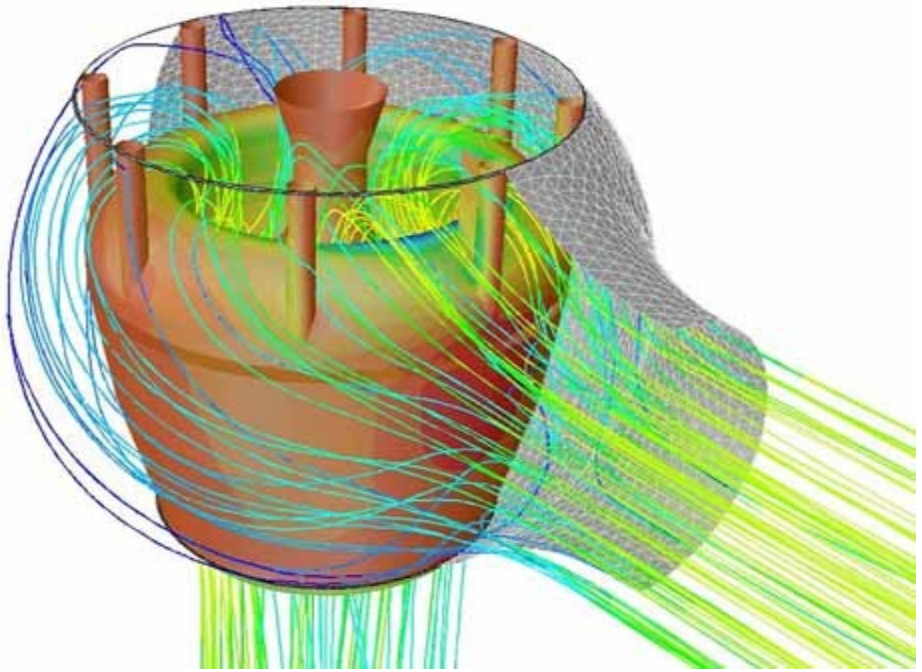
TEFUGEN

Technologies for Future Generation

Applications of Computational Fluid Dynamics (CFD) in Power Plants



By

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Manager, Department of CFD.

Outline

Computational Fluid Dynamics (CFD)

Introduction

CFD In Power Plant

1: Ducts
2: Boiler
3: Electrostatic Precipitator (ESP)
4: Air Preheater (APH)

* Demo CFD Analysis

Introduction

Computational Fluid Dynamics

- Computer based numerical modeling technique
- Solves flow physics & associated phenomenon
- Cost effective design optimization

Why CFD ? Benefits ?…. !

@ Reduce the Pressure Drop (D_P)

@ Uniform Velocity Distribution along the ducts

@ Flow Visualization

@ Avoid Erosion

@ Avoid soot formation

@ Save Fan Load & Power

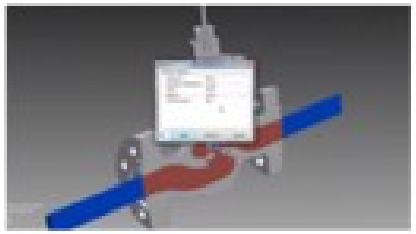
@ Low Maintenance cost

@ Improvement in Boiler efficiency

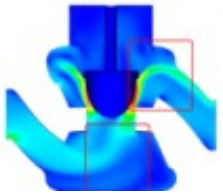
CFD - Work Flow Chart

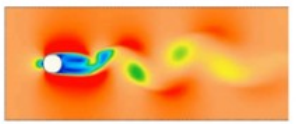
1 Geometry Preparation

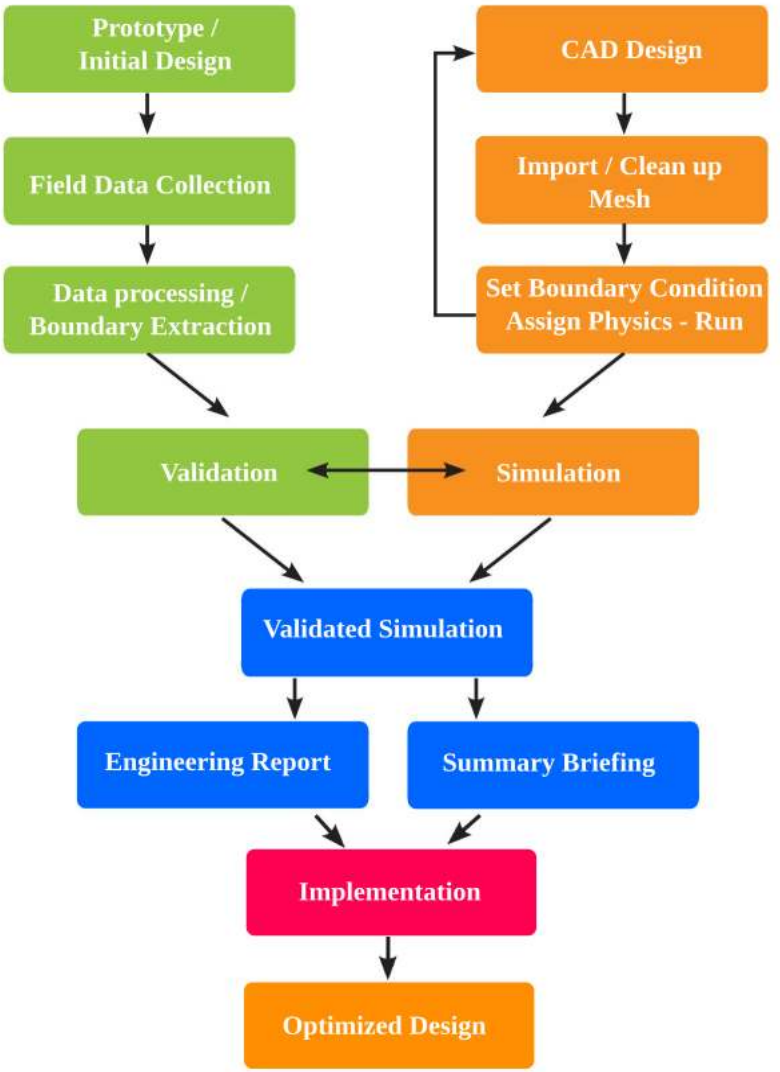
2 Simulation / Run



3 Post – Processing / Results







Post Testing & Manufacturing

- Post testing- to check the working condition of ducts after implementing modifications, obtained through CFD.
- Manufacturing, Supply and Erection of the modifications, as per the CFD analysis.

