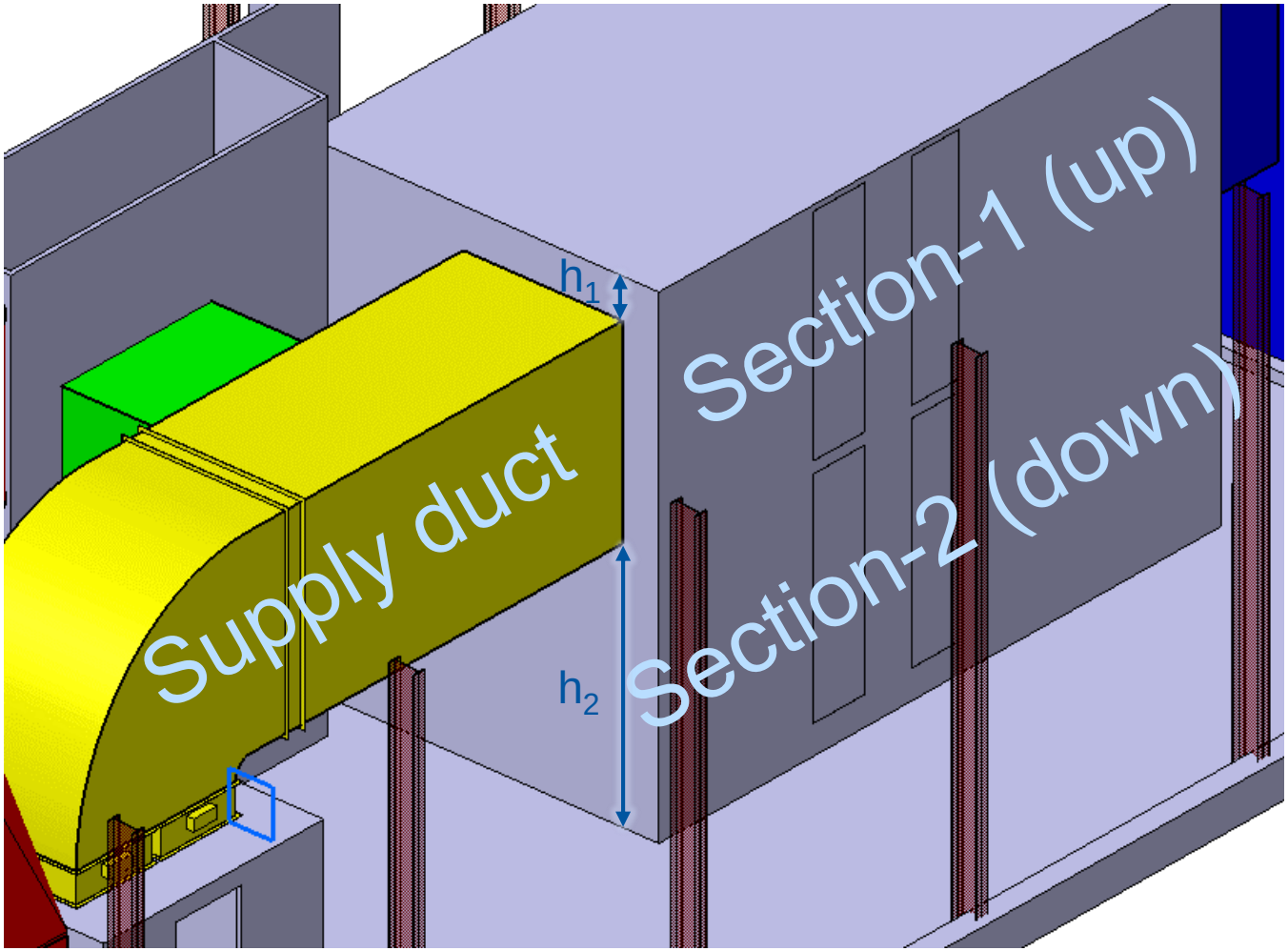

CERN

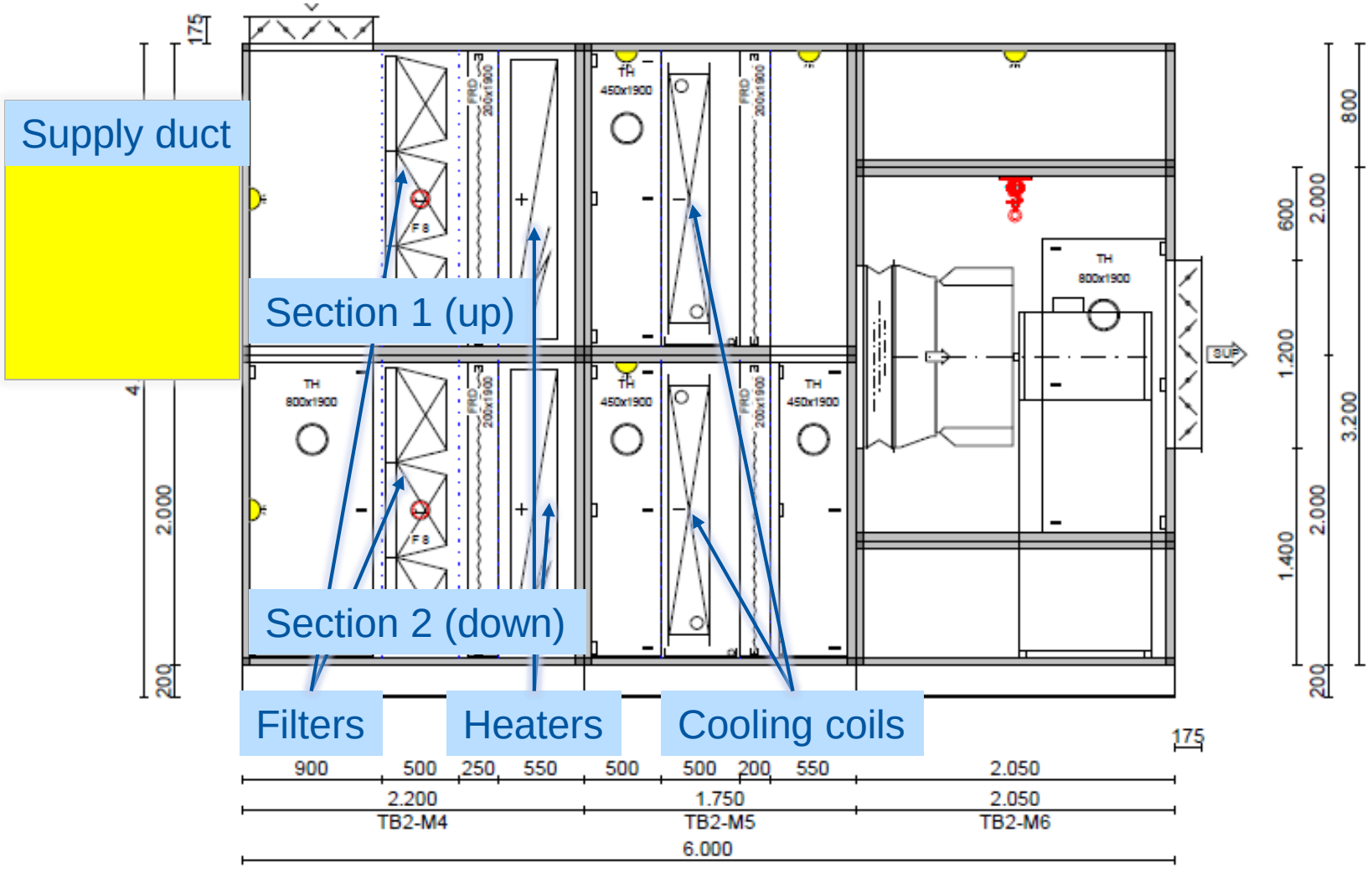
Some CFD simulations for a 2 stream Air Handler Unit

