



35th INTERNATIONAL CAE CONFERENCE AND EXHIBITION

THE ENGINEERING SIMULATION PATH TO DIGITAL TRANSFORMATION

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Oil lubricated bearing support analysis on electric generators with meshless CFD methods

N.Pretto Marelli Motori

D.Pesenti, M. Galbiati EnginSoft



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■ Our core business

MOTORS



GENERATORS



SERVICES



■ Industries we serve

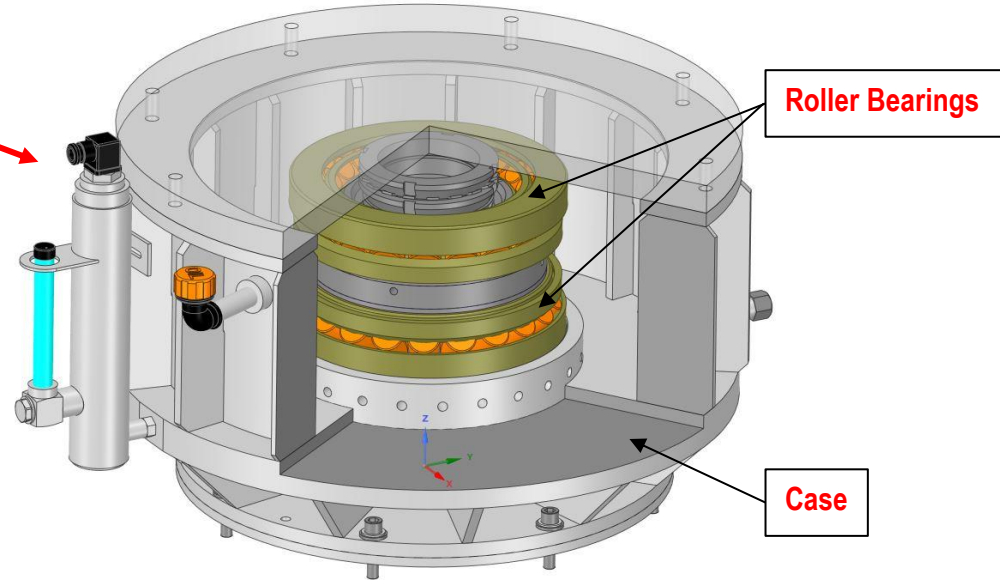
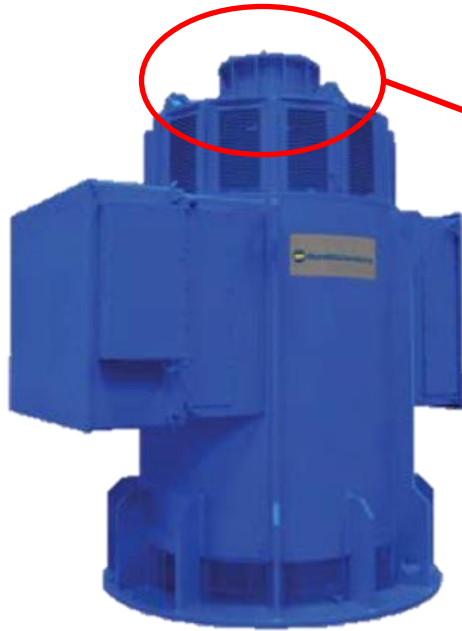
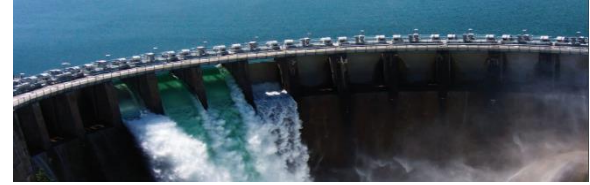
Marine, Oil & Gas, Power generation, Industrial, Cogeneration

