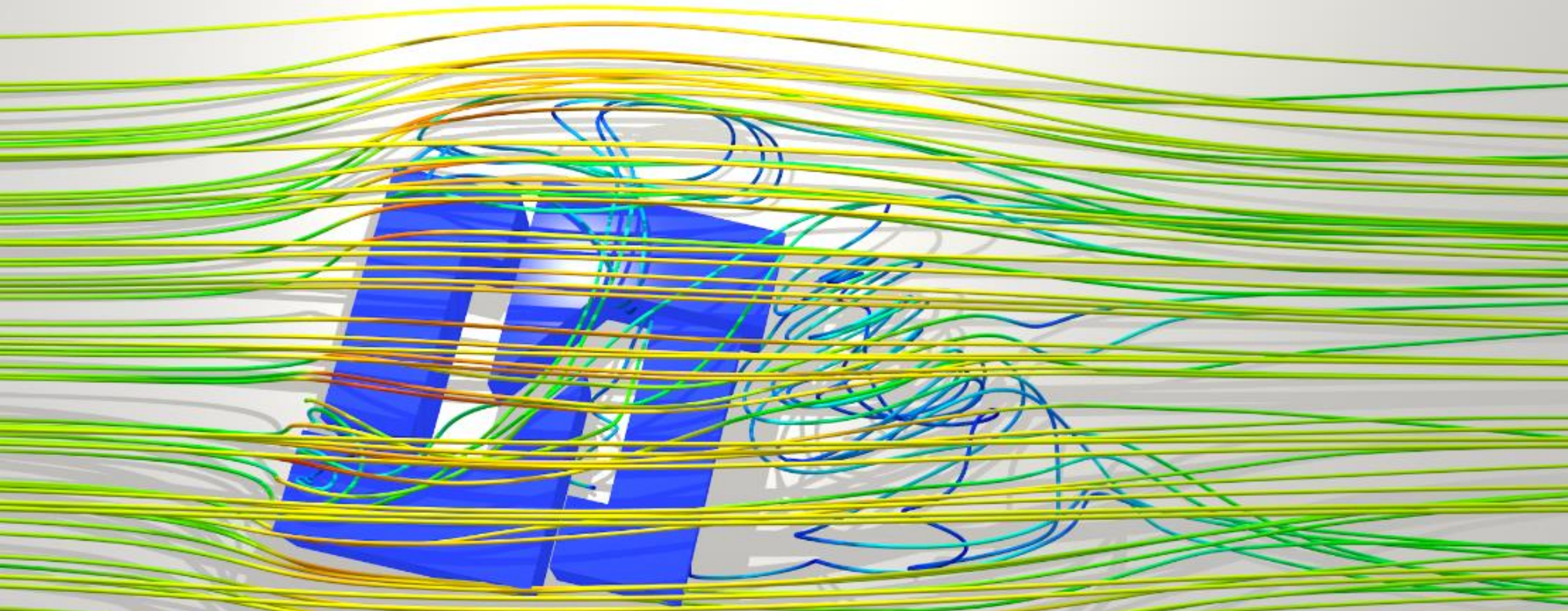
# 넥스트폼이 오픈폼으로 계산했던 문제들



2017. 09. 21. ㈜넥스트폼 김 병 윤

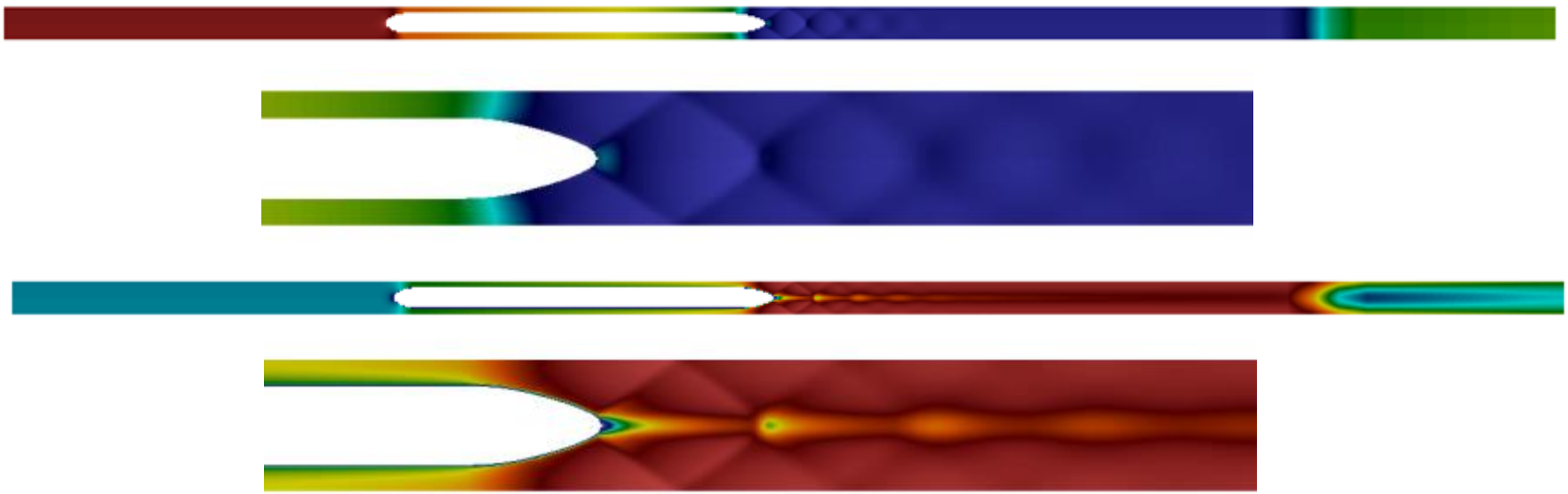
# 왜 이런 발표를...

- 오픈폼 활용의 다양한 사례 소개
- 논문으로 발표하기에는 좀 모자란...
- 오픈폼만 깔면 할 수 있는가? 얼마나 어려운가?
- 주관적 의견. 판단은...

# Hyperloop (2017)

| | |
|---|---|
| 솔버 | • TSLAeroFoam / OF-2.4.x (밀도 기반 압축성 솔버) |
| 격자 | • trelis, axi-symmetry, chtFluentMeshToFoam |
| B.C./물리모델 | • 고속 압축성 유동<br>• subsonicInflow, subsonicOutflow<br>• Non-reflecting BC → 짧은 계산 도메인 |

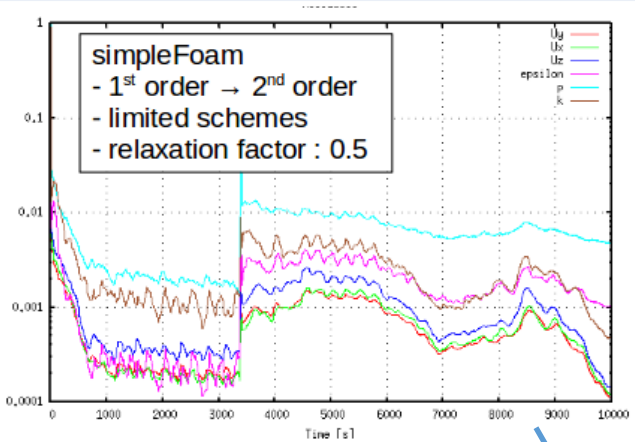
- 솔버 개발 / 경계조건 개발

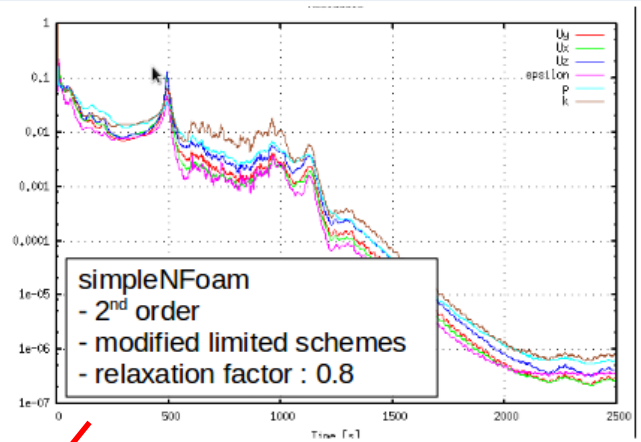


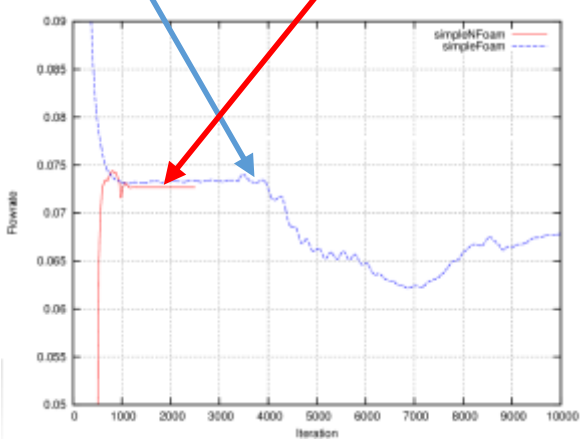
# Manifold (2017)

| | |
|---|---|
| 솔버 | • simpleNFoam / OF-4.1 |
| 격자 | • cfMesh |
| B.C./물리모델 | • totalPressure |

- NFoam solver → 솔버의 안정성, 수렴성, 정확도 향상



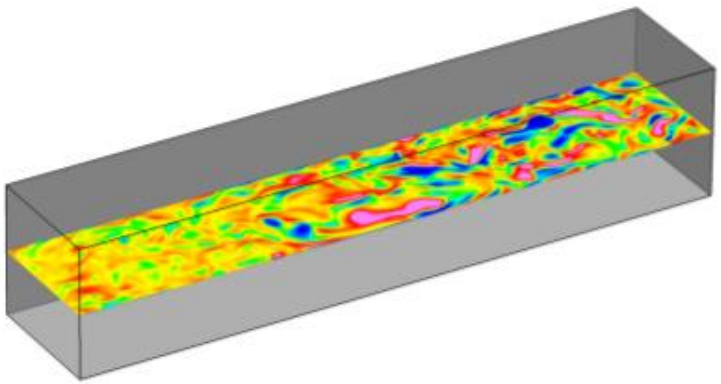


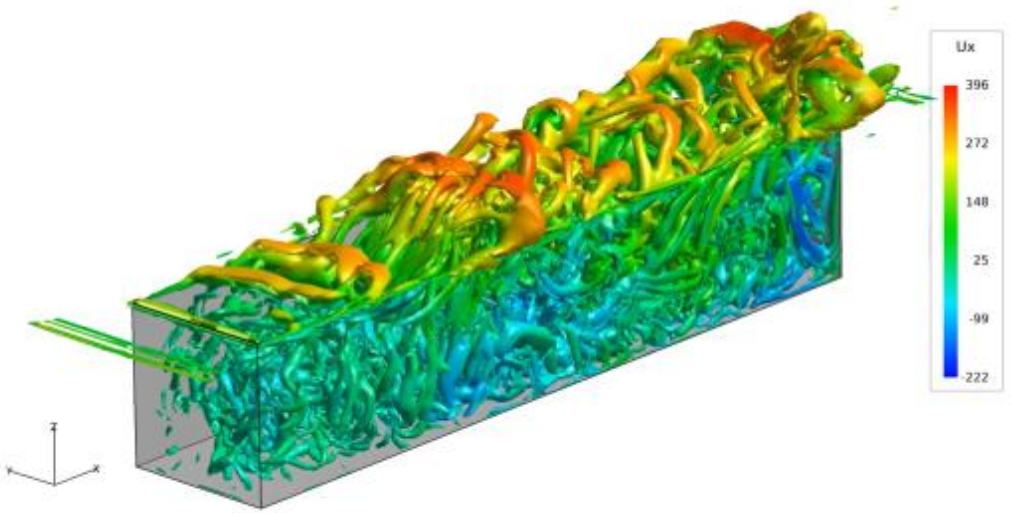

NEXTfoam open source CFD consulting

# 압축성 cavity flow (2017)

| | |
|---|---|
| 솔버 | • buoyantPCNFoam / OF-4.1 (압력 기반 압축성 솔버) |
| 격자 | • cfMesh |
| B.C./물리모델 | • 고속 압축성 유동<br>• CsubsonicInflow, CsubsonicOutflow<br>• kOmegaSST, DES<br>• noise utility |

