



Finite Element Analysis of Induction Heating Process Design for SMART Foundry 2020

(SMART=Sustainable Metal casting using Advanced Research and Technology)

Presented By:

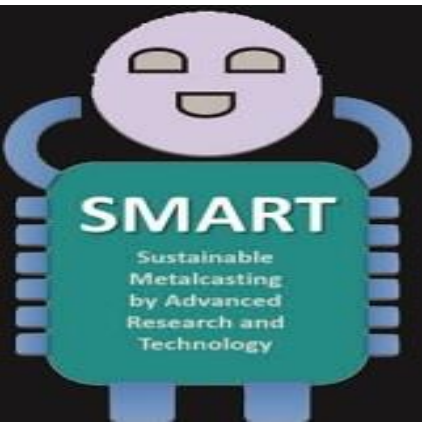
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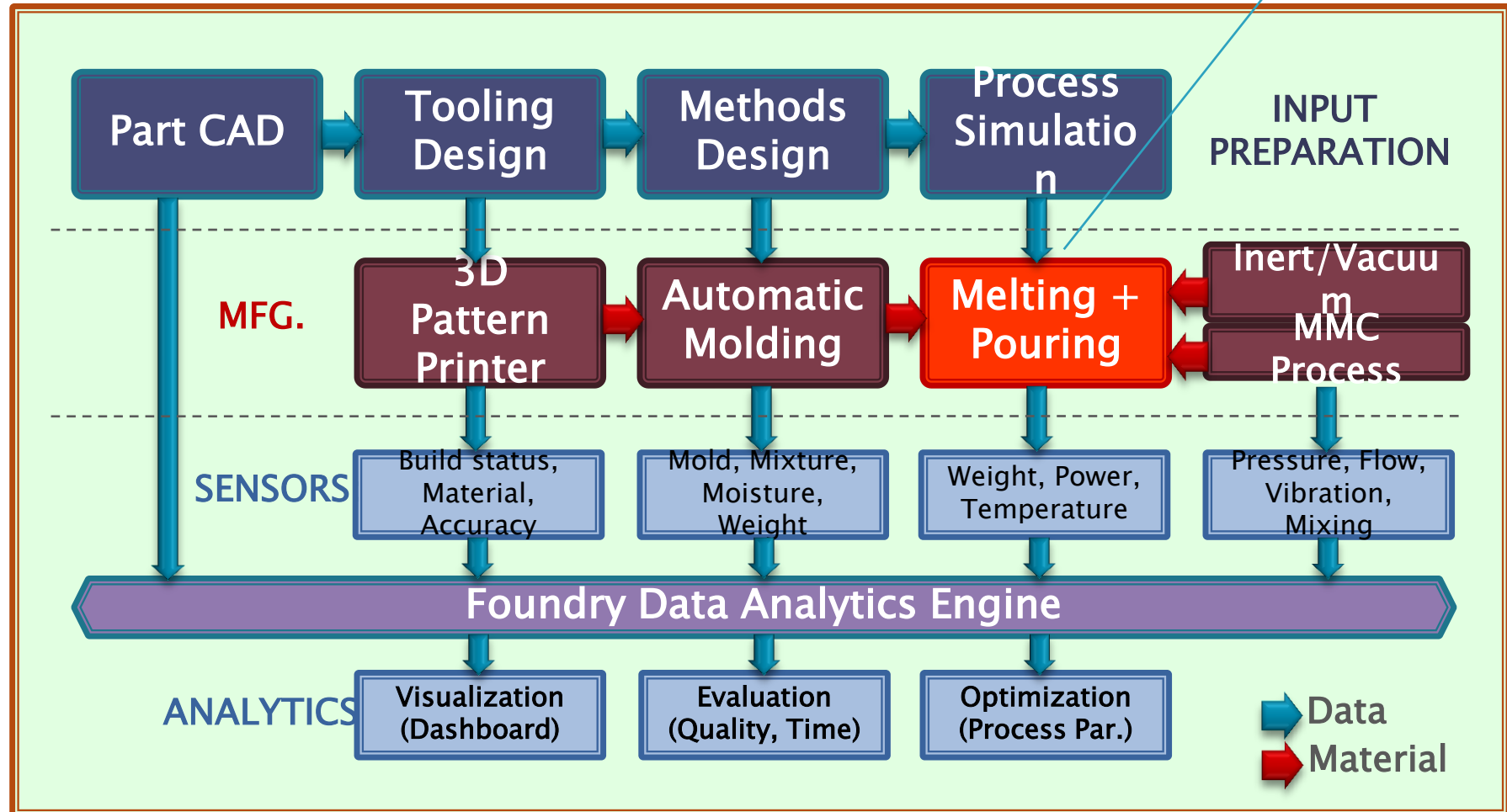
Overview of Presentation

- ▶ SMART Foundary 2020
- ▶ Module: Melting & Direct Casting
- ▶ 3D Scanning for Reverse Engineering
- ▶ Induction furnace @VNIT
- ▶ CAD Model
- ▶ COMSOL Modelling
- ▶ Results & Conclusions



