POLITECNICO
DI TORINO
Dipartimento Energia
"Galileo Ferraris"

MAG-2.4-T007-D002
(*Extra*)
Sizing and preliminary design of feeders

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EUROfusion

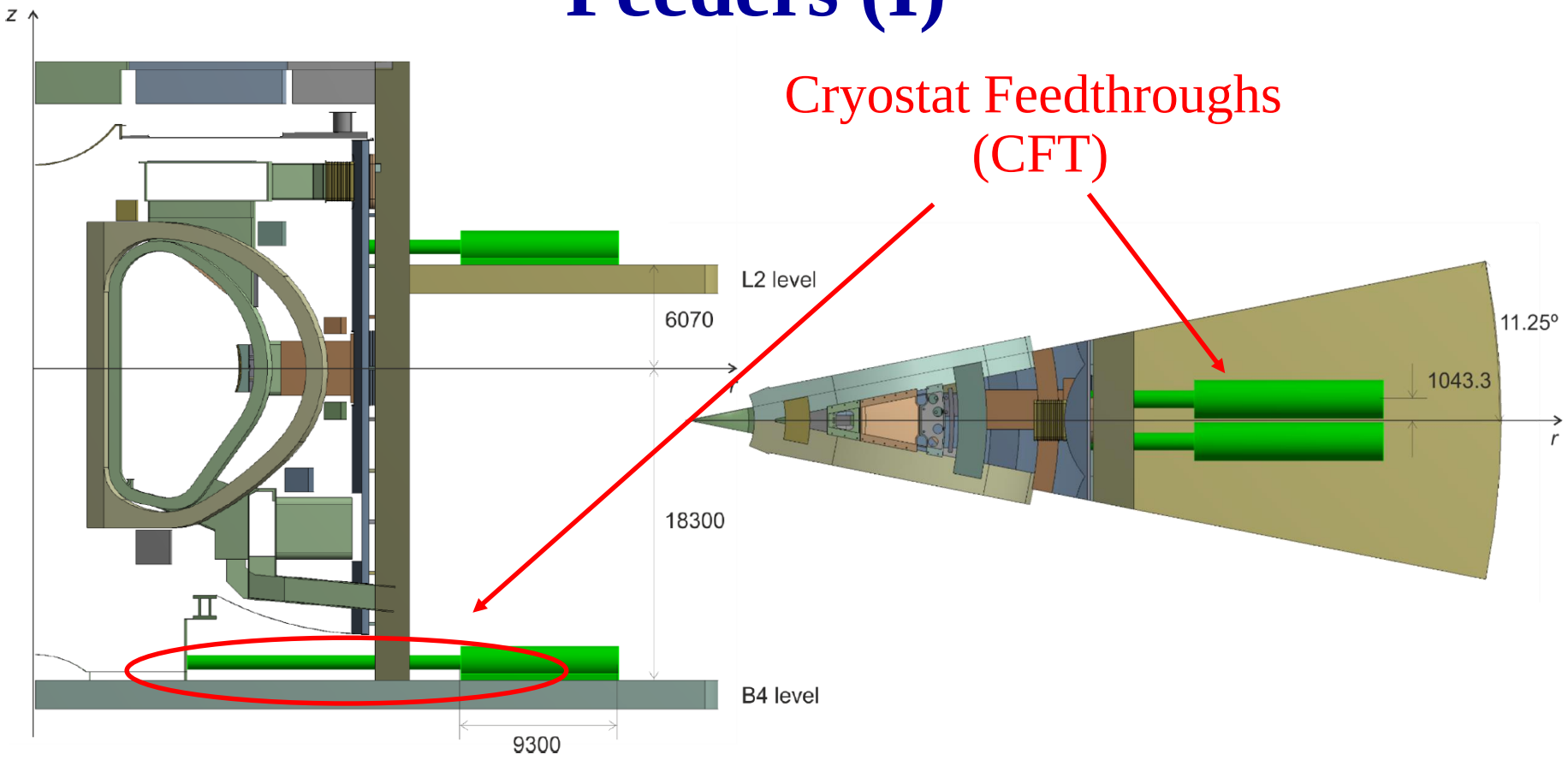
Focus of the activity

Support for the activity carried out at SPC:

- **Feeders:** Evaluation of the heat load to He lines along the Cryosat FeedThroughs