- 솔버 개발 / 경계조건 개발

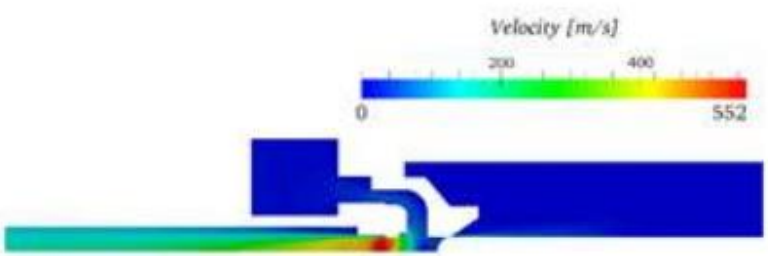


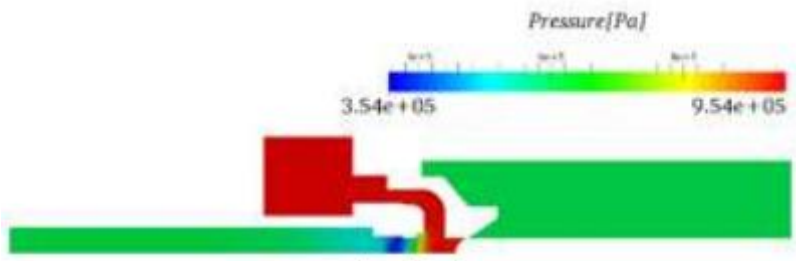


# 초고압차단기 (2017)

| | |
|---|---|
| 솔버 | • buoyantPCNFoam / OF-4.1 (압력 기반 압축성 솔버) |
| 격자 | • msh, layering |
| B.C./물리모델 | • 고속 압축성 유동<br>• 물성치 lookup table<br>• 전기장 계산 |

- 솔버개발

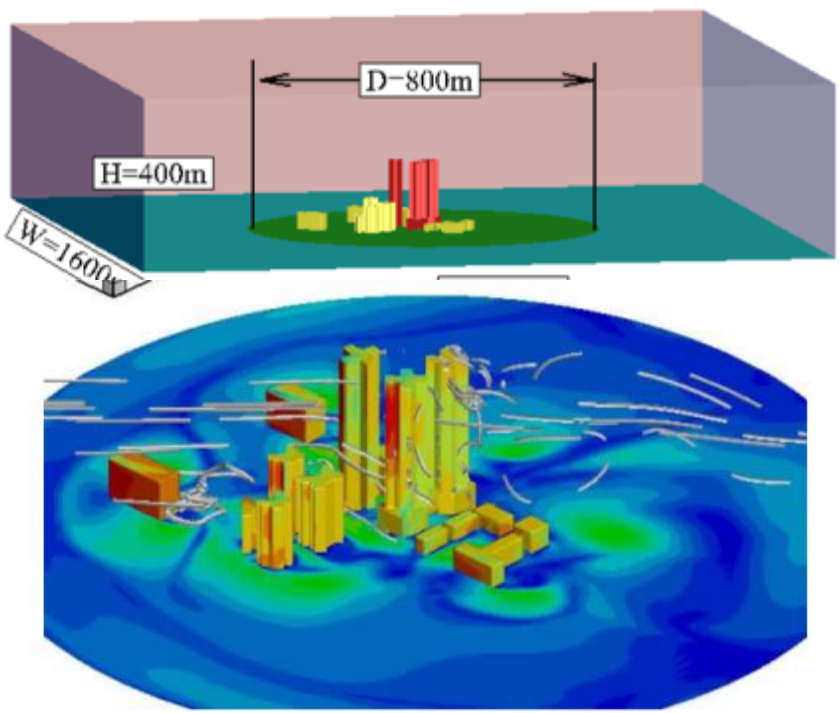


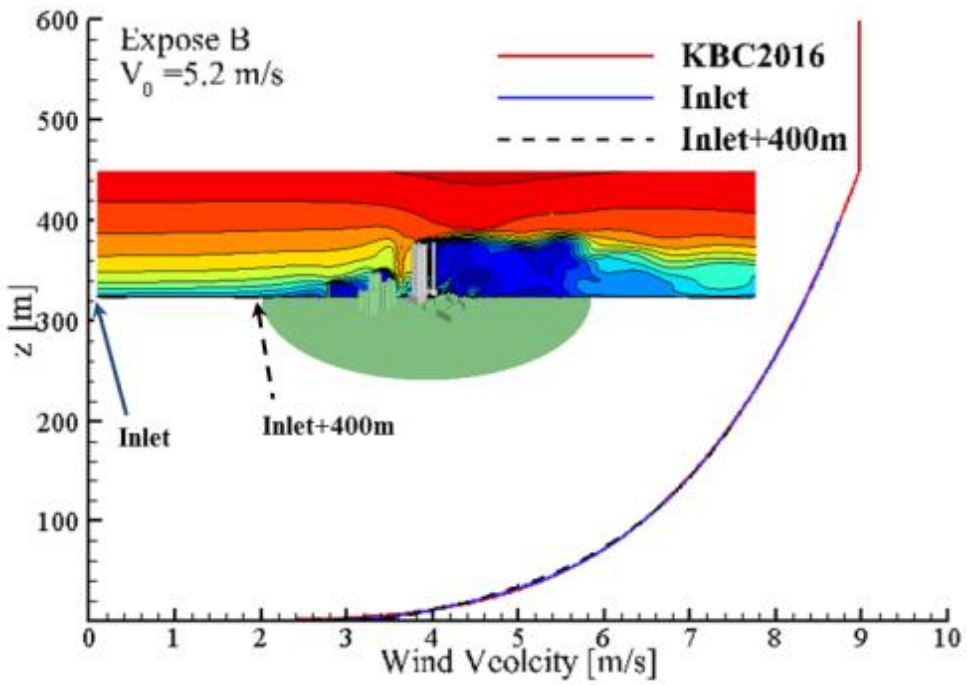




# 건축물 풍압해석 (2017)

| | |
|---|---|
| 솔버 | • simpleNFoam / OF-2.4 |
| 격자 | • AutoCAD → Salome → cfMesh |
| B.C./물리모델 | • 대기경계층 조건(groovyBC)<br>• 기상자료 분석 → 풍압해석 → 연돌효과 계산 |

- NFoam solver

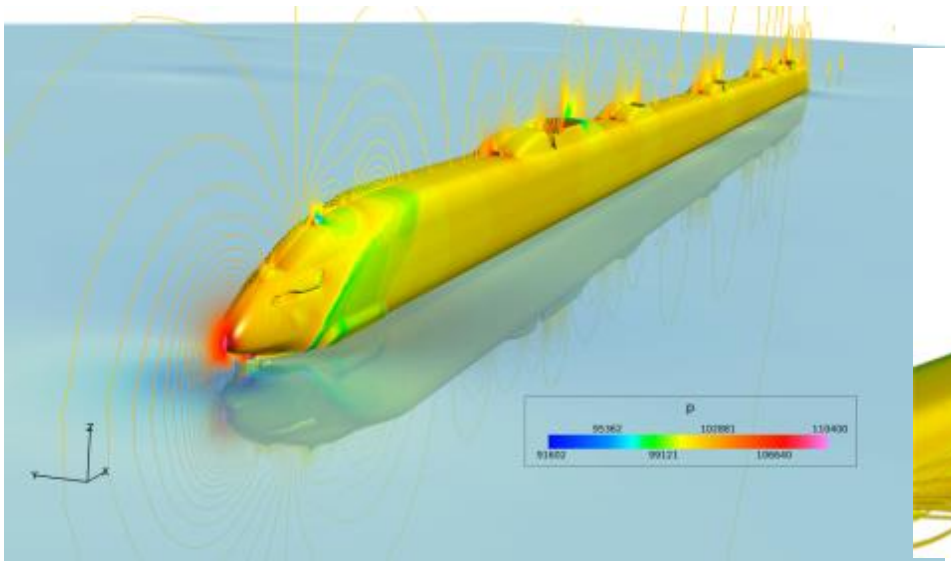


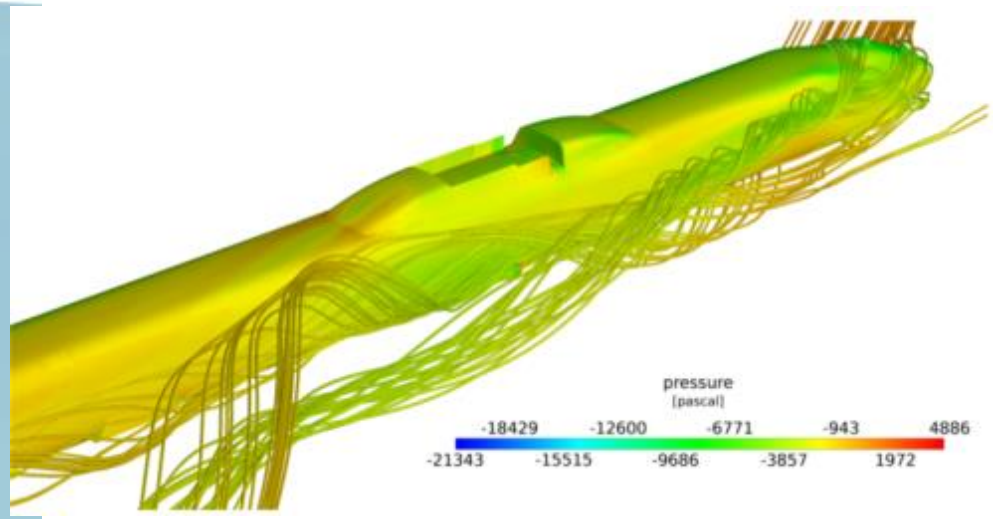



# 철도차량 (2017)

| | |
|---|---|
| 솔버 | • simpleNFoam, pimpleNFoam, pimpleDyMNFoam / OF-4.1 |
| 격자 | • msh, dynamicMesh |
| B.C./물리모델 | • 주행저항, 측풍, 교행, 열차풍 |

- NFoam solver

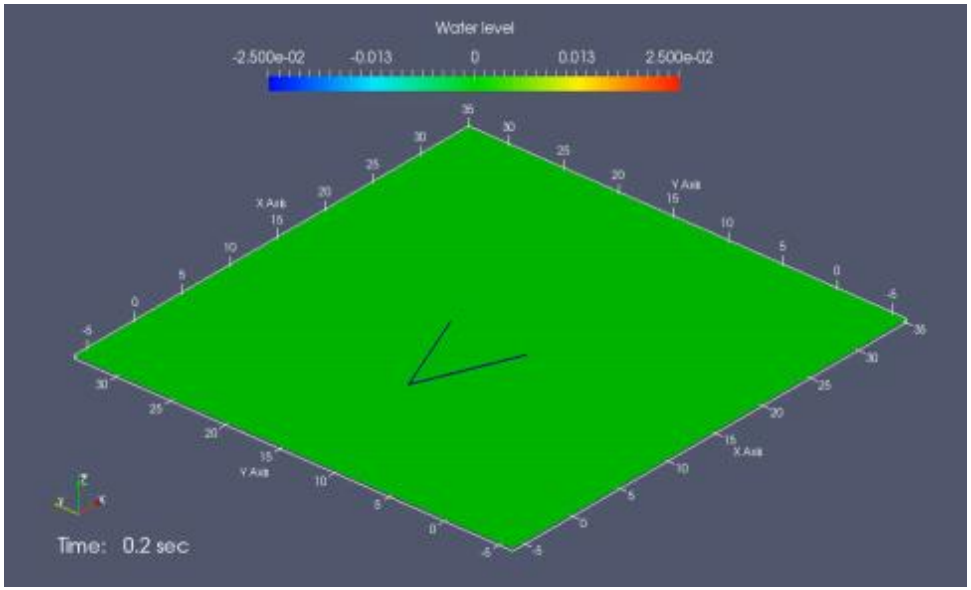


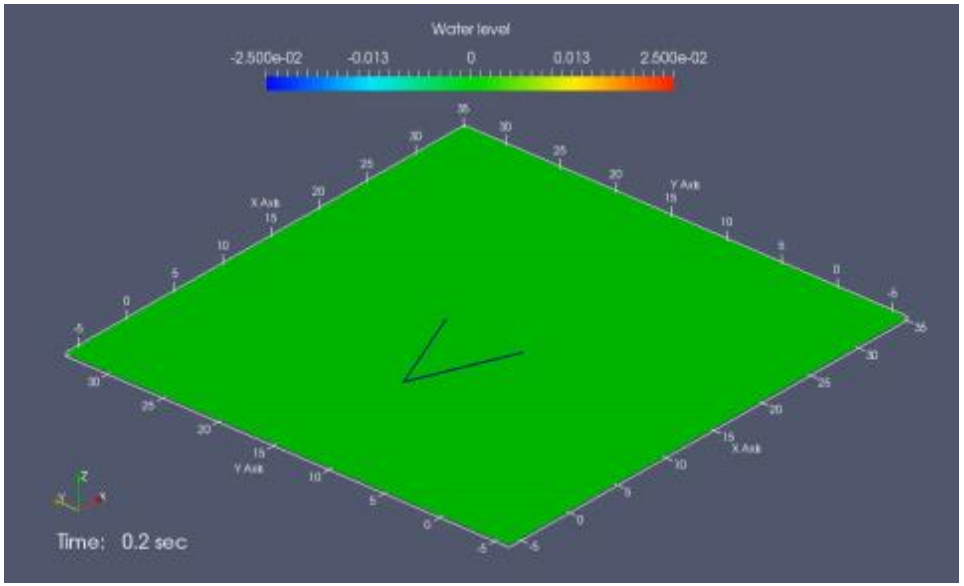
# 부유식 파랑 저감 장치(RIBS) (2017)

| | |
|---|---|
| 솔버 | • waveIWMDyMFoam, porousWaveIWMFoam / OF-2.4.0 |
| 격자 | • blockMesh, snappyHexMesh |
| B.C./물리모델 | • VOF 다상유동, porous<br>• 계류라인을 포함한 6자유도 운동<br>• Mass source를 이용한 조파, sponge layer를 이용한 소파 |