Flue Gas Duct

Economizer to APH Inlet duct system of a 210 MW palnt

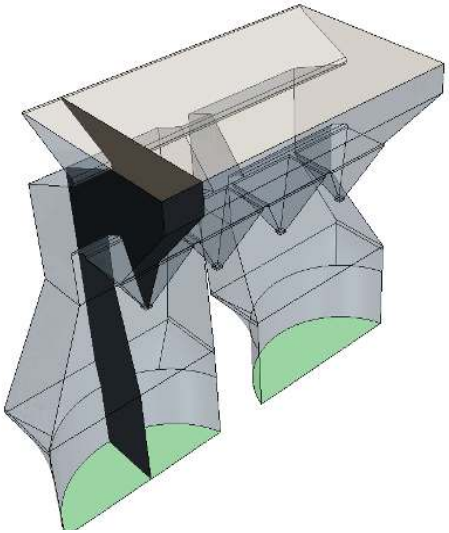
Flow distribution optimization Analysis & Post processing

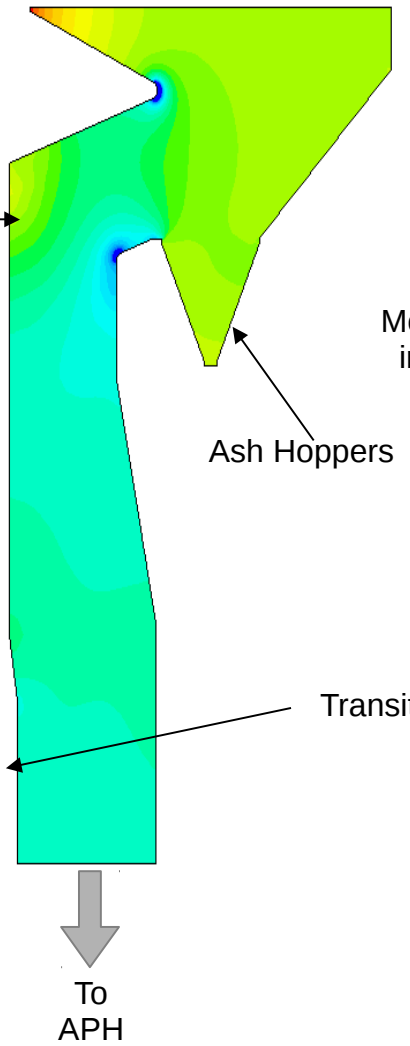
ECONOMIZER OUTLET

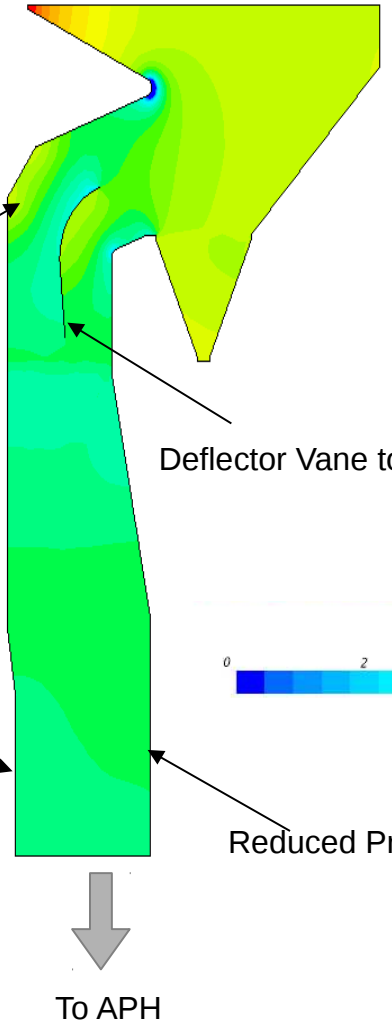
ECONOMIZER OUTLET

BASE DESIGN

OPTIMIZED DESIGN



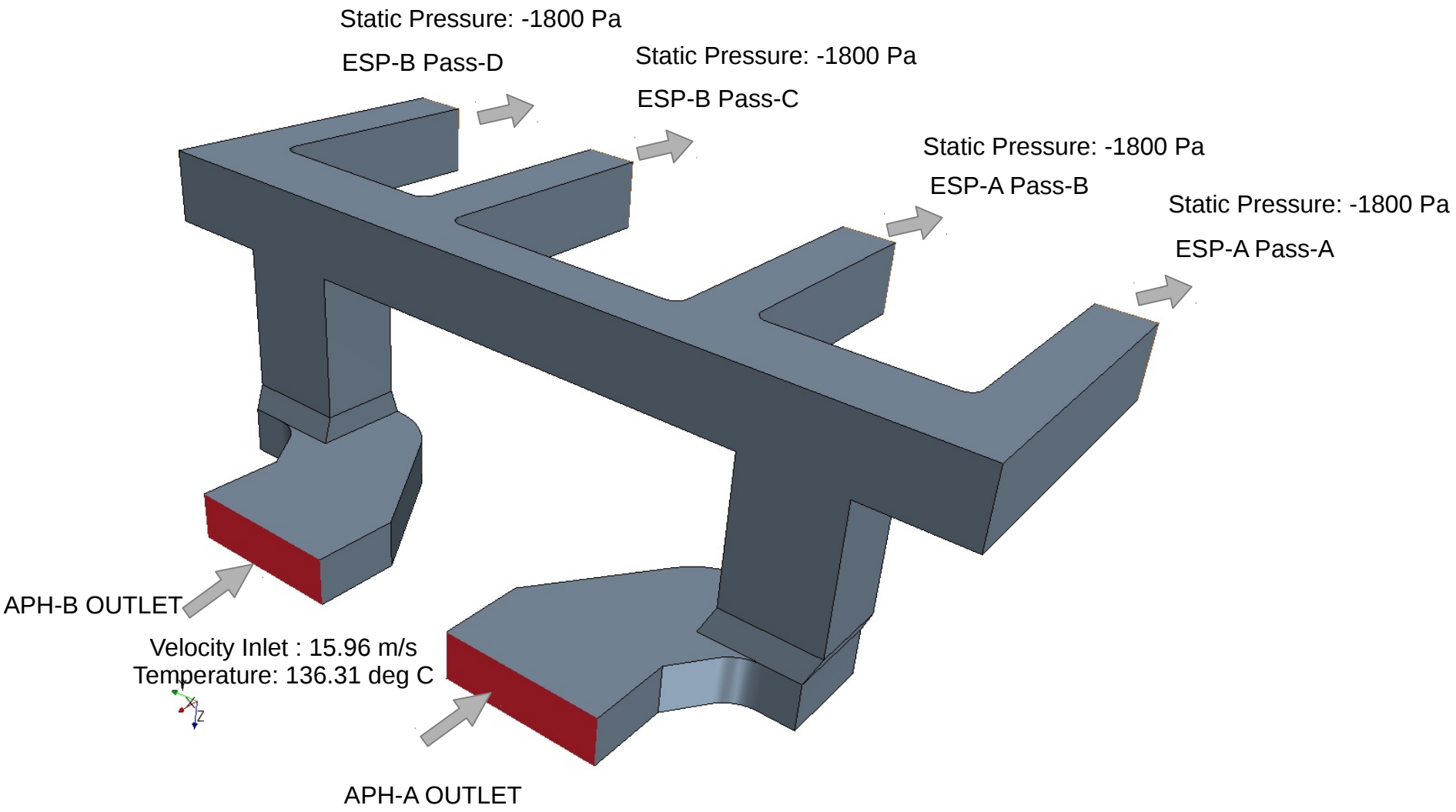




Flue Gas Duct

