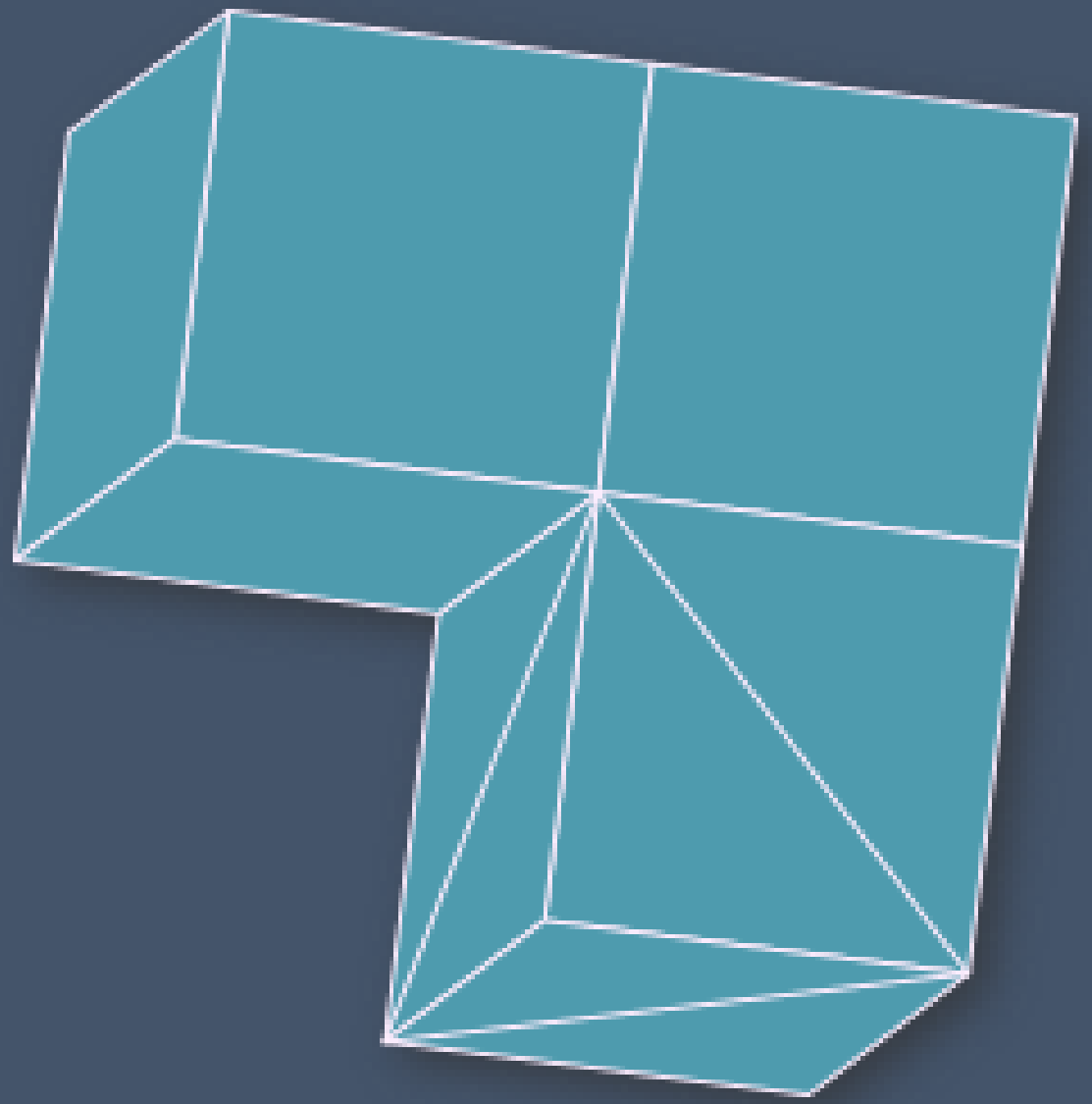
Kratos Objectives and Timeline

Pooyan Dadvand



Objective

Creating a monster?

> 120 developers

> 2.5 million line of code

Objective

Creating a monster?

> 120 developers

> 2.5 million line of code

No, that was a side effect!

Objectives

A framework for development of multi-physics solutions

Which should be:

- **Flexible** and **extensible**
- **Modular** enabling multi-disciplinary **team working**
- **Scalable** to large and complex problems

Kratos Timeline

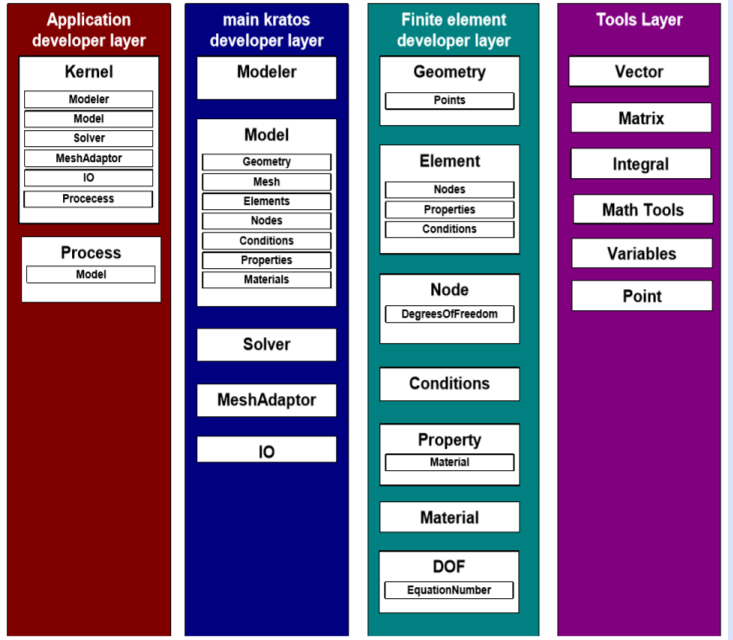
2001

Everything started in C4 office where **Xavi Royo** and I decided to join in development of an adaptive multi-physics solver

Javier Mora
First who joined

Most of the design has been done during pilgrimage to Santiago with **Xavi**

Prof. Oñate approves the first design



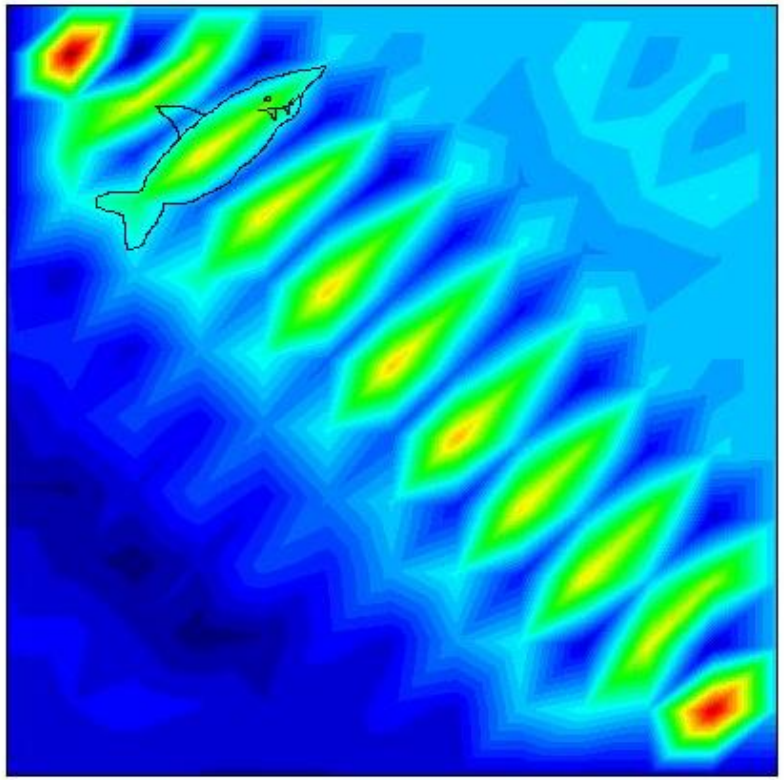
LGPL License

Unfortunately Xavi passed away some months later leaving me alone on this way…

2002

Riccardo joined the team

Convection Diffusion solution still with stabilization problem!



Too fast shark in the sunset

The first Kratos art!

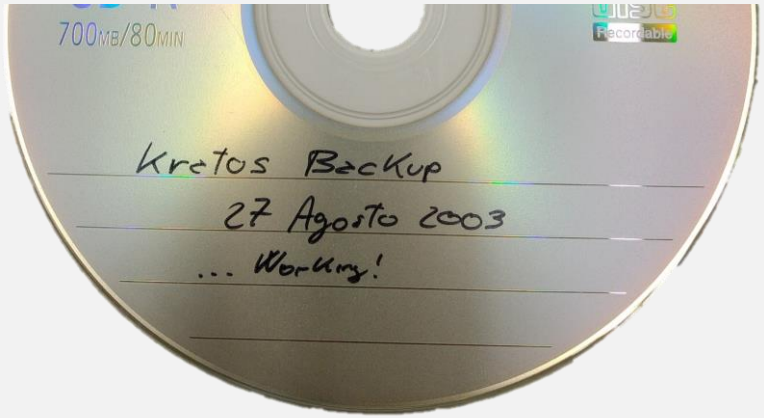
2003

All star team
- Riccardo Rossi
- Santiago Badia
- Roberto Flores
- Ruben Otin

- Structural
- Fluid
- Electro magnetics
- Thermal

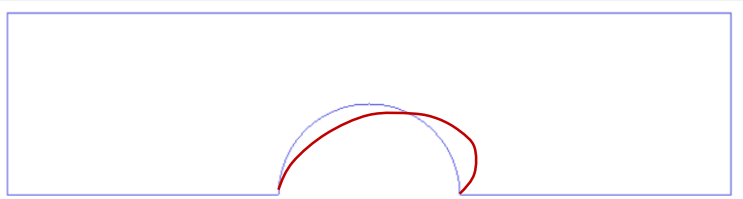
Riccardo is back!

