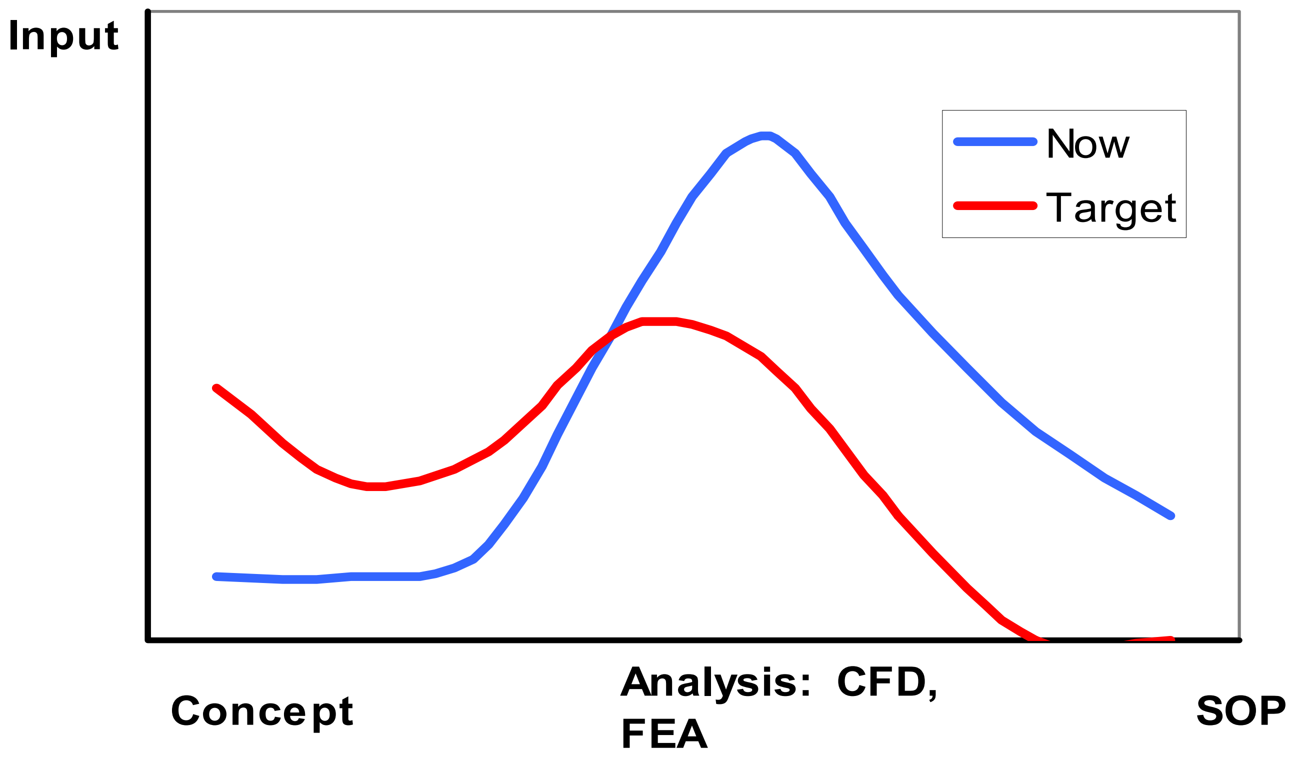
KULI-CFD

A New Approach

Combined Simulations

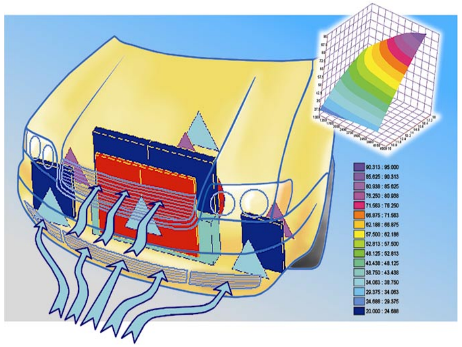
Rudolf Reitbauer

Usage of Simulation in Development Process



Questions ?

Network Method

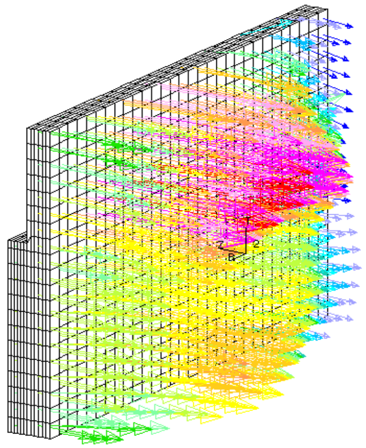


KULI

What is the influence of uneven air flow on cooling performance ?

What about heat transfer impact to the air flow analysis ?

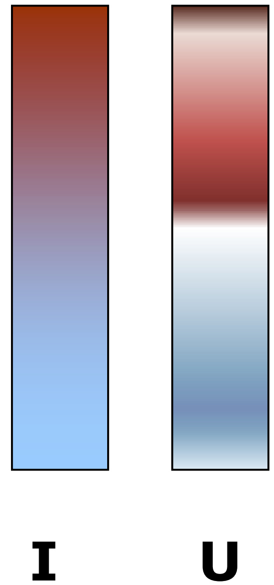
3D-CFD



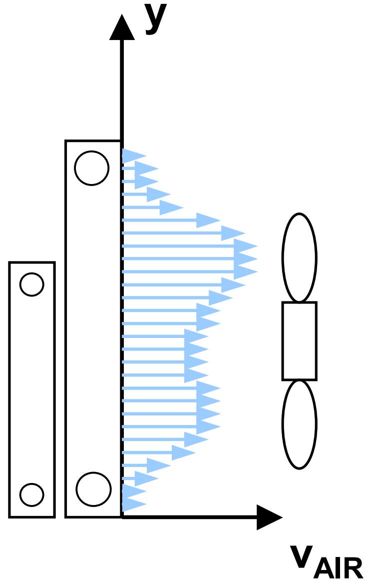
STAR CD
FLUENT
FIRE

Influences on cooling performance

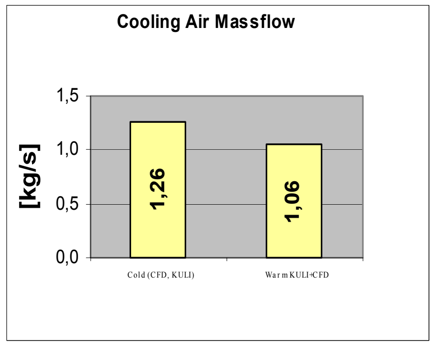
- **Different temperature gradients ETD**



- **Uneven Airflow**



- **Mass flow cold/warm**



Joint simulation - our strategy

- **CFD people are looking critical to 1-dimensional tools**
- **1D people point out the flexibility and speed**