APH Outlet to ESP Inlet duct system of a 300 MW plant

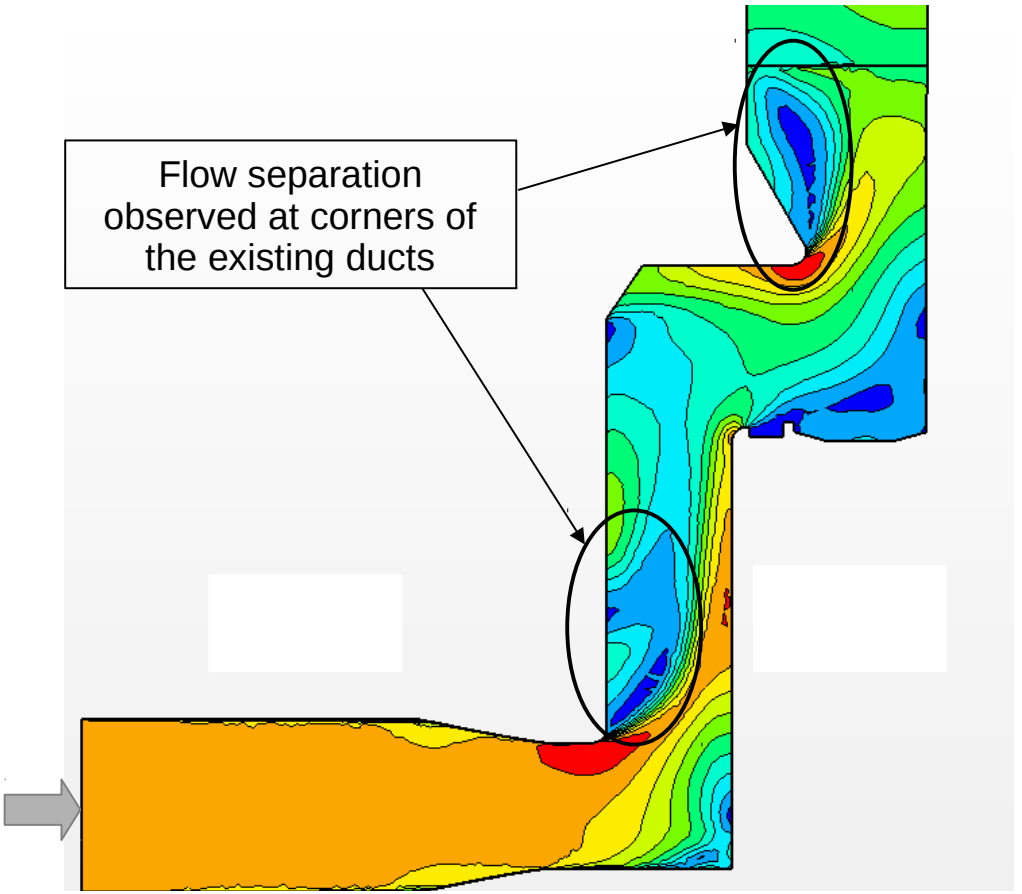
CAD Model Creation



Secondary Air Ducts

Duct system of a typical 500 MW plant

Flow distribution optimization Analysis & Post processing

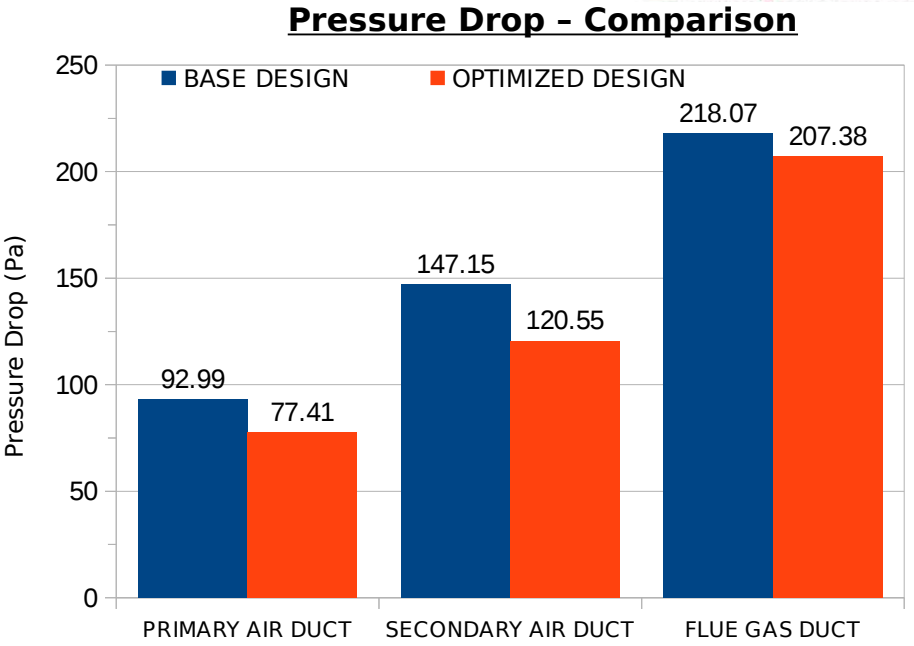


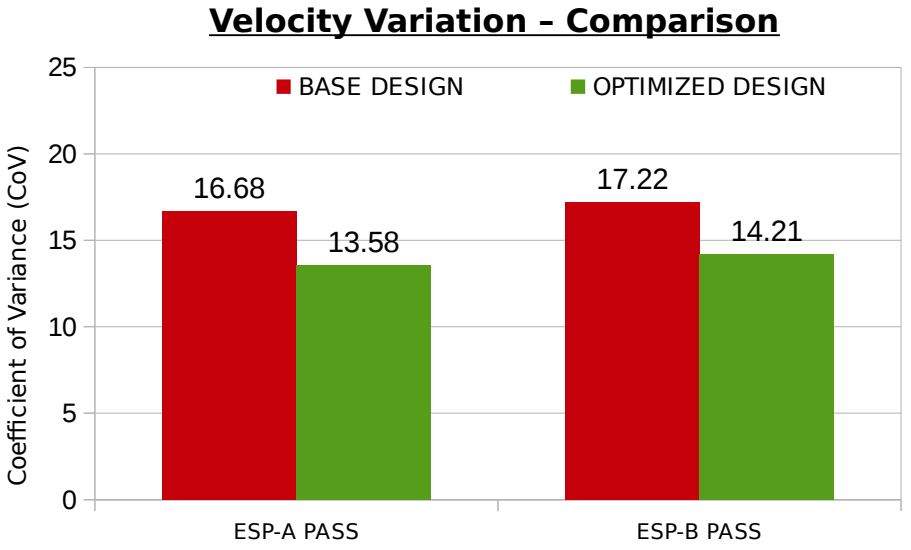
Pressure

- Pressure drop savings
- Wall pressure prediction
