

[CFD-ACE+ License]

CFD-ACE+ Solution Packages



(주)경원이앤씨

Package Reference	Solver Modules (2 Processes License)	Pre and Post Modules
ACE-SP-01	ACE+ Basepack Flow, Turbulence, Heat, Radiation(P1, STS, DOM)	1 Geom and 1 View (Used Concurrently)
ACE-SP-02	ACE+ Multiphysics-1 Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM) Multiphase, Stress, Electric, Magnetics	
ACE-SP-03	ACE+ Multiphysics-2 Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM, MC) Spray, Chemistry, Stress	
ACE-SP-04	ACE+ Plasma Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM, MC) Spray, Chemistry, Electric, Magnetics, Plasma	
ACE-SP-05	ACE+ Total Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM, MC) Cavitation, Mixing, Spray, VOF, Two Fluid, Chemistry, Stress, Electric, Magnetics, Plasma	
TOPO-SP-01	TOPO+Basepack Package	1 Geom and 1 View (Used Concurrently)
ACE-PP-01	ACE Pre & Post Package	1 Geom and 1 View (Used Concurrently)
ACE-PP-02	ACE VisCART Package	1 Geom and 1 View (Used Concurrently)
ACE-PP-03	ACE CAD Import Package	CAD import for : STEP, IGS, Pro/e, CATIA, SolidWorks, Unigraphics
ACE-HP-01	Parallel 8	None
ACE-HP-02	Parallel 16	
ACE-HP-03	Parallel 32	
ACE-HP-04	Parallel 64	
ACE-HP-99	Each Parallel After 64	
FAS-SP-01	Fastran Solver Package (1 Process License)	None

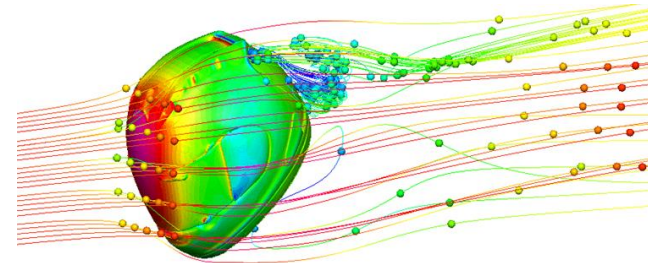
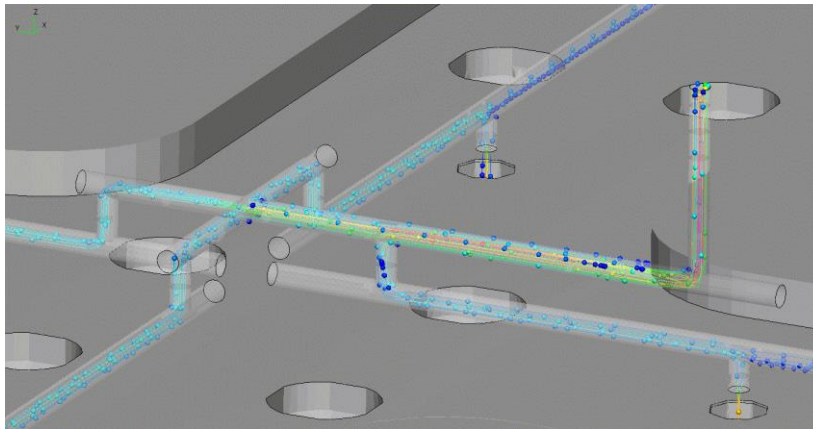
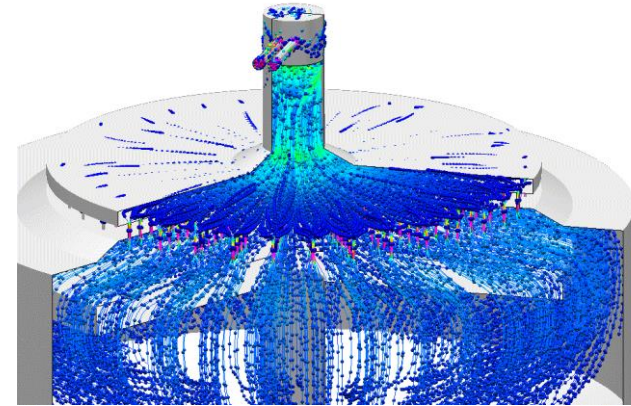
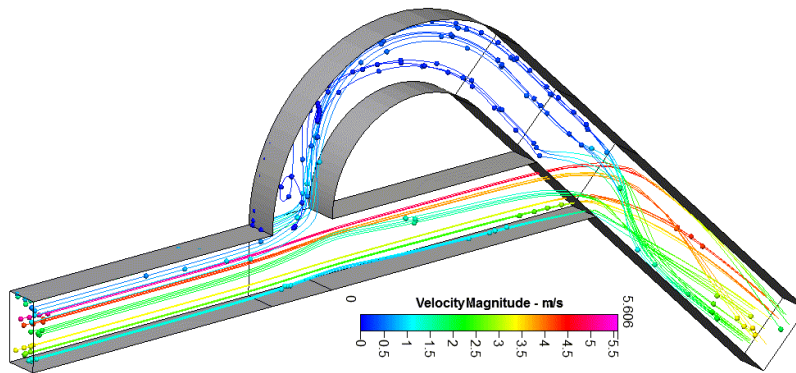
Package Reference : ACE-SP

Package Reference	Solver Modules (2 Processes License for All)	Pre and Post Modules
ACE-SP-01	ACE+ Basepack Flow, Turbulence, Heat, Radiation(P1, STS, DOM)	1 Geom and 1 View (Used Concurrently)
ACE-SP-02	ACE+ Multiphysics-1 Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM) Multiphase, Stress, Electric, Magnetics	
ACE-SP-03	ACE+ Multiphysics-2 Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM, MC) Spray, Chemistry, Stress	
ACE-SP-04	ACE+ Plasma Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM, MC) Spray, Chemistry, Electric, Magnetics, Plasma	
ACE-SP-05	ACE+ Total Package Flow, Turbulence, Heat, Radiation(P1, STS, DOM, MC) Cavitation, Mixing, Spray, VOF, Two Fluid, Chemistry, Stress, Electric, Magnetics, Plasma	

- 모든 ACE+ Solution Package에는 Flow, Heat, Turbulence, Radiation(P1, STS, DOM), User-scalar, Grid Deformation, User Subroutines 모듈 포함
- 각 Package는 2 process의 solver를 동시에 구동 가능하며, GEOM과 VIEW를 하나씩 동시에 실행 가능

