optimization

Danfoss Power Solutions		Danfoss Climate Solutions		Danfoss Drives	
 Construction	 Industry	 Residential Heating	 Cooling	 Industry	 Brewery
 Forestry	 Agriculture	 District Heating	 Air Conditioning	 Automotive	 HVAC

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Danfoss RAC: SNV optimization

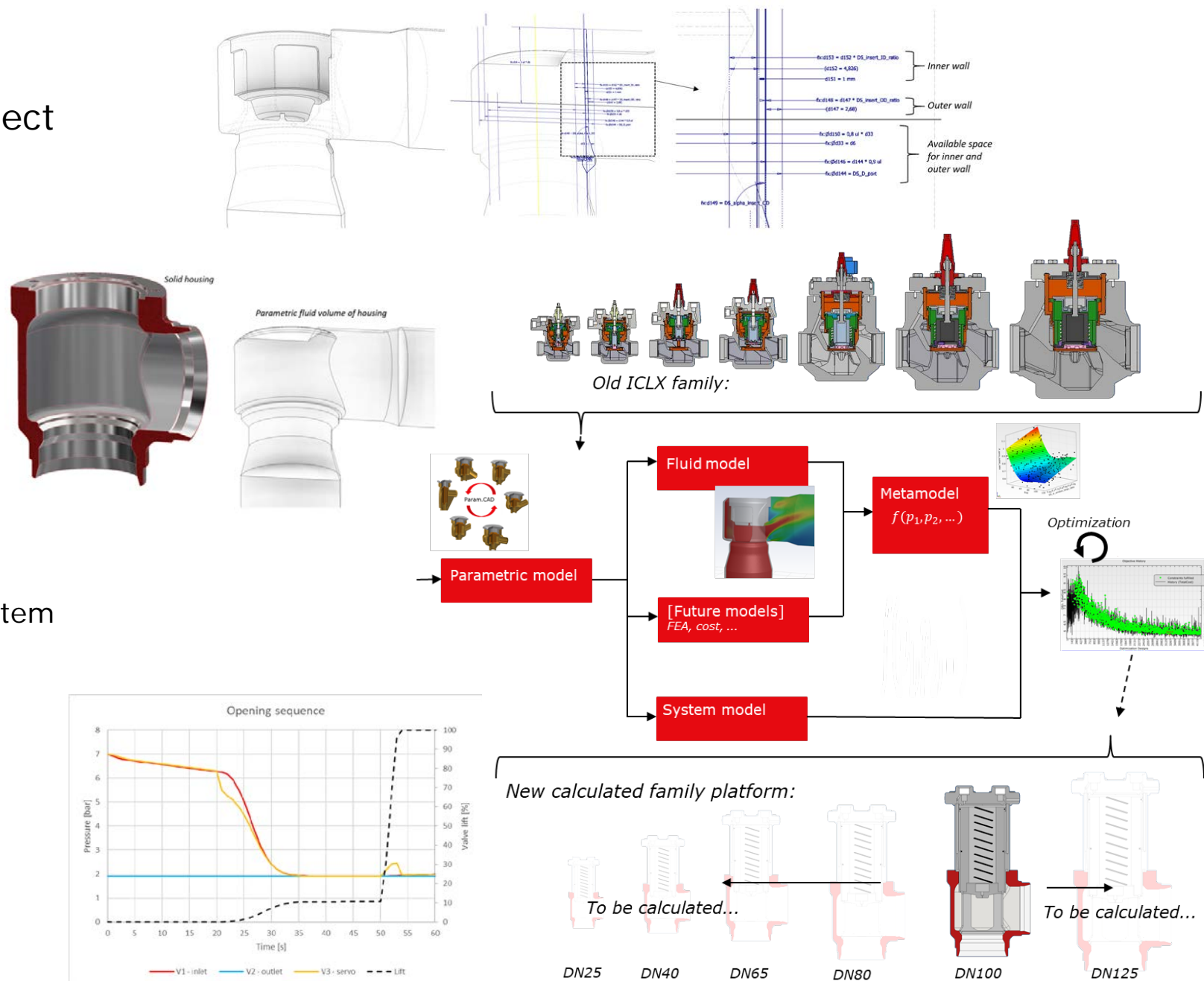
- Multidisciplinary optimization
 - Similar implementation as previous NRV case
 - FEA, CFD, cost:
 - Torque max load
 - Burst pressure
 - Flow capacity
 - Optimization objectives/constraints:
 - Minimize cost (or weight+height)
 - Maintain requirements (burst, capacity, torque)



