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John Doe provisional
left main stenting

European Bifurcation Club



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Case description

LM predilation

3.0 x 10 NC Hiryu (20 atm)

Stent deployment in LM-LAD

3.0 x 23 Xience Prime (12 atm)

POT

4.5 x 10 NC Hiryu (14 atm)

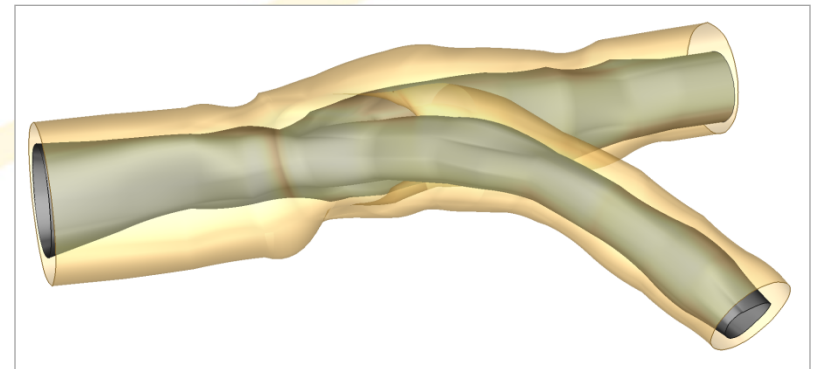
Kissing inflation (14 atm)

3.5 x 10 NC Hiryu in LAD

2.5 x 10 NC Hiryu in LCX

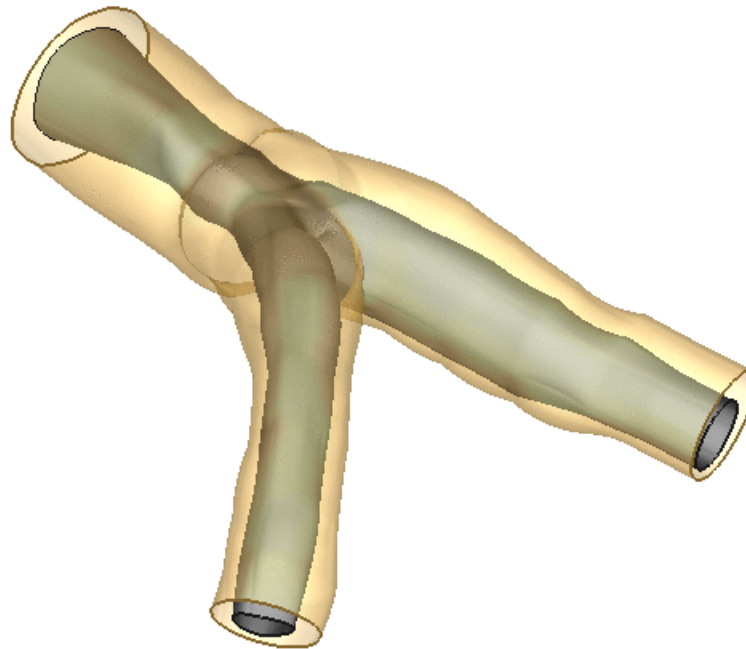


(Rotterdam)





Three-dimensional LM model

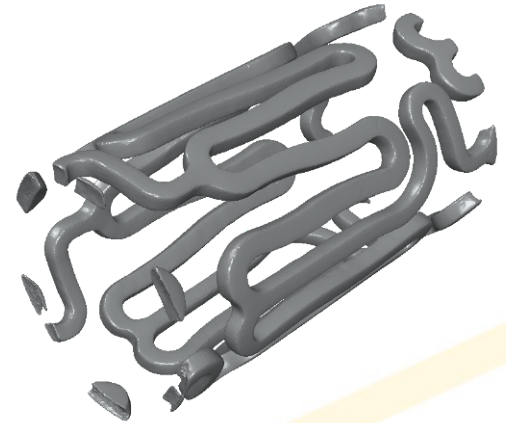




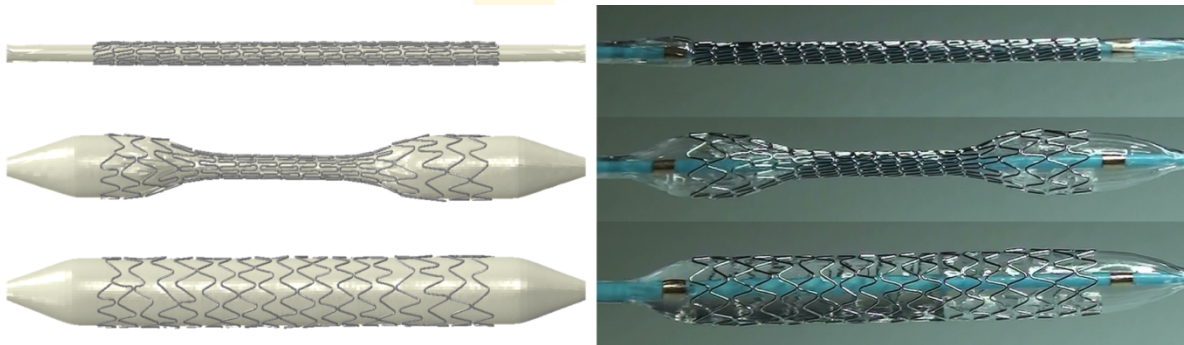
Validated device models

An accurate model of the Xience Prime was created using high resolution microCT scanning

The virtual compliance of all balloon models matches the real compliance behaviour



microCT scan (1 μ m resolution)



simulated deployment



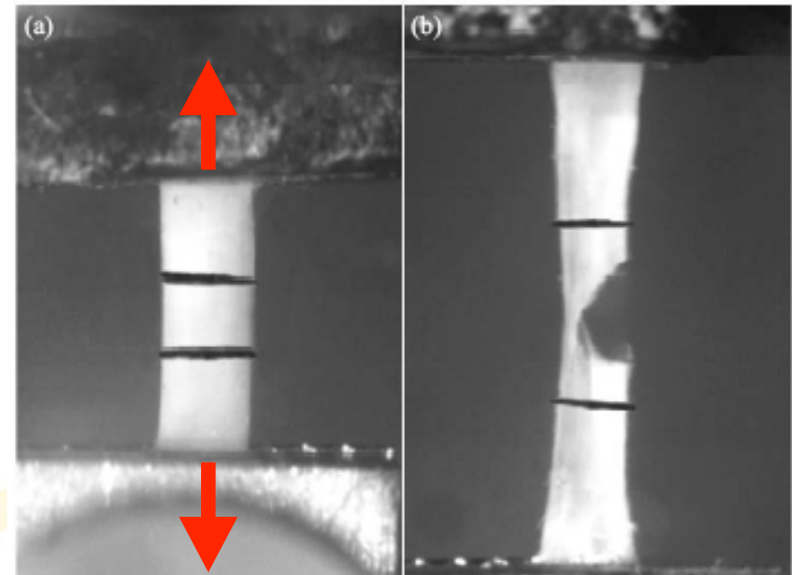
real deployment

Mechanical behaviour of the vessel wall

Different mechanical properties were assigned to the individual arterial layers and to the plaque