- Detailed study of Pressure distribution & Pressure values

Flow

- Better flow distribution
- Detailed study of-
  - Velocity
  - Density
  - Temperature
- Reduce erosion
- Reduction in ID & FD fan current consumption





Boiler First And Second Pass Flow Optimization (150 MW Plant)

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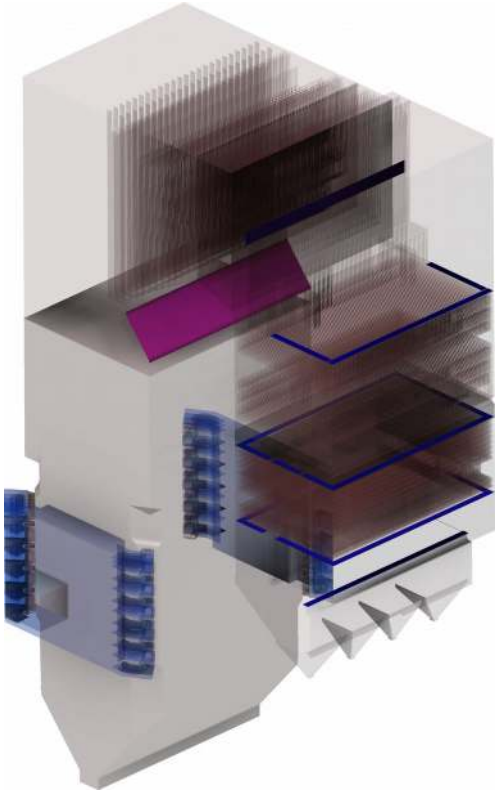