2 stream AHU geometry

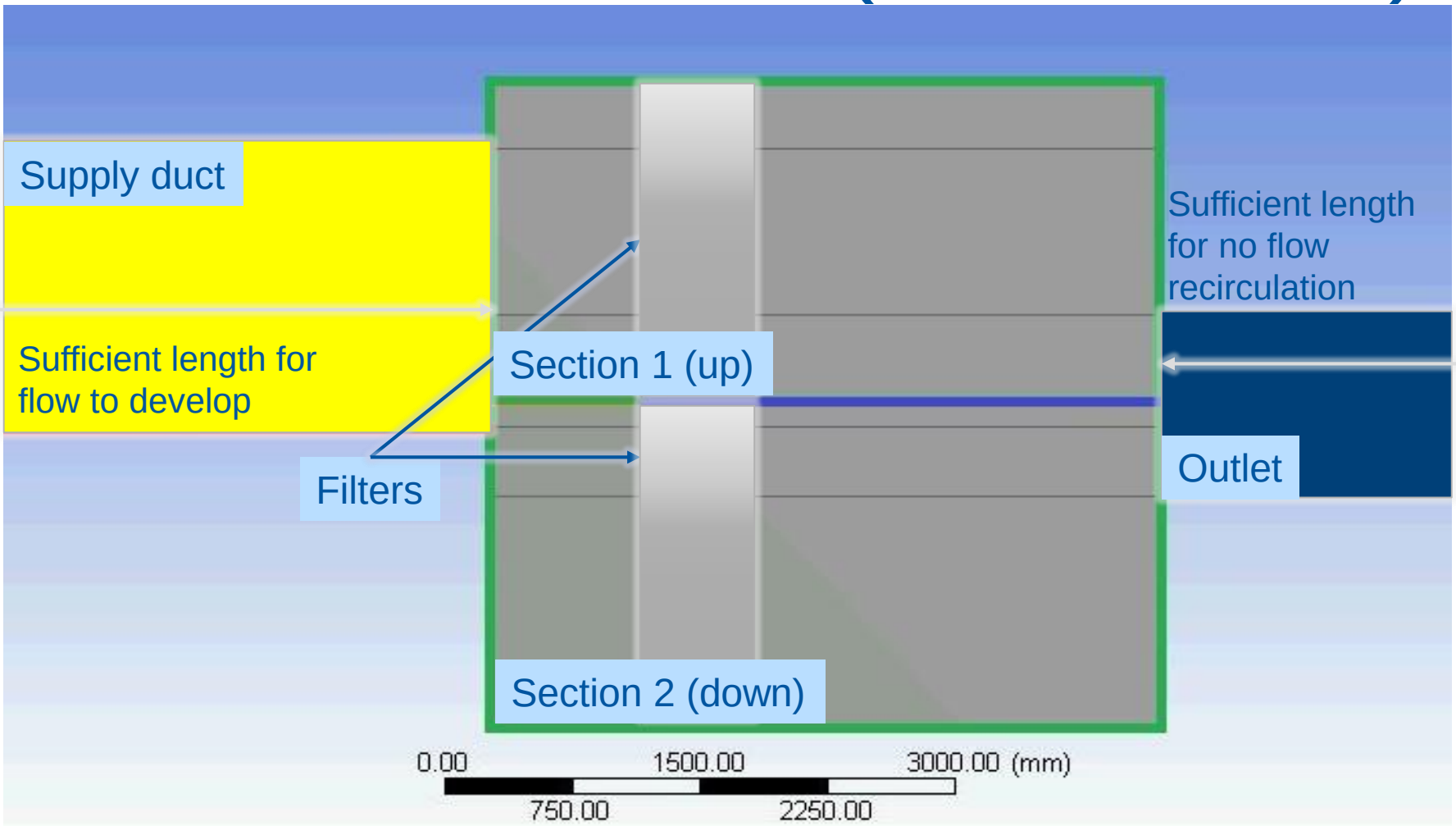


Problem: will the high positioning of supply air duct (see $h_1<h_2$) result in uneven flow rate distribution of the two sections?

2D representation



Numerical model (not to scale)



Numerical model

Fluid properties:

Density (ρ)	1.225	kg/m^3
Dynamic viscosity (v)	$1.79*10^{-5}$	Pa s

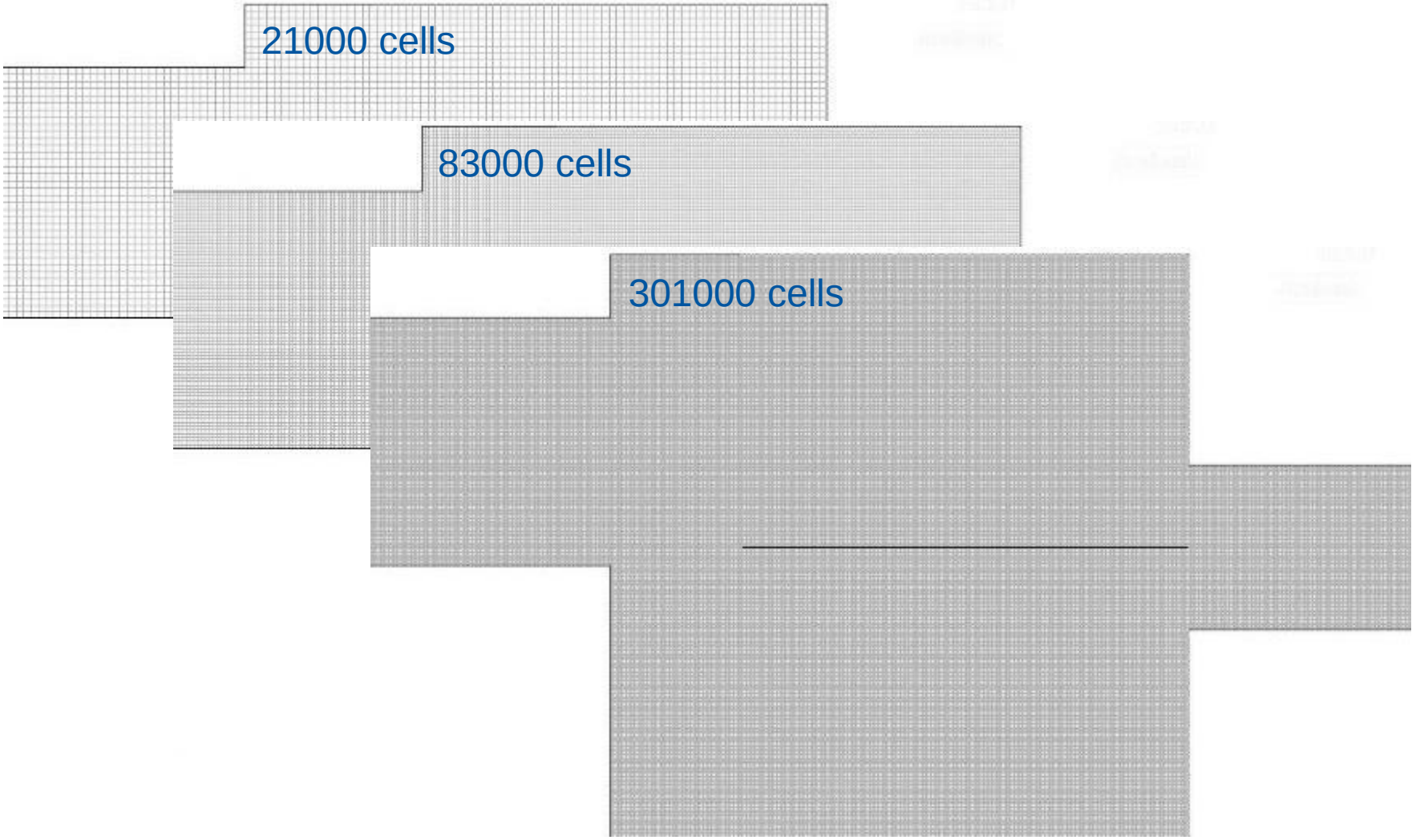
Supply properties for the 2D model:

Duct height	1.7 m	Inlet cross section	1.7 m^2
2D section considered	1 m	Hydraulic diameter	1.26

Flow properties:

Volume flow rate	70000 m^3/h
Inlet mean velocity	11.4 m/s

Mesh dependency studies



Parametrisation of porous zone

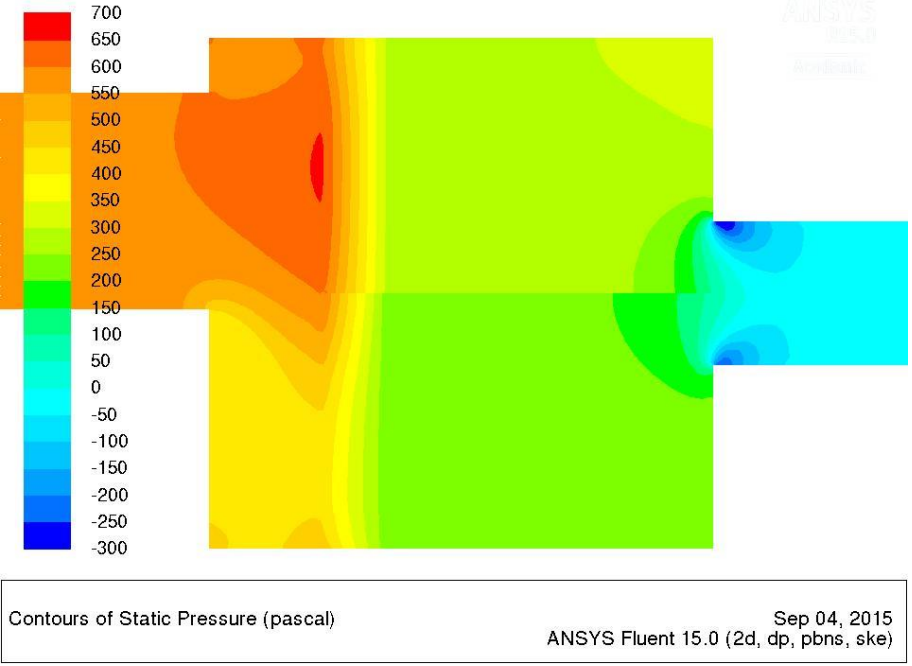
- Pressure loss due to the filter added as a source in the momentum equation
- Parameterised as an inertial loss term in the flow direction

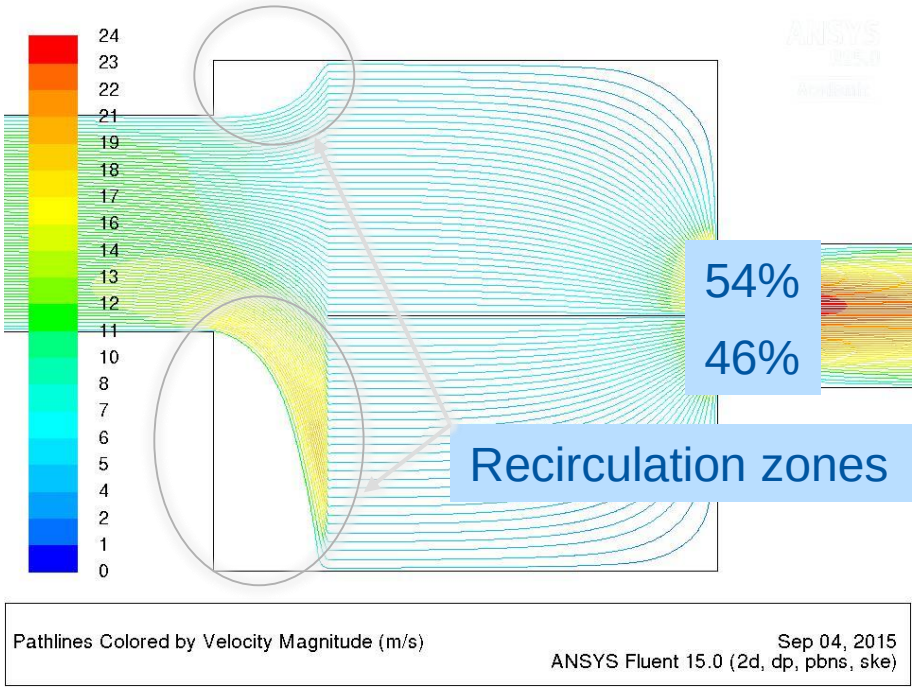
$$\Delta p = C * l * \frac{\rho}{2} v^2$$

Where p is pressure, C [1/m] is viscous resistance, l is the length of the filter, ρ is density and v assuming flow in the whole cross section.