Working!



but the code was too complex and slow

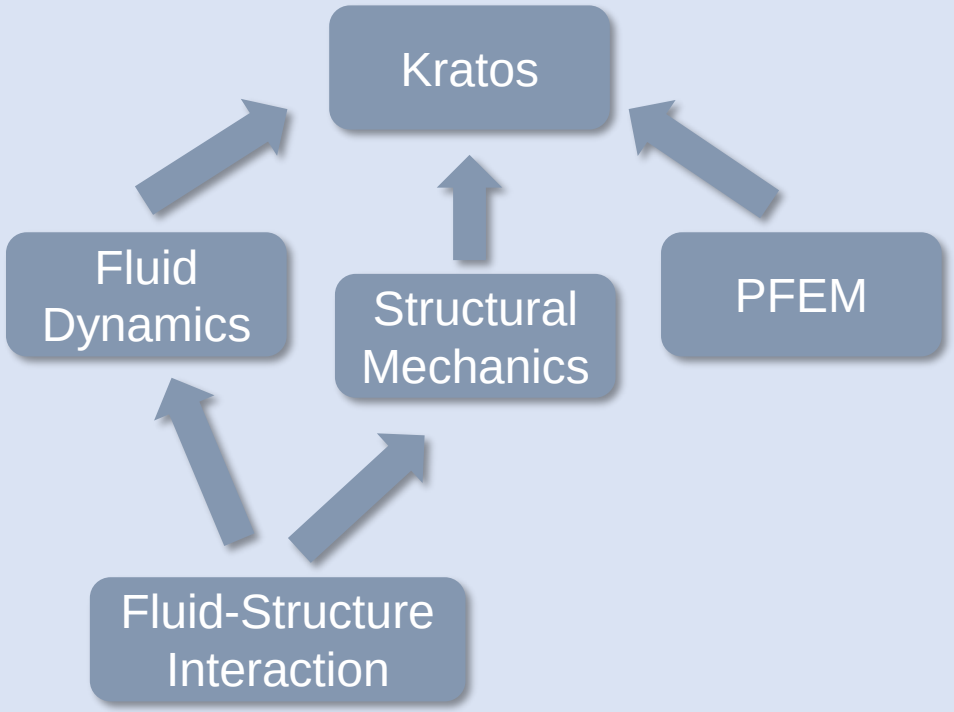
First FSI: a 2D bubble



Catching Roland's attention!

Reimplementing the code from scratch base on the original design but taking into account the version 0 experience

- Reducing flexibility
- Increasing the performance
- Separating applications form core
- Reducing implementation complexities
- Still very flexible data structure
- Changing our own scripting input with Python



2004

Meanwhile all developers **except Riccardo** changed to other codes…

2005

Institute for Structural Mechanics joined the project

STATIK DYNAMIK
RUHR-UNIVERSITÄT BOCHUM

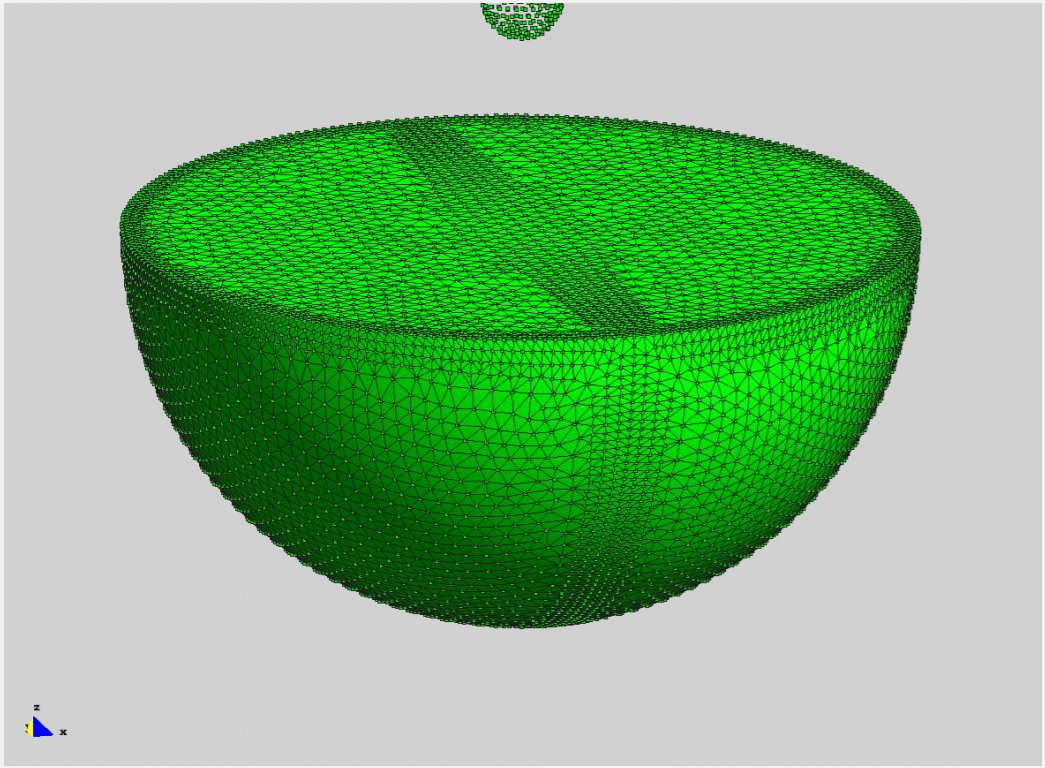
giving an important push to structural application

Prof. Idelsohn support for PFEM in Kratos

Pavel Ryzhakov started with PFEM

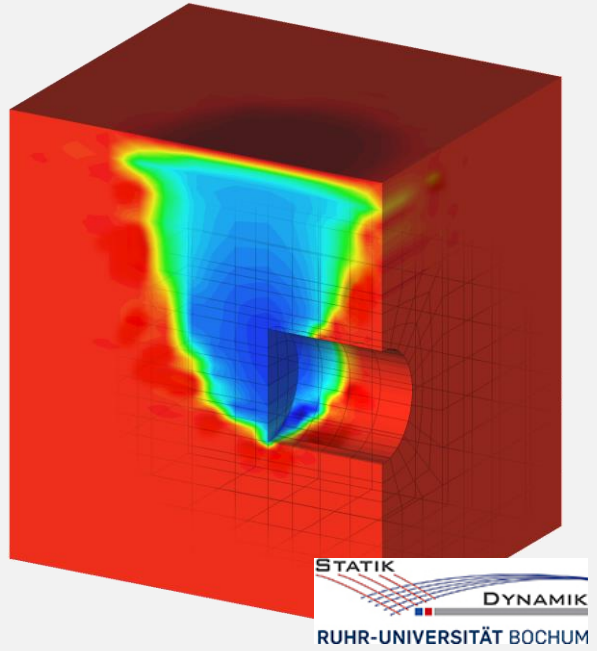
Janosch Stascheit started with tunneling process

PFEM implementation in Kratos improves the remeshing capability and robustness of fluid solver



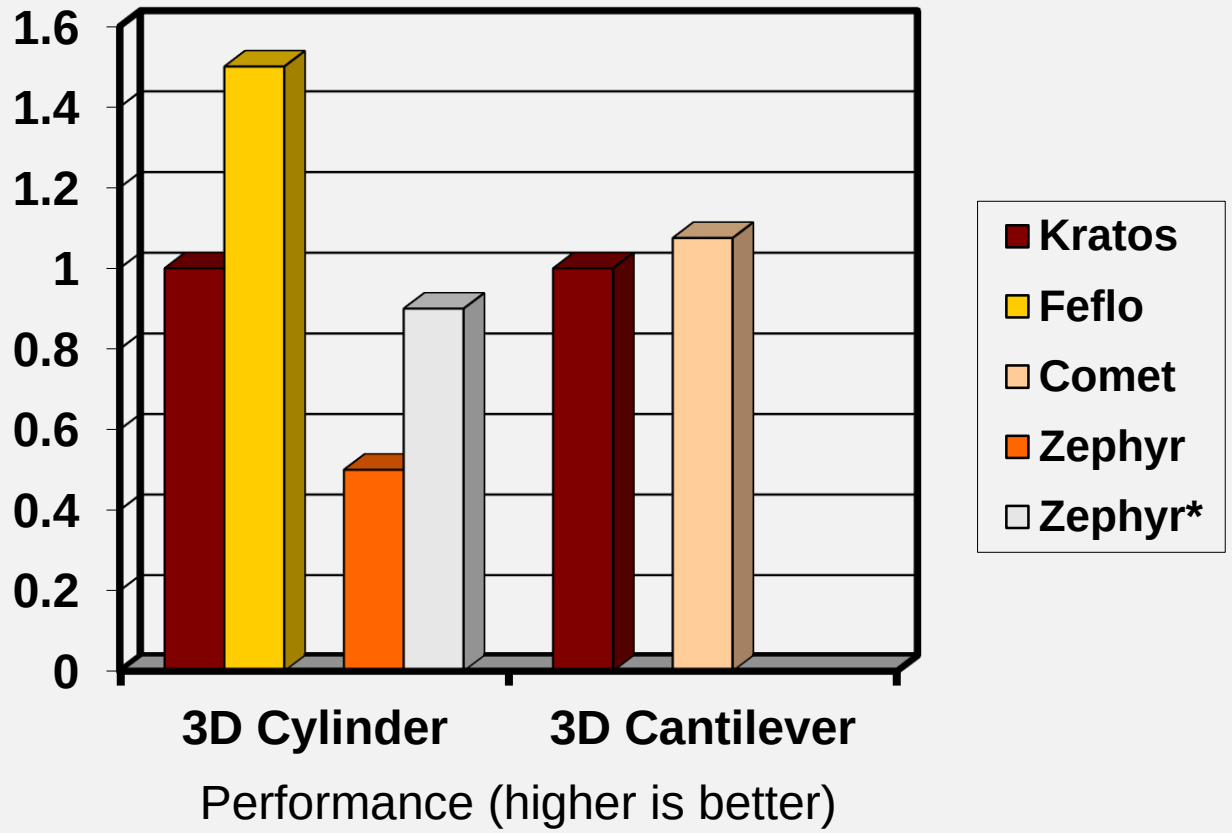
Antonia Joined!