■ Global footprint

Italy, Germany, UK, Spain, USA, South Africa, UAE, Malaysia, Vietnam, Korea



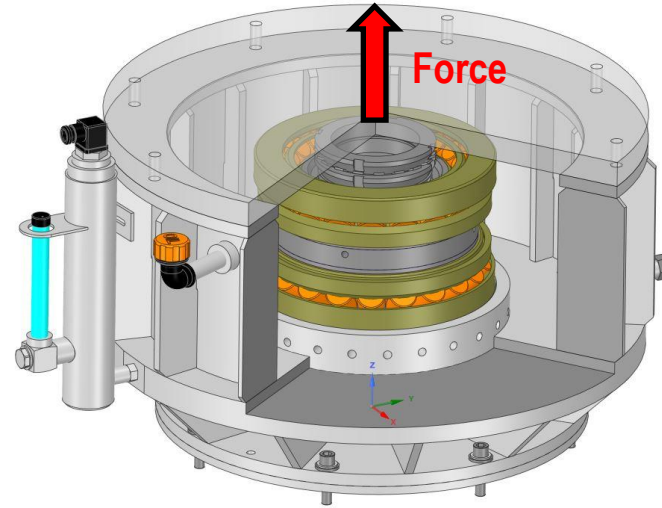
Case study



- Vertical Marelli Motori electric generator.
Typical application → Hydroelectric power generation

- Vertical oil bearing thrust support

Case study



- 2 Bearings → 2 Operating conditions, 2 load cases
 - Nominal speed (750 rpm)
 - Overspeed (1500 rpm)
- Oil pumping system
- In the **PAST** : trial and error approach
- **NOWADAYS**: CAE simulation



Overview



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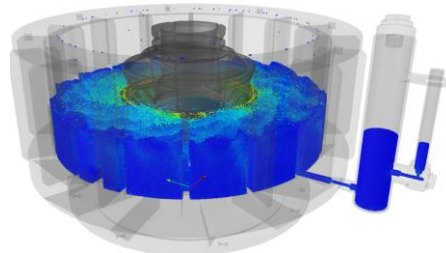
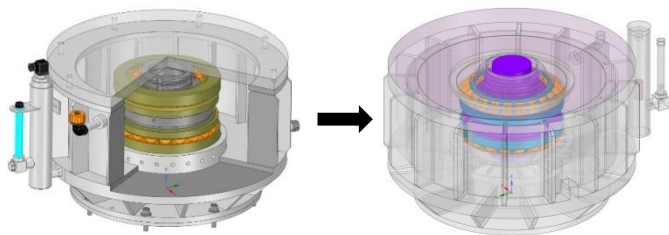
CAD 3D Model
Clean up

