[PiQ²]
Developing Expertise

New Challenges in Simulation

ZINC
DIE CASTING
Conference 2022

October 5-7
Koblenz, Germany

ZINC international zinc association Initiative ZINK

Some words about PiQ²

- Established in 2011
- Head Offices in **Brescia (IT)**
- Member of the **Technological Hub of CSMT**

MISSION

Move advanced simulation technology from the **research labs** to the **foundry** level and bring **practical experience** from the **shop floor** to the **desk**.

VISION

Simulation should be an **everyday tool**: **easy** to be used and **helpful** during all the die design process from draft definition up to the final die details.

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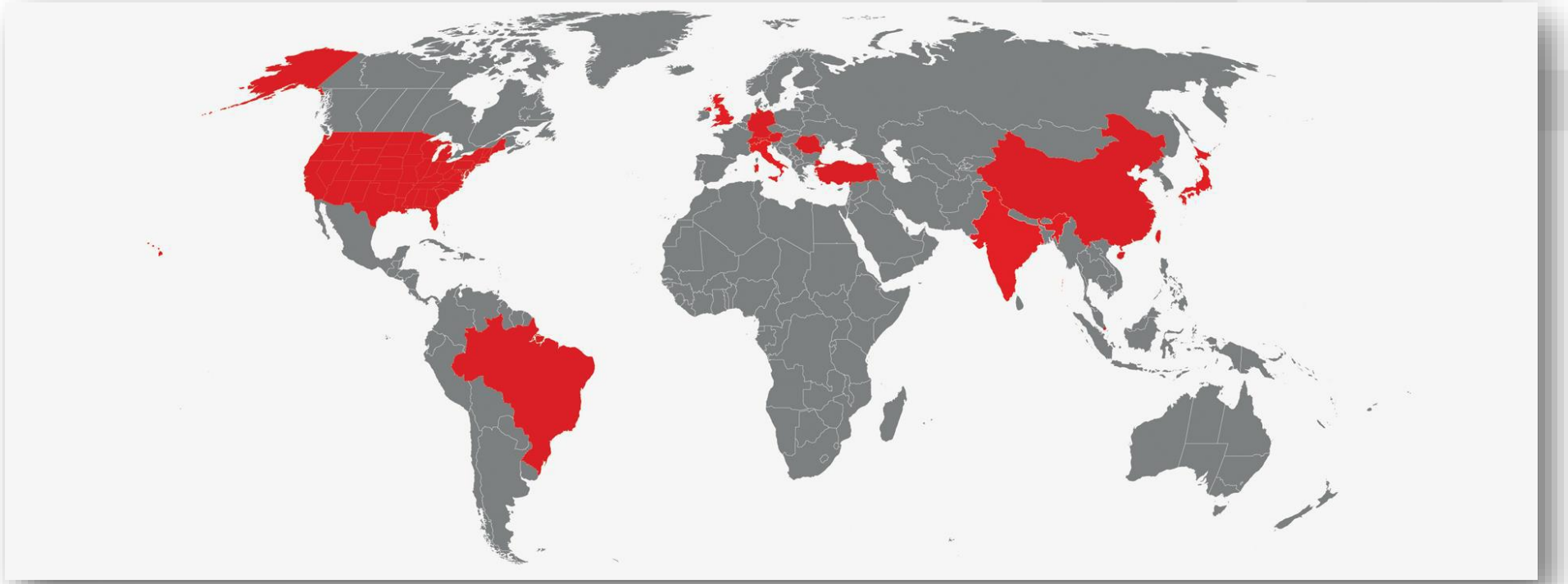
Our market



- **Customers:** Italy, Austria, UK, Singapore, China, Japan, India, Romania, Brazil, Turkey, Germany, Switzerland, USA.
- **Dealers:** Italy, Turkey, China, HongKong, Japan.
- **88** software customers
- **102** licenses

(38% ZINC DIECASTERS AND DIE MAKERS)

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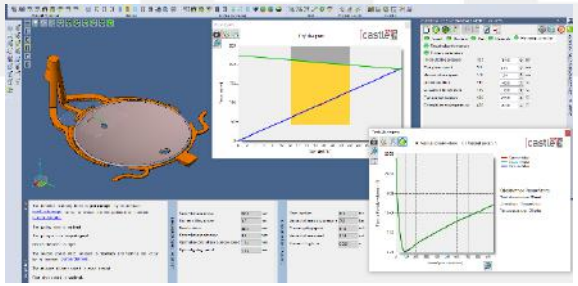
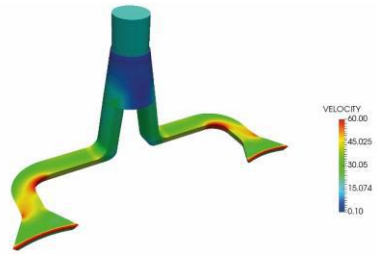
Our core business: castle

castle MIND — **HPDC PROCESS OPTIMIZATION**

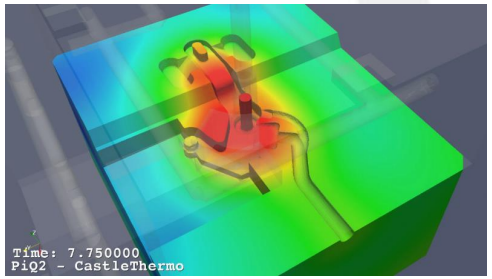


castle RUN — **RUNNER OPTIMIZATION**



castle BODY — **FILLING AND SOLIDIFICATION**

castle THERMO — **THERMAL SIMULATION**



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Zinc Hot Chamber Simulation:

The seven challenges:

1. **Start simulating before simulating!**
2. **Don't waste time** simulating **trash runners**
3. Simulate **the right injection profile**
4. Catch even **smaller geometry details**
5. Simulate **hot runners**. Spicy solution!
6. Catch **smaller air porosities**
7. Take care of **die life**

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Zinc Hot Chamber Simulation:

Start simulating before simulating!

Zinc parts and moulds require the same - if not more - accuracy in **dimensioning gates**, **runners**, **nozzle** than GigaCastings.

Before starting to design and simulate a die, **make some kind of simulation** in order to understand **WHAT and HOW** are you going to design!

Running a time consuming filling simulation to **understand that gating is too small** is **silly**…

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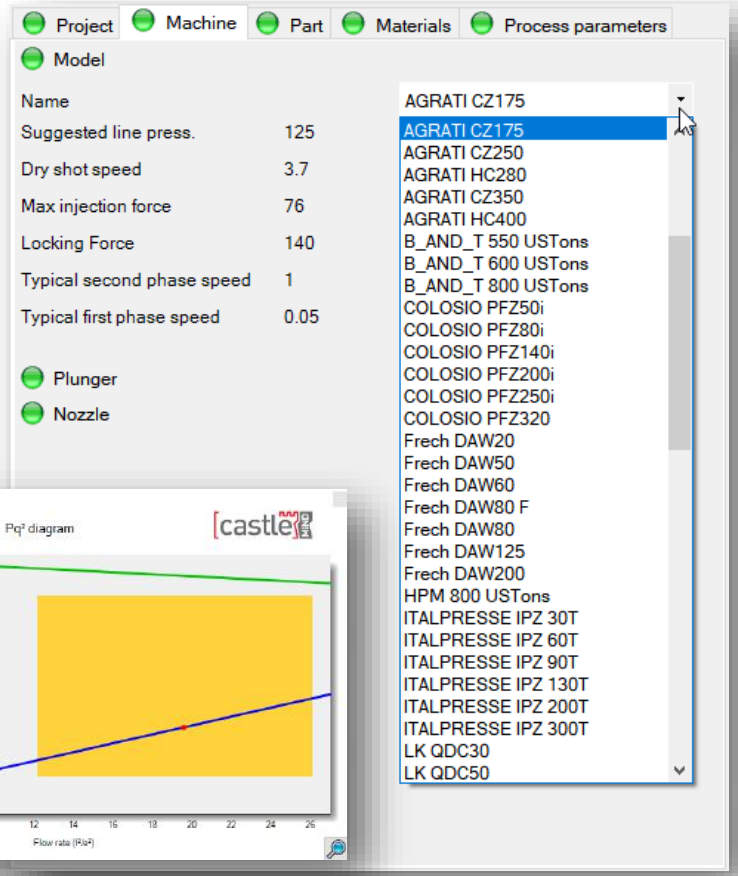
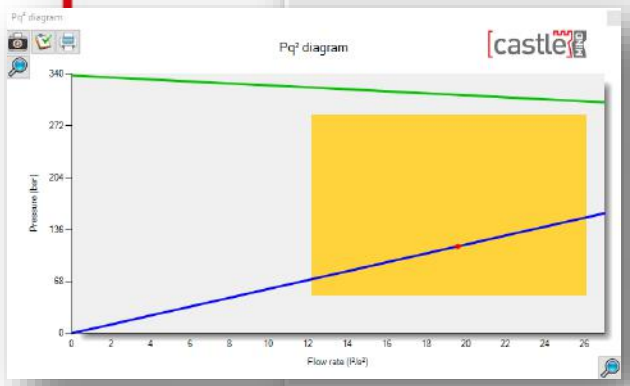
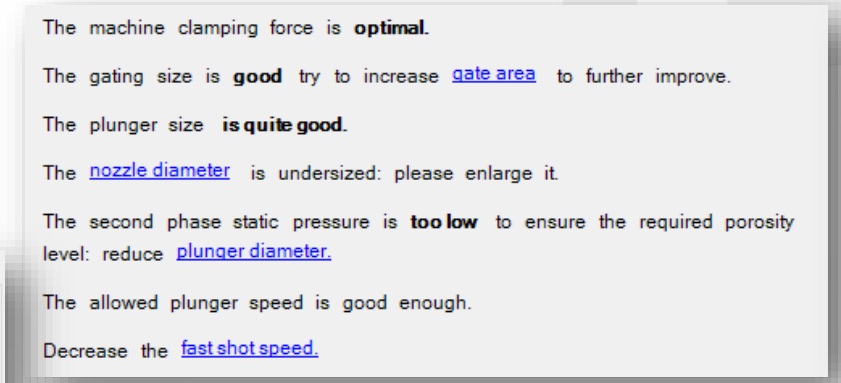
Zinc Hot Chamber Simulation:

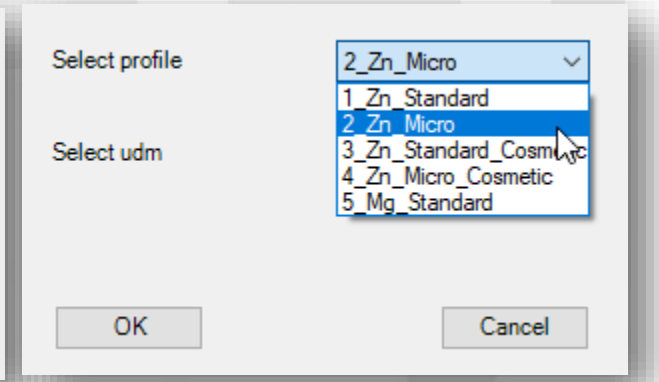
Start simulating before simulating!

