ESSS

SIMULATING THE FUTURE

APLICACIONES ANSYS HPC EN LA INDUSTRIA

WHPC14

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www.esss.com.ar

19 YEARS OF EXPERIENCE

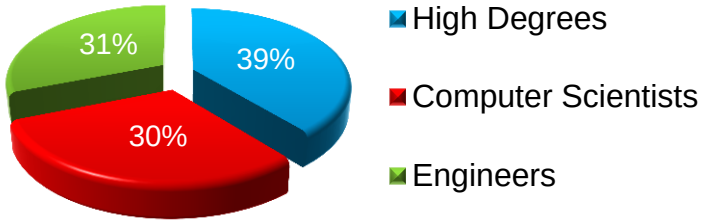
Since 1995 providing the most comprehensive simulation solutions to the market

WHAT WE DO?

- Reduce product development time
- Optimize processes
- Improve product performance

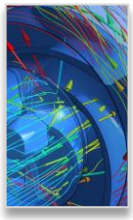
TEAM PROFILE

High-quality services and support to customers



LOCATIONS

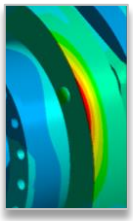
ESSS SIMULATION TECHNOLOGY



FLUID DYNAMICS

- Multiphase flow
- Heat and mass transfer
- Turbulence
- Chemical reaction

ANSYS



STRUCTURAL ANALYSIS

- Coupled thermal stress
- Static, dynamic
- Fracture, fatigue
- Linear, non-linear

ANSYS

ELECTROMAGNETICS

- Electromechanical
- High frequency & speed devices EMC/EMI
- Circuit simulations
- System integration
- Chip Level Simulation

ANSYS Apache

MULTIDISCIPLINARY OPTIMIZATION

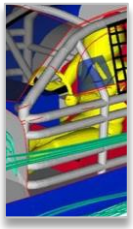
- Process integration
- Design optimization

modeFRONTIER

VCOLLAB

- Visualization
- Documentation
- Collaboration
- Virtual Reality
- CAE Data Reduction

VCollab



SCIENTIFIC VISUALIZATION

- Parallel processing, VR, collaboration
- Post-processing
- Cluster-based rendering

EnSight

GEOLOGY & RESERVOIR ENGINEERING

- Reservoir modeling and simulation
- Basin modeling and simulation
- Well data interpretation
- Geological modeling

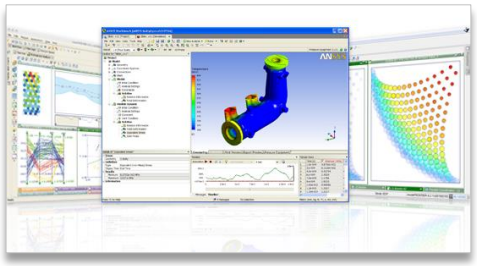
KRAKEN

MICROSTRUCTURAL CHARACTERIZATION

- 2D / 3D image processing
- 2D / 3D properties characterization
- 3D visualization

chimera

SERVICES

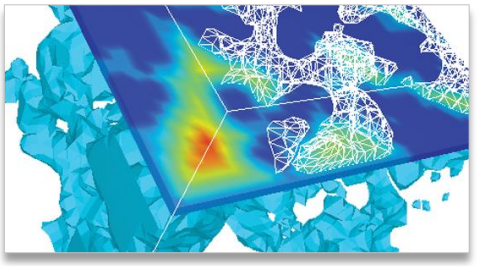


SOFTWARE

- ANSYS
- modeFRONTIER
- EnSight
- VCollab
- KRAKEN
- Chimera

CONSULTING SERVICES

- Modeling activities (R&D)
- Troubleshooting
- Integration of technologies
- Value-added services

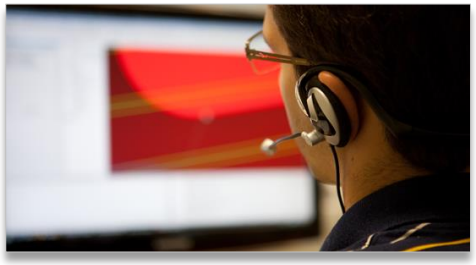


CUSTOM DEVELOPMENT

- Design of new applications
- Multiplatform GUI
- Numerical methods
- Parallel processing
- Scientific visualization

TRAINING

- 60+ training courses
- Postgraduate courses
- Online courses
- 900+ attendees per year



TECHNICAL SUPPORT

- Phone
- E-mail
- Online
- On-site

ACADEMIC PROGRAM

- Student / Academic & Research
- Affordable prices
- Great flexibility
- Partnership program

ANSYS Global Presence

Over **2,700** employees

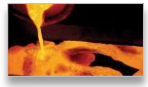
75+ sales offices on **3** continents

Network of sales channel partners in **40+** countries

17 major development centers on **3** continents

BUILDING INTERNATIONAL PRESENCE

+500 CUSTOMERS

- OIL & GAS 
- MARINE AND OFFSHORE 
- AUTOMOTIVE 
- AEROSPACE 
- ELECTRONICS 
- APPLIANCES 
- MECHANICAL PROCESSES 
- METALLURGY 
- POWER GENERATION 
- TURBOMACHINERY 
- CHEMICAL PROCESSES 
- ENVIRONMENT 

Argentina Main Customers

YPF

FLARGENT

AESA

IMPSA

CONAE

TGS

Pan American ENERGY

FLOWSERVE

INVAP

FAdeA
Fábrica Argentina de Aviones "Brig. San Martín" S.A.

TECNA

SECCO
Industrias Juan F. Secco S. A.

Ternium

fate

NA·SA

TenarisSiderca

TECHINT

CONICET

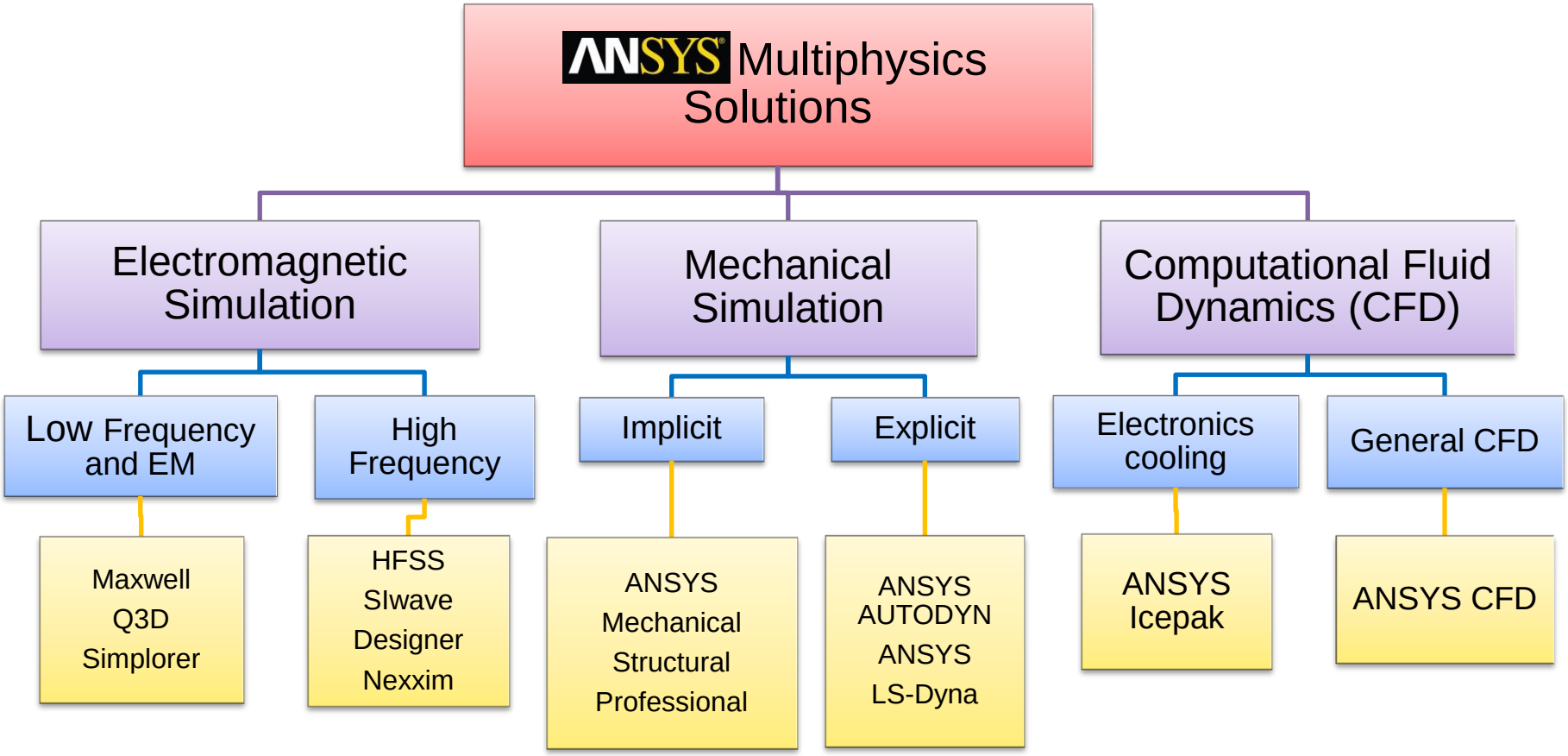
CNEA

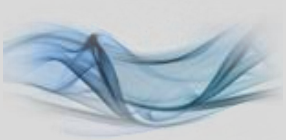
INTI

UNIVERSIDAD NACIONAL DEL COMAHUE
1972

UNIVERSIDAD NACIONAL DE CUYO
MENDOZA ARGENTINA

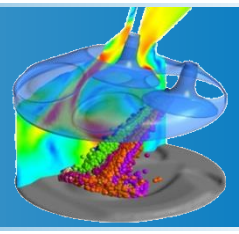
ANSYS SOLUTIONS



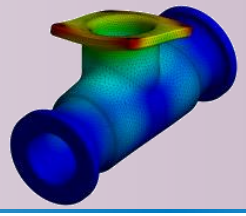


Fluid Mechanics:
From Single-Phase Flows

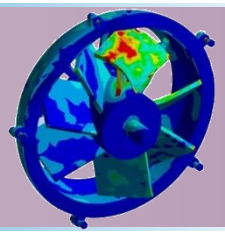
To Multiphase
Combustion



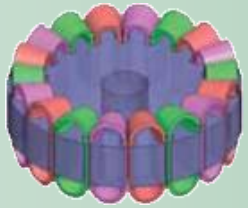
Structural Mechanics:
From Linear Statics



