

# **3D Calcium Image and Guidewire Simulation by CCTA**

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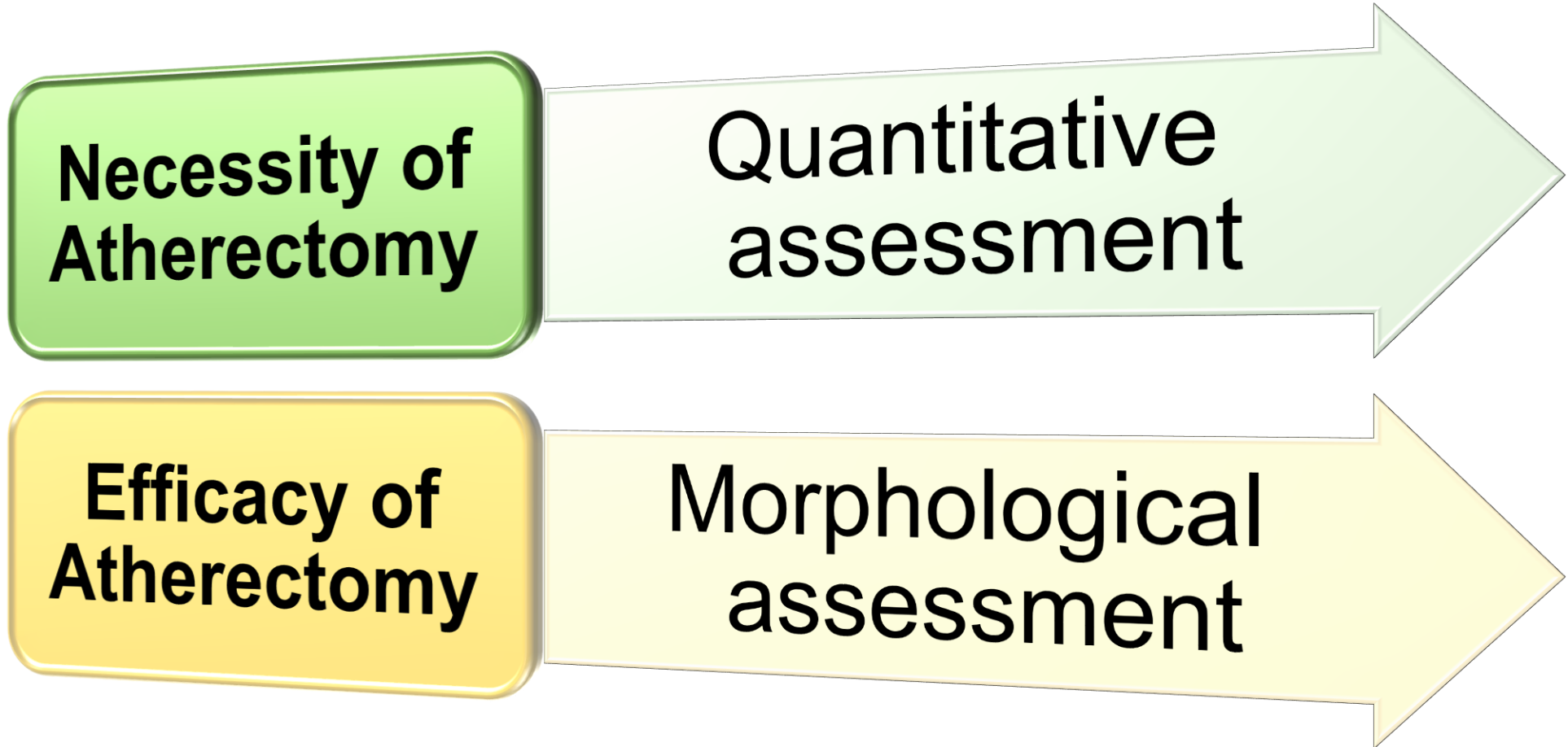
# Disclosure

- The authors have no financial conflicts of interest to disclose concerning the presentation.

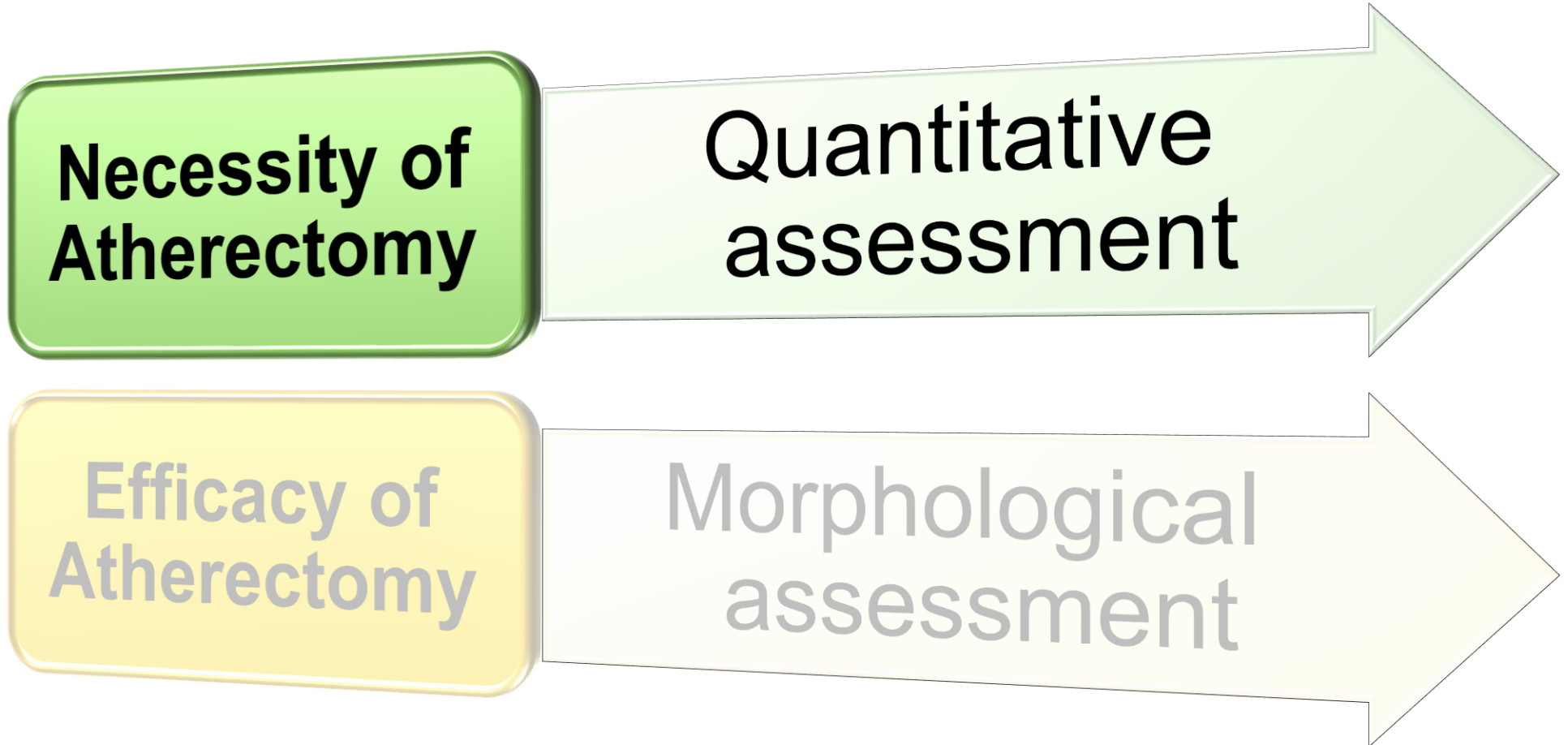
**Calcified lesion is eternal challenge.**



