VELaSSCo

Visualization for Extremely Large-Scale Scientific Computing

Dr. Abel Coll

CIMNE

The University of Edinburgh
School of Engineering

Inria informatics mathematics

Atos

SINTEF

Fraunhofer IGD

Jotne

SEVENTH FRAMEWORK PROGRAMME

May 2nd 2016

Pre-workshop CAxMan, CIMNE, Barcelona

Summary

1. Introduction
2. Motivation
3. Project objectives
4. Current status of the project
5. Next steps
6. Conclusions

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VELaSSCo basic information

Proposal number: **619439**
Project Officer: **Mr. Pierre-Paul SONDAG**
Name of the coordinating person: **Dr. Abel COLL**

Participant organisation name	Short name	Country
International Center for Numerical Methods in Engineering	**CIMNE**	ES
School of Engineering. The University of Edinburgh	**UNEDIN**	UK
STIFTELSEN SINTEF	**SINTEF**	NO
Institut national de recherche en informatique et en automatique	**INRIA**	FR
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. Fraunhofer-Institut für Graphische Datenverarbeitung	**FRAUNHOFER**	DE
Jotne EPM Technology	**JOTNE**	NO
Atos Spain S.A.	**ATOS**	ES

3 years project (2014 –2016)

393 persons x month

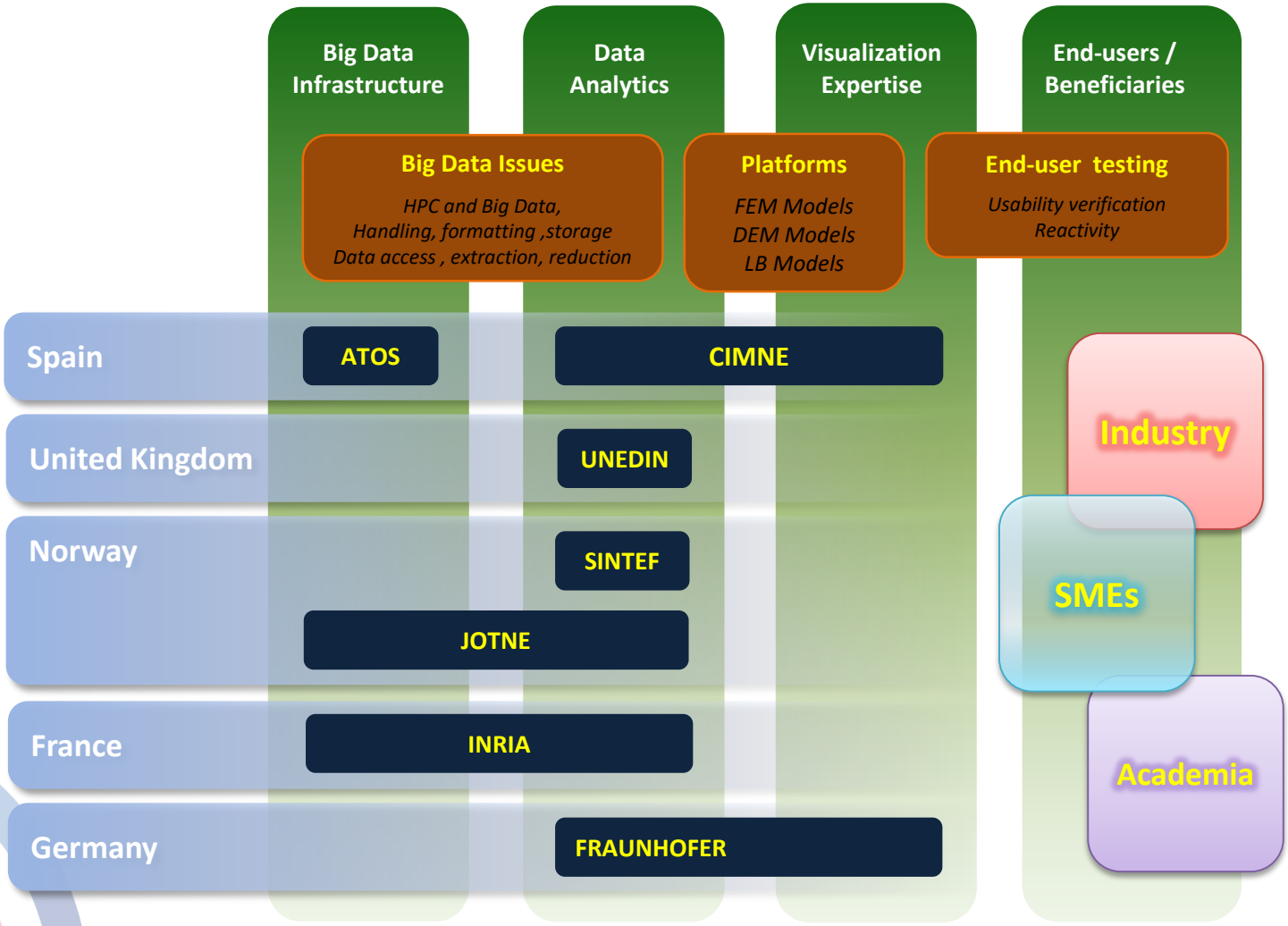
The total costs of VELaSSCo are **4.441.603 €**, and total funding is **3.294.000 €** (original 3.294.425 €)

Introduction

*The **Vision** of VELaSSCo is to provide **new visual analysis methods for large-scale simulations** serving the petabyte era and preparing the exabyte era.*

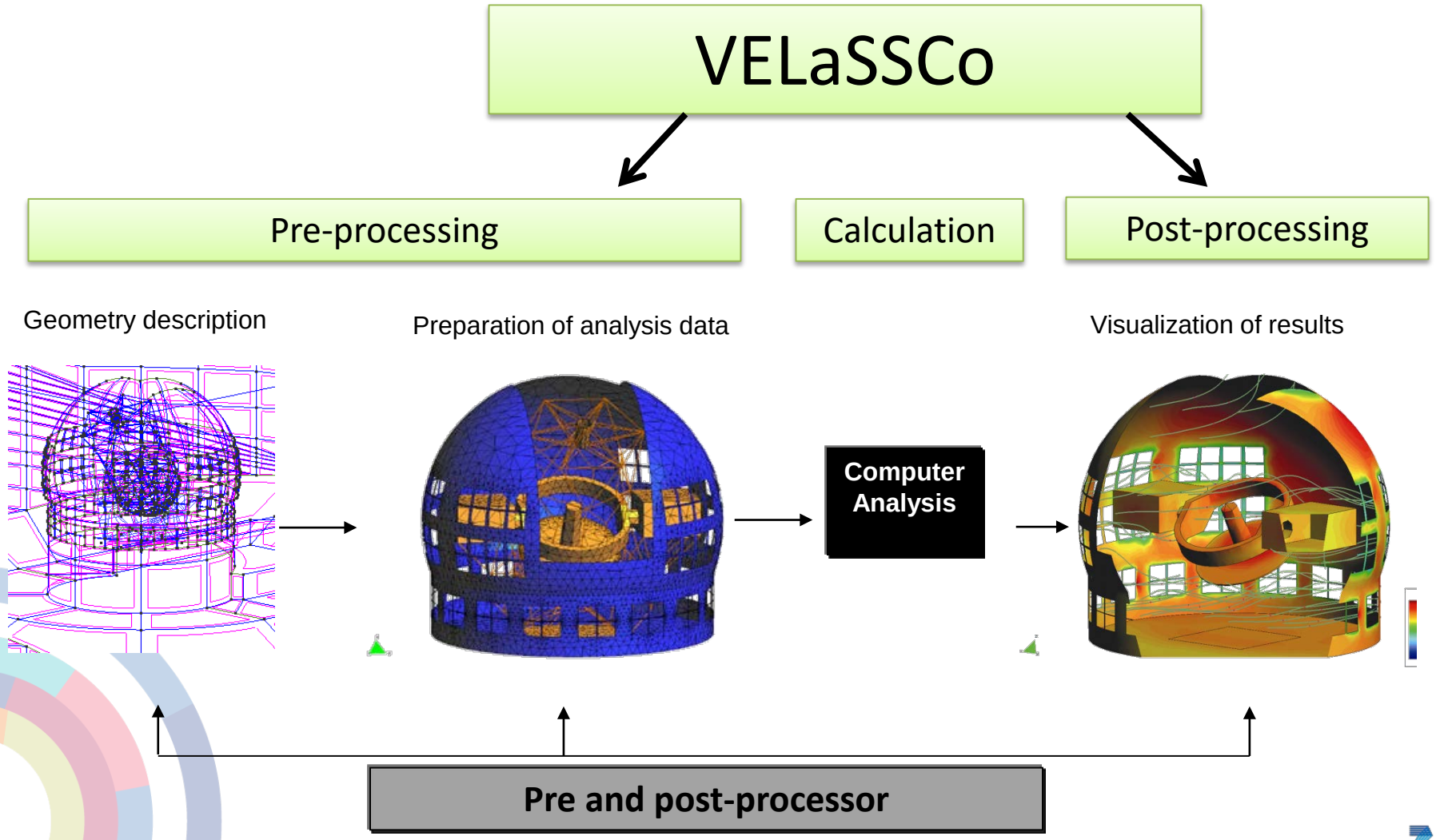
*It does this by adopting **Big Data** **tools and architectures** for the engineering and scientific community and by leveraging new ways of in-situ processing for data analytics and hardware accelerated interactive visualization.*

VELaSSCo consortium as a whole



Summary

Brief introduction to numerical simulations

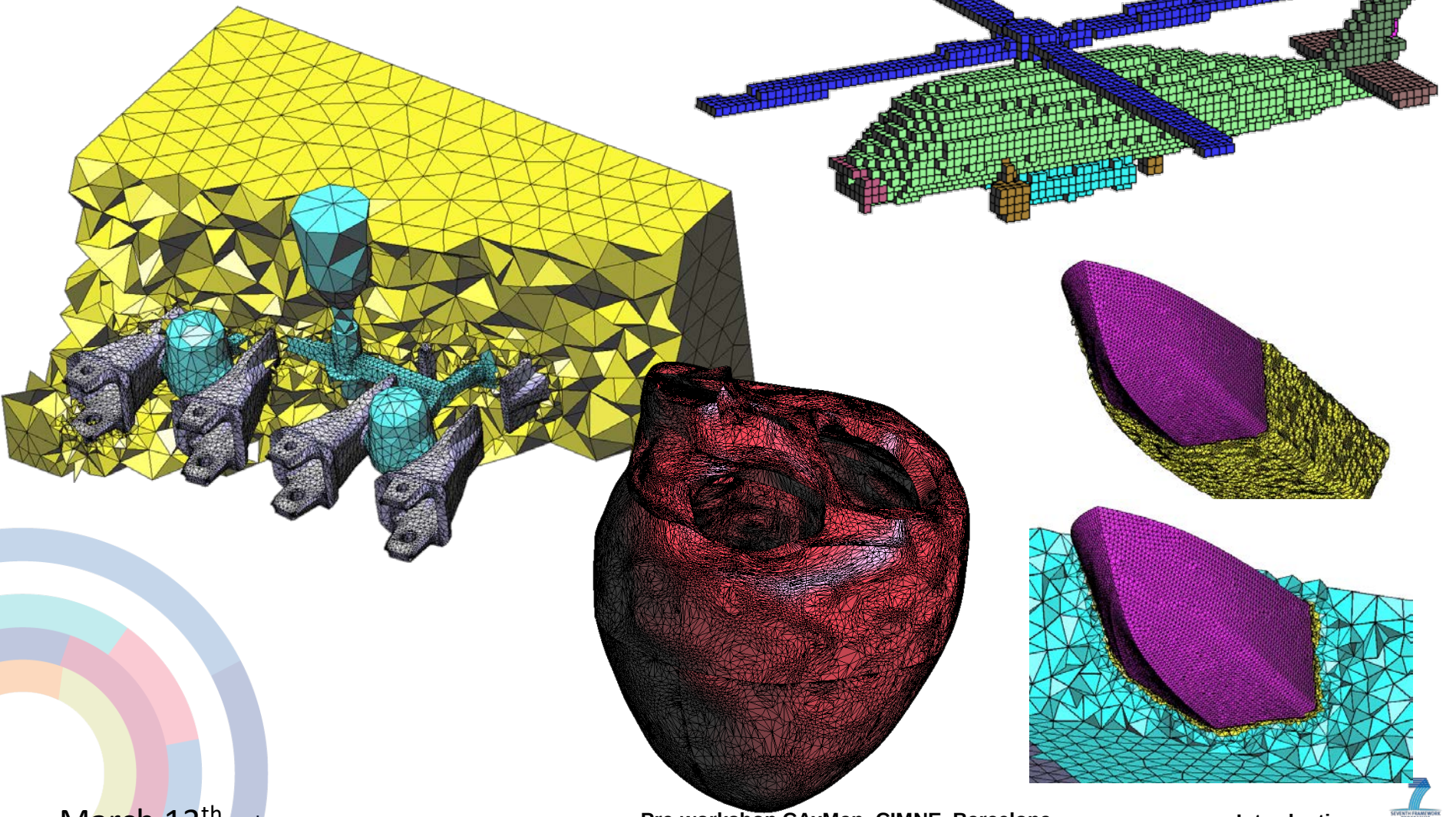


Current bottleneck

- Nowadays the **huge amount of data** provided by the solver in HPC **cannot be stored** in one single machine, so it is mandatory:
  - **Distributed post-processing**
  - **Distributed visualization**