Package Reference : ACE-SP

Flow



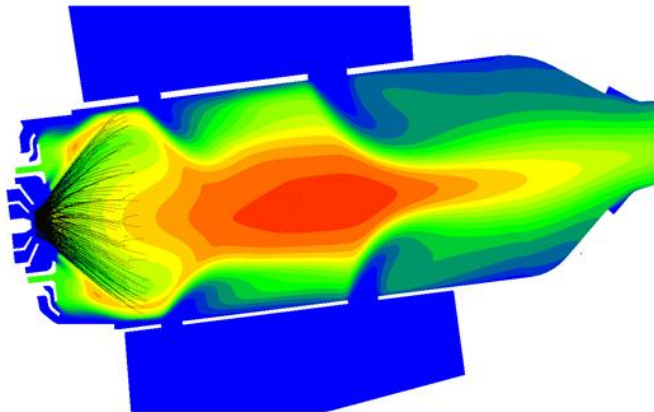
Package Reference : ACE-SP

Turbulence

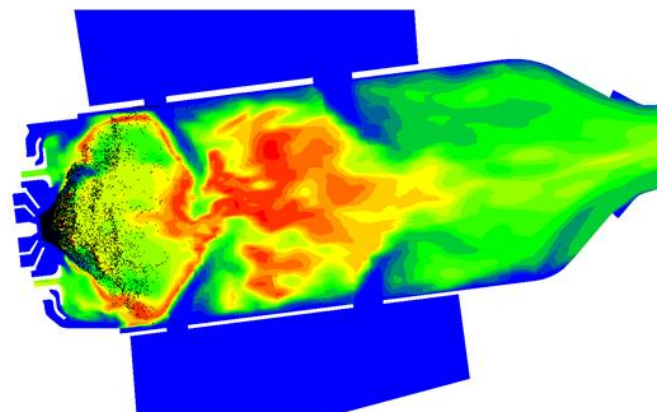
RANS(Reynolds averaged Navier Stokes)

- ⇒ K-epsilon
- ⇒ K-omega
- ⇒ Low Reynolds
- ⇒ Spalart-Allmaras
- ⇒ V2-F

LES(Large Eddy Simulation)



RANS



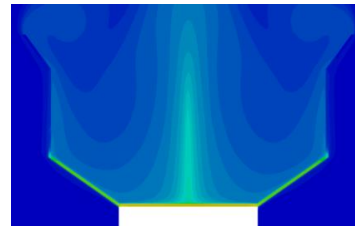
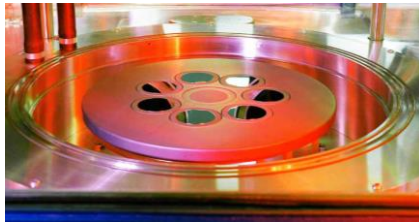
LES

Package Reference : ACE-SP

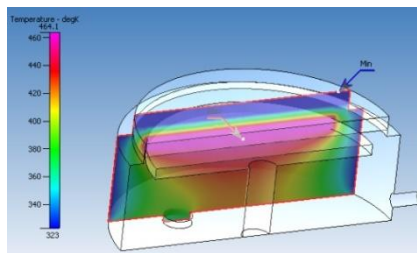
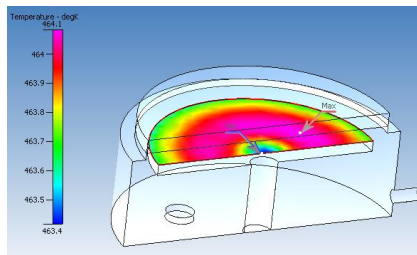
Heat

전도(conduction), 자연 대류(natural convection), 강제 대류(forced convection)

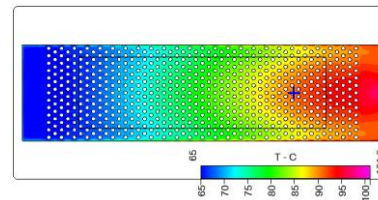
복합 열전달(전도+대류, conjugate heat transfer), 상변화(Ice melting, Solidification)