- waves2Foam을 기반으로 필요한 기능을 포함한 솔버 및 경계조건 개발



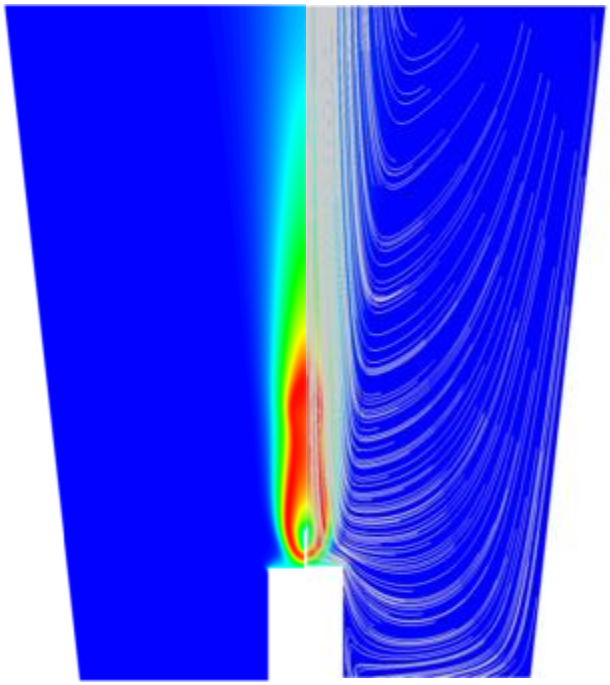

alpha=5e-4

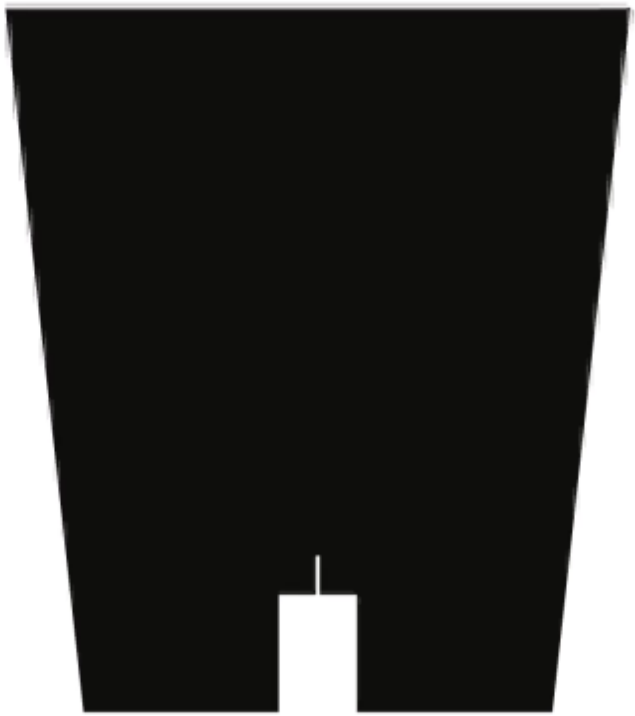



alpha=5e-6

# 촛불 (2016)

| | |
|---|---|
| 솔버 | • fireFoam / OF-2.4.0 |
| 격자 | • trelis, axi-symmetry, chtFluentMeshToFoam |
| B.C./물리모델 | • groovyBC<br>• P1 radiation with grey emission model<br>• infinitelyFastChemistry |

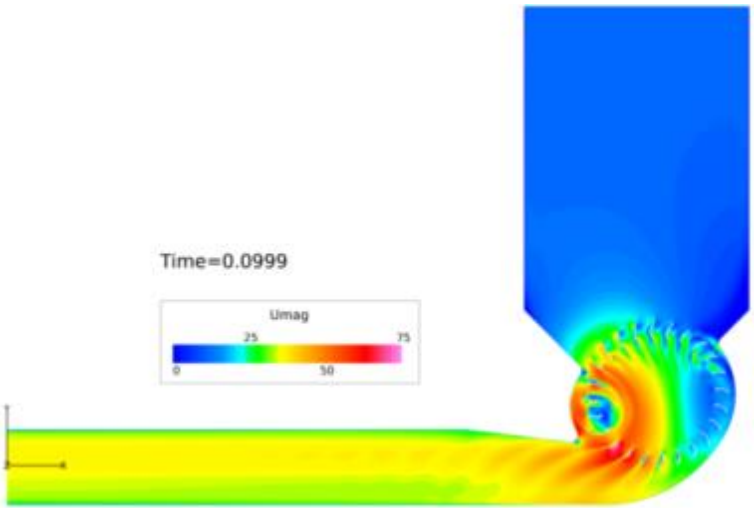


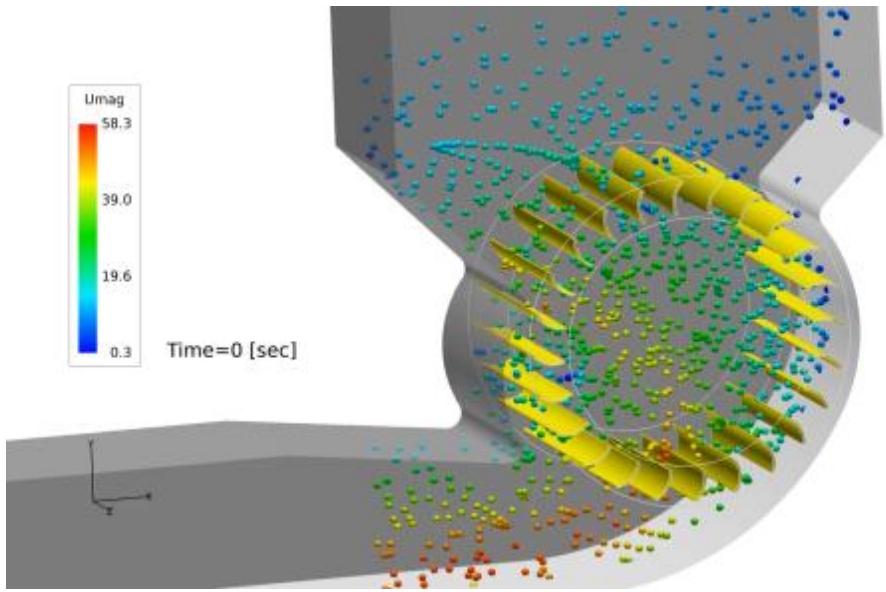


# Fan (2016)

| | |
|---|---|
| 솔버 | • pimpleDyMNFoam / OF-4.1 |
| 격자 | • ANSA, sliding mesh |
| B.C./물리모델 | • flowRateInlet / fixed pressure |

- NFoam solver

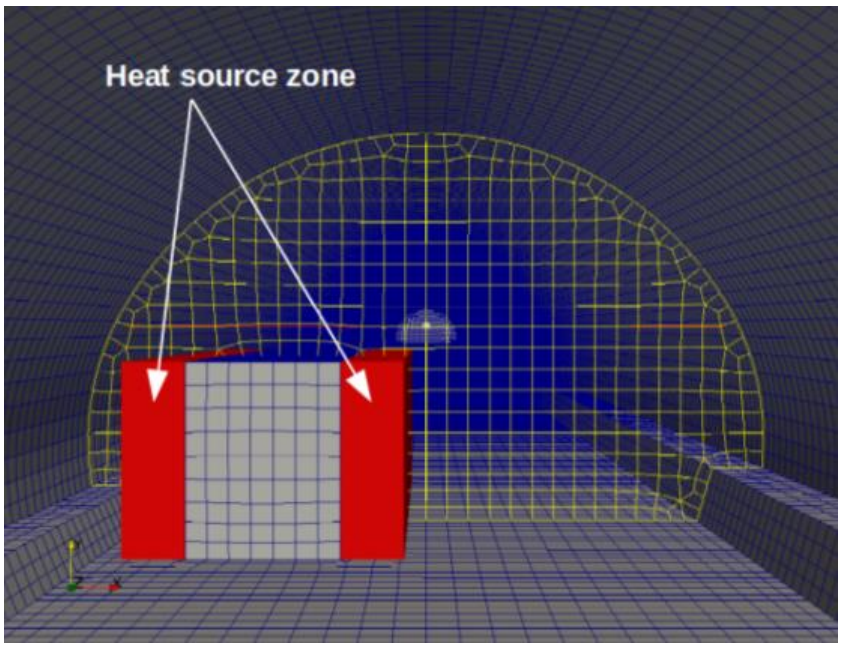


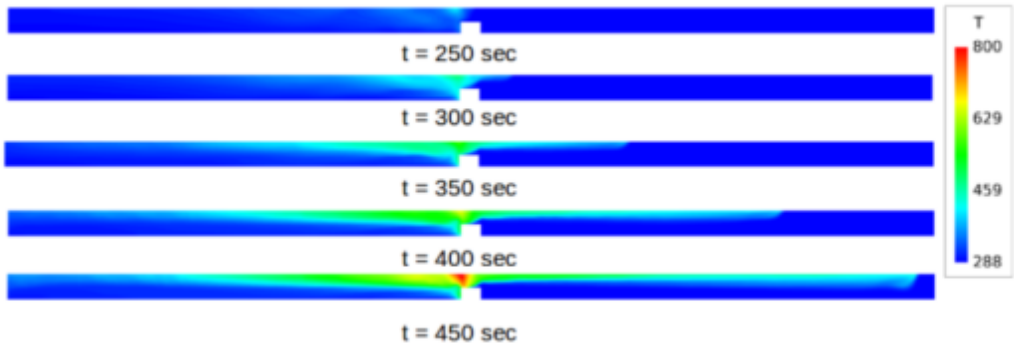



# 터널 화재 (2016)

| | |
|---|---|
| 솔버 | • buoyantPimpleNFoam / OF-2.3.x |
| 격자 | • snappyHexMesh |
| B.C./물리모델 | • codedSource (화재성장곡선)<br>• Buoyant source term in kEpsilon model |

- NFoam solver, ~~난류모델수정~~

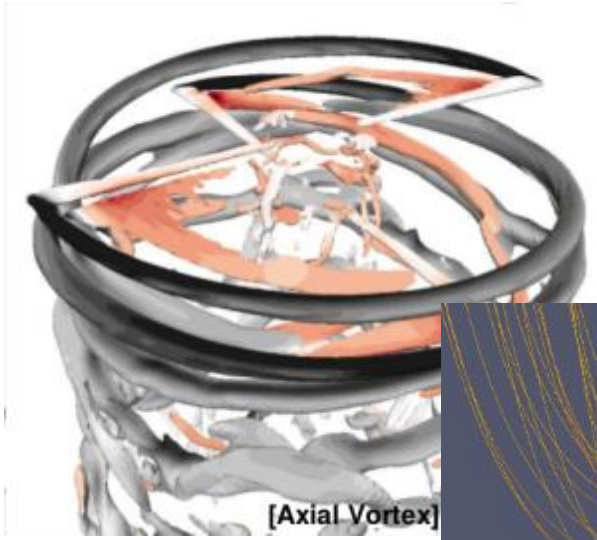


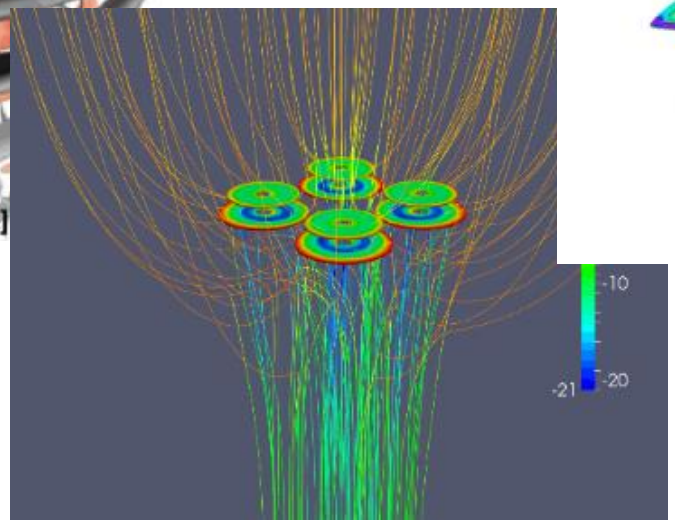



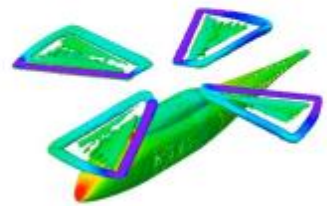
# 다중로터 비행체 (2016)