- In the transversal direction a considerably larger value is given to discourage flow in that direction.

Base geometry with filter modelled





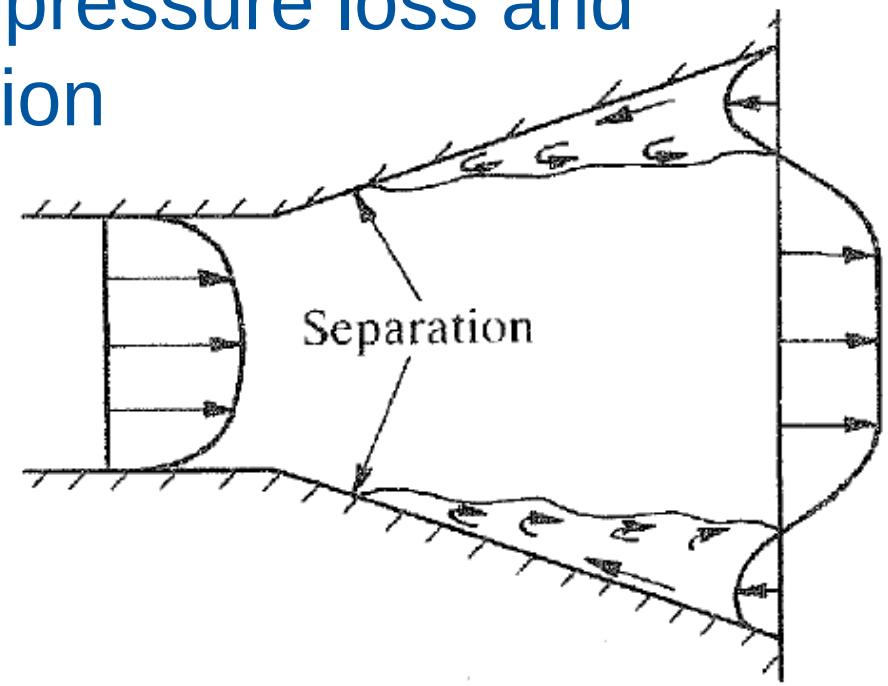
Pressure builds up before the filter which helps to even out the flow.

Note the increase in the pressure scale due to the pressure loss in the filter

Option of adding a diffuser

- Decreases velocity, increases pressure
- Care must be taken with the angle
- Separation increases pressure loss and unevens flow distribution

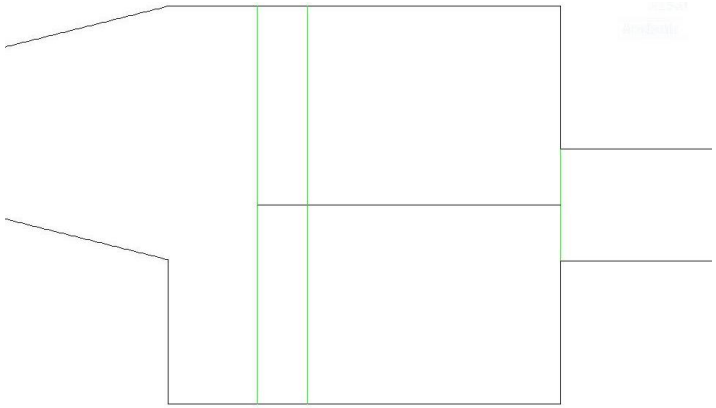
From Miller – Internal Flow Systems



Tested diffuser geometries I

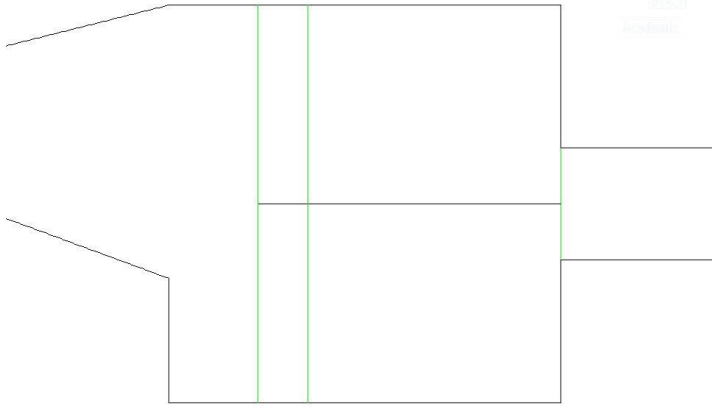
Diffuser length 1.7 m

Symmetric



Top and bottom chamfered by 0.425 m

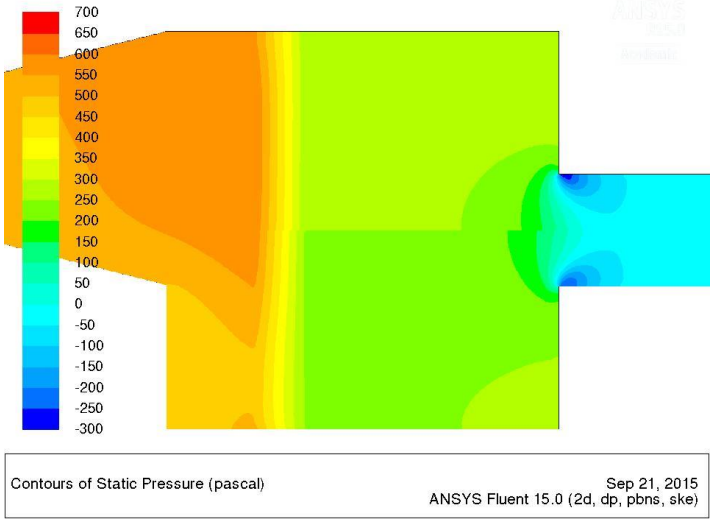
Asymmetric



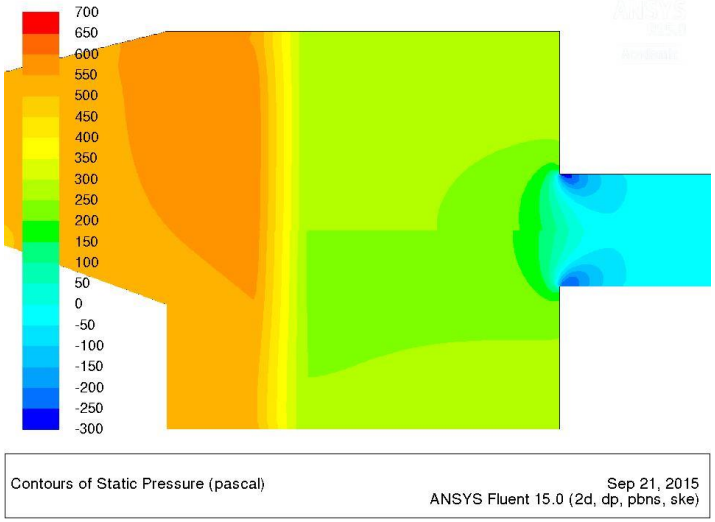
Top chamfered by 0.425 m, bottom by 0.625 m

