

TCT AP 2008

VH and OCT of Bioabsorbable eluting Stent

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On behalf of the ABSORB Investigators

Thoraxcenter, Erasmus Medical Center, Rotterdam, the Netherlands

PW Serruys declares no conflict of interest

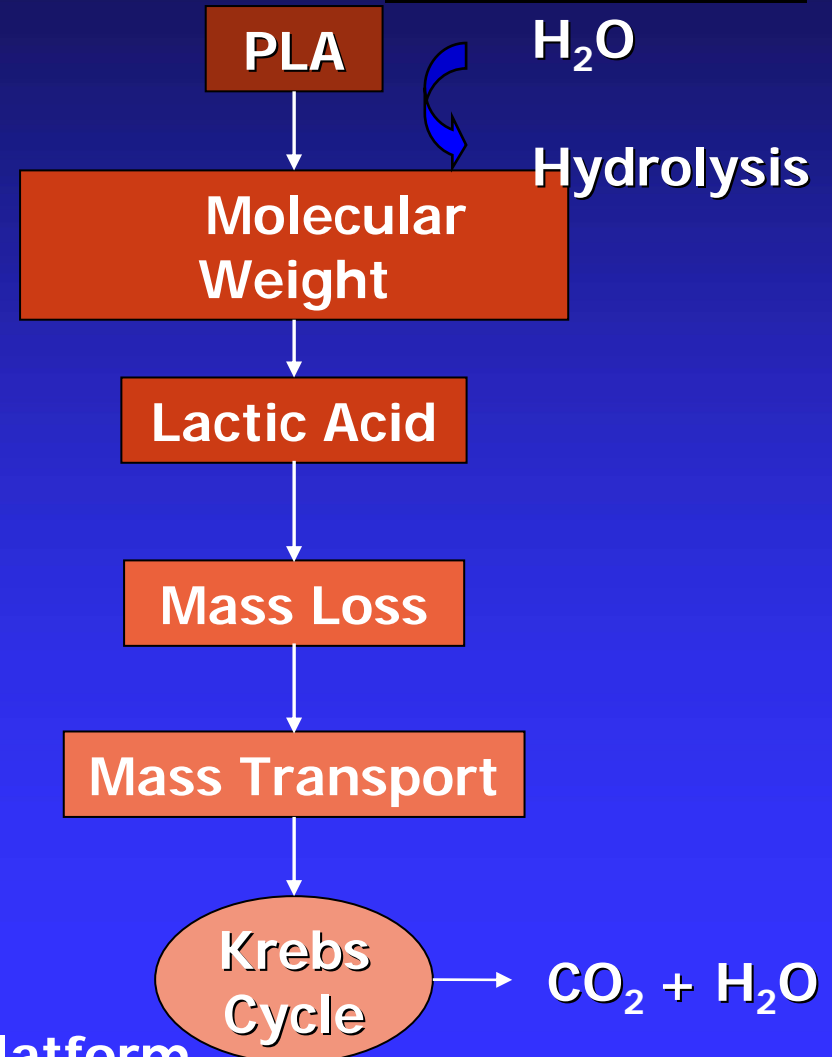
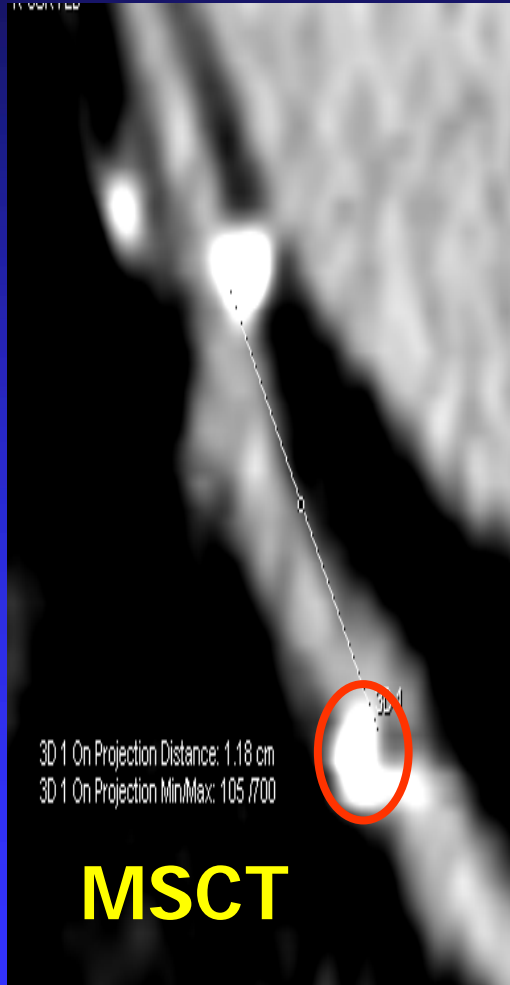
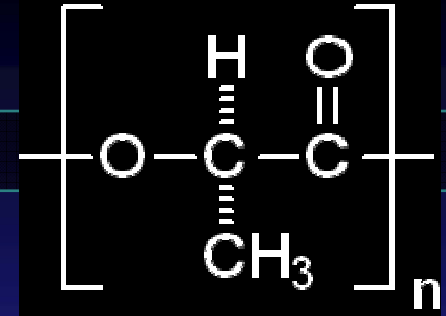
Coronary Arena

11:42-54, April 24, 2008

Why Bioresorbable Stents?

Nothing Left Behind:	Potential for reduced LST?
	Potential for reduced anti-platelet therapy?
	Facilitate treatment of ISR?
	Keep the CABG option?
	Peripheral lesions where strut fracture is a problem
	Reduced long term impact to minor side branches
	Improved CT / MR imaging compatibility
No tradeoffs:	No compromise in deliverability
	No loss of vessel support
	No inflammatory reaction related to bioabsorption
New applications:	Pediatric (aorta, pulmonary artery)
	Delivery of drugs which cannot be delivered systemically?

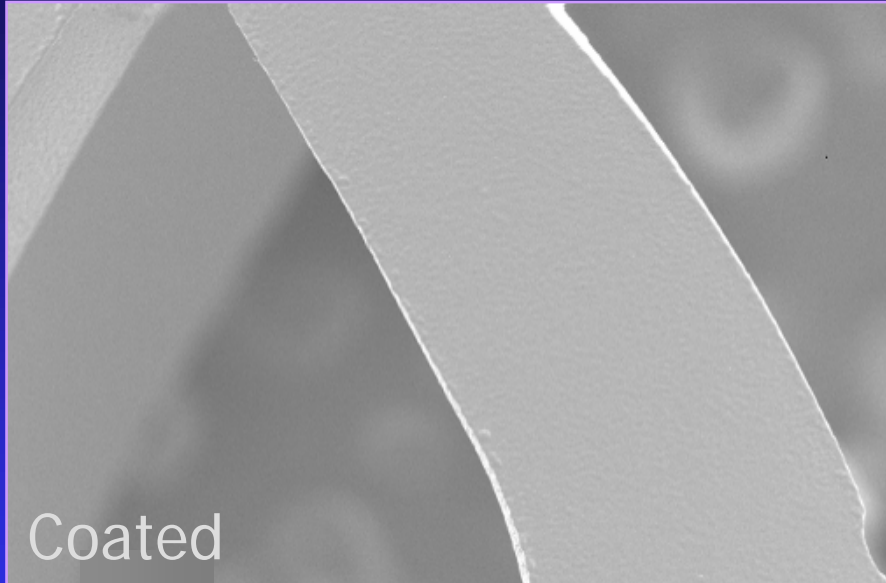
Poly -L- Lactide (PLLA) Everolimus Eluting Stent



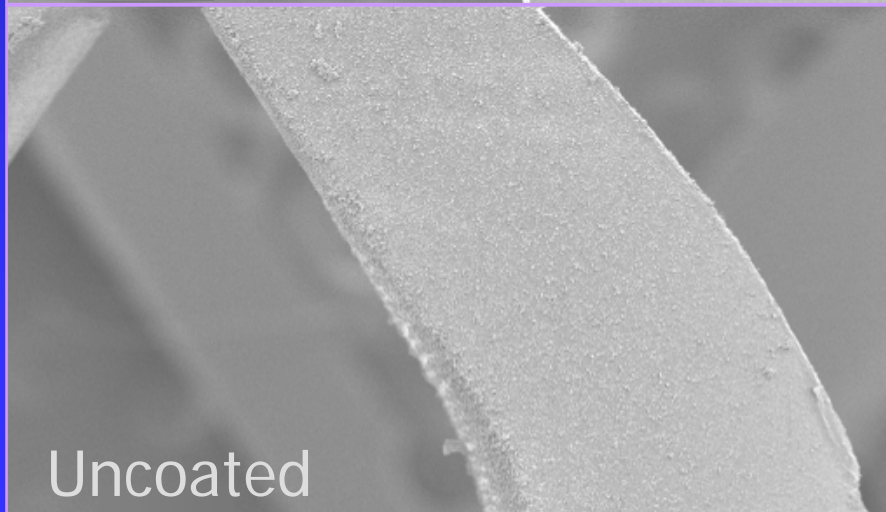
2 . Absorbable metallic or polymeric platform

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

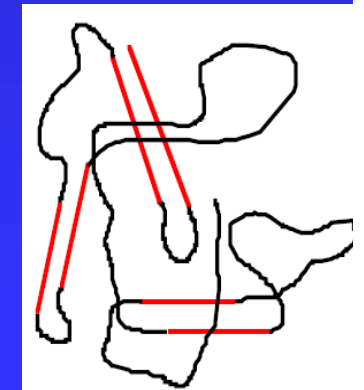
Poly-lactic Acid (PLA) Polymer



Everolimus/PLA Matrix Coating
Thin coating layer
Lower crystallinity
1:1 ratio of Everolimus/PLA matrix
Conformal Coating
Controlled drug release



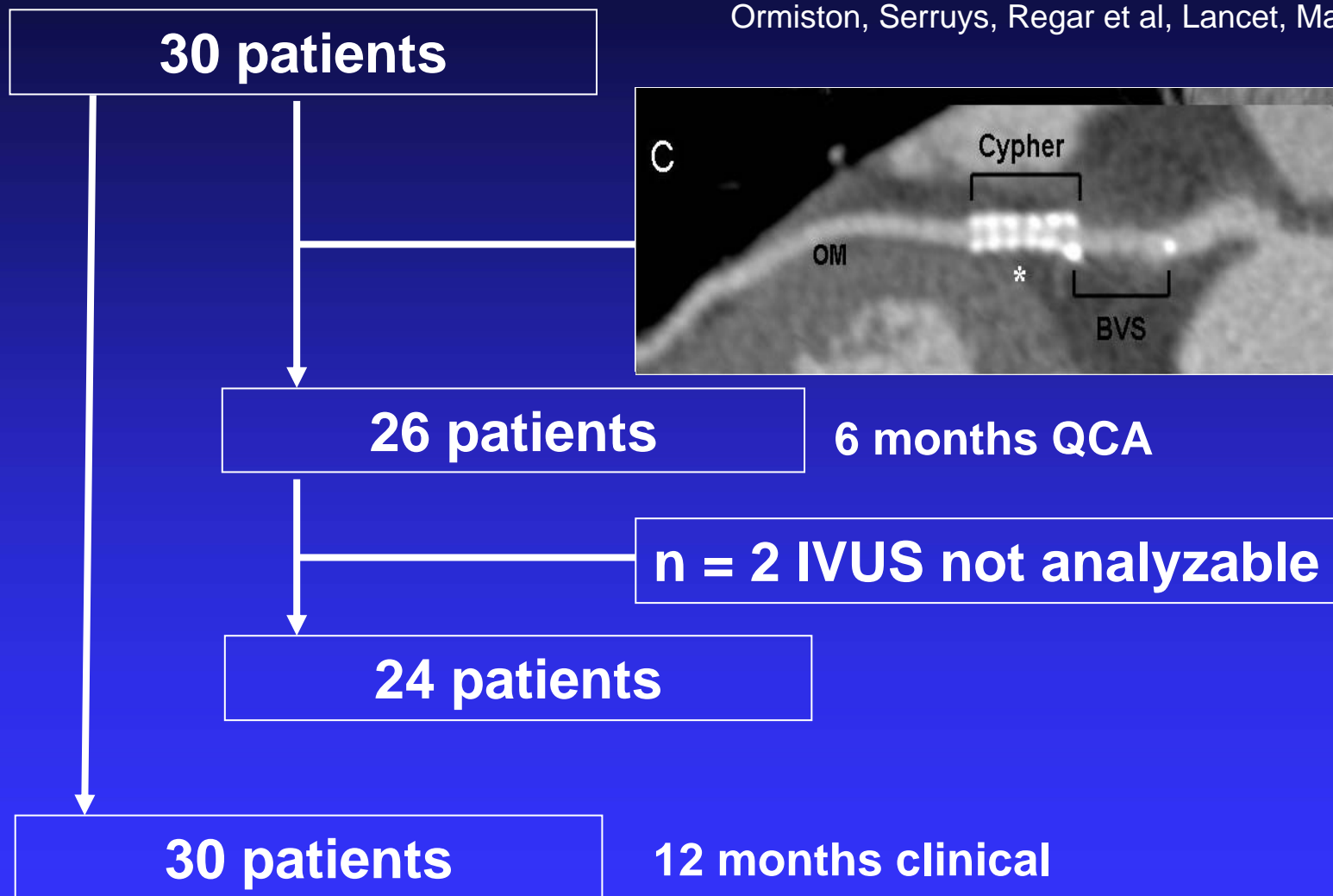
PLA Stent Backbone
Provides stent integrity
Higher crystallinity
Processed for increased radial strength