Tunneling process
courtesy of Janosch Stascheit



2006

Kratos starting to be comparable to single purpose codes in performance

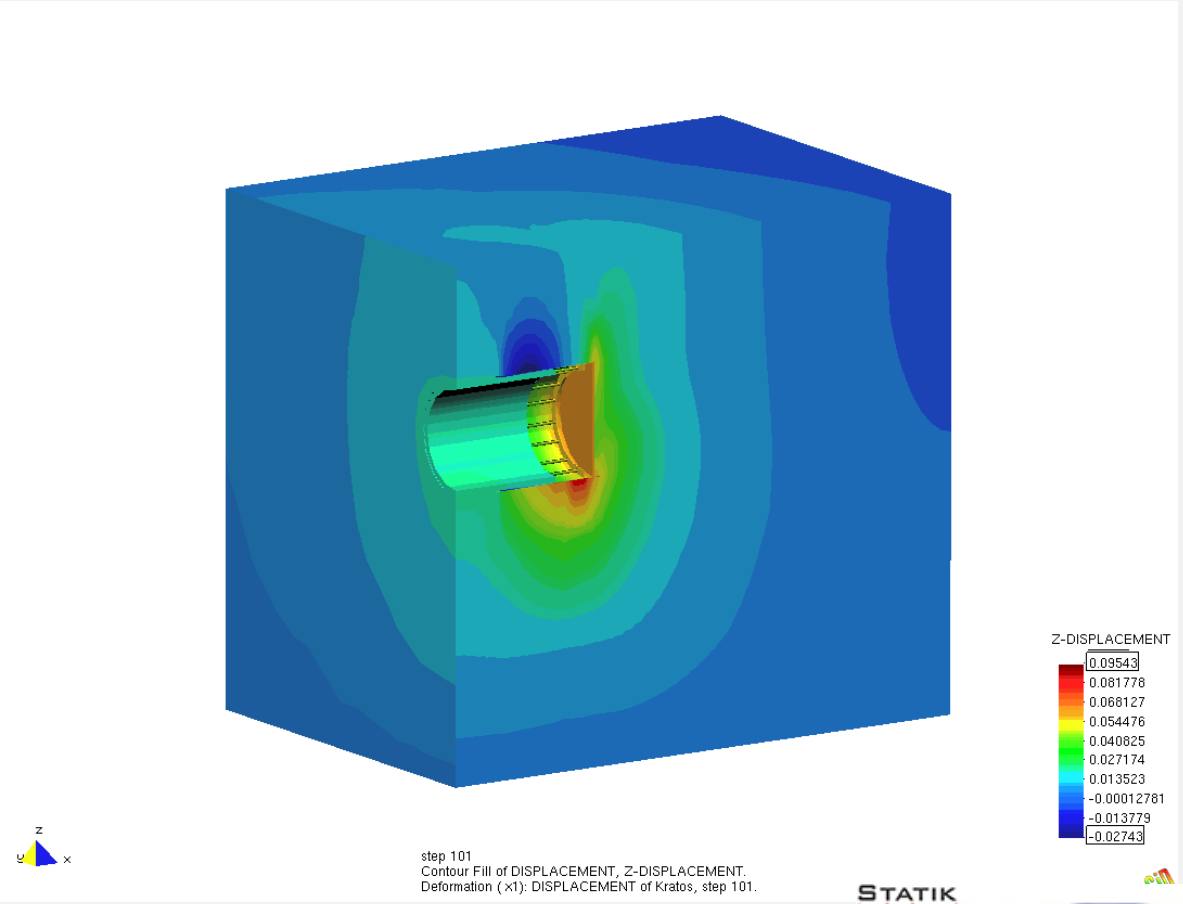


Starting with MPI parallelization

First Industrial use as composite shell solver inside a company inhouse solution

2007

MPI parallel tunneling process



Courtesy of Janosch Stascheit

STATIK DYNAMIK
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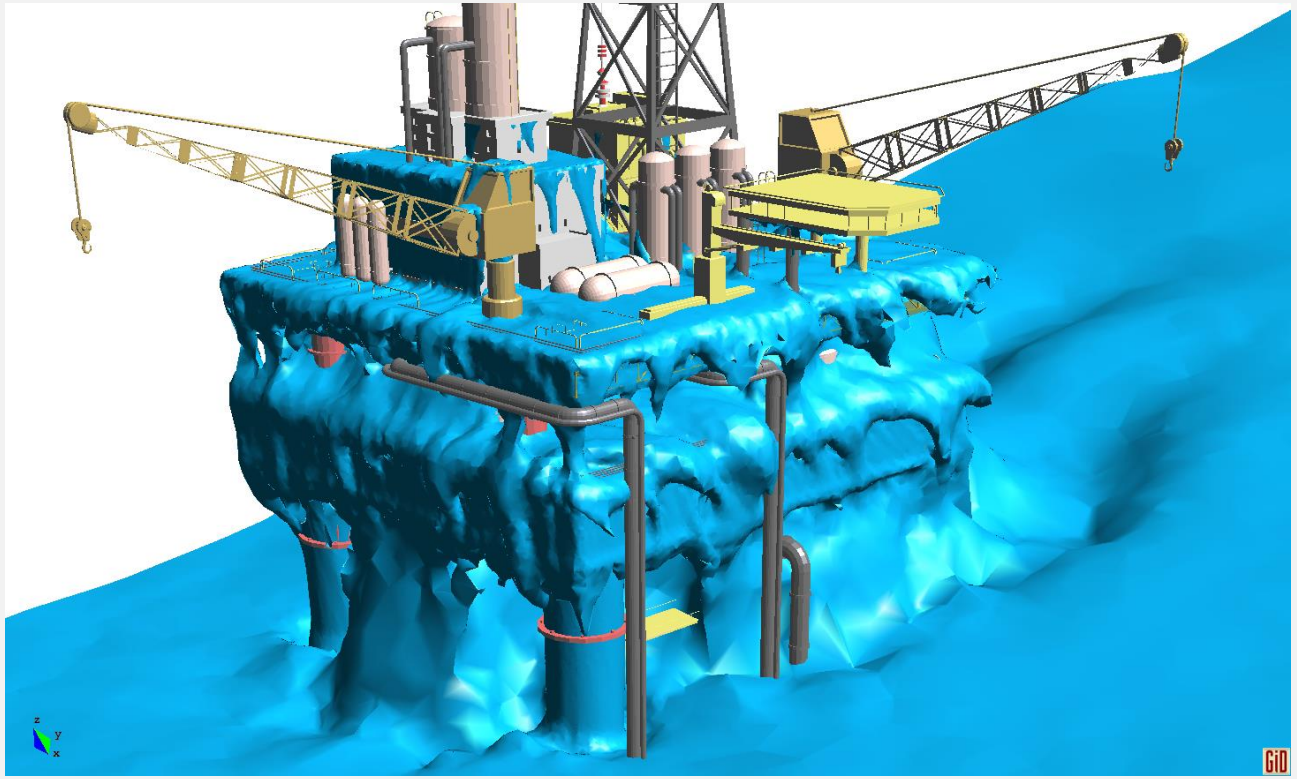
Jordi Cotela joins

2008

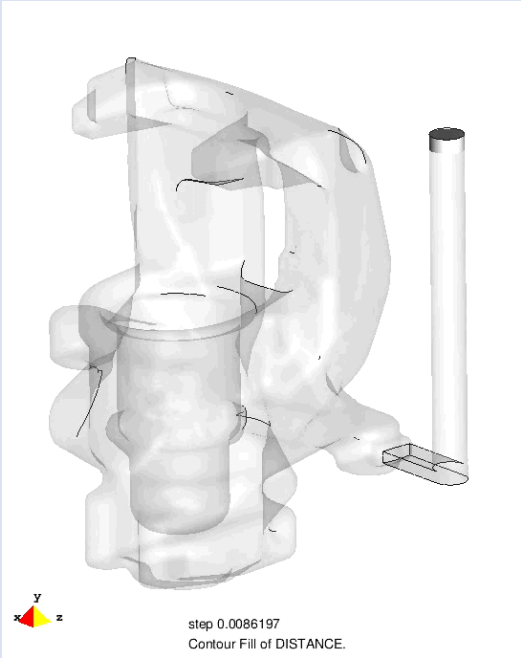
Level set free surface tracking



Team growing!

2009

Click2Cast solver prototype

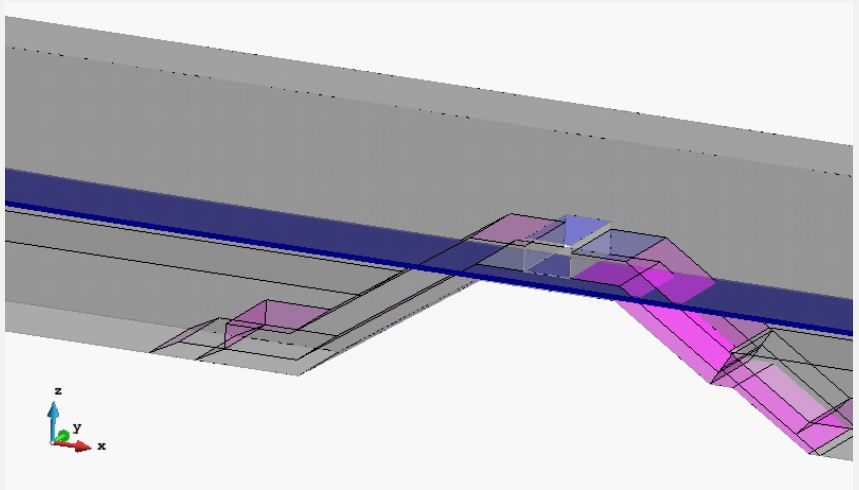


2010

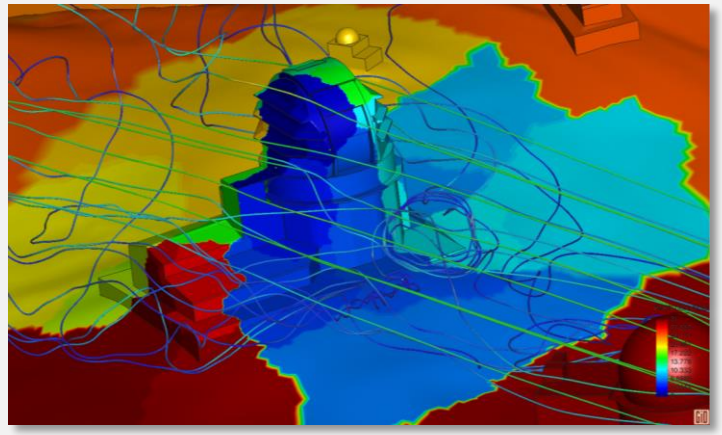
Static chair on board!

Beginning of a long and very close collaboration with strong impact on many parts of Kratos!

