COMPUTATION TIME OPTIMIZATION USING PYANSYS AND PYVISTA: EXAMPLE WITH M-FEM

CONTENT

DAES

#InSimulationWeTrust – Engineering et Consulting

- Multiphysics and different sectors
- Extended team sharing time between different clients and projects
- Correlation simulation – tests
- Automatization: Apps and scripts

Sectors

DAES - INNOVATION

Energy

New nuclear & fusion

Watchmakers

Sports Performance

Medtech

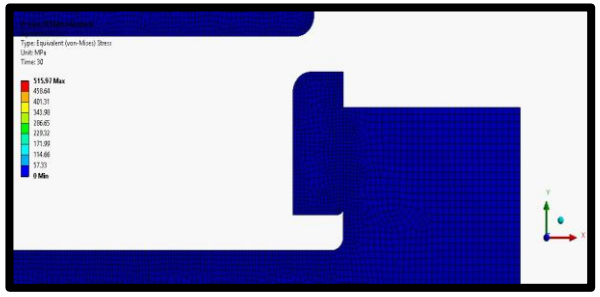
Transport

Space

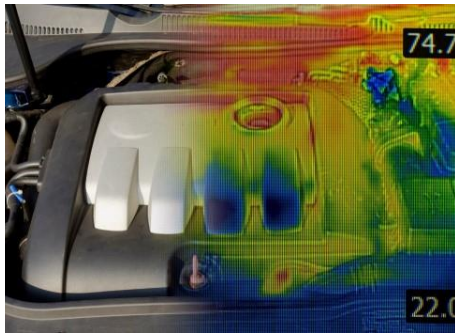
Common Denominator

Expertise

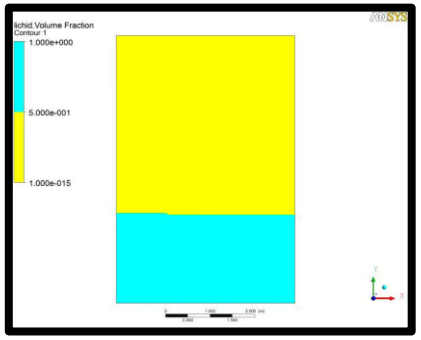
DAES - INNOVATION



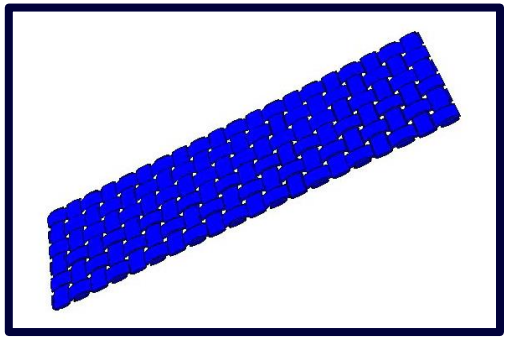
Structural



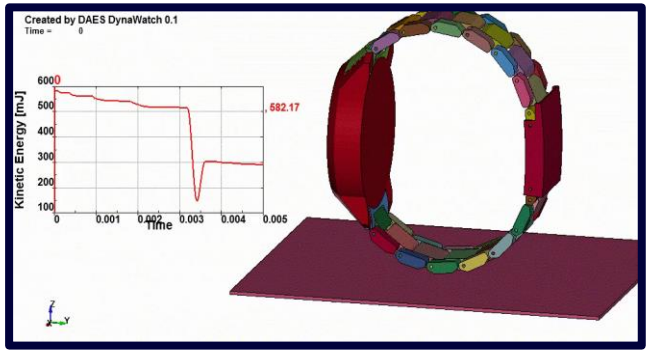
Thermal



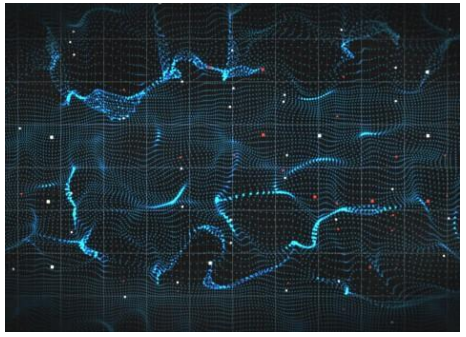
CFD



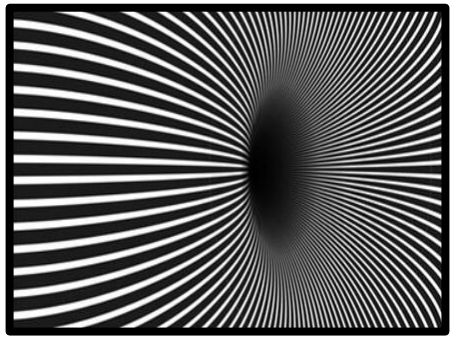
Materials



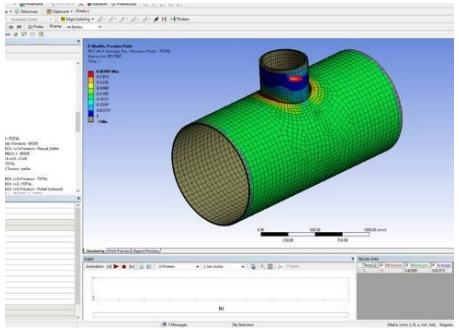
Explicit & Implicit



Electromagnetics



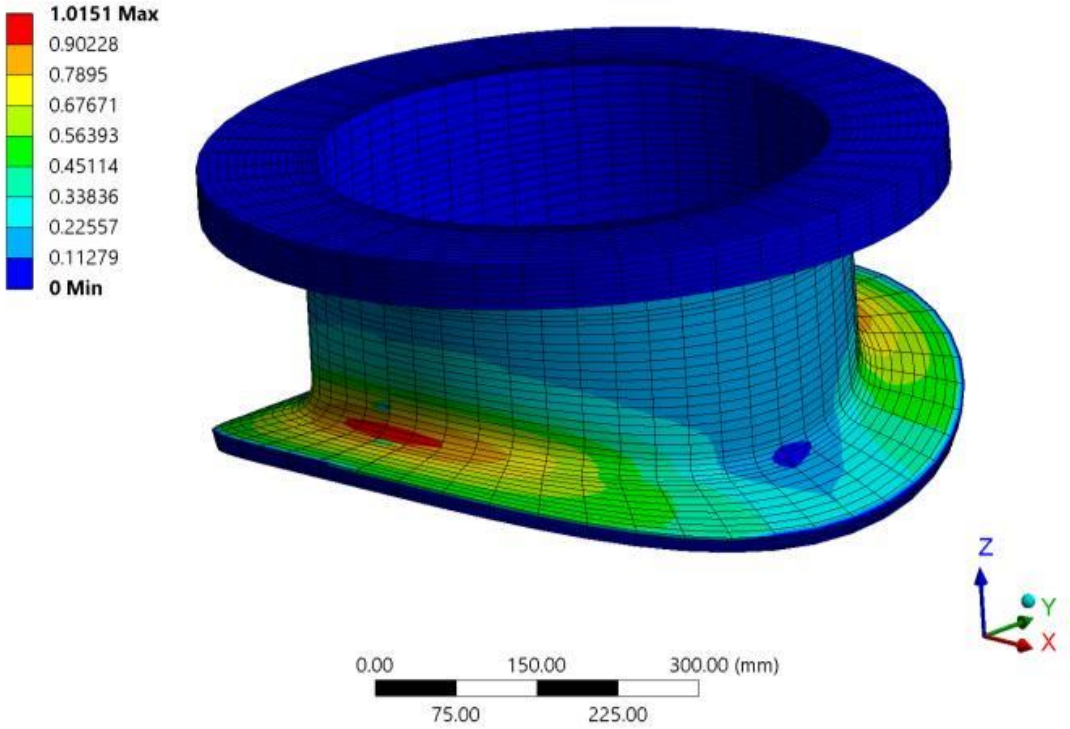