# Why do we need to evaluate calcification?



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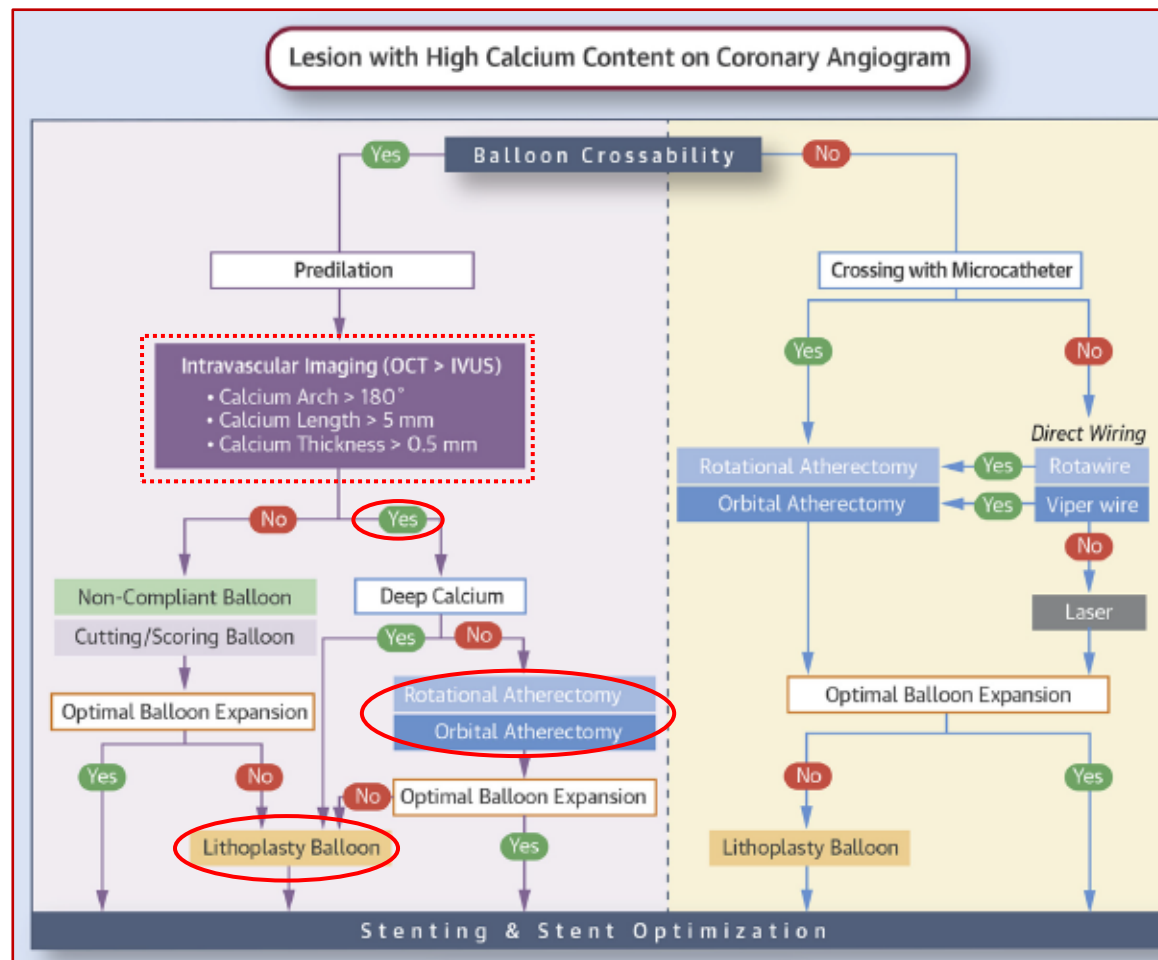
# Interventional approach to calcified lesions

## Management of Calcific Coronary Artery Lesions

### Is it Time to Change Our Interventional Therapeutic Approach?

Giovanni Luigi De Maria, MD, PhD,\* Roberto Scarsini, MD,\* Adrian P. Banning, MD

| Diagnostic Accuracy                    | Angiography | IVUS  | OCT   |
|----------------------------------------|-------------|-------|-------|
| Severe LHCC                            | ● ● ●       | ● ● ● | ● ● ● |
| Mild/Moderate LHCC                     | ●           | ● ●   | ● ● ● |
| Deep calcium                           | ●           | ● ● ● | ● ● ● |
| Calcium arch                           | ✗           | ● ● ● | ● ● ● |
| Calcium thickness                      | ✗           | ✗     | ● ● ● |
| Longitudinal calcium length            | ✗           | ●     | ● ● ● |
| Non-homogeneous plaque / Necrotic core | ✗           | ● ● ● | ●     |

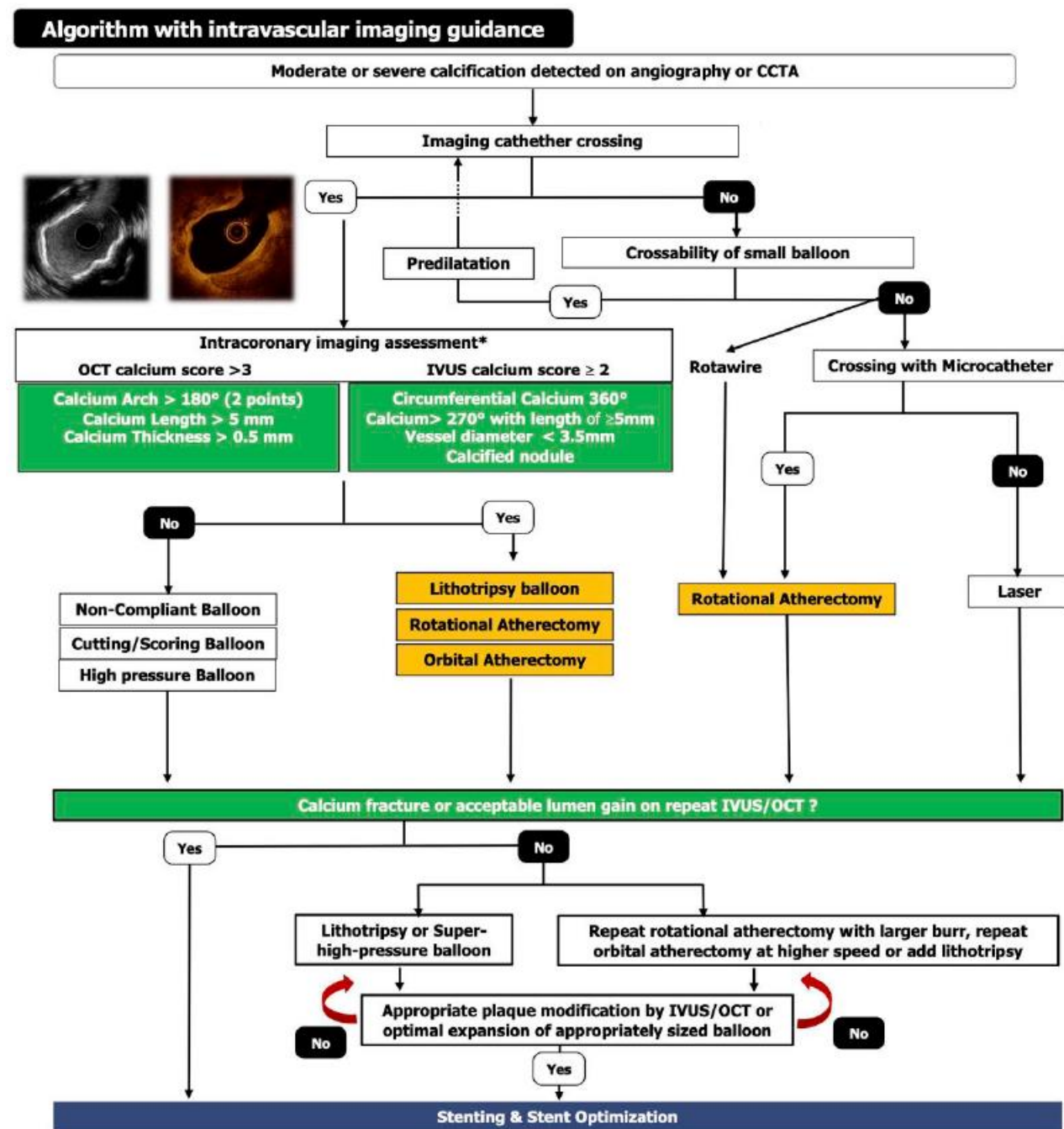
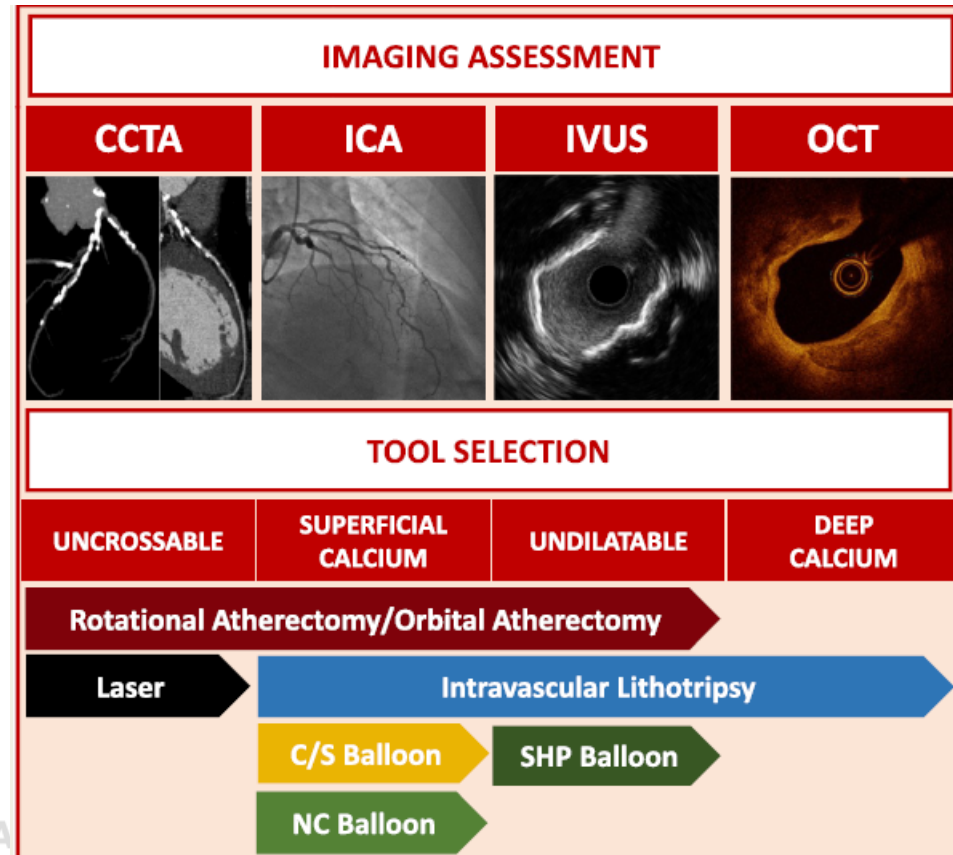