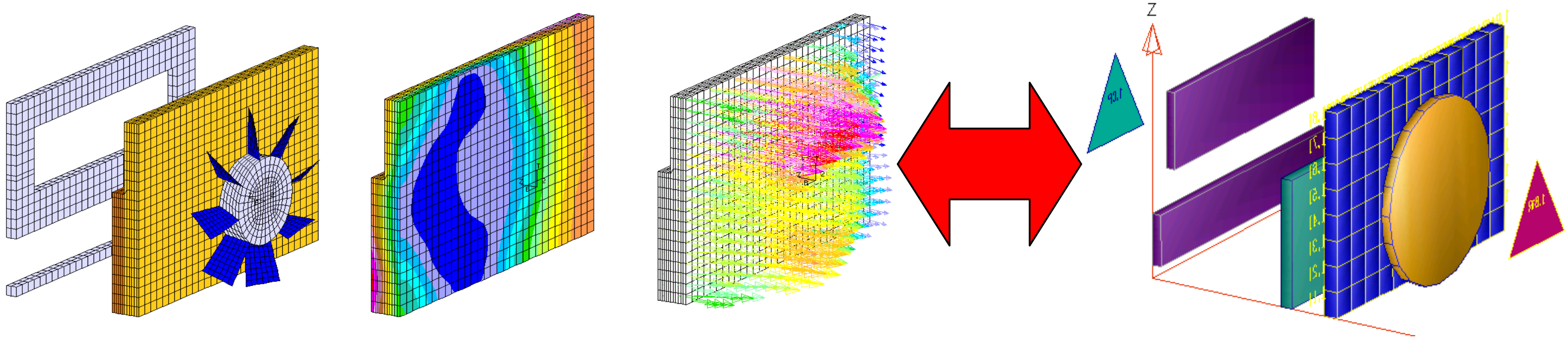
- **KULI and CFD tools play together**
- **Use both benefits to get more efficiency in development**
- **Check plausibility (i.e. CFD massflow)**

- **Direct interface and data exchange**

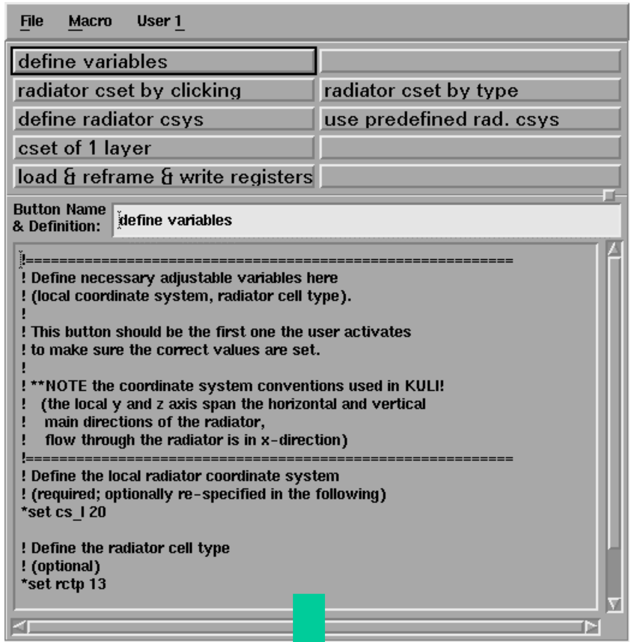
- **Vision of YIN and YANG**
- **Next step is “said and done”**

KULI ADVANCED

- **Interface KULI-CFD Data: FLUENT, STAR CD, FIRE**



Data Exchange



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291348	-4.73332214	377.200012	3.02046227
291354	-9.46665955	368.000000	3.09280634
291360	-4.73332214	363.400024	3.21569037
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291372	-4.73332214	349.600006	3.46484470
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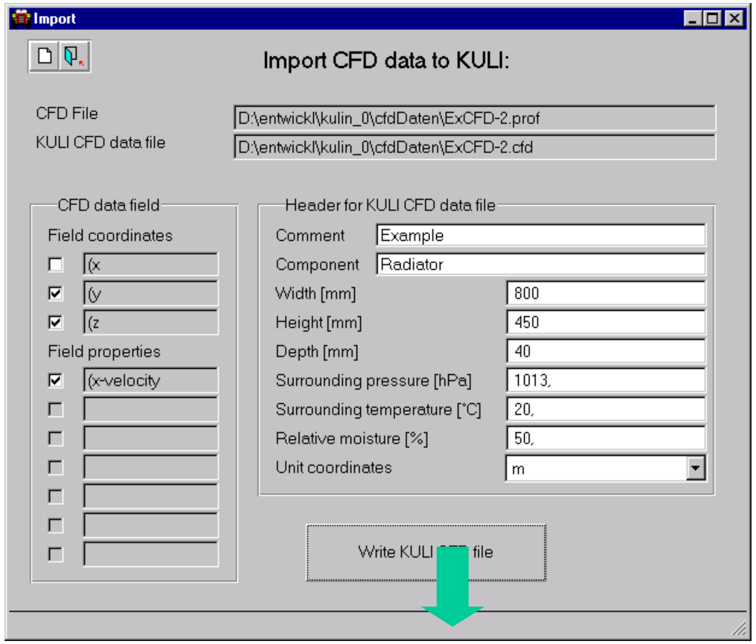


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COMMENT_DEPTH                 = 20
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SURROUNDING_TEMPERATURE       = 20
RELATIVE_MOISTURE             = 50
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SURFIT_SMOOTHING_FKT          = 0
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0.0196    0.2192    2.8977
0.0391    0.2192    2.9648
..............................
0.0750    -0.0196   3.3092
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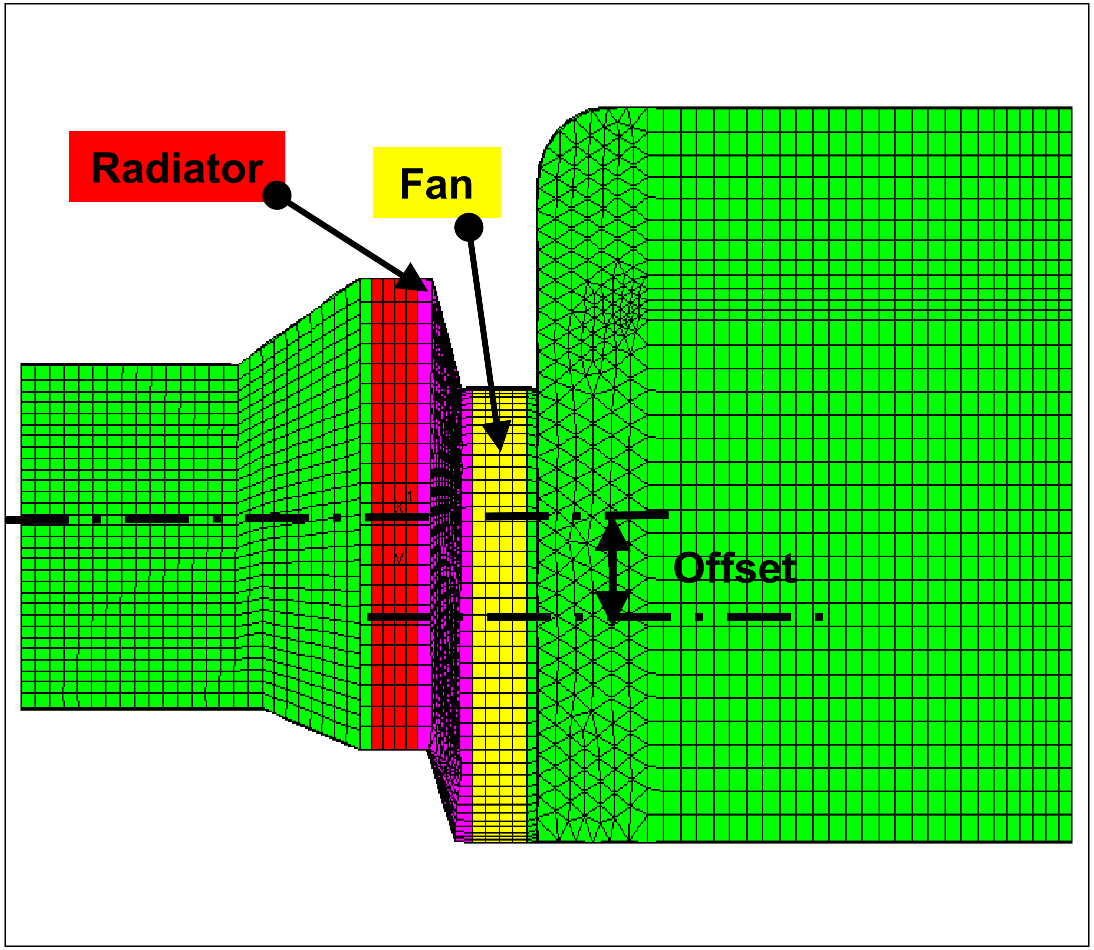
Farm Tractor Installation