- **Die casting machine capability MUST** be checked through **PQ² calculations**

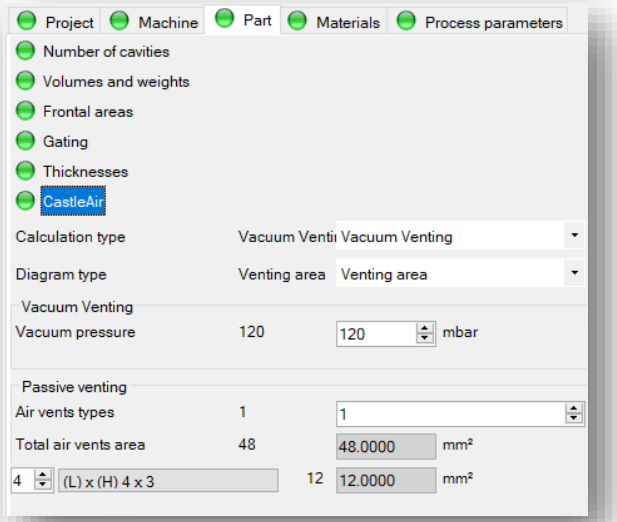


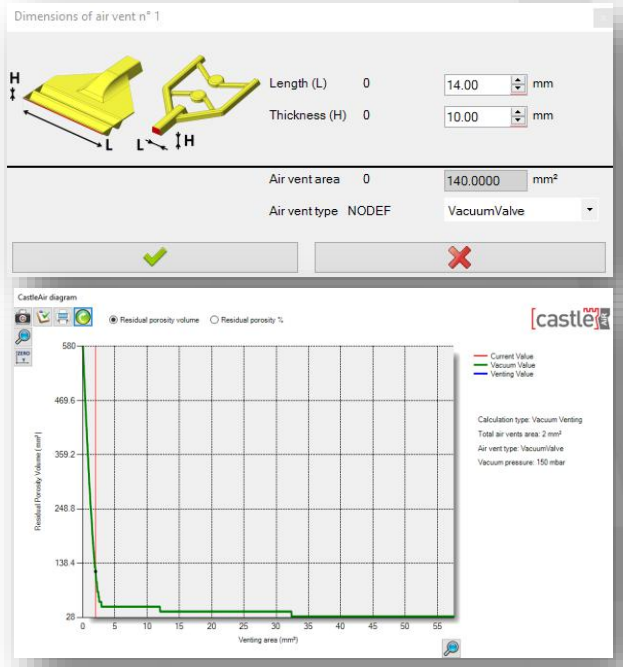






- **Venting and vacuum outflows** need to be calculated as well

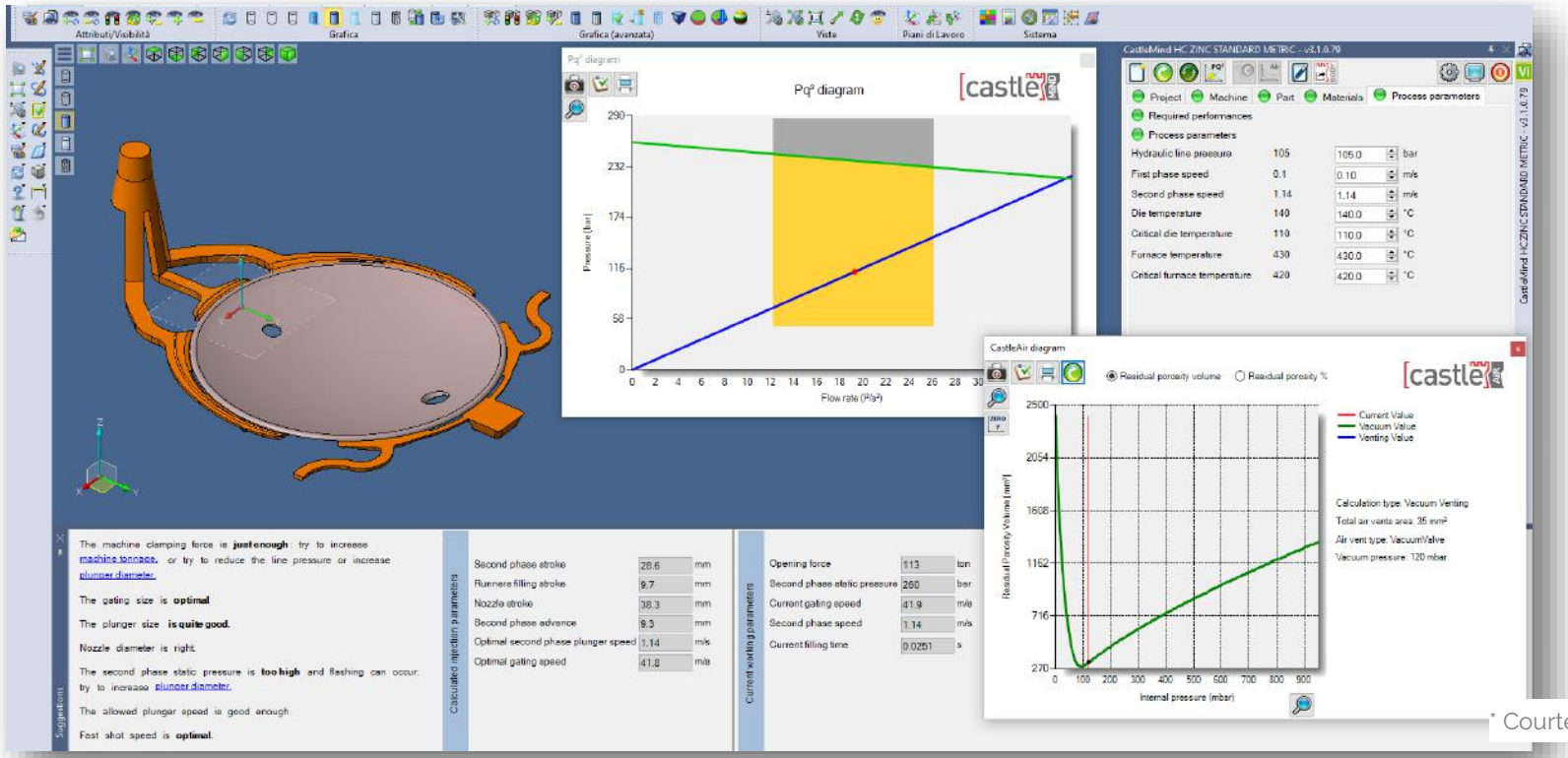




Our solution:

CastleMIND is an optimization tool based on an expert system that allows to:

- Make a **global setting evaluation before die design**
- Optimize **shape and process parameters** of new products
- **Forecast issues** that can occur in the castings during the production
- Predict **near-actual simulation parameters**



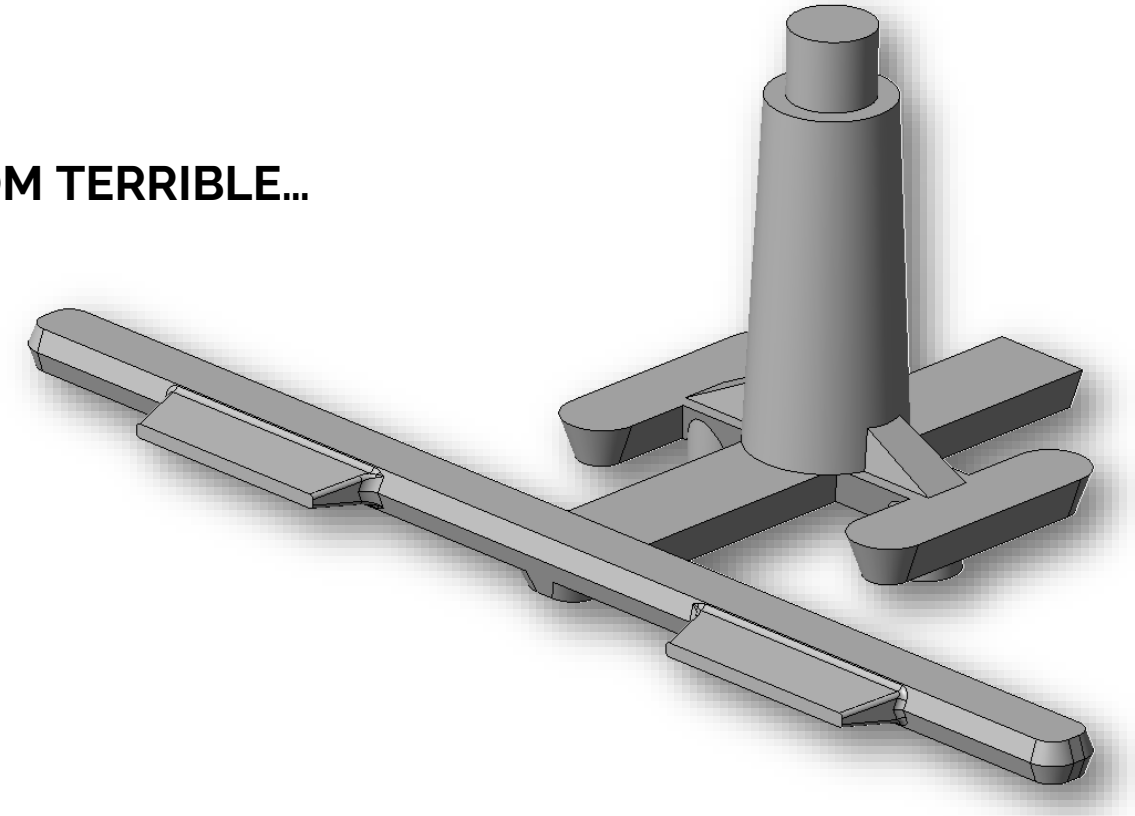
* Courtesy of Bruschi

Zinc Hot Chamber Simulation:

Don’t waste time simulating trash runners

The **shape and dimensions of the sprue** are a main factor when looking for **high quality parts**.
Don’t waste time to simulate parts filling before optimizing **runners shape**.
Even for **modular dies**, invest some time to **optimize sprue and runner**.

FROM TERRIBLE…



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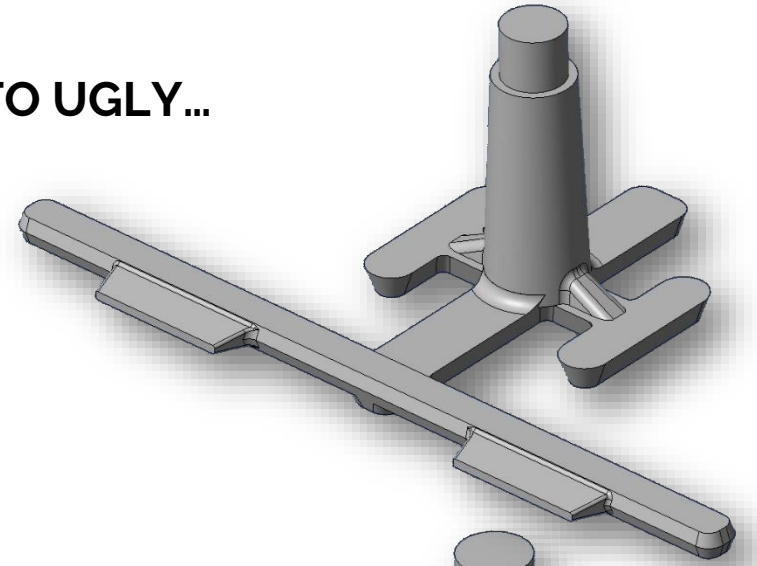
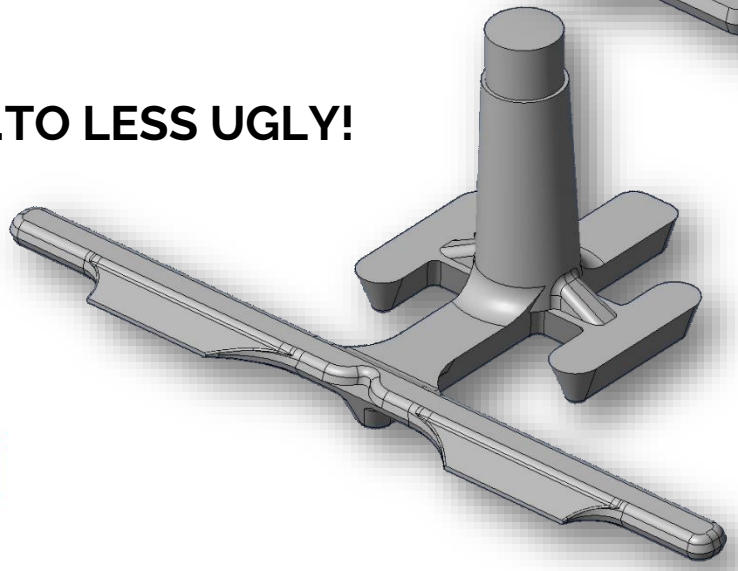
Zinc Hot Chamber Simulation:

Don't waste time simulating trash runners

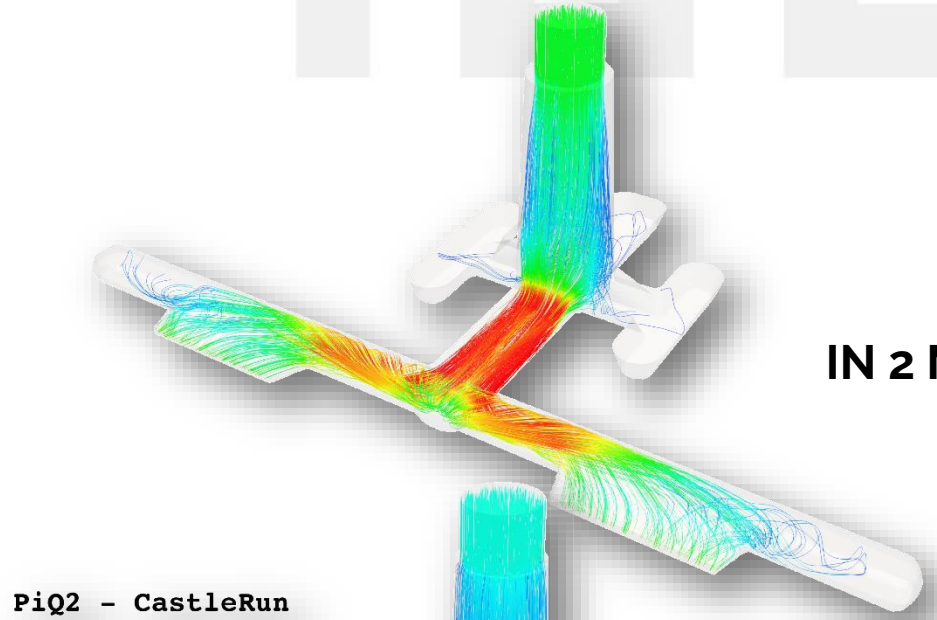
…TO UGLY…



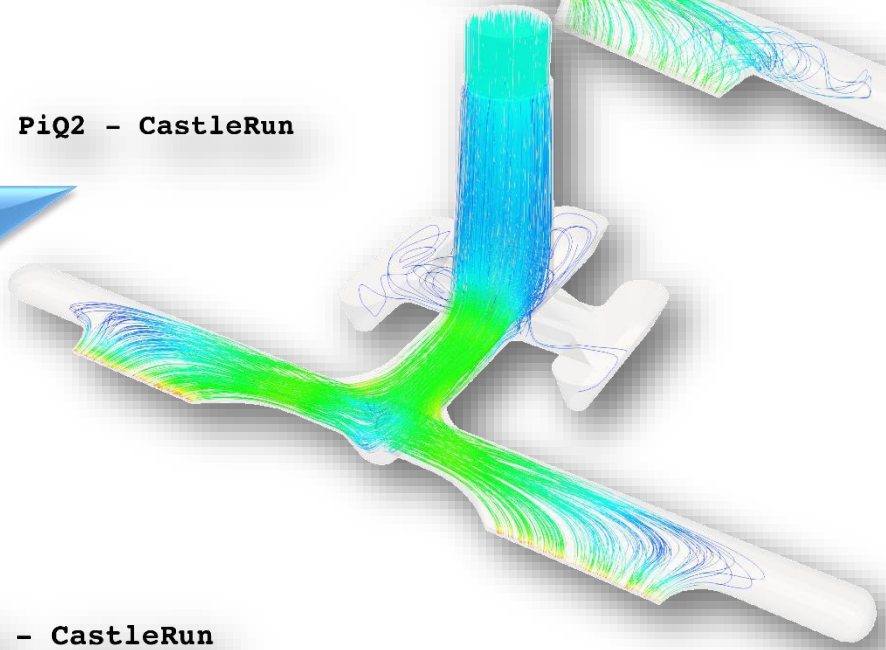
…TO LESS UGLY!



PiQ2 - CastleRun



IN 2 MINUTES!



PiQ2 - CastleRun

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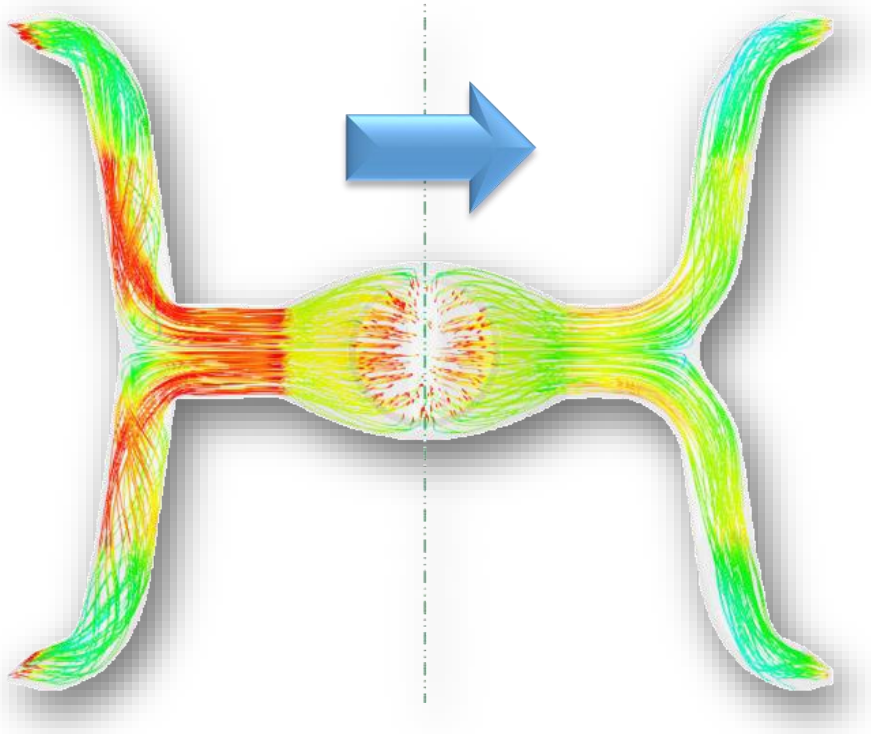
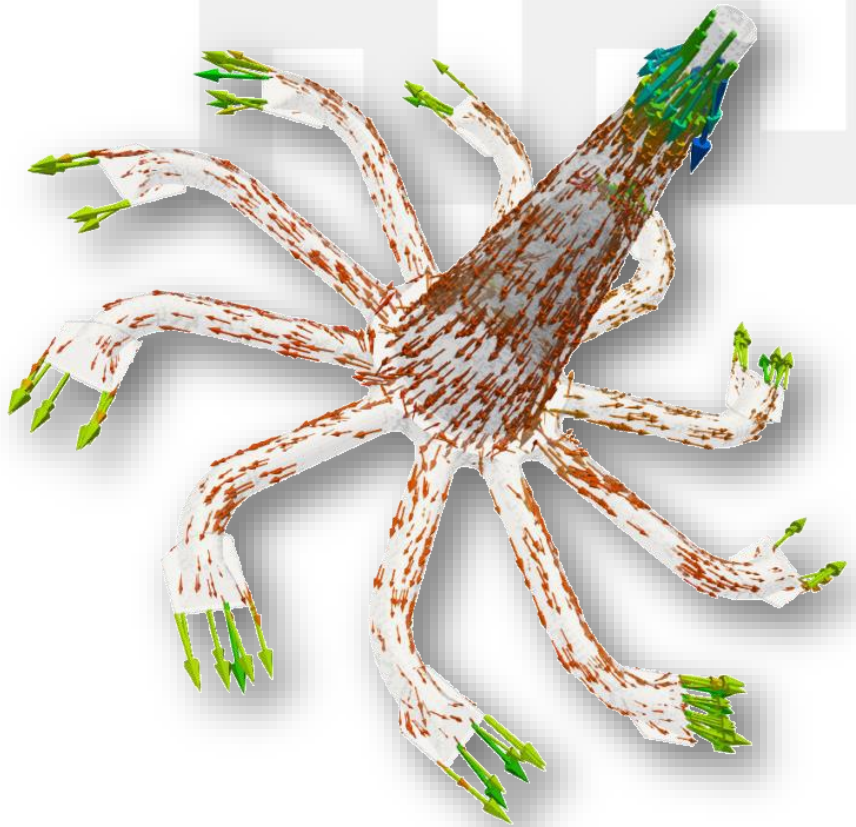
Our solution:

Often the runners are the **only one degree of freedom** left to the die maker.
Errors in the shape of the feeding system will definitely affect the quality of the casting.





CastleRUN allows optimizing the geometry upstream of the gatings to avoid problems in the casting: **IN ONE MINUTE!**

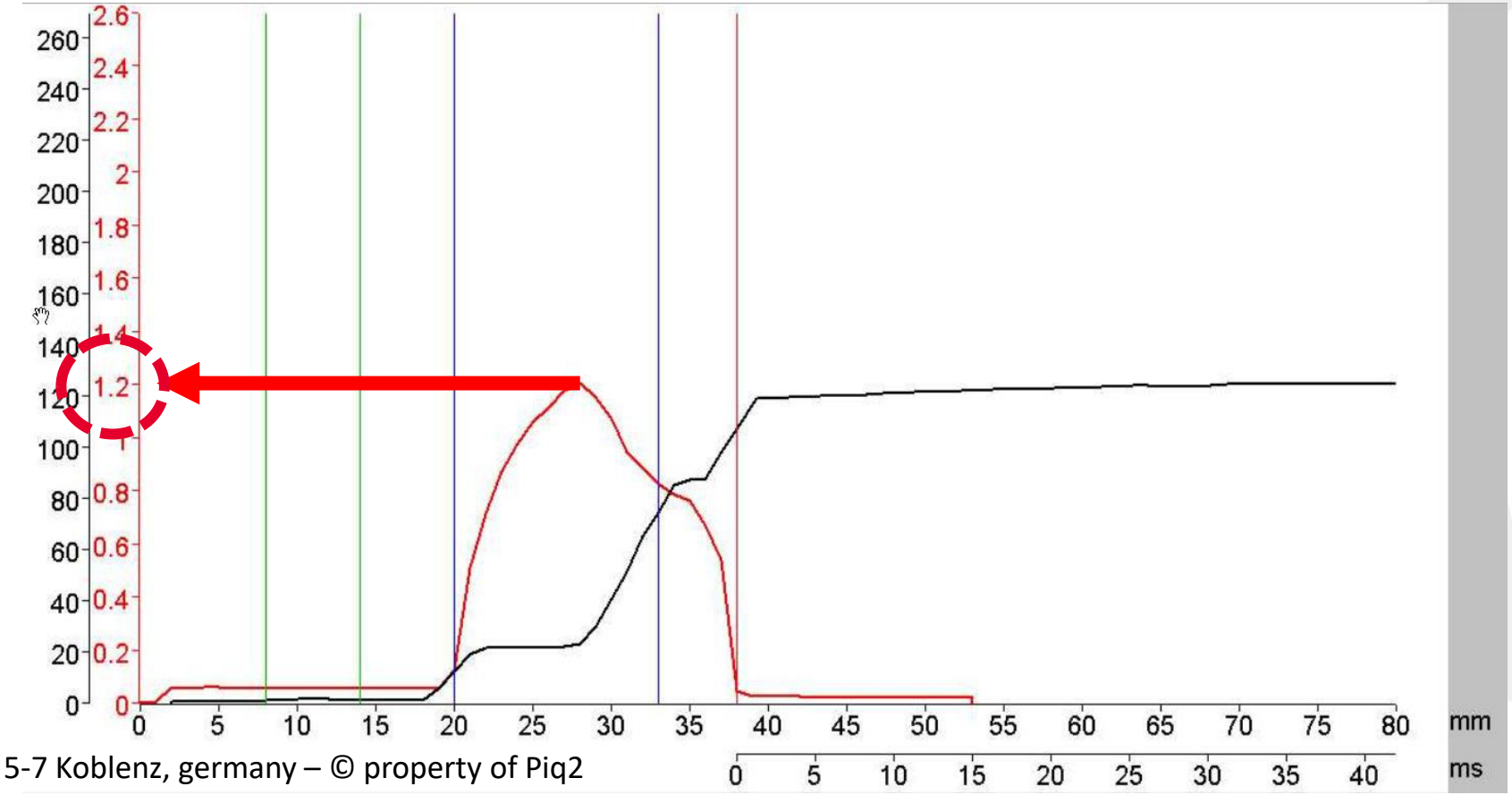
Zinc Hot Chamber Simulation:

Simulate the right injection profile

The **correct injection profile** must be adopted to simulate the **actual process**.
Part filling lasts only **few milliseconds**, and everything happens in a blink.
Be sure to **understand the injection profile** coming from the DC machine, or calculate plausible injection parameters from scratch

This is not the actual part filling plunger speed!