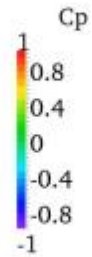
| | |
|---|---|
| 솔버 | • actuatorPimpleFoam/LTSActuatorPimpleFoam |
| B.C./물리모델 | • Actuator disk/surface model |

- 솔버개발



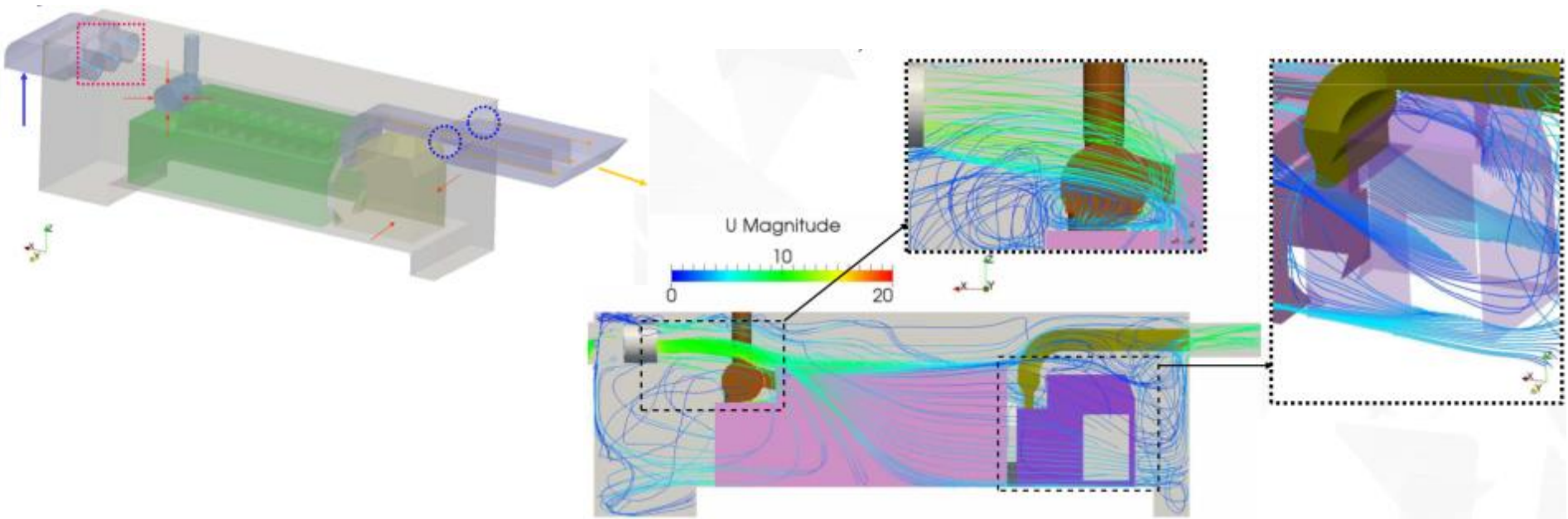





# PPS 환기해석 (2016)

| | |
|---|---|
| 솔버 | • buoyantSimpleNFoam / OF-2.4 |
| 격자 | • msh |
| B.C./물리모델 | • fan (성능곡선)<br>• baffle : turbulentTemperatureCoupledBaffleMixed |

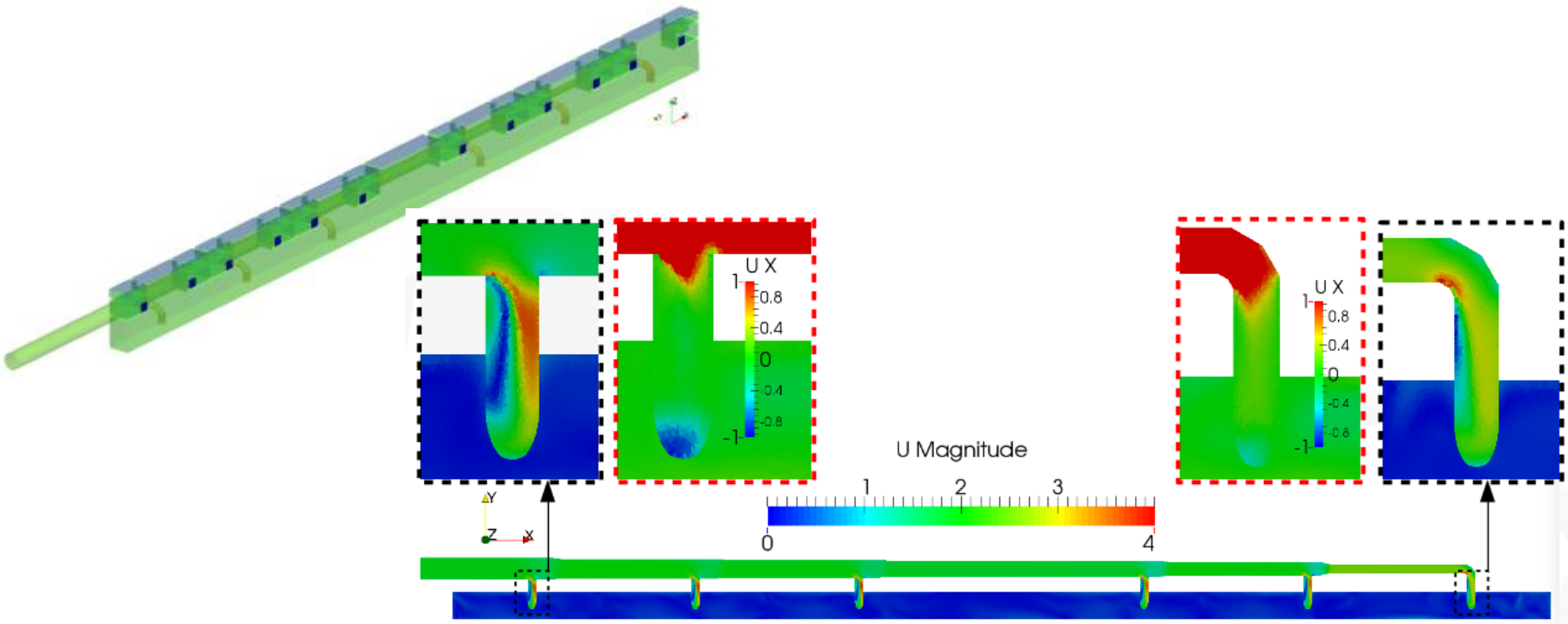
- NFoam solver



# 물재생센터 (2016)

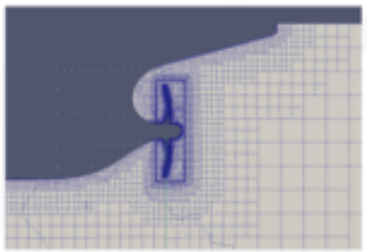
| | |
|---|---|
| 솔버 | • simpleNFoam / OF-2.4 |
| 격자 | • msh |
| B.C./물리모델 | • - |

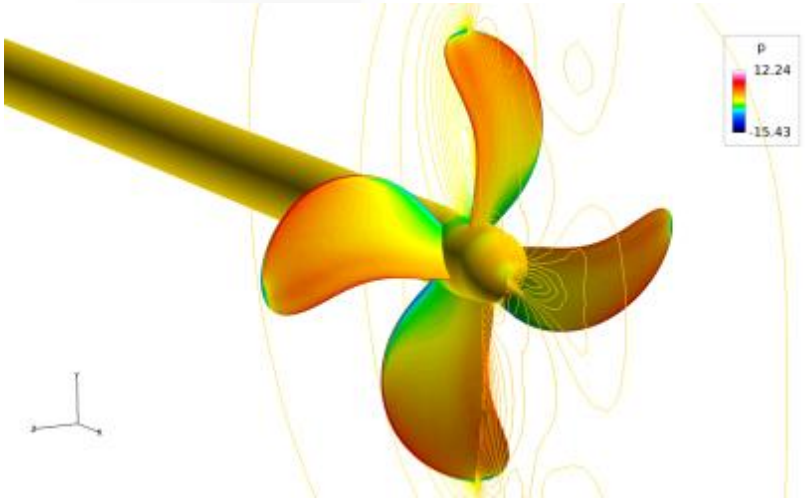
- NFoam solver

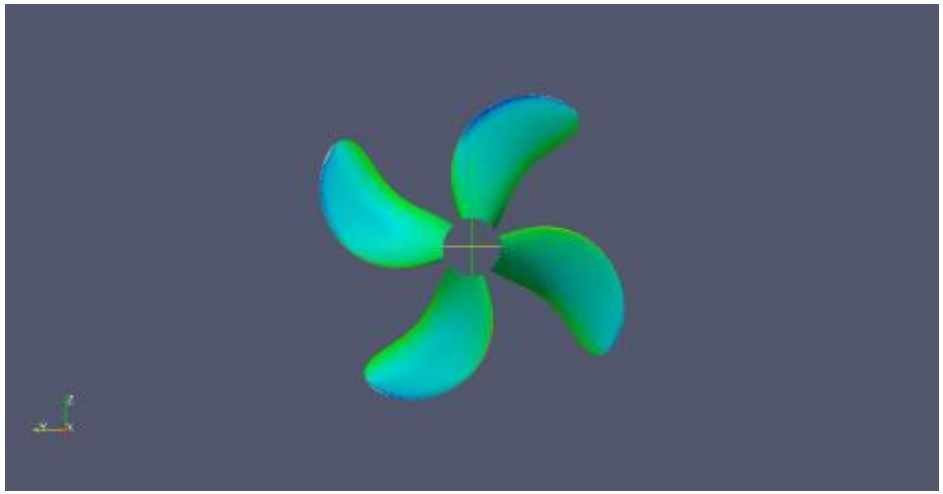


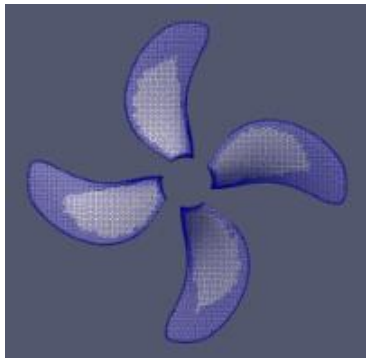
# 프로펠러 캐비테이션 (2016)

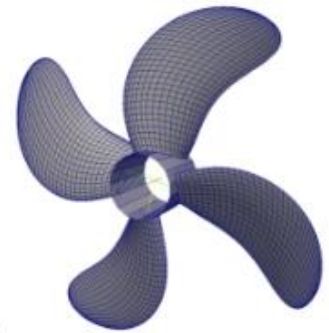
| | |
|---|---|
| 솔버 | • interPhaseChangeDyMFoam / OF-2.4.0 |
| 격자 | • snappyHexMesh, sliding mesh |
| B.C./물리모델 | • 소음 해석을 위한 data mapping |