Problem

- Offset of Axes
- Flow Deflection

1. Step

3D-CFD Model inc. fan, porosity

↓

Cold Flow Velocity Distribution

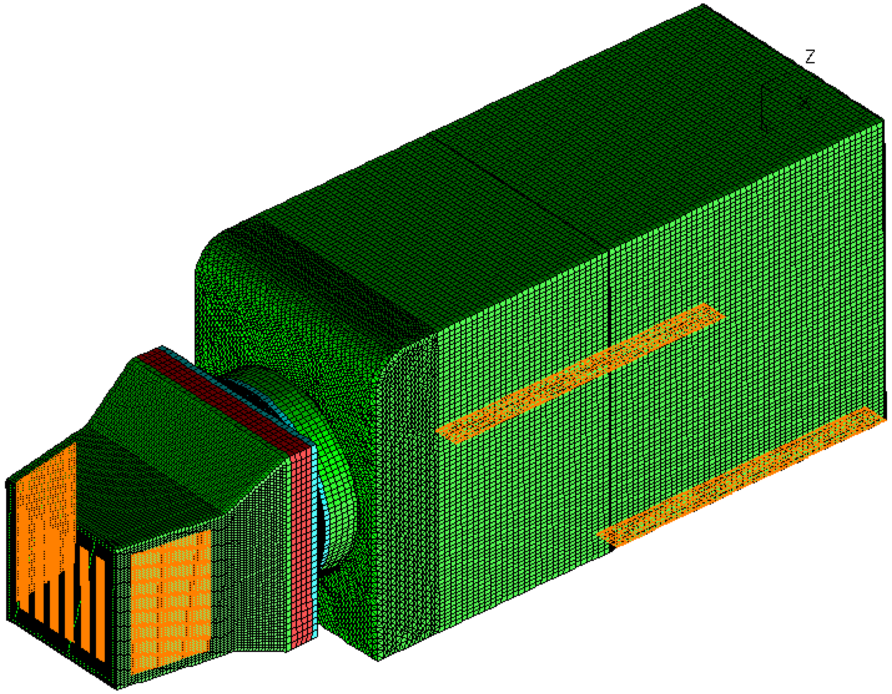
2. Step

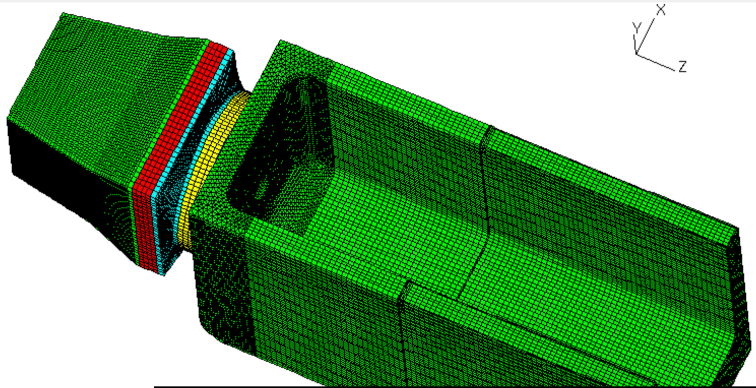
KULI Model inc. heat transfer

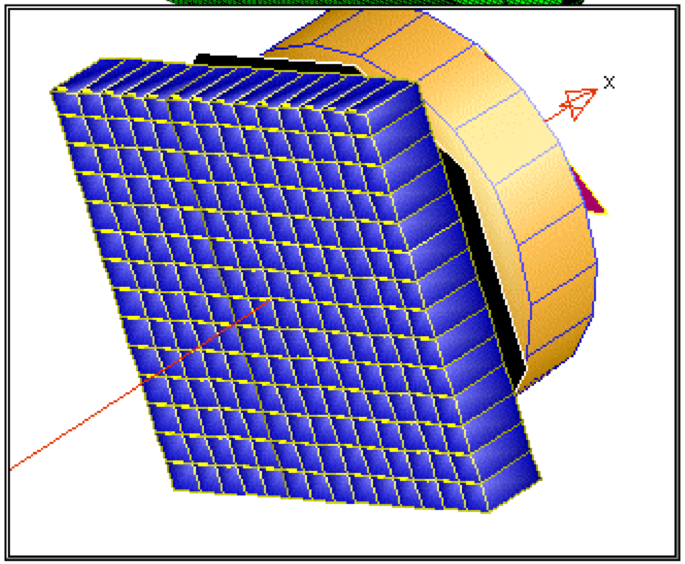
↓

Radiator Temperature Distribution
Hot Air Properties
Influence on Cooling Performance