Optics



App &Scripts

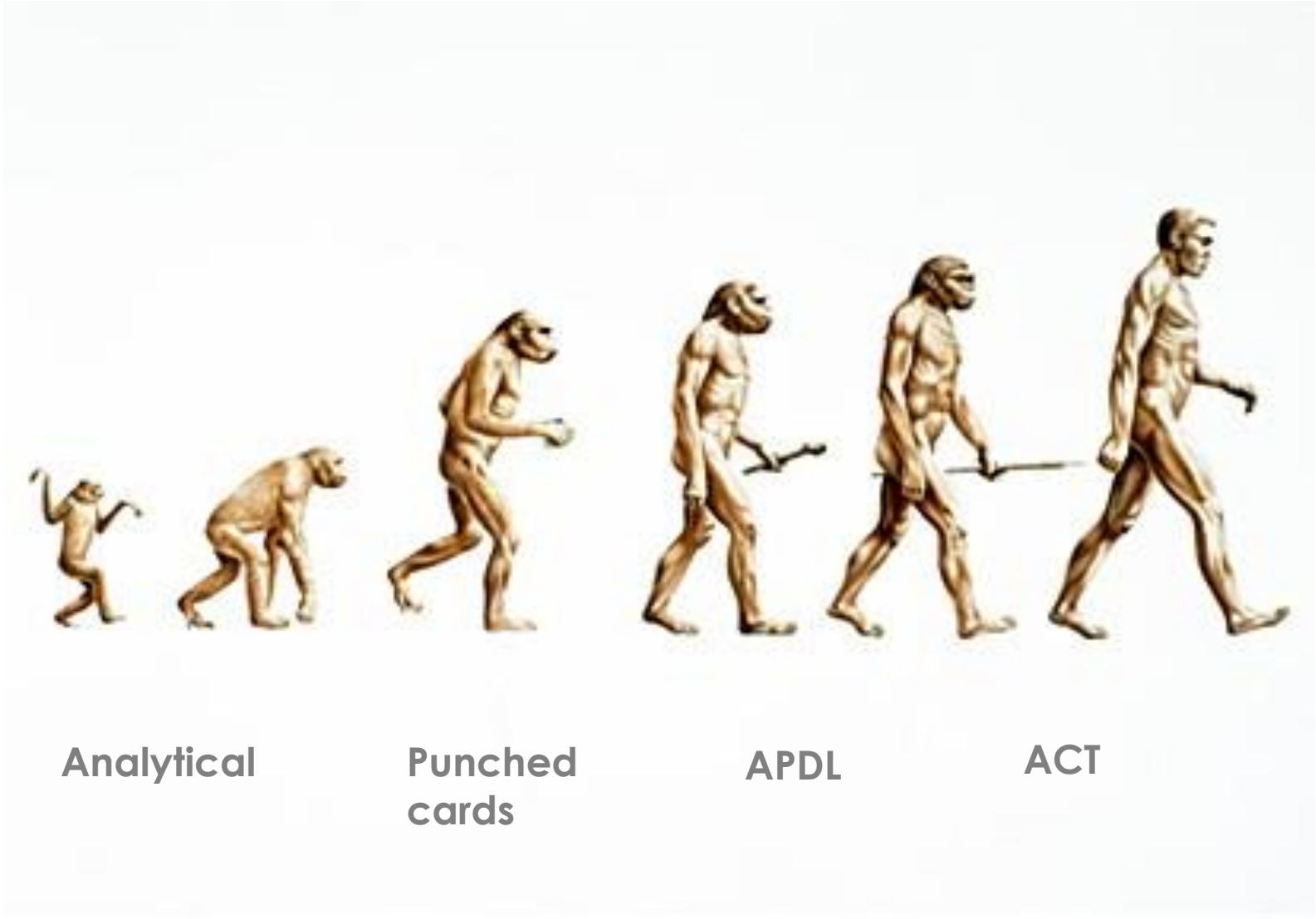
WHY M-FEM?

M-FEM: App for RCC-M and ASME III



- M-FEM simplifies the post-processing regarding civil nuclear norms (RCC-M for EU and ASME III for USA)
- Full automation of some tasks
- Criteria already implemented
- User friendly in Mechanical environment thanks to Ansys Customisation Toolkit (ACT)

Working evolution



Analytical

Punched cards

APDL

ACT

PyANSYS

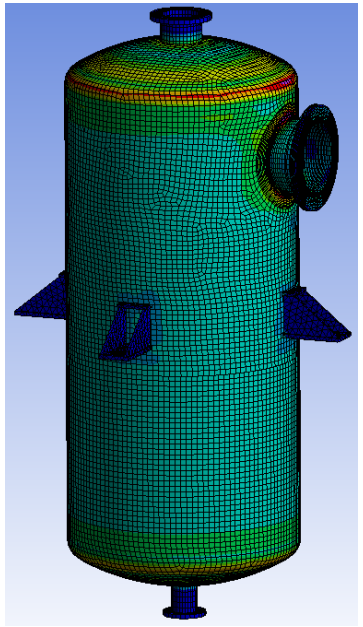
Benefits

Boring tasks that can lead to errors

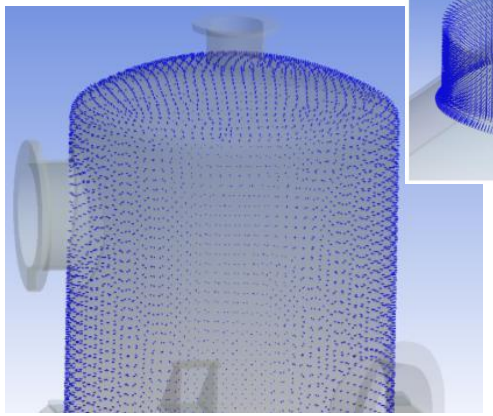
- Patch creations:
  - ➔ Where should I create my path?
  - ➔ Is my path well defined (orthogonal)?
  - ➔ How many paths should I create?
- Orientation of forces and moments unknown:
  - ➔ Which orientation is the worst?
- Automatic stress linearisation
- Did I cover all the critical zones?
  - Mapping over the whole region

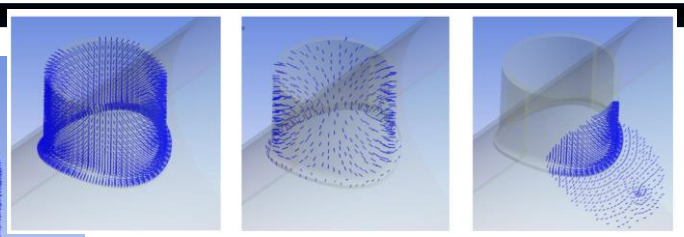
What does M-FEM?