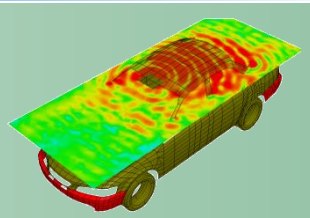
To High-Speed Impact



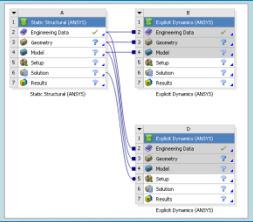
Electromagnetics:
From Low-Frequency
Windings



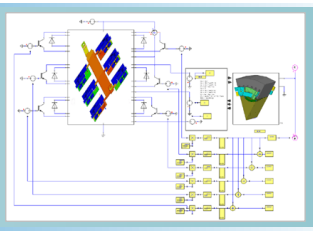
To High-Frequency
Field Analysis



Systems:
From Data Sharing

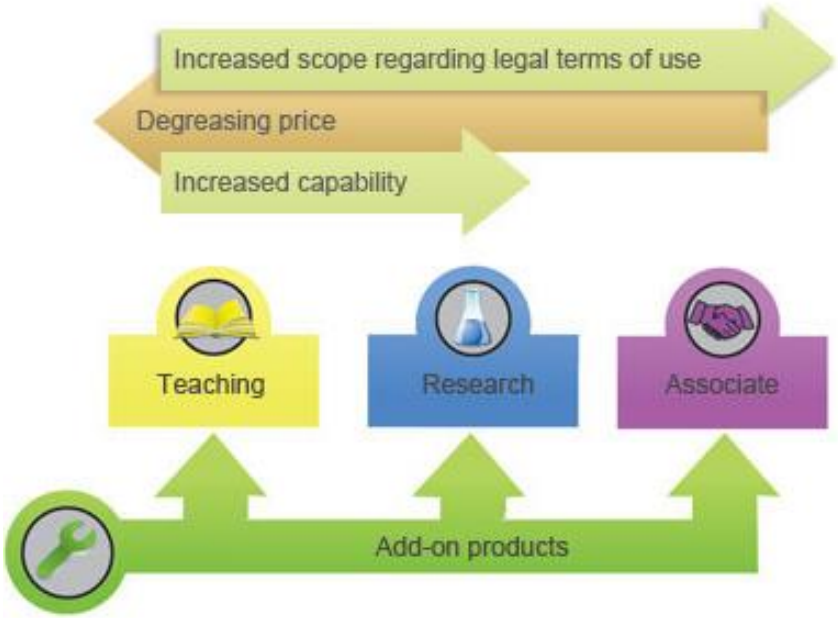


To Multi-Domain
System Analysis



ACADEMIC PROGRAM

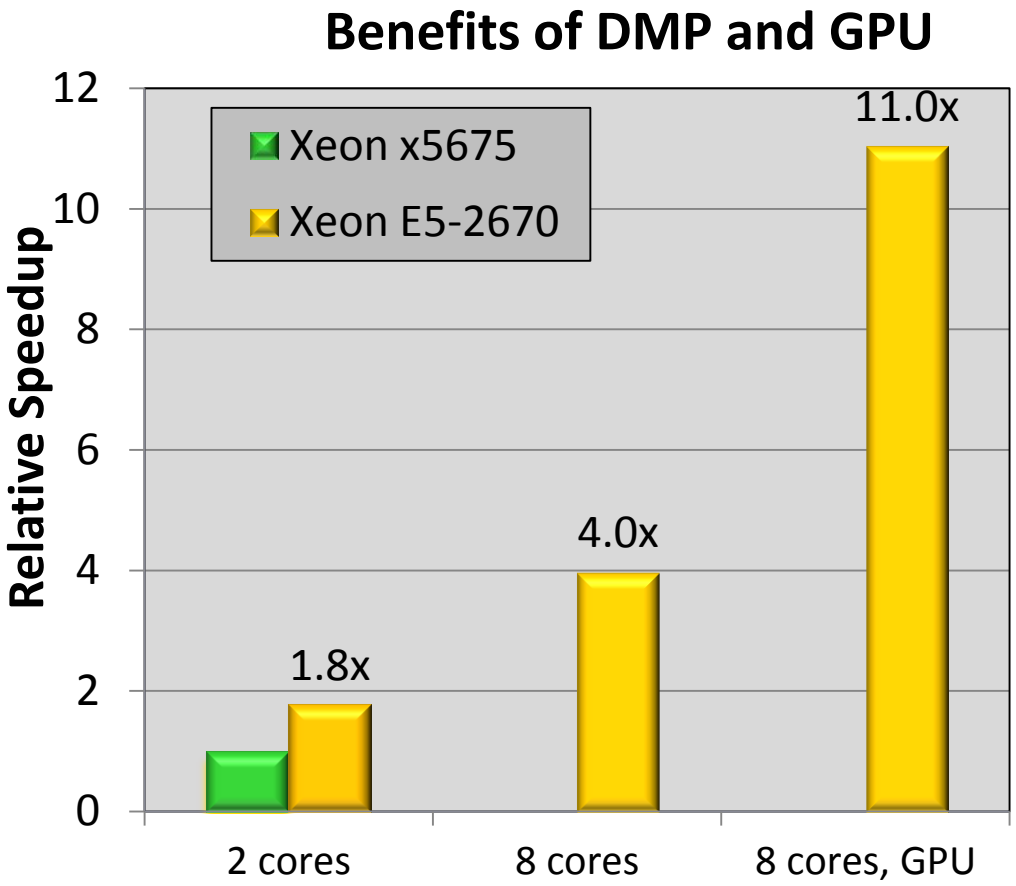
- Engineering simulation software solutions for academic and research applications at reduced costs and great flexibility
- Essential initiative to ensure that students, researchers and professors have access to advanced simulation technologies
- More than 3000 academics, from 100 Latin American research and education institutions, are using engineering simulation software provided by ESSS every year



HPC for Structural Mechanics

Maximizing Performance

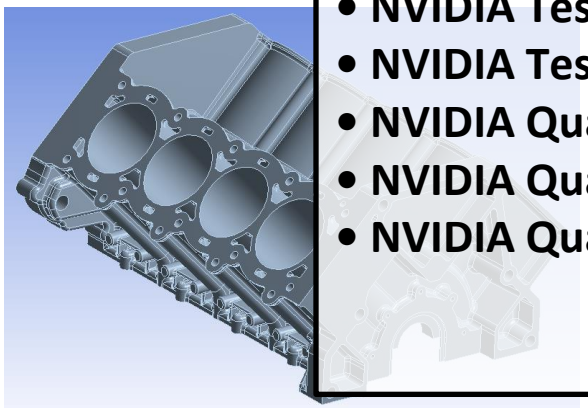
- Turbine model
- 2.1 million DOF
- Nonlinear static analysis
- Sparse solver (DMP)
- Windows 7 workstation
  16 Intel Xeon E5-2670 cores,
  128 RAM, Tesla K20c



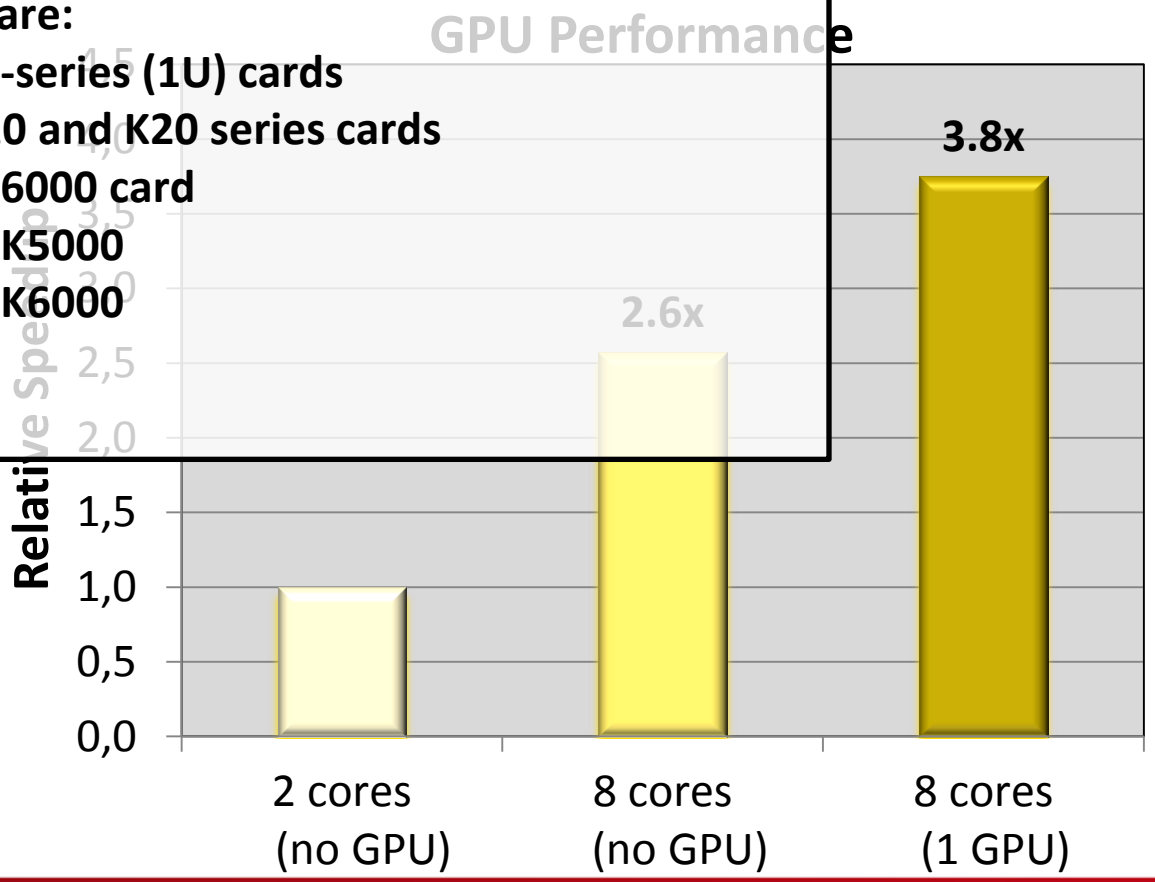
Maximizing Performance
GPU Acceleration Capability

- **GPUs can offer significantly faster time to solution**

Supported hardware:
- **NVIDIA Tesla 20-series (1U) cards**
- **NVIDIA Tesla K10 and K20 series cards**
- **NVIDIA Quadro 6000 card**
- **NVIDIA Quadro K5000**
- **NVIDIA Quadro K6000**