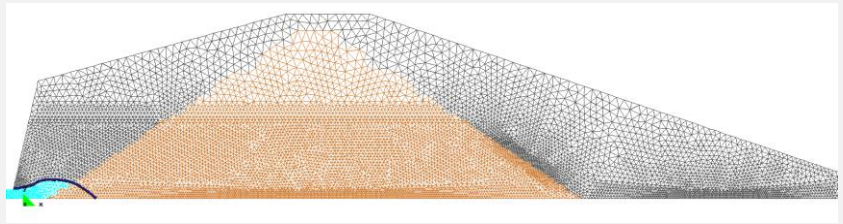
Fluid in porous media



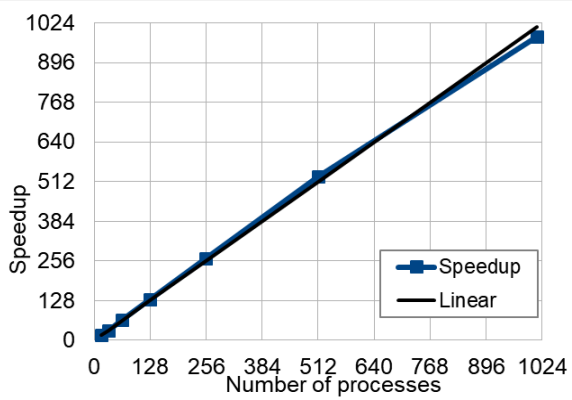
Reaching 10M elements



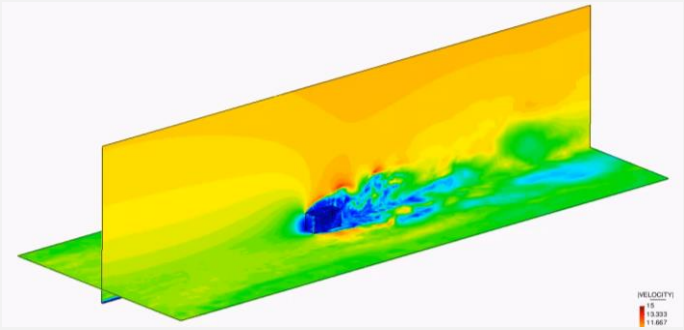
Porosity with damage prediction



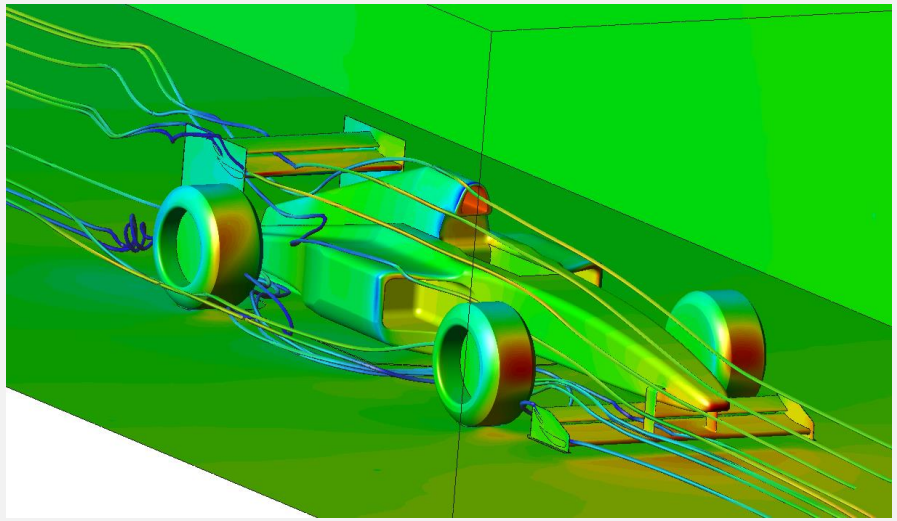
Reaching 1000 cores scalability



Silsoe cube the first collaborative master thesis TUM-CIMNE



Reaching 100M elements

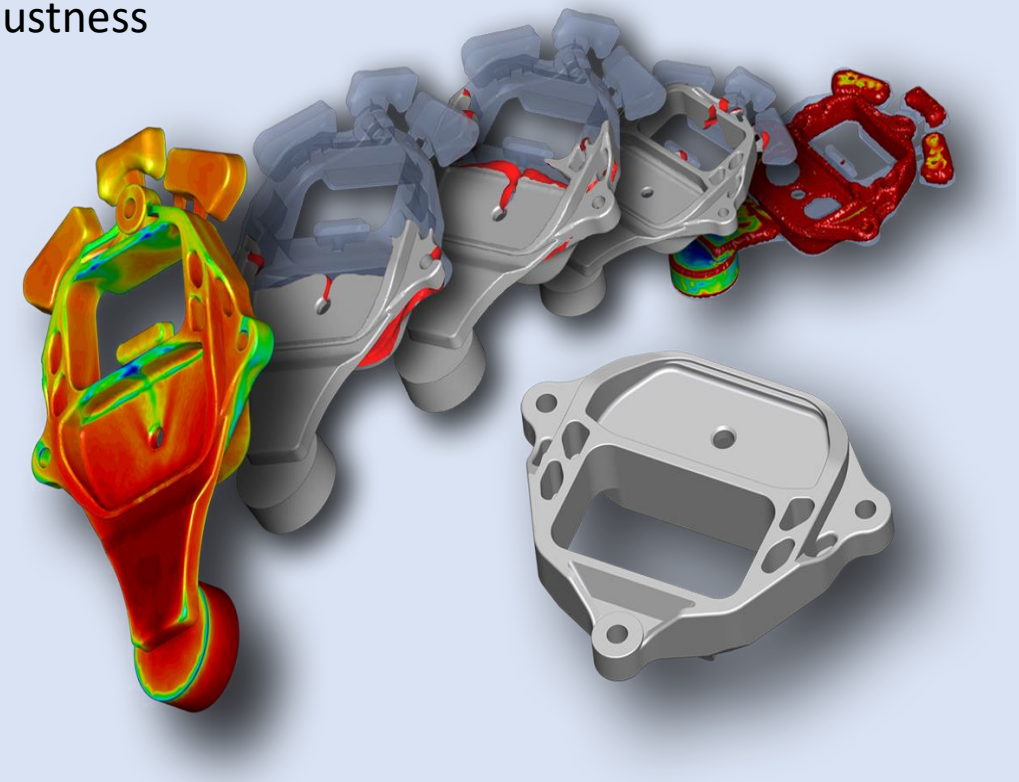


Pablo Becker starting PFEM2

2011

Click2Cast V1.0 release

Click2Cast development pushes considerably the level set and two fluid solutions among increasing the fluid solver robustness



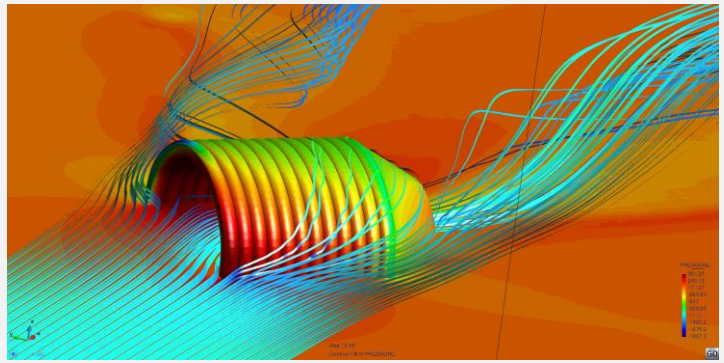
Kratos FSI course

First Kratos as **platform for teaching** at TUM
A collaborative course between TUM and UPC