SMART Foundry 2020

COMSOL
Analysis



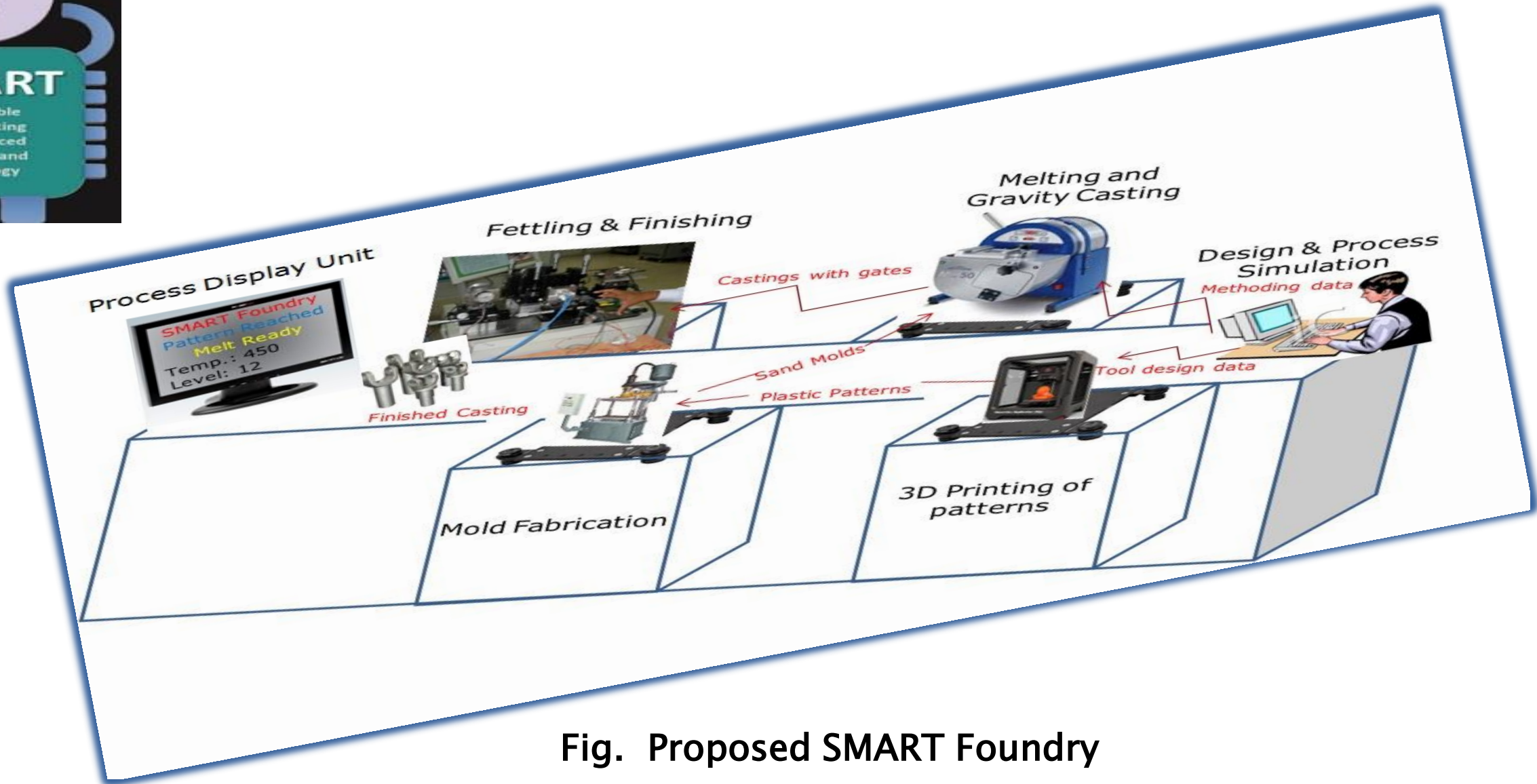
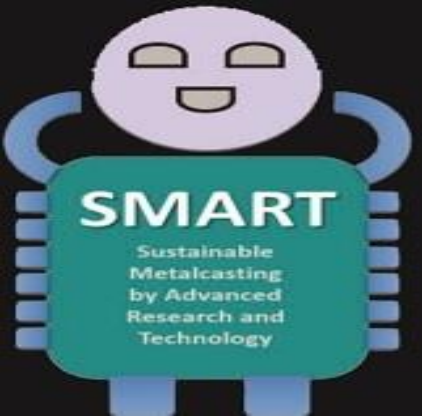
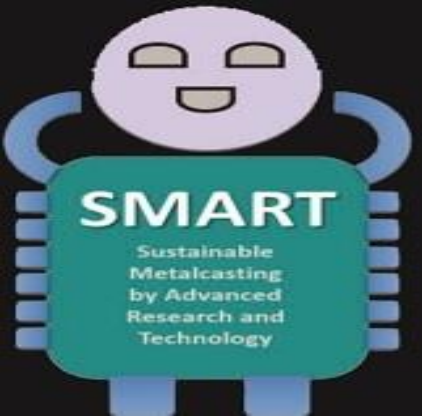
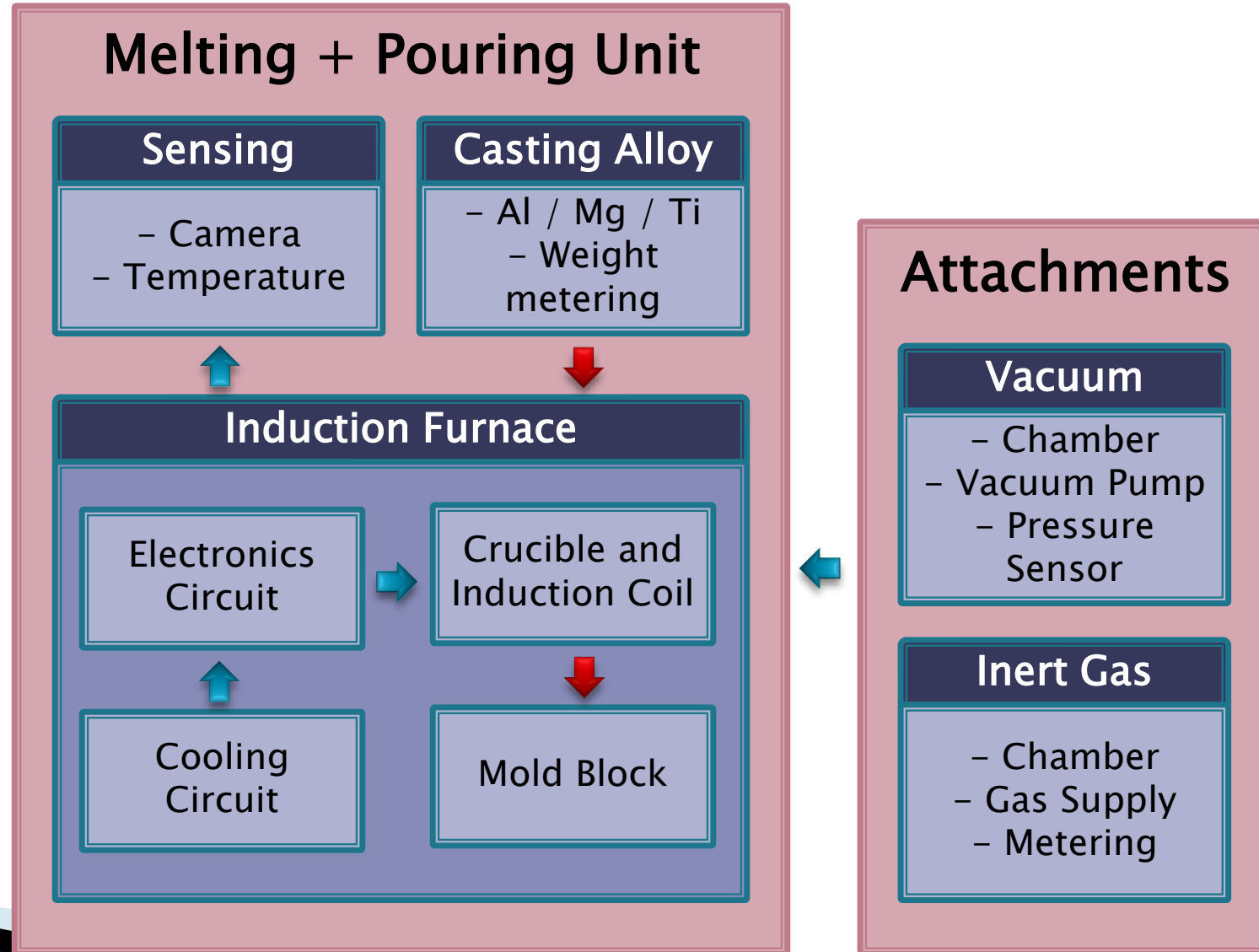