De Maria, G.L. et al. J Am Coll Cardiol Interv. 2019;12(15):1465-78.



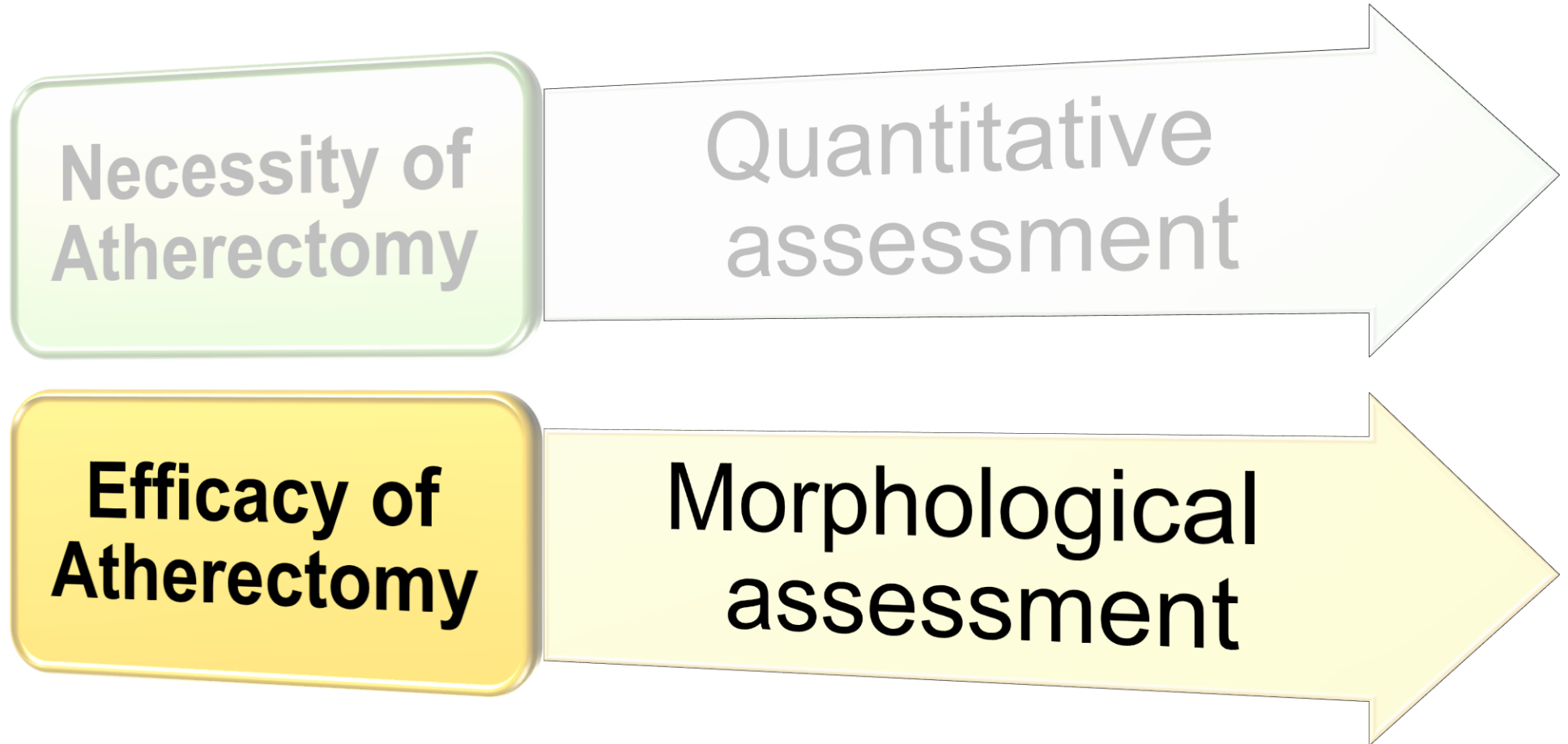
# Management strategies for heavily calcified coronary stenoses: an EAPCI clinical consensus statement in collaboration with the EURO4C-PCR group

Emanuele Barbato <sup>1\*</sup>, Emanuele Gallinoro <sup>2</sup>, Mohamed Abdel-Wahab <sup>3</sup>, Daniele Andreini <sup>2,4</sup>, Didier Carrié <sup>5</sup>, Carlo Di Mario <sup>6</sup>, Dariusz Dudek <sup>7</sup>, Javier Escaned <sup>8</sup>, Jean Fajadet <sup>9</sup>, Giulio Guagliumi <sup>10</sup>, Jonathan Hill <sup>11</sup>, Margaret McEntegart <sup>12,13</sup>, Kambis Mashayekhi <sup>14</sup>, Nikolasos Mezilis <sup>15</sup>, Yoshinobu Onuma <sup>16,17</sup>, Krzysztof Reczuch <sup>18</sup>, Richard Shlofmitz <sup>19</sup>, Giulio Stefanini <sup>20</sup>, Giuseppe Tarantini <sup>21</sup>, Gabor G. Toth <sup>22</sup>, Beatriz Vaquerizo <sup>23</sup>, William Wijns <sup>24</sup>, and Flavio L. Ribichini <sup>25</sup>



(Eur Heart J. 2023;44:4340-4356)