BSD License

An important move toward more collaborative framework

Wind simulation of inflatable hangar

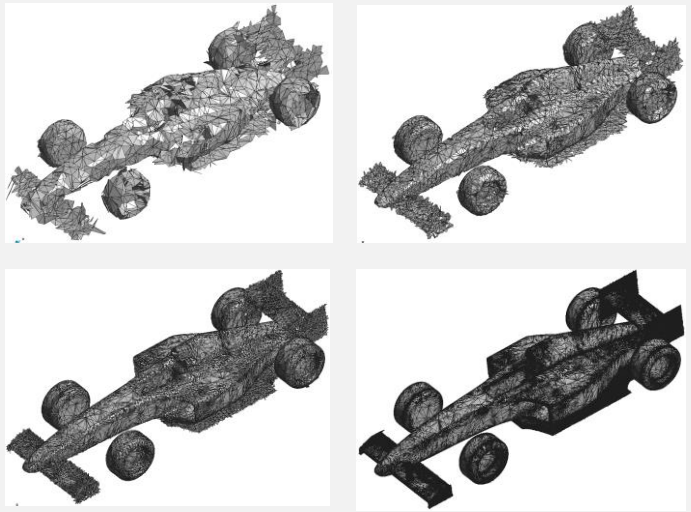


Miguel Angel starting DEM

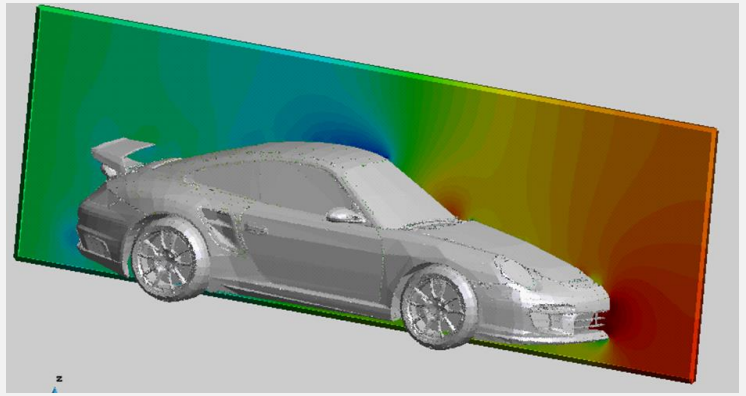
Josep M. Joined

2012

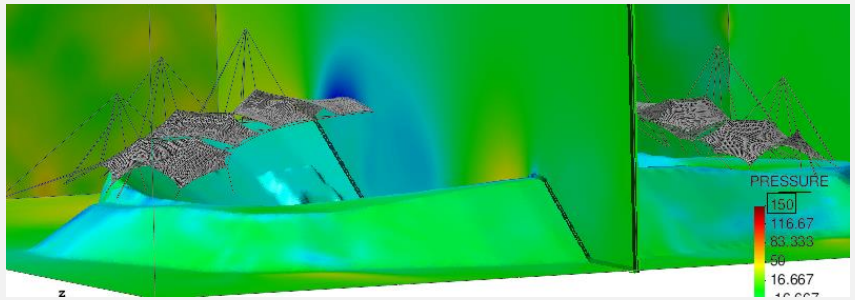
Implicit geometry description



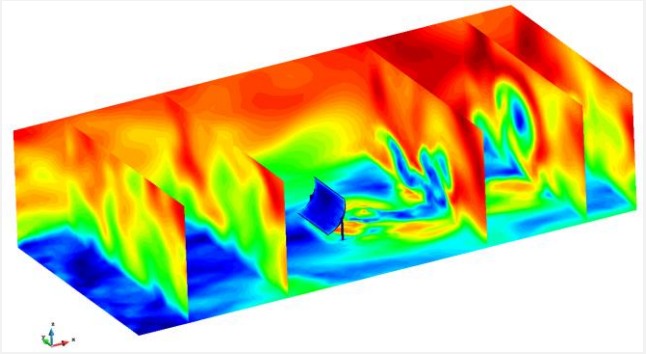
Embedded Fluid Prototype



Computational Wind Engineering



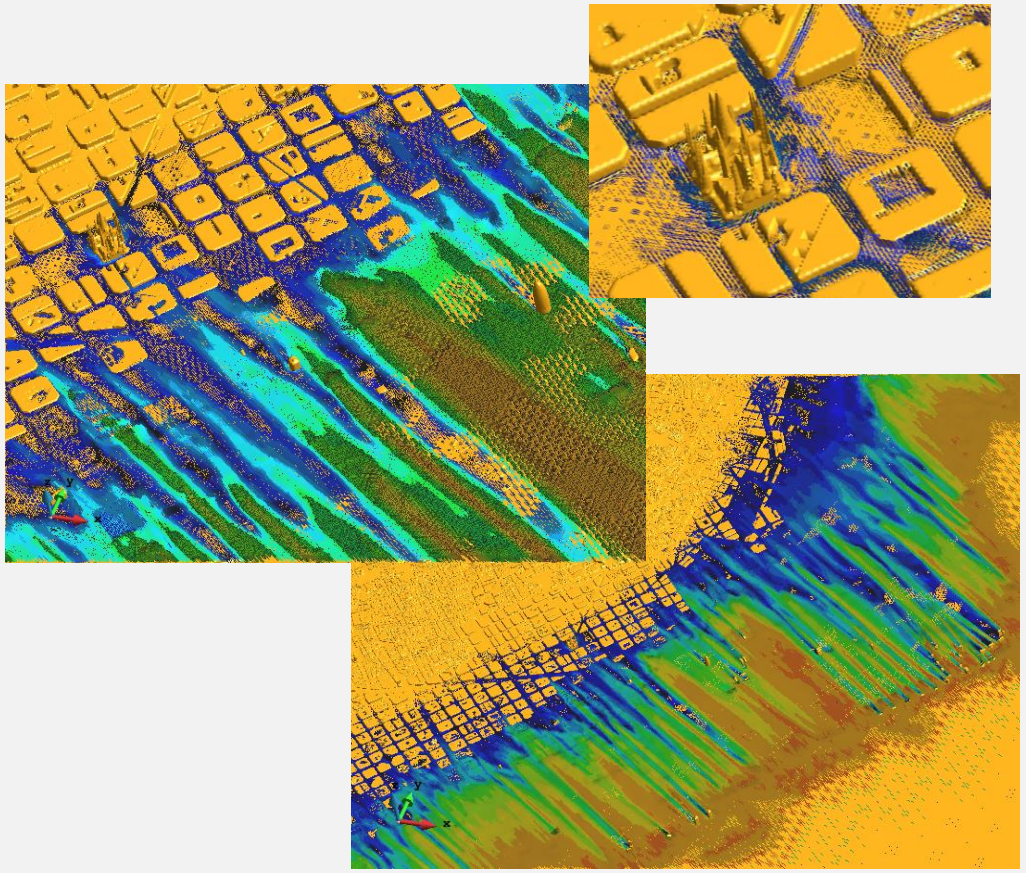
ABENGOA supporting Kratos



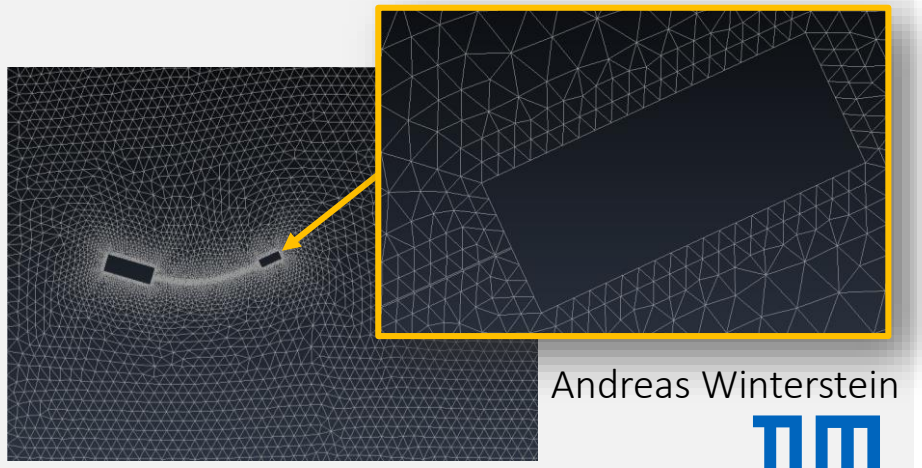
Michael Andre joined

2013

Wind simulation over entire Barcelona city with 4m resolution reaching 400 millions of elements

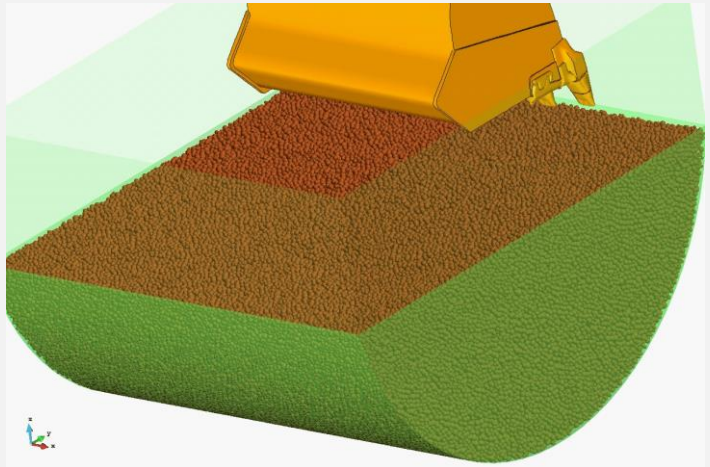


Robust mesh updating strategy



Andreas Winterstein

DEM Spherical particles

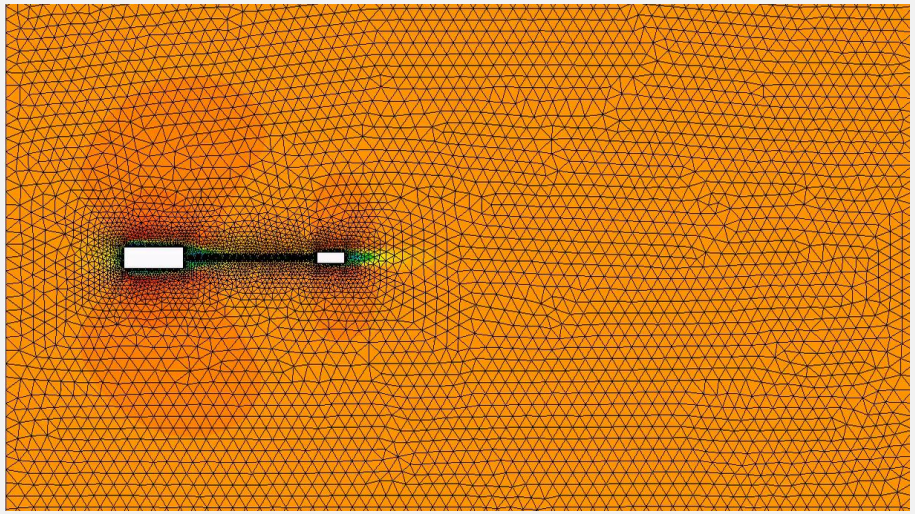


Co-simulation started by Aditya Ghantasala

2014

2015

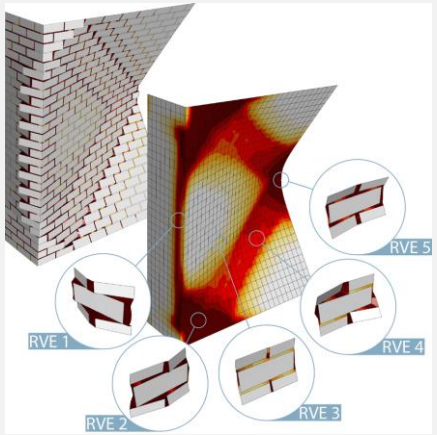
FSI becomes robust Andreas Winterstein@



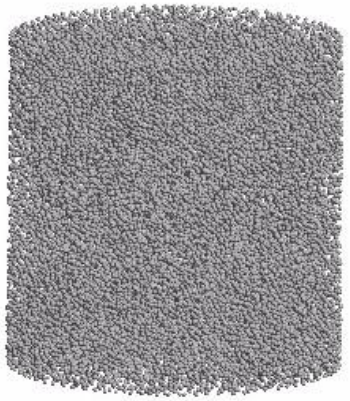
Altair acquired Clic2Cast and became aware of Kratos