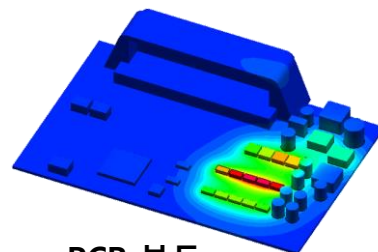
Bucket 내부



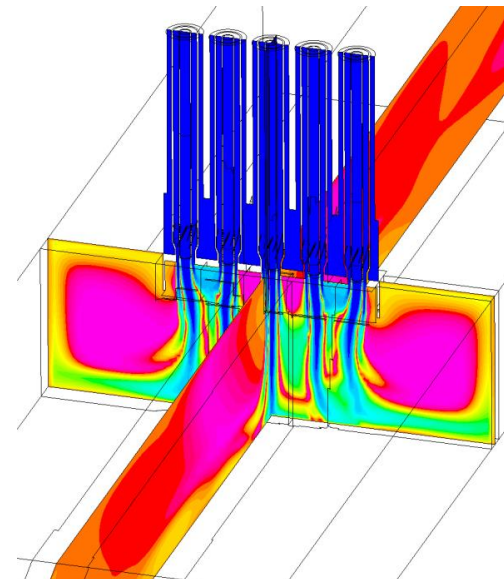
CVD chamber



방열 Fin



PCB 보드



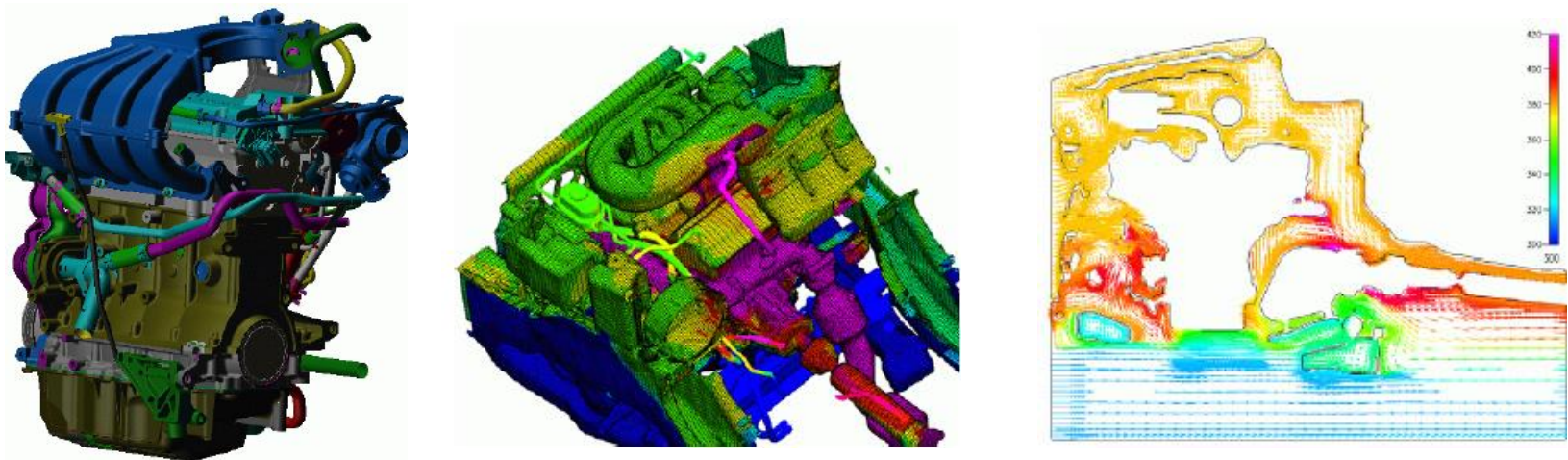
Package Reference : ACE-SP

Radiation

P1 Method(P1)

Surface to Surface(STS)

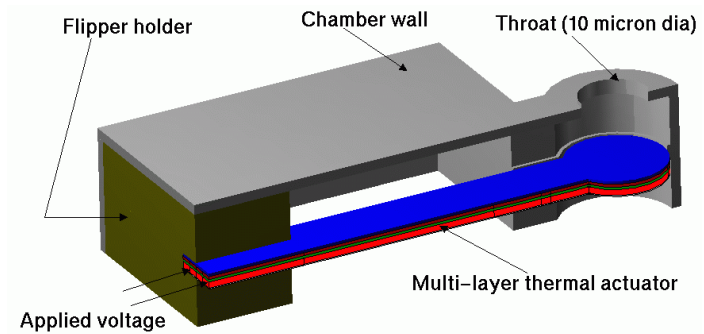
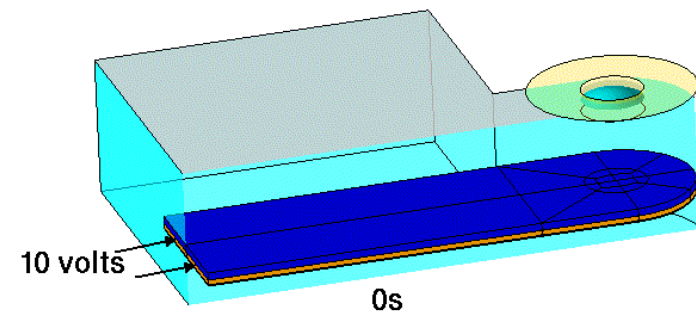
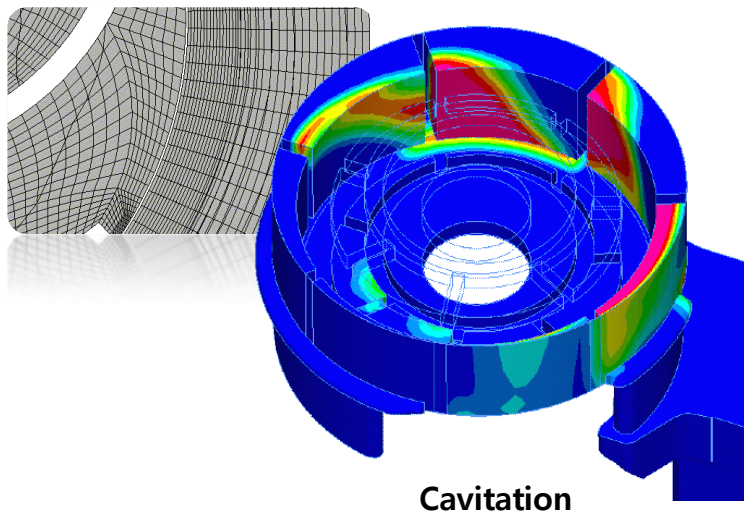
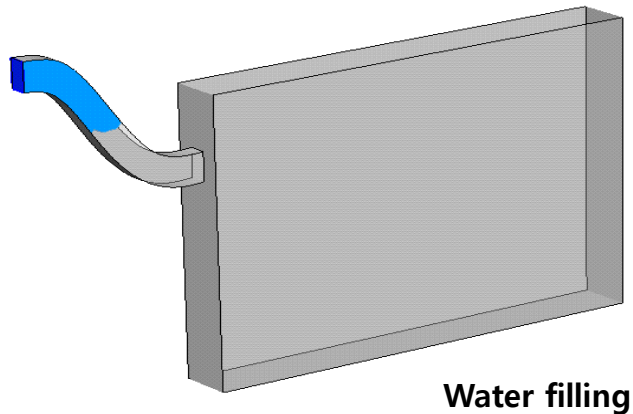
Discrete Ordinate Method(DOM)



Radiation을 고려한 자동차 후드 내부 해석

Package Reference : ACE-SP

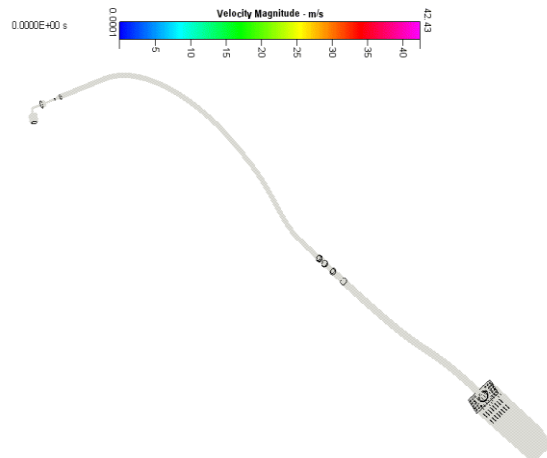
Multiphase : VOF (Volume of Fluid), Cavitation, Two fluid