Analysis Models



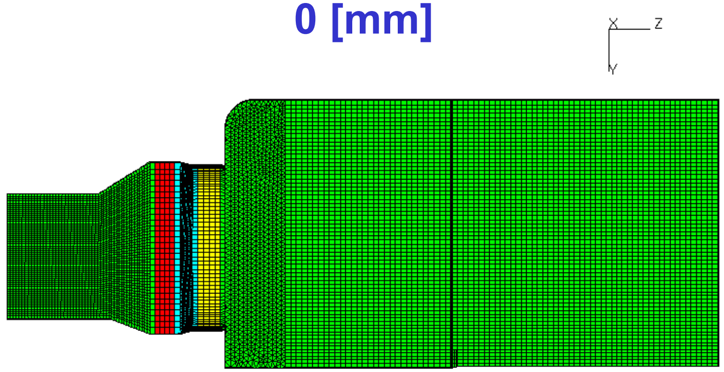


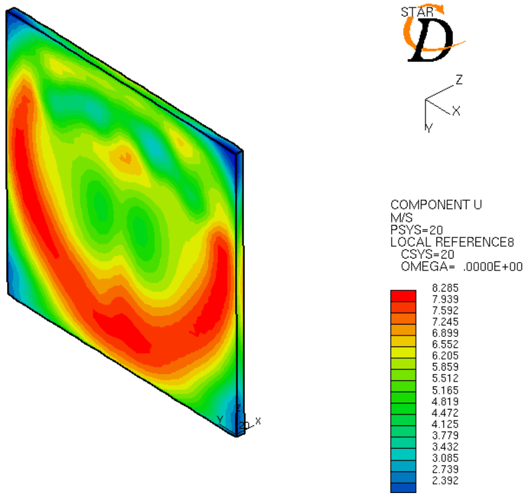


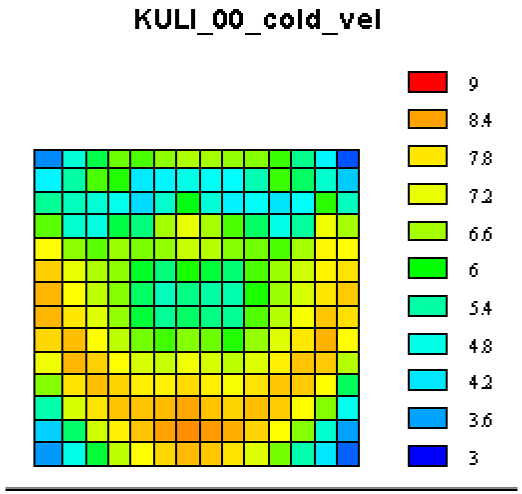
STAR-CD Mesh **KULI Model**

Axes Offset Variants

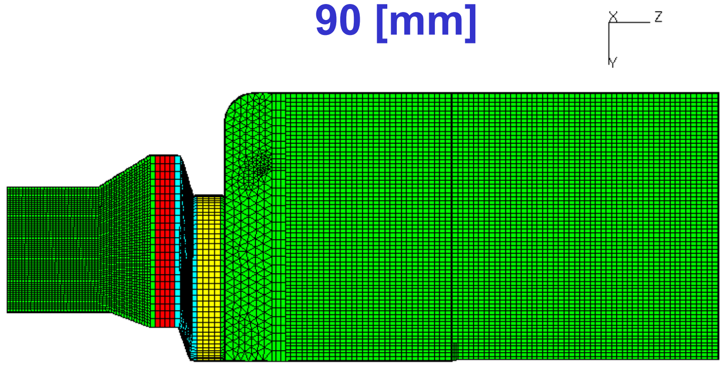
0 [mm]

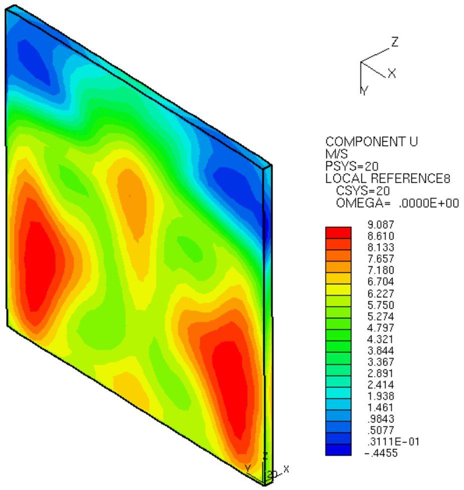


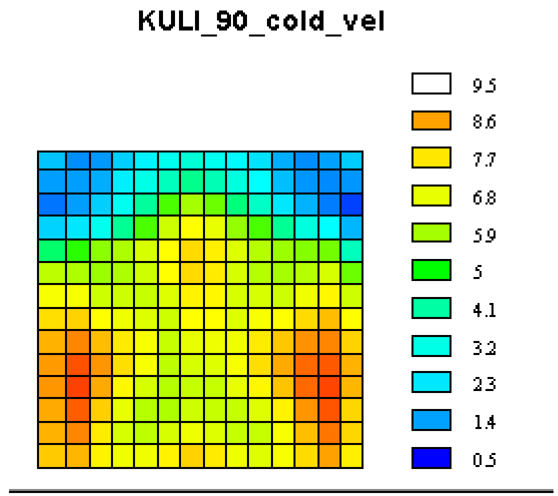




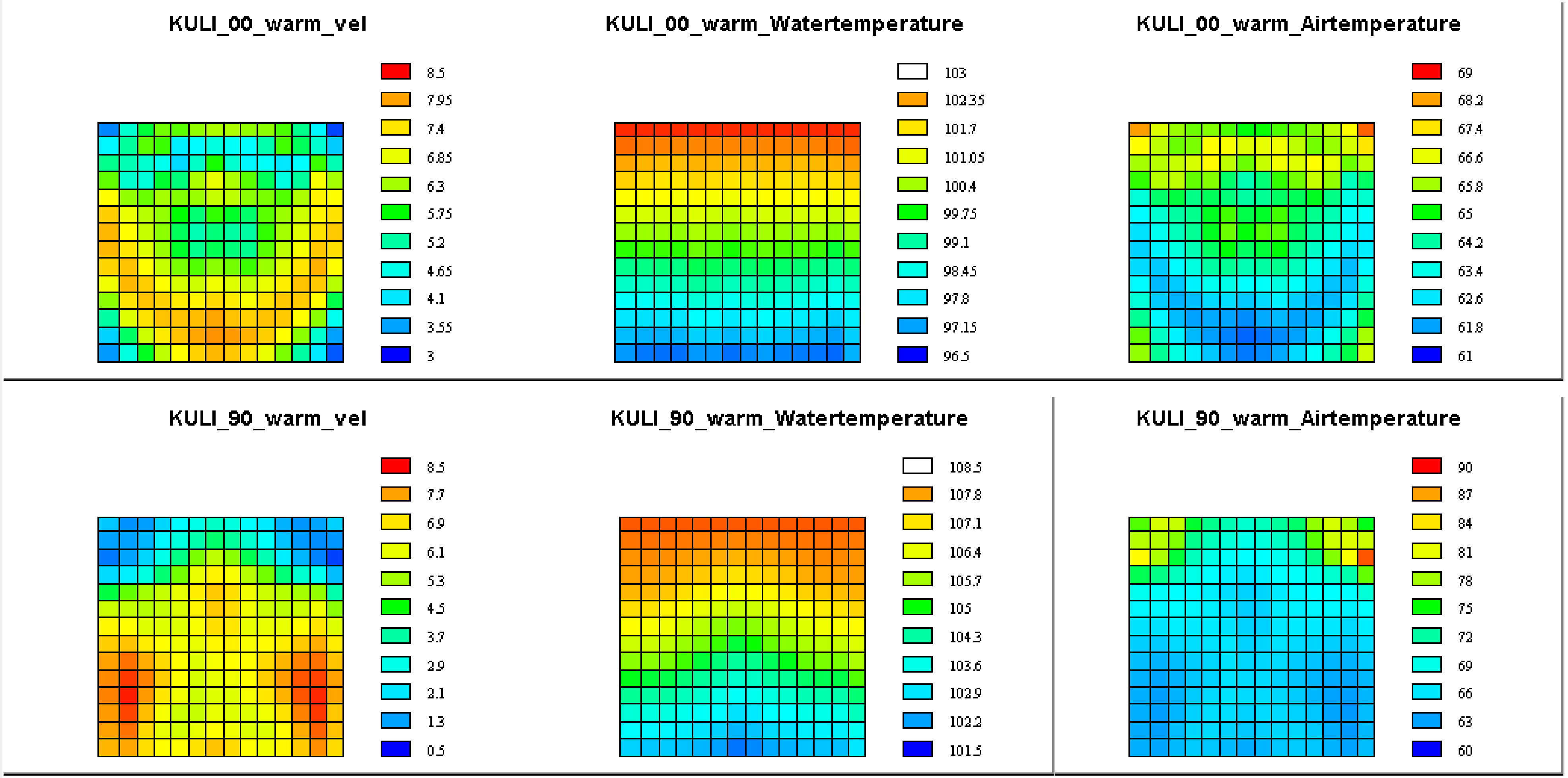
90 [mm]