Altair

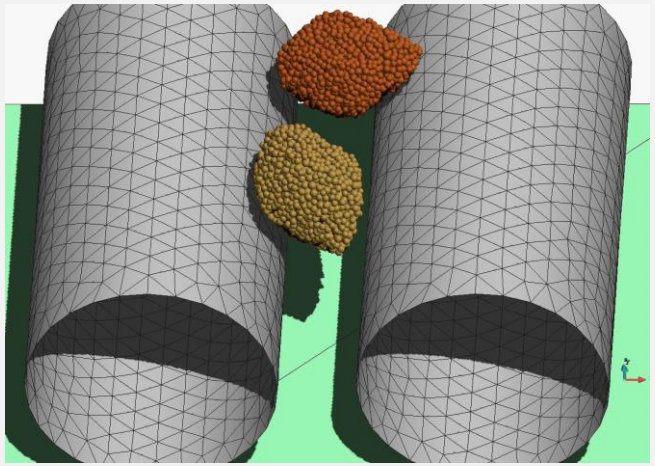
Multi scale simulation



MPM application



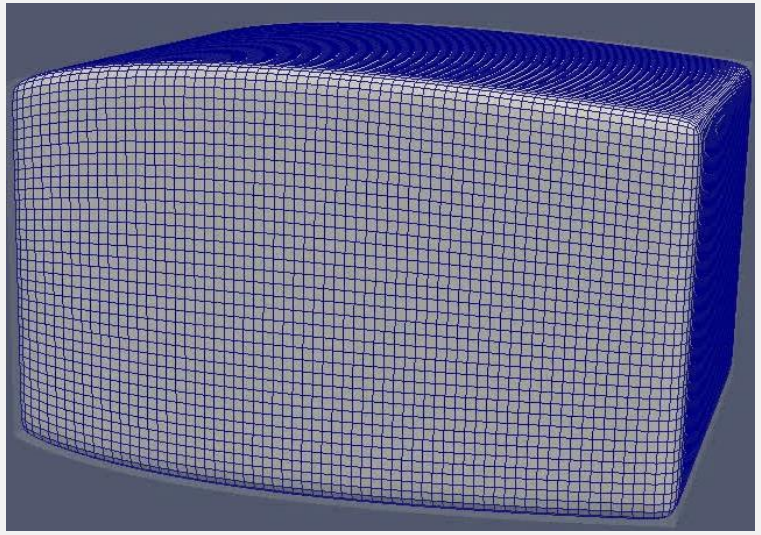
Multi spheres DEM



Vicente Mataix start committing!

2016

Optimization



by Daniel Baumgärtner @

Altair started new projects based on Kratos

Swimming dem

Getting crowded!!

SIEMENS

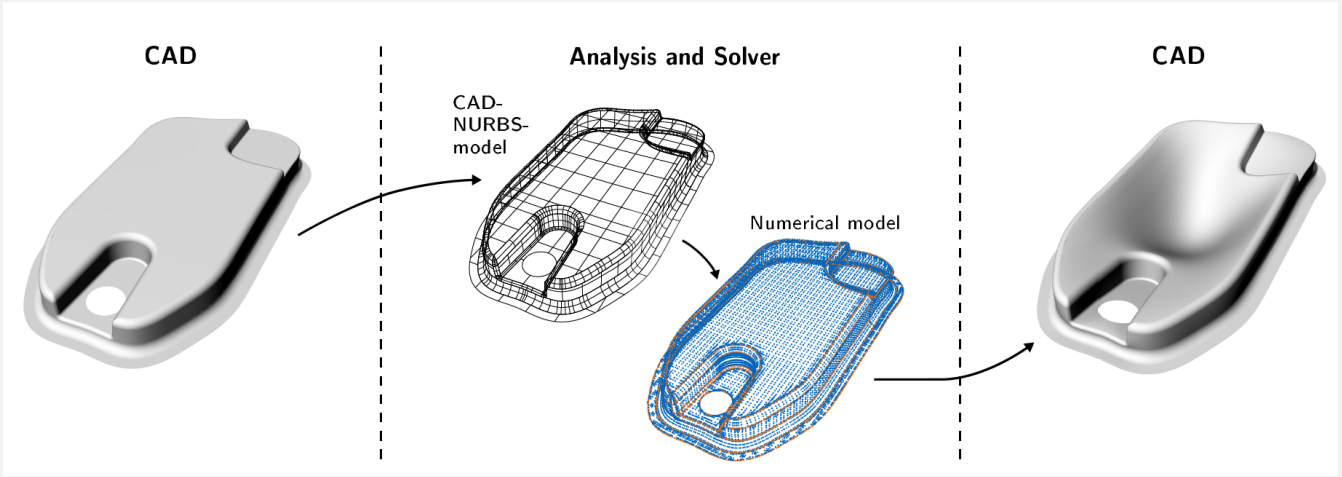
Siemens on board! Their continuous support since then was an **important push** in Kratos as open R+D framework

DO_NOT_DEFINE_NDEBUG macro added!!

Ruben Zorrilla

Philipp joined

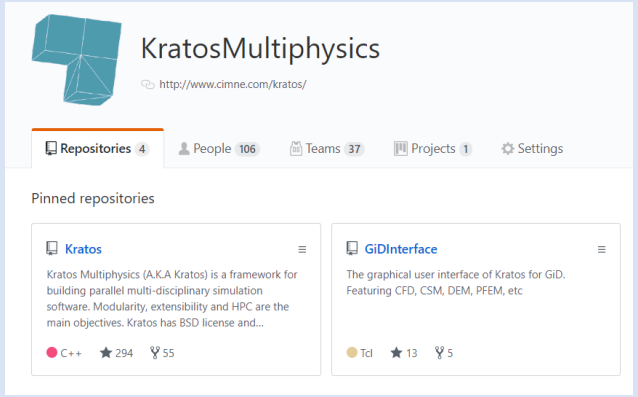
IGA application



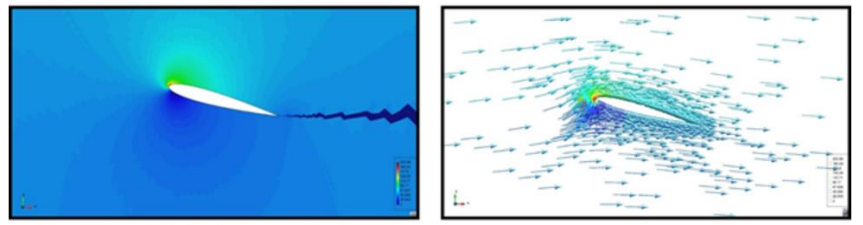
Tobias Teschemacher @ TUM

Moving to GitHub

One of the most important moves toward larger community



Potential flow for aero-space applications



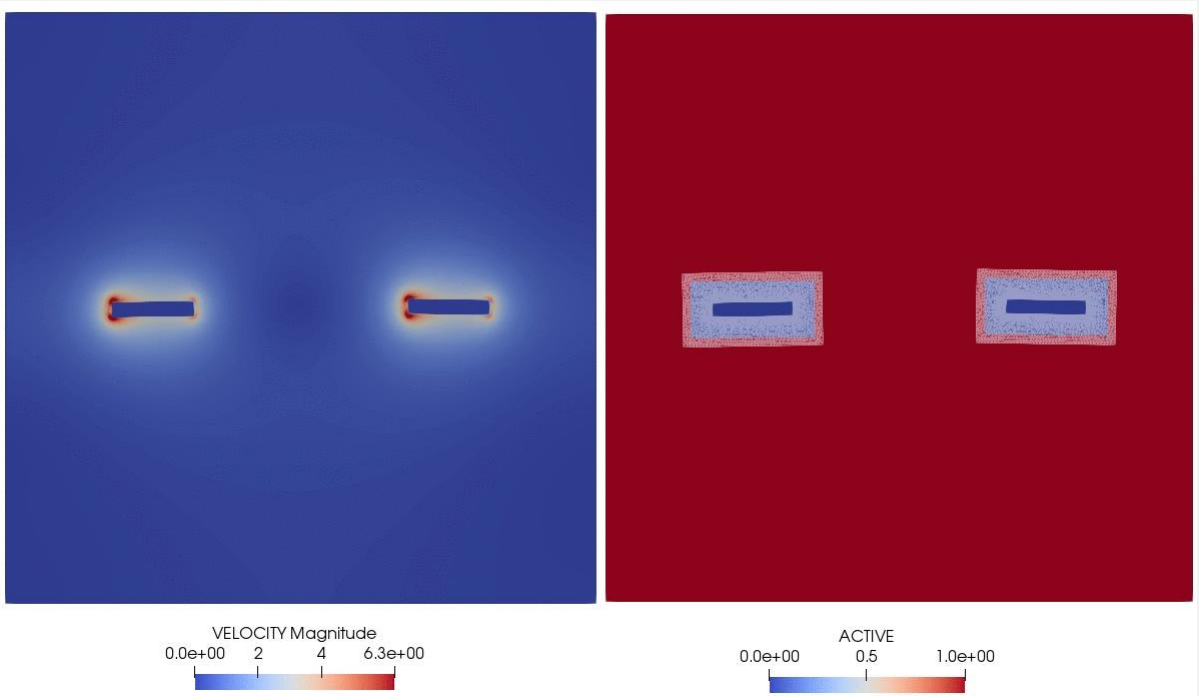
Not matching grid mapping

Airbus joined AIRBUS

Important collaborative push in research in Kratos framework

2017

Chimera



Aditya Ghantasala @

FSI with embedded

Deltares on board

Deltares
Enabling Delta Life

A new push to geomechanics

Opening to other codes…

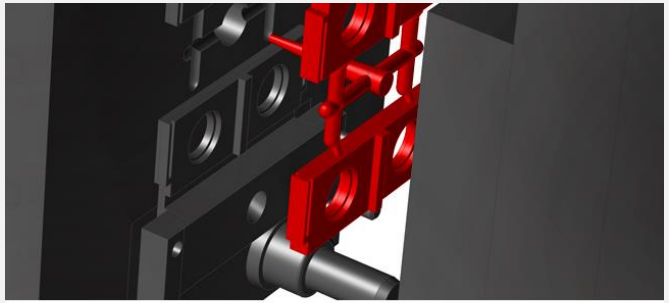
Co-Simulation Application

MPC Added to the core

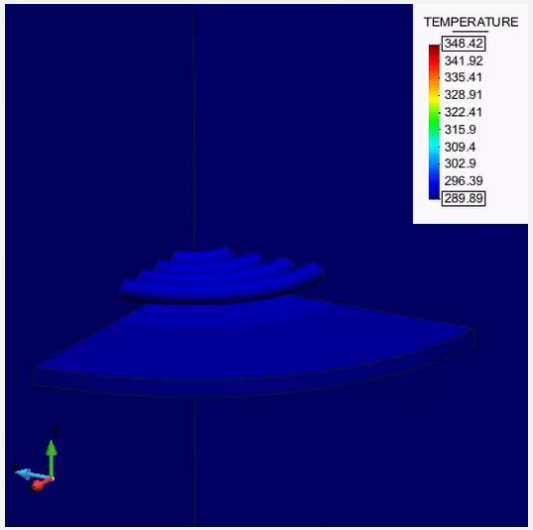
Pizza for each release!