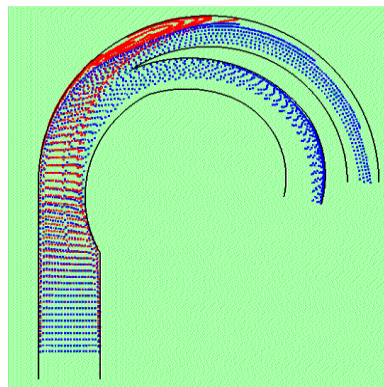
Ink jet 해석

Package Reference : ACE-SP

Spray, Macro particle



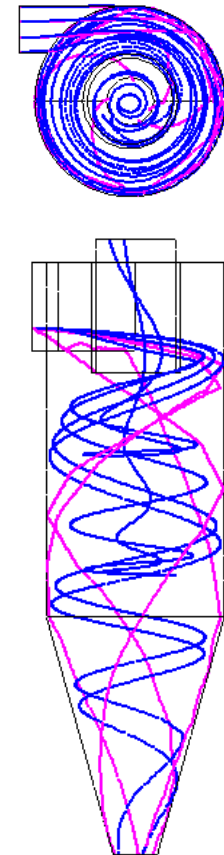
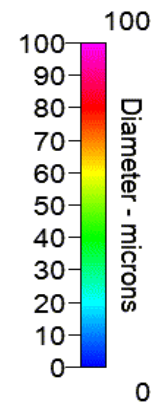
유동에 따른 입자 추적



Aerosol separator



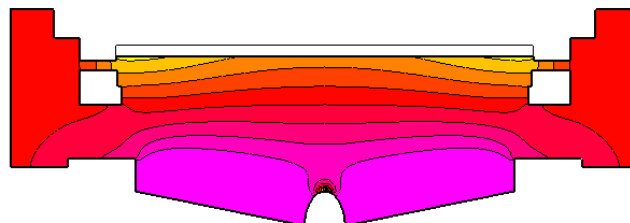
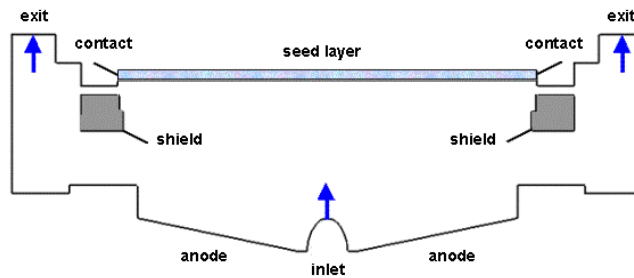
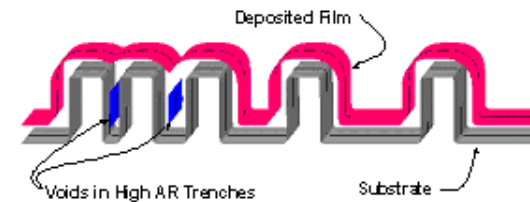
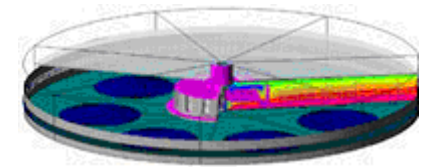
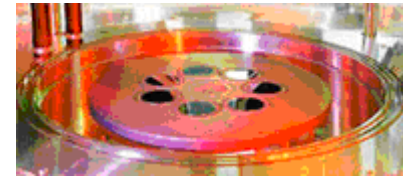
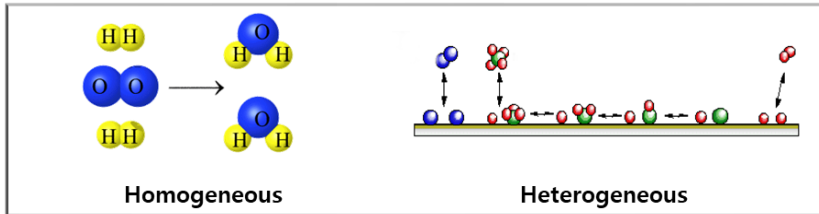
Spray 거동 및 evaporation



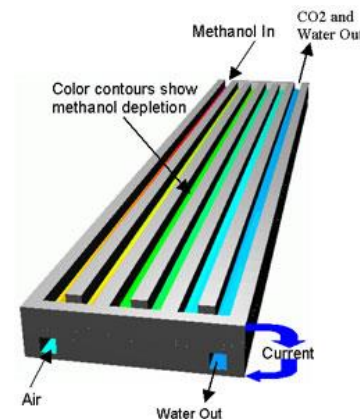
Cyclone separator

Package Reference : ACE-SP

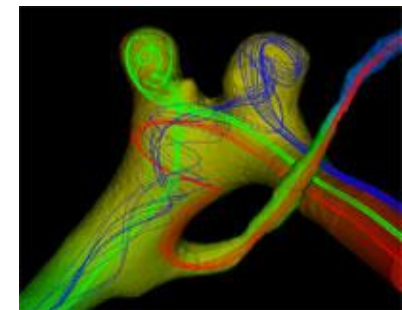
Chemistry



Electroplating



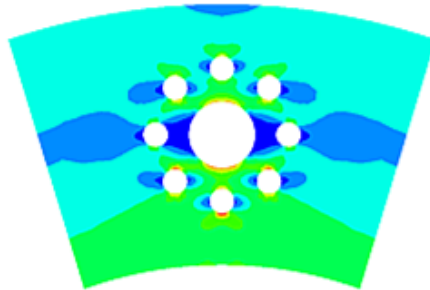
Fuel cell



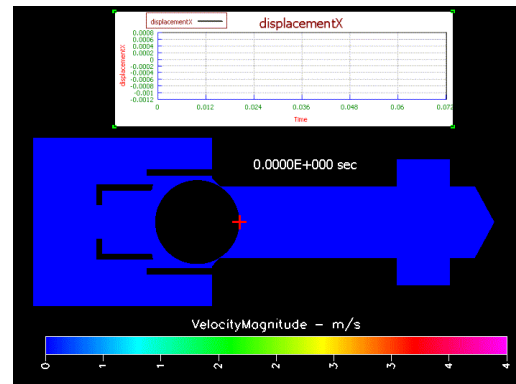
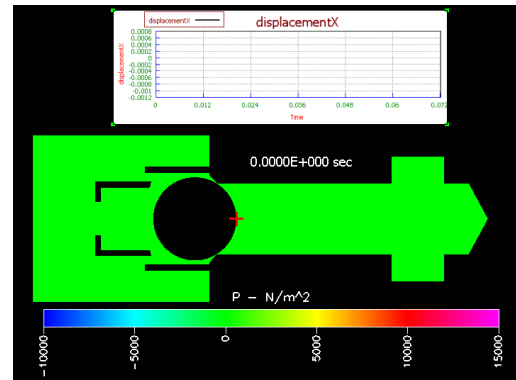
Bio chemistry