Fig. Proposed SMART Foundry



Module : Melting and Direct Casting





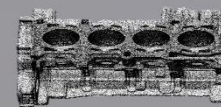
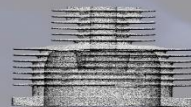
3D Scanning for Reverse Engineering

Creation of 3D models without CAD:
Rapid manufacture of spare parts

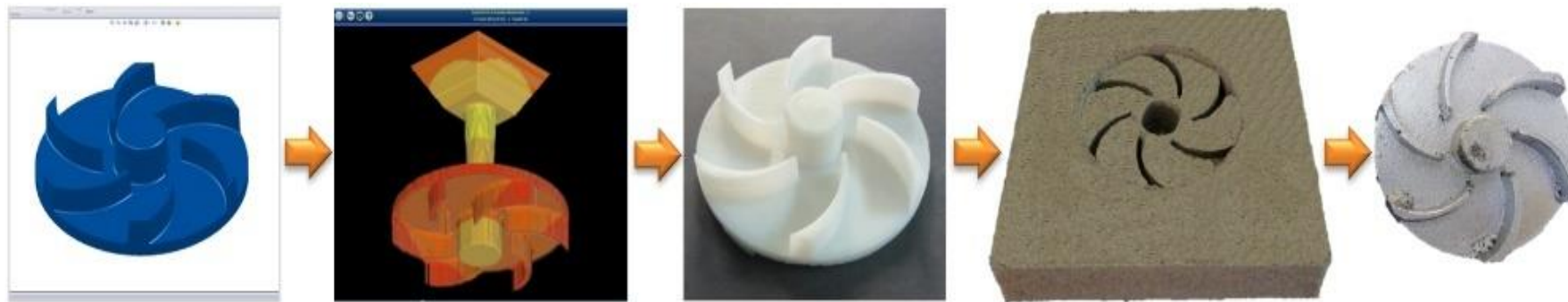


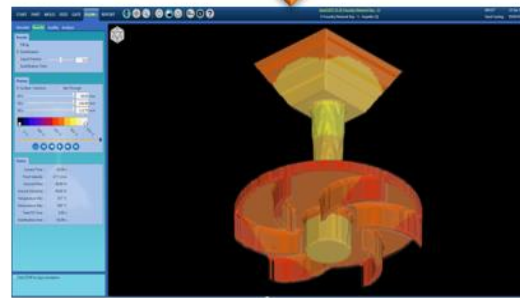
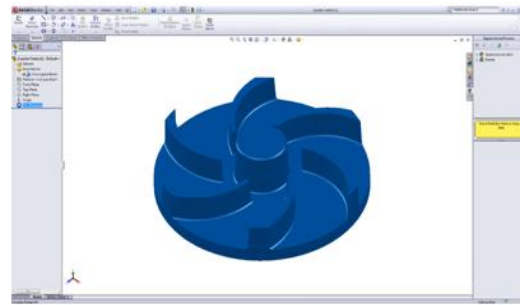
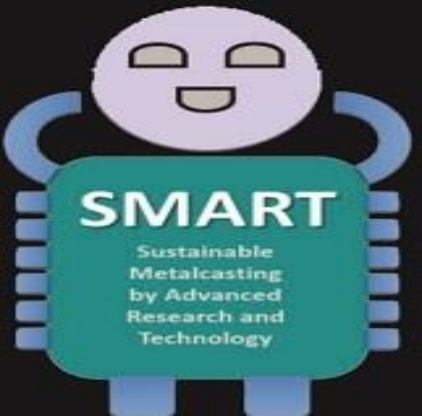
Tripod-mounted systems scanning rotating objects give less than 0.1% error.

Hand-held and phone based scanning is less accurate, but costs much less, making it widely accessible.



Steps:





3D CAD and Simulation



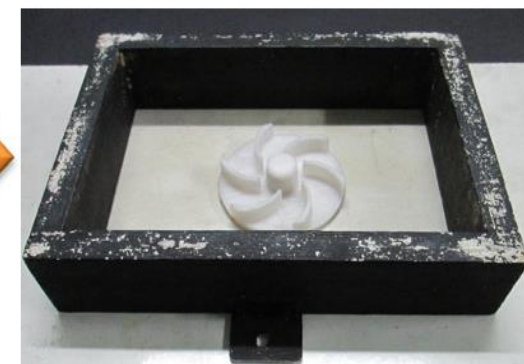
3D Printing



Melting + Pouring



Plastic Pattern



No-Bake Molding



Cast Part

Fig. Low cost rapid manufacturing methodology developed with industry partners

Area to be Explored

- ▶ Melting + Pouring

Induction Furnace @ VNIT Nagpur



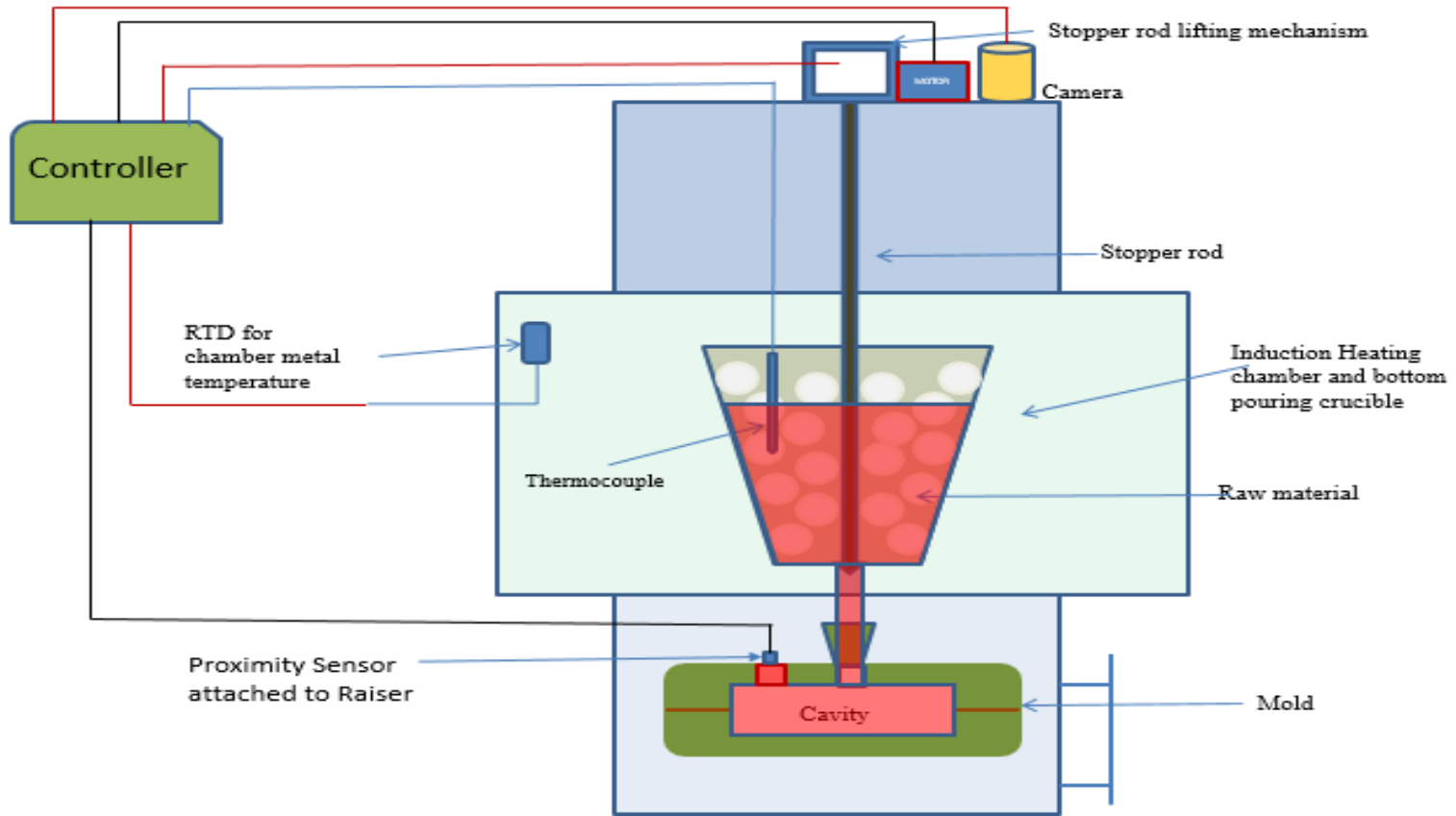
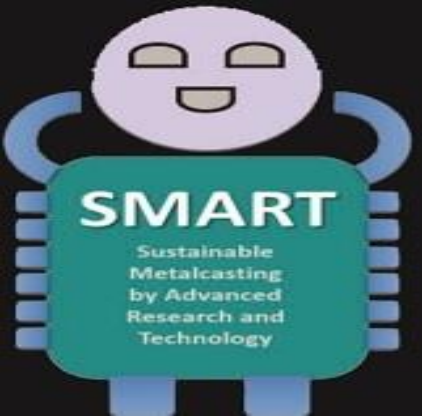
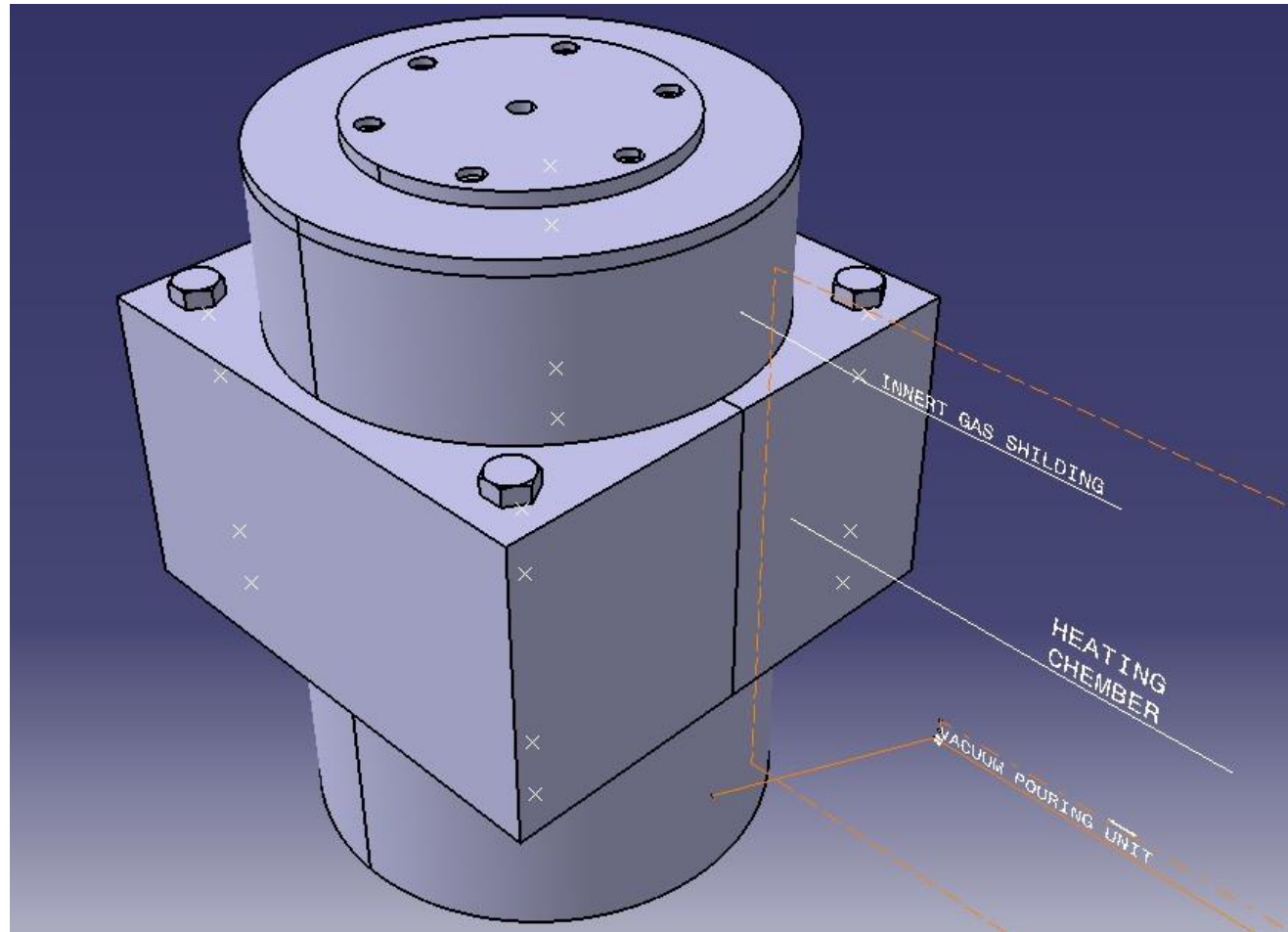