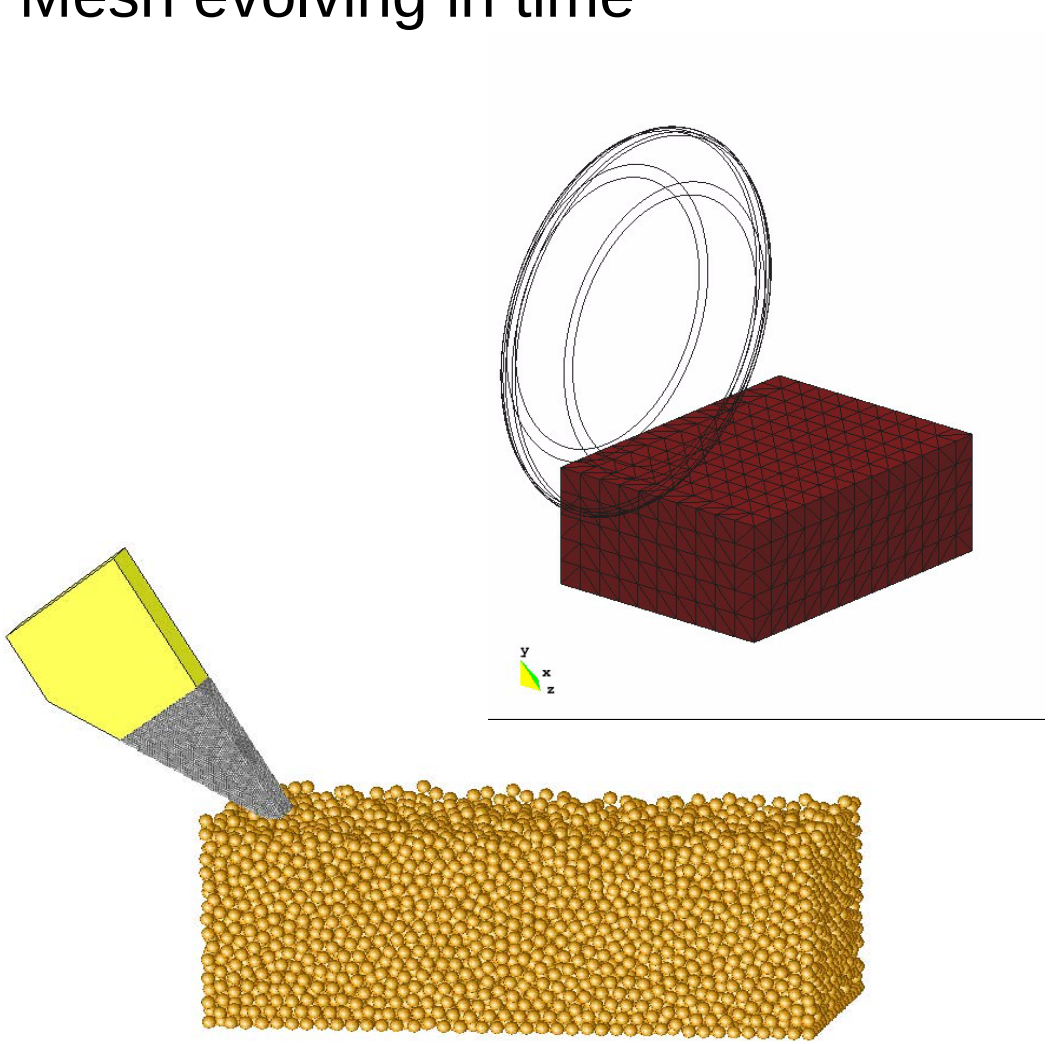
Mesh: the main data

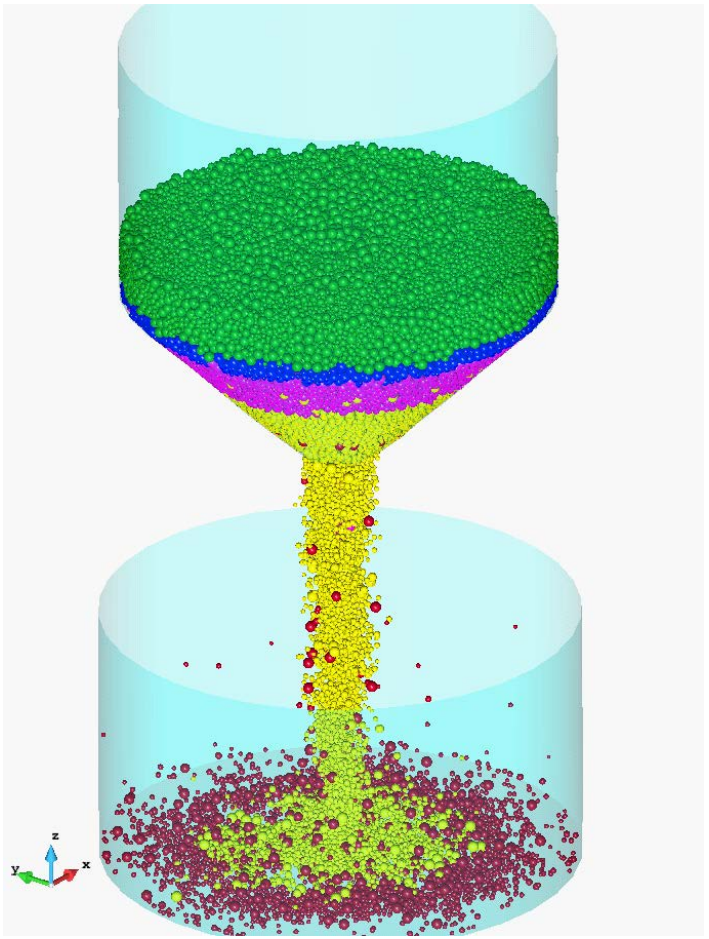
- Mesh static in time



Mesh: the main data

- Mesh evolving in time





Calculation: solver

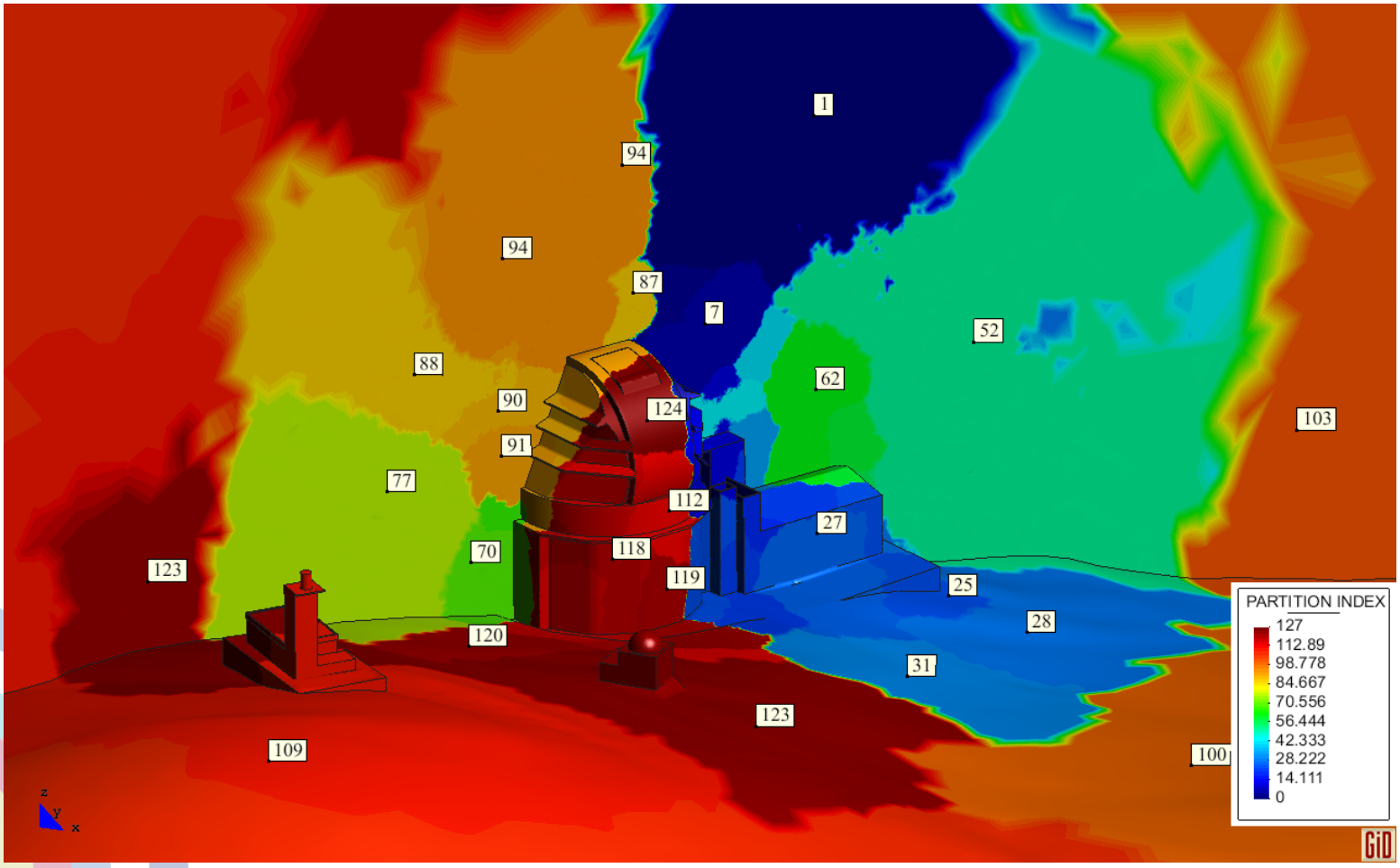
- Nowadays we can run very large simulations using HPC infrastructures
- Clusters with distributed computation nodes
- Data generated in the simulation:
  - Mesh
  - Results on mesh

  for each time step! (several thousands)

  (several Gb per time step, which involves several hundreds of Tb for the whole simulation)