Package Reference : ACE-SP

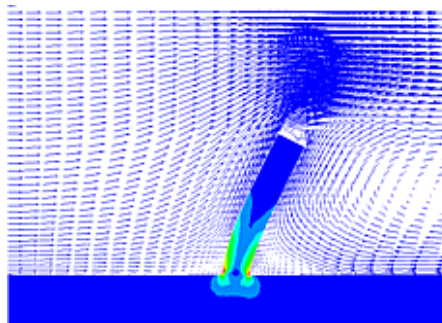
Stress & Grid deformation



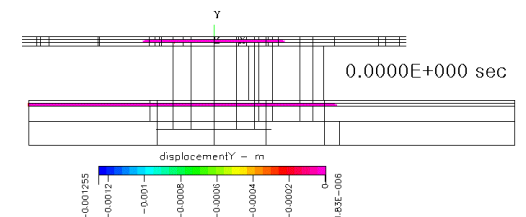
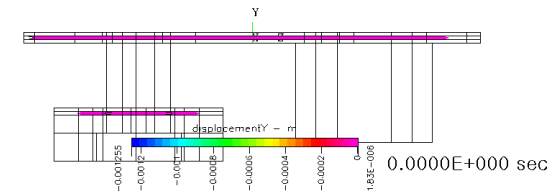
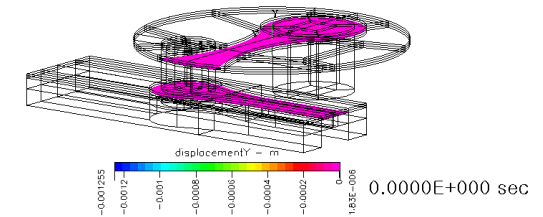
구조물의 응력 해석



Check valve



Fluid-stress



Dual plate valve

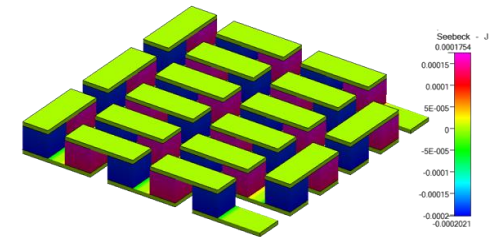
Package Reference : ACE-SP

Electric, Magnetic, Plasma

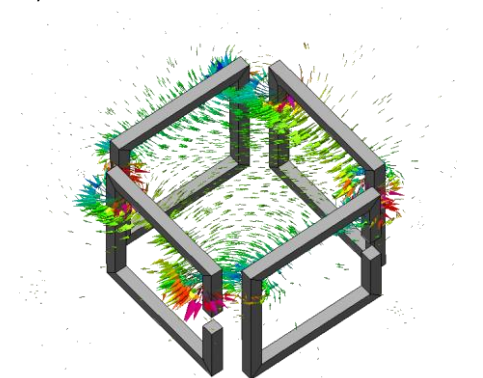
Electric : Electrostatic, DC/AC conduction, Piezoelectric materials,
Peltier/Seebeck effect, Electro thermal flow

Magnetic : Static, AC, DC+AC, Maxwell equation

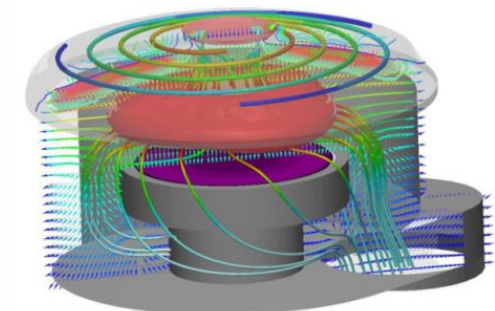
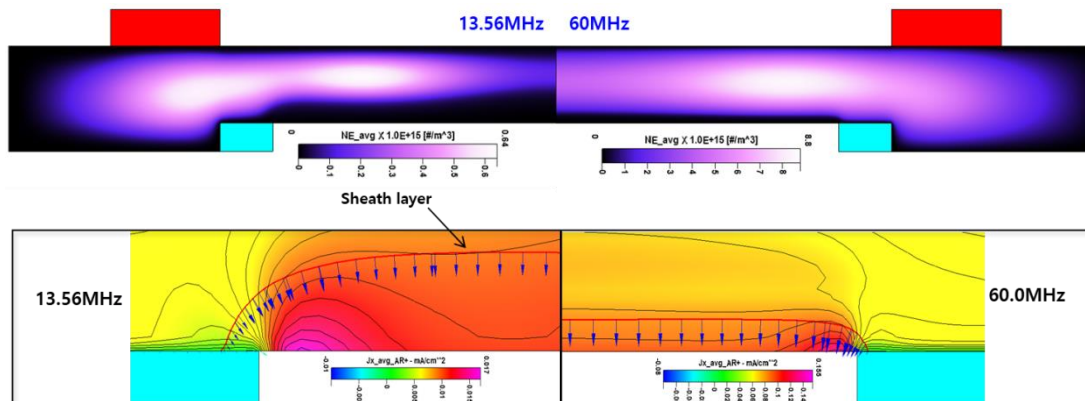
Plasma : Inductively Coupled Plasmas(ICP), Direct Current(DC),
Capacitively Coupled Plasmas(CCP)