Fig. Induction melting with direct pouring and data acquisition

Induction Furnace CAD Model



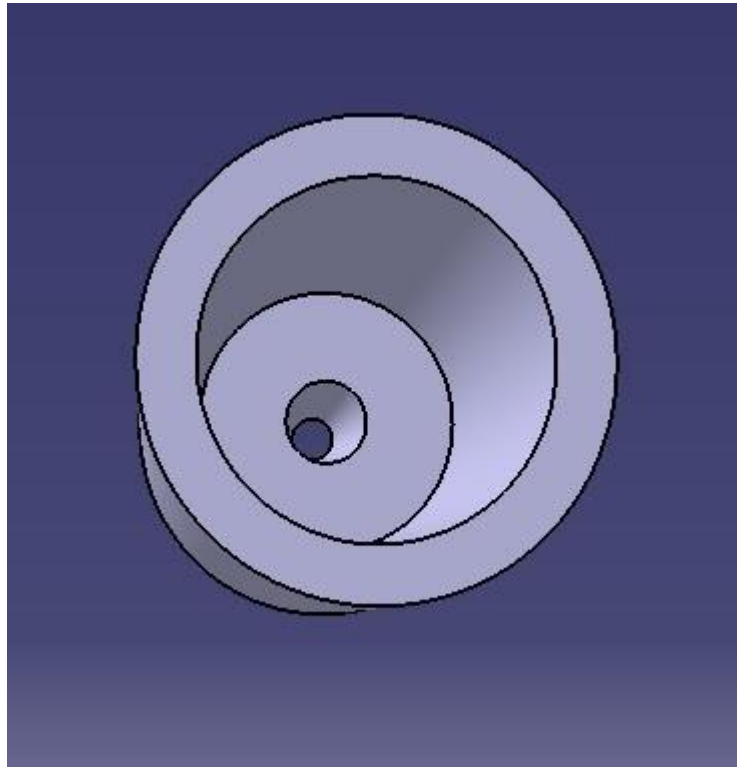


Figure 2 Bottom Pouring Crucible



Figure 3 Crucible with Tapping Rod

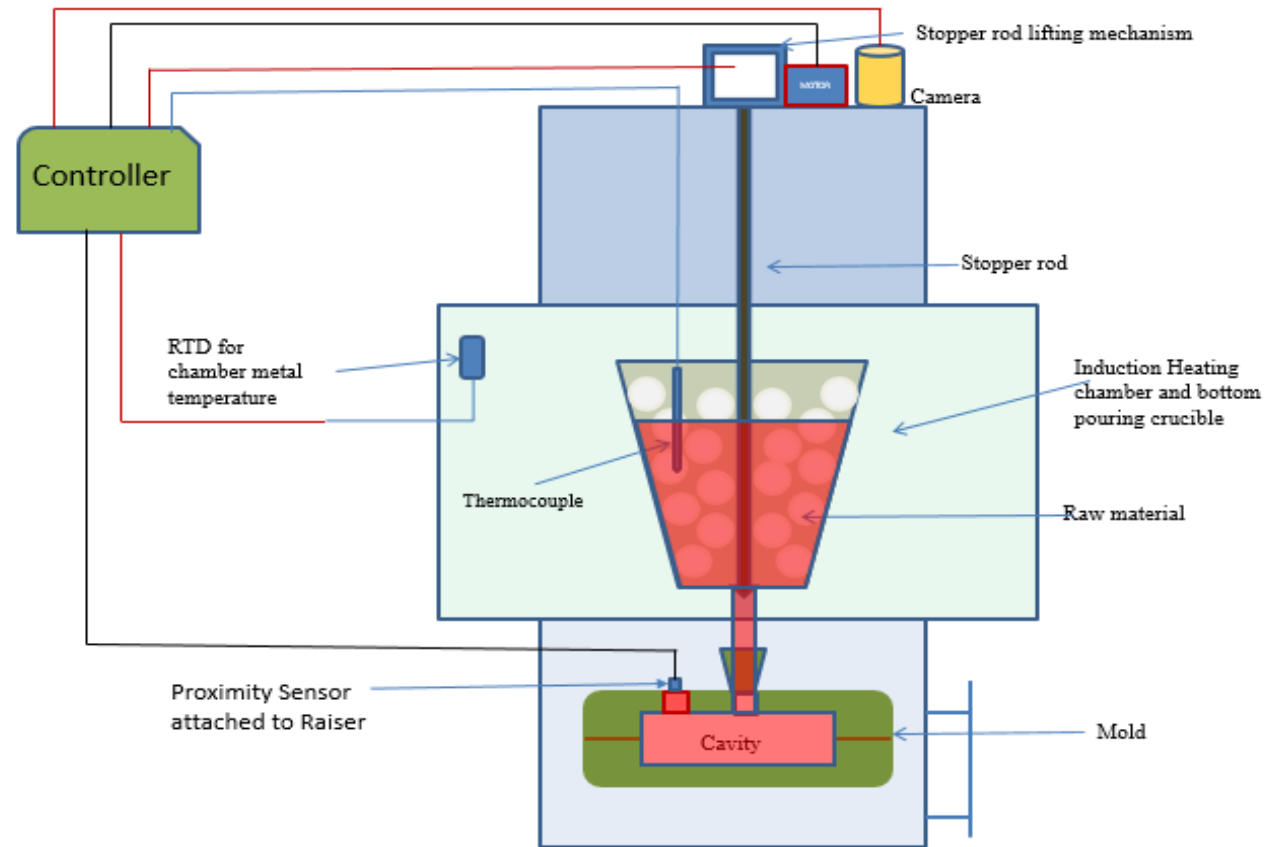
COMSOL

- ▶ Numerical model Validation
- ▶ Main features of the model
- ▶ Geometry & Meshing
- ▶ Governing equations and Boundary Conditions
- ▶ Numerical results