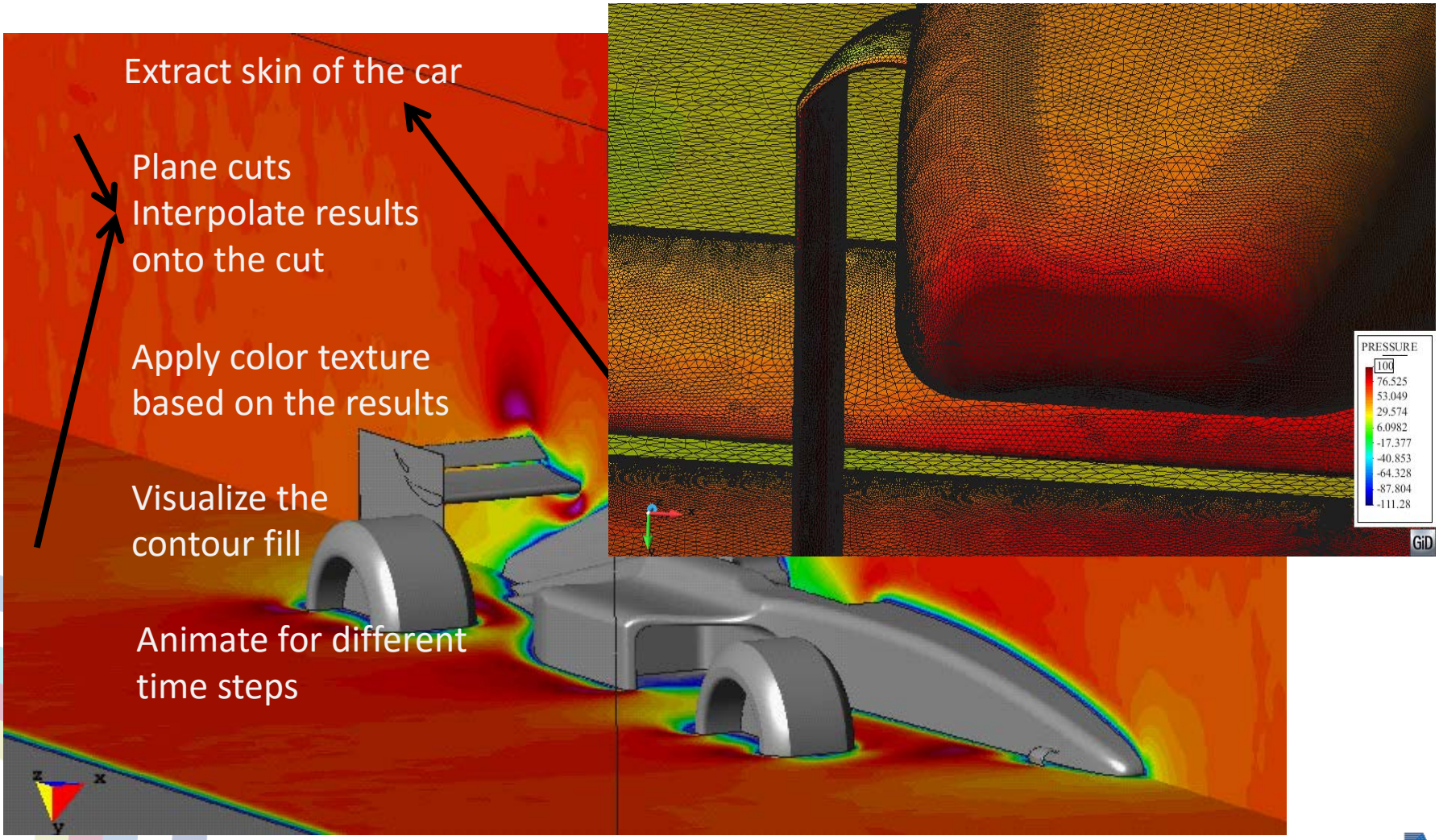
Calculation: solver

- Domain partitioning for distributed calculation



Postprocessing

- Postprocessing operations (data analytics) and visualization of results



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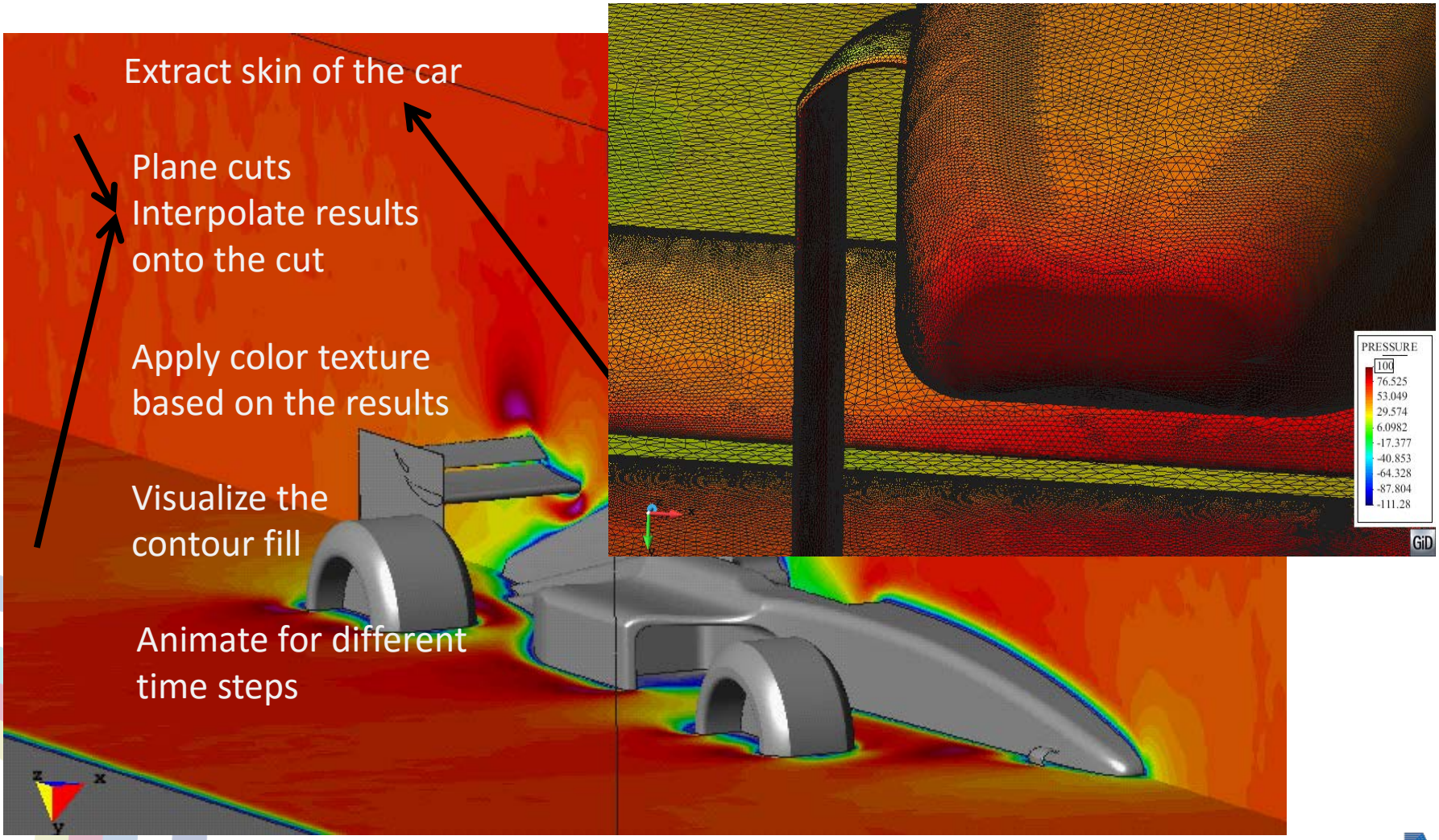
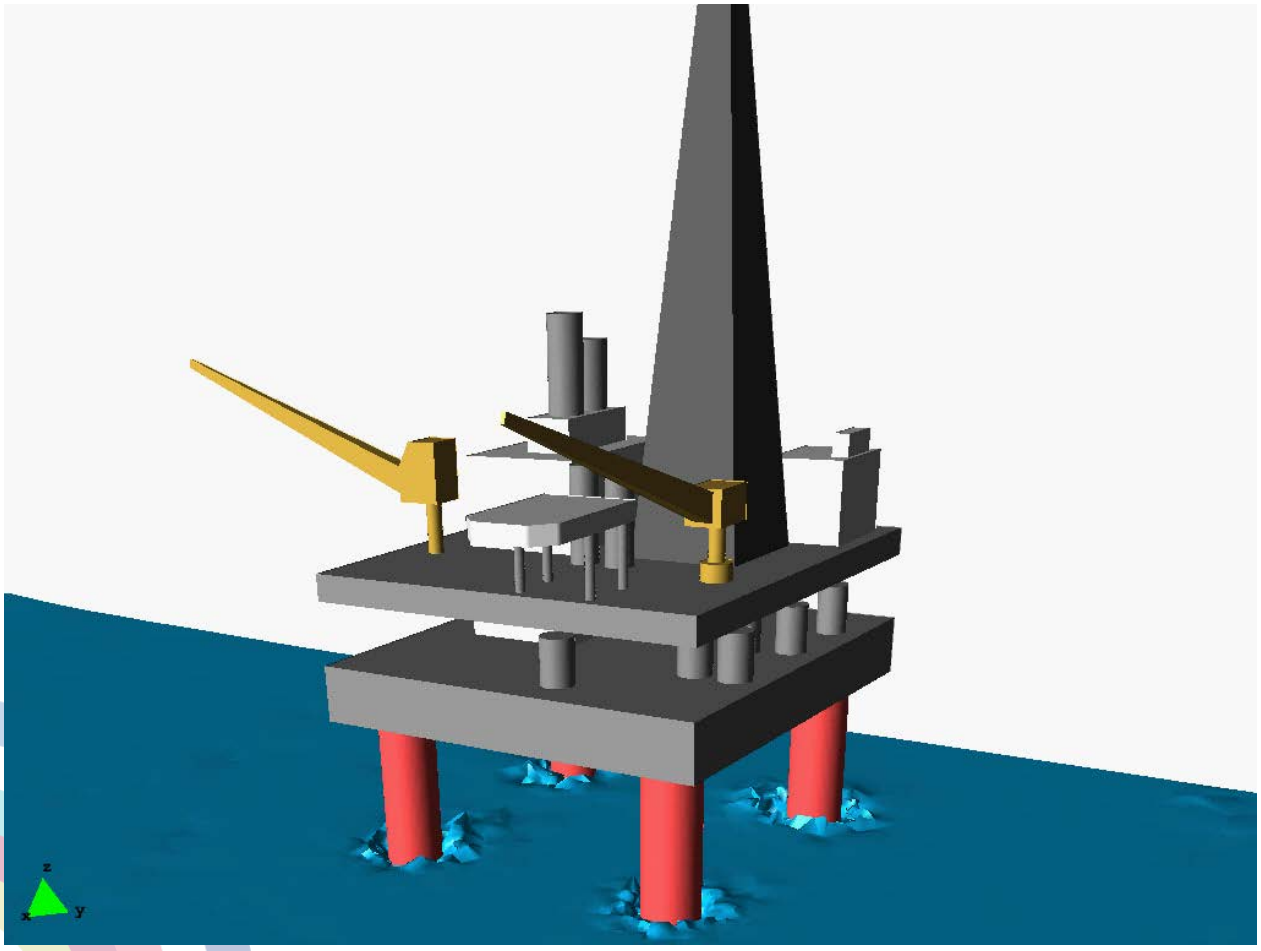