Most of the times, we're filling gooseneck and runner there!



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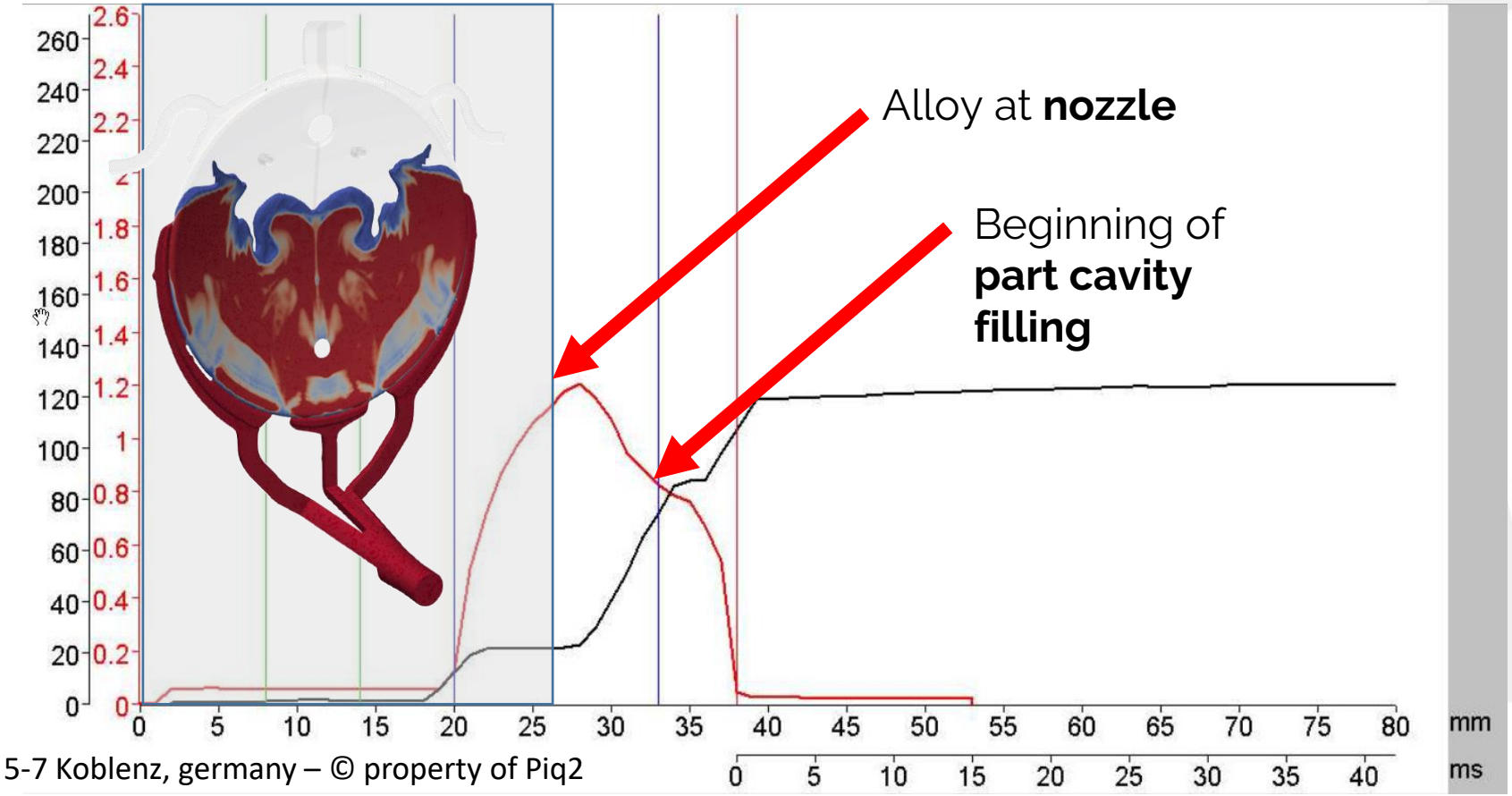
Simulation virtually starts when alloy is at the nozzle tip

Most of the plunger travel is in deceleration. Take care!



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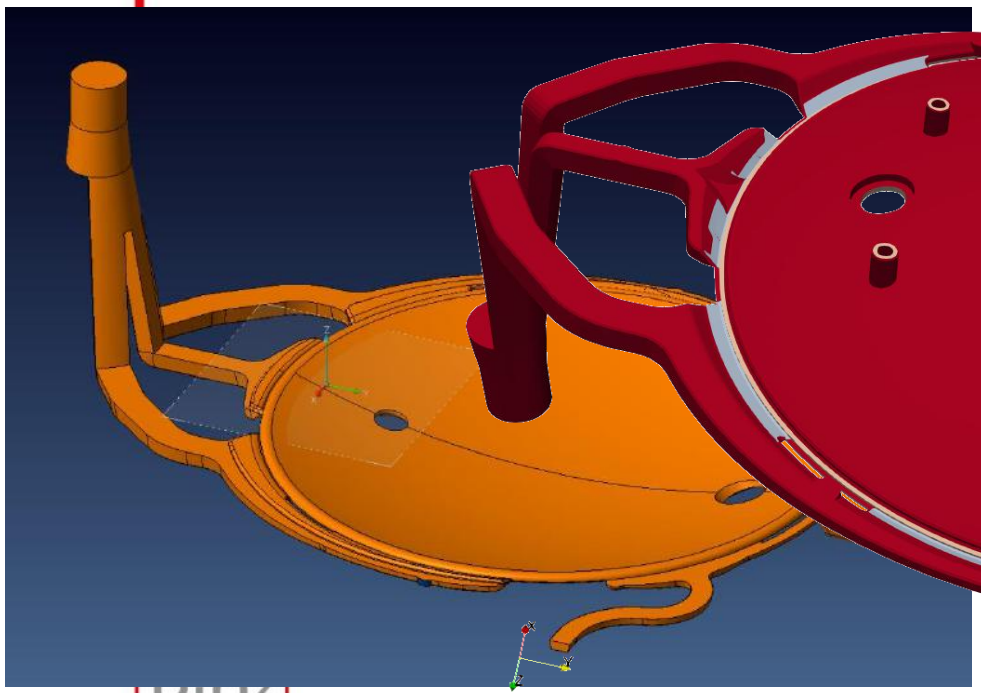
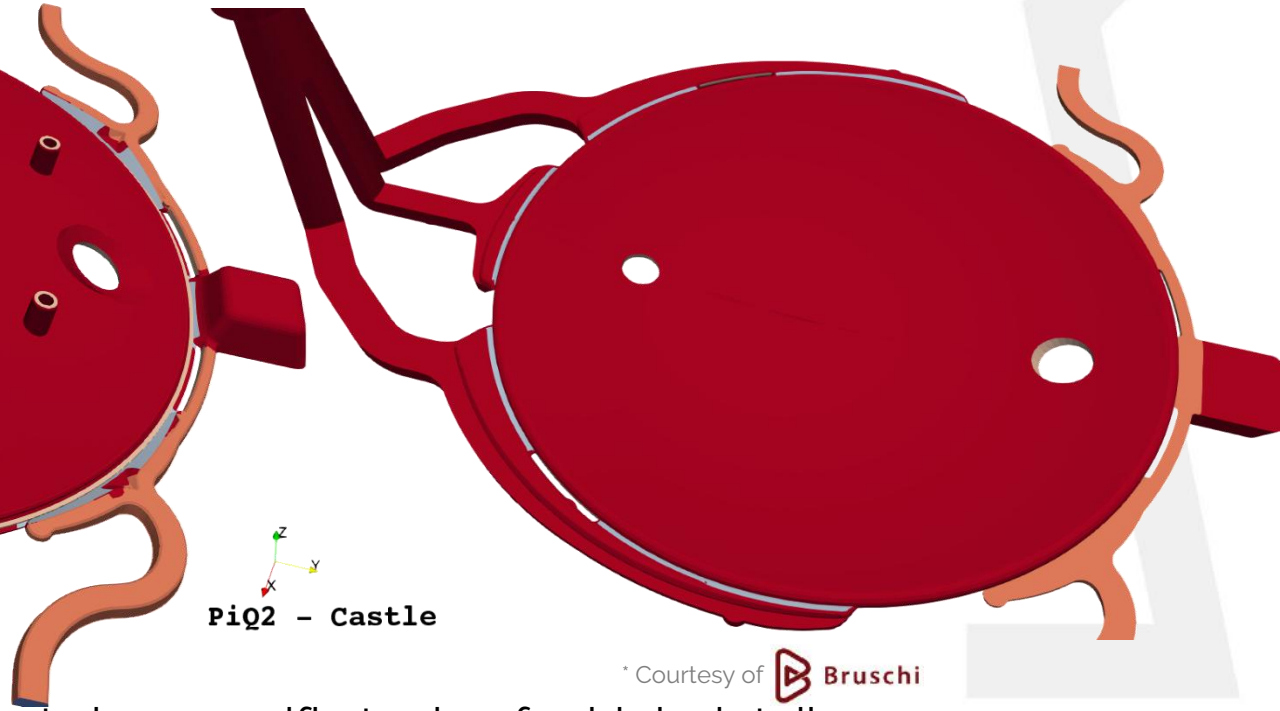
Zinc Hot Chamber Simulation:

Catch even smaller geometry details

Even if big, Zinc parts always have very **small details** that can **influence the filling pattern**.
Few hundreds of millimeter may seem a silly detail for more, but not for a 0.3mm gating thickness.
Small thickness, **curved walls** must be modelled with the **highest degree of accuracy**.
Too **small elements in mesh**, too **long calculation times!**



PiQ2 - Castle



PiQ2 - Castle

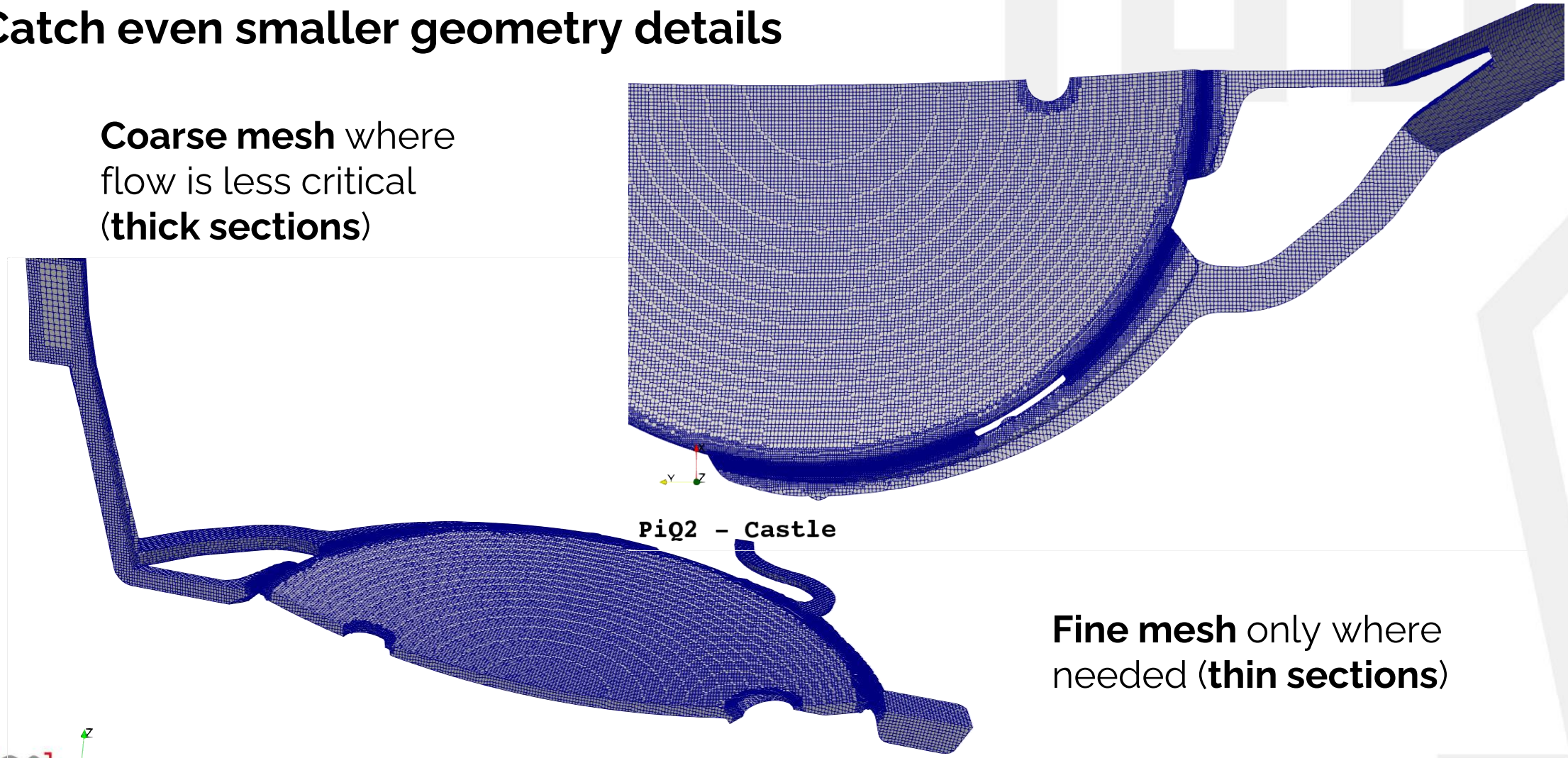
* Courtesy of Bruschi

Arbitrary local refinement of mesh element size, specific tuning for high detail

Zinc Hot Chamber Simulation:

Catch even smaller geometry details

Coarse mesh where flow is less critical (**thick sections**)



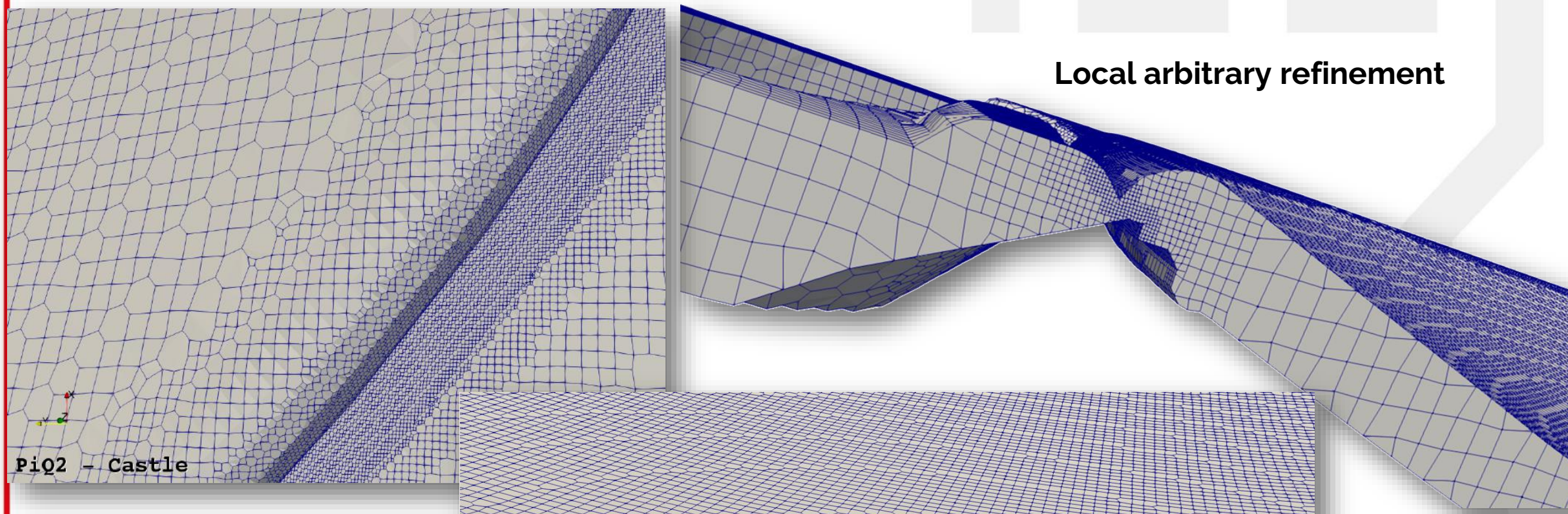
Fine mesh only where needed (**thin sections**)

PiQ2 - Castle

Arbitrary local refinement of mesh element size, specific tuning for high detail

Zinc Hot Chamber Simulation:

Catch even smaller geometry details



Local arbitrary refinement

* Courtesy of Bruschi

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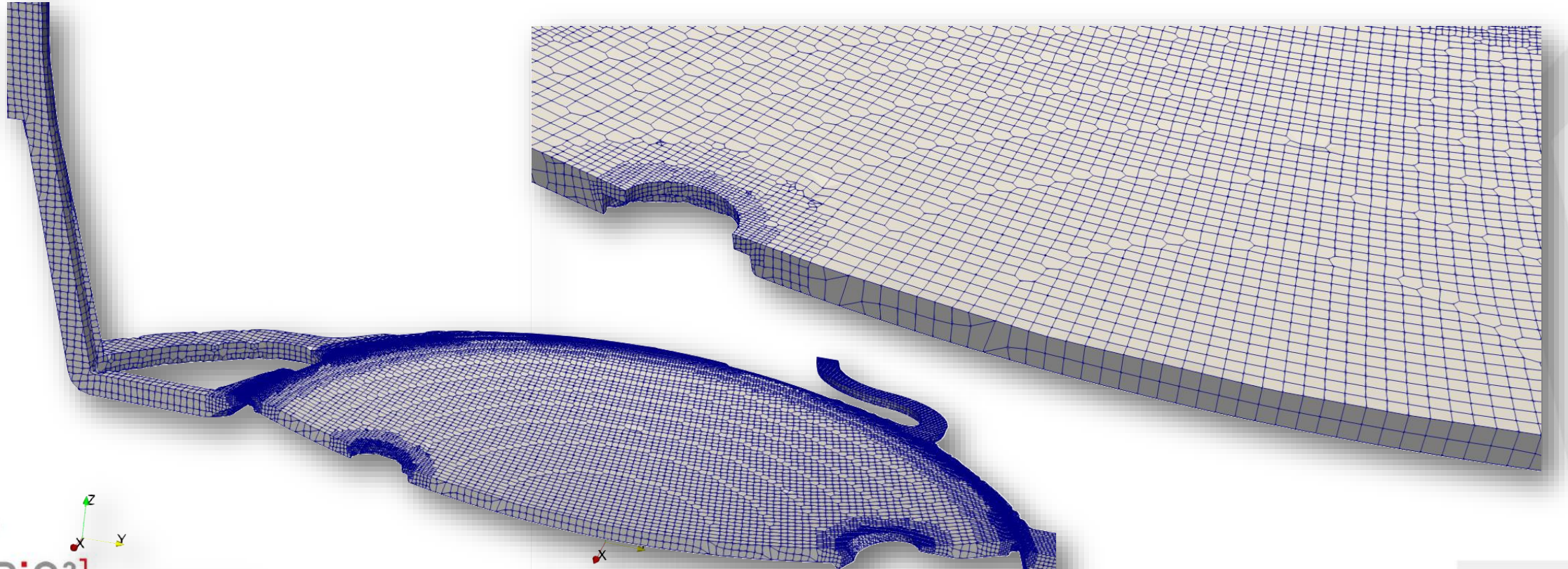
Conformal hybrid mesh

Zinc Hot Chamber Simulation:

Catch even smaller geometry details

Wall friction becomes more and more important! Be careful of influence of mesh coarseness on **results accuracy**