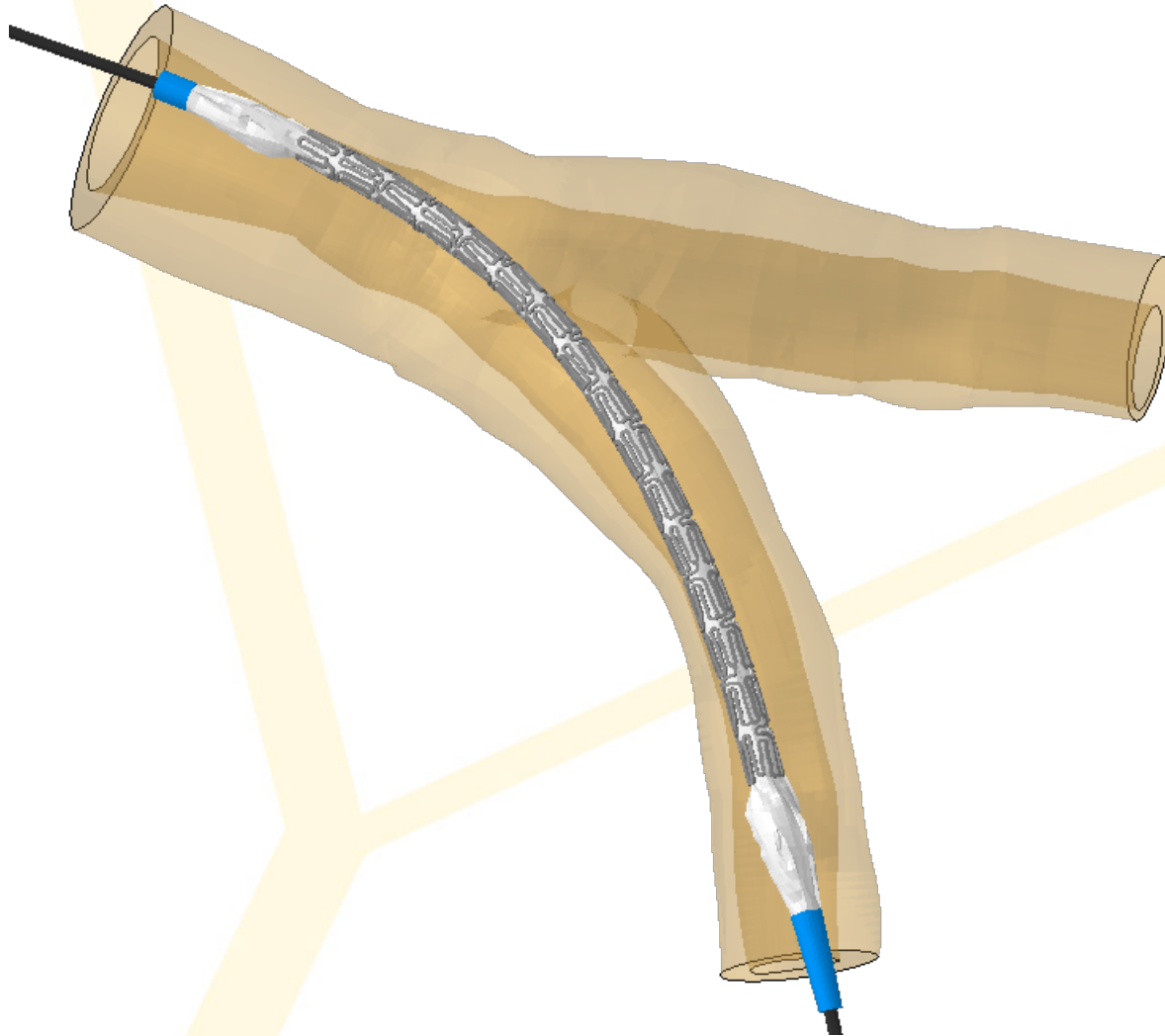
These properties were obtained by performing uniaxial tensile tests using 13 postmortem LAD arteries (Holzapfel et al., 2005, Am J Physiol Heart Circ Physiol)