Pressure build-up

Symmetric



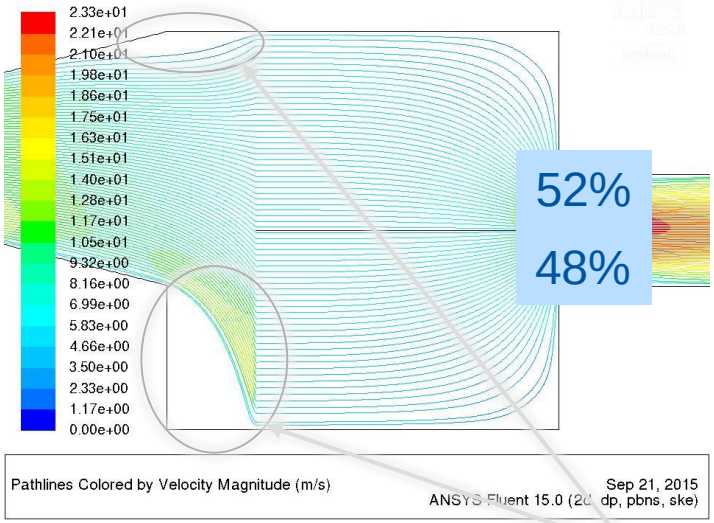
Asymmetric



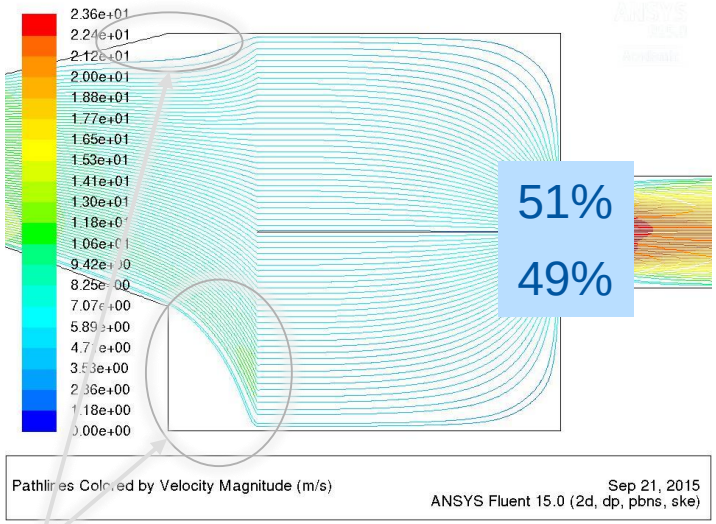
Due to the less abrupt change in pressure compared to the sudden opening version, and to the smaller recirculation zones (see next slide):
overall pressure loss in the system is reduced by
~62Pa ~77Pa