# Why do we need to evaluate calcification?





# Rotablator sometimes strike out...

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Pre

568/981

538/981

513/981

LMT

Bifurcation core

LAD ostium

598/974

555/974

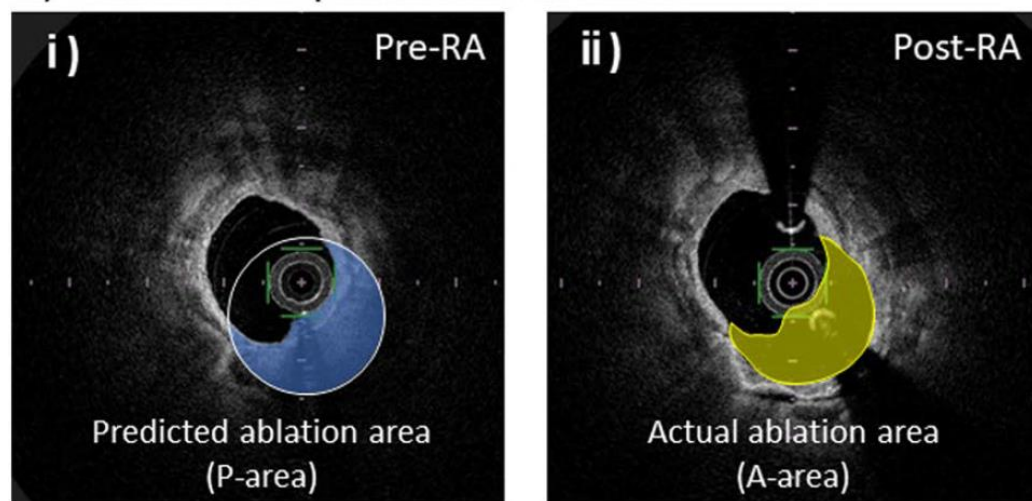
537/974

Post Rota 2.0mm

## Prediction of the debulking effect of rotational atherectomy using optical frequency domain imaging: a prospective study

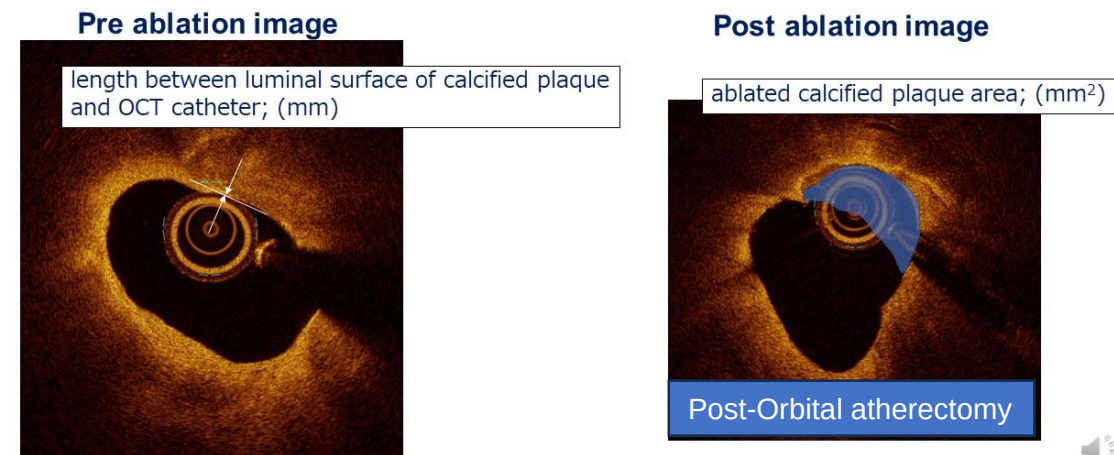
Tomoyo Hamana<sup>1</sup> · Hiroyuki Kawamori<sup>1</sup> · Takayoshi Toba<sup>1</sup> · Makoto Nishimori<sup>1,2</sup> · Kosuke Tanimura<sup>1</sup> · Shunsuke Kakizaki<sup>1</sup> · Koichi Nakamura<sup>1</sup> · Daichi Fujimoto<sup>1</sup> · Satoru Sasaki<sup>1</sup> · Yuto Osumi<sup>1</sup> · Masayoshi Fujii<sup>1</sup> · Seigo Iwane<sup>1</sup> · Tetsuya Yamamoto<sup>1</sup> · Shota Naniwa<sup>1</sup> · Yuki Sakamoto<sup>1</sup> · Yuta Fukuishi<sup>1</sup> · Koshi Matsuhama<sup>1</sup> · Ken-ichi Hirata<sup>1</sup> · Hiromasa Otake<sup>1</sup> 

### B) Wire-based prediction method

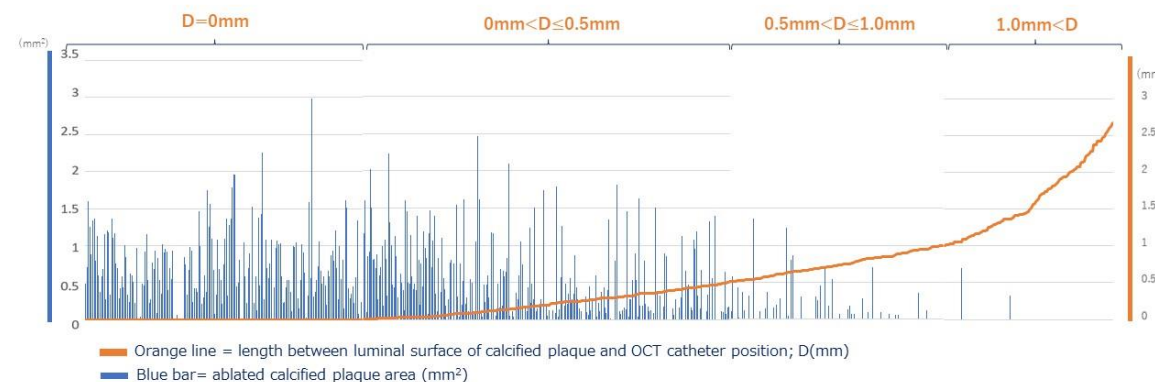


(Cardiovasc Interv Ther. 2023 Jul;38(3):316-326)

### Corresponding OCT cross-sectional frames



### Device Bias and efficacy of ablation



Relationship between device bias and ablated calcified plaque area of all cross-sectional frames with co-registration of pre, and post ablation OCT image (n = 574), acquired from 21 patients.

(Tanaka K, Okutsu M, et al. CVIT2021)