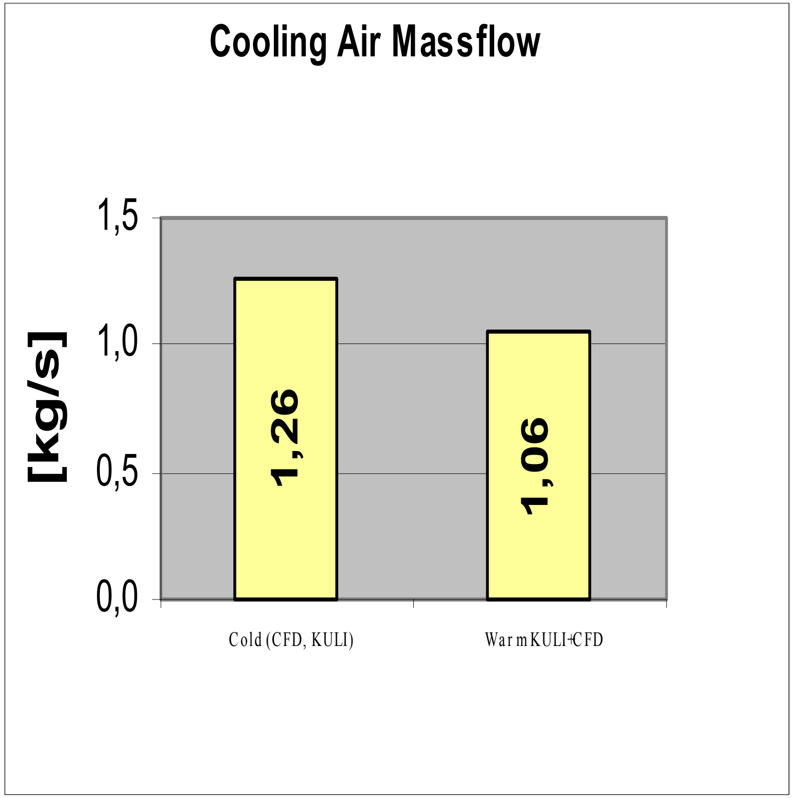


Simulation Results incl. Heat Transfer

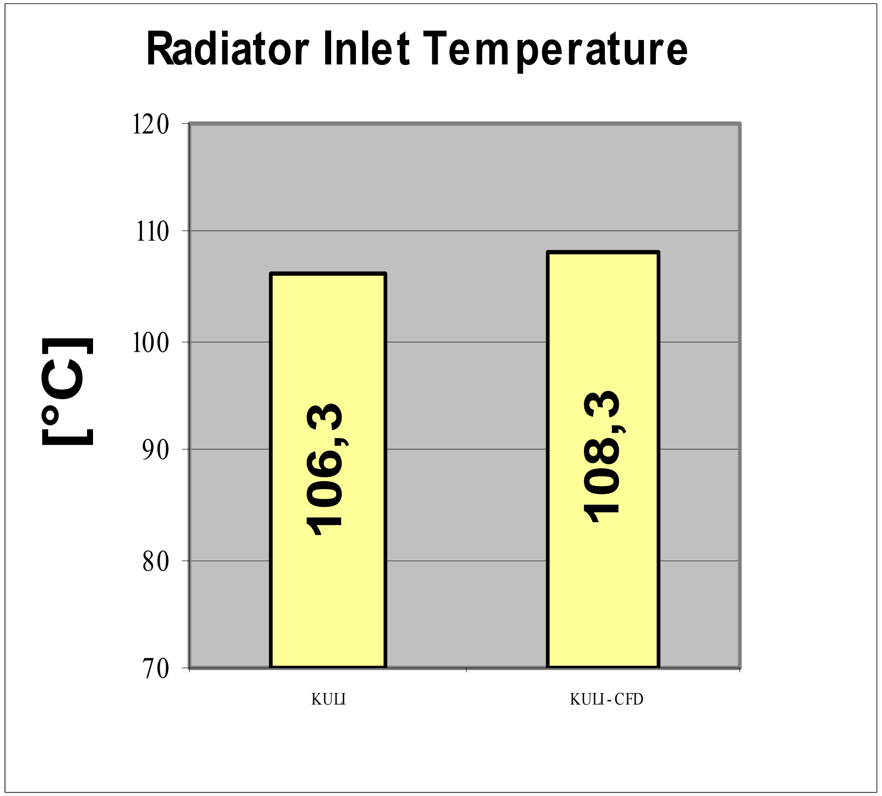


Influence on Cooling System Performance

Mass flow: cold-warm



Temperature: 1D - 1D/3D model



Purpose and Targets

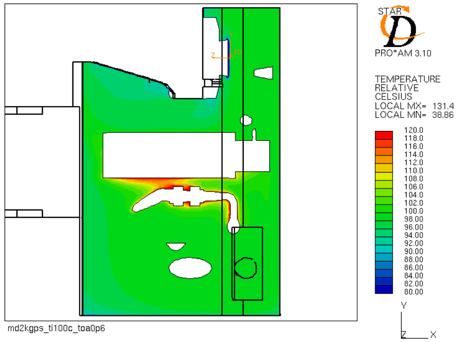
Prototype fully capsulated

High performance 380 PS

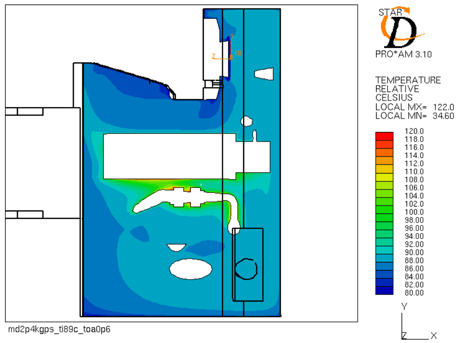
- Increase A.C.T.
- O.T.D. Intercooler decrease
- Reduce Engine Room Temperature hot spots (-15K)