The average mechanical behaviour was used

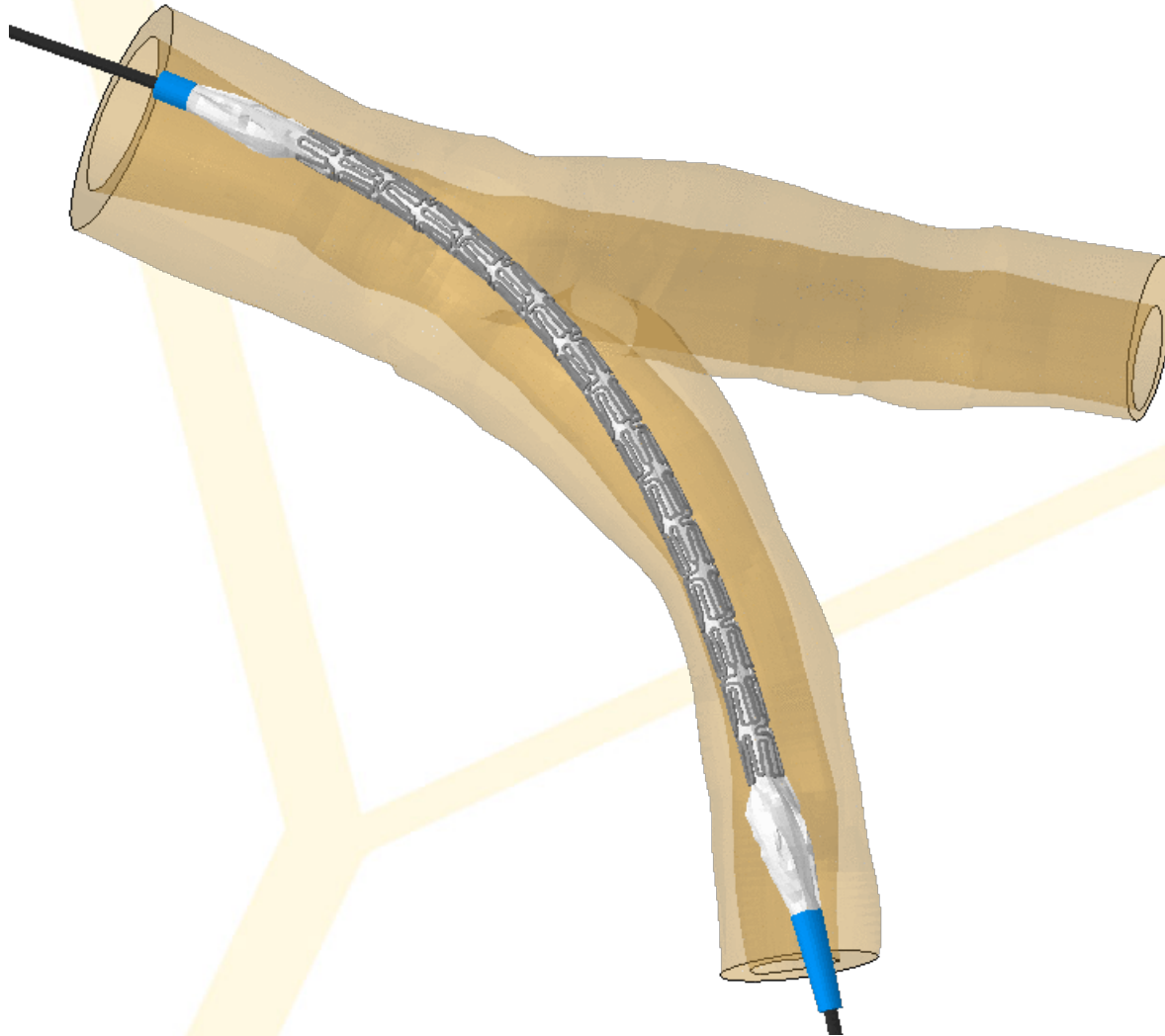


Courtesy Prof. G. Holzapfel

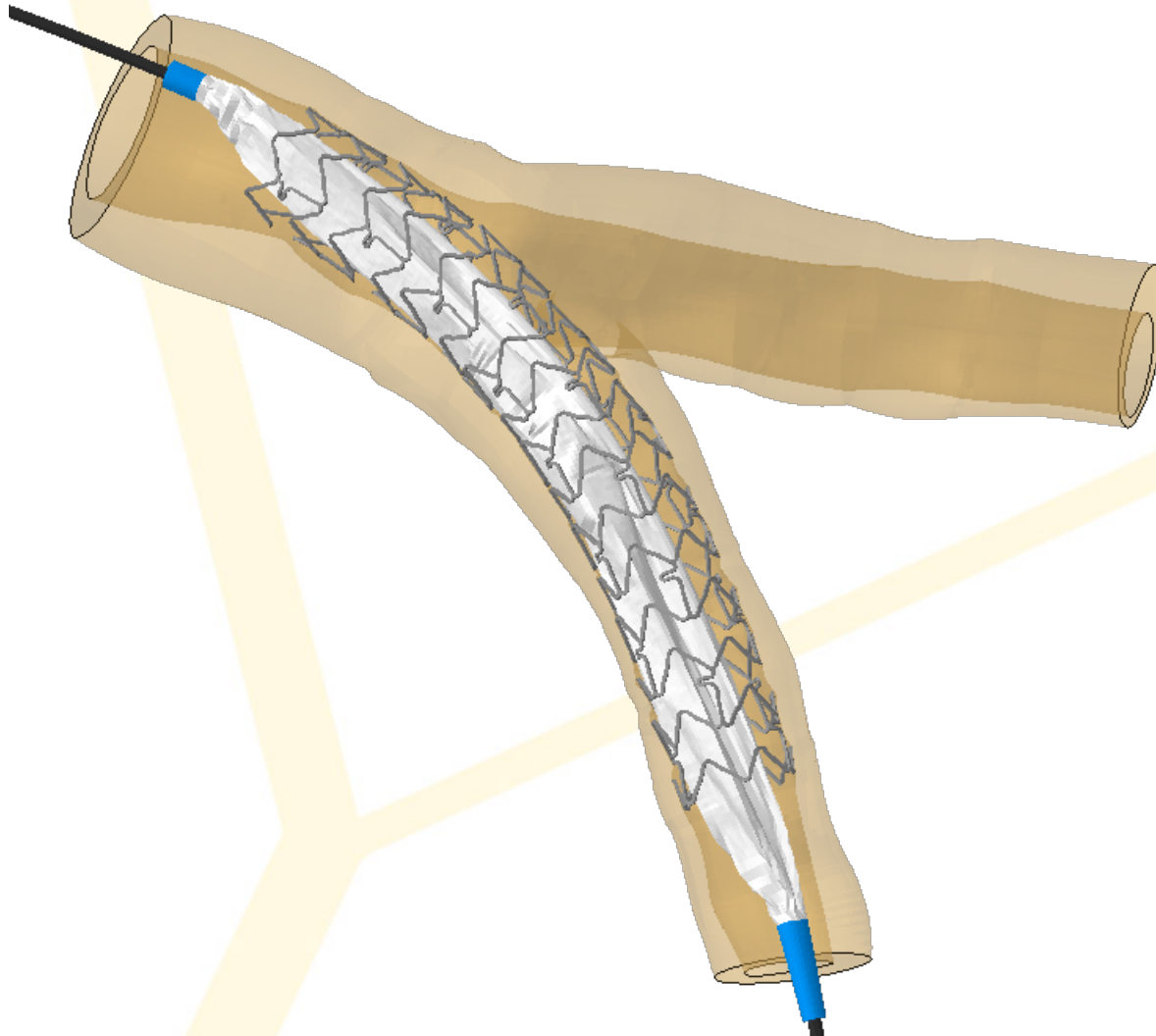
Stent deployment



Stent deployment



Stent deployment

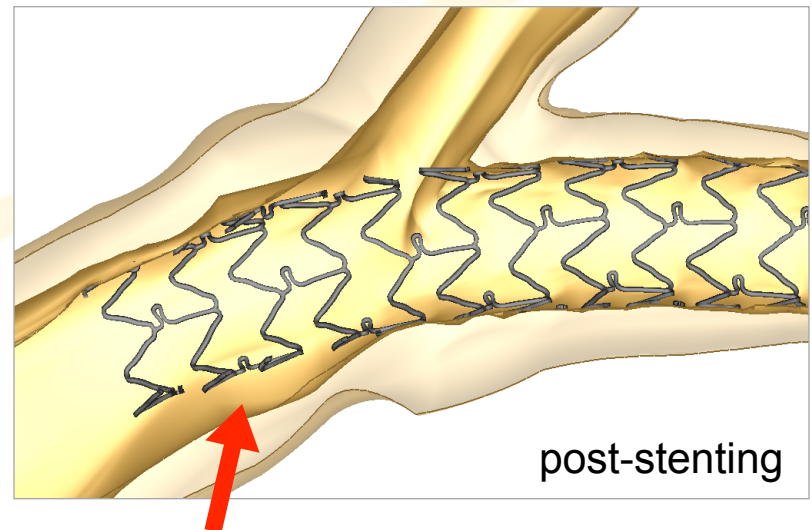
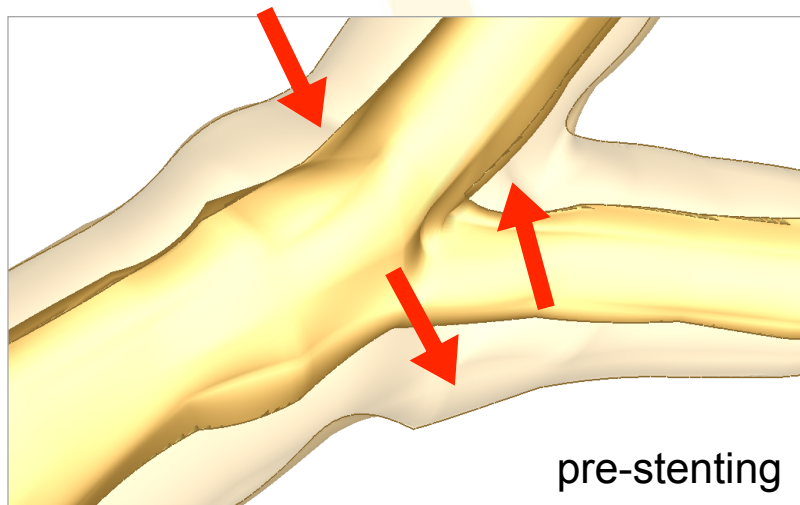


Stent deployment

Simulated stent deployment significantly enlarges the diameter of the LAD.

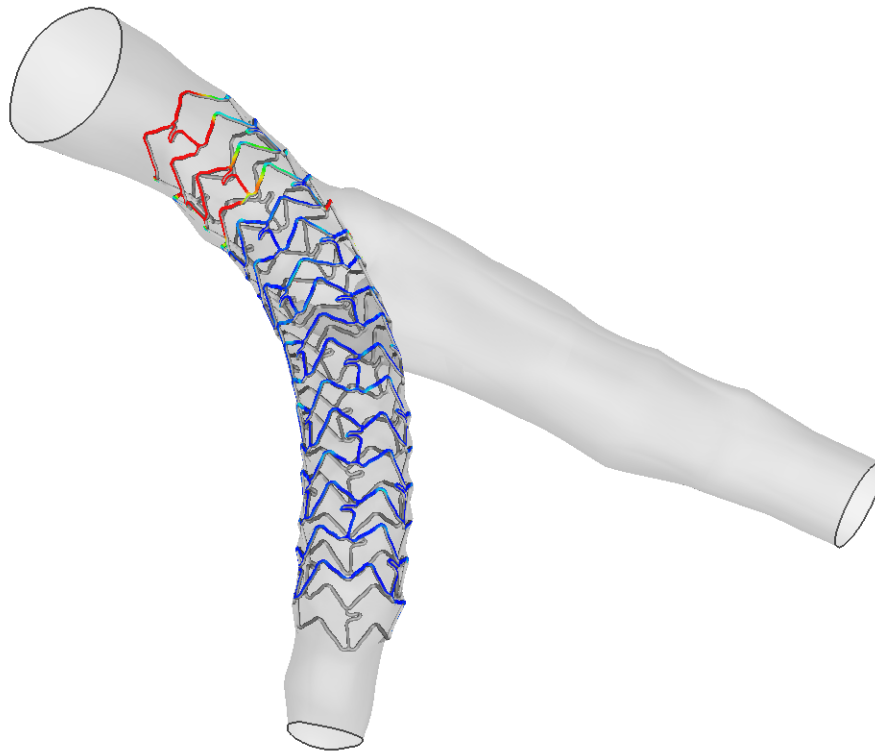
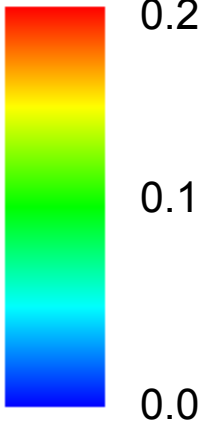