M-FEM overview



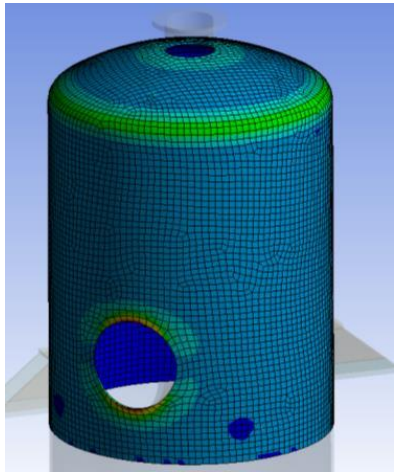
Path Creations





- Through-the-thickness automated paths creation
- On specific area or whole model
- User defined path density and points
- Compatible with shell or solid meshes

Automated post-processing on all paths

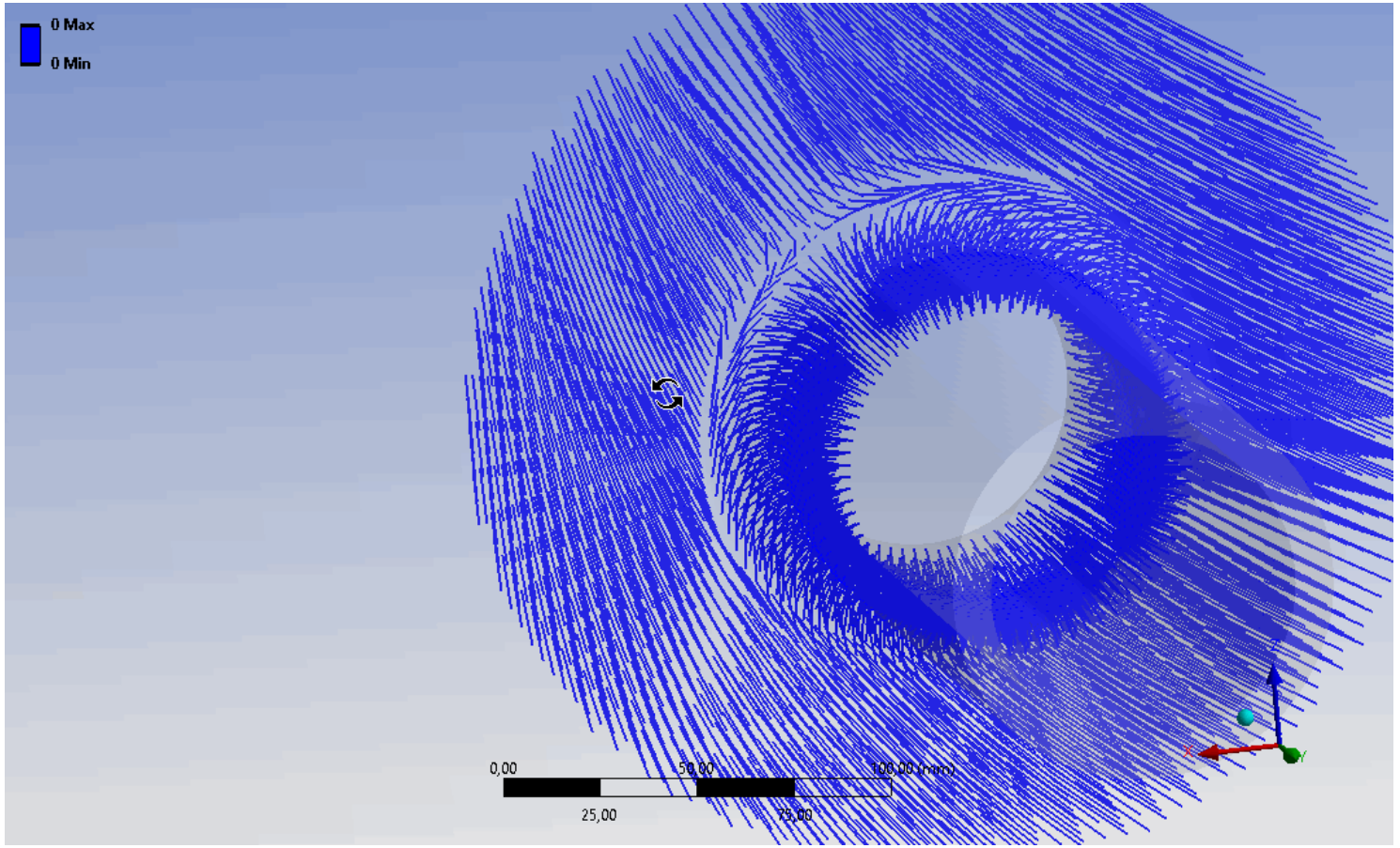


- Ansys FE solution
- Load case definition
- Analysis setup

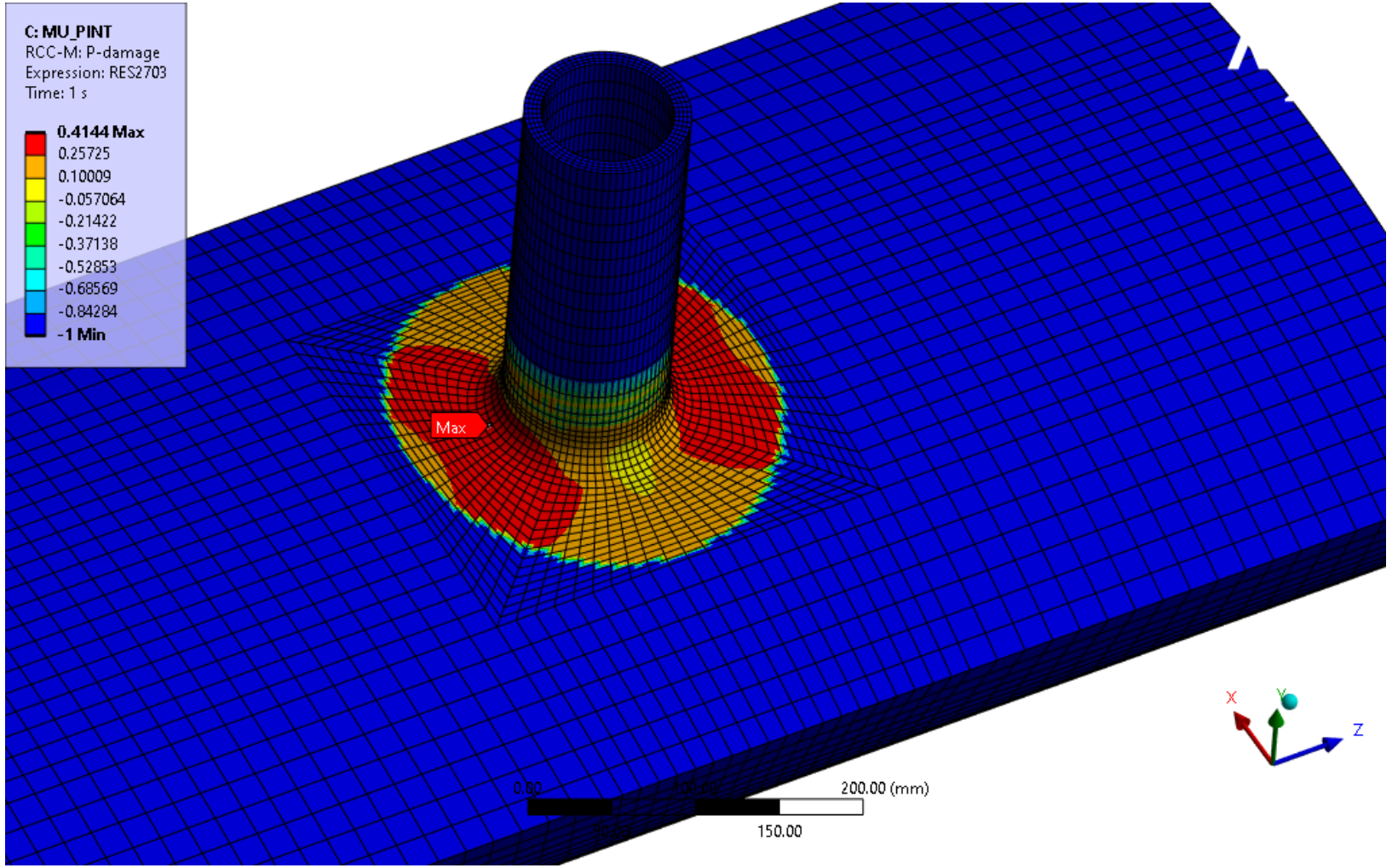
Calculation and results visualization:

- Primary damage
- Progressive Deformation
- Thermal ratcheting
- Fatigue analysis