ABSORB trial-QCA/IVUS

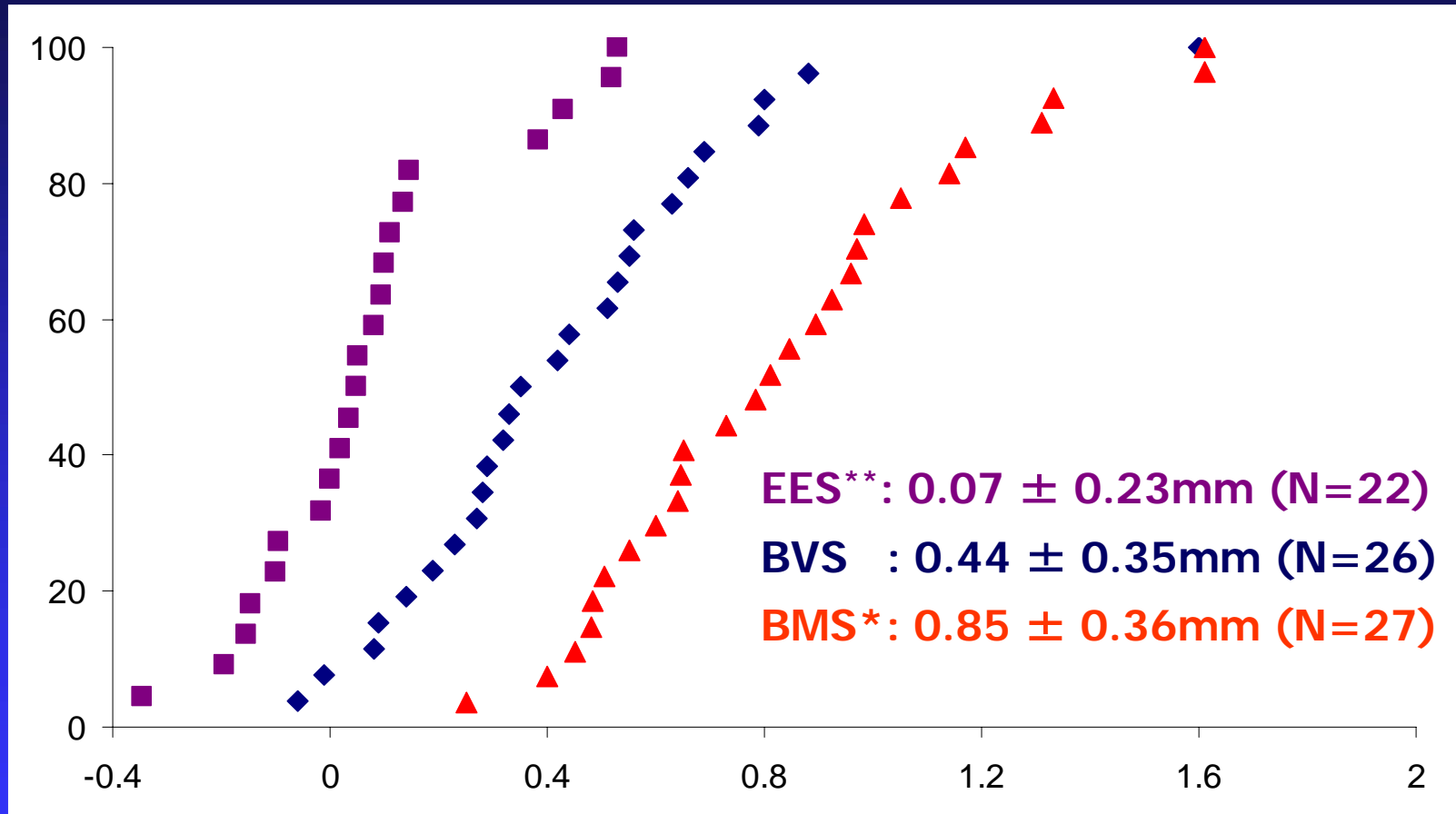
Patient inclusion

Ormiston, Serruys, Regar et al, Lancet, Mar 15, 2008



*One procedure: 3 Cypher stents used to treat the target lesion : study stent implanted in non target lesion due to partial stent dislodgment.

Late Loss

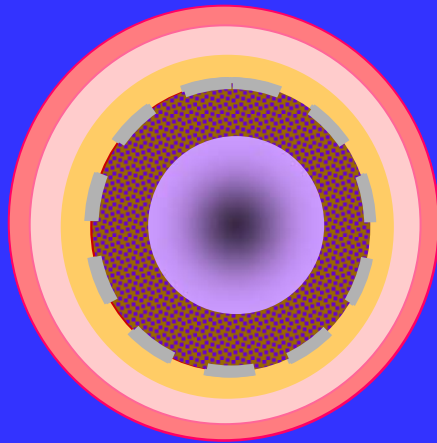


* BMS loss from SPIRIT FIRST (n=27)

** EES loss of pts with 3.0 x 18mm for single lesion from SPIRIT FIRST and II (n=22)

What is Contributing to Late Loss?

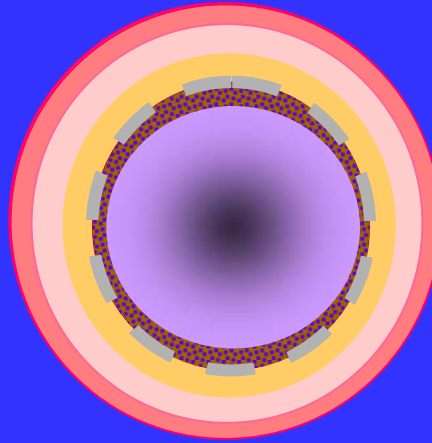
**SPIRIT-First
ML vision Stent**



Late Loss = 0.87mm

Δ Vessel Area	= -1.9%
Δ Stent Area	= -2.0%
Δ Lumen Area	= -29.4%
NIH Area (mm ²)	= 1.98
% VO	= 28.1%

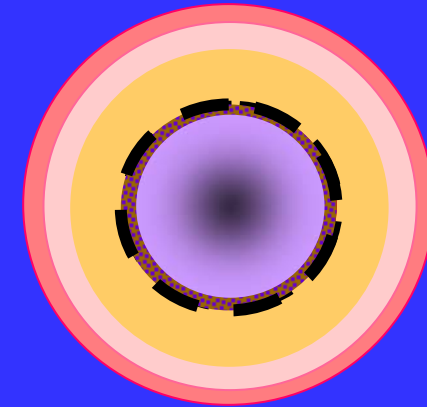
**SPIRIT-First
Xience V stent**



Late Loss = 0.10mm

Δ Vessel Area	= +1.2%
Δ Stent Area	= -0.3%
Δ Lumen Area	= -7.2%
NIH Area (mm ²)	= 0.50
% VO	= 8.0%

**ABSORB
BVS stent**



Late Loss = 0.44mm

Δ Vessel Area	= -0.4%
Δ Stent Area	= -11.7%
Δ Lumen Area	= -16.6%
NIH Area (mm ²)	= 0.30
% VO	= 5.5%

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

12 month Clinical Results

Hierarchical	30 Days 30 Patients	12Months 30 Patients
Cardiac Death (%)	0.0% (0)	0.0% (0)
MI (%)	0.0% (0)	3.3% (1)*
Q-Wave MI	0.0% (0)	0.0% (0)
Non Q-Wave MI	0.0% (0)	3.3% (1)*
Ischemia Driven TLR (%)	0.0% (0)	0.0% (0)
by PCI	0.0% (0)	0.0% (0)
Ischemia Driven MACE (%)	0.0% (0)	3.3% (1)*

•This patient also underwent a TLR, not qualified as ID-TLR, since the DS was 42%.
One patient withdrew consent from the study, however, at 12 months the patient was alive, had not been admitted a hospital, so did not undergo any percutaneous or surgical intervention

Ormiston, Serruys, Regar et al, Lancet, Mar 15, 2008

BVS
Stent

The Absorb trial

IVUS

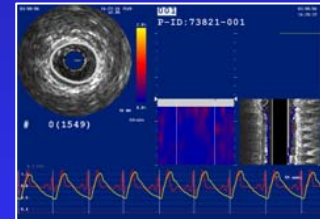
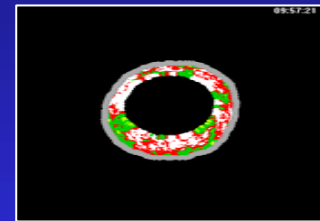
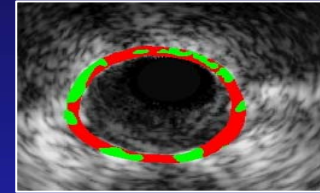
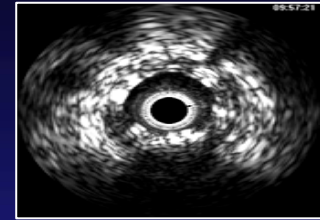
Echogenicity

IVUS-VH

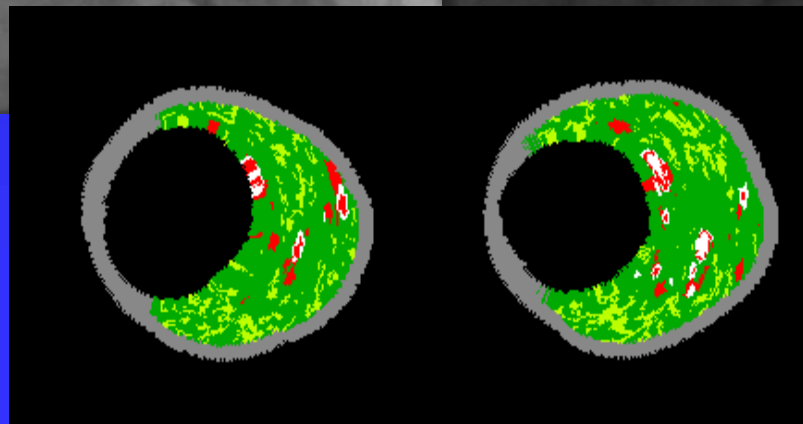
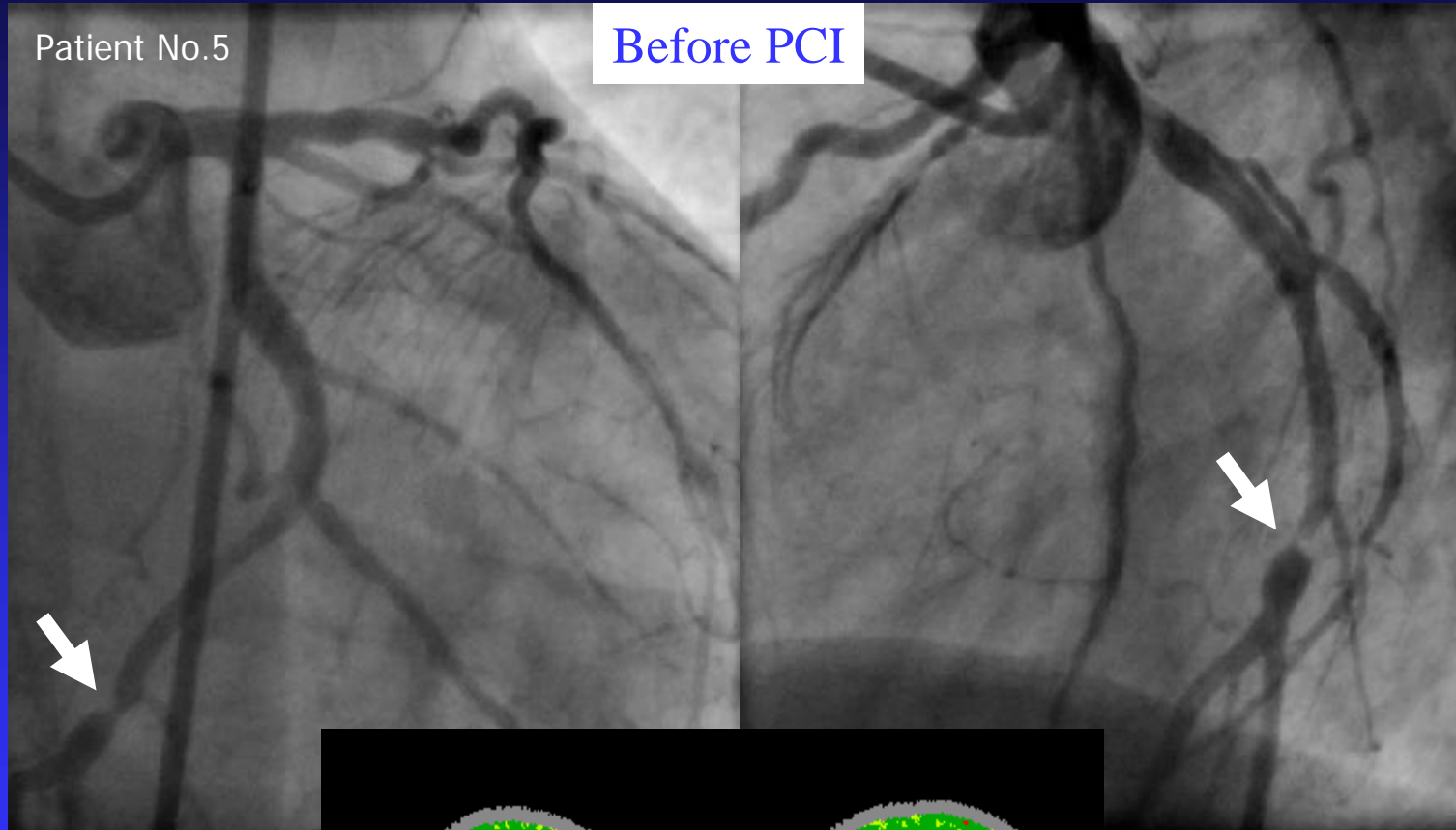
Palpography