Seebeck effect



Magnetic Field



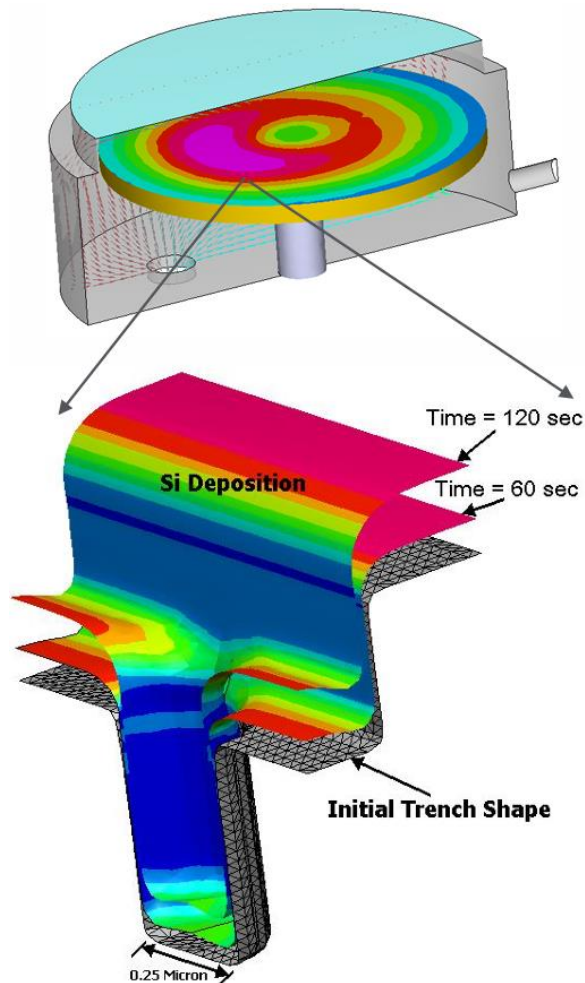
Package Reference : TOPO-SP

Feature Scale Topography Evolution Simulation Tool

TOPO-SP-01	TOPO+Basepack Package	1 Geom and 1 View (Used Concurrently)
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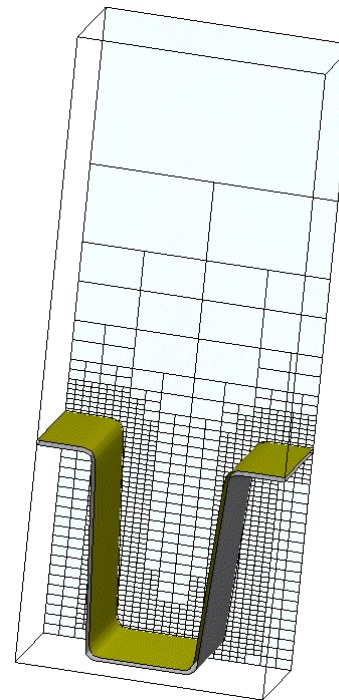
Package Reference : TOPO-SP

TOPO+ Backpack Package

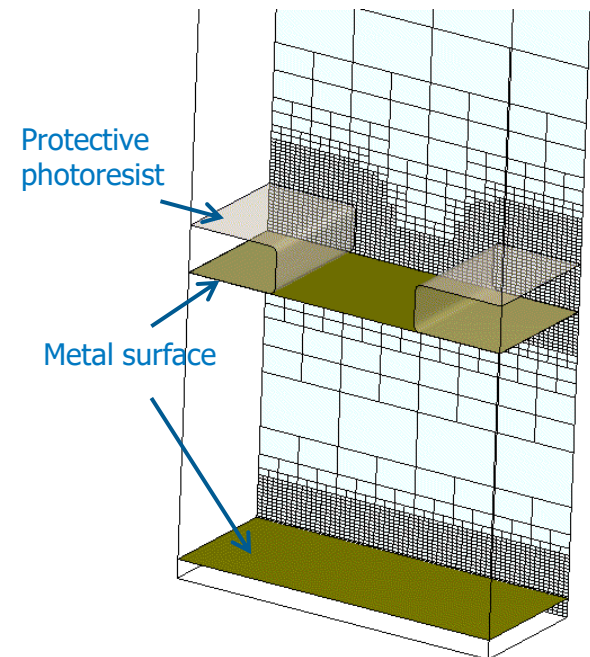


ACE-SOLVER를 통해 계산 된 박막 증착과 웨이퍼 표면에서의 에칭 결과(Reactor scale)를 바탕으로, 웨이퍼 표면 형상이 진화되어 가는 과정을 Feature scale(microns)기준으로 시뮬레이션 가능.

level set 방법을 통해 표면 반응의 궤적을 추적하며, 계산을 위한 격자는 adaptive meshing을 사용.



Simple PVD
(Ti_{gas} → Ti_{Bulk})



Simple Cl⁺ etch

Package Reference : ACE-PP-01

CFD-GEOM : 형상 모델링 및 격자 생성

CFD-VIEW : 해석 결과 시각화, 데이터 추출 및 분석

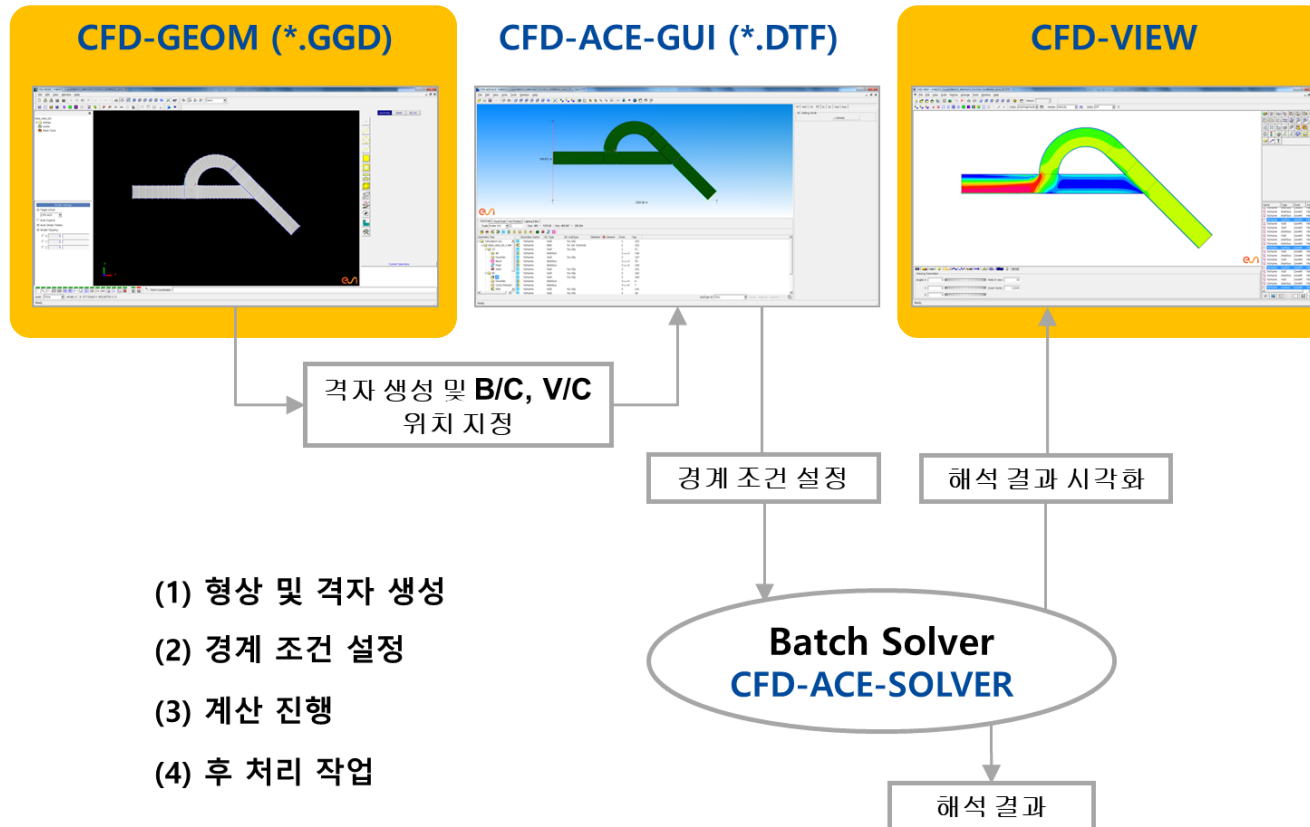
ACE-PP-01	ACE Pre & Post Package	1 Geom and 1 View (Used Concurrently)
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Package Reference : ACE-PP-01