- **Current Leads**: Evaluation of heat transfer in the heat exchanger

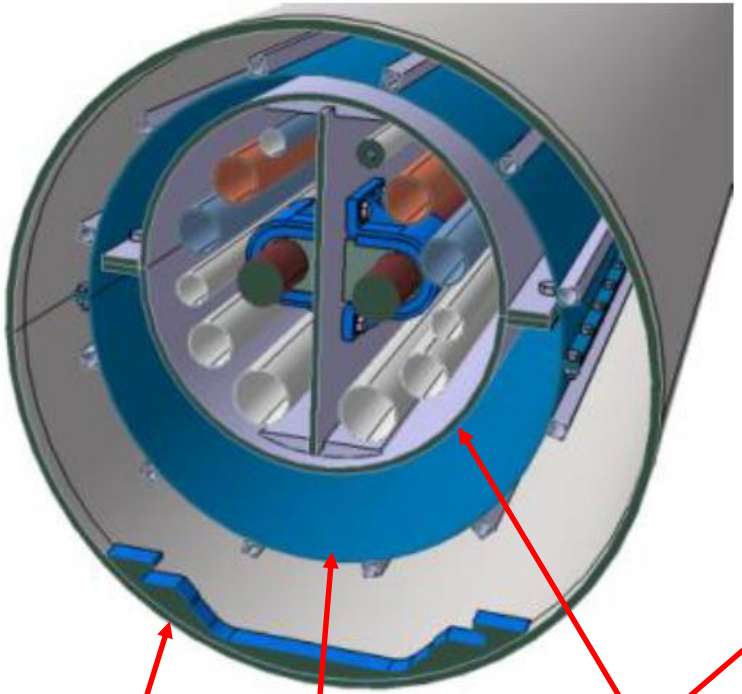
Feeders (I)



The details of the cross section is still to be defined → we refer to ITER design

Feeders (II)