- ▶ Conclusions

It is a high temperature vacuum distillation furnace used for recovery of heavy metals

Functions :

- Melt and consolidate of heavy metals
- distill the volatile metals and salts
- operate in inert containment box
- heat reasonably fast while being capable of holding temperature



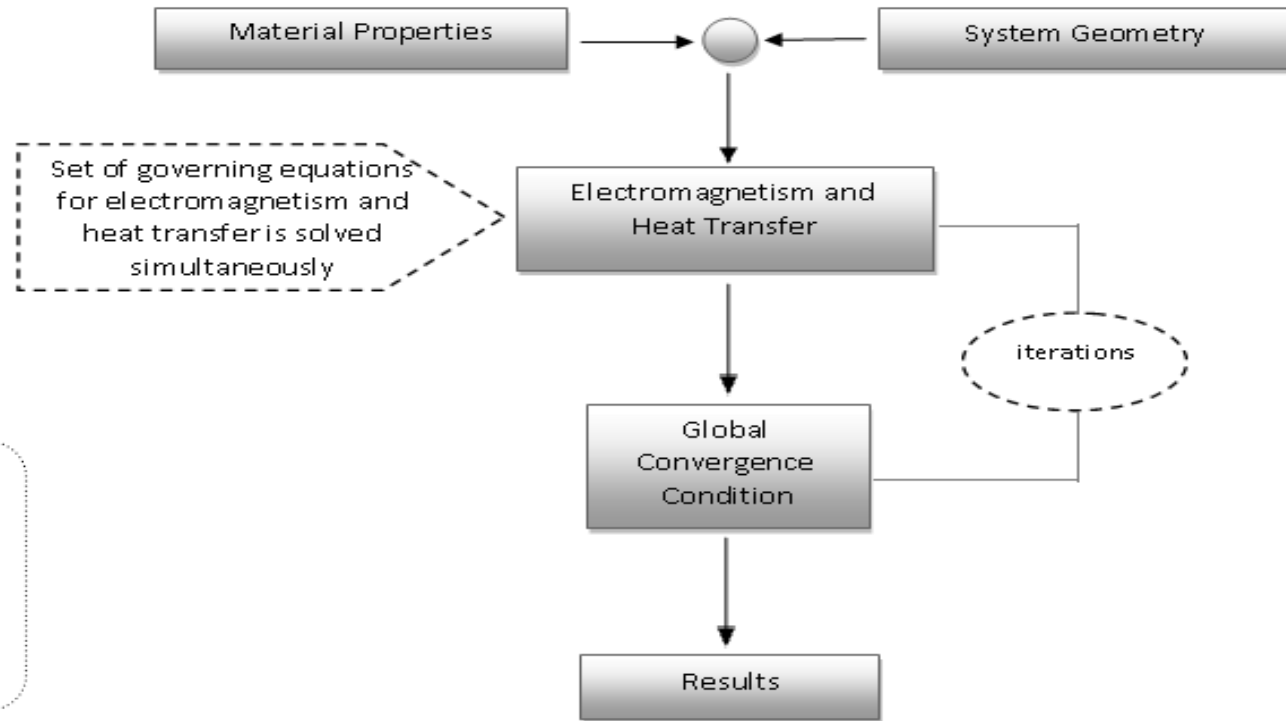
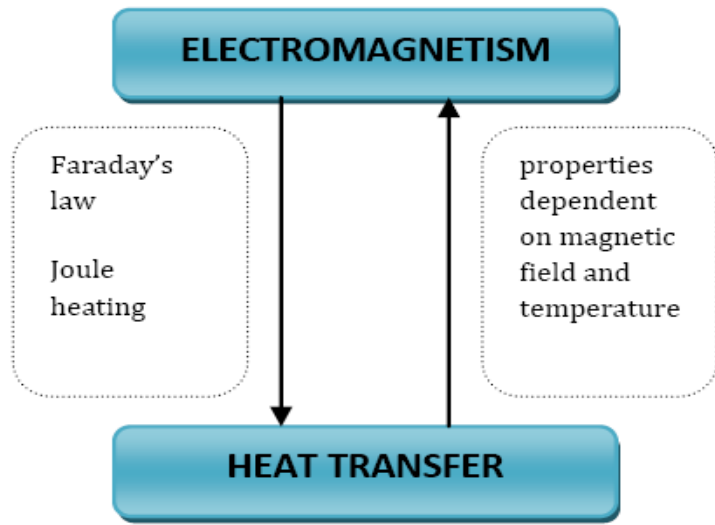
COMSOL Modelling