Created paths

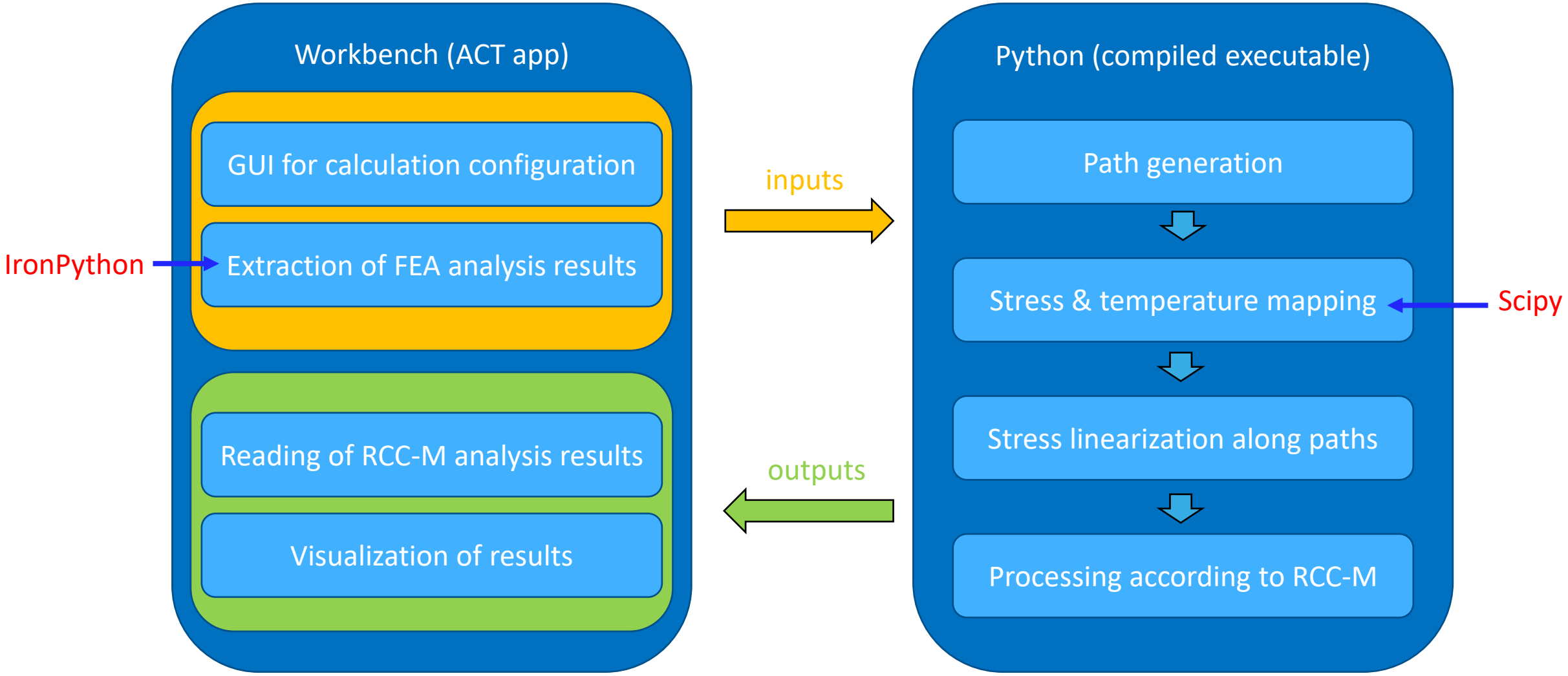


Mapping Results

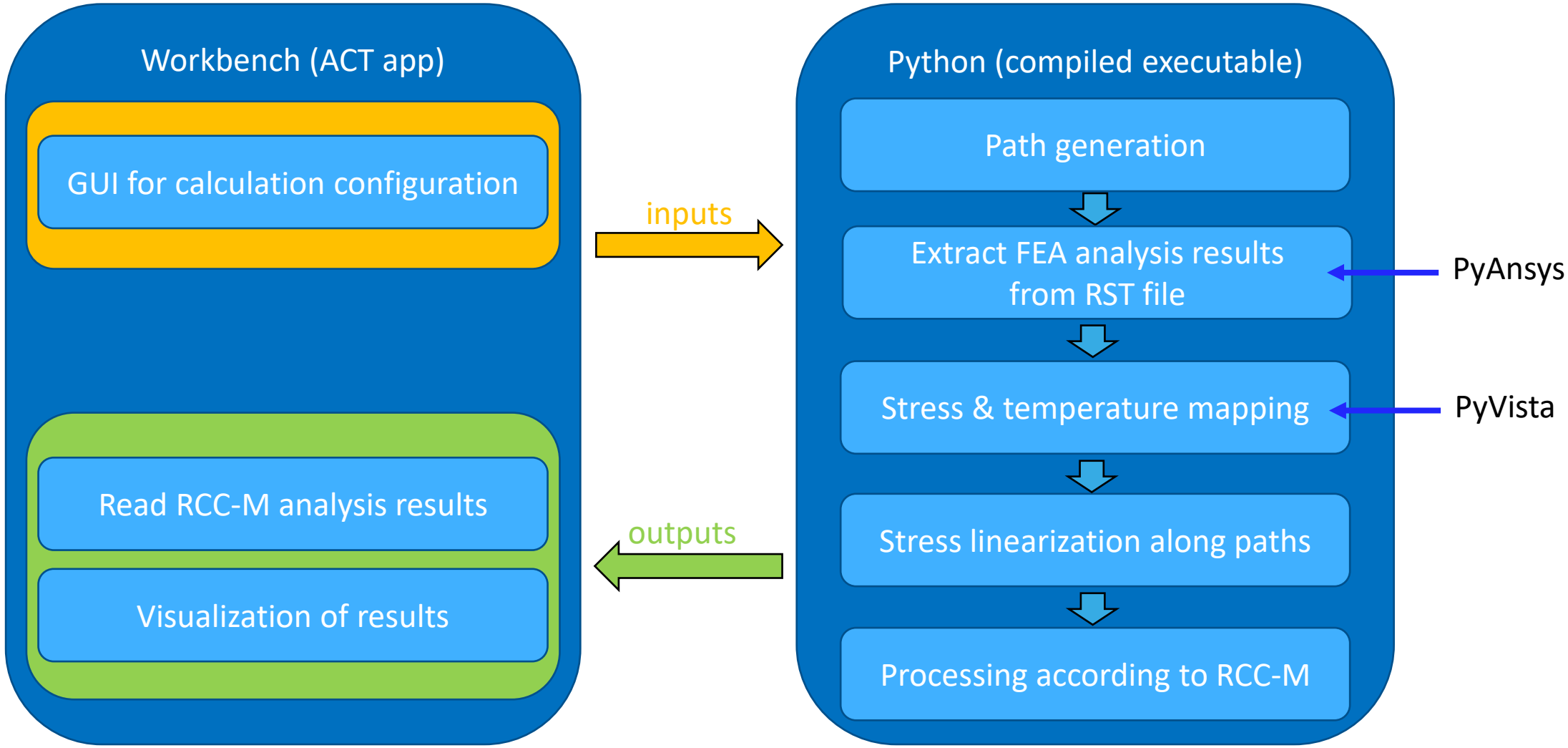


V1 ->V2: PYANSYS PYVISTA

M-FEM architecture v1



M-FEM architecture v2



M-FEM improvements

Two potential improvements:

1. Extraction of FEA results analysis
   - IronPython is a user friendly interface to Ansys Mechanical data structure 👍
   - but is very slow to extract large datasets of results 👎
2. Interpolation of stress and temperature along paths
   - Scipy library is a powerful scientific library 👍
   - But is very slow to map data and find intersections between path and surfaces 👎