Postprocessing

- Isosurfaces



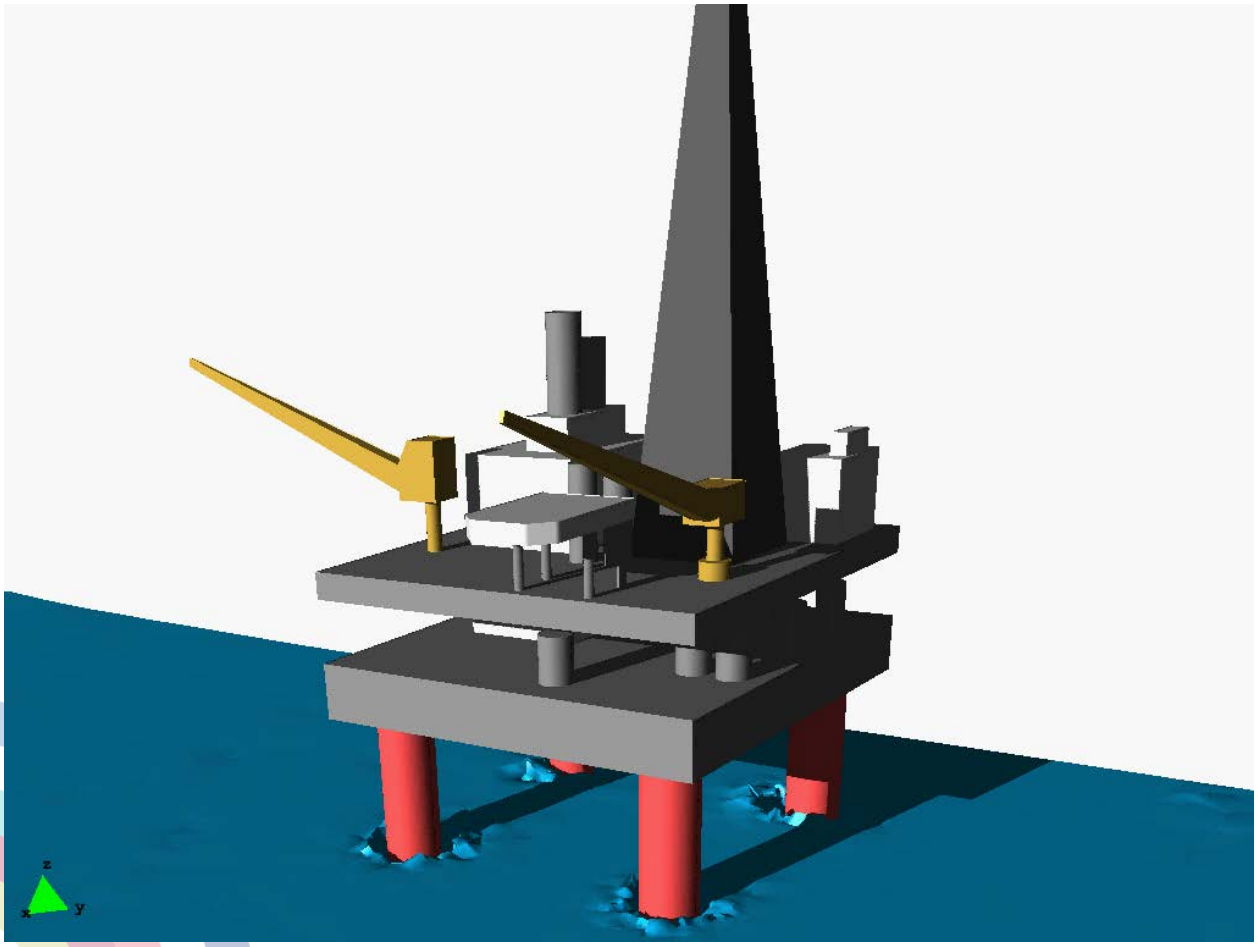
Extract skin of the model

Create isosurface of pressure equal to 0

Animate for each time step

Postprocessing

- Isosurfaces



Extract skin of the model

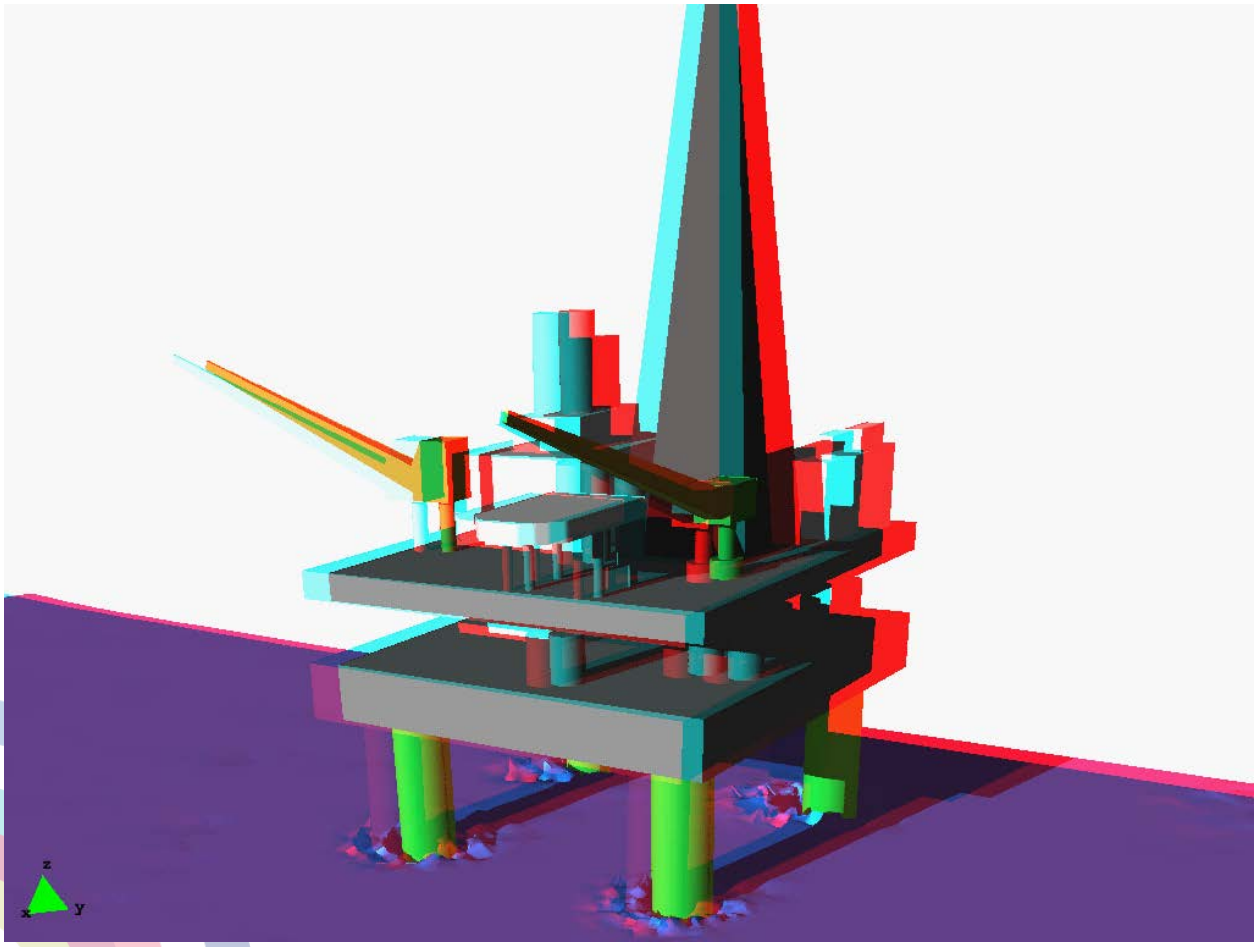
Create isosurface of pressure equal to 0

Animate for each time step

Compute shadows projected onto the iso-surface

Postprocessing

- Isosurfaces



Extract skin of the model

Create isosurface of pressure equal to 0

Animate for each time step

Compute shadows projected onto the iso-surface

Build up a stereoscopic visualization

Current bottleneck

- Nowadays the **huge amount of data** provided by the solver in HPC **cannot be stored** in one single machine, so it is mandatory:
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  - **Distributed visualization**

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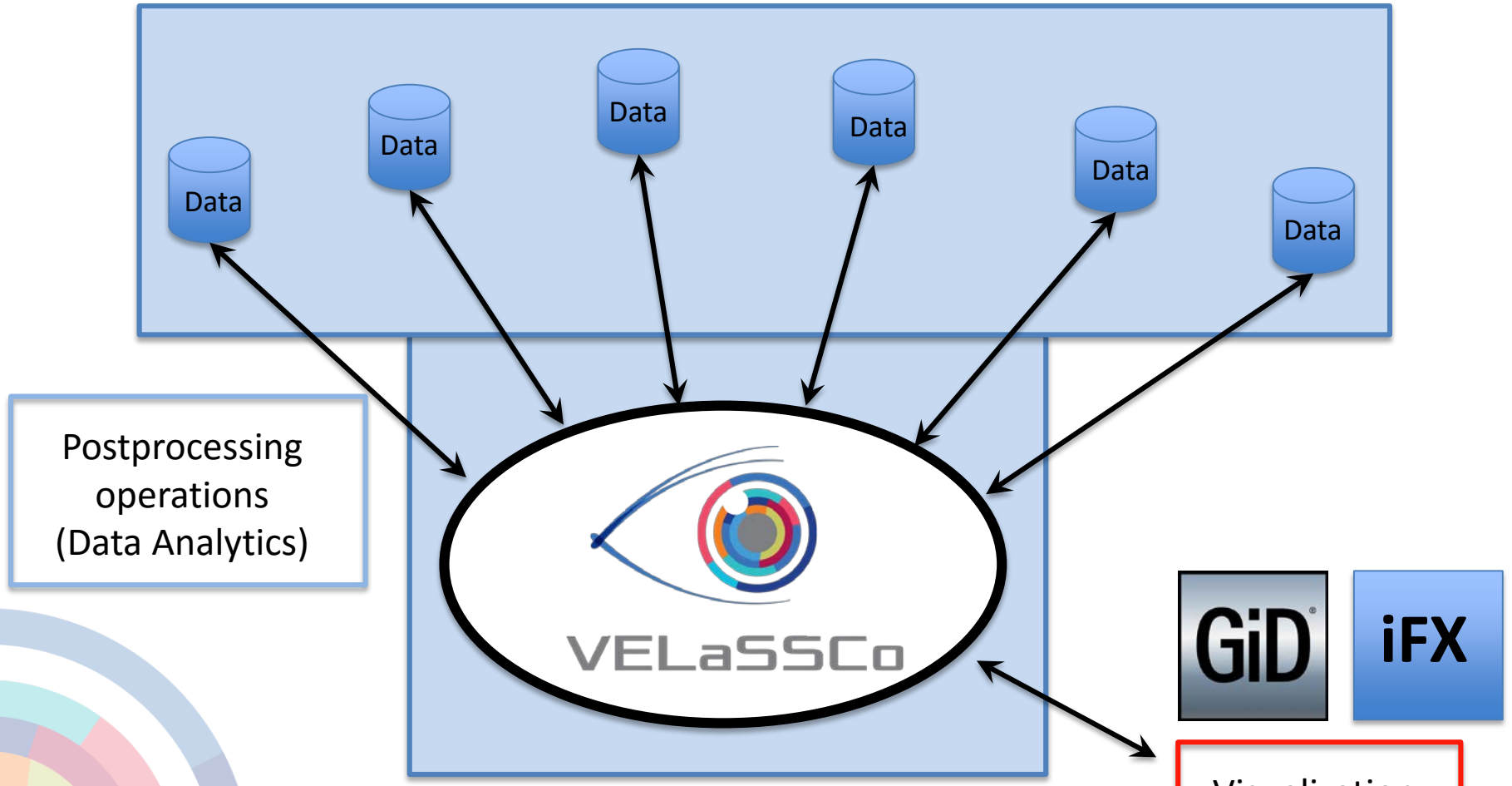
Objective of VELaSSCo

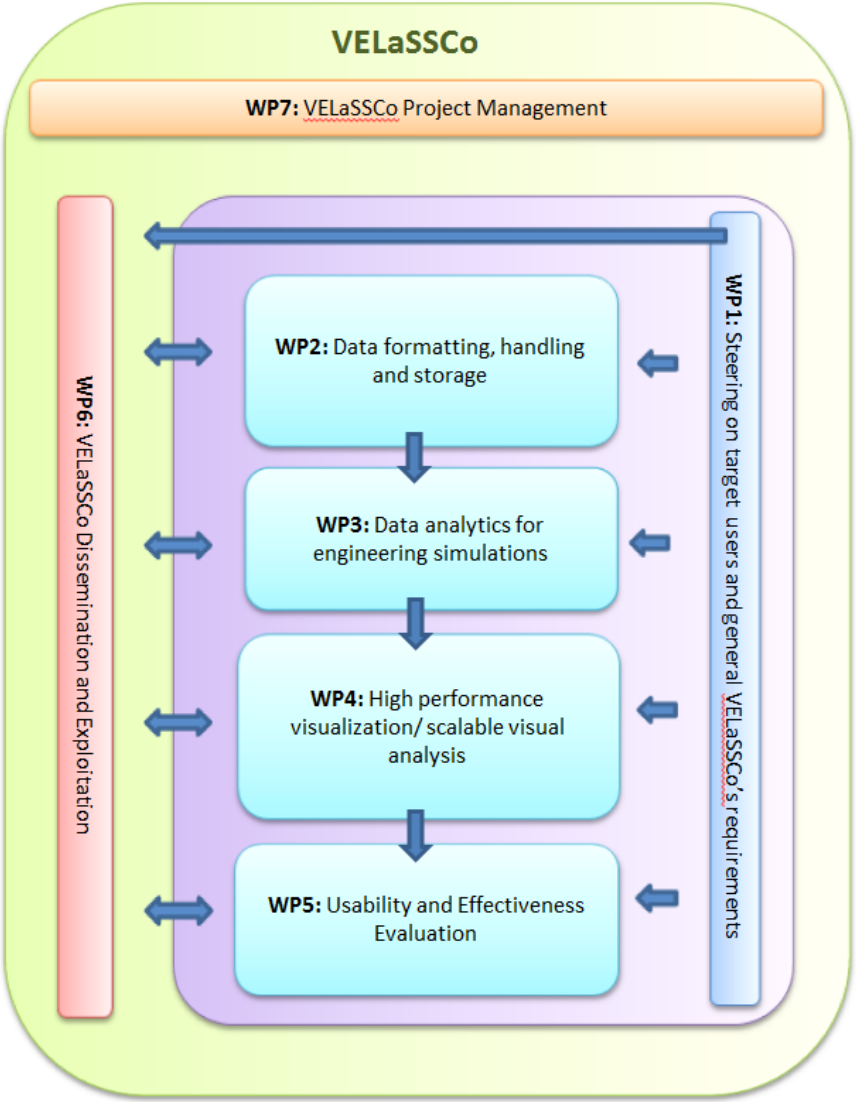
- The main **objective of VELaSSCo** project is to build the VELaSSCo Platform, a system that performs distributed **post-processing operations and visualization of very large simulations**.