Engine Room Temperature Level

Actual Configuration 1.92 kg/s   100 °C air after fan



Target Configuration 2.35 kg/s   89 °C air after fan



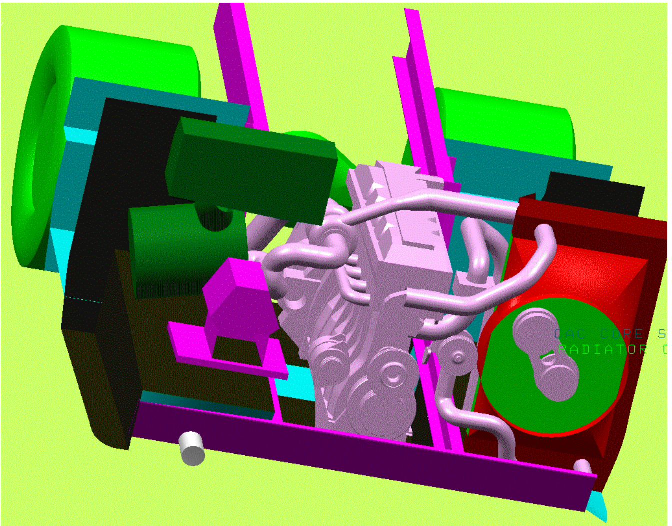
Engine Room Model Flow Patterns

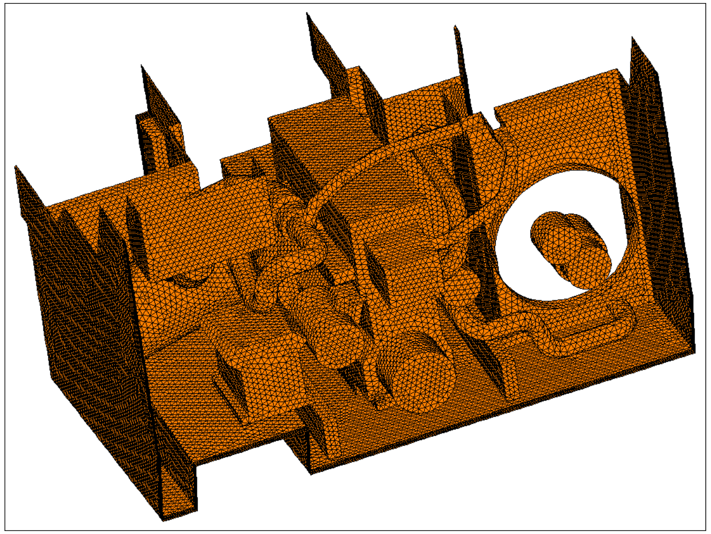
CFD Investigations

STAR CD at ECS

577.000 Cells

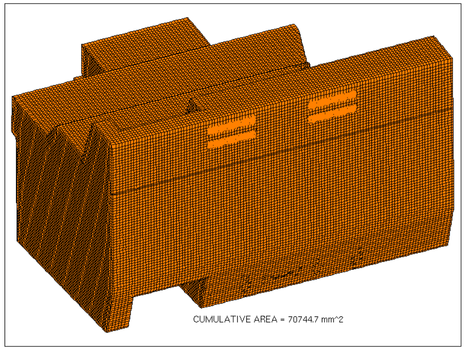
17 Variations

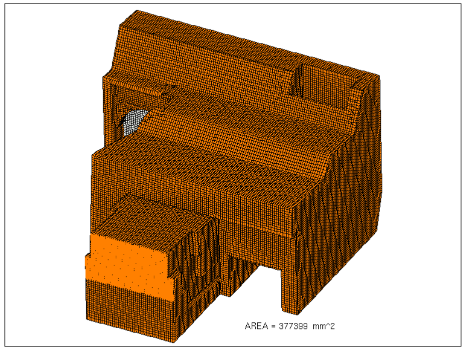


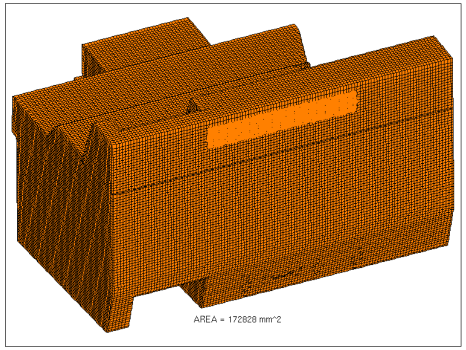