Proposal:

1. Use PyAnsys to read FEA results from RST file (no data extraction or file management required anymore)
2. Use PyVista to find the intersection between paths and surface, and interpolate the FEA results at intersections

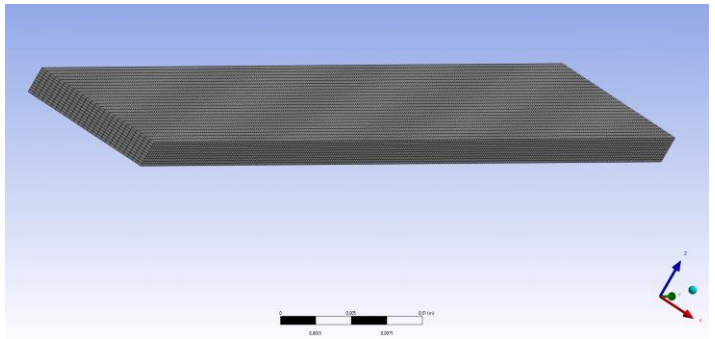
Remarks:

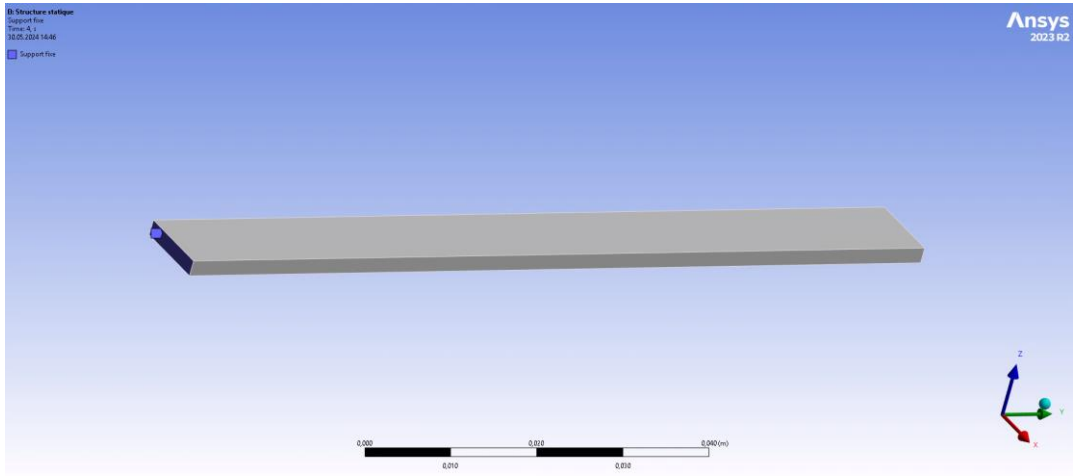
- PyVista is a free licensed open-source Software around 3D visualization and mesh analysis in Python
- PyAnsys (PyDPF-Core) provides numerical simulation users and engineers with a toolbox for accessing and transforming simulation data