Preparation of
CFD model

Computation
on GPU

Post-processing of
Particle CFD Results

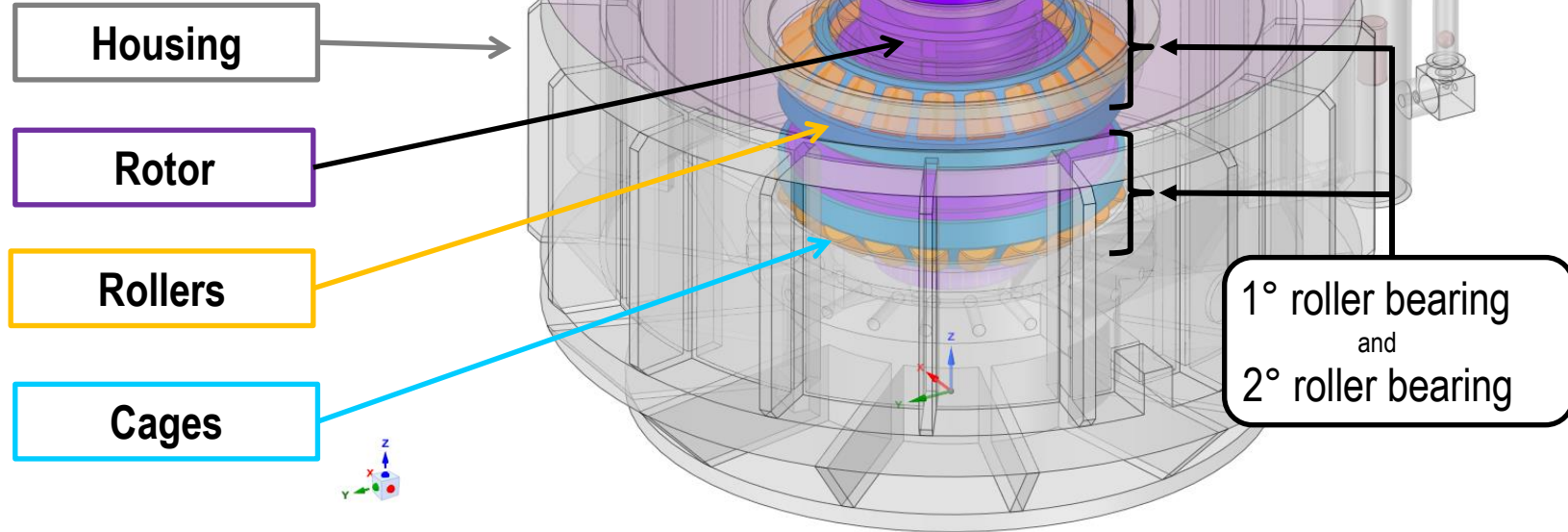
or CPU



Geometry

Model loaded in ParticleWorks

Geometry was splitted in 4 different components:

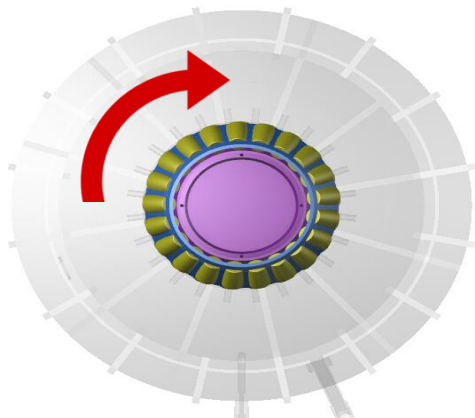


Geometry



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Rotations – shaft and cages



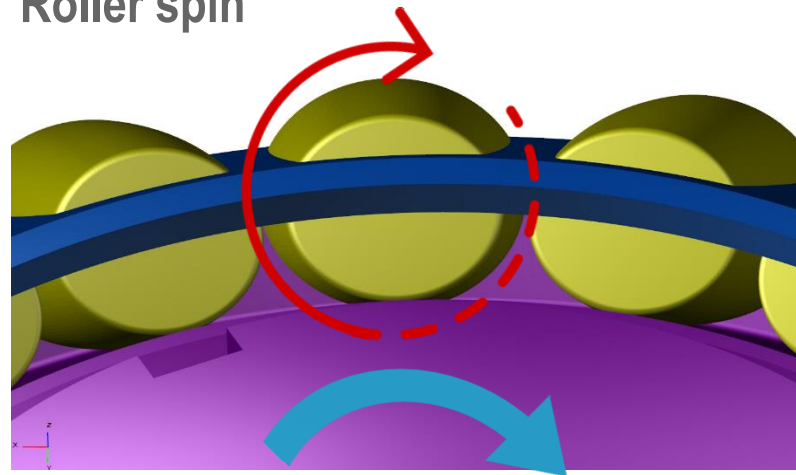
Rotor: 750 / 1500 RPM

Cages: 340.2 / 678 RPM

Roller: 2556 / 5106 RPM



Roller spin



Rotational frequency of the shaft washer		Rotational frequency of the rolling element and cage assembly		Rotational frequency of a rolling element about its own axis	
rpm	Hz	rpm	Hz	rpm	Hz
750	12.5	340.2	5.67	2556	42.6
1500	25	678	11.3	5106	85.1