2018

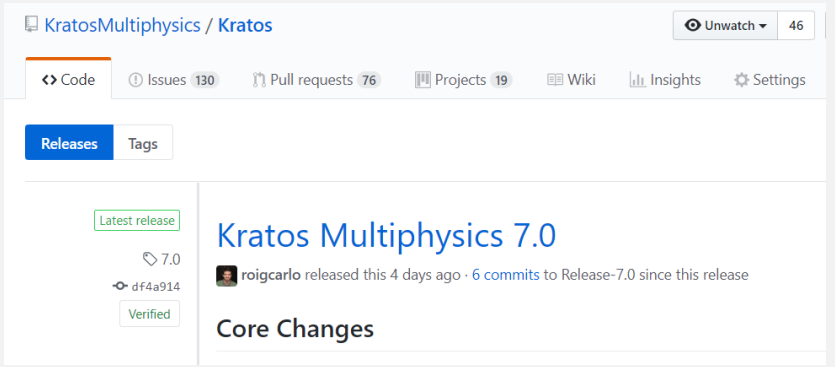
Inspire Mold base on Kratos



Conjugate heat transfer



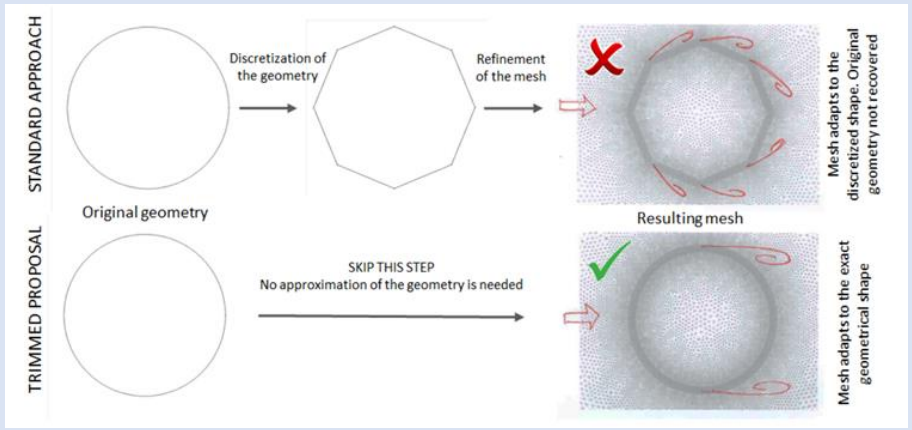
Kratos Release 7.0.0, *Augustiner*



2019

Next

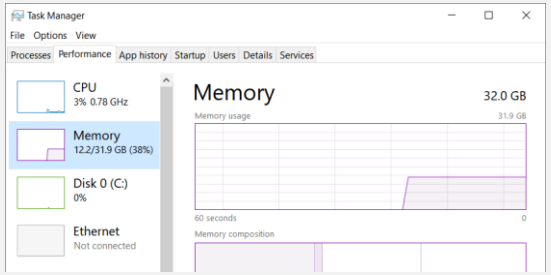
Exact geometry kernel



MPI Core for easier development in MPI

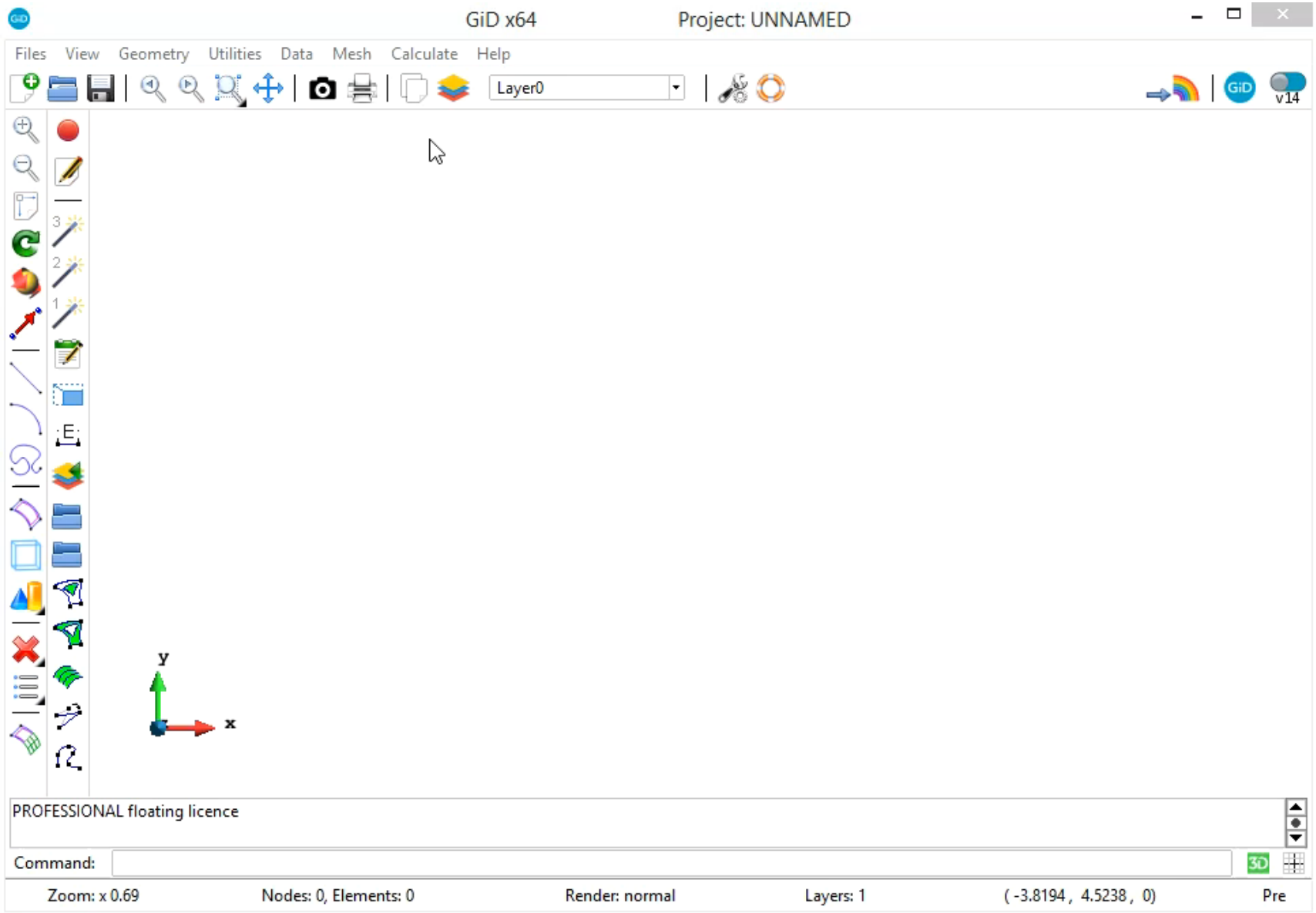
Multi stages

Improving the memory efficiency of core



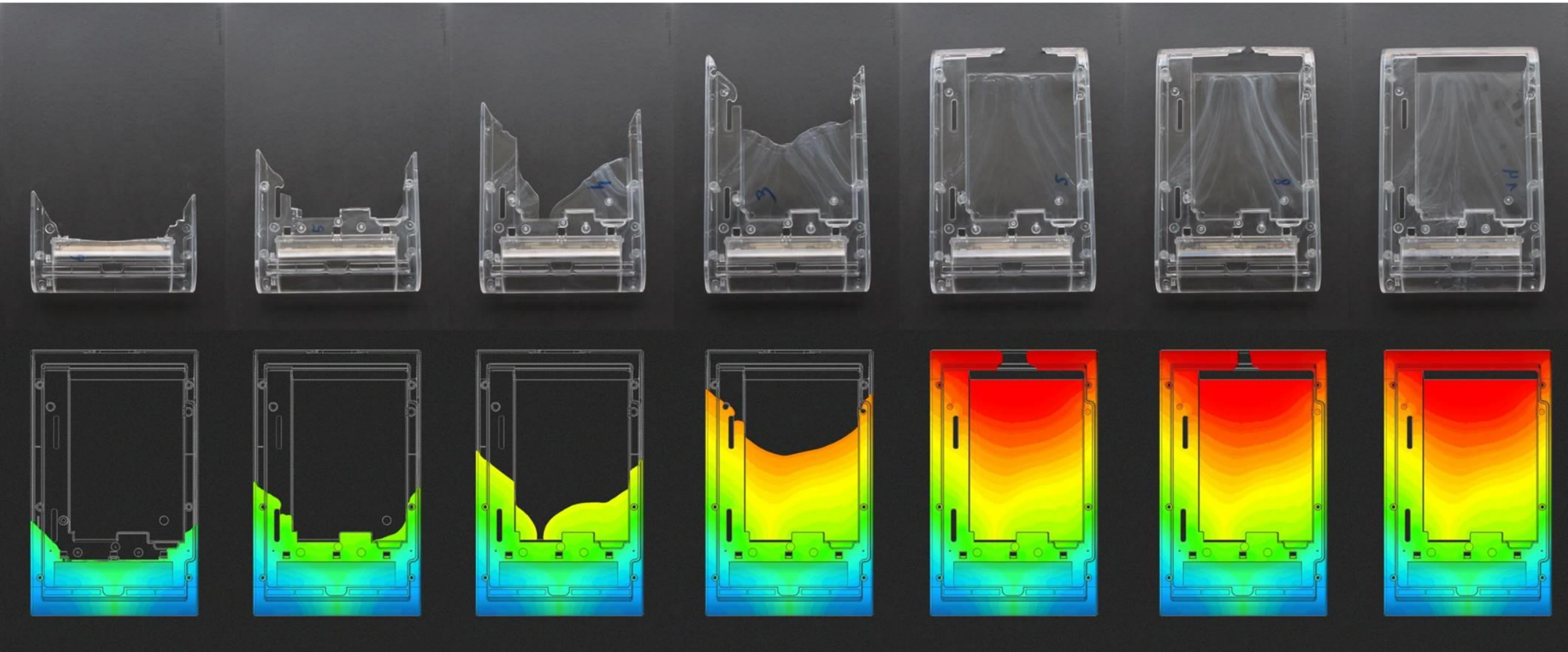
Monte Carlo and beyond

Applications: Kratos Multiphysics

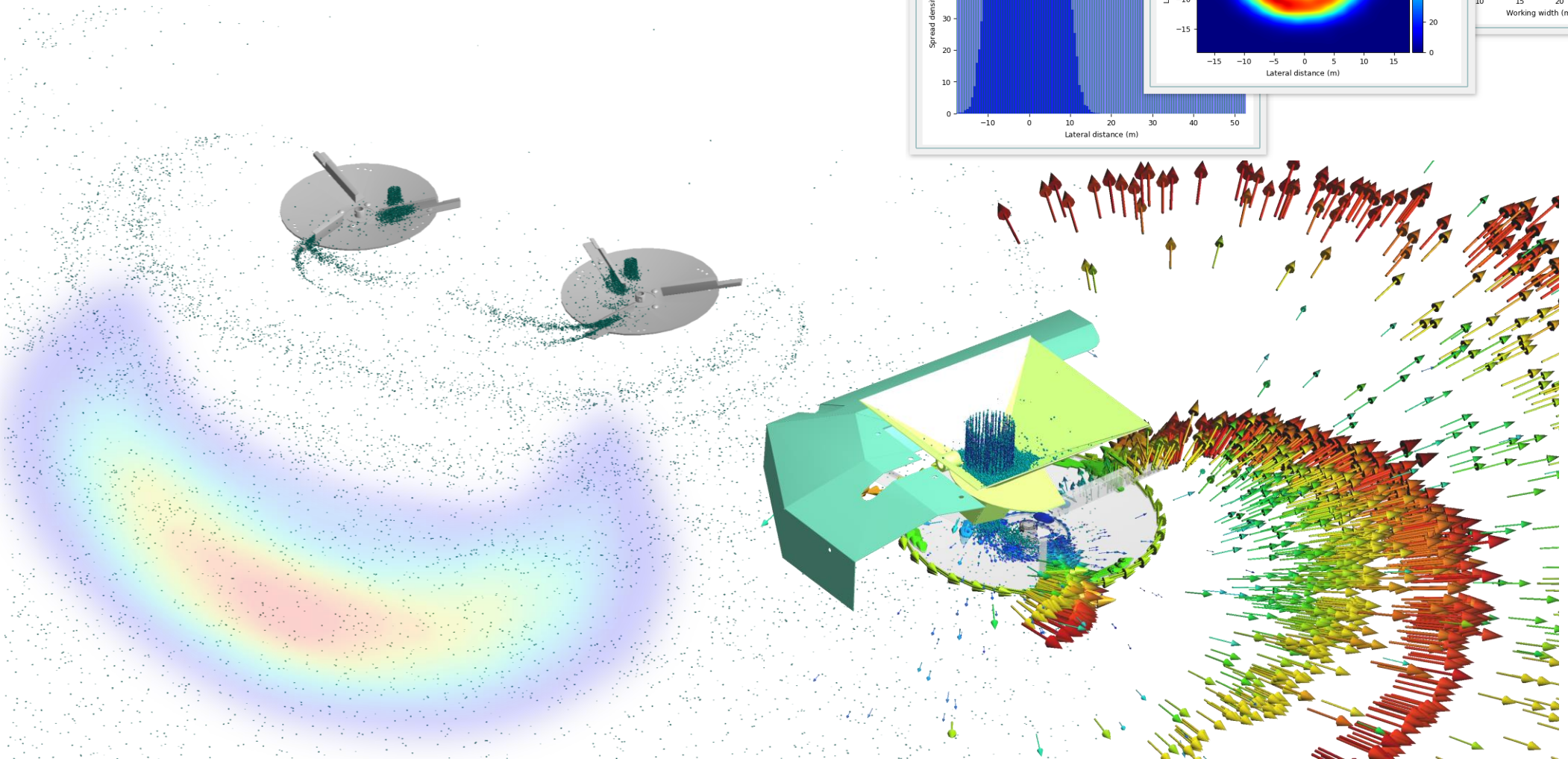


Applications: Altair Inspire Cast

Applications: Altair Inspire Mold



SpreadDEM

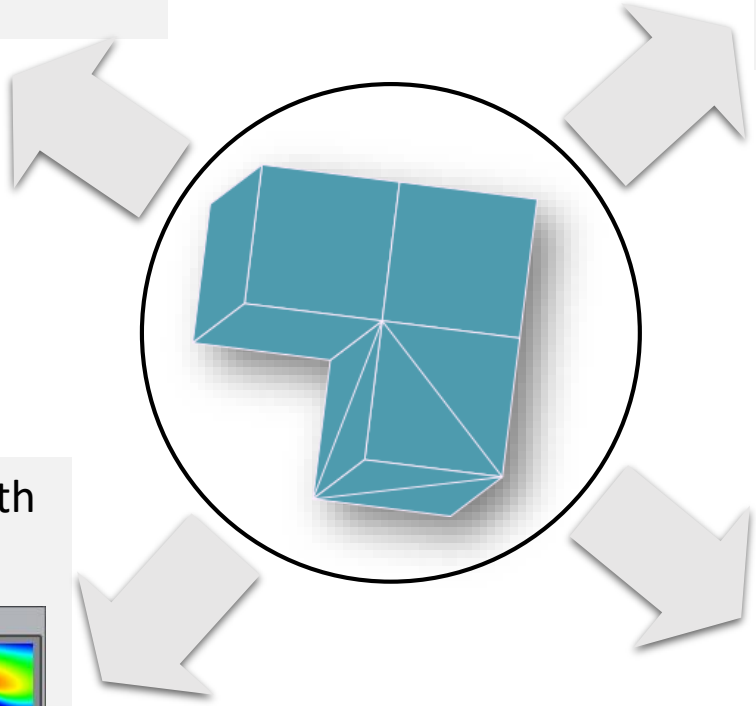

SpreadDEM postprocess results
Moving transverse distribution
Overlapping configuration:
Forward speed:
8
km/h
Working width:
23
m
Update
Spread density (Kg/ha)
Lateral distance (m)
SpreadDEM postprocess results
Static spread pattern
Save image
Longitudinal distance (m)
Lateral distance (m)
Spread density (Kg/ha)
SpreadDEM postprocess results
Coefficient of variation