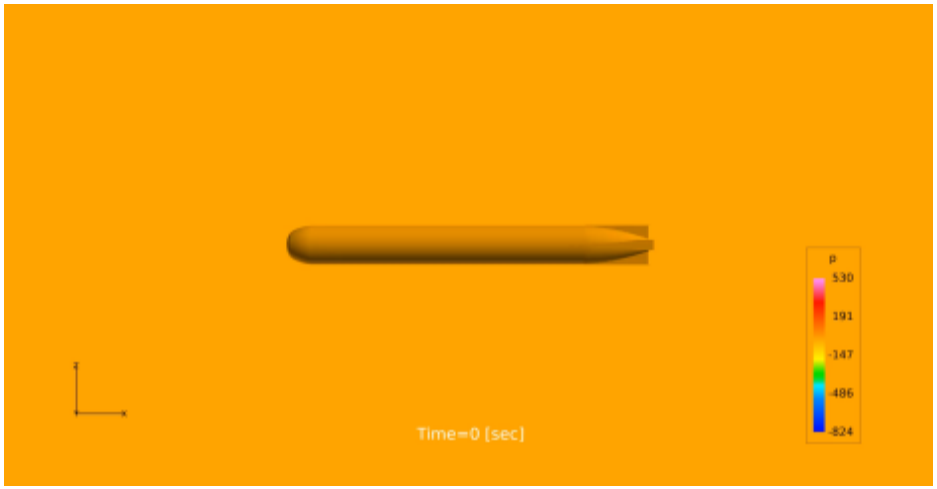


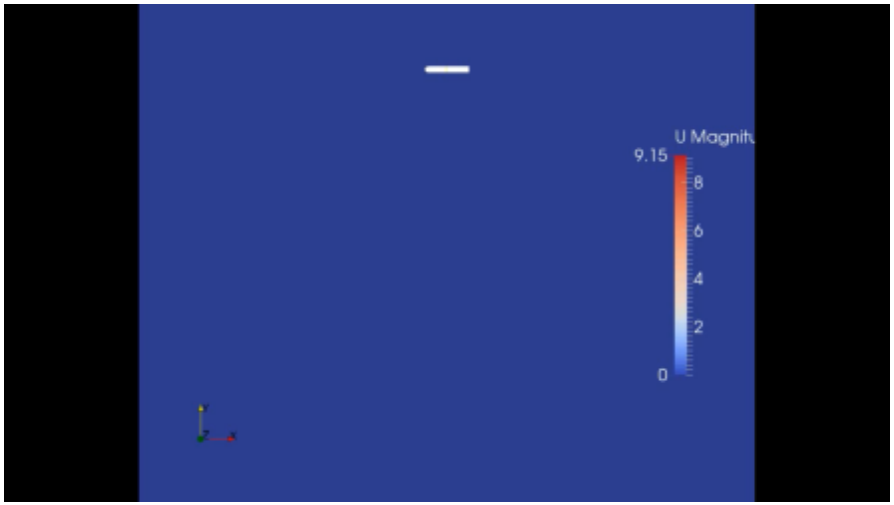


# 어뢰 (2016)

| | |
|---|---|
| 솔버 | • simpleNFoam, pimpleDyMNFoam / OF-2.4.0 |
| 격자 | • cfMesh, dynamic mesh |
| B.C./물리모델 | • 저항해석<br>• Fin 성능 해석<br>• PMM 해석 |

- NFoam solver

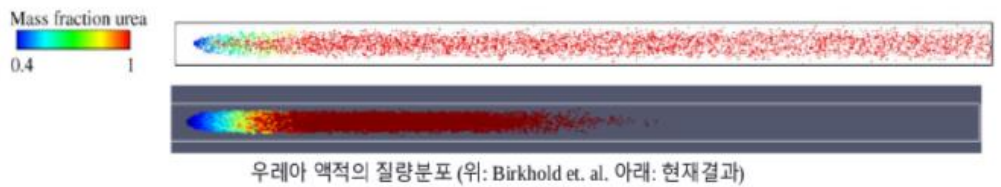


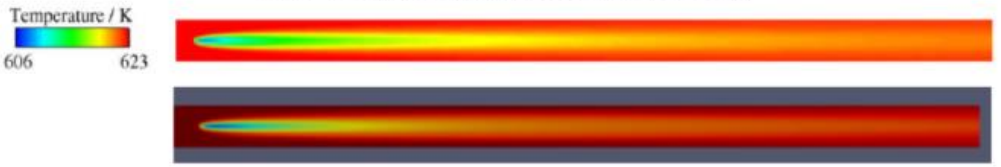
# SCR (2015)

| | |
|---|---|
| 솔버 | • HHILTSReactingParcelFoam / OF-2.3.x |
| 격자 | • snappyHexMesh |
| B.C./물리모델 | • Porous zone, spray model<br>• Modified Arrhenius equation<br>• DIPPR vapor pressure model<br>• 구역별 반응속도 지정 |

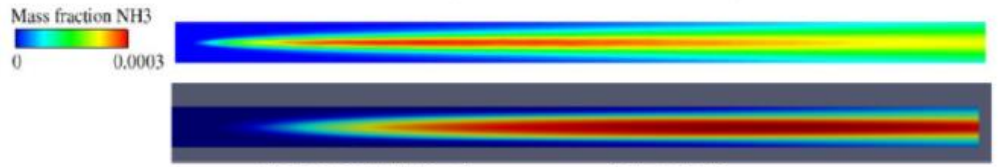
- 물리모델 개발, 솔버 개발



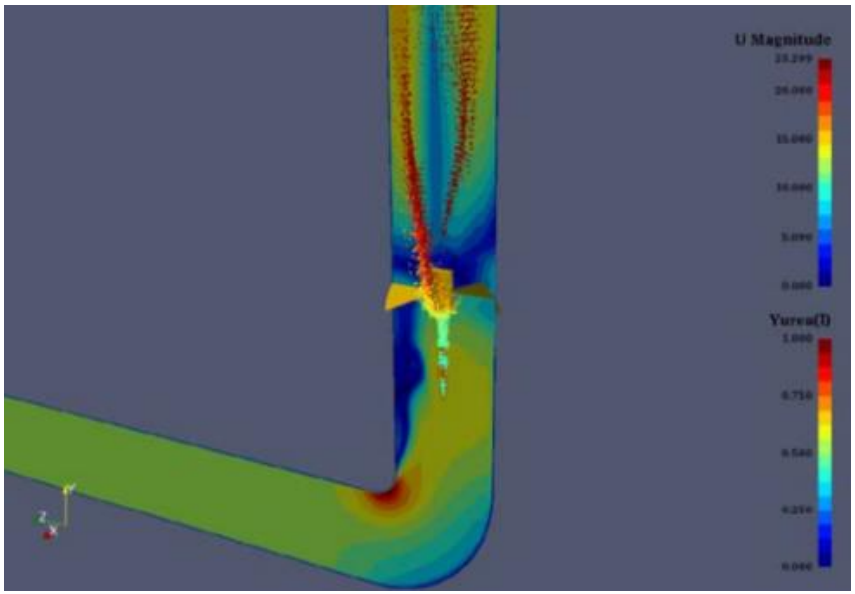
우레아 액적의 질량분포 (위: Birkhold et. al. 아래: 현재결과)



액적분사 시 온도분포 (위: Birkhold et. al. 아래: 현재결과)



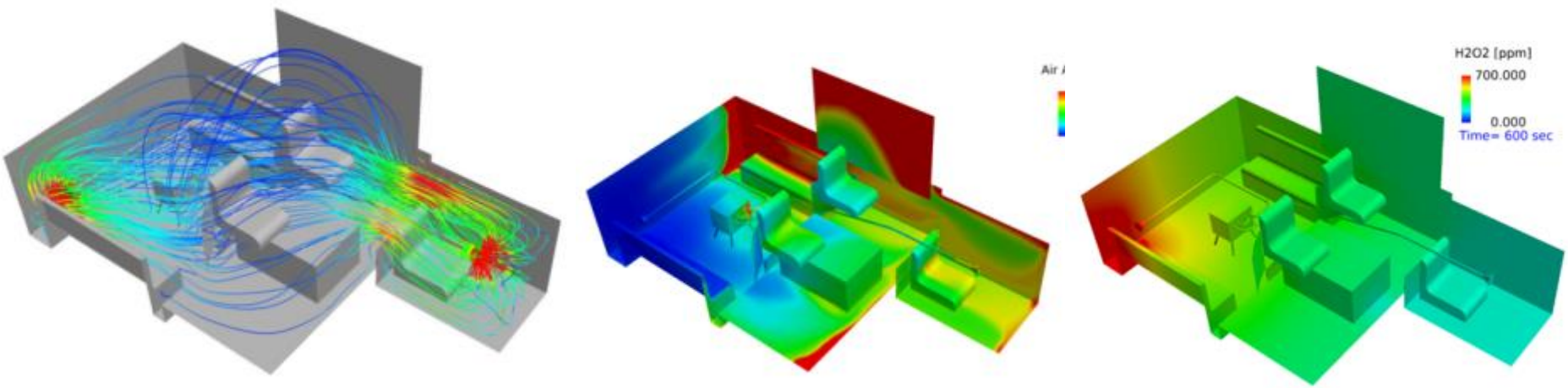
암모니아의 질량분율 (위: Birkhold et. al. 아래: 현재결과)



# 제독성능 해석 (2015)

| | |
|---|---|
| 솔버 | • samyangFoam / OF-2.4 |
| 격자 | • msh |
| B.C./물리모델 | • Natural convection, species transport<br>• 포화증기 농도 계산, 평형 증기압 계산<br>• H2O2 응축 개시 농도 계산, H2O2 응축량 계산<br>• 공기연령 계산 |

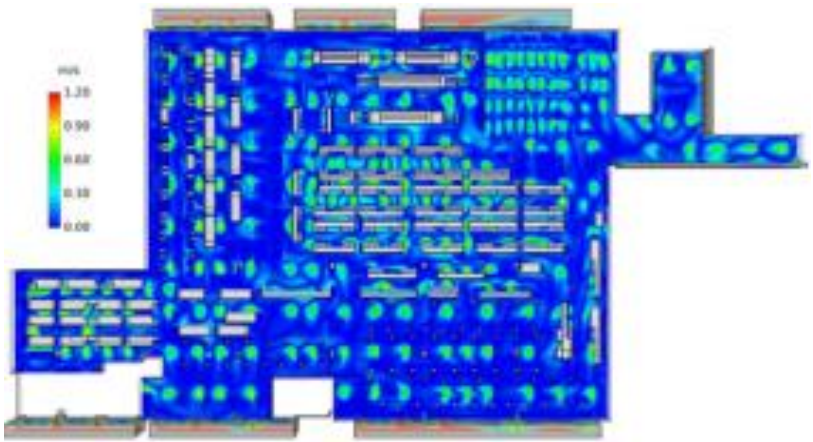
- 응축 모델 개발, 솔버 개발

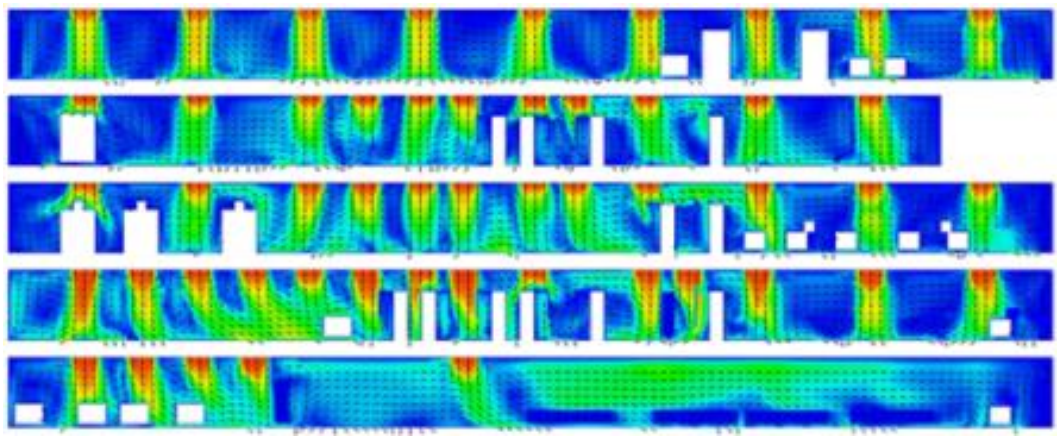


# 클린룸 (2015)

| | |
|---|---|
| 솔버 | • simpleNFoam / OF-2.3.x |
| 격자 | • msh |
| B.C./물리모델 | • Porous zone, porousJumpPressure<br>• Fixed velocity zone (pressureGradientExplicitSource) |