OCT

MSCT

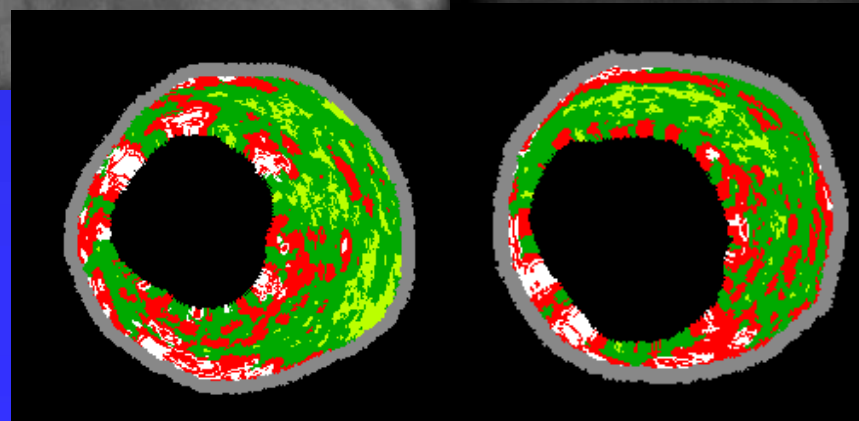
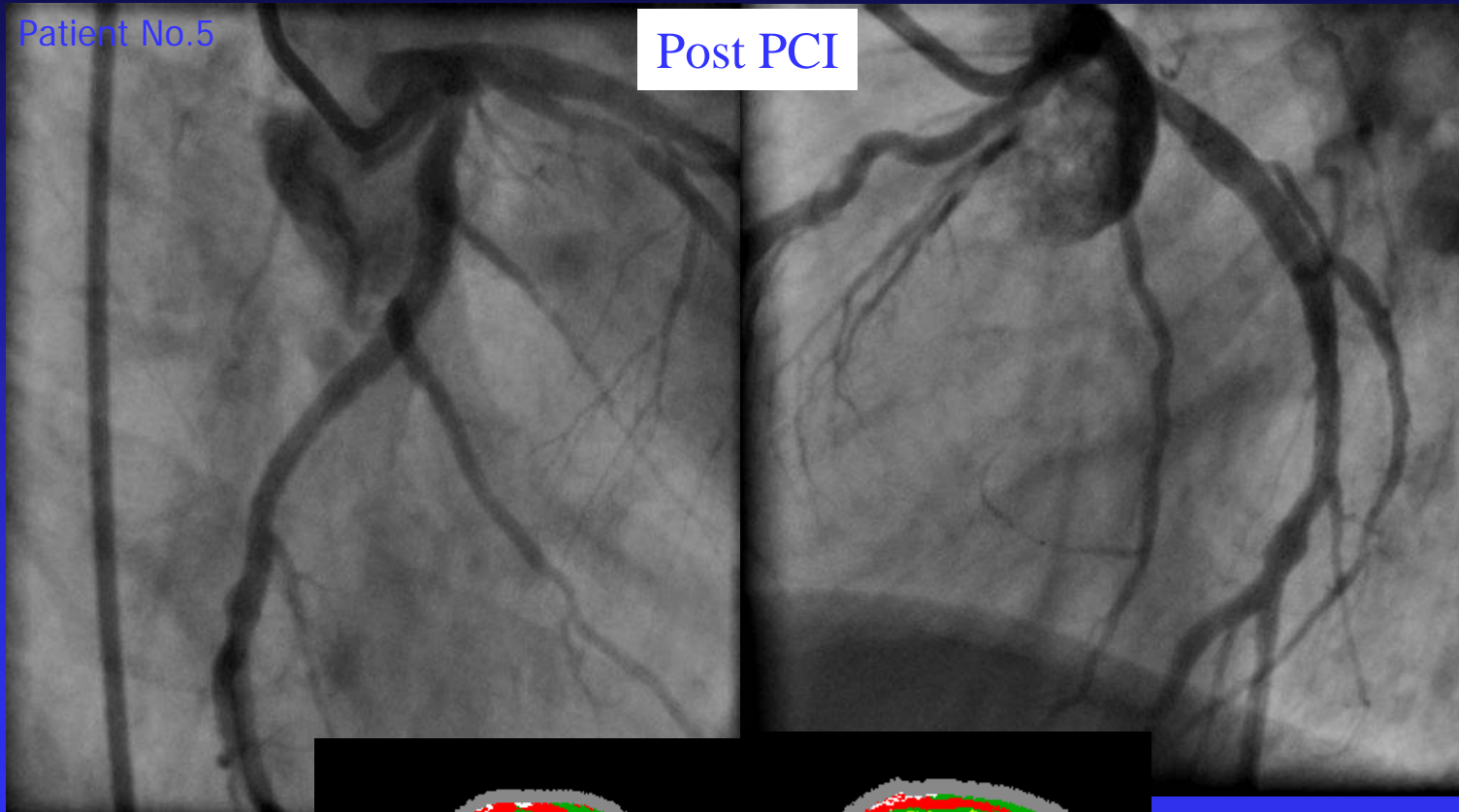


IVUS-VH pre BVS implantation



Ormiston, Serruys, Regar et al, Lancet, Mar 15, 2008

IVUS-VH post BVS implantation



Ormiston, Serruys, Regar et al, Lancet, Mar 15, 2008

Pre-stenting

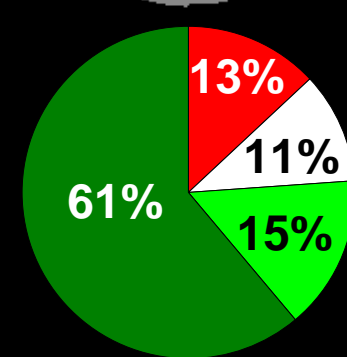
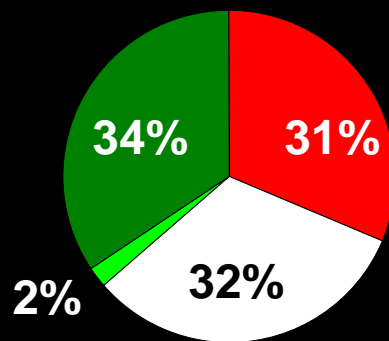
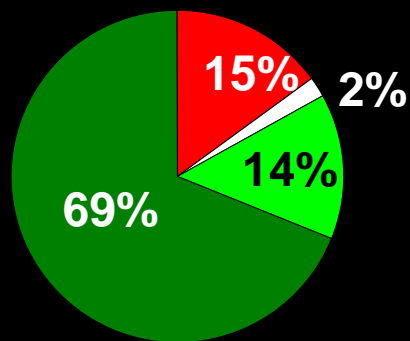
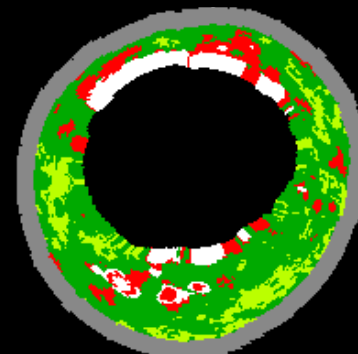
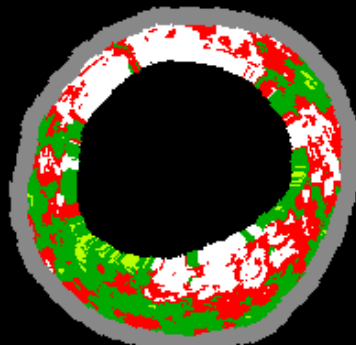
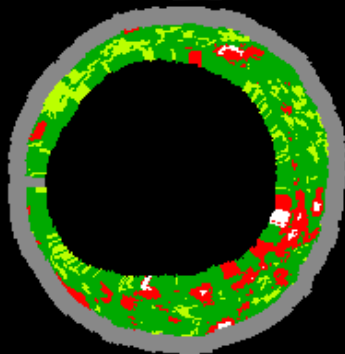
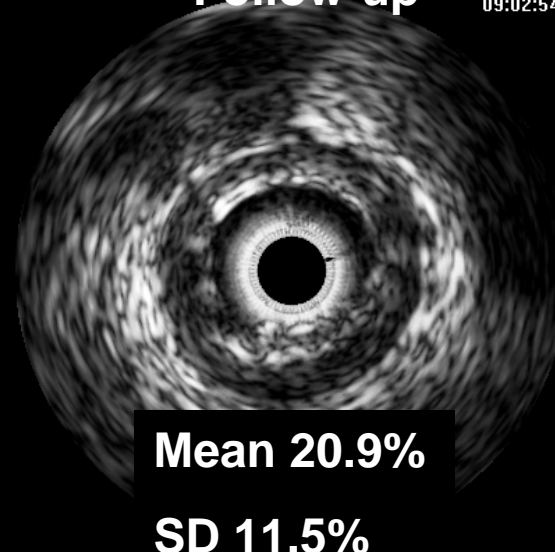
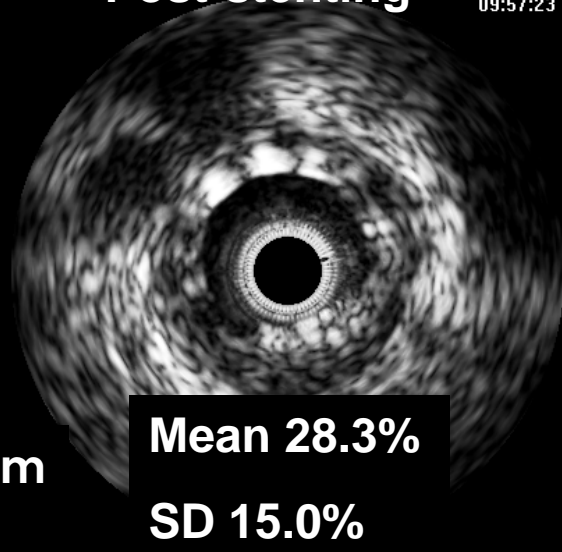
09:38:31

Post-stenting

09:57:23

Follow-up

09:02:54



Fibrous

Fibrofatty

Dense Calcium

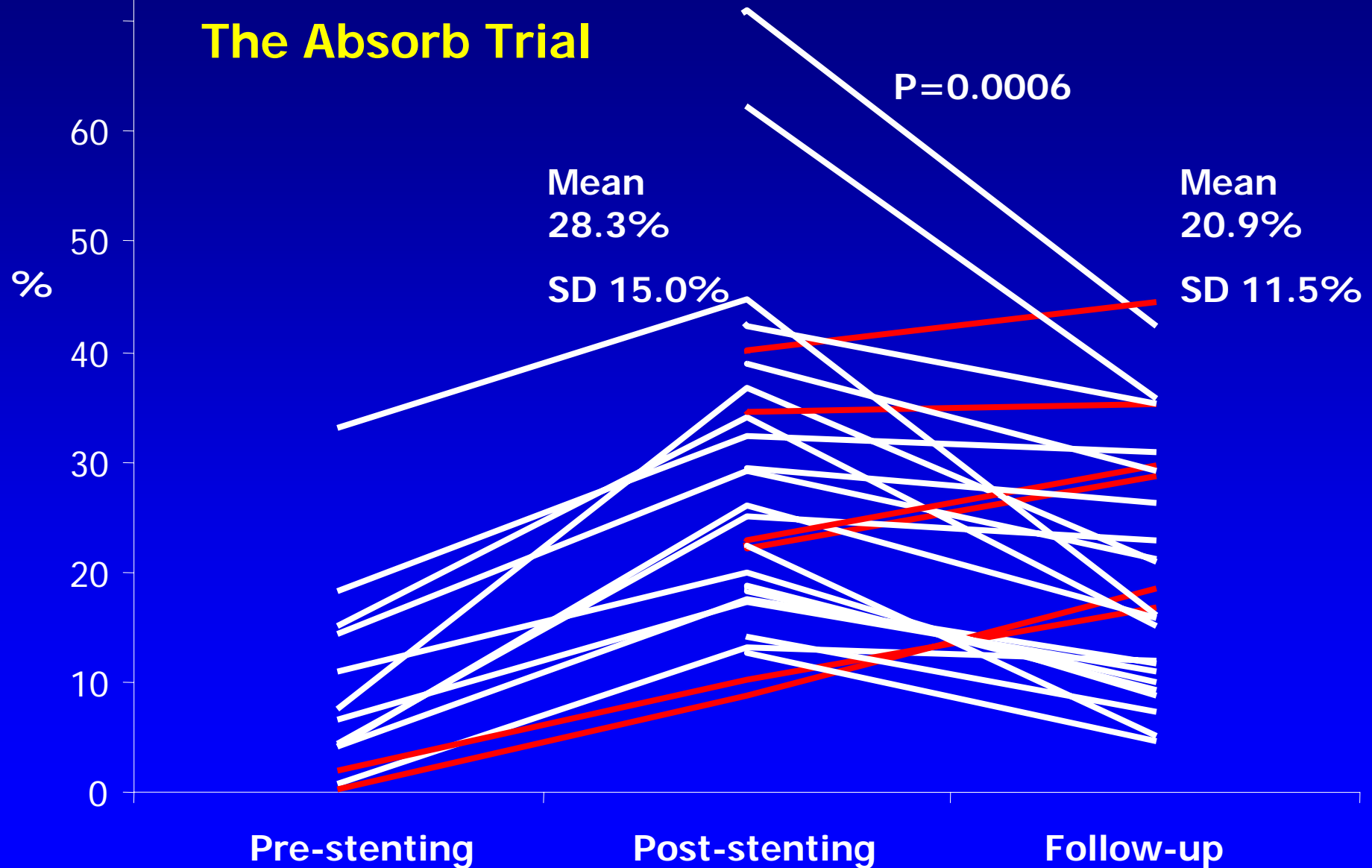
Necrotic Core

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Dense Calcium, n= 27 pts

Ormiston, Serruys, Regar et al,
Lancet, Mar 15, 2008

The Absorb Trial



Potential usefulness of virtual histology to characterize the temporal changes in bioabsorbable everolimus-eluting stents.

- The quantitative assessment of the radiofrequency change at 6 mos suggests a reduction of the DC compatible with early struts modification of the biomaterial of the struts; Imaging at late FU (2 yrs) will further confirm the surrogate value of VH in assessing the bioabsorption process of the BVS.