COMSOL Modules

- Tightly coupled phenomena

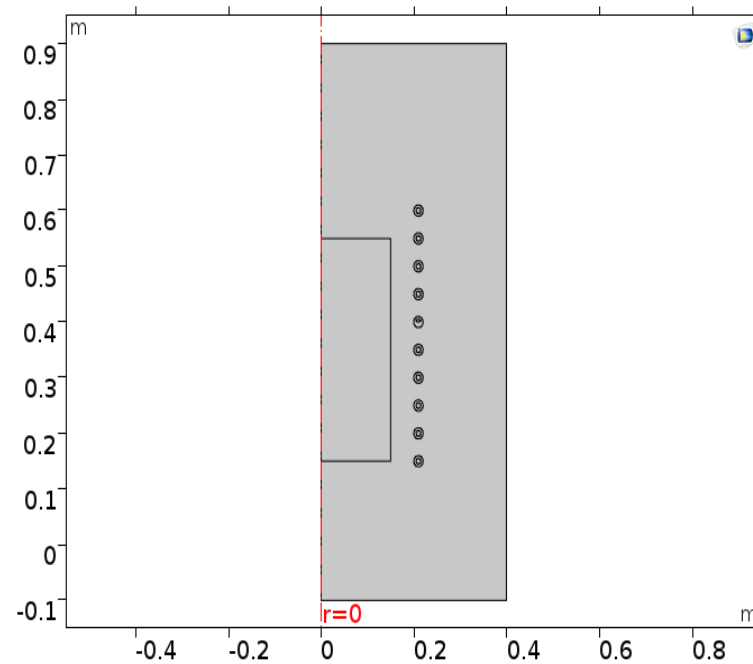
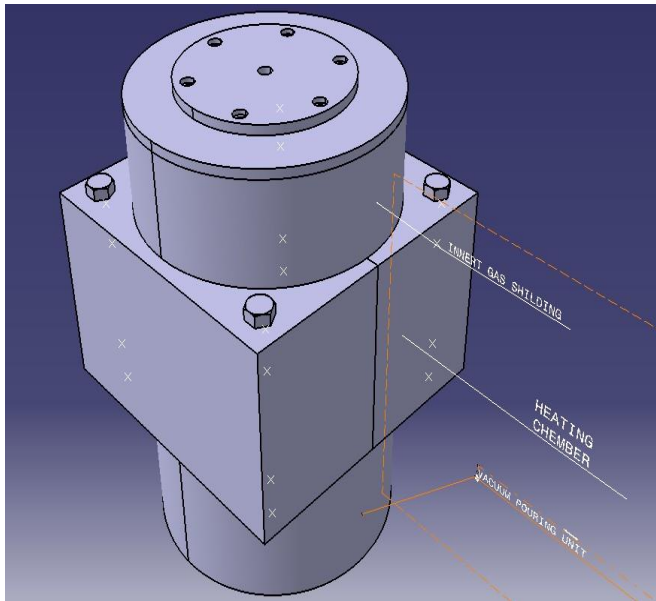
- Non linear