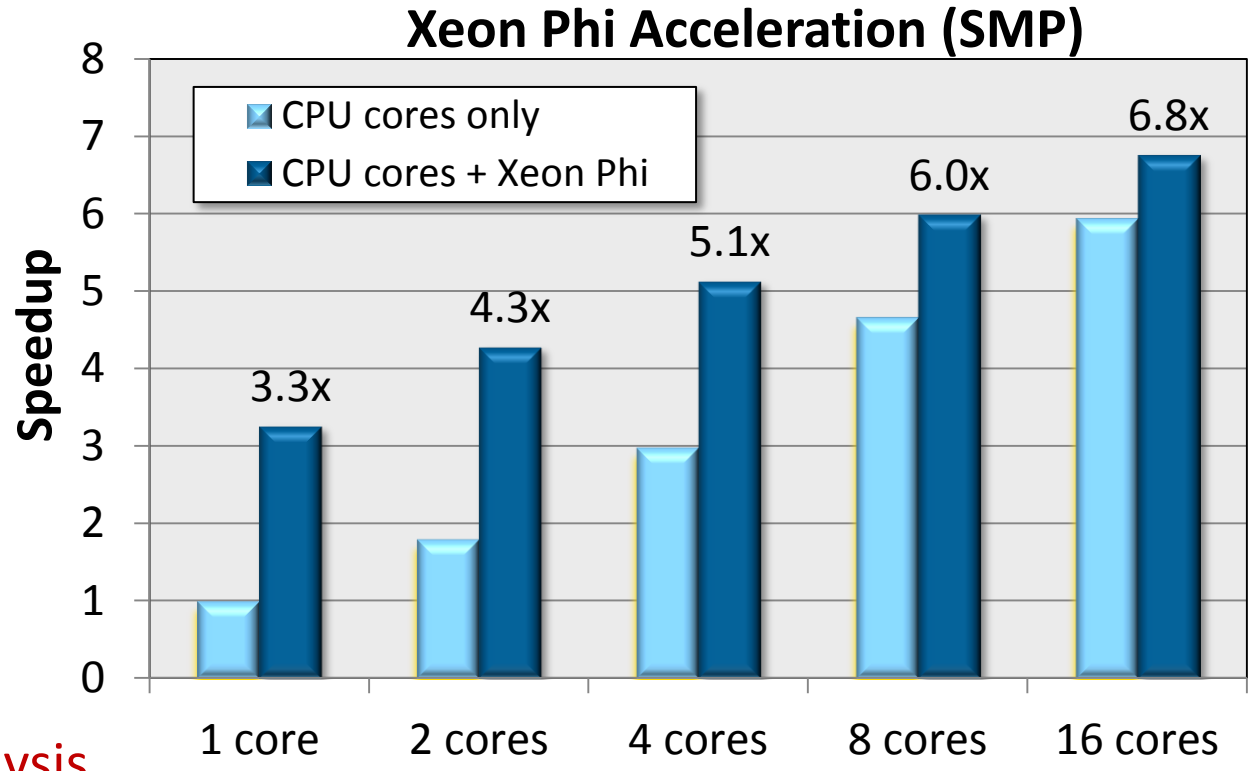
- 6.5 million DOF
- Linear static analysis
- Sparse solver (DMP)
- 2 Intel Xeon E5-2670 (2.6 GHz, 16 cores total), 128 GB RAM, SSD, 4 Tesla C2075, Win7



R15.0 GPU Acceleration Capability

– Intel Xeon Phi coprocessors are now supported!

· Significant speedups can be achieved with single Xeon Phi card

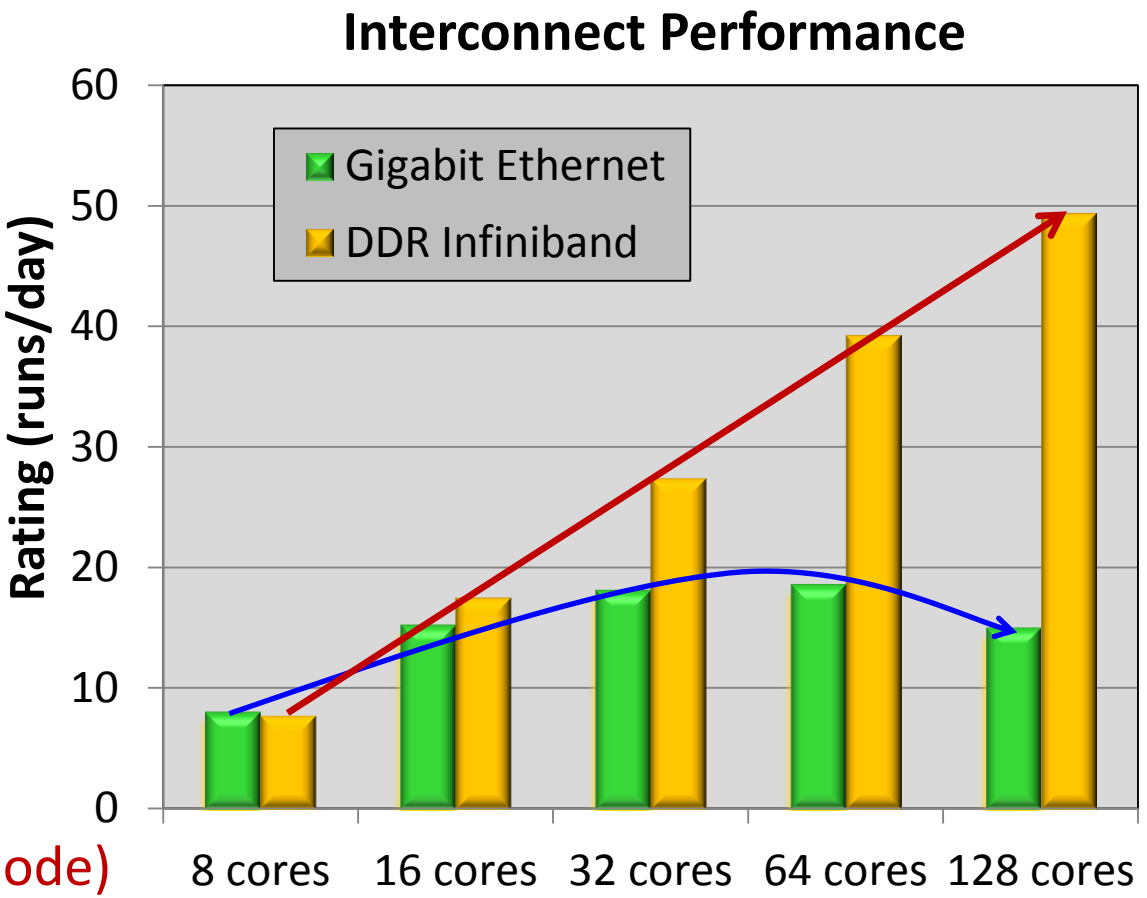


- Turbine model
- 2.1 million DOF
- SOLID187 elements
- Nonlinear static analysis
- Linux workstation (2 Intel Xeon E5-2670, 7120A Xeon Phi, 64 GB RAM)

Maximizing Performance
Distributed ANSYS Performance

- **Need fast interconnects to feed fast processors**

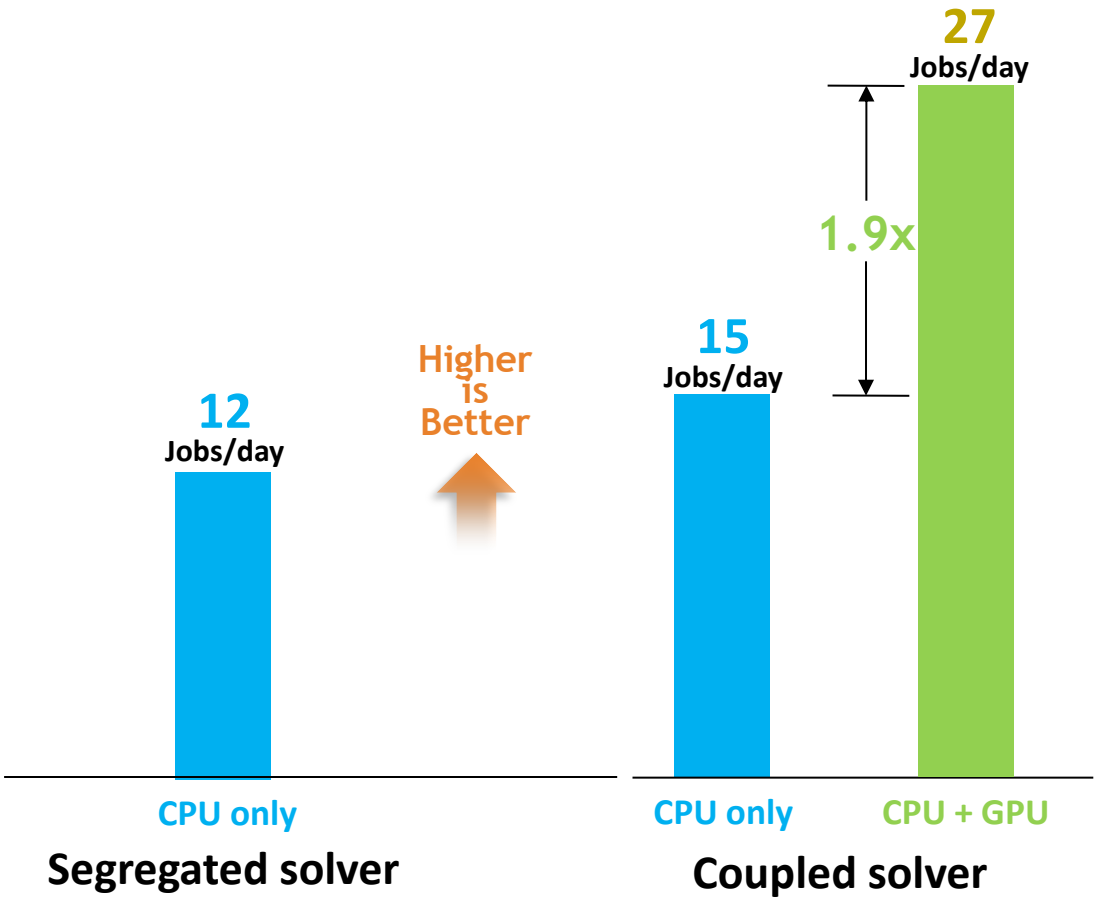
- Turbine model
- 2.1 million DOF
- SOLID187 elements
- Nonlinear static analysis
- Sparse solver (DMP)
- Linux cluster (8 cores per node)