ITER design



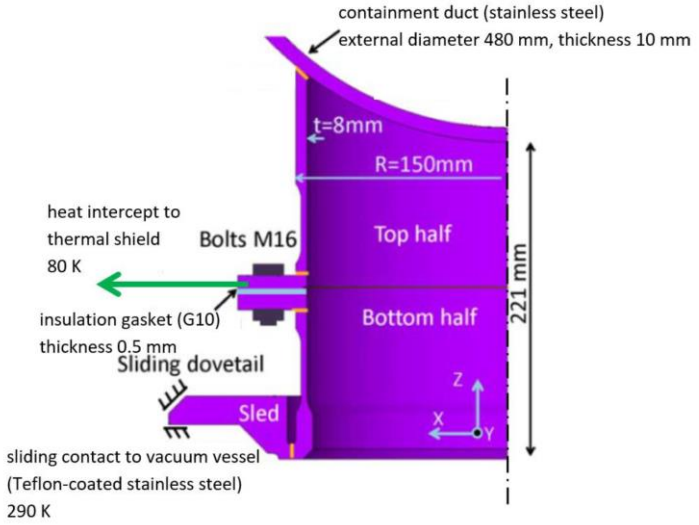
Containment Duct

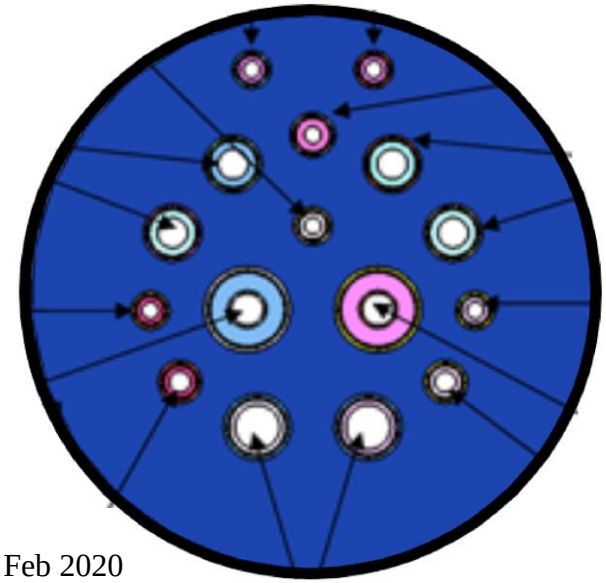
Thermal Shield

Vacuum Duct

Vacuum Barrier

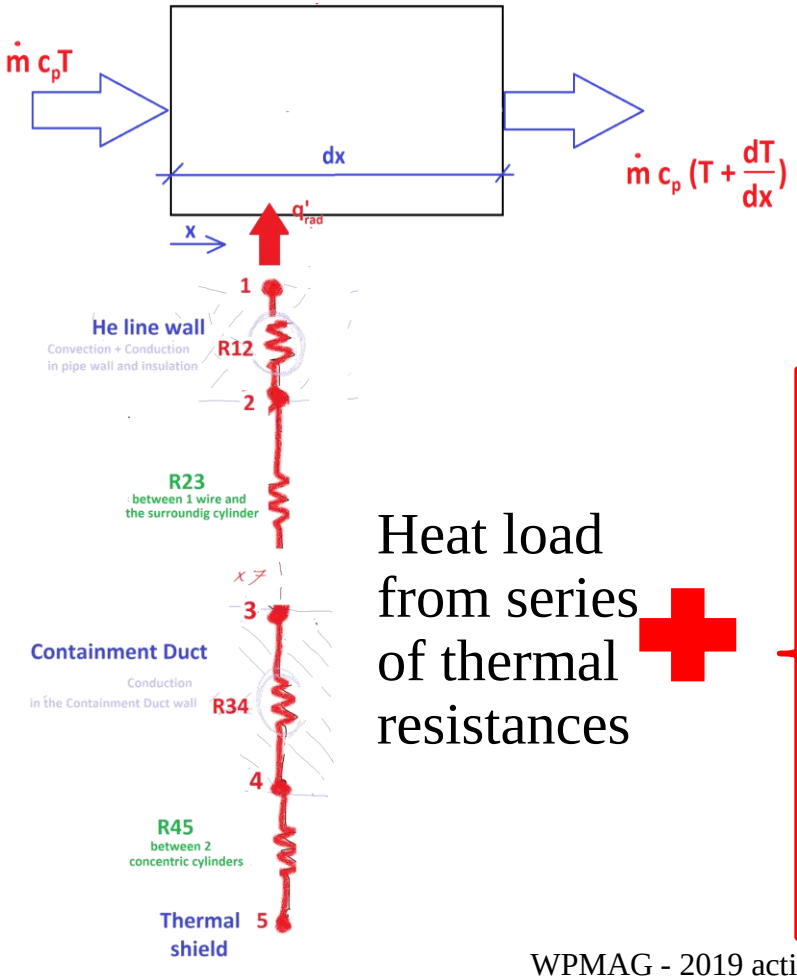
Cold mass supports



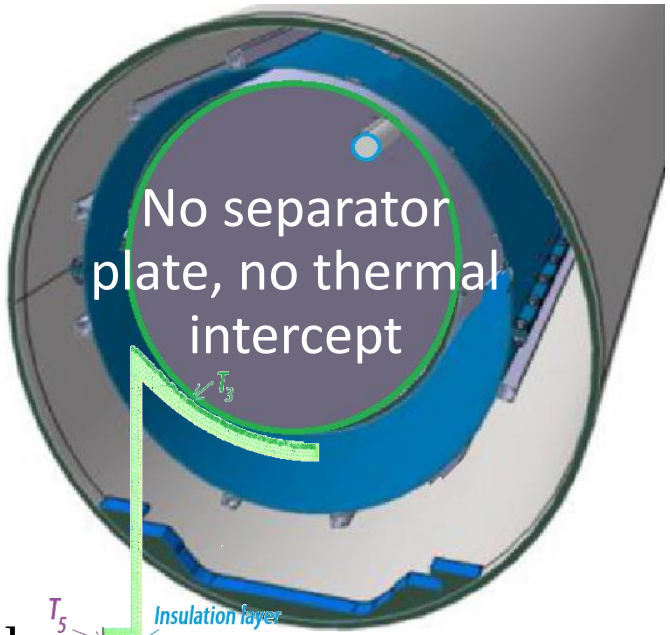


Thermal analysis of feeders (I)