**Table 1** Comparison of clinically available coronary imaging tools

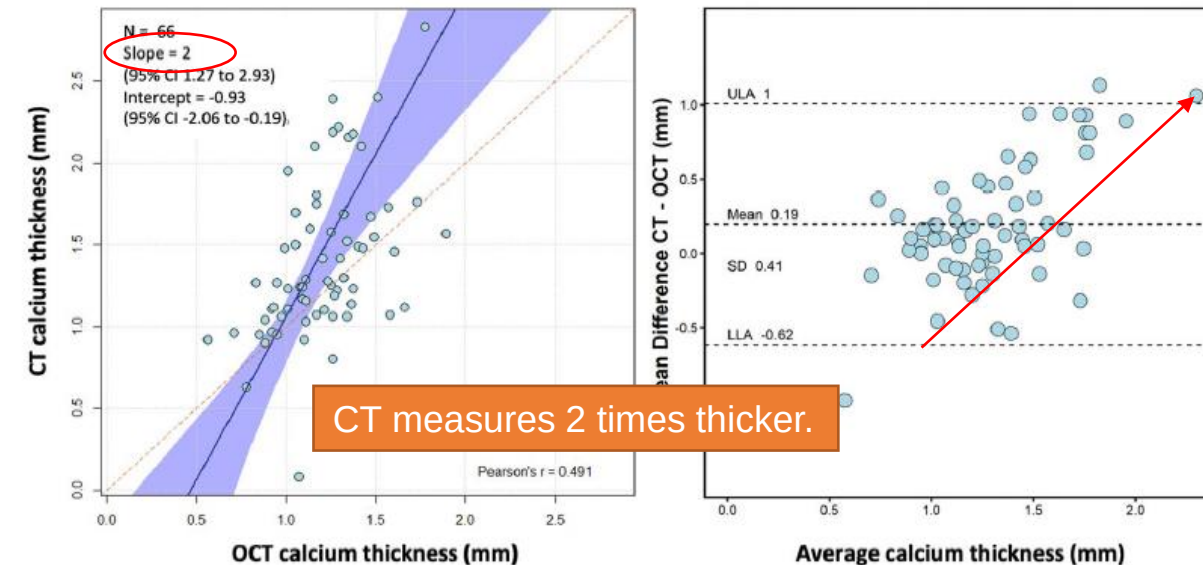
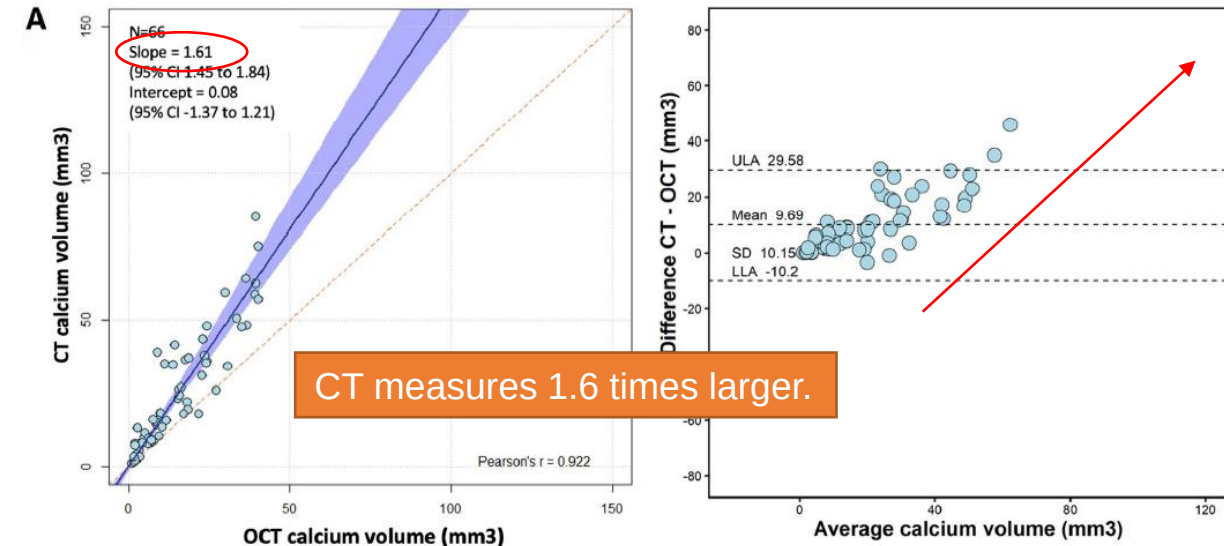
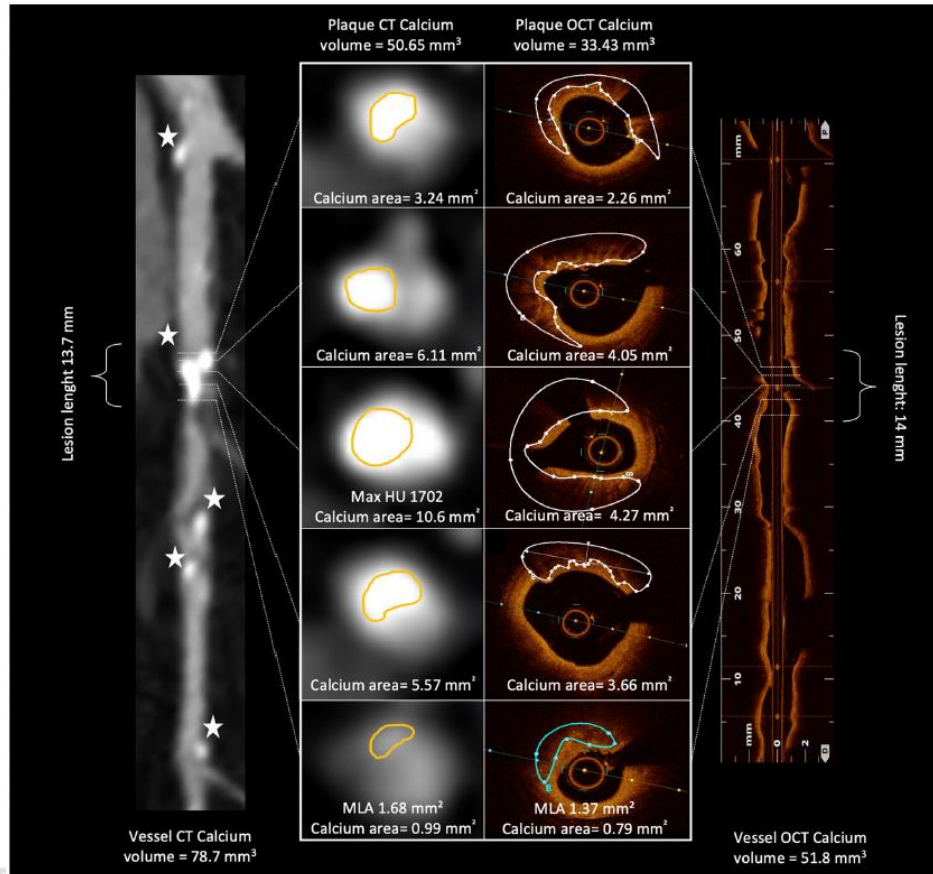
|                                    | <u>Non-invasive imaging prior to the catheterization laboratory</u> |         | ICA                 | <u>Intravascular imaging in the catheterization laboratory</u> |              |
|------------------------------------|---------------------------------------------------------------------|---------|---------------------|----------------------------------------------------------------|--------------|
|                                    | CCTA                                                                | CS      |                     | OCT                                                            | IVUS         |
| Spatial resolution                 | 0.2–0.5 mm                                                          | 1.25 mm | 0.5–0.6 mm          | 15–20 $\mu$                                                    | 50–200 $\mu$ |
| Contrast needed                    | Yes                                                                 | No      | Yes                 | Yes                                                            | No           |
| Time of data acquisition           | 1–5 min                                                             | 1 min   | 15 min <sup>a</sup> | <5–10 s                                                        | 2–4 min      |
| Availability                       | +++                                                                 | +++     | +++                 | +                                                              | ++           |
| Additional cost                    | +                                                                   | +       | +                   | +++                                                            | +++          |
| Tissue penetration (non-calcified) | +++                                                                 | +++     | +++                 | +                                                              | ++           |
| Global assessment of calcification | +++                                                                 | +++     | +                   | -                                                              | -            |
| Calcium volume quantification      | +                                                                   | -       | -                   | ++                                                             | -            |
| Calcium arc                        | ++                                                                  | -       | -                   | +++                                                            | +++          |
| Calcium thickness                  | +                                                                   | -       | -                   | +++                                                            | -            |
| Longitudinal calcium length        | +                                                                   | -       | -                   | +++                                                            | +++          |



# CT evaluation correlates well with OCT measurements, however, agreement is not good.

## Quantification of calcium burden by coronary CT angiography compared to optical coherence tomography

G. Monizzi<sup>1,2,3</sup> · J. Sonck<sup>1,4</sup> · S. Nagumo<sup>1,5</sup> · D. Buytaert<sup>1</sup> · L. Van Hoe<sup>6</sup> · L. Grancini<sup>2</sup> · A. L. Bartorelli<sup>2,3</sup> · P. Vanhoenacker<sup>6</sup> · P. Simons<sup>6</sup> · O. Bladt<sup>6</sup> · E. Wyffels<sup>1</sup> · B. De Bruyne<sup>1</sup> · D. Andreini<sup>2,3</sup> · C. Collet<sup>1</sup>