A serious malapposition can be observed in the LM. Therefore, performing a proximal optimisation (POT) seems recommended before inserting an additional guidewire.

This top view shows a reduction of LCX diameter (circular => elliptic). This is due to a combination of carina shift AND a movement of the lateral wall.



Strut apposition analysis

**Strut-artery
distance [mm]**



Strut apposition analysis

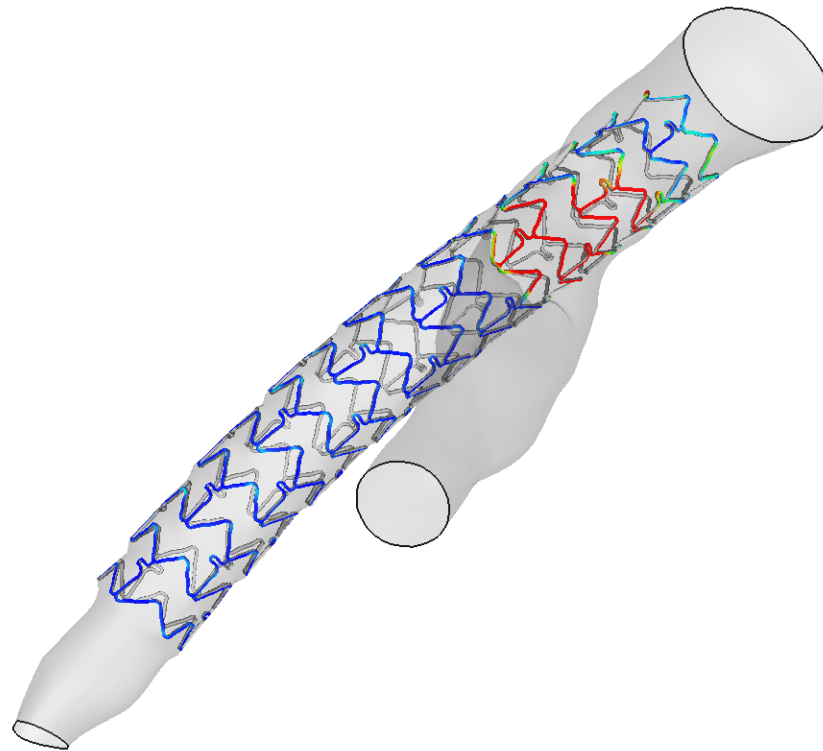
Strut-artery
distance [mm]