HPC for CFD

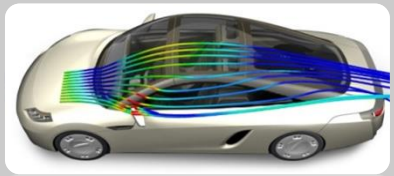
ANSYS Fluent 15.0

- Faster Coupled Solver with GPUs



Convergence criteria: 10e-03 for all variables; No of iterations until convergence: segregated CPU-2798 iterations (7070 secs); coupled CPU-967 iterations (5900 secs); coupled 985 iterations (3150 secs)

Sedan Model



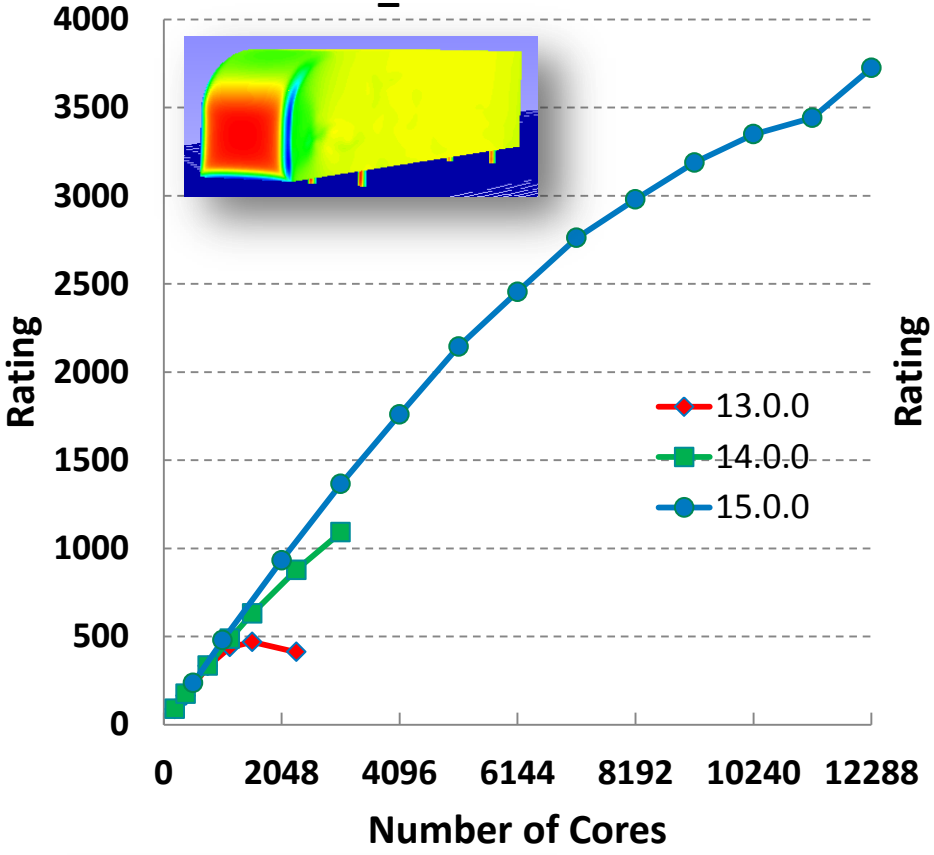
- Sedan geometry
- 3.6M mixed cells
- Steady, turbulent
- External aerodynamics
- Coupled PBNS, DP
- CPU: Intel Xeon E5-2680; 8 cores
- GPU: 2 X Tesla K40

NOTE: Times for total solution until convergence

Take Advantage of HPC

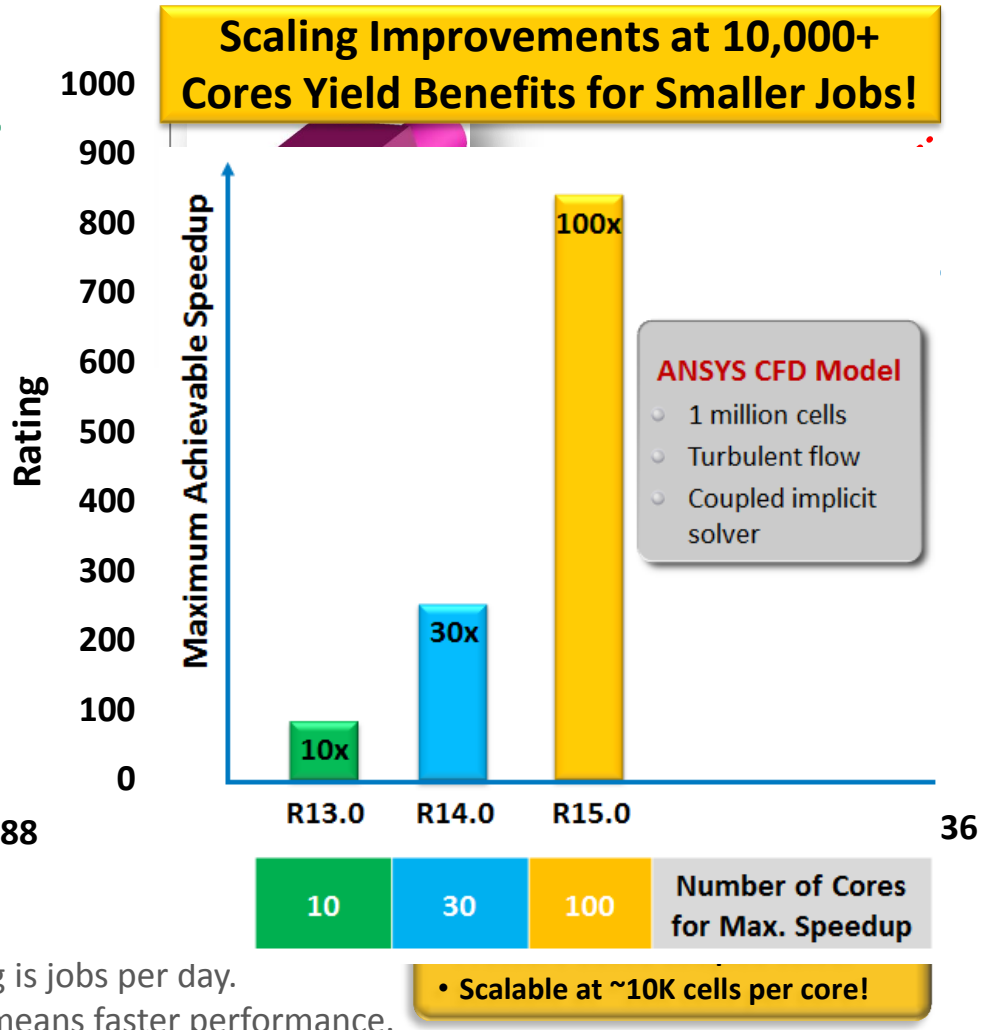
Parallel Efficiency Improvements by Release

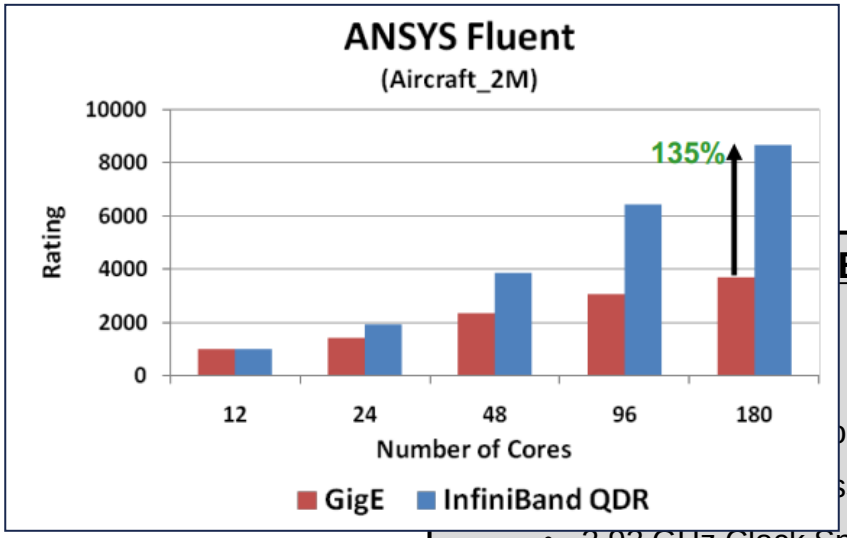
Continuous development effort to improve HPC scaling in Fluent

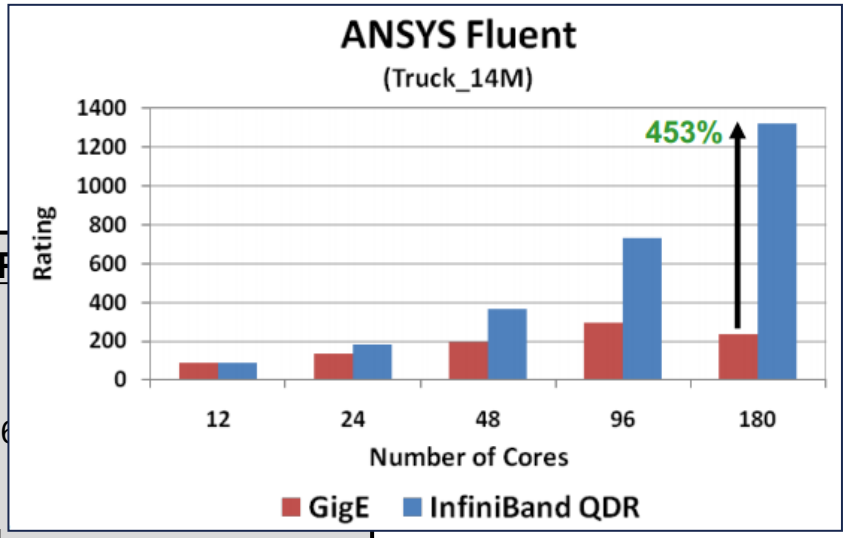


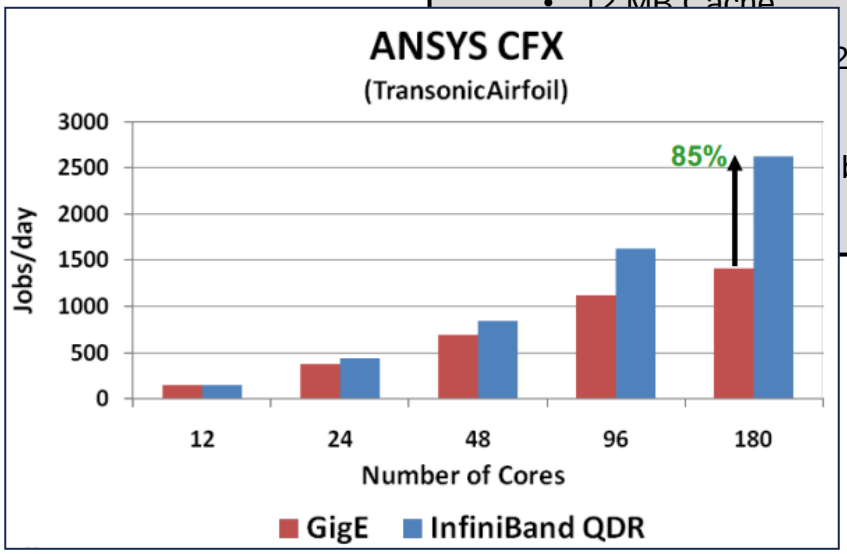
- Segregated implicit solver
- Scalable at ~10K cells per core!