BVS
Stent

The Absorb trial

IVUS

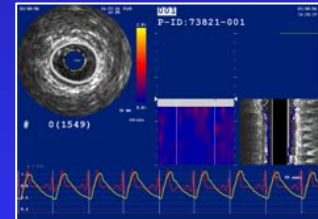
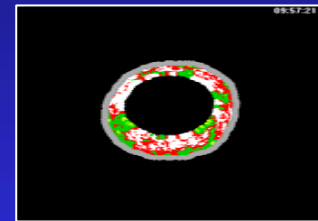
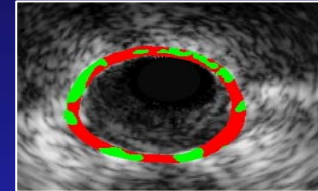
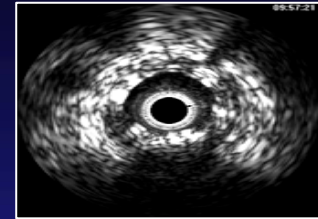
Echogenicity

IVUS-VH

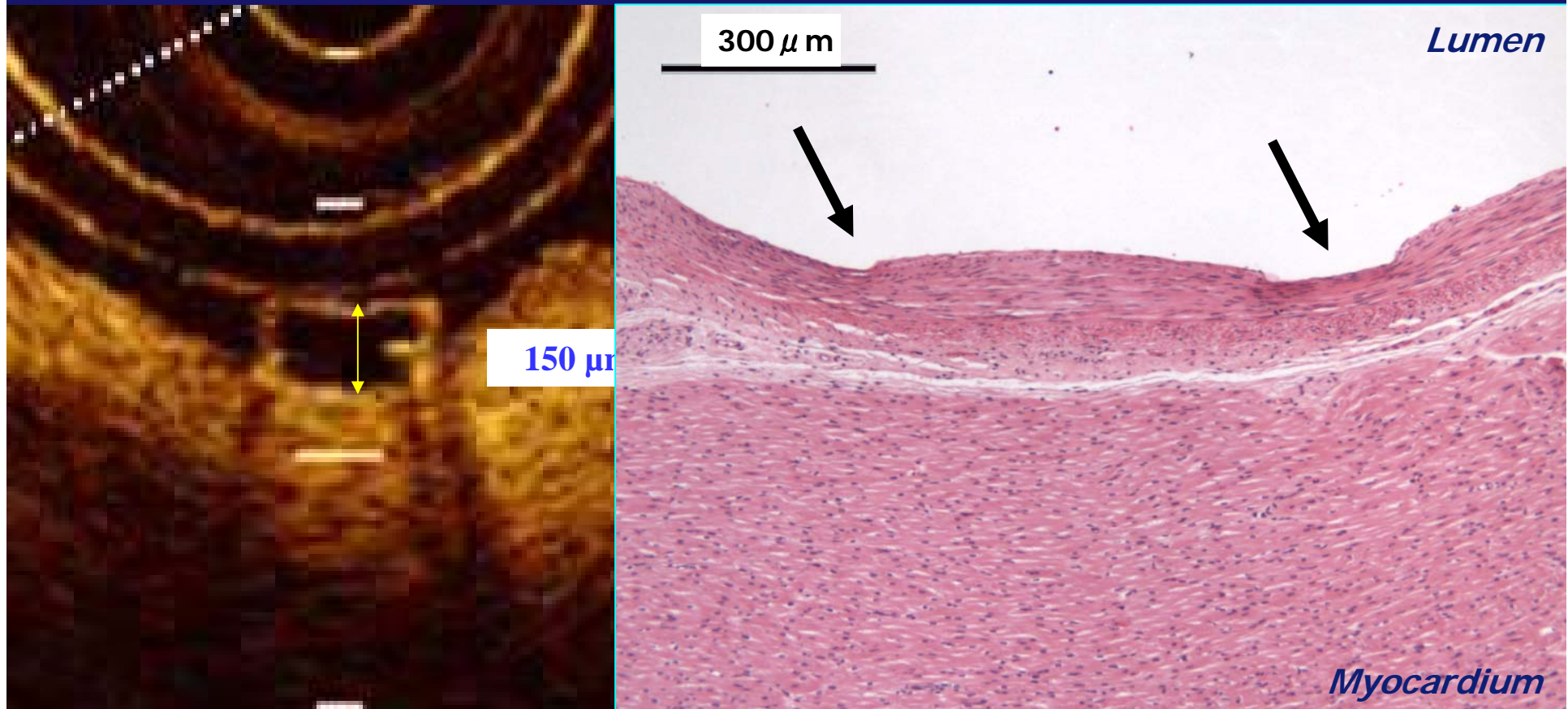
Palpography

OCT

MSCT



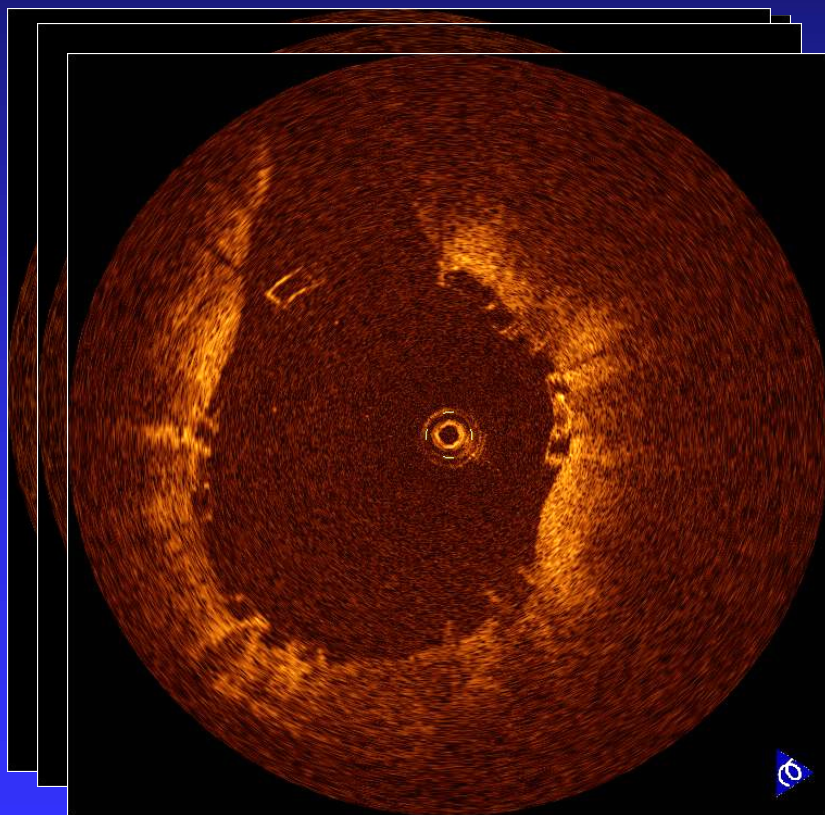
Can we measure at follow-up the mass reduction of the strut ?



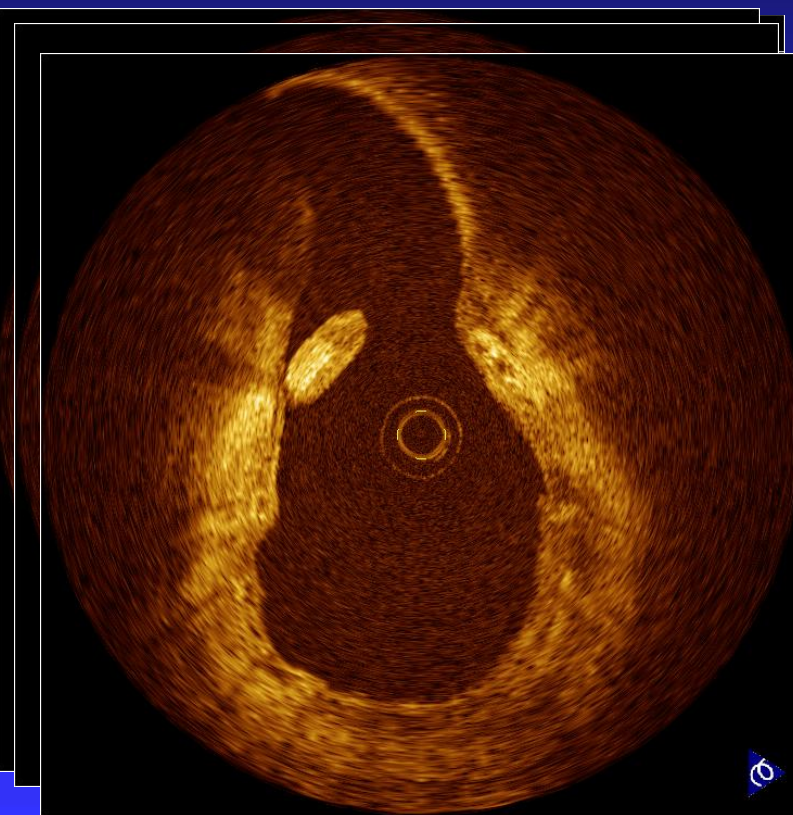
Ormiston, Serruys, Regar et al, Lancet, Mar 15, 2008

Case Example

Baseline



FUP



ƒ proximal side branch

Ormiston, Serruys, Regar et al, Lancet, Mar 15, 2008

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

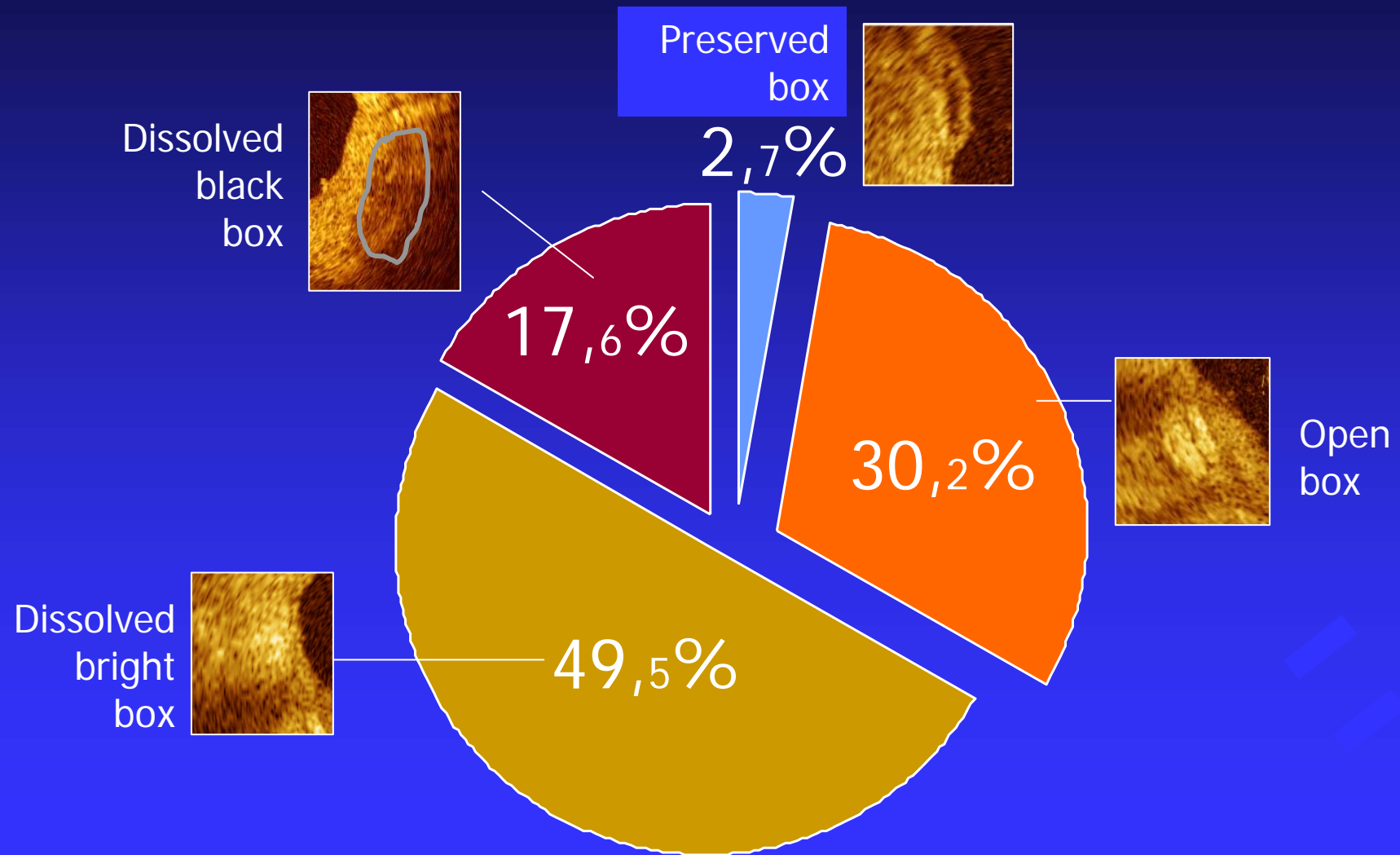
Qualitative OCT Parameters

Follow-Up Stent Strut Appearance

A	B	C	D
Preserved box	Open box	Dissolved bright box	Dissolved black box
Sharp defined, bright reflection borders with preserved box shaped appearance Strut body shows low reflection	Luminal and abluminal "long-axis" borders thickened bright reflection; "short axis" borders not visible	Partially visible bright spot, contours poorly defined no box shaped appearance	Black spot, contours poorly defined, often confluent no box shaped appearance

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Stent Strut Appearance (FUP) – Analysis B

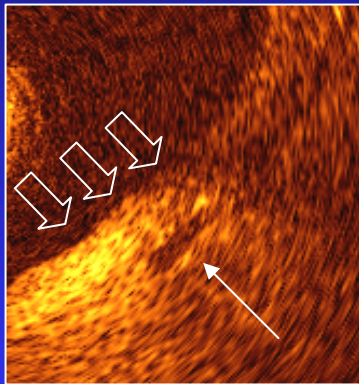


Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Qualitative OCT Parameters

Follow-Up Stent Strut Coverage

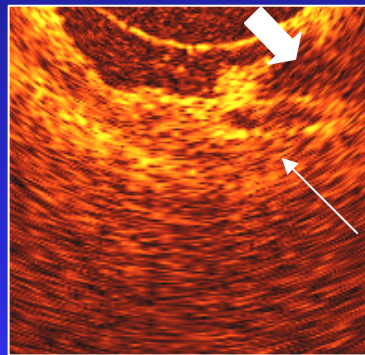
A



Complete

Strut is covered on luminal side with tissue and fully embedded in vessel wall
Or strut is circumferentially covered if a strut was incomplete apposed