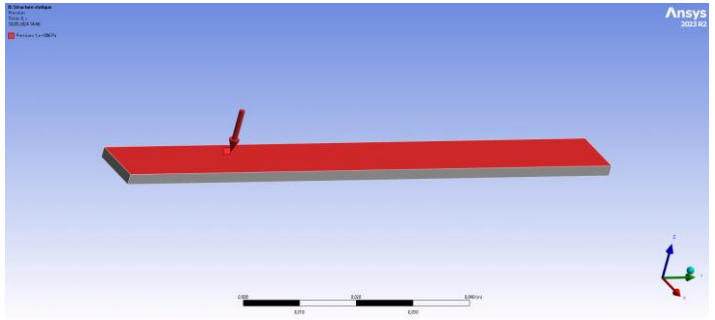
Cas test 1 (Model size)

- Clamped beam with uniform pressure on top
- Quadratic mesh (Hex20) with different element sizes
- 12 300 and 19 100 paths computed

	Coarse mesh	Midsize mesh	Fine mesh
# elements	21 000	40 000	62 500
# nodes	94 300	179 100	277 600



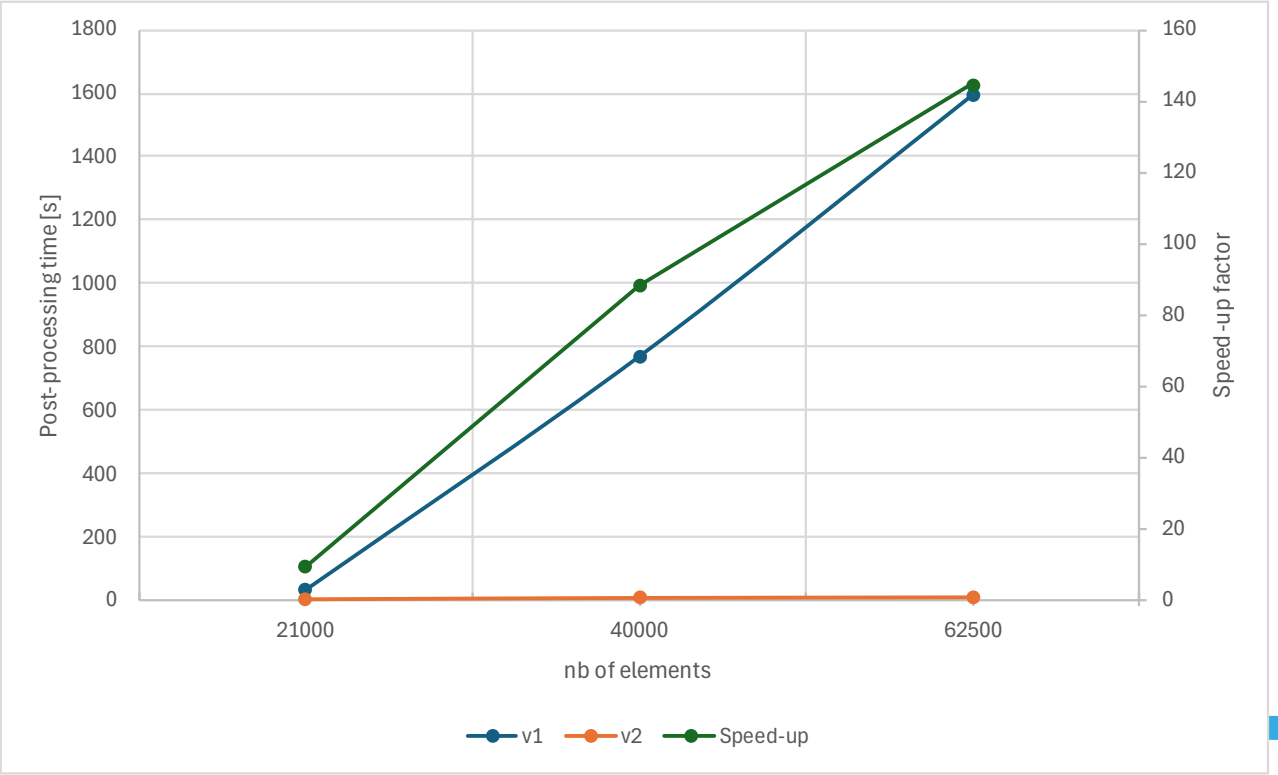




Résultats

Mesh	Number of elements	V1 [s]	V2[s]	Factor
Coarse	21000	33.1	3.5	9.4
Midsize	40000	770.3	8.7	88.5
Fine	62500	1596.9	11.0	144.8