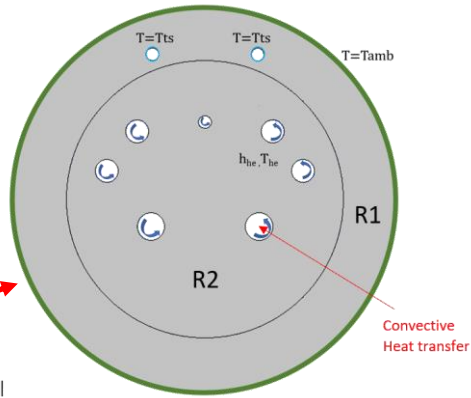
- For the He along the He feeding line for TF, simple enthalpy balance



Heat load from series of thermal resistances



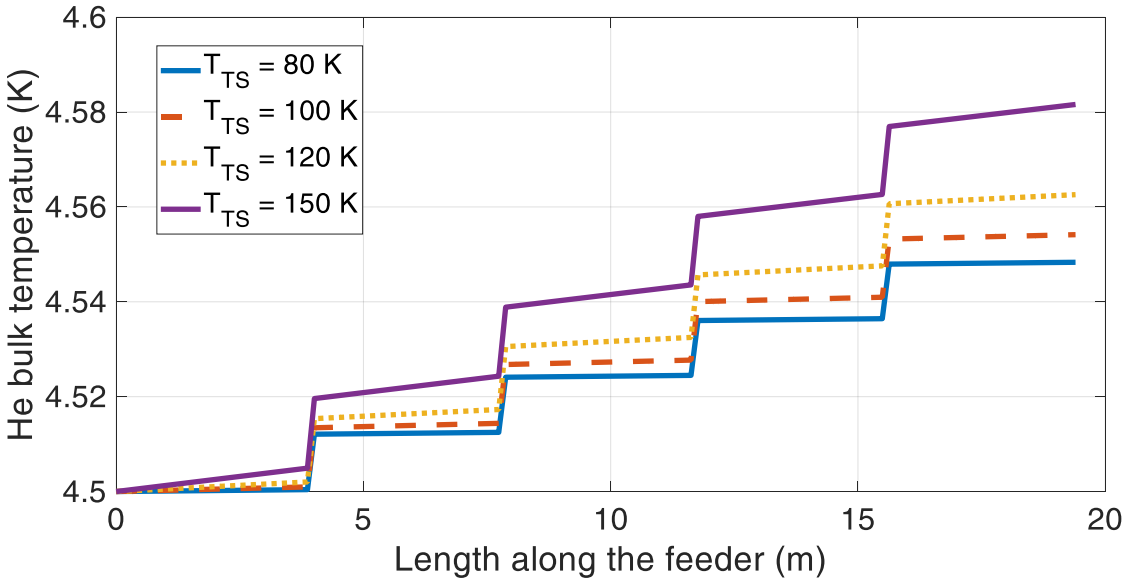
- Local contribution due to Cold mass supports (2D conduction)



- Local contribution of Vacuum Barrier

Thermal analysis of feeders (II)

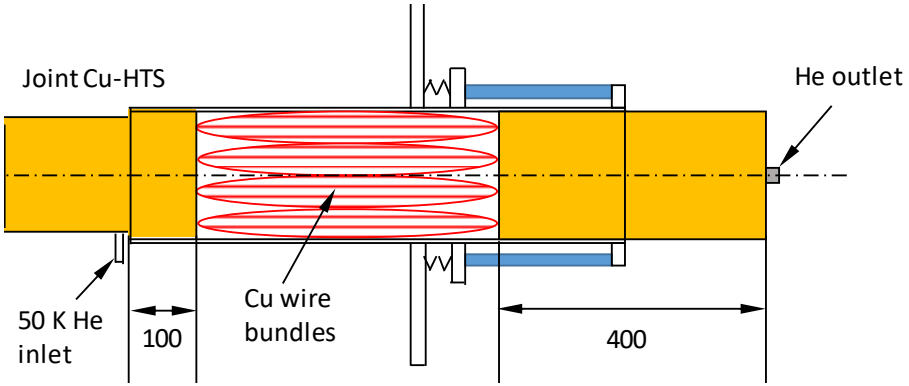
- Contribution of the Vacuum Barrier too high O(100 W) → need for a **Thermal Intercept** that would cool down the entire barrier to the temperature of the Thermal Shield, as done in ITER
- For a mass flow rate of ~ 100 g/s, T increase of ~ 0.05 – 0.08 K to He lines → need for **separator plate / thermal intercept in the CD** (currently at a temperature ~ T_{TS})