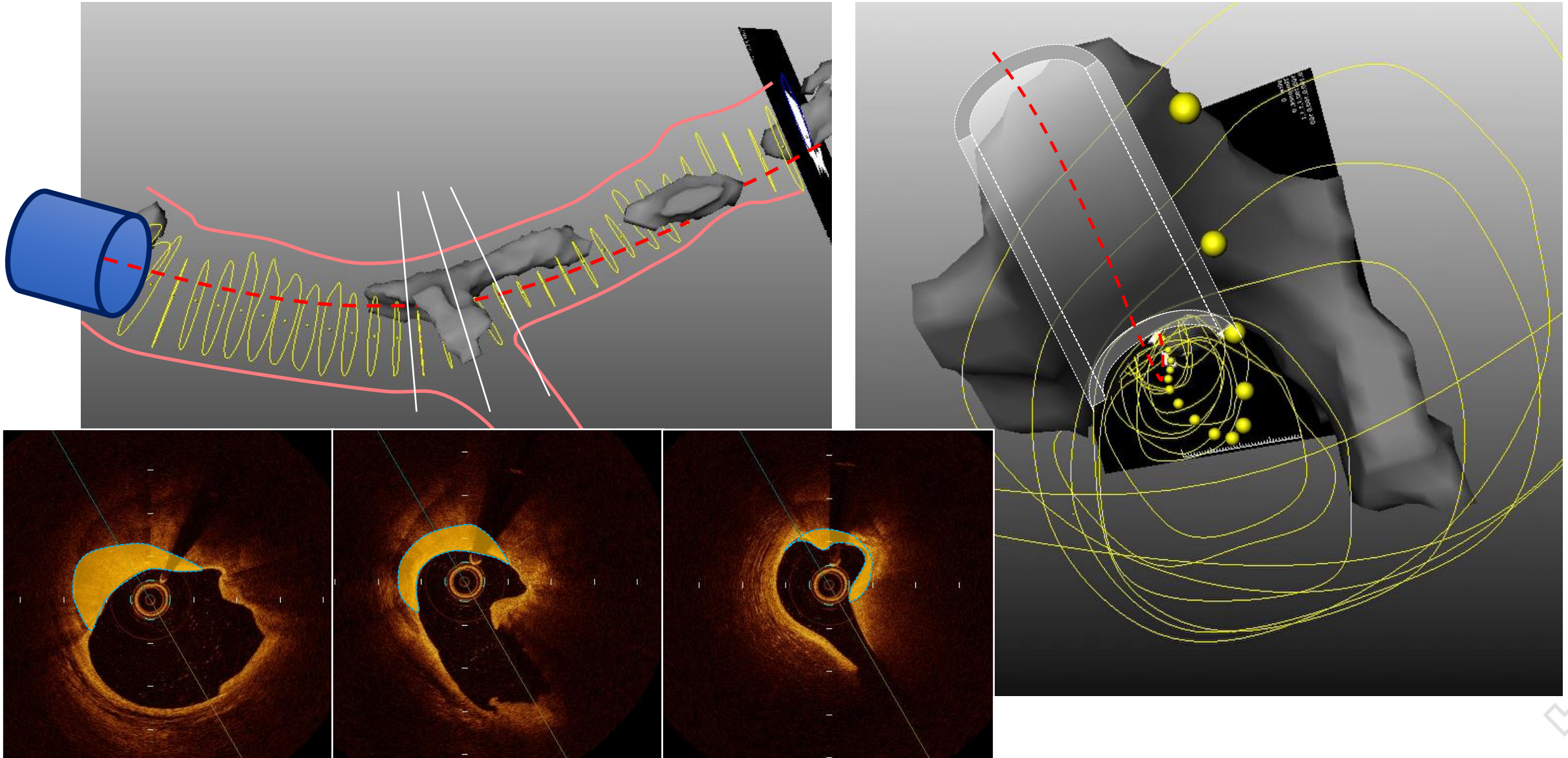


# Challenges for CCTA to evaluate calcification

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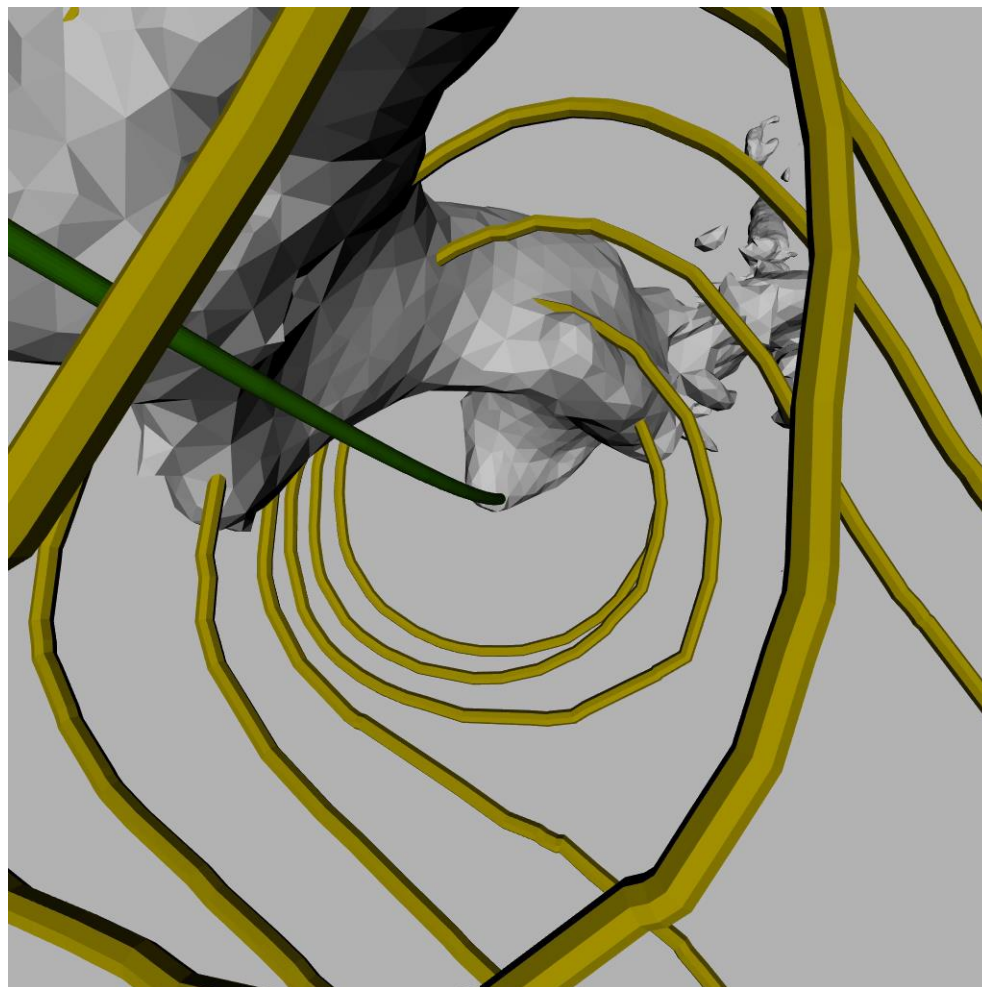
- Construction of actual calcification form
- Simulation of guide wire bias