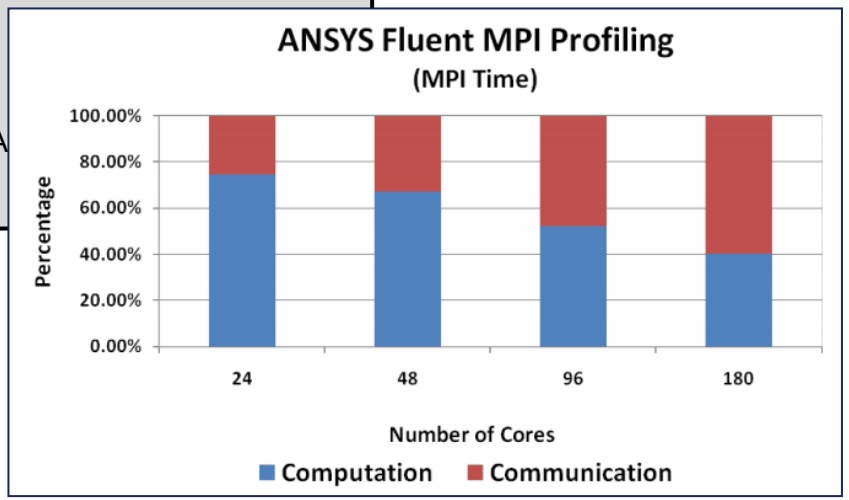
Rating is jobs per day.
A higher rating means faster performance.




ANSYS Fluent
(Aircraft_2M)
Rating
10000
8000
6000
4000
2000
0
135%
12
24
48
96
180
Number of Cores
GigE
InfiniBand QDR


ANSYS Fluent
(Truck_14M)
Rating
1400
1200
1000
800
600
400
200
0
453%
12
24
48
96
180
Number of Cores
GigE
InfiniBand QDR

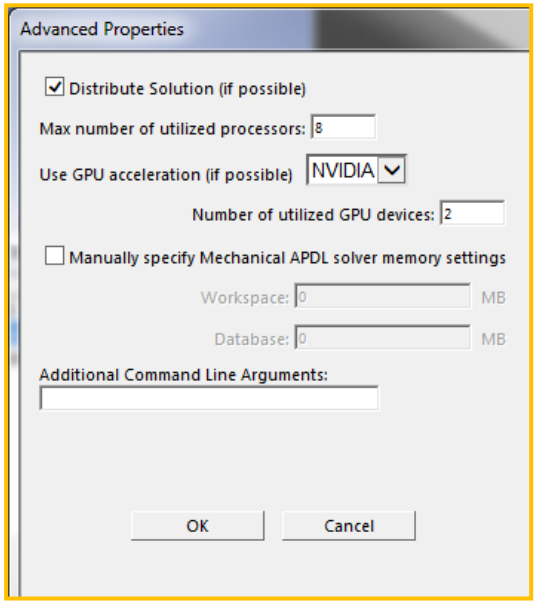

ANSYS CFX
(TransonicAirfoil)
Jobs/day
3000
2500
2000
1500
1000
500
0
85%
12
24
48
96
180
Number of Cores
GigE
InfiniBand QDR


ANSYS Fluent MPI Profiling
(MPI Time)
Percentage
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
24
48
96
180
Number of Cores
Computation
Communication

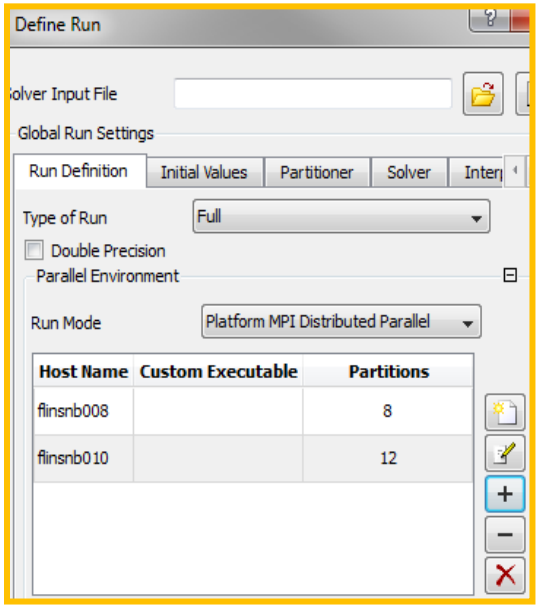
HPC Configuration

- Easy to Set-up

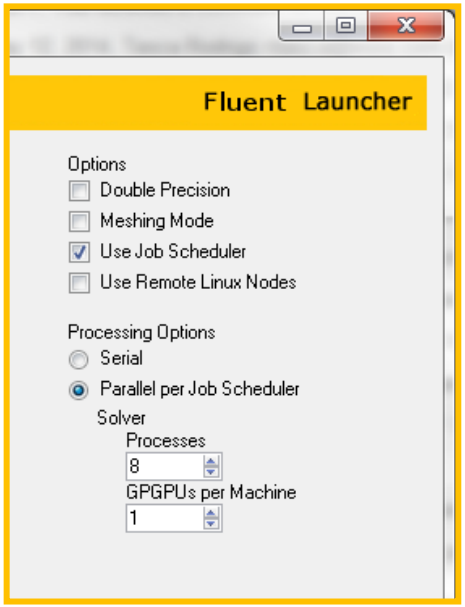
ANSYS Mechanical



ANSYS CFX



ANSYS Fluent

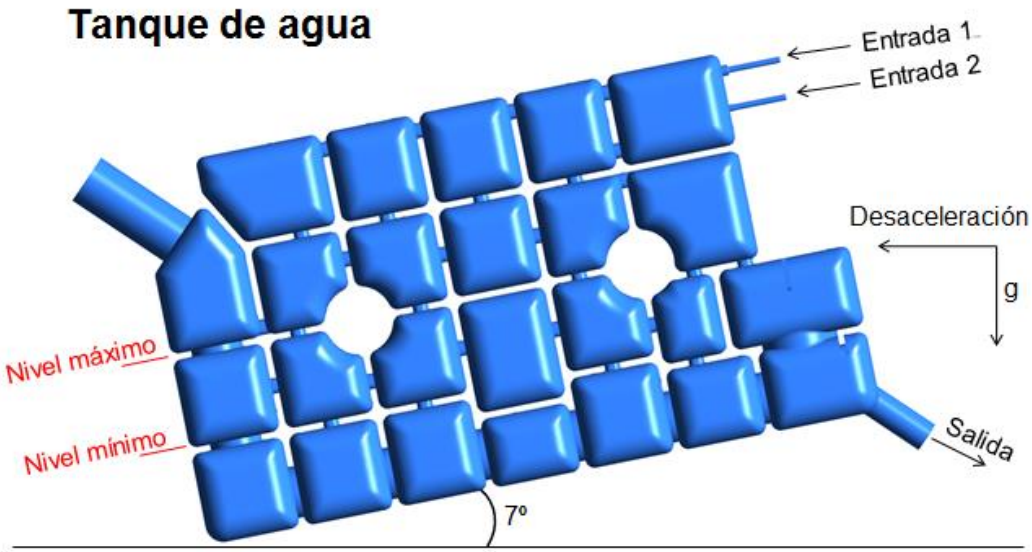


Aplicaciones
Alto costo computacional

Caso Nº1: Tanque de agua

Descripción del problema:

- Tanque de agua.



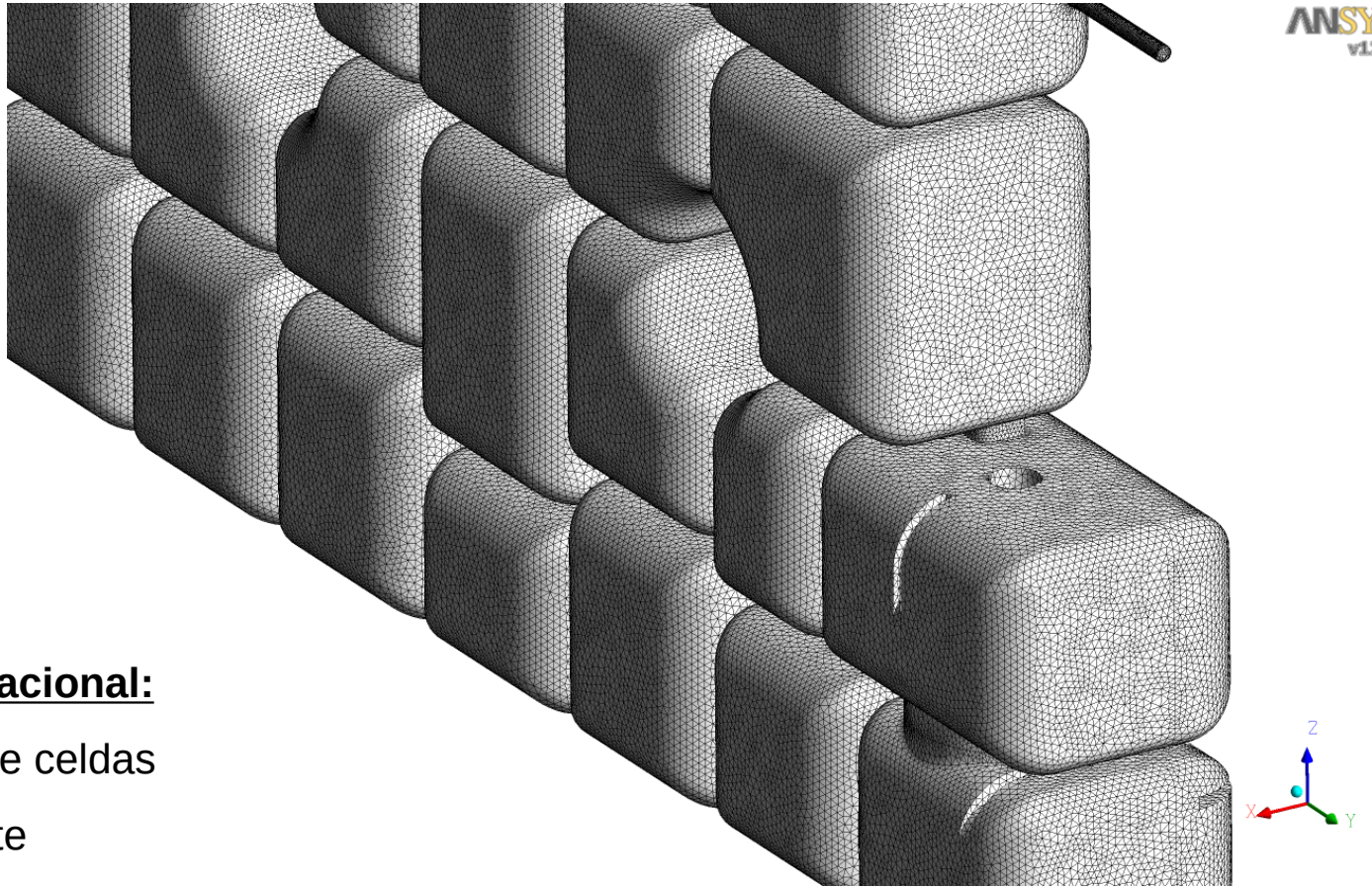
Objetivos:

- Estudio transiente de sloshing dentro de tanque de agua. Predecir contacto con sensores.

Metodología:

- Desarrollar un modelo computacional CFD del tanque.
- Simulación transiente. Alto costo computacional.
- Generar gráficos de contacto del agua en los sensores de nivel para una curva de desaceleración establecida por norma.

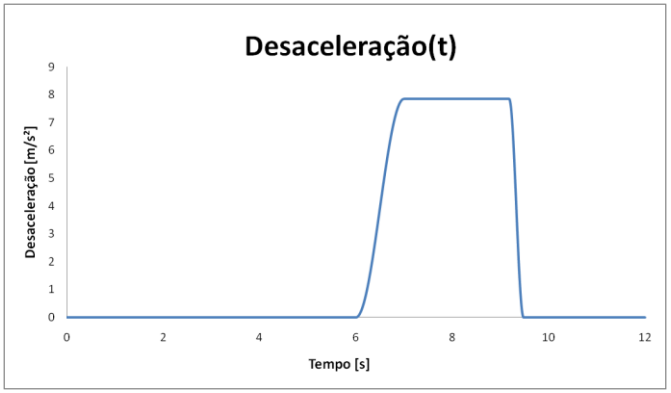
Caso Nº1: Tanque de agua



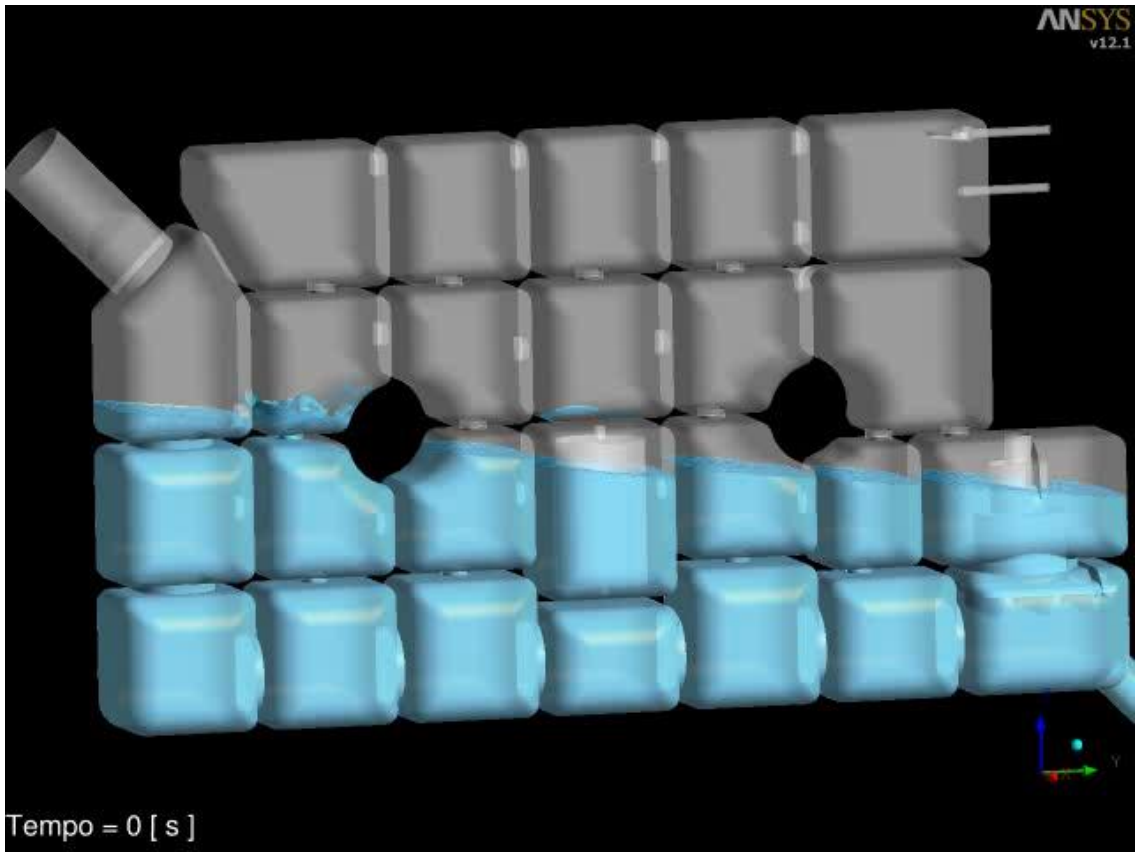
Alto costo computacional:

- Aprox. 1 millón de celdas
- Análisis transiente
- 12 segundos de simulación
- Paso de tiempo: 0,025 segundos
    - Total: 480 pasos de tiempo. 50 iteraciones por paso de tiempo

Caso Nº1: Tanque de agua



Resultados: Sloshing



Tiempo de simulación:

- 1 semana de procesamiento
- 16 procesadores Intel® Xeon® Processor X5355 de 4 cores. 64 cores, 1Gb por core.

Caso Nº2: Riser FCC

Descripción del problema:

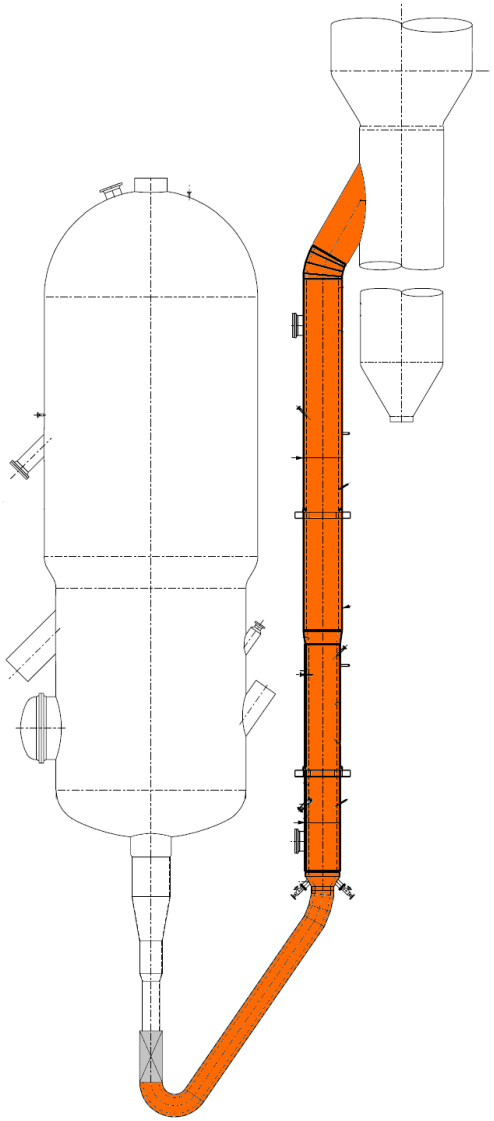
- Riser de unidad FCC.

Objetivos:

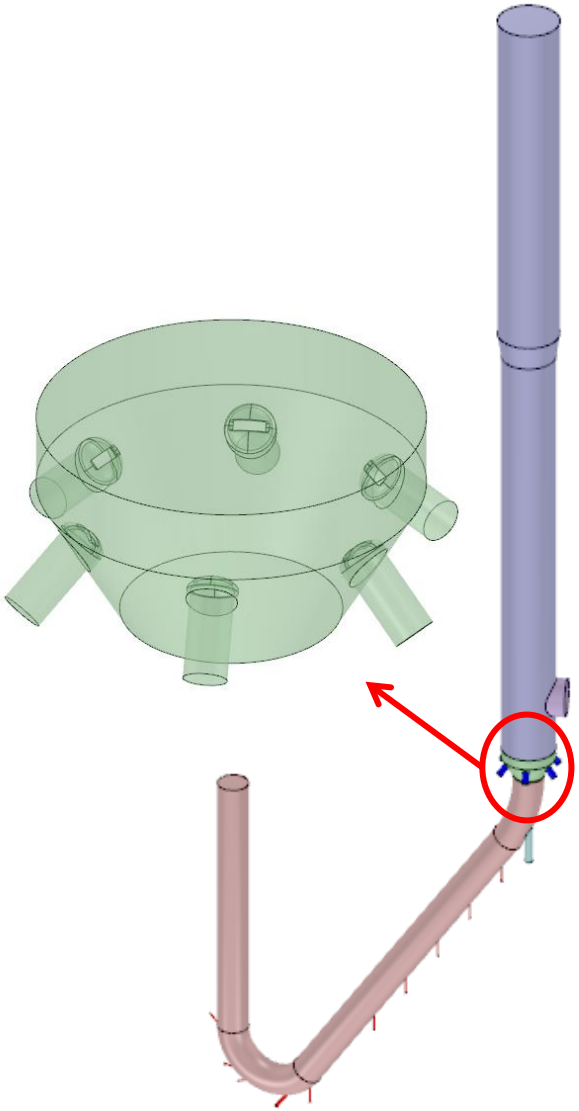
- Estudio transiente del flujo de partículas sólidas fluidizadas dentro de un riser de una unidad FCC.