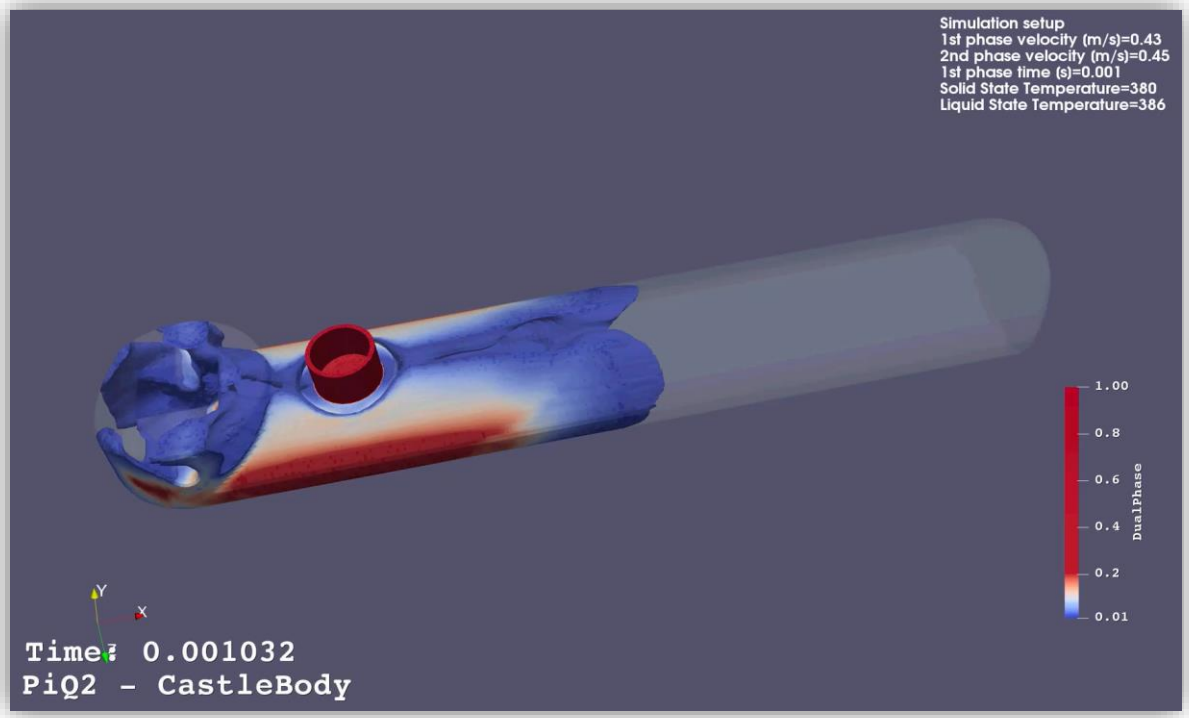


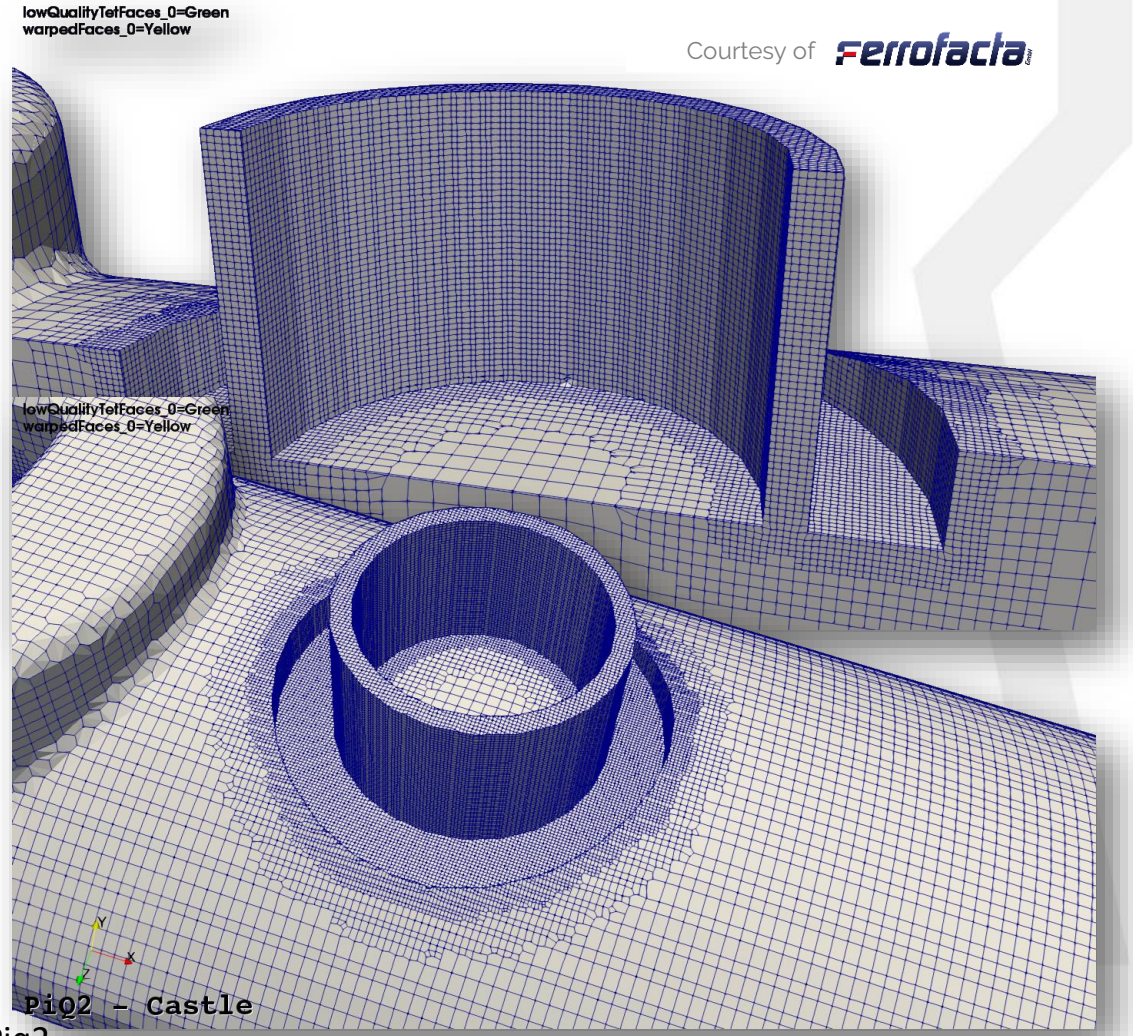
* Courtesy of Bruschi

Zinc Hot Chamber Simulation:

Simulate hot runners. Spicy solution!

Hot runner technology simulations are not completely «out of the box». Some software tuning is needed.





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Specific **meshing for anular nozzle**
Specific **injection profile** optimization

Zinc Hot Chamber Simulation:

Catch smaller air porosities

Filling of zinc parts lasts an **eye-blink** (few milliseconds), with extremely high velocities (**more than 200km/h**)

Liquid metal droplets emulsify with air bubbles.

Air bubbles are compressed to hundreds of bars to very small porosities, **smaller than mesh element**.

Air porosities of few **hundredth of millimiter** are not a problem for aluminum… but **a tragedy for most Zinc parts** .

* Courtesy of Bruschi

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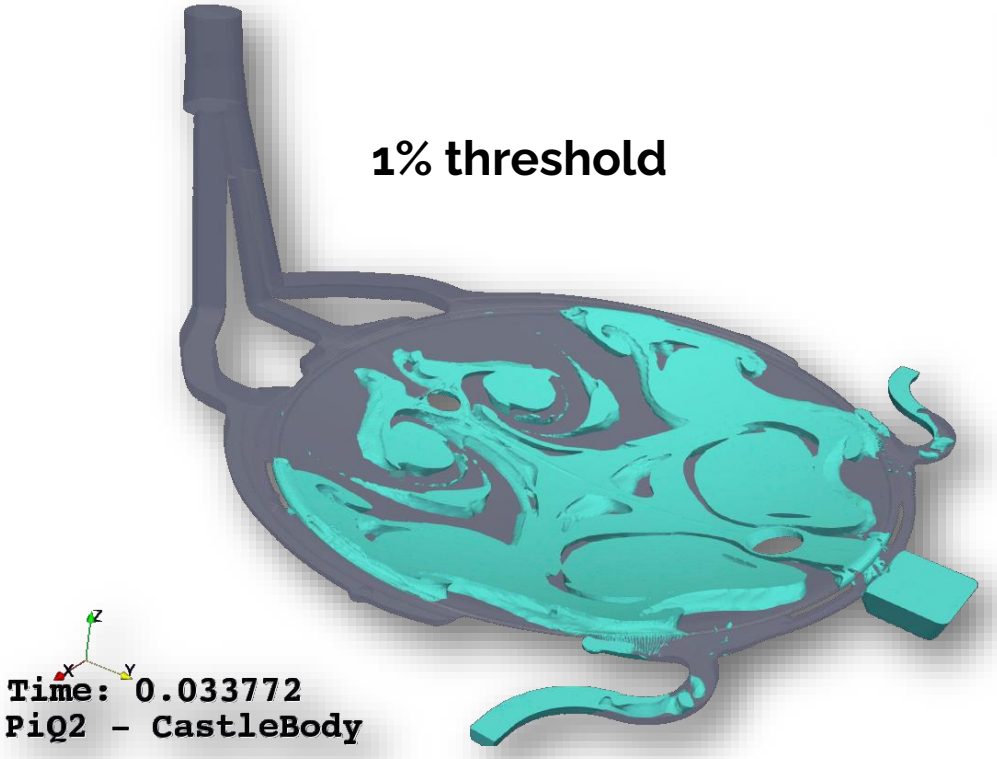
Dual phase technology: allows simulation of emulsifyed alloy

Zinc Hot Chamber Simulation:

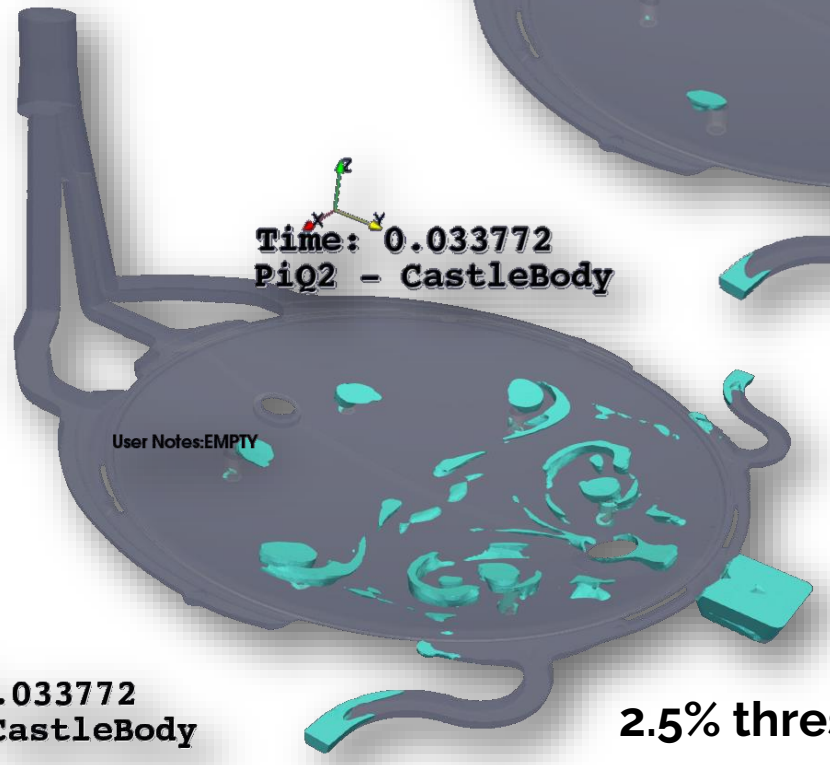
Catch smaller air porosities

1% threshold

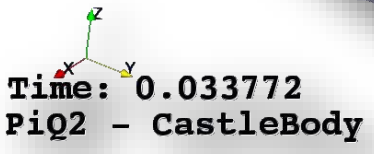


Simulation setup
1st phase velocity (m/s)=1.14
2nd phase velocity (m/s)=1.15
1st phase time (s)=0.009
Solid State Temperature=381
Liquid State Temperature=387

5% threshold



Takes into account the pressure that is developped at the end of filling stage



2.5% threshold

User Notes:EMPTY

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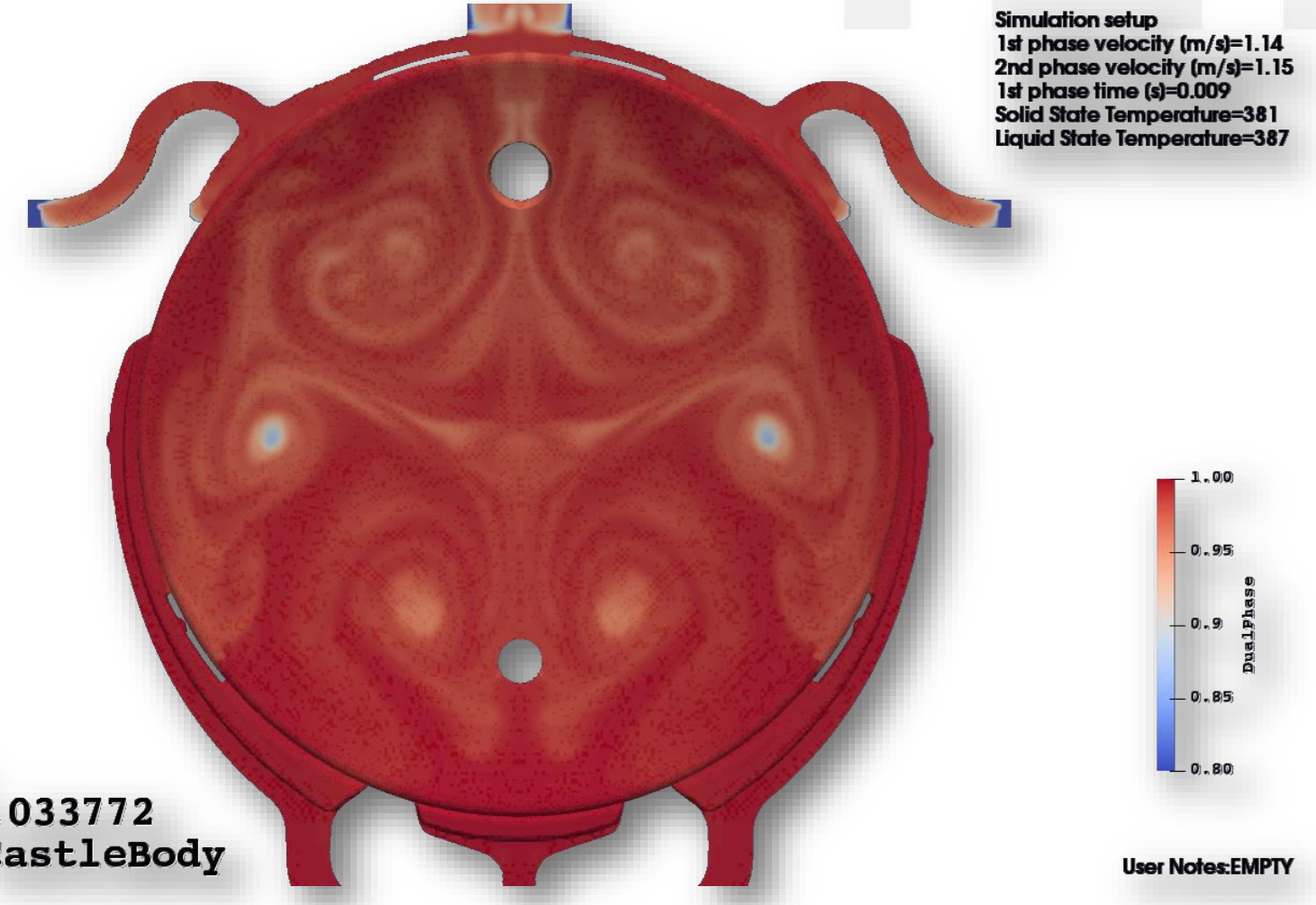
Zinc Hot Chamber Simulation:

Catch smaller air porosities



Dual phase alloy-air mix distribution

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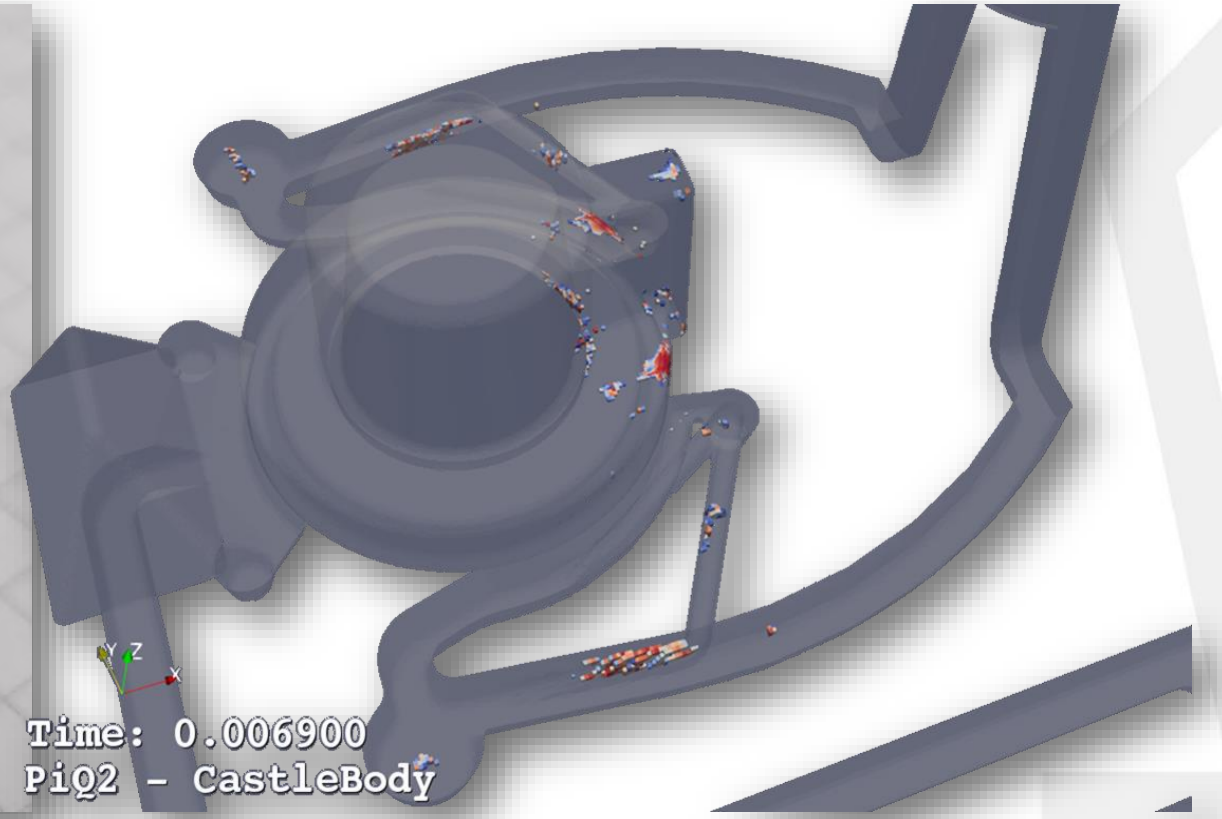
Zinc Hot Chamber Simulation:

Take care of die life

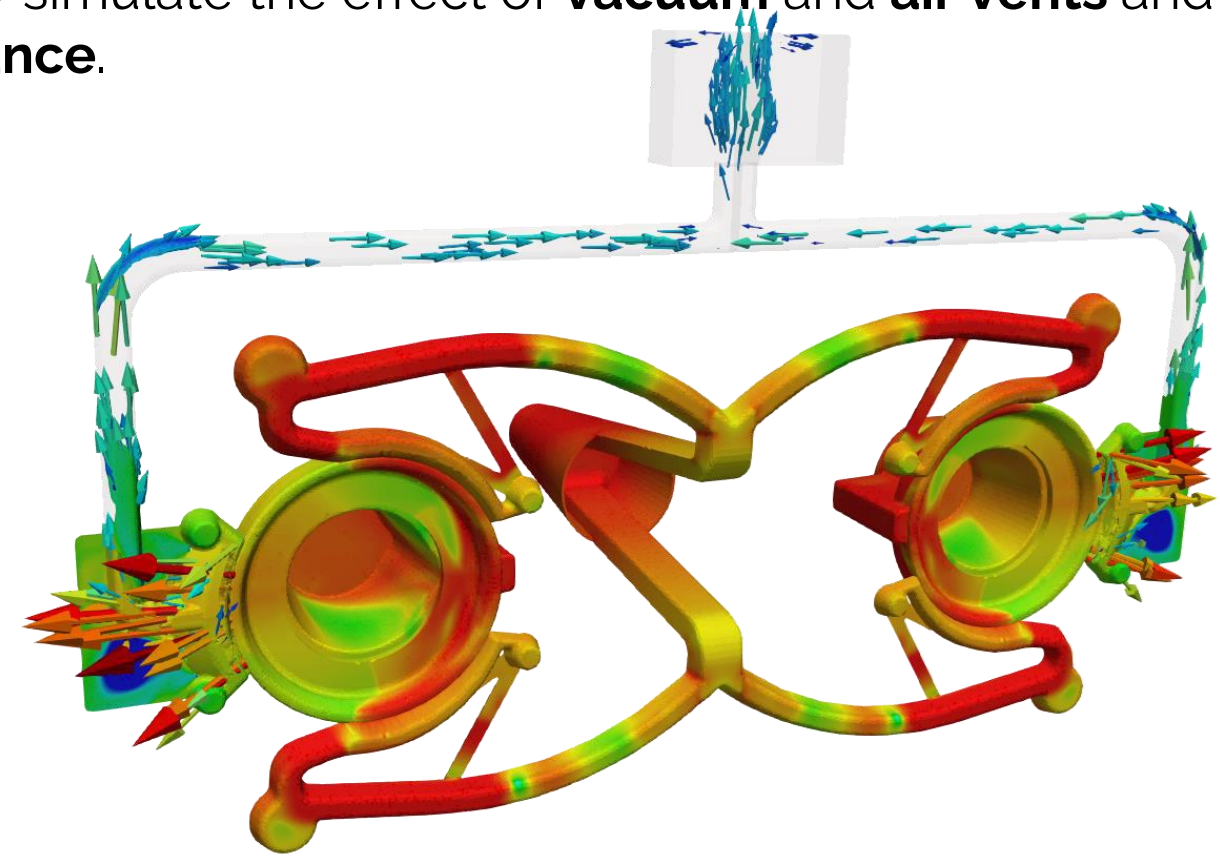
Cavitation sometime happens when using **vacuum with wrong parameters**
➔ Development of **cavitation criteria** in collaboration with Bruschi foundry R&D



* Courtesy of Bruschi

Our solution:

- **Locally refined hybrid mesh** to catch details of flow
- **Dual Phase technology**: consider the **flow of both metal and air**.
- Simulate the effect of **metal spray** caused by the speed and the impact of the fluid with the air.
- Physically simulate the effect of **vacuum** and **air vents** and **evaluate their performance**.

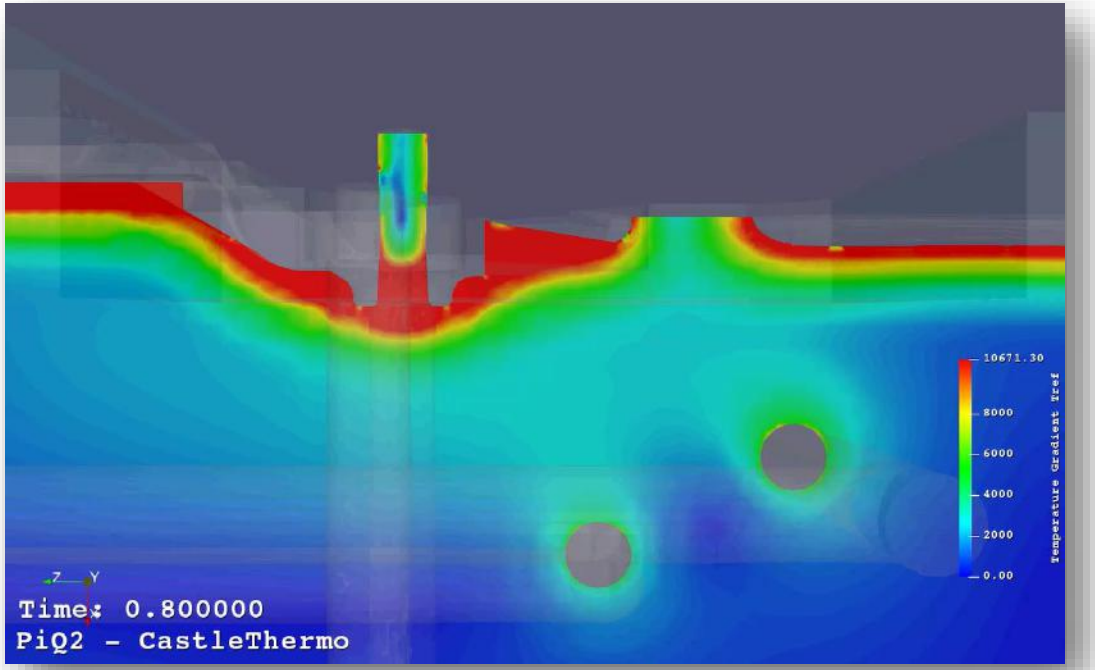


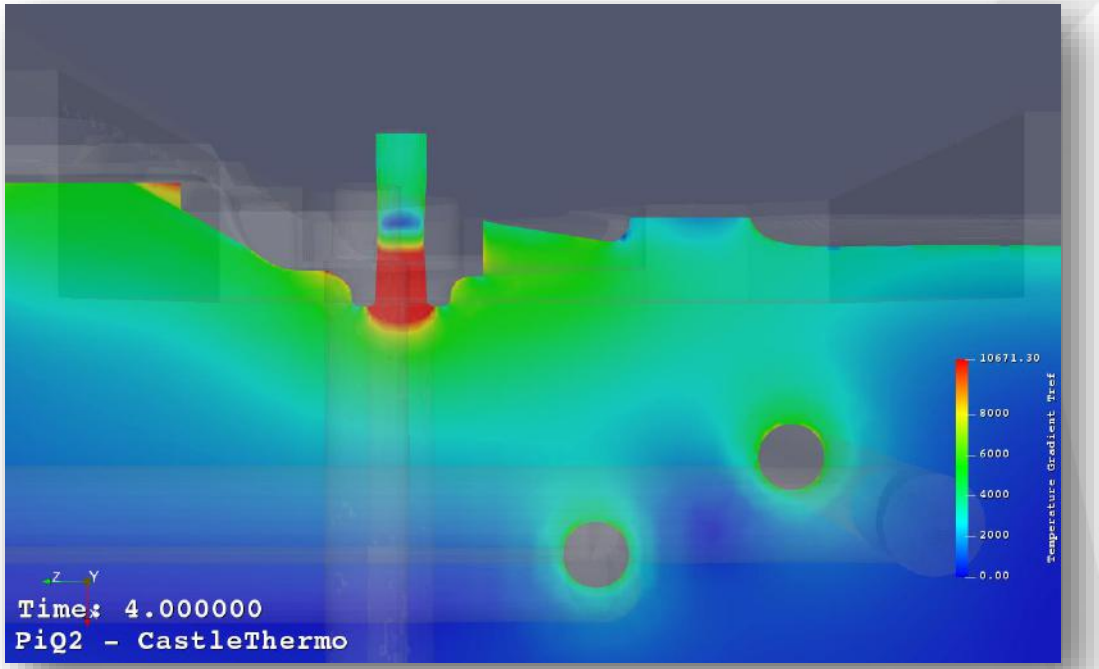
* Courtesy of Bruschi

Zinc Hot Chamber Simulation:

Take care of die life

Yes, moulds are small… but cycle time too! And die spraying is uneffective to remove heat.
When asking for long lasting performaces, thermal balance of the die becomes a matter.