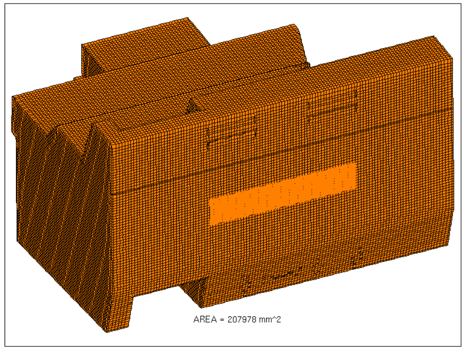
Engine Room

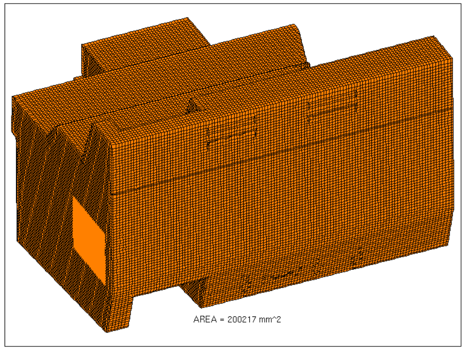
Variation Boundary Conditions

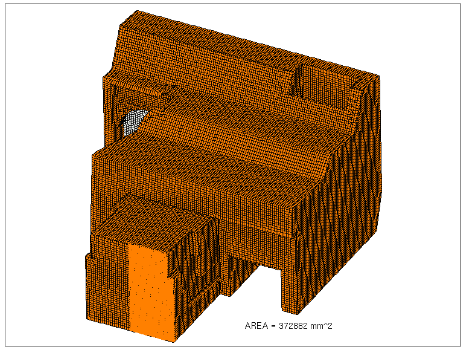






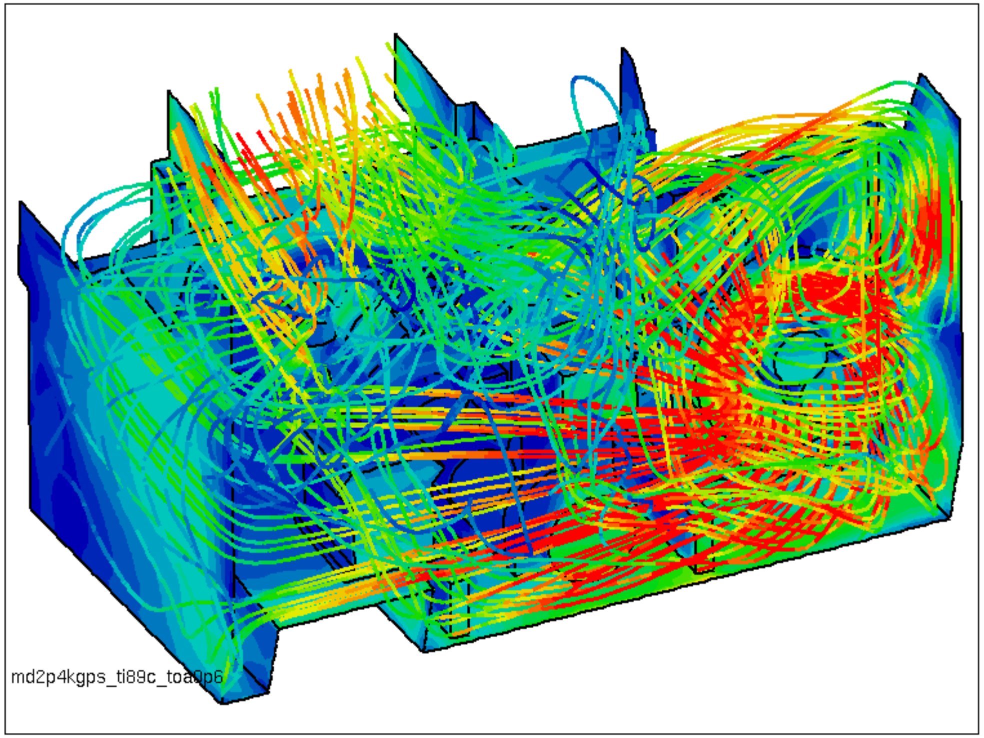


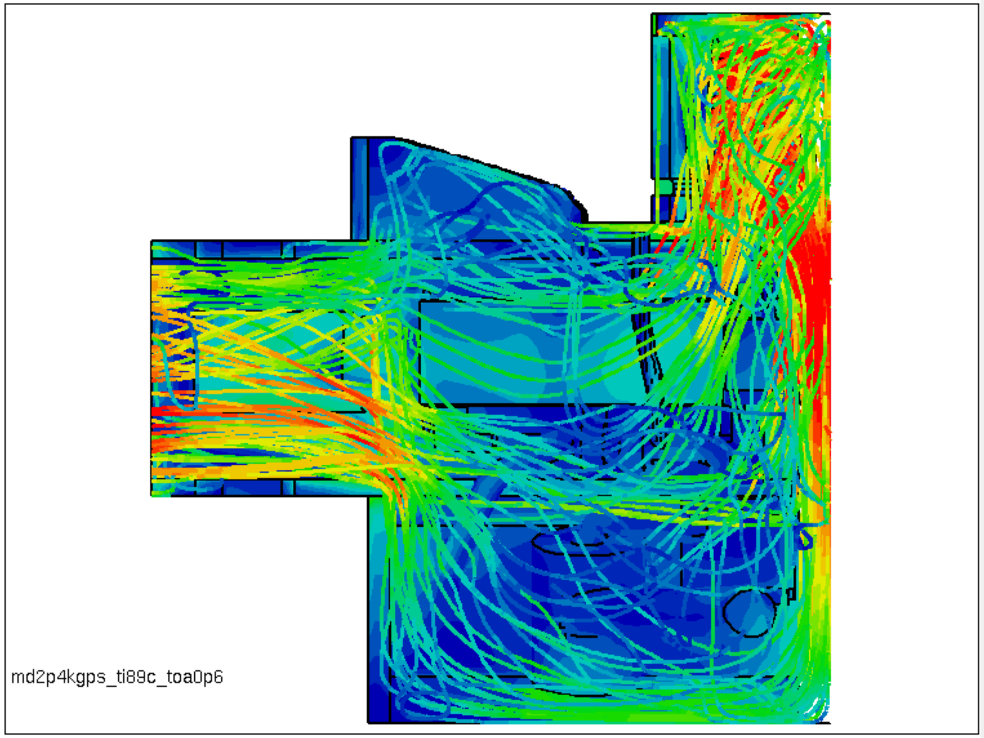




Engine Room Velocity Flow Patterns

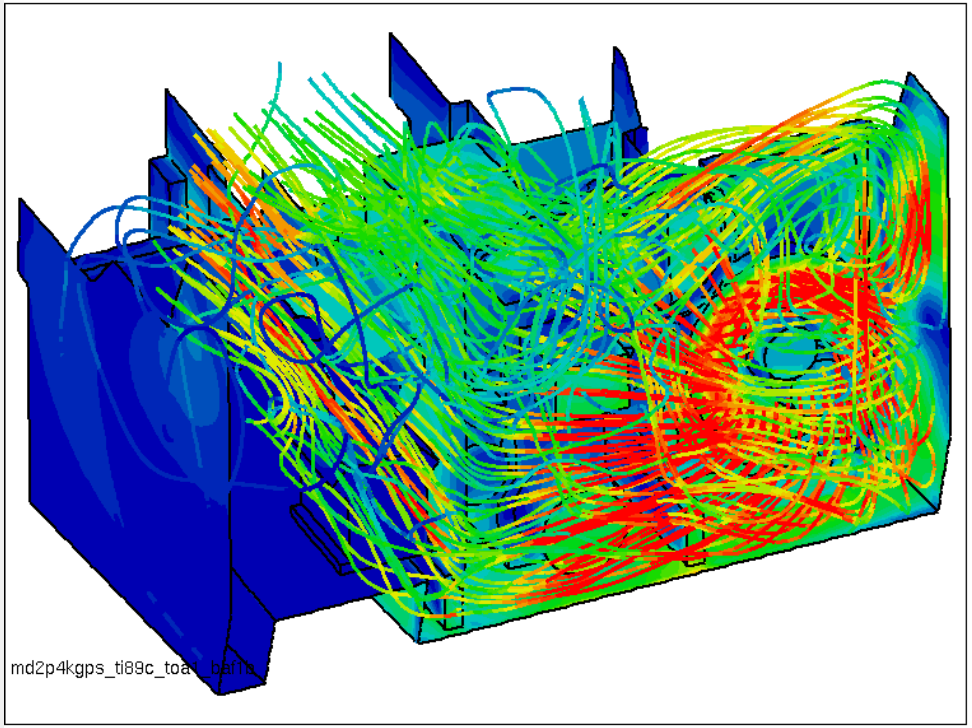
Actual Configuration

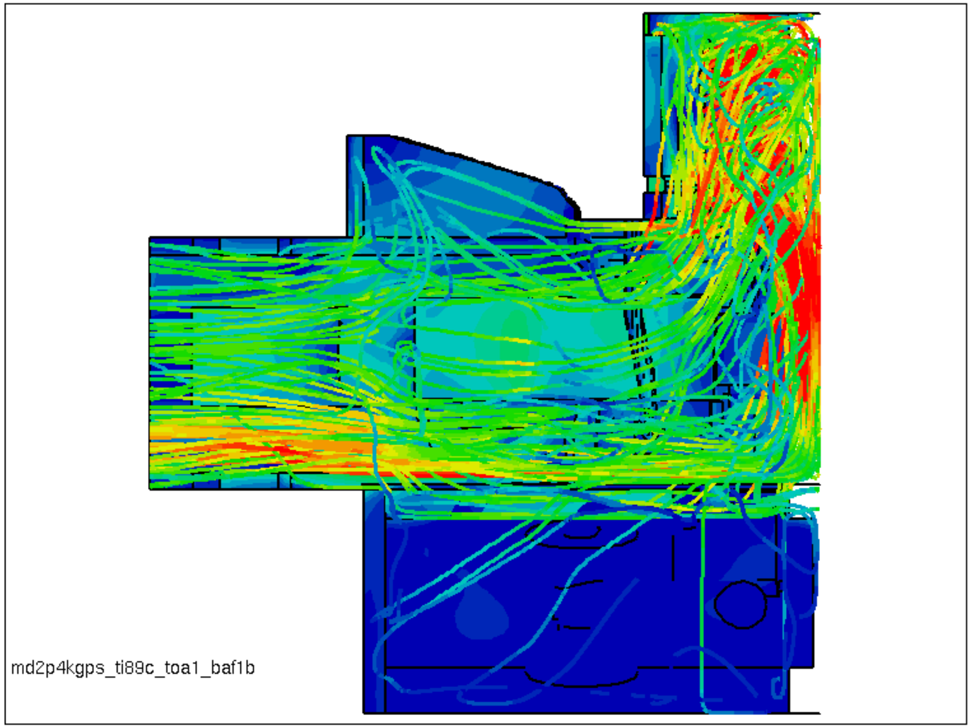




Engine Room Velocity Flow Patterns