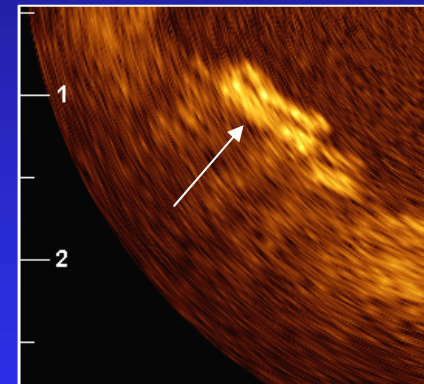
B



Incomplete

Strut partially covered with tissue

C

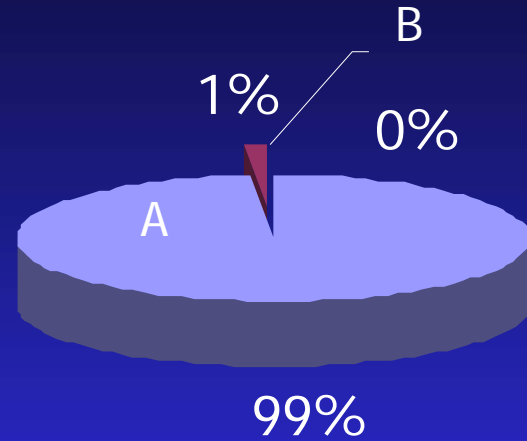


Not visible

no visible tissue around stent struts

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Stent Strut Coverage (FUP)

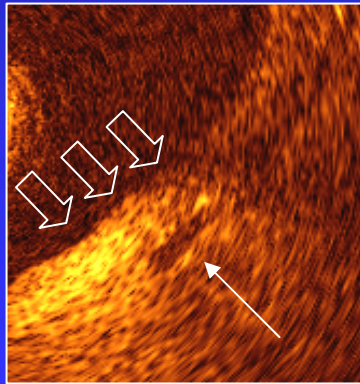


n= 13 stents
n=671 struts

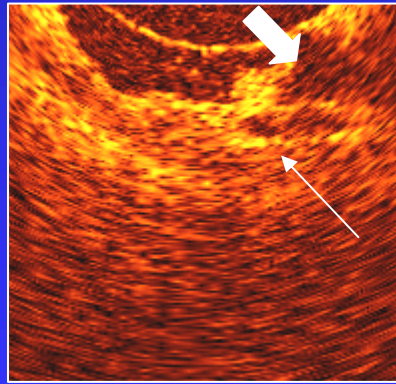
A 

B 

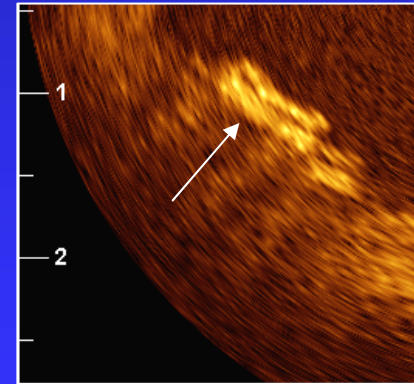
C 



Complete



Incomplete

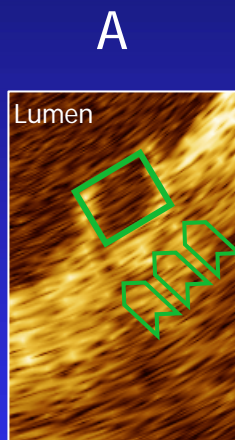


Not visible

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

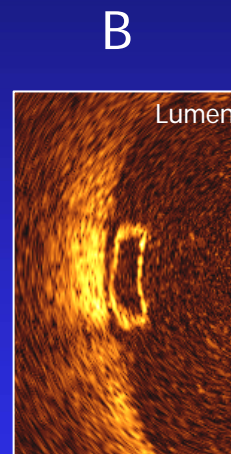
Qualitative OCT Parameters

Baseline Stent Strut / Vessel Wall Interaction



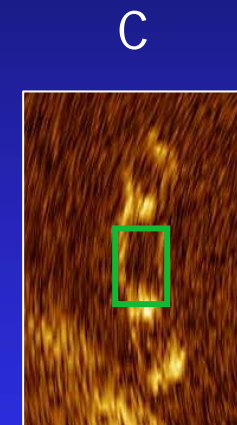
Strut Apposition

Strut is fully attached with its abluminal side to the vessel wall or embedded in the tissue.



Strut Alignment

Strut is not attached with its abluminal side to the vessel. Distance between vessel wall is less than the thickness of struts

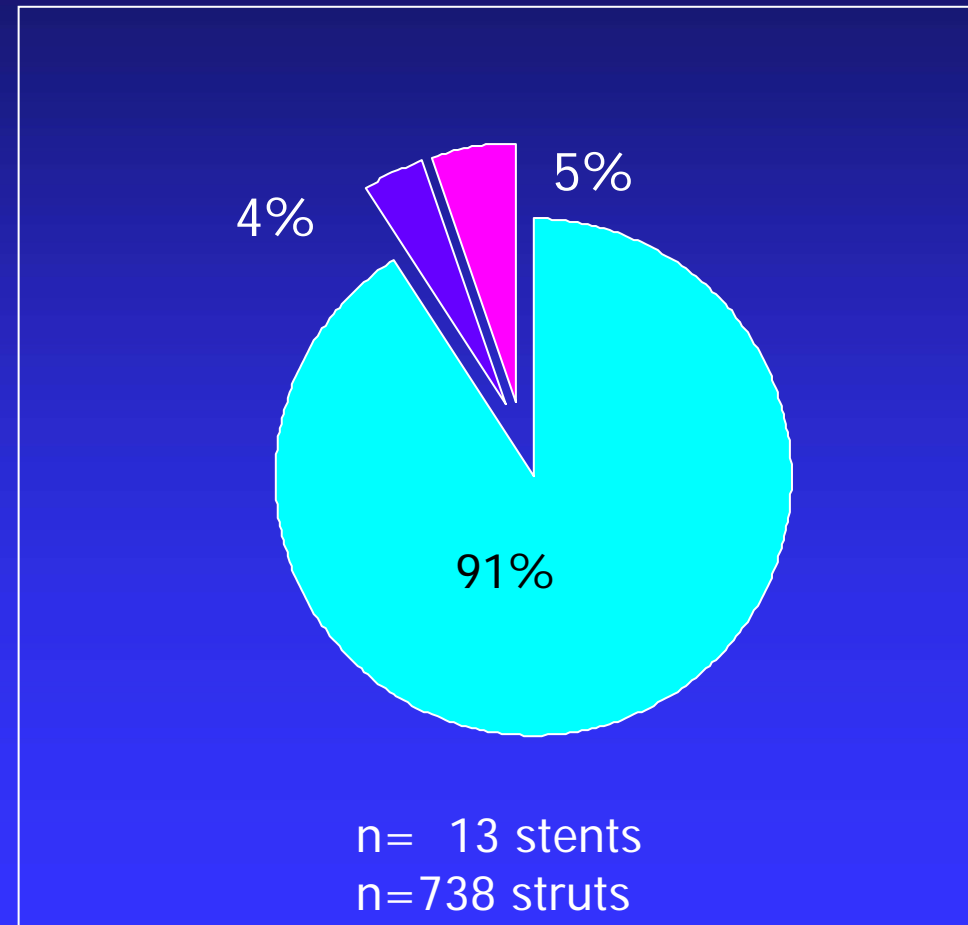
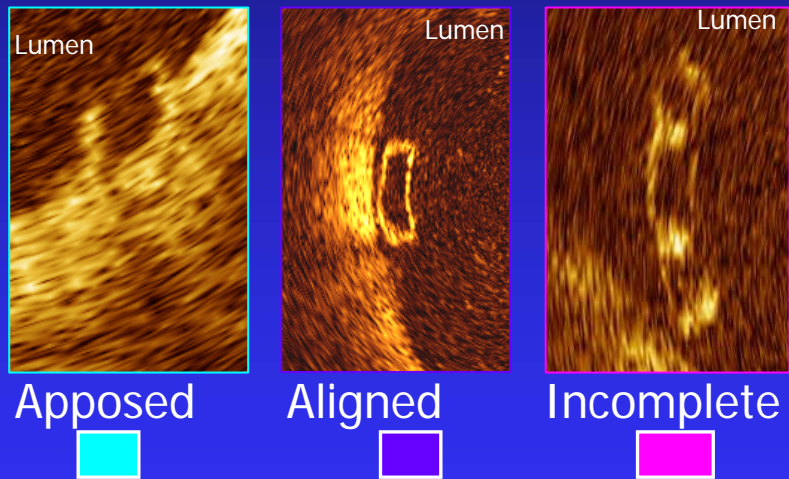


Incomplete Strut Apposition (ISA)

Strut clearly separated from vessel wall, with evidence of flush between the strut and vessel wall

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

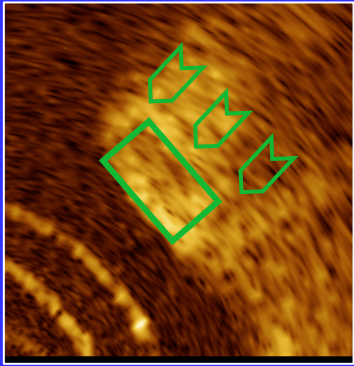
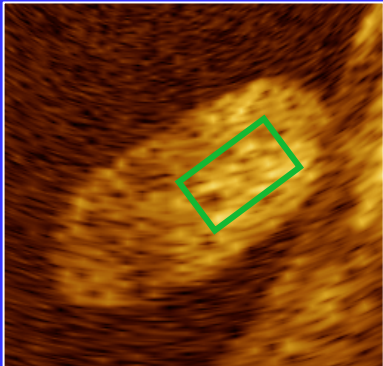
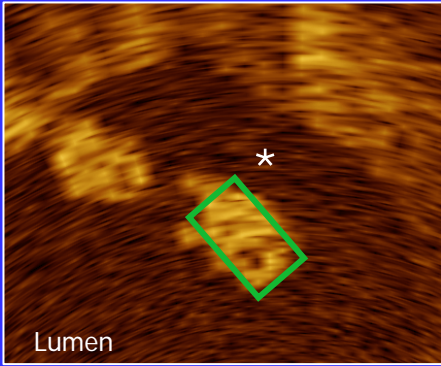
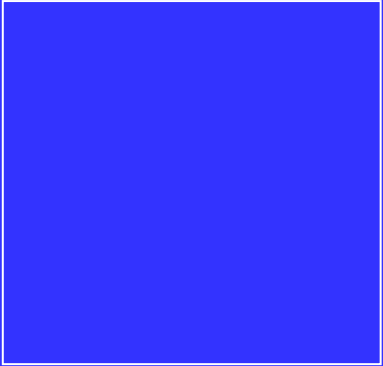
Stent Strut Apposition Baseline



Bioabsorbable Drug Everolimus Eluting Stent (BVS)

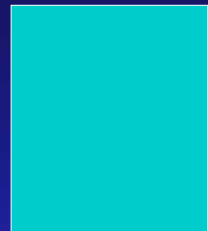
Qualitative OCT Parameters

Follow-Up Stent Strut / Vessel Wall Interaction

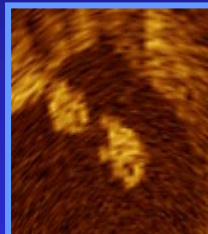
A	B	C	D
			
Apposition	PISA	LAISA	Resolved ISA
<p>Strut is fully attached to vessel wall or embedded in the tissue. The luminal surface of the stent continues smoothly to the adjacent tissue.</p>	<p>Persistent incomplete strut apposition with incomplete vessel wall contact as observed at baseline * Can be associated with side branch</p>	<p>Late acquired incomplete strut apposition with incomplete vessel wall contact not present at baseline* * Can be associated with side branch</p>	<p>Alignment or ISA present after the procedure but no longer present at follow-up</p>