- To address this objective, VELaSSCo brings together **Simulation** and **Big Data.**

VELaSSCo Platform

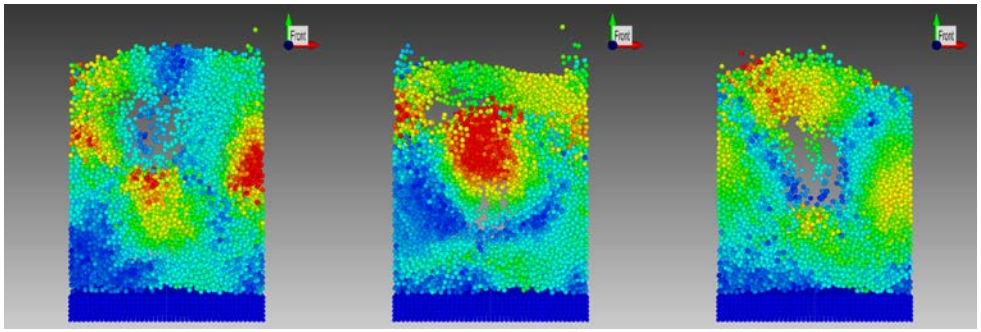


WPs distribution



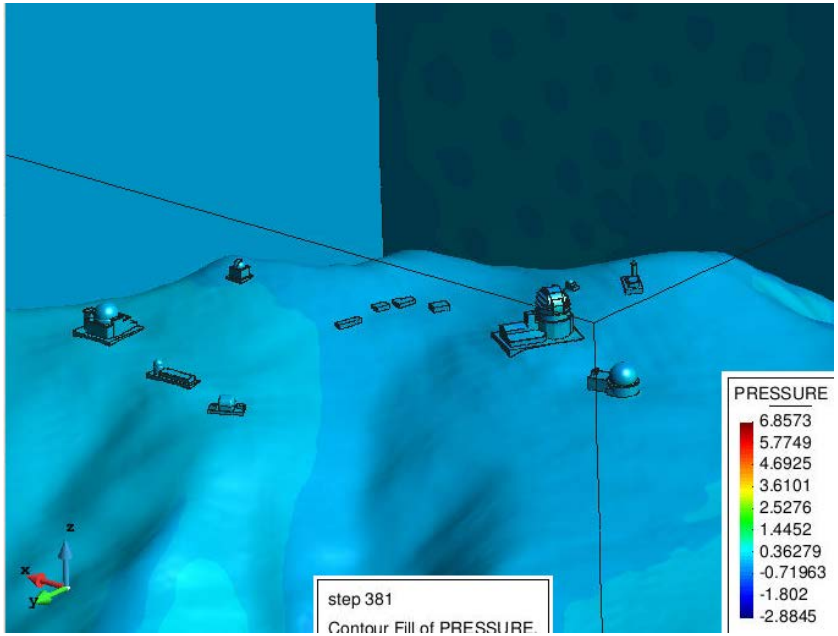
Some numbers…

- Data sizes we are currently working with at **first prototype level**



Fluidized bed DEM example:

- 12.000 particles / time-step
- 3000 contacts (p2p and p2w) / time-step
- 40.000 time-steps
- Mass, volume and velocity vector, and force vector for contacts



Telescope FEM example:

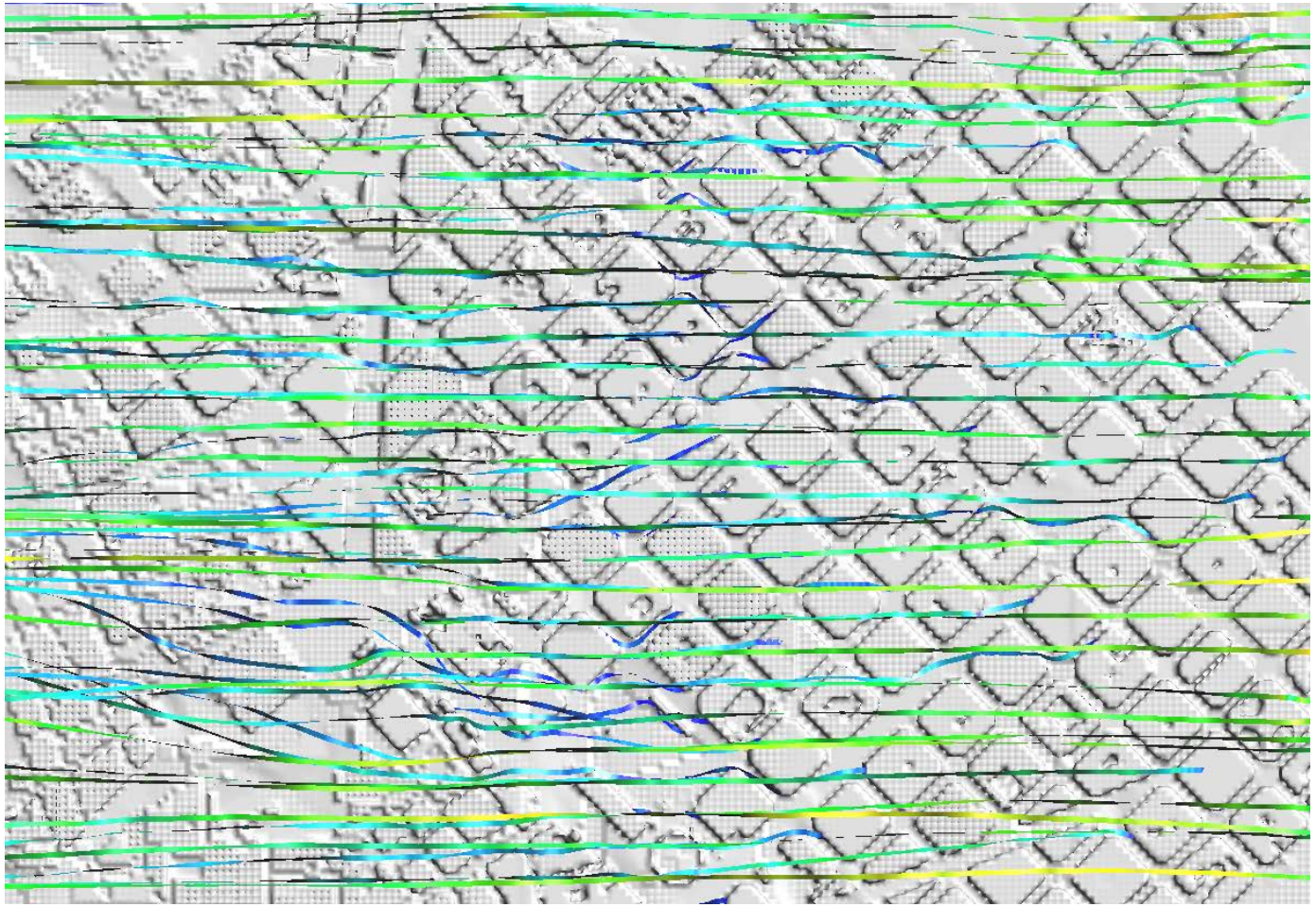
- 4 M nodes, 24 M tetrahedra
- 19 time steps
- Partition index, pressure and velocity (5 doubles)

Some numbers…

- Data sizes we already have for the **final prototype** of VELaSSCo Platform
  - Barcelona model:
    - ~**100M Tetrahedra** (4 m resolution), ~384 subdomains
    - ~340 time-steps
    - 227 GB disk space

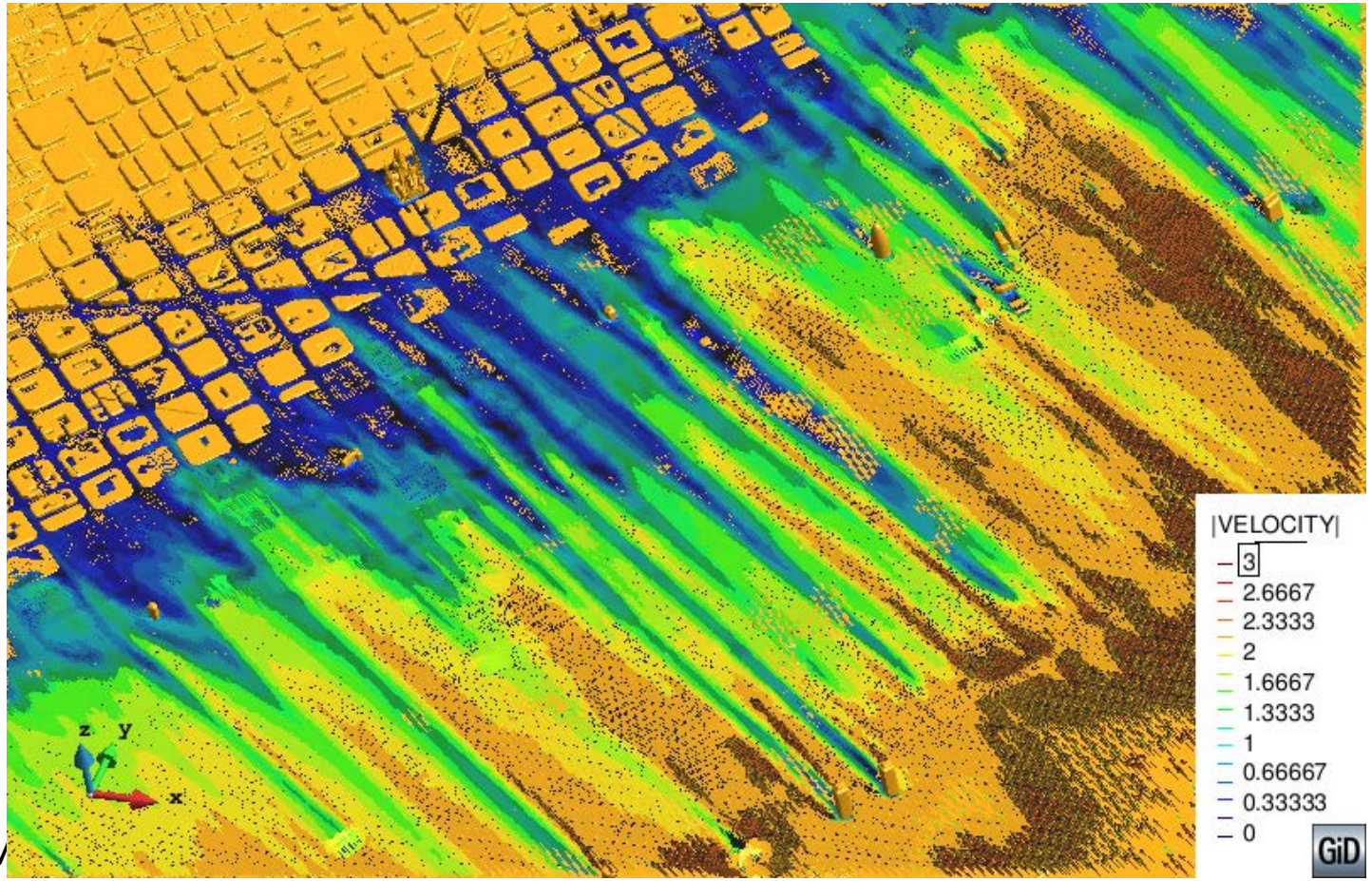
Simulations done in the framework of Numexas EU funded project

Barcelona model



Mesh of 6.000.000 elements (8 m resolution)