- x10 faster minimum
- Acceleration increases with mesh size



Cas test 2: Details

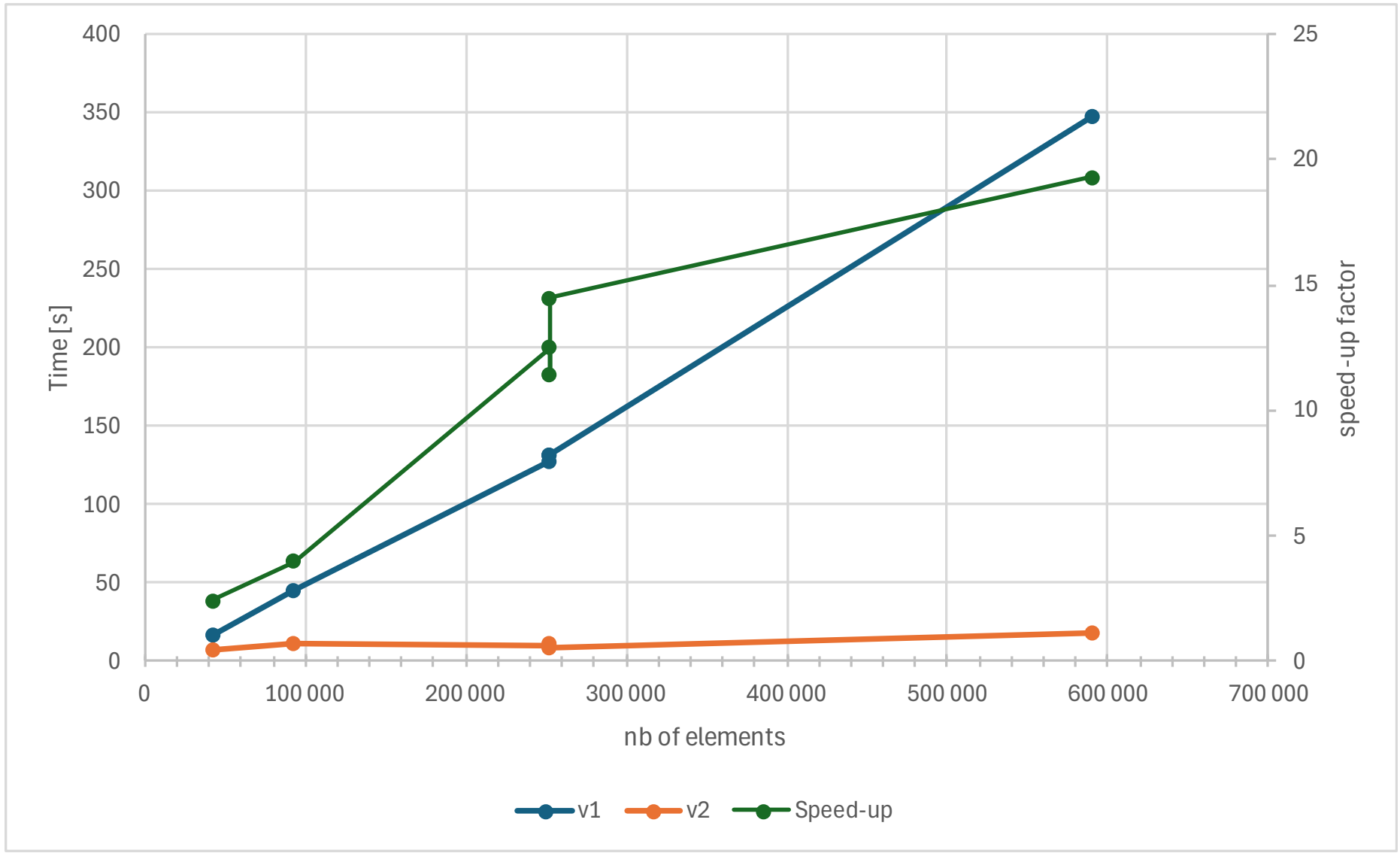
- Impact PyANSYS only

Analysis	V1 [s]	v2 [s]	Facteur
55 000 nodes, 4 time steps	75	5	15
330 000 nodes, 4 time steps	1534	9	170

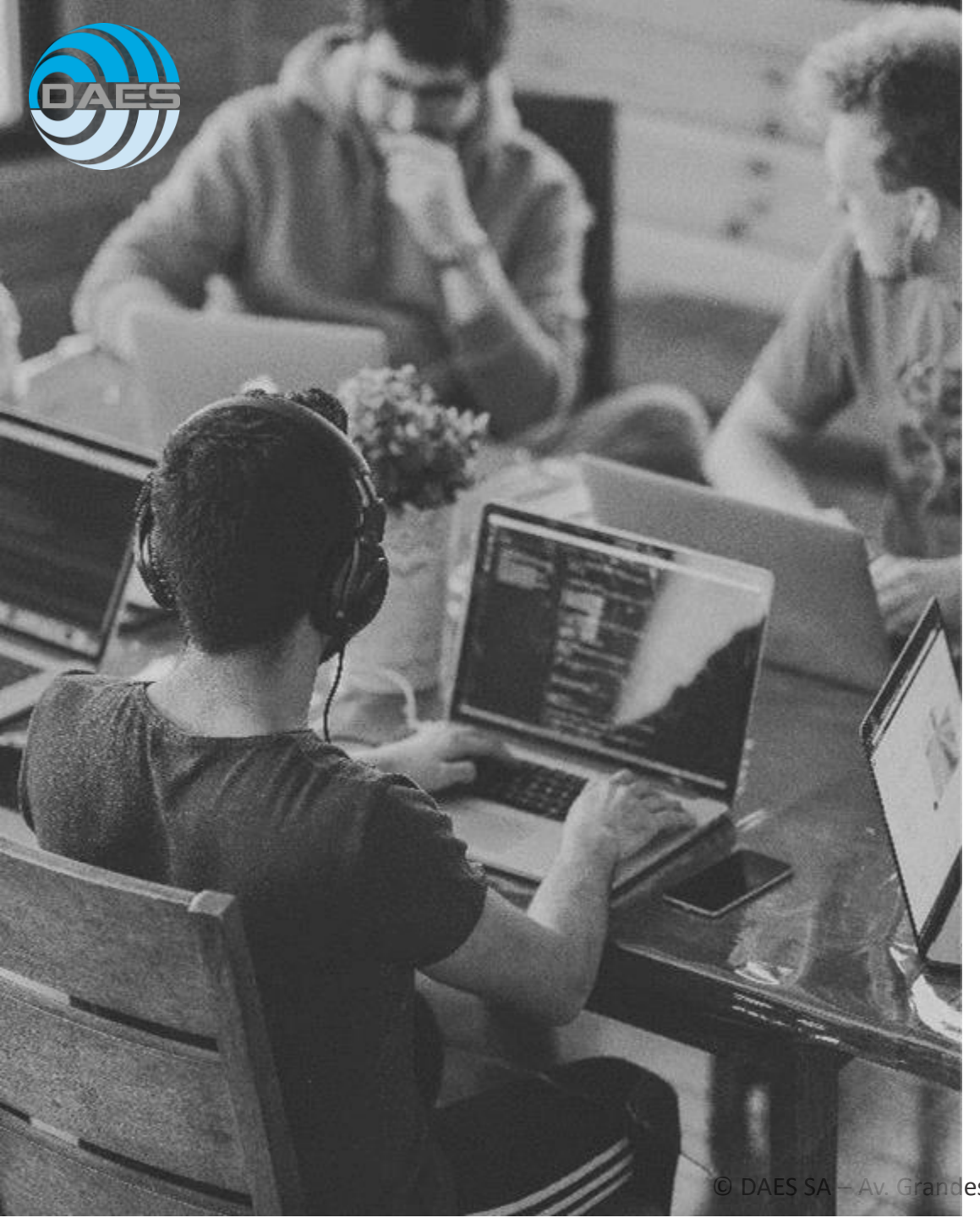
- Impact PyVista only

Nodes	Time steps	Path	Points per path	v1 (seconds)	v2 (seconds)	Reduction factor
42 000	4	1	50	17.3	7.1	2.4
93 000	4	1	50	44.7	11.1	4.0
252 000	4	1	50	127.2	10.2	12.5
252 000	4	1	100	130.9	11.5	11.4
252 000	4	11	50	131.5	9.1	14.5
590 000	4	11	100	347.8	18	19.3

Impact PyVista



Perspectives



DEVELOPMENTS

- Finished
  - Same platform for RCC-M et ASMEIII
  - Integration of Pyansys & Pyvista functionalities:
    - Speed up of RST files
    - Speed up of stress interpolation to the paths
- Possible next steps:
  - Linear combination without linear interpolation for faster analysis – fast checking (if still necessary)
  - Additional information for user
  - Parallel computing (if still needed)
  - Post-processing from different meshes (WB environment)

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Keep in Touch with Your Extended Company