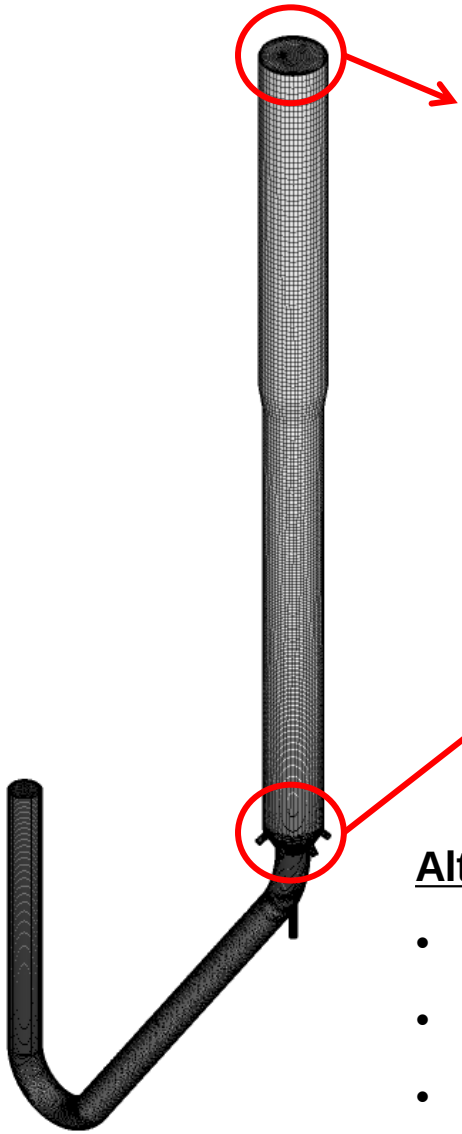
Metodología:

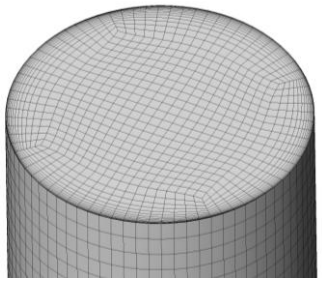
- Desarrollar un modelo computacional CFD del riser.
- Simulación transiente. Alto costo computacional.
- Estudiar el comportamiento y distribución de las partículas de catalizador dentro de la unidad.

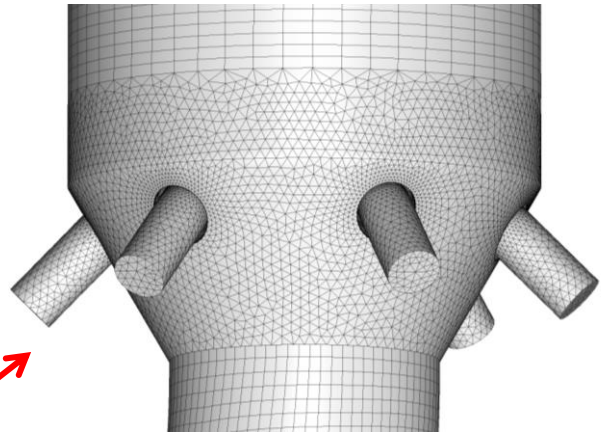


Caso Nº2: Riser FCC







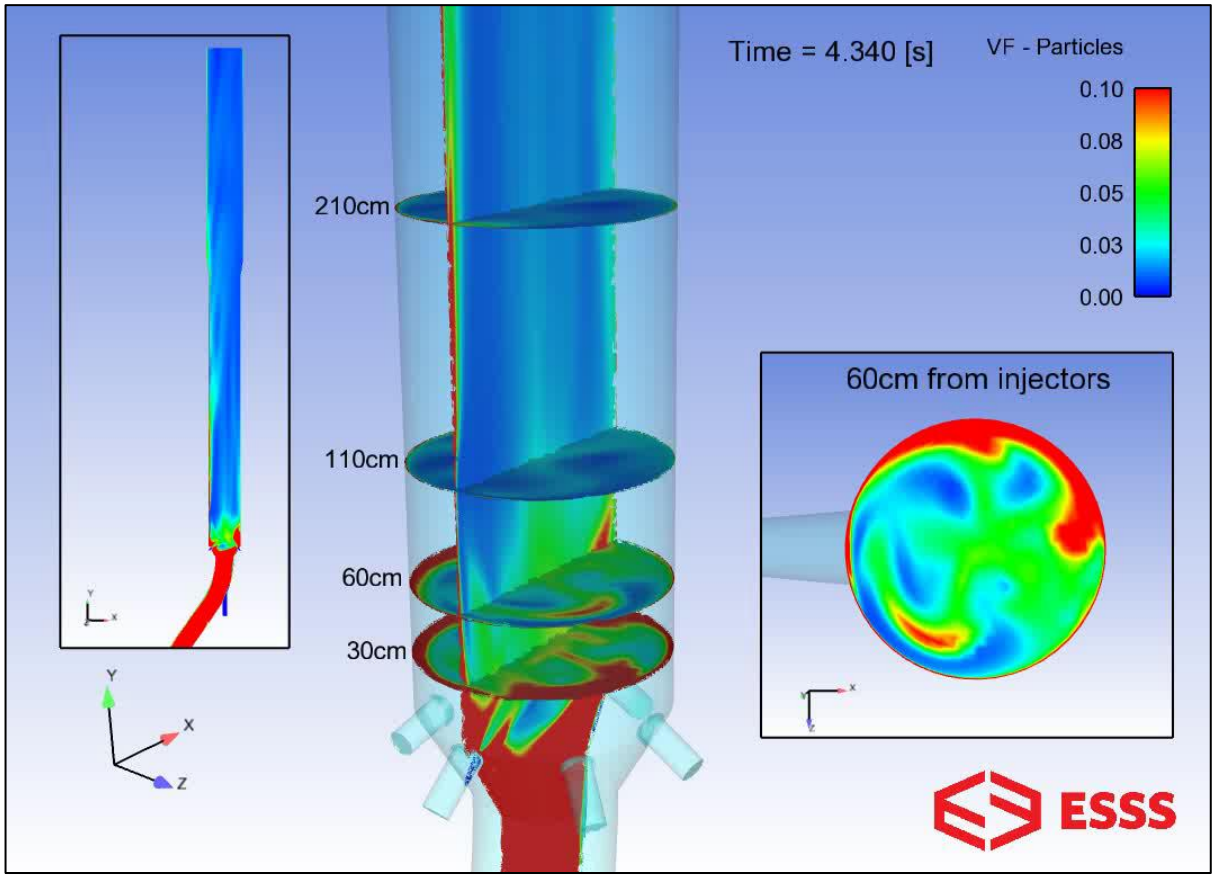


Alto costo computacional:

- Aprox. 1,5 millones de celdas
- Análisis transiente
- 43 segundos de simulación
- Paso de tiempo: 0,0002 segundos

Caso Nº2: Riser FCC

Resultados: Distribución de part. de catalizador



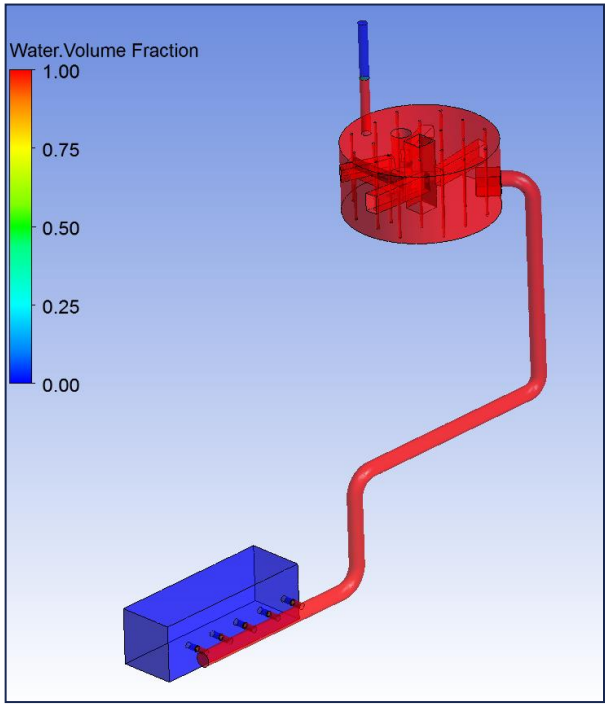
Tiempo de simulación:

- Total: 215000 pasos de tiempo. 10 iteraciones por paso de tiempo
- 4 semana de procesamiento
- 16 procesadores Intel® Xeon® Processor X5355 de 4 cores. 64 cores, 1Gb por core.

Caso Nº3: Vaciado de tanque

Descripción del problema:

- Tiempo de vaciado de un tanque.



Objetivos:

- Estudio transiente del flujo agua dentro de un tanque. Cálculo de curva de caudal de vaciado del tanque.

Metodología:

- Desarrollar un modelo computacional CFD del tanque.
- Simulación transiente. Alto costo computacional.
- Generar una curva de caudal de agua vs tiempo a la salida del tanque.

Alto costo computacional:

- Aprox. 700 mil celdas
- Análisis transiente
- 20 segundos de simulación
- Paso de tiempo aprox. 1e-5 segundos.

Tiempo de simulación:

- 10 iteraciones por paso de tiempo
- 6 semanas de procesamiento
- 16 nodos con 2 Intel® Xeon® Processor E5420 de 4 cores. 128 cores, 2Gb por core.

Benchmarks

Scalability Test Comparison

Comparative analysis of performance of two different HPC Clusters working with ANSYS Fluent 14.5:

- **HPC Cristina:** One of the most powerful units of Argentina. Processors Intel® Xeon® E5420 Release 2007.

- **HPC R-Systems:** Optimized HPC cluster resource provided by the company R-Systems. Processors Intel® Xeon® E3-1270 Release 2011.