Overlapping configuration:
Save data
Save image
Working width (m)

Where do we stand?

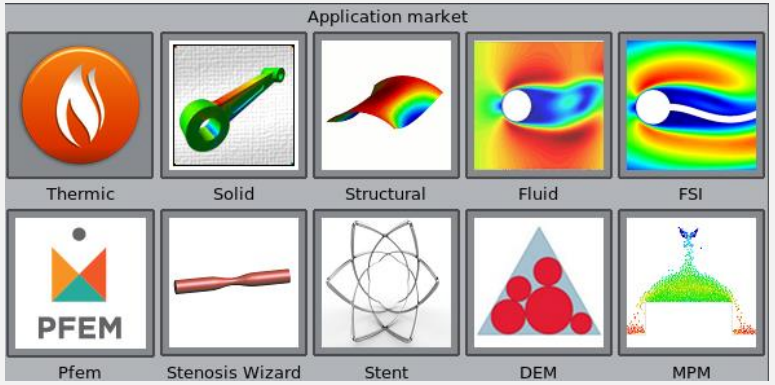
A consolidated and very active community
Collaborating from around the world

Modern development practices to improve the quality of the code

- GitHub
- Code review
- Testing
- Hierarchy of committees ensuring the effectiveness of decisions

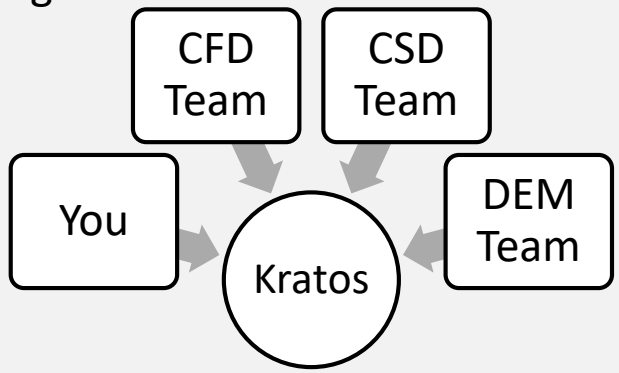


A flexible and modular framework with extension to many different solutions



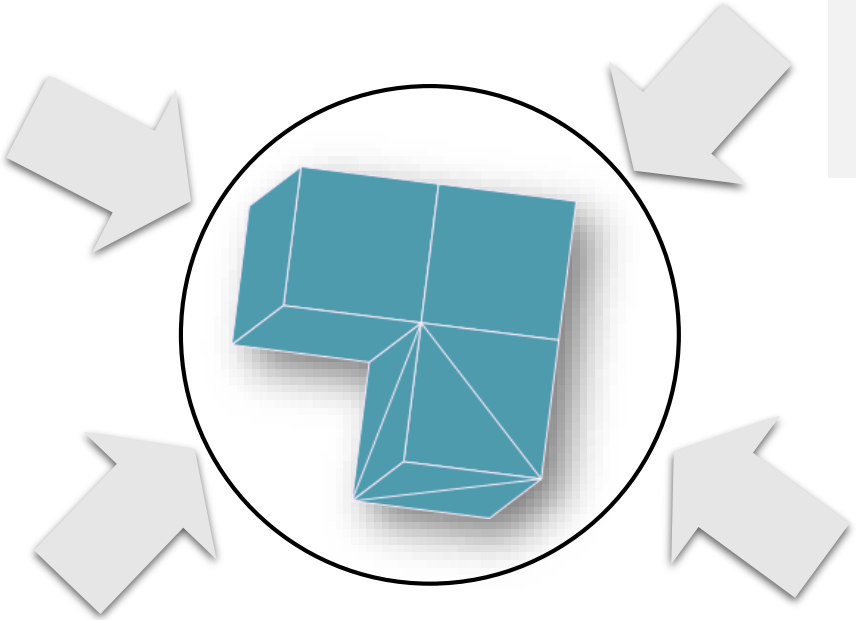
Prepared for multi-disciplinary team working

- The modularity avoids unnecessary dependency which results in less conflicts
- Kratos defines the standards and protocols of communication not persons in charge of coupling



Why we are open to collaborate?

Different expertise



Innovative ideas

More fun!

More contributors

KratosMultiphysics

http://www.cimne.com/kratos/

Repositories 4 | People 106 | Teams 37 | Projects 1 | Settings

So hope to have you on board!

https://github.com/KratosMultiphysics/Kratos