ACE Pre & Post Package : CFD-GEOM, CFD-VIEW

CFD-GEOM : 형상 모델링 및 격자 생성

CFD-VIEW : 해석 결과 시각화, 데이터 추출 및 분석



Package Reference : ACE-PP-02

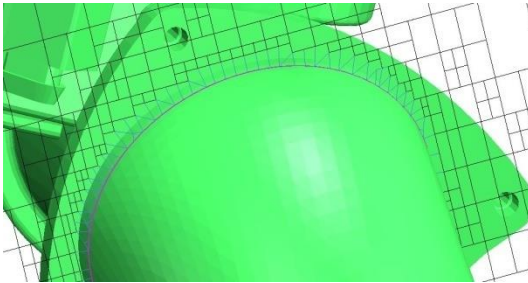
CFD-VisCART : 비정형 자동 격자 생성 프로그램

ACE-PP-02	ACE VisCART Package	1 Geom and 1 View (Used Concurrently)
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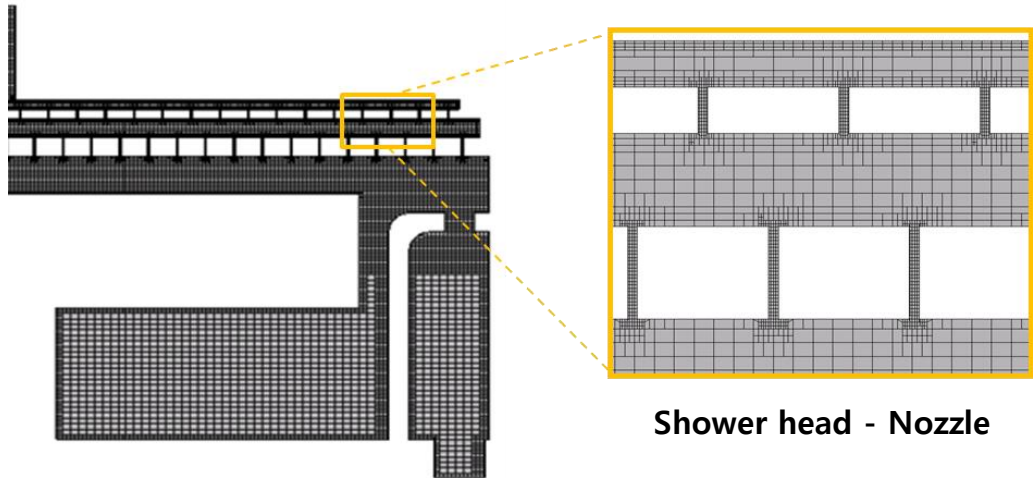
Package Reference : ACE-PP-02

ACE VisCART Package

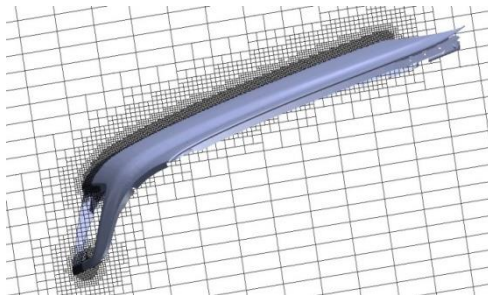
CAD를 기반으로 하는 3-D adaptive Cartesian 격자 생성 시스템



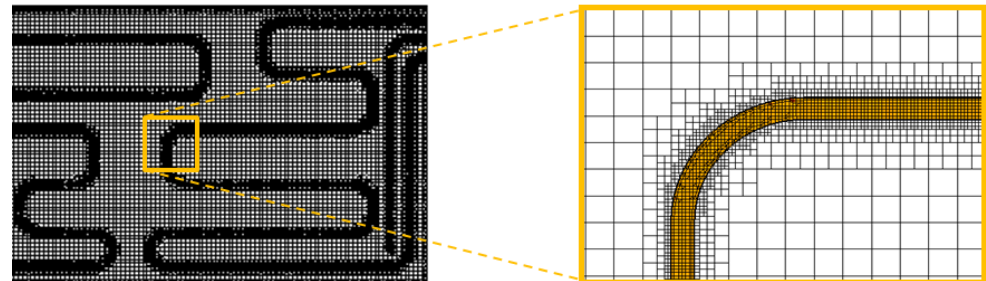
Body-fitted mesh



Shower head - Nozzle



Geometry based Adaption



Heat transfer

Package Reference : ACE-PP-03

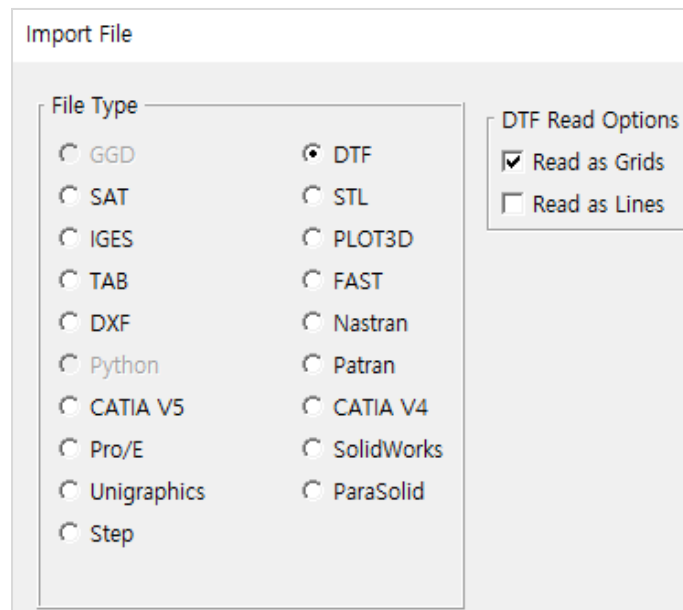
ACE-PP-03	ACE CAD Import Package	CAD import for : STEP, IGS, Pro/e, CATIA, SolidWorks, Unigraphics
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Package Reference : ACE-PP-03

ACE CAD Import Package

SAT 파일 타입은 기본 제공

CAD import for : STEP, IGS, Pro/e, CATIA, SolidWorks, Unigraphics



Package Reference : ACE-HP

해석 속도 향상을 위한 병렬 계산 옵션

ACE-HP-01	Parallel 8
ACE-HP-02	Parallel 16
ACE-HP-03	Parallel 32
ACE-HP-04	Parallel 64
ACE-HP-99	Each Parallel After 64