- NFoam solver

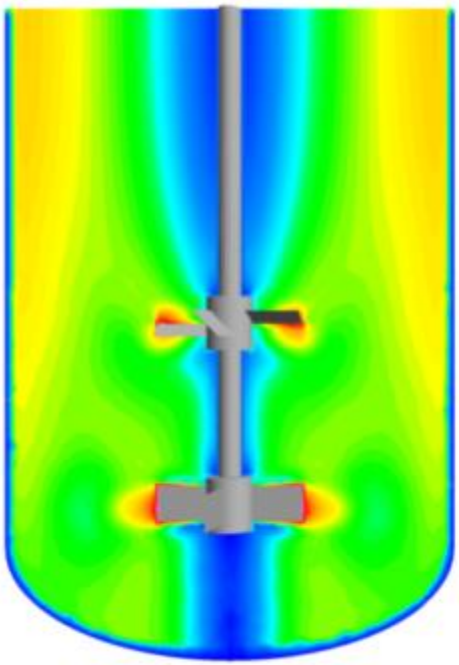


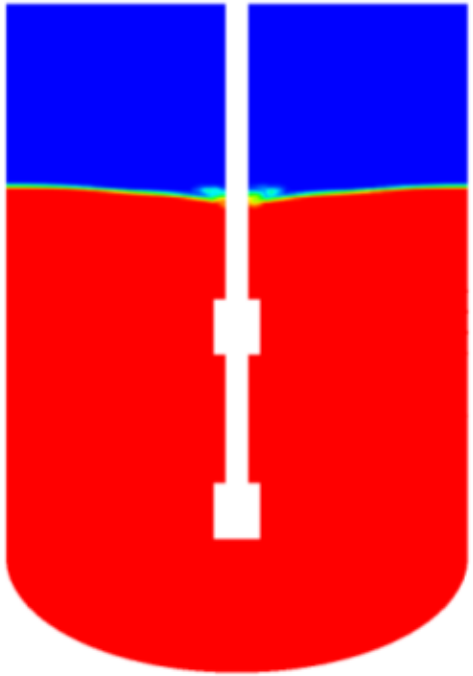


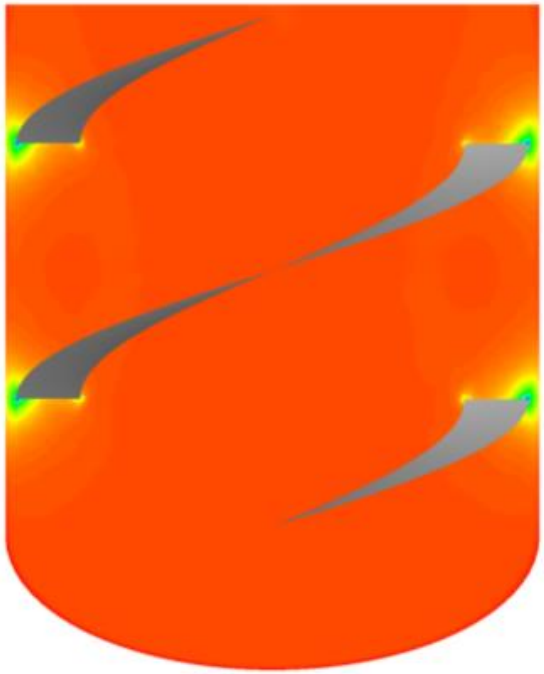
# Mixer (2014)

| | |
|---|---|
| 솔버 | • simpleN/pimpleDyMFoam, interDyMFoam, buoyantBoussinesqFoam / OF-2.3.x |
| 격자 | • msh |
| B.C./물리모델 | • 단상유동 / 다상유동 / 열전달<br>• Non-Newtonian fluid (temperatureDependentBirdCarreau model) |

- NFoam solver, non-Newtonian model 개발



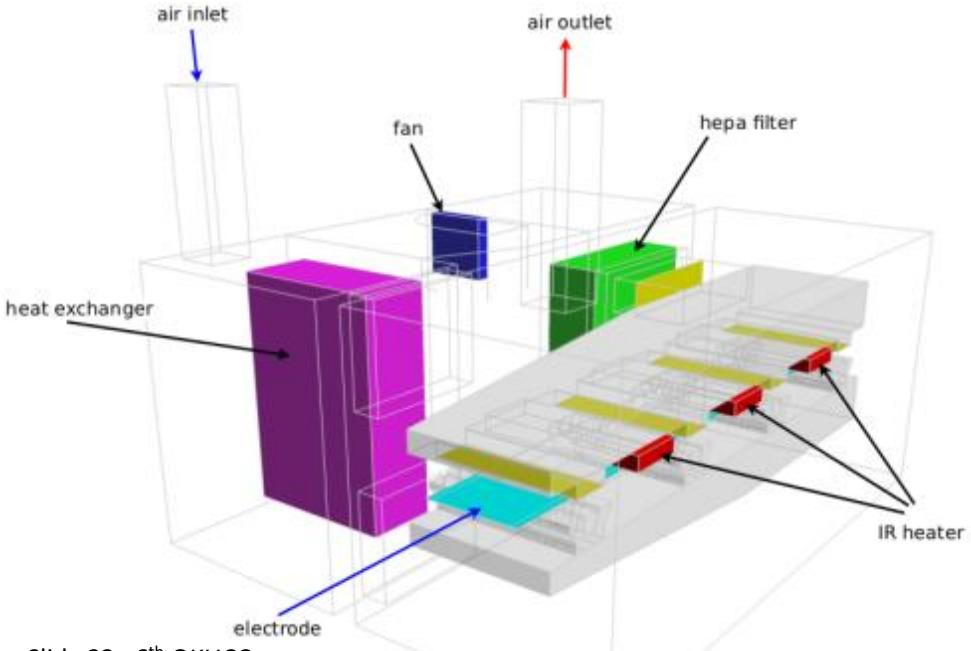


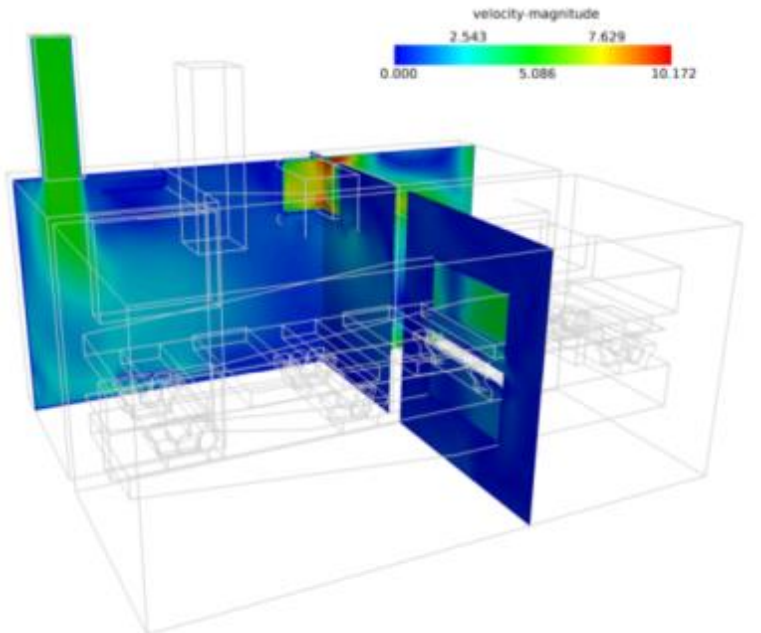


# 건조기 (2014)

| | |
|---|---|
| 솔버 | • LGCDryerSimpleFoam / OF-2.3.x (conjugated heat transfer solver) |
| 격자 | • msh |
| B.C./물리모델 | • Temperature dependent scalar diffusivity<br>• Vapor pressure model<br>• Water evaporation model<br>• IR Heater model |

- 물리모델 개발, 솔버 개발

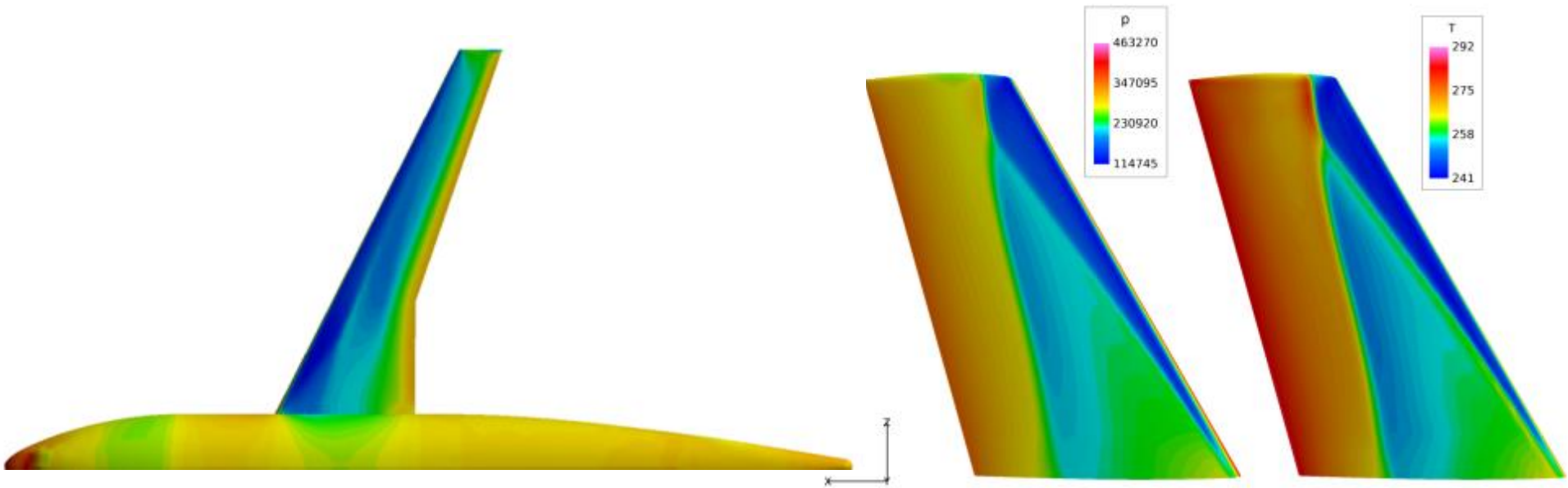


# DLR-F6 / ONERA M6 (2013)

| | |
|---|---|
| 솔버 | • TSLAeroFoam / OF-1.6-ext (밀도 기반 압축성 솔버) |
| 격자 | • snappyHexMesh, msh |
| B.C./물리모델 | • 고속 압축성 유동<br>• farfieldRiemann |

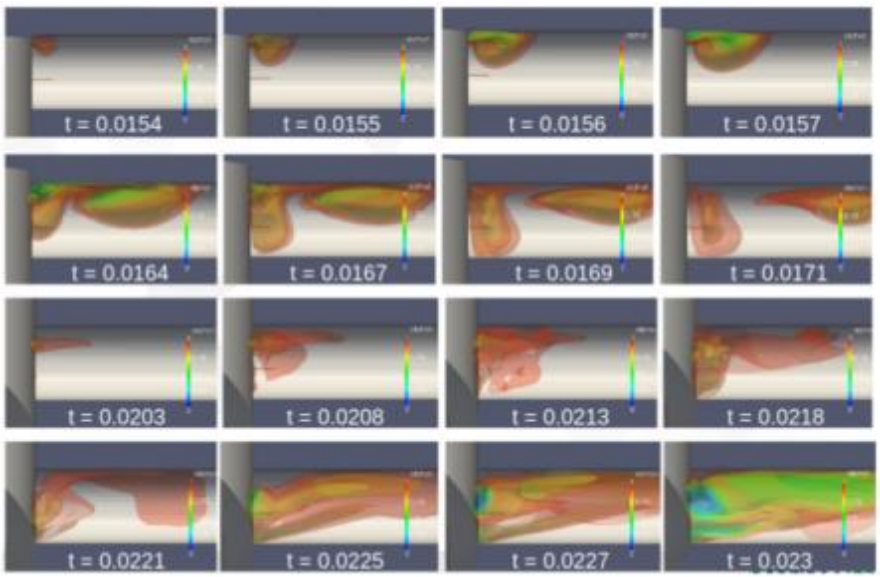
- 솔버 개발, 경계조건 개발

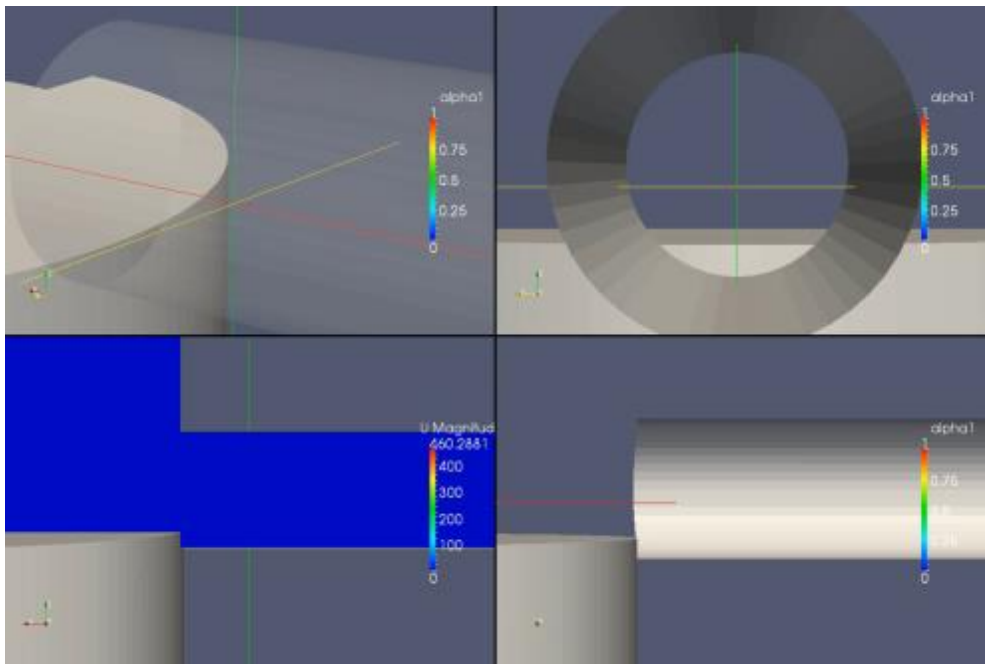


# 플런저 펌프 캐비테이션 (2013)

| | |
|---|---|
| 솔버 | • cavDyMFoam / OF-1.6-ext |
| 격자 | • msh<br>• Layering, ggi, cyclicGgi |
| B.C./물리모델 | • timeVaryingUniformFixedValue (outlet pressure profile)<br>• Schnerr & Sauer cavitation model |