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Courtesy of DYNACAST SOLUTIONS MADE SOLID

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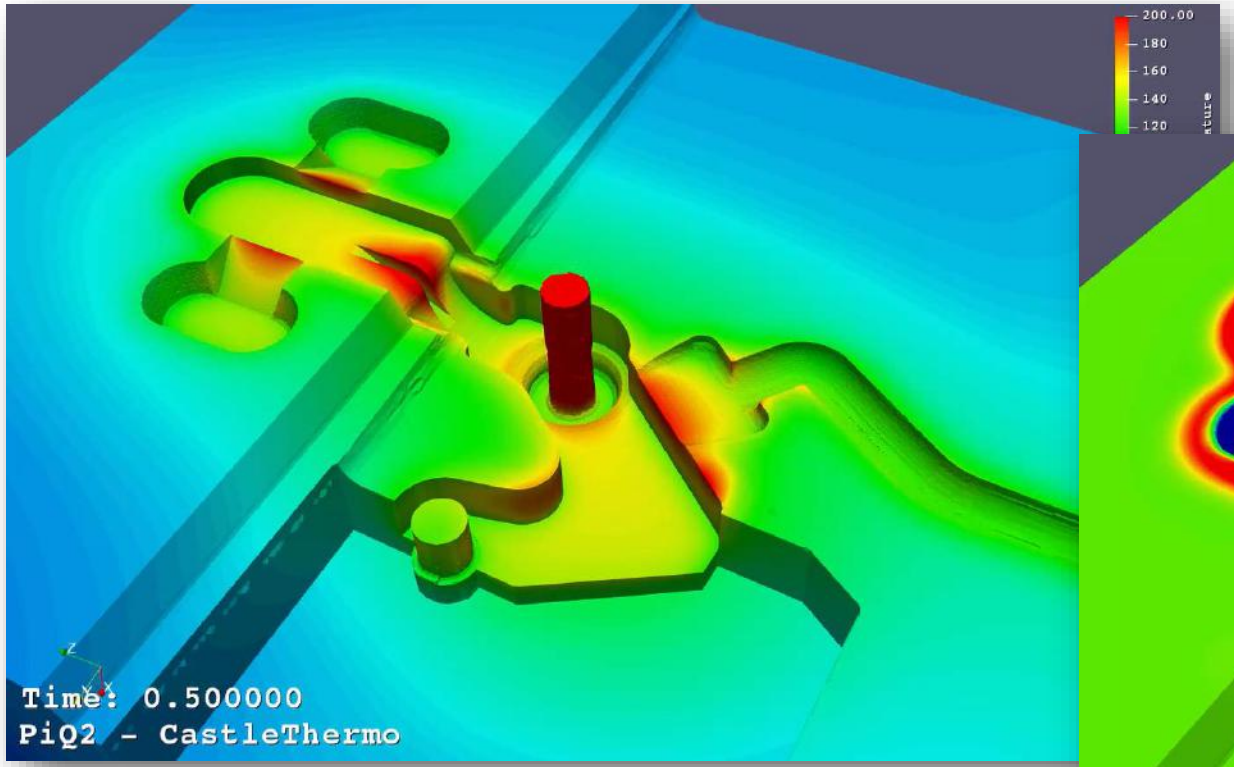
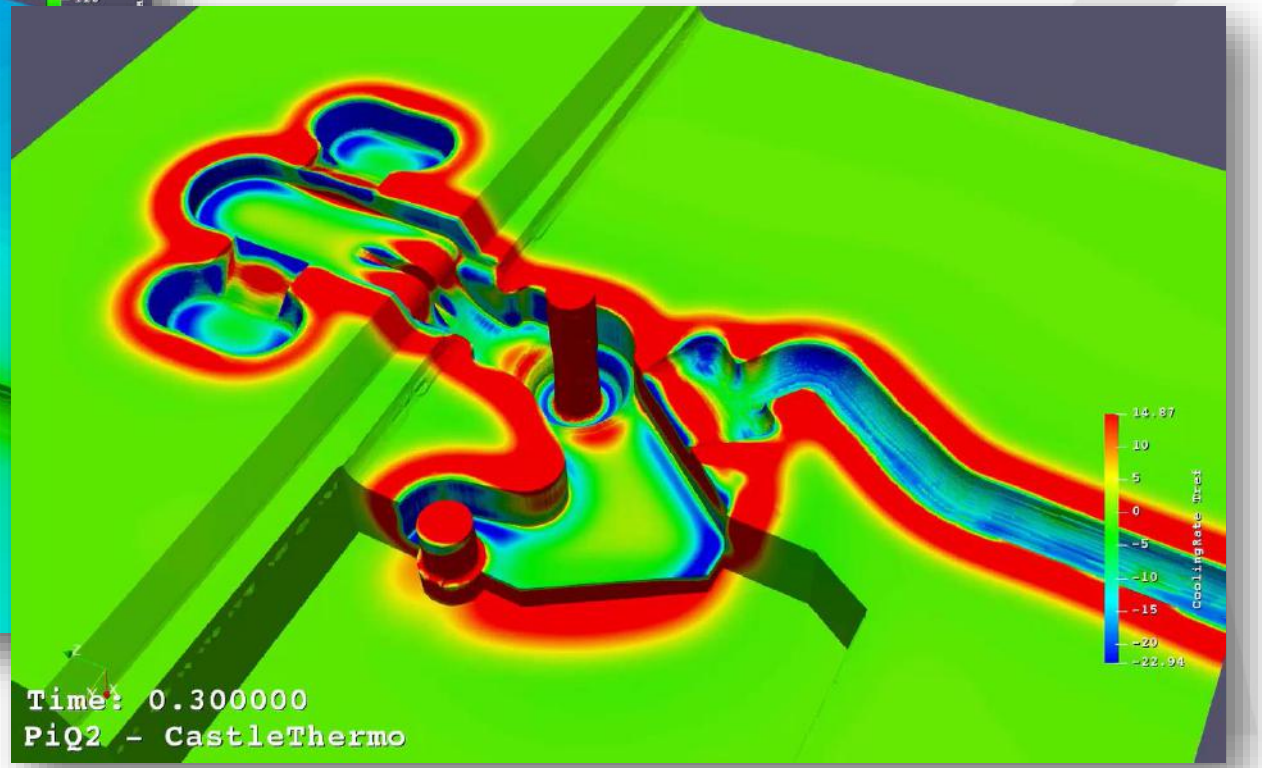


TEMPERATURE

Courtesy of DYNACAST



THERMAL SHOCK

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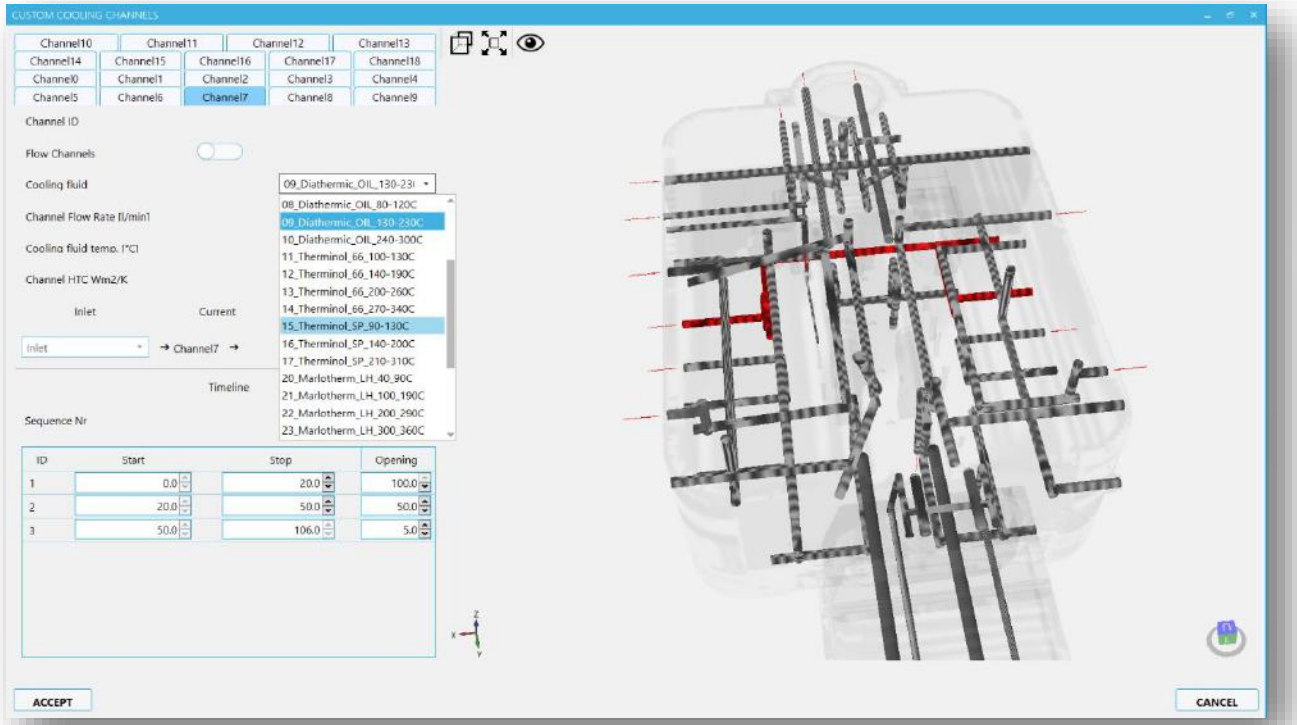
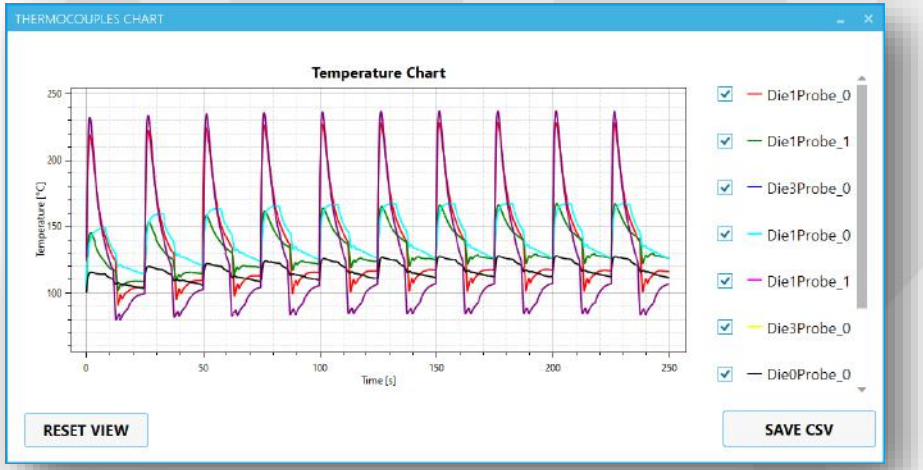
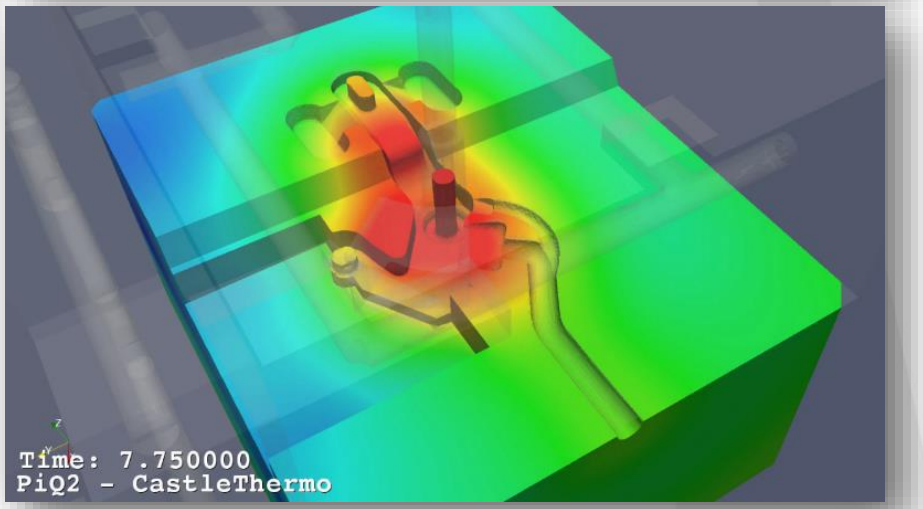
Our solution:

- Simulation of die **thermal behaviour**
- **Thermal management** circuit
- Spraying of **releasing agent**







Courtesy of DYNACAST

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THANK YOU

COSTAMP HPDC

COSTAMP PLASTIC

COSTAMP LPDC & GRAVITY brambilla

P.A.M.A.

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