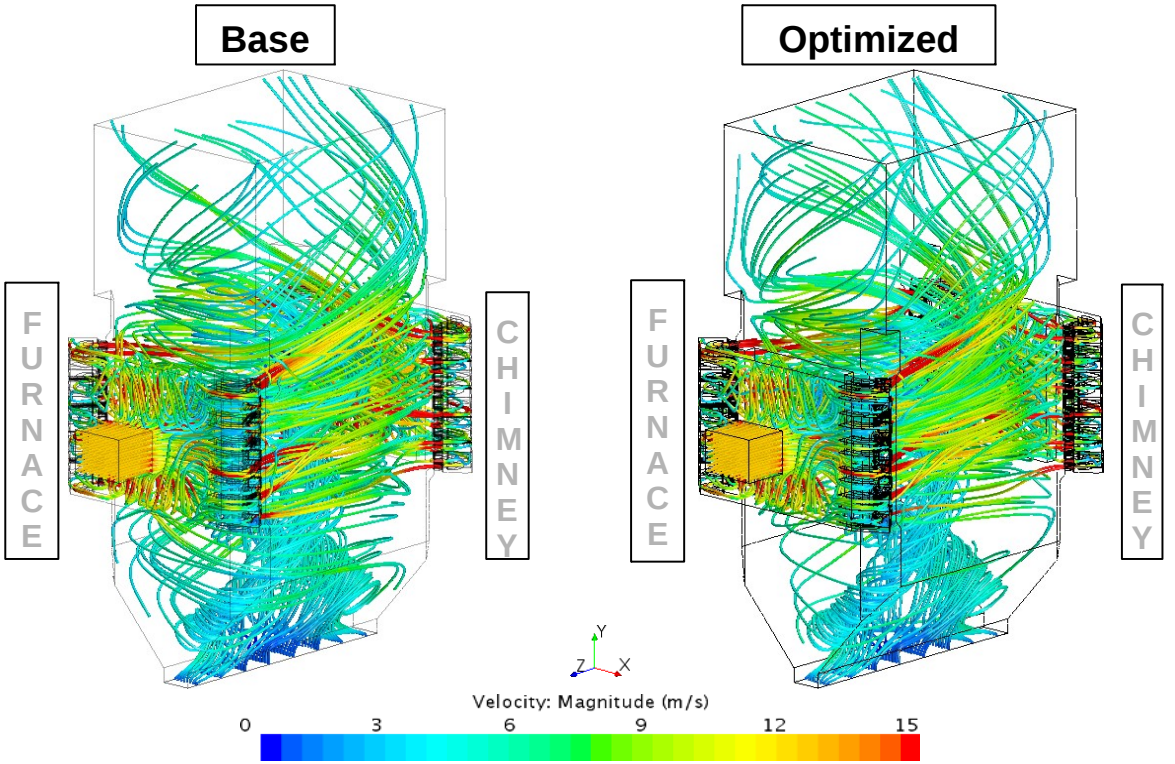

CAVT- Discussion

- CAVT using CFD analysis helps in reducing the time required to identify suitable boiler tube erosion control / prevention mechanism to be implemented within boiler pass.

- A detailed assessment of the flow pattern and high velocity zones within various sections of the boiler could be obtained.

- Choice of actual model approach instead of porous media approach in CFD analysis indicates, that better understanding of flow pattern could be obtained near boiler tubes and helps in obtaining a better erosion control mechanism.

ESP SYSTEM

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- Design optimization
- Reduce erosion
- Enhance flow characteristics
- Improve collecting efficiency
- Better thermal & pressure distribution
- Reduce particulate emission

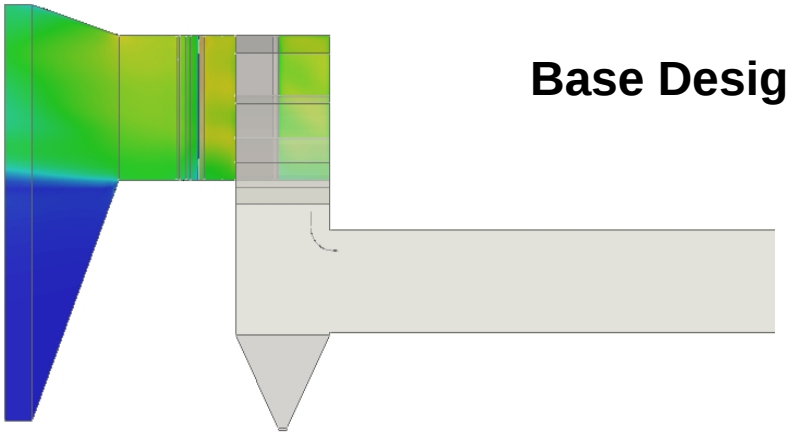
HEAVY erosion due to ash deposition in the outlet funnel without screen

ESP SYSTEM

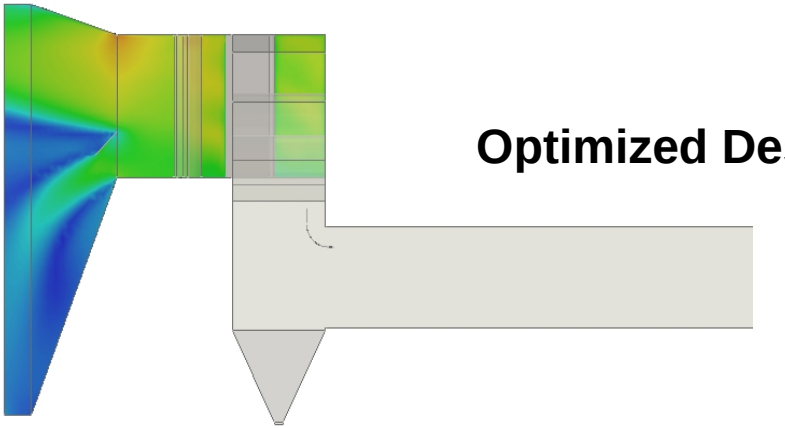
ESP System- Flow analysis

- Field flow uniformity
- Field pressure distribution
- Increase collecting efficiency
- Optimized designs to,
  - Improve performance
  - Reduce pollution
  - Lesser downtime