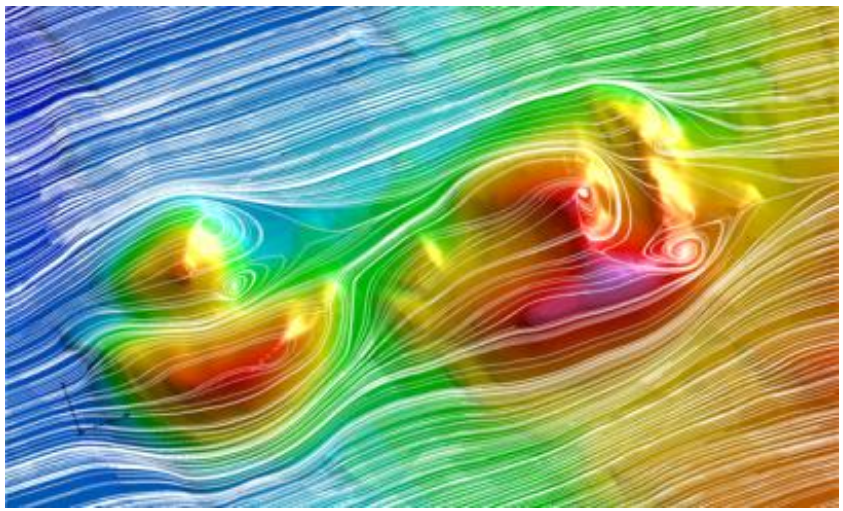
- 솔버 개발(SNUFOAM 솔버 수정), ~~solidBodyMotionFunction~~ 개발

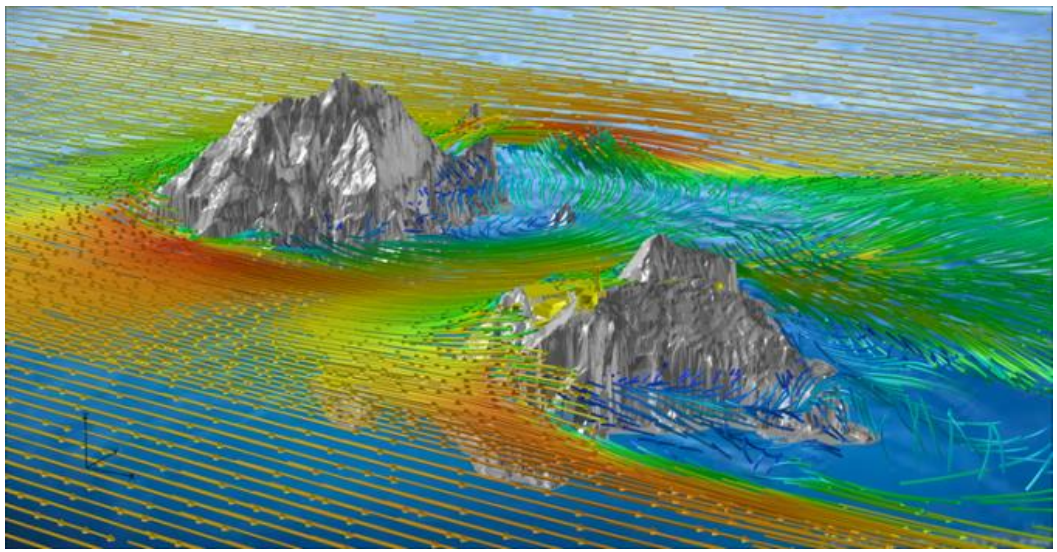


# windscape (2012)

| | |
|---|---|
| 솔버 | • simpleFoam / OF-2.0 |
| 격자 | • ATWIND (DEM → 3D hexahedral mesh) |
| B.C./물리모델 | • 대기경계층 조건 |

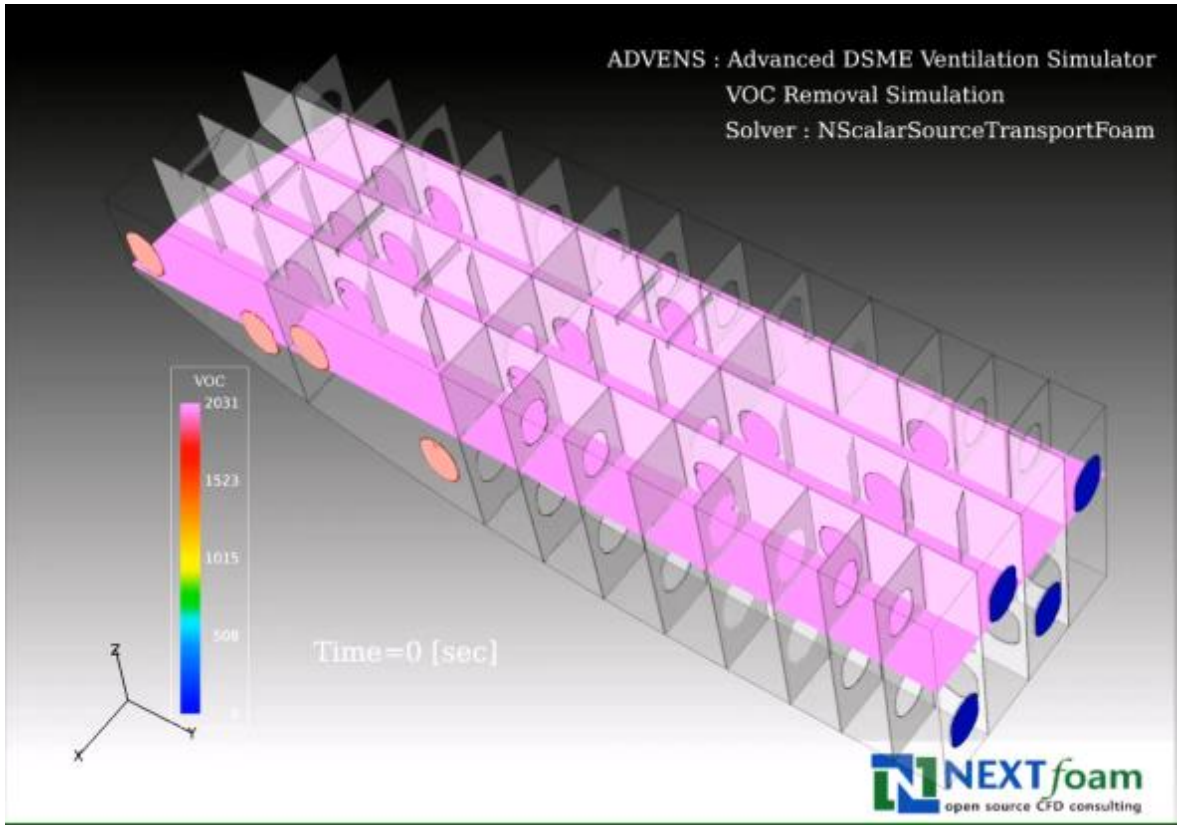




# 선박 블록 내부 환기 해석(2012)

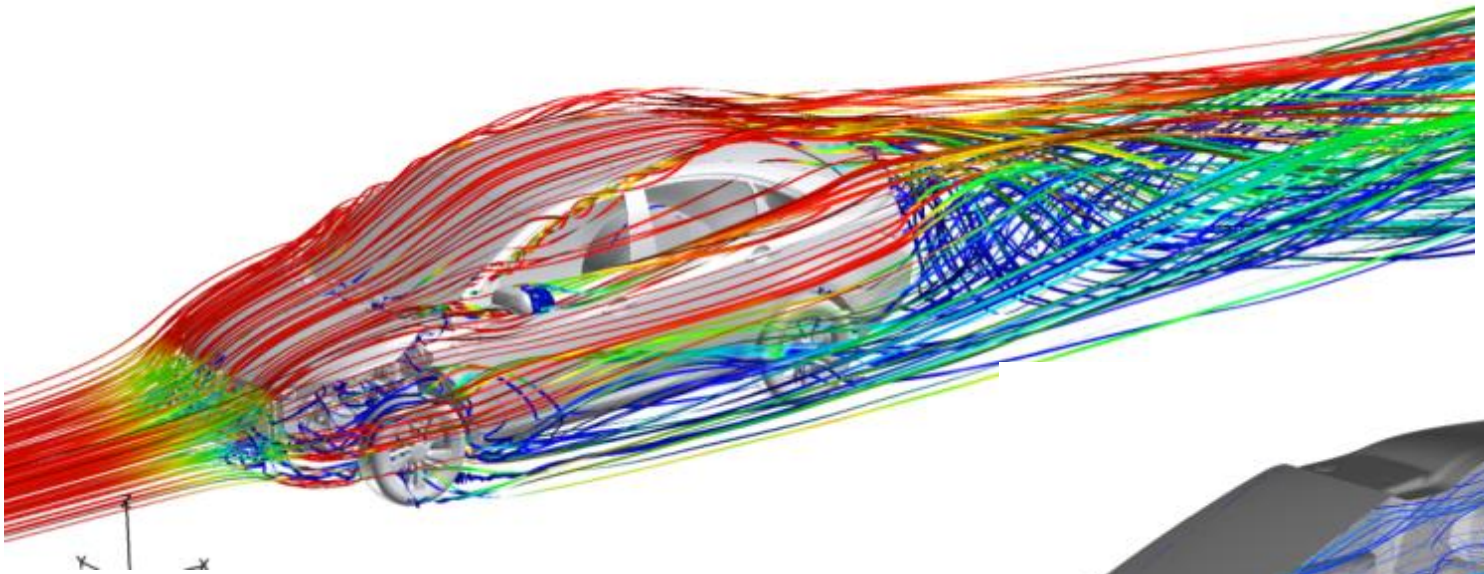
| | |
|---|---|
| 솔버 | • simpleFoam, NScalarSourceTransportFoam, airAgeFoam / OF-2.0 |
| 격자 | • snappyHexMesh |
| B.C./물리모델 | • VOC source |

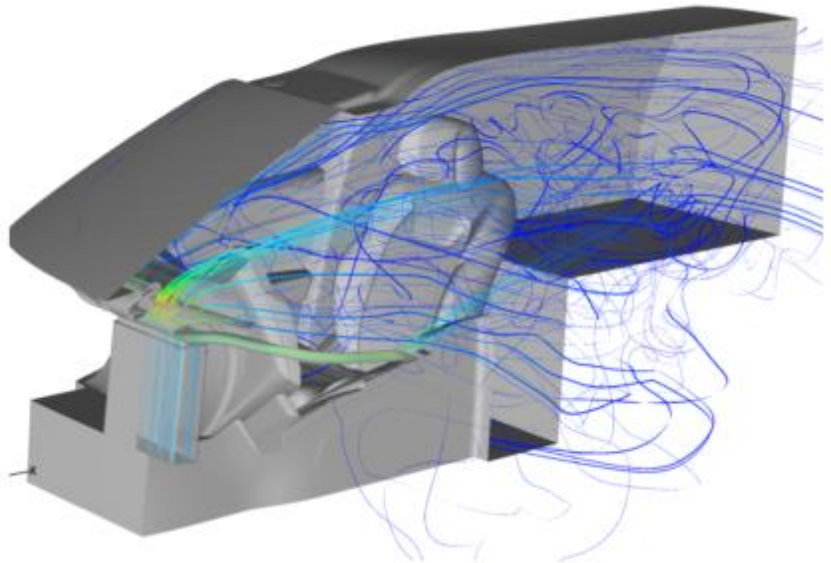
- 솔버 개발 - airAgeFoam



# 자동차 외부 유동 / 내부 유동(2012)

| | |
|---|---|
| 솔버 | • simpleFoam / OF-1.6-ext |
| 격자 | • ccm<br>• subsetMesh |