Streamline structure and flow rates

Symmetric



Asymmetric

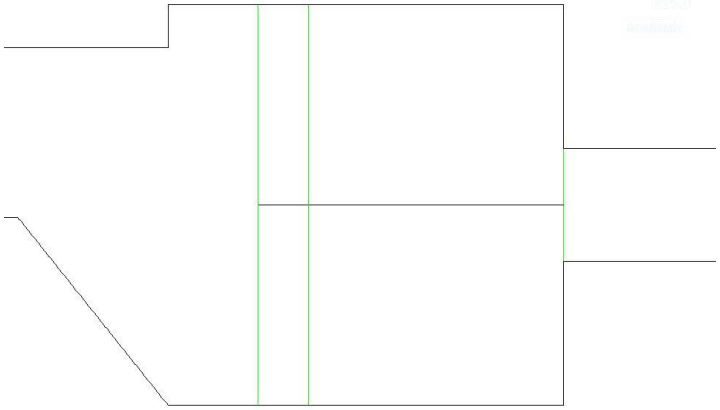


Recirculation zones

Tested diffuser geometries II

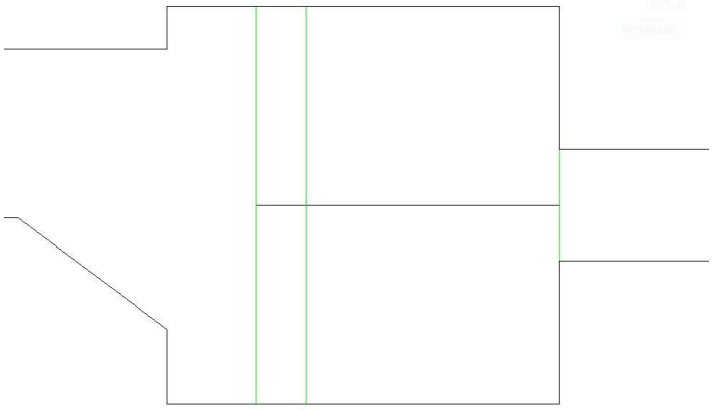
Diffuser length 1.5 m

Asymmetric 2



Bottom chamfered till edge

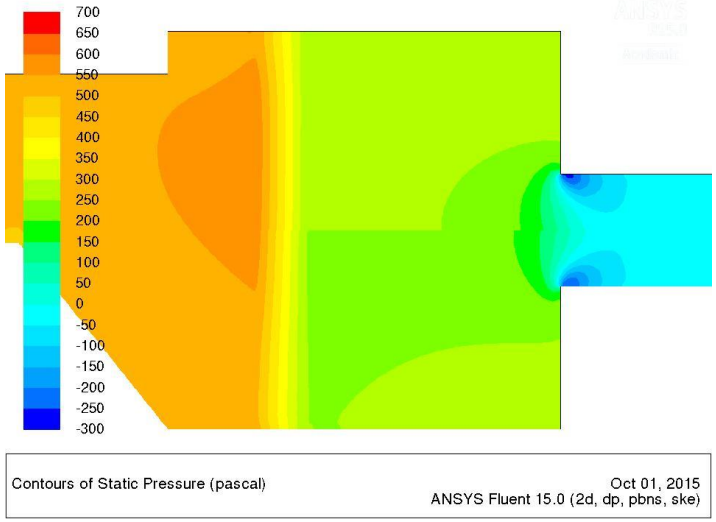
Asymmetric 3



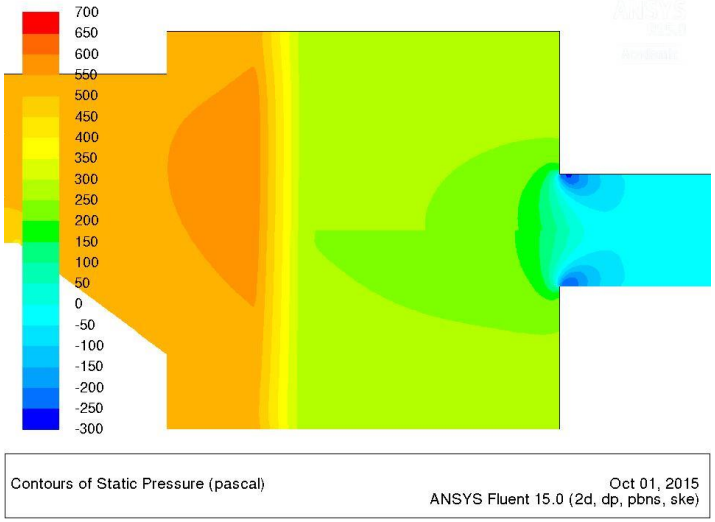
Bottom chamfered by 0.925 m

Pressure build-up

Asymmetric 2



Asymmetric 3

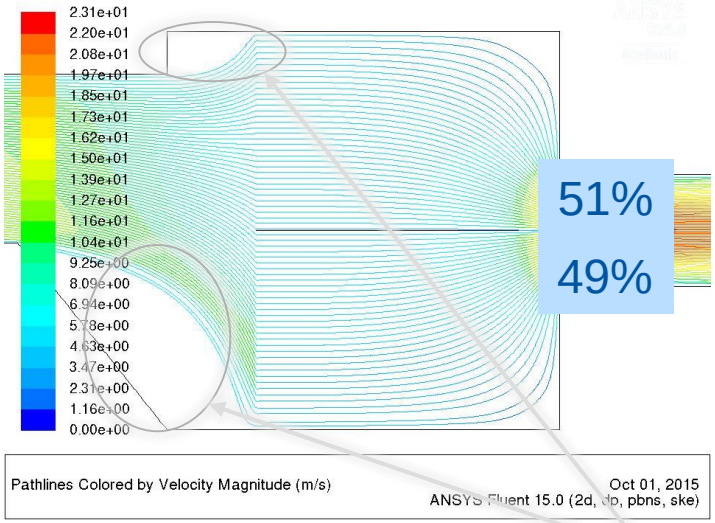


Overall pressure loss in the system is reduced by ~71Pa

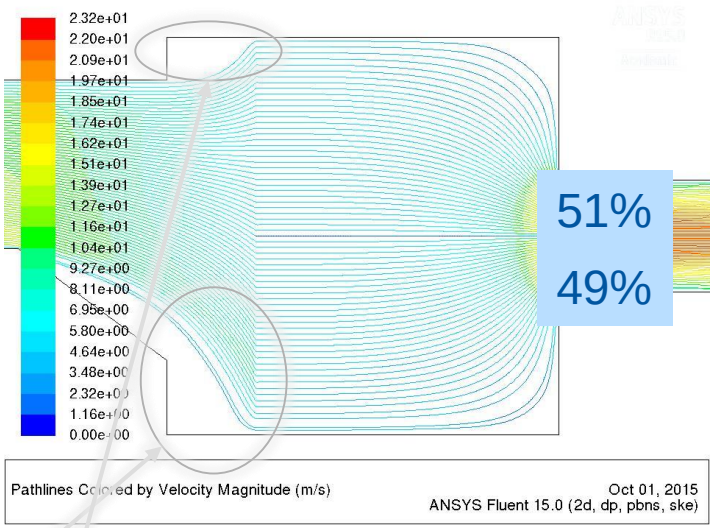
80~Pa

Streamline structure and flow rates

Asymmetric 2

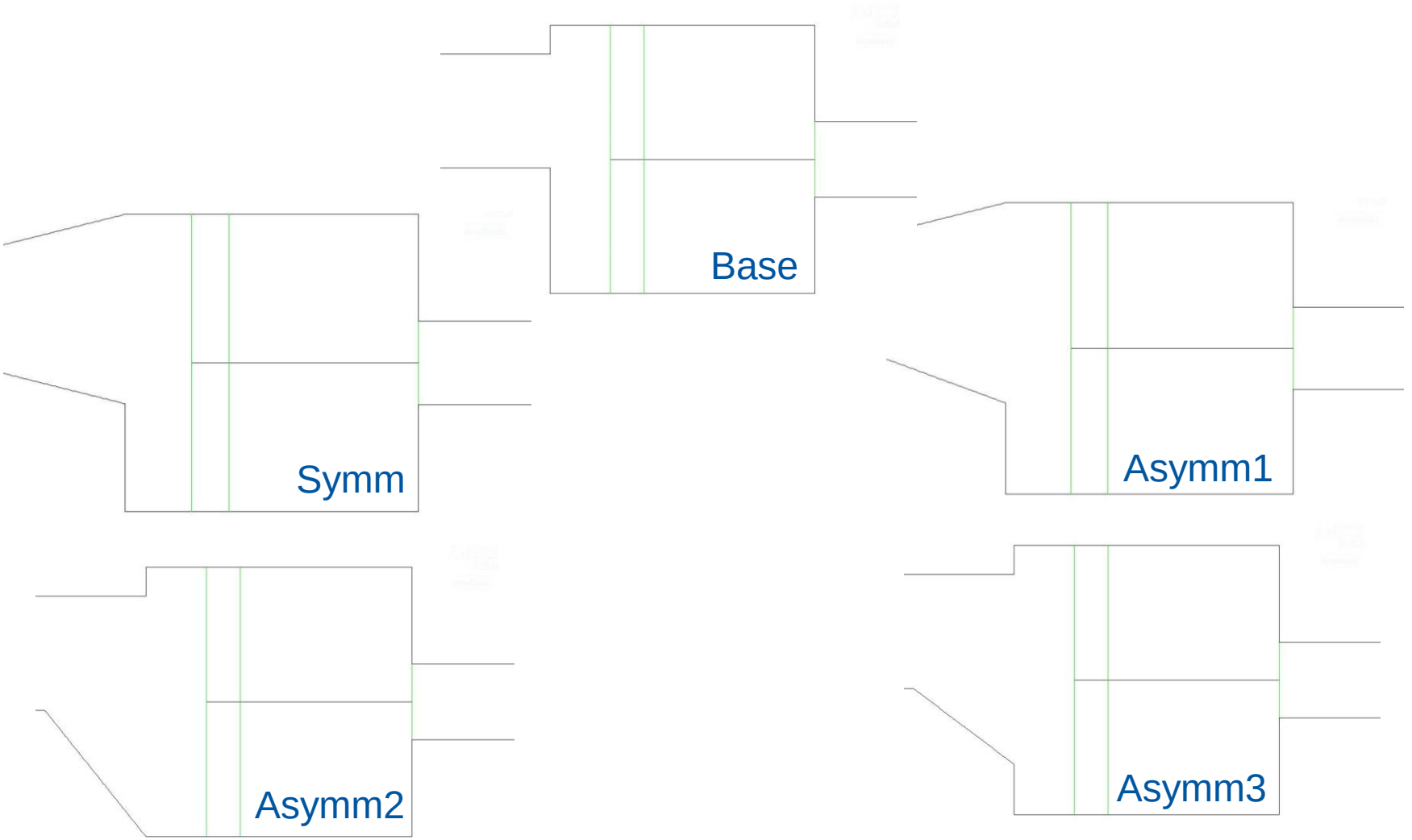


Asymmetric 3