Gas Distribution Analysis Within ESP

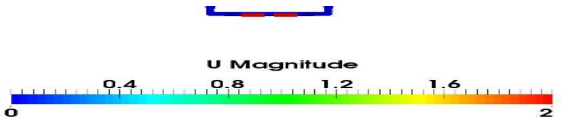


Base Design

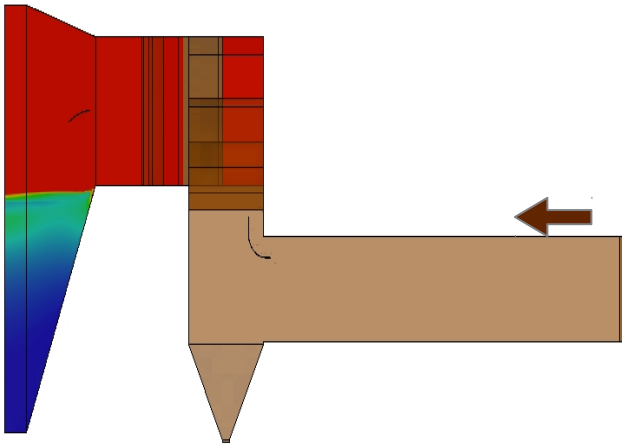


Optimized Design

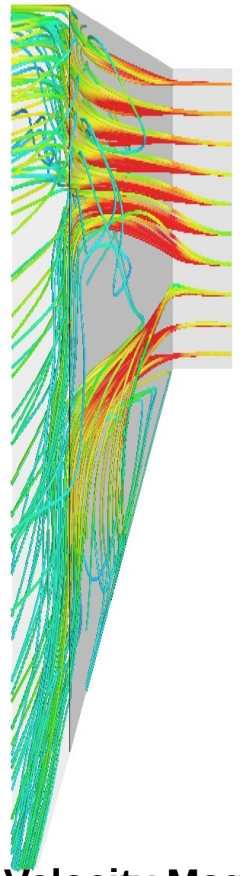
Velocity Magnitude (m/s)