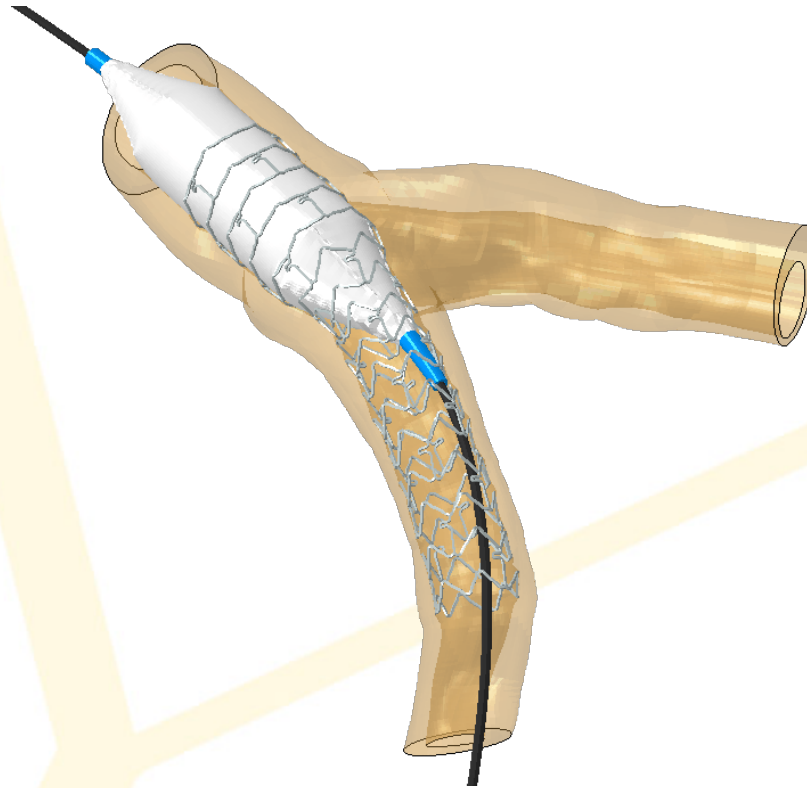
0.2

0.1

0.0



Proximal optimisation technique (POT)

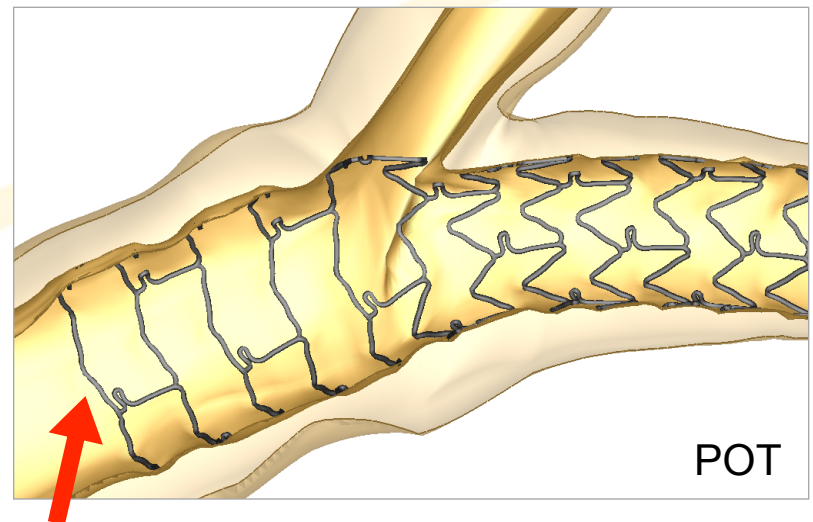
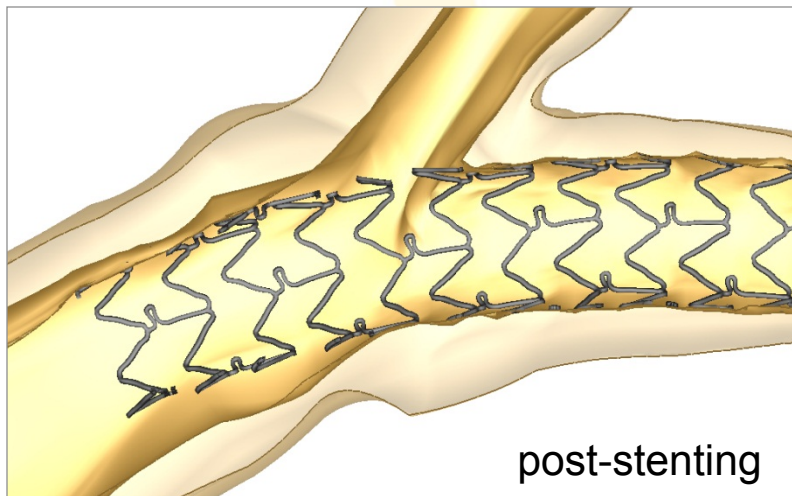


Proximal optimisation technique (POT)

The stent is now nicely apposed to the LM vessel wall

There is a further reduction of LCX diameter

Inflating a 4.5 mm balloon in this 3.0 mm stent design leads to a full straightening of the stent struts