# Concept



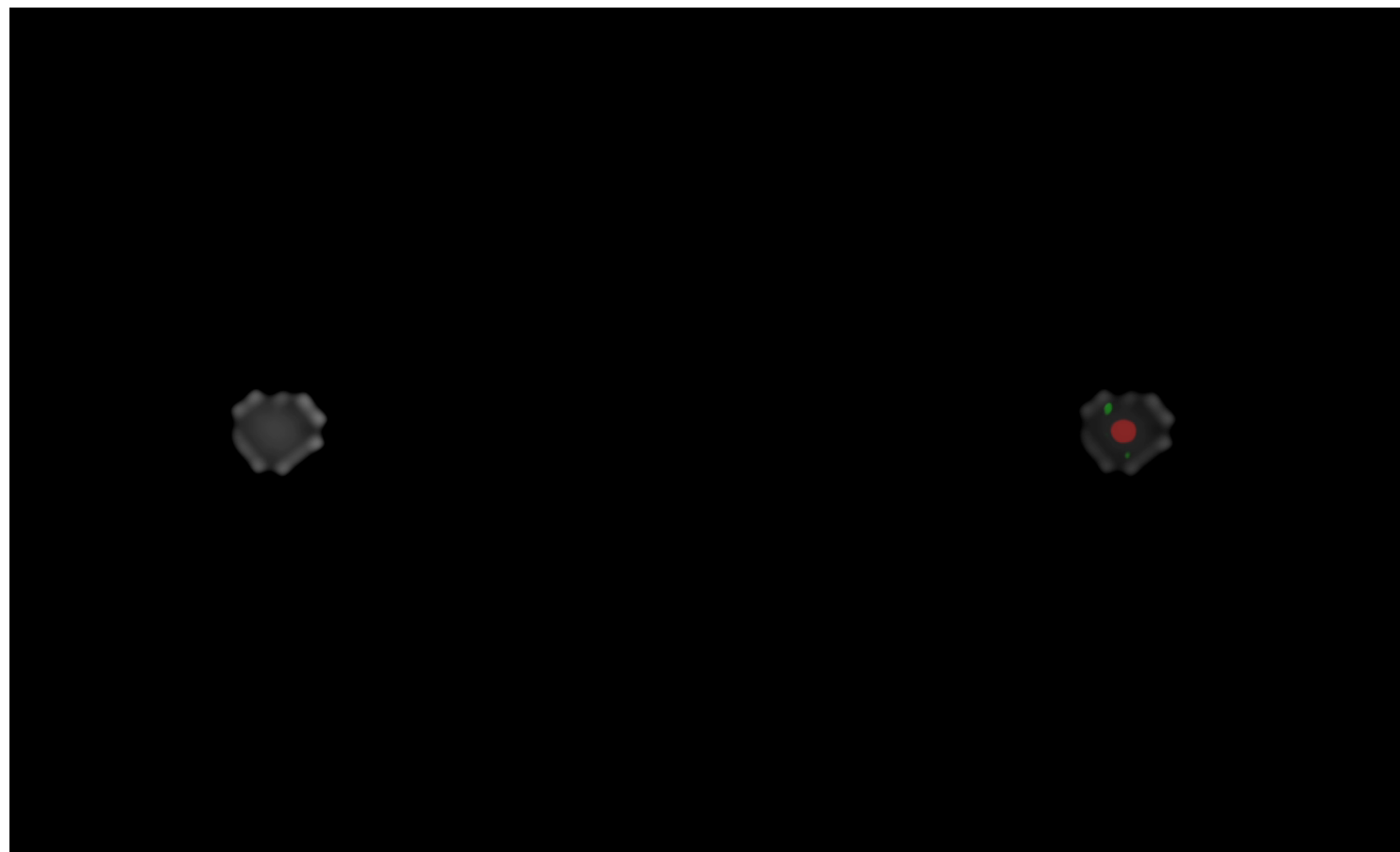
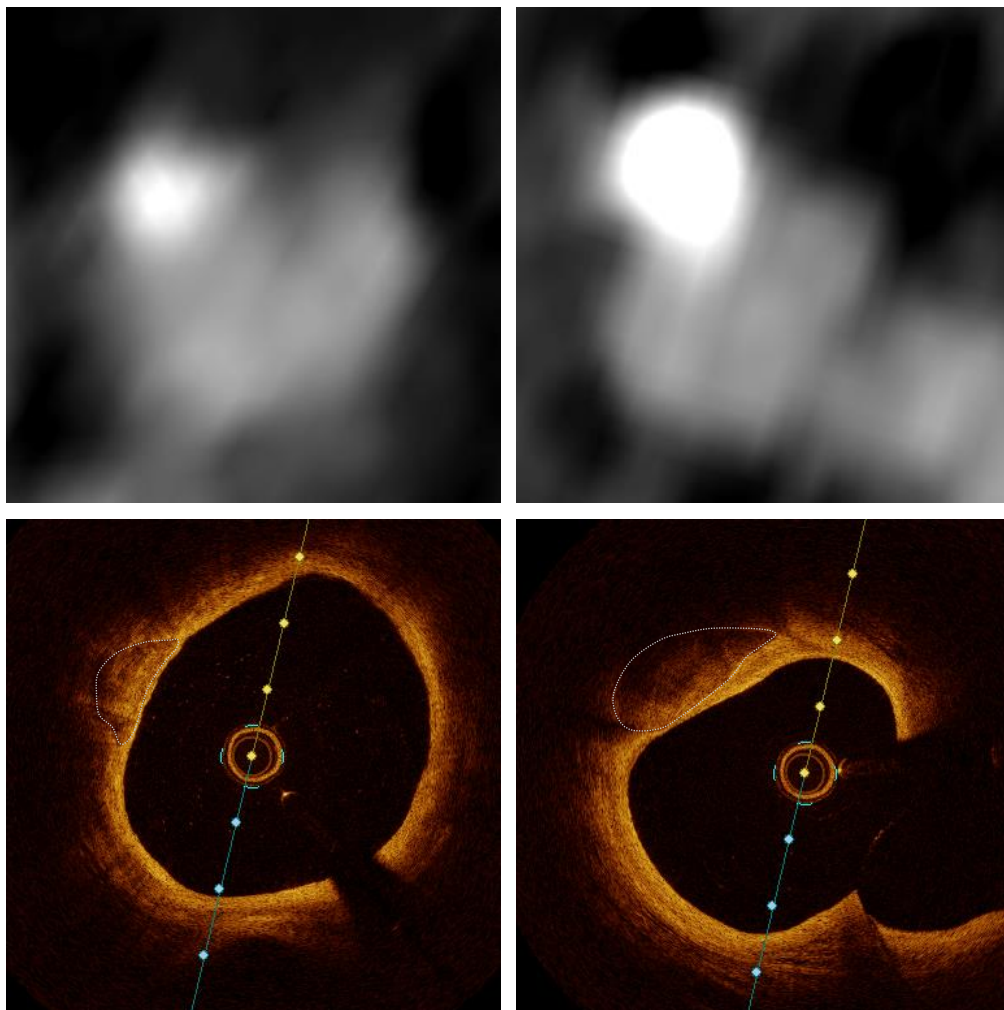


# Welcome to the CT world.

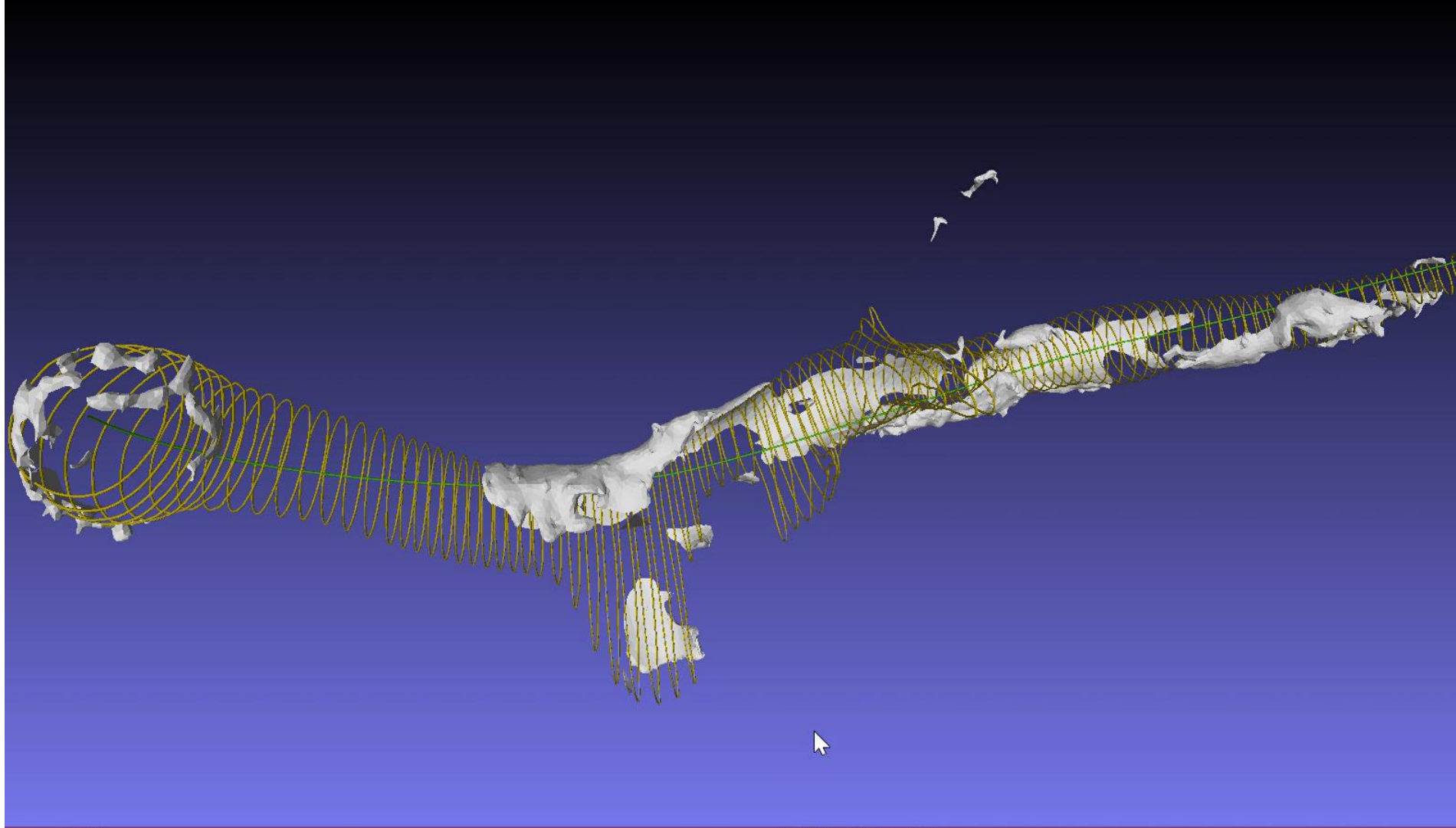


# 1st challenge: Construction of real calcification figure

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## 2nd challenge: Guide wire bias simulation program