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

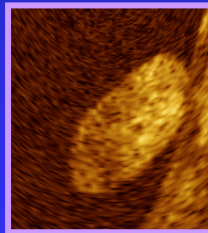
Stent Strut Apposition Follow-up



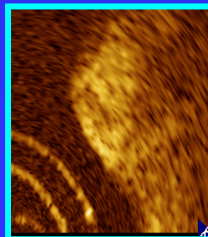
Resolved
ISA



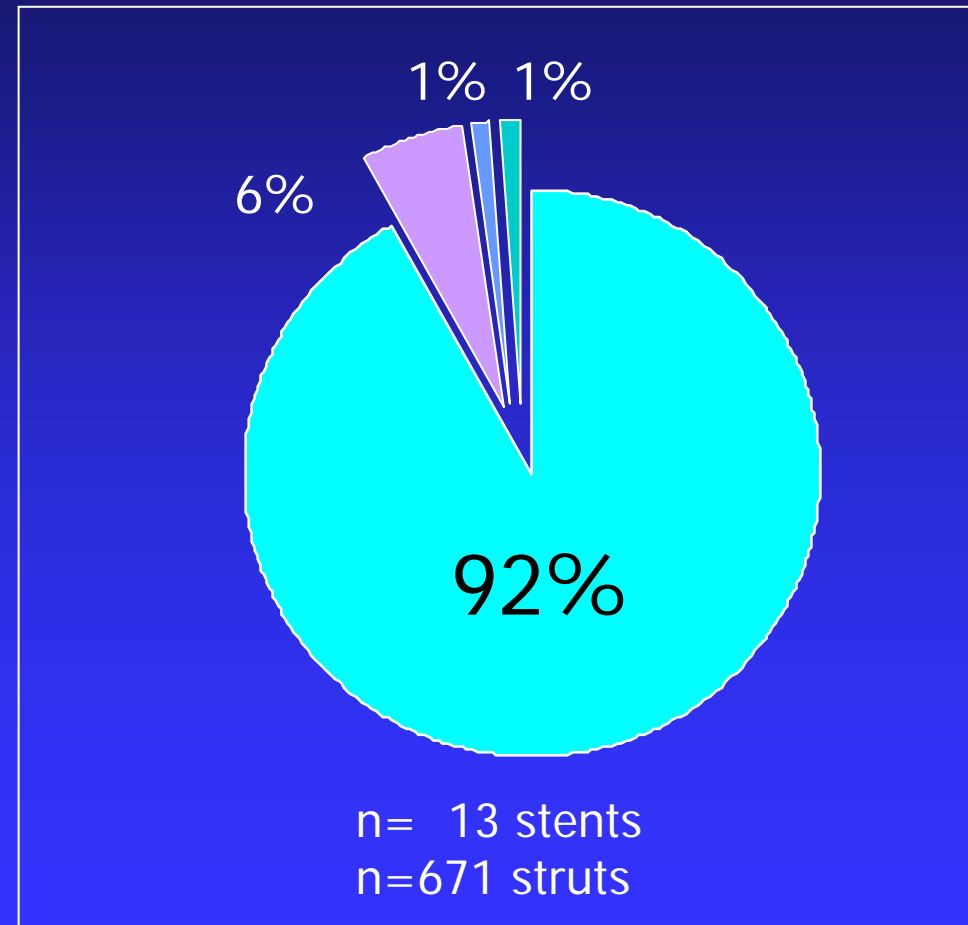
LAISA



PISA

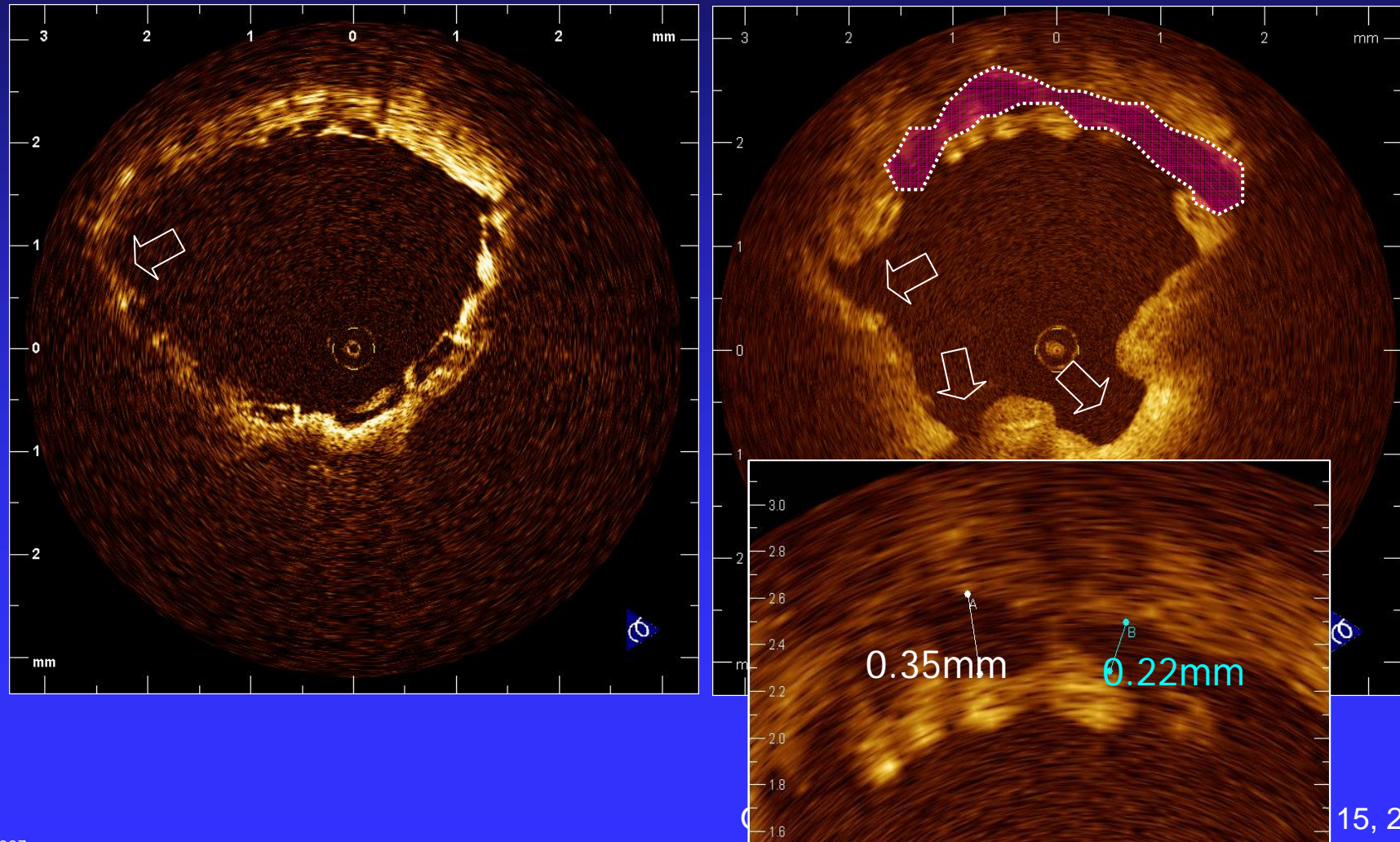


Apposed



Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Late Acquired Incomplete Strut Apposition (LAISA)



Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Summary & Conclusion

At baseline,

- Virtually all struts (91%) were well apposed to the vessel wall with a mean stent area of $6,72 \pm 1,13 \text{mm}^2$
- *Leading cause for incomplete strut apposition was the presence of a side branch. Struts were "free" in the lumen of the carina.*

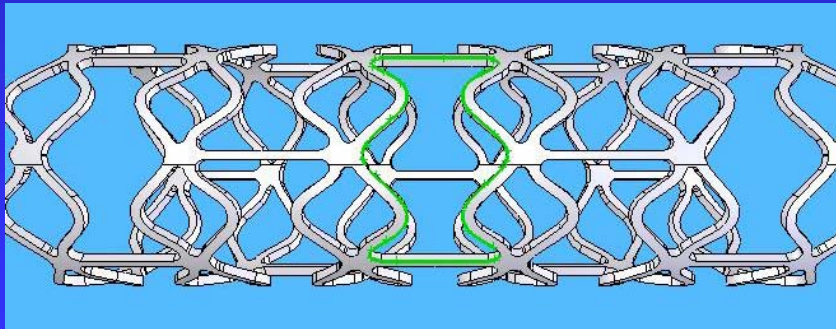
At 6 months follow-up,

- Virtually all struts (99%) showed tissue coverage.
- Two third of the struts showed changes in strut geometry and in optical properties (dissolved bright box or dissolved black box appearance).
- Late acquired incomplete stent apposition was observed in 3/13 of stents (23%). The clinical significance of this finding is unknown.

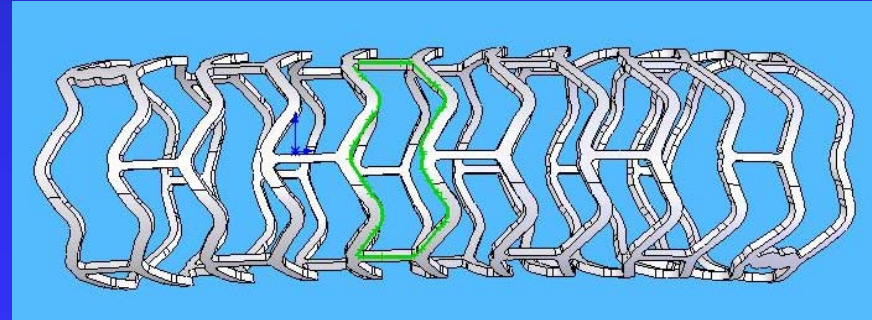
Conclusions

At 6 months follow-up Everolimus eluting from a bioabsorbable polymer is safe and effective:

- Acceptable in-stent late loss (0.44mm) possibly driven by bioactive remodelling or mechanical late recoil which is being addressed by a modification of the stent design



3.0 x 12 mm Gen. 1.0



3.0 x 12 mm Gen. 1.1

Conclusions

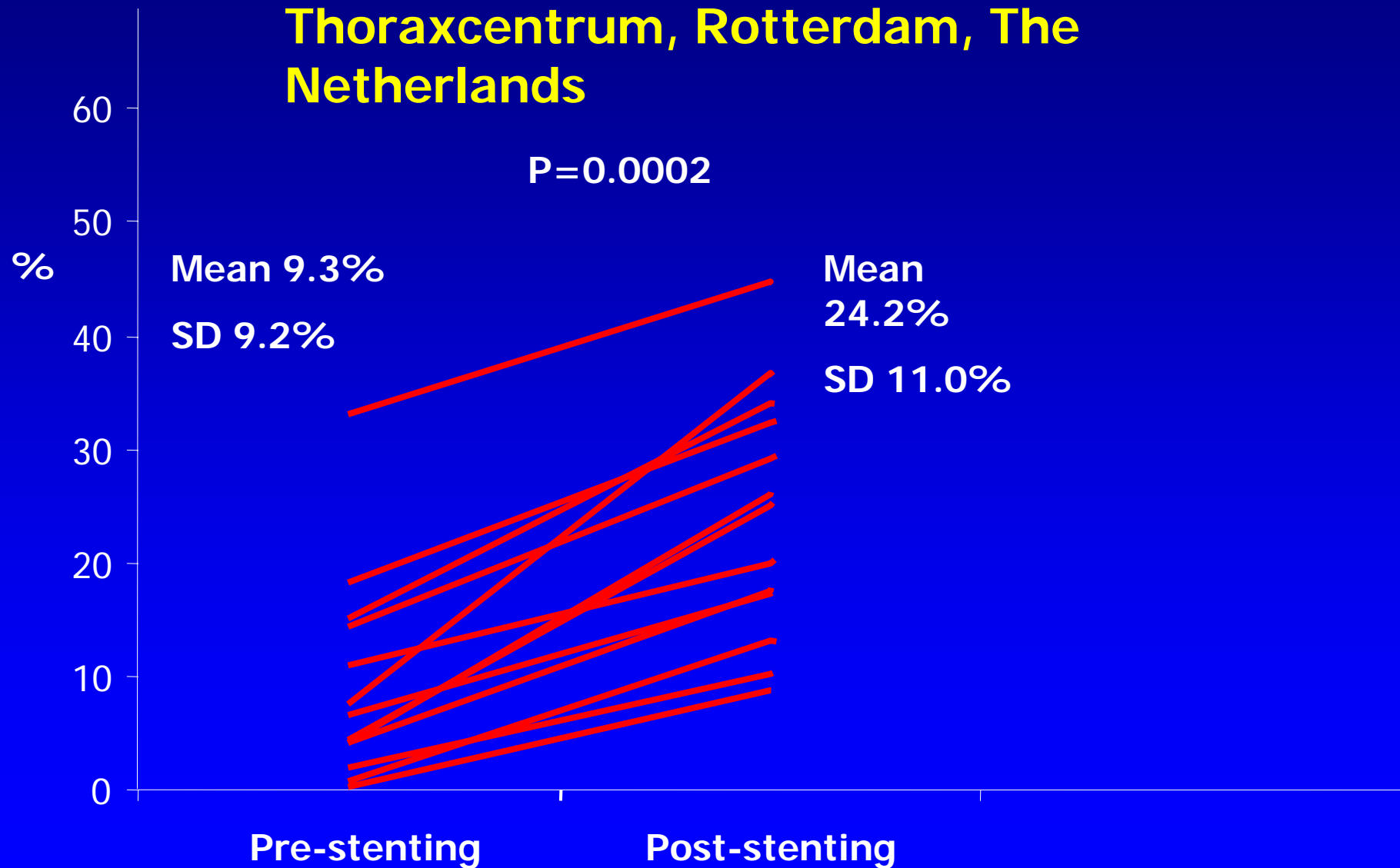
At 12 months follow-up, the bioabsorbable everolimus eluting stent is safe and effective:

- Acceptable in-stent late loss (0.44mm) possibly driven by bioactive remodelling or mechanical late recoil which is being addressed by a modification of the stent design
- Reduced intra-stent neointimal hyperplasia
Overall, stent area obstruction is a low 5.5%. A value close to SPIRIT FIRST and SPIRIT II trials (Everolimus metallic DES)
- Low MACE rate (3.3%), no ID-TLR
- No occurrence of Late Stent Thrombosis

Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Dense Calcium, n= 13 pts

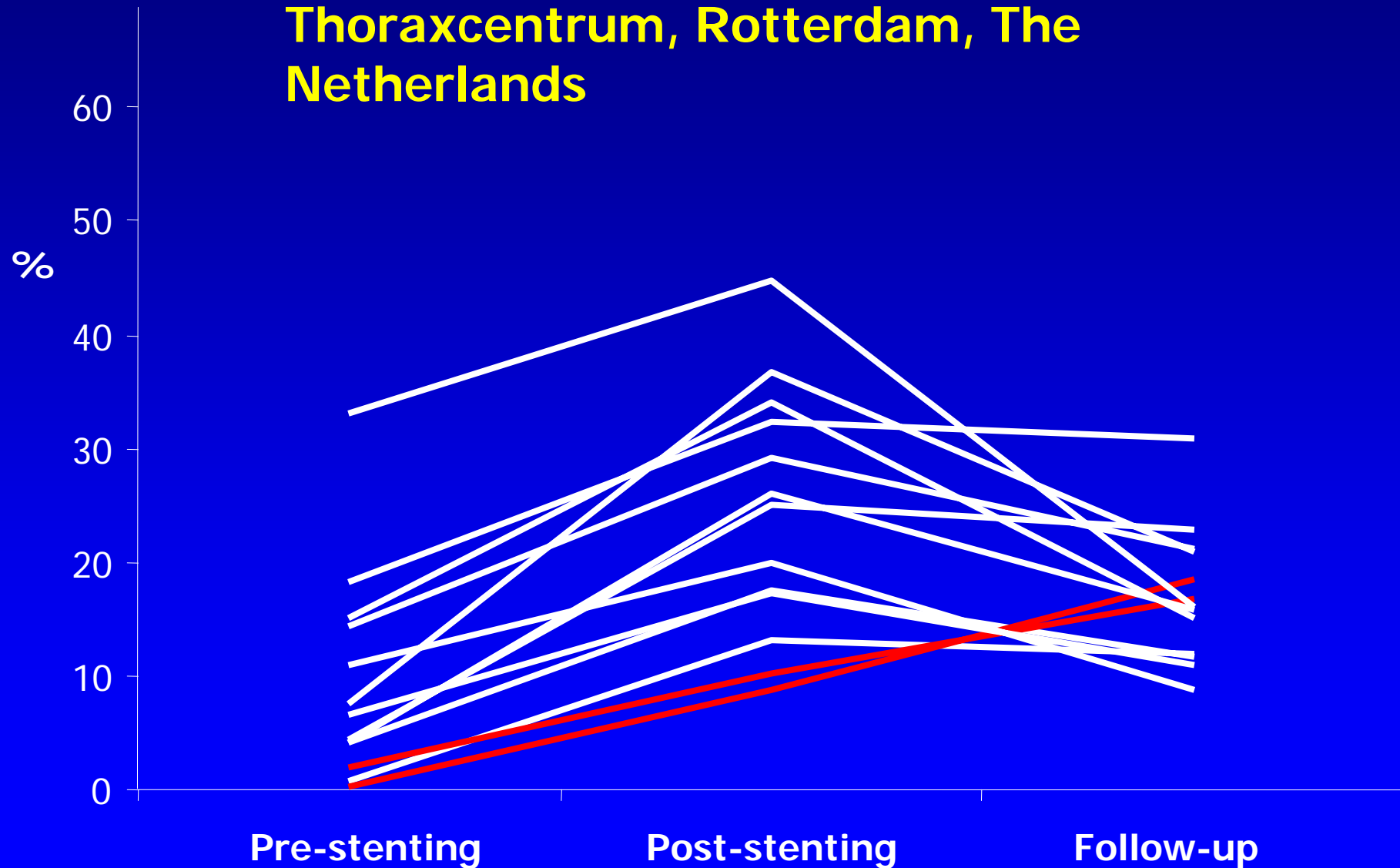
Thoraxcentrum, Rotterdam, The Netherlands