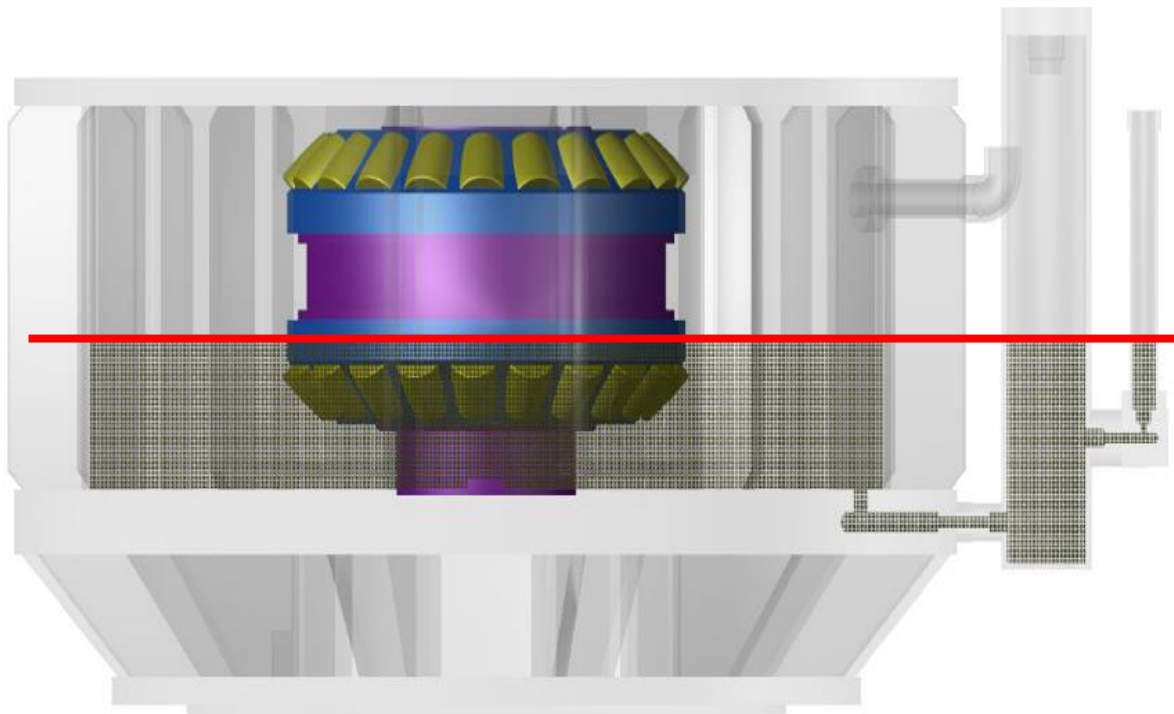
Geometry

Oil level initialization



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78 mm = 13 L



Results



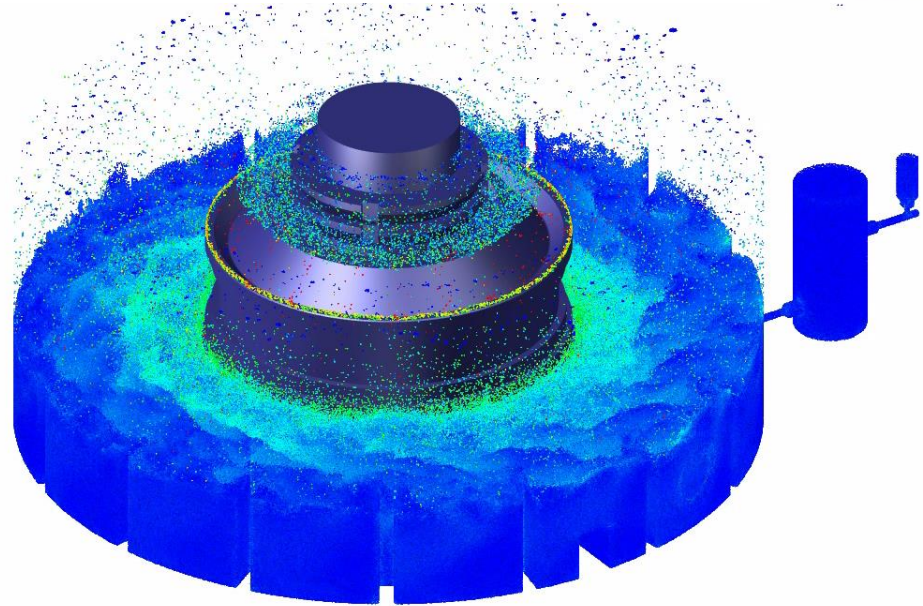
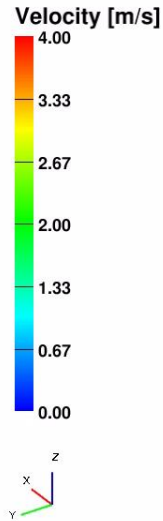
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2 test: ➤ 750 rpm
➤ 1500 rpm

Settings adopted:

- Small ramp to the rotational speed
- Particle size of 1 mm
- CFD Model stable after 6-8 seconds of simulated time



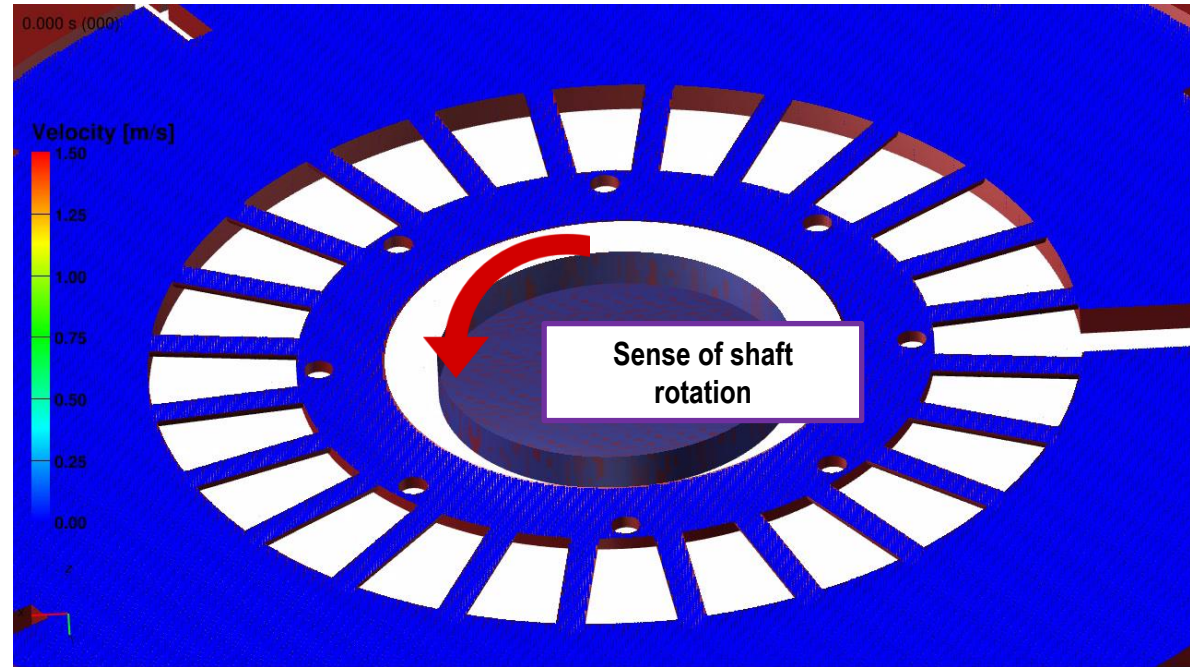
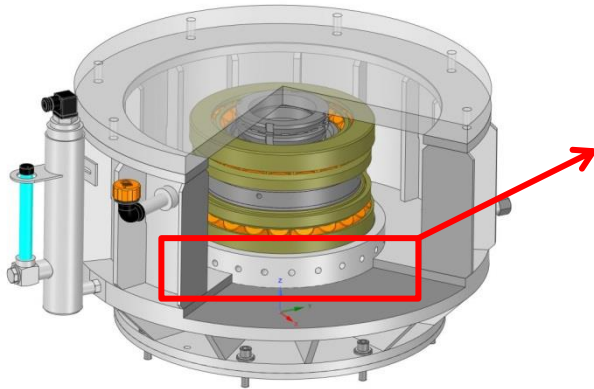
Results



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Radial channels cross section view

- Get an easy access inside the object for a deeper view.
- Visually we were able to better understand the phenomena in action.