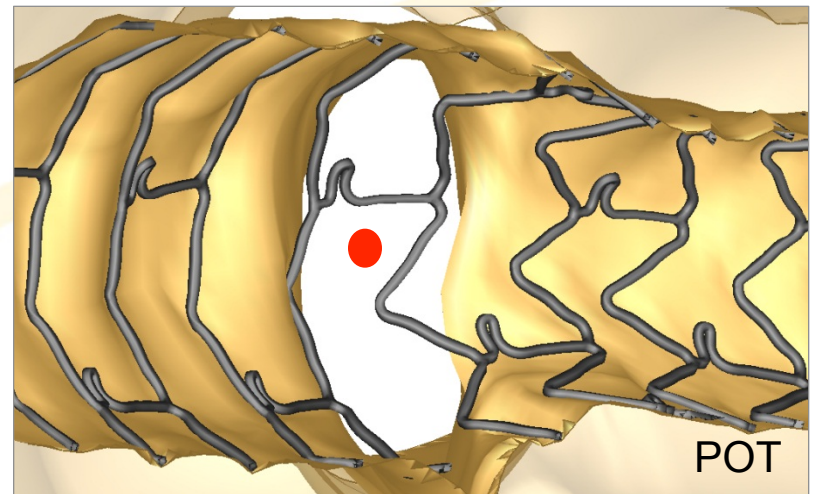
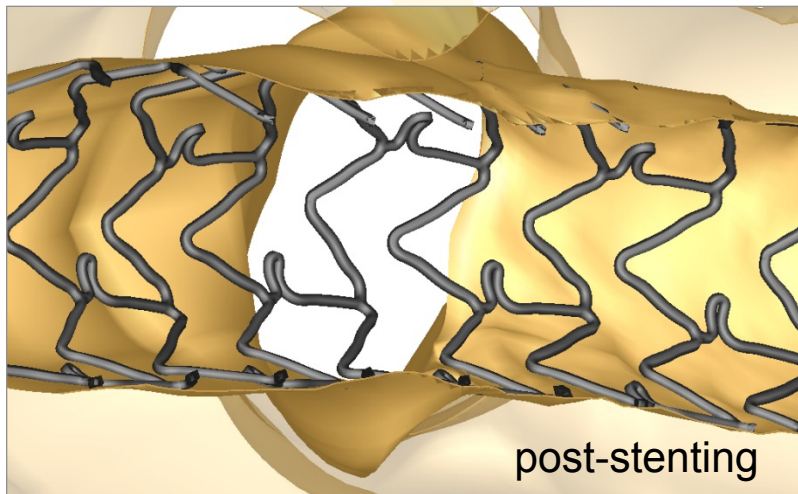


Proximal optimisation technique (POT)

Proximal optimisation seems to reduce the number of cells covering the side branch ostium

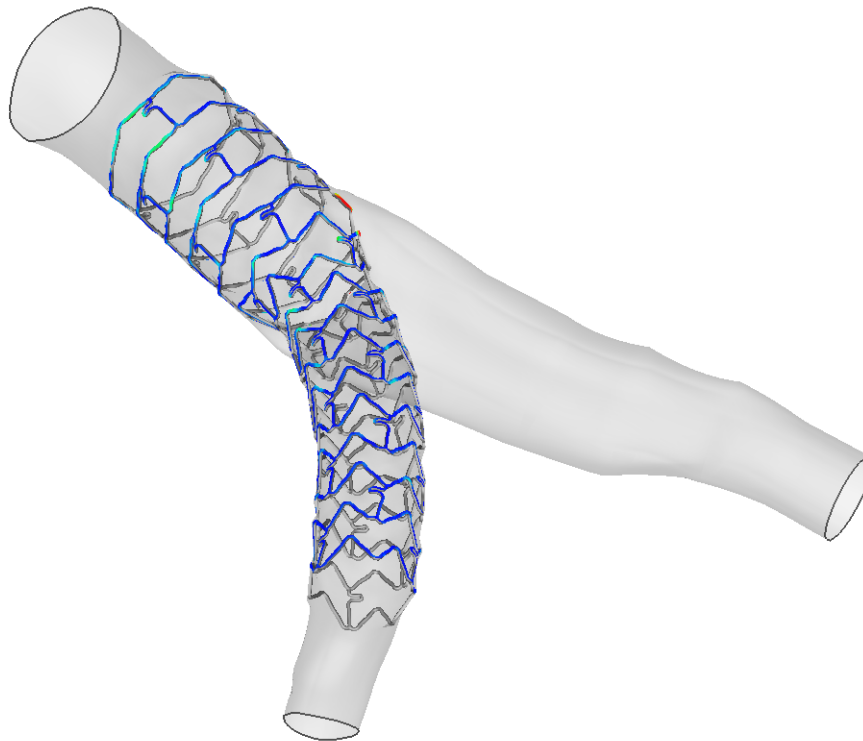
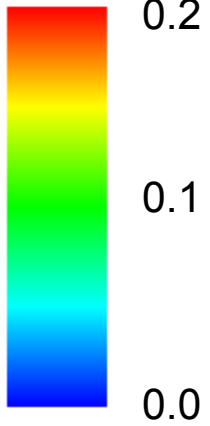
It also enlarges these cells, possibly facilitating side branch access

The location where the guidewire goes into the side branch is indicated with the red circle



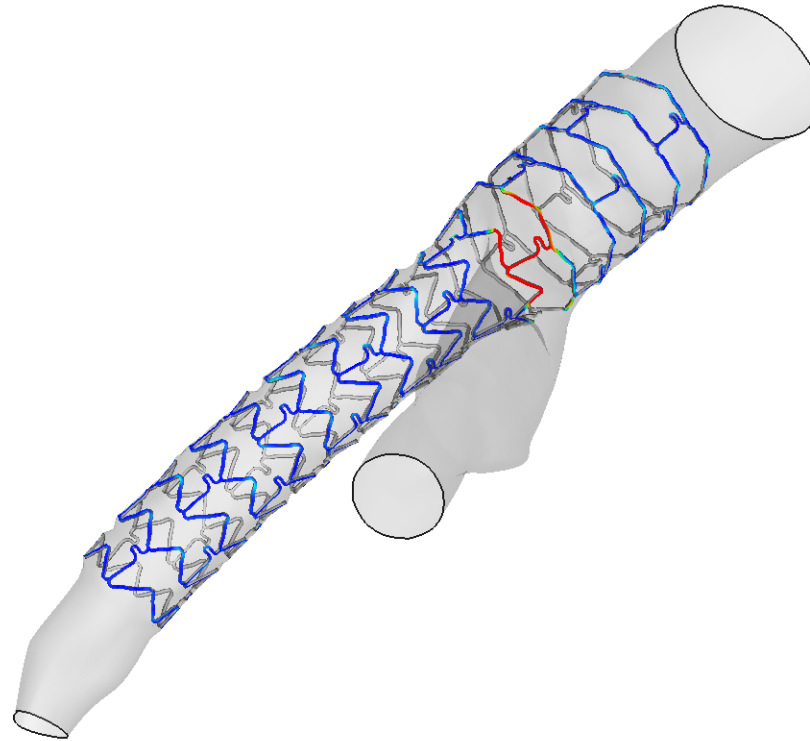
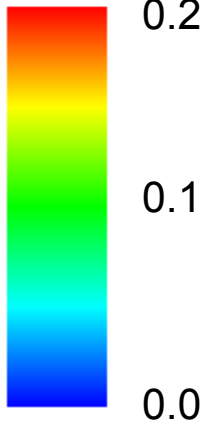
Strut apposition analysis