Scalability Test Comparison

HPC CLUSTER CRISTINA

- OS: Linux CentOS 5
- 70 nodes (in this test will only be used up to 16 nodes)
- 2 Intel® Xeon® Processor E5420 per node
  - 4 cores per processor
  - 2,50 GHz Clock Speed
  - 12 MB Cache
  - Launch Date: Q4 2007
- 8 cores per node
- 16Gb RAM per node (2Gb RAM per core)
- Infiniband (40Gbps)

HPC CLUSTER R-SYSTEMS

- OS: Linux Red Hat Enterprise 6.4
- 32 nodes
- 1 Intel® Xeon® Processor E3-1270 per node
  - 4 cores per processor
  - 3,4 GHz Clock Speed
  - 8 MB Cache
  - Launch Date: Q2 2011
- 4 cores per node
- 16Gb RAM per node (4Gb RAM per core)
- Infiniband (40Gbps)

Scalability Test Comparison

SOLVER INFORMATION

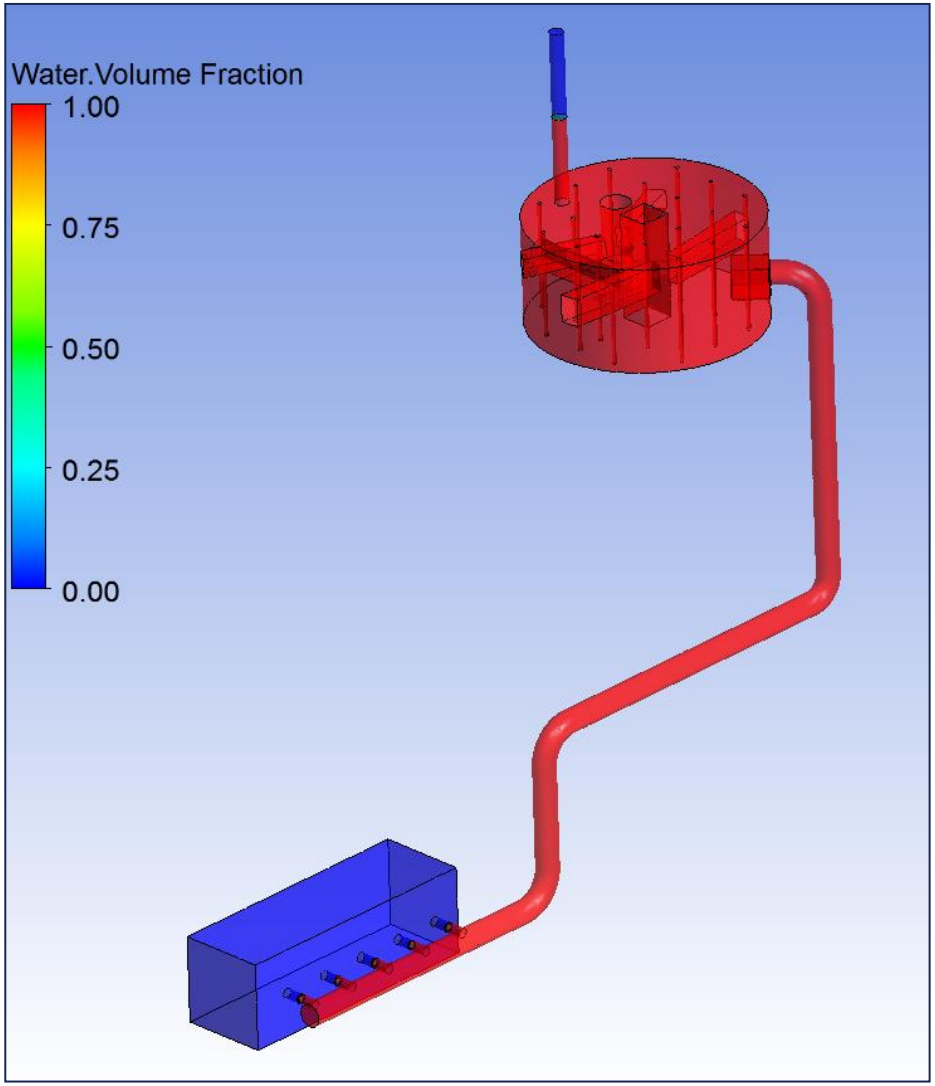
- ANSYS FLUENT 14.5

MESH INFORMATION

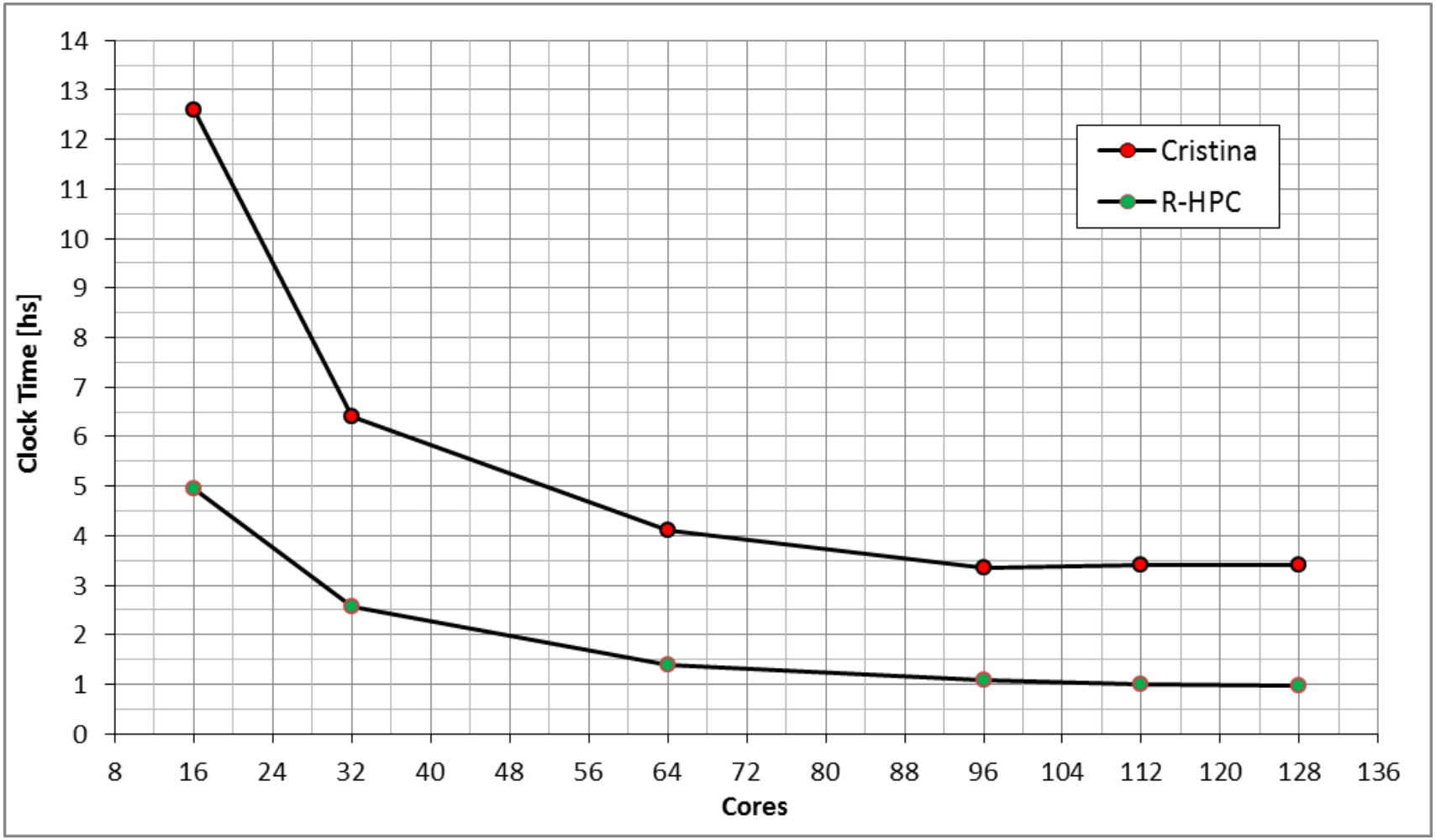
- Element type: Polyhedral
- Nodes: 3.9 millions
- Elements: 680 mil

SIMULATION DETAILS

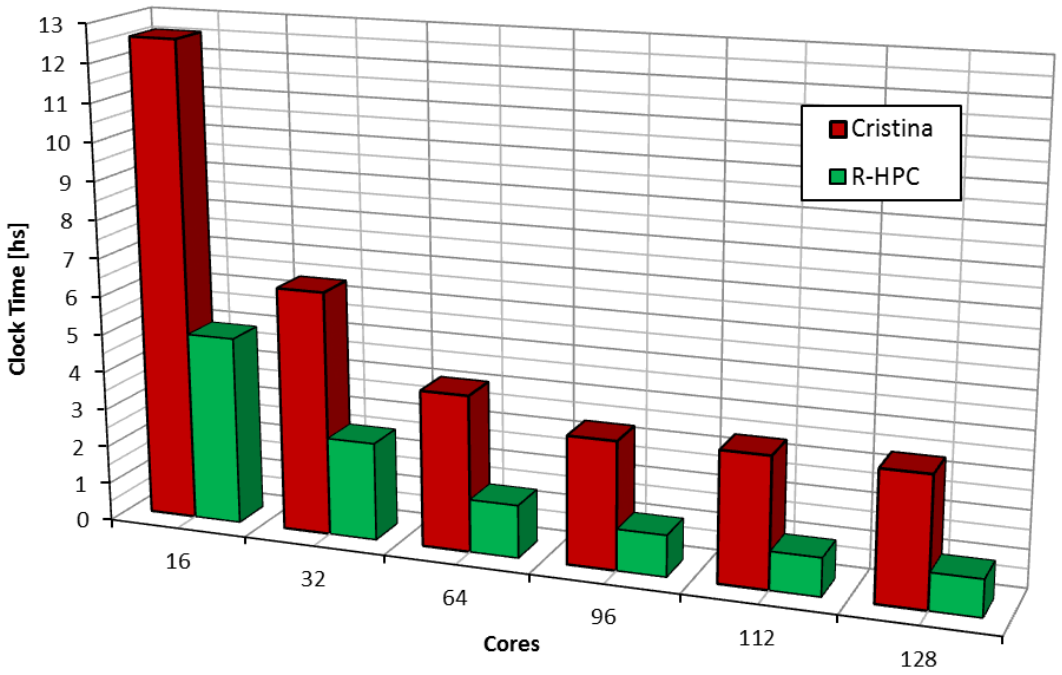
- Analysis Type: Transient
- 2000 Timesteps
- 100 iterations per Timestep (max)
- Around 0,27 seconds of total simulation time



Scalability Test Comparison



Scalability Test Comparison



	Cristina		R-SYSTEMS		
Cores	Clock Time [hs]	Simulation Speed [s/day]	Clock Time [hs]	Simulation Speed [s/day]	**Speed Comparison**
16	12,58	0,510	4,95	1,404	**2,5x faster**
32	6,40	1,003	2,57	2,707	**2,5x faster**
64	4,10	1,565	1,38	5,023	**3,0x faster**
96	3,35	1,916	1,08	6,414	**3,1x faster**
112	3,42	1,878	1,00	6,949	**3,4x faster**
128	3,40	1,888	0,97	7,189	**3,5x faster**

Muchas gracias!

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