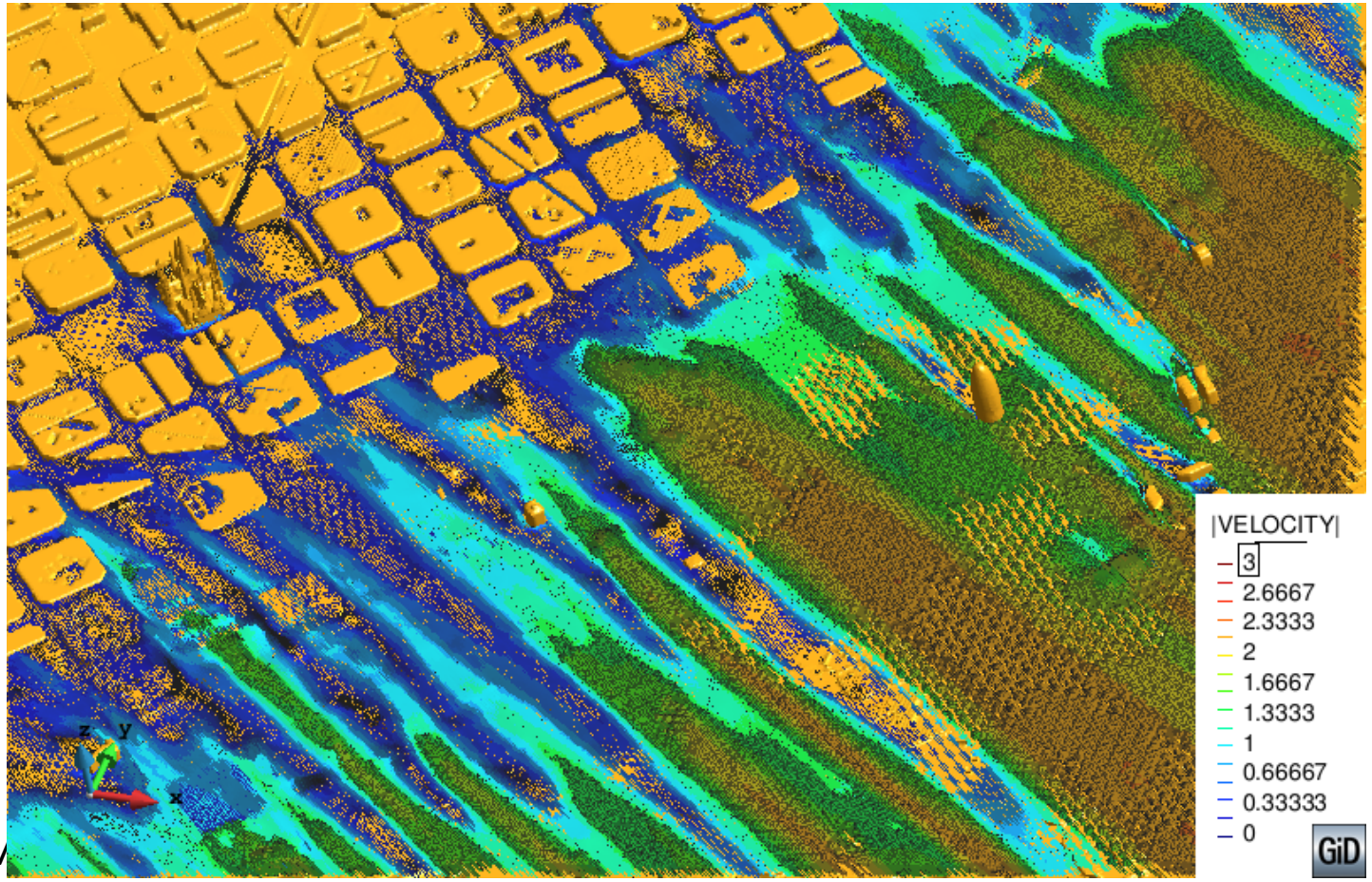
Barcelona model



M

400M elements correspond to a resolution of 4m.

Barcelona model



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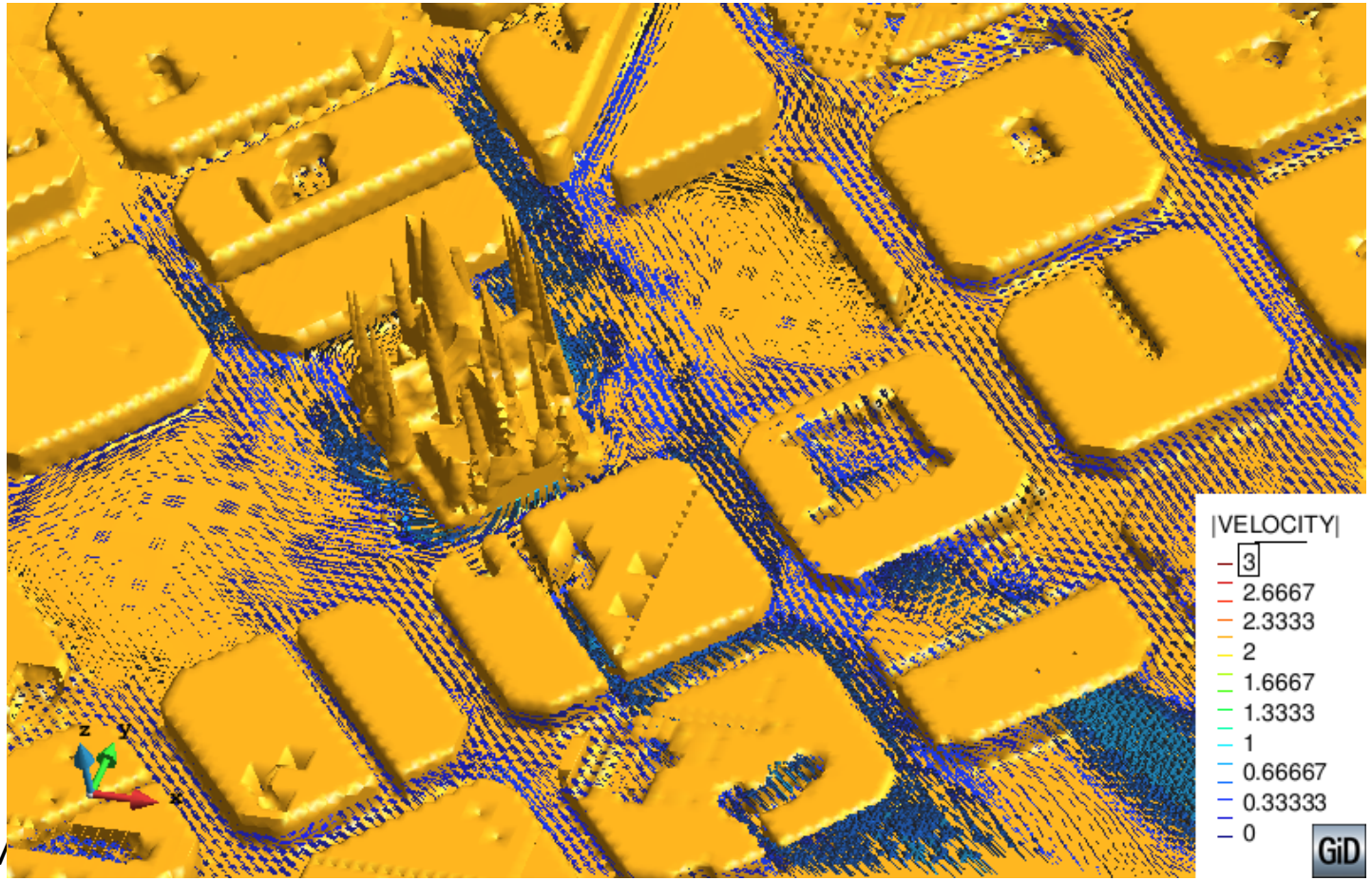
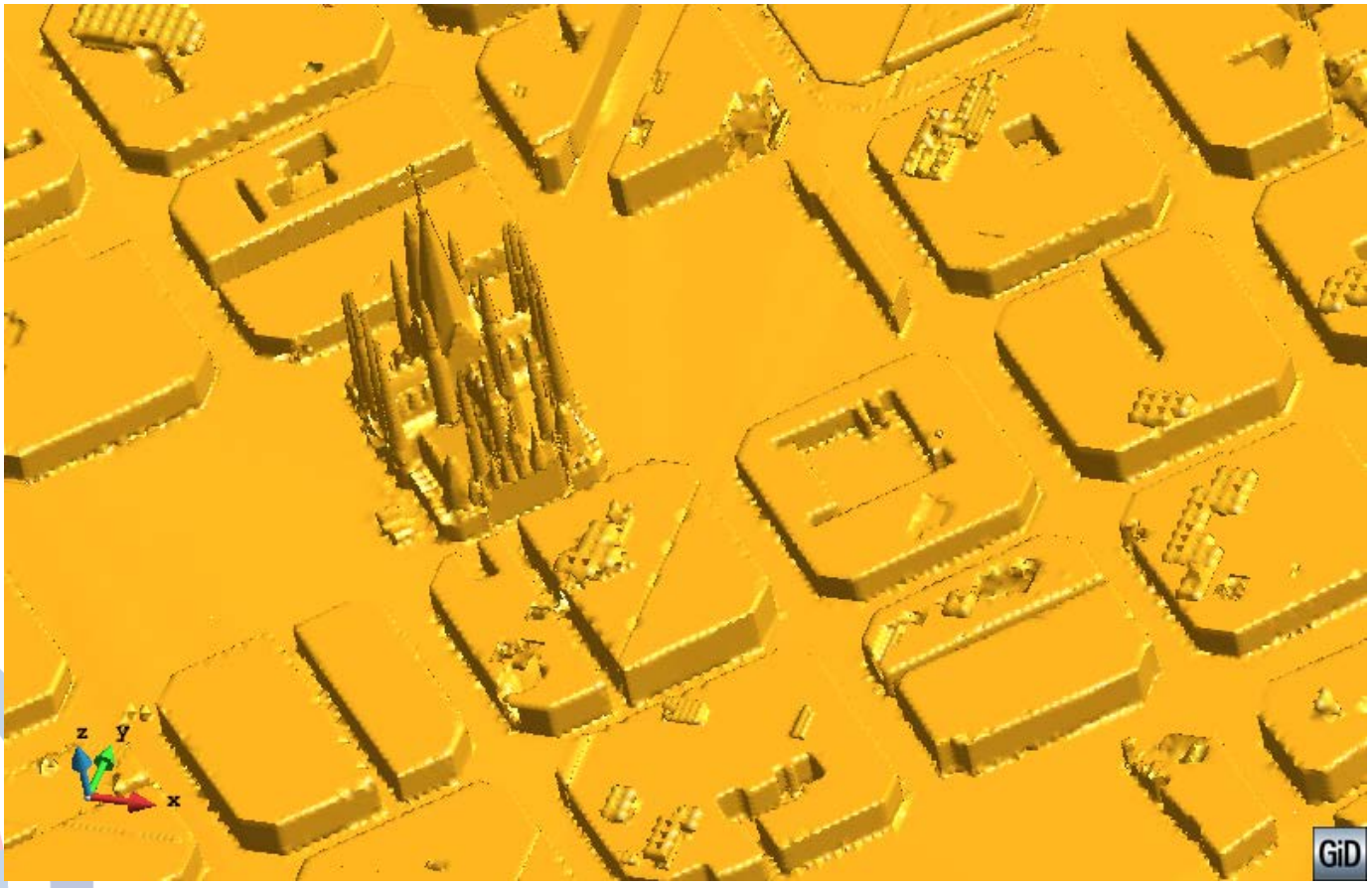


M

400M elements correspond to a resolution of 4m.