Bioabsorbable Drug Everolimus Eluting Stent (BVS)

Dense Calcium, n= 13 pts

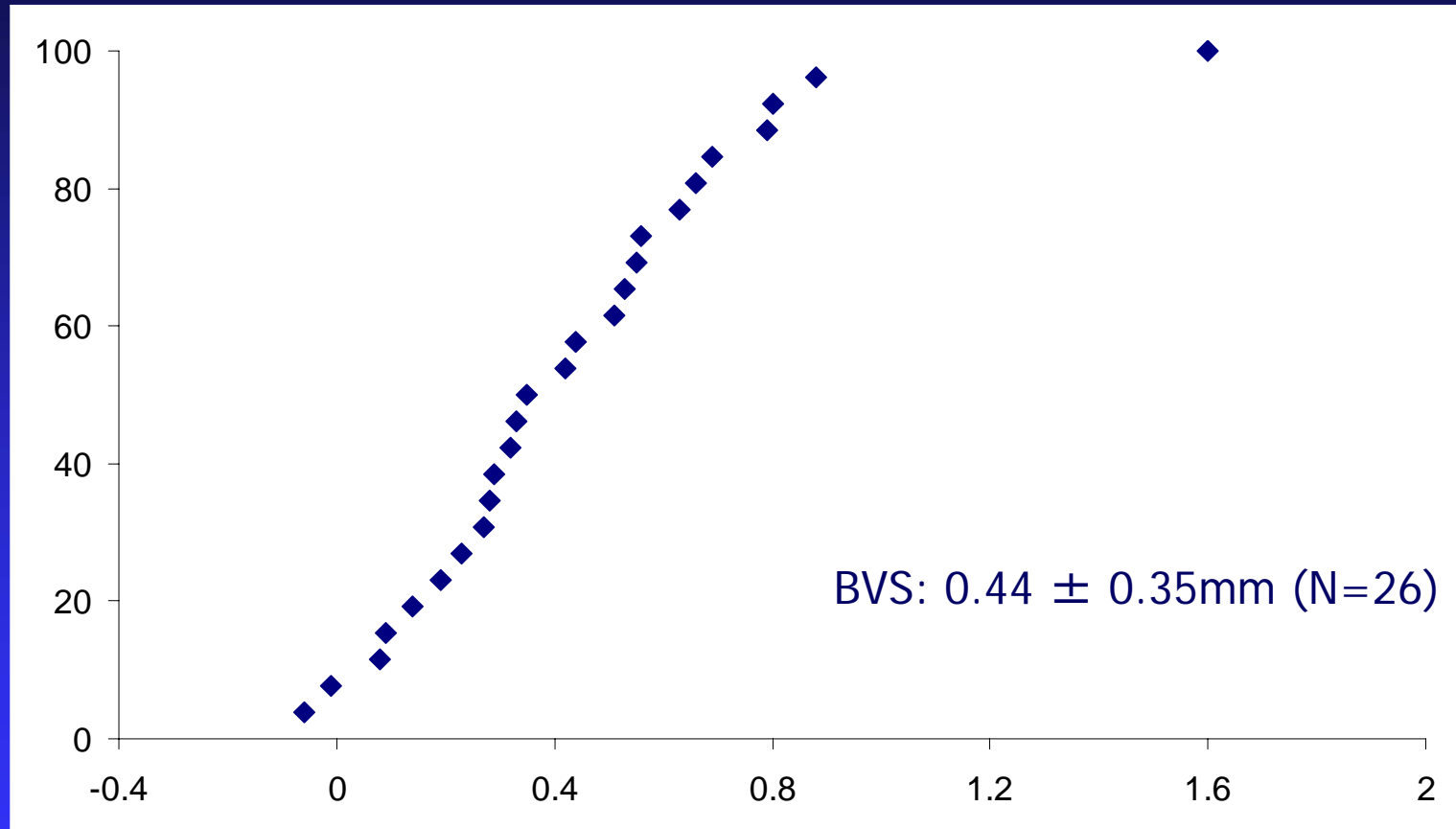
Thoraxcentrum, Rotterdam, The Netherlands



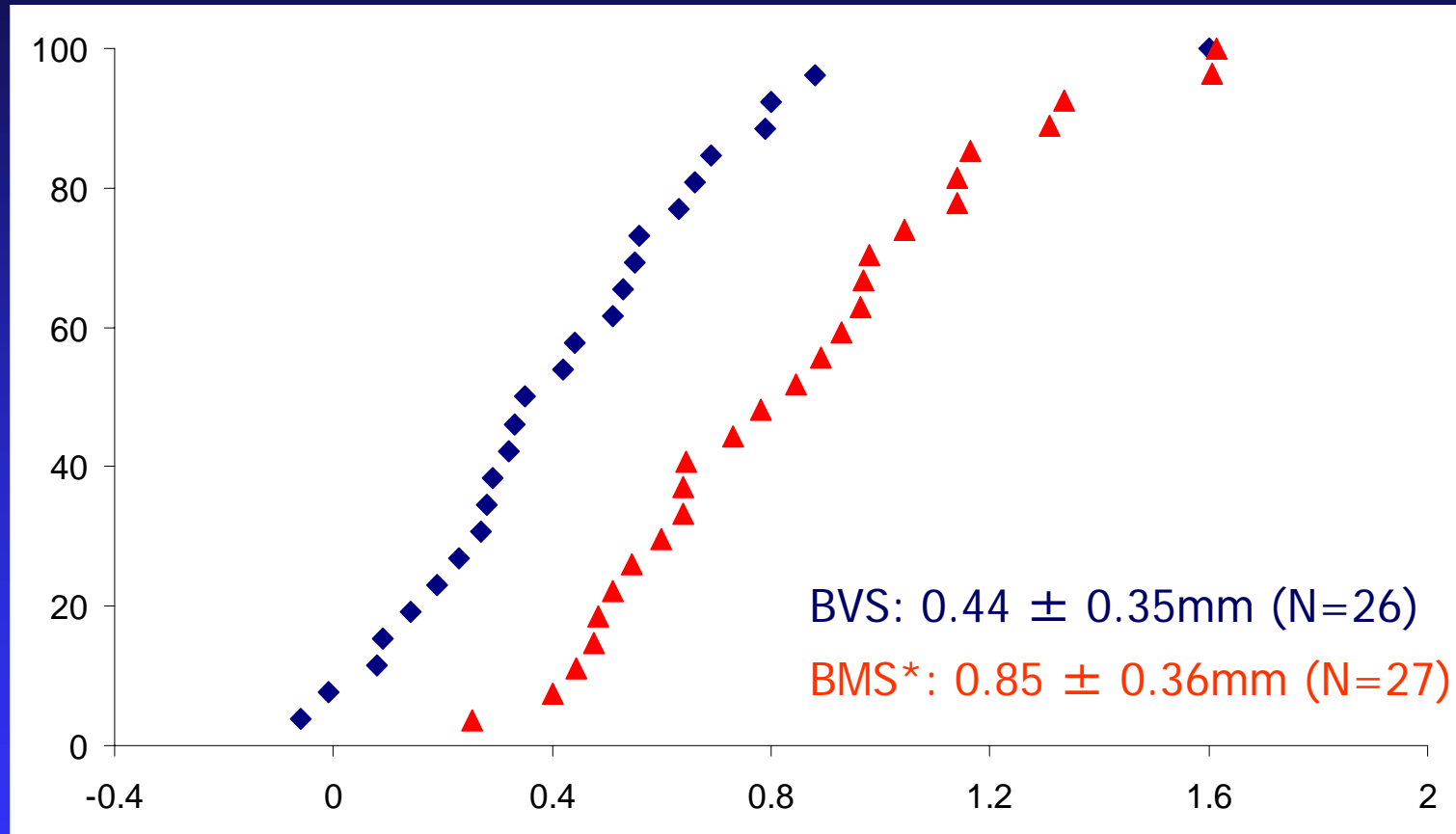
Follow-up Schedule

- **Clinical follow-up at 30, 180, 270 days and 1, 2, 3, 4, 5 years**
- **Angiography, IVUS, IVUS-Virtual Histology (VH) and Palpography for all patients at baseline, 180 days and 2 years**
- **Optical Coherence Tomography (OCT) at baseline, 180 days and 2 years in up to 10 patients in each cohort**
- **Multi-slice Computed Tomography (MSCT) scan optional at 18 months**
- **Coronary vasomotion test optional at 2 years**

Late Loss



Late Loss



* BMS loss from SPIRIT FIRST (n=27)



ABSORB MSCT



Imaging Group

Thoraxcenter



Pre-processing

Storage

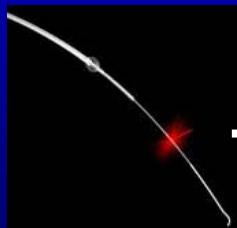
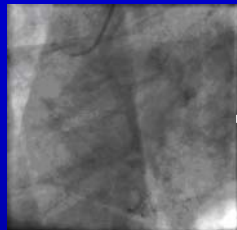
Post-processing & Analyses



Gating & Filtering

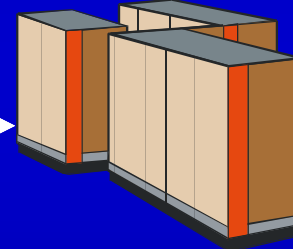


Gating



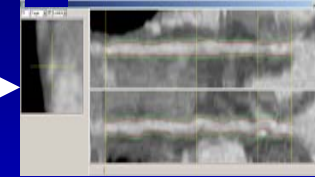
AVI -> DICOM

Gating!

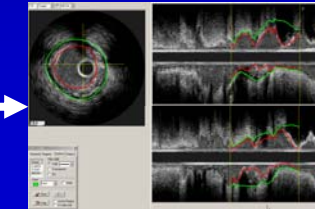


THO-PACS

QMSCTA



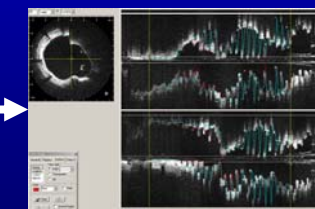
QCU



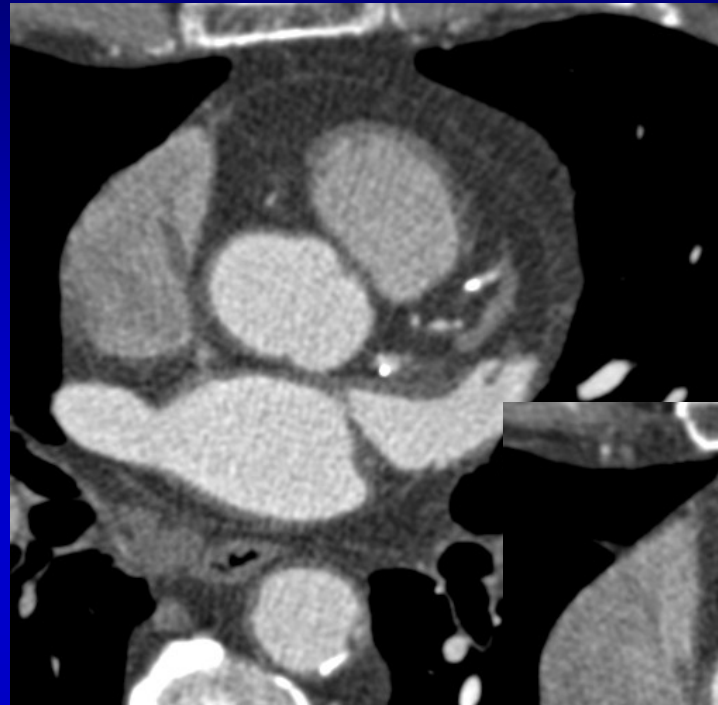
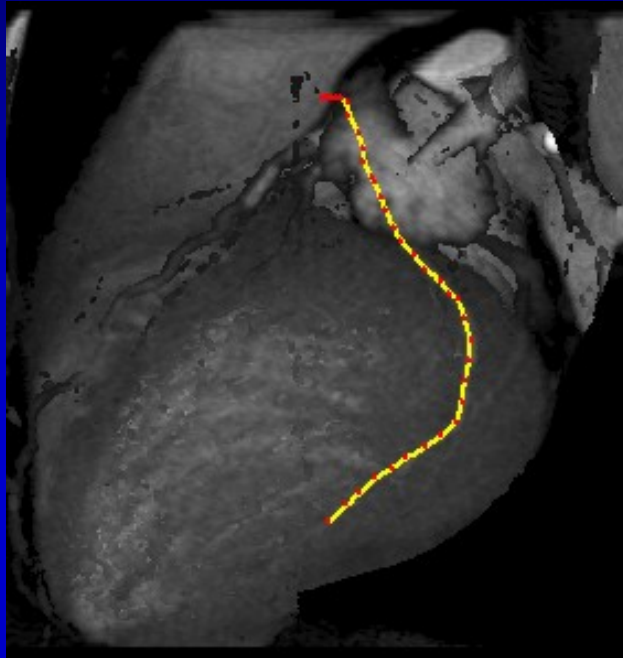
QCA