Package Reference : ACE-HP

Parallel

- 해석을 여러 프로세스에서 나누어 실행하는 기능으로 해석시간 단축 가능
- 프로세스간의 정보를 주고 받으면서 동시 계산 진행
(데이터 전송 시간으로 인해 프로세스 수와 계산 시간이 정확히 반비례하지 않음)

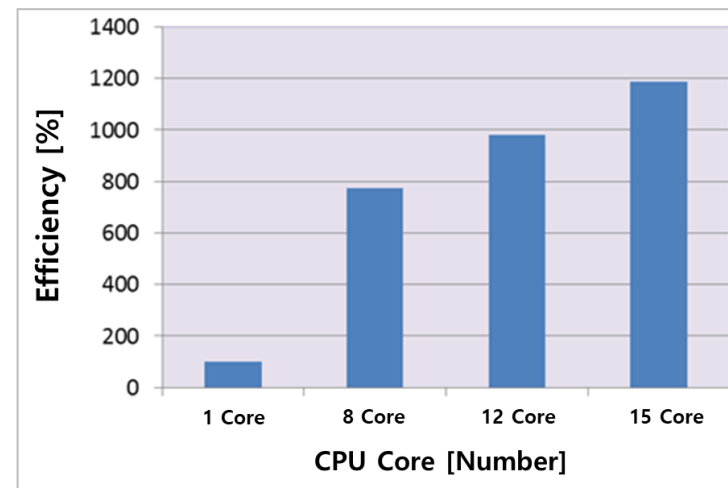
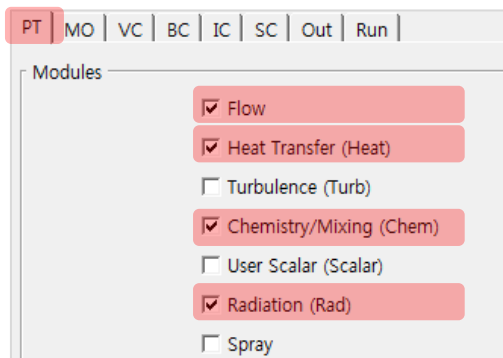
해석 적용 모듈 및 Core수에 따른 병렬 계산 시간 비교

- 사용모듈 : **Flow, Heat, Chemistry/Mixing, Radiation**

격자 수 : 약 960만개

해석 결과 저장 간격 : 200 Iteration

총 계산 반복 횟수 : 2000 Iteration



	1 Core	8 Core	12 Core	15 Core
Time[Hour]	322.1	41.7	32.9	27.1
Time[Day]	13.4	1.7	1.3	1.1
Efficiency[%]	100	772	979	1189

➔ 15Core 병렬 해석 진행으로 시간 소요에 대한 효율이 1Core 대비 약 1189%로 높음(사용 모듈에 따라 상이)

Package Reference : FAS-SP-01

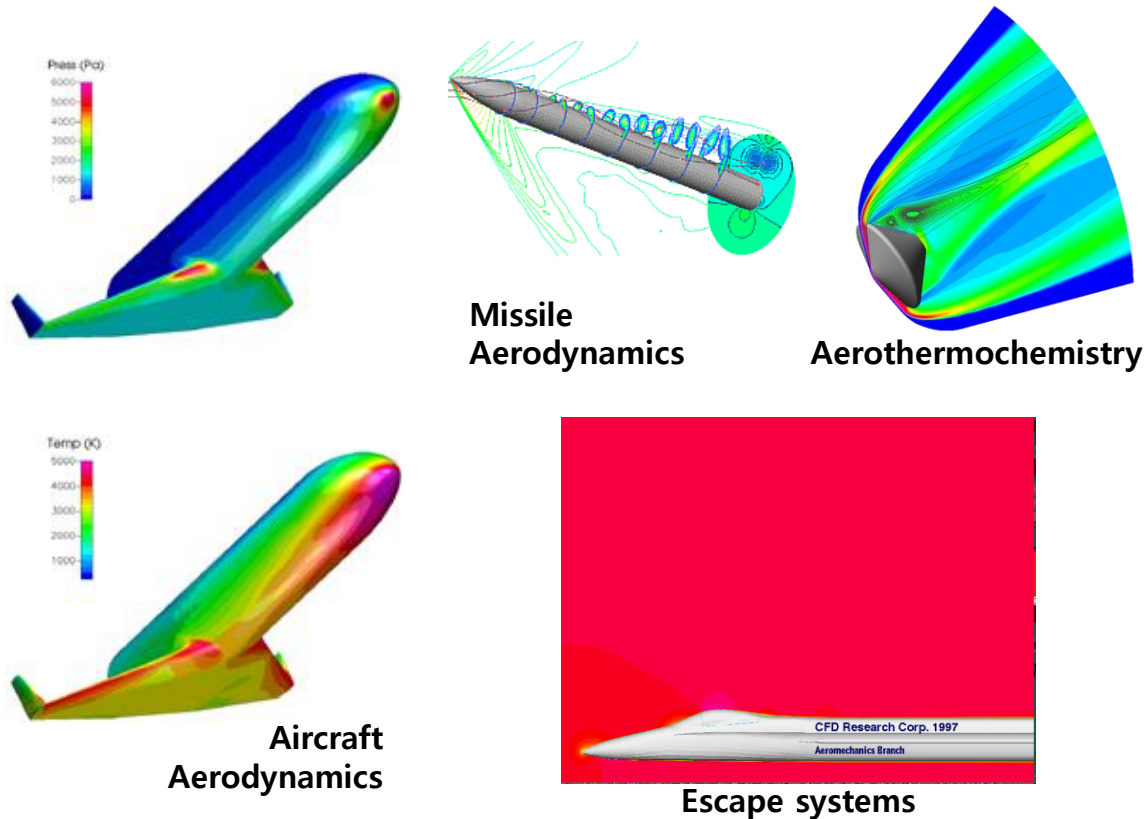
Moving multi-body dynamics를 고려할 수 있는 압축성 유동 solver

FAS-SP-01	Fastran Solver Package(1 Process License)
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Package Reference : FAS-SP-01

Fastran Solver Package

- Moving multi-body dynamics를 고려할 수 있는 압축성 유동 solver
- 6DOF(degree of freedom)과 강체 운동(rigid body motion)의 연결된 해석 가능
- 다물체 이동(multiple moving bodies)시 자동화 격자(Chimera grid) 적용



Thank you for your attention