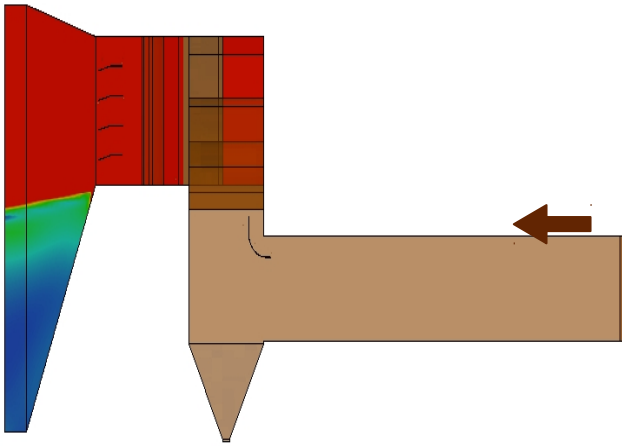


ESP SYSTEM



Optimization Run-1

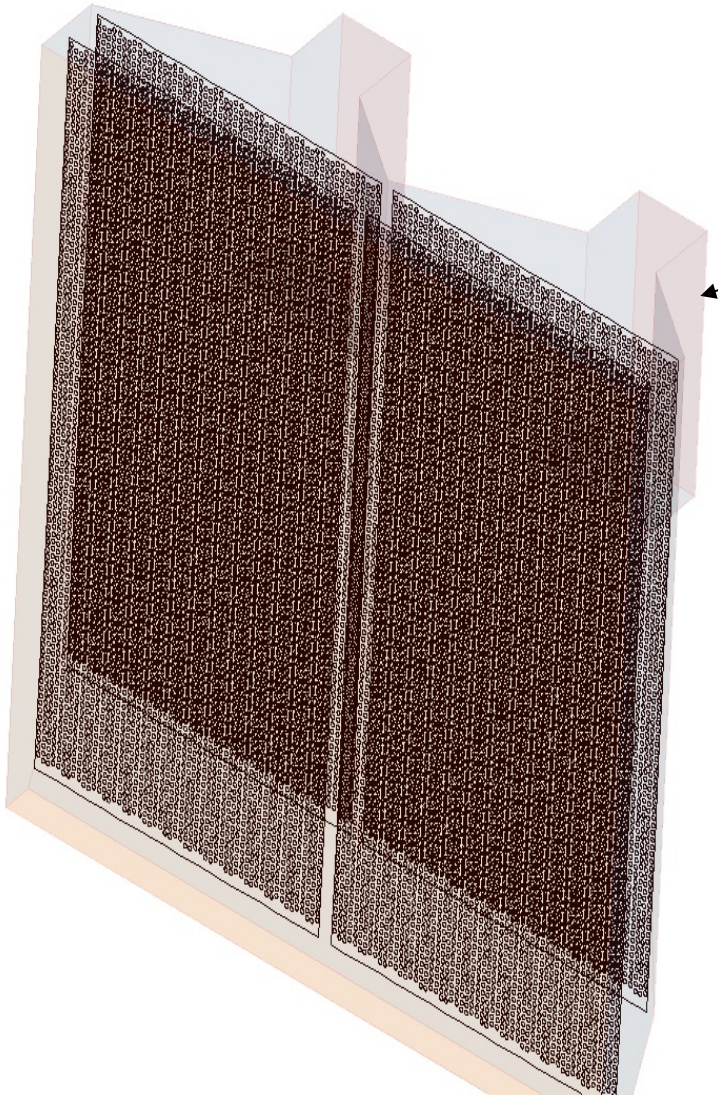




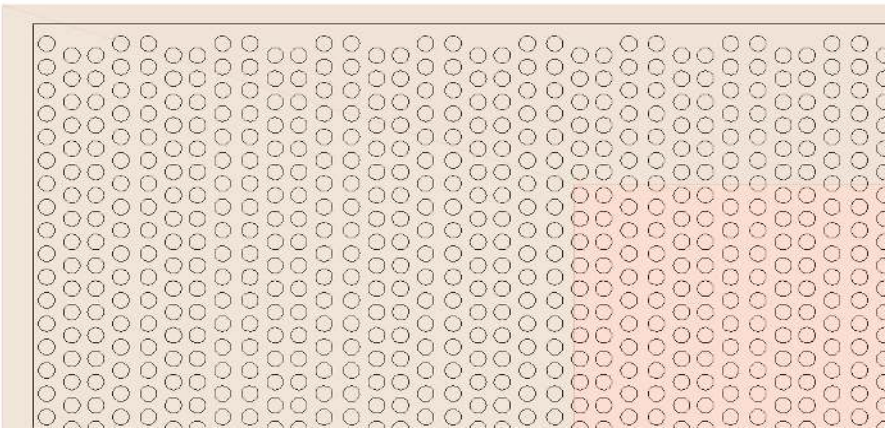
Optimization Run-2

Geometry - ESP Inlet Funnel

Stage 3: Introduction of GD Screens & Deflector Plates



GD Screen



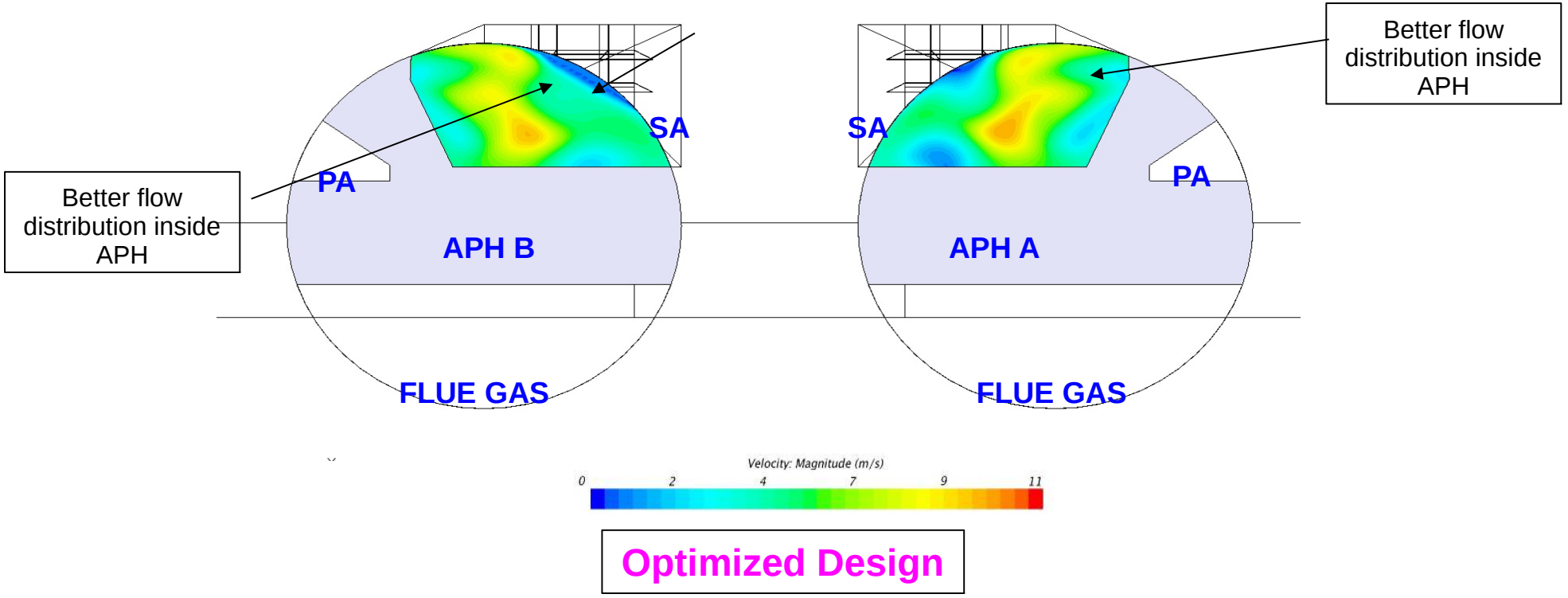
Result Comparison

Trials	Velocity Average At First Field Entry (m/s)	Velocity Average At First Field Entry (m/s)	CoV
1	0.377	0.982	28.00
2	0.366	1.015	32.00
3	0.357	0.986	25.00

Representative values (May vary from case to case)