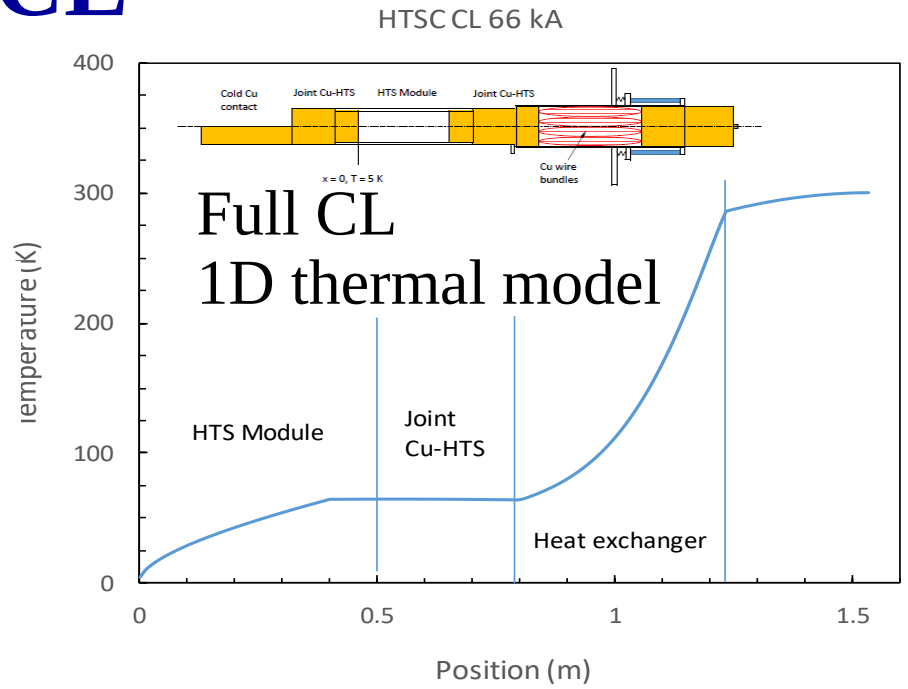


To be continued in 2020…

Thermal-hydraulic analysis of HX of the CL

1D tehrmal model of CL HX based so far on heat transfer correlations

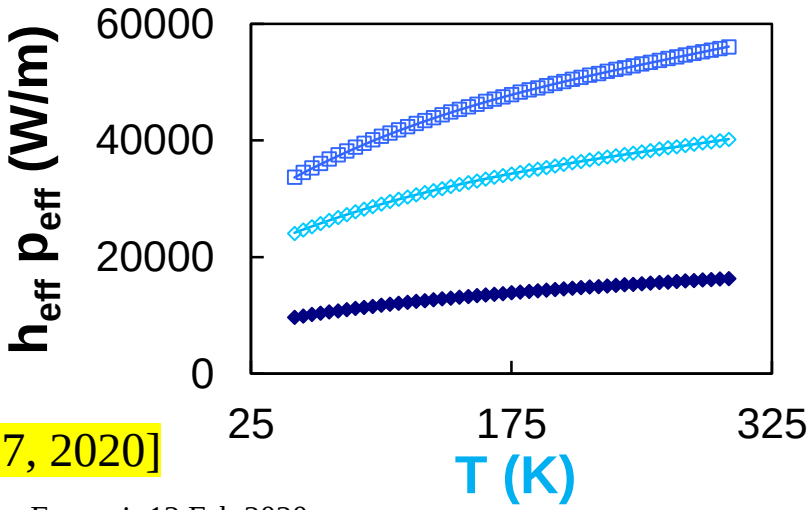




$$Nu(T, \dot{m}_{He}) = \left(0.4\, Re^{0.5} + 0.2\, Re^{\frac{2}{3}}\right) Pr^{0.4}$$

(Nusselt packed-bed correlation)