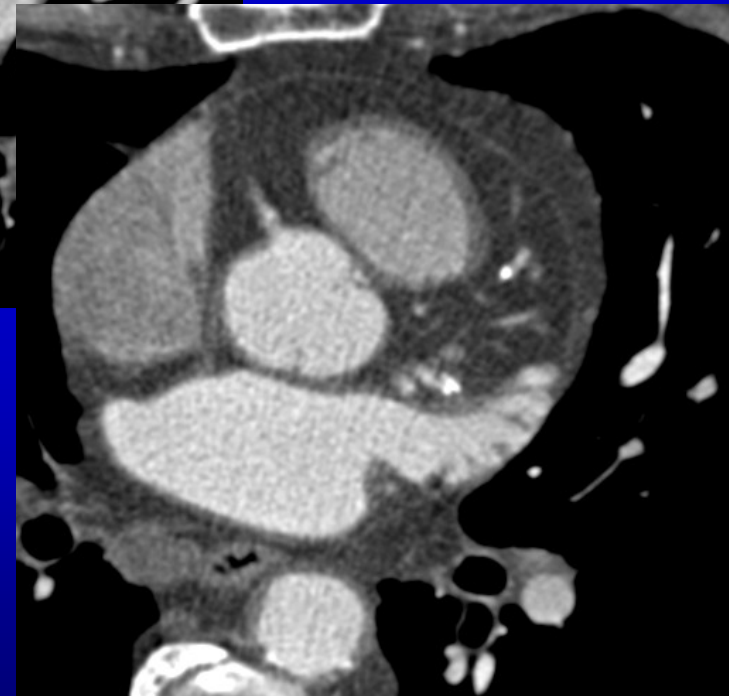
QOCT



MSCT Examination of a BVS Stent in LCX



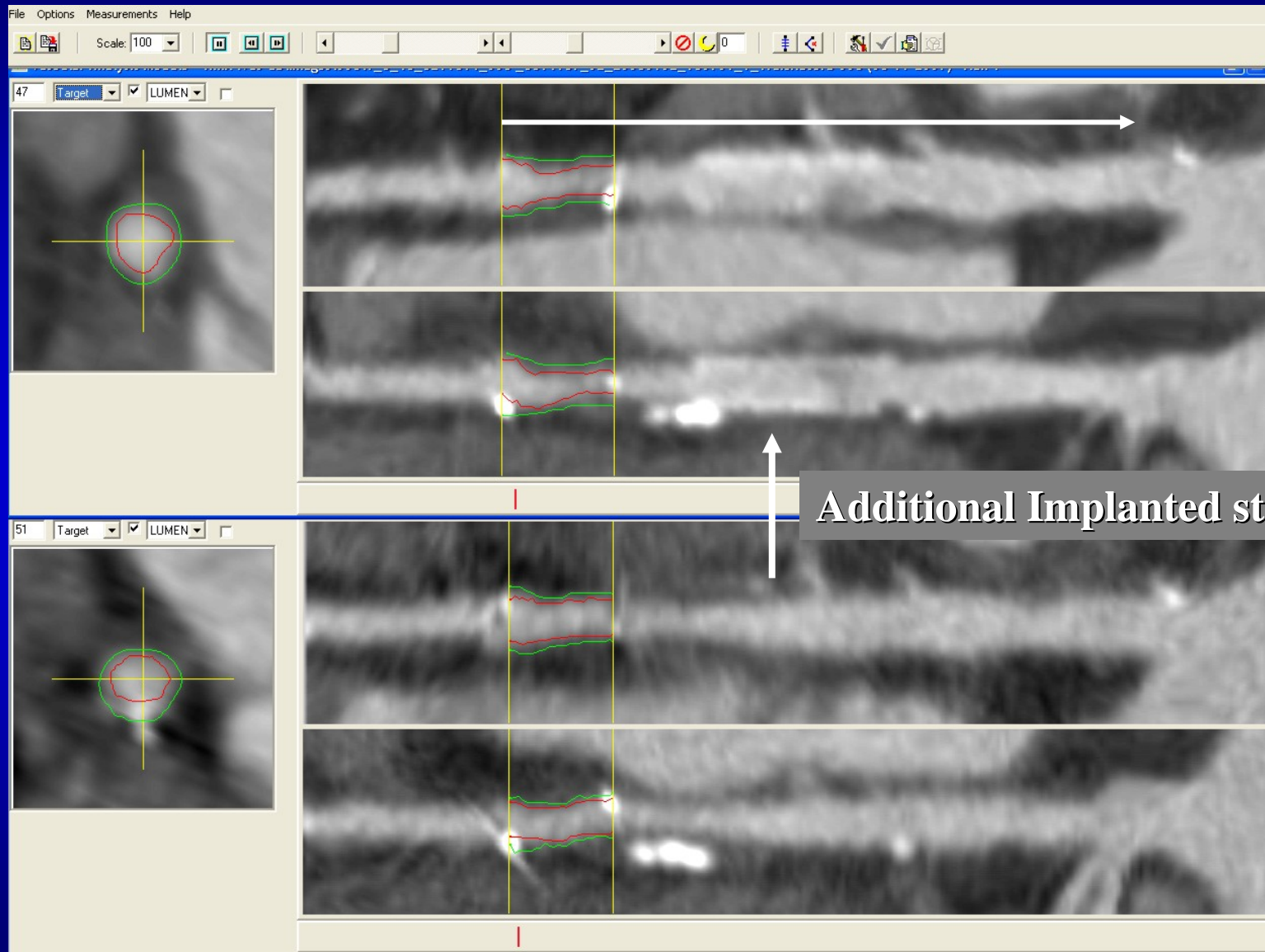
Proximal
location



Distal
location



Baseline vs. Follow-up MSCT



FUP
18M

Additional Implanted stent

BL



Quantitative Measurements II

Study/Intervention

Institution Name Curad BV
 Study ID 3551349.01
 Study Description Cardiac^Card01_DS_Coronair (Adult)
 Study Date / Time 21-06-2006 / 18:17:22
 Referring Physician

	Mean	SD	Max	(F)	Min	(F)
Area (mm²)						
Lumen	10.02	0.77	11.38	201	8.27	210
Vessel	17.17	1.03	20.21	213	15.53	195
Plaque (Vessel)	7.16	1.49	10.60	213	5.32	197

Patient

Name
 Identification number
 Gender / BirthDate

Unknown /

Acquisition

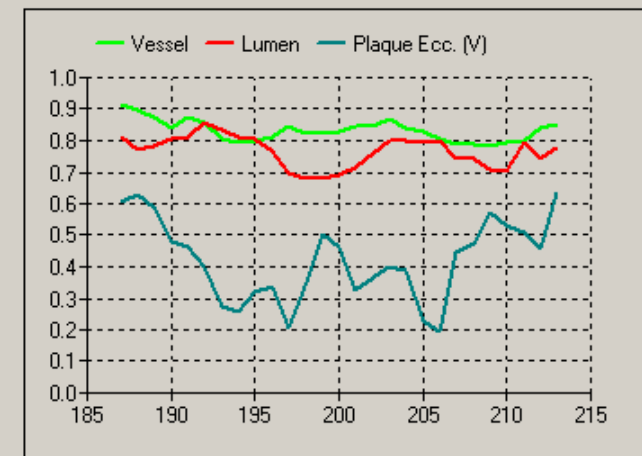
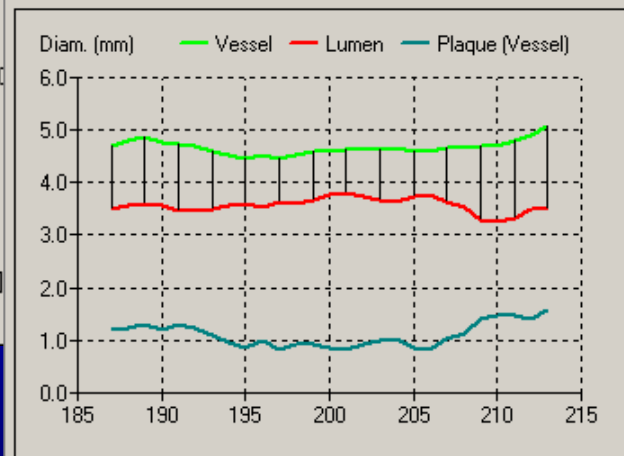
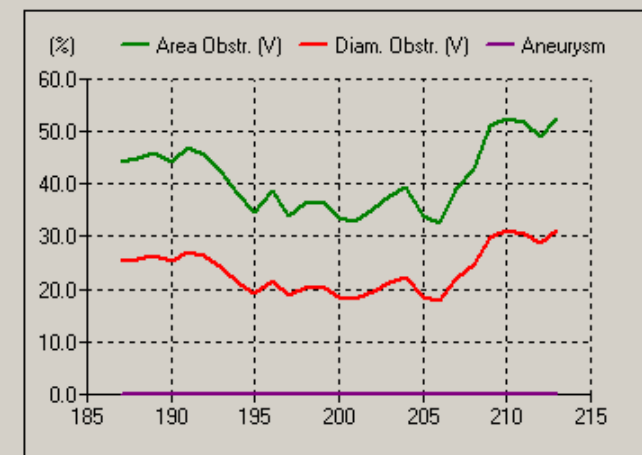
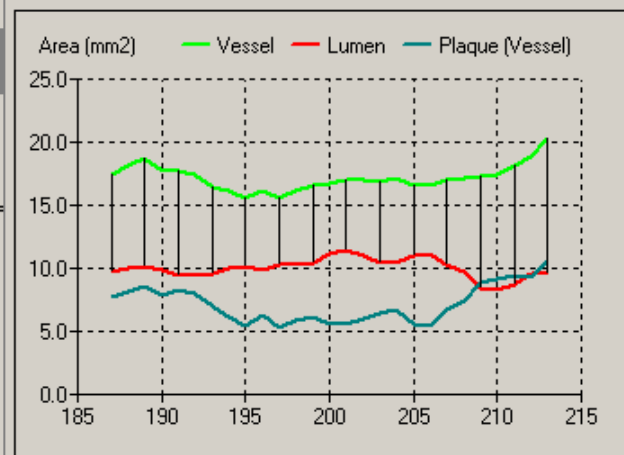
US Scanner type
 Derivation Description MSCT --> JPEG CQ
 Motorized Pullback speed 0.50
 X Pixel Size 0.0600 mm
 Y Pixel Size 0.0600 mm
 Slice Thickness 0.4285 mm
 Total number of Frames 332
 Total Length 142.26 mm
 Diagnostic Quality Good
 Comments

Analysis (Version 3.31)

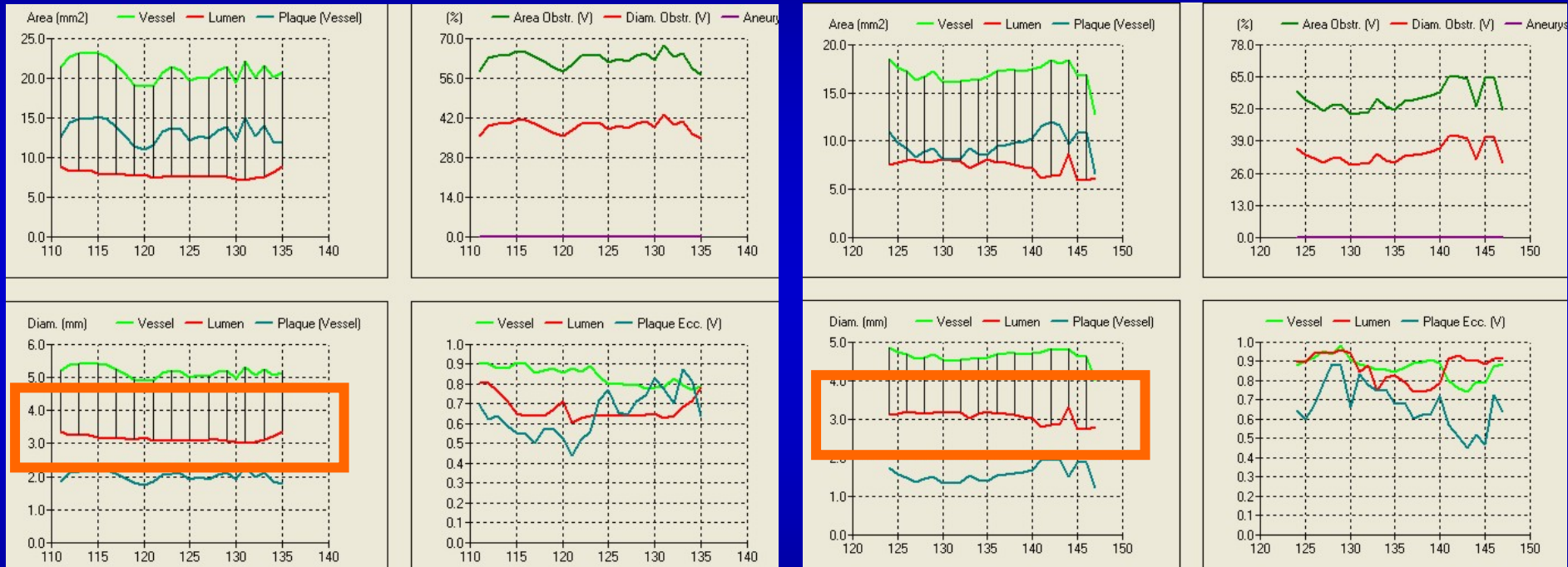
User Name Unknown User
 Analysis Status NEW
 Last Change by Unknown User
 Last Change Date 30/10/2006 14:38:10
 CVIS 30 MHz Correction Not Applied
 Crossing Contours Not Allowed

Regions

Segment Not specified
 Number of Regions 1
 Analysis Region Target
 Frames 187 - 213 [11.57 mm]



Quantitative Measurements III



BL

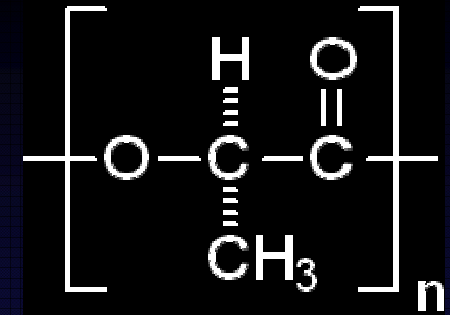
FUP



ML VISION® SDS

Polymeric Eluting (PLA)

Everolimus



Thoraxcenter  Erasmus MC 

BVS stent

 **Abbott**
Vascular