Air Preheater

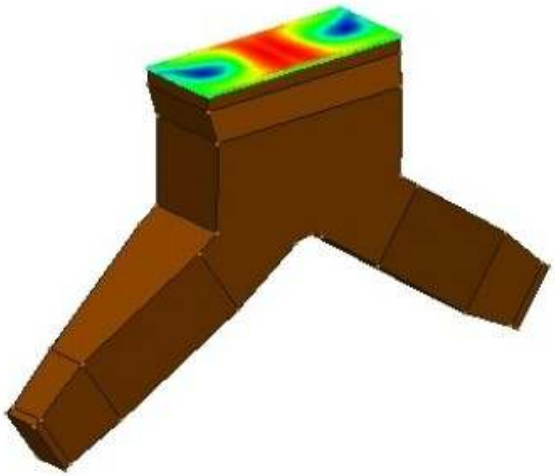
Inter Connecting Duct Flow Distribution

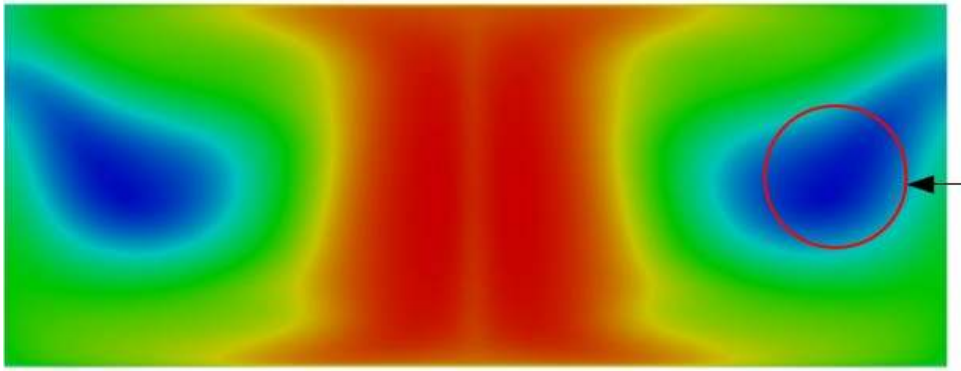


Optimized Design

Air Preheater

Inter Connecting Duct Flow Distribution





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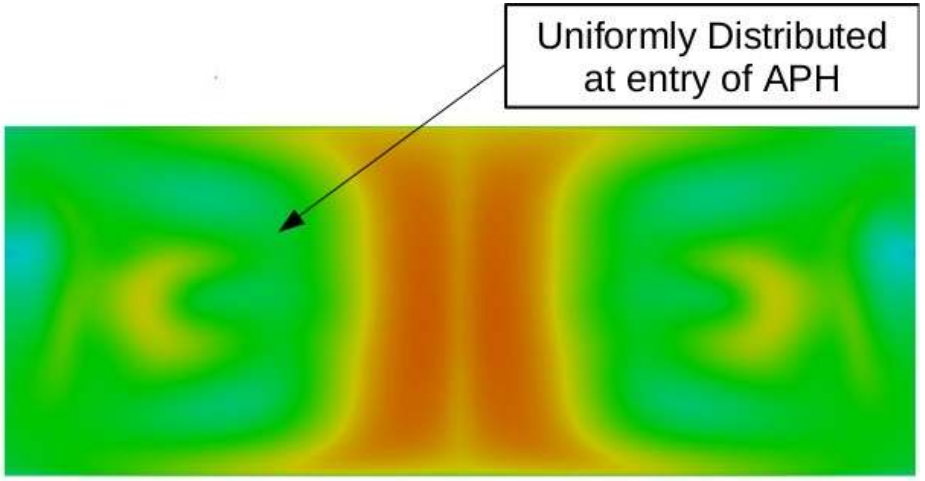
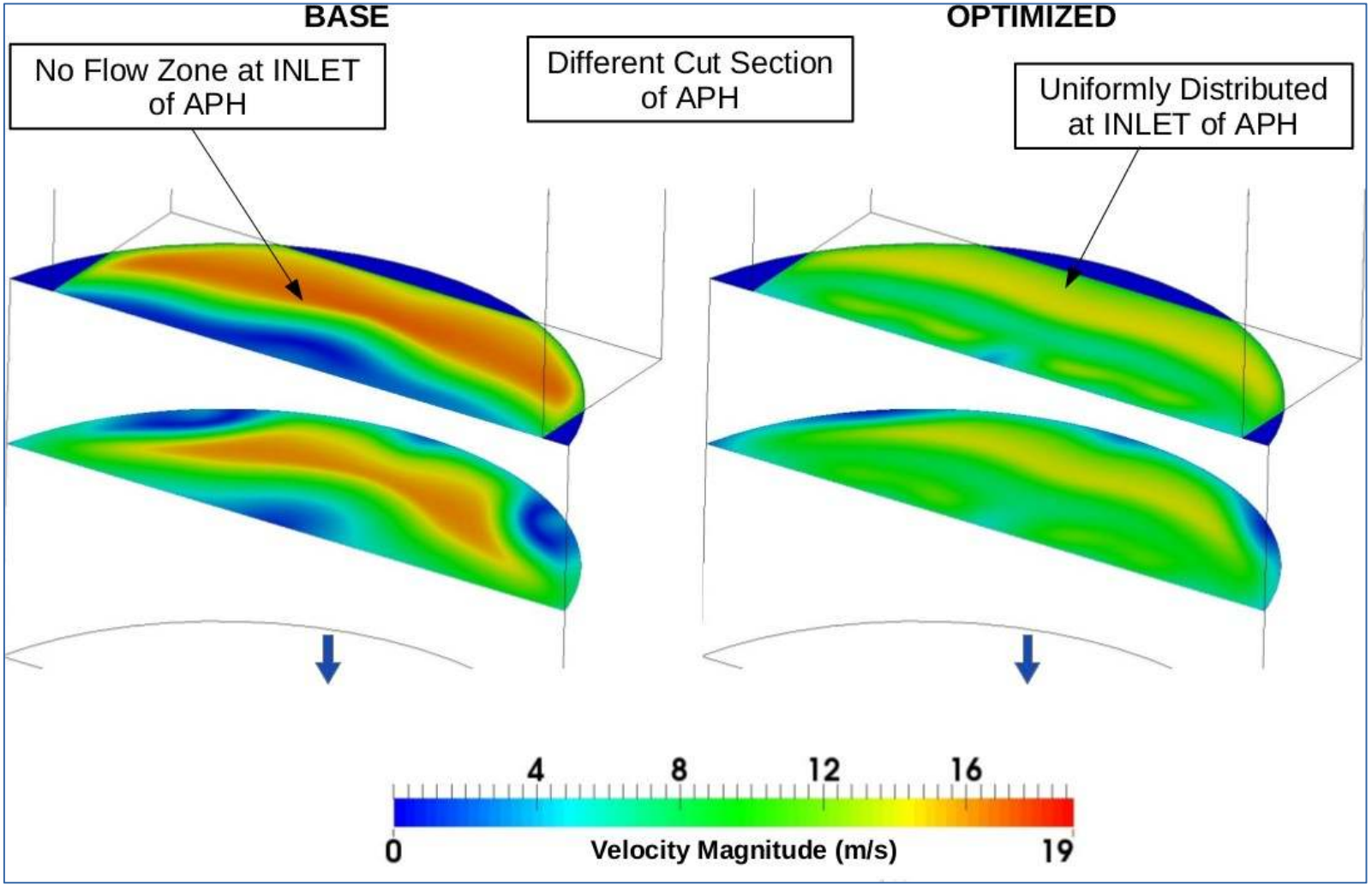


Optimized Design

Air Preheater

Inter Connecting Duct Flow Distribution



Questions ?

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Thank You All