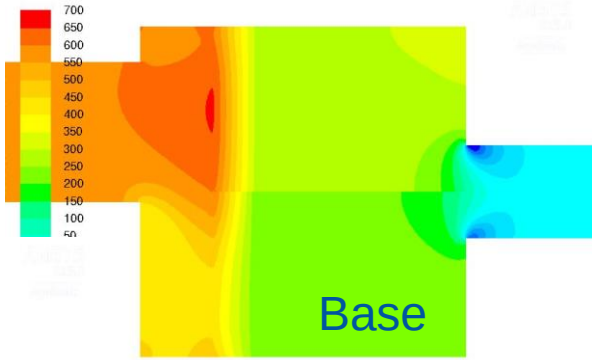


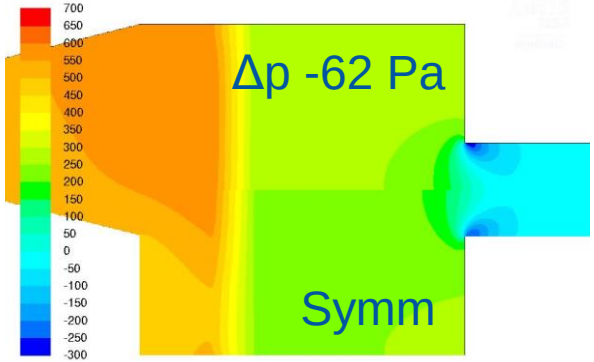
Recirculation zones

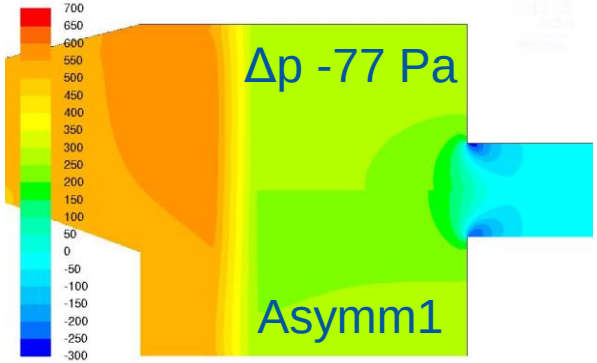
All tested geometries

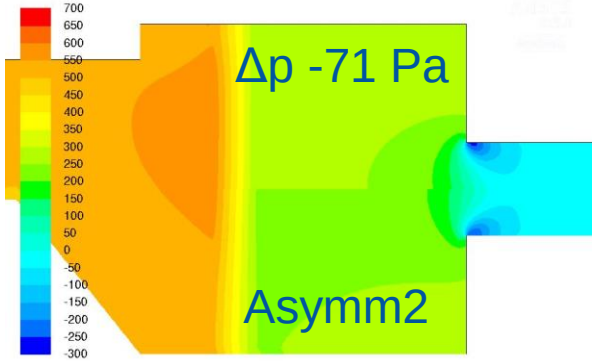


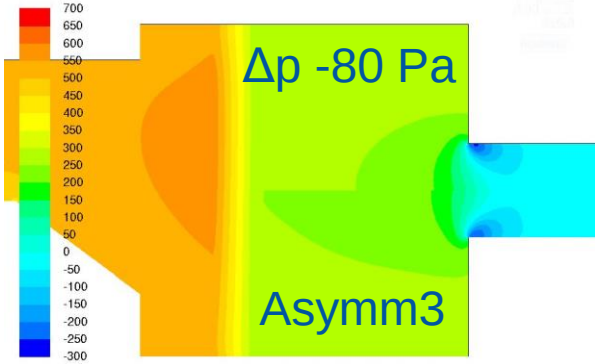
All tested geometries



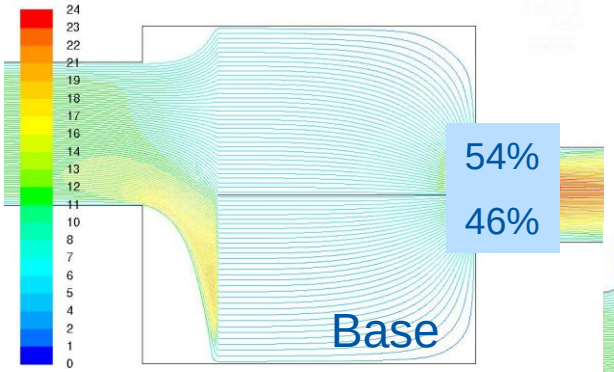


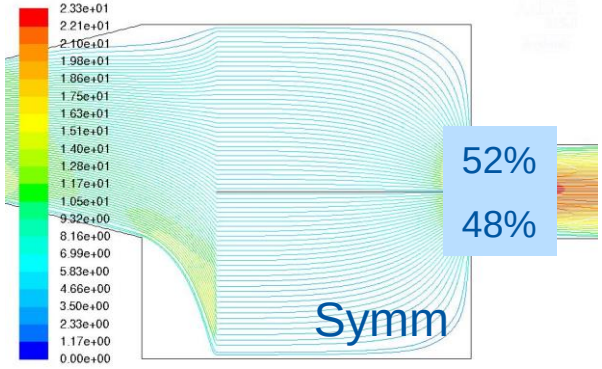


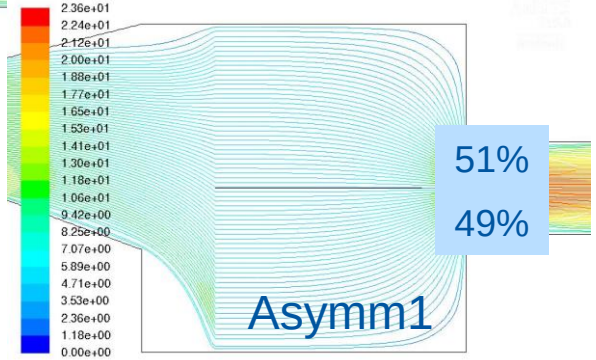


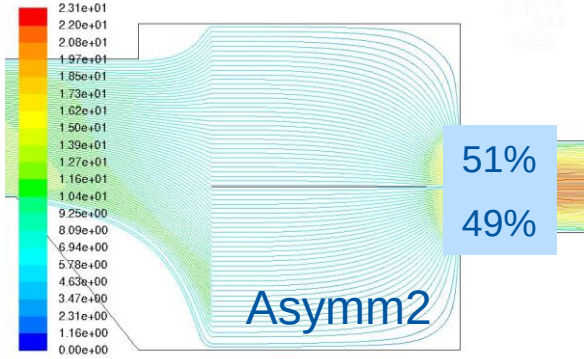


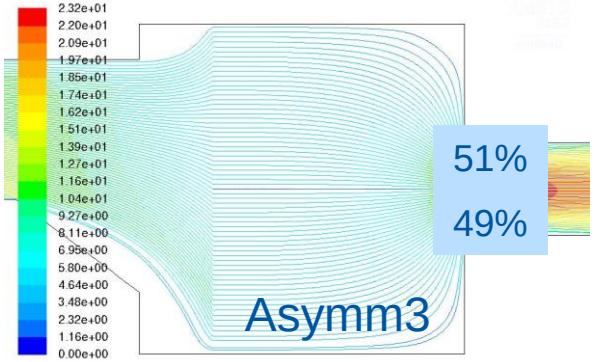
All tested geometries











Conclusions

- The 2D calculations show 54-46% flow rate inequality for the base setup with only the filter modelled;
- This can be improved by the installation of a diffuser-like gain geometry;