**Strut-artery
distance [mm]**

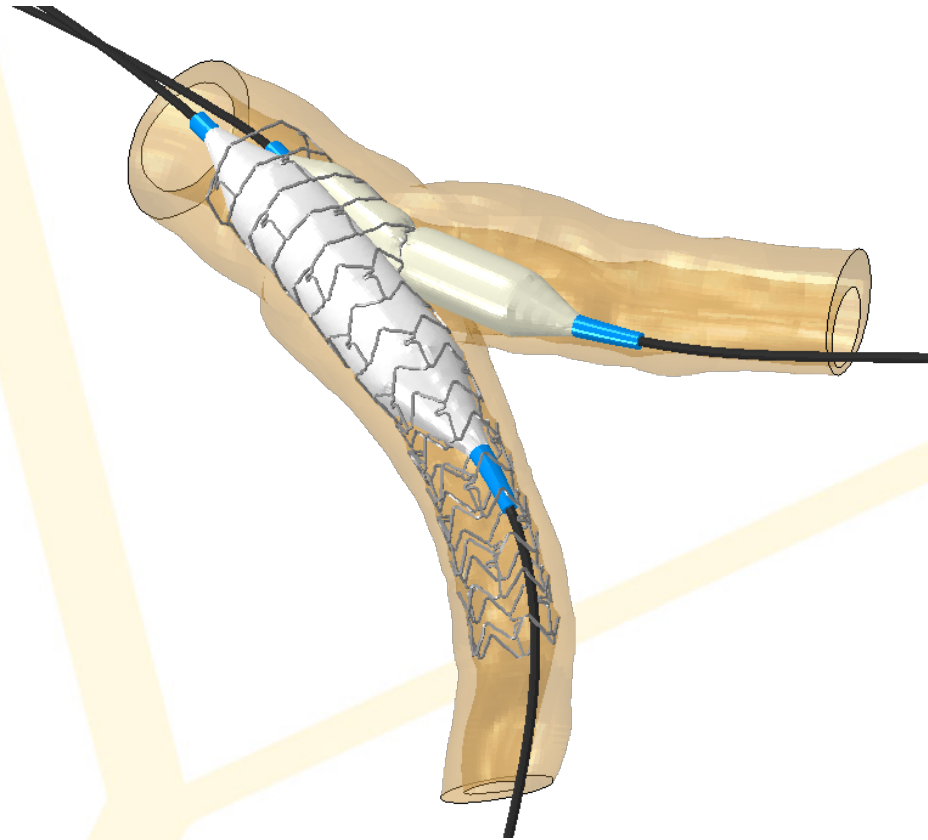


Strut apposition analysis

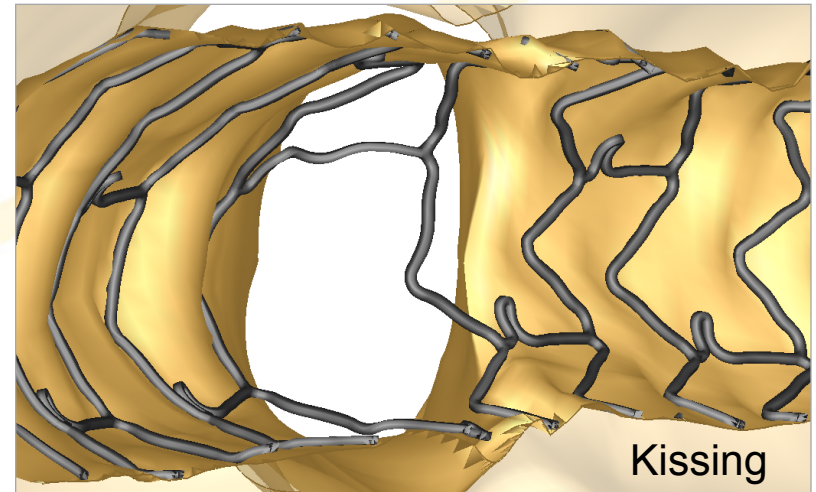
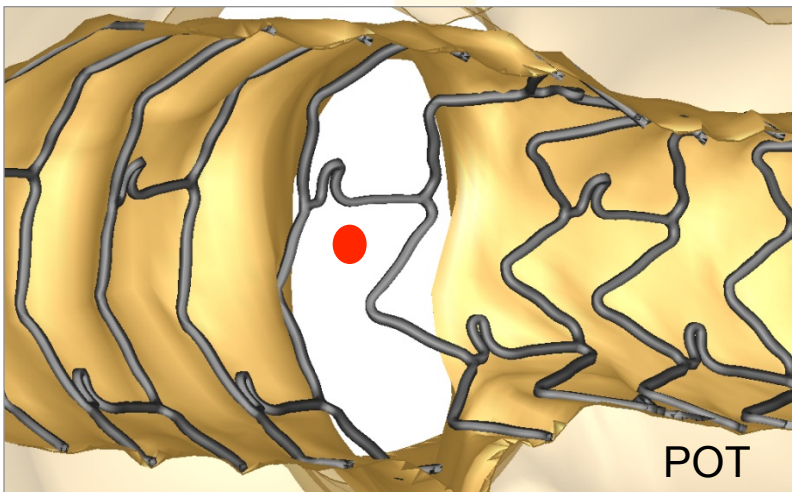
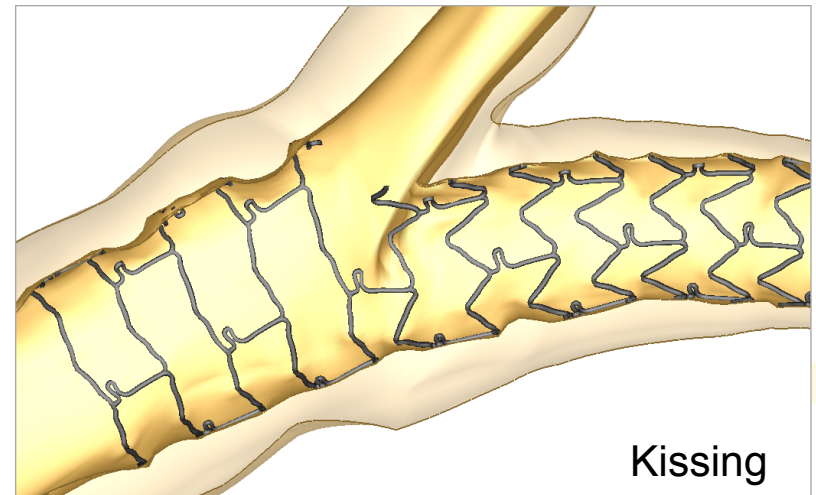
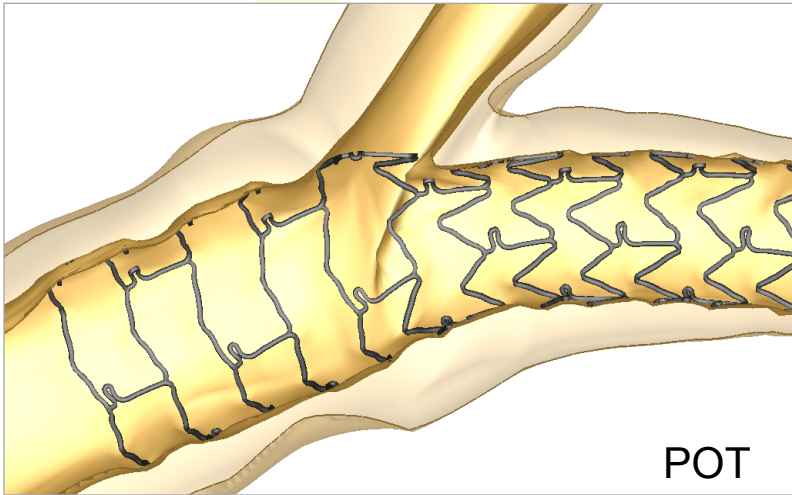
Strut-artery
distance [mm]