$\mu(T, \omega)$, $\sigma(T)$, $C(T)$, $k(T)$

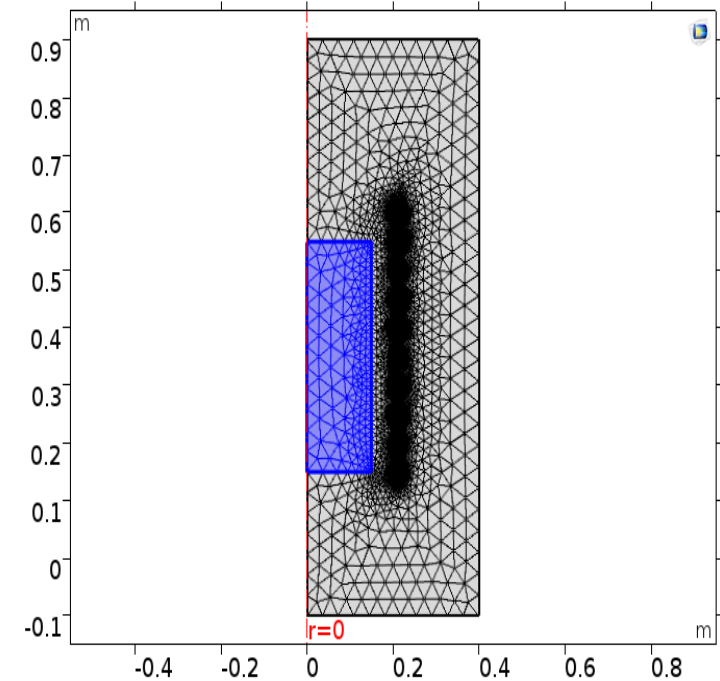


Geometry in COMSOL

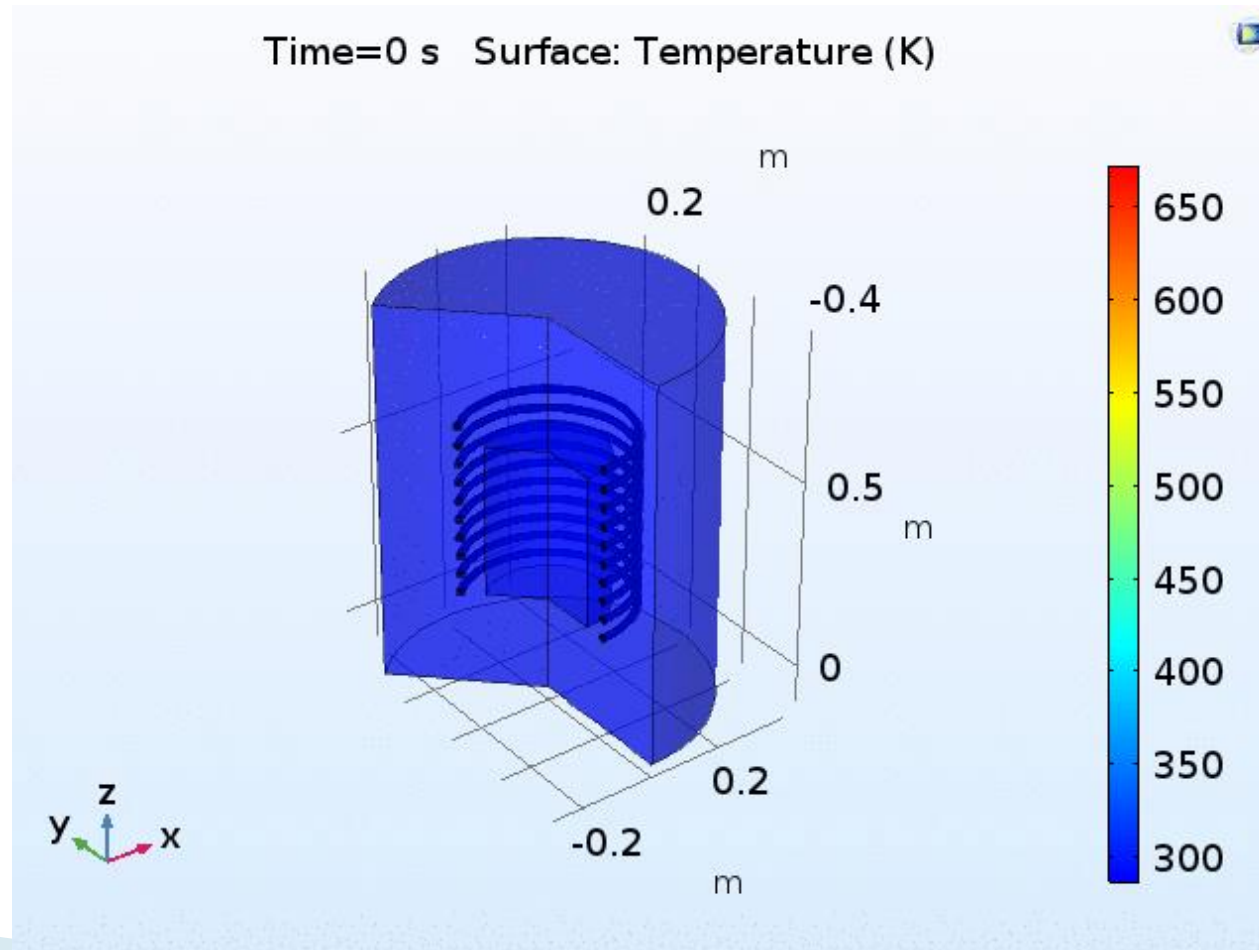
2D Axis Symmetric



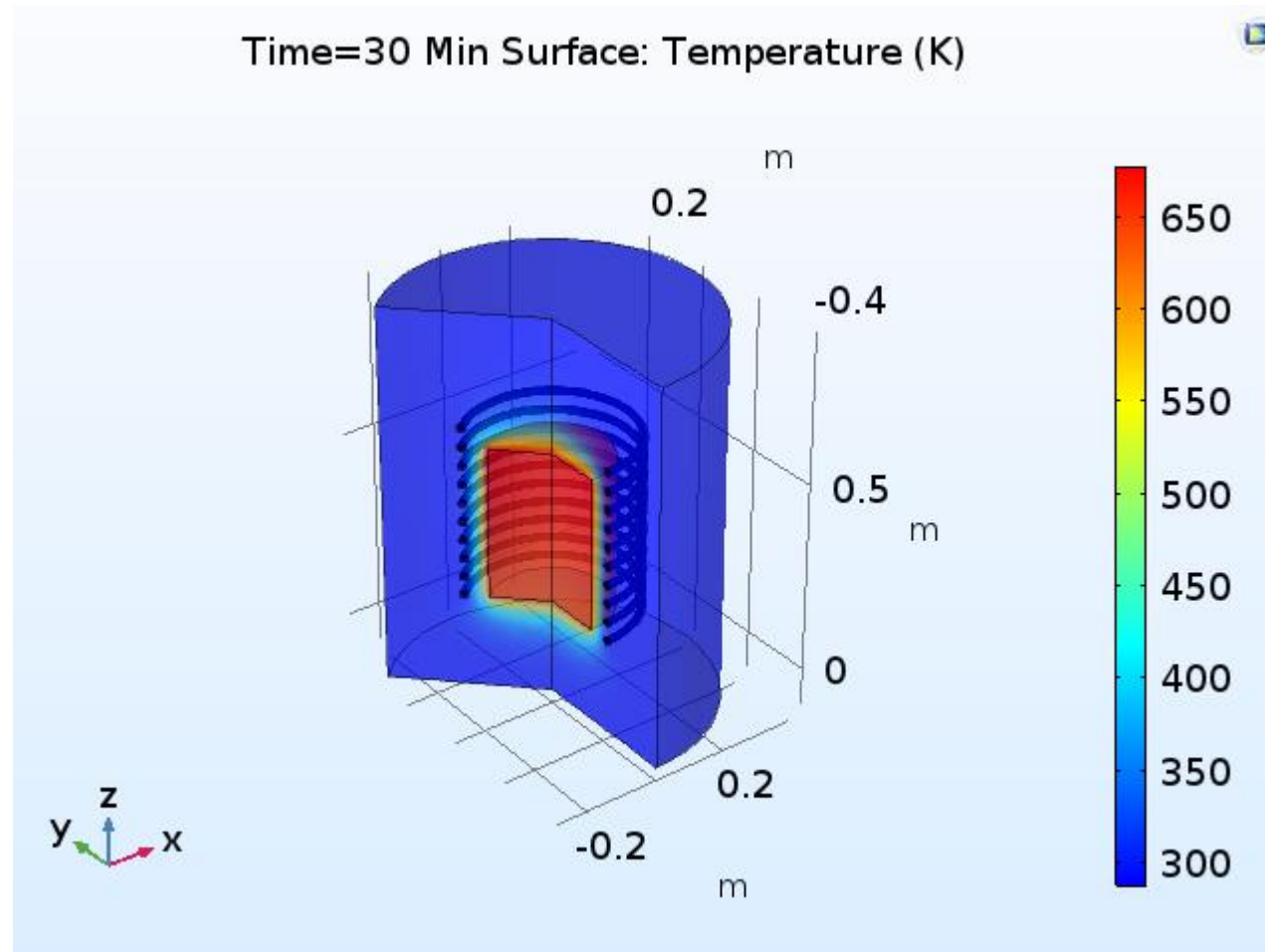
Fine Meshing



Temperature Profile



Temperture Profile



Conclusions

- ▶ Transient Thermal analysis of mock-up induction furnace is being carried out in this study which is highly important for operation and control of the process.
- ▶ Preliminary model : it will aid in improving the design.
- ▶ The results of this study have shown that the temperature of the crucible rises to 650 oC in 30 min of heating time at frequency of 60 Hz and current of 22amp. Aluminium is likely to melt under these conditions.
- ▶ The coil temperatures are above the acceptable temperature of Al material, hence different cooling technique is to be adopted.
- ▶ These results will be compared with the experimental results which will be obtained during the operation of mock up facility.

Thank You !