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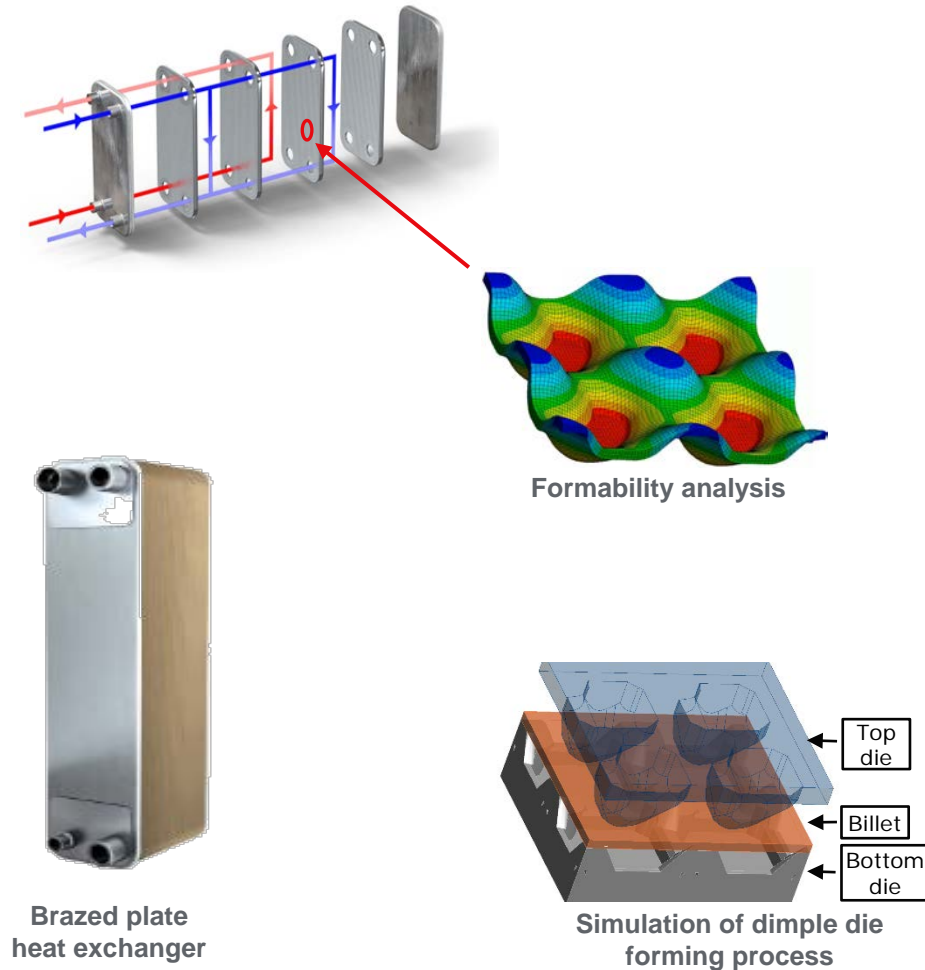
Danfoss RAC: Family automation project

- Project:
 - How to do MDO on a full valve family?
 - Parametric geometry for full family size
 - Include system model in loop
- Parametric CAD model
 - Based on housing platform
 - Parametrization: Relative to housing
- System model
 - Interaction with customer refrigeration system (hot gas equalization)
 - Linked to CFD MOP
 - Transient valve behaviour
 - Evaluation of several operating conditions
- MOP study:
 - MOP to fit entire family (lift and size)
 - Accurate MOP for each size (lift only)



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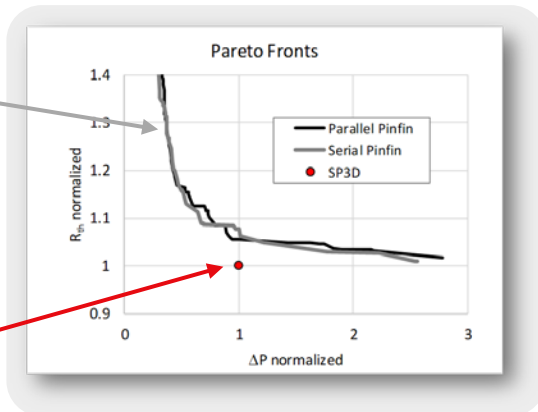
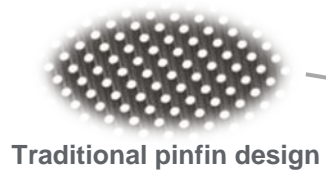
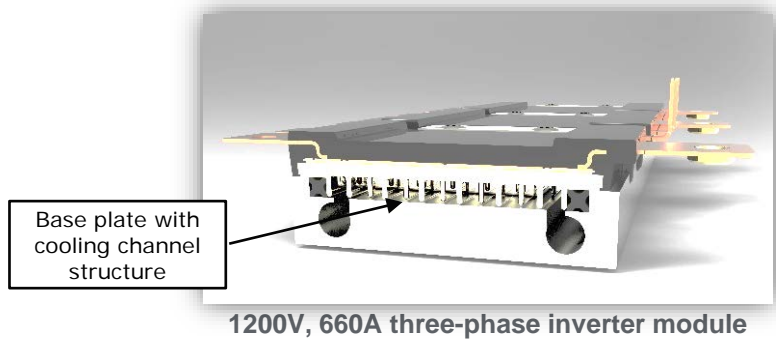
Danfoss HEX: Optimal dimple designs for new brazed plate heat exchanger



- **Optimal design:** best compromise between the enhancement of the total heat transfer and the reduction in the overall pressure drop.
- The relationship between thermal and fluid dynamic performance, manufacturing feasibility, and cost was explored upfront in concept development.
 - Simulations of the sheet metal forming process were included in the optimization workflow.
- Evaluated design robustness considering performance cost and formability.
- Multi-disciplinary team to cut through barriers to good design.

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Danfoss SiliconPower: Optimized cooling channel structure for high-power density inverter module



- **Optimal design:** best compromise between the reduction of thermal resistance (R_{th}) and the reduction in the overall pressure drop (Δp).
- Comparison of two topologies: exploration of the pinfin design space (Pareto solutions, see figure) vs. current SP3D design.
 - *There is no pinfin design that can outperform the current SP3D solution (for the given operating conditions).*
- Exploration of various SP3D design alternatives; predicted performance improvement if overcoming current manufacturing limitations.

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Backup slides

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Slide.name

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