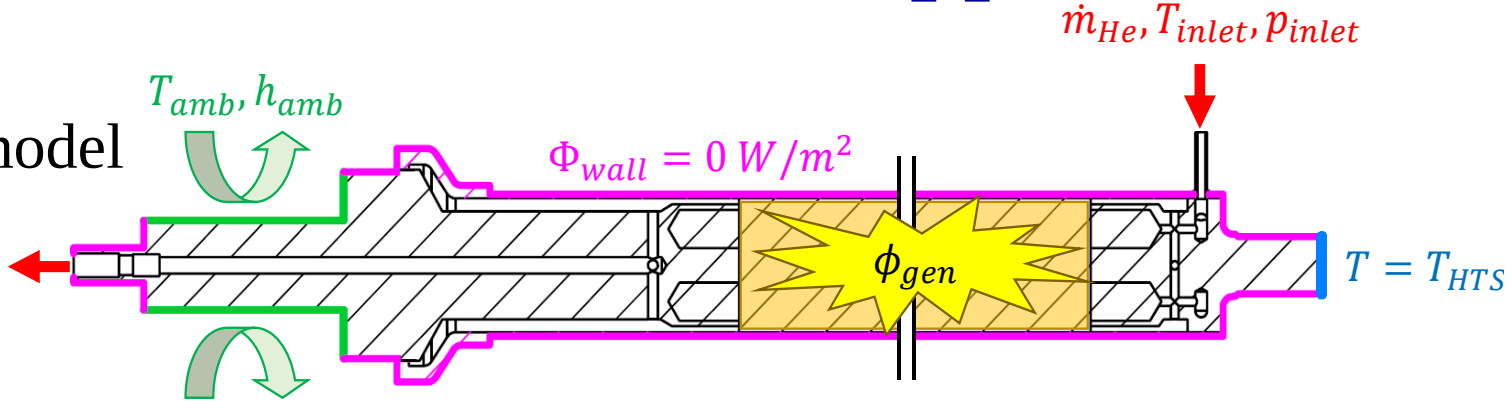
$$h_{eff} p_{eff} = f(Nu) = f(T, \dot{m}_{He})$$

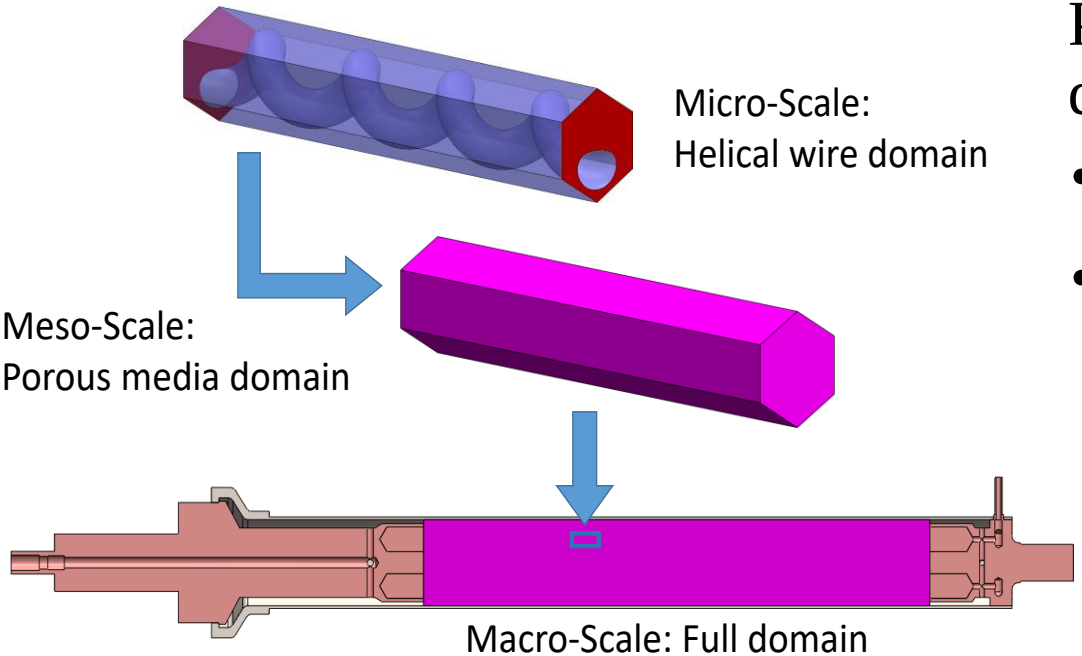


[R. Guarino. R. Wesche, Final report MAG-2.4-T007, 2020]

3D model of HX – CFD approach

HX section model





Porous medium CFD model definition

- ΔP characterization ✓
- Thermal characterization ($T_{He} \neq T_{Copper}$) ***To be done in 2020…***

Model-based correlations for $h_{eff} p_{eff}$

Thank you for your attention!