Estimated time for simulations



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- These simulations ran on a GPU TESLA V100

ID	Rotational speed	Time step	1 s simulated [days]	Time simulated [seconds]	# of particles / initial volume of oil	N° of cores
02	750 RPM	4e-5	0.3	26.22	13 M / 13 L	GPU V100
03	1500 RPM	1e-5	1.8	12.89	13 M / 13 L	GPU V100

- Potential of the software:

Easy and fast
model setup



Relatively fast GPU
calculation time



Could explore
diverse designs



Reducing developing time



The target is to perform a final
physical design at 1st attempt



Conclusions (1/2)

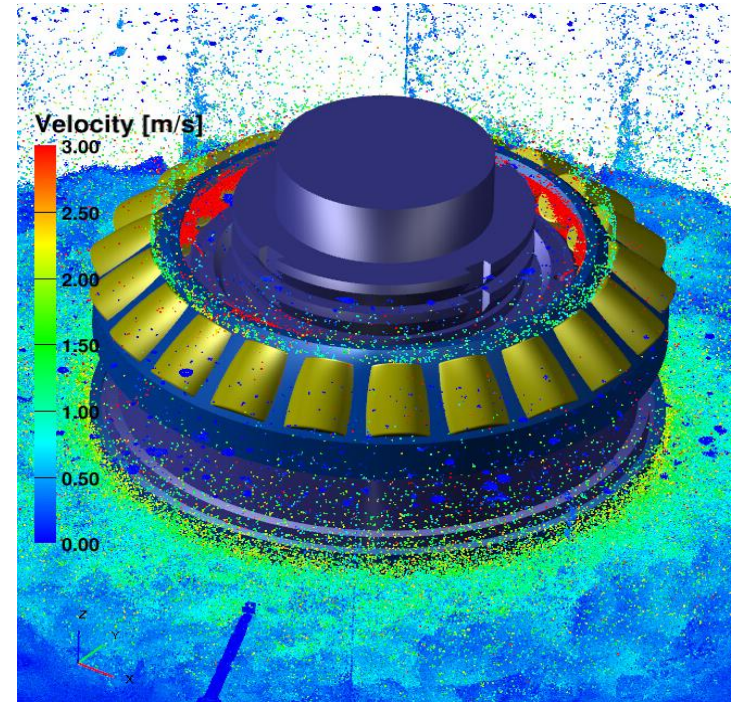
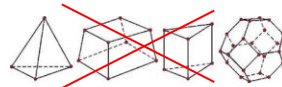


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■ The Marelli experience with the software:

Particleworks® Vs traditional CFD softwares:

- **Better calculation performance** → no big hardware investments (only good GPU needed)
- **Mesh free** → Easier CFD model setup
- Could realize **complex moving geometries** that would otherwise be difficult to realize with traditional calculation methods.



Conclusions (2/2)



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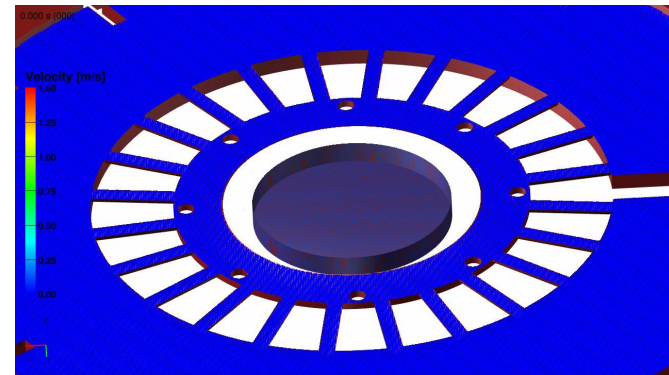
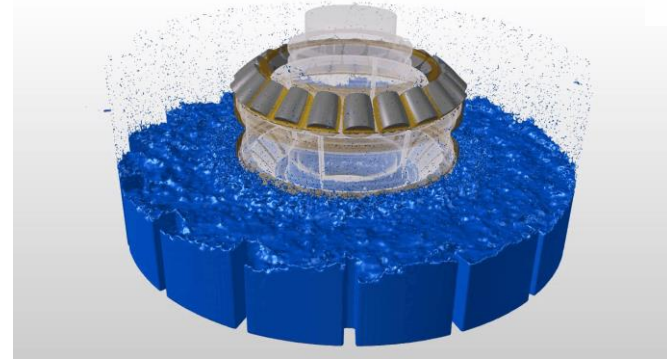
Advantages obtained:

- To provide additional **understanding** of the oil flow and how the bearing support performs at different operating speeds.
- To **calculate the oil flowrate** in the bottom radial channels (very difficult to attend in physical tests)



Remaining challenges:

- To **test** the physical support in reality to validate the numerical simulations.





Thank you for your attention!
Grazie per l'attenzione!

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