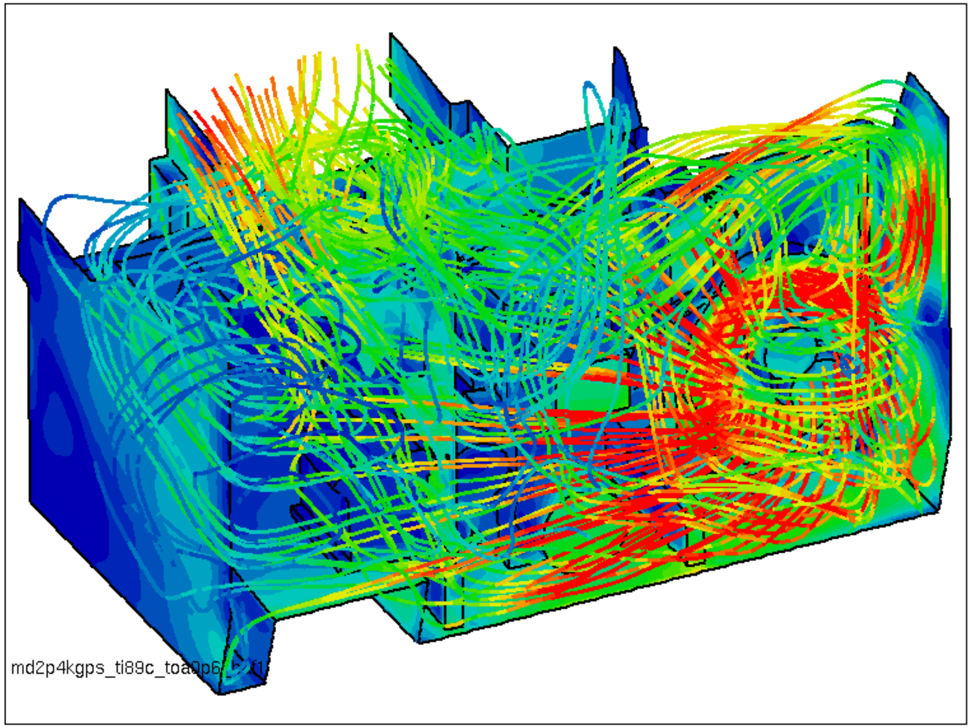
Closed Baffle

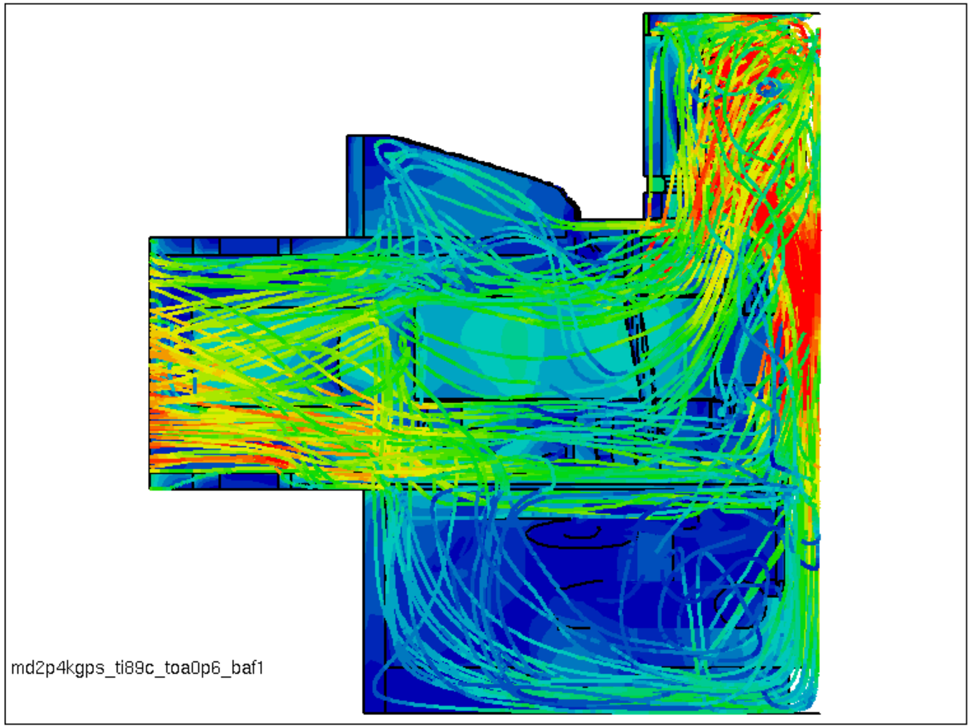




Engine Room Velocity Flow Patterns

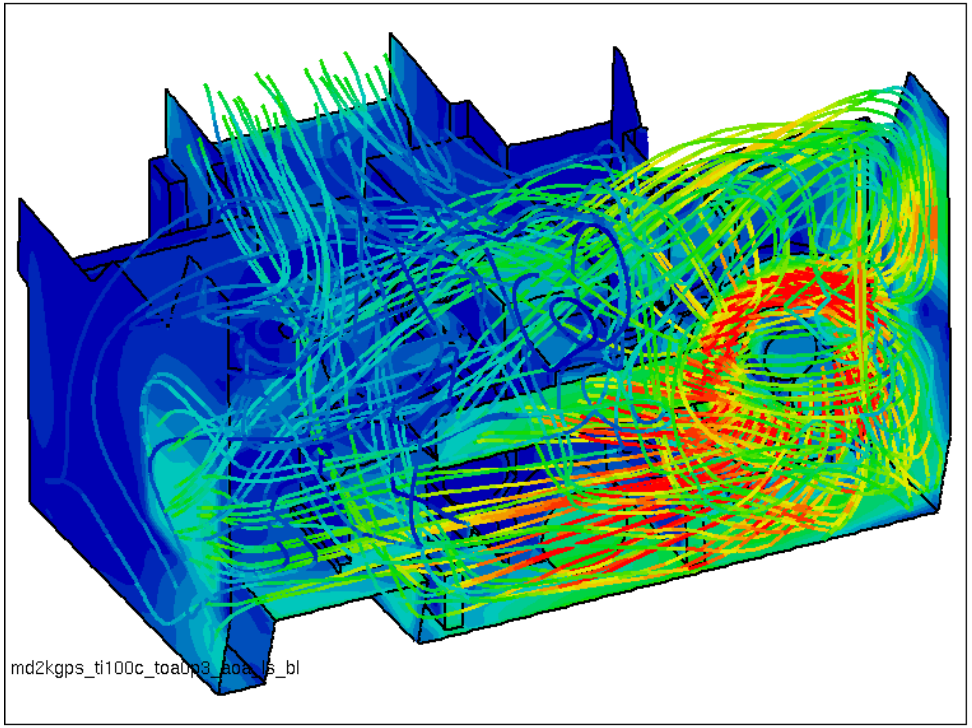
Open Baffle

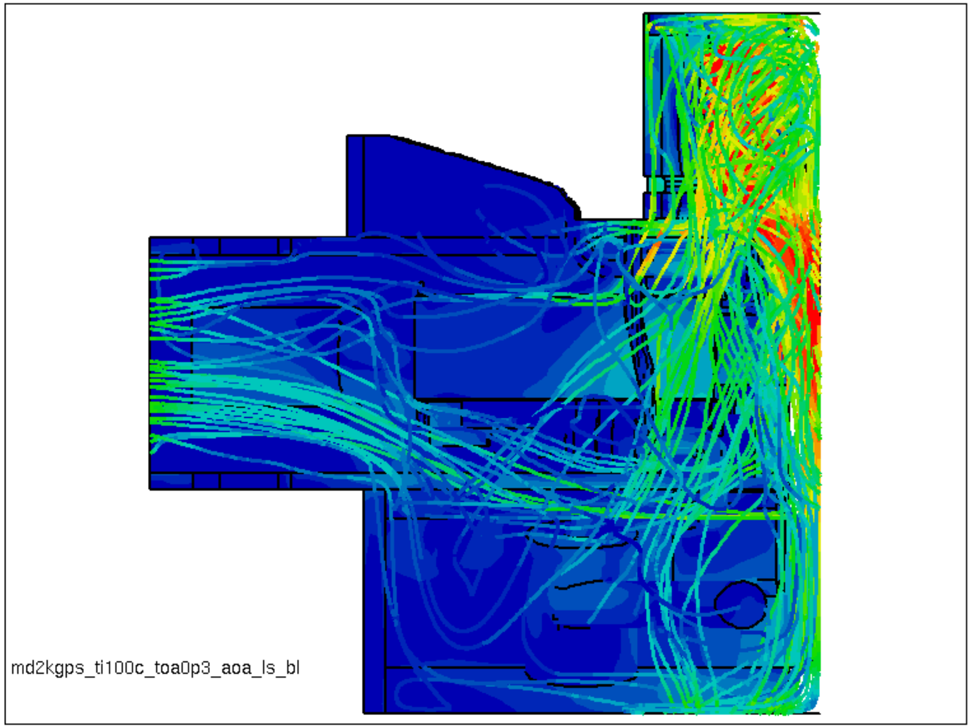




Engine Room Velocity Flow Patterns

Lamp Area Open, Side Open





Proposals

- **HOW to insert baffle for guiding air flow (maintenance attention)**

- **WHERE to open back or side (noise attention)**