Julien Nussbaum

Engineer Senior

Mechanical / dynamic

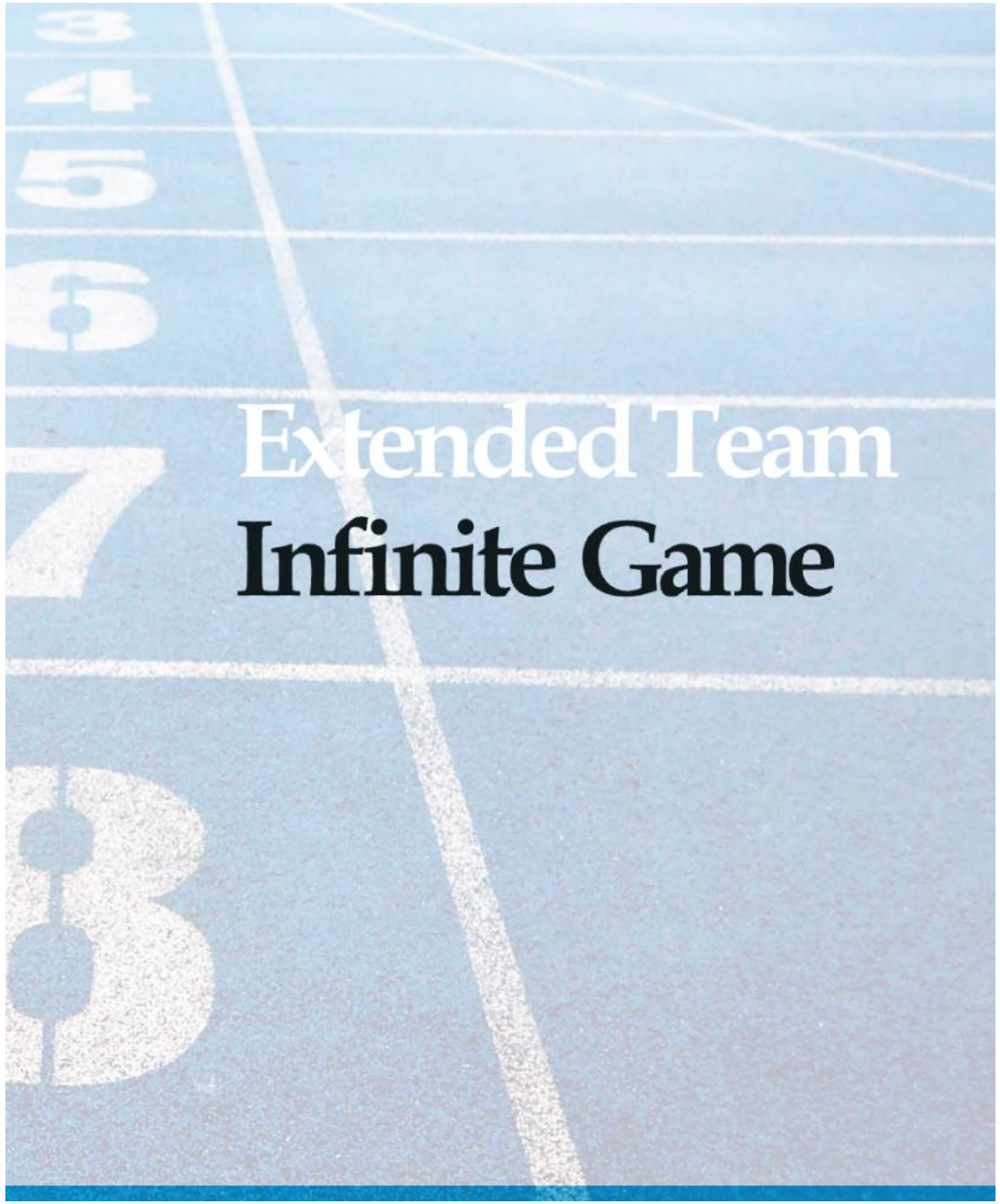
fatigue / programming

Basel

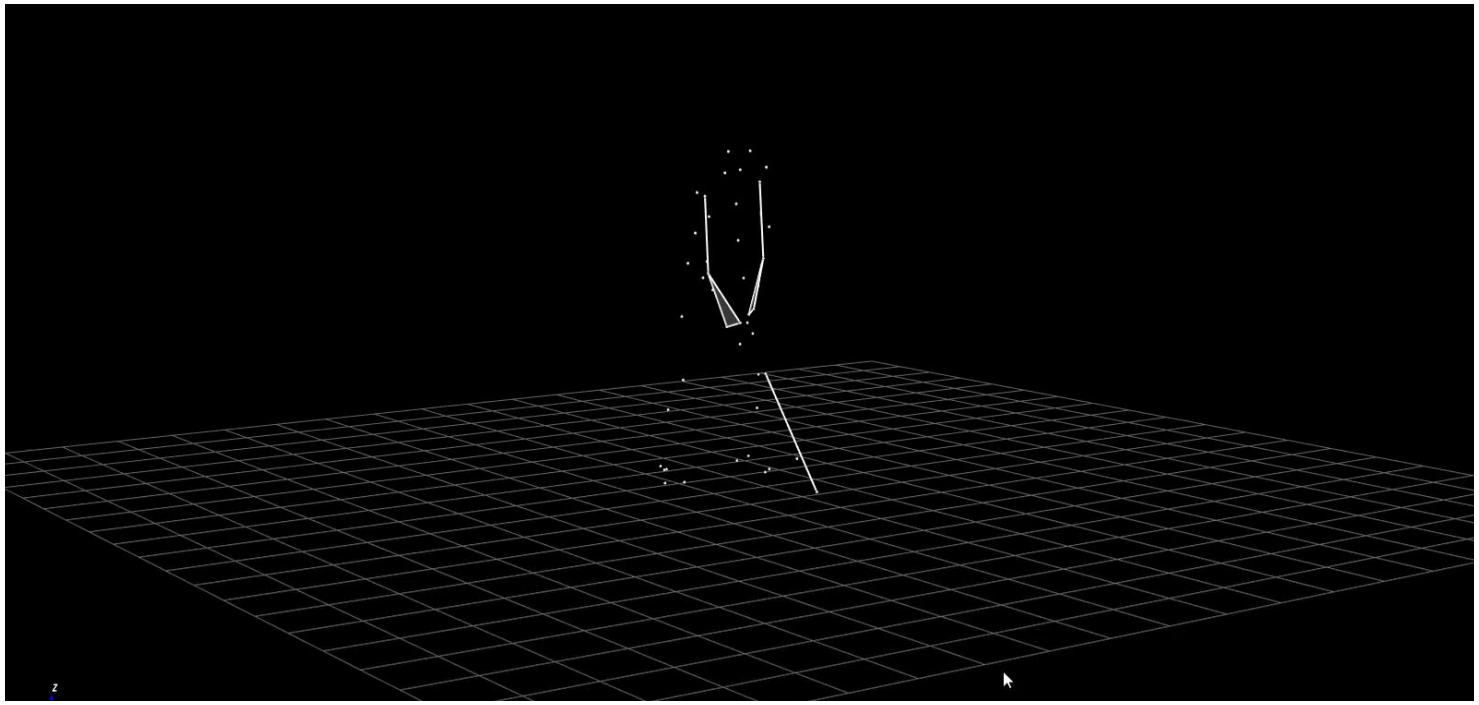
François MOLETTE

Engineering Director

Winterthur



Thank you for your attention



Special video for Markus Dutly!