- The diffuser can also cause pressure loss reduction in the system.

	Diffuser geometry variations			
	Symm	Asymm1	Asymm2	**Asymm3**
Pressure loss reduction	62 Pa	77 Pa	71 Pa	**80 Pa**
Flow rate ratio	52%-48%	51%-49%	51%-49%	**51%-49%**

Thank you for your attention!

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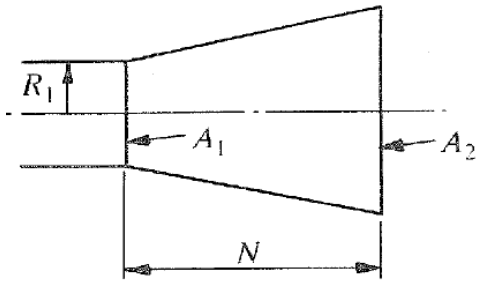
Flow stability in a diffuser - theory

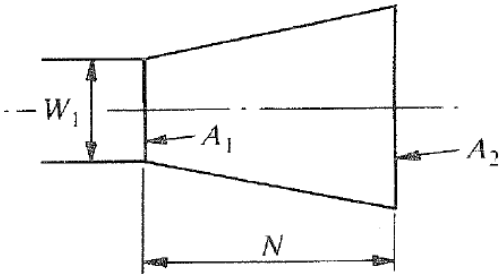
Conical



Non-dimensional length = N/R_1

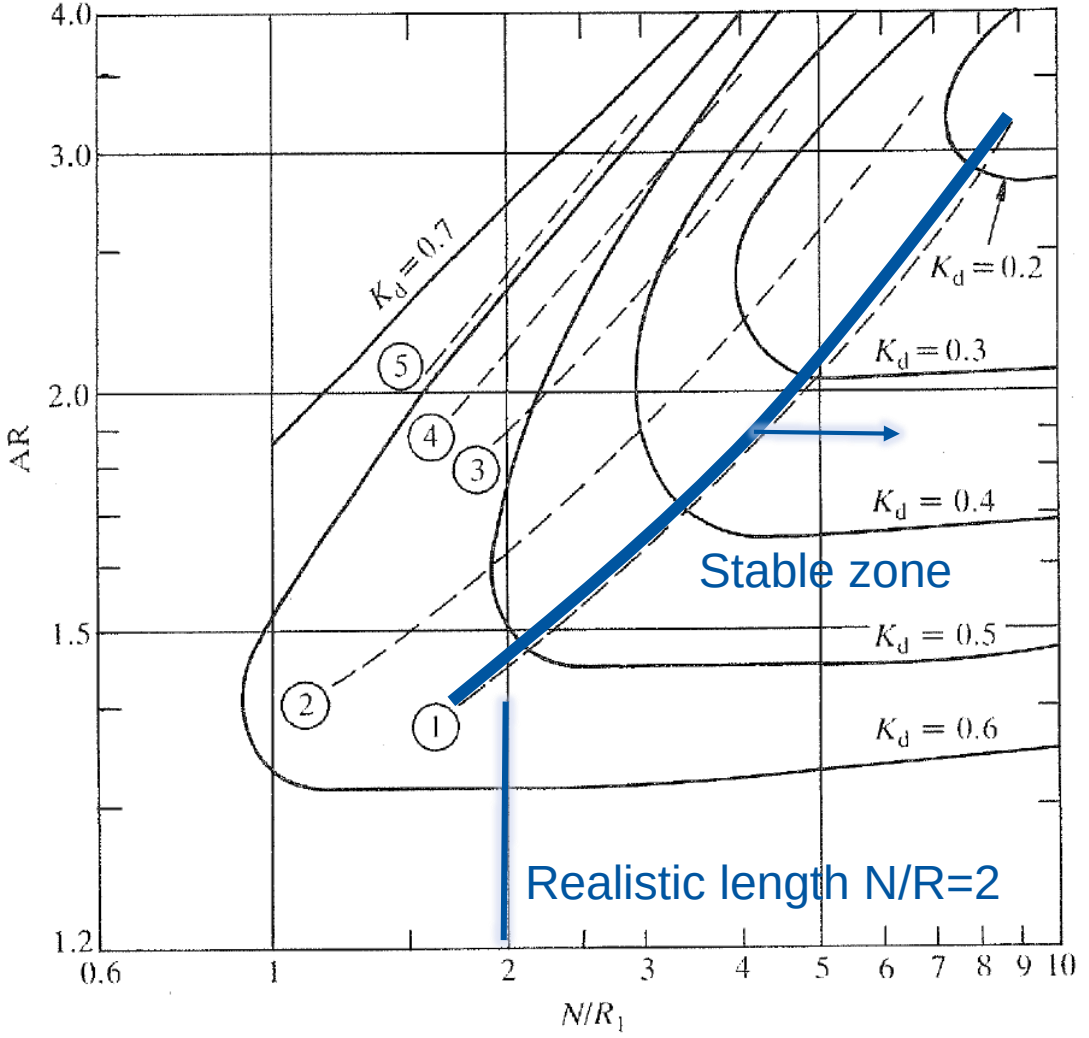
Non-dimensional area ratio = A_2/A_1

Rectangular



Non-dimensional length = N/W_1

Non-dimensional area ratio = A_2/A_1



Results with empty sections