Some numbers…

- Data sizes we are expecting in the **next future**
  - Barcelona model: ~**1300M Tetrahedra** (2 m resolution)



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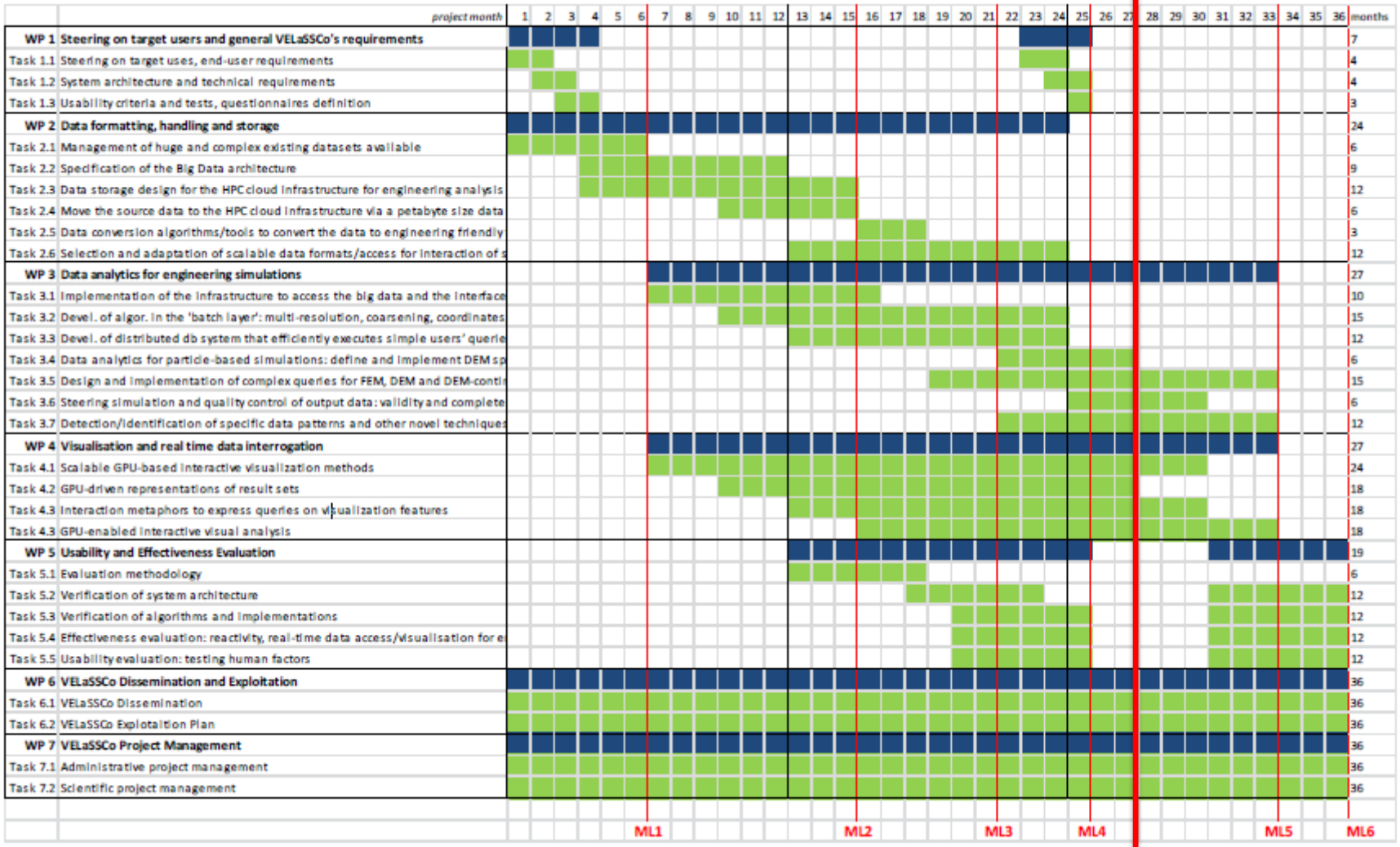
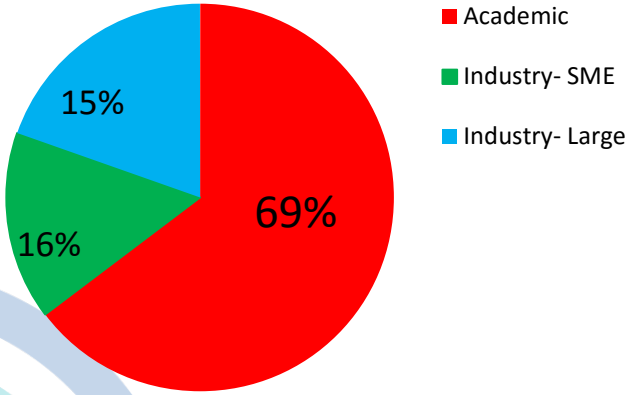
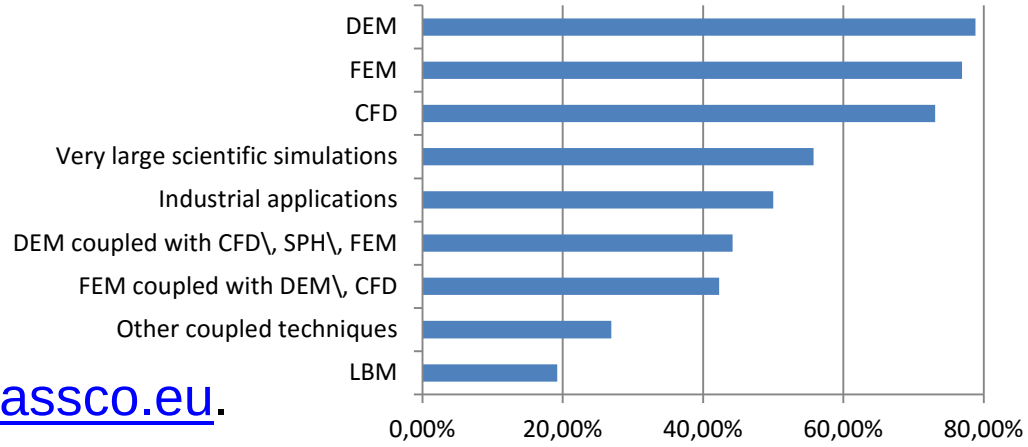
Project progress



User Panel

- We have created a user panel (around 50 members):
  - Collect requirements
  - Perform evaluations of the platform
  - Periodically updated about the status of the project

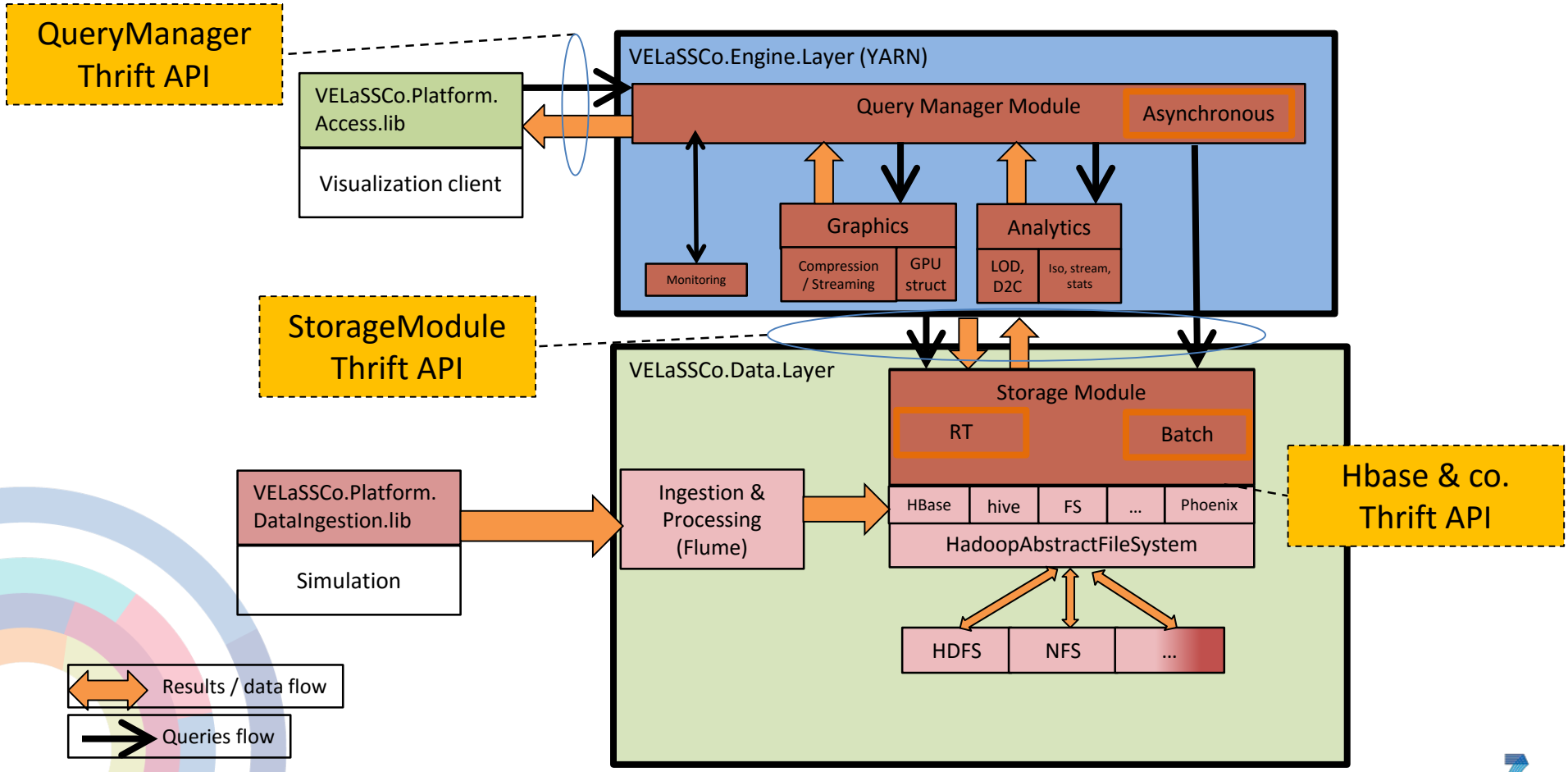




Join our user panel at www.velassco.eu.

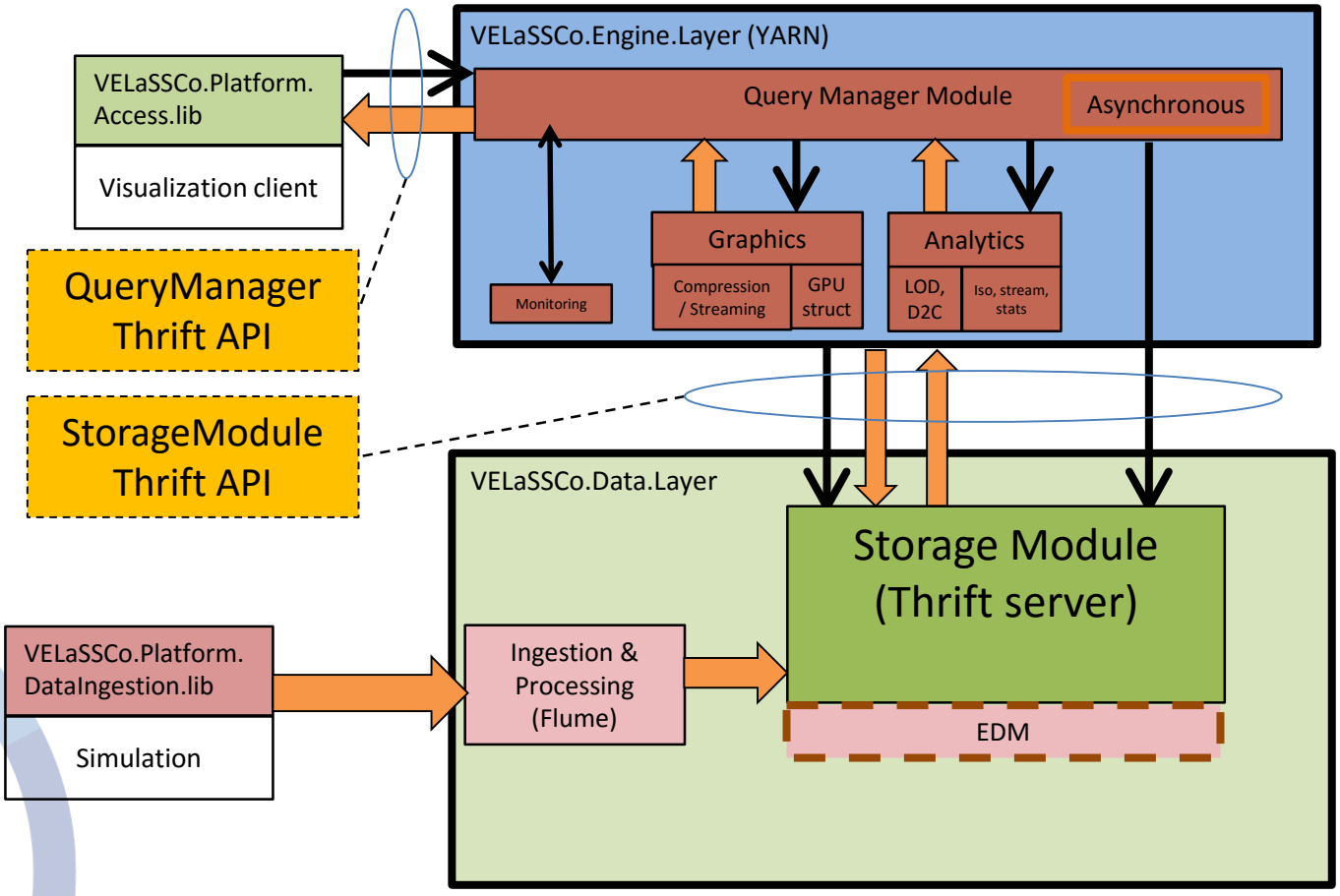
Big Data architecture

- The Open Source:

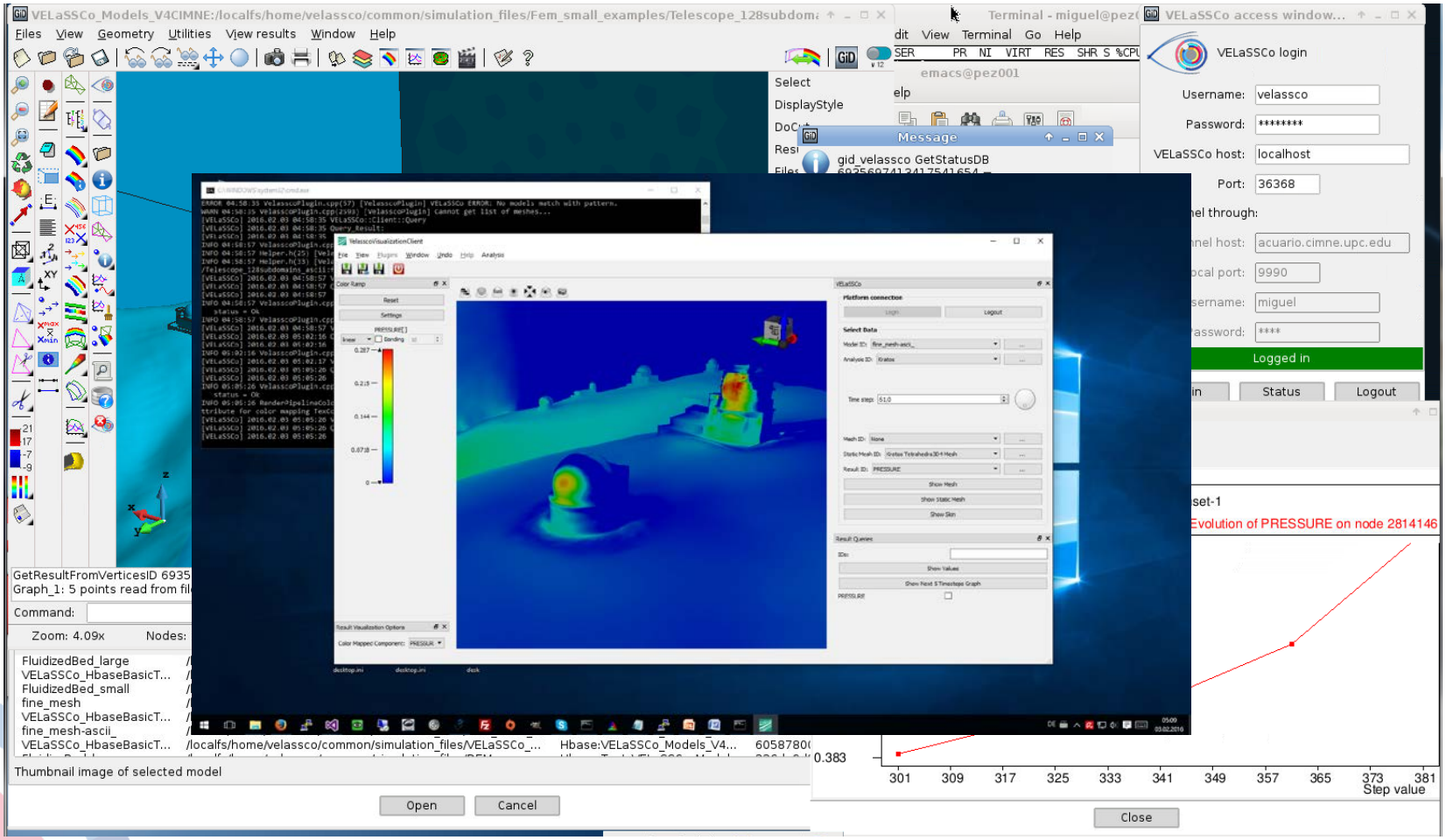


Architecture (updated 21.10.2015)

- The Close Source version:



First prototype of VELaSSCo Platform



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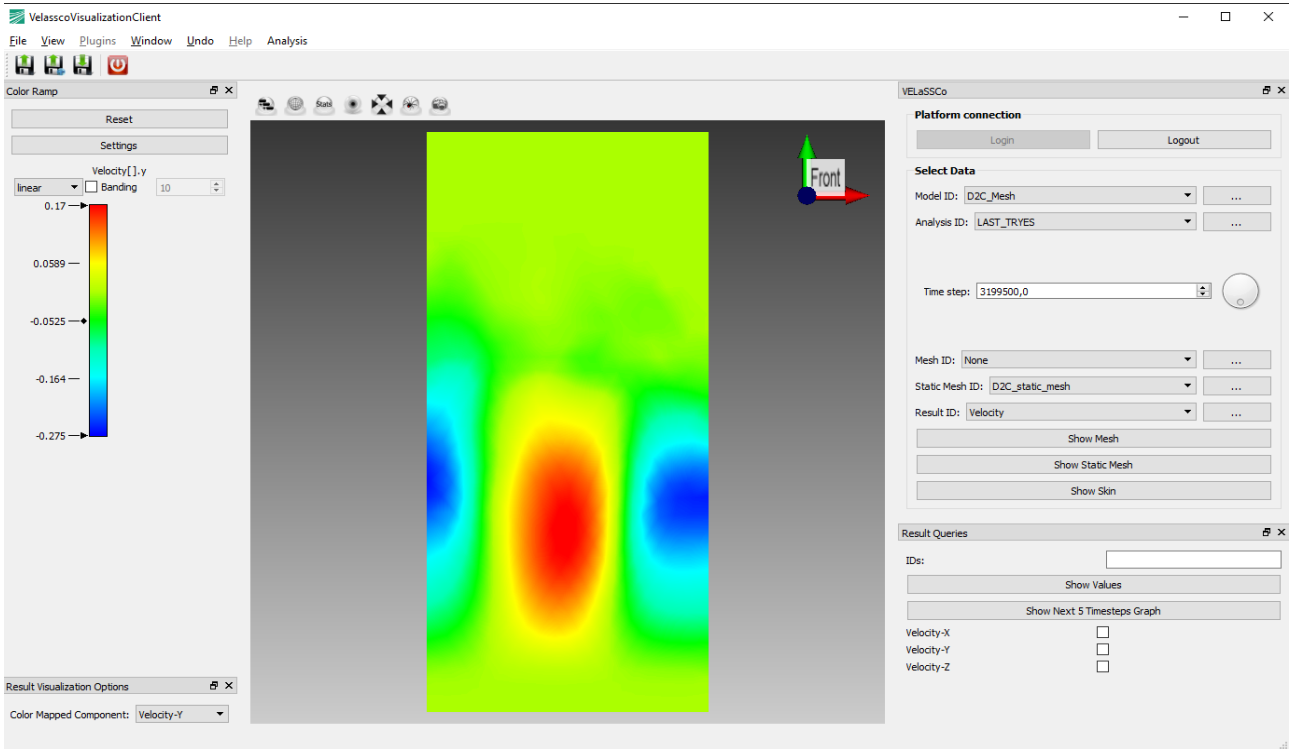

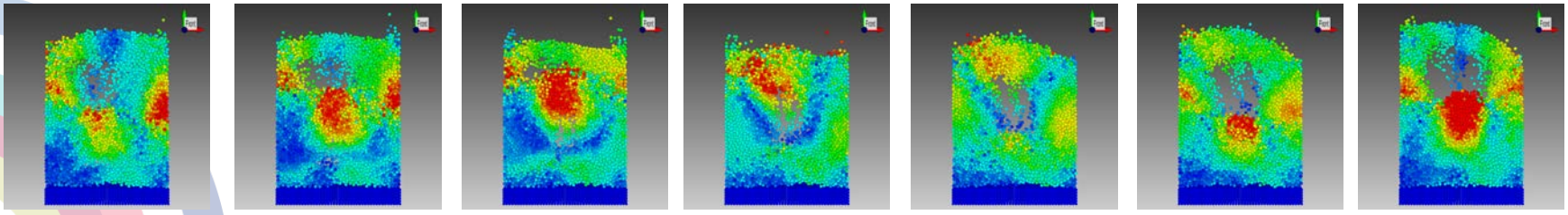

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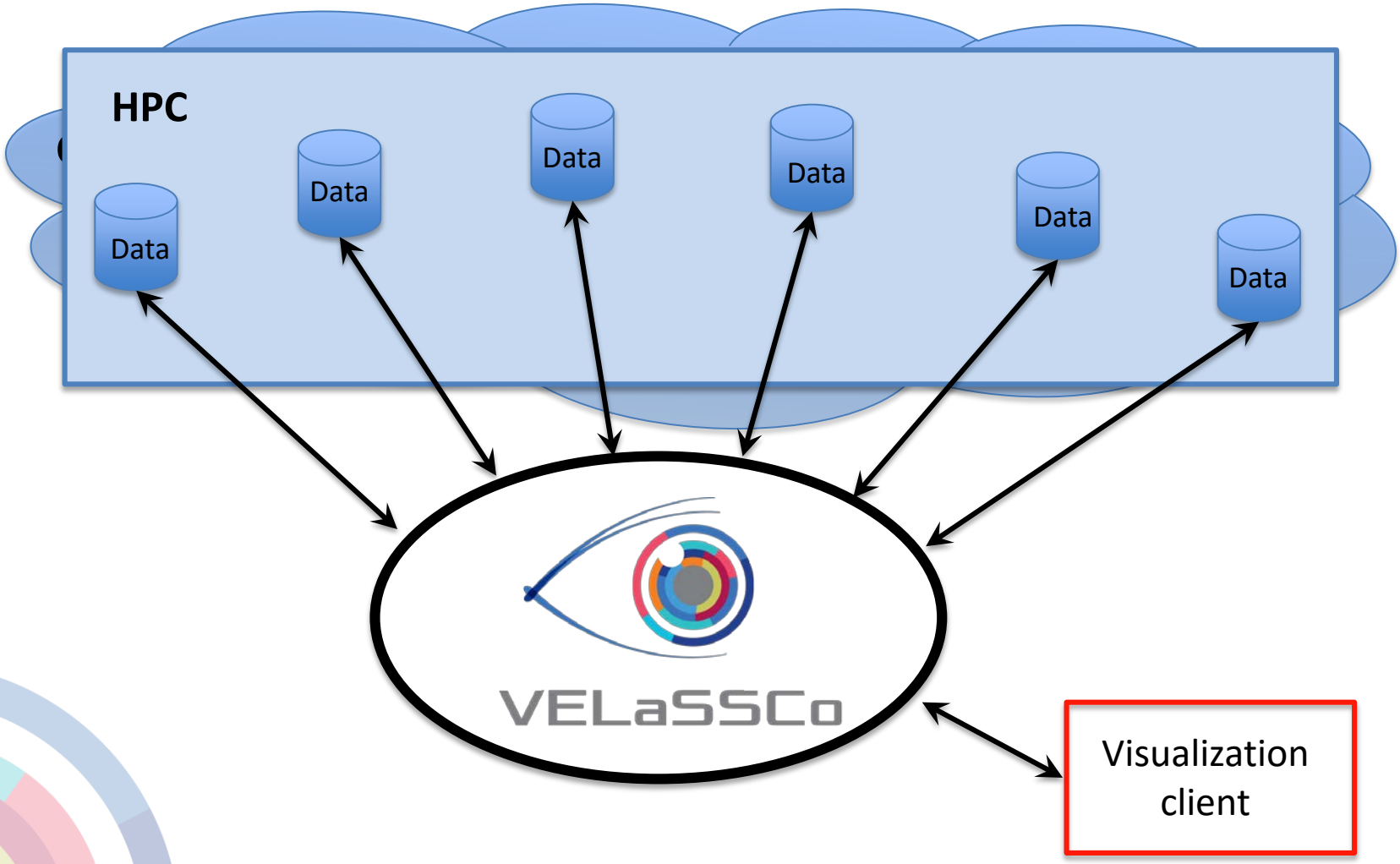
Next steps

- Final prototype to be ready by September 2016
- Evaluation event to be held on October/November 2016
- Integration as a product in some partners strategy
- Take advantage of some ‘opened doors’…

VELaSSCo Platform



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Conclusions

- We have reached the first prototype of VELaSSCo platform obtaining a prof of concept of it
- We are learning a lot from putting together BigData and Simulation worlds
- We have promising results in order to change the paradigm of postprocessing and visualization for numerical simulations

VELaSSCo

Thank you for your attention

Project coordinator – Dr. Abel Coll

www.velassco.eu

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