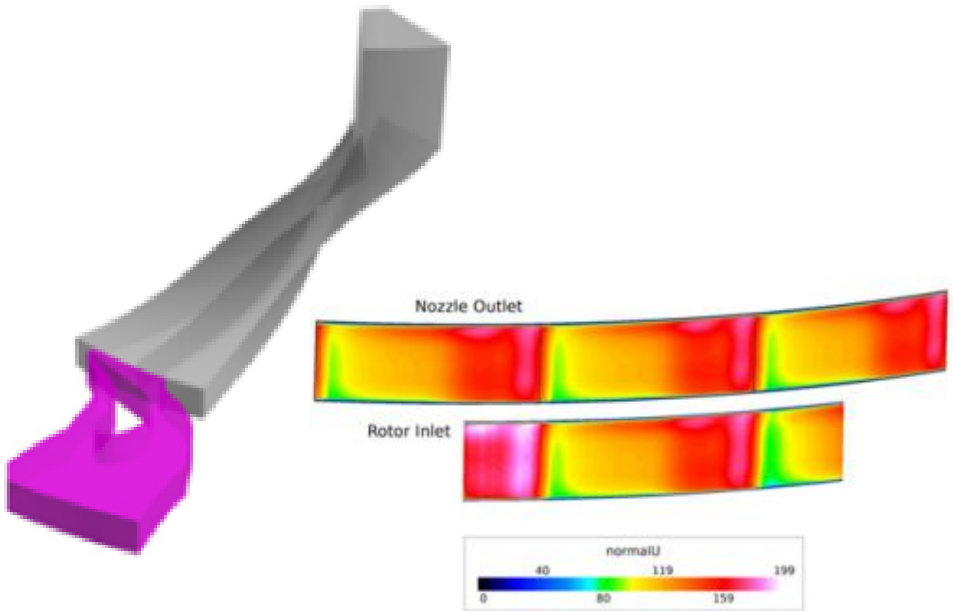


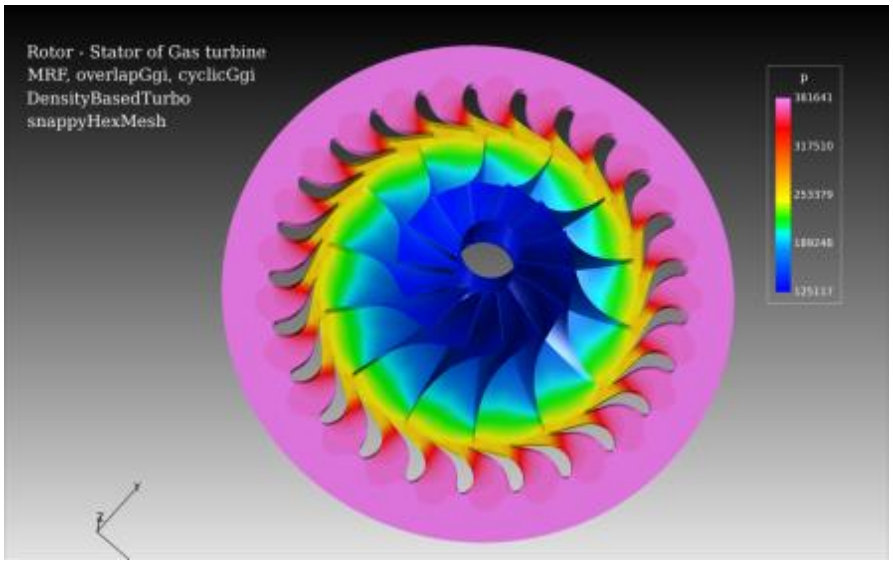


# 가스터빈엔진의 원심 터빈(2012)

| | |
|---|---|
| 솔버 | • densityBasedTurbo / OF-1.6-ext (밀도 기반 외재적 압축성 솔버) |
| 격자 | • msh, snappyHexMesh<br>• overlapGgi, cyclicGgi |
| B.C./물리모델 | • 고속 압축성 유동<br>• totalPressure, isentropicTotalTemperature<br>• MRF |

- 공개 솔버

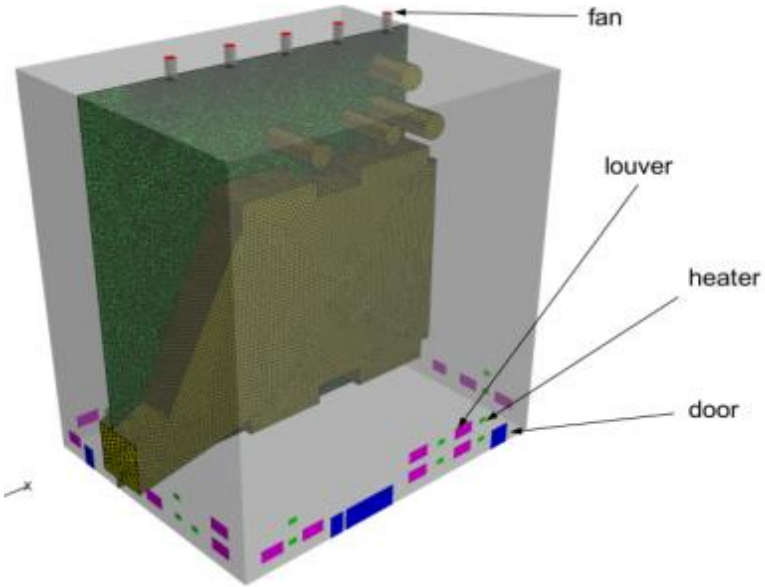


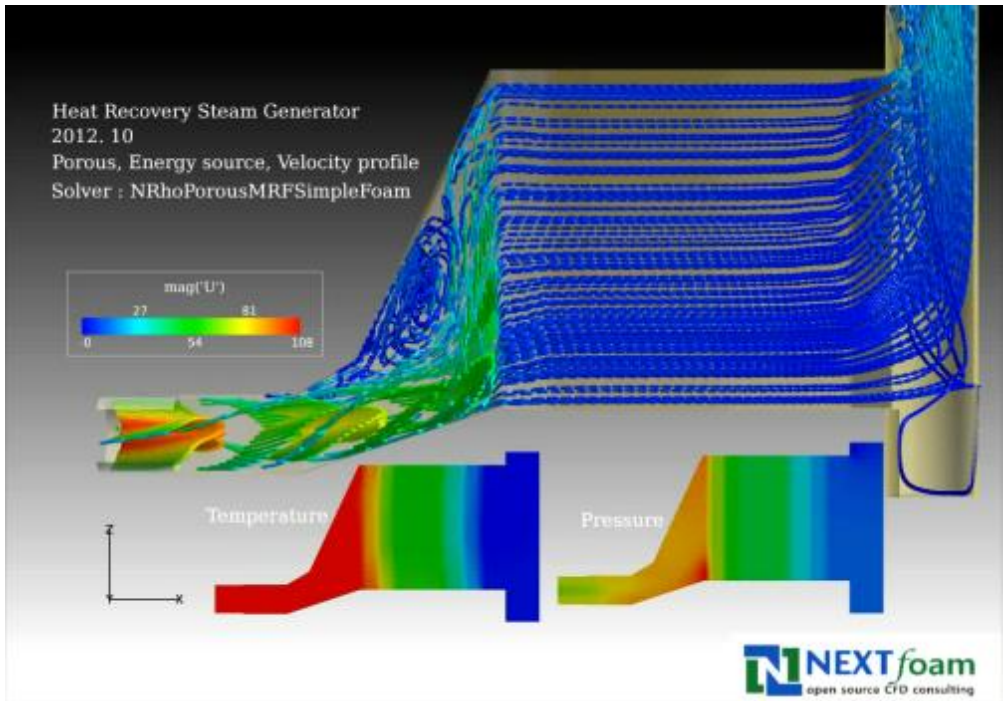



# HRSG Enclosure / inelt duct(2012)

| | |
|---|---|
| 솔버 | • buoyantSimpleFoam, NRhoPorousMRFSimpleFoam / OF-2.0 |
| 격자 | • msh |
| B.C./물리모델 | • wallHeatTransfer, turbulentHeatFluxTemperature<br>• timeVaryingMappedFixedValue (inlet velocity profile)<br>• porous zone model<br>• scalarExplicitSource (heat sink) |

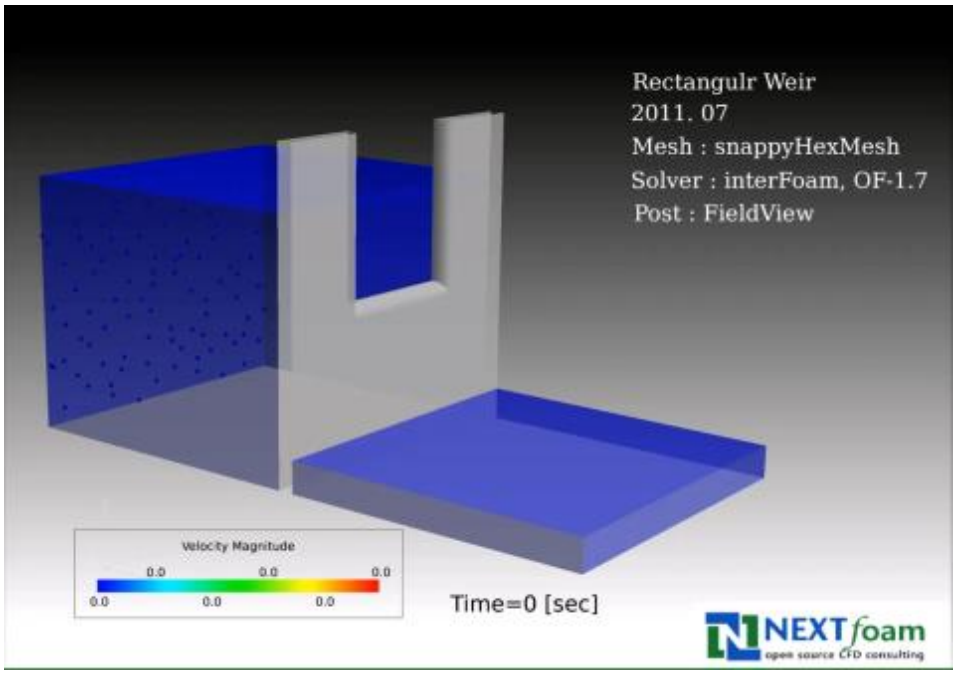
• 솔버수정

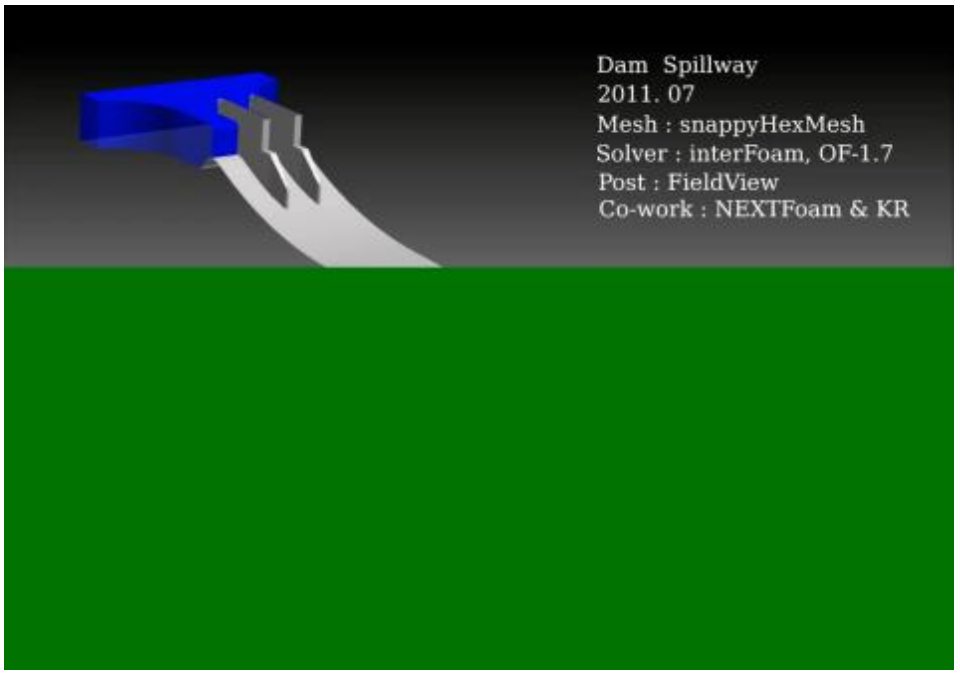


# 위어, 댐 (2011)

| | |
|---|---|
| 솔버 | • interFoam/ OF-1.7 |
| 격자 | • Harpoon, snappyHexMesh |



# 감사합니다.