Final kissing inflation



Final kissing inflation



Strut apposition analysis

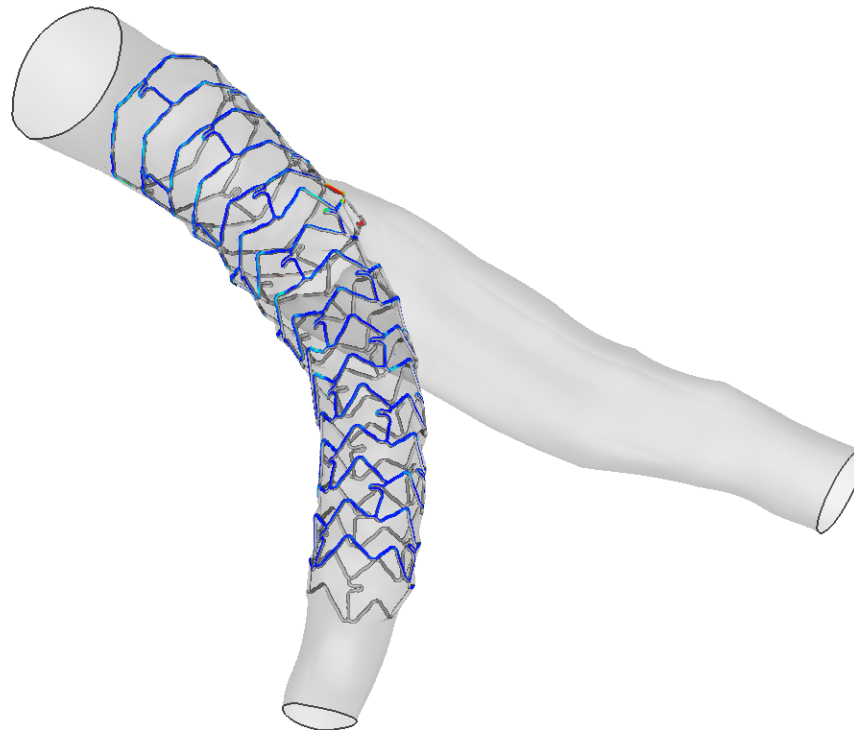
Strut-artery
distance [mm]



0.2

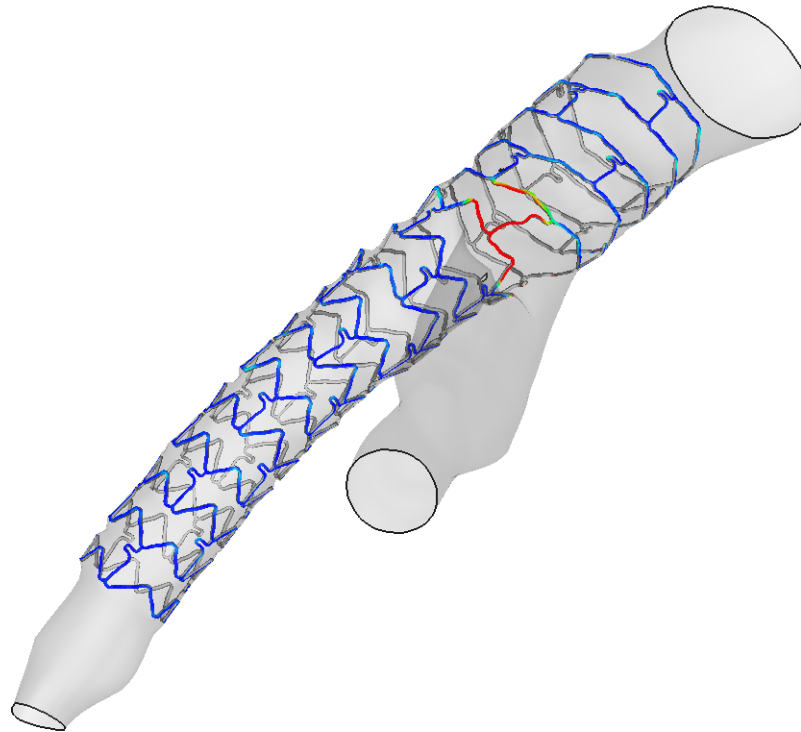
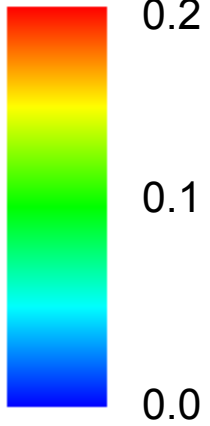
0.1

0.0



Strut apposition analysis

Strut-artery
distance [mm]





Conclusions

Performing a complete bifurcation stenting procedure using finite element simulations within a patient-based model is feasible

This 'virtual patient treatment' approach needs to be validated and calibrated using post-operative imaging modalities (e.g. 10 patients)

This technology could be used

- For training purposes
- To get more insights in techniques and devices
- To optimize techniques and devices
- To get additional information during a clinical trial
- ... and for pre-operative planning



Thank you

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