# Accuracy of GW simulation model Ver.2

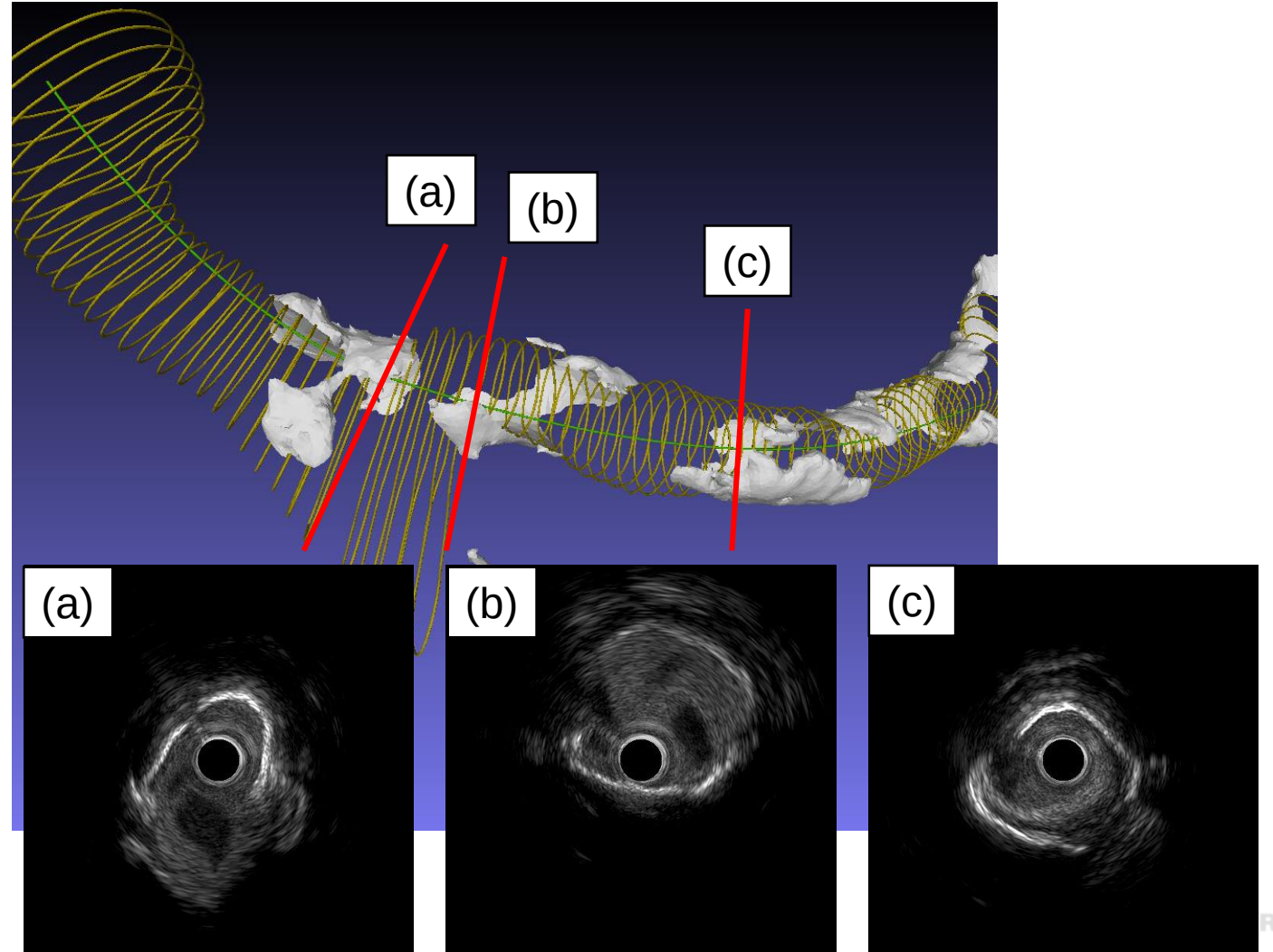
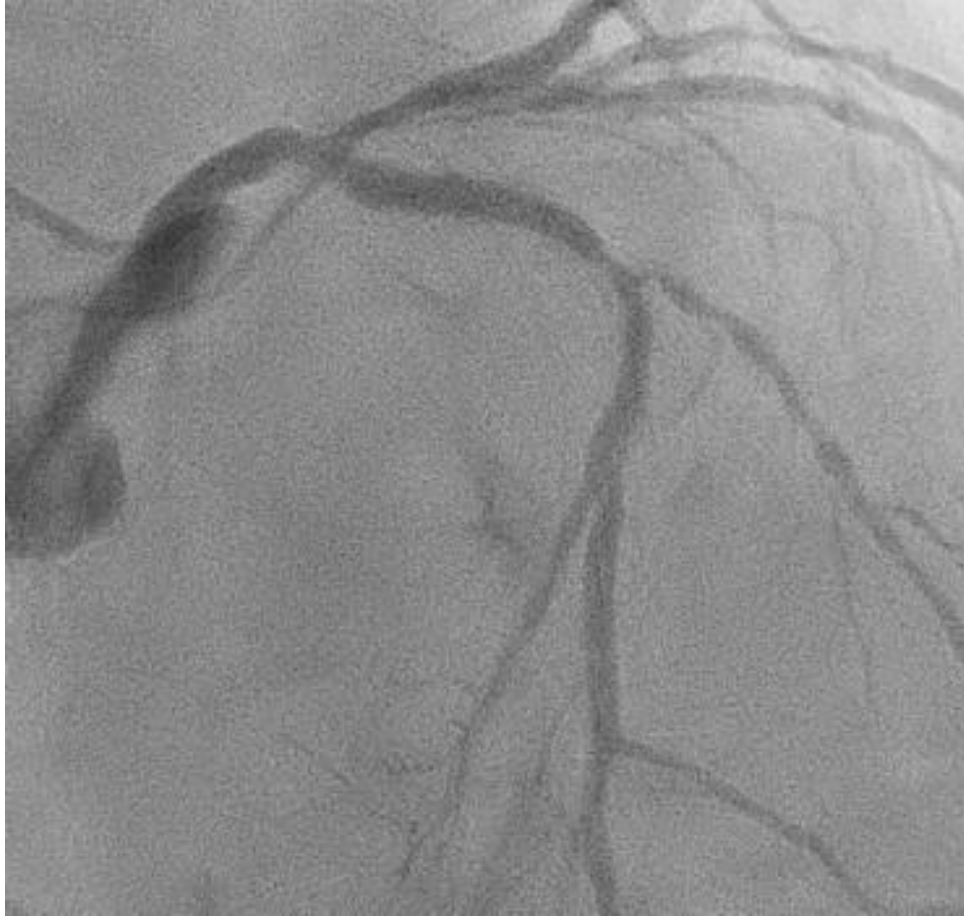
Total 36 calcified segments of 16 vessels

|                       |               |
|-----------------------|---------------|
| Correct calcium image | 91.6% (33/36) |
|-----------------------|---------------|

|                    |               |
|--------------------|---------------|
| Contact estimation | 88.9% (32/36) |
|--------------------|---------------|



# Case



# Future challenges

1. Precise calcium imaging
2. Accuracy of GW bias simulation
3. Guide wire bias strength

# The goal is almost there.

